Time Stamp
OPTION 003

TIME STAMP
MANUAL SUPPLEMENT

(FOR THE INTERACTIVE STATE ANALYZER USER'S MANUAL)

✔NWIS

NORTHWEST INSTRUMENT SYSTEMS, INC.

■■■■ READ THIS FIRST

This supplement is intended to be used with the *Model 2100 Interactive State Analyzer User's Manual.* It adds information to the manual that shows you how to install and operate the Option 003 Time Stamp board.

This supplement is organized similarly to the *Model 2100 Interactive State Analyzer User's Manual.* You can place this supplement at the back of the manual binder, or you can insert its pages into the appropriate manual sections.

The following paragraphs explain the μAnalyst requirements for the Time Stamp board. The PC Compatibility Requirements for the board are the same as those for the Interactive State Analyzer.

■■■■ μANALYST REQUIREMENTS

To operate the Time Stamp, you must have access to following μAnalyst components.

- ■ μAnalyst 2000 Mainframe
- ■ Model 2100 Interactive State Analyzer
- ■ SYSTEM DISK, Version 1.00, DOS Compatible
- ■ HELP DISK, Version 1.00, DOS Compatible

If you do not have all of the components listed above, contact Northwest Instrument Systems, Inc.

Time Stamp
OPTION 003

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■■■ LIST OF ILLUSTRATIONS

The Northwest Instrument Systems' Time Stamp board, option 003, adds performance analysis capabilities to the Model 2100 Interactive State Analyzer (ISA). The Time Stamp is a special version of the state analyzer's 16-channel memory board. Elapsed time between samples is recorded along with the data. Performance analysis capabilities are based on this time data. The Time Stamp's asynchronous clock can also be used as the sample clock for the state acquisitions.

The Time Stamp hardware consists of a 16-channel memory board and a P2902 16-channel probe.

More than one Time Stamp board can be installed in the μAnalyst mainframe, but time data is taken only from the Time Stamp board installed in the lowest numbered slot. Additional Time Stamp boards are treated by the system as 16-channel memory boards. Time Stamp channels count as part of the 80 channel maximum supported by the Interactive State Analyzer.

The Time Stamp's hold clock may be level- or edge-clocked. For a complete discussion of clocking, refer to Section 5 of the *Interactive State Analyzer User's Manual*.

From a user standpoint, Time Stamp operation is identical to other state analyzer memory boards. The μAnalyst system software described at the front of this manual recognizes the Time Stamp board and provides the needed software for its operation. Otherwise, it operates as a 16-channel memory board. For a complete set of Time Stamp specifications, refer to Appendix A of this supplement.

■■■ INSTALLING THE TIME STAMP BOARD

This section describes installation of the Time Stamp board. You need not be concerned with this section if you ordered the Time Stamp with your Interactive State Analyzer. The factory has taken care of the installation for you. Remember that the 16 channels from the Time Stamp count toward the 80 channel system maximum.

It is assumed that you already know how to install the μAnalyst mainframe and its PC interface. If not, review Section 2 of the *Interactive State Analyzer User's Manual* before proceeding.

Installing the Time Stamp Board:

1. Remove power from the μAnalyst mainframe.

CAUTION _____

Damage to your instrument circuit boards may occur if the boards are installed or removed while the μAnalyst is receiving power.

2. Remove the top cover from the μAnalyst mainframe.

3. Position the Time Stamp board over the μAnalyst slot desired, remembering the following:

   a. The Time Stamp board must be installed in a higher numbered slot than the state analyzer controller.

   b. The Time Stamp board must be adjacent to other state analyzer memory boards. That is, you cannot separate the Time Stamp board from the other state analyzer boards by an empty slot or by boards of another product, such as the Interactive Timing Analyzer.

4. Once in position, seat the board in the edge connectors using firm, steady pressure. Do not force.

5. Replace the top cover of the μAnalyst.

▰▰▰ CONNECTING THE DATA PROBE

Figure 2-1 illustrates how the P2902 probe is connected to the Time Stamp board. Observe that the probe has a keyed connector that only attaches to the board in one way. Do not attempt to force the connection; the probe should attach easily.

