HEWLETT® PACKARD

User's Guide

HP E1747A
Timing Pattern Analysis Software

User's Guide

This guide describes how to use the HP E1747A Timing Pattern Analysis software, a companion to the HP E1741A Time Interval Analyzer Software.

HP E1747A
Timing Pattern Analysis Software

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General

This product and related documentation must be reviewed for familiarization with this safety markings and instructions before operation.

This product is a safety Class I instrument (provided with a protective earth terminal).

Before Cleaning

Disconnect the product from operating power before cleaning.

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Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

Indicates hazardous voltages.

Indicates earth (ground) terminal.

or

Indicates terminal is connected to chassis when such connection is not apparent.

Safety Considerations (contd)

Indicates Alternating current.

Indicates Direct current.

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BODILY INJURY OR DEATH MAY RESULT FROM FAILURE TO HEED A WARNING. DO NOT PROCEED BEYOND A WARNING SIGN UNTIL THE INDICATED CONDITIONS ARE FULLY UNDERSTOOD AND MET.

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1

Getting Started

Learning About the HP E1747A

1

In this Chapter

This chapter describes the HP E1747A Timing Pattern Analysis software and its application for analyzing measurement data.

The following items are provided in this chapter:

- How to Get Started
- Timing Pattern Analysis Setup
- Viewing the Pattern Analysis Results
- How Code Spacings Are Determined
- Pattern Analysis Results
- How the Wildcard Can Affect Pattern Analysis
- A Getting Started Procedure

HP E1747A Timing Pattern Analysis Software Overview

The HP E1747A Timing Pattern Analysis software is a tool that provides the ability to search through a series of consecutive time interval measurements for a timing pattern that you specify. Once the timing pattern has been matched, this new data subset can be viewed and analyzed in any of the HP E1725C/E1741A Time Interval Analyzer's display windows. The results can help you determine if pattern-dependent effects are influencing the data readback process and ultimately the performance of the media under test.

As an example, suppose you have found that by examining the resulting histograms of random RLL (1,7) pattern, the 2T code spacing is limiting timing margin. The Timing Pattern Analysis software allows you to determine not only the 2T interval, but the specific combination of intervals preceding and following the 2T interval that cause the worst case effect. In addition, this capability lets you "deconvolve" overlapping distributions into reasonably Gaussian separate distributions. This removes the limitation of having to analyze these distributions in aggregate only.

How to Get Started

Before you can use the Timing Pattern Analysis software, you need to have installed the HP E1725C/E1741A Time Interval Analyzer (TIA) software on your computer and be familiar with its operation. It is especially important for you to know how to execute a data acquisition and interpret the measurement results on the various display windows. See the *HP E1725C/E1741A Time Interval Analyzer Getting Started Guide* or the *Online Help* for assistance.

Collecting the Data (for Pattern Analysis)

Before using the Timing Pattern Analysis software, you need to first acquire a series of sequential time intervals. To do this, perform these common tasks (described in detail in the *Online Help*).

- Configuring the TIA
- Controlling the Measurement
- Defining the Segments
- Setting the Clock

NOTE

When making choices on the **TIA Setup** window, be sure to set the Record mode to **sequential** and the pacing to **every edge** (or **every Nth edge**) and verify that the measurement rate is not greater than 80 MHz.

Recommendation

You should begin with a relatively short sequential record (a few thousand measurements) to avoid the long processing time that is required for large records.

Timing Pattern Analysis Setup

The **Pattern Analysis** dialog box is used to setup the Timing Pattern Analysis software. This dialog box is accessed with the **Pattern>Pattern analysis ...** menu selection.

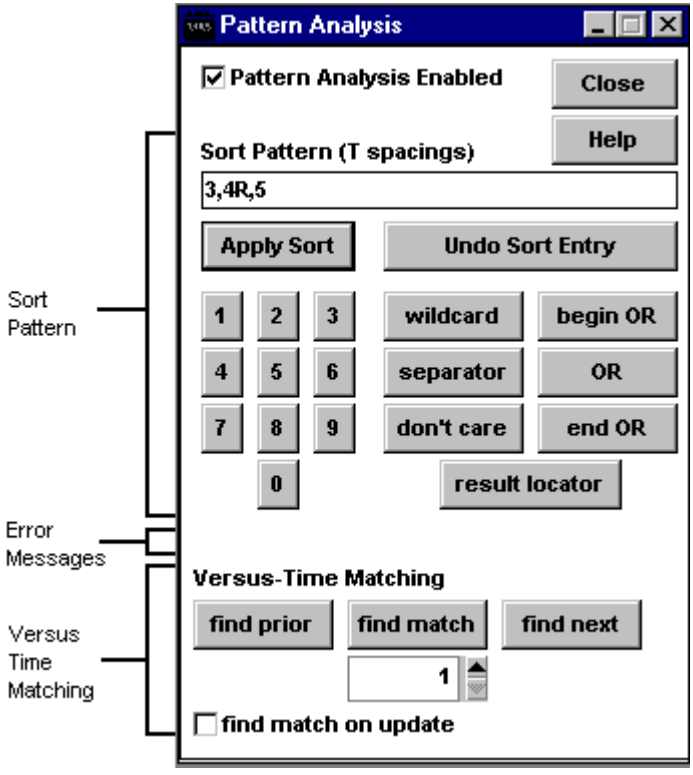


Figure 1-1. Pattern Analysis Dialog Box

This dialog box is divided into three areas:

- Sort Pattern (T spacings)—contains the controls for creating a sort pattern.
- Error Messages—displays error messages related to pattern analysis.
- Versus-Time Matching—contains the controls for viewing pattern matches.

Sort Pattern (T spacings)

You define a timing pattern (sort pattern) on this part of the **Pattern Analysis** dialog box. A timing pattern is based on code spacings whose characteristics are defined on the **Define Segments & Clock** dialog box. Once you apply the sort pattern to the collected data, the Timing Pattern analysis software searches through the acquisition to find pattern matches. The result is a subset of data that matches the pattern that you specified.

A sort pattern allows you to filter any particular data pattern from the overall acquisition and study how that specific pattern is affecting the performance of your device under test.

The sort pattern is of the form (<expression1>, <expression2>, ...) where each expression identifies an interval (or “T” spacing) that is matched in that string position.

Creating the Sort Pattern

The controls at the top of the **Pattern Analysis** dialog box are used to enter a sort pattern. The following table summarizes the function of each control.

Table 1-1. Sort Pattern Controls

Button or Control	Character*	Used to:
Numeric Keypad	0–9	Enter the code spacings that define the sort pattern.
wildcard	*	Consider every code spacing in the wildcard position and histogram each as a separate distribution. Only one wildcard is allowed in a sort pattern.
separator	,	Separate each sort pattern expression.
don't care	X	Identify a place holder where the T spacings in this position are not considered.
begin OR	[	Indicate the beginning of an OR expression.
OR	|	Consider the T code spacings on both sides of the OR character.
end OR	]	Indicate the ending of an OR expression.
result locator	R	Output sorting results for this expression. Each sort pattern must contain one result locator.

* These symbols can also be entered using the computer's keyboard.

To see how you could use these controls to create a sort pattern, see chapter 2.

Error Messages

This area reports error messages for both the Sort Pattern (T spacings) and the Versus-Time Matches. A list of error messages and corrective actions are located in chapter 4 of this guide.

Versus-Time Matching

This area provides the means for displaying a specific pattern match horizontally centered on the Versus-Time display (**Display>Versus-Time**). The controls in this area allow you to specify the specific pattern match as follows:

Table 1-2. Versus-Time Matching Controls

Button or Control	Used to:
Match Position	Enter the number of a sorting match to display on the Versus-Time window.
find prior	Find and display the prior sorting match from the match entered on the Match Position box.
find match	Find and display the match that is entered on the Match Position box. Matches are shown centered on the Versus-Time display.
find next	Find and display the next match from the match entered on the Match Position box.
find match on update	Find and display the match on the Versus-Time window when the display is updated or when you apply a different sort pattern.

