User Manual

Tektronix

TDS6000 Series
Digital Storage Oscilloscope
071-7012-00

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## Glossary

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# TDS6000 Series User Manual
Preface

This is the user manual for the TDS4000 Series oscilloscope. It covers the following information:

- Describes the capabilities of the oscilloscope, how to install it, and how to reinstall its software.
- Explains how to operate the oscilloscope, how to control acquisition of, processing of, and input/output of information.
- Lists the specifications and accessories of the oscilloscope.

About This Manual

This manual is composed of the following chapters:

- Getting Started shows you how to configure and install your oscilloscope and provides an incoming inspection procedure.
- Operating Basics uses maps to describe the various interfaces for controlling the oscilloscope, including the front panel and the software user interface. These maps provide overview of the product and its features from several viewpoints.
- Reference comprises an encyclopedia of topics (see Overview on page 3-1) that describe the oscilloscope interface and features, and gives background and basic information on how to use them. The online help on-board the oscilloscope explains the interface, features, and their stages in detail. Descriptions of all programming commands are found in the TDS4000 Series Programmer Online Guide manual.
- Appendixes provide additional information including the specifications, measurements, and dealing information.

Related Manuals and Online Documents

This manual is part of a document set of standalone-accelerator manuals and online documentation; this manual mainly focuses on installation, background, and user information needed to use the product features. See the following list for other documents supporting oscilloscope operation and service. (Manual part numbers are listed in Accessories & Options on page 3-20.)

<table>
<thead>
<tr>
<th>Manual name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS4000 Series Online Help</td>
<td>An online help system integrated with the user interface application that ships with the product. This help is presented in the oscilloscope.</td>
</tr>
<tr>
<td>TDS4000 Series Quick Reference</td>
<td>A quick reference to major features of the oscilloscope and how they operate.</td>
</tr>
<tr>
<td>TDS4000 Series Programmer Online Guide</td>
<td>An alphabetical listing of the programming commands and other information related to programming the oscilloscope over the GPIB.</td>
</tr>
<tr>
<td>TDS4000 Series Service Manual</td>
<td>Describes how to service the oscilloscope to the module level. This optional manual must be ordered separately.</td>
</tr>
</tbody>
</table>

For more information on how the product documentation relates to the oscilloscope operating interface and features, see Documentation Map on page 3-2.

Contacting Tektronix

Phone: 1-800-403-6282

Address: Tektronix, Inc.
1000 S.W. Kootenai Drive
PO Box 810
Beaverton, OR 97077
USA

Web site: www.tektronix.com

Sales support: 1-800-403-6282, select option 1

Service support: 1-800-403-6282, select option 2

Technical support: Email: techsupport@tektronix.com
                1-800-403-9259, select option 2
                6 a.m. - 6 p.m. Pacific time

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

This chapter describes the TDS6000 Series and their options. Following this description are three sections:

• Installation shows you how to configure and install the oscilloscope, as well as how to reinstall the system software included with the product.
• Incoming Inspection provides a procedure for verifying basic operation and functionality.
• Accessories lists the standard and optional accessories for this product.

Key Features

The TDS6000 Series oscilloscope is a high-performance solution for verifying, debugging, and troubleshooting sophisticated electronic designs. The oscilloscope features exceptional signal acquisition performance, operational simplicity, and open connectivity to the design environment. Classic analog-style controls, a large backlit seven-inch display, and graphical menus provide intuitive control.

Open access to the Windows operating system enables unprecedented customization and expandability. Key features include:

• Up to 6 GHz bandwidth and 20 GS/s real-time sampling rate
• Record lengths up to 250,000 samples
• 2.5% DC vertical gain accuracy
• Four input channels (each with 8-bit resolution), CH 3 signal output, and auxiliary trigger input and output
• Sample, envelope, peak-detect, high-resolution, and average acquisition modes
• Full programmability, with an extensive GPIB command set and a message-based interface
• Trigger modes include edge, logic, pulse, and sequence at up to 3 GHz bandwidth
• Powerful built-in measurement capability, including histograms, automatic measurements, and measurement statistics
• A large 15.4-inch (394.2 mm) color display that supports color grading of waveform data to show sample density

Product Software

The oscilloscope includes the following software:

• System Software, which includes a specially configured version of Windows 98, comes preinstalled on the oscilloscope. Windows 98 is the operating system on which the user interface application of this product runs, and provides an open desktop for you to install other compatible applications. Do not attempt to install any version of Windows that is not specifically provided by Tektronix for use with your oscilloscope.
• TDS6000 Product Software comes preinstalled on the oscilloscope. This software, running on Windows 98, is the oscilloscope application. The software allows viewing and saving oscilloscope pictures, and provides the user interface (UI) and all other oscilloscope control functions.
• Support Software is not preinstalled on the oscilloscope. The Product Software compact disc, included with the oscilloscope, contains the following software and files that may be useful to you:
  • Release notes. This PDF file contains release notes and updates that should not be included in other product documentation.
  • GPIB Programmer Online Help software. This software, in an online help format, contains the information you need to program the oscilloscope through its GPIB interface. A printable PDF file of this information is also available on the compact disc.
  • Performance Verification Procedures. The compact disc contains software and procedures to perform a semi-automated performance verification as well as instructions to perform a manual performance verification.

See the instructions included with the Product Software compact disc for information about installing the support software.

Occasionally new versions of software for your oscilloscope may become available at our web site. See Contacting Tektronix on page xv in Preface.

Software Upgrade

Tektronix may offer software upgrade kits for the oscilloscope. Contact your Tektronix service representative for more information (see Contacting Tektronix on page xv).
Installation

This chapter covers installation of the oscilloscope, addressing the following topics:

- Unpacking on page 1-5
- Checking the Environment Requirements on page 1-6
- Connecting Peripherals on page 1-6
- Powering On an Oscilloscope on page 1-8
- Powering Off an Oscilloscope on page 1-9
- Creating an Emergency Startup Disk on page 1-10
- Installing Software on page 1-11
- Connecting the Network on page 1-12

CAUTION: Be sure to create your emergency startup disk as described on page 1-10. You may need that disk if you ever need to reinstall Windows 98 from the oscilloscope hard drive.

Unpacking

Verify that you have received all of the parts of your oscilloscope. The graphical packing list shows the standard accessories that you should find in the shipping carton (please depend on the options you ordered). You should also verify that you have:

- The correct power cord for your geographical area.
- The compact disk that includes copies of the software installed on the oscilloscope and additional support software that may be useful. To load the Operating System, Readout Software, and Optional Applications Software, mount the product software in a safe location where you can easily retrieve it.

Connecting Peripherals

The peripheral connections are the same as those you would make on a personal computer. This connection matrix is shown in Figure 1-1. See Table 1-1 on page 1-11 for additional connection information.

Powering On the Oscilloscope

Follow these steps to power on the oscilloscope for the first time:

1. Either one of the following fuse sizes can be used. Each size requires a different fuse cap. Both fuses must be the same type. See Table 1-2 and Figure 1-2.

Optional Applications Software

NOTE: Store the certificate of authenticity (Microsoft Windows 98 license agreements) that accompanies the compact disk in a safe location. This certificate proves your ownership of the Microsoft operating system on your oscilloscope. If you lose or misplace this certificate, you may have to purchase a new Microsoft license if the hard disk in your oscilloscope ever needs rebuilding or replacement.

- All the standard and optional accessories that you ordered.

Remember to fill out and send in the customer registration card. The registration card is packaged with this manual.

Checking the Environment Requirements

Read this section before attempting any installation procedures. This section describes site considerations, power requirements, and ground connections for your oscilloscope.

Site Considerations

The oscilloscope is designed to operate on a bench or on a cart in the normal position (on the bench face). For proper cooling, at least three inches (7.62 cm) of clearance is required on both sides of the oscilloscope, and the bottom requires the clearance provided by the oscilloscope feet.

If you operate the oscilloscope while it is sitting on the rear feet, make sure that you properly route any cables coming out of the rear of the oscilloscope to avoid damaging them.

CAUTION: To prevent damage to the oscilloscope, ensure proper cooling by keeping the bottom and sides of the oscilloscope clear of obstruction.

Operating Requirements

The specifications in Appendix A list the operating requirements for the oscilloscope. Power source, temperature, humidity, and altitude are listed.

Connecting the Network

The peripheral connections are the same as those you would make on a personal computer. This connection matrix is shown in Figure 1-1. See Table 1-1 on page 1-11 for additional connection information.

Powering On the Oscilloscope

Follow these steps to power on the oscilloscope for the first time:

1. Either one of the following fuse sizes can be used. Each size requires a different fuse cap. Both fuses must be the same type. See Table 1-2 and Figure 1-2.

Table 1-2: Line fuse location

<table>
<thead>
<tr>
<th>Fuse type</th>
<th>Description</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 amp</td>
<td>Dale F1-10</td>
<td>10A01000000</td>
</tr>
<tr>
<td>15 amp</td>
<td>Dale F1-15</td>
<td>15A01000000</td>
</tr>
</tbody>
</table>

CAUTION: To avoid product damage, power off the oscilloscope before installing any accessories except a USB mouse or keyboard to the oscilloscope computer. (You can connect and disconnect USB devices with the power on.) See Powering Off the Oscilloscope on page 1-9.

Table 1-1: Additional accessory connection information

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor</td>
<td>If you use a non-remote monitor, you may need to change the Windows 98 display settings to the proper resolution for that monitor.</td>
</tr>
<tr>
<td>Printer</td>
<td>Connect the printer to the EPP interface panel and connect it to the printer. If your printer has a USB interface, connect the printer to the USB interface. (For information on printer usage, see Printing information on page 1-10.)</td>
</tr>
<tr>
<td>Scanner</td>
<td>Refer to the operator's handbook for information on installing the software.</td>
</tr>
<tr>
<td>Other</td>
<td>Here is the necessary information on the Product Software CD for power source, temperature, humidity, and altitude described in this manual.</td>
</tr>
</tbody>
</table>
2. Connect the power cord.
3. If you have an external monitor, connect the monitor to the oscilloscope (see page 1-15), insert the power cord, and power on the monitor.
4. Turn the Power switch on at the rear panel. (See Figure 1-2 on page 1-8 for switch location.)
5. If the oscilloscope does not power up, push the On/Standby switch to power on the oscilloscope (see Figure 1-3 for the switch location).

Figure 1-2: On/Standby switch location

Powering Off the Oscilloscope

When you push the front-panel On/Standby switch, the oscilloscope starts a shutdown process (including a Windows shutdown) to preserve settings and then power off. Avoid using the rear-panel power switch or disconnecting the line cord to power off the oscilloscope.

**NOTE:** If you do not use the On/Standby switch to power off the oscilloscope, the oscilloscope will be in the factory Default Setup when powered on the next time.

To completely remove power to the oscilloscope, perform the shutdown just described, and then set the power switch on the rear panel to off.

---

**Creating an Emergency Startup Disk**

Now that you have completed the basic installation process, you should create an emergency startup disk that you can use to restart your oscilloscope in case of a major hardware or software failure. You should make this disk, and then store it in a safe place.

**CAUTION:** The disk is stored in a safe place, it may allow you to recover your Windows 98 installation without rebuilding the entire oscilloscope hard disk.

The emergency startup disk contains basic files to restart your oscilloscope. It also contains files to check the hard disk.

Follow these steps to create the emergency startup disk:

1. Minimize the oscilloscope application by selecting Minimize in the File menu.
2. Click the Windows Start button, point to Settings, and click Control Panel.
3. In the Control Panel window, double-click Add/Remove Programs.
4. Click the tab for the Startup Disk page.
5. Insert a floppy disk into the disk drive and follow the on-screen instructions to create the startup disk.

---

**Backing Up User Files**

You should always back up your user files on a regular basis. Use the Back Up tool to back up files stored on the hard disk. The Back Up tool is located in the System Tools folder in the Accessories folder.

1. If the Windows backup program is not installed on your oscilloscope, please perform the following steps:
   - Minimize the oscilloscope application by selecting Minimize in the File menu.
   - Click the Windows Start button, point to Settings, and then Control Panel.
   - Double-click Add/Remove Programs to display the dialog box.
   - Click the Windows Setup tab.
   - Under Components, double-click System Tools.
   - Select the backup check box and then click OK.

---

**Installing Software**

The oscilloscope system and application software is pre-installed at the factory. If you have to reinstall the software for any reason, refer to the instructions that accompany the CDs that are shipped with the oscilloscope. If you need to restore the operating system, you also need the Windows license information from the Certificate of Authenticity that is shipped with the oscilloscope.

**Software Release Notes**

Read the software release notes README.TXT ASCII file on the product-software CD before performing installation procedures. This file contains additional installation and operation information that supersedes other product documentation.

To view the README.TXT file, open the My Computer Windows accessory. Then open the file on the Product Software CD.

**Accessory Software**

The Product Software CD also contains accessory software and files that you can choose to install on the oscilloscope or in another computer. Refer to the instructions that accompany the CD for installation information.

**GPIB Programs Offline Help System**

You can install the GPIB Programmer offline help on the oscilloscope or on another computer. This may be more convenient if you have no access to the oscilloscope. You can copy all your commands from this help information and code them into your programs. The information includes the following content:

- GPIB configuration information for the oscilloscope
- Lists of the command groups and the commands they contain
6. In the Close Program dialog box, select Windows494lnstallservices and then select End Task.
7. If a confirmation dialog box appears, select End Task again.
8. Press the CTRL, ALT, and DELETE keys a third time.
9. In the Close Program dialog box, verify that the tasks TekScope and Windows494lnstallservices are not running, and then select Close to close the dialog box.

The TekScope application will restart after you restart the entire system, following the installation of the desktop application software.

Options
Some options contain software that needs to be installed and/or enabled. To do the installation, follow the specific instructions that come with the option.

TekScope provides a key that you must enter (one time) to enable all the options that you have purchased for your TekScope. To enter the key, select Option "Installations" in the Utilities menu, and then follow the on-screen instructions.

Connecting to a Network
You can connect the TekScope to a network to enable printing, file sharing, internet access, and other communications functions. Before you make the connection, do the following steps to enable network access to the TekScope.

1. Begin with the TekScope power off.
2. Attach a keyboard and mouse to the TekScope.
4. As the TekScope begins to boot, press the P key on the keyboard repeatedly until the message "Loading SETUP" appears.
5. In the BIOS Setup Utility use the right-arrow key on the keyboard to highlight the Advanced menu at the top of the screen.
6. Use the arrow keys to highlight PCl Configuration (Peripheral Configuration on some instruments) on the Advanced screen, and then press Enter.
7. Use the arrow keys to highlight Embedded Controller in the Peripheral Configuration screen, and then press Enter.
8. Use the arrow up or down key to highlight Enabled and then press Enter.

Setting up a Dual Display
Use the following steps to set up the TekScope for dual display operation. You can operate the TekScope while having full use of Windows and other applications on the external monitor.

1. Power off the TekScope so that you can connect an external monitor to the rear of the TekScope.
2. Connect a keyboard and mouse to the TekScope.
3. Connect an external monitor to the lower VGA port of the rear panel of the TekScope.
4. Power on the TekScope and the external monitor.

Installation
5. Watch for a message on the external monitor telling you that Windows has successfully initialized the display adapter.
6. The TekScope should detect that the new monitor was connected, follow the instructions on the TekScope display to install new drivers for the monitor.
7. Type a Control M to minimize the TekScope application.
8. In the Windows desktop, right-click the mouse and then select Properties to display the Display Properties dialog box.
9. Select the Settings tab and click the ground-out monitor in the display box.
10. Click yes when you are prompted to enable the new monitor.
11. Set the resolution that you want to use on the external monitor.
12. Click on the external monitor in the display box and drag it to the correct orientation.

CAUTION:
Do not change the resolution or color settings for the external LCD monitor. The internal resolution must be 800 x 600 and the color setting must be High Color (16 bit).

13. Click OK to apply the settings. The new monitor will display your internal desktop area.

To make the best use of the new display area, do these additional steps to move the Windows controls to the external monitor:
1. Click and hold on the Windows task bar in the area shown in Figure 1-4, and then drag it upwards and toward the external monitor. The task bar will then go to the side of the external monitor, then to the side of the external monitor, and finally to the bottom of the external monitor.

Figure 1-4: Drag area for Windows task bar
Incoming Inspection

This chapter contains instructions for performing the Incoming Inspection Procedure. This procedure verifies that the oscilloscope is operating correctly after shipment, but does not check product specifications. This procedure contains the following parts:

- Self Tests on page 1-17 provide instructions for performing the internal self tests.
- Functional Tests on page 1-19 measure the time- and amplitude-reference signals at the PROBE COMPENSATION connector.
- Perform the Extended Diagnostics on page 1-27 provides instructions for performing internal self calibration and the extended diagnostics.

If the oscilloscope fails any test within this section, it may need service. To contact Tektronix for service, see Contacting Tektronix on pages 1-28 through 1-30.

Make sure you have put the oscilloscope into service as detailed in Installation starting on page 1-1. Then assemble the following test equipment and proceed with the procedure that follows.

Assemble Equipment

Self tests do not require any test equipment. The functional tests require the following test equipment:

- A P7240 probe.
- A short fixture, Tektronix part number 097-0044-00.
- One BNC cable, such as Tektronix part number 01-0076-00.
- One 1.44 MHz, 3.5 inch format disk to check the system.
- One TCA-BNC Teleconstant adapter, or one SMA mate-to-BNC female adapter, such as Tektronix part number 015-1036-00.

Self Tests

This procedure uses internal routines to verify that the oscilloscope functions and was adjusted properly. No test equipment or procedures are required.

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Functional Tests

The purpose of these procedures is to confirm that the oscilloscope functions properly. A list of required test equipment is shown on page 1-17.

NOTE: These procedures verify that the oscilloscope features operate. They do not verify that the oscilloscope meets limits.

Therefore, when the instructions in the functional tests that follow call for you to verify that a signal appears on the screen that is above five divisions in amplitude or has a period of about one horizontal division, and so forth, do NOT interpret the quantities given as limits.

NOTE: Do not make changes to the front-panel settings that are not called out in the procedures. Such verification procedures will require you to set the oscilloscope to certain default settings before verifying functions. If you make changes to these settings other than those called out in the procedures, you may obtain invalid results. In this case, redo the procedure from step 1.

When you are instructed to push a front-panel button or screen button, the button may already be selected (on label will be highlighted). If this is the case, it is not necessary to push the button.

<table>
<thead>
<tr>
<th>Equipment required</th>
<th>Description</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>One P7240 probe</td>
<td>One probe male and female fixture, Tektronix part number 097-0044-00</td>
<td></td>
</tr>
</tbody>
</table>

1. Initialize the oscilloscope: Push the front-panel DEFAULT SETUP button.
2. Hook up the signal source: Connect one end of the BNC cable to the PROBE COMPENSATION output connector in the oscilloscope. Connect the remaining end of the BNC cable to the Extaria's/GAIN CAL cable connector in the fixture as shown in Figure 1-1 on page 1-20.
3. Install a P7240 probe in the channel input you want to test (beginning with CH 1).
4. Connect the probe tip to the GAIN CAL pin on the fixture as shown in Figure 1-5 on page 1-20.
5. Turn off all channels. If any of the front-panel channel buttons are lit, push these buttons to turn off the displayed channels. See Figure 1-6.

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Incoming Inspection

Figure 1-5: Universal test hookup for functional tests (CH 1) shown

Figure 1-6: Channel button location

6. Select the channel to test. Push the channel button for the channel that you are currently testing. The button dimmed, and the channel display comes on.
7. Set up the oscilloscope:
   - Push the front panel AUTOSET button. This sets the horizontal and vertical scale and vertical offset for a scalable display and sets the trigger source to the channel that you are testing.
   - Touch the Vert button, and then touch Offset. Confirm that the CH1 Offset is 1.0 V.

5. Verify that the channel is operational: Confirm that the following statements are true:
   - The vertical scale resistor for the channel under test shows a setting of about 100 mV, and a square-wave probe-compensation signal about 4 divisions in amplitude (about 400 mV) in the screen.
   - The front-panel POSITION knob (for the channel you are testing) moves the signal up and down the screen when rotated.
   - Turning the vertical SCALE knob counter-clockwise for (the channel that you are testing) decreases the amplitude of the waveform on-screen, turning the knob clockwise increases the amplitude, and returning the knob to 10 mV returns the amplitude to about 4 divisions.

9. Verify that the channel acquires all acquisition modes: From the Horiz/Acq menu, select Horiz/Acquisition Setup... Click the Acquisition on in the normal window that displays. Click each of the five acquisition modes and confirm that the statements are true:
   - Sample mode displays an actively acquiring waveform on the screen. (Note that here a small amount of noise present on the square wave).
   - Peak Detent mode displays an actively acquiring waveform on the screen with the noise present in Sample mode and peak detent.
   - Hi Res mode displays an actively acquiring waveform on the screen with the noise that was present in Sample mode reduced.
   - Average mode displays an actively acquiring waveform on the screen with the noise reduced.
   - Envelope mode displays an actively acquiring waveform on the screen with the noise displayed.
   - Waveform Database or Waveform mode displays an actively acquiring and displays a waveform that is the accumulation of several acquisitions.

10. Test all channels: Repeat steps 2 through 9 until all four input channels are verified.

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3. Set up the oscilloscope: Push the front panel AUTOSET button.
4. Touch the Vert button, and then touch Offset. Adjust the CH1 Offset to 0.8 V using the multipurpose knob.
5. Set the Vertical SCALE to 100 mV per division.
6. Set the time base: Set the horizontal SCALE to 200 μs/div. The time-base readout is displayed at the bottom of the instrument.

7. Verify that the time base operates: Confirm the following statements:
   - One period of the square wave probe-compensation signal is about five horizontal divisions on-screen for the 200 μs/div horizontal scale setting.
   - Rotating the horizontal SCALE knob clockwise expands the waveform on the screen (more horizontal divisions per waveform period), counter-clockwise reduces it, and rotating the horizontal scale to 200 μs/div returns the period to about five divisions.

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9. Remove the test fixture: Disconnect the cable and adapter from the channel input and the probe compensation output.

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11. Remove the test fixture: Disconnect the BNC cable, fixture, and the probe from the channel input and the probe compensation output.

Equipment required: One BNC cable One TCA-SMA TestConnect adapter

Preparation mode:

1. Initialize the oscilloscope: Push the front-panel DEFAULT SETUP button.
2. Hook up the signal source: Connect the BNC cable from the probe compensation output to the CH1 input through a TCA-SMA adapter as shown in Figure 1-7.

Figure 1-7: Setup for time base test

3. Set up the oscilloscope: Push the front panel AUTOSET button.
4. Touch the Vert button, and then touch Offset. Adjust the CH1 Offset to 0.8 V using the multipurpose knob.
5. Set the Vertical SCALE to 100 mV per division.
6. Verify that the main trigger system operates: Confirm that the following statements are true:
   - The trigger level readout for the A (main) trigger system changes with the trigger-LEVEL knob.
   - The trigger-LEVEL knob can trigger and untrigger the square-wave signal as you turn it. (Leave the signal untriggered).
   - Pushing the front-panel trigger LEVEL knob sets the trigger level to the 50% amplitude point of the signal and triggers the signal that you just left untriggered. (Leave the signal untriggered.)

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Verify that the delayed trigger system operates: 

- Set up the delayed trigger:
  - From the Trigger menu, select A==B Sequence. This displays the A==B Sequence tab of the trigger setup control window.
  - Click the Trigger After Time button under A Then B.
  - Click the B Trigger Level control in the control window.
- Confirm that the following statements are true:
  - The trigger-level readout for the B trigger system changes to reflect the lower multipurpose level.
  - As you adjust the lower multipurpose-level level, the square-wave probe-compensation signal becomes triggered and untriggered.
  - (Leave the signal triggered.)
- Verify the delayed trigger counter:
  - Double click the Trigger Delay control to pop up a numeric keypad for that control.
  - Click the numeric keypad to set a trigger delay of 1 second and then click Enter.
  - Verify that the trigger READY indicator on the front panel flashes about once every second as the waveform is updated on-screen.

Remove the test lead. Disconnect the cable and adapter from the channel input and the Probe Compensation output.

### Equipment Required
- One BNC cable
- One TCO SMA To Convert adapter
- One 1 MΩ, 55 pF 500V-capped AC-cable

### Prerequisites
- None

1. Initialize the oscilloscope: Push the front-panel DEFAULT SETUP button.
2. Hook up the signal source: Connect the BNC cable from the probe compensation output to the CH1 input through a TCO SMA adapter as shown in Figure 1-9.

Perform the Extended Diagnostics

Extended diagnostics and self-calibration perform a more detailed functionality check than the incoming inspection and Power-on diagnostics.

**NOTE:** Allow a 10-minute warm-up before running the self-calibration.

Disconnect any attached probes from the oscilloscope. Then select the Utilities menu. Run the self-calibration followed by the extended diagnostics by first selecting the Instrument Calibrations and then the Instrument Diagnostics tabs. Results of the tests display on their respective pages.

Checking the Underlying System (Optional)

To check the hardware and Windows software underlying the TDS oscilloscope UI layer interface, run the OAPWinDiag Diagnostic from the Windows Start menu as follows:

1. Quit the oscilloscope application before making the external diagnostics.
2. Display the Task Manager by pressing CTRL, ALT, and Delete.
3. Select TaskManager, and then click End Task.

**NOTE**: About 10 seconds after starting 2nd Task, a program not responding window may appear. If it does, click End Task.
Acceressories and Options

Accessories

This section lists the standard and optional accessories available for the oscilloscope, as well as the product options.

Standard

The following accessories are shipped with the oscilloscope:

<table>
<thead>
<tr>
<th>Accessory</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>graphical packing list (read me first)</td>
<td>011-1201-xx</td>
</tr>
<tr>
<td>User Manual</td>
<td>011-2101-xx</td>
</tr>
<tr>
<td>Core Reference manual (8 languages)</td>
<td>020-2425-xx</td>
</tr>
<tr>
<td>Product Software CD</td>
<td>063-2041-xx</td>
</tr>
<tr>
<td>Operating System Restore CD</td>
<td>063-3077-xx</td>
</tr>
<tr>
<td>Optional Application Software CD</td>
<td>063-3668-xx</td>
</tr>
<tr>
<td>online help (part of the application software)</td>
<td>—</td>
</tr>
<tr>
<td>Performance Verification tp check the product software CD</td>
<td>—</td>
</tr>
<tr>
<td>Power Supply Guide (rever the product software CD)</td>
<td>—</td>
</tr>
<tr>
<td>481.5M, 1.0GHz, and 2GHz-6406 Calibration Certificate</td>
<td>—</td>
</tr>
<tr>
<td>Fast TestConnect-to-SMA adapter</td>
<td>TCA-SMA</td>
</tr>
<tr>
<td>U.S. Power Cord</td>
<td>191-0124-xx</td>
</tr>
<tr>
<td>DeskStand, w/telescoping legs</td>
<td>017-0649-00</td>
</tr>
<tr>
<td>Mouse</td>
<td>119-6299-xx</td>
</tr>
<tr>
<td>Front Cover</td>
<td>200-4653-xx</td>
</tr>
<tr>
<td>Accessory Pouch</td>
<td>016-1447-xx</td>
</tr>
</tbody>
</table>

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Options

The following options can be ordered for the oscilloscope:

- Option 1G: K42M Instrument Cart
- Option U1: Rack Mount Kit (suches: hardware and instructions for mounting to rackmount configuration)
- Option S2: Add addressable probes, 3 GHz, differential probe
- International Power Cord Options:
  - Option A1: Universal (Europe 220 V, 50 Hz)
  - Option A2: United Kingdom 240 V, 50 Hz
  - Option A3: Australia 240 V, 50 Hz
  - Option A5: Switzerland 220 V, 50 Hz
  - Option AC: China 220 V, 50 Hz
- Option A9: No power cord
- Option 3I: TD6416X, lite analysis application with documentation
- Option 1BH: JSH2.0, Test application with documentation
- Option SM: Max soil testing with documentation
- Option ST: Serial pattern triggering with documentation
- Option TDS61LP: Field upgrade options. More are available: consult Tektronix (see page xx) for complete list of available TDS61LP options with installation instructions
- Service options:
  - Option C3: Calibration services extended to cover five years
  - Option C5: Certification services extended to cover five years
  - Option D1: Calibration data report
  - Option D5: Test Data for calibration services in Option C3

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Accessories and Options

Optional

The accessories in Table 1-4 are ordered for use with the oscilloscope at the time this manual was originally published. Consult a current Tektronix catalog for additional, changes, and details.