Also note the P4 and P5 designations Figure 2-1. These square-pin connectors are used to feed internal and external time-bas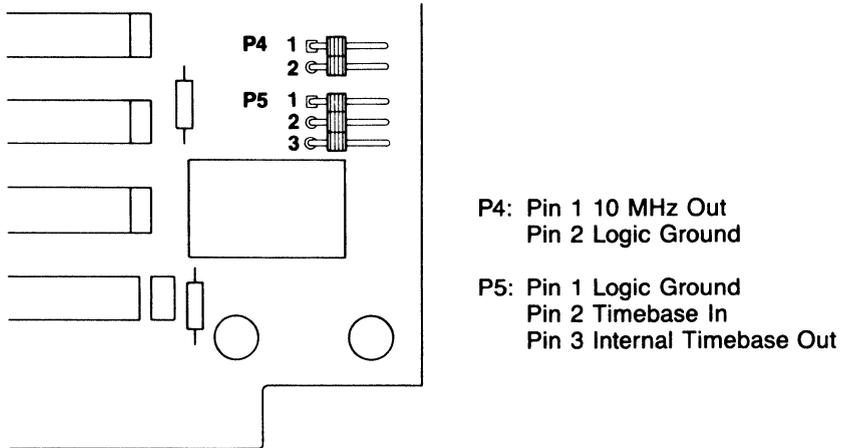e signals to and from the Time Stamp. Figure 2-2 provides a close-up of these connectors. Refer to this illustration for the following explanation.

00844-001
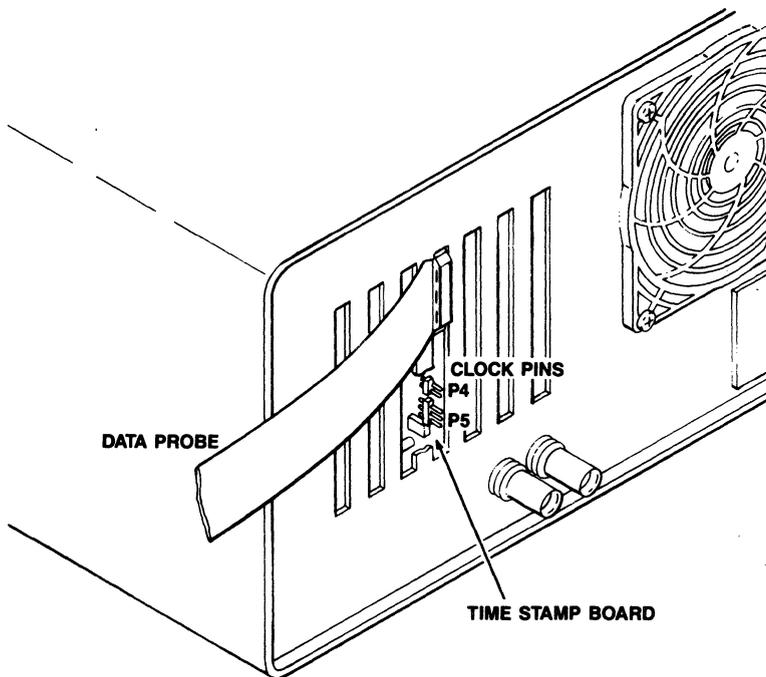
■ **Figure 2-1. Probe Connections.**

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P4: Pin 1 10 MHz Out
     Pin 2 Logic Ground

P5: Pin 1 Logic Ground
     Pin 2 Timebase In
     Pin 3 Internal Timebase Out

■ **Figure 2-2. Clock Connections.**

For the internal 20 MHz clock operation (which is the most common mode of operation), the square-pin jumper should be across pins 2 and 3 of P5. This jumper is initially set at the factory for internal timebase operation.

To operate from an external clock input, the external clock cable provided must be connected to pins 1 and 2 of P5. Make sure that the ground side of the cable connector, marked with a small dot, is connected to the ground pin (Pin 1). The Time Stamp needs a TTL signal to operate. For additional signal requirements, refer to the external signal specifications portion of Appendix A.

To use the Time Stamp's 10 MHz output signal, connect the external clock cable to Pins 1 and 2 of P4. Again, be sure to connect the ground side of the cable connector to the ground pin (Pin 1). Appendix A contains specifications for this TTL signal.

Connect the Time Stamp, clock, and other memory board probes to the system under test as required.

■■■ LOADING THE SOFTWARE

Load the μAnalyst software as specified in Section 3 of the *Interactive State Analyzer User's Manual.* Since the Time Stamp software is fully contained in the system operating software package, it is loaded with the overall state analyzer program.

The following section describes how the Time Stamp interacts with the various state analyzer menus. If you are new to the state analyzer, you should review Section 5 of *Interactive State Analyzer User's Manual* before proceeding here. You may also want to go through the manual's Demonstration session in Section 7.

■■■ FORMAT MENU

As indicated by the arrow in Figure 3-1, *Format Menu*, a T group has been added to the Display Order field. The position of the T within the field determines the position of the Time Stamp time data column within the display. You must be in edit mode to change the Display Order field.

