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4. Move the cursor to the [start] field and select [center] with the NEXT[ ] key. Three more fields for resource terms are automatically added, one after each of the first three sequence terms. The added fields are shown in figure 4-33.

NOTE

Use ROLL up key to see resource terms c and d.

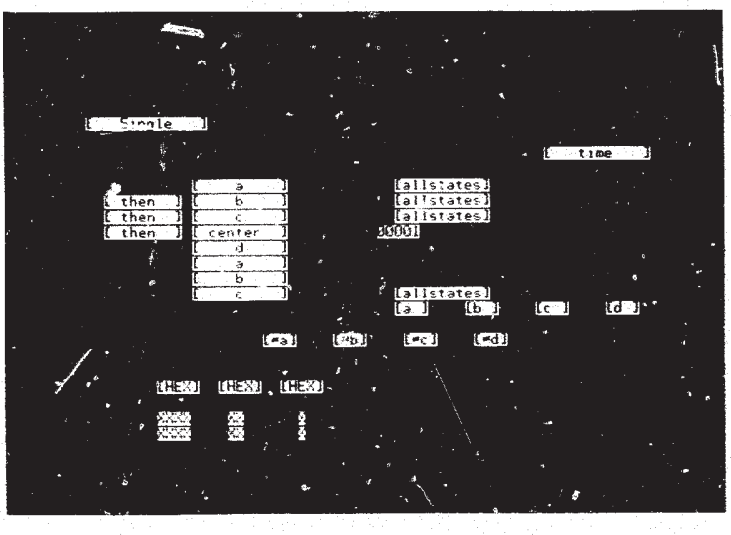


Figure 4-33. Store Qualifying Data Between Sequence Terms

5. Move the cursor to any of the storing fields (while storing on the 1630A/D), and use the NEXT[ ] or PREV[ ] key to specify one resource term.

6. To OR store qualifiers between sequence terms, press INSERT to add as many as four ORed store qualifiers. The maximum amount of store qualifiers are shown in figure 4-34. In fact, figure 4-34 contains the maximum amount of resource terms used for sequence triggering, sequence restart, and store qualifying.

NOTE

Use ROLL up key to see resource terms c and d.

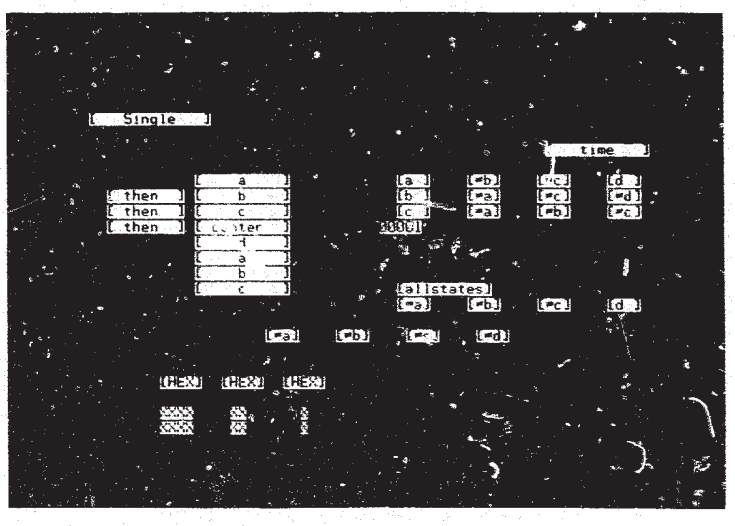


Figure 4-34. Maximum Amount of Resource Terms For the State Trace Specification

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[Compare/Edit Compare/Full Compare] Trace Modes

The compare modes of the 1630 Logic Analyzers provide the means to compare traces with previously stored data. In the compare mode, a trigger point is specified and traces are compared with a previously defined compare list of data. The compare modes are useful for production line testing and fault analysis. The trace is checked at selected points with reference to the trigger. For example, a compare list might specify the value FFFF (hex) should be found in the fifth transaction (line + 0005 in the trace memory) after the trigger.

The [Compare] mode of the 1630A/D has been renamed the [Edit Compare] on the 1630G but operates the same. Up to 16 events may be specified to set a basis for comparison for continuous state flow. The comparison events need not be continguous, but rather are defined by line number in 1630 memory. The compare termination condition may be set for a trace that matches the comparison sequence (compare trace mode [until =]), or when a new state flow fails to match the compare list (compare trace mode [until #]).

1. Press TRACE and use the NEXT[] or PREV[] key to select [Compare] on the 1630A/D or [Edit Compare] on the 1630G.

2. Enter the parameters shown in figure 4-35. The relocation and user base information is the same as previously set up in figures 4-10 and 4-13.

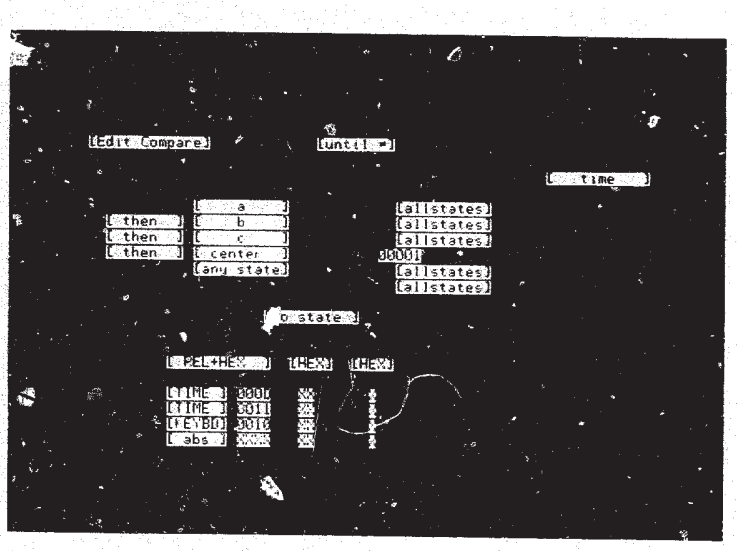


Figure 4-35. [Compare/Edit Compare] State Trace Specification

3. Press RUN to obtain a listing which will be used to compose a compare image. When in a compare mode, the analyzer takes continuous traces. Press STOP to switch into single trace mode and obtain a state listing.

4. The trace will be displayed in the [Compare + State] Listing.

5. Select [Mark] and [Compare Image] to make a compare list.

6. Choose 5 lines for compare events. In figure 4-36 lines –1, 2, 6, 9, and 13 have been selected.

   a. Move the cursor to the inverse video field at the center of the listing.

   b. Use the ROLL keys to place each line to be inserted in the inverse video field.

   c. Press INSERT. The line is entered into the compare list and is marked by inverse video.

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NOTE

When using the 1630A/D, move cursor into the inverse video field and enter compare item. DON'T CARE (X) identifies channels which will not be included in the comparison for the line.

d. Up to 16 lines may be entered for the compare list.

NOTE

To delete a line from the compare list, place the line to be deleted in the center inverse video field and press the blue shift key and DELETE.

7. Move the cursor to the **[Mark]** field and change it to **[Show]**. The compare list will be displayed as in figure 4-36.



Figure 4-36. The [Compare/Edit Compare] List

8. Press RUN. The analyzer will run a continuous trace until the trace does not have the same events on the lines specified in the compare list. Figure 4-37 is the first trace taken which is not the same as the compare list.

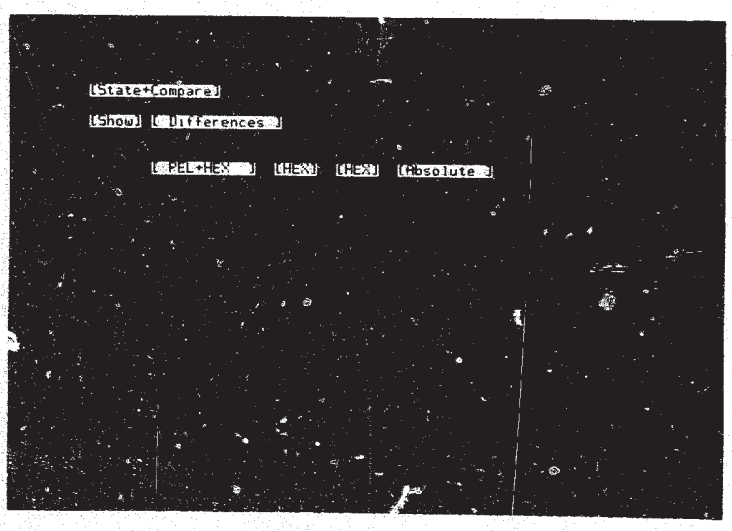


Figure 4-37. Trace Taken in Compare [until ≠] Mode

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9. Change [Show] to [Mark]. The original listing plus the compare states are displayed in the list, as in figure 4-38. Only the compare states that are different from the original states are marked with an asterisk.

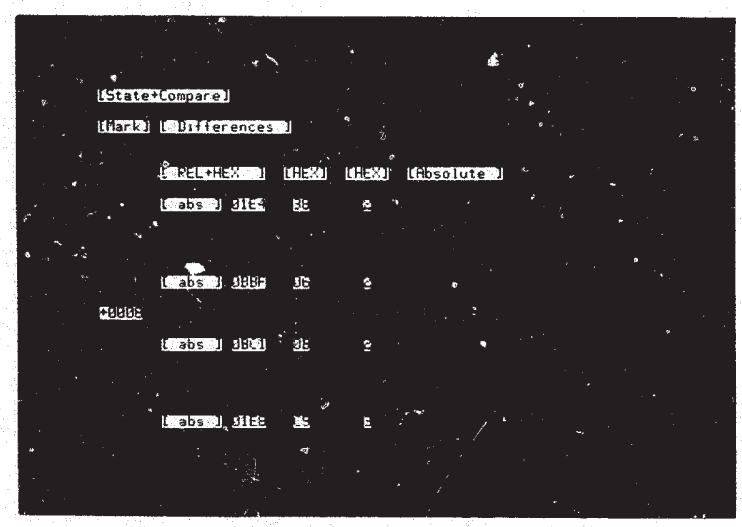


Figure 4-38. Original Compare List with Compare Event Differences

10. Pressing RUN will produce different state listings.

The [Full Compare] mode of the 1630G provides the means to compare an entire stored list with a trace.

The [Full Compare] Mode of the 1630G allows comparison of an entire trace of up to 1024 states. The compare termination condition may be set for a trace that matches the compare image (compare trace mode [until =]) or for when a trace fails to match the compare list (compare trace mode [until ≠]).

1. Press TRACE and use the NEXT[ ] or PREV[ ] key to select [Full Compare].

2. Enter the resource terms as shown in figure 4-39.

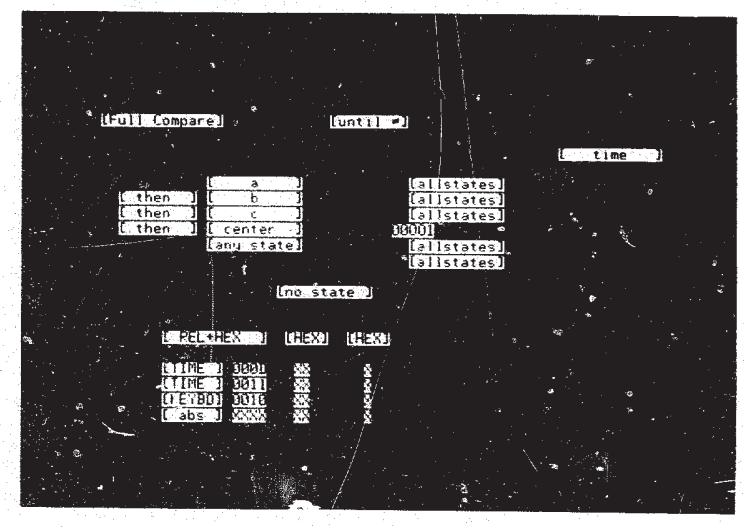


Figure 4-39. [Full Compare] State Trace Specification

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3. Press RUN to obtain a trace from which the compare list will be composed. When in a compare mode, the analyzer takes continuous traces. Press STOP to switch into single trace mode.

4. The list will be displayed on the analyzer in the [Full Compare] [Trace] List. A note above the states listed indicates when the compare list is empty. The message at the top of the screen, "INSERT to store compare image", indicates the displayed list may be entered as the compare image.

5. Press INSERT and the entire list will be entered as the compare image. Notice that the note that was previously displayed has been replaced with [Mark] Differences. The [Mark] field may be changed to [Show] Differences with the NEXT[ ] or PREV[ ] key.

6. Press RUN. The analyzer will take continous traces until a trace is not the same as the compare image previously stored with the INSERT key.

7. To re-observe the compare image, move the cursor to the [Trace] field and press the NEXT[ ] or PREV[ ] key to select [Image].

8. To enter a new compare image, the display must be showing the [Full Compare] [Trace] List, which will be the last trace that was captured by the analyzer. The message "INSERT to store compare image" will be displayed. Press insert and the new image will overwrite the previously stored compare image.

NOTE

There are certain conditions that cause the analyzer to erase the compare image. If the State Trace Specification menu is changed to [Single] or [Continous] and an XY Chart or Waveform display is created, the list will be erased. If either SYSTEM [Storage Operations] or [Peripherals] are selected, the compare image will be erased. THE COMPARE IMAGE CANNOT BE STORED ON DISC MEMORY.

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THE STATE DISPLAY

List Displays

List displays may be obtained when any of the state trace mode measurements are being performed, except when in the time interval overview mode. The content and use of the list display depends upon which trace mode is being used. Therefore, list displays are discussed for each trace mode.

[Single] LIST DISPLAYS

Figure 4-40 shows a typical list of states that were captured from a logic software system. Line 0000 (the trigger line) is on screen. Lines –0003 through –0001 show three lines of pretrigger information (a pretrigger sequence in the Trace Specification.)

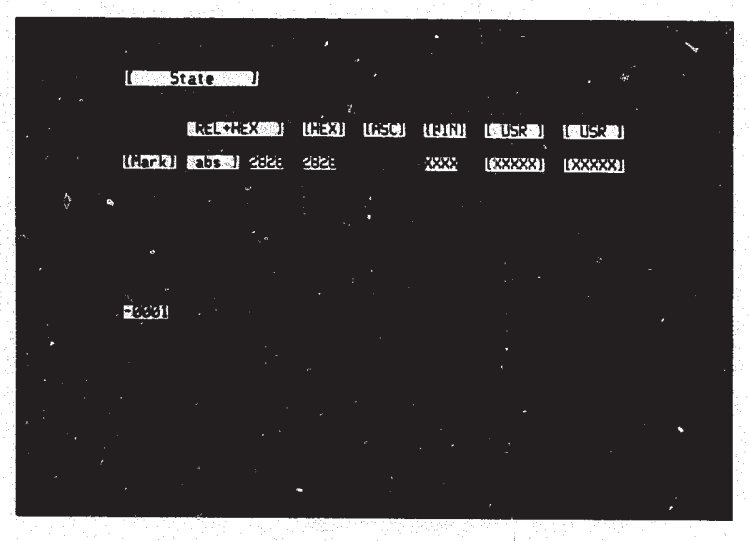


Figure 4-40. Typical List Display In Single Trace Mode

Display Control Fields

Base:	hexadecimal, decimal, octal, binary, ASCII (for labels from 6 to 16 bits), user (values assigned in **[User Base]** menu), and REL+HEX (values assigned in **[Relocation]** menu).
[Mark]:	places asterisk beside each line number that has values specified in **[Mark]** line.
[Show]:	shows only those lines on screen that have values specified in **[Show]** line.
Line no.:	inverse-video field can be changed to any line number in memory. Display window will shift to area in memory which includes selected line.
Display Information:	blanked while analyzer gathers states. If states are captured at a slow rate, top line will show count of states still to be captured. After trace complete, up to 16 lines of state memory will be on screen. Every label defined in Format Specification will be on screen (subject to max screen width). Labels can be reordered by placing cursor in the base field under a label and pressing blue SHIFT key plus LABEL right arrow or left arrow key.
Roll Indicator:	arrow(s) in upper right hand corner. Indicate whether display window can be positioned up, down, left, or right by ROLL keys.

