

User Manual



TDSDDM1 Disk Drive Measurement Application 071-0174-02

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Printed in the U.S.A.

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Preface

This manual contains operating information for the TDSDDM1 Disk Drive Measurement Application. The manual consists of the following chapters:

- The chapter *Getting Started* briefly describes the TDSDDM1 Disk Drive Measurement Application and provides installation instructions.
- The chapter *Operating Basics* covers basic operating principles of the application.
- The chapter *Reference* describes how to perform specific tasks.
- The *Appendices* provide a list of specifications.

Related Documentation

The following documents are related to the use of this product:

- The *TDS 500D, TDS 600B, & TDS 700D Digitizing Oscilloscope User Manual* (Tektronix part number 071-0130-XX) provides operating instructions for general oscilloscope features.
- The *International Disk Drive Equipment and Materials Association (IDEMA) 1995 Standards Binder*, section T for Test Methods, is the source document for test criteria used by the TDSDDM1 Disk Drive Measurement Application.

Conventions

This manual uses the following conventions:

- For brevity, this manual generally refers to the TDSDDM1 Disk Drive Measurement Application as the Disk Drive Measurement Application or simply as the application.
- When steps require that you make a sequence of selections using front panel controls and menu buttons, an arrow (→) marks each transition between a front panel button and a menu, or between menus. Also, whether a name is a main menu or side menu item is clearly indicated: Press VERTICAL MENU → Coupling (main) → DC (side) → Bandwidth (main) → 250 MHz (side).

Contacting Tektronix

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



Getting Started

Product Description

The TDSDDM1 Disk Drive Measurement Application is a software package that adds disk drive measurement and analysis capability to a Tektronix oscilloscope. With this application you can quickly and easily set up, acquire, and analyze signals from your disk drives, in accordance with IDEMA (International Disk Drive Equipment and Materials Association) standards.

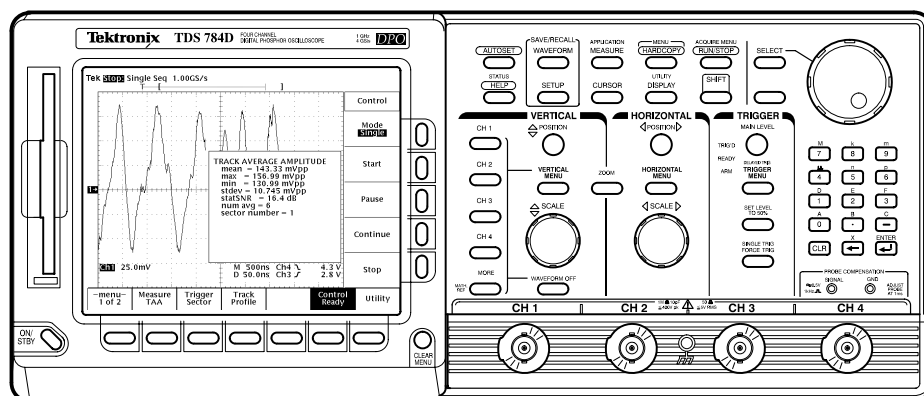


Figure 1-1: TDSDDM1 Disk Drive Measurement Application

Compatibility

The Disk Drive Measurement Application is compatible with the following Tektronix oscilloscopes:

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

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

Requirements and Restrictions

The TDS Run-Time Environment V1.1 software or above must be installed on the oscilloscope to operate the Disk Drive Measurement Application.

The application does not support control by external GPIB commands.

Updates

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

For instructions, see *Updates Through a Web Browser* on page 1–4.

Accessories

There are no standard accessories for this product.

The P6246 and P6247 Differential Probes are recommended for connecting to Read channel signals.

Installation

This application resides on a floppy disk. You can download updates, if any, from the Tektronix ftp site through a web browser.

NOTE. To operate the Disk Drive Measurement Application, the TDS Run-Time Environment V1.1 or above must be installed on your oscilloscope.

Installing the Application

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

1. Create a backup copy of the floppy disks. You can now store the original disks and work from the backup copies.

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

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

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

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

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

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

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

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

Updates Through a Web Browser

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

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

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

1. Access the ftp site at <ftp://ftp.tek.com/mbd/support/00-index.html#1>.
2. Scroll through the files to the TDSJIT1 application, select the file, and download it to your hard disk drive. If necessary, unzip the file.
3. Copy the application from the hard disk to a blank DOS-formatted floppy disk.
4. Follow the *Installing the Application* procedure on page 1–3.

Disk Drive Connection

For best signal fidelity, we recommend you use a differential probe and two standard probes. For connection to the Read channel signal, use a differential probe, such as the Tektronix P6247 probe. For connection to the Index and Sector signals, use standard oscilloscope probes, such as the Tektronix P6139A passive probe or P6243 active probe.

There are two connection configurations, primary and secondary.

Primary Setup Use the primary setup if you want the oscilloscope to control the disk measurements. The primary setup is used for most configurations.

Connect the disk drive to the oscilloscope as shown in Figure 1–2.

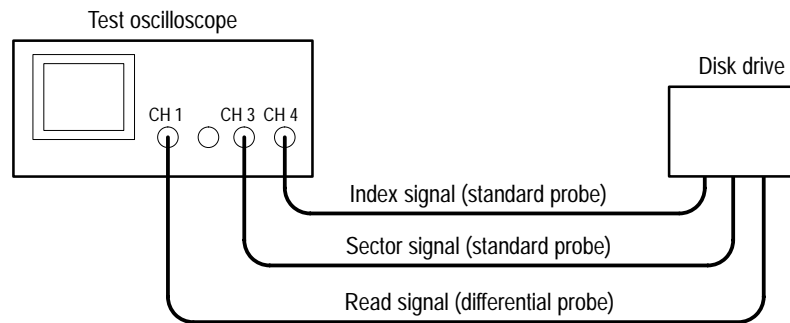


Figure 1–2: Primary setup connections

Table 1–1 shows the default channel-to-signal assignments. You can change the channel assignments to match your configuration. See *Configuring the Input Channels* on page 1–11 for more information.

Table 1–1: Primary setup channel assignments

Channel	Description
Ch 1	Read signal from the 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. Some disk drives 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. The Disk Drive Measurement Application does not support this configuration.

Secondary Setup

When using the secondary setup, you must specifically program the test measurement control sequences.

Connect the disk drive to the oscilloscope as shown in Figure 1-3.

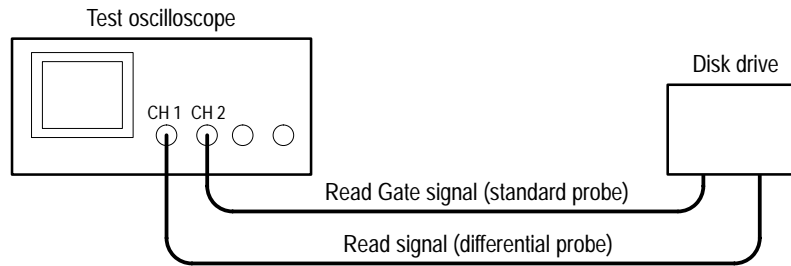


Figure 1-3: Secondary setup connections

Configuration

This section describes configuration tasks that you should perform before you start taking measurements. For the most part, these tasks configure the oscilloscope and Disk Drive Measurement Application to correctly acquire the signals from the disk drive under test. Additional setup parameters, concerned more with configuring specific measurements, are located in the *Setup Parameters* section beginning on page 3–5.

Setting Up the Oscilloscope Trigger

Before starting measurements, you must manually set up the trigger, as described in the following procedure:

1. Connect the Index, Sector, and Read signals to channels 4, 3, and 1 respectively.
2. Set the oscilloscope to the desired sample rate using the horizontal SCALE knob. (The sample rate is usually 500 MS/s, or 1, 2, or 4 GS/s.)
3. Set the time interval:
 - a. Fit the waveform to the screen by pressing HORIZONTAL MENU → Record Length (main) → Fit to Screen (side). Select ON.
 - b. In the same menu, select a record length appropriate to the signal under test.
4. Set up the trigger:
 - a. Set the trigger coupling to DC by pressing Coupling (main) → DC (side).
 - b. Set the slope by pressing Slope (main) and then selecting positive or negative slope (side). (Select the slope appropriate to your disk drive signal.)
 - c. Set the mode to Normal by pressing Mode & Holdoff (main) → Normal (side).
 - d. Set the level by pressing Level (main) and then selecting a level appropriate to your signal.

Setting Up the Application Trigger

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

- Trigger Mode, which selects the input trigger signal
- Start/Stop Sector (used with the Sector Trigger Mode only), which specifies the range of sectors to be measured
- Preamble Duration (used with the Sector Trigger Mode only), which the application uses to automatically remove the preamble from the measurement calculations

Set up the trigger parameters as follows:

1. If you have not already done so, start the application as follows:
 - a. Press SETUP → Select Application (main).
 - b. Using the general purpose knob, select hd0, and then press SELECT. (Depending on previous actions, you might not need to do this step.)
 - c. Using the general purpose knob, select TDSDDM1.APP.
 - d. Press Activate Application (side).
2. Press Trigger (main) → Mode (side). See Figure 1–4. Select one of the following:

Sector	Select Sector if you want to perform a measurement over a range of sectors rather than over the entire track. The oscilloscope uses the main trigger to trigger on the Index pulse. The delayed trigger is used to monitor sectors as follows: Delayed trigger—triggerable after Events/Time Delay Edge Source—Sector signal Delay Count—sequences through sector numbers Delay Time—preamble duration Sector is the default Trigger Mode selection.
Read Gate	Select Read Gate if you want to trigger on the Read Gate signal. The delay trigger is not used with this selection.
User	Select User if you want to use your own custom trigger setup. When you select User, the application does not alter the trigger settings.
Index	Select Index if you want to trigger on the Index signal. The delay trigger is not used with this selection.

3. If you selected the Sector mode, set the Start and Stop Sectors now using the side menu selections.

- Set the Preamble Duration. Using the general-purpose knob, select a value that is greater than the actual signal preamble duration. This ensures that none of the preamble is acquired and that the preamble is not included in the measurement.

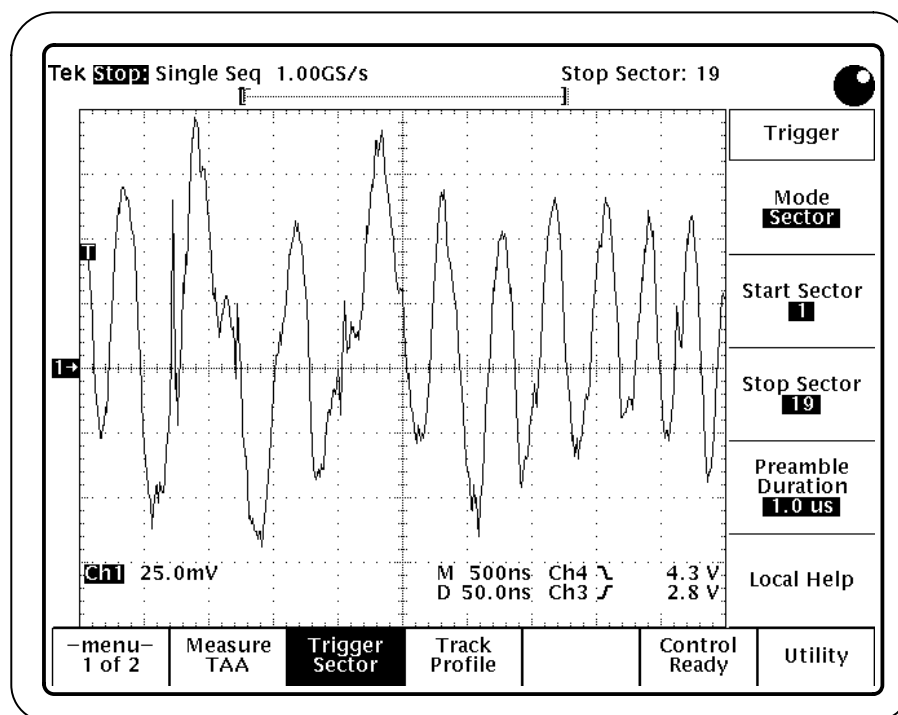


Figure 1-4: Selecting the sectors to measure

Hysteresis

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

Hysteresis is a global setting that is used by measurements such as TAA, PW50, time asymmetry, and time between peaks.

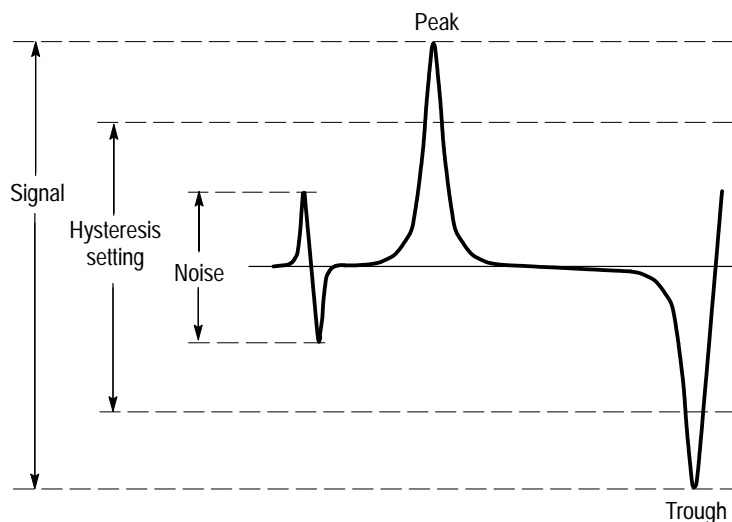


Figure 1-5: Using hysteresis to avoid false identification of peaks

Set the hysteresis levels as follows:

1. Press –menu– (main) to display the second page of menu selections.
2. Press Hysteresis (main) → Hysteresis (side). See Figure 1-6.
3. Specify the hysteresis value.

The units for hysteresis are in divisions. The value you enter is used for the positive hysteresis level and its negative is used for the negative level. For example, if you enter a value of 2 divisions, the hysteresis levels are at +2 divisions and –2 divisions.

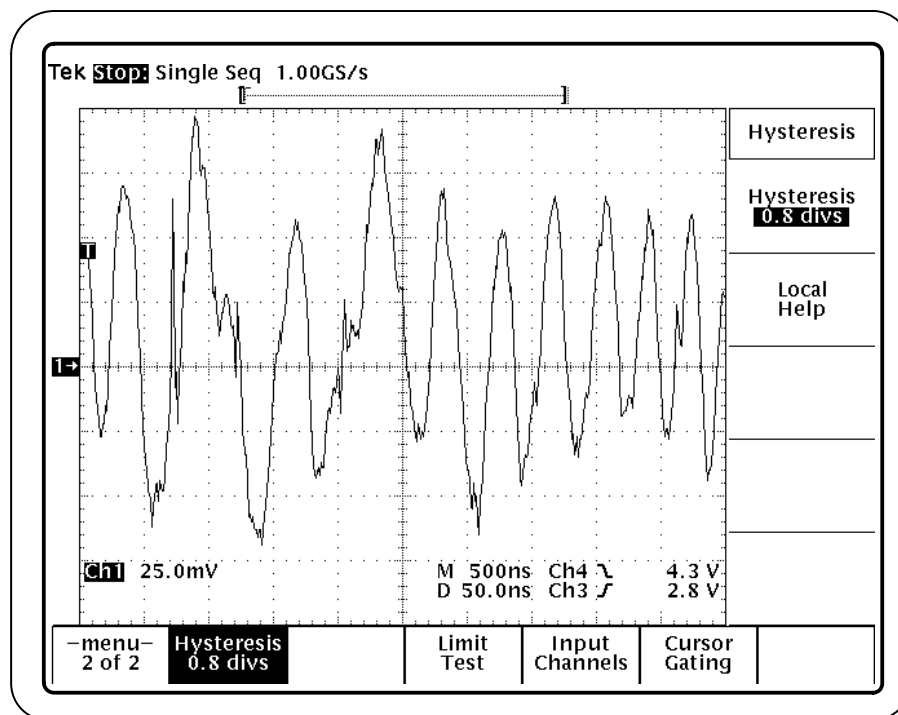


Figure 1-6: Hysteresis menu

Configuring the Input Channels

If you are using the default channel configuration, this topic does not apply to you.

