# Reference Manual

## HP 10390A
## System Performance Analysis Software

for the HP 1650A/1651A Logic Analyzers,
HP 1650B/1651B Logic Analyzers, and
HP 16510A/16510B Logic Analyzer Modules
used in the
HP 16500A Logic Analysis System




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# 1

# General Information

## Introduction

The HP 10390A System Performance Analysis Software (SPA) is a software package for the HP 1650A/1651A, HP 1650B/1651B Logic Analyzers, and HP 16510A/16510B Logic Analyzer Modules used in the HP 16500A Logic Analysis System. The SPA software provides you with a set of functions for performing statistical analysis on your target system. SPA functions include the State Overview, State Histogram, and Time Interval modes.

To be successful with this software package, you should be familiar with the operation of the logic analyzer or the logic analysis system you are using. If you are not familiar with these, please refer to the appropriate getting started guide or front-panel operation reference manual that is associated with your logic analyzer.

This manual is organized as follows:

- Chapter 1 outlines typical SPA applications, lists the equipment required, and describes the operating characteristics for each SPA mode.
- Chapter 2 describes how you install the SPA software.
- Chapter 3 describes how to load the system software and how to access the SPA menus. Also, it describes selecting the SPA modes and setting the specifications.
- Chapter 4 is a detailed description of the measurement processes used by the SPA package. This theory of operation explains how the SPA software samples and sorts the data from the target system, and how the on-screen measurement values are computed for the State Overview, State Histogram, and Time Interval modes.
- Chapter 5 leads you through the State Overview, State Histogram, and Time Interval modes. It also tells how to set up SPA for the three modes, how to interpret the acquired data, and how to make measurements on specific areas of interest.

- Chapter 6 tells you how to use SPA with other measurement systems, such as a state or timing analyzer. In addition, chapter 6 describes how to run multiple SPA systems and how to configure SPA to operate with the intermodule bus of the HP 16500A Logic Analysis System.

Error messages and warnings used by SPA are the same as those used by each of the logic analyzers. Refer to the appropriate reference manual for descriptions of these messages.

If you are just getting started, chapters 1 through 3 are recommended reading. Reading chapter 4 is optional. If you are an experienced user, reading chapters 5 and 6 will help you with your SPA measurements. Use chapters 1 through 4 for review when necessary.

## What is System Performance Analysis ?

The logic analyzer's state or timing analyzer is used to make quantitative measurements on specific events in the target system. For example, they can measure a specific time interval on a microprocessor's control lines or can find out how a particular subroutine was called.

System Performance Analysis, on the other hand, is used for qualitative measurements on the target system. SPA provides statistical analysis functions so you can determine how efficiently your target system is operating.

SPA repeatedly samples signals of interest, such as an address bus or the output of a counter. The multiple data sets from the repeated sampling are then used to build histograms and to compile statistics that describe your target system's performance over time.

Some typical examples of SPA applications include:

- Obtain an overview of system activity.
- Identify software problems that lock up the microprocessor.
- Determine the best-case and worst-case execution times for a software module or a state machine.
- Establish standards for software modules or state machines.
- Identify inefficient use of mass storage and other peripherals.
- Evaluate memory utilization, such as illegal access in protected portions of memory, and locality of execution.

## Equipment Required

The HP 10390A System Performance Analysis software is designed to operate on the HP 1650A/1651A or HP 1650B/1651B Logic Analyzers, or the HP 16500A Logic Analysis System with at least one HP 16510A/16510B Logic Analyzer Module (State/Timimg module) installed.

## Operating Characteristics

The following describes the operating characteristics of the HP 10390A System Performance Analysis software for the three SPA measurement modes.

### State Overview

The State Overview mode displays a bar chart of a label's value versus a number of occurrences of each value in the defined range of the label. State Overview is available on any label defined in the State Format Specification.

The X-axis is the defined range for the specified label divided into 256 buckets. For example, a 16-bit label has an X-axis range of 0 to FFFFH. If the full 16-bit range is specified, each of the 256 buckets has a range of 256.

The range of the specified label is user-definable. For example, for a 16-bit label, the range of the X-axis can be defined as all or any portion from 0 to FFFFH.

The Y-axis is the relative number of occurrences in each bucket.

Maximum value of the Y-axis is constantly updated to reflect the number of occurrences in the bucket that has the most occurrences, and is displayed as "Max count."

Total number of occurrences over all buckets is presented as "Total counts."

Two markers are available on the X-axis to determine the range of a bucket and number of occurrences in any bucket.

Choice of base for specified label is user-definable.

## State Histogram

The State Histogram mode displays states that occur within user-defined ranges of a label. State Histogram is available on any label defined in the State Format Specification.

Maximum number of ranges is 11.

"Include/Exclude other states" is available and displays a histogram of all states or only those contained in defined ranges.

Trace "All States" or pattern "Qualified States."

"Total samples" displays the total number of occurrences in all displayed ranges.

Choice of base for specified label is user-definable.

## Time Interval

The Time Interval mode displays time intervals between user-defined start and end events.

Start and end events can be defined over all labels defined in the State Format Specification.

60 ns is the minimum sample period.

40 ns is the minimum time interval resolution.

Maximum number of time intervals is 8.

Time interval range size is 10 ns to 999,000,000 seconds.

Calculated statistics provides Maximum time, Minimum time, Average time, and Total number of time intervals sampled (one time interval defined to be a paired start/end event).

Auto-Range feature automatically scales the 8 time intervals over maximum and minimum times specified with logarithmic scale or linear scale.

Choice of base for labels is user-definable.

# 2

# Installing the Software

## Introduction

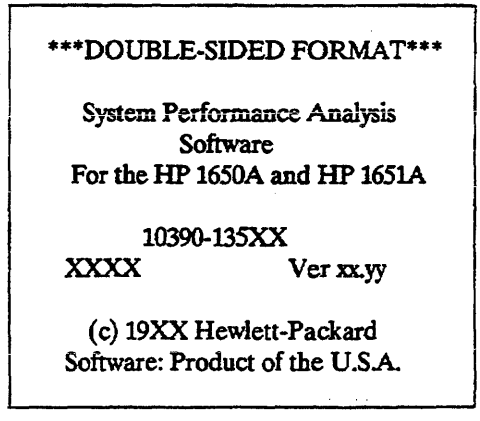
When you unpack your HP 10390A System Performance Analysis (SPA), you will find 3.5-inch flexible disks for operating SPA. Depending on your order, you will receive one of the following packages:

- One disk for the HP 1650A/1651A Logic Analyzers and one disk for the HP 1650B/1651B Logic Analyzers.
- One disk for the HP 16500A Logic Analysis System (with at least one HP 16510A or HP 16510B State/Timing Card installed) and three composite disks.

You should make a working copy of the master disks shipped with the HP 10390A SPA and save the master disks as back-ups.

## Installing Software in the HP 1650A/1651A

The SPA disk for the HP 1650A/1651A is identified by the following label:




The SPA software is installed by inserting the HP 10390A System Performance Analysis master disk for the HP 1650A/1651A in the disk drive and applying power to the instrument.

## What's on the Master Disk?

The HP 10390A System Performance Analysis master disk for your HP 1650A/1651A Logic Analyzers contains the following file:

| File name | Type | Description |
|---|---|---|
| SYSTEM_ | 1650/1_system | HP165x SPA System Rev xx.yy |

This is the entire operating system for your HP 1650A/1651A. You use this disk for all State, Timing, and System Performance Analysis instead of the SYSTEM_ file that came with the logic analyzer.

## Duplicating Files to a Working Disk

Before using your master disks, make duplicate copies of them. Store the original disks in a safe place and use the duplicate copies as working copies. Refer to chapter 6, "Duplicating the Operating System Disk," in the *HP 1650A/1651A Logic Analyzers Reference Manual* for complete information on how to make a duplicate of the master disk shipped with the SPA package.

# Installing Software in the HP 1650B/1651B

The SPA disk for the HP 1650B/1651B is identified by the following label:

> ***DOUBLE-SIDED FORMAT***
>
> System Performance Analysis
> Software
> For the HP 1650B and HP 1651B
>
> 10390-135XX
> XXXX Ver xx.yy
>
> (c) 19XX Hewlett-Packard
> Software: Product of the U.S.A.

The SPA software is installed by inserting the HP 10390A System Performance Analysis master disk for the HP 1650B/1651B in the disk drive and applying power to the instrument.

### What's on the Master Disk?

The HP 10390A System Performance Analysis master disk for your HP 1650B/1651B Logic Analyzers contains the following file:

| File name | Type | Description |
|---|---|---|
| SYSTEM_ | 1650/51_system | HP 165XB SPA System Vxx.yy |

This is the entire operating system for your HP 1650B/1651B. You use this disk for all State, Timing, and System Performance Analysis instead of the SYSTEM_ file that came with the logic analyzer.

### Duplicating Files to a Working Disk

Before using your master disks, make duplicate copies of them. Store the original disks in a safe place and use the duplicate copies as working copies. Refer to chapter 6, "Duplicating the Operating System Disk," in the *HP 1650B/1651B Logic Analyzers Reference Manual* for complete information on how to make a duplicate of the master disk shipped with the SPA package.

## Installing Software for the HP 16510A/ 16510B

The SPA disk for the HP 16500A Logic Analysis System with at least one HP 16510A or HP 16510B State/Timing Card installed is identified by the following label:

***DOUBLE-SIDED FORMAT***

System Performance Analysis
Software
For the HP 16510A/B

10390-135XX
XXXX Ver xx.yy

(c) 19XX Hewlett-Packard
Software: Product of the U.S.A.

The SPA software is installed by inserting an HP 16500A System disk that contains the SPA software into one of the disk drives and applying power to the instrument. Refer to "Creating New System Disks" later in this chapter for information on how to create a new system disk.

## What's on the SPA Master Disk?

The HP 10390A System Performance Analysis master disk for your HP 16500A Logic Analyzer System contains the following files:

| File name | Type | Description |
|---|---|---|
| SYSTEM_ | 16500A _ system | HP 16500A System Software Vxx.yy |
| SYSTEM_031 | 16510B _ system | 35M State/100M Timing/SPA Vxx.yy |

On this disk, SYSTEM_031 is the operating system software for the HP 16510A/16510B State/Timing Card, including all State, Timing, and SPA features.

To operate the SPA on an HP 16510A/16510B State/Timing Card installed in the HP 16500A Logic Analysis System, this SYSTEM_031 file must be used in conjunction with SYSTEM_, the HP 16500A system software.