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[Continuous] LIST DISPLAYS

The list in the continuous trace mode is like the list in the single trace mode, except that "Continuous Trace in Process" appears at the top. In this mode, the analyzer makes a continuous series of single traces, updating the display each time it completes a trace. The content of the list will change as each new trace is completed if the display is updated with different information. To stop a continuous trace, press the STOP key. This causes the analyzer to complete its trace in progress and not start a new trace.

[Compare] LIST DISPLAYS

Figure 4-41 shows a typical display that may be obtained in the [Compare/Edit or Full Compare] mode. On the top line, either the display of [State] or [State+Compare] may be selected. If [State] is selected, the display will show only the content of the trace memory, just as you would see in the [Single] trace mode. The [State+Compare] display is unique to the [Compare/Edit or Full Compare] trace modes.

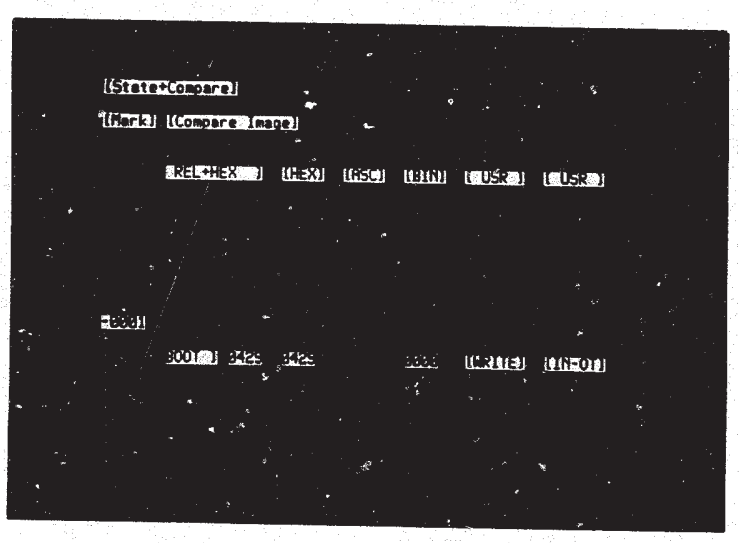


Figure 4-41. Typical List Display In Compare Trace Mode

Display Control Fields

[Mark]:	places integrated display of trace list and Compare list on screen.
[Show]:	places only lines of Compare List on screen in [Show] mode or marks lines of Compare List in [Mark] mode.
[Compare Image]:	all lines of Compare List can be on screen.
[Differences]:	only lines of Compare List that are different from corresponding lines in trace list can be on screen in [Show] mode or marked in [Mark] mode.

[Overview] LIST DISPLAYS

List or waveform displays may not be obtained when the analyzer is making an overview measurement.

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Waveform Displays

Figure 4-42 shows a typical state waveform display. It represents the states on eight channels. Waveform displays may be obtained in any of the state trace modes, except overview. The information on the display is the same, regardless of the trace mode where it was obtained.

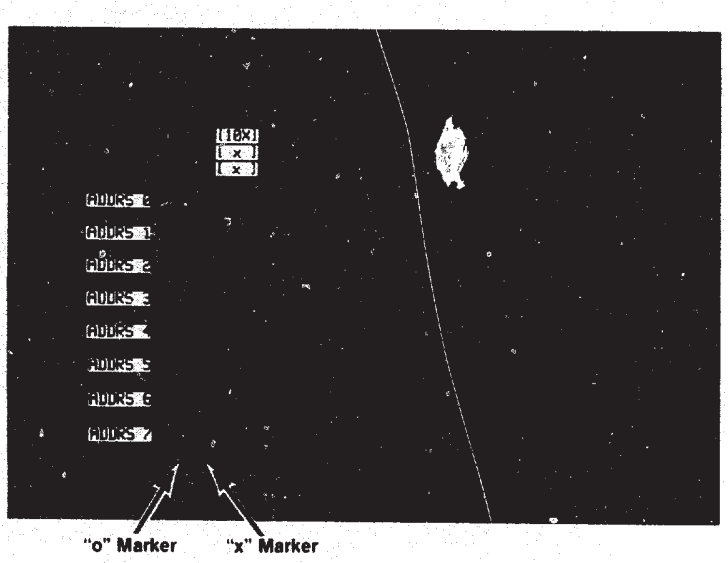


Figure 4-42. Typical State Waveform Display

Display Content: 1 to 16 channels (X2 vertical magnification with 8 or less channels).

Channels on Display: any bit in any position, identified by label name and bit number (if in multi-bit label) on left-hand side.

Display control fields Magnification: selects from 1X to 40X. Bright bar in dotted line at bottom shows position of display window in memory.

Magnify About: moves magnified display window to area around "x" or "o" markers.

Cursor Moves: selects "x", "o", or "x&o" markers to be moved by CURSOR keys. Scale at top shows number of states between "o" and "x" on display.

Bit Labels: press NEXT[ ] key to bring any bit to any point.
press INSERT and DELETE to add or remove channels.
press CLEAR ENTRY to turn off a channel.
press LABEL up-arrow or down-arrow to move a channel up or down on the display.

Roll Indicator: arrows in upper, right-hand corner indicate whether display window can be positioned left or right by ROLL keys.

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XY Charts Of Label Activity

The analyzer can format XY charts of the activity collected from any labeled set of bits. These charts can show patterns of activity. Figure 4-43 shows a typical XY chart of a label.

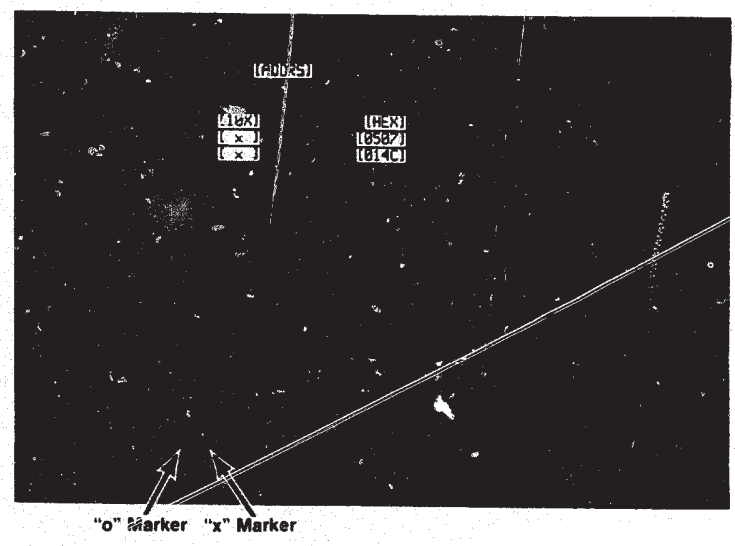


Figure 4-43. Typical State XY Chart Of A Label

Display Control Fields

Magnification:	selects from 1X to 40X. Bright bar on dotted line at bottom shows position of display window in memory.
Magnify About:	moves magnified display window to area around "x" or "o" markers.
Cursor Moves:	selects "x", "o", or "x&o" markers to be moved by CURSOR keys. Scale at top shows number of states between "x" and "o" on the display.
Max and Min:	selects vertical display scale.

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Chapter 5. Performance Analysis Measurements

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Chapter 5
Performance Analysis Measurements

INTRODUCTION

As the software begins to push the limits of the hardware of a system, the need for more efficient code becomes much more apparent. The software must be able to respond to all of its inputs in a timely fashion, with little or no delays. Performance Analysis allows the programmer to analyze code—to find bottlenecks and inefficiencies. The Overview Measurements of the 1630 series logic analyzers (available in the state-only configuration) provide the programmer with tools with which to perform this analysis. These tools allow the programmer to analyze module processor usage, intermodule linkage, module duration, and time-based interaction.

The output of these tools appear as bar graphs (called histograms) relating the relative actions between measured items. These histograms are presented in the chart menu after the trace specification has been set up for an overview measurement. With the exception of the Time Positional measurement, these measurements execute in a continuous random sample mode. A sample consists of 1024 qualified states. The time between states varies randomly to insure random sampling. To stop a measurement immediately, press the STOP key twice. The first press will force the analyzer to take one more sample and then quit. Two consecutive STOPs will force the analyzer to abort the current sample.

The following chapter describes the overview measurements, and provides example usages of these measurements.

The 1630A/D analyzers can show two types of histograms: state label histograms and time interval histograms. The 1630G analyzer can show two types of state label histograms (counting states or program activity), time interval histograms, time position histograms and linkage histograms.

STATE LABEL OVERVIEW MEASUREMENT

State Label Overview Measurement allows the programmer to define module code ranges and then compute the amount of time spent within these modules, relative to each other, or relative to the entire system software. The ranges are defined for one of the eight possible labels defined in the format menu. (For a typical inverse assembler application, these would be ADDR, DATA, and STAT.) The ranges may be defined as any locations between the maximum and minimum values possible for that label.

State Label Measurement is very beneficial in improving overall system performance. It allows the programmer to define sections of code critical to the overall system or module performance, and thereby avoid wasting time attempting to optimize code that does not noticeably affect overall performance.

For example, a module that performs floating point processing is found to be noticeably slow. The floating point module consists of seven routines: F_ADD, F_SUB, F_MUL, F_DIV, F_CMP, F_MOVE, and F_NORM. These routines provide floating point addition, subtraction, multiplication, division, comparison, moves, and normalization. To improve the module performance, the individual routines are defined in the State Label Trace menu, and then analyzed, as in the following steps.

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To define the seven routines, first change the label next to the [State Label] field to [ADDR] with the NEXT[ ] key. (ADDR must be previously defined in the Format menu.) Then move the cursor to the ALL label at the lower left corner of the display. Change this label to "FADD". Then define the low and high addresses for this routine. Add the remaining labels (FSUB, FMUL, FDIV, FCMP, FMOVE, FNORM) by pressing INSERT and filling in the corresponding fields.

Next move up to the [states] field. This defines how memory accesses following opcode fetches will be counted. In the [states] mode, the accesses will be counted individually from the opcode fetches, adding to labels defining the memory area, if such labels exist. In the [program activity] mode, these accesses will be counted along with the preceding opcode fetch in the range of the opcode fetch. Therefore, in the [states] mode, stack accesses are counted as occurring at the stack location while in the [program activity] mode the stack accesses would be counted as occurring in the location of the opcode preceding the stack accesses. For this example, the [states] mode is used. Figure 5-1 is the State Label Overview Trace Specification for this example measurement.

The State Label Trace samples the program activity in groups of 1024 states per sample. In between each sample, a random delay is invoked to insure random sampling. After running the given example, the routine F_NORM was found to consume the majority of the floating point processing time. Refer to figure 5-2. F_MOVE also was found to consume a great deal of processing time. By making the F_NORM and F_MOVE routines more efficient, the module performance could be greatly improved. Therefore, a great increase in module performance could be achieved by modifying only two of the module's routines.

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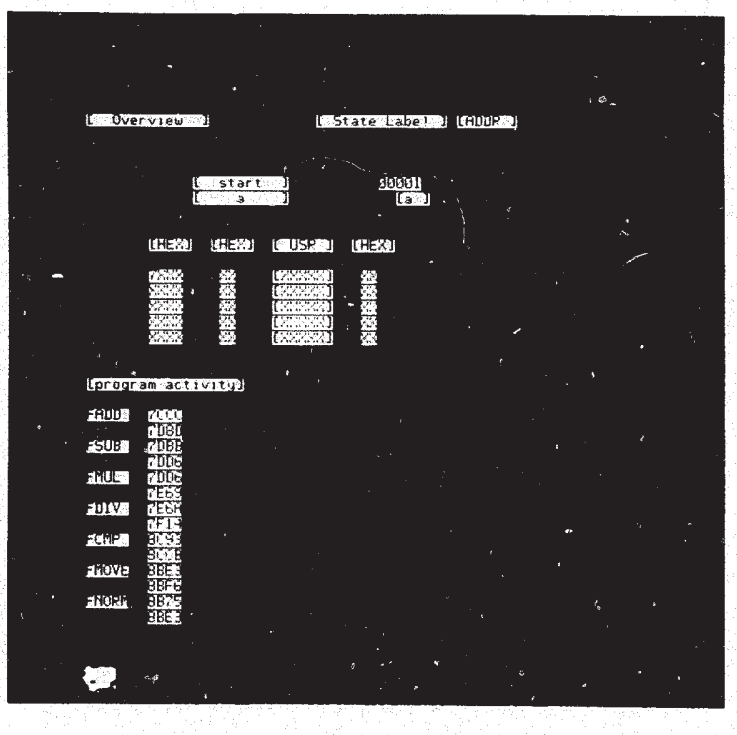


Figure 5-1. Example State Label Overview Trace Specification

NOTE

Use ROLL up key to see entire display.

Sequence Terms:	refer to State Trace discussion.
Trigger Location:	refer to State Trace discussion.
Occurrence Count:	refer to State Trace discussion.
Trigger Term:	refer to State Trace discussion.
Store Qualifiers:	refer to State Trace discussion.
Restart Terms:	refer to State Trace discussion.
Resource Terms:	refer to State Trace discussion.
Count Field:	selects whether memory accesses following an opcode fetch should be counted in the opcode fetch's range or in the range they map into.
Range Labels:	provide names for defined activity ranges. More ranges can be added by pressing INSERT.
Range Fields:	define the minimum and maximum locations for the activity range. More ranges can be added by pressing INSERT.
Readouts Available:	state Label Histogram only.

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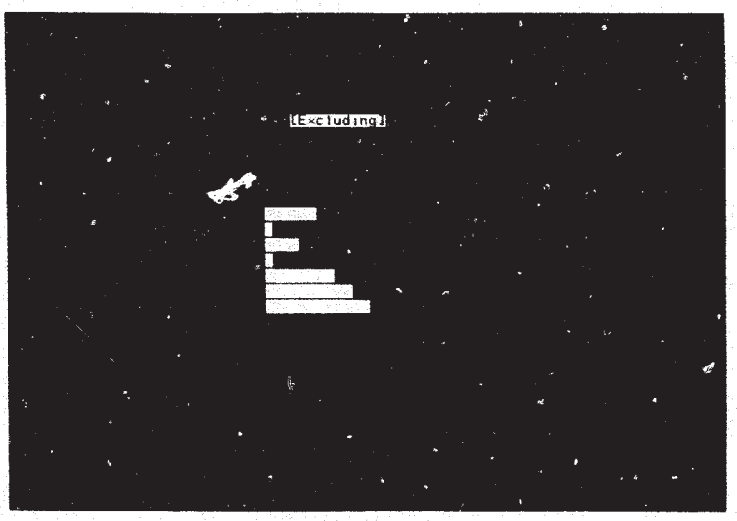


Figure 5-2. State Label Overview Chart of Example Measurement

Total Samples:	the total number of sampled states acquired and sorted at this point in time.
[Including] Field:	defines if percentages should be computed from the total samples or from the total number of samples that fall within a defined range.
Histogram:	provides a percentage-based bar graph of range usage.

TIME INTERVAL OVERVIEW MEASUREMENT

Time Interval Overview Measurement provides a histogram of the time spent within a routine with a known entry and known exit point, or the time spent between transition points. It is useful in finding exceptional cases such as a routine that occasionally runs much too long, or much too short. It also provides information for code optimization, allowing the programmer to optimize the code for the conditions under which a routine operates the most.

For example, consider an interrupt driver that has only one entry point and one exit point. The interrupt driver will call one of six predefined handlers, or will simply return, depending on the current system conditions and register. Each of these handlers returns control to the driver, which returns control to the operating system through its exit point.

The measurement is configured by setting the timer to start on the resource term [a], where [a] defines the address of the entry to the routine, and by setting the timer to stop on the resource term [b], where [b] defines the exit address of the routine. The time ranges are set to likely values by entering values and units for the limits of each of the ranges from 1 to 8. Figure 5-3 is the State Line Interval Overview Trace Specification for this example measurement.