Table 1-4: Optional accessories

<table>
<thead>
<tr>
<th>Accessory</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Manual</td>
<td>071-7971-xx</td>
</tr>
<tr>
<td>Trans El Box</td>
<td>016-1220-xx</td>
</tr>
<tr>
<td>Scope Cart</td>
<td>04000 (Option 1G)</td>
</tr>
<tr>
<td>P6046 400 MHz differential probe</td>
<td>02046</td>
</tr>
<tr>
<td>P6241 1.2 GHz differential probe</td>
<td>02041</td>
</tr>
<tr>
<td>P6240 1.6 GHz differential probe</td>
<td>02040</td>
</tr>
<tr>
<td>P6249 2 GHz differential probe</td>
<td>02049</td>
</tr>
<tr>
<td>P6250 3 GHz differential probe</td>
<td>02050</td>
</tr>
<tr>
<td>P6251 4 GHz differential probe</td>
<td>02051</td>
</tr>
<tr>
<td>P6252 5 GHz differential probe</td>
<td>02052</td>
</tr>
<tr>
<td>P6253 6 GHz differential probe</td>
<td>02053</td>
</tr>
<tr>
<td>P6254 7 GHz differential probe</td>
<td>02054</td>
</tr>
<tr>
<td>P6255 8 GHz differential probe</td>
<td>02055</td>
</tr>
<tr>
<td>TekConnect-to-SMA adapter</td>
<td>TCA-SMA</td>
</tr>
<tr>
<td>TekConnect-to-BNC adapter</td>
<td>TCA-BNC</td>
</tr>
<tr>
<td>TekConnect-to-9 pin adapter</td>
<td>TCA-9</td>
</tr>
<tr>
<td>Waveform, waveform creation software</td>
<td>TFT100</td>
</tr>
<tr>
<td>WSTRO WaveStor Software</td>
<td>WSTRO</td>
</tr>
<tr>
<td>GPIB cable (1 m)</td>
<td>022-0995-01</td>
</tr>
<tr>
<td>GPIB cable (2 m)</td>
<td>021-0995-00</td>
</tr>
<tr>
<td>USB Keyboard</td>
<td>116-6553-xx</td>
</tr>
<tr>
<td>Small keyboard, touch, USB interface</td>
<td>116-542-xx</td>
</tr>
<tr>
<td>Replacement hard disk</td>
<td>099-1028-xx</td>
</tr>
</tbody>
</table>

NOTE: The P6239 is not supported by the oscilloscope.

TDS6000 Series User Manual

TDS6000 Series User Manual
This chapter acquaints you with how to use the oscilloscope functions and operating. It consists of several maps that describe the system, its operation, and its documentation:

- **Documentation Map**: on page 2-3, lists the documentation that supports the oscilloscope.
- **System Overview Map**: on page 2-4, describes the high-level operating blocks and operating cycle of the oscilloscope.
- **User Interface Map**: on page 2-5, describes the elements of the User Interface (UI) application, which provides complete control of the oscilloscope.
- **Front Panel/IO Map**: on page 2-6, describes the elements of the oscilloscope front panel and some references relevant to each element.
- **Display Map**: on page 2-8, describes the elements of the oscilloscope front panel and some references relevant to each element.
- **Front Panel/IO Map**: on page 2-8, describes the input/output ports and peripherals.

For information on configuring and customizing your oscilloscope, refer to Chapter 1, Getting Started.

---

**System Overview Maps**

The oscilloscope is a highly capable waveform acquisition, test, and measurement system. The following model provides background information on its operation, which, in turn, may provide you insight on how the oscilloscope can be used.

**Functional Model Map**

The model consists of four high-level subsystems or processes (embodied in a variety of hardware and software functions) and the "data" that connect them.

- **Digital Signal Acquisition**: Acquires a waveform record from each signal that you input to each channel using the following subsystems:
  - **Input Channels**: Condition the input signal, primarily through the use of analog hardware, before the signal is converted to digital form.
  - **Trigger System**: Recognizes a specific event of interest on the input trigger signal and informs the Timebase of the occurrence of the trigger event.

---

**Documentation Map**

This oscilloscope ships with documents individually tailored to address different aspects or parts of the product features and interface. The table below cross-references each document to the oscilloscope features and interfaces it supports:

<table>
<thead>
<tr>
<th>Description</th>
<th>Reference Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation, Specification, and Operation Instructions</td>
<td>User Manual</td>
</tr>
<tr>
<td>Online Help System</td>
<td>Access online help from the oscilloscope for detailed and comprehensive information on all controls and displays. Online help includes procedures for using oscilloscope features.</td>
</tr>
<tr>
<td>Analysis and Connectivity Tools</td>
<td>Waveform Analysis and Connectivity Tools Guide</td>
</tr>
<tr>
<td>GPS Controls</td>
<td>Online Programming Guide</td>
</tr>
</tbody>
</table>

You may also obtain the optional service manual for this product if you want to act as service or perform test this oscilloscope. See Accessories & Options on page 1-29.

---
Overview

This chapter describes in detail how to use the many features of the TDS6006 Digital Storage Oscilloscope series. Please refer to the following sections on using this chapter.

- Each section in this chapter provides background information needed to operate your oscilloscope effectively and is organized with the most important features first. The procedures emphasize using the front panel when possible.

- Lower-level detailed stage procedures are in the online help system.

The table that follows on page 3-1 lists operating tasks and the sections in this chapter that document those tasks.

<table>
<thead>
<tr>
<th>Tasks or subtopics</th>
<th>Subtopics or subtopics</th>
<th>Section title</th>
<th>Contents</th>
<th>Page no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal input</td>
<td>Acquiring Waveforms</td>
<td>Overview of section contents</td>
<td>2-2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Signal Connection and Conditioning</td>
<td>Overview of signal connection and conditioning using front panel, and setup</td>
<td>3-4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To Repeat the Oscilloscope</td>
<td>Auto-repeat of the acquisition, triggering systems and front channels</td>
<td>3-10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Repeating Background</td>
<td>Background information on rear signal conditioning</td>
<td>3-12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sampling Acquisition</td>
<td>Background and setup of acquisition operation and real-time</td>
<td>3-15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acquisition Control Background and setup of acquisition controls</td>
<td>3-25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acquiring Waveforms</td>
<td>Background and setup for acquiring</td>
<td>3-32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tracing Functions</td>
<td>Tracing from the front panel</td>
<td>3-38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advanced Tracing</td>
<td>Overview and setup for tracing on specific pulse and logic waveforms</td>
<td>3-47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sequential Tracing</td>
<td>Overview and setup for tracing after display or triggering on events</td>
<td>3-71</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tasks or topics</th>
<th>Subtopics or subtopics</th>
<th>Section title</th>
<th>Contents</th>
<th>Page no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display Functions</td>
<td>Display Measurements</td>
<td>Display settings</td>
<td>Using triple features and customizing</td>
<td>3-79</td>
</tr>
<tr>
<td></td>
<td>Using the BeamFormat Display</td>
<td>Display setup and display setup of the display</td>
<td>3-80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Setting Zoom Controls</td>
<td>Overview and use of zoom</td>
<td>3-87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Customizing the Display</td>
<td>Customizing display settings</td>
<td>3-87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring Waveforms</td>
<td>Setting for measuring waveforms</td>
<td>3-99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Setting Automatic Measurements</td>
<td>Overview and setup for setting automatic measurements</td>
<td>3-105</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Memory Control Measurement</td>
<td>Overview and setup for setting memory measurements</td>
<td>3-109</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring Waveforms</td>
<td>Overview and setup for measuring waveforms</td>
<td>3-115</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimizing Measurement Accuracy</td>
<td>Overview of setting for display measurements</td>
<td>3-116</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measuring Waveforms</td>
<td>Functions for processing waveforms, including capturing waveforms, and so on</td>
<td>3-117</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimizing Measurement Accuracy</td>
<td>Functions for processing waveforms, including capturing waveforms, and so on</td>
<td>3-118</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimizing Measurement Accuracy</td>
<td>Functions for processing waveforms, including capturing waveforms, and so on</td>
<td>3-118</td>
<td></td>
</tr>
</tbody>
</table>
Acquiring Waveforms

Before you can do anything (display, print, measure, analyze, or otherwise process) a waveform, you must acquire the signal. This oscilloscope comes equipped with the features that you need for acquiring your waveforms before further processing them according to your requirements. The following topics cover acquiring signals and digitizing them into waveform records:

- **Signal Connection and Conditioning:** How to connect waveforms to the oscilloscope channels, how to scale and position the channels and timescale for acquiring waveforms.
- **Setting Acquisition Controls:** How to choose the appropriate acquisition mode for acquiring your waveforms, how to start and stop acquisition.
- **Acquisition Control Background:** Background information on the data sampling and acquisition process.

NOTE. This section describes how the vertical and horizontal controls define the acquisition of line waveforms. These controls also define how all waveforms are displayed. Both line and derived waveforms (math waveforms, reference waveforms, and so on) use the sections that follow cover display-related usage:

- **Displaying Waveforms** on page 3-79.
- **Creating and Using Math Waveforms** on page 3-127.

Connecting and Conditioning Your Signals

For more background on acquisition window concepts, see **Input Conditioning Background** on page 3-12.

The oscilloscope automatically obtains and displays a stable waveform of usable size. Pushing the Amplitude button automatically sets up the oscilloscope controls based on the characteristics of the input signal. Amplified is much faster and easier than a manual control-by-control setup.

The oscilloscope can be used to test its factory default settings. Some input conditioning controls or features may be limited when other control settings are in effect. Voltage offset is incompatible with reference waveforms because offset is in acquisition control.

Read the following topics related to waveform acquisition; for details that can make it easier to set up and acquire your waveforms.

Probes and Signal Connection. Select the probe or cable that best fits your acquisition needs. Whether it's measuring an active probe or a digital device, or connecting to a test fixture through SMA cables to characterize a device. The connection to the oscilloscope depends on your application.

Terminal provides a variety of probes and cables for this product. For a list of probes available at the same Accessories and Options on page 3-26. You can also check your terminal catalog for connection accessories that may support your application. More information about your probes can be found in the user manuals and accessories product.

Four acquisition channels are available. Each channel can be displayed as a waveform or a waveform (plus or minus waveform) for math waveforms (math and reference waveforms, for example).

Coupling. All oscilloscopes and probes specify a maximum signal level. (See Specifications in your user's manual in n between limits.) Exceeding the limit, even momentarily, will damage the input channel. Use external inputs if necessary to prevent exceeding the limits. Coupling defense may further damage input signals in high-level inputs.

The input resistance of each input channel is 50 ohm. To properly terminate signals in other impedances, use an adapter.

All probes expect a specific coupling and input termination. Both coupling and input termination resistances are displayed on screen.

Acquiring Waveforms

**Signal Connection and Conditioning:**

This section presents an overview of the oscilloscope features related to setting up the input signals for digitizing and acquisition. It addresses the following topics:

- How to run on channels and adjust vertical scale, position, and offset.
- How to set horizontal scale, position, and access record length and trigger-position controls.
- How to get a basic trigger on your waveform.

**NOTE.** This manual uses the terms vertical acquisition window and horizontal acquisition window throughout this section and elsewhere. These terms refer to the vertical and horizontal dimensions of the range of the input signals that are acquired by the acquisition systems. The terms do not refer to any windowing or display windows on screen.

Figure 3-1 shows the model for each input channel.

**Figure 3-1: Input and Acquisition Systems and Controls**

Use input conditioning to ensure the oscilloscope acquires the data that you want to display, measure, or otherwise process. To ensure the best possible data for displaying and further processing, do the following:

- Set the vertical scale to center the size of the vertical acquisition window for each channel. To center the waveforms, set the vertical position on the waveform to center the waveforms. Set the vertical sweep range to capture part of all of the vertical amplitude of the input signal. When vertical scaling is set too low, it can cause a fraction of the input signal's range (the increased distortions, the vertical offset control can be used to determine which portion of the input signal is captured by the vertical acquisition window.

- Set horizontal scale to center the size of the horizontal acquisition window for each channel. To center the horizontal position on the waveform to center the waveforms. Set the horizontal position to specify the window relative to a trigger and to control where in the input signal (data stream) the horizontal acquisition window acquires.
### To Set Up Signal Input

**Overview**
- Use the procedure that follows when setting up the oscilloscope to scale and position input signals for acquisition. For more information, display the online help while performing the procedure.

<table>
<thead>
<tr>
<th>Overview</th>
<th>To set up signal input</th>
<th>Related control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparations</td>
<td>1. The acquisition system should be set to run continuously.</td>
<td><img src="image1" alt="Diagram" />See page 3-10 for acquisition setup and page 3-20 for trigger setup.</td>
</tr>
<tr>
<td>Connect input signal</td>
<td>2. Connect to the signal to be acquired using proper probes and connecting techniques.</td>
<td><img src="image2" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>3. After more details on correct using the input setup, push the vertical button to display the vertical control window, and then touch the HELP button.</td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td>Select the input signal channel</td>
<td>4. Push a channel button (CH 1-CH 4) to select the signal channel. A channel button is lit when its channel is on.</td>
<td><img src="image4" alt="Diagram" /></td>
</tr>
<tr>
<td>Select input coupling</td>
<td>5. Touch Vert to display the Vertical control window. To change the input coupling, select the channel tab, and then select from:</td>
<td><img src="image5" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>- DC to couple both the AC and DC components of an input signal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- GND to disconnect the input signal from the acquisition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Touch Close to close the window.</td>
<td><img src="image6" alt="Diagram" /></td>
</tr>
</tbody>
</table>

---

### To Autoset the Oscilloscope

**Overview**
- AutoSets automatically sets up the oscilloscope to perform acquisition, display histogram, arrow, and vertically based on the characteristics of the input signal. AutoSets is much faster and easier than a manual control-by-control setup. When the input signal is connected, do as AutoSets to automatically set up the oscilloscope:

<table>
<thead>
<tr>
<th>Overview</th>
<th>To autoset the oscilloscope</th>
<th>Related control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparations</td>
<td>1. Signals must be connected to channels. A triggering source must be provided.</td>
<td><img src="image7" alt="Diagram" />See page 3-10 for trigger setup.</td>
</tr>
<tr>
<td>Execute</td>
<td>2. Push the Autoset button to execute AutoSets.</td>
<td><img src="image8" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>If you use AutoSet when one or more channels are disabled, the oscilloscope will display the last enabled channel for horizontal scaling and triggering. All channels in use are individually vertically scaled.</td>
<td><img src="image9" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>If you use AutoSet when no channels are displayed, the oscilloscope will display channel one (CH 1) and adjust it.</td>
<td><img src="image10" alt="Diagram" /></td>
</tr>
<tr>
<td>Prompt</td>
<td>2. Select Lower Probes in the Utility menu to display the prompt before AutoSet window. Touch Autoset to toggle between On and Off.</td>
<td><img src="image11" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>On: OFF to set up by performing an autoset when the AUTOSET button is pushed.</td>
<td><img src="image12" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>Off: To set up by displaying a prompt before performing an autoset when the AUTOSET button is pushed.</td>
<td><img src="image13" alt="Diagram" /></td>
</tr>
<tr>
<td>Done</td>
<td>Touch Close to view your prompt selection.</td>
<td><img src="image14" alt="Diagram" /></td>
</tr>
</tbody>
</table>

**Note:** AutoSets may change the vertical position and position the waveform appropriately. If your normal offset is 0, setting an autooffset probe is recommended. If you are not using an autooffset probe and your signal contains offset noise or off-frequency compensation signals, you may need to adjust the Vertical offset and SCALE to display the signal.
Acquiring Waveforms

To Reset the Oscilloscope

You may want to revert to the factory default setup if, so, reset the oscilloscope.

Overview | To reset the oscilloscope | Control elements and resources
--- | --- | ---
Prerequisites | 1. The oscilloscope is powered up and running. | Control knobs, buttons,
| | | other control elements
| | | See Also: 6-14, page 1-8
Exercise 2. Push the DEFAULT SETUP button.

To Get More Help

You can get help on the vertical and acquisition controls by accessing online help.

Overview | To get more help | Control elements and resources
--- | --- | ---
Prerequisites | 1. Oscilloscope powered up and running. | Control knobs, buttons,
| | | and other control elements
Access | 2. Touch the Help button in the bar mode or select Help on | See Page: 1-8
vertical set up Help | | Help menu or menu bar.
| | | 3. You can also select topics in the vertical window Help
| | | Contents tree in the Help menu, as shown at right.

Input Conditioning

This section contains background information that can help you more effectively set up the acquisition window for each channel.

Input. If you want the oscilloscope samples in real-time or random equivalent time, both sampling systems provide probe information by using the trigger to stop an already running acquisition. Both sampling systems also sample the input after it is scaled, providing improved input protection and dynamic range.

CAUTION. To prevent damaging the acquisition system, do not override the inputs and observe static-safe procedure.

Artifact Considerations.Artifact acquires samples from the input signal and attempts to rate the following attribute based on the input data:

- Evaluation of the signal and set the size and vertical offset of the vertical acquisition window to acquire the signal with good resolution, but without clipping.
- Set the trigger to the approximate midpoint of the signal being acquired and switch to each trigger mode.

Vertical Acquisition Window Considerations. You can set the vertical size, position, and offset for each channel independently of other channels. Vertical scale, position, and offset specify the vertical acquisition window for each channel. Parts of the signal amplitude that fall within the vertical window are acquired. This is not to exceed (if any) the size.

The offset control sets the center DC level from the input signal before the vertical scale factor is applied, and the vertical position control sets a constant number of divisions of signal after the scale factor is applied to the resulting difference.

The vertical scale and position controls have the following effects on the vertical acquisition window and the displayed waveform:

- The vertical scale per division that you can select determines the vertical size of the acquisition window. Changing the scale factor to contain all of a waveform and the size of the vertical acquisition window that contain the entire waveform, but only one window contains the entire waveform in the graticule as shown.
a. SCALE setting determines the vertical acquisition window size; here 100 mV/div x 10 divisions (5 graticule divisions + 1 division of position)

![Diagram of vertical window settings]

b. Vertical offset and position can change the location of the acquired waveform within the acquisition window, representing it as a base waveform appears in the graticule

![Diagram of vertical offset and position settings]

Figure 3-2: Setting vertical range and position of input channels

The vertical offset control adjusts the vertical acquisition window and the displayed waveform as follows:

- The vertical range (window) is always centered around the offset value. It is the voltage level at the middle of the vertical acquisition window. With no (zero) offset, as shown in Figure 3-2 and in (b), the voltage level is zero (ground).

- As you vary vertical offset, the middle voltage level moves relative to the waveform. With zero offset, the waveform moves only in the horizontal plane. As the offset moves the middle of the vertical acquisition window up and down on the input signal, Figure 3-3 shows how offset moves the acquisition window to control the portion of the waveform amplitudes the window captures.

- Applying a negative offset moves the vertical range down relative to the DC level of the input signal. Likewise, applying a positive offset moves the vertical range up. See Figure 3-3.

![Diagram of vertical offset and position settings]

Figure 3-3: Varying offset moves the vertical acquisition window on the waveform

Horizontal Acquisition Window Considerations. The oscilloscope lets you define the horizontal acquisition window, which is set several parameters that determine the location of an incoming signal that becomes the waveform record when acquired. (See e.g., Vertical Window on page 3-15.) These parameters specify the horizontal acquisition window and are applied to all channels in parallel. (See Independent vs. Shared Window on page 3-13.) These parameters are:

- The trigger condition you set determines the point on the waveform that triggers the oscilloscope.

Horizontal Scale vs. Record Length vs. Sample Interval vs. Resolution. These parameters all relate to each other and specify the horizontal acquisition window. Because the horizontal acquisition window must fit within the 10 horizontal divisions display, for most cases you will set the duration of the horizontal acquisition window (10 divisions x 10 divisions) as described in (d) below. In selecting a record length in samples, you effectively set the horizontal acquisition window/sample rate for the horizontal acquisition window (waveform record). The relationship between these horizontal elements follows:

1. Time Duration (seconds) = 10 divisions x Vertical scale (mV/div)
2. Time Duration (seconds) = Sample Interval (seconds/sample) x Record Length (samples),
   where:
   Time Duration is the horizontal acquisition window time duration
   Sample Interval is the time duration between samples
   Record Length is the number of samples in the record

![Diagram of horizontal acquisition window definition]

Figure 5-1: Horizontal Acquisition window definition

In (b) above, note that it is Sample Interval that varies to accommodate the window time duration (and its scale setting) and the Record Length setting as these latter two elements can be set by you. These elements behave as follows:

- If Record Length or Time Duration vary, Sample Interval varies to accommodate, up to the highest sample rate. Sample Rate = highest sample rate / highest resolution.

- If Sample Rate reaches its lowest limit, Record Length must decrease in Sample Rate decreases (you set lower sample settings), or Time Duration must increase (lower sample settings), or Record Length decreases (you set lower sample settings). The equation becomes:

Maximum Record Length = Time Duration x Sample Interval

For example, at 200 pico-seconds and 10 divisions, the record length must be 4000 points.

Max Rec Length = 200 pico-seconds x 10 div x 10 div = 2000 samples

Max Rec Length = 500 samples

NOTE: As implied from the operation just described, resolution and the equation above, sample interval and sample rate (see equation 2 above), must not be set freely, but must be derived. You can, however, check the resolution at any time in the resolution menu (also note, that the Resolution control actually displays the record length to increase sample density. The above discussion also assumes that horizontal scale is held constant. You can, however, choose to hold the sample rate constant instead, by selecting either Sample Rate as constant or Sample Rate as constant, User Preferences menu.

Independent vs. Shared Window. The oscilloscope applies the same horizontal acquisition window to all channels from which it acquires data. Unlike the vertical acquisition window, you set this independent for each channel (the same horizontal resolution, record length, and horizontal position). Both the same trigger source apply to all channels simultaneously. One trigger, for a single trigger source, will locate a common horizontal acquisition window for all waveforms, which you can shift in parallel by setting the horizontal position control.

The horizontal acquisition window determines the waveform records extracted from all signals present in an individual channel. You can think of the horizontal acquisition window as cutting away any input signals present in the input channels to extract the waveform information from the waveform records. See Figure 5-1.
Acquiring Waveforms

Setting Acquisition Controls

This section presents overviews of the acquisition features of the oscilloscope — those that start and stop acquirements and those that control how the oscilloscope processes the data as it is acquired (just sampled, or averaged or enveloped). Special features, keys to setting, and operation controls are covered.

![Diagram of acquisition controls](image)

The following table indicates which acquisition features and modes are incompatible with other features or modes:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Incompatible with</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope length</td>
<td>Envelope</td>
<td>Acquirements until the specified number of waveforms have been acquired are averaged.</td>
</tr>
<tr>
<td>Vertical position</td>
<td>Scope length</td>
<td>Scope length and vertical position are aligned.</td>
</tr>
<tr>
<td>Horizontal position</td>
<td>Scope length</td>
<td>Scope length and horizontal position are aligned.</td>
</tr>
<tr>
<td>Acquirements</td>
<td>Scope length</td>
<td>Scope length and acquirements are aligned.</td>
</tr>
<tr>
<td>Vertical position</td>
<td>Horizontal position</td>
<td>Vertical position and horizontal position are aligned.</td>
</tr>
<tr>
<td>Horizontal position</td>
<td>Vertical position</td>
<td>Vertical position and horizontal position are aligned.</td>
</tr>
<tr>
<td>Acquirements</td>
<td>Vertical position</td>
<td>Vertical position and acquirements are aligned.</td>
</tr>
<tr>
<td>Horizontal position</td>
<td>Horizontal position</td>
<td>Horizontal position and acquirements are aligned.</td>
</tr>
</tbody>
</table>

Using the Acquisition Controls

Consider the mode you want to use to acquire data:

- **Envelope**: Continuously, or subsequent waveforms are acquired, the oscilloscope measures the maximum/minumum (min) and maximum/mean values in adjacent sample intervals, creating an envelope of the number of waveforms you specify. Once the specified number of waveforms is finished, the data is cleared and the process starts over Again, this is similar to the Peak Detect mode, but Envelope mode, unlike Peak Detect, graphs peaks over many trigger events.
- **Average**: The oscilloscope measures the number of waveforms you specify into the acquired waveform, creating a running average of the input signal. This mode reduces random noise.

Acquiring and displaying a noisy square wave signal illustrates the difference between the modes. Now, low level shows the noise while Envelope captures its extremes.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope length</td>
<td>Acquirements until the specified number of waveforms have been acquired are averaged.</td>
</tr>
<tr>
<td>Vertical position</td>
<td>Scope length and vertical position are aligned.</td>
</tr>
<tr>
<td>Horizontal position</td>
<td>Scope length and horizontal position are aligned.</td>
</tr>
<tr>
<td>Acquirements</td>
<td>Scope length and acquirements are aligned.</td>
</tr>
<tr>
<td>Vertical position</td>
<td>Horizontal position and vertical position are aligned.</td>
</tr>
<tr>
<td>Horizontal position</td>
<td>Vertical position and horizontal position are aligned.</td>
</tr>
<tr>
<td>Acquirements</td>
<td>Vertical position and acquirements are aligned.</td>
</tr>
<tr>
<td>Horizontal position</td>
<td>Horizontal position and acquirements are aligned.</td>
</tr>
</tbody>
</table>

Waveform Database: Using waveform database technology, the oscilloscope processes a much larger sample of data. The waveform database is a three-dimensional accumulation of waveform data over several acquisitions. In addition to maintaining and updating the database, the database contains a count of the number of times a specific waveform point (time and amplitude) has been acquired. The database is 2048 lines by 500 columns with a 94 bit counter for each pixel location. You can see color-coded graphs of the database to highlight waveform activity. Parametric measurements derived from the database use standard techniques to produce more usable, accurate results.

If you select infinite Persistence, the cursor scans continuously. An infinite waveform data base is required for some Cosine measurement.

Samples sets the minimum number of samples required to complete a single acquisition sequence and the minimum number of samples required to complete a mask test. Samples also sets the minimum number of samples acquired before the display is refreshed.

The actual number of samples acquired is determined by the Samples setting, the selected Record Length, and if in equivalent time acquisitions, the actual number of samples acquired is an acquisition. For example, if the Record Length is 500 points and Samples is set to 500 points, then 50 acquisitions are required to acquire 500 points and 1,000 points are acquired.

Adding the Acquisition Controls

Consider the mode you want to use to acquire data:

- **Sample**: The oscilloscope does not post-processing of acquired samples. The oscilloscope saves the first sample (or perhaps many) during each acquisition interval (the acquisition interval is the time covered by the waveform record defined by the record length). Sample mode is the default mode.

- **Peak Detect**: The oscilloscope alternates between saving the lowest sample in one acquisition interval and the highest sample in the next acquisition interval. This mode works with real-time, noninterpolated sampling.

- **Hi Res**: The oscilloscope creates a record point by averaging all samples taken during an acquisition interval. HI Res results in a higher resolution, lower-bandwidth waveform. This mode only works with real-time, noninterpolated sampling.

A key advantage of HI Res is its potential for increasing resolution regardless of the signal height. Table 3-1 indicates you can obtain up to 15 significant bits with HI Res mode. Note that the resolution improvements are limited to speeds slower than 40 ns.

### Additional resolution bits

<table>
<thead>
<tr>
<th>Time base speed</th>
<th>Mode of resolution</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 ns to 200 ns</td>
<td>10 bits / 10 bits</td>
<td>&lt; 16 MHz</td>
</tr>
<tr>
<td>500 ns to 1 µs</td>
<td>11 bits / 12 bits</td>
<td>&lt; 25 MHz</td>
</tr>
<tr>
<td>1 µs to 10 µs</td>
<td>11 bits / 12 bits</td>
<td>&lt; 50 MHz</td>
</tr>
<tr>
<td>10 µs to 100 µs</td>
<td>12 bits / 13 bits</td>
<td>&lt; 1.5 MHz</td>
</tr>
<tr>
<td>100 µs to 1000 µs</td>
<td>13 bits / 14 bits</td>
<td>&lt; 250 kHz</td>
</tr>
<tr>
<td>1 µs and shorter</td>
<td>14 bits</td>
<td>&lt; 250 kHz</td>
</tr>
</tbody>
</table>

### Global Controls

Like the horizontal controls, the acquisition controls apply to all active channels for example, channel 1 cannot acquire on Sample mode while channel 2 acquires in E-cep mode. You cannot stop channel 4 from acquiring (2 channels only). Other horizontal channels continue to acquire.

### Preventing Aliasing

Under certain conditions, a waveform may be aliased on screen. Read the following description about aliasing and the suggestions for preventing it.

When a waveform aliases, it appears on screen with a frequency lower than the actual waveform being input or it appears unstable even though the TRUG 100 light is lit. Allowing output becomes the oscilloscope is not sampling the signal fast enough to construct an accurate waveform record. (See Figure 3-6.)

