User Manual

Tektronix

TDSDDM2
Disk Drive Measurements Application

071-0815-01

This document supports software version 1.0.0
and above.

www.tektronix.com

Copyright © Tektronix, Inc. All rights reserved. Licensed software products are owned by Tektronix or its suppliers and are protected by United States copyright laws and international treaty provisions.

Use, duplication, or disclosure by the Government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013, or subparagraphs (c)(1) and (2) of the Commercial Computer Software – Restricted Rights clause at FAR 52.227-19, as applicable.

Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supercedes that in all previously published material. Specifications and price change privileges reserved.

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

TEKTRONIX and TEK are registered trademarks of Tektronix, Inc.

WARRANTY

Tektronix warrants that the media on which this software product is furnished and the encoding of the programs on the media will be free from defects in materials and workmanship for a period of three (3) months from the date of shipment. If a medium or encoding proves defective during the warranty period, Tektronix will provide a replacement in exchange for the defective medium. Except as to the media on which this software product is furnished, this software product is provided “as is” without warranty of any kind, either express or implied. Tektronix does not warrant that the functions contained in this software product will meet Customer’s requirements or that the operation of the programs will be uninterrupted or error-free.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period. If Tektronix is unable to provide a replacement that is free from defects in materials and workmanship within a reasonable time thereafter, Customer may terminate the license for this software product and return this software product and any associated materials for credit or refund.

THIS WARRANTY IS GIVEN BY TEKTRONIX IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX’ RESPONSIBILITY TO REPLACE DEFECTIVE MEDIA OR REFUND CUSTOMER’S PAYMENT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

Table of Contents

General Safety Summary ix
Preface xi
Related Documentation and Online Help xi
Conventions xii
Contacting Tektronix xii

Getting Started

Product Description **1–1**
Compatibility 1–1
Requirements and Restrictions 1–2
Updates Through the Web Site 1–2
Accessories 1–3

Installation **1–5**
Applying a New Label 1–5
Installing the Application 1–6
From the Compact Disc 1–7
From Floppy Disks 1–7
Enabling the Application 1–8
Connecting to a System Under Test 1–8
Primary Setup 1–9
Secondary Setup 1–10

Configuration **1–11**
Setting Up the Oscilloscope Trigger 1–11
Setting Up the Application Trigger 1–12
Hysteresis 1–14
Configuring the Input Waveforms 1–16

Operating Basics

Basic Operations **2–1**
Application Interface 2–1
Using Basic Oscilloscope Functions 2–2
Using Online Help 2–2
Minimizing and Maximizing the Application 2–2
Returning to the Application 2–3
Application Directories and File Names 2–3
Setting Up the Application 2–4
Selecting a Measurement 2–4
Configuring a Measurement 2–9
Taking Measurements 2–15
Taking New Measurements 2–15
Localizing Measurements 2–16
Analyzing the Results 2–16
Viewing Statistics 2–18
Viewing Plots 2–18
Clearing Results 2–19
Saving the Results to a File 2–19
Logging Statistics 2–19

Data Log File Format 2–20
Viewing a Data Log File 2–21
Saving and Recalling Setups 2–21
Saving a Setup 2–22
Recalling a Saved Setup 2–23
Recalling the Default Setup 2–24
Exiting the Application 2–24

Tutorial 2–25
Setting Up the Oscilloscope 2–25
Starting the Application 2–25
Recalling a Waveform File 2–26
Taking a TAA Measurement 2–27
Saving the Results to a Data Log File 2–29
Viewing a Data Log File 2–29
Stopping the Tutorial 2–31
Returning to the Tutorial 2–31

Application Examples 2–33
Configuring a Measurement 2–34
Specifying a Range of Sectors 2–34
Specifying a Limit Test 2–34
Specifying Gating 2–34
Specifying Hysteresis 2–35
Specifying a Filter 2–35
Using Reference Waveforms 2–35
Measuring TAA 2–35
Measuring PW50 2–36
Measuring Asperity 2–37
Measuring Overwrite 2–38
Measuring Resolution 2–40
Measuring Baseline Shift 2–40
Measuring NLTS 2–41
Measuring SNR 2–43
Creating and Viewing Track Profile Plots 2–45

GPIB Program Example 2–49
Guidelines 2–49
Program Example 2–49

Reference

Menu Structure 3–1

Parameters 3–3
Measurements Menu 3–3
TAA/PW50 Menu 3–3
NLTS/Other Menu 3–4
Save/Recall Menu 3–6
Minimize Menu 3–6
Inputs Menu 3–6
Inputs/Trigger Menu 3–6
Inputs Filters Menu 3–7
Inputs General Menu 3–7
View Menu 3–8

Plot Track Profile Menu 3–8
Log Statistics Menu 3–8
Help Menu 3–8
Sequence Control Menu 3–9

Appendices

Appendix A: Measurement Algorithms A–1
Oscilloscope Setup Guidelines A–1
TAA Measurements A–1
TAA+ and TAA– Measurements A–3
PW50 Measurements A–3
PW50+ and PW50– Measurements A–5
NLTS Measurements A–6
NLTS Initial Measurement A–7
NLTS 1st Adjacent Measurement A–7
NLTS 2nd Adjacent Measurement A–8
Other Measurements A–9
SNR Measurement A–9
Asperity Measurement A–9
Overwrite Measurement A–10
Resolution Measurement A–10
Baseline Shift Measurement A–11
Snapshot Measurements A–12
Amplitude Asymmetry (Amplitude asym) A–13
Timing Asymmetry (Time asym) A–13
Time Peak-to-Trough (Time PT) and Time Trough-to-Peak (Time TP) A–14
Calculating Statistics A–14
Maximum Value A–14
Minimum Value A–14
Mean Value A–15
Standard Deviation Value A–15

Appendix B: Track Profile Plots B–1
Using Track Profiles B–1
About the Track Profile Reference Memory B–1

Appendix C: GPIB Command Syntax C–1
Starting the Application C–2
VARIABLE:VALUE TDS COMMAND C–2

Index

List of Figures

Figure 1–1: TDSDDM2 Disk Drive Measurements Application 1–1
Figure 1–2: TDS7000 series oscilloscope label location 1–6
Figure 1–3: TDS5000 series oscilloscope label location 1–6
Figure 1–4: Primary setup connections 1–9
Figure 1–5: Secondary setup connections 1–10
Figure 1–6: Spectral Control T tab for a TDS7104 oscilloscope 1–11
Figure 1–7: Sector Trigger Mode default values 1–13
Figure 1–8: One track 1–14
Figure 1–9: Using hysteresis to avoid false identification of peaks . . . 1–15
Figure 1–10: Hysteresis option 1–15

Figure 2–1: Application interface 2–1
Figure 2–2: Returning to the application 2–3
Figure 2–3: TAA/PW50 Measurements menu 2–4
Figure 2–4: How to enter Limit Test option values 2–5
Figure 2–5: NLTS/Other Measurements menu 2–6
Figure 2–6: NLTS Parameter options 2–7
Figure 2–7: How the application calculates the polynominal index . . 2–8
Figure 2–8: SNR Parameter options 2–8
Figure 2–9: Asperity Parameter options 2–9
Figure 2–10: Inputs/Trigger menu 2–9
Figure 2–11: Inputs Filters menu 2–11
Figure 2–12: Filter characteristics 2–12
Figure 2–13: Using both Highpass and Lowpass filters 2–12
Figure 2–14: Inputs General menu 2–14
Figure 2–15: Sequence Control menu 2–15
Figure 2–16: Results as statistics and as a Track Profile plot 2–17
Figure 2–17: Example of viewing data in a .csv file 2–17
Figure 2–18: Plot Track Profile menu 2–18
Figure 2–19: Log Statistics menu 2–19
Figure 2–20: Log file directory 2–20
Figure 2–21: Save/Recall Measurements menu 2–21
Figure 2–22: Save directory 2–22
Figure 2–23: Recall directory 2–23
Figure 2–24: Exit menu 2–24

Figure 2–25: Starting the application 2–26
Figure 2–26: Oscilloscope reference waveform setup 2–26
Figure 2–27: Waveform directory to recall reference waveforms . . . 2–27
Figure 2–28: Inputs/Trigger menu setup 2–27
Figure 2–29: Taking a measurement 2–28
Figure 2–30: TAA lesson: statistical results 2–28
Figure 2–31: Log Statistics menu with default file name 2–29
Figure 2–32: Log file with default file name 2–30
Figure 2–33: TAA.csv file viewed in Wordpad 2–30
Figure 2–34: PW50 measurement results example 2–36
Figure 2–35: Asperity measurement results example 2–37
Figure 2–36: Overwrite measurement, PASS 1 example 2–39
Figure 2–37: Overwrite measurement results, PASS 2 example 2–39
Figure 2–38: Baseline Shift measurement results example 2–41
Figure 2–39: NLTS measurement results example 2–43
Figure 2–40: SNR measurement results example 2–45
Figure 2–41: Track Profile plot example 2–46
Figure 2–42: Track Profile plot with cursors 2–47

List of Tables

Table 1–1: Compatible oscilloscopes **1–1**
Table 1–2: Primary setup channel assignments **1–9**
Table 1–3: Default channel assignments **1–16**

Table 2–1: Application interface items **2–2**
Table 2–2: Default directory names **2–3**
Table 2–3: File name extensions **2–3**
Table 2–4: TAA/PW50 measurements options **2–4**
Table 2–5: Limit Test options **2–5**
Table 2–6: Limit Test entry methods **2–5**
Table 2–7: NLTS/Other Measurements options **2–6**
Table 2–8: NLTS Parameter options **2–7**
Table 2–9: SNR Parameter options **2–8**
Table 2–10: Trigger options **2–10**
Table 2–11: Filters options **2–11**
Table 2–12: General options **2–14**
Table 2–13: Sequence Control menu **2–15**
Table 2–14: Plot Track Profile options **2–18**
Table 2–15: Log Statistics options **2–20**
Table 2–16: Save/Recall Measurements options **2–22**
Table 2–17: Waveform files and application examples **2–33**

Table 3–1: TAA/PW50 Limit Test area parameters **3–4**
Table 3–2: NLTS/Other Limit Test area parameters **3–4**
Table 3–3: NLTS Parameters area **3–5**
Table 3–4: SNR Parameters area **3–5**
Table 3–5: Asperity Parameter area **3–6**
Table 3–6: Save/Recall Measurements menu parameters **3–6**
Table 3–7: Input Channels area parameters **3–6**
Table 3–8: Trigger area parameters **3–7**
Table 3–9: Filter 1 and Filter 2 areas parameters **3–7**
Table 3–10: General menu parameters **3–7**
Table 3–11: Plot Track Profile menu parameters **3–8**
Table 3–12: Log Statistics menu parameters **3–8**
Table 3–13: Sequence Control menu parameters **3–9**

Table C–1: VARIABLE:VALUE TDS COMMAND arguments and queries C–2
Table C–2: Measurement results queries C–5
Table C–3: Results returned by measurements C–7

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.

Ground the Product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

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.

Connect the ground lead of the probe to earth ground only.

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

Use Proper Fuse. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

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

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

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:



Preface

This manual contains operating information for the TDSDDM2 Disk Drive Measurements Application. The manual consists of the following chapters:

- The *Getting Started* chapter briefly describes the TDSDDM2 Disk Drive Measurements 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.

  The *Application Examples* section includes examples of tests and measurements to give you ideas on how to solve your own measurement problems.

  To show you how to operate the application using GPIB commands, this chapter also contains 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 *Track Profile Plots* appendix contains information about using track profile plots.
- 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.

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

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 contains 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*.

IDEMA Standard. The *International Disk Drive Equipment and Materials Association (IDEMA) 1995 Standards Binder*, section T for Test Methods, is the source document for test criteria used by theTDSDDM2 application. Polynomials must be valid according to the 1995 IDEMA “white paper.”

Conventions

This manual uses the following conventions:

- This manual refers to the TDSDDM2 Disk Drive Measurements Application as the TDSDDM2 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 between a menu and an option. For example, one of the steps to recall a setup file would appear as Measururements>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 TDSDDM2 Disk Drive Measurements Application is a Java™-based application that enhances basic capabilities of some Tektronix oscilloscopes.

The application provides disk drive measurements, can display the results as statistics or as a plot, and can save the results to a data log file.

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

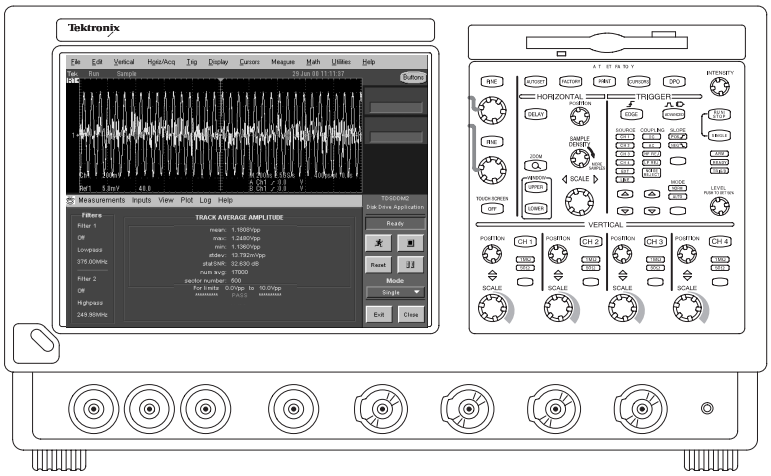


Figure 1–1: TDSDDM2 Disk Drive Measurements Application

Compatibility

The Disk Drive Measurements 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	1.20 or above
TDS7404	1.30 or above
TDS7254	1.3.1 and above
TDS5054 and TDS5104	1.00 or 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 TDSDDM2 application.

The TDSDDM2 application does not support hard disk drives that mark the beginning of a track by the absence of a sector pulse.

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, refer to *From Floppy Disks* procedure on page 1–7.

Accessories

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

To connect the Read Signal input to an oscilloscope channel, Tektronix Differential Probes are recommended, such as the P6247 or P6248 probe for TDS7054 and TDS7104 oscilloscopes, or the P7330 probe for a TDS7404 oscilloscope.

Installation

This section contains information on the following tasks:

- Applying a new label
- Installing the TDSDDM2 application
- Enabling the application
- 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 NO TAG 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.

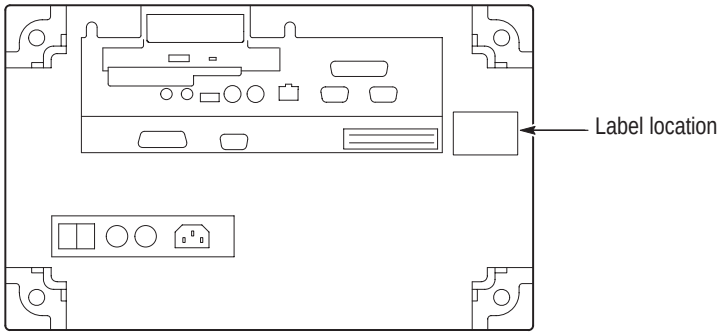


Figure 1–2: TDS7000 series oscilloscope label location

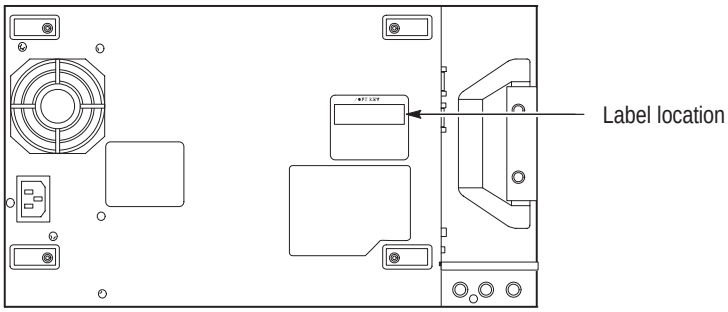


Figure 1–3: TDS5000 series oscilloscope label location

Installing the Application

Normally, the TDSDDM2 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 TDSDDM2 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 compact disc (CD).

From the Compact Disc

To install the TDSDDM2 application from the optional applications software CD for your instrument, 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 Tdsddm2 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 TDSDDM2 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.*

---

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 NO TAG on page NO TAGNO TAG shows the location of the label on the back of the oscilloscope.

Connecting to a System Under Test

For best signal accuracy, you should use one differential probe and two standard probes. For connection to the Read signal, use a differential probe, such as the Tektronix P6247 or P6248 probe for TDS7054 and TDS7104 oscilloscopes, or the P7330 probe for a TDS7404 oscilloscope. For connection to the Index and Sector signals, use standard oscilloscope probes, such as the P6139A passive probe or P6243 active probe for TDS7054 and TDS7104 oscilloscopes, or the P7240 active probe for a TDS7404 oscilloscope.

Table 1–2 shows the default channel-to-signal assignments. You can change the channel assignments to match your configuration.

Table 1–2: Primary setup channel assignments

Channel	Description
Ch 1	Read signal from the disk drive preamp channel
Ch 2	Read Gate signal (optional)
Ch 3	Sector pulse, marking the beginning of the sector on the track
Ch 4	Index pulse, marking the beginning of the track

***NOTE**. The TDSDDM2 application does not support disk drives that mark the beginning of a track by the absence of a sector pulse. For this case, a timeout trigger setup is needed to identify the beginning of the track.*

There are two connection configurations, primary and secondary.



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

Power down the SUT before connecting probes to it.

Primary Setup

Use the primary setup if you want the oscilloscope to control the disk measurements. The primary setup is used for most configurations. Connect the disk drive to the oscilloscope as shown in Figure 1–4.

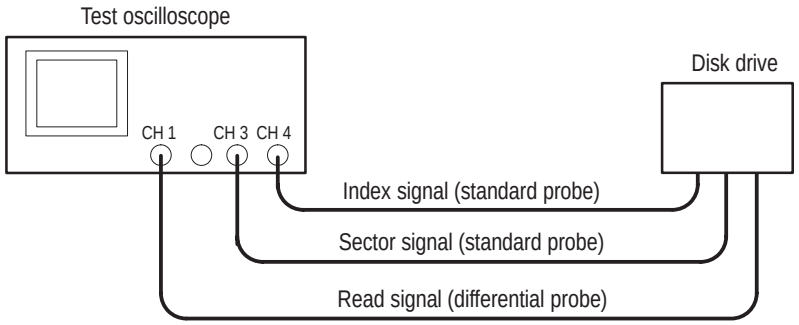


Figure 1–4: Primary setup connections

Secondary Setup

When using the secondary setup, you must specifically program the test measurement control sequences. Refer to the *GPIB Program Example* section and to the *GPIB Command Syntax* appendix in this manual for more information on how to control the application with a GPIB program.

Connect the disk drive to the oscilloscope as shown in Figure 1–5.

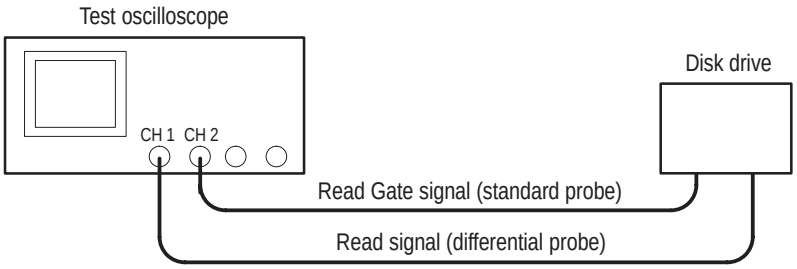


Figure 1–5: Secondary setup connections

Configuration

This section describes configuration tasks that you should perform before you start taking measurements. For the most part, these tasks configure the oscilloscope and Disk Drive Measurements Application to correctly acquire the signals from the disk drive under test. You can find more information on setup parameters for specific measurements in the *Parameters* section on page 3–3.

Setting Up the Oscilloscope Trigger

If you use the Read Gate, User, or Index Trigger mode in the application, you must manually set up the oscilloscope trigger. To do so, follow these steps:

1. Connect the Index, Sector, and Read signals to Ch 4, Ch 3, and Ch 1 respectively.
2. Go to Math in the oscilloscope menu bar and select Spectral Controls> T tab. Figure 1–6 shows the T tab.



Figure 1–6: Spectral Control T tab for a TDS7104 oscilloscope

3. Use the Multipurpose (MP) knobs to set the Sample Rate to 500 MS/s, 1.25 GS/s, 2.5 GS/s, 5 GS/s, or 10 GS/s.
4. Use the MP knobs to set the Record Length to 50,000, 100,000, 200,000 or 400,000.

   For NLTS measurements, set the Record Length to at least 200,000.
5. Set up the trigger:
   a. Go to Trig in the menu bar, access the A Event (Main) Trigger Setup menu, select the A Event tab, and set the Coupling to DC.
   b. Set the Slope to the appropriate edge for your disk drive signals, rising or falling.
   c. Set the Level to an appropriate level for your disk drive signals, or select Set 50%.
   d. Select the Mode tab, and set the Trigger Mode to Normal.
   e. Set the Holdoff to Auto.

Setting Up the Application Trigger

Before you begin to take measurements, you should specify the following trigger parameters:

- Trigger mode, which selects the input trigger signal
- Start Sector and Stop Sector (used with the Sector Trigger mode only), which specifies the range of sectors to be measured
- Preamble (used with the Sector Trigger mode only), which the application uses to avoid acquiring the preamble

Set up the trigger parameters as follows:

1. Start the application. Go to the File menu in the oscilloscope menu bar and select Run Application> Disk Drive Measurements 2.

