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HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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HEWLETT PACKARD

OPERATING AND PROGRAMMING MANUAL

HP 54201A/D
DIGITIZING OSCILLOSCOPE

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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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HP 54201A/D
OPERATING AND PROGRAMMING MANUAL

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SAFETY CONSIDERATIONS

GENERAL - This is a Safety Class I instrument (provided with terminal for protective earthing).

OPERATION - BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage, the correct fuse is installed, and Safety Precautions are taken (see the following warnings). In addition, note the instrument's external markings which are described under "Safety Symbols."

WARNING

- Servicing instructions are for use by service-trained personnel. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

- BEFORE SWITCHING ON THE INSTRUMENT, the protective earth terminal of the instrument must be connected to the protective conductor of the (mains) powercord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.

- If this instrument is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.

- Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury.

- Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.

- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

- Do not install substitute parts or perform any unauthorized modification to the instrument.

- Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

- Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

- Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

SAFETY SYMBOLS



Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the product.



Indicates hazardous voltages.



Earth terminal (sometimes used in manual to indicate circuit common connected to grounded chassis).

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood or met.

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SECTION 1
GENERAL INFORMATION

1-1. INTRODUCTION

This manual contains information concerning the operation and programming of the HP 54201A and HP 54201D Digitizing Oscilloscopes. When information concerns both models the system will be referred to as the HP 54201A/D.

1-2. MANUAL ORGANIZATION

Section 1, General Information. This section contains a description of this manual and the instrument.

Section 2, Getting Started. This section explains how to prepare the HP 54201A/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 HP 54201A/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 HP 54201A/D.

Section 5, State Triggering with the HP 54201D. This section discusses the operation of the state triggering feature of the HP 54201D.

Section 6, Peripherals. This section provides information for making hardcopy prints of the HP 54201A/D display using a plotter or graphic printer.

Section 7, Remote Control Operation. This section discusses the remote operation of the HP 54201A/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 HP 54201A/D. This section provides programming instructions for the instrument, including the instruction set, syntax diagrams, and other detail programming reference information.

1-3. DESCRIPTION

The HP 54201A and HP 54201D Digitizing Oscilloscopes are dedicated, two-channel, simultaneous, waveform acquiring digital storage oscilloscopes with full HP-IB programmability, digitized waveform data output, and resident parametric waveform measurements.

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The HP 54201A/D is a general purpose digitizing oscilloscope with 300 MHz repetitive bandwidth and a single-shot digital storage bandwidth of 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 HP 54201D has all the features of the HP 54201A with the addition of parallel and serial logic trigger qualification capabilities. The HP 54201D includes 3 pods, each containing 8 bit + 1 parity bit + clock organization.

The key features of the HP 54201A/D Digitizing Oscilloscopes are:

- 300 MHz repetitive bandwidth with ±200 ps time-interval accuracy.
- 200 megasamples/second sample rate, 50 MHz single-shot bandwidth using post capture data interpolation.
- Capture two channels simultaneously.
- Holdoff-by-events to trigger acquisition after a specified number of events.
- Pre-trigger viewing.
- All front panel controllable parameters can be programmed via HP-IB.
- Continuously updated automatic waveform parameter measurements with user-defined thresholds.
- Waveform math: Ch1+Ch2 and Ch1-Ch2.
- Set up aids such as automatic waveform scaling, ECL/TTL preset levels, and save/recall of front-panel setups.
- One button hardcopy to HP-IB printers and plotters.
- Digital logic trigger qualification (HP 54201D only).

1-3. ACCESSORIES SUPPLIED

The following accessories are supplied with the instruments:

HP 54201A/D: Two HP 10017A 10:1 divider probes.
One BNC to probe tip adapter.
One 2.3 meter (7.5 ft) power cord.
One Operating and Programming Manual.
One Service Manual.

HP 54201D (only): Three HP 10271A 10-bit State Data Probes.

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SECTION 2
GETTING STARTED

2-1. PREPARATION FOR USE

2-2. Power Requirements

The HP 54201A/D requires a power source of either 115 or 230 VAC -22% to +10%; single phase, 48 to 66 Hz; 275 watts maximum.

CAUTION

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

2-3. Line Voltage Selection

Before turning ON the instrument verify that the Voltage Selector switch on the rear panel matches the input line voltage. The 6 Amp fuse installed satisfies both voltage settings of 115 and 230 VAC.

2-4. 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 available.

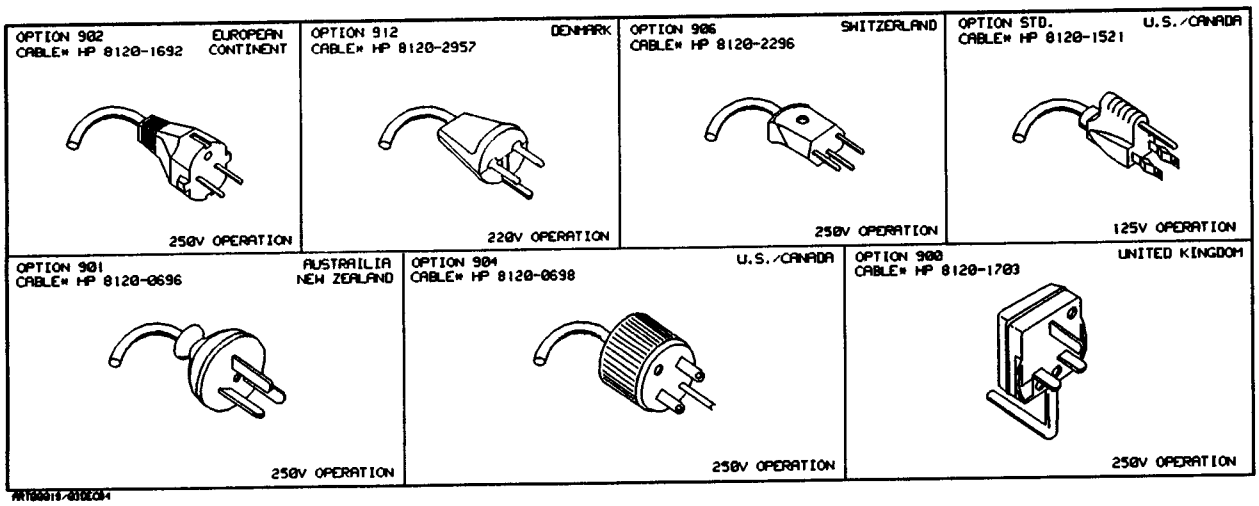


Figure 2-1. Power Cord Configurations

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2-5. OPERATING ENVIRONMENT

The HP 54201A/D will operate to all specifications, within the temperature and humidity range given in table 1-2 of the HP 54201A/D Service Manual. 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.

2-6. CLEANING REQUIREMENTS

When cleaning the HP 54201A/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.

CAUTION

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

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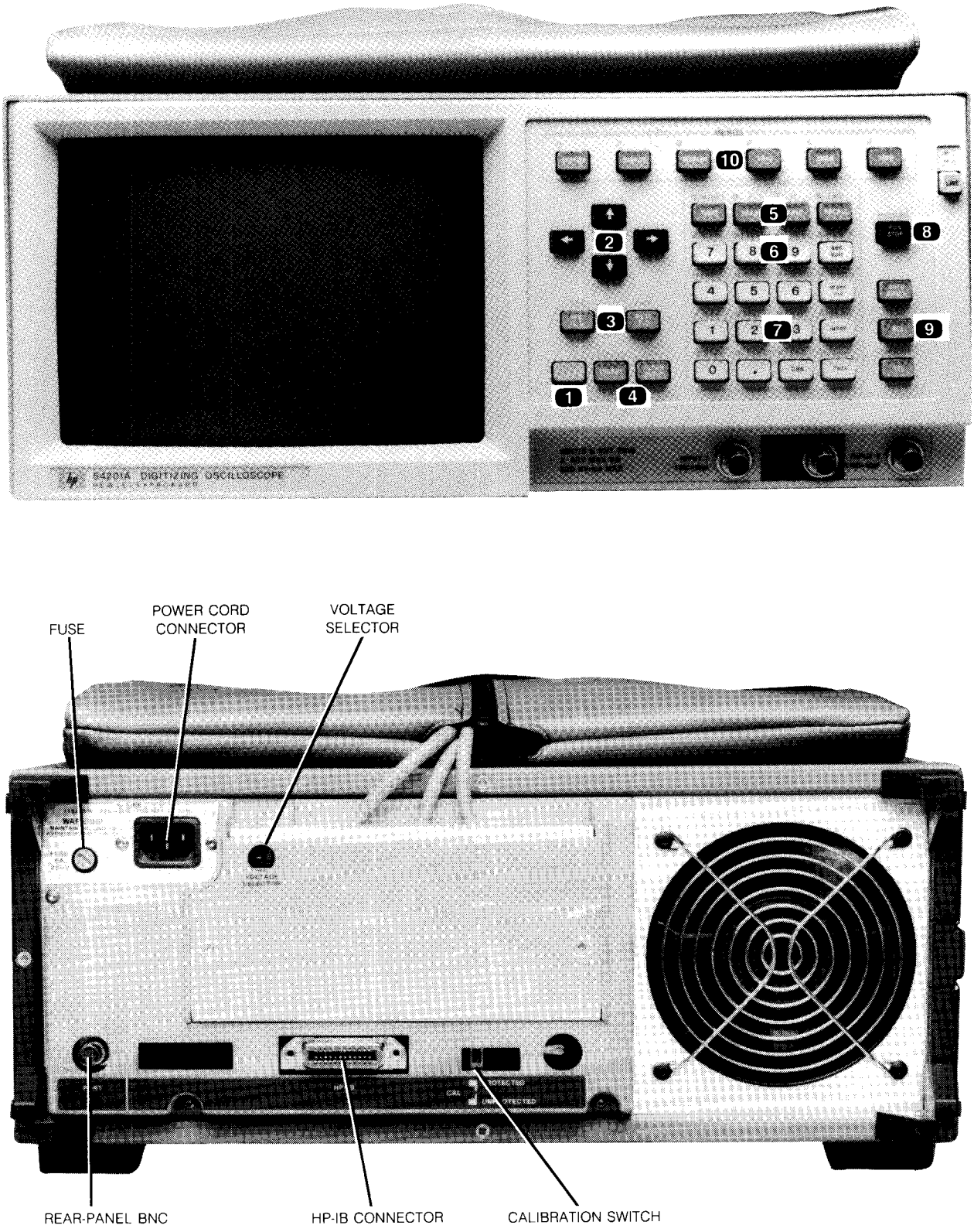


Figure 3-1. Front and Rear Panel Controls

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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 HP 54201A/D Digitizing Oscilloscope. Figure 3-1 is the front panel of the HP 54201A/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 HP 54201A/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 HP 54201D only, and is used for some self test and calibration routines on the HP 54201A/D.

The DELETE key removes the same selection fields from the TRIGGER "State" menu on the HP 54201D 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 (HP 54201D only).

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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. All instrument setup and waveform memories are non-volatile when instrument power is removed.

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.

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

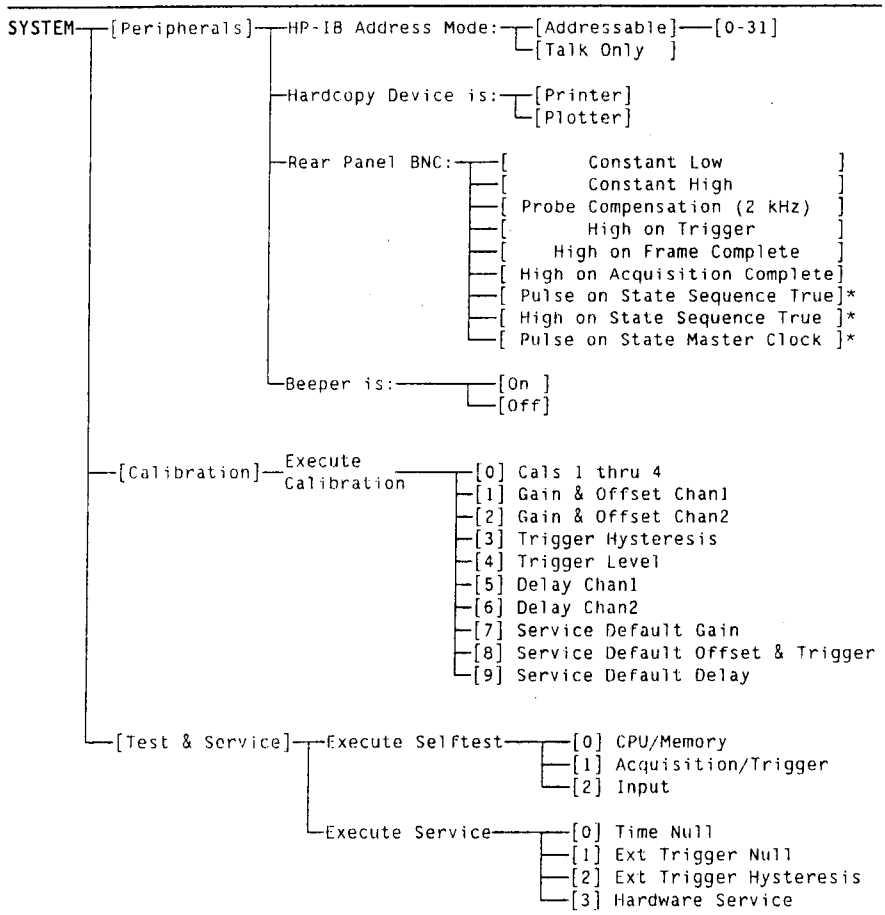
These keys are used to scale the instrument controls. AUTOSCALE selectively searches for and scales the vertical, trigger, and timebase sections together or each section may be scaled independent of the others.

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

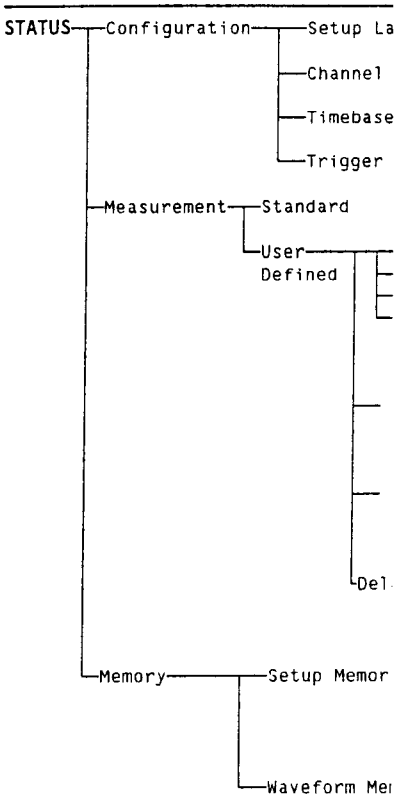
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SYSTEM MENU

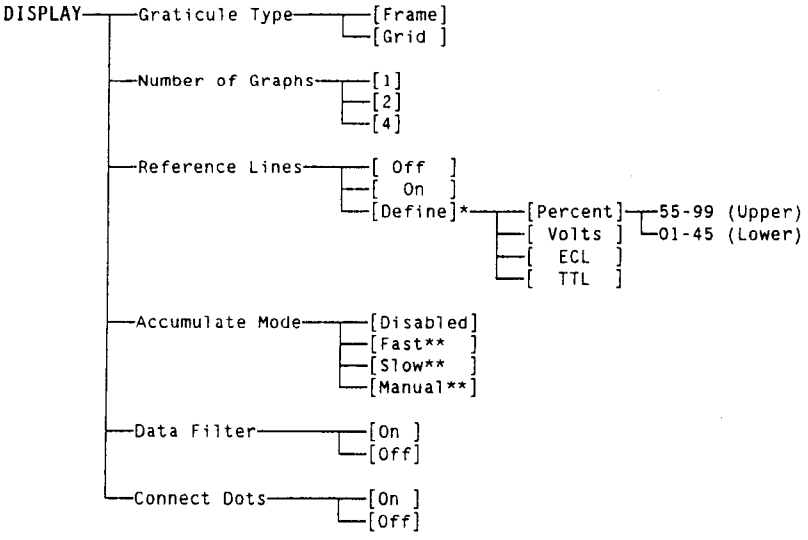


* 54201D only

STA

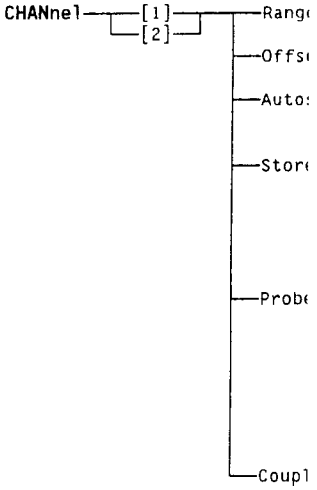


DISPLAY MENU



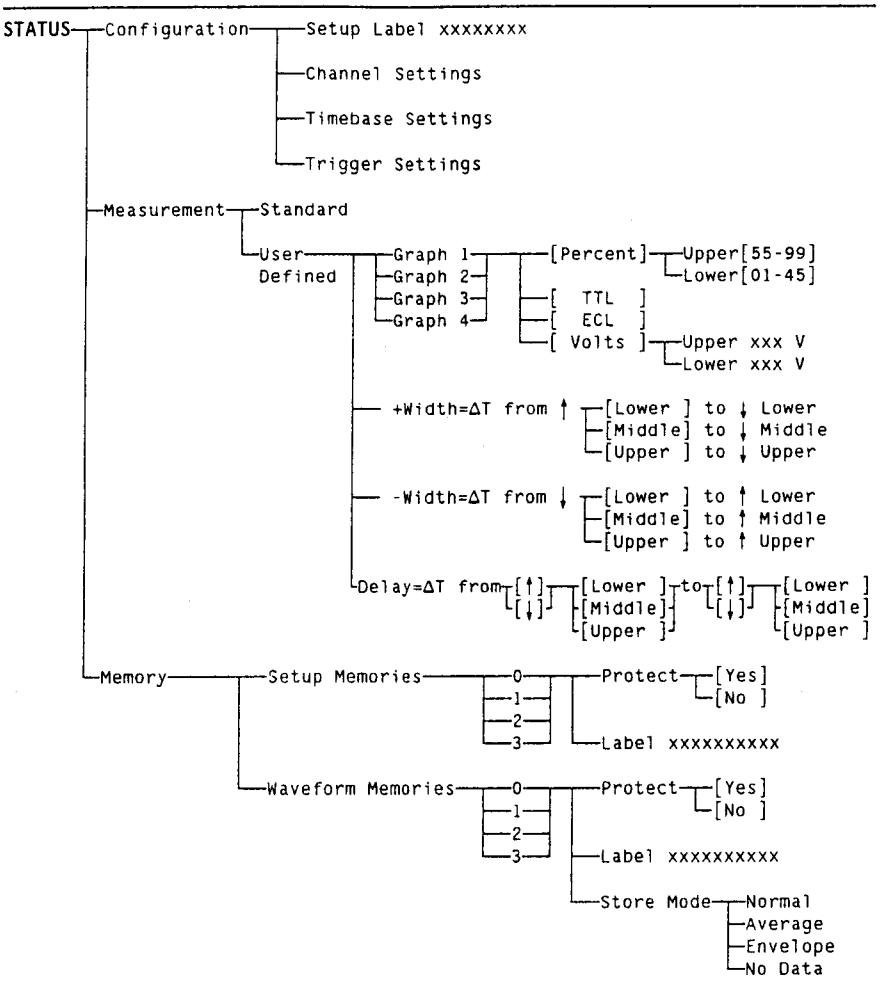
* Accumulate Mode must be disabled before reference lines can be enabled or defined.
** Reference lines must be off before accumulate mode can be enabled.

CHAN

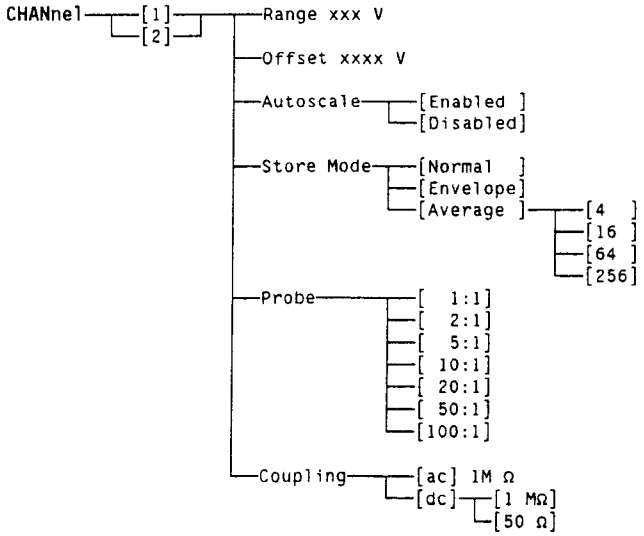


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STATUS MENU



CHANNEL MENU



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MENU

xxxxxx

gs

ngs

gs

```
1─┬──[Percent]─┬─Upper[55-99]
2─┤            └─Lower[01-45]
3─┤  [  TTL  ]
4─┘  [  ECL  ]
     [ Volts ]─┬─Upper xxx V
               └─Lower xxx V

=ΔT from ↑ ─┬─[Lower ] to ↓ Lower
            ├─[Middle] to ↓ Middle
            └─[Upper ] to ↓ Upper

=ΔT from ↓ ─┬─[Lower ] to ↑ Lower
            ├─[Middle] to ↑ Middle
            └─[Upper ] to ↑ Upper

from─┬─[↑]─┬─[Lower ]─to─┬─[↑]─┬─[Lower ]
     └─[↓]─┼─[Middle]    └─[↓]─┼─[Middle]
           └─[Upper ]          └─[Upper ]

     0─┬──Protect─┬─[Yes]
     1─┤          └─[No ]
     2─┤
     3─┘  └─Label xxxxxxxxxx

     0─┬──Protect─┬─[Yes]
     1─┤          └─[No ]
     2─┤
     3─┘  ├─Label xxxxxxxxxx
          └─Store Mode─┬─Normal
                       ├─Average
                       ├─Envelope
                       └─No Data
```

TRIGGER MENU

```
TRIGger─┬─[Analog]─┬─Source──────┬─[ Chan 1 ]─┬─[+ Slope]
        │          │             ├─[ Chan 2 ]─┤
        │          │             │            └─[- Slope]
        │          │             └─[External]─┘
        │          ├─Level──────┬─[Adjust* ]─[xxx V]
        │          │             ├─[Centered]
        │          │             └─ xxx V**
        │          ├─Auto Scale─┬─[Enabled]
        │          │             └─[Disabled]
        │          ├─On Event───[0 - 59999]
        │          └─Coupling**─┬─[.2 MΩ]
        │          │             └─[50 Ω ]─Probe[1:1 to 100:1]
        │          ***
        └─[State]─┬─Trigger─┬─[   Analog Only   ]
                  │  Mode   ├─[   State Only    ]
                  │         └─[State Arms Analog]
                  ├─Define──┬─[Assignment]─┬─State Mode─┬─[  Normal   ]
                  │         │              │            ├─[ Qualified ]
                  │         │              │            ├─[Missing Bit]
                  │         │              │            └─[ Extra Bit ]
                  │         │              ├─Multiplexing (Normal Mode Only)
                  │         │              ├─Clock Assignments
                  │         │              ├─Pod Thresholds
                  │         │              ├─Labels
                  │         │              ├─Polarity
                  │         │              └─Bit Assignment
                  │         └─[Sequence]─┬─Sequence Terms
                  │                       ├─Restart Terms
                  │                       ├─Number Base
                  │                       └─Resource Terms
```

* Adjust and Centered not valid for External Trigger Source.
** External trigger only.
*** HP 54201D only.

. MENU

V

x V

```
─┬─[Enabled ]
 └─[Disabled]

─┬─[Normal  ]
 ├─[Envelope]
 └─[Average ]─┬─[4  ]
              ├─[16 ]
              ├─[64 ]
              └─[256]

─┬─[  1:1]
 ├─[  2:1]
 ├─[  5:1]
 ├─[ 10:1]
 ├─[ 20:1]
 ├─[ 50:1]
 └─[100:1]

─┬─[ac] 1M Ω
 └─[dc]─┬─[1 MΩ]
        └─[50 Ω]
```

TIMEBASE MENU

```
TIMEbase─┬─Mode──────┬─[Auto  ]
         │           ├─[Trig'd]
         │           └─[Single]
         ├─Range xxx xs─┬─[Real Time ]
         │              └─[Repetitive]
         ├─Delay xxx xs
         ├─Auto Scale──┬─[Disabled]
         │             ├─[Period  ]
         │             ├─[+ Pulse ]
         │             ├─[- Pulse ]
         │             ├─[Rise    ]
         │             └─[Fall    ]
         └─Reference──┬─[Left  ]
                      ├─[Right ]
                      └─[Center]
```

Figure 3-2
HP 54201A/D Menu Tree

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LOCAL Key 9

LOCAL is the shifted function of the ECL key. When LOCAL is selected the HP 54201A/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 HP 54201A/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 (HP 54201D only). Alpha characters G through Z share keys with other shifted functions. The 54201A/D 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 HP 54201A/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
Voltage difference between cursor O and cursor X (ΔV)
Time difference between cursor O and cursor X (ΔT)

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.

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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	frequency (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 (+width/period)
DELAY	delay from first edge on graph to first edge on another graph (minimum delay, maximum delay, average delay, or delay of last acquisition)
V ampl	voltage amplitude (0 to 100%)
V max	absolute maximum voltage
V min	absolute minimum voltage
V rms	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 measurements may be displayed on the upper right portion of the display. These measurements are updated each time the HP 54201A/D acquires new data.

3-5. MENU KEYS 10

The row of six keys at the top of the HP 54201A/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.

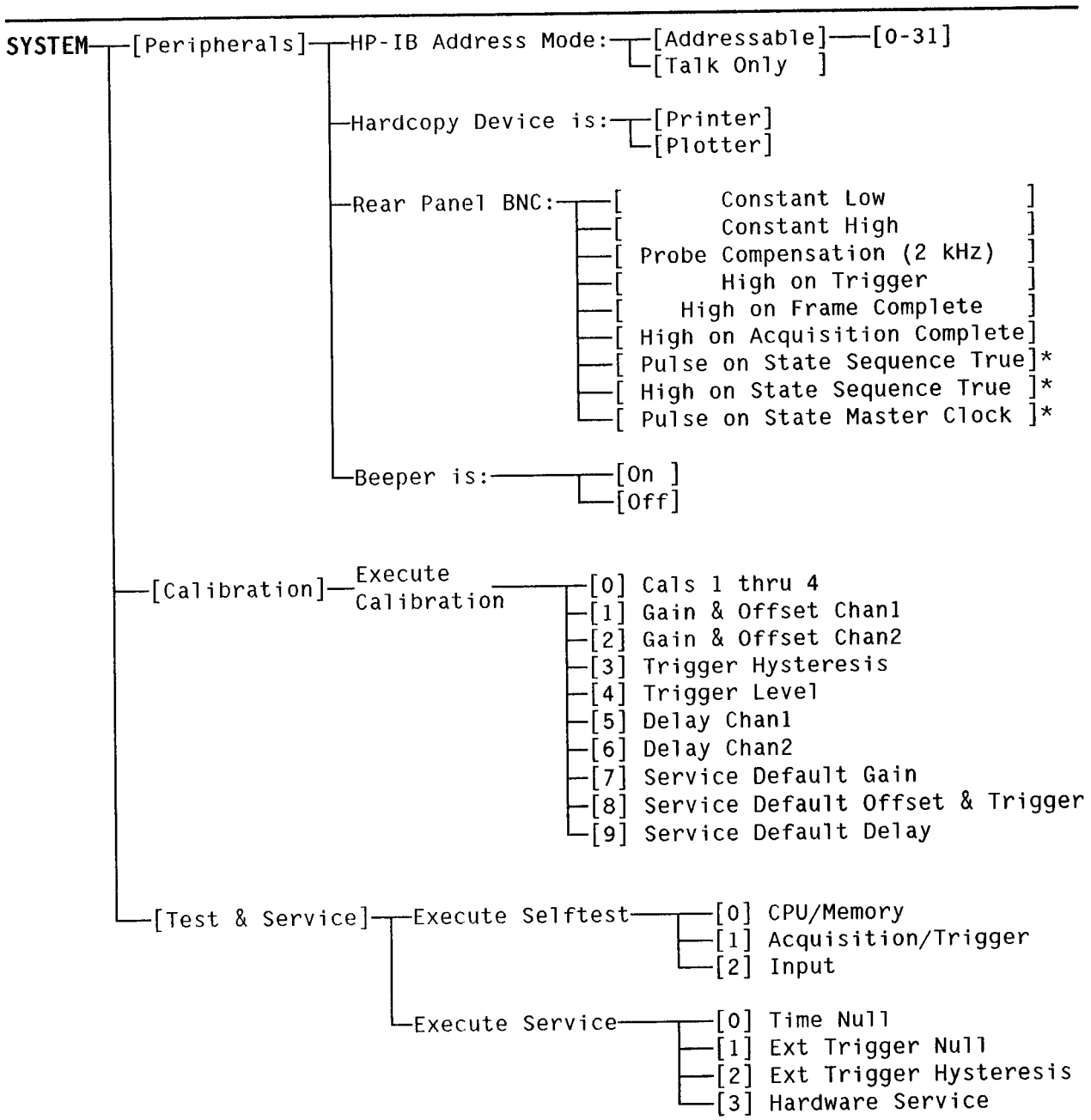
Menu keys SYSTEM, STATUS, and DISPLAY (and TRIG for HP 54201D only) have submenus. The last selected submenu is displayed when the menu key is pressed. The field select cursor is restored to the same location as the last time the menu was accessed. When power is applied to the HP 54201A/D, the last menu 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.

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3-6. 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.



* 54201D only

Figure 3-3. SYSTEM Menu Tree

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SYSTEM PERIPHERALS SUBMENU (Figure 3-4). This menu sets up the HP 54201A/D to communicate with other instruments/controllers via HP-IB, controls the output of the rear panel BNC connector, and selects beeper mode.

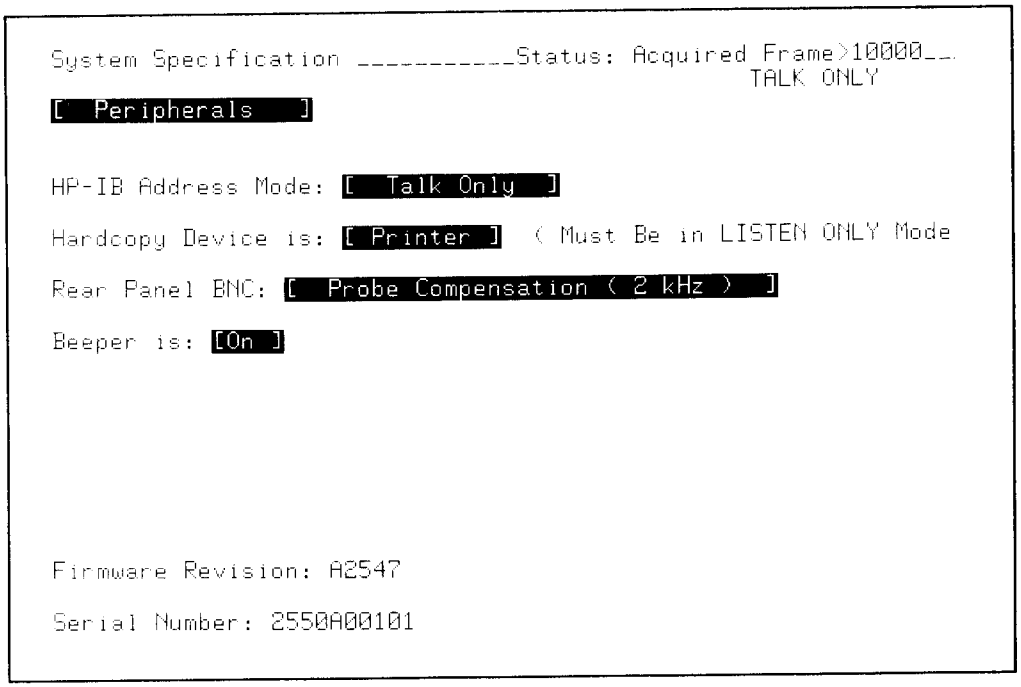


Figure 3-4. SYSTEM Peripherals Submenu

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HP-IB Address Mode. To use the HP 54201A/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 HP 54201A/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 HP 54201A/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 54201A and nine conditions for the HP 54201D. All outputs are a TTL level. 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 HP 54201A/D receives a trigger.
- ***High on Frame Complete*** - This output goes high when the HP 54201A/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*** (HP 54201D only) - This selection gives pulse output whenever the state sequence is found.
- ***High on State Sequence True*** (HP 54201D only) - The output goes high when state sequence provides a trigger for the HP 54201D.
- ***Pulse on State Master Clock*** (HP 54201D 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.

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SYSTEM CALIBRATION SUBMENU (Figure 3-5) This submenu allows the user to execute automatic gain, offset, trigger hysteresis, trigger level, and delay calibration for channel 1 and channel 2 from the front panel. A rear-panel switch protects the calibration factors from inadvertent changes. This CAL 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.

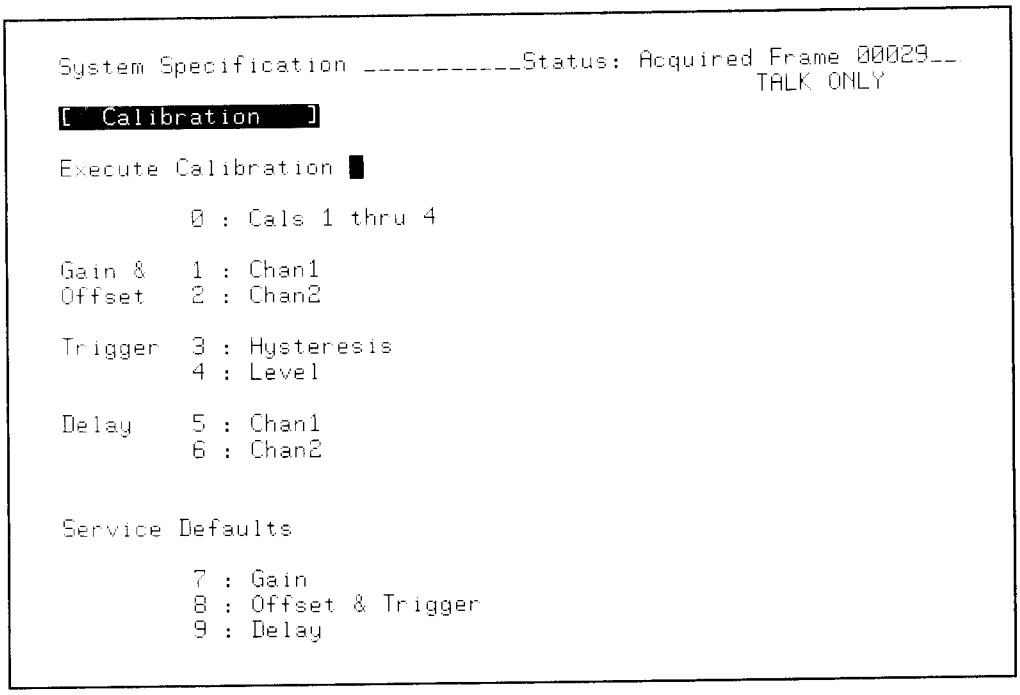


Figure 3-5. SYSTEM Calibration Submenu

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

Note

Instrument must be allowed to warm up for at least 30 minutes prior to executing front-panel calibration.

To execute the calibration routines, press the SYSTEM menu key, then press the NEXT/PREV key until the Calibration menu is displayed as shown in figure 3-5. Move the blinking-cursor to the Execute Calibration field and enter the number of the routine you wish to execute. Follow the instructions displayed on screen and watch the status line at the end of the calibration to see if the instrument calibrated successfully. An audible beep will be heard when the selected calibration routine is complete.

When front-panel calibration is complete, set the rear-panel CAL switch to the PROTECTED position.

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SYSTEM TEST & SERVICE SUBMENU. (Figure 3-6). The self test section of this menu allows the user to verify that more than 90% of the HP 54201A/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 (HP 54201D 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 5 seconds per channel to execute.

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

The service section of this menu executes routines required for servicing the HP 54201/A/D. Refer to the HP 54201A/D Service Manual for detailed information on this function.

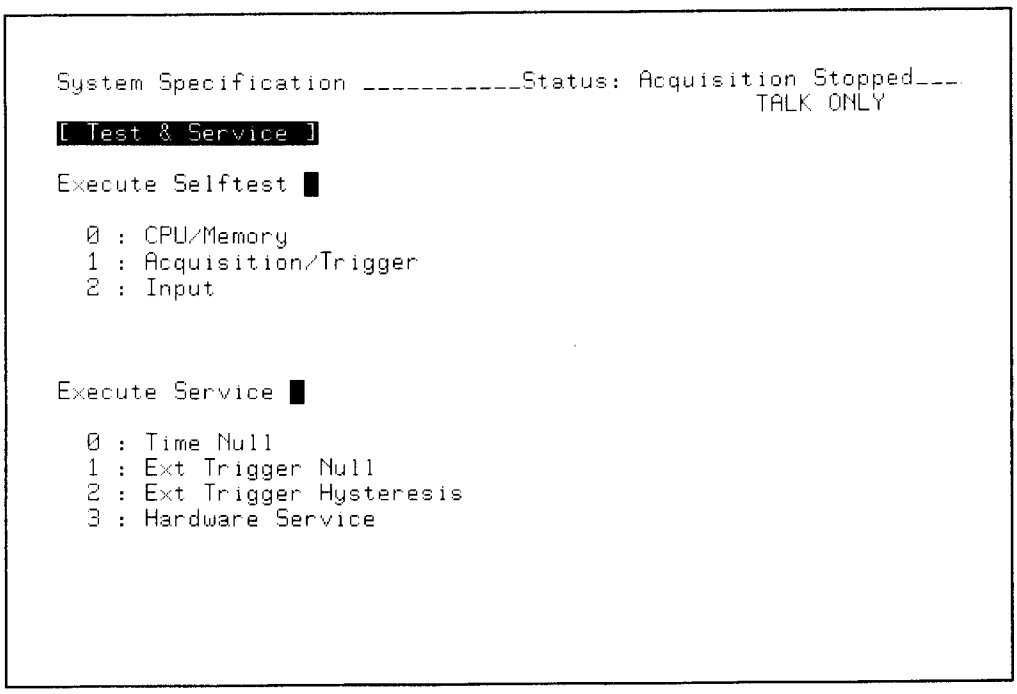


Figure 3-6. SYSTEM Test & Service Submenu

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3-7. 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.

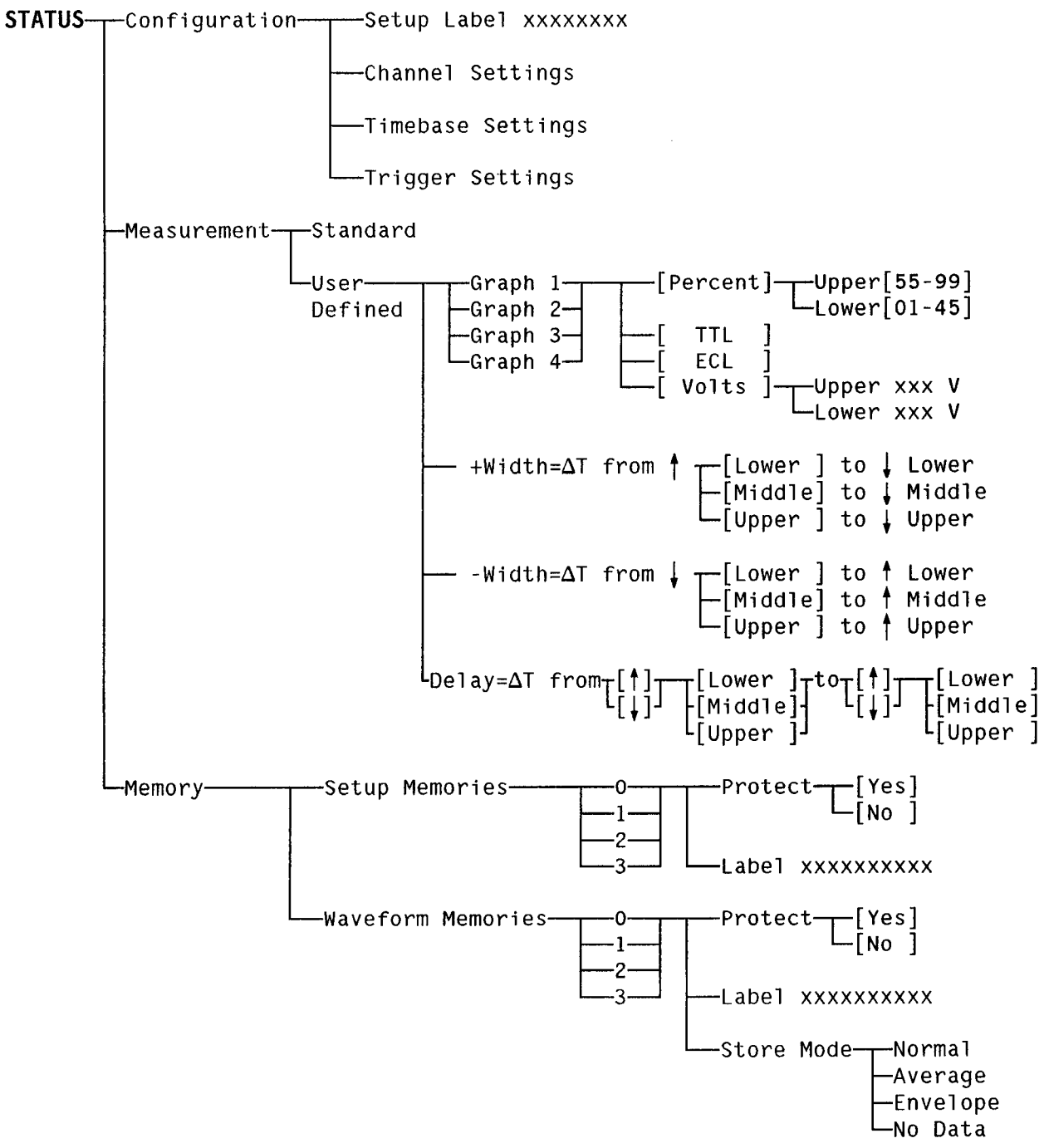


Figure 3-7. STATUS Menu Tree

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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 using the Channel, Time or Trigger menu which are discussed later in this chapter. In addition to the setup information covered by these menus, the configuration submenu contains a setup label, channel waveform math selection, and channel labels.

