User Manual

Tektronix

TDSPSM1
Processor Specifications Measurements Application

071-0581-00

This document supports software version 1.0.0 and above.

Warning
The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

Printed in the U.S.A.

Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

Connect and Disconnect Properly. Connect the probe output to the measurement instrument before connecting the probe to the circuit under test. Disconnect the probe input and the probe ground from the circuit under test before disconnecting the probe from the measurement instrument.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Symbols and Terms

Terms in this Manual. This term may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

Preface

This manual contains operating information for the TDSPSM1 Processor Specifications Measurements Application. The manual consists of the following chapters:

- The chapter *Getting Started* briefly describes the TDSPSM1 Processor Specifications Measurements Application, lists oscilloscope compatibility, and provides installation instructions.
- The chapter *Operating Basics* covers basic operating principles of the application and includes a tutorial that teaches you how to set up the application to acquire a waveform, take measurements, and view the results.
- The chapter *Reference* includes a diagram of the menu structure and descriptions of parameters.
- The appendix *Measurement Algorithms* contains information on measurement guidelines and on how the application takes the measurements.

Related Documentation

The user manual for your oscilloscope provides general information on how to operate the oscilloscope.

Conventions

This manual uses the following conventions:

- This manual refers to the TDSPSM1 Processor Specifications Measurements Application as the TDSPSM1 application or as the application.
- When steps require that you make a sequence of selections using front-panel controls and menu buttons, an arrow (→) marks each transition between a front panel button and a menu, or between menus. Names that are for a main menu or side menu item are clearly indicated: Press VERTICAL MENU → Coupling (main) → DC (side) → Bandwidth (main) → 250 MHz (side).

Contacting Tektronix

Product Support	For application-oriented questions about a Tektronix measurement product, call toll free in North America: 1-800-TEK-WIDE (1-800-835-9433 ext. 2400) 6:00 a.m. – 5:00 p.m. Pacific time Or contact us by e-mail: tm_app_supp@tek.com For product support outside of North America, contact your local Tektronix distributor or sales office.
Service Support	Contact your local Tektronix distributor or sales office. Or visit our web site for a listing of worldwide service locations. http://www.tektronix.com
For other information	In North America: 1-800-TEK-WIDE (1-800-835-9433) An operator will direct your call.
To write us	Tektronix, Inc. P.O. Box 1000 Wilsonville, OR 97070-1000

Getting Started

Product Description

The TDSPSM1 Processor Specifications Measurements Application is a Java™-based application that enhances basic capabilities of TDS oscilloscopes. The application offers many of the same timing measurements, but does not require any external equipment or lengthy procedures that may be prone to error.

Oscilloscopes can take only one measurement in an acquisition waveform. The TDSPSM1 application can take and accumulate measurements throughout an entire waveform effectively taking cycle-to-cycle timing measurements.

The application can display the measurement results in a numeric format as statistics and in two graphical formats as a histogram or profile plot.

Figure 1 shows an example of the results of a Channel-to-Channel Delay measurement.

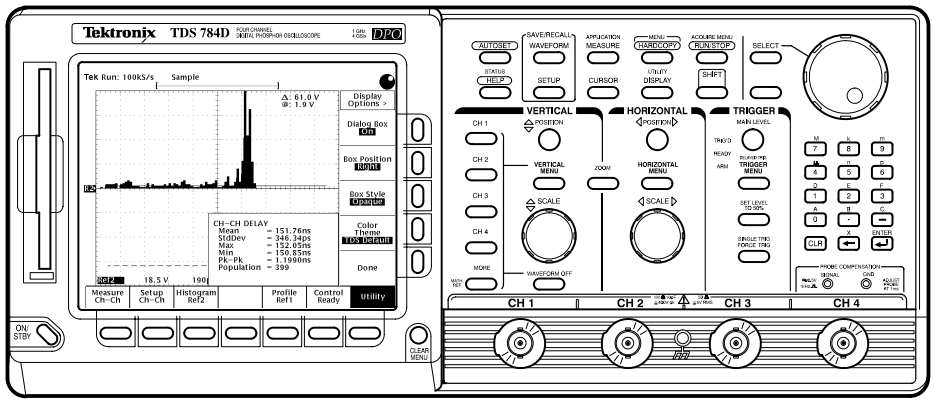


Figure 1: TDSPSM1 Processor Specifications Measurements Application

Compatibility

The Processor Specifications Measurements Application is compatible with the following Tektronix oscilloscopes:

- All TDS 500D and 700D Digital Phosphor Oscilloscopes with Option HD (hard disk drive) or Option 2M (hard disk drive plus 8 MB record length)
- TDS 600C Digitizing Oscilloscopes with an Option HD (hard disk drive)
- TDS 700C Color Digitizing Oscilloscopes serial number B020100 and up, with Option HD (hard disk drive) or Option 2M (hard disk drive plus 8 MB record length), and with firmware version 5.2e and up

For a current list of compatible oscilloscopes, check the Tektronix, Inc. web site, http://www.tektronix.com/Measurement/scopes/index.html in the Software and Drivers category.

Requirements and Restrictions

The TDS Run-Time Environment V1.1 and above must be installed on the oscilloscope to operate the Processor Specifications Measurements Application.

The application does not support control by external GPIB commands.

Updates Through a Web Browser

You can find information about this and other applications at the Tektronix, Inc. web site, http://www.tektronix.com/Measurement/scopes/index.html in the Software and Drivers category. Check this site for application updates that you can download and for free applications.

To install an application update, you will need to download it from the Tektronix ftp site to a hard disk, copy it to a blank DOS-formatted floppy disk, and then install it on your oscilloscope.

***NOTE**. More information about changes to the application or installation is in a Readme.txt file on the ftp site. You should read it before you continue.*

To copy the application from a web browser, follow these steps:

1. Access the ftp site at ftp://ftp.tek.com/mbd/support/00–index.html#1.
2. Scroll through the files to the TDSPSM1 application, select the file, and download it to your hard disk drive. If necessary, unzip the file.
3. Copy the application from the hard disk to a blank, DOS-formatted floppy disk.
4. Follow the *Installing the Application* procedure on page 3.

Accessories

There are no standard accessories for this product.

Installation

The TDSPSM1 floppy disk contains the Processor Specifications Measurements Application. You can download updates, if any, from the Tektronix ftp site through a web browser.

NOTE. *To operate the Processor Specifications Measurements Application, the TDS Run-Time Environment V1.1 or above must be installed on your oscilloscope.*

Installing the Application

To install the application from the floppy disk to your oscilloscope, follow these steps:

1. Power off the oscilloscope.

NOTE. *Additional information about the application or installation is located in a* Readme.txt *file on the floppy disk. You should insert the floppy disk into a DOS-based personal computer and read the* Readme.txt *file before you continue.*

If you are updating the application, the Readme.txt *file on the Tektronix ftp site supercedes the* Readme.txt *file on the TDSPSM1 floppy disk.*

2. Insert the disk in the floppy disk drive and power on the oscilloscope.

NOTE. *To verify that the TDS Run-Time Environment V1.1 or above is installed, watch for the name to appear at the top of the display when you power on the oscilloscope. If it does not appear, contact your local Tektronix sales office.*

After performing the power-up selftest, the oscilloscope automatically begins the installation procedure.

As the application loads from the disk, the oscilloscope displays a clock icon to indicate that it is busy. Also, the floppy disk drive LED is on, indicating activity. If the clock icon continues to display after the floppy disk LED has gone out, a problem has occurred with the installation. Repeat the above procedure. If the problem persists, contact your Tektronix representative.

When the installation is complete, an Installation Complete message displays.

3. Remove the floppy disk and cycle the power to the oscilloscope.

Connecting to a System Under Test

You can use any compatible probe to connect between your System Under Test (SUT) and the oscilloscope. The connection is usually to a clock signal.

Most measurements require two waveforms. The AC Timing measurements only require one waveform.

WARNING. *To avoid electric shock, you must ensure that power is removed from the SUT before attaching a probe to it. Do not touch exposed conductors except with the properly rated probe tips. Refer to the probe manual for proper use.*

Power down the SUT before connecting the probe to it.

Table 1 shows the default channel-to-waveform assignments.

Table 1: Channel assignments

Channel or reference	Waveform assignment
Ch 1	Principal waveform, such as the Clock signal
Ch 2	Relative waveform, usually data
Ref1	Profile graphical format
Ref2	Histogram graphical format

Operating Basics

Operating Basics

This section contains information on the following topics and tasks:

- Application menu structure
- Using basic oscilloscope functions
- Configuring the display
- Setting up the application
- Taking measurements
- Viewing the results
- Saving and recalling setups
- Exiting the application

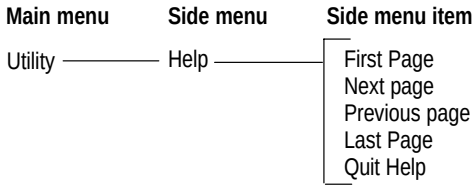
Application Menu Structure

There are two types of menus in the application menu structure: main menus and side menus. Some side menus contain common menu items as shown in Table 2.

Main and Side Menus

The main menu names appear in the bottom of the display and the side menu names appear on the right side of the display. To see the complete application menu structure, refer to Figure 32 on page 39.

When you press the front-panel button associated with a main menu, the side menu changes. In many cases, when you press a side menu, new side menu items appear. As an example, the next figure shows you how to access the Help selections through the main Utility menu and the Help side menu.



Common Menu Items

Table 2 lists common side menu items.

Table 2: Common menu items

Menu item	Description
Cancel	Cancels the message being displayed.
Done	Indicates that you are through making changes to that set of side menus. The application returns to the previous menu.
OK	Confirms the action.

Utility Menus

Table 3 lists the Utility menus.

Table 3: Utility menus

Utility name	Description
Help	Accesses the online help information and view various pages.
Exit	Exits the application.
Save/Recall Setup	Accesses the save and the recall menus for application setups.
Display Options	Accesses other menus where you can change display settings, such as the message box location on the display.

Using Basic Oscilloscope Functions

You can use the Utility menu to access help information about the application. You can also use other oscilloscope functions and easily return to the application.

Using Local Help

The application includes local help information about the measurements modes, with some explanation of the individual controls.

To display the local help, follow these steps:

1. Press Utility (main) → Help (side).
2. Use the side menu buttons to navigate through the help.

Returning to the Application

You can easily switch between the TDSPSM1 application and other oscilloscope functions.

To access other oscilloscope functions, press the desired front panel control. To return to the application, push the SHIFT and then the APPLICATION front-panel menu buttons as shown in Figure 2.

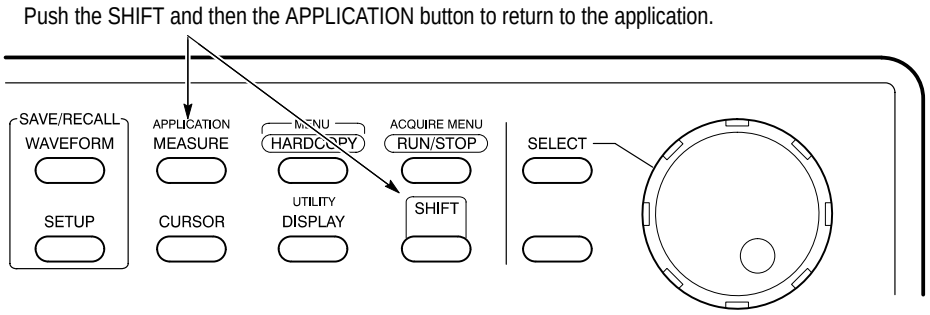


Figure 2: Returning to the application

Warning Messages

All timing measurements provide a warning if the input conditions do not support accurate measurements. For example, the Period measurement warns you if you do not have at least two cycle-start edges in the acquired waveform.

Configuring the Display

You can change how dialog boxes appear on your oscilloscope, as well as the color of waveforms. The next figure shows how to access the display options and Table 4 lists the options with a brief description of each.

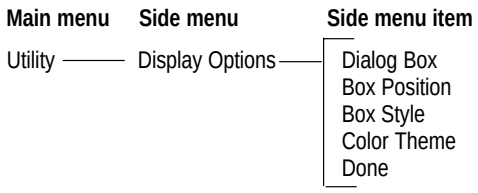


Table 4: Display options

Display option	Description
Dialog box (visibility)	Select Show or Hide to make dialog boxes visible or invisible.
Box position*	Select where on the display to position dialog boxes: Left, Middle, or Right.
Box style	Select the style of dialog boxes to be Opaque or Transparent.
Color Theme	Select a set of colors for waveforms and dialog boxes. The various TDS oscilloscopes offer 14 useable colors. Your choices are based on the color combinations available for the TDS oscilloscope in use.

