



HEWLETT  
PACKARD

**OPERATING, PROGRAMMING AND SERVICE MANUAL**

# **MODEL 54200A/D DIGITIZING OSCILLOSCOPE**

## **SERIAL NUMBERS**

This manual applies directly to instruments with serial number prefixes:

54200A; 2445A and 2511A  
54200D; 2445A and 2513A

For additional important information about serial numbers, see **INSTRUMENTS COVERED BY MANUAL** in Section I.

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## **SAFETY**

*This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual, must be heeded. Refer to Section I and the Safety Summary for general safety considerations applicable to this product.*

*This apparatus has been designed and tested in accordance with IEC publication 348, safety requirements for electronic measuring apparatus, and has been supplied in a safe condition. This manual contains some information and warnings which have to be followed by the user to ensure safe operation and to retain the apparatus in safe condition.*

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# SECTION 1

## GENERAL INFORMATION

WARNING
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*Service information included in this manual is for use of trained service personnel. To avoid electrical shock, do not perform any service procedures in the manual or do any servicing to the 54200A/D unless you are qualified.*

### 1-1. INTRODUCTION

This manual contains technical information concerning the installation, operation, programming, maintenance, and servicing of the 54200A and 54200D Digitizing Oscilloscopes. When information concerns both models the system will be referred to as the 54200A/D.

### 1-2. MANUAL ORGANIZATION

**Section 1, General Information.** This section contains a description of this manual and the instrument. This section also gives the specifications, general characteristics, operating characteristics and recommended test equipment for the 54200A/D.

**Section 2, Installation.** This section explains how to prepare the 54200A/D for use.

**Section 3, Front Panel Controls and Menus.** This section familiarizes the user with the front panel controls and menu structures of the 54200A/D.

**Section 4, Front Panel Exercises.** This section provides step-by-step exercises to familiarize the user with making measurements from the front panel of the 54200A/D.

**Section 5, State Triggering with the 54200D.** This section discusses the operation of the state triggering feature of the 54200D.

**Section 6, Peripherals.** This section provides information for making hardcopy prints of the 54200A/D display using a plotter or graphic printer.

**Section 7, Remote Control Operation.** This section discusses the remote operation of the 54200A/D over HP-IB, including compatibility, remote/local modes, local lockout, learn and calibration strings, and notation and definitions. This section should be reviewed before writing programs for this instrument.

**Section 8, Programming the 54200A/D.** This section provides programming instructions for the instrument, including the instruction set, syntax diagrams, and other detailed programming reference information.

**Section 9, Performance Tests.** This section describes both the self test capabilities of the 54200A/D as well as the procedures for the full Performance Test.

**Section 10, Adjustments.** The 54200A/D requires several adjustments to restore specified performance after some major repairs have been made. This section provides the necessary adjustment procedures.

**Section 11, Replaceable Parts.** This section contains ordering information and a list of all replaceable parts in the 54200A/D system.

**Section 12, Service.** This section contains disassembly and assembly procedures and documentation and procedures for isolation and replacement of faulty circuit boards.

**Service Group 12A, Power Supply.** This section contains block diagrams and component level theory, troubleshooting and schematic information necessary to service the 54200A/D power supply.

**Appendix A, Self Test Documentation.** This section contains a brief overview of how the 54200A/D self tests work and what portions of the 54200A/D circuitry they check.

### 1-3. INSTRUMENTS COVERED BY THIS MANUAL

Attached to the instrument is a serial number sticker. The serial number is in the form 0000A00000. It is in two parts; the first four digits and the letter are the serial prefix and the last five digits are the suffix. The prefix is the same for all identical 54200A or 54200D instruments; the prefix only changes when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual applies to instruments with serial number prefix(es) listed under SERIAL NUMBERS on the title page. The serial number is also displayed on the 54200A/D screen when the SYSTEM Peripherals menu is selected.

An instrument manufactured after the printing of this manual may have a serial number prefix not listed on the title page. This unlisted serial prefix indicates the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a yellow Manual Changes supplement. The supplement contains "change information" that explains how to adapt the manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement is identified by the manual print date and part number, both of which appear on the manual title page. Complimentary copies of this supplement are available on request.

Shown on the title page is a microfiche part number. This number can be used to order 4 X 6 inch microfilm transparencies of this manual. Each microfiche contains up to 96 photoduplicates of the manual pages.

## 1-4. DESCRIPTION

The Hewlett-Packard Models 54200A and 52400D Digitizing Oscilloscopes are dedicated, multi-channel, simultaneous, waveform acquiring digital storage oscilloscopes with full HP-IB programmability, digitized waveform data output, and resident parametric waveform measurements.

The 54200A/D is primarily for simultaneous single-shot measurements, however it will serve many general purpose oscilloscope needs. The single-shot digital storage bandwidth is 50 MHz (200 megasamples/second) with infinite store time and waveform data output. It also provides parametric information about the analog characteristics of waveforms.

The 54200D has all the features of the 54200A with the addition of parallel and serial logic trigger qualification capabilities. The 54200D includes 3 pods, each containing 8 bit + 1 parity bit + clock organization.

Following is a list of key measurement features of the 54200A/D Digitizing Oscilloscope System:

- 200 megasamples/second sample rate, 50 MHz single-shot bandwidth using post capture data interpolation.
- Capture two channels simultaneously.
- 1 kbyte of acquisition memory per channel.
- 1 screen diameter of pre-trigger storage for display.
- All front panel controllable parameters can be programmed via HP-IB.
- Pulse parameter measurement answers are provided.
- TTL and ECL preset capabilities.
- Auto scaling.
- Digital logic trigger qualification (54200D only).

## 1-5. ACCESSORIES SUPPLIED

The following accessories are supplied with the 54200:

54200A/D: Two Model 10017A 10:1 divider probes.  
One BNC to probe tip adapter.  
One 2.3 meter (7.5 ft) power cord.  
One Operating, Programming, and Service Manual.

54200D (only): Three Model 10271A 10-bit State Data Probes.

## 1-6. SPECIFICATIONS

Instrument specifications are listed in table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Table 1-2 lists general characteristics, not specifications but typical characteristics included as additional information for the user.

Table 1-1. Specifications

<b>MODELS 54200A and 54200D</b> <sup>1,2</sup>			
<b>VERTICAL (Channel 1 and 2)</b>			
<b>Range:</b> 40 mV to 40 V full-scale, continuously calibrated with two digit resolution.			
<b>Gain Accuracy:</b> ±2% of full-scale. <sup>3</sup>			
<b>Analog to Digital Conversion Accuracy (ADC):</b> ±1.6% of full-scale. <sup>4</sup>			
<b>Offset Accuracy:</b>			
	<u>Channel Range</u>	<u>Offset Accuracy</u> <sup>3</sup>	
	40 mV to 390 mV	±1% of offset ±5 mV	
	400 mV to 40 V	±1% of offset ±50 mV	
<b>Dc Offset Range/Resolution:</b>			
	<u>Channel Range</u>	<u>Offset Range</u>	<u>Offset Resolution</u>
	40 mV to 390 mV	±2 V	approximately 1.2 mV
	400 mV to 40 V	±20 V	approximately 12 mV
<b>Voltage Measurement Accuracy (DC):</b>			
Single Cursor (X or 0): Gain Accuracy + ADC Accuracy + Offset Accuracy			
Dual Cursor: Gain Accuracy + 2 * (ADC Accuracy) (X to 0 measurements on the same waveform)			
<b>Bandwidth (-3 dB):</b>			
DC coupled: dc to 50 MHz			
AC coupled: 3 Hz to 50 MHz			

Table 1-1. Specifications (continued)

**Transition Time:** 7 ns maximum (10% to 90%).

**Input Coupling:** ac or dc.

**Input RC:** 1 MΩ ±2%, shunted by approximately 14 pF.

**Maximum Input Without Distortion:** <sup>5</sup>

<u>Channel Range</u>	<u>Input (dc + peak ac)</u>
40 mV to 390 mV	±2 V
400 mV to 40 V	±20 V

**Maximum Safe Input Voltage:** ±40 V (dc + peak ac).

**TIME BASE (Horizontal)**

**Range:** 50 ns to 10 sec full-scale (10 divisions), in a 1-2-5 sequence.

**Time Measurement Accuracy:** ±2 ns or ±0.2% of Time Range, whichever (Single and Dual Cursor) is greater. <sup>6</sup>

**DELAY (Time Offset)**

**Pre/Post-Trigger Range:**

<u>Time Range</u>	<u>Pre-Trigger Range</u>	<u>Post-Trigger Range</u>
50 ns to 5 μs	Up to 5 μs	Up to 1 ms
10 μs to 10 s	Up to 1 screen diam.	Up to 260 screen diam.

**Pre/Post-Trigger Resolution:** Adjustable in steps of 0.1 (coarse) and 0.004 (fine) screen diameters.

**Accuracy:** ±1 sample clock period.

**TRIGGER (Analog)**

**Sources:** Channel 1, channel 2, or External trigger input.

**Sensitivity:** 1/8 of full-scale.

Table 1-1. Specifications (continued)

**Level Range/Resolution:**

<u>Full-scale Range</u>	<u>Trigger Range</u>	<u>Trigger Resolution</u>
40 mV to 390 mV	±2 V	approximately 2.4 mV
400 mV to 40 V	±20 V	approximately 24 mV

<u>Level Accuracy:</u>	<u>Trigger Range</u>	<u>Level Accuracy</u>
	40 mV to 390 mV	±2% ±5 mV
	400 mV to 40 V	±2% ±50 mV

**External Trigger Input:**

Bandwidth	} Same as channel 1 and 2.
Rise Time	
Input Coupling	
Input RC	
Input Range	
Maximum Safe Input Voltage	

**MODEL 54200D (only) <sup>1,2</sup>**

**STATE TRIGGER MODE**

**Clock Repetition Rate:**

Single Phase: 25 MHz maximum with single clock and single edge specified; 20 MHz maximum with any ORed combination of clocks and edges.

Multiplexed: Master-slave clock timing; master clock must follow slave clock by at least 10 ns and precede next slave clock by 50 ns or more.

**Clock Pulse Width:** ≥20 ns at threshold.

**Setup Time:** ≥20 ns, the time data must be present prior to the clock transition

**Hold Time:** 0 seconds, the time data must be present after the clock transition

Table 1-1. Specifications (continued)

**STATE PROBES (10271A)**

**Input RC:** 100k $\Omega$   $\pm$ 2% shunted by approximately 5 pF at the probe body.

**Minimum Input:** 600 mV p-p.

**Minimum Input Overdrive:** 250 mV or 30% of input amplitude whichever is greater.

**Maximum Safe Input:**  $\pm$ 40 V peak.

**Threshold Range:** -9.9 V to +9.9 V in 100 mV increments.

**Threshold Accuracy:**  $\pm$ 2.5%  $\pm$ 120 mV.

**Dynamic Range:**  $\pm$ 10 V about threshold.

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**Notes**

1. Specifications apply after a 30 minute warm up period.
2. Single-shot reconstruction uncertainty =  $\pm$ 1 ns.  
(applies to Time Ranges of 50 ns through 2  $\mu$ s)
3. Specifications apply within  $\pm$ 10 $^{\circ}$ C of Auto-calibration temperature.
4. Can be improved by averaging.
5. Maximum peak ac input voltage without distortion is 20 Vp-p for frequencies greater than 20 MHz.
6. Dual cursor specifications apply for measurements made on the same or simultaneously acquired waveforms.

Table 1-2. General Characteristics

### REAR-PANEL BNC OUTPUTS

One output BNC is located on the rear panel with TTL output levels. High is  $\geq 2$  V into 50 ohms; low is  $\leq 0.4$  V into 50 ohms. This output may be programmed from the front panel or remotely (via HP-IB) to provide the following output waveforms:

#### 54200A/54200D

1. Constant low
2. Constant high
3. 2.000 kHz probe compensation source  
(If used without 50 $\Omega$  termination, falling edge must be used for compensation)
4. High on trigger
5. High on frame complete
6. High on acquisition set

#### 54200D only

7. Pulse on state sequence true
8. High on state sequence true
9. Pulse on state master clock

### POWER:

115 VAC: -22% to +10% (90 - 127 VAC).  
230 VAC: -22% to +10% (180 - 253 VAC).  
Frequency Range: 48 to 66 Hz.  
275 VA Maximum.

### OPERATING ENVIRONMENT:

*Temperature:* 0 to +55°C (32 to 131°F).  
*Humidity:* Up to 95% relative humidity at +40°C (non-condensing).  
*Altitude:* To 4600 meters (15 000 feet).  
*Vibration:* Vibrated in three planes for 15 minutes each with 0.38 mm (0.015 inch) excursions at 5 to 55 Hz.

**X-RAY EMISSION:** Less than 0.05 mr/hr measured with Victorean Model 440RF/C.

### WEIGHT:

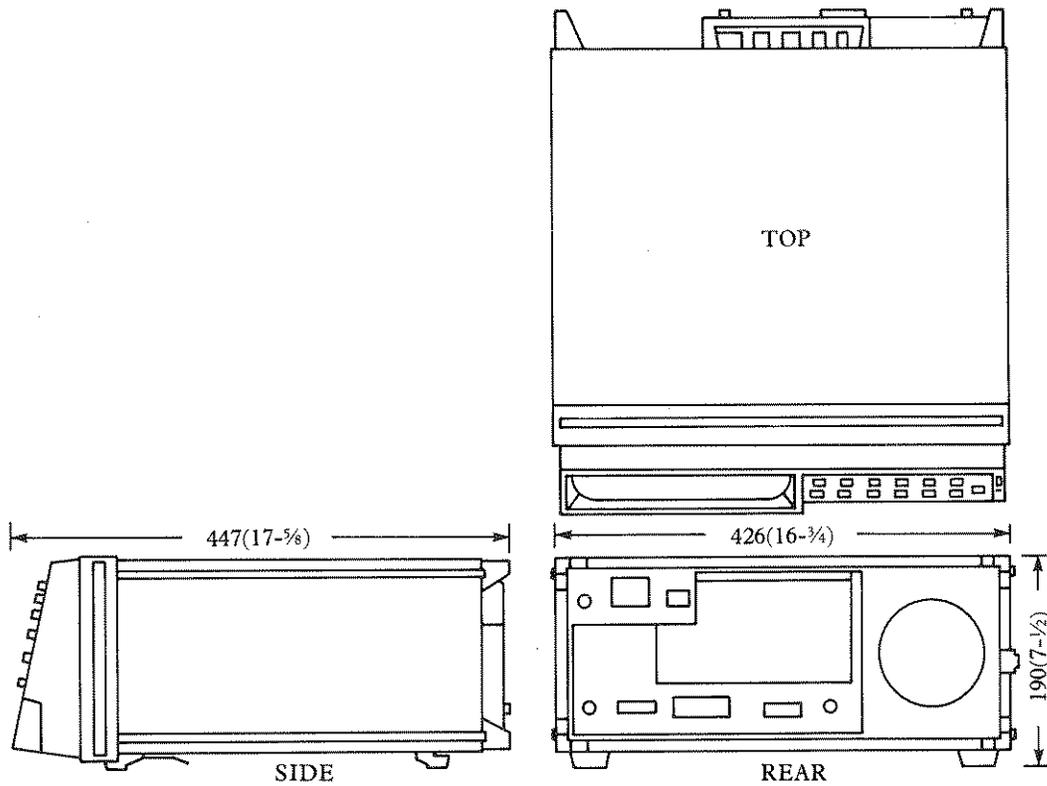
54200A: net 11.4 kg (25 lbs); shipping 15.9 kg (35 lbs).  
54200D: net 12.7 kg (28 lbs); shipping 21.8 kg (38 lbs).

Table 1-2. General Characteristics (Continued)

**DIMENSIONS:**

**NOTES:**

1. Dimensions are for general information only. If dimensions are required for building special enclosures, contact your HP field engineer.
2. Dimensions are in millimetres and (inches).



## 1-7. OPERATING CHARACTERISTICS

Table 1-3 lists the Operating Characteristics. This is a summary of the 54200A/D's operating capabilities. Complete operating and programming instructions are contained in the 54200A/D Operating and Programming manual.

Table 1-3. Operating Characteristics

<b>MODELS 54200A and 54200D</b>	
<b>DIGITIZER</b>	
<i>Digitizing Technique:</i>	REAL-TIME DIGITIZING; all data points are digitized sequentially, at equal increments in time on each acquisition.
<i>Digitizing Rate:</i>	100 samples/second to 200 megasamples/second (determined by the time base range setting).
<i>Resolution:</i>	6 bits; 1 part in 64; effective resolution may be increased by using data filtering/averaging.
<i>Acquisition Record Length:</i>	1001 samples (1000 intervals).
<b>CHANNEL 1 and 2 INPUTS (Vertical)</b>	
<i>Probe Factors:</i>	1:1, 2:1, 5:1, 10:1, 20:1, 50:1, or 100:1 probe attenuation factors may be entered to scale the probe tips.
<i>Channel Isolation:</i>	50 dB from dc to 50 MHz.
<b>TIMEBASE (Horizontal)</b>	
<i>Expand Mode:</i>	X and O cursors can be used to window an area of interest and expand it to full screen. Expansions of up to 20X can be obtained.
<i>Reference Location:</i>	The reference point can be positioned at the left edge, center, or right edge of the display. The reference point is that point where the time is offset from the trigger point by the delay time.
<b>TRIGGER (Analog)</b>	
<i>Level Range:</i>	
<i>Track Mode:</i>	Maintains the same voltage range as the internal trigger source selected (tracks either channel 1 or 2).

Table 1-3. Operating Characteristics (Continued)

**Adjust Mode:** Vertical scaling of the trigger display channel may be adjusted within specified ranges independent of the internal channels (1 and 2) vertical scaling.

<u>Internal Ch1 or Ch2 Range</u>	<u>Trigger Channel Adjust Range</u>
≤390 mV	40 mV to 4.0 V
≥400 mV	400 mV to 40 V

**Edge:** Positive or negative slope may be selected for any source.

## DISPLAY

**Data Display Formats:** One, two or four waveforms can be displayed at the same time. They can be real-time inputs (Chan 1, 2, or Trigger display) or stored waveforms (from waveform memories 0, 1, 2, or 3) in any combination.

### Display/Store Modes:

**Normal:** The display is repetitively updated with each new waveform acquisition.

**Accumulate:** All successive waveform acquisitions are displayed until erased. Erasure modes are manual, slow (after 64 acquisitions) and fast (after 16 acquisitions).

**Envelope:** Provides a display of the running maximum and minimum voltage at each sample point for a repetitive input waveform.

**Average:** Provides a display of the average voltage at each sample point for 4, 16, 64, or 256 user defined waveform acquisitions. On each acquisition,  $1/n$  times the new data is added to  $(n-1)/n$  of the previous value at each time coordinate. Operates in a continuous mode.

**Reference Lines:** Two horizontal reference lines may be defined and displayed for each graph. Reference lines may be positioned in terms of voltage or percent of waveform amplitude. When making automatic measurements, these lines indicate the upper and lower measurement thresholds.

**Graticules:** Full grid or frame with tic marks.

Table 1-3. Operating Characteristics (Continued)

**MEASUREMENT AIDS**

**Automatic Measurements:** The following waveform measurements can be performed automatically on real-time or stored waveforms. The standard measurement thresholds are the 10%, 50%, and 90% points of the waveform. In the User Defined mode; voltages, percentages, or ECL and TTL presets may be used to define the upper and lower thresholds. Measurements are continuously updated with each new acquisition.

Frequency	Duty Cycle
Period	Delay
(+) Pulse Width	V(amplitude)
(-) Pulse Width	V(maximum)
Rise Time	V(minimum)
Fall Time	V(rms)

**Cursors:** Two cursors (X and 0) are provided for making voltage and time measurements on displayed waveforms. Both absolute and differential values are provided. Dual cursor measurements can be made between two points on the same waveform or between two points on different waveforms.

**Waveform Memories:** Four memories are provided for waveform storage. Two are non-volatile (0 and 1) and two are volatile (2 and 3). Labels may be assigned to each memory.

**SETUP AIDS**

**Auto-Scale:** Pressing the Auto-Scale key causes the vertical and horizontal ranges, offset and trigger level to be set appropriately to display the input signals. Period, + pulse, - pulse, rising edge, or falling edge may be selected as the horizontal display criteria. Requires a duty cycle of >1%, frequency >50 Hz, and amplitude >20 mV p-p. Vertical, horizontal, and trigger auto scaling functions may be selectively enabled or disabled.

**Presets:** Scales the vertical range, offset and trigger level to predetermined values for displaying ECL or TTL waveforms.

**Alias Detection:** An alias detection feature detects Nyquist aliasing (less than 2 data points/period) and advises the user via a message on the CRT.

Table 1-3. Operating Characteristics (Continued)

**SETUP MEMORIES:** Four front panel setups (0 through 3) may be saved in non-volatile memory. Labels may be assigned to each setup.

#### **PROGRAMMABILITY**

All instrument settings and operating modes including automatic waveform measurements may be remotely programmed via HP-IB (IEEE-488). HP-IB programming complies with the recommendations of IEEE Std. 728-1982, "Recommended Practice for Code and Format Conventions".

#### **HARDCOPY OUTPUT**

The CRT display (including menus) can be transferred directly to HP-GL compatible digital plotters and raster graphics printers. The peripheral used must have listen-only mode.

#### **MODEL 54200D (Only)**

#### **STATE TRIGGER MODES <sup>1</sup>**

**State Only:** Triggers waveform acquisition immediately after the state sequence specification has been fulfilled.

**State Arms Analog:** Arms the analog trigger when the state sequence specification has been fulfilled.

#### **ASSIGNMENT**

##### **State Modes:**

**Normal:** State patterns up to 27 channels wide may be defined as trigger qualification. Up to four unique state patterns can be qualified on in a user defined sequence.

**Qualified:** State sequence search does not begin until after the "Qualify" clock has occurred. The slave clock is defined as the "Qualify" clock.

**Missing bit:** Pre-defines the last state in the sequence specification to detect a missing bit in a string of serial data and triggers the acquisition.

**Extra bit:** Pre-defines the last state in the sequence specification to detect an extra bit in a string of serial data and triggers the acquisition.

Table 1-3. Operating Characteristics (Continued)

## SEQUENCE

**Resources:** Four user-definable terms (a,b,c, and d) plus the absence of of these terms, Any State or No State may be used in any combination. A term is the AND combination of bit patterns in each label. Each term can be the combination of up to eight user defined labels. Terms may be used as often as desired.

**Trigger:** Up to four resource terms may be used in any sequence to establish the state trigger specification. The last term in the sequence may use up to four resource terms in an ORed or ANDed format.

**Occurrence:** Occurrence of the last event in the sequence may be specified up to  $n = 59999$ .

**Restart:** One to four resource terms may be used in an ORed condition for a sequence restart condition.

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1. State Trigger Modes use HP Model 10271A probes for state inputs.

### 1-8. RECOMMENDED TEST EQUIPMENT

Table 1-4 lists the equipment required to adjust and troubleshoot the 54200A/D. Other equipment may be substituted if it meets or exceeds the critical specifications given in table 1-4.

Table 1-4. Recommended Test Equipment

INSTRUMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL	USE*
Oscilloscope	Bandwidth: 275 MHz	HP 1725A	T
Desktop Controller	HP Series 200 with BASIC 2.0 Operating System HP-IB Interface	HP 9826/36	A,T
Signature Multimeter	HP-IB controllable, with DVM Range: -50 V to +50 V DC Accuracy: $\leq 0.5\%$	HP 5005B	A,T
Function Generator	Frequency: 1 MHz to 50 MHz	HP 8116A	P,A
Pulse Generator	Dual channel Repetition rate: 100 MHz Transition time: 1.3 ns, variable Amplitude: 5 volts Basic timing accuracy: $\leq 3\%$	HP 8161A	P
RF Voltmeter	Accuracy: $\pm 3\%$ at 50 MHz	HP 3406A	P
Time Mark Generator	Time marks: 2 ns to 0.5 s	Tektronics TG501	P
Dc Power Supply	Range: $\pm 100$ mV to $\pm 5$ V Accuracy: $\pm 0.1\%$	HP 6111A	P
50 Ohm Termination	Accuracy: $\leq 1\%$	HP 10100C	P
Blocking capacitor	0.18 $\mu$ F, 200V	HP 10240B	P
50 $\Omega$ Sampling Tee	—————	HP 11063A	P
54200A/D Product Support Kit	No Substitute	HP Part No. 54200-69501	P,A,T
* P=Performance Testing, A=Adjustments, T=Troubleshooting			



## SECTION 2 INSTALLATION

### 2-1. INTRODUCTION

This section contains the initial operation information for the Model 54200A/D. Included are power and grounding requirements, operating environment requirements, cleaning methods and storage and shipment requirements.

### 2-2. PREPARATION FOR USE

**2-3. POWER REQUIREMENTS.** The 54200A/D requires a power source of either 115 or 230 VAC -22% to +10%; single phase, 48 to 66 Hz; 275 watts maximum.



*The instrument may be damaged if the Line Voltage Select Switch is not properly set to match the input voltage.*

**2-4. LINE VOLTAGE SELECTION.** Before turning ON the instrument verify that the Line Voltage Select Switch on the rear panel matches the input line voltage. The 6 Amp fuse installed satisfies both voltage settings of 115 and 230 VAC.

**2-5. POWER CABLE.** This instrument is equipped with a three-wire power cable. When connected to an appropriate AC power outlet, this cable grounds the instrument cabinet. The type of power cable plug shipped with the instrument depends on the country of destination. See figure 2-1 for option numbers of power cables and plug configurations. Part numbers for each cable option are listed in the replaceable parts section of this manual.

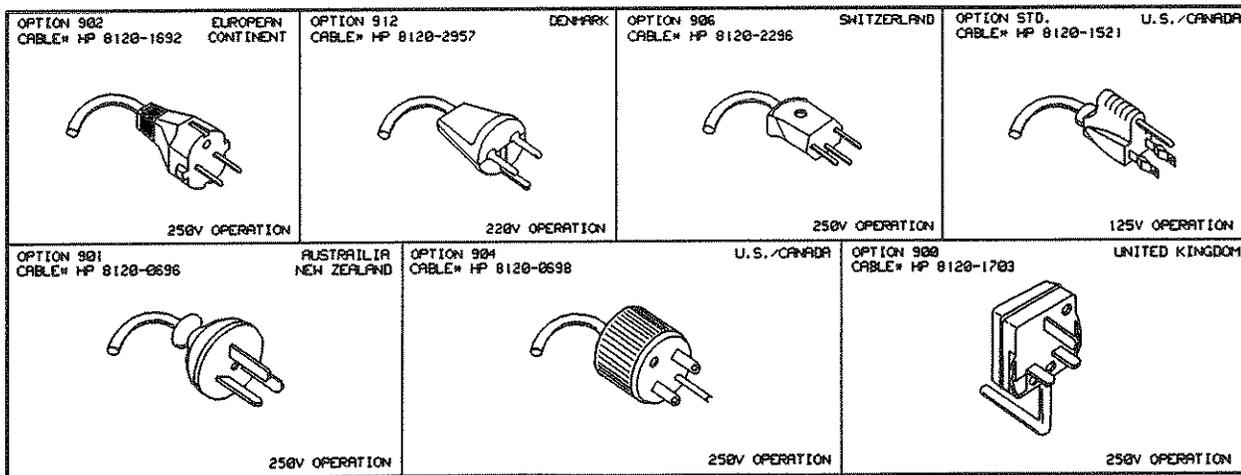


Figure 2-1. Power Cord Configurations

## 2-6. OPERATING ENVIRONMENT

The operating environment is noted in table 1-2. Note should be made of the non-condensing humidity limitation. Condensation within the instrument can cause poor operation or malfunction. Protection should be provided against internal condensation.

The 54200A/D will operate to all specifications, within the temperature and humidity range given in table 1-2. However, reliability is enhanced by operating the instrument within the following ranges.

Recommended Temperature: 20 to 35°C (68 to 95°F)

Recommended Humidity: 20 to 80% non-condensing

High temperature/humidity combinations should be avoided.

## 2-7. CLEANING REQUIREMENTS

When cleaning the 54200A/D, CAUTION must be exercised on which cleaning agents are used. USE MILD SOAP AND WATER. If a harsh soap or solvent is used, the water-base paint finish WILL BE damaged.



*BE CAREFUL when cleaning the keyboard. Water can damage the keyboard circuitry if it seeps under the keys.*

## 2-8. STORAGE AND SHIPMENT

### 2-9. Environment

The instrument may be stored or shipped in environments within the following limits:

**Temperature:** ..... -40°C to +75°C  
**Humidity:** ..... Up to 90% at 65°C  
**Altitude:** ..... Up to 15 300 metres (50 000 Feet)

The instrument should also be protected from temperature extremes which cause condensation within the instrument. Condensation within the instrument may cause malfunction if the instrument is operated under these conditions.

## 2-10. Packaging

**2-11. TAGGING FOR SERVICE.** If the instrument is to be shipped to a Hewlett-Packard office for service or repair, attach a tag showing owner (with address), complete instrument serial number, and a description of the service required.

**2-12. ORIGINAL PACKAGING.** If the original packing material is not available or is unserviceable, material identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is to be shipped to a Hewlett-Packard office for servicing, attach a tag showing owner (with address), model number, complete instrument serial number, and a description of the service required. Mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and serial number.

**2-13. OTHER PACKAGING.** The following general instructions should be used for repacking with commercially available materials.

- a. Wrap instrument in heavy paper or plastic.
- b. Use a strong shipping container. A double-wall carton made of 350 lb. test material is adequate.
- c. Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect control panel with cardboard.
- d. Seal shipping container securely.
- e. Mark shipping container FRAGILE to ensure careful handling.
- f. In any correspondence, refer to instrument by model number and full serial number.

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## SECTION 3

# FRONT PANEL CONTROLS AND MENUS

### 3-1. INTRODUCTION

This chapter will help familiarize the user with the front panel operation of the 54200A/D Digitizing Oscilloscope. Figure 3-1 is the front panel of the 54200A/D shown with numbered callouts for groups of keys. The function of each key is described in the following paragraphs. Figure 3-2 is a menu tree describing the row of six menu keys at the top of the 54200A/D keyboard. These menu keys are described in detail later in this section.

### 3-2. KEYBOARD

The keyboard has 39 keys, 37 of which serve two or more functions. These secondary functions are accessed by pressing the BLUE shift key **1**. When the shift key is pressed and active, "SHIFT" is displayed in the upper right corner of the display. For some functions the shift key will stay active until pressed a second time. Other functions automatically turn off the shift key to facilitate further user keyboard entries.

#### FIELD / CURSOR Arrow Keys **2**

The field arrows move the blinking field cursor from field to field within the menus displayed on the CRT. When waveform display cursor functions are selected, the arrow keys move the X and O waveform cursors. The left and right arrows move the X and O cursors horizontally along the waveform, and the up and down arrows move the X and O cursors from one graph to another if more than one graph is displayed.

#### NEXT[ ] / PREV[ ] / FINE Keys **3**

The NEXT[ ] and PREV[ ] keys cycle through choices within the field that contains the blinking cursor. In a numeric field, the NEXT[ ] key increments the selection while the PREV[ ] key decrements the selection. The shifted function of NEXT[ ] and PREV[ ] provides a FINE increment or decrement in numeric fields.

#### INSERT / DELETE / CLEAR ENTRY / DON'T CARE Keys **4**

The INSERT key is used for adding selection fields in the TRIGGER-STATE menu on the 54200D only, and is used for some self test and calibration routines on the 54200A/D.

The DELETE key removes the same selection fields from the TRIGGER-STATE menu on the 54200D only. When automatic measurements are displayed, the DELETE key removes the measurement highlighted by the blinking field cursor.

The CLEAR ENTRY key returns the selected field to the default power up condition. It removes all characters from a selected LABEL field and removes automatic measurements the same as the DELETE key.

The DON'T CARE key enters a space in a LABEL field or is used for entering logic levels in the TRIGGER-STATE menu (54200D only).

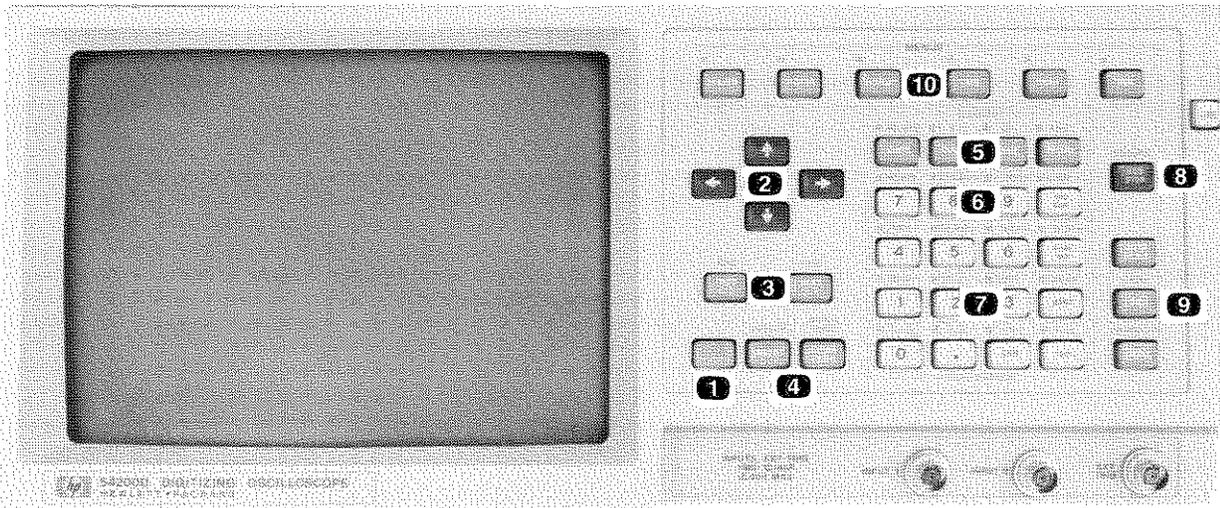


Figure 3-1. Front Panel Controls

### **COPY, ERASE, SAVE, and RECALL Keys** 5

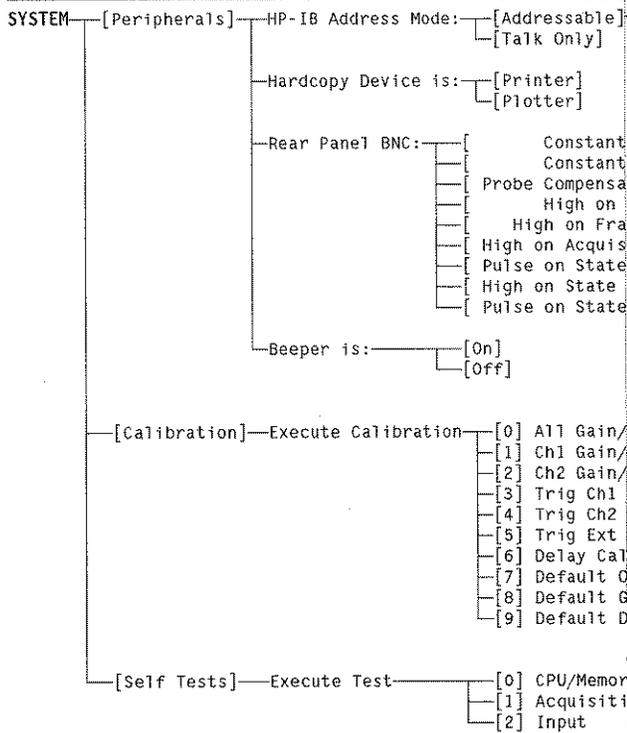
The COPY and ERASE keys operate only on the waveform graphs. The COPY key copies the contents and scale factors of graph 1, 2, 3, or 4 to a second graph (1, 2, 3, or 4). The ERASE key removes all waveform information from the specified graph (1, 2, 3, or 4).

The SAVE and RECALL keys operate on waveform graphs in memory or on instrument setups in memory. SAVE stores a waveform graph or instrument setup to a specified memory (0, 1, 2, or 3). RECALL is used to recall a waveform previously stored in memory and display it on a specified graph or to return the instrument controls to a previously saved setting. Instrument setup memories are all non-volatile. Waveform memories 0 and 1 are non-volatile and memories 2 and 3 are volatile.

### **Numeric Entry / Units Keys** 6 7

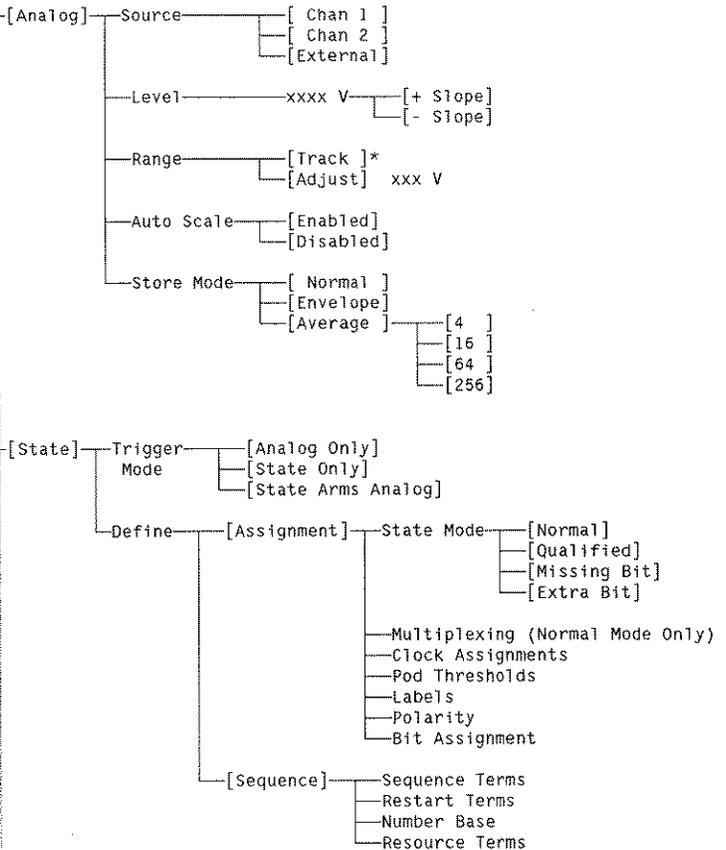
Numeric entry keys 0 through 9, decimal point, and CHS (change sign) are used when entering label names in LABEL fields or are used to enter numerical data in numeric fields. When entering data in numeric fields, the desired number is first keyed in followed by the appropriate units factor (sec, msec, usec, nsec, Volt, or mV). When the CHS key is pressed when entering a label, a minus sign will be inserted. The CHS key may be used to toggle the sign (positive or negative) when entering voltage offset, trigger level, and delay time, or can toggle the sign on and off after the numeric field has been entered.

**SYSTEM MENU**



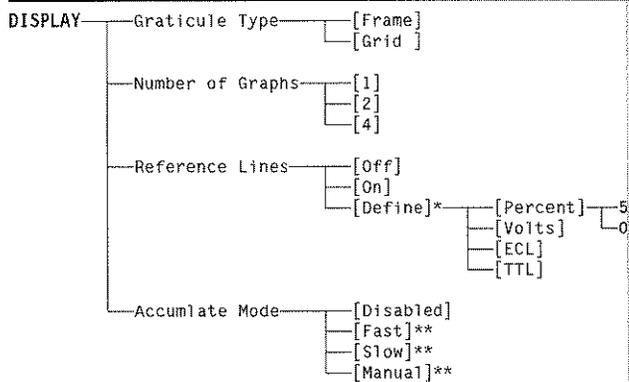
\* 54200D only

**TRIGGER MENU**



valid for External Trigger Source.

**DISPLAY MENU**



\* Accumulate Mode must be disabled before reference lines can be enabled or defin  
 \*\* Reference lines must be off before accumulate mode can be enabled.

**TIMEBASE MENU**

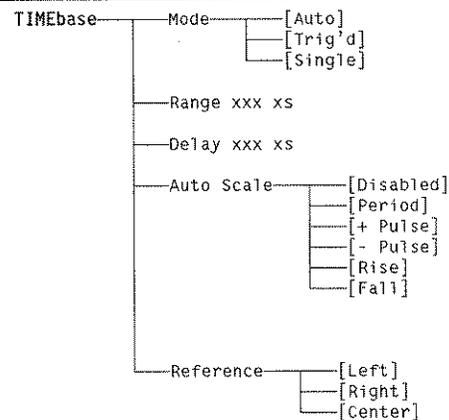


Figure 3-2  
 54200A/D Menu Tree  
 3-3

**RUN / STOP / RESUME Key 8**

The RUN/STOP key is a toggle function that will either start or stop acquisition depending on the previous condition. When RUN is selected the acquisition starts from scratch and no previous data is displayed. When the shifted function RESUME is selected, acquisition resumes from the point when acquisition was terminated in the average, envelope, or accumulate modes. If RESUME is selected when the instrument is actively acquiring data (RUN selected), acquisition will stop.

**AUTOSCALE, ECL, and TTL Keys 9**

These keys are used to scale the instrument controls. AUTOSCALE selectively searches for and scales the vertical, trigger, and timebase sections together or each section may be scaled independent of the others.

ECL and TTL keys are used to set Channel 1, Channel 2, and the trigger to range and offset values appropriate for probing ECL and TTL logic levels.

	CHANNEL 1/CHANNEL 2		TRIGGER	
	Range	Offset	Range	Level
ECL	2.0 V	-1.0 V	2.0 V	-1.3 V
TTL	6.0 V	2.5 V	6.0 V	1.4 V

**LOCAL Key 9**

LOCAL is the shifted function of the ECL key. When LOCAL is selected the 54200A/D returns to the local mode if being remotely controlled by a computer.

**HARDCOPY Key 9**

HARDCOPY is the shifted function of the TTL key. When HARDCOPY is selected the entire screen display is output to a plotter or printer. The HP-IB address mode specified on the SYSTEM "Peripherals" menu must be set to "Talk-Only" mode. The hardcopy device may be specified as printer or plotter on the same menu. The printer or plotter connected to the 54200A/D must be in the "Listen-Only" mode.

**Alpha Characters 5 6 7 10**

The alpha characters (A through Z) are all shifted functions and are used to define labels on graphs, setup memories, waveform memories, and state trigger lines (54200D only). Alpha characters G through Z share keys with other shifted functions. The 54200 determines if the alpha function should apply or if the other secondary function should apply depending on the selection field being modified.

### 3-3. CURSOR FUNCTIONS **2** **5** **6**

The 54200A/D has an X and an O cursor that can be moved about on the waveform displays. All waveform cursor functions are accessed in the SHIFT mode. Keys X, O, and X&O select the active waveform cursor or cursors. Cursor functions such as movement, expansion, or jump to edge operate only on the active cursor.

The cursor VALUES key is a toggle function which changes the left-hand side of the display from graph labeling information to cursor measurement information and vice versa. Cursor measurement information displayed is:

- Active cursor
- Voltage at cursor X
- Time at cursor X from trigger point
- Voltage at cursor O
- Time at cursor O from trigger point
- Delta voltage between cursor X and cursor O
- Delta time between cursor X and cursor O

The cursor EXPAND key expands to full screen the section of the waveform between the X and the O cursors. The cursor NORMAL key returns the waveform to the original time scale factor. When a waveform is expanded, a small arrow is displayed at the outside of the upper left edge of the graph. An arrow pointing to the left indicates that data to the left of the cursors of the unexpanded graph is not being displayed. An arrow pointing to the right indicates data to the right is not displayed, and an arrow pointing both directions indicates data to the left and to the right is not being displayed.

If the X and O cursors are on different graphs and X&O is made active, EXPAND will stretch both graphs to the same scale factor. If the X and the O cursors are on different graphs and X is made active, the section of the graph between the X cursor and the right-hand side of the graph will be expanded. If X and O are on different graphs and O is made active, the section of the graph between the O cursor and the left-hand side of the graph will be expanded.

The ←EDGE key will jump the active cursor to next edge to the left of that cursor. The EDGE→ key will jump the active cursor to the next edge to the right of that cursor. The X cursor will jump to the data point nearest to the crossing of the lower threshold and edge of the waveform. The O cursor will jump to the data point nearest to the crossing of the upper threshold and edge of the waveform. The thresholds are defined in the STATUS "Measurement" menu.

### 3-4. MEASUREMENT FUNCTIONS **7**

Twelve automatic pulse parameter measurements may be made from the keyboard on any specified graph. These measurements are:

- FREQ** - 1/period
- PERIOD** - time from first edge to next like edge
- +WIDTH** - +pulse width
- WIDTH** - -pulse width
- RISE** - rise time
- FALL** - fall time
- DUTY** - duty cycle
- DELAY** - delay from first edge on one graph to first edge on another graph
- V<sub>ampl</sub>** - voltage amplitude (0 to 100%)
- V<sub>max</sub>** - absolute maximum voltage
- V<sub>min</sub>** - absolute minimum voltage
- V<sub>rms</sub>** - rms voltage

All timing measurements except frequency and period are threshold dependent. Standard thresholds may be used or user-defined thresholds may be specified in the STATUS "Measurement" menu.

Up to 3 time measurements may be displayed on the upper left portion of the display and up to 3 voltage measurement may be displayed on the upper right portion of the display. These measurements are updated each time the 54200A/D acquires new data.

### 3-5. KEY-DOWN POWER-UP RESET

Holding any key down during power-up will preset the 54200A/D to a predetermined condition. Hold the key down long enough for the power-up tune to be completed.

### 3-6. MENU KEYS **10**

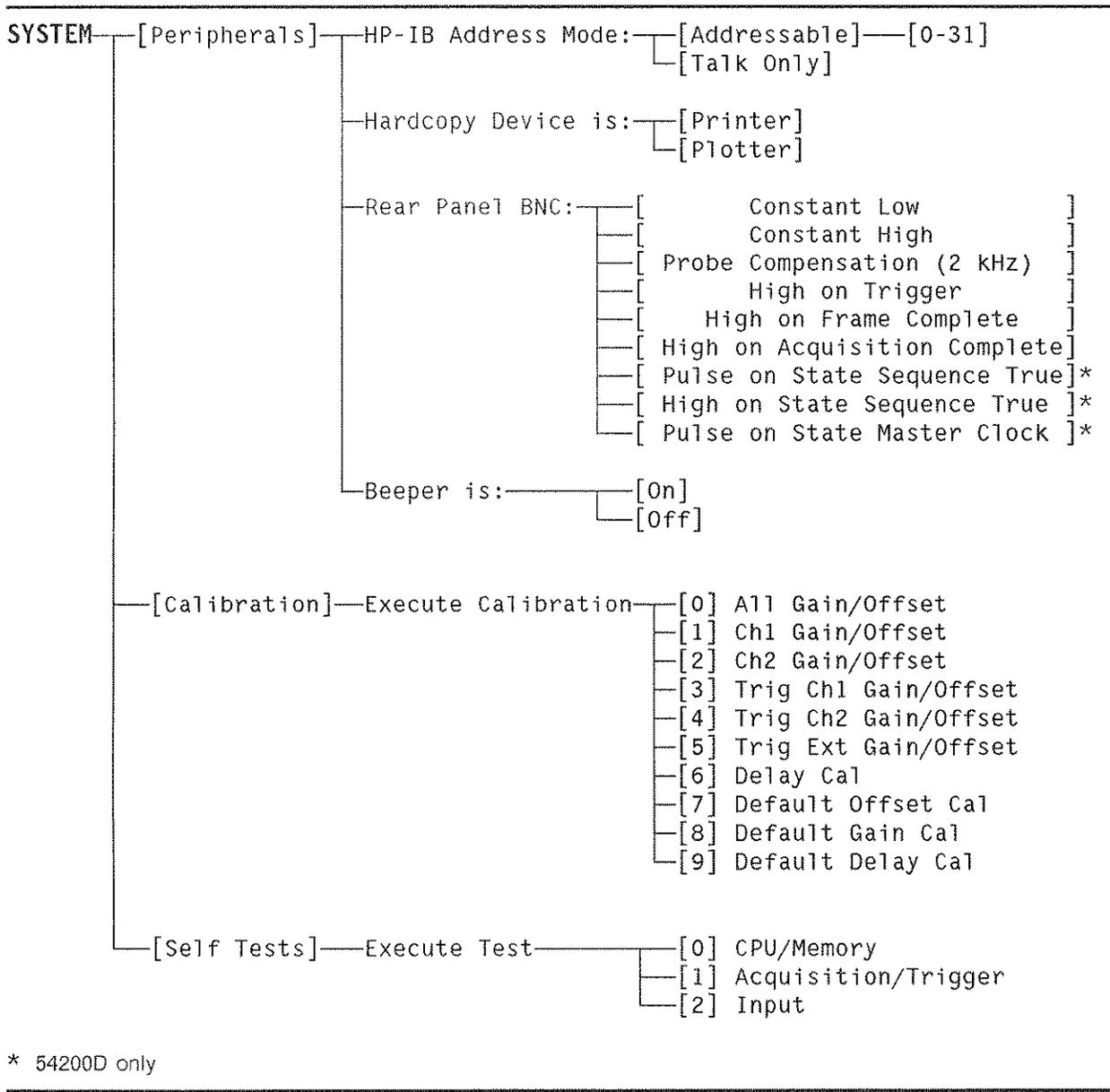
The row of six keys at the top of the 54200A/D keyboard are menu keys that define the CRT display. The menu keys are toggle keys--pressing a menu key causes the menu to be displayed; pressing the menu key again clears the menu and restores the normal trace display for the current operating state.

Menu keys SYSTEM, STATUS, and DISPLAY (and TRIG for 54200D only) have submenus. The last selected submenu is displayed when the menu key is pressed. The field select cursor is restored to the same location as the last time the menu was accessed. When power is applied to the 54200A/D, the last menu to be displayed before power off is the first menu to be displayed at power on and the field select cursor is placed at the beginning of the first field.

The menu maps for the six menu keys are shown in the following figures.

### 3-7. SYSTEM Menu

The SYSTEM menu allows the user to execute automatic calibration, execute self-test utilities, and configure peripherals. The SYSTEM menu has three submenus--Peripherals, Calibration, and Self Tests as shown in the SYSTEM menu tree in figure 3-3.



\* 54200D only

Figure 3-3. SYSTEM Menu Tree

**SYSTEM PERIPHERALS SUBMENU** (Figure 3-4). This menu sets up the 54200A/D to communicate with other instruments/controllers via HP-IB, controls the output of the rear panel BNC connector, and selects beeper mode.

```
System Specification-----Status: Acquired Frame 00479___  
TALK ONLY  
[ Peripherals ]  
  
HP-IB Address Mode: [ Talk Only ]  
Hardcopy Device is: [ Printer ] ( Must Be in LISTEN ONLY Mode  
Rear Panel BNC: [ Probe Compensation ( 2 kHz ) ]  
Beeper is: [On ]  
  
Firmware Revision: A2511  
Serial Number: 2432A00052
```

Figure 3-4. SYSTEM Peripherals Submenu

**HP-IB Address Mode.** To use the 54200A/D with a controller, set the HP-IB address mode to Addressable with the NEXT[ ]/PREV[ ] key and select the desired address by using the numeric keypad. To use with a printer or plotter, set the address mode to Talk Only with the NEXT[ ]/PREV[ ] key.

**Hardcopy Device is.** To use the 54200A/D with a printer or plotter, set the HP-IB address mode to Talk Only with the NEXT [ ]/PREV[ ] key, set hardcopy device to Printer or Plotter as desired, and then set the address on the printer or plotter to Listen Only. Press the **HARDCOPY** key (SHIFT TTL) to output the 54200A/D screen contents to the printer or plotter.

**Rear Panel BNC.** The output of the BNC on the rear panel can be programmed for six possible conditions for the 54200A and nine conditions for the 54200D. All outputs are a TTL level into 50 ohms, although the self-tests and calibration procedures will operate without the 50-ohm termination. Select the appropriate output by pressing the NEXT[ ]/PREV[ ] key. The possible outputs are:

- **Constant Low** - The output is held at a logic 0. This is the default condition when a key-down power-up reset is executed.
- **Constant High** - The output is held at a logic 1.
- **Probe Compensation (2 kHz)** - This output is a 2-kHz square wave used for probe compensation. If the signal is used without a 50-ohm termination, the falling edge must be used for compensation.
- **High on Trigger** - This output latches high when the 54200A/D receives a trigger.
- **High on Frame Complete** - This output goes high when the 54200A/D stops acquiring data for one frame.
- **High on Acquisition Complete** - This output goes high when the desired number of averages (4, 16, 64, or 256) has been attained.
- **Pulse on State Sequence True (54200D only)** - This selection gives pulse output whenever the state sequence sequence is found.
- **High on State Sequence True (54200D only)** - The output goes high when state sequence provides a trigger for the 54200D.
- **Pulse on State Master Clock (54200D only)** - A 20 ns pulse is output when the specified state master clock occurs.

**Beeper is.** This selection turns the audible warning beeper on or off by pressing the NEXT[ ]/PREV[ ] key.

**SYSTEM CALIBRATION SUBMENU (Figure 3-5)** This submenu allows the user to execute automatic gain and offset calibration for Channel 1, Channel 2 and Trigger (Channel 1, Channel 2, and External), and Delay calibration. A rear-panel switch protects the calibration factors from inadvertent changes. This switch must be set to the unprotected position before executing automatic calibration. Error message "Cal RAM Write Protected" will be displayed if calibration is attempted with the switch in the protected position.

```
System Specification-----Status: Acquiring Frame 00509_
                                     TALK ONLY
[ Calibration ]
Execute Calibration █
0 : All Gain/Offset
1 : Ch1 Gain/Offset
2 : Ch2 Gain/Offset
3 : Trig Ch1 Gain/Offset
4 : Trig Ch2 Gain/Offset
5 : Trig Ext Gain/Offset
6 : Delay Cal
7 : Default Offset Cal
8 : Default Gain Cal
9 : Default Delay Cal
```

Figure 3-5. SYSTEM Calibration Submenu.

Calibration 0 calibrates gain and offset for Channel 1, Channel 2, and all trigger paths. Individual gain and offset calibration for a channel or trigger may be executed by choosing 1, 2, 3, 4, or 5. Calibration 6 calibrates delay and calibration 7, 8, and 9 set default calibration factors. A normal calibration would require calibrations 0 and 6 to be executed. Calibrations 7, 8, and 9 are used for factory setup or would be used after a major repair to the instrument for initial setup procedures.

Calibration 0 takes about one minute to execute. To initiate this or any other calibration, move the blinking field cursor to the Execute Calibration field and enter the appropriate number from the numeric key pad. Follow the directions on screen and watch the status line at the end of the calibration to see if the instrument calibrated successfully.

Calibration 6 executes in about 20 seconds. Enter the number 6 from the numeric keypad and follow the directions printed on screen.

Any calibration features that require connecting the rear panel BNC to a front panel BNC do not require the signal be terminated with 50 ohms.

**SYSTEM SELF TESTS SUBMENU. (Figure 3-6).** The self-test menu allows the user to verify that more than 90% of the 54200A/D circuitry is functioning properly. Self test 0 checks out the microprocessor board and takes about five seconds to execute. Self test 1 checks portions of the acquisition system and the state trigger (54200D only) and executes in about ten seconds. Self test 2 checks the rest of the acquisition system including the analog signal path and takes about 15 seconds to execute.

To initiate any of the self tests, move the blinking field cursor to the Execute Test field and enter the desired test number from the numeric key pad. Follow the directions displayed on the screen for each test.

```
System Specification_____Status: Acquiring Frame 00030..
                                     TALK ONLY
Self Tests
Execute Test
0 : CPU/Memory
1 : Acquisition/Trigger
2 : Input
```

Figure 3-6. SYSTEM Self Tests Submenu

### 3-8. STATUS Menu

The STATUS menu consists of a tabular presentation of all of the instrument settings, threshold definitions, and waveform and setup memory allocation. The STATUS menu has three sub-menus--Configuration, Measurement, and Memory as shown in the STATUS menu tree in figure 3-7.

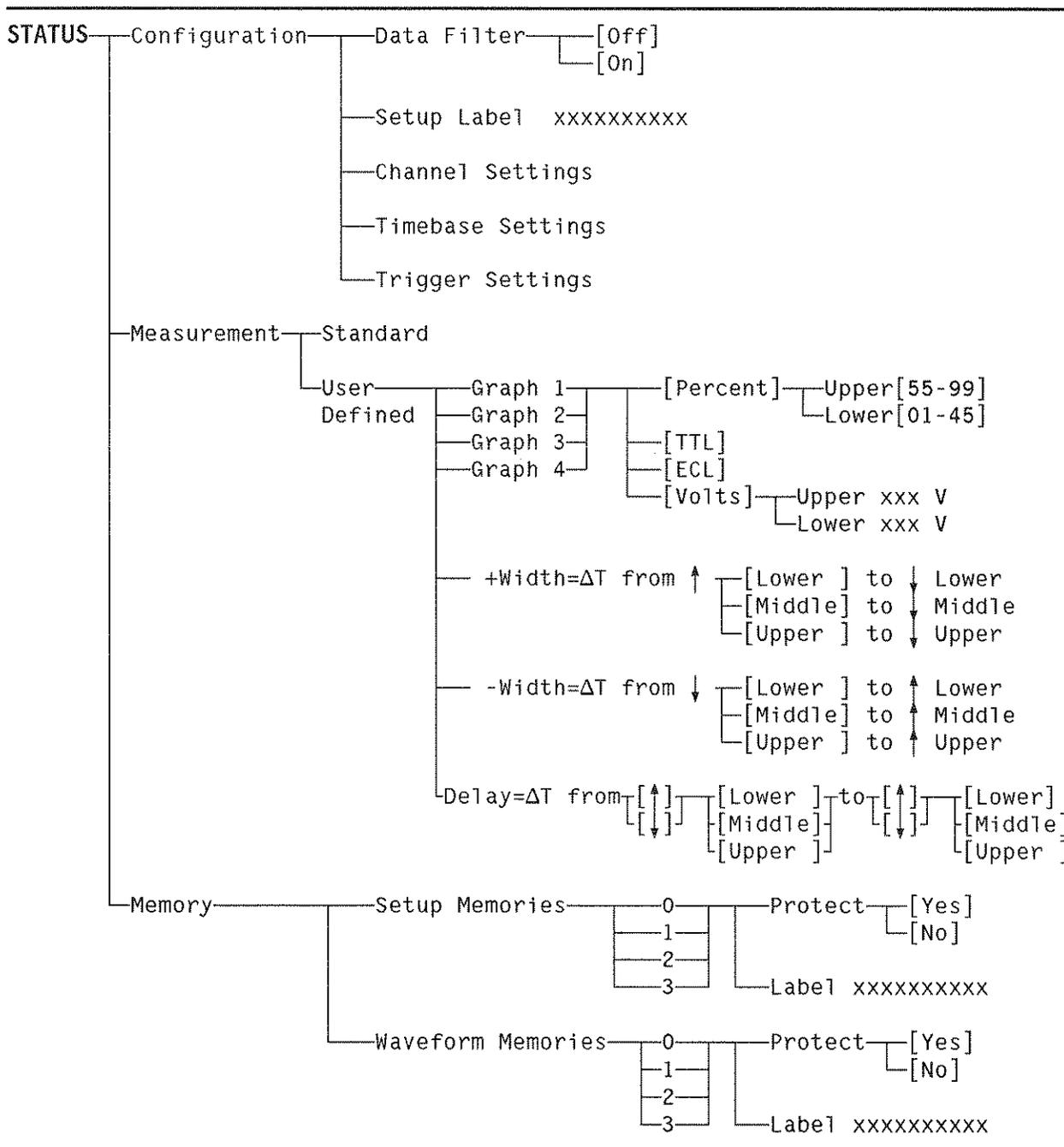


Figure 3-7. STATUS Menu Tree

**STATUS CONFIGURATION SUBMENU (Figure 3-8).** This submenu provides a display to view all of the channel, time, and trigger setups. The setups may be changed in this menu or may be changed by going to the specific channel, time or trigger menu. In addition to setup information, the configuration submenu contains a data filter, labels for setup, channel, and trigger, and an alias test.

```

Status [Configuration] -----Status: Acquiring Frame 01196_
                                     TALK ONLY
Data Filter [ On ]           Setup Label 123456

Channel
-----
Input 1      Input 2      Timebase
-----
Range        7.8 V        40 mV        Sampling @ 1.00 MHz
Offset       -3.142 V     0.000 V     Mode [ Auto ]
Label
Coupling     [dc] [ 1:1 ] [dc] [ 1:1 ] Delay [ 0.000 s ]
Store Mode   [ Normal ] [ Normal ] Reference [ Left ]
Auto Scale   [ Enabled ] [ Enabled ] Alias Test [ Enabled ]
Auto Scale   [ Enabled ] [ Enabled ] Auto Scale [ Period ]

Trigger
-----
Mode [ Analog Only ]      * Refer to State Trigger Menus
                          for Assignment and Sequence
Analog Source [ Chan 1 ]  Auto Scale [ Enabled ]
Level         -3.142 V [ + Slope ] Store Mode [ Normal ]
Range         [ Track ] 7.8 V Coupling [dc] [ 1:1 ]
Label

```

Figure 3-8. STATUS Configuration Submenu

**Data Filter.** At time ranges of  $5\ \mu\text{s}$  and slower, the data may be put through a digital filter to improve the data resolution to seven bits. The data filter field toggles either on or off. At time ranges faster than  $5\ \mu\text{s}$ , the data is always put through a digital reconstruction filter that provides seven-bit resolution. Toggling the data filter control at these faster ranges has no effect. To look at the raw data at time ranges faster than  $5\ \mu\text{s}$ , go to the  $5\ \mu\text{s}$  range, turn off the data filter, and expand the graph using the cursor EXPAND key.

**Setup Label.** Each instrument setup may be labeled for future reference. This label is also shown in the STATUS Memory submenu if the setup has been saved.

**Channel and Trigger Channel Labels.** Each input channel may be labeled to provide a signal recognition aid. These labels are shown in the graph labeling area when waveform graphics are displayed.

**Alias Test.** The alias detection circuit warns to user when the digitizing rate is too slow to reconstruct the input signal accurately. An aliased waveform can look like an untriggered display. Without alias detection, much time can be wasted trying to trigger an oscilloscope that is already triggering perfectly. Alias detection warns the user of the aliased condition so that the digitizing rate may be increased.

The sample rate may be increased by manually adjusting the time range to a shorter time window or by performing a time Auto Scale. The time Auto Scale will always select a digitizing rate fast enough to avoid aliasing.

Alias detection is performed only on the trigger source. Alias detection compares the trigger frequency to the digitizing frequency. Using the Nyquist criteria, if the trigger frequency exceeds 1/2 the digitizing frequency, the alias warning is displayed. The trigger frequency is determined about the trigger level, thus it typically is the fundamental frequency and will not detect aliasing in the ringing of a pulse. Alias detection works best on repetitive signals and does not always detect aliasing in a single-shot burst. Alias detection is not active at the 200 Megasample/second digitizing ranges; the system is bandwidth limited to 50 MHz to reduce the risk of aliasing.

**STATUS MEASUREMENT SUBMENU** This submenu specifies the thresholds used in making automatic measurements and for the edge-find cursor operations. Standard predefined threshold definitions may be selected, or user-defined thresholds may be specified in percentages, voltages, or voltages preset for TTL or ECL logic levels.

**Standard (Figure 3-9).** In standard measurement mode all four graphs are set to 10% for lower threshold, 50% for middle threshold, and 90% for upper threshold. Pulse widths and delay are measured from the middle (50%).

```

Status  Measurement -----Status: Acquiring Frame 00549...
                                     TALK ONLY
Mode  Standard

Thresholds:   Graph 1   Graph 2   Graph 3   Graph 4
Upper         90 %    90 %    90 %    90 %
Middle        50 %    50 %    50 %    50 %
Lower         10 %    10 %    10 %    10 %

Definitions:  An Edge (↑,↓) MUST Cross Both Upper and Lower
Freq = 1 / Period
Period = ΔT, First ↓ Middle to Next Like Edge
+ Width = ΔT, First ↑ Middle to Next ↓ Middle
- Width = ΔT, First ↓ Middle to Next ↑ Middle
Rise = ΔT, First ↑ Lower to Upper
Fall = ΔT, First ↓ Upper to Lower
Duty = + Width / Period
Delay = ΔT, First ↑ Middle to First ↑ Middle
V ampl = ΔV, 100 % - 0 % Using Histogram
V max = Absolute Maximum Voltage
V min = Absolute Minimum Voltage
V rms = Root Mean Square Voltage Over 1 Period
    
```

Figure 3-9. STATUS Measurement Standard Mode Submenu

**User-Defined (Figure 3-10).** Lower and upper thresholds may be defined for each individual graph in percentage, voltage, or preset voltages for TTL and ECL logic levels. Middle thresholds are set to the average of the upper and lower thresholds after the upper and lower thresholds have been set. Lower percentage thresholds may be set from 1 to 45 percent, and upper percentage thresholds may be set from 55 to 99 percent.

The thresholds for making pulse width and delay measurements may be specified as lower, upper, or middle threshold. Delay measurements may specify either rising or falling edge.

```

Status [ Measurement ] -----Status: Acquiring Frame 01326...
                                     TALK ONLY
Mode [ User Defined ]

Thresholds:   Graph 1   Graph 2   Graph 3   Graph 4
Specify as   [ Percent ] [ Volts ] [ TTL ] [ ECL ]
Upper        99 %     1.00 V   2.00 V   -1.17 V
Middle       50 %     0.00 V   1.40 V   -1.35 V
Lower        10 %     -1.00 V   0.80 V   -1.48 V

Definitions: An Edge (↑,↓) MUST Cross Both Upper and Lower
Freq = 1 / Period
Period = ΔT, First ↓ Middle to Next Like Edge
+ Width = ΔT, First ↑ [Upper] to Next ↓ Upper
- Width = ΔT, First ↓ [Lower] to Next ↑ Lower
Rise = ΔT, First ↑ Lower to Upper
Fall = ΔT, First ↓ Upper to Lower
Duty = + Width / Period
Delay = ΔT, First [↑] [Upper] to First [↑] [Middle]
V ampl = ΔV, 100 % - 0 % Using Histogram
V max = Absolute Maximum Voltage
V min = Absolute Minimum Voltage
V rms = Root Mean Square Voltage Over 1 Period

```

Figure 3-10. STATUS Measurement User-Defined Mode Submenu

**STATUS MEMORY SUBMENU (Figure 3-11).** This submenu provides a display to label instrument setup memories and waveform storage memories and allows these memories to be protected from being inadvertently overwritten. The waveform memories show the storage mode the instrument was in when the data was put into memory: normal, average, envelope, or no data. No data indicates the memory is empty.

All four setup memories are saved (non-volatile) on power down and are saved when a key-down power-up reset is executed. Only the first two of four waveform memories (0 and 1) are saved on power down and no waveform memories are saved on key-down power-up reset.

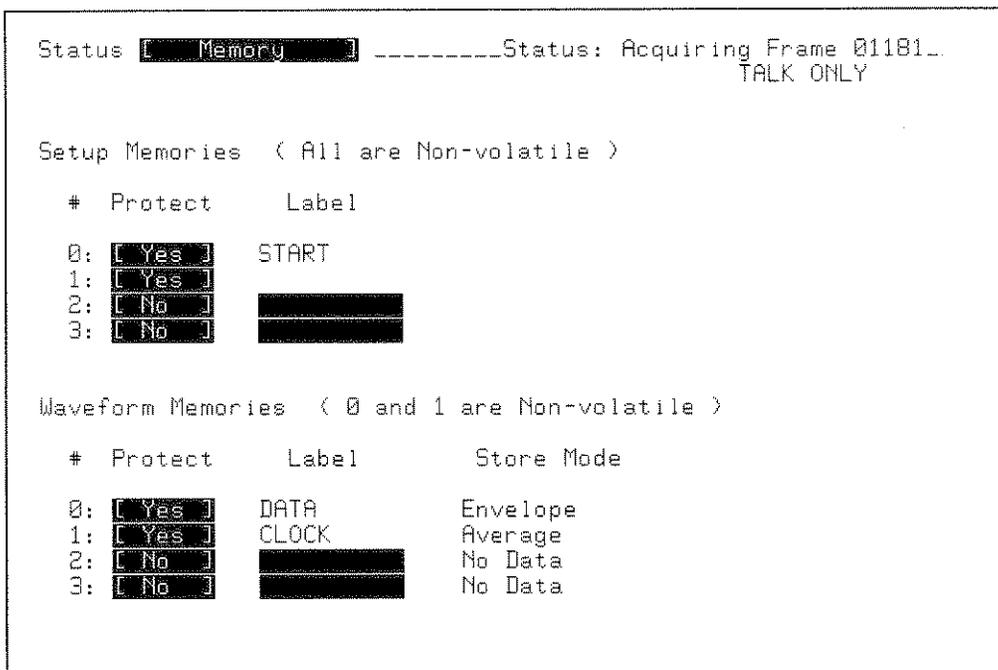
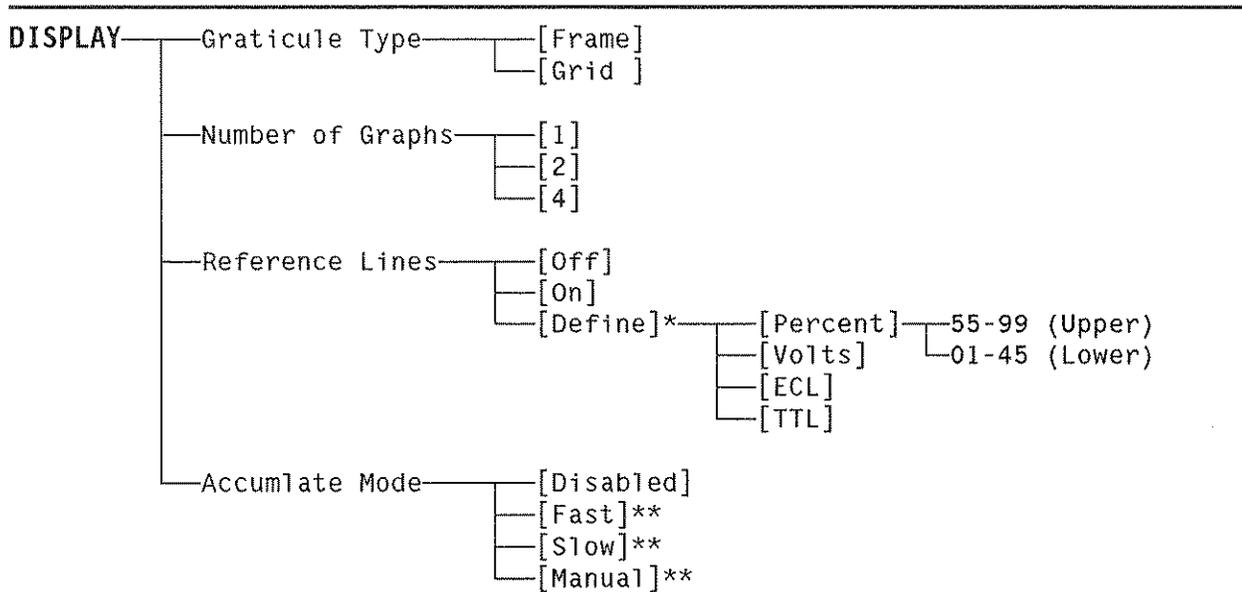


Figure 3-11. STATUS Memory Submenu

### 3-9. DISPLAY Menu.

The DISPLAY menu allows the user to define how the graph area is displayed. The DISPLAY menu tree is shown in figure 3-12. An example DISPLAY menu is shown in figure 3-13.



\* Accumulate Mode must be disabled before reference lines can be enabled or defined.

\*\* Reference lines must be off before accumulate mode can be enabled.

---

Figure 3-12. DISPLAY Menu Tree

**Graticule Type.** Selecting frame graticule type removes all grid lines from the interior of the graph area. A grid graticule type puts an 8x10 grid in the graphics area.

**Number of Graphs.** One, two, or four graphs can be selected to be displayed. The graphs may be Channel 1, Channel 2, Trigger, or Memory 0 through 3 and may be in any order. The top graph is always graph 1. The graph labels are to the left of the displayed waveform any time the cursor values are not displayed.

**Reference Lines.** This function displays upper and lower thresholds used in automatic measurements on each graph that contains waveform data. When off, the reference lines are removed. When on, the reference lines are displayed. When in the define mode, the reference lines are displayed and the reference threshold values are displayed to the left of each graph when the DISPLAY menu is selected. If the STATUS Measurement menu is in the user-defined mode, the values may also be adjusted from this area. The accumulate mode must be disabled before reference lines can be enabled or defined.

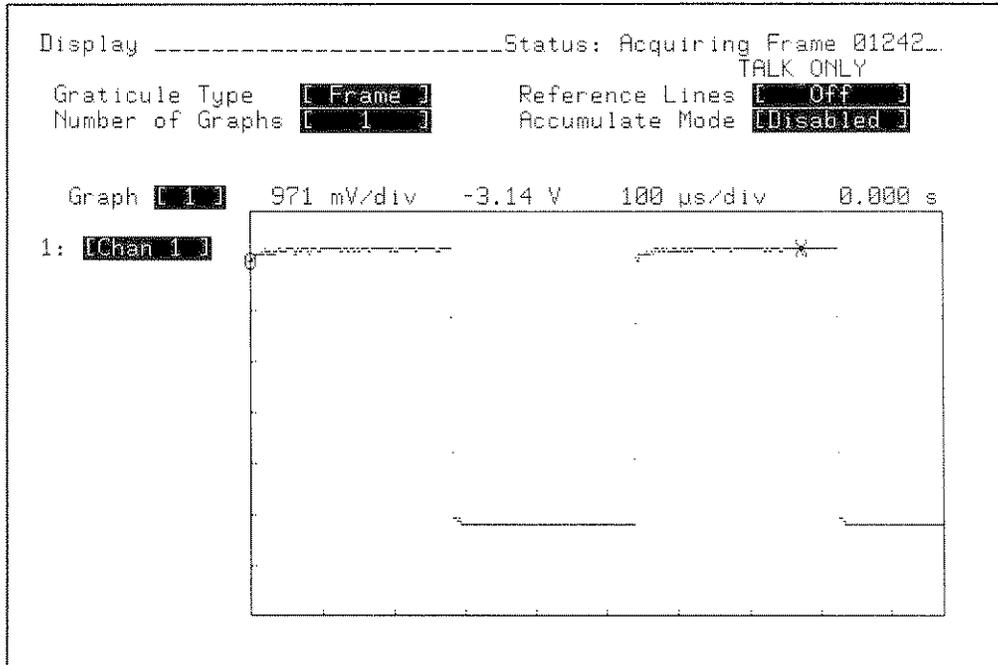
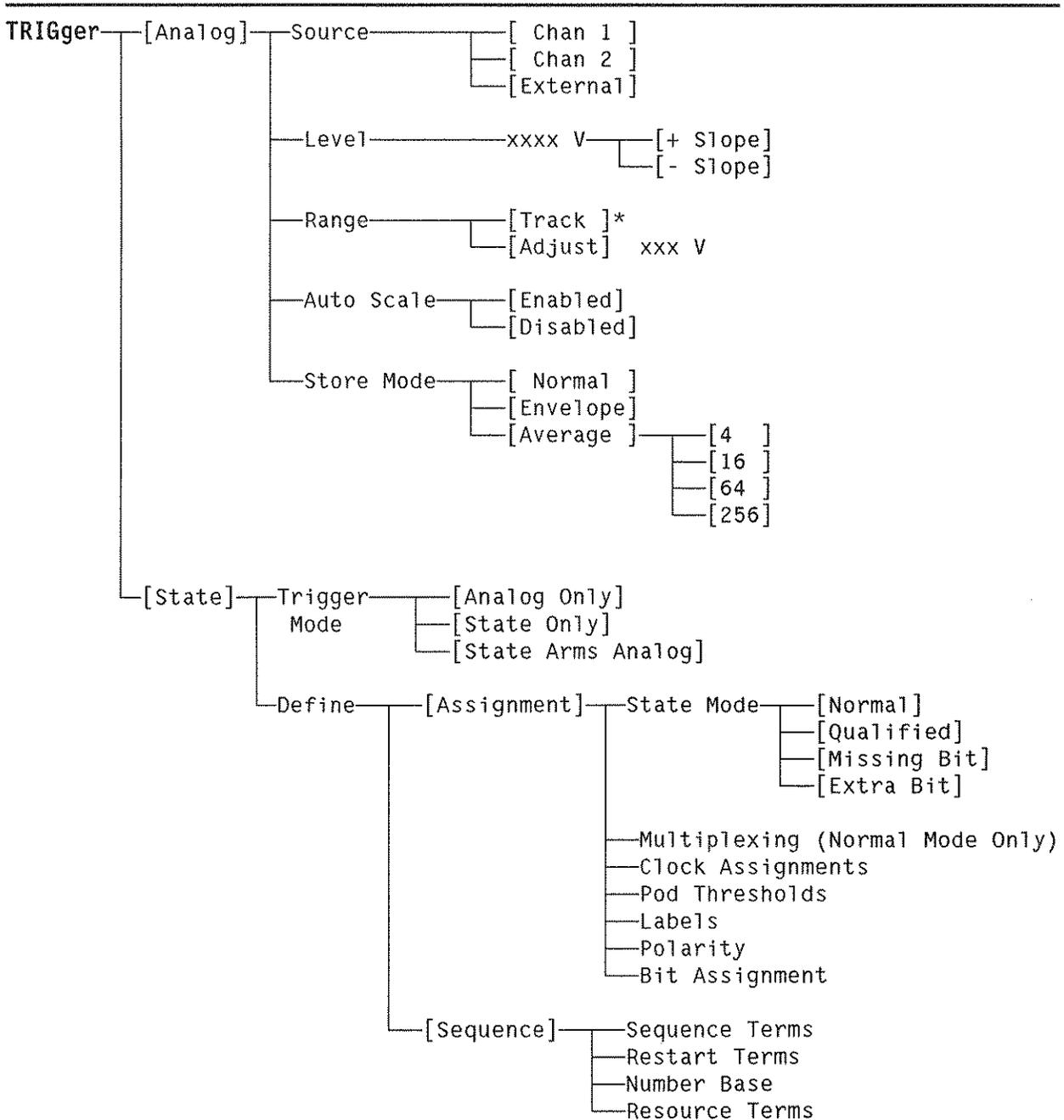


Figure 3-13. Example DISPLAY Menu

**Accumulate Mode.** The accumulate mode displays the present acquisition on screen along with all previous acquisitions. The accumulate mode can be selected to erase automatically after 16 acquisitions (fast), after 64 acquisitions (slow), or manual erase. To manually erase an individual graph, press the ERASE key and enter the appropriate graph number in the "Erase Graph [ ]" field. To manually erase acquisitions on all graphs at once, press the RUN/STOP key twice. The accumulate mode is enabled for all graphs displayed and is for display purposes only. Automatic measurements and cursors operate on the last acquisition only. Reference lines must be off before the accumulate mode can be enabled.

### 3-10. TRIG Menu

The 54200A has a single menu for analog triggering. The 54200D has an additional state trigger menu. The TRIG menu tree is shown in figure 3-14.



\* Track not valid for External Trigger Source.

Figure 3-14. TRIG Menu Tree

**TRIG ANALOG SUBMENU.** The TRIG Analog submenu provides selections for all standard analog oscilloscope trigger parameters. An example TRIG analog submenu is shown in figure 3-15.

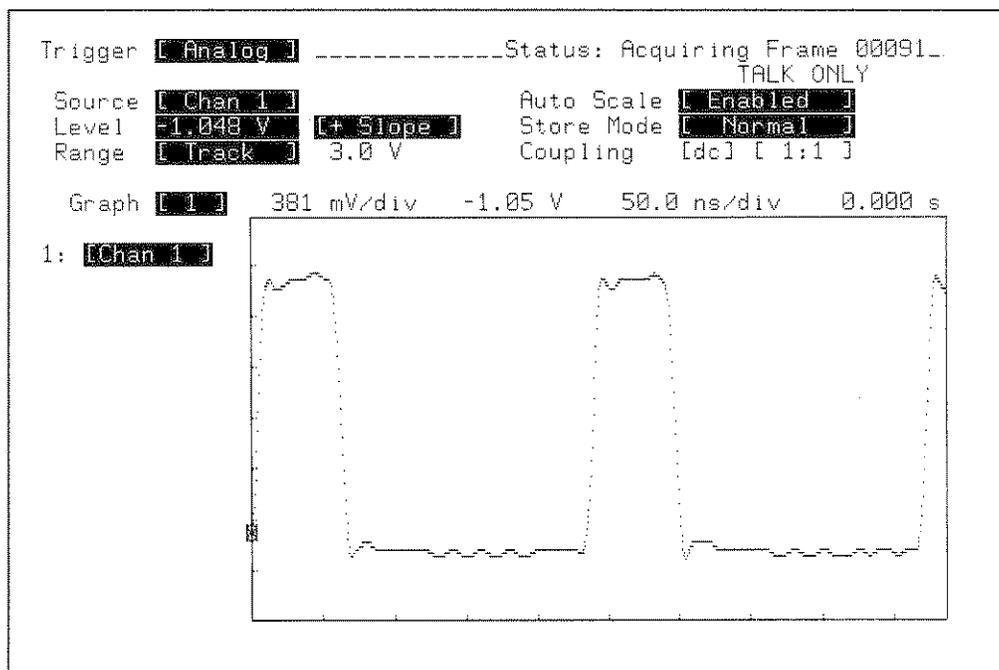


Figure 3-15. Example TRIG Analog Submenu

**Source.** This field selects either channel 1, channel 2, or the external trigger input as the trigger source.

**Level and Slope.** The level field sets the voltage level at which the 54200A/D triggers. Level can be incremented or decremented by pressing the NEXT or PREV key. Level can be changed in fine increments or decrements by pressing the FINE key (shift NEXT or shift PREV). A level may be also entered using the numeric key pad followed by the appropriate units factor key, either Volt or mV. The field adjacent to level determines whether the 54200A/D triggers on the positive slope or the negative slope of the trigger source.

**Range.** When triggering on either Channel 1 or Channel 2, the range may be selected as either Track or Adjust. When Track is selected, the trigger full-scale range is set to the same value as the full-scale range of channel 1 or channel 2, whichever was chosen as the trigger source.

When Adjust is selected, the trigger full-scale range may be adjusted independent of the full-scale range of channel 1 or channel 2 trigger source. This allows triggering on and viewing of an entire pulse, while the internal channel is expanded to look at the top of the pulse. When Adjust is selected the range can be incremented or decremented by pressing the NEXT or PREV key. The range can be changed in fine increments or decrements by pressing the FINE key (shift NEXT or shift PREV). The range may be also entered using the numeric key pad followed by the appropriate units factor key, either Volt or mV.

When External trigger source is selected, the range acts the same as the channel ranges. It is the full-scale voltage range displayed when Trig is selected as a graph source (trigger view). In this mode the 54200A/D is essentially a three-channel oscilloscope, with the restriction that the instrument must be triggered on the external trigger input.