In some cases, your configuration might not match the channel assignments used by this Disk Drive Measurement Application. Table 1-2 lists the default input channel assignments.

Table 1-2: Default input channel assignments

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

¹ This signal is used for triggering only when the Trigger/Mode/Read Gate menu item has been selected.

² This signal is used for triggering only when the Trigger/Mode/Sector menu item has been selected.

If necessary, you can reconfigure the input channels to match your configuration using the Input Channels menu, as follows:

1. From the application display, go to the Input Channels menu by pressing **-menu-** (main) → **Input Channels** (side). See Figure 1-7.
2. Using the side menu buttons, assign the disk drive signals to the appropriate channels.

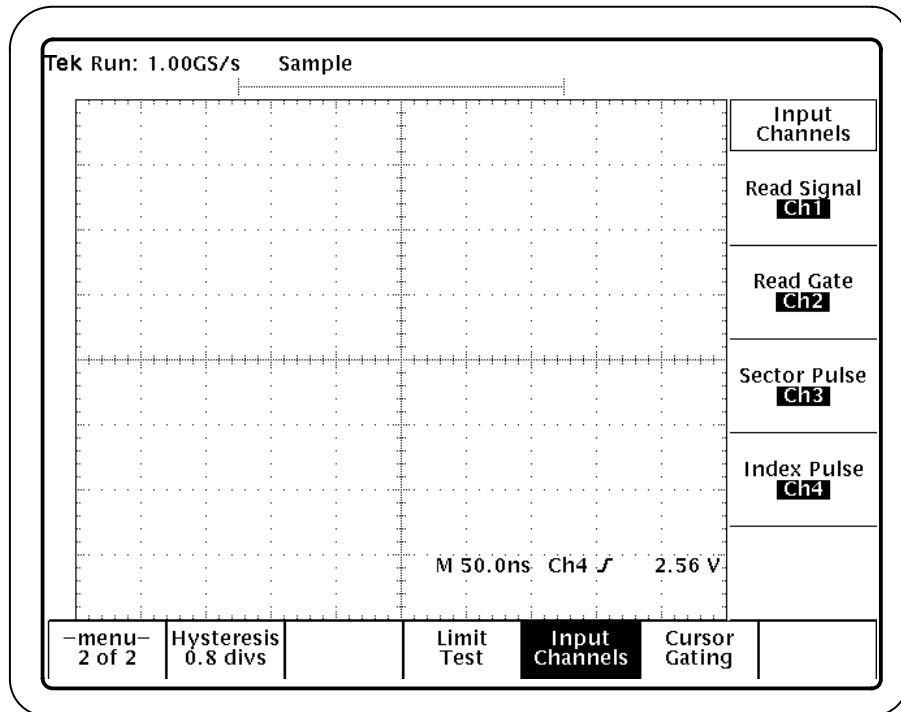


Figure 1-7: The Input Channels menu



Operating Basics

Functional Overview

This section describes how to use the basic functions of the Disk Drive Measurement Application. Further details about the basic functions and descriptions of more advanced features are included in the *Reference* section.

Starting the Application

After the Disk Drive Measurement Application has been installed in the oscilloscope, start the application as follows:

1. Press SETUP → Select Application (main). See Figure 2–1.
2. Using the general purpose knob, select hd0, and then press SELECT. (Depending on previous actions, you might not need to do this step.)
3. Using the general purpose knob, select TDSDDM1.APP.
4. Press Activate Application (side).

The application starts up and displays as shown in Figure 2–2.

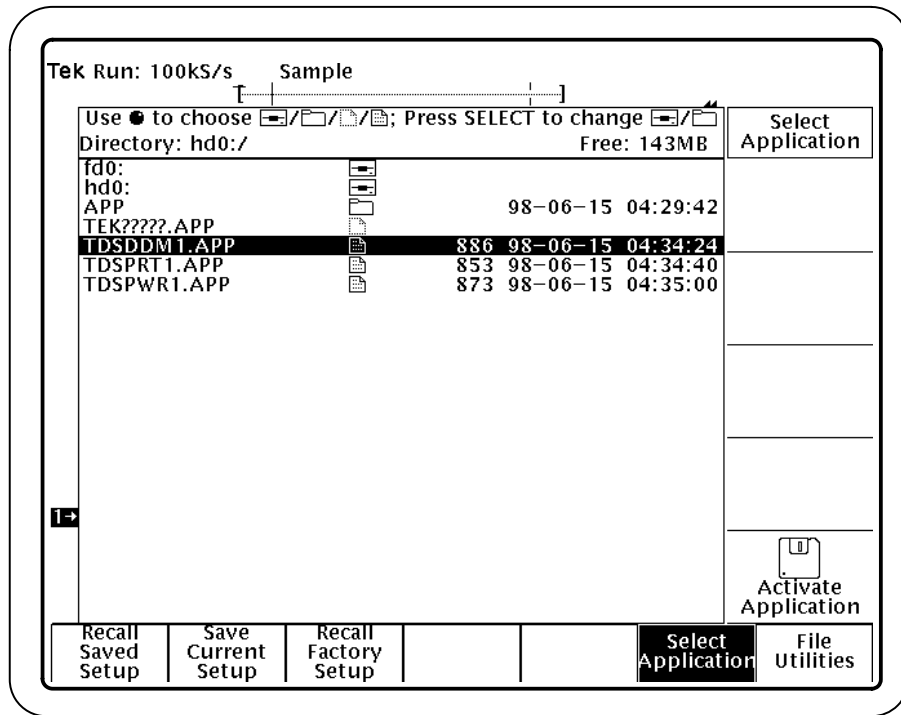


Figure 2-1: Starting the application

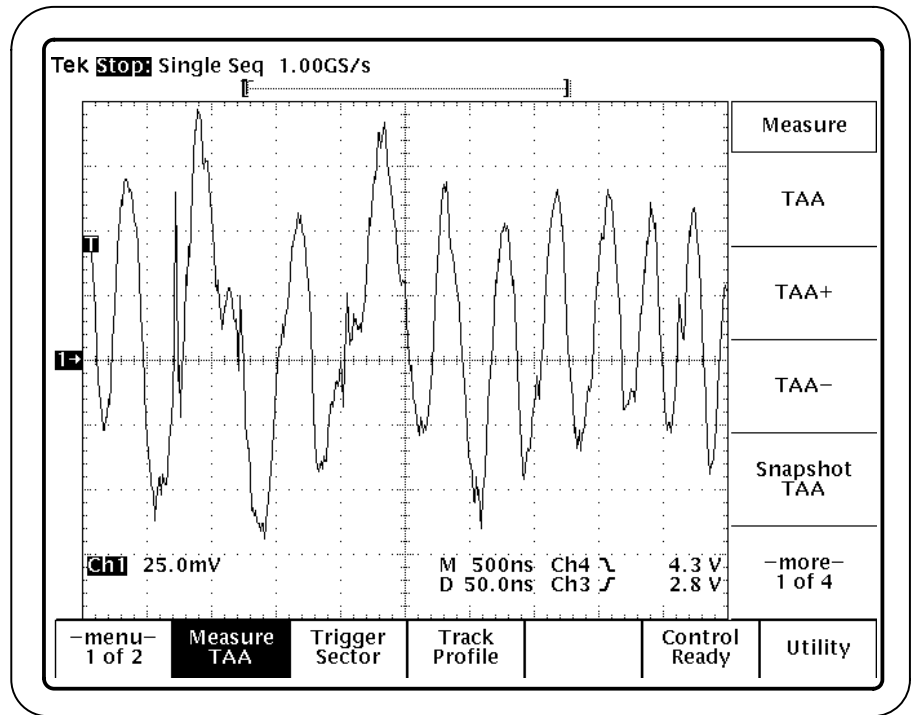


Figure 2-2: Disk Drive Measurement Application initial display

Leaving the Application

You can switch between the Disk Drive Measurement Application and other oscilloscope functions. To access primary oscilloscope functions, press the desired front panel control. To return to the application, push the SHIFT and APPLICATION front-panel menu buttons as shown in Figure 2-3.

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

Push the SHIFT and APPLICATION buttons to return to the application.

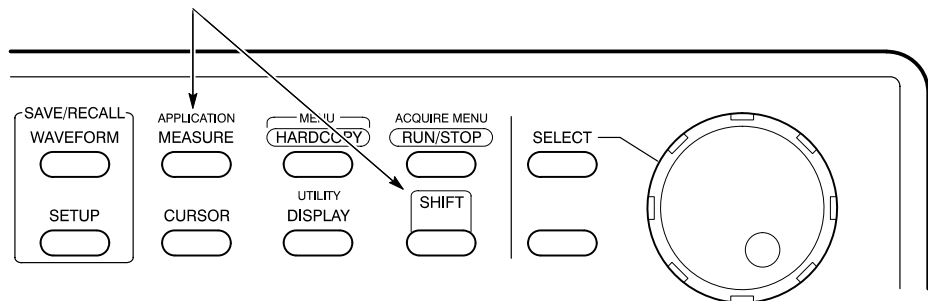


Figure 2-3: Returning to the application

Starting the Measurement

Start the measurement as follows:

1. Select the type of measurement to execute, as follows:
 - a. Display the Measure menu by pressing Measure (main). See Figure 2–4. If the measurement you want is not shown, press –more– (side).
 - b. Select a measurement.
 - c. Make any further selections required by the measurement. (See *Measurement Descriptions* on page 3–11 for information about individual measurements.)

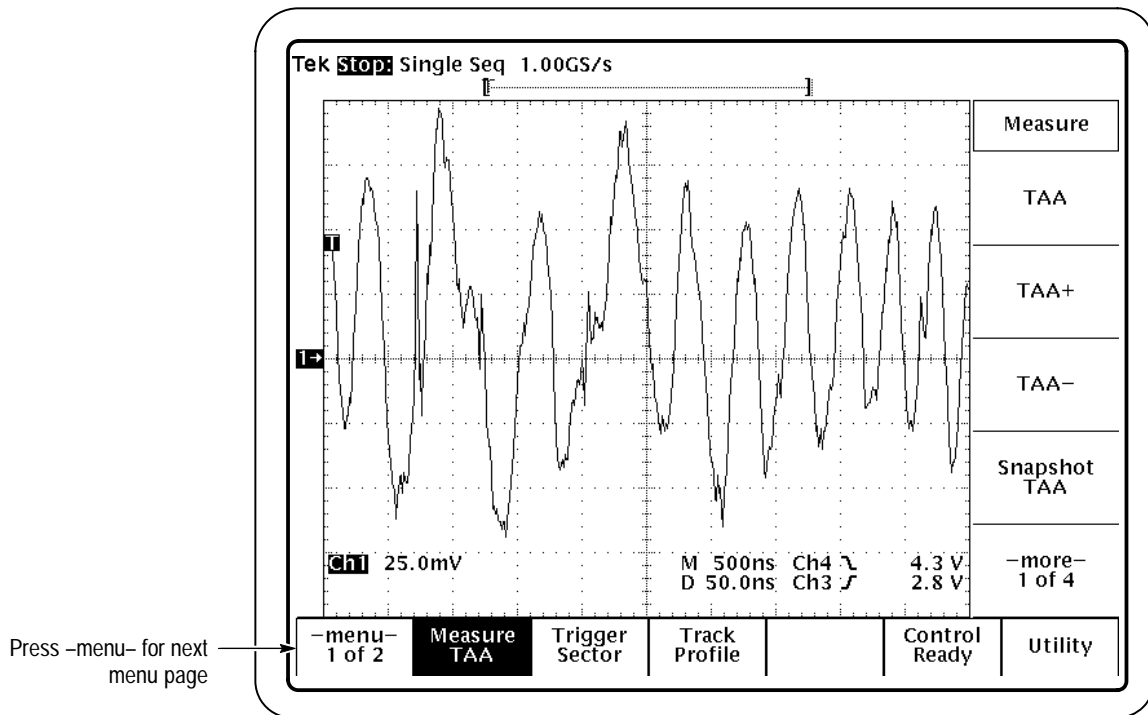


Figure 2–4: Selecting a measurement from the Measure menu

2. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–8, *Measuring Over a Range of Sectors* on page 3–6, and *Cursor Gating* on page 3–7.
3. Press Control (main).
4. Press Mode (side) to select Single or Free Run acquisition mode.

The Single option performs the measurement and then stops. The Free Run option performs the measurement continually.

In the event that the measurement requires an external operation to occur before it may continue, the readout changes to Pause. After fulfilling the requirements specified in the message box, you must press Continue (side) to finish the measurement.

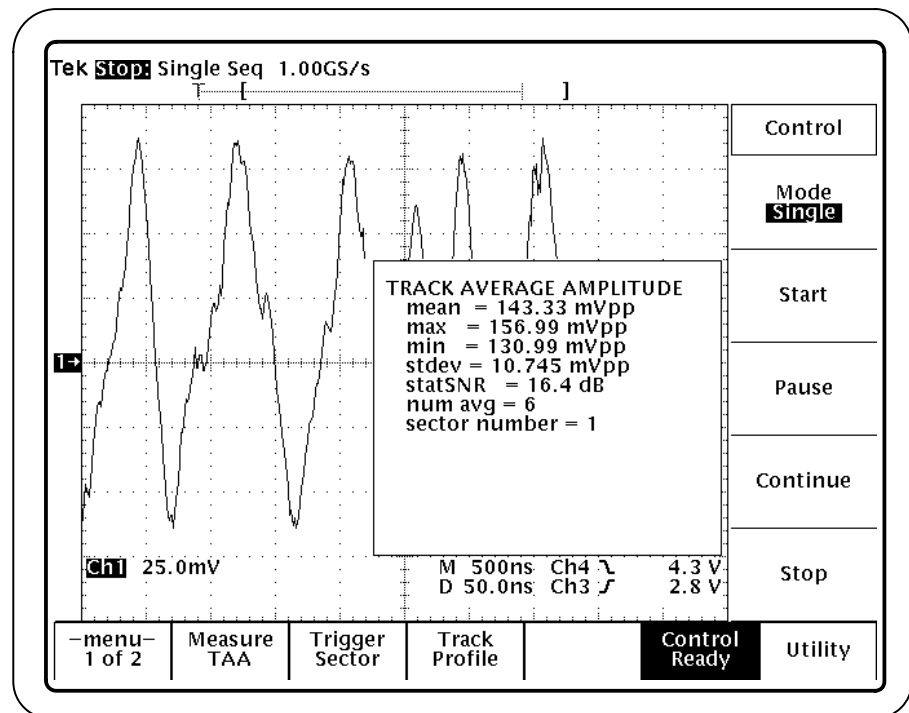


Figure 2–5: The Control menu

5. Press Start (side).
6. Wait for the measurement to complete (Single), or push the Stop side menu button to manually stop the measurement.

In single mode, when the measurement has successfully completed, the screen displays the updated measurement data. All measurement processing halts, but the waveform acquisitions continue to update on the screen.

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

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

Viewing the Waveform

To view parts of the waveform that are obscured by the measurement display readout, push the CLEAR MENU button, located near the lower right of the display.

To return to the application display, push the SHIFT and APPLICATION front-panel menu buttons.

Using the Local Help

The application includes help information, available from within the application menus. The help included with the application is independent of the main oscilloscope help, and it operates somewhat differently. The application help does not identify and explain individual controls; instead, it provides information about the measurements themselves.