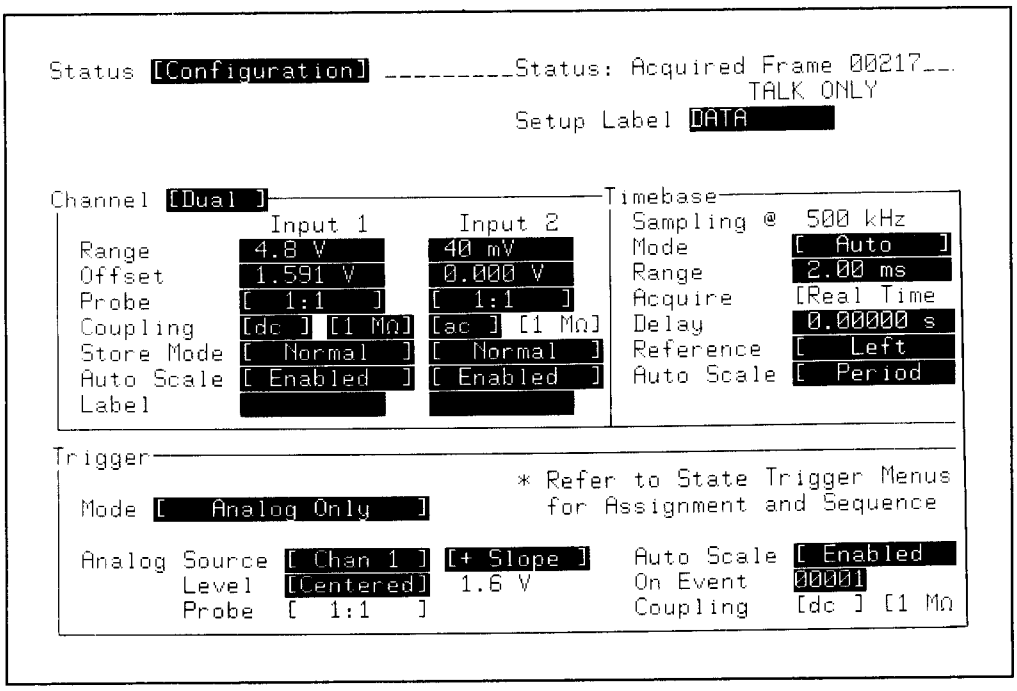


Figure 3-8. STATUS Configuration Submenu

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.

Waveform Math. The Channel field allows the user to display normal Channel 1 and Channel 2 waveforms (Dual mode), or to display waveform math capabilities of Channel 1+2 or Channel 1-2. These selections can only be made from the STATUS Configuration menu.

When 1+2 or 1-2 is selected, Channel 1+2 or Channel 1-2 replaces Channel 2 on the graphs. The waveform math occurs as a software function after the two input signals have been acquired, therefore these modes do not provide the full benefit of common mode rejection as a true differential system. When either Channel 1+2 or Channel 1-2 is selected, Channel 1+2 (or 1-2) coupling, coupling impedance, probe attenuation, and Auto Scale mode are set to be the same as Channel 1. The input range for Channel 1+2 (or 1-2) is set double that of Channel 1 because the possible range of the resultant waveform is twice that of the individual ranges. For Channel 1-2 mode, the offset is set to zero since the offset applied to each input is the same. For Channel 1+2 mode, the offset is set double that of Channel 1.

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.

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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: Acquired Frame 00286__
                                                    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

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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.

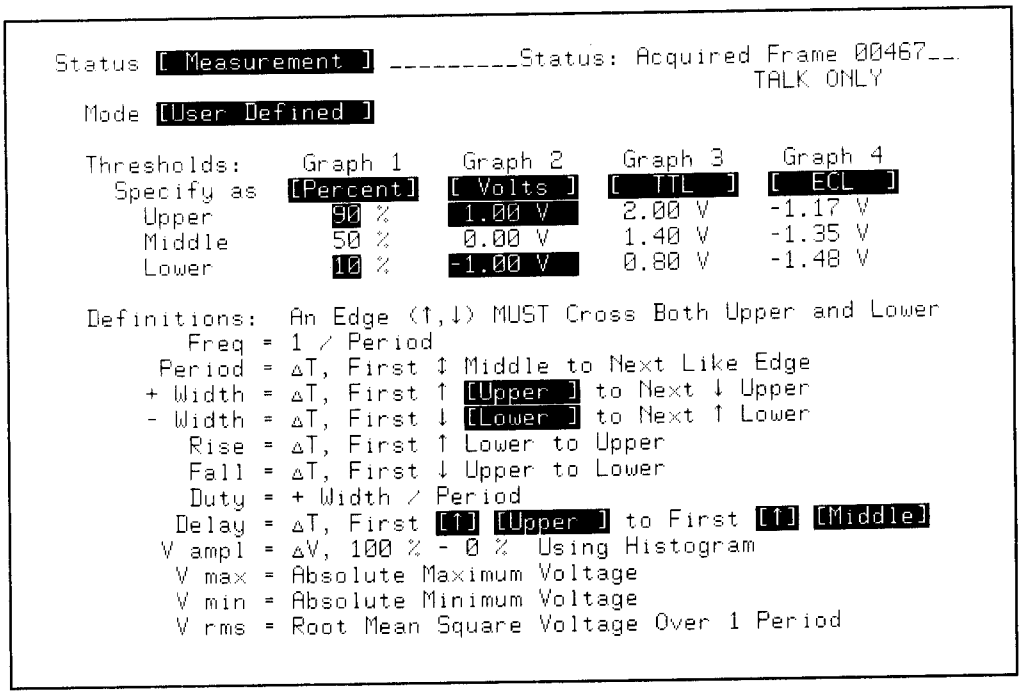


Figure 3-10. STATUS Measurement User-Defined Mode Submenu

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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 setup and waveform memories are saved (non-volatile) on power down. All setup memories are saved when a key-down power-up reset is executed, but are forced to not-protected status. All waveform memories are erased on key-down power-up reset. A complete description of key-down power-up reset is given at the end of this chapter.

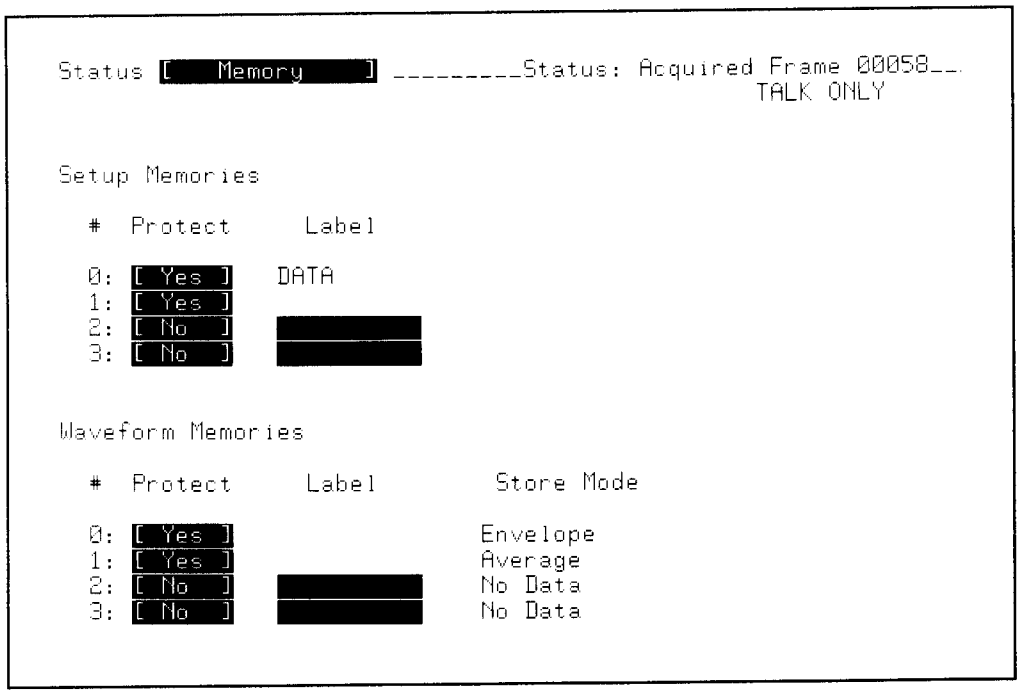
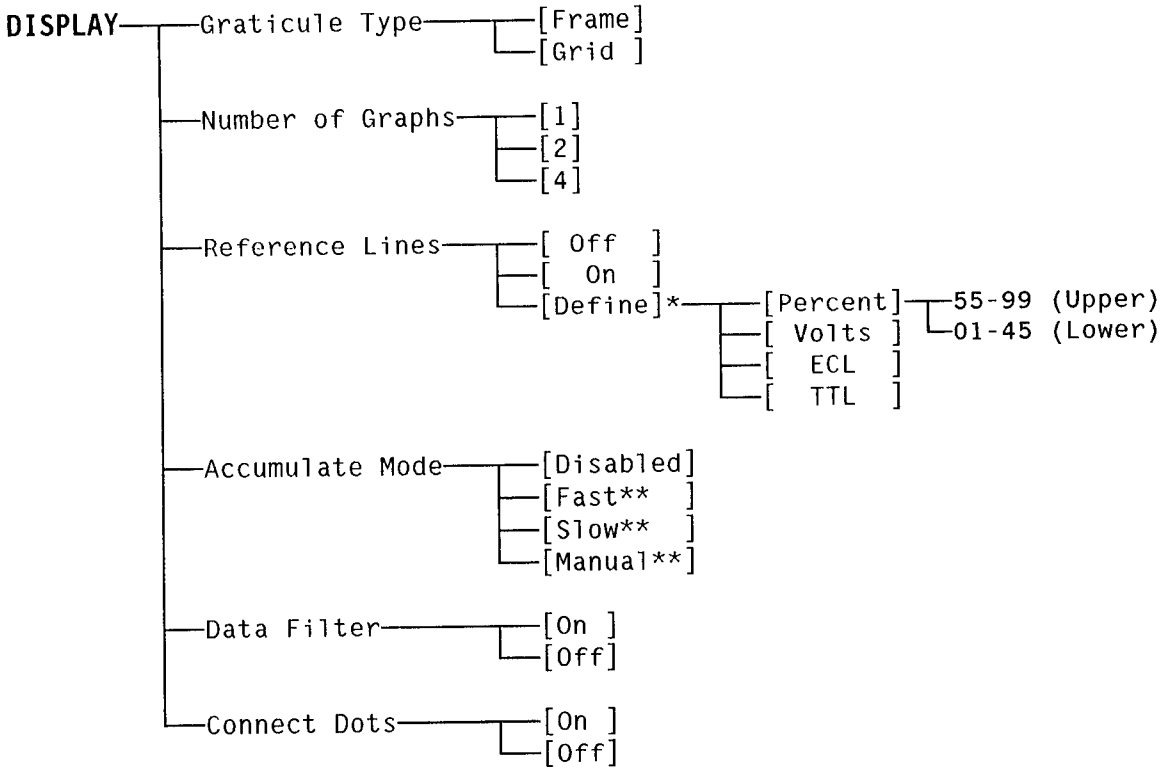


Figure 3-11. STATUS Memory Submenu

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3-8. 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. In Channel Dual mode (from the STATUS Configuration menu) the graphs may be Channel 1, Channel 2, 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. In Channel 1+2 mode, the graphs may be Channel 1, Channel 1+2, or any of the waveform memories. In Channel 1-2 mode, the graphs may be Channel 1, Channel 1-2, or any of the waveform memories.

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.

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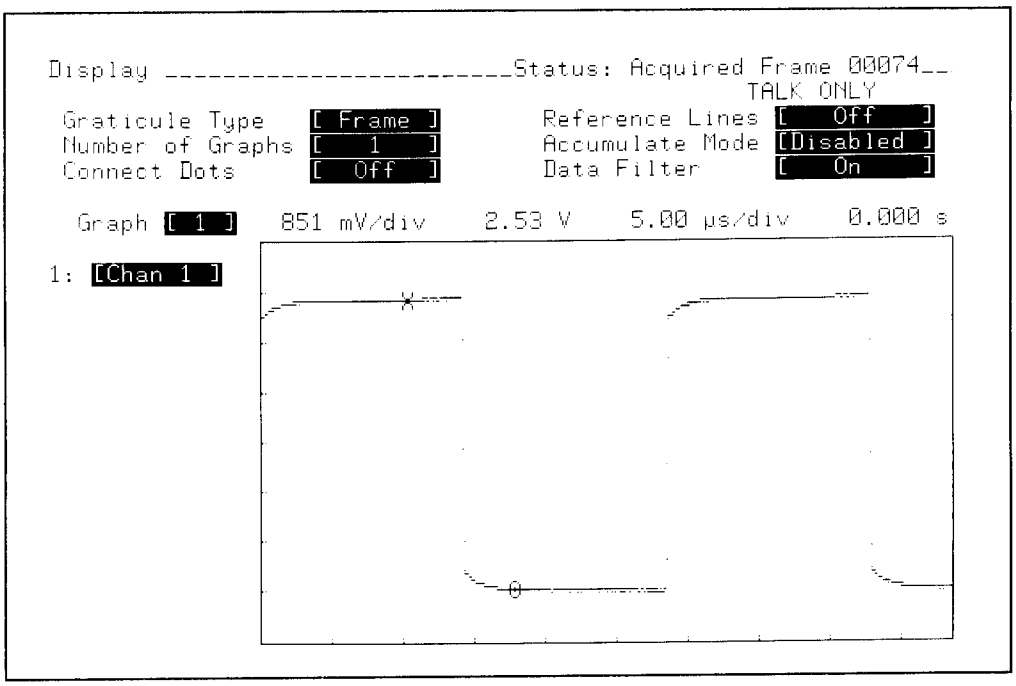


Figure 3-13. Example DISPLAY Menu

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.

Data Filter. Three types of data filters which extend resolution to 7 bits are available to the user depending on the time range and sampling mode selected.

Real time sampling, 5 µs to 10 s range – Data is put through a 3-point, moving-average filter. The filter may be toggled on or off. The voltage at displayed data point n is defined as:

$$V_{n\ filtered} = 1/4(V_{n-1}) + 1/2(V_n) + 1/4(V_{n+1})$$

Real time sampling, 50 ns to 2 µs range – Data is put through a digital reconstruction filter. The data filter is always on. To look at the raw data, go to the 5 µs range, turn off the data filter, and expand the graph using the cursor EXPAND key.

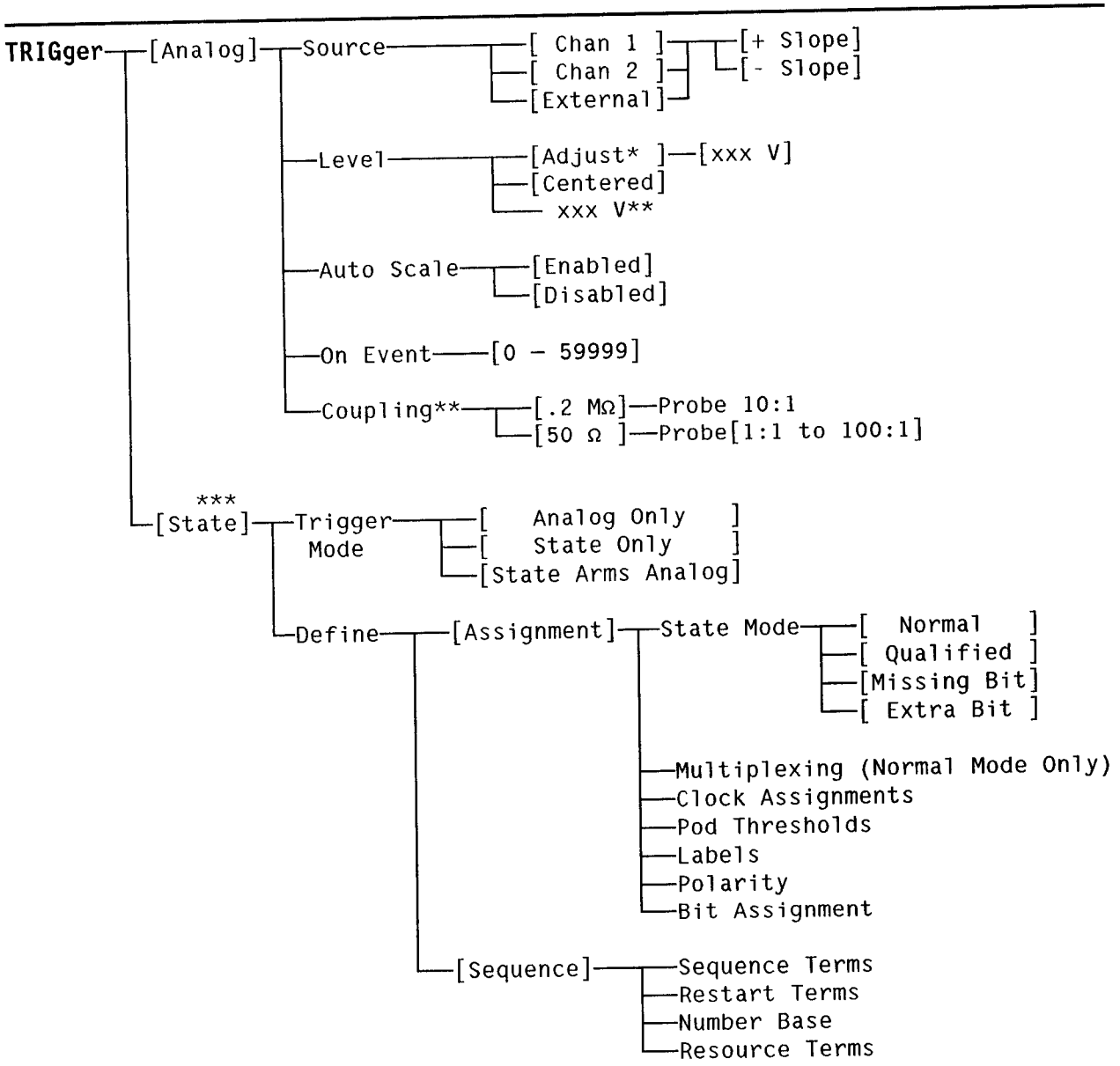
Repetitive sampling, all time ranges – During repetitive sampling, more than one sample may occur at a given data point on a graph during a single acquisition frame. When the data filter is toggled on, these samples for a given data point are averaged together.

Connect Dots. Connect dots provides a display of the sample points connected by straight lines. Connect dots is selectable either on or off. When on, sample points on all graphs (active or memory) are connected.

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3-9. TRIG Menu

The 54201A has a single menu for analog triggering. The HP 54201D has an additional state trigger menu. The TRIG menu tree is shown in figure 3-14.



* Adjust and Centered not valid for External Trigger Source.
** External trigger only.
*** HP 54201D only.

Figure 3-14. TRIG Menu Tree

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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.

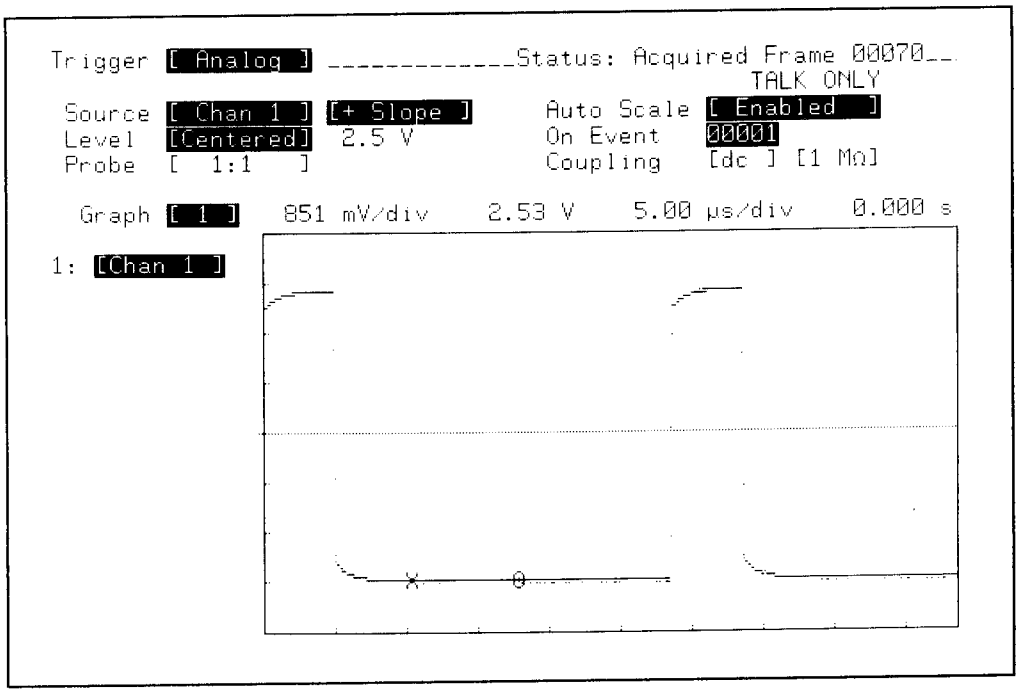


Figure 3-15. Example TRIG Analog Submenu

Source. This field selects either channel 1, channel 2, or the external trigger input as the trigger source. The field adjacent to Source determines whether the HP 54201A/D triggers on the positive slope or the negative slope of the trigger source.

Level. The level field sets the voltage level at which the HP 54201A/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.

When triggering on either Channel 1 or Channel 2, the trigger level is displayed as a dotted line on the graph whenever the trigger menu is displayed. The trigger level may be selected as either Centered or Adjust. When Centered is selected, the trigger level is set to the same value as the offset level of channel 1 or channel 2, whichever was chosen as the trigger source.

When Adjust is selected, the trigger level may be adjusted independent of the offset level of channel 1 or channel 2 trigger source. When Adjust is selected, the trigger level can be incremented or decremented by pressing the NEXT or PREV key. The level can be changed in fine increments or decrements by pressing the FINE key (shift NEXT or shift PREV). The level may be also entered using the numeric key pad followed by the appropriate units factor key, either Volt or mV. The following table shows trigger sensitivity, range of trigger level, and resolution.

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Trigger Parameters

Parameter	Trigger Source	
	Channel 1, Channel 2	External Trigger
Sensitivity:	1/8 of full scale (dc to 250 MHz)	60 mV (dc to 250 MHz, 50Ω dc coupled) 1 V (dc to 100 MHz, .2 MΩ coupled)
Range:	±0.75 times full scale	±2 V
Resolution:	0.02 times full scale	20 mV

When External trigger source is selected, the trigger level may be entered the same as Adjust mode for Channel 1 or Channel 1 trigger level.

Probe. The probe attenuation factor is selectable from 1:1 to 100:1 when trigger source is external and coupling is 50Ω dc. When external trigger coupling of .2 MΩ dc is selected the probe attenuation factor is set to 10:1. This provides a 10:1, 1 MΩ input at the HP 10017A or HP10018A probe tip. The attenuation factor tracks the source when trigger source is channel 1 or channel 2.

Auto Scale. When the Auto Scale function is enabled and the front-panel AUTO SCALE key is pressed, the HP 54201A/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 parameters set on the TRIG Analog submenu.

On Event. This selection allows you to delay triggering the instrument until *n* trigger events (holdoff-by-events) have occurred. *n* is selectable from 1 to 59999 events.

When using the HP 54201D in the State Arms Analog trigger mode, you can get two levels of digital delay; one through the pod inputs, and one through the front panel inputs using holdoff-by-events. Refer to "Armed Digital Delay" in Section 5 for detailed information.

Coupling. Trigger coupling for internal trigger sources tracks the coupling of the channel 1 or channel 2 source. Input coupling for external trigger can be selected as 50Ω dc, or can be selected as .2 MΩ dc with 10:1 probe attenuation factor.

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TRIG STATE SUBMENU (HP 54201D only). In addition to analog edge triggering the HP 54201D 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.

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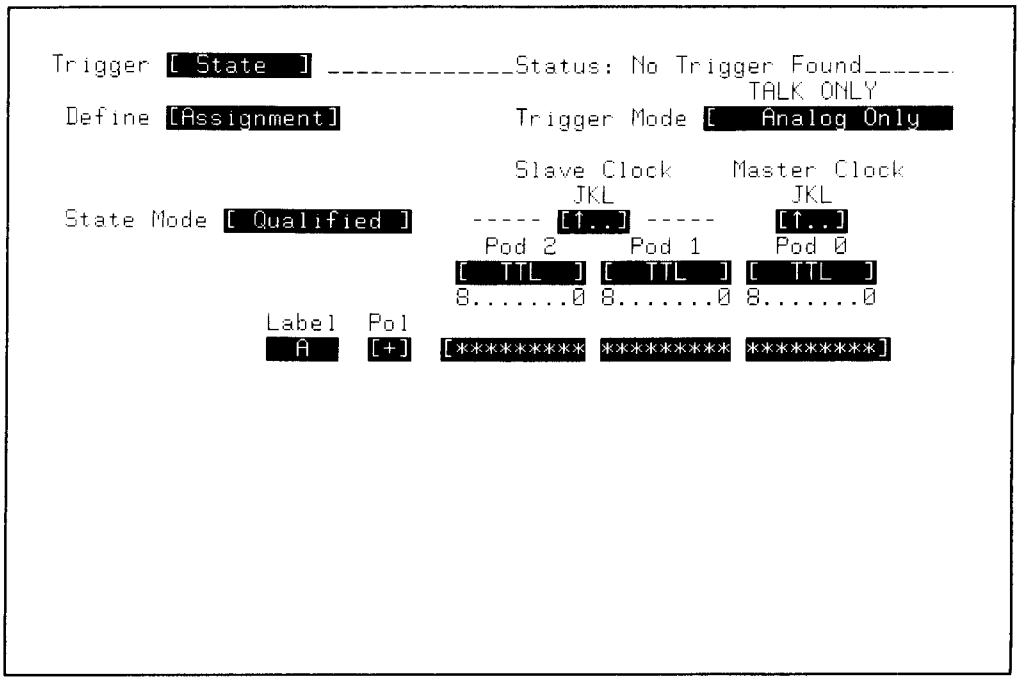


Figure 3-16. Example State Trigger Assignment Menu (Qualified Mode)

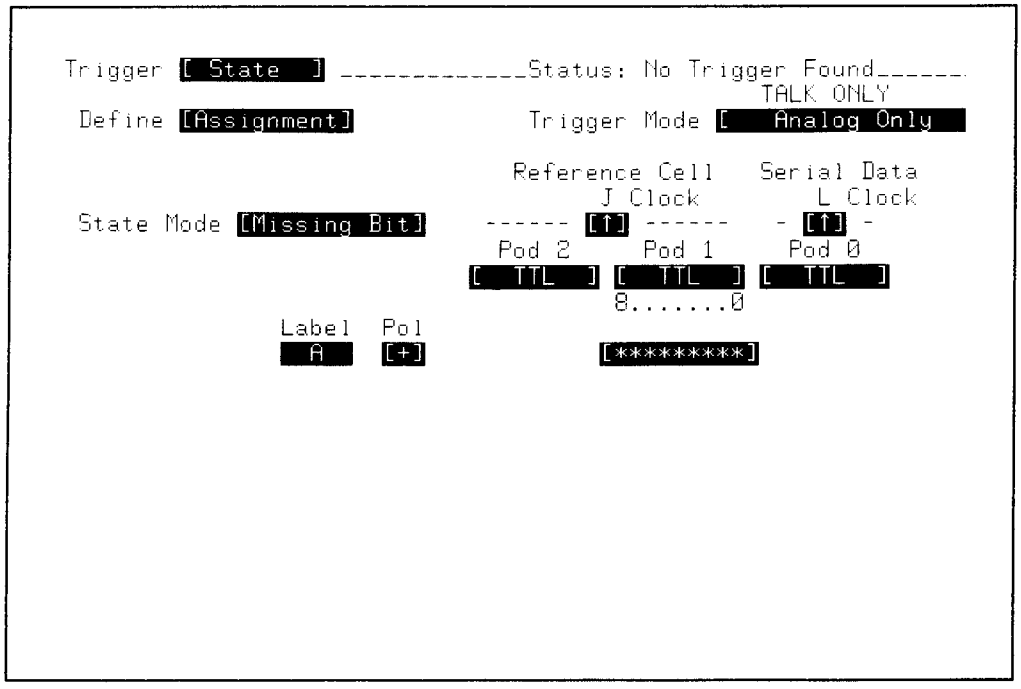


Figure 3-17. Example State Trigger Assignment Menu (Missing-bit Mode)

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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.

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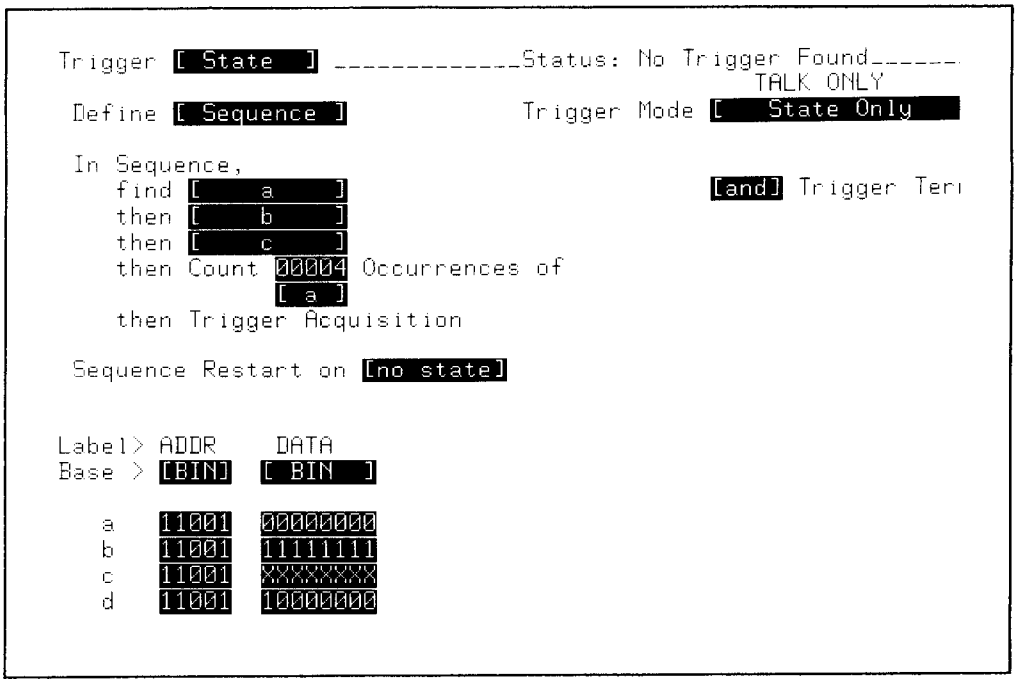


Figure 3-18. Example State Trigger Sequence Menu

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.

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3-10. CHAN Menu.

The CHAN menu provides selections to configure input channel parameters. The CHAN Menu tree is shown in figure 3-19. An example CHAN menu is shown in figure 3-20.

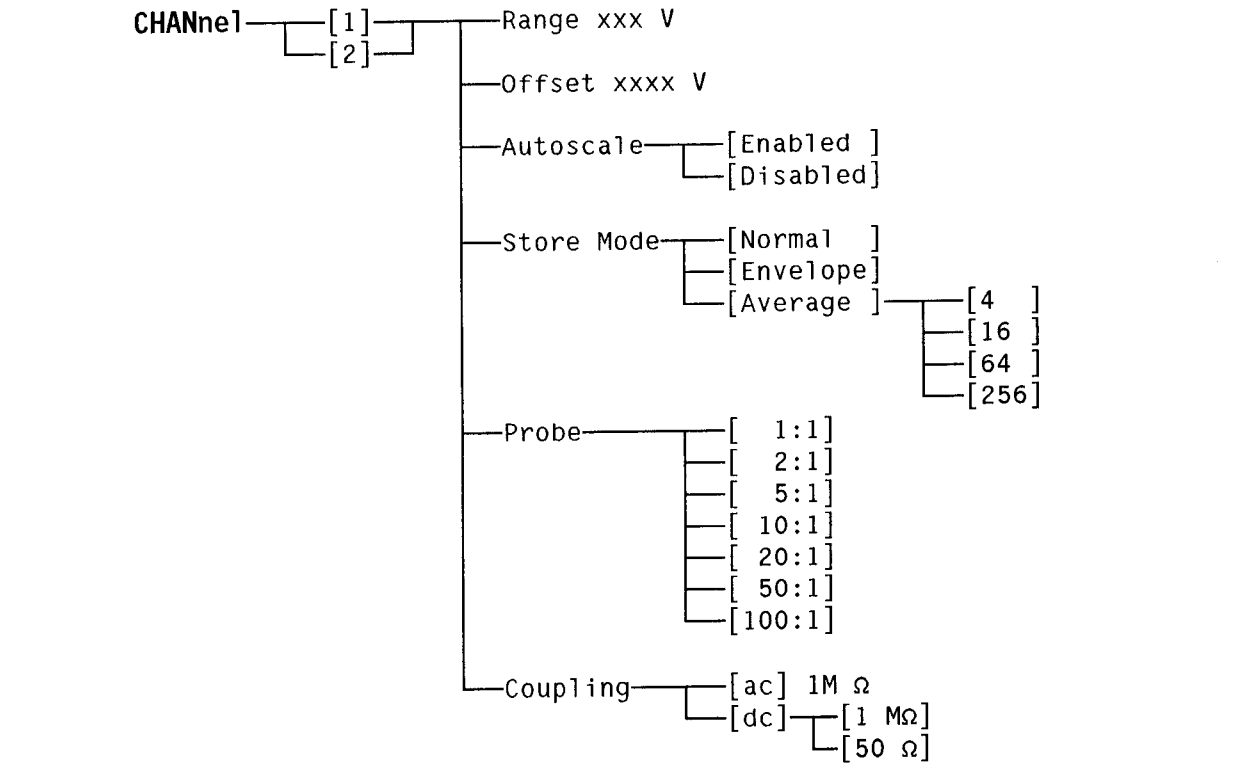


Figure 3-19. CHAN Menu Tree

Channel. Channel 1 or channel 2 may be assigned to the menu by moving the blinking cursor to the channel selection field and pressing the NEXT or PREV key.

Range. Range sets the full-scale voltage range shown on a graph for the selected channel. This range is from 40 mV to 16 V full-scale calibrated with two digit resolution. 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). A range may be also entered using the numeric key pad followed by the appropriate units factor key, either Volt or mV.

Offset. Offset is the dc voltage that is subtracted from the input signal. When displayed on the HP 54201A/D, the offset voltage is the voltage at the vertical center of the graph. Offset allows expanding signals about a voltage of interest for increased resolution. Offset can be incremented or decremented by pressing the NEXT or PREV key. Offset can be changed in fine increments or decrements by pressing the FINE key (shift NEXT or shift PREV). Offset may be also entered using the numeric key pad followed by the appropriate units factor key, either Volt or mV. Remember the input signal operating range without distortion is ±1 channel range from vertical center screen.

Channel Range	Offset Range	Offset Resolution
40 mV to 790 mV	±1.5 V	1 mV
800 mV to 16 V	±30 V	20mV

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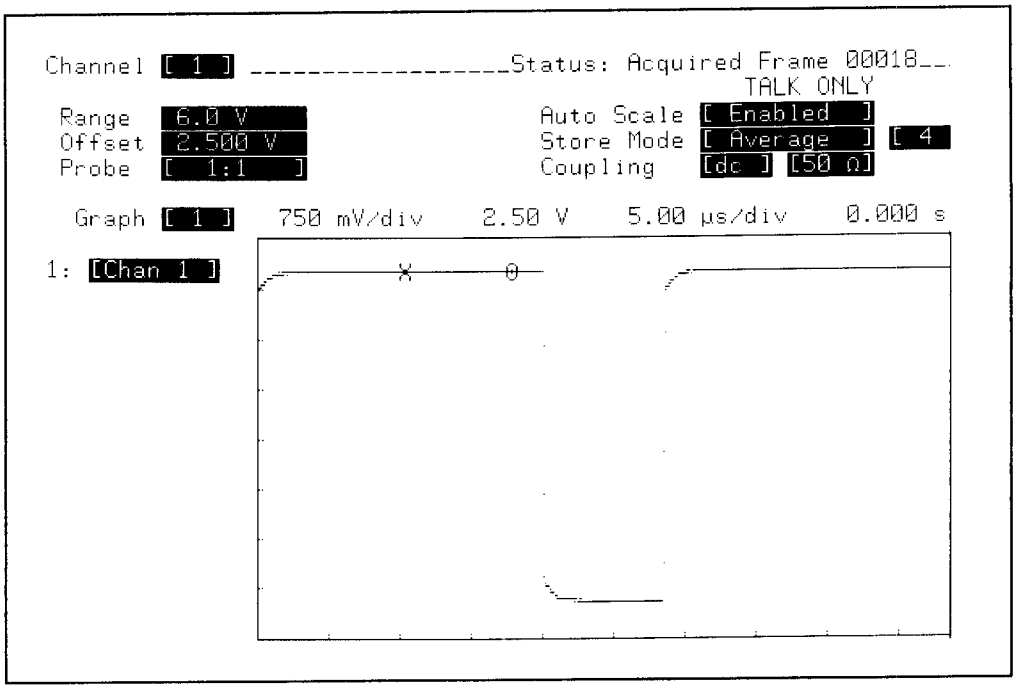


Figure 3-20. Example CHAN Menu

Auto Scale. When the Auto Scale function is enabled and the front-panel AUTO SCALE key is pressed, the HP 54201A/D searches for and rescales the selected channel to display the signal within the graph. If Auto Scale is disabled, pressing the front-panel AUTO SCALE key will not change any of parameters set on the CHAN menu. The Auto Scale function for each channel may be enabled or disabled independently.

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.

Probe. The probe attenuation factor (1:1 to 100:1) should be entered for each channel to match the probe that is connected to that channel. This allows the HP 54201A/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.

Coupling. The input coupling for Channel 1 or Channel 2 may be selected as 1 MΩ ac, 1 MΩ dc, or 50Ω dc.

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3-11. 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.

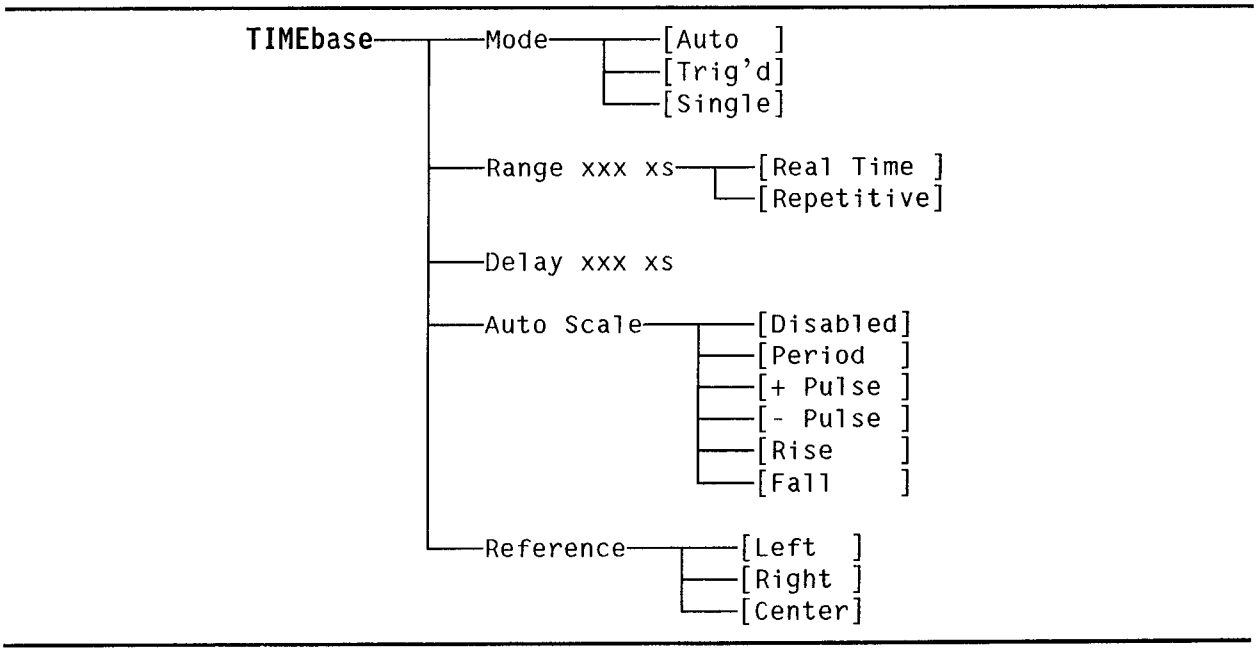


Figure 3-21. TIME Menu Tree

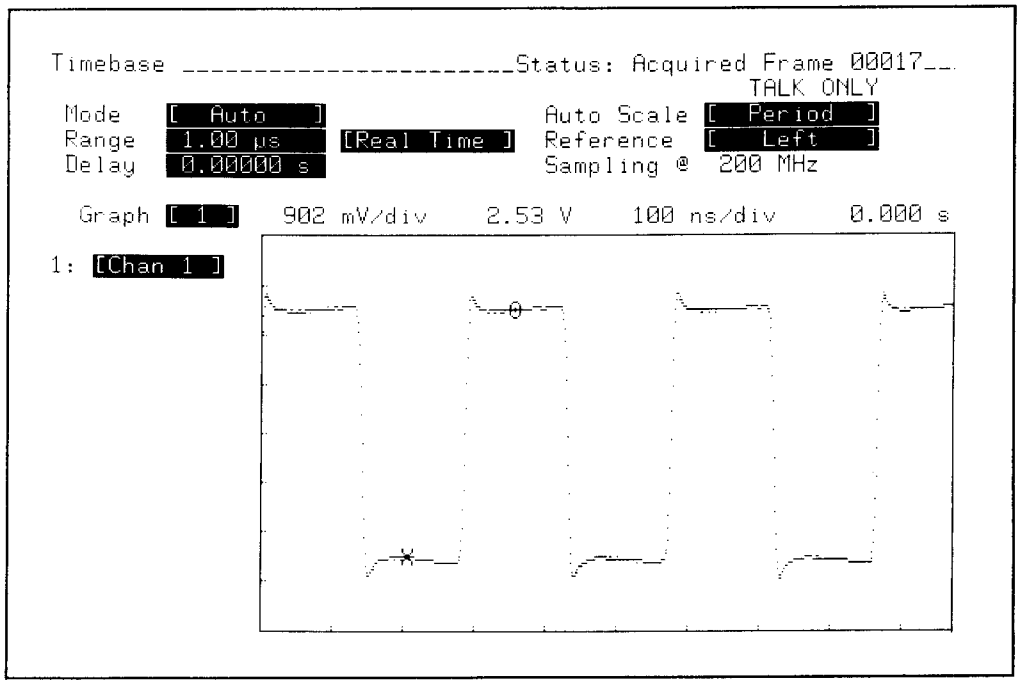


Figure 3-22. Example TIME Menu

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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 real time mode, or from 20 microseconds to 10 nanoseconds in repetitive sampling mode. The range can be varied 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, μsec, or nsec). If the value entered in not in the 1-2-5 sequence, the HP 54201A/D will round the entry to the nearest valid time.

