Instructions

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12R01 PERFORMANCE ANALYSIS ROM PACK

A 1240 Logic Analyzer with the 12R01 Performance Analysis ROM Pack can be used to perform a variety of tasks in software and hardware analysis. Two alternate methods of analysis are available with the pack: State Overview and Event Measurement.

State Overview counts the occurrences of events within a defined range, and has the advantage of using the 1240's advanced triggering features to acquire the data that is to be processed. Event Measurement allows a variety of measurement techniques, such as counting clock cycles and occurrences, or taking time measurments. The two methods combined in this pack work together to provide a highly flexible software and hardware analysis tool.

Insert this manual at the back of your *1240 Logic Analyzer Operator's Manual*, or in the 1240 Optional Accessories binder.

12R01 — PERFORMANCE ANALYSIS ROM PACK

PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL

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PREFACE

This manual is a supplement to the *1240 Logic Analyzer Operator's Manual.* It contains complete instructions for use of the 1240 with the 12R01 Performance Analysis ROM Pack. The manual is intended for use by both the novice and more experienced users, but assumes familiarity with the 1240 Logic Analyzer.

Section 1 of this manual gives a brief overview of the ROM pack, followed by installation and power-up procedures.

Section 2 descibes all menus and features provided by the ROM pack for both State Overview and Event Measurement functions.

Section 3 contains several sample applications of both State Overview and Event Measurement.

All service information is located in the *1240 Logic Analyzer Service Manual.*

RELATED DOCUMENTS

In addition to this manual, the *1240 Logic Analyzer Operator's Manual* will help you understand and operate your Performance Analysis ROM Pack.

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LIST OF ILLUSTRATIONS

OVERVIEW AND POWER-UP PROCEDURE

The Performance Analysis ROM Pack provides two separate features that aid in the development and test of software and hardware for microprocessor-based products.

State Overview. State Overview is used to look at the activity levels of various event ranges. The State Overview function lets you define up to 11 pairs of range values, entered as a lower bound, an optional name, and an upper bound. Each range is also associated with a specific channel group defined in the Channel Grouping menu.

Once the ranges have been entered, you begin acquiring data using the standard 1240 triggering. When an acquisition is complete, State Overview software searches the acquired data for matches between the ranges and the channel groups they are associated with. Each time an event falls within a range associated with the event's channel group, a counter for that range is incremented.

In the display, the total number of matches for each range is given. The total number of acquisition cycles that occurred on the given timebase are also counted. The percentage of matches to total acquisition cycles on the given timebase is shown as a histogram for each range.

See *State Overview* in section 2 of this manual for details and instructions.

Event Measurement. Event Measurement lets you take a closer look at event activity. It provides an alternate method of analyzing data that does not use the normal 1240 triggering, but acquires data only on defined events. In Event Measurement, a *measurement* contains three elements: the start measurement event, an optional target event, and the stop measurement event.

If no target event is defined, you may choose to count the clock cycles during each measurement or time the duration of each measurement. If the target within the measurement consists of a single event, occurrences of the target event can be counted or timed during each measurement. If the target event consists of two events, the interval between these two events is timed during each measurement.

The statistical totals from all defined events can be compared in one menu. Or, if you desire a more detailed look at one event, the data acquired on an event can be broken into distribution intervals and viewed alone. See *Event Measurement* in Section 2 of this manual for details and instructions.

CAPABILITIES

The Performance Analysis ROM Pack allows the 1240 to perform a variety of hardware and software analysis tasks using entirely non-intrusive analysis methods. Some of the ROM Pack capabilities are:

- analyzing memory use
- determining activity levels of modules and sub-routines
- determining excecution time of program modules
- finding problem areas in the interface between hardware and software

OPTIONAL ACCESSORIES

No optional accessories are available with the 12R01 Performance Analysis ROM Pack.

PERFORMANCE ANALYSIS MENUS

The State Overview menus do not interact with Event Measurement menus. Data acquired using one function has no effect on the other.

Use the Performance Analysis menu to access all menus for both functions. The menus are:

State Overview:

- Enter Ranges - to specify the event ranges and the channel groups they are associated with.
- View Range Histograms - to display range data.

Event Measurement:

- Enter Events - to define the events and the type of measurement to be used.
- Enter Distribution Intervals - to define the distribution intervals that a single event is to be displayed in.
- View One Event - to see data from a single event displayed in distribution intervals.
- View All Events - to see the statistics from each event compared with others.

INSTALLATION AND POWER-UP

1240 Connections. When using the Performance Analysis ROM Pack, you must first connect the 1240 to the system under test using the standard 1240 probes and connectors. Refer to the *1240 Logic Analyzer Operator's Manual* for details on how to make these connections.

Installing the ROM Pack. Install ROM packs in the slot directly beneath the probe connections on the right side-panel (see Figure 1-1). To install a pack, slide the pack (label side up) past the hinged slot cover and push it slowly and firmly into the connector. Two guides on the top cover of the pack ensure the pack will be installed correctly.

ROM packs can be installed or removed while the power is off. If the power is on, the Storage Memory Manger menu must be displayed on the screen and you must press the LOAD NEW PACK soft key immediately after installing the pack.

CAUTION

Static discharge can damage the semiconductor devices in a ROM pack. Discharge static from a pack before installing it by momentarily laying the pack (label side up) on top of the 1240.

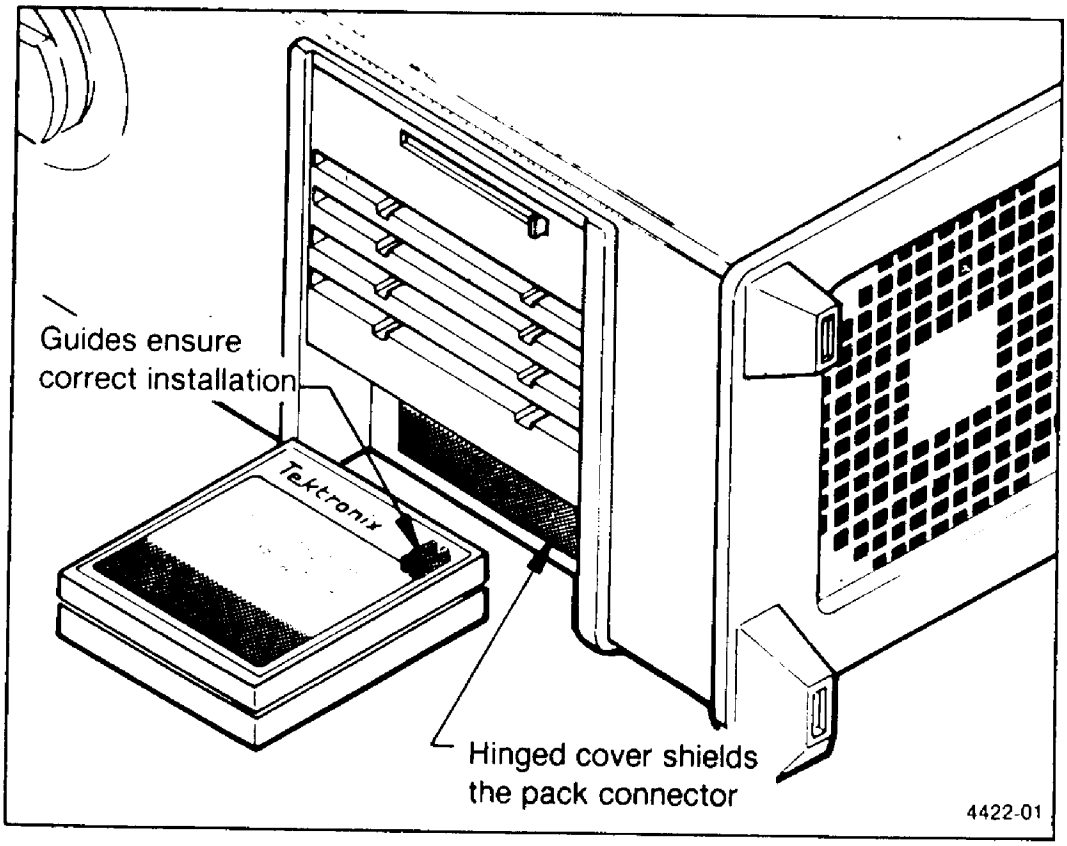


Figure 1-1. Installing a ROM pack.

Loading the ROM Pack Contents. If you install the Performance Analysis ROM Pack while power is off, the contents of the pack will be automatically loaded into the 1240 on powering up. To install the Performance Analysis ROM pack while power is on, you must first enter the Storage Memory Manager menu. Install the ROM pack, then press the LOAD NEW PACK soft key.

Removing the ROM Pack. To unload the ROM pack from the 1240 while power is on, enter the Storage Memory Manager menu, pull the ROM pack straight out of the 1240, then press LOAD NEW PACK. If power is off, simply pull the pack out of the 1240.

Power-Up Diagnostics. If 1240 power-up diagnostics reveal an error, the 1240 remains under diagnostic control. Refer to the *1240 Operator's Manual* for an explanation of power-up conditions. If no error is present, the 1240 automatically exits the diagnostic monitor and displays the Operation Level menu.

OPERATING INSTRUCTIONS

Overview

When the Performance Analysis ROM Pack is installed and loaded, a soft key labelec PERF. ANALYSIS MENU appears at the top of the Storage Memory Manager menu Touching the PERF. ANALYSIS MENU soft key causes the Performance Analysis menu to appear. Use the Performance Analysis menu to access both the State Overview and Event Measurement menus provided by the 12R01 Performance Analysis ROM Pack.

PERFORMANCE ANALYSIS MENU

The Performance Analysis menu, shown in figure 2-1, is a control menu used only tc select from the six other Performance Analysis menus. The first two menus listed Enter Ranges and View Range Histograms, work together to provide the State Overview function. They have no interaction with the four menus listed under Event Measurement.

State Overview uses the Enter Ranges menu to define ranges, and the View Range Histograms menu to display data. Data acquired on ranges defined in the Enter Ranges menu is available only in the View Range Histograms menu. Event Measurement uses the Enter Events and Enter Distribution Intervals menus to define events and their displays, and the View One Event and View All Events menus to display the data. Data acquired on events defined in the Enter Events menu will be available only in the View One Event menu or the View All Events menu.

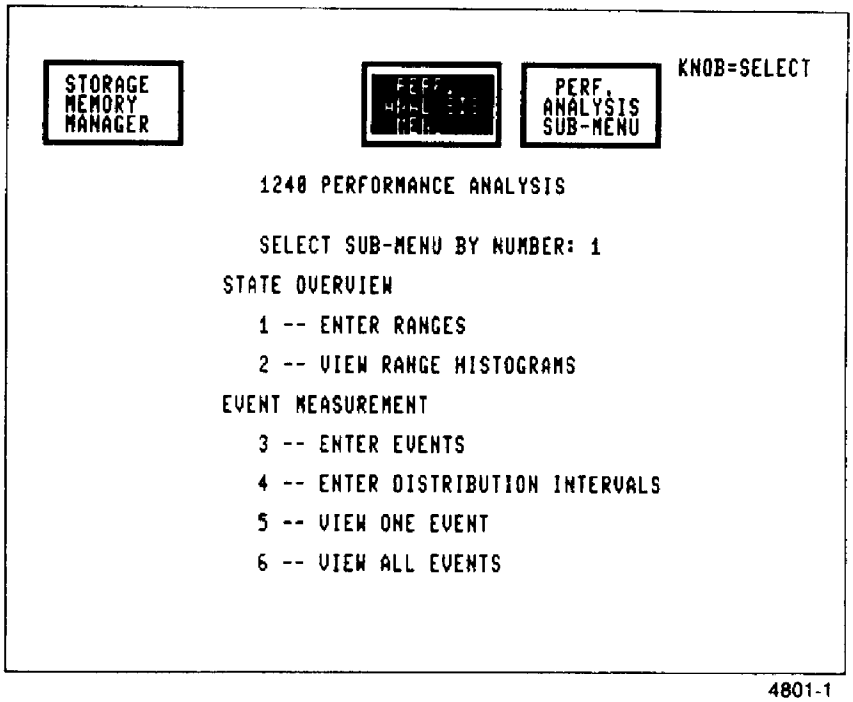


Figure 2-1. Performance Analysis menu. This menu has only one select field. Selections are 1-6. The State Overview selections do not communicate with the Event Measurement selections. When a valid input is received, this menu is exited and the selected menu appears. Using the data entry keys to enter a value causes the selected menu to appear immediately. If you use the SCROLL knob or SELECT keys to select a value, you must touch the PERF. ANALYSIS SUBMENU soft key to call up the chosen menu.