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**Note** 

When referring to software, the "revision number" is sometimes referred to as the "version number." The revision number on the disk labels is "Ver xx.yy" and the revision number listed on the disk files is "Vxx.yy." The "xx" digits on the left side of the decimal point reflect major changes in the software and the "yy" digits on the right side of the decimal point reflect minor changes. The HP 16510A/16510B SPA system file, named SYSTEM_031, and the HP 16500A mainframe system file, named SYSTEM_, must have the same "xx" revision number. Also, any other HP 16500A module software must have the same "xx" revision number as these two files.

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## What's on the Composite Disks?

The three composite disks, sent with the SPA master disk for your HP 16500A system, contain the HP 16500A mainframe system operation software, operation software for each system module, and performance verification software for each system module.

The composite disks are identified by the following label:

> ***Double-Sided Format***
>
> Composite System Disc #1
>
> 16500-135XX
> XXXX Ver xx.yy
>
> Serial Number XXXX
> (c) Copyright 19XX, Hewlett-Packard
> Software Product of the U.S.A.

Composite disks #2 and #3 will say "Composite System Disc #2" and "Composite System Disc #3" on the second line from the top.

Composite System Disk #1 contains the following files:

| File name | Type | Description | |
|---|---|---|---|
| SYSTEM_ | 16500A _system | HP 16500A System Software | Vxx.yy |
| SYSTEM_001 | 001 _system | 1 GHz Timing Analyzer | Vxx.yy |
| SYSTEM_011 | 011 _system | 400 MSample/s Dig Scope | Vxx.yy |
| SYSTEM_031 | 16510B _system | 35M State/100M Timing | Vxx.yy |

**Note** 

The SYSTEM_031 file on this composite disk does not contain the same information as the SYSTEM_031 file found on the SPA disk.

Composite System Disk #2 contains the following files:

| File name | Type | Description | |
|---|---|---|---|
| SYSTEM_ | 16500A_system | HP 16500A System Software | Vxx.yy |
| SYSTEM_021 | 021_system | 50Mbits/s Pattern Gen | Vxx.yy |

Composite System Disk #3 contains files for the performance verification for each system module.

## Creating New System Disks

The SYSTEM_ 16500A_system files on all disks contain the same information. The SYSTEM_031 16510A_system files found on Composite Disk #1 and the SPA disk are different files.

The recommended file management is to create three working disks. One disk will contain the HP 16500A System Software and the new HP 16510A/16510B SPA Software. One disk will contain the HP 16500A System Software and the HP 16510A/16510B Software without SPA, from Composite Disk #1. One disk will contain the software for any other system modules installed in your HP 16500A mainframe. The number "xx" in the software revision "Vxx.yy" of all files must be the same.

To create new working system disks, copy files to disks in the following structure:

System Disk with SPA

| | | | |
|---|---|---|---|
| SYSTEM_ | 16500A _system | HP 16500A System Software | Vxx.yy |
| SYSTEM _031 | 16510B _system | 35M State/100M Timing/SPA | Vxx.yy |

System Disk without SPA

| | | | |
|---|---|---|---|
| SYSTEM_ | 16500A _system | HP 16500A System Software | Vxx.yy |
| SYSTEM_031 | 16510B _system | 35M State/100M Timing | Vxx.yy |

Module Software

| | | |
|---|---|---|
| SYSTEM_XXX | module software (not State/Timing) from Composite Disks | Vxx.yy |

Refer to Chapter 6 of the *HP 16500A Logic Analysis System Installation/Operation Reference* Manual for complete information on how to format a new disk and copy the required files.

To easily switch between the system disk with SPA and the system disk without SPA, use the module software disk in the rear disk drive and use the system software disk of your choice in the front disk drive.

# 3

# Getting Started

## Introduction

This chapter describes how to load the system software into your logic analyzer and how to access the System Performance Analysis (SPA) menus. Also, it describes selecting the SPA modes and setting the specifications.

## Getting Started on the HP 1650A/1651A or the HP 1650B/1651B

To get started on the HP 1650A/1651A or the HP 1650B/1651B Logic Analyzers, you need to load the SPA software and access the menus.

### Loading the Software

After duplicating the files to a working disk as described in chapter 2, you must load the SPA software at power-up. Insert the system disk in the logic analyzer's disk drive and apply power to the instrument.

### Accessing the Menus

After the logic analyzer has finished loading the operating system, you will see the System Configuration menu, as shown in Figure 3-1. Using the knob, move the cursor to the Type field of Analyzer 1 and/or Analyzer 2 and press SELECT. Place the cursor on your choice of Timing, State, or SPA in the pop-up menu and press SELECT.

**Note** 

For complete information on the front panel operation, please refer to the appropriate front-panel reference manual or getting started guide.

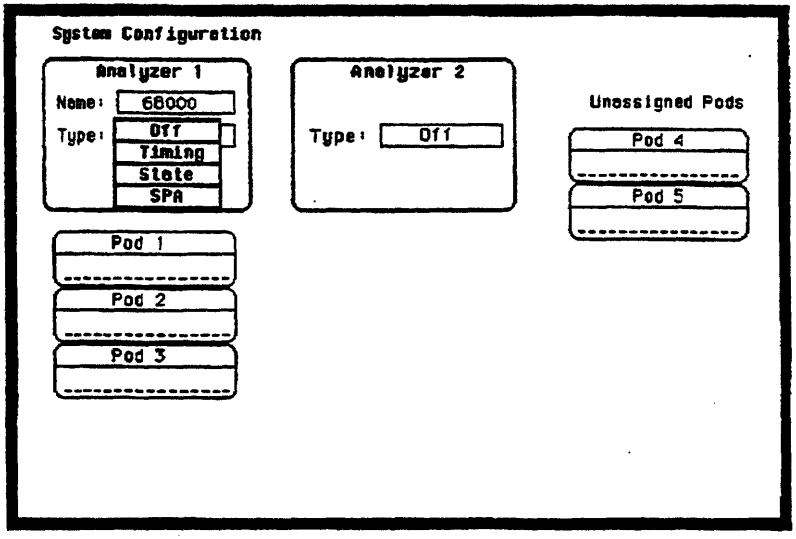


*Figure 3-1. "Type" Pop-up in Analyzer 1 System Configuration Menu. (HP 1650A shown, others are similar.)*

## Getting Started on the HP 16510A/ 16510B

To get started on the HP 16510A/16510B Logic Analyzer Modules used in the 16500A Logic Analysis System, you need to load the SPA software and access the menus.

### Loading the Software

After creating the system disk as described in Chapter 2, you must load the SPA software at power-up by inserting the system disk in one of the analyzer's disk drives and applying power to the instrument.

After loading the SPA software in a HP 16500A with multiple HP 16510A/16510B State/Timing modules, all the State/Timing modules will contain SPA.

Refer to the front-panel operation reference manual of your logic analyzer for complete information on how to load the system disk.

### Accessing the Menus

After the logic analyzer has finished loading the operating system, you must move from the System Configuration menu to the State/Timing Configuration menu. When the State Configuration menu is displayed, touch the "Type" field of Analyzer 1 and/or Analyzer 2. In the resulting pop-up, you can choose Timing, State, or SPA.

The HP 16510A/16510B State/Timing Configuration is similar to figure 3-1.

**Note**

For complete information on the front panel operation, please refer to the appropriate front-panel reference manual or getting started guide.

## Selecting State Overview, State Histogram, or Time Interval Modes

To access one of the three SPA modes, go to the display or trace menu. For the HP 1650A/1651A or HP 1650B/1651B, press the DISPLAY or TRACE key. For the HP 16510A/16510B, touch the menu selection field (second from the top left) and select SPA.

Once in the SPA menu, you can move from State Overview, State Histogram, or Time Interval Modes by selecting the "Trace mode" field as shown in Figure 3-2a and 3-2b. If you change modes while the logic analyzer is acquiring data, it will stop the acquisition. See figure 3-2a and 3-2b for the "Trace mode" pop-up.

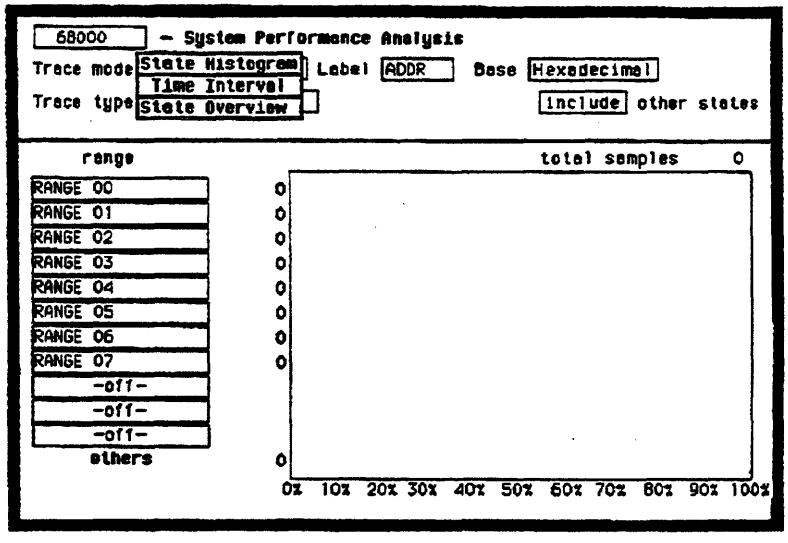


*Figure 3-2a. HP 1650A SPA State Histogram with "Trace Mode" Pop-up. (HP 1651A and HP 1650B/1651B are similar.)*

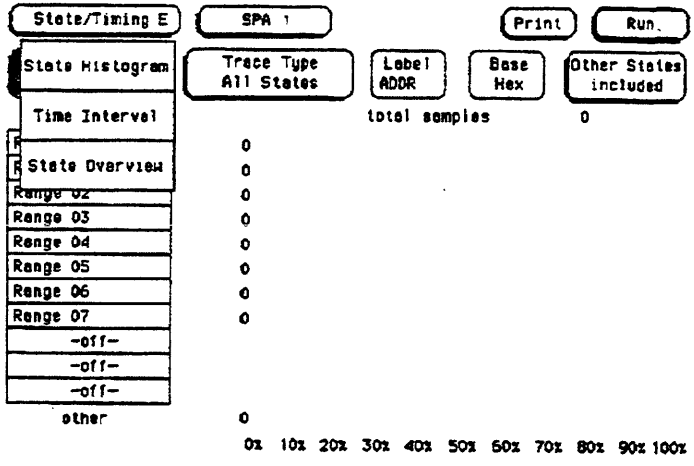


*Figure 3-2b. HP 16510A SPA State Histogram with Trace Mode Pop-up. (HP 16510B is similar.)*

## Assigning Pods

In addition to configuring Analyzer 1 and/or Analyzer 2 for SPA, you must physically connect the probes to your target system and assign pods to the SPA analyzer in the System Configuration menu. Once the pods are connected and assigned, you then set up the Format Specification menu.