As in State Label Overview, the analyzer runs in a continuous sample mode. A [start] trace is always performed. When this example was run, the histogram in figure 5-4 was generated. The histogram indicates that the majority of the time, the driver operates in the 1.0 ms to 4.0 ms range. It also shows that the driver executes a great deal of the time in the 5.0 µs to 1.0 ms range. Since the only handler to operate in the latter range is the unknown interrupt case, the results indicate that there is a severe problem with undefined interrupts. The maximum field indicates that one of the handlers can run for over 5.0 ms. Since the handler keeps interrupts turned off during this time, the large processor usage of this handler could be dangerous.

This measurement might also be used to monitor the time elapsed between the acknowledgement and processing of an interrupt. In the case of a clock value update, large delays between the interrupt occurring and the processing of the interrupt could indicate a slowing of the clock value.

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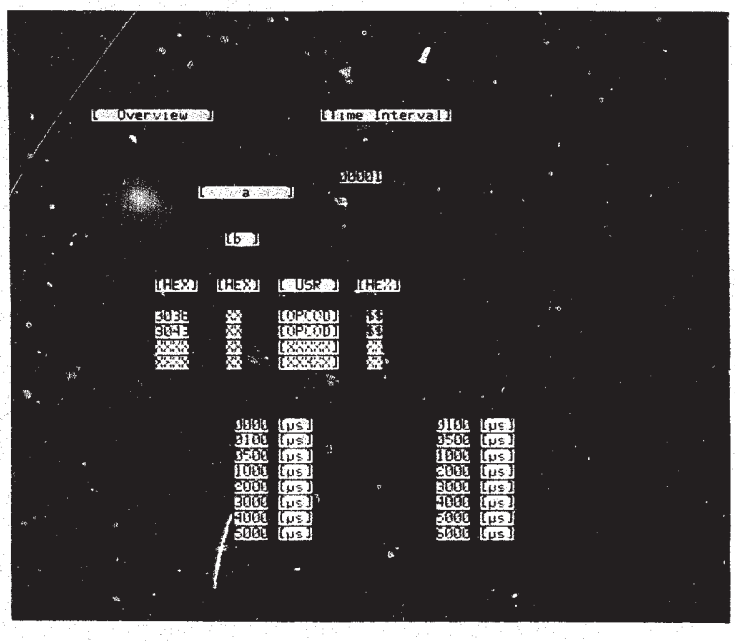


Figure 5-3. Example State Time Interval Overview Trace Specification

NOTE

Use ROLL up key to see entire display.

Sequence Terms:	one or two sequence terms may be defined. Refer to State Trace discussion for more information.
Occurrence Counter:	refer to State Trace discussion.
Start Term:	the matching pattern to be applied to start the counter. This value can be as simple as an [any state] or as complex as four OR'd states.
Stop Term:	the matching pattern to be applied to stop the counter. This value can be as simple as an [any state] or as complex as four OR'd states.
Interval Ranges:	the ranges in which the collected data should be grouped into. The left field determines the minimum value of the range and the right field determines the maximum value of the range. These values can be as small as 0 μs or as large as 9999s.
Readouts Available:	Time Interval Histogram only.

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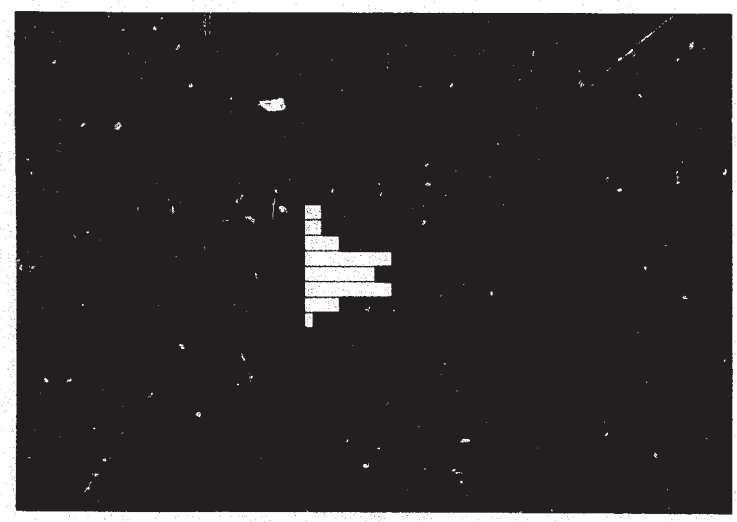


Figure 5-4. State Time Interval Overview Chart of Example Measurement

Total Samples:	the total number of states sampled and sorted at any point in time.
Total Time:	the accumulated time of all of the time intervals recorded on the display.
Minimum:	the shortest time acquired.
Maximum:	the longest time acquired.
Average:	the average time of all the times acquired.
Last:	the duration of the last interval acquired.
Histogram:	a percentage bar graph of the number of intervals acquired that fall within one of the defined ranges.

TIME POSITIONAL MEASUREMENTS

The time positional measurement provides a histogram of the number of occurrences of an event over a specified period of time. This measurement is useful in the counting actions that occur in great quantities, or that occur at large intervals. The period of time is divided into up to 1023 equal sub-intervals. Each of these reports the total number of occurrences of the event during that sub-interval.

For example, to monitor the number of writes to an HP-IB communication chip data register over a ten second period, configure the logic analyzer to measure 1000 periods of 10 ms each. Set both the store qualifier and the trigger term to the resource term **[a]**. Then set the resource term **[a]** to the address of the HP-IB chip with a status of **[WRITE]**. Figure 5-5 is the example measurement State Time Positional Overview Trace Specification.

The measurement will then begin on the first write to the specified address, and will continue for ten seconds. At completion, the chart menu will display a vertical histogram of 1000 bars. Each of these bars represents the number of HP-IB chip writes to occur during that 10 ms sub-interval. Figure 5-6 is the Time Positional histogram chart of the example measurement.

The time positional histogram provides a visual image of the flow of events within the system. In the example provided, the histogram suggests that data is output through the HP-IB port in small bursts with large intervals in between. The histogram also shows that while the burst transfer rate is acceptable, the effective transfer rate for a ten second period is very poor. By reducing the size of the intervals between transfers, the designer could increase the effective transfer rate without attempting to increase the burst transfer rate.

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In the upper left corner of the chart menu, the number of occurrences contained within the bars located at the x and o cursors are displayed. The time interval spanned between the cursors is also displayed. When the chart menu is in a magnification of 1X, the sub-intervals are grouped into sets of four with only the bar of the interval containing the largest count being displayed. Likewise, in a magnification of 2X, the sub-intervals are grouped into sets of two. All other magnifications display the sub-intervals individually.

The LIST menu is also available in this overview measurement. It displays the counts contained in each of the sub-intervals along with the absolute time from trigger at which that sub-interval ended. This count can be displayed individually for each sub-interval, or in a cumulative mode by toggling the select field under the "Occurrences" heading. Figure 5-7 is the Time Positional Listing for this example measurement.

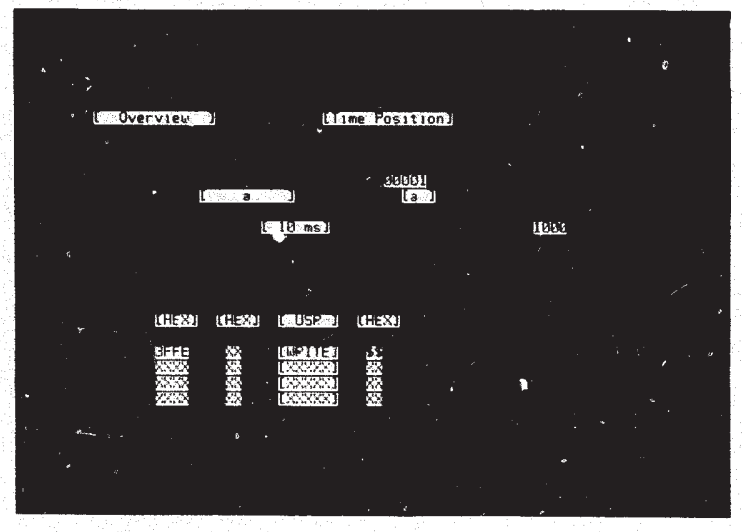


Figure 5-5. Example State Time-Positional Trace Specification

Sequence Terms:	one or two sequence terms may be selected from the resource terms, by pressing INSERT in the occurrence field. Refer to State Trace discussion for more information.
Occurrence Count:	refer to State Trace discussion.
Trigger Term:	refer to State Trace discussion.
Store Qualifiers:	refer to State Trace discussion.
Restart Terms:	refer to State Trace discussion.
Measurement Period:	the length of each sub-interval (from 1 μs to 200 s.)
Number of Periods:	the total number of sub-intervals to measure.
Readouts Available:	Histogram Chart or Sub-interval List.

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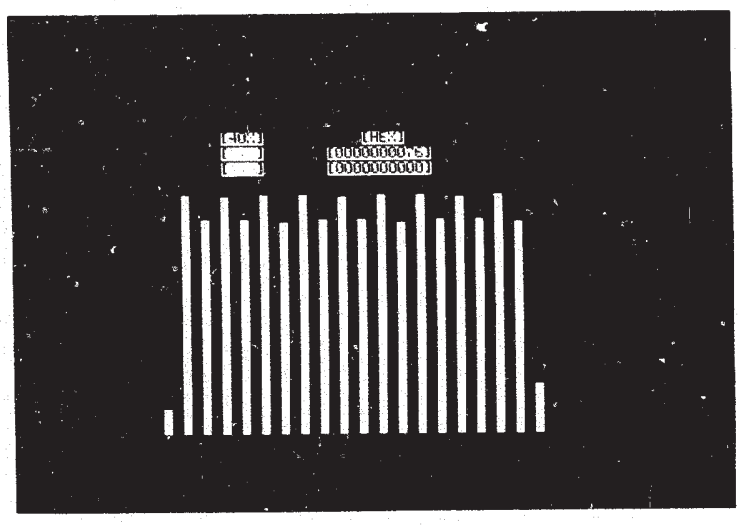


Figure 5-6. State Time Positional Overview Chart of Example Measurement

Magnification:	the magnification of the chart display from 1X to 40X. The bright bar on the dotted line at the bottom shows position of the display window within the total measurement interval.
Magnify About:	forces the display to the area around either the "x" or "o" cursor.
Cursor Moves:	selects either the "x" or "o" cursor, or both cursors, to move when the cursor left or right keys are pressed.
Max and Min:	select the vertical display area. These can be set to the max and min of the displayed data by pushing INSERT when the "INSERT to autoscale" message appears. A "*" will appear by the "Min" or "Max" label if data is being clipped, within the display window, at the top or bottom of the display area.
"x-Cursor" and "o-Cursor":	display the number of occurrences contained within the bars positioned at the corresponding cursors.
"Time x to o":	total time spanned between the "x" and "o" cursors.

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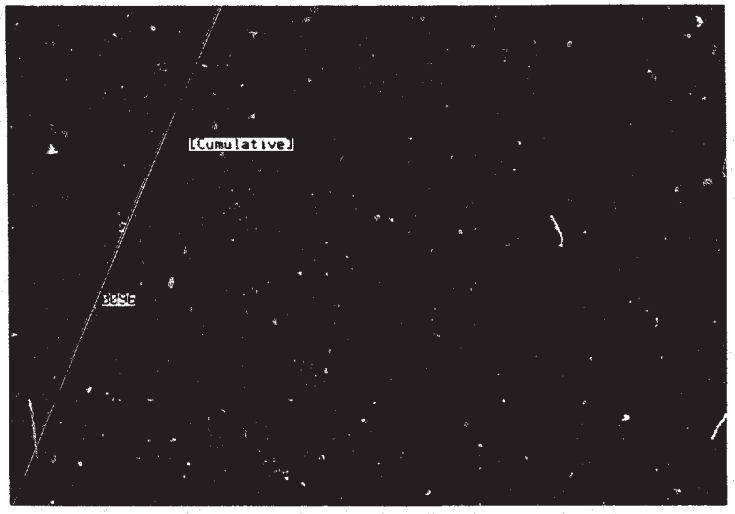


Figure 5-7. State Time Positional Listing for Example Measurement

Interval:	a number from 0 to 1023 representing the sub-interval number.
Occurrences:	the count contained within the corresponding sub-interval in either an individual, or cumulative (relative to the start of the measurement) mode.
Absolute Time:	the amount of time that elapsed from the start of the measurement to the end of the corresponding sub-interval.
Period:	the time length of the individual sub-intervals associated with this data.

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LINKAGE OVERVIEW MEASUREMENTS

The Linkage Overview Measurement provides a histogram of the relative number of calls made between modules, or the number o references made to devices or memory locations. A link is defined as two events occurring one immediately after the other in the state memory. Up to eight of these events can be defined, in a manner similar to the definition of resource terms. Up to eight link types, made up of two of any of these defined events, may also be defined. The histogram chart for Linkage Measurement displays the percentage of valid links for a defined link type versus the sum of the valid links found for all of the defined link types.

This measurement is useful in obtaining information about inter-module usage, or for obtaining information about resource usage among several different modules. Therefore, this measurement might be used to monitor the usage of an HP-IB communication chip by tasks performing system HP-IB input and output, printer output, and mass storage input and output. The Linkage Histogram would provide information as to which of the tasks was using the chip the most and which was using it the least. It would also provide information as whether the tasks were using the chip more for input or for output transactions. The measurement can also be useful in finding unexpected usage between modules by using the [other] and [any] events.

Using this example, the events would be defined as the writes from and the reads to the HP-IB chip within the individual modules. (In this case: System in, System out, Printer out, Disc in, Disk out.) Two more events would be defined as the HP-IB routines which write to the chip, given as H_WRT (write) and H_RD (read). To define events, enter the event name in the label field of the "Events" section, and the address, data, and/or status masks in the corresponding fields. More events can be added by pressing INSERT from any one of these fields. Figure 5-8 is the State Linkage Overview Trace Specification for this example measurement.

Link types for this example are: (System in) followed by (read), (System out) followed by (write), (Printer out) followed by (write), (Disc in) followed by (read), and (Disc out) followed by (write). Link types are defined by entering the link type name in the label fields under the "Linkages" section. Events for the link types are selected by using the NEXT and PREV keys to select from the predefined event labels, or to select an [any] or [other]. [any] allows an event to be paired with any state following (therefore, it acts as a "don't care" event). [other] allows a valid link to its paired event when the link is not valid for any other link type with the same paired event. Therefore, if a link type contained a leading event of [other] followed by a trailing event of [H_RD], a link of some state followed by a state matching [HH_RD] would be a valid link for this type only if its leading state did not match any of the leading states of link types with trailing events of [H_RD].

As in the State Label and Time Interval measurements, the logic analyzer runs in a continuous random sample mode. When this example was run, the results shown in figure 5-9 were obtained. The results indicate that the printer uses the HP-IB communication chip more than the other processes. If the effective transfer rate for mass storage were low, these results might indicate that the printer process controls HP-IB chip more often than the mass storage process, and might need its priority lowered.

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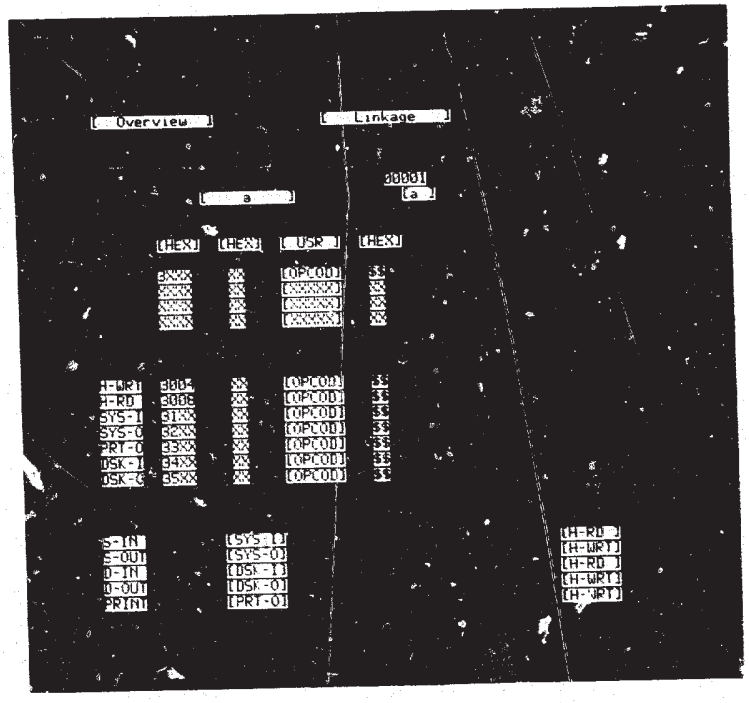


Figure 5-8. Example State Linkage Trace Specification

NOTE

Use ROLL up key to see entire display.