Display the local help as follows:

1. Display the help by pressing Utility (main) → Help (side).
2. Use the side menu buttons to navigate within the help.

Tutorial

This tutorial shows you how to use some basic features of the Disk Drive Measurement Application. In addition, it teaches you how to exit the application and how to save and recall setups. Further operating information is located in the *Reference* chapter.

Preparation

To perform the tutorial examples, you must have already installed the Disk Drive Measurement Application in the oscilloscope, connected the probes to a disk drive, and performed the configuration tasks appropriate to your disk drive under test. For information, see *Installation* on page 1–3 and *Configuration* on page 1–7.

If you have not already done so, start the application as follows:

1. Press **SETUP** → **Select Application**. See Figure 2–1.
2. Using the general purpose knob, select **hd0**, and then press **SELECT**.
3. Using the general purpose knob, select **TDSDDM1.APP**.
4. Press **Activate Application** (side).

The application starts up and displays its initial screen.

Example 1: Measuring the Track Average Amplitude

In this example, you will measure the track average amplitude (TAA) over a range of sectors and display the results.

1. Select the TAA measurement by pressing **Measure (main)** → **TAA (side)**.
2. Specify a range of sectors to measure as follows:
 - a. Press **Trigger (main)** → **Mode (side)**. Select **Sector**.
 - b. Press **Start Sector (side)**, and set the value to 1.
 - c. Press **Stop Sector (side)**, and set the value to 10.
3. Set the Preamble Duration. Using the general-purpose knob, select a value that is greater than the actual signal preamble duration. This ensures that none of the preamble is acquired and that the preamble is not included in the measurement.

4. Start the measurement by pressing Control (main) → Start (side).
5. Wait for the measurement to complete, then view the results as shown in Figure 2–6.

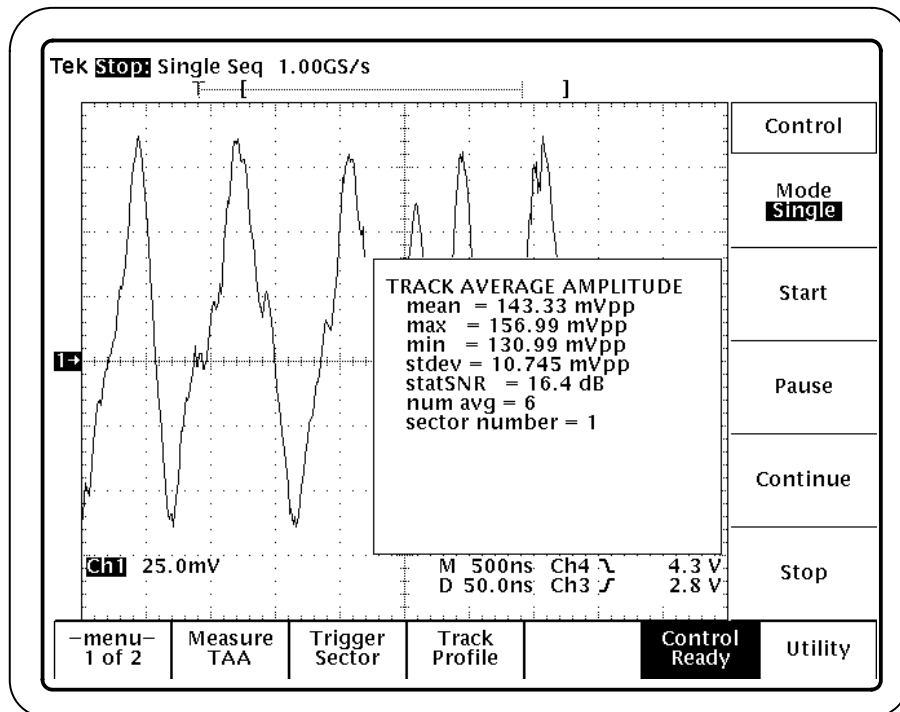


Figure 2–6: Track average amplitude (TAA) measurement

Example 2: Measuring the Pulse Width at 50%

In this example, you will measure the pulse width at 50% (PW50) and use limit testing to include a pass/fail measurement result. Instead of measuring around the entire track, you will use cursor gating to localize the measurement. In addition, you will use the hysteresis feature, to avoid identifying noise as actual signals.

1. Select the PW50 measurement by pressing Measure (main) → PW50 (side).
2. Select cursor gating by pressing –menu– (main) → Cursor Gating (main) → On/Off (side). Select ON.
3. Place the cursors over the desired segment of the waveform.

4. Enable hysteresis by pressing Hysteresis (main) → Hysteresis (side). Using the general purpose knob, set a hysteresis value that is appropriate for your disk drive signal, such as 1.5 divs.

The hysteresis value, in divisions, is reflected above and below the waveform baseline. For example, if you choose a value of 2.0 divs, the hysteresis level ranges from -2.0 divs to +2.0 divs.

5. Enable limit testing by pressing Limit Test (main) → On/Off (side). Select ON.
6. Press Upper Limit (side), and use the general purpose knob to select an upper limit for this test, such as 100 μ s.
7. Press Lower Limit (side), and use the general purpose knob to select a lower limit for this test, such as 1 ns.
8. Press -menu- (main) → Control (main) → Start (side) to start the test.
9. Wait for the measurement to complete, then view the results as shown in Figure 2-7.

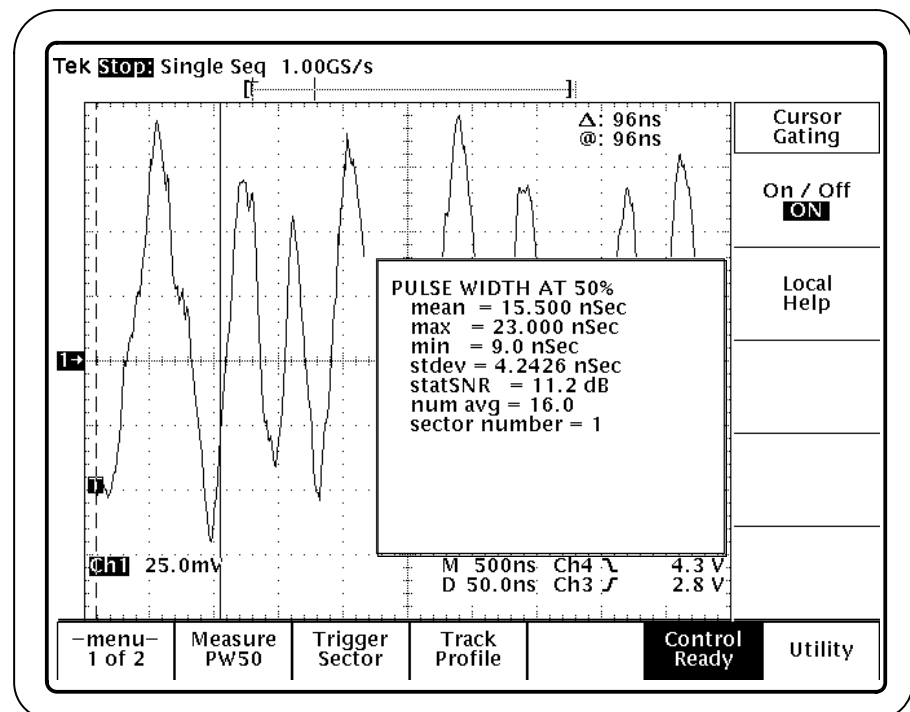


Figure 2-7: Pulse width at 50% (PW50) measurement with cursor gating

Example 3: Creating and Viewing Track Profiles

Track profiles 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.

In this example, you will take a TAA measurement and view the track profile.

1. Turn the cursor gating feature off by pressing –menu– (main) → Cursor Gating (main) → On/Off (side). Select OFF. (This feature was set in Example 2.)
2. Select the track profile feature by pressing Track Profile (main) → On/Off (side). Select ON.
3. Press Track Profile To (side). Select Ref1.
4. If you did not already specify a range of sectors (in Example 1), do so now. See step 2 on page 2–7 for information.
5. Select the TAA measurement by pressing Measure (main) → TAA (side).
6. Press Control (main) → Start (side) to start the measurement. The measurement data is displayed. (The data is also stored in the reference memory Ref1.)
7. Start the measurement by pressing Control (main) → Start (side). Wait for the results to display.
8. Display the track profile waveform by pressing MORE → Ref1 (main). See Figure 2–8.

Now you can view the results of each execution of the measurement algorithm by moving the cursor along the track profile waveform:

9. Return to the Track Profile menu by pressing Track Profile (main).
10. Press CURSOR → Function V Bars (main) → V Bars (side) to display the vertical bar cursors.
11. Move the cursor to a point of interest on the track profile waveform.
12. Press Value At Cursor (side) or Sector At Cursor (side) to view the measurement results at the current cursor position.

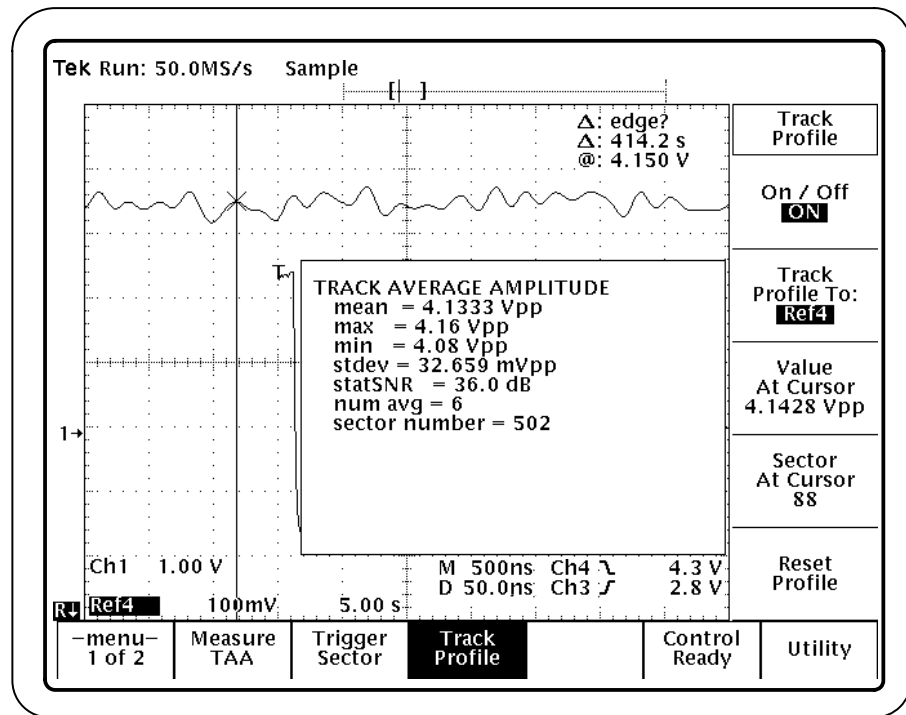


Figure 2-8: Track profile measurement

Example 4: Saving a Setup and Exiting the Application

You might need to save the oscilloscope setup and the application setup.

To save the oscilloscope setup, refer to the user manual for your oscilloscope. The procedure varies between models. The setup is always saved in the APPS/TDSJIT1/TEMP directory on the oscilloscope.

To save the application setup, follow these steps:

1. Press the SHIFT and then the APPLICATION button to return to the application.
2. Press Utility (main) → Save Setup (side).
3. Press Save to Selected File (side).
4. To exit the application, press Utility (main) → Exit (side). To confirm, press OK (side).

Example 5: Recalling a Setup

To return to the tutorial setup, you can recall the saved oscilloscope setup from the hard disk. You will also need to restart the application.

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

To recall the application setup, follow these steps:

1. Start the application as described on page 2–7.
2. Press Utility (main) → Recall Setup (side).



Reference

Menu Structure

This section discusses the menus used in the TDSDDM1 Disk Drive Measurement Application. Included are brief descriptions of the menus and a menu structure map which shows the relationship between menus.

Menu Summary

There are two pages of menu selections in the Disk Drive Measurement Application. (Press -menu- (main) to access the second page of menus.)

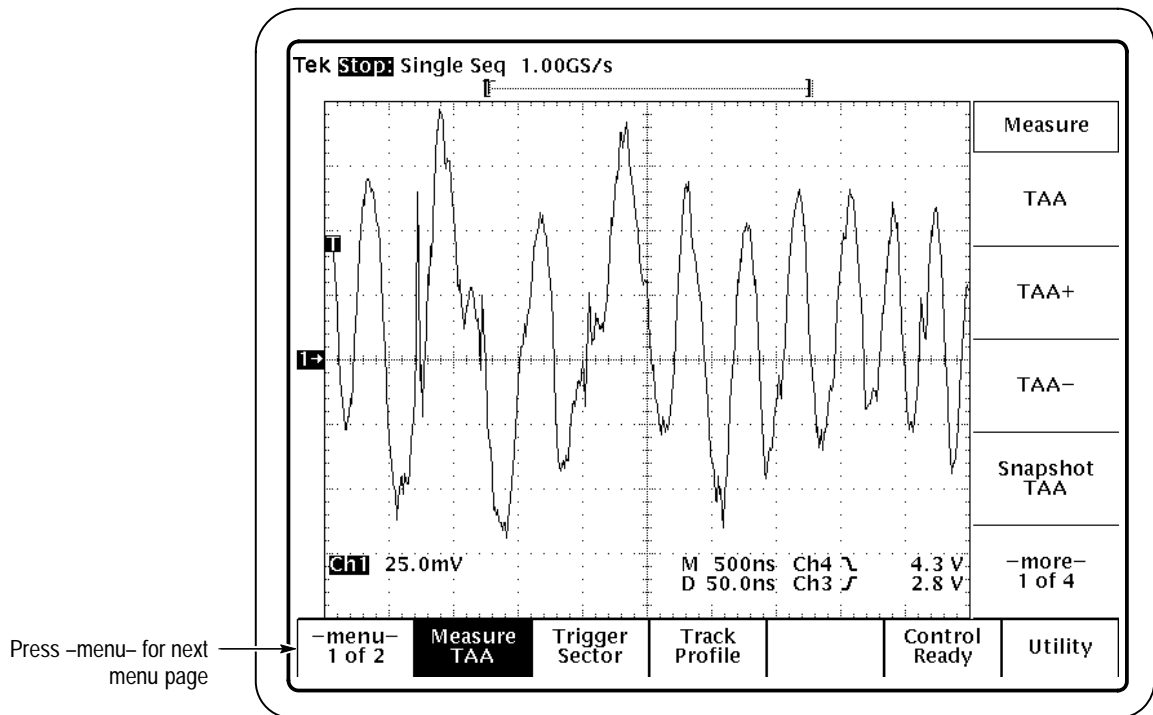


Figure 3-1: Selecting menus

The following topics briefly summarize the menus.