Acquiring Waveforms

Acquiring Waveforms

Also, consider how you want to control acquisition; you have two main options that you can select from the Run/Stop control window (one Run/Stop from the Home/Aux menu).

- **Run/Stop Button Only**: Sets the oscilloscope to start and stop the acquisition only when you push the Run/Stop button, available on the front panel, or on the Run/Stop control window. If triggered to Run, the acquisition will start at a valid trigger source. If triggered to Stop, the acquisition stops immediately.

- **Single Acquisition**: In addition to the Run/Stop button, which can always stop the acquisition, the SINGLE button (or Single Channel control) will automatically stop the acquisition once the complete sequence is sampled. See Step 5, Select mode, on page 3-24, on how to access the online help from the Run/Stop control window for more information.

### Aliasing

Under certain conditions, a waveform may be aliased on screen. Read the following description about aliasing and the suggestions for preventing it.

*When a waveform aliases, it appears on screen with a frequency lower than the actual waveform being input or it appears unstable even though the TRUG 100 light is lit. Allowing output becomes the oscilloscope is not sampling the signal fast enough to construct an accurate waveform record. (See Figure 3-6.)*

### Aliasing

**Method to Check and Eliminate Aliasing**

To quickly check for aliasing, slowly increase the horizontal scale (rms per division setting) if the shape of the displayed waveform changes drastically or becomes neither a faster time base setting, your waveform was probably aliased.
To avoid aliasing, be sure to sample the input signal at a rate more than twice as fast as the highest frequency component. For example, a signal with frequency components of 50 MHz would need to be sampled at a rate faster than 100 MHz to represent it accurately and to avoid aliasing. The following tips may help you minimize aliasing on a signal:

- Try adjusting the horizontal scale for proper waveform display.
- Try pushing the AUTOSET button.
- Try minimizing the acquisition to a single waveform. Envelope selection will show the highest and lowest values on multiple acquisitions and can detect faster signal components over time.

### To Set Acquisition Modes

The procedure follows to set the data acquisition mode and specify acquisition parameters. For more information, refer to the relevant section when performing the procedure.

<table>
<thead>
<tr>
<th>Overview</th>
<th>To set acquisition mode</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites 1.</td>
<td>Oscilloscope must be turned on and connected to the desired instrument.</td>
<td><img src="image1.png" alt="Diagram" /></td>
</tr>
<tr>
<td>2.</td>
<td>Select Acquisition Mode from the HorSet menu to display the Acquisition Mode control window.</td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

### Acquiring Waveforms

#### Overview

#### To set acquisition mode

<table>
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<td><img src="image2.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

#### Control elements and resources

- **Select the acquisition mode:** Touch to choose the acquisition mode, choose from the following modes:
  - Sample
  - Peak Detect
  - H Res
  - Envelope
  - Average
  - WM Database
  - For average and Envelope modes only, select the number of acquisitions to average or envelope.

- **Set the stop mode:**
  1. Push the RUN/STOP button on the RUN/STOP control window to trigger between acquiring (Running) and stopping acquisitions.
  2. Push the SINGLE button on the RUN/STOP control window to acquire enough waveforms to satisfy the acquisition mode and then stop.

---

### To Start and Stop Acquisition

Use the procedure that follows to start and stop acquisitions.

<table>
<thead>
<tr>
<th>Overview</th>
<th>To start and stop acquisitions</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Oscilloscope must be turned on and connected to the desired instrument.</td>
<td><img src="image1.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>
| 2. | Select the acquisition mode, choose from the following modes:
  - Sample
  - Peak Detect
  - H Res
  - Envelope
  - Average
  - WM Database
  - For average and Envelope modes only, select the number of acquisitions to average or envelope. | ![Diagram](image2.png) |
| 3. | Push the RUN/STOP button to start acquiring. | ![Diagram](image3.png) |
| 4. | Push the SINGLE button on the RUN/STOP control window to acquire enough waveforms to satisfy the acquisition mode and then stop. | ![Diagram](image4.png) |

---

### For more help

- See references listed at right.
- See the User Manual for more information.
**Acquisition Control Background**

This section contains background information on the data sampling and acquisition process that can help you more effectively setup the acquisition window of each channel. This section:

- Describes the acquisition hardware.
- Defines the sampling process, sampling modes, and the waveform record.
- Describes the normal acquisition cycles.

**Acquisition Hardware**

Before a signal can be acquired, it must pass through the input channel where it is scaled and digitized. Each channel has a dedicated input amplifier and digitizer as shown in Figure 3-7, each channel can produce a stream of digital data from which waveform records can be extracted. See Signal Conditioning and Conditioning on page 3-4 for further description of scaling, positioning, and DC offset of channels.

![Digitizer configuration](image)

**Sampling Process**

Acquisition is the process of sampling the analog input signal of an input channel, converting it into digital data, and assembling it into a waveform record, which is then stored in acquisition memory. Sampling, then, is the process that produces a waveform record per trigger event (see Figure 3-9 on page 3-29). The input term width is the vertical range of the amplifier and sampled.

![Waveform record and its defining parameters](image)

**Real-time Sampling**

The two general methods of sampling are real-time and equivalent-time. This oscilloscope uses both real-time and equivalent-time sampling.

In real-time sampling, the oscilloscope digitizes all the points it acquires after one trigger occurs (see Figure 3-10). Always use real-time sampling to capture single-shot or transient events.

![Real-time sampling](image)

**Equivalent-time Sampling**

The oscilloscope uses equivalent-time sampling to extend its sample rate beyond its real-time maximum sampling rate, but only under two conditions.

![Figure 3-10: Real-time sampling](image)

**Sampling Modes**

The oscilloscope's acquisition system can process the data as it is acquired, averaging or deconvolving the waveform data to produce enhanced waveform results. Once the waveform record is analyzed, you can see the waveform data using enhanced waveform records. See Signal Conditioning and Conditioning on page 3-4 for further description of scaling, positioning, and DC offset of channels.

![Waveform Record](image)

**WAVEFORM RECORD**

While sampling the input signal provides the data that makes up the waveform record for any given channel, the oscilloscope builds the waveform record through the use of some common parameters (functions) that affect the waveform in all channels.

Figure 3-9 shows how these common parameters define the waveform record, as shown in the figure, the vertical scale of the input signal is the same for all channels. The time scale of the waveform record is determined by the trigger point. All waveform samples are located in time with respect to the trigger point.
Acquiring Waveforms

The type of equivalent-time sampling the oscilloscope uses is called random equivalent-time sampling. Although it takes the samples sequentially in time, it takes them randomly with respect to the trigger. Random sampling occurs because the oscilloscope sample clock rate is synchronized with respect to the input signal and the trigger signal. The oscilloscope takes samples independently of the trigger position and displays them based on the time difference between the sample and the trigger.

Interpolation

Your oscilloscope can interpolate between the samples it acquires. Like the equivalent-time sampling, it does so only when it does not have all the real samples it needs to fill its displayed waveform. When setting the zoom to progressively larger amounts of expansion, the oscilloscope then interpolates to create the intervening points in the displayed waveform. There are two options for interpolation: linear or sincx. (The oscilloscope can also interpolate samples to acquire new samples; see Equivalent-Time Sampling on page 3-28).

Linear interpolation computes real points between actual acquired samples by using a straight line fit. It assumes all the interpolated points fall in their appropriate vertical position on that straight line. Linear interpolation is useful for many waveforms such as pulse trains.

Sincx interpolation computes real points using a curve fit between the actual values acquired. It assumes all the interpolated points fall along that curve. Sincx is particularly useful when acquiring more recorded waveforms such as sine waves. Actually, it is appropriate for general use, although it may introduce some overshoot or undershoot in signals with fast rise times.

Table 3-1: How interleaving affects sample rate

<table>
<thead>
<tr>
<th>Number of channels in use</th>
<th>Maximum digitizing rate when real-time sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 MHz</td>
</tr>
<tr>
<td>2</td>
<td>10 MHz</td>
</tr>
<tr>
<td>3 or 4</td>
<td>6.666 MHz</td>
</tr>
</tbody>
</table>

Interleaving

The oscilloscope can interleave its channels to attain higher digitizing rates without equivalent-time sampling. The oscilloscope applies the digitizing resources of unused channels (the k, channels that are turned off) to sample those that are in use turned on. Table 3-1 lists how interleaving more than one digitizer to sample a channel reduces the maximum digitizing rate.

Once you set horizontal scale to exceed the maximum digitizing rate for the number of channels in use (see Table 3-1), the oscilloscope will not be able to get enough samples to create a waveform record. At that point, the oscilloscope will switch from real to equivalent-time sampling to obtain additional samples. (See Equivalent-Time Sampling on page 3-28).

Triggering

To properly acquire data, that is, to use the oscilloscope to sample a signal and digitize it into a waveform record that you want to measure or otherwise process, you need to set up the trigger conditions. This section provides background on, and the procedures for using, the basic elements of triggering: source, level, delay, and so on. This section covers the following topics:

- Trigger Concepts which describes some basic principles of triggering and the following trigger parameters: type, source, coupling, holdoff, mode, and so on
- Triggering from the Front Panel which describes how to use the front-panel triggering controls each of which is common to most of the trigger types the oscilloscope provides.
- Additional Trigger Parameters which describes how to access common trigger builts in the Trigger control window.
- Advanced Triggering which describes trigger types that you can use to trigger specific high-signals phenomena.
- Sequential Triggering which describes how to combine the A (main) and B (delayed) trigger systems to capture impulse events.

Figure 3-12: Triggered versus untriggered displays

The trigger event establishes the time-zero point in the waveform record. All points in the record are located in time with respect to that point. The oscilloscope continuously acquires and retains enough sample points to fill the trigger portion of the waveform record (the part of the waveform that is displayed before, or to the left of, the trigger event on screen). When a trigger event occurs, the oscilloscope begins acquiring sample points to build the posttrigger portion of the waveform record. It displays the portion to the right of the trigger event. Once a trigger is detected, the oscilloscope will continue to accept another trigger until the acquisition is complete and the holdoff time has expired.

Trigger Sources

The trigger source provides the signal that triggers acquisition. Use a trigger source that is synchronized with the signal that you are acquiring and displaying. You can select your trigger from the following sources:

- Logic channel: for the most commonly used trigger sources. You can select any one of the four input channels. The channel you select as a trigger source will dominate whether it is displayed or not.
- AC Line Voltage: a convenient trigger source when you are looking at signals related to the power line frequency. Example include devices such as lighting equipment and power supplies. Because the oscilloscope generates the trigger from the power line, you do not have to worry about a channel input.
- Auxiliary Trigger (Aux TRIG) provides a fifth source you can use as a trigger source when you need to use the four input channels for other signals. For example, you might want to trigger on a 1kHz signal displayed from other logic signals. Termed the auxiliary trigger, connect the signal to the Auxiliary Trigger input connector on the front panel. The Auxiliary Trigger input is only compatible with most probes, but can you display the auxiliary trigger signal.
Triggering

Trigger Types

The oscilloscope provides two categories of trigger types:

- **Edge trigger** is the simplest and most commonly used trigger type. You can use it with analog or digital signals. An edge trigger occurs whenever the trigger point crosses the specified voltage level in the specified direction (the trigger slope).

- **Advanced triggers** are a collection of trigger types that are primarily used with digital signals to detect specific conditions. The glitch, restart, width, transition, and direction types trigger on unique properties of pulses that you can specify.

The patterns and rules trigger on logic combinations of several signals. The automatic edge triggers are available on the A (Main) trigger only.

Trigger Nodes

The trigger mode determines how the oscilloscope behaves in the absence of a trigger event:

- **Normal trigger mode** enables the oscilloscope to acquire a waveform only when it is triggered. If you trigger, the oscilloscope will acquire a waveform. If no waveform occurs, none is displayed. See Figure 3-12. To change the waveform that occurs, use the Trigger level control, which controls the trigger sensitivity. (You can push FORCE TRIGGER, in the Tool Control window, to force the oscilloscope to acquire a waveform.)

- **Auto trigger mode** enables the oscilloscope to acquire a waveform even if a trigger does not occur. Auto mode uses a timer that starts after a trigger event occurs. If no trigger event is detected before the timer times out, the oscilloscope fences a trigger. The length of time it waits for a trigger event depends on the time base setting.

When no trigger occurs, this timer is blank. If no waveform appears on the display, see Figure 3-12. Automatic trigger mode. Automatic acquisitions will not be triggered at the same point on the waveform. Therefore, the waveform will appear to roll across the screen. Of course, if valid triggers occur, the display will become stable on screen.

![Triggered versus untriggered displays](image)

Figure 3-12: Triggered versus untriggered displays

[TD56000 Series User Manual]

Trigger Holdoff

**Trigger holdoff** can help stabilize triggering. When the oscilloscope recognizes a trigger event, it displays the trigger signal until acquisition is complete. In addition, the trigger system remains enabled during the holdoff period that follows each acquisition. You can adjust holdoff to obtain stable triggering when the oscilloscope is triggering on complex trigger conditions as shown in Figure 3-13. A digital pulse train is a good example of a complex waveform. (See Figures 3-14 and 3-15) Each pulse looks like any other, as many possible trigger points exist. Not all of these will result in the same display. The holdoff period allows the oscilloscope to trigger on the correct edge, resulting in a stable display.

Holdoff is adjustable from 200 to (minimum holdoff available) in 10 seconds (maximum holdoff available). To see how to set holdoff, see page 3-33. You can also set the holdoff value in holdoff window; holdoff is available when A only, edge triggering is selected.

![Trigger Holdoff](image)

Figure 3-13: Holdoff adjustment for complex waveforms

[TD56000 Series User Manual]

Trigger Coupling

Trigger coupling determines what part of the signal is passed to the trigger circuit. Edge triggering can use all available coupling types: AC, DC, Low Frequency Rejection, High Frequency Rejection, and Noise Rejection. All the adjusted triggering types use only AC coupling. See **To Set the Trigger Coupling** on page 4-40 for a description of each coupling type.

Horizontal Position

Horizontal position is adjustable and defines where on the waveform record the trigger occurs. It is the point where the oscilloscope acquires before and after the trigger event. The part of the record that occurs before the trigger is the pretrigger portion. The part that occurs after the trigger is the posttrigger portion. When horizontal delay is off, the reference marker shows the trigger position in the waveform. Displaying trigger information is useful when troubleshooting. For example, if you are trying to find the cause of an unwanted glitch in your test circuit, you can trigger on the glitch and make the pretrigger period large enough to capture that before the glitch. By analyzing what happened before the glitch, you can narrow down which circuits are faulted.

Slope and Level

The slope control determines whether the oscilloscope fences the trigger point on the rising or the falling edge of the signal. (See Figure 3-15.)

- **Set trigger slope by pushing the SLOPE button on the front panel to toggle between the positive-going and negative-going edge.**

The level control determines when on the edge the trigger point occurs. (See Figure 3-15.) You can set the trigger level with the LEVEL knob on the front panel. Push the LEVEL knob to automatically set the trigger level to the 50% amplitude point of the signal.

![Slope and level controls help define the trigger](image)

Figure 3-15: Slope and level controls help define the trigger

[TD56000 Series User Manual]

Delayed Trigger System

You can trigger with the A (Main) trigger system alone or you can combine the A (Main) trigger with the B (Delayed) trigger to trigger on sequential events. When using sequential triggering, the A trigger event sets the trigger level and the B trigger event triggers the oscilloscope when the B trigger conditions are met. A and B triggers can (and typically do) have separate

[TD56000 Series User Manual]
To trigger, push the TRIGGER button on the front panel. The 50% trigger level is set by default. To change the trigger level, use the channel A/D gain knob. To set trigger level, use the trigger level control knob. To set trigger width, use the trigger width control knob. To set trigger slope, use the trigger slope control knob. To set trigger mode, use the trigger mode control knob. To set trigger mode, use the trigger mode control knob.

To check trigger status, use the trigger status lights. The trigger status lights are located on the front panel. To check trigger status, use the channel A/D gain knob. To set trigger level, use the trigger level control knob. To set trigger width, use the trigger width control knob. To set trigger slope, use the trigger slope control knob. To set trigger mode, use the trigger mode control knob.

To set trigger level, use the trigger level control knob. To set trigger width, use the trigger width control knob. To set trigger slope, use the trigger slope control knob. To set trigger mode, use the trigger mode control knob.

To check trigger status, use the trigger status lights on the front panel. To set trigger level, use the trigger level control knob. To set trigger width, use the trigger width control knob. To set trigger slope, use the trigger slope control knob. To set trigger mode, use the trigger mode control knob.
Additional Trigger Parameters

Some additional trigger parameters are accessible only through the trigger control window:
- Hold-off
- Trigger level presets
- Force trigger
- Single sequence

Use the procedures that follow to set up these additional trigger parameters. For more information, display online help while performing the procedure.

Overview | Additional trigger parameters | Control elements and resources
--- | --- | ---
To set hold-off:
1. From the trigger control window, click on the Trigger tab.
2. Select Enable Hold-off.
3. Enter the hold-off time in the Hold-off field.

To select a preset trigger level:
1. From the trigger control window, click on the Trigger tab.
2. Select Select Preset.
3. Select the preset trigger level.

To disable hold-off:
1. From the trigger control window, click on the Trigger tab.
2. Select Disable Hold-off.

To set trigger level:
1. From the trigger control window, click on the Trigger tab.
2. Select Trigger Level.
3. Enter the trigger level value.

To set trigger level preset:
1. From the trigger control window, click on the Trigger tab.
2. Select Set Preset.
3. Select the trigger level preset.
4. Enter the trigger level value.

To set trigger level from the keypad:
1. From the trigger control window, click on the Trigger tab.
2. Select Trigger Level.
3. Enter the trigger level value.

To set trigger level using a function key:
1. From the trigger control window, click on the Trigger tab.
2. Select Function Key.
3. Select the function key.
4. Enter the trigger level value.

To set trigger level using a knob:
1. From the trigger control window, click on the Trigger tab.
2. Select Knob.
3. Rotate the knob to set the trigger level value.

To set trigger level using a potentiometer:
1. From the trigger control window, click on the Trigger tab.
2. Select Potentiometer.
3. Rotate the potentiometer to set the trigger level value.

To set trigger level using a slider:
1. From the trigger control window, click on the Trigger tab.
2. Select Slider.
3. Slide the slider to set the trigger level value.

To set trigger level using a manually entered value:
1. From the trigger control window, click on the Trigger tab.
2. Select Manually Enter.
3. Enter the trigger level value.

To set trigger level using an external source:
1. From the trigger control window, click on the Trigger tab.
2. Select External Source.
3. Connect the external source.
4. Enter the trigger level value.

To set trigger level using an internal source:
1. From the trigger control window, click on the Trigger tab.
2. Select Internal Source.
3. Select the internal source.
4. Enter the trigger level value.

To set trigger level using an acquired waveform:
1. From the trigger control window, click on the Trigger tab.
2. Select Acquired Waveform.
3. Select the acquired waveform.
4. Enter the trigger level value.

To set trigger level using a trigger level preset:
1. From the trigger control window, click on the Trigger tab.
2. Select Preset Level.
3. Select the trigger level preset.
4. Enter the trigger level value.
Advanced Triggering

The oscilloscope can trigger on glitches or fast pulses, or it can trigger based on the width, slew rate, or time period of a pulse. These capabilities make the oscilloscope suitable for such tasks as untimed monitoring for, and copying off, a power supply glitch or GO/NO GO slow rate testing of operational amplifiers. This subsection describes how to use advanced triggering: glitches, fast, width, transition (rise/fall), and manual triggering.

The oscilloscope can also trigger on a logic or linear pattern and on the state of a logic pattern at the time it is checked. The oscilloscope can trigger on data that violates setup and hold times relative to a clock. This subsection also describes how to use the advanced triggering pattern, state, and sample hold.

You can check the advanced trigger status in the legend. The legend indicates the trigger type and has shown source, levels, and any other parameters that are important for the particular trigger type. Figure 3-16 shows an example readout for the main trigger type.

```
Figure 3-16: Example advanced trigger readout
```

Read the following topics; they provide guidelines that can help prevent false steps in setting up to trigger on your waveforms.

**Glitch Trigger.** A glitch trigger occurs when the trigger source detects a pulse narrower (or wider) than some specified time. It can trigger on glitches of either polarity. Or you can set the glitch trigger to reject glitches of either polarity.

**Ramp Trigger.** A ramp trigger occurs when the trigger source detects a short pulse that crosses one threshold but fails to cross a second threshold before returning to the first. You can set the oscilloscope to detect any positive or negative ramp pulse, or only those wider than a specified minimum width.

**Table 3-4: Pattern and state logic**

<table>
<thead>
<tr>
<th>Pattern</th>
<th>State</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AND</td>
<td>Clipped AND</td>
<td>If all of the conditions selected for the logic input are TRUE, then the oscilloscope triggers.</td>
</tr>
<tr>
<td>NAND</td>
<td>Clipped NAND</td>
<td>If any of the conditions selected for the logic input are TRUE, then the oscilloscope triggers.</td>
</tr>
<tr>
<td>OR</td>
<td>Clipped OR</td>
<td>If any of the conditions selected for the logic input are TRUE, then the oscilloscope triggers.</td>
</tr>
<tr>
<td>NOR</td>
<td>Clipped NOR</td>
<td>If none of the conditions selected for the logic input are TRUE, then the oscilloscope triggers.</td>
</tr>
</tbody>
</table>

**State Trigger.** A state trigger occurs when the logic is assigned to the logic function (the circuit to be TRUE or at your option FALSE) at the time the clock changes state. When you set a state trigger, you define:

- The conditions for triggering: channels 1, 2, and 3
- The level for triggering: levels 0 and 1
- The Boolean logic function: all AND, NAND, OR, and NOR
- The condition for triggering: whether the trigger occurs when the Boolean function becomes TRUE (logic high) or FALSE (logic low)

The state (and pattern) logic choices are summarized in Table 3-4.

**Setup/Hold Trigger.** A setup/hold trigger occurs when a logic input changes state inside of a setup and hold time relative to the clock. When you use setup/hold triggering, you define:

- The clock controlling the logic input (the data source) and the channel containing the clock (the clock source)
- The clock high or low level
- The clock edge to use
- The setup and hold times
- The Boolean logic function: all AND, NAND, OR, and NOR

The oscilloscope checks the data waveform (the data source) for transitions occurring within the setup and hold window. If any occur, the oscilloscope triggers with the trigger point located at the clock edge. You set setup and hold times by using the setup/hold violation waveform when the data is transitioning. When data is stable, you set the clock edge and level.

**Setup/Hold Triggering**

Setup and hold triggering uses the setup/hold violation zone to detect when data is unstable too near the time it is clocked. Each time trigger behavior occurs, the oscilloscope checks the data waveform (the data source) for transitions occurring within the setup and hold window. If any occur, the oscilloscope triggers with the trigger point located at the clock edge.

Positive setting for both setup and hold times (the most common application) loads the setup violation zone so it spans the clocking edge. (See the waveform in Figure 3-17.) The oscilloscope checks the data waveform (the data source) for transitions occurring within the setup and hold window. If any occur, the oscilloscope triggers with the trigger point located at the clock edge.

**Negative Settings**

Negative settings use the setup violation zone to detect when data is stable too near the time it is clocked. When data is stable, you set the clock edge and level.

**NOTE:** Keep the hold-time setting as high as possible. If you require 1 μs hold time, set the hold-time setting to 1 μs; if you require 0 μs hold time, set the hold-time setting to 0 μs.
### To Trigger on a Glitch

When you select the type Glitch, the oscilloscope will trigger on a pulse narrower (in width) than some specified time. To set up for glitch triggering, do the following procedures.

<table>
<thead>
<tr>
<th>Overview</th>
<th>To trigger on a glitch</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precondition</td>
<td>The oscilloscope must be set with a signal connected to an input channel. Acquisition settings should be set to allow the time of the input to be captured.</td>
<td></td>
</tr>
<tr>
<td>Select the triggering source</td>
<td>From the list box, touch Trigger and select the A Event tab of the Trigger control window.</td>
<td></td>
</tr>
<tr>
<td>Select the polarity and width</td>
<td>To specify which channel becomes the trigger source, trigger source, and select the source from the list.</td>
<td></td>
</tr>
<tr>
<td>5. To specify the pulse polarity, touch Pos (positive), Neg (negative), or either from the Polarities window. Pos looks at positive-going pulses, Neg looks at negative-going pulses, Either looks at both positive and negative going.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. To specify the width of the glitch, touch Width, and set the width using the multipurpose knob or keypad.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### To Trigger on a Burst Pulse

When you select the type Burst, the oscilloscope will trigger on a single pulse that meets some threshold. To set up for burst triggering, do the following procedures.

<table>
<thead>
<tr>
<th>Overview</th>
<th>To trigger on a burst pulse</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select the triggering source</td>
<td>From the list box, touch Trigger and select the A Event tab of the Trigger control window.</td>
<td></td>
</tr>
<tr>
<td>2. Trigger Burst.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select the polarity</td>
<td>To specify which channel becomes the trigger source, trigger source, and select the source from the list.</td>
<td></td>
</tr>
<tr>
<td>3. To specify the direction of the input pulse, touch Polarity and select the positive, negative, or either from the window. Pos looks at positive-going pulses, Neg looks at negative-going pulses, Either looks at both positive and negative-going.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set to trigger when</td>
<td>To determine how wide a burst pulse the oscilloscope will trigger on.</td>
<td></td>
</tr>
<tr>
<td>1. Touch Trigger When and select from the list. a. Occurs when all input pulses exceed the width you set. b. Occurs when all input pulses regardless of width. c. Occurs when only one input pulse exceeds the width you set. d. Occurs when the number of the input pulse, trigger Width, and set the value using the multipurpose knob or keypad.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Image: Diagram showing the triggering process and parameters for both Glitch and Burst triggers.
<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on pulse width</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set the level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Touch Level, and use the multimeter’s range or keypad to set the trigger level.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on pulse width</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set mode and horizon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Mode bar/level bar can be set for standard trigger types. To set mode and horizon, refer to “Set Mode” on page 3-42 and to Set the Trigger Mode on page 3-36.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on pulse width</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Select the source</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. To specify which channel becomes the trigger source, touch Source and select the source from the list.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on pulse width</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set to polarity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. To specify the polarity of the pulse, touch Pos (positive) or Neg (negative) from the window.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on pulse width</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set to triggering</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. To set the range of widths for which the triggering occurs, touch and drag the slider to set the range. Set the trigger count and delay to trigger count to the following range.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on pulse width</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Select the time</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Touch Trigger Time and select the A Eivot tab of the Trigger control window.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on transition time</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Select transition triggering</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. From the Test tab, touch Thg and select the A Eivot tab of the Trigger control window.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on transition time</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Select the source</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. To specify which channel becomes the trigger source, touch Source and select the source from the list.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Trigger based on transition time</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Select polarity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. To specify the trigger edge, touch Pos (positive) and touch Neg (negative) or Position from the window.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Overview | To trigger based on transition time | Control elements and resources
--- | --- | ---
Set the transition level 1. Touch the Upper Level or Lower Level button and use the multipurpose knob or keypad to set the values for the upper and lower levels.
2. Touch the Stop button, select the Oscilloscope tab, and then touch Level to display the level settings.
The level settings determine the voltage component of time base multiplication. To finish displaying transition via transition time, set the time component by using the following steps:
3. Touch Time and use the multipurpose knob or keypad to set the data time value.

Triggering

To trigger based on pulse timeout

When you select the Type Timeout, the oscilloscope will trigger when a pulse transition does not occur within a specified time limit. That is, the trigger will occur value, depending on the polarity you select, the signal stays high at or stays lower than the trigger level for the time value. To set up the timeout triggering, do the following procedures:

Overview | Trigger based on pulse timeout | Control elements and resources
--- | --- | ---
Select timeout triggering 1. From the toolbar, touch Set and select the A Event tab at the Trigger control window.
2. Touch Timeout.

Select the source 1. To specify which channel becomes the trigger source, touch Source and select the source from the list.

Set to trigger time 1. Touch Time. Set Low or Set High from the Trigger window.
2. Touch Time. Set Low or Set High from the Trigger window.
3. Touch Time. Set Low or Set High from the Trigger window.
4. Touch Time. Set Low or Set High from the Trigger window.

Set the timeout level 1. To set the delay, select Delay Time and use the multipurpose knob or keypad to set the delay.

To trigger when

The oscilloscope compares the pulse edges of the trigger source against the bases level and sets the delay (time) in the window. To select whether to trigger on edges with transitions (times) longer than or shorter than the delay set by these controls, use the following steps:

1. Touch Trigger When Transition to or Trigger When Transition Time >.
2. Touch Trigger When Transition Time < or Trigger When Transition Time >.