2. Select Inputs> Input/Trigger and select one of the following Trigger Modes:

Sector	Select Sector mode if you want to perform a measurement over a range of sectors rather than over the entire track. The application sets up the following oscilloscope trigger controls: A Event trigger – the Source is the Index Pulse B Event trigger – the Source is the Sector Pulse A –> B Seq trigger (delayed trigger) – the Trig Event is the Start Sector number, Horiz Delay is On, and the Trig on nth event is the Preamble duration
Read Gate	Select Read Gate mode if you want to trigger on the Read Gate signal. The A –> B Seq is not used with this selection.
User	Select User mode if you want to use your own custom trigger setup. When you select User, the application does not set up the oscilloscope trigger controls. User is the default Trigger Mode selection.
Index	Select Index mode if you want to trigger on the Index Pulse signal. The A –> B Seq is not used with this selection.

***NOTE**. If you select the Read Gate, User, or Index Trigger mode, you must manually set up the oscilloscope trigger as described on page 1–11.*

3. For the Sector Trigger Mode, use the MP knob (or keypad) to select values for the Start Sector and Stop Sector options. Figure 1–7 shows the default values.

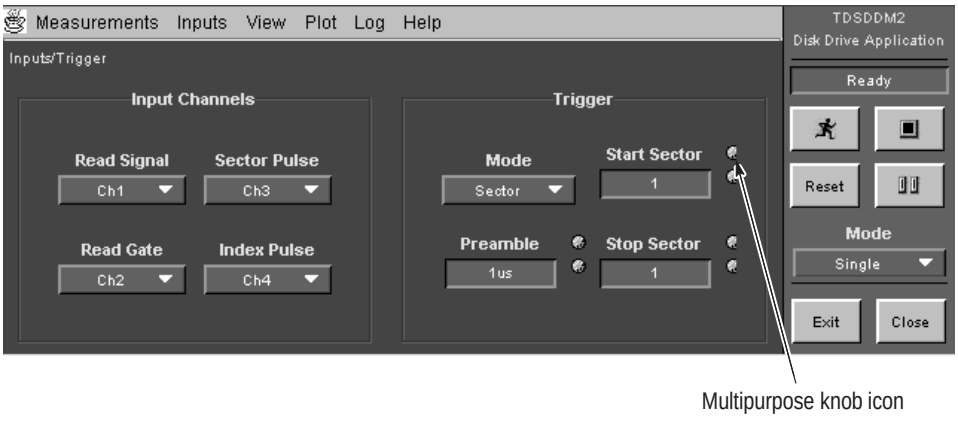


Figure 1–7: Sector Trigger Mode default values

***NOTE**. The A –> B Seq trigger has a minimum count setting of 1. If you want to trigger on sector 0, you must enter the value of N, where N is the total number of sectors on the track. The first Sector Pulse after the Index Pulse is sector 1.*

Figure 1–8 shows how the sectors are numbered with respect to the B Event trigger in the oscilloscope application.

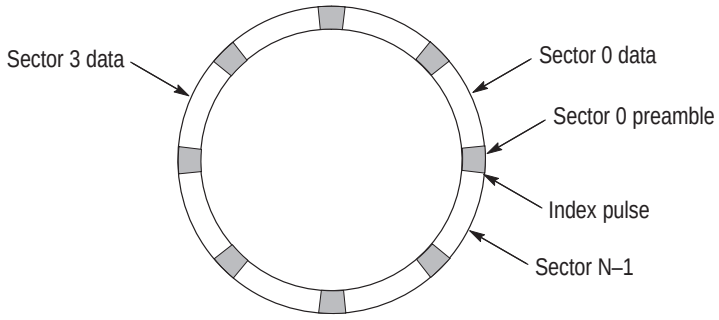


Figure 1–8: One track

4. For the Sector Trigger Mode, set the Preamble option. Use the MP knob (or keypad) to select a value that is greater than the actual signal preamble duration. This ensures that the application does not acquire the preamble and excludes it from the measurement.

Hysteresis

Many of the measurements search for a local event called a peak and trough pair. You can set the hysteresis level so that noise will not cause false identification of peaks in the Read waveform. For a peak or trough to be found, the signal must be greater than the hysteresis level.

The application uses the value of the Hysteresis option in many measurements, such as TAA, PW50, Asymmetry (for TAA Snapshot and PW50 Snapshot measurements), Overwrite, Resolution, and Baseline Shift.

Figure 1–9 shows how to use the hysteresis to avoid false identification of peaks and troughs.

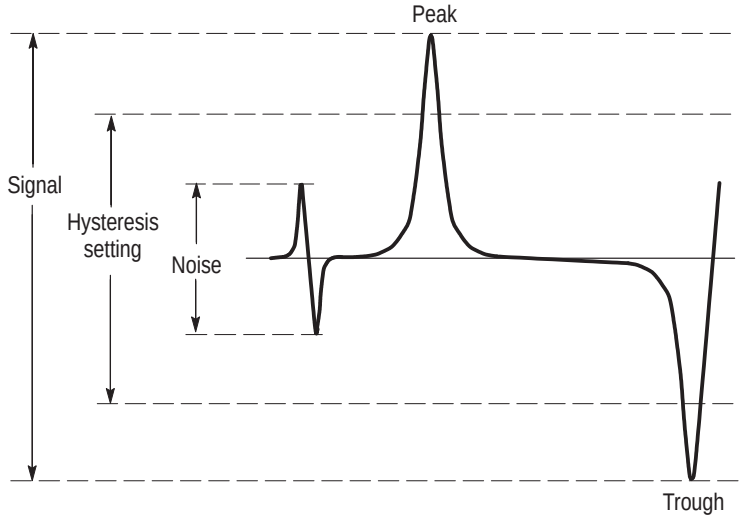


Figure 1–9: Using hysteresis to avoid false identification of peaks

To set the hysteresis levels, follow these steps:

1. Select Inputs> General.
2. Use the multipurpose knob (or keypad) to select a value in the Hysteresis option.

The units for hysteresis are in divisions. The application uses the value for both the positive hysteresis level and the negative hysteresis level. For example, if you select a value of 2 divisions, the hysteresis levels are set to +2 divisions and –2 divisions above and below the waveform baseline.

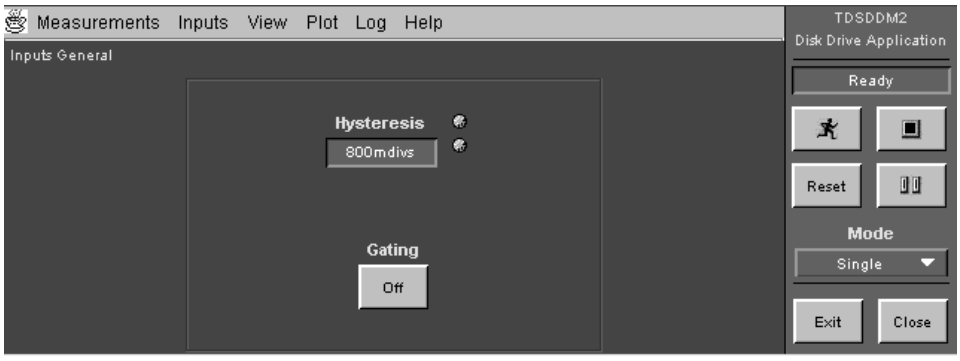


Figure 1–10: Hysteresis option

Configuring the Input Waveforms

Your configuration may not match the TDSDDM2 waveform assignments. Table 1–3 lists the default channel assignments.

Table 1–3: Default channel assignments

Description	Channel
Read signal from the preamp channel	Ch 1
Read Gate signal (optional)*	Ch 2
Sector Pulse, marking the beginning of the sector on the track**	Ch 3
Index Pulse, marking the beginning of the track**	Ch 4

*** Uses this signal when you select the Read Gate Trigger Mode.**

**** Uses these signals when you select the Sector Trigger Mode.**

NOTE. *Oscilloscope channels (Ch1, Ch2, Ch3, and Ch4) connect to real, live signals (waveforms) as opposed to waveforms that have been saved as .wfm files and can be recalled into reference memory (Ref1, Ref2, Ref3, and Ref4).*

If necessary, you can reconfigure the input waveforms to match your disk drive configuration. To do so, follow these steps:

1. Go to the Inputs menu in the menu bar and select Input/Trigger. Figure 1–7 on page 1–13 shows the Inputs/Trigger menu.
2. Use the list box for each signal and select the waveform that matches your configuration.

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.

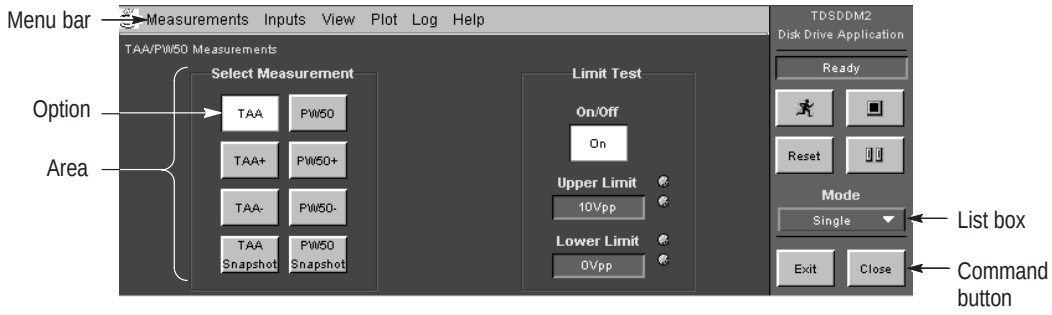


Figure 2–1: Application interface

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 TDSDDM2 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 TDSDDM2 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.

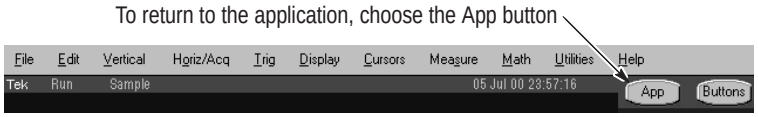


Figure 2–2: Returning to the application

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\tdsddm2	Home location
C:\TekApplications\tdsddm2\data	Data log files
C:\TekApplications\tdsddm2\setups	Setup files
C:\TekApplications\tdsddm2\waveforms	Waveform 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
.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 disk drive measurements from the SUT, you can plot the results, and you can save the statistical results to a data log file.

Selecting a Measurement

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

TAA/PW50 Measurements Menu. To access the TAA/PW50 Measurements menu, go to the Measurements menu in the menu bar and choose TAA/PW50. Figure 2–3 shows the TAA/PW50 Measurements menu.

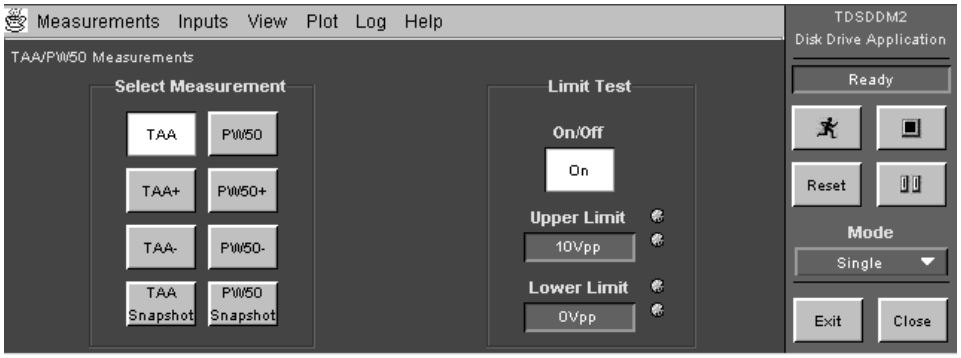


Figure 2–3: TAA/PW50 Measurements menu

Table 2–4 lists the TAA/PW50 measurements with a brief description of each.

Table 2–4: TAA/PW50 measurement options

Option	Description
TAA	Track Average Amplitude: average peak-to-peak value of data from the Read signal input
TAA+	Average positive peak value
TAA–	Average negative peak value
TAA Snapshot	Provides a summary of TAA measurements
PW50	Pulse Width at 50% of the Peak Amplitude: average pulse width at 50% of the peak, that includes both peaks and troughs; can also measure around a complete track if specified in the oscilloscope trigger setup
PW50+	Includes only the positive peaks

Table 2–4: TAA/PW50 measurement options (Cont.)

Option	Description
PW50-	Includes only the troughs
PW50 Snapshot	Provides a summary of PW50 measurements

Limit Test Area. Table 2–5 lists options in the Limit Test area with a brief description of each. For some measurements, such as TAA, PW50, Overwrite, Resolution, and Baseline Shift, these are the only options.

Table 2–5: Limit Test options

Option	Description
On/Off	Enables the application to display PASS or FAIL results based on the limits
Upper Limit	Maximum limit allowed for the measurement mean value
Lower Limit	Minimum limit allowed for the measurement mean value

Figure 2–4 shows the methods you can use to enter Limit Test values.

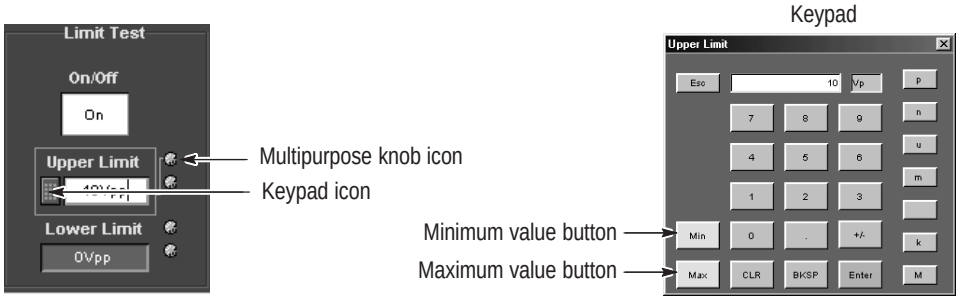


Figure 2–4: How to enter Limit Test option values

Table 2–6 lists methods that you can use to enter values for Limit Test options.

Table 2–6: Limit Test 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

NLTS/Other Measurements Menu. To access the NLTS/Other Measurements menu, go to the Measurements menu in the menu bar and choose NLTS/Other.

Figure 2–5 shows the NLTS/Other Measurements menu.

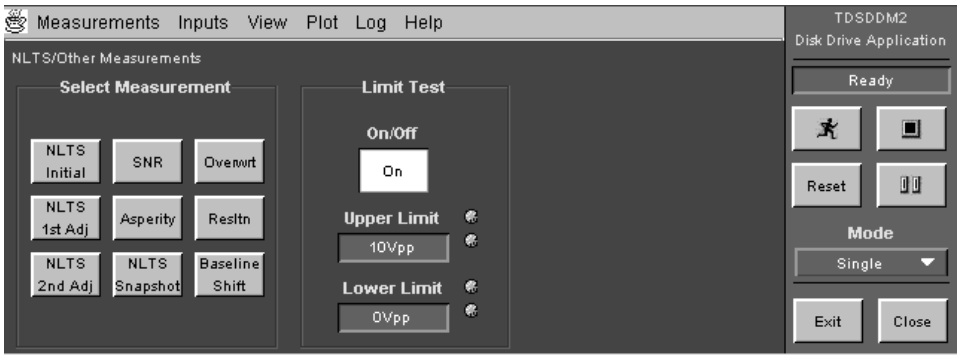


Figure 2–5: NLTS/Other Measurements menu

Table 2–7 lists the NLTS/Other measurement options with a brief description of each.

Table 2–7: NLTS/Other Measurements options

Option	Description
NLTS Initial	Non-Linear Transition Shift; measures NLTS caused by a transition in the current bit cell which reverses the direction of the previous magnification
NLTS 1st Adjacent	Measures NLTS caused by a transition in the previous bit cell which opposes the transition in the current bit cell; also called the first adjacent
NLTS 2nd Adjacent	Measures NLTS caused by a transition which is two bit cells before the current bit cell; also called the second adjacent
NLTS Snapshot	Provides a summary of NLTS measurements
SNR	Signal-to-Noise Ratio; determines the ratio of the variance of the readback signal to the readback noise and expresses the ratio in dB units
Asperity	Large signal caused when the disk drive head strikes the media; the application compares the mean value of TAA samples to the amplitudes of peak/trough pairs and saves values that exceed the Threshold option; also saves the sector number and time relative to the start of the waveform data record
Overwrite	Determines the amount of residual signal remaining from a previous write when new data is written to the same location

Table 2–7: NLTS/Other Measurements options (Cont.)

Option	Description
Resolution	Determines the ratio of a high-frequency TAA pattern to a low-frequency TAA pattern, expressed as a percentage (write a low-frequency TAA pattern to a track, measure it, erase it, write a high-frequency TAA pattern to the same track, and measure again)
Baseline Shift	Difference between the baseline of the positive pulse and the baseline of the negative pulse

Figure 2–6 shows the parameter options for NLTS measurements.

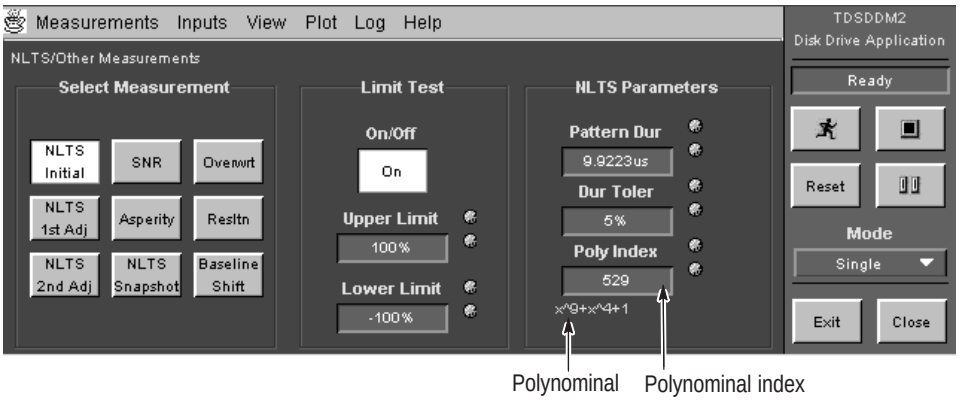


Figure 2–6: NLTS Parameter options

Table 2–8 lists the NLTS Parameter options with a brief description of each.

Table 2–8: NLTS Parameter options

Option	Description
Pattern Dur	Initial length of time for one repetition of the pseudo-random bit data pattern; enter your best estimate
Dur Toler	Tolerance (accuracy) of the initial value in the Pattern Dur option; a smaller percentage helps the application take the measurement more quickly
Poly Index	Application uses x=2 to obtain condensed notations of selected pseudo-random binary sequence polynominals; you should use the same polynominal that generates the data pattern written to the media; when you use the multipurpose knob, invalid polynominals do not appear as selections

NOTE. *The application initially uses the estimated value that you enter for the Pattern Dur option. The application then uses autocorrelation to precisely measure the duration pattern and replaces the estimated value.*

Figure 2–7 shows an example of how the application uses x = 2 to calculate the polynominal index.

$$Polynominal = x^9 + x^4 + 1$$
$$Polynominal\ index = 2^9 + 2^4 + 1 = 529$$

Figure 2–7: How the application calculates the polynominal index

Figure 2–8 shows the parameter options for the SNR measurement.

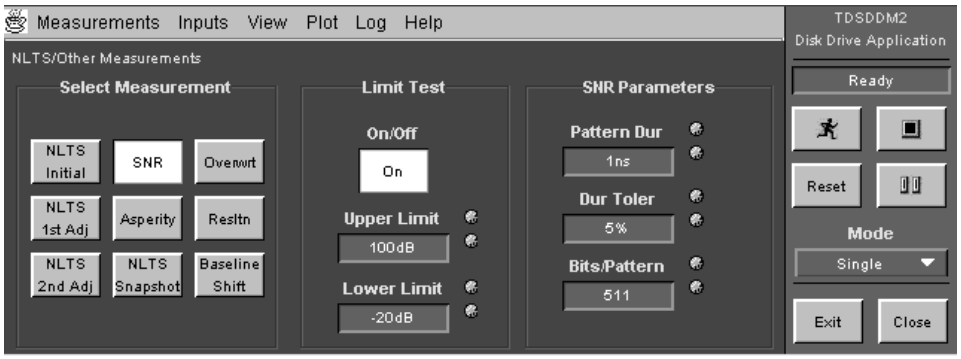


Figure 2–8: SNR Parameter options

Table 2–9 lists the SNR Parameter options with a brief description of each.

Table 2–9: SNR Parameter options

Option	Description
Pattern Dur	Number of bits per pattern period for general patterned data, depending on what was previously recorded on the hard disk For pseudo-random data of pseudo-noise type generated with shift registers (pseudo-random binary sequence), number of bits per pattern is 2^{L-1}, where L is the order of the characteristic polynominal
Dur Toler	Same as in Table 2–8
Bits/Pattern	Periodic signals used for SNR measurements defined as isolated periodic transitions (low frequency), isolated high-density periodic transitions (high frequency), or patterned data such as pseudo-random sequences; use two bits per pattern for low-frequency and high-frequency patterns

The value for the Threshold option determines if the application identifies a signal as an asperity. Figure 2–9 shows the Threshold option.