Delay. Delay allows the user to look at an acquisition window a specified amount of time before or after the trigger event. The pre- trigger range is shown in the table below. The post-trigger range is at least 200 screen diameters for all time ranges.

Sampling Mode	Time Range	Pre-Trigger Range
Real Time	50 ns to 5 μs	Up to 10 μs
	10 μs to 10 s	Up to 2 screen diameters
Repetitive	10 ns to 20 μs	Up to 2 screen diameters

Pre- and post-trigger resolution are adjustable in steps of 0.1 (coarse) and 0.001 (fine) screen diameters, or the least significant digit, whichever is greater.

Additional delay may be added by using the On Event feature discussed in the analog trigger menu.

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.

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Sampling. Sampling is the real time digitizing rate used by the HP 54201A/D to acquire the waveform in real time sampling mode. 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 μs to 50 ns have a digitizing rate of 200 megasamples/second. This field is not present in Repetitive sampling mode, when the random repetitive sampling rate is 25 MHz.

3-12. THE GRAPH DISPLAY

The display is in the graph mode any time the SYSTEM, STATUS, or TRIG State (HP 54201D 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.

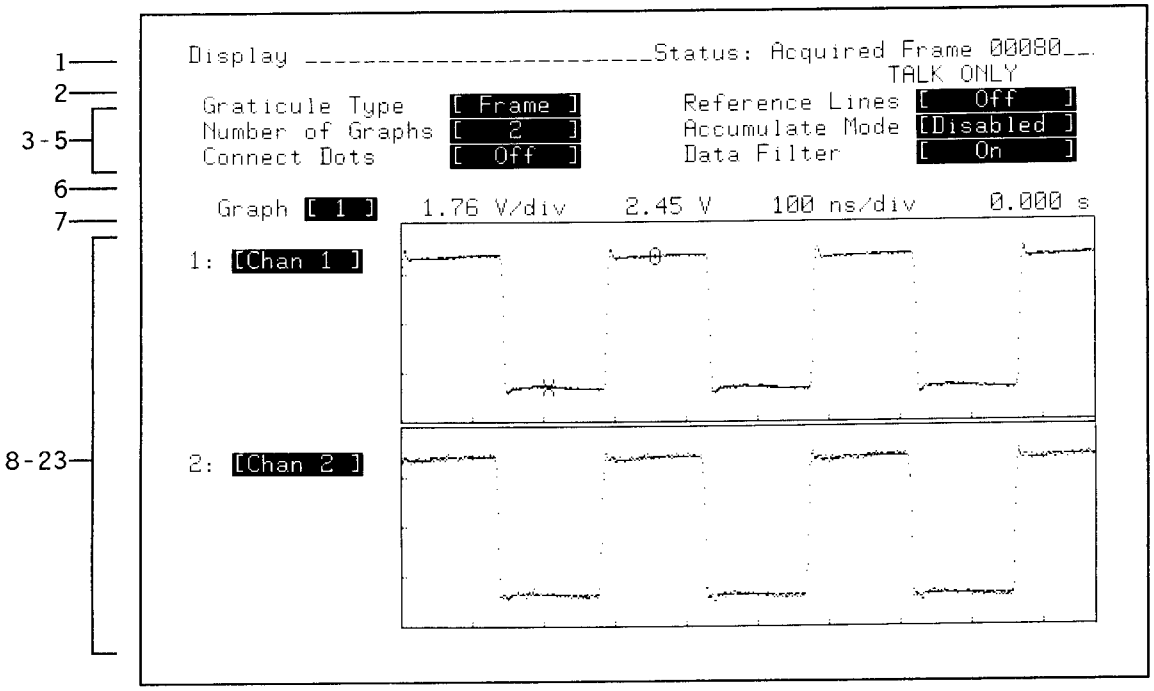


Figure 3-23. Graph Mode Display

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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).

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.

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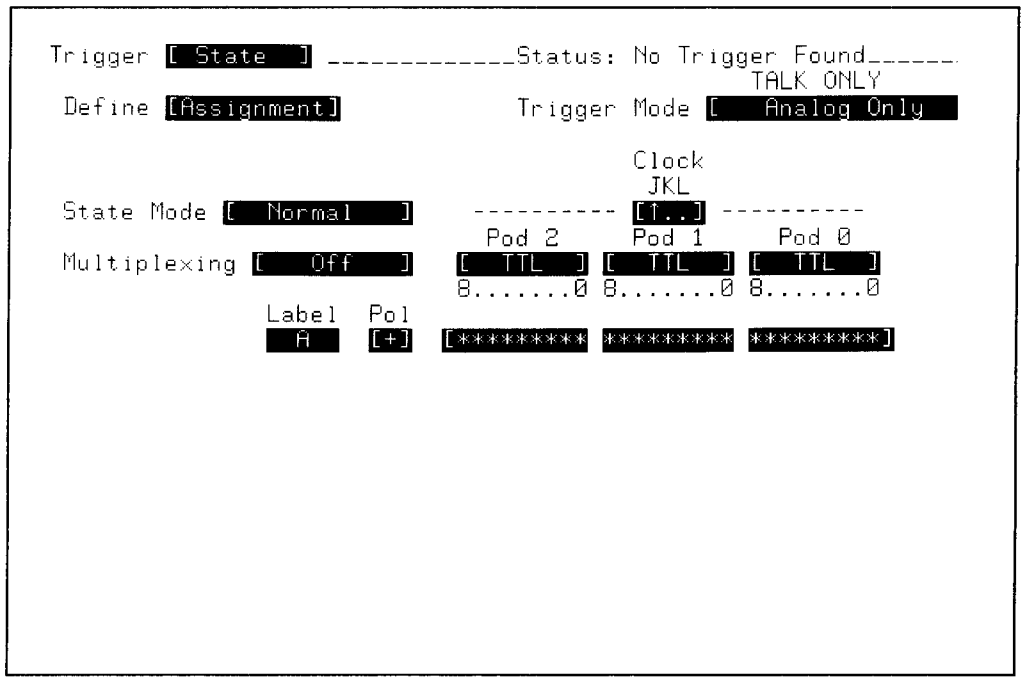
3-13. KEY-DOWN POWER-UP RESET

Holding any key down during power-up will preset the HP 54201A/D to a predetermined condition. Key-down power-up reset is a very important feature to use to clear the instrument if the instrument experiences a lockup state and will not respond to any key press or programming command. Hold the key down long enough for the power-up tune to be completed. The preset conditions are shown in the following table.

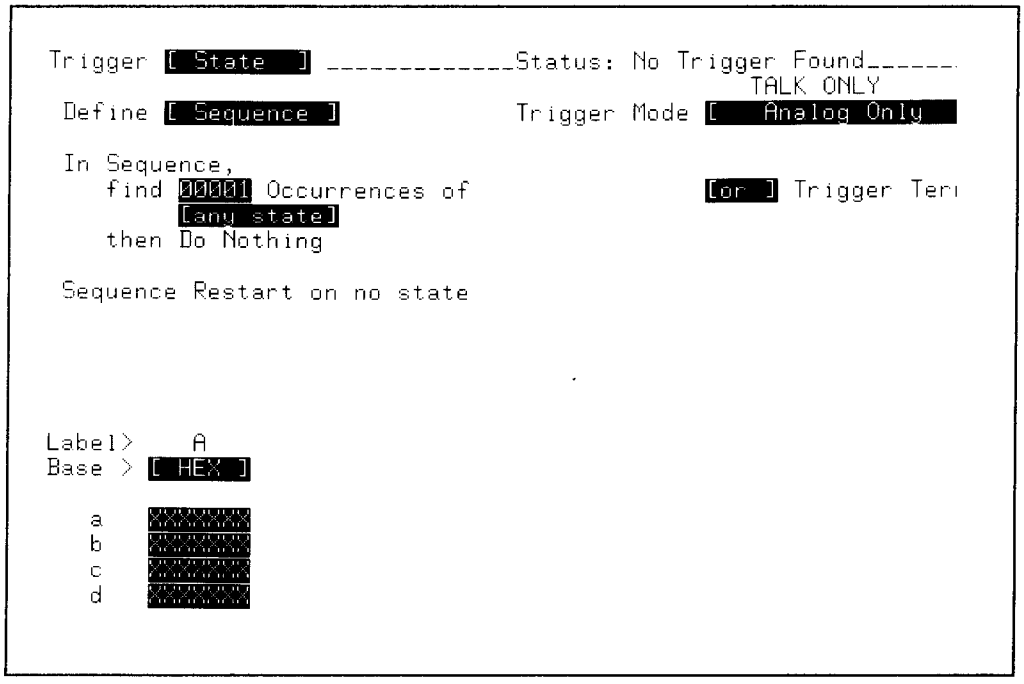
CONDITION	SETTING
TIMEBASE:	
Sweep mode	Auto
Time range	10 μs
Reference	Center
Delay	0.0 s
Autoscale	Period
Acquire mode	Real time
CHANNELS:	
Mode	Dual Channel
Range	5.0 V
Offset	0.0 V
Store mode	Normal
Labels	(blank)
Coupling	1 MΩ dc
Probe attenuation	1:1
Autoscale	Enabled
TRIGGER:	
Mode	Analog
Source	Channel 1
Level	0.0 V Centered
Slope	Positive
Label	(blank)
Autoscale	Enabled
On Event	00001
DISPLAY:	
Graticule	Frame
# of graphs	2
Graph sources	
1	Channel 1
2	Channel 2
Connect dots	Off
Reference lines	Off
Accumulate mode	Disabled
Data filter	On
MEASUREMENTS:	Standard
OTHER:	
Running	True
HP-IB address/mode	Not changed
Hardcopy device	Printer
Rear BNC	Constant low
Beeper	On
Setup labels	(blank)
Stored setups	Unprotected
Stored waveforms	Cleared

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STATE SETTINGS:



Trigger State Assignment Menu after Key-Down Power-Up Reset



Trigger State Sequence Menu after Key-Down Power-Up Reset

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SECTION 4
FRONT PANEL EXERCISES

4-1. INTRODUCTION

This chapter will further familiarize the user with the front panel operation of the HP 54201A/D Digitizing Oscilloscope by performing some actual measurements.

This exercise requires a HP 54201A/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-kΩ resistor, and a 3300 pF capacitor. An HP Model 8116A option 001 provides all the required generator functions and has a 50Ω output.

4-2. SETUP

Set up the generator to give a 35-kHz square wave with an amplitude of 5 volts and an offset of 2.5 volts. Connect the signal output of the generator to the channel one input of the HP 54201A/D. Connect the trigger output of the generator to the channel two input.

Preset the HP 54201A/D to known conditions by holding any key down and powering up the instrument. Hold the key down for about three seconds.

Press the STATUS menu key on the HP 54201A/D, then using the field arrow keys, move the blinking selection cursor to the Channel Coupling impedance field. Press the NEXT or PREV key to change 1 MΩ to 50 Ω for both Input 1 and Input 2.

Get a waveform on screen by pressing the AUTO SCALE key (figure 4-1).

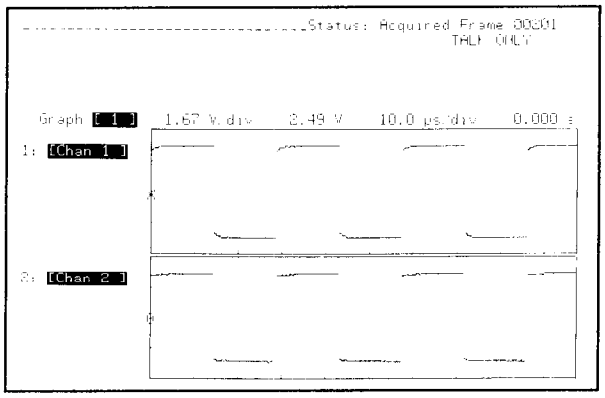


Figure 4-1.

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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 arrow keys, 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 (figure 4-2).

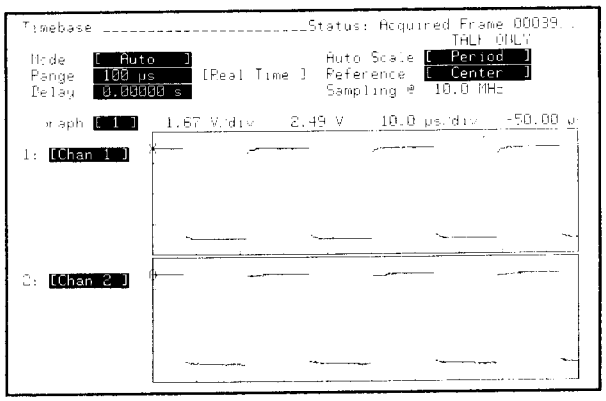


Figure 4-2

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 54201A/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, µsec, 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 (figure 4-3).

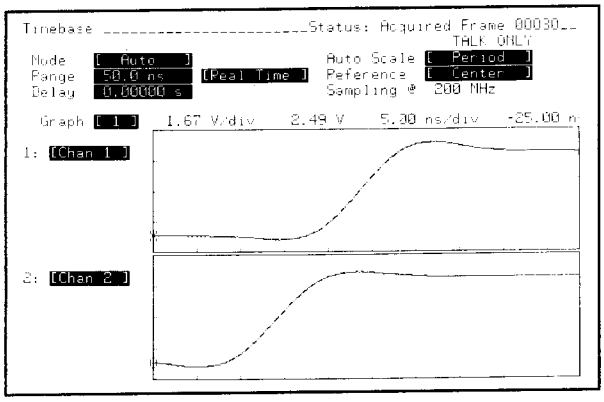


Figure 4-3

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4-4. 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 (figure 4-4).

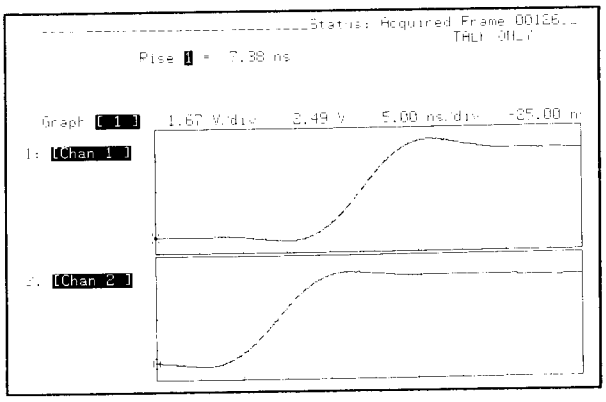


Figure 4-4

4-5. 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 (figure 4-5). 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.

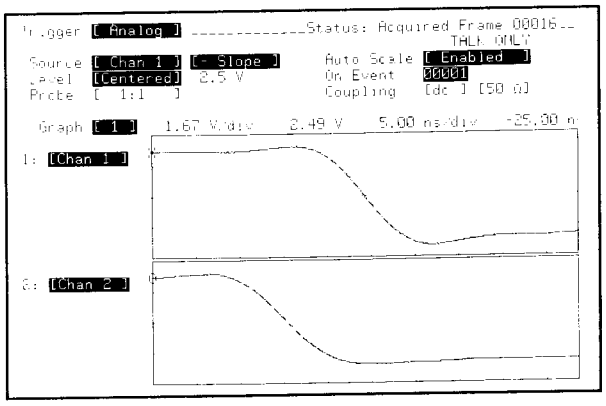


Figure 4-5

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 (figure 4-6).

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.

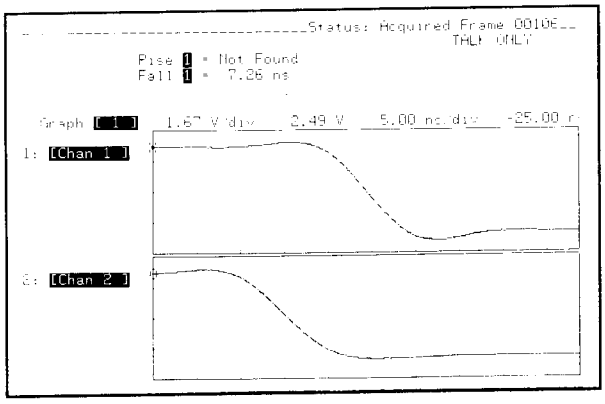


Figure 4-6

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4-6. MEASURING FREQUENCY AND 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 (figure 4-7). Remember that the 1 specifies that the measurement will be made on graph 1.

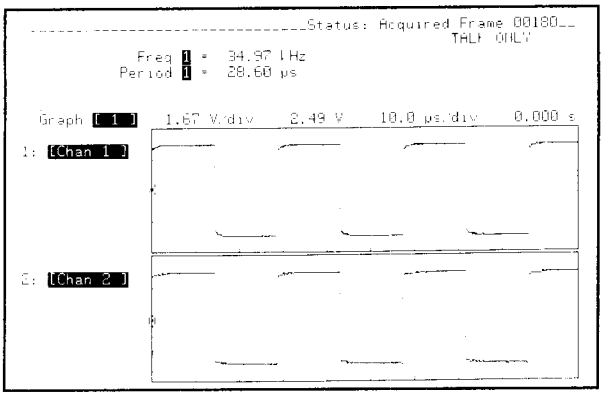


Figure 4-7

4-7. CURSOR MEASUREMENTS

Cursors provide a manual method of making measurements. Using the cursors allows precise examination of particular points of interest. 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 (figure 4-8).

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.

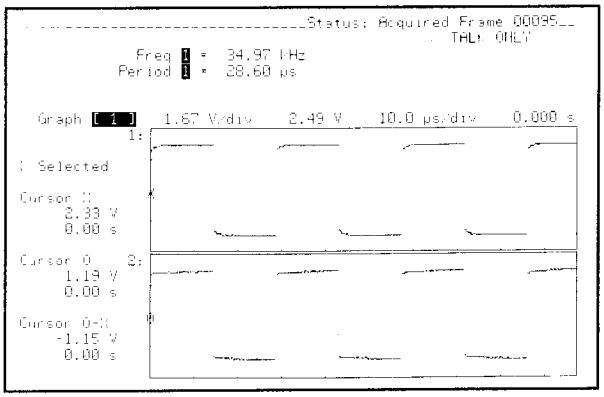


Figure 4-8

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 voltage and time values of the O cursor minus the X cursor (ΔV and ΔT)

Make a manual 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 (figure 4-9). Cursor O-X time 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.

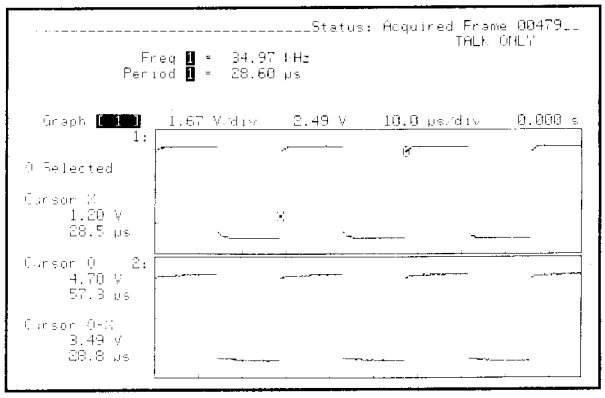


Figure 4-9

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4-8. EXPANDING GRAPHS

4-9. 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 and place the O cursor one division to the right of the rising edge (figure 4-10); then press EXPAND (figure 4-11).

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.

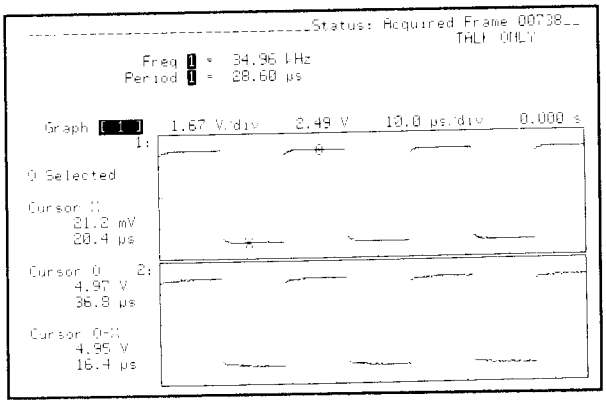


Figure 4-10

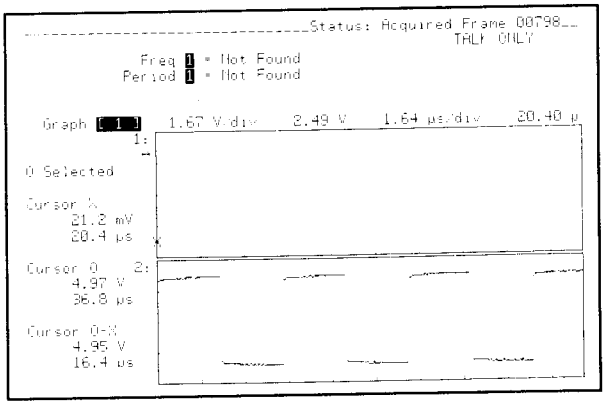


Figure 4-11

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4-10. 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. (figure 4-12). Press X&O, then press EXPAND (figure 4-13). then press EXPAND. Both graphs should now be expanded to the same scale factor.

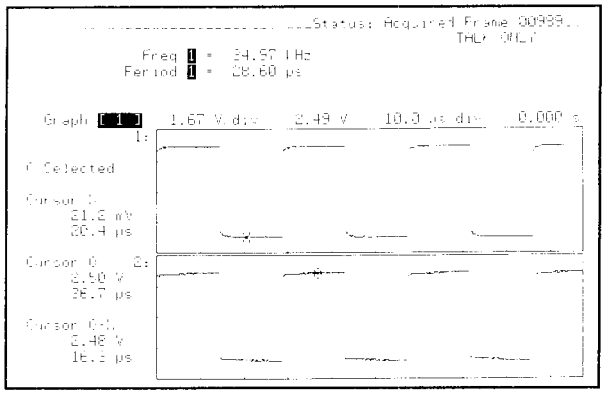


Figure 4-12

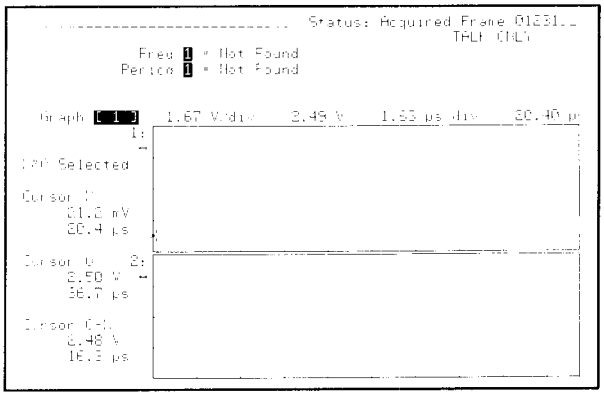


Figure 4-13

4-11. CONNECT DOTS

When waveforms are expanded, the sample dots are spread apart and may not be easy to see clearly. To allow the waveform to be viewed clearly, the HP 54201A/D has a connect-the-dots feature. Press the DISPLAY menu key and change the Connect Dots field from off to on. Notice that the sample dots are now connected by straight lines (figure 4-14).

Change Connect Dots to Off. Press NORMAL to return to the unexpanded scale factor. Then to remove the cursor values and return to the graph labels, press VALUES while the SHIFT key is active.

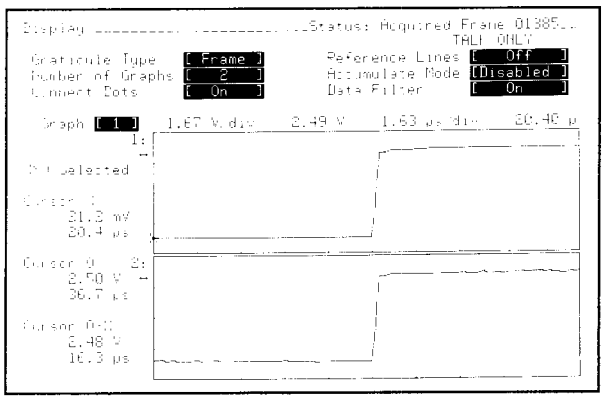


Figure 4-14

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4-12. LOOKING AT PULSES

4-13. 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 in the Auto Scale field (figure 4-15). Press AUTO SCALE, then press SHIFT, +WIDTH, 1 (figure 4-16). 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.

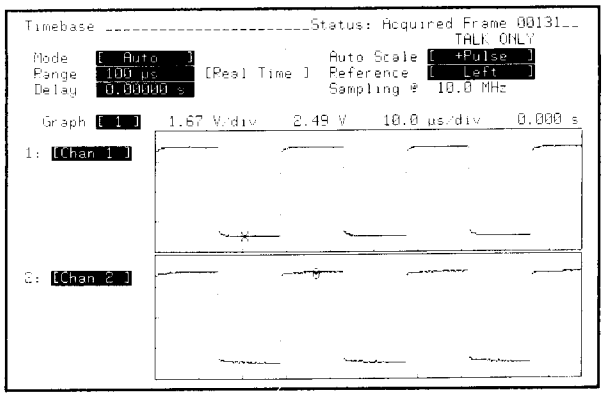


Figure 4-15

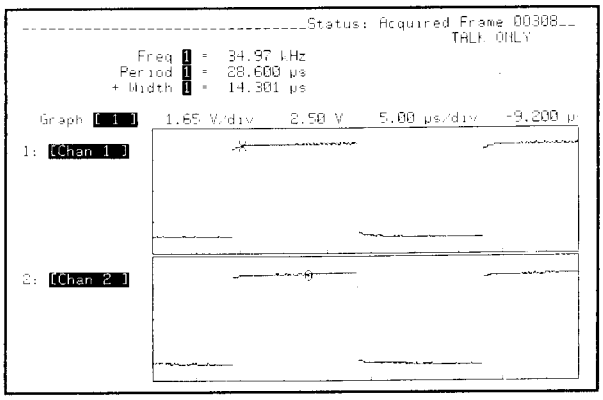


Figure 4-16

4-14. 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 (figure 4-17).

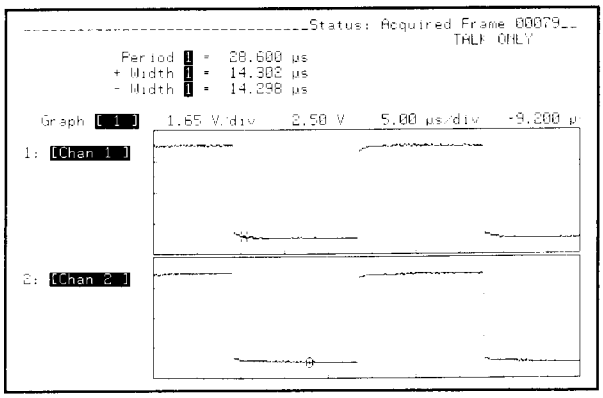


Figure 4-17

4-15. DUTY CYCLE

Duty cycle can be measured by adjusting the time range to show two periods (100 µs if a 35-kHz signal is being used), then press SHIFT, DUTY, 1 (figure 4-18). 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.

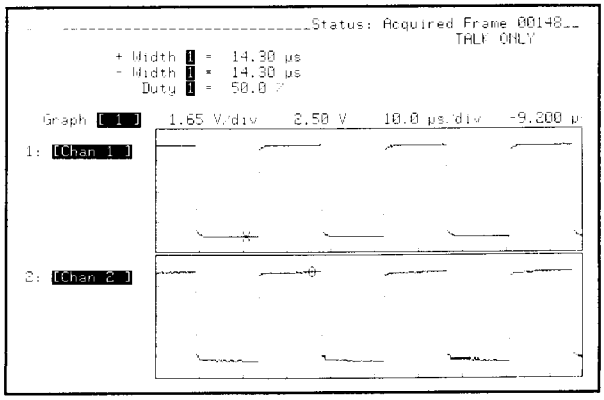


Figure 4-18

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4-16. WAVEFORM STORAGE

Waveforms may be saved for later reference. To save a waveform first press SAVE (figure 4-19), change the storage selection from Setup to Graph, then select 1 (figure 4-20); 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 (figure 4-21). 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 (figure 4-22), and enter 0 for memory. The contents of memory 0 is now displayed on both graphs 1 and 2 (figure 4-23).

Automatic measurements and cursors can be used on stored waveforms.

Press the RUN-STOP key to start acquisitions again. Graph 1 will now be Channel 1 again and Graph 2 will be Channel 2.

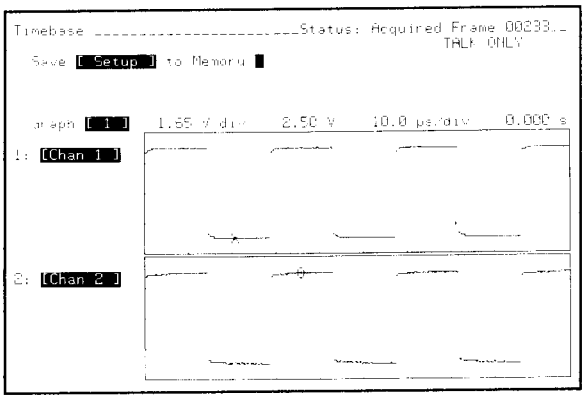


Figure 4-19

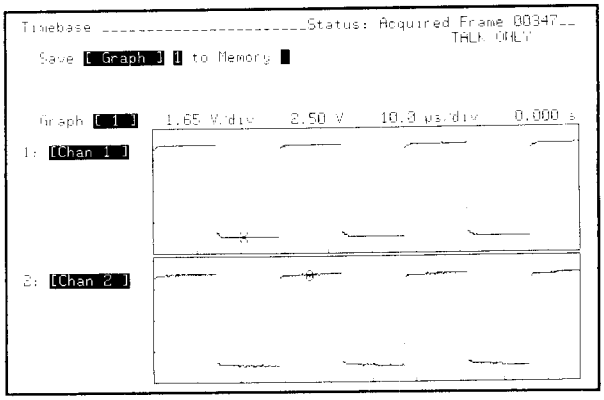


Figure 4-20

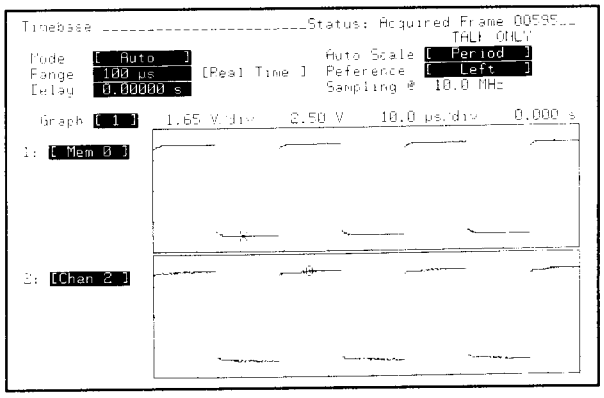


Figure 4-21

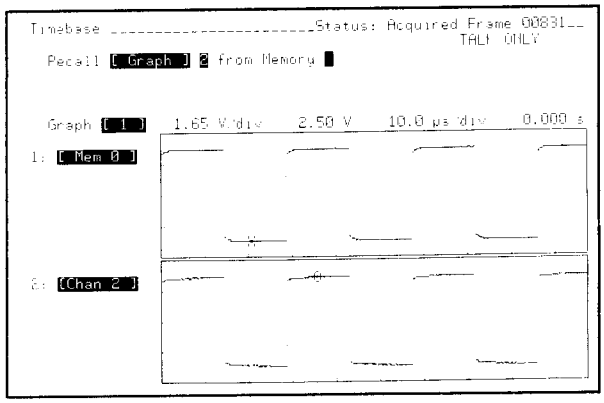


Figure 4-22

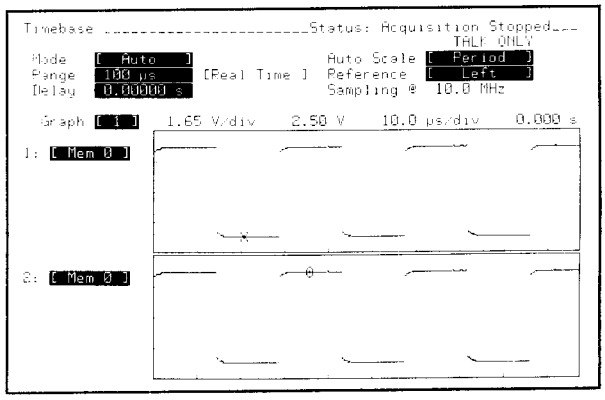


Figure 4-23

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4-17. RECOVERING FROM A LOST FRONT PANEL SETUP

The HP 54201A/D has a unique feature to help you recover an unstored front panel setup. Suppose you have the instrument front panel setup to a special configuration, and inadvertently hit the TTL, ECL, or AUTO SCALE key. To recover your lost setup, immediately press the RECALL key, change Graph to Memory if required (figure 4-24), and enter 9 in the "Setup from Memory" field. Your lost setup will now be returned. RECALL Setup 9 must be the first keystrokes made after the inadvertent entry, or the setup will be lost.

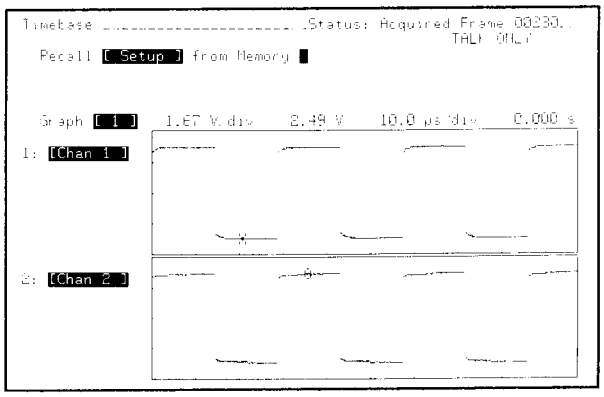


Figure 4-24

4-18. 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 54201A/D accomplishes this easily with TTL/ECL presets and Vmax and Vmin measurements.

The input signal was previously chosen to simulate TTL levels. Press the TTL preset key. Next press SHIFT, Vmax, 1; then SHIFT, Vmin, 1 (figure 4-25). Vmax shows the maximum value of the waveshape or the TTL high. Vmin 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.

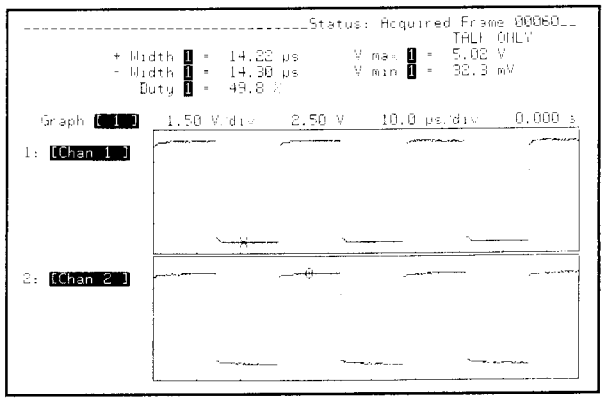


Figure 4-25

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4-19. 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 (figure 4-26).

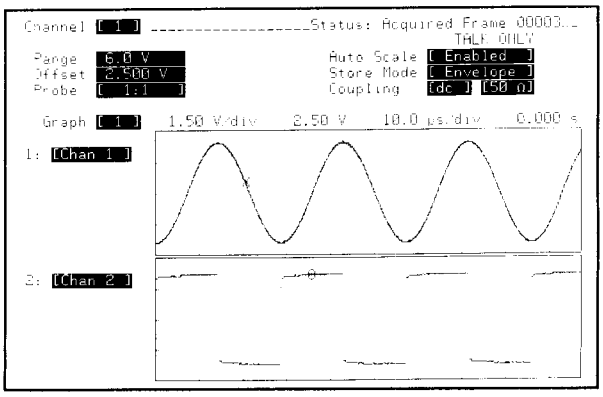


Figure 4-26

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 (figure 4-27). This is similar to making a voltage drift measurement.

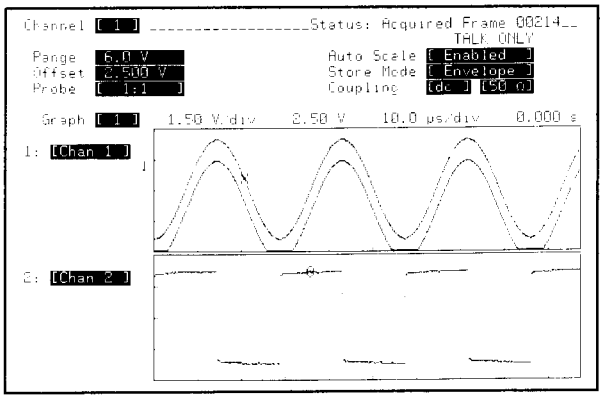


Figure 4-27

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 signal generator offset from 1.5 volts to 2.5 volts in 100 mV increments. Notice that the accumulation mode retains all waveshapes for display purposes (figure 4-28). 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.

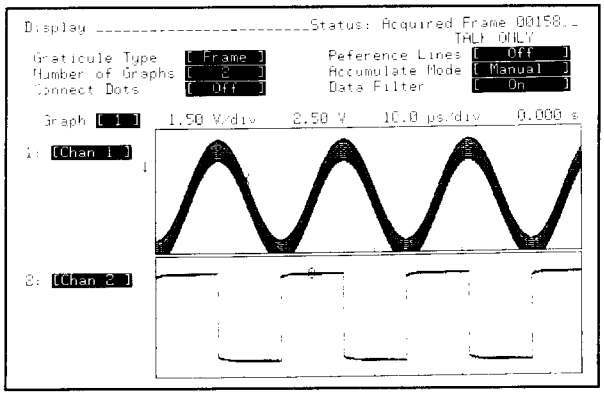


Figure 4-28

Cursors operate on envelope waveforms but not accumulation waveforms. All front panel auto-measurements except V_{min} 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 (figure 4-29). Go to the CHAN menu and change the channel 1 store mode from Envelope back to Normal. Change the generator signal back to a 35-kHz square wave.

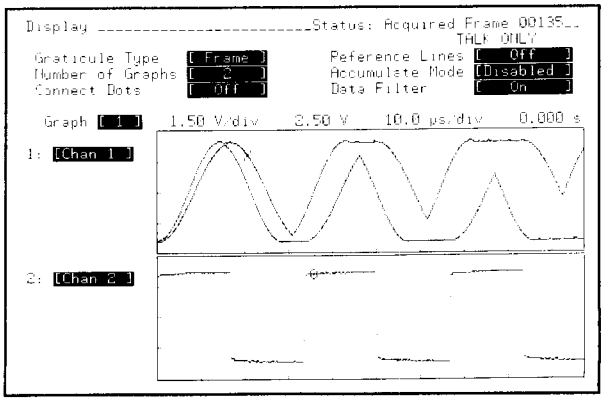


Figure 4-29

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4-20. 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 (figure 4-30). Reconnect the input, and the instrument will capture and display one acquisition (figure 4-31).

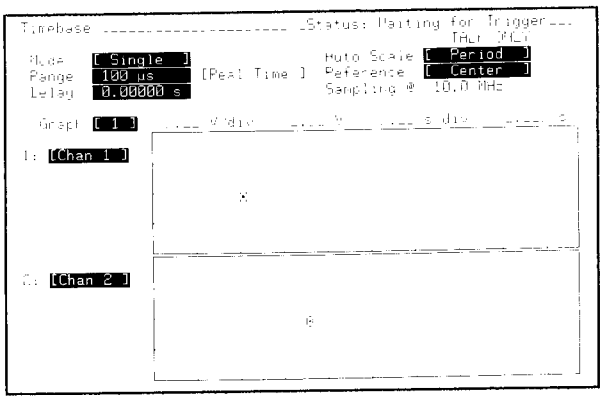


Figure 4-30

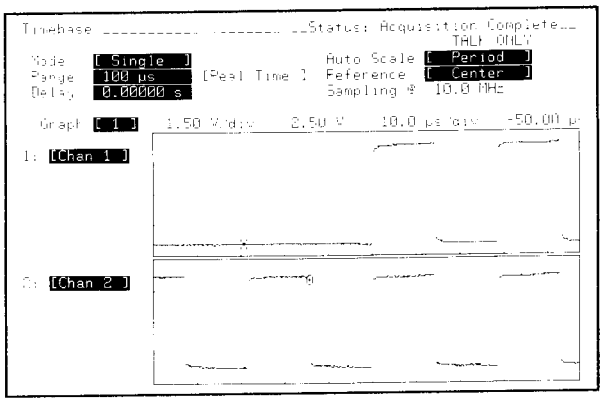


Figure 4-31

4-21. TRIGGERED MODE

Change the timebase mode to triggered (Trig'd) and press RUN- STOP. Disconnect the channel 1 input and notice that the last acquisition stays on screen (figure 4-32). 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.