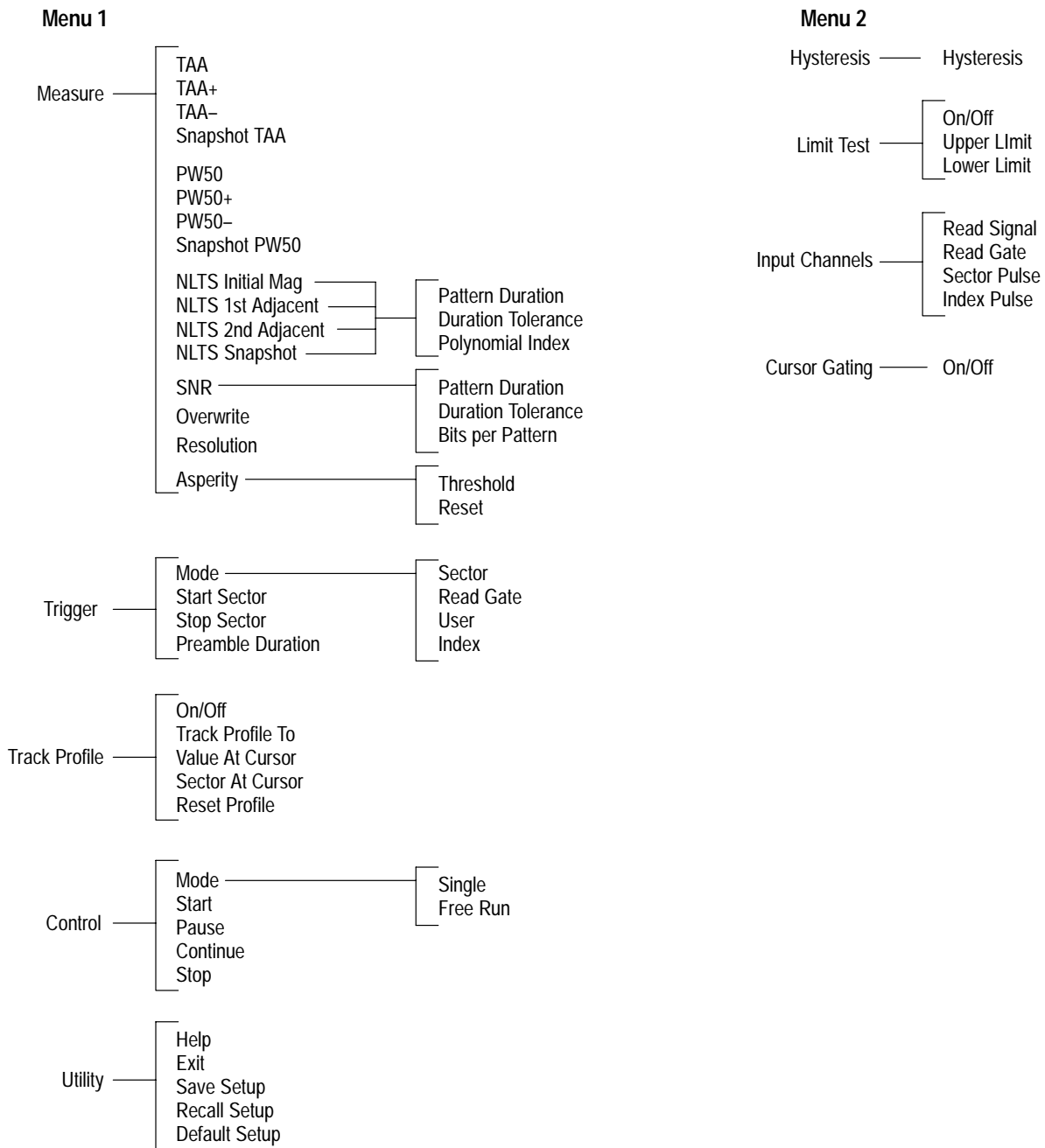
Measure Menu

Use the Measure menu to select a disk drive measurement. Measurement descriptions start on page 3-11.

Trigger Menu	Use the Trigger menu to select the input trigger signal. This menu is important in specifying setup parameters for the disk drive signals. Using one of the Trigger menu selections, Sector, you can limit the measurement to a range of sectors. See <i>Specifying the Trigger</i> on page 1–8 and <i>Measuring Over a Range of Sectors</i> on page 3–6 for more information.
Track Profile Menu	Use the Track Profile menu if you want to save the measurement data in a track profile. You can use the track profile to graphically characterize the measurement data. See <i>Track Profiles</i> on page 3–45 for more information.
Control Menu	Use the Control menu to start and stop measurements. Additional acquisition control selections are also available, such as pause and acquisition mode control. See <i>Starting the Measurement</i> on page 2–4 for more information.
Utility Menu	Use the Utility menu to save and recall instrument setups. See <i>Saving and Recalling Setups</i> on page 3–5 for more information.
Hysteresis Menu	Use the Hysteresis menu to reduce the effects of noise on measurements. Set thresholds such that only real peaks and troughs are measured, rather than measuring noise. See <i>Hysteresis</i> on page 1–9 for more information.
Limit Test Menu	Use the Limit Test menu if you want to add a pass/fail result to the measurement. See <i>Adding Pass/Fail Results to Measurement Data</i> on page 3–9 for more information.
Input Channels Menu	Use the Input Channels menu if your channel assignment configuration does not match the default configuration, as described in <i>Configuring Input Channels</i> on page 1–11.
Cursor Gating Menu	Use the Cursor Gating menu if you want to localize measurements to a specific area of the waveform. See <i>Cursor Gating</i> on page 3–7 for more information.

Menu Structure

The following figure shows the relationship of the application menus.



Setup Parameters

This section describes procedures that change how measurements are taken. For example, you can localize the area of measurement by specifying a range of sectors or a segment of the waveform. Additional configuration parameters, concerned more with hardware and signal setup, are located in the *Configuration* section beginning on page 1–7.

Saving and Recalling Setups

To speed up the configuration process, you can save and recall application menu settings. The save/recall function is controlled from the application Utility menu. As shown in Figure 3–2, you have the following selections:

- To store the current application settings, press Utility (main) → Save Setup (side). The settings are stored in the file `tdsddm1.ini` on the hard disk. Once you have saved a setup, that setup will be recalled upon starting the Disk Drive Measurement Application. The `tdsddm1.ini` file is not updated automatically; you must use Save Setup to update the file.

NOTE. *If you want to save your current configuration, be sure to use the Save Setup feature to store the current application settings. The settings are not saved automatically.*

You can also manually return to the settings in the file `tdsddm1.ini` at any time. To recall the setup, press Utility (main) → Recall Setup (side).

- To recall the factory default menu settings, press Utility (main) → Default Setup (side).

The Disk Drive Measurement Application Save/Recall function is totally independent of the primary oscilloscope Save/Recall function, which is stored in nonvolatile RAM.

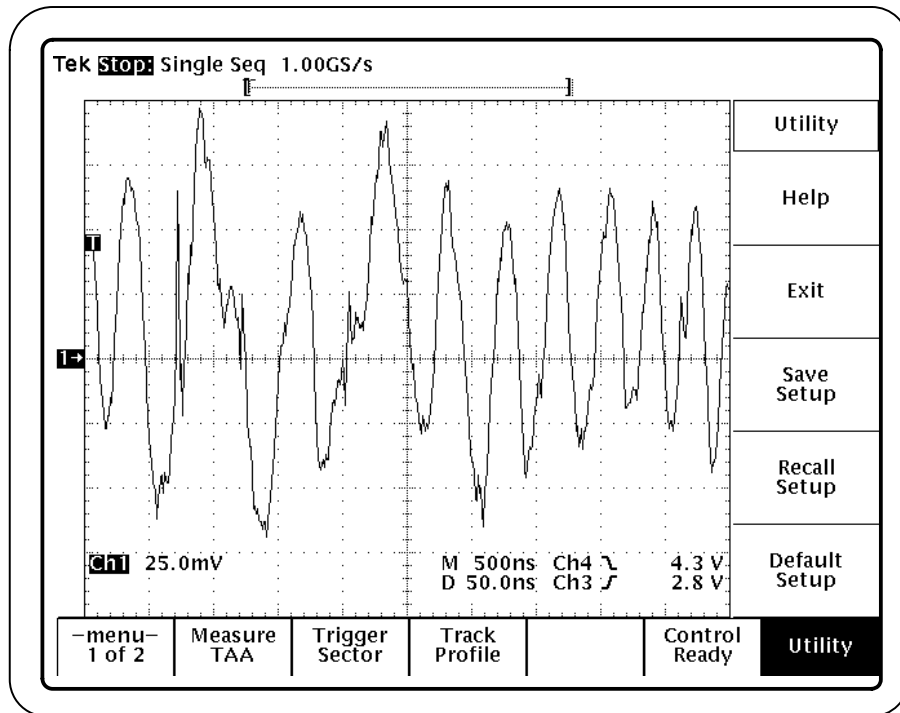


Figure 3-2: Save Setup and Recall Setup selections in the Utility menu

Measuring Over a Range of Sectors

To reduce measurement time, or to focus on a specific area of the disk, you can specify that the measurement take place over a limited range of sectors.

Before starting the measurement, specify the range of sectors to be measured as follows:

1. Press Trigger (main) → Mode (side). Select Sector. See Figure 3-3.
2. Specify the sector range:
 - a. Press Start Sector (side).
 - b. Use the general purpose knob to specify the sector.
 - c. Repeat for the Stop Sector.
3. If you have not already done so, set the Preamble Duration as described in step 4 of *Setting Up the Application Trigger*, on page 1-8.

See also *Cursor Gating* on page 3-7 for another method of localizing measurements.

NOTE. The Sector Number field displays a ? if the Trigger Mode setting is not Sector.

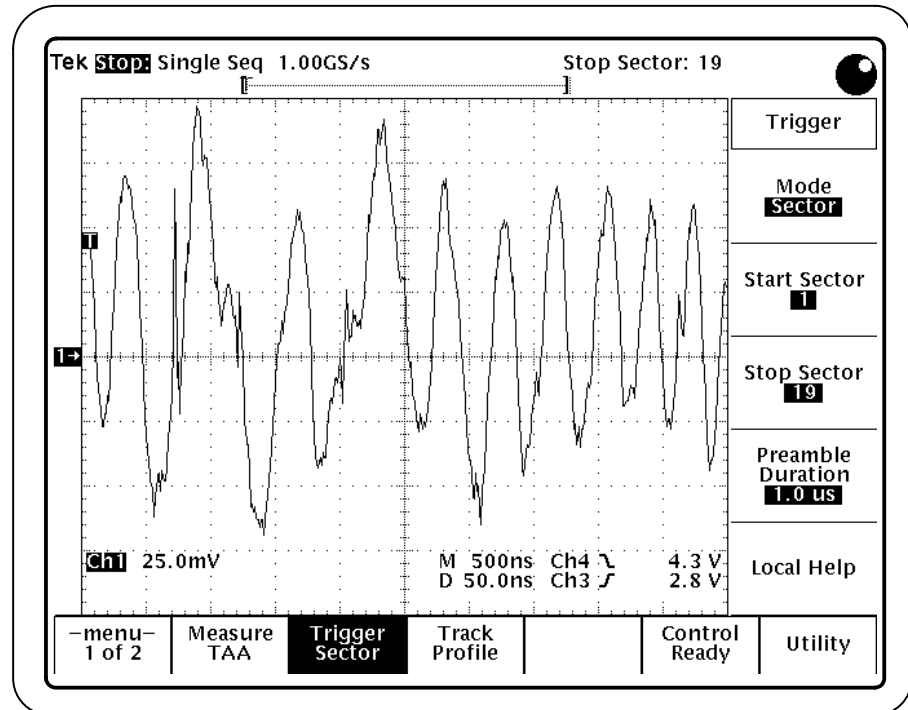


Figure 3-3: Selecting the sectors to measure

Cursor Gating

To localize a measurement to a specific area of interest, you can use cursor gating. With cursor gating, you use the oscilloscope cursors to indicate the area of interest on the waveform record. See Figure 3-4.

Localizing measurement can speed up processing and eliminate unwanted data from your analysis.

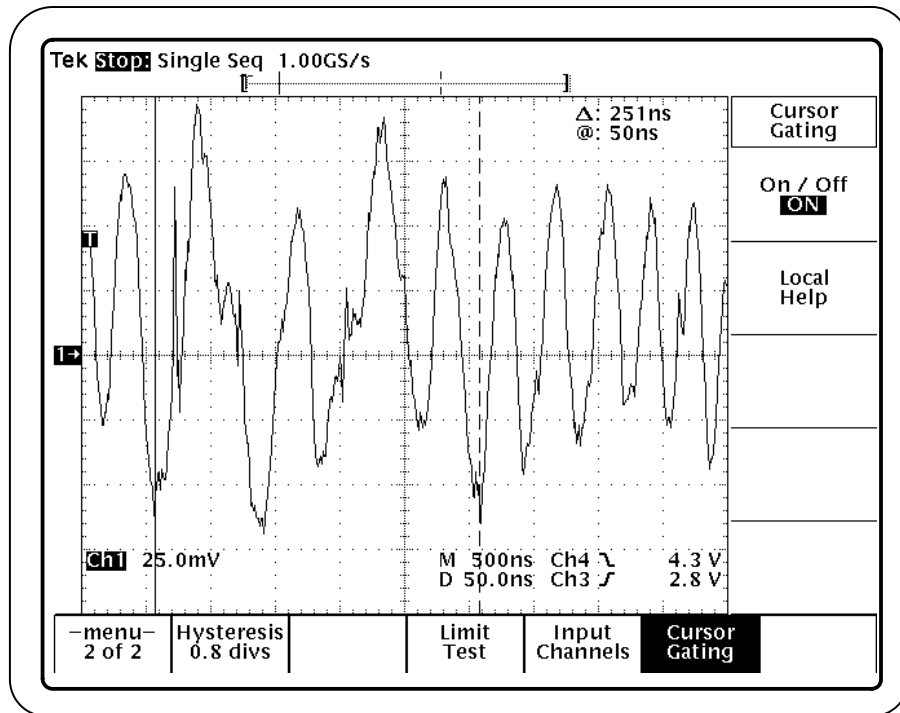


Figure 3-4: Localizing a measurement using cursor gating

Before starting the measurement, specify the portion of the waveform to be measured as follows:

1. Press Cursor Gating (main) → On/Off (side). Select ON. See Figure 3-4. When cursor gating is On, the cursors are turned on and the read channel is selected.
2. Place the cursors at the beginning and end of the waveform segment of interest.

When you perform the measurement, only the data between the cursors will be measured.

When cursor gating is Off, the application measures the full record length.

NOTE. The cursor gating function in this menu applies to the measurements in the Disk Drive Measurement Application only. It does not apply to measurements in the main Measure menu of the oscilloscope.

Localizing Measurements: an Alternate Method

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

Adding Pass/Fail Results to Measurement Data

You can add a pass/fail test result to the measurement data, based on whether the data falls within specified limits. See Figure 3–5 for an example.

```

TRACK AVERAGE AMPLITUDE
mean = 102.4mVpp
min = 92.16
max = 112.64
stdev = 14.481
SNR = 10.9dB
num avg = 2
sector number = ???

For limits: 80.0 to 140.0 mVpp
***** PASS *****

```

Figure 3–5: Limit Test results

Use the Limit Test menu to set upper and lower limits to be used by the measurements. See Figure 3–6.

To include Limit Test results, do the following:

1. Select a measurement from the Measure menu (main).
2. Press –menu– (main) → Limit Test (main) → On/Off (side). Select ON. See Figure 3–6.
3. Set the upper and lower limits for the measurement.
4. Repeat steps 1 and 3 for each measurement.

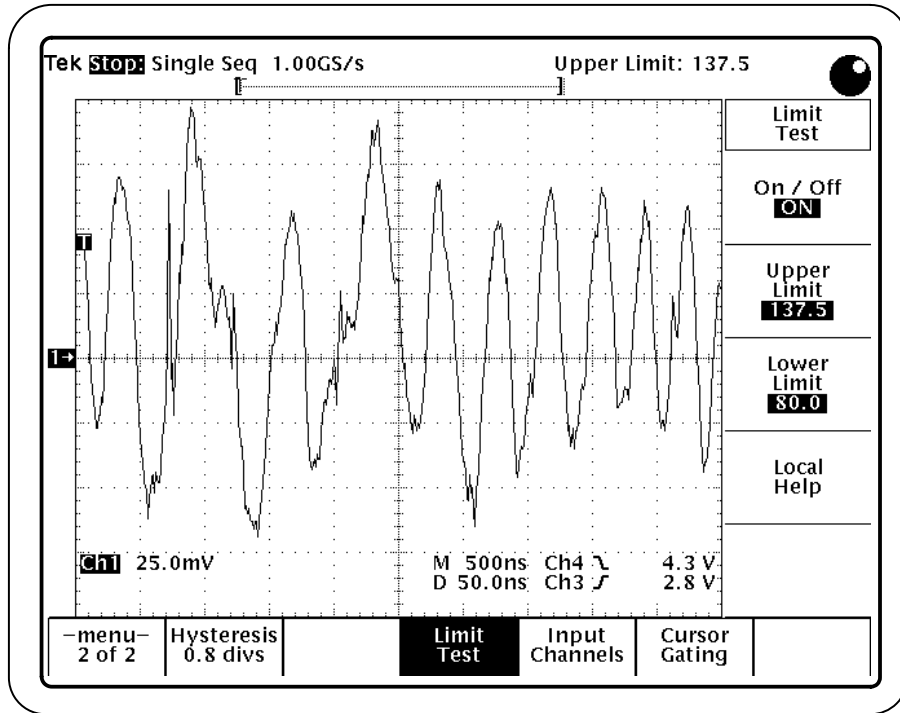


Figure 3-6: Setting pass/fail limits

Measurement Descriptions

The following pages describe the measurements you can make with the Disk Drive Measurement Application package. The descriptions include information about how to take the measurement and information about the algorithm used to perform the measurement operation.