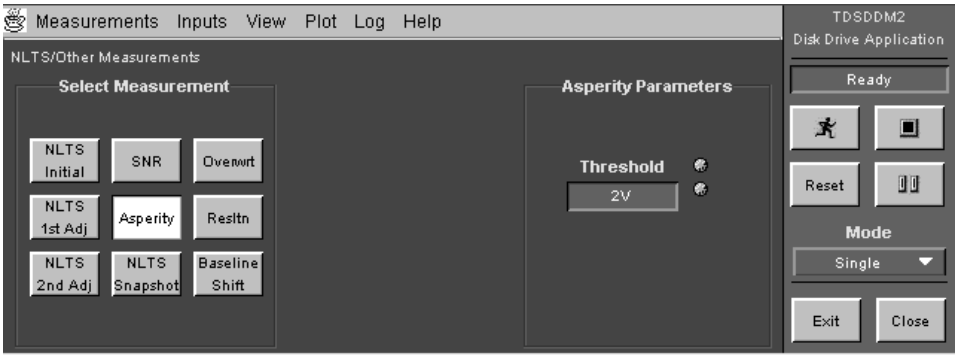


Figure 2–9: Asperity Parameter options

Configuring a Measurement

There are three Inputs menus: Inputs/Trigger, Inputs Filters, and Inputs General.

Inputs/Trigger. To configure the input waveforms for a measurement, go to the Inputs menu in the menu bar and choose Inputs/Trigger. Figure 2–10 shows the Inputs/Trigger menu.

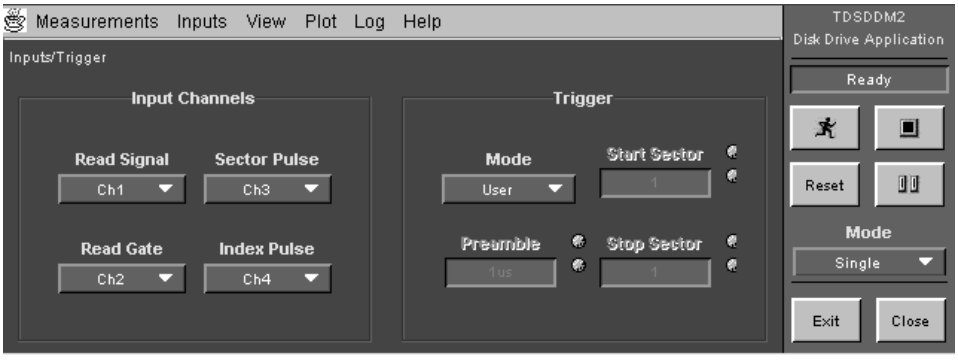


Figure 2–10: Inputs/Trigger menu

Table 1–3 on page 1–16 lists the default channel assignments. The application has the following Input Channels options:

- Read Signal: a waveform that performs a read operation from a sector
- Read Gate: a waveform that indicates the beginning of a read operation; the application Trigger mode must be set to Read Gate to use this input

- Sector Pulse: a waveform that indicates the beginning of a sector; the application Trigger mode must be set to Sector to trigger with this and the Index Pulse inputs
- Index Pulse: a waveform that indicates the beginning of a track; the application Trigger mode must be set to Index or to Sector to trigger with this input

Table 2–10 lists the Trigger options with a brief description of each.

Table 2–10: Trigger options

Option	Description
Mode	
Sector	Triggers on the Sector Pulse and Index Pulse inputs; uses oscilloscope delayed triggers to monitor various sectors
Read Gate*	Triggers on the Read Gate input; since delayed triggers are not used, you must program the disk drive to sequence through a range of sectors and leave a delay that is long enough for the application to take a measurement
User*	Uses the oscilloscope trigger exactly as specified
Index*	Triggers on the Index Pulse input; oscilloscope delayed trigger is not used
Preamble**	Time required to initialize a disk drive before signals become stable; the duration of the preamble varies between disk drive manufacturers
Start Sector**	Specifies the sector on which to start the measurement
Stop Sector**	Specifies the sector on which to stop the measurement

*** Refer to *Setting up the Oscilloscope Trigger* on page 1–11.**

**** Only available when Sector is the trigger mode.**

***NOTE**. For more information on how the application Trigger modes affect the oscilloscope trigger controls, refer to step 2 on page 1–13.*

Filters. You can modify the Read Signal input by applying filters that block specific frequency bands. You can configure each filter as a Highpass filter to block out the low frequency band, or as a Lowpass filter to block out the high frequency band. You can also configure the filters by selecting a Slope and a Cutoff Frequency based on the sample rate.

To configure a filter for a measurement, go to the Inputs menu in the menu bar and choose Filters. Figure 2–11 shows the Inputs Filters menu.

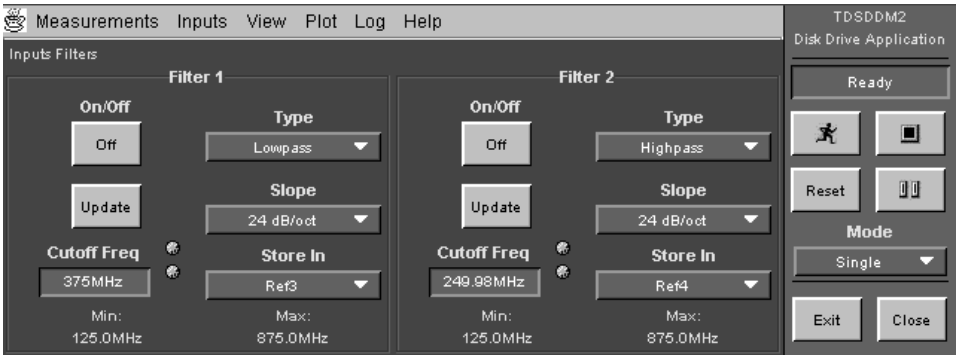


Figure 2–11: Inputs Filters menu

Table 2–11 lists options for Filter 1 and Filter 2 with a brief description of each.

Table 2–11: Filters options

Option	Description
On/Off	Enables the application to use a filter as defined by the remaining options
Cutoff Freq	Excludes frequencies above (Low pass filter) or below (High pass filter) the value specified for measurements
Update	Updates the Cutoff Freq value if you change the sample rate (Horizontal Scale knob) of the oscilloscope The Min and Max values show the range for the Cutoff Freq option; the Min value is 5% of the sample rate and the Max value is 35% of the sample rate
Type	
High pass	Blocks the low frequency band and passes on only the high frequency band of the waveform
Low pass	Blocks the high frequency band and passes on only the low frequency band of the waveform
Slope	Defines the slope of the filter in dB/octave units
Store In	Selects the reference memory in which to store the filtered waveform, if any

Figure 2–12 shows the filter characteristics of the various filter options.

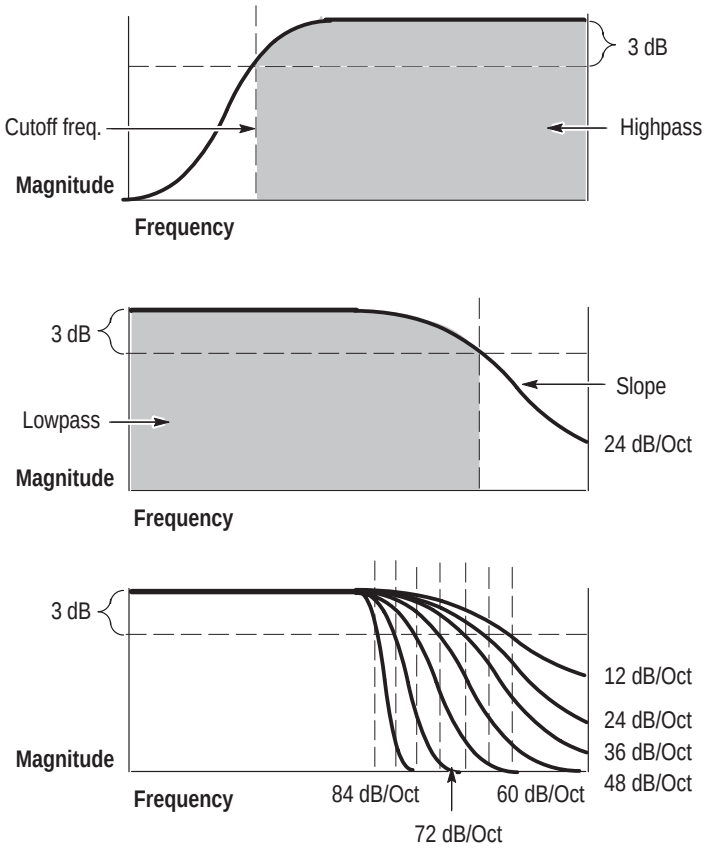


Figure 2–12: Filter characteristics

Using Both Highpass and Lowpass Filters. When you use both filters, the application first applies Filter 1 to the Read Signal input and then Filter 2. You should be aware that you can select a Cutoff Frequency value that filters out the entire waveform or all but a small amount of noise. Figure 2–13 shows the spectrum of the waveform passed to take measurements when you use both the Highpass and the Lowpass filters.

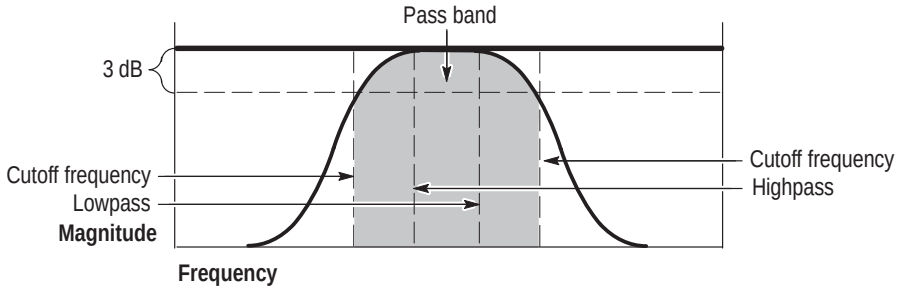


Figure 2–13: Using both Highpass and Lowpass filters

Filtering Transient Responses. At the beginning and end of the filtered waveform, there will be a transient response caused by the response of the filter to a discontinuity. You can use Gating in the Inputs General menu to exclude the discontinuity from the measurement calculations. To do this, follow these steps:

1. Select Inputs> Filters> On> Store In and the desired reference memory, Ref1, Ref2, Ref3, or Ref4.
2. Select Single Mode and press  to start the measurement sequence.
3. Remove the Read Signal input waveform from the display. If the input is a channel, press the front-panel channel button to remove the waveform.
4. Observe the displayed Ref waveform and verify that the amplitude is correct.

   You can see transient responses at the beginning and end of the waveform.
5. Select Inputs> General> Gating> On.
6. Move the vertical cursors so that there are no transient responses between them; this excludes the transient responses from the measurement.
7. Press  to start the measurement sequence.
8. Repeat step 3 to remove the Read Signal waveform from the display.
9. Observe the displayed Ref waveform. If necessary, adjust the Cutoff Frequency value; steeper slopes yield longer transient responses.
10. If necessary, repeat step 6.
11. Select Inputs> Filters> Store In> None. The application will display measurement results faster when reference memories are not used.

Cutoff Frequency Values and Sample Rate. When you start the application, or recall the default setup, the application uses the current oscilloscope sample rate to calculate a Min and Max range for Cutoff Frequency values. The Min and Max range displays at the bottom of the Inputs Filter menu. The application also sets the Lowpass filter to 15% of the sample rate and the Highpass filter to 10%. You can adjust the Cutoff Frequency value within the Min and Max range.

When you change the sample rate and choose the Update command button, the Min value is set to 5% of the sample rate and the Max value is set to 35% for both filters. The application retains the value of the Cutoff Frequency if it is within the updated range. If the value is outside the updated range, the application adjusts the Cutoff Frequency to the closest value within the updated range.

***NOTE**. If the value of the Cutoff Frequency is below the updated range, the application sets it to the Min value. If the value is above the updated range, the application sets it to the Max value.*

To change the sample rate and adjust the filter frequencies, follow these steps:

1. Use the Horizontal Scale knob on the oscilloscope to change the sample rate.
2. Choose the Update command button for either filter. The Min and Max values for both filters change relative to the new sample rate.
3. Adjust the Cutoff Frequency value according to your needs.

General. To configure the hysteresis or the gating for a measurement, go to the Inputs menu in the menu bar and choose General. Figure 2–14 shows the Inputs General menu.

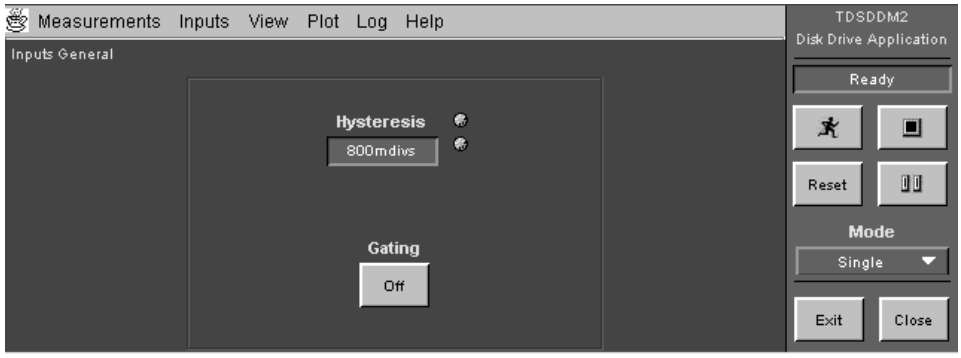


Figure 2–14: Inputs General menu

Table 2–12 lists the General options with a brief description of each.

Table 2–12: General options

Option	Description
Hysteresis	Filters out noise that could cause false identification of peaks; refer to Figure 1–9 on page 1–15 for more information
Gating	Area between cursors on the waveform from which measurements are taken

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 a 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 2–26.*

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.

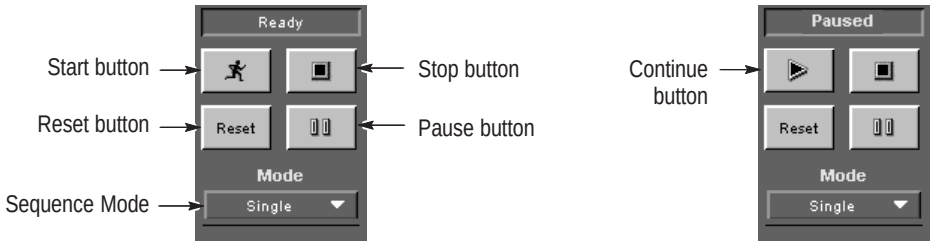


Figure 2–15: Sequence Control menu

To acquire data from waveforms, follow these steps:

1. Select a Sequence mode. See Table 2–13.

Table 2–13: 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
Start/Continue button	Starts to take measurements from the input waveform(s) When paused, continues taking measurements

Table 2–13: Sequence Control menu (Cont.)

Option/button	Description
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. Refer to *Setting Up the Oscilloscope Trigger* on page 1–11 for information on how to adjust the Record Length and Sample Rate in the Math> Spectral Controls menu (T tab) on the oscilloscope.

An Alternative Method. There is another way to control the amount of data to measure without using gated cursors or specifying a range of sectors. You can do this by adjusting the Preamble Duration in the application Sector menu and the Record Length or Horizontal Scale in the oscilloscope horizontal menu. By specifying both the starting point and the total length of the measurement in this way, you can effectively size the area of interest.

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

Analyzing the Results

You can view the results as statistics or graphically as a plot. Figure 2–16 shows an example of the results display formats.

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

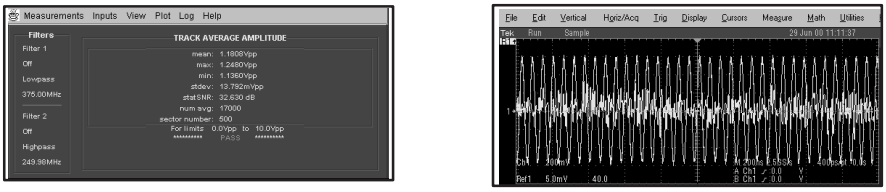


Figure 2–16: Results as statistics and as a Track Profile plot

You can also log the data to a .csv file for viewing in a text editing, spreadsheet, database, or data analysis program. Figure 2–17 shows an example of how a .csv file might look in a spreadsheet program.

tdsddm2	Version 1.0 Mon Jul 17 13:23:41 PDT 2000			
Result Type	TAA			
Upper Limit	10			
Lower Limit	0			
Limit Test State	On			
Hysteresis	0.8			
Mean	1.14785			
Std Dev	0.01524			
Maximum	1.192			
Minimum	1.104			
Stat SNR	31.5148			
Num Events	350			
Sector	Mean	Std Dev	Stat SNR	Num Avg
1	1.1488	0.01693	30.8074	35
2	1.14971	0.0122	33.46	35
3	1.14537	0.01351	32.5448	35
4	1.14811	0.01771	30.2116	35
5	1.14282	0.01582	31.1329	35
6	1.14445	0.01611	31.0091	35
7	1.14785	0.01376	32.0989	35
8	1.1456	0.01686	30.7221	35
9	1.15131	0.01443	32.0131	35
10	1.15291	0.01312	32.852	35

Figure 2–17: Example of viewing data in a .csv file

***NOTE**. Statistical results vary widely across the different measurements. Because of this, each measurement has a unique format for the statistics in a log file.*

Viewing Statistics

To access the View Results menu, go to the View menu in the menu bar and choose Results. Refer to the *Applications Examples* section to see examples of statistical results for each type of measurement.

The statistical information that displays will vary by measurement. In general, the View Results menu contains statistical values for the mean, the maximum (Max), the minimum (Min), the standard deviation (StdDev), the SNR statistics (StatSNR), the number of peaks, troughs or peak/trough pairs used for the average values (num avg), and the sector number.

Viewing Plots

There is one plot format: Track Profile. The format plots the results such that the vertical axis represents the mean measurement value and the horizontal axis represents the measurement number.

To access the Plot Track Profile menu, go to the Plots menu in the menu bar and choose Track Profile. Figure 2–18 shows the Plot Track Profile menu.

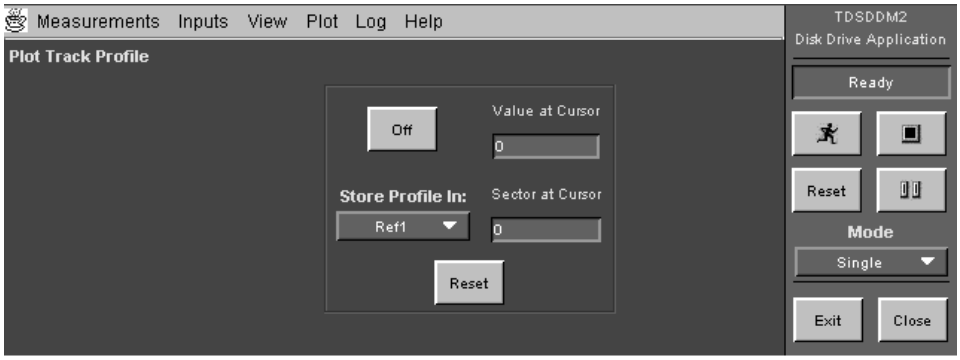


Figure 2–18: Plot Track Profile menu

Table 2–14 lists the Plot Track Profile options with a brief description of each.

Table 2–14: Plot Track Profile options

Option	Description
On/Off	Enables the application to plot track data
Store Profile In:	Selects the reference memory in which to store data for the plot
Reset	Clears all data in the plot

When the application trigger mode is set to Sector, the Plot Track Profile menu also contains the following readouts:

- Value at Cursor displays the measurement value and is in units relative to the measurement (V, Mhz, dBs).
- Sector at Cursor displays the measurement number or the sector number at the cursor

For more information on Track Profiles, refer to *Creating and Viewing Track Profile Plots* on page 2–45.

Clearing Results

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

Saving the Results to a File

You can save most measurement results as statistics to a data log file.

NOTE. *The application does not log results from the Overwrite or the Resolution measurements.*

Logging Statistics

Logging saves the statistical results from measurements to a data log file. To access the Log Statistics menu, go to the Log menu in the menu bar and choose Statistics.

Figure 2–19 shows the Log Statistics menu.

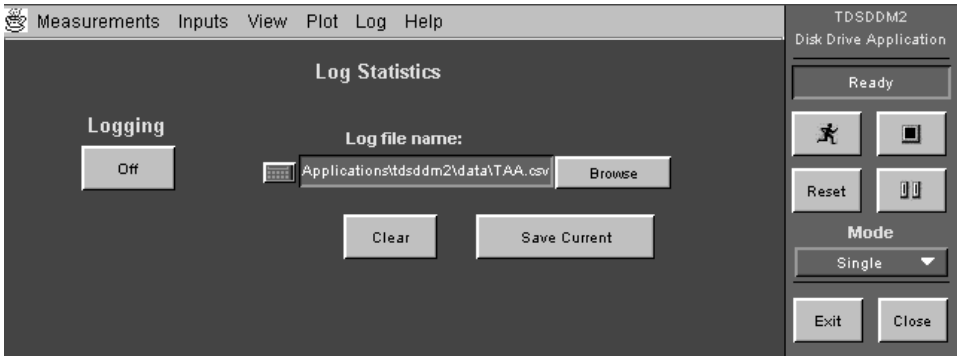


Figure 2–19: Log Statistics menu

Table 2–15 lists the Log Statistics options with a brief description of each.

Table 2–15: Log Statistics options

Option/button	Description
Logging	Enables the application to save the results to a data log file
Clear	Deletes the data log file for the selected measurement; 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 2–20 shows an example of the Log file directory that displays when you select Browse.



Figure 2–20: 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 remaining rows contain information for the measurements. The information will vary with the measurements being logged.