To set mode and holdoff

Mode and holdoff can be set for all standard trigger types. To set mode and holdoff, refer to the Set Mode or Set Holdoff on page 5-40. To learn more about trigger mode and holdoff, see the descriptions Trigger Modes on page 5-30 and Trigger Holdoff on page 5-36.
Triggering

Overview

When you select a pattern, the oscilloscope will trigger when the inputs to the logic function of the pattern trigger. To see patterns trigger, do the following procedures.

Overview

- To define the logic
- To set the trigger
- To define pattern inputs
- To set thresholds

Overview

To define a signal qualified pattern

Overview

To trigger on a State

Overview

To define a pattern

Overview

To define a state

Overview

To define output

Overview

To define function

Overview

To define trigger

Overview

To define pattern type

Overview

To define pattern

Overview

To define trigger type

Overview

To define trigger pattern

Overview

To define trigger

Overview

To define trigger

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To define trigger type

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To define trigger type
Overview

To trigger on an event

Select the event.

1. From the pull-down menu of the Trigger menu, select the event.

2. Touch Setup/hold.

Select the data source.

3. To select the channel that will be sampled, touch Data Source, and select the source from the list. Do not select the same channel for both the data and clock source.

Control elements and resources

To trigger on a selectable data violation

4. To select the channel that is to be monitored and the edge to use to clock, touch Clock Source, and select the channel from the list.

5. To select the edge to use to clock, select either Pos or Neg from the Clock Edge window.

6. To select the clock that is to be monitored, touch Clock, and select the clock source.

Overview

To trigger on setup/hold time violations

7. To define the data source, touch Data Source, and select the source from the list. Do not select the same channel for both the data and clock sources.

Control elements and resources

To trigger on setup/hold time violation

8. To set the setup time and the hold time, hold down the Setup/hold button, hold down the Hold button, and set the time.

9. Touch Hold Time, and use the multipurpose knobs or keypad to set the hold time. See Figure 3-30.

Positive setup time always adds to the clock edge. Positive hold time always subtracts from the clock edge. Setup time always adds to the clock edge by a level of 0 (In, +) or 1 (In + 1). Hold time always subtracts from the clock edge by a level of 0 (In, -) or 1 (In - 1).

In most cases, you will enter positive values for both setup and hold time. Positive values add the offset time to the setup time before the clock edge or to the hold time after the clock edge. You can also enter negative values for both setup and hold time to subtract the offset time from the level before the clock edge or to subtract the offset time from the level after the clock edge. You can use the "Suct/hold violation" by selecting hold or time type. See Figure 3-30.

Figure 3-30: Triggering on a setup/hold time violation

To set the setup and hold time

To set the setup and hold time, hold down the Setup/hold button, and set the time to hold.

10. To set the setup time and hold time, hold down the Setup/hold button, and set the time to hold.

To set the mode and hold time

To set the mode and hold time, hold down the Setup/hold button, and set the time to hold.

To set the mode and hold time, hold down the Setup/hold button, and set the time to hold.

TD6000 Series User Manual
Sequential Triggering

In applications that involve two or more signals, you may be able to use sequential triggering to capture more complex events. Sequential triggering uses the A (Main) trigger to arm the trigger system, and then uses the B (Delayed) trigger to trigger the oscilloscope if a specific condition is met. You can choose one of two trigger conditions:

- Trigger After Time. After the A trigger arms the trigger system, the oscilloscope triggers on the next B trigger event that occurs after the Trigger Delay Time. You can set the trigger delay time with the keypad on the multipurpose keys.

- Trigger on nth Event. After the A trigger arms the trigger system, the oscilloscope triggers on the nth B event. You can set the number of B events with the keypad on the multipurpose keys.

NOTE: The traditional delayed trigger mode called "Ramp After" is served by Horizontal Delay. You can use horizontal delay to delay acquisition from any trigger event, whether from the A (Main) trigger alone or from a sequential trigger that sets both the A (Main) and B (Delayed) triggers. See Triggering with Horizontal Delay on page 5-32 for more information.

Using Sequential Triggering

Read the following topics to gain greater insights on your waveforms.

Trigger Sources. In most cases, it makes sense to set separate trigger sources for the A (Main) and B (Delayed) triggers. Use is not recommended as a source for the B trigger.

Trigger Types. When using sequential triggering, the A trigger must be set to one of the following types: Edge, Oscil, Wait, or Timeout. The B trigger is always Edge type.

Figure 3-19: Triggering with Horizontal Delay off

Figure 3-20: Triggering with Horizontal Delay on

The flow diagram in Figure 3-21 summarizes all combinations of triggering and horizontal delay.

Figure 3-21: Trigger and Horizontal Delay summary
### To Trigger on a Sequence

Use the procedure that follows when setting up the oscilloscope to trigger on a sequence. For more information, display online help while performing the procedure.

<table>
<thead>
<tr>
<th>Overview</th>
<th>To Trigger on a sequence</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preparations</strong></td>
<td>1. The oscilloscope must be initialized with a signal connected to an input channel. Acquisition system should be set to Auto, and the vertical and horizontal controls should be set appropriately for the signal to be observed.</td>
<td><img src="image" alt="Image" /> See page 3.1-10 for acquisition setup</td>
</tr>
<tr>
<td><strong>To trigger on a sequence</strong></td>
<td>2. From the menu bar, touch Trig and select the A-Volt B-Ike tab of the Trigger control window.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>3. Touch A Only to turn off sequential triggering.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td><strong>To trigger on B after A</strong></td>
<td>4. To set the propagation delay, touch A-Ike and select the A-Volt B-Ike tab of the Trigger control window.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>5. Touch Trig After Time.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>6. To set the trigger delay, touch Trig Delay and use the multipurpose knob or keypad to set the time.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>7. To set the B trigger level, touch B-Ike Level and use the multipurpose knob or keypad to set the level.</td>
<td><img src="image" alt="Image" /></td>
</tr>
</tbody>
</table>

---

### To set up the triggering

<table>
<thead>
<tr>
<th>Overview</th>
<th>To Trigger on Sequence</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>To set the B Event trigger, from the menu bar, touch Trig and select the B Event tab of the Trigger control window.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>13.</td>
<td>To specify which channel triggers the B trigger source, touch Source and select the source from the list.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>14.</td>
<td>Coupling is the same as the A Trig coupling.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>15.</td>
<td>To specify the direction of the edge, touch Trig and select Pos (positive) or Neg (negative) from the window.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>16.</td>
<td>Pos monitors positive-going edges. Neg monitors negative-going edges.</td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>17.</td>
<td>To set the B trigger level, touch B-Ike Level and use the multipurpose knob or keypad to set the level. Note: You can also touch the level by entering the B trigger level in the right-top corner of the B trigger pop-up.</td>
<td><img src="image" alt="Image" /></td>
</tr>
</tbody>
</table>
| **For further assistance** | Touch the Help button in the Trigger control window to access the online assistance specific to triggering conventions. | ![Image](image) Set page 3.1-12 for information on where to access Help.
Displaying Waveforms

This oscilloscope includes a flexible, customizable display that you can control to display the waveforms you acquire. This section presents the following topics:

- Using the Waveform Display
- Setting Zoom Controls
- Customizing the Display

Displaying Waveforms

Touch Screen (not shown): A feature that lets you touch on-screen controls or touch and drag active objects to reposition the oscilloscope.

Some features of the display follow.

Flexible Display Control: Front-panel knobs and buttons support quick access to the most often used controls — those that display, position, and scale waveforms. Mouse, keyboard, and touch-screen interfaces support complex setup of all the display parameters. Anything you can do with the menus, you can do with the touch screen.

Fast Access to Zoom: Waveform inspection has never been easier. Just touch and drag a box around the portion of interest and select zoom from the options offered, and the portion of interest displays zoomed in the magnified graphics.

Acquisition Preview: When the next acquisition is desired due to slow triggers or long acquisition delays, an acquisition preview attempts to tell what the next acquisition will look like. Acquisition preview does not re-evaluate math waveforms or represent changes in trigger levels, trigger modes, or different acquisition modes.

Using the Display

Read the following topics to provide the details that can help you set up the oscilloscope display so that it best supports your data-analysis tasks.

Waveform Display: In general, the method of displaying a waveform is to define the waveform, if necessary (math and reference waveforms), and then turn it on. Table 3-7 maintains this process as it applies to the different waveforms.

Using the Waveform Display

The waveform shown below is displayed as part of the User Interface (UI) application. The UI application takes up the entire screen of the oscilloscope and the generator takes up none of the UI application. Some terms that are useful in discussing the display follow.

(1) Display area: The area where the waveform appears. The display comprises the timebase and graticules, the waveform, histograms, and some readings.

(2) Graticule: A grid marking the display area. When Zoom is on, the upper graticule displays unmagified waveforms and the lower graticule displays magnified waveforms.

(3) Horizontal-scale reference: For magnified and unmagified waveforms.

(4) Horizontal reference: A cursor that you can position to set the point around which channel waveforms expand and contract horizontally or vertically as you change the Horizontal Scale control or press the ZOOM button. The reference is also the trigger point when the horizontal delay is 0.

Table 3-8: Defining and displaying waveforms

<table>
<thead>
<tr>
<th>Waveform</th>
<th>To define:</th>
<th>To turn on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel: QT-OFF</td>
<td>QT channel</td>
<td>Press the Vertical QL button to toggle the channel on or off.</td>
</tr>
</tbody>
</table>
| Reference: Multi-Page | Define an active reference waveform by:
|                  |          | From the Data menu select whether both Displays are toggle display of the vertical reference on or off. |
| Math: Math-Expr  | Define a math waveform by creating a math waveform using existing channels (channel, math, and reference waveforms, and measurements). The operation can be performed by using the math button and then selecting Math Function. |
|                  | When selecting a math waveform, turn on in the math setup area window. |

Operations on Waveforms: In general, the method of adjusting (vertically scaling, centering, positioning, and so on) is from the front panel. Adjust a waveform using its Vertical Scale and Position knobs.

Table 3-9: Operations performed based on the waveform type

<table>
<thead>
<tr>
<th>Control functions</th>
<th>Waveform supports:</th>
<th>Operating notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Scale</td>
<td>Yes/Yes</td>
<td>Waveforms are adjusted according to the zoom stack setting.</td>
</tr>
<tr>
<td>Vertical Position</td>
<td>Yes/Yes</td>
<td>Waveforms are adjusted according to the zoom stack setting.</td>
</tr>
<tr>
<td>Vertical Offset</td>
<td>Yes/Noliter</td>
<td>Waveforms are adjusted according to the zoom stack setting.</td>
</tr>
<tr>
<td>Horizontal Position</td>
<td>Yes/Yes</td>
<td>Waveforms are adjusted according to the zoom stack setting.</td>
</tr>
<tr>
<td>Horizontal Offset</td>
<td>Yes/Yes</td>
<td>Waveforms are adjusted according to the zoom stack setting.</td>
</tr>
<tr>
<td>Zoom Reference</td>
<td>Yes/No</td>
<td>Waveforms are adjusted according to the zoom stack setting.</td>
</tr>
<tr>
<td>Math Manipulate</td>
<td>Yes/Yes</td>
<td>Waveforms are adjusted according to the zoom stack setting.</td>
</tr>
<tr>
<td>Math Function</td>
<td>Yes/Yes</td>
<td>Waveforms are adjusted according to the zoom stack setting.</td>
</tr>
</tbody>
</table>

Table 3-7: Operations performed based on the waveform type
To Display Waveforms in the Main Graphics

Use the procedures that follow to become familiar with the display adjustments that you can make.

Overview

To display waveforms in the main graphics

- To display waveforms in the main graphics:
  1. The oscilloscope must be installed and operating.
  2. The acquisition system must be running continuously.

Set horizontal display parameters

- To select a channel to display the waveform:
  1. Set a channel button to select the waveform (3 displays).
  2. A channel button lights when its channel is on.

- To define a math waveform, see “Defining a Math Waveform” on page 3-124. For information on reference waveforms, see “Setting and Referencing Waveforms” on page 3-130.

Set horizontal display parameters

- To make sure the horizontal grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- To make sure the reference grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- The Spline Utility uses the record length (see discussion on page 3-17) to subdivide the waveform into small equal segments.

- The ratio of the waveform to the zoom input is set to 1:1.

- To set the horizontal scale, use the Horizontal Scale control on the front panel.

- The position of the waveform is set by using the Horizontal Position control on the front panel.

- To set the time base, use the Time base control on the front panel.

- The refresh rate is determined by the number of points per cycle (see discussion on page 3-17).

- The horizontal grid is selected for all waveforms, and the acquisition system is running continuously.

- To display waveforms in the main graphics:
  1. The oscilloscope must be installed and operating.
  2. The acquisition system must be running continuously.

- To select a channel to display the waveform:
  1. Set a channel button to select the waveform (3 displays).
  2. A channel button lights when its channel is on.

- To define a math waveform, see “Defining a Math Waveform” on page 3-124. For information on reference waveforms, see “Setting and Referencing Waveforms” on page 3-130.

- To make sure the horizontal grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- To make sure the reference grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- The Spline Utility uses the record length (see discussion on page 3-17) to subdivide the waveform into small equal segments.

- The ratio of the waveform to the zoom input is set to 1:1.

- To set the horizontal scale, use the Horizontal Scale control on the front panel.

- The position of the waveform is set by using the Horizontal Position control on the front panel.

- To set the time base, use the Time base control on the front panel.

- The refresh rate is determined by the number of points per cycle (see discussion on page 3-17).

- The horizontal grid is selected for all waveforms, and the acquisition system is running continuously.

- To display waveforms in the main graphics:
  1. The oscilloscope must be installed and operating.
  2. The acquisition system must be running continuously.

- To select a channel to display the waveform:
  1. Set a channel button to select the waveform (3 displays).
  2. A channel button lights when its channel is on.

- To define a math waveform, see “Defining a Math Waveform” on page 3-124. For information on reference waveforms, see “Setting andReferencing Waveforms” on page 3-130.

- To make sure the horizontal grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- To make sure the reference grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- The Spline Utility uses the record length (see discussion on page 3-17) to subdivide the waveform into small equal segments.

- The ratio of the waveform to the zoom input is set to 1:1.

- To set the horizontal scale, use the Horizontal Scale control on the front panel.

- The position of the waveform is set by using the Horizontal Position control on the front panel.

- To set the time base, use the Time base control on the front panel.

- The refresh rate is determined by the number of points per cycle (see discussion on page 3-17).

- The horizontal grid is selected for all waveforms, and the acquisition system is running continuously.

- To display waveforms in the main graphics:
  1. The oscilloscope must be installed and operating.
  2. The acquisition system must be running continuously.

- To select a channel to display the waveform:
  1. Set a channel button to select the waveform (3 displays).
  2. A channel button lights when its channel is on.

- To define a math waveform, see “Defining a Math Waveform” on page 3-124. For information on reference waveforms, see “Setting and Referencing Waveforms” on page 3-130.

- To make sure the horizontal grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- To make sure the reference grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- The Spline Utility uses the record length (see discussion on page 3-17) to subdivide the waveform into small equal segments.

- The ratio of the waveform to the zoom input is set to 1:1.

- To set the horizontal scale, use the Horizontal Scale control on the front panel.

- The position of the waveform is set by using the Horizontal Position control on the front panel.

- To set the time base, use the Time base control on the front panel.

- The refresh rate is determined by the number of points per cycle (see discussion on page 3-17).

- The horizontal grid is selected for all waveforms, and the acquisition system is running continuously.

- To display waveforms in the main graphics:
  1. The oscilloscope must be installed and operating.
  2. The acquisition system must be running continuously.

- To select a channel to display the waveform:
  1. Set a channel button to select the waveform (3 displays).
  2. A channel button lights when its channel is on.

- To define a math waveform, see “Defining a Math Waveform” on page 3-124. For information on reference waveforms, see “Setting and Referencing Waveforms” on page 3-130.

- To make sure the horizontal grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- To make sure the reference grid is selected, push the Zoom button to engage it. Use the horizontal zoom to scale and position the waveform on screen to aid in analysis.

- The Spline Utility uses the record length (see discussion on page 3-17) to subdivide the waveform into small equal segments.

- The ratio of the waveform to the zoom input is set to 1:1.

- To set the horizontal scale, use the Horizontal Scale control on the front panel.

- The position of the waveform is set by using the Horizontal Position control on the front panel.

- To set the time base, use the Time base control on the front panel.

- The refresh rate is determined by the number of points per cycle (see discussion on page 3-17).

- The horizontal grid is selected for all waveforms, and the acquisition system is running continuously.
Setting Zoom Controls

The oscilloscope can zoom in on a waveform without changing the acquisition parameters (sample rate, record length, and so on). This section describes how to use Zoom and how it interacts with the selected waveform.

To use Zoom, press the (Zoom) button. When you want to expand a waveform to inspect small features or that waveform or compare the features to the zoomed waveform(s). For example, to temporarily expand the front portion of a pulse to inspect the transitions, use Zoom to expand it horizontally and vertically.

Using with Waveforms

To help you use zoom effectively, consider how it operates on waveforms. When you zoom into a waveform, the oscilloscope vertically expands or contracts one waveform at a time. Also, the oscilloscope only vertically positions one waveform at a time when the Zoom button is pressed.

When zooming horizontally, Zoom expands or contracts waveform(s) that you select, all the live waveforms, or all live and reference waveforms, depending on the setting for Horizontal Lock in the Zoom menu.

To zoom waveforms

Use the procedure that follows to zoom a waveform. For more information, display online help when performing the procedure.

Overview
To zoom waveforms

Control elements and resources

Prerequisites

1. The oscilloscope must be initialized and operating.
2. Oscilloscope must be powered on, with horizontal and vertical controls and triggering set up.

See page 2-20 for Trigger setup.

Overview
To zoom waveforms

Control elements and resources

Zoom a waveform

4. Push the (Horizontal) or (Vertical) button to access the menu you want to adjust in the Zoom panel.

5. Touch the (Horizontal) or (Vertical) button in the control window to access the menu you want to modify in the zoom window.

6. Use the multimal key to adjust the scale and position of the waveform.

7. Note that as you zoom in or out the waveform you selected in the box, its scale changes accordingly, but you can still make adjustments to the waveform within the box. Note that as you zoom in or out for a zoomed acquisition, the multimal displays the box relative to the unzoomed waveforms, not the box relative to the waveform you are zooming into.

8. To select the waveform that you want to zoom in or out, select the channel (CH1, CH2, or Reference CH1, CH2, and Reference) and the waveform you want to zoom in or out. Touch the layout button with the zoom in or zoom window.

Overview
To zoom waveforms

Control elements and resources

Set up zoom

7. To display the Zoom setup window, touch Setup in the control window.

8. Depending on the selection for Zoom Lock, zoom affects the selected waveforms, live waveforms, or all live, real, and reference waveforms. If set, which means the horizontal zoom controls affect both the real waveforms and the zoomed waveforms. If set, which means the horizontal zoom controls affect both the real and zoomed waveforms.

9. Note that the zoomed waveform in the zoomed window is individually adjustable.

10. All waveforms are adjusted at the same time.

Checking the zoom scale and position

8. To quickly determine the zoom scale and position of a zoomed waveform, check the zoom window.

9. To zoom the horizontal spans, display the horizontal waveform and the lower (Zoom) window.

10. The horizontal window displays the vertical and horizontal scale and position in the control window.

11. From the Zoom control window, touch Position or Scale and use the multimal knob to change the zoom position and scale.
Customizing the Display

Use the display customizing features in the oscilloscope to present the display elements — color, graphic style, waveform representations, and so on — according to your preferences.

From the Color Palette, you can select temperature, spectral, or gray scale color grading of a waveform so that its data color or intensity reflects the sample density of the data included area of the waveform.

Using Display Controls

Read the following topics; they provide the details that can help you set up the display system so that it displays waveforms and other display elements as you prefer.

Display Settings: Table 3-7 lists display attributes that you can set and where they are located.

### Display Settings: Table 3-7

<table>
<thead>
<tr>
<th>Display attribute</th>
<th>Menu name</th>
<th>Access</th>
<th>Entry</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger Level Marker</td>
<td>On/Off</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Choose a fixed level marker at the trigger level.</td>
</tr>
<tr>
<td>Trigger Level Marker</td>
<td>On/Off</td>
<td>Dbl</td>
<td>Dbl</td>
<td>to the trigger level marker.</td>
</tr>
<tr>
<td>Trigger 1 Trigger 2</td>
<td>Display</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Toggle on-off and trigger 1 at the trigger 1.</td>
</tr>
<tr>
<td>LSO Backlight Timeout</td>
<td>Display</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Toggle the backlight timeout on and off and set the delay.</td>
</tr>
<tr>
<td>LSO Backlight Timeout</td>
<td>Display</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Use a reference waveform to display the trigger level marker.</td>
</tr>
<tr>
<td>Data and Time</td>
<td>Display</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Toggle on-off and display the time in the system data format.</td>
</tr>
<tr>
<td>Set Date and Time</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Use the date and time settings.</td>
</tr>
</tbody>
</table>

The Menu name refers to the menu found in the main bar or tool bar at the top of the oscilloscope screen.

**Normal and Persistence Displays:** Use the display persistence to control how waveforms are displayed.

- **Display Waveforms without Persistence:** each new waveform overlays the previously acquired waveform for a channel. You can choose to display normal waveforms as vectors, which displays lines between the recorded points (vector shown) or displays only the recorded points (vector off) which displays the recorded points only. You can also choose an interpolation mode. See Interpolation below.

- **Variable Persistence:** accumulates the waveform-occupant points on access and displays them only for a specified interval. Positions waveforms continuously from the display area to the waveform buffer, which displays the recorded points only. You can also choose an interpolation mode. See Interpolation below.

- **Infinite Persistence:** accumulates the data waveform-points and only displays them for a limited time, which displays the recorded points only. The display area only shows the waveform points that are being displayed for a limited time. See Interpolation below.

### Interpolation

When plotted to a specified point, the waveform is displayed as a smooth curve. If a waveform is being displayed, the oscilloscope uses an interpolation algorithm to produce a smooth curve between the waveform points. There are two options for interpolation.

- **Spline Interpolation:** connects points using a curve-fit between the actual sample points. The curve-fit assumes all the interpolated points fall along the curve. Spline interpolation is particularly useful when acquiring noisy waveforms because it smooths the waveform.

- **Linear Interpolation:** assumes that the waveform value between two adjacent samples is the same as the waveform value at the sample point. Linear interpolation is useful for many waveforms such as pulse trains.

### Table 3-7: Customizable display elements

<table>
<thead>
<tr>
<th>Display attribute</th>
<th>Menu name</th>
<th>Access</th>
<th>Entry</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger Level Marker</td>
<td>On/Off</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Choose a fixed level marker at the trigger level.</td>
</tr>
<tr>
<td>Trigger Level Marker</td>
<td>On/Off</td>
<td>Dbl</td>
<td>Dbl</td>
<td>to the trigger level marker.</td>
</tr>
<tr>
<td>Trigger 1 Trigger 2</td>
<td>Display</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Toggle on-off and trigger 1 at the trigger 1.</td>
</tr>
<tr>
<td>LSO Backlight Timeout</td>
<td>Display</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Toggle the backlight timeout on and off and set the delay.</td>
</tr>
<tr>
<td>LSO Backlight Timeout</td>
<td>Display</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Use a reference waveform to display the trigger level marker.</td>
</tr>
<tr>
<td>Data and Time</td>
<td>Display</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Toggle on-off and display the time in the system data format.</td>
</tr>
<tr>
<td>Set Date and Time</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Dbl</td>
<td>Use the date and time settings.</td>
</tr>
</tbody>
</table>

The Menu name refers to the menu found in the main bar or tool bar at the top of the oscilloscope screen.
**Displaying Waveforms**

### Set Display Styles
Use the procedures that follow to become familiar with the display adjustments that you can make.

<table>
<thead>
<tr>
<th>Overview</th>
<th>Set display styles</th>
<th>Related control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prerequisites</strong></td>
<td>The oscilloscope must be powered on, with any waveform that you wish to display or edit.</td>
<td>See page 3-23 for acquisition setup and page 3-22 for trigger setup.</td>
</tr>
</tbody>
</table>

### Access the display setup dialog box
1. From the toolbar, touch Set Up, and then select the Appearance tab. See right.

### Select the display style and persistence and waveform integration mode
2. From the Display Persistence group, choose Off to display a display with no acquisition data persistence. Off displays Waveforms with new data replacing the data from previous waveform acquisitions. Variable persistence continuously averages the recorded points until you change the acquisition settings. Variable persistence accumulates recorded points for a specified time. Each point changes in a time window.
3. Select Vectors to use a display that superimposes waveform data. Vectors display lines between waveform data. Data display waveform record points as line. When Sample no samples, the grapher displays interpolated data at a lower intensity.
4. Adjust the display intensity by dragging a slider to the desired level. For more information, see Information on page 3-10.

### Customize Grayscale and Waveforms
Use the procedures that follow to become familiar with the display adjustments that you can make.

<table>
<thead>
<tr>
<th>Overview</th>
<th>Customize what you can make</th>
<th>Related control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prerequisites</strong></td>
<td>Display the waveforms to be measured on the screen. The waveform can be a channel, reference, or math waveform.</td>
<td>See page 3-23 for acquisition setup and page 3-22 for trigger setup.</td>
</tr>
</tbody>
</table>

### Change waveform color
1. From the Display setup control window, select the Color tab.
2. Choose a color palette from the Color Palette list.

### Change grayscale style
1. From the Display setup control window, select the Object tab. See right.
2. Touch the Full, Shift, Grays Scale, or Yarn button to select that style of grayscale.

---

**Summary**

- **Set Display Styles**: Use the procedures to access the display setup dialog box and select the display style and persistence and waveform integration mode.
- **Customize Grayscale and Waveforms**: Use the procedures to customize the display appearance and waveform presentation.

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**TD36000 Series User Manual**

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**Related control elements and resources**

- **Select a persistence mode**: From the Display setup control window (see right), choose.
  - Infinite Persistence to make data (wave) infinite.
  - Performance: to reduce background noise by averaging the waveform records acquired in a build-up of data in the displayed waveform.
  - Variable Persistence to make data measurable, but also delay new waveform display acquisition data to new waveform records acquired, but with continuous replacement of the older data.
  - If you select Variable Persistence, select a time at which the data display fades away.

- **Continue with next procedure**: For more ways to customize the display, see the next procedure.

- **See Customization and Waveforms on page 2-02.**
Measuring Waveforms

Taking Automatic Measurements

The oscilloscope automatically takes and displays waveform measurements. This section describes how to set up the oscilloscope to take measurements for you.

Because automatic measurements use the waveform record points, and in Post Acquisition mode measurements use a two-dimensional array of points, automatic measurements are usually more accurate than cursor and graticule measurements. And the oscilloscope does the work, continuously taking, updating, and displaying these measurements.

Some features of automatic measurements follow:

Annotate Waveforms. You can create text to mark characteristic levels that you find in the waveform, including waveform features such as peak-to-peak, peak-to-peak, or peak-to-peak. See section 3-102 for more information.

Customize Measurements. To allow you to control over how your waveform data is displayed, you can select from a variety of measurement types. See section 3-102 for more information.

See Statistics on Measurement Results. To see how automatic measurements vary statistically, you can obtain a set of the Min, Max, Mean, and Standard Deviations of the measurement results. See section 3-102 for more information.

Using Automatic Measurements

Select Measurement Parameters. You can select from an extensive range of parameters to measure; for a list, see Appendix B: Automatic Measurements Supported.

Measure Part of a Waveform. You can zoom into the waveform to view a section at a higher magnification or display a waveform. You can zoom into the waveform to view a section of the waveform. You can also select from a variety of measurement types.

Select Measurement Sources. Select from a variety of measurement sources: channel, reference, and test waveform.

Take Measurement in a Frame. In PostAcquisition mode, measurements are taken only on the displayed frame.

Read the following topics to understand what you can set up to measure automatically:

Measurement Sources. The oscilloscope takes automatic measurements of the following categories: Amplitude, Time, Linearity, and Decorrelation. See section 3-102 for more information.

Number of Measurements. The oscilloscope can take and update up to eight measurements at a time. You can apply measurements to any combination of sources (described below). You can take all eight measurements on CH1, for example, or you can take measurements on CH1, CH2, CH3, and CH4, or a combination thereof.

Measurement Sources. All channel, reference, and test waveform can be used as sources for the automatic measurements. Some measurements, such as delay and phase, require two sources. For example, delay would be used to measure an input from one measurement source and output to another source (C2).