**Auto Scale.** When the Auto Scale function is enabled and the front-panel AUTO SCALE key is pressed, the 54200A/D searches for and sets up a trigger level. If Auto Scale is disabled, pressing the front-panel AUTO SCALE key will not change any of parameters set on the TRIG Analog submenu.

**Store Mode.** Store mode determines how the acquired data is processed before the data for Trig (trigger view) is shown on a graph. Either normal, average, or envelope mode may be chosen.

*Normal.* Normal mode displays one voltage value for each time value of the present acquisition.

*Average.* Average mode displays the average voltage value of the present acquisition and voltage values from previous acquisitions with each time value. Either 4, 16, 64, or 256 averages may be selected.

*Envelope.* Envelope mode displays only the minimum voltage for each time value and the maximum voltage for each time value.

**TRIG STATE SUBMENU (54200D only).** In addition to analog edge triggering the 54200D can also trigger on a state condition or arm the analog trigger after a state condition. Detailed state trigger information is given in Section 5 of this manual. The state submenu is selected by moving the blinking cursor to the trigger field and pressing the NEXT or PREV key. This only chooses the state submenu and does not change the trigger from analog to state.

Two selections, the assignment menu and the sequence menu, are available in the state trigger submenu and are selected from the Define field.

**State Trigger Assignment Menu (Figure 3-16 and 3-17).** The Assignment functions assigns information about the pod inputs and how they will be used.

**Trigger Mode.** This selection determines whether the instrument will trigger on the conditions specified in the analog trigger submenu (Analog Only), or will trigger on the conditions set up in the state trigger submenu (State Only), or whether the state conditions will first be found and then used to arm the analog trigger (State Arms Analog). This Trigger Mode field is also present in the State Trigger Sequence menu.

**State Mode.** Four state modes are available:

*Normal.* State patterns up to 27 channels wide may be defined as trigger qualification. Up to four unique state patterns can be qualified on, in a user-defined sequence.

*Qualified.* State sequence search does not begin until after the qualify clock has occurred. The slave clock is defined as the qualify clock.

*Missing Bit.* This mode predefines the last state in the sequence specification to detect a missing bit in a string of serial data and triggers the acquisition.

*Extra Bit.* This mode predefines the last state in the sequence specification to detect an extra bit in a string of serial data and triggers the acquisition.

With Missing Bit and Extra Bit, the J clock is used to define the reference time interval or cell for which a missing or extra bit will be checked. The serial data is input as the L clock.

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [Assignment]           Trigger Mode [ Analog Only ]

                               Slave Clock   Master Clock
                               JKL           JKL
State Mode [ Qualified ]     ----- [↑.] ----- [↑.] -----
                               Pod 2       Pod 1       Pod 0
                               [ TTL ] [ TTL ] [ TTL ]
                               8.....0 8.....0 8.....0

Label Pol
  [ A ] [↑] [*****] [*****] [*****]
    
```

Figure 3-16. Example State Trigger Assignment Menu (Qualified Mode)

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [Assignment]           Trigger Mode [ Analog Only ]

                               Reference Cell  Serial Data
                               J Clock       L Clock
State Mode [ Missing Bit ]   ----- [↑] ----- [↑] -----
                               Pod 2       Pod 1       Pod 0
                               [ TTL ] [ TTL ] [ TTL ]
                               8.....0
                               [*****]

Label Pol
  [ A ] [↑]
    
```

Figure 3-17. Example State Trigger Assignment Menu (Missing-bit Mode)

**Clocks.** Three ORed clocks operate in a single-phase or two-phase demultiplexing mode. Clock edges can be selected as positive, negative, or both positive and negative for each clock. Different edge selections may be made on the same clock if it is used in each phase of the multiplexed mode. The specified clock edge determines when the data on the state channels is clocked into the instrument for trigger comparisons.

**Pod Thresholds.** The comparator thresholds for each of the pods may be set to a level suitable for TTL, ECL, or may be user-defined in volts.

**Multiplexing.** The clocks may be multiplexed in Normal mode for use with microprocessors that multiplex their data and address lines.

**Labels.** Up to eight different five-character labels may be designated in Normal and Qualified mode for any combination of input lines for ease in setting specifications. Missing-bit mode and Extra-bit mode only allow one label. To enter a label, use the alphabetic characters provided when the shift key is active. To obtain more labels, move the blinking field cursor to the first label field, then press INSERT. To remove a label, move the blinking field cursor to that label and press DELETE (shift INSERT).

**Pol.** This field selects logic polarity. Selecting plus (+) indicates positive logic; voltages above the threshold are logic 1 and voltages below the threshold are logic 0. Selecting minus (-) indicates negative logic; voltages above the threshold are logic 0 and voltages below the threshold are logic 1.

**Pod Assignment.** This field assigns a particular state channel to a grouping defined by the label. An asterisk (\*) means the channel is active. A period (.) means the channel is not part of that grouping.

**State Trigger Sequence Menu (Figure 3-18).** The Sequence function sets up a sequence of state terms that determines the state trigger condition.

**Trigger Mode.** This selection determines whether the instrument will trigger on the conditions specified in the analog trigger submenu (Analog Only), or will trigger on the conditions set up in the state trigger submenu (State Only), or whether the state conditions will first be found and then used to arm the analog trigger (State Arms Analog). This Trigger Mode field is also present in the State Trigger Assignment menu.

**Resource Terms.** These are defined at the bottom of the state trigger sequence menu. Label> is a carryover from the assignment menu. Base> determines whether the channels grouped under label are expressed in hexadecimal, binary, octal, or decimal format. Four resource terms (a, b, c, and d) may be defined by the user for use in sequence triggering.

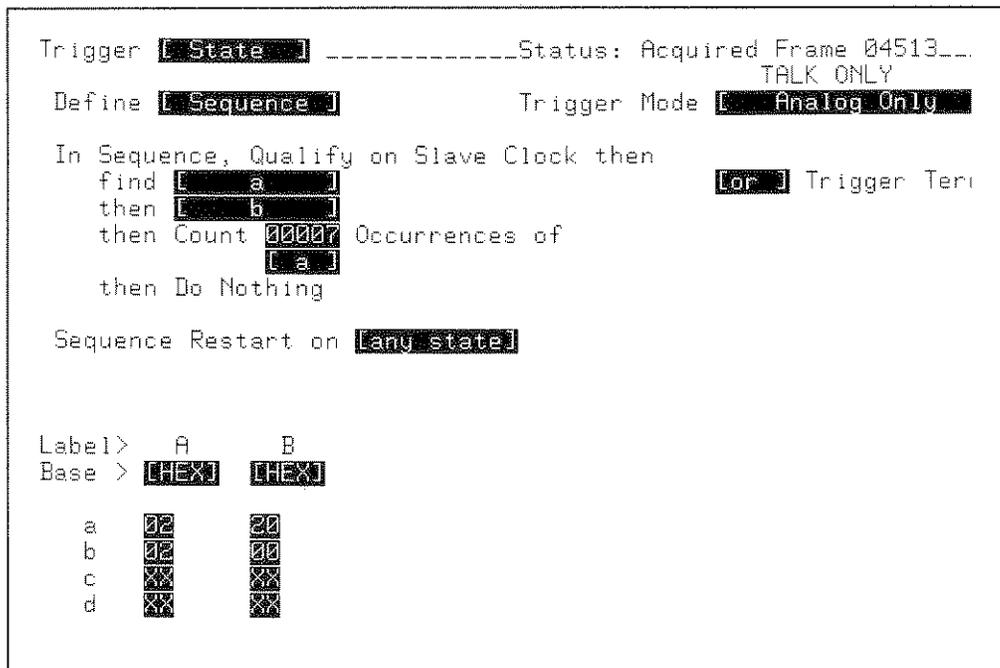


Figure 3-18. Example State Trigger Sequence Menu

**Sequence.** Four user-defined terms (a, b, c, and d), the not equal of those terms, any state, or no state may be used in any combination to define a sequence of events on which to be triggered.

Initially, only one term is shown. To add more terms, move the blinking field cursor to the occurrences field and press INSERT. Up to three more terms may be added. To remove a term, move the blinking cursor to that term and press the DELETE key.

**Last Sequence Term.** All four resource terms and their not equal terms may be used in any ORed or ANDed configuration to specify the last sequence term. To do this, move the blinking field cursor to the last sequence term (after occurrence specification) and change any state to the desired resource term (either a, b, c, d, ≠a, ≠b, ≠c, or ≠d). For more terms, press INSERT while the blinking field cursor is on the resource term. To remove extra terms, move the cursor to the undesired term and press the DELETE key.

**Trigger Terms.** This entry determines whether the last sequence term will OR or AND the resource terms together.

**Occurrences.** Occurrences of the last event in the sequence may be specified from 1 to 59999 occurrences.

**Restart.** One to four resource terms may be used in an ORed condition for a sequence restart condition. The sequence restart selection field appears when a resource term is inserted into the sequence.



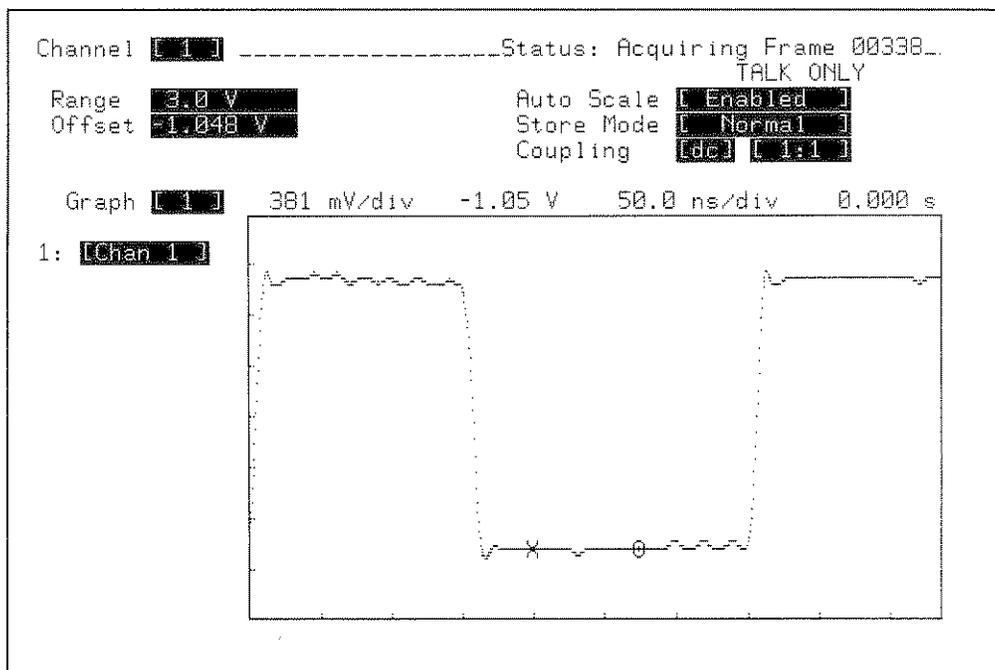


Figure 3-20. Example CHAN Menu

**Store Mode.** Store mode determines how the acquired data is processed before the data is shown on a graph. Either normal, average, or envelope mode may be chosen.

*Normal.* Normal mode displays one voltage value for each time value of the present acquisition.

*Average.* Average mode displays the average voltage value of the present acquisition and voltage values from previous acquisitions with each time value. Either 4, 16, 64, or 256 averages may be selected.

*Envelope.* Envelope mode displays only the minimum voltage for each time value and the maximum voltage for each time value.

**Coupling and probe attenuation factor.** The input coupling for Channel 1 or Channel 2 may be selected as either ac or dc. The probe attenuation factor should be entered for each channel to match the probe that is connected to that channel. This allows the 54200A/D to correct all scale factors for the attenuation ratio of the probe. When this is used, all automatic measurements and cursor value readouts are corrected to reflect the attenuation factor. When coupling and probe attenuation factors are changed on the CHAN menu, these values are automatically changed on the TRIG menu to match unless externally triggered.

### 3-12. TIME Menu.

The TIME menu allows the user to define all timebase related parameters. The TIME Menu tree is shown in figure 3-21. An example TIME menu is shown in figure 3-22.

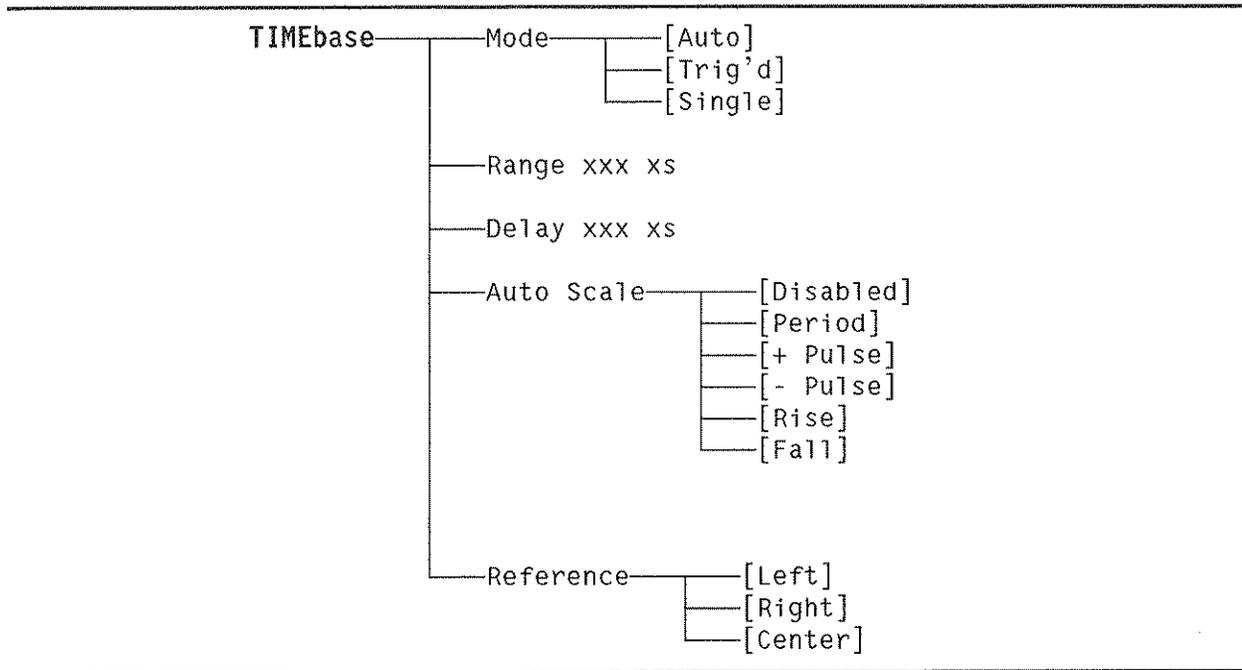


Figure 3-21. TIME Menu Tree

**Mode.** Auto, Triggered, or Single timebase modes may be selected.

*Auto.* Auto mode waits for a specified length of time (determined by the time range) for a trigger. If a trigger does not occur within that time, the contents of the acquisition memory are displayed with no trigger correlation.

*Trig'd.* Triggered mode waits until a trigger is received before the graph is updated. There is no time limit in triggered mode; if a trigger does not occur, the screen is not updated. The status line of the display will advise "Waiting for Trigger".

*Single.* Single mode clears the graph and displays the acquisition when a single trigger is received. A new acquisition is not made until the instrument is manually reset by pressing the RUN/STOP key. When the trigger has occurred, the status line of the display will advise "Acquisition Complete".

**Range.** Range sets the full-scale time from the left side of the graph to the right side of the graph. Range can be varied from 10 seconds to 50 nanoseconds in a 1-2-5 sequence by pressing the NEXT or PREV key. The range can also be entered by using the numeric key pad followed by the appropriate units factor key (sec, msec,  $\mu$ sec, or nsec). If the value entered is not in the 1-2-5 sequence, the 54200A/D will round the entry to the nearest valid time.

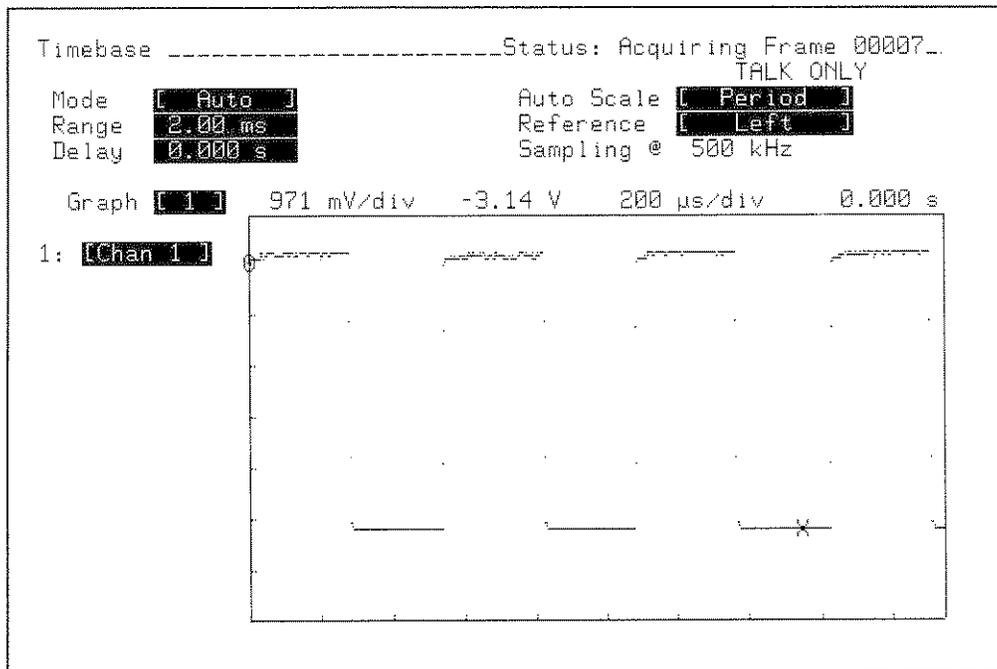


Figure 3-22. Example TIME Menu

**Delay.** Delay allows the user to look at an acquisition window a specified amount of time before or after the trigger event. In the 50-ns to 5- $\mu$ s time range, the pre-trigger range is up to 5  $\mu$ s and the post-trigger range is up to 1 ms. In the 10- $\mu$ s to 10-s time range, the pre-trigger range is up to 1 screen diameter and the post-trigger range is up to 260 screen diameters.

**Auto Scale.** This selection changes the search criteria when the AUTO SCALE key on the front panel is pressed. Timebase Auto Scale may be disabled or selected to auto scale on period, positive pulse, negative pulse, rising edge, or falling edge. Auto Scale scales the timebase to display the selected portion of the waveform. When the timebase Auto Scale is disabled, the timebase is not rescaled when the front panel AUTO SCALE key is pressed; vertical and trigger may be rescaled depending on their Auto Scale settings.

**Reference.** Reference places the trigger event plus delay at the Left, Center, or Right side of the graph, depending on the selection. If delay is zero, a Left reference places the trigger event at the left side of the graph; a Center reference places the trigger event at the center of the graph; and a Right reference places the trigger event at the right side of the graph.

**Sampling.** Sampling is the digitizing rate used by the 54200A/D to acquire the waveform. The digitizing rate depends upon the time range selected and can only be changed indirectly by changing the time range. All time ranges from 5  $\mu$ s to 50 ns have a digitizing rate of 200 megasamples/second.

### 3-13. THE GRAPH DISPLAY

The display is in the graph mode any time the SYSTEM, STATUS, or TRIG State (54200D only) menus are turned off. Refer to the example display shown in figure 3-23.

- Line 1:** The left side of line 1 shows which menu, if any, is being displayed. The right side of line 1 shows instrument status messages such as "No Trigger Found" or "Acquired Frame". Warning messages and error messages are also displayed on this portion of line 1 and are accompanied by an audible beep when initially displayed.
- Line 2:** The right side of line 2 indicates HP-IB status and indicates when the SHIFT function is active.
- Lines 3-5:** These three lines display the menu selections for DISPLAY, TRIG Analog, CHAN, and TIME menus when active, or display the measurement answers when these menus are turned off.
- Line 6:** Line 6 is always blank.
- Line 7:** This line displays the scale factors for the selected graph (either 1, 2, 3, or 4). The scale factors displayed, from left to right, are:

- Vertical sensitivity (volts/division),
- Vertical offset (volts),
- Time sensitivity (seconds/division),
- Time from the trigger event to the left side of the graph (seconds).

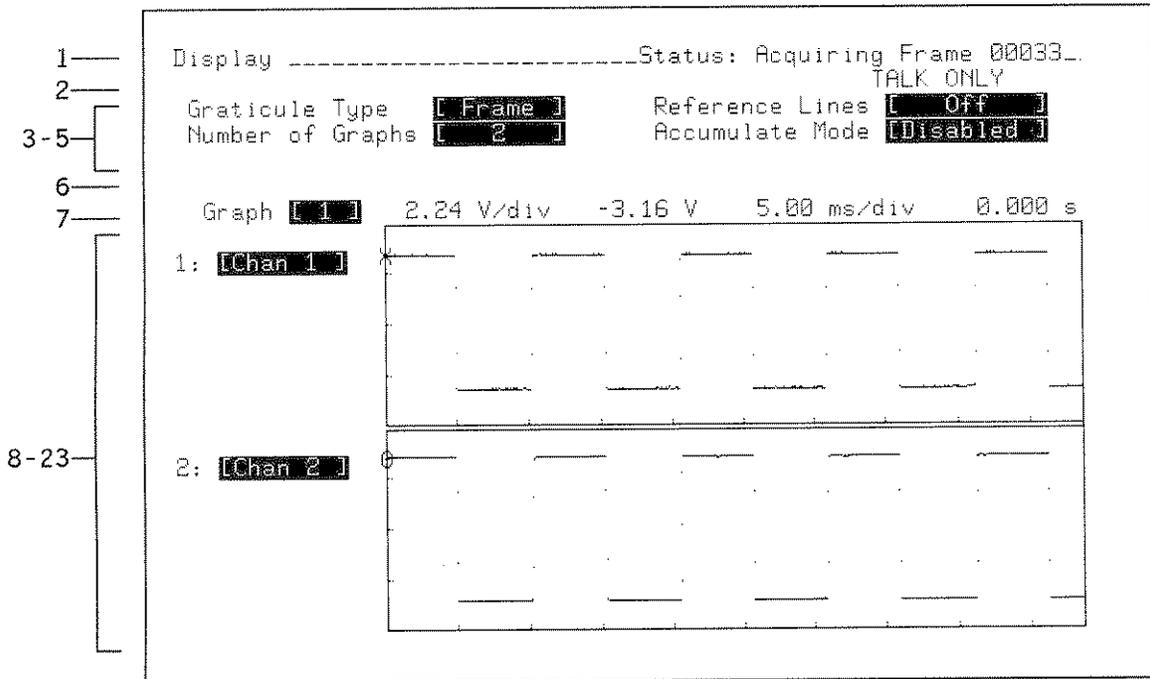


Figure 3-23. Graph Mode Display

**Lines 8-23:** The right portion of these lines display the acquired waveforms. The DISPLAY menu allows 1, 2, or 4 graphs to be displayed.

The portion of these lines to the left of the displayed graphs can display four different sets of information: graph labels, cursor values, reference line values, and out-of-range arrows.

**Graph Labels.** The graph labels tell what source of information is being displayed on each graph (Chan 1, Chan 2, Trig, Mem 0, Mem 1, Mem 2, Mem 3, or Off). The label for a graph may be changed by pressing the NEXT or PREV key. If a user defined line has been defined on the STATUS menu for a source, that label is displayed directly below the graph label.

**Cursor Values.** Pressing SHIFT VALUES toggles between the graph labels and cursor values. When cursor values is selected the following information is displayed:

- Voltage at X cursor
- Time from trigger to X cursor
- Voltage at O cursor
- Time from trigger to O cursor
- Delta voltage from O cursor to X cursor
- Delta time from O cursor to X cursor

**Reference Line Values.** Reference line values for graphs may be displayed and can be changed by selecting the DISPLAY menu and selecting [Define] Reference Lines. Each graph can be assigned two threshold levels for automatic measurements or for visual reference. The levels may be specified in either volts or as a percent of the waveform amplitude, or ECL or TTL preset values may be selected.

**Out-of-range Arrows.** Just outside the left margin of each graph, a small arrow appears whenever the waveform is driven off-screen. Vertical arrows indicate that a portion of the graph information is off-screen either above or below the graph and not just at the edge of the graphics. A horizontal arrow indicates that the graph is expanded. An arrow to the left indicates that information to the left is not being displayed and an arrow to the right indicates that information to the right is not being displayed.

## SECTION 4

# FRONT PANEL EXERCISES

### 4-1. INTRODUCTION

This chapter will further familiarize the user with the front panel operation of the 54200A/D Digitizing Oscilloscope by performing some actual measurements.

This exercise requires a HP 54200A/D, two BNC cables, and a signal generator capable of providing a 35 kHz square/sine wave of 5 volts amplitude and 2.5 volts offset, and a trigger output. The swept frequency measurement requires a generator with a sweep frequency output, a 1-k $\Omega$  resistor, and a 3300 pF capacitor. An HP Model 8116A option 001 provides all the required generator functions and has a 50 $\Omega$  output.

### 4-2. SETUP

1. Set up the generator to give a 35-kHz square wave with an amplitude of 5 volts and an offset of 2.5 volts. If a generator with a 50 $\Omega$  output is being used, set an amplitude of 2.5 volts and an offset of 1.25 volts. This amplitude will double going into the HP 54200A/D 1 M $\Omega$  input.
2. Connect the signal output of the generator to the channel one input of the HP 54200A/D. Connect the trigger output of the generator to the channel two input.
3. Preset the HP 54200A/D to known conditions by holding any key down and powering up the instrument. Hold the key down for about three seconds.
4. Get a waveform on screen by pressing the AUTO SCALE key.

### 4-3. LOOKING AT WAVEFORM EDGES

The instrument is currently triggered on a positive edge of the square wave. To look at this edge in greater detail, move the trigger point from the left edge of the screen to center screen. First, press the TIME menu key; next, using the FIELD arrows, move the blinking selection cursor from the mode selection field to the reference selection field. Press the NEXT key to change the reference from left to center.

The reference field places the reference point (trigger plus delay) at the left edge of the screen; at center screen; or at the right edge of the screen.

Since the delay equals zero right now, the reference point is the trigger point.

This is an example of how all the controls of the HP 54200A/D operate. The blinking selection cursor is moved to the desired selection field and the NEXT/PREV keys are used to roll through the possible selections.

Numeric selection fields without brackets [ ] may be changed using the NEXT or PREV key (which act as increment/decrement keys), or by entering the desired number from the numeric key pad followed by the desired units (sec, Volt, msec, mV,  $\mu$ sec, or nsec).

With a center reference, the time range can be changed to a faster value and still keep the reference point at center screen. This makes it easy to look at rising or falling edges. Using the arrow keys, move the blinking selection cursor to the range selection field. The time range is the full-scale time from the left side of a graph to the right side of the graph. Varying this value has the same effect as the sweep speed control on analog oscilloscopes. Press the PREV key to decrement the range value. Continue pressing the PREV key until the positive edge can be seen over one to two horizontal divisions.

### 4-3. RISE TIME MEASUREMENT

All automatic measurements are continuously updated and made on the data shown on screen. To make a rise time measurement, there must be at least nine data points on the edge. Make the rise time measurement by pressing SHIFT, RISE, 1. The 1 specifies that the measurement will be made on graph 1. Measurements may be specified for up to four different graphs. The rise time of the waveform should be showing on the display in the upper left.

### 4-4. FALL TIME MEASUREMENT

To make a fall time measurement the falling edge must be displayed on screen. This is done by specifying a negative slope for the trigger. Select the trigger menu by pressing the TRIG menu key. Move the blinking selection cursor to the selection field showing + Slope. Press the NEXT key to select - SLOPE.

Notice the display is now showing the negative edge. Display the measurement results again by turning off the TRIG menu. This is done by pressing the TRIG key again. Each of the menu keys has a toggle function that switches between the measurement results, if any, and the desired menu.

The rise time should not have an answer since the rising edge is not shown on screen. Make the fall time measurement by pressing SHIFT, FALL, 1.

Measurements slow the update rate slightly since computation time is required. Measurements can be turned off by moving the blinking selection cursor to the undesired measurement and pressing CLEAR ENTRY or SHIFT DELETE. Remove both the rise time measurement and the fall time measurement.

### 4-5. MEASURING FREQUENCY/PERIOD

To measure the frequency, at least one period must be displayed on screen. Press AUTO SCALE to rescale the waveform. To measure the frequency, press SHIFT, FREQ, 1. To measure the period, press SHIFT, PERIOD, 1. Remember that the 1 specifies that the measurement will be made on graph 1.

## 4-6. CURSOR MEASUREMENTS

Cursors provide a manual method of making measurements. Cursor measurements are made by first turning on the cursor values. To do this, make the shift function active by pressing SHIFT, then press VALUES.

All cursor functions are performed while SHIFT is active. A message in the upper right of the screen tells when SHIFT is on. To move a cursor, activate the desired cursor by pressing X, O, or X&O. Next press the desired left, right, up, or down cursor arrow. The left and right arrows move the cursors horizontally along the waveform. The up and down arrows move the cursors from one graph to the graph above or below it.

The left side of the screen shows which cursor is active; the voltage values of the X and O cursors, the time from the trigger event to the X and O cursors, and  $\Delta V$  and  $\Delta T$  (where  $\Delta$  is the value of X minus the value of O).

Make a period measurement by activating the X cursor, then press ←EDGE or EDGE→ until X is on a positive edge of the waveform. Next, select the O cursor, move it to the top graph using a vertical arrow; then press ←EDGE or EDGE→ to put O on the closest positive edge next to the X cursor.  $\Delta T$  gives the period measurement. This method gives a slight error since the X cursor jumps to the lower threshold and the O cursor jumps to the upper threshold. To correct for this error, move either cursor to the corresponding place on the waveform as the other cursor.

## 4-7. EXPANDING GRAPHS

### 4-8. Expanding One Waveform

Graphs are expanded horizontally by positioning the X and O cursors about the area to be enlarged, then press EXPAND. Expand about the rising edge of the waveshape by placing the X cursor one division to the left of the rising edge; then place the O cursor one division to the right of the rising edge; then press EXPAND.

The expansion is performed on the graph with the active cursor. If both cursors are on the same graph, as in this case, it does not matter which cursor is active.

Notice the little arrow to the left of the graph advising that the graph is expanded horizontally. Vertical arrows would indicate the waveform is off screen vertically.

Automatic measurements may be performed on expanded waveshapes remembering that the measurement will be made on the data shown on screen.

Press NORMAL to return the waveshape to its unexpanded scale factor.

#### 4-9. Expanding Two Graphs to the Same Scale

What if two related graphs are displayed and examination both graphs is desired in finer detail while maintaining the timing relationship between the graphs? This can be done by placing the X cursor on one of the graphs, the O cursor on the other graph, making X&O active, and pressing EXPAND. This expands the time between X and O.

Using the down arrow, move the O cursor to the lower graph. Press X&O, then press EXPAND. Both graphs should now be expanded to the same scale factor. Press NORMAL to return to the unexpanded scale factor.

To remove the cursor values and return to the graph labels, press VALUES while the SHIFT key is active.

#### 4-10. LOOKING AT PULSES

##### 4-11. Positive Pulse Width

To measure a positive pulse width using automatic measurements, first show a positive pulse on screen. To do this, go to the TIME menu and select +Pulse for Auto Scale. Press AUTO SCALE, then press SHIFT, +WIDTH, 1. As in all automatic measurements, the 1 specifies that the measurement will be made on graph 1. The answer is shown in the measurement results area.

##### 4-12. Negative Pulse Width

To measure a negative pulse width, go to the TIME menu and select -Pulse for Auto Scale, then press AUTO SCALE. This will display a negative pulse on screen. Next, press SHIFT, -WIDTH, 1.

##### 4-13. DUTY CYCLE

Duty cycle can be measured by adjusting the time range to show two periods (100  $\mu$ s if a 35-kHz signal is being used), then press SHIFT, DUTY, 1. Signals may be scaled manually, as in this example, or using Auto Scale, as in previous examples. Return the TIME menu Auto Scale to period and press AUTO SCALE.

#### 4-14. WAVEFORM STORAGE

Waveforms may be saved for later reference. To save a waveform first press SAVE, then change the storage selection from setup to graph, select 1; next select memory 0. This saves the contents of graph 1 in memory 0.

Similarly, instrument setups may also be saved using the SAVE key. There are four instrument setup memories and four waveform memories.

To recall the waveform, one of two methods may be used. The first method uses the NEXT/PREV keys. Move the blinking selection cursor to the graph 1 label field. Roll through the selections until memory 0 is showing. This displays the contents of memory 0 on graph 1.

The second method uses the RECALL key in the same manner as the SAVE key was used. Press RECALL, then change setup to graph, select 2, and enter 0 for memory. The contents of memory 0 is now displayed on both graphs 1 and 2.

Automatic measurements and cursors can be used on stored waveforms.

Use the NEXT or PREV key in the channel label area to return graph 1 to channel 1 and graph 2 to channel 2. Press the RUN- STOP key to start acquisitions again.

#### 4-15. LOOKING AT THE RINGING ON TOP OF A PULSE

Offset may be used to increase the vertical resolution about the area of interest. Using the X cursor, measure the value of the top baseline of the square wave (it should be around 5 volts). Go to the channel 1 menu by pressing the CHAN menu key. Make sure that channel 1 is selected in the upper left corner. Enter the value of the X cursor for offset using the numeric keys and the appropriate scale factor (Volt or mV). Using the PREV key, change the channel 1 range to 400 mV.

Do not go beyond 400 mV, as the offset limit will be exceeded for the given range and the range and offset will have to be re-entered to get the waveform back on screen. Press AUTO SCALE to return to a complete waveform.

#### 4-16. TROUBLESHOOTING LOGIC

Troubleshooting a class of logic problems can be accomplished by quickly probing a number of different points and verifying whether a signal is there, whether the logic high is a legitimate value, and whether the logic low is a legitimate value.

The HP 54200A/D accomplishes this easily with TTL/ECL presets and  $V_{max}$  and  $V_{min}$  measurements.

The input signal was previously chosen to simulate TTL levels. Press the TTL preset key. Next press SHIFT,  $V_{max}$ , 1; then SHIFT,  $V_{min}$ , 1.  $V_{max}$  shows the maximum value of the waveshape or the TTL high.  $V_{min}$  shows the minimum value of the waveshape or the TTL low. Some care must be exercised to include the effect of overshoot.

Because these measurements are continuously updated, probe from point-to-point while glancing at the display to verify the line is switching, and also verify the high and low levels.

#### 4-17. MEASURING WORST-CASE JITTER

Variations of signals can be measured using the envelope mode. Since the parameters of channel 1 will be changed a stable trigger point will have to be established. Go to the TRIG menu and change the trigger source from channel 1 to channel 2. Adjust the trigger level if necessary. Change the signal source to a sine wave. Go to the CHAN menu and change the channel 1 Store Mode from Normal to Envelope.

Change the signal generator offset from 2.5 volts to 1.5 volts in 100 mV increments. Watch the channel 1 display as this is done. The maximum and minimum excursions of the waveshape are shown. This is similar to making a voltage drift measurement.

Start the measurement over by pressing ERASE then enter 1 in Erase Graph field. Now go to the DISPLAY menu and select manual for the accumulation mode. Change the offset from 1.5 volts to 2.5 volts in 100 mV increments. Notice that the accumulation mode retains all waveshapes for display purposes. Manual accumulation erases the graph when the acquisition is restarted; fast accumulation erases the graph after 16 acquisitions; slow accumulation erases the graph after 64 acquisitions.

Cursors operate on envelope waveforms but not accumulation waveforms. Auto-measurements will operate on the maximum array of an envelope. Cursors and auto-measurements operate on the last acquired frame when in the accumulate mode.

Disable the accumulation mode. Restart the acquisition by pressing ERASE then enter 1 in the Erase Graph field. Observe timing jitter by changing the frequency of the signal from 35 kHz to 30 kHz in 1 kHz increments. Go to the CHAN menu and change the channel 1 store mode from envelope back to normal. Change the generator signal back to a square wave.

#### 4-18. SINGLE-SHOT CAPTURE

To demonstrate a single-shot capture, first go to the TRIG menu and change the trigger source from channel 2 to channel 1. Next, go to the TIME menu and change the mode from auto to single and the reference from left to center. Changing the reference from left to center allows the entire first pulse to be seen. Disconnect the channel 1 input and press RUN-STOP, the instrument is now waiting for a trigger. Reconnect the input, and the instrument will capture and display one acquisition.

#### 4-19. TRIGGERED MODE

Change the timebase mode to triggered and press RUN- STOP. Disconnect the channel 1 input and notice that the last acquisition stays on screen. This is useful when probing, as the last acquisition remains on screen when the probe is lifted. Reconnect the input and the display starts updating again.

#### 4-20. AUTO MODE

Change the timebase mode to auto and disconnect the the channel 1 input. This time the instrument continues sweeping without a trigger to show where the voltage of the input is. Reconnect the input.

## 4-21. SWEPT FREQUENCY RESPONSE

Another typical measurement made with oscilloscopes is to measure the frequency response of a test circuit. This measurement requires a signal generator with the capability of sweeping frequencies; an HP 8116A with option 001 is used to describe the the measurement.

First set up the HP 8116A to sweep from 1 kHz to 500 kHz with a sine wave of amplitude 2.5 volts and offset of 1.25 volts. This gives a 5-volt signal with 2.5 volts of offset into the HP 54200A/D 1 megohm input. Choose an internal sweep (I.SWP) mode for the HP 8116A. Set the start (STA) frequency at 1 kHz, the stop (STP) frequency at 500 kHz, the sweep time (SWT) at 50 ms, the high level (HIL) at 2.5 volts, the low level (LOL) at 0 volts, and select a sine wave.

Connect the signal output of the HP 8116A to the channel 1 input of the HP 54200A/D. Connect the start of sweep output (rear panel of HP 8116A, X-OUT) to the channel 2 input of the HP 54200A/D. Press the TTL preset key. Select channel 2 as the trigger source. Change the time range to 200 ms and adjust the time delay to get an entire sweep ramp of channel 2 on screen.

Thus far the vertical and horizontal controls have been set up the same as for any signal. Now set up the controls that are unique for measuring a frequency response. Go to the STATUS Configuration menu and turn off the data filter and disable the alias test. The alias test adds appreciable time to the update rate at slow sweep speeds and channel 1 is intentionally aliased anyway. Go to the CHAN menu and put channel 1 in the envelope mode.

The swept frequency response from 1 kHz to 500 kHz should be displayed. Because this is not testing a circuit, there are only two parallel lines. To look at a more interesting response, connect a simple low-pass filter using a 1-k $\Omega$  resistor and a 3300-pF capacitor. This gives a roll-off characteristic around 48 kHz.



## SECTION 5

# STATE TRIGGERING WITH THE 54200D

### 5-1. INTRODUCTION

State triggering in an oscilloscope is a new concept, that with some familiarization and practice, can become a very powerful tool. Even though a primary function of a circuit may be analog, nearly all state of the art designs include some kind of digital control. State triggering on the digital control can be accomplished using the 27 parallel bits of state trigger, while the analog input of the oscilloscope can probe analog or digital signals to be characterized. The 27 bits are for state triggering only and cannot be viewed on the 54200D display.

**Note**

*This section discusses the various modes and triggering techniques in a tutorial manner, therefore it is advantageous to operate the 54200D while reading this section of the manual.*

### 5-2. STATE TRIGGER MENUS

Two selections, the Assignment menu and the Sequence menu are available in the State Trigger menus. Figure 5-1 is a menu tree showing the selections available from the State Trigger menus. At the end of this section is a quick reference to the State Trigger menus.

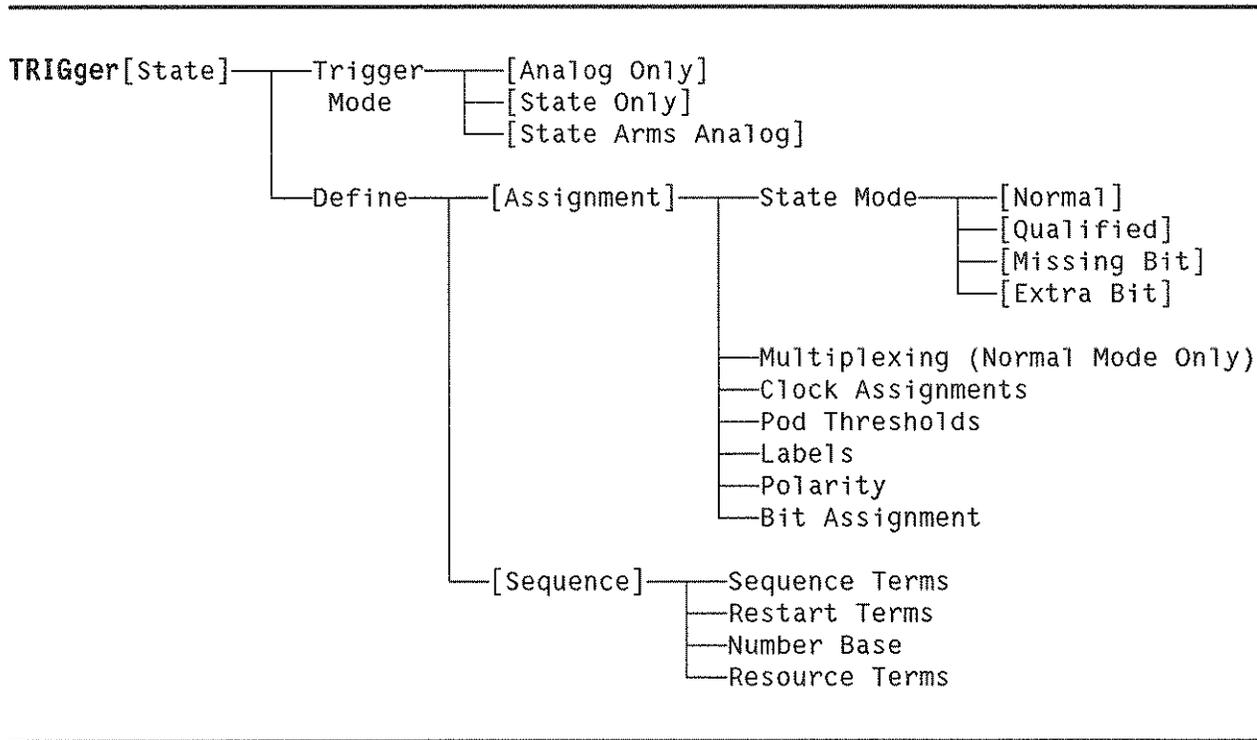


Figure 5-1. State Trigger Menu Tree

### 5-3. STATE TRIGGER INPUTS

The 54200D uses three HP Model 10271A ten-channel probes to input 27 channels of state trigger and three clocks. These inputs can be used in a multiplex configuration when triggering on microprocessor systems with multiplexed buses. To connect these probes to the system under test perform the following:

1. Snap on the adapters for each of the general purpose probe pods.
2. Connect the line for each probe bit to monitor a node in the system under test. Leave extra lines unconnected. Do not connect signals with different threshold levels (some TTL and some ECL, for example) in the same probe pod.
3. Connect the ground probe from each pod to a ground point in the system under test.

### 5-4. STATE TRIGGER ASSIGNMENT MENU

The state trigger must monitor inputs from the digital system under test in exactly the same manner as the digital system interprets the outputs/inputs. Therefore, the clock assignments and voltage thresholds utilized by the system must also be used by the 54200D state trigger. The type of information is specified in the oscilloscope state trigger Assignment menu. The Assignment menu is also used to group incoming channels and assign labels (names) to the groups. Assigning labels to groups (such as address, data, and status channels) makes state triggering much easier for the user to interpret.

To display the default state trigger Assignment menu, set the 54200D power to off, then set the power to on while holding down any front panel key (key-down power-on). This presets the 54200D to a known setup. Press the TRIG menu key. This is the menu for setting up the oscilloscope analog trigger (conventional oscilloscope triggering). The blinking cursor should be in the Analog field. Press the NEXT or PREV key to display the trigger STATE menu. The display should appear as shown in figure 5-2.

### 5-5. Trigger Mode Assignment

Move the blinking cursor to the Trigger Mode field and press the NEXT or PREV key to cycle through the three trigger mode options. Trigger mode determines whether the instrument will trigger on the conditions specified in the analog trigger submenu [Analog only], or will trigger on the conditions set up in state trigger submenus [State only], or whether the state conditions will first be found and then used to arm the analog trigger [State Arms Analog]. This trigger mode field is also present in the State Trigger Sequence menu.

### 5-6. State Mode Assignment

Move the blinking cursor to the State Mode field and press the NEXT or PREV key to cycle through four state modes that are available.

*[Normal]*. State patterns up to 27 channels wide may be defined as trigger qualification. Up to four unique state patterns can be qualified on, in a user-defined sequence. This mode is identical to that of state triggering in the HP 1630 and HP 1631 Logic Analyzers.

**[Qualified].** When in the qualified mode, multiplexing is automatically turned on. In addition, the state sequence search does not begin until after the qualify clock has occurred. The slave clock is defined as the qualify clock. All other operation is identical to the [Normal] mode.

**[Missing Bit].** This mode predefines the last state in the sequence to detect a missing bit in a string of serial data and triggers the acquisition.

**[Extra Bit].** This mode predefines the last state in the sequence specification to detect an extra bit in a string of serial data and triggers the acquisition.

With Missing Bit and Extra Bit modes, the J clock is used to define the reference time interval or cell for which a missing or extra bit will be checked. The serial data is input as the L clock.

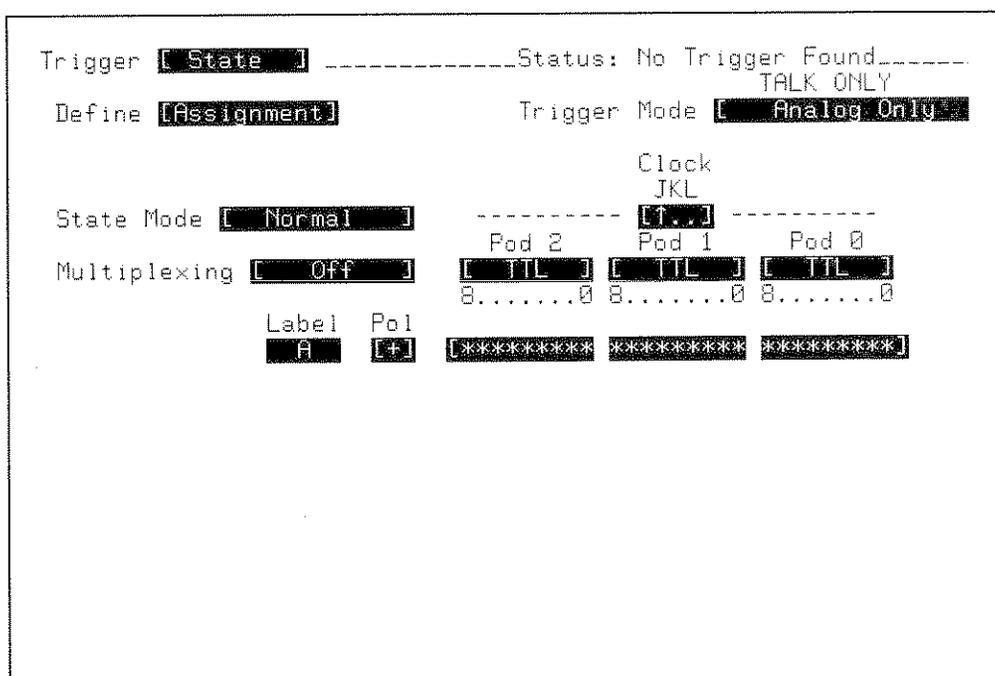


Figure 5-2. State Trigger Default Menu

### 5-7. Clock Assignments

The 54200D state trigger must recognize data (input patterns) on the same clock edge as the system under test. Three ORed clocks are available in the state trigger Assignment menu. The default clock assignment specifies to monitor input data on the positive edge of the J clock. Other clock specifications may be made by moving the cursor to the ORed clock field on the Assignment menu and using the NEXT or PREV key to select different clocks and edges.

## 5-8. Multiplex Assignment

Some digital systems may use multiplexing in which certain signal lines are used for different information at different times. For example, data bits and address bits may be multiplexed on the same pins of the microprocessor. The oscilloscope state trigger can demultiplex these lines. To set the multiplexing mode on, move the cursor to the Multiplexing field in the state trigger Assignment menu and press the NEXT or PREV key. The slave clock latches in information from Pod 1 and Pod 2, while the master clock latches in information from Pod 0. On the occurrence of master clock, both sets of information are checked for pattern recognition and correct sequence occurrence. Therefore, the master clock must follow the slave clock. To select clock assignments, move the cursor to the clock field and use the NEXT or PREV keys. Rising edge, falling edge, either edge, or inactive (.) may be selected for the J, K, and L clocks.

## 5-9. Threshold Assignments

Input threshold levels can be selected for each pod. The threshold is selected by moving the cursor into the field under an individual pod and selecting TTL, ECL, or absolute voltages between -9.9 V and +9.9 V.

### Note

*All probe connections within a pod are assigned the same threshold level.*

## 5-10. Label Assignments and Polarity

Move the cursor to the Label field in the state trigger Assignment menu. A message will momentarily appear on the display screen indicating a new label may be added. Press the INSERT key and a new label field will be added. Labels are entered with numeric keys and/or the blue shift key and the alphabetic characters. Labels are deleted by pressing the DELETE key (shift INSERT) when the blinking cursor is on the line of the label to be deleted.

### Note

*When operating in the Missing Bit or Extra Bit state modes, only one label field may be assigned.*

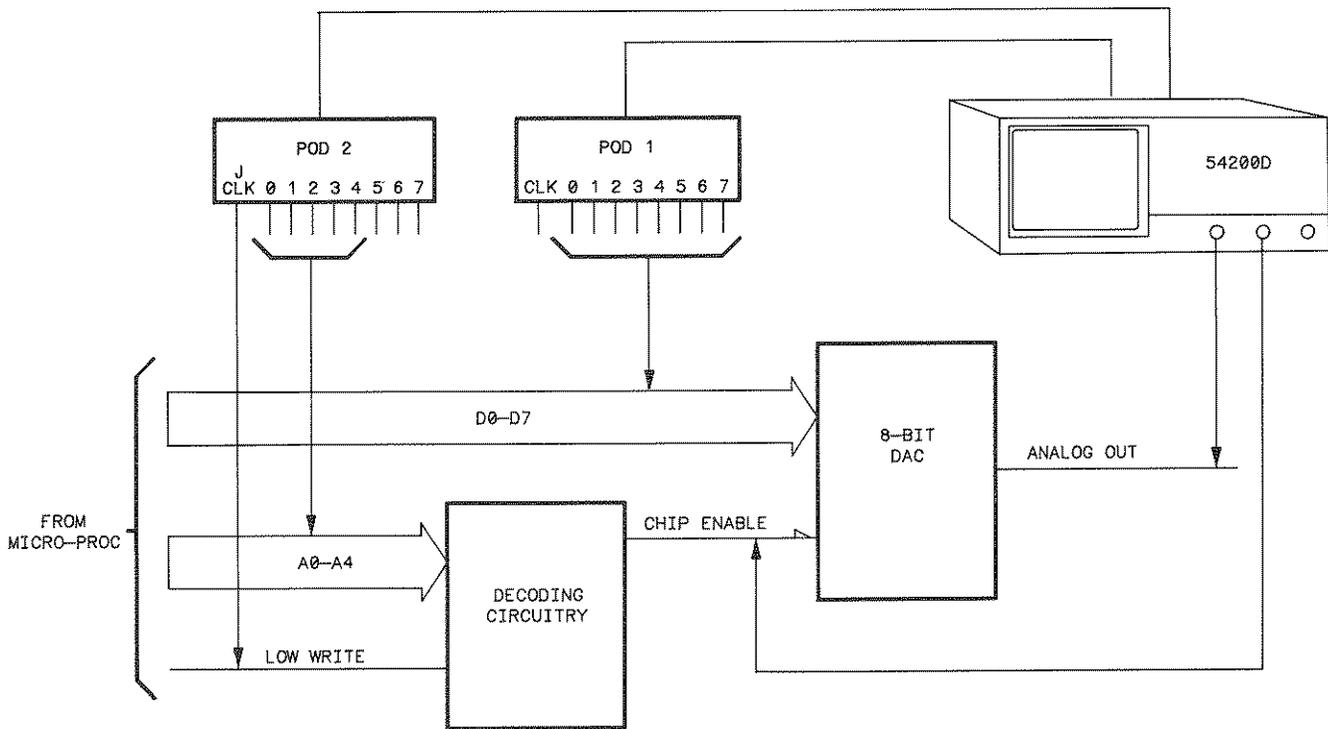
Notice the Pol (polarity) field to the right of the Label field. By using the NEXT or PREV key, + or - may be selected to indicate whether a voltage above the threshold voltage is to be defined as a 1 or a 0. A + in this field indicates voltages above the threshold are 1 and voltages below the threshold are 0. Choosing - defines the opposite polarity.

The asterisk field to the right of the Pol field assigns which input probes will be active for each label field. An "\*" designates that input bit as active. A "." designates that input bit as inactive or ignored, and is referred to as a "masked off" bit. To assign status to an input bit, press the NEXT or PREV key while in the asterisk field.

### Note

*The bits assigned to labels need not be physically adjacent. For example, bit 2 in Pod 0 could be combined with bit 5 in Pod 2 for assignment of a single label consisting of the two probe channels.*

To clarify what we have covered so far, let's consider a specific example. Assume that you want to trigger when a certain word is written to a DAC. Assume also that this is an 8-bit DAC with a 5-bit address bus decoded to select the DAC chip select input. In the state trigger Assignment menu, select the Trigger Mode to be [State Only], the State Mode to be [Normal], and Multiplexing to be [Off]. One of the clock lines should be connected to an I/O write control line for the microprocessor. In this example (figure 5-3), the rising edge of the J clock from Pod 2 has been assigned as the state clock. Move the blinking cursor down to the first label field and change the label to "ADDR". To assign the lower five bits of Pod 2 to monitor the 5-bit address bus, move the cursor into the asterisk field and press the NEXT or PREV key until only the last five bits of Pod 2 have an "\*", while all other bits of Pod 0, 1, and 2 have a "." assigned. Placing a "." in the field is called masking off, or ignoring, a bit. While the cursor is on the top Label line, press the INSERT key to create a new Label assignment line. Label this line "DATA" and mask off all bits except the last eight bits of Pod 1. The state trigger Assignment menu should now be completely set up to define the inputs as shown in figure 5-4. The actual trigger conditions required are defined by the state trigger Sequence menu. This menu is discussed in the next section.



B5420012

Figure 5-3. Example Normal Mode State Triggering Setup

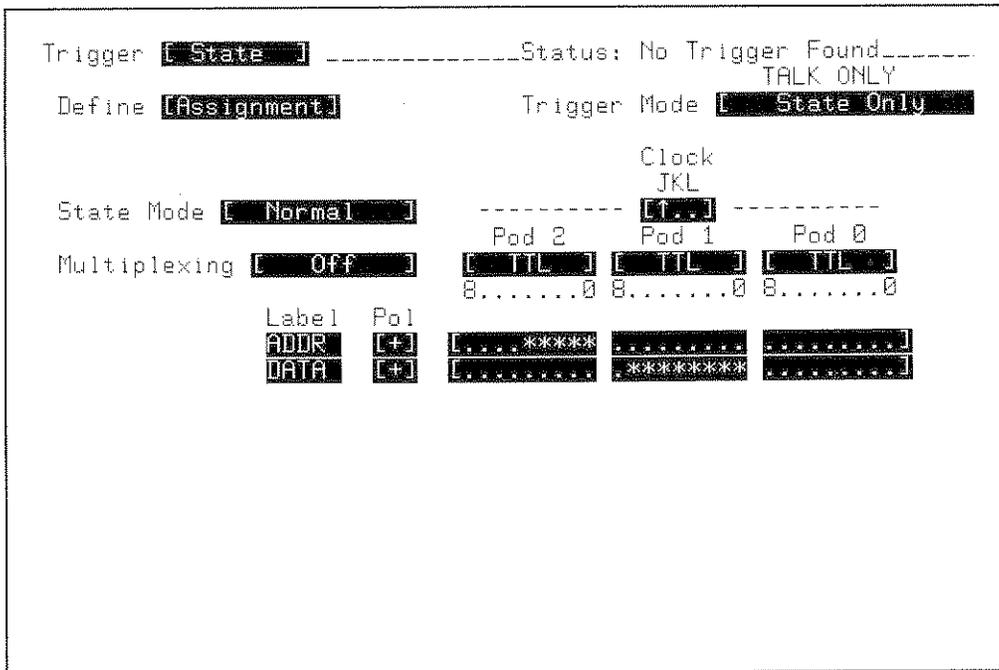


Figure 5-4. State Trigger Assignment Menu Setup

### 5-11. STATE TRIGGER SEQUENCE MENU

The state trigger sequence specification determines the conditions under which the state trigger will cause the oscilloscope to trigger acquisition of data. With the state trigger Assignment menu setup as specified in the preceding example, move the cursor to the Define Assignment field and press the NEXT or PREV key to display the Define Sequence menu.

### 5-12. Trigger Mode Assignment

Move the blinking cursor to the Trigger Mode field. Press the NEXT or PREV key to cycle through the three trigger mode selections and note the change in the sequence specification. In trigger mode [State Only] the state condition specified will trigger the oscilloscope acquisition. In the [State Arms Analog] mode, state conditions and sequences must first be satisfied, and then the analog trigger (Channel 1, Channel 2, or External) will trigger the oscilloscope acquisition. In the [Analog Only] mode, state conditions and sequences will "Do Nothing" as the sequence specification states. In the Analog Only mode, triggering is totally dependent upon analog inputs as in a conventional oscilloscope. The Trigger Mode field is also present in the state trigger Assignment menu. Return the Trigger Mode to [State Only].

### 5-13. Resource Terms

There are four resource terms from which state patterns may be specified; a, b, c, and d. For each label field specified in the Assignment menu, a corresponding column will be positioned next to the resource terms. When defining the resource terms, each term is an ANDed function of each column. For convenience, the user may specify the resource terms in any combination of the four value bases, hexadecimal, binary, octal, and decimal. Move the cursor to the Base field under one of the columns labeled "ADDR" or "DATA" and cycle through the four selections by pressing the NEXT or PREV key.

**Note**

An "X" specifies a "don't care" state, while a "\$" specifies an undefined state. "Don't cares" in one value base cannot always be translated to another base; when this happens a "\$" is displayed.

To make this easier to understand, specify the base for each column to be [BIN] (binary). "ADDR" should be 5 bits wide and "DATA" should be 8 bit wide as previously specified in the Assignment menu. For our example, assume the DAC address is 11001 and that we desire to trigger the oscilloscope on various inputs written to the DAC, while monitoring the DAC analog output with the oscilloscope analog inputs. Move the cursor to the field to the right of the resource terms "a" and specify the "ADDR" as 11001 by using the numeric key pad. Move the cursor to the "DATA" field of resource term "a" and specify all 8 bits as 0's.

**Note**

If a "don't care" bit is inadvertently changed to a 1 or a 0, change it back by pressing the DON'T CARE key (shift CLEAR ENTRY).

Move the cursor to the "ADDR" column of the "b" resource term and specify the bits as 11001. Move the cursor to the "DATA" column of the "b" resource terms and specify all 8 bits as 1's. Move the cursor to the "ADDR" field of resource term "c" and specify the bits as 11001, but leave the "DATA" field of resource term "c" as don't cares. Move the cursor to the "ADDR" column of resource term "d" and specify the bits as 11001. Move the cursor to the "DATA" column of resource term "d" and specify the bits as 10000000. The resource definitions should now appear as shown in figure 5-5.

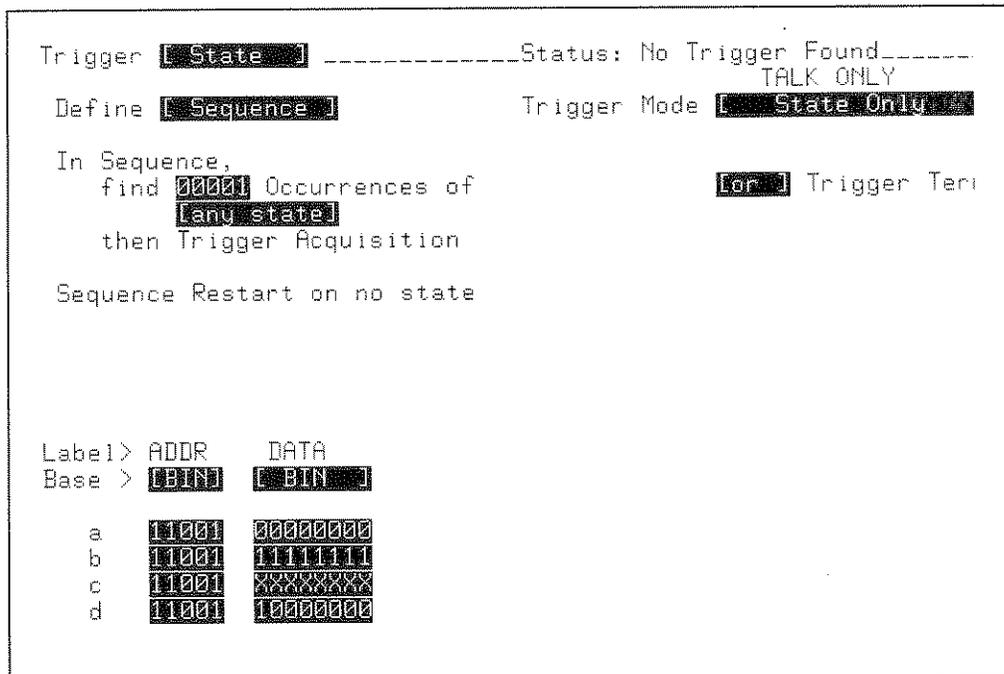


Figure 5-5. Sequence Menu Resource Definitions

## 5-14. State Sequence Specification

The Sequence Specification may consist of up to 4 sequence terms with the last term occurring up to 59999 times. In addition, the last term may be an ORed or ANDed combination of up to 4 individual terms. Sequence Restart may be specified and can consist of up to four ORed terms.

Move the blinking cursor into the sequence specification so that it is in the field labeled [any state]. This is the trigger term which is the last term in a possible of 4 sequence terms. The sequence specification should presently be setup to trigger the acquisition after finding one occurrence of [any state]. States are checked on the edge of the clock specified in the Assignment menu, or when multiplexing, the master clock. In this example, a trigger will be generated on each positive transition of the J clock input.

Press the NEXT key one time to display [a]. The oscilloscope will now trigger whenever state pattern "a" is found. As we have defined resource term "a", this will occur each time the DAC is written to with all zeros on the data bus. The DAC is written to any time 11001 is present on the decoding circuitry input when the J clock goes high.

Press the NEXT key again to display [b]. The oscilloscope will now trigger each time all ones are written to the DAC as defined by resource term "b".

Press the NEXT key again to display [c]. The oscilloscope will now trigger any time the DAC is written to regardless of what is on the DATA bus, as defined by term "c".

Press the NEXT key again to display [d]. The oscilloscope will now trigger whenever 10000000 is written to the DAC as defined by term "d".

Press the NEXT key again to display [≠a]. This is defined as anything other than term "a". It is not the complement of "a". With this specification, the oscilloscope will trigger anytime other than when the DAC is written to with all zeros.

Continue pressing the NEXT key to cycle through the remaining selections (≠b, ≠c, and ≠d) until term [a] is displayed again. Press the INSERT key once to display a second sequence term, then press the NEXT key to display term [b] as the second term. The oscilloscope is now specified to trigger whenever state pattern "a" or "b" occurs. In our example, the oscilloscope will trigger whenever all zeros or all ones are written to the DAC.

Move the blinking cursor to the Trigger Term field where [or] is displayed. Press the NEXT or PREV key to display [and]. The sequence terms now are an ANDed function of state patterns "a" and "b". For our DAC example, the ANDed function of "a" and "b" can never occur.

Change the sequence terms to [≠a] and [≠b]. This is a valid condition for our example, and is equivalent to saying: trigger on any state other than "a" or "b". If anything other than all zeros or all ones is written to the DAC, the oscilloscope will trigger.

Up to four ORed or ANDed terms may make up the sequence term by pressing the INSERT key while the cursor is on one of the sequence terms. To delete ORed or ANDed terms, move the cursor to the term to be deleted and press the DELETE key (shift INSERT).

For our example, change the sequence term to be [a] only. Move the blinking cursor to the Occurrences field. The last sequence term in the list may be specified to occur up to 59999 times before generating a trigger. To change the number of occurrences, enter the desired value by using the numeric key pad or by pressing the NEXT or PREV key to increment or decrement the value. Specify the number of occurrences to be "4". The oscilloscope will now trigger every fourth time the DAC is written to with all zeros on the data bus.

While the blinking cursor is in the Occurrences field, press the INSERT key. The sequence specification should say: find [a] then Count 4 Occurrences of [a]. This is equivalent to finding 5 occurrences of "a" before triggering the oscilloscope.

Press the INSERT key two more times. The sequence specification should now read: find [a], then [a], then [a] then Count 4 Occurrences of [a]. This is equivalent to finding 7 occurrences of "a" before triggering the oscilloscope. We should now have 4 sequence terms specified, which is the maximum allowed.

Change the second term to [b] and the third term to [c]. The sequence specification should now read: find [a], then [b], then [c] then Count 4 Occurrences of [a] as shown in figure 5-6. Each sequence term must be found before the next sequence term will be searched for. If the sequence of events does not occur as specified in the state trigger sequence specification, then the oscilloscope will not trigger. The oscilloscope will now trigger only after all zeros are written to the DAC, followed by all ones written to the DAC, followed by anything written to the DAC, followed by four more writes to the DAC with all zeros on the data bus.

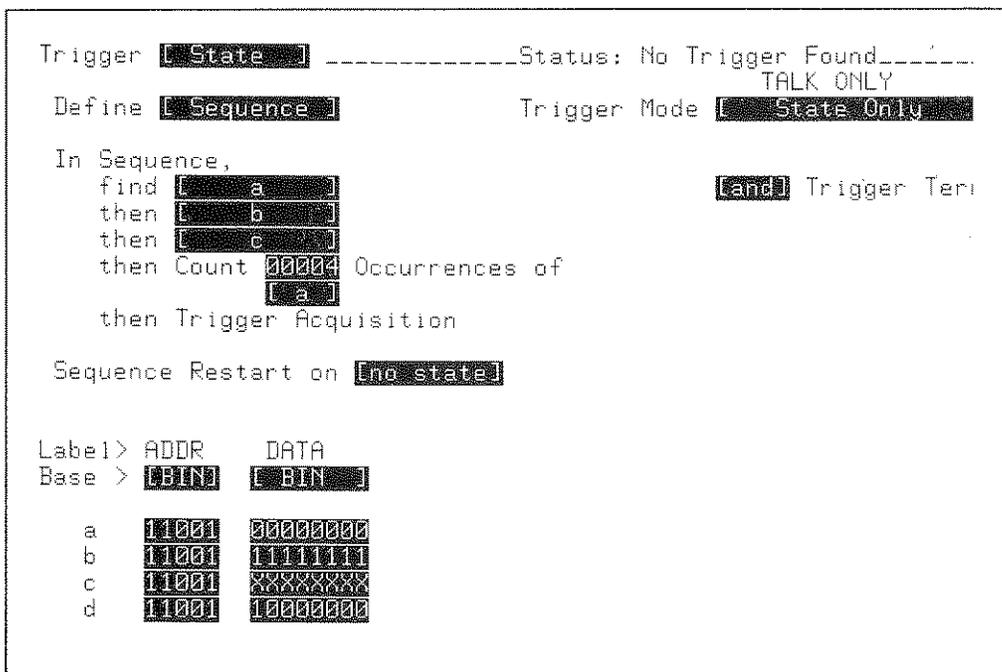


Figure 5-6. State Trigger Sequence Menu

Move the blinking cursor down to the Sequence Restart field. A sequence restart on [no state] is equivalent to not having a restart condition. Cycle through all the possible restart conditions by pressing the NEXT key. A sequence restart on [any state] means that for a sequence specification to generate a trigger, each term in the specification must immediately follow the term before it without a break. For example, with the presently displayed setup, state pattern "b" must be the very next state that is present on the next clock after the initial occurrence of "a", and state pattern "c" must be the very next state that is present on the next clock after the initial occurrence of "b", and so on until the full sequence specification is satisfied.

If the sequence restart term is [no state], state pattern "b" must be the next state after the initial occurrence of "a", but "b" doesn't necessarily have to occur on the next clock cycle; it could occur several clock cycles later.

If a restart condition is encountered, the sequence search starts over beginning with the first sequence term.

**Note**

*When a restart condition is specified, the sequence specification takes priority over the restart condition, and the oscilloscope is triggered if the sequence specification is satisfied.*

The restart term can consist of up to four individual ORed terms. These terms can be entered by pressing the INSERT key while the cursor is in the Sequence Restart field. To delete ORed terms, press the DELETE key.

Specify the restart term to restart on state pattern [d]. The state trigger specification should now appear as shown in figure 5-7. Figure 5-8. shows a flow chart for trigger sequence.

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [ Sequence ]           Trigger Mode [ State Only ]

In Sequence,
  find [ a ]
  then [ b ]
  then [ c ]
  then Count 00004 Occurrences of
         [ a ]
  then Trigger Acquisition

Sequence Restart on [ d ]

Label> ADDR   DATA
Base > [ BIN ] [ BIN ]

a  [ 11001 ] [ 00000000 ]
b  [ 11001 ] [ 11111111 ]
c  [ 11001 ] [ XXXXXXXX ]
d  [ 11001 ] [ 10000000 ]
    
```

Figure 5-7. State Trigger Sequence Menu

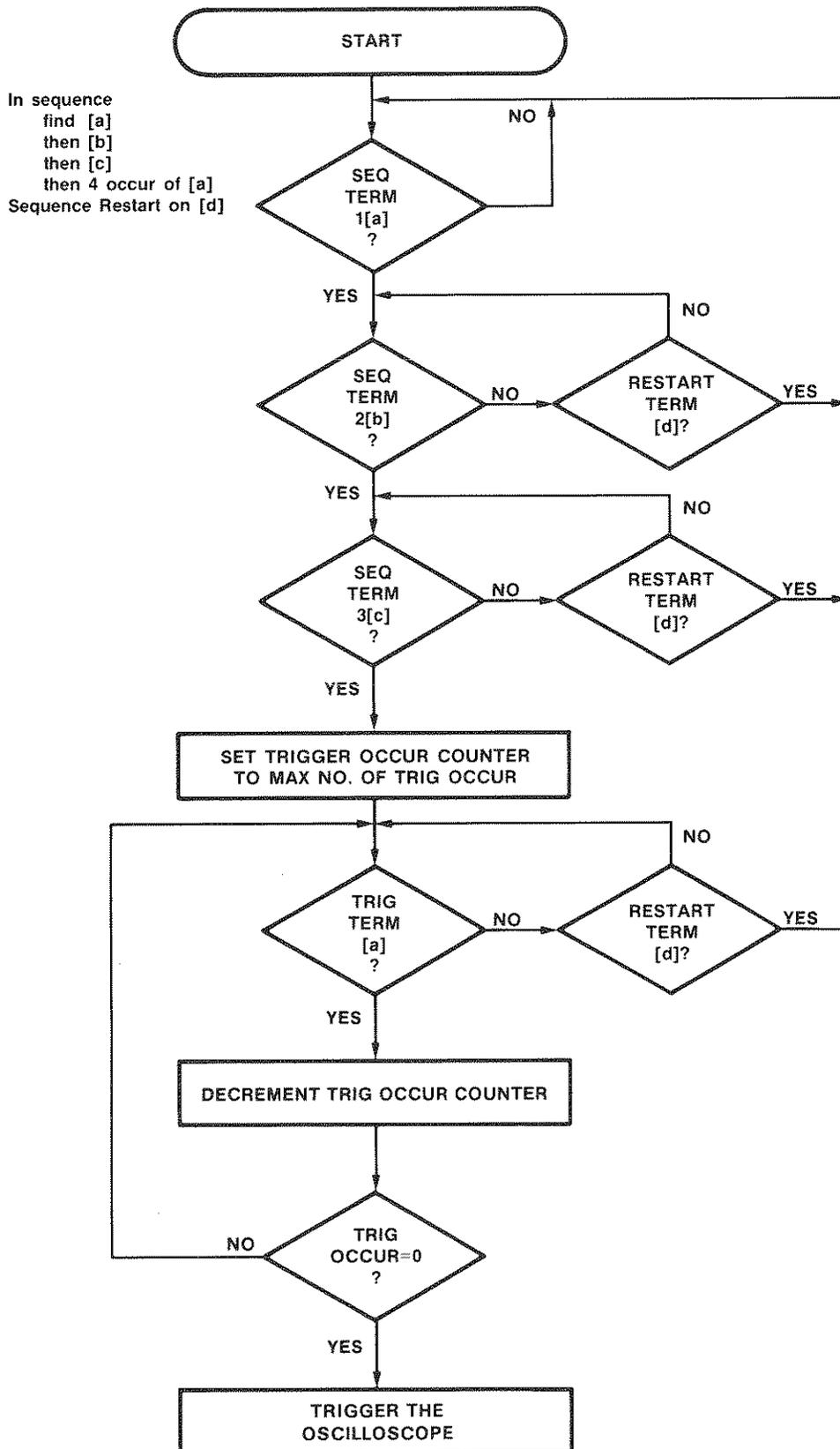


Figure 5-8. State Sequence Triggering Flowchart

### 5-15. USING QUALIFIED MODE FOR "ARMED DIGITAL DELAY"

As discussed in the previous section, specifying a trigger after N occurrences of [anystate] is equivalent to triggering after N occurrences of the clock. For a set of single shot events, this technique allows you to delay by events to a specific event before triggering. For repeated events it may be necessary to arm, or qualify, the start of the delay. This is accomplished by specifying operation in the Qualified state mode, which is selected from the state trigger Assignment menu. The following is a specific example showing how to use the Qualified mode to digitally delay the trigger.

When working with disc drives, it is often necessary to monitor waveforms at any point on a track. This can be accomplished by arming on the index pulse and then counting N number of clock cycles.

Perform a key-down power up reset on the 54200D. This will preset the 54200D to a specific default state. Press the TRIG menu key, then press the NEXT key to display the state trigger Assignment menu. Assign the Trigger Mode as [State Only] and assign the State Mode as [Qualified]. When in the Qualified mode, multiplexing is automatically turned on. Assign the Slave Clock to be the rising edge of K clock and connect the K clock probe of Pod 1 to the index pulse signal on the disc drive unit. Assign the Master Clock to be the rising edge of of the J clock and connect the J clock probe of Pod 0 to the system phase lock loop clock on the disc drive unit. The Assignment menu should now appear as shown in figure 5-9.

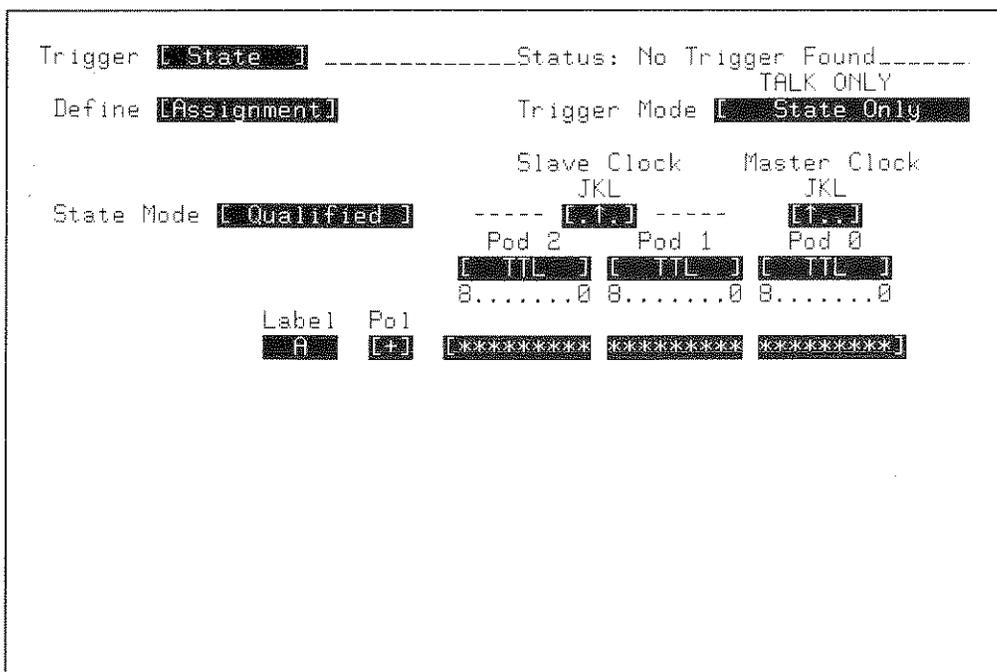


Figure 5-9. Assignment Menu for Digital Delay (Example 1)

Move the blinking cursor to the Define field and press the NEXT key to display the state trigger Sequence menu. Change the number of occurrences to 500. The Sequence menu should now appear as shown in figure 5-10. The 54200D will now trigger after the 500th occurrence of a system clock after the index pulse. Remember, [anystate] is the same as master clock occurrences, which in this example are rising transitions of the J clock, which is connected to the disc drive phase lock loop clock.

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [ Sequence ]           Trigger Mode [ State Only ]

In Sequence, Qualify on Slave Clock then
  find 00500 Occurrences of           [or] Trigger Teri
  [any state]
  then Trigger Acquisition

Sequence Restart on [no state]

Label>   A
Base > [ HEX ]

a [XXXXXXXXXX]
b [XXXXXXXXXX]
c [XXXXXXXXXX]
d [XXXXXXXXXX]

```

Figure 5-10. Sequence Menu for Digital Delay (Example 2)

Even though specifying a digital delay in this manner may at first be somewhat awkward, there are advantages to having it as a part of the state trigger. In addition to qualifying on a slave clock and counting master clocks [anystate], you can also specify within the sequence to find defined states. For example, if the disc drive that you are testing has real time serial to parallel processing, it might be advantageous to find a word identifying a particular sector on the track before counting system clocks. Figure 5-11 and 5-12 show the state trigger Assignment and Sequence menus for an example such as described above. The slave clock is connected to the index pulse, the master clock to the system clock, and data inputs of one of the pods are connected to the parallel bus output of the disc drive unit. State "d" is defined as the sector identification for sector #4. Acquisition is triggered only after finding the index pulse, then sector #4, and finally 200 occurrences of the system clock.

Besides providing a very versatile method of digital delay, the analog inputs of the oscilloscope are free to probe analog signals such as the data being read from the disc (read data), and the differentiated signal of read data. If the digital delay were part of the analog trigger section, the analog inputs would always be connected to digital signals for triggering rather than monitoring the critical analog signals that must be characterized.

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [ Assignment ]           Trigger Mode [ State Only ]

                                     Slave Clock   Master Clock
                                     JKL           JKL
State Mode [ Qualified ] ----- [ ↑ ] ----- [ ↑ ] -----
                                     Pod 2       Pod 1       Pod 0
                                     [ TTL ] [ TTL ] [ TTL ]
                                     0.....0 0.....0 0.....0

Label  Pod
ADDR  [+ ] [.....] [.....] [.....]
    
```

Figure 5-11. State Assignment Menu for Digital Delay (Example 2)

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [ Sequence ]           Trigger Mode [ State Only ]

In Sequence, Qualify on Slave Clock then
  find [ d ] [Or] Trigger Teri
  then Count 0000 Occurrences of
  then Trigger Acquisition
  then Trigger Acquisition
Sequence Restart on [any state]

Label> ADDR
Base > [BIN]

a [0001]
b [0010]
c [0011]
d [0100]
    
```

Figure 5-12. Sequence Menu for Digital Delay (Example 2)

### 5-16. EXTRA BIT AND MISSING BIT MODES

Oscilloscopes have traditionally only been able to trigger on the "known". This is fine when the waveforms under test are predictable. However, when troubleshooting unpredictable waveforms, triggering at the proper time may be difficult or impossible to do with a conventional oscilloscope. Two bit fault modes were implemented within the 27-bit parallel state triggering capability of the 54200D to enable the digitizing oscilloscope to trigger on the "unknown" or fault condition. When the fault occurs, the HP54200D pre-trigger acquisition and built-in measurement capabilities allows you to perform a thorough cause-and-effect analysis of the failure. Through the missing and extra bit triggering modes, the HP54200D can catch intermittent and mysterious hardware failures that might otherwise be overlooked. Bit-fault triggering has numerous applications, especially in detecting faults during digital signal transmission and in disc drive measurements.

### 5-17. The Faults

A missing bit (signal dropout) is the absence of a signal transition within a given time window. This window is referred to as the reference cell. An extra bit (glitch) is the occurrence of two or more transitions within a time window. Figures 5-13 and 5-14 illustrate two examples of these cases.