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 after the date and time in the rows of logged data.*

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.*

You must take measurements in Free Run mode to accumulate data points and store them in one data log file. Figure 2–17 on page 2–17 shows an example of a .csv file in a spreadsheet program.

Saving and Recalling Setups

You can use the Save/Recall Measurements menu to save and to 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 2–21 shows the Save/Recall Measurements menu.

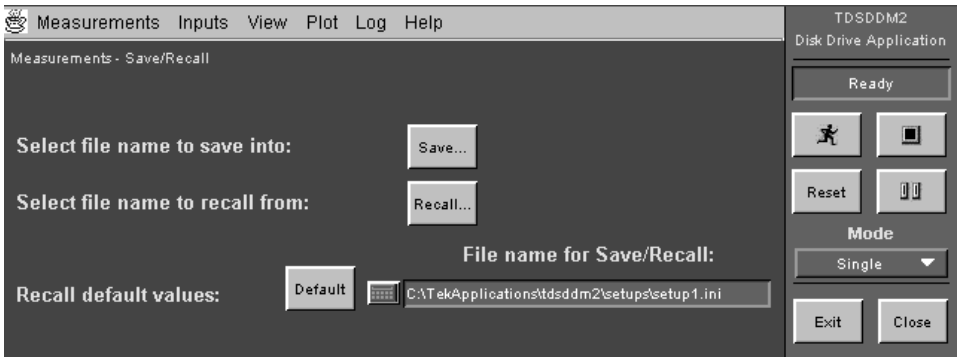


Figure 2–21: Save/Recall Measurements menu

Table 2–16 lists the Save/Recall Measurements options with a brief description of each.

Table 2–16: Save/Recall Measurements options

Option/button	Description
Save	Allows you to select a file in which to save the application setup file
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 oscilloscope settings 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 settings to a setup file, follow these steps:

1. Select Measurements > Save/Recall.
2. Select the Save button. Figure 2–22 shows an example of how the directory displays when you select the Save button.



Figure 2–22: Save directory

3. Select the directory in which the setup file will be saved.

4. Select or enter a file name. The application appends a .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 settings from a saved setup file, follow these steps:

1. Select Measurements > Save/Recall.
2. Select the Recall button. Figure 2–22 shows an example of how directory displays when you select the Recall button.

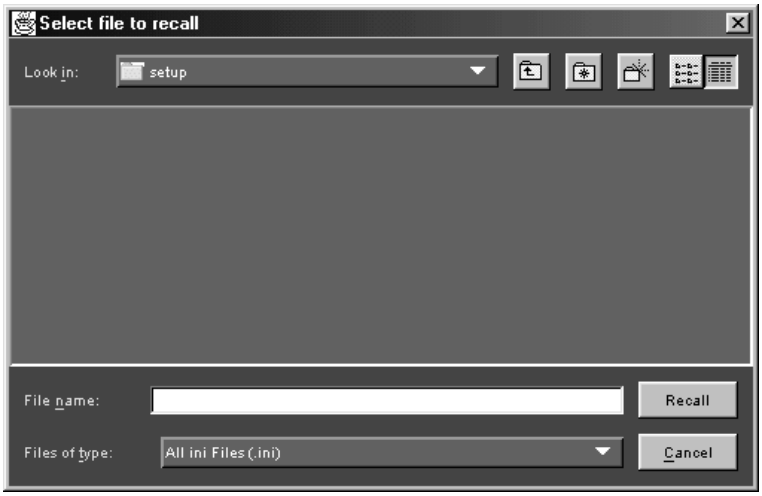


Figure 2–23: Recall directory

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 Default.

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 2–24 shows the Exit menu.

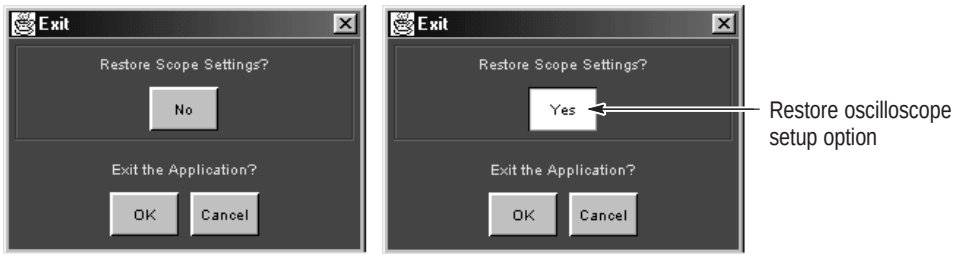


Figure 2–24: Exit menu

Tutorial

This tutorial teaches you how to set up the application, take a measurement, view the results, and log 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 a waveform file

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 perform these lessons, the application must be installed and enabled on the oscilloscope. See *Installation* on page 1–5. To start the application, go to the File menu in the oscilloscope menu bar and select Run Application> Disk Drive Measurements. Figure 2–25 shows how the application starts up and displays.

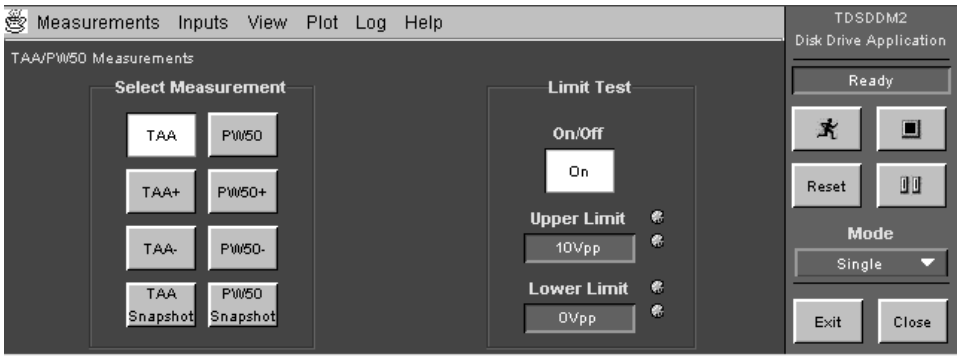


Figure 2–25: Starting the application

Recalling a Waveform File

The application includes a TAA waveform that you can use with this tutorial. The taapw50.wfm file is from a Read Signal.

To recall the taapw50.wfm file to Ref1 on to the oscilloscope, follow these steps:

1. Go to the File menu in the menu bar and access Reference Waveforms> Reference Setup. Figure 2–26 shows the Ref tabs.

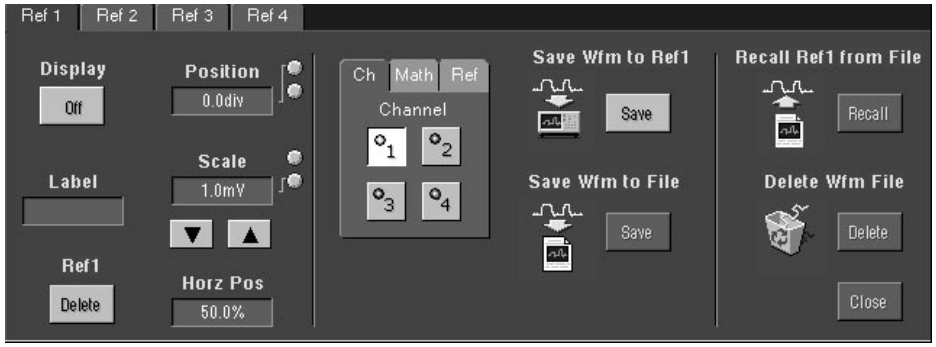


Figure 2–26: Oscilloscope reference waveform setup

2. Select the Ref 1 tab and Recall. Choose the c:\TekApplications\tdsddm2\waveforms directory. Figure 2–27 shows a list of waveform files that appear.

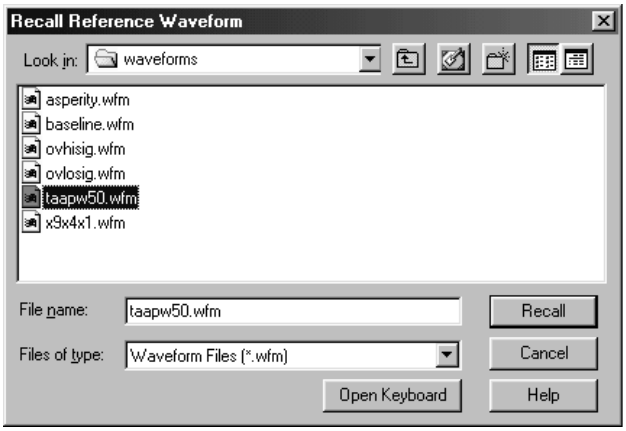


Figure 2–27: Waveform directory to recall reference waveforms

3. Select the taapw50.wfm file and Recall.

Taking a TAA Measurement

In this example, you will learn how to use the application to take a Track Average Amplitude (TAA) measurement. To take a TAA measurement, refer to Figure 2–28, and follow these steps:

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

2. Select Inputs> Input/Trigger> Input Channels> Read Signal> Ref 1. Figure 2–28 shows the Input/Trigger menu setup.

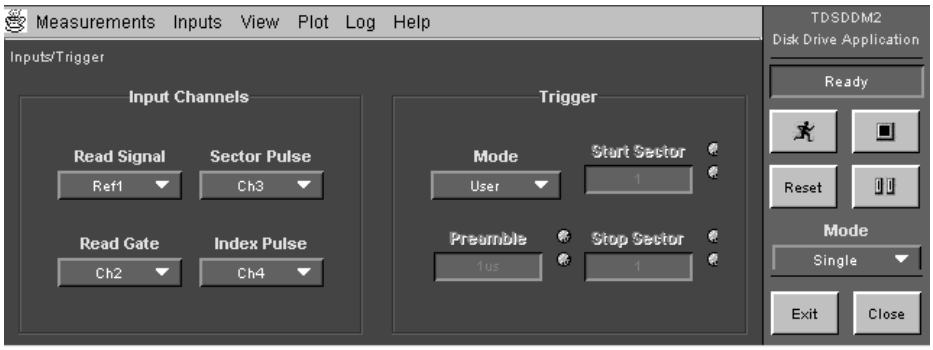


Figure 2–28: Inputs/Trigger menu setup

3. Press  to start the acquisition as shown in Figure 2–29.

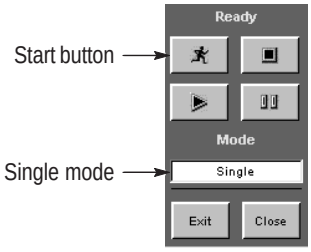


Figure 2–29: Taking a measurement

Figure 2–30 shows the statistical results.

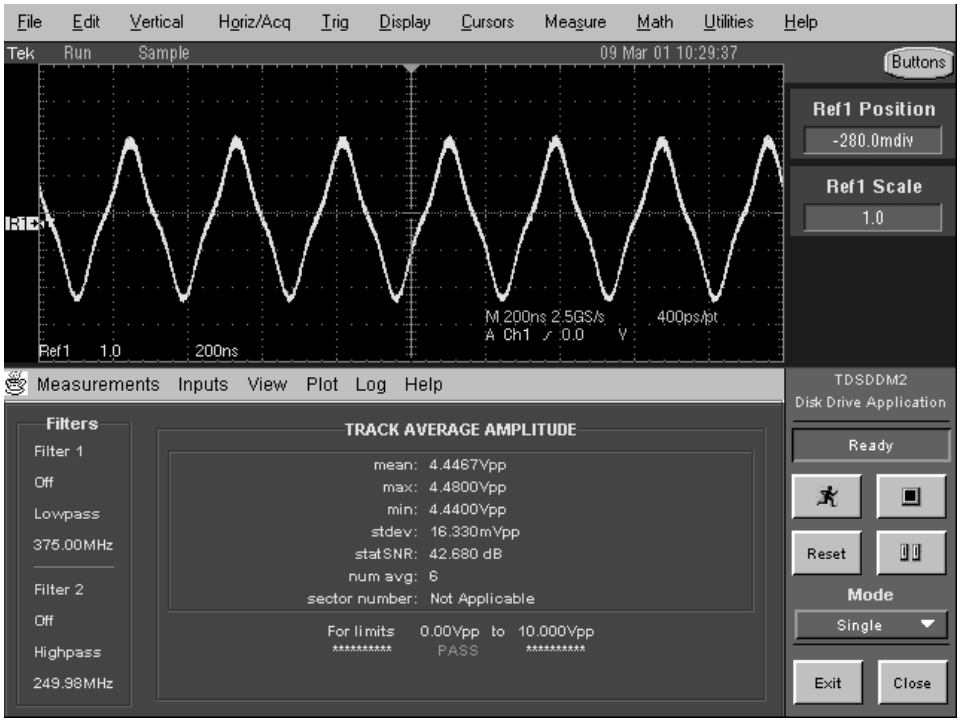


Figure 2–30: TAA lesson: statistical results

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 2–31 shows an example of the default application directory and log file name.

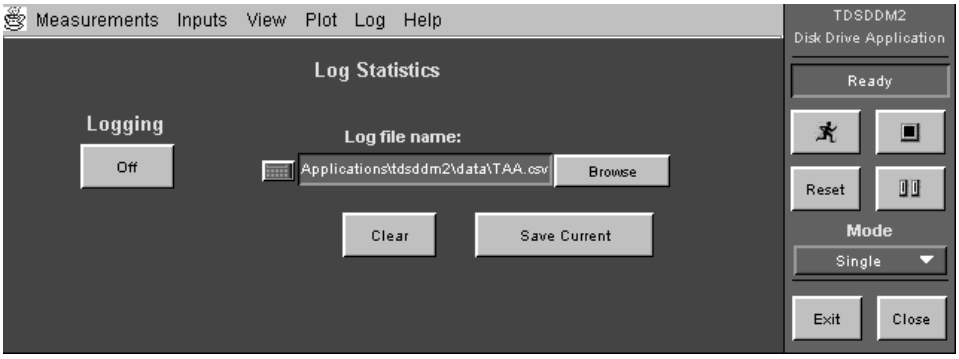


Figure 2–31: Log Statistics menu with default file name

2. Select Logging On.
3. Press  to start the acquisition.
4. Select Logging Off before viewing the data log file.
5. 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\tdsddm2\data directory.
4. Select All Documents (*.*) for the Files of Type.

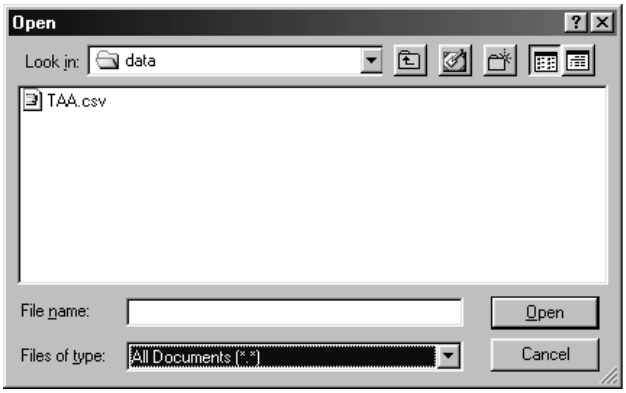


Figure 2–32: Log file with default file name

5. Select the TAA.csv file and Open. Figure 2–33 shows the TAA.csv file viewed in Wordpad.

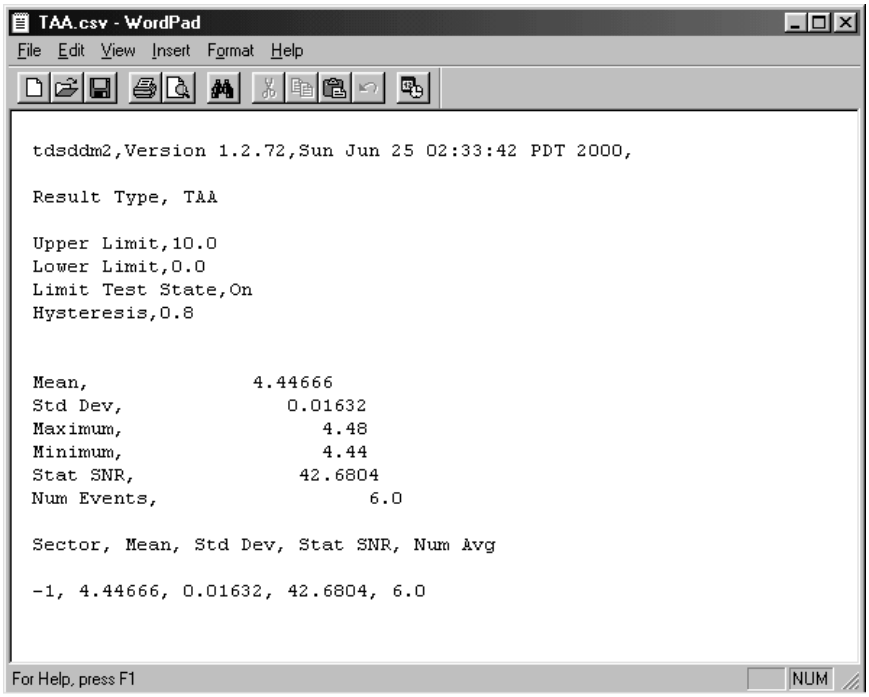


Figure 2–33: TAA.csv file viewed in Wordpad

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 2–22 and to *Exiting the Application* on page 2–24.

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 2–23.

Application Examples

This section presents many application examples. The simplified examples highlight the application measurements and give you ideas on how to use the application to solve your own test problems.

- Measuring TAA
- Measuring PW50
- Measuring Asperity
- Measuring Overwrite
- Measuring Resolution
- Measuring Baseline Shift
- Measuring NLTS
- Measuring SNR
- Creating and viewing track profiles

To use these examples, you must have the TDSDDM2 application installed and enabled on the oscilloscope, the probes connected to your disk drive system under test (SUT), and the configuration tasks performed as needed for your SUT. For information, see *Installation* on page 1–5 and *Configuration* on page 1–11.

To start the application, refer to page 2–25.

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

The application includes waveform files that you can recall to a reference memory to try out each example in this section. Table 2–17 lists the waveform file names.

Table 2–17: Waveform files and application examples

File name	Measurement	File name	Measurement
taapw50.wfm	TAA and PW50	asperity.wfm	Asperity
ovlosig.wfm	Overwrite	baselineShift.wfm	Baseline Shift
ovhisig.wfm	Overwrite	x9x4x1.wfm	NLTS and SNR

Configuring a Measurement

You can configure any measurement to help you analyze measurement results. The application includes the following possible configurations:

- Taking measurements from a range of sectors
- Adding a limit test
- Using cursors (gating)
- Specifying hysteresis to filter out noise
- Using filters to focus the application on specific parts of a waveform

Specifying a Range of Sectors

To specify a range of sectors from which to take measurements, follow these steps:

1. Select Inputs> Inputs/Trigger> Trigger Mode> Sector.
2. Select Start Sector> (number).
3. Select Stop Sector> (number).
4. Set the Preamble option. Use the multipurpose knob, and select a value that is greater than the actual signal preamble duration. This ensures that the preamble is not acquired and is not included in the measurement.

Specifying a Limit Test

To use limit testing to include a pass/fail measurement result, follow these steps:

1. Select Limit Test On.
2. Use the multipurpose knob to set a value for the Upper Limit option that is appropriate for your SUT.
3. Use the multipurpose knob to set a value for the Lower Limit option that is appropriate for your SUT.

The Asperity measurement does not need to test limits.

Specifying Gating

Instead of measuring around the entire track, you can use cursor gating to localize the measurement. To specify gating, follow these steps:

1. Select Inputs> General> Gating On.
2. In the oscilloscope program, position the cursors to bound the part (on either side) of the waveform that you want to measure.
3. Select App to return to the application.

Specifying Hysteresis

You can use the Hysteresis option to avoid identifying noise as actual signals.

To specify hysteresis, select Inputs/General> Hysteresis and use the multipurpose knob to set a value for the Hysteresis option that is appropriate for your SUT.

The hysteresis value, in divisions, is reflected above and below the waveform baseline. For example, if you choose a value of 1.5 divs, the hysteresis level ranges from –1.5 divs to +1.5 divs.

Specifying a Filter

You can modify the Read Signal input by applying filters that block specific frequency bands. This removes information from the measurement that is not useful to analyze. To use Filters, refer to page 2–10.

Using Reference Waveforms

To attain the results shown in each figure (except for Track Profile) from the specified .wfm file, you need to define the following general setup:

1. In the oscilloscope menu bar, select File> Recall Default Setup.
2. Recall the appropriate .wfm file to one of the reference memories; refer to page 2–26.
3. Select Measurements> Save/Recall> Recall default values.
4. Select the appropriate measurement from either the TAA/PW50 or NLTS/ Other Measurements menus.
5. Select the reference memory as the Read Signal input option in the Inputs/ Trigger menu.

Measuring TAA

In this example, you can measure the track average amplitude (TAA). To take a TAA measurement, follow these steps:

1. Select Measurements> TAA/PW50> TAA.
2. To configure the measurement, refer to *Configuring a Measurement* on page 2–34.
3. Set the Sequence Mode to Single or Free Run.
4. Select  to start the measurement.
5. When the measurement is complete, the statistical results automatically display. Figure 2–30 on page 2–28 shows an example of TAA measurement results based on the taapw50.wfm file.