Figure 3-25: High/Low tracking methods

High/Low Method. The level that the automatic measurement system derives as the High (Top) or Low (Bottom) for a waveform depends on whether the waveform is defined as high or low level. Since this is a statistical approach (it assumes that most of the measurements are above or below the midpoint), a High/Low level measurement is not the same as a true high or low level measurement. Therefore, the following methods should be used:

- High/Low Method. The level that the automatic measurement system derives as the High (Top) or Low (Bottom) for a waveform depends on whether the waveform is defined as high or low level. Since this is a statistical approach (it assumes that most of the measurements are above or below the midpoint), a High/Low level measurement is not the same as a true high or low level measurement. Therefore, the following methods should be used:

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  - High/Low Method. The level that the automatic measurement system derives as the High (Top) or Low (Bottom) for a waveform depends on whether the waveform is defined as high or low level. Since this is a statistical approach (it assumes that most of the measurements are above or below the midpoint), a High/Low level measurement is not the same as a true high or low level measurement. Therefore, the following methods should be used:
### Measuring Waveforms

#### To Take Automatic Measurements

The procedure that follows to quickly take a measurement based on the default settings for High/Low and for reference levels:

<table>
<thead>
<tr>
<th>Overview</th>
<th>To take automatic measurements</th>
<th>Related control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove measurements</td>
<td>6. To remove the measurement, touch Clear, and the last measurement selected is removed.</td>
<td><img src="image" alt="Clear button" /></td>
</tr>
<tr>
<td>7. To remove any measurement in the measurement list, touch the measurement list, and then touch the Delete button.</td>
<td><img src="image" alt="Delete button" /></td>
<td></td>
</tr>
<tr>
<td>8. To remove any measurements in the measurement list, touch the Delete button.</td>
<td><img src="image" alt="Delete button" /></td>
<td></td>
</tr>
<tr>
<td>Display measurement statistics</td>
<td>12. From the Measurements control window, touch Setup, and then touch the reference levels.</td>
<td><img src="image" alt="Setup button" /></td>
</tr>
<tr>
<td>13. To select from the oscilloscope displays of waveforms, touch Setup, and then select from the waveforms.</td>
<td><img src="image" alt="Setup button" /></td>
<td></td>
</tr>
<tr>
<td>14. To select from the oscilloscope displays of waveforms, touch Setup, and then select from the waveforms.</td>
<td><img src="image" alt="Setup button" /></td>
<td></td>
</tr>
<tr>
<td>15. To select from the oscilloscope displays of waveforms, touch Setup, and then select from the waveforms.</td>
<td><img src="image" alt="Setup button" /></td>
<td></td>
</tr>
<tr>
<td>16. To select from the oscilloscope displays of waveforms, touch Setup, and then select from the waveforms.</td>
<td><img src="image" alt="Setup button" /></td>
<td></td>
</tr>
</tbody>
</table>

---

#### Reference level calculation methods

The High and Low levels from which the reference levels are calculated are the levels established using the selected High/Low method described on page 3-102.

![Reference level calculation methods](image)
Measuring Waveforms

16. From the Measurement setup window, touch the SnapShot button to display a window of all single waveform measurements.

Note: The Snapshot measurements are taken on the selected waveform. The SnapShot window is used to see the channel that the measurements were taken on and the reference levels used.

17. Snapshot measurements are not continuously updated. To update reference measurements, touch the SnapShot Again button.

Phase, Delay, and Amplitude measurements are not included in a snapshot.

18. Touch the Help button in the Measurements setup context window to access the online assistance.

See page 3-20 for tips about using online help.

To Locate a Measurement

Use the procedure that follows to take a measurement over a segment of the waveform (otherwise, the entire waveform is included in the measurement).

<table>
<thead>
<tr>
<th>Overview</th>
<th>To take automatic measurements</th>
<th>Related control elements and resources</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Pre-requisites</th>
<th>To locate a measurement</th>
<th>Related control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Set up as usual procedure.</td>
<td></td>
<td>See to Use Automatic Measurements on page 3-104</td>
</tr>
</tbody>
</table>

Access gating

2. From the next bar, select Buses, and then select Gating from the Measurement setup context window. See right.

<table>
<thead>
<tr>
<th>Table 3-8: Cursor functions (types)</th>
<th>Parameter measured</th>
<th>Cursor contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal cursors</td>
<td>Horizontal current (measured amplitudes, volts, mV)</td>
<td>Each cursor measures with respect to:</td>
</tr>
<tr>
<td></td>
<td>V1 = Level @ Cursor 1 with respect to the source ground level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V2 = Level @ Cursor 2 with respect to the source ground level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V1 - V2 = Level @ Cursor 2 - Level at Cursor 1</td>
<td></td>
</tr>
<tr>
<td>Vertical cursors</td>
<td>Vertical current: measure distance from 0 in seconds or 0μs, Each cursor measures with respect to:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T1 = Time @ Cursor 1 with respect to the trigger point</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T2 = Time @ Cursor 2 with respect to the trigger point</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T1 - T2 = Time @ Cursor 2 - Time @ Cursor 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T1 is the number of nanoseconds of this cursor from its normal trigger point for a normal template</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T2 is the number of nanoseconds of this cursor from its normal trigger point for a normal template</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pointer current measured with voltage and time. Each cursor is in effect. Both vertical and horizontal cursors. These pointer functions can be moved off the waveform.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I1 = Current @ Cursor 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I2 = Current @ Cursor 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I1 - I2 = Current @ Cursor 2 - Current @ Cursor 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cursors can measure channel, reference, and math waveforms. You must set the source of each cursor explicitly in the Cursor Setup control window.

Cursors are not available with histograms, or NT mode.

Using Cursors

Cursor operation is easy. You move the cursors on screen and read the results in the cursor readouts. The following key points will help you use the cursors effectively.

Cursor Types. There are two cursor types: Cursor 1 and Cursor 2. You can move cursors with the mouse/pointer keys or the mouse position controls in the Cursor Setup control window.

<table>
<thead>
<tr>
<th>Cursor 1</th>
<th>Cursor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>+25μs/80V</td>
<td>+25μs/80V</td>
</tr>
<tr>
<td>+25μs/80V</td>
<td>+25μs/80V</td>
</tr>
</tbody>
</table>

Figure 3-10: Horizontal cursors measure amplitudes.

Cursors Are Display-Limited. You cannot move a cursor off screen. Also, if you move waveforms, the cursors do not track. This is a cursor stays at its screen position, ignoring changes to horizontal and vertical scale and position, and vertical offset (gain and split cursors will track a waveform vertically).

Cursors Ignore the Selected waveform. Each cursor measures its source, defined in the Cursor Setup control window. Selecting a waveform for scaling or setting the coupling, the CH J front-panel button, for example, does not change the source of each cursor measure.

After you have selected the source from the Cursor Setup control window, you can operate the cursor from the four-panel keys and buttons.
**Cursor Time Source Independently.** Each cursor can take a different, independent source, with each source having its own amplitude scale. Consider the example presented by Figures 3-28 on page 3-110:

- Cursor 1 is set to measure Channel 3 (C3), which is set to 100 mV per division, so the cursor reads 8 V/div relative to its ground at 3 divisions x 100 mV/div, or about 300 mV.
- Cursor 2 is set to measure Channel 4 (C4), which is set to 20 mV per division, so the cursor reads 32 mV relative to its ground at 3 divisions x 20 mV/div, or about 60 mV.

Note that the value of each incremental division is not readily apparent relative to the cursor itself, because the cursor is not the origin of the reflection. To do so, the 2V readout displays the result of Y - V1 = 160 mV + 300 mV = -240 mV, automatically accounting for the different amplitude settings of the sources.

**NOTE:** If a cursor moves out of the correct range, check the source of each cursor in the Cursor setup dialog box. Each cursor position relates to the amplitude and waveform settings of its source.

---

**Vertical Cursor Measure from the Trigger Point.** Remember that each vertical cursor measures from the trigger point to itself. This relationship is shown in Figure 3-29 on page 3-111.

---

**To Set the Cursor Sources.** You must target the cursors to the sources that they are to measure. To do so, use the procedure that follows:

1. **Display the cursor controls window.**
   - Click on the Cursors button on the front panel.
2. **Select the cursor sources.**
   - Click on the desired channel(s) in the Channels area.
3. **Select the cursor type.**
   - Click on the desired cursor type (Horizontal or Vertical).
4. **Change cursor position.**
   - Use the arrow keys to move the cursor.

---

**Measuring Waveforms**

Note that a vertical cursor measures a y-value from the Trigger-Point component, which varies directly with the horizontal position set for the trigger point. To set the amount of time to the trigger point, set the Horizontal DELAY to 0 and set the Horizontal DUAL to 0. Move the horizontal position readout to the point of interest, and adjusting this value to the cursor readsout.

---

**Table 3-5: Cursor units**

<table>
<thead>
<tr>
<th>Cursor</th>
<th>Standard units</th>
<th>Readout names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>mm, cm</td>
<td>V1, V2, AV</td>
</tr>
<tr>
<td>Vertical</td>
<td>seconds, id</td>
<td>T1, T2, OT, PL, FL, FL</td>
</tr>
<tr>
<td>Depth</td>
<td>mm, cm, seconds</td>
<td>V1, V2, AV, T1, T2, OT</td>
</tr>
</tbody>
</table>

1. If the V1 and V2 units do not match, the ST readout defaults to the smallest by the VT readout.

**Measuring Waveforms**

**Set cursor tracking.**

1. **To change the cursor tracking from the Cursor controls window.**
2. **To change the cursor tracking in the Cursor setup window.**
3. **To select a cursor type.**
4. **To change cursor position.**

---

**Measuring Waveforms**

**Overview**

<table>
<thead>
<tr>
<th><strong>Measuring Waveforms</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>To set the cursor sources (Cont.)</td>
</tr>
<tr>
<td>Set cursor tracking</td>
</tr>
<tr>
<td>1. To change the cursor tracking from the Cursor controls window.</td>
</tr>
<tr>
<td>2. To change the cursor tracking in the Cursor setup window.</td>
</tr>
<tr>
<td>3. To select a cursor type.</td>
</tr>
<tr>
<td>4. To change cursor position.</td>
</tr>
</tbody>
</table>

---

**Measuring Waveforms**

**Overview**

<table>
<thead>
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</tr>
<tr>
<td>Set cursor tracking</td>
</tr>
<tr>
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<tr>
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</tr>
<tr>
<td>4. To change cursor position.</td>
</tr>
</tbody>
</table>

---

**Measuring Waveforms**

**Overview**

<table>
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</tr>
<tr>
<td>Set cursor tracking</td>
</tr>
<tr>
<td>1. To change the cursor tracking from the Cursor controls window.</td>
</tr>
<tr>
<td>2. To change the cursor tracking in the Cursor setup window.</td>
</tr>
<tr>
<td>3. To select a cursor type.</td>
</tr>
<tr>
<td>4. To change cursor position.</td>
</tr>
</tbody>
</table>
Taking Histograms

The oscilloscope can display histograms computed from the selected waveform data. You can display both vertical (voltage) and horizontal (time) histograms, but only one at a time. Use histogram measurement to get statistical measurement data for a section of a waveform along one axis.

![Histograms](image)

Figure 3-30: Horizontally histogram view and measurement data

A histogram curve can be any waveform (channel or math), including a reference waveform.

In addition to using limit controls to set histogram box boundaries, you can also use standard Windows drag-and-drop to resize and reposition the histogram box.

Using Histograms

Histogram Size: The maximum vertical histogram size is 200. The maximum horizontal size is 500.

Histogram Counting Stays On: Turning on histograms starts histogram counting and data accumulation. A sample histogram display is shown in Figure 3-30. Histogram data is continuously accumulated until you explicitly turn off histograms. This allows you to continue collecting histogram data even when you turn off the histogram display.

Histograms are not available in FastFrame or Zoom modes.
### Measuring Waveforms

#### To Start and Reset Histogram Counting

**Overview**

Use the procedure that follows to quickly take a measurement based on the default settings for histograms.

**Prerequisites**

1. The oscilloscope must have a waveform displayed.

**Open histogram setup window**

2. From the tool bar, touch the Menu button and then touch the Advanced button to display the Histogram setup window.

**Set, display, and reset histogram sources and type**

3. Select either the Source Ch A, Ch B, or Ref Signal and then select the waveform source to the histogram.

4. Touch Histogram Mode Hotz or Vert to reset histogram counting and display the histogram data. Hotz displays a horizontal histogram that shows how many time values are visible in the histogram box. Vert displays a vertical histogram that shows how many vertical units are visible in the histogram box. Off turns off histogram counting and display.

**Optimize the histogram counts**

5. Touch Reset to reset the histogram count. Histograms track numbers of counts. Clicking Reset resets these counts to zero and begins counting from zero.

**Set histogram displays options**

6. Touch Display to toggle the display of the selected histogram on or off.

7. Select Linear or display histogram data linearly for improved performance. Select Log to display histogram data logarithmically for improved performance. Logarithmic scaling provides better visual details for between ten counts.

8. Touch Scale to display histogram data logarithmically. The maximum counts are scaled logarithmically. Logarithmic scaling provides better visual details for between ten counts.

**Set histogram limit controls**

9. Touch Adjust Histogram Box Limits and set the Top Limit, Bottom Limit, Left Limit, and Right Limit controls to set the size of the histogram box. The histogram box selects the portion of the waveform used for histograms.

10. Touch Adjust Histogram Box Location and use the X Location and Y Location controls to set the location of the histogram box.

### Histogram Measurements

Table A-1 on page B-1 includes a list of the available histogram measurements and a brief description of each.

### Optimizing Measurement Accuracy

The procedures given here will increase the accuracy of the measurements that you take.

This oscilloscope can compensate itself and the attached probes, optimizing the internal signal path used to acquire the waveforms that you measure. Compensation optimizes the capability of the oscilloscope to take accurate measurements based on the ambient temperature.

### Measuring Waveforms

#### To Connect the Probe to the Datasheet Fixture

**Overview**

To compensate or calibrate probes you must connect the Datasheet/Cal Cal to the oscilloscope using the procedure that follows.

**Prerequisites**

1. The oscilloscope must be powered on. Allow a 20 minute warm up.

**Connect the fixture**

2. Make up the signal source. Install a probe cable into the channel input that you want to calibrate (beginning with ORI). Connect the probe to the oscilloscope as described in the following figures.

3. Connect the probe tip to the datasheet fixture as described in the following figures.


5. Connect one end of the probe to the oscilloscope's second channel as described in the following figures.

6. Connect the remaining end of the probe to the oscilloscope's second channel as described in the following figures.

**Note:** The 7532A probe is not supported.
Measuring Waveforms

To Calibrate Probes

1. The oscilloscope should be powered on. Allow a 20 minute warm up.
   - Notes:Probe with an attenuation factor of greater than 10X cannot be compensated. Probes with <20% gain error or >20% off center cannot be compensated.

2. Connect the probe tip to the 100Ω resistor.

3. Connect the ground to the 100Ω resistor.

4. Then connect the probe tip to the 100Ω resistor.

5. Turn on the oscilloscope to display the calibration waveform.

6. Select the calibration channel to which the probe is attached.

7. Touch the Calibrate button to advance any pin placement calibration bias.

8. Touch the Calibrate button.

9. When the routine is finished, remove the connections.

For further assistance, see page 2-121. TDS6000 Series User Manual

Measuring Waveforms

To Destep Channels

You can adjust a relative time delay for each channel. This lets you align the signals to compress or expand the signals that may occur in both cables of interfering signals. The oscilloscope applies a delay value after it completes each acquisition; therefore, the delay values do not affect logic triggering. Also, the delay has no effect on XY and XYZ display formats.

1. The oscilloscope should be powered on. Allow a 20 minute warm up.

See page 3-123 to acquire setup and Power on Oscilloscope at page 1-1.

TDS6000 Series User Manual

For further assistance

See page 3-125 to learn about using online help.
### Measuring Waveforms

#### Overview

<table>
<thead>
<tr>
<th>Task</th>
<th>Control Elements and Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Connect the test to the oscilloscope (see To Connect Probe Calibration Feature on page 3-123)</td>
<td></td>
</tr>
<tr>
<td>2. Connect up to four probes to the test.</td>
<td></td>
</tr>
<tr>
<td>3. Display all the channels that you want to display.</td>
<td></td>
</tr>
<tr>
<td>4. Push the SETUP button on the oscilloscope.</td>
<td></td>
</tr>
<tr>
<td>5. Adjust the Vertical SCALE and POSITION for each channel so that the signals overlap or are centered on screen.</td>
<td></td>
</tr>
<tr>
<td>6. Adjust the horizontal POSITION so the triggered rising edge is at center screen.</td>
<td></td>
</tr>
<tr>
<td>7. Adjust the center screen.</td>
<td></td>
</tr>
<tr>
<td>8. Adjust the center screen so that the first rising edge is at center screen.</td>
<td></td>
</tr>
<tr>
<td>9. Adjust the POSITION so that the first rising edge is at center screen.</td>
<td></td>
</tr>
<tr>
<td>10. From the tool bar, touch the VERT button to display the Vertical setup control window.</td>
<td></td>
</tr>
<tr>
<td>11. Touch the Polarity button to display the Vertical setup control window.</td>
<td></td>
</tr>
<tr>
<td>12. Select one of the lower channels.</td>
<td></td>
</tr>
<tr>
<td><strong>Note:</strong> Do not select a channel where the signal is less than 10% of the screen's full scale.</td>
<td></td>
</tr>
<tr>
<td>13. Touch Display Time, and use the multipurpose knob to adjust the trigger time to that channel so that its scope appears with that of the failed channel.</td>
<td></td>
</tr>
<tr>
<td>14. Repeat steps 12 and 13 for each additional channel that you want to display.</td>
<td></td>
</tr>
<tr>
<td>15. Remove the connections.</td>
<td></td>
</tr>
</tbody>
</table>

---

### Creating and Using Math Waveforms

Once you have acquired waveforms or taken measurements on waveforms, the oscilloscope can mathematically combine them to create waveforms that support your diagnostic task. For example, you might have a waveform obtained by background noise. You can obtain a cleaner waveform by subtracting the background noise from your original waveform. Or, you can integrate a single waveform into an integral math waveform as shown below.

![Math waveform](image)

Web spectral analysis you can analyze waveform in the frequency domain. The spectrum is similar to a dedicated spectrum analyzer, refining you of the detailed of the underlying algorithms (see Figure 3-3).

### Defining Math Waveforms

This section supports the mathematical combination and functional transformations of waveforms that it acquires. Figure 3-32 shows this concept.

![Math waveform](image)

**Figure 3-32: Functional transformation of an acquired waveform**

You create math waveforms to support the analysis of your channel or reference waveforms. By combining and transforming your waveforms and other defined math waveforms, you can derive the data view that your application requires. You can create math waveforms that result from:

- Mathematical operations on one or several waveforms: add, subtract, multiply, and divide
- Functional transform of waveforms, such as integrating, differentiating, and so on.
Some examples of typical math waveforms follow:

<table>
<thead>
<tr>
<th>Table 3-10: Math expressions and the math waveforms produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>To...</td>
</tr>
<tr>
<td>Normalize a waveform</td>
</tr>
<tr>
<td>1V</td>
</tr>
<tr>
<td>Multiply</td>
</tr>
<tr>
<td>Add</td>
</tr>
<tr>
<td>Subtract</td>
</tr>
<tr>
<td>Square</td>
</tr>
<tr>
<td>Invert</td>
</tr>
<tr>
<td>Absolute</td>
</tr>
</tbody>
</table>

Sources: Math Waveforms can incorporate the following sources:
- Channel waveforms
- Reference waveforms
- Measurements (automated measurements) that measure channel, reference, histogram, or math waveforms
- Math waveforms

Source Dependencies: As you create math waveforms using the Math Waveform control window, the math waveform can be derived from other math waveforms. For example, if you have a waveform 1 and a waveform 2, you can create a math waveform 3 by performing an arithmetic operation on waveforms 1 and 2. The new waveform 3 will inherit the properties of waveforms 1 and 2, such as amplitude and frequency.

In addition, math waveforms can be used to generate new waveforms from existing ones. For example, if you have a waveform 1 and you want to create a new waveform 3 that is the sum of waveform 1 and waveform 2, you can use the math waveform control window to perform the addition operation on the two waveforms. The resulting waveform 3 will inherit the properties of waveforms 1 and 2, such as amplitude and frequency.
Figure 3-34: Peak-to-peak amplitude measurement of a derivative waveform

Offset, Position, and Scale. The settings you make for offset, scale, and position affect the math waveform you obtain. Note the following tips for obtaining a good display:

- You should scale and position the source waveform so that it is contained on screen. (Off-screen waveforms may be clipped, resulting in errors in the derivative waveform.)
- You can use vertical position and vertical offset to position your source waveform. The vertical position and vertical offset will not affect your derivative waveform unless you position the source waveform off screen so it is clipped.

Waveform Integration. The Math capabilities of the oscilloscope include waveform integration. This allows you to display an integral math waveform that is an integrated version of the acquired waveform.

Integral waveforms find use in the following applications:

- Measuring power and energy, such as in switching power supplies
- Characterizing mechanical transducers, as when integrating the output of an accelerometer to obtain velocity

To define a math waveform:

5. Use the control window to edit the math expression. To choose a math expression, use the math selection feature. Use the math expression editor to create a new math expression.

6. Select the Time, Freq, or Math button to display the available functions.

7. Touch a function button to enter the function in the math expression. Select an operation to perform the function on the math waveform.

8. Use the Home and/or math buttons to move within the math expression. Use the math expression arrow to create portions of the expression.

9. Touch Apply to apply your new math expression to the math waveform.
Creating and Using Math Waveforms

Operations on Math Waveforms

This oscilloscope supports many of the same operations for math waveforms that it provides for channel (live) and reference waveforms. For example, you can measure math waveforms with cursors. This section introduces these operations.

- Vertical display scaling and positioning
- Using automatic measurements
- Using cursor measurements
- Using histogram on math waveforms

Overview

<table>
<thead>
<tr>
<th>Overview</th>
<th>To use a math waveform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply averaging</td>
<td>To define a math waveform</td>
</tr>
<tr>
<td>13. Touch A-E to display the Math Averaging control window. The option in the window says to the math waveform defined by the expression.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>To use a math waveform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finished</td>
<td>For further assistance</td>
</tr>
<tr>
<td>12. Only if you've defined the math expression in your application, and the [Apply] button. Then click the OK button to display the dialog box. See To Use Math Waveforms on page 3-128 for more procedures.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>To use a math waveform</th>
</tr>
</thead>
<tbody>
<tr>
<td>View</td>
<td>For further assistance</td>
</tr>
<tr>
<td>14. Touch the Help button in the tool bar to locate specific instructions on math waveforms.</td>
<td></td>
</tr>
</tbody>
</table>

See a picture of the help box on page 3-126 for overview of the user help system.

Creating and Using Math Waveforms

Many of the same oscilloscope tools that prove to be powerful adjuncts for displaying, processing, and analyzing other waveforms also work on math waveforms. For example, in addition to the operations listed above, you can save math waveforms as references.

Independent horizontal scaling. Each math waveform that you create derives its horizontal scale and position from the source that you include in its math expression. You can adjust these controls for the source waveforms and your adjustments will affect the math waveform as the source spans. You can also assign single waveforms, including math waveforms, using zoom.

Using Math Waveforms

Basically, you use the same techniques to work with math waveforms that work with channel waveforms.

Consider the source, be aware that changes to source waveforms that you include in a math-expression are reflected in the math waveform. However, if C13 is 6 divisions high at 100 mV per division, then at 50 mV per division C13 is 3 divisions high. Any math using C13 will be affected by this change because the C13 voltage levels have not changed. See Source Dependencies on page 3-123.

How to manage displaying. Turn on and off the display of math waveforms from the Math control window. Use the same control-window controls (waveform selection buttons, vertical position and scale knobs). Mouse operations for positioning waveforms are screen sensitive. See a picture of the help box on page 3-126.

To Use Math Waveforms

The procedures that follows demonstrates some common operations you can perform on math waveforms:

Overview

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<thead>
<tr>
<th>Overview</th>
<th>To use math waveforms</th>
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<tbody>
<tr>
<td>Prerequisites</td>
<td>Related control elements and resources</td>
</tr>
<tr>
<td>6. The math equation must be defined and displayed. See Use Math Waveform on page 3-124</td>
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Creating and Using Math Waveforms

Overview

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<tr>
<th>Overview</th>
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<tr>
<td>Selected display</td>
<td>Use automatic measurements</td>
</tr>
<tr>
<td>1. Touch the Math button to display the Math control window.</td>
<td></td>
</tr>
<tr>
<td>2. Touch any Math button to move the math waveform the selected waveform.</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Overview</th>
<th>To use math waveforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set scale and position</td>
<td>Use automatic measurements</td>
</tr>
<tr>
<td>1. Touch Position or Scale and use the multipurpose knob to change or position the waveform on screen as you want it.</td>
<td></td>
</tr>
<tr>
<td>2. Touch Position or Scale and use the multipurpose knob to change the waveform vertical position and scale by fine tuning the waveform handle and then using the multipurpose knob to adjust the scale and position.</td>
<td></td>
</tr>
<tr>
<td>3. Touch Position or Scale and use the multipurpose knob to change horizontal value position and scale by fine tuning the waveform handle and then using the multipurpose knob to adjust the scale and position.</td>
<td></td>
</tr>
</tbody>
</table>

Creating and Using Math Waveforms

Overview

<table>
<thead>
<tr>
<th>Overview</th>
<th>To use math waveforms</th>
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<tbody>
<tr>
<td>Take automatic measurements</td>
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</tr>
<tr>
<td>5. Touch the Math button, select the math tab, and touch a channel button to choose a math waveform from the math menu. See page 3-119.</td>
<td></td>
</tr>
<tr>
<td>6. Select a measurement for more information, see using Automatic Measurements on page 3-119.</td>
<td></td>
</tr>
<tr>
<td>7. To display the measurement, touch Display to toggle it on.</td>
<td></td>
</tr>
<tr>
<td>8. Read the results in the measurements readout.</td>
<td></td>
</tr>
</tbody>
</table>
Creating and Using Math Waveforms

Defining Spectral MathWaveforms

The math capabilities of the oscilloscopes include spectrum analysis of a waveform. This section describes a spectral analyzer that allows you to control the analysis interactively with time domain and frequency domain controls. These controls, the time domain controls with the frequency domain controls, provide a complete spectral analyzer.

Signals may be represented by their characteristic in both the time and the frequency domain. The frequency domain, by decomposing and transforming source waveforms into spectral math waveforms, you can simultaneously view signal characteristics in both domains.

This spectral analyzer provides a complete set of controls and features that allow you to make time and frequency domain measurements without the need to learn extensive details about FFT algorithms.

- **Frequency Domain Controls.** You can operate the spectral analyzer using traditional spectrum analyzer controls. You can set the center frequency, span, and resolution bandwidth directly.

- **Time Domain Controls.** The spectral analyzer has time domain controls for the acquired waveform. These controls set the time duration and the inclusion time between samples. You can easily set the required sample rate and record length.

- **Gain Controls.** These controls are the bridge between the time domain to the frequency domain. You can perform spectral analysis on a gated region of the input waveform. This gating also determines the resolution bandwidth of the analyzer.

- **Window Functions.** There are eight different window functions that shape the filter response of the spectral analyzer.

- **Magnitude Versus Frequency.** You can display log data in dB or linear mode. You can display the raw or imaginary parts of the spectrum magnitude only. Real/Imag and Reference level options give complete control over the vertical position and offset of the spectrum. The log axis dB level can be disabled manually or set to display with a single button touch.

- **Phase V/S Frequency.** You can display phase data as a function of frequency in radians or degrees. You can set the noise phase for magnitudes below a threshold level. Finally, you can select Phase unwrapping and AFPS, group delay.

**Spectral Analyzer**. You can turn on averaging in the frequency domain for noise and magnitude waveforms.

Using Spectral Math Controls

Read the following topics; they provide details that can help you create the spectral waveform that best supports your data analysis needs.

The spectral analyzer contains five primary control categories. These are shown in Table 3-11.

<table>
<thead>
<tr>
<th>Time controls</th>
<th>State controls</th>
<th>Frequency controls</th>
<th>Magnitude controls</th>
<th>Phase controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Position</td>
<td>Center</td>
<td>Scale, offset, level, gain</td>
<td>Imag, fl Olivier, group delay</td>
</tr>
<tr>
<td>Duration, waveform length</td>
<td>Duration</td>
<td>Scale</td>
<td>Default</td>
<td>Center threshold</td>
</tr>
<tr>
<td>Duration, sample rate</td>
<td>Window</td>
<td>Proportion bandwidth</td>
<td>Default, offset, phase linear</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Using the time controls. The operation of the time domain controls for the spectral analyzer is summarized by the following rules:

- **Duration.** Select the time from the beginning to the end of the acquired waveform. You may set duration using the record length control or the sample rate control.

