User Manual

Tektronix

TDSJIT2
Jitter Analysis Measurements Application

071-0814-02

This document supports software version 1.0.0
and above.

www.tektronix.com

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

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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.

To Avoid Fire or Personal Injury

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Symbols and Terms

Terms in this Manual. These terms may appear in this manual:

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

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product. These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product. The following symbol may appear on the product:

CAUTION Refer to Manual

Preface

This manual contains operating information for the TDSJIT2 Jitter Analysis Application. The manual consists of the following chapters:

- The *Getting Started* chapter briefly describes the TDSJIT2 Jitter Analysis Application, lists oscilloscope compatibility, and provides installation instructions.
- The *Operating Basics* chapter 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.

  To show you how to operate the application using GPIB commands, this chapter includes a simple GPIB program.
- The *Reference* chapter includes a diagram of the menu structure and descriptions of parameters.
- The *Measurement Algorithms* appendix contains information on measurement guidelines and on how the application takes the measurements.
- The *GPIB Command Syntax* appendix contains a list of arguments and values that you can use with the GPIB commands and their associated parameters.

Related Documentation and Online Help

You can access information on how to operate the oscilloscope and application through the following related documents and online help:

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

Application Online Help. The application has an online help system that covers all its features. You can access the help topics through a table of contents or index.

Programmer Information. The online help for your oscilloscope provides details on how to use GPIB commands to control the oscilloscope.

You can also download this file with examples from the www.Tektronix.com web site. Refer to *Updates Through the Web Site* on page 1–2 for information on how to download the file.

Installation Manual. The *Optional Applications Software on Windows-Based Oscilloscopes Installation Manual* contains the following information:

- Software warranty (same as in this manual)
- Software license agreement
- List of all available applications, compatible oscilloscopes, and relevant software and firmware version numbers
- How to apply a new label
- Installation instructions based on the type of oscilloscope,
- How to enable an application
- How to download updates from the Tektronix web site

NOTE. *The installation manual always contains the most up-to-date information and procedures. Since installation procedures may be different for the TDS7000 series and subsequent oscilloscopes, be sure to check the installation manual before you install the application software.*

You can find a portable document format (PDF) file of the installation manual in the Documents directory on the *Optional Applications Software on Windows-Based Oscilloscopes Installation CD-ROM*.

Conventions

This manual uses the following conventions:

- This manual refers to the TDSJIT2 Jitter Analysis Application as the TDSJIT2 application or as the application.
- This manual refers to any product on which this application will run as an oscilloscope
- When steps require that you make a sequence of selections using the application interface, the > delimiter marks each transition menus and options. For example, one of the steps to recall a setup file would appear as Measurements> Save/Recall> Recall.

Contacting Tektronix

Phone	1-800-833-9200*
Address	Tektronix, Inc. Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, OR 97077 USA
Web site	www.tektronix.com
Sales support	1-800-833-9200, select option 1*
Service support	1-800-833-9200, select option 2*
Technical support	Email: techsupport@tektronix.com 1-800-833-9200, select option 3* 1-503-627-2400 6:00 a.m. – 5:00 p.m. Pacific time

* **This phone number is toll free in North America. After office hours, please leave a voice mail message.**
Outside North America, contact a Tektronix sales office or distributor; see the Tektronix web site for a list of offices.

Getting Started

Product Description

The TDSJIT2 Jitter Analysis Application is a Java-based application that enhances basic capabilities of some Tektronix oscilloscopes.

The application provides jitter analysis measurements, can display the statistical results of up to six measurements, can display the results as plots, can save the results to a data log file, and can save the worst case waveforms to files.

Figure 1–1 shows an example of statistical results for a Clock Period measurement in the application part of the display (lower half) and a Histogram plot of those results in the oscilloscope part of the display (upper half).

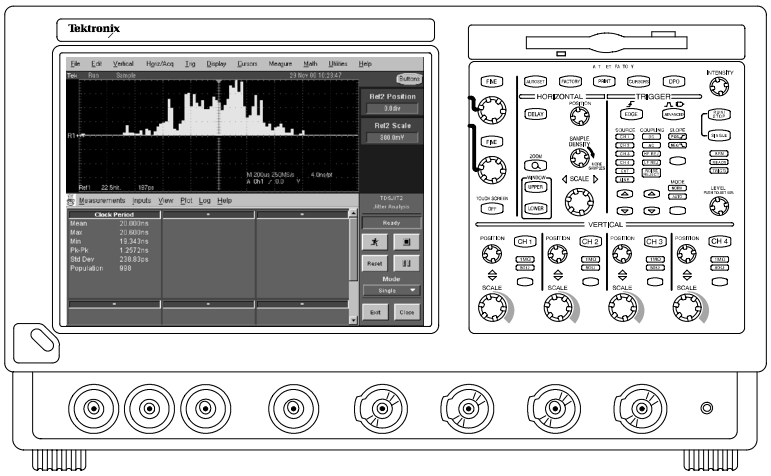

Figure 1–1: TDSJIT2 Jitter Analysis Application

Compatibility

The Jitter Analysis Application is compatible with several TDS7000 series oscilloscopes. Table 1–1 lists the oscilloscopes and firmware version numbers.

Table 1–1: Compatible oscilloscopes

Model number*	Firmware version
TDS7054 and TDS7104	1.2.0 and above
TDS7404	1.3.0 and above
TDS7254	1.3.1 and above
TDS5054 and TDS5104	1.0.0 and above

*** For a current list, see the Software and Drivers category on www.tektronix.com.**

Requirements and Restrictions

The Sun™ Java Run-Time Environment V1.2.2 or above must be installed on the oscilloscope to operate the TDSJIT2 application.

NOTE. *This application may be compatible with future models of oscilloscopes that have different specifications. If this occurs, menus or options that are unavailable will appear dim if they are beyond the acquisition capability of the oscilloscope.*

Updates Through the Web Site

You can find information about this and other applications at the Tektronix Inc. web site, www.tektronix.com. Check this site for application updates and for other free applications.

To install an application update, you will need to download it from the Tektronix web site to the oscilloscope hard disk.

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

To download an application from the web site, follow these steps:

1. Access www.tektronix.com/Software & Drivers/Oscilloscopes.
2. Scroll through the files to the application that you want, select the file, and download it to your hard disk drive. If necessary, unzip the file.

   If your oscilloscope is connected to a network, you do not need to follow the remaining steps.
3. If your oscilloscope is not connected to a network, copy the application from the hard disk to blank, DOS-formatted floppy disks.

NOTE. *To ensure that the files were downloaded successfully, always unzip the files on a hard disk before copying them to floppy disks.*

4. To install the application, follow the *From Floppy Disks* procedure on page 1–5.

Accessories

There are no standard accessories for this product other than this manual.

Installation

This section contains information on the following tasks:

- Applying a new label
- Installing the TDSJIT2 application
- Enabling the application
- Deskewing the probes and channels
- Connecting to a system under test

***NOTE**. The* Optional Applications Software on Windows-Based Oscilloscopes Installation Manual *contains up-to-date information and procedures. Since installation procedures may be different for the TDS7000 series and other oscilloscopes, be sure to check this manual before you install the software.*

You can find a portable document format (PDF) file of the installation manual in the Documents directory on the *Optional Applications Software on Windows-Based Oscilloscopes Installation CD-ROM*.

Applying a New Label

If you receive a newer version of this application, or purchase an application that did not exist when you bought your oscilloscope, you need to apply a new label to the rear panel of the oscilloscope. The label contains important information, such as the serial number of the oscilloscope, options purchased for that serial number, and an authorized Option Installation key number. Each label is unique.

Figure 1-2 shows where to apply the new label on the back of a TDS7000 series oscilloscope.

Figure 1-3 shows where to apply the new label on the back of a TDS5000 series oscilloscope.

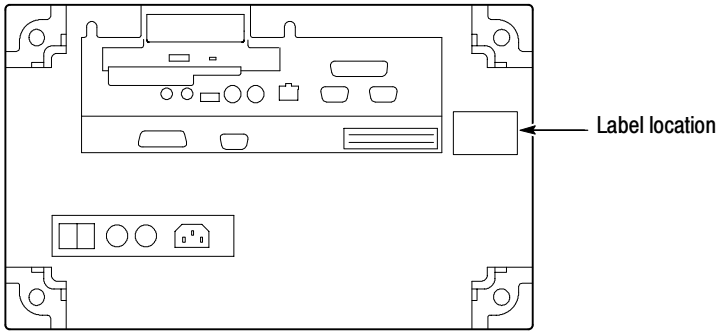

Figure 1- 2: TDS7000 series oscilloscope label location

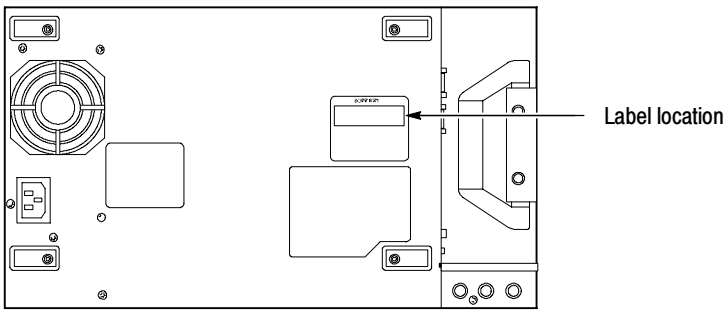

Figure 1- 3: TDS5000 series oscilloscope label location

Installing the Application

Normally, the TDSJIT2 application resides on the hard disk drive of your oscilloscope. However, you may still need to install the application software for the following reasons:

- You receive an application introduced after you received your oscilloscope
- You have to rebuild the hard drive

NOTE*. To operate the TDSJIT2 application, the Java Run-time Environment (JRE) V1.2.2 or above must be installed on your oscilloscope.*

If the JRE is not installed, a message displays when you try to start the application. If the message appears, reinstall the JRE from the optional applications software for Windows-based oscilloscopes compact disc (CD).

From the Compact Disc

To install the TDSJIT2 application from the optional applications software for Windows-based oscilloscopes CD, follow these steps:

1. If the keyboard is not installed, connect it to the oscilloscope rear panel (the optional-accessory keyboard plugs into the USB connector).
2. Power on the oscilloscope to start Windows.
3. Install the optional applications software CD in the CD-ROM reader on the rear-panel of the oscilloscope.
4. Select the My Computer icon.
5. In the Exploring – My Computer window, select the D: (CD-ROM) drive.
6. The Java Run-time Environment software must be installed before you can install optional application software. If the Java Run-time Environment software is already installed, skip to step 7; otherwise, follow these steps:
   a. Select the Jre directory.
   b. Select the .exe file in the Jre directory.
   c. Accept all default settings recommended by the install program.
7. Select the Tdsjit2 directory.
8. Select the Setup.exe file to start the install program.
9. Follow the instructions given by the install program. The oscilloscope must reboot to complete the installation process.

From Floppy Disks

To install the TDSJIT2 application from floppy disk, follow these steps:

1. Power on the oscilloscope to start Windows.
2. Insert disk #1 in the floppy disk drive.
3. Select the My Computer icon.
4. In the Exploring – My Computer window, select the A: (3 1/2 Floppy) drive.

***NOTE**. Additional information about the application or installation is located in a* Readme.txt *file on the floppy disk. Read the file before you continue.*

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

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5. Select the Setup.exe file to start the install program.
6. Follow the on-screen instructions.

Wait until after the floppy disk drive LED has gone out to remove each floppy disk and insert another.

7. When the installation is complete, the oscilloscope will restart. You need to remove the final floppy disk when prompted.

Enabling the Application

You will need to enter the authorized Option Installation Key to enable the application. The key is specific to the serialized oscilloscope and options for which it was purchased.

NOTE. *Do not enter this key until all application software that you have purchased has been installed.*

To enter the key number, follow these steps:

1. If the oscilloscope powered on in the toolbar mode (default), select the Menu button (upper right corner of the display) to put the oscilloscope into menu-bar mode. In menu-bar mode you should see a PC-style menu across the top of the display.
2. Go to the Utility menu in the menu bar and select Option Installation.
3. Follow the on-screen instructions to enter the alphanumeric key number exactly as it is printed on the rear-panel label. Figure 1–2 on page 1–4 shows the location of the label on the back of the oscilloscope.

Deskewing the Probes and Channels

To ensure accurate results for two-channel measurements, it is important to first deskew the probes and oscilloscope channels before you take measurements from your system under test (SUT). Deskewing is where the oscilloscope adjusts the relative delay between signals to accurately time correlate the displayed waveforms.

NOTE. *To produce good deskew results, you should connect the probes to the fastest signal in your SUT.*

The application includes an automated deskew utility that you can use to deskew any pair of oscilloscope channels. The following procedure describes how to deskew two channels. Channel 1 (and the probe connected to it) is the reference point used to deskew channel 2. The steps to deskew the third and fourth channels are the same.

To deskew a pair of probes and oscilloscope channels, follow these steps:

1. Follow the procedure on page 1–9 to connect similar probes to CH1 and CH2 on the oscilloscope.
2. Connect the probes to the fastest signal in your SUT.
3. Set up the oscilloscope as follows:
   a. Use the Horizontal Scale knob to set the oscilloscope to an acquisition rate so that there are two or more samples on the deskew edge.
   b. Use the Vertical Scale and Position knobs to adjust the signals to fill the display (view the full amplitude) without missing any part of the signals.
   c. Set the Record Length so that there are more than 100 edges in the acquisition.

   Figure 1–4 shows an example of signal path skew found in similar probes.

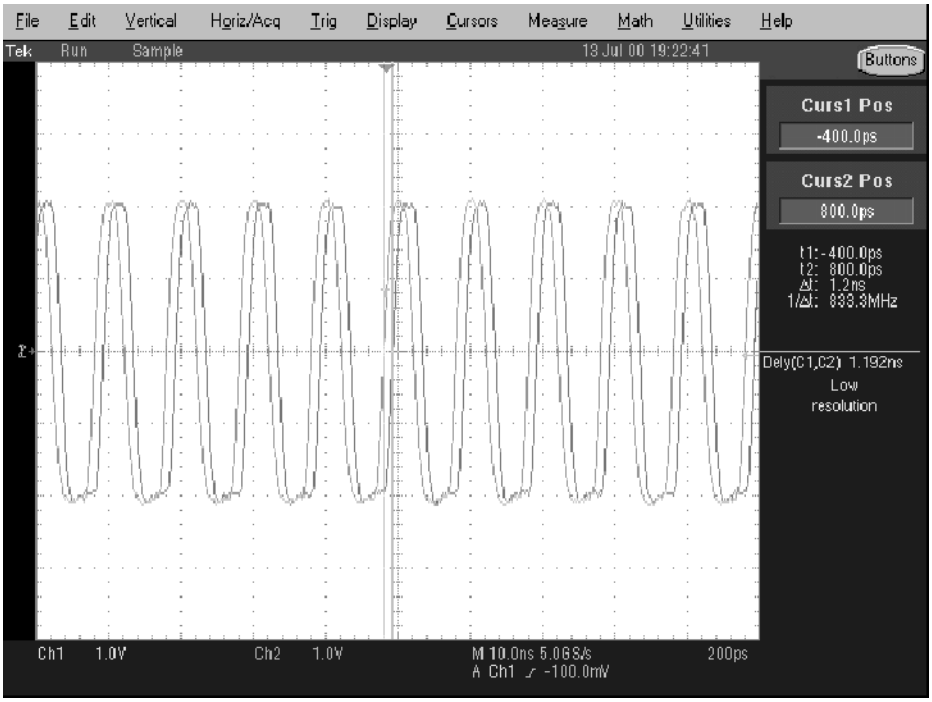


Figure 1- 4: Typical signal path skew

4. Start the application as described on page 2–33.
5. Select Inputs> Main > and set the Source to Ch 1. The Source waveform is the reference point to which the remaining channels are deskewed.

6. Select Inputs> 2nd> and set the Source to Ch 2, the channel to be deskewed.
7. To start the deskew utility, select Deskew and confirm the operation.
8. Select appropriate values in the Enter inputs menu, and then select OK. Figure 1–5 shows the Enter inputs menu.

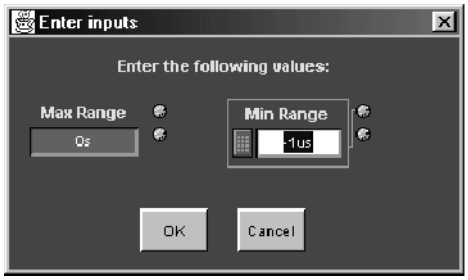


Figure 1-5: Enter inputs menu

The utility displays information as it deskews the channels, such as the number of samples processed and specified. Figure 1–6 shows an example of the utility when it is finished. In this example, the skew between channels 1 and 2 was reduced to about 57 ps.

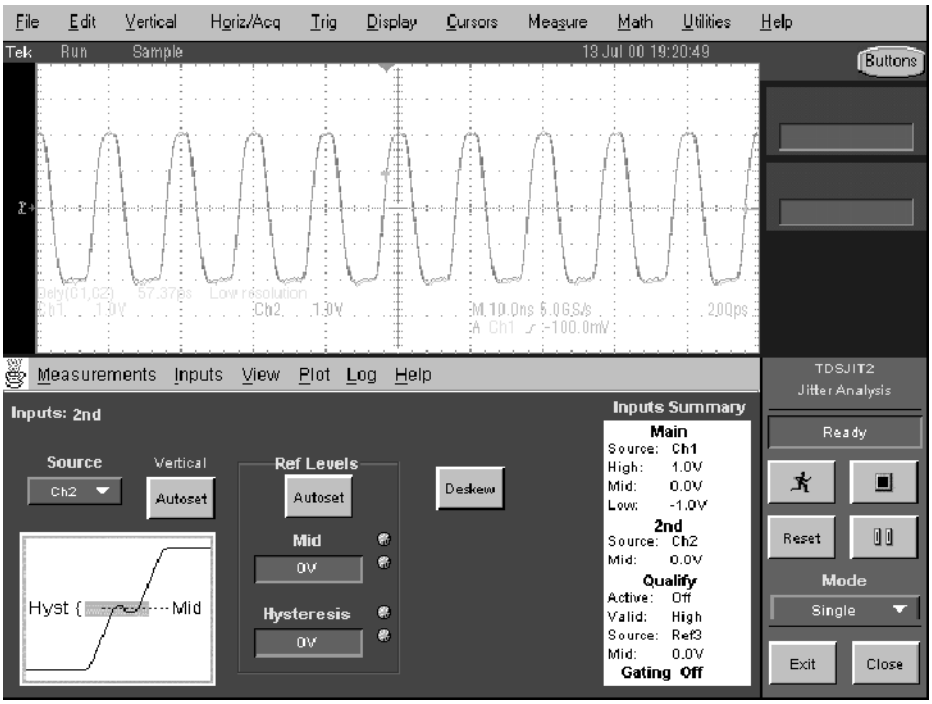


Figure 1-6: Deskew complete

9. Do not change the Input: Main channel, and deskew the remaining channels.

Connecting to a System Under Test

You can use any compatible probes to connect between your SUT (system under test) and oscilloscope. One connection is usually to a clock signal.