Viewing the Pattern Analysis Results

You view and analyze the Pattern Analysis results in the Histogram, Segmented-Histogram or Window Margin displays. Figure 1-2 shows the results of applying the sort pattern (3,4R,5) to a data acquisition in a Histogram window.

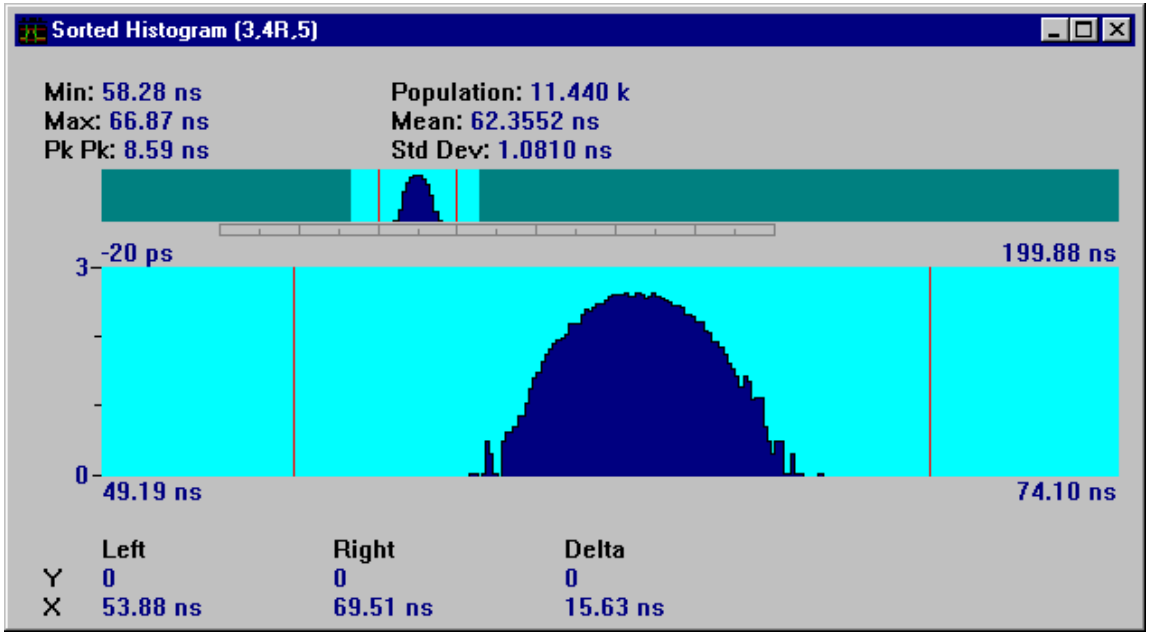


Figure 1-2. Sorted Histogram Results

The title bar indicates that this display shows pattern analysis results. The sort pattern is shown at the right of the title bar. The Panorama display shows the distribution(s) just as it would for any other data acquisition. In this example, the 4T code spacings were histogrammed due to its association with the result locator (R) in the sort pattern.

The 4T spacings were placed in the third segment because of the settings specified on the Define Segments & Clock dialog box (**Segment>Define Segments & Clock**). That is, the first segment center was set to twice the clock period. As a result, any histogrammed 2T spacings would be positioned in the first segment, the 3T spacings in the second segment and so on.

How Code Spacings Are Determined

The Timing Pattern Analysis software automatically decodes the data pattern that is acquired by using information provided on the Define Segments & Clock dialog box (**Segment>Define Segments & Clock**).

The **Clock Period** and **Clock Frequency** entry boxes are where you supply information about the expected clock rate. These entry boxes are coupled in an inverse relationship and are provided so you can enter the clock information in the mode you prefer, i.e. time or frequency.

The Timing Pattern Analysis software uses the clock information to overlay a mathematical clock on the acquired data. From this, the process of determining the actual data pattern is straightforward. One clock period represents one T code spacing.

Pattern Analysis Results

When using the Timing Pattern Analysis software, the type of result obtained depends on the **Source** and **Use** selections on the **TIA Setup** window. Suppose a sort pattern of (3,R4) is applied to an acquisition.

If Source is **Input 1 only** and Use is also **Input 1 only**, then the displayed result is histogrammed data-to-data intervals. A 3T code spacing followed by a 4T code spacing is matched and the 4T interval is histogrammed. As with all pattern analysis results, you can analyze them in the **Histogram**, **Segmented-Histogram** or **Window Margin** displays. Data-to-data intervals are also histogrammed if the Source is **Input 2 only** and Use is **Input 2 only**. The only difference is now data is acquired on Input 2.

If the Source is **Input 1 only** and Use is **Input 1 to Computed CLK**, the displayed result is histogrammed data to computed clock intervals. For the example sort pattern, a 3T code spacing followed by a 4T code spacing is matched and the interval from the initial edge of the 4T interval to the nearest computed clock edge is histogrammed. The initial edge is used in this case because of the location of the R in the sort pattern (3,R4). A sort pattern of (3,4R) would result in a histogram interval of the last edge of the 4T interval to the nearest computed clock edge. These comments also apply if the Source is **Input 2 Only** and Use is **Input 2 to Computed CLK**. If you have your clock at Input 2, this can be a great way to observe how your clock is deviating from the ideal.

Finally, if the Source is **Input 1 to 2** and Use is **Input 1 to 2**, the displayed result is histogrammed Input 1 to 2 intervals (most likely data-to-clock intervals). For the example sort pattern, a 3T code spacing followed by 4T code spacing is matched and the 1 to 2 interval associated with the initial edge of the 4T spacing is histogrammed. This is like Use **Input 1 to Computed CLK** except the clock is now measured instead of mathematically constructed. See chapter 2 for sort pattern examples of data-to-clock matched intervals.

How the Wildcard Can Affect Pattern Analysis Results

When a wildcard is added to a sort pattern (with the result locator associated with another expression), it affects how you interpret the results. Suppose a sort pattern of (3R,*) is applied to an acquisition.

If Use on the TIA Setup window (**Control>TIA Setup**) is single-channel (**Input 1 only** or **Input 2 only**), the wildcard can change the positioning of the histogrammed result. For the example sort pattern, a 3T code spacing followed by any code spacing is matched and the 3T interval is histogrammed into the segment associated with the code spacing that followed the 3T.

If Use is two-channel (**Input 1 to Computed CLK**, **Input 2 to Computed CLK**, or **Input 1 to 2**), as with the case above, the wildcard changes the positioning of the histogrammed result. For the example sort pattern, the interval from the last edge of the 3T code spacing to the nearest clock (measured or computed) is histogrammed into the segment associated with the code spacing that followed the 3T. See chapter 2 for examples of using the wildcard character in a sort pattern.

A Getting Started Procedure

Provided below is a check list of steps to get you started using the Timing Pattern Analysis software. Using this checklist, especially when you are first learning about the software, can ease frustrations and assure pattern analysis results.

☑ Acquire the Data to Sort

1 Go to **Control>TIA Setup** and set up a data acquisition to collect the data you want to analyze for timing patterns.

Be sure you have selected the **sequential** Record Mode and pacing is set to **every edge**. Also complete the setups on the **Input** window and **Span & Resolution** dialog box.

2 Go to **Control>Define Segments & Clock** and complete both the segments and clock portions of this dialog box.

After you provide this information make sure you click "**Apply changes**" so these values can take affect in the software. If you need assistance, see Defining Segments or Setting the Clock common tasks in the *Online Help*.

3 On the Time Interval Analyzer software tool bar, click **Run** to acquire the data.

☑ Define the Sort Pattern

1 Go to **Display>Histogram**.

This activates the Histogram window and enables the Pattern Analysis menu selection.

2 Go to **Pattern>Pattern analysis...**.

The Pattern Analysis dialog box appears.

3 Click the **Pattern Analysis Enabled** box to enable sorting.

4 Create a sort pattern by entering the pattern that you want to match using the Sort Pattern controls.

As you enter a pattern it is shown on the Sort Pattern display. If you make a mistake, click **Undo Sort Entry** to revert back to the previously applied sort pattern.

☑ Apply the Sort Pattern and Verify Results

1 Click **Apply Sort** to apply the sort pattern to the acquired data.

As data patterns are matched, they are numbered sequentially.