State Overview

State Overview lets you acquire data on a set of defined ranges. Each range has a lower-bound event and an upper-bound event, and is defined for a specific group from the Channel Grouping menu. After a data acquisition is made (using the standard 1240 triggering) each cycle of the acquired data is searched to find any matches between the channel groups and the ranges defined for them. A match occurs any time the value of a group at a given cycle is greater than or equal to the lower-bound value and less than or equal to the upper-bound value of a range associated with that group.

A cumulative count of the matches is kept for each range, and that count is displayed as a total count, a percentage of the total number of acquisition cycles on the associated channel group's given timebase, and as a bar graph (or histogram) proportional in length to that percentage.

Data Acquisition. All triggering for data acquisition in State Overview must be set up and performed using the 1240's Trigger Spec menu. However, the START key does not work with State Overview. All acquisition is begun using soft keys. As with auto-run, State Overview acquisition continues until you manually halt it. To stop acquisition, press the STOP key, any of the Menu keys, or any of the Menu soft keys at the top of a screen.

The Enter Ranges menu is used to define ranges. The View Range Histograms menu is used to display data acquired on those ranges. As with the other 1240 menus, any field or data associated with timebase T2 is highlighted.

Soft Keys. On the bottom of both menus used in State Overview you will find soft keys labeled BEGIN SAMPLING and CONTINUE SAMPLING. The BEGIN SAMPLING soft key starts acquisition after setting all data or accumulated totals to zero. The CONTINUE SAMPLING soft key also begins data acquisition, but the new data is accumulated into the old totals rather than resetting the totals to zero. When you touch one of these keys, the View Range Histograms menu appears. The LOAD FROM ACTIVE CURSOR soft key loads the event from the active data cursor in the state table into the bound field in which the cursor is located. Glitches are not loaded.

The following paragraphs explain the operation of the Enter Ranges menu and the View Range Histograms menu. See *Section 3* of this manual for sample applications of State Overview.

Beating. If you use all don't cares in the Trigger Spec menu, it is possible to set up ranges whose acquire/process cycle time is such that the 1240 looks at exactly the same portion of code on each acquisition. The result will be that the same ranges are repeatedly sampled, while others are ignored. If this occurs, move the trigger from its current position to another position in acquisition memory.

ENTER RANGES MENU

The Enter Ranges menu is used to define a lower and upper bound for up to 11 event ranges. Ranges must be associated with channel groups from the Channel Grouping menu (several ranges can be associated with one group).

You may also enter an identifying name of up to eight characters for each range. To enter a name, use the data entry keys, SELECT keys, or SCROLL KNOB to select a character, then move the cursor to the next position. See callout 4 in Figure 2-2.

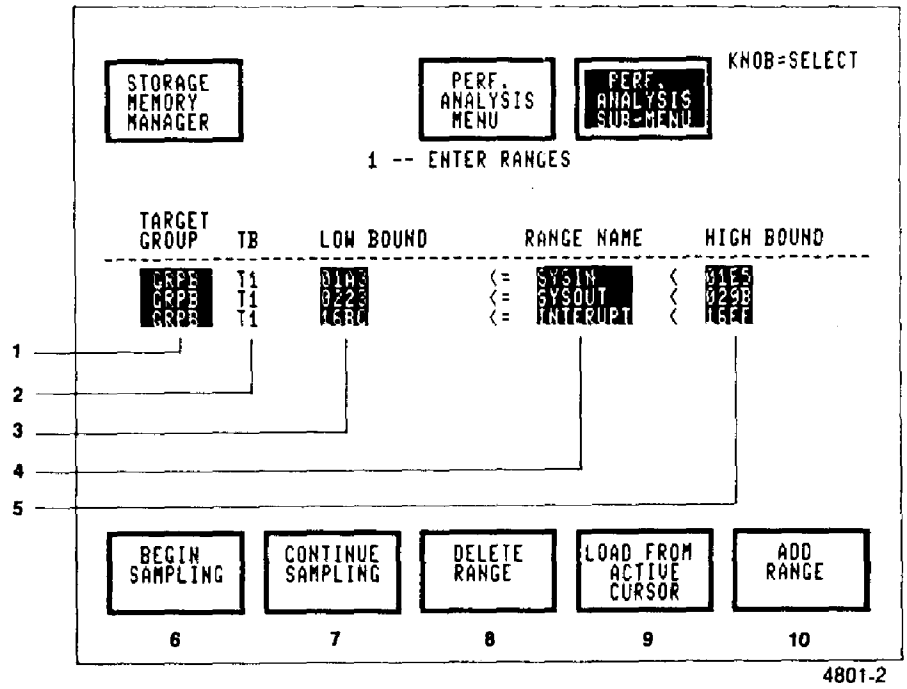
Ranges may be entirely distinct from each other, or they may overlap. Events falling into more than one range will be counted in all ranges for which they are defined. For example, you might set up range 1 from 0 to 14, range 2 from A to 1E, and range 3 from 15 to 28 (all in hex). In that case, occurrences between 0 and 9 would count in range 1, occurrences between A and 14, inclusive, would count in ranges 1 and 2, occurrences between 15 and 1E, inclusive, would count in ranges 2 and 3, and occurrences between 1F and 28, inclusive, would count in range 3. If the lower bound event equals the upper bound event, then that single event forms a range.

The bound values must be entered in the input radix defined for their associated group. Only 11 digits can be entered in a bounds field. If more than 11 digits are necessary for the assigned channel group, the bounds field will automatically be switched to hexadecimal. This means that if you are using a binary radix and have more than 11 channels assigned to the group, you will have to make your bounds entries in hexadecimal.

NOTE

If you define a set of ranges, acquire data on them, then change the ranges, you must use BEGIN SAMPLING *to get valid data. If you use* CONTINUE SAMPLING *to get new data, the data will be invalid.*

See Figure 2-2 for an example of the Enter Ranges menu with ranges defined.



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1 Channel group selections available in this field are determined by the setup in the Channel Grouping menu. Use this field to specify the group you wish to define the range for. Your selection here determines the size and input radix of the bounds fields. If you select a group here, then change the name of that group in the Channel Grouping menu, this menu will change to match.

2 Indicates the timebase of the channel group you have chosen to define the range for. All data associated with timebase T2 is highlighted. This is not a select field.

3 The value you enter here will determine the lower bound of the range. The value is included in the range.

4 Use this field to name the range. Select from letters A-Z, numbers 0-9, special characters / , . : ^ $ and a blank space.

5 The value you enter here will determine the upper bound of the range. The value is included in the range. (Though not shown, comparison is actually <=.)

6 Erases all previously acquired data and totals then begins a new acquisition. Also causes the View Range Histograms menu to appear.

7 Begins acquisition without initializing previous totals to zero. New data is accumulated into previous totals. Also causes the View Range Histograms menu to appear.

8 Deletes the line of range-definition fields that the cursor is on.

9 Loads the value from the active data cursor in the state table into the bound field your cursor is now on.

10 Adds a new line of range-definition fields. New line appears below current cursor location, and is a copy of the line the cursor was on. Up to 11 range definition fields are available at one time.

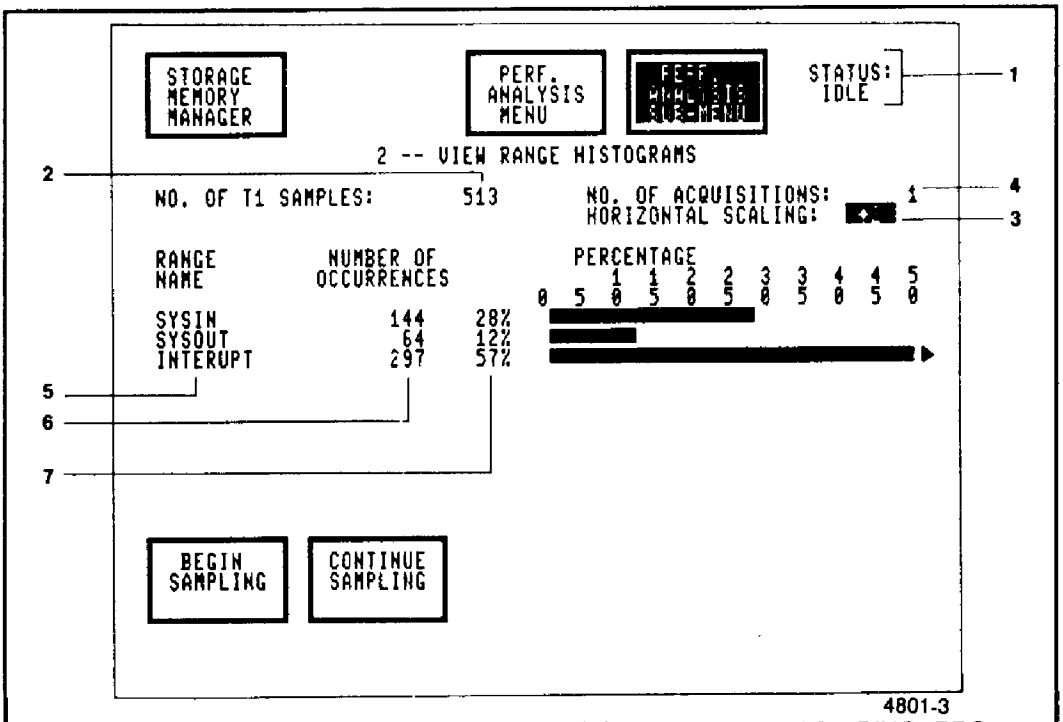
Figure 2-2. Enter Ranges menu. Example ranges and range names have been entered.

VIEW RANGE HISTOGRAMS MENU

The View Range Histograms menu is used as a data display: HORIZONTAL SCALING is the only select field. Bars in the histogram are ordered by name in the same sequence as the Enter Ranges menu. If you enter ranges in the Enter Ranges menu and then start acquisition, this menu will appear immediately. If you start or continue acquisition in this menu, the menu begins displaying data as it is acquired. As with auto-run setups, using State Overview causes the 1240 to continue making acquisitions and updating the display screen until you press the STOP key, any of the Menu keys, or any of the Menu soft keys at the top of a screen.

In case of an overlap in ranges, data falling into more than one range will be counted and displayed in all applicable ranges. See the previous section on the Enter Ranges menu for an example.

The percentage for each range reflects the number of matches out of the total number of cycles acquired on its associated timebase. The presence of other ranges has no effect on that percentage.



1 Current State Overview status. Possible states are ACQUIRING, PROCESSING, and IDLE.

2 Number of samples that occurred on each timebase. If the 1240 is set up for one timebase, only that timebase will appear.

3 Triangular arrow (at right of bar in histogram) indicates data extends off screen. Increase HORIZONTAL SCALING to see all data.

4 Total number of acquisitions made.

5 This is the range name you entered in the Enter Ranges menu. Ranges defined on T2 will have their names highlighted.

6 Total number of matches between the range and its associated group.

7 Percentage of matches out of the total number of events acquired on the channel group associated with the range. The histogram also represents this percentage.

Figure 2-3. View Range Histograms. Example data has been acquired.