Measuring PW50

In this example, you can measure the pulse width at 50% (PW50). To take a PW50 measurement, follow these steps:

1. Select Measurements> TAA/PW50> PW50.
2. To configure the measurement, refer to *Configuring a Measurement* on page 2–34.
3. Set the Sequence Mode to Single or Free Run.
4. Select  to start the measurement.
5. When the measurement is complete, the statistical results automatically display. Figure 2–34 shows an example of PW50 measurement results based on the taapw50.wfm file.

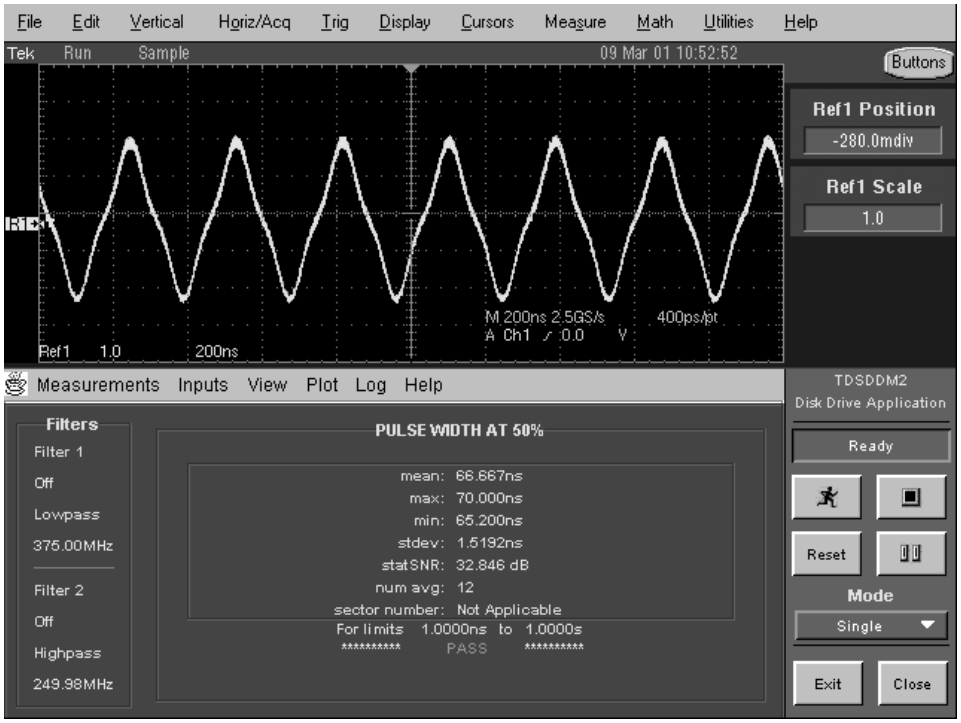


Figure 2–34: PW50 measurement results example

Measuring Asperity

In this example, the oscilloscope will detect asperities. To take an Asperity measurement, follow these steps:

1. Select Measurements> NLTS/Other> Asperity.
2. Use the multipurpose knob to set a value for the Threshold option. The recommended initial setting is at least twice the peak value of the signal. If the signal crosses this level, it is counted as an asperity. No additional asperities are counted until the signal crosses zero volts again.
3. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–12.
4. Set the Sequence Mode to Single.
5. Select  to start the measurement.
6. When the measurement is complete, a list of asperities, sector locations and time locations automatically display. Figure 2–38 shows an example of the results based on the asperity.wfm file with the Asperity Threshold as 1.5 V.

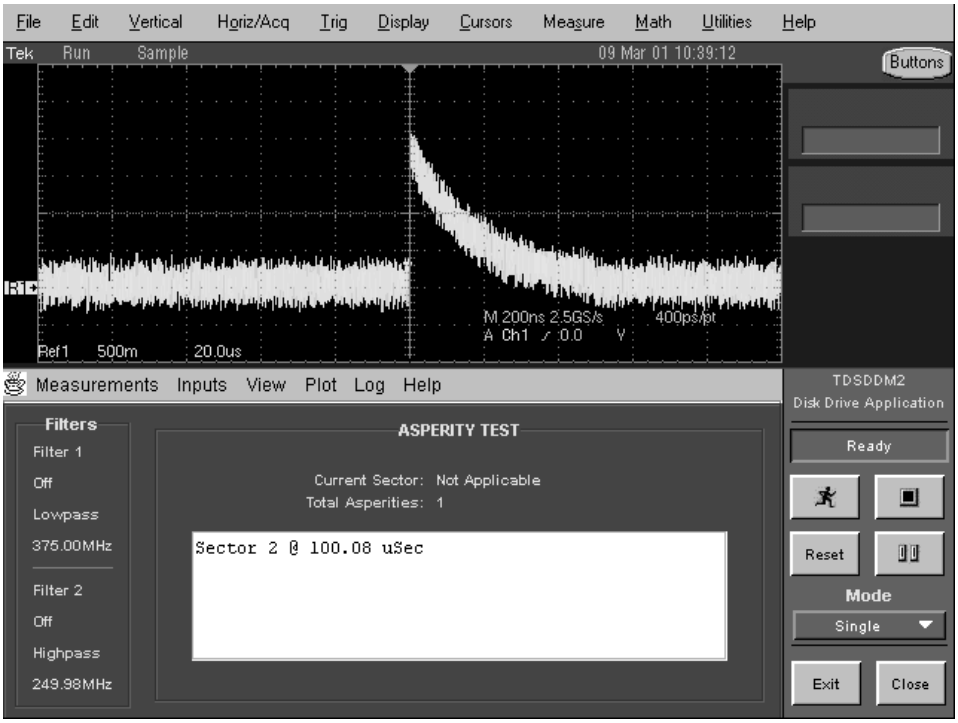


Figure 2–35: Asperity measurement results example

Measuring Overwrite

In this example, you can measure the overwrite amount of residual signal remaining from a previous write when new data is written to the same location. The application overwrites part of the disk drive to take this measurement.

To measure the overwrite, you will also need a personal computer.

NOTE. *Select a record length on the oscilloscope of 5,000 or more for Overwrite measurements. This increases the frequency and the measurement resolution.*

To take an Overwrite measurement, follow these steps:

1. Erase the track by using a permanent magnet or using the PC to perform a DC erase for many revolutions on a three band track of overlapping tracks centered on the specified radius.
2. Write a low-frequency data pattern of isolated pulses to the track.

   To try out this example, recall the ovlosig.wfm file to a reference memory.
3. Select Measurements> NLTS/Other> Overwrt.
4. Set the Sequence Mode to Single or Free Run.
5. Select  to start the measurement. The application measures the magnitude of the signal and then pauses.

   The Sequence Control displays Paused For Action and the results display PASS 1 in the upper right corner. Figure 2–36 shows an example of the Overwrite measurement Pass 1 results based on the ovlosig.wfm file
6. Without erasing the previous data, overwrite the track with a high-frequency data pattern.

   If you are trying out this example, you can overwrite the ovlosig.wfm file with the ovhisig.wfm file. To do this, recall the ovhisig.wfm file to the same reference memory used for the ovlosig.wfm file.
7. Select  to continue. The results display PASS 2 in the upper right corner.

   When the measurement is complete, the statistical results automatically display. Figure 2–37 shows an example of the Overwrite measurement Pass 2 results based on the ovlosig.wfm and ovhisig.wfm files.



Figure 2–36: Overwrite measurement, PASS 1 example



Figure 2–37: Overwrite measurement results, PASS 2 example

Measuring Resolution

In this example, you can measure the resolution of a head and disk combination. The application determines the ratio of two TAA measurements of a low-frequency pattern to a high-frequency pattern. The result is a percentage.

To measure the resolution, you will also need a personal computer.

To take a Resolution measurement, follow these steps:

1. Erase the track by using a permanent magnet or using the PC to perform a DC erase for many revolutions on a three band track of overlapping tracks centered on the specified radius.
2. Use the PC to write a high-frequency data pattern of isolated pulses to the disk.
3. Select Measurements> NLTS/Other> Resltn.
4. Set the Sequence Mode to Single.
5. Select  to start the measurement. The oscilloscope performs a TAA measurement of the high-frequency pattern and then pauses.

   The Sequence Control displays Paused For Action and the results display PASS 1 in the upper right corner.
6. Erase the track again as described in step 1.
7. Use the PC to write a low-frequency data pattern of isolated pulses to the disk.
8. Select  to continue. The results display PASS 2 in the upper right corner.
9. When the measurement is complete, the statistical results automatically display.

An example is not included because it is similar to the Overwrite measurement.

Measuring Baseline Shift

In this example, you will measure the difference between the baseline of a positive pulse and the baseline of a negative pulse. To take a Baseline Shift measurement, follow these steps:

1. Select Measurements> NLTS/Other> Baseline Shift.
2. Set the Sequence Mode to Single or Free Run.
3. Select  to start the measurement.

4. When the measurement is complete, the statistical results automatically display. Figure 2–38 shows an example of a Baseline Shift measurement results based on the baselineShift.wfm file.

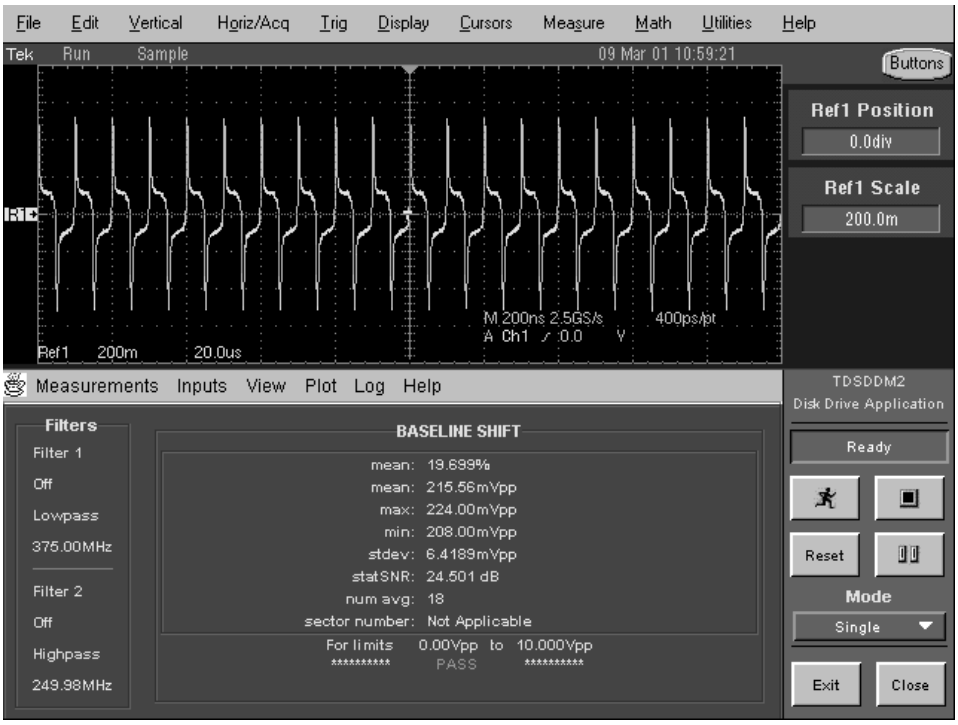


Figure 2–38: Baseline Shift measurement results example

Measuring NLTS

To take NLTS measurements, your setup must meet the following requirements:

- The waveform selected for the measurement must correspond to a bit pattern written on the disk generated using a valid (maximum length) polynomial; among other things, this might require that you disable RLL encoding.
- The disk drive waveform must have at least 1,000 samples.
- There must be at least eight samples per bit.
- The oscilloscope must acquire at least three periods of the pattern where the period is the amount of time before the pseudo-random bit pattern begins to repeat itself; to do this depends on the sample rate of the oscilloscope, the estimated value that you enter for the Pattern Dur option, and the number of bits per period (based on the polynominal used).

To take an NLTS measurement, follow these steps:

1. Select Measurements> NLTS/Other> NLTS Initial.
2. Select Pattern Dur and specify a value.

   The pattern duration is the length of time of the period of a pseudo-random data pattern in the readback signal. The pattern duration can be an estimate, as long as the estimate is within the tolerance that you specify in step 3; the application will measure the exact duration of the pattern. (Due to variations in revolution speed between disk drives, specifying the pattern duration is necessarily an estimate.)
3. Select Dur Toler and specify the tolerance of your pattern duration estimate (up to 30%). Using a tighter tolerance reduces measurement time.

NOTE. *If you know the exact duration of the data pattern, you can reduce the measurement time by specifying a Duration Tolerance of 0%. The application will use the Pattern Duration that you specify without attempting to adjust to the actual duration of the pseudo-random pattern.*

---

4. Select Poly Index and use the multipurpose knob to specify the pseudo-random binary sequence polynomial. This should be the same polynomial used to generate the data pattern written to the media.

   For valid results, it is essential that you specify the same polynominial as the one used for recording data on the hard disk (media). Both polynomials must be valid according to the 1995 IDEMA “white paper.”

   The NLTS measurement is based on autocorrelation and uses a polynomial to generate a pseudo-noise sequence. Select the polynomial using the multipurpose knob; all selections provide a valid pseudo-noise sequence. (The application removes invalid polynomials from the selection set.) The polynomial index value on the scale is a condensed notation of the selected polynomial, obtainable by making x=2. For example:

   $$Polynominal = x^9 + x^4 + 1$$

   $$Polynominal\ index = 2^9 + 2^4 + 1 = 529$$

5. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–12.
6. Set the Sequence Mode to Single or Free Run.
7. Press  to start the acquisition.

8. When the measurement is complete, the statistical results automatically display. Figure 2–39 shows an example of NLTS Initial measurement results based on the x9x4x1.wfm file.



Figure 2–39: NLTS measurement results example

Measuring SNR

To take SNR measurements, your setup must meet the following requirements:

- The disk drive waveform must have at least 1,000 samples
- There must be at least eight samples per bit
- The oscilloscope must acquire at least three periods of the pattern where the period is the amount of time before the pseudo-random bit pattern begins to repeat itself; to do this depends on the sample rate of the oscilloscope, the estimated value that you enter for the Pattern Dur option, and the number of bits per period

To take an SNR measurement, follow these steps:

1. Select Measurements> NLTS/Other> SNR.

2. Select Pattern Dur and specify a value.

The pattern duration is the length of time of the period of a pseudo-random pattern in the readback signal. The pattern duration can be an estimate, as long as the estimate is within the tolerance that you specify in step 3; the application will measure the exact duration of the pattern. (Due to variations in revolution speed between disk drives, specifying the pattern duration is necessarily an estimate.)

3. Select Dur Toler and specify the tolerance of your pattern duration estimate (up to 30%). Using a tighter tolerance reduces measurement time.

NOTE. *If you know the exact duration of the data pattern, you can reduce the measurement time by specifying a Duration Tolerance of 0%. The application will use the Pattern Duration that you specify without attempting to adjust to the actual duration of the pseudo-random pattern.*

---

4. Select Bits/Pattern and specify a value.

   Periodic signals used for the SNR measurement are isolated low-density periodic transitions (low frequency), isolated high-density periodic transitions (high frequency), or patterned data such as pseudo-random sequences.

   - If you are using a high-frequency pattern consisting of constantly spaced isolated transitions, use two bits per pattern for the low frequency and high frequency patterns.
   - For general patterned data, use the number of bits per pattern period, depending on what was previously recorded on the disk.
   - For pseudo-random data of pseudo-noise type generated with shift registers (pseudo-random binary sequence), the number of bits per pattern is $2^L - 1$, where L is the order of the characteristic polynomial. For example, for a 9th order polynomial the value would be 511 (2^9–1); for a 7th order polynomial the value would be 127 (2^7–1).

5. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–12.

6. Set the Sequence Mode to Single.

7. Press  to start the acquisition.

8. When the measurement is complete, the statistical results automatically display. Figure 2–40 shows an example of SNR measurement results based on the x9x4x1.wfm file.



Figure 2–40: SNR measurement results example

Creating and Viewing Track Profile Plots

Track Profile plots are reference memory waveforms that contain a history of measurement results. You can use track profiles to observe sector-to-sector variations in measurements and to identify the location of flaws within a track.

NOTE. *The result of creating a Track Profile plot from a reference waveform is a short straight line.*

To create and view a Track Profile plot, follow these steps:

1. Select a measurement from either the TAA/PW50 or NLTS/Other Measurements menus.
2. To configure the measurement, refer to *Configuring a Measurement* on page 2–34.
3. Select Inputs> General> Gating Off.
4. Select Plot> Track Profile> Store Profile In:> any reference memory.

***NOTE**. As soon as you select Plot> Track Profile> On, the application deletes all information contained in the selected reference memory.*

5. Select Plot> Track Profile> On.
6. Set the Sequence Mode to Single or Free Run.
7. Select  to start the measurement. The measurement results are saved as statistics and are stored as a track profile plot in the reference memory selected in step 4.

   Figure 2–41 shows an example of a Track Profile plot from a TAA measurement.

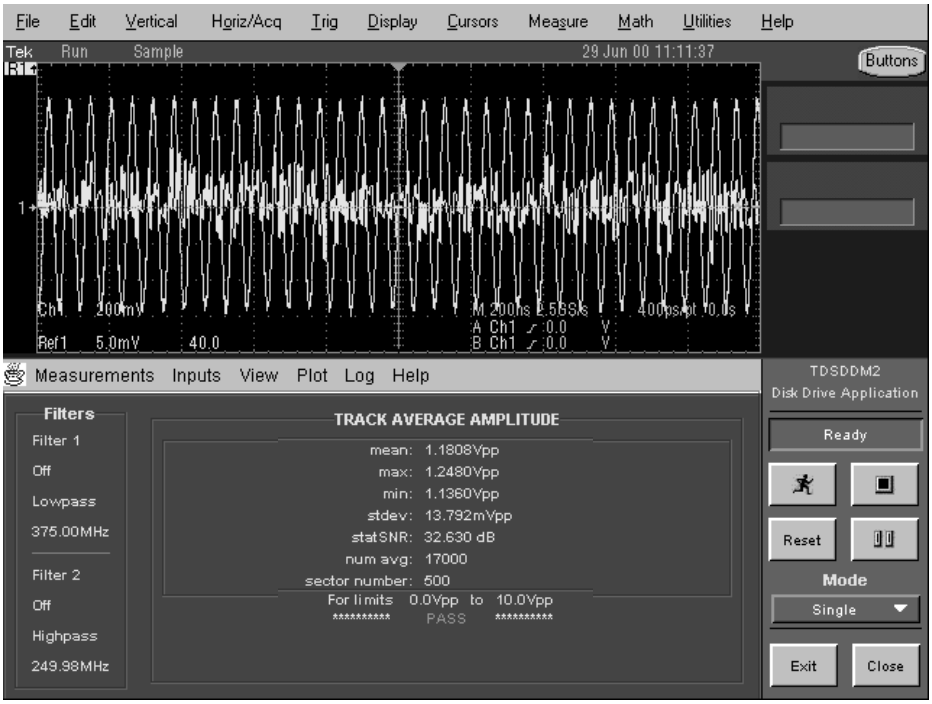


Figure 2–41: Track Profile plot example

8. If you use the Sector Trigger mode, you can also use the vertical cursors on the oscilloscope. To use the vertical cursors, press the Cursors front-panel button. The default Cursor Type is V Bars.
9. Select App to return to the application. Figure 2–42 shows an example of a Track Profile plot with vertical cursors.

You can view the results of each execution of the measurement algorithm by moving the cursor along the Track Profile plot. The Value at Cursor and Sector at Cursor readouts show the measurement results at the current location of the cursor. The Value at Cursor readout is in units relative to the measurement (such as V, MHz, dBs).

NOTE. *The readout values are only available with the current Track Profile plot; they are not available with waveforms that are recalled as a reference memory. You also must select the Sector Trigger mode to use cursors with Track Profiles.*

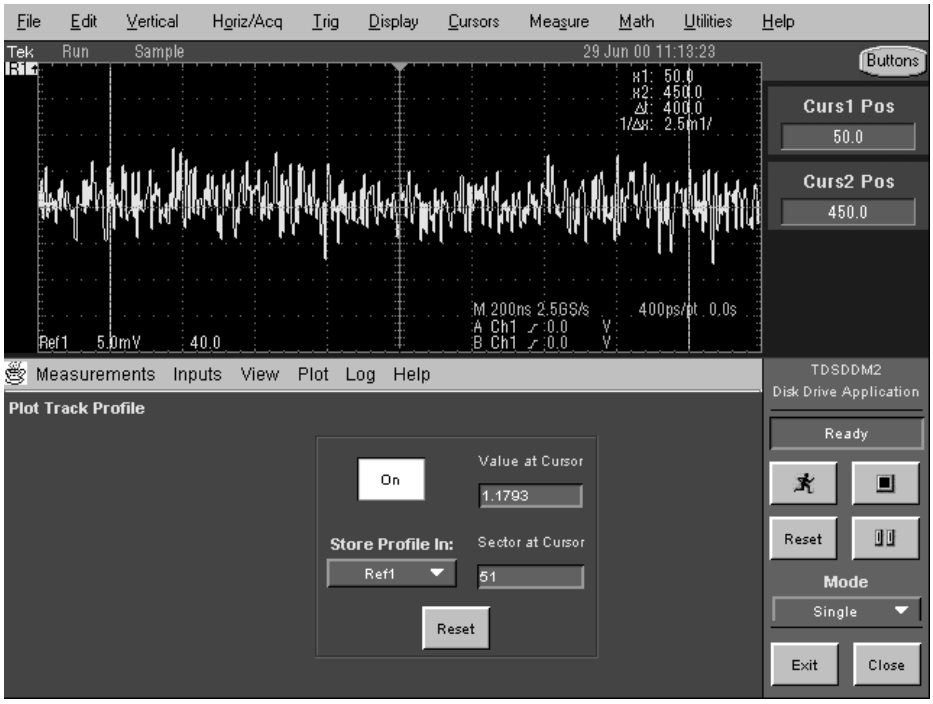


Figure 2–42: Track Profile plot with cursors

10. To save the reference waveform containing the plot, follow these steps:

- **a.** Go to the File menu in the menu bar of the oscilloscope and access Reference Waveforms> Reference Setup.
- **b.** Select the appropriate Ref tab and Save Wfm to File.