Sequence Terms:	refer to State Trace discussion.
Occurrence Count:	refer to State Trace discussion.
Trigger Term:	refer to State Trace discussion.
Store Qualifier:	refer to State Trace discussion.
Restart Terms:	refer to State Trace discussion.
Events:	the events consist of a label with a pattern matching field. More events can be added by pressing INSERT within one of these fields.
Linkages:	the link types consist of a label and a pair of events, one leading and one following. Events are selected using the NEXT and PREV keys. More link types may be added by pressing INSERT within the label field.
Readouts Available:	Linkage Histogram only.

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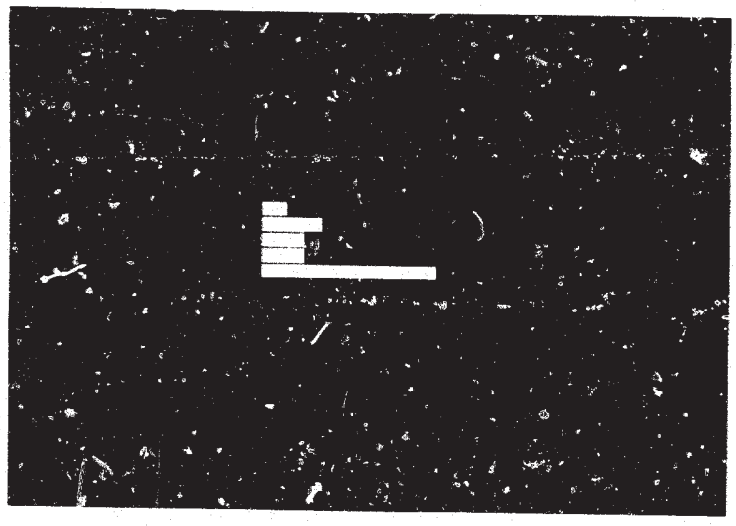


Figure 5-9. State Linkage Overview Chart for Example Measurement

Total Samples: the total number of state samples sorted at the current point in time.

Total Links: the total number of event pairs from the total samples that matched at least one of the link types.

Histogram: bar chart of the percent of total links which matched each of the individual link types. Note: the sum of the percentages may add up to more than 100% if the links found match more than one of the link types.

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Chapter 6
Timing Measurements

INTRODUCTION

Timing analysis is directed toward timing relationships between I/O signals or control lines, and propagation delays between or across logic gates.

When the logic analyzer is configured for timing analysis, samples of data are taken, asynchronously, on every pulse of a clock internal to the analyzer. The analyzer determines whether the data is less or greater than a prespecified threshold voltage level and displays the result as either a logic 1 or 0. The display stays at the same level until the next sample is taken.

Glitches

Glitches are handled by a glitch detection circuit which is independent of the sampling rate. Dual detectors are on an alternate sample period with a slight overlap. Each detector looks for two threshold crossings, identifying a glitch. If a glitch is found, it is stored in a memory separate from the timing data. When glitch detection is on, the assigned timing channels are halved.

Triggering

Trigger detection is accomplished by a method independent of the sampling clock. To eliminate false triggering, the analyzer has a filter which is used when specifying trigger duration. Trigger pattern duration is selectable from 20ns to 1ms to qualify the trigger on a time basis.

Edge triggering is available on four channels per pod assigned to timing measurements. It is used where a pattern may not be adequate for triggering or may be used to qualify a pattern. With edge detection, triggering can take place on an edge that doesn't show up in the trace (glitch triggering).

When the analyzer finds the trigger, the tracepoint is positioned as specified in the specification menu (at start, center, or end of trace). The trace specification tells the analyzer when to stop the measurement. Enough information is captured after the trigger to place it properly in trace memory. Usually timing measurements are taken with the trigger in the center trace position. The tracepoint may be delayed up to 9999 seconds after the trigger.

SIMPLE TIMING MEASUREMENTS

The following procedure shows how to make measurements of time-related activity in logic systems. How to trigger traces of electrical activity and how to compose desired displays and measure activity on the displays are described in step by step processes.

Activating The Timing Analyzer

1. Press the SYSTEM key.

2. Press the ROLL down key one time or CURSOR down key two times. This moves the bright bar to the second analyzer configuration. All channels which can collect timing information are activated for timing measurements.

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No channels are active for state measurements. See figure 6-1.



Figure 6-1. Selecting the Timing Analyzer Configuration of the 1630D (1630A and 1630G have 8 less channels)

3. Press the RUN key. The analyzer will execute a measurement at the default specification (trigger on anything), and present a waveform display on screen. This display is at X1 magnification. It shows the entire 1K memory content on screen. Unconnected timing bits are constant lows. See figure 6-2.

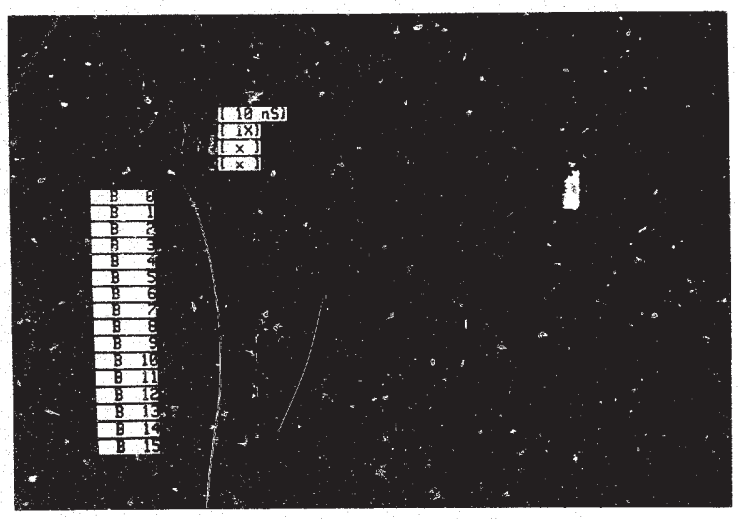


Figure 6-2. Default Timing Measurement For 1630D (1630A and 1630G have 8 less channels)

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Controlling The Timing Display

1. Move the cursor to the Magnification field in the Timing Waveform Diagram.
2. Press the NEXT[] key to obtain 4X magnification. This shows a window in the timing memory. One-fourth of the memory is on screen.
3. Press the ROLL down key to see the window move through the timing memory (display moves across the screen).
4. Press the NEXT[] key several times to see the magnifications available. Select a magnification factor that leaves several waveform transitions on screen.
5. Press and hold the CURSOR right key until the "x" marker moves out onto the display area. Place the "x" marker on one of the waveform transitions on the display. The first line above the waveforms on the right-hand side of the screen shows the measurement of time between the start of the memory and the position where you placed the "x" (o to x).
6. Press the NEXT[] key several times to see that magnification of the display occurs around the area in memory you selected by the positon of "x". See figure 6-3.

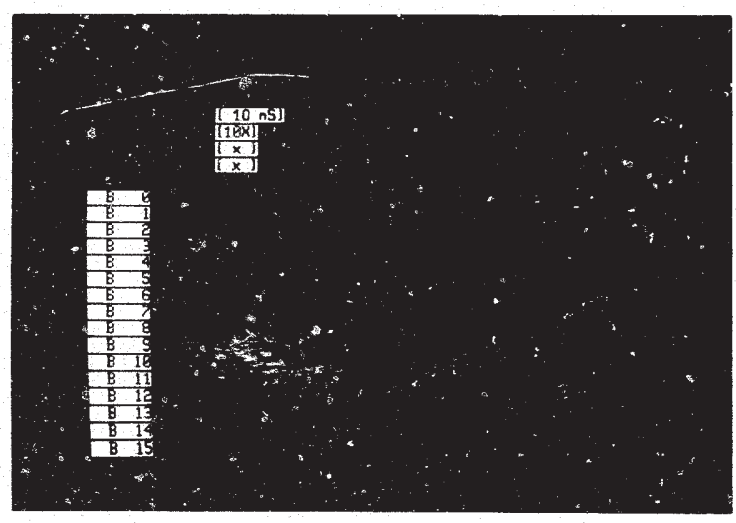


Figure 6-3. Magnification Around "x"

7. Press the CURSOR down key to move the cursor to the Magnify About field.
8. Press the NEXT[] key to change "x" to "o".
9. Move the cursor up into the Magnification field.
10. Press the NEXT[] key several times. Notice that display magnification now occurs around the position of "o" (at the start of the timing memory).
11. Select a magnification that leaves the "x" marker on screen.
12. Press the CURSOR down key to move the cursor to the Cursor Moves field.
13. Press the NEXT[] key to change "x" to "o".

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14. Press the CURSOR right key and hold it to move the "o" out on the display. Notice the time measurement indication change as the "o" moves closer to the "x".

15. Place the "o" marker on another waveform transition on the display.

16. The time measurement indication on the display will show you the measure of time between the two waveform transitions you selected using the "x" and "o" markers.

17. With the cursor in the Cursor Moves field, press the NEXT[] key to obtain the [x&o] indication. With this selection, the "x" and "o" markers will move together and maintain a constant interval between them. You can use these two markers together to compare intervals between any two points of interest on the display.

18. Move the cursor into the Magnification field and use the NEXT[] key to obtain a X1 display.

19. Use the CURSOR right and CURSOR left keys to move the "o" and "x" markers together to another set of waveform transitions on the display.

20. Place the "x" marker on one of the waveform transitions.

21. Move the cursor down into the Cursor Moves field and press the PREV[] key to select Cursor Moves [o].

22. If the events are not the same distance apart as the first set, use the CURSOR keys to move the "o" marker alone. You can measure the dimension between the two new waveform transitions.

23. Press the CURSOR left and CURSOR right keys. Notice that the "o" marker can cross the "x" marker, and the measurement indication above the traces will correct itself (show "x to o" or "o to x").

Selecting Trace Positions On The Display

1. Press the CURSOR down key to move the cursor into the B5 field.

2. Press the PREV[] key several times. You can place any of the bits from the timing memory at any location on the display. You can also turn off a display channel, if desired.

3. Press the DELETE key several times. You can eliminate channels from the display, if desired. Note that the vertical display is magnified when eight or less channels are on screen.

4. Press the INSERT key several times. You can add channels to the display, up to a maximum of 16 channels in non-glitch mode and 8 in glitch mode. See figure 6-4.

5. Press the blue SHIFT key and DEFAULT. This restores all channels in the display to their original positions.

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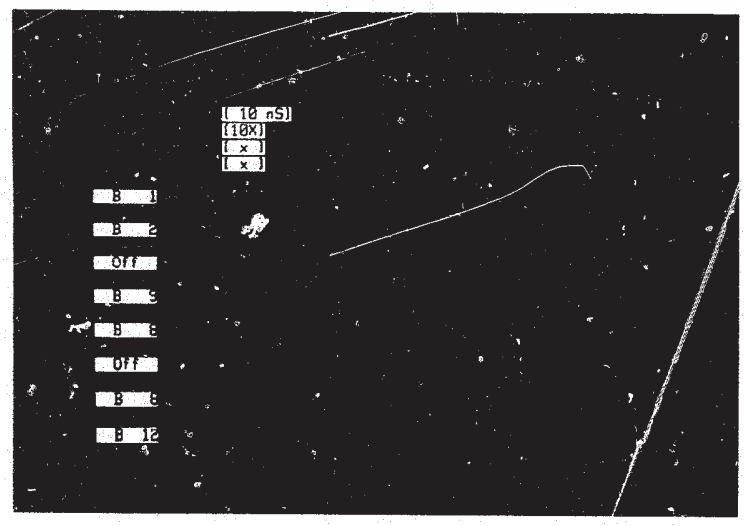


Figure 6-4. Selecting Waveform Positions On Display

Triggering On A Timing Event

1. Find a point on the waveform display where two of the channels are high at the same time that one of the other channels has a transition from low to high (change display magnification, if necessary). Write down these three channel numbers and their conditions.

2. Press the TRACE key.

3. Use the CURSOR keys to place the cursor in the row of X's in the Pattern field. This is an AND field. Its default state is all don't cares. All "1" or "0" specifications that you enter in this field must be met during the same clock period in order for the timing analyzer to recognize its trigger.

4. Use the CURSOR keys to place the cursor at the points in the Pattern field which correspond to the bits that you noted as having high states. Enter a "1" from the keyboard in each of these two bits. (B0 is the first bit on the right-hand side of the field.)

5. Use the CURSOR keys to place the cursor in the Edge field. The Edge field is an OR field. You can specify recognition of low-to-high transitions, high-to-low transitions, or both transitions in any of the bits where such selections are available. If any of the selected transitions occurs in any bit during a clock period, the entire field is satisfied.

6. Use the CURSOR keys to position the cursor on the point in this field corresponding to the bit you noted as having a low-to-high transition (B0 is on the right-hand side).

7. If there is a dot in the field where you positioned the cursor, press the NEXT[] key one time to obtain the rising-edge arrow. If there is an N/A (not available) notation in this field, you will have to return to the WFORM display and select new channels, a different one with a low-to-high transition and two other channels that are high, if required. Edge recognition is not available for all of the timing bits. See figure 6-5.

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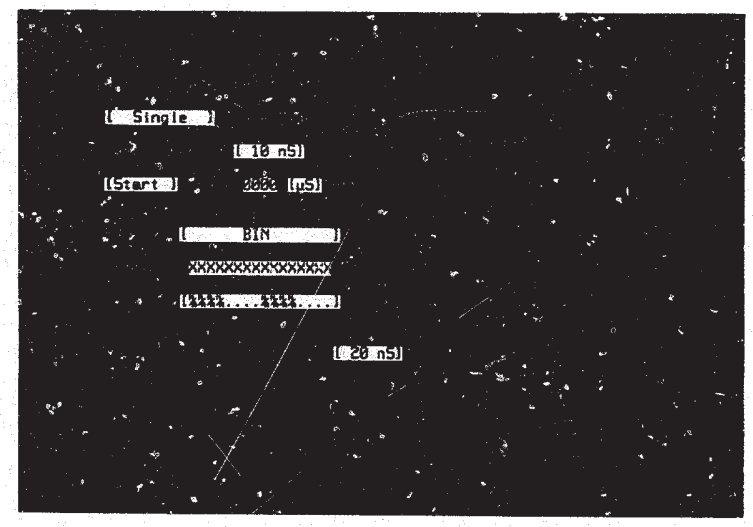


Figure 6-5. Triggering On A Pattern And Edge Transition

8. Press the RUN key. The analyzer will search the incoming activity until it finds a clock period in which both of the high channels you specified are high and a low-to-high transition occurs in the channel you selected. Then the analyzer will trigger a trace and fill its memory.