*** Box position is fixed when taking AC Timing measurements.**

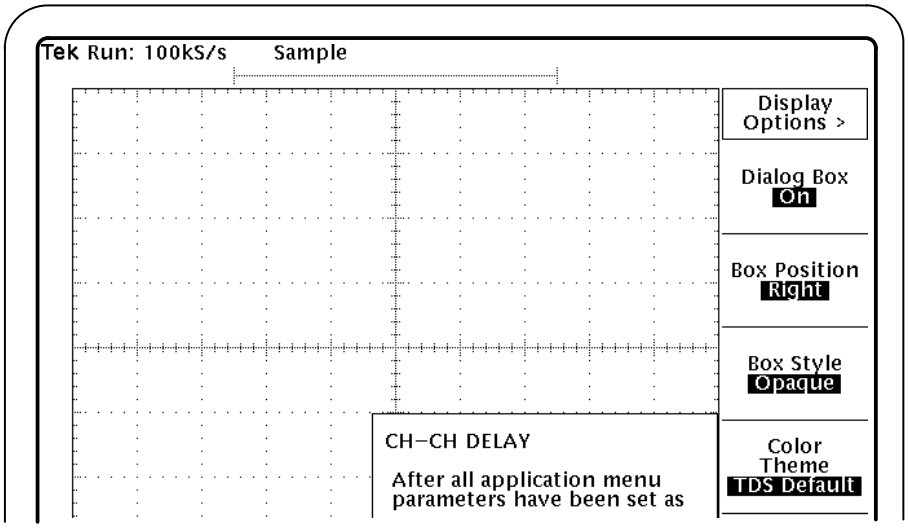


Figure 3: Display Options side menu

Setting Up the Application

You can set up the application to take nine measurements and to display the results in up to three ways.

Measurement Setup

The next figure shows how to access the measurement setup menus and Table 5 lists the TDSPSM1 measurements with a brief description of each.

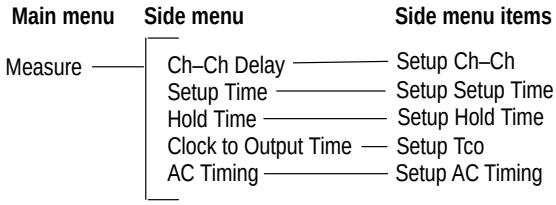


Table 5: Measurements

Measurement name	Description
Channel-to-Channel Delay	Difference in time between individual specific points on two waveforms. The points are defined by an edge and a voltage reference level.
Setup Time	Elapsed time between when an input signal crosses a voltage reference level followed by the clock signal crossing its own voltage level.
Hold Time	Elapsed time between when the clock signal crosses a voltage reference level followed by an input signal crossing its own voltage level.

Table 5: Measurements (Cont.)

Measurement name	Description
Clock to Output Time (Tco)	Elapsed time between when the clock signal crosses a voltage reference level followed by an output signal crossing its own voltage level.
AC Timing	Timing characteristics of a waveform based on voltage reference levels.

The next figure shows how to access the AC Timing measurement selections, and Table 6 lists these selections with a brief description of each.

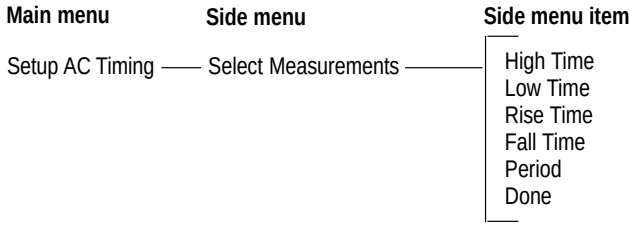


Table 6: AC Timing measurements

Measurement	Description
High Time	Amount of time a waveform remains above the high reference voltage level.
Low Time	Amount of time a waveform remains below the low reference voltage level.
Rise Time	Elapsed time from when a rising edge crosses the low reference voltage level and then the high reference voltage level.
Fall Time	Elapsed time from when a falling edge crosses the high reference voltage level and then the low reference voltage level.
Period	Elapsed time between when a waveform crosses a specific reference voltage level twice.

Table 7 lists the setup menus with their corresponding waveform source side menus.

Table 7: Setup menus and waveform source side menus

Setup menu	Source side menu	Description
Ch-Ch Delay	From Edge	Principal waveform used to calculate the difference in time between two edges.
	To Edge	Second waveform.
	Range minimum	Lower time interval boundary used to limit the search.
	Range maximum	Upper time interval boundary used to limit the search.
Setup Time Hold Time	Clock Input	The principal waveform, clock, used to calculate the elapsed time between when this waveform and a data waveform crosses a specified voltage reference level.
	Data Edge Input	Second waveform, data.
	Range minimum	Lower time interval boundary used to limit the search.
	Range maximum	Upper time interval boundary used to limit the search.
Tco	Clock Input	The principal waveform, clock, used to calculate elapsed time between when this waveform and an output waveform crosses a specified voltage reference level.
	Output Edge Input	Second waveform, output.
	Range minimum	Lower time interval boundary used to limit the search.
	Range maximum	Upper time interval boundary used to limit the search.
AC Timing	Input	Waveform used to calculate timing characteristics.

There are several clock-to-data and data-to-clock timing variations that you must consider to properly specify the Range Minimum and Range Maximum values.

When the application takes a Channel-to-Channel Delay Time measurement, every edge specified in the To Edge menu item generates a measurement as long as an edge specified in the From Edge menu item occurs within the Range Minimum and Range Maximum values.

When the application takes a Setup Time, Hold Time, or Clock-to-Output Time measurement, every data edge or edge specified in the To Edge menu item generates a measurement as long as a clock edge occurs within the Range Minimum and Range Maximum values.

You can use the default range values for most simple timing measurements. For the Channel-to-Channel Delay measurement, the default values are –1,000 ns and 1,000 ns . For the Setup Time, Hold Time, and Clock-to-Output Time measurements, the default values are 0 ns and 1,000 ns.

***NOTE**. Press CURSOR → V Bars (side), return to the application, and use the vertical cursors to estimate the Range Minimum and Range Maximum values.*

Figure 4 shows a simple timing diagram of a Setup Time (T_{SU}) and a Hold Time (T_{HOLD}) measurement. Small numbers are shown for the range values, even though the default values will work in most cases.

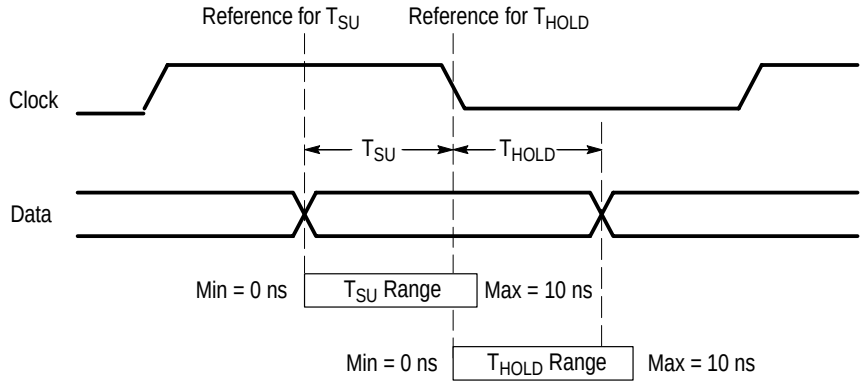


Figure 4: Simple timing diagram and positive range values

Figure 5 shows positive range values for a simple Setup Time measurement. You can also use positive range values for simple Hold Time measurements.

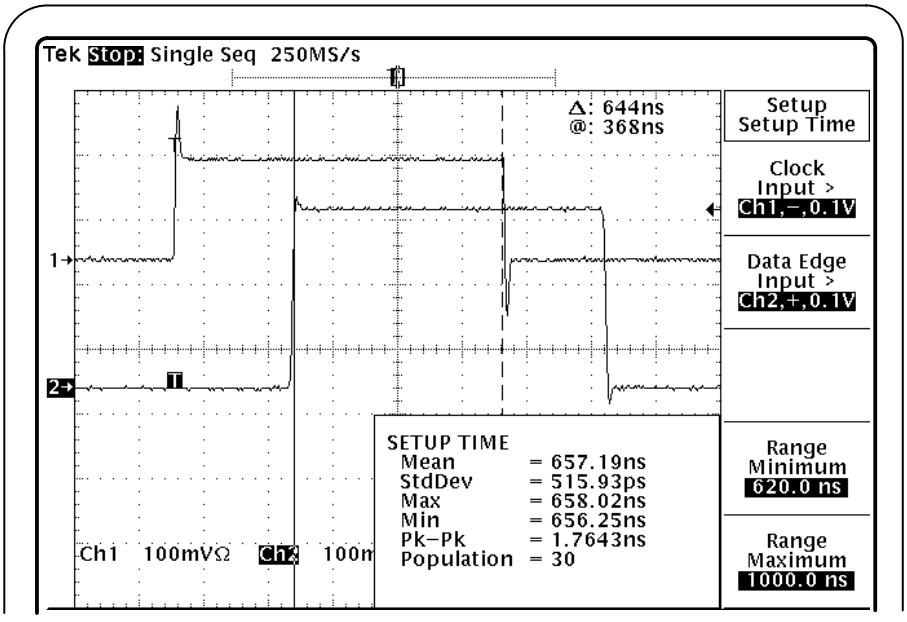


Figure 5: Positive range values for a Setup Time measurement

NOTE. *You can use these same techniques to determine the range values for the Channel-to-Channel Delay Time and Clock-to-Output Time measurements.*

Figure 6 shows a negative range value used for the Hold Time measurement. It also shows a Setup Time measurement where the range values are used to exclude a transition between the data transition and clock edge to be measured.

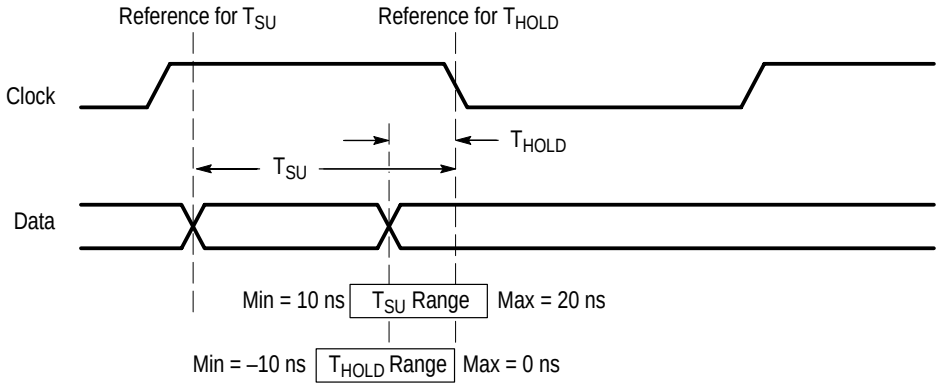


Figure 6: Complex setup time and hold time with a negative range value

Figure 7 shows a negative range value used for a Hold Time measurement.

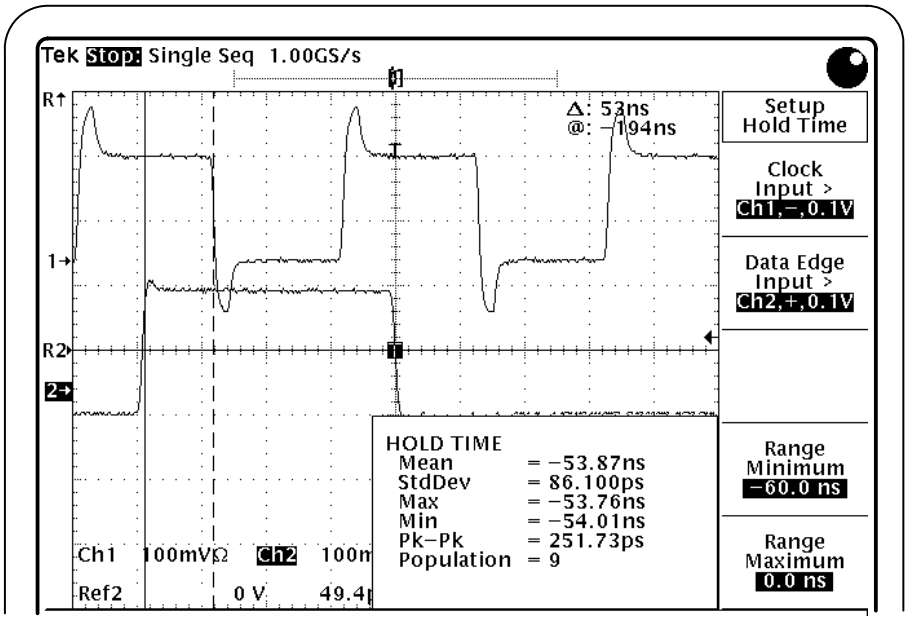


Figure 7: Negative Hold Time measurement and negative range value

Figure 8 shows a Setup Time measurement where the range values are used to exclude a data transition.