11. To clear the Track Profile plot, select Reset.

GPIB Program Example

This section contains an example of a GPIB program that can execute the TDSDDM2 application. The oscilloscope hard disk and the optional applications compact disc both contain this program in the ddm2ctrl.c file. The file resides on the hard drive in the C:\Program Files\TekApplications\tdsddm2 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
- Select a measurement
- Select an input
- Define a waveform
- 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.*

```
/* C Program Example: TDSDDM2 GPIB control                */
/* ======================================================================
 * This sample program is for Tektronix Java application TDSDDM2 --
 * Disk Drive Measurements
 *
 * Note1: In order to build the .exe correctly, copy gpib-32.obj from
 * "C:\Program Files\National Instruments\GPIB\NI488\LangInt\C\" or
 * "C:\Program Files\GPIB-NT\LangInt\C\ to
 * the workspace.
 *
 */

 #include <string.h>
 #include <stdio.h>
 #include <sys/timeb.h>
 #include <windows.h>
 #include "C:\GPIB-NT\LangInt\C\decl-32.h"

 int start_application(/* in */ int scope);
 int do_single_test(/* in */ int scope);

 void main (void)
 {
      char read_buffer    [100] = "";
      char write_buffer [100] = "";
      int      scope;
      int      status;

      /*
       * Open session for IBIC
       */
      scope = ibfind ("DEV2");
      status = ibpad (scope, 1);
      status = ibtmo (scope, T10s);
      status = ibwrt (scope, write_buffer, strlen (write_buffer));

      /*
       * Start Application
       */
      if (start_application(scope)){
         printf ("Application is started up!\n");

         /*
          * Turn on a measurement (TAA)
          */
         sprintf (write_buffer, "%s", "Variable:value \"measurement\",\"TAA\"");
         status = ibwrt (scope, write_buffer, strlen (write_buffer));
         /*
          * Select Source Type -- REF
          */
         sprintf (write_buffer, "%s", "Variable:value \"readSignal\", \"Ref1\"");
```

```
   status = ibwrt (scope, write_buffer, strlen (write_buffer));


   /*
    * Recall Waveform to Ref
    */
   sprintf (write_buffer, "%s", "recall:waveform
    \"c:\\TekApplications\\tdsddm2\\waveforms\\diskdrive.wfm\", REF1");

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


   /*
    * Display Ref1
    */
   sprintf (write_buffer, "%s", "select:ref1 on");
   status = ibwrt (scope, write_buffer, strlen (write_buffer));


   /*
    * Turn on Log Statistics for TAA measurement
    */
   sprintf (write_buffer, "%s", "Variable:value \"TAAloggerState\",\"On\"");
   status = ibwrt (scope, write_buffer, strlen (write_buffer));
   /*A Timer is needed after setting the loggerState on*/
Sleep(2000);

   /*
    * Do a single test
    */

   if (do_single_test(scope)){

         /*
          * Set Measurement for which you want to query test result -- TAA
          */
         sprintf (write_buffer, "%s", "Variable:value \"resultFor\", \"TAA\"");
         status = ibwrt (scope, write_buffer, strlen (write_buffer));

         /*A Timer is needed after setting the measurement to be queried*/
         Sleep(500);
         /*
          * Query mean result
          */
         sprintf (write_buffer, "%s", "Variable:value? \"mean\"");
         status = ibwrt (scope, write_buffer, strlen (write_buffer));
         status = ibrd (scope, read_buffer, sizeof (read_buffer));

         if (ibcnt != 3) {               /* It's not an empty string */
            read_buffer [ibcnt] = 0;  /* Get rid of extra characters */
            printf ("Mean TAA = ");
```

```
                printf ("%s", read_buffer);
                }
            }
        else
                printf ("*** Fail to query result ***\n");



    }
    else{
       printf ("*** Fail to start Application ***\n");
       return;
    }

    /*
     * Display Off for Ref1 before exiting
     */
    sprintf (write_buffer, "%s", "select:ref1 off");
    status = ibwrt (scope, write_buffer, strlen (write_buffer));


    /*
     * Exit application
     */
    printf ("Exit application!\n");
    sprintf (write_buffer, "%s", "Variable:value \"application\",\"exit\"");
    status = ibwrt (scope, write_buffer, strlen (write_buffer));

    /*
     * Program Ending
     */
    printf ("Program Terminating Normally\n\n");

    return;

}


/*---------------------------------------------------------------------------
 * Function: start_application
 * Argument: scope
 * Return: 1 if success, 0 otherwise
 *
 * This function starts the application and comfirms the completion of startup
 */
 int start_application(/* in */ int scope)
 {
     char read_buffer    [100];
     char write_buffer [100];
     char app_name[30] = "\"tdsddm2\"\n";
     int     status;
```

```
     int      timer = 0;
     int      i = 0;

     /*
      * Has application already been 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;  /* Get rid of extra characters */

     if (strcmp(app_name, read_buffer) == 0){
        return 1;                 /* Application is running, don't need to do anything */
     }

     /*
      * If application is not started up, start it and wait for application to completely
      * start up
      */

     sprintf (write_buffer, "%s", "Application:activate \"Disk Drive Measurements V2\"");
     status = ibwrt (scope, write_buffer, strlen (write_buffer));
   printf ("Starting application, please wait...\n");
     while (strcmp(app_name, read_buffer) != 0){
        timer = timer + 2;
        if (timer > 45) {      /* The application normally take 24 seconds to start up */
              printf ("***Application start up time out***\n");
              return 0;        /* Something is wrong if application does not start up in 30s */

        }
        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;/* Get rid of extra characters */
     Sleep(2000);

     }
     /* Application start up! */

     return 1;
 }

/*---------------------------------------------------------------------------
 * Function: do_single_test
 * Argument: scope
 * Return: 1 if success, 0 otherwise
 *
 * This function does a single measurement
 */
 int do_single_test(/* in */ int scope)
 {
```

```
    char read_buffer    [100];
    char write_buffer [100];
    char state[10]      = "\"Ready\"\n";
    int     status;
    int     timer = 0;
    int     i = 0;

    /*
     * Start measurement
     */
  printf ("Do a single test...\n");
    sprintf (write_buffer, "%s", "Variable:value \"sequencerState\",\"Sequencing\"");
    status = ibwrt (scope, write_buffer, strlen (write_buffer));

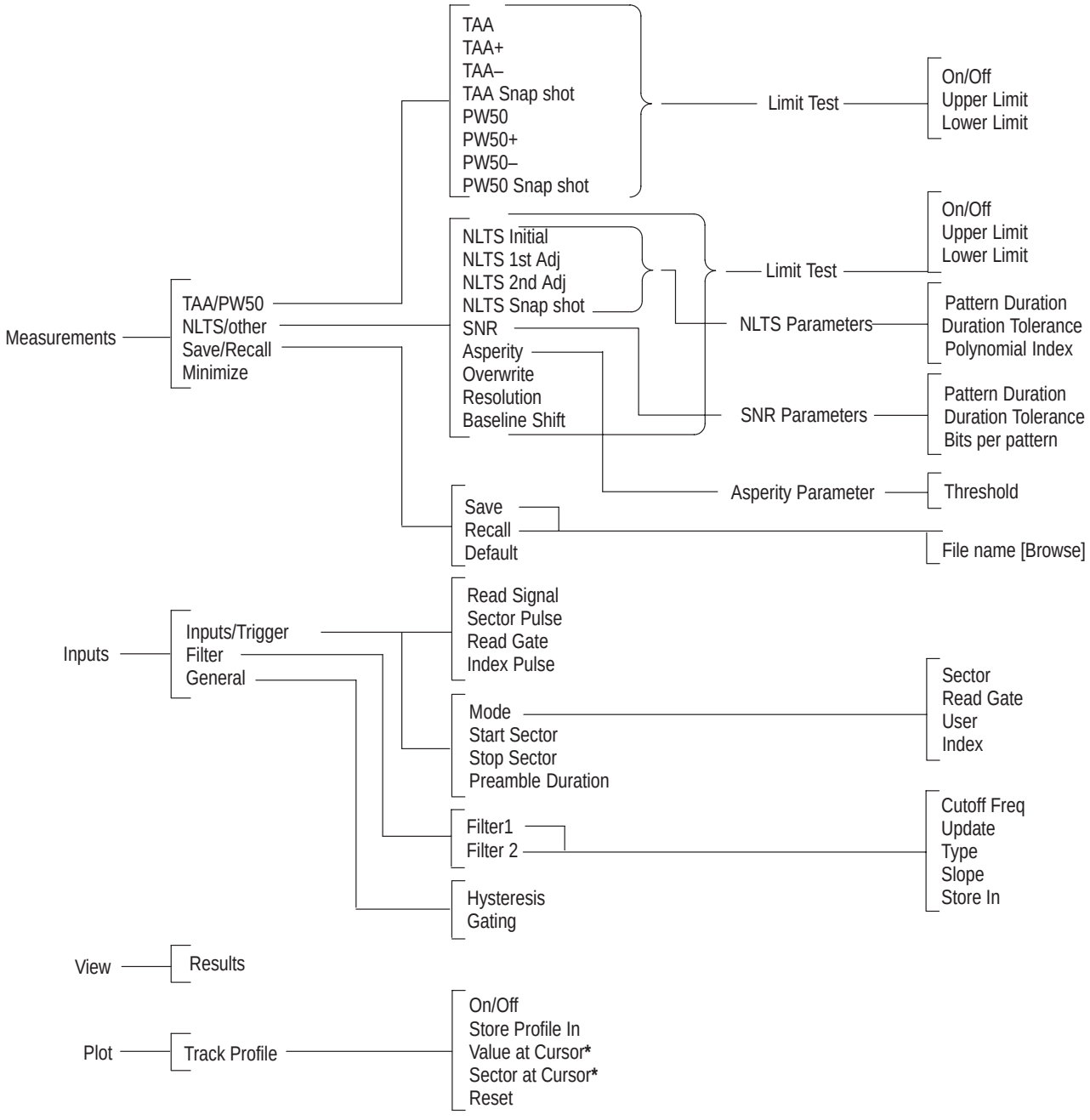
  do{
       timer = timer + 2;
       if (timer > 60) {/* Assuming a single test takes less than 60 seconds */
            printf ("***Test time out***\n");
            return 0;        /* Something is wrong if sequencerState does not come back
                             * to Ready */
       }
       sprintf (write_buffer, "%s", "Variable:value? \"sequencerState\"");
       status = ibwrt (scope, write_buffer, strlen (write_buffer));
       status = ibrd (scope, read_buffer, sizeof (read_buffer));
       read_buffer [ibcnt] = 0;/* Get rid of extra characters */
    Sleep(2000);
    }while (strcmp(state, read_buffer) != 0);

    return 1;
}
```

Reference

Menu Structure

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



***Displays numeric values only**

Figure 3–1: Menu structure

Figure 3–2 shows the structure of the Log, Help, and Sequence Control menus.

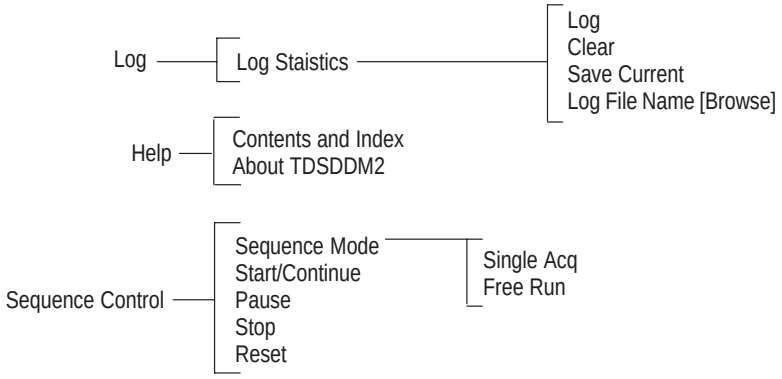


Figure 3–2: Menu structure (continued)

Parameters

This section describes the TDSDDM2 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 D: GPIB Command Syntax* for a complete list of the GPIB command syntax with the arguments, variables and variable values that correspond to the TDSDDM2 parameters.

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

Measurements Menu

There are four Measurements menu items: TAA/PW50, NLTS/Other, Save/Recall, and Minimize.

TAA/PW50 Menu

The options in the TAA/PW50 Measurements menu are:

- TAA, default
- TAA+
- TAA–
- TAA Snapshot
- PW50
- PW50+
- PW50–
- PW50 snapshot

Table 3–1 lists the parameters for the Limit Test area for each measurement and the selections or range of values available for each.

Table 3–1: TAA/PW50 Limit Test area parameters

Measurement	Option	Selections	Default setting
All	On/Off	On, Off	On
TAA, TAA+, TAA Snapshot	Upper Limit	0 V_{pp} to 10.0 V_{pp} in units of 1 mV_{pp}	10.0 V_{pp}
	Lower Limit	0 V_{pp} to 10.0 V_{pp} in units of 1 mV_{pp}	0.0 V_{pp}
TAA–	Upper Limit	–10.0 V_{pp} to 0 V_{pp} in units of 1 mV_{pp}	0.0 V_{pp}
	Lower Limit	–10.0 V_{pp} to 0 V_{pp} in units of 1 mV_{pp}	–10.0 V_{pp}
PW50, PW50+, PW50–, PW50 Snapshot	Upper Limit	0 s to 1.0 s in units of 50 ps	1.0 s
	Lower Limit	0 s to 1.0 s in units of 50 ps	0 s

NLTS/Other Menu

The options in the NLTS/Other Measurements menu are:

- NLTS Initial
- NLTS 1st Adj
- NLTS 2nd Adj
- NLTS Snapshot
- SNR
- Asperity
- Overwrite
- Resolution
- Baseline shift

Table 3–2 lists the parameters for the Limit Test area for each measurement and the selections or range of values available for each.

Table 3–2: NLTS/Other Limit Test area parameters

Measurement	Option	Selections	Default setting
All*	On/Off	On, Off	On
NLTS Initial, NLTS 1st Adj, NLTS 2nd Adj, NLTS Snapshot	Upper Limit	–100% to 100% in units of 0.1%	100%
	Lower Limit	–100% to 100% in units of 0.1%	–100%

Table 3–2: NLTS/Other Limit Test area parameters (Cont.)

Measurement	Option	Selections	Default setting
SNR	Upper Limit	–20.0 dB to 100 dB in units of 0.1 dB	100.0 dB
	Lower Limit	–20.0 dB to 100 dB in units of 0.1 dB	–20.0 dB
Baseline Shift	Upper Limit	–5.0 V_{pp} to 10.0 V_{pp} in units of 1 mV_{pp}	10.0 V_{pp}
	Lower Limit	–5.0 V_{pp} to 10.0 V_{pp} in units of 1 mV_{pp}	0.0 V_{pp}
Overwrt	Upper Limit	0 dB to 100 dB in units of 0.01 dB	100.0 dB
	Lower Limit	0 dB to 100 dB in units of 0.01 dB	0.0 dB
Resltn	Upper Limit	0.1% to 200% in units of 0.1%	200%
	Lower Limit	0.1% to 200% in units of 0.1%	100m%

***There is no Limit Test area for the Asperity measurement.**

Table 3–3 lists the NLTS Parameters area and the selections or range of values available for each.

Table 3–3: NLTS Parameters area

Option	Selections	Default setting
Pattern Dur	1.0 ns to 1.0 ms in units of 1.0 ns	9.922 µs
Dur Toler	0% to 30% in units of 1%	5%
Poly Index	19 to 4073	529

Table 3–4 lists the SNR Parameters area and the selections or range of values available for each.

Table 3–4: SNR Parameters area

Option	Selections	Default setting
Patten Dur	1.0 ns to 1.0 ms in units of 1.0 ns	9.922 µs
Dur Toler	0% to 30% in units of %1	5%
Bits/Pattern	1 to 8191	511

Table 3–5 lists the Asperity Parameter area and the range of values.

Table 3–5: Asperity Parameter area

Option	Selections	Default setting
Threshold	0.0 V to 10.0 V in units of 10 mV	2.0 V

Save/Recall Menu

Table 3–6 lists the parameters for the Save/Recall Measurements menu and the selections available for each.

Table 3–6: Save/Recall Measurements menu parameters

Option	Selections	Default setting
Save	None	C:\TekApplications\tdsddm2\setups\setup1.ini
Recall	None	C:\TekApplications\tdsddm2\setups\setup1.ini
Default	None	

Minimize Menu

There are no parameters for the Minimize function.

Inputs Menu

There are three Inputs menus: Inputs/Trigger, Inputs Filter, and Inputs General.

Inputs/Trigger Menu

Table 3–7 lists the parameters for the Input Channels area and the selections or range of values available for each.

Table 3–7: Input Channels area parameters

Option	Selections	Default setting
Read Signal	Ch 1, Ch 2, Ch 3, Ch 4, Ref 1, Ref 2, Ref 3, Ref 4, Math1, Math 2, Math 3, Math 4	Ch 1
Read Gate	Ch 1, Ch 2, Ch 3, Ch 4	Ch 2
Sector Pulse	Ch 1, Ch 2, Ch 3, Ch 4	Ch 3
Index Pulse	Ch 1, Ch 2, Ch 3, Ch 4	Ch 4

Table 3–8 lists the parameters for the Trigger area and the selections or range of values available for each.

Table 3–8: Trigger area parameters

Option	Selections	Default setting
Mode	Sector, Read Gate*, User*, Index*	User
Preamble**	0 s to 250.0 s in units of 1.0 ns	1.0 µs
Start Sector**	1 to 1000 in units of 1 sector	1
Stop Sector**	1 to 1000 in units of 1 sector	1

* **Refer to *Setting up the Oscilloscope Trigger* on page 1–11.**

** **Only available when Sector is the trigger mode.**

Inputs Filters Menu

Table 3–9 lists the parameters for the Filter 1 and Filter 2 areas and the selections or range of values available for each.

Table 3–9: Filter 1 and Filter 2 areas parameters

Option	Selections	Default setting
On/Off	On, Off	Off
Cutoff Freq	5% to 35% of the Sample Rate	
Update	None	
Type	Lowpass, Highpass	Lowpass, Filter 1 Highpass, Filter 2
Slope	12 dB/oct to 84 dB/oct in units of 12 dB/oct	24 dB/oct
Store In	None, Ref 1, Ref 2, Ref 3, Ref 4	Filter 1 in Ref 3 Filter 2 in Ref 4

NOTE. *The Update command button changes the Cutoff Freq value if you change the Sample Rate on the oscilloscope.*

Inputs General Menu

Table 3–10 lists the parameters for the Inputs General menu and the selections or range of values available for each.

Table 3–10: General menu parameters

Option	Selections	Default setting
Hysteresis	0.1 divs to 5.0 divs in units of 0.1 divs	0.8 divs
Gating	On, Off	Off

View Menu

There are no parameters for the View Results menu.

Plot Track Profile Menu

Table 3–11 lists the parameters for the Plot Track Profile menu, and the selections or range of values available for each.

Table 3–11: Plot Track Profile menu parameters

Option	Selections	Default setting
On/Off	On, Off	Off
Store Profile In:	Ref1, Ref2, Ref3, Ref4	Ref1
Reset	None	

Log 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

Option	Selections	Default setting
Logging	On, Off	Off
Clear	None	
Save Current	None	
Log File Name: Browse	Any file	C:\TekApplications\tdsddm2\data\<measurement>.csv

Help Menu

There are no parameters for the Help menu.

Sequence Control Menu

Table 3–13 lists the parameters in the Sequence Control menu and the selections available.

Table 3–13: Sequence Control menu parameters

Parameter	Selections	Default setting
Mode	Single, Free Run	Single
Start (or Continue)	None	
Pause	None	
Stop	None	
Reset	None	

Appendices

Appendix A: Measurement Algorithms

The TDSDDM2 application takes disk drive measurements. This appendix contains information about the algorithm used by the application to perform each measurement

Unless specifically stated otherwise, all measurements in the Disk Drive Measurements Application are conducted in accordance with procedures specified in the *International Disk Drive Equipment and Materials Association (IDEMA) Disk Drive Standard*.

***NOTE**. Refer to the* Applications Examples *section for information on how to perform each measurement. Each example includes a detailed procedure.*

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 TDS oscilloscope.
3. The time per division must be set small enough to capture sufficient waveform detail and avoid aliasing.
4. Use a differential probe on the Read channel signal to reject noise and remove DC bias.

TAA Measurements

The Track Average Amplitude is the average peak-to-peak value of the data on the Read Signal input over the specified range of sectors.

IDEMA specifies the measurement to be over one complete track revolution.

The application calculates this measurement using the following equation:

$$TAA = \frac{1}{N} \sum_{i=0}^{N-1} V_{pp}(i)$$

Where: N is the number of positive and negative pulse pairs

V_{pp} is the peak-to-peak voltage

The application performs the measurement according to the following algorithm:

1. Find all of the peak-to-trough pairs in the data area to be measured.

Find the peak by searching from the first crossing of the signal above the positive hysteresis level to the crossing of the signal below the negative hysteresis level. (See Figure A–1.) Keep the maximum value over this range. Take one sample on either side of the maximum value and average the three values to obtain the positive peak value. This is done to remove noise bias which would otherwise occur.