To remove the Time Stamp time data column from the display, enter an X for don't care over the T. To re-establish display of the Time Stamp time data, enter a T where desired in the Display Order field.
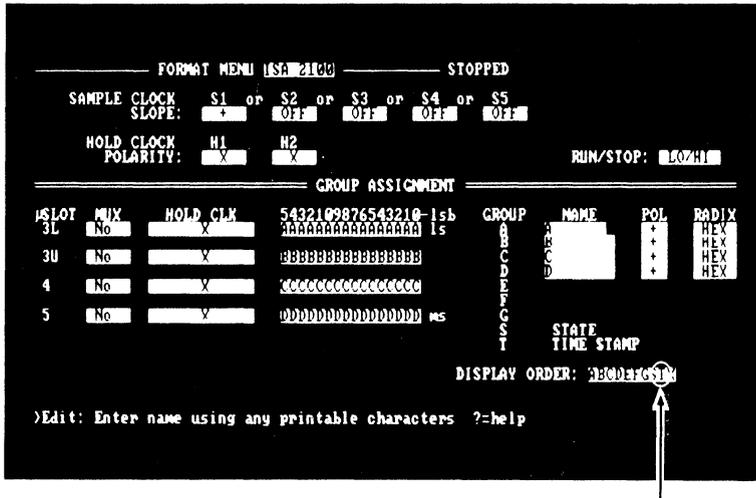
00844-003

■ Figure 3-1. Format Menu.

████ TRIGGER-STORE AND SYMBOL MENUS

Programming an acquisition for the Time Stamp is no different than programming the state analyzer in general. Remember, the Time Stamp board is nothing more than a 16-channel memory board that also records time.

The only thing that will change is the way you approach programming. For example, if you are interested in how much time is spent in a given subroutine, you would set up the Trigger-Store Menu so that when the starting address of the subroutine is encountered on the address bus, the event is stored. Then, when the exiting address is encountered, another store takes place. Other address events would not be stored thus reflecting the time spent in the subroutine. (You will see how to do this later on in the Applications section of this supplement.)

■■■ DISPLAY MENU

Refer to Figure 3-2, *Display Menu*. One new column has been added, the Time Data column. In addition, two cursors, the active cursor and the reference cursor, have been added, along with cursor movement controls.
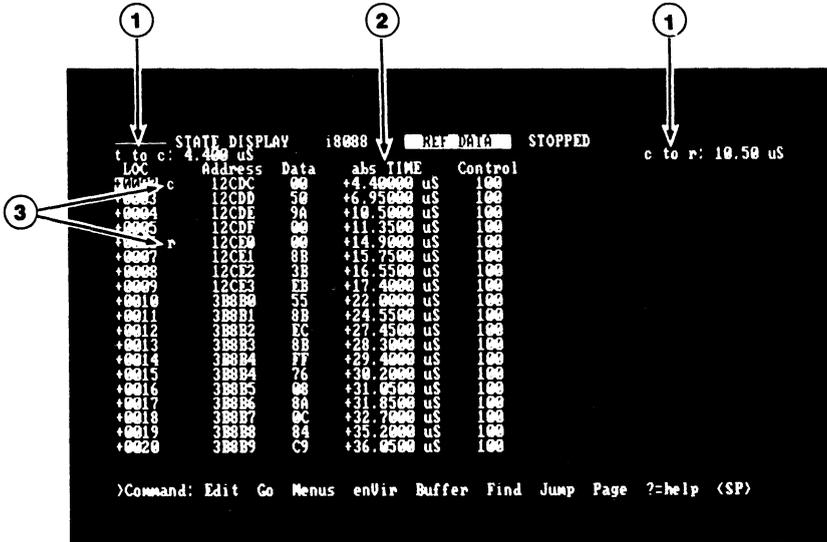
00844-004

```
         (1)                    (2)                        (1)


         ── STATE DISPLAY    i8088     ■REF DATA■  STOPPED
    t to c: 4.400 uS                                          c to r: 10.50 uS
      LOC    Address  Data    abs TIME    Control
(3) ──── c  12CDC    00     +4.40000 uS   100
         ─  12CDD    50     +6.95000 uS   100
    +0004    12CDE    9A     +10.5000 uS   100
    +0005    12CDF    00     +11.3500 uS   100
    ────  r  12CD0    00     +14.9000 uS   100
    +0007    12CE1    8B     +15.7500 uS   100
    +0008    12CE2    3B     +16.5500 uS   100
    +0009    12CE3    EB     +17.4000 uS   100
    +0010    3B8B0    55     +22.0000 uS   100
    +0011    3B8B1    8B     +24.5500 uS   100
    +0012    3B8B2    EC     +27.4500 uS   100
    +0013    3B8B3    8B     +28.3000 uS   100
    +0014    3B8B4    FF     +29.4000 uS   100
    +0015    3B8B4    76     +30.2000 uS   100
    +0016    3B8B5    08     +31.0500 uS   100
    +0017    3B8B6    8A     +31.8500 uS   100
    +0018    3B8B7    0C     +32.7000 uS   100
    +0019    3B8B8    84     +35.2000 uS   100
    +0020    3B8B9    C9     +36.0500 uS   100

    )Command: Edit  Go  Menus  enVir  Buffer  Find  Jump  Page  ?=help  (SP)
```

■ **Figure 3-2. Display Menu.**

(1) Time Readouts—*t* to *c* and *c* to *r*.