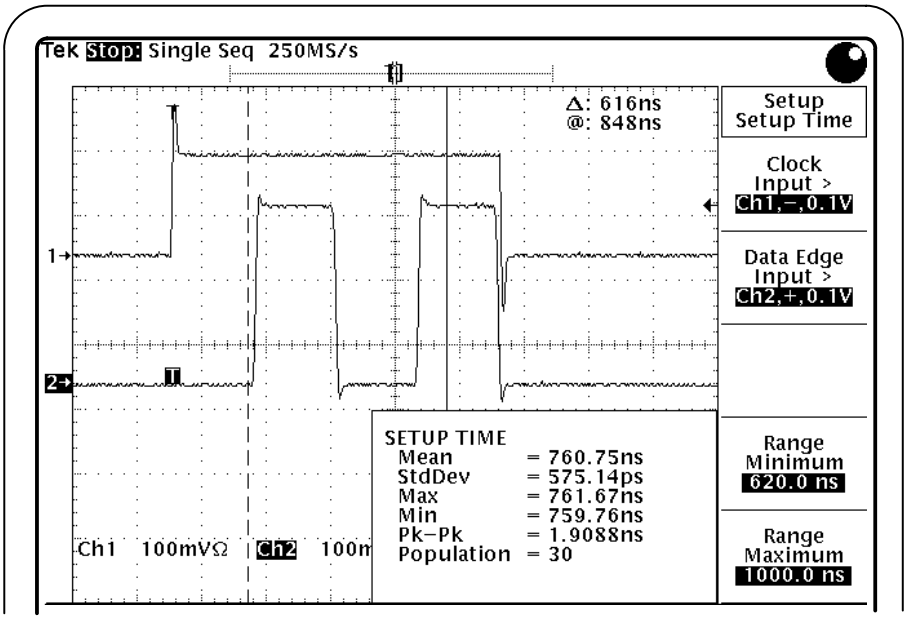


Figure 8: Setup Time measurement with a data transition excluded by range values

Figure 9 shows a negative range value used for the Setup Time measurement. It also shows a Hold Time measurement where the range values are used to exclude a transition between the clock edge and data transition to be measured.

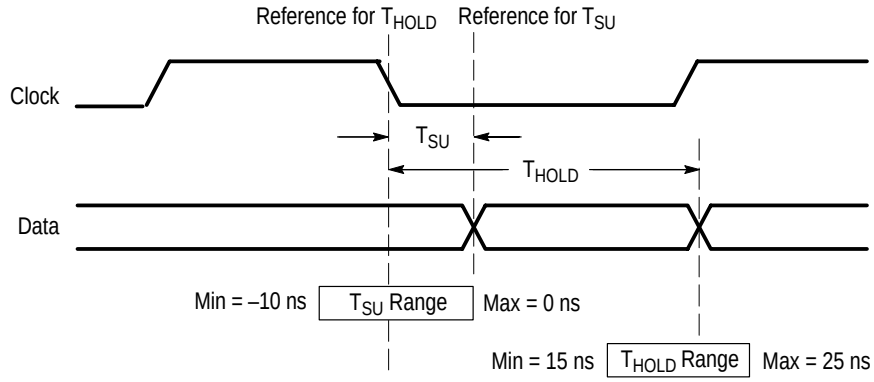


Figure 9: Complex hold time and setup time with a negative range value

Figure 10 shows a negative range value used for a Setup Time measurement.

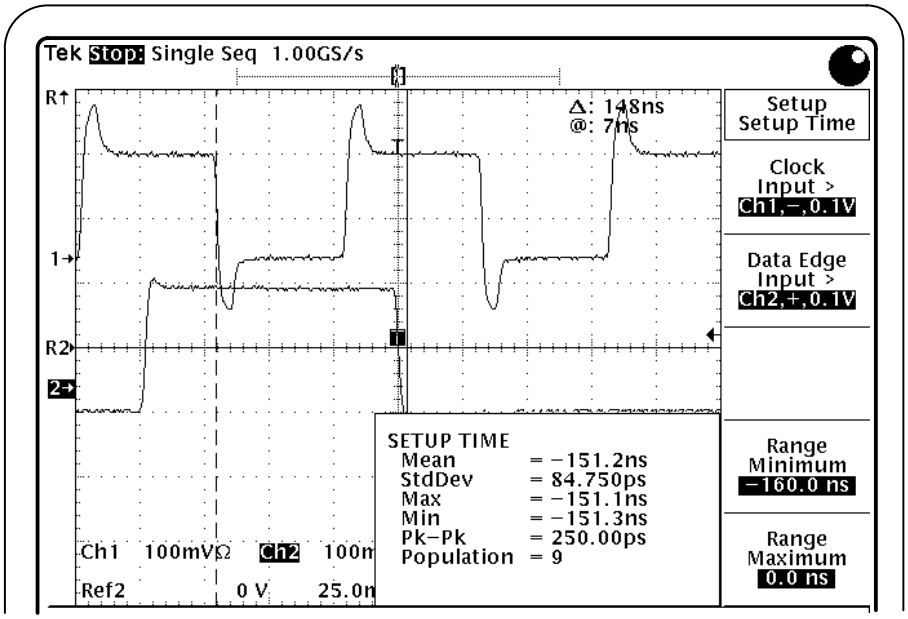


Figure 10: Negative Setup Time measurement and negative range value

Figure 11 shows a Hold Time measurement where the range values are used to exclude a data transition.

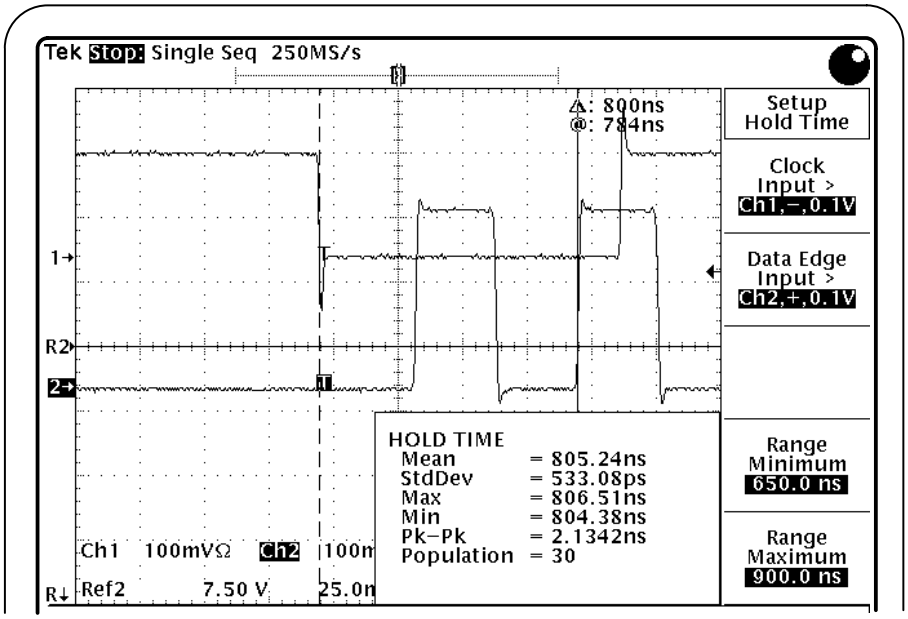
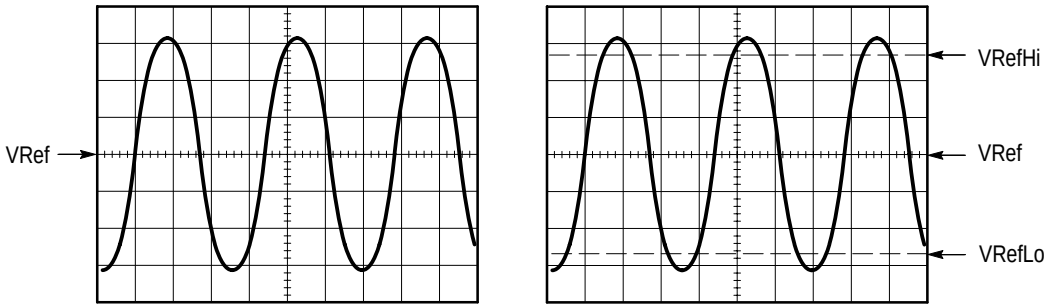


Figure 11: Hold Time measurement with a data transition excluded by range values

You can use the source side menu to select and define the waveform from which to take measurements, and where to start (and end) measurements.

The Channel-to-Channel Delay Time, Setup Time, Hold Time, and Clock-to-Output Time measurements require one voltage reference level to calculate the activity on the defined waveforms. The AC Timing measurements require three voltage reference levels. Figure 12 shows how to set the voltage reference levels.



Ch-Ch Delay Time, Setup Time, Hold Time, and Clock-to-Output Time measurements

AC Timing measurements

Figure 12: How to set voltage reference levels

The next figure shows how to access the source side menus and the waveform definition side menu items.

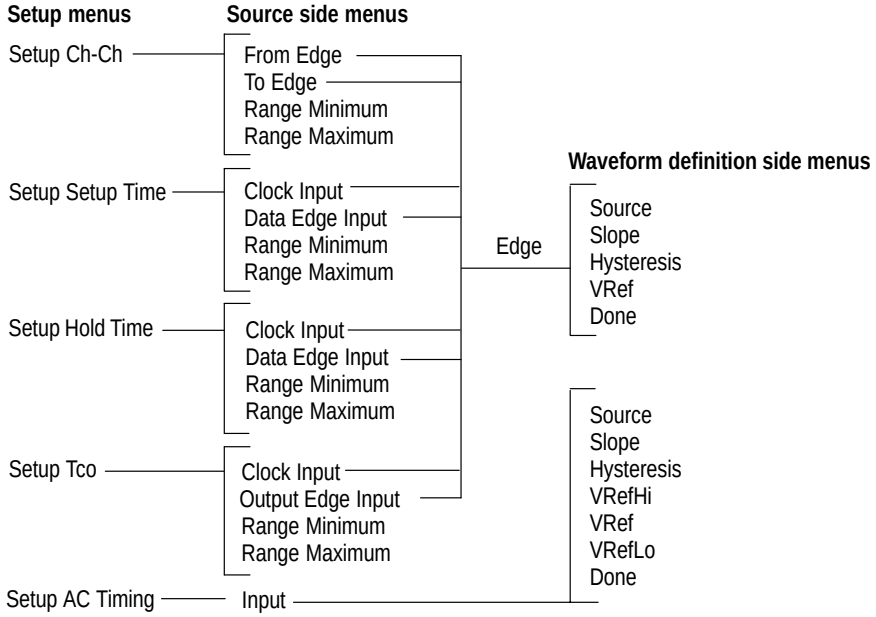


Table 8 lists the signal definition side menus with a brief description of each.

Table 8: Waveform definition side menu items

Menu item	Description
Source	You can select an active waveform, a reference waveform, or a math waveform as the signal or clock source.
Slope	You can select the edge on which to start the measurement: Rise, Fall, or Transitional.
Hysteresis	You can select the threshold margin, in graticule divisions, relative to the reference level which the voltage must cross to be recognized as changing. The margin is the voltage reference level *plus or minus half* the hysteresis.
VRefHi*	You can specify where on the slope, in Volts, to set the high threshold.
VRef	You can specify where on the slope, in Volts, to set the middle threshold.
VRefLo*	You can specify where on the slope, in Volts, to set the low threshold.

*** Only required for AC Timing measurements.**

NOTE. *The application detects the minimum and maximum voltage levels of the waveform. If the reference voltage level plus or minus the hysteresis falls outside of 2.5% to 97.5% of the waveform peak-to-peak range, no measurement is taken.*

Display Results Setup

Table 9 lists the display formats of the results with a brief description of each. You can use a graphical format to customize the display of the results for easier analysis.

Table 9: Results display formats

Displayed as	Descriptions
Statistics	The results display as numeric values for the mean, the standard deviation, the peak-to-peak, the maximum and minimum voltage levels, and the population of the measurements. This is the default display of the results.
Histogram format	A bar graph that represents the distribution of timing measurements.
Profile format	A dot graph that represents consecutive values for each measurement.

The next figure shows how to save the results in a graphical formats and how to access the graphical format definitions side menu items.