Event Measurement

Four menus are used to provide the Event Measurement functions. They are Enter Events, Enter Distribution Intervals, View One Event, and View All Events. As with the State Overview menus, you can access Event Measurement menus through the Performance Analysis menu. This section of the manual contains information relating directly to the use of the menus that control the Event Measurement functions. See *Section 3* for sample uses of Event Measurement.

Event Measurement lets you define a section of data to locate the event you wish to analyze. In Event Measurement, a measurement consists of a Start Measurement event, an optional target event, and a Stop Measurement event. The data acquired in a single occurrence of the Start Measurement/Stop Measurement cycle is defined as a *sample*. When you start sampling, the 1240 repeatedly takes the same kind of measurement sample until you stop the sampling. Within each sample some type of measurement takes place, and this information is then processed for display.

The target event may be a single event that you wish to count occurrences of, or an event you wish to time. It can also be two events, in which case the 1240 will measure the time between them. If you choose not to have a target event, you can time the duration of each sample, or count the clock cycles that occur on a given timebase during each sample. Up to four separate events can be defined.

Unlike State Overview, Event Measurement does not use the standard 1240 trigger frame to control acquisition. Instead, data sampling is controlled by the Start Measurement/Stop Measurement events specified in the Enter Events menu. When you press the BEGIN SAMPLING soft key to begin sampling, the 1240 will continue to take samples and accumulate data until you press any of the Menu keys, any of the Menu soft keys at the top of screen, or the STOP key. The display is updated once a second.

The Start Measurement event is specified by two levels of event recognizers. Either timebase may be used in those word recognizers, and the basic format is: START MEASUREMENT AFTER N OCCURRENCES ON TX OF (WORD1) FOLLOWED BY M OCCURRENCES ON TY OF (WORD2). The measurement is qualified to begin after both events have been found. If you want to start the measurement after only one event, enter the value for the event in the second event recognizer and don't cares (X) in the first event recognizer. If you reverse this order, your measurement could be off by one clock cycle, or the start event might not be found at all.

The Stop Measurement event consists of a single event recognizer, and a counter to specify how many times that event must occur before the measurement sample ends.

Soft Keys. On the bottom of all menus used in Event Measurement you will find soft keys labeled BEGIN SAMPLING and CONTINUE SAMPLING. The BEGIN SAMPLING soft key starts acquisition after setting all data or accumulated totals to zero. If you touch the BEGIN SAMPLING soft key in the View One Event menu, all events will have their values reset to zero. The CONTINUE SAMPLING soft key also begins data acquisition, but adds the new data to the old rather than resetting the totals to zero.

The DEFAULT EVENT SPEC. soft key in the Enter Events menu resets all event recognizer fields for the displayed event to X (don't care), the iteration counts to 1, OF NOT to OF, and timebase fields to T1 (if any groups are defined on T1). No change is made until you confirm the action by pressing the X key.

The LOAD FROM ACTIVE CURSOR soft key loads the event from the active data cursor in the state table into the event recognizer field in which the cursor is located. Any glitches will also be loaded, even if the glitch display is OFF.

Data Display. Data acquired on events defined in the Enter Events menu is available in one of two menus. If you choose to display in the View All Events menu, all events are sampled. In that case, the summed times or counts of all samples (Start Measurement/Stop Measurement cycles) of each event can be displayed as the average of all samples, the largest single sample, or the smallest single sample. See *View All Events* later in this section for a detailed explanation.

Defined events can also be sampled alone, with results displayed in the View One Event menu. These individual results are first divided into distribution intervals using the Enter Distribution Intervals menu. If you begin sampling using distribution intervals, each time the count (or time) from an event sample falls into a user-defined interval, the counter for that interval is incremented by one. See *Enter Distribution Intervals* later in this section for a detailed explanation.

ENTER EVENTS MENU

This menu is used to control data acquisition for Event Measurement functions. As previously described, the three main items to be specified in this menu are the Start and Stop measurement events, the target event, and the type of measurement to be used. Up to four separate events can be defined.

The five optional methods of collecting data during each sample are described below. These options are selected under MEASUREMENT TYPE, and are only selectable when you are in event 1 (indicated in the EVENT ENTERED field). When you change the MEASUREMENT TYPE in event 1, it is automatically changed for all events. This is necessary since the View All Events menu must have a common basis to compare the events by. The choice you make under MEASUREMENT TYPE affects the entire area marked by callout 6 in Figure 2-4.

None of the five measurement methods are cumulative. Each sample total is distinct, and it is never added to other sample totals. If you compare the events, the results can be shown as an average, maximum, or minimum value for each sample of an event. If you look at a measurement using distribution intervals, each sample is represented as a single increment in an interval group total.

Count Occurrences. In Figure 2-4, the default entry, COUNT OCCURRENCES, is selected under MEASUREMENT TYPE. The COUNT OCCURRENCES selection causes the 1240 to count the number of times that the target event occurs during each sample (Start Measurement/Stop Measurement cycle).

Count Cycles. Selecting COUNT CYCLES causes the 1240 to count the total number of clock cycles that occur on the selected timebase during each sample.

Time Occurrences. This selection causes the 1240 to measure the time that a single target event is present. The timer is started when the target event is recognized, and stopped when any other word is recognized. If the event occurs more than once in a sample, the time from all occurences is accumulated to achieve the sample total. See figures 2-5 and 2-6.

Measure Total Time. This selection causes the 1240 to time the duration of each sample. The timer is started when the Start Measurement event is recognized, and stopped when the Stop Measurement event is recognized. Timing resolution is 10 ns. See figures 2-5 and 2-6.

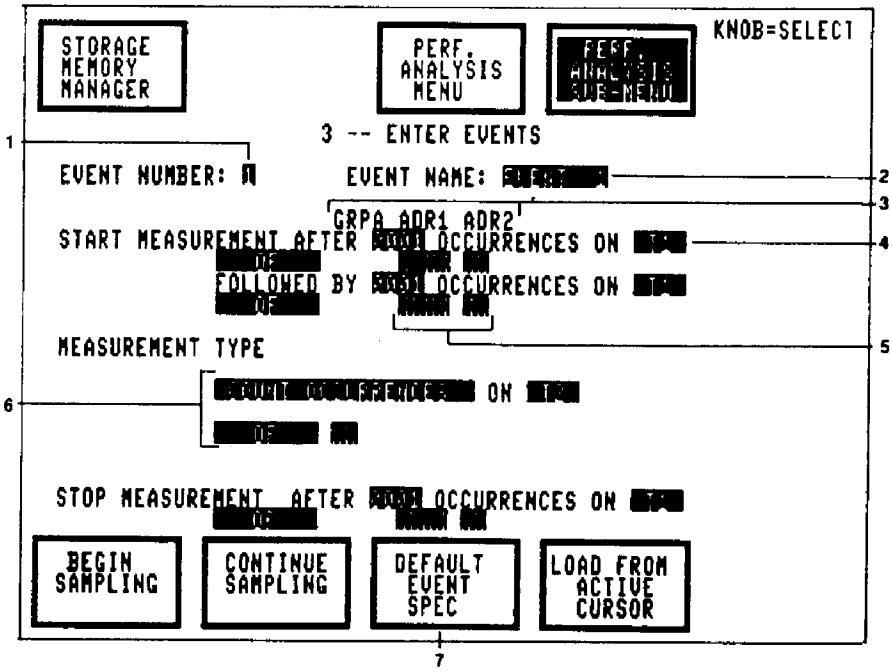
Accumulate Time. This selection allows you to define a second measurement within the first, then time the inner measurement during each sample. The inner measurement consists of a start event and a stop event, and the timer will be started and stopped as those events are recognized. The time from all occurrences of the inner measurement is accumulated to achieve each sample total.

With ACCUMULATE TIME, the Stop Measurement event does not provide an iteration selection. It is automatically set up for one iteration. If the Stop Measurement event occurs after the first level of the Start Measurement event has occurred, but before the second level, it resets the 1240 to begin looking for the first level event again. The 1240 also resets this way if the Stop Measurement event occurs after the second level Start event but before the inner measurement begins. In either case no events are timed. If the Stop Measurement event occurs after the start event of the inner measurement but before the stop event of the inner measurement, a time measurement is taken, but it reflects the time from the inner measurement start to the outer measurement Stop, rather than the time between the two events defining the inner measurement. These restrictions apply only to the ACCUMULATE TIME mode.

NOTE

If you define an event, sample data, then change the event, you must use BEGIN SAMPLING to get valid data. If you use CONTINUE SAMPLING to get new data, the data will be invalid.

Figure 2-4 shows the Enter Events menu with COUNT OCCURRENCES selected. Figure 2-5 shows the other possible contents of the area marked in callout 6 of Figure 2-4. Figure 2-6 gives a diagram explaining exactly how various measurements are taken.



1 Selections are 1-4. Up to four events may be defined, to be viewed alone, or together for comparison.

2 Use this field to name the event. The maximum number of characters in this field is 8. Select from letters A-Z, numbers 0-9, special characters / , . : ^ $ and a blank space.

3 Group names. Names associated with T2 are highlighted.

4 Selections are T1 and T2 if the 1240 is set up for dual-timebase operation. An event recognizer field can be associated with only one timebase. Your selection in this field determines which groups are displayed in the event value fields. In this figure, the Start Measurement event contains only groups associated with T1, and the target event contains only groups associated with T2.

5 Event recognizer fields, one field per channel group. The number of digits available in a field is determined by the input radix selected for that group in the Channel Grouping menu. You can select OF, or OF NOT to precede each event.

6 Selections are COUNT OCCURRENCES, COUNT CYCLES, MEASURE TOTAL TIME, TIME OCCURRENCES, and ACCUMULATE TIME. The configuration of this area is determined by your selection. COUNT OCCURRENCES has been selected in this figure. The MEASUREMENT TYPE can only be selected when you are in event number 1 (see callout 1). See Figure 2-5 for the effects of other selections on this area.

7 Resets the event recognizer fields to X (don't care), the iteration counts to 1, OF NOT to OF, and the timebase fields to T1 (if any groups are defined on T1). No change is made until you confirm the action by pressing the X (don't care) key.

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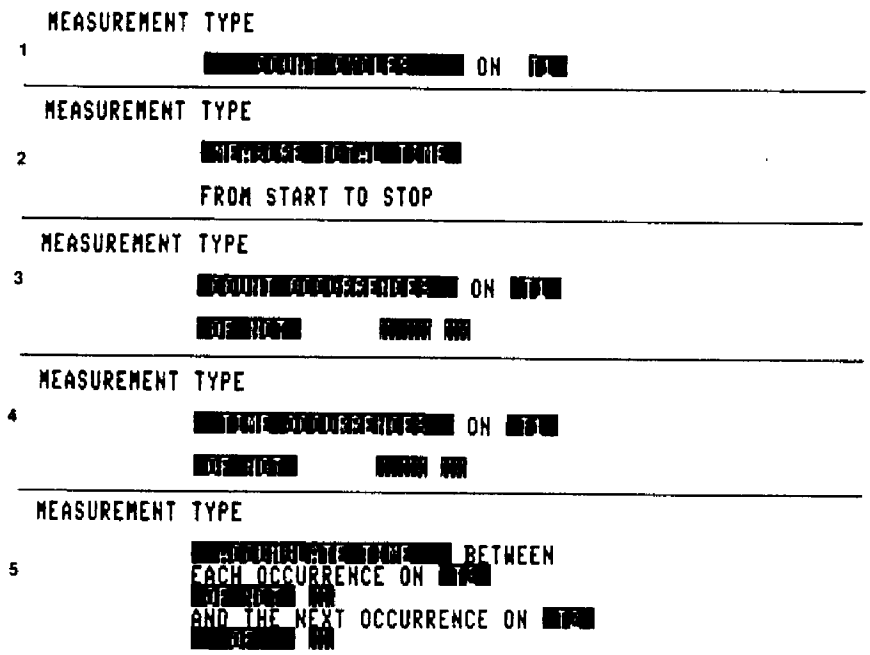
Figure 2-4. Enter Events menu. The Enter Events menu with COUNT OCCURRENCES selected.