The Clock-to-Data measurements and the Skew measurement require two input channels or two reference waveforms.

Table 1–2 shows the default channel-to-waveform and reference waveform-to plot assignments. You can change the assignments to match your configuration.

Table 1-2: Default waveform assignments

Channel or reference	Waveform assignment
Ch 1	Main input waveform, such as a clock signal
Ch 2	Second (2nd) input waveform
Ref1	Histogram plot format for the first measurement
Ref2	Time Trend plot format for the first measurement
Ref3	Cycle Trend plot format for the first measurement
Ref4	Spectrum plot format for the first measurement

WARNING. *To avoid electric shock, you must ensure that power is removed from the SUT before attaching probes 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 probes to it.

Operating Basics

Basic Operations

This section contains information on the following topics and tasks:

- Application interface
- Using basic oscilloscope functions
- Setting up the application
- Taking measurements
- Warning messages
- Analyzing the results
- Saving the results to a file
- Viewing a data log file
- Saving and recalling setups
- Exiting the application

Application Interface

The application uses a Windows type of interface. Figure 2–1 shows the Menu bar and some of the buttons and boxes that you use to operate the application.

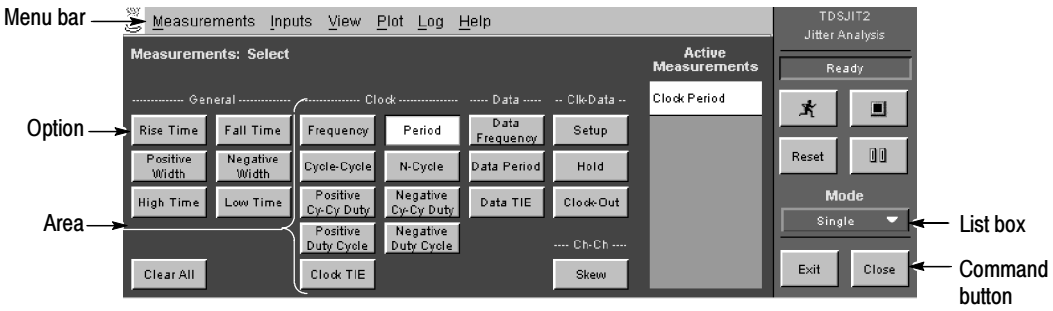


Figure 2- 1: Application interface

NOTE*. The oscilloscope application shrinks to half size and appears in the top half of the display when the application is running.*

Table 2–1 lists the interface items with a brief description of each.

Table 2-1: Application interface items

Item	Description
Menu bar	Located at the top of the application display and contains application menus
Area	Visual frame that encloses a set of related options
Option button	Button that defines a particular command or task
List box	Box that contains a list of items from which you can select one item
Box	Box that you can use to type in text, or to enter a value with the Keypad or a Multipurpose knob
Scroll bar	Vertical or horizontal bar at the side or bottom of a display area that can be used for moving around in that area
Browse	Displays a window where you can look through a list of directories and files
Command button	Button that initiates an immediate action

NOTE. *For a quick overview of the complete menu structure, refer to Figure 3–1 and Figure 3–2 starting on page 3–1.*

Using Basic Oscilloscope Functions

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

Using Online Help

The application includes Online Help about the application menus and controls.

To display the Online Help, follow these steps:

1. Choose the Help menu from the TDSJIT2 menu bar.
2. Use the Contents, TOC, or Index tabs to navigate through the help.

Minimizing and Maximizing the Application

The application remains displayed when you minimize the oscilloscope. To minimize the application, select Measurements> Minimize.

To maximize the application, select TDSJIT2 in the Windows toolbar.

Returning to the Application

When you access oscilloscope functions, the oscilloscope fills the display. You can access oscilloscope functions in the following ways:

- Select the Close button in the application display
- Choose the Menu-bar or Toolbar mode on the oscilloscope and access menus
- Press front-panel buttons

To return to the application, choose the App button. Figure 2–2 shows the App button.

Figure 2-2: Returning to the application

Application Directories and File Names

The application uses directories to save and recall setup files and also uses extensions appended to file names to identify the file type.

Default Directories. Table 2–2 lists default directory names.

Table 2-2: Default directory names

Directory name	Used for
C:\TekApplications\tdsjit2	Home location
C:\TekApplications\tdsjit2\log	Data log files
C:\TekApplications\tdsjit2\setup	Setup files
C:\TekApplications\tdsjit2\waveforms	Saved waveform files; can recall to reference memories
C:\TekApplications\tdsjit2\data	Temporary measurement files

File Name Extensions. Table 2–3 lists file name extensions used or generated by the application.

Table 2-3: File name extensions

Extension	Type
.csv	Log file that uses a “comma separated variable” format
.ini	Application setup file

Table 2-3: File name extensions (Cont.)

Extension	Type
.set	Oscilloscope setup file saved and recalled with an .ini file; both files will have the same name
.wfm	Waveform file that can be recalled into a reference memory

Setting Up the Application

You can set up the application to take up to six measurements at the same time. In addition, you can plot the results in four formats, and save the statistical results or worst case waveforms to a file to view later.

Selecting a Measurement

There are four Measurements menu items. One allows you to select measurements, one allows you to configure a measurement, one allows you to save and recall measurement setups, and one allows you to minimize the application.

To access the Select Active Measurements menu, go to the Measurements menu in the menu bar and choose Select Measurement. Figure 2–3 shows the Select Active Measurements menu.

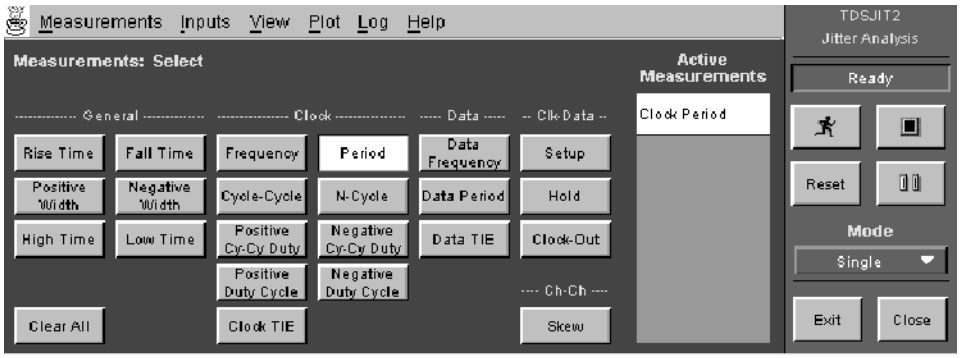


Figure 2-3: Select Active Measurements menu

NOTE. *Choose the* Clear All *command button to remove all the measurements in the list of Active Measurements.*

Table 2–4 lists the measurements with a brief description of each.

Table 2-4: Select Active Measurements areas and options

Area	Option	Description
General	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
	Positive Width	Amount of time a waveform remains above the mid reference voltage level
	Negative Width	Amount of time a waveform remains below the mid reference voltage level
	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
Clock	Period*	Elapsed time between consecutive crossings of the mid reference level by the waveform in the specified direction; see the Common Cycle Start Edge option on page 2-6
	Frequency*	Inverse of the period for each clock cycle
	Cycle-Cycle*	Difference in period measurements from one cycle to the next
	N-Cycle*	Difference in elapsed time between two consecutive groups of N-cycles where N is a configuration option number that you can set
	Positive Cy-Cy Duty	Difference between two consecutive positive widths
	Negative Cy-Cy Duty	Difference between two consecutive negative widths
	Positive Duty Cycle*	Ratio of the positive portion of the cycle relative to the period
	Negative Duty Cycle*	Ratio of the negative portion of the cycle relative to the period
	TIE*	Difference in time between the designated edge on a sampled clock waveform to the designated edge on a calculated clock waveform with a constant frequency (zero jitter)
Data	Data Period	Elapsed time between when a waveform crosses a specific reference voltage level in the same direction twice
	Data Frequency	Inverse of the period for each data cycle
	Data TIE	Difference in time between the data edges on a sampled data waveform to the data edges on a calculated data waveform with a constant rate (zero jitter)
Clk-Data	Setup Time*	Elapsed time between when a data waveform crosses a voltage reference level followed by the clock signal crossing its own voltage level
	Hold Time*	Elapsed time between when the clock waveform crosses a voltage reference level followed by a data waveform crossing its own voltage level
	Clock-Out Time*	Elapsed time between when the clock waveform crosses a voltage reference level followed by an output waveform crossing its own voltage level
Ch-Ch	Skew*	Difference in time between two “similar” edges on the Main and 2nd input waveforms with the assumption that every edge in the Main waveform has a corresponding edge (either the same or opposite polarity) in the 2nd waveform; edge locations are referenced to the mid reference voltage level

*** Requires configuration.**

Configuring a Measurement

Many measurements require configuration, as indicated in Table 2–4. To access the Configure Measurements menu, go to the Measurements menu in the menu bar and choose Configure.

NOTE. *The Configure menu that displays is for the measurement selected in the list of Active Measurements.*

You do not need to configure the following measurements:

- General area (all): Rise Time, Fall Time, Positive Width, Negative Width, High Time and Low Time
- Clock area: Positive Cy-Cy Duty, and Negative Cy-Cy Duty
- Data area (all): Data Frequency, Data Period, and Data TIE

Figure 2–4 shows the Configure Measurements menu for the General area measurements.

Figure 2- 4: General measurements configuration

Common Cycle Start Edge Option. The Common Cycle Start Edge option defines which edge of the Main input is used to calculate all active clock-based measurements.

Figure 2–5 shows the Common Cycle Start Edge configuration option used in many measurements. This is the only configuration option for the following Clock area measurements: Frequency, Period, Cycle-Cycle, Positive Duty Cycle, Negative Duty Cycle, and TIE.

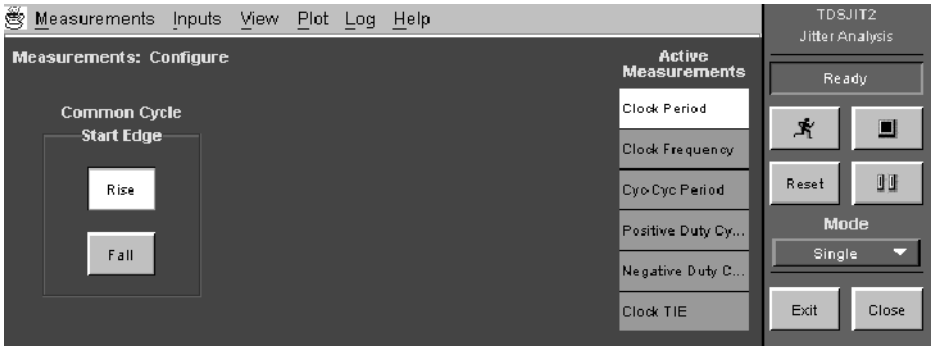


Figure 2-5: Common Cycle Start Edge option configuration

N-Cycle Configuration Options. Figure 2–6 shows configuration options for the N-Cycle measurement.

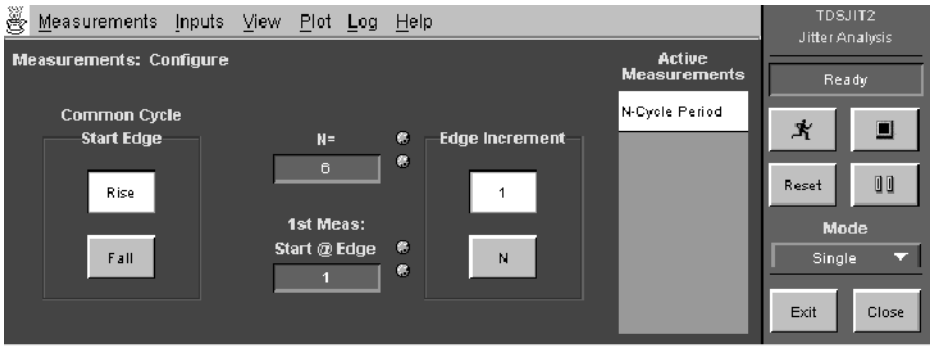


Figure 2-6: N-Cycle configuration options

Table 2–5 lists the configuration options for the N-Cycle measurement with a brief description of each.

Table 2-5: N-Cycle configuration options

Option	Description
N=	Number of cycles in an N-cycle group
1st Meas: Start @ Edge	Number of cycles skipped prior to starting the measurement
Edge Increment	Specifies whether consecutive measurements (each spanning 2N cycles) jump forward one cycle (option 1) or N cycles in the waveform (option N)

Clk-Data Area Configuration Options. Figure 2–7 shows configuration options for the Clk-Data area measurements.

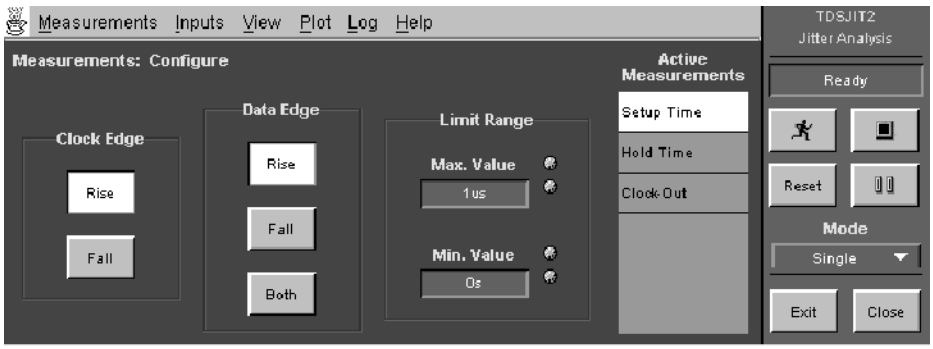


Figure 2-7: Clk-Data area configuration options

Table 2–6 lists the configuration options for the three Clk-Data measurements with a brief description of each.

Table 2-6: Clk-Data measurements configuration options

Option	Description
Clock Edge	Edge on the clock waveform used to take the measurement; you can define the waveform in the Inputs: Main menu
Data Edge	Edge on the data waveform used to take the measurement; you can define the waveform in the Inputs: 2nd menu
Limit Range	Specify the minimum and maximum range of valid measurement values

Skew Configuration Options. Figure 2–8 shows configuration options for the Skew measurement.

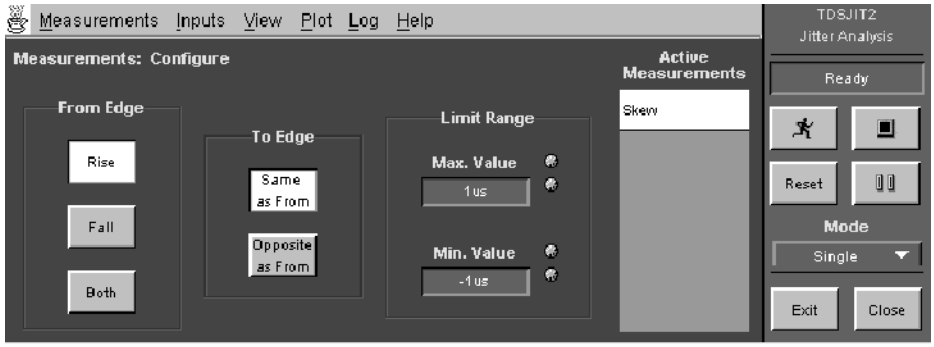


Figure 2-8: Skew configuration options

Table 2–7 lists the configuration options for the Skew measurement with a brief description of each.

Table 2-7: Skew configuration options

Option	Description
From Edge	Edge on the Main waveform used to take the measurement
To Edge	Edge on the 2nd waveform used to take the measurement
Limit Range	Same as Table 2–6

Specifying Inputs

The application takes measurements from waveforms specified as inputs.

***NOTE**. All General, Clock, and Data area measurements require a Main input.*

All Data measurements require you to select the channel (reference memory or math waveform) for the data signal as the Main Input Source.

All two-channel measurements that include a clock require you to select the channel (reference memory or math waveform) for the clock signal as the Main Input Source.

All Clk-Data and Ch-Ch area measurements require both a Main input and a 2nd input.

To access the Inputs: Main and Inputs: 2nd menus, go to the Inputs menu in the menu bar and choose Main or 2nd. Figure 2–9 shows the Inputs: Main menu.

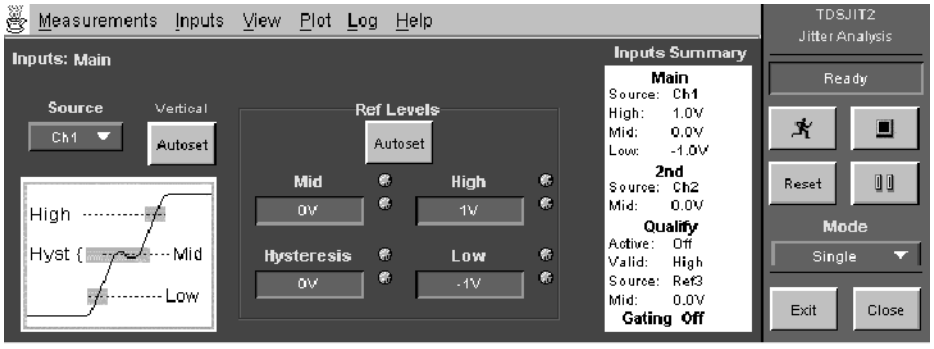


Figure 2-9: Inputs: Main menu

***NOTE**. The Inputs Summary shows the settings of all the Input menus.*

Table 2–8 lists the Inputs menus options with a brief description of each.

Table 2-8: Inputs: Main and 2nd options

Option	Description
Source*	A "live" (channel), reference, or math waveform used as the signal or clock source; all sources for the Main, 2nd, and Qualify inputs must have the same Horizontal Sample Rate, Record Length, and Position to assure that measurements function properly
Vertical Autoset	Changes the vertical scale and position for Ch 1, Ch 2, Ch 3, and Ch 4 waveforms so that they occupy the full vertical space available on the display without any part of the waveform missing (clipped); uses 80% of the Acquisitions ADC range
Ref Levels	
Autoset	Thresholds are set as a percentage of the voltage levels relative to the minimum and maximum levels of the peak-to-peak values
Mid	Where to set the middle threshold level on the slope, in volts; refer to Figure 2-10
Hysteresis	Threshold margin, in volts, 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
High**	Where on the slope, in volts, to set the high threshold level
Low**	Where on the slope, in volts, to set the low threshold level

**** Only available for the waveform defined in the Inputs: Main menu.**

*** For two-channel measurements that include a clock, select the channel (reference memory or math waveform) for the clock signal as the Main Input Source. For Data measurements, select the channel for the data signal as the Main Input Source.**

Figure 2–10 shows how to determine the voltage reference levels.