9. See figure 6-6. Note the vertical, dashed line on the display. This line identifies the trigger point.

10. Move the cursor up into the Sample Period field and press the NEXT[] key several times.

11. Press the RUN key to take a measurement using the new sample period.

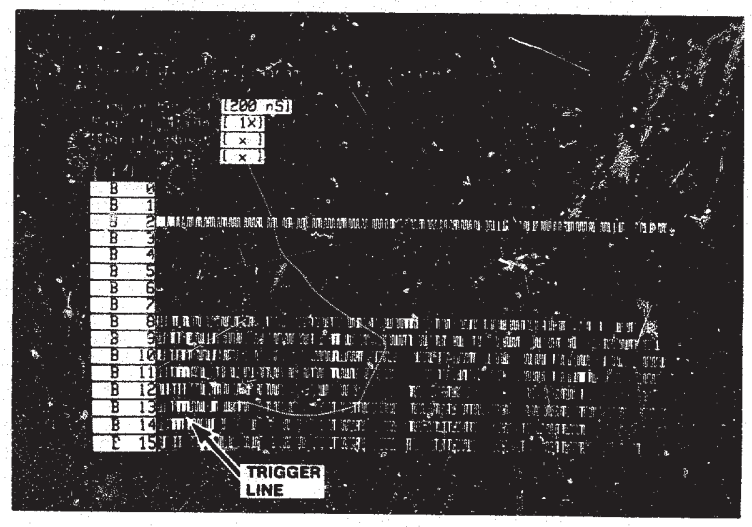


Figure 6-6. Triggering On A Timing Event

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THE TIMING FORMAT SPECIFICATION

Timing Format Specification [Assignment]

The [Assignment] menu allows you to set up the analyzer to present information in a format that will be useful. In the [Assignment] menu, you perform two setup assignments: label assignments and threshold assignments. See figure 6-7.

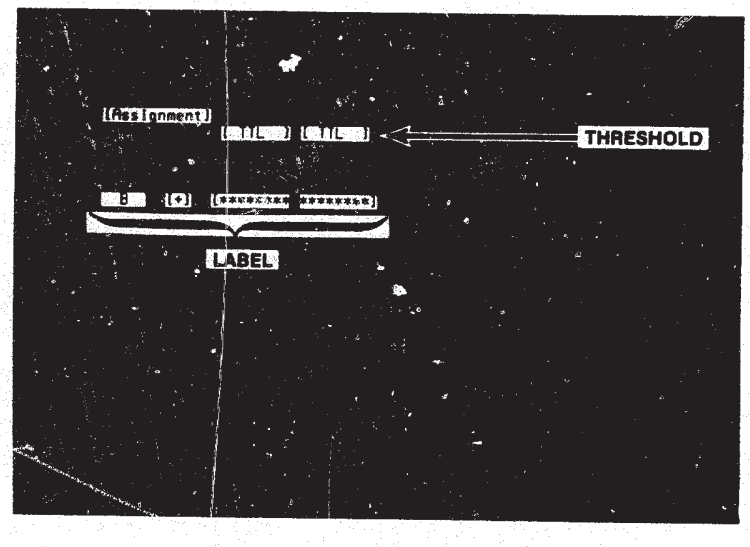


Figure 6-7. Timing Assignment Format Specification

LABEL ASSIGNMENTS

When the analyzer makes a measurement, it collects the states from all input bits (whether part of a label or not). When a label is assigned to a bit, that bit is available to the display. The analyzer cannot place the activity from a bit on the display unless that bit has a label assigned to it.

A benefit of labeling sets of bits during a timing analysis is that abnormal occurrences can be easily identified, such as when two handshake lines are high during the same instant of time.

The label capabilities and limitations are as follows:

Maximum no. of labels:	16
Label size:	1 to 5 alphanumeric characters.
Label content:	1 to all bits. Same bit can be included in all labels.
Label polarity:	[+] = positive-true; [–] = negative-true (only affects LIST displays and TRACE specification).
Label bit arrangement:	(Example of 4-bit label)

	POD1	POD0	
	7....0	7....0	
HNDSK	**	**	
	.. .. ..	.. .. ..	
MSB	1 1	1 1	LSB

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Pod Threshold Assignments

The pod threshold capabilities and limitations are as follows:

Pod assignments:	Each pod defined separately.
Thresholds available:	TTL, ECL, selectable from –9.9 V to +9.9 V, in 0.1 V increments.

Timing Format Specification [User Base]

The [User Base] menu allows names to be displayed in place of numbers when identifying states found on labeled bits. Different names can identify each of the states, such as "ACTIV" and "INACT" to identify the two states found on the interrupt bit.

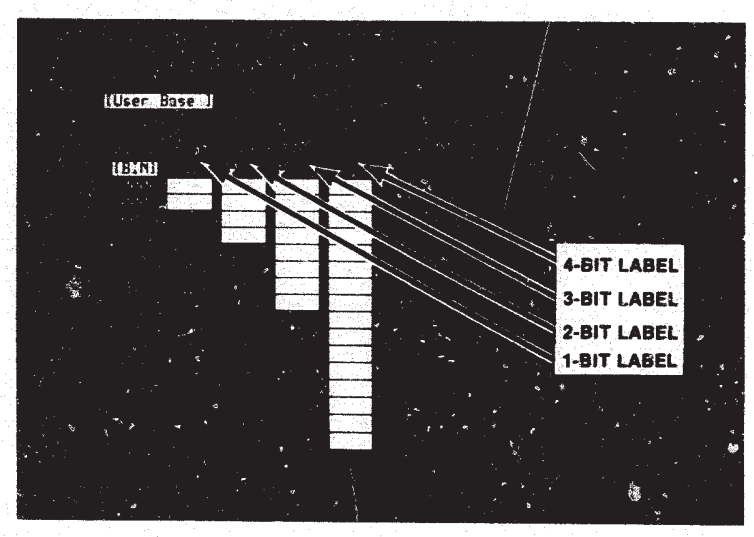


Figure 6-8. Timing User Base Format Specification

The [User Base] capabilities and limitations are as follows:

Max labels on menu:	8.
Label size:	1 to 4 bits.
Max names/label:	One name for each possible value (16 names on a 4-bit label).
Name Composition:	1 to 5 alphanumeric characters.

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THE TIMING TRACE SPECIFICATION

There are two timing trace modes offered by the analyzer: [Single], and [Continuous]. These two trace modes are described separately in the following paragraphs. Figure 6-9 is the timing trace Specification menu.

[Single] Timing Trace Specification

The [Single] trace mode is used to capture a single trace of timing activity for each bit in the timing probe pod(s). This menu allows selection of sample period, trigger location, trigger activity, and trigger duration.

[Continuous] Timing Trace Specification

In the [Continuous] mode of timing measurement, the analyzer performs a measurement just like in [Single]. As soon as the measurement is complete and the display is updated, the analyzer begins another measurement. This will continue until STOP is pressed.

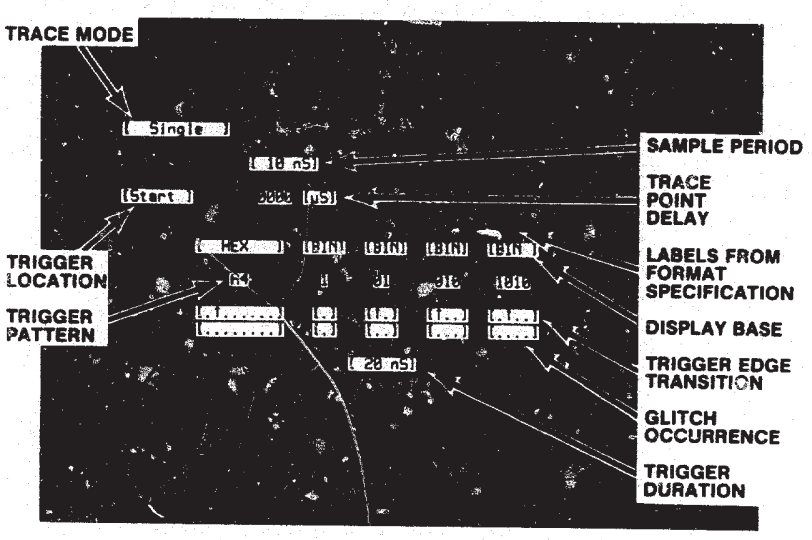


Figure 6-9. Timing Trace Specification (with [Glitch] Selected)

Sample Period:	from one sample every 10 ns to one sample every 500 ms (24 sample period selections)
Trigger Location:	[Start], [Center], or [End] (determines amount of pretrigger and posttrigger time in memory).
Trigger:	combination of pattern and edge.
Pattern:	"And" field composed of 1, 0, or X logic levels on all bits in all labels.
Edge:	"OR" field composed of positive-going, negative-going, either-edge, or off [.] for each capable bit. Bits not capable of edge recognition are identified by N/A.
Duration:	from 20 ns to 1 ms (period that pattern must remain stable to be recognized as trigger) in 1, 2, 5 sequence.
Trace Point Delay:	from 0000 ns to 9999 sec after trigger recognition. Max delay depends on Sample Period selected. Note: the analyzer rounds off the delay entry to the nearest multiple of four times the selected sample period.

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THE TIMING DISPLAY

The analyzer can present three kinds of displays: waveforms, lists, and XY charts. These displays are described in this chapter.

Waveform Displays

Figure 6-10 is a typical timing waveform display. It shows the states of six channels during a measurement. The probe channels shown on the waveform display are identified on the left-hand side of the display by their label names and numbers which identify bit positions within the label.

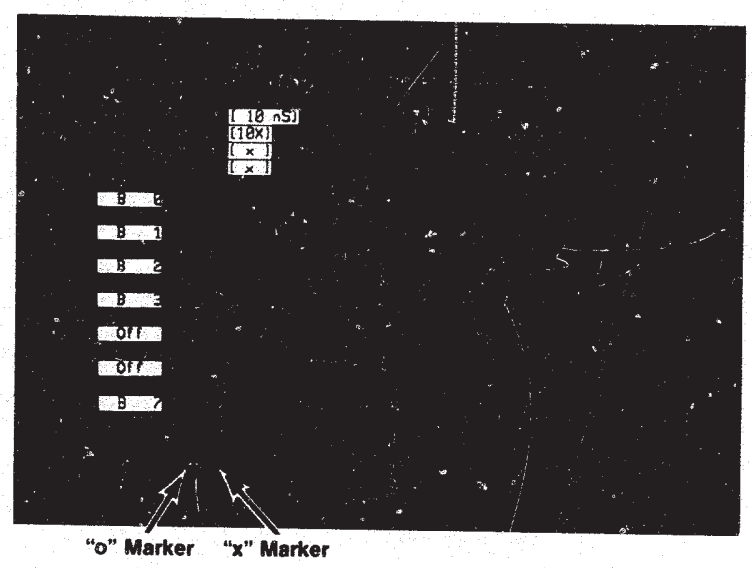


Figure 6-10. Typical Timing Waveform Display

Display Content:	1 to 16 channels (X2 vertical magnification with 8 or less channels.)
Channels on Display:	Any bit in any position, identified by label name and bit number (if in multi-bit label) on left-hand side.
Display control fields	
Sample Period:	10 ns to 500 ms. Sample period may be changed and obtain new traces when in this menu.
Magnification:	selects from 1X to 40X. Bright bar in dotted line at bottom shows position of display window in memory.
Magnify About:	Moves magnified display window to area around "x" or "o" markers.
Cursor Moves:	Selects "x", "o", or "x&o" markers to be moved by CURSOR keys. Scale at top shows time period between "o" and "x" on display.
Label Moves:	Shift and cursor changes order of labels.
Bit Labels:	Press NEXT[] key to bring any bit to any point. Press INSERT and DELETE to add or remove channels. Press CLEAR ENTRY to turn off a display channel. Press LABEL up-arrow or down-arrow to move a channel up or down on the display.
Roll indicator:	arrows in upper right-hand corner indicate whether display window can be positioned left or right by ROLL keys.

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List Displays

List displays can be obtained when timing measurements are being performed. Figure 6-11 is a typical list of timing information captured from a logic software system. The time column shows the absolute time interval between each line of information and the trigger line.

The message "Continuous Trace in Process" appears at the top of the display when in the [Continuous] trace mode. In this mode, the analyzer makes a continuous series of single traces, updating the display after it completes each trace. The content of the list will change after each new trace is completed if the display is updated with new information. To stop a continuous trace, press the STOP[] key. This causes the analyzer to complete the trace it has in progress and not to start a new trace.



Figure 5-11. Typical List Display Of Timing Activity

Display Control Fields

Base:	hexadecimal, decimal, octal, binary, ASCII (for labels from 6 to 16 bits), and user (values assigned in [User Base] menu). User values not specified are shown in hexadecimal numbers.
[Mark]:	places asterisk beside each line number that has values specified in [Mark] line.
[Show]:	shows only those lines on screen that have values specified in [Show] line.
Line no.:	inverse-video field can be changed to any line number in memory. Display window will shift to area in memory which includes selected line.
Display Information:	Blanked while analyzer gathers activity. If timing activity is captured at a slow rate, top line will show amount of memory still to be filled. After trace complete, up to 16 lines of activity from memory will be on screen. Every label defined in Format Specification will be on screen (subject to max screen width). Labels can be reordered by placing cursor in the base field under a label and pressing the blue SHIFT key plus LABEL right-arrow or left-arrow key.
Roll Indicator:	arrow(s) in upper right-hand corner. Indicate whether display window can be positioned up, down, left, or right by ROLL keys.
Time column:	shows absolute time between each sample and trigger line.

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Chart Displays

The analyzer can format XY charts of the activity collected from any labeled set of bits. You can use these charts to see patterns of activity. Figure 6-12 is a typical XY chart for label A (a label composed of four bits).

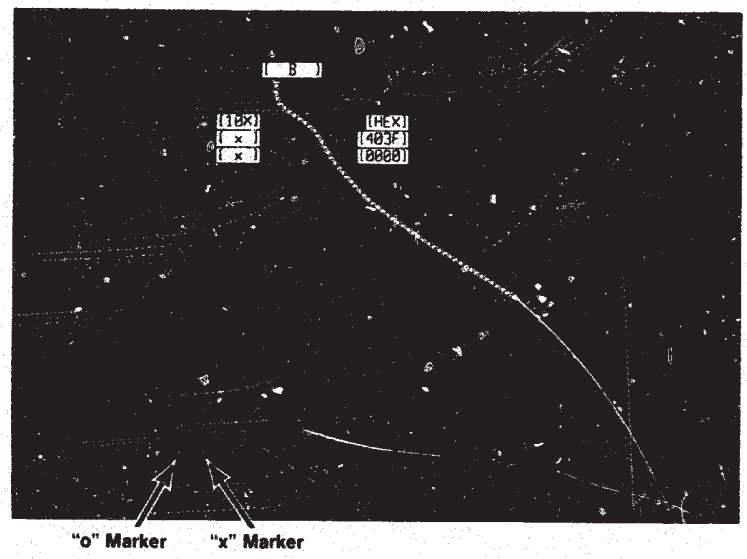


Figure 6-12. Typical Timing XY Chart Of A Label

Display Control Fields

Magnification:	selects from 1X to 40X. Bright bar on dotted line at bottom shows position of display window in memory.
Magnify About:	Moves magnified display window to area around "x" or "o" markers.
Cursor Moves:	selects "x", "o", or "x&o" markers to be moved by CURSOR keys. Scale at top shows period of time between "x" and "o" on the display.
Max and Min:	selects vertical display scale.

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Chapter 7. Interactive State And Timing Measurements

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Chapter 7
Interactive State and Timing Measurements

INTRODUCTION

The analyzer can perform simultaneous state and timing measurements when in interactive state and timing mode. The capabilities of the analyzer are nearly the same as when performing dedicated state or timing measurements. The analysis mode named as master finds the specified trigger point and arms the second analysis mode. If the second analyzer is set in a free-run mode, it effectively is triggered by the master analyzer. By using the interactive analysis modes, asynchronous and synchronous signals from the target system may be correlated.

THE FORMAT SPECIFICATION

The FORMAT Specification menus for [State] and [Timing] will show only the probe bits assigned to each analysis function. The capabilities and limitations of the Format Specification menus are the same as when performing state-only or timing-only measurements.

THE TRACE SPECIFICATION

The TRACE Specification for [State] and [Timing] is the same as described in chapter 4 for state measurements and in chapter 6 for timing measurements except for operating modes and the Master field.