1 This selection causes the 1240 to count the cycles that take place during each sample. The timebase is selectable if the 1240 is set up for two timebase operation.

2 This selection causes the 1240 to time the duration of each sample.

3 This selection causes the 1240 to count every occurrence of the target event during each sample.

4 This selection causes the 1240 to measure the time (or times) that the target event is present in each sample.

5 This selection causes the 1240 to measure the time between the two words specifying the inner measurement. If the inner measurement occurs more than once, all times are added to achieve the sample total. See *Accumulate Time* in the preceeding text for details on the Stop Measurement event.

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Figure 2-5. Menu displays for possible selections in the EVENT FUNCTION field. Timebases are selectable if the 1240 is set up for dual-timebase operation. These are only portions of an actual menu. See the preceding text for detailed explanations of each choice.

The diagrams below give three examples of time measurements. All three diagrams begin sampling with:

START MEASUREMENT AFTER 1 OCCURRENCES ON T1 OF A
FOLLOWED BY 1 OCCURRENCES ON T1 OF B. The sample ends with: STOP MEASUREMENT AFTER 1 OCCURRENCES ON T1 OF C.

A Z represents any event that does not need to be specified.

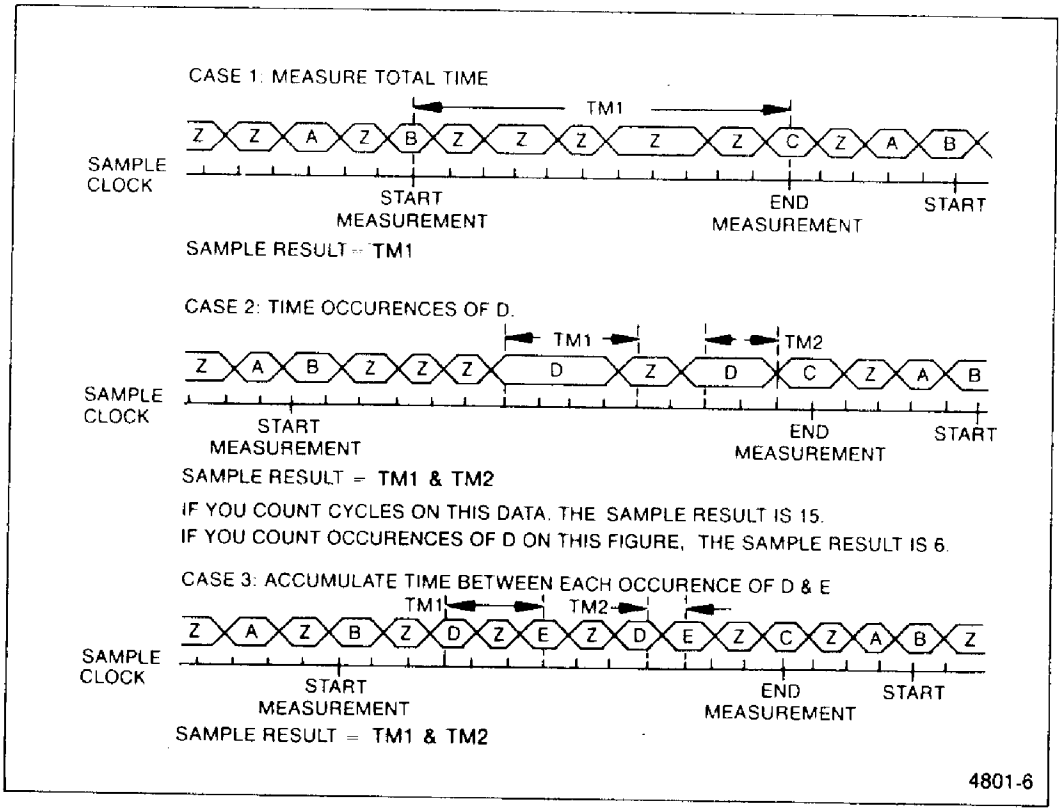


Figure 2-6. Diagrammed examples of Event Measurement.

ENTER DISTRIBUTION INTERVALS MENU

If you desire a more detailed look at one event using the Event Measurement function, you can divide sampled data for the event into distribution intervals. A distribution interval is a range of occurrences formed by a low-bound value and a high-bound value.

Since several measurement types are available in the Enter Events menu, the bound values can be by time or by count. After defining events in the Enter Events menu and entering distribution intervals, you begin taking samples. If a sample result falls into a defined distribution interval, the counter for that interval is incremented by one. For example, if you defined a distribution interval ranging from 20 ns to 50 ns, and took a sample that returned a value of 30 ns, the counter for the 20 to 50 ns interval would be incremented by one.

To gather data on the distribution intervals, you must begin sampling in the Enter Events menu, the Enter Distribution Intervals menu, or the View One Event menu. If you begin sampling in the View All Events menu, the distribution intervals are ignored.

Three basic methods of dividing the data into distribution intervals are available through this menu. These methods are EXPONENTIAL, LINEAR, and VARIABLE. All three methods allow you to define up to 12 intervals. An interval can refer to a range of counts or a range of clocked times, depending on the method of measurement you have selected in the Enter Events menu. As the example for VARIABLE intervals shows, the lower bound of an interval is included in the interval, but the upper bound is not.

When you make a selection, using the INTERVALS field shown in callout 1 of Figure 2-7, the menu will be configured to suit that selection.

Variable Distribution Intervals. Figure 2-7 shows the Enter Distribution Intervals menu with VARIABLE selected in its INTERVALS field, and MEASURE TOTAL TIME selected in the Enter Events menu.

Values entered on adjacent lines define a distribution interval. Interval values entered for VARIABLE distribution intervals may be increasing, decreasing, or mixed, and they may overlap. If we used a count measurement, for example, we could enter the values 5, 12, 7, and 16 on successive lines. The first line of the histogram would then represent each time that the event occurred from 5 to 11 times, the second line would represent the 7 to 11 interval, and the third line the 7 to 15 interval. With these intervals defined, a sample with 5 or 6 occurrences would be counted only in the first interval, a sample with 7 to 11 occurrences would be counted in all three distribution intervals, and a sample with 12 to 15 occurrences would be counted only in the third interval.

The default intervals for this menu start at 0 and go to 1200 in increments of 100 for count. The intervals start at .1 ms and go to 1.4 ms in increments of .1 ms for time.

Linear Distribution Intervals. As an example using COUNT OCCURRENCES, we want to take samples of an event and count the number of samples in which the target event occurred within its measurement 0-9 times, 10-19 times, 20-29 times, and so on up to 110-119 times. This is done by selecting LINEAR in the Enter Distribution Intervals menu, then entering 0 in the START RANGES AT field, and 10 as the STEP VALUE. If you begin sampling data, then press the STOP key after taking only five samples, the 1240 will record five totals. If these totals were 14, 8, 20, 7, and 23, the View Histogram Of One Event menu would display 2 as the NUMBER OF OCCURRENCES for the 0-9 interval, 1 for the 10-19 interval, 2 for the 20-29 interval, and 0 for all intervals above that.

The default intervals for linear distribution use a base of 0 with a step value of 100 for count intervals. For time intervals, the base is 100 μs, with a step value of 100 μs . Figure 2-8 gives an example setup for LINEAR distribution intervals.

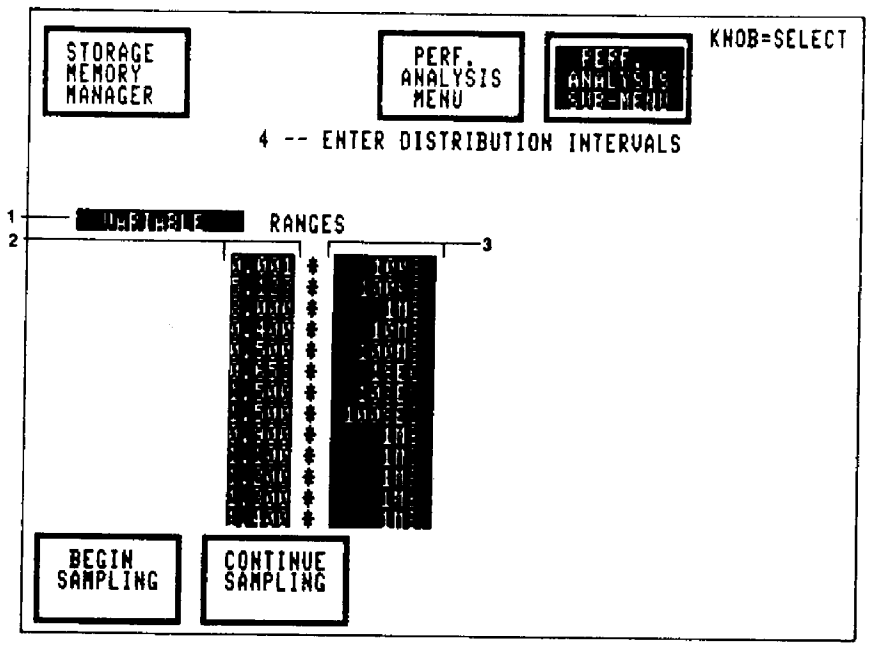
Exponential Distribution Intervals. With exponential distribution intervals, you must enter a base value from a 1-2-5 sequence. The View One Event menu will then automatically be configured with 12 values increasing in 1-2-5 steps starting with the base value. For example, if you enter 200 as the base, the next values will be 500, 1000, 2000, 5000, etc. As with LINEAR and VARIABLE distribution intervals, the entries may be by time or count, depending on the type of measurement you have selected in the Enter Events menu. If the intervals are by count, selections range from 1 to 1017. If the intervals are by time, you can select base values from 10 ns to 100 ms.

The default base count value for this menu is 1. The default base time value for this menu is 50 ns. Figure 2-8 shows the configuration for EXPONENTIAL distribution intervals.

All of the distribution interval choices will be configured for either time intervals or count intervals, depending on the choice you have made in the Enter Events menu. If measurements are by count, the intervals vary from 0 to 9*10111. If the measurements are by time, the possible intervals vary from 0 to 999.9 seconds in increments of

10 ns, and two fields must be used to enter an interval value. The lefthand field is the multiplicand for the righthand field, which is a select field with entries ranging from 10 μs to 100 seconds. To enter time intervals smaller than 10 μs you must enter a decimal value in the left column. For example, to enter a bound value of 20 ns for a distribution interval, you must enter 0.002 in the left column and 10 μs in the right. Whether by count or by time, the upper bound of an interval is not included in the interval. When by count, the upper bound is one less than the stated value. When by time, the upper bound is 10 ns less than the stated value.

Another way of stating this is: low-bound ≤ X < high-bound. If the lower bound value equals the upper bound value, no interval is defined.