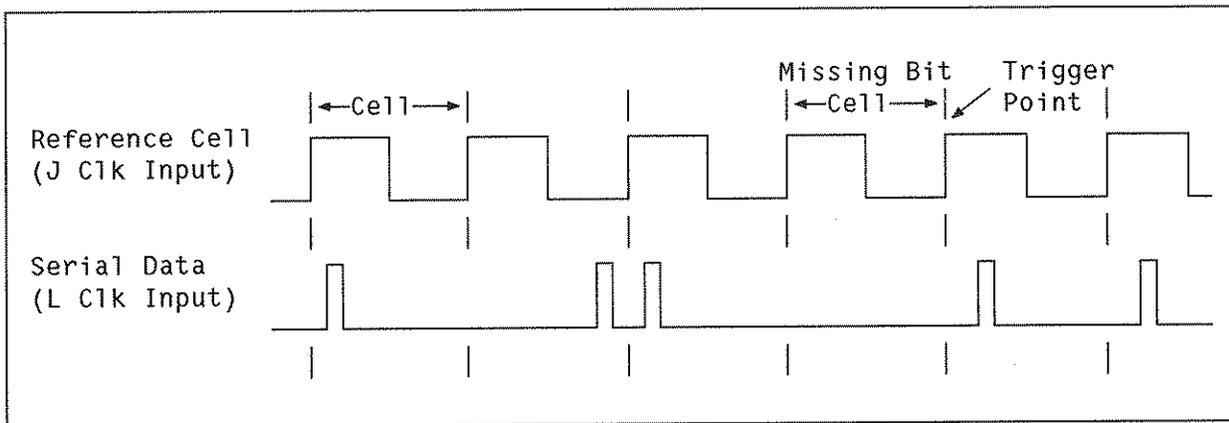


Figure 5-13. Missing Bit Timing Diagram

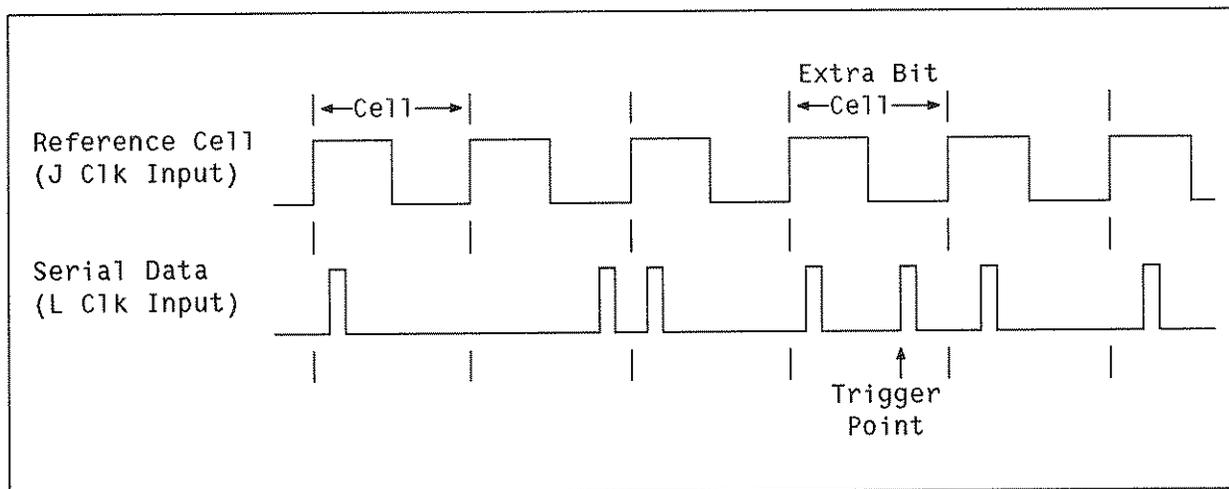


Figure 5-14. Extra Bit Timing Diagram

For the HP54200D to detect a fault, a reference signal and serial data (signal under test) must be applied to the "J" and "L" clock inputs on the oscilloscope state pods. The pod inputs are logic analyzer type triggering probes which are separate from the analog inputs. In the examples shown in figure 5-13 and 5-14, the reference input is a simple repetitive clock with the serial data input being a return-to-zero (RZ) signal. Depending upon the application, various combinations of edge selections can be made defining reference cell boundaries and data transitions. For example, if in the examples of figures 5-13 and 5-14, the serial data was non-return-to-zero (i.e., one transition per reference cell), then the serial data would be specified as both rising and falling edges.

### 5-18. Faulty Serial Data Transmission

Digital signal transmission is simply the transmission of a digital signal from one point to another. The signal may be transmitted over a long transmission line, or simply from the input to output of a logic gate buffer. By defining the input signal as the reference and the output signal as the serial data, the HP54200D can easily detect and trigger on intermittent glitches or dropouts during signal transmission. Two such examples are described in detail below.

### 5-19. Data Transmission Dropout

A microprocessor bus address line was intermittently dropping out at a point several gates away from its source. Through the use of the bit-fault triggering modes of the 54200D, the faulty component was quickly discovered. The intermittent part was an ECL to TTL translator. To detect this failure, the ECL input was defined as the reference cell input with the cell boundaries specified from rising to rising edge. The TTL output was specified as the serial data with data transitions defined as each falling edge. The state trigger setup time specification for the 54200D is 20 ns. When functioning normally, the output of the translator should follow the input with very little delay ( $\ll 20$  ns), therefore the rising edge of the output could not be defined as the data transition. Data transitions can not be within 20 ns of either cell boundary. In this example, the falling edge of the output is not in violation of the setup specification.

Figure 5-15 is a hardcopy output of the input and output signals as acquired by the HP54200D. The top graph shows the ECL input to the translator while the bottom graph shows the TTL output. Between each rising edge of the input (reference cells), the output had one falling edge (serial data), except for the cell shown between the X and O cursors. The TTL output was intermittently dropping out for short durations. By operating in the missing bit mode, the HP54200D detected the drop-out and triggered the oscilloscope on the very next cell boundary (rising edge) of the reference input (top graph, center screen). Figure 5-16 shows the state trigger assignment menu setup, while figure 5-17 shows the sequence specification menu. Triggering on this fault requires only the connection of two state pod inputs and the specifying of edges and trigger levels for these two inputs.

### 5-20. Catching the Glitch

The HP54200D can also easily detect and trigger on a glitch by operating in the extra bit mode. Figure 5-18 shows an example of an ECL output intermittently glitching high. Note that in the reference cell between the X and O cursors, the output has two falling edges. The trigger point is at center screen coincident with the second falling edge (extra bit) of the output signal. The setup for this measurement was identical to that of the dropout example except that the state mode was selected as extra bit rather than missing bit.

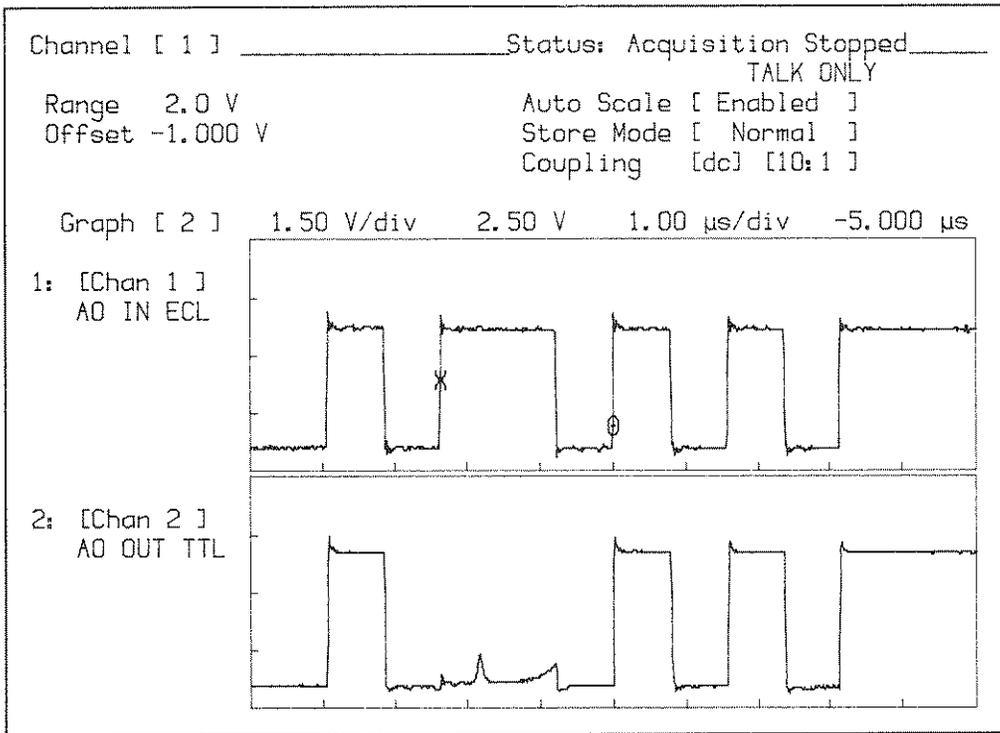


Figure 5-15. Missing Bit (Signal Dropout) Detection

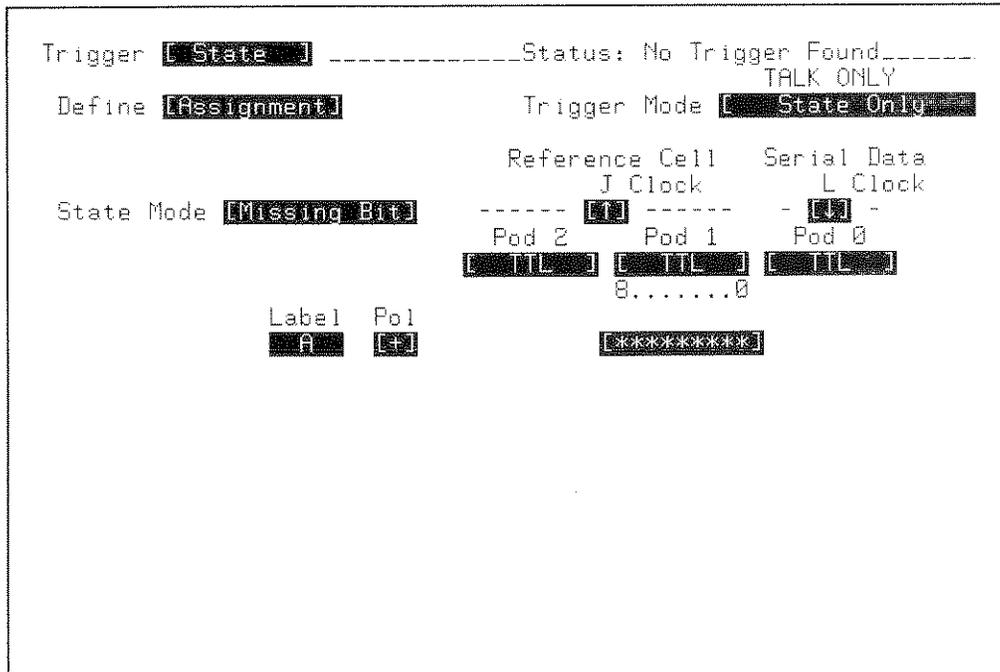


Figure 5-16. State Trigger Assignment Menu

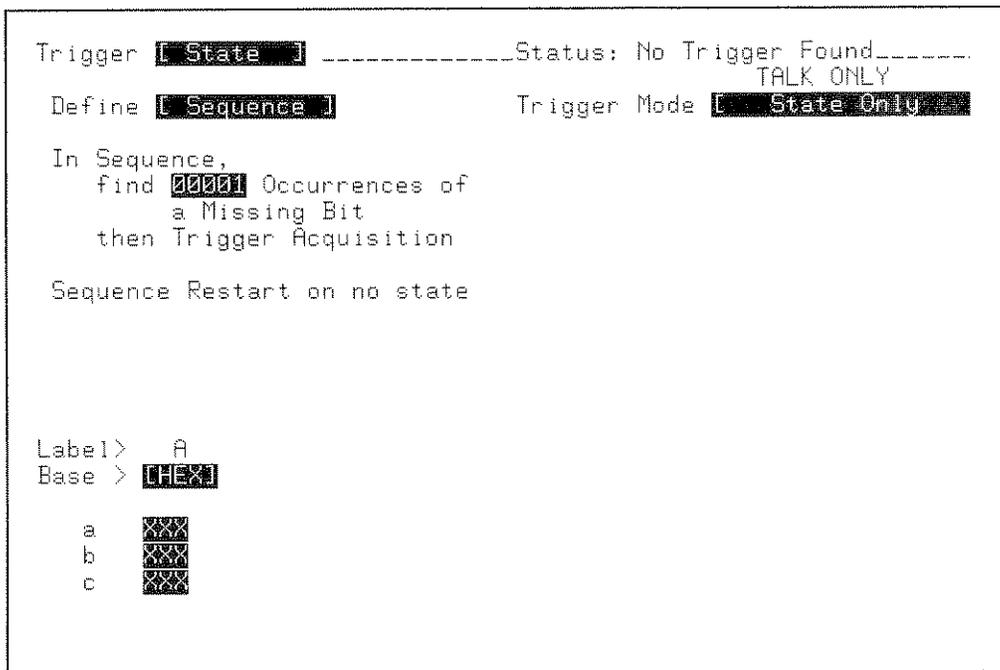


Figure 5-17. State Trigger Sequence Menu

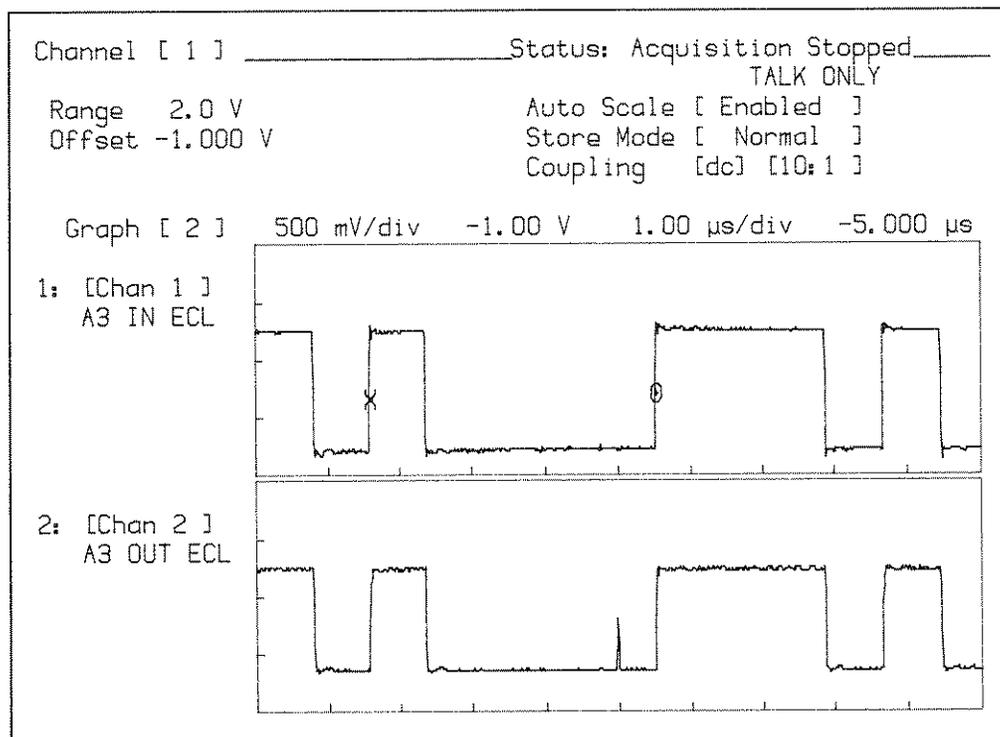


Figure 5-18. Extra Bit (Glitch) Detection

## 5-21. QUICK REFERENCE TO STATE TRIGGER MENUS

The 54200D can trigger on a state condition or arm the analog trigger after a state condition. Select the TRIG State submenu by pressing the TRIG menu key, then move the blinking cursor to the Trigger field and press the NEXT or PREV key until a Trigger State menu appears. This only chooses the state submenu and does not change the trigger from analog to state.

Two selections, the Assignment menu and the Sequence menu, are available in the State Trigger submenu and are selected from the Define field.

## 5-22. State Trigger Assignment Menu

The Assignment function (figure 5-19 and 5-20) assigns information about the pod inputs and how they will be used.

**TRIGGER MODE.** This selection determines whether the instrument will trigger on the conditions specified in the analog trigger submenu (Analog Only), or will trigger on the conditions set up in the state trigger submenu (State Only), or whether the state conditions will first be found and then used to arm the analog trigger (State Arms Analog). This Trigger Mode field is also present in the State Trigger Sequence menu.

**STATE MODES.** Four state modes are available:

**Normal Mode.** The The normal mode provides state triggering with up to four unique state patterns of up to 27 bits each that may be qualified on in a user-defined sequence. The last state can be an ORed or ANDed combination of up to four state patterns and can be specified to occur from one to 59 999 times before satisfying a complete state sequence. Up to four ORed sequence terms allow restarting the complete sequence if the restart term occurs before the proper sequence is completed. Upon satisfying a sequence specification, the 54200D can be defined to trigger immediately, or trigger on the next valid analog trigger.

**Qualified Mode.** The qualified mode enables the user to perform digital delay triggering, which is very useful for triggering on a serial bit string. State sequence search does not begin until after the qualify clock has occurred. The slave clock is defined as the qualify clock. One application involves triggering on the  $n$ th sector pulse on a disc after an index pulse by qualifying on the index pulse, and define the sequence to trigger after the  $n$ th occurrence of any state.

**Missing Bit Mode.** This mode predefines the last state in the sequence specification to detect a missing bit in a string of serial data and triggers the acquisition. A reference clock provided by the user is compared with the input serial data. There must be one data bit transition in the serial data within each reference clock cycle. If the data bit is missing, the 54200D detects it and triggers the acquisition on the next reference clock edge. When in this mode, the last state in the sequence specification can be defined to search for up to 59999 missing bits. The J clock is used to define the reference time interval or cell for which a missing or extra bit will be checked. The serial data is input as the L clock.

**Extra Bit Mode.** This mode predefines the last state in the sequence specification to detect an extra bit in a string of serial data and triggers the acquisition. A reference clock provided by the user is compared with the input serial data. There must be one data bit transition in the serial data within each reference clock cycle. If more than one data bit transition occurs within any reference clock cycle, the 54200D triggers on the extra bit. When in this mode, the last state in the sequence specification can be defined to search for up to 59999 extra bits. As in the Missing Bit mode, the J clock is used to define the reference time interval or cell for which a missing or extra bit will be checked. The serial data is input as the L clock.

**CLOCKS.** Three ORed clocks operate in a single-phase or two-phase demultiplexing mode. Clock edges can be selected as positive, negative, or both positive and negative for each clock. Different edge selections may be made on the same clock if it is used in each phase of the multiplexed mode. The specified clock edge determines when the data on the state channels is clocked into the instrument for trigger comparisons.

**POD THRESHOLDS.** The comparator thresholds for each of the pods may be set to a level suitable for TTL, ECL, or may be user-defined in volts.

**MULTIPLEXING.** The clocks may be multiplexed in Normal mode for use with microprocessors that multiplex their data and address lines.

**LABELS.** Up to eight different five-character labels may be designated in Normal and Qualified mode for any combination of input lines for ease in setting specifications. Missing-bit mode and Extra-bit mode only allow one label. To enter a label, use the alphabetic characters provided when the shift key is active. To obtain more labels, move the blinking field cursor to the first label field, then press INSERT. To remove a label, move the blinking field cursor to that label and press DELETE (shift INSERT).

**POL.** This field selects logic polarity. Selecting plus (+) indicates positive logic; voltages above the threshold are logic 1 and voltages below the threshold are logic 0. Selecting minus (-) indicates negative logic; voltages above the threshold are logic 0 and voltages below the threshold are logic 1.

**POD ASSIGNMENT.** This field assigns a particular state channel to a grouping defined by the label. An asterisk (\*) means the channel is active. A period (.) means the channel is not part of that grouping.

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [Assignment]           Trigger Mode [ Analog Only ]

                               Slave Clock   Master Clock
                               JKL          JKL
State Mode [ Qualified ]     ----- [1..] ----- [1..]
                               Pod 2       Pod 1       Pod 0
                               [ TTL ] [ TTL ] [ TTL ]
                               B.....0 B.....0 B.....0

Label  Pol
  A    [+ ] [*****] [*****] [*****]
    
```

Figure 5-19. Example State Trigger Assignment Menu (Qualified Mode)

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [Assignment]           Trigger Mode [ Analog Only ]

                               Reference Cell  Serial Data
                               J Clock        L Clock
State Mode [ Missing Bit ]   ----- [1] ----- [1] -
                               Pod 2       Pod 1       Pod 0
                               [ TTL ] [ TTL ] [ TTL ]
                               B.....0
                               [*****]

Label  Pol
  A    [+ ]
    
```

Figure 5-20. Example State Trigger Assignment Menu (Missing-bit Mode)

### 5-23. State Trigger Sequence Menu

The Sequence function (figure 5-21) sets up a sequence of state terms that determines the state trigger condition.

**TRIGGER MODE.** This selection determines whether the instrument will trigger on the conditions specified in the analog trigger submenu (Analog Only), or will trigger on the conditions set up in the state trigger submenu (State Only), or whether the state conditions will first be found and then used to arm the analog trigger (State Arms Analog). This Trigger Mode field is also present in the State Trigger Assignment menu.

**RESOURCE TERMS.** These are defined at the bottom of the state trigger sequence menu. Label> is a carryover from the assignment menu. Base> determines whether the channels grouped under label are expressed in hexadecimal, binary, octal, or decimal format. Four resource terms (a, b, c, and d) may be defined by the user for use in sequence triggering.

**SEQUENCE.** Four user-defined terms (a, b, c, and d), the not equal of those terms, any state, or no state may be used in any combination to define a sequence of events on which to be triggered.

Initially, only one term is shown. To add more terms, move the blinking field cursor to the occurrences field and press INSERT. Up to three more terms may be added. To remove a term, move the blinking cursor to that term and press the DELETE key.

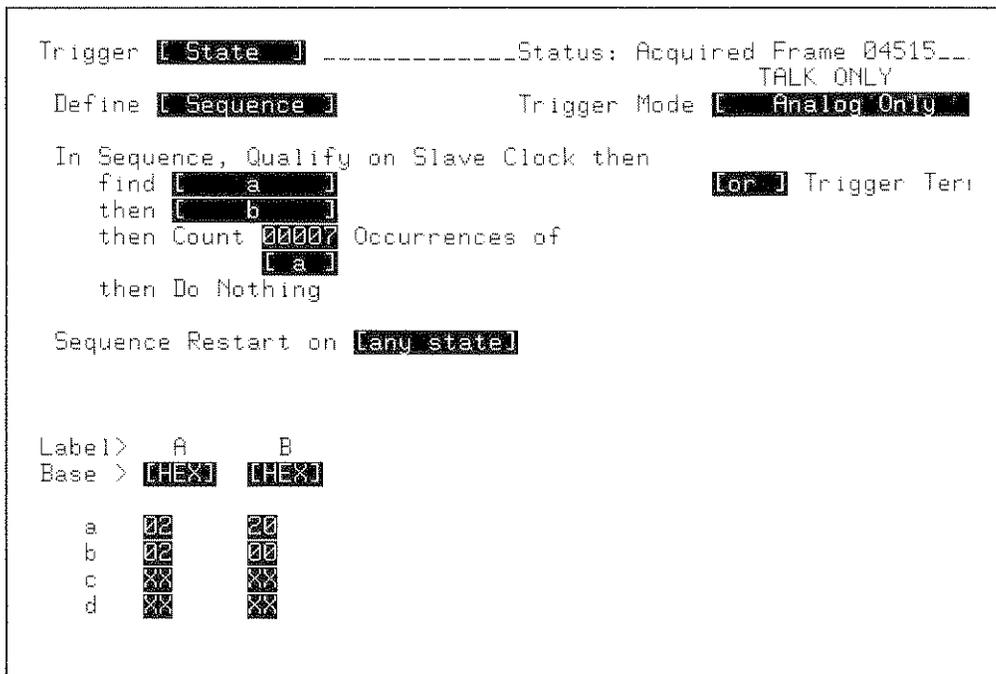


Figure 5-21. Example State Trigger Sequence Menu

**LAST SEQUENCE TERM.** All four resource terms and their not equal terms may be used in any ORed or ANDed configuration to specify the last sequence term. To do this, move the blinking field cursor to the last sequence term (after occurrence specification) and change any state to the desired resource term (either a, b, c, d, ≠a, ≠b, ≠c, or ≠d). For more terms, press INSERT while the blinking field cursor is on the resource term. To remove extra terms, move the cursor to the undesired term and press the DELETE key.

**TRIGGER TERMS.** This entry determines whether the last sequence term will OR or AND the resource terms together.

**OCCURRENCES.** Occurrences of the last event in the sequence may be specified from 1 to 59999 occurrences.

**RESTART.** One to four resource terms may be used in an ORed condition for a sequence restart condition. The sequence restart selection field appears when a resource term is inserted into the sequence.



## SECTION 6

# PERIPHERALS

### 6-1. INTRODUCTION

The 54200A/D has the capability of making a hardcopy dump to various HP-IB graphics printers and plotters without the use of a controller. This section will show you how to use the 54200A/D with a graphics printer or plotter.

### 6-2. SETTING UP THE 54200A/D

When a controller is not connected to the 54200A/D and you want to dump to a graphics printer or plotter, press the front panel SYSTEM menu key. If the Peripherals submenu is not displayed, press the NEXT/PREV key until the Peripherals submenu appears (Figure 6-1). Move the blinking field cursor to the HP-IB Address Mode field and press NEXT/PREV key if Talk Only is not displayed to set address mode to Talk Only.

If a hardcopy dump is desired using a controller, refer to the SYSTEM programming commands PLOT and PRINT in Section 8.

```

System Specification_____Status: Acquired Frame 00481___
                                     TALK ONLY
[ Peripherals ]

HP-IB Address Mode: [ Talk Only ]

Hardcopy Device is: [ Printer ] ( Must Be in LISTEN ONLY Mode

Rear Panel BNC: [ Probe Compensation ( 2 kHz ) ]

Beeper is: [ On ]

Firmware Revision: A2511

Serial Number: 2432A00052

```

Figure 6-1. SYSTEM Peripherals Submenu

### 6-3. GRAPHICS PRINTERS

The 54200A/D will interface directly with graphics printers that use the Hewlett-Packard Raster Graphics Standard and the HP-IB.

Connect the graphics printer to the HP-IB connector on the rear panel of the 54200A/D using an HP-IB interface cable. Before the graphics printer is energized, locate the HP-IB configuration switch on the printer and set the LISTEN ALWAYS (or LISTEN ONLY) switch to the True (1) position (refer to the printer manual). It is important that this switch is set before the power is applied to the printer because most printers only read these switch settings when power is first turned on.

After the printer has been connected to the 54200A/D and the printer configuration switch has been set to LISTEN ALWAYS, press the 54200A/D front panel SYSTEM menu key. Display the Peripherals submenu and move the blinking field cursor to the Hardcopy Device Is field. If Printer is not displayed in this field, press the NEXT/PREV key to display Printer.

The hardcopy function will dump exactly what is displayed on the 54200A/D display. Set up the display exactly as it is to be printed, then press the HARDCOPY (shift TTL) key to print the display. The status line of the display will read "WAIT Hardcopy in Progress". To abort the hardcopy, press the CLEAR ENTRY key. If the printer is not connected or not working properly, the status line of the display will report "WARNING Transmission Aborted" then will display "No Hardcopy Device".

### 6-4. PLOTTERS

The 54200A/D will interface directly with a plotter that uses the Hewlett-Packard Graphics Language (HP-GL) and an HP-IB interface.

Connect the plotter to the HP-IB connector on the rear panel of the 54200A/D using an HP-IB interface cable. Before the plotter is energized, locate the HP-IB configuration switch on the plotter and set the LISTEN ALWAYS (or LISTEN ONLY) switch to the True (1) position (refer to the plotter manual). It is important that this switch is set before the power is applied to the plotter because most plotters only read these switch settings when power is first turned on.

After the plotter has been connected to the 54200A/D and the plotter configuration switch has been set to LISTEN ALWAYS, press the 54200A/D front panel SYSTEM menu key. Display the Peripherals submenu and move the blinking field cursor to the Hardcopy Device Is field. If Plotter is not displayed in this field, press the NEXT/PREV key to display Plotter.

The hardcopy function will dump exactly what is displayed on the 54200A/D display. Set up the display exactly as it is to be plotted, then press the HARDCOPY (shift TTL) key to plot the display. The status line of the display will read "WAIT Hardcopy in Progress". To abort the hardcopy, press the CLEAR ENTRY key. If the plotter is not connected or not working properly, the status line of the display will report "WARNING Transmission Aborted" then will display "No Hardcopy Device".

## **SECTION 7**

# **REMOTE CONTROL**

### **7-1. REMOTE OPERATION, HEWLETT-PACKARD INTERFACE BUS**

The 54200A/D can be operated through the Hewlett-Packard Interface Bus (HP-IB). Menu functions (except protect status on memories), remote only functions, and most front panel functions (except the LINE switch and cursor functions), are programmable through the HP-IB. Bus compatibility, programming, and data format are described in the following paragraphs.

The notation used in this section to describe bus communications is defined at the end of this section in the Notation Conventions and Definitions paragraph.

In this manual, the 54200A/D program codes are listed in ASCII code. Table 7-1, Commonly Used Code Conversions, includes a listing of ASCII characters and some commonly used equivalent codes.

For more information about HP-IB, refer to IEEE Std 488-1978 (or the identical ANSI Standard MC1.1), "IEEE Standard Digital Interface for Programmable Instrumentation" and IEEE Std 728-1982 "IEEE Recommended Practice for Code and Format Conventions".

### **7-2. HP-IB COMPATIBILITY**

The 54200A/D complete bus compatibility as defined in IEEE Std 488-1978 is presented in Table 7-2.

The programming capability of the instrument is further described by the twelve HP-IB meta messages in the left hand column of table 7-2. Foremost among these is the Data message. Data messages contain the program codes that set the instrument mode of operation.

### **7-3. HP-IB STATUS DISPLAY**

The status of the 54200A/D on the HP-IB is annunciated on the CRT by an HP-IB status message. This message describes the 54200A/D remote/local status, address status, and whether or not the instrument is requesting service via the SRQ bus control line.

Table 7-1. Commonly Used Code Conversions

HP-IB	ASCII	Decimal	Binary	Octal	Hexa- decimal	HP-IB	ASCII	Decimal	Binary	Octal	Hexa- decimal			
Addressed Command Group (ACG)	GTL	NUL	0	00 000 000	000	00	Talk Address	T0	@	64	01 000 000	100	40	
		SOH	1	00 000 001	001	01	T1	A	65	01 000 001	101	41		
		STX	2	00 000 010	002	02	Group (TAG)	T2	B	66	01 000 010	102	42	
	SDC PPC	ETX	3	00 000 011	003	03	Note 2	T3	C	67	01 000 011	103	43	
		EOT	4	00 000 100	004	04		T4	D	68	01 000 100	104	44	
		ENQ	5	00 000 101	005	05		T5	E	69	01 000 101	105	45	
		ACK	6	00 000 110	006	06		T6	F	70	01 000 110	106	46	
		BEL	7	00 000 111	007	07		T7	G	71	01 000 111	107	47	
		GET TCT	BS	8	00 001 000	010		08	T8	H	72	01 001 000	110	48
			HT	9	00 001 001	011		09	T9	I	73	01 001 001	111	49
	LF		10	00 001 010	012	0A	T10	J	74	01 001 010	112	4A		
	VT		11	00 001 011	013	0B	T11	K	75	01 001 011	113	4B		
	Universal Command Group (UCG)	LLO	FF	12	00 001 100	014	0C	T12	L	76	01 001 100	114	4C	
			CR	13	00 001 101	015	0D	T13	M	77	01 001 101	115	4D	
			SO	14	00 001 110	016	0E	T14	N	78	01 001 110	116	4E	
SI			15	00 001 111	017	0F	T15	O	79	01 001 111	117	4F		
DCL PPU		DLE	16	00 010 000	020	10	T16	P	80	01 010 000	120	50		
		DC1	17	00 010 001	021	11	T17	Q	81	01 010 001	121	51		
		DC2	18	00 010 010	022	12	T18	R	82	01 010 010	122	52		
		DC3	19	00 010 011	023	13	T19	S	83	01 010 011	123	53		
		DC4	20	00 010 100	024	14	T20	T	84	01 010 100	124	54		
		NAK	21	00 010 101	025	15	T21	U	85	01 010 101	125	55		
		SYN	22	00 010 110	026	16	T22	V	86	01 010 110	126	56		
SPE SPD		ETB	23	00 010 111	027	17	T23	W	87	01 010 111	127	57		
		CAN	24	00 011 000	030	18	T24	X	88	01 011 000	130	58		
		EM	25	00 011 001	031	19	T25	Y	89	01 011 001	131	59		
		SUB	26	00 011 010	032	1A	T26	Z	90	01 011 010	132	5A		
	ESC	27	00 011 011	033	1B	T27	[	91	01 011 011	133	5B			
	FS	28	00 011 100	034	1C	T28	\	92	01 011 100	134	5C			
	GS	29	00 011 101	035	1D	T29	]	93	01 011 101	135	5D			
RS	30	00 011 110	036	1E	T30	^	94	01 011 110	136	5E				
US	31	00 011 111	037	1F	UNT	_	95	01 011 111	137	5F				
Listen Address Group (LAG) Note 1	L0	SP	32	00 100 000	040	20	Secondary Command Group (SCG) Note 3	S0	.	96	01 100 000	140	60	
	L1	!	33	00 100 001	041	21	S1	a	97	01 100 001	141	61		
	L2	"	34	00 100 010	042	22	S2	b	98	01 100 010	142	62		
	L3	#	35	00 100 011	043	23	S3	c	99	01 100 011	143	63		
	L4	\$	36	00 100 100	044	24	S4	d	100	01 100 100	144	64		
	L5	%	37	00 100 101	045	25	S5	e	101	01 100 101	145	65		
	L6	&	38	00 100 110	046	26	S6	f	102	01 100 110	146	66		
	L7	'	39	00 100 111	047	27	S7	g	103	01 100 111	147	67		
	L8	(	40	00 101 000	050	28	S8	h	104	01 101 000	150	68		
	L9	)	41	00 101 001	051	29	S9	i	105	01 101 001	151	69		
	L10	*	42	00 101 010	052	2A	S10	j	106	01 101 010	152	6A		
	L11	+	43	00 101 011	053	2B	S11	k	107	01 101 011	153	6B		
	L12	,	44	00 101 100	054	2C	S12	l	108	01 101 100	154	6C		
	L13	-	45	00 101 101	055	2D	S13	m	109	01 101 101	155	6D		
	L14	.	46	00 101 110	056	2E	S14	n	110	01 101 110	156	6E		
	L15	/	47	00 101 111	057	2F	S15	o	111	01 101 111	157	6F		
	L16	0	48	00 110 000	060	30	S16	p	112	01 110 000	160	70		
	L17	1	49	00 110 001	061	31	S17	q	113	01 110 001	161	71		
	L18	2	50	00 110 010	062	32	S18	r	114	01 110 010	162	72		
	L19	3	51	00 110 011	063	33	S19	s	115	01 110 011	163	73		
	L20	4	52	00 110 100	064	34	S20	t	116	01 110 100	164	74		
	L21	5	53	00 110 101	065	35	S21	u	117	01 110 101	165	75		
	L22	6	54	00 110 110	066	36	S22	v	118	01 110 110	166	76		
	L23	7	55	00 110 111	067	37	S23	w	119	01 110 111	167	77		
	L24	8	56	00 111 000	070	38	S24	x	120	01 111 000	170	78		
	L25	9	57	00 111 001	071	39	S25	y	121	01 111 001	171	79		
	L26	:	58	00 111 010	072	3A	S26	z	122	01 111 010	172	7A		
L27	;	59	00 111 011	073	3B	S27	{	123	01 111 011	173	7B			
L28	<	60	00 111 100	074	3C	S28		124	01 111 100	174	7C			
L29	=	61	00 111 101	075	3D	S29	]	125	01 111 101	175	7D			
L30	>	62	00 111 110	076	3E	S30	~	126	01 111 110	176	7E			
UNL	?	63	00 111 111	077	3F	S31	DEL	127	01 111 111	177	7F			

NOTES: 1. L<n>#MLA assigned to device number <n>.  
 2. T<n> = MTA assigned to device number <n>.  
 3. Meaning defined by Primary Command Group code.

Table 7-2. HP-IB Message Reference Table

HP-IB META MESSAGE	APPLICABLE	INSTRUMENT RESPONSE	RELATED COMMANDS AND CONTROL LINES	INTERFACE FUNCTIONS
Data	Yes	Most front panel, menu, and remote functions. Also all instrument settings may be read via the HP-IB.	DAB EOI EOS MLA UNL MTA UNT OTA	L3 T5
Trigger	Yes	Responds as if the DIGitize system command were issued.	GET MLA	DT1
Clear	Yes	Responds by: * Terminating bus communication * Clearing serial poll bits * Clearing input and output buffers * Clearing error, msg and key queues	DCL SDC	DC1
Remote	Yes	Enabled to remote mode when the REN bus control line is true. However, it remains in local until it is addressed to listen the first time.	REN MLA	RL1
Local	Yes	Returns from remote to local when it receives the Local message or the LOCAL key is pressed. Settings remain unchanged after the remote-to-local transition.	GTL MLA	RL1
Local Lockout	Yes	When in remote, and local lockout is in effect, the front panel is disabled. Only the system controller can return the instrument to local.	LLO	RL1

Table 7-2. HP-IB Message Reference Table (Continued)

HP-IB META MESSAGE	APPLICABLE	INSTRUMENT RESPONSE	RELATED COMMANDS AND CONTROL LINES	INTERFACE FUNCTIONS
Clear Lockout Set/ Local	Yes	Returns to local and local lockout is cleared when the REN bus control line goes false.	REN	RL1
Pass/ Take Control	No	The controller subset is not implemented.	TCT	C0
Require Service	Yes	Sets the SRQ line true when one of the service request conditions occur, if it has been enabled to send the RQS message for that condition.	SRQ	SR1
Status Byte	Yes	Responds to a Serial Poll Enable (SPE) bus command by sending an 8-bit byte when it is addressed to talk. Bit 6 (RQS bit) is true if the 54200A/D has set the SRQ bus control line true. The byte is cleared after it is read by the HP-IB controller if the RQS bit was set.	SPE SPD STB	T5
Status Bit	Yes	Responds to a parallel poll.	PPE PPC PPD PPU	PP1
Abort	Yes	Is unaddressed to listen or talk.	IFC	T5 L3
<p>1. Commands, Control lines and Interface functions are defined in IEEE Std 488-1978. Knowledge of these might not be necessary if your controller manual described programming in terms of the twelve HP-IB Messages shown in the left column.</p> <p>2. The 54200A/D Digitizing Oscilloscope complete bus capability as defined in IEEE Std 488-1978 is: SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT1, C0, E1</p>				

## 7-4. REMOTE MODE

### 7-5. Remote Capability

The 54200A/D communicates on the bus in both remote and local modes. In remote, all front panel controls but the LINE switch and the LOCAL and SHIFT keys are disabled. When Local Lockout is in effect, the LOCAL key is also disabled.

The 54200A/D can be addressed to listen or talk while in remote mode. When addressed to listen, the instrument automatically stops talking and responds to DATA messages. When addressed to talk, the instrument stops listening and sends either a Data message (if available) or the Status Byte. Whether addressed or not, the 54200A/D responds to the Local, Local Lockout, Clear Lockout/Set Local, Trigger, Status bit, and Abort Messages and, in addition, the instrument may issue the Require Service message.

### 7-6. Local-to-remote Mode Changes

The 54200A/D switches to remote upon receipt of the Remote message. The Remote message has two parts:

- Remote Enable (REN) bus control line true
- Device listen address (MLA - MY LISTEN ADDRESS) received once while REN true

All instrument settings remain unchanged with the local-to-remote transition. However, the remote-to-local transition does disable the front panel with the exceptions mentioned above. The HP-IB status display will show "Remote" to indicate remote mode.

If the instrument is set to talk-only mode, the local-to-remote transition is inhibited.

## 7-7. LOCAL MODE

### 7-8. Local Capability

In local, the 54200A/D front panel controls are operational. Although it will not respond to input Data messages in local mode, if addressed to talk, the instrument can send Data messages and the Status Byte. Whether addressed or not, the instrument responds to the Remote, Local, Local Lockout, Clear Lockout/Set Local, Trigger, Status bit, and Abort messages. It also can issue the Require Service message in local mode.

### 7-9. Remote-to-Local Mode Changes

The instrument always switches to local from remote whenever it receives the Local message (GTL) or the Clear Lockout/Set Local message. (The Clear Lockout/Set Local message sets the Remote Enable control line (REN) false.) If it is not in Local Lockout mode, the instrument also switches to local when the front panel LOCAL key is pressed.

The instrument settings remain unchanged during remote-to-local transitions except:

- Any data transfers are aborted.
- Screen is turned on.
- DEBug command mode (if on) is turned off.

The "Remote" indication on the HP-IB status display will disappear as the remote-to-local change is made.

## 7-10. LOCAL LOCKOUT

When program control is interrupted, which can happen by returning the instrument to local via the front panel LOCAL key, data or settings could be changed. This would leave the instrument in an unknown state. To prevent this, a local lockout may be used. Local lockout allows return-to-local only under program control.

### Note

*Return-to-local can also be accomplished by turning the instrument off, then on again with the LINE switch. However, this technique has two potential disadvantages:*

- *It defeats the purpose of local lockout (that is, the system controller may lose control of the instrument).*
- *Other HP-IB conditions reset to default states at power-on.*

*SRQ can be asserted to signal cycling the instrument power.*

## 7-11. ADDRESSING

The 54200A/D interprets the byte on the eight bus data lines as an address or a bus command if the bus is in the command mode (Attention control line (ATN) true). In addressable mode, the instrument may be addressed to listen or to talk.

Once addressed to listen, the instrument remains configured to listen until it receives an Abort message (IFC), its own talk address (MTA), or a universal unlisten command (UNL) from the controller. Once addressed to talk, the instrument remains configured to talk until it receives an Abort message (IFC), another instrument talk address (OTA), its own listen address (MLA), or a universal untalk command (UNT). The HP-IB status display indicates on the CRT when the instrument is addressed to talk ("Talk") or addressed to listen ("Listen").

The 54200A/D is shipped from the factory in the addressable mode, with its talk address set to "0" (ie, T0). Refer to Table 7-1 for equivalent address codes. The instrument can also be configured in the talk-only mode. This mode enables limited bus operation without an HP-IB system controller. The instrument address and addressing mode may be displayed or changed from the front panel. Complete instructions for these procedures are given in the Systems Peripherals Submenu paragraph in Section 3 of this manual.

## 7-12. Talk-only Mode

If the instrument is set to talk-only mode, it is always configured as a talker and does not respond to any of the bus messages. This mode must be selected if the 54200A/D is to drive a printer or a plotter without the aid of an HP-IB controller. Refer to Section 6 of this manual for more information on use of the 54200A/D with a printer or plotter.

## 7-13. HP-IB TURN-ON DEFAULT CONDITIONS

Several HP-IB parameters are reset at power-on. However, both the instrument address and addressing mode are preserved in non-volatile memory.

HP-IB parameter default conditions are:

- HP-IB local mode
- Local-lockout cleared
- Unaddressed (if in normal addressing mode)
- Status byte register cleared

## 7-14. DATA MESSAGES

The 54200A/D communicates on the HP-IB primarily with Data messages. The instrument interprets a byte on the eight bus data lines as a Data message when the bus is in the data mode (Attention control line (ATN) false).

The instrument can both receive and send Data messages. Input Data messages include the instrument program commands (device-dependent commands) used to program front panel functions, menu functions, and all remote functions. Output Data messages include instrument status information, the settings of specific functions, measurement results and the Learn String and waveforms.

Of special consideration is the Learn String which can be sent and received by the instrument. It is a binary data string that contains a condensed coding of the entire instrument state. The Learn String is described later in this section and in the descriptions of the "SETup" and "SETup?", programming commands in section 8 of this manual.

## 7-15. RECEIVING THE DATA MESSAGE

The 54200A/D responds to Data messages when it is in the remote mode (REN control line true) and is addressed to listen.

## 7-16. Input Data Message Format

Input Data messages contain a string of device dependent commands (program commands) and an End-of-String (EOS) message. The program codes within a Data message are executed after the EOS message is received. The following format rules must be observed for all input Data messages:

- A linefeed (<LF>) or an EOI are used as the End-of-String (EOS) message. Each Data message must be terminated by a <LF> or by asserting the EOI bus signal line with the last byte in the message.
- The carriage return character (<CR>) is not required before <LF>. Preceding <LF>, <CR> is treated as "no operation" and may be repeated as many times as permitted by the maximum string length limitation.
- When several program commands are sent in a Data message, a semicolon (preferred), or space must be used to separate each program command from each other.
- Multiple arguments for a command must be separated by commas.
- The maximum length of a Data message is 256 characters (including: semicolons, commas, <SP>, <CR>, and <LF>), except those messages that include binary data blocks. Binary data blocks must begin within the first 256 bytes of the data message.

Errors in Data messages syntax are trapped and can be reported via the HP-IB. For details about detecting and reporting format errors refer to the "STatus?" and "ERRor?" programming commands in section 8 of this manual.

## 7-17. Program Order Considerations

Commands are interpreted and setups are changed in the 54200A/D as they are received and found to be syntactically correct. Commands preceding an error in multi-command messages are executed up to the point where the error is detected. This provides consistent operation whether command are sent one per message or several per message.

## 7-18. Program Command Format

Program commands consist of a header followed by a parameter field. Headers may be of a Long or Short (abbreviated) form. This allows the programmer to use full words or abbreviations for program commands. Command arguments can be words, or numbers in most cases. This allows one programmer to generate readable code, and allows another programmer to generate code that is more efficient in the use of space in his computer.

Program Code Parameters may be of four types:

- Strings** - Any collection of ASCII characters excluding quotation marks (decimal 34) surrounded by quotation marks.
- Blocks** - A block of data in formats as defined by IEEE Std 728-1982.
  - #A** - This format is a binary block with the format: <#><A><length word><DAB...DAB>. The length word is a 15 bit binary integer representing the number of DABs. DABs are the data bytes themselves. <#> and <A> are ASCII bytes.
  - #Y** - This format is an ASCII representation of a binary number with the format: <#><Y><DAB...DAB>. All bytes are ASCII.
  - #O** - This format is an ASCII representation of an octal number with the format: <#><O><DAB...DAB>. All bytes are ASCII.
  - #H** - This format is an ASCII representation of a hexadecimal number with the format: <#><H><DAB...DAB>. All bytes are ASCII.
- Numeric** - Any integer (NR1 format), decimal (NR2 format), or exponential value (NR3 format). The character <E> or <e> may be used to delimit the mantissa of exponential parameters. Spaces are not allowed between the <+>, <->, <E>, <.>, or between digits. Refer to figure 8-2 in Section 8 for syntax diagrams of NR1, NR2, and NR3 numeric representations.
- Alpha** - Some commands require or allow alpha arguments such as "ON" or "OFF". These arguments are ASCII strings that start with an alpha character and are followed by printable character except a <SP>, <,>, <.>, <#>, <">, or <\_>.

The general rules of program command format are:

- The 54200A/D sends and receives Data messages in standard 7-bit ASCII code.
- The instrument responds equally to upper and lower case characters.
- Parameter fields containing multiple parameters require a comma (,) to delimit individual parameters.

Errors in Data messages syntax are trapped and can be reported via the HP-IB. For details about detecting and reporting format errors refer to the "STAtus?" and "ERRor?" programming commands in Section 8 of this manual.

## 7-19. SENDING THE DATA MESSAGE.

The 54200A/D can send Data messages in local or remote mode, when it is addressed to talk, or in the talk-only mode.

### Note

*Before the instrument is addressed to talk, the desired output data must be specified with the appropriate input Data message.*

## 7-20. Output Data Message Format

Output Data messages include the settings of individual functions, instrument status information and binary Learn String data. Refer to the "LONGform", "HEADER", and "ARGument" programming commands in Section 8 of this manual for more information on output format selection.

### Note

*Exponential values are sent by the 54200A/D with the ASCII character "E" (upper case) as the separator between the mantissa and the exponent.*

## 7-21. LEARN MODE

If the 54200A/D receives a "SETup?" (Setting query) programming command and is then addressed to talk, it sends the Learn String. The Learn String consists of 990, 8-bit bytes preceded by a <#> <A> <length word> containing information about configuration. This binary data can be stored in the controller memory for future use.

This binary data block can be returned to the 54200A/D by preceding the data blocks with the "SETup" command. Refer to the "SETup" programming command in Section 8 of this manual for more detailed information.

## 7-22. RECEIVING THE CLEAR MESSAGE

The 54200A/D responds to the Clear message <DCL> and Selected Device Clear message <SDC> by:

1. Clearing all serial poll status bits.
2. Clearing the input and output buffers.
3. Clearing the error, msg, and key queues.

## 7-23. RECEIVING THE TRIGGER MESSAGE.

The 54200A/D responds to the Trigger message (<GET> bus command) in the same way that it responds to a DIGitize system command.

## 7-24. RECEIVING THE REMOTE MESSAGE

The Remote message has two parts. First, the remote enable bus control line (REN) is held true, then the device listen address <MLA> is sent by the controller. The 54200A/D is enabled to go into remote when REN goes true but it does not actually switch into remote until addressed to listen the first time. No instrument settings are changed by the transition from local to remote. When actually in remote mode, the instrument displays "Remote" in the HP-IB status display to indicate remote mode.

## 7-25. RECEIVING THE LOCAL MESSAGE

The Local message returns the 54200A/D to front panel control. The local message (GTL bus command) addresses the instrument to listen and then switches it from remote to local mode. The remote indicator ("Remote") in the HP-IB status display will turn off when the Local message is received. No instrument settings are changed by the remote-to-local transition.

Although the Local message returns front panel control, it does not clear local lockout. Unless the instrument receives the Clear Lockout/Set Local message, if local lockout is in effect, it will return to local lockout mode the next time it goes to remote.

## 7-26. RECEIVING THE LOCAL LOCKOUT MESSAGE

The Local Lockout message (LLO bus command) disables the 54200A/D front panel LOCAL key. Local lockout is accepted when the instrument is in either remote or local mode. Afterwards, whenever the instrument is in remote mode, lockout is in effect. While the instrument is in local lockout, the remote-to-local transition can only be made from the system controller by sending the Clear Lockout/Set Local message or the Local message.

## 7-27. RECEIVING THE CLEAR LOCKOUT/SET LOCAL MESSAGE

The Clear Lockout/Set Local message (REN control line false) returns the Measurement System from remote to local mode and clears the local lockout condition. No instrument settings are changed by this message. It is accepted while the instrument is in either remote or local mode. If the instrument is in remote mode, the remote indicator ("Remote") in the HP-IB status display is blanked when the Clear Lockout/Set Local message is received.

## 7-28. RECEIVING THE PASS CONTROL MESSAGE

The 54200A/D does not implement the controller subset, therefore, it does not respond to the Pass Control message.

## 7-29. SENDING THE REQUIRE SERVICE MESSAGE

The 54200A/D sends the Require Service message (by setting the SRQ bus control line and bit 6 of the status byte true) when a previously programmed condition occurs. The instrument can send the Require Service message in either local or remote mode. The Require Service message is cleared when a serial poll is executed by the system controller. During serial poll, the SRQ control line is reset immediately before the instrument places the Status Byte message on the bus. Table 7-3 includes the conditions that can be selected to cause the Require Service message. If no conditions are selected, the Require Service message is disabled.

The 54200A/D indicates having sent the Require Service message by displaying "SRQ" in the HP-IB status display. This indicator is turned off during the serial poll when the SRQ control line is reset.

If the 54200A/D is set to talk-only mode, it cannot send the Require Service message.

### 7-30. SENDING THE STATUS BYTE MESSAGE

The Status Byte message consists of one 8-bit byte in which the bits are set according to the conditions described by Table 7-3. The 54200A/D sends the Status Byte message when it is addressed to talk and it receives the Serial Poll Enable (SPE) bus command from the HP-IB system controller.

If the instrument is set to talk-only mode, it does not respond to the SPE or SPD (Serial Poll Disable) commands and cannot send the Status Byte.

Bits in the status byte are set depending on the instrument state. If a condition occurs that causes one of the bits in the status byte to be set and if its corresponding bit in the RQS mask is set, the Require Service message will be sent.

If the RQS bit is set, indicating that the instrument sent the Require Service message, and a serial poll is executed, all bits in the status byte will be cleared. If the RQS bit is clear and a serial poll is executed, the status byte will be left unchanged.

If a condition that caused one of the bits in the status byte to be set is removed and if the corresponding bit in the RQS mask is clear, the corresponding bit in the status byte will be cleared.

To supplement the information in the Status Byte, the "ERRor" "KEY", "MSG", and "RDY" queries can be used to determine what specific error occurred.

### 7-31. THE STATUS WORD

The instrument status word is a 16-bit integer containing information about the instrument conditions that set the ready bit in the status byte and/or generate a Require Service message. See Tables 7-3 and 7-4 for a description of the bits in the Status Word. The upper 8 bits of the Status Word are known collectively as the ready byte, while the lower 8 bits correspond to the status byte sent during a serial poll.

A companion 16 bit word, the request mask, is used to specify both those conditions in the ready byte that set the ready bit in the status byte, and those conditions in the status byte that generate a Require Service message. The bits in the request mask have the same meanings as those in the instrument status word. The ready bit in the status byte is set when all of the conditions corresponding to bits in the ready mask are true at the same time. This bit is actually set on the transition of the last condition to become true.

The "REQuest" programming command is used to specify the request mask while the "STATus" programming command can be used to read the instrument status word. For more information refer to these two commands in Section 8 of this manual.

### 7-32. SENDING THE STATUS BIT MESSAGE

The 54200A/D responds to a Parallel Poll Enable (PPE) bus command; and send the Status Bit message.

### 7-33. RECEIVING THE ABORT MESSAGE

The Abort message (IFC control line true) halts all bus activity. When the 54200A/D receives the Abort message, it becomes unaddressed and stops talking or listening. The Require Service message and the Status Byte are unaffected by the Abort message.

### 7-34. NOTATION CONVENTIONS AND DEFINITIONS

The following conventions are used in this manual in descriptions of remote (HP-IB) operation:

- < > Angular brackets enclose descriptive words or characters that are used to symbolize a program code parameter or an HP-IB command. For example, <A> represents the ASCII character 'A'.
- ::= "is defined as". For example, <A> ::= <B> indicates that <A> can be replaced by <B> in any statement containng <A>.
- { } When several items are enclosed by braces, one, and only one of these elements must be selected.
- | "or": Indicates a choice of exactly one element from a list. For example, <A>|<B> indicates <A> or <B> but not both.
- ... An ellipsis (trailing dots) is used to indicate that the preceding element may be repeated one or more times.
- [ ] Square brackets indicate that the enclosed items are optional.
- !X!N An exclamation mark used in this form indicates a parameter may be repeated from X up to N times.

The following definitions are used:

- d ::= A single ASCII numeric character, 0-9
- n ::= A single ASCII non-zero, numeric character, 1-9
- <LF> ::= ASCII linefeed (decimal 10)
- <CR> ::= ASCII carriage return (decimal 13)
- <SP> ::= ASCII space (decimal 32)

Table 7-3. The Lower Byte of the Status Word  
(The Status Byte)

BIT	MASK WEIGHT	STATUS BIT CONDITION
7	128	MSG = High indicates that a message was displayed on the status line of the display. A MSG query is used to determine the message code.
6	64	RQS = Requesting service - High indicates that this instrument requested service.
5	32	ERR = Error - High indicates an error occurred. An ERR query is used to determine error code.
4	16	RDY = Ready - High indicates the instrument is ready. This is based on the ready mask. A RDY query is used to determine condition.
3	8	LCL = Local switch or power cycle - High indicates that the instrument has been switched to local from the front panel power was cycled off then on again.
2	4	FPS = Front panel service request - High indicates a front panel key has been pressed. A KEY query is used to determine the key code.
1	2	PWR = Not used, always 0.
0	1	RQC = Request control - Not used, always 0.
<p>Notes: 1. To set the RQS bit and SRQ bus control line true, the condition must be enabled in the RQS mask.</p> <p>2. If no condition is enabled, the 54200A/D can not set the SRQ bus control line nor the RQS bit true. However, bits 2-5 and 7 of the status byte are set to indicate which conditions have occurred.</p>		

Table 7-4. The Upper Byte of the Status Word  
(The Ready Byte)

BIT	MASK WEIGHT	READY BIT CONDITION
15	32768	Not used, always 0.
14	16384	Cal = High indicates that self calibration has completed execution.
13	8192	Test = High indicates that the requested self test has completed execution.
12	4096	Hard = Hardcopy complete - High indicates that the last byte of printer or plotter dump has been sent and received
11	2048	Data = Data available - High indicates that something is in the buffer waiting to be read.
10	1024	Acq = Acquisition complete - High indicates that all waveforms are acquired.
9	512	Trig = Triggered - High indicates that the instrument is receiving triggers.
8	256	Parse = Parse complete - High indicates that the last command has completed parsing.
<p>Note: The Ready bit (bit 4) of the Status Byte (Table 7-3) is set if all of the ready conditions specified in the RQS mask are true.</p>		



## SECTION 8

# PROGRAMMING THE 54200A/D

### 8-1. INTRODUCTION

This section provides instructions to allow you to program the 54200A/D. The 54200A/D is a fully HP-IB bus programmable instrument. Menu functions (except protect status on memories), remote-only functions, and front panel functions (except the line switch and cursor movements) are programmable through the HP-IB.

### 8-2. COMMAND STRUCTURE

The 54200A/D programming commands are divided into three types: system commands, subsystem selectors, and subsystem commands. A programming command tree is shown in figure 8-1, and a programming command cross-reference is shown in table 8-1.

**System commands** control general oscilloscope functions and may be issued at any time. They do not change the subsystem selection.

**Subsystem selectors** are commands that switch from one subsystem to another and are valid at any time with one important exception: certain subsystem selector commands also look like subsystem command parameters. For example the keywords CHANNEL, GRAPH, and TRIGGER are used both as subsystem selectors and as command parameters. Care must be taken to follow the correct rules of syntax and punctuation to avoid creating errors or unwanted results in the program.

The nine subsystems are:

- Acquire
- Channel
- Display
- Graph
- Measure
- State (54200D only)
- Timebase
- Trigger
- Waveform

**Subsystem commands** are legal only when the subsystem has been previously selected and control a particular portion of the oscilloscope, for example the timebase. Only one subsystem may be selected at a time, and any command which is not a system command or a subsystem selector is assumed to be a command for the selected subsystem.

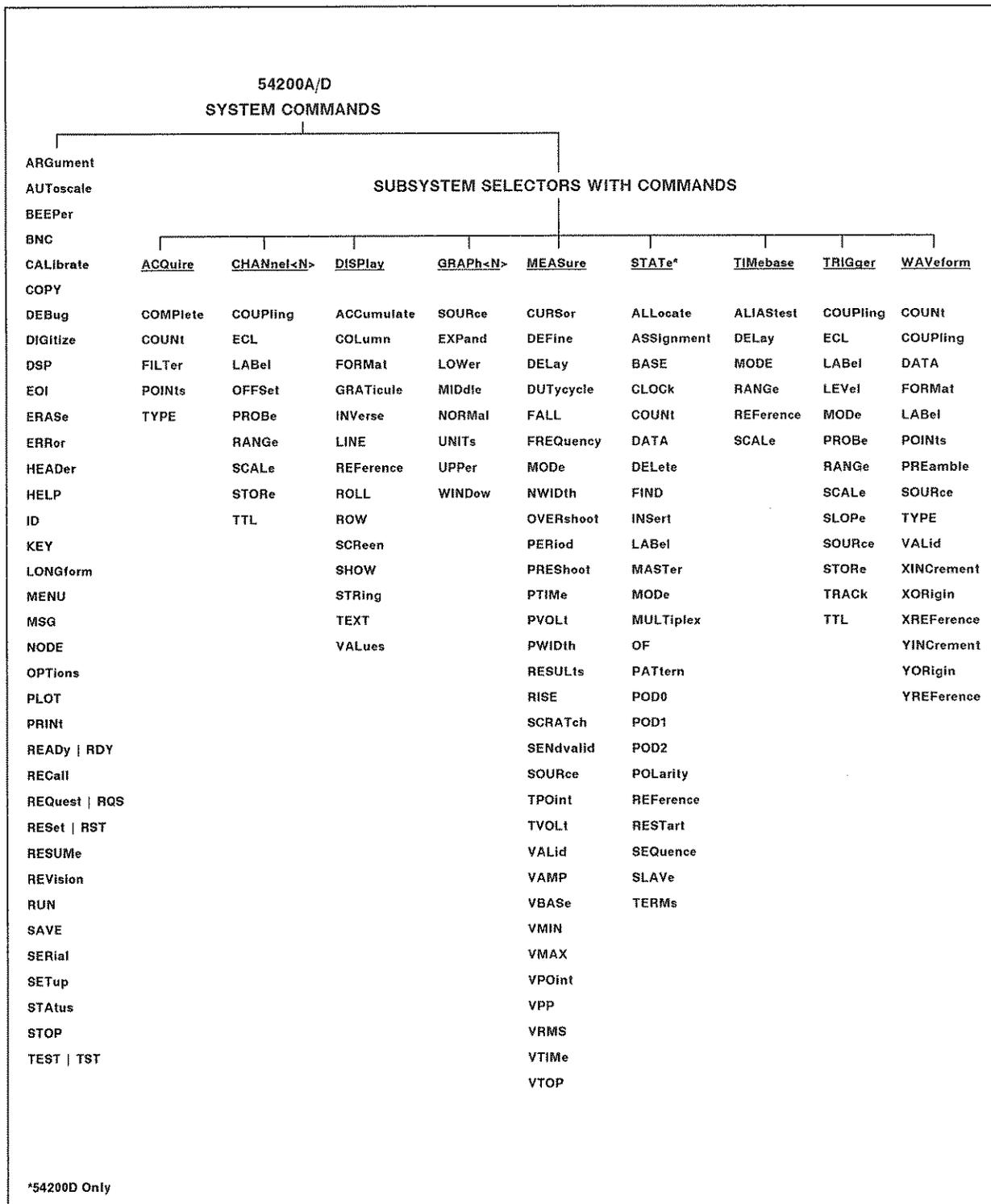


Figure 8-1. Programming Command Tree

Table 8-1. Alphabetical Command Cross-Reference

COMMAND	WHERE USED	COMMAND	WHERE USED	COMMAND	WHERE USED
<b>ACCumulate</b>	Display subsystem	<b>LABel</b>	Channel subsystem	<b>SAVE</b>	System command
<b>ACQuire</b>	Subsystem selector	<b>LABel</b>	State subsystem	<b>SCALE</b>	Channel subsystem
<b>ALIAStest</b>	Timebase subsystem	<b>LABel</b>	Trigger subsystem	<b>SCALE</b>	Timebase subsystem
<b>ALLocate</b>	State subsystem	<b>LABel</b>	Waveform subsystem	<b>SCALE</b>	Trigger subsystem
<b>ARGument</b>	System command	<b>LEVel</b>	Trigger subsystem	<b>SCRATch</b>	Measure subsystem
<b>ASSignment</b>	State subsystem	<b>LINE</b>	Display subsystem	<b>SCReen</b>	Display subsystem
<b>AUToscale</b>	System command	<b>LONGform</b>	System command	<b>SENdvalid</b>	Measure subsystem
		<b>LOWer</b>	Graph subsystem	<b>SEQuence</b>	State subsystem
<b>BASE</b>	State subsystem			<b>SERial</b>	System command
<b>BEEPer</b>	System command	<b>MASTer</b>	State subsystem	<b>SETup</b>	System command
<b>BNC</b>	System command	<b>MEASure</b>	Subsystem selector	<b>SHOW</b>	Display subsystem
		<b>MENU</b>	System command	<b>SLAVe</b>	State subsystem
<b>CALibrate</b>	System command	<b>MIDDLE</b>	Graph subsystem	<b>SLOPe</b>	Trigger subsystem
<b>CHANnel</b>	Subsystem selector	<b>MODE</b>	Timebase subsystem	<b>SOURce</b>	Graph subsystem
<b>CLOCK</b>	State subsystem	<b>MODE</b>	Measure subsystem	<b>SOURce</b>	Measure subsystem
<b>COLUMN</b>	Display subsystem	<b>MODE</b>	State subsystem	<b>SOURce</b>	Trigger subsystem
<b>COMPLETE</b>	Acquire subsystem	<b>MODE</b>	Trigger subsystem	<b>SOURce</b>	Waveform subsystem
<b>COPY</b>	System command	<b>MSG</b>	System command	<b>STATe</b>	Subsystem Selector
<b>COUNT</b>	State subsystem	<b>MULTiplex</b>	State subsystem	<b>STATus</b>	System command
<b>COUNT</b>	Acquire subsystem			<b>STOP</b>	System command
<b>COUNT</b>	Waveform subsystem	<b>NODE</b>	System command	<b>STORe</b>	Channel subsystem
<b>COUPLing</b>	Channel subsystem	<b>NORMAl</b>	Graph subsystem	<b>STORe</b>	Trigger subsystem
<b>COUPLing</b>	Trigger subsystem	<b>NWIDth</b>	Measure subsystem	<b>STRing</b>	Display subsystem
<b>COUPLing</b>	Waveform subsystem				
<b>CURSor</b>	Measure subsystem	<b>OF</b>	State subsystem	<b>TERMs</b>	State subsystem
		<b>OFFSet</b>	Channel subsystem	<b>TEST   TST</b>	System command
<b>DATA</b>	State subsystem	<b>OPTions</b>	System command	<b>TEXT</b>	Display subsystem
<b>DATA</b>	Waveform subsystem	<b>OVERshoot</b>	Measure subsystem	<b>TIMEbase</b>	Subsystem selector
<b>DEBUg</b>	System command			<b>TPOInt</b>	Measure subsystem
<b>DEFine</b>	Measure subsystem	<b>PATtern</b>	State subsystem	<b>TRACK</b>	Trigger subsystem
<b>DELay</b>	Measure subsystem	<b>PERiod</b>	Measure subsystem	<b>TRIGger</b>	Subsystem selector
<b>DELay</b>	Timebase subsystem	<b>PLOT</b>	System command	<b>TTL</b>	Channel subsystem
<b>DELete</b>	State subsystem	<b>POD0</b>	State subsystem	<b>TTL</b>	Trigger subsystem
<b>DIGitize</b>	System command	<b>POD1</b>	State subsystem	<b>TVOLt</b>	Measure subsystem
<b>DISPlay</b>	Subsystem selector	<b>POD2</b>	State subsystem	<b>TYPE</b>	Acquire subsystem
<b>DSP</b>	System command	<b>POINts</b>	Acquire subsystem	<b>TYPE</b>	Waveform subsystem
<b>DUTYcycle</b>	Measure subsystem	<b>POINts</b>	Waveform subsystem		
		<b>POLarity</b>	State subsystem	<b>UNITs</b>	Graph subsystem
<b>ECL</b>	Channel subsystem	<b>PREamble</b>	Waveform subsystem	<b>UPPer</b>	Graph subsystem
<b>ECL</b>	Trigger subsystem	<b>PREShoot</b>	Measure subsystem		
<b>EOI</b>	System command	<b>PRINT</b>	System command	<b>VALid</b>	Measure subsystem
<b>ERASe</b>	System command	<b>PROBe</b>	Channel subsystem	<b>VALid</b>	Waveform subsystem
<b>ERRor</b>	System command	<b>PROBe</b>	Trigger subsystem	<b>VALues</b>	Display subsystem
<b>EXPand</b>	Graph subsystem	<b>PTIME</b>	Measure subsystem	<b>VAMP</b>	Measure subsystem
		<b>PVOLt</b>	Measure subsystem	<b>VBASe</b>	Measure subsystem
<b>FALL</b>	Measure subsystem	<b>PWIDth</b>	Measure subsystem	<b>VMAX</b>	Measure subsystem
<b>FILTer</b>	Acquire subsystem			<b>VMIN</b>	Measure subsystem
<b>FIND</b>	State subsystem	<b>RANGE</b>	Channel subsystem	<b>VPOInt</b>	Measure subsystem
<b>FORMat</b>	Display subsystem	<b>RANGE</b>	Timebase subsystem	<b>VPP</b>	Measure subsystem
<b>FORMat</b>	Waveform subsystem	<b>RANGE</b>	Trigger subsystem	<b>VRMS</b>	Measure subsystem
<b>FREQuency</b>	Measure subsystem	<b>READy   RDY</b>	System command	<b>VTIME</b>	Measure subsystem
		<b>RECall</b>	System command	<b>VTOP</b>	Measure subsystem
<b>GRAPH</b>	Subsystem selector	<b>REFerence</b>	Display subsystem		
<b>GRATicule</b>	Display subsystem	<b>REFerence</b>	State subsystem	<b>WAVeform</b>	Subsystem selector
		<b>REFerence</b>	Timebase subsystem	<b>WINDow</b>	Graph subsystem
<b>HEADER</b>	System command	<b>REQuest   RQS</b>	System command		
<b>HELP</b>	System command	<b>REStart</b>	State subsystem	<b>XINCrement</b>	Waveform subsystem
		<b>RESULts</b>	Measure subsystem	<b>XORigin</b>	Waveform subsystem
<b>ID</b>	System command	<b>RESUMe</b>	System command	<b>XREFerence</b>	Waveform subsystem
<b>INSert</b>	State subsystem	<b>RESet   RST</b>	System command		
<b>INVerse</b>	Display subsystem	<b>REVision</b>	System command	<b>YINCrement</b>	Waveform subsystem
		<b>RISE</b>	Measure subsystem	<b>YORigin</b>	Waveform subsystem
<b>KEY</b>	System command	<b>ROLL</b>	Display subsystem	<b>YREFerence</b>	Waveform subsystem
		<b>ROW</b>	Display subsystem		
		<b>RUN</b>	System command		

### 8-3. COMMAND ABBREVIATIONS

Every command and every alpha parameter has at least two forms, a short form and a long form, although in some cases these are identical. The longform throughout this manual is shown with leading upper case letters and trailing lower case letters. The shortform is only the upper case letters. The short form is obtained by truncating the longform using the following rule:

If the longform has more than 4 characters,  
then if the 4th character is a vowel or the same as the 3rd character,  
then truncate to 3 characters,  
else truncate to 4 characters.

Example - LONGFORM abbreviates to LONG and is shown as LONGform  
REFERENCE abbreviates to REF and is shown as REFERENCE  
STATE abbreviates to STAT and is shown as STATE

In the case where two or more short forms would be identical, all but one is changed slightly to differentiate between the commands. For example RESET is abbreviated to RES, RESUME is abbreviated to RESUM, and RESTART is abbreviated to REST. In the command descriptions that follow, each command is given in both long and short forms.

Some commands also have industry standard forms, such as RQS for REQUEST and RDY for READY. These are also valid forms in the 54200A/D instruction set.

The commands may be executed using either long or short form. When a query is executed and the HEADER command is set ON, the answer returned to the controller will be returned in the long form format if the LONGform command has been set ON and will be returned in short form format if the LONGform command has been set OFF. If the HEADER command is set OFF, neither long nor short form format will be returned to the controller.

### 8-4. ALPHA AND NUMERIC ARGUMENTS

Most of the programming commands that require parameters can use either alpha or numeric arguments as their parameters. For these commands, the syntax of the command gives the relationship between the numeric and alpha arguments.

For example if the syntax of a command is:

```
SCReen { [ OFF | 0 ]  
         [ ON  | 1 ] }
```

executing SCREEN OFF is the same as SCREEN 0 *and*

executing SCREEN ON is the same as SCREEN 1

The commands may be executed using either alpha or numeric arguments. When a query is executed, the answer returned to the controller will be returned in alpha format if the ARGument command has been set to ALPHa and will be returned in numeric format if the ARGument command has been set to NUMERIC.

## 8-5. NOTATION CONVENTIONS AND DEFINITIONS

The following conventions are used in this manual in descriptions of remote (HP-IB) operation:

- < >    Angular brackets enclose descriptive words or characters that are used to symbolize a program code parameter or an HP-IB command. For example, <A> represents the ASCII character 'A'.
- ::=    "is defined as". For example, <A> ::= <B> indicates that <A> can be replaced by <B> in any statement containing <A>.
- { }    When several items are enclosed by braces, one, and only one of these elements must be selected.
- |    "or": Indicates a choice of exactly one element from a list. For example, <A>|<B> indicates <A> or <B> but not both.
- ...    An ellipsis (trailing dots) is used to indicate that the preceding element may be repeated one or more times.
- [ ]    Square brackets indicate that the enclosed items are optional parameters.
- !X!N    An exclamation mark used in this form indicates a parameter may be repeated from X times up to N times.

The following definitions are used:

- d ::= A single ASCII numeric character, 0-9
- n ::= A single ASCII non-zero, numeric character, 1-9
- <LF> ::= ASCII linefeed (decimal 10)
- <CR> ::= ASCII carriage return (decimal 13)
- <SP> ::= ASCII space (decimal 32)

## 8-6. SYNTAX DIAGRAMS

At the beginning of the system command section and each subsystem command section are syntax diagrams showing the proper syntax for each command. All characters contained in a circle or oblong are literals, and must be entered exactly as shown. Words and phrases contained in rectangles are names of items used with the command and are described in the accompanying text of each command. The syntax diagrams show only the alpha argument for each command. Refer to the command text for numeric arguments. Each line can only be entered from one direction as indicated by the arrow on the entry line. Any combination of commands and arguments that can be generated by following the lines in the proper direction is syntactically correct. An argument is optional if there is a path around it. Alpha arguments must be separated with a space; numeric arguments and queries (?) do not require a space.

## 8-7. PROGRAMMING AIDS

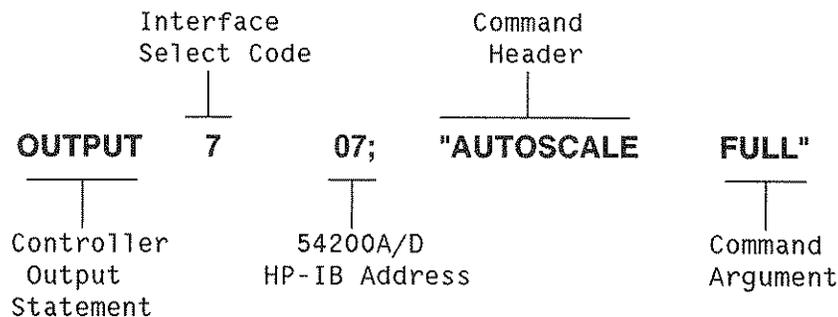
The system DEBUg command helps those who are unfamiliar with the command syntax to find programming errors. When DEBUg ON is issued, each command is shown on the 54200A/D display as the command is received over the HP-IB. The commands are defined as either inputs or outputs and appear within the < > symbols with imbedded carriage returns (CR) and line feeds (LF). The form in which commands are displayed on the 54200A/D is dependent on the current status of the system LONGform, HEADer, and ARGument commands. Spelling and syntax errors can be quickly located and corrected by stepping through a program. If an error occurs, the error is highlighted with an inverse video cursor on the 54200A/D display. An error message is then displayed, followed by message text, on the status line of the 54200A/D.

The system HELP? command returns the entire command set of the 54200A/D organized by subsystem. Refer to the System Command portion of this section for detailed information on this aid.

## 8-8. PROGRAMMING EXAMPLES

All programming examples used in this section are given in HP Series 200 Desktop Computer enhanced BASIC programming language. For all examples, the 54200A/D interface select/address code is set to 707.

The following diagram shows how the commands are sent to the 54200A/D:



## 8-9. DATA OUTPUT (QUERY) FORMAT TO CONTROLLER

If a query command (command followed by "?") is sent to the 54200A/D, a response message is generated and sent back to the controller the next time the 54200A/D is addressed to talk.

The command header will be returned if HEADer command has been set ON and will not be returned if set OFF.

The command argument will be returned as an alpha argument if ARGument command has been set to ALPha and will be returned as a numeric argument if set to NUMeric.

Headers and alpha arguments will be returned in the longform if LONGform command has been set ON and will be returned in the shortform if set OFF.

## 8-10. INPUT DATA FORMAT FROM CONTROLLER

Input Data messages contain a string of device dependent commands (program commands) and an End-of-String (EOS) message. The program codes within a Data message are executed after the EOS message is received. The following format rules must be observed for all input Data messages:

- A linefeed (<LF>) or an EOI are used as the End-of-String (EOS) message. Each Data message must be terminated by a <LF> or by asserting the EOI bus signal line with the last byte in the message.
- The carriage return character (<CR>) is not required before <LF>. Preceding <LF>, <CR> is treated as "no operation" and may be repeated as many times as permitted by the maximum string length limitation.
- When several program commands are sent in a Data message, a semicolon (preferred), or space must be used to separate each program command from each other.
- Multiple arguments for a command must be separated by commas.
- The maximum length of a Data message is 256 characters (including: semicolons, commas, <SP>, <CR>, and <LF>), except those messages that contain binary data blocks. Binary data blocks must begin within the first 256 bytes of the data message.

## 8-11. Program Order Considerations

Commands are interpreted and setups are changed in the 54200A/D as they are received and found to be syntactically correct. Commands preceding an error in multi-command messages are executed up to the point where the error is detected. This provides consistent operation whether command are sent one per message or several per message.

## 8-12. Program Command Format

Program commands consist of a header followed by a parameter field. Headers may be of a Long or Short (abbreviated) form. This allows the programmer to use full words or abbreviations for program commands. Command arguments can be words, or numbers in most cases. This allows one programmer to generate readable code, and allows another programmer to generate code that is more efficient in the use of space in his computer.

Program Code Parameters may be of four types:

- Strings** - Any collection of ASCII characters excluding quotation marks (decimal 34) surrounded by quotation marks.
- Blocks** - A block of data in formats as defined by IEEE Std 728-1982.
  - #A** - This format is a binary block with the format: <#><A><length word><DAB...DAB>. The length word is a 16 bit binary integer representing the number of DABs. DABs are the data bytes themselves. <#> and <A> are ASCII bytes.
  - #Y** - This format is an ASCII representation of a binary number with the format: <#><Y><DAB...DAB>. All bytes are ASCII.
  - #O** - This format is an ASCII representation of an octal number with the format: <#><O><DAB...DAB>. All bytes are ASCII.
  - #H** - This format is an ASCII representation of a hexadecimal number with the format: <#><H><DAB...DAB>. All bytes are ASCII.
- Numeric** - Any integer (NR1 format), decimal (NR2 format), or exponential value (NR3 format). The character <E> or <e> may be used to delimit the mantissa of exponential parameters. Spaces are not allowed between the <+>, <->, <E>, <.>, or between digits. Refer to figure 8-2 for syntax diagrams of NR1, NR2, and NR3 numeric representations.
- Alpha** - Some commands require or allow alpha arguments such as "ON" or "OFF". These arguments are ASCII strings that start with an alpha character and are followed by printable character except a <SP>, <,>, <,>, <#>, <">, or <\_>.

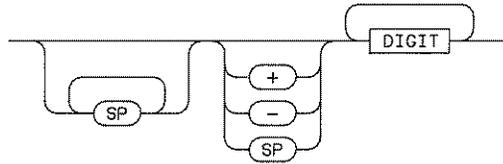
### 8-13. General Program Command Format Rules

The general rules of program command format are:

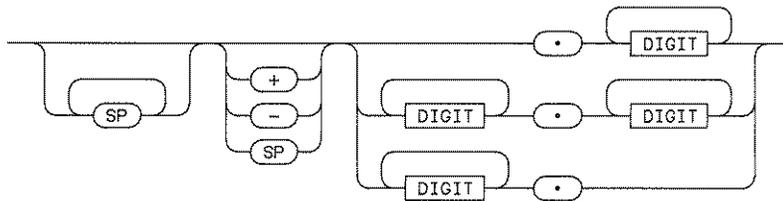
- The 54200A/D sends and receives Data messages in standard 7-bit ASCII code.
- The instrument responds equally to upper and lower case characters.
- The instrument responds equally to longform and shortform command headers and alpha arguments.
- The instrument responds equally to alpha and numeric arguments.
- Parameter fields containing multiple parameters require a comma (,) to delimit individual parameters.
- Alpha enumerated arguments must be separated from the command header with a space; numeric enumerated arguments and queries (?) do not require a space.

Errors in Data messages syntax are trapped and can be reported via the HP-IB. For details about detecting and reporting format errors refer to the system "STatus?" and "ERRor?" programming commands.

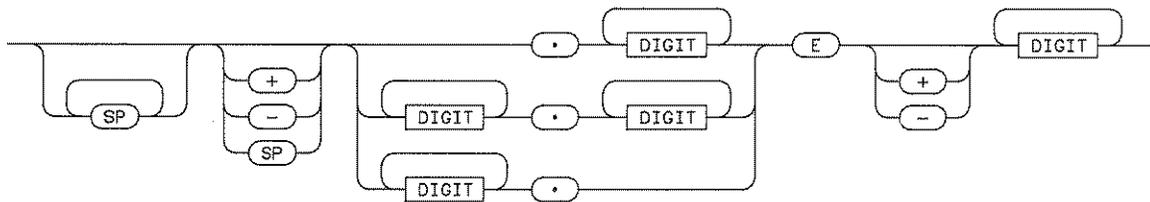
### Integer Format NR1



### Decimal Format NR2



### Exponential Format NR3



85420011

Figure 8-2. Numeric Formats NR1, NR2, and NR3 used in Command Arguments



## SYSTEM COMMANDS

---

System commands provide general utility functions useful in many subsystems, or special functions which are simple to specify. Note the hierarchical structure of the system and subsystem commands that was shown in Programming Command Tree, Figure 8-1.

### SUBSYSTEM SELECTORS

The nine subsystem selectors are commands which allow access to subsystem functions. All have a query form which provides a means to interrogate all settings in that subsystem. Subsystem selectors are:

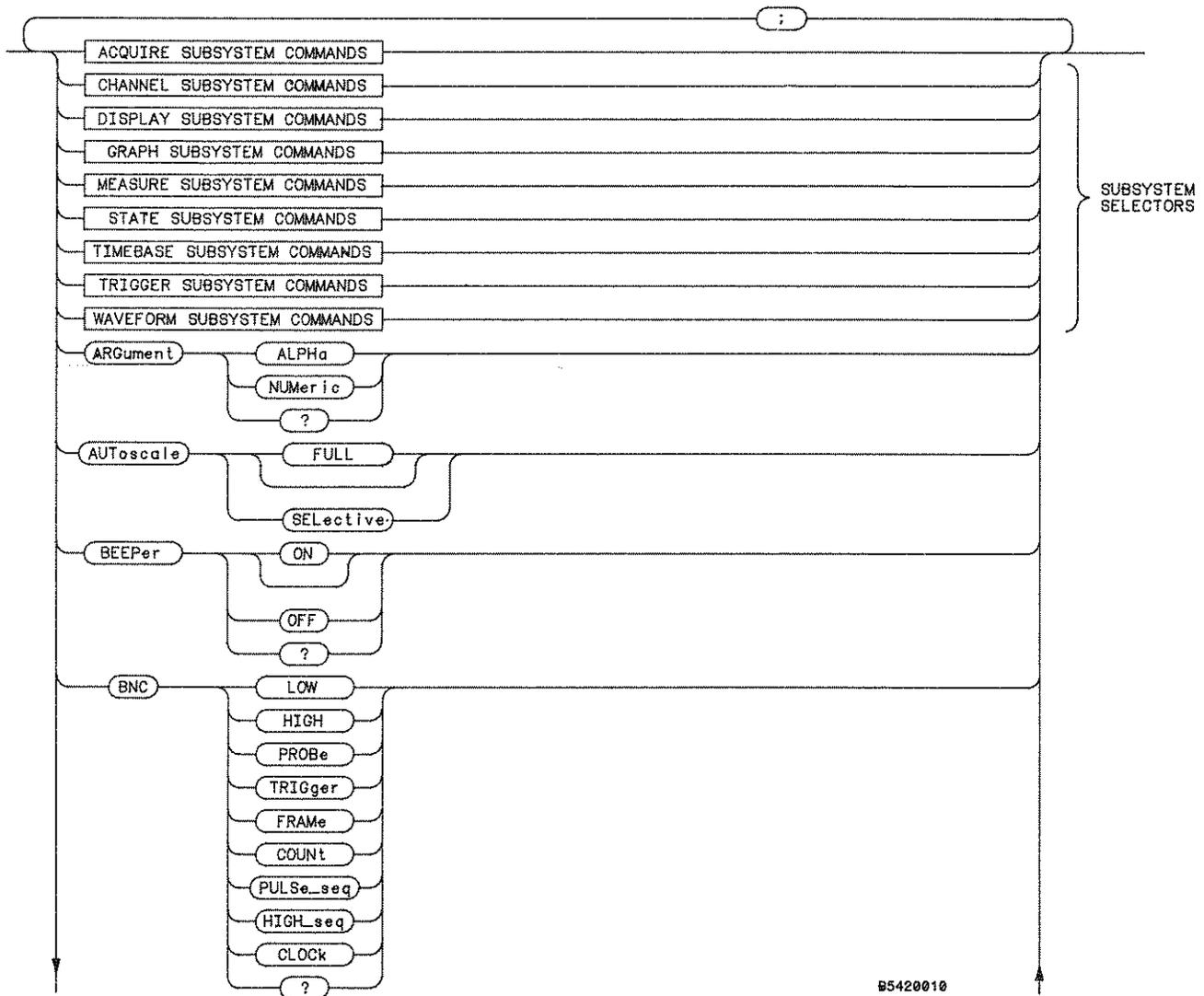
ACQuire  
 CHANnel <N>  
 DISPLay  
 GRAPh <N>  
 MEASure  
 STATe  
 TIMEbase  
 TRIGger  
 WAVEform

These commands are detailed in the corresponding subsystem.