## Setting Up the State Format Specification

SPA uses portions of the State Analyzer to acquire and sort the data. As a State Analyzer function, SPA samples the target system synchronously and must have at least one state input clock from the target system. You select the input clocks for the State analyzer and SPA in the State Format Specification menu.

When a State or Timing analyzer is changed to SPA, SPA will retain the State or Timing Format Specification. For complete details on changing from a State or Timing Analyzer to SPA, see chapter 6, "Using SPA With Other Features."

The State and Timing Format Specification menus provide symbol tables. You can use any defined symbols to specify the Low and High values in State Overview, to define the ranges in State Histogram, the qualified states in State Histogram, or to specify the Start and End conditions in Time Interval.

Your ability to use existing State or Timing configurations with SPA depends on your application and target system. If your SPA measurement uses the same physical signals from the target system as an existing State or Timing configuration, it may be easier to load that configuration from the disk instead of entering a new one.

This manual assumes you already have a basic understanding of Hewlett- Packard logic analyzers. Probing, pod assignments, state input clocks, and the Format Specification will not be covered here. For complete information on these topics, refer to the getting started guide or front-panel reference manual for your logic analyzer.

## Clock Period in the State Format Specification

Time Interval mode uses the count time feature of the state analyzer. When running Time Interval mode, the Clock Period field in the State Format Specification should be set to "> 60 ns" because the count time feature is limited to a minimum 60 ns state clock period.

If the Clock Period is set to "< 60 ns" when you select "Run" in Time Interval, then the Clock Period will be set to "> 60 ns" to allow Time Interval to execute.

# 4

# SPA Measurement Processes

## Introduction

This chapter introduces you to the measurement processes of the HP10390A System Performance Analysis (SPA) software. It tells you how to select the appropriate trace mode and labels. It also explains how SPA samples and sorts data.

## Selecting and Changing Trace Modes

SPA has three Trace modes: State Overview, State Histogram, and Time Interval. These are selected by the "Trace mode" field in the SPA data display.

Only the currently displayed Trace mode is affected during an acquisition. While acquiring and viewing data in one Trace mode, the other two Trace modes are not updated. If the Trace mode or any other critical variable is changed during an acquisition, the logic analyzer stops the acquisition and displays "Warning: Run HALTED due to variable change."

Each Trace mode only performs statistics on its own data base. Therefore, if acquisitions are completed in two different Trace modes, the two modes will not contain the same data.

For example, after power-up, you select the Time Interval mode and press RUN. After the data accumulates for a period, press STOP. You then select the State Overview mode and the screen will be blank since no data has been acquired in this mode. You again press RUN and let data accumulate and press STOP. In this example, two separate data sets are acquired, the first for Time Interval mode, the second for State Overview. You can now move between the modes and see the correct data for the associated measurement.

This seperate aquisition data applies to all three Trace modes. In this way, three separate views of the target system can be acquired and stored in SPA.

## Sampling Methods and Data Sorting

SPA provides a statistical summary of target system behavior over time. The greater the number of samples, the more accurate the statistics. Therefore, SPA always samples repetitively and will continue to sample and update the display until STOP is pressed or a sampling variable is changed on the display. In the HP 16510A/16510B, most SPA measurements will use Repetitive Run mode.

After SPA completes an acquisition, each sample in the current acquisition is compared to the ranges or buckets for the current Trace mode. If the sample matches a range or bucket, it is sorted into that range or bucket and the process is performed on the next sample in the acquisition, until the entire acquisition has been sorted. After the entire acquisition has been sorted, the histograms and displayed statistics are updated, and the analyzer is re-armed for the next acquisition.

Refer to the following sections on the three Trace modes for details on sorting criteria and statistical computation.

Between each successive acquisition, there is blind time to unload the captured data, update the display and re-arm the acquisition system. The length of the blind time is a function of the complexity of the SPA measurement.

## Selecting and Changing Labels

A "label" in Hewlett-Packard logic analyzers is defined to be any named group of 32 or less data channels.

The State Overview and State Histogram modes monitor one label at a time. Any labels that are defined in the State Format Specification are available. A typical example is the ADDR (address) label used in many of the Hewlett-Packard inverse assembler configurations. Often, SPA measurements will use the ADDR label to monitor memory activity.

Time Interval mode uses all of the labels in the State Format Specification to define the start and stop events. While State Overview and State Histogram deal with recorded states, Time Interval deals with time. Times are defined with start and stop patterns, and the patterns stretch across all labels.

**Note**

Changing from one label to another in State Overview or State Histogram mode or changing the Start or End pattern in Time Interval erases any configuration and data for the original label. When returning to the original label, the display returns to its default mode. Loss of configurations and data when changing between labels can be prevented by saving configurations of interest to the disk before making the change, or by printing the results.

## State Overview Mode

State Overview mode is an X, Y chart of the activity on a specified label. It provides a global view of the distribution of activity of the target system signals grouped under the specified label.

### X-Axis Scaling

The X-axis represents the defined range of the specified label and is divided into a series of buckets. The range of the X-axis is defined by the "Low value" and "High value" fields and is divided equally among the buckets. For example, if the range defined by the low and high values is 1100, then 1100 divided by 256 equals 4.29. This value will be rounded up to 5, and each bucket will have a range of 5, and only 220 buckets will be used (1100/5 = 220). The display grid will be truncated on the right because only 220 buckets are displayed.

If the full range of the label or the portion of the label defined by the Low value and High value is less than 255, then the number of buckets will be the difference between the Low and High values.

The Low and High values can be specified as discrete values in Binary, Octal, Decimal, or Hexadecimal. If Symbols have been defined in the State Format Specification, they can also be used for the low and high values.

### Data Sampling and Sorting

When RUN is pressed, all input channels defined in the State Format Specification are sampled using the clock inputs defined in the State Format Specification. Once 1,024 samples (memory depth of the analyzer) have been acquired, they are sorted into the buckets of the specified label, then the State Overview display is updated. The acquisition is repeated until STOP is pressed or until a display variable is changed.

### Y-Axis Scaling

The display builds a vertical histogram where the Y-axis represents the relative number of occurrences in each of the buckets. As successive 1K samples are acquired and sorted, the display is constantly re-scaled vertically so that the limit of the Y-axis represents the largest number of occurrences in any bucket.

The Y-axis maximum limit is displayed in "Max count."

### Total Counts

The "Total counts" field is the total number of states sampled since the measurement was started.

### X and O Markers

Markers can be placed on any bucket to determine the number of occurrences in that bucket. The "X Mark count" and "O Mark count" fields display the number of occurrences at the markers. The markers move only on the bucket boundaries.

The range of each bucket can be determined by selecting the "X marker" or "O marker" fields and noting the change in the marker value in the pop-up as the marker is moved slowly across the display.

## State Overview Example

An example of a State Overview measurement is testing for access to a reserved area of memory. In this case, the address bus of the target system would need to be grouped under a single label, such as ADDR. By selecting the ADDR label in State Overview mode, and defining the full range of the label (Low value = 0000, High value = FFFFH with a 16-bit ADDR label), activity over the entire address range can be monitored. Access into reserved memory is easily identified.

By selecting only the range of the reserved area of memory with the Low and High values, the number of address values per bucket is decreased and a more detailed analysis can be performed.

Figure 4-1 shows a sample State Overview display for this example from the HP 1650A.

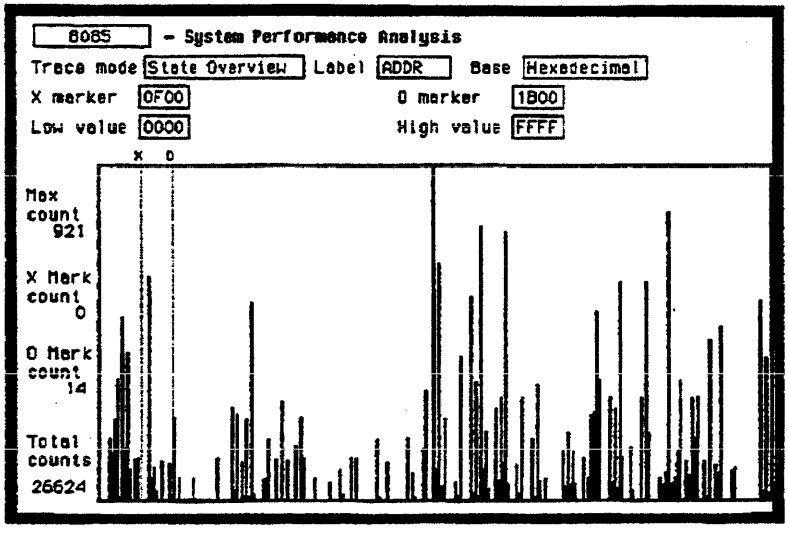


*Figure 4-1. SPA State Overview Example.*
*(HP 1650A shown, others similar.)*

## State Histogram Mode

State Histogram mode displays relative activity of ranges of a specified label. The ranges can also be compared to activity on the rest of the label not defined in the ranges. Data qualification is possible with State Histogram, so data can be "filtered" during acquisition.

### Data Sampling and Sorting

When RUN is pressed, all input channels defined in the State Format Specification are sampled using the clock inputs defined in the State Format Specification. Once 1,024 samples (memory depth of the analyzer) have been acquired, each sample in the acquisition is compared to each defined range and the range's count is incremented if the sample's value is within the range inclusively, then the State Histogram display is updated. The acquisition is repeated until STOP is pressed or until a display variable is changed.

The histogram is displayed on a percentage scale, each bar represents the fraction of all samples in that range. For example, if a bar reaches the 40% value on the display, then the range for that bar contains 40% of all the samples displayed. If the total percentages of all bars equals greater than 100%, then ranges have been overlapped and data has been counted twice.