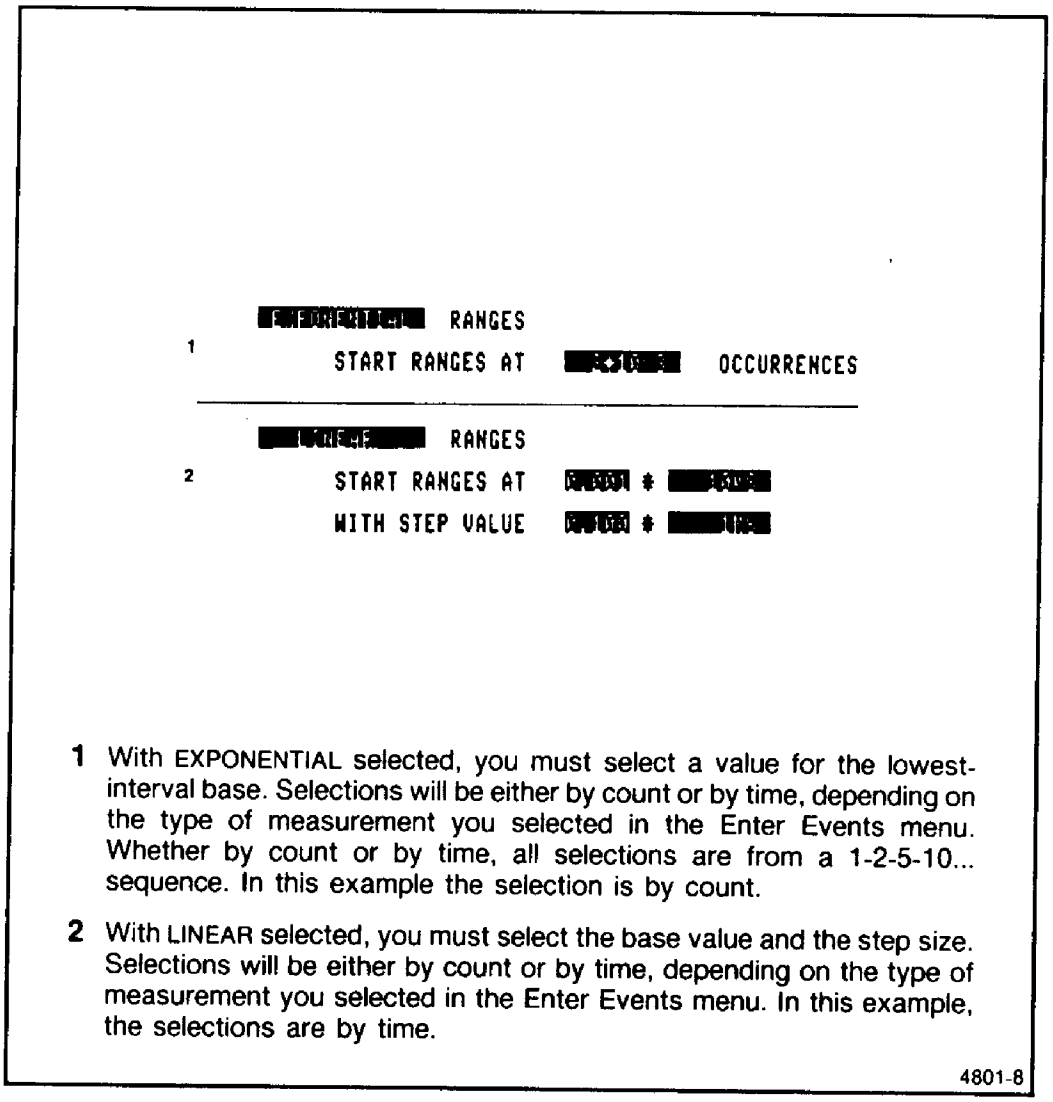
1 Selections are EXPONENTIAL, LINEAR, and VARIABLE.

2 If measurement is by time, this field takes inputs from 0 to 9.999. The number you enter here is used as a multplicand with the time select field (callout 3) to determine the value of the interval bound. If measurement is by count, you can enter numbers ranging from 0 to 11 digits, and the time field is not displayed.

3 Selections are 10 and 100 in microseconds (μs), and 1, 10, or 100 in milliseconds (ms) and seconds (s). This field is multiplied by the value in the previous field to determine the value of the interval bound. For example, the first interval determined in this figure is for values greater than or equal to 10 ns and less than 512.3 μs. The second interval is for values greater than or equal to 512.3 μs and less than 8 ms. This field is only displayed if measurement is by time.

4801-7

Figure 2-7. Enter Distribution Intervals menu with VARIABLE selected. Figure 2-8 shows the variations of the Enter Distribution Intervals menu with EXPONENTIAL and LINEAR selected.



1 With EXPONENTIAL selected, you must select a value for the lowest-interval base. Selections will be either by count or by time, depending on the type of measurement you selected in the Enter Events menu. Whether by count or by time, all selections are from a 1-2-5-10... sequence. In this example the selection is by count.

2 With LINEAR selected, you must select the base value and the step size. Selections will be either by count or by time, depending on the type of measurement you selected in the Enter Events menu. In this example, the selections are by time.

4801-8

Figure 2-8. Variations of the Enter Distribution Intervals menu. Configurations for EXPONENTIAL and LINEAR are shown here. These are only portions of an actual menu. The complete menu, with VARIABLE distribution intervals selected, is shown in Figure 2-7.

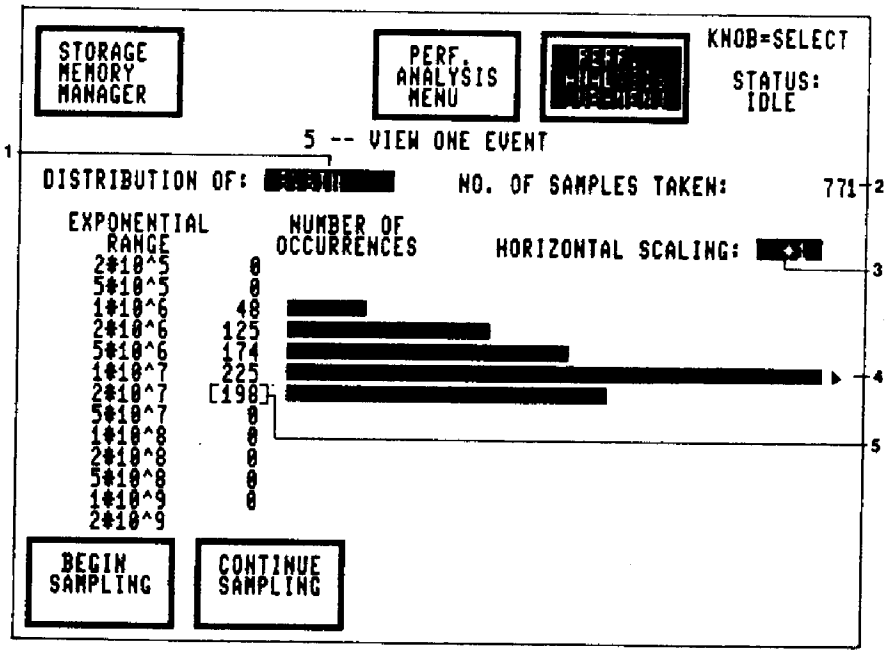
VIEW ONE EVENT MENU

The View One Event menu is used to display data collected on distribution intervals. The displayed data will be based on a count or a clocked time, depending on the measurement you selected in the Enter Events menu.

This menu contains select fields that allow you to choose the event you wish to see, and to control the scaling of the bar graph (histogram). A small triangular arrow at the end of a single bar indicates that the data extends off the edge of the screen. To see data that extends off the screen, increase the value of the HORIZONTAL SCALING.

Interval values are determined in the Enter Distribution Intervals menu. If you change the interval values you must take new samples to obtain data for those intervals.

In this menu, the BEGIN SAMPLING soft key only resets data to zero for the event being viewed. Other event retain old data.



1 Select the name of the event you want to see. Any event you defined in the Enter Events menu is available as a selection here.

2 Indicates the total number of samples taken for each event. If the defined events cover all possibilities, this field will be equal to the sum of the number of occurrences in each interval.

3 Selections are *1, *2, *5, *10, and *20. This field determines the relative size of the bar graph on the screen. A larger number gives a shorter graph.

4 Indicates the histogram extends off the screen. To see all data, increase the value in HORIZONTAL SCALING.

5 Indicates the number of times that the event occurred within the interval. In this callout the interval is $2*10\uparrow7 \leq X < 5*10\uparrow7$, and the event samples fell into that range 198 times. Histogram bars always represent the interval between the value listed on the same line and the value listed on the following line.

6 Resets data to zero and starts sampling for the event being viewed. Other events are unaffected.

4801-9

Figure 2-9. View One Event. Data has been sampled for EXPONENTIAL intervals.

NOTE

If you define distribution intervals, sample data, then change the intervals, you must use BEGIN SAMPLING to get valid data. If you use CONTINUE SAMPLING to get new data, the new data will be invalid.

VIEW ALL EVENTS MENU

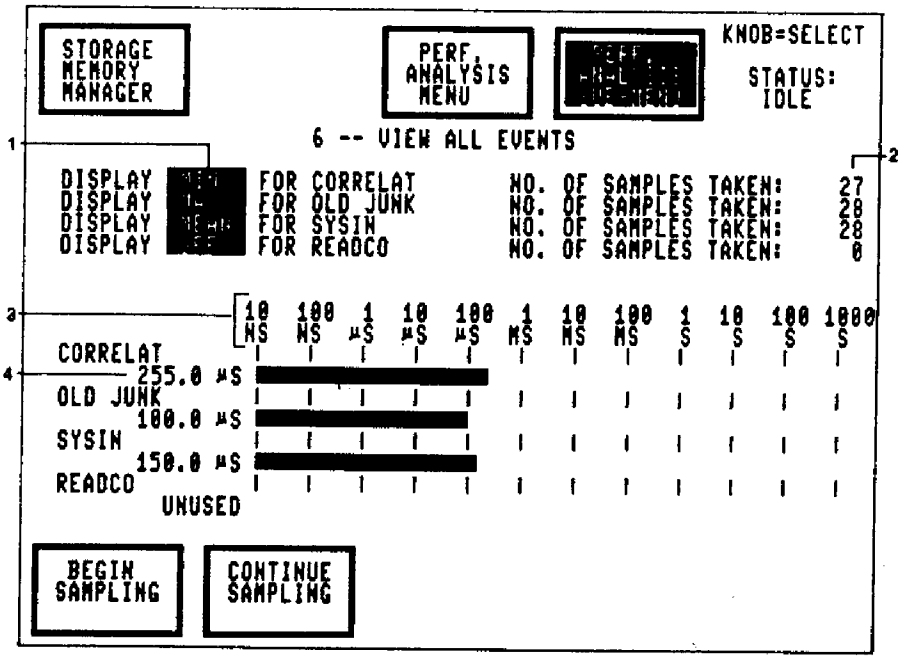
This menu is a data display that lets you compare up to four events defined in the Enter Events menu. The comparison is by count or by time, depending on the selection you made in the first event of the Enter Events menu. Events in the View All Events menu are always compared on a logarithmic scale.

All the events defined in the Enter Events menu will be listed in this menu. A select field lets you choose which of the events you wish to sample and display in the comparison.

Figure 2-10 shows the View All Events menu with four events defined. For each event you can choose to display the minimum single sample value, the maximum single sample value, or the cumulative mean of all samples. You can also choose not to sample an event.

For example, you can set up to COUNT THE OCCURRENCES of an event, then start sampling and press the STOP key after three samples have been taken. If the 1240 counted 13 occurrences of the event in the first measurement, 8 occurrences in the second measurement, and 24 occurrences in the third, this would cause the View All Events menu to display 8 with MIN selected, 24 with MAX selected, and 15 with MEAN selected. If you selected OFF, the display would show UNUSED rather than a number.

Events are listed and sampled in sequence as they are numbered in the Enter Events menu. In this example setup for figure 2-10, the 1240 would first look for and sample the CORRELAT event, then OLD JUNK, then SYSIN, and back to CORRELAT, skipping READCO since it is OFF.



1 Selections are MIN, MAX, MEAN, and OFF. If you select OFF, the field name will appear in the histogram, but no samples will be taken for that event and UNUSED will be displayed in place of the count or time. If you select MEAN, the average number of occurrences, cycles, or time for all samples of an event will be displayed. If you select MIN or MAX, the largest or smallest sample of an event will be displayed. Since this field can be changed while sampling, events may or may not be sampled the same number of times.

2 Tells the number of times that each defined event has been sampled. Since you can turn an event OFF or ON while samples are being taken, these numbers may vary greatly even though the events are sampled in sequence.