- **Resolution.** Determines the time between samples. Duration is kept constant as resolution changes. Therefore, the resolution affects both the sample rate and the record length simultaneously.

- **Most often, you will want to use a short record length because long record lengths slow the response of the oscilloscope. However, long record lengths allow the noise level to rise slowly and increase the frequency resolution for the spectral math waveform. More important, they might be used to cancel the waveform features that you want to isolate in the waveform.

**Examples of how duration and resolution affect the acquired waveform are shown in Figure 3-38.**
Creating and Using Math Waveforms

Figure 3-36: Definition of gate parameters

The gate must reside within the dwell time interval of the source waveform. If the source waveform duration is adjusted and the gate position and width are set within the limits, the width of the gate affects the resolution bandwidth of the spectral analyzer. See Using Spectral Math Controls on page 3-143 for more details.

The data contained in the gate region is transformed to the frequency domain.

The gate is indicated on the display using dashed marks (similar to cursors). The default gate width setting is equal to the duration of the source waveform.

Using the frequency domain controls, the gate region of the source waveform is transformed into the frequency domain. A spectral waveform may be either a magnitude or a phase magnitude. The horizontal units are always Hz. The vertical units are always 1 Hz. The vertical units depend on whether the phase or the magnitude is selected. The frequency domain controls are used for the spectral waveform to set the span, center, and resolution bandwidth.

The trace (i.e., the upper frequency) of the source waveform is equal to the current sample rate divided by two. Therefore, if the span is set to twice the sample rate, the trace will be at the desired value and if you want to keep the same source waveform duration, go to the horizontal units division. If you want to add the sample rate using the resolution control, or, if you want to align the source waveform duration, adjust the sample rate control. If you decrease the sample rate, the span setting may decrease, so, to keep the span less than the sample rate divided by two.

Figure 3-37: Effects of frequency domain control adjustments

Creating and Using Math Waveforms

Resolution Bandwidth: RBW is the 3-dB down bandwidth of the spectral analyzer. The resolution bandwidth is calculated as a result of the spectral analyzer. The resolution bandwidth is calculated as a result of the spectral analyzer. The resolution bandwidth is calculated as a result of the spectral analyzer. The resolution bandwidth is calculated as a result of the spectral analyzer.

Different window functions produce different signal response stages in the spectrum and result in different resolution bandwidths.

The resolution bandwidth is the ratio of the frequency spectrum to the input waveform. The resolution bandwidth is the ratio of the frequency spectrum to the input waveform. The resolution bandwidth is the ratio of the frequency spectrum to the input waveform. The resolution bandwidth is the ratio of the frequency spectrum to the input waveform.

When the window is a rectangular window, the resolution bandwidth is necessarily equal to the span and the center frequency. When the window is a Gaussian window, the resolution bandwidth is equal to the span and the center frequency. When the window is a Gaussian window, the resolution bandwidth is equal to the span and the center frequency. When the window is a Gaussian window, the resolution bandwidth is equal to the span and the center frequency. When the window is a Gaussian window, the resolution bandwidth is equal to the span and the center frequency.

Using the magnitude controls, the vertical scale can be either linear or log. You can select these options by touching Math menu button. Touch the Spectral Analysis Setup button, and select the Mag tab. Select the desired scale type from Linear, dB, or dBm.

Linear: When the spectrum is linear magnitude the vertical units are the same as the source waveform. Usually this is used. However, it may also be watts or decibels.

dB: This sets the vertical scale of the magnitude spectrum to dB. Use the Reference Level Offset to set the vertical position in the magnitude spectrum.

The following equation applies:

\[ \text{dB} = 20 \log_{10} \left( \frac{\text{X}}{\text{Ref}} \right) \]

Where X is a complex data point in the spectrum and Ref is the Reference-Level Offset value.

Offset: This selects dB as described in the above equation, but it also sets the Reference-Level Offset to a value that is equivalent to 1 mV of power into 50 ohms. Therefore, if the input units are volts, then the value is set to 2.326 mV. If the input units are amperes, then the value is set to 40 uA. If the input units are watts, then the value is set to 1 mW.

Reference Level: This sets the vertical position of the displayed spectrum. Its value is the magnitude of the top of the display screen. When this control is adjusted, the spectral waveforms along with its zero reference marker move vertically on the screen (see Figure 3-36). This control does not change the spectral data.

Figure 3-38: Effects of adjusting the reference level

Reference Level Offset: This changes the value of Ref in the equation for dB. As shown above, unlike the reference level control, this control simply changes the zero reference position but does not change the actual data values in the spectrum. The reference level is shown on the display screen as the zero reference level. The display shows the spectral waveforms in a vertical position with respect to the
waveform references. This moves the waveform without changing the
Reference-Level control setting. Sometimes it is beneficial to adjust this cont
so that the peak of the fundamental is at zero dB. Then you can measure other
harmonics in terms of how many dB they are down from the fundamental. Touch
the dilate button to print this level to the equivalent of 1 mW into 50 ohms.

Figure 3-20: Effects of adjusting the reference level offset control

Real and Imaginary Magnitudes. You can use the spectral analyzer to display the
linear magnitude of the real data or the imaginary data in the spectrum. This is
useful if you process the spectrum off line and then superimpose it back into a time
domain trace. You could save the real and the imaginary spectrum into a
reference memory. You can export the waveform directly into Mathcad, Mathscript,
and Excel documents and spendet in data files.

To turn on real or imaginary spectrum, first touch the Math tab, then the
Display/Edit Expression button, and select the ZHist tab. Touch either the
Real or the Imaginary items to enter an expression. Touch the CS tab and one of
the channel buttons, ‘(time apply.

Using the Phase Controls. You can set the vertical units to degrees, radians, or
inserts of group delay. You select these choices by touching the Math button,
the Spectral Analysis Setup button, and then selecting the Phase tab. Select the
desired clock type from Degrees, Radians, or Group Delay.

Phase Reference Point. Phase is a relative measurement that must have a fixed
reference point. The phase value is specified with respect to this phase
reference point.

For the spectral analyzer, the phase reference point is the 50% position of the
gate, that is, the middle of the gate interval of the data that is input to the spectral
analysis. This is true for all window functions except for the Tek Exponential window. This window has a reference point at the 25% position of the gate.

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Creating and Using Math Waveforms

This feature is not useful for analysis of harmonic content of signals where the
phase response is a continuous.

Impulse Response Testing. When performing impulse response testing of a
system, place the impulse at the zero-phase reference point of the acquisition.
This produces a correct phase display. Because the Tek Exponential window has
its zero phase reference point at the 25% point, most of the impulse
response is captured. All other window functions have their phase reference point
at the 50% position in the gate region.

There are several ways to adjust the position of the zero phase reference point
with respect to your input signal:

- Adjust the ramp generator position
- Perform time alignment using the four-panel trigger level control
- Adjust the front-panel HORIZONTAL POSITION control

Using windows to filter. There are eight different spectral analyzer windows:

- Boberleigh
- Hanning
- Hanning
- Kaiser-Bessel
- Gaussian
- Blackman-Harris
- FlatTop
- Exponential

In the time domain, when a window is a rectangular function equal in length to the
gate duration. For most windows this function repeats itself at both ends of the gate
region. Before comparison of the spectral transform, the window is multiplied,
sample by sample, times the input data in the gate region. The window function
attenuates the start and stop-up response in the frequency domain. The
window function affects the ability to resolve frequency in the output spectrum.
This can affect the accuracy of the magnitude and phase measurements.

Figure 3-41: Winnowing the time domain record

Acoustic magnitude measurements require that the input source waveform be
windrowed within the gate region. This means that waveform presentation such as
impulse response and spectrum do not change significantly as a function of time
within the gate region that is input to the spectral analyzer. Also, the gate width
must be greater than the delay needed to the output of the full frequency of the span of
the spectral analyzer. That is, these must be at least one cycle of the harmonic
being measured within the gate region.

Choice of a window. Your choice of window function will depend on the input
source characteristics which you want to observe and the characteristics of the
window functions. The window characteristics are shown in Table 3-12.

<table>
<thead>
<tr>
<th>Window</th>
<th>1 dB BW in Hz</th>
<th>Spectral leak</th>
<th>Inward-</th>
<th>Zero phase</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanning</td>
<td>1.38</td>
<td>3.36 dB</td>
<td>0.13</td>
<td>98%</td>
<td>1.0</td>
</tr>
<tr>
<td>Hanning</td>
<td>1.38</td>
<td>3.36 dB</td>
<td>0.13</td>
<td>98%</td>
<td>1.0</td>
</tr>
<tr>
<td>Hanning</td>
<td>1.38</td>
<td>3.36 dB</td>
<td>0.13</td>
<td>98%</td>
<td>1.0</td>
</tr>
<tr>
<td>Kaiser-Bessel</td>
<td>1.38</td>
<td>3.36 dB</td>
<td>0.13</td>
<td>98%</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 3-12: Window characteristics
Table 3-12: Window characteristics (Cont.)

<table>
<thead>
<tr>
<th>Window</th>
<th>3-dB BW in bins</th>
<th>Scalefactor</th>
<th>Integer %</th>
<th>Zero phase reference</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackman</td>
<td>1.0</td>
<td>0.85 dB</td>
<td>-20 dB</td>
<td>0%</td>
<td>0.0007, 0.41649, 0.14129, 0.0111</td>
</tr>
<tr>
<td>Gaussian</td>
<td>1.0</td>
<td>0.75 dB</td>
<td>-90 dB</td>
<td>0%</td>
<td>0.02144, 0.02086, 0.02086, 0.01232, 0.00835463</td>
</tr>
<tr>
<td>Kaiser</td>
<td>1.8</td>
<td>0.2089 dB</td>
<td>-50 dB</td>
<td>0%</td>
<td>0.0007, 0.41649, 0.14129, 0.0111</td>
</tr>
<tr>
<td>Bartlet</td>
<td>1.0</td>
<td>0.65 dB</td>
<td>-30 dB</td>
<td>0%</td>
<td>0.0007, 0.41649, 0.14129, 0.0111</td>
</tr>
</tbody>
</table>

3-dB BW in bins. This is the bandwidth of the filter response of the spectrum analyzer to a sine-wave input for a given window function. It is given in units of bins. A bin is the interval between spectral samples when the interpolation factor is FFT zero fill factor. The bandwidth is measured between the points on the line that are 3-dB down from the peak of the lobes. The bandwidth in Hz may be computed by dividing the BW in bins by the gate duration in seconds. This is also referred to as resolution bandwidth (RBW).

Coherent gain: The gain factor normally associated with different window functions is correct only into the magnitude spectrum output. Therefore, the magnitudes on the output spectrum do not change as different windows are selected. The window is a set of analysis settings so that the zero fill is used in the FFT. Under this condition, different window functions change the phase of the output spectrum. The result is that of filtering or windowing the input spectrum. This is not true for the FFT, which is non-coherent, and the output spectrum is not affected by the window function. The zero fill is not used in the output spectrum, and the phase of the output spectrum is not affected by the window function.

Scallop Loss: This is the magnitude error of the spectral analyzer when the frequency of the observed signal is exactly half way between two frequency samples of the spectrum. The interpolation factor due to zero fill of the FFT is one. When zero fill is applied, scallop loss is essentially eliminated because of the interpolation in the frequency domain due to zero fill. If you work with open settings less than full and zoom with larger extrapolation bandwidth settings, zero fill is used only most of the time (see Figures 3-42 and 3-43).

Figure 3-42: Example of scallop loss for a Hanning window with zero fill

Nearest Side Lobe: This is the difference in magnitude between the spectral line peak in the spectrum and the zero side lobe due to energy leakage. Different windows have different leakage characteristics. The line is the resolution bandwidth of the window. The zero fill is the leakage in the spectrum.

Zero Phase Reference: This is the position in the time domain gate that is in the reference point for the output spectrum. That is, if the line input has its peak at the zero phase reference position, then it reads out as zero phase in the spectrum. If the phase is to be correct when doing impulse response testing, the impulse in the waveform must be located at this position in the gate interval.

Coefficients: These are used to generate the windows which are constructed from a cosine series. For the Gaussian window the value of 'n' is given instead of a set of coefficients. This can be found in the Handbook of Digital Signal Processing Engineering Applications by Elzey.

Figure 3-43: Time and frequency domain graphs for the Gaussian window

Rectangular Window. This window is equal to unity (see Figure 3-44). This means the data samples in the gate are not modified before they are input to the spectral analyzer. This window has the narrowest resolution bandwidth of any of the windows, but it also has the most spectrum leakage and the highest side lobes.

Figure 3-44: Time and frequency domain graphs for the Rectangular window
Hannings Window: This window is unique in that the time domain shape does not taper all the way to zero at the ends (see Figure 3-45). This makes it a good choice if you process the real and imaginary parts of the spectrum off line and invert transform 1 back to the time domain. Because the data does not taper to zero you can then remove the effect of the window function from the result.

Hannings, Kaiser-Bessel, and Blackman-Harris Windows. These windows have various resolution bandwidths and scaling issues (see figures 3-46, 3-47, and 3-48). Choose the one that best allows you to view the signal characteristics that you are interested in. The Blackman-Harris has a low amount of energy leakage compared to the other windows. The Hannings has the narrowest resolution bandwidth, but higher side lobes.

Figure 3-45: Amplitude-time graphs of the Hannings window.

Figure 3-46: Time and frequency graphs for the Hannings window.

Figure 3-47: Amplitude-time graphs for the Kaiser-Bessel window.

Figure 3-48: Time and frequency graphs for the Blackman-Harris window.

Figure 3-49: Amplitude-frequency graphs of the Kaiser-Bessel window.
Creating and Using Math Waveforms

Figures 3-48: Time and frequency domain graphs for the Paraboloid window

There are only two samples per cycle of a signal that have a frequency equal to one half of the sample rate. This is the highest oscillated signal that can be captured in the frequency domain. Therefore, when you analyze phase, make sure to oversample the signal sufficiently such that the one sample interval of jitter that is showing up in the phase is acceptable to the accuracy you wish to achieve.

Effects of Jitter: Average and High Res acquisition modes. The result of averaging the time domain acquisition using either average mode or High Res acquisition mode affects the frequency response of the oscilloscope. This is true to the one sample of jitter in the acquisition system. Both High Res and average acquisition modes have the same effect on the frequency response. These methods cause the response to roll off from a magnitude of one at DC to a magnitude of 0.64 at Nyquist which is the frequency equal to one half of the sample rate. This is true regardless of the real time sample rate setting.

Frequency Domain Averaging. You can test the average for a math waveform by selecting the math expression, sometimes it is more desirable to average in the spectrum than in the time domain. For example, consider a signal that has time domain components that are a significant factor in the trigger. If you average in the time domain, these components may go to zero or produce strange nondeterministic effects in the output waveform. Thus, these signal components may end up not appearing in the spectrum. However, if averaging is done in the frequency domain, these components will be preserved.

Recognizing Aliasing

Aliasing occurs when the input frequency of a signal is greater than one half of the sampling frequency (the sample rate). The sample rate must be high enough so that the signals in the spectrum appear at their correct frequency as opposed to a lower aliased frequency value. Also, complex signal shapes that have many harmonics in them, such as a triangle or square wave, can appear to be OK in the time domain when in fact many of the harmonics at that signal are aliased.

One way to check for aliasing is to increase the sample rate and observe whether any of the harmonics move to different frequency locations.

Another way to recognize aliasing is to realize that higher order harmonics usually have decreasing magnitudes compared to lower order harmonics. Thus, if you see a series of increasing harmonic magnitudes as frequency increases then you can suspect that there may be aliasing. In the spectral math waveform, the actual higher frequency components are undersampled, and therefore, they appear as lower frequency aliases that fold back around the Nyquist point. (See Figure 3-51.) You may test by increasing the sample rate and observing if aliases move to different frequency positions.

Creating and Using Math Waveforms

Figure 3-50: Tek Exponential window in the time and the frequency domain

Effects of trigger jitter. The oscilloscope acquisition system has a sample clock that is synchronous with respect to the input signal. This means that from one acquisition to the next, samples may be at a different position on the waveform with respect to the trigger. Samples may vary in position by up to one sample interval.

Creating and Using Math Waveforms

Figure 3-51: How aliased frequencies appear in a spectral waveform

Another way to observe aliasing, if you have a variable frequency signal source is to adjust the frequency slowly while watching the spectral display. If some of the harmonics are aliased, you will see the harmonics decreasing in frequency when they should be increasing or vice versa.

To Take Current Measurements of a Spectral Math Waveform. Once you have displayed a spectral math waveform, use cursors to measure its frequency, magnitude or phase angle. Use the procedure To Take a Cursor Measurement found in Taking Cursor Measurements on page 3-136.

To Take Automated Measurements of a Spectral Math Waveform. You can use automated measurements to measure spectral math waveforms. Use the procedure To Take Automated Measurements found in Taking Automated Measurements on page 3-100.
Creating and Using Math Waveforms

To Select a Predefined Special Math Waveform

Use the procedure that follows to select a predefined math waveform. A predefined math waveform may be acquired, or have acquired data. Therefore, you do not have to be displayed to be used.

Overview

To select a predefined special math waveform

Prerequisites

1. All channel and reference waveforms and automatic measurement settings that you will use in your math waveform must be acquired, or have acquired data. Measurement settings are defined, and so on.

Related control elements and resources

Display the math control window

1. From the toolbar, touch the Math tab to display the Math control window.

Select a predefined special analysis math waveform

1. Touch Math or Phase to select a predefined magnitude or phase special analysis waveform. Select a predefined special analysis waveform from the list.

To Define a Spectral Math Waveform

Use the procedure that follows that defines a spectral math waveform. If necessary, you should first ensure that the spectra you use exist. Channel sources must be acquiring or have acquired data. Those sources do not have to be displayed to be used.

Overview

To define a spectral math waveform

Prerequisites

1. All channel and reference waveforms and automatic measurement settings that you will use in the spectral math waveform must be acquired, or have acquired data. Measurement settings are defined, and so on.

Related control elements and resources

Display the math control window

1. From the toolbar, touch the Math tab to display the Math control window.

Set the magnitude scale

1. Select the Math tab.

2. To select the vertical scale type, touch Scale Off, DB, or Lin. The units will be dB, A, V, or whatever units are attached to the spectral analysis math waveform.

3. Linear - Magnitude is displayed in linear scale.

4. dB - Magnitude is displayed using dB scale.

5. Reference level scale is set to predefined values for dB or not set.

6. Tip: You can change the scale and position by first touching the waveform handle and then using the manipulate controls to adjust the scale and position.

7. To set the reference level, touch Level and use the move cursor arrows to adjust to the reference level.

8. Reference level is the level at the top of the display screen. It only applies to magnitude waveforms.

Adjusting the reference level for a magnitude waveforms with respect to the reference level at the top of the display, but does not change the position of the reference level with respect to the vertical reference.

Tip: Offset option removes zero dB from the output waveform. Changing offset moves the waveform with relative to its horizontal reference. When the zero is adjusted to the offset, the offset is displayed as zero dB in the output.

Set the phase scale

1. Select the Phase tab.

2. To select the vertical scale type, touch other Degree, or Gradian. The units will be degrees, or radians.

3. Degrees scale in degrees. Phase is displayed using degrees on the nodes, whereas radians are displayed using radians as the scale.

4. Radian and the phase range is radians. Phase is displayed using radians as the scale, whereas radians are used from 0 to π.

5. GroundDisplay scales the phase spectrum and displays it derivative.

Use Phase Controls on page 3-18 to scale the display. Use the math control window to adjust the display parameters.

15. To specify whether to auto-select a phase in a spectral analysis phase waveform, touch button to toggle it on or off.

16. To set the level to 0 dB, a magnitude in the spectrum must exceed a trace (the reference point to which the offset of noise in your phase waveform), touch Suppression Threshold, and use the mouse cursor to select a level. Level is displayed in the Trace window, then in phase. The Trace won (for example, see Figure 3-40 or page 3-154).

17. Touch the Control tab.

18. Touch Button to toggle phase to display the same controls for another math waveform. Touch the Trace Display Domain Control button to display the trace to on or off.
Overview | To define a spectral math waveform | Related control elements and resources
--- | --- | ---
Select the window type | | 19. To select the window type, touch Window Type, and select from the list. See FFT Windows on page 3-151 for a description of the available FFT windows. Rectangular — Bank selects a window in which the window function is a rectangular function, which sets the window to be flat. In a rectangular window, the frequency spectrum of the main signal is unbiased, and the frequency components below 0 Hz. Hamming, Hann, Blackman-Harris Kaiser, Blackman, and Flattop — These windows are based on polynomial basis functions. Each of these filter bases and spectral leakage characteristics. Use the window with the best fit to the spectrum you want to observe in the spectrum. Gaussian — Select this option to display the shrinking in the frequency domain of the waveform. Use the Gaussian window to display the shrinking in the frequency domain of the waveform. | | 20. Set the frequency domain controls | The spectral analyzer can be used to filter the spectrum of the time domain waveform. The frequency of the output must be within the bandwidth setting determined by the sample rate. Select the frequency range in the frequency domain. The input can be performed on the frequency range in the frequency domain. | Set the frequency range in the frequency domain. | | Table: Frequency Domain Controls | See Figure 3-31 on page 3-147 to see how the action is performed. Touch Apply Source and use the multifunction control to select the frequency range. | See Figure 3-31 on page 3-147 to see how the action is performed. Touch Apply Source and use the multifunction control to select the frequency range. | | | Higher sample rates allow you to select a higher frequency range. | Higher sample rates allow you to select a higher frequency range. | | | To set the resolution of the spectral analysis, touch Control and use the multifunction control or keyboard to set the resolution. | To set the resolution of the spectral analysis, touch Control and use the multifunction control or keyboard to set the resolution. | | | Resolution bandwidth determines the useful of a frequency range. To display the frequency range, touch the full button. | Resolution bandwidth determines the useful of a frequency range. To display the frequency range, touch the full button. | | | To set the resolution bandwidth, touch Full BW and use the multifunction control to set the resolution. | To set the resolution bandwidth, touch Full BW and use the multifunction control to set the resolution. | | | | To set the resolution bandwidth, touch Full BW and use the multifunction control to set the resolution. | | | For further assistance | Touch Help button in the lower left corner of the window to access additional help for this waveform. | Touch Help button in the lower left corner of the window to access additional help for this waveform. |
### Data Input/Output

This section describes the input and output capabilities of your oscilloscope. Specifically, it covers:
- Saving and Recalling Setup on page 3-173
- Saving and Recalling Waveforms on page 3-180
- Exporting and Copying Waveforms on page 3-188
- Printing Waveforms on page 3-196
- Remote Communication on page 3-203

### Saving and Recalling a Setup

This oscilloscope can save a number of different oscilloscope setups for later recall, limited only by the space that you have to store the setups.

For saving and recalling different setups, you can switch from setup to setup without having to find manually recall your settings and then manually set them. This capability is useful when you want to:
- Save and recall a setup that optimizes the oscilloscope for displaying and analyzing a specific signal.
- Save a series of setups to help automate a procedure through recall of a sequence of saved setups as part of execution of the procedure.
- Export a setup for testing with a second oscilloscope. The Save Setup and the Recall Setup control window provide for including and viewing comments with your saved setups. You can store information, reminders, or other notes with each setup, that describes each setup you save and its intended application.

If you do not have keyboard connected, you can still enter comments and save setup files. The Save and Recall Setup windows include the Virtual Keyboard. When you touch or click a setup name, the oscilloscope displays a keyboard on screen that you can use with your mouse or touch screen to enter the setup name, setup file name, and comments.

---

### To Save Your Setup

To save your setup, follow these steps:

1. **Prerequisites**
   - The oscilloscope must be powered on.
   - The oscilloscope is connected via USB or GPIB.

2. **To save your setup**
   - **Prerequisites:** The oscilloscope must be powered on. The oscilloscope is connected via USB or GPIB.
   - **Process:**
     - Open the Setup Menu.
     - Select the Setup File Manager.
     - Choose the destination file.
     - Touch the Save button.

3. **Display the setup control window**
   - From the tool bar, touch Setup and select the Save Setup tab of the Setup control window.

4. **Save the setup**
   - Touch the save button to save the current setup.

---

### Data Input and Output

The oscilloscope includes the following items when saving setups:
- Waveforms in Ch1 to Ch4 and references (Ref-A, Ref-B). Control settings (scale, position, and so on) are saved but not the waveform data. Upon recall of the setup, the settings are applied, but the data is not restored.
- Waveforms in Math: Waveforms (Math1:Math4). Control settings and the math expression are recalled but not the waveform data. Upon setup recall, however, the recalled math waveform expressions will be applied, but math waveform data is not restored.
- User Options that are stored in the Windows Registry. These include all options accessed by first selecting Utilities (menu bar) and then User Preferences (Utilities menu).

You cannot recall into a channel or a math waveform. The oscilloscope recalls each waveform into the reference waveform locations (Ref-A, Ref-B).

If you want to save a waveform in a custom format for other applications, such as a spreadsheet, use the export function (see Exporting and Copying Waveforms on page 3-188).

A few things to remember when saving and recalling setups:

- **All Settings are Retained.** The oscilloscope includes almost all oscilloscope settings, with a few exceptions (see user options) in the saved setup.
- **Retaining Current Settings.** Recalling a setup replaces the current setup with the recalled setup. If you do not want to lose your current setup, save it to its own save file for later recall before you recall a setup.
- **Avoiding Setup/View Path Mismatch.** Saved setups may contain settings inappropriate for waveforms currently in your oscilloscope. For example, if you save a setup that displays a math waveform that is in the average of reference 1, when you recall the setup, if the reference is simple, the math and reference waveforms are not displayed.
8. Name your setup file:
   - Accepting the default file name that appears in the File name field.
   - If the displayed name is the default, enter the name you want to use.
   - If you choose a file name that is not in the list, enter the name you want to use.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - If you choose a file name that is not in the list, enter the name you want to use.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.

9. If you choose a file name that is not in the list, enter the name you want to use.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.
   - Make sure the name is unique. If you have more than one setup file in the list, enter a new name.

10. Save your setup:
    - Touch the Save button to save the setup file. To cancel without saving, touch the Cancel button.

For further assistance:
11. For more help on saving setup files, touch the Help button in the toolbar bar to view context help on screen.

See page 3-223 to learn about using online help.

Saving and Recalling Waveforms

The oscilloscope can save any number of waveforms, limited only by the space you have available.

By saving a waveform, you can recall it at a later time for comparison, evaluation, and documentation. This capability is helpful when you want to:
- Recall a waveform for further evaluation or comparison with other waveforms.
- Expand the waveform history of the oscilloscope. The oscilloscope supports four reference, four channels, and four math waveforms. If you save more than four waveforms, you can save the additional reference to disk for recall later.
- The Reference-Waveform control window contains a Label field for labeling comments with your saved waveforms. Using comments you can store information, results, or recall, describing each waveform that you save.
- Virtual Keyboarding. If you set your keyboard to record, you can enter plain text and enter waveform names. The Reference-Waveform control window includes a Keyboard button. When you use this feature, the oscilloscope displays a virtual keyboard on screen that you can use to enter waveforms names, file names, and comments.
- You can recall a channel or math waveform. The oscilloscope recalls each waveform into one of the reference waveform locations (Red, Blue, Green, and Yellow).
To Save Your Waveform

Use the procedure that follows to save a waveform or waveforms to a reference location, like a floppy disk, a hard disk, or third party storage device.

Overview | To save a waveform
---|---
Prerequisites
1. The oscilloscope must be powered on.
2. Make sure the waveform to be saved exists, that is, its source must be a channel, an analog math waveform, or an active reference. Display the waveform with the panel in which you want to save it.
For help in setting up the oscilloscope, go to page 3-19.

Control elements and resources
- See menu On Oscilloscope on page 3-19.
- See menu On Save Waveform on page 3-19.
- See page 3-19 for acquisition setup.
- See page 3-20 for trigger setup.

Display the reference control window
3. From the tool bar, touch File and select the File menu at the reference location to which you want to save the waveform.

Select the waveform to save
4. Select the Ch, Blatt, or Filt tab of the waveform that you want to save, and then touch the number of the channel, math, or reference waveform that you want to save.

Label the waveform
5. If you want to label the waveform, touch Label, and configure your keyboard or the keypad to create a label for your waveform.

Save the waveform to a file
6. Touch Save. You can save your waveform. Data in the existing reference location will be overwritten.
**Overview**

To clear references:

- The oscilloscope must be powered on. You must have access to a waveform used by the application.
- See page 3-92 to learn about stored reference files.

**To Clear References**

**Procedure**

1. From the top menu, touch File and select the list (File 1 to File 4) of the reference file you want to delete.

**Control elements and resources**

- See page 3-92 to learn about stored reference files.