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

Measurement Features

There are two main groups of measurement types: standard measurements and snapshot measurements. In addition, you can use track profiles to provide a history of the track measurements. See Figure 3–7. Standard measurements provide data associated with a specific measurement. Snapshots list measurement data for that measurement group. Track profiles collect all the data for each individual track and display the data graphically.

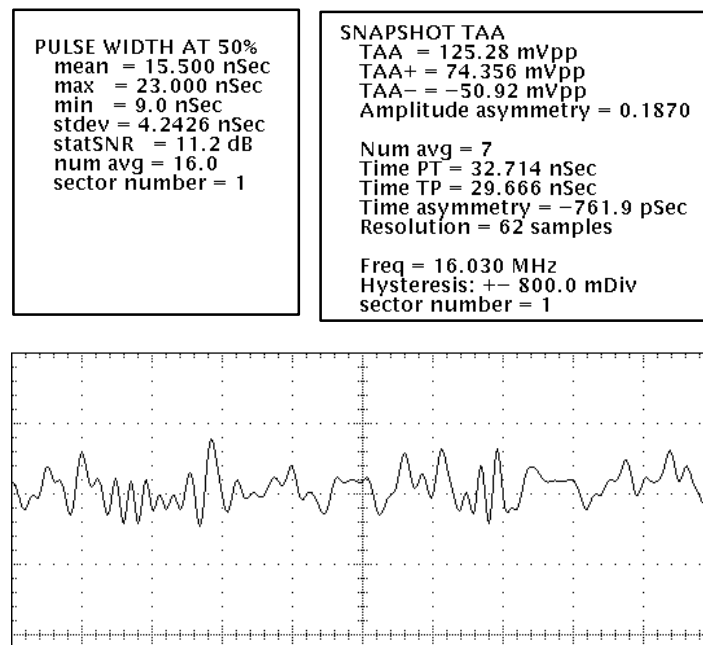


Figure 3–7: Standard measurement, snapshot measurement, and track profile

Measurements do not continuously update unless you select Free Run mode in the Control menu before starting the measurement. To take another measurement, press Start (side) again.

Warning Messages

Standard measurements (not snapshots) provide a warning if the input conditions do not support accurate measurements. The application warns you if the number of samples in the measurement is less than 25. Similarly, the application warns you of low vertical resolution if the number of digitizing levels is below 50.

Track Average Amplitude, TAA

The track average amplitude, TAA, is the average peak-to-peak value of the data on the Read channel signal over the specified range of sectors. IDEMA specifies the duration to be over one complete track revolution.

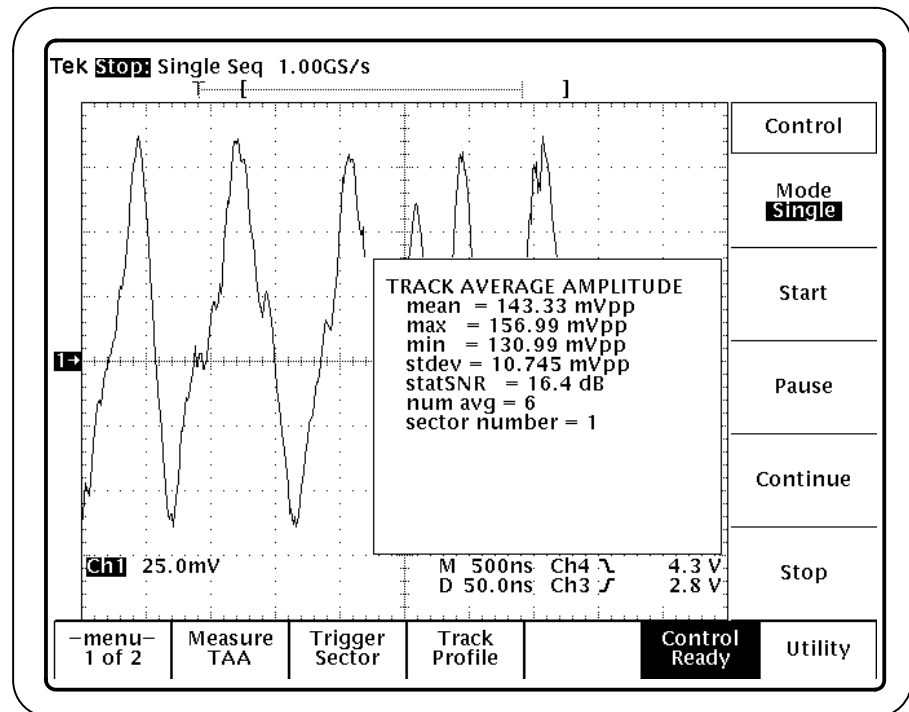


Figure 3-8: Track average amplitude measurement

Definition The track average amplitude measurement, TAA, is defined as follows:

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

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

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

- Procedure** From the Disk Drive Measurement Application display, follow these steps:
1. Select the TAA measurement by pressing Measure (main) → TAA (side).
 2. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–8, *Measuring Over a Range of Sectors* on page 3–6, and *Cursor Gating* on page 3–7.
 3. Press Control (main) → Start (side) to start the measurement.
 4. Wait for the measurement to complete, then view the results as shown in Figure 3–8.

Test Methodology 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 3–9.) Keep the maximum value over this range. Take one sample on either side of the maximum value and average the three values to obtain the positive peak value. This is done to remove noise bias which would otherwise occur.
2. Search the range from the negative hysteresis crossing to the next positive hysteresis crossing; keep the minimum value. Take one sample on either side of the minimum value and average the three values to obtain the negative peak value.
3. Average all measured peak-to-peak values. The result is the TAA value.

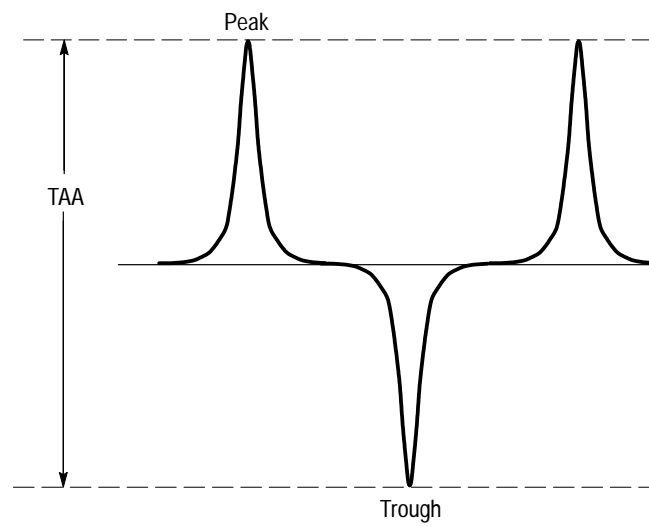


Figure 3-9: TAA measurement

Track Average Amplitude (Plus), TAA+ Track Average Amplitude (Minus), TAA-

The track average amplitude (plus), TAA+, is the average positive peak value of the data on the read channel signal over the specified range of sectors. IDEMA specifies the duration to be over one complete track revolution.

The track average amplitude (minus), TAA-, is the average negative peak value of the data on the read channel signal over the specified range of sectors. IDEMA specifies the duration to be over one complete track revolution.

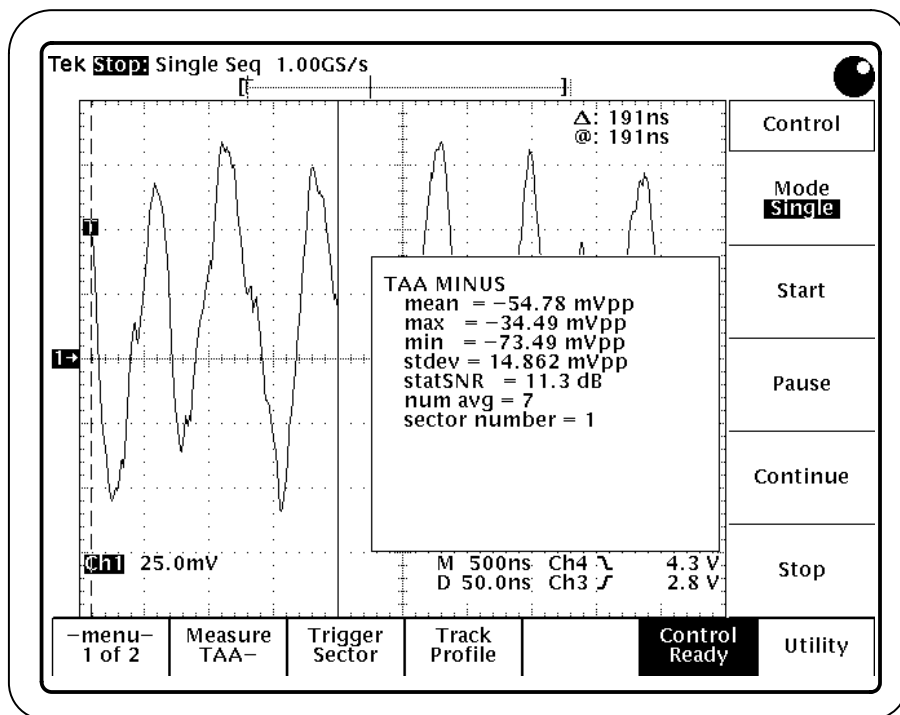


Figure 3-10: TAA- measurement

Definition The track average amplitude positive or negative measurement is defined as follows:

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

Where: N is the number of positive or negative pulses

V_p is the peak (positive or negative) voltage

The application measures enough peak/trough pairs to provide a good statistical average.

Procedure From the Disk Drive Measurement Application menu, follow these steps:

1. Select the TAA+ or TAA- measurement by pressing Measure (main) → TAA+ (side) or TAA- (side).
2. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–8, *Measuring Over a Range of Sectors* on page 3–6, and *Cursor Gating* on page 3–7.
3. Press Control (main) → Start (side) to start the measurement.
4. Wait for the measurement to complete, then view the results.

Test Methodology

The application performs the measurement according to the same algorithm used in the TAA measurement, described on page 3–13, with the exception that only positive pulses are measured for TAA+ and only negative pulses are measured for TAA-.

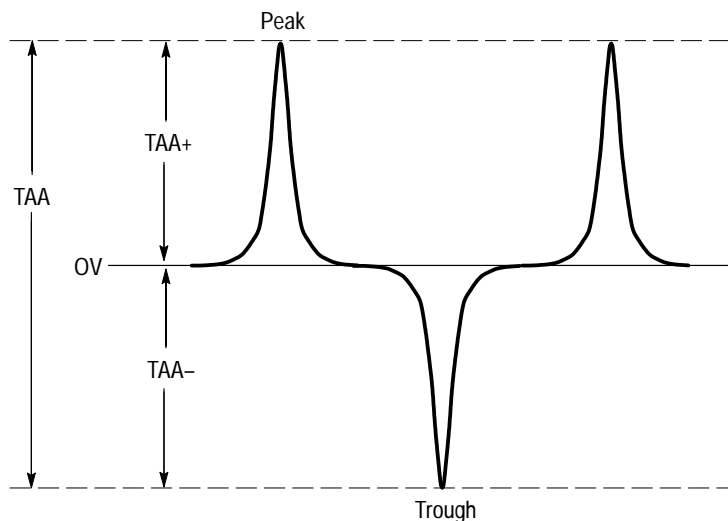


Figure 3–11: TAA+ and TAA- measurements

Pulse Width at 50%, PW50

The pulse width at 50% measurement, PW50, is the average pulse width at 50% of the pulse peak of a group of both positive and negative pulses.

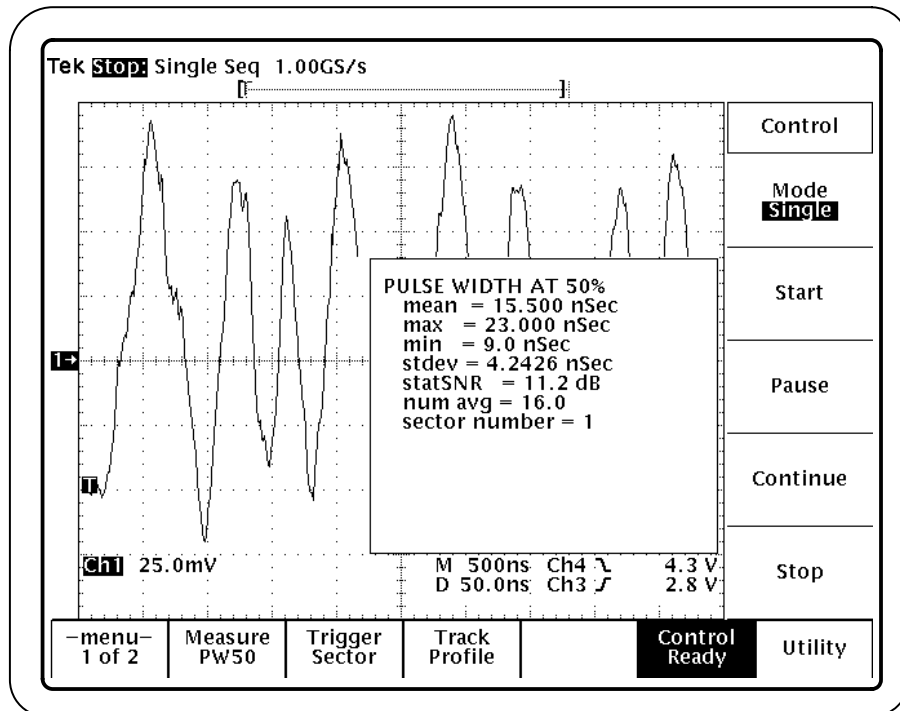


Figure 3-12: PW50 measurement

Definition PW50 is defined as the pulse width at 50% of the peak value of the pulse. Both peaks and troughs are measured. The baseline reference for measuring the peak or trough is zero volts.

Procedure From the Disk Drive Measurement Application display, follow these steps:

1. Select the PW50 measurement by pressing Measure (main) → PW50 (side). (If necessary, press –more– (side) until the PW50 measurement is shown.)
2. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–8, *Measuring Over a Range of Sectors* on page 3–6, and *Cursor Gating* on page 3–7.
3. Press Control (main) → Start (side) to start the measurement.

4. Wait for the measurement to complete, then view the results as shown in Figure 3–12.

Test Methodology

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 non-uniform segments, such as write splices, servo gaps, and header fields.

The hysteresis setting is used 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 the user can specify a smaller region of each track segment to measure by using the cursors or by decreasing the record length.

This measurement requires the user 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. Display the measurement result. (The display also reads out the standard deviation of the measurement for all pairs used.)