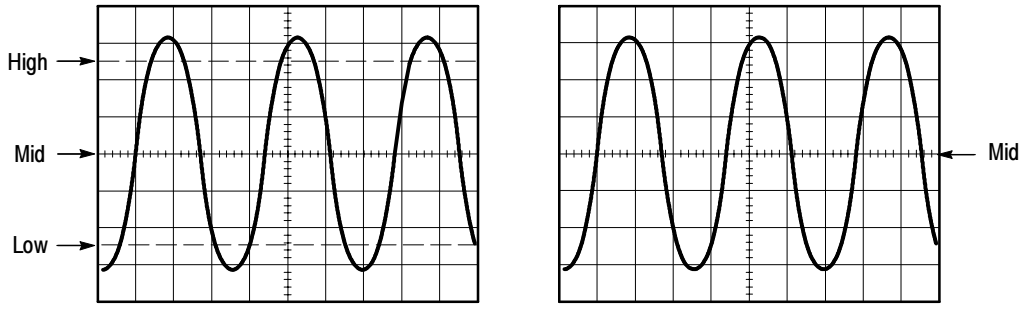


Figure 2-10: How to determine voltage reference levels

***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.*

Figure 2–11 shows the methods that you can use to enter Autoset Ref Level values. The application displays this menu when you select Autoset in the Inputs: Main, Inputs: 2nd, or Inputs: Qualify menus.

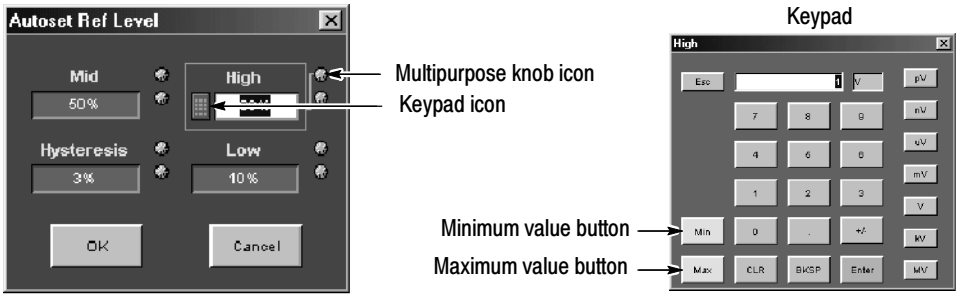


Figure 2- 11: How to enter Autoset Ref Level values

Table 2–9 lists methods that you can use to enter values in the Autoset Ref Level menu.

Table 2- 9: Autoset Ref Level menu entry methods

Entry method	Description
Keypad	Icon appears when you select the box; select and use to enter a value
Multipurpose knob	When you select the multipurpose (MP) knob, a line appears between the knob and the box; turn the knob on the oscilloscope to select a value

Figure 2–12 shows the Inputs: 2nd menu.

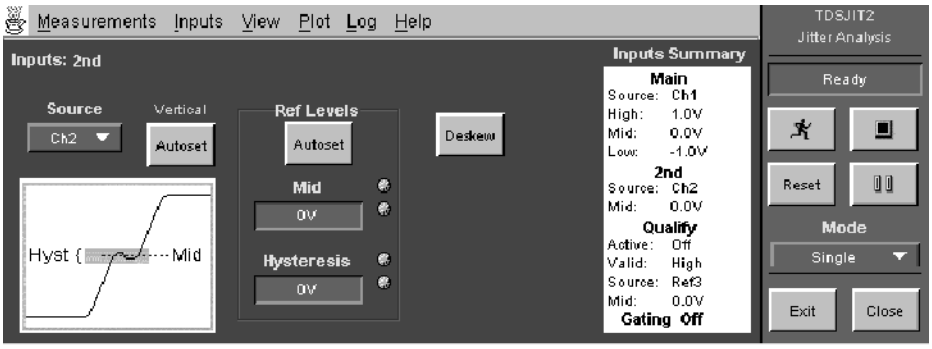


Figure 2-12: Inputs: 2nd menu

Deskew Option. Starts the automatic deskew between the source designated as the Main input and the source designated as the 2nd input. To perform the deskew procedure, refer to *Deskewing the Probes and Channels* on page 1–6.

Specifying Qualifiers

Qualifiers allow you to focus the application on more narrowly defined conditions before taking measurements. This is one way to filter out information that is not useful to analyze.

To access the Inputs: Qualify menu, go to the Inputs menu in the menu bar and choose Qualify. Figure 2–13 shows the Inputs: Quality menu.

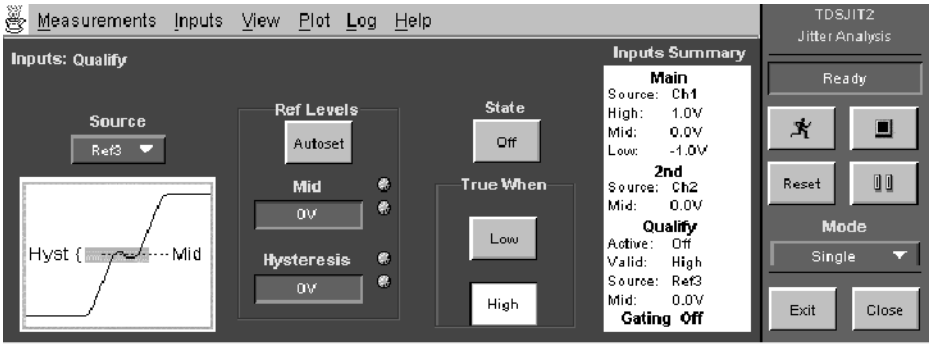


Figure 2-13: Inputs: Qualify menu

Table 2–10 lists the Inputs: Qualify areas and options with a brief description of each.

Table 2-10: Inputs: Qualify areas and options

Area	Description
Source	A “live” (channel), reference, or math waveform used to qualify the signal or clock source; all sources for the Main, 2nd, and Qualify inputs must have the same Horizontal Sample Rate, Record Length, and Position to assure that measurements function properly
Ref Levels	Same as the descriptions in Table 2-8 on page 2-10
State	Specifies if the Qualifier option is enabled or not
True When	State condition is met when the qualifier is a logical low (0) or a logical high (1)

Figure 2-11 on page 2-11 shows the Autoset Ref Level menu. The application also displays this menu when you select Autoset in the Qualify menu.

***NOTE**. The Qualifier Input and Gating functions are mutually exclusive. If you enable both, the application displays an error message.*

Specifying Gating/Other

Gating allows you to focus the application on a specific area of the waveform bound by cursors before taking measurements. This is one way to filter out information that is not useful to analyze.

To access the Inputs: Gating/Other menu, go to the Inputs menu in the menu bar and choose Gating/Other. Figure 2-14 shows the Inputs: Gating/Other menu.

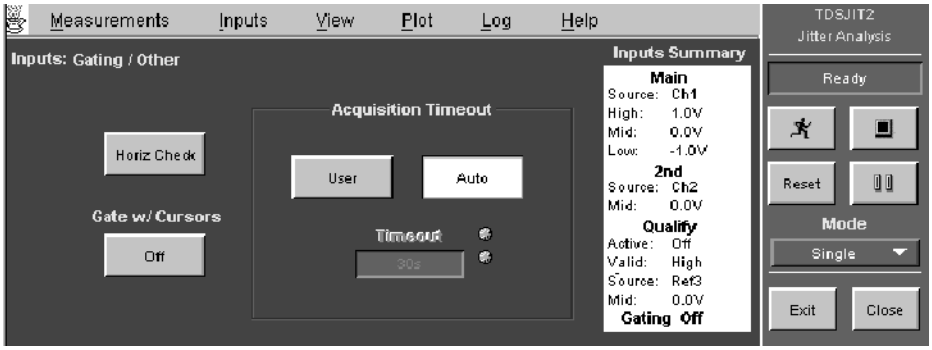


Figure 2-14: Inputs: Gating/Other menu

Table 2-11 lists the Gating/Other options with a brief description of each.

Table 2-11: Inputs: Gating/Other options

Option	Description
Horiz Check	Checks if the Sample Rate is appropriate for the selected measurements; accurate measurements require at least two samples per edge; for best results, set the Horizontal Resolution on the oscilloscope to be as close as but not greater than the following: Resolution < Min (rise time, fall time)/2.5, where Rise and Fall are measured from 10% to 90%
Gate w/Cursors	Specifies if gating with cursors is enabled or not; use oscilloscope cursors to define one specific part of the waveform on which to take measurements; another type of qualifier
Acq Timeout	Sets an appropriate amount of time that the application will wait to acquire data before it stops and displays an error message; Auto sets the timeout to less than 0.1 hours; User allows you to enter a larger timeout value
Timeout	When User is selected, you can set the timeout from 0.1 hour to 24 hours

Taking Measurements

If you want to change trigger settings or localize the measurement, you should do so before you take any measurements.

***NOTE**. If you select a reference or math waveform as the source, you will need to recall and display the waveform before the application can take a measurement. For information on how to do this, refer to* Recalling a Waveform File *on page 2–32.*

Remember to select Reset to set the results to zero if you change the oscilloscope Vertical or Horizontal time settings between measurements.

Taking New Measurements

The Sequence Control menu is always accessible in the lower right part of the application display. Figure 2–15 shows the Sequence Control menu.

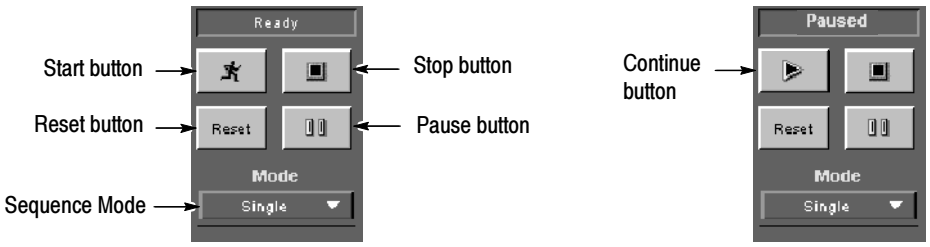


Figure 2-15: Sequence Control menu

To acquire data from waveforms, follow these steps:

1. Select a Sequence mode. See Table 2–12.

Table 2-12: Sequence Control menu

Option/button	Description
Mode	
Single	If the input source is Ch1, Ch2, Ch3, or Ch4, the application acquires a new waveform(s); for all sources, the application performs measurements on the waveform(s) and stops
Free Run	Repeatedly acquires the input waveform(s) and takes measurements; disables the Time Trend, Cycle Trend, and Spectrum plots
Single No Acq	Performs measurements on the input waveform(s) and stops
Start/Continue button	Starts to take measurements from the input waveform(s) When paused, continues taking measurements
Pause button	Pauses and resumes when you select the Continue button or stops when you select the Stop button
Stop button	Stops taking measurements
Reset button	Resets all result values to zero

2. Press  to start the measurement sequence.

***NOTE**. Do not change oscilloscope settings while a measurement is being taken, since this can cause an invalid measurement.*

Localizing Measurements

By specifying the trigger position, the starting point, and the length of the waveform, you can effectively filter out information that is not useful to analyze before taking a measurement.

To focus the application measurement on a part of the waveform, you can use the Inputs: Gating menu. You can also adjust the Record Length, Scale or pretrigger information in the oscilloscope Horizontal menu, or the trigger level and slope in the Trigger menu.

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

Warning Messages

The application displays and saves warning messages if the input conditions do not support accurate measurements. You can view the accumulated messages in the View Warnings menu. To access the View Warnings menu, go to the View menu in the menu bar and choose Warnings.

Figure 2–16 shows the View Warnings menu with a message.

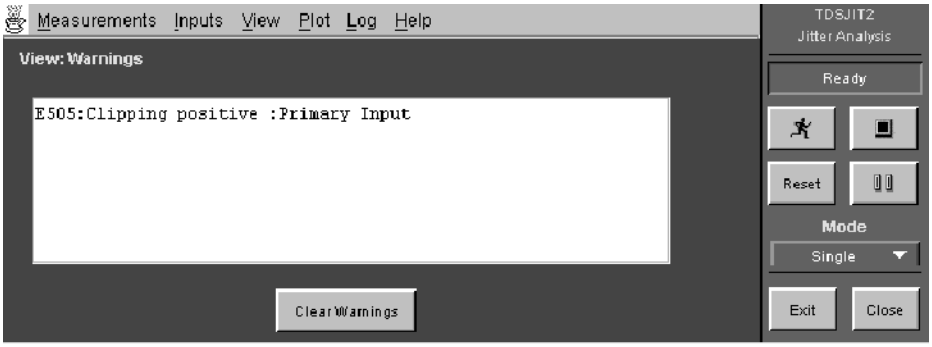


Figure 2- 16: View Warnings menu

To remove all of the messages, select Clear Warnings.

Analyzing the Results

You can view the results as statistics or graphically as plots. Figure 2–17 shows an example of the various results display formats.

NOTE. *Stop the acquisition before viewing the results as plots if you are taking measurements in the Free Run mode.*

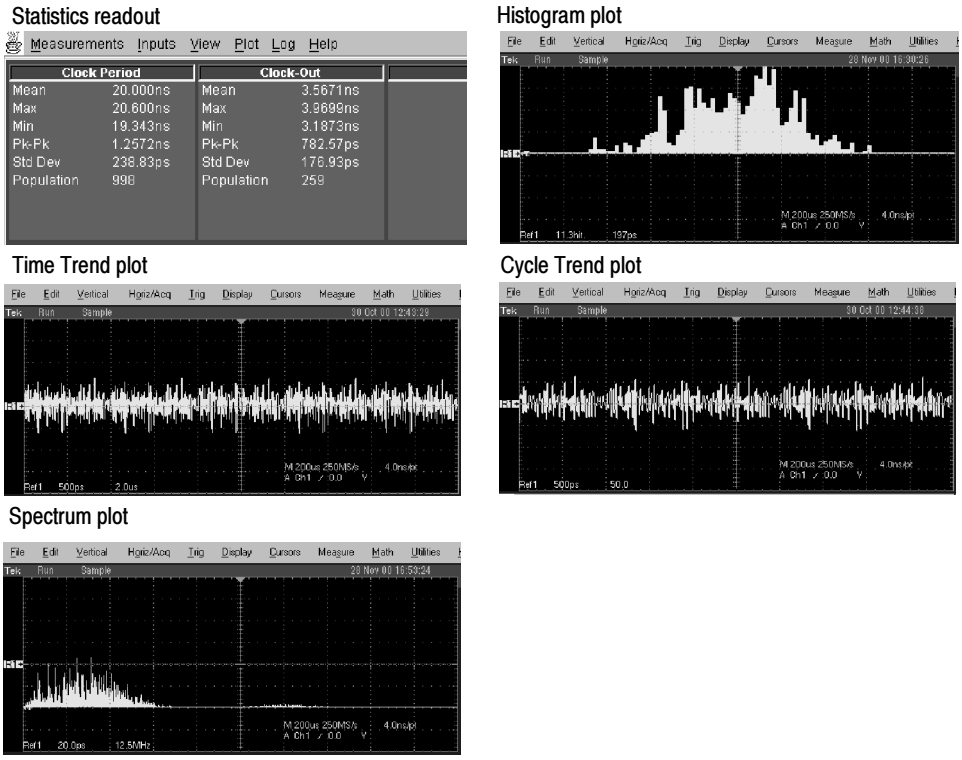


Figure 2- 17: Results as statistics and in four display formats

You can also log the data to a .csv file for viewing in a text editing, spreadsheet, database, or data analysis program. Figure 2–18 shows an example of how a .csv file might look in a spreadsheet program.

TDSJIT2 Version V1.1.13 Tue Jul 17 15:11:50 PDT 2001							
Result Type	Cycle-Cycle(s)	Clock Out(s)	Clock Period(s)	Clock TIE(s)	Setup Time(s)	Clock Frequency(Hz)	Low Time(s)
Mean		3.57E-09	2.00E-09				
Std Dev		1.77E-10	2.39E-10				
Maximum		3.97E-09	2.06E-09				
Minimum		3.19E-09	1.93E-09				
Peak Peak		7.83E-10	1.26E-09				
Population		259	998				
Positive Mean							
Positive Max							
Positive Population							
Negative Mean							
Negative Max							
Negative Population							
Estimated Frequency							
Measurement Results from Most Recent Acquisition							
Serial Number	Clock Period						
1	2.02E-08						
2	1.93E-08						
3	2.00E-08						
4	2.03E-08						
5	2.03E-08						

Figure 2- 18: Example of viewing data in a .csv file

Viewing Statistics

To access the View Results menu, go to the View menu in the menu bar and choose Results. The application can display results for up to six measurements. Figure 2–19 shows an example of the results for three measurements.

The statistical information that displays will vary by measurement. In general, the View Results menu contains statistical 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 samples used to calculate the statistics).

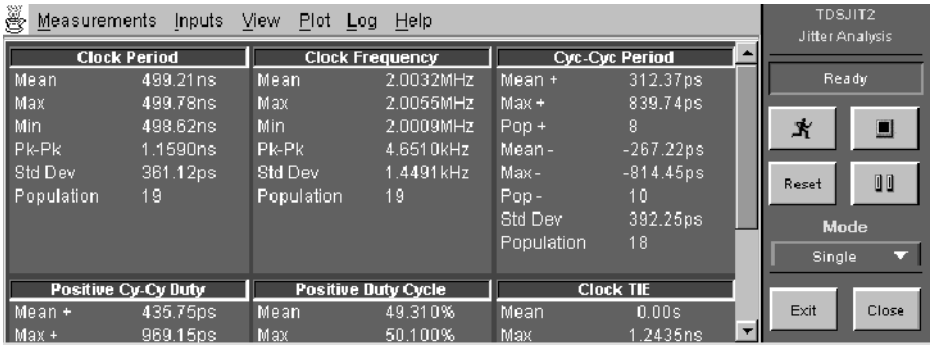


Figure 2-19: View Results menu, example of three measurements

Viewing Plots

You can graphically plot the results for easier analysis. There are four plot formats: Histogram, Time Trend, Cycle Trend, and Spectrum. To access the Select Plot menu, go to the Plot menu in the menu bar and choose Select. Figure 2–20 shows the Select Plot menu.

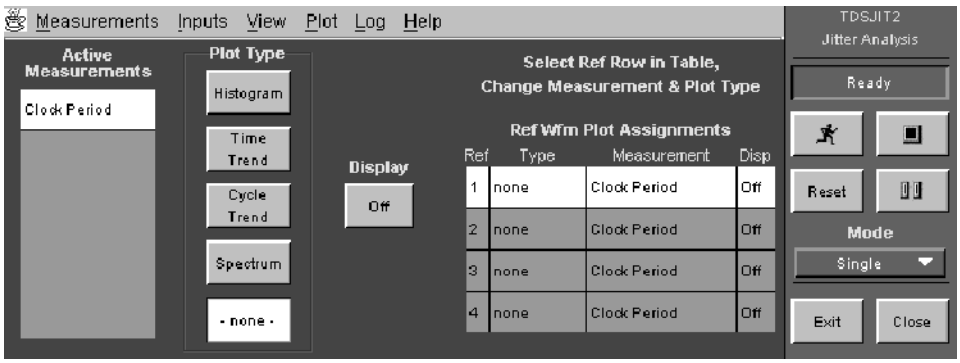


Figure 2-20: Select Plot menu

The Ref Wfm Plot Assignments list shows each reference memory and the plot format of the measurement stored in it. You can store one measurement in all four formats.

