

Online Help



TDSDDM2 Disk Drive Measurements Application

077-0026-00

Adapted from Online Help, version 3.0.0

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General Safety Summary

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

Only qualified personnel should perform service procedures.

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

To Avoid Fire or Personal Injury:

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

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

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

Symbols and Terms: The following terms and symbols may appear in the online help.



WARNING. *Warning statements identify conditions or practices that could result 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: The following 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(s) may appear in the product:

 CAUTION
Refer to Help

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 Installation chapter gives a brief explanation on connection configuration.
- The Configuration chapter briefly explains setting up the oscilloscope and the application trigger, and configuring the input waveforms.
- The Operating Basics chapter covers basic operating principles of the application, setting up the application, taking measurements, and analyzing the results.
- The Application Examples chapter includes examples of tests and measurements to give you ideas on how to solve your own measurement problems.
- The GPIB Program Example chapter shows a simple GPIB program.
- The Parameters 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

In addition to the Online Help, you can access other information on how to operate the oscilloscope and application through the following related documents:

- Installation Instructions; the installation instructions provide information on how to install software.
- 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.

 **Tip** You can also download the file with programmer information and examples from the Tektronix Web site. Refer to the installation manual for information on how to download the file.

Refer to the *Optional Applications Software on a Windows-Based Oscilloscope Installation Manual* for the following information:

- Software warranty
- List of all available applications, compatible oscilloscopes, and relevant software and firmware version numbers
- Applying a new label
- Installing an application
- Enabling an application
- Downloading updates from the Tektronix Web site

You can find a PDF (portable document format) file for this document in the Documents directory on the *Optional Applications Software on a Windows-Based Oscilloscope CD*. The CD booklet only contains information on installing the application from the CD and on how to apply a new label.

Conventions

Online help topics use the following conventions:

- Refers to the TDSDDM2 Disk Drive Measurements Application as the TDSDDM2 application or as the application.
- Refers to any product on which this application runs as an "oscilloscope."
- Menus and options may appear in gray if they are beyond the capability of the oscilloscope.
- Displays of an oscilloscope are from a TDS7104 model; there may be subtle differences in the displays from other types of oscilloscopes.
- When steps require 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 Measurements> Save/Recall> Recall.

Using Online Help

Online help has many advantages over a printed manual because of advanced search capabilities. Selecting Help on the right side of the application's Menu bar brings up the help file.

The main (opening) Help screen shows a series of book icons and three tabs along the top menu, each of which offers a unique mode of assistance:


- **Table of Contents (TOC) tab** - organizes the Help into book-like sections. Click a book icon to open a section; select any of the topics listed under the book.
- **Index tab** - enables you to scroll a list of alphabetical keywords. Click the topic of interest
- **Find tab** - allows a text-based search. Follow these steps:
 - 1. Type the word or phrase you wish to find in the search box.
 - 2. Select some matching words in the next box to narrow your search.
 - 3. Choose a topic in the lower box, and then click the Display button.
 - To print a topic, select the Print button from the help topics menu bar.
 - Select Options from the menu bar for other commands, such as to annotate a topic, keep the help window on top or to use system colors.

- Select the Back button to return to the previous help window. Sometimes you can jump from one topic to another through a hyperlink. If the Back button is "grayed out" or a jump is not available, choose the "Help Topics" button to return to the originating help folder.
- Browse buttons (Next >> and Previous <<) allow you to move forward and backward through topics in the order of the Table of Contents (TOC).
- Sometimes you will see the bolded word, "**Note**," in topic text. This indicates important information.

***Note:** Certain aspects of the Online help are unique to applications that run on the oscilloscope.*

Green text (with dotted underline) indicates a "Popup." Click the green text to display a brief help message. Click to return to the topic.

***Note:** Green-underlined text indicates a Jump (hyperlink) to another topic. Select the green text to jump to the related topic. For example, click the green text to jump to the topic on Online Help and Related Documentation.*

 **Tip** You can tell when the cursor is over an active hyperlink (button, jump, or popup), because the cursor "arrow" changes to a small "hand."

Note the "light bulb" and word "Tip" in the graphic above. This graphic indicates additional information to help you function faster or more efficiently.

Feedback

Tektronix values your feedback on our products. To help us serve you better, please send us your suggestions, ideas, or comments on the application.

Direct your feedback via email to techsupport@tektronix.com or FAX at (503) 627-5695 and include the following information. Please be as specific as possible.

General information:

- Instrument model number and hardware options if any, with serial number
- Probes used
- Your name, company, mailing address, phone number, FAX number, email address

- Please indicate if you would like to be contacted by Tektronix about your suggestion or comments


Application specific information:

- Software version number
- Description of the problem such that technical support can duplicate the problem
- The setup file of the oscilloscope and the application is also required to identify the problem
- If possible, save the waveform on which you are performing the measurement as a .wfm file

Note: To find the Software version number, click Help > About in the application.

Once you have gathered this information, you can contact technical support by fax or through email. If using email, be sure to enter in the subject line "TDSDDM2 Problem" in the subject line, and attach the .wfm files.

You can then attach the file to your email (depending on the capabilities of your email editor).

 **Tip** To include screen shots, from the oscilloscope menu bar, select File> Export.... The Export Dialog box displays. Enter a file name with a .bmp extension and Save. The file is saved in the C:\TDS7000\Images directory. You can then attach the file to your email (depending on the capabilities of your email editor).

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.

The figure below 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).

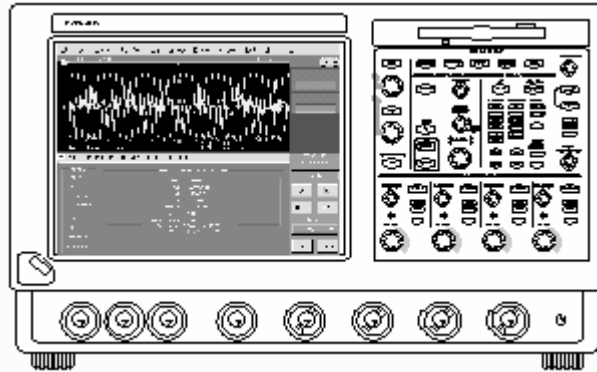


Figure 1: TDSDDM2 Disk Drive Measurements Application

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

Compatibility

For information on oscilloscope compatibility, refer to the *Optional Applications Software on Windows-Based Oscilloscopes Installation Manual*, Tektronix part number 071-1888-XX. The manual is available as a PDF file.

Requirements and Restrictions

The Sun Java Run-Time Environment V1.4.2 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.

Accessories

There are no standard accessories for this product other than the 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

Refer to the Optional Applications Software on a Windows-Based Oscilloscope Installation Manual for the following information:

- List of applications, compatible oscilloscopes, and relevant software and firmware version numbers
- Applying a new label
- Installing an application
- Enabling an application
- Downloading updates from the Tektronix Web site

Note: To 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 T DS7000 series and other oscilloscopes, be sure to check this manual before you install the software.

If you need to locate the corresponding Portable Document Format (PDF) file of this document, you can find it in the Documents directory on the *Optional Applications Software on a Windows-Based Oscilloscope CD*. The CD booklet only contains information on installing the application from the CD and on how to apply a new label.

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 the TDS7054 and TDS7104 oscilloscope, or the P7330 probe for the TDS7404 oscilloscope. For connection to the Index and Sector signals, use standard oscilloscope probes, such as the Tektronix P6139A passive probe or P6243 active probe for the TDS7054 and TDS7104 oscilloscope, or the P7240 active probe for the TDS7404 oscilloscope.

The table below shows the default channel-to-signal assignments. You can change the channel assignments to match your configuration.

Table 1: Primary setup channel assignments

Table of 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.

P

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 below.

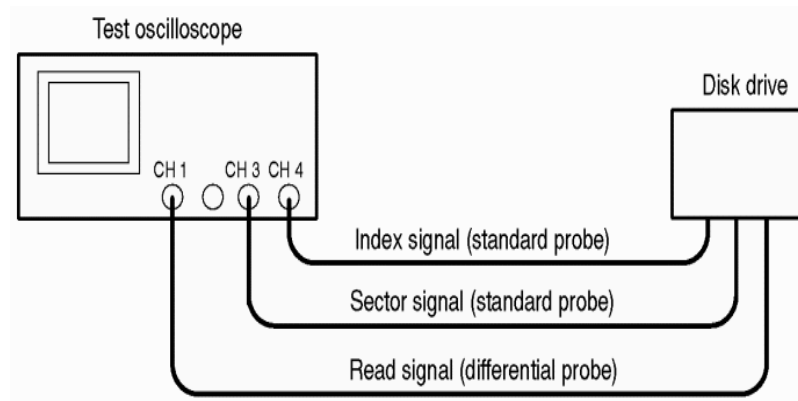


Figure 2: Primary setup connections

Secondary Setup

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

Connect the disk drive to the oscilloscope as shown below.

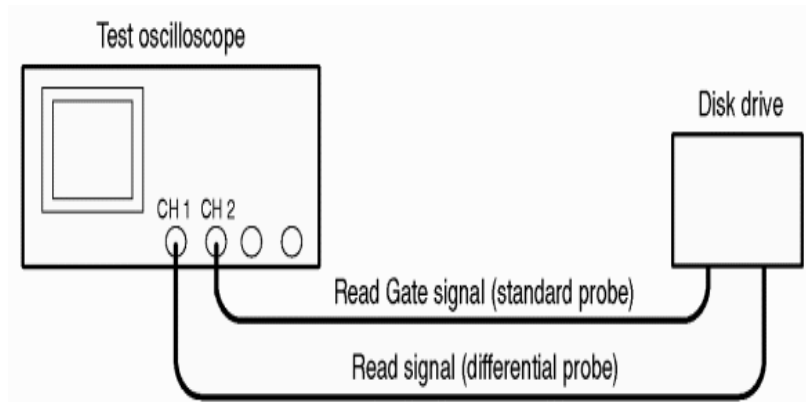


Figure 3: Secondary setup connections



Configuration

There are 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.

These tasks are:

- Setting Up the Oscilloscope Trigger
- Setting Up the Application Trigger
- Hysteresis
- Configuring the Input Waveforms

Note: You can find more information on setup parameters for specific measurements in about application parameters.

Setting Up the Oscilloscope Trigger

If you use the Read Gate, User or Index Trigger mode, you must manually set up the 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.

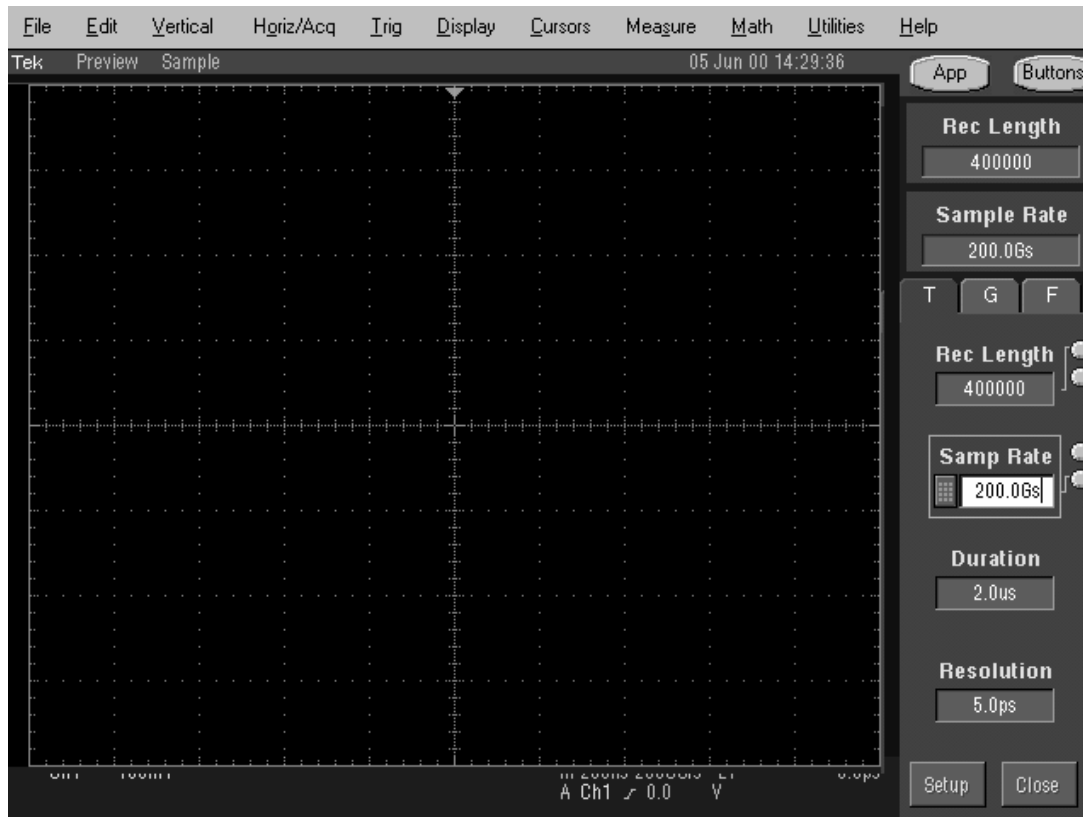


Figure 4: Spectral Control T tab for a TDS7104 oscilloscope

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.
5. For NLTS measurements, set the Record Length to at least 200,000.
6. 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:

7. Start the application. The way you start the application depends on the oscilloscope model. To start the application do one of the following:
 - Select File > Run Application > Disk Drive Measurements 2 in the oscilloscope menu bar.
 - Select App > Disk Drive Measurements 2 in the oscilloscope menu bar.
 - Select Analyze > Disk Drive Measurements 2 in the oscilloscope menu bar.

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

Table 2: Trigger modes

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 in the topic, Setting Up the Oscilloscope Trigger.

9. For the Sector Trigger Mode, use the MP knob (or keypad) to select values for the Start Sector and Stop Sector options.

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.