Operating Modes:
1. [Single/Continous/Compare] in the 1630A/D.
2. [Single/Continous/Edit or Full Compare] in the 1630G.
3. Both state and timing analyzers operate in the same mode. [Overview] performance analysis measurements not available in the interactive state/timing mode.

Master: Selects one analysis function, either state or timing, to look for its trigger before the other can look for a trigger.

INTERACTIVE STATE/TIMING DISPLAYS

The information available in LIST and WFORM displays is the same as in the dedicated [State] and [Timing] modes. The XY CHART displays are the same as in dedicated [State] or [Timing] modes. Overview histogram displays are not available when the analyzer is used for interactive state/timing measurements.

INTERACTIVE STATE/TIMING TRIGGERING

When making a combined measurement, one of the measurement functions will be designated Master and the other one Slave. When a trace begins, the Master will look for its trigger and the Slave will be disabled. When the Master finds its trigger, it will send the "trigger found" information to the Slave. This will allow the Slave to look for its trigger.

The trigger points in the state and timing memories will be nearly the same points in time as long as the measurement function performing as slave has a "don't care" trigger. Except for the trigger point, there will be no correlation between states stored in the state memory and points of activity stored in the timing memory.

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There is a case where the measurement function performing as Slave will store its trigger before the measurement function performing as Master. This occurs when the trace point defined for Master is a trigger condition plus a delay period, and the trigger condition for Slave is "don't care" with no delay. When the trace begins, the Master will look for its trigger, and the Slave will be disabled. When the Master finds its trigger, it will send the "trigger found" information to the Slave. The Slave will find and store its trigger immediately, but the Master will wait until after it has counted its specified delay.

SPECIAL USE FOR STOP KEY

When making an interactive measurement, the state and timing measurement functions must both complete their measurements before the results of either measurement can be viewed. If one of the functions does not complete its measurement, the analyzer may display a message such as "waiting for trigger". If the STOP key is pressed, the display of information from the function that was completed can be viewed. The function that failed to complete will not offer a display because its information will not be meaningful.

MAKING COORDINATED STATE AND TIMING MEASUREMENTS

The following procedure shows how the state and timing measurement functions can perform independent measurements using separate trigger events at the same time. This procedure also demonstrates the ability of one of the measurement function modes (state or timing) to arm the other function to perform its trigger recognition.

Setup for State and Timing Measurements

1. Press the SYSTEM key.

2. Press the ROLL down arrow key to select the combined state and timing system specification assigning 8 channels to the timing analyzer. Figure 7-1 is the system specification of the 1630D. The 1630A will have 27 state and 8 timing channels assigned in the interactive mode. The 1630G will have 57 state and 8 timing channels assigned in the interactive mode.

NOTE

The figures in this chapter are taken from the 1630D Logic Analyzer.



Figure 7-1. Combined State/Timing Analyzer System Configuration for the 1630D

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3. Press the FORMAT key. Set up the [Assignment] menu the same as in figure 7-2. There are two differences in this menu in interactive mode: the least significant pod (8 bits) is omitted and the Multiplex field now has eight fewer bits in the master clock field. The [Relocation] modules have been set-up as in figure 3-10.

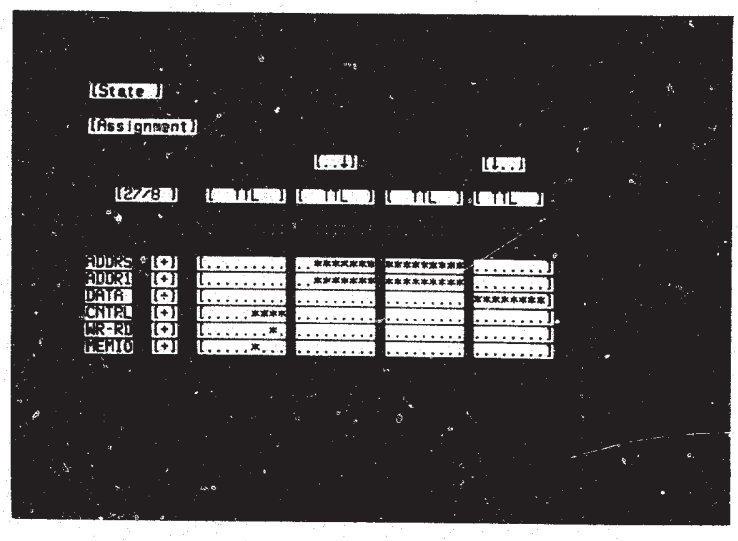


Figure 7-2. State Assignment Format Specification

4. Press the TRACE key. The state trace specification will be on screen. See figure 7-3. Set up the trace specification to trigger when it finds the first occurrence of a state that matches the specification in row "a". Move the cursor into the trigger field and press NEXT[], as required, to obtain [a].

5. Move the cursor down into the ADDRS field in row "a" and enter [TIME]+0011. Use the NEXT[] key to obtain [TIME] and the numeric keys to obtain +0011 as in figure 7-3.

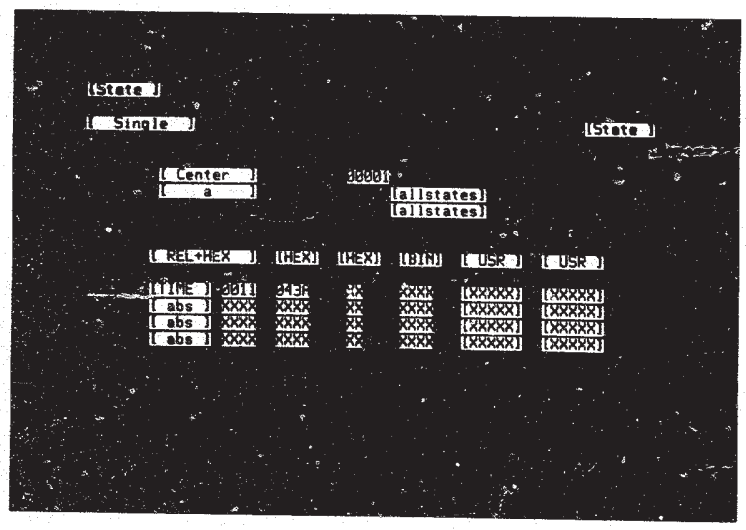


Figure 7-3. State Trace Specification in State/Timing Measurements

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Executing Coordinated Measurements

1. Press the RUN key. The analyzer will find the state you specified as its trigger, and complete a state trace. If the analyzer does not find its state trigger (TIME+0011 on the 16 address lines of the address bus), the message "Waiting for State Trigger" will be on screen. In this case, press the STOP key. The message "Trace Aborted" will be on screen, along with a listing of the last eight transactions before you pressed the STOP key.

2. Write down one of the executions shown on the display under the ADDRS label (such as TIME+001A).

3. Press the TRACE key.

4. Move the cursor down into the row "b" line.

5. Enter the module name and offset value from step 2 (use keyboard NEXT[] and hexadecimal keys). See figure 7-4.

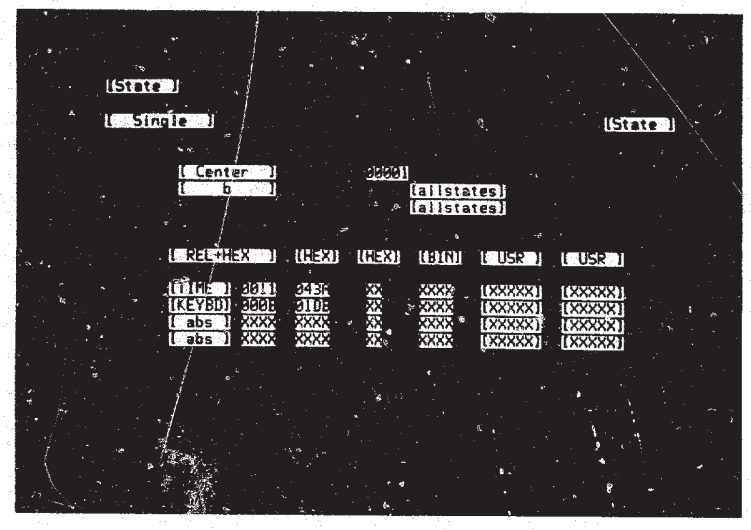


Figure 7-4. State Trace Specification With Trigger In Row "b"

6. Move the cursor up into the trigger field and press the NEXT[] key to change [a] to [b]. This sets the analyzer to trigger when it finds the state in row "b" (the state from step 2).

7. Press the RUN key. The analyzer will find the state specified as its trigger, and complete a state trace. It will show the message "Trace Complete" at the top of the display. The state selected as the trigger will be on line 0000.

8. Press the LIST key several times. Notice that pressing any of the INPUT DISPLAYS and OUTPUT DISPLAYS keys switches between the state analyzer and timing analyzer.

9. Press the FORMAT key. Press it a second time, if necessary, to place the [Timing] format specification on screen.

10. Check the display of the Activity line. If bit 2 in the timing pod shows no activity, connect bit 2 (the third line) from the timing probe to any active node in the target system.

11. Press the TRACE key. See figure 7-5.

12. Move the cursor into the Pattern field and enter a pattern of XXXX1X1X (with a binary display base).

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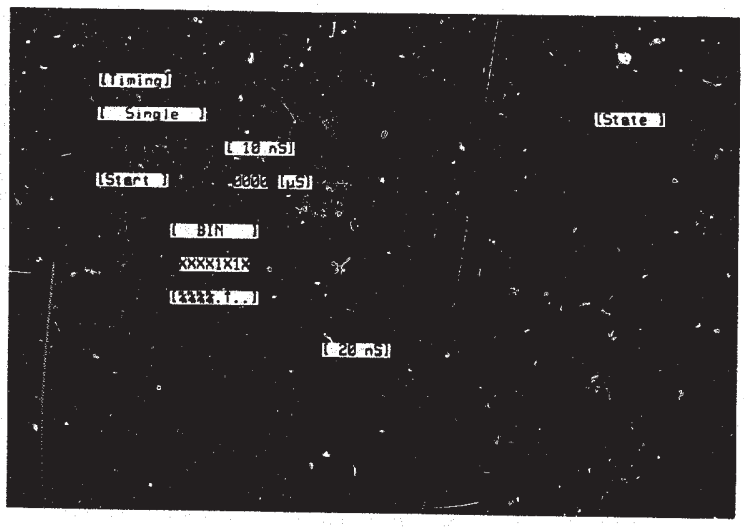


Figure 7-5. Timing Trace Specification For Combined State/Timing Measurements

13. Move the cursor down into the Edge field and use the NEXT[] key to enter a positive-going transition requirement (up arrow) for channel B2 (third from right-hand side) of the timing pod.

14. Press the RUN key. The state measurement in the analyzer will be completed as before. After the state trigger has been found, the timing function will search for the timing trigger. If it finds the timing trigger, it will complete its trace and show a waveform display. If it does not find its trigger, the analyzer will show the message "Waiting for Timing Trigger" on screen. In this case, press the STOP key. The message on screen will show "Trace Aborted". There will be waveforms displayed.

15. Press the LIST key two times. The trace list that was completed by the state measurement function will be displayed. It will show the state trigger on screen, along with other states it captured.

16. Press the TRACE key two times. This will place the trace specification for the timing function on screen.

17. Move the cursor down into the Pattern field and press and hold the DON'T CARE key until the field is all "X's". This can also be done by pressing CLEAR ENTRY. Now the timing analyzer trigger will be satisfied when the first low-to-high edge is found on channel 2 in pod 0.

18. Press the RUN key. The analyzer will search through the incoming states until it finds the state trigger. When it finds the state trigger, it will begin capturing states into memory, and at the same time, it will arm the timing analyzer to search for its trigger. The timing analyzer will monitor the incoming activity until it finds a rising edge on bit B2. Then it will store a series of samples of activity to complete its timing measurement. It will show "Trace Complete" on the top of the screen, and waveforms of timing information across the display. See figure 7-6.

19. Press the TRACE key. See figure 7-7.

20. Move the cursor into the "Master" field and press the NEXT[] key to change [State] to [Timing]. This makes the analyzer recognize its timing trigger before it can arm the state function to recognize the state trigger.

21. Press the RUN key. The analyzer will begin its measurement by looking for the condition that satisfies its timing trigger. When it finds this condition (rising edge on B2), it starts collecting timing information, and arms the state measurement function to look for its trigger. The timing analyzer displays its waveform information on screen while the state function completes its measurement.

22. Press the LIST key. The display will show a listing of the timing activity. See figure 7-8.

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23. Press the LIST key again. The display will change to a listing of the information from the state analysis function.

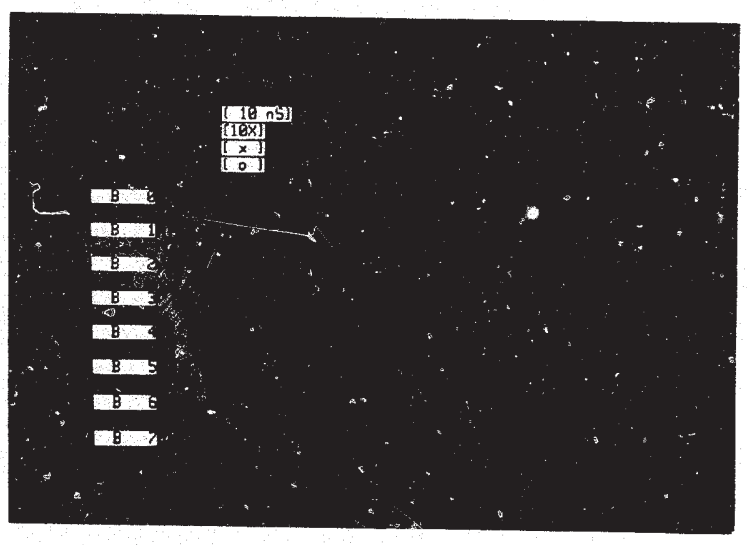


Figure 7-6. Timing Waveform Display

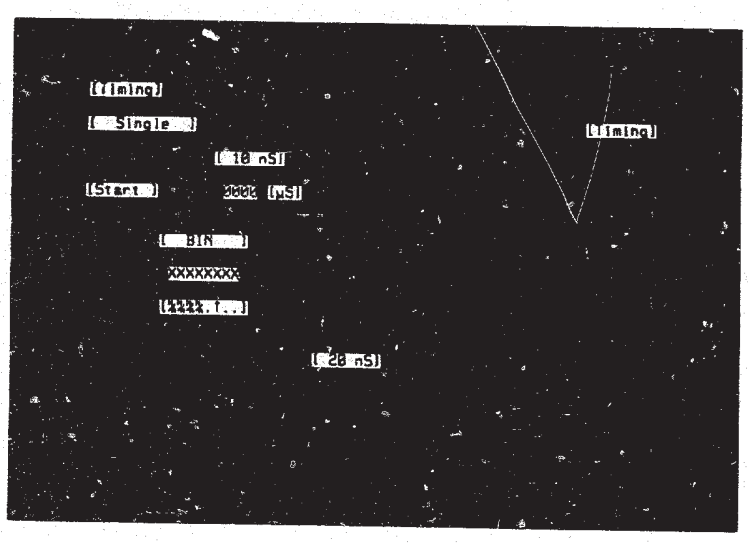


Figure 7-7. Timing Trace Specification With Master [Timing]

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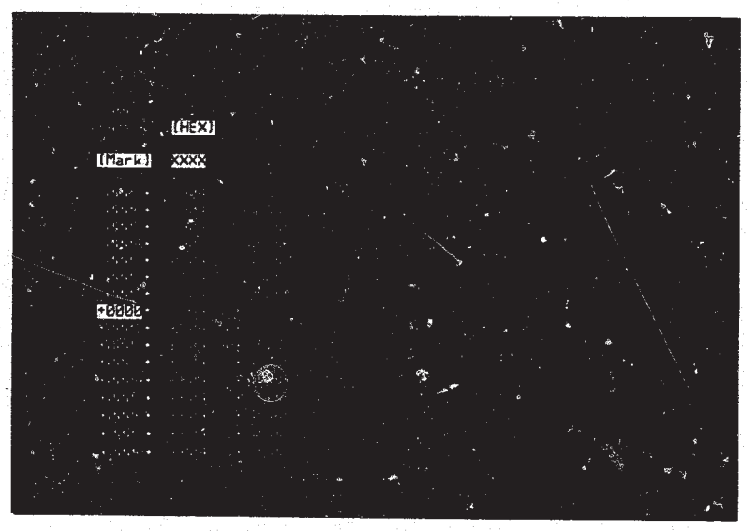


Figure 7-8. Timing Listing Display

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Chapter 8. The Peripherals Menus

[Peripherals] System Configuration 8-1
1630A/D System [Peripherals] Specification Menu 8-1
1630G System [Peripherals] Specification Menu 8-2

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Chapter 8
The Peripherals Menus

[PERIPHERALS] SYSTEM CONFIGURATION

In this menu, the way the analyzer will interact with peripherals through its interface connectors is set up. The analyzer clock and beeper are also set from this menu. The analyzer beeps at predetermined points in operation and when error conditions are detected. If desired, the beeper may be turned off. Figure 8-1 is the peripherals menu of the 1630A/D. Figures 8-2 and 8-3 are the peripherals menu of the 1630G. Figure 8-3 has messages and fields pertaining to inverse assemblers and configurations when they have been saved in internal storage. See Appendix D for more information on storage operations.