To configure a plot, change the following Select Plot options:

1. Select a reference memory in the Ref column of the table.
2. Select a measurement from the list of Active Measurements.
3. Select a plot option from the Plot Type area.
4. Select On for the Display option.

***NOTE**. If you change any of the plot parameters, the Display option is set to Off.*

Table 2–13 lists the Select Plot areas and options with a brief description of each.

Table 2-13: Select Plot areas and options

Area/option	Description
Active Measurement	Lists the measurements activated in the Select Measurements menu
Plot Type	
Histogram	Plots the results such that the horizontal axis represents the measurement values and the vertical axis represents the number of times that the value occurred
Time Trend*	Plots the results such that the vertical axis represents the measurement value and the horizontal axis represents the time the measurement occurred; the horizontal time span is the same as the input waveform
Cycle Trend*	Plots the results such that the vertical axis represents the measurement value and the horizontal axis represents the index number of the measurement
Spectrum*	Plots the spectral content of the Time Trend plot where the vertical axis represents jitter magnitude and the horizontal axis represents jitter frequency
None	Clears the reference memory so that it is available for other uses
Display, On/Off	If On, displays the selected measurement in the specified plot format, and stores it in the selected reference memory.

*** Plot is disabled when taking measurements in Free Run mode.**

***NOTE**. You can select the same type of plot as long as the measurements are different. If you set up two identical plot type and measurement combinations, an error message displays.*

To access the Vertical/Horizontal Axis Plot menu, go to the Plots menu in the menu bar and choose Vert/Horiz Axis. Figure 2–21 shows the Vert/Horiz Axis menu for the Histogram plot.

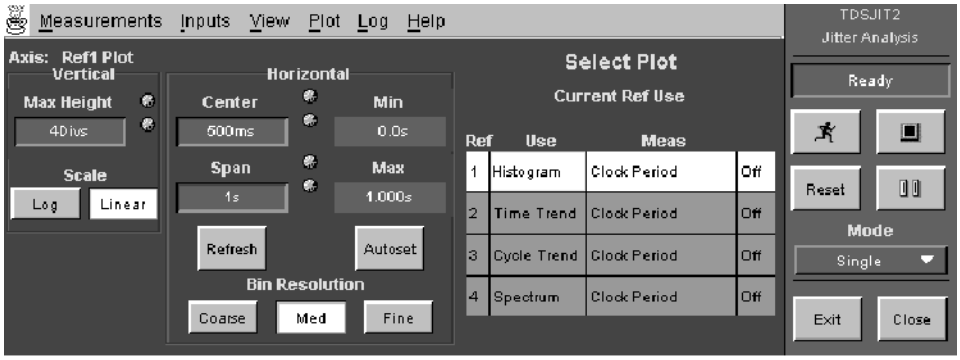


Figure 2-21: Vert/Horiz Axis Plot menu: Histogram plot

Table 2–14 lists the Vert/Horiz Axis Plot menu area and options for the Histogram plot with a brief description of each.

Table 2-14: Vert/Horiz Axis Plot options for Histogram plots

Area/option	Description
Vertical	
Max. Height	Maximum height of the plot in number of divisions
Scale	Vertical axis is in logarithmic or in linear scale
Horizontal	
Center	Numeric value for the horizontal center position of the histogram
Span	Numeric value for the total horizontal range of the histogram
Bin Resolution	Resolution as defined by bins to be Coarse (20 bins), Medium (100 bins), or Fine (500 bins)
Refresh	Updates the plot with the latest Center and Span values entered
Autoset*	Uses the results to determine logical values for the Center and Span options if the population of the measurement is 3 or more, and redraws the plot in the corresponding reference memory

* **You must make a measurement and plot the data before using the Autoset option.**

The Horizontal area includes two readouts that display the following values:

- Min shows: Center - Span/2
- Max shows: Center + Span/2

Figure 2–22 shows the Vert/Horiz Axis Plot menu for the Time Trend plot.

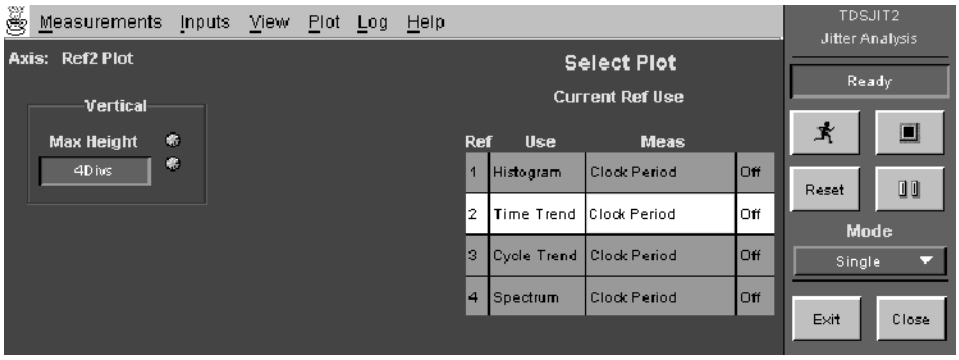


Figure 2-22: Vert/Horiz Axis Plot menu: Time Trend plot

Table 2–15 lists the Vert/Horiz Axis Plot menu option for the Time Trend plot with a brief description.

Table 2-15: Vert/Horiz Axis Plot option for Time Trend plots

Option	Description
Vertical Max. Height	Maximum height of the plot in number of divisions

Figure 2–23 shows the Vert/Horiz Axis Plot menu for the Cycle Trend plot.

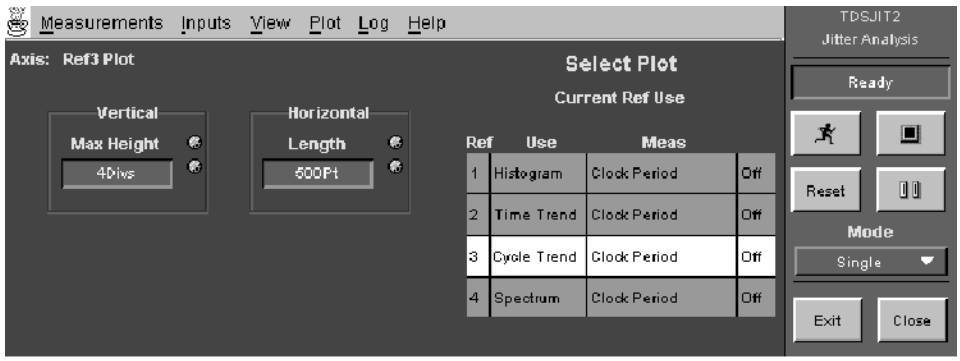


Figure 2-23: Vert/Horiz Axis Plot menu: Cycle Trend plot

Table 2–16 lists the Vert/Horiz Axis Plot menu options for the Cycle Trend plot with a brief description of each.

Table 2-16: Vert/Horiz Axis Plot options for Cycle Trend plots

Option	Description
Vertical Max. Height	Maximum height of the plot in number of divisions
Horizontal Length	Length of the plot in number of record points

Figure 2–24 shows the Vert/Horiz Axis Plot menu for the Spectrum plot.

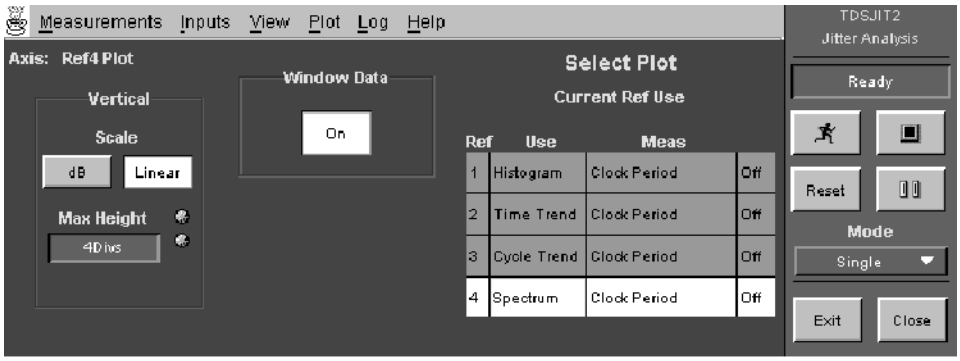


Figure 2-24: Vert/Horiz Axis Plot menu: Spectrum plot

Table 2–17 lists the Vert/Horiz Axis Plot menu options for the Spectrum plot with a brief description of each.

Table 2-17: Vert/Horiz Axis Plot options for Spectrum plots

Parameter	Description
Vertical Scale	Vertical axis is in dB or linear scale
Max. Height	Maximum height of the plot in number of divisions
Window Data	Reduces spectral leakage in the Fast Fourier Transform (FFT) waveform; a Hanning window (raised cosine) on the Time Trend data

Clearing Results

To reset the results to zero, choose the Reset button in the Sequence Control menu. You do not have to wait for a measurement to complete to clear the results.

Saving the Results to a File

You can save the results for all active measurements as statistics to a data log file or save the worst case waveforms to waveform files.

Logging Statistics

This type of logging saves the statistical results of all activated measurements and the individual result points for the measurement at the top of the list to a data log file. To access the Statistics Log menu, go to the Log menu in the menu bar and choose Statistics.

Figure 2–25 shows the Log: Statistics menu.

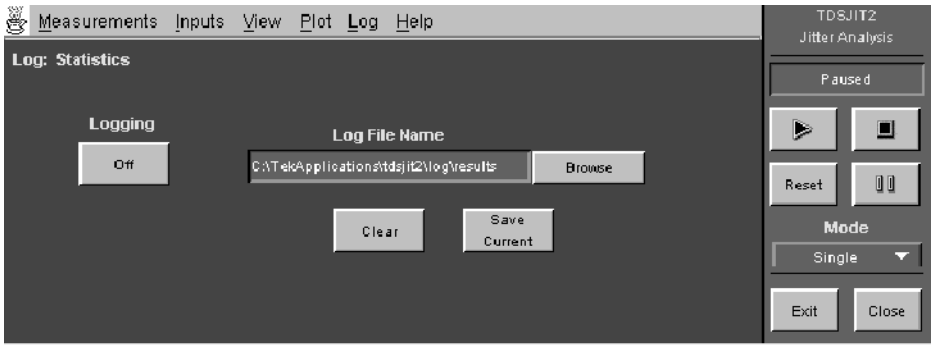


Figure 2-25: Log: Statistics menu

Table 2–18 lists the Log: Statistics options and buttons with a brief description of each.

Table 2-18: Log: Statistics options and buttons

Option/button	Description
Logging	Enables the application to save the statistical results for all active measurements, as well as the individual results to a data log file
Clear	Clears the data log file; you must disable the logging before you can clear the contents of the data log file
Save Current	Stores the current measurement results in a “comma separated variable” formatted file (.csv file) that you can view at a later time
Log File Name: Browse	Allows you to select the directory in which to save the data log file and to enter a name for the file; the extension must be .csv

Figure 2–26 shows an example of the Log file directory that displays when you select Browse.

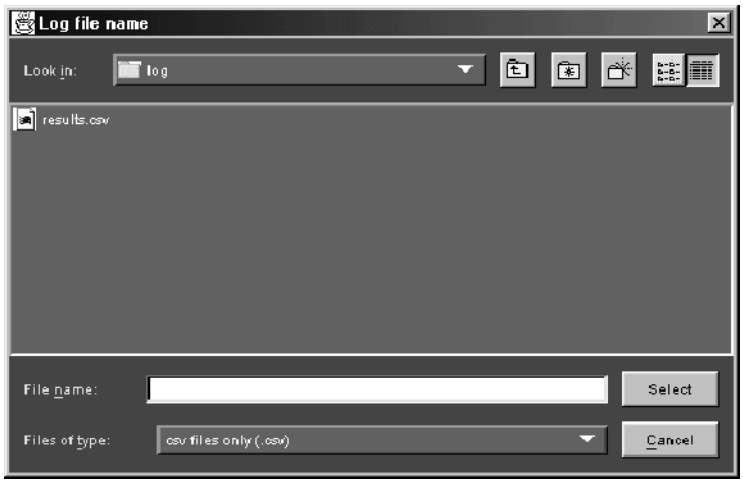


Figure 2-26: Log file directory

Data Log File Format

The data log file consists of one header row and rows of logged information. The header row contains the application name, the version number of the application, and the date and time on which the file was created. The next set of rows contain statistical information from the last acquisition for all activated measurements and the individual result points for the measurement at the top of the list.

Figure 2–18 on page 2–17 shows a formatted .csv file.

***NOTE**. If you are using a GPIB program to execute the application, such as in automated test environments, you can add your own annotation through the logAnnotate GPIB command. You can add information consisting of up to 20 characters; the custom information will appear as the last column in the individual result records of that acquisition.*

Logging Min/Max Waveforms

This type of logging saves the acquired waveforms where the minimum and maximum worst cases occur. When enabled, the waveforms are saved to a set of .wfm files.

To access the Log Min/Max Wfm menu, go to the Log menu in the menu bar and choose Min/Max Wfm. Figure 2–27 shows the Log Min/Max Wfm menu.

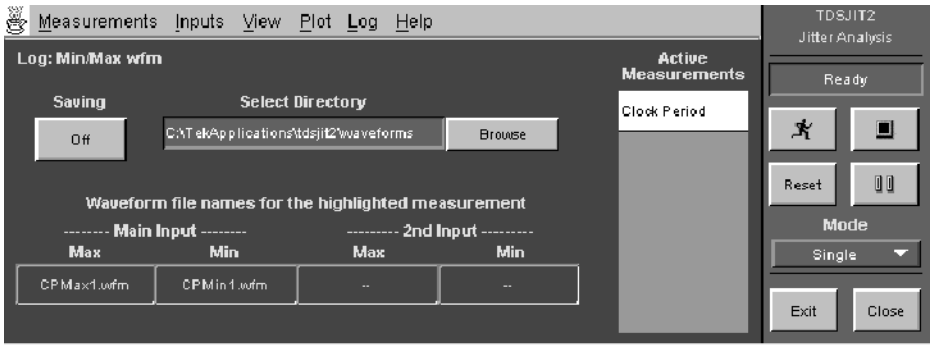


Figure 2-27: Log: Min/Max Wfm menu

***NOTE**. File names for the waveforms are unique to each measurement. The application displays the file names when you select an active measurement although worst case waveforms are saved for all active measurements.*

The Min1 and Max1 waveform files are for the Main input and the Min2 and Max2 waveform files are for the 2nd input.

Table 2–19 lists the Log Min/Max Wfm options with a brief description of each.

Table 2-19: Log Min/Max Wfm options and buttons

Option/button	Description
Active Measurements	Lists the measurements activated in the Select Measurement menu; the application can save the worst case waveforms for all measurement from this list
Saving	Enables the application to save the minimum and maximum worst cases to waveform files
Select Directory: Browse	Allows you to select a directory in which to save the worst case waveform files

Table 2–20 lists the file names of the minimum and maximum worst case waveforms for various measurements.

Table 2-20: File names for Min/Max waveforms

Measurement	Min waveform	Max waveform
Rise Time	RISEMin1.wfm	RISEMax1.wfm
Fall Time	FALLMin1.wfm	FALLMax1.wfm
Positive Width	PWMin1.wfm	PWMax1.wfm
Negative Width	NWMin1.wfm	NWMax1.wfm
High Time	HIGHMin1.wfm	HIGHMax1.wfm
Low Time	LOWMin1.wfm	LOWMax1.wfm
Frequency	CFMin1.wfm	CFMax1.wfm
Period	CPMin1.wfm	CPMax1.wfm
Cycle-Cycle	CCPMin1.wfm	CCPMax1.wfm
N-Cycle	NCPMin1.wfm	NCPMax1.wfm
Positive Cy-Cy Duty	PCCDMin1.wfm	PCCDMax1.wfm
Negative Cy-Cy Duty	NCCDMin1.wfm	NCCDMax1.wfm
Positive Duty Cycle	PDCMin1.wfm	PDCMax1.wfm
Negative Duty Cycle	NDCMin1.wfm	NDCMax1.wfm
TIE	TIEMin1.wfm	TIEMax1.wfm
Data Frequency	DFMin1.wfm	DFMax1.wfm
Data Period	DPMin1.wfm	DPMax1.wfm
Data TIE	DTIEMin1.wfm	DTIEMax1.wfm
Setup Time	SUMin1.wfm SUMin2.wfm	SUMax1.wfm SUMax2.wfm
Hold Time	HOLDMin1.wfm HOLDMin2.wfm	HOLDMax1.wfm HOLDMax2.wfm
Clock-Out Time	TCOMin1.wfm TCOMin2.wfm	TCOMax1.wfm TCOMax2.wfm
Skew Time	SKEWMin1.wfm SKEWMin2.wfm	SKEWMax1.wfm SKEWMax2.wfm

Viewing a Data Log File

You can view the .csv data log file (comma separated variable format) in a text editing, spreadsheet, database, or data analysis program for further analysis.

***NOTE**. You can use Notepad or Wordpad to quickly view the results in the data log file.*

If you take different measurements and store them in one data log file, you can group the measurements by sorting them in a program on a personal computer. Figure 2–18 on page 2–17 shows an example of an edited .csv file in a spreadsheet program.

Saving and Recalling Setups

You can use the Save/Recall Measurements menu to save and recall different configuration setups. To access the Save/Recall Measurements menu, go to the Measurements menu in the menu bar and choose Save/Recall.

Figure 2–28 shows the Save/Recall Measurements menu.

Figure 2-28: Save/Recall Measurements menu

Table 2–21 lists the Save/Recall Measurements options with a brief description of each.

Table 2-21: Save/Recall Measurements options

Option	Description
Save	Allows you to select a file in which to save the application setup
Recall	Allows you to select a file from which to recall the application setup
Default	Recalls the Default application setup values
File name for Save/Recall	Displays the name of the last file used to save or recall a setup

***NOTE**. The Measurements > Save/Recall function includes the settings of the oscilloscope application. When you exit the application, you can choose whether to restore the settings of the oscilloscope to those present before starting the application.*

Do not edit the .ini or the .set files, or recall setup files not generated by the application, since this can cause the application to become unstable.

Saving a Setup

To save the application and oscilloscope settings to a file, follow these steps:

1. Select Measurements > Save/Recall.
2. Select the Save button. Figure 2–29 shows an example of how the directory displays when you select the Save button.

Figure 2-29: Save directory

3. Select the directory in which the setup file will be saved.
4. Select or enter a file name. The application appends an .ini extension to the name of setup files.
5. Choose Save.

***NOTE**. The application also saves the oscilloscope setup to a .set file when you save an application setup. Both the application .ini file and oscilloscope .set file have the same file name.*

Recalling a Saved Setup

To recall the application and oscilloscope settings from a saved setup file, follow these steps:

1. Select Measurements > Save/Recall.
2. Select the Recall button. Figure 2–30 shows an example of how the directory displays when you select the Recall button.