The pulse width at 50% measurement, PW50, is the average width of a group of positive and negative pulses. The pulses making up the tested group are selected by the following criteria:

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

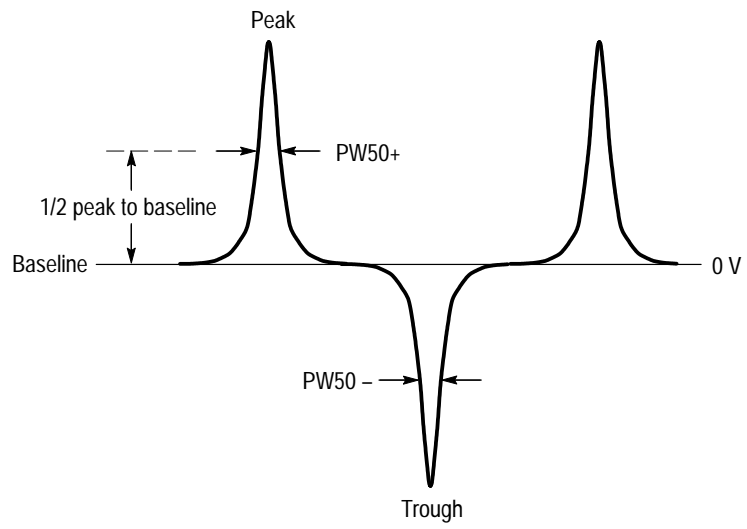


Figure 3-13: Parameters for PW50 disk drive measurements

50% Pulse Width (Positive), PW50+

50% Pulse Width (Negative), PW50–

The PW50+ measurement is the average pulse width around a track. It is the width of the pulse at 50% of TAA+. Only positive pulses are measured.

The PW50– measurement is the average pulse width around a track. It is the width of the pulse at 50% of TAA–. Only negative pulses are measured.

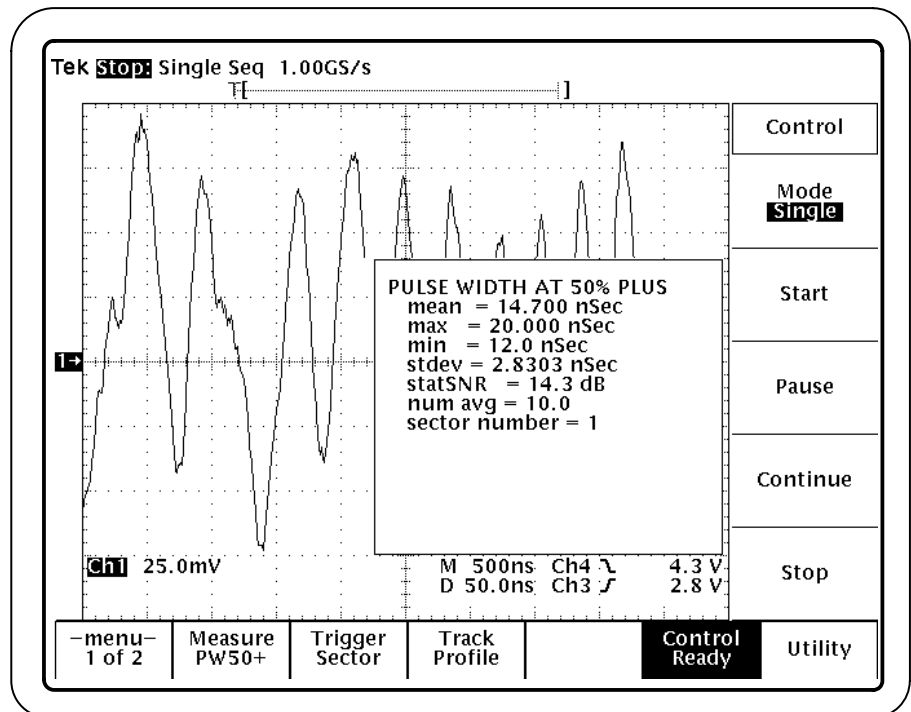


Figure 3–14: PW50+ measurement

Definition PW50+ is defined as the pulse width at 50% of the peak value of the pulse. Only peaks are measured. The baseline reference for measuring the peak is zero volts.

PW50– is defined as the pulse width at 50% of the trough value of the pulse. Only troughs are measured. The baseline reference for measuring the trough is zero volts.

Test Methodology The application performs the measurement according to the same algorithm used in the PW50 measurement, described on page 3–18, with the exception that only positive pulses are measured for PW50+ and only negative pulses are measured for PW50–.

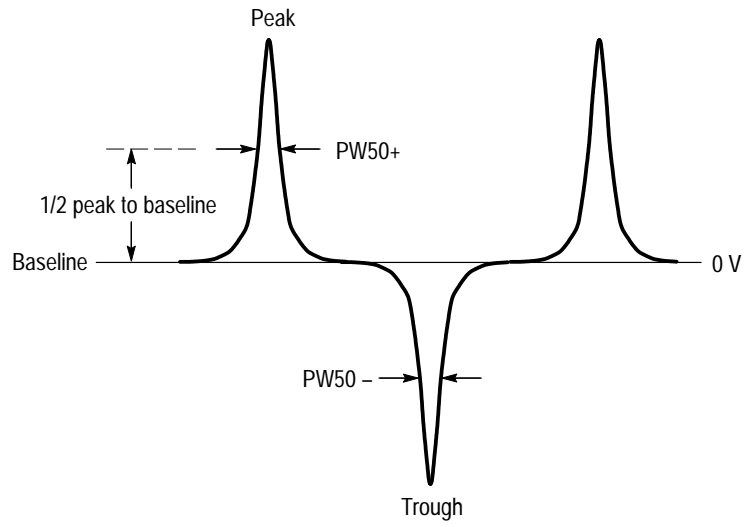


Figure 3-15: Parameters for PW50+ and PW50- disk drive measurements

Nonlinear Transition Shift, NLTS

The nonlinear transition shift measurement, NLTS, measures three types of nonlinear transition shift on the media:

- 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 adjacent transition, or 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.

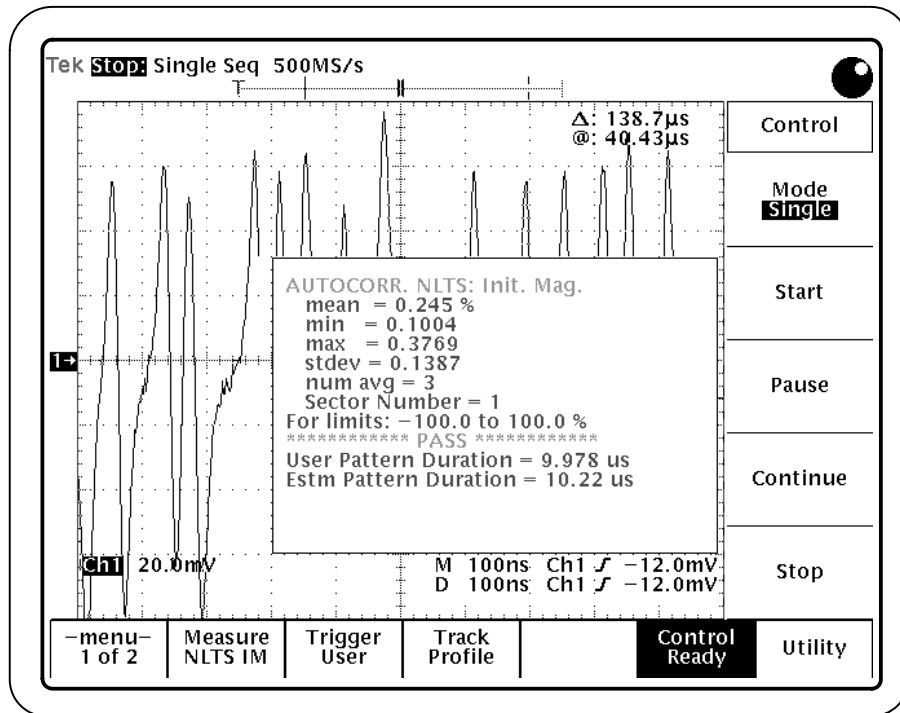


Figure 3-16: NLTS measurement

Definition 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 Initial Magnetization. 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 NLTS initial magnetization measurement assumes the following:

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

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

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

T is the bit period

ϵ_0 is the amount of shift

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

The measurement reports the nonlinear effect as a percentage of T; that is, $\frac{\epsilon_0}{T}$

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

The NLTS first adjacent transition measurement assumes the following:

$$\tilde{V}(t) \approx V\left(t + \frac{1}{2}\epsilon_1\right) + \frac{1}{2}\frac{\epsilon_1}{T}V\left(t + \frac{1}{2}\epsilon_1 - \frac{3}{2}T\right) - \frac{1}{2}\frac{\epsilon_1}{T}V\left(t + \frac{1}{2}\epsilon_1 + \left(M_1 - \frac{1}{2}\right)T\right)$$

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

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

T is the bit period

ϵ_1 is the amount of shift

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

The measurement reports the nonlinear effect as a percentage of T; that is, $\frac{\epsilon_1}{T}$

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

The NLTS second adjacent transition measurement assumes the following:

$$\tilde{V}(t) \approx V(t) - \frac{1}{2}\frac{\epsilon_2}{T}V\left(t - \frac{3}{2}T\right) + \frac{1}{2}\frac{\epsilon_2}{T}V\left(t - \frac{5}{2}T\right) + \frac{1}{2}\frac{\epsilon_2}{T}V\left(t + \left(M_1 - \frac{1}{2}\right)T\right) - \frac{1}{2}\frac{\epsilon_2}{T}V\left(t + \left(M_2 - \frac{1}{2}\right)T\right)$$

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

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

T is the bit period

ϵ_2 is the amount of shift

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

The measurement reports the nonlinear effect as a percentage of T ; that is, $\frac{\epsilon_2}{T}$

Procedure

For this measurement you must specify the polynomial used to generate a pseudo-random data pattern which is written to the disk. You are also responsible for specifying the cycle repeat time of the data pattern within a known tolerance.

From the Disk Drive Measurement Application display, follow these steps:

1. Access the NLTS measurements by pressing Measure (main). (If necessary, press –more– (side) until the NLTS measurement is shown.)
2. Select one of the NLTS measurements in the side menu. See Figure 3–17.

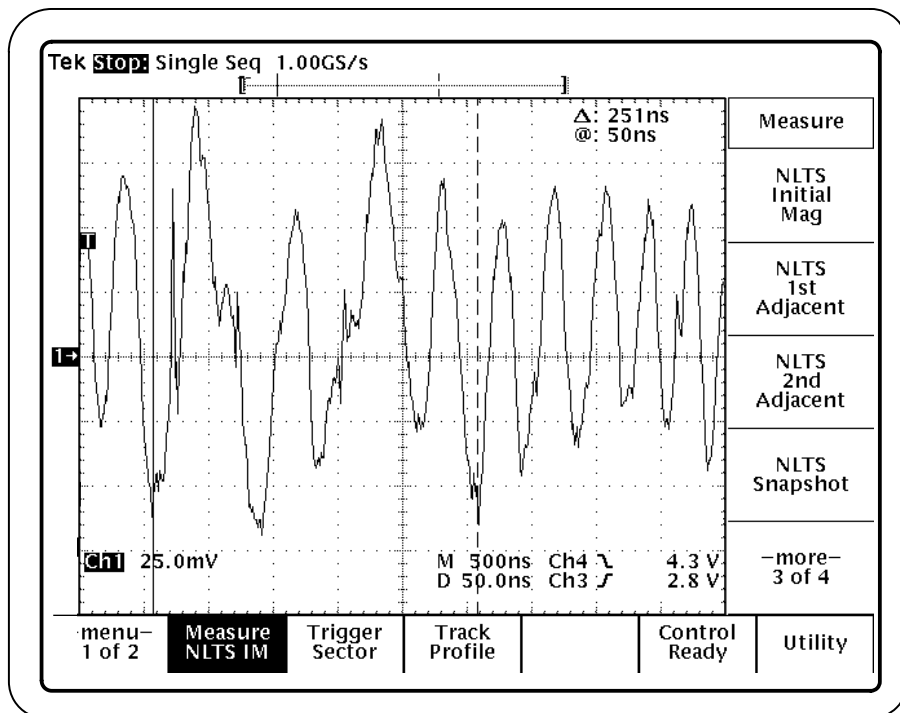


Figure 3–17: Selecting an NLTS measurement

3. Press Pattern Duration (side). Specify a value.

The pattern duration is the length of time of a pseudo-random data pattern period 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 4; the application will determine the exact duration of the pattern. (Due to variations in revolution speed between disk drives, specifying the pattern duration is necessarily an estimate.)

4. Press Duration Tolerance (side). 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 to a minimum 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 data pattern.*

5. Press Polynomial Index (side). Use the general purpose 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. See Figure 3–18.

The NLTS measurement is based on autocorrelation and uses a polynomial to generate a pseudo-noise sequence. Selecting the polynomial using the general purpose knob is a simple procedure; 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 $x=2$.

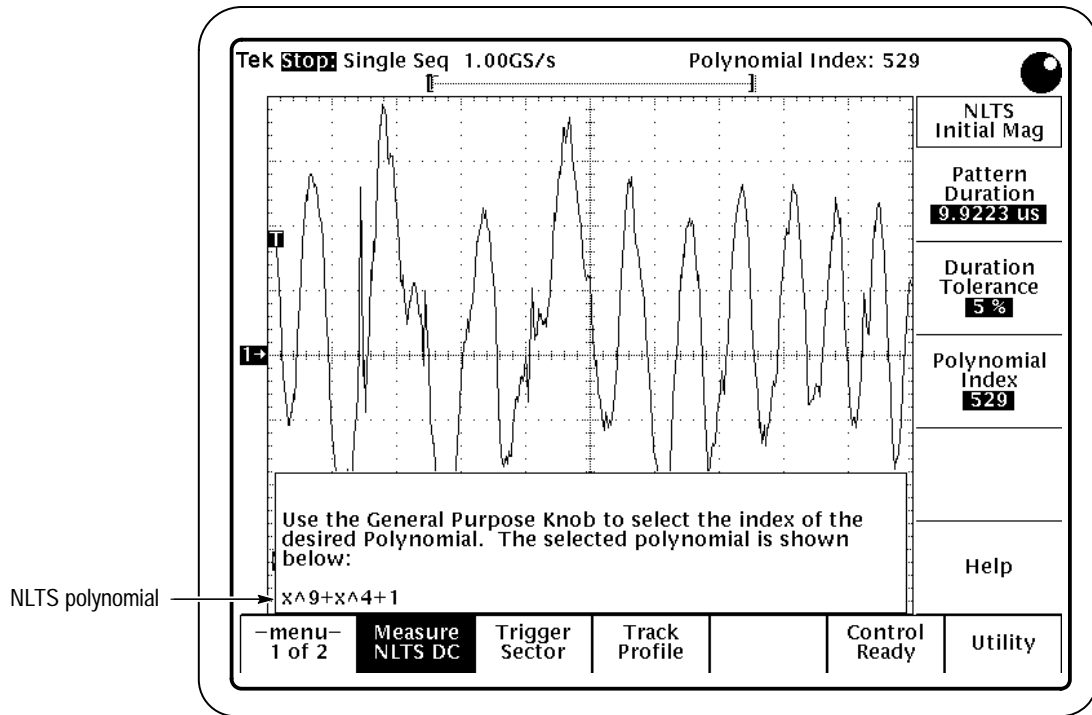


Figure 3-18: Specifying the NLTS polynomial

6. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1-8, *Measuring Over a Range of Sectors* on page 3-6, and *Cursor Gating* on page 3-7.
7. Press Control (main) → Start (side) to start the measurement.
8. Wait for the measurement results to display.