3 This example makes comparisons by time, with values ranging from 10 ns to 1000 seconds. If the comparison is by count, this field will be replaced by fields ranging from 1 to 10111.

4 This number is the cumulative mean, maximum, or minimum sample for the event. The histogram bar represents the same value. UNUSED indicates that OFF has been selected and the event was not sampled.

4801-10

Figure 2-10. View All Events menu. Example data has been sampled for three events.

APPLICATION EXAMPLES

The examples in this section are intended to show some of the capabilities of the Performance Analysis features. They will help familiarize you with the operation and interaction of the menus provided for State Overview and Event Measurement. All examples use entirely imaginary code and subroutine names. They are not intended as hands on experiments that you can set up and repeat.

These examples assume that you are familiar with the 1240 in general, and know how to make the necessary connections between the 1240 and a system under test.

Example One

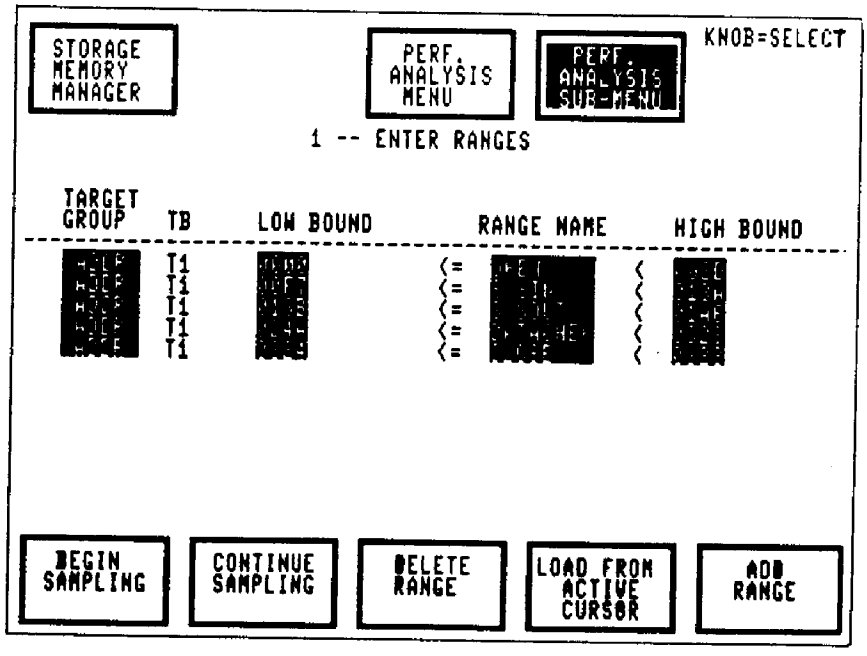
PART ONE

This example shows how to use State Overview to help improve the efficiency of a small program. We want to look at several of the subroutines in our code that we suspect might be taking a large piece of the execution time. Our example program will be 1000 bytes of code.

We must first set up the Timebase, Memory Config, and Channel Grouping menus to correctly acquire data from the microprocessor. Since we are using a short piece of code, we want to capture all of the data. To do this we will go into the Trigger Spec menu and set it up to acquire data on the first occurrence of any word (don't care) using the synchronous timebase. We will trigger after memory full with the trigger position in the center of memory.

The next step is to determine the exact addresses of the subroutines we are interested in. In this example the addresses will be in hexadecimal. We wish to look at five subroutines: Open, Sysin, Sysout, Datachek, and Close. Open starts at 0000 and ends at address 002D, Sysin starts at address 00F7 and ends at address 013A, Sysout starts at address 013B and ends at address 01A6, Datachek starts at address 024A and ends at address 0323, and Close starts at address 0324 and ends at address 03E7.

Figure 3-1 shows the Enter Ranges menu with these subroutines defined as ranges.

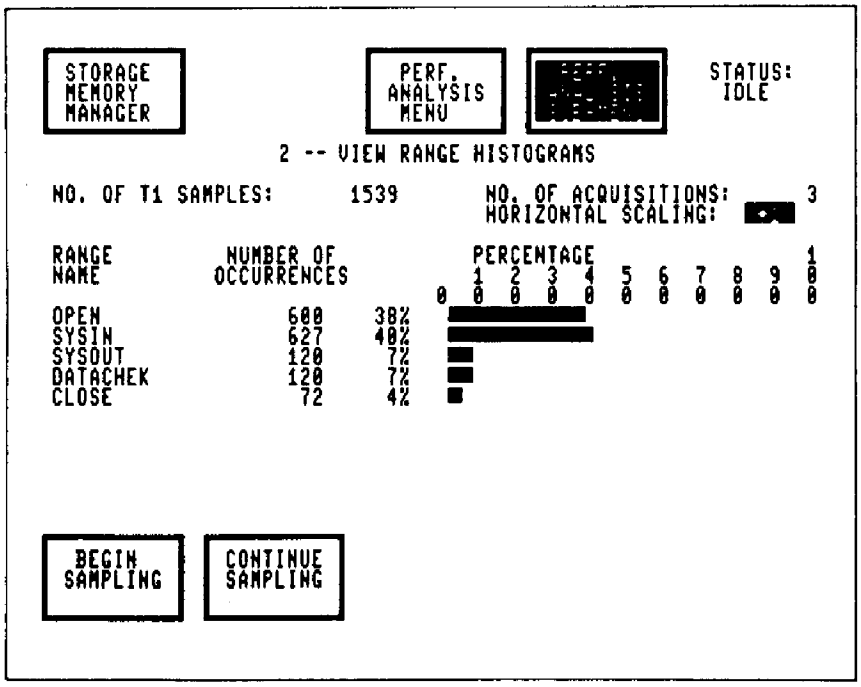


4801-11

Figure 3-1. Example 1: Setup for Enter Ranges menu.

Once the ranges have been entered, we touch the BEGIN SAMPLING soft key. The 1240 will acquire data until the acquisition memory is full. This data is processed and displayed in the View Range Histograms menu while the 1240 acquires data again. The acquire/display cycle continues until we press the STOP key, a Menu key, or a Menu soft key.

Figure 3-2 shows the View Range Histograms menu after several acquisitions have been made and the STOP key has been pressed.



4801-12

Figure 3-2. Example 1: View Range Histograms display. Ranges shown were defined in the Enter Ranges menu. The most active subroutines are Open and Sysin.

Summary. In this example we wanted to find the best way to improve the efficiency of a program. We defined five subroutines as our areas of interest, and used the 1240 to capture all the code in the program.

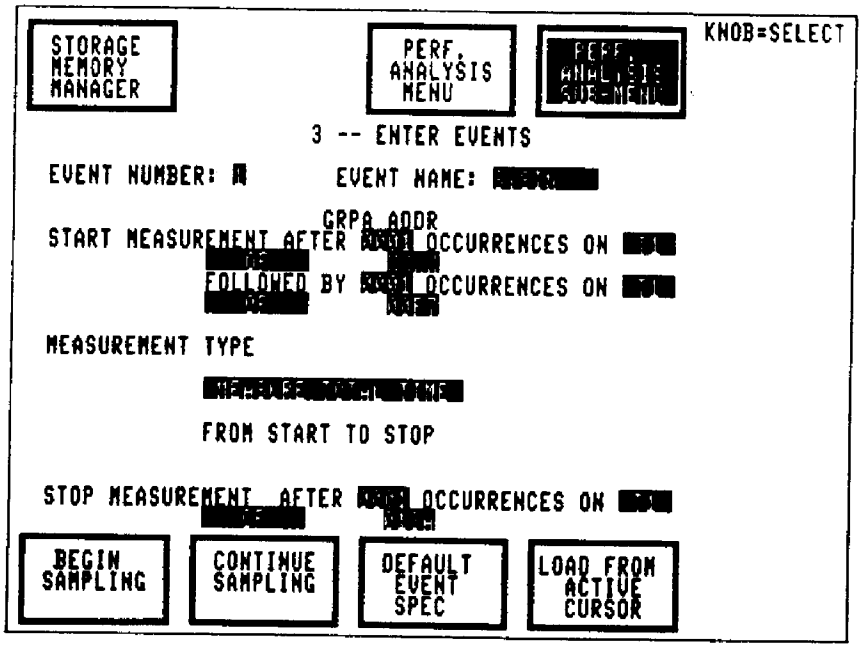
As can be seen in Figure 3-2, the two subroutines Open and Sysin took far more execution cycles than the others. It appears that the best place to focus our attention in optimizing this code is on these two subroutines.

PART TWO

In this example we will use Event Measurement to look more closely at the Sysin and Open subroutines that we defined in part 1. Since State Overview only counts occurrences of state values falling in defined ranges, we need to use Event Measurement to see how much time is really being spent in those areas.

Unlike State Overview, Event Measurement does not use the standard 1240 triggering. This means that we must define measurement events to locate the data we wish to sample. We first go to the Enter Events menu, enter the name Sysin for event number one, and select MEASURE TOTAL TIME under MEASUREMENT TYPE. The first-level event recognizer in the Start Measurement event is set to X (don't care). For the second level of the Start Measurement event we use the same address that we previously used as the lower bound for Sysin in the Enter Ranges menu. We use the upper bound of the Sysin range as the Stop Measurement event.

This process is repeated in event number two for the area we have named Open. We do not make a selection under MEASUREMENT TYPE for Open, since that area is configured to match event number 1. Figure 3-3 shows the Enter Events menu setup Sysin.



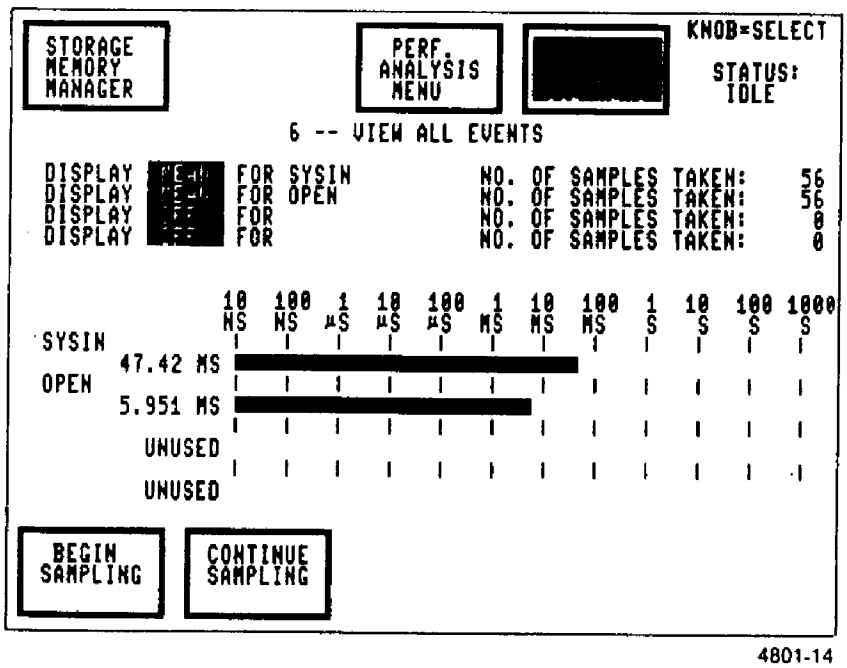
4801-13

Figure 3-3. Example 1: Setup for Enter Events menu. Sysin is defined. The MEASUREMENT TYPE field is selectable only for Sysin, which is event number 1. The measurement type for event number 2, named Open, is automatically configured to match event number 1.By selecting MEASURE TOTAL TIME we will determine the actual time spent in each area.

Once these events have been defined, we must go to the Performance Analysis menu to access the View All Events menu. We then select MEAN in the VIEW EVENT field for both Sysin and Open.