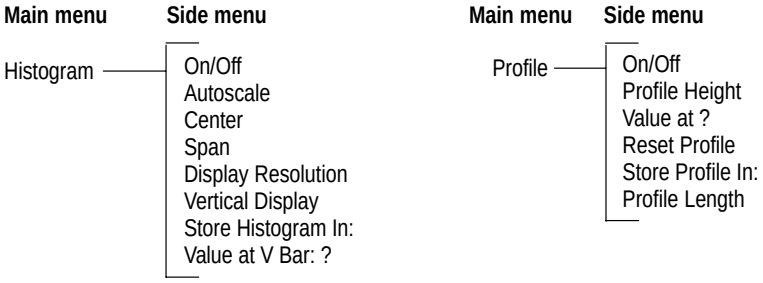


Table 10 lists menu items used to customize the Histogram graphical format with a brief description of each.

Table 10: Histogram format side menu items

Menu item	Description
On/Off	Enables the results to be stored in a reference waveform.
Autoscale	After taking measurements, uses the results to determine logical values for the Center and Span menu items.
Center	Uses the GP knob or keypad to specify a numeric value for the horizontal center position of the histogram.
Span	Uses the GP knob or keypad to specify a numeric value for the total horizontal range of the histogram.
Display resolution	Selects the resolution as defined by bins to be Low (20 bins), Medium (50 bins), or High (500 bins).
Vertical Display	Selects the vertical axis to be linear or logarithmic.
Store Histogram In	Selects a reference waveform in which to store the results.
Value at V Bar: ?	Uses vertical cursors to view vertical values.

Table 11 lists menu items used to customize the Profile graphical format with a brief description of each.

Table 11: Profile format side menu items

Menu item	Description
On/Off	Enables the results to be stored in a reference waveform.
Profile Height	Selects the height of the profile in number of divisions.
Value at _ ?	Uses to view vertical values by index number.
Reset Profile	Resets profile waveform results to zero.
Store Profile In:	Selects a reference waveform in which to store the results.
Profile Length	Selects the record length of the profile in number of divisions.

Taking Measurements

Once you have set up the application, you can take measurements.

If you want to change trigger settings or localize the measurement, you should do so before you take any measurements. The application defaults to the reference voltage level as defined for the waveform source (refer to Table 8 on page 16).

NOTE. *If you select a reference or math waveform as the source, you will need to display the waveform before a measurement can be taken. To display the waveform, press the MORE button and the appropriate main menu item.*

NOTE. *Remember to reset the result values (Control (main) → Reset All) if you change the Vertical or the Horizontal time settings after starting to take measurements.*

Acquiring Waveforms

When the measurement parameters are set up, you can acquire waveforms. To do so, follow these steps:

1. Press Control (main). Table 12 lists menu items in the Control menu, and Figure 13 shows the Control menu..

Table 12: Control menu items

Menu item	Description
Mode	
Single	Performs measurements on a single acquisition and stops.
Free Run	Repeatedly acquires a waveform, takes timing measurements, and arms the trigger.
Start/Continue	The application starts to take measurements from one or two waveforms
Pause	The application stops taking measurements and continues when you press Start again.
Stop	The application stops taking measurements.
Reset All	Resets all result values (numeric and graphical) to zero. You do not have to wait for a measurement to complete to reset the results.

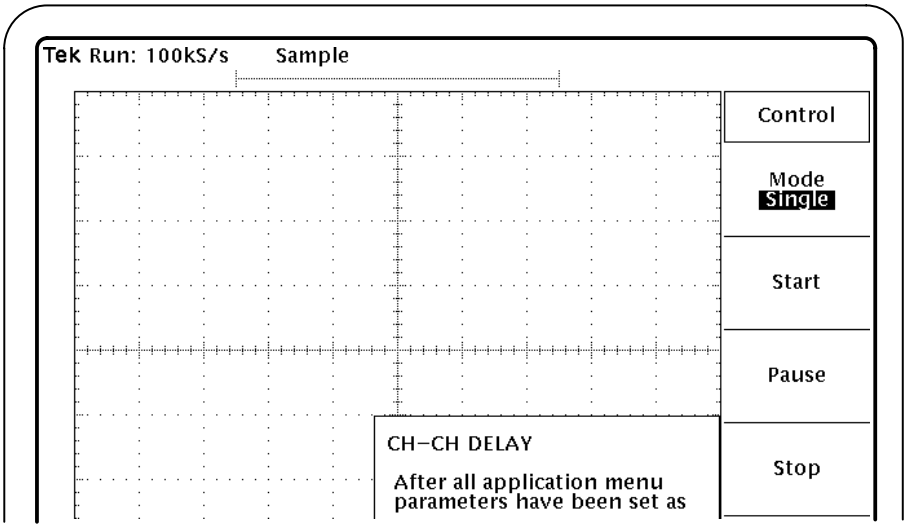


Figure 13: Control menu

2. Press Mode (side) to select Single or Free Run acquisition mode.
3. Press Start (side).

***NOTE**. Do not change oscilloscope settings while a measurement is being taken. Doing so can invalidate the measurement.*

Do not attempt to execute external GPIB commands to control the oscilloscope while running the application. Doing so may interrupt the process.

Localizing Measurements

You can control the amount of data to measure by adjusting the Record Length or Horizontal Scale in the oscilloscope horizontal menu, or the Trigger Position. By specifying the Trigger Position, the starting point, and the total length of the measurement, you can effectively size the area of interest.

***NOTE**. If an error message displays because there are not enough cycles from which to take a measurement, you should increase the Record Length.*

Viewing the Results

The application provides information on the variation of timing measurements as values in a Statistics readout, or graphically in a Histogram or a Profile format.

NOTE. *Stop the acquisition before viewing the results in a graphical format if you are operating the oscilloscope in the Free Run acquisition mode.*

Figure 14 shows an example of the results display formats.

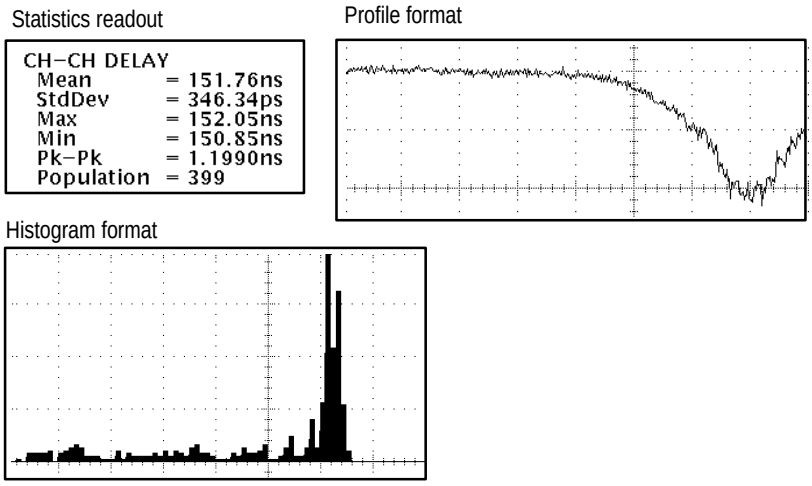


Figure 14: Example of the results display formats

NOTE. *If the application results show a Population with a value of zero, increase the Expected Range value in the Source Definition side menu items.*

Statistics

By default, the measurement results appear in the Statistics readout. The Statistics readout contains values for the mean, the standard deviation (StdDev), the peak-to-peak (Pk-Pk), the maximum (Max) and minimum (Min) values, and the population (the number of cycles used to calculate the values).

To view parts of the waveform that are obscured by the Statistics readout, push the CLEAR MENU button. To return to the application, push the SHIFT then the APPLICATION front-panel menu buttons

NOTE. *To view the waveform and the results, you can adjust the placement of the Statistics readout in the display through the Display Options side menu.*

The next figure shows how to make the Statistics readout visible or invisible.

Main menu	Side menu	Side menu item
Utility	Display Options	Dialog Box: On/Off

Graphical Formats

There are two graphical formats available: Histogram or Profile.

NOTE. *The application can display the results in a graphical format from only one AC Timing measurement. (There are five.) The last AC Timing measurement for which you select "On" is the one saved in a graphical format.*

Histogram To view the results in the Histogram format, press MORE → Ref# (main). Ref# is the reference waveform that you selected in the Store Histogram In menu item.

The horizontal axis (center and span) represents the measurement values and the vertical axis represents the number of times that the value occurred.

NOTE. *Use the Horizontal SCALE knob to adjust the horizontal scale of the waveform to fit the screen for proper viewing.*

Profile. To view the results in the Profile format, press MORE → Ref# (main). Ref# is the reference waveform that you selected in the Target menu item.

The vertical axis represents the measurement value and the horizontal axis represents the index number of the measurement. This can be useful for observing the variation of a measurement.

Clearing Results

To reset the results to zero, press Control (main) → Reset All (side). You do not have to wait for a measurement to complete to clear the results.

Saving and Recalling Setups

You can use the Save/Recall Setup menu to save and recall application setups. Figure 15 shows the Save/Recall Setup menu.

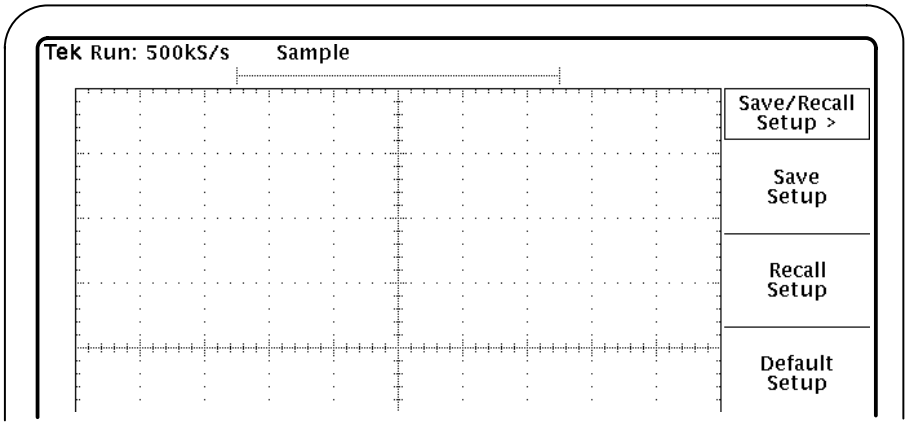


Figure 15: Save/Recall menu

The TDSPSM1 application Save/Recall function is totally independent of the primary oscilloscope Save/Recall function stored in nonvolatile RAM.

Save Setup

To save an application setup, press Utility (main) → Save/Recall Setup (side) → Save Setup (side).

The `HD0:/APP/TDSPSM1/TEMP/TDSPSM1.INI` file contains stored settings. Once you have saved a setup, you must recall it to use it again. The application always starts with the default settings.

***NOTE**. If you want to save the existing configuration, you must use Save Setup to store the present application settings.*

Recall Setup

To recall a saved application setup, press Utility (main) → Save/Recall Setup (side) → Recall Setup (side).

The application recalls the settings saved in the `HD0:/APP/TDSPSM1/TEMP/TDSPSM1.INI` file.

Default Setup

To recall the default application setup, press Utility (main) → Save/Recall Setup (side) → Default Setup (side).

The application recalls the default settings.

Exiting the Application

To exit the application, press Utility (main) → Exit (side). To confirm, press OK (side).

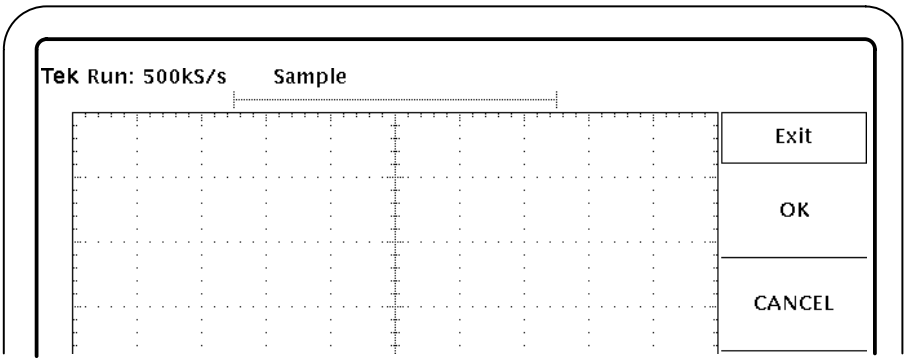


Figure 16: Exit menu

Tutorial

This tutorial teaches you how to set up, and take two types of measurements, and view the results in the various formats. In addition, it teaches you how to exit the application and how to save and recall setups. Further operating information is located in the *Operating Basics* section.

Before you begin the tutorial, you must do the following tasks:

- Set up the oscilloscope
- Start the application
- Load the reference waveforms

Setting Up the Oscilloscope

To set up the oscilloscope, follow these steps:

1. Press SETUP → Recall Factory Setup (main) → OK Confirm Factory Init (side) to set the oscilloscope to the default factory settings.
2. Press the WAVEFORM OFF button as often as necessary to remove active waveforms.