Measurement Requirements

The NLTS measurement has the following requirements:

- The waveform under test must have at least 1000 samples.
- There must be at least eight samples per bit.
- The oscilloscope must capture at least three periods of the pattern. This depends on the waveform length, the oscilloscope sample rate specified, the pattern duration specified, and the number of bits per period. The number of bits per period for a pseudo-noise sequence depends on the polynomial used.

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 NLTS measurement is based on a time domain cross-correlation method, as detailed in the IDEMA Test and Measurement Committee PRML Working Group Working Paper *Nonlinear Distortion Measurement Techniques*, September 1995.

The application performs the measurement according to the following algorithm:

1. Acquire three or more cycles of the waveform.
2. The user specifies 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 the user specifies a Duration Tolerance of 0%.) Compute the actual cycle time and delay values. NLTS 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 NLTS measurement uses several cycles of the waveform to improve the accuracy of the measurement, averaging over multiple single-waveform-cycle NLTS values.

NLTS values for the auto-correlation method are linearly related to the autocorrelation of the acquired waveform at different time delays.

Signal-to-Noise Ratio, SNR

The signal-to-noise ratio measurement, SNR, 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.

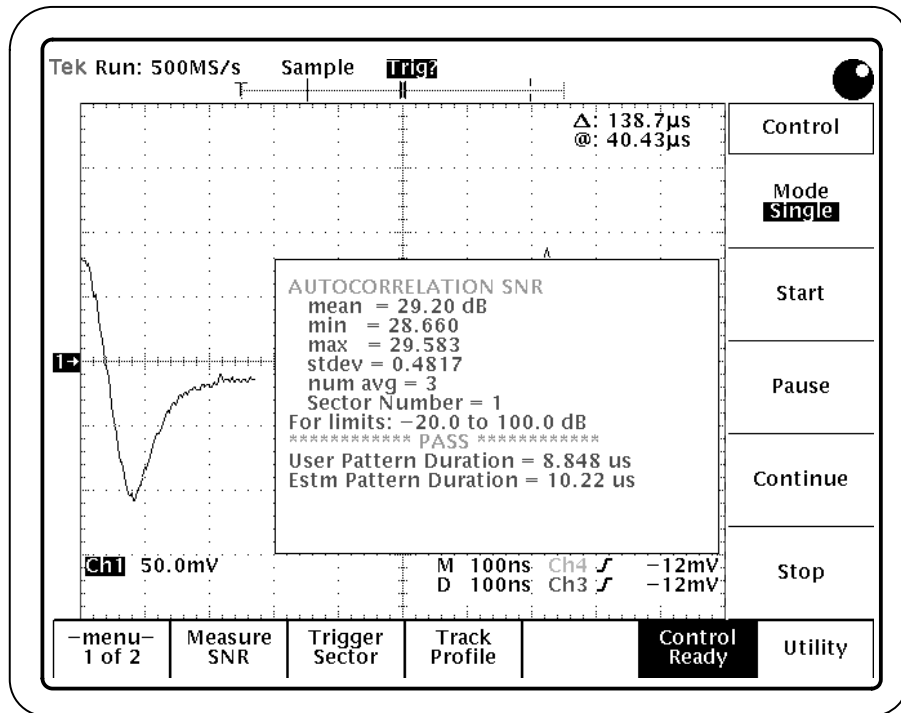


Figure 3–19: SNR measurement

Definition 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 SNR measurement is defined as follows:

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

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

Procedure From the Disk Drive Measurement Application display, follow these steps:

1. Select the SNR measurement by pressing Measure (main) → SNR (side). (If necessary, press –more– (side) until the SNR measurement is shown.)
2. Press Pattern Duration (side). Specify a value.

The pattern duration is the length of time of the bit data pattern period 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 determine the exact duration of the pattern. (Due to variations in revolution speed between disk drives, specifying the pattern duration is necessarily an estimate.)

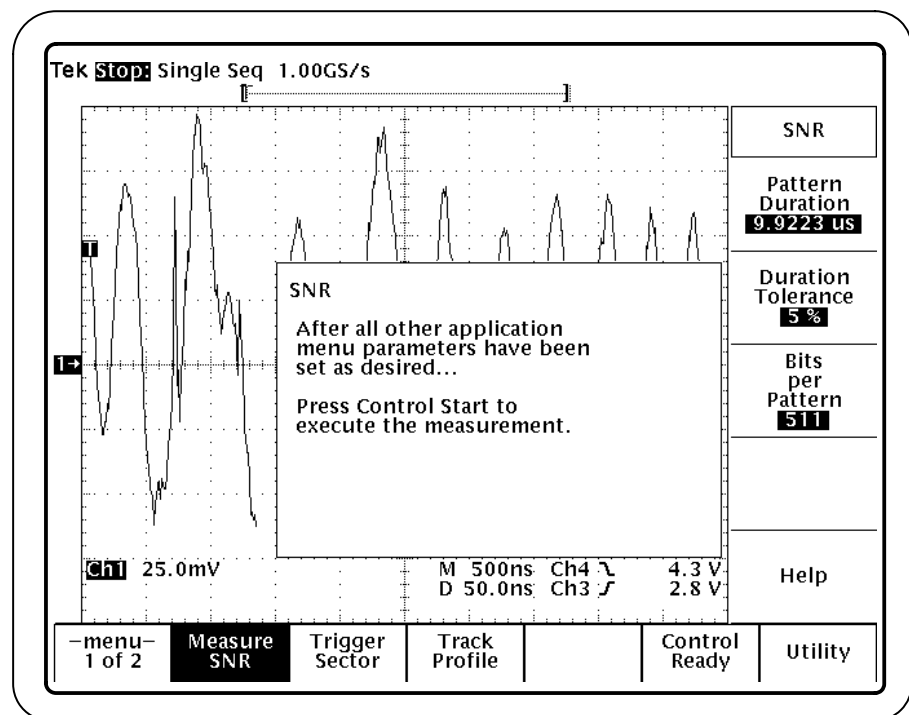


Figure 3–20: Specifying the SNR parameters

3. Press Duration Tolerance (side). 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 to a minimum 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 data pattern.*

4. Press Bits per Pattern (side).

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

5. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–8, *Measuring Over a Range of Sectors* on page 3–6, and *Cursor Gating* on page 3–7.

6. Press Control (main) → Start (side) to start the measurement.

7. Wait for the measurement results to display.

Measurement Requirements

The SNR measurement has the following requirements:

- The waveform under test must have at least 1000 samples.
- There must be at least eight samples per bit.
- The oscilloscope must capture at least three periods of the pattern. This depends on the waveform length, the oscilloscope sample rate specified, the pattern duration specified, and the number of bits per period.

Test Methodology

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.

Overwrite

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.

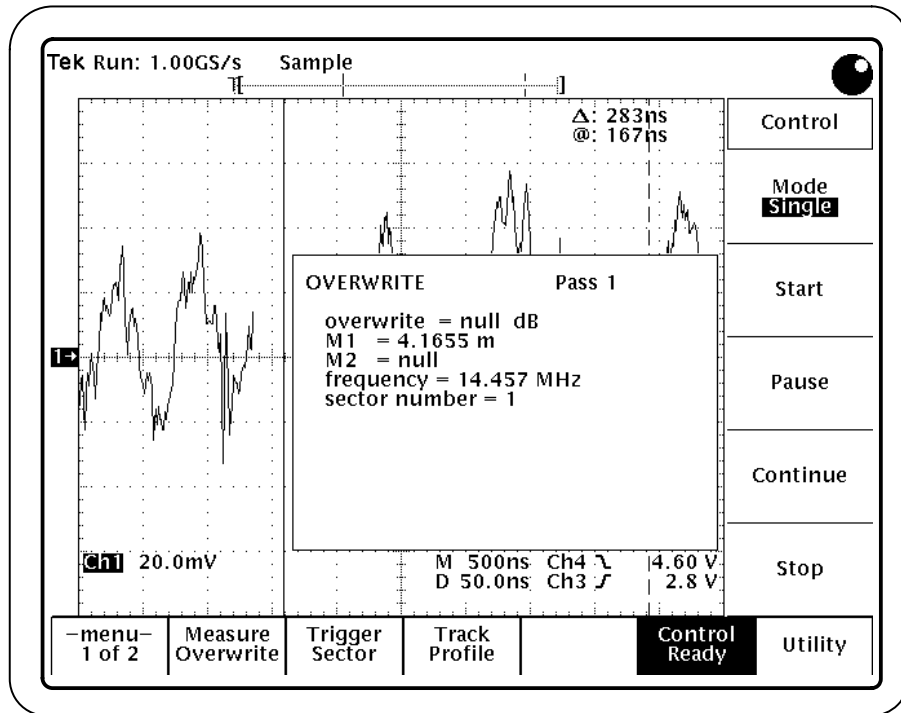


Figure 3-21: Overwrite measurement

Definition The Overwrite measurement is defined as follows:

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

Where: V_r is the residual RMS amplitude

V_o is the RMS amplitude

- Procedure** From the Disk Drive Measurement Application display, follow these steps. Note that this measurement requires external interaction with a PC.
1. Erase the track using the PC or by using a permanent magnet.
 2. Write a low-frequency data pattern of isolated pulses to the track.
 3. Select the overwrite measurement by pressing Measure (main) → Overwrite (side). (If necessary, press –more– (side) until the Overwrite measurement is shown.)
 4. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–8, *Measuring Over a Range of Sectors* on page 3–6, and *Cursor Gating* on page 3–7.
 5. Press Control (main) → Start (side) to start the measurement.

The application computes the magnitude of the signal and then pauses, waiting for input.
 6. Without erasing the previous data, overwrite the track with the high-frequency pattern.
 7. Press Continue (side). The application measures the magnitude of the high-frequency signal.
 8. Wait for the measurement results to display.

- Test Methodology** 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 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

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.

From the resolution measurement, you can infer the raw write density of the disk.

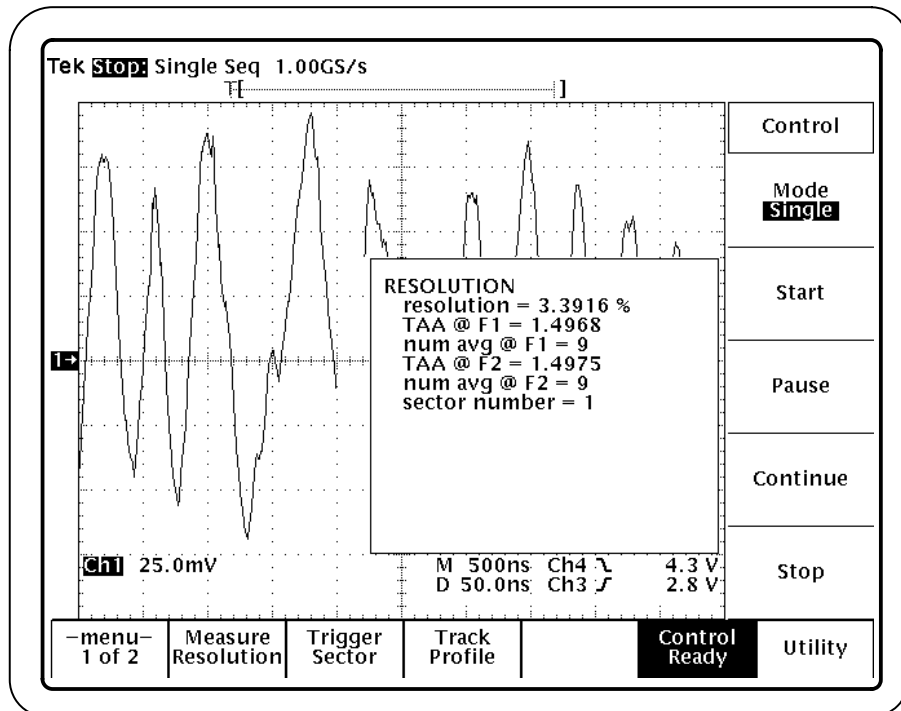


Figure 3–22: Resolution measurement

Definition The resolution measurement is the ratio of TAA at two different write frequencies, as follows:

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

Where: f_1 is the high-frequency TAA measurement

f_2 is the low-frequency TAA measurement

Procedure From the Disk Drive Measurement Application display, follow these steps. Note that this measurement requires external interaction with a PC.

1. Erase the disk using the PC or by using a permanent magnet.
2. Using the PC, write a high-frequency data pattern of isolated pulses to the disk.
3. Select the resolution measurement by pressing Measure (main) → Resolution (side). (If necessary, press –more– (side) until the Resolution measurement is shown.)
4. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–8, *Measuring Over a Range of Sectors* on page 3–6, and *Cursor Gating* on page 3–7.
5. Press Control (main) → Start (side) to start the measurement.

The oscilloscope performs a TAA measurement of the high-frequency pattern over the selected range of sectors and then pauses, waiting for input.

6. Erase the disk track using the PC.
7. Using the PC, write a low-frequency data pattern of isolated pulses to the disk.
8. Press Continue (side) to resume the measurement.
9. Wait for the measurement results to display.

Test Methodology 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_1 .
3. Measure the TAA over the selected range of sectors.
4. Erase the test track.
5. Overwrite the track with data at a low frequency f_2 .
6. Measure the TAA over the selected range of sectors.
7. Calculate the ratio of the low-frequency TAA to the high-frequency TAA.
8. Display the results.

Asperity

The asperity measurement determines whether the head has hit a flaw in the media surface (a thermal asperity has occurred).

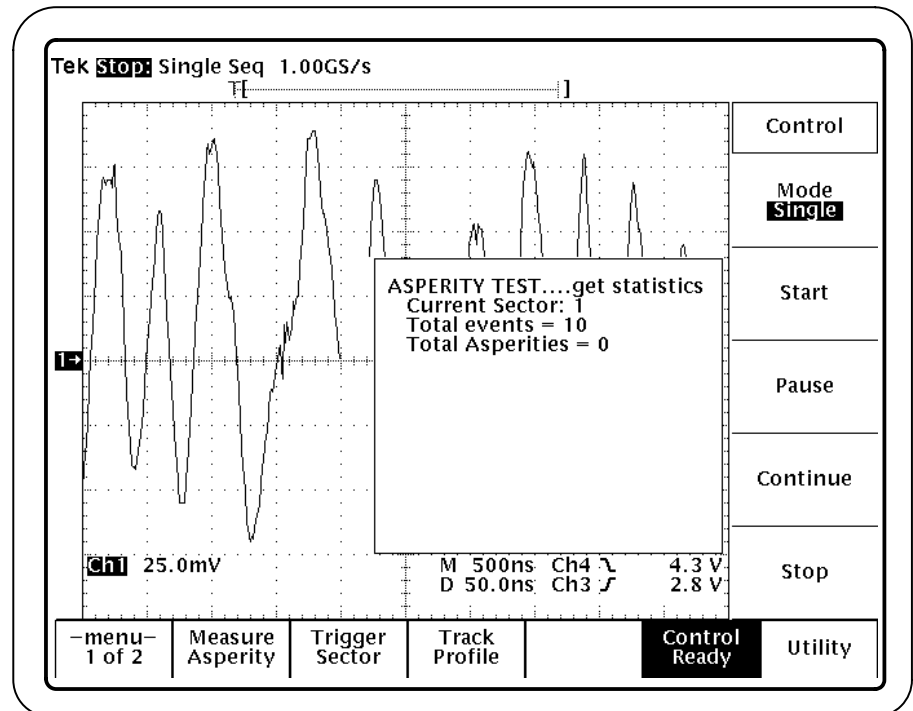


Figure 3-23: Asperity measurement

Definition When the head hits the surface of the media, a large voltage spike results. The application identifies these voltage spikes as thermal asperities.

Procedure From the Disk Drive Measurement Application display, follow these steps:

1. Select the Asperity measurement by pressing Measure (main) → Asperity (side). (If necessary, press –more– (side) until the Asperity measurement is shown.)
2. Specify the Threshold by pressing Threshold (side), and then selecting a value. The Threshold value specifies how large the positive peak signal must be before it is considered an asperity. The Threshold is expressed as a voltage.