### State Histogram vs. State Overview

State Histogram is similar to State Overview, but there are key differences between the two modes. State Overview shows relative distribution of activity over a single contiguous range of a label. State Histogram also allows several non-contiguous ranges of a label to be defined.

State Overview requires minimal setup, and provides a quick "overview" of system activity. State Histogram requires more setup, but provides greater resolution and measurement flexibility.

State Overview mode does not display data that falls out of the range of its Low and High values. State Histogram, on the other hand, has an "Include/Exclude other states" feature that will present a histogram of any activity that does not fall into the defined ranges (see "Include/Exclude Other States," later in this chapter).

State Overview samples and displays all activity on the specified label. But State Histogram allows data qualification so that only activity of interest is sampled and displayed (see "Trace Type: All States vs. Qualified States," later in this chapter).

### Range Specifiers

Up to 11 ranges are available. The ranges are defined by specifying a low and high value on the specified label, and a name you define. The ranges need not be contiguous. If two ranges overlap in any manner, then acquired data will be counted in both ranges.

If a range has a low and high value and a name defined, and it is turned off, it will retain the low and high value and name when turned back on.

### User-Defined Ranges vs. Symbols

When defining low and high values for the State Histogram ranges, you may use symbols instead of entering discrete values. Symbols can only be used for labels selected in the State Histogram mode if they are defined in the State Format Specification, and only if the Base in the State Histogram menu is set to Symbol.

Pattern or Range Symbols defined in the State Format Specification can be used to set the low or high value of a range.

In the HP 1650A/1651A or HP 1650B/1651B, Range Symbols can also be accessed with the "SYMBOL" field in the range pop-up. Selecting a range symbol with "SYMBOL" automatically sets the low and high values to lower and upper values of the symbol.

### Total Samples

The "total samples" field displays the total number of samples in all the displayed ranges. If "Include Other States" is selected, then "total samples" is the total of all displayed samples plus the Other States. If any ranges are overlapped and samples fall in multiple buckets, these samples are only counted once in total samples.

### Number of Samples Per Range

Displayed next to each bar is a value representing the number of samples for that range. The ratio of these values determines the relative size of the histograms. These values are updated as the repeated acquisitions are sorted and displayed.

### Include/Exclude Other States

Usually, the defined ranges will not cover the entire range of the specified label. The "Include/Exclude Other States" field provides an optional histogram showing all activity on the specified label that does not fall within any of the defined ranges. By selecting "Exclude," the relative activity of only the defined ranges is displayed. If "Include" is selected, the "Other" histogram appears under the ranges.

If a range is turned off, any activity in that range is included in Other states. The activity of a turned off range is included whether "Include" or "Exclude" other states is displayed or not.

### Trace Type: All States vs. Qualified States

Similar to a state analyzer, State Histogram mode can qualify data as it is sampled. Qualifying data while sampling, allows only data of interest to be stored, while the rest is "thrown away."

When "Trace Type" is set to "Qualified States," a new field appears in the upper row of the display. The new field, "Specify Qualified States," is where the data qualification is defined. The data qualification need not be on the label selected in the State Histogram menu; data qualification is defined over all labels defined in the State Format Specification as a combination of values in the current base and don't cares.

For example, a microprocessor target system memory may contain two arrays. In State Histogram, the address ranges of the arrays can be defined and the relative activity in the arrays monitored. But, what if you only want to monitor writes to the array? In this case, you can define the data qualification as "Memory Write" on the STATUS label.

States that do not meet the qualification criteria are not stored by the analyzer, so they are not included in "Other States."

## State Histogram Example

A computer system has several I/O devices, such as a data terminal, disk drive, tape drive, and printer. Each device has its own service routines stored in memory. The problem is that one or more of the devices is tying up the CPU.

The address bus of the system is monitored using State Histogram to define the memory blocks where the service routines are stored. The histograms quickly show that the print spooler is not working, because the printer is constantly interrupting the CPU and consumes 80% of address bus activity compared to the disk, tape, and terminal.

Figure 4-2 shows a sample State Histogram display for this example from the HP 1650A.

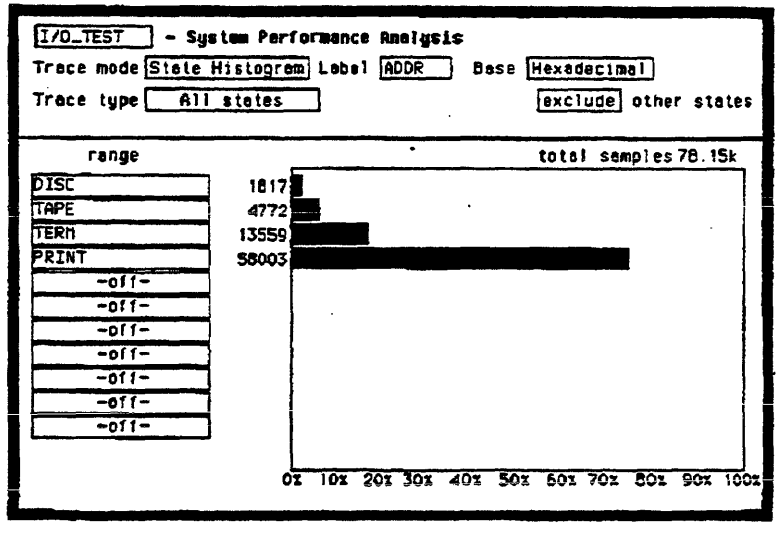


*Figure 4-2. State Histogram Example. (HP 1650A shown, others similar.)*

## Time Interval Mode

Time Interval mode shows distribution of execution time of a single event. The event is defined by specifying Start and End conditions as patterns across all labels defined in the State Format Specification.

### Data Sampling and Sorting

When you press RUN, the analyzer samples the target system using the clock inputs defined in the State Format Specification. During acquisition, the state analyzer searches the data for the Start and End conditions, and uses its count time feature to time the event. The time durations for each Start/End pair are then sorted into user-definable Time interval ranges on the display.

Acquisition continues until you press STOP or until you change a display variable.

As the data is sampled, timed, and the time values are sorted, the histogram for each Time interval range is updated. Each acquisition contains 256 samples, or Start/End pairs because half of the memory is used to store the Start/End pairs, and half of the memory stores the time values.

If two time intervals are adjacent and have a common boundary (the upper limit of one equals the lower limit of the next), and a sampled time interval falls on the common boundary, the sample will be sorted into the higher time interval.

### Start/End Conditions

Start and End conditions for Time Interval are specified on all labels defined in the State Format Specification as a combination of values in the current base and don't cares.

If a Start or End condition is not found during an acquisition, the histogram will not be updated. The analyzer will continue until the Start and Stop event are both found.

Start and End conditions need not be adjacent in the data stream. For example, when the state analyzer sees the specified Start condition, it will start the timer. If the Start condition occurs again before the End condition occurs, the timer will not be reset.

### Minimum 60 ns Sample Clock Period

The state analyzer uses its count time feature to time the event defined by the Start/End conditions. Time Interval mode is limited to a minimum sample clock period of 60 ns. Therefore, samples must be greater than or equal to 60 ns apart. The maximum resolution of the time tag counter, however, is 40 ns. As a result, the interval between stored samples can be measured up to a 40 ns resolution.

Because of the minimum 60 ns Clock Period in the Time Interval mode, the Clock Period field in the State Format Specification should be set to "> 60 ns" when running Time Interval. Selecting RUN in Time Interval will set Clock Period to "> 60 ns" if it is not already set.

### Time Interval Ranges

Up to 8 Time Interval ranges are available. Each range has a lower and upper limit which can be entered manually. The "Auto-range" feature will automatically scale the 8 ranges. The minimum allowable limit is 0 ns, the maximum 999,000,000 seconds.

Ranges do not have to be contiguous. However, gaps between ranges increase the risk of missed data. If two ranges overlap, data will be counted in both ranges. This applies to any number of overlapping ranges, or any portions of overlapping ranges. Common boundaries of adjacent ranges are not considered to be overlapped.

A range can be turned off by setting the lower and upper values to zero. All the ranges may be quickly initialized to off by selecting "Auto-Range" and setting the "Minimum" and "Maximum Time" to zero.

### Auto-Range

The Time Interval ranges can be scaled quickly by selecting "Auto-Range." This option requires a global Minimum Time and Maximum Time for the 8 Time Interval ranges. The 8 ranges are then scaled using either a log scale or linear scale.

The smallest increment allowable using Auto-scale is 10 ns. If the time interval defined by the Minimum and Maximum times is too small to allow all 8 ranges to be scaled, Auto-range will scale as many as possible and exclude some upper time interval ranges. The resolution of each time interval is greater than or equal to 40 ns.

### Min, Max, and Avg Time Statistics

The Time Interval mode display shows three statistics: Maximum (Max) time, Minimum (Min) time, and Average (Avg) time. These values are displayed whether or not they fall into any of the Time interval ranges. Therefore, they are helpful in determining if the appropriate Time intervals have been chosen.

The maximum resolution of the statistics is 40 ns.

### Total Samples

"Total samples" is displayed above the histogram. A sample is defined as one Start/End pair. The Total samples field is not updated until the analyzer's memory is full (256 Total samples per acquisition) or until STOP is pressed.

### Time Interval Example

An team of applications programmers are writing a math package for a spreadsheet. They need to develop standards for the various math functions. Using Time Interval mode, they can test the execution time of each of the math functions.

For each math function, they enter the starting and ending addresses in the Time Interval menu. They run the math function while monitoring its execution time with their logic analyzer in the Time Interval mode. Using Auto-range, they can quickly vary the time interval ranges for either greater time coverage or greater time resolution.

If the programmers wanted to see the details of the time intervals, they could set up a state analyzer measurement (not using SPA) and capture the activity between the start and stop events. The details could then be viewed in the state listing menu.

Figure 4-3 shows a sample Time Interval display for this example from the HP 1650A.