Starting the Application

To perform these lessons, the TDSPSM1 application must be installed on the oscilloscope. See *Installation* on page 3.

To start the application, refer to Figure 17, and follow these steps:

1. Press SETUP → Select Application (main).
2. Use the general purpose (GP) knob to select hd0: and press SELECT.
3. Use the GP knob to select the TDSPSM1.APP file and press Activate Application (side).

The application starts up and displays as shown in Figure 18.

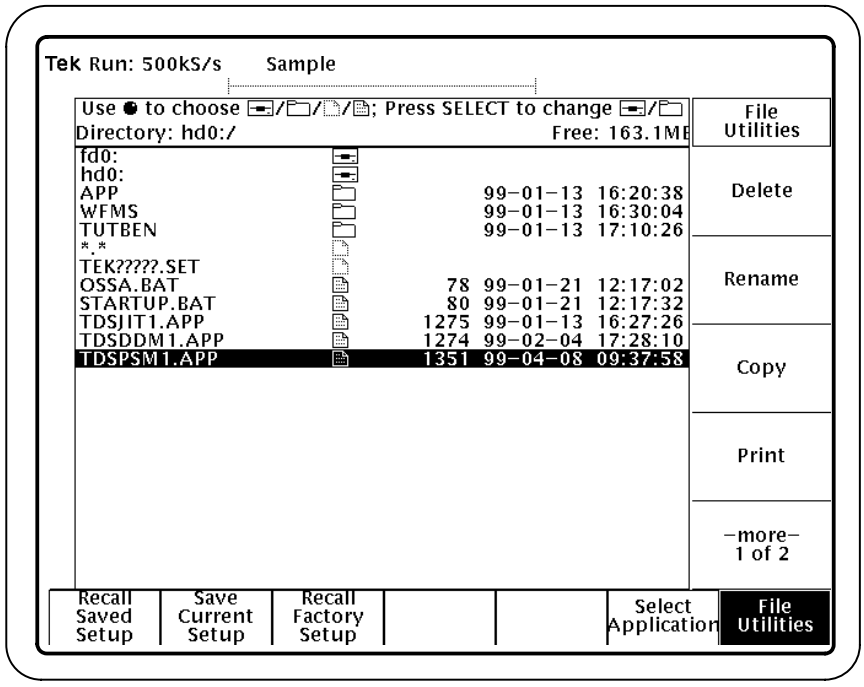


Figure 17: Starting the application

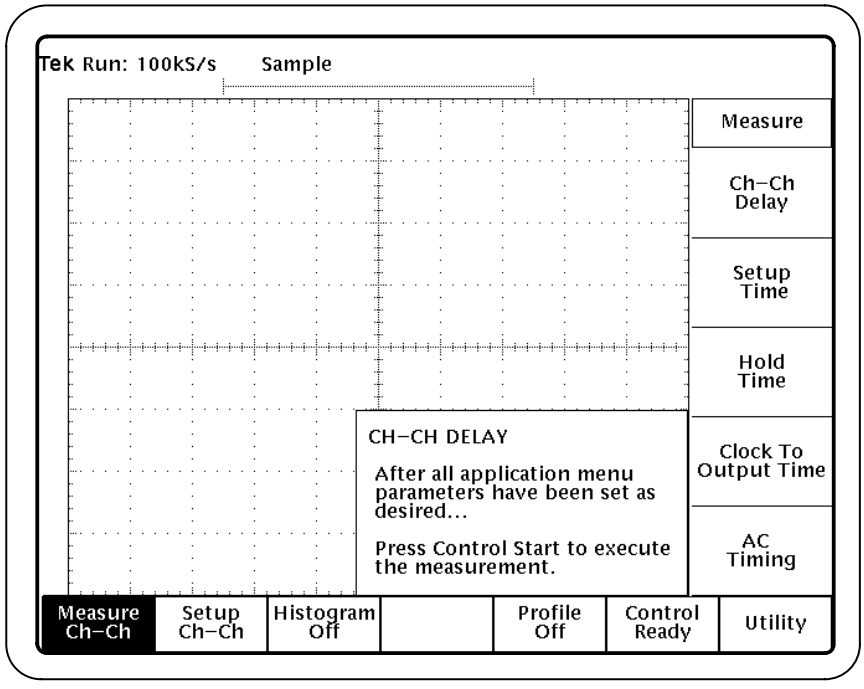


Figure 18: TDSPSM1 application initial display

Loading the Reference Waveform Files

The application includes two reference waveform files for use with this tutorial.

To load the reference waveform files, follow these steps:

1. Press WAVEFORM → Recall Wfm to Ref (main) → Recall from file (side).
2. Use the general purpose (GP) knob to select hd0: and press SELECT.
3. Use the GP knob to select WFMS and press SELECT.
4. Use the GP knob to select PRIMARY.WFM; press Ref 3 active/empty (side).
5. Press Recall from file (side).
6. Use the GP knob to select RELATIVE.WFM; press Ref 4 active/empty (side).
7. Press MORE → Ref 3 (main) to display the Primary waveform.
8. Press MORE → Ref 4 (main) to display the Relative waveform.
9. Press the SHIFT, and then the APPLICATION front-panel menu button to return to the application.

Taking Measurements from Two Waveforms

In this example, you will learn how to use the application to calculate the delay between two sources as defined by two individual reference voltage levels.

To become familiar with the Ch-Ch Delay measurement, follow these steps:

1. Press Measure (main) → Ch–Ch Delay (side).
2. Press Setup Ch–Ch (main) → From Edge (side).
   a. Press Source (side) and select Ref3. See Figure 19.
   b. Press VRef (side) and use the keypad to enter 2.0 V. See Figure 19.
   c. Press Done (side).

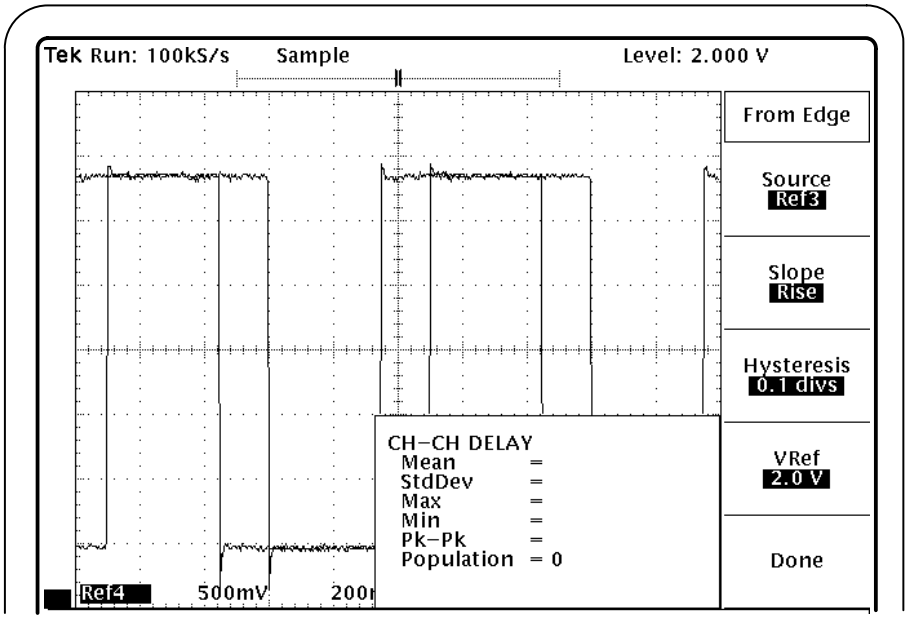


Figure 19: From Edge menu, source

3. Press To Edge (side).

a. Press Source (side) and select Ref4. See Figure 20.

b. Press VRef (side), and use the keypad to enter 2.0 V.

c. Press Done (side).

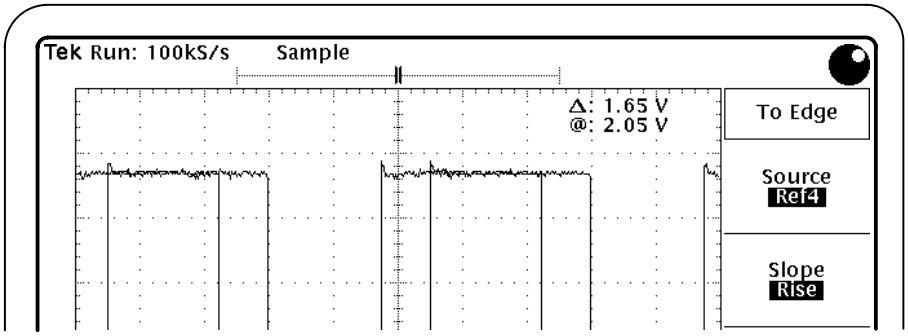


Figure 20: To Edge menu, source

Figure 21 shows the completed setup for the Ch-Ch measurement.

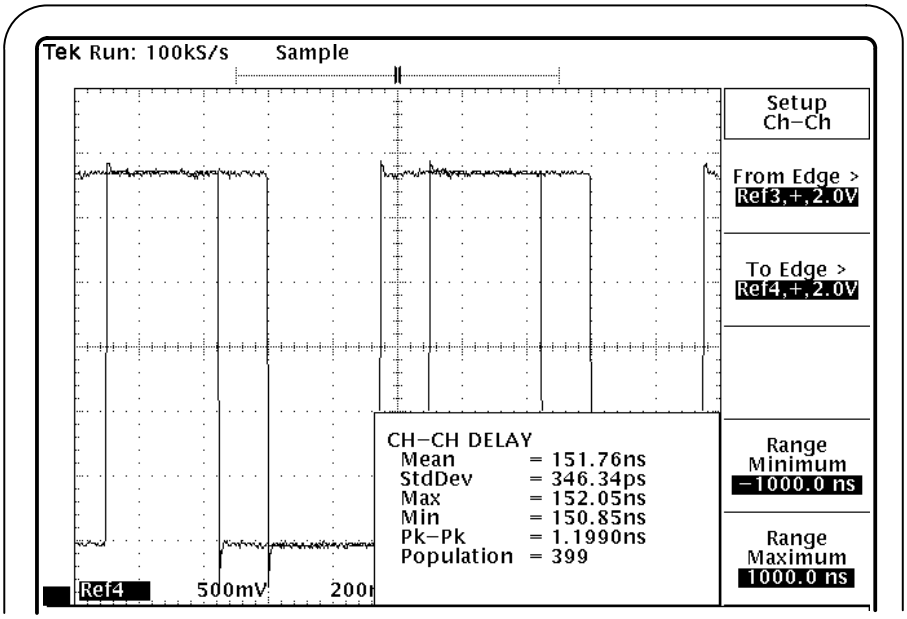


Figure 21: Ch-Ch Delay setup complete

4. To take the measurement, press Control (main) → Start (side).

NOTE. *When the input is a reference waveform, the measurement performs a single measurement cycle regardless of the acquisition mode.*

The Control menu (main) displays Control Sequencing while the application is executing. When the Control menu displays Control Ready, the application has completed the calculations.

5. Wait for the calculations to complete. Figure 22 shows the Statistics readout.

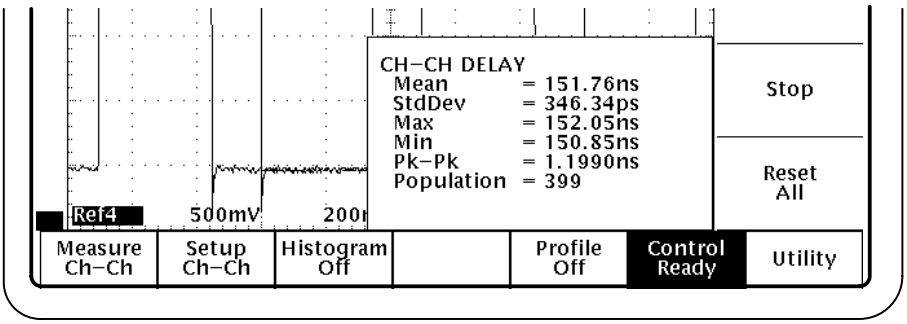


Figure 22: Ch-Ch Delay lesson: Statistics readout

6. Press Histogram (main) → On/Off (side) to select On. Ref2 appears under Histogram to indicate that the results will be stored in Ref2. See Figure 23.

   Press Autoscale (side). The value for Center (side) becomes the Mean value of the signal and the value for Span (side) is 2.1 times the Max-minus-Mean or Mean-minus-Min value, whichever is larger.