### SYSTEM COMMANDS:

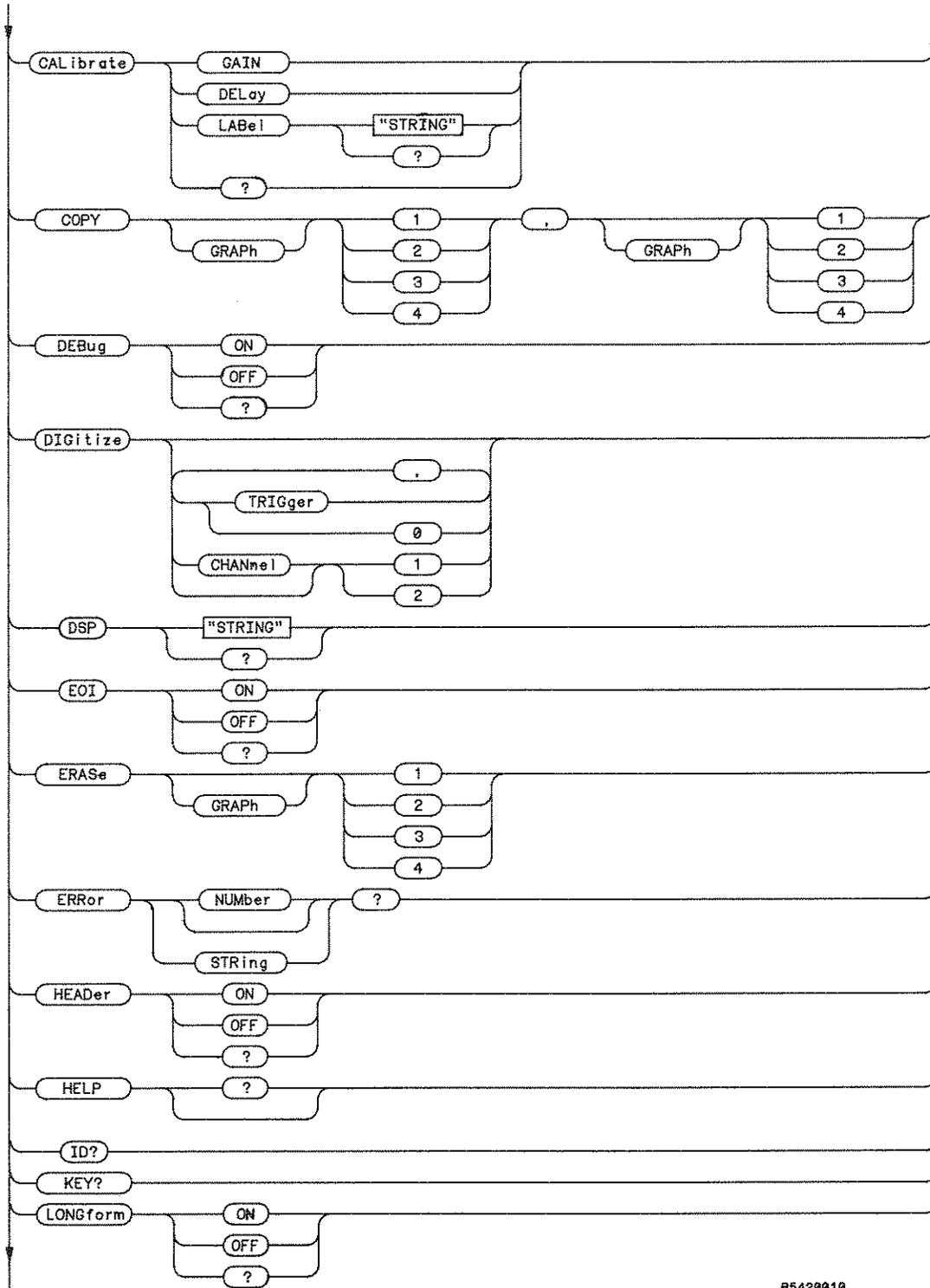
ARGument	MSG
AUToscale	NODe
BEEPer	OPTions
BNC	PLOT
CALibrate	PRINT
COPY	REAdy   RDY
DEBUg	RECa11
DIGitize	REQueSt   RQS
DSP	RESet   RST
EOI	RESUMe
ERASe	REVisiOn
ERRor	RUN
HEADer	SAVE
HELP	SERial
ID	SETup
KEY	STATus
LONGform	STOP
MENU	TEST   TST

# SYSTEM COMMANDS



System Command Syntax Diagram

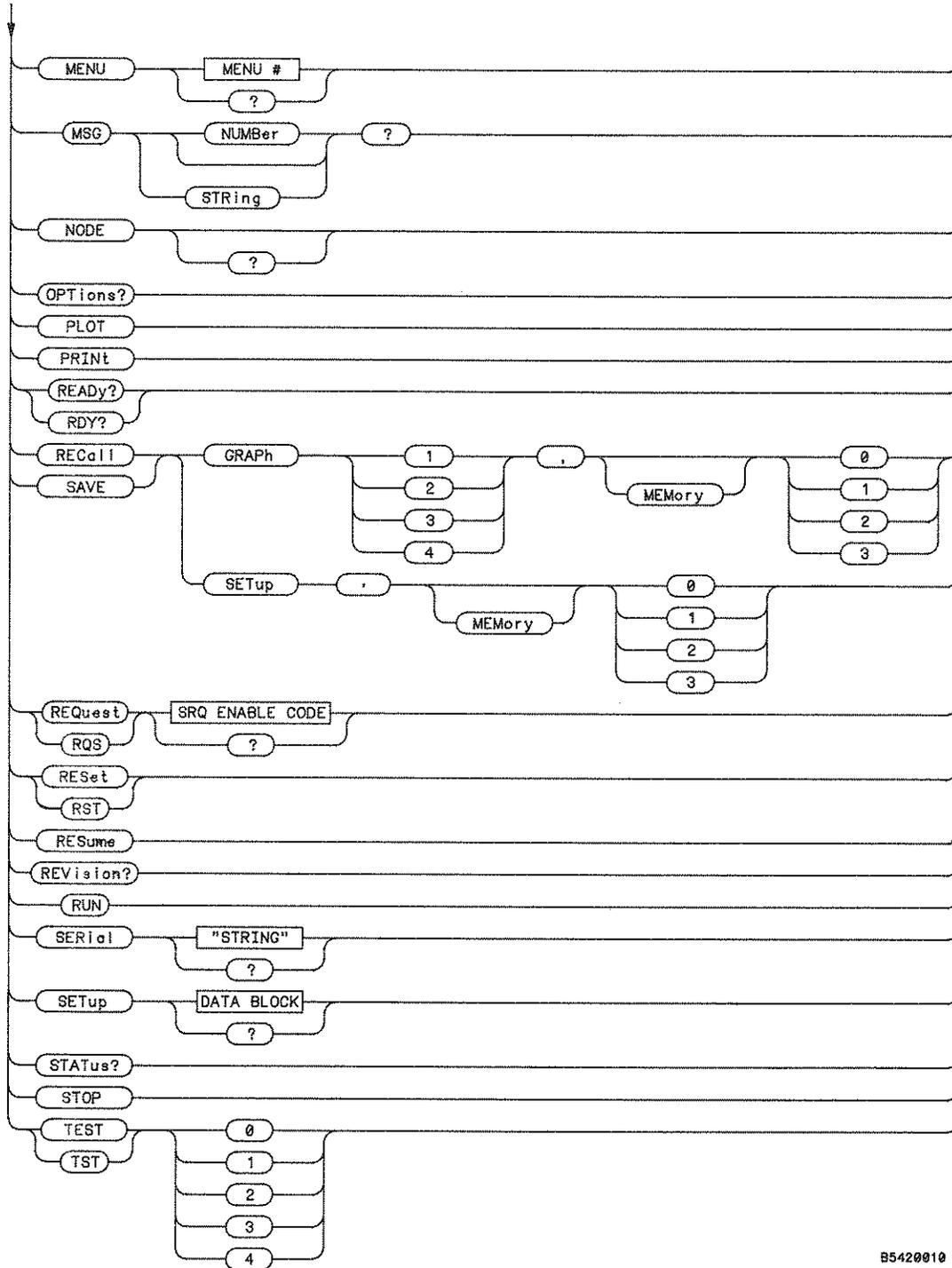
# SYSTEM COMMANDS



85420010

System Command Syntax Diagram (Cont)

# SYSTEM COMMANDS



B5420010

System Command Syntax Diagram (Cont)

## SYSTEM COMMANDS

---

### ARGument

Command sets output mode (instrument response to a query) for commands that have both alpha and numerical arguments. If set to alpha, the arguments are returned in alpha format and follow the same abbreviation rules as commands. If set to numeric, the arguments are returned in numerical format. This does not affect input data messages to the 54200A/D -- arguments may be input in either alpha or numerical form regardless of how the ARGument command is set. Query returns current argument mode.

Command Syntax: ARGument { [ALPha | 1 ]  
[NUMeric | 0 ] }

Example: OUTPUT 707;"ARGUMENT NUMERIC"

Query Syntax: ARGument ?

Returned Format : [ARGument]<argument><crlf>

Example: OUTPUT 707;"ARGUMENT?"  
ENTER 707;Argument\$  
PRINT Argument\$

---

### AUToscale

Command which performs autoscale per CHANnel, TIMEbase, and TRIGger subsystem specifications if SELECTIVE is specified. If FULL is specified or no argument is specified, a full autoscale (period and all inputs) is performed. Autoscale rearranges graph sources such that signals found (chan1 or chan2) are presented on the first graphs (1, and 2 if two inputs have signals). Any sources not autoscaled or autoscaled with no input signals are displayed on subsequent graphs. The remaining graphs are turned off unless they contain memory waveforms. Active sources are displayed in normal mode (i.e., not expanded) and will be displayed on no more than one graph after autoscale.

Command Syntax: AUToscale [ FULL | 0 ]  
[ SElective | 1 ]

Example: OUTPUT 707;"AUTOSCALE SELECTIVE"

## SYSTEM COMMANDS

---

### BEEPer

Commands sets beeper mode. If no argument is passed, a beep is sounded and the beeper is turned on. Query returns the current beeper mode.

Command Syntax: BEEPer [ OFF | 0 ]  
                  [ ON | 1 ]

Example: OUTPUT 707;"BEEP OFF"

Query Syntax: BEEPer ?

Returned Format : [BEEPer]<argument><crlf>

Example: OUTPUT 707;"BEEPER ?"  
          ENTER 707;Beep\$  
          PRINT Beep\$

---

### BNC

Command sets the output mode of the rear-panel BNC. Query returns the current mode of rear-panel BNC.

Command Syntax: BNC {[ LOW | 0 ]  
                  [ HIGH | 1 ]  
                  [ PROBe | 2 ]  
                  [ TRIGger | 3 ]  
                  [ FRAME | 4 ]  
                  [ COUNT | 5 ]  
                  [ PULSE\_SEQ | 6 ] (54200D only)  
                  [ HIGH\_SEQ | 7 ] (54200D only)  
                  [ CLOCK | 8 ] } (54200D only)

Example: OUTPUT 707;"BNC PROBE"

Query Syntax: BNC ?

Returned Format: [BNC ]<argument><crlf>

Example: OUTPUT 707;"BNC ?"  
          ENTER 707;Bnc\$  
          PRINT Bnc\$

## SYSTEM COMMANDS

### CALibrate

If GAIN or DELay is specified, 54200A/D performs a self cal. If LABEL is specified, 54200A/D accepts a quoted string up to 64 characters in length that may be used to indicate when the cal was performed, when the next cal should be done, etc. The rear-panel cal switch must be set the unprotected position for all of these, otherwise an error is generated.

#### Note

*GAIN requires all front panel inputs to 54200A/D be disconnected before being executed or an erroneous cal will be performed. DELay requires rear-panel BNC be connected to INPUT 1 or an erroneous cal will be performed.*

**Command Syntax:** CALibrate {[ GAIN | 0 ]  
[ DELay | 1 ]  
[ LABEL <string> | 2 <string> ]}

Example: OUTPUT 707;"CAL LABEL "CAL PERFORMED XX/XX/XX""

**Query Syntax:** CALibrate [ LABEL ] ?

If the LABEL argument is specified, 54200A/D returns the current cal label:

Returned Format : [CALibrate ]< 64 character quoted string><crlf>

Example: DIM Cal\$[80]  
OUTPUT 707;"CALIBRATE LAB ?"  
ENTER 707;Cal\$  
PRINT Cal\$

If no argument is sent, then 54200A/D outputs calibration data:

Returned Format :

[CALibrate ]	
<NR1>,!17!<NR1><crlf>	(Chan 1 gain)
<NR1>,!17!<NR1><crlf>	(Chan 2 gain)
<NR1>,!17!<NR1><crlf>	(Trig 1 gain)
<NR1>,!17!<NR1><crlf>	(Trig 2 gain)
<NR1>,!17!<NR1><crlf>	(Trig Ext gain)
<NR1>,!11!<NR1><crlf>	(Chan 1 offset)
<NR1>,!11!<NR1><crlf>	(Chan 2 offset)
<NR1>,!05!<NR1><crlf>	(Trig 1 offset)
<NR1>,!05!<NR1><crlf>	(Trig 2 offset)
<NR1>,!05!<NR1><crlf>	(Trig Ext offset)
<NR1><crlf>	(I offset)
<NR1><crlf>	(I max)
<NR1><crlf>	(I spurious)
<NR3><crlf>	(Delay cal)
<NR1><crlf>	(Trig 1 adjust)
<NR1><crlf>	(Trig 2 adjust)

## SYSTEM COMMANDS

---

### CALibrate (cont)

```
Example: OUTPUT 707;"HEADER ON;LONGFORM ON"  
DIM Ca1$[800]  
OUTPUT 707;"CAL ?"  
ENTER 707 USING "-K";Ca1$  
PRINT USING "K";Ca1$
```

A sample of the print output of this program sequence would look like:

```
CALIBRATE  
201, 99, 51, 198, 97, 50, 198, 70, 22, 201, 99, 51, 198, 97, 50, 198, 70, 22  
209, 102, 52, 208, 102, 52, 205, 73, 21, 209, 102, 52, 208, 102, 52, 205, 73, 21  
233, 119, 66, 231, 117, 63, 229, 87, 32, 233, 119, 66, 231, 117, 63, 229, 87, 32  
236, 119, 65, 229, 119, 64, 233, 86, 32, 236, 119, 65, 229, 119, 64, 233, 86, 32  
236, 119, 65, 230, 117, 64, 230, 87, 33, 236, 119, 65, 230, 117, 64, 230, 87, 33  
255, 250, 255, 245, 255, 248, 255, 237, 255, 244, 255, 216  
1, 109, 1, 58, 1, 87, 0, 238, 1, 56, 0, 11  
0, 14, 0, 13, 0, 15  
0, 13, 0, 19, 0, 14  
255, 254, 255, 244, 0, 14  
33  
75  
0  
28.20E-09  
0  
0
```

## SYSTEM COMMANDS

---

### COPY

Command which copies data from first graph specified to second graph specified.

**Command Syntax:** COPY <copy specification>

<copy specification> ::= [GRAPh]<graph #>, [GRAPh]<graph #>

<graph #> ::= { 1 | 2 | 3 | 4 }

Example: OUTPUT 707;"COPY GRAPH 1,GRAPH 2"

---

### DEBUg

The system DEBUg command helps those who are unfamiliar with the command syntax to find programming errors. When DEBUg ON is issued, each command is shown on the 54200A/D display as the command is received over the HP-IB. The commands are defined as either inputs or outputs and appear within the < > symbols with imbedded carriage returns (CR) and line feeds (LF). The form in which commands are displayed on the 54200A/D is dependent on the current status of the system LONGform, HEADer, and ARGument commands. Spelling and syntax errors can be quickly located and corrected by stepping through a program. If an error occurs, the error is highlighted with an inverse video cursor on the 54200A/D display. An error message is then displayed, followed by message text, on the status line of the 54200A/D.

Query returns the current debug mode.

**Command Syntax:** DEBUg { [ ON | 1 ]  
[ OFF | 0 ] }

Example: OUTPUT 707;"DEB ON"

**Query Syntax:** DEBUg ?

Returned Format : [DEBUg]<argument><crlf>

Example: OUTPUT 707;"DEBUG?"  
ENTER 707;Debug\$  
PRINT Debug\$

## SYSTEM COMMANDS

---

### DIGitize

Upon receipt of the DIGitize command, all graphs are turned off and acquisition is stopped. DIGitize automatically assigns channels to their default graphs for convenience of measurements following acquisition. The DIGitize command then causes 54200A/D to start running, as if the RUN command had been sent.

When each requested source completes its acquisition, it is "turned off" (no longer acquired).

When all are acquired, acquisition is stopped as though the STOP command had been issued and the message "Acquisition Complete" is displayed in the status line.

#### Note

*This command does not have a finite number of arguments, therefore the last argument cannot be punctuated with a ",".*

If no argument is included with DIGitize, then the current graph sources determine what is acquired. If no active sources are assigned to any graphs, the default is made as follows:

- If one graph is displayed, channel 1 is assigned to graph 1.
- If two graphs are displayed, channel 1 is assigned to graph 1 and channel 2 is assigned to graph 2.
- If four graphs are displayed, channel 1 is assigned to graph 1, channel 2 is assigned to graph 2, and trigger view is assigned to graph 3.
- All other graphs are set to off.

Command Syntax : DIGitize [<acquire spec>[,<acquire spec>]!0!N! ]

```
<acquire spec> ::= { [ TRIGger | 0 ]  
                    [ CHANne11 | 1 ]  
                    [ CHANne12 | 2 ] }
```

Example: OUTPUT 707;"DIGITIZE TRIGGER,CHANNEL1"

## SYSTEM COMMANDS

---

### DSP

Command places string up to 32 characters long in the message area of the 54200A/D display. Priority is higher than normal advisories, lower than errors. The null string ("") clears the DSP message. Query returns advisory string currently in status line.

**Command Syntax:** DSP <quoted string>

Example : OUTPUT 707;"DSP ""Set offset, then press CONTINUE"""

**Query Syntax:** DSP ?

Returned Format: [DSP]<string><crlf>

Example: DIM Dsp\$[40]  
OUTPUT 707;"DSP?"  
ENTER 707;Display\$  
PRINT Dsp\$

---

### EOI

Command sets EOI mode for data outputs. If on, then EOI is asserted with the last data byte sent. Command does not affect response to EOI on input data messages. Query returns the current status of EOI.

**Command Syntax:** EOI { [ ON | 1 ]  
[ OFF | 0 ] }

Example: OUTPUT 707;"EOI OFF"

**Query Syntax:** EOI ?

Returned Format : [EOI]<argument><crlf>

Example: OUTPUT 707;"EOI?"  
ENTER 707;Eoi\$  
PRINT Eoi\$

---

### ERASe

Command erases specified graph. If the graph contains a memory waveform, the graph is turned off. If the graph contains an active source (channel or trigger) then the waveform display is erased and the acquisition count for that waveform is set to "0" (no data acquired yet).

**Command Syntax:** ERASe [GRAPh] { 1 | 2 | 3 | 4 }

Example: OUTPUT 707;"ERASE GRAPH 1"

## SYSTEM COMMANDS

---

### ERRor

Query which responds with the error code for the first error condition since ERRor?, device clear, RESet, instrument power-on, or RQS<mask spec>. If STRing is specified, a quoted string up to 32 characters long is returned. If NUMber is specified or no argument is sent, only the error number is returned. All errors will halt parsing. Refer to system MSG query for other types of messages.

Query Syntax: ERRor [ NUMber | 0 ]  
 [ STRing | 1 ] ?

Returned Format : [ERRor][<NR1><crlf> | <string><crlf>]

Example: OUTPUT 707;"ERROR STRING ?"  
 ENTER 707;String\$  
 PRINT String\$

Device Dependent Error Messages (Primarily from local operation):

<u>ERROR NO.</u>	<u>ERROR STRING</u>
3	Register Write Protected
4	Not Allowed In This Menu
5	Graphics Must Be On
8	Use [NEXT] [PREV] Keys
9	Numeric Entry Required
10	Use Hex Keys
11	Use Alphanumeric Keys
13	Requires Correction First
15	DON'T CARE Not Allowed
16	Use 0 or 1
17	Use 0, 1, or DON'T CARE
18	Use 0 thru 7
19	Use 0 thru 7 or DON'T CARE
20	Use 0 thru 3
21	Use 0 thru 3 or DON'T CARE
22	Value is Too Large
23	CHS Not Allowed
24	Use CHS Key
25	Value Not Allowed
30	Maximum INSERT's Used
31	Use 0 thru 9
39	Turn Lines Off First
40	Disable Accumulate First
43	Must Be in Talk Only
49	Value Out of Range
54	FAILED Test <N> / FAILED Cal <N>
58	No Hardcopy Device
70	Cal RAM Write Protected
89	Local Lockout In Effect
90	Key Not Allowed in Remote

## SYSTEM COMMANDS

---

### ERRor (cont)

Standardized HP-IB Error Messages:

<u>ERROR NO.</u>	<u>ERROR STRING</u>
-100	In Controller Command
-110	Invalid Header
-119	Command Header Expected
-120	In Numeric Argument
-121	Numeric Data Expected
-123	Numeric Overflow
-125	Invalid Representation
-129	Missing Argument
-130	In Non-numeric Argument
-131	Character Data Expected
-132	String Data Expected
-133	Block Data Expected
-134	String Too Long
-135	Block Length
-136	Block Checksum
-137	Invalid Argument
-139	Missing Argument
-142	Too Many Arguments
-143	Missing Argument Delimiter
-150	Query Expected
-151	Query Not Permitted
-200	Execution Not Possible
-211	Settings Conflict
-212	Number Out of Range
-231	Input Buffer Overflow
-233	Output Buffer Empty
-300	Hardware Failure
-302	System Fault
-311	RAM Failure
-312	RAM Data Loss
-313	CAL Factor Loss
-321	ROM Checksum
-322	Firmware Incompatible
-330	Power-up Failed

## SYSTEM COMMANDS

---

### HEADer

Command sets command header echo mode for query responses; query responses will only return the command header when HEADer is set ON. Query form of this command returns the current echo mode.

Command Syntax: HEADer { [ ON | 1 ]  
                  [ OFF | 0 ] }

Example: OUTPUT 707;"HEADER ON"

Query Syntax: HEADer ?

Returned Format : [HEADer]<argument><crlf>

Example: OUTPUT 707;"HEADER ?"  
          ENTER 707;Header\$  
          PRINT Header\$

---

### HELP

Query which returns all commands in tabular form organized by subsystem. The command arguments are not output. "?" optional for this query.

Query Syntax: HELP [?]

Returned Format: [HELP]<string with imbedded <crLf's> >

Example: OUTPUT 707;"EOI ON"  
          DIM Help\$[2000]  
          OUTPUT 707; "HELP?"  
          ENTER 707 USING "-K"; Help\$  
          PRINT USING "K"; Help\$

---

### ID

Query which returns model identification string, HP54200A or HP54200D.

Query Syntax: ID ?

Returned Format: [ID ]"HP54200A"<crLf> or  
                  [ID ]"HP54200D"<crLf>

Example: OUTPUT 707;"ID ?"  
          ENTER 707;Id\$  
          PRINT Id\$

## SYSTEM COMMANDS

### KEY

Query which returns the code of the first key pressed in the key buffer. A key queue of length 10 is held. If more than 10 keys have been pressed, the most recent key is the last in the buffer.

Query Syntax: KEY ?

Returned Format: [KEY]<key code><crlf>

Example: OUTPUT 707;"KEY?"  
 ENTER 707;Key\$  
 PRINT Key\$

CODE	KEY	CODE	KEY	CODE	KEY
1	NEXT[ ]/FINE	34	CHS	67	B
2	PREV[ ]/FINE	35	Not assigned	68	C
3	← FIELD	36	Not assigned	69	D
4	→ FIELD	37	sec/Volt	70	E
5	↑ FIELD	38	msec/mV	71	F
6	↓ FIELD	39	usec	72	G
7	← CURSOR	40	nsec	73	H
8	→ CURSOR	41	Not assigned	74	I
9	↑ CURSOR	42	Not assigned	75	J
10	↓ CURSOR	43	.	76	K
11	SYSTEM MENU	44	SAVE	77	L
12	STATUS MENU	45	RECALL	78	M
13	DISPLAY MENU	46	COPY	79	N
14	TRIG MENU	47	ERASE	80	O
15	CHAN MENU	48	Not assigned	81	P
16	TIME MENU	49	0	82	Q
17	RUN/STOP	50	1	83	R
18	RESUME	51	2	84	S
19	AUTO SCALE	52	3	85	T
20	ECL	53	4	86	U
21	HARDCOPY	54	5	87	V
22	TTL	55	6	88	W
23	CLEAR ENTRY	56	7	89	X
24	INSERT	57	8	90	Y
25	DELETE	58	9	91	Z
26	LOCAL	59	Not assigned	92	RISE MEASUREMENT
27	CURSOR VALUES	60	←EDGE	93	FALL MEASUREMENT
28	DON'T CARE	61	EDGE →	94	DUTY MEASUREMENT
29	CURSOR X	62	FREQ MEASUREMENT	95	DELAY MEASUREMENT
30	CURSOR O	63	PERIOD MEASUREMENT	96	VampI MEASUREMENT
31	CURSOR X&O	64	+WIDTH MEASUREMENT	97	Vmax MEASUREMENT
32	CURSOR NORM	65	-WIDTH MEASUREMENT	98	Vmin MEASUREMENT
33	CURSOR EXPAND	66	A	99	Vrms MEASUREMENT
				100	BLUE SHIFT KEY

## SYSTEM COMMANDS

---

### LONGform

Command sets longform mode for instrument responses to queries. If OFF then command headers and alpha arguments are sent from 54200A/D in the abbreviated form, else the whole word is output. This does not affect input data messages to the 54200A/D -- headers and arguments may be input to the 54200A/D in either long or short form regardless of how the LONGform command is set. Query returns the LONGform status.

Command Syntax: LONGform {[ ON | 1 ]  
[ OFF | 0 ]}

Example: OUTPUT 707;"LONG 1"

Query Syntax: LONGform ?

Returned Format : [LONGform]<argument><crlf>

Example: OUTPUT 707;"LONGFORM?"  
ENTER 707;Long\$  
PRINT Long\$

---

### MENU

Command displays the desired menu. Menus 41 and 42 are available for the 54200D only. The 54200A treats 41 or 42 as parameter errors. Query returns the current menu selected.

Command Syntax: MENU {[ 0 ] (None/measurement answers)  
[ 10 ] (System Peripherals)  
[ 11 ] (System Calibration)  
[ 12 ] (System Self Tests)  
[ 20 ] (Status Configuration)  
[ 21 ] (Status Measurements)  
[ 22 ] (Status Memory)  
[ 30 ] (Display)  
[ 40 ] (Trigger Analog)  
[ 41 ] (Trigger State Assignment)  
[ 42 ] (Trigger State Sequence)  
[ 50 ] (Channel 1)  
[ 51 ] (Channel 2)  
[ 60 ] (Timebase)  
[ 70 ]} (Text-see Display subsystem TEXT command)

Example: OUTPUT 707;"MENU 40"

Query Syntax: MENU ?

Returned Format: [MENU ]<NR1><crlf>

Example: OUTPUT 707;"MENU ?"  
ENTER 707;Menu\$  
PRINT Menu\$

## SYSTEM COMMANDS

---

### MSG

Query which responds with the message code for the first advisory since MSG query, device clear, RESet, instrument power-on, or RQS<mask spec>. If STRing is specified, a quoted string up to 32 characters long is returned. If NUMber is specified or no argument is sent, only the message number is returned. Text, Status, Warning, and Wait messages but not ERRor messages are returned. Refer to system ERRor query for error messages. The MSG query clears the advisory bit in the status byte (if set and no SRQ is pending).

Query Syntax: MSG [ NUMBER | 0 ]  
[ STRing | 1 ] ?

Returned Format : [MSG][<NR1><crlf> | <string><crlf> ]

Example: OUTPUT 707;"MSG NUMBER?"  
ENTER 707;Message  
PRINT Message

Device Dependent Message Codes:

<u>MSG NO.</u>	<u>MESSAGE STRING</u>
1	Power-Up Complete
6	Expansion Limit Reached
7	No Waveform Exists
12	Press STOP Key First
14	End of Waveform
26	INSERT to Add Sequence Term
27	INSERT to Add OR'd Pattern
28	INSERT to Add New Label
29	One "*" Required For Each Label
32	Each Label Must Have a Name
33	All Names Must Be Unique
34	At Least 1 Clock Edge Required
35	Delay Rounded
36	Enter 55 to 99 %
37	Enter 1 to 45 %
38	DELETE to Remove Field
41	INSERT to Add AND'd Pattern
42	Only One Label Allowed
44	Signal Aliased
45	Command Ignored
46	Coupled Function Changed
47	Offset/Trig Will Change
48	INSERT-Proceed Else CLEAR ENTRY
50	Enter Cal 0 thru 9
51	Enter Test 0 thru 2
52	No Edge Found

## SYSTEM COMMANDS

---

### MSG (cont)

<u>MSG NO.</u>	<u>MESSAGE STRING</u>
55	Hardcopy in Progress
56	Acquired Frame <N> (See Note)
57	Hardcopy Device Down
59	No Ext Trig Auto
60	Hardcopy Aborted
61	< Not defined >
62	< Not defined >
63	Waiting to Send Data
64	Waiting to Receive Data
65	< Not defined >
66	Executing Autoscale
67	Exceeds Graph Scale
68	Enter Address 0 thru 30
69	Default Complete
71	< Not defined >
72	Armed by State Trigger
73	Trigger On State Only
74	Enter Graph 1 thru 4
75	Enter Memory 0 thru 3
76	Auto Scale Disabled
77	Offset/Trig Rounded
78	Threshold Limited
79	Enter Value and Units
80	Signal Not Found
81	< Not defined >
82	Acquisition Stopped
83	Acquisition Complete
84	No Trigger Found
85	Waiting for Trigger
87	SHIFT Selects Alphabet
88	< Not defined >

#### Note

*Frame number returned may not agree with count displayed when message was generated.*

#### Standardized HP-IB Warning Messages:

<u>MSG NO.</u>	<u>MESSAGE STRING</u>
-122	Number Rounded
-230	Transmission Aborted

## SYSTEM COMMANDS

---

### NODE

Command that resets 54200A/D parser to SYStem node. If query, 54200A/D returns currently selected node (system or subsystem).

Command Syntax: NODE

Example: OUTPUT 707;"NODE"

Query Syntax: NODE ?

Returned format: [NODE]([ SYSTEM | 0 ]  
 [ CHANnel | 1 ]  
 [ TRIGger | 2 ]  
 [ TIMEbase | 3 ]  
 [ DISPlay | 4 ]  
 [ GRAPh | 5 ]  
 [ ACQuire | 6 ]  
 [ WAVEform | 7 ]  
 [ MEASure | 8 ]  
 [ STATE | 9 ])<crlf>

Example: OUTPUT 707;"NODE ?"  
 ENTER 707;Node\$  
 PRINT Node\$

---

### OPTions

Query which returns what options are installed in 54200A/D. There currently are no options.

Query Syntax: OPTions ?

Returned Format : [OPTions ](NONE | 0 )<crlf>

Example: OUTPUT 707;"OPTIONS?"  
 ENTER 707;Option\$  
 PRINT Option\$

## SYSTEM COMMANDS

---

### PLOT

Command sets hardcopy device to plotter and does hardcopy dump of 54200A/D display in a format acceptable to an HPGL plotter as soon as the 54200A/D is next addressed to talk.

Command Syntax: PLOT

Example:

```

210 CLEAR 707           ! Clear interface buffers.
220 OUTPUT 707;"PLOT"  ! Starts plotter buffering.
230 SEND 7;UNT UNL     ! Clears bus, set ATN line at controller true.
240 SEND 7;LISTEN 5    ! Tells plotter at address 5 to listen.
250 SEND 7;TALK 7      ! Sets 54200A/D to talk mode.
260 SEND 7;DATA        ! Sets ATN line at controller to false
270                    ! so data can be transferred.
280 WAIT 50            ! Wait 50 seconds for transfer to finish
290 !                  Note: If programming, use the SRQ capabilities
300 !                  of the 54200A/D to determine if the transfer
310 !                  is complete. Attempting to program the
320 !                  54200A/D while making a hardcopy dump will
330 !                  cause errors.
340 !

```

---

### PRINT

Command sets hardcopy device to printer and does hardcopy dump of 54200A/D display in a format acceptable to a printer compatible with the HP RASTER GRAPHICS STANDARD as soon as the printer is next addressed to talk.

Command Syntax: PRINT

Example:

```

210 CLEAR 707           ! Clear interface buffers.
220 OUTPUT 707;"PRINT" ! Starts print buffering.
230 SEND 7;UNT UNL     ! Clears bus, set ATN line at controller true.
240 SEND 7;LISTEN 1    ! Tells printer at address 1 to listen.
250 SEND 7;TALK 7      ! Sets 54200A/D to talk mode.
260 SEND 7;DATA        ! Sets ATN line at controller to false
270                    ! so data can be transferred.
280 WAIT 25            ! Wait 25 seconds for transfer to finish
290 !                  Note: If programming, use the SRQ capabilities
300 !                  of the 54200A/D to determine if the transfer
310 !                  is complete. Attempting to program the
320 !                  54200A/D while making a hardcopy dump will
330 !                  cause errors.
340 !

```

## SYSTEM COMMANDS

### REaDy | RDY

Query which returns an integer equivalent to the 54200A/D ready register (ready byte of the status word). The ready register is dynamic and indicates the current status of the instrument. The ready register is defined as follows:

Query Syntax: { REaDy | RDY } ?

Returned Format: [REaDy]<NR1><crlf>

```
Example: OUTPUT 707;"REaDy?"
         ENTER 707;Ready$
         PRINT Ready$
```

*The Ready Register*

BIT	MASK WEIGHT	READY BIT CONDITION
7	128	Not used, always 0.
6	64	Cal = High indicates that self calibration has completed execution.
5	32	Test = High indicates that the requested self test has completed execution.
4	16	Hard = Hardcopy complete - High indicates that the last byte of printer or plotter dump has been sent and received
3	8	Data = Data available - High indicates that something is in the buffer waiting to be read.
2	4	Acq = Acquisition complete - High indicates that all waveforms are acquired.
1	2	Trig = Triggered - High indicates that the instrument is receiving triggers. Can only be set while running; if stopped, reflects status previous to stopping.
0	1	Parse = Parse complete - High indicates that the last command has been completely parsed.

## SYSTEM COMMANDS

---

### RECall

Command displays a waveform from 54200A/D memory on the specified graph or, restores the specified instrument setup. Refer to the SAVE command to save waveforms or setups.

**Command Syntax:** RECall { [GRAPH<graph#>,[MEMory]<memory#>]  
[ [SETup,][MEMory]<memory#> ] }

<graph#> ::= { 1 | 2 | 3 | 4 }  
<memory#> ::= { 0 | 1 | 2 | 3 }

Examples: OUTPUT 707;"RECALL GRAPH 1,2" *is equivalent to*  
OUTPUT 707;"RECALL GRAPH 1,MEMORY 2"

OUTPUT 707;"RECALL SETUP,MEMORY 0" *is equivalent to*  
OUTPUT 707;"RECALL SETUP 0" *and*  
OUTPUT 707;"RECALL 0"

---

### REQuest | RQS

The REQuest command sends an SRQ enable code which is an integer representing the binary weighted values of the condition bits in the ready mask and the RQS mask.

The ready mask determines what ready conditions cause the ready bit in the status byte to be set. The RQS mask determines what conditions will cause an SRQ to be issued.

Setting the SRQ enable code clears any pending SRQ, as well as all errors, messages and keys awaiting query.

Bits 0, 1, 6 are don't cares and are always set to zero.

Query returns the current SRQ enable code.

**Command Syntax:** { REQuest | RQS }<SRQ enable code>

Example: OUTPUT 707;"RQS 56"

**Query Syntax:** { REQuest | RQS } ?

Returned Format: [REQuest]<SRQ enable code><crlf>

Example: OUTPUT 707;"REQUEST ?"  
ENTER 707;Request\$  
PRINT Request\$

## SYSTEM COMMANDS

### REQuest | RQS (cont)

The ready mask is defined as follows:

*The Ready Byte*

BIT	MASK WEIGHT	READY BIT CONDITION
15	32768	Not used, always 0.
14	16384	Cal = High indicates that self calibration has completed execution.
13	8192	Test = High indicates that the requested self test has completed execution.
12	4096	Hard = Hardcopy complete - High indicates that the last byte of printer or plotter dump has been sent and received
11	2048	Data = Data available - High indicates that something is in the buffer waiting to be read.
10	1024	Acq = Acquisition complete - High indicates that all waveforms are acquired.
9	512	Trig = Triggered - High indicates that the instrument is receiving triggers. Can only be set while running; if stopped, reflects status previous to stopping.
8	256	Parse = Parse complete - High indicates that the last command has been completely parsed.

## SYSTEM COMMANDS

### REQuest | RQS (cont)

The RQS mask is defined as follows:

*The Status Byte*

BIT	MASK WEIGHT	STATUS BIT CONDITION
7	128	MSG = High indicates that a message was displayed on the status line of the display. A MSG query is used to determine the message code.
6	64	RQS = Not used, always 0.
5	32	ERR = Error - High indicates an error occurred. An ERRor query is used to determine error code.
4	16	RDY = Ready - High indicates the instrument is ready. This is based on the ready mask. A RDY query is used to determine condition.
3	8	LCL = Local switch or power cycle - High indicates that the instrument has been switched to local from the front panel or that the power was cycled off then on again.
2	4	FPS = Front panel service request - High indicates a front panel key has been pressed. A KEY query is used to determine the key code.
1	2	PWR = Not used, always 0.
0	1	RQC = Not used, always 0.
<p>Notes: 1. To set the RQS bit and SRQ bus control line true, the condition must be enabled in the RQS mask.</p> <p>2. If no condition is enabled, the 54200A/D can not set the SRQ bus control line nor the RQS bit true. However, bits 2-5 and 7 of the status byte are set to indicate which conditions have occurred.</p>		

## SYSTEM COMMANDS

---

### RESet | RST

The 54200A/D has three distinct and non-overlapping levels of reset capabilities; two are HP-IB bus commands and one is a 54200A/D system command.

1. IFC (HP-IB bus command)
  - Per IEEE-488, resets only the device interface functions (T, TE, L, LE, and C) as defined.
2. DCL or SDC (HP-IB bus commands)
  - Resets the parser state so that no subsystem is enabled.
  - Clears device status word (system STATUS command), and KEY, MSG, and ERROR queues.
  - Clears all IEEE-488 input and output buffers.
  - DOES NOT affect any device variables handled by system RESet command, in particular:
    - WAVEform FORMat
    - LONGform
    - EOI
    - HEADer
    - ARGument
    - RQS
3. RESet (RST) 54200A/D system command.
  - Resets parser state so that no subsystem is enabled.
  - Clears device status word (system STATUS command), and KEY, MSG, and ERROR queues.
  - Basically the same as key-down power up, except no system tests are performed or corresponding failure default actions.
  - Changes these command variables:
    - WAVEform FORMat = WORD
    - EOI = ON
    - LONGform = OFF
    - HEADer = OFF
    - ARGument = NUMeric
    - RQS = 32512 (Ready bits all true except bit 15, status bits all false)
    - Sets GRAPH, TRIGger, and WAVEform SOURce parameters to CHANnel 1
    - Sets MEASure SOURce parameter to GRAPH1

**Command Syntax:** RESet | RST

Example: OUTPUT 707;"RST"

When RESet system command has been executed, the condition of the 54200A/D is as follows:

<u>CONDITION</u>	<u>SETTING</u>
<b>TIMEBASE:</b>	
Sweep mode	Auto
Time Range	10 us
Reference	Center
Delay	0.0 s
Autoscale	Period
Alias detect	On

## SYSTEM COMMANDS

---

### RESet | RST (cont)

<u>CONDITION</u>	<u>SETTING</u>
<b>CHANNELS:</b>	
Range	5.0 V
Offset	0.0 V
Store mode	Normal
Labels	" "
Coupling	DC
Probe Attenuation	1:1
Autoscale	Enabled
<b>TRIGGER:</b>	
Mode	Analog only
Range	Track (5.0 V)
Source	Channel 1
Level	0.0 V
Slope	Positive
Store mode	Normal
Label	Blank
Autoscale	Enabled
<b>DISPLAY:</b>	
Graticule	Frame
# of graphs	2
Graph sources	
1	Channel 1
2	Channel 2
Reference lines	Off
Accumulate mode	Disabled
<b>MEASUREMENTS:</b>	
	Standard
<b>OTHER:</b>	
Running	True
HP-IB address/mode	Not changed
Hardcopy device	Printer
Rear BNC	Constant low
Beeper	On
Setup Labels	Blank
Stored:	
Setups	Unprotected
Waveforms	Cleared
Data filter	On
<b>STATE:</b>	
All settings	See menus next page

# SYSTEM COMMANDS

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [ Assignment ]           Trigger Mode [ Analog Only ]

                                     Clock
                                     JKL
State Mode [ Normal ]           ----- [ 1 ] -----
Multiplexing [ Off ]           Pod 2   Pod 1   Pod 0
                                [ TTL ] [ TTL ] [ TTL ]
                                8.....0 8.....0 8.....0
Label  Pol
  [ A ]  [ + ] [*****] [*****] [*****]
    
```

Trigger State Assignment Menu after RESet

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [ Sequence ]           Trigger Mode [ Analog Only ]

In Sequence,
  find [ 0001 ] Occurrences of           [ Or ] Trigger Teri
  then Do Nothing
  [ any state ]
Sequence Restart on no state

Label>   A
Base >   [ HEX ]

a [*****]
b [*****]
c [*****]
d [*****]
    
```

Trigger State Sequence Menu after RESet

## SYSTEM COMMANDS

---

### RESUMe

Command causing 54200A/D to resume running. This differs from the RUN command in that averaging or enveloping continue with the data already obtained.

Command Syntax: RESUMe

Example: OUTPUT 707;"RESUME"

---

### REVision

Query which returns the revision date of 54200A/D firmware.

Query Syntax: REVision ?

Returned Format : [REVision]<date code><crlf>

<date code>::=<NRI> (YYWW : where YY is years since 1960  
and WW is week of that year)

Example: OUTPUT 707;"REVISION?"  
ENTER 707;Rev\$  
PRINT Rev\$

---

### RUN

Command causing 54200A/D to start running. Same as pressing the 54200A/D front-panel RUN key. Waveforms are initialized to count of 0 (no data) and when terminal count is satisfied the ACQ bit is set in the ready byte (see READy command). Differs from the DIGitize command in that acquisition is not halted when terminal count is satisfied. RUN does not disturb graph source selection or expansion, so is very useful for specialized measurements.

Command Syntax: RUN

Example: OUTPUT 707;"RUN"

## SYSTEM COMMANDS

---

### SAVE

Command saves the waveform or setup in the specified memory. If the memory is protected, an error is generated and SAVE is not executed. Protection can be cleared via the RESet command, but cannot be set via HP-IB. Refer to RECall command to recall waveforms and setups.

**Command Syntax:** SAVE {[GRAPh<graph#>],[MEMory]<memory#>}  
[ [SETup,] [MEMory]<memory#> ]}

<graph#> ::= { 1 | 2 | 3 | 4 }  
<memory#> ::= { 0 | 1 | 2 | 3 }

Examples: OUTPUT 707;"SAVE GRAPH 1,2" *is equivalent to*  
OUTPUT 707;"SAVE GRAPH 1, MEMORY 2" *and*

OUTPUT 707;"SAVE SETUP, MEMORY 0" *is equivalent to*  
OUTPUT 707;"SAVE SETUP 0" *and*  
OUTPUT 707;"SAVE 0"

---

### SERial

Command programs the serial number of the 54200A/D. Any string is accepted up to 10 characters. If less than 10 characters, it is padded with spaces to length 10. A checksum is made and the value is stored in non-volatile RAM. The rear-panel cal switch must be set to the not protected position, otherwise SERIAL is a query-only command. Query returns 54200A/D serial number.

**Command Syntax:** SERIAL <string>

Example: OUTPUT 707;"SERIAL ""2511A01219"""

**Query Syntax:** SERIAL ?

Returned Format : [SERial]<serial number code><crlf>

Example: OUTPUT 707;"SERIAL?"  
ENTER 707;Serial\$  
PRINT Serial\$

## SYSTEM COMMANDS

---

### SETup

Command sets up 54200A/D according to learn string. Query returns 54200A/D learn string. Block length is 984 bytes. Block format #A is discussed in paragraph 8-12 at the front of this section.

Query Syntax: SETup ?

Returned Format: [SETup] <block type A>

Example: DIM Learn\$[1000]  
OUTPUT 707;"HEADER OFF;SETUP?"  
ENTER 707 USING "-K";Learn\$

Command Syntax: SETup <#A>,<number of bytes in learn string>  
<learn string>

Example: OUTPUT 707 USING "#,K";"SETUP ",Learn\$

---

### STatus

The instrument status word is a 16-bit binary word which is returned as an integer, and contains information about the instrument conditions that set the ready bit in the status byte and/or generate a Require Service message. The upper 8 bits of the status word are known collectively as the ready byte, while the lower 8 bits correspond to the status byte sent during a serial poll. The STatus query is used to read the status word representing the current status of the 54200A/D. Unlike the response to a serial poll, the conditions are dynamic, not latched. Therefore the status response reflects current status.

A companion 16 bit word, the request mask, is used to specify both those conditions in the ready byte that set the ready bit in the status byte, and those conditions in the status byte that generate a Require Service message. The bits in the request mask have the same meanings as those in the instrument status word. The ready bit in the status byte is set when all of the conditions corresponding to bits in the ready mask are true at the same time. This bit is actually set on the transition of the last condition to become true. The REQuest system command is used to specify the request mask.

Query Syntax: STatus ?

Returned Format: [STatus]<NR1>

Example: OUTPUT 707;"STATUS?"  
ENTER 707;Status\$  
PRINT Status\$

## SYSTEM COMMANDS

---

### STatus (cont)

The ready byte of the 16-bit status word is defined as follows:

*The Upper Byte of the Status Word  
(The Ready Byte)*

BIT	MASK WEIGHT	READY BIT CONDITION
15	32768	Not used, always 0.
14	16384	Cal = High indicates that self calibration has completed execution.
13	8192	Test = High indicates that the requested self test has completed execution.
12	4096	Hard = Hardcopy complete - High indicates that the last byte of printer or plotter dump has been sent and received
11	2048	Data = Data available - High indicates that something is in the buffer waiting to be read.
10	1024	Acq = Acquisition complete - High indicates that all waveforms are acquired.
9	512	Trig = Triggered - High indicates that the instrument is receiving triggers. Can only be set while running; if stopped, reflects status previous to stopping.
8	256	Parse = Parse complete - High indicates that the last command has been completely parsed.

## SYSTEM COMMANDS

---

### STatus (cont)

The status byte of the 16-bit status word is defined as follows:

*The Lower Byte of the Status Word  
(The Status Byte)*

BIT	MASK WEIGHT	STATUS BIT CONDITION
7	128	MSG = High indicates that a message was displayed on the status line of the display. A MSG query is used to determine the message code.
6	64	RQS = Requesting service - High indicates that this instrument requested service.
5	32	ERR = Error - High indicates an error occurred. An ERRor query is used to determine error code.
4	16	RDY = Ready - High indicates the instrument is ready. This is based on the ready mask. A RDY query is used to determine condition.
3	8	LCL = Local switch or power cycle - High indicates that the instrument has been switched to local from the front panel or that the power was cycled off then on again.
2	4	FPS = Front panel service request - High indicates a front panel key has been pressed. A KEY query is used to determine the key code.
1	2	PWR = Not used, always 0.
0	1	RQC = Not used, always 0.

## SYSTEM COMMANDS

---

### STOP

Command which causes 54200A/D to stop running.

**Command Syntax:** STOP

**Example:** OUTPUT 707;"STOP"

---

### TEST | TST

Command which executes the specified self test. Failures are reported as errors and may be queried with ERROR?.

#### Note

*Inputs must be properly configured before the TEST command is issued:*

- TEST 0 - No special configuration required.*
- TEST 1 - All input signals must be disconnected.*
- TEST 2 - Connect rear panel BNC to INPUT 1 BNC.*
- TEST 3 - Connect rear panel BNC to INPUT 2 BNC.*
- TEST 4 - Connect rear panel BNC to EXT TRIG BNC.*

**Command Syntax:** {TEST | TST} <test number>

<test number> ::= 0	(Self test 0: CPU/Memory)
1	(Self test 1: Acquisition/Trigger)
2	(Self test 2: Channel 1 Input)
3	(Self test 2: Channel 2 Input)
4	(Self test 2: External Trigger Input)

**Example:** OUTPUT 707;"TEST 4"

# SYSTEM COMMANDS

---

Notes

## ACQUIRE SUBSYSTEM

---

### ACQUIRE

The acquire subsystem allows the store mode for channel 1, channel 2, and trigger to be set the same with two commands, TYPE and COUNT. The POINTs and COMPlete commands are included to provide compatibility between HP 54200A/D programs and HP 54100A/D programs. The TYPE and COUNT functions may be selectively programmed by using the STORe command of the channel and trigger subsystems.

The ACQUIRE command selects acquire subsystem as the destination for the commands that follow.

The ACQUIRE query responds with the settings of the acquire subsystem. Store mode and completion criteria for all active sources are set to be the same as those in effect for channel 1.

**Command Syntax:** ACQUIRE

Example: OUTPUT 707;"ACQUIRE"

**Query Syntax:** ACQUIRE?

Returned Format: [ ACQUIRE <crLf> ]  
 [ TYPE ]<argument><crLf>  
 [ POINTs ]<NR1><crLf>  
 [ COUNT ]<NR1><crLf>  
 [ COMPlete ]<NR1><crLf>  
 [ FILTer ]<argument><crLf>

Example: DIM Acquire\$[70]  
 OUTPUT 707;"ACQUIRE?"  
 ENTER 707 USING "-K";Acquire\$  
 PRINT USING "K";Acquire\$

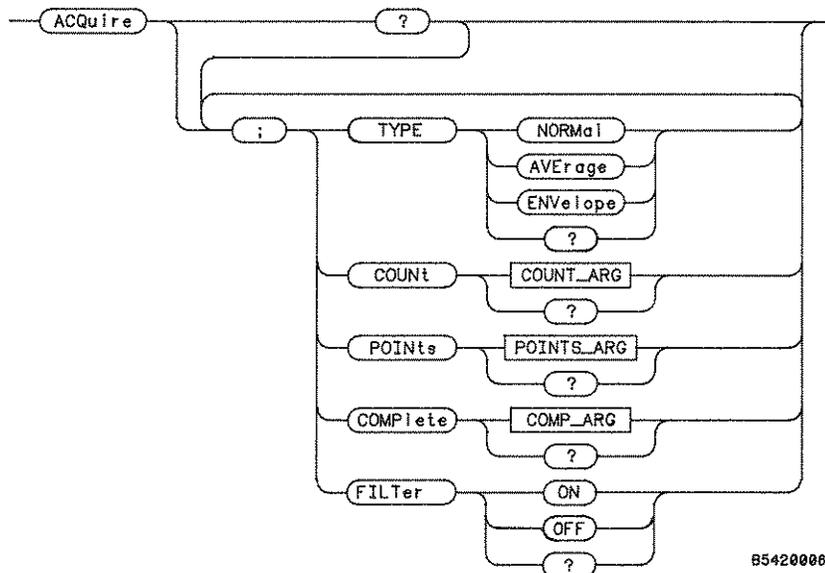
# ACQUIRE SUBSYSTEM

---

## ACQUIRE Commands:

COMPLete  
COUNT  
FILTer  
POINTs  
TYPE

---



85420006

ACQUIRE Subsystem Syntax Diagram

## ACQUIRE SUBSYSTEM

---

### COMPLete

Command does nothing, must be a valid integer. Query returns the completion criteria, 100%.

**Command Syntax:** COMPLete <NR1>

Example: OUTPUT 707;"COMPLETE 100"

**Query Syntax:** COMPLete ?

Returned Format: [COMPLete] <NR1><crlf>

Example: OUTPUT 707;"COMPLETE?"  
 ENTER 707;Complete\$  
 PRINT Complete\$

---

### COUNT

If store mode is type average, command signifies both the terminal count and the number of averages (sample weighting factor). For the other store modes, command determines the terminal count, that is, the number of frames which were acquired. For normal store mode the count parameter must be 1. For average mode, the COUNT must be exactly 4, 16, 64, or 256. For envelope, COUNT parameter can be 10 to 10,000.

All active sources are set the same.

Query returns the count factor as described above. Channel 2 and trigger type and count are set the same as channel 1 so that the response is consistent for all sources.

**Command Syntax:** COUNT <NR1>

Example: OUTPUT 707;"COUNT 1"

**Query Syntax:** COUNT ?

Returned Format: [COUNT]<NR1><crlf>

Example: OUTPUT 707;"COUNT?"  
 ENTER 707;Count\$  
 PRINT Count\$

## ACQUIRE SUBSYSTEM

---

### FILTer

Command sets the data filter mode. The data filter is a 3-point smoothing, low-pass function that is run on the waveform data to generate 7-bit data when the time range is 5  $\mu$ s or longer. On faster time ranges, where a data interpolator is used, 7-bit data is produced without a data filter.

The FILTer query returns the data filter mode.

A slight speed enhancement is obtained by turning the filter off when acquiring averaged waveforms. The only benefit of the filter on this type of waveform is the low-pass characteristic of the filter, since averaging produces greater than 7-bit resolution.

The filter should be turned off when the absolute magnitude of individual data points is important to the measurement, such as when performing a  $V_{max}$  measurement and there are fewer than three samples on the waveform peak.

The filter should also be turned off when measuring a deliberately aliased signal, such as in swept frequency response measurements.

**Command Syntax:** `FILTer { [ ON | 1 ]  
[ OFF | 0 ] }`

Example: `OUTPUT 707;"FILTER ON"`

**Query Syntax:** `FILTer ?`

Returned Format: `[FILTer]<argument><crlf>`

Example: `OUTPUT 707;"FILTER?"  
ENTER 707;Filter$  
PRINT Filter$`

## ACQUIRE SUBSYSTEM

---

### POINTS

Command does nothing, but must be a valid integer. Query returns the number of data points acquired, 1001.

**Command Syntax:** POINTs <NR1>

Example: OUTPUT 707;"POINTS 1001"

**Query Syntax:** POINTs ?

Returned Format: [POINTs] <NR1><crlf>

Example: OUTPUT 707;"POINTS?"  
 ENTER 707;Points\$  
 PRINT Points\$

---

### TYPE

Command sets the data type for all active sources and makes the count setting of channel 2 and trigger the same as channel 1.

Query responds with the data type of channel 1 and makes channel 2 and trigger the same type and count so that the response is consistent for all sources.

**Command Syntax:** TYPE {[ NORMa1 | 1 ]  
 [ AVErage | 2 ]  
 [ ENVelope | 3 ]}

Example: OUTPUT 707;"ACQUIRE; TYPE NORMAL"

**Query Syntax:** TYPE ?

Returned Format: [TYPE ]<argument><crlf>

Example: OUTPUT 707;"TYPE?"  
 ENTER 707;Type\$  
 PRINT Type\$

# ACQUIRE SUBSYSTEM

---

## Notes

## CHANNEL SUBSYSTEM

---

### CHANnel

The channel subsystem controls all "Y axis" functions, including selecting the type of data to be acquired. Channel 1 and Channel 2 are independently programmable for all functions.

The CHANnel command selects channel 1 or channel 2 as the destination for the commands that follow.

The CHANnel query responds with all of the settings for the specified channel.

**Command Syntax:** CHANnel { 1 | 2 }

Example: OUTPUT 707;"CHANNEL 1"

**Query Syntax:** CHANnel { 1 | 2 } ?

Returned Format: [CHANnel]<NR1><crlf>  
 [PROBe]<NR3><crlf>  
 [RANGe]<NR3><crlf>  
 [OFFSet]<NR3><crlf>  
 [COUPling]<argument><crlf>  
 [LABe1]< 10 chars quoted ><crlf>  
 [STORe]<argument>,<NR1><crlf>  
 [SCALe]<argument><crlf>

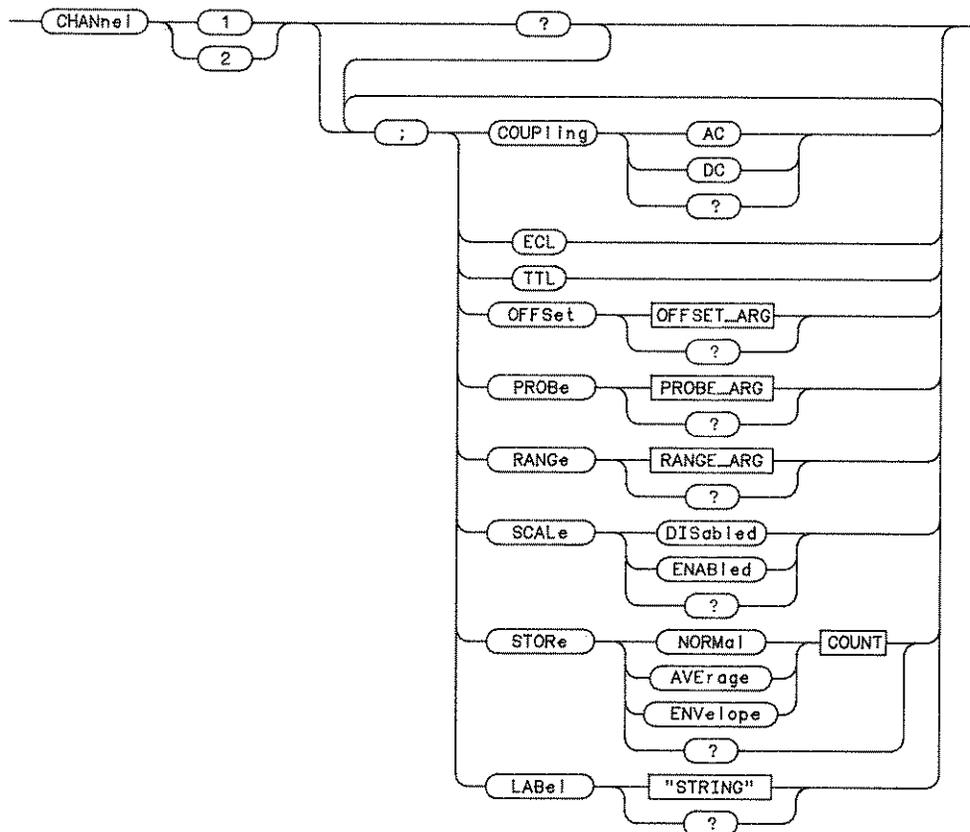
Example: DIM Chan\$[150]  
 OUTPUT 707;"CHANNEL 1?"  
 ENTER 707 USING "-K";Chan\$  
 PRINT USING "K";Chan\$

# CHANNEL SUBSYSTEM

## CHANnel Commands:

- COUPling
- ECL
- TTL
- LABel
- OFFSet
- PROBe
- RANGe
- SCALe
- STORe

Channel commands can be sent to either channel 1 or channel 2 and they are order dependent as follows: Range limits are determined by the current probe attenuation factor. The value limits for offset are determined by the current range selection. So to completely specify channel settings, program PROBe, then RANGe, and then OFFSet.



B5420001

CHANnel Subsystem Syntax Diagram

## CHANNEL SUBSYSTEM

---

### COUPLing

Command selects the input coupling for the selected channel. Query responds with the selected coupling.

Command Syntax: COUPLing { [ DC | 1 ]  
[ AC | 2 ] }

Example: OUTPUT 707;"COUPLING DC"

Query Syntax: COUPLing ?

Returned Format: [COUPLing]<argument><crlf>

Example: OUTPUT 707;"COUPLING?"  
ENTER 707;Coupling\$  
PRINT Coupling\$

---

### ECL

Command presets the selected channel for ECL as follows:

```
COUPLing = DC
OFFSet   = -1.00 V
RANGe    = 2.0 V
SCALE    = DISabled
```

The SCALE (autoscale) function is disabled so that a selective autoscale may be performed, thus preserving the channel settings.

Command Syntax: ECL

Example: OUTPUT 707;"ECL"

---

### TTL

Command presets the selected channel for TTL as follows:

```
COUPLing = DC
OFFSet   = 2.50 V
RANGe    = 6.0 V
SCALE    = DISabled
```

The SCALE (autoscale) function is disabled so that a selective autoscale may be performed, thus preserving the channel settings.

Command Syntax: TTL

Example: OUTPUT 707;"TTL"

## CHANNEL SUBSYSTEM

---

### LABel

Command sets the user label for selected channel. Query responds with the user label for selected channel.

**Command Syntax:** LABel <10 character string>

Example: OUTPUT 707;"LABEL ""TEST 1"""

**Query Syntax:** LABel ?

Returned Format:: [ LABel]< 10 characters quoted ><crlf>

Example: OUTPUT 707;"LABEL?"  
ENTER 707;Label\$  
PRINT Label\$

---

### OFFSet

Command sets channel offset. Offset is  $\pm 2$  V for 40 mV to 390 mV channel range and  $\pm 20$  V for 400 mV to 40 V channel range.

Query responds with the channel offset setting.

**Command Syntax:** OFFSet <NR3>

Example: OUTPUT 707;"OFFSET 400E-3"

**Query Syntax:** OFFSet ?

Returned Format: [OFFSet]<NR3><crlf>

Example: OUTPUT 707;"OFFSET?"  
ENTER 707;Offset\$  
PRINT Offset\$

## CHANNEL SUBSYSTEM

---

### PROBe

Command sets channel probe factor. Must be 1, 2, 5, 10, 20, 50 or 100. Query responds with channel probe factor.

**Command Syntax:** PROBe <NR1>

Example: OUTPUT 707;"PROBE 10"

**Query Syntax:** PROBe ?

Returned Format: [PROBe]<NR3><crlf>

Example: OUTPUT 707;"PROBE?"  
 ENTER 707;Probe\$  
 PRINT Probe\$

---

### RANGe

Command sets channel range. Query responds with current range setting. The allowable range settings (with 2-digit resolution) are based on the PROBe setting and are as follows:

<u>PROBE FACTOR</u>	<u>VALID RANGE SETTING</u>
1:1	40 mV to 40 V
2:1	80 mV to 80 V
5:1	200 mV to 200 V
10:1	400 mV to 400 V
20:1	800 mV to 800 V
50:1	2 V to 2000 V
100:1	4 V to 4000 V

**Command Syntax:** RANGe <NR3>

Example: OUTPUT 707;"RANGE 5.5E0"

**Query Syntax:** RANGe ?

Returned Format: [RANGe]<NR3><crlf>

Example: OUTPUT 707;"RANGE?"  
 ENTER 707;Range\$  
 PRINT Range\$

## CHANNEL SUBSYSTEM

---

### SCALE

Command sets autoscale mode for channel. Query responds with current autoscale mode.

Command Query: SCALE {[ DISAbled | 0 ]  
                  [ ENABled | 1 ]}

Example: OUTPUT 707;"SCALE ENABLED"

Query Syntax: SCALE ?

Returned Format: [SCALE]<argument><crlf>

Example: OUTPUT 707;"SCALE?"  
          ENTER 707;Scale\$  
          PRINT Scale\$

---

### STORE

Command sets the store mode. If average mode is selected, count determines both the terminal count and the number of averages (sample weighting factor). For the other store modes, count determines the terminal count, that is, the number of frames which must be acquired until the waveform is considered ready for analysis.

For normal store mode the count parameter is optional; if sent it must be 1. For average mode, the count must be exactly 4, 16, 64, or 256. For envelope, count can be 10 to 10,000.

The STORE function may also be programmed using the ACQUIRE subsystem TYPE and COUNT commands.

Query responds with the current store mode for the addressed channel.

Command Syntax: STORE < type >,< count >

< type > ::= {[ NORMAl | 1 ]  
              AVERage | 2 ]  
              ENVELOpe | 3 ]}

< count > ::= <NR1>

Query Syntax: STORE ?

Returned Format: [STORE]<argument>,<NR1><crlf>

Example: OUTPUT 707;"STORE?"  
          ENTER 707;Store\$  
          PRINT Store\$

---

## DISPLAY SUBSYSTEM

---

### DISPlay

The display subsystem provides access to 54200A/D functions which control how waveforms are presented on the CRT. It contains commands to select whether the cursor values display is on. Also, a group of commands is provided that allow users to write text messages to screen.

The text display is available when the text menu is on and allows up to 4 lines of text to be displayed in the user definable text area. Five lines of text can be held in memory, the fifth line is not displayed unless the display is rolled up or down.

Text is volatile, it is set to " " at power on. However, once written, the user may display it with "TEXT ON" or display the previous menu by sending "TEXT OFF". The system command "MENU 70" is equivalent to "TEXT ON".

The DISPlay command selects display subsystem as the destination for the commands that follow.

The DISPlay query responds with the settings of the display subsystem.

#### Command Syntax: DISPlay

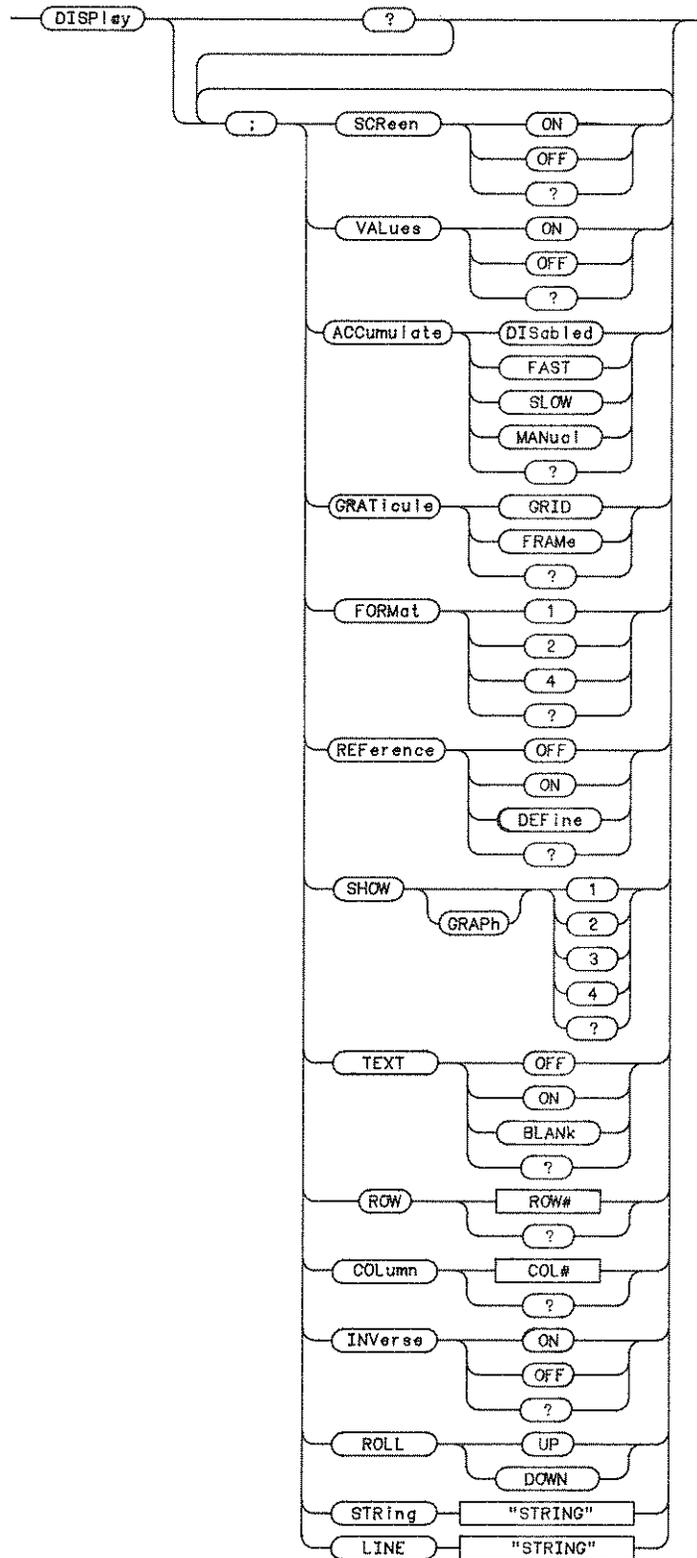
Example: OUTPUT 707;"DISPLAY"

#### Query Syntax: DISPlay ?

```
Returned Format: [ DISPlay ]<crLf>
                 [ FORMat ]<NR1><crLf>
                 [ GRATicule ]<argument><crLf>
                 [ ROW ]<NR1><crLf>
                 [ COLumn ]<NR1><crLf>
                 [ SCReen ]<argument><crLf>
                 [ TEXT ]<argument><crLf>
                 [ INVerse ]<argument><crLf>
                 [ REFerence ]<argument><crLf>
                 [ ACCumulate ]<argument><crLf>
                 [ VALues ]<argument><crLf>
                 [ SHOW ] GRAPh<NR1><crLf>
```

```
Example: DIM Display$[160]
         OUTPUT 707;"DISPLAY?"
         ENTER 707 USING "-K";Display$
         PRINT USING "K";Display$
```

# DISPLAY SUBSYSTEM



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DISPlay Subsystem Syntax Diagram

## DISPLAY SUBSYSTEM

---

### DISPlay Commands:

ACCumulate  
 COL  
 ROW  
 FORMat  
 GRATicule  
 INVerse  
 LINE  
 ROLL  
 REFerence  
 SCReen  
 SHOW  
 STRing  
 TEXT  
 VALues

---

### ACCumulate

Command sets the accumulate mode. If enabled, waveform data is displayed accumulated as it is acquired. If fast is selected, data is erased every 16 frames. Slow erases every 64 frames. Manual doesn't erase (use system ERASE command).

Query returns the current accumulate mode selection.

**Command Syntax:** ACCumulate { [ DISabled | 0 ]  
                                   [ FAST | 1 ]  
                                   [ SLOW | 2 ]  
                                   [ MANuaL | 3 ] }

Example: OUTPUT 707;"ACCUMULATE DISABLED"

**Query Syntax:** ACCumulate ?

Returned Format: [ ACCumulate ]<argument><crlf>

Example: OUTPUT 707;"ACCUMULATE?"  
           ENTER 707;Accum\$  
           PRINT Accum\$

## DISPLAY SUBSYSTEM

---

### COLUMN

Command sets the specified column as the target for LINE or STRING commands. This does not affect the current ROW command specification. Query returns the current column number.

**Command Syntax:** COLUMN < column number >  
< column number > ::= 0..63

Example: OUTPUT 707;"COLUMN 42"

**Query Syntax:** COLUMN ?

Returned Format: [ COLUMN ]<NR1><crlf>

Example: OUTPUT 707;"COLUMN?"  
ENTER 707;Column\$  
PRINT Column\$

---

### ROW

Command sets the specified row as the target for LINE or STRING command. This does not affect the current COLUMN command specification. Query returns the current row number.

**Command Syntax:** ROW { 1 | 2 | 3 | 4 }

Example: OUTPUT 707;"ROW 3"

**Query Syntax:** ROW ?

Returned Format: [ ROW ]<NR1><crlf>

Example: OUTPUT 707;"ROW?"  
ENTER 707;Row\$  
PRINT Row\$

## DISPLAY SUBSYSTEM

---

### FORMat

Command sets the number of graphs displayed; number must be 1, 2, or 4. Query returns the number of graphs displayed.

Command Syntax: FORMat { 1 | 2 | 4 }

Example: OUTPUT 707;"FORMAT 2"

Query Syntax: FORMat ?

Returned Format: [FORMat]<NR1><crlf>

Example: OUTPUT 707;"FORMAT?"  
 ENTER 707;Format\$  
 PRINT Format\$

---

### GRATicule

Command sets the graticule type on the display graph. Query returns the graticule type displayed.

Command Syntax: GRATicule { [ GRID | 1 ]  
 [ FRAME | 2 ] }

Example: OUTPUT 707;"GRATICULE GRID"

Query Syntax: GRATicule ?

Returned Format: [GRATicule]<argument><crlf>

Example: OUTPUT 707;"GRATICULE?"  
 ENTER 707;Grat\$  
 PRINT Grat\$

---

### INVerse

Command sets inverse video display on or off. After INVerse ON is received, all subsequent text is displayed in inverse until INVerse OFF is received.

Command Syntax: INVerse { [ OFF | 0 ]  
 [ ON | 1 ] }

Example: OUTPUT 707;"INVERSE OFF"

## DISPLAY SUBSYSTEM

---

### LINE

Command displays the string starting at the current row and column specification. If the column limit (63) is reached, the text is wrapped to the next line irrespective of word boundaries. At the end of the string, the remainder of the current row is set to " " and row is initialized to the next row and column is set to 0. If column limit is reached on row 4, the display is rolled up and the new line 4 is set to " " before the write operation continues. Refer to the STRing command for similar application.

**Command Syntax:** LINE < any quoted string >

Example: OUTPUT 707;"LINE ""Enter text on this line"""

---

### REFerence

Command sets the reference lines display mode. In define mode, when display menu is on, the graph levels are displayed by the graphs. Query returns the reference lines mode.

**Command Syntax:** REFerence { [ OFF | 0 ]  
[ ON | 1 ]  
[ DEFine | 2 ] }

Example: OUTPUT 707;"REFERENCE OFF"

**Query Syntax:** REFerence ?

Returned Format: [REFerence]<argument><crlf>

Example: OUTPUT 707;"REFERENCE?"  
ENTER 707;Ref\$  
PRINT Ref\$

---

### ROLL

Causes the text lines to roll up or down. Current row and column text pointers are unaffected.

**Command Syntax:** ROLL { [ UP | 1 ]  
[ DOWN | 0 ] }

Example: OUTPUT 707;"ROLL DOWN"

---

## DISPLAY SUBSYSTEM

---

### SCReen

Command controls the 54200A/D display. ON turns normal display on, which has no effect if the display is already on; the last 54200A/D menu is restored. OFF turns everything except line 1 and 2 of the display off, resulting in faster operation when running since in this mode waveform data is not written to graph displays. Accumulated displays are not generated with screen off. This command cancels system command DEBUg display.

Query returns the current screen status.

**Command Syntax:** SCReen { [ ON | 1 ]  
[ OFF | 0 ] }

Example: OUTPUT 707;"SCREEN ON"

**Query Syntax:** SCReen ?

Returned Format: [SCReen]<argument><crlf>

Example: OUTPUT 707;"SCREEN?"  
ENTER 707;Screen\$  
PRINT Screen\$

---

### SHOW

Command selects which graphs scale factors are shown in the scale line; value must be 1, 2, 3, or 4. If higher than maximum graph currently displayed then value is rounded to that graph number with no error.

Query returns graph number shown on current scale-factor line of display.

**Command Syntax:** SHOW [GRAPH] { 1 | 2 | 3 | 4 }

Example: OUTPUT 707;"SHOW GRAPH 4"

**Query Syntax:** SHOW ?

Returned Format: [SHOW] GRAPH <NR1><crlf>

Example: OUTPUT 707;"SHOW?"  
ENTER 707;Show\$  
PRINT Show\$

## DISPLAY SUBSYSTEM

---

### STRing

Command displays the string starting at the current row and column specification. If the column limit (63) is reached, the text is wrapped to the next line irrespective of word boundaries. At the end of the string, the row and column is set to the next available number. If column limit is reached on row 4, the display is rolled up and the new line 4 is set to " " before the write operation continues. Refer to the LINE command for similar application.

**Command Syntax:** STRing < any quoted string >

Example: OUTPUT 707;"STRING ""Press INSERT to continue"""

---

### TEXT

TEXT OFF command sets menu previously displayed before text was turned on (no effect if text isn't on). TEXT ON saves current menu and puts on text menu. TEXT BLANK clears text memory, sets COLumn=1 and ROW=1, but doesn't affect what menu is displayed.

Query returns text on/off status.

**Command Syntax:** TEXT { [ OFF | 0 ]  
[ ON | 1 ]  
[ BLANK | 2 ] }

Example: OUTPUT 707;"TEXT ON"

**Query Syntax:** TEXT ?

Returned Format: [ TEXT ]<argument><crlf>

Example: OUTPUT 707;"TEXT ON"

## DISPLAY SUBSYSTEM

---

### VALues

Command controls the display of the cursor values readout. If off, the labels for the graphs are displayed.

Query returns the values mode.

Command Syntax: VALues { [ OFF | 0 ]  
                  [ ON | 1 ] }

Example: OUTPUT 707;"VALUES ON"

Query Syntax: VALues ?

Returned Format: [ VALues ]<argument><crlf>

Example: OUTPUT 707;"VALUES?"  
          ENTER 707;Values\$  
          PRINT Values\$

# DISPLAY SUBSYSTEM

---

## Notes

## GRAPH SUBSYSTEM

---

### GRAPh

The graph subsystem allows the user to define the graph source and to define graph specific measurement criteria when measurement mode is user defined. X-axis windowing can also be done using the graph subsystem.

The GRAPh command selects the graph that is the destination for the graph commands that follow.

The GRAPh query responds with all of the settings for the specified graph.

**Command Syntax:** GRAPh { 1 | 2 | 3 | 4 }

Example: OUTPUT 707;"GRAPh 1"

**Query Syntax:** GRAPh { 1 | 2 | 3 | 4 } ?

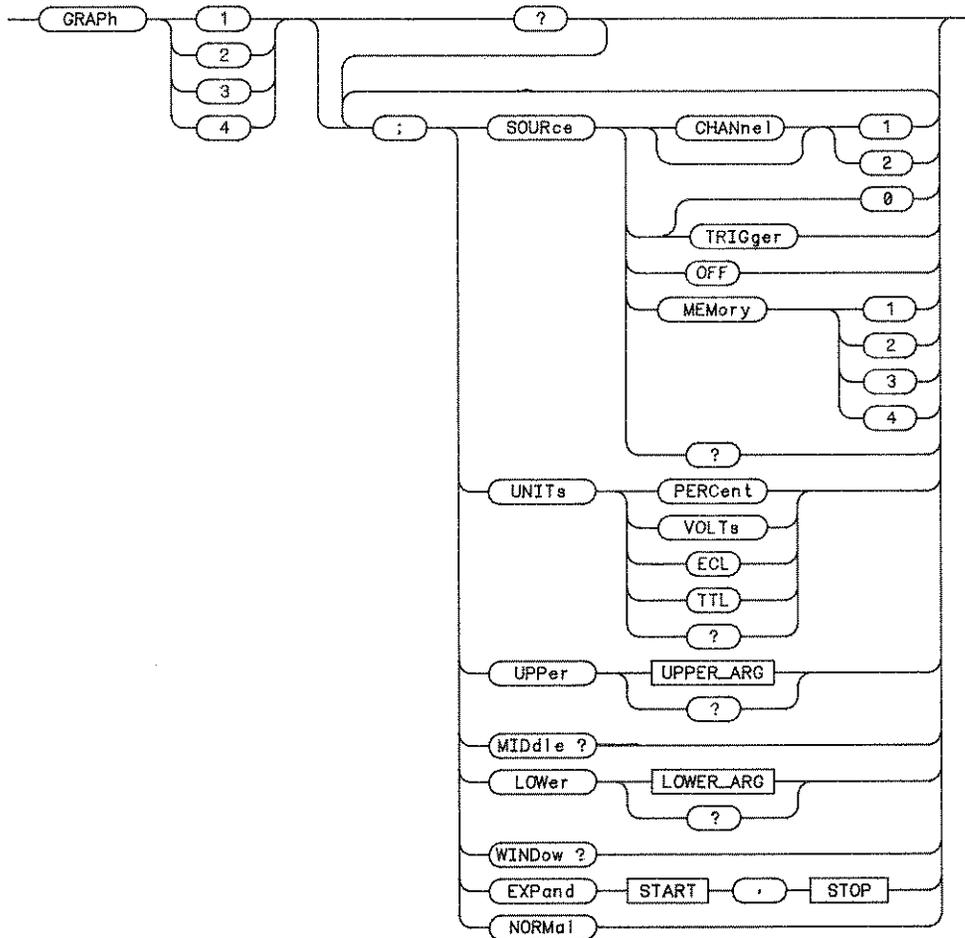
Returned Format: [GRAPh<NR1><crlf> ]  
 [SOURce]<source spec><crlf>  
 [UNITs]<argument><crlf>  
 [UPPer]{<NR1>|<NR3>}<crlf>  
 [LOWer]{<NR1>|<NR3>}<crlf>

Example: DIM Graph\$[70]  
 OUTPUT 707;"GRAPh 2?"  
 ENTER 707 USING "-K";Graph\$  
 PRINT USING "K";Graph\$

# GRAPH SUBSYSTEM

## GRAPh Commands:

SOURce  
 UNITs  
 UPPer  
 LOWer  
 MIDdle  
 WINDow  
 EXPand  
 NORMal



95420007

GRAPh Subsystem Syntax Diagram

## GRAPH SUBSYSTEM

---

### SOURce

Command selects the data source for the currently addressed graph. Query returns the data source displayed on the addressed graph.

```
Command Syntax:  SOURce {[ TRIGger    | 0  ]
                  [ CHANne11  | 1  ]
                  [ CHANne12  | 2  ]
                  [ OFF        ]
                  [ MEMory {0|1|2|3} ]}
```

Example: OUTPUT 707;"SOURCE CHANNEL1"

Query Syntax: SOURce ?

```
Returned Format : [SOURce]{[ CHANne11 ]
                          [ CHANne12 ]
                          [ TRIGger  ]
                          [ OFF      ]
                          [ MEMory0  ]
                          [ MEMory1  ]
                          [ MEMory2  ]
                          [ MEMory3  ]}
```

```
Example: OUTPUT 707;"SOURCE?"
         ENTER 707;Source$
         PRINT Source$
```

## GRAPH SUBSYSTEM

---

### UNITs

Command sets the measurement threshold units when user defined measurement mode is selected. Each units selection has its own settings for upper, middle, and lower.