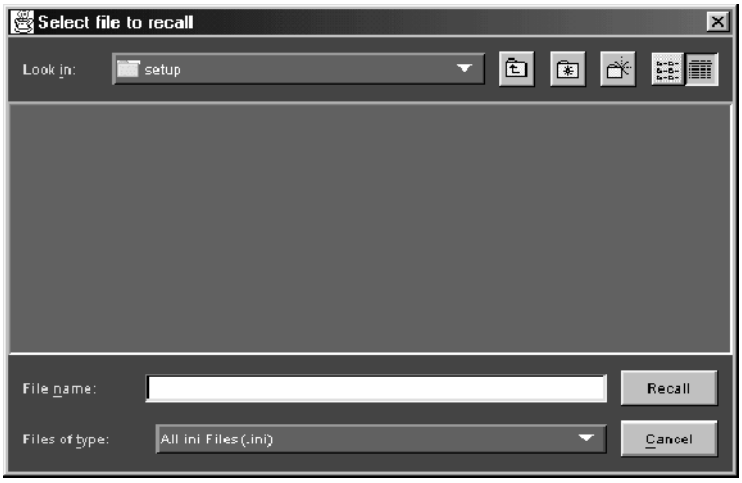


Figure 2- 30: Recall directory

3. Select the directory from which the setup file will be recalled.
4. Select or enter a setup file name.
5. Choose Recall.

***NOTE**. The application also recalls the oscilloscope setup from a .set file when you recall an application setup.*

Recalling the Default Setup

To recall the application settings from the Default setup file, follow these steps:

1. Select Measurements > Save/Recall.
2. Choose Recall default values.

Exiting the Application

To exit the application, choose Exit. When you exit the application, you can select to keep the oscilloscope setup currently in use with the application or to restore the oscilloscope setup that was present before you started the application. Figure 2–31 shows the Exit menu.

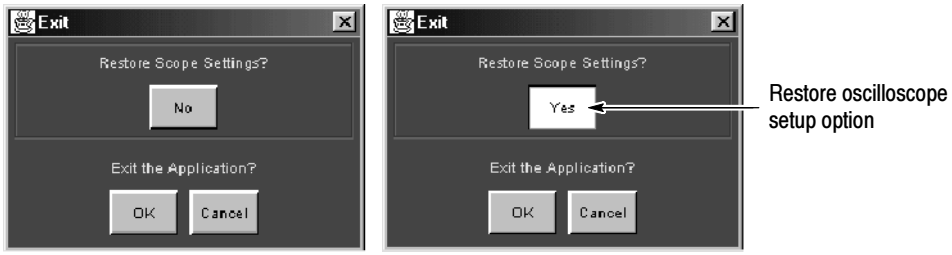


Figure 2-31: Exit menu

Tutorial

This tutorial teaches you how to set up the application, take two types of measurements, and view the results. 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
- Recall the tutorial waveforms

***NOTE**. Figures that show the display of an oscilloscope are from a TDS7104; there may be minor differences if you work through this tutorial with another type of oscilloscope.*

Setting Up the Oscilloscope

To set up the oscilloscope, follow these steps:

1. Go to the File menu in the menu bar and select Recall Default Setup to set the oscilloscope to the default factory settings.
2. Press the individual CH 1, CH 2, CH 3, and CH 4 buttons as needed to remove active waveforms from the display.

Starting the Application

To start the application, go to the File menu in the menu bar and select Run Application> Jitter Analysis 2. The application starts up and displays as shown in Figure 2–32.

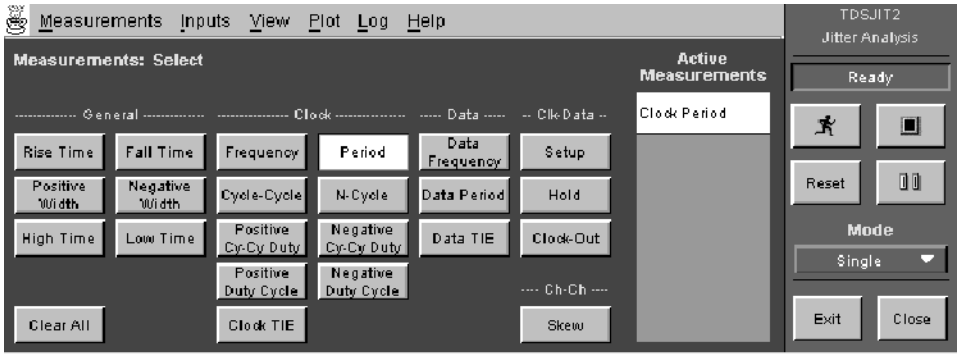


Figure 2-32: Starting the application

Recalling a Waveform File

The application includes waveform files for use with this tutorial. Table 2–22 shows the types of signals that these waveforms represent.

Table 2-22: Waveforms and signal types

Waveform name	Signal type
jit2_clk.wfm	A clock signal
jit2_data.wfm	A data signal

To recall waveforms to Ref2 and Ref3 on the oscilloscope, follow these steps:

1. Go to the File menu in the oscilloscope menu bar and access Reference Waveforms> Reference Setup. Figure 2–33 shows the Ref tabs.

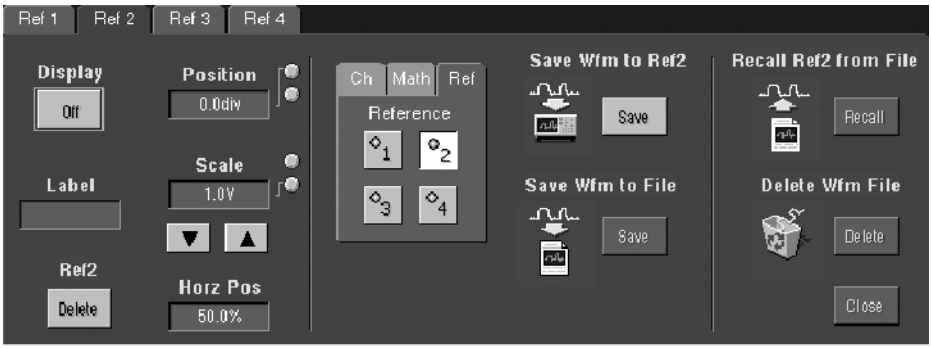


Figure 2-33: Oscilloscope reference memory setup

2. Select the Ref2 tab and Recall. Choose the c:\TekApplications\tdsjit2\waveforms directory. Figure 2–34 shows a list of waveform files that appear.

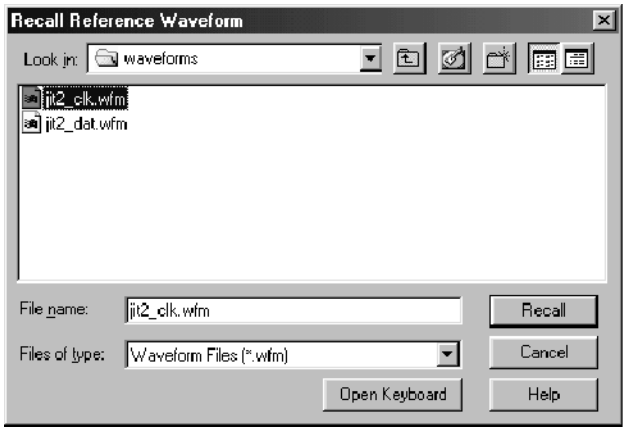


Figure 2-34: Waveform directory and files

3. Select the jit2_clk.wfm file and Recall.
4. Select the Ref3 tab and Recall.
5. Select the jit2_data.wfm file and Recall.
6. Select Display Off for Ref3.
7. To return to the application, choose the App button in the Menu bar.

Taking a Clock Period Measurement

In this example, you will learn how to use the application to take a Clock Period measurement, how to view the results as statistics, and how to view the results in the various plot formats. To perform these lessons, the application must be installed and enabled on the oscilloscope. See *Installation* on page 1–3.

To take a Clock Period measurement, follow these steps:

1. To set the application to default values, select Measurements> Save/Recall> Default.
2. Select Inputs> Main> Source> Ref 2.
3. Select Ref Levels Autoset. Figure 2–35 shows the Autoset Ref Level menu.

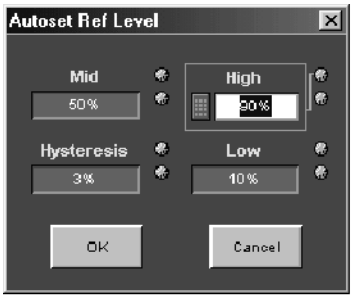


Figure 2-35: Autoset Ref Level menu

4. Select OK. Figure 2–36 shows the Inputs: Main menu setup.

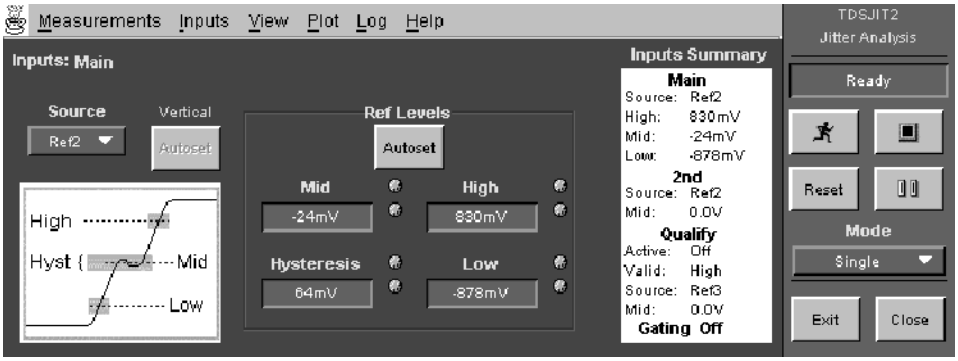


Figure 2-36: Inputs: Main menu setup

5. Press  to start the acquisition as shown in Figure 2–37.

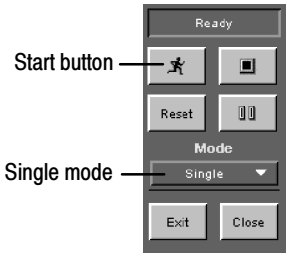


Figure 2-37: Taking a measurement

Figure 2–38 shows the statistical results.

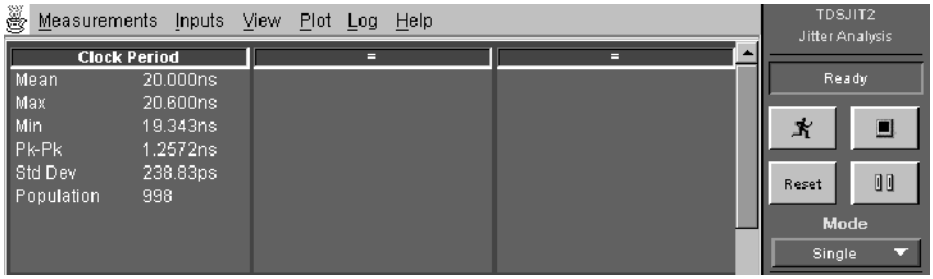


Figure 2-38: Clock Period lesson: statistical results

6. To view the results as a Histogram plot, select Plot> Select> Histogram (button)> Display> On. Figure 2–20 on page 2–18 shows the default for a Histogram plot of the Clock Period measurement to display as Ref1.

7. To view any of the plots, you need to remove the Ref2 waveform from the display. In the oscilloscope menu bar, go to File> Reference Waveforms> Reference Setup> Ref2> Display> Off.

Figure 2–39 shows the Histogram plot. It initially displays as a single bar.

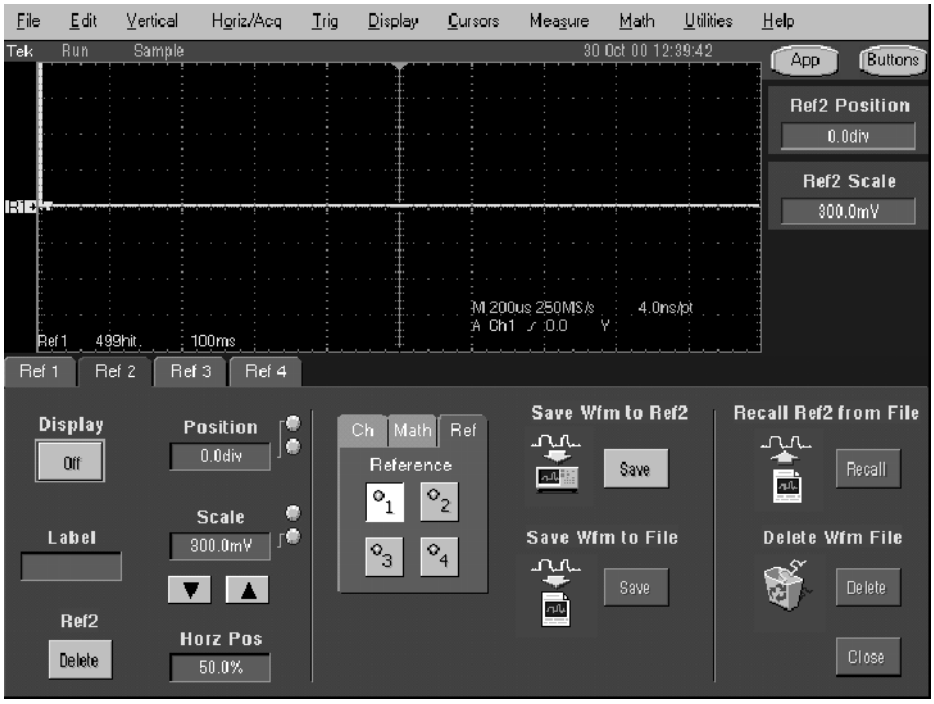


Figure 2-39: Clock Period lesson: Histogram plot

8. To return to the application, choose the App button in the Menu bar.

9. To view the plot using logical Center and Span values, select Plot> Vert/Horiz Axis> Horizontal> Autoset. Figure 2–40 shows the Histogram plot automatically redrawn by the application.

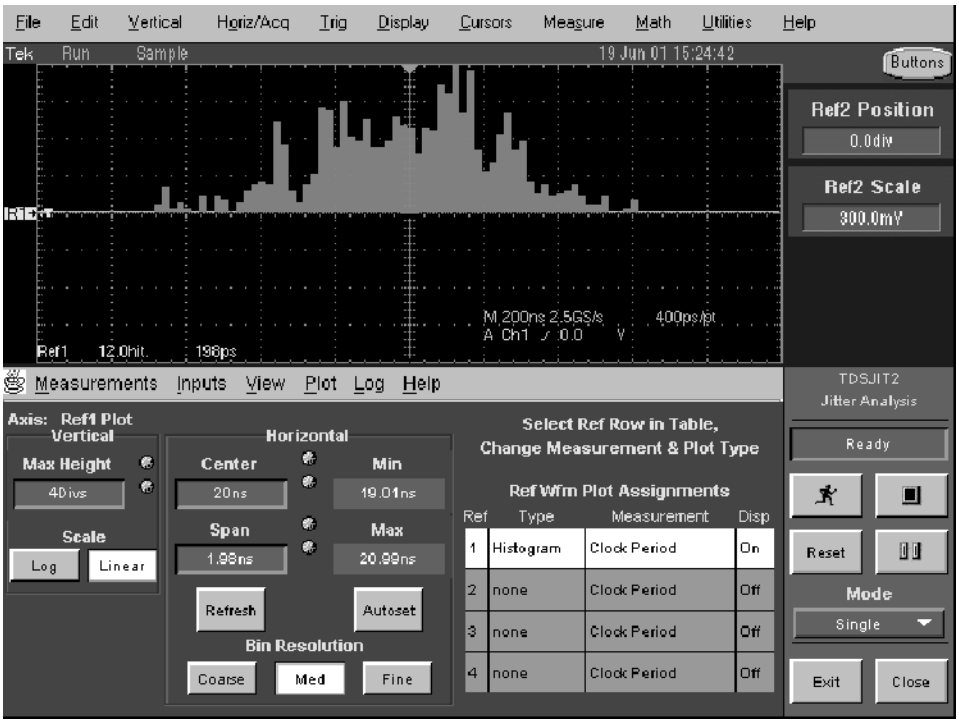


Figure 2- 40: Plot after using Horizontal Autoset in the Vert/Horiz Axis menu

10. Select Plot> Select.

11. To view the results as a Time Trend plot, select Time Trend> Display> On. Figure 2–41 shows the Time Trend plot.

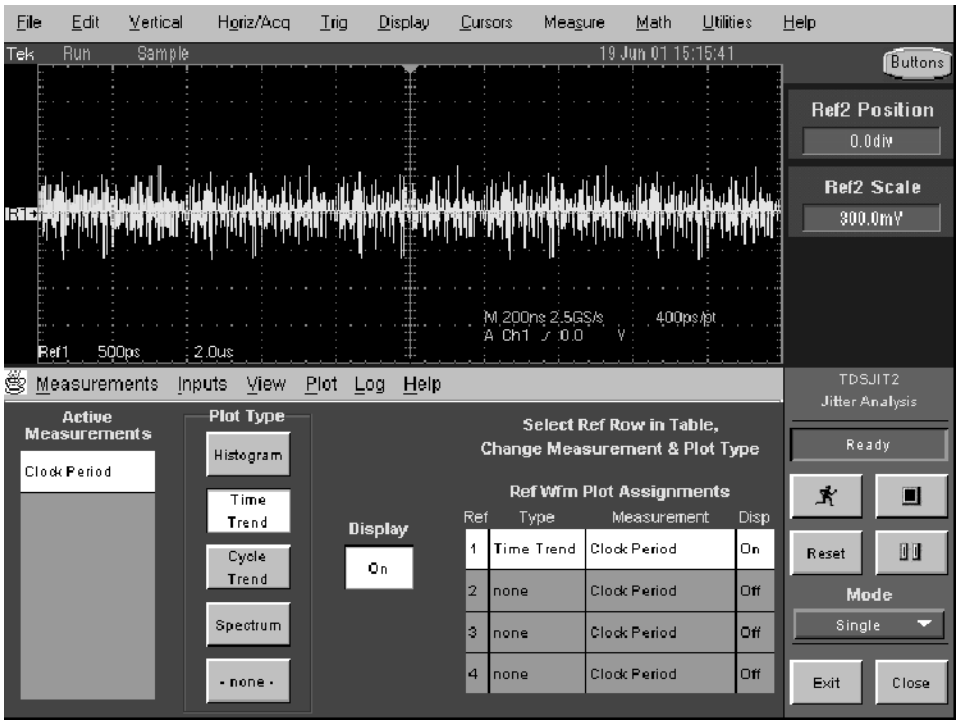


Figure 2-41: Clock Period lesson: Time Trend plot

12. To view the results as a Cycle Trend plot, select Cycle Trend> Display> On. Figure 2–42 shows the Cycle Trend plot.

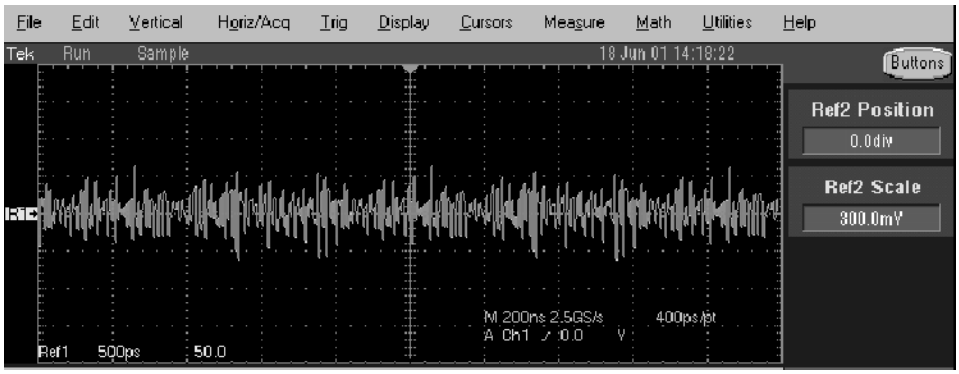


Figure 2-42: Clock Period lesson: Cycle Trend plot

13. To view the results as a Spectrum plot, select Spectrum> Display> On. Figure 2–43 shows the Spectrum plot.

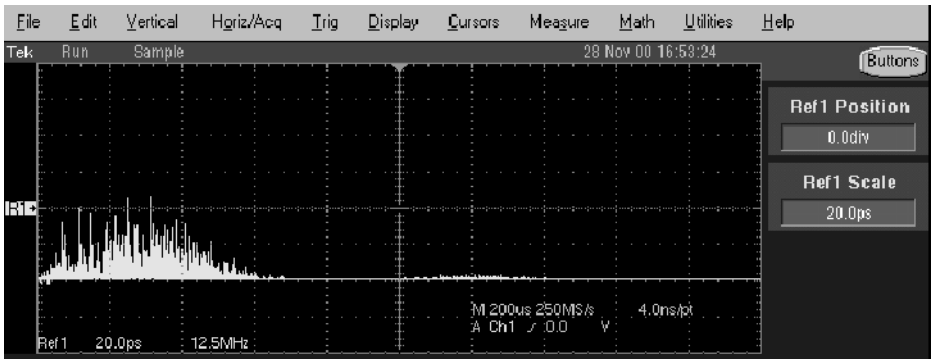


Figure 2- 43: Clock Period lesson: Spectrum plot

Taking a Clock-to-Output Time Measurement

In this example, you will learn how to use the application to take two measurements at the same time: Clock-to-Output Time and Clock Period. You will need two waveforms to take a Clock-Out measurement.