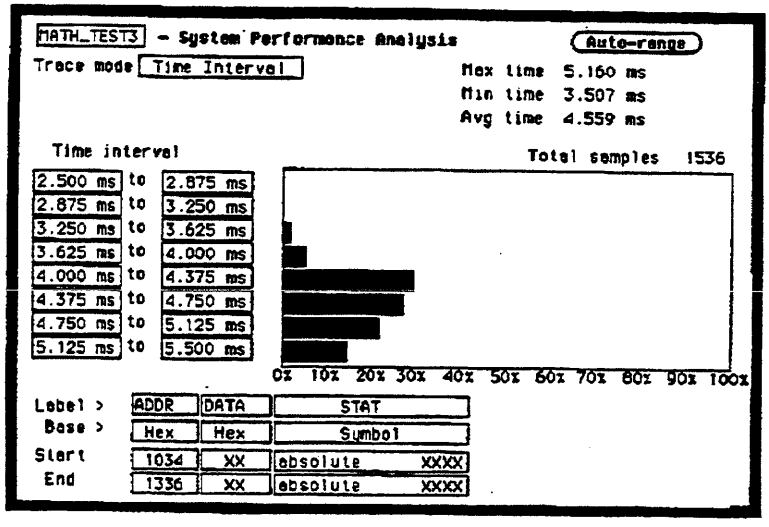


*Figure 4-3. Time Interval Example. (HP 1650A, others similar.)*

## Measurement Example Using All Three Trace Modes

In a 32-bit microprocessor system, you want to determine how efficiently the CPU is being utilized. Critical questions might be: are any processes consuming excessive processing time, are any processes getting stuck in wait loops, and is the system handling service calls and interrupts efficiently?

You connect the HP logic analyzer to the address bus of your system. In the State Format Specification, you define a 32-bit label called ADDR and the state clocking. In many cases, HP provides preprocessors, inverse assemblers and standard configurations for popular microprocessors, and you need not enter the configuration manually or worry about probing issues.

In the State Overview mode, you select the ADDR label and start the acquisition to monitor the entire memory space. After several acquisitions, five areas of relatively high activity begin to build on the histogram. Using the X and O markers to determine the address boundaries of these five regions, you quickly recognize two programs, a

delay routine in the operating system kernel, and a keyboard interrupt routine.

Figure 4-4 shows the State Overview display for this example from the HP 1650A.

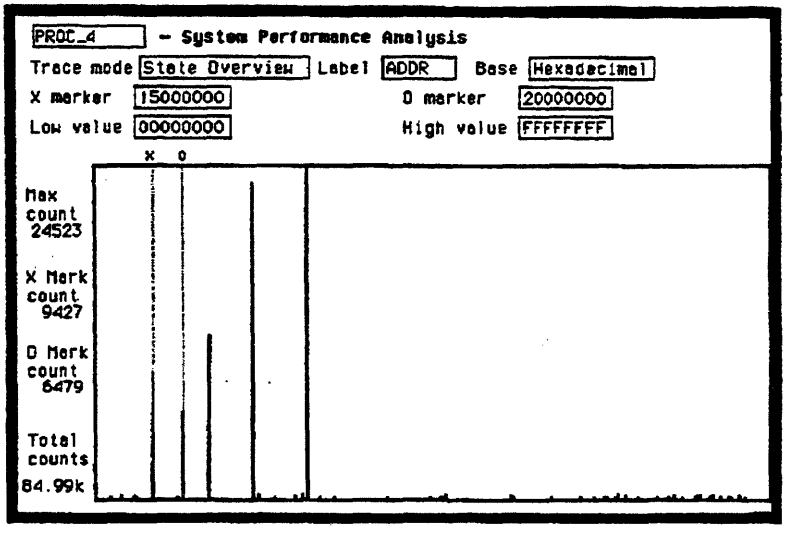


*Figure 4-4. State Overview Display Using all Three Modes. (HP 1650A shown, others similar.)*

Next, you select the State Histogram mode and enter the names and boundaries of the five routines in the State Histogram ranges.

State Histogram then displays the relative activity of the five routines. After several acquisitions, it is apparent that the interrupt routine is being accessed more often than expected.

Figure 4-5 shows the State Histogram display for this example from the HP 1650A.

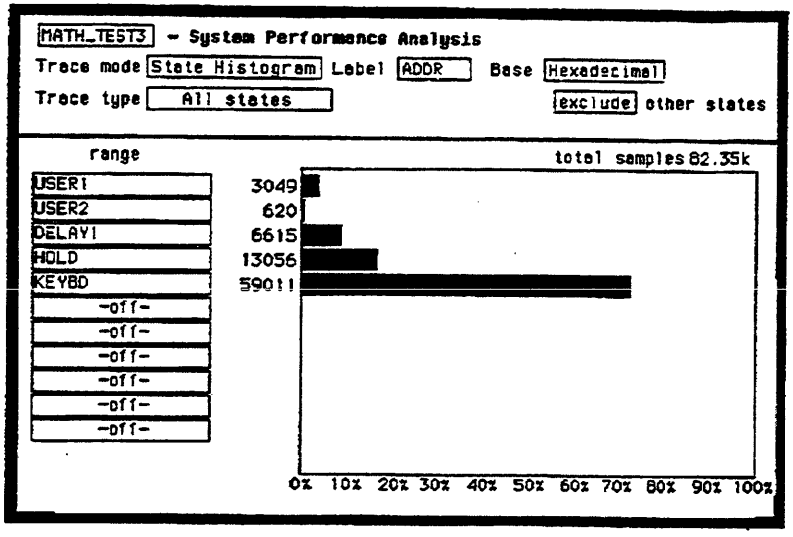


*Figure 4-5. State Histogram Display using All Three Modes. (HP 1650A shown, others similar.)*

You now select the Time Interval mode and enter the Start and End conditions for the suspect interrupt routine. Before altering the default Time interval ranges, you start the acquisition and observe the maximum (Max), minimum (Min), and average (Avg) times. From these values, the typical execution times of the interrupt are apparent, and provide good starting values for the Time Interval Ranges using Auto-range. From the Max time, it is apparent that the interrupt routine is having problems.

Running the acquisition again, you discover that the interrupt usually takes the expected 8 microseconds, but occasionally it takes as long as 8 milliseconds. After experimenting with the target system while monitoring the interrupt with Time Interval mode, a faulty key on the keyboard is discovered. The key is bouncing excessively; resulting in an extended interrupt routine call.

Figure 4-6 shows the Time Interval display for this example from the HP 1650A.

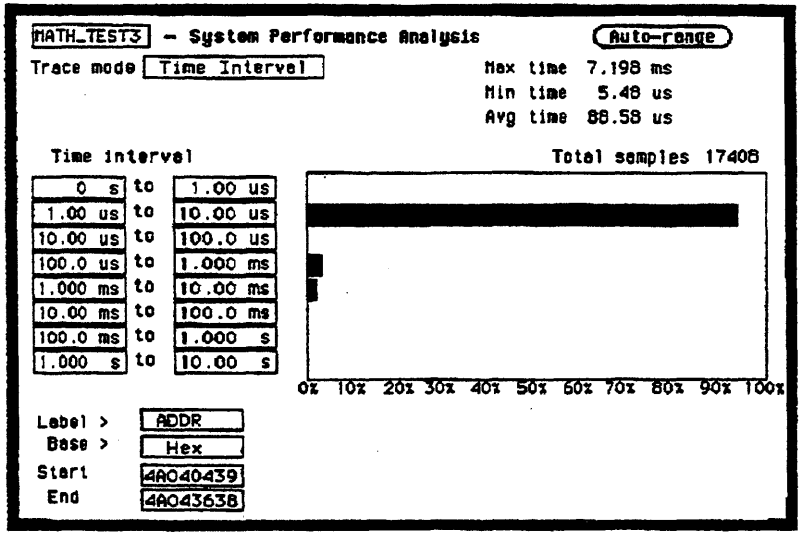


*Figure 4-6. Time Interval Display using All Three Modes. (HP 1650A shown, others similar.)*

# 5

# Using State Overview, State Histogram, and Time Interval

## Introduction

This chapter explains how to select the display fields, set up the logic analyzer and use the State Overview, State Histogram and Time Interval modes of SPA.

## Selecting Display Fields

In this chapter, the "select" operation has different meanings for the HP 1650A/1651A, HP 1650B/1651B Logic Analyzers, or the HP 16500 Logic Analysis System.

With the HP 1650A/1651A or HP 1650B/1651B, you select a field by using the knob to place the cursor on a field, then press the SELECT key.

With the HP 16510A/16510B modules used in the HP 16500A , you select a field by touching it on the touchscreen or, if you're using a mouse, place the mouse cursor on the field and press the left button on the mouse.

## Setting Up the Logic Analyzer

This chapter assumes you have defined the State Format Specification and have connected the logic analyzer probes to the target system. For complete details on these topics, refer to chapter 3, "Getting Started," of this manual, or the appropriate getting started guide and the front-panel operation reference manual for your analyzer.

For a detailed description of State Overview, State Histogram, and Time Interval mode measurement processes, refer to chapter 4, "SPA Measurement Processes," of this manual.

# Using State Overview Mode

## Choosing a Label to Monitor

To select a label to monitor, select the "Label" field in the State Overview display (item 1 in figure 5-1a and 5-1b). In the pop-up, you will see a list of all the labels defined in the State Format Specification. From this list, choose the label you want to monitor.

**Note**

Changing from one label to another will erase the display setup for the first label. If you want to change to a different label, but don't want to lose the setup for the current one, first save the current one to disk or print it.