2 Go to **Display>Versus-Time** to open the **Versus-Time** display.

3 Go to **Versus-Time>Set Y Scale to Segments**.

This is a convenient way to scale the y-axis to match the code spacing so that each grid line will be one code-spacing interval apart.

4 On the **Pattern Analysis** dialog box, enter a number in the Match Position box, under **Versus-Time Matching**, and click **find match** to view that match.

If you enter a match number that does not exist, the Timing Pattern Analysis software automatically truncates this number to the last match found.

5 On the **Versus-Time** display, verify that the pattern matches are the ones you expected.

6 Open a display window to analyze the results (Histogram, Segmented-Histogram, or Window Margin).

2

Pattern Analysis Examples

Sort Patterns and Versus-Time Matching

In this Chapter

This chapter provides numerous examples for applying a sort pattern to a series of consecutive time interval measurements and an example for verifying pattern match results.

The following items are provided in this chapter:

- Sort Pattern Examples
  - The Sample Acquisition
  - Methods for Entering a Basic Sort Pattern
  - Methods for Using the OR Character
  - Methods for Using the Don't Care Character
  - Methods for Using the Wildcard Character
  - Methods for Sorting Data-to-Clock Intervals
- Versus-Time Matching Example

Sort Pattern Examples

Introduction

Included here are several sort pattern examples to get you started using the Timing Pattern Analysis software. Sort patterns are applied in a logical progression. After analyzing all the data in an acquisition, you will use sorting to look at certain patterns or code spacings that appear to be causing timing effects. Depending on these results, you will refine the search pattern even further until you can conclude if certain data patterns are a contributing factor to the timing effect.

Sort Pattern Guidelines

Use the following guidelines when creating a sort pattern. A sort pattern can contain:

- One result locator (R) to identify the position in the sort pattern to histogram (required).
- Up to 14 expressions.
- One wildcard (*).
- Multiple OR expressions. For example: [2|5], [3|4|5] is valid.

The Acquisition Sample

The sort pattern examples that follow assume a data-to-data measurement was made that consisted of the pattern in Figure 2-1. This pattern was first written to the disk and then measured. The examples that follow demonstrate the ability of the Timing Pattern Analysis software to sort any timing pattern from the measurement below using the sort pattern controls.

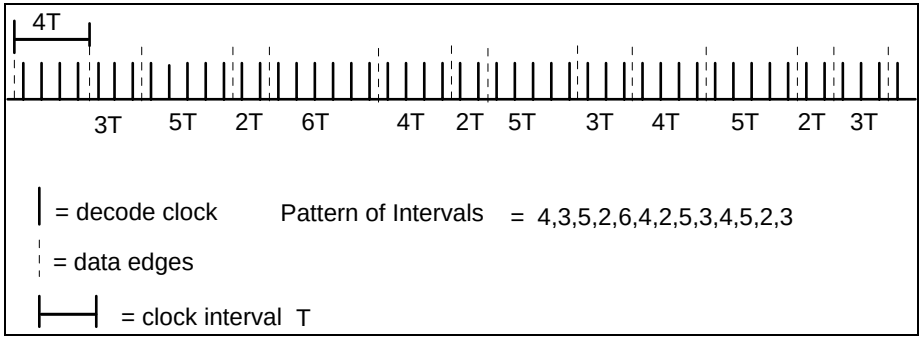


Figure 2-1. Acquisition Sample

Methods for Entering a Basic Sort Pattern

The three basic sort pattern examples in this section make use of numeric expressions to show the correlation between these numerics and code spacings (T).

To Enter a Sort Pattern With a Single Expression

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **2** and **result locator** in the Sort Pattern field.

2R is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches and puts into a distribution every 2T code spacing of the previously acquired data acquisition. In the sort pattern (2R), the 2 means that a 2T spacing is matched and the R means to histogram the 2T when it is found. For this example the R (result locator) may seem unnecessary, but with a more complex sort pattern using multiple expressions, the need for the R will become clearer. In this case, if you looked at the Histogram display there would be one distribution in the corresponding 2T segment with 3 counts.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

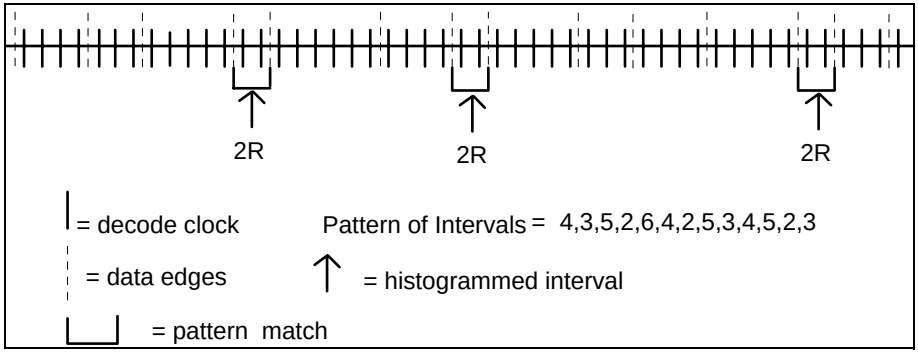


Figure 2-2. Matched Results for Sort Pattern (2R)

To Enter a Basic Sort Pattern With Multiple Expressions

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **3**, **separator**, **5**, **result locator**, **separator**, and **2**.

3,5R,2 is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 3T code spacing, followed by a 5T code spacing, and then a 2T code spacing. The 5T code spacing is put into a distribution because of its association with the R (result locator). The histogram results appear in the segment corresponding to 5T.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

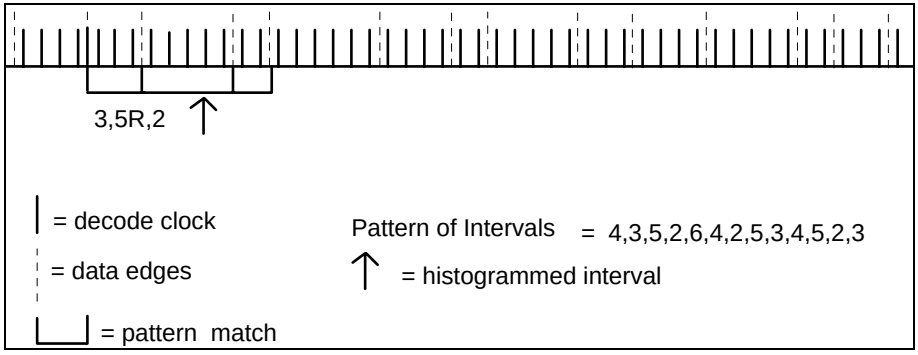


Figure 2-3. Match Results for Sort Pattern (3,5R,2)

To Enter a Basic Sort Pattern (that Shows No Matched Results)

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **3**, **result locator**, **separator**, **5**, **separator**, and **3**.

3R,5,3 is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 3T code spacing, followed by a 5T code spacing, and then a 3T code spacing. The first 3T code spacing of the 3T, 5T, 3T pattern appears in a distribution corresponding to the 3T segment. There are no matches for this sort pattern.

Methods for Using the OR Character

The OR (|) character provides the ability to consider more than one code spacing within a sort pattern position. For example, [2|4], 5R directs the Timing Pattern Analysis software to search for a 2T or 4T code spacing followed by a 5T code spacing. In this case, all the 5T code spacings that match the 2T OR 4T criteria are placed in a distribution. This is equivalent to applying these two sort patterns (2,5R and 4,5R) at once.

The OR character also allows you to direct the Timing Pattern Analysis software to histogram multiple distributions. For example, [3|6]R specifies to put the 3T and the 6T code spacings into distributions corresponding to the 3T and 6T segments.

To Enter a Basic OR Sort Pattern

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **begin OR**, **4**, **OR**, **3**, **end OR**, **separator**, **5**, and **result locator**.