Retain the Input: Main setup for Ref2 from the previous lesson. That waveform will be used in both measurements.

To set up the application to take a Clock Out Time measurement, follow these steps:

1. You need to remove the Spectrum plot from the display. In the oscilloscope menu bar, go to File> Reference Waveforms> Reference Setup> Ref1> Display> Off.
2. You need to redisplay the jit2_clk.wfm file recalled to Ref 2. To do this, select Ref2> Display> On.
3. You also need to display the jit2_data.wfm file recalled to Ref 3. To do this, select Ref3> Display> On.
4. To return to the application, choose the App button in the Menu bar.
5. Select Measurements> Select> Clock-Out in the Clk-Data group.
6. In the Active Measurements list, select Clock-Out.
7. Select Inputs> 2nd> Source> Ref 3.
8. Select Ref Levels Autoset and OK. Figure 2–44 shows the Inputs:2nd menu setup.

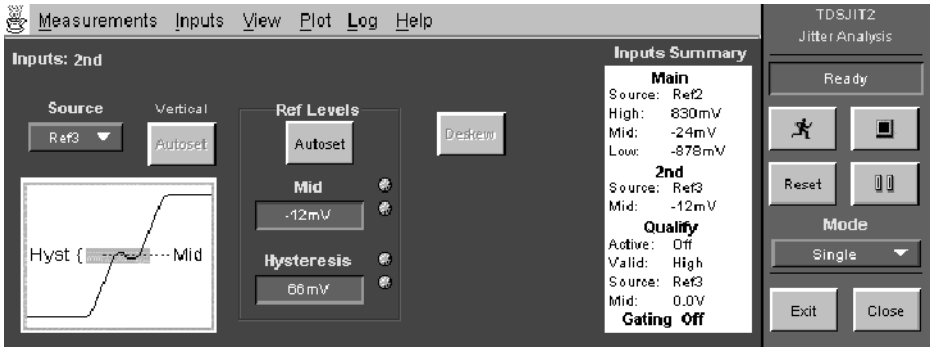


Figure 2-44: Inputs: 2nd menu setup

9. Select Reset to reset any previous results to zero as shown in Figure 2–45.

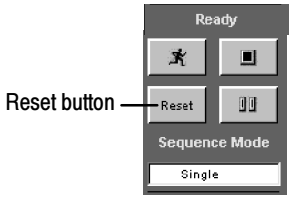


Figure 2-45: Resetting the results

10. Press  to start the acquisition. Figure 2–38 shows the statistical results.

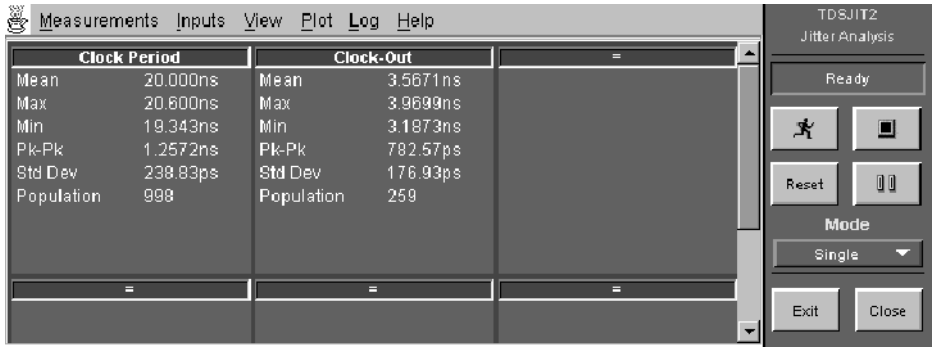


Figure 2-46: Clock-to-Output lesson: statistical results

Saving the Results to a Data Log File

To save the measurement results to a data log file, follow these steps:

1. Go to the Log menu in the menu bar and select Statistics. Figure 2–47 shows an example of the default application directory and log file name.

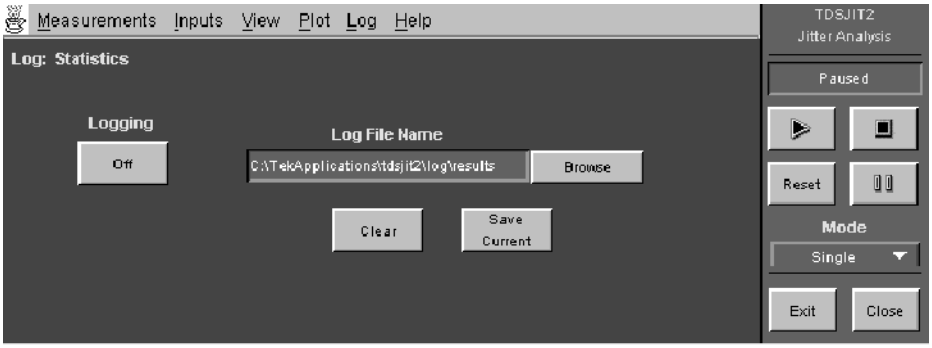


Figure 2- 47: Log Statistics menu with default file name

2. Select Logging On.
3. Press  to start the acquisition.
4. After the measurement completes, press  to log more data to the results.csv file.
5. Select Logging Off before viewing the data log file.
6. Exit the application.

Viewing a Data Log File

To view the data log file in a text editing application, such as Wordpad, follow these steps:

1. From the tool bar, select Start icon> Programs> Accessories> Wordpad.
2. Select File> Open.
3. Locate the C:\TekApplications\tdsjit2\log directory.
4. Select All Documents (*.*) for the Files of Type.

   Figure 2–48 shows the directory and log file with the default name.

Figure 2- 48: Log file with default file name

5. Select the results.csv file and Open. Figure 2–49 shows the .csv file viewed in Wordpad.

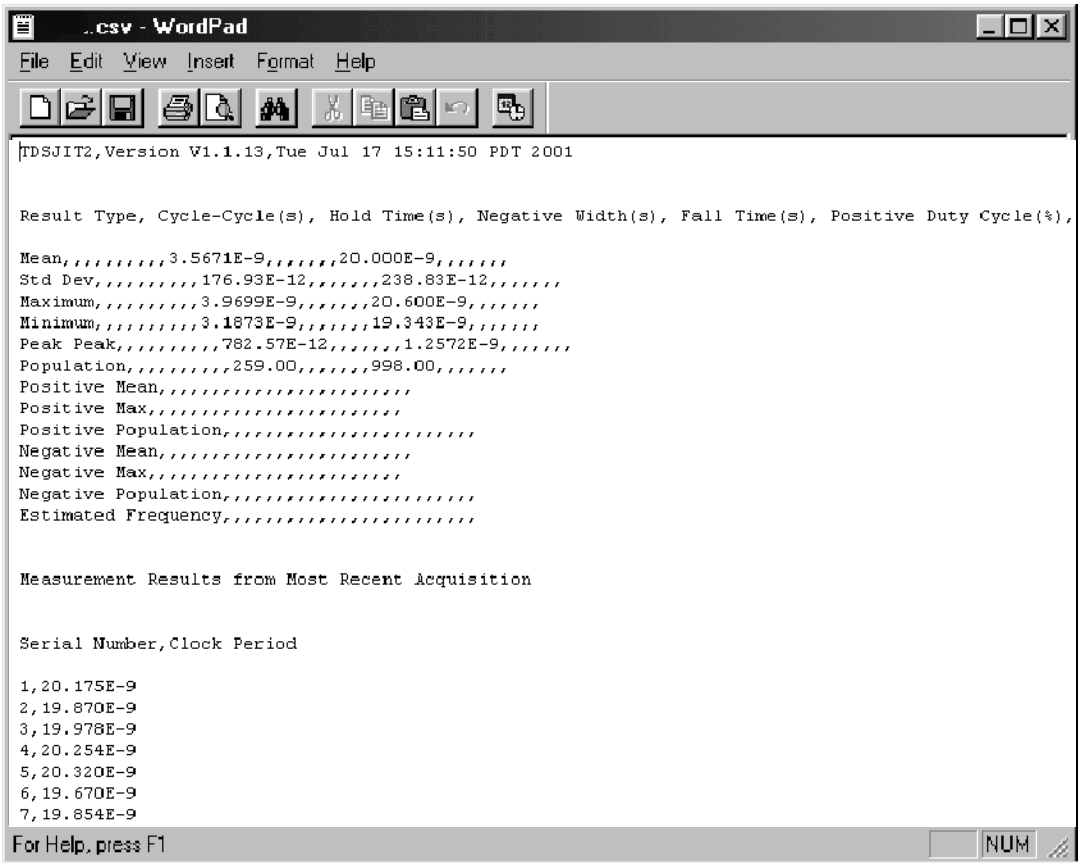


Figure 2- 49: results.csv file viewed in Wordpad

You can also import the .csv file to a DOS-based personal computer and then view the data log file with a spreadsheet, database, or data analysis program.

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 save the application setup and stop your session, refer to *Saving a Setup* on page 2–28 and to *Exiting the Application* on page 2–30.

Returning to the Tutorial

To return to the tutorial setup, you can start the application and then recall the saved setup. To recall the application setup, refer to *Recalling a Saved Setup* on page 2–29.

GPIB Program Example

This section contains an example of a GPIB program that can execute the TDSJIT2 application. The oscilloscope hard disk and the optional applications compact disc both contain this program in the tdsjit2ctrl.c file. The file resides on the hard drive in the C:\Program Files\TekApplications\tdsjit2 directory.

Guidelines

Your GPIB program should comply with the following guidelines:

- The application startup must complete before sending additional GPIB commands to the application (see example).
- The measurements cycle must complete before data is queried (see example).
- The error variable should be checked to ensure that an error has not occurred because of a measurement command problem.

Program Example

This example shows how a GPIB program might execute the application to do the following tasks:

- Start the application
- Recall a setup
- Enable the logger
- Take a measurement
- Check for an error
- Exit the application

Refer to *Appendix B: GPIB Command Syntax* for a complete list of the GPIB command syntax with the arguments, variables, and variable values.

***NOTE**. GPIB commands are case and space sensitive.*

```
/* TDSJIT2
 * This is a reference program to illustrate how to communicate to TDSJIT2
 * using Remote GPIB facilities.

      Typical Application does following steps

      1. Start up the application
      2. Recall a setup
      4. Take a measurement
      5. Display results or errors
      6. Exit the application

      For the current program, we will recall "Default" settings (This has only one active
      measurement - Clock Period).

      You can save setup files according to your own needs using the GUI based interface of
      the application.

 */



#ifdef __cplusplus
extern "C"{
#endif
#include <windows.h>
#include <stdio.h>
#include <stdlib.h>
#include "decl-32.h"
#ifdef __cplusplus
}
#endif


/* Forward Declarations */
int start_application(int scope);
int exit_application(int scope);
int do_single_test (int scope);
int recall_setup( int scope, char *filename);
void display_results(int scope);


// parameters needed to access the device driver handler

#define BDINDEX                 0     // Board Index
#define PRIMARY_ADDR_OF_DMM     1     // Primary address of device
#define NO_SECONDARY_ADDR    0     // Secondary address of device
#define TIMEOUT                 T10s  // Timeout value = 10 seconds
#define EOTMODE                 1     // Enable the END message
#define EOSMODE                 0     // Disable the EOS mode
```

```
//char ReadBuffer[100];   //   Read data buffer
char ErrorMnemonic[21][5]  =  {"EDVR", "ECIC", "ENOL", "EADR", "EARG",
                               "ESAC", "EABO", "ENEB", "EDMA", "",
                               "EOIP", "ECAP", "EFSO", "", "EBUS",
                               "ESTB", "ESRQ", "", "", "", "ETAB"};

/*
 * After each GPIB call, the application checks whether the call
 * succeeded. If an NI-488.2 call fails, the GPIB driver sets the
 * corresponding bit in the global status variable. If the call
 * failed, this procedure prints an error message, takes
 * the device offline and exits.
 */
void GPIBCleanup(int ud, char* ErrorMsg)
{
   printf("Error : %s\nibsta = 0x%x iberr = %d (%s)\n",
           ErrorMsg, ibsta, iberr, ErrorMnemonic[iberr]);
   if (ud != -1)
   {
      printf("Cleanup: Taking device offline\n");
       ibonl(ud, 0);
   }
   exit(0);
}


/* Start Jitter Analysis application */

int start_application( int scope ) {
      char write_buffer[100];
      char read_buffer[100];
      char app_name[] = "\"TDSJIT2\"\n";
      int status, timer;

      /* Start the application */
      sprintf(write_buffer, "%s", "Application:activate \"Jitter Analysis 2\"");
      status = ibwrt(scope, write_buffer, strlen(write_buffer));

      if (ibsta & ERR){
   GPIBCleanup(scope, "Unable to start the application");
       return 0;
   }

      timer = 1;

      while (1) {
         // Check whether application has started
         sprintf(write_buffer, "%s", "Variable:value? \"application\"");
         status = ibwrt(scope, write_buffer, strlen(write_buffer));
         status = ibrd(scope, read_buffer, sizeof(read_buffer));
         read_buffer[ibcnt] = '\0';
```

```
        if (strcmp(app_name, read_buffer) == 0) {
              return 1;
        }

        timer++;
        if (timer > 60) {
              return 0;
        }

        Sleep(1000);
      }
      return 1;

}

int exit_application(int scope) {
      char write_buffer[100];

      printf("Exit Application ...\n");
      sprintf(write_buffer, "%s", "Variable:value \"application\",\"exit\"");
      ibwrt(scope, write_buffer, strlen(write_buffer));

      return 1;

}

int recall_setup(int scope, char* filename) {

      char write_buffer[100];
      char readBuffer[100];
      int status;
      int timer;

      /* Change to Default Directory - From GPIB we can access setup files only in this
      directory */
      sprintf(write_buffer, "%s", "Variable:value \"setupDirectory\",\"Default\"");
      status = ibwrt(scope, write_buffer, strlen(write_buffer));

      if (ibsta & ERR){
   GPIBCleanup(scope, "Unable to communicate with Scope");
       return 0;
   }

      /* set Recall file name */
      sprintf(write_buffer, "%s%s%s", "Variable:value \"recallName\",\"", filename, "\"");
      status = ibwrt(scope, write_buffer, strlen(write_buffer));

      if (ibsta & ERR){
   GPIBCleanup(scope, "Unable to communicate with Scope");
       return 0;
   }
```

```
      /* recall setup */
      sprintf(write_buffer, "%s", "Variable:value \"setup\",\"Recall\"");
      status = ibwrt(scope, write_buffer, strlen(write_buffer));

      if (ibsta & ERR){
   GPIBCleanup(scope, "Unable to communicate with Scope");
       return 0;
   }

      /* Check whether recall is complete or not...If recall is complete
      variable setup value will change to a blank string */
      timer  = 1;

      while (1) {

         if (timer > 60) {
               return 0;
         }
         sprintf(write_buffer, "%s", "Variable:value? \"setup\"");
         ibwrt(scope, write_buffer, strlen(write_buffer));
         /* read the answer */
         ibrd(scope, readBuffer, 99);

         if (ibsta & ERR) {
               GPIBCleanup(scope, "Unable to write to device");
         }

         readBuffer[ibcnt] = '\0';

         if (strcmp(readBuffer,"\" \"\n") == 0) {
               return 1;
         }

         Sleep(1000);

      }
      return 1;
}


int do_single_test (int scope){
      char write_buffer[100];
      char read_buffer[100];

      int timer;

      sprintf(write_buffer, "%s", "Variable:value \"sequencerState\",\"Sequencing\"");
      ibwrt(scope, write_buffer, strlen(write_buffer));

      printf("Executing Test...\n");
      Sleep(100);
```

```
      // Wait for application to come to Ready State
      timer  = 1;

      while (1) {

         if (timer > 90) {
               printf("******Test Time Out ******\n");
               return 0;
         }
         sprintf(write_buffer, "%s", "Variable:value? \"sequencerState\"");
         ibwrt(scope, write_buffer, strlen(write_buffer));
         /* read the answer */
         ibrd(scope, read_buffer, 99);

         if (ibsta & ERR) {
               GPIBCleanup(scope, "Unable to write to device");
         }

         read_buffer[ibcnt] = '\0';

         if (strcmp(read_buffer,"\"Ready\"\n") == 0) {
               printf("Test Complete ...\n");
               return 1;
         }

         Sleep(1000);
      }

}

void display_results(int scope) {

      char write_buffer[100];
      char read_buffer[100];

      // Check for errors
      sprintf(write_buffer, "%s", "Variable:value? \"error\"");
      ibwrt(scope, write_buffer, strlen(write_buffer));

      /* read the answer */
      ibrd(scope, read_buffer, 99);

      if (ibsta & ERR) {
         GPIBCleanup(scope, "Unable to write to device");
      }
      read_buffer[ibcnt] = '\0';

      if (strcmp(read_buffer,"\" \"\n") != 0) {
         printf("Error has Occured. Error: %s\n",read_buffer);
         return;
      }
```