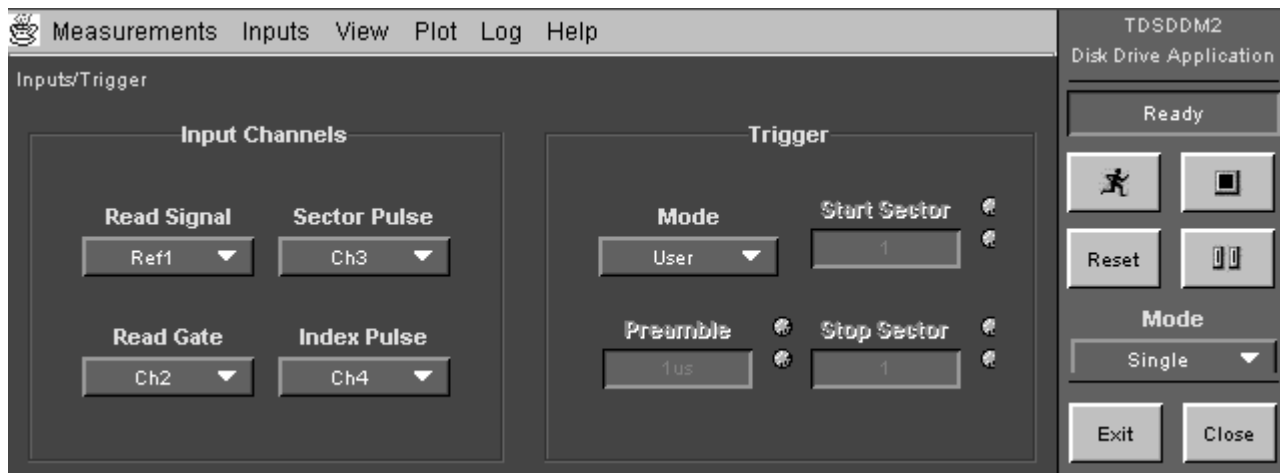


Figure 5: Sector Trigger Mode default values

The following figure shows how the sectors are numbered with respect to the B Event trigger in the oscilloscope application.

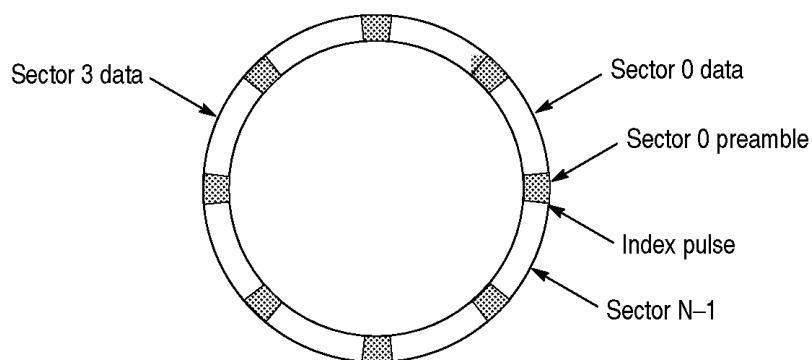


Figure 6: One track

10. 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. The figure below illustrates the use of hysteresis to avoid false identification of peaks.

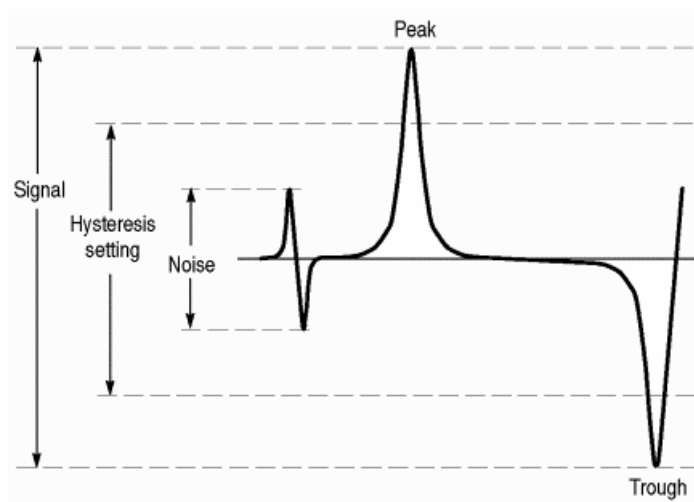


Figure 7: Using hysteresis to avoid false identification of peaks

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.

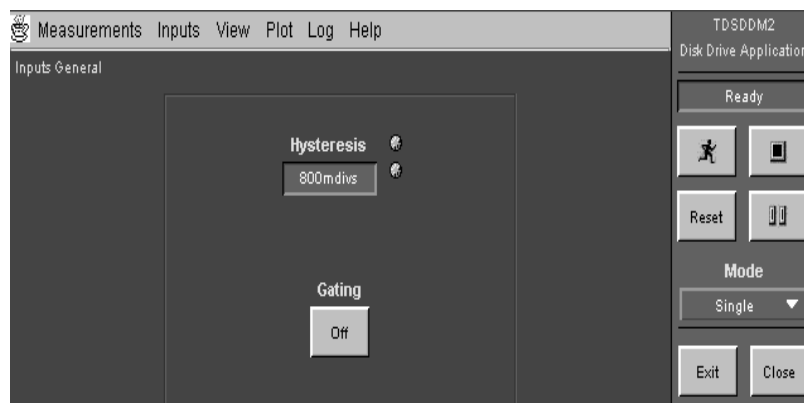


Figure 8: Hysteresis option

Configuring the Input Waveforms

Your configuration may not match the TDSDDM2 waveform assignments. The following table lists the Default channel assignments:

Table 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.
2. Use the list box for each signal and select the waveform that matches your configuration.

Operating Basics

This section contains information on the following topics and tasks:

- Application interface
- Using basic oscilloscope functions
- Setting up the application
- Taking measurements
- 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 interface.

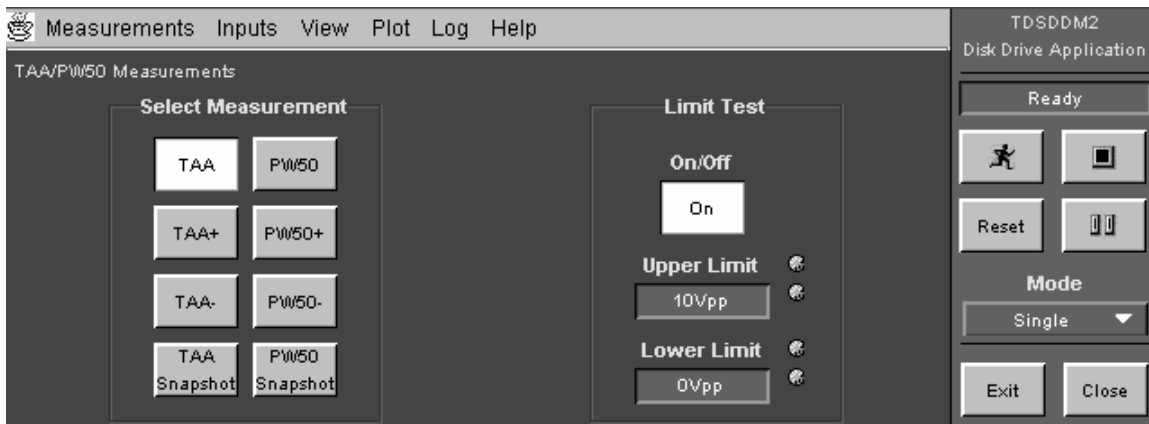


Figure 9: Application interface

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

The following table lists the interface items with a brief description of each:

Table 4: 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

Basic Oscilloscope Functions

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

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 or click the Hide button in the application.

The way you maximize the application depends on the oscilloscope model. To maximize the application do one of the following:

- Select the App > Restore Application on the oscilloscope menu bar.

- Select the Analyze > Restore Application on the oscilloscope menu bar.
- Click the App button on the top right of the oscilloscope.

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 Exit 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 on the Top menu bar of the oscilloscope.

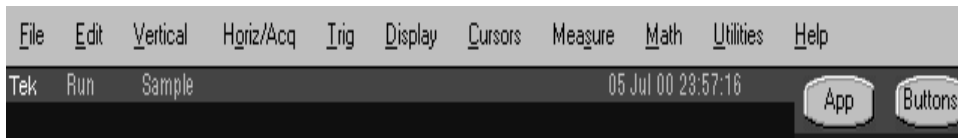


Figure 10: Returning to the application

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

The following table lists default directory names:

Table 5: Default directory names

Directory	Used for
C:\TekApplications\tdsddm2	Home location
C:\TekApplications\tdsddm2\log	Data log files
C:\TekApplications\tdsddm2\setup	Setup files
C:\TekApplications\tdsddm2\waveforms	Waveform files

File Name Extensions

The following table lists File name extensions:

Table 6: File name extensions

Extensions	Descriptions
.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.

To access the TAA/PW50 Measurements menu, go to the Measurements menu in the menu bar and choose TAA/PW50.

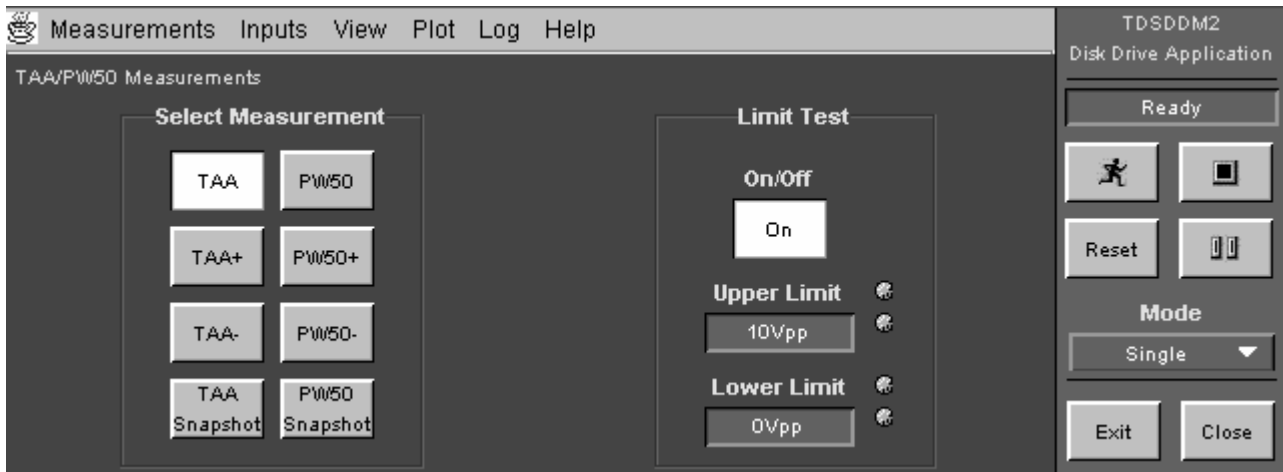


Figure 11: TAA/PW50 Measurements menu

The following table lists the TAA/PW50 measurements with a brief description of each:

Table 7: 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
PW50-	Includes only the troughs
PW50 Snapshot	Provides a summary of PW50 measurements

The following table 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 8: 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

The following figure shows the methods you can use to enter Limit Test values:

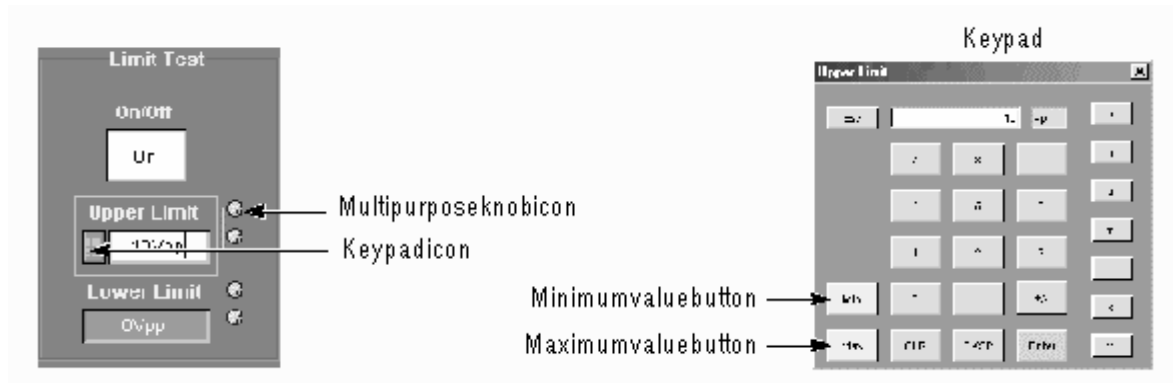


Figure 12: How to enter Limit Test option values

The following table shows the measurement options:

Table 9: 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 select NLTS/Other. The following figure shows the NLTS/Other measurements menu:

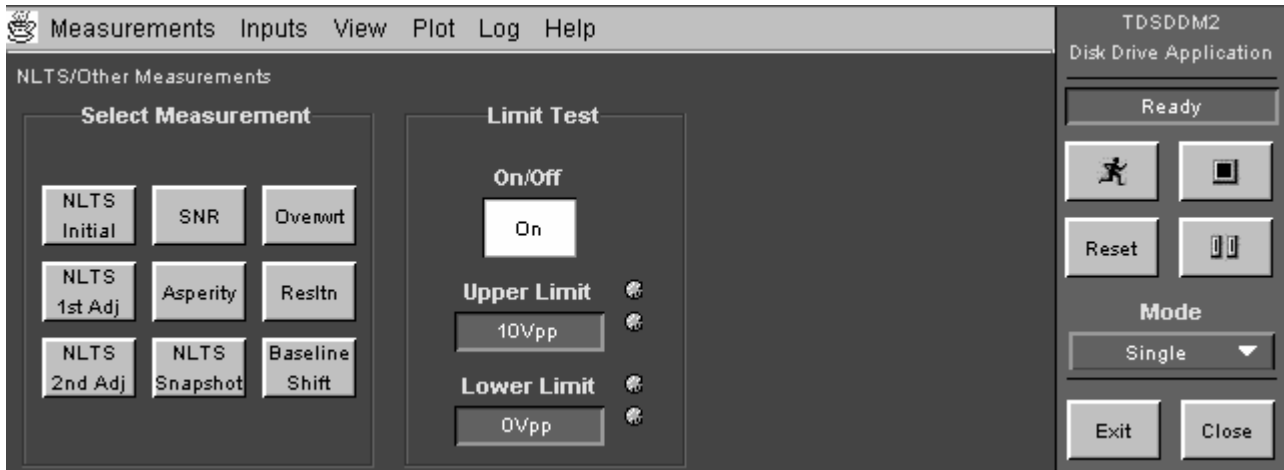


Figure 13: NLTS/Other Measurements menu

The following table lists the NLTS/Other Measurements Options with a brief description of each:

Table 10: NLTS/Other Measurement 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
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

The following figure shows the parameter options for NLTS measurements:

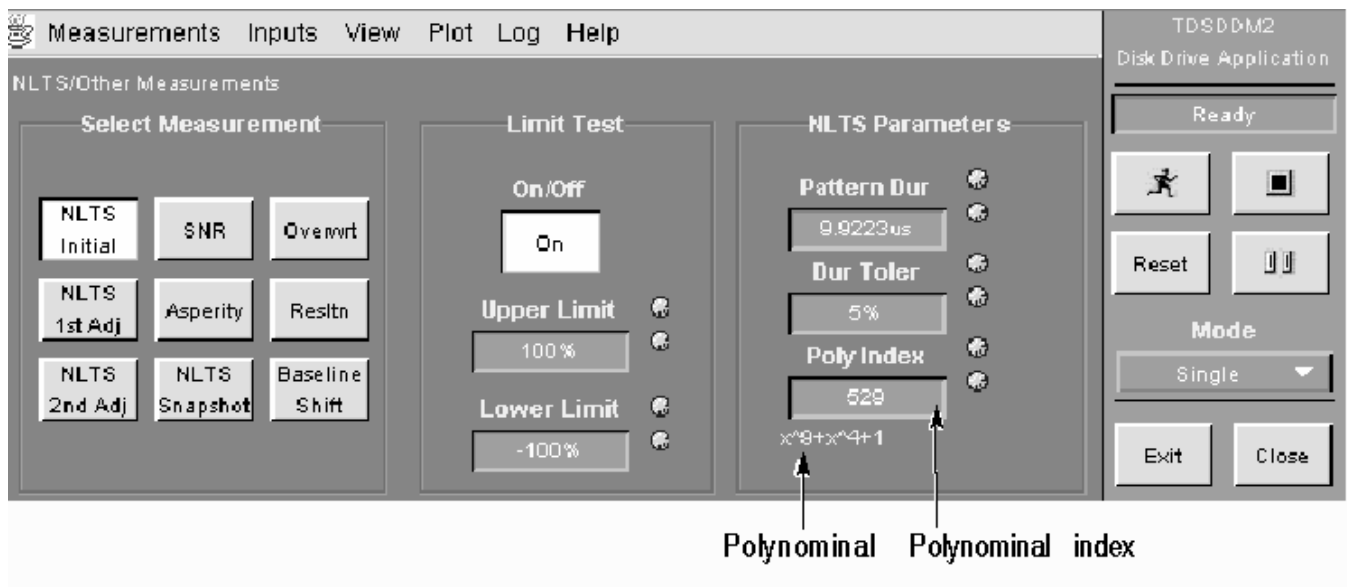


Figure 14: NLTS Parameter options

The following table lists the NLTS Parameter options with a brief description:

Table 11: Table of 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 polynomials; you should use the same polynomial that generates the data pattern written to the media; when you use the multipurpose knob, invalid polynomials 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.