---

**Overview**

- To clear references (cont.):

**Delete a reference waveform file**

4. Touch the Delete button in the Delete Reference Waveform window.

**Control elements and resources**

- Touch Delete in the Delete Reference Waveform window.

---

**Overview**

- To clear references (cont.):

**Find the file directory**

5. Use the file tree drop-down list and buttons (see right) to complete the directory for the file to delete.

**Control elements and resources**

- Use the file tree drop-down list and buttons to complete the directory for the file to delete.

---

**Overview**

- To clear references (cont.):

**Find the file**

6. Touch the folder icon in the file drop-down list to select the file in any subdirectory. Type a name for the file.

**Control elements and resources**

- Touch the folder icon in the file drop-down list to select the file in any subdirectory.

---

**Overview**

- To clear references (cont.):

**Delete the file**

8. Touch the Delete button to delete the file. To display the file without deleting it, touch the Cancel button.

**Control elements and resources**

- Touch the Delete button to delete the file. To display the file without deleting it, touch the Cancel button.
To Export Your Waveform

Use the procedure that follows to export a waveform or waveforms to the Excellon non-hard disk, a floppy disk, or third party storage device.

Overview

To save a waveform

Control elements and resources

1. Select for export

2. From the menu bar, select File, and then select Save to display the Save as dialog.

3. Select the files and waveforms to export.

4. In the dialog, select the save format and location.

5. Click Save to export the selected files.

6. In the Properties window, select Digitizer, GrayScale, or Black & White for the color palette of your exported images.

7. In the View window, select whether you want to export the full-screen or thumbnail only.

8. In the Image window, select whether you want to export using Normal or FlipImage Mode.

9. View Data Format and select the data format from the drop-down list.

Overview

To save a waveform

Control elements and resources

1. Select the waveforms to display the Waveform control window.

2. In the Waveform tab, select the waveforms to export.

3. In the Waveform tab, select the measurement to export.

4. In the Waveform tab, select the data to export.

5. Click Export to export the selected data.

6. The Export window lists all available waveforms, allows for exporting to the destination directory, saving the file, and previewing the file format.
To save a waveform

1. Use the Save in: drop-down list and button bar (top right) to locate the directory in which you want to save the file.

2. Name the file.

   - Select the File type in the Save as Type drop-down list to select the file type to be saved. This is the only output format type (.csv) in this example.
   - Enter the name of the file in the File name field.
   - Tip: If you do not have a laptop keyboard, touch or click the File name field to display a virtual keyboard. You can use the touchscreen or touch screen with the virtual keyboard to type the name into the name field.

3. Save the file.

   - Click the Save button to save the file. The file is saved without asking a file name.

For further assistance

- For more information, touch the Help button to access context-sensitive help.

---

To use exported waveforms

Overview | To use exported waveforms | Control elements and resources
---|---|---

Overview | To use exported waveforms | Control elements and resources
---|---|---

- Begin your chart:
  1. Click on the wave number to select the wave containing your imported waveform value (top right).
  2. Select the chart button from the tool bar (top right) from the level menu.

- Specify a line graph chart
  - From the Chart Wizard, select bar chart and select either Line in the chart Type tab or Smooth line in the Custom chart tab. (See right)

- Finish the chart
  - Click Next to stop through the chart wizard screen setting step 1. Click the Finish button to save the chart.

Tips: This procedure assumes that you have created your external chart. You can type the file name and save it in another directory. The file name is displayed in the Save as Type drop-down list.

Prerequisites
- File Open: Open the file in the chart wizard.
- Save: The file will save to the directory specified in the Save as Type drop-down list.

---

To copy your waveform

Overview | To use exported waveforms | Control elements and resources
---|---|---

Overview | To use exported waveforms | Control elements and resources
---|---|---

- For further assistance
  - For more information, touch the Help button in the window to access context-sensitive help.

See page 3-205 for more information on using online help.
Printing Waveforms

You can print the display screen, including any waveforms displayed. Before you can print, you must install and set up your printer. Consult the instructions that come with your printer. Also, for printer setup instructions, you can display Windows Help and access its sections on printers.

To Print from Front Panel

To print a waveform from the front panel, press the front-panel PRINT button. This display menu will open on the default printer. For additional print options, see the topics that follow.

To Print from Menu Bar

To print a waveform, from the application menu bar, select the File menu, and then select Print. The Printconcert displays the standard MS Windows 95 Print window shown in Figure 3-52. Access the Windows Help system for more information.

Figure 3-52: Print window

To Set Up the Page

To set the format of the printed page, from the application menu bar, select the File menu, and then select Page Setup. The Page Setup window shown in Figure 3-54.

Paper: Select the paper size and source from the drop-down lists.
Orientation: Select either Portrait or Landscape (see Figure 3-53).
Margins: Set the margins you want for your page.

Figure 3-54: Page setup window
Remote Communication

Remote communication is performed through the GPIB interface. Consult the online Programmer's Guide for help with establishing remote communication and control of the oscilloscope.

To access the Programmer's Guide, locate the Product Software CD that was shipped with the oscilloscope. Install the CD in the personal computer that you want to use, typically your oscilloscope controller. Follow the instructions in the CD booklet.

You can install the guide on the oscilloscope, but that may not be convenient because it will cover the oscilloscope screen.

For information on connecting the oscilloscope to a network to enable printing, file sharing, Internet access, and other communications functions, see Connecting to a Network on page 1-13.
Accessing Online Help

This manual represents only part of the user assistance available to you—the online help system, integrated as part of the oscilloscope user interface, provides quick access to support for operating this oscilloscope. This section describes the help system and how to access it.

This oscilloscope provides the following help resources online:

- **Help Topics**
- **User's Guide**

Much of the information you need to operate this oscilloscope and use it effectively is found online, where you can quickly access it and display it on your oscilloscope screen. (You may need to access the documentation for more information.)

A few keys to remember when using online help follow:

- Use online help to minimize interruption to your work flow.
- Help Topics are there when you need more details about a feature.
- Use the Help Topics instructions on getting the oscilloscope into service, for procedures on maintaining its performance, for listings of specifications, and for overviews of features and their operation.
- Use the online program guide, either displayed on the oscilloscope screen or on your Windows-equipped PC for support on operating the oscilloscope from the GUI.

How to Use Online Help

Use the procedures below to access contextual help and to learn how to use the help system for more information.

<table>
<thead>
<tr>
<th>Overview</th>
<th>To use online help</th>
<th>Control elements and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>To use online help</td>
<td>Control elements and resources</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>1. The oscilloscope must be powered up and running.</td>
<td>See Installation, page 1-6.</td>
</tr>
</tbody>
</table>

TDS6000 Series User Manual

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TDS6000 Series User Manual

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TDS6000 Series User Manual
Appendix A: Specifications

Product and Feature Description

Your TDS6600 Series is shown in Table A-1.

Table A-1: TDS6600 Series

<table>
<thead>
<tr>
<th>Model</th>
<th>Number of Channels</th>
<th>Bandwidth</th>
<th>Maximum sample rate (per channel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS6604</td>
<td>4</td>
<td>8 GHz</td>
<td>16 GSPS</td>
</tr>
</tbody>
</table>

Appendix A: Specifications

Acquisition Features
- Separate Digitizer: Ensure accurate timing measurements with separate digitizers for each channel. Acquisition on multiple channels is always concurrent. The digitizers can also be configured to yield a higher sample rate on a single channel.

Long Record Lengths: Record length from 125,000 points when using channel 1 with 2 or channel 3 with 4, or any three channels, or all 4 channels. Up to 250,000 points when using channel 1 with 3, channel 1 with 4, channel 2 with 3, or channel 2 with 4, or any single channel.

Peak Detect Acquisition Mode: Use filters as narrow as 50 ps even at the lowest time base settings. Peak detect helps you see noise and glitches in your signal.

Acquisition Control: Acquire continuously or set up to capture single-shot acquisitions. Enable or disable optional acquisition features such as time markers.

Horizontal Delay: Use delay when you want to acquire a signal at a significant time interval after the trigger point. Toggle delay on and off to quickly compare the signal as it is at different points in time.

Signal Processing Features
- Average, Envelope, and Hil Res Acquisition: Use Average envelope modes to reduce unwanted noise from your signal. Use Hil Res to capture and display the maximum visualization of the signal. Use Hil Res to increase vertical resolution for lower bandwidth signals.

Waveform Math: Use up to 16 math waveforms using the basic arithmetic functions or create more advanced math waveforms using the math expression editor. Waveform expressions can even contain measurement results and other math waveforms.

Spectral Analysis: Display spectral magnitude and phase waveforms based on your time-domain acquisitions. Control the oscilloscope using the traditional system analysis controls such as span and center frequency.

Display Features
- Color LCD Display: Identify different waveforms easily with color coding. Waveforms, menus, and labels are color matched to increase productivity and reduce operating errors.

Zoom: To take advantage of the full resolution of the oscilloscope you can zoom in on a waveform to see the fine details. Both vertical and horizontal zoom functions are available.

Specifications Tables

Table A-2: Channel input and vertical specifications

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input impedance</td>
<td>1 MΩ (50Ω)</td>
</tr>
<tr>
<td>Vertical coupling</td>
<td>DC and 50Ω</td>
</tr>
<tr>
<td>DC coupling</td>
<td>100 mV (±2% or ±1% (3%))</td>
</tr>
<tr>
<td>Vertical sensitivity</td>
<td>1 mV to 500 mV</td>
</tr>
<tr>
<td>Maximum gain at input</td>
<td>1500 V/m</td>
</tr>
</tbody>
</table>

Online Help: The online help has a complete online help system that covers all of the features. This helps system is content sensitive: help for the displayed control window is automatically shown when you touch the help button. Graphical aids in the help window assist you in getting to the information you need. You can also access the help topics through a table of contents or index.
### Appendix A: Specifications

#### Table A-2: Channel input and vertical specifications (Cont.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective time typical</td>
<td>Now, when input is a 25 MHz sine wave. Input is in the band width of 10 MHz and 1 MHz.</td>
</tr>
<tr>
<td>Delay between channels</td>
<td>&gt; 30 µs between any two channels with the same scale and coupling settings</td>
</tr>
<tr>
<td>Channel-to-channel cross talk</td>
<td>&gt; 0.1 µV at 1-5 GHz for the noise bandwidth, whichever is less. Assumed two channels with the same scale settings</td>
</tr>
</tbody>
</table>

#### Table A-2: Horizontal and acquisition system specifications

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal :</td>
<td>Sample rate range</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>Number of channels acquired</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>8000</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>4000</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>2000</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>1000</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>500</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>50</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>20</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>10</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>5</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>2</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>1</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.5</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.25</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.125</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.0625</td>
</tr>
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<td>Sample rate range</td>
<td>0.03125</td>
</tr>
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<td>Sample rate range</td>
<td>0.015625</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.0078125</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.00390625</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.001953125</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.0009765625</td>
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<td>Sample rate range</td>
<td>0.00048828125</td>
</tr>
<tr>
<td>Sample rate range</td>
<td>0.000244140625</td>
</tr>
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<td>Sample rate range</td>
<td>0.0001220703125</td>
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<td>Sample rate range</td>
<td>0.00006103515625</td>
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<td>Sample rate range</td>
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<tr>
<td>Sample rate range</td>
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<tr>
<td>Sample rate range</td>
<td>0.000000029802322388671875</td>
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<tr>
<td>Sample rate range</td>
<td>0.0000000149011611943359375</td>
</tr>
</tbody>
</table>
## Table A-4: Trigger specifications (Cont.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge trigger sensitivity</td>
<td>Typical: 150 mV 50 ohms, adjustable to 5 V; Optional: 1 V 1 MΩ, adjustable to 5 V</td>
</tr>
<tr>
<td>Linear trigger input sensitivity</td>
<td>0.5 V</td>
</tr>
<tr>
<td>Rise time (max)</td>
<td>50 ns</td>
</tr>
<tr>
<td>Fall time (max)</td>
<td>500 ns</td>
</tr>
<tr>
<td>Transition time (min@10% to 90%)</td>
<td>15 ns</td>
</tr>
<tr>
<td>Rise time (max@10% to 90%)</td>
<td>15 ns</td>
</tr>
<tr>
<td>Fall time (max@10% to 90%)</td>
<td>500 ns</td>
</tr>
<tr>
<td>Setup and hold times</td>
<td>250 ns</td>
</tr>
<tr>
<td>Source output impedance</td>
<td>50 ohms</td>
</tr>
</tbody>
</table>

## Table A-6: Triggerspecifications (Cont.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced trigger input sensitivity</td>
<td>Typical: 150 mV 50 ohms, adjustable to 5 V; Optional: 1 V 1 MΩ, adjustable to 5 V</td>
</tr>
<tr>
<td>Linear trigger input sensitivity</td>
<td>0.5 V</td>
</tr>
<tr>
<td>Rise time (max)</td>
<td>50 ns</td>
</tr>
<tr>
<td>Fall time (max)</td>
<td>500 ns</td>
</tr>
<tr>
<td>Transition time (min@10% to 90%)</td>
<td>15 ns</td>
</tr>
<tr>
<td>Rise time (max@10% to 90%)</td>
<td>15 ns</td>
</tr>
<tr>
<td>Fall time (max@10% to 90%)</td>
<td>500 ns</td>
</tr>
<tr>
<td>Setup and hold times</td>
<td>250 ns</td>
</tr>
<tr>
<td>Source output impedance</td>
<td>50 ohms</td>
</tr>
</tbody>
</table>
### Table A-4: Trigger specifications (Cont.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum time between edges (14.5 nsec) and trigger (8 Event)</td>
<td>10.5 nsec from the edge time, the 8 trigger event and the 14.5 nsec edge time.</td>
</tr>
<tr>
<td>Minimum time between edges (8 Event)</td>
<td>10.5 nsec from the edge time, the 8 trigger event and the 14.5 nsec edge time.</td>
</tr>
<tr>
<td>Maximum frequency, typical</td>
<td>100 MHz</td>
</tr>
<tr>
<td>Trigger position error, typical</td>
<td>Edge trigger: DC coupling for target having a slight rise at the trigger point of 0.5 divisions</td>
</tr>
<tr>
<td>Acquisition mode</td>
<td>EMG</td>
</tr>
<tr>
<td>Sample Dense</td>
<td>2x waveform interval + 220 nsec</td>
</tr>
<tr>
<td>Trigger threshold range</td>
<td>15 to 23 nsec, 0 percent of full scale for settings of 10 nsec. A delay of 4 nsec is added to the threshold setting.</td>
</tr>
</tbody>
</table>

### Table A-5: Serial Trigger specifications (Option ST Only)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial trigger number of 0th</td>
<td>36</td>
</tr>
<tr>
<td>Serial trigger encoding type</td>
<td>8bit</td>
</tr>
<tr>
<td>Serial trigger baud rate limits</td>
<td>16 to 1.25 Mbaud</td>
</tr>
<tr>
<td>Signal trigger level definition</td>
<td>0.55 to 0.70 V peak</td>
</tr>
<tr>
<td>Remote trigger level definition</td>
<td>0.55 to 0.70 V peak</td>
</tr>
<tr>
<td>Trigger width-definition-definition-position accuracy</td>
<td>± 1 nsec, 0 percent of full scale for settings of 10 nsec. A delay of 4 nsec is added to the threshold setting.</td>
</tr>
<tr>
<td>Acquisition mode</td>
<td>EMG</td>
</tr>
<tr>
<td>Sample: Average</td>
<td>2x waveform interval + 220 nsec</td>
</tr>
<tr>
<td>Trigger threshold range</td>
<td>15 to 23 nsec, 0 percent of full scale for settings of 10 nsec. A delay of 4 nsec is added to the threshold setting.</td>
</tr>
</tbody>
</table>

### Table A-6: Display specifications

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display type</td>
<td>712 x 240 x 0.4 mm [640 x 192 x 0.4 mm]</td>
</tr>
<tr>
<td>Display resolution</td>
<td>640 horizontal x 480 vertical pixels</td>
</tr>
<tr>
<td>Point pitch</td>
<td>0.23 mm horizontal, 0.22 mm vertical</td>
</tr>
<tr>
<td>Response time (typical)</td>
<td>30 ns, white to black</td>
</tr>
<tr>
<td>Display refresh rate</td>
<td>60 Hz, 60 frames per second</td>
</tr>
<tr>
<td>Viewing angle (typical)</td>
<td>60 degrees</td>
</tr>
<tr>
<td>Displayable intensity range</td>
<td>Supports Windows-SVGA high color mode (12-bit)</td>
</tr>
</tbody>
</table>

### Table A-7: Input/output port specifications

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel port (IEEE 1284)</td>
<td>DB-25 connector, supports the following modes: standard bus mode, enhanced EISA compatible, enhanced PCI compatible, and parallel port (IEEE 1284) standard mode.</td>
</tr>
<tr>
<td>Serial port</td>
<td>RS-232C, supports DTE and DTE compatible modes.</td>
</tr>
<tr>
<td>Keyboard port</td>
<td>PS/2 compatible, does not support PS/2 compatible, does not support PS/2 compatible.</td>
</tr>
<tr>
<td>Mouse port</td>
<td>PS/2 compatible, supports the following modes: standard, compatible, and PS/2 compatible.</td>
</tr>
<tr>
<td>LAN port</td>
<td>10/100BaseT supported, supports 10BaseT and 100BaseT.</td>
</tr>
<tr>
<td>Audio ports</td>
<td>Line-in, line-out, for stereo microphone input and stereo line output.</td>
</tr>
<tr>
<td>USB port</td>
<td>Supports USB 2.0, supports connection of USB hub. The USB interface supports the following modes: standard and high-speed.</td>
</tr>
<tr>
<td>GPIB port</td>
<td>IEEE 488-2 standard interface</td>
</tr>
</tbody>
</table>

### Table A-8: Power source specifications

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal input voltage</td>
<td>100 - 240 V, 50/60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>300 mA, 0.9 W</td>
</tr>
<tr>
<td>Source voltage and frequency</td>
<td>100 to 240 V, 50/60 Hz</td>
</tr>
<tr>
<td>CAT II</td>
<td></td>
</tr>
<tr>
<td>Fuse rating</td>
<td>2A</td>
</tr>
<tr>
<td>External dimension</td>
<td>3.5 x 1.25 x 0.8 in</td>
</tr>
<tr>
<td>External power</td>
<td>15 W, 500 mA, 100 VAC</td>
</tr>
<tr>
<td>Input power</td>
<td>15 W, 500 mA, 100 VAC</td>
</tr>
<tr>
<td>Input voltage</td>
<td>100 - 240 V, 50/60 Hz</td>
</tr>
<tr>
<td>Input current</td>
<td>15 W, 500 mA, 100 VAC</td>
</tr>
<tr>
<td>Input frequency</td>
<td>100 - 240 V, 50/60 Hz</td>
</tr>
<tr>
<td>Input voltage</td>
<td>100 - 240 V, 50/60 Hz</td>
</tr>
<tr>
<td>Input current</td>
<td>15 W, 500 mA, 100 VAC</td>
</tr>
<tr>
<td>Input frequency</td>
<td>100 - 240 V, 50/60 Hz</td>
</tr>
<tr>
<td>Load voltage</td>
<td>100 - 240 V, 50/60 Hz</td>
</tr>
<tr>
<td>Load current</td>
<td>15 W, 500 mA, 100 VAC</td>
</tr>
<tr>
<td>Load frequency</td>
<td>100 - 240 V, 50/60 Hz</td>
</tr>
</tbody>
</table>
Appendix A: Specifications

Table A-10: Mechanical specifications

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>13 kg (29 lb) with full accessories and paper; 24 kg (53 lb) when packaged for worldwide shipment.</td>
</tr>
<tr>
<td>Friction Mount</td>
<td>9.1 kg (20 lb) for worldwide shipment.</td>
</tr>
</tbody>
</table>

Dimensions

<table>
<thead>
<tr>
<th>Type</th>
<th>With front cover</th>
<th>Without front cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Width</td>
<td>328 mm (12.9 in)</td>
<td>287 mm (11.3 in)</td>
</tr>
<tr>
<td>Overall Height</td>
<td>426 mm (16.75 in)</td>
<td>426 mm (16.75 in)</td>
</tr>
<tr>
<td>Overall Depth</td>
<td>435 mm (17.13 in)</td>
<td>435 mm (17.13 in)</td>
</tr>
</tbody>
</table>

Reload condition (Trolley): 164 mm (6.45 in) height, 332 mm (13 in) width, 670 mm (26.25 in) length.

Coating: Functional air-drying with no Anti-Mist.

 ensuite electrical insulation to a maximum of 6 mm (0.24 in) thickness.

Construction material: 1. Carbon particles are supported on a conductive matrix. 2. Core panel is conductive to plastic laminate. 3. Circuit boards are laminated to plastic laminate. Overhead is coated and finished with a polyurethane finish.

Appendix A: Specifications

Table A-11: Environmental specifications

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature, operating</td>
<td>4°C (40°F) to 50°C (122°F), excluding hopper drive and DC/DC converter drives.</td>
</tr>
<tr>
<td>Humidity, operating</td>
<td>20% to 80% relative humidity with a maximum dew point of -10°C (14°F) at a relative humidity of 80% (122°F).</td>
</tr>
</tbody>
</table>

Table A-12: Certifications and compliances (Cont.)

<table>
<thead>
<tr>
<th>Category</th>
<th>Standards or description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE Declaration of Conformity — EMC</td>
<td>EN 61326-1:2016/1.AA</td>
</tr>
</tbody>
</table>
### Appendix B: Automatic Measurements Supported

This appendix provides a list of all supported measurements and their definitions. An illustration showing the levels used to take measurements is also included.

#### Table B-1: Supported measurements and their definition

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amplitude</strong></td>
<td>Voltage measurement. The high value from the low value threshold over the entire waveform or gated region.</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>Area measurement. Voltage over time measurement. The area under the entire waveform or gated region is negative. Area measured above ground is positive, area below ground is negative.</td>
</tr>
<tr>
<td><strong>Cycles Area</strong></td>
<td>Voltage over time measurement. The area over the first cycle in the waveform or the first cycle in the gated region.</td>
</tr>
<tr>
<td><strong>Runt Width</strong></td>
<td>Timing measurement. The duration of a burst, measured over the entire waveform or gated region.</td>
</tr>
<tr>
<td><strong>Crest Factor</strong></td>
<td>Voltage measurement. The ratio of the maximum output voltage to the maximum output voltage of the waveform or gated region.</td>
</tr>
<tr>
<td><strong>Delay</strong></td>
<td>Timing measurement. The time between the first cycle in the waveform or the first cycle in the gated region.</td>
</tr>
<tr>
<td><strong>Fall Time</strong></td>
<td>Timing measurement. The time taken for the falling edge of the first pulse in the waveform or gated region to fall from a High to Low value (10% to 90% of a Low level value). Input data includes 10% of the first pulse.</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>Timing measurement. The period of the waveform or the period of the waveform in the waveform or gated region.</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>The value used as 100% when High, Low, and Low are updated as its value in full time and time measurements. Calculated from the maximum and minimum values. The minimum value under the maximum value threshold. The highest maximum value under the maximum value threshold. The minimum maximum value under the maximum value threshold.</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>The value used as 10% when High, Low, and Low are updated as its value in full time and time measurements. Calculated from the maximum and minimum values. The minimum value under the maximum value threshold. The highest maximum value under the maximum value threshold. The minimum maximum value under the maximum value threshold.</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>Voltage measurement. The maximum value under the waveform or gated region.</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>Voltage measurement. The arithmetic mean over the entire waveform or gated region.</td>
</tr>
</tbody>
</table>

#### Table B-1: Supported measurements and their definition (Cont.)

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak to Peak</strong></td>
<td>Voltage measurement. The absolute difference between the maximum and minimum amplitude over the entire waveform or gated region.</td>
</tr>
<tr>
<td><strong>Phase</strong></td>
<td>Timing measurement. The amount of waveform offset or phase difference. Expressed in degrees or time. The waveform offset is expressed in degrees or time.</td>
</tr>
<tr>
<td><strong>Period</strong></td>
<td>Timing measurement. The amount of waveform offset or phase difference. Expressed in seconds.</td>
</tr>
<tr>
<td><strong>Positive Cycle</strong></td>
<td>Timing measurement. The number of cycles in the waveform or gated region. The ratio of the positive cycle width to the signal period expressed as a percentage.</td>
</tr>
<tr>
<td><strong>Positive Overshoot</strong></td>
<td>The amount of waveform offset or phase difference. Expressed in degrees or time. The waveform offset is expressed in degrees or time.</td>
</tr>
<tr>
<td><strong>Positive Width</strong></td>
<td>Timing measurement of the first pulse in the waveform or gated region. The distance between the first pulse and the end of the pulse.</td>
</tr>
<tr>
<td><strong>Rise Time</strong></td>
<td>Timing measurement. The time taken for the leading edge of the first pulse in the waveform or gated region to rise from a Low to High value (10% to 90% of the first pulse).</td>
</tr>
<tr>
<td><strong>RMS</strong></td>
<td>Voltage measurement. The root mean square voltage over the entire waveform or gated region.</td>
</tr>
<tr>
<td><strong>Width</strong></td>
<td>The average value of the acquired points minus the peak-to-peak width.</td>
</tr>
<tr>
<td><strong>Shift</strong></td>
<td>The standard deviation (Root Mean Square) deviation of the acquired points within the acquired waveform.</td>
</tr>
<tr>
<td><strong>Hit in Box</strong></td>
<td>The number of points in the histogram box at the boundary.</td>
</tr>
</tbody>
</table>

#### Figure B-1: Levels used to determine measurements
Appendix C: Cleaning

Use these procedures to clean your oscilloscope. If additional cleaning is required, have your oscilloscope serviced by qualified service personnel.

Exterior Cleaning
Clean the exterior surface of the chassis with a dry lint-free cloth or a soft, follicle-free brush. If any dirt remains, use a cloth or swab dipped in a 70% isopropyl alcohol solution. Use a clean, soft, follicle-free cloth and remover. Do not use any solvent or rubber cement on any part of the chassis.

Clean the thumbwheel switch using a dampened cleaning solvent. Do not spray or wet the switch directly.

**CAUTION**: Do not use chemical cleaning agents which might damage the plastics used in the oscilloscope. Use only aqueous water when cleaning the front-panel buttons. Use a 70% isopropyl alcohol solution to clean the switch and other plastic display surfaces. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Flat Panel Display Cleaning

The display is soft plastic and must be handled with care during cleaning.

**CAUTION**: Improper cleaning agents or methods can damage the flat panel display.
Do not use abrasive cleaners or commercial glass cleaners to clean the display surface.
Do not spray liquids directly on the display surface.
Do not contact the display with excessive force.

Clean the flat panel display surface by gently rubbing the display with a clean, soft, follicle-free cloth or a cloth made of microfiber or a soft, follicle-free cloth. When cleaning, use a gentle, circular motion. If the display is very dirty, moisten the cloth with distilled water or a 70% isopropyl alcohol solution and gently rub the display surface. Avoid using excess force or you may damage the plastic display surface.

**CAUTION**: To prevent getting moisture inside the oscilloscope during normal cleaning, use only enough liquid to dampen the cloth or applicator.

Appendix D: Menu Bar Commands

Both the oscilloscope menu bar and a tool bar allow you to control oscilloscope operation. Where possible, this manual describes operations using both, the menu bar and the tool bar. This appendix describes functions available from the menu bar. For more information about these commands, see the online help.

File Commands

Table D-1 lists the commands available from the File menu on the menu bar.