The Time Readout fields provide continuous time measurements from the trigger point to the active cursor, and from the active cursor to the reference cursor. Because these fields are measurements, the values shown are absolute. If one cursor is repositioned in the data so that it is earlier than the other, the field designation is updated by reversing the letter sequence. For example, if the active cursor is before the trigger point, the field reads *c* to *t*. If after, the field reads *t* to *c*.

② TIME (Absolute or Relative)

The TIME column indicated in Figure 3-2 is the Time Stamp time data. If the relative mode is selected in the Display Environment Submenu, the number listed is the time from the current sample to the next sample. If the absolute mode is used, the time is from the trigger sample to the current sample. The Display Environment Submenu fields are explained in the next subsection.

Figure 3-3 illustrates the difference between absolute and relative time modes.

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ABSOLUTE TIME

LOC	ADDR	
– 0004	FFE0	
– 0003	0151	
– 0002	27D0	Absolute time of LOC – 3
– 0001	27D2	
TRIG	27D4	
+ 0001	27D6	

RELATIVE TIME

LOC	ADDR	
– 0004	FFE0	
– 0003	0151	Relative time of LOC – 3
– 0002	27D0	
– 0001	27D2	
TRIG	27D4	
+ 0001	27D6	

■ **Figure 3-3. Absolute and Relative Time.**

③ Cursors

There are two cursors in the display: the active (*c*) cursor and the reference (*r*) cursor. Each cursor is identified by a lower case letter, *c* or *r*.

The *c* cursor is maintained at the top of the display. This means that when the cursor keys are used, the data scrolls up or down accordingly.

The *r* cursor, once positioned, remains with that line of data. The data window can be scrolled so that the *r* cursor may no longer be seen. You can move the *r* cursor by using the Align_cursors or Switch_cursors commands.

The Align_cursors command moves the *r* cursor to the current location of the *c* cursor. The Switch_cursors command exchanges the positions of the *r* and *c* cursors.

■■■ DISPLAY ENVIRONMENT SUBMENU

As shown in Figure 3-4, several Time Stamp fields have been added to the Display Environment Submenu. To enter the Display Environment Submenu, enter V for enVironment, then D for Display from the command line. The submenu will automatically be in edit mode. Press the escape key to exit the submenu.
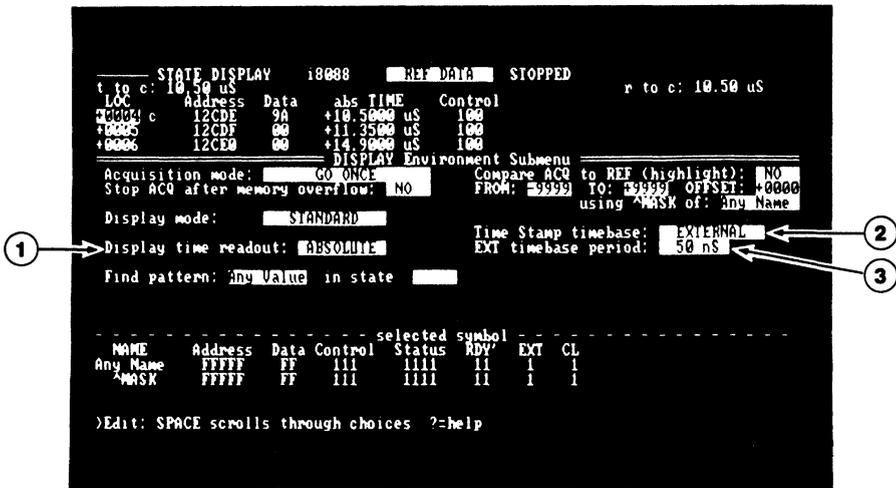
00844-006

■ **Figure 3-4. Display Environment Submenu.**

① Display Time Readout

This field selects what kind of time measurement is seen in the Display Menu.

Using the space bar, select:

■ ABSOLUTE—read the Time Stamp time data as elapsed time from the trigger event to a given line of state data. Data recorded before the trigger event is displayed as a negative value.