Query returns the units selection in the user-defined mode for the addressed graph.

#### Note

*If the 54200A/D is currently in standard measurement mode, the query will still return the user-defined UNITs selection.*

**Command Syntax:** UNITs { [ PERCent | 0 ]  
[ VOLTs | 1 ]  
[ TTL | 2 ]  
[ ECL | 3 ] }

Example: OUTPUT 707;"UNITs PERCENT"

**Query Syntax:** UNITs ?

Returned Format: [UNITs ]<argument><crlf>

Example: OUTPUT 707;"UNITs?"  
ENTER 707;Units\$  
PRINT Units\$

---

### UPPer

Command sets upper measurement threshold if UNITs has been set to VOLTs or PERCent. The upper limit is preset for ECL and TTL. If UNITs has been set to PERCent, the allowable upper limit is from 55% to 99%.

Query returns the value of the upper measurement threshold.

**Command Syntax:** UPPer <upper limit>

Example: OUTPUT 707;"UPPER 85" (assuming UNITs has been set to PERCent)

**Query Syntax:** UPPer ?

Returned Format: [UPPer ] { [ <NR1> ] (if percent)  
[ <NR3> ] (if volts)  
[ <NR2> ] } <crlf> (if TTL or ECL)

Example: OUTPUT 707;"UPPER?"  
ENTER 707;Upper\$  
PRINT Upper\$



## GRAPH SUBSYSTEM

---

### WINDow

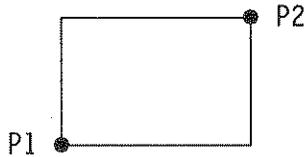
Query which returns a pair of (X,Y) coordinates describing the time and voltage limits of the graph display. Effectively these are P1 and P2 coordinates as used in plotter or HP Series 200 Controller window commands.

Query Syntax: WINDow ?

Returned Format: [WINDow]<NR3>,<NR3>,<NR3>,<NR3><cr>f>

where the first NR3 pair is the P1 (time,volts) and  
the second NR3 pair is the P2 (time,volts).

Example: DIM Window\$[50]  
OUTPUT 707;"WINDOW?"  
ENTER 707;Window\$  
PRINT Window\$



### EXPand

The graph expand function uses time rather than cursor location as the expansion criteria. The command sets the time at the starting point of the graph and at the stopping point of the graph. The graph must contain valid data or an error is generated.

The start time must be greater than or equal to the time of the first point of the waveform. The stop time must be less than or equal to the time of the last point. Minimum time (Stop - Start) must be  $\geq 54$  sample intervals, i.e., the minimum number of points displayed must be  $\geq 55$ .

The WINDow command is useful to determine the min and max values for start and stop times respectively.

Command Syntax: EXPand <start time>,<stop time>

Example: OUTPUT 707;"EXPAND 50E-9,125E-9"

---

### NORMal

Command sets graph to show entire waveform, unexpanded.

Command Syntax: NORMal

Example: OUTPUT 707;"NORMAL"

## MEASURE SUBSYSTEM

---

### MEASure

The measure subsystem provides access to the front panel measurement functions and also provides some special functions particularly useful in systems applications.

The MEASure command selects the measure subsystem for the commands that follow.

The MEASure query responds with the settings of the measure subsystem.

#### Command Syntax: MEASure

Example: OUTPUT 707;"MEASURE"

#### Query Syntax: MEASure ?

```
Returned Format: [ MEASure <crlf> ]
                 [ SOURce ] <source spec><crlf>
                 [ MODE ]<argument><crlf>
                 [ SENDvalid ]<argument><crlf>
                 [ DEFine]{DELay | 0 },<meas spec><crlf>
                 [ DEFine]{NWIDth | 1 },<meas spec><crlf>
                 [ DEFine]{PWIDth | 2 },<meas spec><crlf>
                 [ DEFine]{ENVelope | 3 },<meas spec><crlf>
```

```
Example: DIM Measure$[180]
         OUTPUT 707;"MEASURE?"
         ENTER 707 USING "-K";Measure$
         PRINT USING "K";Measure$
```

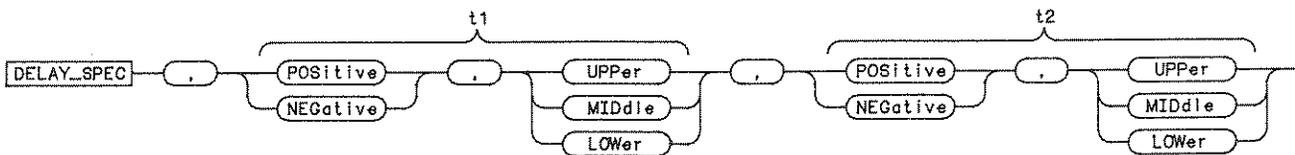
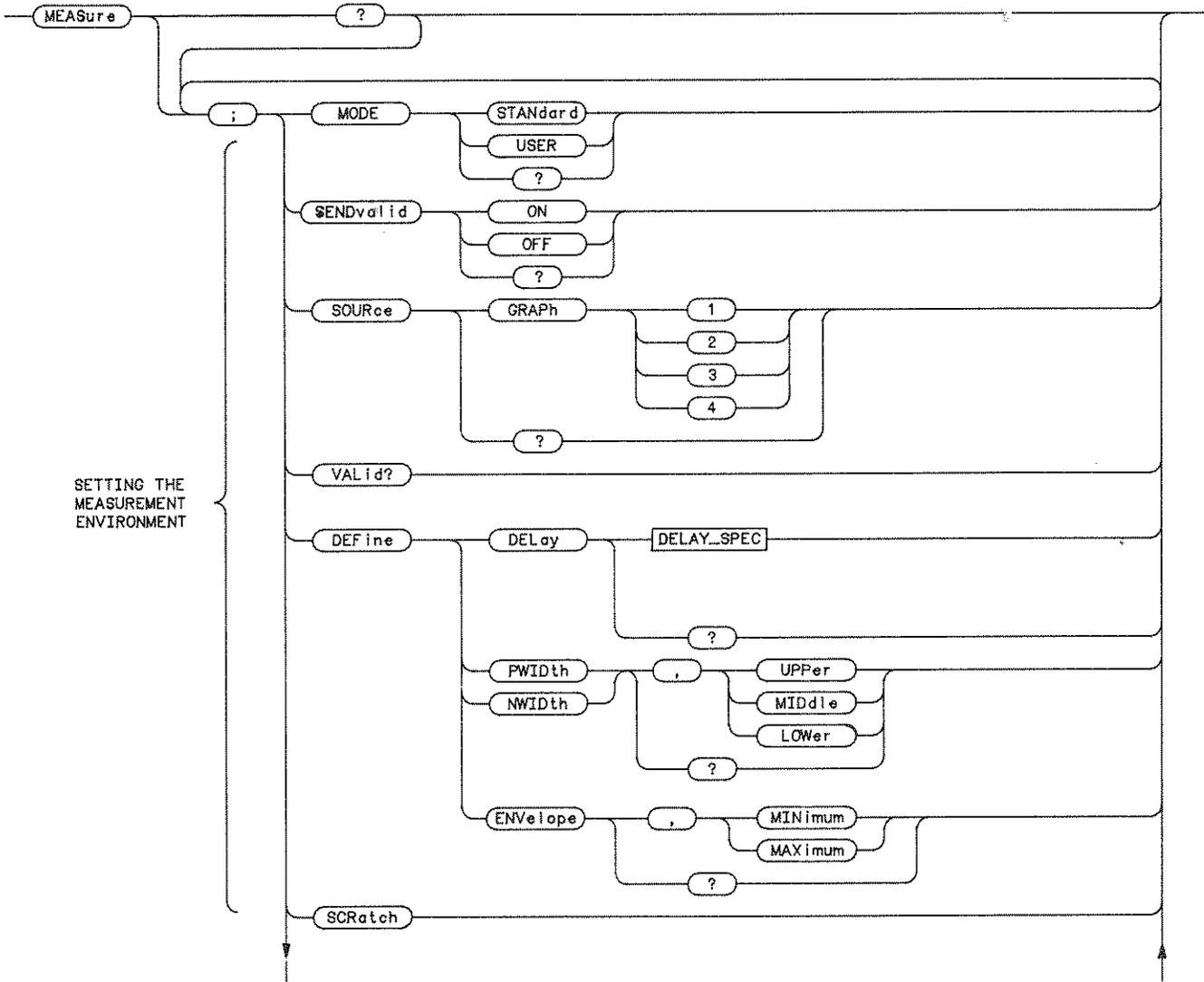
## MEASURE SUBSYSTEM

---

### MEASure Commands:

MODE	}	Setting the Measurement Environment
SENDvalid		
SOURCE		
VALID		
DEFine		
SCRatch		
RESULTS		Getting Answers
FREQUENCY	}	Defined Measurements
PERiod		
PWIDTH		
NWIDTH		
RISE		
FALL		
DUTYcycle		
VAMP		
VPP		
VMAX		
VMIN		
VRMS		
VTOP		
VBASE		
OVERshoot		
PREShoot		
DELay		
PTIME	}	Fundamental Measurements
VTIME		
PVOLT		
TVOLT		
TPOINT		
VPOINT		
CURSor		

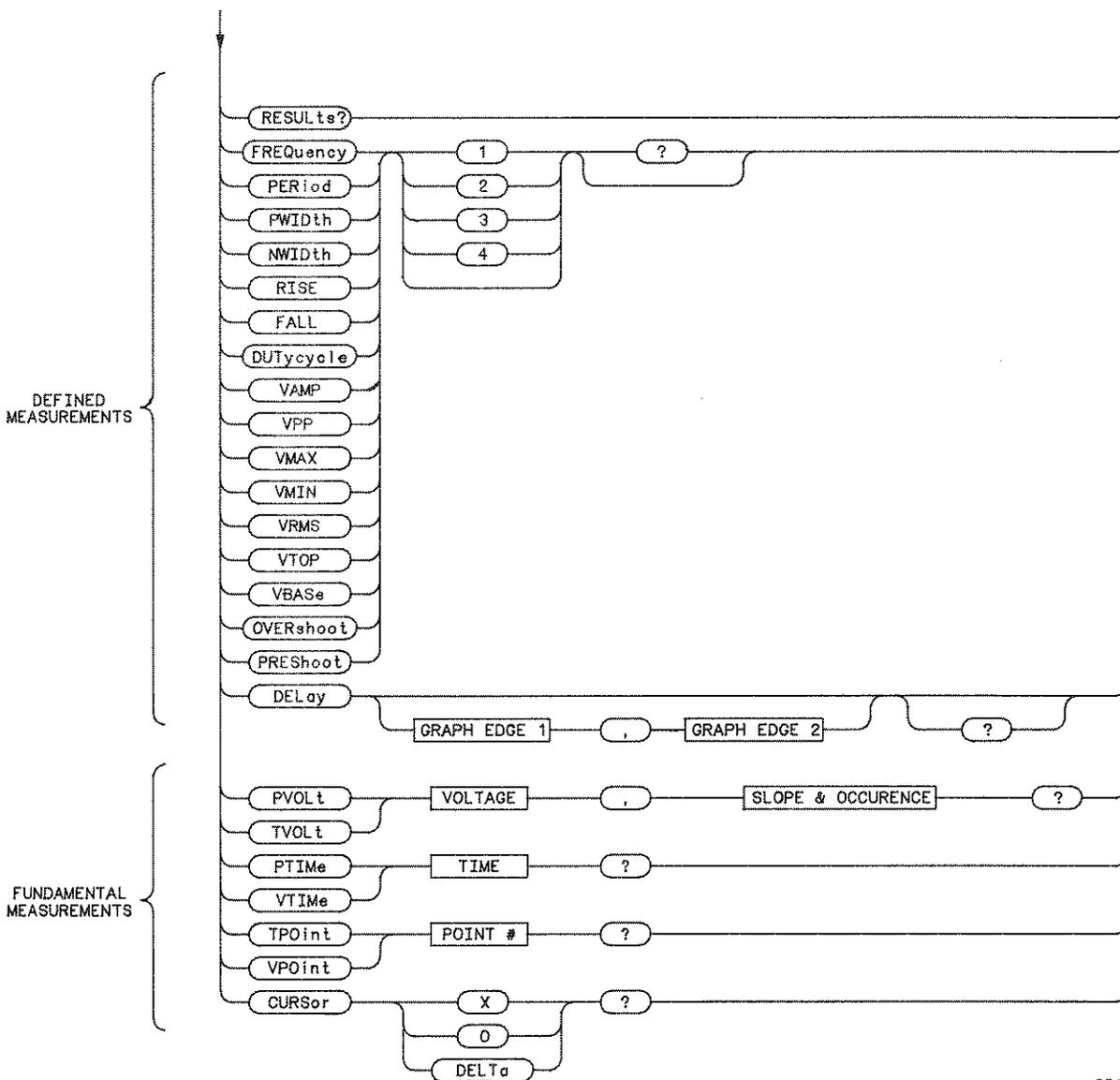
# MEASURE SUBSYSTEM



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MEASURE Subsystem Syntax Diagram

# MEASURE SUBSYSTEM



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MEASure Subsystem Syntax Diagram (Cont)

## MEASURE SUBSYSTEM

---

### SETTING THE MEASUREMENT ENVIRONMENT

54200A/D provides two basic modes for measurements, standard and user defined. In standard mode, reference levels are preset and measurement definitions are fixed. In user defined mode, reference levels may be individually selected for each graph and certain measurement definitions may be customized to better suit your application.

Graph reference thresholds are set in the graph subsystem.

All measurements are based upon the time voltage windows defined by the four graphs; measurements always reference graphs, not channels or memories directly. By expanding a graph, you can select a region of the waveform data to measure.

For graphs containing waveforms that are actively being acquired, the measurement occurs when the waveform is completely acquired, that is, the count parameter has been satisfied.

---

### MODE

Command sets the measurement mode (definitions and thresholds). User mode definitions are set by the MEASure DEFINE command. USER mode thresholds are set by the GRAPH subsystem UNITS, UPPER, and LOWER commands.

Query returns the current measurement mode.

**Command Syntax:** MODE { [ STANDARD | 0 ]  
[ USER | 1 ] }

Example: OUTPUT 707;"MODE STANDARD"

**Query Syntax:** MODE ?

Returned Format: [MODE]<argument><cr>f>

Example: OUTPUT 707;"MODE?"  
ENTER 707;Mode\$  
PRINT Mode\$

## MEASURE SUBSYSTEM

---

### SENDvalid

If command SENDvalid is ON, an optional parameter is sent by the 54200A/D with measurement RESULTS queries that qualifies the result. This parameter indicates why an invalid result occurred or that the measurement result is good data. The optional validity parameter returned with the RESULTS query is:

```
<validity> ::= { [ GOOD_DATA      | 1 ]
                 [ NO_WAVEFORM   | 0 ]
                 [ SCALING?      | -1 ]
                 [ THRESHOLD?    | -2 ]
                 [ CLIPPED       | -3 ]
                 [ NOT_FOUND     | -6 ] }
```

The SENDvalid query returns the current SENDvalid selection, ON or OFF.

**Command Syntax:** SENDvalid { [ ON | 1 ]  
[ OFF | 0 ] }

Example: OUTPUT 707;"SENDVALID ON"

**Query Syntax:** SENDvalid ?

Returned Format: [SENDvalid]<argument><crlf>

Example: OUTPUT 707;"SENDVALID?"  
ENTER 707;Send\$  
PRINT Send\$

---

### SOURCE

Command selects the graph to be addressed for the measurements that follow. This graph will be the default for measurement commands as well as the one used for the VALid query.

Query returns the currently addressed graph.

**Command Syntax:** SOURCE [GRAPH]{ 1 | 2 | 3 | 4 }

Example: OUTPUT 707;"SOURCE GRAPH 1"

**Query Syntax:** SOURCE ?

Returned Format:: [SOURCE] GRAPH<NR1><crlf>

Example: OUTPUT 707;"SOURCE?"  
ENTER 707;Source\$  
PRINT Source\$

## MEASURE SUBSYSTEM

---

### VALid

Query which returns the valid status for the currently addressed graph. The VALid arguments are the same as defined by SENDvalid.

Query Syntax: VALid ?

```
Returned Format: [VALid] {[ GOOD_DATA | 1 ]
                  [ NO_WAVEFORM | 0 ]
                  [ SCALING? | -1 ]
                  [ THRESHOLD? | -2 ]
                  [ CLIPPED | -3 ]
                  [ NOT_FOUND | -6 ]} <crlf>
```

```
Example: OUTPUT 707;"VALID?"
         ENTER 707;Valid$
         PRINT Valid$
```

---

### DEFine

When the measurement MODE command has been set to USER mode, definitions for customizing measurements can be set using the DEFine command.

The DEFine query returns the currently defined user definitions.

```
Command Syntax: DEFine {[ DELay | 0 ]
                        [ PWIDTH | 1 ]
                        [ NWIDTH | 2 ]
                        [ ENVELOPE | 3 ]} ,<measurement specification>
```

The PWIDTH measurement is made from the first rising threshold defined by the measurement specification to the next falling threshold. The NWIDTH measurement is made from the first falling threshold defined by the measurement specification to the next rising threshold. For both width measurements,

```
<measurement specification> ::= {[ MIDDLE | 0 ]
                                   [ UPPER | 1 ]
                                   [ LOWER | 2 ]}
```

```
Example: OUTPUT 707;"DEFINE PWIDTH,MIDDLE"
```

## MEASURE SUBSYSTEM

---

### DEFine (cont)

For DELay, both edge polarity and threshold level is definable,

```
<measurement specification> ::= <polarity>,<level>,<polarity>,<level>
```

```
<polarity> ::= {[ POSitive | 0 ]
                [ NEGative | 1 ]}
```

```
<level> ::= {[ MIDdle | 0 ]
              [ UPPer | 1 ]
              [ LOWer | 2 ]}
```

Example: OUTPUT 707;"DEFINE DELAY,POSITIVE,UPPER,POSITIVE,UPPER"

DEFine ENvelope allows the selection of the minimum waveform or the maximum waveform for the basic measurement commands VTIME, VPOINT, TVOLT, and PVOLT. For ENvelope,

```
<measurement specification> ::= {[ MINimum | 0 ]
                                   [ MAXimum | 1 ]}
```

Example: OUTPUT 707;"DEFINE ENVELOPE,MAXIMUM"

Query Syntax: DEFine {[ DELay ]  
 [ PWidth ]  
 [ NWidth ]  
 [ ENvelope ]} ?

```
Returned Format: [DEFine] {[ DELay | 0 ]
                       [ NWidth | 1 ]
                       [ PWidth | 2 ]
                       [ ENvelope | 3 ]} ,<meas spec><crlf>
```

```
Example: DIM Define${60}
          OUTPUT 707;"DEFINE DELAY?"
          ENTER 707;Define$
          PRINT Define$
```

---

### SCRatch

Command clears the voltage and time measurement lists from the display.

Command Syntax: SCRatch

Example: OUTPUT 707;"SCRATCH"

## MEASURE SUBSYSTEM

---

### EXECUTING MEASUREMENTS

The two modes of execution of measurements in the 54200A/D are immediate and queued.

- Immediate mode is performed when a measurement is specified as a query. The measurement is performed as the command is parsed and the results are entered into the output buffer.
- In queued mode, the measurement is added to the display list. The queued measurements are performed as a part of the normal acquisition cycle and results are displayed on screen. The results may be read over HP-IB by using the RESULTS query.

In addition to the defined measurement functions on the front panel, two other groups of fundamental measurements exist. The cursor values may be read over HP-IB and a set of general purpose time, voltage, and point measurements are provided.

#### Note

*The measurement will not be completed until the the parameter set up by the COUNT command in the ACQUIRE subsystem or the STORE command in the CHANNEL or TRIGGER subsystem has been satisfied. If the store mode is average, 4 to 256 acquisitions must be made before the measurement is complete (default is 4). If the store mode is envelope, 10 to 10000 acquisitions must be made before the measurement is complete (default is 100).*

---

### RESULTS

RESULTS is a query which causes the 54200A/D to output the list of active measurements.

Query Syntax: RESULTS ?

Returned Format: [RESULTS ]<# of measurements><crlf>  
 [<Time measurement list>]  
 [<Volt measurement list>]

<# of measurements> ::= integer from 0 to 6

<Time measurement list> and <Volt measurement list> ::=

```
[<measurement name> ]<value>[,<validity>]<crlf>
[<measurement name> ]<value>[,<validity>]<crlf>
[<measurement name> ]<value>[,<validity>]<crlf>
```

## MEASURE SUBSYSTEM

---

### RESULTS (cont)

Number of answers returned in Time measurement list can be from 0 to 3.

Number of answers returned in Volt measurement list can be from 0 to 3.

Validity parameter only returned if SENDvalid command is set ON.

```
<validity> ::= {[ GOOD_DATA      | 1 ]  
                [ NO_WAVEFORM   | 0 ]  
                [ SCALING?      | -1 ]  
                [ THRESHOLD?    | -2 ]  
                [ CLIPPED       | -3 ]  
                [ NOT_FOUND     | -6 ] }
```

```
Example: DIM Results$[200]  
         OUTPUT 707;"RESULTS?"  
         ENTER 707 USING "-K";Results$  
         PRINT Results$
```

---

### Defined Measurements

The following measurements are defined for 54200A/D:

```
<measurement name> ::= FREquency  
                        PERiod  
                        PWIDth  
                        NWIDth  
                        RISE  
                        FALL  
                        DUTycycle  
                        VAMP  
                        VPP  
                        VMAX  
                        VMIN  
                        VRMS  
                        VTOP  
                        VBASE  
                        OVERshoot  
                        PREShoot  
                        DELay
```

## MEASURE SUBSYSTEM

---

### Defined Measurements (cont)

With the exception of DELay, all follow the syntax:

**Command/Query Syntax:** <measurement name>[<graph number>][?]

DELay is specified with:

**Command/Query Syntax:** DELay [<graph of first edge>,<graph of second edge>][?]

If no graph is specified, the default graph is measured.

If the command form is specified, the measurement is added to the appropriate measurement list (time or volt) on the 54200A/D display and the answers are returned to the controller using the RESULTS query. If more than 3 measurements are specified for either the time or volt list, only the last 3 are retained (performed) and any others are discarded.

Example: OUTPUT 707;"FREQUENCY 1"      or  
 OUTPUT 707;"DELAY 1,2"

If the query form is specified, the measurement is performed immediately and not displayed on the 54200A/D. The results are placed in the output buffer of the 54200A/D with the following format for non-delay measurements:

Returned Format: [<meas name><graph number>,<graph number>,<value>[,<validity>]<crlf>

Example: DIM Rise[30]  
 OUTPUT 707;"RISE?"  
 ENTER 707;Rise\$  
 PRINT Rise\$

and with the following format for delay measurements:

Returned Format:

[<meas name><graph number>,<graph number>,<value>[,<validity>]<crlf>

Example: DIM Delay\$[30]  
 OUTPUT 707;"DELAY 1,2 ?"  
 ENTER 707;Delay\$  
 PRINT Delay\$

#### Note

*When any of these defined measurements are performed on envelope type waveforms, the minimum wave data is always used.*

## MEASURE SUBSYSTEM

---

### Fundamental Measurements

The following measurements are basic voltage, time, and point queries that can be used to create custom measurements not handled by the defined measurements. All queries reference the current measurement source waveform.

PTIME  
VTIME  
PVOLT  
TVOLT  
TPOInt  
VPOint

---

#### PTIME

If point of time is requested, the nearest point preceding the requested time is returned.

Query Syntax: PTIME <time> ?

Returned Format: [PTIME]<NR1><crlf>

Example: DIM Ptime\$[25]  
OUTPUT 707;"PTIME 500E-6 ?"  
ENTER 707;Ptime\$  
PRINT Ptime\$

---

#### VTIME

Query returns the interpolated voltage at the specified time.

#### Note

*If the waveform is type envelope and user mode is selected for measurements, the user definition of min/max is used to select which waveform to measure.*

Query Syntax: VTIME <time> ?

Returned Format: [VTIME ]<NR3><crlf>

Example: DIM Vtime\$[25]  
OUTPUT 707;"VTIME 2E-3 ?"  
ENTER 707;Vtime\$  
PRINT Vtime\$

## MEASURE SUBSYSTEM

---

### PVOLT

When point of voltage is requested, the waveform is searched from the first displayed point until an interval is found that contains the requested voltage.

The sign of <slope & occurrence> selects rising (+) or falling (-) edge. The magnitude of this parameter selects the occurrence count. For example, if <slope & occurrence>= -2, the waveform is searched for the second occurrence of the specified voltage on a negative slope. The nearest point preceding this interval is returned.

#### Note

*If the waveform is type envelope and user mode is selected for measurements, the user definition of min/max is used to select which waveform to measure.*

Query Syntax: PVOLT <voltage>,<slope & occurrence > ?

Returned Format: [PVOLT ]<NR1><crlf>

```
Example: DIM Pvolt$[25]
          OUTPUT 707;"PVOLT 200E-3,-3 ?"
          ENTER 707;Pvolt$
          PRINT Pvolt$
```

---

### TVOLT

When time of voltage is requested, the waveform is searched from the first displayed point until an interval is found that contains the requested voltage. Then a linear interpolation is done to estimate the time the voltage was traversed.

The sign of <slope & occurrence> selects rising (+) or falling (-) edge. The magnitude of this parameter selects the occurrence count. For example, if <slope & occurrence>= -2, the waveform is searched for the second occurrence of the specified voltage on a negative slope.

#### Note

*If the waveform is type envelope and user mode is selected for measurements, the user definition of min/max is used to select which waveform to measure.*

Query Syntax: TVOLT <voltage>,<slope & occurrence > ?

Returned Format: [TVOLT ]<NR3><crlf>

```
Example: DIM Tvolt$[25]
          OUTPUT 707;"TVOLT 5.5,+2 ?"
          ENTER 707;Tvolt$
          PRINT Tvolt$
```

## MEASURE SUBSYSTEM

---

### TPoint

Query returns the time of the specified point (1 to 1001).

Query Syntax: TPoint <point number> ?

Returned Format: [TPoint ]<NR3><crlf>

```
Example: DIM Tpoint$[25]
          OUTPUT 707;"TPOINT 267 ?"
          ENTER 707;Tpoint$
          PRINT Tpoint$
```

---

### VPoint

Query returns the voltage of the specified point (1 to 1001).

#### Note

*If the waveform is type envelope and user mode is selected for measurements, the user definition of min/max is used to select which waveform to measure.*

Query Syntax: VPoint <point number> ?

Returned Format: [VPoint ]<NR3><crlf>

```
Example: DIM Vpoint$[25]
          OUTPUT 707;"VPOINT 426 ?"
          ENTER 707;Vpoint$
          PRINT Vpoint$
```

## MEASURE SUBSYSTEM

---

### Cursor Values

Although the cursors are not programmable via the HP-IB, the cursor values may be read.

---

### CURSOR

If a query with X or O argument is executed, the 54200A/D returns an x,y pair representing the time and voltage at the point of the specified cursor.

If a query with the DELTA argument is executed, the 54200A/D returns an x,y pair representing the  $\Delta$  time and  $\Delta$  voltage between the points of the X and the O cursors.

The optional validity parameter is only returned if the SENDvalid command has been set to ON.

Query Syntax: CURSOR { [ DELTA | 0 ]  
                   [ X | 1 ]  
                   [ O | 2 ] } ?

Returned Format: [CURSOR ]<argument>,<Time>,<Voltage>[,<validity>]<crlf>

<Time> and <Voltage> are number type NR3

```
<validity> ::= { [ GOOD_DATA | 1 ]
                 [ NO_WAVEFORM | 0 ]
                 [ SCALING? | -1 ]
                 [ THRESHOLD? | -2 ]
                 [ CLIPPED | -3 ]
                 [ NOT_FOUND | -6 ] }
```

```
Example: DIM Cursor$[25]
         OUTPUT 707;"CURSOR DELTA ?"
         ENTER 707;Delta$
         PRINT Delta$
```

# MEASURE SUBSYSTEM

---

## Notes

## STATE SUBSYSTEM

---

### STATE

The state subsystem is available only on the 54200D and provides a means to program the state trigger function. The two major groupings of the state trigger commands are assignment and sequence.

- Assignment consists of defining the mode of state operation, and specifying the probe thresholds, labels and patterns.
- Sequence is the actual specification of the events that are needed before a state trigger is generated.

The STATE command selects the state subsystem as the destination for the commands that follow. The STATE query responds with all of the settings for the state subsystem.

**Command Syntax:** STATE

Example: OUTPUT 707;"STATE"

**Query Syntax:** STATE ?

Returned Format: [STATE <crLf> ]  
 [ASSignment <crLf>]  
 [MODE]<argument><crLf>  
 [MULTiplex]<argument><crLf> (normal mode only)  
 < clock specification >  
 [POD0 ]<NR2><crLf>  
 [POD1 ]<NR2><crLf>  
 [POD2 ]<NR2><crLf> (normal and qualified modes only)  
 {< label specification >}!!8! (maximum is 1 for bit fault modes)  
 [SEquence <crLf>]  
 [FIND ] <sequence find list><crLf>  
 [COUNT ]<NR1><crLf>  
 [OF ]<sequence trigger list><crLf>  
 [TERMs ]<argument><crLf>  
 [REStart ]<sequence restart list><crLf>

<clock specification> ::=

For normal mode, multiplexing off:

[CLOCK ] <argument>,<argument>,<argument><crLf>

For normal mode, multiplexing on or for qualified mode:

[MASTer] <argument>,<argument>,<argument><crLf>

[SLAVE ] <argument>,<argument>,<argument><crLf>

For missing or extra bit modes:

[DATA ] <argument><crLf>

[REFerence ] <argument><crLf>

## STATE SUBSYSTEM

---

### STATE (cont)

#### Note

*The following label commands apply to all defined labels. When used individually they refer to the currently addressed label.*

```
<label specification> ::=
  [LAbel ]<5 chars quoted><crlf>
  [POLarity ]<argument><crlf>
  [ALLocate ]<NR1>,<NR1>,<NR1><crlf>
  [BASE ]<argument><crlf>
  [PATtern ] A, <pattern expression><crlf>
  [PATtern ] B, <pattern expression><crlf>
  [PATtern ] C, <pattern expression><crlf>
  [PATtern ] D, <pattern expression><crlf>      (normal and qualified modes only)
```

```
<pattern expression> ::= { [ #H<hexadecimal expression> ]
                           [ <decimal expression> ]
                           [ #0<octal expression> ]
                           [ #Y<binary expression> ] }
```

```
<hexadecimal expression> ::= { 0|1|2|3|4|5|6|7|8|9|a|b|
                                c|d|e|f|A|B|C|D|E|F|X|$ }!1!7!
```

```
<decimal expression> ::= { 0|1|2|3|4|5|6|7|8|9|X|$ }!1!9!
```

```
<octal expression> ::= { 0|1|2|3|4|5|6|7|8|X|$ }!1!9!
```

```
<binary expression> ::= { 0|1|X }!1!27!
```

#### Note

*"\$" valid for query only. An "X" specifies a don't care state, while a "\$" specifies an undefined state. "Don't cares" in one value base cannot always be translated to another base.*

```
Example: DIM State$[500]
          OUTPUT 707;"STATE?"
          ENTER 707 USING "-K";State$
          PRINT USING "K";State$
```

# STATE SUBSYSTEM

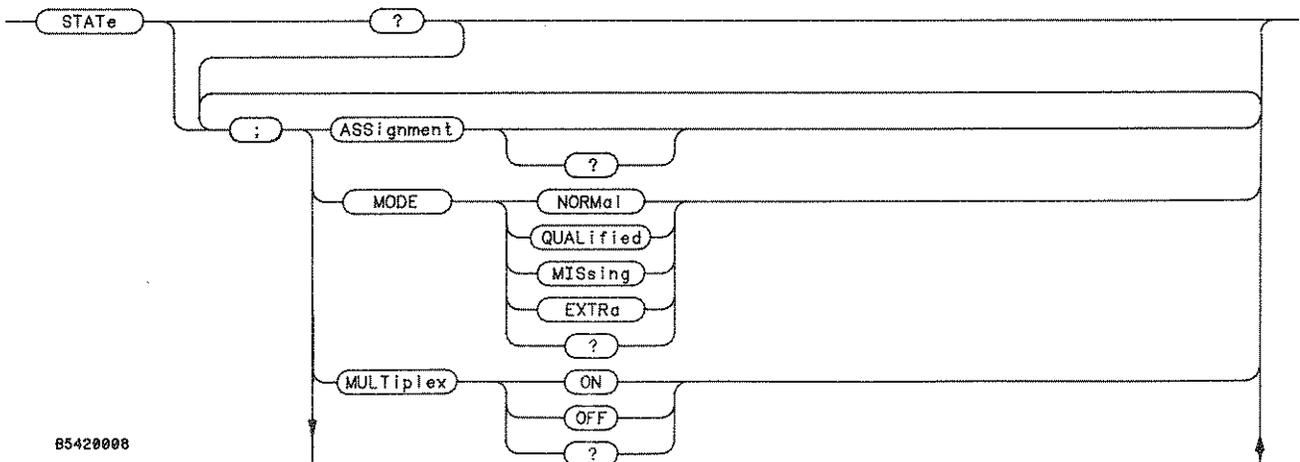
## STATE Commands:

### Assignment Commands

ASSignment  
 MODE  
 MULTiplex  
 CLOCK  
 MASTER  
 SLAVE  
 DATA  
 REFERENCE  
 POD0  
 POD1  
 POD2  
 LABEL  
 INSERT  
 DELETE  
 POLarity  
 ALLOCate  
 BASE  
 PATtern

### Sequence Commands

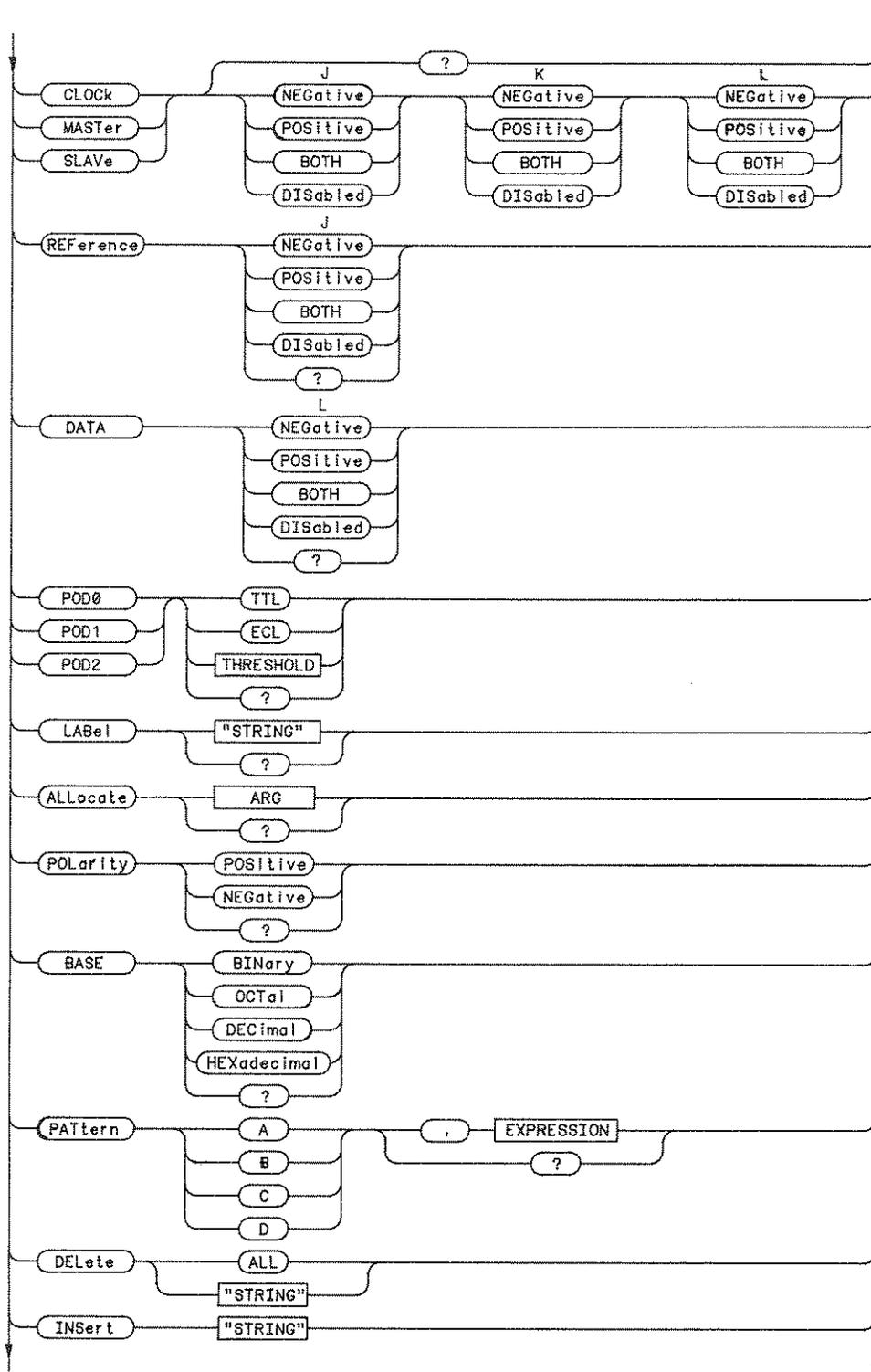
SEQUence  
 FIND  
 COUNT  
 OF  
 TERMS  
 RESTART



B5420008

STATE Subsystem Syntax Diagram (Assignment)

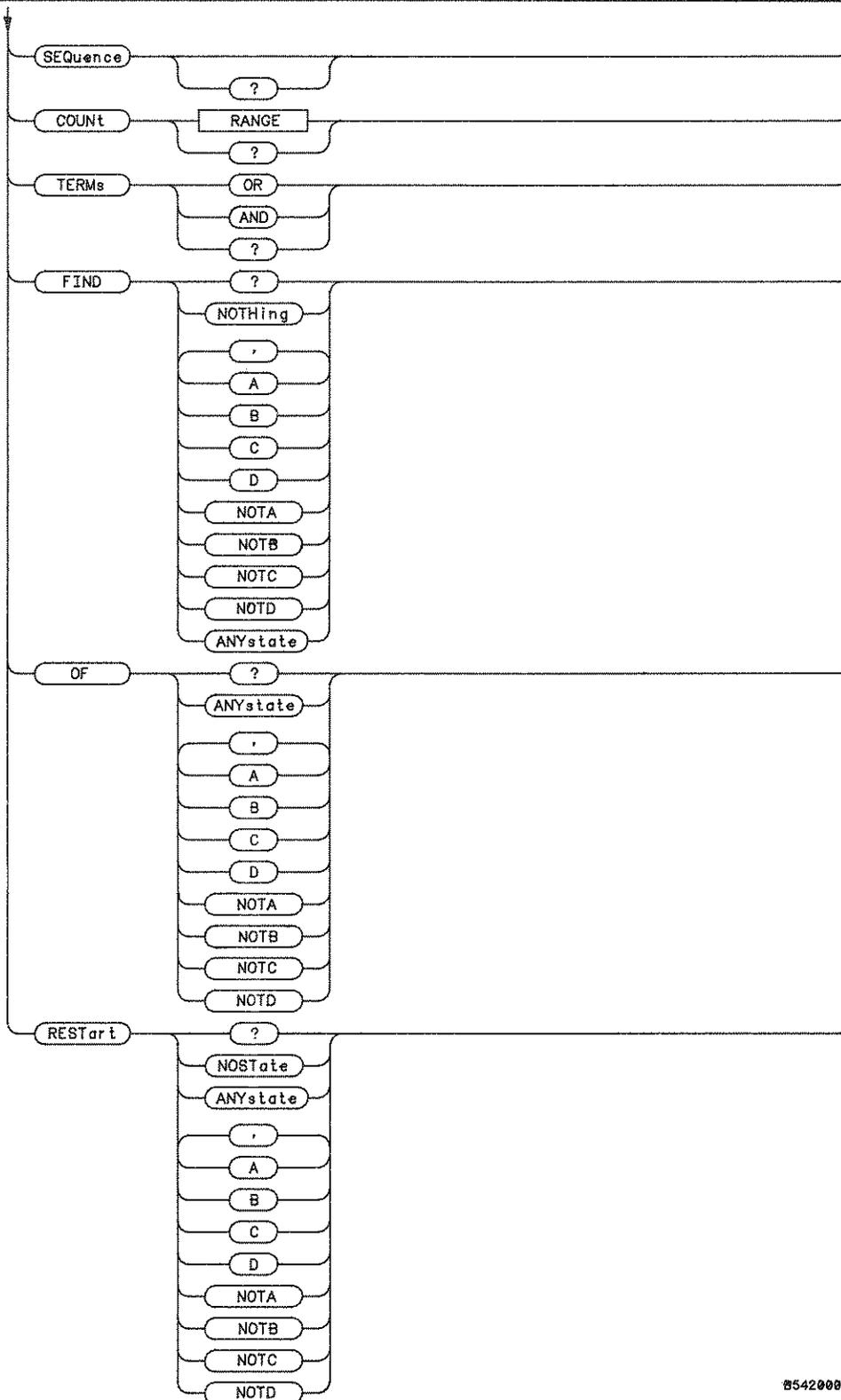
# STATE SUBSYSTEM



B5420008

STATE Subsystem Syntax Diagram (ASSignment cont)

# STATE SUBSYSTEM



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STATE Subsystem Syntax Diagram (SEQUence)

## STATE SUBSYSTEM

---

### Assignment Commands

#### ASSignment

Command enables state assignment queries to be returned intact.  
Query returns the current assignment settings.

Command Syntax: ASSignment

Example: OUTPUT 707;"ASSIGNMENT"

Query Syntax: ASSignment ?

Returned Format: [STATE <crLf> ]  
[ASSignment <crLf>]  
[MODE]<argument><crLf>  
[MULTiplex]<argument><crLf> (normal mode only)  
< clock specification >  
[POD0 ]<NR2><crLf>  
[POD1 ]<NR2><crLf>  
[POD2 ]<NR2><crLf> (normal and qualified modes only)  
{< label specification >}!!18! (maximum is 1 for bit fault modes)

Example: DIM Assign\$[200]  
OUTPUT 707;"ASSIGNMENT?"  
ENTER 707 USING "-K";Assign\$  
PRINT USING "K";Assign\$

---

#### MODE

Command sets the state trigger mode. Query returns the current mode selection.

Command Syntax: MODE {[ NORMAl | 0 ]  
[ QUALified | 1 ]  
[ MISSing | 2 ]  
[ EXTRa | 3 ]}

Example: OUTPUT 707;"MODE QUALIFIED"

Query Syntax: MODE ?

Returned Format: [MODE ]<argument><crLf>

Example: OUTPUT 707;"MODE?"  
ENTER 707;Mode\$  
PRINT Mode\$

## STATE SUBSYSTEM

---

### MULTIplex

Command defines multiplexing of clocks when state is in normal mode; other modes have predefined multiplexing. Query returns the multiplexing mode in effect when in normal mode.

Command Syntax: MULTIplex {[ ON | 1 ]  
[ OFF | 0 ]}

Example: OUTPUT 707;"MULTIPLEX ON"

Query Syntax: MULTIplex ?

Returned Format: [MULTIplex ]<argument><crlf>

Example: OUTPUT 707;"MULTIPLEX?"  
ENTER 707;Mult\$  
PRINT Mult\$

---

### CLOCK

Command sets the clock polarities for the master clock used in the normal mode with multiplexing off. Query returns the master clock settings used in normal with multiplexing off.

Command Syntax: CLOCK <J clock spec>,<K clock spec>,<L clock spec>

< any clock spec > ::= {[ NEGative | 0 ]  
POSitive | 1 ]  
BOTH | 2 ]  
DISabled | 3 ]}

Example: OUTPUT 707;"CLOCK POSITIVE,NEGATIVE,POSITIVE"

Query Syntax: CLOCK

Returned Format: [CLOCK]<J clock spec>,<K clock spec>,<L clock spec><crlf>

Example: DIM Clock\$[50]  
OUTPUT 707;"CLOCK?"  
ENTER 707;Clock\$  
PRINT Clock\$

## STATE SUBSYSTEM

---

### MASTER

Command sets the clock polarities for the master clock used in normal mode with multiplexing on or in qualified mode. Query returns the master clock settings used in normal mode with multiplexing off and qualified modes.

**Command Syntax:** MASTER <J clock spec>,<K clock spec>,<L clock spec>

```
< any clock spec > ::= { [ NEGative | 0 ]
                        [ POSitive | 1 ]
                        [ BOTH | 2 ]
                        [ DISabled | 3 ] }
```

Example: OUTPUT 707;"MASTER NEGATIVE,NEGATIVE,NEGATIVE"

**Query Syntax:** MASTER ?

Returned Format: [MASTER]<J clock spec>,<K clock spec>,<L clock spec><crLf>

```
Example: DIM Master$[50]
         OUTPUT 707;"MASTER?"
         ENTER 707;Master$
         PRINT Master$
```

---

### SLAVE

Command sets the clock polarities for the slave clock used in normal multiplex mode or qualified mode. Query returns the slave clock settings used in normal multiplex and qualified modes.

**Command Syntax:** SLAVE <J clock spec>,<K clock spec>,<L clock spec>

```
< any clock spec > ::= { [ NEGative | 0 ]
                        [ POSitive | 1 ]
                        [ BOTH | 2 ]
                        [ DISabled | 3 ] }
```

Example: OUTPUT 707;"SLAVE POSITIVE,POSITIVE,POSITIVE"

**Query Syntax:** SLAVE ?

Returned Format: [SLAVE]<J clock spec>,<K clock spec>,<L clock spec><crLf>

```
Example: DIM Slave$[50]
         OUTPUT 707;"SLAVE?"
         ENTER 707;Slave$
         PRINT Slave$
```

## STATE SUBSYSTEM

---

### DATA

Command sets the clock polarity for the serial data clock in extra or missing bit modes. Query returns the serial data clock setting used in extra or missing bit modes.

Command Syntax: DATA <L clock spec>

```
< L clock spec > ::= { [ NEGative | 0 ]
                       [ POSitive | 1 ]
                       [ BOTH | 2 ]
                       [ DISabled | 3 ] }
```

Example: OUTPUT 707;"DATA BOTH"

Query Syntax: DATA ?

Returned Format: [DATA ]<L clock spec><crlf>

```
Example: OUTPUT 707;"DATA?"
         ENTER 707;Data$
         PRINT Data$
```

---

### REFerence

Command sets the clock polarity for the reference cell clock used in extra or missing bit modes. Query returns the reference cell clock setting used in extra or missing bit modes.

Command Syntax: REFerence <J clock spec>

```
< J clock spec > ::= { [ NEGative | 0 ]
                       [ POSitive | 1 ]
                       [ BOTH | 2 ]
                       [ DISabled | 3 ] }
```

Example: OUTPUT 707;"REFERENCE POSITIVE"

Query Syntax: REFerence ?

Returned Format: [REFerence ]<J clock spec><crlf>

```
Example: OUTPUT 707;"REFERENCE?"
         ENTER 707;Ref$
         PRINT Ref$
```

## STATE SUBSYSTEM

---

### POD

Command sets the threshold for the specified pod. TTL and ECL are presets. <NR2> has the range -9.9 to 9.9 volts. Query returns the settings for the specified pod. ECL and TTL are returned as voltage values.

**Command Syntax:** { POD0 | POD1 | POD2 } { [ TTL ]  
[ ECL ]  
[ <NR2> ] }

Example: OUTPUT 707;"POD0 TTL"

**Query Syntax:** { POD0 | POD1 | POD2 } ?

Returned Format: [ POD0 | POD1 | POD2 ]<NR2><crlf>

Example: OUTPUT 707;"POD2?"  
ENTER 707;Pod2\$  
PRINT Pod2\$

---

### LABel

The label command addresses a particular label up to five characters long as the destination for the label commands that follow. A valid label name cannot be all spaces (" "). If the label does not exist, then a new label is added to the list, unless the list is full. If all labels had been previously deleted, the dummy first label is replaced with the new label entered.

Label names are sensitive to leading spaces. If the label name is less than 5 characters, spaces are appended to pad to 5 characters. Thus "A" becomes "A ", and "A " is unique from " A".

When a new label is declared, its polarity is defaulted to positive, and all bits are allocated.

In normal and qualified modes, up to 8 labels may be used. In the bit fault modes, only one label is permitted. There is a unique label list held for each of the two cases.

Query returns the currently addressed label.

**Command Syntax:** LABEL <string>

Example: OUTPUT 707;"LABEL ""DATA"""

**Query Syntax:** LABel ?

Returned Format: [LABel ]<string><crlf>

Example: OUTPUT 707;"LABEL?"  
ENTER 707;Label\$  
PRINT Label\$



## STATE SUBSYSTEM

---

### BASE

Command Selects the base in which the pattern resource terms are displayed for the addressed label and sets the base for query responses. Binary is the most useful in many cases since any pattern of don't cares is expressible without "\$".

Query returns the selected display base.

Command Syntax: BASE { [ BINary | 0 ]  
[ OCTal | 1 ]  
[ DECima | 2 ]  
[ HEXadecima | 3 ] }

Example: OUTPUT 707;"HEXADECIMAL"

Query Syntax: BASE ?

Returned Format: [BASE ]<argument><crlf>

Example: OUTPUT 707;"BASE?"  
ENTER 707;Base\$  
PRINT Base\$

---

### DELeTe

Command which deletes either all labels or the label specified. If all labels are deleted, a temporary place holding label is written to the first label location since front panel operation requires at least one label to be displayed. However, this label is replaced when a new label is defined with the LABEL command or the INSERT command. The place holder is considered a valid label if any of its attributes are changed or after reset or power cycle, and it is used for triggering.

Command Syntax: DELeTe { [ ALL ]  
[ <5 characters quoted> ] }

Example: OUTPUT 707;"DELETE ""DATA """

---

### INSert

Command allows a new label to be added to the list directly following the currently addressed label. Similar in action to the label command except the label name must be unique, that is, the insert command cannot be used to merely address a label. Refer to the LABEL command for more details.

Command Syntax: INSert <5 characters quoted>

Example: OUTPUT 707"INSERT" C1k ""

## STATE SUBSYSTEM

---

### PATtern

Command defines the selected resource term for the addressed label. Pattern D is not allowed for missing or extra bit modes.

Query returns the specified pattern expression for the addressed label.

**Command Syntax:** PATtern <which pattern>,<pattern expression>

<which pattern> ::= { A|B|C|D }

<pattern expression> ::= { [ #H<hexadecimal expression> ]  
 [ <decimal expression> ]  
 [ #0<octal expression> ]  
 [ #Y<binary expression> ] }

<hexadecimal expression> ::= { 0|1|2|3|4|5|6|7|8|9|a|b|  
 c|d|e|f|A|B|C|D|E|F|X|\$ }!1!7!

<decimal expression> ::= { 0|1|2|3|4|5|6|7|8|9|X|\$ }!1!9!

<octal expression> ::= { 0|1|2|3|4|5|6|7|8|X|\$ }!1!9!

<binary expression> ::= { 0|1|X }!1!27!

#### Note

*"\$" valid for query only. An "X" specifies a don't care state, while a "\$" specifies an undefined state. "Don't cares" in one value base cannot always be translated to another base.*

Example: OUTPUT 707;"PATTERN A,#Y01110001"

**Query Syntax:** PATtern <which pattern> ?

Returned Format: [PATtern ] <which pattern>,<pattern expression><cr|f>

Example: DIM Pattern\${50}  
 OUTPUT 707;"PATTERN?"  
 ENTER 707;Pattern\$  
 PRINT Pattern\$

## STATE SUBSYSTEM

---

### Sequence Commands

#### SEquence

Command enables sequence queries to be returned intact.  
Query returns the current sequence settings.

Command Syntax: SEquence

Example: OUTPUT 707;"SEQUENCE"

Query Syntax: SEquence ?

Returned Format: [SEquence <crLf> ]  
[FIND ] <sequence find list><crLf>  
[COUNT ]<NRI><crLf>  
[OF ]<sequence trigger list><crLf>  
[TERMs ]<argument><crLf>  
[REStArt ]<sequence restart list><crLf>

Example: DIM Seq\$[200]  
OUTPUT 707;"SEQUENCE?"  
ENTER 707;Seq\$  
PRINT Seq\$

## STATE SUBSYSTEM

---

### FIND

Command defines the sequence terms that must be found before the trigger term. There can be 0, 1, 2, or 3 sequence terms. "FIND NOTHING" specifies the 0 term case. Terms "D" and "NOTD" are not permitted in missing bit and extra bit modes.

Query returns the sequence term list.

**Command Syntax:** FIND < sequence find list >

```
< sequence find list > ::= {[ NOTHING | 0 ]
                             [ <list item> [,<list item> [,<list item> ] ] ] }
```

```
<list item> ::= {[ ANYState | 1 ]
                  [ A       | 2 ]
                  [ B       | 3 ]
                  [ C       | 4 ]
                  [ D       | 5 ]
                  [ NOTA    | 6 ]
                  [ NOTB    | 7 ]
                  [ NOTC    | 8 ]
                  [ NOTD    | 9 ] }
```

Example: OUTPUT 707;"FIND ANYSTATE"

**Query Syntax:** FIND

Returned Format: [FIND ]<sequence find list><crLf>

```
Example: OUTPUT 707;"FIND"
         ENTER 707;Find$
         PRINT Find$
```

---

### COUNT

Command programs the trigger term occurrence count. Range is 1..59999.  
Query returns the occurrence count.

**Command Syntax:** COUNT < NRI >

Example: OUTPUT 707;"COUNT 154"

**Query Syntax:** COUNT ?

Returned Format: [COUNT ]<NRI><crLf>

```
Example: OUTPUT 707;"COUNT?"
         ENTER 707;Count$
         PRINT Count$
```

## STATE SUBSYSTEM

---

### OF

Command defines the trigger term. 1 to 4 terms may be used in the compound expression. Only one term may be specified if using "ANYState" list item. The "TERMs" command defines whether the terms "or" or "and". This command is not valid for missing bit and extra bit modes.

Query returns the compound trigger term.

**Command Syntax:** OF < sequence trigger list >

```
<sequence trigger list> ::=
    <list item>[,<list item>[,<list item>[,<list item>]]]
```

```
<list item> ::= { [ ANYState | 1 ]
                  [ A         | 2 ]
                  [ B         | 3 ]
                  [ C         | 4 ]
                  [ D         | 5 ]
                  [ NOTA      | 6 ]
                  [ NOTB      | 7 ]
                  [ NOTC      | 8 ]
                  [ NOTD      | 9 ] }
```

**Query Syntax:** OF ?

Returned Format: [ OF ] <sequence trigger list ><crlf>

```
Example: DIM OF$[50]
         OUTPUT 707;"OF?"
         ENTER 707;Of$
         PRINT Of$
```

---

### TERMs

Command defines whether to "or" or "and" the trigger terms.  
Query returns the "and" or "or" mode for the trigger terms.

**Command Syntax:** TERMs { [ OR | 0 ]  
 [ AND | 1 ] }

Example: OUTPUT 707;"TERMs AND"

**Query Syntax:** TERMs ?

Returned Format: [ TERMs ]<argument><crlf>

```
Example: OUTPUT 707;"TERMs?"
         ENTER 707;Terms$
         PRINT Terms$
```

## STATE SUBSYSTEM

---

### REStart

Defines the restart expression. 1 to 4 terms may be used in a compound expression. Only one term may be specified if using "NOSTate" or "ANYState" list items. The "D" and "NOTD" terms are not permitted in missing bit or extra bit modes.

Query returns the restart expression.

**Command Syntax:** REStart <sequence restart list>

```
<sequence restart list>::=
  <list item>[,<list item>[,<list item>[,<list item>]]]
```

```
<list item>::= { [ ANYState | 1 ]
                 [ A         | 2 ]
                 [ B         | 3 ]
                 [ C         | 4 ]
                 [ D         | 5 ]
                 [ NOTA      | 6 ]
                 [ NOTB      | 7 ]
                 [ NOTC      | 8 ]
                 [ NOTD      | 9 ]
                 [ NOSTate   | 10 ] }
```

Example: OUTPUT 707;"RESTART B,NOTC"

**Query Syntax:** REStart ?

Returned Format: [REStart ]<sequence restart list><crlf>

```
Example: DIM Restart$[50]
         OUTPUT 707;"RESTART?"
         ENTER 707;Restart$
         PRINT Restart$
```

# STATE SUBSYSTEM

---

## Notes

## TIMEBASE SUBSYSTEM

---

### TIMEbase

The timebase group controls all "X axis" oscilloscope functions.

The TIMEbase command selects timebase as the destination for the commands that follow.

The TIMEbase query responds with all of the settings for the timebase.

#### Command Syntax: TIMEbase

Example: OUTPUT 707;"TIMEBASE"

#### Query Syntax: TIMEbase ?

```
Returned Format : [ TIMEbase]<crlf>
                  [ MODE]<argument><crlf>
                  [ RANGE]<NR3><crlf>
                  [ DELay]<NR3><crlf>
                  [ REFerence]<argument><crlf>
                  [ ALIAStest]<argument><crlf>
                  [ SCALE]<argument><crlf>
```

```
Example: DIM Time$[130]
          OUTPUT 707;"TIMEBASE?"
          ENTER 707 USING "-K";Time$
          PRINT USING "K";Time$
```

# TIMeBASE SUBSYSTEM

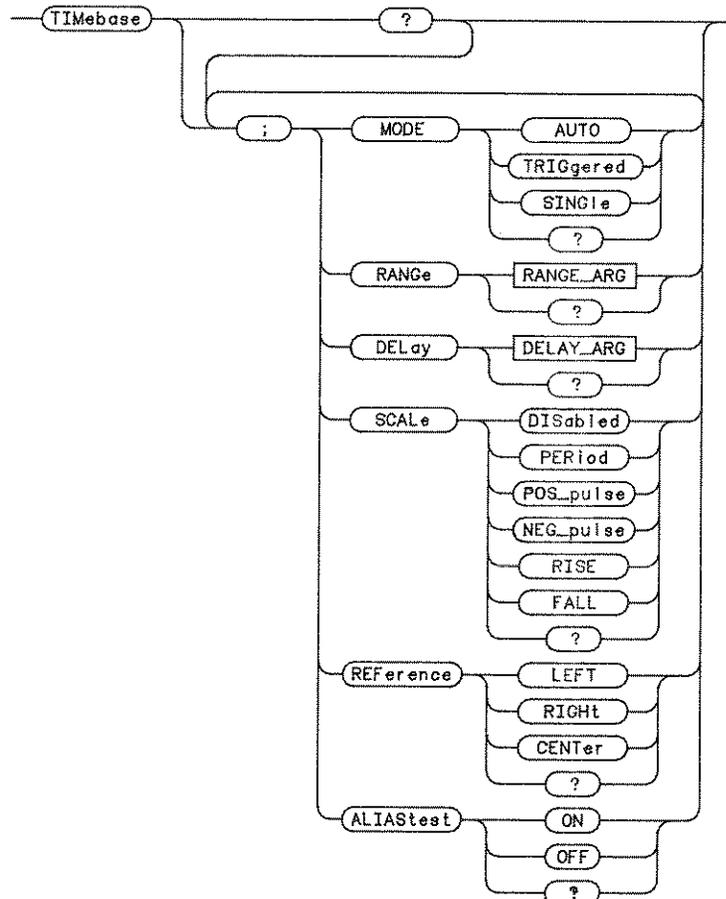
---

## TIMebase Commands:

MODE  
RANGe  
DELay  
REFerence  
ALIAStest  
SCALE  
RATE

Timebase commands are order dependent in that delay limits are determined by the current range setting.

---



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*TIMebase Subsystem Syntax Diagram*

## TIMEBASE SUBSYSTEM

---

### MODE

Command sets the timebase sweep mode.  
Query returns the current sweep mode.

Command Syntax: MODE { [ AUTO | 0 ]  
                  [ TRIGgered | 1 ]  
                  [ SINGLe | 2 ] }

Example: OUTPUT 707;"AUTO"

Query Syntax: MODE ?

Returned Format: [MODE]<argument><crlf>

Example: OUTPUT 707;"MODE?"  
          ENTER 707;Mode\$  
          PRINT Mode\$

---

### RANGE

Command sets timebase range (s/div \* 10 div). Range is from 50 ns to 10 s in a 1-2-5 sequence. If a range is entered that is not in this sequence, the number will be rounded up to the next larger range.

Query returns the current range setting.

Command Syntax: RANGE <NR3>

Example: OUTPUT 707;"RANGE 50E-3"

Query Syntax: RANGE ?

Returned Format:: [RANGe]<NR3><crlf>

Example: OUTPUT 707;"RANGE?"  
          ENTER 707;Range\$  
          PRINT Range\$

## TIMEBASE SUBSYSTEM

---

### DElay

Command sets time to current reference point from trigger. Delay range is defined as follows.

<u>Time Range</u>	<u>Pre-Trigger Delay Range</u>	<u>Post-Trigger Delay Range</u>
50 ns to 5 $\mu$ s	Up to 5 $\mu$ s	Up to 1 ms
10 $\mu$ s to 10 s	Up to 1 screen diam.	Up to 260 screen diam.

Query returns current delay setting.

**Command Syntax:** DELay <NR3>

Example: OUTPUT 707;"DELAY 50E-6"

**Query Syntax:** DELay ?

Returned Format: [DElay]<NR3><crlf>

Example: OUTPUT 707;"DELAY?"  
ENTER 707;DeLay\$  
PRINT DeLay\$

---

### REFerence

Command sets the reference point for delay such that delay specifies the time of point 1 (LEFT), point 501 (CENTer), or point 1001 (RIGHT).

Query returns the current delay reference point.

**Command Syntax:** REFerence { [ LEFT | 0 ]  
[ CENTer | 1 ]  
[ RIGHT | 2 ] }

Example: OUTPUT 707;"REFERENCE CENTER"

**Query Syntax:** REFerence ?

Returned Format: [REFerence]<argument><crlf>

Example: OUTPUT 707;"REFERENCE?"  
ENTER 707;Ref\$  
PRINT Ref\$

## TIMEBASE SUBSYSTEM

---

### ALIAStest

Command sets alias test mode. If on, then a trigger is used to count the number of trigger crossings over the acquisition window to determine whether the fundamental of the trigger signal would generate an alias.

Query returns the currently selected alias test mode.

**Command Syntax:** ALIAStest {[ DISabled | 0 ]  
[ ENABled | 1 ]}

Example: OUTPUT 707;"ALIASTEST ENABLED"

**Query Syntax:** ALIAStest ?

Returned Format: [ALIAStest]<argument><crlf>

Example: OUTPUT 707;"ALIASTEST?"  
ENTER 707;Alias\$  
PRINT Alias\$

---

### SCALE

Command sets autoscale mode for timebase.

Query returns the current autoscale mode.

**Command Syntax:** SCALE {[ DISabled | 0 ]  
[ PERiod | 1 ]  
[ POS\_pulse | 2 ]  
[ NEG\_pulse | 3 ]  
[ RISE | 4 ]  
[ FALL | 5 ]}

Example: OUTPUT 707;"SCALE PERIOD"

**Query Syntax:** SCALE ?

Returned Format: [SCALE]<argument><crlf>

Example: OUTPUT 707;"SCALE?"  
ENTER 707;Scale\$  
PRINT Scale\$

## TIMEBASE SUBSYSTEM

---

### RATE

Command sets time range in terms of sample rate. Sample period is range/1000, rate is 1/period. The rate is displayed on the 54200A/D time menu in the "Sampling @" field.

Query returns the current sample rate.

**Command Syntax:** RATE <NR3>

Example: OUTPUT 707;"RATE 10E7"

**Query Syntax:** RATE ?

Returned Format: [RATE ]<NR3><crlf>

Example: OUTPUT 707;"RATE?"  
ENTER 707;Rate\$  
PRINT Rate\$

## TRIGGER SUBSYSTEM

---

### TRIGger

The trigger group controls all analog trigger functions, including selecting the type of data to be acquired for trigger view.

The TRIGger command selects trigger subsystem as the destination for the trigger commands that follow. Included are the analog trigger and the overall selection of trigger mode (analog, armed, state-only).

The TRIGger query responds with all of the settings for the analog trigger.

**Command Syntax:** TRIGger

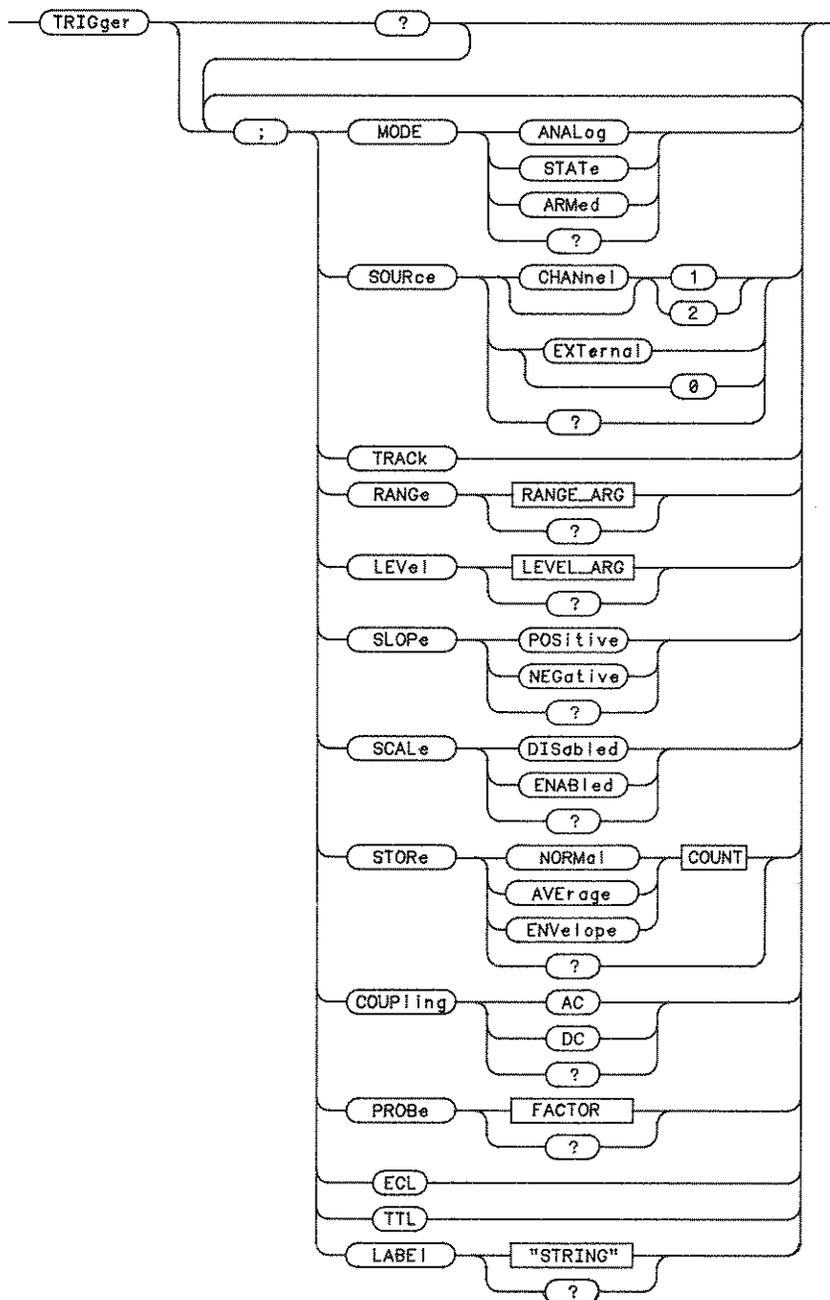
Example: OUTPUT 707;"TRIGGER"

**Query Syntax:** TRIGger ?

Returned Format: [TRIGger<crlf>]  
 [MODE]<argument><crlf>  
 [SOURCE][CHANnel<NR1>| EXTERNAL]<crlf>  
 [PROBe]<NR1><crlf>  
 [RANGe]<NR3><crlf>  
 [SLOPe]<argument><crlf>  
 [LEVe1]<NR3><crlf>  
 [COUP1ing]<argument><crlf>  
 [LABe1]< 10 chars quoted ><crlf>  
 [STORe]<argument>,<NR1><crlf>  
 [SCALe]<argument><crlf>

Example: DIM Trig\$[200]  
 OUTPUT 707;"TRIGGER?"  
 ENTER 707 USING "-K";Trig\$  
 PRINT USING "K";Trig\$

# TRIGGER SUBSYSTEM



B5420002

TRIGger Subsystem Syntax Diagram

## TRIGGER SUBSYSTEM

---

### TRIGger Commands:

MODE  
 SOURce  
 PROBe  
 RANGe  
 LEVe1  
 TRACK  
 SLOPe  
 COUPling  
 SCALe  
 STORe  
 ECL  
 TTL  
 LABe1

Trigger commands are order dependent as follows: Range limits are determined by the current probe attenuation factor for external trigger source. The value limits for level are determined by the current range selection. So to completely specify trigger settings, program PROBe (if external source), then RANGe, and then LEVe1.

Separate level and range settings are held for each trigger source.

---

### MODE

Command sets the trigger mode. Query returns the current trigger mode.

Command Syntax: MODE { [ ANALog | 0 ]  
                   [ STATe | 1 ]  
                   [ ARMed | 2 ] }

Example: OUTPUT 707;"MODE ANALOG"

Query Syntax: MODE ?

Returned Format:: [ MODE]<argument><crlf>

Example: OUTPUT 707;"MODE?"  
 ENTER 707;Mode\$  
 PRINT Mode\$

## TRIGGER SUBSYSTEM

---

### SOURCE

Command sets the specified trigger source.  
Query returns the selected trigger source.

**Command Syntax:** SOURCE { [ EXTERNAL | 0 ]  
                                  [ CHANNEL 1 | 1 ]  
                                  [ CHANNEL 2 | 2 ] }

Example: OUTPUT 707;"SOURCE CHANNEL 1"

**Query Syntax:** SOURCE ?

Returned Format: [ SOURCE][ CHANNEL<NR1>| EXTERNAL]<crlf>

Example: OUTPUT 707;"SOURCE?"  
          ENTER 707;Source\$  
          PRINT Source\$

---

### PROBE

Command sets trigger probe factor, valid only for external. Must be 1, 2, 5, 10, 20, 50 or 100.

Query returns the trigger probe factor. Valid for any source.

**Command Syntax:** PROBE <NR1>

Example: OUTPUT 707;"PROBE 10"

**Query Syntax:** PROBE ?

Returned Format: [ PROBE]<NR3><crlf>

Example: OUTPUT 707;"PROBE?"  
          ENTER 707;Probe\$  
          PRINT Probe\$

## TRIGGER SUBSYSTEM

---

### RANGE

Command sets trigger range. If internal source, then adjust mode is automatically selected. If external source, the allowable range settings (with 2-digit resolution) are based on the PROBE setting and are as follows:

<u>PROBE FACTOR</u>	<u>VALID RANGE</u>	<u>SETTING</u>
1:1	40 mV to	40 V
2:1	80 mV to	80 V
5:1	200 mV to	200 V
10:1	400 mV to	400 V
20:1	800 mV to	800 V
50:1	2 V to	2000 V
100:1	4 V to	4000 V

Query responds with current range setting.

**Command Syntax:** RANGE <NR3>

Example: OUTPUT 707;"RANGE 5.5E0"

**Query Syntax:** RANGE ?

Returned Format: [RANGe]<NR3><crlf>

Example: OUTPUT 707;"RANGE?"  
 ENTER 707;Range\$  
 PRINT Range\$

---

### LEVEL

Command sets trigger level. Trigger level is  $\pm 2$  V for 40 mV to 390 mV range and  $\pm 20$  V for 400 mV to 40 V range.

Query returns the trigger level.

**Command Syntax:** LEVe1 <NR3>

Example: OUTPUT 707;"LEVEL 350E-3"

**Query Sytnax:** LEVe1 ?

Returned Format: [ LEVe1]<NR3><crlf>

Example: OUTPUT 707;"LEVEL?"  
 ENTER 707;Level\$  
 PRINT Level\$

## TRIGGER SUBSYSTEM

---

### TRACK

Command which sets range to track mode if internal source selected. Not valid for external source.

**Command Syntax:** TRACK

Example: OUTPUT 707;"TRACK"

---

### SLOPe

Command sets trigger slope. Query returns the selected slope.

**Command Syntax:** SLOPe {[ POSitive | 1 ]  
[ NEGative | 0 ]}

Example: OUTPUT 707;"SLOPE NEGATIVE"

**Query Syntax:** SLOPe ?

Returned Format: [ SLOPe]<argument><crlf>

Example: OUTPUT 707;"SLOPE?"  
ENTER 707;Slope\$  
PRINT Slope\$

---

### COUPLing

Command selects the input coupling for trigger, valid only for external. Query returns the selected coupling. Valid for any source.

**Command Syntax:** COUPLing {[ AC | 2 ]  
[ DC | 1 ]}

Example: OUTPUT 707;"COUPLING DC"

**Query Syntax:** COUPLing ?

Returned Format:: [ COUPLing]<argument><crlf>

Example: OUTPUT 707;"COUPLING?"  
ENTER 707;Coupling\$  
PRINT Coupling\$

---

## TRIGGER SUBSYSTEM

---

### SCALE

Command sets autoscale mode for trigger.  
Query returns current autoscale mode.

**Command Syntax:** SCALE {[ DISAbled | 0 ]  
[ ENABled | 1 ]}

Example: OUTPUT 707;"SCALE ENABLED"

**Query Syntax:** SCALE ?

Returned Format: [ SCALE]<argument><crlf>

Example: OUTPUT 707;"SCALE?"  
ENTER 707;Scale\$  
PRINT Scale\$

---

### STORE

Command sets the store mode. If average mode is selected, count determines both the terminal count and the number of averages (sample weighting factor). For the other store modes, count determines the terminal count, that is, the number of frames which must be acquired until the waveform is considered ready for analysis.

For normal store mode the count parameter is optional, if sent it must be 1. For average mode, the count must be exactly 4, 16, 64, or 256. For envelope, count can be 10 to 10,000.

Query returns the current store mode for trigger.

**Command Syntax:** STORE < type > < count >

< type > ::= {[ NORMAl | 1 ]  
[ AVErage | 2 ]  
[ ENVelope | 3 ]}

Example: OUTPUT 707;"STORE ENVELOPE,500"

**Query Syntax:** STORE ?

Returned Format: [ STORE]<argument>,<NRI><crlf>

Example: OUTPUT 707;"STORE?"  
ENTER 707;Store\$  
PRINT Store\$

## TRIGGER SUBSYSTEM

---

### ECL

Command presets the trigger for ECL as follows:

```
COUPling = DC
OFFSet   = -1.00 V
RANGe    = 2.0 V
SCALE    = DISabled
```

The SCALE (autoscale) function is disabled so that a selective autoscale may be performed, thus preserving the trigger settings.

**Command Syntax:** ECL

Example: OUTPUT 707;"ECL"

---

### TTL

Command presets the trigger for TTL as follows:

```
COUPling = DC
OFFSet   = 2.50 V
RANGe    = 6.0 V
SCALE    = DISabled
```

The SCALE (autoscale) function is disabled so that a selective autoscale may be performed, thus preserving the trigger settings.

**Command Syntax:** TTL

Example: OUTPUT 707;"TTL"

---

### LABel

Command sets the user label for trigger view. Query returns the user label for trigger view.

**Command Syntax:** LABel < 10 characters quoted >

Example: OUTPUT 707;"LABEL ""Data 1"""

**Query Syntax:** LABel ?

Returned Format:: [ LABel]< 10 chars quoted ><crlf>

```
Example: OUTPUT 707;"LABEL?"
         ENTER 707;Label$
         PRINT Label$
```

## WAVEFORM SUBSYSTEM

---

### WAVEform

The waveform subsystem provides access to waveform data. This includes active data from the channels and trigger as well as static data from the waveform memories.

For the active sources, the following commands are QUERY ONLY with the exception of FORMat. For memory waveforms (addressed directly or via a graph), values may be set or queried using DATA and PREamble or the individual preamble function commands.

Selecting a graph as the waveform source has the benefit that a portion of the whole waveform may be read if the graph is expanded, that is, with a graph you can window the waveform and just read the data of interest.

The WAVEform command addresses the waveform subsystem as the destination of the following commands.

The WAVEform query responds with the current wave source and the validity and preamble function settings for that source.

#### Command Syntax: WAVEform

Example: OUTPUT 707;"WAVEFORM"

#### Query Syntax: WAVEform ?

```
Returned Format: [ WAVEform <crlf> ]
[ SOURCE ]<source spec><crlf>
[ VALid ]<argument><crlf>
[ FORMat ]<argument><crlf>
[ TYPE ]<argument><crlf>
[ POINTs ]<NR1><crlf>
[ COUNT ]<NR1><crlf>
[ XINCrement ]<NR3><crlf>
[ XORigin ]<NR3><crlf>
[ XREFerence ]<NR1><crlf>
[ YINCrement ]<NR3><crlf>
[ YORigin ]<NR3><crlf>
[ YREFerence ]<NR1><crlf>
[ COUPling ]<argument><crlf>
[ LABel ]<10 chars quoted><crlf>
```

```
Example: DIM Wave$[250]
OUTPUT 707;"WAVEFORM?"
ENTER 707 USING "-K";Wave$
PRINT USING "K";Wave$
```

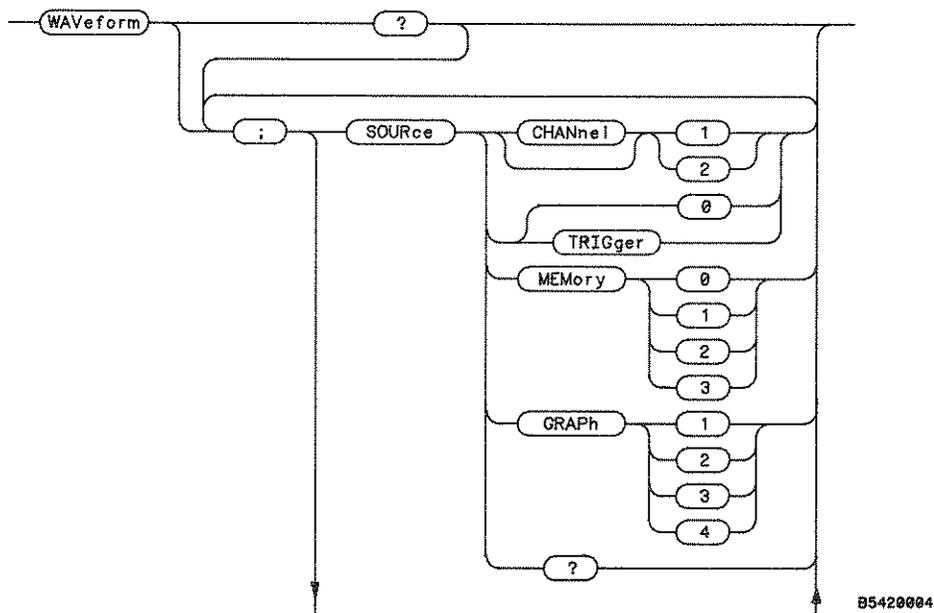
# WAVEFORM SUBSYSTEM

---

## WAVEform Commands:

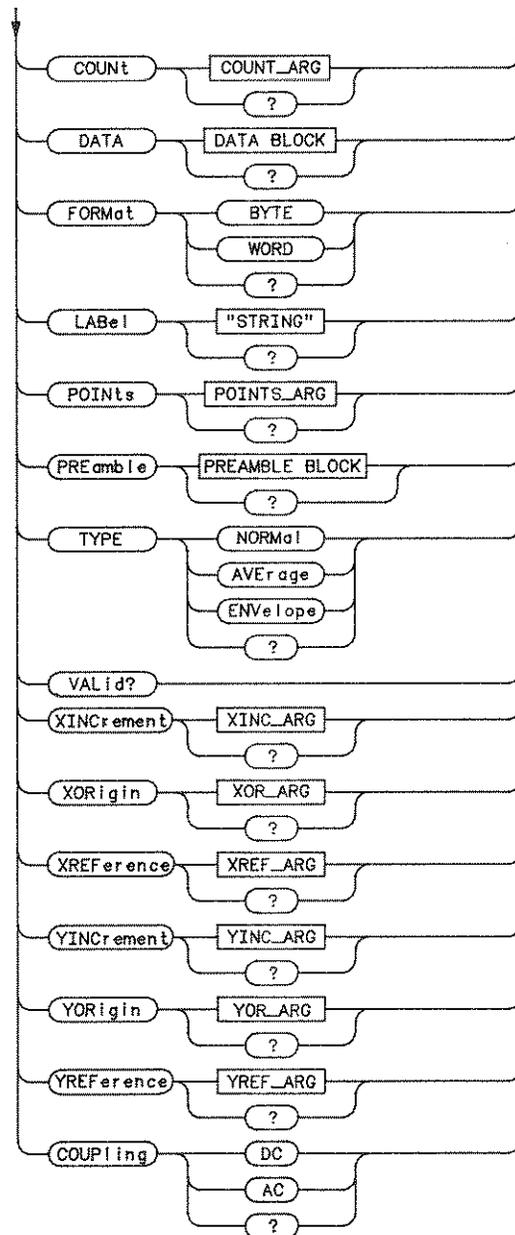
SOURce  
COUPling  
COUNT  
DATA  
FORMat  
LABel  
POINts  
PREAmble  
TYPE  
VALid  
XINCrement  
XORigin  
XREFerence  
YINCrement  
YORigin  
YREFerence

---



WAVEform Subsystem Syntax Diagram

# WAVEFORM SUBSYSTEM



B5420004

WAVEform Subsystem Syntax Diagram (Cont)

## WAVEFORM SUBSYSTEM

---

### SOURCE

Command sets the waveform source for the WAVEform commands that follow.

SOURCE TRIGGER – Sets trigger view (analog trigger) as the waveform addressed. Read only.

SOURCE CHANNEL{1|2} – Sets channel 1 or channel 2 as the waveform addressed. Read only.

SOURCE GRAPH{1|2|3|4} – Sets the waveform displayed on graph 1, 2, 3, or 4 as the addressed waveform. Only data on display is accessible with DATA query. PREAMBLE query returns points and x-origin adjusted for current expansion. Data can be written to graphs if the source is a memory, otherwise read only.

SOURCE MEMORY{0|1|2|3} – Sets memory 0, 1, 2, or 3 as the waveform addressed. Only memory waveforms are read/write.

Query returns the currently selected source.

Command Syntax: SOURCE { [ TRIGGER | 0 ]  
[ CHANNEL1 | 1 ]  
[ CHANNEL2 | 2 ]  
[ GRAPH{1|2|3|4} ]  
[ MEMORY{0|1|2|3} ] }

Example: OUTPUT 707;"SOURCE CHANNEL1"

Query Syntax: SOURCE ?