[4|3],5R is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 4T OR 3T code spacing, followed by a 5T code spacing. The 5T code spacing is put into a distribution corresponding to the 5T segment.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

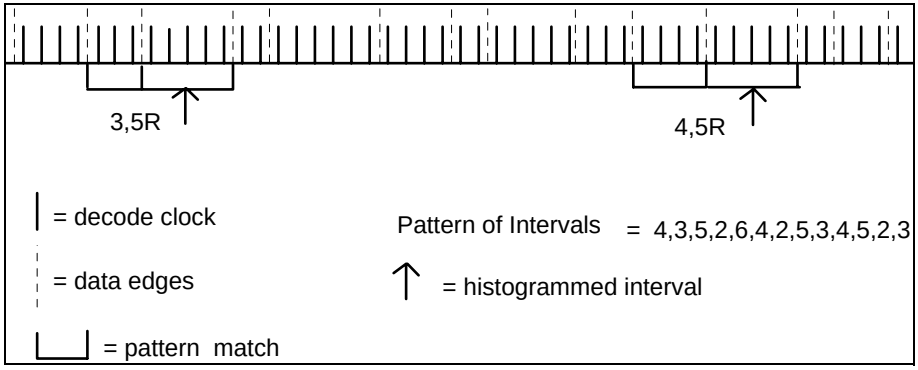


Figure 2-4. Matched Results for Sort Pattern ([4|3],5R)

To Enter an OR Sort Pattern with Multiple Distribution Results

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **begin OR**, **4**, **OR**, **5**, **OR**, **6**, **end OR**, and **result locator**.

[4|5|6]R is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 4T or 5T or 6T code spacing and puts each into a separate distribution. In this case, if you looked at the Histogram display there would be three distributions in the corresponding 4T, 5T and 6T segments.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

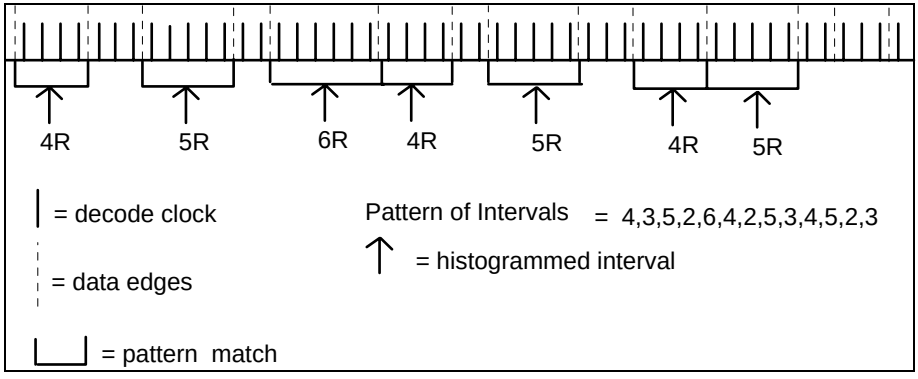


Figure 2-5. Matched Results for Sort Pattern ([4|5|6]R)

Methods for Using the Don't Care Character

The don't care character (X) provides the ability to match any code spacing for a given sort pattern position. For example, 2,X,5R directs the Timing Pattern Analysis software to search for a 2T code spacing, then match any code spacing in the next string position (in other words, all possibilities will match) and then search for a 5T code spacing. You can use the don't care character when you suspect that a code spacing is affected by a non-adjacent spacing.

To Enter a Basic Sort Pattern with Don't Care

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **4**, **separator**, **don't care**, **separator**, **5** and **result locator**.

4,X,5R is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 4T code spacing, followed by any code spacing, and then a 5T spacing. The 5T code spacing is put into a distribution. You might apply this sort pattern to the sample acquisition if you suspected that the 4T code spacing was affecting the timing of the 5T spacing.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

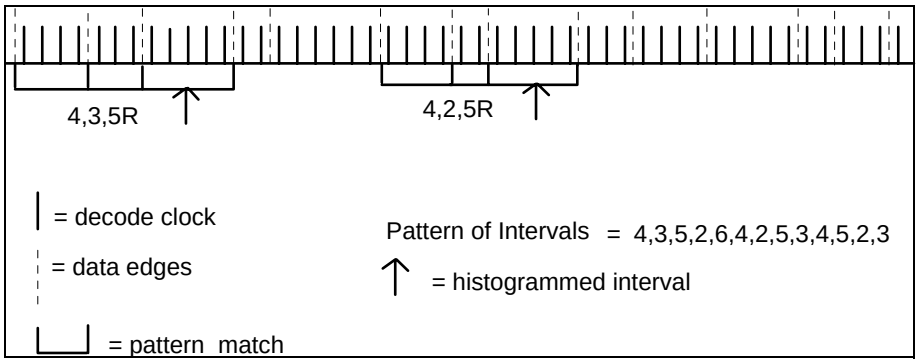


Figure 2-6. Matched Results for Sort Pattern (4,X,5R)

To Enter a Don't Care Sort Pattern with OR

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **2**, **result locator**, **separator**, **don't care**, **separator**, **begin OR**, **3**, **OR**, **4**, and **end OR**.

2R,X,[3|4] is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 2T code spacing followed by any code spacing, and then a 3 OR 4 spacing. The 2T code spacing is put into a distribution. You might apply this sort pattern to the sample acquisition if you suspected that the 3T or 4T code spacing was affecting the performance of the 2T spacing.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

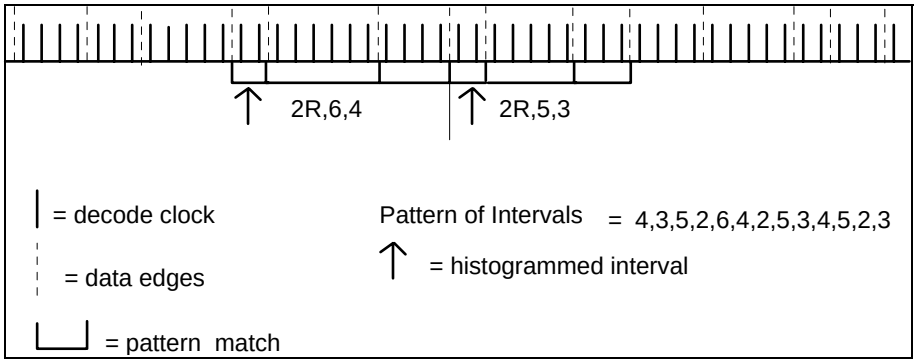


Figure 2-7. Matched Results for Sort Pattern (2R,X,[3|4])

Methods for Using the Wildcard Character

The wildcard character (*) provides the ability to consider every code spacing for a given sort pattern position. For example, (*R,3) directs the Timing Pattern Analysis software to search for and histogram all the code spacings that are followed by a 3T spacing. The resulting histogram is likely to have multiple distributions matching code spacings of (2,3) (3,3) (4,3) and so on. The distributions are displayed in the Segmented-Histogram window in their corresponding segments, i.e. all of the (2,3) matches will be in the segment corresponding to 2T.

The wildcard has a very special use in that you can determine which code spacing (if any) is affecting the performance of another spacing by applying just one sort pattern. Consider, after looking at an acquisition you see that the 2T code spacing does not have a Gaussian shape. You want to find out if there is a code spacing occurring immediately before the 2T spacing that is causing its poor performance. To do this, you could apply this sort pattern:

(*,2R)

Let us carefully analyze what happens in this case. The sort pattern directs the Timing Pattern Analysis software to match every code spacing followed by a 2T code spacing and then histogram the 2T spacing. But herein lies the real power of the wildcard. The 2 interval is histogrammed, but what comes before it determines where it is positioned on the histogram display. Consider the pattern match of (3,2), (one of many possible pattern matches). The 2 interval is placed in the distribution corresponding to 3T. A match of (6,2) puts the 2 interval in the 6T distribution. Following this process, the resulting histogram shows multiple distributions, but each distribution is of a 2 interval. Based on the code spacing that preceded the 2T, the 2T spacings have been split apart.

Why is this useful? When you view the Segmented-Histogram in "overlaid" mode (**Display>Histogram**, **Segment>Overlaid segments**), you can enable and highlight the segments to compare them. When you use the wildcard in this way, you can "deconvolve" aggregate histograms into separate distributions corresponding to a particular timing pattern.