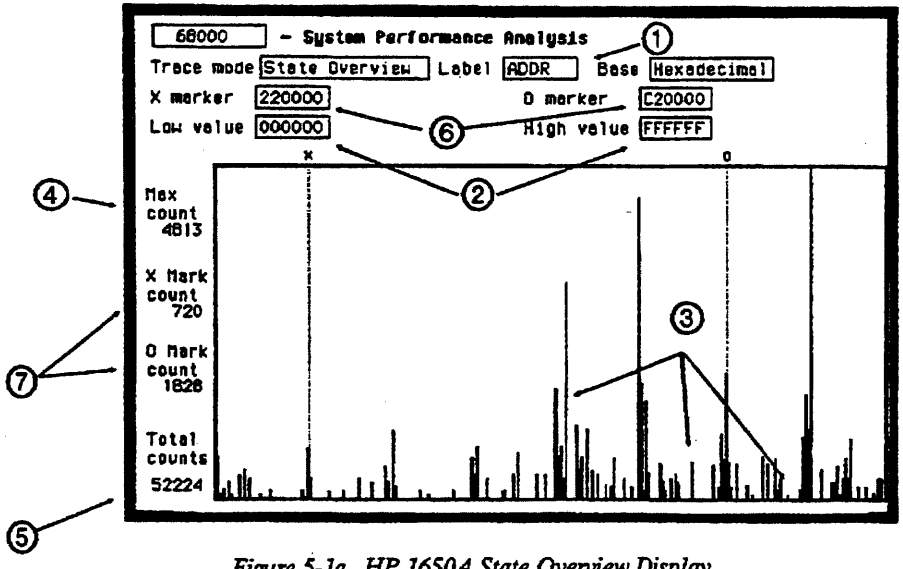


*Figure 5-1a. HP 1650A State Overview Display. (HP 1651A, HP 1650B/1651B similar.)*

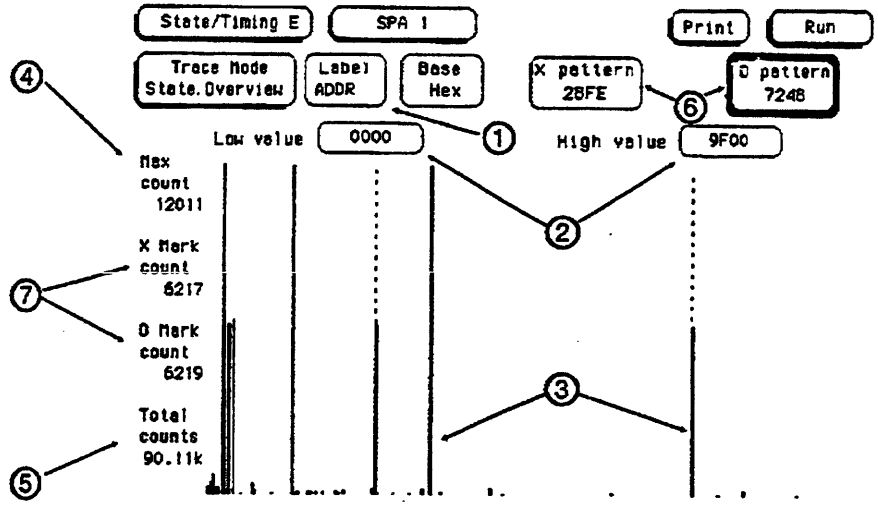


*Figure 5-1b. HP 16510A State Overview Display. (HP 16510B similar.)*

## Specifying Low and High Values

The range of the X-axis is determined by the "Low value" and "High value" fields (item 2 in figure 5-1a and 5-1b). To change the X-axis range, select the "Low value" and/or "High value" fields and enter new limits. The range you have specified will then be divided among the 256 available buckets along the X-axis (unless the range is less than 256 or the histogram frame is truncated due to bucket range round-off).

For example, you might set the low and high values so that the range is 1100. 1100 divided by 256 is 4.29. This will be rounded up to 5, and each bucket will have a range of 5. Since 1100 divided by 5 is 220, the histogram frame will be truncated at the right because the X-axis will have only 220 of the 256 buckets.

The default High and Low values represent the full range of the label you chose. Before changing these values, you may want to run the acquisition and acquire some data to view activity over the entire range of the label. You can then zoom in on areas of interest.

You can enter Low and High values in Binary, Octal, Decimal, Hexadecimal, ASCII, or Symbol.

## Interpreting the Histogram Display

Press RUN to start the State Overview acquisition. In the HP 16510A/16510B, you should select Repetitive Run mode. As the data is sampled and sorted, the buckets along the X-axis will accumulate (item 3 in figure 5-1a and 5-1b). The relative size of the vertical bars show the distribution of activity on the label you chose. The analyzer will continue to sample, sort the data, and update the display until you press STOP or you change a display variable.

The "Max count" (item 4 in figure 5-1a and 5-1b) represents both the current upper limit of the Y-axis and the bucket with the greatest number of data samples. Max count and the limit of the Y-axis will increase as the buckets fill with samples.

Read "Total counts" (item 5 in figure 5-1a and 5-1b) to find the total number of samples taken over the specified range of the label. This is not affected by the Low and High values.

## Using the Markers

To find the number of data samples in any bucket, select the "X marker" or "O marker" field (item 6 in figure 5-1a and 5-1b). Turn the knob to move the marker to the area of interest. Read the "X Mark count" or "O Mark count" values to determine the number of samples in the current bucket (item 7 in figure 5-1a and 5-1b).

As you move either marker across the display, the value in the X Marker or O Marker pop-up will change. The amount of change of the marker's value represents the size of the bucket.

## Zooming In on an Area of Interest

When viewing the State Overview display, you may see areas of high activity and areas of little or no activity. To zoom in on one of these areas for more resolution, put the X and O markers on the boundaries of the area, then adjust the Low and High values to match the X and O marker positions.

# Using State Histogram Mode

## Choosing a Label to Monitor

To select a label to monitor, select the "label" field in the State Histogram display (item 1 in figure 5-2a and 5-2b). In the pop-up, you will see a list of all the labels defined in the State Format Specification. From this list, choose the label you want to monitor.

**Note**

Changing from one label to another will erase the display setup for the first label. If you want to change to a different label, but don't want to lose the setup for the current one, save the current one to disk.

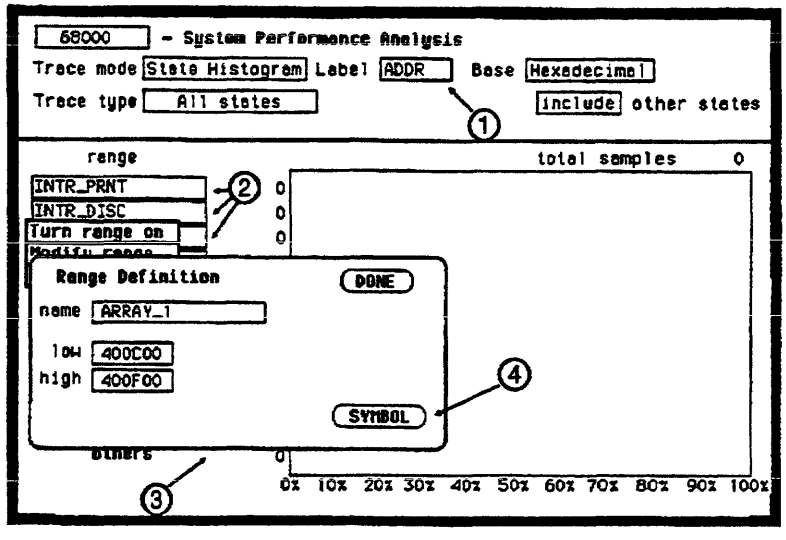


*Figure 5-2a. HP 1650A State Histogram Display. (HP 1651A, HP 1650B/1651B similar.)*

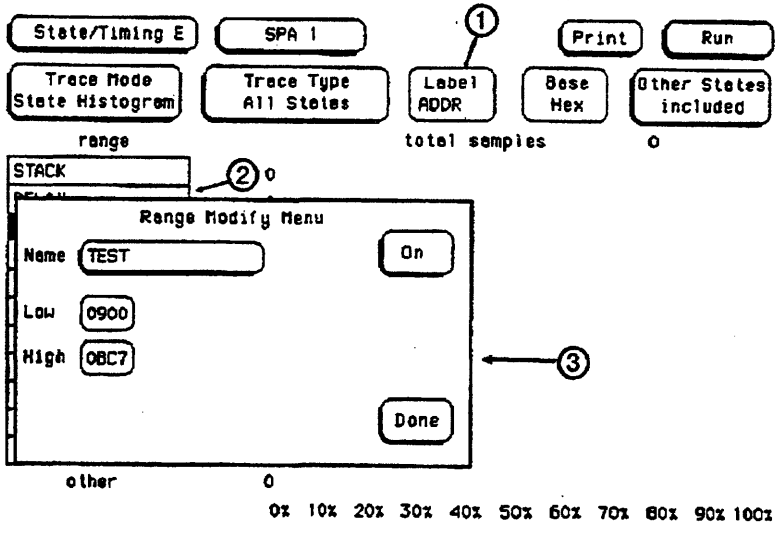


*Figure 5-2b. HP 16510A State Histogram Display. (HP 16510B similar.)*

## Defining the Ranges

To define a range on the specified label, select one of the 11 range fields (item 2 in figure 5-2a and 5-2b). The pop-up gives you the choice of "Turn range on," "Modify range," or "Turn range off."

Select "Modify range" and you will see another pop-up called "Range Definition" (item 3 in figure 5-2a and 5-2b). This pop-up has fields where you should enter the low and high value and a name for the range.

---

**Note**

In the HP 16510A/16510B, there is no pop-up with "Turn range on," "Modify range," or "Turn range off." When you select one of the 11 ranges, you will see the "Range Definition" pop-up.

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## Using Symbols for Ranges

In the State Format Specification, you can define symbols for any available label. The symbols can be defined as Pattern Symbols or as Range Symbols. For complete information on defining and using symbols, refer to the front-panel operation reference manual for your analyzer.

If you set "Base" in the State Histogram display to "Symbol," you can use any defined range or pattern symbol to set the lower and upper values of the ranges.

In the HP 1650A/1651A or HP 1650B/1651B, if you select the "SYMBOL" field in the Range Definition pop-up (item 4 in figure 5-2a), you can set the lower and upper values of the range to any defined range symbol. You can use the SYMBOL field independent of which base you have selected.

## Tracing All States vs. Qualified States

You can qualify the data sampled and sorted in the State Histogram by selecting the "Trace type" field and setting it to "Qualified States" (item 1 in figure 5-3a and 5-3b). This creates a new field at the top of the display called "Specify Qualified States."