1630A/D System [Peripherals] Specification Menu

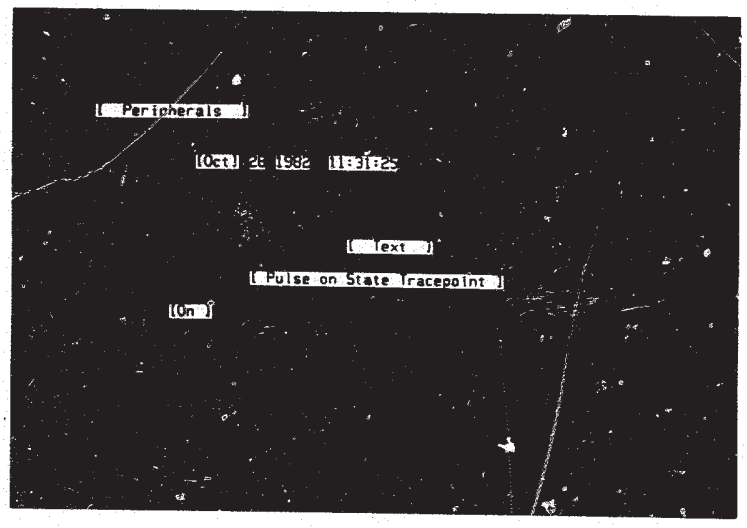


Figure 8-1. 1630A/D [Peripherals] System Specification

Clock Set:

Field used by analyzer to identify when information was captured into memory. Enter [month] day year hour:minute:second. Once set, this clock will continue to keep time as long as analyzer power is on.

Print Non-waveform Menus:

Selects code for information transfer to external printer.

[Text] selects information transfer using ASCII codes.

[Graphics] selects information transfer using HP-GRAPHICS codes.

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Rear Panel Port: Selects control signal to be supplied through the rear panel BNC output PORT to an external device, as follows:

[Pulse on State Tracepoint] - analyzer outputs 15-nsec TTL positive pulse when it finds state tracepoint.

[High til State Tracepoint] - after run start, analyzer outputs TTL high until it finds state tracepoint. Then it switches TTL low.

[Low til State Tracepoint] - after run start, analyzer outputs TTL low until it finds state tracepoint. Then it switches TTL high.

[High on Last Sequence] - analyzer outputs TTL high when it is searching for the last term in a trigger sequence.

[High on Timing Pattern] - analyzer outputs TTL high as long as the timing trigger pattern occurs for longer than the specified valid pattern duration.

[Constant High] - analyzer outputs TTL high.

Beeper: when [On], the analyzer will beep whenever it completes a measurement, and whenever it flashes an error or warning message on screen. When [Off], the analyzer will not beep at any time.

1630G System [Peripherals] Specification Menu

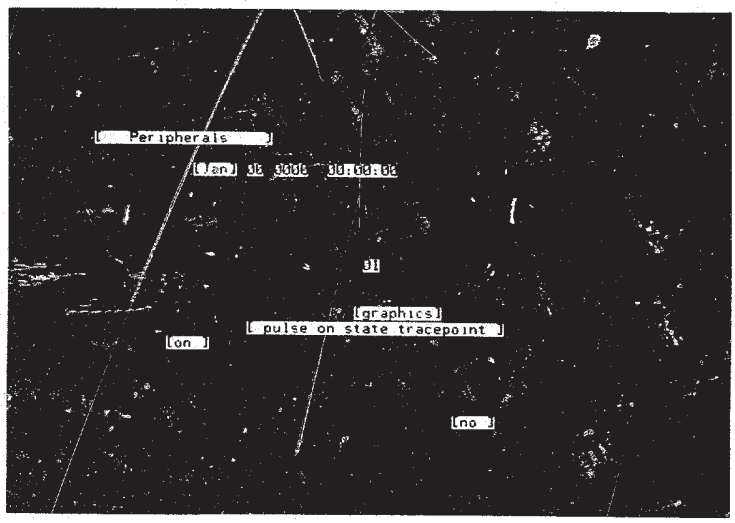


Figure 8-2. 1630G System [Peripherals] Specification Menu Without Internally Stored Information

Clock Set: field used by analyzer to identify when information is captured into memory or stored on the disc. Enter [month] day year hour:minute:second. Once set, this clock will continue to keep time as long as analyzer power is on. Once any entry is made in the clock set field, the entire setting must be properly made.

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HP-IL:
HP-IB: these are controlled by the configuration switches 7 and 8 (the rightmost switches when looking at the rear panel of the 1630. If the switch configuration is 00, then the messages are as follows:

HP-IL: Inactive
HP-IB: 1630G is controller

If the switch configuration is 01, then the messages are as follows:

HP-IL: Inactive
HP-IB: External Controller

If the switch configuration is 10, then the messages are as follows:

HP-IL: External Controller
HP-IB: 1630G is controller

Logic Analyzer HP-IB Address: displays the two-digit HP-IB address that is set by the configuration switches 1 through 6.

Printer HP-IB Address: defaults to 01, however can be manually set to any mumber between 00 and 30 if no other instrument is assigned to that address. If the logic analyzer is set to address 01, then the printer address defaults to 02.

Disc HP-IB Address: defaults to the lowest available HP-IB address (i.e., defaults to 2 if logic analyzer is address 0; otherwise will be at address 0).

Print Non-Waveform Menus in:
Selects code for information transfer to external printer.

[Text] selects information transfer using ASCII codes.

[Graphics] selects information transfer using HP-GRAPHICS codes.

NOTE

Waveform chart menus are always transmitted in HP-GRAPHICS code.

Rear Panel Port: selects control signal to be supplied through the rear panel BNC output PORT to an external device, as follows:

[Pulse on State Tracepoint] - analyzer outputs 15 nsec TTL positive pulse when it finds state tracepoint.

[High until State Tracepoint] - after run start, analyzer outputs TTL high until it finds state tracepoint. Then it switches TTL low.

[Low until State Tracepoint] - after run start, analyzer outputs TTL low until it finds state tracepoint. Then it switches TTL high.

[High on Last Sequence] - analyzer outputs TTL high when it is searching for the last term in a trigger sequence.

[Constant High] - analyzer outputs TTL high.

[Constant Low] - analyzer outputs TTL low.

Beeper: when [On], the analyzer will beep whenever it completes a measurement, and whenever it flashes an error or warning message on screen. When [Off], the analyzer will not beep at any time.

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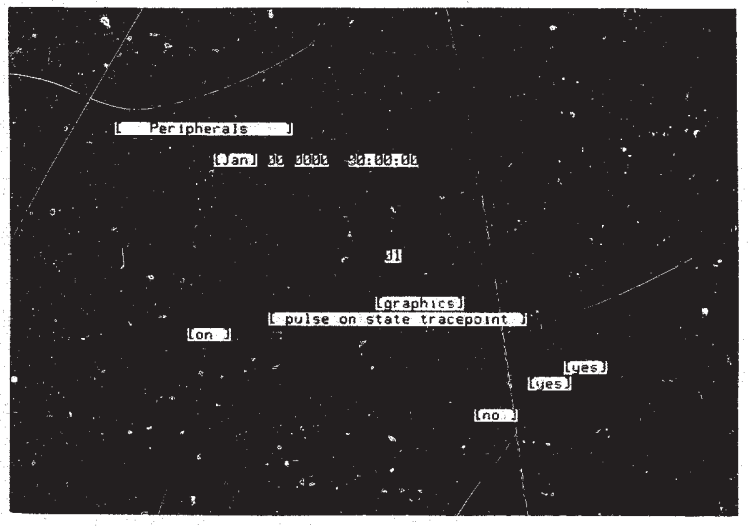


Figure 8-3. 1630G System [Peripherals] Specification Menu With Internally Stored Information

Autoload Inverse Assembler From Internal Storage:

using the PREV[ ], NEXT[ ] keys can be toggled between [yes] and [no]. Anytime the selection to [yes] is made the inverse assembler that is stored in memory is loaded to be active. If [yes] is selected the inverse assembler is automatically loaded the next time the instrument is powered up.

Autoload Configuration From Internal Storage:

using the PREV[ ], NEXT[ ] keys can be toggled between [yes] and [no]. Anytime the selection to [yes] is made the previously stored configuration in memory is loaded to be active. If [yes] is selected the configuration is automatically loaded the next time the instrument is powered up.

NOTE

If "Autoload inverse assembler from internal storage" and "Autoload configuration from internal storage" are both set to [yes] at power up, the inverse is loaded and then the configuration is loaded. If the configuration does not contain the same format specification as the inverse assembler, the inverse assembler may not function properly.

Save Configuration In Internal Storage:

using the PREV[ ], NEXT[ ] keys [yes] can be selected, at which time the current configuration is stored in internal storage, then the selection returns to [no].

If the internal storage is not operating properly when power is applied or when it is attempted to save a configuration in internal storage, the message "Internal storage failed power-up" will replace the peripherals menu entries "Autoload inverse assembler from internal storage" and "Autoload configuration from internal storage". The peripherals menu entry "Save configuration in internal storage" will still be displayed. If [yes] is selected, a reset will be attempted on the internal storage before configuration storage commences. During the reset, the message "WAIT resetting internal storage" will be displayed. If the reset fails, the message "Internal storage failed power-up" will remain on-screen. If the reset is sucessful, the current configuration will saved in internal storage. The "Internal storage failed power-up" message will be replaced with "Autoload configuration from internal storage".

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Chapter 9. Using HP-IB Or HP-IL Interface

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Chapter 9
Using HP-IB or HP-IL Interface

INTRODUCTION

This chapter contains programming instructions for operating the analyzer via HP-IB or HP-IL interfaces. The HP-IB and HP-IL interface capabilities and device-dependent commands are identical. All operations that can be obtained by pressing a front-panel key can also be obtained by using the analyzer device-dependent commands when they are sent over an HP-IB or HP-IL interface from a controller. This chapter provides detailed information about each of the device-dependent commands and how these commands affect the analyzer. The command learn strings of the HP 1630A/D and the HP 1630G are different because the 1630A/D uses HP-IL mass storage and the 1630G uses HP-IB mass storage. Two sections are provided in this chapter to differentiate the command sets.

HP-IB AND HP-IL INTERFACE CAPABILITIES

The following HP-IB and HP-IL interface functions are implemented in the analyzer.

SERVICE REQUEST (SRQ) - Programmable service request for various conditions specified in the Mask Byte (MB) command. Reset when status byte read by SERIAL POLL or via SB command.

SERIAL POLLING - The serial poll represents the unmasked status of the machine and is identical to the SB1 response. Status bits are unmasked using the Mask Byte (MB) command. Serial polling is the preferred method of checking machine status because serial polling will not cause the analyzer to abort any currently pending output. The "SB" command does cause such aborts.

PARALLEL POLLING - Complete parallel polling capability. Sense bit of ENABLE message is used to determine whether a service request is indicated by a 1 or 0 on the specified bit. Request is cleared by a serial poll or by sending SB1.

GROUP EXECUTE TRIGGER - Executes a measurement similar to pressing the RUN key.

REMOTE/LOCAL/LOCAL LOCKOUT - Complete capability.

INTERFACE CLEAR - Clears the interface to an untalk/unlisten state.

DEVICE CLEAR - Aborts any interface operation and clears input/output buffers.

The analyzer will abort any pending output if it receives a new command from the controller before it has been addressed to send its output. For example, if the controller commands a menu change in the analyzer before it addressed the analyzer to talk, the analyzer will abort its status byte message.

KEYBOARD MNEMONICS

The device-dependent commands for keyboard functions are implemented in a mnemonic-per-keystroke format. Table 9-1 lists the HP-IB and HP-IL command mnemonic for each key. Any key mnemonic can be followed by an ASCII number that indicates how many times to repeat that key. For example "CD5" will cause the "Cursor Down" command to be executed five times. Sending the command "NX 10" is the same as pressing the NEXT key ten times.

To send data keys (i.e., numeric 0123456789ABCDEFX or alphabetic values) enclose the ASCII representations of those keys in field delimiters. For example, if a pattern is to be sent after positioning the cursor to a particular field, send the pattern in field delimiters, i.e., OUTPUT 700; "(01XX1533)". Three different field delimiters are allowed: ",", and (). Use the same delimiter at the start and end of a field. Mnemonics can be sent using either upper case or lower case letters. Commands must be delimited by one or more of the

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delimiting characters: semicolon (;), carriage return (cr), or linefeed (lf). When any of the delimiting characters are encounted, following a command, the command will be transmitted. More than one delimiter may be used in a string, however, any one will cause the command to be transmitted. The following examples all cause the command (TC) to be transmitted: TC;, TCcr, TClf, TC;crlf.

Table 9-1. HP-IB/HP-IL Keyboard Mnemonics

Key	Mnemonic	Key	Mnemonic
SYSTEM menu	SM	INSERT	IN
FORMAT menu	FM	DELETE	DE
TRACE menu	TM		
LIST menu	LM	CLEAR ENTRY	CE
WFORM menu	WM	DEFAULT	DM
CURSOR left	CL	NEXT[ ]	NX
CURSOR right	CR	PREV[ ]	PV
CURSOR up	CU	DON'T CARE	
CURSOR down	CD		
LABEL left	LL	RUN	RN
LABEL right	LR	RESUME	RE
LABEL up	LU	STOP	ST
LABEL down	LD	PRINT	PR
		PRINT ALL	PA
ROLL down	RD		
ROLL up	RU		
ROLL left	RL		
ROLL right	RR		

NON-KEYBOARD MNEMONICS

The following HP-IB and HP-IL mnemonics command the analyzer to take actions that are not possible from the keyboard.

BP — Beep. Sounds analyzer beeper.

SYNTAX: BP;

CH — Cursor Home. Moves cursor to known location at upper leftmost field of analyzer display.

SYNTAX: CH;

DB — Display Blank. Clears analyzer display. For proper operation, the SYSTEM [Configuration] menu should be on the display when you issue the "DB" command. The word "REMOTE" will not dissappear from the display. If a trace is in process, the message area of the screen may be asynchronously updated.

SYNTAX: DB;

DR — Display Read. Command causes analyzer to read from display memory, starting from specified row and column, specified number of characters for transfer to HP-IB/HP-IL interface followed by CR I.F. Inverse video characters are sent as the ASCII character value plus 128.

SYNTAX: DR <ROW><COL><BYTE_COUNT>;

where BYTE_COUNT has a maximum integer value of 1472 (23 rows × 64 columns)
ROW is integer value with range of 1 to 23
COL is integer value with range of 1 to 64

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DW — Display Write. Writes ASCII string of 80 or less characters to analyzer display, beginning at position specified by row and column.

SYNTAX: DW[I] <ROW><COL> (STRING);

where I is optional parameter specifying that string be displayed in inverse video.