An example of how the application uses $x=2$ to calculate the polynomial index:

The following figure shows an example of how the application uses $x = 2$ to calculate the polynomial index.

$$\text{Polynomial} = x^9 + x^4 + 1$$

$$\text{Polynomial index} = 2^9 + 2^4 + 1 = 529$$

The following figure shows the parameter options for the SNR measurement:

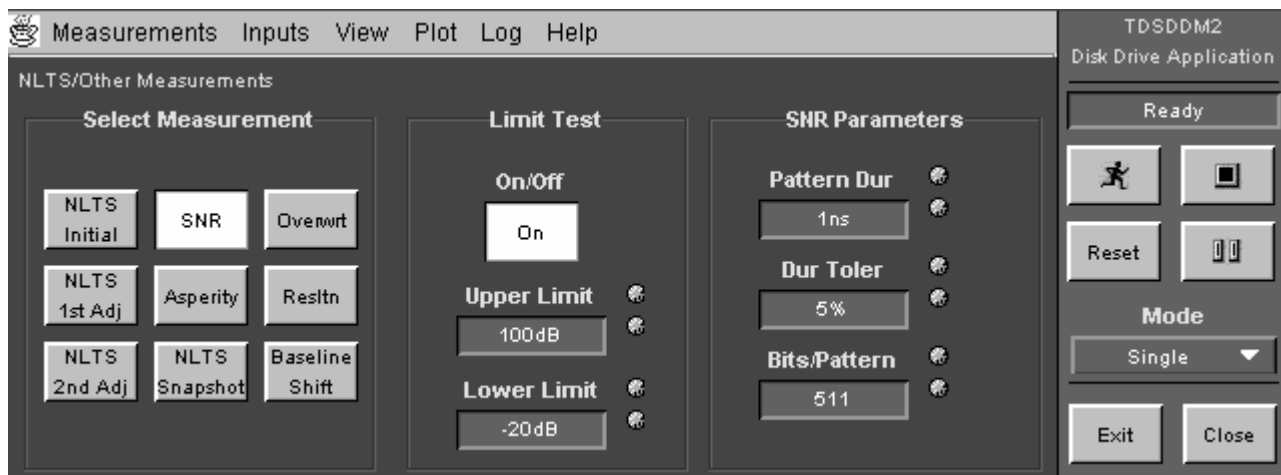


Figure 15: SNR Parameter options

The following table lists the SNR Parameter Options with a brief description:

Table 12: 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 polynomial
Dur Toler	Tolerance (accuracy) of the initial value in the Pattern Dur option; a smaller percentage helps the application take the measurement more quickly
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 the signal as an asperity.

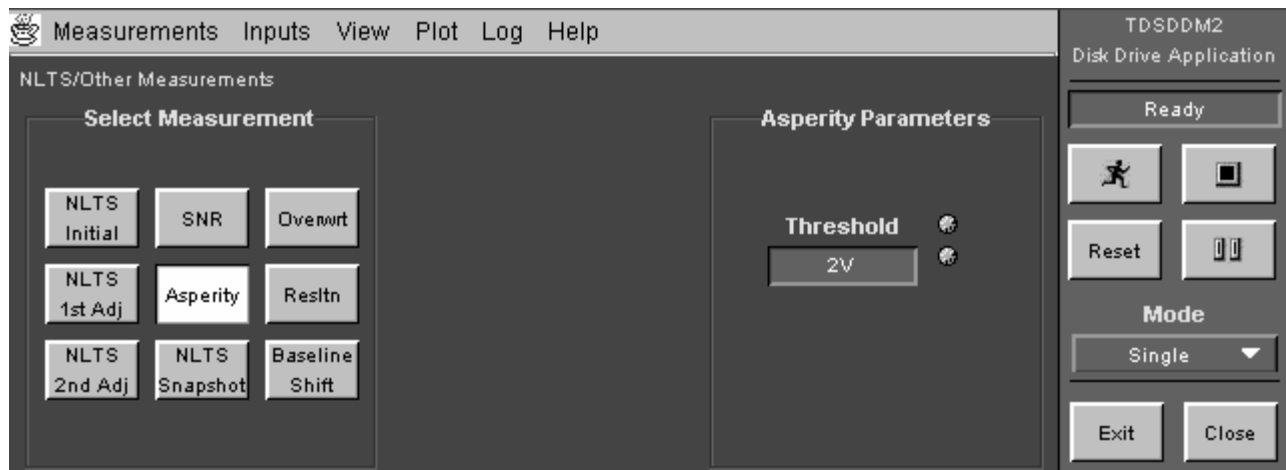


Figure 16: Asperity Parameter options

Configuring a Measurement

There are three Inputs menus that allow you to configure the input waveforms for measurement. To configure these inputs use Inputs/Trigger, Inputs/Filters, and Inputs General.

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

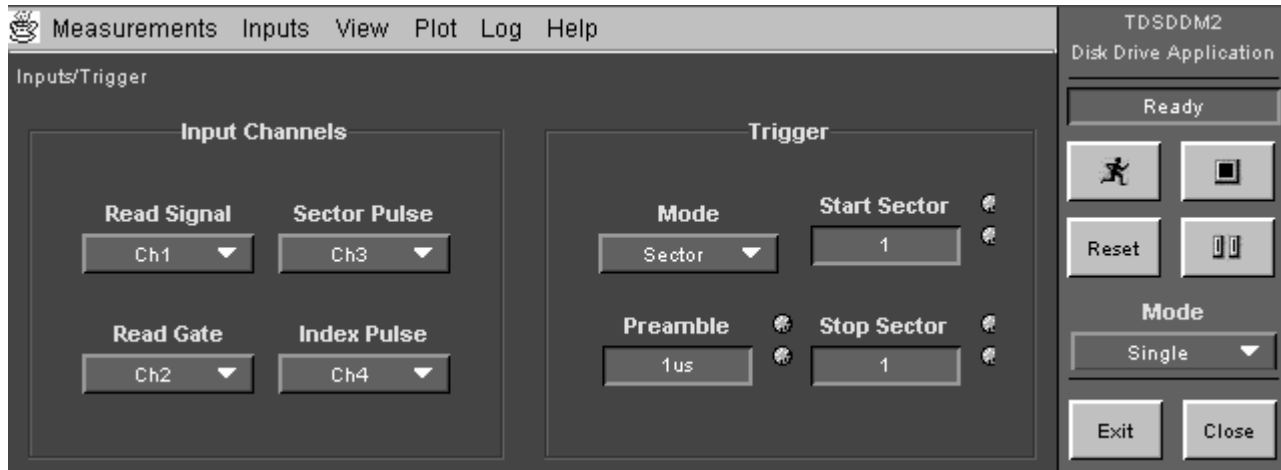


Figure 17: Input/Trigger menu

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.

The following table lists the Trigger Options with a brief description of each:

Table 13: Trigger options

Option Mode	Description
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.	
** 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 of Setting Up the Application Trigger.

You can modify the Read Signal input by applying filters that block specific frequency bands. You can configure each filter as either a Highpass to block out the low frequency band, or as a Lowpass to block out the high frequency band. You can also configure the filters by selecting 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.

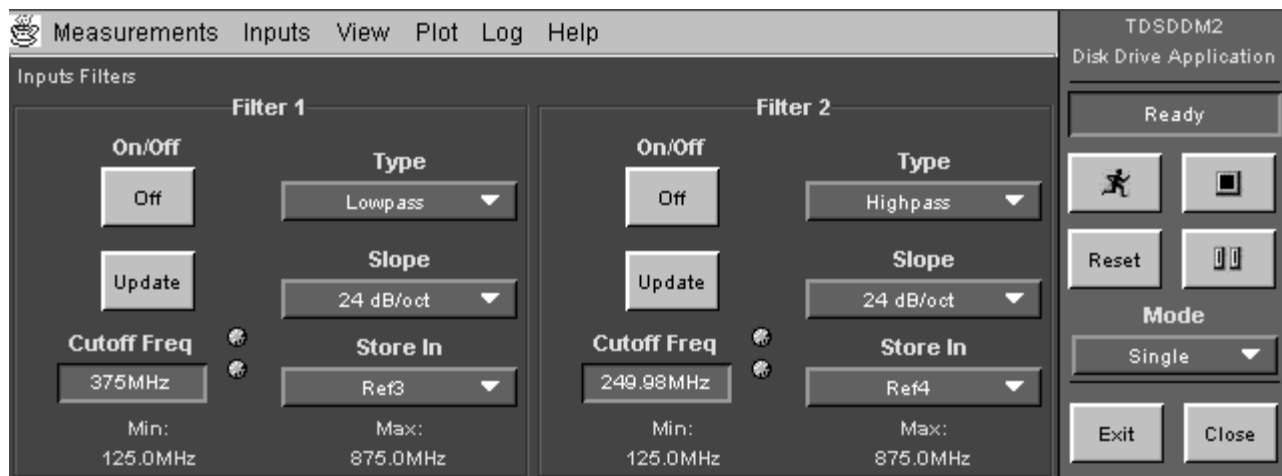


Figure 18: Input Filters menu

The following table lists the options for Filter 1 and Filter 2 with a brief description of each:

Table 14: Filter 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	
Highpass	Blocks the low frequency band and passes on only the high frequency band of the waveform
Lowpass	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

The following figure shows the filter characteristics of the various filters:

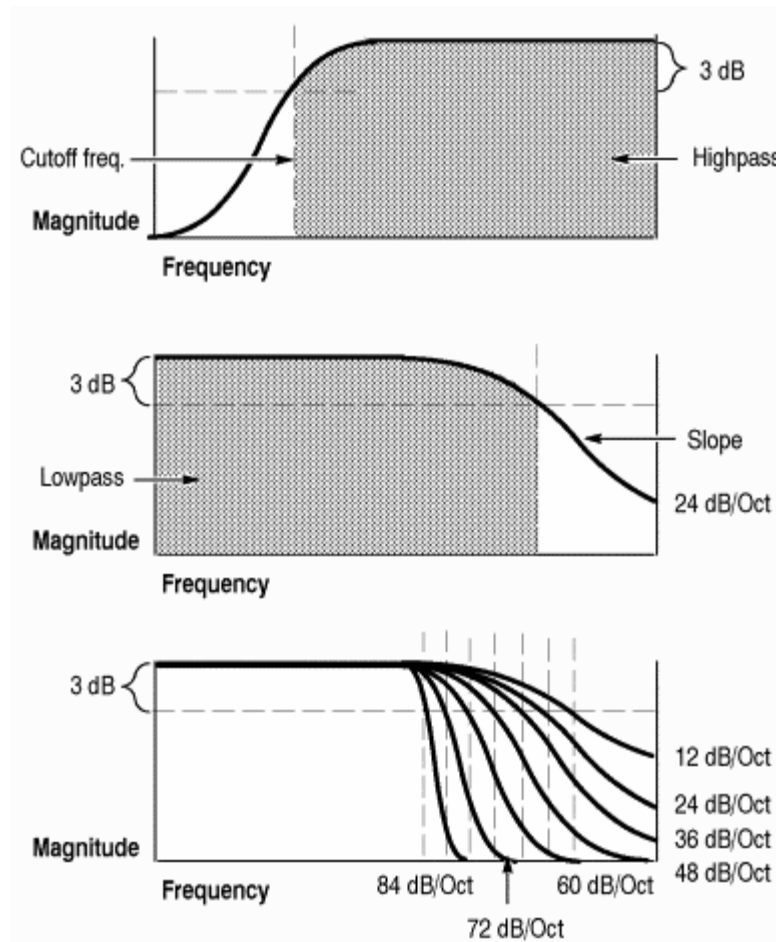


Figure 19: Filter characteristics

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 could select a Cutoff Frequency value that filters out the entire waveform or all but a small amount of noise. The figure below shows the spectrum of the waveform passed to take measurements when you use both the Highpass and the Lowpass filters.