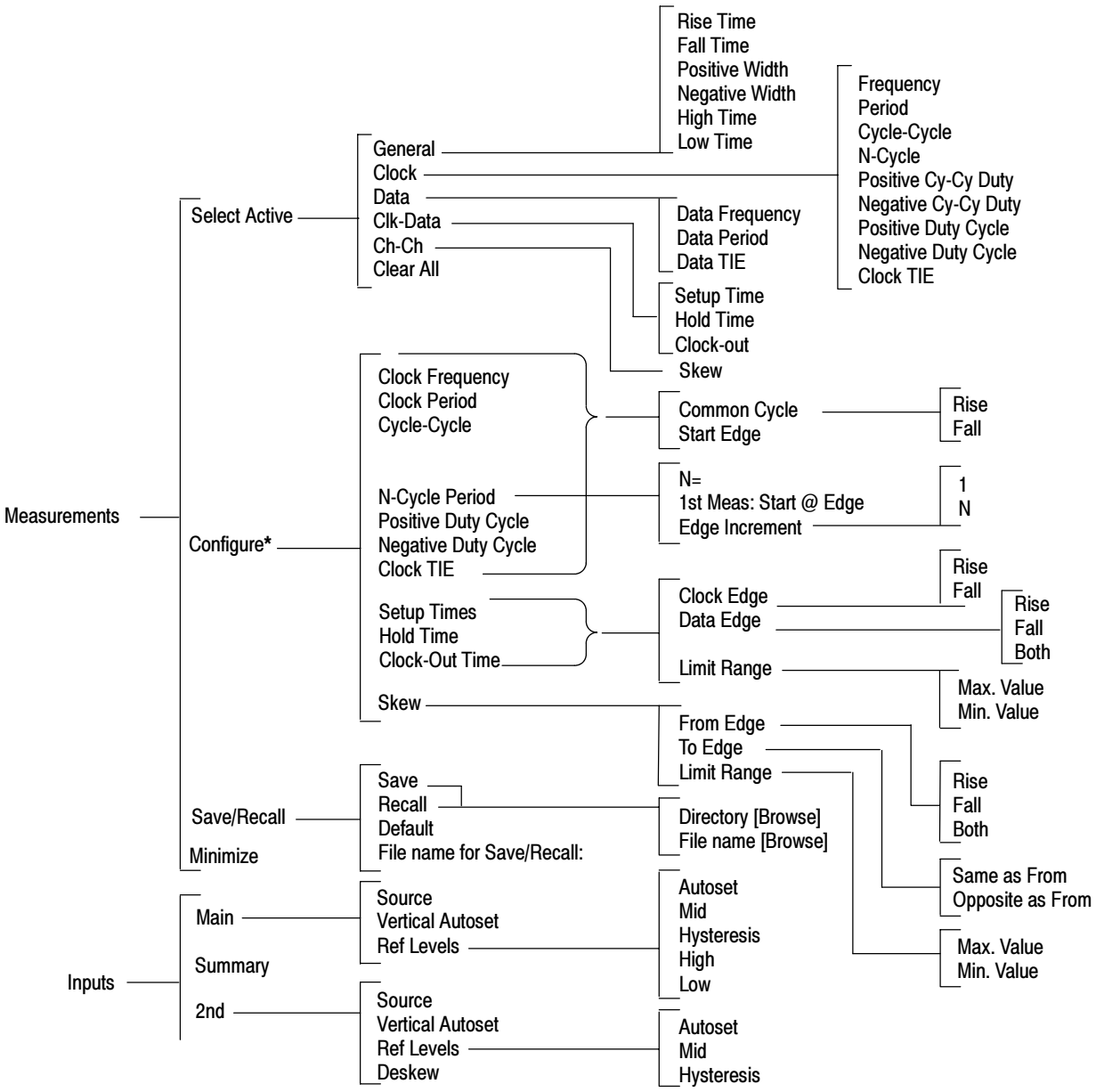
```
// If no error, check for results
sprintf(write_buffer, "%s", "Variable:value \"resultFor\",\"CP\"");
ibwrt(scope, write_buffer, strlen(write_buffer));

Sleep(2000);
printf("\tClock Period Results\n");
// ******** Mean
sprintf(write_buffer, "%s", "Variable:value? \"mean\"");
ibwrt(scope, write_buffer, strlen(write_buffer));

/* read the answer */
ibrd(scope, read_buffer, 99);
read_buffer[ibcnt] = '\0';

printf("mean:%s\n", read_buffer);


// ******** Max
sprintf(write_buffer, "%s", "Variable:value? \"max\"");
ibwrt(scope, write_buffer, strlen(write_buffer));
ibrd(scope, read_buffer, 99);
read_buffer[ibcnt] = '\0';
printf("max:%s\n", read_buffer);

// ******** Min
sprintf(write_buffer, "%s", "Variable:value? \"min\"");
ibwrt(scope, write_buffer, strlen(write_buffer));
ibrd(scope, read_buffer, 99);
read_buffer[ibcnt] = '\0';

printf("min:%s\n", read_buffer);

// ******** PkPk
sprintf(write_buffer, "%s", "Variable:value? \"pkpk\"");
ibwrt(scope, write_buffer, strlen(write_buffer));
ibrd(scope, read_buffer, 99);
read_buffer[ibcnt] = '\0';

printf("pkpk:%s\n", read_buffer);

// ******** stdDev
sprintf(write_buffer, "%s", "Variable:value? \"stdDev\"");
ibwrt(scope, write_buffer, strlen(write_buffer));
ibrd(scope, read_buffer, 99);
read_buffer[ibcnt] = '\0';

printf("stdDe:v%s\n", read_buffer);

// ******** population
sprintf(write_buffer, "%s", "Variable:value? \"population\"");
ibwrt(scope, write_buffer, strlen(write_buffer));
```

```
      /* read the answer */
      ibrd(scope, read_buffer, 99);
      read_buffer[ibcnt] = '\0';

      printf("population:%s\n", read_buffer);

}

int main(){

      int Dev, i;
      char write_buffer[100];
      int status;

      Dev = ibdev (BDINDEX, PRIMARY_ADDR_OF_DMM, NO_SECONDARY_ADDR,
          TIMEOUT, EOTMODE, EOSMODE);

      if (ibsta & ERR){
         GPIBCleanup(Dev, "Unable to open device");
      } else {
         printf("My device id - %i", Dev);
      }

      status = ibwrt(Dev, write_buffer, strlen(write_buffer));

      if (start_application(Dev)) {
         printf("\nApplication started....\n");
      }

      recall_setup(Dev, "Default");

      do_single_test(Dev);

      // Print the results
      display_results(Dev);

      exit_application(Dev);
      /* leave the device back elegantly */
      printf("Cleanup: Taking device offline\n");
      ibonl(Dev, 0);

}
```

Reference

Menu Structure

Figure 3-1 shows the relationship of the application-specific menus.



*** There is no configuration for the Rise Time, Fall Time, Positive Width, Negative Width, High Time, Low Time, Positive Cy - Cy Duty, Negative Cy - Cy Duty, Data Frequency, Data Period, and Data TIE measurements.**

Figure 3-1: Menu structure

Figure 3-2 shows the structure of the remaining menus.

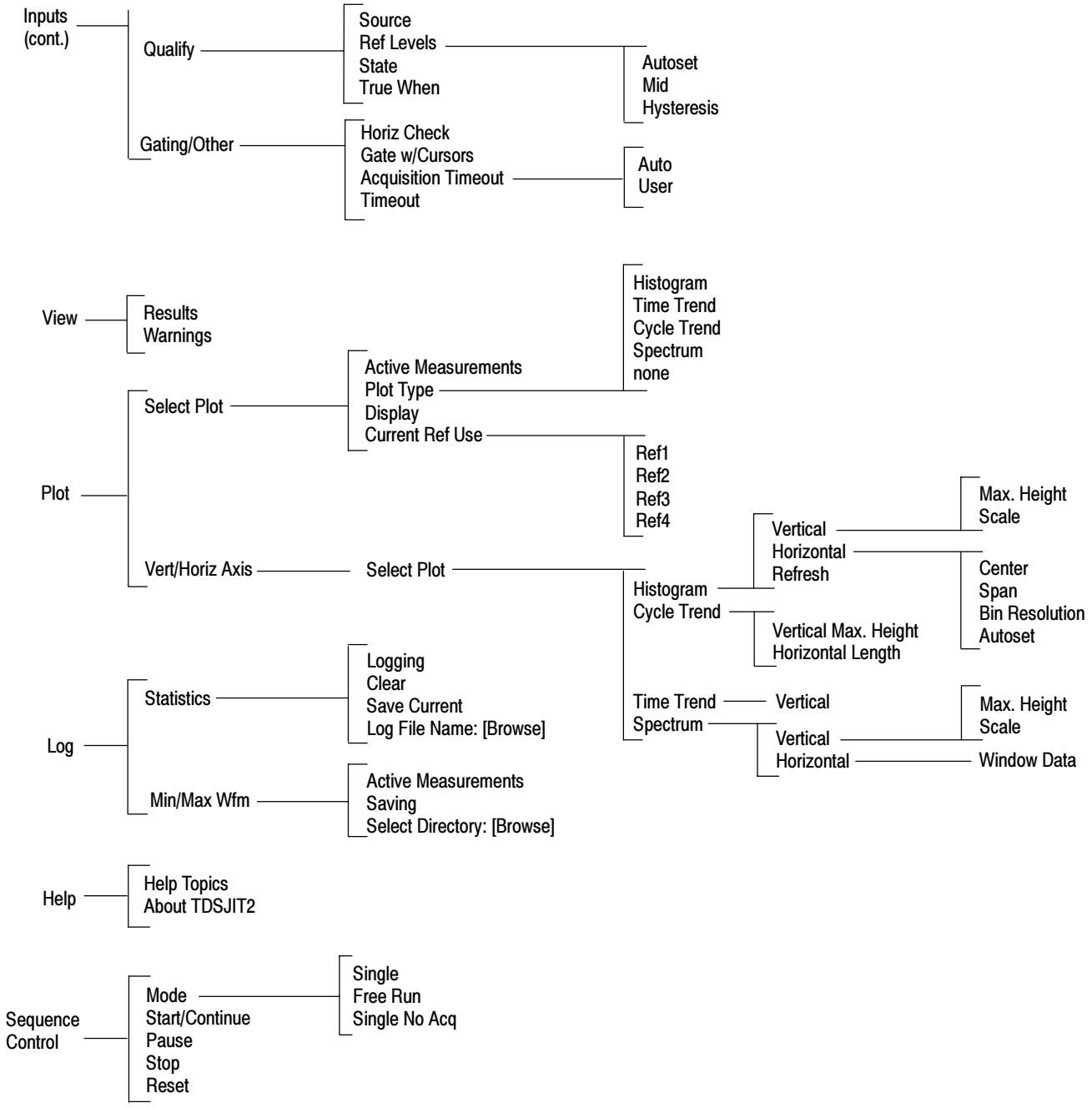


Figure 3-2: Menu structure (continued)

Parameters

This section describes the TDSJIT2 application parameters. You should refer to the user manual for your oscilloscope for operating details of other controls, such as front-panel buttons.

Refer to *Appendix B: GPIB Command Syntax* for a complete list of the GPIB command syntax with the arguments, variables, and variable values that correspond to the TDSJIT2 parameters.

***NOTE**. Incremental unit values shown are valid when the FINE button is enabled on the oscilloscope.*

Measurements Menus

There are four Measurements menu items: Select Active, Configure, Save/Recall, and Minimize.

Select Active Menu

The options in the Select Active Measurements menu by area are as follows:

- General area: Rise Time, Fall Time, Positive Width, Negative Width, High Time and Low Time
- Clock area: Frequency, Period, Cycle-Cycle, N-Cycle, Positive Cy-Cy Duty Cycle, Negative Cy-Cy Duty Cycle, Positive Duty Cycle, Negative Duty Cycle, Clock TIE
- Data area: Data Frequency, Data Period, and Data TIE
- Clk-data area: Setup Time, Hold Time, and Clock-Out
- Ch-Ch area: Skew

Configure Menu

You do not need to configure the following measurements:

- General area (all): Rise Time, Fall Time, Positive Width, Negative Width, High Time and Low Time
- Clock area: Positive Cy-Cy Duty and Negative Cy-Cy Duty
- Data area (all): Data Frequency, Data Period, and Data TIE

Table 3–1 lists the parameters for the Configure Measurements menu and the selections or range of values available for each.

Table 3–1: Configure Measurements menu parameters

Parameter	Selections	Default setting
Common Cycle Start Edge	Rise, Fall	Rise
N=	1 to 1,000 in 1 cycle units	6
1st Meas Start Edge At	1 to 1,000 in 1 cycle units	1
Edge Increment	1, N	1
Clock Edge	Rise, Fall	Rise
Data Edge	Rise, Fall, Both	Rise
Limit Range: Max. Value	-500.0 ms to 500.0 ms in 10 ps units	1.0 μs
Limit Range: Min. Value	-500.0 ms to 500.0 ms in 10 ps units	0 s (-1.0 μs for Skew)
From Edge	Rise, Fall, Both	Rise
To Edge	Same as From, Opposite as From	Same as From

Save/Recall Menu

Table 3–2 lists the parameters for the Save/Recall Measurements menu and the selections available for each.

Table 3–2: Save/Recall Measurements menu parameters

Parameter	Selections	Default setting
Save	None	C:\TekApplications\tdsjit2\setup\setup.ini
Recall	None	C:\TekApplications\tdsjit2\setup\setup.ini
Default	None	

Inputs Menus

There are four Inputs menus: Main, 2nd, Qualify, and Gating/Other.

Main and 2nd Menus

Table 3–3 lists the parameters for the Inputs:Main and Inputs: 2nd menus and the selections or range of values available for each.

Table 3-3: Inputs: Main and Inputs: 2nd menu parameters

Parameter	Selections	Default setting
Source*	Ch1, Ch2, Ch3, Ch4, Ref1, Ref2, Ref3, Ref4, Math1, Math2, Math3, Math4	Ch1
Vertical Autoset	None	
Mid	-10.0 V to 10.0 V in 1 mV units	0.00 V
Hysteresis	0 V to 5.0 V in 1 mV units	10.00 mV
High**	-10.0 V to 10.0 V in 1 mV units	1.00 V
Low**	-10.0 V to 10.0 V in 1 mV units	-1.00 V

*** For two-channel measurements that include a clock, select the channel (reference memory or math waveform) for the clock signal as the Main Input Source. For Data measurements, select the channel for the data signal as the Main Input Source.**

**** Only available for the waveform defined in the Inputs: Main menu.**

Table 3-4 lists the parameters for the Autoset Ref Level menu and the selections or range of values available for each.

Table 3-4: Autoset Ref Level menu parameters

Parameter	Selections	Default setting
Mid	1% to 99% in 1% units	50%
Hysteresis	0% to 50% in 1% units	3%
High*	2% to 99% in 1% units	90%
Low*	1% to 98% in 1% units	10%

*** Only available for the waveform defined in the Inputs: Main menu.**

***NOTE**. The Deskew command button in the Inputs: 2nd menu starts the deskew utility. Refer to the* Deskewing the Probes and Channels *on page 1-6 for more information.*

Qualify Menu

Table 3-5 lists the parameters for the Inputs: Qualify menu and the selections or range of values available for each.

Table 3-5: Inputs: Qualify menu parameters

Parameter	Selections	Default setting
Source	Ch1, Ch2, Ch3, Ch4, Ref1, Ref2, Ref3, Ref4, Math1, Math2, Math3, Math4	Ref3
Ref Levels	Same as in Table 3-3	See Table 3-3
State	Off, On	Off
True When	Low, High	High

Gating/Other Menu

Table 3-6 lists the parameters for the Inputs: Gating/Other menu and the selections or range of values available for each.

Table 3-6: Inputs: Gating/Other menu parameters

Paramter	Selections	Default setting
Horiz Check	None	
Gate w/Cursors	On, Off	Off
Acq Timeout	Auto, User	Auto
Timeout	30 sec to 24 hrs in 30 sec units*	30 sec*

*** When User is selected in the Acq Timeout option.**

View Menus

There are no parameters for the View Results or View Warnings menus.

Plot Menus

There are two Plot menus: Select Plot, and Vert/Horiz Axis Plot.

Select Plot Menu

The Select Plot menu contains the following parameters:

- List of Active Measurements
- Plot Type options: Histogram, Time Trend, Cycle Trend, Spectrum, and none
- Display option
- Current Ref Use table; there is one row for each reference memory: Ref1, Ref2, Ref3, and Ref4

Vert/Horiz Axis Plot Menu

The parameters for the Vertical/Horizontal Axis Plot menu vary according to the format you select for the Plot Type option.

Histogram Plot. Table 3–7 lists the parameters for the Histogram plot format in the Vert/Horiz Axis Plot menu and the selections or range of values available for each.

Table 3–7: Histogram: Vert/Horiz Axis Plot menu parameters

Parameter	Selections	Default setting
Vertical		
Max. Height	1.0 Div to 4.0 Div in 1.0 Div units	4.0 Div
Scale	Log, Linear	Linear
Bin Resolution	Coarse, Med, Fine	Med
Autoset	None	

The parameters for the Horizontal Center and Horizontal Span vary by measurement. Table 3–8 lists the parameter selections and range of values.

Table 3–8: Horizontal Center and Span parameters

Measurements	Parameter	Selections	Default setting
Rise Time, Fall Time, Positive Width, Negative Width, High Time, Low Time, Period, and Data Period	Center	5.0 ps to 10.0 s in units of 5 ps	5 s
	Span	10.0 ps to 10.0 s in units of 10 ps	10 s
Cycle-Cycle, N-Cycle, Positive Cy-Cy Duty, Negative Cy-Cy Duty, TIE, Data TIE, Setup Time, Hold Time, Clock-Out Time, and Skew	Center	–5.0 s to 5.0 s in units of 5 ps	0 s
	Span	10.0 ps to 10.0 s in units of 10 ps	10 s
Frequency, Data Frequency	Center	1 Hz to 10.0 GHz in units of 0.5 Hz	5 GHz
	Span	1 Hz to 10.0 GHz in units of 1 Hz	10 GHz
Positive Duty, and Negative Duty	Center	0% to 100% in units of 5m%	50%
	Span	10m% to 100% in units of 10m%	100%

The Horizontal area includes two readouts that display the following values:

- Min shows: Center – Span/2
- Max shows: Center + Span/2

Time Trend Plot. Table 3–9 lists the parameters for the Time Trend plot format in the Vert/Horiz Axis Plot menu and the selections or range of values available for each.

Table 3-9: Time Trend: Vert/Horiz Axis Plot menu parameter

Parameter	Selections	Default setting
Vertical Max. Height	1.0 Div to 8.0 Div in 1.0 Div units	4.0 Div

Cycle Trend Plot. Table 3-10 lists the parameters for the Cycle Trend plot format in the Vert/Horiz Axis Plot menu and the selections or range of values available for each.

Table 3-10: Cycle Trend: Vert/Horiz Axis Plot menu parameters

Parameter	Selections	Default setting
Vertical Max. Height	1.0 Div to 8.0 Div in 1.0 Div units	4.0 Div
Horizontal Length	500 pt to 50,000 pt in 500 units	500 points

Spectrum Plot. Table 3-10 lists the parameters for the Spectrum plot format in the Vert/Horiz Axis Plot menu and the selections or range of values available for each.