We touch the BEGIN SAMPLING soft key, which causes the Event Measurement software to begin taking successive time measurements from each event. As samples are taken, the data is displayed in the View All Events menu. Regardless of the sample rate, the display is updated approximately once a second. Once a significant number of samples have been taken for each event we press the STOP key.

Data in the View All Events menu can reflect the average, maximum, or minimum sample time of each event. Figure 3-4 shows the View All Events display after data has been accumulated and the STOP key has been pressed. The average time, or MEAN, of the events is displayed.



4801-14

Figure 3-4. Example 1: View All Events display. Data has been acquired for Sysin and Open, and MEAN has been selected as the mode of display for both events. This data indicates the average amount of time spent in Sysin and Open each time they occur.

Although we learned in part 1 that Sysin and Open use approximately the same number of cycles, figure 3-4 shows that Sysin is clearly using a greater amount of time on the average. This indicates that our time would be most efficiently used in attempting to improve the execution time of that subroutine.

By selecting MAX or MIN in the Viewing Mode field you may be able to gain additional useful information. For example, you might be able to tell whether the individual measurement times tend toward their average, or if extreme conditions sometimes exist.

PART THREE

In part 2 we found that the subroutine Sysin accounts for a large portion of the execution time in our program. In order to take a closer look at the subroutine and the possible reasons for its time use, we can divide the sampled data into distribution ranges.

Since the Enter Events menu is already set up to MEASURE TOTAL TIME, we only need to set up the Enter Distribution Intervals menu. In the Enter Distribution Intervals menu we select LINEAR ranges, then enter a base value of 10 NS and a step value of 1 µS. We enter the base value by selecting a multiplicand value of 0.001, and a time value of 10 µS. We enter the step value by selecting 1 as the multiplicand and 1µS as the time (these are simply arbitrary values that we have selected for our first guess). Figure 3-5 shows the setup.

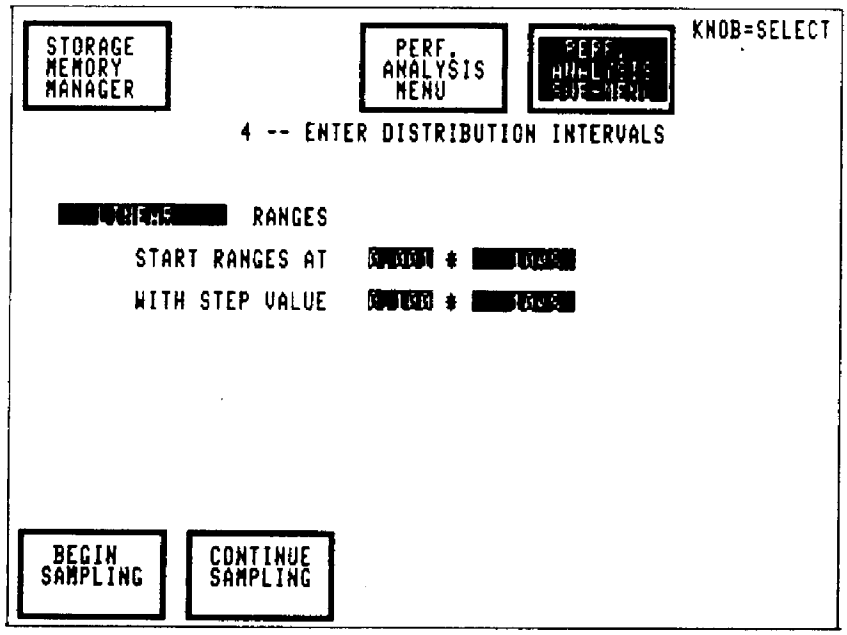


Figure 3-5. Example 1: Setup for Enter Distribution Intervals.

We then go to the View One Event menu, select Sysin as the EVENT BEING VIEWED, and touch the BEGIN SAMPLING soft key. As data from the Sysin event is acquired, the View One Event display will be updated. When we feel there is a significant amount of data displayed on the screen we press the STOP key. Figure 3-6 shows the View One Event display after acquiring data on the subroutine Sysin.

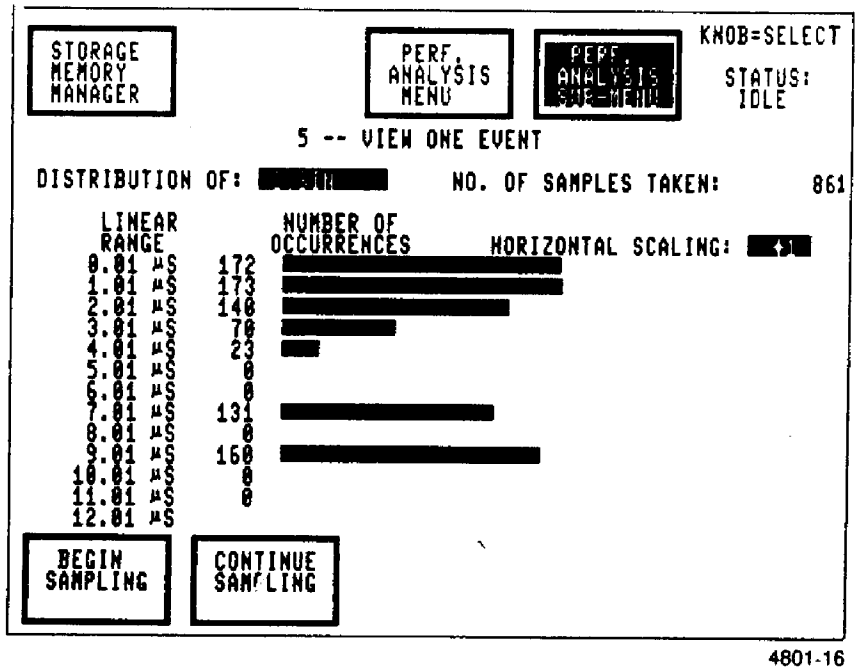


Figure 3-6. Example 1: View One Event display. Data is acquired for Sysin. This display shows that most samples tend toward the average, but that a number of them are disproportionately large.

Since we are familiar with our code, we can probably make a guess as to why this is happening. For example, upon inspecting our code we might discover that Sysin uses a loop whose halt condition is controlled by a global variable. The loop works fine most of the time, but the global variable controlling the loop is sometimes unrealistic and forces it to go through an unusually large number of executions before the halt condition is met.

Summary. In part one of the example we located the most active areas of our program. In part two we found which of those areas took up the greatest amount of time. In part three we wanted a closer look at one area, so we divided the data sampled for Sysin into distribution intervals. Seeing the data divided into distribution intervals made it clear that the subroutine was not operating consistently. This information led us to make a relatively informed guess as to the nature of the problem.

Example Two

PART ONE

This example shows how to use Event Measurement with two timebases to look at two systems sharing a common resource. In this example we will look at a system with two CPUs sharing a RAM unit. In other systems the shared resource might be units such as a disk drive or an I/O port.

We will assume that State Overview has been used to locate a subroutine called Transfer whose main function involves operations between CPU1 and the RAM. The subroutine is not executing properly at all times.

Because we know that the RAM is also used by CPU2, and because we are already pretty sure that this is the area we are interested in, we wish to go directly into the View One Event display to see what we can learn about Transfer.

The first step is to go to the Enter Events menu and define the measurement. We enter 1 occurrence of X (don't care) for the first level of the Start Measurement event, and 1 occurrence of the first address of Transfer for the second level. We then select MEASURE TOTAL TIME as the measurement. Finally, we enter 1 occurrence of the last address of Transfer as the Stop Measurement event.

Our next step is to call up the Enter Distribution Intervals menu and set up distribution intervals we think will be meaningful. As a first guess we will try EXPONENTIAL distribution intervals with a base value of 20 NS. Figure 3-7 shows the Enter Display Ranges menu with this setup entered.

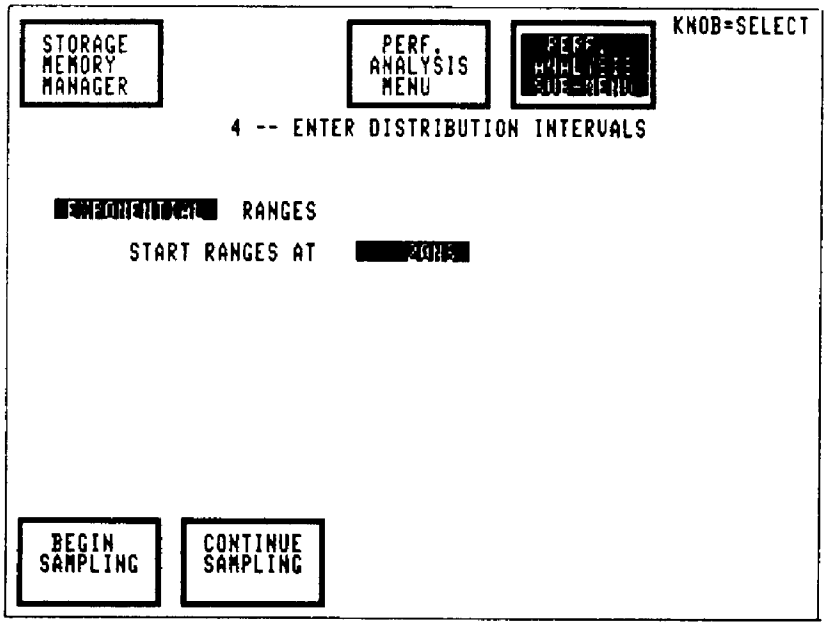


Figure 3-7. Example 2: Setup for Enter Distribution Intervals. As a first guess we have selected a base value of 50 NS. Defined ranges are shown in Figure 3-8.

Once this menu is set up we can touch the BEGIN SAMPLING soft key. The 1240 will go immediately to the View One Event menu, then begin acquiring samples and updating the display. Once a significant amount of data is displayed we press the STOP key to halt sampling. Figure 3-8 shows the View One Event menu with several hundred samples acquired.

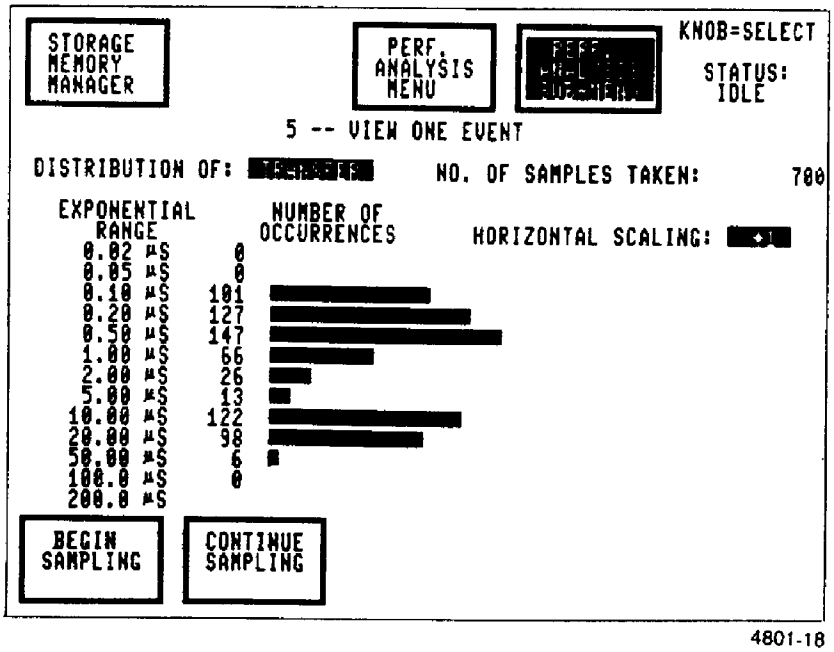


Figure 3-8. Example 2: View One Event display. This display shows some data for the subroutine Transfer.