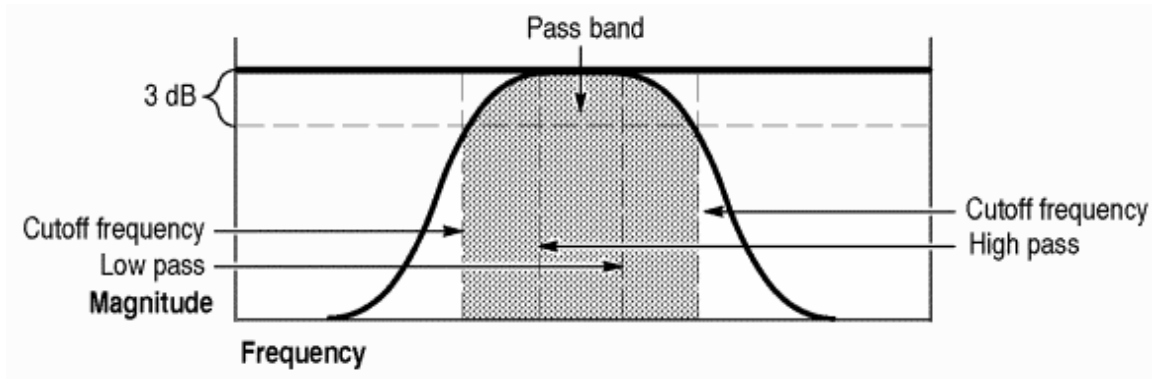




Figure 20: Using both the Highpass and Lowpass filters

At the beginning and end of the filtered waveform, there will be a transient response caused by response of the filter to a discontinuity. You can use Gating in the Inputs General menu to exclude the discontinuity from 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.
5. You can see transient responses at the beginning and the end of the waveform.
6. Select Inputs > General > Gating > On.

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

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 option according to your needs.

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

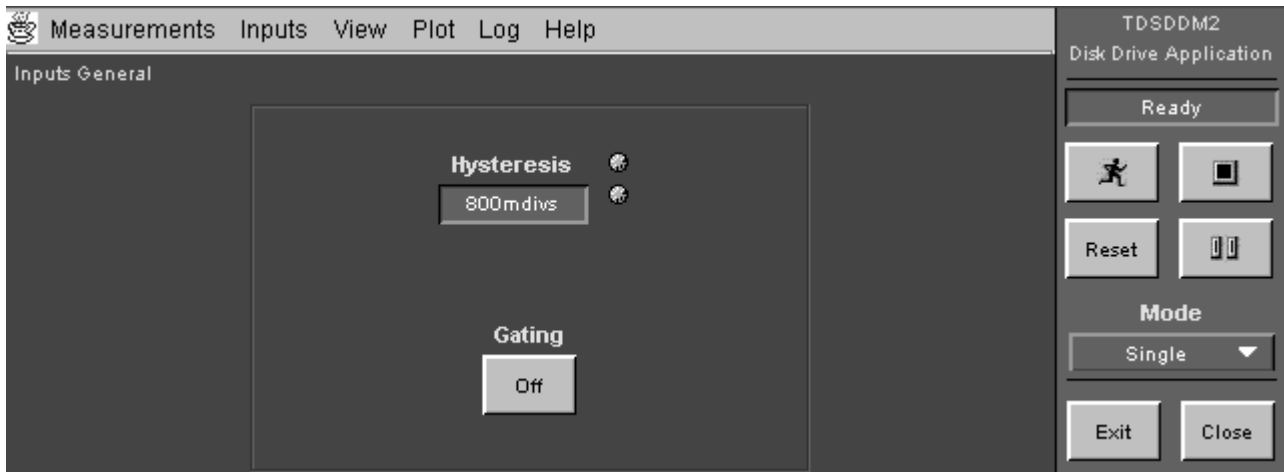


Figure 21: Inputs General menu

The following table lists the General menu with a brief description of each:

Table 15: General options

Option	Description
Hysteresis	Filters out noise that could cause false identification of peaks
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 math waveform as the source, you will need to recall and display the waveform before the application can take a measurement. For an example from the tutorial on how to do this, Refer to *Recalling a Waveform File*.

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. The following figure shows the Sequence Control menu:

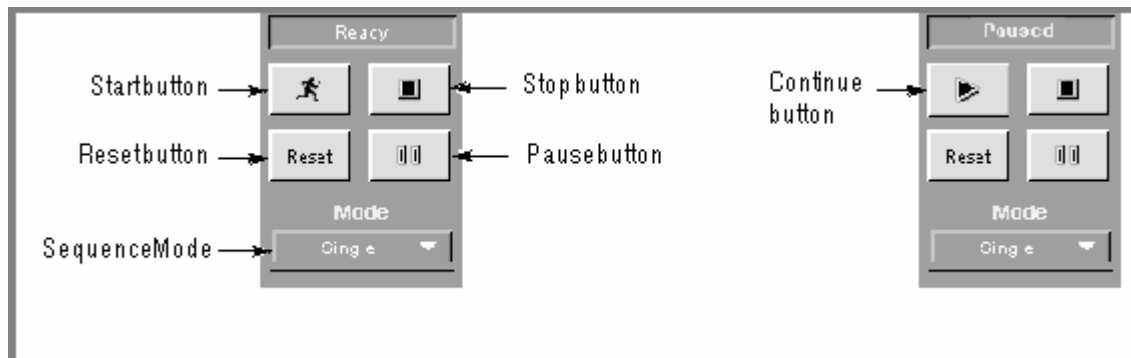


Figure 22: Sequence Control menu

To acquire data from waveforms, follow these steps:

1. Select a Sequence mode, refer the following table:

Table 16: Sequence Control menu

Option/button	Description
Mode	
Single	If the input source is Ch1, Ch2, Ch3, or Ch4, the application acquires a new waveform; for all sources, the application performs measurements on the waveform, 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
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

Note: The Sequence Control menu is always accessible in the right side of the application display.

2. Press the  to start the acquisition.

Note: Do not change oscilloscope settings while taking a measurement, 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* for information on how to adjust the Record Length and the Sample Rate in the Math > Spectral Controls menu (T tab) in the oscilloscope application.

There is an alternative method 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. The following figure shows an example of the results display formats:

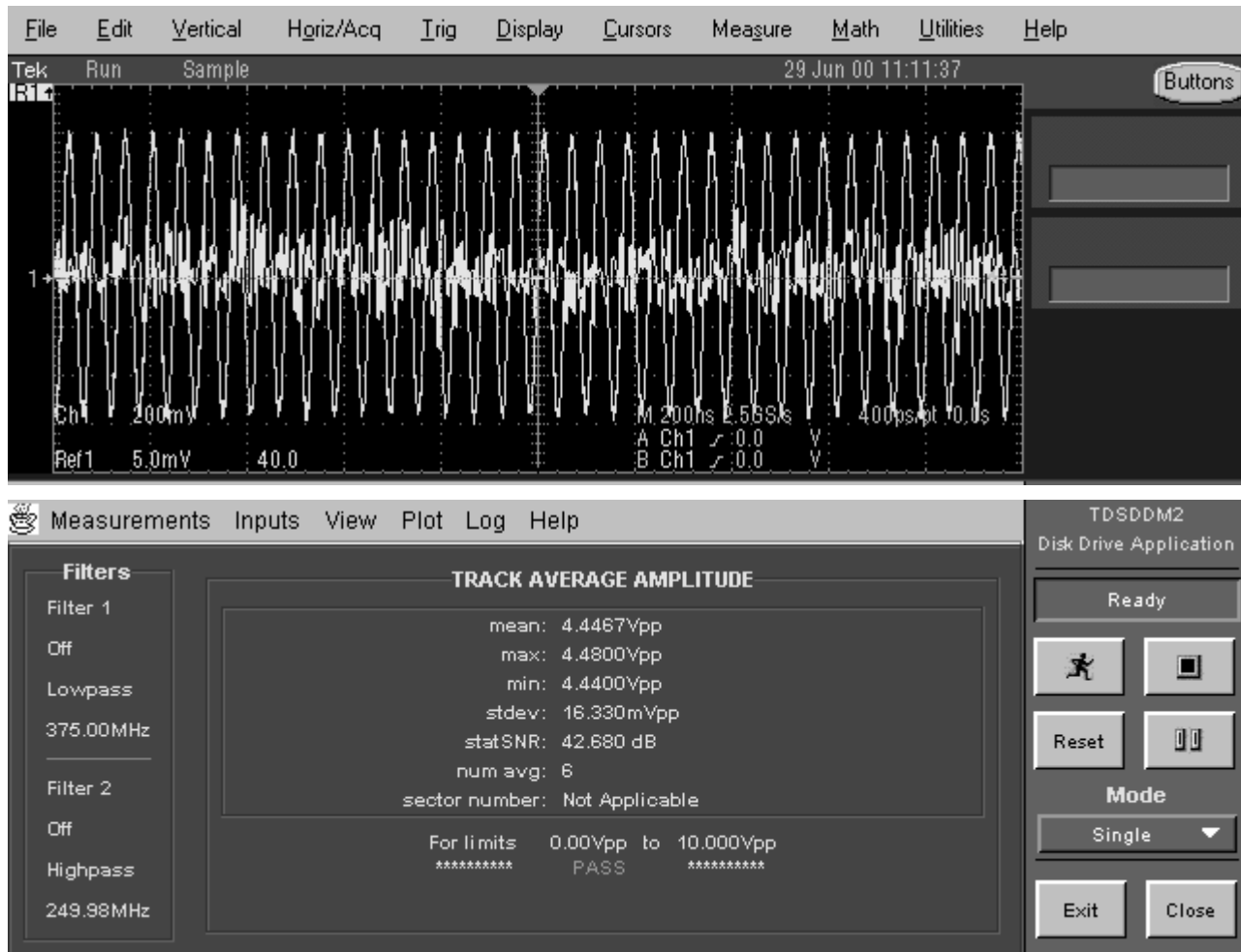


Figure 23: Track Profile Plot example

Note: Stop the acquisition before viewing the results as plots if you are taking Measurements in the Free Run mode.

You can also log the data to a "csv" file for viewing in a spreadsheet, database.

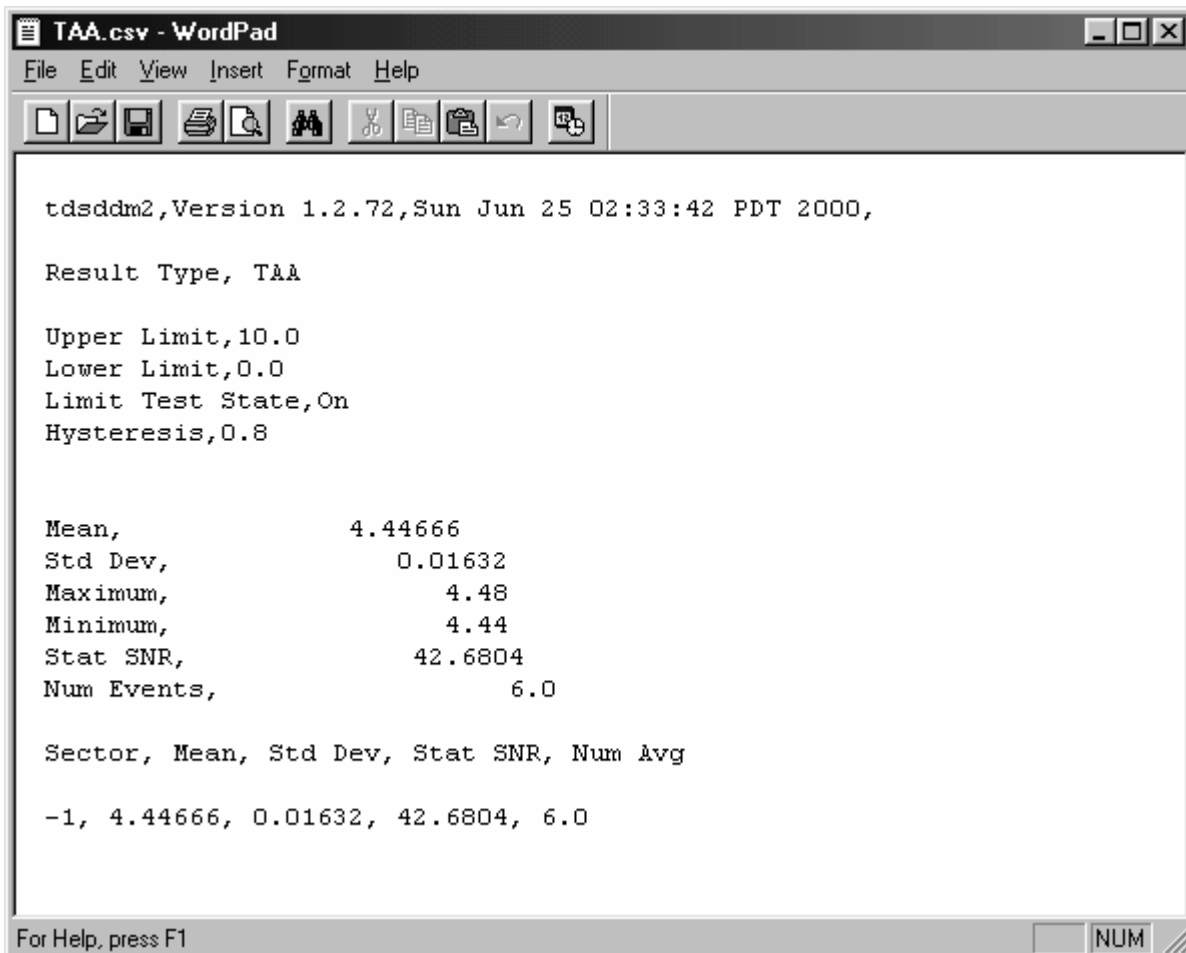


Figure 24: Example of viewing data in a .csv file

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.

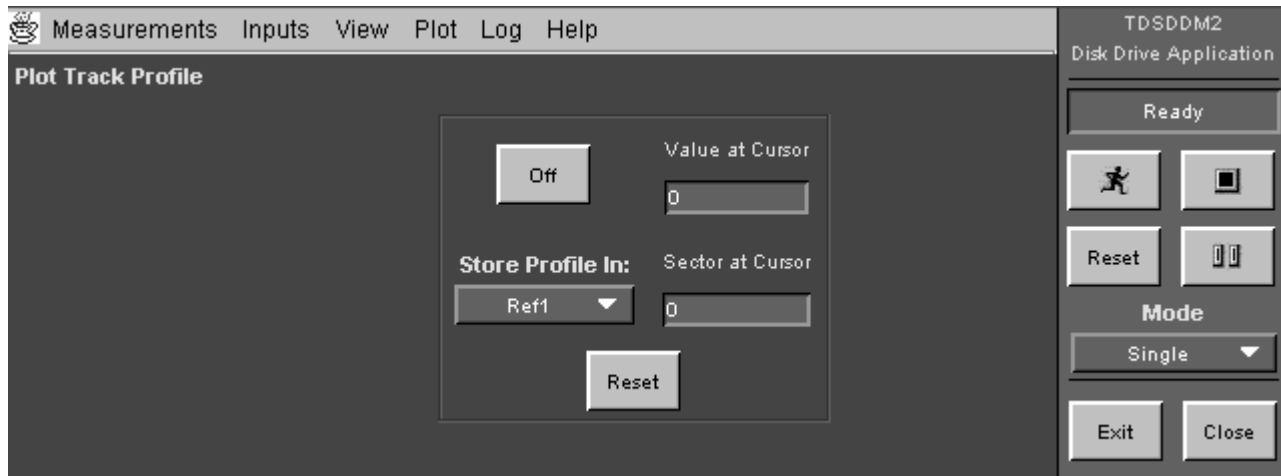


Figure 25: Plot Track Profile menu

The following table lists the Plot Track Profile options with a brief description of each:

Table 17: 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*.