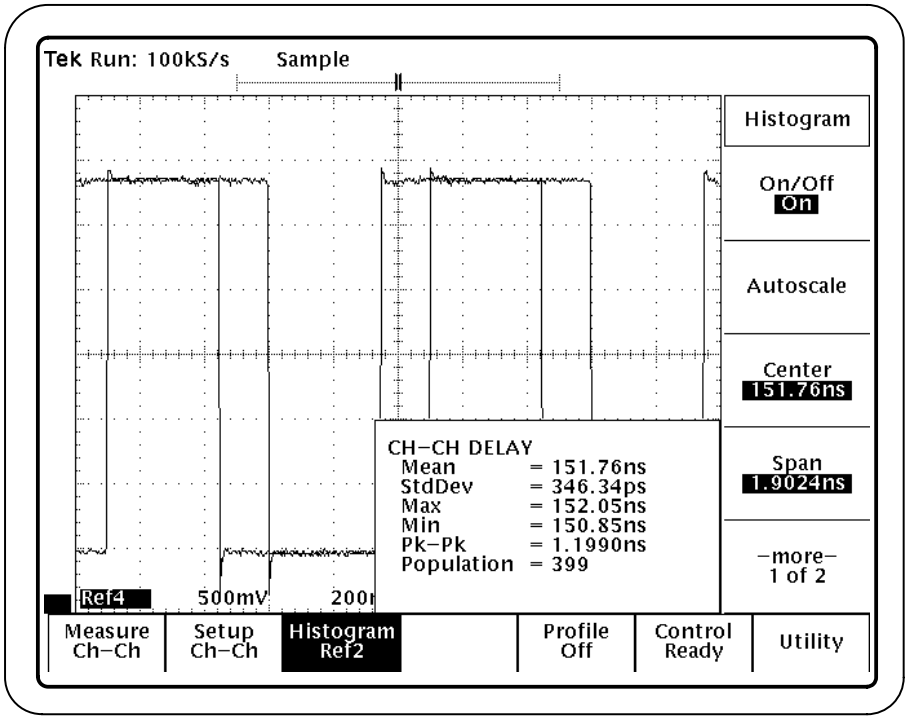


Figure 23: Histogram format menu

NOTE. *When you press Autoscale or when you press Control (main) → Reset All (side), previous measurement results stored in the histogram reference are cleared.*

7. Press Control Ready (main) → Start (side) to retake the measurements.
8. To display the Histogram graphical format, follow these steps:
   - **a.** Press the MORE button.
   - **b.** Press Ref2 to display the Histogram format.
   - **c.** Use the Horizontal SCALE knob to adjust the horizontal scale of the waveform to fit the screen.
9. Press the SHIFT, and then the APPLICATION button.

Figure 24 shows the results in the Histogram format.

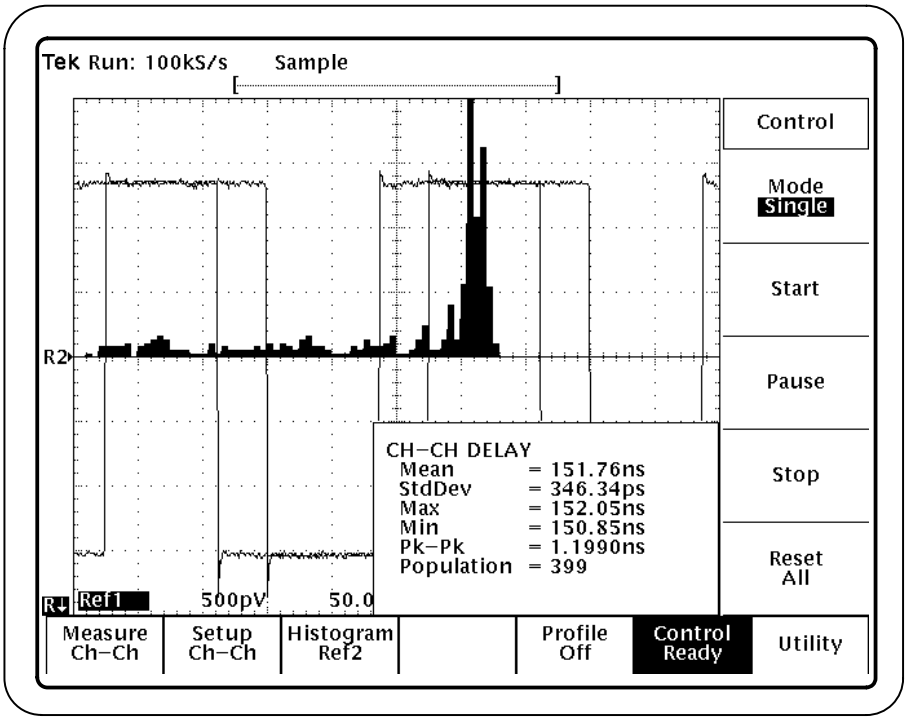


Figure 24: Ch-Ch Delay lesson: Histogram format

10. Press the CURSOR front panel button, and then select V Bars (side) to display the vertical cursors.

11. Press the SHIFT, and then the APPLICATION button.

12. Press Histogram Ref2(main) → –more– 1 of 2 → Value at V Bar:? (side) to view the measurement values at the vertical cursor. Use the GP knob to scroll through the values.

13. Press CURSOR → Off (side) to remove the vertical cursors from the display.

14. Press the MORE, and then the WAVEFORM OFF button.

15. Press the SHIFT, and then the APPLICATION button.

16. To clear the previous results, press Control (main) → Reset All (side).

17. Press Profile (main) → On/Off (side) to select On. Ref1 appears under Profile to indicate that the results will be stored in Ref1. See Figure 25.

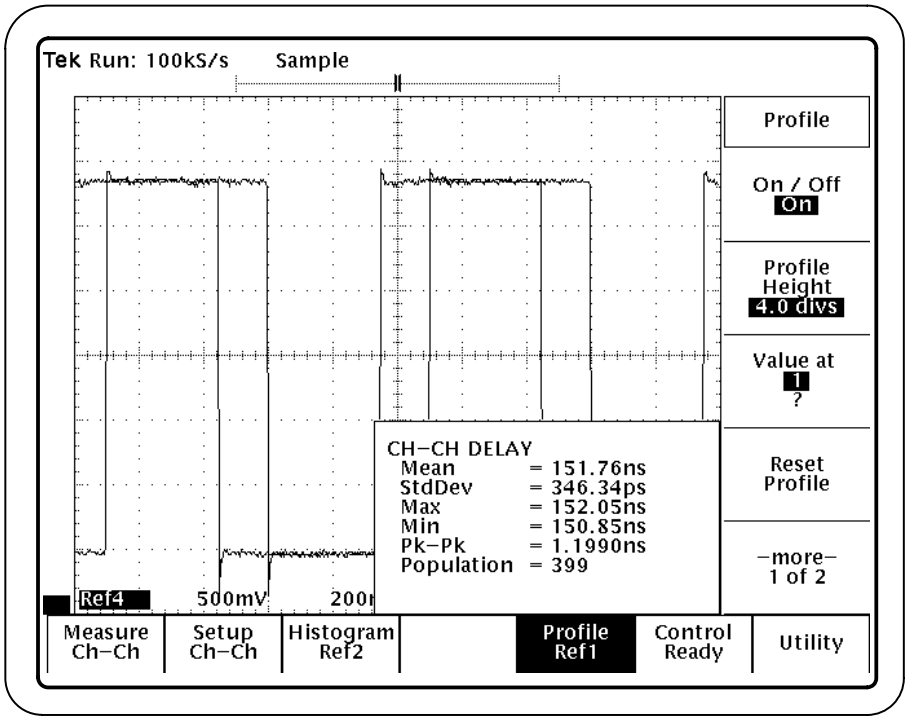


Figure 25: Profile format menu

18. Press Control (main) → Start (side) to retake the measurements.

19. To display the Profile graphical format, follow these steps:

a. Press the MORE button.

b. Press Ref1 to display the Profile format.

20. Press the SHIFT, and then the APPLICATION button.

Figure 26 shows the results in the Profile format.

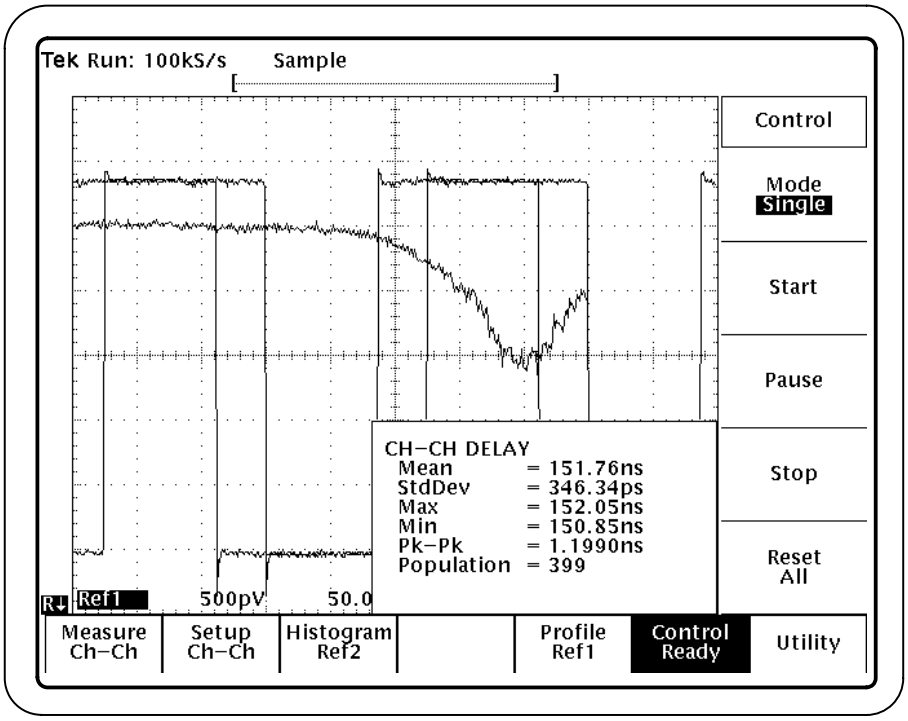


Figure 26: Ch-Ch Delay lesson: Profile format

21. Press Profile (main) → Value at ? (side) to view the measurement values by index number. Use the GP knob to scroll through the values.

You can approximate the index number based on 50 per horizontal division.

22. Press the MORE, and then the WAVEFORM OFF button.

23. Press the SHIFT, and then the APPLICATION button.

Taking AC Timing Measurements

In this lesson, you will learn how to use the application to calculate AC timing measurements as defined by reference voltage levels. You will view the results of a single measurement and of multiple measurements in the Statistics readout.

To become familiar with an AC Timing measurement, follow these steps:

1. Press the MORE → Ref 4 (main) and the WAVEFORM OFF button to remove the secondary waveform from the display.

2. Press the SHIFT, and then the APPLICATION front-panel menu button to return to the application.

3. Press Measure (main) → AC Timing (side).
4. Press Setup AC Timing (main) → Input (side). See Figure 27.
   a. Press –more– 1 of 2 (side) → VRefHi (side) and use the GP knob to enter 3.0V.
   b. Press VRefLo (side) and use the GP knob to enter 1.0 V.
   c. Press Done (side). See Figure 28.

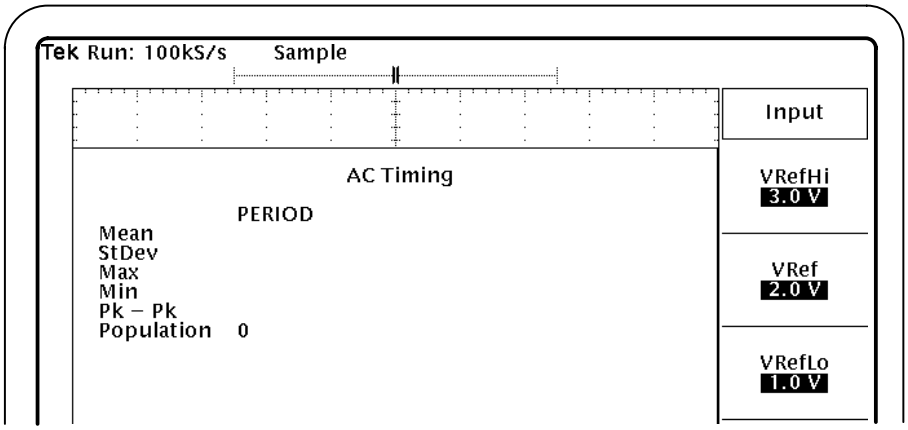


Figure 27: Input menu voltage reference levels

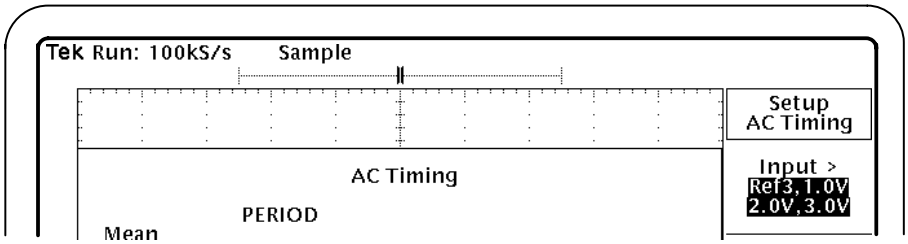


Figure 28: AC Timing setup complete

5. To clear the previous results, press Control (main) → Reset All (side).
6. To see the waveforms and the Statistics readout, press Utility (main) → Display Options (side) → Box Style and select transparent.
7. To take the measurement, press Control (main) → Start (side).