NOTE

Notice from the prior discussion that associating the wildcard with the result locator produces a histogram with multiple distributions. But when the wildcard symbol is used alone in an expression, the result is a deconvolved histogram where one code spacing is displayed in separate distributions.

To Enter a Wildcard Sort Pattern with Multiple Distribution Results

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **wildcard**, **result locator**, **separator**, and **4**.

***R,4** is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every code spacing, followed by a 4T code spacing. When this match occurs, each code spacing preceding a 4T code spacing is histogrammed.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

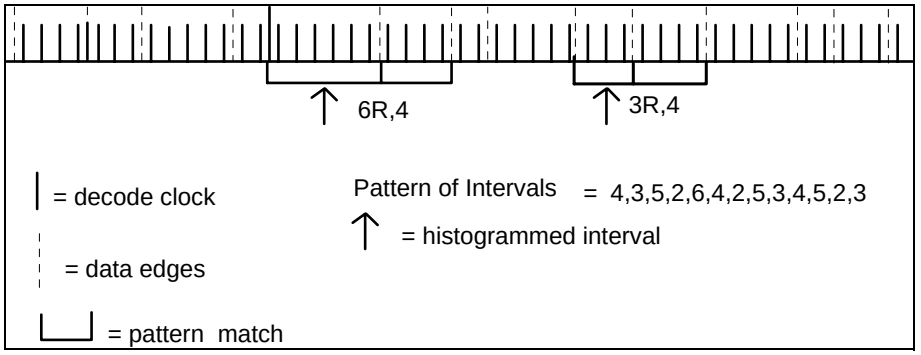


Figure 2-8. Matched Results for Sort Pattern (*R,4)

NOTE

The pattern match of (6R,4) results in the 6T interval being histogrammed in the 6T segment position. Similarly, a match of (3R,4) results in the 3T interval being histogrammed in the 3T segment position.

To Enter a Wildcard Sort Pattern with Deconvolved Distribution Results

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **3**, **result locator**, **separator**, and **wildcard**.

3R,* is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 3T code spacing followed by any code spacing. The 3T spacing is deconvolved and histogrammed according to the spacing that follows it. The resulting histogram contains multiple distributions of the 3T interval.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

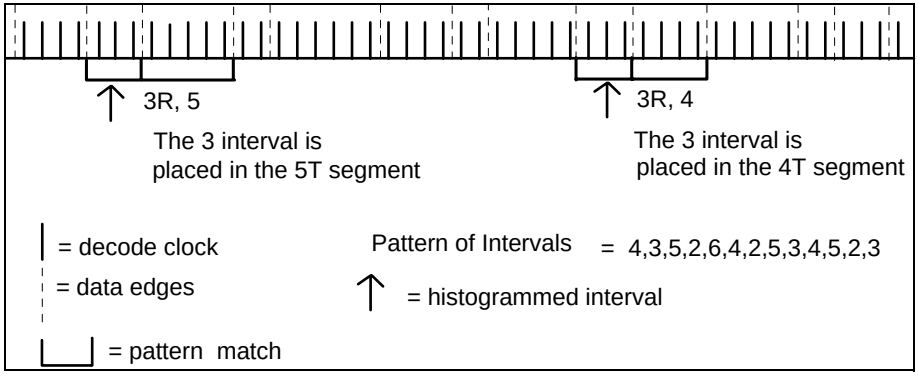


Figure 2-9. Matched Results for Sort Pattern (3R,*)

Methods for Sorting Data-to-Clock Intervals

You can use sorting when the Time Interval Measurement area (on the **TIA Setup** window) is set to **Use** data-to-clock intervals for display and analysis. In this case, the sorting process is the same as for a single input sort, but when a match is found, the data-to-clock interval is placed in the distribution (histogrammed).

The primary difference is that the location of the R (result locator) determines if the data-to-clock interval is taken from the initial edge or the last edge of the data interval. For example, once a pattern match is found for the string (4,2R), the R location (2R) directs the Timing Pattern Analysis software to compare the **last edge** of the 2 code spacing to the nearest clock edge and histogram the resulting interval. A pattern match of (4,R2), directs the Timing Pattern Analysis software to compare the **initial edge** of the 2 code spacing to the clock and histogram that interval. Both an external clock and a computed clock can be used for sorting data-to-clock intervals.

NOTE

All of the prior examples have assumed that the histogrammed result is the code spacing interval associated with the R (result locator). This is true whenever **Use** on the **TIA Setup** window is set to “Input 1 only,” or “Input 2 only”. If the Use selection is something other than these, the histogrammed intervals are based on the Use selection. In such cases, the search pattern match is the same as it is for the single-channel examples, the difference is in the type of result that is histogrammed.

To Enter a Sort Pattern with Last Edge Data-to-Clock Results

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **5**, **separator**, **2** and **result locator**.

5,2R is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 5T code spacing, followed by 2T code spacing. Because of the R location (2R), the **last edge** of the 2T code spacing is compared to the nearest clock edge and the resulting interval is histogrammed.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

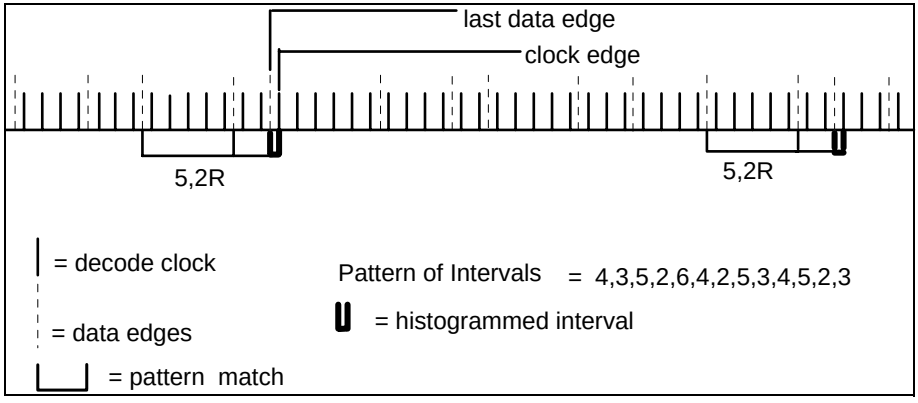


Figure 2-10. Matched Results for Sort Pattern (5,2R)

To Enter a Sort Pattern with Initial Edge Data-to-Clock Results

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **5**, **separator**, **result locator**, and **2**.

5,R2 is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 5T code spacing, followed by 2T code spacing. Because of the R location (R2), the **initial edge** of the 2T code spacing is compared to the next clock edge and the resulting interval is histogrammed.

The following figure shows the matched results based on the sample acquisition of Figure 2-1.

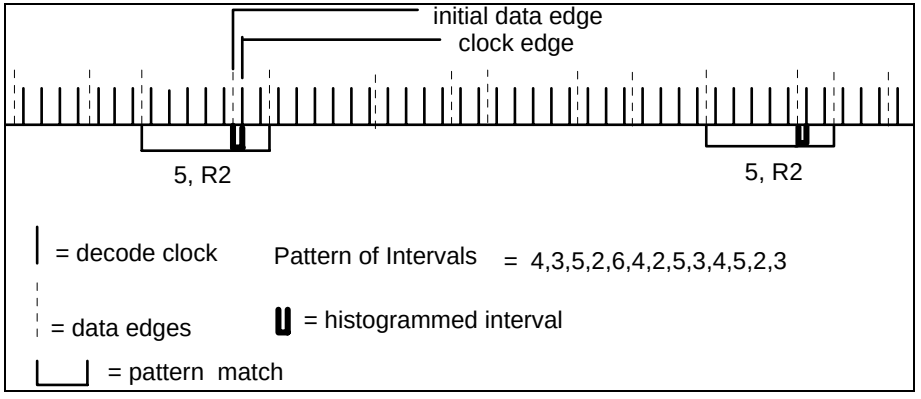


Figure 2-11. Matched Results for Sort Pattern (5,R2)

NOTE

The matching portion is identical for this and the prior example. The difference is the change of the R position with respect to the 2T, which identifies that a different data edge should be histogrammed.