Returned Format : [SOURCE]{ [ CHANNEL1 ]  
[ CHANNEL2 ]  
[ TRIGGER ]  
[ GRAPH1 ]  
[ GRAPH2 ]  
[ GRAPH3 ]  
[ GRAPH4 ]  
[ MEMORY0 ]  
[ MEMORY1 ]  
[ MEMORY2 ]  
[ MEMORY3 ] }

Example: OUTPUT 707;"SOURCE?"  
ENTER 707;Source\$  
PRINT Source\$

## WAVEFORM SUBSYSTEM

---

### COUPling

Command sets the coupling field in the waveform preamble.  
Query returns the coupling for the waveform.

**Command Syntax:** COUPling { [ DC | 1 ]  
[ AC | 2 ] }

Example: OUTPUT 707;"COUPLING AC"

**Query Syntax:** COUPling

Returned Format: [ COUPling]<argument><crlf>

Example: OUTPUT 707;"COUPLING?"  
ENTER 707;Coup\$  
PRINT Coup\$

---

### COUNT

Command sets the count parameter in the memory waveform preamble. If waveform is type average, count signifies both the terminal count and the number of averages (sample weighting factor). For the other store modes, count determines the terminal count, that is, the number of frames which were acquired.

The count parameter must be in the range 0 to 10000. To be meaningful, this value should be set as follows: For normal store mode the count parameter should be 1. For average mode, the count should be exactly 4, 16, 64, or 256. For envelope, count can be 1 to 10,000. If count is set to 0, the waveform will be considered invalid.

Query returns the count factor for the addressed waveform. 0 is returned for invalid waveforms.

**Command Syntax:** COUNT <NR1>

Example: OUTPUT 707;"COUNT 16"

**Query Syntax:** COUNT ?

Returned Format: [ COUNT]<NR1><crlf>

Example: OUTPUT 707;"COUNT?"  
ENTER 707;Count\$  
PRINT Count\$

## WAVEFORM SUBSYSTEM

---

### DATA

54200A/D accepts a waveform data block if the waveform addressed is memory (or a graph displaying memory). Block length must match the defined store mode, format, and points settings. These parameters are set up by the PREAMBLE command.

Query returns the addressed waveforms data points if it is a valid waveform. If running, and the waveform is being acquired, transmission occurs after the specified count has been reached. Invalid waveforms are sent as all 0's.

**Command Syntax:** DATA < Block type A >

**Query Syntax:** DATA ?

Returned Format : [ DATA] #Abb< binary wave data >

where bb is a word (binary integer) giving the number of data bytes in <binary wave data>. Wave data is sent as either bytes or words based upon the current format specification.

The following example shows both the command and query form of DATA, and the steps required to enter preamble data required before loading waveform data into a memory.

```

1850 !
1860 ! Set up scope to accept waveform and preamble data
1870 ASSIGN @Fast TO 707;FORMAT OFF
1880 OUTPUT 707;"HEADER OFF ;EOI ON"
1890 OUTPUT 707;"ACQUIRE;TYPE NORMAL"
1900 !
1910 ! Acquire data
1920 OUTPUT 707;"DIGITIZE CHANNEL 1"
1930 !
1940 ! Set up waveform source
1950 OUTPUT 707;"WAVEFORM;SOURCE CHANNEL 1;FORMAT WORD"
1960 !
1970 ! Input waveform preamble to controller
1980 DIM Pre#[150]
1990 OUTPUT 707;"WAVEFORM PREAMBLE?"
2000 ENTER 707 USING "-K";Pre#
2010 !
2020 !Input waveform data to controller
2030 OUTPUT 707;"DATA?"
2040 ENTER 707 USING "#,2A,W";Header#,Bytes
2050 ! Header# = #A
2060 ! Bytes = 2002
2070 Words=Bytes/2
2080 ALLOCATE INTEGER Wav(Words)
2090 ENTER @Fast;Wav(*)
2100 !
2110 ! Output waveform preamble and data to memory 3
2120 OUTPUT 707;"SOURCE MEMORY3"
2130 OUTPUT 707 USING "#,K";"PREAMBLE ",Pre#
2140 OUTPUT 707 USING "#,7A,W";"DATA #A",Bytes
2150 OUTPUT @Fast;Wav(*)
2160 !
2170 ! Display memory 3 on graph 2
2180 OUTPUT 707;"RECALL GRAPH 2, MEMORY 3"
2190 !

```

## WAVEFORM SUBSYSTEM

---

### FORMat

Command sets the data transmission mode for waveform data points. Data is transferred either as signed 8-bit (BYTE) or 16-bit (WORD), the sign bit is always positive (0). May be sent regardless of what type waveform is addressed.

Query returns the format specification in effect.

**Command Syntax:** FORMat {[ BYTE | 1 ]  
[ WORD | 2 ]}

Example: OUTPUT 707;"FORMAT WORD"

**Query Syntax:** FORMat ?

Returned Format: [ FORMat]<argument><crlf>

Example: OUTPUT 707;"FORMAT?"  
ENTER 707;Format\$  
PRINT Format\$

## WAVEFORM SUBSYSTEM

---

### LABel

Command sets the label field for the addressed waveform. Labels for the volatile waveforms are defaulted to " " at power-on or reset.

Query returns the label for the addressed waveform.

**Command Syntax:** LABel <10 characters quoted>

Example: OUTPUT 707;"LABEL ""Waveform 1"""

**Query Syntax:** LABel ?

Returned Format: [ LABel] <10 characters quoted><crlf>

Example: OUTPUT 707;"LABEL?"  
ENTER 707;Label\$  
PRINT Label\$

---

### POINTs

Command sets the number of points for a memory waveform. Must be in the range from 51 to 1001.

Query returns the number of data points in the addressed waveform. Value is 1001 for active sources, for graphs and memories may be 51 to 1001.

**Command Syntax:** POINTs<NR1>

Example: OUTPUT 707;"POINTS 1001"

**Query Syntax:** POINTs ?

Returned Format: [ POINTs] <NR1><crlf>

Example: OUTPUT 707;"POINTS?"  
ENTER 707;Points\$  
PRINT Points\$

## WAVEFORM SUBSYSTEM

---

### PREamble

Command sets the preamble for the addressed waveform if it is a memory or a graph displaying a memory. All items must be sent in exactly the prescribed order, delimited by commas.

Query returns the preamble block for the selected waveform.

In the examples given below, the PREamble query is shown first to show how the preamble can be stored in the controller. The PREamble command is then given to show how to re-enter the waveform preamble into a 54200A/D memory. Refer to the DATA command for more information.

**Query Syntax:** PREamble ?

```
Returned Format: [PREamble]
                 <format Parameter>,
                 <type Parameter>,
                 <points NR1>,
                 <count NR1>,
                 <xincrement NR3>,
                 <xorigin NR3>,
                 <xreference NR1>,
                 <yincrement NR3>,
                 <yorigin NR3>,
                 <yreference NR1>,
                 <coupling Parameter>,
                 <label 10 chars quoted><crLf>
```

```
Example: DIM Pre$[150]
         OUTPUT 707;"HEADER OFF"
         OUTPUT 707;"PREAMBLE?"
         ENTER 707;Pre$
         PRINT Pre$
```

**Command Syntax:** PREamble <preamble block>

```
<preamble block> ::= <format>,
                    <type>,
                    <points>,
                    <count>,
                    <xincrement>,
                    <xorigin>,
                    <xreference>,
                    <yincrement>,
                    <yorigin>,
                    <yreference>,
                    <coupling>,
                    <label><crLf>
```

```
Example: OUTPUT 707 USING "#,K";"PREAMBLE ",Pre$
```

## WAVEFORM SUBSYSTEM

---

### TYPE

Command sets the data type for memory waveforms.  
Query returns the data type of the selected waveform.

**Command Syntax:** TYPE {[ NORMAl | 1 ]  
                          [ AVErage | 2 ]  
                          [ ENVelope | 3 ]}

Example: OUTPUT 707;"TYPE NORMAL"

**Query Sytnax:** TYPE ?

Returned Format: [TYPE ]<argument><crlf>

Example: OUTPUT 707;"TYPE?"  
          ENTER 707;Type\$  
          PRINT Type\$

---

### VALid

This command has no effect, but the parameter must be in range 0,1, or -3.

Query returns validity of data for the addressed waveform or graph. To be valid, count must be non-zero and equal to the terminal count specified in ACQUIRE, CHANNEL or TRIGGER subsystems. WAVEform TYPE must be 1, 2, or 3.

**Command Syntax:** VALid {[ GOOD\_data | 1 ]  
                          [ NO\_data | 0 ]  
                          [ CLIPped | -3 ]}<crlf>

Example: OUTPUT 707;"VALID GOOD\_DATA"

**Query Syntax:** VALid ?

Returned Format: [VALid] {[ GOOD\_data | 1 ]  
                          [ NO\_data | 0 ]  
                          [ CLIPped | -3 ]}<crlf>

Example: OUTPUT 707;"VALID?"  
          ENTER 707;Valid\$  
          PRINT Valid\$

## WAVEFORM SUBSYSTEM

---

### XINCrement

Command sets the time range and time per sample for memory waveform only. NR3 is equal to time range ÷ 1000.

Query returns the x increment (time per sample) for any addressed waveform.

**Command Syntax:** XINCrement <NR3>

Example: OUTPUT 707;"XINCREMENT 200E-6"

**Query Syntax:** XINCrement ?

Returned Format: [ XINCrement]<NR3><crlf>

Example: DIM Xinc\$[30]  
OUTPUT 707;"XINCREMENT?"  
ENTER 707;Xinc\$  
PRINT Xinc\$

---

### XORigin

Command sets the time of the first data point for memory waveforms only.

Query returns the time of the first data point (x origin) of any selected waveform.

**Command Syntax:** XORigin <NR3>

Example: OUTPUT 707;"XORIGIN 0E0"

**Query Syntax:** XORigin ?

Returned Format: [ XORigin]<NR3><crlf>

Example: OUTPUT 707;"XORIGIN?"  
ENTER 707;Xor\$  
PRINT Xor\$

## WAVEFORM SUBSYSTEM

---

### XREFerence

Command sets the point at which time x origin exists for memory waveforms only. Must be 1.

Query returns the point number at which x origin exists for any selected waveform. Always 1.

**Command Syntax:** XREFerence 1

Example: OUTPUT 707;"XREFERENCE 1"

**Query Syntax:** REFerence ?

Returned Format: [ XREFerence]<NR1><crlf>

Example: OUTPUT 707;"XREFERENCE?"  
ENTER 707;Xref\$  
PRINT Xref\$

---

### YINCrement

Command sets the volts per q level and y axis range for the memory waveform only. This value is interpreted with the current format selection.

Query returns the y increment (volts per q level) for any addressed waveform. This value is scaled for the data format specification currently set.

**Command Syntax:** YINCrement <NR3>

Example: OUTPUT 707;"YINCREMENT 201.6E-6"

**Query Syntax:** YINCrement ?

Returned Format: [ YINCrement]<NR3><crlf>

Example: DIM Yinc\$[30]  
OUTPUT 707;"YINCREMENT?"  
ENTER 707;Yinc\$  
PRINT Yinc\$

## WAVEFORM SUBSYSTEM

---

### YORigin

Command sets the voltage at the midpoint of the voltage range, the same as offset for memory waveforms only.

Query returns the y origin of the selected waveform, the voltage at "center screen" for any selected waveform.

**Command Syntax:** YORigin <NR3>

Example: OUTPUT 707;"YORIGIN 2.3E0"

**Query Syntax:** YORigin ?

Returned Format: [ YORigin]<NR3><crlf>

Example: OUTPUT 707;"YORIGIN?"  
ENTER 707;Yorg\$  
PRINT Yorg\$

---

### YREFerence

Command has no effect but must be 62 (BYTE) or 15872 (WORD) depending upon FORMat selection.

Query returns the y reference value. This value is used to normalize q level values (the way waveforms are sent) prior to conversion to volts.

**Command Syntax:** YREFerence <NR1>

Example: OUTPUT 707;"YREFERENCE 15872"

**Query Syntax:** YREFerence ?

Returned Format: [ YREFerence]<NR1><crlf>

Example: OUTPUT 707;"YREFERENCE?"  
ENTER 707;Yref\$  
PRINT Yref\$



## SECTION 9

# PERFORMANCE TESTS

### 9-1. INTRODUCTION

This section describes the 54200A and 54200D Self Tests and Performance Test Procedures. The Self Tests, resident in ROM, are a series of tests that confirm proper function of the mainframe hardware and firmware. While the Self Tests provide the user with a confidence level of greater than 90%, it does not verify the critical specifications given in table 1-1 of Section 1. The Performance Tests test for complete instrument compliance to these critical specifications.

### 9-2. EQUIPMENT REQUIRED

The only equipment required for the Self Test is a standard BNC cable, 1 meter in length. The equipment required to perform the Performance Tests is listed in table 9-1. Other equipment may be substituted if it meets or exceeds the critical specifications listed in table 9-1.

### 9-3. TEST RECORD

Results of performance tests may be tabulated on the Performance Test Record (table 9-2) at the end of this section. The Test Record lists all of the tested specifications and their acceptable limits. The results recorded at incoming inspection can be used for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.

### 9-4. CALIBRATION INTERVAL

There is no recommended calibration interval. Adjustment needs are defined by the pass/fail status of resident self-tests and calibration routines. A failure of a SYSTEM menu self-test should be followed by resident SYSTEM menu calibration routines 0 and 6. The self-tests should then be re-selected to check whether the self-calibration routines corrected the error. Repeated failure of a self-test, or failure of a self-calibration routine may dictate the need of a particular hardware adjustment.

Always end the adjustment session with SYSTEM menu calibration routines 0 and 6, and then perform the SYSTEM menu self-tests to assure proper operation of the 54200A/D. Persistent failure of one of the self-tests is an indication of a faulty board.

#### Note

*Allow instrument to warm up for at least 30 minutes prior to beginning performance tests.*

### 9-5. RECOMMENDED TEST EQUIPMENT

Table 9-1 lists the equipment required to performance test the 54200A/D. Other equipment may be substituted if it meets or exceeds the critical specifications given in table 9-1.

Table 9-1. Recommended Test Equipment

INSTRUMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Function Generator	Frequency: 1 MHz to 50 MHz	HP Model 8116A
Pulse Generator	Dual channel Repetition rate: 100 MHz Transition time: 1.3 ns, variable Amplitude: 5 volts Basic timing accuracy: $\leq 3\%$	HP Model 8161A Opt. 020
RF Voltmeter	Accuracy: $\pm 3\%$ at 50 MHz	HP Model 3406A
Time Mark Generator	Time marks: 2 ns to 0.5 s	Tektronics TG501
Dc Power Supply	Range: $\pm 100$ mV to $\pm 5$ V Accuracy: $\pm 0.1\%$	HP Model 6111A
50 $\Omega$ Termination	Accuracy: $\leq 1\%$	HP Model 10100C
Blocking Capacitor	0.18 $\mu$ F, 200V	HP Model 10240B
Product Support Kit	No substitute	HP Part No. 54200-69501
50 $\Omega$ Sampling Tee	_____	HP Model 11063A
Adapter	GR874-to-BNC(m)	HP Part No. 1250-0849
Adapter	GR874-to-BNC(f)	HP Part No. 1250-0850
Adapter	BNC(f)-to-Dual Banana	HP Part No. 1251-2277
BNC Tee (Qty 2)	1 male, 2 female	HP Part No. 1250-0781
BNC Cable (Qty 2)	9-inch	HP Model 10502A
BNC Cable (Qty 4)	48-inch	HP Model 10503A

## 9-6. SELF TEST FUNCTION VERIFICATION

The Self Tests, resident in ROM, are a series of tests that confirm proper function of the mainframe hardware and firmware. While the Self Tests provide the user with a confidence level of greater than 90%, it does not verify the critical specifications given in table 1-1 of Section 1. Perform The Performance Tests test for complete instrument compliance to these critical specifications.

To execute the self tests, press the SYSTEM menu key and press the NEXT/PREV key until the Self Tests menu displayed is as shown below Press any arrow key to move the blinking cursor to the Execute Test field. Enter either 0, 1, or 2 and follow the instructions displayed on screen. An audible beep will be heard when each self test has been completed.

```
System Specification-----Status: Acquired Frame 00044___  
TALK ONLY  
[ Self Tests ]  
Execute Test █  
  0 : CPU/Memory  
  1 : Acquisition/Trigger  
  2 : Input
```

*SYSTEM Self Tests Menu*

## Performance Tests

---

### 9-7. DC OFFSET ACCURACY TEST

**Specification:**

<u>Channel</u>	<u>Range</u>	<u>Offset</u>	<u>Accuracy</u>
	40 mV to 390 mV	±1% of offset	±5 mV
	400 mV to 40 V	±1% of offset	±50 mV

**Equipment Required:**

DC Supply ..... HP Model 6111A  
BNC(f)-to-Dual Banana Adapter ..... HP Part No. 1251-2277

**Procedure:**

1. Set DC Supply output to 1.00 V.
2. Configure STATUS Configuration menu as shown in figure 9-1.
3. Connect a BNC(f)-to-Dual Banana adapter to the DC Supply.
4. Connect a BNC cable from the plug to the Channel 1 input of the 54200A/D.
5. The display should appear similar to figure 9-2.
6. Select the VMIN and VMAX measurements on the 54200A/D. The limits are 0.99 V and 1.01 V.
7. Adjust the output of the DC Supply to -1.00 V.
8. Set 54200A/D Channel 1 offset to -1.00 V.
9. The limits of VMIN and VMAX are -0.99 V and -1.01 V.
10. Set 54200A/D Channel 1 voltage range to 400 mV.
11. The limits of VMIN and VMAX are -0.94 V and -1.06 V.
12. Adjust the output of the DC Supply to +1.00 V.
13. Set 54200A/D Channel offset to +1.00 V.
14. Limits of VMIN and VMAX are 0.94 V and 1.06 V.
15. Repeat steps 4 through 14 substituting Channel 2 for Channel 1.

Performance Tests

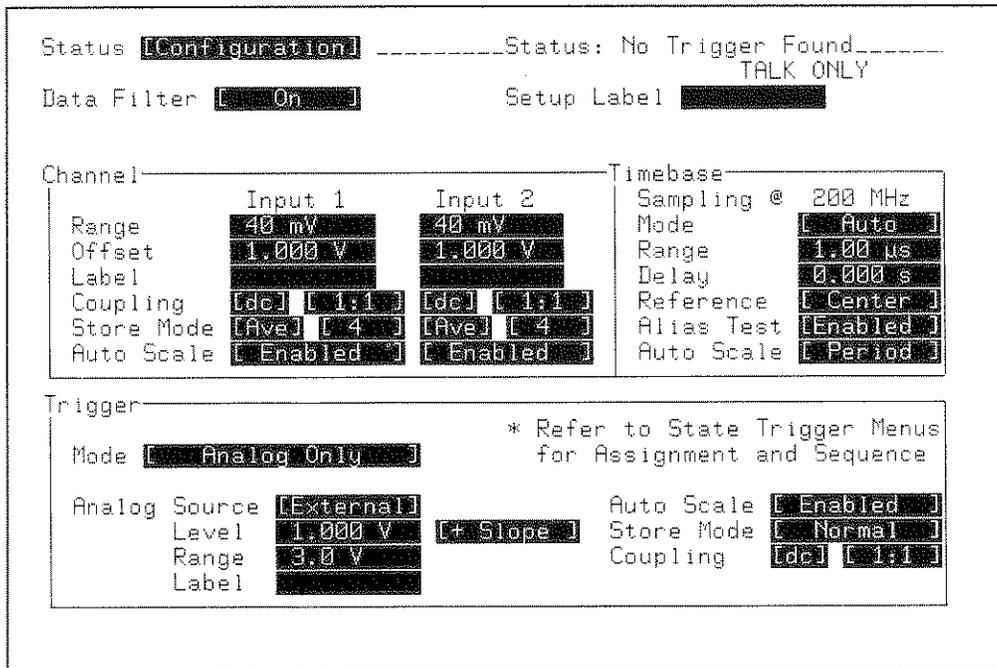


Figure 9-1. STATUS Configuration Menu

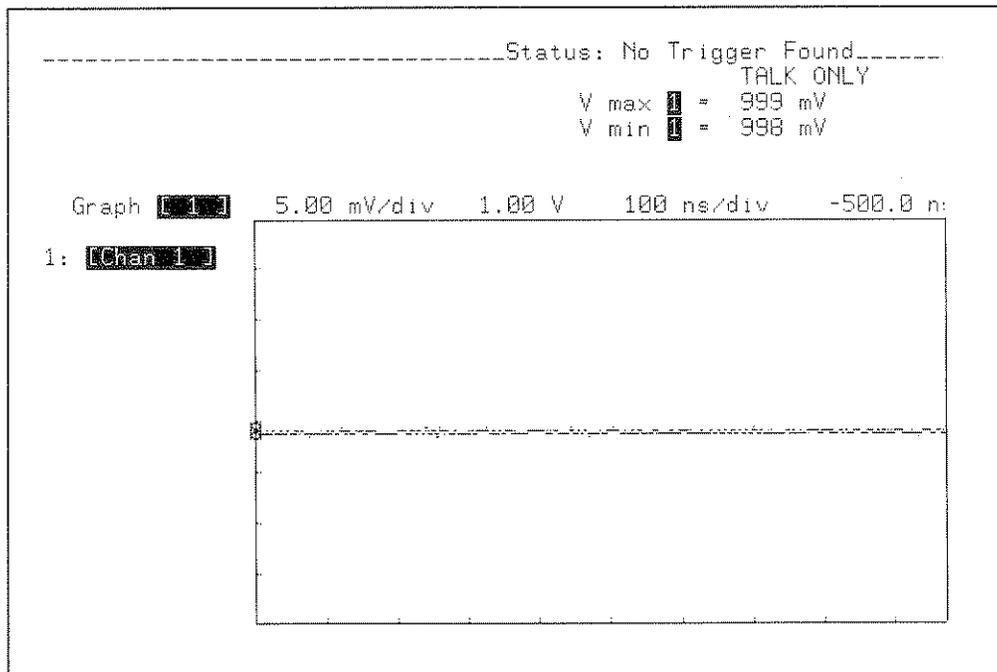


Figure 9-2. DISPLAY Waveform

## Performance Tests

---

### 9-8. VOLTAGE MEASUREMENT ACCURACY TEST

**Specification:**

$$\begin{array}{r}
 \text{Gain Accuracy} + \text{ADC Accuracy} + \text{Offset Accuracy} \\
 = \left( \begin{array}{l} \pm 2\% \text{ of} \\ \text{full scale} \end{array} \right) + \left( \begin{array}{l} \pm 1.6\% \text{ of} \\ \text{full scale} \end{array} \right) + \begin{array}{l} \text{Channel Range} \\ (40 \text{ mV to } 390 \text{ mV} \\ (400 \text{ mV to } 40 \text{ V} \end{array} \quad \begin{array}{l} \text{Offset Accuracy} \\ \pm 1\% \text{ of offset } \pm 5 \text{ mV} \\ \pm 1\% \text{ of offset } \pm 50 \text{ mV} \end{array}
 \end{array}$$

**Equipment Required:**

DC Supply ..... HP Model 6111A  
 BNC(f)-to-Dual Banana Adapter ..... HP Part No. 1251-2277

**Procedure:**

1. Set DC Supply output level to +100 mV.
2. Configure STATUS Configuration menu as shown in figure 9-3.
3. Connect a BNC(f)-to-Dual Banana Plug to the DC Supply.
4. Connect a BNC cable from the plug to the Channel 1 input of the 54200A/D through a 50 ohm terminator.
5. The display should appear similar to figure 9-4.
6. Select the VMIN and VMAX measurements on the 54200A/D. The limits are 85 mV and 115 mV.
7. Adjust the output of the DC supply to -100 mV.
8. Limits of VMIN and VMAX are -85 mV and -115 mV.
9. Adjust the output of the DC Supply to -5.00V.
10. Set 54200A/D Channel 1 voltage range to 20 V.
11. Limits of VMAX and VMIN are -4.23 V and -5.77 V.
12. Adjust the output of the DC Supply to +5.00 V.
13. Limits of VMAX and VMIN are 4.23 V and 5.77 V.
14. Repeat steps 4 through 13 substituting Channel 2 for Channel 1.

Performance Tests

```

Status [Configuration] -----Status: No Trigger Found-----
                                     TALK ONLY
Data Filter [ On ]           Setup Label [          ]

Channel-----
Input 1      Input 2      Timebase-----
Range        300 mV       300 mV       Sampling @ 200 MHz
Offset       0.000 V     0.000 V     Mode [ Auto ]
Label        [          ] [          ]           Range [ 1.00 µs ]
Coupling     [dc] [ 1:1 ] [dc] [ 1:1 ]         Delay [ 0.000 s ]
Store Mode   [Ave] [ 4 ] [Ave] [ 4 ]         Reference [ Center ]
Auto Scale   [ Enabled ] [ Enabled ]         Alias Test [ Enabled ]
Auto Scale   [ Enabled ] [ Enabled ]         Auto Scale [ Period ]

Trigger-----
Mode [ Analog Only ]           * Refer to State Trigger Menus
                                for Assignment and Sequence
Analog Source [External]       Auto Scale [ Enabled ]
Level [ 1.000 V ] [+ Slope ]  Store Mode [ Normal ]
Range [ 3.0 V ]                Coupling [dc] [ 1:1 ]
Label [          ]
    
```

Figure 9-3. STATUS Configuration Menu

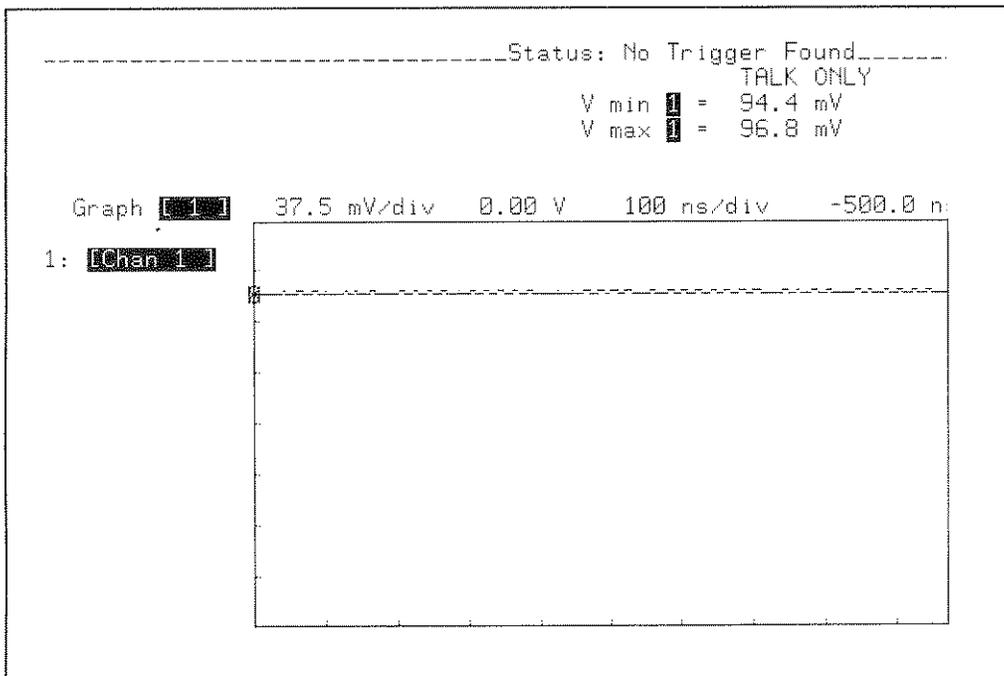


Figure 9-4. DISPLAY Waveform

## Performance Tests

---

### 9-9. BANDWIDTH (-3dB) TEST

**Specification:**

DC coupled	dc to 50 MHz
AC coupled	10 Hz to 50 MHz

**Equipment Required:**

Function Generator	HP Model 8116A
RF Voltmeter	HP Model 3406A
50 $\Omega$ Sampling Tee	HP Model 11063A
50 $\Omega$ Termination	HP Model 10100C
GR874-to-BNC(m) Adapter	HP Part No. 1250-0849
GR874-to-BNC(f) Adapter	HP Part No. 1250-0850

**Equipment Setup:**

	<u>8116A</u>
Sinewave Amplitude:	2 V
Frequency:	200 kHz
OFFSET:	0 V

**Procedure:**

1. Configure STATUS Configuration menu as shown in figure 9-5.
2. Configure the system shown in figure 9-6.
3. Record the reading of the RF Voltmeter.
4. Select the VRMS measurement on the 54200A/D. Record this number and multiply it by 0.707 to find the specification limit.
5. Change the frequency of the Function Generator to 50 MHz.
6. Adjust the amplitude of the Function Generator so that the RF Voltmeter has the same reading as the number recorded in step 3.
7. Change the Timebase Range of the 54200A/D to 200 ns.
8. Select the VRMS measurement. It should be greater than or equal to the number recorded in step 4.
9. Repeat for Channel 2 and the External Trigger Channel, specifying that channel as the trigger source each time.

### Performance Tests

```

Status [Configuration] ----- Status: No Trigger Found -----
                                     TALK ONLY
Data Filter [ On ] Setup Label [ ]

Channel-----
Range      Input 1      Input 2      Timebase
Offset     0.000 V     0.000 V     Sampling @ 100 MHz
Label
Coupling   [ac] [ 1:1 ] [ac] [ 1:1 ] Mode [ Auto ]
Store Mode [Ave] [ 16 ] [Ave] [ 16 ] Range [ 10.0 us ]
Auto Scale [ Enabled ] [ Enabled ] Delay [ 0.000 s ]
Reference [ Center ]
Alias Test [ Enabled ]
Auto Scale [ Period ]

Trigger-----
Mode [ Analog Only ] * Refer to State Trigger Menu
                        for Assignment and Sequence
Analog Source [ Chan 1 ] Auto Scale [ Enabled ]
Level [ 0.000 V ] [+ Slope ] Store Mode [Ave] [ 16 ]
Range [ Track ] 3.0 V Coupling [ac] [ 1:1 ]
Label
    
```

Figure 9-5. STATUS Configuration Menu

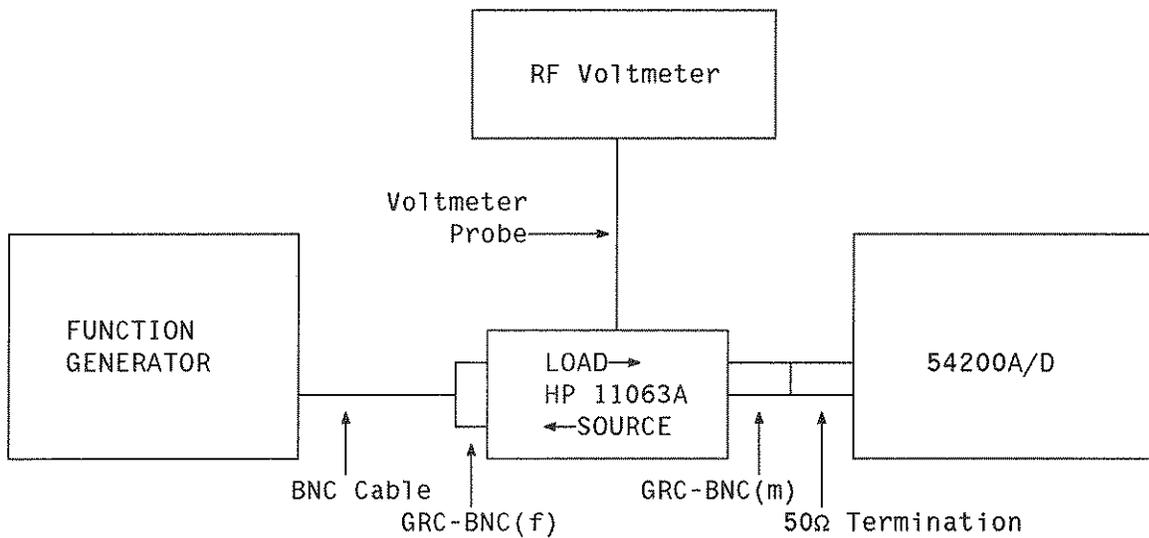


Figure 9-6. Bandwidth Test Connections.

## Performance Tests

---

### 9-10. TRANSITION TIME TEST

**Specification:**  $\leq 7$  ns (10% to 90%)

**Equipment Required:**

Pulse generator ..... HP Model 8161A  
50 $\Omega$  Termination ..... HP Model 10100C

**Equipment Setup:**

8161A  
PER: 200ns  
WID: 100 ns  
LEE: 1.3 ns  
TRE: 1.3 ns  
HIL: +1 V  
LOL: -1 V

**Procedure:**

1. Configure STATUS Configuration menu as shown in figure 9-7.
2. The STATUS Measurement menu should be in standard mode.
3. Connect a BNC cable from the pulse generator to Channel 1 of the 54200A/D, through a 50 ohm terminator.
4. The waveform should appear as shown in figure 9-8.
5. Select the RISE measurement on the 54200A/D. It should be  $\leq 7$  ns.
6. Repeat the measurement for Channel 2 and the External Trigger channel, changing the trigger source to the corresponding channel each time.
7. Change the Trigger slope to (-).
8. Re-connect the BNC cable from the pulse generator to Channel 1 of the 54200A/D, through a 50 ohm terminator.
9. Specify Channel 1 as the trigger source.
10. Select the FALL measurement on the 54200A/D. It should be  $\leq 7$  ns.
11. Repeat the measurement for Channel 2 and the External Trigger channel, changing the trigger source to the corresponding channel each time.

### Performance Tests

```

Status [Configuration] -----Status: Waiting for Trigger----
                                     TALK ONLY
Data Filter [ On ]           Setup Label [          ]

Channel-----
Range      Input 1      Input 2      Timebase-----
Offset     4.0 V       4.0 V       Sampling @ 200 MHz
Label      0.000 V     0.000 V     Mode [ Trig'd ]
Coupling   [dc] [ 1:1 ] [dc] [ 1:1 ] Range      200 ns
Store Mode [Ave] [ 16 ] [Ave] [ 16 ] Delay      0.000 s
Auto Scale [ Enabled ] [ Enabled ] Reference [ Center ]
Alias Test [Enabled ] Auto Scale [ Period ]

Trigger-----
Mode [ Analog Only ] * Refer to State Trigger Menus
                       for Assignment and Sequence
Analog Source [ Chan 1 ] Auto Scale [ Enabled ]
Level         0.000 V [ + Slope ] Store Mode [Ave] [ 16 ]
Range        [ Track ] 4.0 V      Coupling   [dc] [ 1:1 ]
Label
    
```

Figure 9-7. STATUS Configuration Menu

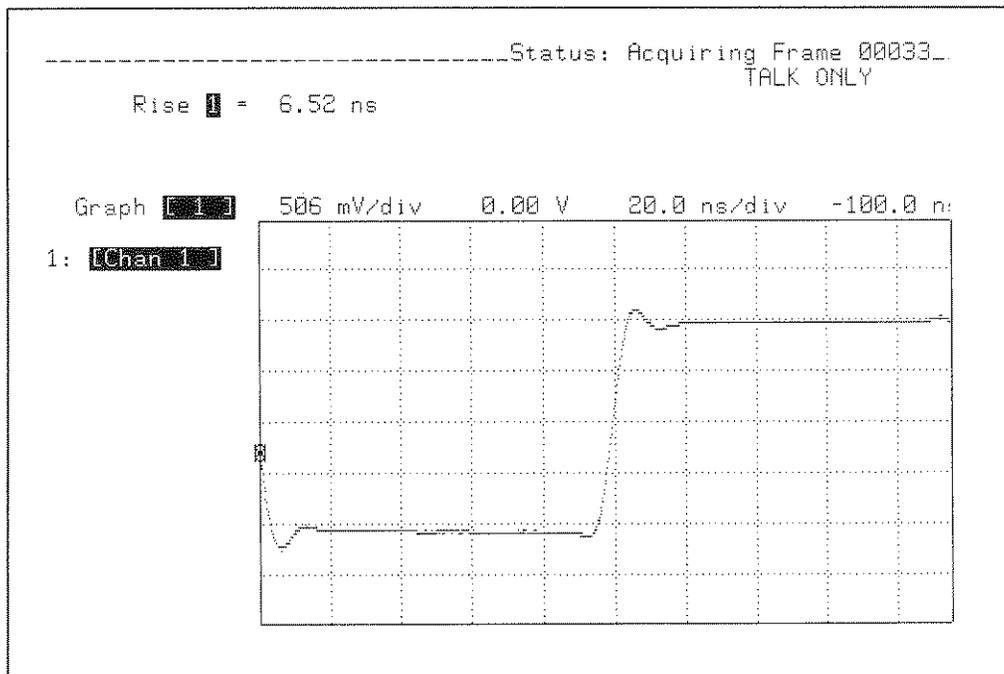


Figure 9-8. DISPLAY Waveform

## Performance Tests

---

### 9-11. TIME MEASUREMENT ACCURACY TEST (SINGLE AND DUAL CURSORS)

**Specification:**  $\pm 2$  ns or  $\pm 0.2$  % of time range, whichever is greater.

**Equipment Required:**

Time Mark Generator ..... Tektronics TG 501  
50 $\Omega$  Termination ..... HP Model 10100C

**Procedure:**

1. Set the output of the Time Mark Generator to 100 ns.
2. Configure STATUS Configuration menu as shown in figure 9-9.
3. Connect a BNC cable from the output of the Time Mark Generator to the Channel 1 input of the 54200A/D through a 50 ohm terminator.
4. Position the X cursor at the peak voltage of the first marker.
5. Position the O cursor at the peak voltage of the second marker.
6. The display should appear similar to figure 9-10.
7. Read the  $\Delta T$  reading on the display. The limits of  $\Delta T$  are 98 ns and 102 ns.

Performance Tests

```

Status [Configuration] -----Status: Waiting for Trigger---
                                     TALK ONLY
Data Filter [ On ]           Setup Label [ ]

Channel-----Timebase-----
Range      Input 1      Input 2      Sampling @ 200 MHz
Offset     2.5 V       40 V        Mode       [ Single ]
Label      500.0 mV    0.000 V    Range     [ 200 ns ]
Coupling   [dc] [ 1:1 ] [dc] [ 1:1 ] Delay     [ 0.000 s ]
Store Mode [ Normal ] [ Normal ] Reference [ Left ]
Auto Scale [ Enabled ] [ Enabled ] Auto Scale [ Period ]

Trigger-----
Mode [ Analog Only ] * Refer to State Trigger Menus
                                     for Assignment and Sequence
Analog Source [ Chan 1 ] Auto Scale [ Enabled ]
Level         500.0 mV [ + Slope ] Store Mode [ Normal ]
Range        [ Track ] 2.5 V      Coupling   [dc] [ 1:1 ]
Label
    
```

Figure 9-9. STATUS Configuration Menu

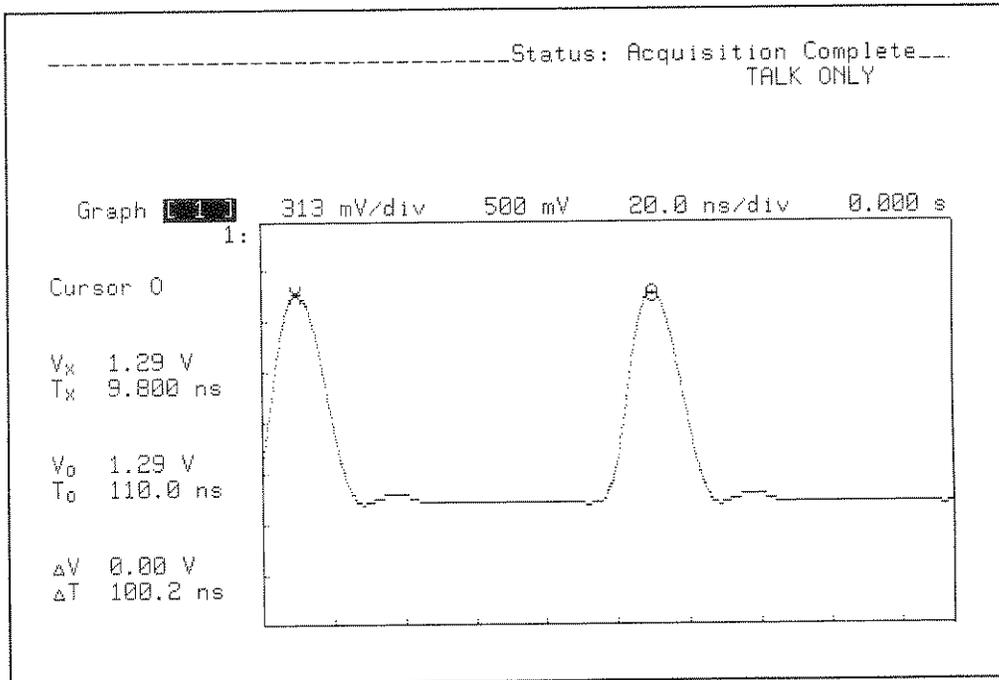


Figure 9-10. DISPLAY Waveform

## Performance Tests

---

### 9-12. TRIGGER (ANALOG) LEVEL ACCURACY TEST

**Specification:**

<u>TRIGGER RANGE</u>	<u>LEVEL ACCURACY</u>
40 mV to 390 mV	$\pm 2\% \pm 5$ mV
400 mV to 40 V	$\pm 2\% \pm 50$ mV

**Equipment Required:**

Function Generator ..... HP Model 8116A  
50 $\Omega$  Termination ..... HP Model 10100C

**Equipment Setup:**

8116A

Frequency (triangle): 100 kHz  
Offset: 0.0 V  
Amplitude: 3.0 V

**Procedure:**

1. Configure STATUS Configuration menu as shown in figure 9-11.
2. Connect a BNC cable from the Function Generator to Channel 1 through a 50 Ohm terminator.
3. Display the Trigger Channel. The waveform should appear similar to figure 9-12.
4. Move the X cursor to the position where Tx is equal to 0.
5. Limits of Vx are 877 mV and 923 mV.
6. Change 54200A/D trigger slope to (-) and trigger level to -900 mV.
7. Move the X cursor to the position where Tx = 0.
8. Limits of Vx are -877 mV and -923 mV.
9. Change 54200A/D Channel 1 voltage range to 400 mV.
10. Move the X cursor to the position where Tx is equal to 0. Limits of Vx are -832 mV and -968 mV.
11. Change 54200A/D trigger slope to (+) and trigger level to 900 mV.
12. Move the X cursor to the position where Tx = 0v. Limits of Vx are 832 mV and 968 mV.

Performance Tests

```

Status [Configuration] -----Status: Waiting for Trigger-----
                                     TALK ONLY
Data Filter [ On ]           Setup Label [ ]

Channel-----
Input 1      Input 2      Timebase-----
Range        80 mV        40 V        Sampling @ 200 MHz
Offset       0.000 V      0.000 V      Mode [ Trig'd ]
Label                                     Range        500 ns
Coupling     [dc] [ 1:1 ] [dc] [ 1:1 ]      Delay        0.000 s
Store Mode   [ Normal ] [ Normal ]          Reference    [ Center ]
Auto Scale   [ Enabled ] [ Enabled ]        Alias Test   [ Disabled ]
                                           Auto Scale   [ Period ]

Trigger-----
Mode [ Analog Only ]          * Refer to State Trigger Menus
                               for Assignment and Sequence
Analog Source [ Chan 1 ]      Auto Scale [ Enabled ]
Level         900.0 mV [ + Slope ] Store Mode [ Ave ] [ 16 ]
Range         [ Track ] 80 mV   Coupling    [dc] [ 1:1 ]
Label
    
```

Figure 9-11. STATUS Configuration Menu

```

Trigger [ Analog ] -----Status: Acquiring Frame 00018...
                                     TALK ONLY
Source [ Chan 1 ]           Auto Scale [ Enabled ]
Level  900.0 mV [ + Slope ] Store Mode [ Average ] [ 16 ]
Range  [ Track ] 80 mV     Coupling  [dc] [ 1:1 ]

Graph [ 1 ] 10.0 mV/div 900 mV 50.0 ns/div -250.0 ns

Cursor X
Vx 905 mV
Tx 0.000 s

V0 860 mV
T0 -250.0 ns

ΔV -44.5 mV
ΔT -250.0 ns
    
```

Figure 9-12. DISPLAY Waveform

## Performance Tests

---

### 9-13. TRIGGER SENSITIVITY TEST

**Specification:** 1/8 of full scale

**Equipment Required:**

Function Generator ..... HP Model 8116A  
50Ω Termination ..... HP Model 10100C

**Equipment Setup:**

8116A

Frequency (sinewave):	1 kHz
Amplitude:	5.0 V
Offset:	0.00 V

**Procedure:**

1. Configure STATUS Configuration menu as shown in figure 9-13.
2. Connect a BNC cable from the output of the Function Generator to the EXT TRIG input of the 54200A/D, through a 50 ohm terminator.
3. Display the TRIG channel. The triggered waveform should appear similar to figure 9-14.
4. Move the X cursor to the Tx = 0.0 s position.
5. Note the value of Vx.
6. Change the trigger slope to [-slope] and note the value of Vx.
7. The difference in the Vx value { Vx[+slope] minus Vx[-slope] } should be between 250 mV and 500 mV.

Performance Tests

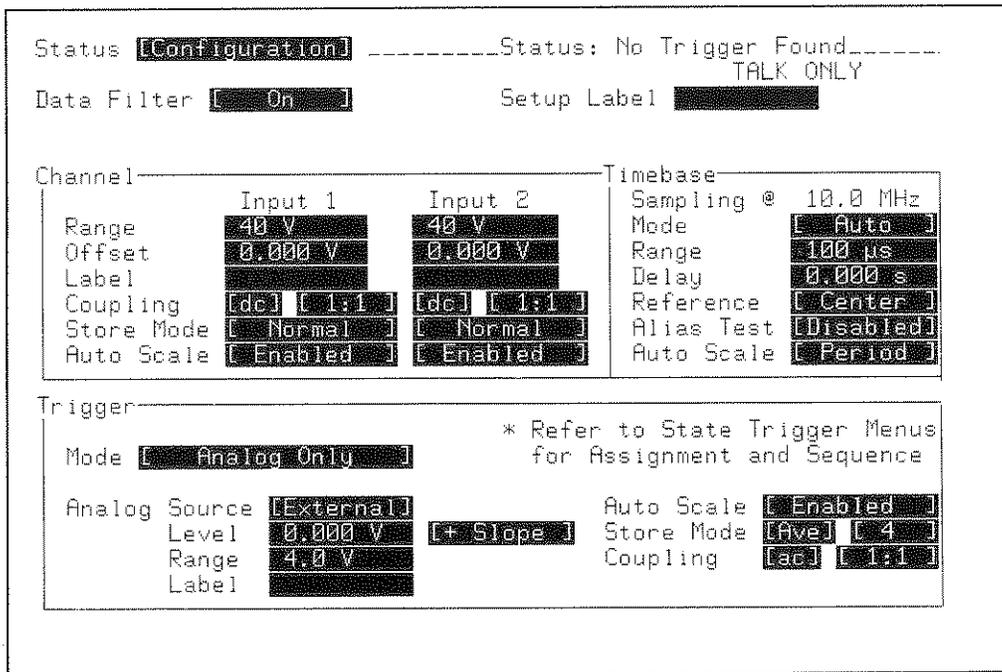


Figure 9-13. STATUS Configuration Menu

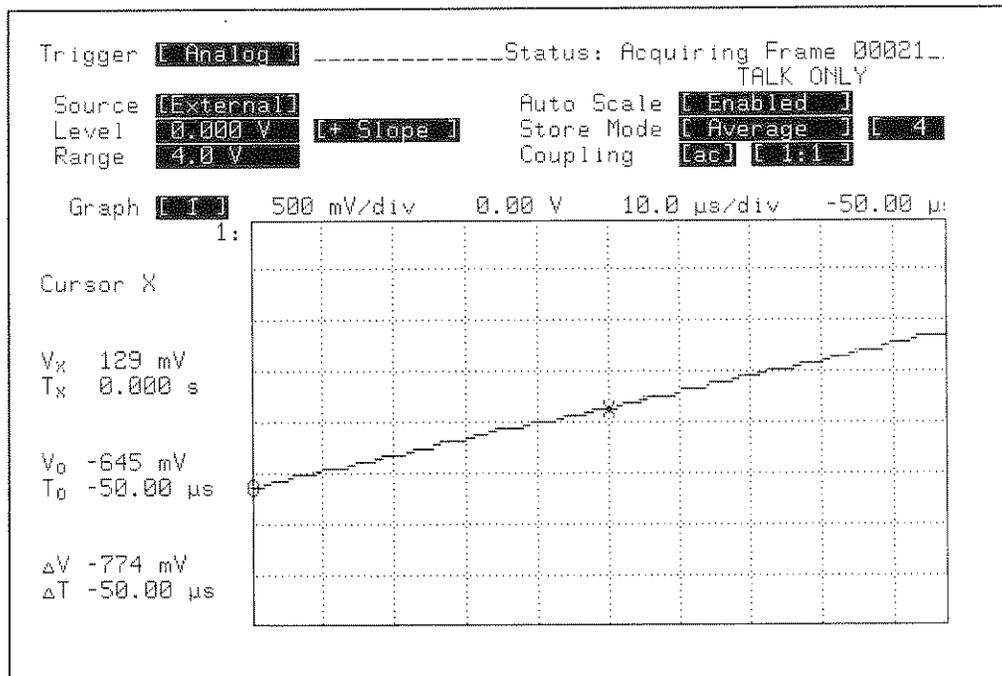


Figure 9-14. DISPLAY Waveform

## Performance Tests

---

### 9-14. SETUP TIME TEST (54200D Only)

**Specifications:**  $\geq 20$  ns; The time data must be present prior to the clock transition.

**Equipment Required:**

Pulse Generator .....	HP Model 8161A
Product Support Kit .....	HP Part No. 54200-69501
50 $\Omega$ Termination (Qty 3) .....	HP Model 10100C
BNC Tee (Qty 2) .....	HP Part No. 1250-0781
BNC Cable, 9-inch (Qty 2) .....	HP Model 10502A
BNC Cable, 48-inch (Qty 3) .....	HP Model 10503A

**Equipment Setup:**

	<u>8161A</u>		
Ext Slope:		Pos	
Period (PER):		200 ns	
		<u>A Output</u>	<u>B Output</u>
Width (WID):		100 ns	50 ns
Leading Edge (LEE):		1.3 ns	1.3 ns
Trailing Edge (TRE):		1.3 ns	1.3 ns
High Level (HIL):		+4 V	+4 V
Low Level (LOL):		0 V	0 V
Delay (DEL):		75 ns	0.00 ns

**Procedure:**

1. Configure the STATUS Configuration menu as shown in figure 9-15.
2. Configure the STATUS Measurement menu as shown in figure 9-16.
3. In the SYSTEM Peripherals menu select Rear Panel BNC: [Pulse On State Sequence True].
4. Configure the TRIGGER State / Define [Assignment] menu as shown in figure 9-17.
5. Configure the TRIGGER State / Define [Sequence] menu as shown in figure 9-18.
6. Connect POD 0 to the State Board Test fixture, HP Part No 54200-63801 (part of Product Support Kit).
7. Connect a BNC tee to the BNC labeled "CLOCK" on the State Board Test fixture.
8. Connect a BNC cable from the "B" output of the pulse generator to the "CLOCK" BNC tee, and a short BNC cable from the "CLOCK" BNC tee to the Channel 2 input of the 54200D through a 50 $\Omega$  termination.
9. Connect a BNC tee to the BNC labeled "DATA" on the State Board Test fixture.
10. Connect a BNC cable from the "A" output of the pulse generator to the "DATA" BNC tee, and a short BNC cable from the "DATA" BNC tee to the Channel 1 input of the 54200D through a 50 $\Omega$  termination.

## Performance Tests

11. Connect a BNC cable from the rear panel BNC of the 54200D to the front panel EXT TRIG input of the 54200D through a 50Ω termination.
12. Configure the display as shown in figure 9-19. Observe the waveforms displayed on the 3 channels. They should appear similar to those shown in figure 9-19. If not, repeat steps 1 through 11.
13. While observing the pulses displayed on the EXT TRIG channel, increment the pulse generator output "A" delay in 1 ns steps until the pulses on the "STATE TRIG" display disappear.
14. Now decrement the delay in 1 ns steps until the pulses reappear on that channel.
15. Select the DELAY measurement on the 54200D and set to "Delay 1 to 2". The DELAY measurement should read  $\leq 20$  ns.
16. Change the output "A" delay of the pulse generator to 75 ns.
17. Repeat steps 12 through 15 for POD 1, with the following change: in step 5, reconfigure the menu in figure 9-18 with "Occurrences of [ b ]".
18. Change the output "A" delay of the pulse generator to 75 ns.
19. Repeat steps 12 through 15 for POD 2, with the following change: in step 5, reconfigure the menu in figure 9-18 with "Occurrences of [ c ]".

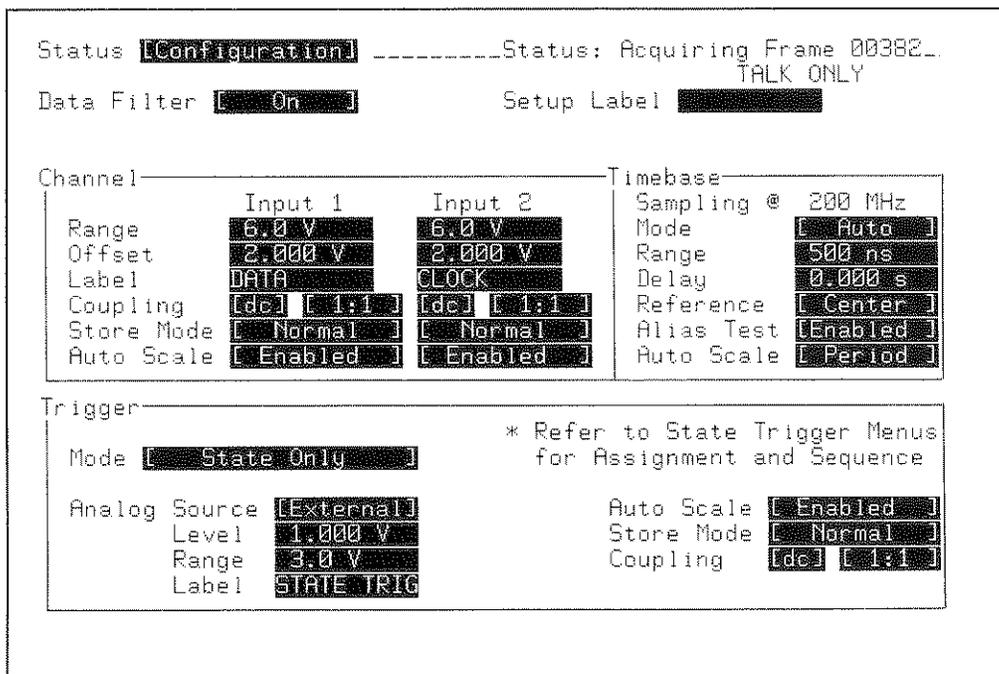


Figure 9-15. STATUS Configuration Menu

### Performance Tests

```

Status [ Measurement ] -----Status: Acquiring Frame 00399_
                                     TALK ONLY
Mode [ User Defined ]

Thresholds:      Graph 1      Graph 2      Graph 3      Graph 4
Specify as [Percent] [Percent] [Percent] [Percent]
Upper           90 %         90 %         90 %         90 %
Middle          50 %         50 %         50 %         50 %
Lower           10 %         10 %         10 %         10 %

Definitions: An Edge (↑,↓) MUST Cross Both Upper and Lower
Freq = 1 / Period
Period = ΔT, First ↓ Middle to Next Like Edge
+ Width = ΔT, First ↑ [Middle] to Next ↓ Middle
- Width = ΔT, First ↓ [Middle] to Next ↑ Middle
Rise = ΔT, First ↑ Lower to Upper
Fall = ΔT, First ↓ Upper to Lower
Duty = + Width / Period
Delay = ΔT, First [↓] [Middle] to First [↑] [Middle]
V ampl = ΔV, 100 % - 0 % Using Histogram
V max = Absolute Maximum Voltage
V min = Absolute Minimum Voltage
V rms = Root Mean Square Voltage Over 1 Period
    
```

Figure 9-16. STATUS Measurement Menu

```

Trigger [ State ] -----Status: Waiting for Trigger----
                                     TALK ONLY
Define [ Assignment ]           Trigger Mode [ State Only ]

                                Clock
                                JKL
State Mode [ Normal ] ----- [ 1111 ] -----
Multiplexing [ Off ]           [ + ] 2.0V [ + ] 2.0V [ + ] 2.0V
                                8.....0 8.....0 8.....0

Label Pol
POI0 [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ]
POI1 [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ]
POI2 [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ] [ + ]
    
```

Figure 9-17. TRIGGER State / Define [Assignment] Menu

Performance Tests

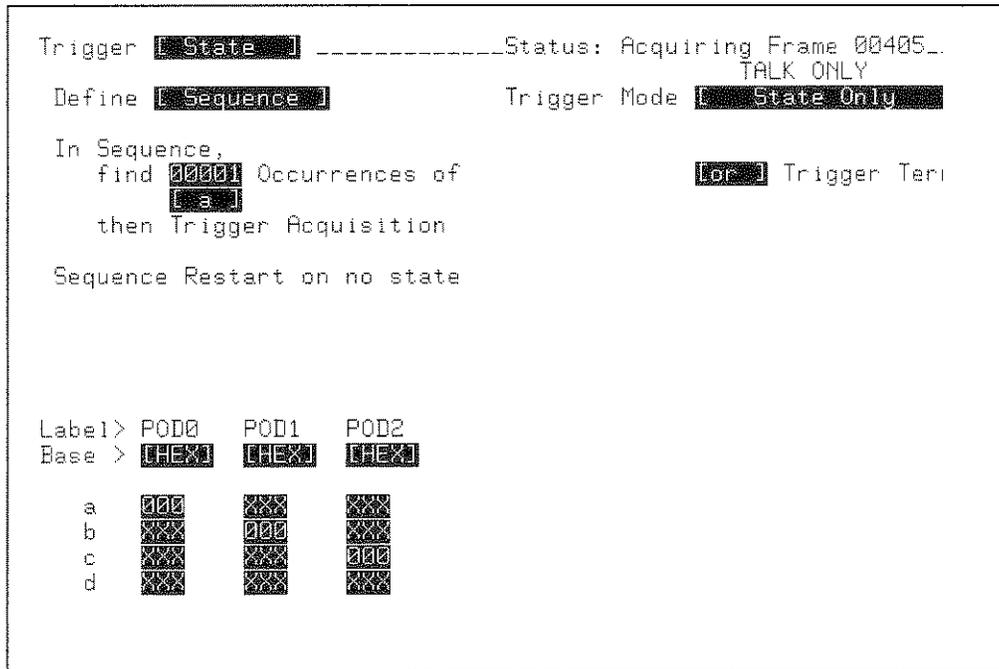


Figure 9-18. TRIGGER State / Define [Sequence] Menu

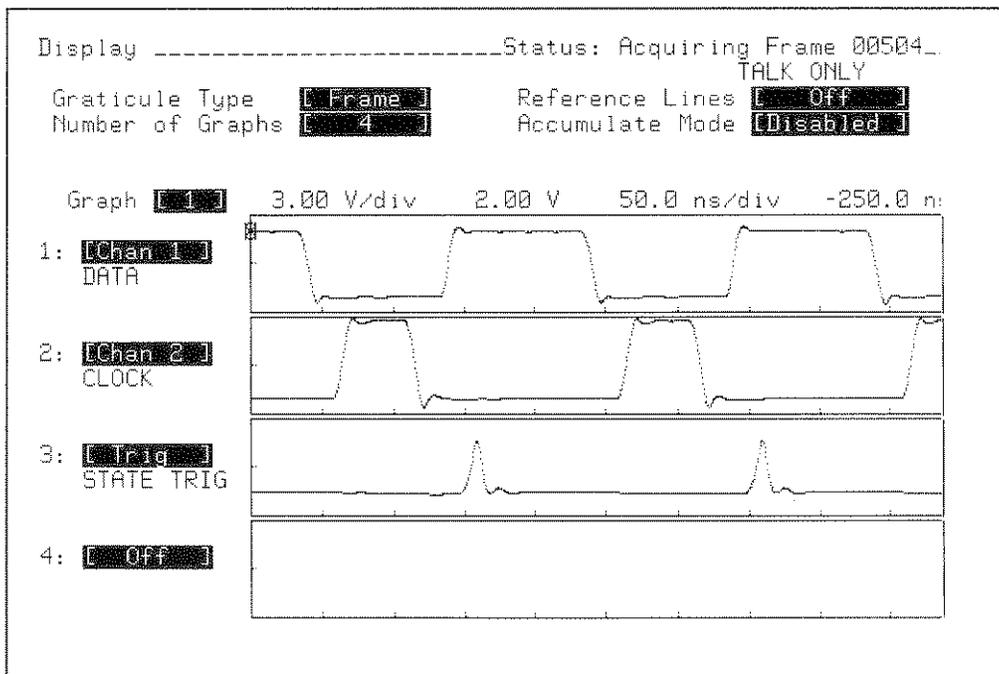


Figure 9-19. Display Configuration and Setup Test Waveforms

## Performance Tests

---

### 9-15. HOLD TIME TEST (54200D Only)

**Specifications:** 0 seconds; The time data must be present after the clock transition.

**Equipment Required:**

Pulse Generator ..... HP Model 8161A  
 Product Support Kit ..... HP Part No. 54200-69501  
 50Ω Termination (Qty 3) ..... HP Model 10100C  
 BNC Tee (Qty 2) ..... HP Part No. 1250-0781  
 BNC Cable, 9-inch (Qty 2) ..... HP Model 10502A  
 BNC Cable, 48-inch (Qty 3) ..... HP Model 10503A

**Equipment Setup:**

8161A

Ext Slope:	Pos		
Period (PER):	200 ns		
		<u>A Output</u>	<u>B Output</u>
Width (WID):	100 ns	50 ns	
Leading Edge (LEE):	1.3 ns	1.3 ns	
Trailing Edge (TRE):	1.3 ns	1.3 ns	
High Level (HIL):	+4 V	+4 V	
Low Level (LOL):	0 V	0 V	
Delay (DEL):	105 ns	0.00 ns	

**Procedure:**

1. Configure the STATUS Configuration menu as shown in figure 9-15.
2. Configure the STATUS Measurement menu as shown in figure 9-20.
3. In the SYSTEM Peripherals menu select Rear Panel BNC: [Pulse On State Sequence True].
4. Configure the TRIGGER State / Define [Assignment] menu as shown in figure 9-17.
5. Configure the TRIGGER State / Define [Sequence] menu as shown in figure 9-21.
6. Connect POD 0 to the State Board Test fixture, HP Part No. 54200-63801 (part of Product Support Kit).
7. Connect a BNC tee to the BNC labeled "CLOCK" on the State Board Test fixture.
8. Connect a BNC cable from the "B" output of the pulse generator to the "CLOCK" BNC tee, and a short BNC cable from the "CLOCK" BNC tee to the Channel 2 input of the 54200D through a 50Ω termination.
9. Connect a BNC tee to the BNC labeled "DATA" on the State Board Test fixture.
10. Connect a BNC cable from the "A" output of the pulse generator to the "DATA" BNC tee, and a short BNC cable from the "DATA" BNC tee to the Channel 1 input of the 54200D through a 50Ω termination.

## Performance Tests

---

11. Connect a BNC cable from the rear panel BNC of the 54200D to the front panel EXT TRIG input of the 54200D through a 50 $\Omega$  termination.
12. Configure the display as shown in figure 9-19. Observe the waveforms displayed on the 3 channels. They should appear similar to those shown in figure 9-19. If not, repeat steps 1 through 11.
13. While observing the pulses displayed on the EXT TRIG channel, decrement the pulse generator output "A" delay in 1 ns steps until the pulses on the "STATE TRIG" display disappear.
14. Now increment the delay in 1 ns steps until the pulses reappear on that channel.
15. Select the DELAY measurement on the 54200D and set to "Delay 2 to 1". The DELAY measurement should read  $\leq 0$  ns.
16. Change the output "A" delay of the pulse generator to 105 ns.
17. Repeat steps 12 through 15 for POD 1, with the following change: in step 5, reconfigure the menu in figure 9-21 with "Occurrences of [ b ]".
18. Change the output "A" delay of the pulse generator to 105 ns.
19. Repeat steps 12 through 15 for POD 2, with the following change: in step 5, reconfigure the menu in figure 9-21 with "Occurrences of [ c ]".

```

Status: [ Measurement ] -----Status: Acquiring Frame 00442_
                                     TALK ONLY
Mode: [ User Defined ]

Thresholds:      Graph 1      Graph 2      Graph 3      Graph 4
Specify as:     [Percent]    [Percent]    [Percent]    [Percent]
Upper           90 %         90 %         90 %         90 %
Middle          50 %         50 %         50 %         50 %
Lower           10 %         10 %         10 %         10 %

Definitions: An Edge (↑,↓) MUST Cross Both Upper and Lower
Freq = 1 / Period
Period = ΔT, First ↓ Middle to Next Like Edge
+ Width = ΔT, First ↑ [Middle] to Next ↓ Middle
- Width = ΔT, First ↓ [Middle] to Next ↑ Middle
Rise = ΔT, First ↑ Lower to Upper
Fall = ΔT, First ↓ Upper to Lower
Duty = + Width / Period
Delay = ΔT, First [↑] [Middle] to First [↓] [Middle]
V ampl = ΔV, 100 % - 0 % Using Histogram
V max = Absolute Maximum Voltage
V min = Absolute Minimum Voltage
V rms = Root Mean Square Voltage Over 1 Period

```

Figure 9-20. STATUS Measurement Menu

## Performance Tests

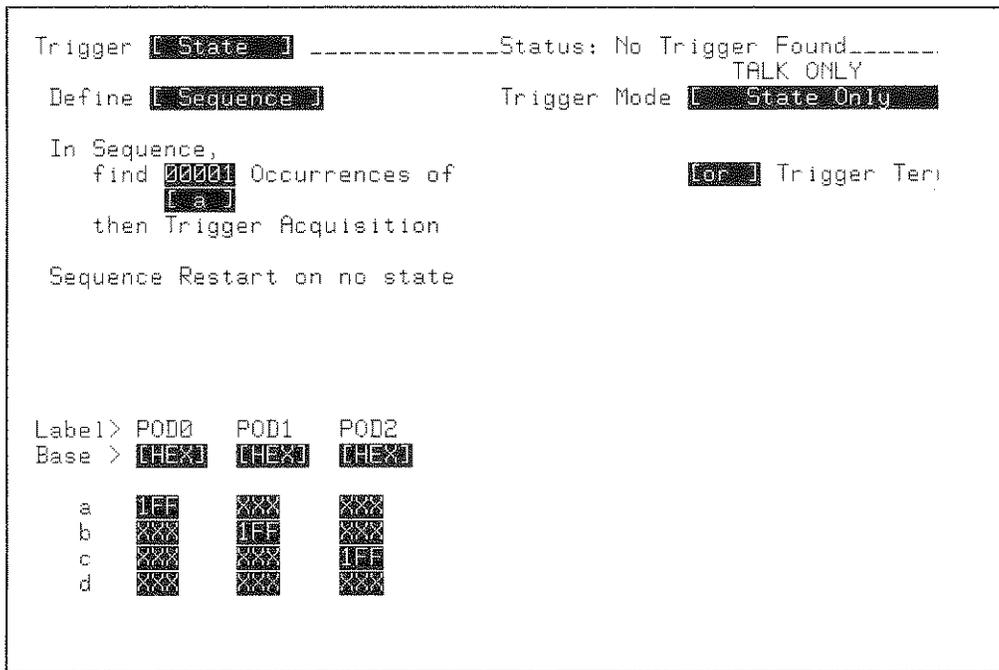


Figure 9-21. TRIGGER State / Define [Sequence] Menu

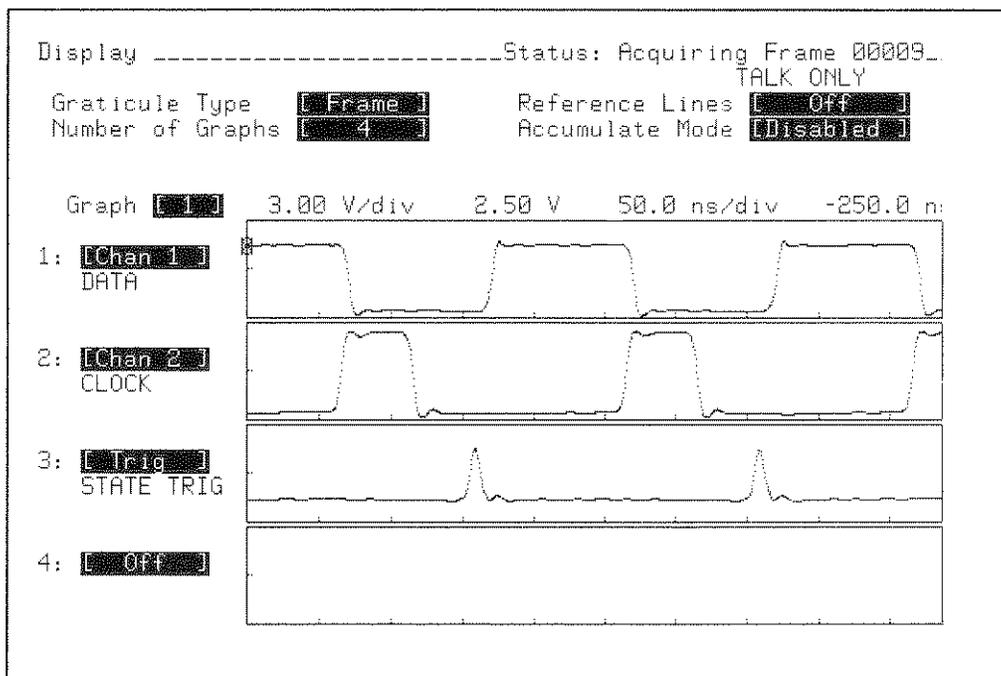


Figure 9-22. Display Configuration and Hold Test Waveforms

## Performance Tests

---

### 9-16. CLOCK PULSE WIDTH TEST (54200D Only)

**Specifications:**  $\geq 20$  ns at threshold.

**Equipment Required:**

Pulse Generator .....	HP Model 8161A
Product Support Kit .....	HP Part No. 54200-69501
50 $\Omega$ Termination (Qty 2) .....	HP Model 10100C
BNC Tee .....	HP Part No. 1250-0781
BNC Cable, 9-inch .....	HP Model 10502A
BNC Cable, 48-inch (Qty 2) .....	HP Model 10503A

**Equipment Setup:**

<u>8161A</u>	
Period (PER):	200 ns
	<u>B Output</u>
Width (WID):	25 ns
Leading Edge (LEE):	1.3 ns
Trailing Edge (TRE):	1.3 ns
High Level (HIL):	+4 V
Low Level (LOL):	0 V
Delay (DEL):	0 ns

**Procedure:**

1. Configure the STATUS Configuration menu as shown in figure 9-15.
2. Configure the STATUS Measurement menu in Standard mode.
3. In the SYSTEM Peripherals menu select Rear Panel BNC: [Pulse On State Sequence True].
4. Configure the TRIGGER State / Define [Assignment] menu as shown in figure 9-17.
5. Configure the TRIGGER State / Define [Sequence] menu as shown in figure 9-23.
6. Connect POD 0 to the State Board Test fixture, HP Part No. 54200-63801 (part of Product Support Kit).
7. Connect a BNC tee to the BNC labeled "CLOCK" on the State Board Test fixture.

## Performance Tests

---

8. Connect a BNC cable from the "B" output of the pulse generator to the "CLOCK" BNC tee, and a short BNC cable from the "CLOCK" BNC tee to Channel 2 input of the 54200D through a 50 $\Omega$  termination.

### Note

*The 9 data channels of the POD do not have a signal input during this test.*

9. Connect a BNC cable from the rear panel BNC of the 54200D to the front panel EXT TRIG input on the 54200D through a 50 $\Omega$  termination.
10. Configure the display as shown in figure 9-24. Observe the two waveforms displayed on the 54200D. The two waveforms should appear similar to those shown in figure 9-24.
11. While observing the pulses displayed on the channel labeled "STATE TRIG", decrement the pulse generator output "B" width in 1 ns steps until the pulses on the "STATE TRIG" display disappears.
12. Increment the width until the "STATE TRIG" pulse reappears.
13. Select the + WIDTH measurement on the 54200D and insert "2".
14. The measurement should read  $\leq 20$  ns.
15. Change the "B" output width of the pulse generator to 25 ns.
16. Disconnect POD 0 and connect POD 1. Repeat steps 10 through 14.
17. Change the "B" output width of the pulse generator to 25 ns.
18. Disconnect POD 1 and connect POD 2. Repeat steps 10 through 14.
19. Change the "B" output width of the pulse generator to 25 ns.
20. Select the complement mode for the "B" output of the pulse generator.

### Note

*If the pulse generator does not have the complement mode, simply change the output pulse width to 175 ns.*

21. In the TRIGGER State / Define [Assignment] menu (figure 9-17), change the J, K, and L clocks to the falling ( $\downarrow$ ) edge.

## Performance Tests

---

22. Disconnect POD 2 and connect POD 0.
23. The waveforms displayed on screen should be similar to figure 9-25.
24. Repeat steps 11 through 15 using the - WIDTH measurement of the 54200D instead of the + WIDTH measurement.
25. Disconnect POD 0 and connect POD 1.
26. The waveforms displayed on screen should be similar to figure 9-25.
27. Repeat steps 11 through 15 using the - WIDTH measurement of the 54200D instead of the + WIDTH measurement.
28. Disconnect POD 1 and connect POD 2.
29. The waveforms displayed on screen should be similar to figure 9-25.
30. Repeat steps 11 through 14 using the - WIDTH measurement of the 54200D instead of the + WIDTH measurement.

```

Trigger [ State ] -----Status: Acquiring Frame 00001...
                                     TALK ONLY
Define [ Sequence ]           Trigger Mode [ State Only ]

In Sequence,
  find 0000 Occurrences of          [or] Trigger Teri
  [any state]
  then Trigger Acquisition

Sequence Restart on no state

Label> POD0   POD1   POD2
Base > [HEX] [HEX] [HEX]

a  [FF] [XX] [XX]
b  [XX] [FF] [XX]
c  [XX] [XX] [FF]
d  [XX] [XX] [XX]
    
```

Figure 9-23. TRIGGER State / Define [Sequence] Menu

### Performance Tests

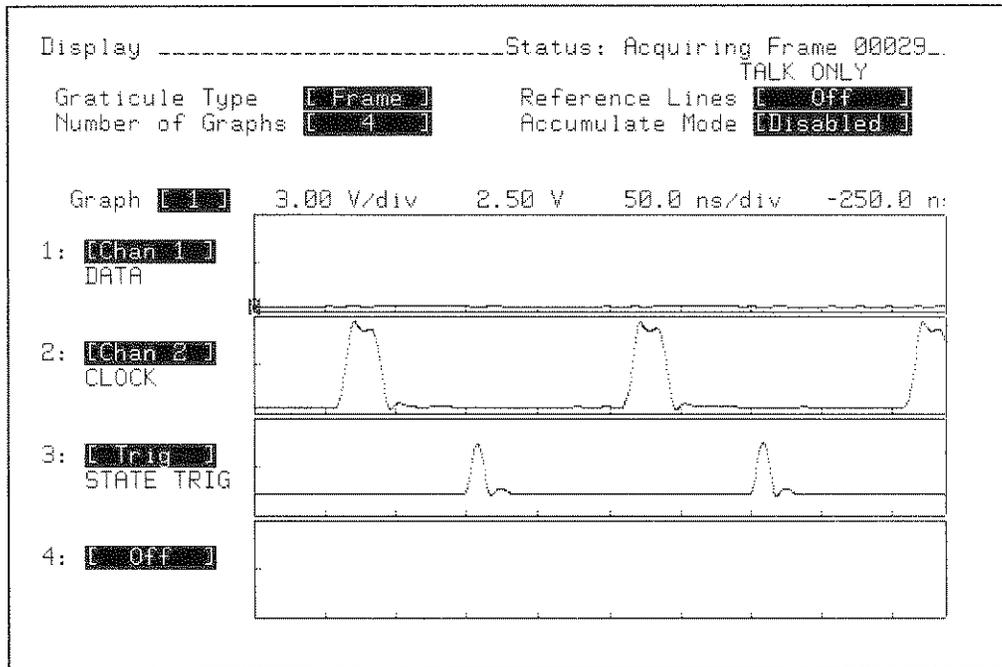


Figure 9-24. DISPLAY Configuration and Clock Pulse Width Test Waveforms

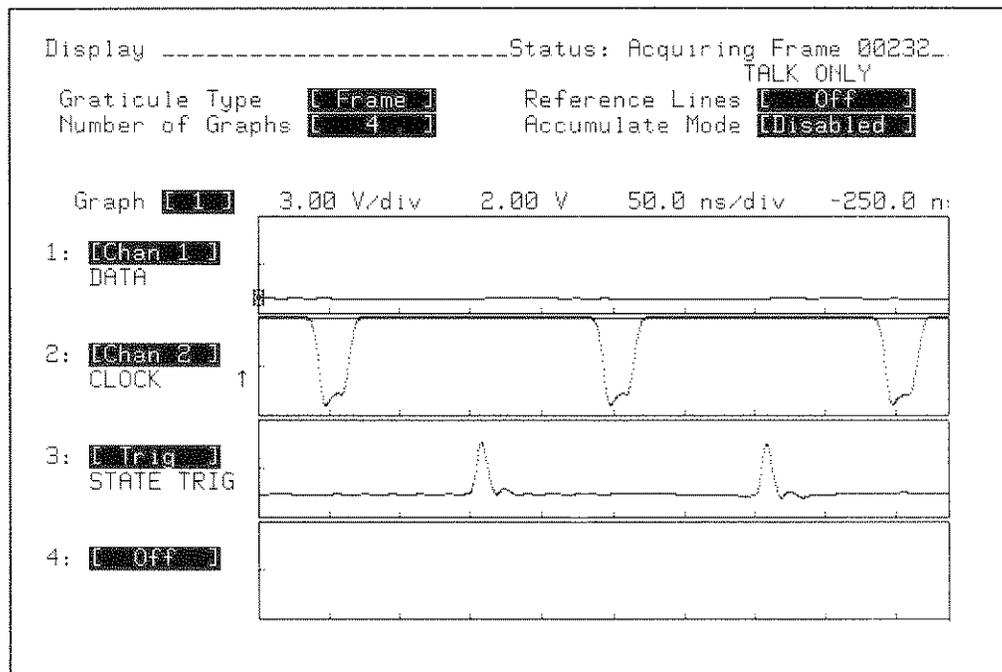


Figure 9-25. Clock Pulse Width Test Waveforms

**Performance Tests**

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**9-17. CLOCK REPETITION RATE TEST (54200D Only)**

**Specifications:** Single phase - 25 MHz maximum with single clock and single edge specified.

**Equipment Required:**

Pulse Generator ..... HP Model 8161A  
 Product Support Kit ..... HP Part No. 54200-69501  
 50Ω Termination (Qty 2) ..... HP Model 10100C  
 BNC Tee ..... HP Part No. 1250-0781  
 BNC Cable, 9-inch ..... HP Model 10502A  
 BNC Cable, 48-inch (Qty 2) ..... HP Model 10503A

**Equipment Setup:**

<u>8161A</u>	
Period (PER):	50 ns
	<u>B Output</u>
Width (WID):	15 ns
Leading Edge (LEE):	1.3 ns
Trailing Edge (TRE):	1.3 ns
High Level (HIL):	+4 V
Low Level (LOL):	0 V
Delay (DEL):	0 ns

**Procedure:**

1. Configure the STATUS Configuration menu as shown in figure 9-15.
2. Configure the STATUS Measurement menu in Standard mode.
3. In the SYSTEM Peripherals menu select Rear Panel BNC: [Pulse On State Sequence True].
4. Configure the TRIGGER State / Define [Assignment] menu as shown in figure 9-17.
5. Configure the TRIGGER State / Define [Sequence] menu as shown in figure 9-23.
6. Connect POD 0 to the State Board Test fixture, HP Part No. 54200-63801 (part of Product Support Kit).
7. Connect a BNC tee to the BNC labeled "CLOCK" on the State Board Test fixture.

## Performance Tests

---

8. Connect a BNC cable from the "B" output of the pulse generator to the "CLOCK" BNC tee, and a short BNC cable from the "CLOCK" BNC tee to Channel 2 input of the 54200D through a 50 $\Omega$  termination.

### Note

*The 9 data channels of the POD do not have a signal input during this test.*

9. Connect a BNC cable from the rear panel BNC of the 54200D to the front panel EXT TRIG input on the 54200D through a 50 $\Omega$  termination.
10. Configure the display as shown in figure 9-26. Observe the two waveforms displayed on the 54200D. The two waveforms should appear similar to those shown in figure 9-26.
11. While observing the pulses displayed on the channel labeled "STATE TRIG", decrement the pulse generator period in 1 ns steps until the "STATE TRIG" waveform begins to drop pulses as shown in figure 9-27.
12. Increment the period of the pulse generator "B" output until the "STATE TRIG" waveform pulses are again present.
13. Select the FREQ measurement on the 54200D and for graph 2. The frequency should be  $\geq 25$  MHz.
14. Set the period of the pulse generator to 50 ns.
15. Disconnect POD 0 and connect POD 1. Repeat steps 10 through 13.
16. Set the period of the pulse generator to 50 ns.
17. Disconnect POD 1 and connect POD 2. Repeat steps 10 through 13.