NOTE. *When the input is a reference waveform, the measurement performs a single measurement cycle regardless of the acquisition mode.*

8. Wait for the calculations to complete. Figure 29 shows the Statistics readout for the Period measurement only.

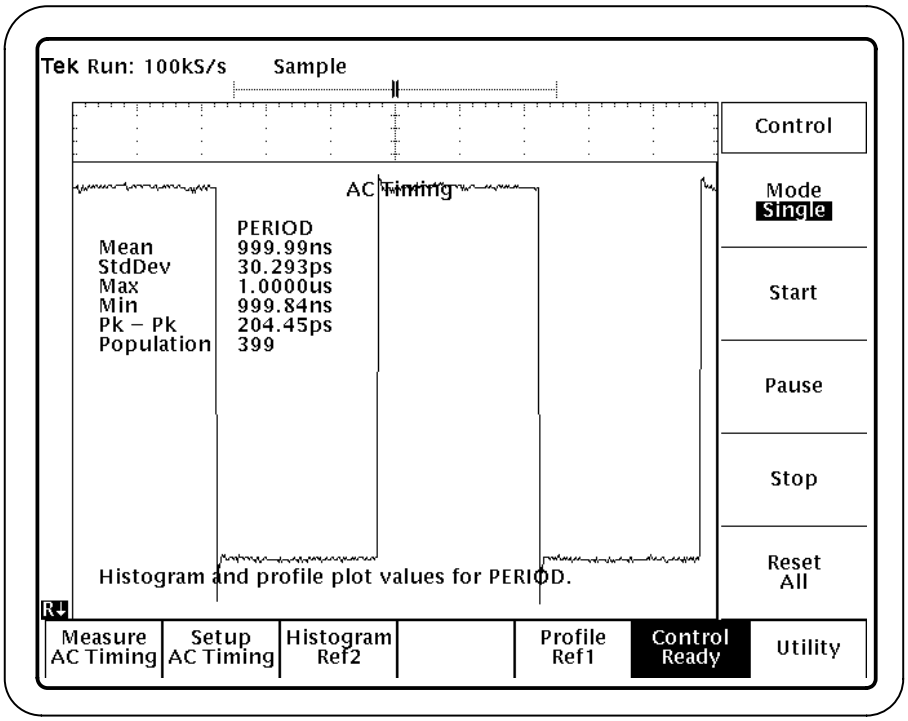


Figure 29: AC Timing lesson, Period measurement: Statistics readout

9. Press Setup AC Timing (main) → Select Measurements (side), and select "ON" for each measurement. See Figure 30.

10. Press – more – 1 of 2 (main) → Done (side).

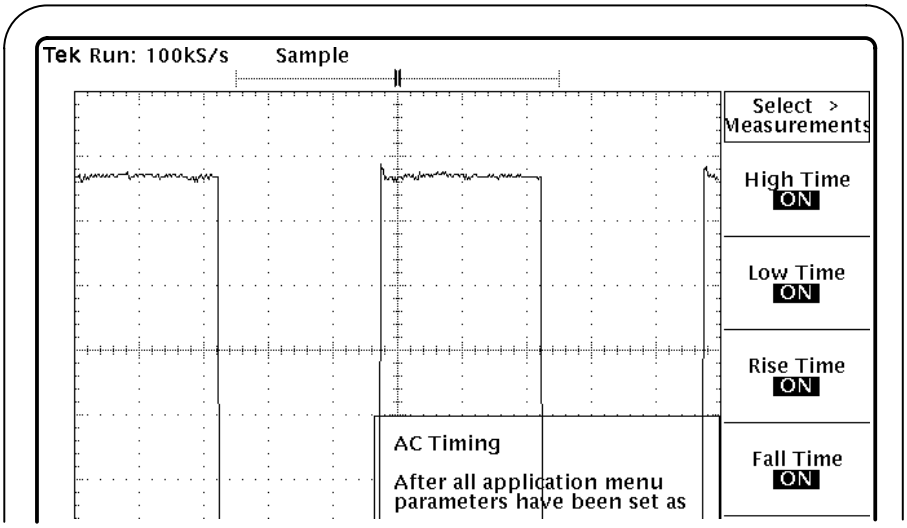


Figure 30: All AC Timing measurements selected

11. To clear the previous results, press Control (main) → Reset All (side).

12. To take the measurement, press Start (side). Figure 31 shows the results.

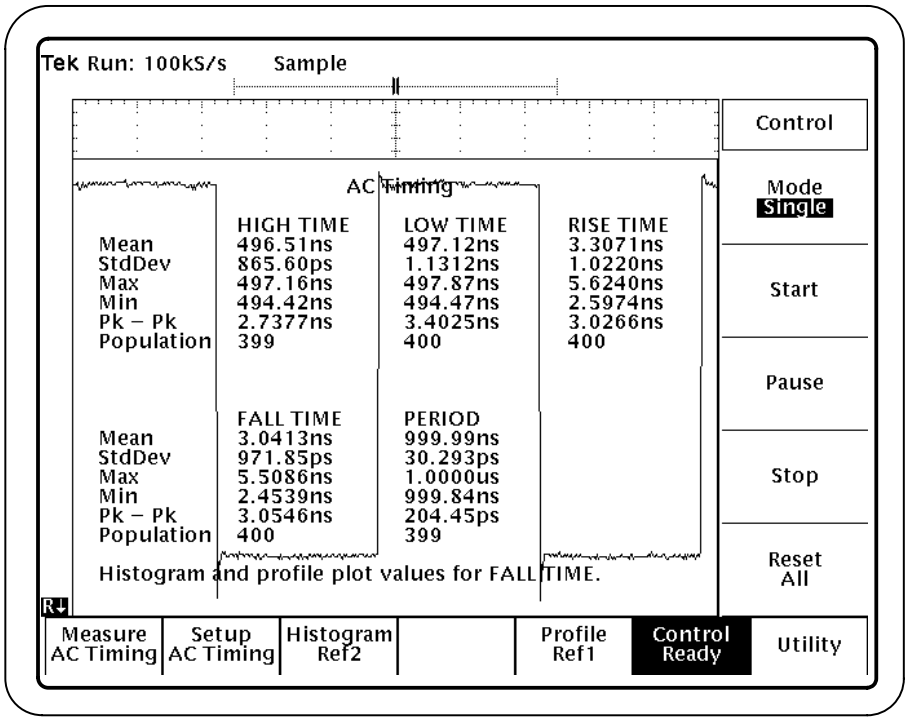


Figure 31: All AC Timing measurements lesson: Statistics readout

NOTE. *The message in the bottom of the display also changed to remind you of which measurement results are currently stored in the histogram and profile reference waveforms.*

13. To display the results in the other formats, follow steps 6 through 23 starting on page 30. These steps include how to view individual measurement values and remove the formats from the display.

NOTE. *To view vertical values in a Histogram or Profile format, press Utility (main) → Display Options (side) → Dialog Box and select Off.*

Stopping the Tutorial

If you need more than one session to complete the tutorial lessons, you can stop the tutorial and return to it another time. To do so, you will need to save the oscilloscope setup and then the application setup.

To save the oscilloscope setup, refer to the user manual for your oscilloscope. The procedure varies between models. The setup is always saved in the APPS/TDSPSM1/TEMP directory on the oscilloscope.

To save the application setup and stop your session, refer to *Saving a Setup* on page 22 and to *Exiting the Application* on page 23.

Returning to the Tutorial

To return to the tutorial setup, you can recall the saved oscilloscope setup from the hard disk, and then restart the application.

To recall the oscilloscope setup, refer to the user manual for your oscilloscope. The procedure varies between models.

To recall the application setup, refer to *Recalling a Setup* on page 22.

Reference

Menu Structure

Figure 32 shows the relationship of the application-specific menus.

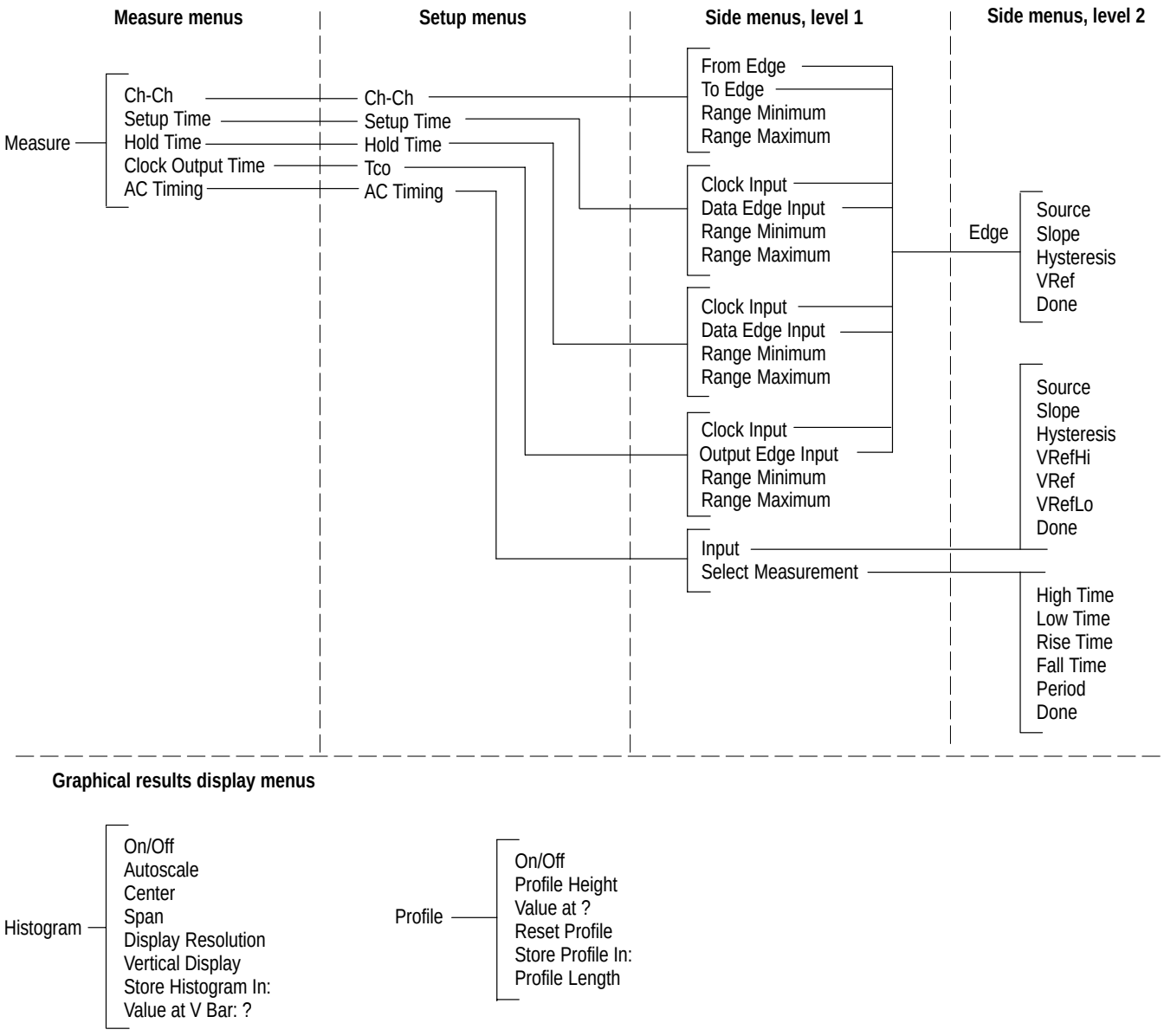


Figure 32: Application-specific menu structure

Figure 33 shows the structure of the Control and Utility menus.