2. Search the range from the negative hysteresis crossing to the next positive hysteresis crossing; keep the minimum value. Take one sample on either side of the minimum value and average the three values to obtain the negative peak value.

3. Average all measured peak-to-peak values. The result is the TAA value.

Figure A–1 shows how a TAA measurement is defined.

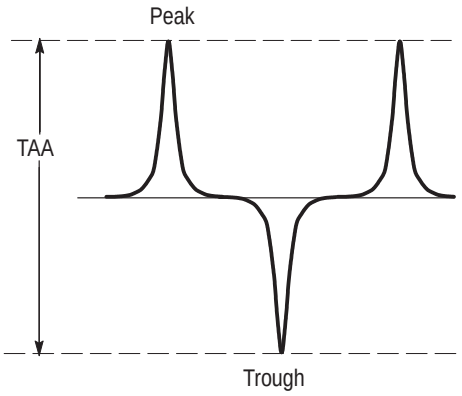


Figure A–1: TAA measurement

TAA+ and TAA– Measurements

The TAA+ measurement is the average positive peak value of the data on the Read Signal input over the specified range of sectors. The TAA–measurement is the average negative peak value of the data on the Read Signal input over the specified range of sectors.

The application calculates these measurements using the following equation:

$$TAA \pm = \frac{1}{N} \sum_{i=0}^{N-1} V_p(i)$$

Where: N is the number of positive or negative pulses

V_p is the peak (positive or negative) voltage

The baseline reference for measuring TAA+ or TAA– is zero volts.

The application performs the measurement according to the same algorithm used in the TAA measurement, described on page A–2, except only positive pulses are measured for TAA+ and only negative pulses are measured for TAA–.

Figure A–2 shows how TAA+ and TAA– measurements are defined.

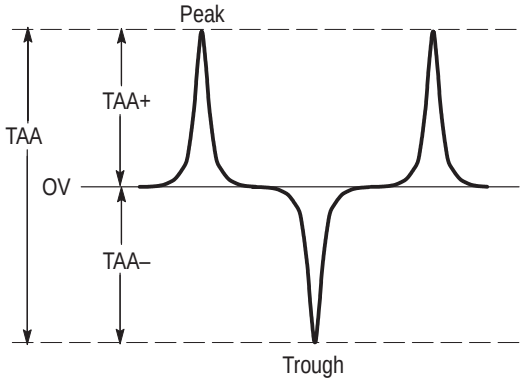


Figure A–2: TAA+ and TAA– measurements

PW50 Measurements

The PW50 measurement is the average pulse width at 50% of the pulse peak of a group of both positive and negative pulses. Peaks and troughs are measured. The baseline reference for measuring the peak or trough is zero volts.

Figure A–3 shows how a pulse width at 50% is defined.

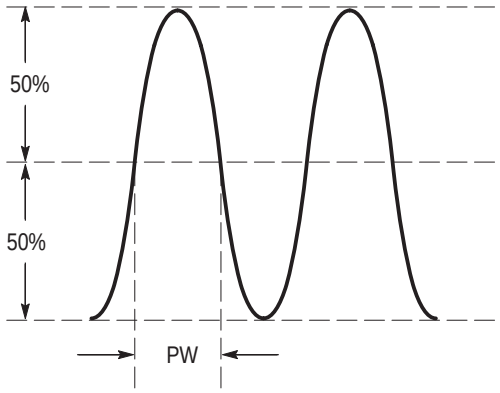


Figure A–3: Pulse width at 50%

The application calculates this measurement using the following equation:

$$PW = \frac{1}{N} \sum_{i=0}^{N-1} PW(i)$$

Where: N is the number of positive and negative pulse pairs

PW is the pulse width at 50%

The application performs the measurement according to the following algorithm:

1. Set the disk drive to the specified speed.
2. Position the head to the desired gap, radius, and skew angle.
3. Precondition the media service. (See the IDEMA standard, document T3-91, for information about preconditioning the media service.)
4. Write the specified frequency at the specified current for one revolution of the disk.
5. Measure the peak-to-peak analog amplitude of the Read Signal for one entire revolution, excluding all nonuniform segments, such as write splices, servo gaps, and header fields. Uses the hysteresis value when looking for peaks.
6. Compute the track average amplitude around the entire track by summing up the peak-to-peak voltages of each plus and minus pulse pair. Divide the result by the number of pulse pairs.

7. Perform the measurement by acquiring one segment at a time, measuring it, and combining all the results for the final value. To speed up the measurement process, you can specify a smaller region of each track segment to measure by using the cursors gating or by decreasing the record length.

   This measurement requires you to specify the number of segments on the track to be tested.

8. Use a value of 1/2 of the TAA value as the threshold level at which to measure the pulse width of each positive and negative pulse. Compute the average pulse width around the track for all pulses measured.

9. Displays the results in the View Results menu, saves the results as a Track Profile plot in a reference memory, or logs the data to a file. (The results also display the standard deviation of the measurement for all pairs used.)

The pulses making up the tested group are selected by the following criteria:

- There must be enough pulses around the recording track to provide an adequate statistical sample.
- The spacing between pulses must minimize any interaction between the measured pulses.

Figure A–4 shows how PW50 measurements are defined.

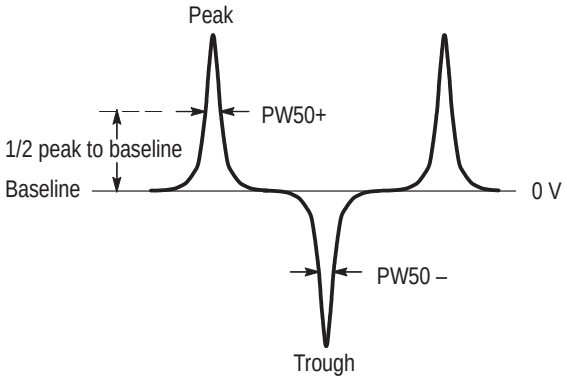


Figure A–4: PW50 measurements

PW50+ and PW50– Measurements

The PW50+ measurement is the pulse width at 50% of the peak value of the pulse; only peaks are measured. The PW50– measurement is the pulse width at 50% of the trough value of the pulse; only troughs are measured.

The application performs the measurement according to the same algorithm used in the PW50 measurement, described on page A–3, except only positive pulses are measured for PW50+ and only negative pulses are measured for PW50–.

NLTS Measurements

The NLTS measurement calculates three types of nonlinear transition shift on the disk drive media as follows:

- Initial magnetization (DC erased)
- First adjacent transition
- Second adjacent transition

The initial magnetization of the media can affect the position at which transitions (reverses in magnetization) are recorded. Initial magnetization is characterized by a delay in a transition, occurring when the new transition reverses the direction of the previous magnetization.

The second transition in a series of consecutive transitions is called the first adjacent transition. The first adjacent transition is characterized as follows: when write data requires transitions on consecutive data bits, the latter transition is shifted earlier in time. In other words, when one transition in a series occurs, then the following transition occurs earlier than it should.

All subsequent transitions in the series of consecutive transitions are grouped into the category called second adjacent transition. Second adjacent transitions are similar to first adjacent transitions. The difference is that the transitions are separated by two bit periods, not one.

When nonlinear transition shift can be characterized, its behavior can be mitigated with write pre-compensation.

There is no NLTS specification in the IDEMA standard. The NLTS measurement is based on a time domain cross-correlation method detailed in the IDEMA Test and Measurement Committee PRML Working Group Working Paper *Nonlinear Distortion Measurement Techniques*, September 1995.

Test Methodology

The NLTS measurement algorithm assumes that the acquired signal consists of a periodic signal and independent additive noise. The noise is assumed to be responsible for all the nonperiodic behavior of the acquired waveform.

The application performs the measurement according to the following algorithm:

1. Acquire three or more cycles of the pseudo-random pattern sequence read from the disk drive.
2. You specify the polynomial used to generate the waveform, the approximate duration of one period of the periodic signal captured in the waveform, and the tolerance of the approximation.

***NOTE**. The specified polynomial must generate a pseudo-noise (maximum length) sequence, or the measurement will not proceed.*

3. (This step is not performed if you specify a Duration Tolerance of 0%.) Compute the actual cycle time and delay values. Cycle time is the period of time required for the pseudo-random pattern until it begins to repeats itself.

NLTS guarantees that the real cycle time is determined by the measurement if your initial estimate for the cycle time is within the specified tolerance (up to 30%) of its real value.

The NLTS measurement uses several cycles of the pseudo-random pattern waveform to improve the accuracy of the measurement, averaging over multiple single-waveform-cycle NLTS values.

NLTS Initial Measurement

The NLTS initial magnetization measurement assumes the following sequence:

1. The medium is initially magnetized in one direction (DC-erased)

2. Transitions that are written by a head field in the opposite direction are shifted later by an amount ε_0.

The application calculates this measurement using the following equation:

$$\tilde{V}(t) \approx V\left(t - \frac{1}{2}\varepsilon_0\right) - \frac{1}{2}\frac{\varepsilon_0}{T}V\left(t - \frac{1}{2}\varepsilon_0 + \left(M_0 - \frac{1}{2}\right)T\right)$$

Where:

$\tilde{V}(t)$ is the playback voltage for a readback channel affected by NLTS initial magnetization

$V(t)$ is the playback voltage in the absence of nonlinear effects

T is the bit period

ε_0 is the amount of shift

M_0 is an integer, whose unique value is determined by the polynomial used to generate the recorded pseudo-noise bit sequence

The measurement reports the nonlinear effect as a percentage of T; that is, $\frac{\varepsilon_0}{T}$.

NLTS 1st Adjacent Measurement

The NLTS first adjacent transition is the condition where the location of a transition is shifted earlier by an amount ε_1 due to another transition one bit interval earlier.

The application calculates this measurement using the following equation:

$$\tilde{V}(t) \approx V\left(t + \frac{1}{2}\varepsilon_1\right) + \frac{1}{2}\frac{\varepsilon_1}{T}V\left(t + \frac{1}{2}\varepsilon_1 - \frac{3}{2}T\right) - \frac{1}{2}\frac{\varepsilon_1}{T}V\left(t + \frac{1}{2}\varepsilon_1 + \left(M_1 - \frac{1}{2}\right)T\right)$$

Where: $\tilde{V}(t)$ is the playback voltage for a readback channel affected by NLTS first adjacent transition

V(t) is the playback voltage in the absence of nonlinear effects

T is the bit period

ε_1 is the amount of shift

M_1 is an integer, whose unique value is determined by the polynomial used to generate the recorded pseudo-noise bit sequence

NLTS 2nd Adjacent Measurement

The NLTS second adjacent transition is similar to the NLTS first adjacent transition, with the exception that there are two bit intervals between the transitions. The amount of shift in this case is ε_2. The direction of the shift is determined by the direction of the transitions (earlier if the transitions are opposite, and later if the transitions are in the same direction).

The application calculates this measurement using the following equation:

$$\tilde{V}(t) \approx V(t) - \frac{1}{2}\frac{\varepsilon_2}{T}V\left(t - \frac{3}{2}T\right) + \frac{1}{2}\frac{\varepsilon_2}{T}V\left(t - \frac{5}{2}T\right) + \frac{1}{2}\frac{\varepsilon_2}{T}V\left(t + \left(M_1 - \frac{1}{2}\right)T\right) - \frac{1}{2}\frac{\varepsilon_2}{T}V\left(t + \left(M_2 - \frac{1}{2}\right)T\right)$$

Where: $\tilde{V}(t)$ is the playback voltage for a readback channel affected by NLTS second adjacent transition

V(t) is the playback voltage in the absence of nonlinear effects

T is the bit period

ε_2 is the amount of shift

M_1 and M_2 are integers, whose unique values are determined by the polynomial used to generate the recorded pseudo-noise bit sequence

The measurement reports the nonlinear effect as a percentage of T; that is, $\frac{\varepsilon_2}{T}$.

Other Measurements

The Signal-to-Noise Ratio (SNR), Asperity, Overwrite, Resolution, and Baseline Shift measurements perform other specialized operations.

SNR Measurement

The SNR measurement determines the ratio of the variance of the readback signal to readback noise. The measured noise consists of media noise, crosstalk, electronic noise, and other noise types characteristic to disk drives. Electronic readback noise effects can be mitigated by the averaging operation performed by the SNR measurement.

Signal-to-noise ratio is defined in terms of variances of the signal and noise, and thus is independent of DC offsets of the readback voltage. The SNR measurement algorithm assumes that the acquired signal consists of a periodic signal and independent additive noise. The noise is assumed to be responsible for all the nonperiodic behavior of the acquired waveform. Noise samples are assumed to be independent and identically distributed.

The application calculates this measurement using the following equation:

$$SNR = 10 \ log_{10} \left(\frac{\sigma_s^2}{\sigma_n^2} \right)$$

Where: σ_s^2 is the variance of the noise-free periodic signal

σ_n^2 is the variance of the noise

The application performs the measurement according to the following algorithm:

1. Acquire three or more cycles of the waveform.
2. The user specifies the number of bits in the data pattern and the duration of the pattern, within a known tolerance.
3. (This step is not performed if the user specifies a Duration Tolerance of 0%.) Compute the actual cycle time and delay values. SNR guarantees that the real cycle time is determined by the measurement if the initial user estimate for the cycle time is within the specified tolerance (up to 30%) of its real value.

   The SNR measurement uses several cycles of the waveform to improve the accuracy of the measurement, averaging over multiple single-waveform cycle SNR values.

Asperity Measurement

The Asperity measurement determines whether the head has hit a flaw in the media surface (a thermal asperity has occurred). When the head hits the surface of the media, a large voltage spike results.

The application performs the measurement according to the following algorithm:

1. You enter a threshold value to specify what is considered an asperity. the threshold needs to be set to a level greater than TAA.
2. Begin testing for asperities, checking each peak/trough pair against the specified threshold. If the TAA for a peak/trough pair exceeds the threshold, report an asperity.
3. Display the results: the sector number where the asperity occurred and the time relative to the start of the acquired data record.

Overwrite Measurement

The Overwrite measurement determines the amount of residual signal remaining from a previous write after new data is written to the same location. The strength of the residual signal depends on the coercivity of the media, write current amplitude, and saturation characteristics of the head.

The application calculates this measurement using the following equation:

$$Overwrite(dB) = 20\ log\left(\frac{V_r}{V_o}\right)$$

Where: V_r is the residual RMS amplitude

V_o is the RMS amplitude

The application performs the measurement according to the following algorithm:

1. Erase the test track.
2. Write data for one revolution at a low rate f1.
3. Measure the RMS amplitude (V_o) through a narrow band filter tuned to f1.
4. Overwrite the track with data at a high frequency f2.
5. Measure residual RMS amplitude (V_r) at f1 again.
6. Calculate the results.
7. Display the results.

Resolution Measurement

The Resolution measurement is a ratio of two TAA measurements: a low-frequency pattern to a high-frequency pattern.

The result is expressed as a percentage. You can use this measurement to infer the raw write density of the disk.

The application calculates this measurement using the following equation:

$$Resolution = \frac{TAA(f_2)}{TAA(f_1)} * 100\%$$

Where: f_1 is the low-frequency TAA measurement

f_2 is the high-frequency TAA measurement

The application performs the measurement according to the following algorithm:

1. Erase the test track.
2. Write data for one revolution at a high frequency f_2.
3. Measure the TAA over the selected range of sectors.
4. Erase the test track.
5. Write the track with data at a low frequency f_1.
6. Measure the TAA over the selected range of sectors.
7. Calculate the ratio of the high-frequency TAA to the low-frequency TAA.
8. Display the results.

Baseline Shift Measurement

The Baseline Shift measurement is the difference between the baseline of the positive pulse and the baseline of the negative pulse.

The application calculates this measurement using the following equation:

$$Baseline\ Shift = \frac{100\ (v1 - v2)}{V_{pp}\%}$$

Where: *v1* is the baseline of the positive pulse

v2 is the baseline of the negative pulse

The application performs the measurement according to the following algorithm:

1. Measure the time position of a positive peak.
2. Measure the time position of the following negative peak and the following positive peak.
3. Use the peak-to-peak value (V_{pp}) of the Read signal and calculate the difference between the two baselines.
4. Display the results.

Snapshot Measurements

To see the summary measurements available for TAA, PW50, or NLTS, you can use the snapshot version of these measurements. Figure A–5 shows snapshot measurement data for the different measurements.



Figure A–5: Snapshot measurement data

Snapshots can take the following measurements:

- Amplitude asymmetry
- Time asymmetry
- Time peak-to-trough
- Time trough-to-peak

Amplitude Asymmetry (Amplitude asym)

The Amplitude Asymmetry measurement uses TAA values to compare the symmetry of the positive and negative pulses. It is available only in the TAA snapshot display.

A zero value for amplitude asymmetry indicates that the signal is totally symmetric. A non–zero value indicates the percent of asymmetry of the signal. The range is from –100% to 100%.

The application calculates this measurement using the following equation:

$$Amplitude\ asym = 100\left(\frac{|TAA+| - |TAA-|}{Peak} \right)$$

Where:

TAA+ is the mean of the calculated TAA+ measurement, as defined on page A–2

TAA– is the mean of the calculated TAA– measurement, as defined on page A–2

Peak Value is the larger of the absolute value of TAA+ or the absolute value of TAA–

Time Asymmetry (Time asym)

The Time Asymmetry measurement measures the ability of the head and the media combination to process positive and negative transitions identically. The time asymmetry measurement is based on timing between pulse peaks. It is available only in the PW50 snapshot display.

The application calculates this measurement using the following equation:

$$Time\ asym = \frac{1}{4N} \sum_{(i\ =\ 1...N)} (|\ T_1 - T_2|\ )$$

Where:

i indexes negative pulses

N is the number of measured time intervals

T_1 is the time from the prior positive pulse to the current pulse

T_2 is the time from the current pulse to the next positive pulse

These measurements operate as other measurements in the sense that a range of sectors is defined, and the measurement average and standard deviation calculated. The range of the measurement within each sector is determined by the cursors.

Time Peak-to-Trough (Time PT) and Time Trough-to-Peak (Time TP)

The time peak-to-trough (Time PT) is the time from a positive peak to the next negative peak (trough). The time trough-to-peak (Time TP) is the time from a trough to the next positive peak.

Figure A–6 shows how the Time PT and Time TP measurements are defined.

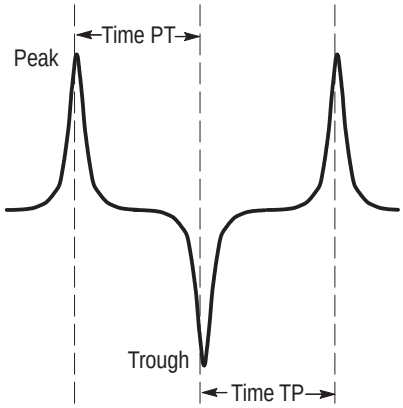


Figure A–6: Time PT and Time TP measurements

Calculating Statistics

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

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 statistic using the following equation:

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

Minimum Value

The application calculates this statistic using the following equation:

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

Mean Value

The application calculates this statistic 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 statistic using the following equation:

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

Appendix B: Track Profile Plots

Track Profile plots are reference memory waveforms that contain measurement results from each track sector. The results are distributed over a 500 point record. You can use track profiles to help analyze a measurement in the following ways:

- Observe sector-to-sector variations in measurements
- Identify the location of flaws within a track
- Observe characteristics of measurement variations around a track which may be due to causes such as head height variations or surface media defects

The resulting Track Profile plot represents the value of the measurement as a function of sector number over a range of sectors, which can be specified in the Inputs/Trigger menu. The Trigger Mode must be set to Sector and you have to use the vertical cursors on the oscilloscope for the application to display the Sector at Cursor readout.

For an example of a Track Profile plot with readouts, refer to Figure 2–42 on page 2–47.

Using Track Profiles

To create a Track Profile plot, follow the procedure on page 2–45.

To view ongoing track profile results, set the Sequence Mode to Free Run. When the Track Profile plot reaches its 500-point capacity, the application continues to acquire data and the plot scrolls across the screen as new points are added and old points are deleted. For an example of this, refer to Figure 2–41 on page 2–46.

About the Track Profile Reference Memory

At the beginning of the measurement, the reference memory is filled with null values. At the end of each sector measurement, the value for that measurement is stored in the reference memory and a display cycle is activated. This causes the reference memory waveform to sweep across the screen as the measurement progresses around the track. You then have a clear indication of the progress of the entire measurement over the specified range of sectors.

Values are stored in the reference memory as one point per measurement result, up to a maximum of 500 points. If more than 500 points/measurements are taken, the oldest results are discarded. Any unused points at the end of the reference memory record are set to null values.

Appendix C: 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 TDSDDM2 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 tdsddm2ctrl.c file on the oscilloscope hard drive and on the optional applications compact disc contains 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 TDSDDM2 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 the Application

To start the TDSDDM2 application, you must send the oscilloscope the following GPIB command:

```
application:activate "Disk Drive Measurements 2"
```

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 C–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 C–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 active application
measurement	{TAA, TAA+, TAA–, Snapshot TAA, PW50, PW50+, PW50–, Snapshot PW50, NLTS Initial, NLTS 1st Adjacent, NLTS 2nd Adjacent, Snapshot NLTS, SNR, Overwrite, Resolution, Asperity, Baseline Shift}	Sets the type of measurement to take	Returns the measurement currently selected
Limits limitTest		Query only	Returns " " when Off and Pass or Fail when On
limitTestState	{On, Off}	Sets the state of the limit test	Returns the state of the limit test

Table C–1: VARIABLE:VALUE TDS COMMAND arguments and queries (Cont.)