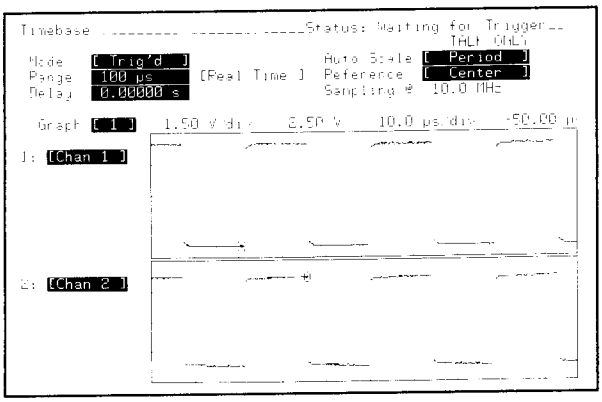


Figure 4-32

4-22. 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 (figure 4-33). Reconnect the input.

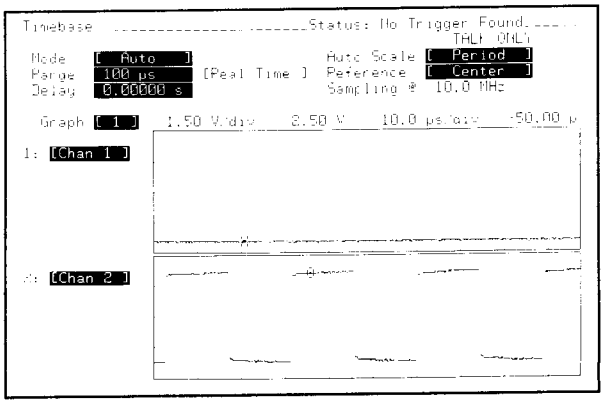


Figure 4-33

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4-23. 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 54201A/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 54201A/D. Connect the start of sweep output (rear panel of HP 8116A, X-OUT) to the channel 2 input of the HP 54201A/D. Press the TTL preset key. Select channel 2 as the trigger source. Set Channel 1 and Channel 2 coupling to 1 MΩ dc Change the time range to 200 ms and adjust the time delay to get an entire sweep ramp of channel 2 on screen (figure 4-34).

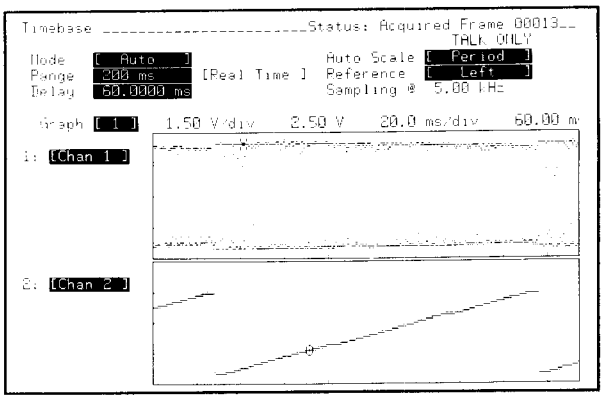


Figure 4-34

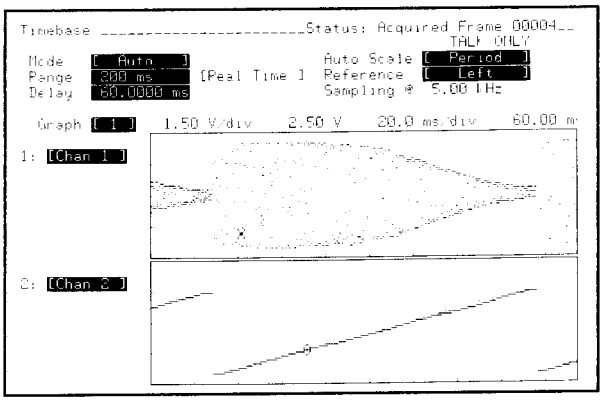


Figure 4-35

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 DISPLAY menu and turn off the data filter. 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 (figure 4-34). To look at a more interesting response, connect a simple low-pass filter using a 1-kΩ resistor and a 3300-pF capacitor. This gives a roll-off characteristic around 48 kHz (figure 4-35).

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SECTION 5
STATE TRIGGERING WITH THE HP 54201D

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 HP 54201D display.

Note

This section discusses the various modes and triggering techniques in a tutorial manner, therefore it is advantageous to operate the HP 54201D 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.

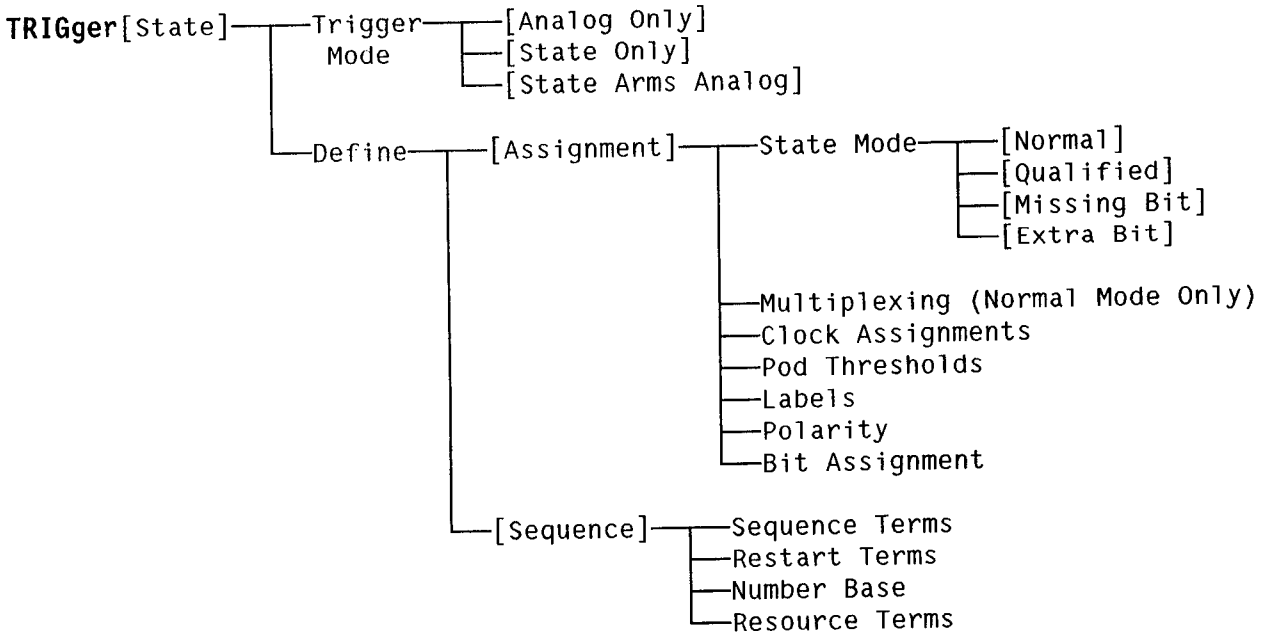


Figure 5-1. State Trigger Menu Tree

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5-3. STATE TRIGGER INPUTS

The HP 54201D 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 HP 54201D 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 HP 54201D power to off, then set the power to on while holding down any front panel key (key-down power-on). This presets the HP 54201D 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 the 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.

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[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.

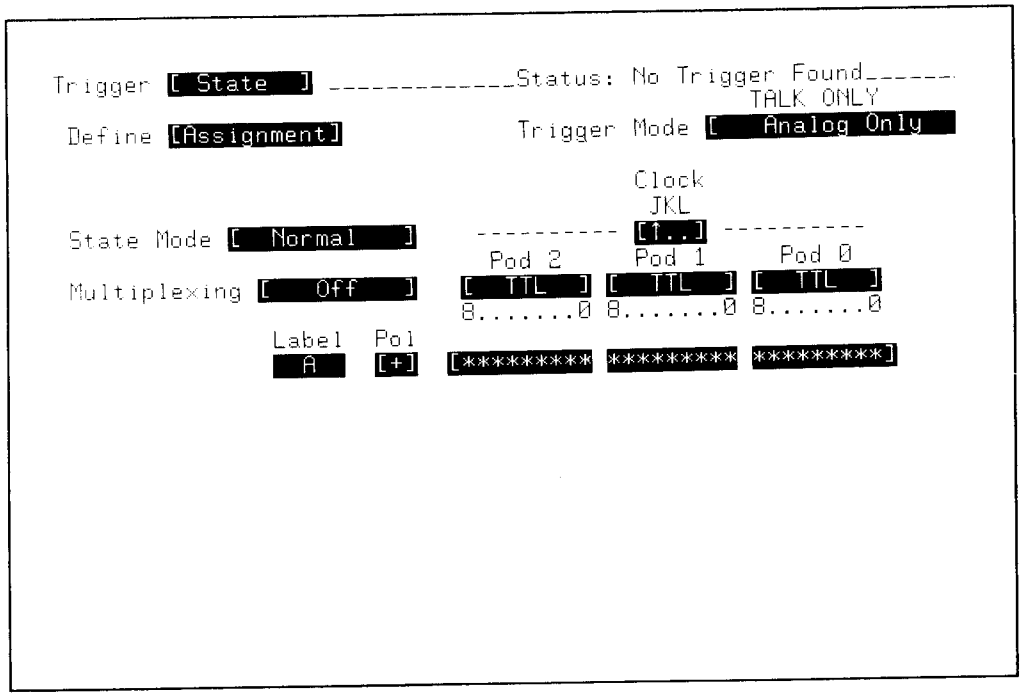


Figure 5-2. State Trigger Default Menu

5-7. Clock Assignments

The HP 54201D 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.

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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.

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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.

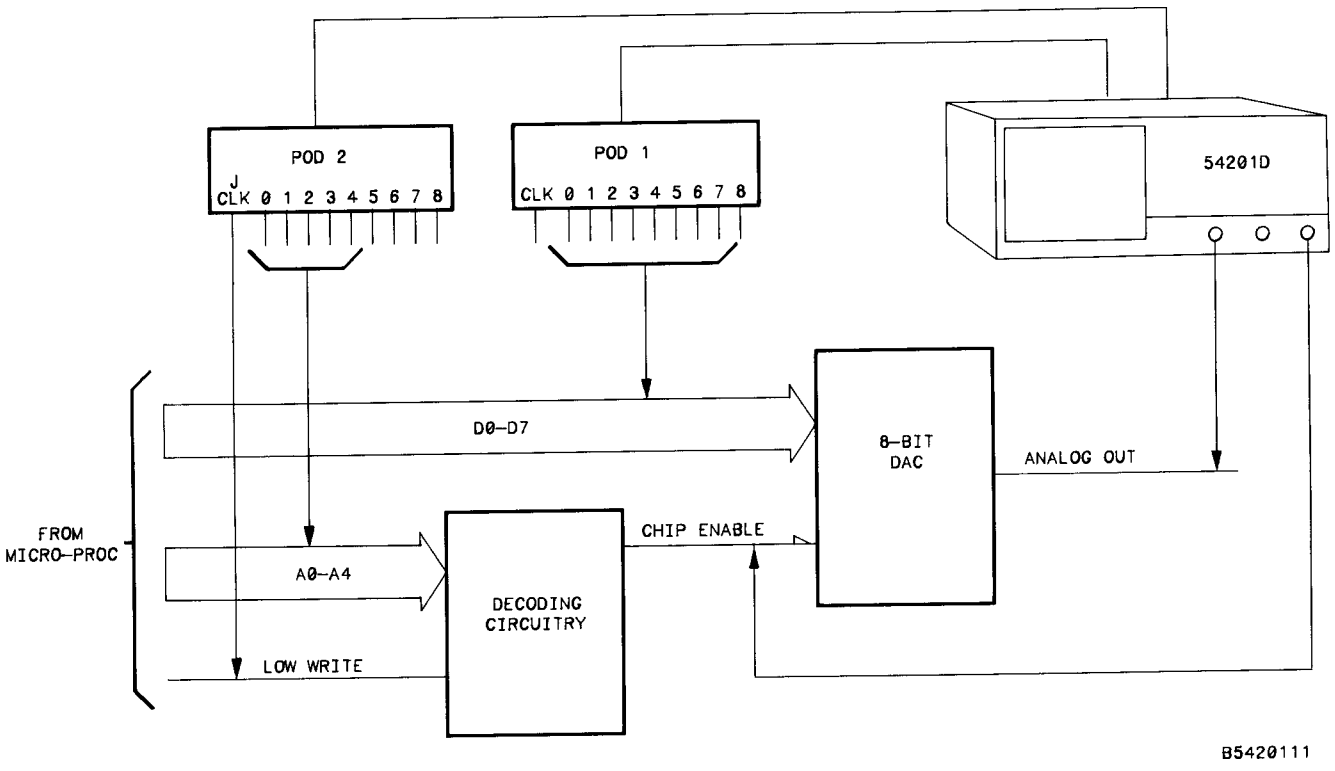


Figure 5-3. Example Normal Mode State Triggering Setup

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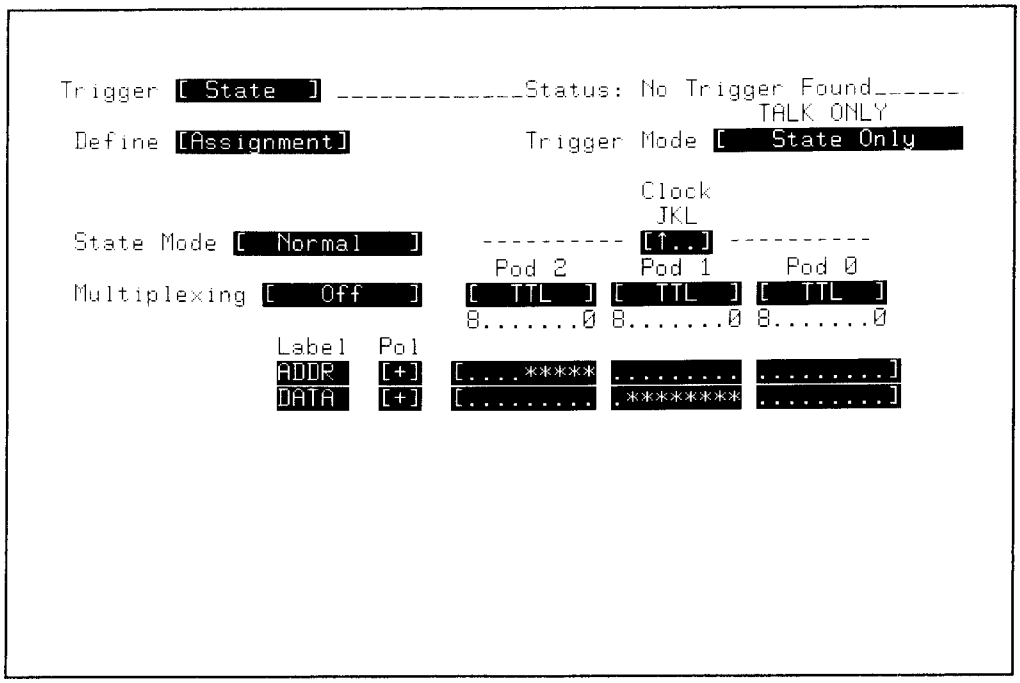


Figure 5-4. State Trigger Assignment Menu Setup

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.

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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.

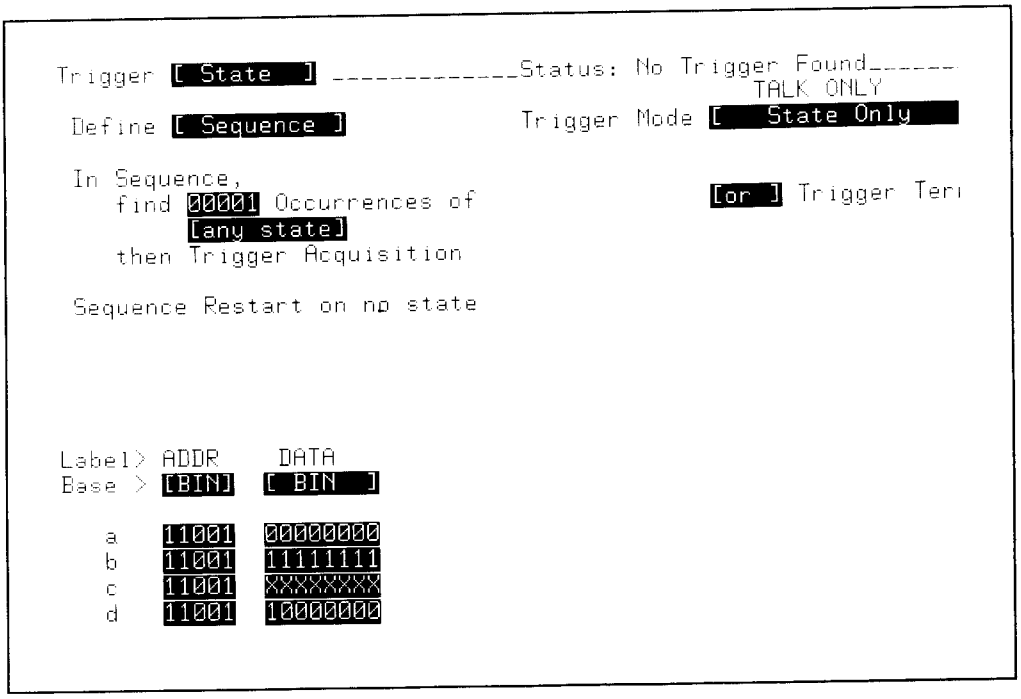


Figure 5-5. Sequence Menu Resource Definitions

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5-14. State Sequence Specification

The Sequence Specification may consist of up to 4 sequence terms with the last term occurring up 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).

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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.

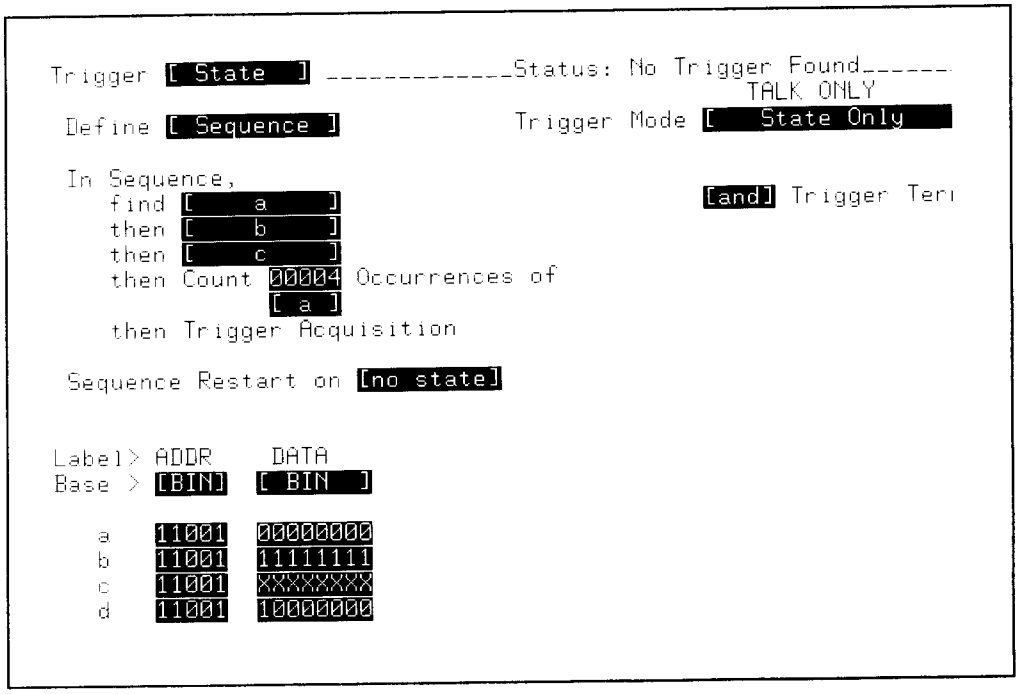


Figure 5-6. State Trigger Sequence Menu

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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 a shown in figure 5-7. Figure 5-8. shows a flow chart for trigger sequence.

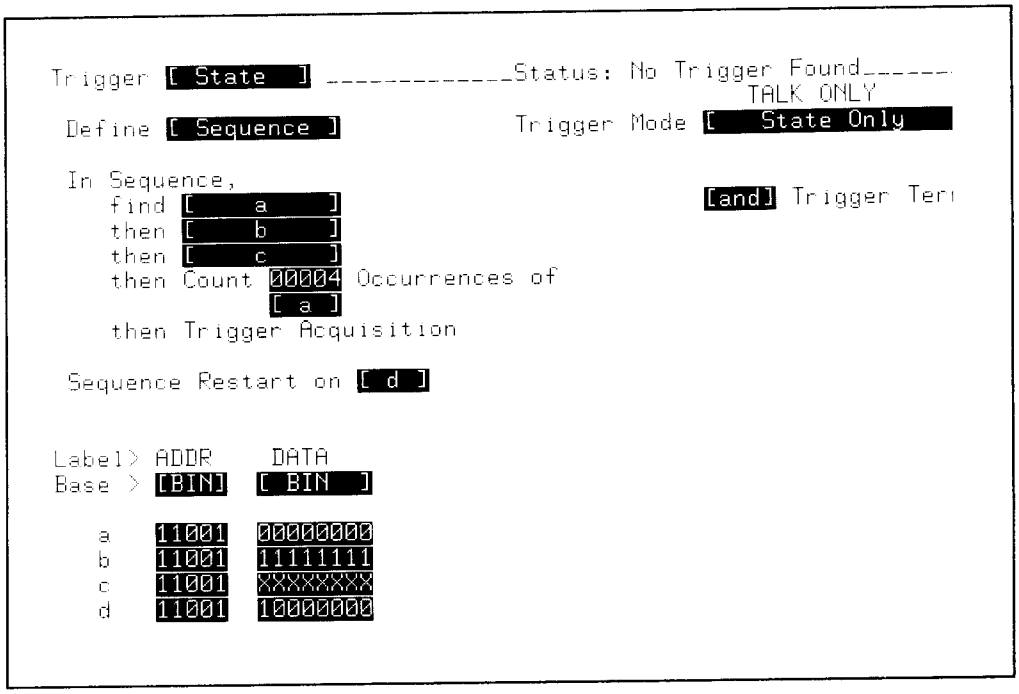


Figure 5-7. State Trigger Sequence Menu

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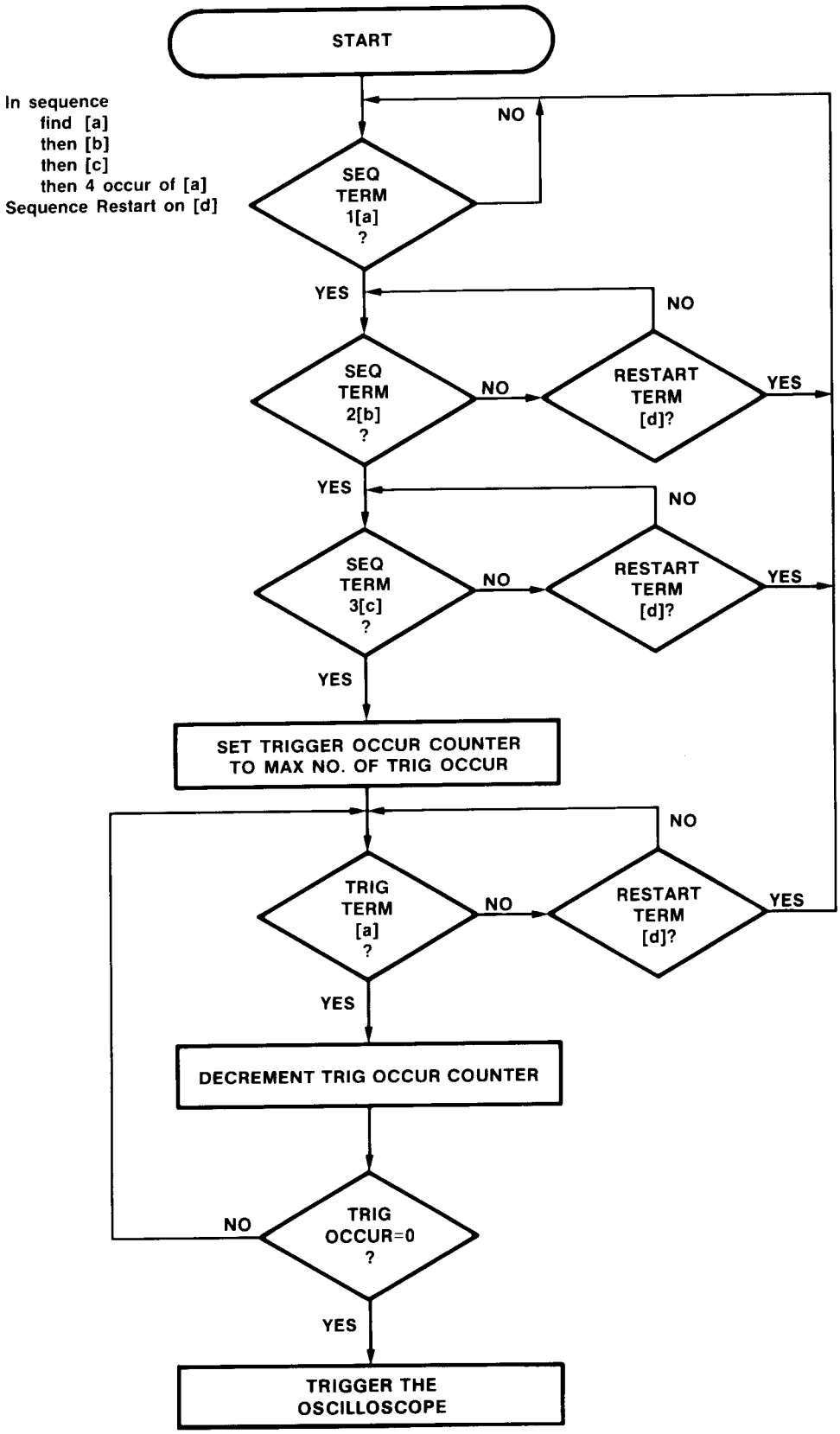


Figure 5-8. State Sequence Triggering Flowchart

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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 HP 54201D. This will preset the HP 54201D 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.

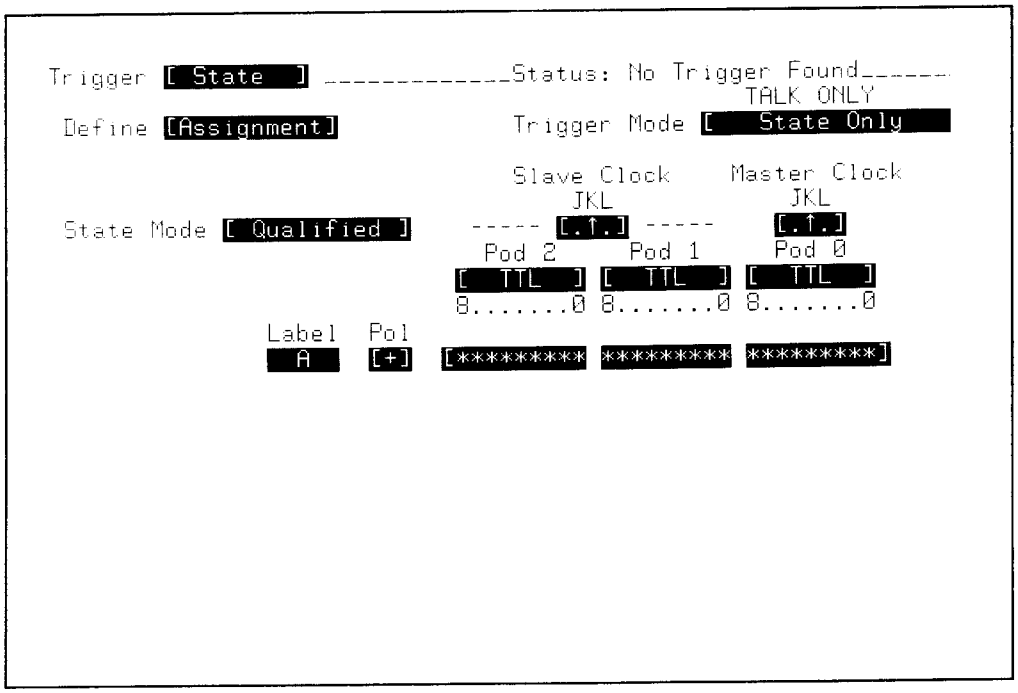


Figure 5-9. Assignment Menu for Digital Delay (Example 1)

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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 HP 54201D 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.

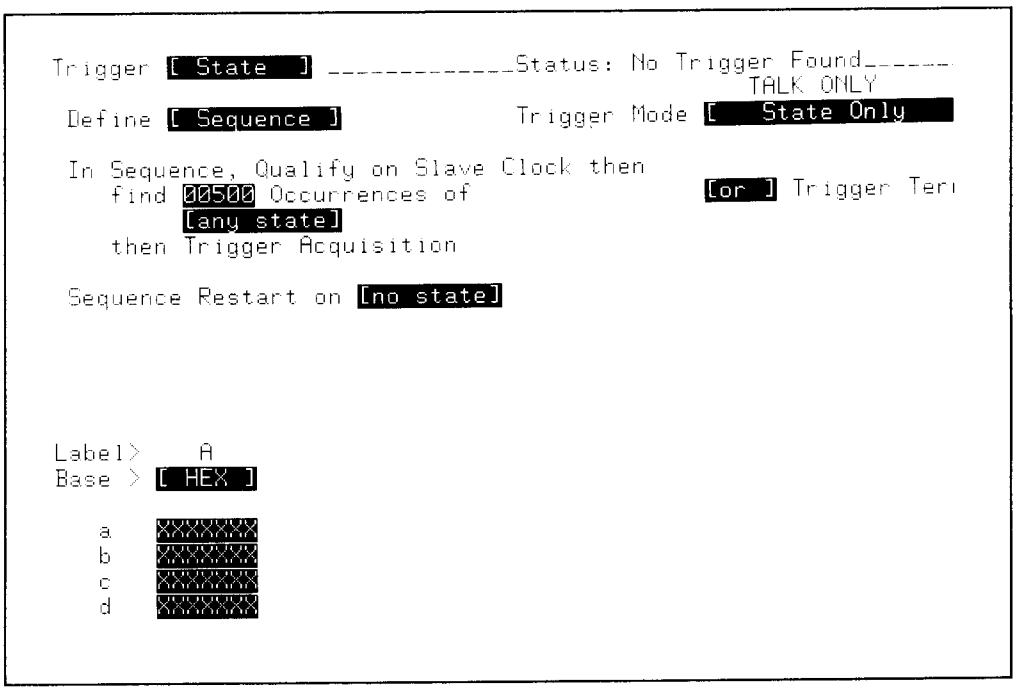


Figure 5-10. Sequence Menu for Digital Delay (Example 1)

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.

Two levels of digital delay may be realized by using this same setup with the following changes. Change Trigger Mode to State Arms Analog, then go to the analog trigger menu and specifiy the On Event (holdoff-by-events) field to be any number from 1 to 59999. Now, one state trigger (500th occurance of a system clock after the index pulse) will satisfy one event of On Event counter.

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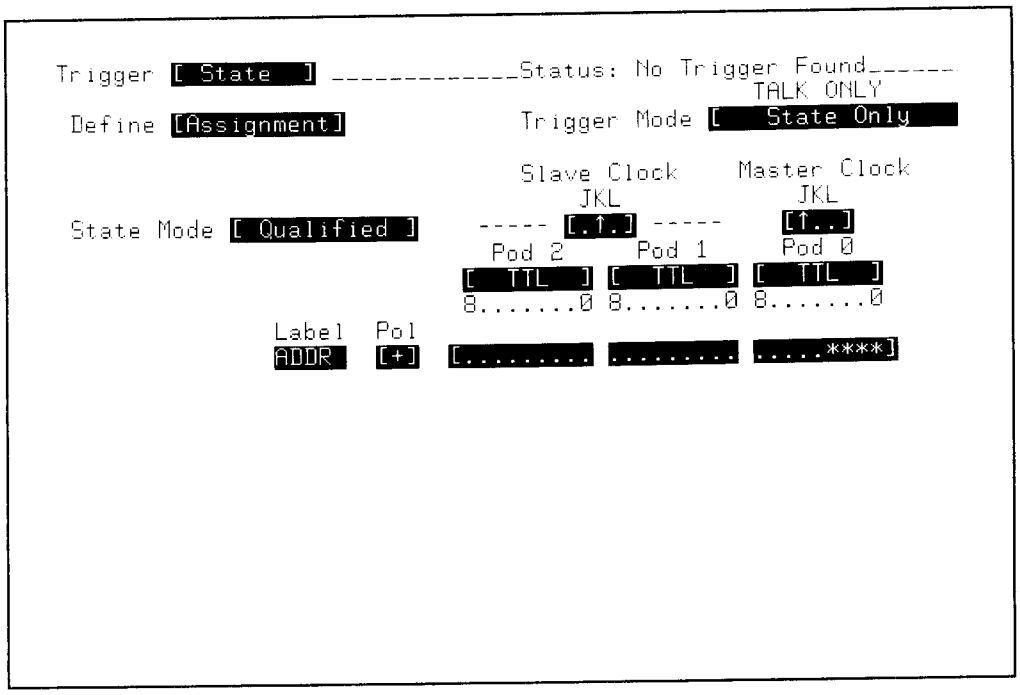


Figure 5-11. State Assignment Menu for Digital Delay (Example 2)

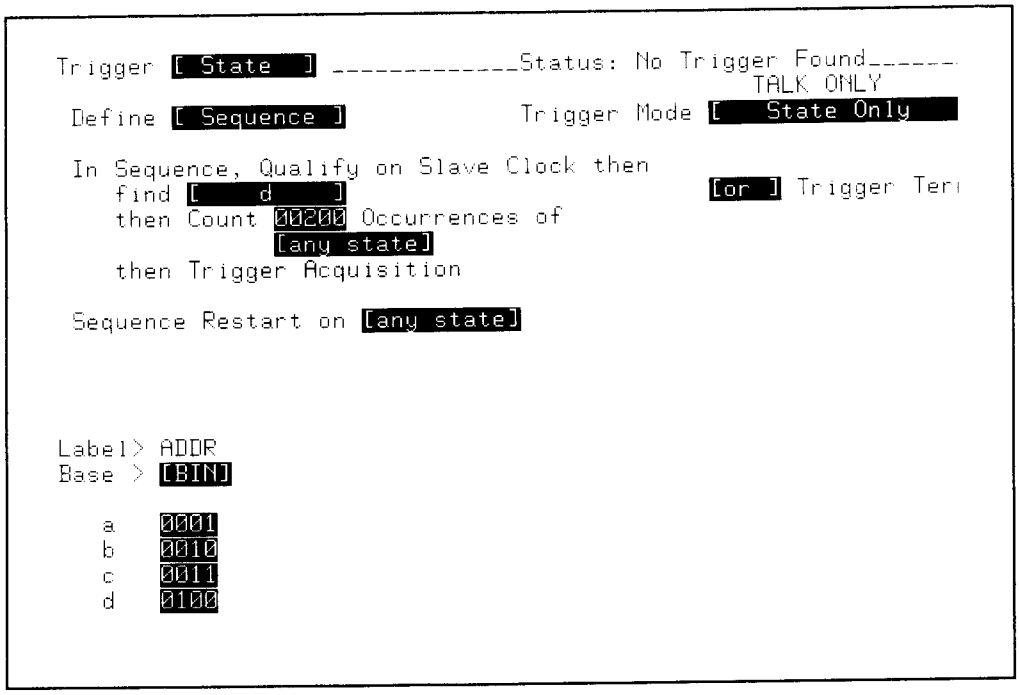


Figure 5-12. Sequence Menu for Digital Delay (Example 2)

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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 HP 54201D to enable the digitizing oscilloscope to trigger on the "unknown" or fault condition. When the fault occurs, the HP 54201D 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 HP 54201D 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.

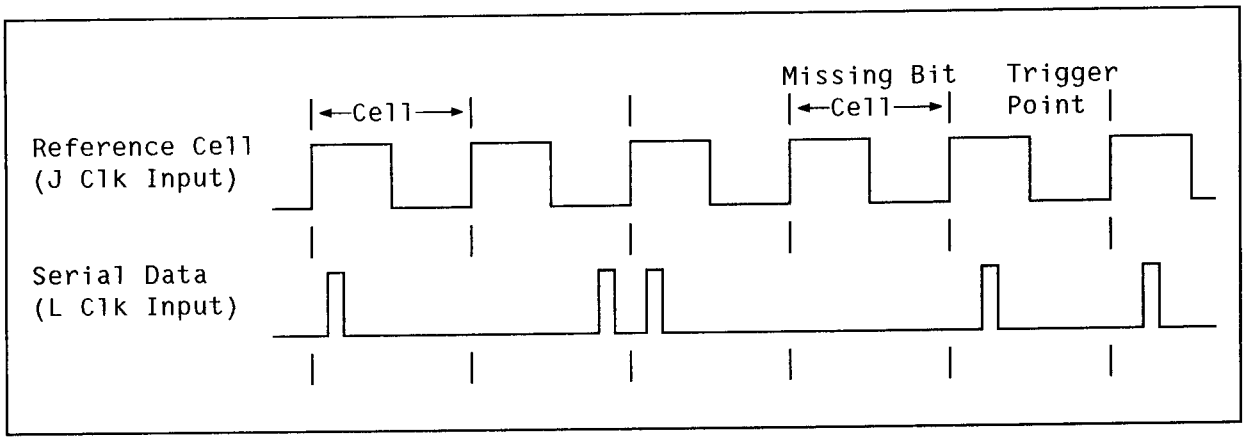


Figure 5-13. Missing Bit Timing Diagram

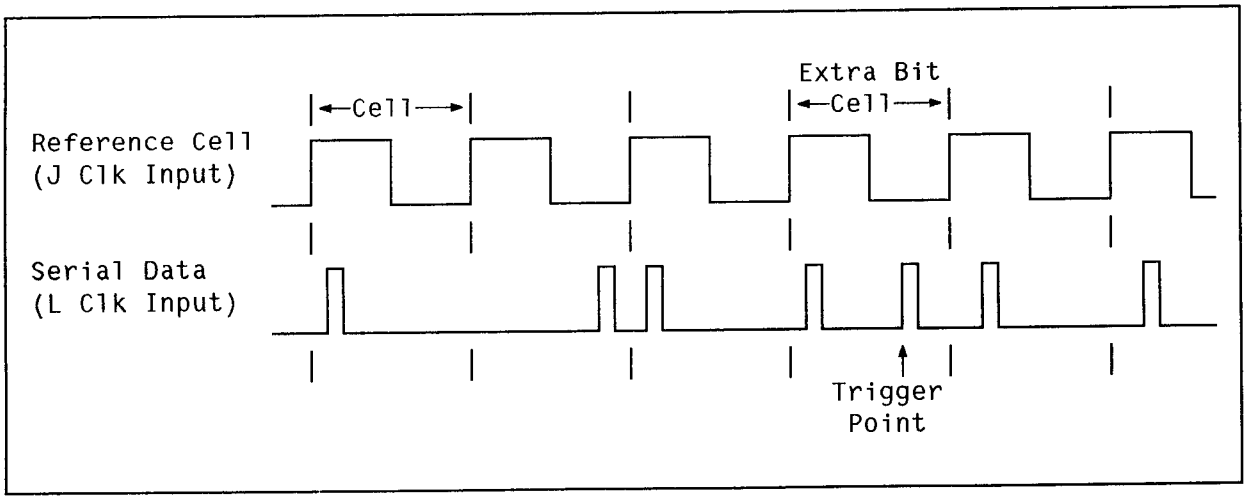


Figure 5-14. Extra Bit Timing Diagram

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For the HP 54201D 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 HP 54201D 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 HP 54201D, 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 HP 54201D is 20 ns. When functioning normally, the output of the translator should follow the input with very little delay (<<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 HP 54201D. 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 HP 54201D 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 HP 54201D 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.