Versus-Time Matching Example

This Versus-Time Matching example demonstrates how to use the Versus-Time Matching controls on the Pattern Analysis dialog box while viewing pattern matches in the **Versus-Time** window.

1 On the **Pattern Analysis** dialog box (**Pattern>Pattern analysis**), press **3**, **separator**, **4**, **result locator**, **separator**, and **5**.

3,4R,5 is displayed on the Sort Pattern window.

2 Click **Apply Sort**.

The Timing Pattern Analysis software matches every 3T code spacing followed by a 4T spacing and then a 5T. The R means to histogram the 4T spacing when a pattern match is found.

3 Open the **Versus-Time** window (**Display>Versus-Time**).

4 Select **Versus-Time>Set Y Scale to Segments**.

This is a convenient way to scale the y-axis to match the code spacing so that each grid line will be one code-spacing interval apart.

5 On the Pattern Analysis dialog box enter 6 in the "**find match**" box.

The 6th pattern match now appears on the **Versus-Time** window. You can see the 3,4,5 sequence on the display. The Y scale minimum is 0T and the next grid line is 1T, and so on. The 4T is exactly centered because it is the one histogrammed.

6 Look at the upper left portion of this display to see in what data block this match was found.

7 Center the 5th match on the **Versus-Time** window.

To do this click "**find prior**" or enter 5 in the box and then click "**find match**."

8 Click "**find match on update**" to automatically center the 5th match on the Versus-Time window during the next measurement update or change of sort pattern.

3

Timing Pattern Analysis Software Demonstration

In this Chapter

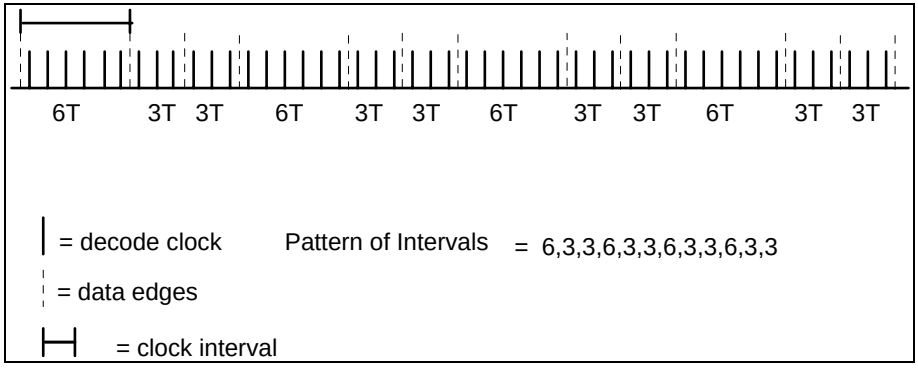
This chapter provides a demonstration of the Timing Pattern Analysis software using data that was acquired with the HP E1725C measuring an actual disk drive. The data was then saved in a file using the menu selection, **File>Save data**. You can recall this measurement data from a stored file that was installed during the HP E1741A installation process. This demonstration can be worked with or without having the HP E1740A Time Interval Analyzer hardware present.

Tri-bit Data Pattern

This demonstration uses a data pattern measured from a hard disk drive with the HP E1725C. Data-to-data time intervals were captured sequentially and pacing was set to every edge. The sequential data has been saved to disk and is recalled for this demonstration.

The drive used to gather this data uses RLL (2,7) coding and has a 66.66667 ns decode window (T). A tri-bit data pattern (6T, 3T, 3T) was written on the media.

A sample of the measurement data would be as follows:



Start

1 Select **File>Use saved data**.

2 Open the demo subdirectory and click on the file "**tribit.tid**".

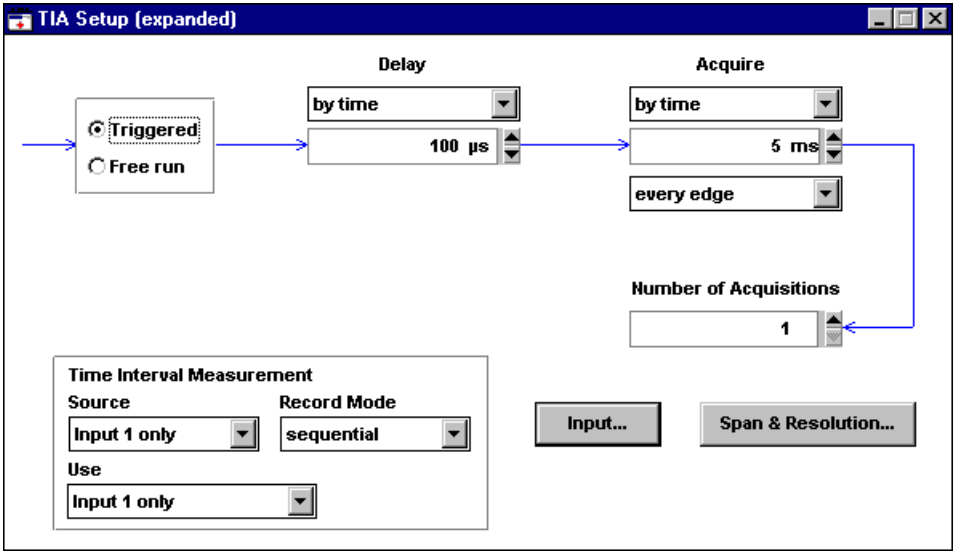
3 Click the **OK** button.

Overview

The tri-bit pattern was written to test the drive's response to code spacing extremes. Since this drive has a decode window or "T" spacing of 66.66667 ns and uses RLL (2,7) coding, interval extremes would be 3T (200 ns) and 8T (536 ns). However, for the purposes of this demonstration, intervals of 3T and 6T are used. This demonstration will use the Timing Pattern Analysis software to analyze the ability of the drive to write this sequence.

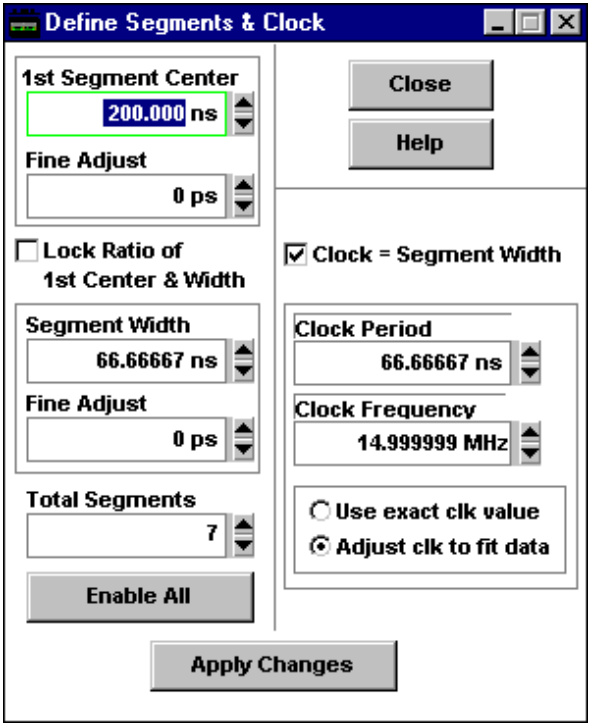
Acquiring the Tri-bit Pattern

1 Select **Control>TIA setup**.



This is the TIA Setup window used to acquire the data. Notice that the Record Mode is set to **sequential** and pacing to **every edge**. Although not shown here, the **Input** window and **Span and Resolution** dialog box were also set according to the characteristics of the signal at Input 1. You may access them now by selecting the buttons at the bottom right of this window.