Table 3-11: Spectrum: Vert/Horiz Axis Plot menu parameters

Parameter	Selections	Default setting
Vertical Max. Height	1.0 Div to 8.0 Div in 1.0 Div units	4.0 Div
Scale	dB, Linear	Linear
Window Data	On, Off	On

Log Menus

There are two Log menus: Statistics and Min/Max Wfm.

Statistics Menu

Table 3-12 lists the parameters for the Log Statistics menu and the selections or range of values available for each.

Table 3-12: Log Statistics menu parameters

Parameter	Selections	Default setting
Logging	On, Off	Off
Clear	None	

Table 3-12: Log Statistics menu parameters (Cont.)

Parameter	Selections	Default setting
Save Current	None	
Log File Name: Browse	Any file	C:\TekApplications\tdsjit2\log\results

Min/Max Wfm Menu

Table 3-13 lists the parameters for the Log Min/Max Wfm menu and the selections or range of values available for each.

Table 3-13: Log Min/Max Wfm menu parameters

Parameter	Selections	Default setting
Saving	On, Off	Off
Select Directory: Browse	Any directory	C:\TekApplications\tdsjit2\waveforms

The Log Min/Max Wfm menu includes readouts that display the file names for the minimum and maximum worst case waveforms for the Main input and for the 2nd input, if used. Table 2-20 on page 2-25 lists the waveform file names.

Help Menu

There are no parameters for the Help menu.

Sequence Control Menu

Table 3-14 lists the parameters in the Sequence Control menu and the selections available.

Table 3-14: Sequence Control menu parameters

Parameter	Selections	Default setting
Mode	Single, Free Run, Single No Acq	Single
Start (or Continue)	None	
Pause	None	
Stop	None	
Reset	None	

Appendices

Appendix A: Measurement Algorithms

The TDSJIT2 application can take timing measurements from one or two waveforms. The number of waveforms used by the application depends on the type of measurement being taken.

Single waveform measurements are: Rise Time, Fall Time, Positive Width, Negative Width, High Time, Low Time, Clock Period, Clock Frequency, Cycle-Cycle, N-Cycle, Positive Cycle-Cycle Duty, Negative Cycle-Cycle Duty, Positive Duty Cycle, Negative Duty Cycle, Clock TIE, Data Period, Data Frequency, and Data TIE. Dual waveform measurements are: Setup Time, Hold Time, Clock-to-Output, and Skew.

Oscilloscope Setup Guidelines

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

1. The signal is any channel, reference, 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 oscilloscope.
3. The sample rate 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 steps:

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 number of edges in the waveform to calculate the measurement as follows:
   - Single edge: Rise Time, Fall Time
   - One edge pair: Pulse Width, High Time, Low Time
   - Two cycle-start edges: Period, Frequency, Duty Cycle
   - Three cycle-start edges: Cycle-to-Cycle, TIE

- 2N + 1 cycle-start edges: N-Cycle
- Two edges on each of two waveforms: Skew

4. Performs the measurement.
5. Displays the results as statistics, saves the results as a plot format in a reference waveform, or saves the results to a data log file.

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 data transitions are not one-to-one.

Single Waveform Measurements

The Rise Time and Fall Time algorithms use both the VRefHi and VRefLo reference voltage levels. Each edge is defined by the slope, voltage reference level (threshold), and hysteresis.

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:

$$T_n^{Rise} = T_n^{Hi+} - T_n^{Lo+}$$

Where: T^{Rise} is the rise time.

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

T^{Lo+} 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:

$$T_n^{Fall} = T_n^{Lo-} - T_n^{Hi-}$$

Where: T^{Fall} is the fall time.

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

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

Positive and Negative Width Measurements

The Positive Width and the Negative Width measurements are the difference in time (positive or negative) between the leading edge and trailing edge of a pulse. The trailing edge is the opposite polarity (direction) of the leading edge.

The application calculates this measurement using the following equation:

$$W_n^+ = T_n^- - T_n^+$$

$$W_n^- = T_n^+ - T_n^-$$

Where: W^+ is the positive pulse width.

W^- is the negative pulse width.

T^- is the VRefMid crossing on the falling edge.

T^+ is the VRefMid crossing on the rising edge.

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:

$$T_n^{Hi} = T_n^{Hi-} - T_n^{Hi+}$$

Where: T^{Hi} is the high time.

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

T^{Hi+} 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:

$$T_n^{Low} = T_n^{Lo+} - T_n^{Lo-}$$

Where: T^{Low} is the low time.

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

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

Clock Frequency Measurement

The Clock Frequency measurement calculates the inverse of the clock period for each cycle.

The application calculates this measurement using the following equation:

$$F_n^{Clock} = 1/P_n^{Clock}$$

Where: F^{Clock} is the clock frequency.

P^{Clock} is the period.

Clock Period Measurement

The Clock Period measurement calculates the duration of a cycle as defined by a start and a stop edge. Edges are defined by slope, threshold, and hysteresis.

The application calculates this measurement using the following equation:

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

Where: P^{Clock} is the clock period.

T is the VRefMid crossing time in the Common Cycle Start Edge direction.

Cycle-to-Cycle Measurement

The Cycle-to-Cycle measurement calculates the difference in period measurements from one cycle to the next.

The application calculates this measurement using the following equation:

$$\Delta P_n = P_{n+1}^{Clock} - P_n^{Clock}$$

Where: ΔP is the difference between adjacent periods.

P^{Clock} is the period.

N-Cycle Measurement

The N-Cycle measurement calculates the difference in period measurements from cycles that are a defined number of cycles apart.

The application calculates this measurement using the following equation:

$$\Delta NP_n = \left(T^+_{n+2N} - T^+_{n+N}\right) - \left(T^+_{n+N} - T^+_n\right)$$

Where: ΔNP is the difference between adjacent N-cycle periods.

T^+ is the VRefMid crossing time in the Common Cycle Start Edge direction.

Positive and Negative Cycle-to-Cycle Duty Measurements

The Positive Cycle-to-Cycle Duty and Negative Cycle-to-Cycle Duty measurements calculate the ratio of the positive (or negative) portion of the cycle relative to the period from one cycle to the next.

The application calculates this measurement using the following equation:

$$\Delta W^+_n = W^+_n - W^+_{n-1}$$

$$\Delta W^-_n = W^-_n - W^-_{n-1}$$

Where: ΔW^+ is the positive cycle-to-cycle duty.

ΔW^- is the negative cycle-to-cycle duty.

W^+ is the positive pulse width.

W^- is the negative pulse width.

Positive and Negative Duty Cycle Measurements

The Positive Duty Cycle and Negative Duty Cycle measurements calculate the ratio of the positive (or negative) portion of the cycle relative to the period.

The application calculates this measurement using the following equation:

$$D^+_n = W^+_n / P^{Clock}_n$$

$$D^-_n = W^-_n / P^{Clock}_n$$

Where: D^+ is the positive duty cycle.

D^- is the negative duty cycle.

W^+ is the positive pulse width.

W^- is the negative pulse width.

P^{Clock} is the period.

Clock TIE Measurement

The Clock TIE measurement calculates the difference in time between the designated edge on a sampled clock waveform to the designated edge on a calculated clock waveform with a constant frequency (zero jitter).

The application calculates this measurement using the following equation:

$$TIE_n^{Clock} = T_n - T'_n$$

Where: TIE^{Clock} is the clock time interval error.

T_n is the specified clock edge.

T'_n is the calculated ideal clock edge.

Data Frequency Measurement

The Date Frequency measurement calculates the inverse of the data period for each cycle.

The application calculates this measurement using the following equation:

$$F_n^{Data} = 1/P_n^{Data}$$

Where: F^{Data} is the data frequency.

P is the period.

Data Period Measurement

The Date Period measurement calculates the duration of a cycle as defined by a start and a stop edge. Edges are defined by slope, threshold, and hysteresis.

The application calculates this measurement using the following equation:

$$P^{Data} = (T_n^{Data} - T_{n-1}^{Data})/(C_n - C_{n-1})$$

Where: P^{Data} is the data period.

T^{Data} is the VRefMid crossing time in either direction.

C_n is the calculated clock cycle location of $T^{Data}{}_n$.

Data TIE Measurement

The Date TIE measurement calculates the difference in time between the designated edge on a sampled data waveform to the designated edge on a calculated data waveform with a constant frequency (zero jitter).

The application calculates this measurement using the following equation:

$$TIE_n^{Data} = T_n^{Data} - T_n^{Data'}$$

Where: TIE^{Data} is the data time interval error.

T^{Data} is the data edge, the VRefMid crossing time in either direction.

$T^{Data'}$ is the calculated ideal data edge time.

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.

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 closest data edge to the clock edge that falls within the range limits is used.

The application calculates this measurement using the following equation:

$$T_n^{Setup} = T_i - T_n^{Data}$$

Where: T^{Setup} is the setup time.

T is the Main input (clock) $VRefMid_{Main}$ crossing time in the specified direction.

T^{Data} is the 2nd input (data) $VRefMid_{2nd}$ crossing time in the specified direction.

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 closest data edge to the clock edge that falls within the range limits is used.

The application calculates this measurement using the following equation:

$$T_n^{Hold} = T_n^{Data} - T_i$$

Where: T^{Hold} is the hold time.

T is the Main input (clock) $VRefMid_{Main}$ crossing time in the specified direction.

T^{Data} is the 2nd input (data) $VRefMid_{2nd}$ crossing time in the specified direction.

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 closest data edge to the clock edge that falls within the range limits is used.

The application calculates this measurement using the following equation:

$$T_n^{ClkOut} = T_n^{do} - T_i$$

Where: T^{ClkOut} is the clock-to-output time.

T is the Main input (clock) $VRefMid_{Main}$ crossing time in the specified direction.

T^{do} is the 2nd input (data) $VRefMid_{2nd}$ crossing time in the specified direction.

Skew Measurement

The Skew measurement calculates the difference in time between the designated edge on a principle waveform to the designated edge on another waveform. The closest data edge to the clock edge that falls within the range limits is used.

The application calculates this measurement using the following equation:

$$T_n^{Skew} = T_n - T_n^S$$

Where: S is the period.

T is the Main input $VRefMid_{Main}$ crossing time in the specified direction.

T^S is the 2nd input $VRefMid_{2nd}$ crossing time in the specified direction.

Calculating Statistics

The application calculates statistics for each selected measurement, and logs the statistics on a cycle-cycle basis in a fairly large waveform. The standard statistics are for the Maximum, Minimum, Mean, Standard Deviation, and Population.

The application continues to calculate statistics until you press the Reset button in the Sequence Control menu. This resets all values to zero.

Maximum Value

The application calculates this value using the following equation:

$$Max\,(X) \;=\; \text{Highest value of X}$$

Minimum Value

The application calculates this value using the following equation:

$$Min\,(X) \;=\; \text{Lowest value of X}$$

Mean Value

The application calculates this value using the following equation:

$$Mean\,(X) \;=\; \overline{X} \;=\; \frac{1}{N}\sum_{n=1}^{N} X_n$$

Standard Deviation Value

It may seem odd that the equation for the estimate of the Standard Deviation contains a $1/(N-1)$ scaling factor. If you knew the true mean of X and used it in place of the estimated mean $\overline{X}$, then you would, in fact, scale by $1/N$. But, $\overline{X}$ is an estimate and is likely to be in error (or bias), causing the estimate of the Standard Deviation to be too small if scaled by $1/N$. This is the reason for the scaling shown in the equation. (Refer to Chapter 9.2 in A. Papoulis, *Probability, Random Variables, and Stochastic Processes*, McGraw Hill, 1991.)

The application calculates this value using the following equation:

$$Standard\ Deviation\,(X) \;=\; \sigma_x \;=\; \sqrt{\frac{1}{(N-1)}\sum_{n=1}^{N}(X_n-\overline{X})^2}$$

Cycle-Cycle Value

The application calculates this value using the following equation:

$$X_{CC_n} = X_n - X_{n-1}$$

Max Positive Difference Value

The application calculates this value using the following equation:

$$Max\ (X_{CC}) = \text{Highest value of } X_{CC}$$

Max Negative Difference Value

The application calculates this value using the following equation:

$$Max\ (-X_{CC}) = -\text{Lowest value of } X_{CC}$$

Mean Difference (Cycle-Cycle Mean) Value

The application calculates this value using the following equation:

$$Mean\ (|X_{CC}|) = \text{Average value of } X_{CC} \text{ magnitude}$$

RMS (Root Mean Square) Difference Value

The application calculates this value using the following equation:

$$RMS\ (X_{CC}) = X_{RMS} = \sqrt{\frac{1}{N}\sum_{n=1}^{N} {X_{CC_n}}^2}$$

Population Value

The application calculates this value using the following equation:

$$Population\ (X) = N$$

Appendix B: GPIB Command Syntax

This appendix describes the GPIB command syntax that you can use in your GPIB program to do the following tasks:

- Start the TDSJIT2 application
- Recognize an active application with GPIB protocol
- Program and read application setup parameters
- Sequence measurements
- Read measurement results

To use GPIB commands with your oscilloscope, you can use the following reference materials:

- The tdsjit2ctrl.c file on the oscilloscope hard drive and on the optional applications compact disc for an example of a GPIB program that can execute the application
- The *GPIB Program Example* section for guidelines to use while designing a GPIB program
- The *Parameters Reference* section for incremental units and default values of TDSJIT2 parameters
- The programmer information in the online help of your oscilloscope

Description. Gives the function of the command, conditions of its use, and its interactions with other commands.

Syntax. Gives the valid select and query command forms. The required arguments are listed in their proper order.

For example, in the syntax definition

```
PATH= <Ad><Ars>

the arguments <Ad> and <Ars> are required in the order indicated
```

Arguments. The arguments to a command are defined along with their range of values.

Returns. Defines the data returned in response to a command query.

Starting and Setting Up the Application

To start the TDSJIT2 application, you must send the oscilloscope the following GPIB command:

```
application:activate "Jitter Analysis 2"
```

The application uses the VARIABLE:VALUE command with arguments to execute the application. The set of arguments does not include variable names and variable values necessary to *select and configure* the measurements in the GPIB program.

You must manually set up the application and oscilloscope by selecting and configuring the measurements that you want to take through your GPIB program, and save the setup. To save a setup, refer to *Saving a Setup* on page 2–28. You need to use the name of the saved setup file as the value for the `setupDirectory` and `saveName` variables in your GPIB program.

VARIABLE:VALUE TDS COMMAND

Description

VARIABLE:VALUE TDS COMMAND accepts string arguments for a control or data variable and a value to which to set the argument.

Syntax

VARIABLE:VALUE

```
VARIABLE:VALUE "<variable name>","<variable value>"

the arguments <variable name> and <variable value> are required
in the order indicated.

VARIABLE:VALUE? "<variable name>" for query
```

Arguments and Returns

Table B–1 lists the arguments, their function, and the query returns.

CAUTION. *Commands are case and space sensitive. Your program will not operate correctly if you do not follow the capitalization and spaces precisely.*

Table B-1: VARIABLE:VALUE TDS COMMAND arguments and queries

Variable name	Variable value	Function	Query form
application	{exit}	Terminates the active application	Returns the name of the currently active application
Sequencer			
sequenceMode	{Single_NoAcq, Free Run, Single}	Sets the sequencer mode	Returns the sequencer mode
sequencerState	{Ready, Paused, Sequencing}	Sets the state of the sequencer: Sequencing, Ready, Paused	Returns the state of the sequencer
reset	{results}	Clears the active measurement results and the plot displays	No query form
Save/Recall			
setup	{Default, Recall, Save}	Sets the Save/Recall/Default action	No query form
recallName	Any string from 1 to 8 characters from A to Z and/or zero to nine	Sets the recalled setup file name	Returns the saved setup file name
saveName	Any string from 1 to 8 characters from A to Z and/or zero to nine	Sets setup file name	Returns the setup file name
setupDirectory	{Default}	Sets the directory to the default directory	No query form
Logging Results			
logAnnotate*	A string from 1 to 20 characters from A to Z and/or zero to nine	Provides custom annotation to the statistics log file	Returns the logAnnotate string when set
loggerDestination	A string using characters from A to Z and/or zero to nine	Sets the statistics log file name	Returns the statisics log file name
logDirectory	{Default}	Sets the directory to the default directory	No query form
logger	{Reset}	Clears the current statistics log file	No query form
loggerState	{On, Off}	Sets the state of the statistics log; when on, the statistics from the current acquisition are logged	Returns the state of the data log
Result Variables			
resultFor	{CF, CP, TIE, CCP, NCP, PCCD, NCCD, PDC, NDC, PW, NW, RISE, FALL, HIGH, LOW, DF, DP, DTIE, SU, HOLD, TCO, SKEW}	Sets the measurement for which results are requested	Returns the selected measurement; see Table B-2 for the queries associated with resultFor

*** Custom annotation in the data log file is only available through GPIB execution of the application.**

You need to use the VARIABLE:VALUE? form to enter measurement results queries in your GPIB program. Before you can do this, you must first set the measurement with the resultFor command. Table B–2 lists the measurement results queries for the measurement selected in the resultFor variable.

Table B–2: Measurement results queries

Variable name	Function
calcFrequency	Returns the calculated frequency of the result for the measurement selected in the resultFor variable
error	Returns the error, if any, from the last measurement taken
max	Returns the maximum value of the result for the measurement selected in the resultFor variable
mean	Returns the mean value of the result for the measurement selected in the resultFor variable
min	Returns the minimum value of the result for the measurement selected in the resultFor variable
pkpk	Returns the peak-to-peak value of the result for the measurement selected in the resultFor variable
population	Returns the population for the result for the measurement selected in the resultFor variable
positiveMax	Returns the positive maximum value for the result of the measurement selected in the resultFor variable
positiveMean	Returns the positive mean value of the result for the measurement selected in the resultFor variable
positivePopulation	Returns the positive population for the result for the measurement selected in the resultFor variable
negativePopulation	Returns the negative population for the result for the measurement selected in the resultFor variable
negativeMax	Returns the negative maximum value of the result for the measurement selected in the resultFor variable
negativeMean	Returns the negative mean value of the result for the measurement selected in the resultFor variable
stdDev	Returns the standard deviation value of the result for the measurement selected in the resultFor variable
warning	Returns the warning, if any, from the last measurement taken

Table B–3 lists the results returned for various measurements.

Table B–3: Results returned by measurements

Measurement	Results returned
All	population, stdDev
CF, CP, TIE, PDC, NDC, PW, NW, RISE, FALL, HIGH, LOW, DF, DP, DTIE, SU, HOLD, TCO, SKEW	mean, max, min, pk-pk
CCP, NCP, PCCD, NCCD	positiveMean, positiveMax, positivePopulation, negativeMean, negativeMax, negativePopulation,
TIE, DTIE	calcFrequency* (appears on screen as Est Freq in a results.csv file)

*** For TDSJIT2 versions below V1.1, additional measurements returned calcFrequency.**

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