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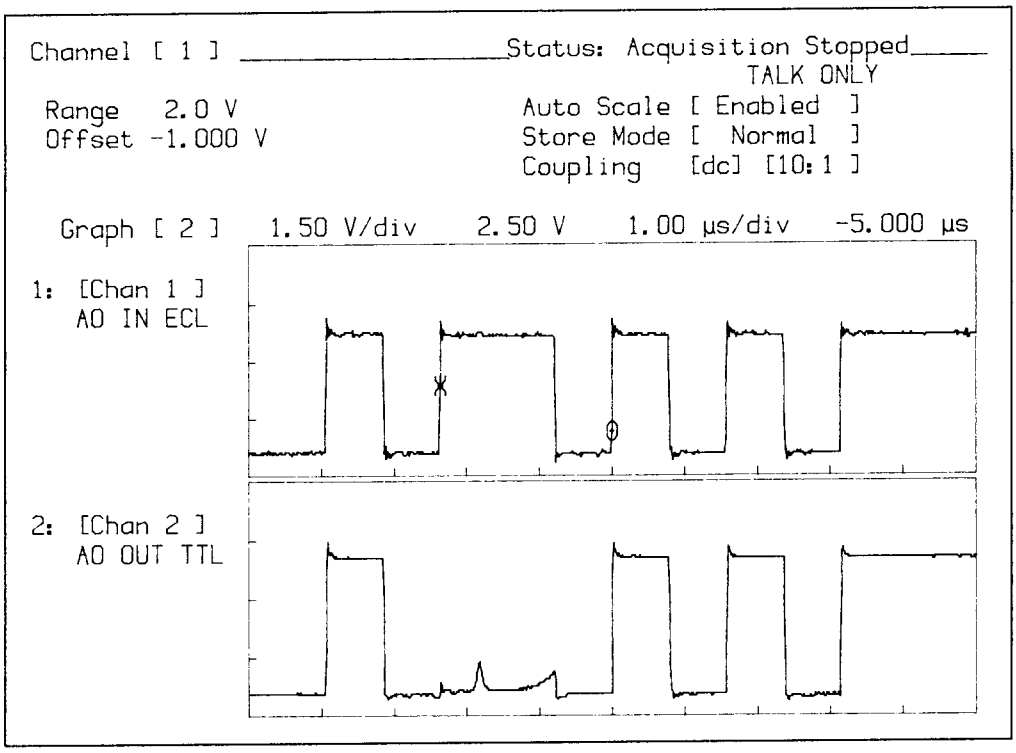


Figure 5-15. Missing Bit (Signal Dropout) Detection

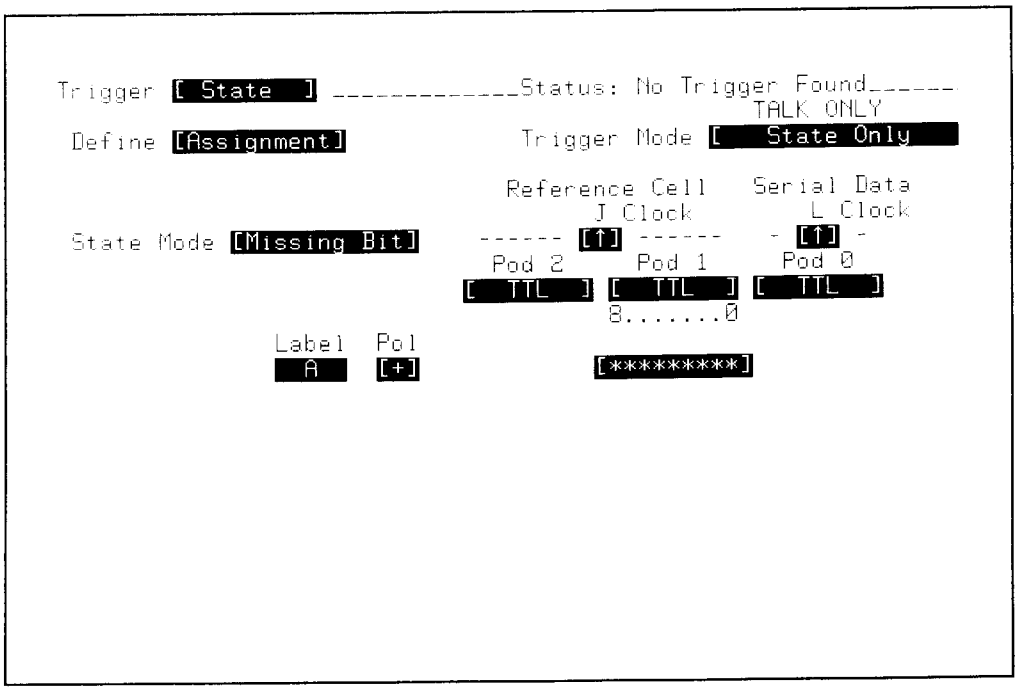


Figure 5-16. State Trigger Assignment Menu

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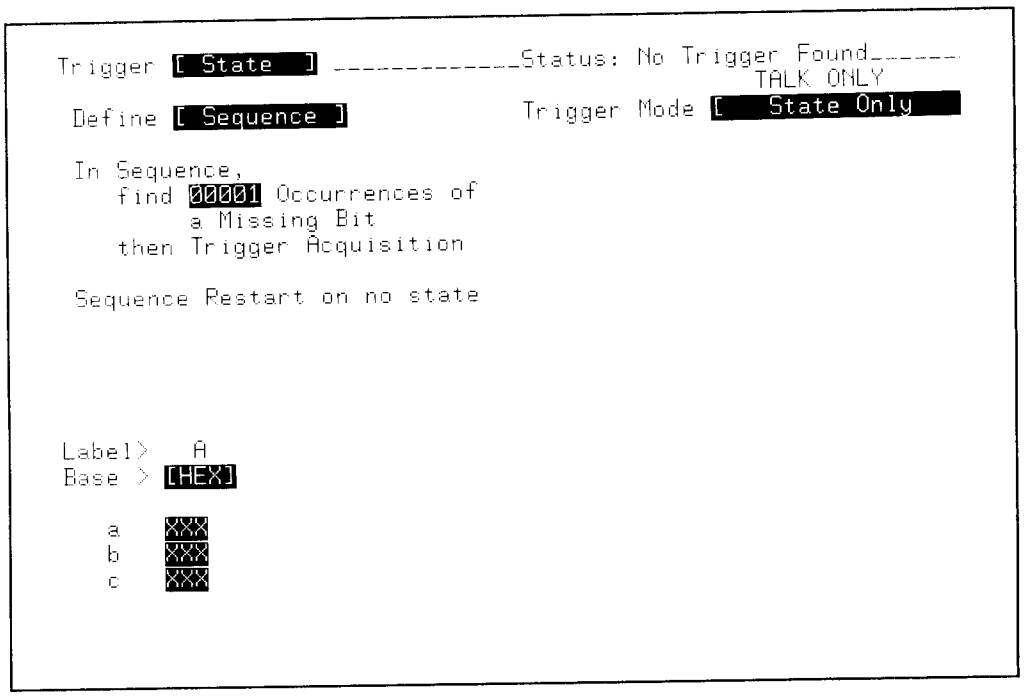


Figure 5-17. State Trigger Sequence Menu

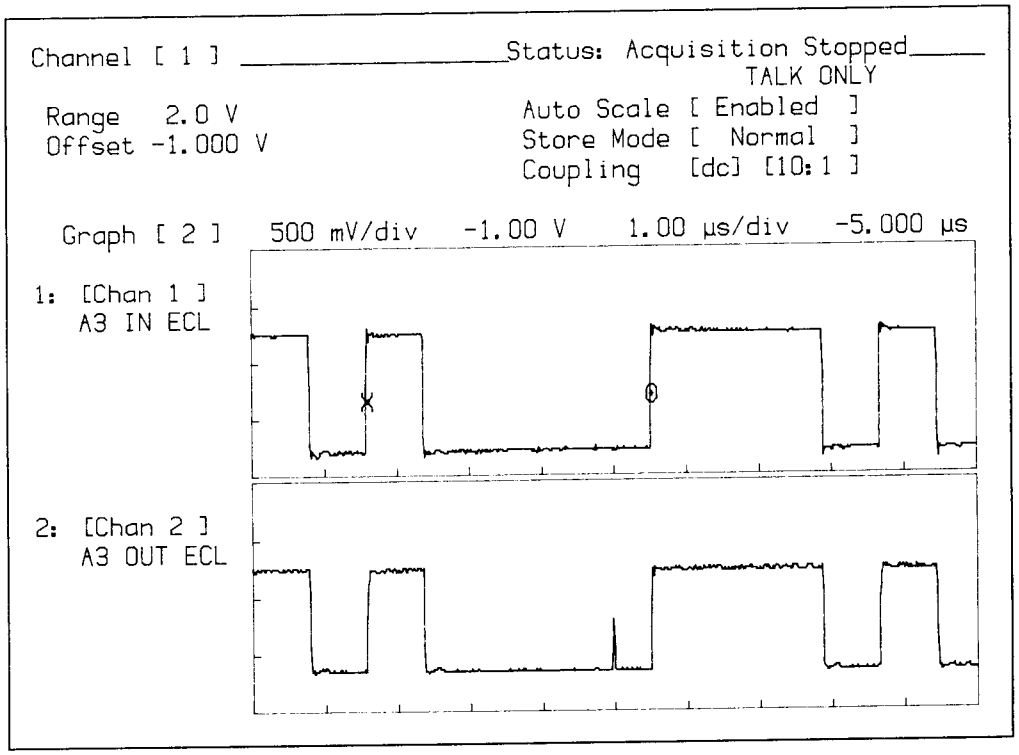


Figure 5-18. Extra Bit (Glitch) Detection

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5-21. QUICK REFERENCE TO STATE TRIGGER MENUS

The HP 54201D 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 HP 54201D 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 HP 54201D 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.

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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 HP 54201D 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.

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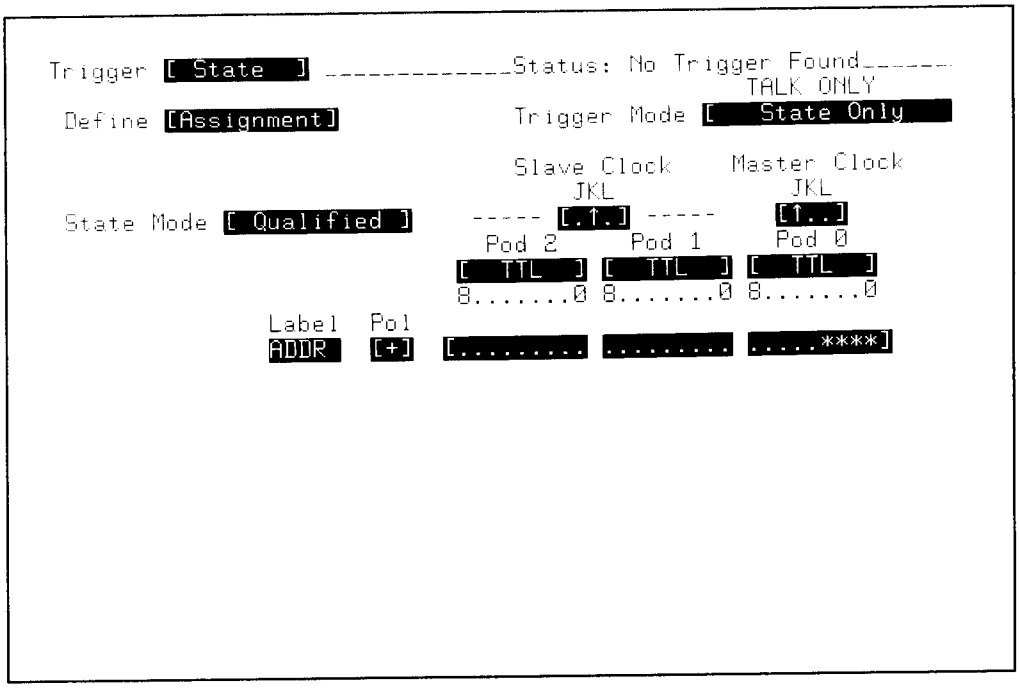


Figure 5-19. Example State Trigger Assignment Menu (Qualified Mode)

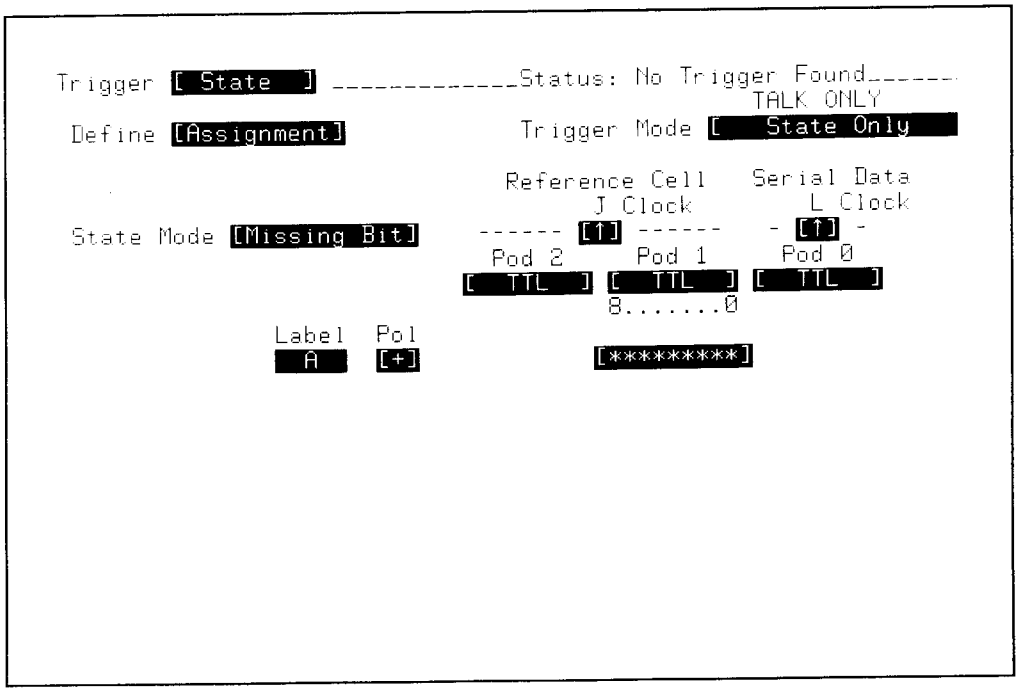


Figure 5-20. Example State Trigger Assignment Menu (Missing-bit Mode)

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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.

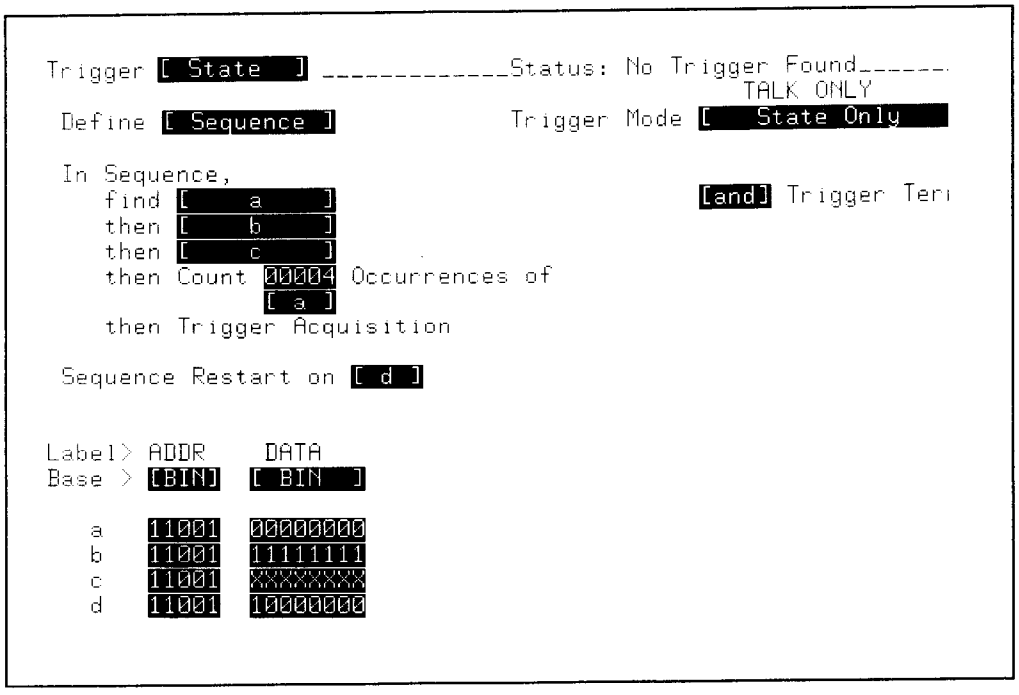


Figure 5-21. Example State Trigger Sequence Menu

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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.

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SECTION 6
PERIPHERALS

6-1. INTRODUCTION

The HP 54201A/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 HP 54201A/D with a graphics printer or plotter.

6-2. SETTING UP THE HP 54201A/D

When a controller is not connected to the HP 54201A/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.

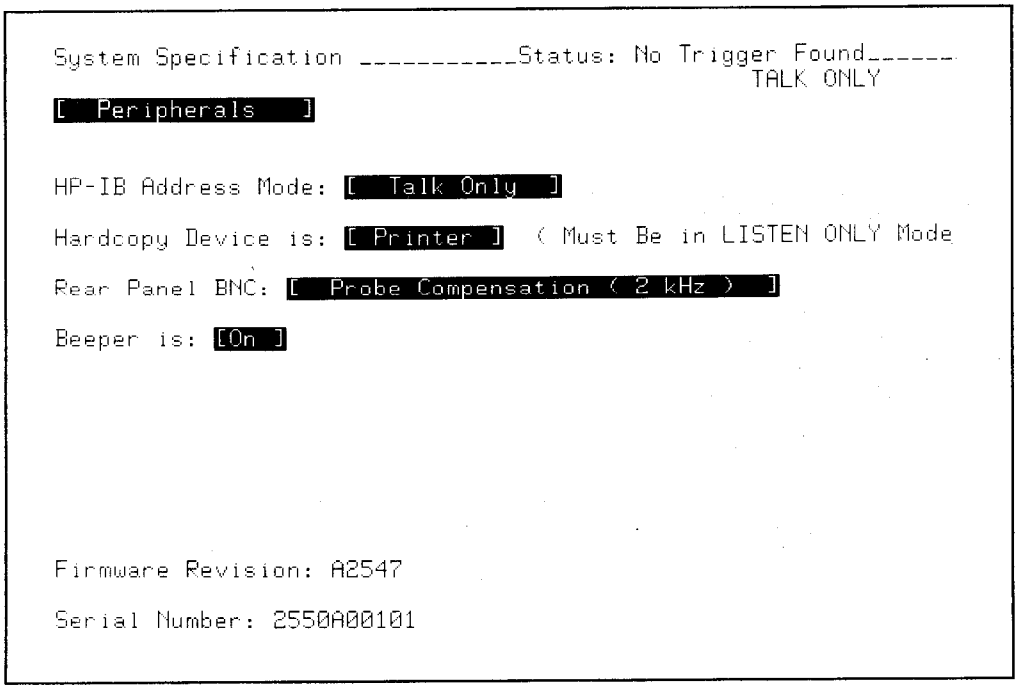


Figure 6-1. SYSTEM Peripherals Submenu

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6-3. GRAPHICS PRINTERS

The HP 54201A/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 HP 54201A/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 HP 54201A/D and the printer configuration switch has been set to LISTEN ALWAYS, press the HP 54201A/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 HP 54201A/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 HP 54201A/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 HP 54201A/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 HP 54201A/D and the plotter configuration switch has been set to LISTEN ALWAYS, press the HP 54201A/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 HP 54201A/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".

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SECTION 7
REMOTE CONTROL

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

The HP 54201A/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 control), 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 HP 54201A/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 HP 54201A/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 HP 54201A/D on the HP-IB is annunciated on the CRT by an HP-IB status message. This message describes the HP 54201A/D remote/local status, address status, and whether or not the instrument is requesting service via the SRQ bus control line.

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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 Group (TAG) Note 2	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		T2	B	66	01 000 010	102	42
		ETX	3	00 000 011	003	03		T3	C	67	01 000 011	103	43
	SDC	EOT	4	00 000 100	004	04		T4	D	68	01 000 100	104	44
	PPC	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	BS	8	00 001 000	010	08		T8	H	72	01 001 000	110	48
	TCT	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
		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
Universal Command Group (UCG)	LLO	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
	DCL	DC4	20	00 010 100	024	14		T20	T	84	01 010 100	124	54
	PPU	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
		ETB	23	00 010 111	027	17		T23	W	87	01 010 111	127	57
	SPE	CAN	24	00 011 000	030	18		T24	X	88	01 011 000	130	58
	SPD	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.

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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 MLA EOI UNL EOS 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

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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 HP 54201A/D has set the SRQ bus control line true. The byte is cleared after it is read by the HP-IB contorller 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

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.

2. The HP 54201A/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

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7-4. REMOTE MODE

7-5. Remote Capability

The HP 54201A/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 HP 54201A/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 HP 54201A/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 HP 54201A/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 "REM" 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 HP 54201A/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.

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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 "REM" 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 HP 54201A/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 HP 54201A/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.

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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 HP 54201A/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 HP 54201A/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 HP 54201A/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.

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7-15. RECEIVING THE DATA MESSAGE

The HP 54201A/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 HP 54201A/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.

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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 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 <DEL>.

The general rules of program command format are:

- The HP 54201A/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.

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7-19. SENDING THE DATA MESSAGE.

The HP 54201A/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, otherwise the instrument sends nothing.

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 HP 54201A/D with the ASCII character "E" (upper case) as the separator between the mantissa and the exponent.

7-21. LEARN MODE

If the HP 54201A/D receives a "SETup?" (instrument setup query) command and is then addressed to talk, it sends the Learn String. The learn string is a binary data block (type A) that contains instrument configuration. This binary data can be stored in the controller memory for future use.

The learn string can be returned to the HP 54201A/D restore configuration. Refer to the "SETup" programming command in Section 8 of this manual for more detailed information.

7-22. RECEIVING THE CLEAR MESSAGE

The HP 54201A/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 HP 54201A/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 HP 54201A/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 "REM" in the HP-IB status display to indicate remote mode.

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7-25. RECEIVING THE LOCAL MESSAGE

The Local message returns the HP 54201A/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 ("REM") 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 HP 54201A/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 ("REM") 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 HP 54201A/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 HP 54201A/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 HP 54201A/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 HP 54201A/D is set to talk-only mode, it cannot send the Require Service message.

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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 HP 54201A/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 HP 54201A/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 HP 54201A/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.

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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.

Notes:
1. To set the RQS bit and SRQ bus control line true, the condition must be enabled in the RQS mask.
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.

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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.

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.

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SECTION 8
PROGRAMMING THE HP 54201A/D

8-1. INTRODUCTION

This section provides instructions to allow you to program the HP 54201A/D. The HP 54201A/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 HP 54201A/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 special system commands that address portions of the instrument. Only one subsystem may be selected at any given time. At power on, no subsystem is selected.

The nine subsystems are:

Acquire allows the store mode for Channel 1 and Channel 2 to be set at the same time.

Channel controls all Y axis oscilloscope functions, including the type of data to be acquired.

Display controls how waveforms, cursor data, and text is displayed and written on the screen.

Graph allows the user to define the graph source, define graph specific measurement criteria when measurement mode is defined, and perform X-axis windowing.

Measure provides access to front-panel and special-function waveform measurements.

State available only on HP 54201D. Provides a means to program the state trigger function.

Timebase controls all X-axis oscilloscope functions.

Trigger controls all analog trigger oscilloscope functions.

Waveform provides access to waveform data, including active data from channels as well as static data from waveform memories.

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Subsystem commands may be issued once a subsystem has been selected. For example, once the timebase subsystem has been selected, any timebase command may be issued.

This tree structured approach to instrument control offers several advantages to the programmer. Equivalent functions appearing in several subsystems may be programmed with the same syntax once the appropriate subsystem is selected. For example:

```
CHANNEL1;COUPLING DC
CHANNEL2;COUPLING DC
TRIGGER;SOURCE EXTERNAL;COUPLING DC
WAVEFORM;SOURCE MEMORY1;COUPLING DC
```

Generally, the tree structure allows more rapid instrument configuration. For best performance, select a subsystem and make all setting changes required at one time, then select another subsystem and make all changes, and so on. Note that once a subsystem is selected, it remains selected until either a new subsystem is selected, the system commands NODE or RESet are received, or the HP-IB clear meta message (see table 7-2) is received. Once selected, a subsystem may be programmed with one data message with multiple commands, or may be programmed with several data messages with single commands, whichever is convenient.

For example, a task may be output as a single data message with multiple commands:

```
OUTPUT 707;"WAVEFORM;SOURCE MEMORY1;COUPLING DC"
```

or may be sent as multiple data messages, each with a single command:

```
OUTPUT 707;"WAVEFORM"
OUTPUT 707;"SOURCE MEMORY1"
OUTPUT 707;"COUPLING DC"
```

However, best performance is obtained when longer data messages are transmitted that fully utilize the HP 54201A/D 256-byte input buffer.

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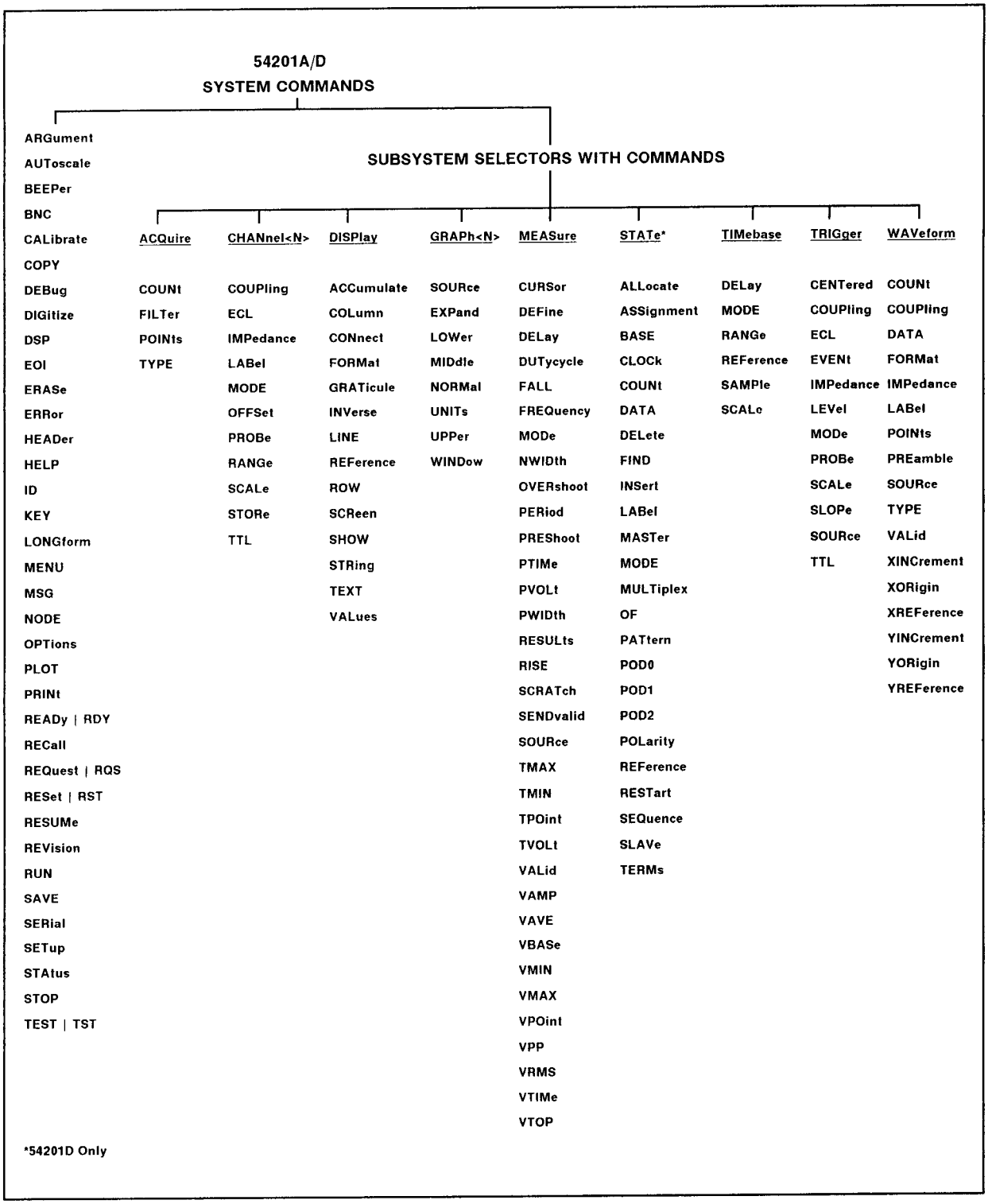


Figure 8-1. Programming Command Tree

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Table 8-1. Alphabetical Command Cross-Reference

COMMAND	WHERE USED
ACCumulate	Display subsystem
ACQuire	Subsystem selector
ALLocate	State subsystem
ARGument	System command
ASSignment	State subsystem
AUToscale	System command
BASE	State subsystem
BEEPer	System command
BNC	System command
CALibrate	System command
CENTered	Trigger subsystem
CHANnel	Subsystem selector
CLOCk	State subsystem
COLumn	Display subsystem
CONnect	Display subsystem
COPY	System command
COUNt	State subsystem
COUNt	Acquire subsystem
COUNt	Waveform subsystem
COUPling	Channel subsystem
COUPling	Trigger subsystem
COUPling	Waveform subsystem
CURSor	Measure subsystem
DATA	State subsystem
DATA	Waveform subsystem
DEBug	System command
DEFine	Measure subsystem
DELay	Measure subsystem
DELay	Timebase subsystem
DELete	State subsystem
DIGitize	System command
DISPlay	Subsystem selector
DSP	System command
DUTycycle	Measure subsystem
ECL	Channel subsystem
ECL	Trigger subsystem
EOI	System command
ERASe	System command
ERRor	System command
EVENt	Trigger subsystem
EXPand	Graph subsystem
FALL	Measure subsystem
FILTer	Acquire subsystem
FIND	State subsystem
FORMat	Display subsystem
FORMat	Waveform subsystem
FREQuency	Measure subsystem
GRAPh	Subsystem selector
GRATicule	Display subsystem
HEADer	System command
HELP	System command
ID	System command
IMPedance	Channel subsystem
IMPedance	Trigger subsystem
IMPedance	Waveform subsystem
INSert	State subsystem
INVerse	Display subsystem
KEY	System command
LABel	Channel subsystem
LABel	State subsystem
LABel	Waveform subsystem
LEVel	Trigger subsystem
LINE	Display subsystem
LONGform	System command
LOWer	Graph subsystem
MASTer	State subsystem
MEASure	Subsystem selector
MENU	System command
MIDdle	Graph subsystem
MODE	Channel subsystem
MODE	Measure subsystem
MODE	State subsystem
MODE	Timebase subsystem
MODE	Trigger subsystem
MSG	System command
MULTiplex	State subsystem
NODE	System command
NORMal	Graph subsystem
NWIDth	Measure subsystem
OF	State subsystem
OFFSet	Channel subsystem
OPTions	System command
OVERshoot	Measure subsystem
PATTern	State subsystem
PERIod	Measure subsystem
PLOT	System command
POD0	State subsystem
POD1	State subsystem
POD2	State subsystem
POINts	Acquire subsystem
POINts	Waveform subsystem
POLarity	State subsystem
PREamble	Waveform subsystem
PRESHoot	Measure subsystem
PRINt	System command
PROBe	Channel subsystem
PROBe	Trigger subsystem
PTIMe	Measure subsystem
PVOLt	Measure subsystem
PWIDth	Measure subsystem
RANGe	Channel subsystem
RANGe	Timebase subsystem
READy | RDY	System command
RECall	System command
REFerence	Display subsystem
REFerence	State subsystem
REFerence	Timebase subsystem
REQuest | RQS	System command
RESTart	State subsystem
RESULts	Measure subsystem
RESUMe	System command
RESet | RST	System command
REVision	System command
RISE	Measure subsystem
ROW	Display subsystem
RUN	System command
SAMPle	Timebase subsystem
SAVE	System command
SCALe	Channel subsystem
SCALe	Timebase subsystem
SCALe	Trigger subsystem
SCRATch	Measure subsystem
SCReen	Display subsystem
SENDvalid	Measure subsystem
SEQuence	State subsystem
SERial	System command
SETup	System command
SHOW	Display subsystem
SLAVe	State subsystem
SLOPe	Trigger subsystem
SOURce	Graph subsystem
SOURce	Measure subsystem
SOURce	Trigger subsystem
SOURce	Waveform subsystem
STATe	Subsystem Selector
STAtus	System command
STOP	System command
STORe	Channel subsystem
STRing	Display subsystem
TERMs	State subsystem
TEST | TST	System command
TEXT	Display subsystem
TIMebase	Subsystem selector
TMAX	Measure subsystem
TMIN	Measure subsystem
TPOint	Measure subsystem
TRIGger	Subsystem selector
TTL	Channel subsystem
TTL	Trigger subsystem
TVOLt	Measure subsystem
TYPE	Acquire subsystem
TYPE	Waveform subsystem
UNITs	Graph subsystem
UPPer	Graph subsystem
VALid	Measure subsystem
VALid	Waveform subsystem
VALues	Display subsystem
VAMP	Measure subsystem
VAVE	Measure subsystem
VBASe	Measure subsystem
VMAX	Measure subsystem
VMIN	Measure subsystem
VPOint	Measure subsystem
VPP	Measure subsystem
VRMS	Measure subsystem
VTIMe	Measure subsystem
VTOP	Measure subsystem
WAVeform	Subsystem selector
WINDow	Graph subsystem
XINCrement	Waveform subsystem
XORigin	Waveform subsystem
XREFerence	Waveform subsystem
YINCrement	Waveform subsystem
YORigin	Waveform subsystem
YREFerence	Waveform subsystem

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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 RESULTS is abbreviated to RESUL. 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 HP 54201A/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.

In addition to providing some memory savings in your application program, the use of short form gives slightly faster command transmission and execution time at the expense of readability.

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.

The HP 54201A/D parses input data messages using alpha arguments somewhat faster than those using numerics; however, in response to queries, the two formats are equivalent in execution time.

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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.

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8-7. PROGRAMMING AIDS

The system DEBug command helps those who are unfamiliar with the command syntax to find programming errors and to understand the formats used to transmit data from the instrument to the controller. When DEBug ON is issued, each data message is shown on the HP 54201A/D display just as it is received or transmitted over the HP-IB. The data messages appear within the < > symbols including imbedded carriage returns (CR) and line feeds (LF). Thus, 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 HP 54201A/D display. An error message is then displayed, followed by message text, on the status line of the HP 54201A/D to indicate the nature of the error.

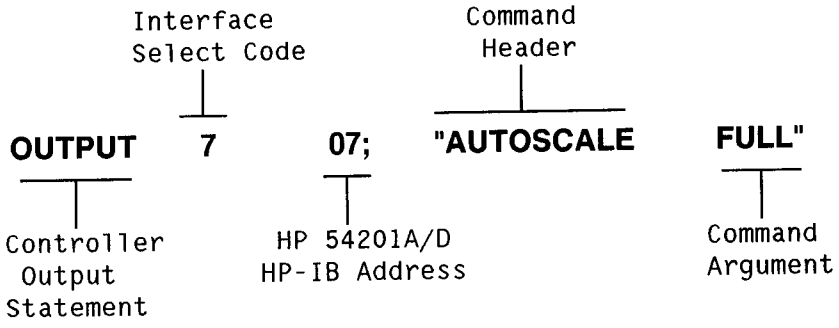
The system HELP? command returns the entire command set of the HP 54201A/D organized by subsystem. Refer to the System Command portion of this section for detailed information on this aid.

In addition, querying a subsystem (such as CHANnel1?) or specific functions is often a useful means to obtain an example of program syntax.

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 HP 54201A/D interface select/address code is set to 707.

The following diagram shows how the commands are sent to the HP 54201A/D:



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

If a query command (command followed by "?") is sent to the HP 54201A/D, a response message is generated and sent back to the controller the next time the HP 54201A/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 HP 54201A/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.

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8-12. Program Code Parameters

Program Code Parameters may be of four types:

Strings - Any collection of ASCII characters 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> is used to delimit the mantissa of exponential parameters. Spaces are not allowed within the numeric paramter 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 <DEL>.

8-13. General Program Command Format Rules

The general rules of program command format are:

- The HP 54201A/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 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.

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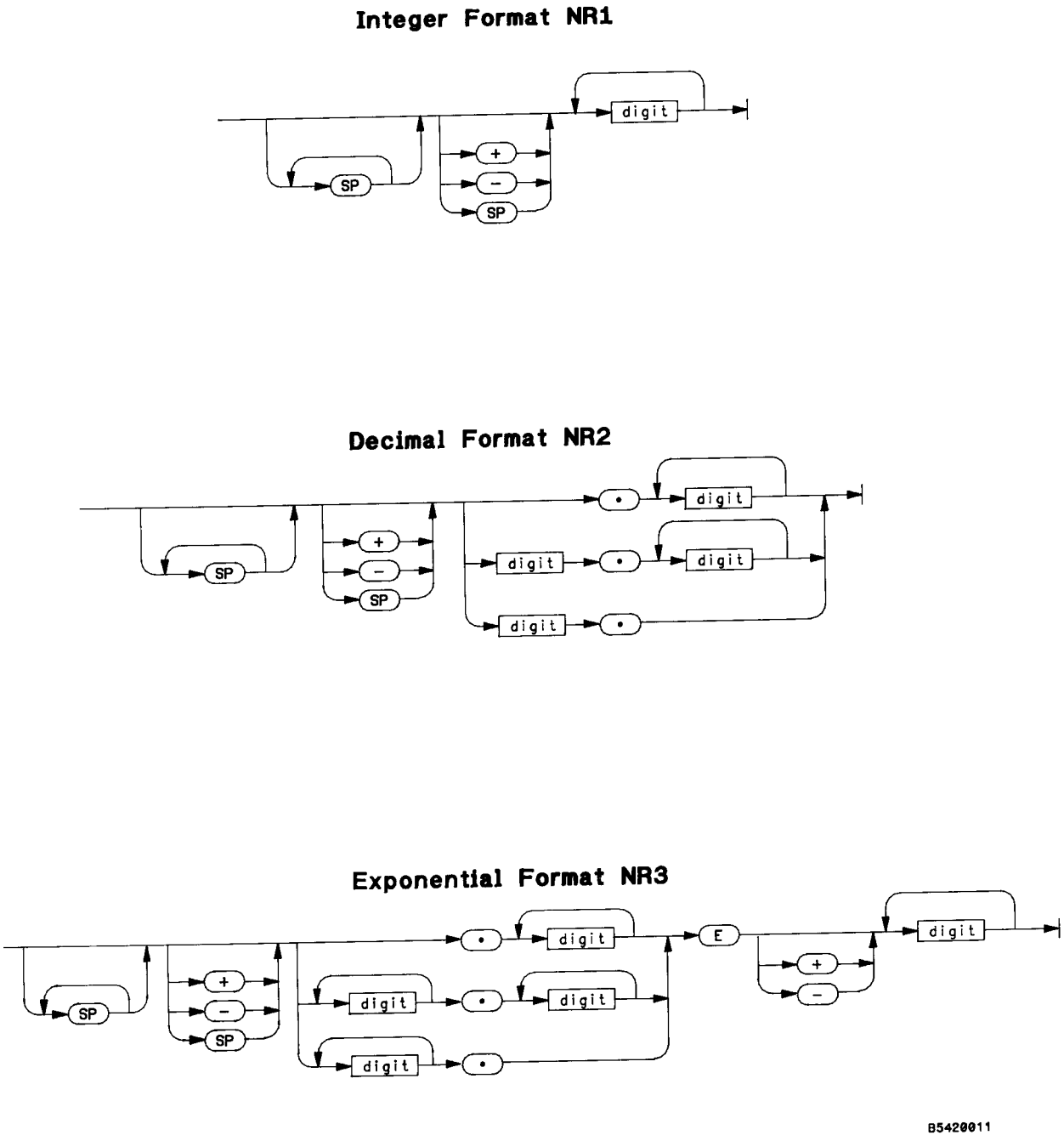


Figure 8-2. Numeric Formats NR1, NR2, and NR3 used in Command Arguments

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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
```

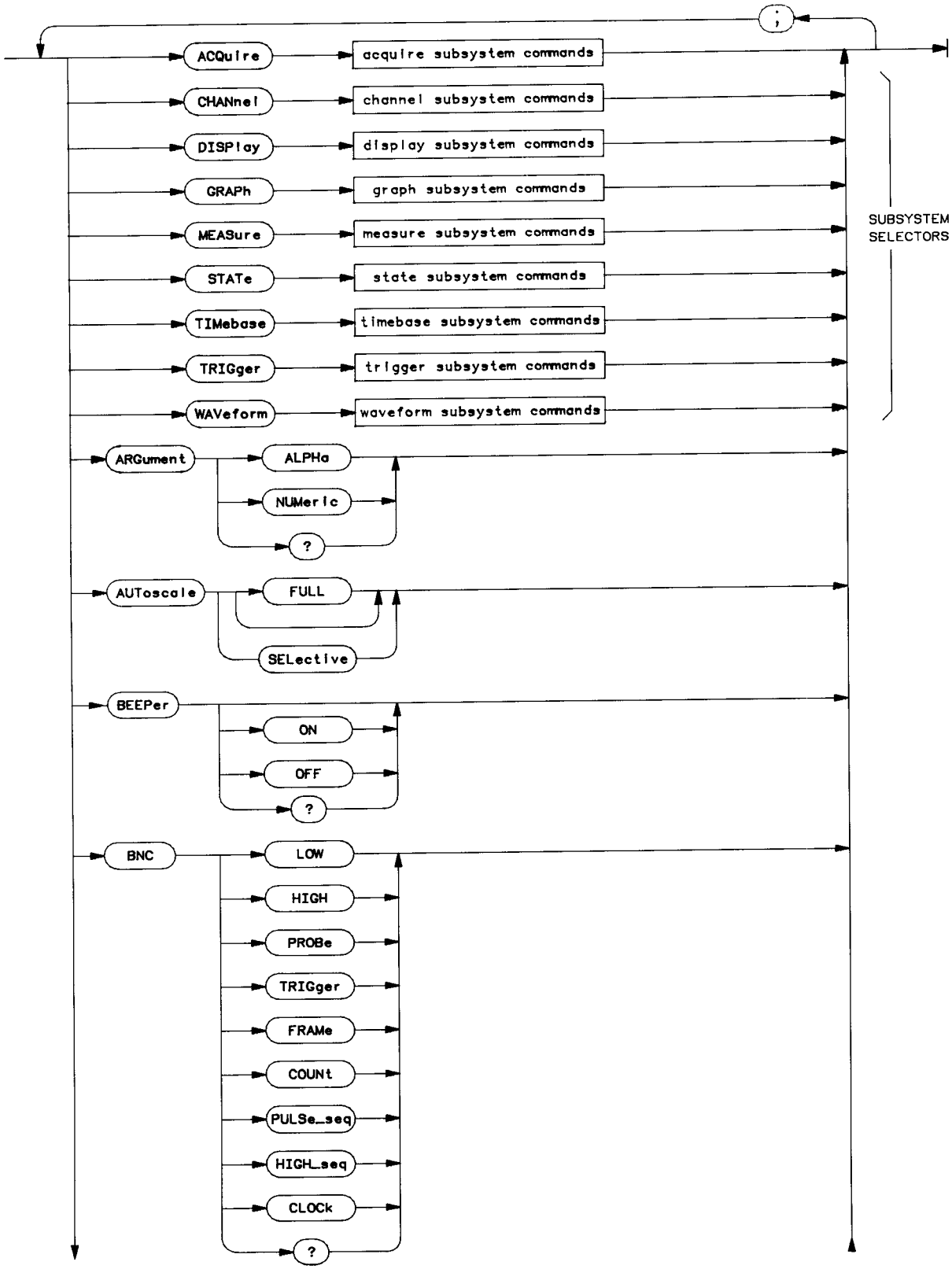
These commands are detailed in the corresponding subsystem.

SYSTEM COMMANDS:

```
ARGument
AUToscale
BEEPer
BNC
CALibrate
COPY
DEBug
DIGitize
DSP
EOI
ERASe
ERRor
HEADer
HELP
ID
KEY
LONGform
MENU
MSG
NODE
OPTions
PLOT
PRINt
READy | RDY
RECall
REQuest | RQS
RESet | RST
RESUMe
REVision
RUN
SAVE
SERial
SETup
STAtus
STOP
TEST | TST
```

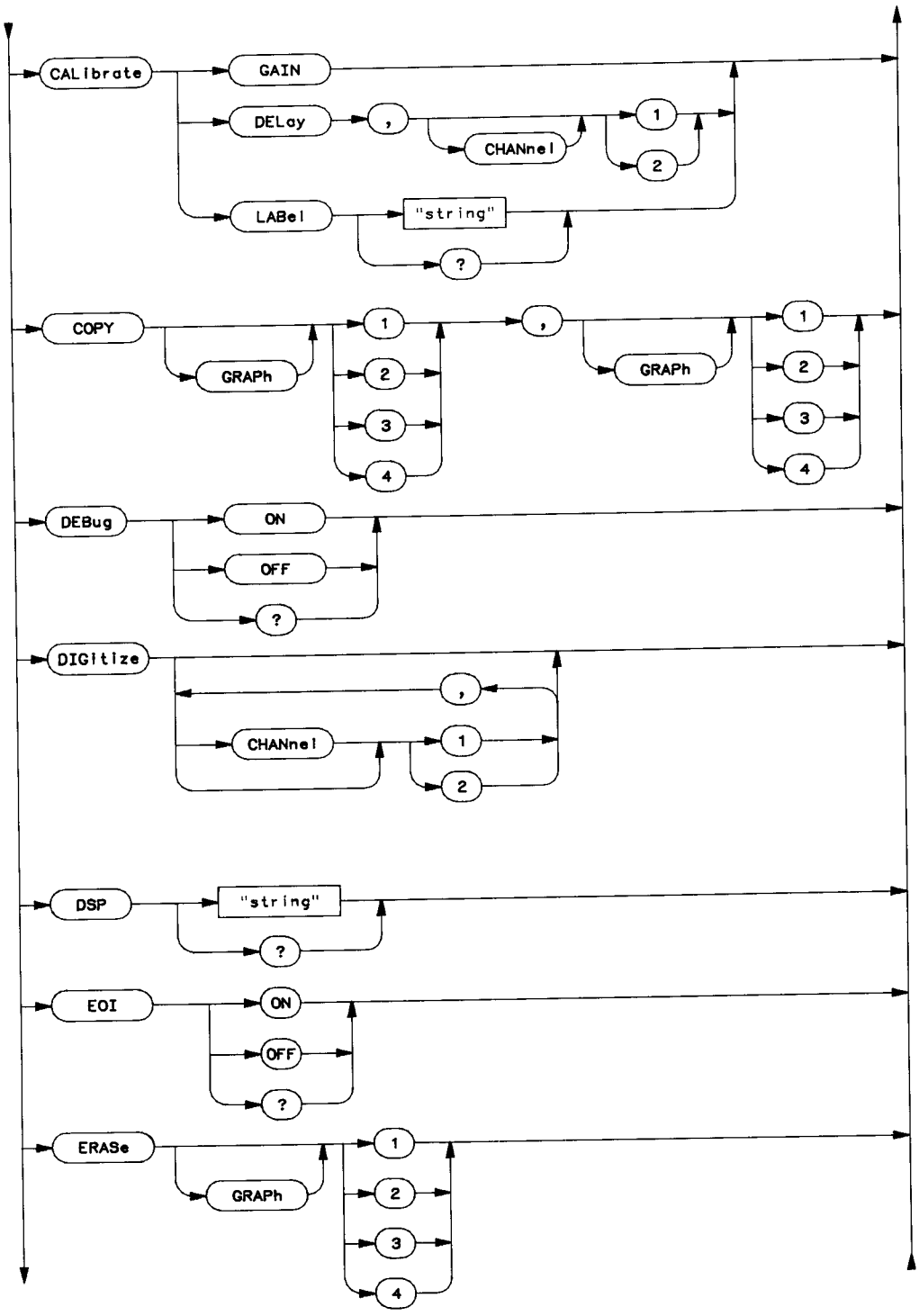

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SYSTEM COMMANDS



System Command Syntax Diagram

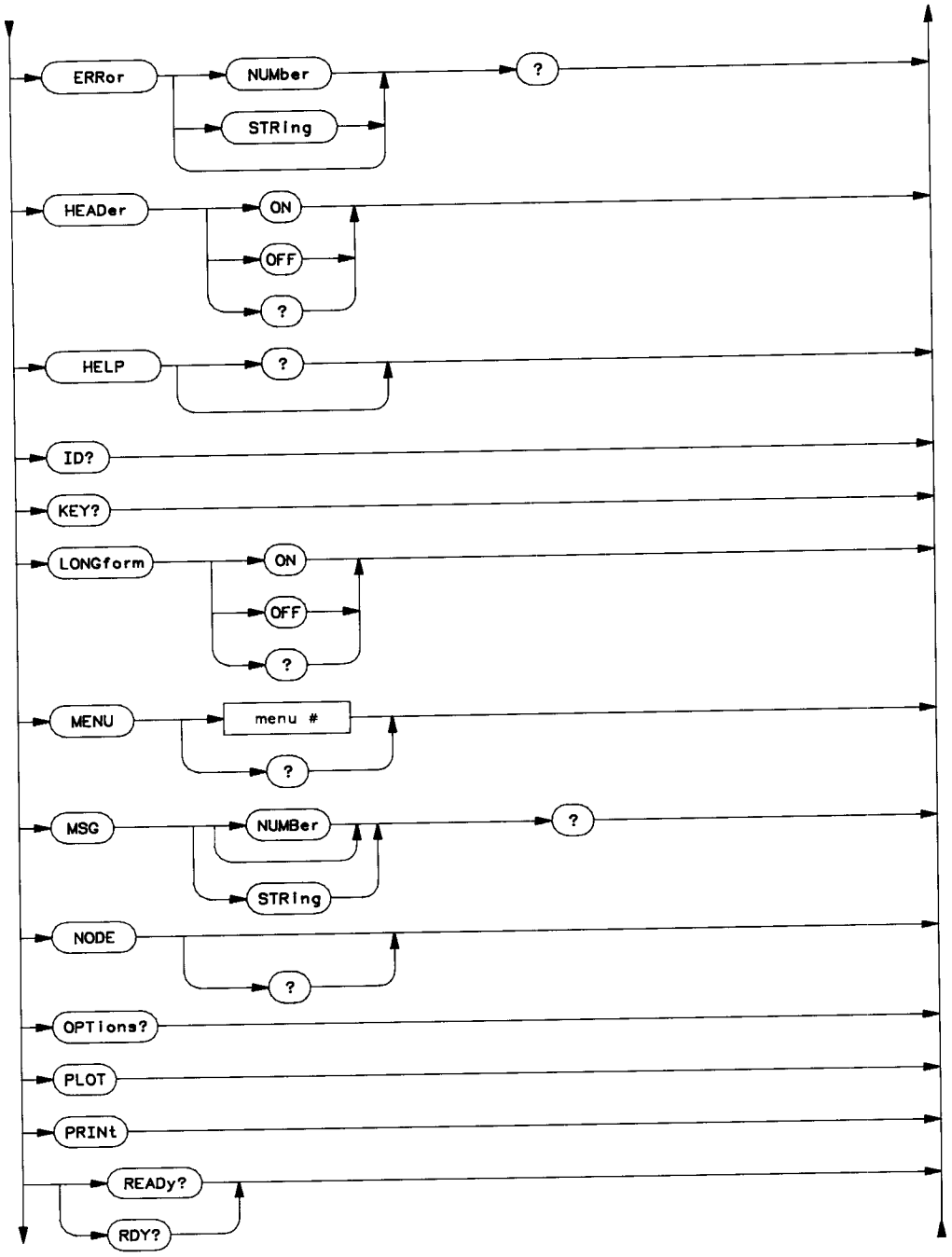
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System Command Syntax Diagram (Cont)

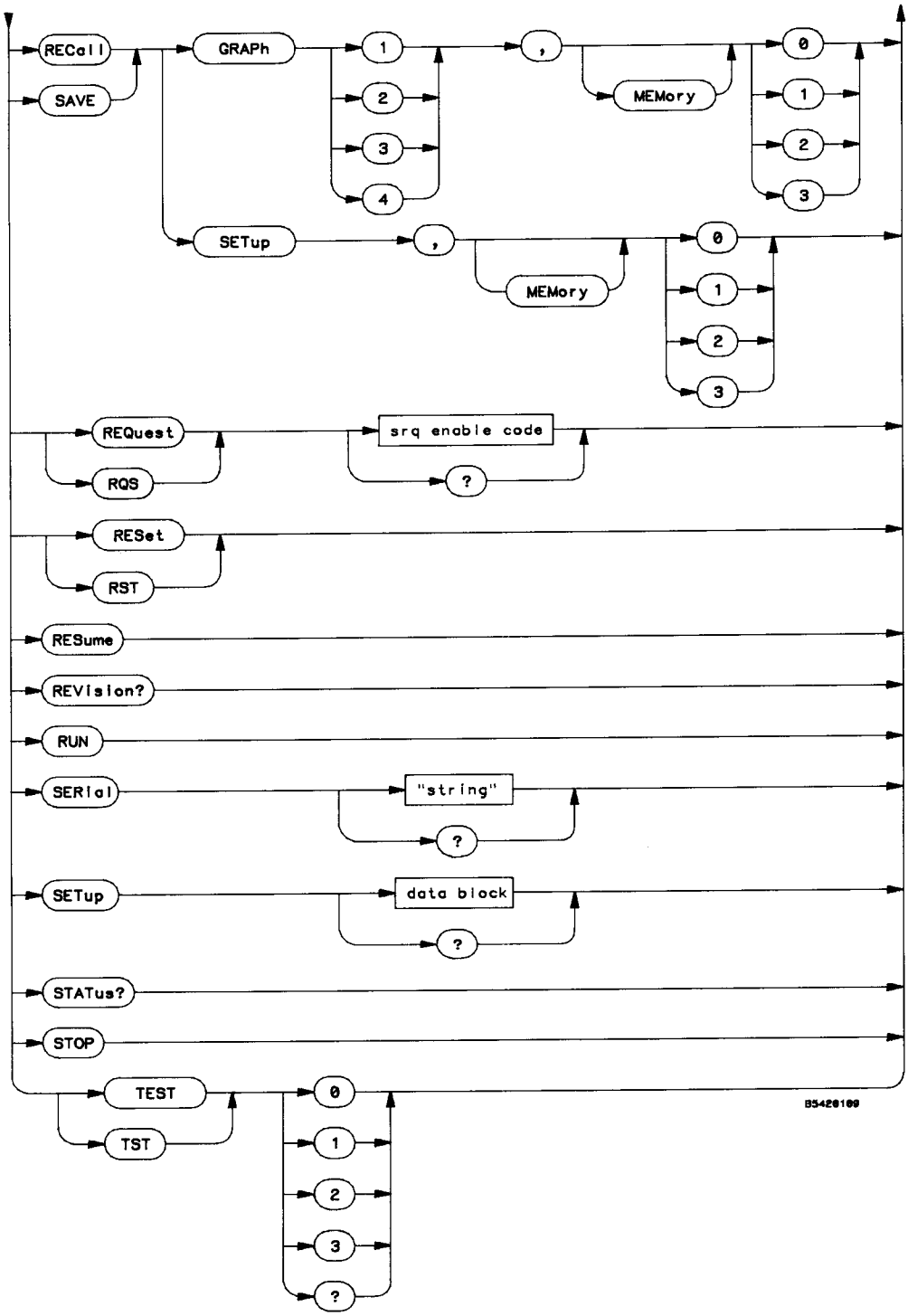
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SYSTEM COMMANDS



System Command Syntax Diagram (Cont)

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System Command Syntax Diagram (Cont)

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SYSTEM COMMANDS

ARGument

command/query

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 NR1. This does not affect input data messages to the HP 54201A/D -- arguments may be input in either alpha or numerical form regardless of how the ARGument command is set. ARGument is set to NUMeric when the system RESet command is executed.

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

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 both 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"
```


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SYSTEM COMMANDS

BEEPer

command/query

Commands sets beeper mode. If no argument is passed, a beep is sounded without affecting the beeper status. 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/query

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] (HP 54201D only)
[HIGH_SEQ | 7] (HP 54201D only)
[CLOCk | 8]} (HP 54201D only)

Example: OUTPUT 707;"BNC PROBE"

Query Syntax: BNC ?

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

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

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SYSTEM COMMANDS

CALibrate

command/query

If GAIN or DELay is specified, HP 54201A/D performs a self cal. If LABel is specified, HP 54201A/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 HP 54201A/D be disconnected before being executed or an erroneous cal will be performed. DELay requires rear-panel BNC be connected to INPUT 1 or INPUT 2 as appropriate, or an erroneous cal will be performed.

Command Syntax: CALibrate {[GAIN | 0]
[DELay | 1] {,[CHANnel1 | 1][CHANnel2 | 2]}
[LABel<string> | 2<string>]}

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

OUTPUT 707;"CALIBRATE DELAY,CHANNEL1"

Query Syntax: CALibrate LABel ?

This query 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$
```


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SYSTEM COMMANDS

COPY

command

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

command/query

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 HP 54201A/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 input and output buffers are displayed exactly as they are received or sent with the exception that binary blocks are represented in an abbreviated fashion. 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 HP 54201A/D display. An error message is then displayed, followed by message text, on the status line of the HP 54201A/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$

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SYSTEM COMMANDS

DIGitize

command

Upon receipt of the DIGitize command, and the DIGitize command is sent with an argument (CHANnel1 or CHANnel2), 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 HP 54201A/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, and there is an active channel on at least one graph, all graphs are left alone – none are turned off or unexpanded. This facilitates some special measurements such as delay between channel 1 and a reference waveform in memory.

If no argument is included with DIGitize, and there is no active channel on any graph, then the current graph sources determine what is acquired; 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, and channel 2 is assigned to graph 2.
- All other graphs are set to off.

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

<acquire spec> ::= [CHANnel1 | 1]
[CHANnel2 | 2]

Example: OUTPUT 707;"DIGITIZE CHANNEL1,CHANNEL2"

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SYSTEM COMMANDS

DSP

command/query

Command places string up to 32 characters long in the message area of the HP 54201A/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$[40]
          OUTPUT 707;"DSP?"
          ENTER 707;Dsp$
          PRINT Dsp$
```

EOI

command/query

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

Command erases specifed graph. If the graph contains a memory waveform, the graph is turned off. If the graph contains a channel waveform 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"
```


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SYSTEM COMMANDS

ERRor

query

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):

ERROR NO.	ERROR STRING
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
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
58	No Hardcopy Device
70	Cal RAM Write Protected
86	Hardware Failure
89	Local Lockout In Effect
90	Key Not Allowed in Remote
126	RAM Data Loss
127	Firmware Error

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ERRor (cont)

Standardized HP-IB Error Messages:

ERROR NO.	ERROR STRING
-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
-330	Power-up Failed

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SYSTEM COMMANDS

HEADer

command/query

Command sets command header echo mode for query responses; query responses will only return the command header when HEADer is set ON. HEADer is set OFF by the RESet command. 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

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

Query which returns model identification string, HP 54201A or HP 54201D.

Query Syntax: ID ?

```
Returned Format:  [ID ]"HP 54201A"<crlf>   or
                  [ID ]"HP 54201D"<crlf>

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


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KEY

query

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	Vampl 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

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SYSTEM COMMANDS

LONGform

command/query

Command sets longform mode for instrument responses to queries. If OFF then command headers and alpha arguments are sent from HP 54201A/D in the abbreviated form, else the whole word is output. This does not affect input data messages to the HP 54201A/D -- headers and arguments may be input to the HP 54201A/D in either long or short form regardless of how the LONGform command is set. LONGform is set OFF by the RESet command. 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/query

Command displays the desired menu. Menus 41 and 42 are available for the HP54201D only. The HP 54201A 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$
```


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SYSTEM COMMANDS

MSG

query

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:

MSG NO.	MESSAGE STRING
1	Power-Up Complete
6	Expansion Limit Reached
7	No Waveform Exists
12	Enter Hardware Test
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
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

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SYSTEM COMMANDS

MSG (cont)

MSG NO.	MESSAGE STRING
55	Hardcopy in Progress
56	Acquired Frame <N> *(See Note)*
57	Hardcopy Device Down
59	No Ext Trig Auto
60	Hardcopy Aborted
62	Enter Service 0 thru 3
63	Waiting to Send Data
64	Waiting to Receive Data
65	Mode Configured in Status Menu
66	Executing Autoscale
67	Exceeds Graph Scale
68	Enter Address 0 thru 30
69	Default Complete
71	Slow Trigger
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	Trigger Changed
82	Acquisition Stopped
83	Acquisition Complete
84	No Trigger Found
85	Waiting for Trigger
87	SHIFT Selects Alphabet

Note

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

Standardized HP-IB Warning Messages:

MSG NO.	MESSAGE STRING
-122	Number Rounded
-230	Transmission Aborted

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SYSTEM COMMANDS

NODE

command/query

Command that resets HP 54201A/D parser to SYStem node. If query, HP 54201A/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

Query which returns what options are installed in HP 54201A/D. There currently are no options.

Query Syntax: OPTions ?

```
Returned Format : [OPTions ]{NONE | 0 }<crlf>
```

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


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SYSTEM COMMANDS

PLOT

command

Command sets hardcopy device to plotter and does hardcopy dump of HP 54201A/D display in a format acceptable to an HPGL plotter as soon as the HP 54201A/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 54201A/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 54201A/D to determine if the transfer
310   !                        is complete.  Attempting to program the
320   !                        54201A/D while making a hardcopy dump will
330   !                        cause errors.
340   !
```

PRINt

command

Command sets hardcopy device to printer and does hardcopy dump of HP 54201A/D display in a format acceptable to a printer compatible with the HP RASTER GRAPHICS STANDARD as soon as the HP 54201A/D is next addressed to talk.

Command Syntax: PRINt

Example:

```
10    CLEAR 707              ! Clear interface buffers.
20    OUTPUT 707;"PRINT"     ! Starts print buffering.
30    SEND 7;UNT UNL         ! Clears bus, set ATN line at controller true.
40    SEND 7;LISTEN 1        ! Tells printer at address 1 to listen.
50    SEND 7;TALK 7          ! Sets 54201A/D to talk mode.
60    SEND 7;DATA            ! Sets ATN line at controller to false
70                           ! so data can be transferred.
80    WAIT 25                ! Wait 25 seconds for transfer to finish
90    !               Note:    If programming, use the SRQ capabilities
100   !                        of the 54201A/D to determine if the transfer
110   !                        is complete.  Attempting to program the
120   !                        54201A/D while making a hardcopy dump will
130   !                        cause errors.
140   !
150   END
```


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READy | RDY

query

Query which returns an integer equivalent to the HP 54201A/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.

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SYSTEM COMMANDS

RECall

command

Command displays a waveform from HP 54201A/D memory on the specified graph or, restores the specified instrument setup. Refer to the SAVE command to save waveforms or setups. RECall SETup9 is a special function which returns the instrument to the state it was in before AUTOscale, ECL, or TTL was executed.

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

<graph#> ::= { 1 | 2 | 3 | 4 }
<memory#> ::= { 0 | 1 | 2 | 3 | 9 }

Examples:
```
OUTPUT 707;"RECALL GRAPH1,2"          is equivalent to
OUTPUT 707;"RECALL GRAPH1,MEMORY2"

OUTPUT 707;"RECALL SETUP,MEMORY0"     is equivalent to
OUTPUT 707;"RECALL SETUP0"            and
OUTPUT 707;"RECALL0"
```

REQuest | RQS

command/query

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$
```


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REQuest | RQS (cont)

The ready mask is defined as follows:

The Ready Mask

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.

Note: To set the RDY bit in the status byte, all of the conditions set true (1) in the ready mask must be true in the READY registers (logical AND).

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SYSTEM COMMANDS

REQuest | RQS (cont)

The RQS mask is defined as follows:

The Status Mask

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.

Notes:
1. To set the RQS bit and SRQ bus control line true, the condition must be enabled in the RQS mask.
2. If no condition is enabled, the HP 54201A/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.

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SYSTEM COMMANDS

RESet | RST

command

The HP 54201A/D has three distinct levels of reset capabilities; two are HP-IB bus commands and one is a HP 54201A/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) HP 54201A/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 HP 54201A/D is as follows:

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SYSTEM COMMANDS

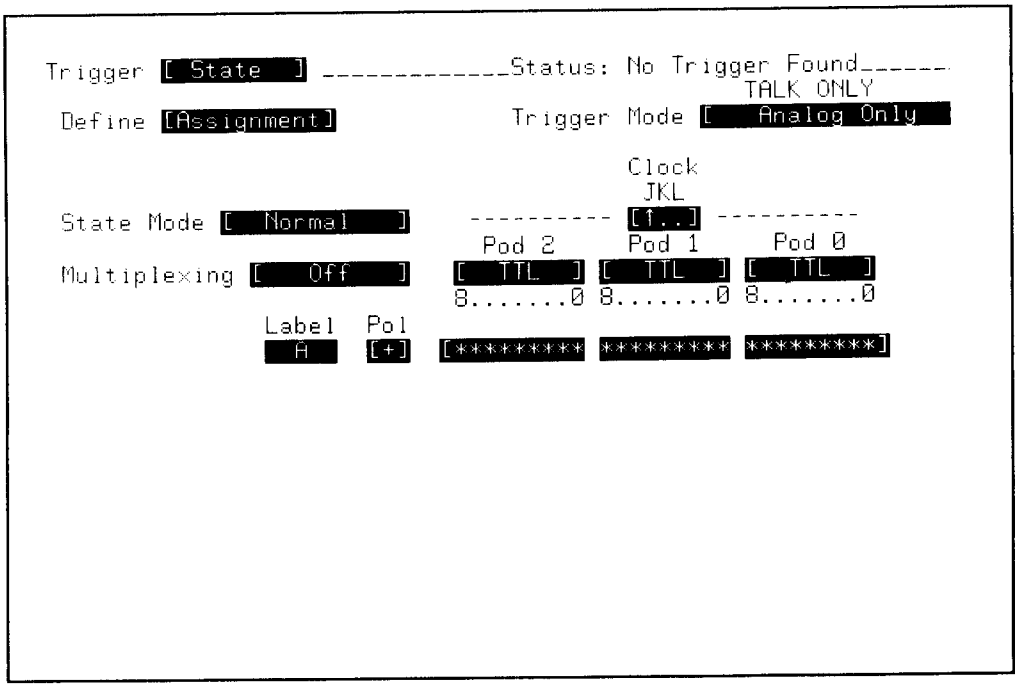
RESet | RST (cont)

CONDITION	SETTING
TIMEBASE:	
Sweep mode	Auto
Time range	10 μs
Reference	Center
Delay	0.0 s
Autoscale	Period
Acquire mode	Real time
CHANNELS:	
Mode	Dual Channel
Range	5.0 V
Offset	0.0 V
Store mode	Normal
Labels	(blank)
Coupling	1 MΩ dc
Probe attenuation	1:1
Autoscale	Enabled
TRIGGER:	
Mode	Analog
Source	Channel 1
Level	0.0 V Centered
Slope	Positive
Label	(blank)
Autoscale	Enabled
On Event	00001
DISPLAY:	
Graticule	Frame
# of graphs	2
Graph sources	
1	Channel 1
2	Channel 2
Connect dots	Off
Reference lines	Off
Accumulate mode	Disabled
Data filter	On
MEASUREMENTS:	Standard
OTHER:	
Running	True
HP-IB address/mode	Not changed
Hardcopy device	Printer
Rear BNC	Constant low
Beeper	On
Setup labels	(blank)
Stored setups	Unprotected
Stored waveforms	Cleared

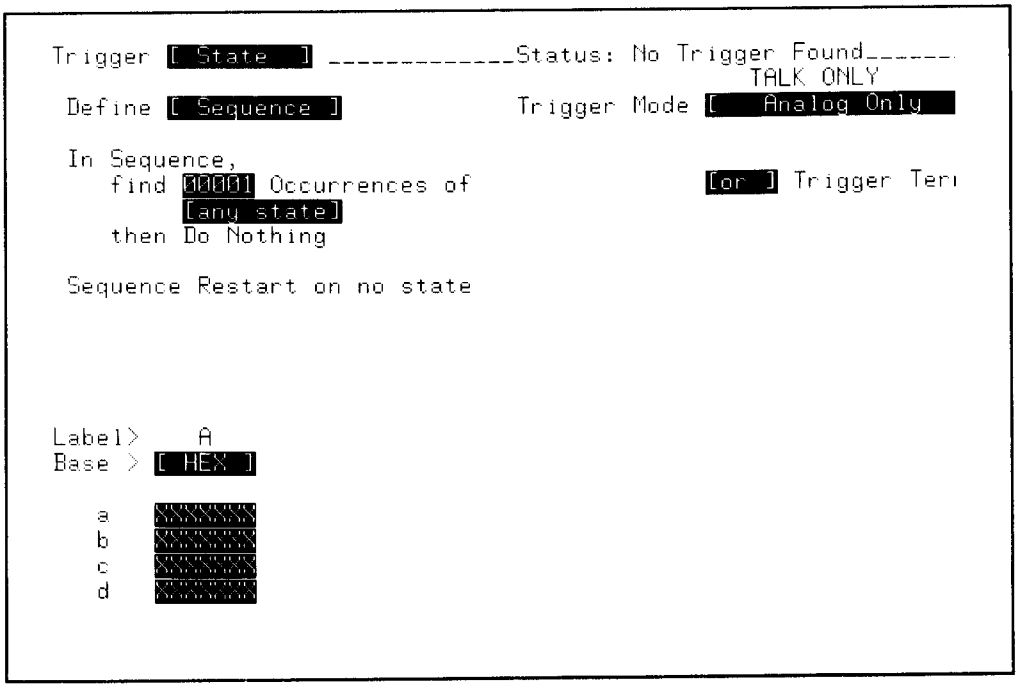
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RESet | RST (cont)

STATE SETTINGS:



Trigger State Assignment Menu after RESet



Trigger State Sequence Menu after RESet

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SYSTEM COMMANDS

RESUMe

command

Command causing HP 54201A/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

Query which returns the revision date of HP 54201A/D firmware.

Query Syntax: REVision ?

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

     <date code>::=<NR1> (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

Command causing HP 54201A/D to start running. Same as pressing the HP 54201A/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"
```


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SYSTEM COMMANDS

SAVE

command

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/query

Command programs the serial number of the HP 54201A/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 HP 54201A/D serial number.

Command Syntax: SERial <string>

Example:
```
OUTPUT 707;"SERIAL ""2601A01219"""
```

Query Syntax: SERial ?

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

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


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SYSTEM COMMANDS

SETup

command/query

Command sets up HP 54201A/D according to learn string. Query returns HP 54201A/D learn string. Block length is 978 bytes (982 including the "#A" and two-byte count value). Block format #A is discussed in Program Code Parameters paragraph at the front of this section. This command allows instrument setups to be stored in the controller. This data can then be sent back to the HP 54201A/D when this controller-stored setup is desired.

Query Syntax: SETup ?

Returned Format: [SETup] <block type A>

```
Example:  DIM Learn$[982]
          OUTPUT 707;"HEADER OFF;SETUP?"
          ENTER 707 USING "-K";Learn$
```

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

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

STAtus

query

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 HP 54201A/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$
```


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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.

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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.

STOP

command

Command which causes HP 54201A/D to stop running.

Command Syntax: STOP

```
Example:  OUTPUT 707;"STOP"
```


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TEST | TST

command/query

Command form executes the specified self test. Failures are reported as errors. If the query form of the command is used, the specified self test is executed and the result of the test is returned in the form of a 16-bit word. A result of 0 indicates the test passed.

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.

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)
```

```
Example:  OUTPUT 707;"TEST 3"
```

Query Syntax: {TEST | TST}<test number>?

```
Returned Format: [TEST | TST]<NR1>
```

```
Example:  OUTPUT 707;"TEST3?"
          ENTER 707;Test3$
          PRINT Test3$
```

In this example, assume the result returned in Test3$ is the number 384.

then 384 = 256 + 128, therefore bits 9 and 8 were set. Refering to bits 9 and 8 for TEST3 in the table on the next page, you can see that CHAN 1 and CHAN 2 failed.

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SYSTEM COMMANDS

TEST | TST (cont)

TEST Query Result Register Encoding

BIT	BINARY WEIGHT	TEST0	TEST1	TEST2 and TEST3
15	16384	0	0	0
14	8192	0	STATE BOARD FAILED	0
13	4096	0	STATE POD FAILED	0
12	2048	0	INTERPOLATOR FAILED	0
11	1024	0	AUTOSCALE FAILED	0
10	512	0	FISO FAILED	0
9	256	0	CHAN 2 FAILED	CHAN 2 FAILED
8	128	0	CHAN 1 FAILED	CHAN 1 FAILED
7	64	0	0	0
6	32	0	ACQUISITION/TRIGGER FAILED	0
5	16	0	0	INPUT TEST FAILED
4	8	RAM FAIL	0	0
3	4	ROM FAIL	0	0
2	2	0	0	0
1	1	STC FAIL	0	0
0	0	HPIB FAIL	0	0

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ACQUIRE SUBSYSTEM

ACQuire

command/query

The acquire subsystem allows the store mode for channel 1 and channel 2 to be set the same with two commands, TYPE and COUNt. The POINts command is included to provide compatibility between HP HP 54201A/D programs and HP 54100A/D programs. The TYPE and COUNt functions may be selectively programmed by using the STORe command of the channel subsystem.

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>
                  [ FILTer ]<argument><crlf>

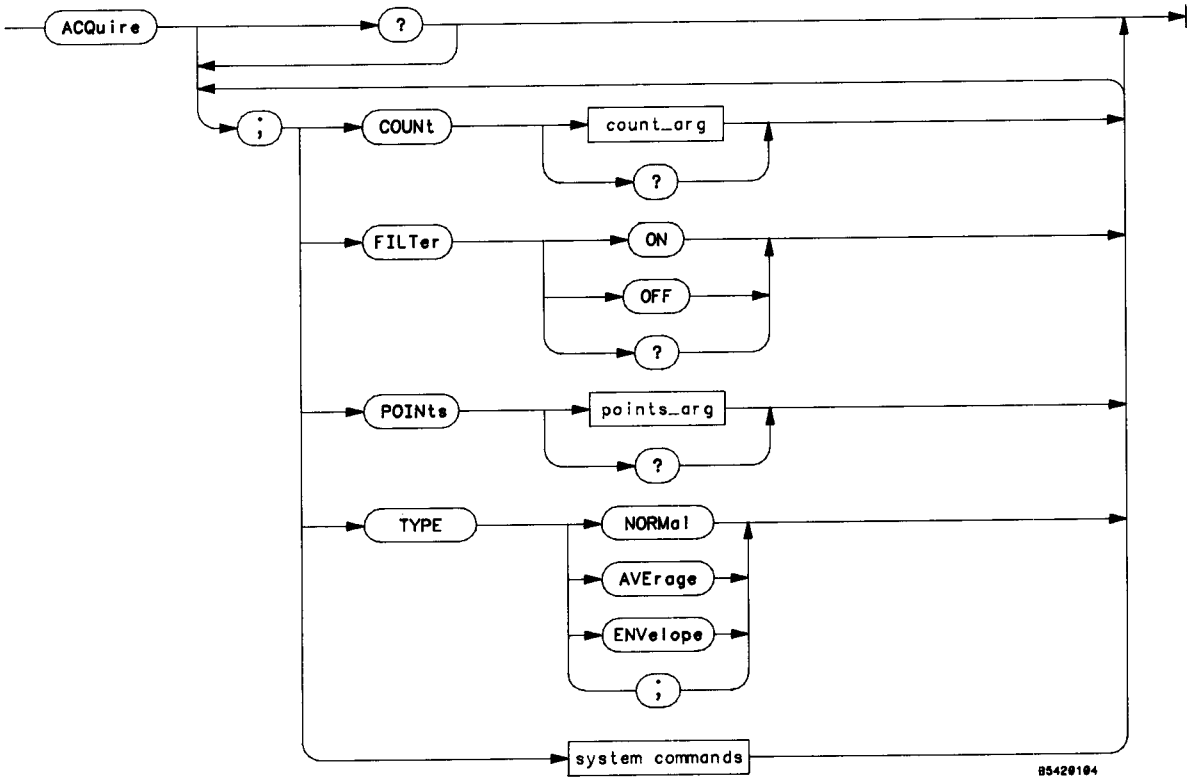
Example:  DIM Acquire$[70]
          OUTPUT 707;"ACQUIRE?"
          ENTER 707 USING "-K";Acquire$
          PRINT USING "K";Acquire$
```


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ACQUIRE SUBSYSTEM

ACQuire Commands:

```
COUNt
FILTer
POINts
TYPE
```



ACQuire Subsystem Syntax Diagram

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COUNt

command/query

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 can be 1 to 10,000.

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 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$
```


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ACQUIRE SUBSYSTEM

FILTer

command/query

Command sets the data filter mode, which extends resolution to 7-bits. Three types of data filters are available to the user depending on the time range and sampling mode selected.

Real time sampling, 5 μs to 10 s range – Data is put through a 3-point, moving-average filter. FILTer may be ON or OFF. The voltage at displayed data point n is defined as:

$$V_{n\ filtered} = 1/4(V_{n-1}) + 1/2(V_n) + 1/4(V_{n+1})$$

Real time sampling, 50 ns to 2 μs range – Data is put through a digital reconstruction filter. FILTer is always on regardless of how the command is sent. However, if FILTer is programmed OFF in this mode, and you switch to either of the other filter time ranges, the filter will be off.

Repetitive sampling, all time ranges – During repetitive sampling, more than one sample may occur at a given data point on a graph during a single acquisition frame. When FILTer is set ON, these samples for a given data point are averaged together.

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$
```


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ACQUIRE SUBSYSTEM

POINts

command/query

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/query

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

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

Command Syntax:

```
TYPE {[ NORMal    | 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$
```


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CHANNEL SUBSYSTEM

CHANnel

command/query

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>
[IMPedance]<argument><crlf>
[LABel]< 10 chars quoted ><crlf>
[STORe]<argument>,<NR1><crlf>
[SCALe]<argument><crlf>
[MODE]<argument><crlf>
```

Example:
```
DIM Chan$[150]
OUTPUT 707;"CHANNEL 1?"
ENTER 707 USING "-K";Chan$
PRINT USING "K";Chan$
```

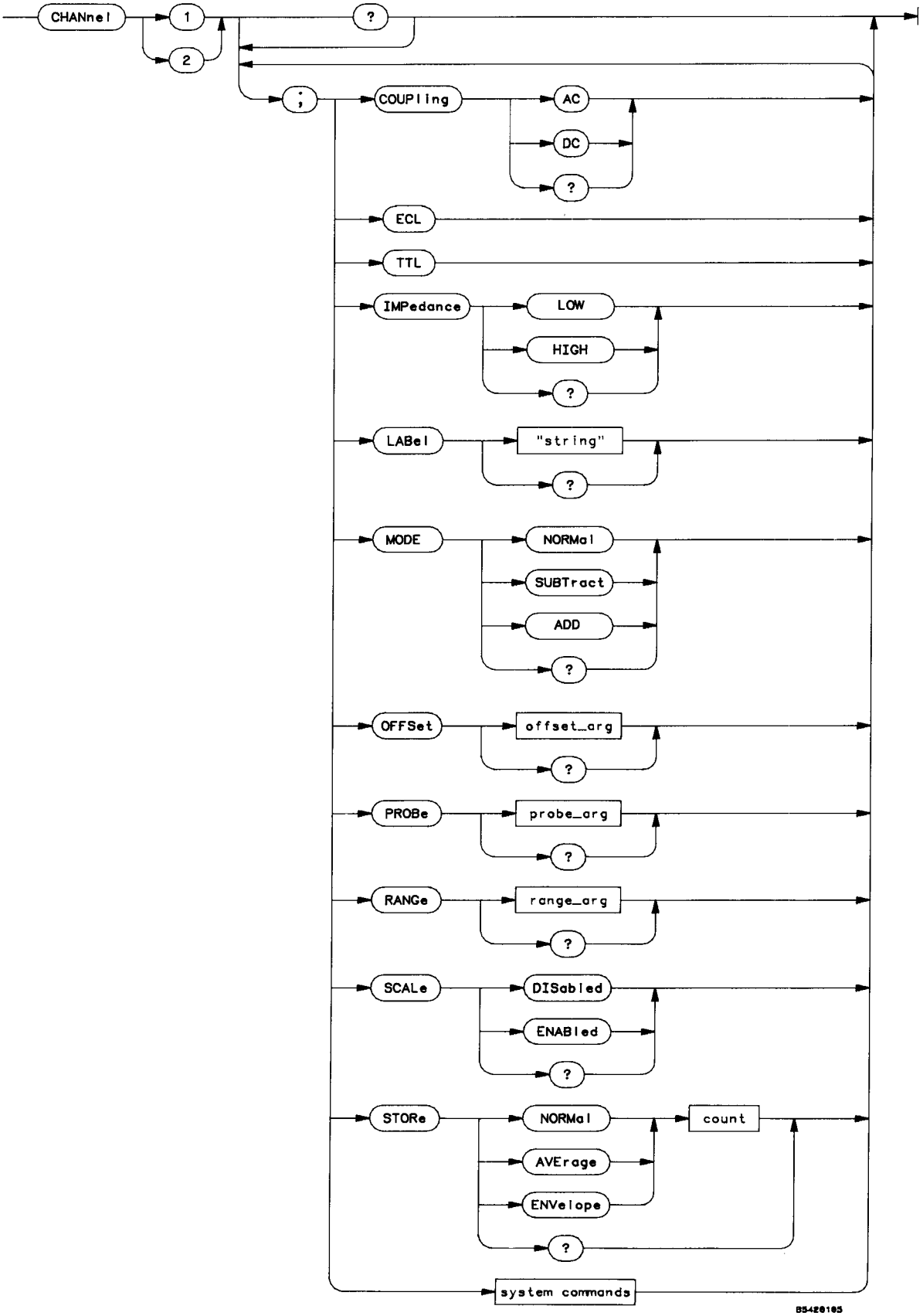
CHANnel Commands:

COUPling
ECL
TTL
IMPedance
LABel
MODE
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.

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CHANNEL SUBSYSTEM



CHANnel Subsystem Syntax Diagram

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CHANNEL SUBSYSTEM

COUPling

command/query

Command selects the input coupling for the selected channel. If AC coupling is selected, and 50Ω impedance is in effect, impedance will be changed to 1 MΩ (see IMPedance command). 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

Command presets the selected channel for ECL as follows:

```
COUPling  = DC          SCALe      = DISabled
OFFSet    = -1.00 V     PROBe      = unchanged
RANGe     = 2.0 V       IMPedance  = unchanged
```

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

Command presets the selected channel for TTL as follows:

```
COUPling  = DC          SCALe      = DISabled
OFFSet    = 2.50 V      PROBe      = unchanged
RANGe     = 6.0 V       IMPedance  = unchanged
```

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"

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CHANNEL SUBSYSTEM

IMPedance

command/query

Command sets the impedance for dc input coupling, 50Ω or 1 MΩ. Ac input coupling is always 1 MΩ. Attempting to set LOW impedance for AC coupling will generate an error. Query returns impedance of selected channel coupling.

Command Syntax: IMPedance {[LOW | 0]
[HIGH | 1]}

Example: OUTPUT 707;"IMPEDANCE HIGH"

Query Syntax: IMPedance ?

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

Example: OUTPUT 707;"IMPEDANCE?"
ENTER 707;Imped$
PRINT Imped$

LABel

command/query

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$

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MODE

command/query

Command selects input configuration for Channel 2: NORMal (Dual channel), SUBTract (Ch1-Ch2), or ADD (Ch1+Ch2). In NORMal mode, channels acquire data present at the corresponding inputs (INPUT 1 and INPUT 2). Channel 1 operates only in NORMal mode. Channel 2 may be set to act as a differential input in which the signal present at INPUT 2 is either subtracted from or added to the signal at INPUT 1. The subtraction or addition occurs as a software function after the two input signals have been acquired, therefore these modes don't provide the full benefit of common mode rejection as a true differential input system.

If either the SUBTract or ADD mode is selected for channel 2, all channel functions are slaved together except store mode and label. When channel 1 is addressed, setting probe factors, range, offset, coupling, or impedance controls these functions for both inputs. When channel 2 is addressed, probe, coupling, and impedance will be the same as selected for channel 1. However, range and offset are in terms of the resultant sum or difference waveform. For either ADD or SUBTract mode, the possible range of the resultant waveform is twice that of the individual input ranges. For SUBTract mode, the resultant offset can only be zero since the offset applied to each input is the same. For add mode, the resultant offset is twice that applied to each input.