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 Results to a File

You can save (log) the results for all active measurements 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. The following figure shows the Log Statistics menu.

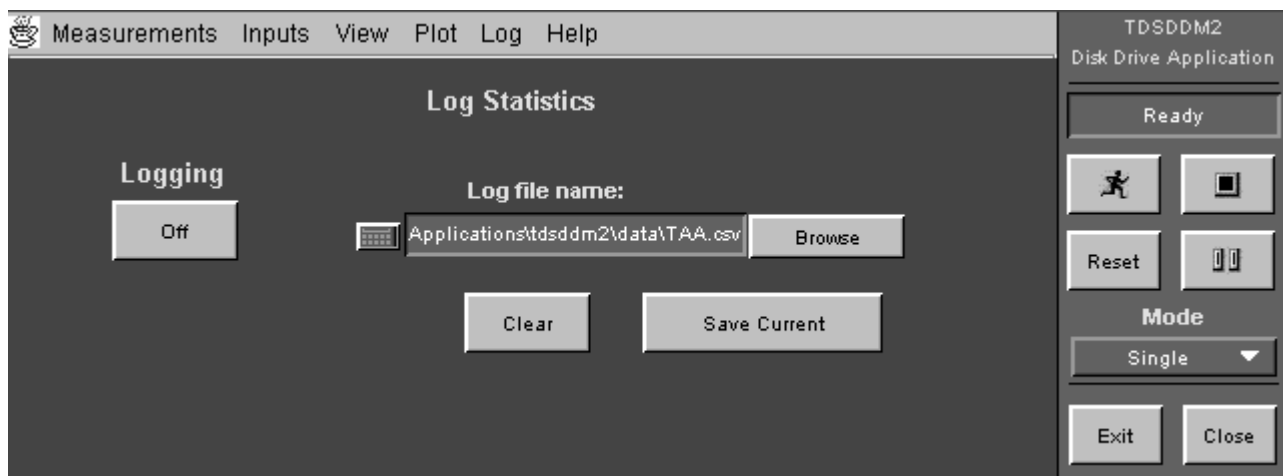


Figure 26: Log Statistics menu

The following table lists the Log Statistics options with a brief description of each:

Table 18: Log Statistics options

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

The following figure shows an example of the Log file directory that displays when you select Browse.

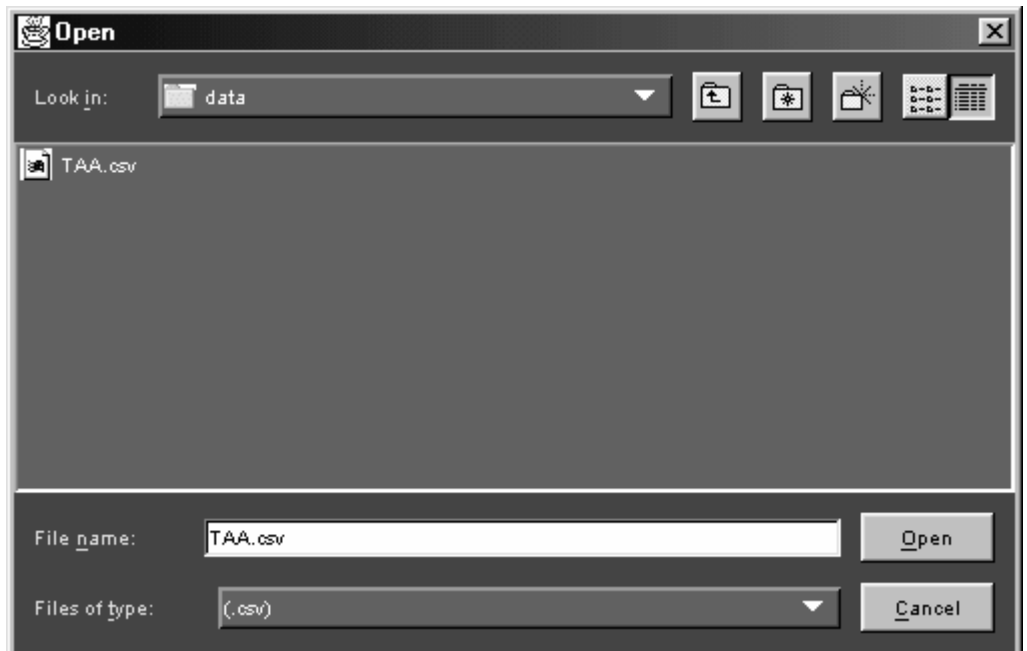


Figure 27: Log file directory

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 spreadsheet, database, and text editing or data analysis program for further analysis.

You must take measurements in Free Run mode to accumulate data points and store them in one data log file. Display a spreadsheet example of a data log file (csv).

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

Saving and Recalling Setups

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

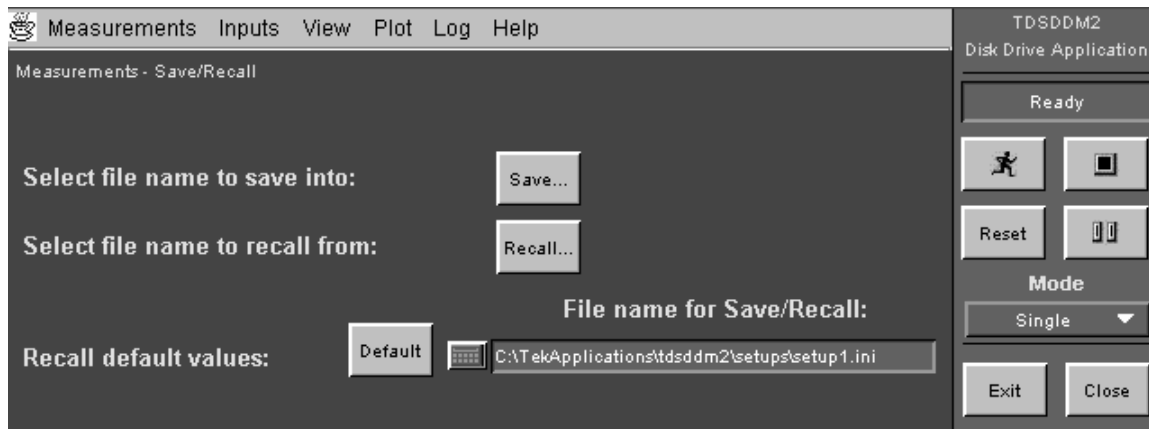


Figure 28: Save/Recall Measurements menu

You may also wish to display the Save/Recall Measurement Options.

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



CAUTION. 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.

Table 19: Save/Recall Measurement options

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

Note: The Measurements > Save/Recall function includes the settings of the oscilloscope application. When you exit the application, you can choose whether to restore 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.
3. Select the directory in which the setup file will be saved.
4. Select or enter a file name. The application appends an ".ini" extension to the name of setup files.
5. Choose Save.

Note: The application also saves the oscilloscope setup to a ".set" file when you save an application setup. Both the application ".ini" file and oscilloscope ".set" file has the same file name.

Recalling a Saved Setup

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

1. Select Measurements > Save/Recall.
2. Select the Recall button.
3. Select the directory from which the setup file will be recalled.
4. Select or enter a setup file name.
5. Choose Recall.

Note: The application also recalls the oscilloscope setup from a ".set" file when you recall an application setup.

Recalling the Default Setup

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

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

Exiting the Application

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

Tutorial

This tutorial teaches you how to set up the application, take a measurement, view the results, and log the results. Refer to the topic, *About Basic Operations*, for more operating information.

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

- Set up the oscilloscope
- Start the application
- Recall a waveform file

Note: Displays of an oscilloscope are from a TDS7104 model; there may be minor differences in the displays from other types of oscilloscopes.

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. Refer the installation procedure.

The way you start the application depends on the oscilloscope model. To start the applications do one of the following:

- Select File > Run Application > Disk Drive Measurements 2 in the oscilloscope menu bar.
- Select App > Disk Drive Measurements 2 in the oscilloscope menu bar.
- Select Analyze > Disk Drive Measurements 2 in the oscilloscope menu bar.

Application Startup (Measurements) Menu

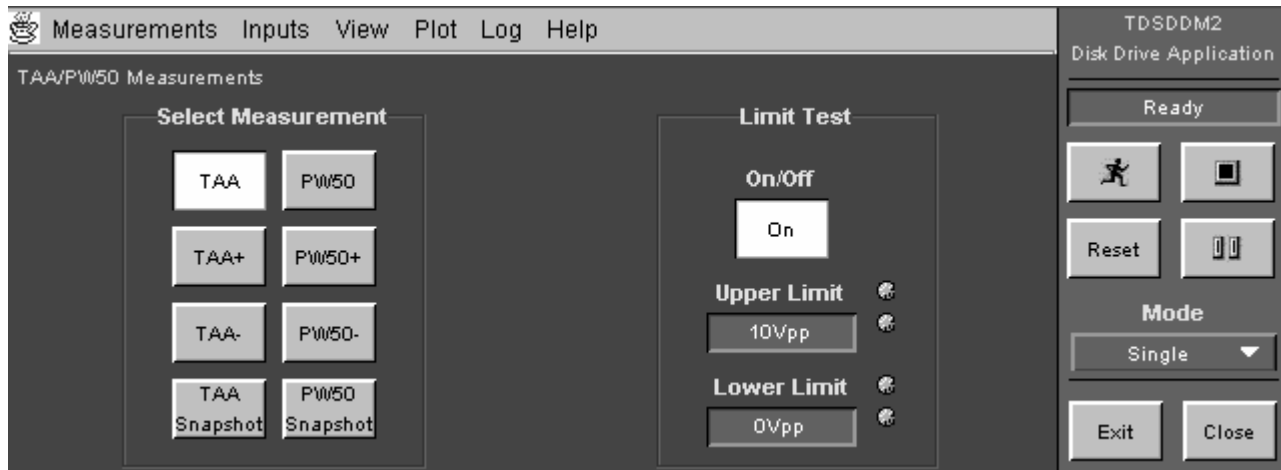


Figure 29: Starting the application

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.

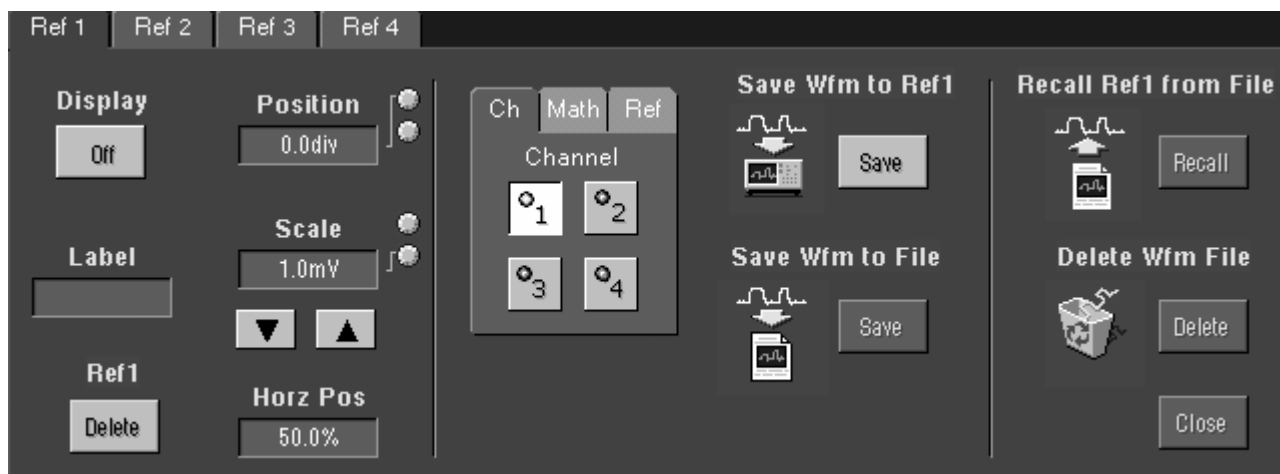


Figure 30: Oscilloscope reference waveform setup

2. Select the Ref 1 tab and Recall. Choose the c:\TekApplications\tdsddm2\waveforms directory.

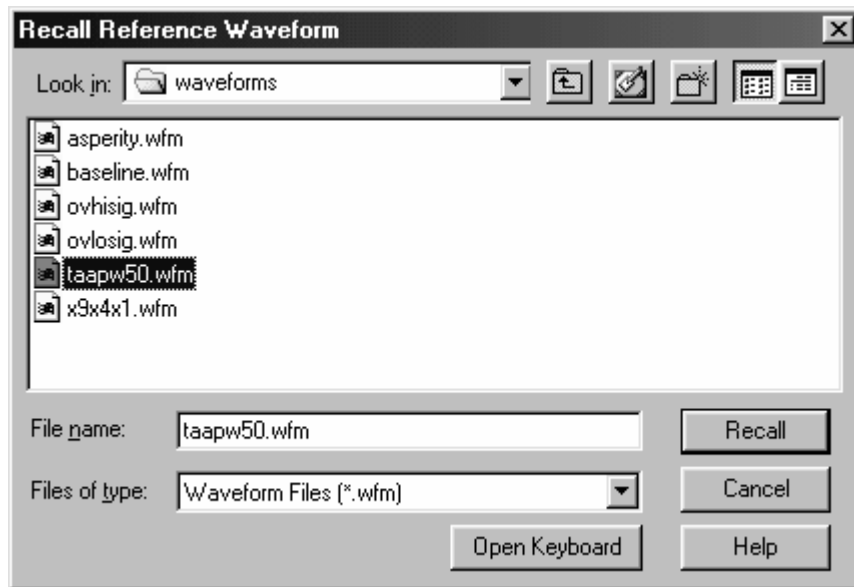


Figure 31: Waveform directory to recall reference waveforms

3. Select the taapw50.wfm file and select Recall.
4. To return to the application, choose the App button in the Menu bar.

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 the Inputs/Trigger menu setup below 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.