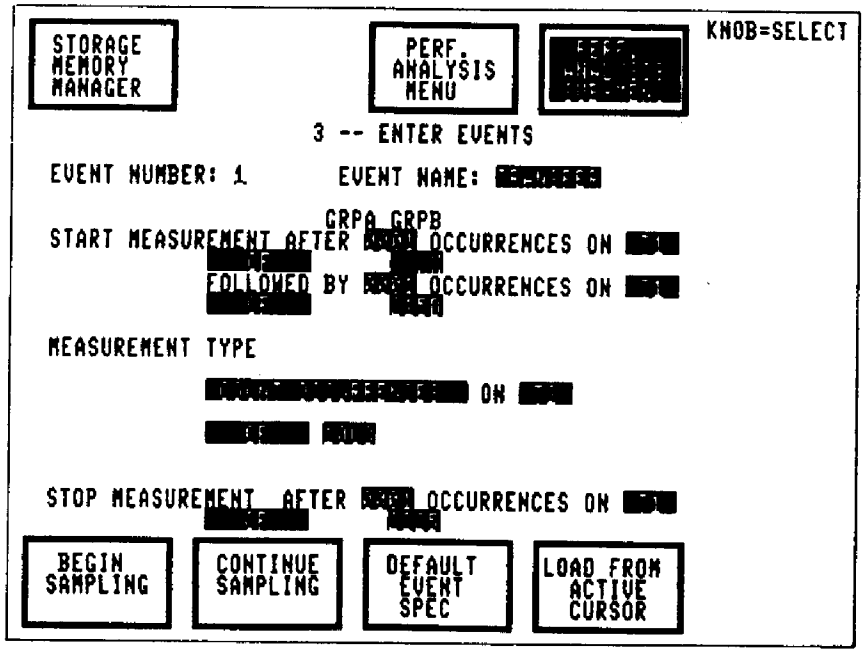
As can be seen in figure 3-8, the Transfer subroutine has an abnormal use curve. Rather than all uses tending toward a norm, the histogram has two peaks: a significant number of the samples show that the routine is taking an excessive amount of time to execute.

We know that this routine causes CPU1 to interact heavily with the RAM area. We also know that the RAM is shared by CPU2. It is a good guess that the RAM is busy with CPU2 when it is called by CPU1, even though we have intentionally set up the timing in the system so that this kind of interference shouldn't occur.

PART TWO

To see how the two CPUs and the RAM are interacting, we are going to use the View All Events display with two timebases.

What we really want to know is whether CPU2 is locking out the RAM at times when CPU1 is supposed to have exclusive access to it. To look at this we need to set up the 1240 for Operation Level 3, which allows dual-timebase sampling. We then use the Enter Events menu to define a measurement whose start and stop events are the first and last lines of the subroutine Transfer, which causes CPU1 to interact with the RAM. These events will use timebase T1. Within this measurement we are going to COUNT OCCURRENCES of a block transfer instruction on CPU2, that we know will only occur if CPU2 is using the RAM area. This event will use timebase T2. Figure 3-9 shows the Enter Events menu set up for this two-timebase sampling.



4801-19

Figure 3-9. Example 2: Setup for Enter Events menu. We are sampling data on two timebases to discover if there is activity on both when there should only be activity on one.

Since the 1240 is able to sample each timebase independently and then time-correlate the data, we can monitor activity on one system relative to events on the other system.

To finish this example, we begin acquiring samples. If we come up with a zero result (no occurrences of the event on T2), then we know that CPU2 is not using the RAM when it is being called by CPU1, and our problem lies elsewhere. However, if occurrences are counted, we know that the timing between the devices is incorrect and some type of handshaking between the two CPUs is required.

APPENDIX A

STORING AND LOADING ROM PACK SETUPS

The 1240 provides a special feature that allows the user to store Performance Analysis ROM Pack-related setups in a 12RS01 RAM pack. This information can later be retrieved to configure the Performance Analysis menus, without repeating the time-consuming setup steps initially required.

STORING PERFORMANCE ANALYSIS SETUPS

To store the setups you have created while using your 12R01 Performance Analysis ROM Pack, you must take the following steps.

1. Enter the Storage Memory Manager menu, then remove the Performance Analysis ROM Pack.
2. Install a RAM pack in the slot vacated by the ROM pack.
3. Touch the LOAD NEW PACK soft key.
4. Select PA_SET in the FILETYPE field.
5. Select PACK in the STORE IN field on the new file line.
6. Touch the STORE NEW FILE soft key.

All user-supplied data relevant to the 12R01 Performance Analysis ROM Pack will be saved in the RAM pack.

LOADING SETUPS FROM RAM PACKS

To retrieve the Performance Analysis setups you have stored in a RAM pack, you must take the following steps in the Storage Memory Manager menu.

1. Install and load the Performance Analysis ROM Pack into the 1240.
2. Remove the ROM pack and replace it with the desired RAM pack.
3. Touch the LOAD NEW PACK soft key.
4. Select the desired file in the SELECTED field, then touch the LOAD FILE soft key.
5. Remove the RAM pack and install the Performance Analysis ROM Pack, then touch the LOAD NEW PACK soft key.

The Performance Analysis ROM Pack menus will be configured as they were when the PA_SET file was stored in the RAM pack.

APPENDIX B

ERROR AND PROMPT MESSAGES

The following error and prompt messages are specific to the 12R01 Performance Analysis ROM Pack; they are not normally used by the 1240. If you get an error message that is not listed here, refer to the *1240 Logic Analyzer Operator's Manual.*

AVAILABLE RANGES ARE DEFINED: CHANGE AN EXISTING RANGE. You have defined all 11 ranges for State Overview. To define a new range you must delete or change previously defined ranges.

DON'T CARE INVALID IN THIS FIELD.

GLITCH INVALID IN THIS FIELD.

MAXIMUM NUMBER OF SAMPLES EXCEEDED. This message occurs when you have acquired more data samples than the Performance Analysis ROM Pack can handle. The last valid data remains in the display and the 1240 becomes idle.

MAXIMUM NUMBER OF OCCURRENCES EXCEEDED. This message appears in View One Event menu. Value of a range has a limit of 99,999. If this value is exceeded the error message will be displayed and the 1240 will stop acquiring.

MAXIMUM NUMBER OF ACQUISITION EXCEEDED. This message appears in the View Range Histograms menu. If the value associated with the number of acquistion exceeds 999,999, this message will be displayed and the 1240 will stop acquiring.

MOVE CURSOR TO A BOUNDS FIELD. This message indicates that you have attempted to use the LOAD FROM ACTIVE CURSOR soft key when not in a low-bound or high-bound field.

MOVE FIELD CURSOR TO AN EVENT RECOGNIZER GROUP FIELD.

NO EVENT SELECTED FOR VIEWING. This message indicates you attempted to start sampling with all events OFF in the View All Events menu.

NO VALID DATA FOR THIS GROUP AT THAT LOCATION. This message indicates that you attempted to load from active cursor when data does not exist in that location for the selected group.

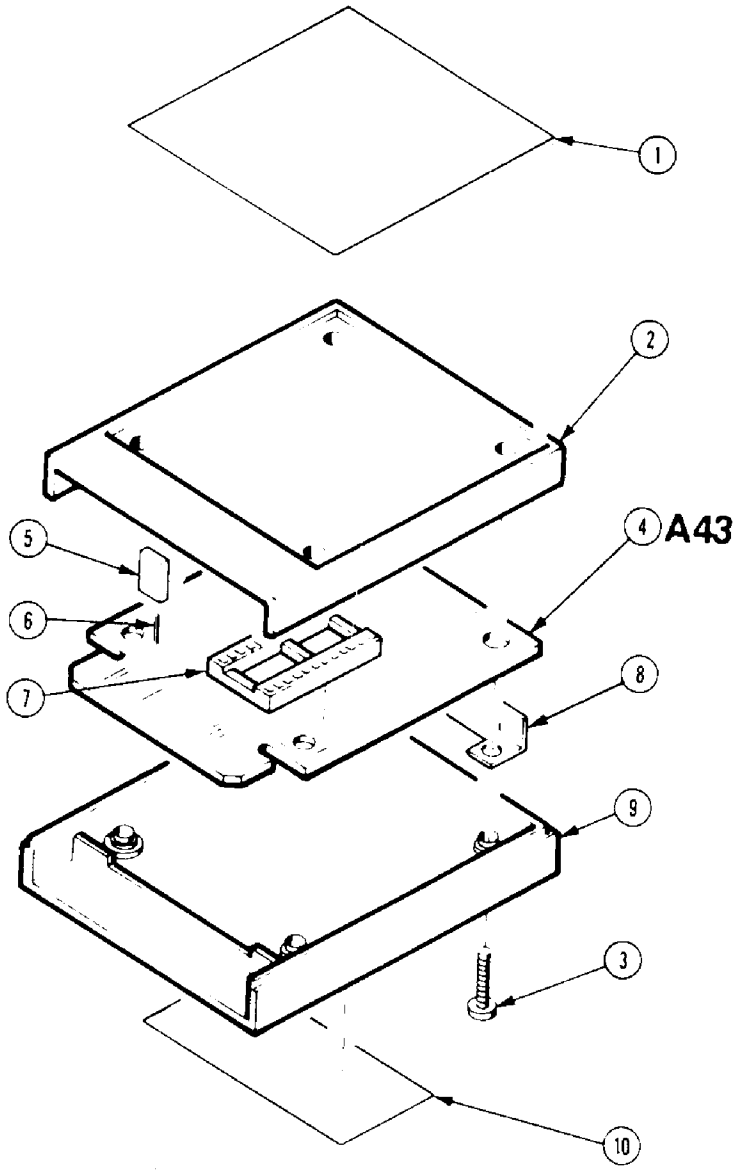
PRESS "STOP" TO TERMINATE ACQUISTION. This message indicates that you have pressed begin or continue sampling while sampling was taking place.

USE 1-4 OR SELECT

USE 1-6 OR SELECT.

REPLACEABLE PARTS LIST
PERFORMANCE ANALYSIS ROM PACK — 12R01

NUMBER	TEK. P/N	DESCRIPTION
ELECTRICAL (REFER TO SCHEMATIC IN 1240 SERVICE MANUAL)		
A43	670-8172-00	CRT. BOARD ASSY: 32/64K MEMORY ROM PACK (U200, U300 EPROMs ARE NOT PART OF A43)
A43C100	281-0775-00	CAP, FIXED, CER, DI: 0.1 uF, 20%, 50V
A43C400	281-0775-00	CAP, FIXED, CER, DI: 0.1 uF, 20%, 50V
		CHASSIS PARTS
U200	160-2458-01	MICROCKT, DGTL: 16384 x 8 EPROM, PRGM
U300	160-2457-01	MICROCKT, DGTL: 16384 x 8 EPROM, PRGM
MECHANICAL (REFER TO EXPLODED VIEW DRAWING)		
1	334-5228-00	1 MARKER, IDENT: MKD 12R01
2	200-2503-01	1 COVER, ROM PACK: TOP
		(ATTACHING PARTS)
3	211-0012-00	4 SCREW, MACHINE: 4.40 x 0.375, PHD, STL
		— — * — —
4	- - - - -	CKT BOARD ASSY: 32/64K MEMORY ROM PACK (SEE A43 REPL)
5	131-0993-00	2 • BUS CONDUCTOR: 2 WIRE, BLACK
6	131-0608-00	6 • TERMINAL, PIN: 0.365 L x 0.025 PH BRZ GOLD
7	136-0755-00	2 • SKT, PL-IN ELEC: MICROCIRCUIT, 28 DIP
8	337-3122-00	1 SHIELD, ELEC: STATIC
9	200-2504-01	1 COVER, ROM PACK: BOTTOM
10	334-4727-00	1 MARKER, IDENT: MKD PROM PROGRAM IDENT
		STANDARD ACCESSORIES
	070-4801-00	1 MANUAL, TECH: INSTRUCTION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A43
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* When an index entry has more than one page reference, the one in bold type is the primary reference.