The recommended initial setting is at least twice the peak value of the signal. If the signal crosses this level, it is counted as an asperity. No additional asperities are counted until the signal crosses zero volts again.

3. If you want to change trigger settings or localize the measurement, do so now. The application defaults to the settings specified in the Trigger menu. For further information, see *Setting Up the Application Trigger* on page 1–8, *Measuring Over a Range of Sectors* on page 3–6, and *Cursor Gating* on page 3–7.
4. Press Control (main) → Start (side) to start the measurement.
5. Wait for the measurement to complete, then view the results as shown in Figure 3–12.

Test Methodology

The application performs the measurement according to the following algorithm:

1. The user enters a threshold value to specify what is considered an asperity.
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.

NOTE. *If the Fit to Screen function is enabled, then the time readout for the asperity is measured from the left side of the screen to the asperity position.*

The application enters each asperity into a queue for display. Up to ten asperities are listed; if more than ten asperities are displayed, the list scrolls to display the latest asperities.

Snapshot Measurements

To see the summary measurements available for TAA, PW50, or NLTS, use the snapshot version of these measurements. Figure 3–24 shows snapshot measurement data for two different measurements.

Select snapshot measurements in the same way you select regular measurements.

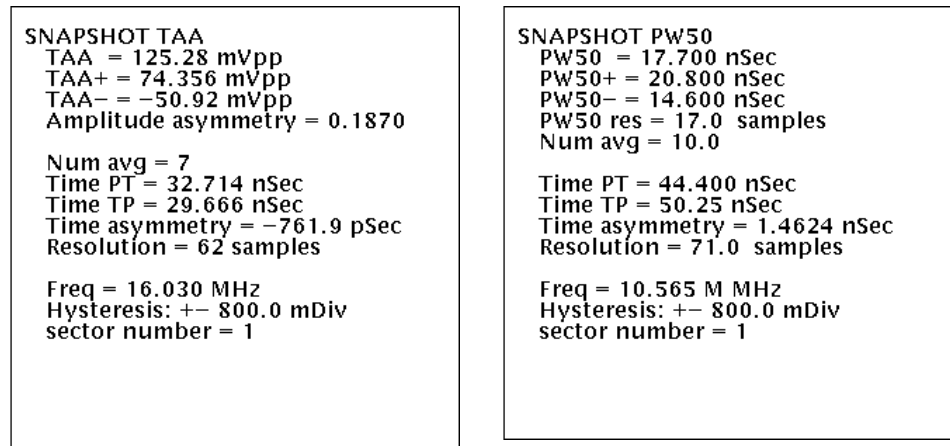


Figure 3–24: Snapshot measurement data

Snapshot Measurement Definitions

The following measurements are used in snapshots.

Vertical Asymmetry (Vert asym)

The vertical asymmetry measurement uses TAA values to compare the symmetry of the positive and negative pulses.

The vertical asymmetry is measured for each sector, and then the values are averaged to provide a single vertical asymmetry value. The vertical asymmetry value has no units and can range from -1.0 to 1.0. Interpret the values as follows:

0.0 indicates that $TAA+ = TAA-$

1.0 indicates that $TAA- = 0.0$ (no negative pulses)

-1.0 indicates that $TAA+ = 0.0$ (no positive pulses)

The vertical asymmetry measurement is not available as an individual measurement. It is available only in the TAA snapshot display.

The vertical asymmetry measurement is defined as follows:

$$Vert\ asym = \left(\frac{TAA+ + TAA-}{TAA} \right)$$

Where: TAA is the TAA measurement for a given sector, as defined on page 3-13

TAA+ is the TAA+ measurement for a given sector, as defined on page 3-16

TAA- is the TAA- measurement for a given sector, as defined on page 3-16

Timing Asymmetry, A

The timing asymmetry measurement, A, measures the ability of the head/media combination to process positive and negative transitions identically.

The timing asymmetry measurement is not available as an individual measurement. It is available only in the TAA and PW50 snapshot displays and is not available over the GPIB bus.

The timing asymmetry measurement is based on timing between pulse peaks, calculated as follows:

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

Where: i indexes negative pulses

N is the number of measured time intervals

T₁ is the time from the prior positive pulse to the current pulse

T₂ 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.

A constant frequency sequence is written onto a track.

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

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

These measurements are available only as part of the Snapshot measurements.

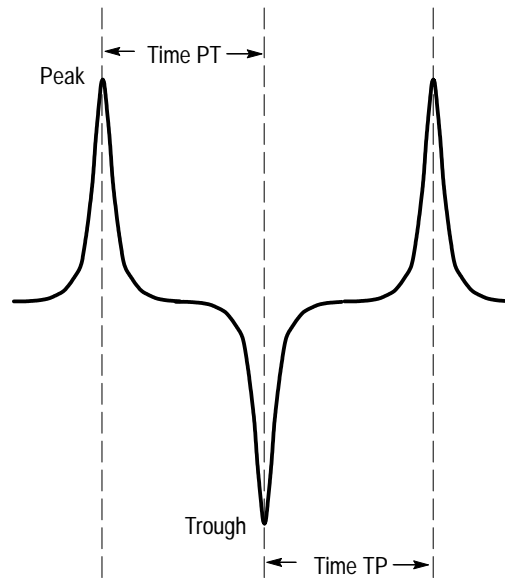


Figure 3–25: Time PT and Time TP measurements

Track Profiles

Track profiles 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 observe sector-to-sector variations in measurements and to identify the location of flaws within a track. Using this feature you can better 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 then represents the value of the measurement as a function of sector number over a range of sectors which can be specified in the Trigger menu. (The Trigger Mode must be set to Sector to enable the sector readout.)

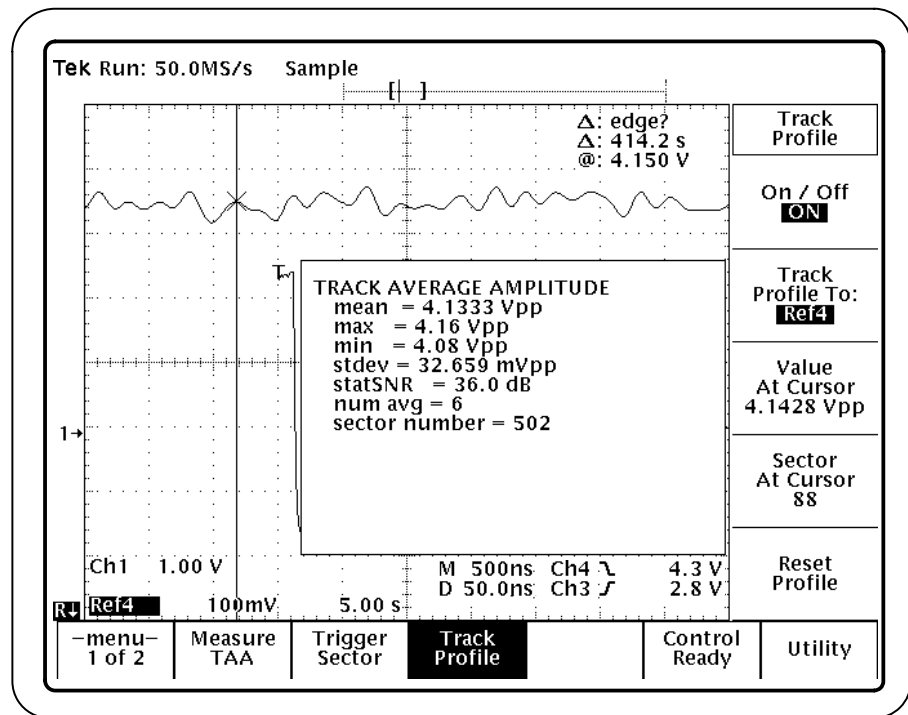


Figure 3-26: Track profile waveform

Using Track Profiles

From the Disk Drive Measurement Application display, perform these steps:

1. Press Track Profile (main) → Off/On (side). Select ON. See Figure 3–27.
2. Select a reference memory to use as the track profile by pressing Track Profile To (side). The application turns on the selected Ref waveform so it becomes visible on the screen.

NOTE. *The application uses the oscilloscope general purpose reference memories to store track profiles.*

3. Start the measurement, as you normally would. The measurement values are now stored as a track profile in the reference memory.

To clear the track profile reference memory, press Track Profile (main) → Reset Profile (side).

You can view ongoing track profile results by setting the Control Mode to Free Run. (Press Control (main) → Mode (side). Select Free Run.) When the track profile reference memory reaches its 500-point capacity, the application continues to acquire data and the track profile scrolls across the screen as new points are added and old points are deleted. See Figure 3–28 on page 3–48 for an example of a track profile waveform during Free Run mode.

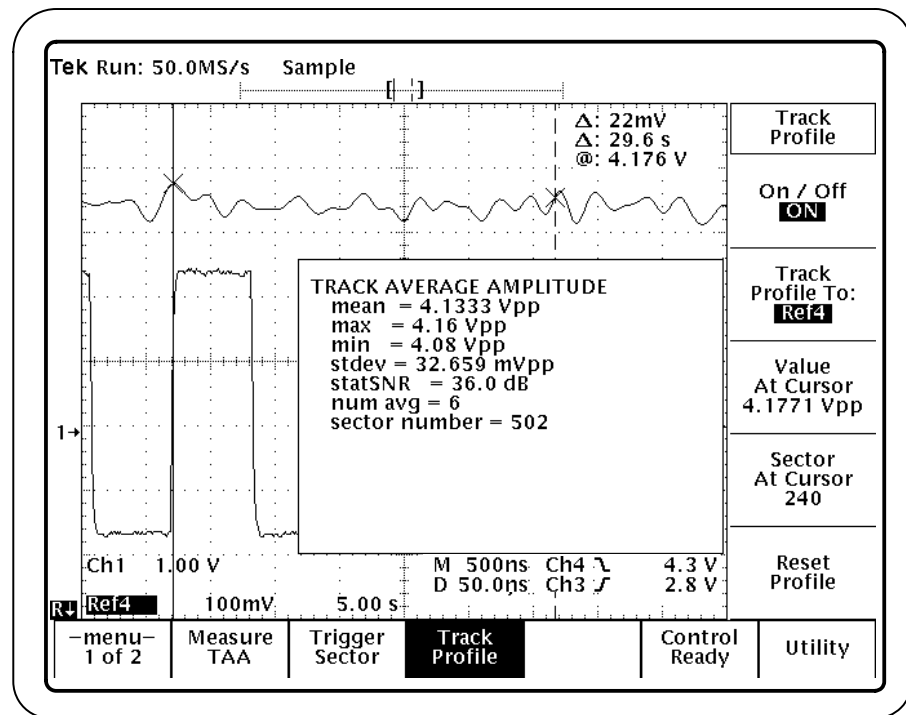


Figure 3-27: Specifying the track profile parameters

Displaying Reference Waveform Values

You can display a readout of the measurement at a given point on the track profile waveform as follows:

1. Press Track Profile (main).
2. Select the track profile waveform (the reference waveform) by pressing MATH, REF. (You must specify the reference waveform used for the track profile so that the associated cursor displays, or you cannot view the track profile cursor values.)
3. Move the cursor to the desired location on the track profile waveform.

The Value at Cursor is always expressed in volts, regardless of other measurement settings.

The cursor readout values in the side menu are available only with current track profile waveforms; they are not available with waveforms that are later recalled from memory. In addition, the cursor readout values in the side menu are deleted when you do the following:

- Change the measurement type in the Measure menu
- Press Reset Profile

About the Track Profile Reference Memory

At the beginning of the measurement, the reference memory is filled with null values. (Figure 3–28 shows a track profile waveform as the data is being stored. The right portion of the waveform represents the memory which has not yet been filled.) At the end of each track 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.

The measurements are stored in reference memory as 16-bit integers. A scale factor or units are associated with the C-waveform header. This is accessible so that the application can scale the measurements into the reference waveform. (As long as the reference waveform has the scale factors in the waveform header set up correctly, then when a cursor is attached to the reference waveform it will read out the correct value for the measurement.)

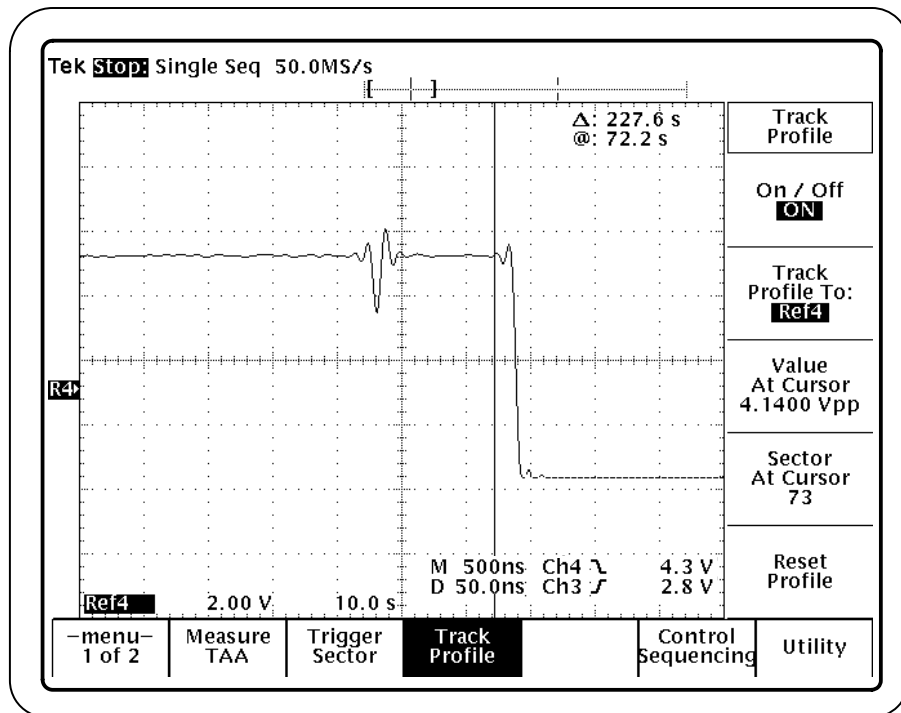


Figure 3–28: Track profile reference memory



Appendices

Appendix A: Specifications

Table A–1 lists the measurements provided by the TDSDDM1 Disk Drive Measurement Application.

Table A–1: TDSDDM1 Disk Drive Measurement Application measurements

Measurement name	Abbreviation	Description
Track Average Amplitude	TAA	Measures the average peak-to-peak value of the data on the Read signal.
Track Average Amplitude Plus	TAA+	Measures the average positive peak value of the data on the Read signal.
Track Average Amplitude Minus	TAA–	Measures the average negative peak (trough) value of the data on the Read signal.
Pulse Width at 50%	PW50	Measures the average pulse width of the Read signal.
Pulse Width at 50% Plus	PW50+	Measures the average positive pulse width of the Read signal.
Pulse Width at 50% Minus	PW50–	Measures the average negative pulse width of the Read signal.
Nonlinear Transition Shift Initial Magnetization	NLTS Initial Mag	Measures non-linear transition shift due to initial DC erasure.
Nonlinear Transition Shift 1st Adjacent	NLTS 1st Adjacent	Measures non-linear transition shift due to adjacent transitions spaced 1 bit apart.
Nonlinear Transition Shift 2nd Adjacent	NLTS 2nd Adjacent	Measures non-linear transition shift due to adjacent transitions spaced 2 bits apart.
Signal-to-Noise Ratio	SNR	Measures the signal-to-noise ratio of the readback signal to readback noise.
Overwrite		Measures the amount of residual signal remaining from a previous write operation after new data is written to the same location.
Resolution		Measures the ratio of two TAA measurements, performed at two different write frequencies.
Asperity		Locates thermal asperities on the media surface.



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