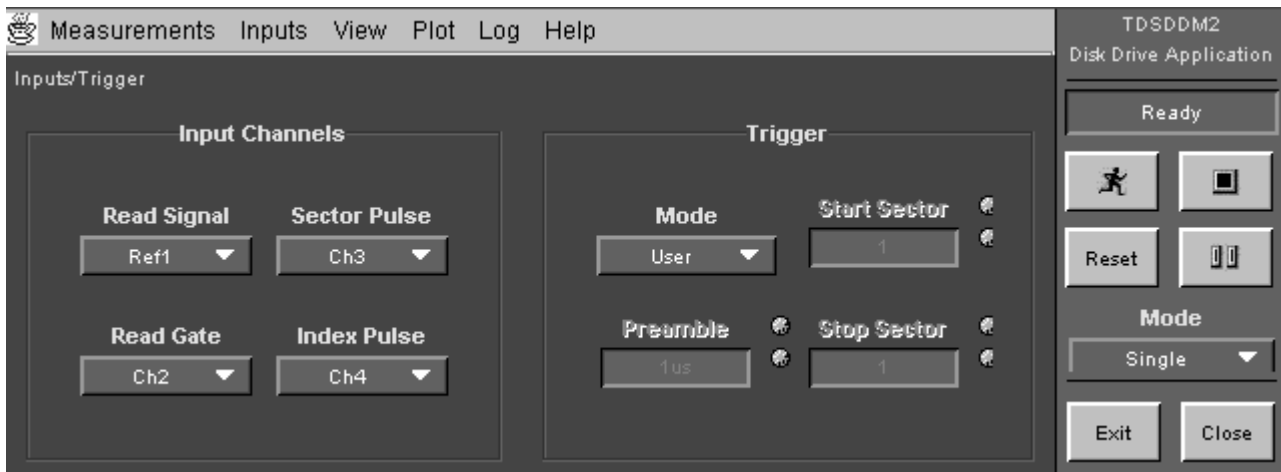



Figure 32: Inputs/Trigger menu setup

- Press  to start the acquisition. The following figure shows the statistical results:

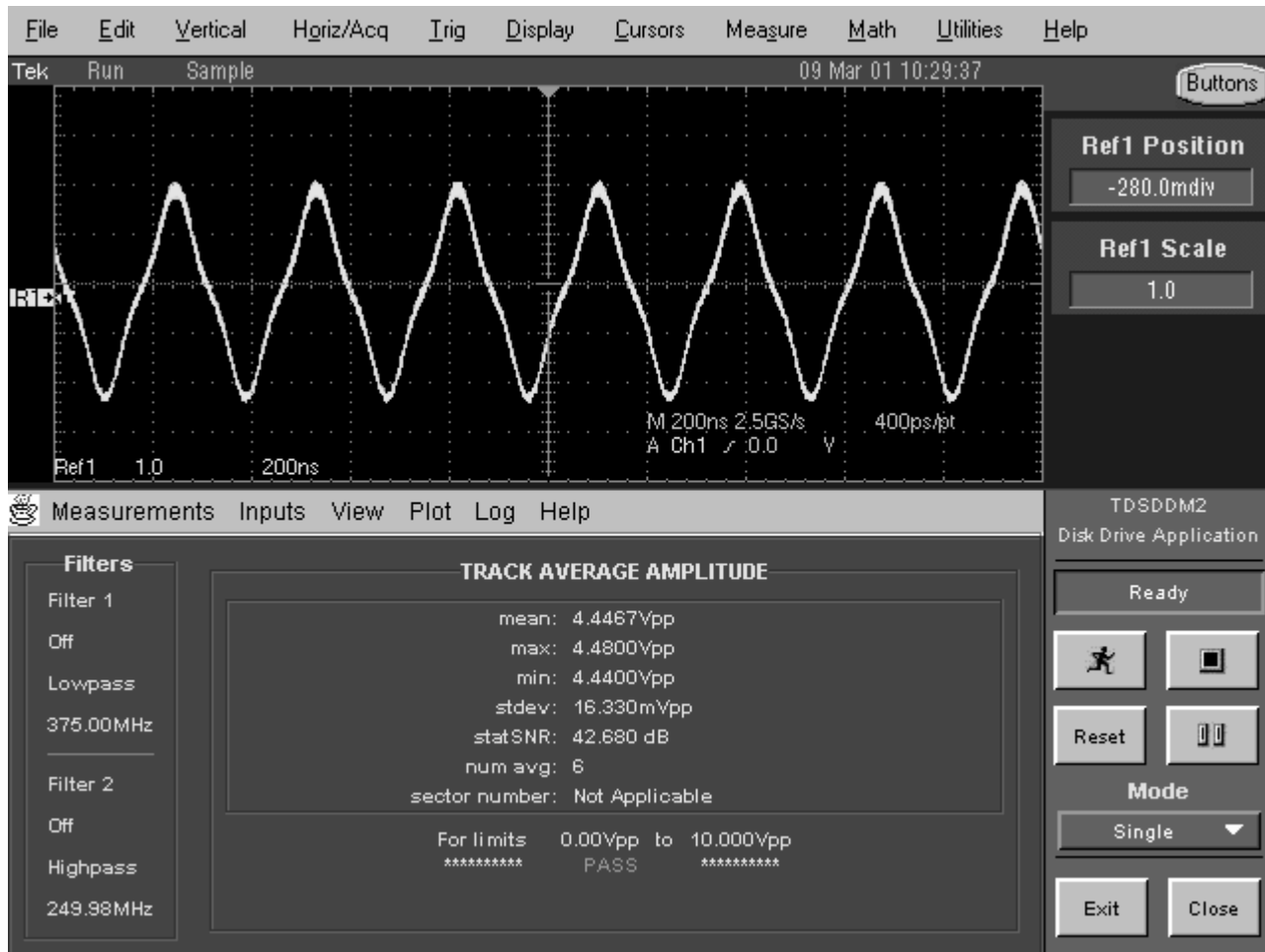



Figure 33: TAA lesson: statistical results

Saving the Results to a Data Log File

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

- Go to the Log menu in the menu bar and select Statistics.
Display an example of the default application directory and log file name.
- Select Logging On.
- Press  to start the acquisition.
- Select Logging Off before viewing the data log file.
- 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. The following figure displays the Log file with default file name.

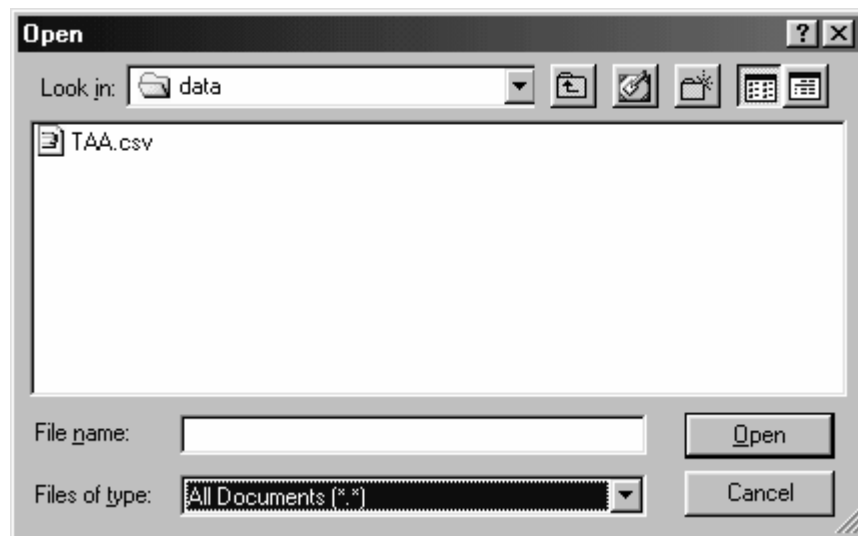
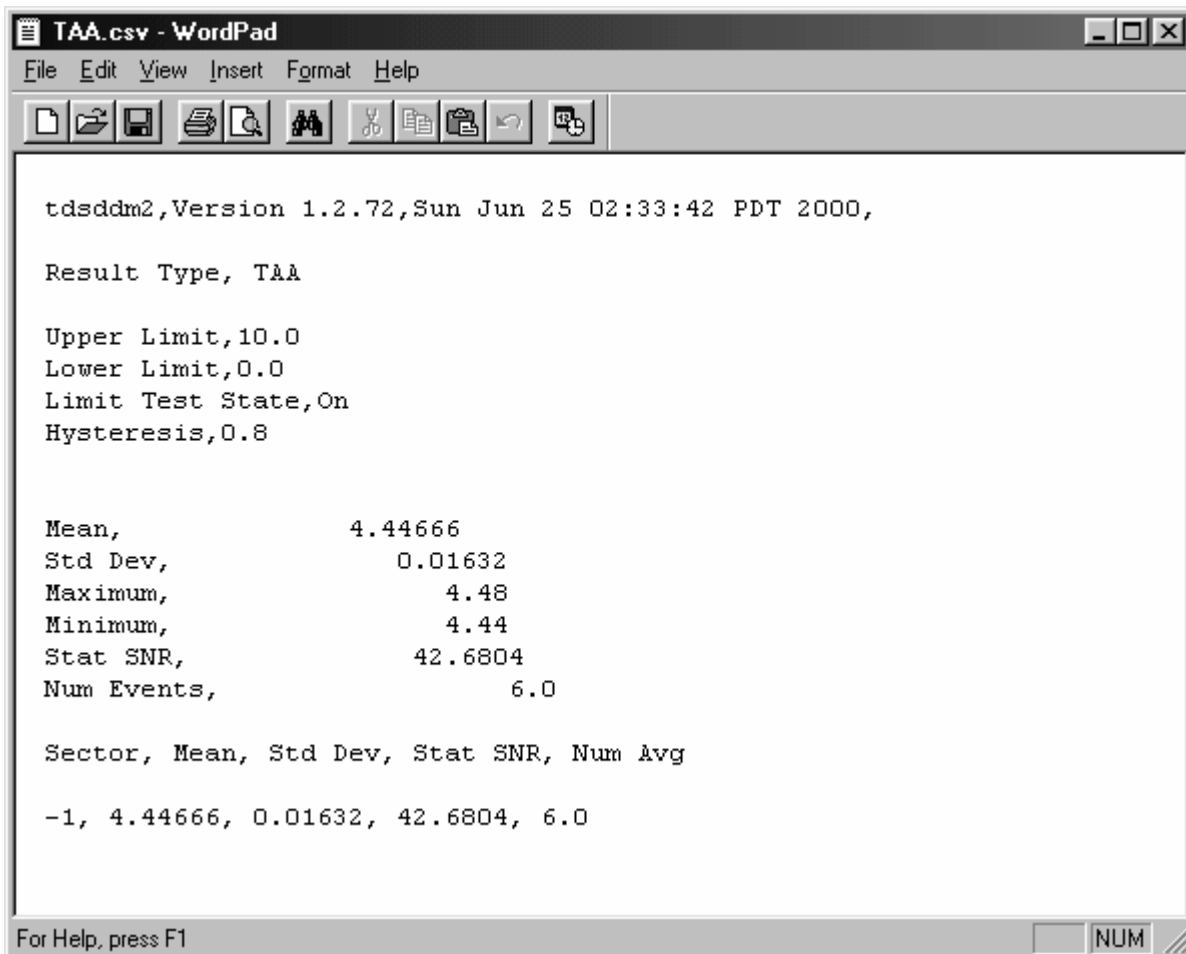


Figure 34: Log file with default file name

5. Select the TAA.csv file and Open. The following figure displays an example of TAA.csv file viewed in Wordpad.



```
t dsddm2,Version 1.2.72,Sun Jun 25 02:33:42 PDT 2000,
Result Type, TAA
Upper Limit,10.0
Lower Limit,0.0
Limit Test State,On
Hysteresis,0.8
Mean,          4.44666
Std Dev,       0.01632
Maximum,       4.48
Minimum,       4.44
Stat SNR,      42.6804
Num Events,    6.0
Sector, Mean, Std Dev, Stat SNR, Num Avg
-1, 4.44666, 0.01632, 42.6804, 6.0
```

Figure 35: 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*.

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*.

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 procedures* and *Configuring the application*.

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. The following table lists the waveform file names and corresponding measurements.

Table 20: Waveform files and application examples

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

- Specifying a Range of Sectors
- Specifying a Limit Test
- Specifying Gating
- Specifying hysteresis
- Specifying a Filter

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. View Entry Methods menu showing multipurpose knob.
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 bind 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.


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 *Display reference waveform files directory*.
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. Refer to the example of TAA measurement results based on the taapw50.wfm file.

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*.
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.

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*.
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. The following figure shows an example of PW50 measurement results based on the taapw50.wfm file.

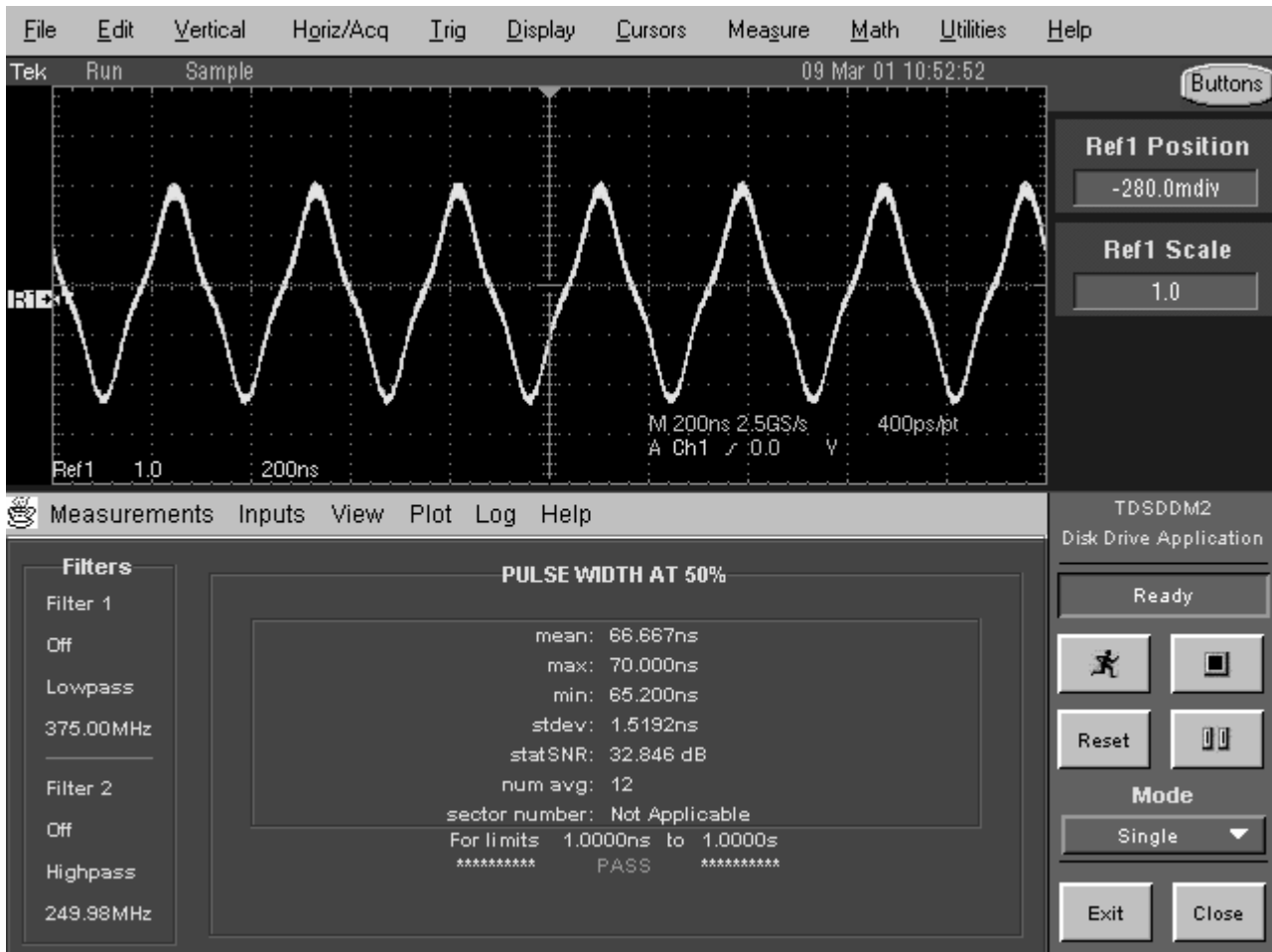



Figure 36: PW50 measurement results example

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 that is appropriate for your SUT. 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, refer to *Setting Up the Application Trigger*.
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. The following figure shows an example of Asperity measurement results based on the asperity.wfm file.