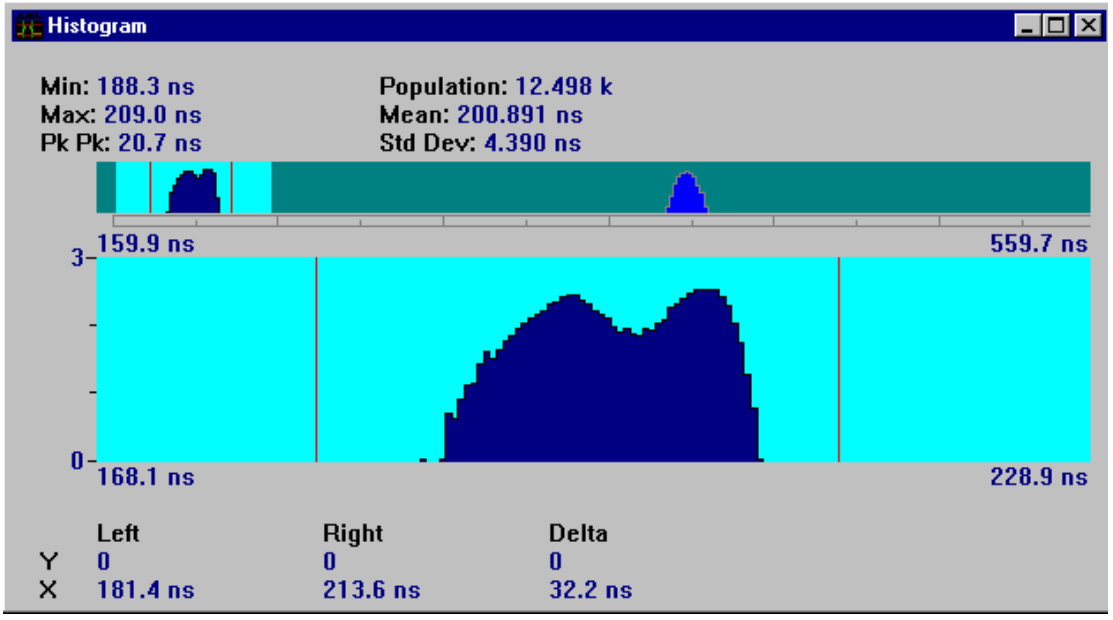
2 Select **Display>Define Segments & Clock**.



This is the **Define Segments & Clock** window which provides information about the code spacing and the characteristics of the encode clock. Notice the clock period of the encode clock (T) is set to 66.66667 ns. The “Fit clock to data” selection indicates that the clock value will be adjusted to accommodate the actual clock rate of the incoming data. Setting the “Segment Width” equal to the clock period defines each segment width to be 66.66667 ns. The “Total Segments” is set to 6 because the code spacing RLL 2,7 allows for 6 interval spacings (3T, 4T, 5T, 6T, 7T, and 8T). These settings allow each interval to be placed in its own distribution segment when viewing the results. The first segment center is set to 200 ns because the shortest interval expected is 3T (66.66667 x 3 = 200 ns).

If the “1st Segment Center” entry was set to 0, then a 0T, 1T, and 2T segment would also become available. Since they should not occur with this coding scheme, they were not defined for this example. You can experiment with this by setting the “1st Segment Center” entry to 0 and increasing the number of segments to 9, and then clicking “Apply Changes”.

3 Select **Display>Histogram**.



This histogram display shows the expected distributions at the 3T and 6T intervals. The segment display shows 6 segment distributions corresponding to the 3T through 8T code spacings.

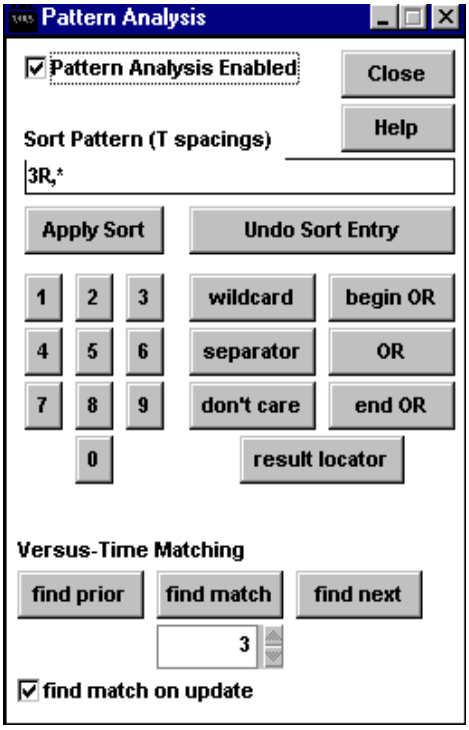
According to the tri-bit pattern there should be twice as many 3T spacings as 6T spacings. You can confirm that this is true by putting the markers around each distribution and observing the reported population.

You can “zoom-in” or magnify the data by pressing the ↑ key on the keyboard. The larger, main display shows the magnified view. You can also drag (with the mouse) the zoomed area on the panorama display to any portion of interest.

When studying the two distributions, notice that the 3T distribution is not Gaussian, and appears to be composed of several overlapping distributions. The need now arises for further analysis. The Timing Pattern Analysis software is a tool that can help you determine if pattern dependent effects are influencing the 3T interval.

Applying a Sort Pattern and Verifying Results

1 Select **Pattern>Pattern analysis**.

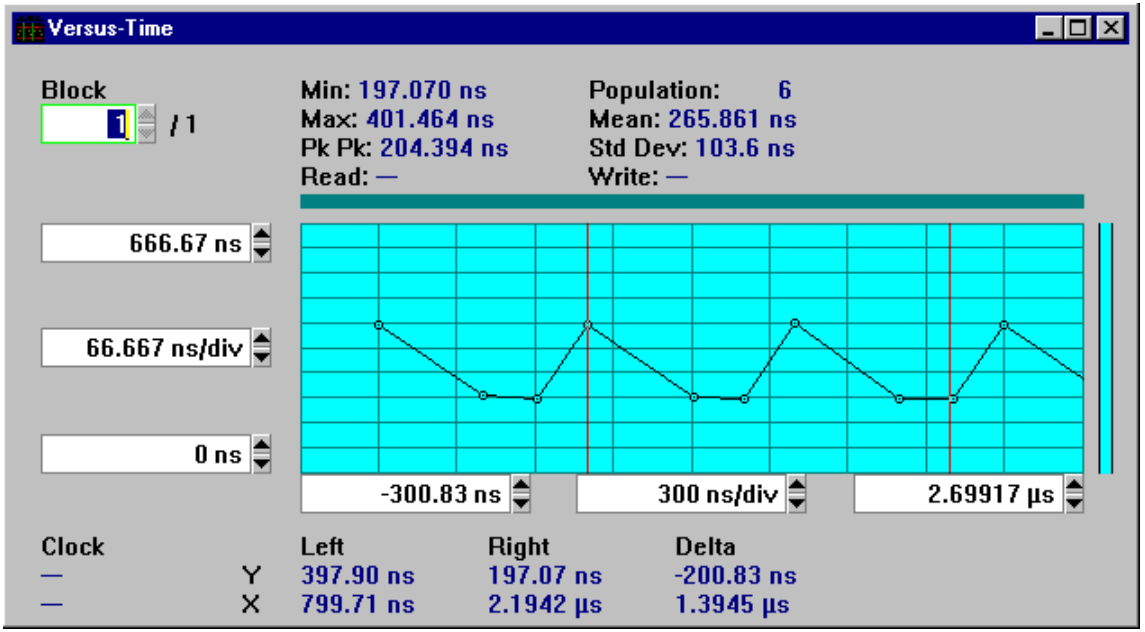


This is the Pattern Analysis dialog box where you setup the Timing Pattern Analysis software.

2 Click on the **Pattern Analysis Enabled** box to activate this dialog box, and click **Apply Sort**.

The sort pattern applied to the tri-bit data acquisition is 3R,* (as shown). This directs the Timing Pattern Analysis software to locate all the 3T intervals followed by any code spacing. The 3T interval is histogrammed, but positioned in the segment associated with the code spacing that followed it (this is due to the *). In the pattern match of (3,**3**) the 3T is histogrammed into segment **one** (3T is defined as the "First Segment Center" on the Define Segments & Clock dialog box). Following the same logic, the pattern match of (3,**6**) results in the 3T being histogrammed into segment **four**. The result is that the (3,3) pattern and the (3,6) pattern are split apart into separate distributions. The Histogram display (**Display>Histogram**) that you were looking at in step 3 now shows you these distributions.