■ RELATIVE—indicate the duration of each sample. Relative time is defined to be the time from the current sample to the next sample.

② Time Stamp Timebase

This field determines which timebase is used by the Time Stamp hardware.

Using the space bar, select:

■ INTERNAL—use the 20 MHz clock on the Time Stamp board. When using this internal timebase, you should install the square-pin jumper across pin 2 (EXT) and pin 3 (INT) of the P5 connector. The P5 connector is located at the rear of the Time Stamp board, and is accessible through the slot opening of the μAnalyst chassis. Refer to Figure 2-1 if necessary.

■ EXTERNAL—allow an external timebase signal to be used. The external timebase signal is connected to pin 2 of connector P5. (Pin 1 of P5 is the state analyzer's logic ground.) The external signal level is TTL, with a maximum frequency of 20 MHz. For additional electrical specifications, refer to Appendix A of this supplement. Note that the EXT Timebase Period field, described below, also appears.

■ BUS CYCLES—use the state analyzer's sample clock as the timebase. The position of the jumper on P5 is irrelevant. Each sample clock pulse increments the Time Stamp time counter. All time readouts in the Display Menu are then shown in units of sample clocks (Clks).

③ **EXT Timebase Period**

This field allows you to provide the appropriate time multiplier to the display software when an external timebase is used. In this way, the correct times are displayed in the Display Menu. In order for the displayed time data to be accurate, your external timebase must match the period selected.

Using the space bar, select: 50 ns, 100 ns, 200 ns, 500 ns, 1 μs, 2 μs, 5 μs, 10 μs, 20 μs, 50 μs, 100 μs, 200 μs, or 500 μs.

☞ **NOTE**

This field is available only when Time Stamp Timebase field is set to external.

■■■ HISTOGRAM MENU

The OCCURRENCE DISTRIBUTION Histogram is the original form of the state analyzer Histogram display. Two new forms of the Histogram Menu have been added to support the Time Stamp: TIME DISTRIBUTION and TIME A to B DISTRIBUTION. These are explained later under callout number 1, *Select Histogram Type.* If you need additional background information on the Histogram Menu, refer to the *Interactive State Analyzer User's Manual.*

While some of the Histogram fields are common to two or more of the histogram types, only those fields added to support the Time Stamp are discussed here. New fields that are common to both displays have the same callout number within Figure 3-5. (In Figure 3-5 only the bar graph versions of the two Histograms are pictured. While not shown, the table versions can also be displayed.)

00844-007

TIME DISTRIBUTION

TIME A TO B DISTRIBUTION
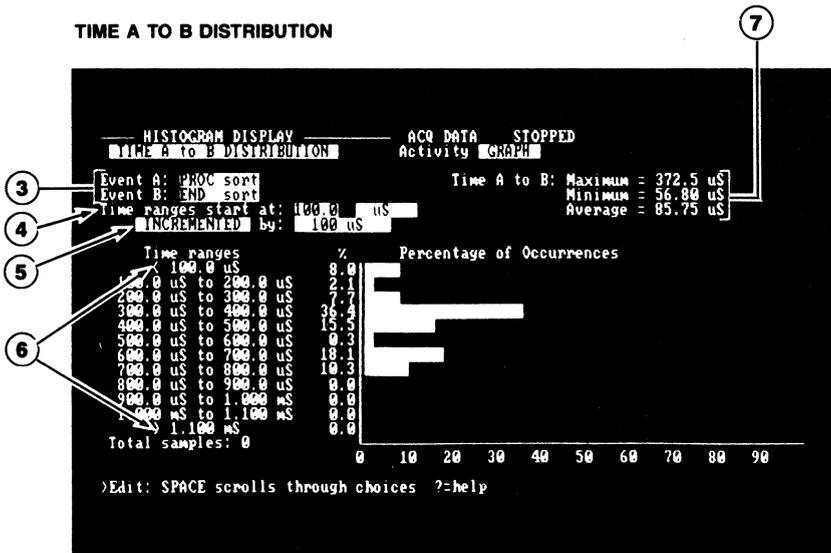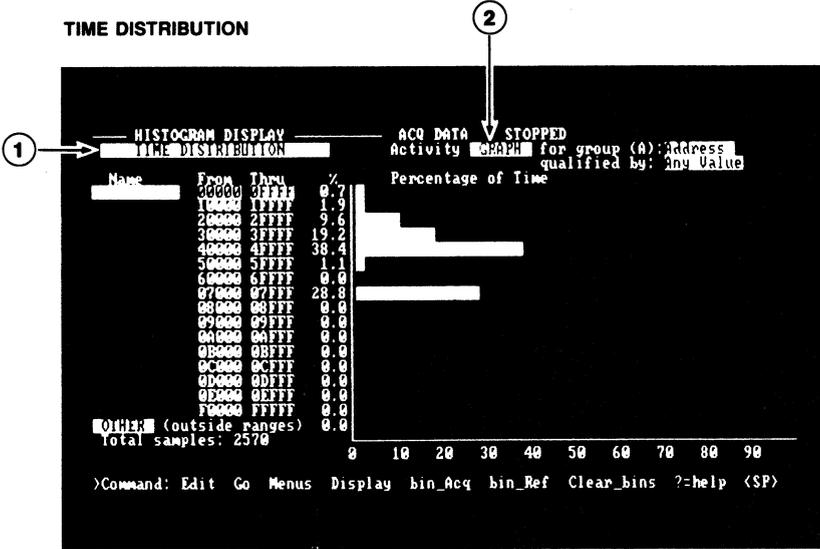
■ **Figure 3-5. Histogram Displays.**