Query returns the current input configuration.

Command Syntax: MODE {[NORMal | 0]
SUBtract | 1]
ADD | 2]}

Example: OUTPUT 707;"MODE ADD"

Query Syntax: MODE ?

Example: OUTPUT 707;"MODE?"
ENTER 707;Mode$
PRINT Mode$

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CHANNEL SUBSYSTEM

OFFSet

command/query

Command sets channel offset. Offset is ±1.5 V for 40 mV to 790 mV channel range and ±30 V for 800 mV to 16 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$
```

PROBe

command/query

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$
```


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CHANNEL SUBSYSTEM

RANGe

command/query

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 for dual channel mode. Range settings are doubled for CH1+CH2 and CH1-CH2 modes.

PROBE FACTOR	NORMAL MODE VALID RANGE SETTING
1:1	40 mV to 16 V
2:1	80 mV to 32 V
5:1	200 mV to 80 V
10:1	400 mV to 160 V
20:1	800 mV to 320 V
50:1	2 V to 800 V
100:1	4 V to 1600 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$
```

SCALe

command/query

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$
```


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CHANNEL SUBSYSTEM

STORe

command/query

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 not sent it defaults to 1.
Valid range is from 1 to 10,000
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$
```


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DISPLAY SUBSYSTEM

DISPlay

command/query

The display subsystem provides access to HP 54201A/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 SCReen command is particularly useful. By turning SCReen OFF, you can obtain significant improvements in instrument response times.

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"
```

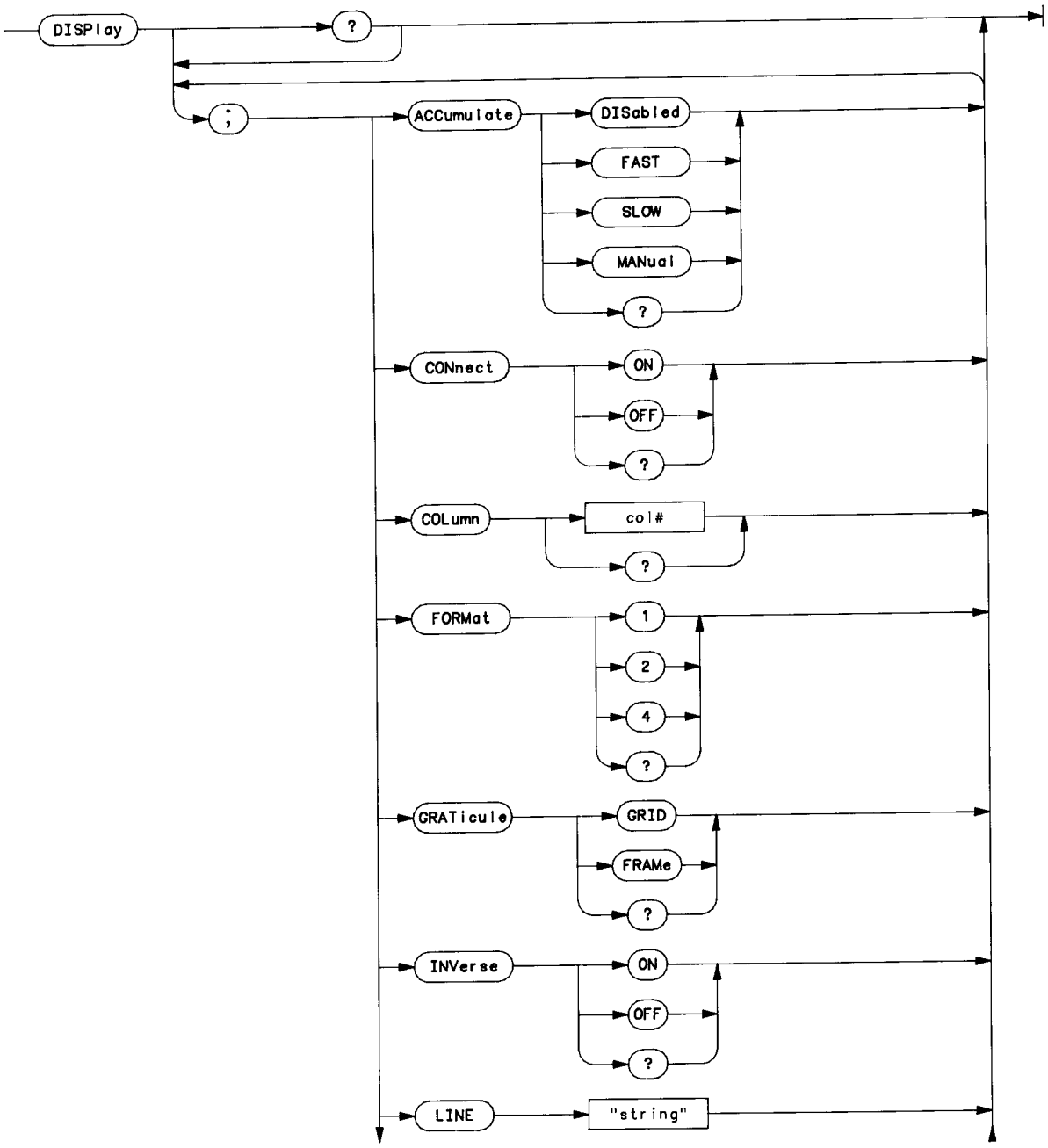
Query Syntax: DISPlay ?

```
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>
                  [ CONnect ]<argument><crlf>

Example:  DIM Display$[160]
          OUTPUT 707;"DISPLAY?"
          ENTER 707 USING "-K";Display$
          PRINT USING "K";Display$
```


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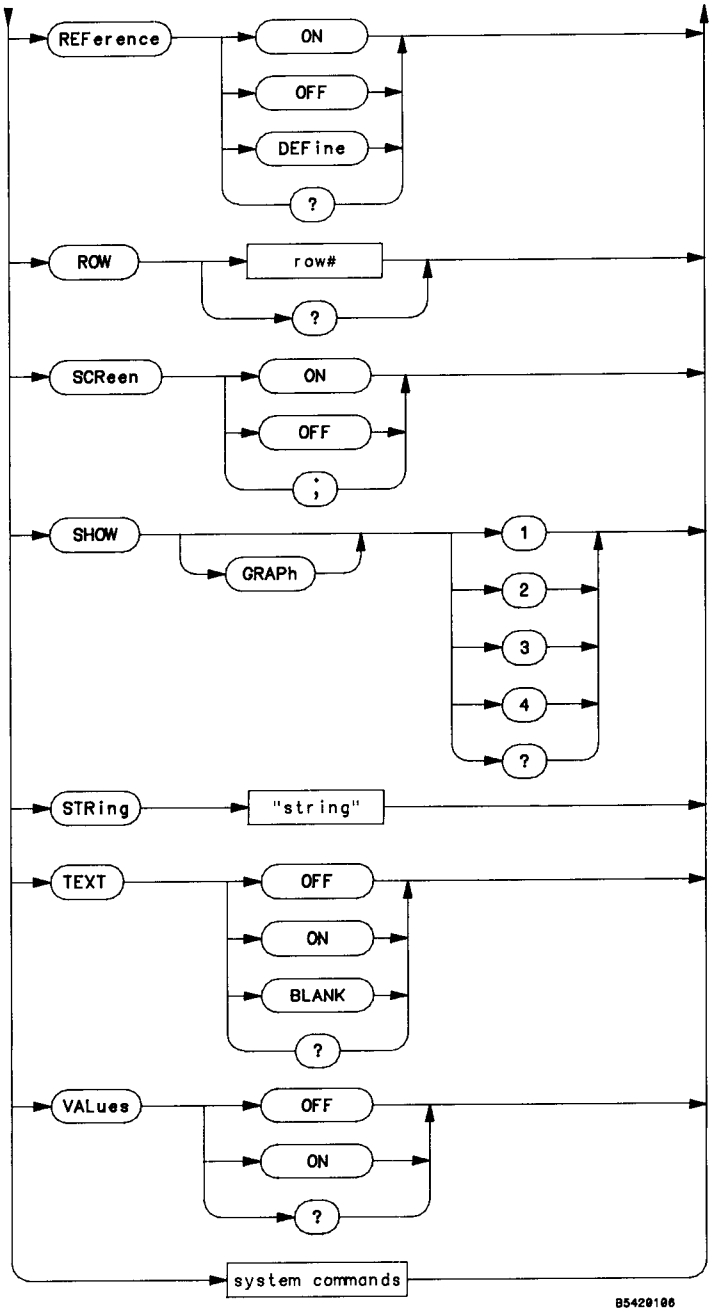
DISPLAY SUBSYSTEM



DISPlay Subsystem Syntax Diagram

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DISPLAY SUBSYSTEM



DISPlay Subsystem Syntax Diagram (cont)

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DISPLAY SUBSYSTEM

DISPlay Commands:

ACCumulate
COL
CONnect
ROW
FORMat
GRATicule
INVerse
LINE
REFerence
SCReen
SHOW
STRing
TEXT
VALues

ACCumulate **command/query**

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$

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COLumn

command/query

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/query

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$

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DISPLAY SUBSYSTEM

CONnect

command/query

Command sets connect dots mode for displayed waveforms on or off. Query returns status of connect dots mode.

Command Syntax: CONnect {[OFF | 0]
[ON | 1]

Example: OUTPUT 707;"CONNECT ON "

Query Syntax: CONnect ?

Example: OUTPUT 707;"CONNECT?"
ENTER 707;Connect$
PRINT Connect$

FORMat

command/query

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$

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GRATicule

command/query

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

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"

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DISPLAY SUBSYSTEM

LINE

command/query

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/query

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$
```


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DISPLAY SUBSYSTEM

SCReen

command/query

Command controls the HP 54201A/D display. ON turns normal display on, which has no effect if the display is already on; the last HP 54201A/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/query

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$
```


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DISPLAY SUBSYSTEM

STRing

command

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 appliation.

Command Syntax: STRing < any quoted string >

```
Example:  OUTPUT 707;"STRING ""Press INSERT to continue"""
```

TEXT

command/query

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"
```


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VALues

command/query

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$
```


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GRAPH SUBSYSTEM

GRAPh

command/query

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>|<NR2>|<NR3>}<crlf>
                  [LOWer]{<NR1>|<NR2>|<NR3>}<crlf>

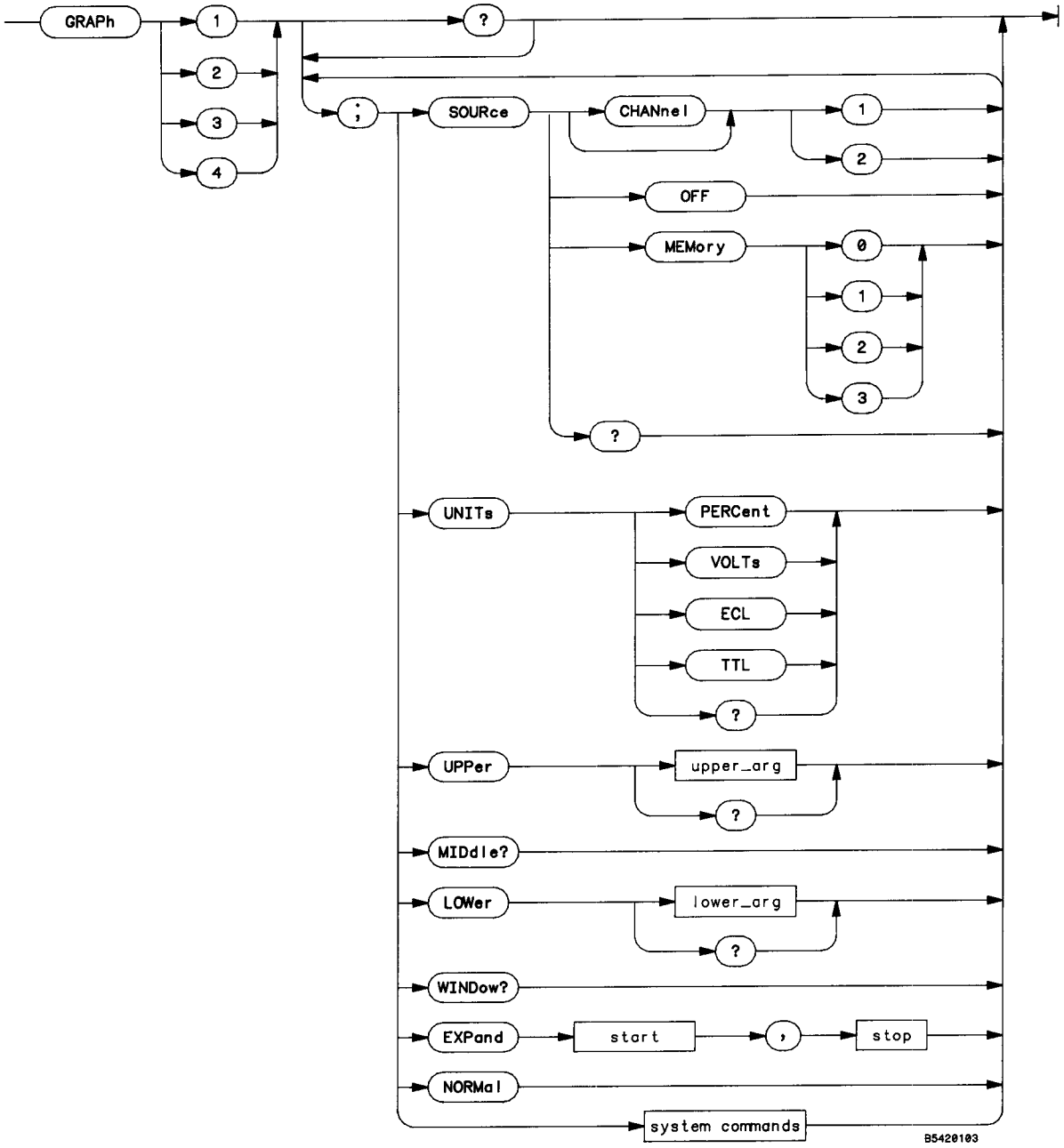
Example:  DIM Graph$[70]
          OUTPUT 707;"GRAPH 2?"
          ENTER 707 USING "-K";Graph$
          PRINT USING "K";Graph$
```

GRAPh Commands:

SOURce
UNITs
UPPer
LOWer
MIDdle
WINDow
EXPand
NORMal

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GRAPH SUBSYSTEM



GRAPh Subsystem Syntax Diagram

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SOURce

command/query

Command selects the data source for the currently addressed graph. When a new source is selected for a graph, the graph is initialized to an unexpanded (i.e. normal) display of the waveform data.

Query returns the data source displayed on the addressed graph.

Command Syntax: SOURce {[CHANnel1 | 1]
[CHANnel2 | 2]
[OFF]
[MEMory {0|1|2|3}]}

Example: OUTPUT 707;"SOURCE CHANNEL1"

Query Syntax: SOURce ?

Returned Format : [SOURce]{[CHANnel1]
[CHANnel2]
[OFF]
[MEMory0]
[MEMory1]
[MEMory2]
[MEMory3]}

Example: OUTPUT 707;"SOURCE?"
ENTER 707;Source$
PRINT Source$

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GRAPH SUBSYSTEM

UNITs

command/query

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 HP 54201A/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/query

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$
```


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GRAPH SUBSYSTEM

MIDdle

query

Query which returns the value of the middle measurement threshold.

Query Syntax: MIDdle ?

```
Returned Format:  [MIDdle] {[ <NR1> ]              (if percent)
                           [ <NR3> ]              (if volts)
                           [ <NR2> ]} <crlf>      (if TTL or ECL)

Example:  OUTPUT 707;"MIDDLE?"
          ENTER 707;Middle$
          PRINT Middle$
```

LOWer

command/query

Command sets lower measurement threshold if UNITs has been set to VOLTs or PERCent. The lower limit is preset for ECL and TTL. If UNITs has been set to PERCent, the allowable lower limit is from 1% to 45%.

Query returns the value of the lower measurement threshold.

Command Syntax: LOWer <lower limit>

```
Example:  OUTPUT 707;"LOWER 25"  (assuming UNITs has been set to PERCent)
```

Query Syntax: LOWer ?

```
Returned Format:  [LOWer ] {[ <NR1> ]              (if percent)
                           [ <NR3> ]              (if volts)
                           [ <NR2> ]} <crlf>      (if TTL or ECL)

Example:  OUTPUT 707;"LOWER?"
          ENTER 707;Lower$
          PRINT Lower$
```


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GRAPH SUBSYSTEM

WINDow

query

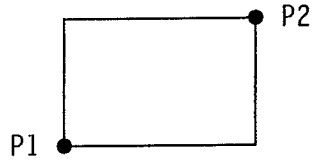
Query returns a pair of (X,Y) coordinates describing the time and voltage limits of the graph display. Effectively these are P1 and P2 coordinates as used in plotter or HP Series 200 Controller window commands.

Query Syntax: WINDow ?

Returned Format: [WINDow]<NR3>,<NR3>,<NR3>,<NR3><crlf>

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

command

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 ≥54 sample intervals, i.e., the minimum number of points displayed must be ≥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

Command sets graph to show entire waveform, unexpanded.

Command Syntax: NORMal

Example: OUTPUT 707;"NORMAL"

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MEASURE SUBSYSTEM

MEASure

command/query

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$
```


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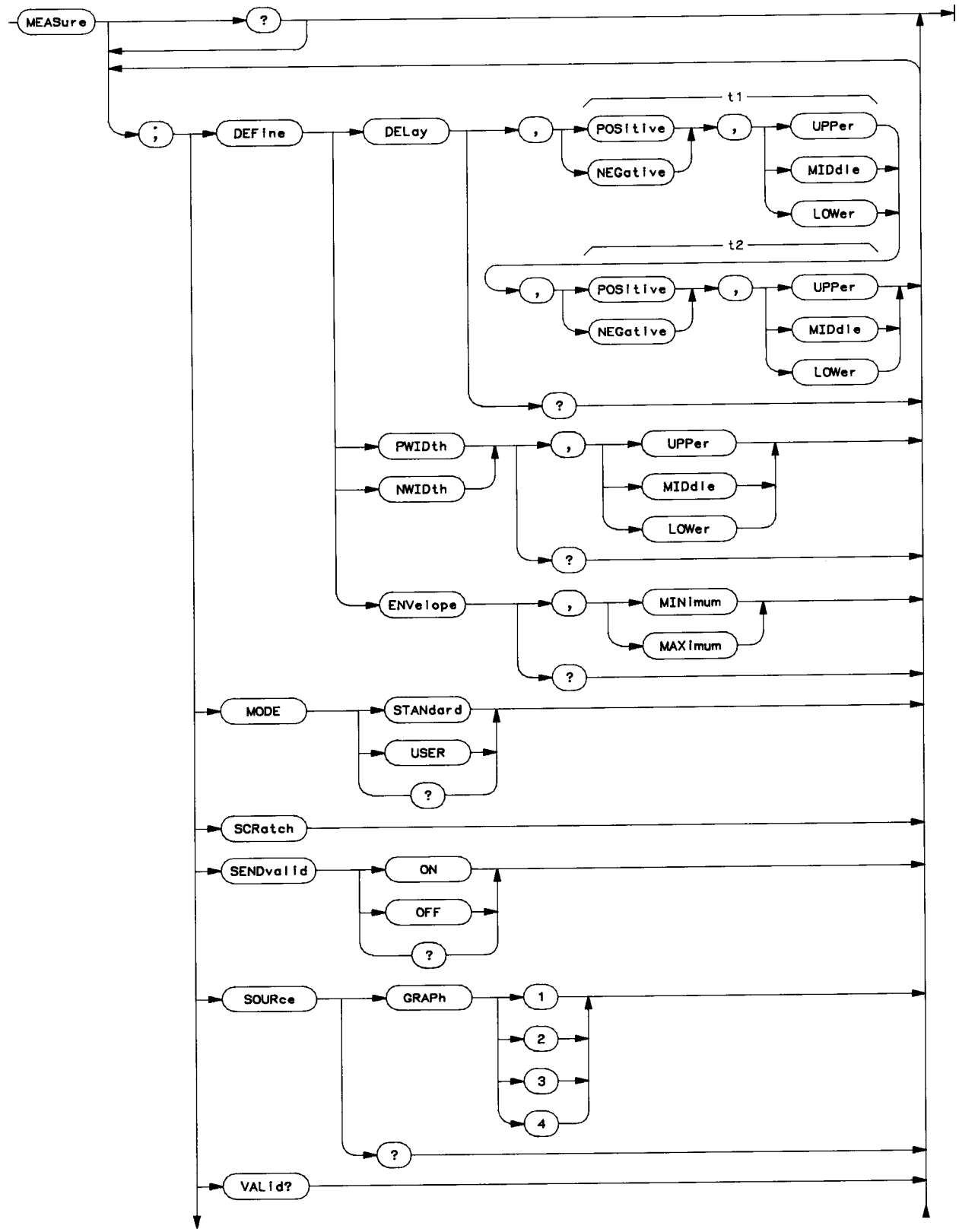
MEASURE SUBSYSTEM

MEASure Commands:

DEFine MODE SCRatch SENDvalid SOURce VALid	Setting the Measurement Environment
RESULts	Getting Answers (Displayed on screen)
DELay DUTycycle FALL FREQuency NWIDth OVERshoot PERiod PREShoot PWIDth RISE TMAX TMIN VAMP VAVE VBASe VMAX VMIN VPP VRMS VTOP	Defined Measurements (Putting answers on screen or readout via HP-IB)
PTIMe VTIMe PVOLt TVOLt TPOint VPOint CURSor	Fundamental Measurements (HP-IB readout only)

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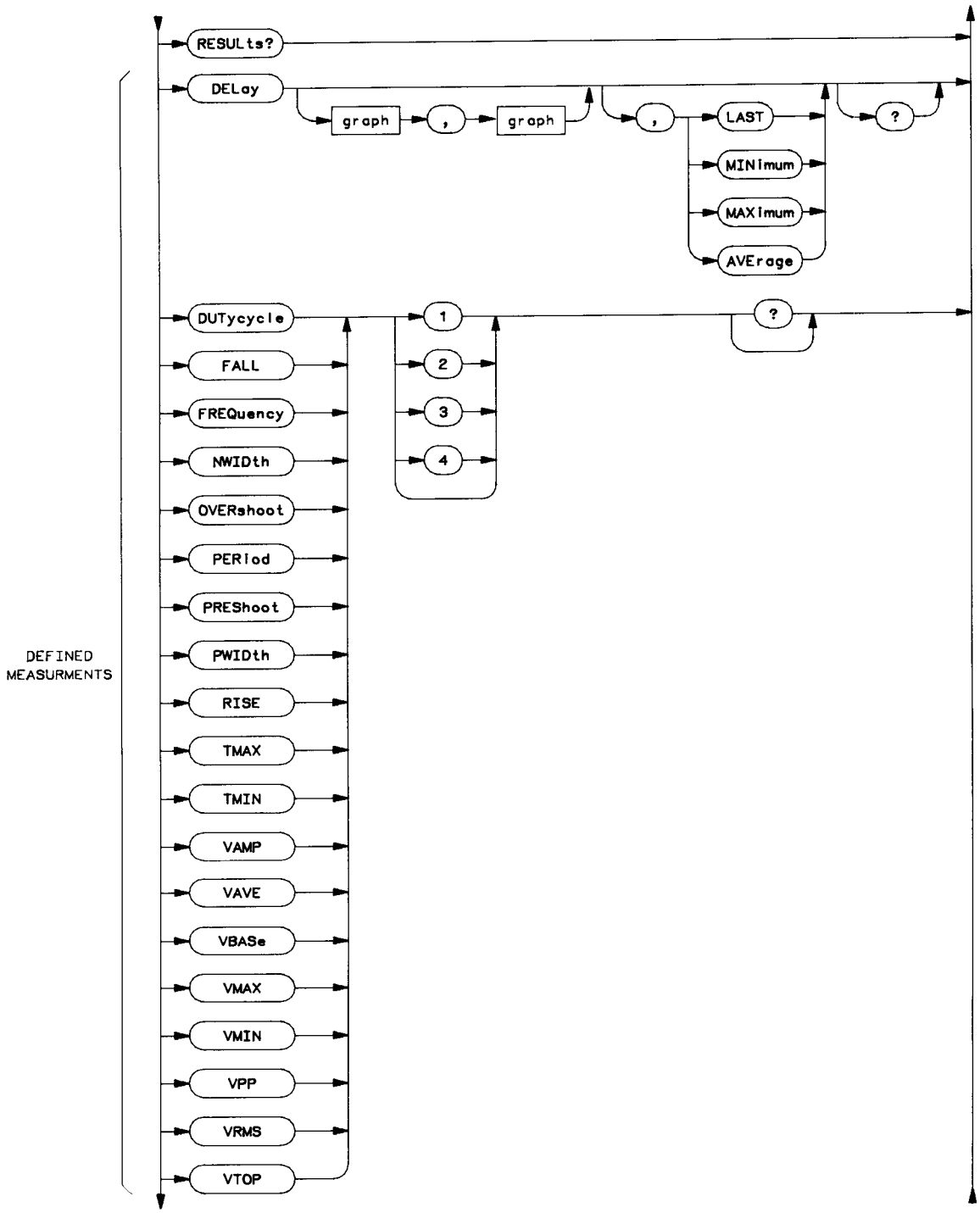
MEASURE SUBSYSTEM



MEASure Subsystem Syntax Diagram

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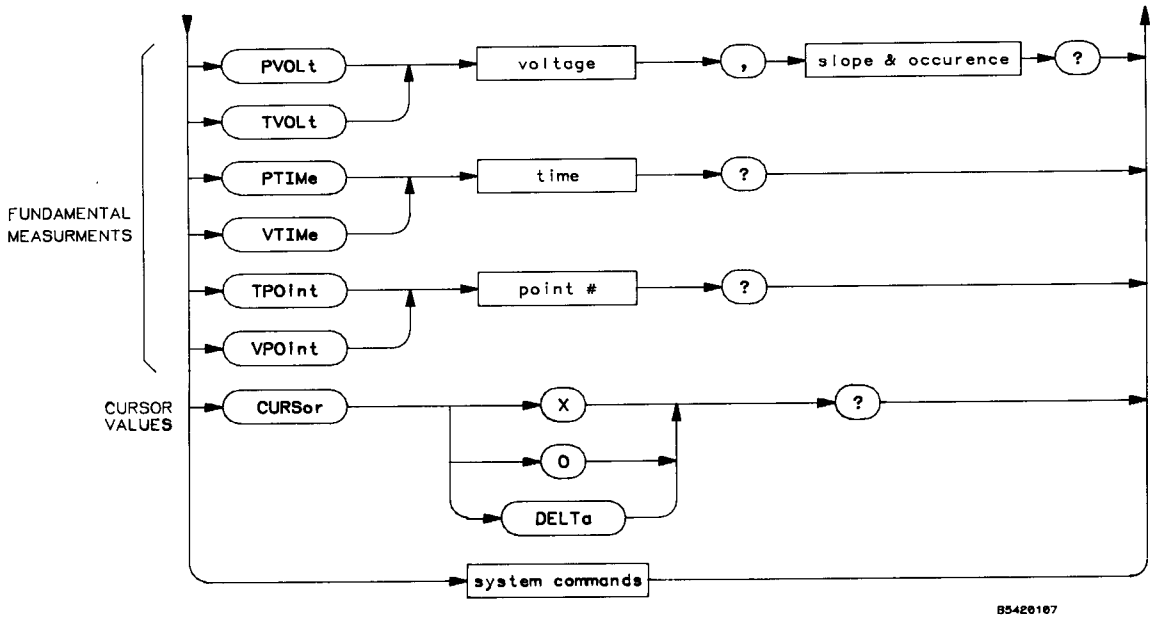
MEASURE SUBSYSTEM



MEASure Subsystem Syntax Diagram (Cont)

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MEASURE SUBSYSTEM



MEASure Subsystem Syntax Diagram (cont)

SETTING THE MEASUREMENT ENVIRONMENT

HP 54201A/D provides two basic modes for measurements, standard and user defined. In standard mode, graph 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.

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MEASURE SUBSYSTEM

MODE

command/query

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><crlf>

```
Example:  OUTPUT 707;"MODE?"
          ENTER 707;Mode$
          PRINT Mode$
```

SOURce

command/query

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$
```


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MEASURE SUBSYSTEM

SENDvalid

command/query

If command SENDvalid is ON, an optional parameter is sent by the HP 54201A/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$
```

VALid

query

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$
```


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MEASURE SUBSYSTEM

DEFine

command/query

Several of the instrument measurements can be customized to suit special requirements using the DEFine command. These definitions can be set at anytime, but only take effect when the MODE command has been set to USER mode.

The DEFine query returns the current definition for the specified measurement.

```
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"
```

For DELay, both edges can be set independently. For each 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 fundamental measurement commands VTIMe, VPOint, TVOLt, and PVOLt. For ENVelope,

```
<measurement specification> ::= {[ MINimum | 0 ]
                                 [ MAXimum | 1 ]}
```

```
Example:  OUTPUT 707;"DEFINE ENVELOPE,MAXIMUM"
```


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DEFine (cont)

```
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

Command clears the voltage and time measurement lists from the display.

```
Command Syntax:  SCRatch

    Example:  OUTPUT 707;"SCRATCH"
```


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MEASURE SUBSYSTEM

EXECUTING MEASUREMENTS

The two modes of execution of measurements in the HP 54201A/D are immediate and queued.

- In immediate mode (query form), the measurement is performed as the command is parsed and the results are entered into the output buffer. If the waveform being measured is currently being acquired, the measurement is postponed until the waveform reaches its terminal count criteria as specified with the CHANnel STORe command or ACQuire COUNt command.

- In queued mode (command form), the measurement is added to the display list on screen. 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. If the instrument is in RUN mode (System command), the measurements are updated each time a new frame is acquired. If the instrument is in DIGitize mode (System command), the measurements are updated when the digitized operation is fully completed.

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.

RESULts **query**

RESULts is a query which causes the HP 54201A/D to output the list of active measurements which is displayed on screen.

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>
```


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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 USING "K";Results$
```

Defined Measurements

The following measurements are defined for HP 54201A/D:

DELay delay from first specified edge on one graph to the next specified edge on same graph, or to first specified edge on another graph.

DUTycycle (+WIDth / PERiod)

FALL fall time of first falling edge from upper to lower threshold.

FREQuency (1/PERiod)

NWIDth ΔT from first falling edge threshold to next rising edge threshold.

OVERshoot (VMAX − VTOP)

PERiod ΔT from first edge middle threshold to next like edge middle threshold.

PREShoot (VBASe − VMIN)

PWIDth ΔT from first rising edge threshold to next falling edge threshold.

RISE Rise time of first rising edge from lower to upper threshold.

TMAX Time at which first occurrence of VMAX occurred.

TMIN Time at which first occurrence of VMIN occurred.

VAMP (VTOP − VBASe), see note next page

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MEASURE SUBSYSTEM

Defined Measurements (cont)

VAVE Average voltage calculated on full period of waveform if available, else calculation based on full graph.

VBASe 0% level voltage, see note below.

VMAX Absolute maximum voltage.

VMIN Absolute minimum voltage.

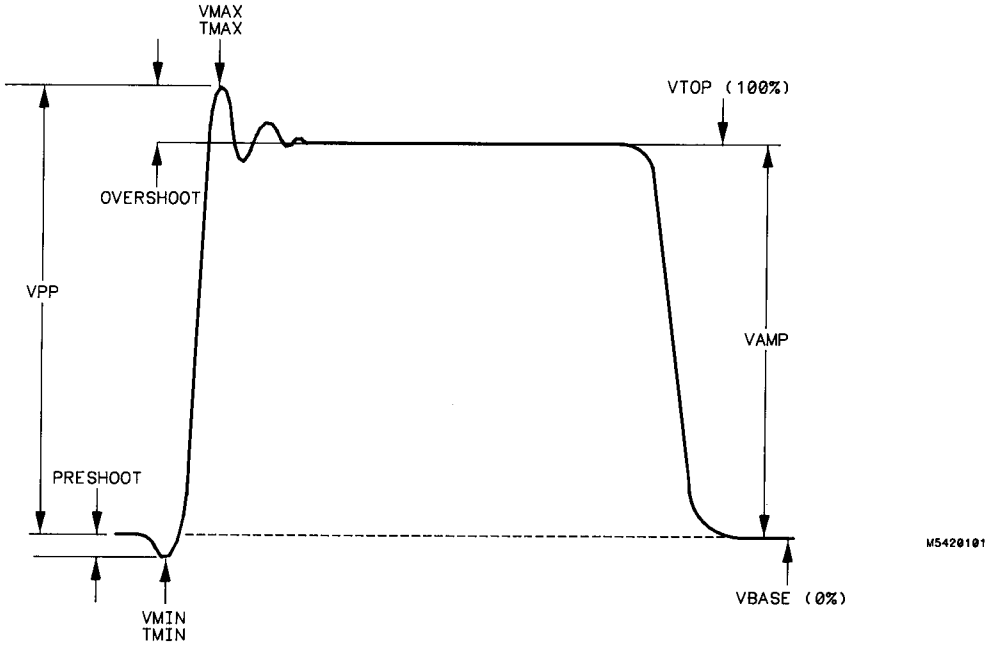
VPP (VMAX − VMIN)

VRMS True rms voltage (dc + ac component). Ac couple to remove ac component. Calculated on full period of waveform if available, else calculation based on full graph.

VTOP 100% level voltage, see note below.

Note

The 0% level and 100% level are determined from the occurrence density histogram of the data points windowed in a graph. The histogram is computed by summing the number of occurrences of each quantization level in the waveform data. The quantization level with the greatest number of occurrences in the top half of the waveform corresponds to the 100% level. The quantization level with the greatest number of occurrences in the bottom half of the waveform corresponds to the 0% level. If the computed 0% and 100% levels do not contain a significant number of occurrences (at least 5% of the total number of data points windowed in the graph), then the 0% level and 100% level default to the values of VMIN and VMAX. All percentage thresholds area calculated from the 0% and 100% levels.



Waveform Definitions

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MEASURE SUBSYSTEM

Defined Measurements (cont)

All defined measurements, except DELay, follow the syntax:

Command/Query Syntax: <measurement name>[<graph number>][?]

If no graph is specified, the graph specified with the MEASure SOURce command is measured.

If the command form is specified, the measurement is added to the appropriate measurement list (time or volt) on the HP 54201A/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;"FREQUENCY1"      or

          OUTPUT 707;"VMAX4"
```

If the query form is specified, the measurement is performed immediately and not displayed on the HP 54201A/D. The results are placed in the output buffer of the HP 54201A/D with the following format for non-delay measurements:

```
Returned Format:  [<measurement name>]<value>[,<validity>]<crlf>

Example:  DIM Rise[30]
          OUTPUT 707;"RISE?"
          ENTER 707;Rise$
          PRINT Rise$
```

Note

When any of these defined measurements (except TMAX, TMIN, VMIN, VMAX, and VPP) are performed on envelope type waveforms, the maximum wave data is always used. All wave data is used for TMAX, TMIN, VMIN, VMAX, and VPP.

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MEASURE SUBSYSTEM

Defined Measurements (cont)

DELay

command/query

Command Syntax:

```
DELay [<graph#>,<graph#>[,[LAST | MINimum | MAXimum | AVErage]
```

LAST - delay measured for last acquistion.
MINimum - minimum delay measured for on acquisitions since DELay executed.
MAXimum - maximum delay measured for on acquisitions since DELay executed.
AVErage - average of delay measured for all acquisitions since DELay executed.

If no graph is specified, the graph specifed with the MEASure source command is measured.

When the command form is specified, the DELay measurement is added to the time measurement list on the HP 54201A/D display and the answers are returned to the controller using the RESULts query. The LAST measurement will be made if not specified otherwise. If more than 3 measurements are specified for the time list, only the last 3 are retained (performed) and any others are discarded.

Example:
```
OUTPUT 707;"DELAY1,2"
```
or
```
OUTPUT 707;"DELAY1,4,MINIMUM"
```

Query Syntax: `DELay [<graph#>,<graph#>]?`

When the query form is specified, only the LAST measurement will be performed. The measurement is performed immediately and not displayed on the HP 54201A/D. The results are placed in the output buffer of the HP 54201A/D with the following format:

Returned Format: `[DELay]<value>[,<validity>]<crlf>`

Example:
```
DIM Delay$[30]
OUTPUT 707;"DELAY1,2?"
ENTER 707;Delay$
PRINT Delay$
```

When the DELay measurement is performed on envelope type waveforms, the maximum wave data is used except for one case. When the edges defined by the DEFine command are on the same graph (graphs defined by DELay command) and when the edge polarity and threshold levels are the same for each edge, the delay is measured from the edge threhold on the maximum wave data to the like edge threshold on the minimum wave data. This is a convenient way to make a jitter measurement.