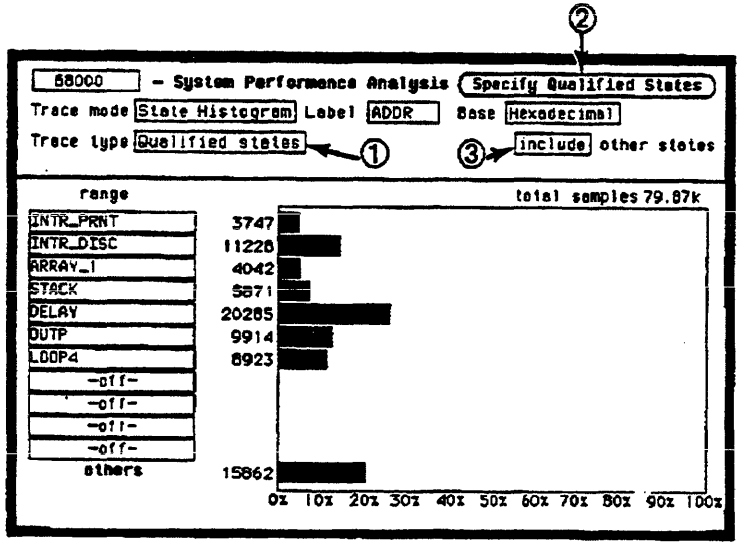


*Figure 5-3a. HP 1650A State Histogram Display. (HP 1651A, HP1650B/1651B similar.)*

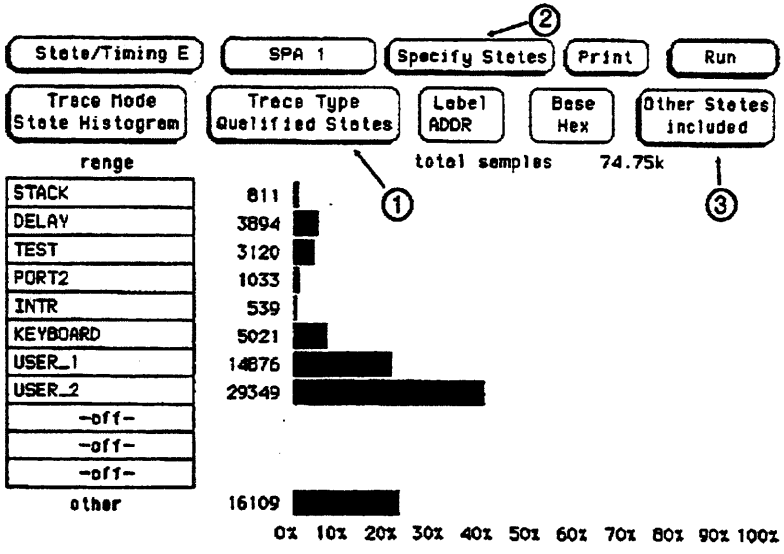


*Figure 5-3b. HP 16510A State Histogram Display. (HP 16510B similar.)*

Select "Specify Qualified States" (item 2 in figure 5-3a and 5-3b) and you will see a pop-up that contains a pattern field for every label defined in the State Format Specification. Use the pattern fields to define the data qualification.

For example, in the State Histogram you may want to monitor the address bus of a microprocessor system to examine memory activity. But you may want to monitor only writes to memory. In the "Specify Qualified State" pop-up, you can tell the analyzer to sample only memory writes by entering under the STATUS label the bit pattern or Symbol that corresponds to memory writes.

## Interpreting the Histogram Display

Press RUN to start the State Histogram acquisition. In the HP 16510A/16510B, you should select the Repetitive Run mode. The relative activity over the ranges you defined is displayed as histograms (see figure 5-3a and 5-3b). The "total samples" field shows the total number of data samples displayed in all of the ranges. The number of samples for each range is displayed to the left of each histogram.

The percentage amounts of the histograms total 100% (note the scale at the bottom of the display). If they add up to more than 100%, you have overlapped two or more ranges, and the data samples are being counted in multiple ranges.

The analyzer will continue to sample, sort the data, and update the display until you press STOP or you change a display variable.

## Include/Exclude Other States

The histograms show the relative distribution of activity over the ranges you've defined. In most cases, the ranges won't cover the full range of the label you've chosen to monitor.

To view the activity over the entire range of the label, including activity not covered by the ranges, select the "other states" field and change it to "include" (item 3 in figure 5-3a and 5-3b). Another histogram bar called "other" will appear at the bottom of the display. This will show activity not covered by the ranges. You can toggle include/exclude if the analyzer is stopped or if it is running since it only effects the display and not the data string.

Note that changing between "include" and "exclude" changes the absolute sizes of the histograms. Unless you have defined overlapping ranges, the total percentage size of the all the range histograms plus the "other" histogram should equal 100%.

## Using Time Interval Mode

You use Time Interval mode to determine the distribution of time between two specific events. The state analyzer uses its count time feature to time the event; therefore, in Time Interval mode, the minimum state clock period is 60 ns (states must be at least 60 ns apart). In Time Interval mode the Clock Period field in the State Format Specification should be set to " > 60 ns." If you select RUN in Time Interval, the Clock Period field will be set to " > 60 ns" if it is not already set.

### Specifying an Event

In order to use Time Interval mode, you must define an event that you want timed. At the bottom of the display, note the "Start" and "End" fields (item 1 in figure 5-4a and 5-4b). To define an event, select the appropriate labels in the Start and End fields to define the boundaries.

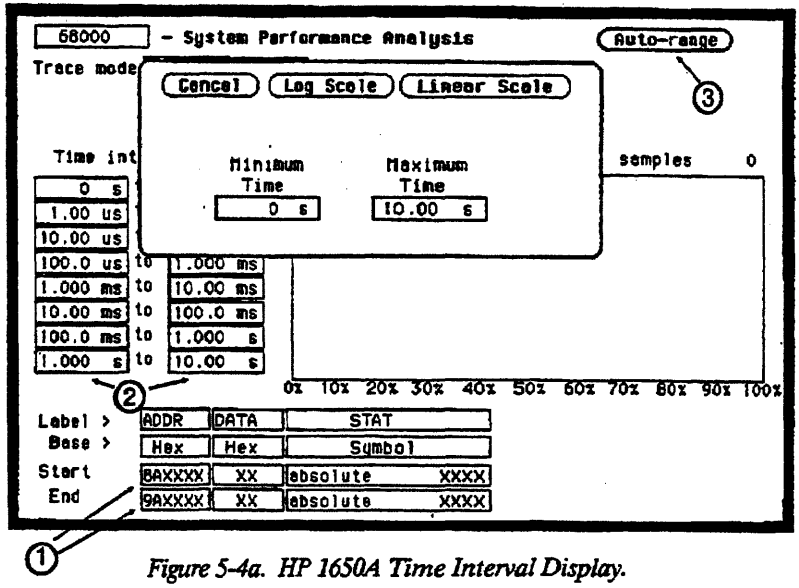


*Figure 5-4a. HP 1650A Time Interval Display. (HP 1651A, HP 1650B/1651B similar.)*

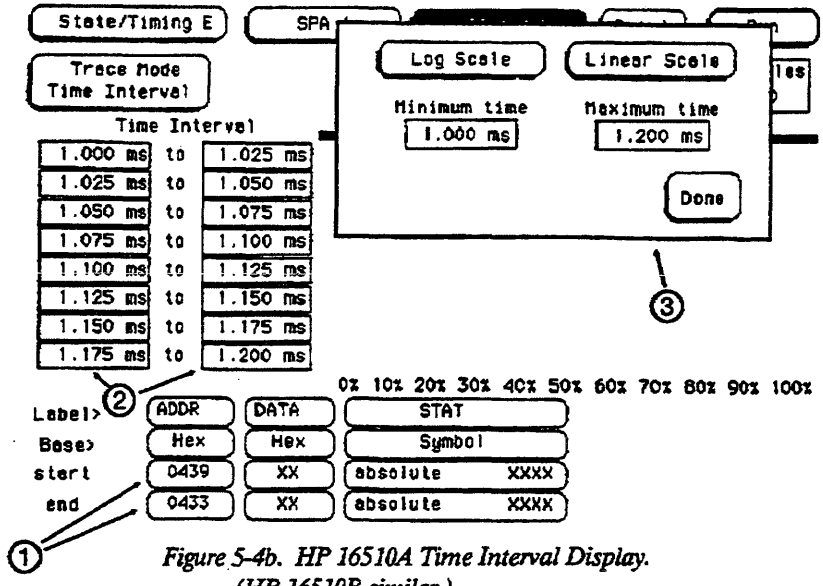


*Figure 5-4b. HP 16510A Time Interval Display. (HP 16510B similar.)*

For example, Start and End might be the beginning and ending addresses of a subroutine stored in memory. If you're timing a counter period, Start and End might be the initial and final count values.

Note that in Start and End, you are not limited to a single label. You define the event over all available labels as patterns including don't cares. Be sure that the Start and End conditions actually occur in the target system or the analyzer will not find the timing reference points and will not make the time interval measurement. You may want to use the state analyzer (not SPA) to verify that the Start and Stop events actually occur.

## Defining the Time Interval Ranges

Before changing the ranges from their default values, you may want to press RUN and acquire some data. From this initial run, the maximum (Max), minimum (Min), and average (Avg) statistics on the display will help you choose the appropriate set of time interval ranges.

To define the ranges, select the fields for the lower and upper limits (item 2 in figure 5-4a and 5-4b) and enter the limits of the range. The ranges do not need to be contiguous, but if you leave gaps between the ranges, critical data may be missed. Also, if you overlap ranges, data may be counted multiple times and present a misleading histogram.

## Using Auto-range

To quickly set up all 8 time interval ranges, select the "Auto-range" field (item 3 in figure 5-4a and 5-4b). Enter the "Minimum Time" and "Maximum Time" for all 8 ranges combined. Then, when you select "Log Scale" or "Linear Scale," all 8 ranges will be scaled accordingly between the Minimum and Maximum times. See figure 5-4a and 5-4b for the "Auto-Range" pop-up. Common boundaries of adjacent ranges are not considered overlapped. Values that fall on the common boundary will be included in the highest range.

A fast way to set up the Time Interval display is to define your Start and End events and press RUN using the default ranges. In the HP 16510A/16510B, you should select Repetitive Run mode. After accumulating data for a while, press STOP. Then select "Auto-range" and enter the "Min time" and "Max time" display statistics in the Auto-range "Minimum Time" and "Maximum Time" fields. When you select "Log Scale" or "Linear Scale," the ranges will be defined automatically.

## Interpreting the Histogram Display

As the state analyzer samples the data, it searches for Start/End event pairs. One event pair is considered one sample. After 256 samples (pairs) are acquired, the time value for each event pair is compared to each defined time interval range. The range's count is incremented if the time value falls within that range.