① **Histogram Type**

This field determines the nature of the Histogram display.

Using the space bar, select:

■ OCCURRENCE DISTRIBUTION—this is the standard histo-gram where a distribution of event occurrences is a function of data ranges. In this mode the number of events that fall within each range is accumulated then displayed in either bar graph or tabular format.

■ TIME DISTRIBUTION—this form of the histogram shows a distribution of event durations as a function of data ranges. The time durations of the events are accumulated in addition to the number of events that fall within each range. The accumulative time in each range can then be displayed in bar graph or tabular format. The tabular display also includes the number of events in each range, along with the average time per event for each range.

■ TIME A to B DISTRIBUTION—this form of the histogram allows a display which shows a distribution of the time between two events: A and B. The A and B events are defined by using symbols from the state analyzer's Symbol Menu.

In this mode, the histogram works by first scanning the acquired data for the last occurrence of A before B. This marks the beginning of what is called a module. The data is then scanned for the last occurrence of B before the next A. This marks the end of the module. The time duration of this portion of memory between A and B—or the module—is cal-culated and then placed in the appropriate time range. This process is repeated until the end of the data is reached. The number of module durations in each programmed time range is then displayed in bar graph or tabular format. (For information on how to establish the time ranges, refer to the descriptions below of the Time Ranges and Time Range Interval fields.)

☞ **NOTE**
TIME DISTRIBUTION and TIME A to B DISTRIBUTION options are used exclusively with Time Stamp time data.

② Activity

This field selects the format of the histogram display, bar graph or table.

Using the space bar, select:

- GRAPH—display the histogram information in bar graph form.

- TABLE—display the histogram information in tabular form.

③ Event Specification

These fields allow you to select the symbols that are used as the A and B events. Enter the symbol name; or, using the control-S key, scroll through the existing list of symbols. If you need to change a symbol go to the state analyzer's Symbol Menu.

☞ NOTE
The event specification fields appear only when TIME A to B DIS-TRIBUTION is selected in the Histogram Type field.

④ Time Ranges

This field works with the Time Range Interval fields to establish the actual time ranges that make up the TIME A to B HISTO-GRAM. These fields set the initial range value.

The Time Ranges field is a four-digit floating point number. Enter the numbers desired from the keyboard.

The second field is the exponent for the previous four-digit floating point number. The space bar selects time exponents for internal timebase operations, or clock exponents for external timebase operations. The time exponents include ns, μs, ms, and s, while the clock exponents include Clks (clocks), Kclks (kiloclocks), or Mclks (megaclocks).

☞ NOTE
The Time Ranges field appears only when TIME A to B DISTRIBU-TION is selected in the Histogram Type field.

⑤ Time Range Interval

These fields determine how the ranges are to be built, based on the initial range value set in the Time Ranges field. The time ranges are built by either incrementing or multiplying a value selected in the second field.

Using the space bar in the first field, select:

■ INCREMENTED—repeatedly add the value selected in the second field to the value set in the Time Ranges field. The values selectable in the second Time Range Interval field are as follows: 100 ns, 200 ns, 500 ns, 1 μs, 2 μs, 5 μs... up through 10 s. Incrementing example: assume the starting range is 700 ns and the increment value is 200 ns. The ranges created by the system would be as follows: 700 ns, 900 ns, 1.1 μs, 1.3 μs, 1.5 μs, and so on.

If the Time Stamp timebase is BUS CYCLES, the selectable value range will change to the following: 1 Clks, 2 Clks, 5 Clks ... up through 100 MClks.