Performance Tests

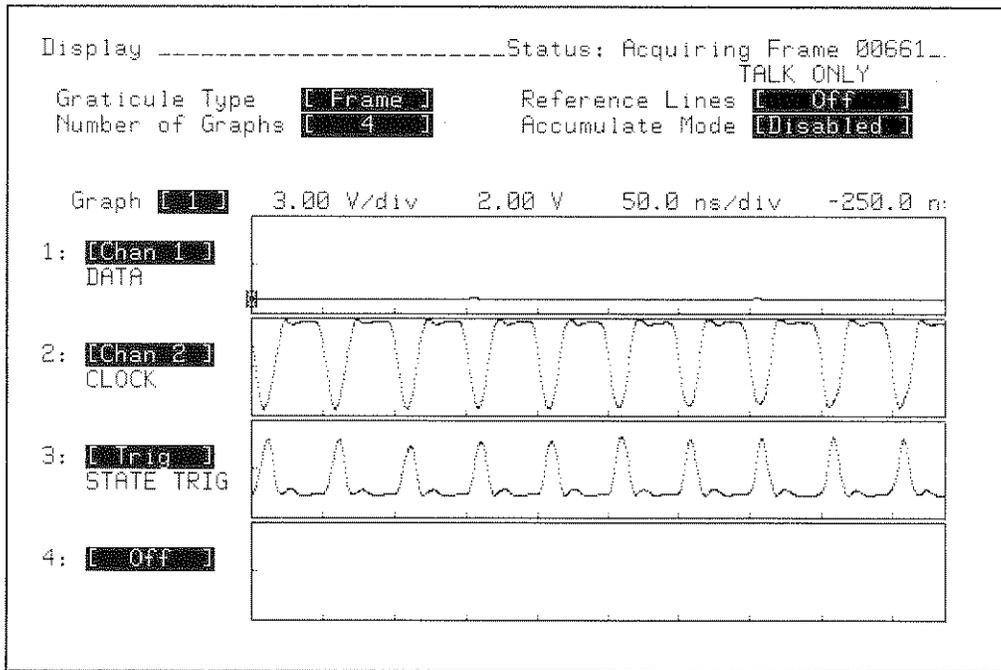


Figure 9-26. DISPLAY Configuration and Clock Repetition Rate Test Waveforms

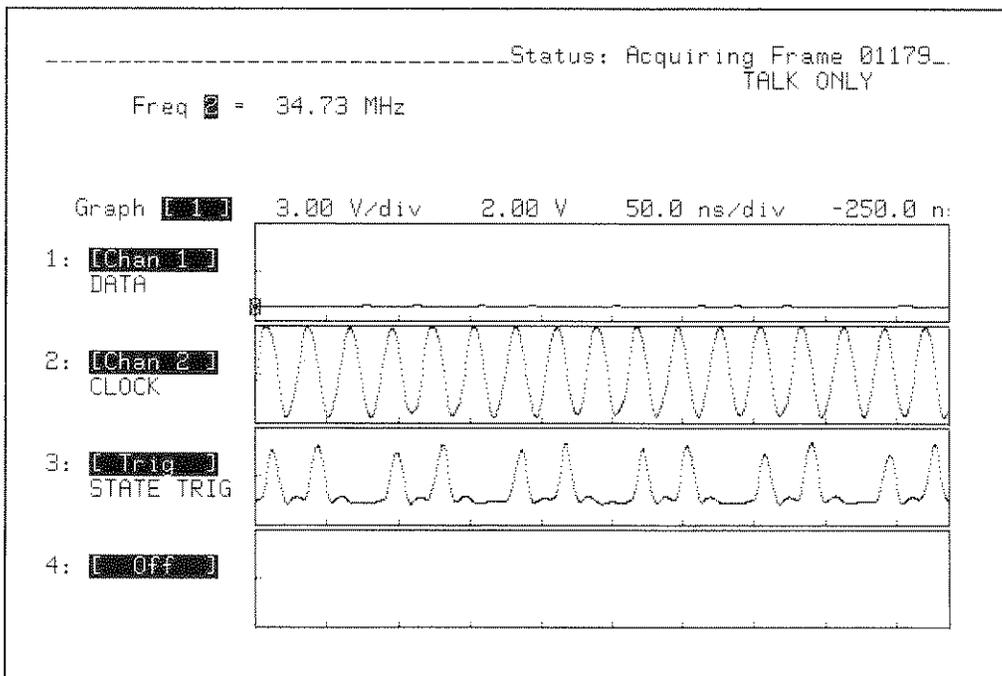


Figure 9-27. Clock Repetition Rate Test Waveforms

## Performance Tests

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### 9-18. MINIMUM INPUT TEST (54200D Only)

**Specifications:** 600 mV peak-to-peak

**Equipment Required:**

Pulse Generator . . . . .	HP Model 8161A
Product Support Kit . . . . .	HP Part No. 54200-69501
Blocking Capacitor . . . . .	HP Model 10240B
50Ω Termination (Qty 2) . . . . .	HP Model 10100C
BNC Tee . . . . .	HP Part No. 1250-0781
BNC Cable, 9-inch . . . . .	HP Model 10502A
BNC Cable, 48-inch (Qty 2) . . . . .	HP Model 10503A

**Equipment Setup:**

	<u>8161A</u>	
Period (PER):		100 ns
		<u>B Output</u>
Width (WID):		50 ns
Leading Edge (LEE):		1.3 ns
Trailing Edge (TRE):		1.3 ns
High Level (HIL):		+0.65 V
Low Level (LOL):		0 V
Delay (DEL):		0 ns

**Procedure:**

1. Configure the STATUS Configuration menu as shown in figure 9-28.
2. In the SYSTEM Peripherals menu select Rear Panel BNC: [Pulse On State Sequence True].
3. Configure the TRIGGER State / Define [Assignment] menu as shown in figure 9-29.
4. Configure the TRIGGER State / Define [Sequence] menu as shown in figure 9-23.
5. Connect POD 0 to the State Board Test fixture, HP Part No. 54200-63801 (part of Product Support Kit).
6. Connect a BNC tee to the BNC labeled "CLOCK" on the State Board Test fixture.
7. Connect the blocking capacitor to the "B" output of the pulse generator.
8. Connect a BNC cable from the "B" output of the pulse generator to the "CLOCK" BNC tee, and a short BNC cable from the "CLOCK" BNC tee to Channel 2 input of the 54200D through a 50Ω termination.

**Note**

*The 9 data channels of the POD do not have a signal input during this test.*

## Performance Tests

---

9. Connect a BNC cable from the rear panel BNC of the 54200D to the front panel EXT TRIG input on the 54200D through a 50Ω termination.
10. Configure the display as shown in figure 9-30. The displayed waveforms should appear similar to those shown in figure 9-30.
11. While observing the pulses displayed on the channel labeled "STATE TRIG", decrement the High Level (HIL) output of the pulse generator period in 0.01 volt steps until the waveform labeled "STATE TRIG" starts to drop pulses.
12. Increment the High Level (HIL) in 0.01 volt steps until the pulses are again present.
13. The High Level (HIL) readout on the pulse generator should be  $\leq 0.6$  V.
14. Change the High Level (HIL) of the pulse generator to 0.65 V.
15. Disconnect POD 0 and connect POD 1. Repeat steps 10 through 13.
16. Change the High Level (HIL) of the pulse generator to 0.65 V.
17. Disconnect POD 1 and connect POD 2. Repeat steps 10 through 13.

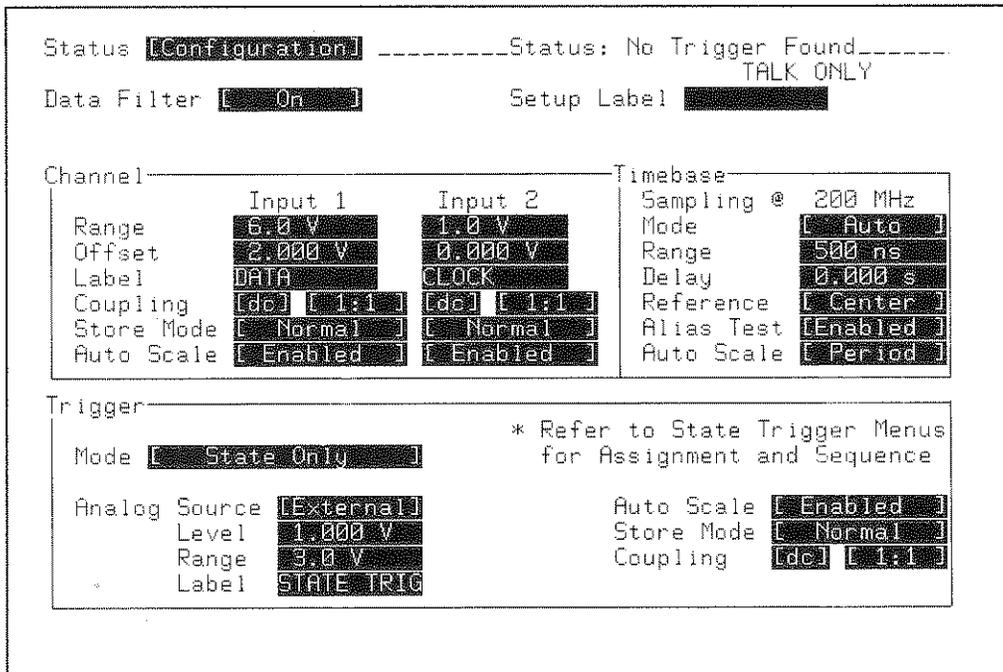


Figure 9-28. STATUS Configuration Menu

### Performance Tests

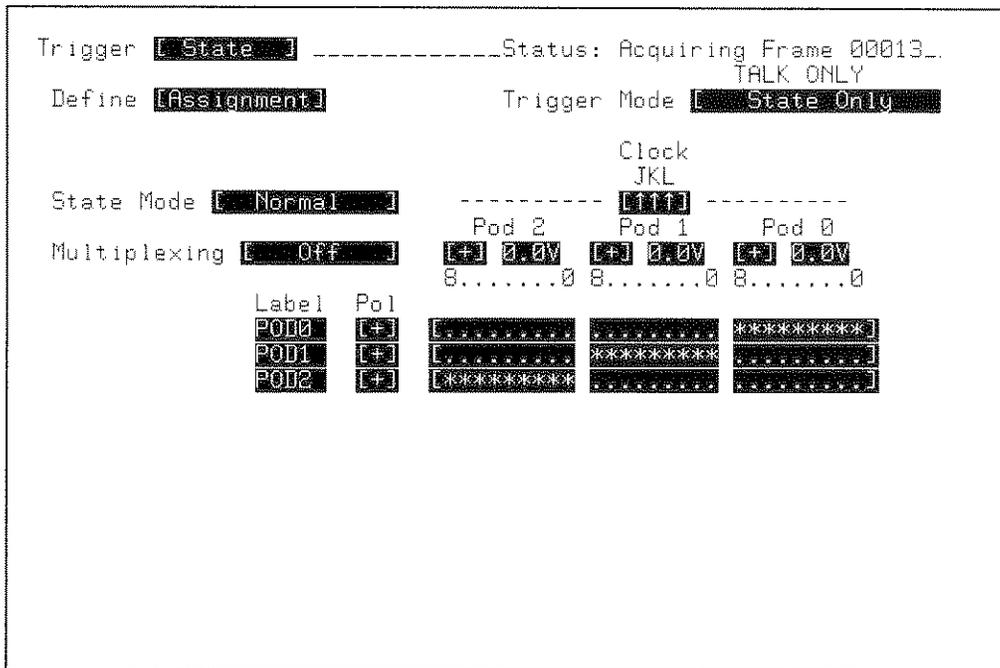


Figure 9-29. TRIGGER State / Define [Assignment] Menu

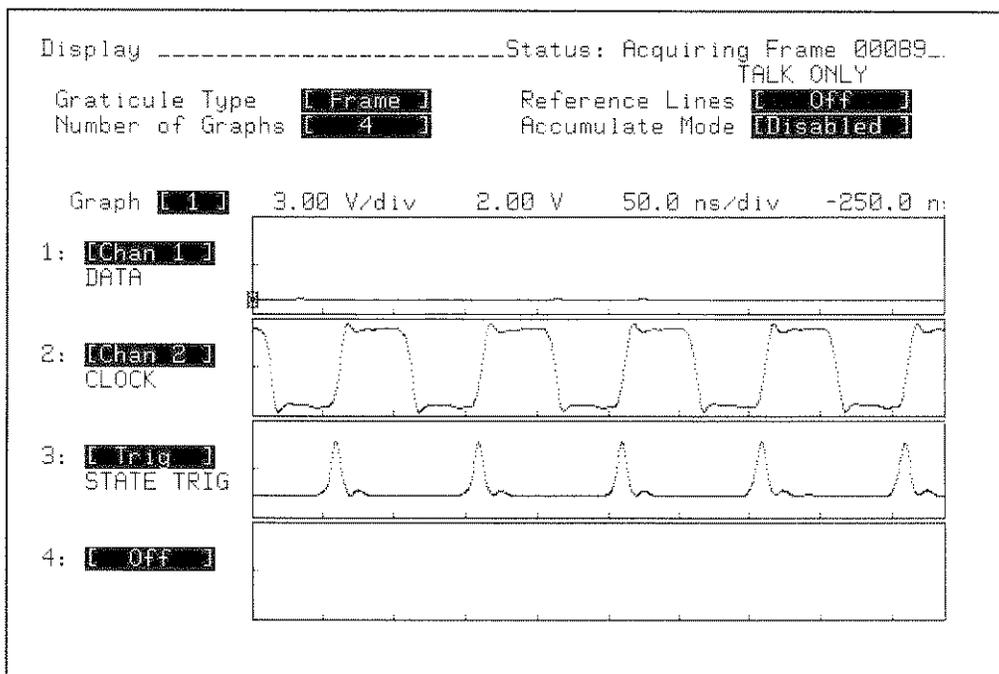


Figure 9-30. DISPLAY Configuration and Minimum Input Test Waveform

**Performance Tests**

---

**9-19. THRESHOLD ACCURACY TEST (54200D Only)**

**Specifications:** ±2.5% ±120 mV.

**Equipment Required:**

Dc Supply ..... HP Model 6111A  
 Pulse Generator ..... HP Model 8161A  
 Product Support Kit ..... HP Part No. 54200-69501  
 50Ω Termination (Qty 2) ..... HP Model 10100C  
 BNC Tee ..... HP Part No. 1250-0781  
 BNC Cable, 9-inch ..... HP Model 10502A  
 BNC Cable, 48-inch (Qty 4) ..... HP Model 10503A  
 BNC(f)-to-Dual Banana Adapter ..... HP Part No. 1251-2277

**Equipment Setup:**

<u>8161A</u>	<u>6111A</u>
Period (PER):	100 ns      Output: +4.3 V
	<u>B Output</u>
Width (WID):	50 ns
Leading Edge (LEE):	1.3 ns
Trailing Edge (TRE):	1.3 ns
High Level (HIL):	5.00 V
Low Level (LOL):	0 V
Delay (DEL):	0 ns

**Procedure:**

1. Configure the STATUS Configuration menu as shown in figure 9-31.
2. In the SYSTEM Peripherals menu select Rear Panel BNC: [Pulse On State Sequence True].
3. Configure the TRIGGER State / Define [Assignment] menu as shown in figure 9-32.
4. Configure the TRIGGER State / Define [Sequence] menu as shown in figure 9-21.
5. Connect a BNC(f)-to-dual banana adapter and BNC tee to the DC Supply. Connect a BNC cable from the DC Supply BNC tee to the Channel 1 input of the 54200D. Connect another BNC cable from the DC Supply BNC tee to the "DATA" input on the State Board Test fixture, HP Part No. 54200-63801 (part of Product Support Kit).
6. Connect POD 0 to the State Board Test fixture.
7. Connect a BNC tee to the BNC labeled "CLOCK" on the State Board Test fixture.
8. Connect a BNC cable from the "B" output of the pulse generator to the "CLOCK" BNC tee, and a short BNC cable from the "CLOCK" BNC tee to Channel 2 input of the 54200D through a 50Ω termination.

## Performance Tests

---

9. Connect a BNC cable from the rear panel BNC of the 54200D to the front panel EXT TRIG input of the 54200D through a 50 $\Omega$  termination.
10. Configure the display as shown in figure 9-33. The waveforms should appear similar to those shown in figure 9-33.
11. Decrease the output of the DC Supply in 0.01 volt steps until the "STATE TRIG" waveform begins to drop pulses.
12. Increase the output of the DC Supply until the "STATE TRIG" pulses reappear as shown in figure 9-33. The DC Supply should read  $\geq 3.78$  V and  $\leq 4.22$  V.
13. Change the output level of the DC Supply to +4.3.
14. Reconfigure the menu shown in figure 9-21 with "Occurrences of [ b ]". Disconnect POD 0 and connect POD 1. Repeat steps 10 through 13.
15. Reconfigure the menu shown in figure 9-21 with "Occurrences of [ c ]". Disconnect POD 1 and connect POD 2. Repeat steps 10 through 12.
16. Reconfigure the "B" output of the pulse generator as follows:
  - High Level (HIL): 0 V
  - Low Level (LOL): -5.00 V
17. Change the output level of the DC Supply to -4.3 V.
18. Reconfigure the menu shown in figure 9-31 Channel 1 and Channel 2 offset to -2.5 V.
19. Disconnect POD 2 and connect POD 0.
20. Reconfigure the menu in figure 9-21 with "Occurrences of [ a ]".
21. Reconfigure the menu in figure 9-32 with thresholds of -4.0 V.
22. The "STATE TRIG" pulses should be missing on the display.
23. Increase (more positive) the output level of the DC Supply in 0.01 volt steps until the "STATE TRIG" waveform appears as shown in figure 9-33. The DC Supply should read  $\leq -3.78$  V and  $\geq -4.22$  V.
24. Change the output level of the DC Supply to -4.3 V.
25. Reconfigure the menu in figure 9-21 with "Occurrences of [ b ]". Replace POD 0 with POD 1 and repeat steps 22 through 24.
26. Reconfigure the menu in figure 9-21 with "Occurrences of [ c ]". Replace POD 1 with POD 2 and repeat steps 22 and 23.

Performance Tests

```

Status [ Configuration ] -----Status: Acquiring Frame 00001_
                                     TALK ONLY
Data Filter [ On ] Setup Label [ ]

Channel-----
Input 1      Input 2      Timebase-----
Range        6.0 V        8.0 V        Sampling @ 200 MHz
Offset       2.500 V      2.500 V      Mode [ Auto ]
Label        DATA        CLOCK          Range [ 500 ns ]
Coupling     [dc] [ 1:1 ] [dc] [ 1:1 ] Delay [ 0.000 s ]
Store Mode   [ Normal ]   [ Normal ]   Reference [ Center ]
Auto Scale   [ Enabled ]  [ Enabled ]  Alias Test [ Enabled ]
                                     Auto Scale [ Period ]

Trigger-----
Mode [ State Only ] * Refer to State Trigger Menus
                                     for Assignment and Sequence
Analog Source [ External ] Auto Scale [ Enabled ]
Level [ 1.000 V ] Store Mode [ Normal ]
Range [ 3.0 V ] Coupling [dc] [ 1:1 ]
Label STATE TRIG
    
```

Figure 9-31. STATUS Configuration Menu

```

Trigger [ State ] -----Status: No Trigger Found-----
                                     TALK ONLY
Define [ Assignment ] Trigger Mode [ State Only ]

State Mode [ Normal ]
Multiplexing [ Off ]

Clock
JKL [↑↑↑]
Pod 2 Pod 1 Pod 0
[+] 4.0V [+] 4.0V [+] 4.0V
8.....0 8.....0 8.....0

Label Pol
POD0 [+]
POD1 [+]
POD2 [+]
    
```

Figure 9-32. TRIGGER State / Define [Assignment] Menu

### Performance Tests

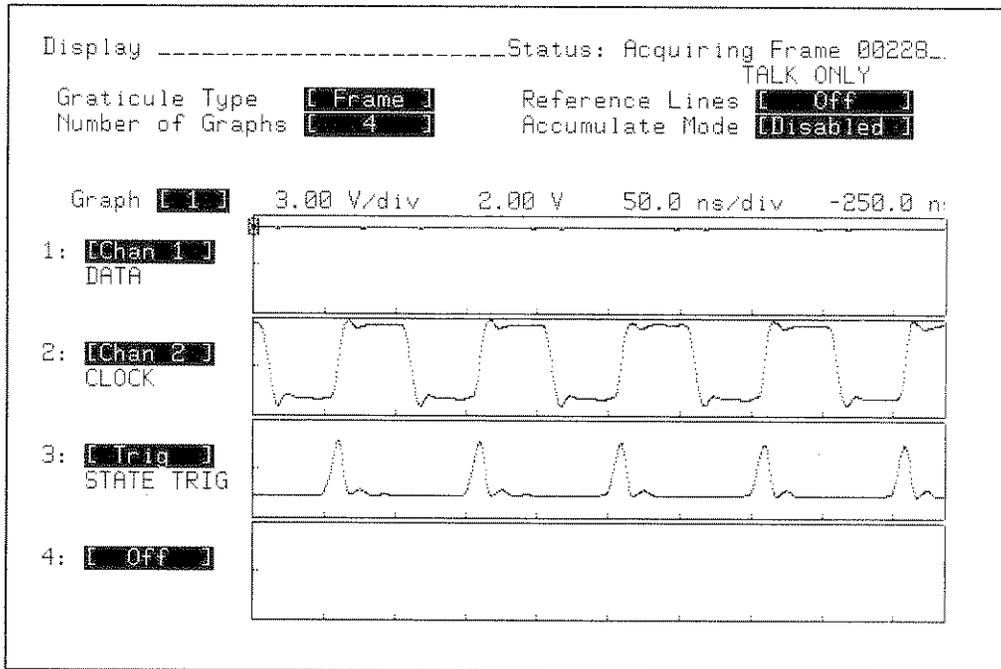


Figure 9-33. DISPLAY Configuration and Threshold Test Waveforms

Table 9-2. Model 54200A/D Performance Test Record

TEST	LIMITS	MEASURED																					
<b>9-7.</b> DC OFFSET ACCURACY	0.99 V to 1.01 V  -0.99 V to -1.01 V  -0.94 V to -1.06 V  0.94 V to 1.06 V	<table border="0"> <tr> <td></td> <td style="text-align: center;">VMIN</td> <td style="text-align: center;">VMAX</td> </tr> <tr> <td>CH.1</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.2</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.1</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.2</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.1</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.2</td> <td>_____</td> <td>_____</td> </tr> </table>		VMIN	VMAX	CH.1	_____	_____	CH.2	_____	_____	CH.1	_____	_____	CH.2	_____	_____	CH.1	_____	_____	CH.2	_____	_____
	VMIN	VMAX																					
CH.1	_____	_____																					
CH.2	_____	_____																					
CH.1	_____	_____																					
CH.2	_____	_____																					
CH.1	_____	_____																					
CH.2	_____	_____																					
<b>9-8.</b> VOLTAGE MEASUREMENT ACCURACY	85 mV to 115 mV  -85 mV to -115 mV  -4.23 V to -5.77 V  4.23 V to 5.77 V	<table border="0"> <tr> <td></td> <td style="text-align: center;">VMIN</td> <td style="text-align: center;">VMAX</td> </tr> <tr> <td>CH.1</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.2</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.1</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.2</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.1</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>CH.2</td> <td>_____</td> <td>_____</td> </tr> </table>		VMIN	VMAX	CH.1	_____	_____	CH.2	_____	_____	CH.1	_____	_____	CH.2	_____	_____	CH.1	_____	_____	CH.2	_____	_____
	VMIN	VMAX																					
CH.1	_____	_____																					
CH.2	_____	_____																					
CH.1	_____	_____																					
CH.2	_____	_____																					
CH.1	_____	_____																					
CH.2	_____	_____																					
<b>9-9.</b> BANDWIDTH (-3dB)	RF Voltmeter _____ VRMS @ 200 kHz _____  $\text{VRMS} * 0.707 = \frac{\text{Limit}}{\quad}$	CH.1 _____ CH.2 _____ EXT. _____																					
<b>9-10.</b> TRANSITION TIME	<table border="0"> <tr> <td style="text-align: center;"><math>\leq 7</math> ns</td> <td style="text-align: center;">RISE</td> </tr> <tr> <td style="text-align: center;"><math>\leq 7</math> ns</td> <td style="text-align: center;">FALL</td> </tr> </table>	$\leq 7$ ns	RISE	$\leq 7$ ns	FALL	<table border="0"> <tr> <td>CH.1</td> <td>_____</td> </tr> <tr> <td>CH.2</td> <td>_____</td> </tr> <tr> <td>EXT.</td> <td>_____</td> </tr> <tr> <td>CH.1</td> <td>_____</td> </tr> <tr> <td>CH.2</td> <td>_____</td> </tr> <tr> <td>EXT.</td> <td>_____</td> </tr> </table>	CH.1	_____	CH.2	_____	EXT.	_____	CH.1	_____	CH.2	_____	EXT.	_____					
$\leq 7$ ns	RISE																						
$\leq 7$ ns	FALL																						
CH.1	_____																						
CH.2	_____																						
EXT.	_____																						
CH.1	_____																						
CH.2	_____																						
EXT.	_____																						
<b>9-11.</b> TIME MEASUREMENT ACCURACY	98 ns to 102 ns	_____																					

Table 9-2. Model 54200A/D Performance Test Record

TEST	LIMITS	MEASURED														
<b>9-12.</b> TRIGGER (ANALOG) LEVEL ACCURACY	877 mV to 923 mV  -877 mV to -923 mV  -832 mV to -968 mV  832 mV to 968 mV	_____  _____  _____  _____														
<b>9-13.</b> TRIGGER SENSITIVITY	250 mV to 500 mV	PASS      FAIL _____    _____														
<b>9-14.</b> SETUP TIME (54200D)	$\leq 20$ ns	POD0 _____ POD1 _____ POD2 _____														
<b>9-15.</b> HOLD TIME (54200D)	$\leq 0$ ns	POD0 _____ POD1 _____ POD2 _____														
<b>9-16.</b> CLOCK PULSE WIDTH (54200D)	$\leq 20$ ns	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"></td> <td style="text-align: center;">+WIDTH</td> <td style="text-align: center;">-WIDTH</td> </tr> <tr> <td>POD0</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>POD1</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>POD2</td> <td>_____</td> <td>_____</td> </tr> </table>		+WIDTH	-WIDTH	POD0	_____	_____	POD1	_____	_____	POD2	_____	_____		
	+WIDTH	-WIDTH														
POD0	_____	_____														
POD1	_____	_____														
POD2	_____	_____														
<b>9-17.</b> CLOCK REPETITION RATE (54200D)	$\geq 25$ MHz	POD0 _____ POD1 _____ POD2 _____														
<b>9-18.</b> MINIMUM INPUT (54200D)	$\leq 0.60$ V	POD0 _____ POD1 _____ POD2 _____														
<b>9-19.</b> THRESHOLD ACCURACY (54200D)	3.78 V to 4.22 V    -3.78 V to -4.22 V	<table style="width: 100%; border: none;"> <tr> <td>POD0</td> <td>_____</td> </tr> <tr> <td>POD1</td> <td>_____</td> </tr> <tr> <td>POD2</td> <td>_____</td> </tr> <tr> <td colspan="2"> </td> </tr> <tr> <td>POD0</td> <td>_____</td> </tr> <tr> <td>POD1</td> <td>_____</td> </tr> <tr> <td>POD2</td> <td>_____</td> </tr> </table>	POD0	_____	POD1	_____	POD2	_____			POD0	_____	POD1	_____	POD2	_____
POD0	_____															
POD1	_____															
POD2	_____															
POD0	_____															
POD1	_____															
POD2	_____															

## SECTION 10 ADJUSTMENTS

### 10-1. INTRODUCTION

This section contains adjustment procedures for the power supply, display driver, analog, and state trigger board. Included in this section is a table of Recommended Test Equipment (table 10-1).

### 10-2. CALIBRATION INTERVAL

There is no recommended calibration interval. Adjustment needs are defined by the pass/fail status of resident self-tests and calibration routines. A failure of a SYSTEM menu self-test should be followed by resident SYSTEM menu calibration routines 0 and 6. The self-tests should then be re-selected to check whether the self-calibration routines corrected the error. Repeated failure of a self-test, or failure of a self-calibration routine may dictate the need of a particular hardware adjustment. Refer to table 12-2 in Section 12 for appropriate adjustments.

Certain adjustments should be checked after a repair has been made. Refer to table 12-1 for adjustments needed for a particular board repair. Performance tests that may be affected by these adjustments are also listed in table 12-1.

Always end the adjustment session with SYSTEM menu calibration routines 0 and 6, and then perform the SYSTEM menu self-tests to assure proper operation of the 54200A/D. Although self tests check for correct functional operation, they do not serve as a performance verification. Persistent failure of one of the self-tests is an indication of a faulty board. In this case refer to the troubleshooting procedures in this manual along with the Service Software.

**FRONT PANEL CALIBRATION.** Front panel calibration allows the user to execute automatic gain and offset calibration for Channel 1, Channel 2 and Trigger (Channel 1, Channel 2, and External), and Delay calibration. A rear-panel switch protects the calibration factors from inadvertent changes. This switch must be set to the unprotected position before executing automatic calibration. Error message "Cal RAM Write Protected" will be displayed if calibration is attempted with the switch in the protected position.

Calibration 0 calibrates gain and offset for Channel 1, Channel 2, and all trigger paths. Individual gain and offset calibration for a channel or trigger may be executed by choosing 1, 2, 3, 4, or 5. Calibration 6 calibrates delay and calibration 7, 8, and 9 set default calibration factors. A normal calibration would require calibrations 0 and 6 to be executed. Calibrations 7, 8, and 9 are used for factory setup or would be used after a major repair to the instrument for initial setup procedures.

Calibration 0 takes about one minute to execute. To initiate this or any other calibration, move the blinking field cursor to the Execute Calibration field and enter the appropriate number from the numeric key pad. Follow the directions on screen and watch the status line at the end of the calibration to see if the instrument calibrated successfully.

Calibration 6 executes in about 20 seconds. Enter the number 6 from the numeric keypad and follow the directions printed on screen.

Any calibration features that require connecting the rear panel BNC to a front panel BNC do not require the signal be terminated with 50 ohms.

**WARNING**

*Read the safety summary at the front of this manual before performing adjustment procedures.*

**CAUTION**

*The adjustments are performed with the top, bottom, and side covers removed. Use care to avoid shorting or damaging internal parts of the instrument.*

**10-3. EQUIPMENT REQUIRED**

Table 10-1 lists the equipment required to adjust the 54200A/D. Other equipment may be substituted if it meets or exceeds the critical specifications given in table 10-1.

*Table 10-1. Recommended Test Equipment*

INSTRUMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Desktop Controller	HP 9826/36-Compatible BASIC 2.0 Operating System HP-IB Interface	HP 9826/36
Digital Voltmeter	Accuracy: $\leq 0.5\%$	HP 5005B
50 Ohm Termination	Accuracy: $\leq 1\%$	HP 10100C
Function Generator	1 MHz to 50 MHz	HP 8116A
Product Support Kit	No substitute	HP Part No. 54200-69501

## Adjustments

---

### 10-4. POWER SUPPLY ADJUSTMENT

**Description:**

This procedure adjusts the -5.2V supply to exactly -5.2 volts and checks all other power supply voltages to ensure they are within limits. These limits apply for any combination of line voltage and instrument board sets.

**Equipment Required:**

Digital Voltmeter ..... HP Model 5005B

**Equipment Setup:**

Set HP5005B Mode to DC Volts.

**Procedure:**

1. Disconnect the 54200A/D power cord and remove top cover.
2. Connect voltmeter leads to ground and -5.2V on the LV board test connector A1TP2 (figure 10-1).
3. Apply power to the 54200A/D.
4. Adjust VOLT ADJ (A1R34) until the measured voltage reads -5.2 ±0.1 volt (figure 10-1).
5. Check each of the remaining supplies to make sure they are within the following limits:

SUPPLY	LIMITS
+5V	+4.75 to +5.25V
+15V	+14.25 to +15.75V
-12V	-11.4 to -12.6V
-2.4V	-2.16 to -2.75V
-5V	-5.10 to -5.30V

6. Disconnect the 54200A/D power cord.

## Adjustments

---

### 10-4. POWER SUPPLY ADJUSTMENT (Continued)

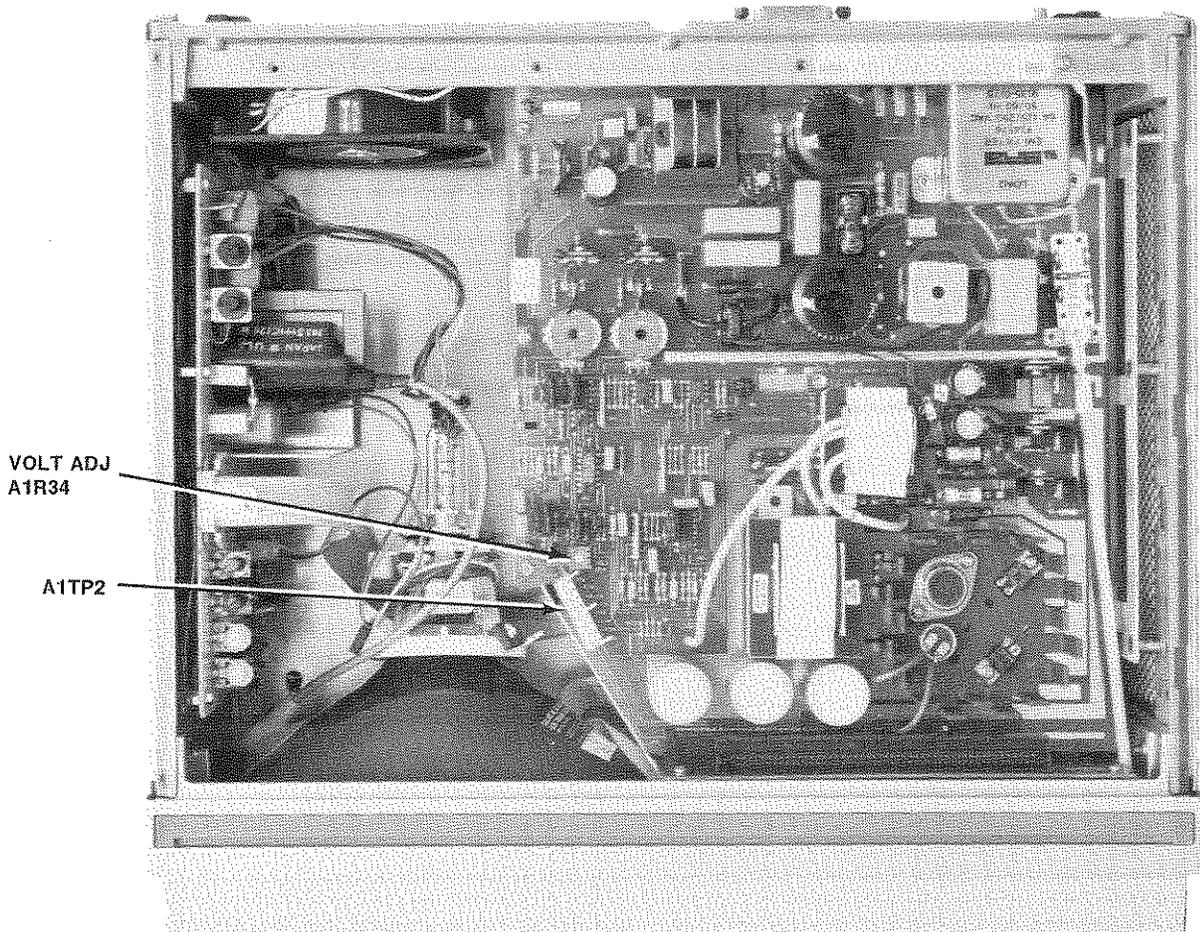


Figure 10-1. Power Supply Adjustment.

## Adjustments

---

### 10-5. DISPLAY SYSTEM ADJUSTMENT

#### Description:

This procedure is in two parts; yoke and display driver. The Yoke Adjustment Procedure must be performed if any part of the Display System is replaced (CRT, display driver, or yoke) or if a display cannot be aligned on the CRT screen using the Display Driver Adjustment Procedure. If the Yoke Adjustment Procedure is performed, the Display Driver Adjustment must then be performed. The Display Driver Adjustment Procedure can be a stand-alone adjustment, however, the Yoke Adjustment Procedure cannot.

#### Note

*It is recommended the test pattern be used and the Display Driver Adjustments be optimized if necessary to determine the need for the Yoke Adjustment.*

It is good practice to discharge the CRT before beginning.

#### 10-5a. YOKE ADJUSTMENT PROCEDURE:

##### Equipment Required:

None

##### Procedure:

1. Disconnect power from the 54200A/D.
2. Remove the top cover.
3. Remove the two yoke connectors.
4. Insure that the yoke is firmly pressed against the flange of the CRT. If not, loosen the yoke neck screw that attaches the yoke to the CRT and slide the yoke against the CRT. Gently tighten the screw until firm.
5. While holding a flexible straight edge from the lower-left corner to the upper-right corner of the CRT (facing the CRT), make a mark about one inch long with a water soluble felt pen across the center of the CRT (figure 10-2).
6. Repeat the above step for the upper-left corner and the lower-right corner forming an "X" in the center of the CRT (figure 10-2).

### Adjustments

---

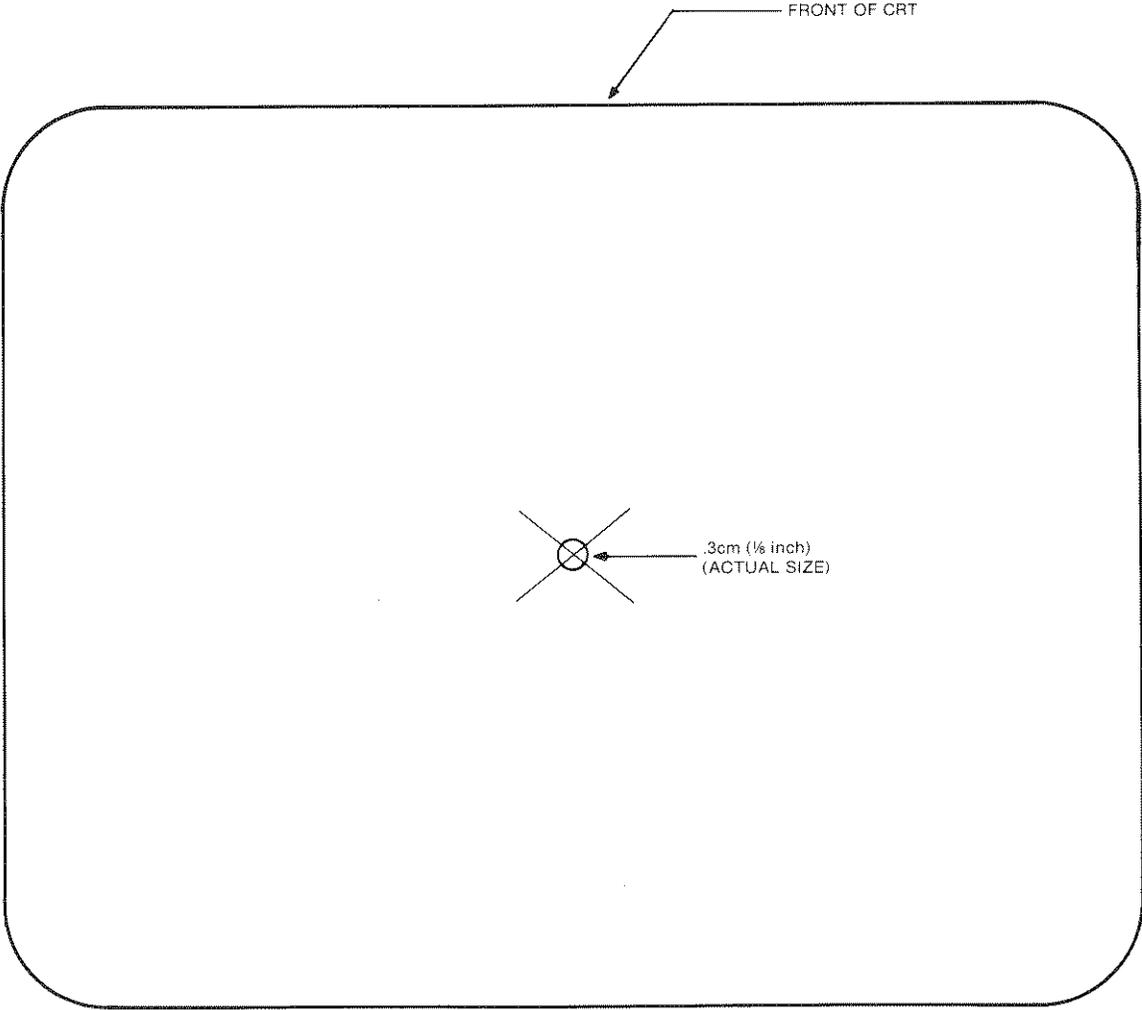


Figure 10-2. Yoke Centering Adjustment.

### Adjustments

#### 10-5. DISPLAY SYSTEM ADJUSTMENT (Continued)

- 7. Adjust BRIGHTNESS control pot to minimum (full counter-clockwise). See figure 10-3 for the display adjustment locations.
- 8. Apply power and turn ON the 54200A/D.
- 9. Adjust BRIGHTNESS control pot until a dot appears on the CRT.
- 10. The dot should appear within a 0.3 cm (1/8 inch) radius of the intersection of the two lines. If this does not occur, align the dot using the centering rings on the yoke. See figure 10-2.
- 11. Turn OFF the 54200A/D and clean the CRT screen with mild soap and water.
- 12. Reconnect the two yoke connectors from the display driver.
- 13. Perform the Display Driver Adjustment Procedure.

#### Display Driver Board

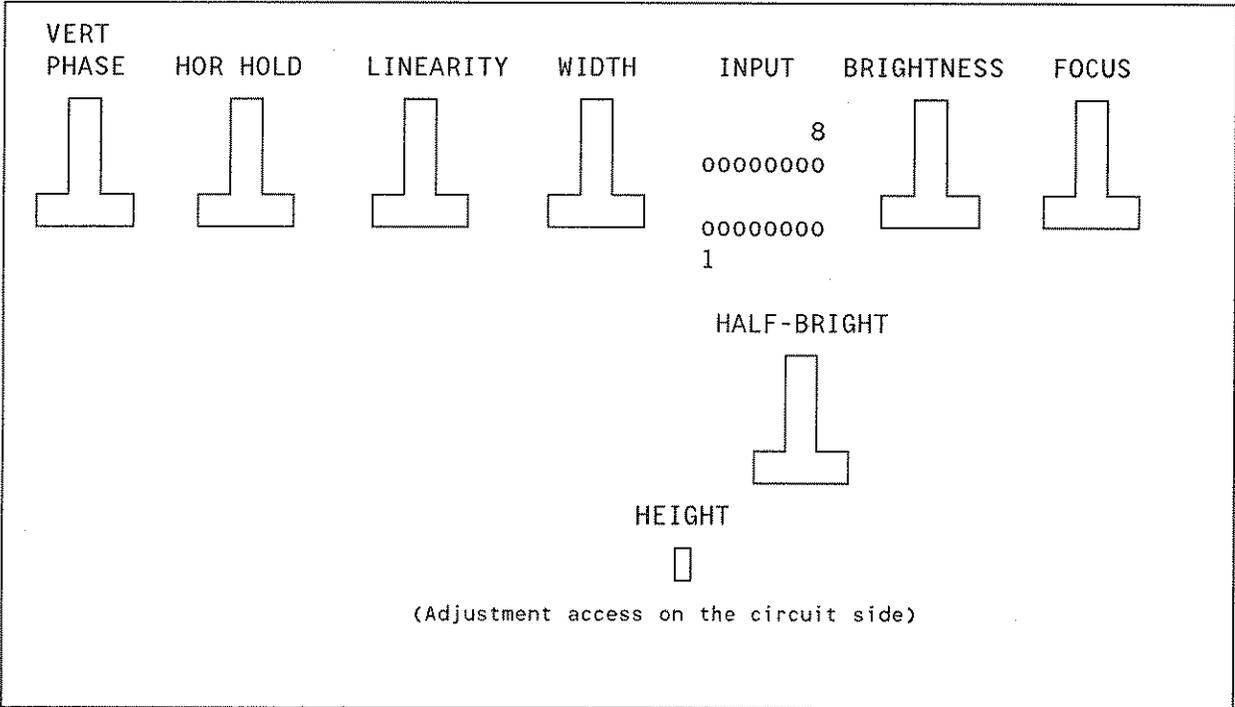


Figure 10-3. Display Adjustment Locations.

## Adjustments

---

### 10-5. DISPLAY SYSTEM ADJUSTMENT (Continued)

#### 10-5b. DISPLAY DRIVER ADJUSTMENT PROCEDURE:

##### Equipment Required:

HP Series 200 Desktop Controller .....	HP Model 9826/9836
54200A/D Service Software .....	HP Part No. 54200-12001 (Part of Product Support Kit, HP Part No. 54200-69501)
HP-IB Cable .....	HP Model 10833A/B/C

##### Equipment Setup:

Connect the 54200A/D HP-IB port to the HP 9826/9836 via the HP-IB cable.

##### Procedure:

1. Disconnect power from the 54200A/D and remove the top cover.
2. Remove the two screws that attach the handle and the left side cover to the frame. Remove the side cover.
3. Set the 54200A/D power on.
4. Insert Service Software 5-1/4" disc into Series 200 Controller.
  - a) If BASIC operating system is resident in Series 200 ROM, switch controller power off, then on again. Service Software will automatically load.
  - b) If BASIC operating system is not resident in Series 200 ROM, boot the system from floppy disc. Then insert the Service software into the right disc drive and type **LOAD "AUTOST"**.
5. Press the RUN key on the controller and follow the instructions displayed on the controller screen.
6. Activate the Grid Adjustment Pattern shown in figure 10-4 by pressing the "Disp Adj" softkey on the controller.
7. Adjust the BRIGHTNESS control pot until the Grid Adjustment Pattern is visible. See figure 10-3 for the display adjustment locations.
8. Adjust the HEIGHT and VERT PHASE (position) until the test Test Pattern fills the screen vertically (figure 10-3).
9. Adjust HORIZ LINEARITY until the width of each square is the same.

## Adjustments

---

### 10-5. DISPLAY SYSTEM ADJUSTMENT (Continued)

10. Adjust HORIZ WIDTH until the total picture width is the same as the width of the outer boundary marks given in figure 10-4. Note that the outer edges of the display may NOT align with the outer boundary marks.

**Note**

*The adjustments in steps 9 and 10 interact. Therefore, reiteration of these two steps may be necessary for best results.*

11. Now adjust the horizontal position by rotating the centering rings on the yoke. Adjust the rings for horizontal movement while minimizing the the vertical movement of the display. The left and right edges should NOW align with the outer boundary marks described in the previous step.

12. Adjust VERT PHASE to vertically align the Test Pattern. This should only require minor adjustment. See figure 10-4 for this measurement.

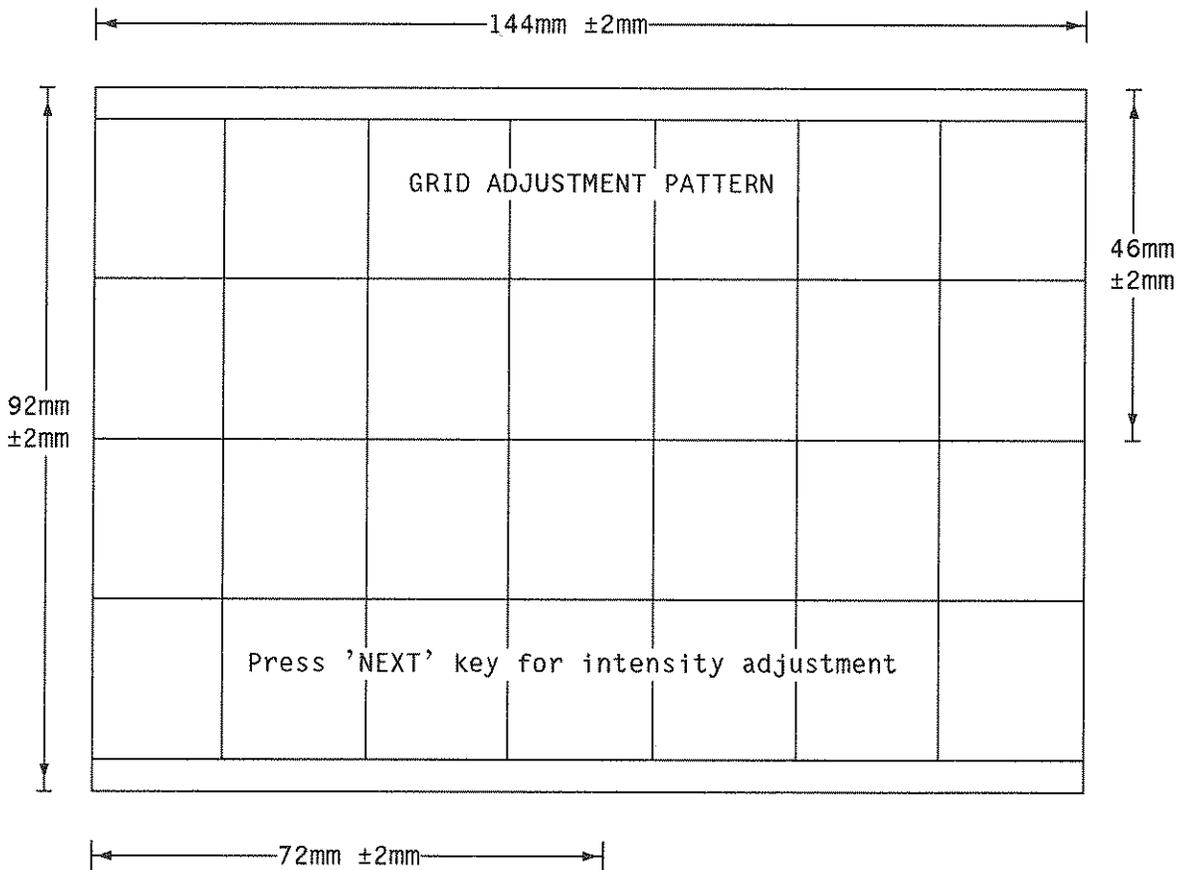


Figure 10-4. Grid Adjustment Pattern



# Adjustments

## 10-6. ANALOG BOARD ADJUSTMENTS

### Description:

The following Analog Board procedures adjust: analog amplifiers for proper differential balance (BALANCE ADJUSTMENT), input attenuator compensation for best square wave response (INPUT COMPENSATION ADJUSTMENTS), analog trigger generator for proper sensitivity (TRIGGER SENSITIVITY ADJUSTMENT), and trigger amplifier for proper differential balance (TRIGGER BALANCE ADJUSTMENT).

### 10-6a. BALANCE ADJUSTMENT PROCEDURE:

#### Equipment Required:

None

#### Procedure:

1. Set the 54200A/D rear-panel Cal switch in the unprotected position (down).
2. Remove the bottom cover and disconnect all inputs.
3. In SYSTEM Calibration menu, select and execute DEFAULT GAIN (7); when DEFAULT GAIN has finished, execute DEFAULT OFFSET (8).
4. Configure the STATUS Configuration menu as shown in figure 10-6.

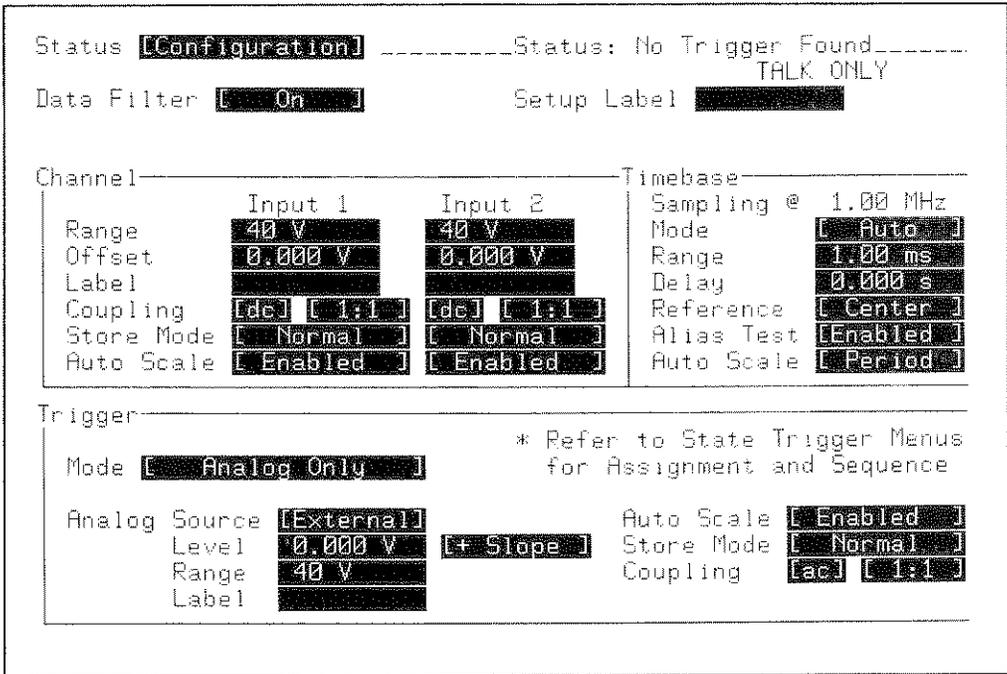


Figure 10-6. 54200A/D Configuration

## Adjustments

### 10-6. ANALOG BOARD ADJUSTMENTS (Continued)

5. Display Chan 1 and note position trace on screen. Now set CHAN Range to 16 V and note trace position. Adjust CH1-3.9V BAL (figure 10-7) while switching between the 16-V range and the 40-V range. The voltage shift on the 40-V range should be equal and opposite to the voltage shift on the 16-V range when adjusted correctly. Do not offset more than  $\pm 4$  V.
6. Repeat step 5 for Chan 2 using CH2-3.9V BAL adjustment.
7. Repeat step 5 for TRIG using the EXT TRIG input and CHT-3.9V BAL adjustment.
8. Select SYSTEM Calibration menu. Execute ALL GAIN AND OFFSET (0). Wait until the gain and offset auto calibration has finished.
9. Set the 54200A/D rear-panel Cal switch to the Protected position (up).

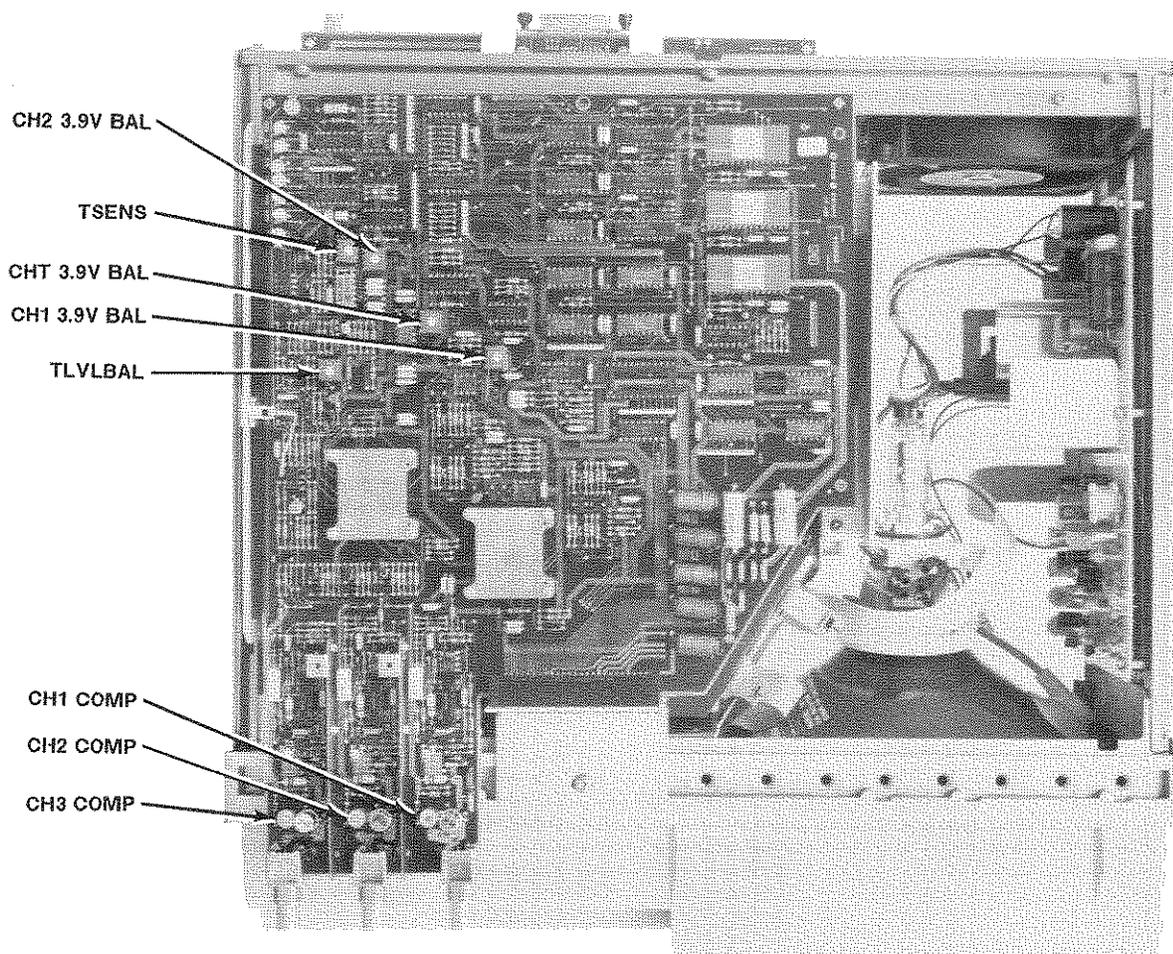


Figure 10-7. Analog Board Adjustment Locations.

## Adjustments

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### 10-6. ANALOG BOARD ADJUSTMENTS (Continued)

#### 10-6b. INPUT COMPENSATION ADJUSTMENTS:

##### Note

*The following procedure adjusts the input compensation of the attenuators, however, these adjustments DO NOT usually drift. It is recommended the input compensation be checked prior to adjustment to determine if adjustment is necessary. If input compensation adjustment is not required, proceed to "Trigger Sensitivity Adjustment".*

#### Equipment Required:

Function Generator ..... HP Model 8116A  
 Product Support Kit ..... HP Part No. 54200-69501

#### Equipment Setup:

Set HP8116A output to 10-kHz square wave, 3 Vp-p, 0 V offset.

#### Procedure:

1. Set the 54200A/D power OFF and remove the Analog Board Assembly (A4). Refer to Analog Board Removal in Section 12.
2. Install the Analog Assembly Extender Board and Analog Assembly Support Brackets from the Product Support Kit into the 54200A/D; then reinstall Analog Board Assembly.
3. Set the 54200A/D power ON.
4. Configure the STATUS Configuration menu as shown in figure 10-8.
5. Display Trig and specify Chan 1 as the trigger source.
6. Connect the function generator output to 54200A/D INPUT 1 BNC and adjust the CH1 COMP adjustment for maximum square wave flatness using an insulated adjustment tool (figure 10-7).
7. Repeat steps 5 and 6 for 54200A/D INPUT 2 and EXT TRIG BNCs by adjusting CH2 COMP and CH3 COMP respectively. Specify the selected input as the trigger source in each case.
8. Set the 54200A/D power to OFF.
9. Remove extender board and supports and reinstall the Analog Assembly into the mainframe.

## Adjustments

Status <span style="border: 1px solid black; padding: 2px;">[Configuration]</span> -----Status: Acquiring Frame 00000_		TALK ONLY	
Data Filter <span style="border: 1px solid black; padding: 2px;">[ On ]</span>	Setup Label <span style="border: 1px solid black; padding: 2px;">[ ]</span>		
Channel		Timebase	
	Input 1	Input 2	Sampling @ 5.00 MHz
Range	4.0 V	4.0 V	Mode <span style="border: 1px solid black; padding: 2px;">[ Auto ]</span>
Offset	0.000 V	0.000 V	Range <span style="border: 1px solid black; padding: 2px;">[ 200 <math>\mu</math>s ]</span>
Label	[ ]	[ ]	Delay <span style="border: 1px solid black; padding: 2px;">[ 0.000 s ]</span>
Coupling	[dc] [ 1:1 ]	[dc] [ 1:1 ]	Reference <span style="border: 1px solid black; padding: 2px;">[ Center ]</span>
Store Mode	[ Normal ]	[Ave] [ 16 ]	Alias Test <span style="border: 1px solid black; padding: 2px;">[ Enabled ]</span>
Auto Scale	[ Enabled ]	[ Enabled ]	Auto Scale <span style="border: 1px solid black; padding: 2px;">[ Period ]</span>
Trigger			
Mode <span style="border: 1px solid black; padding: 2px;">[ Analog Only ]</span>		* Refer to State Trigger Menus for Assignment and Sequence	
Analog Source	[ External ]	Auto Scale	[ Enabled ]
Level	0.000 V	[+ Slope ]	Store Mode <span style="border: 1px solid black; padding: 2px;">[ Normal ]</span>
Range	4.0 V	Coupling	[ac] [ 1:1 ]
Label	[ ]		

Figure 10-8. 54200A/D Configuration

## Adjustments

---

### 10-6. ANALOG BOARD ADJUSTMENTS (Continued)

#### 10-6c. TRIGGER SENSITIVITY ADJUSTMENT:

##### Equipment Required:

Function Generator ..... HP Model 8116A  
 50 $\Omega$  Termination ..... HP Model 10100C

##### Equipment Setup:

Set HP8116A output to 1-kHz sine wave, 5 Vp-p, 0 V offset.

##### Procedure:

1. Configure the STATUS Configuration menu as shown in figure 10-9.
2. Connect the function generator output to the 54200A/D External Trigger Input (Ch 3) through the 50 $\Omega$  termination.
3. Display the TRIG channel.
4. The triggered waveform should appear similar to figure 10-10. If the waveform is not triggered, then turn TSEN (figure 10-7) completely clockwise. Now adjust TLVLBAL until a triggered waveform is displayed.
5. Move the X cursor to the Tx=0.0 s position.
6. While viewing the value of Vx on the display, change the trigger slope to -Slope.
7. Alternate between -Slope and +Slope for each small adjustment of TSENS, noting the difference in the value of Vx.
8. TSENS should be adjusted until the difference in the Vx value {Vx[+Slope] minus [-Slope]} is 375 mV  $\pm$ 125 mV.

## Adjustments

```

Status [Configuration] -----Status: No Trigger Found-----
                                     TALK ONLY
Data Filter [ On ]           Setup Label [          ]

Channel-----
Range      Input 1      Input 2      Timebase-----
Offset     0.000 V     0.000 V     Sampling @ 10.0 MHz
Label      [          ]     [          ]     Mode [ Auto ]
Coupling   [dc] [ 1:1 ]   [dc] [ 1:1 ]   Range [ 100 us ]
Store Mode [ Normal ]   [ Ave ] [ 16 ]   Delay [ 0.000 s ]
Auto Scale [ Enabled ]  [ Enabled ]     Reference [ Center ]
                                     Alias Test [ Enabled ]
                                     Auto Scale [ Period ]

Trigger-----
Mode [ Analog Only ]      * Refer to State Trigger Menus
                               for Assignment and Sequence
Analog Source [ External ]   Auto Scale [ Enabled ]
Level [ 0.000 V ] [ + Slope ]   Store Mode [ Ave ] [ 4 ]
Range [ 4.0 V ]             Coupling [ ac ] [ 1:1 ]
Label [          ]
    
```

Figure 10-9. 54200A/D Configuration

```

Trigger [ Analog ] -----Status: Acquiring Frame 00201_
                                     TALK ONLY
Source [ External ]       Auto Scale [ Enabled ]
Level [ 0.000 V ] [ + Slope ]   Store Mode [ Average ] [ 4 ]
Range [ 4.0 V ]           Coupling [ ac ] [ 1:1 ]

Graph [ 1 ]  500 mV/div  0.00 V  10.0 us/div  -50.00 us
1: [ Trig ]
    
```

Figure 10-10. Trigger Sensitivity Waveform

## Adjustments

---

### 10-6. ANALOG BOARD ADJUSTMENTS (Continued)

#### 10-6d. TRIGGER BALANCE ADJUSTMENT:

##### Equipment Required:

Function Generator ..... HP Model 8116A  
 50 $\Omega$  Termination ..... HP Model 10100C

##### Equipment Setup:

Set HP8116A output to 1-kHz sine wave, 5 Vp-p, 0 V offset.

##### Procedure:

1. Configure the STATUS Configuration menu as shown in figure 10-9. Set the 54200A/D display to single-graph with a grid format using the DISPLAY menu.
2. Connect the function generator output to the 54200A/D External Trigger Input (Ch 3) through the 50 $\Omega$  termination.
3. Display the TRIG channel. The triggered waveform should appear similar to figure 10-10.
4. While switching trigger slope between +Slope and -Slope, adjust TLVLBAL (figure 10-7) until the vertical trace shift is centered about the center horizontal graticule.

## Adjustments

---

### 10-7. STATE TRIGGER BOARD ADJUSTMENT (54200D Only)

#### Description:

This procedure adjusts the State Trigger Board clock circuitry for proper phase and delay to ensure compliance with setup and hold specifications.

#### Equipment Required:

Function Generator ..... HP Model 8116A  
10:1 Divider Probes (Qty. 2, supplied with 54200A/D) ..... HP Model 10017A  
50 $\Omega$  Termination ..... HP Model 10100C  
Product Support Kit ..... HP Part No. 54200-69501

#### Equipment Setup:

Set HP8116A output to 100-kHz square wave, 0 to +5 V, 0 V offset.

#### Procedure:

1. Configure the STATUS Configuration menu as shown in figure 10-11.
2. Configure the TRIG State Assignment menu as shown in figure 10-12.
3. Ensure STATUS Measurement menu is set to Standard Mode.
4. Connect POD 0 to the State Board Test Fixture, HP Part No. 54200-63801 (part of Product Support Kit).
5. Connect a 50 $\Omega$  terminator to the CLK BNC on the State Board Test Fixture; connect a BNC cable from the terminator to the output of the the function generator.
6. Connect the 10:1 divider probes to the State Trigger Board test points as follows (refer to figure 10-13):

A8TP2 to 54200D INPUT 1  
A8TP1 to 54200D INPUT 2

The display should appear similar to figure 10-14. If the triggered waveforms do not appear, adjust the 54200A/D trigger level.

7. Select front panel measurement DELAY 2 to 1.
8. Adjust A8R20 (figure 10-13) until the leading edge of ICK (A8TP2) is delayed 42 to 43 ns from the leading edge of MCK (A8TP1).
9. Move the 54200D Input 2 probe from A8TP1 to A8TP3. The display should appear similar to figure 10-15. Adjust A8R28 until the DELAY measurement from 2 to 1 is approximately zero seconds ( $\pm 1$  ns).

### Adjustments

```

Status [Configuration] -----Status: No Trigger Found-----
                                     TALK ONLY
Data Filter [ On ]           Setup Label [          ]

Channel-----
Range      Input 1      Input 2      Timebase-----
Offset     -1.376 V    -1.200 V    Sampling @ 200 MHz
Label      [          ] [          ] Mode [ Auto ]
Coupling   [dc] [10:1] [dc] [10:1] Range [ 200 ns ]
Store Mode [ Normal ] [ Normal ] Delay [ 0.000e ]
Auto Scale [ Enabled ] [ Enabled ] Reference [ Center ]
Alias Test [Disabled] Auto Scale [ Period ]

Trigger-----
Mode [ Analog Only ] * Refer to State Trigger Menus
                          for Assignment and Sequence
Analog Source [ Chan 1 ] Auto Scale [ Enabled ]
Level [ -1.400 V ] [+ Slope ] Store Mode [ Normal ]
Range [ Track ] 800 mV Coupling [dc] [10:1 ]
Label [          ]
    
```

Figure 10-11. 54200D Status Configuration

```

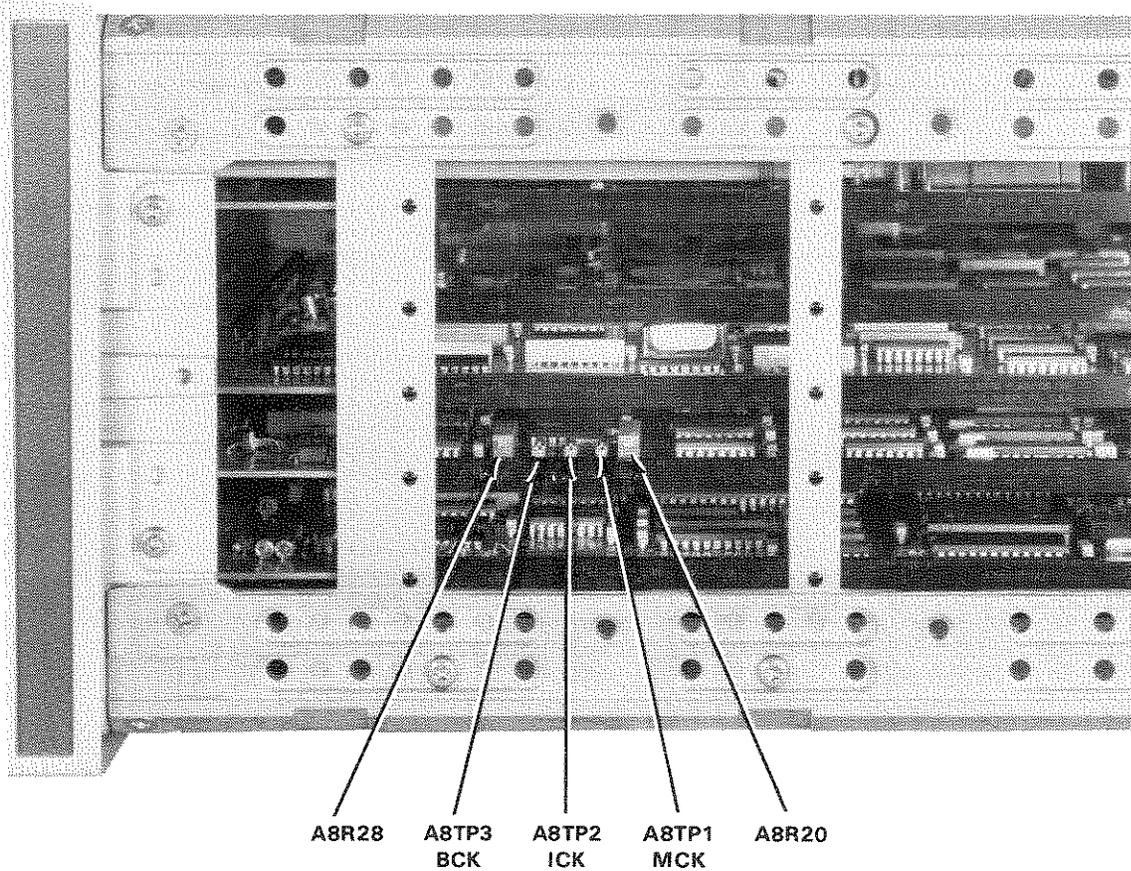
Trigger [ State ] -----Status: Acquiring Frame 02026_
                                     TALK ONLY
Define [Assignment]      Trigger Mode [ Analog Only ]

State Mode [ Normal ]   Clock
                          JKL
                          [ 1 ]
Multiplexing [ Off ]    Pod 2   Pod 1   Pod 0
                          [+] 2.5V [+] 2.5V [+] 2.5V
                          0.....0 0.....0 0.....0
Label Pol
  A [ + ] [ *..... ] [ *..... ] [ *..... ]
    
```

Figure 10-12. 54200D State Trigger Assignment Configuration

## Adjustments

---



*Figure 10-13. State Trigger Board Adjustment Locations*

### Adjustments

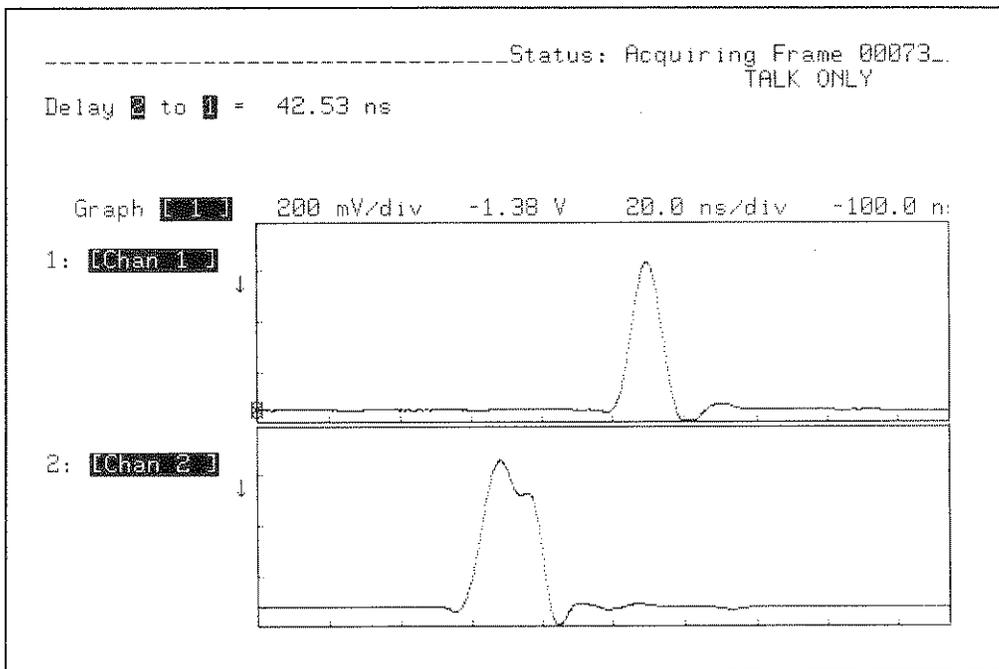


Figure 10-14. A8TP2 to A8TP1 Delay Waveform

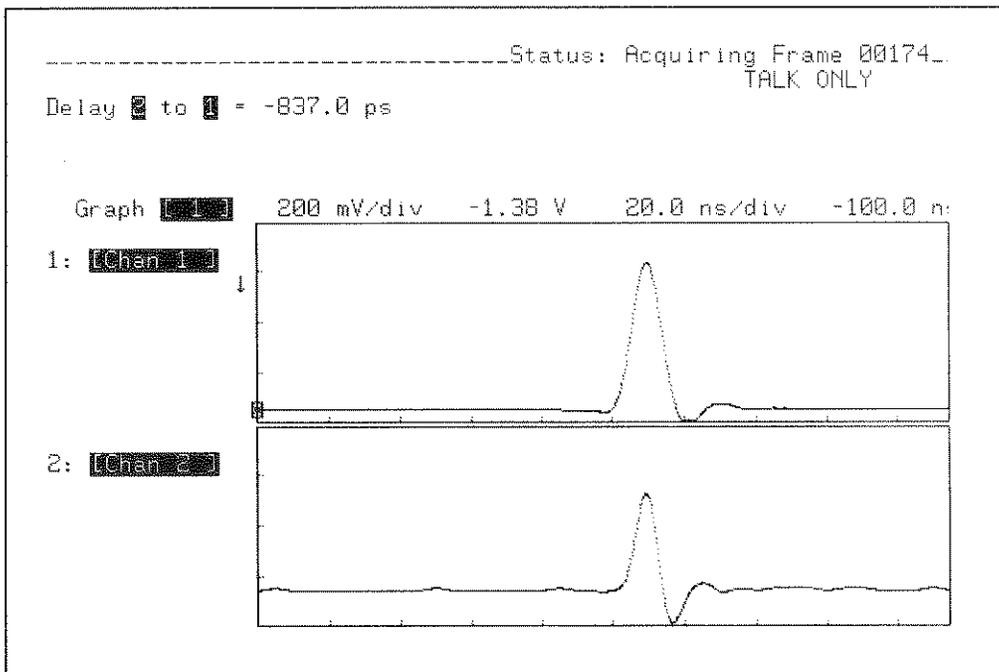


Figure 10-15. A8TP3 to A8TP2 Delay Waveform



## **SECTION 11**

# **REPLACEABLE PARTS**

### **11-1. INTRODUCTION**

This section contains information for ordering parts. Table 11-1 lists abbreviations used in the parts lists. Table 11-2 lists all replaceable parts in reference designator order. Table 11-3 contains the names and addresses that correspond to the manufacturer code numbers. Figure 11-1 shows the mainframe parts locations.

### **11-2. ABBREVIATIONS**

Table 11-1 lists abbreviations used in the parts lists, the schematics, and throughout this manual. The abbreviations in the parts list are always capital letters. However, in other parts of the manual abbreviations may be used with both lowercase and uppercase letters.

### **11-3. REPLACEABLE PARTS LIST**

Table 11-2 is the list of replaceable parts and is organized as follows:

- a. Electrical assemblies in alphanumerical order by reference designation.
- b. Chassis-mounted parts in alphanumerical order by reference designation.
- c. Electrical assemblies and their components in alphanumerical order by reference designation.

The information given for each part consists of the following:

- a. Reference designation.
- b. Hewlett-Packard part number.
- c. Part number Check Digit (CD).
- d. Total quantity (QTY) in instrument (or on assembly). The total quantity is given only once at the first appearance of the part number in the list.
- e. Description of part.
- f. Typical manufacturer of part in an identifying five-digit code.

#### **11-4. ORDERING INFORMATION**

To order a part listed in the material lists, quote the Hewlett-Packard part number, indicate the quantity desired, and address the order to the nearest Hewlett-Packard Sales/Service Office.

To order a part that is not listed in the material lists, include the instrument model number, instrument serial number, a description of the part (including its function), and the number of parts required. Address the order to the nearest Hewlett-Packard Sales/Service Office.

#### **11-5. DIRECT MAIL ORDER SYSTEM**

Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using this system are:

- a. Direct ordering and shipment from the Hewlett-Packard Parts Center in Mountain View, California.
- b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local Hewlett-Packard office when the orders require billing and invoicing).
- c. Prepaid transportation (there is a small handling charge for each order).
- d. No invoices.

To provide these advantages, a check or money order must accompany each order.

Mail order forms and specific ordering information are available through your local Hewlett-Packard office. Addresses and phone numbers are located at the back of this manual.

Table 11-1. Reference Designators and Abbreviations.