Example:
```
DIM Jitter$[30]
OUTPUT 707;"DEFINE DELAY,NEGATIVE,MIDDLE,NEGATIVE,MIDDLE"
OUTPUT 707;"DELAY1,1?"
ENTER 707;Jitter$
PRINT Jitter$
```


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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

query

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

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$
```


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MEASURE SUBSYSTEM

Fundamental Measurements (cont)

PVOLt

query

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

query

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$
```


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MEASURE SUBSYSTEM

Fundamental Measurements (cont)

TPOint

query

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

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$
```


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MEASURE SUBSYSTEM

Cursor Values

Although the cursors are not programmable via the HP-IB, the cursor values may be read.

CURSor

query

If a query with X or O argument is executed, the HP 54201A/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 HP 54201A/D returns an x,y pair representing the Δ time and Δ 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$
```


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STATE SUBSYSTEM

STATe

command/query

The state subsystem is available only on the HP 54201D 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 >}!1!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>
```


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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>     ]
                                   [ #O<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$
```


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STATE SUBSYSTEM

STATe Commands:

Assignment Commands

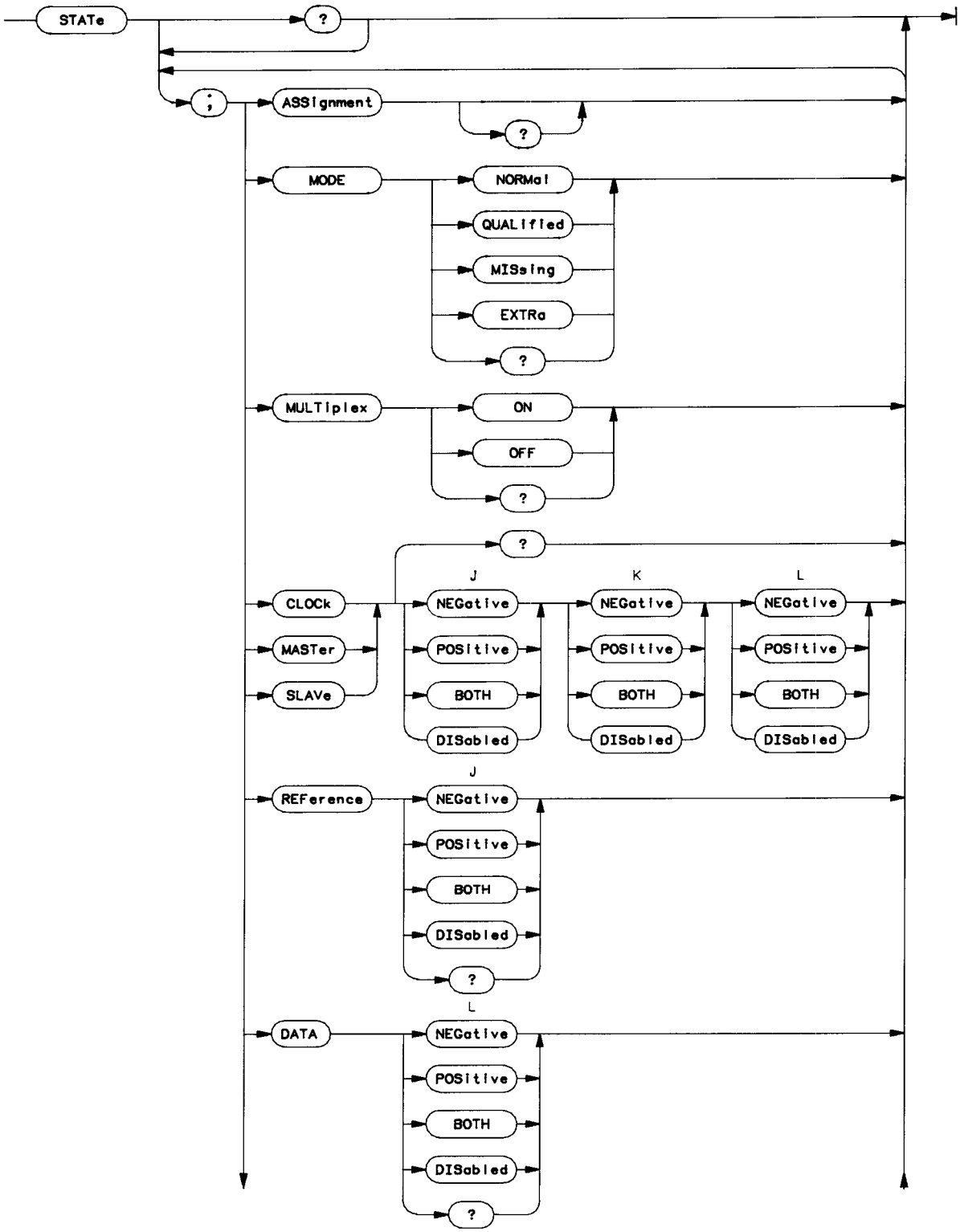
ASSignment
MODE
MULTiplex
CLOCk
MASTer
SLAVe
DATA
REFerence
POD0
POD1
POD2
LABel
INSert
DELete
POLarity
ALLocate
BASE
PATtern

Sequence Commands

SEQuence
FIND
COUNt
OF
TERMs
RESTart

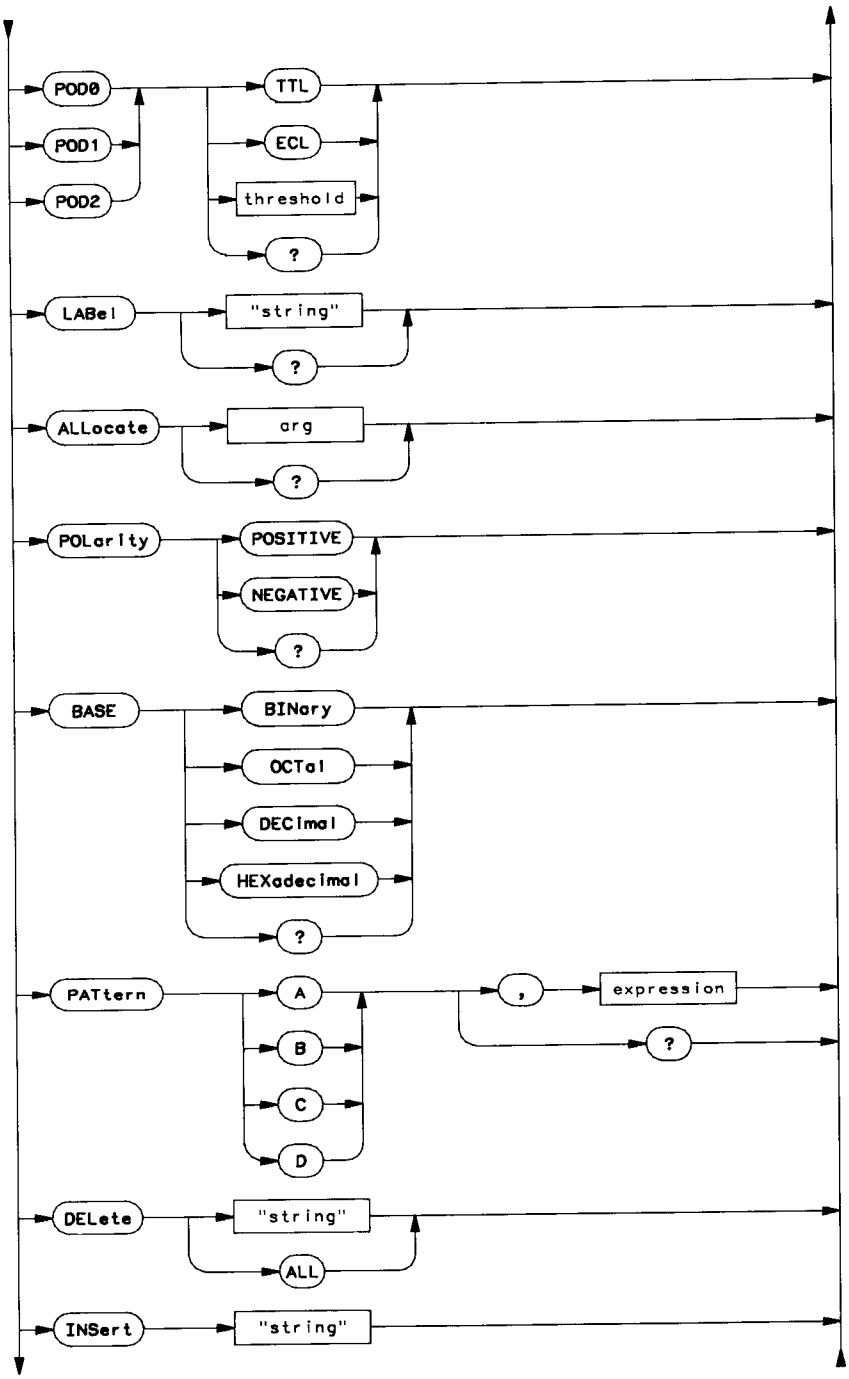
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STATE SUBSYSTEM



STATe Subsystem Syntax Diagram (Assignment)

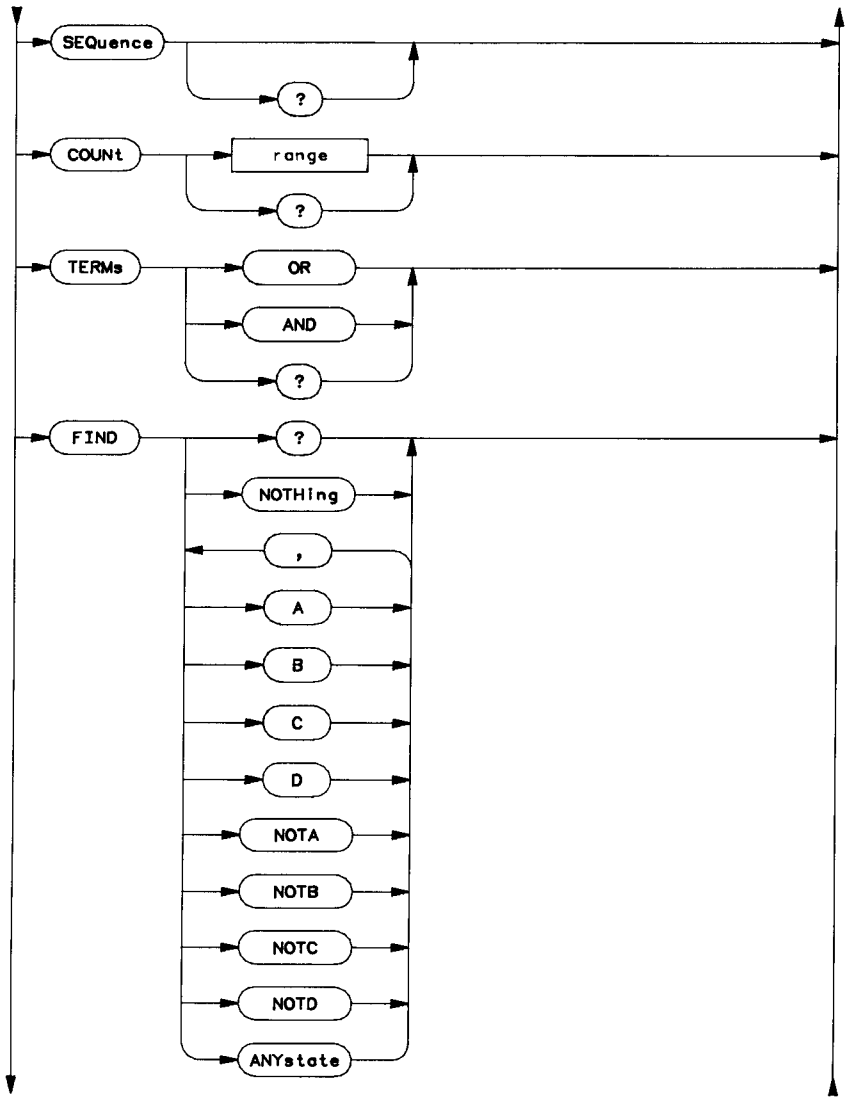
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STATe Subsystem Syntax Diagram (ASSignment cont)

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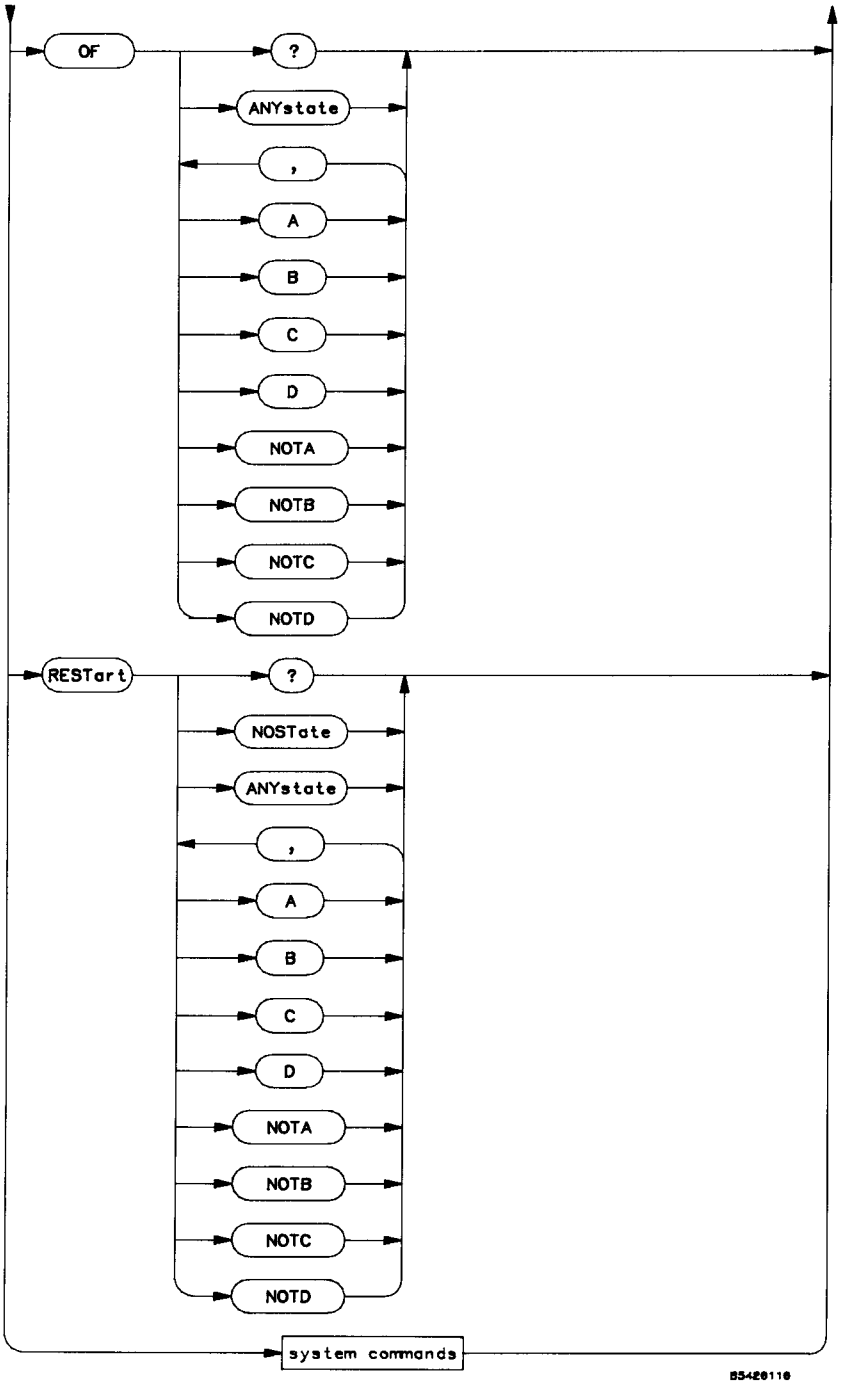
STATE SUBSYSTEM



STATe Subsystem Syntax Diagram (SEQuence)

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STATE SUBSYSTEM



STATe Subsystem Syntax Diagram (SEQuence cont)

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STATE SUBSYSTEM

Assignment Commands

ASSignment

command/query

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 >}!1!8!    (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/query

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$
```


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STATE SUBSYSTEM

MULTiplex

command/query

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/query

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$
```


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STATE SUBSYSTEM

MASTer

command/query

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/query

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$
```


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STATE SUBSYSTEM

DATA

command/query

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/query

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$
```


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STATE SUBSYSTEM

POD

command/query

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

command/query

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$

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STATE SUBSYSTEM

ALLocate

command/query

This command sets the allocation for the label, that is it determines which pins are used on the pods or that label. The <NR1> values are interpreted as mask values much like the RQS mask.

Query returns the allocation of the addressed label.

Command Syntax: ALLocate {[<pod2 NR1>,<pod1 NR1>,<pod0 NR1>] (three pods in normal or qualified mode)

[<pod1 NR1>]} (only one pod in missing or extra bit mode).

Example: OUTPUT 707;"ALLOCATE 511,2,4"

This allocation would be shown on the HP 54201D display as:

label [+] [********* ....*. ......*..]

Query Syntax: ALLocate ?

Returned Format: [ALLocate][{<pod2 NR1>,<pod1 NR1>,<pod0 NR1>]
<pod1 NR1>]}<crlf>

```
Example:  OUTPUT 707;"ALLOCATE?"
          ENTER 707;Allocate$
          PRINT Allocate$
```

POLarity

command/query

Command sets the polarity of the addressed label. Query returns the polarity of the addressed label.

Command Syntax: POLarity {[POSitive | 1]
[NEGative | 0]}

Example: OUTPUT 707;"POLARITY POSITIVE"

Query Syntax: POLarity ?

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

```
Example:  OUTPUT 707"POLARITY?"
          ENTER 707;Polarity$
          PRINT Polarity$
```


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STATE SUBSYSTEM

BASE

command/query

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]
[DECimal | 2]
[HEXadecimal | 3]}

Example: OUTPUT 707;"HEXADECIMAL"

Query Syntax: BASE ?

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

Example: OUTPUT 707;"BASE?"
ENTER 707;Base$
PRINT Base$

DELete

command

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

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" Clk """

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STATE SUBSYSTEM

PATtern

command/query

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>     ]
                           [ #O<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><crlf>

```
Example: DIM Pattern$[50]
         OUTPUT 707;"PATTERN?"
         ENTER 707;Pattern$
         PRINT Pattern$
```


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STATE SUBSYSTEM

Sequence Commands

SEQuence

command/query

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 ]<NR1><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$
```


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STATE SUBSYSTEM

FIND

command/query

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/query

Command programs the trigger term occurrence count. Range is 1 to 59999.
Query returns the occurrence count.

Command Syntax: COUNt < NR1 >

Example: OUTPUT 707;"COUNT 154"

Query Syntax: COUNt ?

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

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


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STATE SUBSYSTEM

OF

command/query

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/query

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$
```


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RESTart

command/query

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$
```


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TIMEBASE SUBSYSTEM

TIMebase

command/query

The timebase group controls all "X axis" oscillscope 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>
                   [ SAMPle]<argument><crlf>
                   [ SCALe]<argument><crlf>
```

```
Example:  DIM Time$[130]
          OUTPUT 707;"TIMEBASE?"
          ENTER 707 USING "-K";Time$
          PRINT USING "K";Time$
```

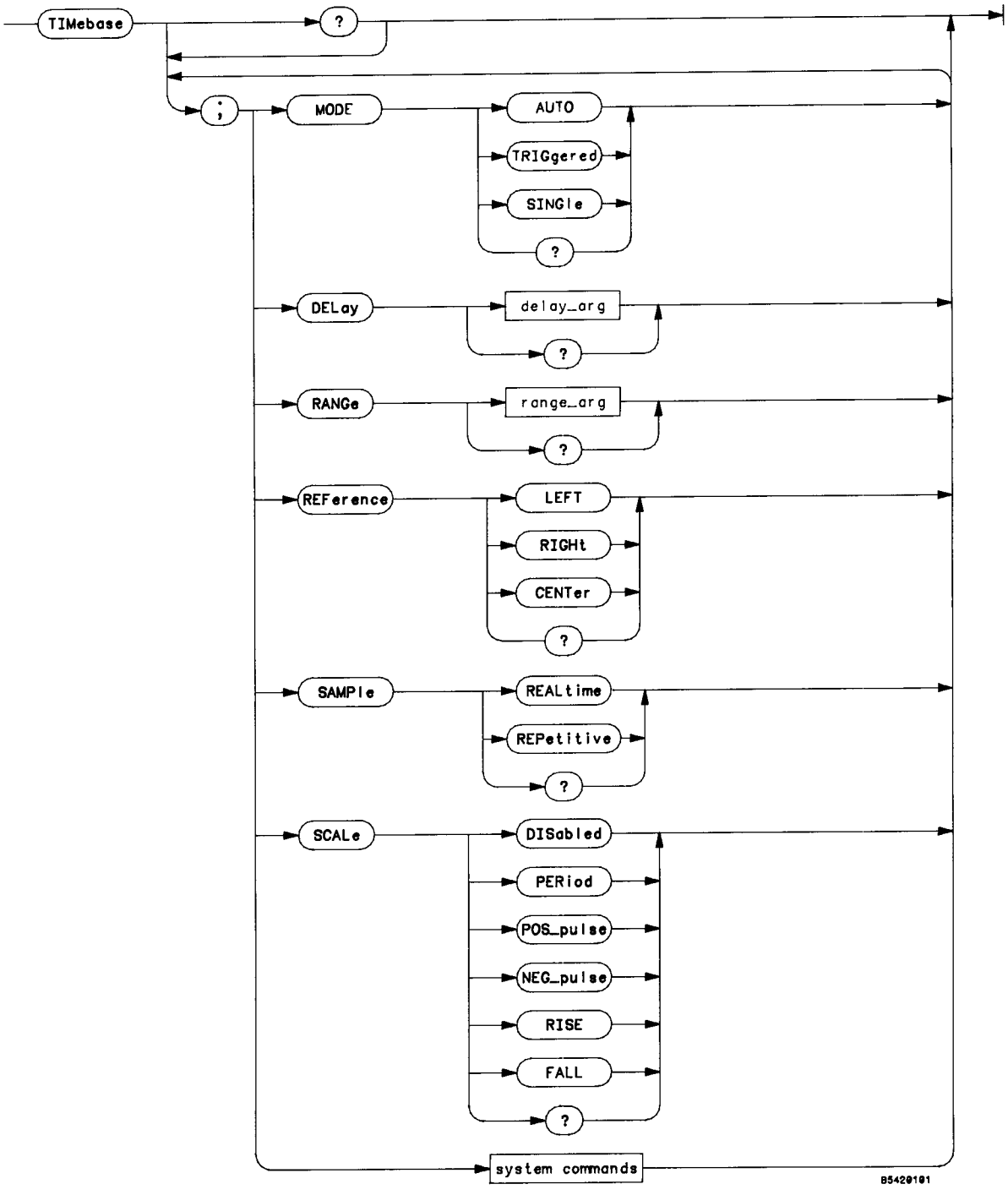
TIMebase Commands:

MODE
RANGe
DELay
REFerence
SAMPle
SCALe
RATE

Timebase commands are order dependent in that delay limits are determined by the current range setting.

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TIMEBASE SUBSYSTEM



TIMebase Subsystem Syntax Diagram

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TIMEBASE SUBSYSTEM

MODE

command/query

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/query

Command sets timebase range (s/div * 10 div). Range is from 10 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. Real time sampling mode range is from 50 ns to 10s and repetitive sampling mode is from 10 ns to 20 μs (see SAMPle command).

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$
```


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TIMEBASE SUBSYSTEM

DELay

command/query

Command sets time to current reference point from trigger. Post-trigger delay range is at least 200 screen diameters (horizontal time ranges). Pre-trigger delay range is defined as follows.

Pre-Trigger Range:

Sampling Mode	Time Range	Pre-Trigger Range
Real Time	50 ns to 5 μs 10 μs to 10 s	Up to 10 μs Up to 2 screen diameters
Repetitive	10 ns to 20 μs	Up to 2 screen diameters

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/query

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$
```


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TIMEBASE SUBSYSTEM

SAMPle

command/query

Command set the sampling mode for the HP 54201A/D. REALtime mode acquires all samples for a displayed waveform on a single sweep with a 50-MHz bandwidth. REPetitive mode acquires samples for a displayed waveform on multiple sweeps with a 300-MHz bandwidth. Valid time range for REALtime sampling mode is 50 ns to 10 s, and valid time range for REPetitive mode is 10 ns to 20 μs. If the time range is greater than 20 μs, REALtime is always used independent of sample mode setting. If the time range is less than 50 ns, REPetitive sampling is always used independent of sample mode setting. In general, if the signal to be acquired is of a low repetition rate or is not truly repetitive and 50 MHz bandwidth is sufficient, REALtime mode is preferable.

Query returns the currently selected sample mode.

Command Syntax: SAMPle {[REALtime | 0]
[REPetitive | 1]}

Example: OUTPUT 707;"SAMPLE REPETITIVE"

Query Syntax: SAMPLE ?

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

```
Example:  OUTPUT 707;"SAMPLE?"
          ENTER 707;Sample$
          PRINT Sample$
```

SCALe

command/query

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$
```


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TIMEBASE SUBSYSTEM

RATE

command/query

Command sets time range in terms of sample rate. Sample period is range/1000, rate is 1/period. The rate is displayed on the HP 54201A/D time menu in the "Sampling @" field when in real time mode. When operating in repetitive mode, rate is in terms of effective sample rate.

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$
```


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TRIGGER SUBSYSTEM

TRIGger

command/query

The trigger group controls all analog trigger functions. 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]<NR3><crlf>
                  [SLOPe]<argument><crlf>
                  [LEVel]<NR3><crlf>
                  [COUPling]<argument><crlf>
                  [IMPedance]<argument><crlf>
                  [EVENt]<NR1><crlf>
                  [SCALe]<argument><crlf>
```

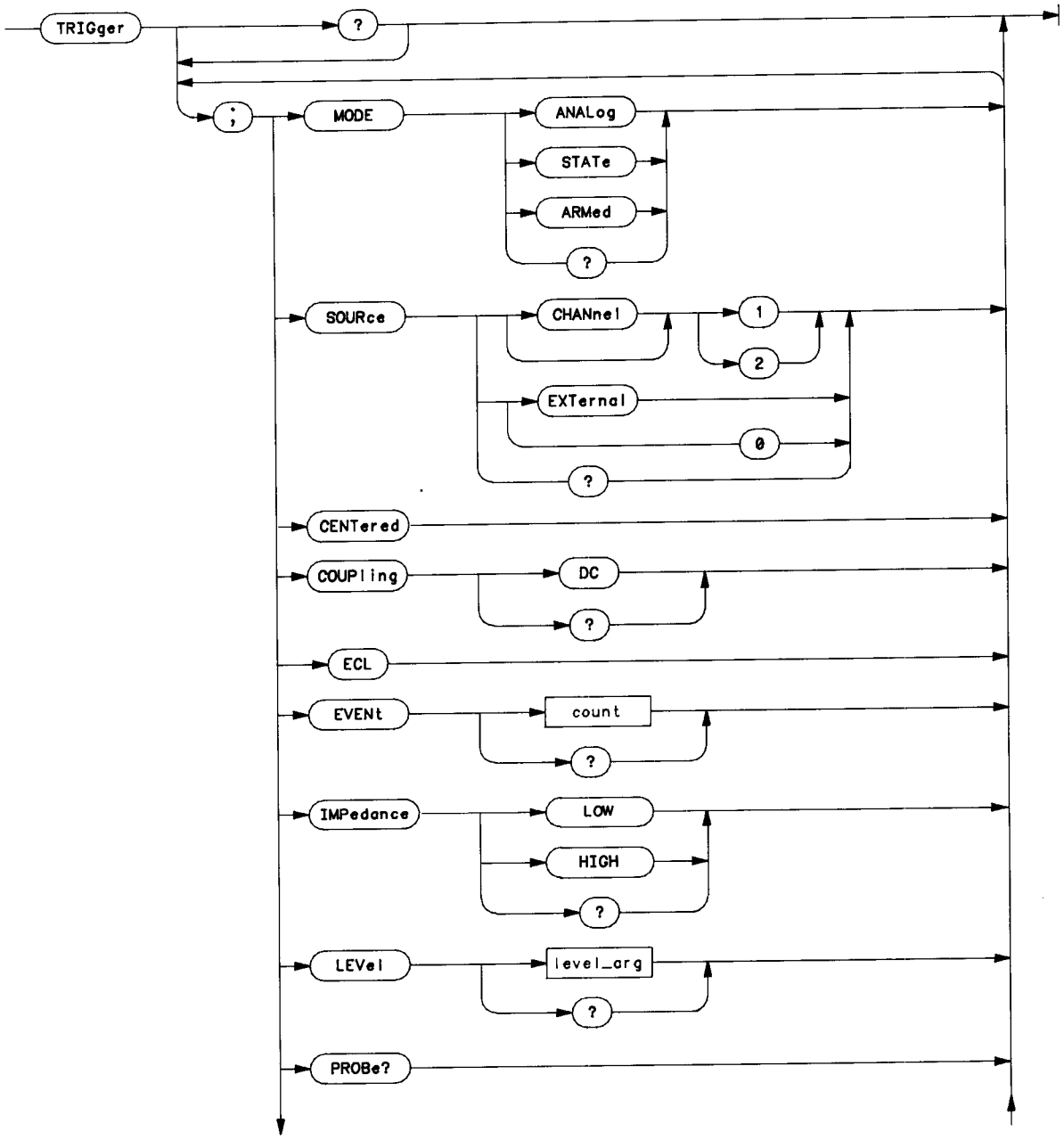
```
Example:  DIM Trig$[200]
          OUTPUT 707;"TRIGGER?"
          ENTER 707 USING "-K";Trig$
          PRINT USING "K";Trig$
```

TRIGger Commands:

MODE
SOURce
CENTered
COUPling
ECL
TTL
EVENt
IMPedance
LEVel
PROBe
SCALe
SLOPe

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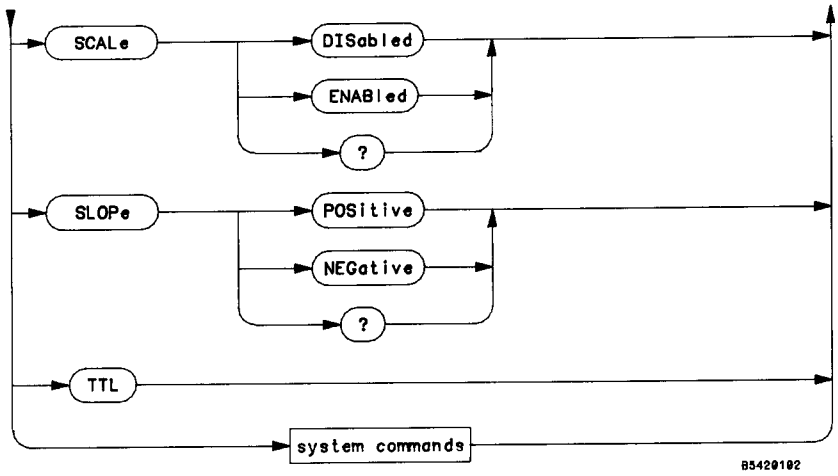
TRIGGER SUBSYSTEM



TRIGger Subsystem Syntax Diagram

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TRIGGER SUBSYSTEM



TRIGger Subsystem Syntax Diagram (Cont)

MODE

command/query

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$

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TRIGGER SUBSYSTEM

SOURce

command/query

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$

CENTered

command

Command sets level to centered mode (trigger level is at center of graph, the same as channel offset) if internal source is selected. Not valid for external source.

Command Syntax: CENTered

Example: OUTPUT 707;"CENTERED"

COUPling

command/query

Command selects the input coupling for trigger, valid only for external and must be DC. Internal trigger path coupling is set by the Channel 1 or Channel 2 source. Command is included to allow trigger subsystem queries to be returned to the instrument. Also refer to IMPedance command.

Query returns the selected trigger path coupling.

Command Syntax: COUPling {[DC | 1]

Example: OUTPUT 707;"COUPLING DC"

Query Syntax: COUPling ?

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

Example: OUTPUT 707;"COUPLING?"
ENTER 707;Coupling$
PRINT Coupling$

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TRIGGER SUBSYSTEM

ECL

command

Command presets the trigger for ECL as follows:

```
SOURce     =  unchanged
SLOPe      =  POSitive
LEVel      =  -1.300 V (Adjust)
PROBe      =  unchanged
SCALe      =  DISabled
COUPling   =  DC
IMPedance  =  unchanged
```

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

Command presets the trigger for TTL as follows:

```
SOURce     =  unchanged
SLOPe      =  POSitive
LEVel      =  1.400 V (Adjust)
PROBe      =  unchanged
SCALe      =  DISabled
COUPling   =  DC
IMPedance  =  unchanged
```

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"

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TRIGGER SUBSYSTEM

EVENt

command/query

Command sets the instrument to trigger after a selected number of events. Allows triggering after 1 to 59999 trigger events have occurred. This command is useful when teamed up with state trigger in state arms analog mode to achieve a digital delay by events. Query returns the current setting of events.

Command Syntax: EVENt <NR1>

```
Example:  OUTPUT 707;"EVENT 1023"
```

Query Syntax: EVENt ?

```
Returned Format:  [EVENt]<NR1><crlf>

Example:  OUTPUT 707;"EVENT?"
          ENTER 707;Event$
          PRINT Event$
```

IMPedance

command/query

Command sets the impedance for external trigger dc input coupling, 50Ω or .2 MΩ. If internal trigger source, programmed value is accepted if it matches channel impedance; internal trigger path does not have a separate impedance control.

Query returns impedance of selected trigger source coupling.

Command Syntax: IMPedance {[LOW | 0]
[HIGH | 1]}

```
Example:  OUTPUT 707;"IMPEDANCE HIGH"
```

Query Syntax: IMPedance ?

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

Example:  OUTPUT 707;"IMPEDANCE?"
          ENTER 707;Imped$
          PRINT Imped$
```


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TRIGGER SUBSYSTEM

LEVel

command/query

Command sets trigger level of selected source. Valid range for internal source is ±.75 times full scale of internal source range. If currently set to centered mode, LEVel defaults trigger level to adjust mode in addition to setting the specified trigger level. Valid range for external trigger source is ±2 V with 1:1 probe.

Query returns the trigger level of the selected source.

Command Syntax: LEVel <NR3>

```
Example:  OUTPUT 707;"LEVEL 350E-3"
```

Query Syntax: LEVel ?

```
Returned Format:  [ LEVel]<NR3><crlf>

Example:  OUTPUT 707;"LEVEL?"
          ENTER 707;Level$
          PRINT Level$
```

PROBe

command/query

Command sets the trigger probe attenuation factor. If trigger source is external, low impedance, PROBe may be set to 1, 2, 5, 10, 20, 50, or 100. If external, high impedance, PROBe must be set to 10. If internal trigger source is selected, PROBe may be programmed, but must match the CHANnel PROBe setting.

Query returns the probe factor of the current trigger 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$
```


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TRIGGER SUBSYSTEM

SCALe

command/query

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$
```

SLOPe

command/query

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$
```


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WAVEFORM SUBSYSTEM

WAVeform

command/query

The waveform subsystem provides access to waveform data. This includes active data from the channels 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>
     [ IMPedance ]<argument><crlf>
     [ LABel ]<10 chars quoted><crlf>

Example:  DIM Wave$[250]
          OUTPUT 707;"WAVEFORM?"
          ENTER 707 USING "-K";Wave$
          PRINT USING "K";Wave$
```


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WAVEFORM SUBSYSTEM

WAVeform Commands:

SOURce
COUPling
COUNt
DATA
IMPedance
FORMat
LABel
POINts
PREamble
TYPE
VALid
XINCrement
XORigin
XREFerence
YINCrement
YORigin
YREFerence

Waveform Definitions

Point# - Horizontal data points on waveform, starting with point 1 at left side of graph. Acquisition may contain from 51 to 1001 points. The number of points taken is set by POINts command.

Q level - Quantization level, vertical position of data point in terms of vertical resolution. Number of q levels defined by mode:

Normal store mode with data filter off - 64 q levels (6-bit resolution).
Normal store mode with data filter on - 128 q levels (7-bit resolution).
Average [4] store mode - 128 q levels (7-bit resolution).
Average [16] store mode - 256 q levels (8-bit resolution).
Average [64] store mode - 512 q levels (9-bit resolution).
Average [256] store mode - 1024 q levels (10-bit resolution).

XINCrement - Time increment between data points.

XORigin - Time of first data point.

XREFerence - Point of X origin, always 1.

YINCrement - Voltage increment per q level.

YORigin - Voltage at vertical center screen.

YREFerence - Value used to normalize q levels in software prior to conversion to volts. If FORMat command set to BYTE, YREFerence is 62, if set to WORD, YREFerence is 15872.

Conversion Formulas

Volts (at Point#) = (Q level - YREF) * YINC + YOR

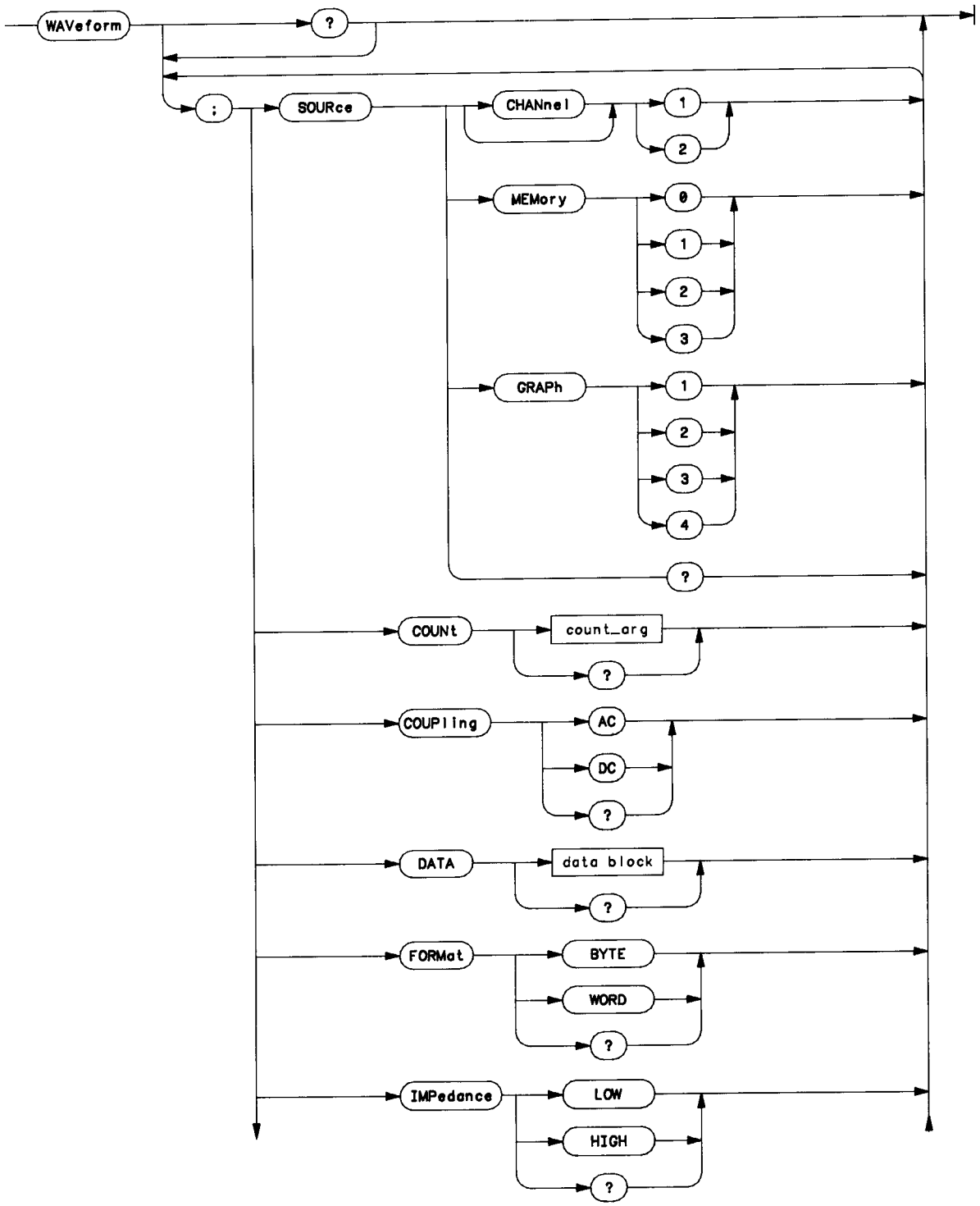
Q level = (Volts - YOR) / YINC + YREF

Time (at Point#) = (Point# - XREF) * XINC + XOR

Point# = (Time - XOR) / XINC + XREF

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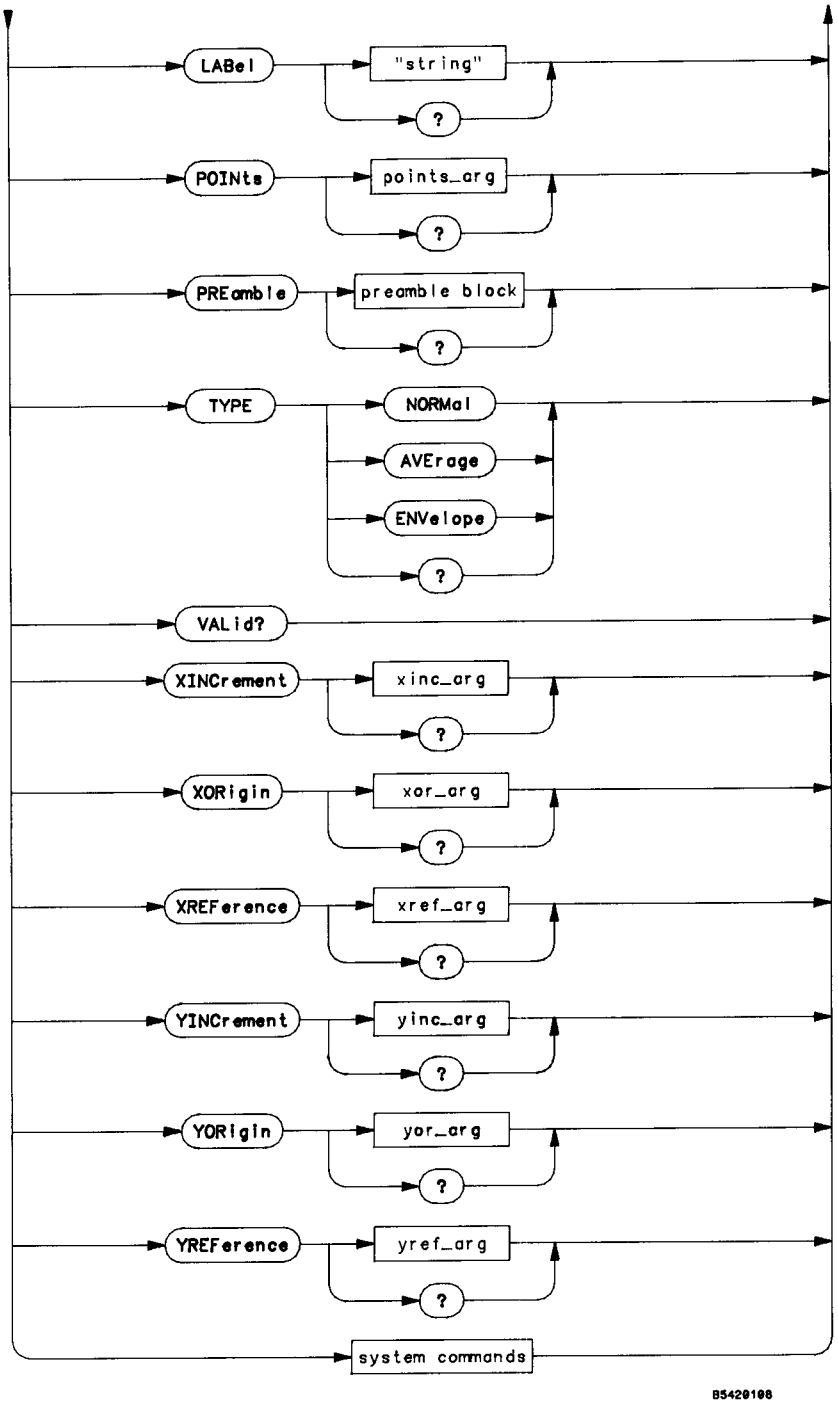
WAVEFORM SUBSYSTEM



WAVeform Subsystem Syntax Diagram

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WAVEFORM SUBSYSTEM



WAVeform Subsystem Syntax Diagram (cont)

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WAVEFORM SUBSYSTEM

SOURce

command/query

Command sets the waveform source for the WAVeform commands that follow.

SOURce CHANnel{1|2} – Sets channel 1 or channel 2 as the waveform addressed. Channel waveforms or preambles cannot be written to directly from the HP-IB. They are modified with the corresponding CHANnel and data acquisition (DIGitize, RUN, and RESUMe) commands.

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 {[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]
[GRAPh1]
[GRAPh2]
[GRAPh3]
[GRAPh4]
[MEMory0]
[MEMory1]
[MEMory2]
[MEMory3]}

Example: OUTPUT 707;"SOURCE?"
ENTER 707;Source$
PRINT Source$

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WAVEFORM SUBSYSTEM

COUPling

command/query

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/query

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$
```


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DATA

command/query

HP 54201A/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  !
```


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WAVEFORM SUBSYSTEM

FORMat

command/query

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$
```

IMPedance

command/query

Command sets the impedance, 50Ω or 1 MΩ, in the waveform preamble.
Query returns the coupling impedance for the waveform.

Command Syntax: IMPedance {[LOW | 0]
[HIGH | 1]}

Example: OUTPUT 707;"IMPEDANCE HIGH"

Query Syntax: IMPedance ?

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

```
Example:  OUTPUT 707;"IMPEDANCE?"
          ENTER 707;Imped$
          PRINT Imped$
```


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WAVEFORM SUBSYSTEM

LABel

command/query

Command sets the label field for the addressed waveform.

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/query

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$
```


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WAVEFORM SUBSYSTEM

PREamble

command/query

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 HP 54201A/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>,
                      <impedance 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>,
                      <impedance>,
                      <label><crlf>

    Example:  OUTPUT 707 USING "#,K";"PREAMBLE ",Pre$
```


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WAVEFORM SUBSYSTEM

TYPE

command/query

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

command/query

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 or greater than the terminal count specified in ACQuire or CHANnel 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$

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WAVEFORM SUBSYSTEM

XINCrement

command/query

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/query

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$
```


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WAVEFORM SUBSYSTEM

XREFerence

command/query

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/query

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$
```


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WAVEFORM SUBSYSTEM

YORigin command/query

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/query

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$
```


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