Legal delimiters for STRING are ",", and ( ).

ID — Send Identification code. Causes analyzer to send identification code indicating instrument configuration followed by CR LF.

SYNTAX: ID;

where returned value is a string containing the instrument model number ("HP1630A", "HP1630D" or "1630G").
HP1630A - (35-channel state, 8 timing)
HP1630D - (43-channel state, 16 timing)
HP1630G - (57-channel state, 8 timing)

KE — Send buffered key. Causes analyzer to send key mnemonic or alphanumeric character followed by CR LF for any key (refer to table 9-1) that has been pressed while in remote mode. Buffer saves up to the last 15 key presses. If no keys have been pressed, the analyzer returns double questions marks (??).

SYNTAX: KE;

MB — Set service request mask byte. Enables SRQ, PP response, and bits in the serial poll and SB1 registers specified in argument. Mask byte is set to 0 at power-on, disabling any service requests.

SYNTAX: MB <mask_value>;

where mask_value is an ASCII integer (i.e., 0 to 255) in decimal format. A service request (SRQ) will be generated if the mask bit for a condition is set to one and that condition occurs. The mask bit positions are:

Bit 0 (1) = Print Complete
Bit 1 (2) = Measurement Complete
Bit 2 (4) = Slow Clock
Bit 3 (8) = Key Pressed (Front Panel Request)
Bit 4 (16) = Not Busy
Bit 5 (32) = Error in Last Command

PU — Power-up. Defaults all instrument menus. Buffered keys, SRQ, PP and status bytes are unmodified.

SYNTAX: PU;

RST — Reset. Reset analyzer to power-up condition as if power was cycled. A one second delay is recommended after RST prior to sending any other remote commands.

SB — Status Byte. Returns analyzer status byte to controller on next read. One of four status bytes may be requested. Status bytes are returned as a single byte without termination. The character decimal value returned represents the status.

SYNTAX: SB N;

where N is an integer value from 1 to 4. If argument N is omitted, the default condition is status byte 1. Requesting status byte 1 or executing a serial poll resets the SRQ and PP response and clears the bits in the serial poll or SB1 register.

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Status Byte 1 - Machine status (of bits currently enabled by Service Request Mask Byte).

Bit 0 (1) = Print Complete
Bit 1 (2) = Measurement Complete
Bit 2 (4) = Slow Clock
Bit 3 (8) = Key Pressed (Front Panel Request)
Bit 4 (16) = Not Busy
Bit 5 (32) = Error in Last Command
Bit 6 (64) = Reserved for indicating Service Request

Status Byte 2 - Machine status of all bits regardless of the service request mask byte. These bits are cleared when the condition causing the bit to be set is cleared.

Same as status byte 1.

Status Byte 3 - Trace status consisting of the service request mask byte. Status is cleared on trace in progress. Q2 represents bits B4 through B7. Q1 represents bits B0 through B3.

Q2 =
0 - No Trace Taken
1 - Trace in Progress
2 - Measurement Complete
3 - Measurement Aborted

Q1 =
0 - Not Active (no measurement in progress)
1 - Waiting for State Trigger Term
2 - Waiting for Sequence Term #1
3 - Waiting for Sequence Term #2
4 - Waiting for Sequence Term #3
5 - Waiting for Time Interval End Term
6 - Waiting for Time Interval Start Term
7 - Slow Clock
8 - Waiting for Timing Trigger
9 - Delaying Timing Trace
10 - Timing Trace in Progress

Status byte 4 - Controller error codes indicating error condition or action required from controller.

Error Code =

4 - value not allowed
8 - use NEXT[ ] PREV[ ] keys
9 - numeric entry required
10 - use hex keys
11 - use alphanumeric keys
13 - requires correction first
15 - DON'T CARE not allowed
16 - use 0 or 1
17 - use 0, 1, or DON'T CARE
18 - use 0 thru 7
19 - use 0 thru 7 or DON'T CARE
20 - use 0 thru 3
21 - use 0 thru 3 or DON'T CARE
22 - value is too large
24 - use CHS key
30 - maximum INSERTs used
40 - disc contains non-HP1630 data
41 - CRC does not match
47 - illegal name file
48 - duplicate HP-IB address
49 - reload disc first
50 - storage operation aborted
51 - file not found
58 - in controller command
60 - write protected disc
61 - RESUME not allowed
62 - invalid in this trace mode
82 - incorrect revision code

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LEARN STRING COMMANDS

The following learn string commands instruct the analyzer to transmit its internal configuration, state acquisition data, and/or timing acquisition data to the controller. Learn string commands provide a means of saving configurations and acquisition data for later use and analysis. Measurement configurations can be stored and reloaded to repeat complex measurements. Likewise, acquisition data can be returned to the analyzer for analysis at a more convenient time. You need only transmit the learn string back to the analyzer to restore configuration or an acquisition. The learn string is transmitted as a receive learn string, that is, nothing need be added or changed in the learn string in order to return it to the logic analyzer.

Each learn string contains the proper mnemonic header (RS, RT, RA) to receive state or timing data, a binary byte-count word, the binary data, and two Cyclic Redundancy Check (CRC) bytes. The binary byte-count word, returned most significant byte (MSB) first and least significant byte (LSB) last, gives the number of bytes contained in the binary data file, including the two CRC bytes but not the byte count word or the mnemonic.

Data Formats

Real data is transmitted in one of the following formats. The format type is indicated by abbreviation in the syntax contents column for each learn string.

(A) - ASCII data

(B) - BCD (binary coded decimal) data

(I) - Integer data (if multi-byte MSB first, LSB last)

(R) - Real data (in floating point decimal format)

(S) - Switch (Boolean data) 0=False, ≠0 (not 0)=True

(T) - Time

Byte 0	Byte 1
0 - 1	0 - ns
1 - 2	1 - us
2 - 5	2 - ms
3 - 10	
4 - 20	
5 - 50	
6 - 100	
7 - 200	
8 - 500	

(W) - Wide special nine byte internal structure in 1630G.
- Wide special six byte internal structure in 1630A/D.

Date/Time Information

Each of the learn strings contain month, day and time information. This data is formatted as follows:

Month - (I) defined using one byte and is an integer value 0 through 11 where 0 = January, 1 = February, etc.

Day - (B) defined using one byte containing two BCD digits.

Hour - (B) defined using one byte containing two padded BCD digits.

Minute - (B) defined using one byte containing two padded BCD digits.

Second - (B) defined using one byte containing two padded BCD digits.

Year - (I) defined using two bytes representing one 16 bit integer transmitted as MSB first and LSB last.

All data that contains more than one byte in the string is transmitted MSB first and LSB last.

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Data Formatting Examples

The following examples are intended to demonstrate decoding of various learn string bytes that are coded in different formats. The bytes are sent from the logic analyzer over the HP-IL cable or the HP-IB bus. These examples assume HP-IB use with an HP Series 200 controller with Basic 2.0 Language Operating System.

ASCII (A) Format

ASCII format is used at various points in many of the logic analyzer learn strings. One usage of the ASCII format is in the State Label Overview Learn String. The last five bytes in each 23 byte interval range represent the state label name formatted in ASCII.

When the following commands are sent from a Series 200 controller to the logic analyzer, the State Label Overview Learn String will be received by the controller. (This example assumes the logic analyzer is in the State Label Overview trace mode and has completed an acquisition.)

```
Output @Logic_analyzer using "#, K";"TS;"
Enter @Logic_analyzer using "%,-K";S$
```

Byte positions 40-44 are the bytes when translated to ASCII and then alpha characters give the name of the first state label range (a total of eight characters are allowed). For instance, if the first range name is "DELAY", bytes 40-44 would be represented:

Parameter:	State assignment label name (State Label Overview Learn String)				
Byte Position:	Byte 40	Byte 41	Byte 42	Byte 43	Byte 44
ASCII:	D	E	L	A	Y
Hexadecimal:	44	45	4C	41	59
Decimal:	68	69	76	65	89

Binary Coded Decimal (B)/Integer (I) Formats

The most common usage of the binary coded decimal and integer formats is the encoding of the Date/Time settings. The precise byte positions of these parameters within the particular learn string is in the learn string listing. The interpretation of this information is given in the following example. The byte positions are from a State Trace Learn String which are bytes 5 through 11 in the learn string. The Date/Time is August 28, 1985 at 10:50:07.

Parameter:	Month	Day	Hour	Min.	Second	Year	Year
Byte Position:	5	6	7	8	9	11	11
Format:	(B)	(B)	(B)	(B)	(B)	(I)	(I)
Hexadecimal:	07	28	10	50	07	07	C1

Interpreting the hexadecimal representations for month, day, hour, and second are straightforward. The month is represented from 0 to 11 as described for month in Date/Time Information previously in this chapter. However, the integer decoding for the year is not as apparent. It can be regarded as having the MSB (most significant byte) coming first as follows:

Byte Position:	Byte 10		Byte 11	
Hexadecimal:	0	7	C	1
Binary:	0000	0111	1100	0001
	16^3	16^2	16^1	16^0

$$(7 \times 16^2) + (12 \times 16^1) + (1 \times 16^0) = 1985$$

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Real Data (R) Format

Data that is structured using the floating point system is indicated with the abbreviation (R) in the contents column of the learn string. The floating point format used in the learn strings consists of 32 bits as shown in the following arrangement.

BYTE 0	BYTE 1	BYTE 2	BYTE 3
EEEEEEES .	MMMMMMMM	MMMMMMMM	MMMMMMMM

Where:

EEEEEEE = 7-bit 2's Complement Power of 2

S = Sign of Mantissa (0=Positive, 1=Negative)

M.....M = 24-bit Unsigned Mantissa (Fraction)

NOTE

When acquisition is timing trace, this number refers to number of marks or number of sample period intervals.

The floating point format is an efficient method of representing large numbers using minimum memory space. The interpretation of a particular parameter using real format is dependent on the context of the parameter. A real number for a parameter involving "time" must be multiplied by a standard time increment which is peculiar to that learn string. An example is in the Timing Trace learn string where the real numbers obtained must be multiplied by the sample period to obtain the proper time. However, in the State Time Interval Overview Learn String, the number obtained is always in seconds which is essentially the same as multiplying by one.

In a case where a parameter does not involve time, the decoded real number is directly translatable. This is evident in the Timing Trace Learn String parameter for the number of marks or runs.

The following example is from a State Time Interval Learn String. A run was made which acquired a total of 76 samples in 145.5 μsec.

Parameter:	Total Number of States			
Byte Position:	14	15	16	17
Format:	(R)	(R)	(R)	(R)
Hexadecimal:	0E	98	00	00

The first byte (byte 14) is the exponent and is decoded as:

Hexadecimal:	0	E
Binary:	0000	1110
		└──indicates positive number
	0000	0111
(EXPONENT):	0	7
		└──indicates binary power of 2^7

The least significant bit in binary representation of the byte indicates the number is positive. The remaining seven bits are then considered a separate binary number which, in this case equals seven. There are two ways to interpret remainder of the number (bytes 15 through 17).

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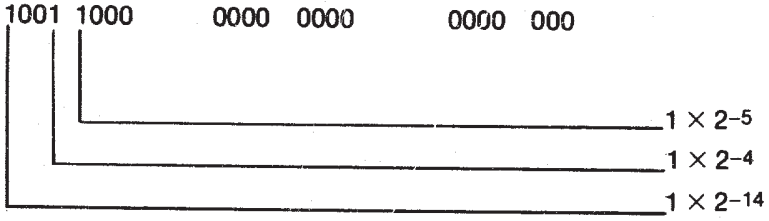
The first way to interpret the remaining number is to use the floating point translation which can be generalized as:

(MANTISSA) X 2 (EXPONENT)

(The mantissa is always a fraction less than one.)

In this case, the binary point is assumed left of byte 15. The mantissa could then be represented in decimal as follows:

Byte Position:	Byte 15	Byte 16	Byte 17
Hexadecimal:	9 8	0 0	0 0
Binary:	1001 1000	0000 0000	0000 000



Decimal: $(1X2^{-14}) + (1X2^{-4}) + (1X2^{-5}) = .594 = (MANTISSA)$

Therefore, the equation (MANTISSA) X 2(EXPONENT) reveals:

$(.594) X 2^{(7)} = 76$ runs

Another method of decoding this number is to move the binary point tc the right the same number of places as the exponent indicates. Then, interpret the binary number directly as a number greater than one as indicated below.

Hexadecimal:	9 8	0 0	0 0
Binary:	.1001 1000	0000 0000	0000 0000

7 places

1001100 = 64 + 8 + 4 = 76 runs

The exponent is a 7-bit 2's complement number, therefore, positive value exponents are not required to be converted to normal binary since they are the same. However, a negative exponent value must first be translated to normal binary representation before interpreting the exponent as a negative number.

The following example of the State Time Interval Overview Learn String parameter for Total Time demonstrates a negative value exponent.

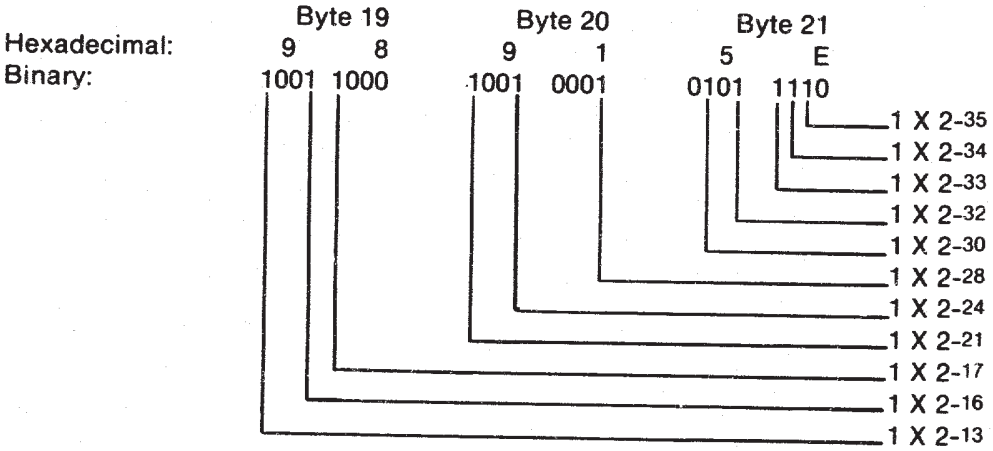
Parameter:	Total Accumulated Time (State Time Interval Overview Learn String)			
Byte Position:	18	19	20	21
Format:	(R)	(R)	(R)	(R)
Hexadecimal:	E8	98	91	5E

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Referring to the real format arrangement example, byte 18 is the exponent byte. Byte 18 is decoded as:

Hexidecimal:	E	8
Binary:	1110	1000
		indicates number is positive
		indicates exponent is negative
7-bit 2's complement:	111	0100
Invert:	000	1011
Add one:	+1	
Exponent:	0001	1100 = −12

Since the binary point is to the left of byte 19, the first place to the right is 2-13. The rest of the number (bytes 19 through 21) can be translated as follows:



The sum of the entire column to the right is 145.44 μsec total accumulated time.

Time (T) Format

Another example involving the Timing Trace Learn String illustrates the prior discussion pertaining to multiplication by a standard time increment. In this example, the timing trace was acquired with a 10 nsec sample period with a mean time between the x and o cursors of 1.52 μsec.

Parameter:	Sample Period (Timing Trace Learn String)	
Byte Position:	11	12
Format:	(T)	(T)
Hexadecimal:	03	00

From the listing for time in the Data Format section of this chapter, this translates to 10 nsec.

Parameter:	Mean Time Between Cursors (Timing Trace Learn String)			
Byte Position:	24	25	26	27
Format:	(R)	(R)	(R)	(R)
Hexadecimal:	1 0	9 8	9 4	7 B
Binary:	0001 0000	1001 1000	1001 0010	0111 1011

28

8 places

positive number

1001 1000 = 128 + 16 + 8 = 152

At 10 nsec: 152 X 10 nsec = 1.52 usec mean time between cursors.

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