3 Select **Display>Versus-Time**.

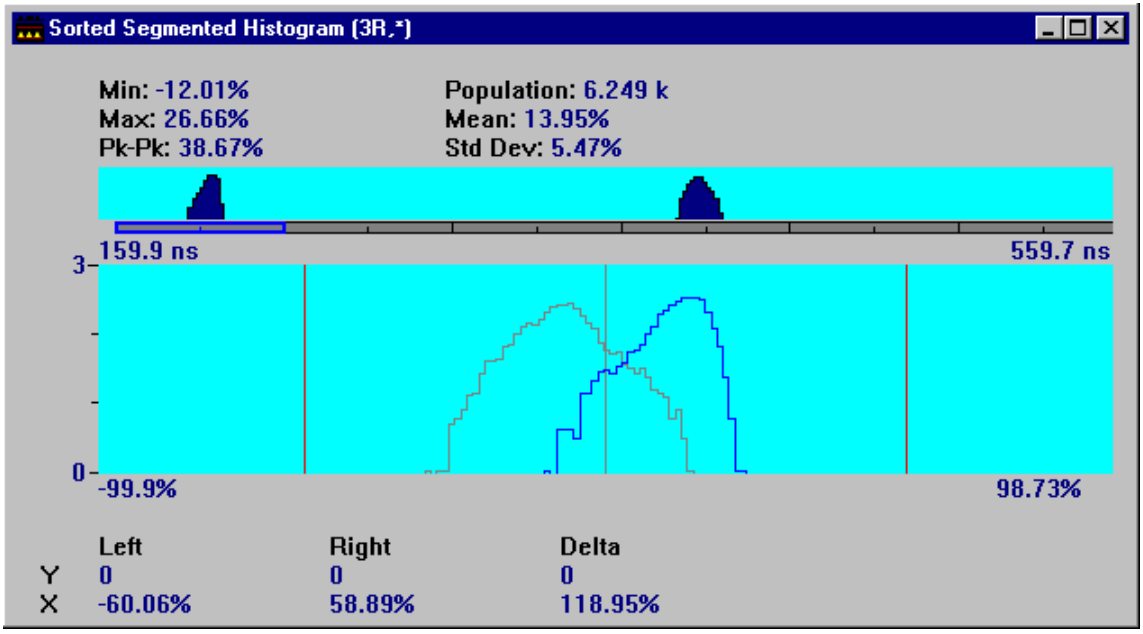


This display shows the measured time intervals versus time. Notice that the vertical axis has been scaled so that each grid line corresponds to 1T interval, making it easier to see the T spacings of the data. This is accomplished with the **Versus-Time>Set Y Scale to segments** menu selection. You can easily see the captured tri-bit pattern of 6T, 3T, 3T, etc.

The pattern matches can be automatically centered in the main display. The control of this feature is on the **Pattern Analysis** dialog box in the Versus-Time match area. You can enter a different match number and then click **find match** to find a different match. For this demonstration 12,498 matches were found.

Analyzing Results

1 Select **Display>Segmented-Histogram**, **Segment>Overlaid segments**, and **Segment>Two-Sided**.



This window shows two distributions of 3T intervals. The (3R,3) match is placed in the distribution corresponding to the first segment and the (3R,6) match is placed in the distribution corresponding to the fourth segment. The pattern matches are positioned in these segment distributions due to the settings previously specified on the **Define Segments & Clock** dialog box. Note that the selected sort pattern is shown on the title bar of this display.

In overlaid mode you can immediately see that the (3,3) pattern match is occurring later than normal and the (3,6) is occurring earlier than normal. Since you have isolated the (3,3) from the (3,6) and now have the two distributions shown on a common reference, it becomes easy to see how the aggregate distribution was produced from these two patterns. What had looked like a single distribution with large amounts of timing asymmetry (when viewing the single, aggregate distribution) is now seen to be two reasonably Gaussian distributions with peak shift. If you want to see the single, aggregate distribution again, select **Segment>Combined segments**.

4

Error Messages

Error Messages

The following tables list the error messages that can be reported on the **Pattern Analysis** dialog box along with corrective actions. Table 4-1 lists the messages that are related to incorrect Sort Pattern entries and Table 4-2 lists the ones related to Versus-Time Matching errors.

Table 4-1. Sort Pattern Error Messages

Error Messages*	Description	Corrective Action
Missing “R” Modifier	The sort pattern is missing a result locator. Example: 3,5	Add a result locator (R) to the sort pattern. Corrected Example: 3,5R
Incomplete Pattern	No search pattern is entered or there is no pattern identified. Example: R	Make sure the sort pattern contains a timing pattern based on T spacings. Otherwise, make sure you follow the sort pattern guidelines detailed in chapter 1. Corrected Example: 3R
Misplaced/Duplicate “R”	Sort pattern contains more than one result locator. Example: 3R,5R	Use only one result locator in the sort pattern. Corrected Example: 3,5R
Misplaced “*”	An expression contains a wildcard and another character. Except for the result locator, there can be no other characters in an expression where the wildcard is used. Example: 4*	Remove the additional characters from the expression that contains a wildcard. Corrected Example: 4R,*
Misplaced/Duplicate “*”	Sort pattern contains more than one wildcard (*). Example: *,4R,*	Use only one wildcard in the sort pattern. Corrected Example: *,4R

Table 4-1. Sort Pattern Error Messages (continued)

Error Messages*	Description	Corrective Action
Misplaced “X”	An expression contains a don’t care and another character. Except for the result locator, there can be no other characters in an expression where the don’t care is used. Example: 4X,4R	Remove additional characters from the expression that contains a don’t care. Corrected Example: X,4R
Misplaced “[”	The begin OR character is not placed at the beginning of an expression (immediately following a comma). Example: 4[,5R	Reposition the begin OR character to the start of an expression. Corrected Example: [4|5]R
Misplaced “]”	The end OR character is used within an expression that does not contain an OR character [|]. Example: 4],5R	Reposition the end OR character to the end of an expression that has an OR character. Corrected Example: [4|5]R
Misplaced “|”	The OR character is used within an expression that does not start with a begin OR character. Example: 2R,6|7	Enter the begin OR character at the start of an expression using the OR character. Corrected Example: 2R,[6|7]
Misplaced Numeric	The expression contains multiple numeric values. An expression can have only one numeric value unless the OR character is used. Example: 4R6	Remove any additional numeric values from the expression. Corrected Example: 4R
Max 14 Patterns	Sort pattern contains too many expressions (maximum 14).	Reduce the number or expressions in the sort pattern.

Table 4-1. Sort Pattern Error Messages (continued)

Error Messages*	Description	Corrective Action
Numeric out of Range	Numeric value is too large. Maximum value is 1,000; corresponding to 1,000 code spacings. Example: 5,3000R	Reduce the numeric value to ≤ 1,000. Corrected Example: 1000R
Invalid Numeric	The expression contains an invalid numeric character. Valid characters are 0–9. Example: 5zR	Remove the non-numeric character. Corrected Example: 5R
Can't do analysis with fast histogram	The record mode on the TIA Setup window is set to fast histogram.	Go to **Control>TIA Setup** and set the record mode to **sequential**.
Match(es) at block start not used.	When Use on the **TIA Setup** window is set to use the computed clock for display and analysis, the first edge of each acquired block is not available. An example is a R5 sort pattern with a 5T spacing between the 1st and 2nd measured edges. In this case, the software would find the match, but not be able to report the 1st edge to computed clock interval.	This is a warning, no corrective action is required.

* The cursor marks the position in the string where the error was found. If there are several problems, the first error found is flagged.

Table 4-2. Versus-Time Matching Error Messages

Error Messages	Description	Corrective Action
No Match Found	No pattern match was found for the applied sort pattern.	Enter a new sort pattern.
Match value set to last match found	No pattern match was found because the match number in the box was too large. Instead the last match found is shown in the **Versus-Time** display.	Enter a lesser number in the box.
Enable vs. time display	The **Versus-Time** display is not opened.	Open the **Versus-Time** display (**Display>Versus-Time**).

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