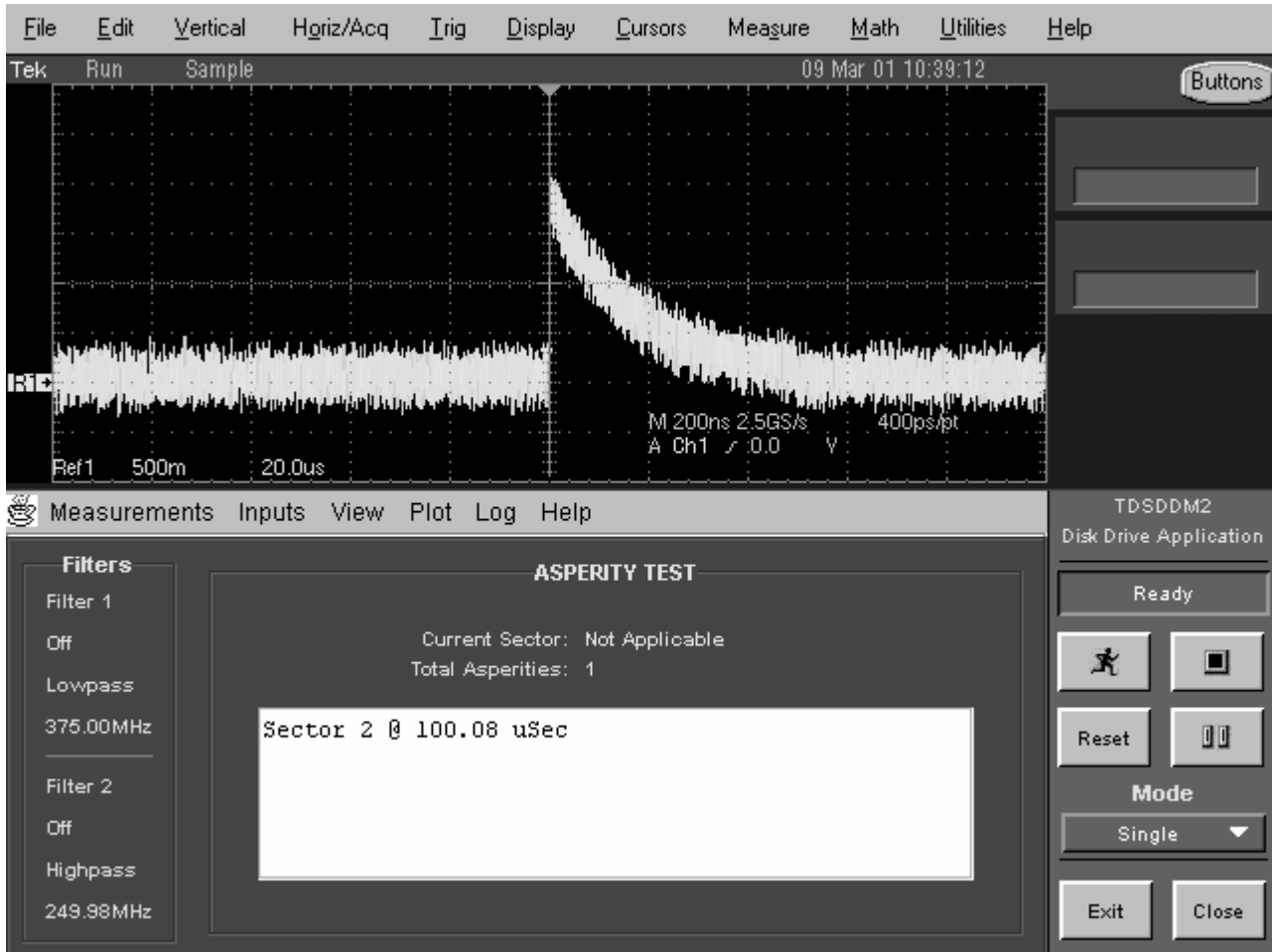


Figure 37: Asperity measurement results example

Note: To attain these results from the asperity.wfm file, in addition to the general procedure, you need to define the Asperity Threshold as 1.5 V.

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. The following figure displays an example of the Overwrite measurement Pass 1 result based on the ovlosig.wfm file:



Figure 38: Overwrite measurement, PASS 1 example

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.

The following figure displays an example of the Overwrite measurement Pass 2 results based on the ovlosig.wfm and ovhisig.wfm files:





Figure 39: 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.

Note: 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.
6. The Sequence Control displays Paused For Action and the results display PASS 1 in the upper right corner.
7. Erase the track again as described in step 1.
8. Use the PC to write a low-frequency data pattern of isolated pulses to the disk.
9. Select  to continue. The results display PASS 2 in the upper right corner.
10. 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 2-39 shows an example of a Baseline Shift measurement results based on the baseline.wfm file. The following figure displays the Baseline Shift measurement results example.

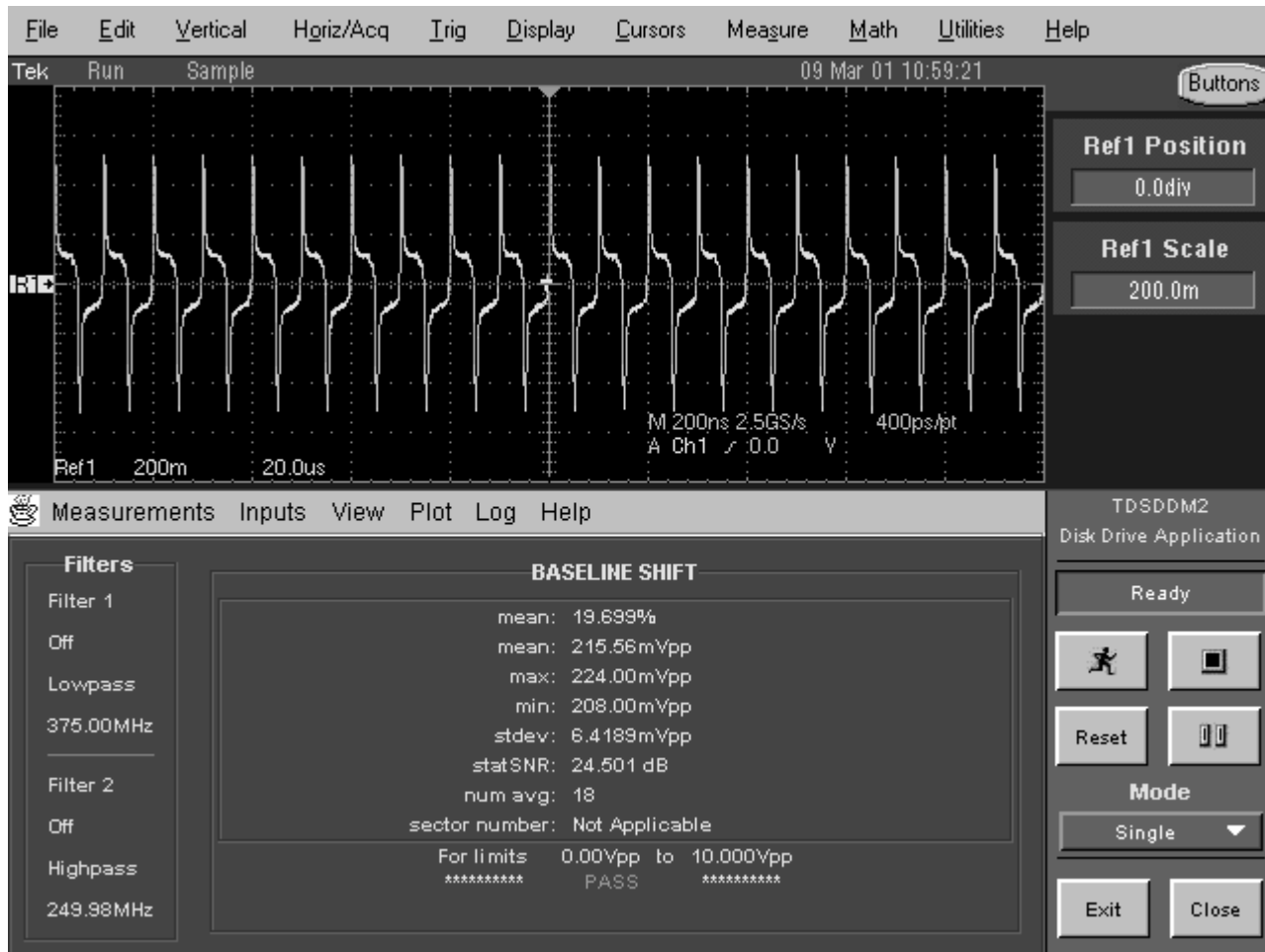


Figure 40: Baseline Shift measurement results example

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 polynomial 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 polynomial 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:

$$\text{Polynomial} = x^9 + x^4 + 1$$

$$\text{Polynomial index} = 2^9 + 2^4 + 1 = 529$$

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, refer to *Setting Up the Application Trigger*.
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. The following figure displays an example of NLTS Initial measurement results based on the x9x4x1.wfm file.



Figure 41: 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, refer to *Setting Up the Application Trigger*.
- 6. Set the Sequence Mode to Single.
- 7. Press  to start the acquisition.
- 8. When the measurement is complete, the statistical results automatically display.

The following figure displays an example of SNR measurement results based on the x9x4x1.wfm file.



Figure 42: 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 Measurement Configurations.
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.

The following figure displays an example of a Track Profile plot from a TAA measurement.

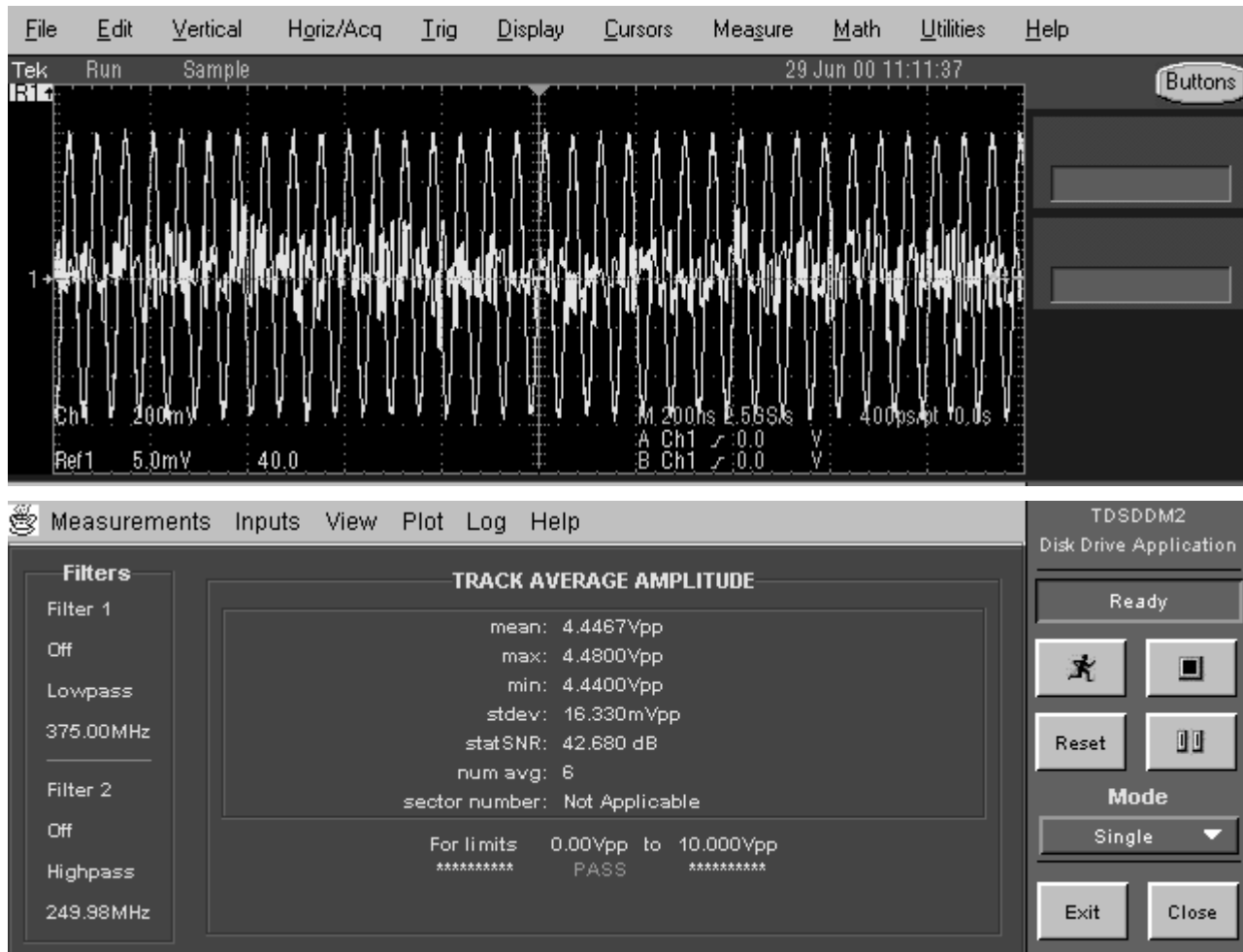


Figure 43: Track Profile plot example

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.