REFERENCE DESIGNATORS							
<b>A</b>	= assembly	<b>F</b>	= fuse	<b>MP</b>	= mechanical part	<b>U</b>	= integrated circuit
<b>B</b>	= motor	<b>FL</b>	= filter	<b>P</b>	= plug	<b>V</b>	= vacuum, tube, neon bulb, photocell, etc
<b>BT</b>	= battery	<b>IC</b>	= integrated circuit	<b>Q</b>	= transistor	<b>VR</b>	= voltage regulator
<b>C</b>	= capacitor	<b>J</b>	= jack	<b>R</b>	= resistor	<b>W</b>	= cable
<b>CP</b>	= coupler	<b>K</b>	= relay	<b>RT</b>	= thermistor	<b>X</b>	= socket
<b>CR</b>	= diode	<b>L</b>	= inductor	<b>S</b>	= switch	<b>Y</b>	= crystal
<b>DL</b>	= delay line	<b>LS</b>	= loud speaker	<b>T</b>	= transformer	<b>Z</b>	= tuned cavity network
<b>DS</b>	= device signaling (lamp)	<b>M</b>	= meter	<b>TB</b>	= terminal board		
<b>E</b>	= misc electronic part	<b>MK</b>	= microphone	<b>TP</b>	= test point		

ABBREVIATIONS							
<b>A</b>	= amperes	<b>H</b>	= henries	<b>N/O</b>	= normally open	<b>RMO</b>	= rack mount only
<b>AFC</b>	= automatic frequency control	<b>HDW</b>	= hardware	<b>NOM</b>	= nominal	<b>RMS</b>	= root-mean square
<b>AMPL</b>	= amplifier	<b>HEX</b>	= hexagonal	<b>NPO</b>	= negative positive zero (zero temperature coefficient)	<b>RWV</b>	= reverse working voltage
<b>BFO</b>	= beat frequency oscillator	<b>HG</b>	= mercury	<b>NPN</b>	= negative-positive-negative	<b>S-B</b>	= slow-blow
<b>BE CU</b>	= beryllium copper	<b>HR</b>	= hour(s)	<b>NRFR</b>	= not recommended for field replacement	<b>SCR</b>	= screw
<b>BH</b>	= binder head	<b>HZ</b>	= hertz	<b>NSR</b>	= not separately replaceable	<b>SE</b>	= selenium
<b>BP</b>	= bandpass	<b>IF</b>	= intermediate freq	<b>OB</b>	= order by description	<b>SECT</b>	= section(s)
<b>BRS</b>	= brass	<b>IMPG</b>	= impregnated	<b>OH</b>	= oval head	<b>SEMICON</b>	= semiconductor
<b>BWO</b>	= backward wave oscillator	<b>INCD</b>	= incandescent	<b>OX</b>	= oxide	<b>SI</b>	= silicon
<b>CCW</b>	= counter-clockwise	<b>INCL</b>	= include(s)	<b>PH BRZ</b>	= phosphor bronze	<b>SIL</b>	= silver
<b>CER</b>	= ceramic	<b>INS</b>	= insulation(ed)	<b>PHL</b>	= phillips	<b>SL</b>	= slide
<b>CMO</b>	= cabinet mount only	<b>INT</b>	= internal	<b>PIV</b>	= peak inverse voltage	<b>SPG</b>	= spring
<b>COEF</b>	= coefficient	<b>K</b>	= kilo=1000	<b>PNP</b>	= positive-negative-positive	<b>SPL</b>	= special
<b>COM</b>	= common	<b>LH</b>		<b>P/O</b>	= part of	<b>SST</b>	= stainless steel
<b>COMP</b>	= composition	<b>LIN</b>	= left hand	<b>POLY</b>	= polystyrene	<b>SR</b>	= split ring
<b>COMPL</b>	= complete	<b>LK WASH</b>	= linear taper	<b>PORC</b>	= porcelain	<b>STL</b>	= steel
<b>CONN</b>	= connector	<b>LOG</b>	= lock washer	<b>POS</b>	= position(s)	<b>TA</b>	= tantalum
<b>CP</b>	= cadmium plate	<b>LPF</b>	= logarithmic taper	<b>POT</b>	= potentiometer	<b>TD</b>	= time delay
<b>CRT</b>	= cathode-ray tube		= low pass filter	<b>PP</b>	= peak-to-peak	<b>TGL</b>	= toggle
<b>CW</b>	= clockwise	<b>M</b>		<b>PT</b>	= point	<b>THD</b>	= thread
<b>DEPC</b>	= deposited carbon	<b>MEG</b>	= milli=10 <sup>-3</sup>	<b>PWV</b>	= peak working voltage	<b>TI</b>	= titanium
<b>DR</b>	= drive	<b>MET FLM</b>	= meg=10 <sup>6</sup>	<b>RECT</b>	= rectifier	<b>TOL</b>	= tolerance
<b>ELECT</b>	= electrolytic	<b>MET OX</b>	= metal film	<b>RF</b>	= radio frequency	<b>TRIM</b>	= trimmer
<b>ENCAP</b>	= encapsulated	<b>MFR</b>	= metallic oxide	<b>RH</b>	= round head or or right hand	<b>TWT</b>	= traveling wave tube
<b>EXT</b>	= external	<b>MHZ</b>	= manufacturer			<b>U</b>	= micro=10 <sup>-6</sup>
<b>F</b>	= farads	<b>MINAT</b>	= mega hertz			<b>VAR</b>	= variable
<b>FH</b>	= flat head	<b>MOM</b>	= miniature			<b>VDCW</b>	= dc working volts
<b>FIL H</b>	= fillister head	<b>MOS</b>	= momentary			<b>W/</b>	= with
<b>FXD</b>	= fixed	<b>MTG</b>	= metal oxide substrate			<b>W</b>	= watts
<b>G</b>	= giga (10 <sup>9</sup> )	<b>MY</b>	= mounting			<b>WIV</b>	= working inverse voltage
<b>GE</b>	= germanium		= "mylar"			<b>WW</b>	= wirewound
<b>GL</b>	= glass	<b>N</b>				<b>W/O</b>	= without
<b>GRD</b>	= grounded	<b>N/C</b>	= nano (10 <sup>-9</sup> )				
		<b>NE</b>	= normally closed				
		<b>NI PL</b>	= neon				
			= nickel plate				

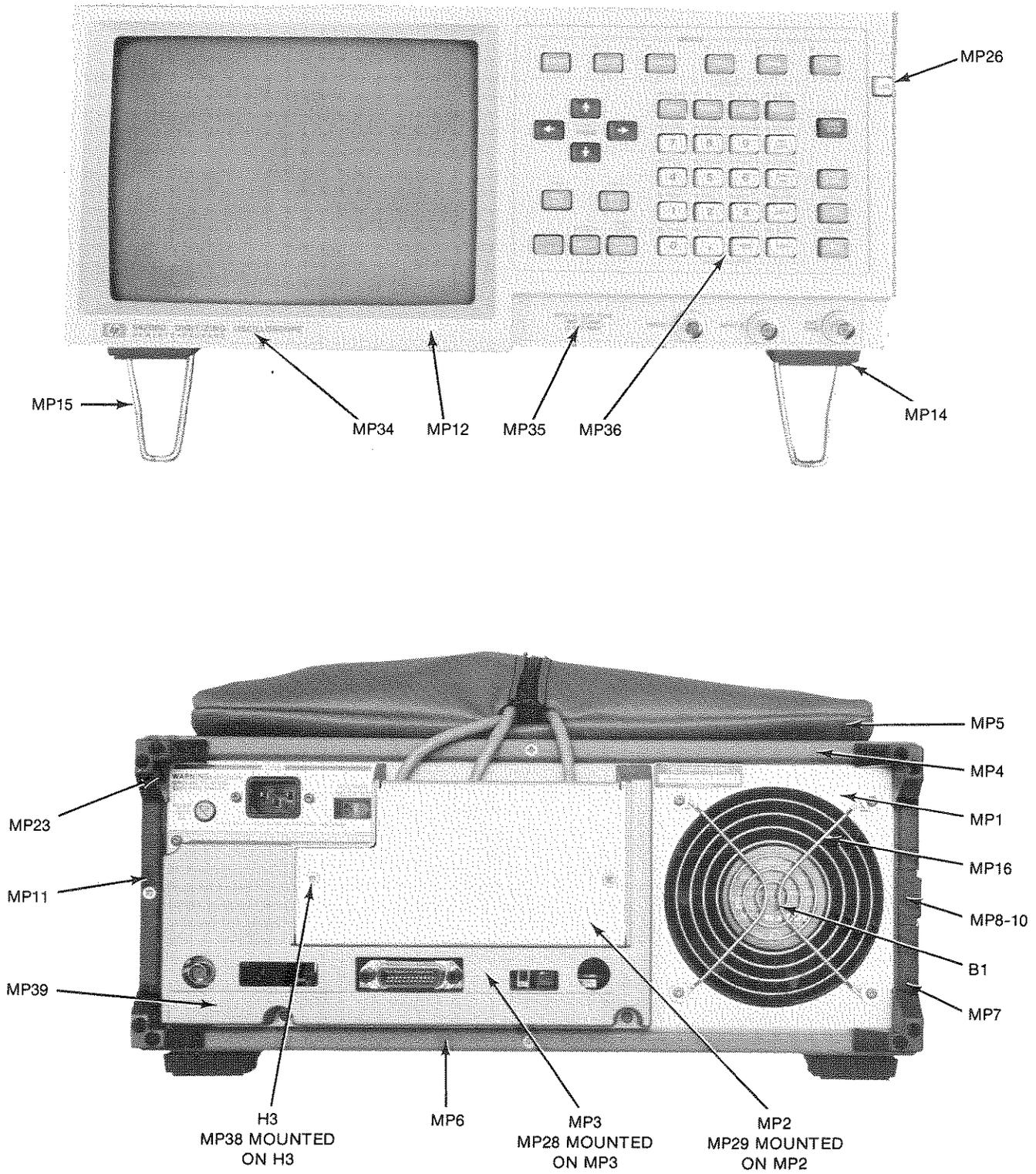


Figure 11-1. Mainframe Parts Location (Sheet 1 of 3)

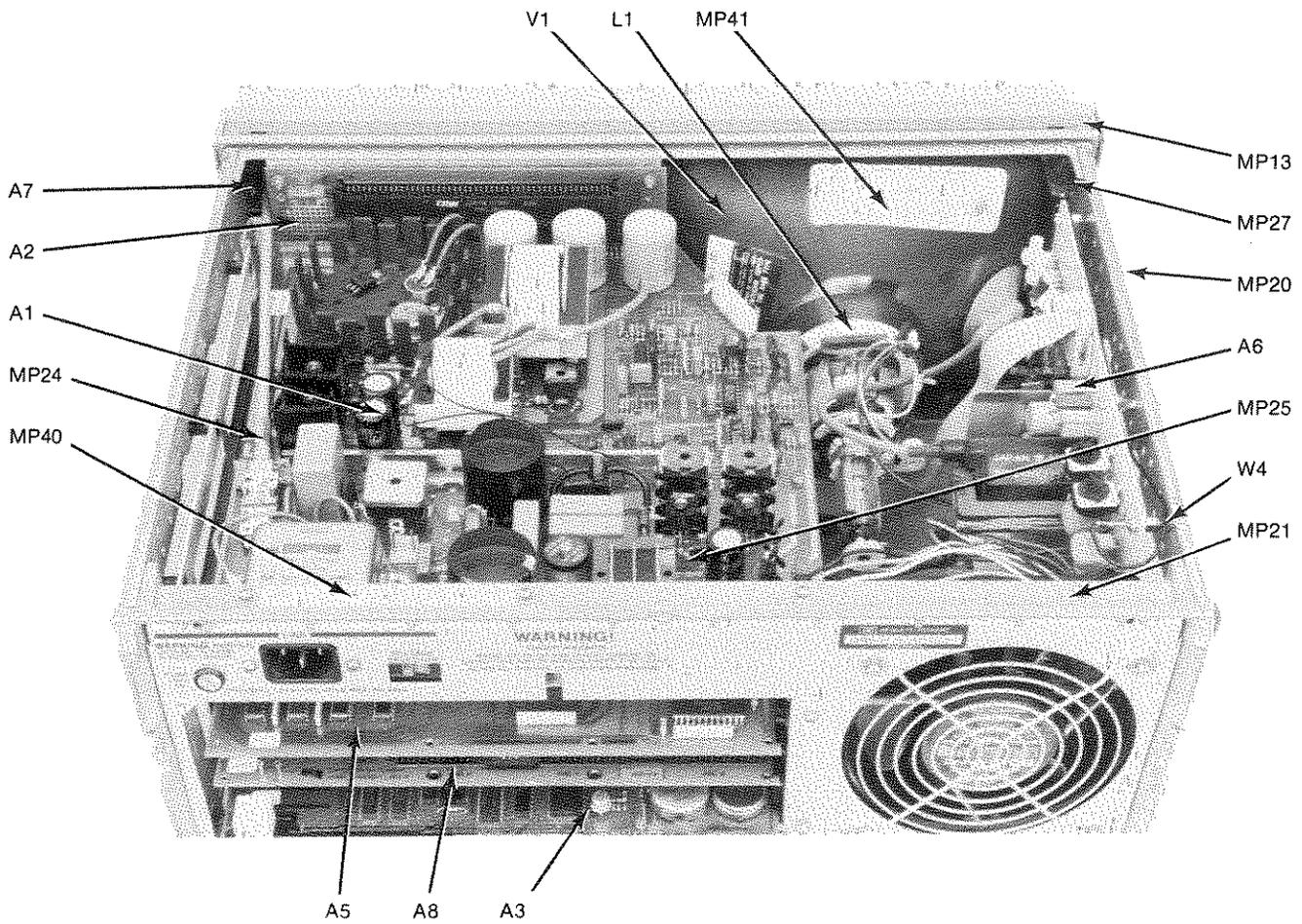


Figure 11-1. Mainframe Parts Location (Sheet 2 of 3)

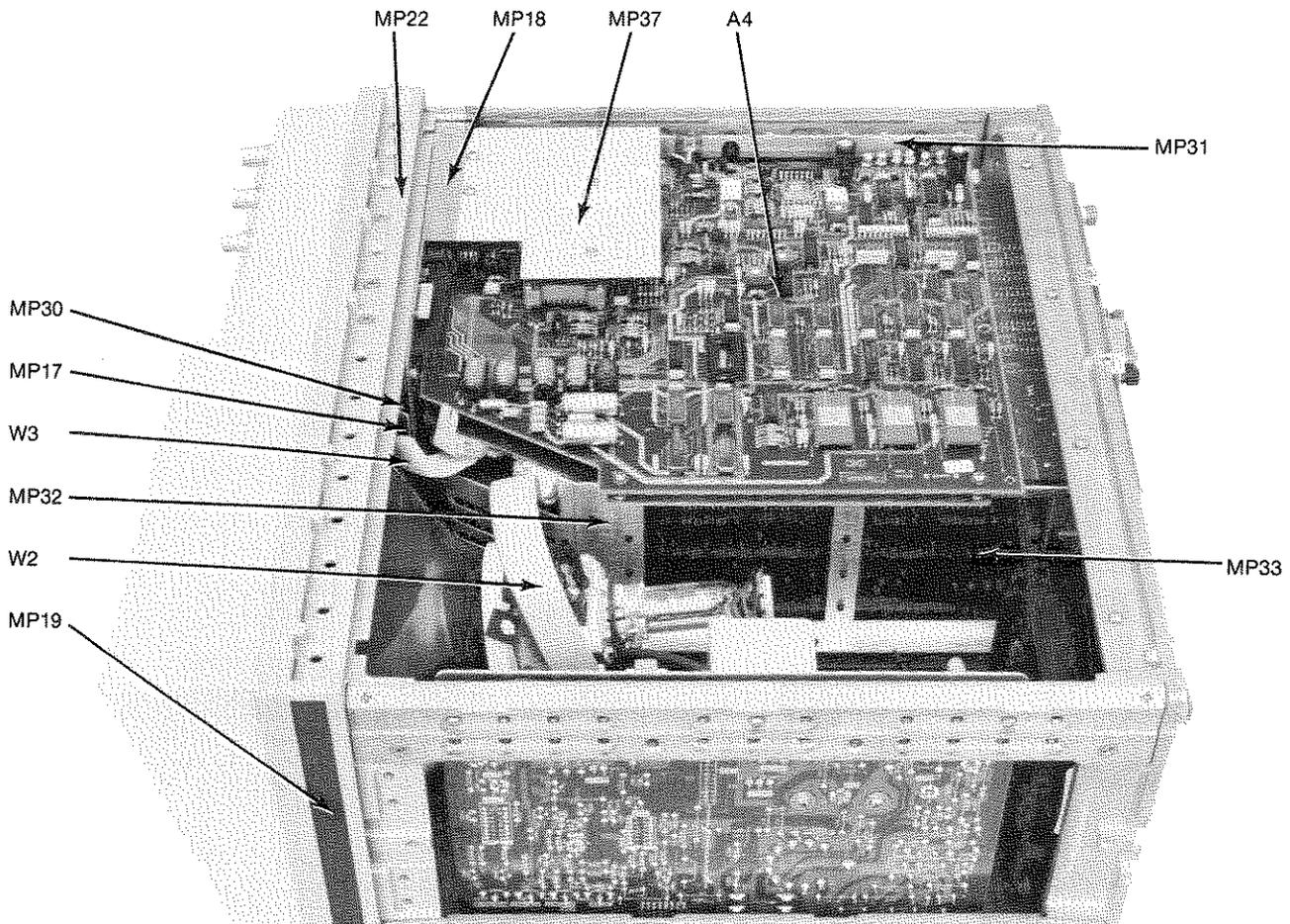


Figure 11-1. Mainframe Parts Location (Sheet 3 of 3)

Table 11-2. Replaceable Parts

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
The following mainframe parts apply only to 54200A/D Serial Prefixes 2445A						
H8	2510-0192	6	16	SCREW-MACH 8-32 .25-IN-LG 100 DEG	00000	ORDER BY DESCRIPTION
H9	2680-0172	1	2	SCREW-MACH 10-32 .375-IN-LG 100 DEG	28480	2680-0172
H18	2360-0195	0	4	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	28480	2360-0195
MP1	01630-00201	3	1	PANEL-REAR	28480	01630-00201
MP2	01630-04102	1	1	REAR DOOR	28480	01630-04102
MP3	01630-44101	4	1	COVER REAR FIN	28480	01630-44101
MP4	01630-04101	0	1	TOP COVER	28480	01630-04101
MP5	1540-0807	2	1	POUCH	28480	1540-0807
MP6	5060-9845	2	1	BOTTOM COVER	28480	5060-9845
MP9	5040-7219	8	1	CAP-STRP HNDL	28480	5040-7219
MP10	5040-7220	1	1	CAP-STRP HNDL	28480	5040-7220
MP11	5060-9915	7	1	COVER-SIDE PERFORATED	28480	5060-9915
MP20	5020-8835	4	4	STRUT-CORNER	28480	5020-8835
MP21	5020-8806	9	1	FRAME-REAR	28480	5020-8806
MP22	5020-8805	8	1	FRAME-FRONT	28480	5020-8805
The following mainframe parts apply only to 54200A Serial Prefix 2511A and beyond and 54200D Serial Prefix 2513A and beyond						
H8	0515-1403	2	16	SCREW-MACH M4 X 0.7 6MM-LG 90 DEG-TORX	28480	0515-1403
H9	0515-1384	8	2	SCREW-MACH M5 X 0.8 10MM-LG 90 DEG-TORX	28480	0515-1384
H18	0515-1402	1	4	SCREW-MACH M3 X 0.6 8MM-LG PAN-HD-TORX	28480	0515-1402
MP1	01630-00202	4	1	PANEL-REAR	28480	01630-00202
MP2	01630-64103	8	1	REAR DOOR	28480	01630-64103
MP3	01630-44102	5	1	COVER REAR FIN	28480	01630-44102
MP4	01630-04105	4	1	TOP COVER	28480	01630-04104
MP5	01630-84501	2	1	POUCH	28480	01630-84501
MP6	5061-9445	0	1	BOTTOM COVER	28480	5061-9445
MP9	5041-6819	4	1	CAP-STRP HNDL	28480	5041-6819
MP10	5041-6820	7	1	CAP-STRP HNDL	28480	5041-6820
MP11	5061-9915	5	1	COVER-SIDE PERFORATED	28480	5061-9915
MP20	5021-5835	0	4	STRUT-CORNER	28480	5021-5835
MP21	5021-5806	5	1	FRAME-REAR	28480	5021-5806
MP22	5021-5805	4	1	FRAME-FRONT	28480	5021-5805
The following mainframe parts apply to all 54200A/D Serial Prefixes						
A1	01630-66525	2	1	POWER SUPPLY BOARD ASSY	28480	01630-66525
A2	54200-66501	5	1	MOTHER BOARD ASSY	28480	54200-66501
A3	54200-69502	2	1	CPU BOARD ASSY	28480	54200-69502
A4	54200-69509	9	1	ANALOG BOARD ASSY	28480	54200-69509
A5	54200-69510	2	1	ACQUISITION BOARD ASSY	28480	54200-69510
A6	0950-1692	3	1	DISPLAY DRIVER BOARD ASSY	28480	0950-1692
A7	01630-66520	7	1	KEYBOARD BOARD ASSY	28480	01630-66520
A8	54200-69505	5	1	STATE TRIGGER BOARD ASSY (54200D ONLY)	28480	54200-69505
B1	3160-0428	9	1	FAN-TBAX 90-CFM 115/230V 50/60-HZ	28480	3160-0428
H1	0515-0430	3	30	SCREW-MACHINE ASSEMBLY M3 X 0.5 6MM-LG	28480	0515-0430
H2	0515-0641	8	12	SCREW-THD-RLG M4 X 0.7 10MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
H3	0570-1171	7	2	SCREW-SPLC 6-32 .468-IN-LG UNCT 100	00000	ORDER BY DESCRIPTION
H4	0590-1611	2	3	NUT-KNRLD-R 1/2-28-THD .094-IN-THK	28480	0590-1611
H5	0624-0598	5	4	SCREW-TPG 8-18 .625-IN-LG PAN-HD-TORX	28480	0624-0598
H6	0624-0520	3	4	SCREW-TPG 6-19 .5-IN-LG PAN-HD-TORX T10	28480	0624-0620
H7	0624-0644	2	4	SCREW-TPG 8-32 .5-IN-LG PAN-HD-TORX T15	28480	0624-0644
H10	3050-0071	5	1	WASHER-FL MTLN NO. 8 .169-IN-ID	28480	3050-0010
H11	3050-0003	3	4	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	28480	3050-0003
H12	3050-0006	6	3	WASHER-SHLDR NO. 10 .2-IN-ID .5-IN-OD	28480	3050-0006
H13	3050-1015	9	3	WASHER-FL MTLN 1/2 IN .625-IN-ID	28480	3050-1016
H14	0515-0374	4	12	SCREW-MACH M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
H15	0515-0943	3	13	SCREW-MACH M4 X 0.7 12MM-LG 100 DEG	00000	ORDER BY DESCRIPTION
H16	0515-1035	6	2	SCREW-MACH M3 8MM-LG TORX T10	00000	ORDER BY DESCRIPTION
H17	2190-0476	9	2	WASHER-LK 82 CTSK EXT T NO. 4 .116-IN-ID	28480	2190-0476
L1	9140-0720	8	1	YOKE	28480	9140-0720
MP7	5060-9882	7	1	COVER-SIDE	28480	5060-9882
MP8	5060-9802	1	1	STRAP HANDLE 12	28480	5060-9802
MP12	7101-0694	1	1	BEZEL-FRONT	28480	7101-0694
MP13	5040-7202	9	1	TRIM STRIP-TOP	28480	5040-7202
MP14	5040-7201	8	4	FEET	28480	5040-7201

See introduction to this section for ordering information

Table 11-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP15	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP16	3160-0092	3	1	FINGER GUARD-FAN	28480	3160-0092
MP17	54200-00603	0	1	SHIELD-KEYBOARD	28480	54200-00603
MP18	54200-00602	9	1	SHIELD FOIL-BOTTOM	28480	54200-00602
MP19	5001-0440	1	2	TRIM-SIDE	28480	5001-0440
MP23	5040-7221	2	4	STANDOFF R PANEL	28480	5040-7221
MP24	5041-3170	4	1	SWITCH SHAFT	28480	5041-3170
MP25	01630-00601	7	1	SHIELD-POWER SUPPLY PLASTIC	28480	01630-00601
MP26	5041-2799	1	1	KEYCAP-LINE	28480	5041-2799
MP27	0360-2109	8	1	GROUND LUG	28480	0360-2109
MP28	8160-0486	4	5	RFI STRIP-FINGERS BE-CU ZINC PLATED	28480	8160-0486
MP29	0403-0179	0	3	BUMPER FOOT-ADH MTG	28480	0403-0179
MP30	01630-01201	5	1	BRACKET-MOTHER BOARD	28480	01630-01201
MP31	01630-01202	6	1	BRKT CD GDE	28480	01630-01202
MP32	01630-01203	7	1	BRKT CTG GDE	28480	01630-01203
MP33	0403-0445	3	10	PC CARD GUIDE	28480	0403-0445
MP34	54200-94302	3	1	LBL IDENT 54200A (54200A ONLY)	28480	54200-94302
MP34	54200-94303	4	1	LBL IDENT 54200D (54200D ONLY)	28480	54200-94303
MP35	54200-94301	2	1	LABEL-FRONT	28480	54200-94301
MP36	54200-94304	5	1	LABEL-KEYBOARD	28480	54200-94304
MP37	54200-04102	2	1	SHLD-BOTTOM COVER	28480	54200-04102
MP38	0510-0043	4	2	RETAINER-RING E-R EXT .141-IN-DIA STL	28480	0510-0043
MP39	54200-94305	6	1	LABEL-REAR PANEL	28480	54200-94305
MP40	7121-3659	6	1	LABEL-WARNING MYLAR	28480	7121-3659
MP41	7121-4002	5	1	LABEL-WARNING 1.23-IN-WD 4-IN-LG PR	28480	7121-4002
V1	2090-0066	1	1	TUBE-ELECTRON	28480	2090-0066
W1	8120-0696	4	1	CABLE ASSY 3-CNDCT GRA-JKT 7.62-MM-OD AUSTRALIA/NEW ZEALAND	28480	8120-0696
W1	8120-1521	6	1	CABLE ASSY 18AWG 3-CNDCT JGK-JKT 115V USA/CANADA	28480	8120-1521
W1	8120-1692	2	1	CABLE ASSY 3-CNDCT MGP-JKT EUROPEAN CONTINENT	28480	8120-1692
W1	8120-1703	6	1	CABLE ASSY 3-CNDCT MGP-JKT UNITED KINGDOM	28480	8120-1703
W1	8120-2296	4	1	CABLE ASSY 3-CNDCT GRA-JKT SWITZERLAND	28480	8120-2296
W1	8120-2957	4	1	POWER CORD SET 3-COND 2-MM-LG DENMARK	28480	8120-2957
W2	8120-3785	8	1	FLAT RIBBON ASSY 16-COND 12-IN-LG	28480	8120-3785
W3	8120-3784	7	1	FLAT RIBBON ASSY 14-COND	28480	8120-3784
W4	01630-81301	4	1	WR-SGL BLK	28480	01630-81301
A1	01630-66525	2	1	POWER SUPPLY BOARD ASSEMBLY	28480	01630-66525
A1C1	0180-0291	3	14	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A1C2	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A1C3	0180-2946	9	3	CAPACITOR-FXD 330UF+50-10% 35VDC AL	28480	0180-2946
A1C4	0160-5473	1	10	CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C5	0180-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C6	0160-5347	8	3	CAPACITOR-FXD 1.0UF 400VDC	28480	0160-5347
A1C7	0160-5347	8		CAPACITOR-FXD 1.0UF 400VDC	28480	0160-5347
A1C8	0140-0180	5	7	CAPACITOR-FXD 2000PF +-2% 300VDC MICA	72136	DM19F202G0300WV1CR
A1C9	0160-5347	8		CAPACITOR-FXD 1.0UF 400VDC	28480	0160-5347
A1C10	0180-3224	8	2	CAPACITOR-FXD 560MF 200VDC	28480	0180-3224
A1C11	0180-3224	8		CAPACITOR-FXD 560MF 200VDC	28480	0180-3224
A1C12	0160-4048	4	1	CAPACITOR-FXD .022UF +-20% 250VAC (RMS)	C0633	PME 271 M 522
A1C13	0160-4962	1	1	CAPACITOR-FXD 1.0UF 250VDC	28480	0160-4962
A1C14	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C15	0140-0180	5		CAPACITOR-FXD 2000PF +-2% 300VDC MICA	72136	DM19F202G0300WV1CR
A1C16	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C17	0140-0180	5		CAPACITOR-FXD 2000PF +-2% 300VDC MICA	72136	DM19F202G0300WV1CR
A1C18	0160-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C19	0140-0199	6	1	CAPACITOR-FXD 240PF +-5% 300VDC MICA	72136	DM15F241J0300WV1CR
A1C20	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C21	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C22	0160-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C23	0140-0180	5		CAPACITOR-FXD 2000PF +-2% 300VDC MICA	72136	DM19F202G0300WV1CR
A1C24	0160-0164	7	3	CAPACITOR-FXD .039UF +-10% 200VDC POLYE	28480	0160-0164
A1C25	0180-2946	9		CAPACITOR-FXD 330UF +50-10% 35VDC AL	28480	0180-2946
A1C26	0180-2946	9		CAPACITOR-FXD 330UF +50-10% 35VDC AL	28480	0180-2946
A1C27	0160-0164	7		CAPACITOR-FXD .039UF +-10% 200VDC POLYE	28480	0160-0164
A1C28	0160-0164	7		CAPACITOR-FXD .039UF +-10% 200VDC POLYE	28480	0160-0164

See Introduction to this section for ordering information

Table 11-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1C29	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C30	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C31	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C32	0160-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C33	0180-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C34	0140-0180	5		CAPACITOR-FXD 2000PF +-2% 300VDC MICA	72136	DM19F202G0300WV1CR
A1C35	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C36	0140-0180	5		CAPACITOR-FXD 2000PF +-2% 300VDC MICA	72136	DM19F202G0300WV1CR
A1C37	0160-2202	8	1	CAPACITOR-FXD 75PF +-5% 300VDC MICA	28480	0160-2202
A1C38	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C39	0160-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C40	0140-0180	5		CAPACITOR-FXD 2000PF +-2% 300VDC MICA	72136	DM19F202G0300WV1CR
A1C41	0160-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C42	0160-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C43	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C44	0160-5473	1		CAPACITOR-FXD .01UF 400VDC	28480	0160-5473
A1C45	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C46	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C47	0180-3046	2	3	CAPACITOR-FXD 3300UF +75-10% 6.3VDC AL	28480	0180-3046
A1C48	0180-3046	2		CAPACITOR-FXD 3300UF +75-10% 6.3VDC AL	28480	0180-3046
A1C49	0180-3046	2		CAPACITOR-FXD 3300UF +75-10% 6.3VDC AL	28480	0180-3046
A1CR1	1906-0006	9	1	DIODE-FW BRDG 400V 1A	18546	VE48
A1CR2	1901-0719	1	2	DIODE-PWR RECT 400V 3A 300NS	04713	MR854
A1CR3	1901-0719	1		DIODE-PWR RECT 400V 3A 300NS	04713	MR854
A1CR4	1906-0224	3	1	DIODE-FW BRDG 600V 25A	04713	MDA2506
A1CR5	1901-0028	5	1	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1CR6	1901-0050	3	10	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR10	1906-0051	4	1	DIODE-FW BRDG 100V 1A	28480	1906-0051
A1CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR14	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR15	1906-0079	6	1	DIODE-FW BRDG 100V 10A	18546	VJ148X
A1CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR17	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR18	1906-0239	0	1	DIODE-CT-RECT 45V 30A	01281	SD-241
A1CR19	1906-0263	0	1	RECT VSK 12	28480	1906-0263
A1CR20	1906-0262	9	1	RECT USE 2402	28480	1906-0262
A1DS1	1990-0652	8	1	LED-LAMP ARRAY LUM-INT=200UCD IF=5MA-MAX	28480	1990-0652
A1E3	2110-0642	3	1	FUSEHOLDER	28480	2110-0642
A1F1	2110-0056	3	1	FUSE 6A 250V NTD 1.25X.25 UL IEC	75915	312006
A1FL1	9135-0175	6	1	FILTER-LINE	28480	9135-0175
A1H1	01830-23201	3	1	COUPLER-SW EXTN	28480	01830-23201
A1H2	0403-0285	9	1	BMPR FT-ADH MTG	28480	0403-0285
A1H3	0515-0211	8	8	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
A1H4	0515-0412	1	1	SCREW-MACH M3 X 0.5 25MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
A1H5	0515-0406	3	4	SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
A1H6	2190-0005	0	12	WASHER-LK EXT T NO. 4 .116-IN-ID	28480	2190-0005
A1H7	2420-0001	5	1	NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
A1H8	3050-0003	3	1	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	28480	3050-0003
A1L1	9140-0624	1	1	INDUCTOR 270UH 10% .725DX.818LG	28480	9140-0624
A1L2	9100-4192	2	1	TRANSFORMER-BALUN	28480	9100-4192
A1MP1	1205-0490	9	4	HEAT SINK 6022BS	28480	1205-0490
A1MP2	2110-0565	9	1	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
A1MP3	1205-0490	9		HEAT SINK 6022BS	28480	1205-0490
A1MP4	1205-0490	9		HEAT SINK 6022BS	28480	1205-0490
A1MP5	1600-1330	6	1	STIFFENER-PCB	28480	1600-1330
A1MP6	1205-0489	6	2	HEAT SINK 6021BS	28480	1205-0489
A1MP7	1205-0489	6		HEAT SINK 6021BS	28480	1205-0489
A1MP8	1205-0490	9		HEAT SINK 6022BS	28480	1205-0490
A1MP9	1205-0486	3	1	HEAT SINK	28480	1205-0486
A1Q1	1854-0827	1	2	TRANSISTOR NPN SI TO-220AB PD=100W	04713	MJE-13009
A1Q2	1854-0827	1		TRANSISTOR NPN SI TO-220AB PD=100W	04713	MJE-13009
A1P1	1251-7864	2	1	CONNECTOR-50 CONTACT (MALE)	28480	1251-7864
A1P2	1251-7826	6	3	CONNECTOR-MALE	28480	1251-7826

See introduction to this section for ordering information

Table 11-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R1	0757-0394	0	3	RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A1R2	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A1R3	0698-3615	8	1	RESISTOR 47 5% 2W MO TC=0+-200	27167	FP42-2-T00-47R0-J
A1R4	0757-0367	7	2	RESISTOR 100K 1% .5W F TC=0+-100	28480	0757-0367
A1R5	0757-0367	7		RESISTOR 100K 1% .5W F TC=0+-100	28480	0757-0367
A1R6	0757-0059	4	1	RESISTOR 1M 1% .5W F TC=0+-100	28480	0757-0059
A1R7	0757-0409	8	2	RESISTOR 274 1% .125W F TC=0+-100	24546	C4-1/8-T0-274R-F
A1R8	0757-0415	6	2	RESISTOR 475 1% .125W F TC=0+-100	24546	C4-1/8-T0-475R-F
A1R9	0757-0409	8		RESISTOR 274 1% .125W F TC=0+-100	24546	C4-1/8-T0-274R-F
A1R10	0757-0415	6		RESISTOR 475 1% .125W F TC=0+-100	24546	C4-1/8-T0-475R-F
A1R11	0757-0280	3	4	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R12	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R13	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R14	0757-0442	9	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R15	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A1R16	0757-0462	3	1	RESISTOR 75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7502-F
A1R17	0757-0437	2	3	RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
A1R18	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R19	0698-8959	3	1	RESISTOR 619K 1% .125W F TC=0+-100	28480	0698-8959
A1R20	0757-0437	2		RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
A1R21	0757-0281	4	1	RESISTOR 2.74K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2741-F
A1R22	0757-0441	8	1	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A1R23	0757-0437	2		RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
A1R24	0757-0795	5	1	RESISTOR 75 1% .5W F TC=0+-100	19701	MF-1/2-T0-75R0-F
A1R25	0698-3603	4	3	RESISTOR 12 5% 2W MO TC=0+-200	27167	FP42-2-T00-12R0-J
A1R26	0698-3603	4		RESISTOR 12 5% 2W MO TC=0+-200	27167	FP42-2-T00-12R0-J
A1R27	0698-3603	4		RESISTOR 12 5% 2W MO TC=0+-200	27167	FP42-2-T00-12R0-J
A1R28	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R29	0757-0288	1	1	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A1R30	0757-0468	9	2	RESISTOR 130K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1303-F
A1R31	0757-0450	9	1	RESISTOR 22.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2212-F
A1R32	0757-0440	7	2	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A1R33	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R34	2190-3211	7	1	RESISTOR-TMR 1K 10% C TOP-ADJ 1-TRN	28480	2190-3211
A1R35	0698-8961	7	1	RESISTOR 909K 1% .125W F TC=0+-100	28480	0698-8961
A1R36	0757-0283	6	1	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A1R37	0757-0459	8	2	RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5622-F
A1R38	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R39	0757-0459	8		RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5622-F
A1R40	0757-0468	9		RESISTOR 130K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1303-F
A1R41	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A1R42	0757-0479	2	1	RESISTOR 392K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-3923-F
A1RP1	1810-0488	8	3	NETWORK-RES 8-SIP4.7K OHM X 4	28480	1810-0488
A1RP2	1810-0488	8		NETWORK-RES 8-SIP4.7K OHM X 4	28480	1810-0488
A1RP3	1810-0488	8		NETWORK-RES 8-SIP4.7K OHM X 4	28480	1810-0488
A1RT3	0837-0172	2	1	THERMISTOR DISC 2.5-OHM	15454	SG-3
A1RV1	0837-0120	0	1	VARISTOR-130VAC	28480	0837-0120
A1RV2	0837-0261	0	1	VARISTOR-220VAC	28480	0837-0261
A1SW1	3101-2582	6	1	SWITCH-SLIDE	28480	3101-2582
A1SW2	3101-2150	4	1	SWITCH-PB DPDT ALING 5A 250VAC	28480	3101-2150
A1SW3	3103-0091	2	1	SWITCH-THRM FXD +110C 6A OPN-ON-RISE	28480	3103-0091
A1T1	9100-4271	8	1	TRANSFORMER-CONT	28480	9100-4271
A1T2	9100-4265	0	2	TRANSFORMER-BASE DRIVE	28480	9100-4265
A1T3	9100-4265	0		TRANSFORMER-BASE DRIVE	28480	9100-4265
A1T4	9100-4163	7	1	TRANSFORMER	28480	9100-4163
A1T5	9100-4266	1	1	TRANSFORMER-POWER	28480	9100-4266
A1T6	9100-4267	2	1	CHOKE-COUPLED	28480	9100-4267
A1TP1	1251-3618	6	1	CONNECTOR 2-PIN M POST TYPE	28480	1251-3618
A1TP2	1251-3900	9	1	CONNECTOR 8-PIN F POST TYPE	28480	1251-3900
A1TP3	1251-7826	6		CONNECTOR-MALE	28480	1251-7826
A1U1	1826-0718	0	1	IC-MC1404	28480	1826-0718
A1U2	1820-2111	9	1	IC DRV R TTL INV	01295	SN75488N
A1U3	1826-0468	7	2	IC COMPARATOR GP 8-DIP-P PKG	04713	MC3423P1
A1U4	1826-0468	7		IC COMPARATOR GP 8-DIP-P PKG	04713	MC3423P1
A1U5	1826-0565	5	1	IC-TL494	28480	1826-0565
A1U6	1826-0161	7	1	IC OP AMP GP QUAD 14-DIP-P PKG	04713	MLM324P
A1VR1	1826-0147	9	2	IC 7812 V RGLTR T0-220	04713	MC7812CP
A1VR2	1826-0106	0	1	IC 7815 V RGLTR T0-220	04713	MC7815CP
A1VR3	1826-0147	9		IC 7812 V RGLTR T0-220	04713	MC7812CP
A1VR4	1826-0221	0	1	IC V RGLTR T0-220	04713	MC7912CT

See introduction to this section for ordering information

Table 11-3. List of Manufacturer Codes

Mfr No.	Manufacturer Name	Address	Zip Code
C0633	RIFA	BROMMA SE	
S0167	FUJITSU LTD	TOKYO JP	
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO	MILWAUKEE WI	53204
01281	TRW INC SEMICONDUCTOR DIV	LAWDALE CA	90260
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS TX	75222
02111	SPECTROL ELECTRONICS CORP	CITY OF IND CA	91745
02114	FERROXCUBE CORP	SAUGERTIES NY	12477
03888	K D I PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
06665	PRECISION MONOLITHICS INC	SANTA CLARA CA	95050
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94042
18546	VARO SEMICONDUCTOR INC	GARLAND TX	75040
11236	CTS OF BERNE INC	BERNE IN	46711
15454	AMETEK/RODAN DIV	ANAHEIM CA	92808
18324	SIGNETICS CORP	SUNNYVALE CA	94086
19701	MEPCO/ELECTRA CORP	MINERAL WELLS TX	76067
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
25403	N.V. PHILIPS-ELCOMA DEPARTMENT	EINDHOVEN HL	02876
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
27167	CORNING GLASS WORKS (WILMINGTON)	WILMINGTON NC	28401
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
34335	ADVANCED MICRO DEVICES INC	SUNNYVALE CA	94086
34649	INTEL CORP	MOUNTAIN VIEW CA	95051
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
72136	ELECTRO MOTIVE CORP	FLORENCE SC	06226
75915	LITTELFUSE INC	DES PLAINES IL	60016
80031	MEPCO/ELECTRA CORP	MORRISTOWN NJ	07960



## SECTION 12

### SERVICE

#### 12-1. INTRODUCTION

The service section provides removal and installation procedures for 54200A/D mainframe components and troubleshooting information for isolating faulty circuit boards.

Service Group 12A at the end of this section provides block and component level theory, troubleshooting and schematic information necessary to service the 54200A/D power supply board.

#### 12-2. SAFETY CONSIDERATIONS

Read the Safety Summary at the front of this manual before servicing this instrument. Before performing each procedure, review it for cautions and warnings. For example, when working around the power supply and display circuitry, caution should be taken to avoid potentially lethal voltages.

#### 12-3. LOGIC CONVENTION

Logic states are defined as follows:

0 – False, negated, inactive, or unasserted state.

1 – True, active, or asserted state.

Voltage levels representing logic states:

LOW (L) – The more negative of two voltage levels.

HIGH (H) – The more positive of two voltage levels.

Signals may be either HIGH true, or LOW true, as indicated by the mnemonics on the schematics.

The 54200A/D includes both TTL and ECL ICs. Worst case voltage levels for troubleshooting and signature analysis purpose are as follows (IC data sheet specifications may be more accurate):

TTL Voltage Levels		ECL Voltage Levels	
Level	Voltage	Level	Voltage
LOW	less than 0.8 V	LOW	less than -1.50 V
HIGH	greater than 2.0 V	HIGH	greater than -1.10 V

## 12-4. ECL ATTRIBUTES

Because ECL inputs are pulled down inside the IC, an unconnected ECL input is LOW.

ECL outputs may be tied together in the same way as open-collector TTL outputs. Thus, they may be wire-ANDed or wire-ORed.

## 12-5. REMOVAL AND INSTALLATION OF MAINFRAME COMPONENTS

This section contains removal instructions for the system PC boards and the CRT. Read the Safety Summary at the front of this manual before servicing this instrument. Refer to figure 12-1 for location of 54200A/D circuit boards.

### WARNING

*Hazardous potentials exist on the power supply, the CRT, and on the display driver board. To avoid electrical shock the following procedures should be closely adhered to. Wait at least three minutes for the capacitors on the power supply and display driver boards to discharge before servicing this instrument. Wear safety glasses!!!*

### CAUTION

*Never install or remove any circuit board with the power switched ON. Component damage may occur!!!*

### Note

*When a board is installed verify that it is fully seated into the connector.*

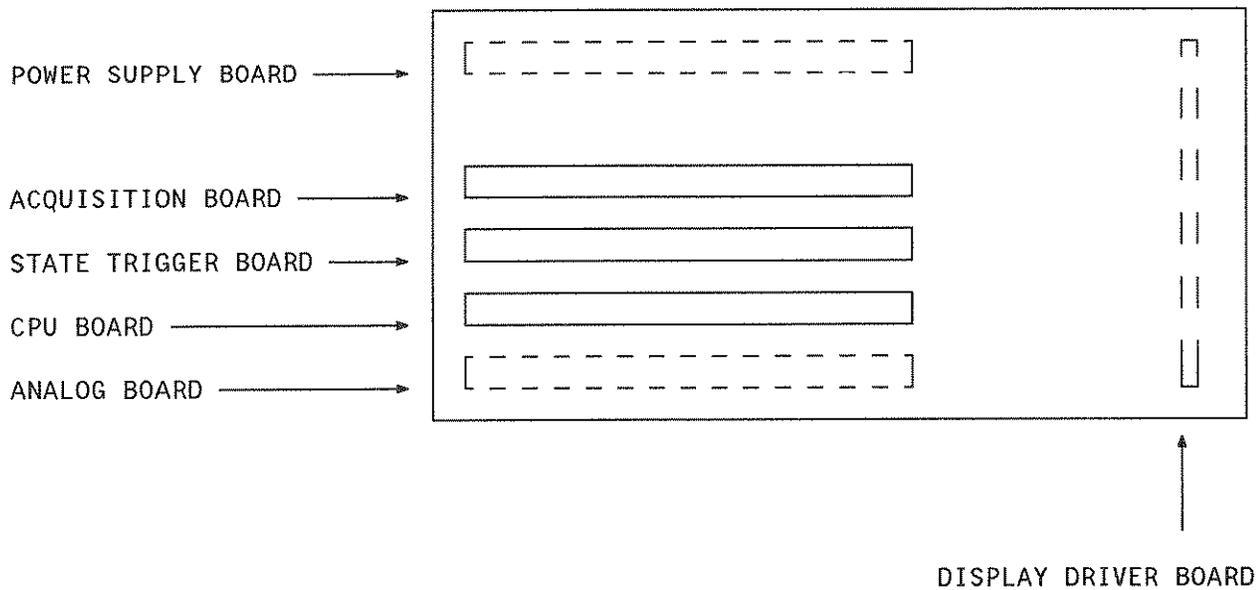


Figure 12-1. 54200A/D Circuit Board Location Diagram (Rear View)

## 12-6. Acquisition Board (and 54200D State Trigger Board) Removal

- a. Switch power OFF and disconnect AC power cord.
- b. Completely remove two screws securing rear door.
- c. Carefully remove probe cable plugs by pulling on their plastic housing (54200D only).
- d. Remove four screws securing rear cover and remove cover.
- e. Carefully remove Acquisition board (or 54200D State Trigger board) by inserting board puller from 54200A/D Product Support Kit into removal holes located at top-center of board.

The Acquisition board (or 54200D State Trigger Board) can be installed by reversing removal procedure.

## 12-7. CPU Board Removal

- a. Follow steps (a) through (d) of Acquisition board removal procedure.
- b. Completely remove two screws securing CPU board to rear panel.
- c. Remove two plastic standoffs and loosen screw securing bottom cover.
- d. Carefully tilt instrument on its side and remove bottom cover.
- e. Disconnect cables from the CPU board that go to keyboard and display driver board.
- f. Carefully remove CPU board by inserting board puller into appropriate removal holes located at the rear of board.

The CPU board can be installed by reversing CPU board removal procedure.

## 12-8. Power Supply Board Removal

### WARNING

*Hazardous voltages are present in the power supply, the CRT, and on the display driver board, even with the main line power switch set in the OFF position and power cord removed. Use extreme caution while servicing the unit with the top cover removed. Wait three minutes for the capacitors on the power supply and display driver boards to discharge to a safe voltage.*

### CAUTION

*Be certain that the perforated side cover is installed on the right-hand side of the instrument (as you face the front of the unit). If the side covers are mis-installed, insufficient air flow will result and component damage may occur.*

- a. Follow steps (a) through (d) of Acquisition board removal procedure.
- b. Completely remove two screws securing CPU board to rear panel.
- c. Remove four plastic standoffs and loosen two screws securing top and bottom covers, and remove covers.
- d. Loosen screw securing perforated side panel and remove.
- e. Remove two screws attaching handle and side cover to frame. Remove cover.
- f. Carefully tilt instrument on its side and remove four screws holding rear panel to bottom of frame.
- g. Disconnect cables from CPU board to keyboard and display driver boards.

- h. Lay instrument back on its base. Carefully remove all of boards from frame by inserting board puller into appropriate removal holes located at rear of each board.
- i. CAREFULLY remove power switch shaft with a 1/4 inch wrench.
- j. Remove two screws by line plug and two screws securing rear panel to card cage.
- k. Remove four screws attaching plastic power supply cover and ground strap to top of frame.
- l. Unplug fan from power supply and gently push out on each corner from inside of rear panel. Rear panel and fan assembly should remove as one unit.
- m. Remove three screws securing power supply board to card cage bracket.
- n. Pull Power Supply board straight back from motherboard connector and remove from frame.

The power supply board can be installed by reversing removal procedure. See figure 12-1 for card cage slot for each board.

### 12-9. Analog Board Removal

- a. Follow steps (a) through (d) of Acquisition board removal procedure.
- b. Completely remove two screws securing CPU board to rear panel.
- c. Remove four plastic standoffs and loosen two screws securing secure top and bottom covers and remove covers.
- d. Loosen screw securing perforated side panel and remove.
- e. Remove two screws attaching handle and side cover to frame. Remove cover.
- f. Carefully tilt instrument on its side and remove four screws holding rear panel to bottom of frame.
- g. Remove two screws by line plug and two screws securing rear panel to card cage.
- h. Remove four screws attaching plastic power supply cover and ground strap to top of frame.
- i. Unplug fan from power supply and gently push out on each corner from inside of rear panel. Rear panel and fan assembly should remove as one unit.
- j. Remove two screws securing Analog board to card cage.
- k. Remove three nuts and three washers securing BNC connectors to front panel.
- l. Carefully pry clip securing ground strap from Analog board to card cage.
- m. Gently pull analog board back while rocking board from side to side, to separate connector from Motherboard.
- n. Pull Analog board straight back from Motherboard and remove from frame.

The Analog board can be installed by reversing removal procedure.

### 12-10. Motherboard Removal

- a. Follow steps (a) through (n) of Power Supply board removal procedure.
- b. Follow steps (j) through (n) of Analog board removal procedure.
- c. Remove six screws that secure motherboard to keyboard cover.

The Motherboard can be installed by reversing removal procedure.

### 12-11. Keyboard Removal

**WARNING**

*Hazardous voltages are present in the power supply, the CRT, and on the display driver board, even with the main line power switch set in the OFF position and power cord removed. Use extreme caution while servicing the unit with the top cover removed. Wait three minutes for the capacitors on the power supply and display driver boards to discharge to a safe voltage.*

- a. Remove four plastic standoffs and loosen two screws securing top and bottom covers.
- b. Carefully lay unit in top-down position and remove 4 screws from front panel frame.
- c. Carefully lay unit in bottom-down position and remove top cover.
- d. Carefully pry up and remove top plastic trim strip and remove screws under trim strip.
- e. Slowly peel away two side vinyl adhesive trim strips, being careful not to tear them.

**CAUTION**

*Discharge the post accelerator lead to the grounding lug ONLY. Component damage will occur if discharged to other areas.*

**Note**

*The CRT may charge up by itself even while disconnected. Discharge the CRT by shorting the post accelerator terminal of the CRT to the ground lug with a jumper lead before handling.*

- f. Short out charge on CRT by connecting a jumper lead between ground lug of CRT and shaft of a screwdriver. Slip screwdriver under protective rubber cup of post accelerator lead and then momentarily touch screwdriver to metal clip of post accelerator lead.
- g. Disconnect post accelerator lead from CRT by firmly squeezing on rubber cup until metal clip disengages from CRT.
- h. Disconnect cable connecting cathode of CRT to display driver.
- i. Disconnect two cables connecting CRT yoke to display driver.
- j. Carefully pull and remove black wire connecting CRT ground lug to display driver.
- k. Remove 3 BNC nuts from front panel.
- l. Remove keyboard cable from CPU board.
- m. Remove four side screws (two screws on each side) that securing front bezel to frame. These are located under adhesive side trim strips.
- n. Carefully pull front bezel away from frame being careful not to scratch bezel or break line switch shaft.
- o. Remove four screws and washers connecting keyboard to front bezel.

To install the Keyboard reverse removal procedure.

## 12-12. CRT Removal

- a. Follow steps (a) through (l) of keyboard removal procedure. All WARNINGS and CAUTIONS apply for CRT removal procedure.
- b. Remove four screws and washers securing CRT to front bezel.

To install a CRT, reverse removal procedure.

## 12-13. Display Driver Board Removal

- a. Turn OFF instrument and remove AC power cord.
- b. Remove two plastic standoffs and loosen screw securing top cover to frame. Remove top cover.
- c. Remove two screws connecting handle and side panel to frame. Remove side cover.



*Discharge the post accelerator lead to the grounding lug ONLY. Component damage will occur if discharged to other areas.*

### Note

*The CRT may charge up by itself even while disconnected. Discharge the CRT by shorting the post accelerator terminal of the CRT to the ground lug with a jumper lead before handling.*

- d. Short out charge on CRT by connecting a jumper lead between ground lug of CRT and shaft of a screwdriver. Slip screwdriver under protective rubber cup of post accelerator lead and then momentarily touch screwdriver to metal clip of post accelerator lead.
- e. Disconnect post accelerator lead from CRT by firmly squeezing on rubber cup until metal clip disengages from CRT.
- f. Disconnect cable connecting cathode of CRT to display driver.
- g. Disconnect two cables connecting CRT yoke to display driver.
- h. Carefully pull and remove black wire connecting CRT ground lug to display driver.
- i. Remove six screws mounting display driver to frame and remove board.

To install the Display Driver board reverse removal procedure.

## 12-14. FAULTY BOARD ISOLATION

Troubleshooting faulty circuit boards in the 54200A/D is accomplished by connecting the 54200A/D to the test equipment as shown in figure 12-2 and loading the Service Software (HP Part No. 54200-12001) from the 54200A/D Product Support Kit (HP Part No. 54200-69501).

Table 12-1 shows the adjustments to be performed from Section 10 when an assembly has been replaced and the performance tests from Section 9 that are affected by the adjustments. The 54200A/D assembly numbers are as follows:

- A1 Power Supply Board Assembly
- A2 Motherboard Assembly
- A3 CPU Board Assembly
- A4 Analog Board Assembly
- A5 Acquisition Board Assembly
- A6 Display Driver Board Assembly
- A7 Keyboard Assembly
- A8 State Trigger Board Assembly (54200D only)
- V1 CRT
- L1 CRT Yoke

Table 12-2 lists which adjustments from Section 10 that can affect the pass/fail status of the 54200A/D front panel SYSTEM menu self-tests.

Figure 12-3 is a schematic diagram of the Keyboard assembly. Service Group 12A at the end of this section provides block and component level theory, troubleshooting and schematic information necessary to service the 54200A/D Power Supply board.

## 12-15. Service Software Disc Loading Procedure

- a. Ensure equipment is connect to the 54200A/D as shown in figure 12-2.
- b. Set the 54200A/D power on.
- c. Insert Service Software 5-1/4" disc into Series 200 Controller.
  - 1) If BASIC operating system is resident in Series 200 ROM, switch controller power off, then on again. Service Software will automatically load.
  - 2) If BASIC operating system in not resident in Series 200 ROM, boot the system from floppy disc. Then insert the Service software into the right disc drive and type **LOAD "AUTOST"**.
- d. Press the RUN key on the controller and follow the instructions displayed on the controller screen.

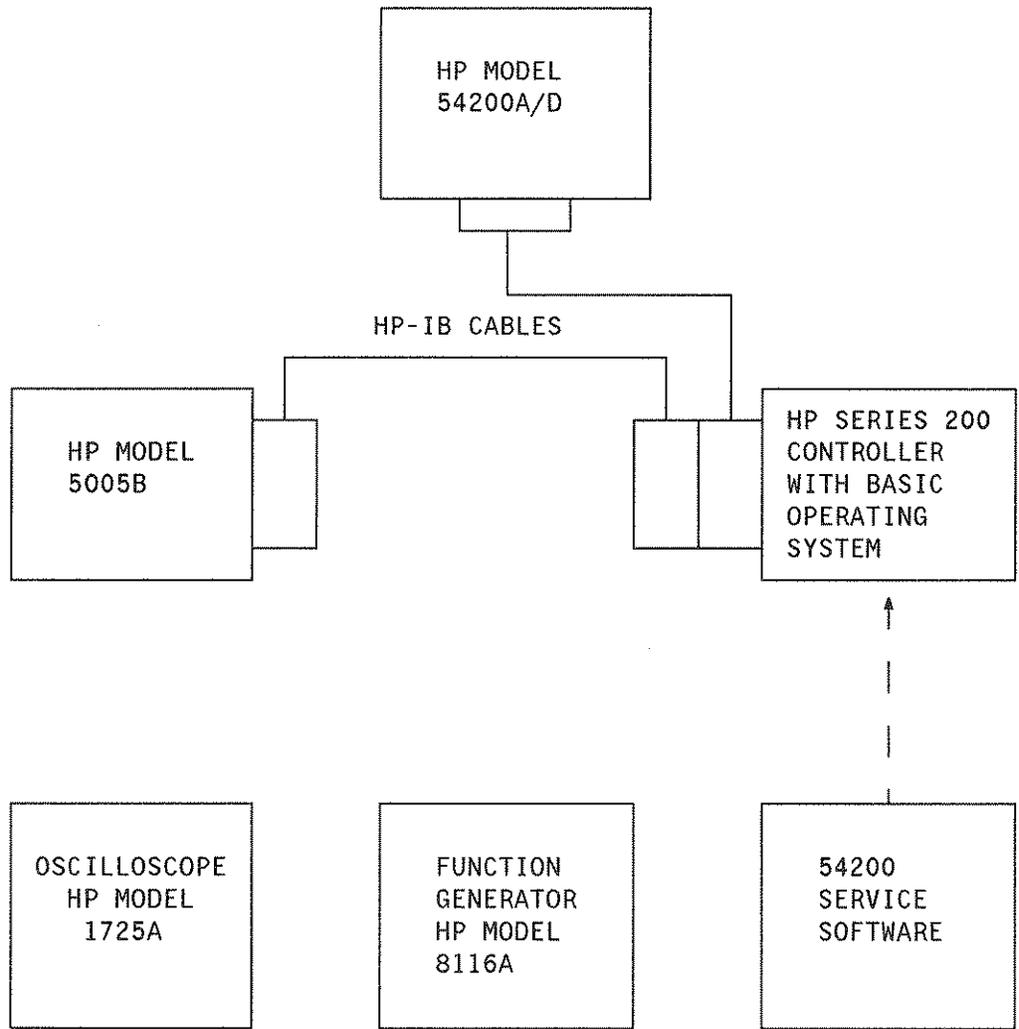


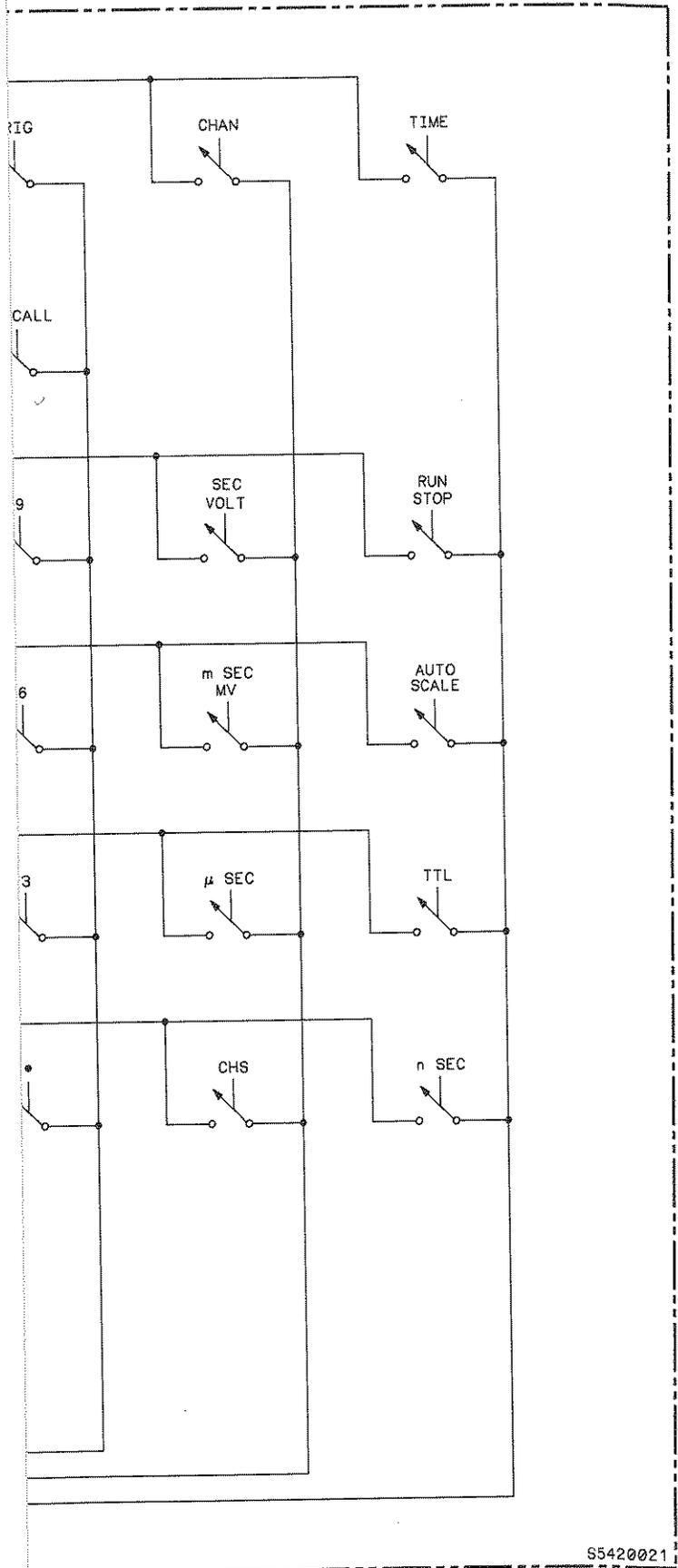
Figure 12-2. Faulty Board Isolation Setup

Table 12-1. Assembly Replacement-to-Adjustment Cross Reference

ADJUSTMENT TO PERFORM AFTER REPLACEMENT	ASSEMBLY EXCHANGED/REPAIRED										
	A4			A5		A3	A8		A1	A6	V1/ L1
10-4. Power Supply									■		
10-5a. Yoke										■	■
10-5b. Display Driver										■	■
10-6a. Balance	■				■						
10-6b. Input Compensation		■									
10-6c. Trigger Sensitivity			■								
10-6d. Trigger Balance				■							
10-7. State Trigger								■			
PERFORMANCE TEST THAT MAY BE AFFECTED BY ADJUSTMENT	A4			A5		A3	A8		A1	A6	V1/ L1
9-7. DC Offset	■				■						
9-8. Voltage Measurement	■				■						
9-9. Bandwidth		■									
9-10. Transition Time		■									
9-11. Time Measurement						■	■				
9-12. Trigger Level-Analog				■							
9-13. Trigger Sensitivity			■								
9-14. Setup Time								■			
9-15. Hold Time								■			
9-16. Clock Pulse Width									■		
9-17. Clock Repetition Rate									■		
9-18. Minimum Input									■		
9-19. Threshold Accuracy									■		

Table 12-2. Self-Test/Adjustment Interaction

BOARD	ADJUSTMENT	SELF TEST		
		0	1	2
Analog	CH1 COMP	N	N	N
	CH2 COMP	N	N	N
	CH3 COMP	N	N	N
	TSENS	N	N	N
	TLVLBAL	N	Y	N
	CH1 3.9V BAL	N	Y	Y
	CH2 3.9V BAL	N	Y	Y
	CHT 3.9V BAL	N	Y	Y
State Trig	R20	N	N	N
	R28	N	N	N
Power Supply	VOLT ADJ	N	N	N
<p>N = Adjustment does not affect pass/fail status of self-test</p> <p>Y = Adjustment affects pass/fail status of self-test. If self test fails, this adjustment should be checked.</p>				



S5420021

Figure 12-3. Keyboard Schematic Diagram  
12-13/(12-14 blank)



## SERVICE GROUP 12A

### POWER SUPPLY

#### 12A-1. INTRODUCTION

This Service Group contains block and component level theory, troubleshooting and schematic information necessary to service the 54200A/D power supply. Service group 12A is separated into two sections: theory and troubleshooting.

#### 12A-2. SAFETY CONSIDERATIONS

##### WARNING

*Hazardous potentials exist on the power supply, the CRT, and on the display driver board. To avoid electrical shock the following procedures should be closely adhered to. Wait at least three minutes for the capacitors on the power supply and display driver boards to discharge before servicing this instrument. Wear safety glasses!!!*

*Several parts of the power supply have lethal voltage and current potentials associated with them. Primary filter capacitors C10 and C11 are very large and have 300 volts across them, + or - 150 Vdc to ground. This provides a great deal of potential energy. With their respective bleeders R4 and R5, the discharge time constant is 60 seconds so even with the supply turned OFF it can be dangerous! Therefore, wait at least three minutes for the supply to discharge before servicing.*

### 12A-3. SPECIFICATIONS

The power supply used in the 54200A/D is a switching power supply that converts the AC line input to six regulated DC voltages. Table 12A-1 contains individual specifications for each voltage.

Table 12A-1. Power Supply Specifications

INPUT		
115 volt range: 90 to 127 VAC Input I <sub>max</sub> = 4 Amps		
230 volt range: 180 to 253 VAC Input I <sub>max</sub> = 2 Amps		
Frequency Range: 48 to 66 Hz in either voltage range.		
OUTPUT		
Volts	% Tolerance	Maximum Current (Amps)
+15	5	0.8
+12	5	0.25
+5	5	6.0
-2.4	1	8.0
-5.2	-5, +10	25.0
-12	5	0.25

### 12A-4. POWER SUPPLY BLOCK DIAGRAM (figure 12A-1)

The 54200A/D power supply is separated into three basic sections; Primary, Control and Secondary. The following is a brief outline of each section.

**PRIMARY SECTION.** The primary section is responsible for providing a rectified and conditioned switching source of approximately plus and minus 150 VDC, along with transformation for control power. The primary section also provides protection to the supply from AC input surge current and overvoltage conditions. This section also drives the internal cooling fan.

**CONTROL SECTION.** Control voltage generation, modulation and switching are the main functions of the control section. However, LED failure indication and failure execution is also a function of this section.

**SECONDARY SECTION.** The secondary section is responsible for filtering, rectification and feedback for the DC power supplies. Also, this section outputs all of the supplies to the test connector and the motherboard.

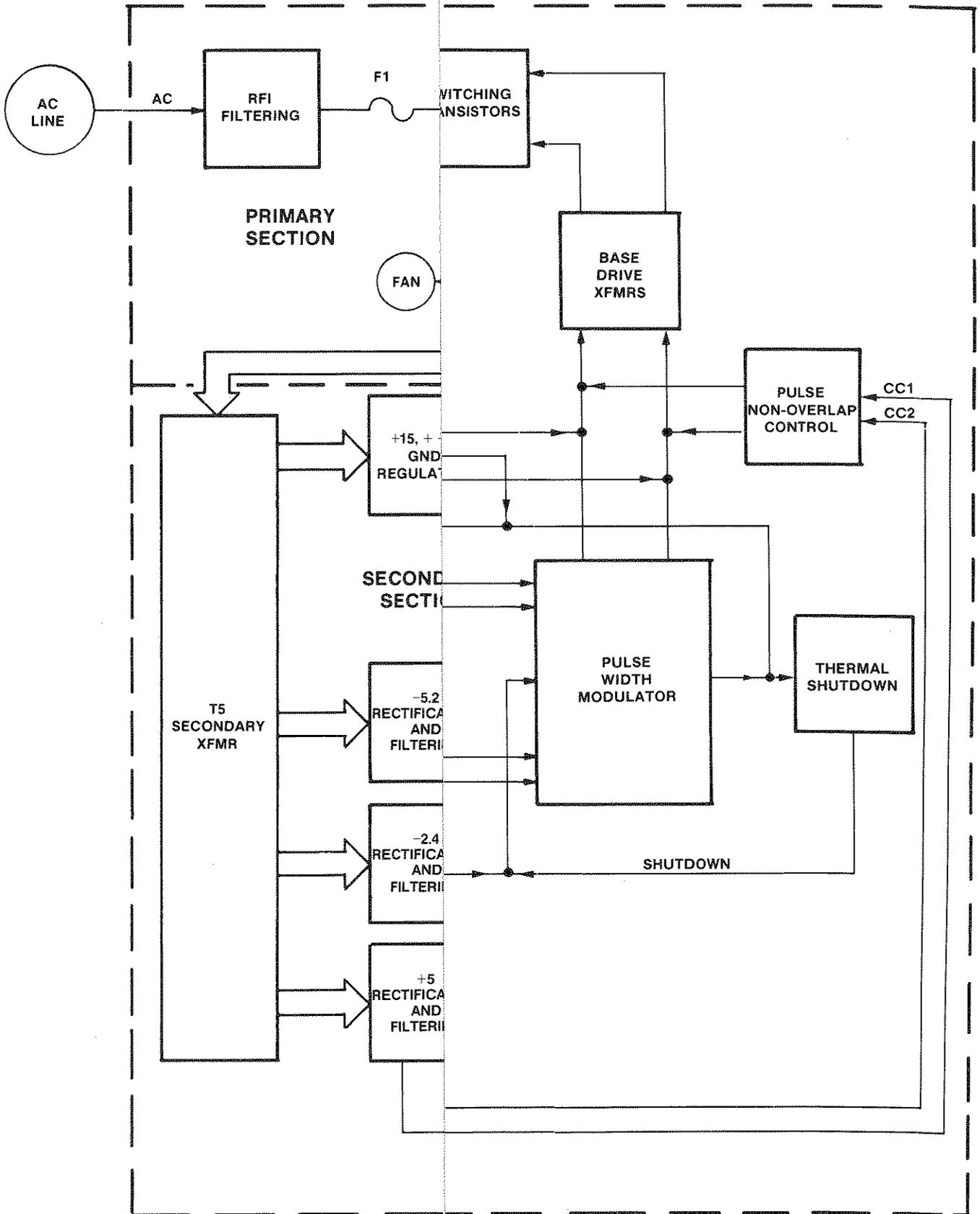


Figure 12A-1. Power Supply Block Diagram  
12A-3/(12A-4 blank)

## NOTES



## 12A-5. POWER SUPPLY THEORY OF OPERATION

The theory of operation gives detailed operation of the circuitry on the power supply board. Refer to power supply schematic 12A-1.

### 12A-6. Primary Section

The power supply begins operation when the power switch (SW2) is turned ON providing AC line to FL1 which filters the AC for radio frequency interference (RFI). According to the setting of the line select switch (SW1), the primary section will operate in two modes, either 115 VAC or 230 VAC.

**12A-7. 115 VAC OPERATION.** Notice the way that the neutral line is wired to the primary output of the bridge rectifier (CR4), only two of the diodes of CR4 are used. These are the two that connect to the AC line input of CR4. This configuration produces  $\approx 300\text{V}$  across the + and - outputs of CR4. During the 115 VAC mode this circuitry forms a half wave voltage doubler. Furthermore, while in the 115 VAC mode the primaries of T1 are in parallel so there is 115 VAC across each primary. The outputs of T1 are in parallel and have the same voltage across them during either the 115 or 230 VAC modes.

**12A-8. 230 VAC OPERATION.** When SW1 is in the 230 VAC mode, all four diodes in the bridge rectifier (CR4) are used. However, the voltage across the + and - outputs of CR4 is still  $\approx 300\text{V}$ . During the 230 VAC mode this circuitry forms a full wave rectifier. While in the 230 VAC mode the primary inputs of T1 will be in series and still have 230 VAC across each primary winding.

The fan, in either the 115 VAC or 230 VAC mode will always have 115 VAC driving it. The varistors RV1 and RV2 on the primary side of T1 are for transient suppression. The thermistor, RT3, provides surge current protection for CR4.

**12A-9. SURGE CURRENT PROTECTION.** Because input filter capacitors C10 and C11 are connected directly across the rectified line, a form of surge current protection is provided to limit line surges during turn on. RT3 provides this protection.

**12A-10. RFI SUPPRESSION.** RFI is generated by unwanted frequency energy caused by the switching components in the power supply. Inductors L2 (balun) and L1 prevent this radio frequency interference from being conducted back into the AC line.

## 12A-11. Control Section

The control section mainly consists of the circuitry needed to control the operation of the pulse width modulator (PWM). Also covered is the error detection and execution circuitry needed to control modulation.

**12A-12. PWM OVERVIEW** (figure 12A-2). A pulse width modulator (PWM) requires four signals for proper modulation: a reference voltage, a feedback from the output to compare with the reference voltage for error detection, feedback current from the output for output current limiting, and a predetermined switching frequency.

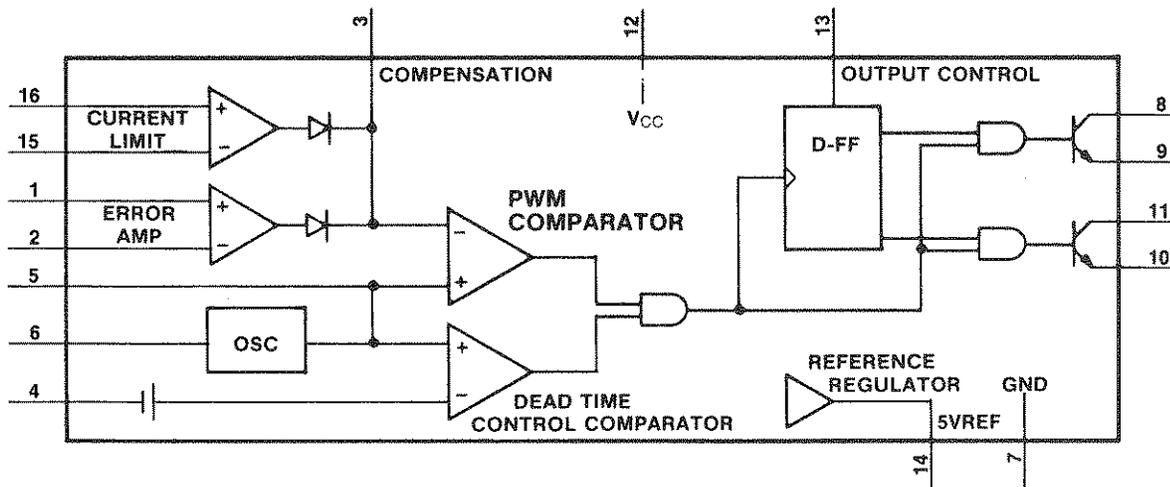


Figure 12A-2. Functional Block Diagram of a PWM

A PWM modulates its output transistors pulse width (ON time) according to the demands of the system. In this manner it controls the amount of current each switching transistor delivers and therefore controls the power. The PWM configuration used by this supply is for push-pull modulation. Push-pull modulation means that each internal open collector output transistor is turned ON alternately by the pulse-steering flip-flop. This configuration is determined by the output control input (OC) pin 13 being tied to the PWM's internal 5V reference regulator, pin 14.

**12A-13. MODULATION CONTROL.** If the +5V feedback voltage at pin 1, U5, is higher than the reference voltage at pin 2, the PWM determines that the output voltage is too high. It then reduces its output transistors pulse widths to within limits.

**12A-14. PWM SOFT START.** When AC is switched ON, capacitor C21 has not charged. This forces the dead-time control input, pin 4 of U5, to follow the 5V reference regulator output, pin 14. Note, when dead-time is high, both outputs are disabled (100% dead-time). While C21 is charging through RP2 (pins 5 and 6), the output pulse widths are allowed to modulate slowly until dead-time is low and 100% modulation is allowed. Soft start is used to prevent large current surges which may occur on power up. Also, a soft start prevents a false signal, possibly created by the control circuitry, from resetting the PWM during power up.

**12A-15. PWM SWITCHING FREQUENCY.** The 42 KHz internal oscillation frequency of the PWM is determined by the RC time constant of R21 and C22 connected to pins 6 and 5 of U5. Therefore, each open collector output transistor (pins 8 and 11) is turning ON and OFF alternately at about 21 KHz.

**12A-16. CURRENT SWITCHING OPERATION** (schematic 12A-1). The open collector outputs, pins 11 and 8 of U5, are complementary and non-overlapping. For zero on-time (zero modulation time), both outputs are high. As demand increases, each output stays low (at different times, non-overlapping) for a longer period until one is going high as the other is going low or until one of the feedback signals limits the pulse duration. Each output is inverted through U2F,G, another open collector device, and alternately causes changing current through the primaries of T2 and T3. These transformers alternately turn Q1 and Q2 ON and OFF which causes the current in the primary of T5 to alternate.

The signals CC1 and CC2 (from U2B,C) prevent or delay the switching of Q1 and Q2. For example, suppose the following condition exists. The power supply is experiencing a heavy demand and must allow close to 100% modulation to meet it. Q1 has turned ON per the request of the PWM and has pulled the one node of T5 to the + primary voltage. Then the PWM tells Q1 to turn OFF and Q2 to turn ON. Q2 can turn ON immediately, but Q1 cannot turn OFF that quickly because of charge storage. The CC2 signal is a feedback signal from the secondary of T5 senses this condition and will not allow Q2 to turn ON until Q1 turns OFF and the voltage on the secondary of T5 stabilizes. To allow Q2 to turn ON sooner would have the effect of shorting the + primary voltage to the - primary voltage for a short period of time (an enormous waste of power not to mention damage to components).

### 12A-17. Control Power Supply

As soon as AC is switched ON, CR1 rectifies AC and starts charging C3, a ripple filter for the 12 volt regulator VR1. The output of VR1 lags the input by about 1 V on power up until it stabilizes at +12 V. VR1 is the power supply for +12C (a control power supply used only on the power supply board). +12C supplies U1 which is the +5 reference source (+5REF).

### 12A-18. PWM Failure Modes

**12A-19. PWM FAILURE EXECUTION.** There are seven failure execution circuits in the 54200A/D power supply. One of these failures, -5.2 current limit, affects the current limit input, U5 pins 15 and 16, of the PWM. Four of the failures affect the Compensation/PWM Comparator input (COMP) pin 3, U5. The COMP input must be allowed to float during normal operation. If an error occurs with the +5 or -2.4 current limit, primary current limit, or thermal shutdown pin 3 will be pulled high and the PWMs' output transistors will be shut OFF. Two of the failures, +5 and -5.2 overvoltage act directly on the drive lines to the Primary Base Drive Transformers.

Several of these failures have LED indicators which indicate the nature of the failure.

**12A-20. PWM CURRENT LIMITING.** This power supply uses fold-back current limiting (figure 12A-3). The actual current limit value is determined by sensing the DC voltage developed across the internal resistance of T6 pins 2,11 and 3,10 (T6 contains six internal inductors). Current limiting of the -5.2V supply works by developing a voltage across C20 that is equivalent to the maximum load current times the internal resistance of T6 pins 2,11 and 3,10. The voltage across C20 is then compared to the reference voltage at pin 15 of U5. The foldback of the maximum current limit value is determined by the decrease in the voltage across R17. When the voltage across R17 decreases, the voltage required across C20 also decreases. The decrease across C20 causes the PWMs internal comparator to go more positive and reduce modulation until the -5.2 output voltage across R16 increases, allowing C20 to charge to the value of the reference voltage.

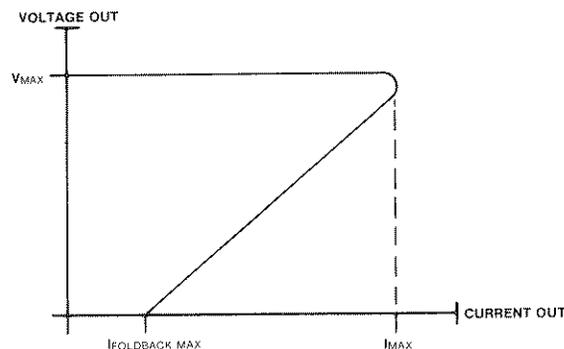


Figure 12A-3. Foldback Current Limiting

**12A-21. +5 CURRENT LIMIT.** This circuit also operates similarly to the PWM except: the DC component is taken from T6 pins 1 and 12; C43 sets the current limit value; R36 sets the foldback limit; and P/O RP3 pins 4 and 3 adjust the foldback limit. When current limit occurs, pin 14 of U6D goes high and biases CR17, which makes pin 3 of U5 more positive and reduces modulation.

**12A-22. -2.4 CURRENT LIMIT.** This circuit operates similarly to the PWM except: the DC component is taken from T6 pins 4 and 9; C45 sets the current limit value; P/O RP3 pins 5 and 6 set the foldback limit; and R40 adjusts the foldback limit. When a current limit occurs, pin 8 of U6C goes high and biases CR16, which makes pin 3 of U5 more positive and reduces modulation.

**12A-23. U3 AND U4 OPERATION.** U3 and U4 are overvoltage sensors. U3 and U4 will turn ON LEDs if an error condition is detected, and both will generate SHUTDOWN. U3 and U4 work in the following manner. When the voltage at pin 2 exceeds the voltage at pin 7 by 2.6 volts, the output pin 8 latches high to turn ON the failure LED and generate SHUTDOWN. The capacitor on pin 3 and pin 4 of U3 and U4 determine the minimum amount of time that an error must exist before they turn ON, thus providing transient protection.

**12A-24. PRIMARY CURRENT LIMIT.** U4 detects an error via T4. The primary side of T4 is in the return loop of the minus primary voltage for the switching transistors. The change of current through the primary of T4 establishes a voltage drop in the secondary, rectified by CR10, divided by R14 and R15, and detected at pin 2 of U4. If the voltage at pin 2 of U4 is greater than 2.6 volts, (a slight delay is provided by C19), U4 latches and turns ON the primary current limit LED "PL" and sets SHUTDOWN high which turns OFF U5.

**12A-25. THERMAL SHUTDOWN.** The circuitry for U3 detects an over temperature condition and generates SHUTDOWN. A normally closed thermal switch (SW3) is mounted on heatsink MP9. When the heatsink exceeds 105 C, the thermal switch opens and U3 detects an error. When pin 8 latches high, the thermal shutdown LED "TH" is turned ON. Then SHUTDOWN is generated and U5 is turned OFF.

**12A-26. +5 OVERVOLTAGE.** An overvoltage failure occurs when the +5 volt supply exceeds 6 volts making the voltage at pin 3 of U6A greater than the 5V reference on pin 2. This in turn makes pin 1 of U6A go high forcing two operations to occur. The first operation biases CR13 which keeps pin 3 of U6A high regardless of the overvolt condition. The second operation biases CR11, thus making the outputs of U2A, U2D and U2E low. With U2E low, the "OV" (overvoltage) LED (P/O DS1) goes ON indicating an overvoltage failure. Furthermore, with U2A and U2D low, U2F and U2G are unable to deliver a switching frequency to the base drive transformers. This turns OFF the supplies. Note, that if an overvoltage failure occurs, the power must be cycled OFF/ON in order to reset the overvoltage circuitry.

**12A-27. -5.2 OVERVOLTAGE.** Except for polarity considerations, the -5.2 overvoltage circuitry operates the same as the +5 overvoltage circuit. This circuit turns OFF at -6.2 volts.

## 12A-28. Secondary Section

**12A-29. +5, -5.2, AND -2.4 SECONDARIES.** Three of the four switching supply secondaries operate relatively the same. The +5 supply will be used as an example of their operation.

The alternating voltage in the center tapped secondary of T5 is full wave rectified by two Schottky diodes (CR20) mounted on a heatsink (MP9). The R27/C28 combination is a snubber network that limits the dv/dt to protect the diodes. CC1 and CC2 (cross conduction 1 and 2) prevent both switching transistors from being ON at the same time and shorting the + and - primary voltages together. P/O T6 and C49 are the filter for the supply. The LED "NORM" being ON indicates that the supply is operating properly.

Except for polarity and the lack of an LED indicator, the -2.4 and -5.2 supplies are the same as the +5 supply.

**12A-30. +15, +12, AND -12 SECONDARIES.** The alternating voltage of T5 is full wave rectified by CR15. R24 and C23 form a snubber network to protect CR15. P/O T6, C25 and C26 filter the outputs of CR15 before they are regulated by VR2, VR3 and VR4. The outputs of the regulators are filtered by C29-31 before the +15, +12 and -12 voltages are supplied to the motherboard.

## 12A-31. LED FAILURE INDICATIONS

Figure 12A-4 is a flow chart that guides the user to the faulty circuit(s) indicated by a power supply failure LED.

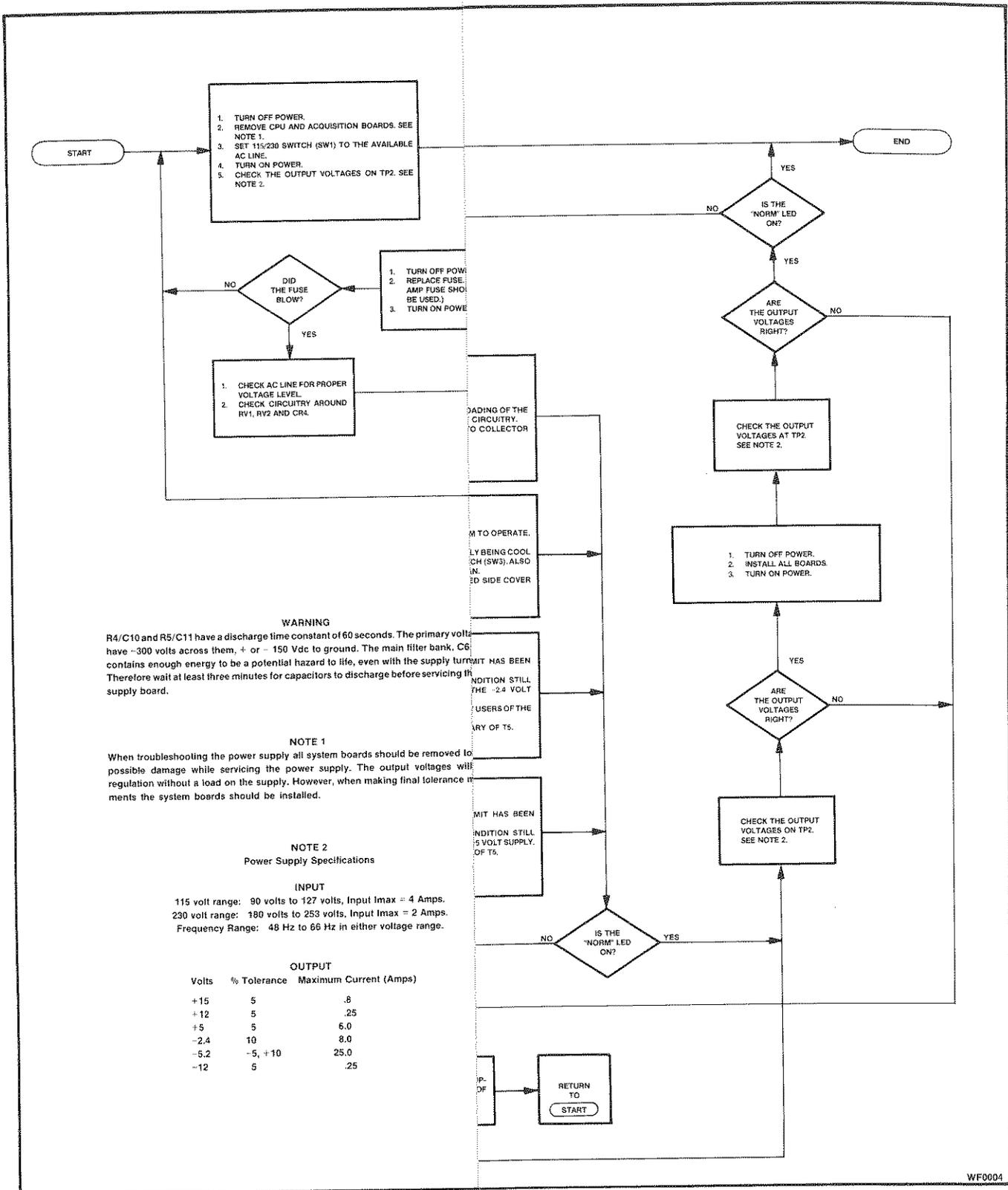


Figure 12A-4. Troubleshooting Flowchart for LED Indicators 12A-11/(12A-12 blank)

**NOTES**