■ MULTIPLIED—in this case, the values in the second Time Range Interval field become the multiplying factor that will be applied to the Time Ranges value. The multiplying factors available are 2, 5, or 10. Multiplying example: if the starting range is 100 ns, and a multiplier of 10 is selected, the ranges created by the system would be as follows: 100 ns, 1 μs, 10 μs, 100 μs ... up through the ten ranges.

☞ **NOTE**
The Time Range Interval fields appear only when TIME A TO B DIS-TRIBUTION is selected in the Histogram Type field.

⑥ Less Than, Greater Than Ranges

These two screen elements are not programmable. They indicate the portion of the data that falls outside of the ranges specified.

⑦ Max, Min, and Average Times

These values are not programmable. They indicate the maximum, minimum, and average times between events A and B. These values are accumulated over all acquisitions, and are cleared by the Clear_bins command.

■■■ APPLICATION NOTES

This section features specific examples of how the Time Stamp can be used.

■■■ EXAMPLE 1—TIMING A SUBROUTINE

Recall the example cited in the Trigger-Store and Symbol Menus portion of Section 3 of this document. We wanted to know how much time was spent in a given subroutine. This is a very simple measurement.

First, the appropriate symbols must be established. We'll call them STARTADD and ENDADD. STARTADD is set to the entry address of the target routine, ENDADD to the exit address. The symbols are created in the Symbol Menu while in edit mode.

For this measurement, the analyzer is set to trigger on the first occurrence of STARTADD. The analyzer is set to store only STARTADD and ENDADD.

Figure 4-1 illustrates how the Trigger-Store Menu is programmed to capture the information desired.

00844-008

■ Figure 4-1. Programming the Trigger-Store Menu.

Once the acquisition is made, go to the Display Menu. Enter V then D to access the Display Environment submenu. Go to the Display Time Readout field and select RELATIVE time as shown in Figure 4-2.

Return to the display menu. The times listed in alternating sequence are the elapsed times inside the target routine, and elapsed times outside the target routine.

00844-009

■ **Figure 4-2. Programming the Display Environment Submenu.**

Once the ranges have been built, the Histogram can be explored. Refer to Figure 4-3.
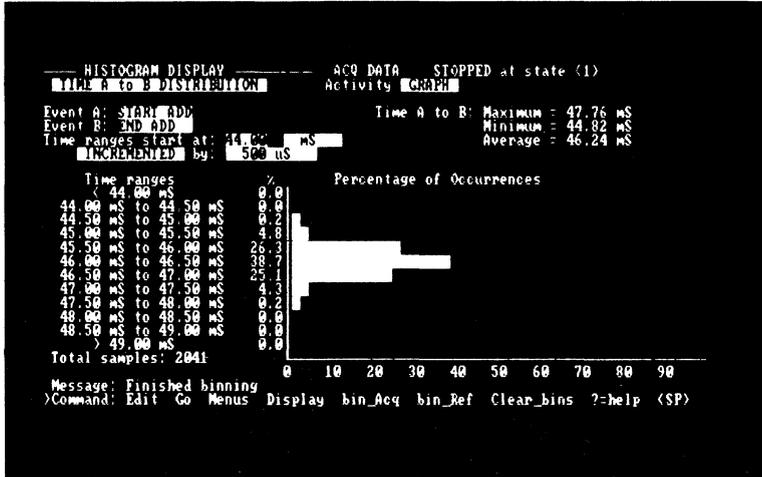
■ **Figure 4-3. Time A to B Histogram.**

■■■ EXAMPLE 2—VERIFYING POWER-UP/POWER-DOWN

Assume that you want to know the sequence of events with a given system under test during power down and power up. Such an event can be set up and data acquired, but without time information, it is difficult (if not impossible) to identify the unique power-down/power-up activities.

Program the Trigger-Store Menu as shown in Figure 4-4.

■ **Figure 4-4. Trigger on Reset at power up.**

Once the acquisition has started, shut off the system under test. Count off two or three seconds, then turn on the system under test.

Looking at the acquired data, you can see the relatively huge two or three second gap of time when the power was down—nothing was happening in the system under test. From this point forward or backward the power on and power down activities can be examined.

EXAMPLE 3—ANALYZING HIGH-LEVEL LANGUAGE PROGRAMS

If you know something about the internal nature of your hardware and software, it is possible to time high-level language routines using the Time Stamp.

Consider the following BASIC program:

. . . 100 REM Body of program

101 REM ISA programmed to recognize the address
    bus activity

102 REM caused by statement 105; thus, the Time Stamp
    starts timing.

105 POKE 59000,0

109 REM Statement 110 is an existing subroutine call

110 GOSUB 5000

111 REM Program now executing target routine; timer
    is running

118 REM Return from subroutine signaled to Time Stamp
    here.

119 POKE 59000,0

120 REM continuation of main program...

Figures 4-5 and 4-6 show the Trigger-Store Menu programming and the symbol values used.