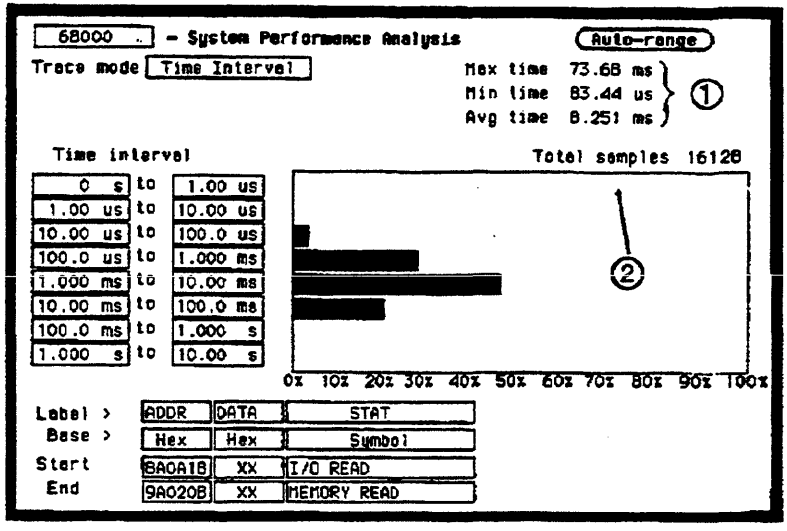


*Figure 5-5a. HP 1650A Time Interval Display.*
*(HP 1651A, HP 1650B/1651B similar.)*

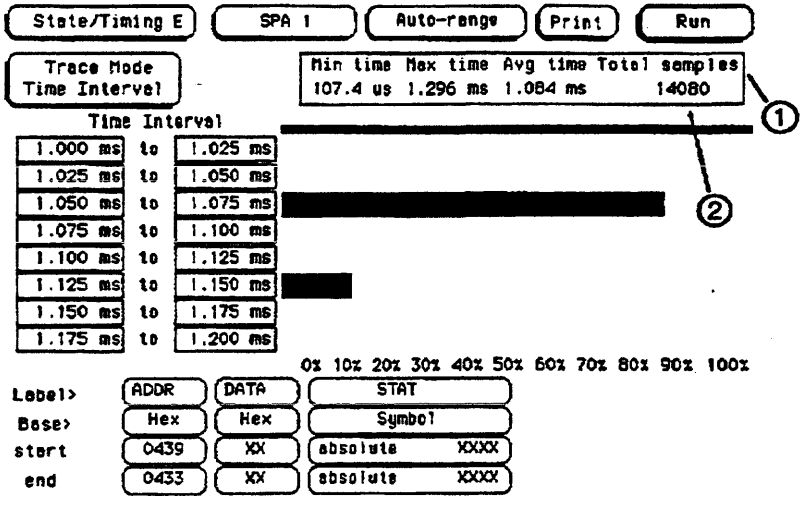


*Figure 5-5b. HP 16510A Time Interval Display.*
*(HP 16510B similar.)*

The analyzer continues to search for Start/End event pairs until you press STOP or until you change a display variable. The distribution of the event's time duration is displayed as histograms (see figure 5-5a and 5-5b).

The "Max time," "Min time," and "Avg time" statistics give you useful statistics for the event you defined no matter what ranges you've set up (item 1 in figure 5-5a and 5-5b).

The "Total samples" field shows the number of Start/End event pairs found by the analyzer, whether they are covered by the ranges or not (item 2 in figure 5-5a and 5-5b).

# 6

# Using System Performance Analysis With Other Features

## Introduction

This chapter describes what other features you can use with SPA and how to use these features.

## Programming With SPA

### With the HP 1650A/1651A

When using SPA software, there is no programming capability for any features in the HP 1650A/1651A.

**Note**

Programming for the State and Timing modes of operation is available for the HP 1650A/1651A using operating system software not containing SPA. Refer to your logic analyzer's programming manual for complete details on programming.

### With the HP 1650B/1651B or the HP 16510A/16510B

When using SPA software, there is no programming capability for SPA features in the HP 1650B/1651B or the HP 16510A/16510B. However, programming for the State and Timing modes of operation is possible using the software containing SPA. Refer to your logic analyzer's programming manual for complete details on programming.

## Changing Between SPA and a State Analyzer

If you have configured a state analyzer in the HP 1650A/1651A, HP 1650B/1651BA, or HP 16510A/16510B logic analyzers, you can quickly change to SPA, or from SPA to a state analyzer. SPA uses many of the state analyzer features; in many cases (especially in microprocessor applications), you will want to use the same State Format Specification in your SPA measurements as you did in your state analysis measurements.

To change between a state analyzer and SPA, select the "Type" field in the System Configuration menu (State/Timing Configuration menu in the HP 16510A/16510B) and select "SPA" or "State" (see figure 1-1).

When you change between state and SPA, the System Configuration (State/Timing Configuration in the HP 16510A/16510B) pod assignments and analyzer names remain unchanged. The State Format Specification also remains unchanged.

### Changing From State to SPA

The first two pattern recognizers in the State Trace Specification become the Start and End terms in the SPA Time Interval mode. The fourth pattern recognizer becomes the Pattern term in the SPA State Histogram Qualified State Specification. If you define the first, second, and fourth pattern recognizers in the State Trace Specification, the values will carry over to SPA.

Any Symbols in the State Format Specification will also carry over to SPA.

### Changing From SPA to State

If you change SPA to a state analyzer, the State Trace Specification returns to its default settings. Any Symbols you define in SPA will carry over to State Format Specification.

## Changing Between SPA and a Timing Analyzer

If you have configured a timing analyzer in the HP 1650A/1651A, HP 1650B/1651B, or HP 16510A/16510B logic analyzers, you can quickly change to SPA, or from SPA to a timing analyzer. SPA uses some of the timing analyzer features; in some cases you may want to use the same Timing Format Specification in your SPA measurements as you did in your timing analysis measurements. In this case, the

Timing Format Specification will become a State Format Specification so you will need to define the state input clock.

To change between a timing analyzer and SPA, select the "Type" field in the System Configuration menu (State/Timing Configuration menu in the HP 16510A/16510B) and select "SPA" or "Timing" (see figure 1-1).

When you change between timing and SPA, the System Configuration (State/Timing Configuration in the HP 16510A/16510B) pod assignments and analyzer names remain unchanged.

### Changing From Timing to SPA

The Timing Format Specification changes to a State Format Specification; i.e. it now has default state input clock specifiers (otherwise, it remains the same). You must select the correct state input clocks for SPA to function as expected. Any Symbols in Timing Format Specification will carry over to SPA.

### Changing From SPA to Timing

The State Format Specification changes to a Timing Format Specification; i.e. the state input clock specifiers go away (otherwise, it remains the same). If you define Symbols in SPA, they will carry over to the Timing Format Specification.

## Using SPA With State or Timing in a Single Logic Analyzer

You can configure a single HP 1650A/1651A, HP 1650B/1651B or HP 16510A/16510B as two separate analyzers. You can choose any paired combination of state, timing, or SPA, with the exception of dual timing analyzers. In the HP 1650A/1651A or HP 1650B/1651B, when you pair SPA with a state or timing analyzer, the state or timing analyzer will default to Repetitive Run mode. This is because the statistical analysis of SPA is most effective over repetitive acquisitions, and SPA is therefore defaulted to Repetitive Run Mode. The paired state or timing analyzer defaults to Repetitive Run mode because two paired analyzers must have the same Trace mode.

In the HP 16510A/16510B, when you pair SPA with a state or timing analyzer, the RUN field will allow "Single" or "Repetitive" Run mode. This preserves the repetitive capability of other modules in the HP 16500A mainframe. You can run SPA in Single Run mode, but

SPA is most effective when run in Repetitive Run mode (see "Using SPA on the HP 16500A Intermodule Bus," later in this chapter).

You may set up SPA to arm the state or timing analyzer. To do this, select the "Armed by" field in the State or Timing Trace Specification and select the name of your SPA analyzer. If you set the arming this way, there are two cases where the state or timing analyzer may never receive its arm signal: 1) if SPA Time Interval mode never finds any Start or Stop conditions, or 2) if SPA State Histogram Trace type is Qualified states and it never finds any qualified states.

## Using Multiple SPA Analyzers in a Single Logic Analyzer

You can configure two SPA analyzers in a single HP logic analyzer, but you can not run them separately. When you press the RUN key, the current or most recently displayed Trace mode (State Overview, State Histogram, or Time Interval) in each of the two SPA analyzers will execute. You need not select the same Trace mode in the two SPA analyzers.

In Repetitive Run mode, if one of the two SPA analyzers has to wait for its Time Interval Start or Stop conditions or its State Histogram qualified states, then the other SPA analyzer will not re-arm until the first one finds its Start, End, or Qualified states and completes the acquisition. If you press STOP, the SPA that has completed its acquisition will update its display.

## Using SPA on Multiple HP 16510A/ 16510B Modules

With the HP 16500A and multiple HP 16510A or 16510B State/Timing modules, you can configure up to ten SPA analyzers in the same mainframe. Any two SPA analyzers you configure in the same HP 16510A/16510B module will function as described in the previous section above, "Using Multiple SPA Analyzers in a Single Logic Analyzer."

You can configure multiple HP 16510A/16510B State/Timing modules over the HP 16500A intermodule bus (and therefore multiple SPA analyzers as well), but this may affect the repetitive sampling techniques of any SPA analyzers included in the configuration (see the following section).

Therefore, if you use SPA on multiple HP 16510A/16510B modules, each module will retain its independent, random repetitive sampling only if run independently.

To access SPA analyzers on multiple HP 16510A/16510B modules, simply touch the module selection field in the HP 16500A touchscreen (the field in the upper left corner of the display). The resulting pop-up will show you a list of all the modules installed (for example, "State/Timing A," "State/Timing B," etc); just select the one you want.

To access one of two SPA modules in a single HP 16510A/16510B module, select the menu selection field (the second field from the upper left) and choose your SPA analyzer in the resulting pop-up.

## Using SPA on the HP 16500A Intermodule Bus

In the HP 16500A Logic Analysis System, you can define an intermodule sequence using various combinations of modules. You can run the intermodule sequence in single or repetitively. In either case, any module in the sequence will trigger and then arm the next module, or the sequence may end.

By its statistical nature, SPA runs best as a repetitive measurement system. If you include SPA in an intermodule sequence in the HP 16500A, the blind time between its repetitive acquisitions is effected because it waits for other modules to trigger and sample.

Therefore, if you include SPA in an intermodule sequence, or Group Run, it will execute and update the SPA displays, but the data may not be acquired in a repetitive fashion, and it may not represent a true statistical analysis of your target system.

If you want to include SPA in intermodule measurements along with other HP 16500A modules, be aware of the above limitations. Another way to make SPA measurements in conjunction with other modules is to run SPA independently (do not include it in the Group Run), and set up the other modules under Group Run as you normally would. In this way, SPA will provide a truer statistical analysis of your target system.

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