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 is in units relative to the measurement (V, MHz, dBs).

Note: The readout values are available only with current Track Profile plots; they are not available with waveforms that are recalled from reference memory. You also must select the Sector Trigger mode to use cursors with track profiles.

The following figure displays an example Track Profile plot with cursors:



Figure 44: Track Profile plot example with cursors

10. To save the reference waveform containing the plot, follow these steps:
 - f. Go to the File menu in the menu bar of the oscilloscope and access Reference Waveforms > Reference Setup.
 - g. 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 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.

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

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.

GPIB Program Example

```

/* 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

```

GPIB Program Example

```
        */
        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 confirms 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! */
}

```

GPIB Program Example

```
        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;
}
```

Parameters

This section describes the TDSDDM2 application parameters, and includes the menu default settings. You should refer to the user manual for your oscilloscope for operating details of other controls, such as front-panel buttons.

The parameters for the menus and options list the selections or range of values available for each and also includes the default values.

Refer to the *GPIB Programming* section of this Help file for a complete list of the GPIB Command Syntax. This entry includes a complete list of the GPIB commands along 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 choices on the Measurements menu: TAA/PW50, NLTS/Other, Save/Recall, Minimize.

TAA/PW50 Menu

The options in the TAA/PW50 Measurements menu are:

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

The following table lists the TAA/PW50 Limit Test Area Parameters

Table 21: 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 TAA/PW50 Measurements menu are:

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

The following table lists the NLTS/Other Limit Test Area Parameters:

Table 22: 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 Lower Limit	-100% to 100% in units of 0.1% -100% to 100% in units of 0.1%	100% -100%
SNR	Upper Limit Lower Limit	-20.0 dB to 100 dB in units of 0.1 dB -20.0 dB to 100 dB in units of 0.1 dB	100.0 dB -20.0 dB
Baseline Shift	Upper Limit Lower Limit	-5.0 V_{pp} to 10.0 V_{pp} in units of 1 m V_{pp} -5.0 V_{pp} to 10.0 V_{pp} in units of 1 m V_{pp}	10.0 V_{pp} 0.0 V_{pp}
Overwrt	Upper Limit Lower Limit	0 dB to 100 dB in units of 0.01 dB 0 dB to 100 dB in units of 0.01 dB	100.0 dB 0.0 dB
Resltn	Upper Limit Lower Limit	0.1% to 200% in units of 0.1% 0.1% to 200% in units of 0.1%	200% 100m%
*There is no Limit Test area for the Asperity measurement.			

The following table lists the NLTS Parameters Area:

Table 23: NLTS Parameters area

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

The following table lists the SNR Parameters Area:

Table 24: SNR Parameters area

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

The following table lists the Asperity Parameters Area:

Table 25: Asperity Parameters area

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

The following table lists the Save/Recall Menu Parameters:

Table 26: 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	

There are no parameters for the Minimize function.

Input Menus

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

Inputs/Trigger menu

The following table lists the parameters for the Input Channels area and the selections available for each:

Table 27: 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

Trigger Area Parameters

The following table lists the parameters for the trigger Area available for each:

Table 28: Trigger area parameters

Option	Selections	Default setting
Mode	Sector, Read Gate*, User*, Index*	User
Preamble**	0 to 250.0 s in units of 1.0 ns	1.0 μ s
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 and to Setting Up the Application Trigger.		
** Only available when Sector is the trigger mode (See Trigger Options.)		

Inputs/Filters Menu

The following table lists the parameters for the Inputs/Filters Menu for each:

Table 29: 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, 24 dB/oct, 36 dB/oct, 48 dB/oct, 60 dB/oct, 72 dB/oct, 84 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

Inputs General Menu

The following table lists the parameters for the Inputs General Menu for each:

Table 30: 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

The following table lists the parameters for the Plot Track Profile Menu for each:

Table 31: 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 Menus

The following table lists the parameters for the Log Statistics Menu for each:

Table 32: Log Statistics menu parameters

Option	Selection	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 33: Sequence Control menu parameters

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

Appendix A: Measurement Algorithms

TDSDDM2 performs disk drive measurements. This section contains information about the algorithms used by the application to execute 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:

- The signal is any channel, reference, or math waveform.
- The vertical scale for the waveform must be set so that the waveform does not exceed the vertical range of the TDS oscilloscope.
- The time per division must be set small enough to capture sufficient waveform detail and avoid aliasing.
- Use a differential probe on the Read channel signal to reject noise and remove DC bias.

Calculating Statistics

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

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

The application calculates this statistic using the following equation:

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

The application calculates this statistic using the following equation:

$$\text{TDSDDM2 Disk Drive Measurements Application}$$

Min X = Lowest value of *X*

The application calculates this statistic using the following equation:

$$\text{Mean } (X) = \bar{X} = \frac{1}{N} \sum_{n=1}^N X_n$$

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, \bar{X} , then you would, in fact, scale by $1/N$. But, \bar{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:

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

TAA Measurements

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 below.) 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.

The following figure shows how a TAA measurement is defined.

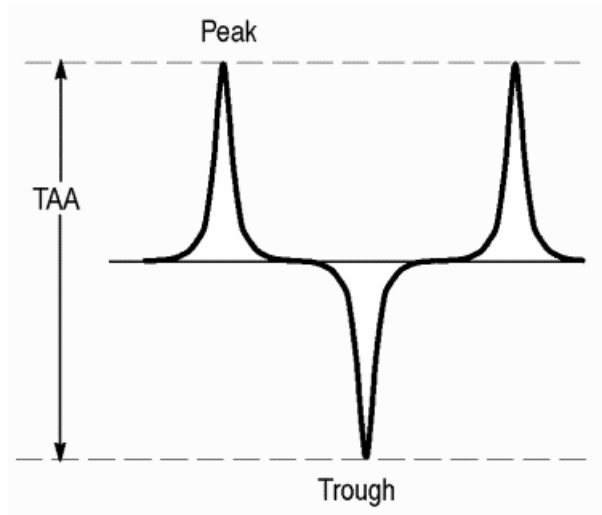


Figure 45: TAA measurement

About 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. The figure below shows the definition of a pulse width at 50%.

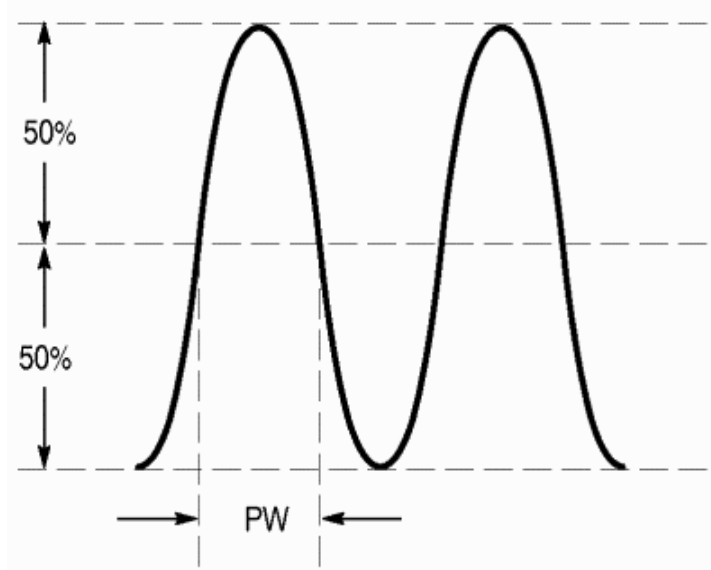


Figure 46: Pulse width at 50%

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 following figure shows the basis for these measurements.

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.

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 measurements except only positive pulses are measured for PW50+ and only negative pulses are measured for PW50-. The following figure shows how PW50+ and PW50- measurements are defined.

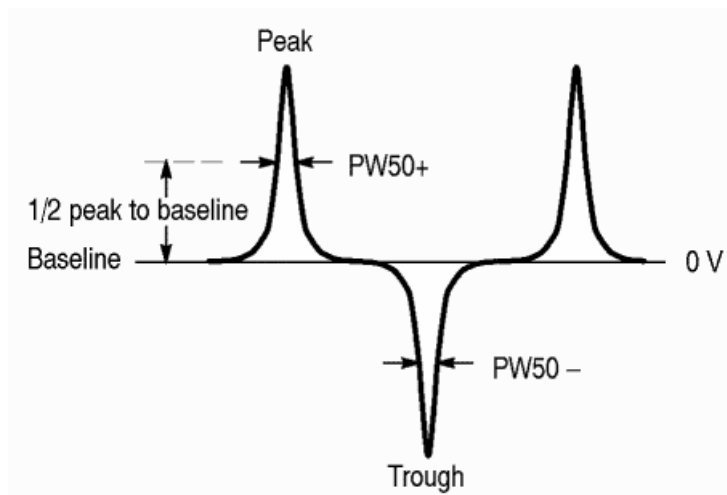


Figure 47: PW50+ and PW50 measurements

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.

NLTS 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:

$$\tilde{V}(t) \approx V\left(t - \frac{1}{2}\epsilon_0\right) - \frac{1}{2}\frac{\epsilon_0}{T}V\left(t - \frac{1}{2}\epsilon_0 + \left(M_0 - \frac{1}{2}\right)T\right)$$

Where: $\tilde{V}(t)$ is the playback voltage for a feedback 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,

Other Measurements

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

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:

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

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 f_1 .
3. Measure the RMS amplitude (V_o) through a narrow band filter tuned to f_1 .
4. Overwrite the track with data at a high frequency f_2 .
5. Measure residual RMS amplitude (V_r) at f_1 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:

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

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. The following figure displays examples of snapshot measurement data for the different measurements.



Figure 48: Snapshot measurement data

Snapshots take the following measurements:

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

Amplitude Asymmetry

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:

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

Where: *TAA+* is the mean of the calculated TAA+ measurement for a given sector.

TAA- is the mean of the calculated TAA- measurement for a given sector

Peak Value is the absolute value of TAA+ or the absolute value of TAA-

Time Asymmetry

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 and Time Trough-to-Peak

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.

The following figure shows the part of the waveform that the application uses to take the measurement:

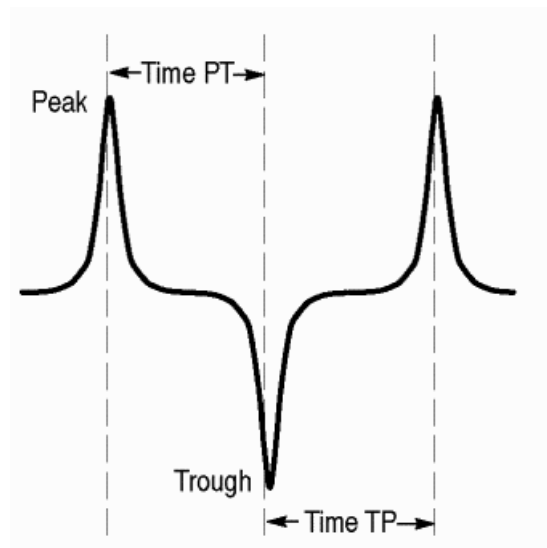


Figure 49: Time PT and Time TP measurements

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.

Using Track Profiles

To create a Track Profile plot, refer to *Creating and Viewing Track Profile Plots*.

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.

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 (located in the `C:\Program Files\TekApplications\tdsddm2` directory) 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

You should be familiar with the following terms when using GPIB command syntax:

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 name>”,“<variable value>”

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

VARIABLE:VALUE? “<variable name>” for query



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

The following table lists the arguments, their function, and the query returns.

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
NLTS/Other Parameters			
patternDuration	String corresponds to a double positive	For NLTS measurements, 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 polynomial value	Returns the polynomial index
bitsPerPattern	String corresponds to a positive integer	For SNR measurements, sets the type of periodic signal	Returns the Read Signal
threshold	String corresponds to a double positive	For Asperity, defines threshold--peaks above this value are an Asperity.	Return value set for threshold.
Input Channels			
readSignal	{Ch1, Ch2, Ch3, Ch4, Ref1, Ref2, Ref3, Ref4, Math1, Math2, Math3, Math4}	Sets the Read Signal input	Returns the Read Signal selection
readGate	{Ch1, Ch2, Ch3, Ch4}	Sets the Read Gate input	Returns the Read Gate selection
indexPulse	{Ch1, Ch2, Ch3, Ch4}	Sets the Index Pulse input	Returns the Index Pulse selection
sectorPulse	{Ch1, Ch2, Ch3, Ch4}	Returns the Sector Pulse input	Returns the Sector Pulse selection
Trigger			
preambleDuration	String corresponds to a positive double*	Sets the time required to initialize a disk drive before the signals become stable	Returns the time required to initialize a disk drive before the signals become stable
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

Appendix C: GPIB Command Syntax

limitTestState	{On, Off}	Sets the state of the limit test	Returns the state of the limit test
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
Filters			
filter1CutoffFreq or filter2CutoffFreq	String corresponds to a positive double*	Sets the cutoff frequency	Returns the cutoff frequency
filter1DestinationName or filter2DestinationName	{Ref1, Ref2, Ref3, Ref4, None}	Sets Filter Destination to a Ref or None	Returns Filter Destination Selection
filter1Slope or filter2Slope	{12 dB/oct, 24 dB/oct, 36 dB/oct, 48 dB/oct, 60 dB/oct, 72 dB/oct, 84 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
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 measurement
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

limitTestState	{On, Off}	Sets the state of the limit test	Returns the state of the limit test
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
Filters			
filter1CutoffFreq or filter2CutoffFreq	String corresponds to a positive double*	Sets the cutoff frequency	Returns the cutoff frequency
filter1DestinationName or filter2DestinationName	{Ref1, Ref2, Ref3, Ref4, None}	Sets Filter Destination to a Ref or None	Returns Filter Destination Selection
filter1Slope or filter2Slope	{12 dB/oct, 24 dB/oct, 36 dB/oct, 48 dB/oct, 60 dB/oct, 72 dB/oct, 84 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
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 measurement
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 statistics 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
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
* You can enter positive double values two ways; for example, 0.000256 or 2.56E-4 (IEEE format).			
** 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 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`.

You need to use the `VARIABLE:VALUE?` form to enter measurement results queries in your GPIB program. The following table lists the measurement results queries for the measurement selected in the `resultFor` variable.

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
Amplitude asymmetry	Only for TAA Snapshot, returns the percent of amplitude asymmetry with zero indicating total symmetry.
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 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
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

The following table lists the results returned for various 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

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