00844-012

■ Figure 4-5. Trigger-store programming for high-level
             language timing.

00844-013

■ Figure 4-6. Symbol values used.

The only caution when using this technique is to be sure that the particular POKE address chosen will not be used by other parts of the program.

☑ NOTE

If several routines are to be timed, each POKE statement can send a different code word (data) to the POKE address selected. The display menu in Figure 4-7 contains a list of routine starts and ends, and shows the time it takes to execute them.

00844-014

■ Figure 4-7. Example Display Menu, with timings.

▮▮▮▮ EXAMPLE 4—STATISTICAL PERFORMANCE ANALYSIS

To decrease the number of acquisitions required to obtain a good statistical sample of program activity when using the Occurrence Distribution Histogram, the ratio of time spent acquiring data relative to the time spent binning or processing data must be increased.

The state analyzer typically spends 5 to 10 milliseconds acquiring data. This is followed by approximately 5 seconds of processing that data to determine the amount of activity in each address range. To get a more accurate picture of program activity, the state analyzer must perform more cycles of acquisition and processing. The number of acquisition and processing cycles may be reduced by using an acquisition time that is a larger percentage of the total cycle.

The acquisition time may be increased by adding delay between successive storage events. To do this, program the Trigger-Store Menu as shown below:

```
START:  IF   Any Value OCCURS 1000 TIMES THEN ——> GOTO STORE
                       NEVER ——————————————————> STORE
STORE:  IF   codefetch OCCURS 0001 TIMES THEN ——> GOTO START
        IF   codefetch OCCURS THEN ———————————> STORE
```

With this setup, the acquisition starts in state START. No data is stored until 1000 sample clocks have occurred. After 1000 sample clocks, the state machine moves on to state STORE. A store will occur here at the next occurrence of a codefetch. When a codefetch is detected, the codefetch event is stored and the state machine moves back to state START.

Note that there is no way to trigger the state analyzer when using this programming, so in the Display Environment submenu set the Stop ACQ After Memory Overflow field to YES. Once memory is full, the state analyzer stops the acquisition and processes the data. Also, set the Acquisition Mode field to GO FOREVER. The acquisition and processing cycles will repeat automatically.

Select the Histogram menu, enter edit mode, set the Histogram Type field to Occurrence Distribution mode, exit edit mode, and press G (go) to start the acquisition. After each acquisition is completed, the data is processed and the Histogram display is updated.

■■■ TIME MEASUREMENT SPECIFICATIONS

- ■ Timebase frequency: 20.0 MHz ± 0.05%
- ■ Time measurement resolution: 50 ns
- ■ Time measurement accuracy: ± (0.05% of period + 50 ns)
- ■ Time measurement range between consecutive stored events: 107 Seconds, max.
- ■ Time measurement range between first and last stored event: 122 Hours, max.

Timing Specifications with the Data Probe (Hold clocking disabled)

- ■ Setup time from valid data to sample clock: 25 ns, min.
- ■ Hold time from sample clock to invalid data: 0 ns, min.

Timing Specifications with the Data Probe (using level hold clocking)

- ■ Setup time from valid data to hold clock HOLD level: 20 ns, min.
- ■ Hold time from hold clock HOLD level to invalid data: 10 ns, min.
- ■ Setup time from hold clock PASS level to sample clock: 30 ns, min.
- ■ Hold time from sample clock to hold clock PASS level: 10 ns, min.

Timing Specifications with the Data Probe (using edge hold clocking)

- ■ Setup time from valid data to edge hold clock: 20 ns, min.
- ■ Hold time from edge hold clock to invalid data: 10 ns, min.
- ■ Setup time from edge hold clock to sample clock: 30 ns, min.
- ■ Hold time from sample clock to edge hold clock: 10 ns, min.

◼◼ EXTERNAL SIGNAL SPECIFICATIONS

External Timebase Clock Input

- Low input voltage range: 0.0 V to +0.8 V

- Low input current: −0.6 mA, max.

- High input voltage range: +2.0 V to +5.0 V

- High input current: +20 μA, max.

- Input frequency: 20.0 MHz, max.

10 MHz clock output signal

☞ **NOTE**

The 10 MHz output is available only when the state analyzer is acquiring data and an external timebase clock is not being used.

- Low output voltage range: 0.0 V to +0.5 V (into open-circuit load)

- High output voltage range: +2.7 V to +5.0 V (into open-circuit load)

- Output impedance: 100 Ω, nominal

- Output frequency: 10.0 MHz ± 0.05%