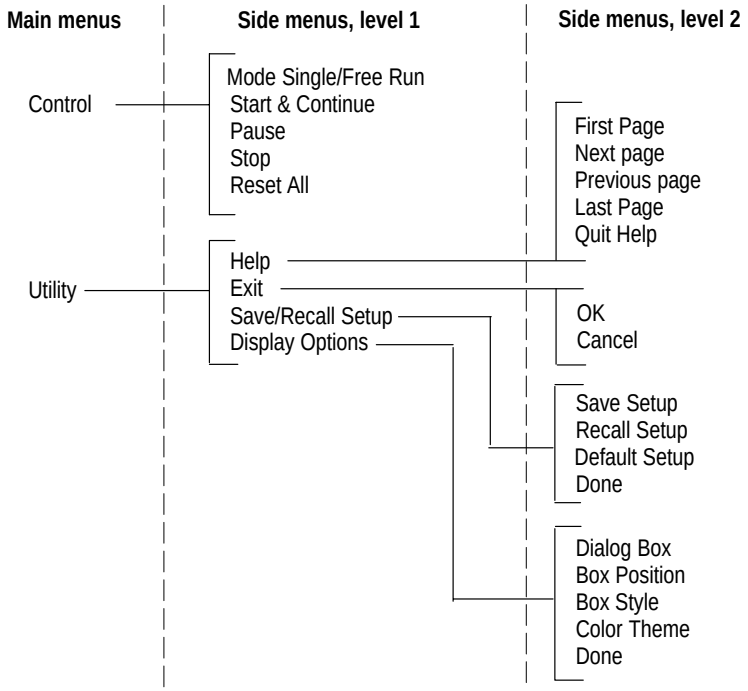


Figure 33: Control and Utility menu structures

Parameters Reference

This section describes the TDSPSM1 application parameters. You should refer to the user manual for your oscilloscope for operating details associated with each front-panel menu button.

Measurement Setup Menus

Table 13 lists the setup menu for each measurement, the parameters, and the selections or range of values available for each.

Table 13: Setup menus and parameters

Measurement	Parameters	Selections
Ch-Ch Delay	From Edge*	
	To Edge*	
	Range Minimum	–1,000 ns to 999.9 ns in 0.1 ns units
	Range Maximum	–999.9 ns to 1000 ns in 0.1 ns units
Setup Time Hold Time	Clock/Trigger Input* Data Edge Input*	
	Range Minimum	–1,000 ns to 999.9 ns in 0.1 ns units
	Range Maximum	–999.9 ns to 1000 ns in 0.1 ns units
Clock Output Time	Clock/Trigger Input*	
	Output Edge Input*	
	Range Minimum	–1,000 ns to 999.9 ns in 0.1 ns units
	Range Maximum	–999.9 ns to 1000 ns in 0.1 ns units
AC Timing	Input*	
	Select Measurement	Rise Time, Fall Time, High Time, Low Time and/or Period

*** Refer to Table 14.**

The application can display the results from one to five AC Timing measurements in the Statistics readout.

Waveform Sources

Table 14 lists the parameters for each waveform source used in the setup menus, and the selections or range of values available for each.

Table 14: Waveform source parameters

Parameter	Selections	Comments
Source	Ch1, Ch2, Ch3, Ch4, Ref1, Ref2, Ref3, Ref4, Math1, Math2, Math3	One source is allowed for each input of a measurement.
Slope	Rise, Fall, Transitional	Transitional is when the voltage crosses the reference level on both rising and falling edges of a waveform.
VRefHi*	–5.0 V to 5.0 V in 1 mV units	If the reference voltage level(s) plus or minus the hysteresis falls outside of 2.5% to 97.5% of the waveform peak-to-peak range, the application does not take any measurements.
VRef	–5.0 V to 5.0 V in 1 mV units	
VRefLo*	–5.0 V to 5.0 V in 1 mV units	
Hysteresis	0 divisions to 1 division in 0.1 units	

***Only required for AC TIming measurements.**

Histogram Graphical Format

Table 15 lists the parameters for the Histogram format and the selections or range of values available for each.

Table 15: Histogram format parameters

Parameter	Selections	Comments
On/Off	On, Off	Stores the results, but does not automatically display them.
Autoscale	None	After taking measurements, uses the results to determine logical values for Center and Span.
Center	–500 to 500 ms in 5 ps units	Use Autoscale to determine a logical value.
Span	10 ps to 1 s in 5 ps units	Use Autoscale to determine a logical value.
Display resolution	High, Medium, Low	The default selection is medium.
Vertical Display	Linear, Log (logarithmic)	The default selection is Linear.

Table 15: Histogram format parameters (Cont.)

Parameter	Selections	Comments
Store Histogram In	Ref1, Ref2, Ref3, Ref4	To display the results, you must press the MORE front panel button and select the reference waveform.
Value at V Bar: ?	None	Press the Cursor front panel button and select V Bars to display values.

NOTE. *The application can display the results in a graphical format from only one AC Timing measurement. (There are five.) The last AC Timing measurement for which you select "On" is the one saved in a graphical format.*

Profile Graphical Format

Table 16 lists the parameters for the Profile format and the selections or range of values available for each.

Table 16: Profile format parameters

Parameter	Selections	Comments
On/Off	On, Off	Stores the results, but does not automatically display them.
Profile Height	0.5 divs to 8.0 divs in 0.5 divisions	The default value is 4 divisions.
Value at _ ?	None	Use the GP knob to scroll through the values by index number. You can approximate the index number based on 50 per horizontal division.
Reset Profile	None	Resets profile waveform results to zero.
Store Profile In:	Ref1, Ref2, Ref3, Ref4	To display the results, you must press the MORE front panel button and select the reference waveform.
Profile Length	500, 1000, 2500, 5000, 15000	The default value is 500.

Control Menu

Table 17 lists the parameters for the Control menu and the selections or range of values available for each.

Table 17: Control menu parameters

Parameter	Selections	Comments
Mode	Single, Freerun	Use Single for one acquisition; use Freerun for continuous acquisitions.
Start/ Continue	None	Starts the acquisition. Continues if the acquisition was paused.
Pause	None	Pauses the acquisition
Stop	None	Stops the acquisition
Reset All	None	Resets all results (numeric and graphic) to zero. Use this function when you change any acquisition settings.

Utility Menu

Table 18 lists each utility menu, the parameters and the selections or range of values available for each.

Table 18: Utility menus and parameters

Utility	Parameters	Selections	Comments
Help	Refer to Figure 33 on page 40.	None	Help returns to the last page viewed.
Exit	Refer to Figure 33 on page 40.	None	Stops the application and returns to the oscilloscope functions
Save/Recall Setup	Save Setup	None	Saves the current setup.
	Recall Setup	None	Recalls the last saved setup
	Default Setup	None	Recalls the default factory setup.
Display Options	Dialog Box	On, Off	Makes dialog boxes visible or invisible
	Box Position*	Left, Middle, Right	The default selection is Right.
	Box Style	Opaque, Transparent	The default is Opaque.
	Color Theme	Based on the TDS oscilloscope choices.	Colors affect dialog boxes and waveforms.

*** Box position is fixed when taking AC Timing measurements.**

Appendix

Appendix A: Measurement Algorithms

The TDSPSM1 application can take timing measurements from one or two waveforms. Dual waveform measurements are: Channel-to-Channel Delay, Setup Time, Hold Time, and Clock Output Time. Single waveform (AC Timing) measurements are: High Time, Low Time, Rise Time, Fall Time, and Period.

Oscilloscope Setup Guidelines

For all measurements, use the following guidelines to set up the oscilloscope:

1. The signal is any channel, reference waveform, or math waveform.
2. The vertical scale for the waveform must be set so that the waveform does not exceed the vertical range of the TDS oscilloscope.
3. The time per division must be set small enough to capture sufficient waveform detail and avoid aliasing.
4. Longer record lengths increase measurement accuracy.

Test Methodology

The application performs the measurement according to the following algorithm:

1. Imports the current waveform.
2. Checks that the reference voltage level plus or minus half the hysteresis are within the 2.5% to 97.5% range of the peak-to-peak waveform values.
3. Checks that there are a minimum of two edges in the waveform to calculate the measurement.
4. Performs the measurement within the time constraints specified in the Range Minimum and Range Maximum menu items.
5. Uses the results in the Statistics readout, or saves the results formatted graphically in a reference waveform.

NOTE. *To take measurements from two waveforms, the application limits the search area to the value in the Expected Range menu item (through the setup menu). Be sure to carefully calculate the Expected Range value.*

Edge-Timing Measurements

All timing measurements are based on the time locations of edges within each acquisition. Edge conditions are defined in the setup menu of each timing measurement. T_n represents the acquisition edge times where *n* is an index between 1 and the number of edges in the acquisition.

The “i” and “j” represent dissimilar acquisition indices.Dissimilar acquisition indices occur when the correlation between clock edges and a data transitions are not one-to-one.

Dual Waveform Measurements

Edge conditions are defined for two waveforms. These algorithms use the VRef values as the reference voltage level. Each edge is defined by the slope, voltage reference level (threshold), and hysteresis.

Channel-to-Channel Delay Measurement

The Channel-to-Channel Delay measurement is the difference in time between the designated edge of a principal waveform and the designated edge of a relative waveform.

The application calculates this measurement using the following equation:

$$D_n = T_i - T^S_j$$

Where: *D* is the delay between the designated edges.

T is the edge position of the principal waveform.

T^S is the edge position of the relative waveform nearest the designated edge of the principal waveform.

The value of D_n is only measured if T_i and T^S_j are within the time constraints specified in the Range Minimum and Range Maximum menu items.

Setup Time Measurement

The Setup Time measurement is the elapsed time between the designated edge of a data waveform and when the clock waveform crosses its own voltage reference level.

The application calculates this measurement using the following equation:

$$S_n = T_i - T^d_j$$

Where: *S* is the setup time.

T is the edge position of the clock waveform.

T^d is the edge position of the data waveform.

The value of S_n is only measured if T_i and T^d_j are within the time constraints specified in the Range Minimum and Range Maximum menu items.

Hold Time Measurement

The Hold Time measurement is the elapsed time between when the clock waveform crosses its own voltage reference level and the designated edge of a data waveform.

The application calculates this measurement using the following equation:

$$H_n = T^d_j - T_k$$

Where: *H* is the hold time.

T is the edge position of the clock waveform.

T^d is the edge position of the data waveform.

The value of H_n is only measured if T^d_j and T_k are within the time constraints specified in the Range Minimum and Range Maximum menu items.

Clock-to-Output Time Measurement

The Clock-to-Output Time measurement is the elapsed time between when the clock waveform crosses its own voltage reference level and the designated edge of a data waveform.

The application calculates this measurement using the following equation:

$$T_{CO_n} = T^o_i - T_j$$

Where: T_{co} is the clock-to-output time.

T is the edge position of the clock waveform.

T^o is the edge position of the resultant output waveform.

The value of T_{COn} is only measured if T^o_i and T_j are within the time constraints specified in the Range Minimum and Range Maximum menu items.

Single Waveform Measurements

AC Timing is the single waveform measurement supported by the TDSPSM1 application. In the AC Timing measurements, edge conditions are defined for one waveform by the slope, voltage reference levels (threshold), and hysteresis.

Most of the AC Timing algorithms use both the VRefHi and VRefLo reference voltage levels. The Period measurement uses only the VRef value as the reference voltage level and ignores the values of VRefHi and VRefLo.

High Time Measurement

The High Time measurement is the amount of time that a waveform cycle is above the VRefHi voltage reference level.

The application calculates this measurement using the following equation:

$$T^H_n = T^F_n - T^R_n$$

Where: T^H is the high time.

T^F is the VRefHi crossing on the falling edge.

T^R is the VRefHi crossing on the rising edge.

Low Time Measurement

The Low Time measurement is the amount of time that a waveform cycle is below the VRefLo voltage reference level.

The application calculates this measurement using the following equation:

$$T^L_n = T^R_n - T^F_n$$

Where: T^L is the low time.

T^R is the VRefLo crossing on the rising edge.

T^F is the VRefLo crossing on the falling edge.

Rise Time Measurement

The Rise Time measurement is the time difference between when the VRefHi reference level is crossed and the VRefLo reference level is crossed on the rising edge of the waveform.

The application calculates this measurement using the following equation:

$$T^R_n = T^{RefHi}_n - T^{RefLo}_n$$

Where: T^R is the rise time.

T^{RefHi} is the VRefHi crossing on the rising edge.

T^{RefLo} is the VRefLo crossing on the rising edge.

Fall Time Measurement

The Fall Time measurement is the time difference between when the VRefLo reference level is crossed and the VRefHi reference level is crossed on the falling edge of the waveform.

The application calculates this measurement using the following equation:

$$T^F_n = T^{RefLo}{}_n - T^{RefHi}{}_n$$

Where: T^F is the fall time.

T^{RefLo} is the VRefLo crossing on the falling edge.

T^{RefHi} is the VRefHi crossing on the falling edge.

Period Measurement

The Period measurement calculates the duration of a cycle as defined by a waveform crossing a specific voltage reference level twice.

The application calculates this measurement using the following equation:

$$P_n = T_{n+1} - T_n$$

Where: P is the period.

T is the VRef crossing on the designated edge.

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