Variable name	Variable value	Function	Query form
limitTestUpper	String corresponds to a positive double*	Sets the upper limit value	Returns the upper limit value
limitTestLower	String corresponds to a positive double*	Sets the lower limit value	Returns the lower limit value
NLTS/Other			
patternDuration	String corresponds to a double positive	For NLTS measuements, sets the initial length of time for the pattern duration value For SNR measurements, sets the number of bits per pattern period for general patterned data	Returns the pattern duration
durationTolerance	String corresponds to a positive integer	Sets the tolerance (accuracy) of the pattern duration	Returns the tolerance
polynomialIndex	String corresponds to a positive integer	Sets the selected pseudo-random binary sequence polynominal value	Returns the polynominal index
bitsPerPattern	String corresponds to a positive integer	For SNR measurements, sets the type of periodic signal	Returns the bits per pattern
threshold	String corresponds to a positive double*	Defines threshold for Asperity	Returns the value set for the threshold
Input channels			
readSignal	{Ch1, Ch2, Ch3, Ch4, Ref1, Ref2, Ref3, Ref4, Math1, Math2, Math3, Math4}	Sets the Read Signal input to a waveform	Returns the Read Signal selection
readGate	{Ch1, Ch2, Ch3, Ch4}	Sets the Read Gate input to a waveform	Returns the Read Gate selection
indexPulse	{Ch1, Ch2, Ch3, Ch4}	Sets the Index Pulse input to a waveform	Returns the Index Pulse selection
sectorPulse	{Ch1, Ch2, Ch3, Ch4}	Sets the Sector Pulse input to a waveform	Returns the Sector Pulse selection
Trigger			
triggerMode	{Index, Read Gate, Sector, User}	Sets the trigger mode	Returns the trigger mode
preambleDuration	String corresponds to a positive double*	Sets the value of the preamble duration	Returns the value of the preamble duration
startSector	String corresponds to a positive integer	Sets the sector on which the measurement starts	Returns the sector on which the measurement starts
stopSector	String corresponds to a positive integer	Sets the sector on which the measurement stops	Returns the sector on which the measurement stops
Filters			
filter1CutoffFreq or filter2CutoffFreq	String corresponds to a positive double*	Sets the cutoff frequency	Returns the cutoff frequency

Table C–1: VARIABLE:VALUE TDS COMMAND arguments and queries (Cont.)

Variable name	Variable value	Function	Query form
filter1DestinationName or filter2DestinationName	{Ref1, Ref2, Ref3, Ref4, None}	Sets the filter destination to a Ref or to none	Returns the filter destination selection
filter1Slope or filter2Slope	{12 dB/oct, 24 dB/oct, 36 dB/oct, 48 dB/oct, 60 dB/oct, 72 dB/oct, 80 dB/oct}	Sets the slope of the filter in dB units	Returns the slope of the filter in dB units
filter1State or filter2State	{On, Off}	Sets the state of the filter	Returns the state of the filter
filter1Type or filter2Type	{Lowpass, Highpass}	Sets the type of filter	Returns the type of filter
General			
gating	{On, Off}	Sets the state of gating	Returns the state of gating
hysteresis	String corresponds to a double positive	Sets the hysteresis value	Returns the hysteresis value
Sequencer			
sequencerMode	{Free Run, Single}	Sets the Sequencer Mode	Returns the Sequencer Mode
sequencerState	{Ready, Paused, Sequencing}	Sets the state of the sequencer	Returns the state of the sequencer
Profiler			
profilerState	{On, Off}	Sets the state of the Profiler plot	Returns the state of the Profiler plot
profilerDestination	{Ref1, Ref2, Ref3, Ref4}	Sets the destination reference memory of the Profiler plot	Returns the destination reference memory of the Profiler plot
Logging Results			
<meas>logAnnotate*	Any string from 1 to 20 characters from A to Z and/or zero to nine	Provides custom annotation to the statistics log file; see measurement in this table for <meas> choices	Returns annotation value if set
<meas>loggerDestination	Any string from 1 to 8 characters from A to Z and/or zero to nine	Sets the statistics log file name; see measurement in this table for <meas> choices	Returns the statisics log file name
<meas>logger	{Reset}	Clears the current statistics log file; see measurement in this table for <meas> choices	No query form
<meas>loggerState	{On, Off}	Sets the state of the statistics log; when on, the statistics from the current acquisition are logged; see measurement in this table for <meas> choices	Returns the state of the data log

*** You can enter positive double values two ways; for example, 0.000256 or 2.56E-4 (IEEE format).**

Table C–1: VARIABLE:VALUE TDS COMMAND arguments and queries (Cont.)

Variable name	Variable value	Function	Query form
Save/Recall			
setup	{Default, Recall, Save}	Causes a Save or a Recall to occur	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 recalled setup file name
saveName	Any string from 1 to 8 characters from A to Z and/or zero to nine	Sets saved setup file name	Returns the saved setup file name
Result Variables			
resultFor	{TAA, TAA+, TAA–, Snapshot TAA, PW50, PW50+, PW50–, Snapshot PW50, NLTS Initial, NLTS 1st Adjacent, NLTS 2nd Adjacent, Snapshot NLTS, SNR, Overwrite, Resolution, Asperity, Baseline Shift}	Sets the measurement for which results are requested	Returns the selected measurmentt; see Table C–2 for the queries associated with resultFor

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

Before you can request result queries, be sure that your program contains the following sequence of GPIB commands:

```
measurement

sequenceMode

sequenceState

resultFor
```

After this sequence, you can query the results. If you have a subsequent sequencing for the same measurement, you must issue another `resultFor` command.

You need to use the VARIABLE:VALUE? form to enter measurement results queries in your GPIB program. Table C–2 lists the measurement results queries for the measurement selected in the resultFor variable.

Table C–2: Measurement results queries

Variable name	Function
1st adj trans	Returns the NLTS value caused by a transition in the previous bit cell, which opposes the transition in the current bit cell
2nd adj trans	Returns the NLTS value caused by a transition, which is two bit cells before the current bit cell

Table C–2: Measurement results queries (Cont.)

Variable name	Function
Amplitude asymmetry	For TAA Snapshot measurements only; returns the percent of amplitude asymmetry with zero indicating total asymmetry
asperity {0 to 9}	Returns the sector number and time in which the asperity occurred for no more than the last 10 asperities
Estm Pattern Duration	Returns the estimated duration of the pattern
frequency	Returns the frequency value
init mag	Returns the initial magnetization value for NLTS only
m1	Returns the magnitude value for the low frequency signal
m2	Returns the magnitude value for the high frequency signal
max	Returns the maximum value
mean	Returns the mean value
meanPercent	Returns the mean value as a percentage for the Baseline Shift measurement
min	Returns the minimum value
num avg	Returns the number of peaks, troughs or peak/trough pairs used for the average values
numAvgAtF1	Returns the number of peak and trough pairs of the high frequency pattern
numAvgAtF2	Returns the number of peak and trough pairs of the low frequency pattern
overwrite	Returns the amount of residual signal remaining from a previous write when new data is written to the same location
pass	Returns Pass 1 or Pass 2 for the Resolution and Overwrite measurements
PW50	Returns the average pulse width at 50% of the peak value measured around a complete track
PW50+	Returns the average pulse width at 50% of the positive peaks value
PW50–	Returns the average pulse width at 50% of the negative peaks value
PW50 res	Returns the number of samples for Pulse Width 50%
resolution	Returns the total number of samples
sector number	Returns the number of sectors included in the measurement
statSNR	Returns the statistics for the SNR measurement
stdDev	Returns the standard deviation value
TAA	Returns the average peak-to-peak value of data from the Read waveform
TAA+	Returns the average positive peak value

Table C–2: Measurement results queries (Cont.)

Variable name	Function
TAA–	Returns the average negative peak value
taaAtF1	Returns the TAA value of the high frequency pattern
taaAtF2	Returns the TAA value of the low frequency pattern
Time asymmetry	Returns the ability of the head and the media to process positive and negative transitions identically; only for TAA and PW50 snapshots
Time PT	Returns the value of the elapsed time from a positive peak to the next negative peak (trough)
Time TP	Returns the value of the elapsed time from a negative peak (trough) to the next positive peak
total asperities	Returns the total number of asperities
User Pattern Duration	Returns the actual duration of the pattern

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

Table C–3: Results returned by measurements

Measurement	Results returned
TAA, TAA+, TAA–, PW50, PW50+, PW50–	mean, max, min, stdDev, statSNR, num avg, sector number
Snapshot TAA	TAA, TAA+, TAA–, Amplitude asymmetry, num avg, Time PT, Time TP, Time Asymmetry, resolution, frequency, hysteresis, sector number
Snapshot PW50	PW50, PW50+, PW50–, PW50 res, num avg, Time PT, Time TP, Time asymmetry, resolution, frequency, hysteresis, sector number
NLTS Initial, NLTS 1st Adjacent, NLTS 2nd Adjacent	mean, min, max, stdDev, num avg, sector number, User Pattern Duration, Estm Pattern Duration
Snapshot NLTS	init mag, 1st adj trans, 2nd adj trans, num avg, sector number, User Pattern Duration, Estm Pattern Duration
SNR	mean, min, max, stdDev, num avg, sector number, User Pattern Duration, Estm Pattern Duration
Asperity	total asperities, sector number, asperity{0-9}
Overwrite	pass, overwrite, m1, m2, frequency, sector number
Resolution	pass, resolution, taaAtF1, numAvgAtF1, taaAtF2, numAvgAtF2, sector number
Baseline Shift	meanPercent, mean, max, min, stdDev, statSNR, num avg, sector number

Index

Index

Symbols

.csv file
- custom annotation with GPIB command, 2–21
- example, 2–17
- format, 2–20
- viewing, 2–29
- viewing in a spreadsheet program, 2–21

A

acquiring data
- reset results, 2–16
- Sequence mode, 2–15
- waveforms, 2–15

address, Tektronix, xiii
Amplitude Asymmetry, A–13
application
- basic functions with an oscilloscope, 2–2
- closing, 2–3
- description, 1–1
- directory names, 2–3
- enabling, 1–8
- exiting, 2–24
- file name extensions, 2–3
- GPIB program example, 2–50
- installing
  - compact disc, 1–7
  - floppy disk, 1–7
- interface, 2–1
- logging results, as statistics, 2–19
- menu structure, 3–1
- minimizing and maximizing, 2–2
- recalling setups, 2–21
- returning, 2–3
- saving results to a file, 2–19
- saving setups, 2–21
- setting up
  - configuring measurments, 2–9
  - selecting measurments, 2–4
- updates, 1–2
- viewing results
  - as plots, 2–18
  - as statistics, 2–18

application examples, 2–33
- Asperity measurement, 2–37
- Baseline Shift measurement, 2–40
- configuration, 2–34
  - filters, 2–35
  - gating, 2–34
  - hysteresis, 2–35
  - limit test, 2–34
  - range of sectors, 2–34
- NLTS measurement, 2–41
- Overwrite measurement, 2–38
- PW50 measurement, 2–36
- reference waveforms, 2–35
- Resolution measurement, 2–40
- SNR measurement, 2–43
- TAA measurement, 2–35
- Track Profile plot
  - creating, 2–45
  - viewing, 2–46
- waveform files, 2–33

area, definition, 2–2
Asperity measurement
- application equation, A–9
- example, 2–37
- parameter options, 2–9
- parameter values, 3–6

B

Baseline Shift measurement
- application equation, A–11
- example, 2–40
- Limit Test area, 2–5
  - parameter values, 3–4

box, 2–2
Browse button, 2–20
buttons
- command, 2–2
- option, 2–2
- Sequence Control, 2–15

C

changing settings during a measurement, 2–16
channel assignments, 1–9, 1–16
Clear command button, 2–20
closing the application, 2–3
command button, 2–2
command syntax, GBIP protocol, C–1
compact disc, 1–7
configuration, 1–11
connecting to a system under test, 1–8
contacting Tektronix, xiii

conventions, xii
Cutoff Frequency, updating values when sample rate is changed, 2–13
cutoff frequency, 2–11

D

data log file
  Clear button, 2–20
  custom annotation with GPIB command, 2–21
  example, 2–17
  format, 2–20
  Save Current button, 2–20
  saving the results tutorial lesson, 2–29
  viewing, 2–21
default setup, 2–24
dim menus or options, 1–2
directory names, 2–3
discontinuity, Gating to filter out, 2–13
disk drives, unsupported, 1–2
downloading updates, 1–2

E

enabling the application, 1–8
exiting the application, 2–24

F

file name extensions, 2–3
filtering out information for analysis, 2–16
Filters area
  Cutoff Frequency, changing the sample rate, 2–13
  filter characteristics, 2–12
  option descriptions, 2–11
  parameter values, 3–7
  using both Highpass and Lowpass, 2–12
  using both Highpass and Lowpass filters, 2–12
floppy disks, 1–7
Free Run sequence mode, 2–15

G

Gating, filter out discontinuity, 2–13
Gating option, 2–14
GPIB protocol
  case sensitive, C–2
  command syntax, C–1
  custom annotation for the data log file, 2–21
  guidelines, 2–49
  oscilloscope operation, xi
  program example, 2–50
grayed out menus or options, 1–2

H

Help menu, no parameters, 3–8
help, online, 2–2
Highpass and Lowpass filters, using both, 2–12
Highpass filter, 2–11
hysteresis, 1–14
Hysteresis option, 1–15, 2–14

I

IDEMA Disk Drive Standard, xii, A–1
Index Pulse definition, 2–10
Index Trigger mode, 1–13, 1–16
Inputs Filters menu, Read Signal input. *See* Filters Area
Inputs General menu, 2–14
  descriptions, 2–14
  Gating option, 2–14
  Hysteresis, 1–14
  Hysteresis option, 2–14
  parameter values, 3–7
Inputs/Trigger menu, 2–9
  Input Channels area, 1–16
    descriptions, 2–9
    parameter values, 3–6
  Trigger area
    descriptions, 2–10
    parameter values, 3–6
installation
  application
    compact disc, 1–7
    floppy disk, 1–7
  disk drive connection
    Primary setup, 1–9
    Secondary setup, 1–10
  downloading updates, 1–2
  up-to-date procedures, xii
interface, application, 2–1

J

JRE, 1–6

K

keypad entry, 2–5

L

label, location on oscilloscope, 1–5
leaving the application, 2–24
lessons. *See* tutorial lessons
Limit Test area
  NLTS/Other, 2–5
    parameter values, 3–4
  TAA/PW50, 2–5
    parameter values, 3–3
  value entry methods, 2–5
list box, 2–2
localizing measurements, 2–16
log file, example, 2–17
Log Statistics menu, 2–19
  parameter values, 3–8
Lowpass and Highpass filters, using both, 2–12
Lowpass filter, 2–11

M

maximizing the application, 2–2
Maximum statistics, application equation, A–14
Mean statistics, application equation, A–15
measurements
  application equations
    Asperity, A–9
    Baseline Shift, A–11
    NLTS 1st Adjacent, A–8
    NLTS 2nd Adjacent, A–8
    NLTS Initial, A–7
    Overwrite, A–10
    PW50, A–4
    PW50+, A–5
    PW50–, A–5
    Resolution, A–11
    Snapshot
      Amplitude Asymmetry, A–13
      Time Asymmetry, A–13
      Time PT (peak-to-trough), A–14
      Time TP (trough-to-peak), A–14
    SNR, A–9
    statistics
      Maximum, A–14
      Mean, A–15
      Minimum, A–14
      Standard Deviation, A–15
    TAA, A–2
    TAA+, A–3
    TAA–, A–3
  focusing on a part of the waveform, 2–16
  GPIB program example, 2–50
  localizing, 2–16
  oscilloscope changes, 2–16
  setting up, 2–4
  Snapshot, A–12
  taking, 2–15
  test algorithms, A–1
  tutorial lessons, 2–25
Measurements menus
  Minimize, 2–2
  NTLS/Other, 2–6
  Save/Recall, 2–21
  TAA/PW50, 2–4
menu structure, overview, 3–1
menus
  Help, 2–2
  Inputs
    Filters, 2–10
    General, 2–14
    Inputs/Trigger, 2–9
  Log, Statistics, 2–19
  Measurements
    NLTS/Other, 2–6
    Save/Recall, 2–21
    TAA/PW50, 2–4
  Plot Track Profile, 2–18, B–1
  Sequence Control, 2–15
  View, Results, 2–18
Minimize menu, no parameters, 3–6
minimizing the application, 2–2
Minimum statistics, application equation, A–14
MP knob, 2–5
multipurpose knob entry, 2–5

N

NLTS measurements
  algorithms, A–6
  application equation
    NLTS 1st Adjacent, A–8
    NLTS 2nd Adjacent, A–8
    NLTS Initial, A–7
  example, 2–41
  Limit Test area, parameter values, 3–4
  parameter options, 2–6
  parameter values, 3–5
NLTS/Other menu, 2–6
  Limit Test area, 2–5
not enough cycles, error message, 2–16

O

online help, 2–2

option button, 2–2
Option Installation key, 1–8
oscilloscope
  accessing functions, 2–3
  basic functions with the application, 2–2
  compatibility, 1–1
  full display, 2–3
  setup guidelines, A–1
Overwrite measurement
  application equation, A–10
  example, 2–38
  Limit Test area, 2–5
    parameter values, 3–4

P

parameters, reference, 3–3
phone number, Tektronix, xiii
Plot Track Profile menu, 2–18
  descriptions, 2–18
  parameter values, 3–8
polynominal index calculation, 2–8
Preamble option, duration, 1–14, 2–16
product
  compatibility, 1–1
  description, 1–1
  requirements and restrictions, 1–2
  updates, 1–2
product support, contact information, xiii
PW50 measurements
  algorithms, A–3
  application equation, A–4
    PW50+, A–5
    PW50–, A–5
  example, 2–36
  Limit Test area, 2–5

Q

quitting the application, 2–24

R

Read Gate definition, 2–9
Read Gate Trigger mode, 1–13, 1–16
Read Signal
  definition, 2–9
  filtering, 2–10
Readme.txt file
  floppy disk, 1–7
  web site, 1–2
recalling
  setups, 2–23
  waveforms to reference memory, 2–26
reference memory
  recalling waveforms, 2–26
  Track Profile plot, B–1
requirements and restrictions, 1–2
Reset All, 2–16, 2–19
Resolution measurement
  application equation, A–11
  example, 2–40
  Limit Test area, 2–5
    parameter values, 3–4
results, reset and clear, 2–19
returning to the application, 2–3

S

sample rate, changing when using filters, 2–13
Save Current button, 2–20
Save/Recall menu, 2–21
  parameters, 3–6
saving a setup, 2–22
sector 0, trigger setup, 1–14
sector pulse, absence to mark the beginning of a track and trigger setup, 1–9
Sector Pulse definition, 2–10
Sector Trigger mode, 1–13, 1–16
Sequence Control, buttons, 2–15
Sequence Control menu, parameters, 3–9
Sequence mode, 2–15
service support, contact information, xiii
setups
  default, 2–24
  Primary, 1–9
  recalling, 2–23
  saving, 2–22
  Secondary, 1–10
  trigger for disk drives that do not use a sector pulse, 1–9
  trigger on sector 0, 1–14
Single sequence mode, 2–15
slope, 2–11
Snapshot measurements
  application equations, A–12
  descriptions, 2–4
SNR measurement
  application equation, A–9
  example, 2–43
  Limit Test area, parameter values, 3–4
  parameter options, 2–8
  parameter values, 3–5

Standard Deviation statistics, application equation, A–15
statistics, application equation
  Maximum, A–14
  Mean, A–15
  Minimum, A–14
  Standard Deviation, A–15
system under test, 1–8

T

TAA measurements
  algorithms, A–1
  application equation, A–2
    TAA+, A–3
    TAA–, A–3
  example, 2–35
  Limit test area, 2–5
  tutorial lesson, 2–27
TAA/PW50 menu, 2–4
  Limit Test area, parameter values, 3–3
taking measurements, 2–15
technical support, contact information, xiii
Tektronix, contacting, xiii
terms, xii
Time Asymmetry, A–13
Time PT, A–14
Time TP, A–14
Track Profile plot
  example, 2–45
  menu, B–1
  parameter options, 2–18
  parameter values, 3–8
track triggering, 1–14
transient response, 2–13
Trigger area
  descriptions, 2–10
  modes, 1–13
  parameters, 1–12
trigger setup
  application, 1–12
  disk drives that do not use a sector pulse, 1–9
  oscilloscope, 1–11
  sector 0, 1–14
tutorial lessons, 2–25
  See also exiting the application; recalling a setup; saving a setup
  saving the results to a data log file, 2–29
  TAA measurement, 2–27

U

Update command button, 2–11
URL, Tektronix, xiii
User Trigger mode, 1–13

V

value entry methods, 2–5
VARIABLE:VALUE TDS COMMAND, C–2
View Results menu
  description, 2–18
  no parameters, 3–8
viewing results
  as plots, 2–18
  as statistics, 2–18

W

web site
  downloading updates, 1–2
  Tektronix address, xiii