<table>
<thead>
<tr>
<th>Menu</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Waveforms</td>
<td>Reference Setup</td>
<td>Displays the Reference Setup window you use to set up and control reference waveform.</td>
</tr>
<tr>
<td></td>
<td>Display Waveform</td>
<td>Displays the Waveform Display window you can use to set or change the display format.</td>
</tr>
<tr>
<td></td>
<td>Save可能</td>
<td>Saves the current waveform file.</td>
</tr>
<tr>
<td></td>
<td>Read可能</td>
<td>Reads a waveform from a file.</td>
</tr>
<tr>
<td></td>
<td>Delete All Files</td>
<td>Deletes all waveform files.</td>
</tr>
<tr>
<td>Instrument Setup</td>
<td>Display Instrument Setup</td>
<td>Displays the Instrument Setup window you use to set up and control instrument setup.</td>
</tr>
<tr>
<td>Recal Dialog Setup</td>
<td>Update Database</td>
<td>Updates the dialog window.</td>
</tr>
<tr>
<td>Run Application</td>
<td>Select enabled applications</td>
<td>Selects the applications that are enabled for use.</td>
</tr>
<tr>
<td>Page Setup</td>
<td>Display the Page Setup dialog</td>
<td>Displays the Page Setup dialog box you use to define the page before sending data to a printer.</td>
</tr>
<tr>
<td>Print</td>
<td>Show printer dialog</td>
<td>Shows you a preview of the page before printing it.</td>
</tr>
</tbody>
</table>

C-2
### Edit Commands

**Table D-7** lists the commands available from the Edit menu on the menu bar.

<table>
<thead>
<tr>
<th>Menu</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copy</td>
<td></td>
<td>Copy makes a full screen, gradient, waveform, or measurement to the display for use with other applications.</td>
</tr>
<tr>
<td>Select from Copy</td>
<td>Full Screen (HS)</td>
<td>Gradient, Waveform, Measurement (STD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selects the full screen you wish to copy from the display.</td>
</tr>
</tbody>
</table>

**Copy Setup**

- Displays the Copy Setup window you can use to set up and copy images, waveforms, and measurements.
- Images: Select the Pixels (Color, Gray/Black, or Black & White), Use Full Screen or Gradient Style, Image Position or Include Legend, Waveform Width, and Waveform Detail, and Data-Ordering used when copying waveforms.
- Measurements: Select the Display Format and Mode of Measurements used when copying measurements.

### Vertical Commands

**Table D-8** lists the commands available from the Vertical menu.

<table>
<thead>
<tr>
<th>Menu</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Setup</td>
<td>Display the Vertical Setup window you use to set the position, scale, offset, and the vertical alignment of vertical traces.</td>
<td></td>
</tr>
<tr>
<td>Zoom Cmd</td>
<td>Display the Zoom command window you use to set the position and scale of vertical traces.</td>
<td></td>
</tr>
<tr>
<td>Display</td>
<td>Display Waveform Display control window you can use to turn the display of waveforms on and off.</td>
<td></td>
</tr>
<tr>
<td>Measure/Scale</td>
<td>Display vertical cursor you position the waveform, and select the vertical resolution.</td>
<td></td>
</tr>
<tr>
<td>Label</td>
<td>Displays a control window you use to label your waveforms.</td>
<td></td>
</tr>
<tr>
<td>Offset</td>
<td>Displays the Vertical Offset control window you use to set the vertical offset and scale of a waveform.</td>
<td></td>
</tr>
</tbody>
</table>

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### Horizontal and Acquisition Commands

**Table D-9** lists the commands available from the Horizon/Acq menu.

<table>
<thead>
<tr>
<th>Menu</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal/Acquisition Setup</td>
<td>Displays the Horizontal and Acquisition Setup window you use to set up the horizontal and vertical systems.</td>
<td></td>
</tr>
<tr>
<td>P/S/C</td>
<td>Position/Scale</td>
<td>Displays the Horizontal scale window you use to set the position, scale, offset, and the horizontal alignment of horizontal traces.</td>
</tr>
<tr>
<td>Aquisition Mode</td>
<td>Displays the Acquisition Mode control window you use to select the acquisition mode.</td>
<td></td>
</tr>
<tr>
<td>Zoom Setup</td>
<td>Displays the Zoom Setup window you use to set up the horizontal and vertical commands.</td>
<td></td>
</tr>
</tbody>
</table>

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### Trigger Commands

**Table D-10** lists the commands available from the Trigger menu on the menu bar.

<table>
<thead>
<tr>
<th>Menu</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick Setup</td>
<td>Displays the Trigger Setup window you use to set up the A Event triggers.</td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td>Displays the Trigger Setup window and sets up the A Event trigger edge.</td>
<td></td>
</tr>
<tr>
<td>Distance</td>
<td>Displays the Trigger Setup window and sets up the A Event trigger distance.</td>
<td></td>
</tr>
<tr>
<td>Slope</td>
<td>Displays the Trigger Setup window and sets up the A Event trigger slope.</td>
<td></td>
</tr>
<tr>
<td>Smallest Event</td>
<td>Displays the Trigger Setup window and sets up the smallest A Event trigger.</td>
<td></td>
</tr>
<tr>
<td>Magnitude</td>
<td>Displays the Trigger Setup window and sets up the largest A Event trigger.</td>
<td></td>
</tr>
<tr>
<td>Logic Pattern Setup</td>
<td>Displays the Trigger Setup window and sets up the logic pattern trigger.</td>
<td></td>
</tr>
<tr>
<td>Closest Trigger</td>
<td>Displays the Trigger Setup window and sets up the closest A Event trigger.</td>
<td></td>
</tr>
<tr>
<td>Remote Trigger</td>
<td>Displays the Trigger Setup window and sets up the remote A Event trigger.</td>
<td></td>
</tr>
<tr>
<td>Logic State Setup</td>
<td>Displays the Trigger Setup window and sets up the logic state trigger.</td>
<td></td>
</tr>
<tr>
<td>A &amp; B Trigger</td>
<td>Displays the Trigger Setup window and sets up the A &amp; B trigger.</td>
<td></td>
</tr>
</tbody>
</table>

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### Display Commands

**Table D-11** lists the commands available from the Display menu.

<table>
<thead>
<tr>
<th>Menu</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display Setup</td>
<td>Displays the Display Setup window, which controls the display appearance, channel, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Appearance</td>
<td>Displays the Pallette window of the Display Setup window, which controls the channel, color, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Screen</td>
<td>Displays the Screen tab of the Display Setup window, which controls the display appearance, channel, color, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Objects</td>
<td>Displays the Objects tab of the Display Setup window, which controls the display appearance, channel, color, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Styles</td>
<td>Displays the Styles tab of the Display Setup window, which controls the display appearance, channel, color, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Data, Vector, Interscan</td>
<td>Displays the Data display window.</td>
<td></td>
</tr>
<tr>
<td>Persistence</td>
<td>Enables persistence of display data.</td>
<td></td>
</tr>
<tr>
<td>TDS6000 Series User Manual</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Appendix D: Menu Bar Commands**

**Appendix D: Menu Bar Commands (Cont.)**

<table>
<thead>
<tr>
<th>Menu</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Setup</td>
<td>Displays the Event Setup window, which controls the display appearance, channel, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Filter</td>
<td>Displays the Filter tab of the Event Setup window, which controls the display appearance, channel, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Screen</td>
<td>Displays the Screen tab of the Event Setup window, which controls the display appearance, channel, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Objects</td>
<td>Displays the Objects tab of the Event Setup window, which controls the display appearance, channel, position, and window.</td>
<td></td>
</tr>
<tr>
<td>Styles</td>
<td>Displays the Styles tab of the Event Setup window, which controls the display appearance, channel, position, and window.</td>
<td></td>
</tr>
</tbody>
</table>

**TDS6000 Series User Manual**
## Measure Commands

### Table D-8: Measure menu commands

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Setup</td>
<td></td>
<td>Displays the setup window you use to specify measurement setup, reference lines, gating, statistics, and histograms.</td>
</tr>
<tr>
<td>SNR filter</td>
<td></td>
<td>Displays a snapshot of all selected waveforms measurements of the selected waveform.</td>
</tr>
<tr>
<td>Amplitude</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Cursor</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Statistics</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Baseline</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Reference Level</td>
<td></td>
<td>Displays the Reference Level setup window you use to set the reference level used by your instrument.</td>
</tr>
<tr>
<td>Gating</td>
<td></td>
<td>Displays the Gating setup window you use to define the reference level of the waveforms you want your measurements to be gated by.</td>
</tr>
<tr>
<td>Waveform Histo</td>
<td></td>
<td>Displays the Waveform Histo setup window you use to set waveforms on your waveforms.</td>
</tr>
<tr>
<td>Reset Histo</td>
<td></td>
<td>Resets histogram settings.</td>
</tr>
<tr>
<td>Histogram Setup</td>
<td></td>
<td>Displays the selected measurement of the histogram.</td>
</tr>
</tbody>
</table>

### Table D-10: Utilities menu commands (Cont.)

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Setup</td>
<td></td>
<td>Displays the measurement setup window you use to specify measurement setup, reference lines, gating, statistics, and histograms.</td>
</tr>
<tr>
<td>SNR filter</td>
<td></td>
<td>Displays a snapshot of all selected waveforms measurements of the selected waveform.</td>
</tr>
<tr>
<td>Amplitude</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Cursor</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Statistics</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Baseline</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Reference Level</td>
<td></td>
<td>Displays the Reference Level setup window you use to set the reference level used by your instrument.</td>
</tr>
<tr>
<td>Gating</td>
<td></td>
<td>Displays the Gating setup window you use to define the reference level of the waveforms you want your measurements to be gated by.</td>
</tr>
<tr>
<td>Waveform Histo</td>
<td></td>
<td>Displays the Waveform Histo setup window you use to set waveforms on your waveforms.</td>
</tr>
<tr>
<td>Reset Histo</td>
<td></td>
<td>Resets histogram settings.</td>
</tr>
<tr>
<td>Histogram Setup</td>
<td></td>
<td>Displays the selected measurement of the histogram.</td>
</tr>
</tbody>
</table>

## Utilities Commands

### Table D-19: Utilities menu commands

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure</td>
<td></td>
<td>Displays the measurement menu you use to specify measurement setup, reference lines, gating, and histogram.</td>
</tr>
<tr>
<td>SNR filter</td>
<td></td>
<td>Displays a snapshot of all selected waveforms measurements of the selected waveform.</td>
</tr>
<tr>
<td>Amplitude</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Cursor</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Statistics</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Baseline</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Reference Level</td>
<td></td>
<td>Displays the Reference Level setup window you use to set the reference level used by your instrument.</td>
</tr>
<tr>
<td>Gating</td>
<td></td>
<td>Displays the Gating setup window you use to define the reference level of the waveforms you want your measurements to be gated by.</td>
</tr>
<tr>
<td>Waveform Histo</td>
<td></td>
<td>Displays the Waveform Histo setup window you use to set waveforms on your waveforms.</td>
</tr>
<tr>
<td>Reset Histo</td>
<td></td>
<td>Resets histogram settings.</td>
</tr>
<tr>
<td>Histogram Setup</td>
<td></td>
<td>Displays the selected measurement of the histogram.</td>
</tr>
</tbody>
</table>

## Help Commands

### Table D-11: Help menu commands

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help on Web</td>
<td></td>
<td>Displays online help on the current webpage.</td>
</tr>
<tr>
<td>Contexts and Index</td>
<td></td>
<td>Displays the contexts and index window.</td>
</tr>
<tr>
<td>Recent Help</td>
<td></td>
<td>Displays the most recent help window that was viewed.</td>
</tr>
<tr>
<td>Specifications</td>
<td></td>
<td>Displays the product specifications.</td>
</tr>
<tr>
<td>Technical Support</td>
<td></td>
<td>Displays the technical support contact information.</td>
</tr>
<tr>
<td>Customer Feedback</td>
<td></td>
<td>Displays the customer feedback window.</td>
</tr>
<tr>
<td>About TDS6000</td>
<td></td>
<td>Displays the About window.</td>
</tr>
</tbody>
</table>

## Appendix D: Menu Bar Commands

### Table D-6: Display menu commands (Cont.)

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dear Place</td>
<td></td>
<td>Displays the Dear Place window that allows you to set up the Dear Place window.</td>
</tr>
<tr>
<td>Web Page</td>
<td></td>
<td>Displays the web page window that allows you to view and edit web pages.</td>
</tr>
<tr>
<td>About</td>
<td></td>
<td>Displays the About window.</td>
</tr>
<tr>
<td>Help</td>
<td></td>
<td>Displays online help on the current webpage.</td>
</tr>
<tr>
<td>Page Setup</td>
<td></td>
<td>Displays the Page Setup window that allows you to set up the page layout.</td>
</tr>
<tr>
<td>Print</td>
<td></td>
<td>Displays the print window that allows you to preview and print documents.</td>
</tr>
<tr>
<td>Save</td>
<td></td>
<td>Displays the save window that allows you to save the current document.</td>
</tr>
<tr>
<td>Exit</td>
<td></td>
<td>Closes the program.</td>
</tr>
</tbody>
</table>

### Table D-8: Math menu commands

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Setup</td>
<td></td>
<td>Displays the Math Setup window that allows you to specify math settings.</td>
</tr>
<tr>
<td>Choose Drv</td>
<td></td>
<td>Displays the Choose Drv window that allows you to select the desired waveform.</td>
</tr>
<tr>
<td>PostScript</td>
<td></td>
<td>Displays the PostScript window that allows you to specify the output format.</td>
</tr>
<tr>
<td>Core2</td>
<td></td>
<td>Displays the Core2 window that allows you to specify the core settings.</td>
</tr>
<tr>
<td>Core2</td>
<td></td>
<td>Displays the Core2 window that allows you to specify the core settings.</td>
</tr>
<tr>
<td>Custom</td>
<td></td>
<td>Displays the Custom window that allows you to specify custom settings.</td>
</tr>
<tr>
<td>Special Unit</td>
<td></td>
<td>Displays the Special Unit window that allows you to specify special units.</td>
</tr>
<tr>
<td>Magnitude Spec</td>
<td></td>
<td>Displays the Magnitude Spec window that allows you to specify magnitude settings.</td>
</tr>
<tr>
<td>Phase Spec</td>
<td></td>
<td>Displays the Phase Spec window that allows you to specify phase settings.</td>
</tr>
<tr>
<td>Special Shape</td>
<td></td>
<td>Displays the Special Shape window that allows you to specify special shapes.</td>
</tr>
<tr>
<td>Set Math Limits</td>
<td></td>
<td>Displays the Set Math Limits window that allows you to specify math limits.</td>
</tr>
<tr>
<td>Equations</td>
<td></td>
<td>Displays the Equations window that allows you to view and edit equations.</td>
</tr>
</tbody>
</table>

### Table D-9: Utilities menu commands

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure</td>
<td></td>
<td>Displays the measurement menu you use to specify measurement setup, reference lines, gating, and histogram.</td>
</tr>
<tr>
<td>SNR filter</td>
<td></td>
<td>Displays a snapshot of all selected waveforms measurements of the selected waveform.</td>
</tr>
<tr>
<td>Amplitude</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Cursor</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Statistics</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Baseline</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Reference Level</td>
<td></td>
<td>Displays the Reference Level setup window you use to set the reference level used by your instrument.</td>
</tr>
<tr>
<td>Gating</td>
<td></td>
<td>Displays the Gating setup window you use to define the reference level of the waveforms you want your measurements to be gated by.</td>
</tr>
<tr>
<td>Waveform Histo</td>
<td></td>
<td>Displays the Waveform Histo setup window you use to set waveforms on your waveforms.</td>
</tr>
<tr>
<td>Reset Histo</td>
<td></td>
<td>Resets histogram settings.</td>
</tr>
<tr>
<td>Histogram Setup</td>
<td></td>
<td>Displays the selected measurement of the histogram.</td>
</tr>
</tbody>
</table>

### Table D-10: Utilities menu commands (Cont.)

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure</td>
<td></td>
<td>Displays the measurement menu you use to specify measurement setup, reference lines, gating, and histogram.</td>
</tr>
<tr>
<td>SNR filter</td>
<td></td>
<td>Displays a snapshot of all selected waveforms measurements of the selected waveform.</td>
</tr>
<tr>
<td>Amplitude</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Cursor</td>
<td></td>
<td>Displays the selected measurement of all selected waveforms.</td>
</tr>
<tr>
<td>Statistics</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Baseline</td>
<td></td>
<td>Displays selected measurement statistics of current measurements.</td>
</tr>
<tr>
<td>Reference Level</td>
<td></td>
<td>Displays the Reference Level setup window you use to set the reference level used by your instrument.</td>
</tr>
<tr>
<td>Gating</td>
<td></td>
<td>Displays the Gating setup window you use to define the reference level of the waveforms you want your measurements to be gated by.</td>
</tr>
<tr>
<td>Waveform Histo</td>
<td></td>
<td>Displays the Waveform Histo setup window you use to set waveforms on your waveforms.</td>
</tr>
<tr>
<td>Reset Histo</td>
<td></td>
<td>Resets histogram settings.</td>
</tr>
<tr>
<td>Histogram Setup</td>
<td></td>
<td>Displays the selected measurement of the histogram.</td>
</tr>
</tbody>
</table>

### Table D-11: Help menu commands

<table>
<thead>
<tr>
<th>Name</th>
<th>Submenu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help on Web</td>
<td></td>
<td>Displays online help on the current webpage.</td>
</tr>
<tr>
<td>Contexts and Index</td>
<td></td>
<td>Displays the contexts and index window.</td>
</tr>
<tr>
<td>Recent Help</td>
<td></td>
<td>Displays the most recent help window that was viewed.</td>
</tr>
<tr>
<td>Specifications</td>
<td></td>
<td>Displays the product specifications.</td>
</tr>
<tr>
<td>Technical Support</td>
<td></td>
<td>Displays the technical support contact information.</td>
</tr>
<tr>
<td>Customer Feedback</td>
<td></td>
<td>Displays the customer feedback window.</td>
</tr>
<tr>
<td>About TDS6000</td>
<td></td>
<td>Displays the About window.</td>
</tr>
</tbody>
</table>
Automatic trigger mode
A trigger mode that causes the oscilloscope to automatically acquire if triggerable events are not detected within a specified time period.

Antenna
A device that transmits and receives radio waves by means of electromagnetic radiation. In a radio receiver, an antenna receives radio waves and converts them into electrical signals, which are then amplified and processed by the receiver's circuits.

Average acquisition mode
In this mode, the oscilloscope averages the waveform that is the result of the sweep of a single acquisition. It averages the waveform for a specified number of cycles and scales the result to the number of averages.

Baseline
The horizontal baseline is used to set the horizontal position of the displayed waveform. It determines the starting point for the vertical display of the waveform.

Bandwidth
The bandwidth of a system defines the frequency range over which it can faithfully reproduce a signal. It is usually specified as the frequency at which the signal level drops by 3 dB (50% amplitude) from the maximum level.

Base level
The base level is the reference or zero level of the horizontal axis. It is used to set the zero position of the waveform display.

Channel
A channel is a pathway for signals. It is a single line that can be used to display one signal at a time. Channels are commonly used in oscilloscopes to display multiple signals simultaneously.

Channel position
The position of a channel in a multichannel oscilloscope cannot be changed. Each channel is fixed in position and cannot be moved or repositioned.

Channel reference indicator
The channel reference indicator shows the position of the channel relative to the other channels. It is used to align the channels for proper alignment and display.

Control window
A group of related controls for a particular function, such as the oscilloscope display, that allows you to control and configure the oscilloscope.

Coulomb
The coulomb is the base unit of electric charge. It is defined as the amount of charge transported by a current of 1 ampere in 1 second.

Data converter
A device that converts data from one format to another. It is used to transfer data between different systems or devices.

Data format
The data format is the way in which data is stored or transmitted. It can be in various formats, such as ASCII, binary, or hexadecimal.

Data model
A data model is a representation of the structure and organization of data in a database or other data storage system.

Data type
The data type is the set of values that a variable or data element can take. It determines the kind of data that a variable can store.

Datum plane
The datum plane is the plane of reference in a coordinate system. It is used to define the position of other planes and objects in the coordinate system.

Datum point
The datum point is the origin of a coordinate system. It is used as a reference point for positioning other points or objects in the coordinate system.

Datum vector
The datum vector is a vector that is used to define the orientation of a coordinate system. It is used to determine the direction of the axes in the coordinate system.

Default values
Default values are the values that are assigned to a variable or data element when it is created or initialized. They are used as the initial values for further processing.

Default behavior
The default behavior is the behavior that occurs when no specific behavior is specified. It is used to indicate that no specific action should be taken.

Default settings
Default settings are the settings that are used as the initial values for a system or device. They are used to specify the initial state of the system or device.

Default unit
The default unit is the unit of measurement used as the default for a variable or data element. It is used to specify the default unit of measurement for a variable or data element.

Default values
Default values are the values that are assigned to a variable or data element when it is created or initialized. They are used as the initial values for further processing.

Default type
The default type is the type of data that is used as the default for a variable or data element. It is used to specify the default type of data for a variable or data element.

Default settings
Default settings are the settings that are used as the initial values for a system or device. They are used to specify the initial state of the system or device.

Default unit
The default unit is the unit of measurement used as the default for a variable or data element. It is used to specify the default unit of measurement for a variable or data element.

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Default settings
Default settings are the settings that are used as the initial values for a system or device. They are used to specify the initial state of the system or device.

Default unit
The default unit is the unit of measurement used as the default for a variable or data element. It is used to specify the default unit of measurement for a variable or data element.

Default values
Default values are the values that are assigned to a variable or data element when it is created or initialized. They are used as the initial values for further processing.

Default type
The default type is the type of data that is used as the default for a variable or data element. It is used to specify the default type of data for a variable or data element.

Default settings
Default settings are the settings that are used as the initial values for a system or device. They are used to specify the initial state of the system or device.

Default unit
The default unit is the unit of measurement used as the default for a variable or data element. It is used to specify the default unit of measurement for a variable or data element.

Default values
Default values are the values that are assigned to a variable or data element when it is created or initialized. They are used as the initial values for further processing.

Default type
The default type is the type of data that is used as the default for a variable or data element. It is used to specify the default type of data for a variable or data element.
Graticule
A grid on the display screen that crosses the horizontal and vertical axes. You can use it to visually measure waveform parameters.

Ground (GND) coupling
Coupling that disconnects the input signal from the vertical system.

H-Box acquisition mode
An acquisition mode in which the oscilloscope averages all samples taken during an acquisition interval to create a single point. This averaging results in a higher-resolution, lower-bandwidth waveform. This mode only works with multiscan, non-interpolated sampling.

High
The value used in 100% in automated measurements (whenever high ref. and low ref. and low ref. values are needed in full time and rise time measurements). May be calculated using either the maximum or the histogram method. With the maximum method (most useful for general waveforms), it is the maximum value found. With the histogram method (most useful for pulses), it refers to the most common value found above the mid-point.

Halted trigger
The first time a trigger signal that satisfies the trigger criterion will accept another trigger signal. Trigger halted helps create a static display.

Horizontal acquisition window
The range of the input signal that the acquisition system requires.

Horizontal bar curves
The two horizontal bars that you position to measure the voltage parameters of a waveform. The oscilloscope displays the values of the active (unaveraged) curve with respect to ground and the voltage value between the bars.

Horizontal Reference Point
The point about which the trace is expanded or contracted when horizontal size adjustments are made. The horizontal reference point remains anchored as the tip of the trace grows or shrinks around it.

Initialize
Setting the oscilloscope to a completely known, default condition.

Interpolation
The way the oscilloscope calculates values for missed points when the oscilloscope cannot acquire all the points for a complete record with a single trigger event. This condition occurs when the oscilloscope is limited in real-time sampling and the time-base is set to a value that exceeds the effective sampling rate of the oscilloscope oscillator. The oscilloscope has two interpolation options: linear or sin^2 interpolation.

Linear interpolation calculates record points in a straight-line fit between the actual values acquired. Sin^2 interpolation calculates record points in a curve fit between the actual values acquired. It assumes all the interpolated points fall in their appropriate points in time that curve.

Intensity
Display brightness.

Interlacing
A method by which these oscilloscopes obtain higher data rates. The oscilloscope applies horizontal blanking to signals coming into the oscilloscope, and then re-activates the horizontal line for the next sweep. This method is used when the data rate of the signals is higher than the oscilloscope's capability.

Knob
A rotary control.

Knob Resolution
The amount of change caused by each click of a knob.

Live Waveform
Waveforms that can update as the acquisition system updates them. Channel waveforms are live waveforms; vertical waveforms are not. Most waveforms are live if they are drawn live waveforms (their expressions): Ch1 + Ref1 defines a live math waveform, Ref1 + Ref2 does not.

Logic state trigger
The oscilloscope checks for defined combinational logic conditions on channels 1, 2, and 3 on a transition of channel 4 that meets the set points and threshold conditions. If the conditions of channels 1, 2, and 3 are met then the oscilloscope triggers.

Logic pattern trigger
The oscilloscope triggers depending on the specified logic conditions of channels 1, 2, 3, and 4. Allowable conditions are AND, OR, NAND, and NOR.

Look
The value used in 5% in automated measurements (whenever high ref. mid ref. and low ref. values are needed in full time and rise time measurements). May be calculated using either the maximum or the histogram method. With the maximum method (most useful for general waveforms), it is the minimum value found. With the histogram method (most useful for pulses), it refers to the most common value found above the mid-point.

Maximum
Amplitude (voltage) measurement of the maximum amplitude. Typically the most positive peak voltage.

Mean
Amplitude (voltage) measurement of the arithmetic mean over the entire waveform.

Measurement
An automated numeric value that the oscilloscope provides directly from the displayed trace in real-time, without operator intervention.

Measurement Parameter
One of several controls that the oscilloscope operator can exercise over the automated measurement processes.

Measurement Statistics
The accumulation of a history of individual measurement outcomes, showing the mean and standard deviation of a measured number of samples.

Measurement Tracking
The process of automatically adjusting the measurement parameters to reflect changes in the trace.

Minimum
Amplitude (voltage) measurement of the minimum amplitude. Typically the most negative peak voltage.

Multipurpose knobs
Front-panel knobs you can use to change the value of the assigned parameter.

NAND
A logic (Boolean) function in which the output of the AND function is complemented (true becomes false, false becomes true). On the oscilloscope, that is a trigger logic pattern and state function.

Negative duty cycle
A timing measurement representing the ratio of the negative pulse width to the signal period, expressed as a percentage.

Negative overfill measurement
Amplitude (voltage) measurement.

Negative overfill measurement = negative amplitude 
Negative overfill measurement = amplitude 
Negative overfill measurement = amplitude 

Negative width
A timing measurement of the distance (time) between two amplitude events -200% (default 95%) and +200% (default 50%) of the negative pulse.

Normal trigger mode
A mode in which the oscilloscope does not acquire a waveform record unless a valid trigger event occurs. It works for a valid trigger event before acquiring waveform data.

NOR
A logic (Boolean) function in which the output of the OR function is complemented (true becomes false, false becomes true). On the oscilloscope, that is a trigger logic pattern and state function.

OR
A logic (Boolean) function in which the output is true if any of the inputs are true. Otherwise the output is false. On the oscilloscope, that is a trigger logic pattern and state function.

Oscilloscope
A device for making a graph of two factors. These are typically voltage versus time.

Peak detect acquisition mode
A mode in which the oscilloscope saves the minimum and maximum samples over two adjacent acquisition intervals. For many glitch-free signals, this mode is multichannel (from the example mode). (Peak detect mode works with real-time, non-interpolated sampling only.)

Peak-to-Peak Amplitude (voltage) measurement of the absolute difference between the maximum and minimum amplitude.

Period
A timing measurement of the time counted by one complete signal cycle it is the reciprocal of frequency and is measured in seconds.

Persistence
The amount of time a data point remains displayed. There are three persistence modes available in the oscilloscope: Variable, Infinite, and Off.

Phase
A timing measurement between two waveforms of the amount one is lead or lag the other in time. Phase is expressed in degrees, where 360° represents one complete cycle of one of the waveforms. Waveforms measured should be of the same frequency or one waveform should be a harmonic of the other.

Preset
A memory point in the display. The oscilloscope displays it in 640 pixels wide by 480 pixels high.

Positive duty cycle
A timing measurement of the ratio of the positive pulse width to the signal period, expressed as a percentage.
Glossary

Positive overshoot
Amplitude (voltage) measurement.

\[ \text{Positive Overshoot} = \frac{\text{Max} - \text{High}}{\text{Amplitude}} \times 100\% \]

Positive width
A timing measurement of the distance (time) between two amplitude points — rising-edge, MidRef (default 50%) and falling-edge, MidRef (default 50%) — on a positive pulse.

Pretrigger
The specified portion of the waveform record that contains data acquired before the trigger event.

Principal Power Switch
The master power switch located on the rear panel of the oscilloscope.

Probe
An oscilloscope input device.

Probe compensation
Adjustment that improves low-frequency response of a probe.

Pulse trigger
A trigger mode in which triggering occurs if the oscilloscope finds a pulse in the specified polarity, width, and optionally amplitude, the user-specified lower and upper time limits.

Quadranting
The process of assigning an analog input that has been sampled, such as a voltage, to a digital value.

Real-time sampling
A sampling mode where the oscilloscope samples fast enough to completely fill a waveform record from a single trigger event. Use real-time sampling to capture single-shot or transient events.

Record length
The specified number of samples in a waveform.

Reference memory
Memory in an oscilloscope used to store waveforms or settings. You can use this waveform later in the processing. The oscilloscope stores the data even when the oscilloscope is turned off or unplugged.

Selected waveform
The waveform on which all measurements are performed, and which is affected by vertical position and scale adjustments. The light bar on one of the channel selector buttons indicates the current selected waveform.

Slew rate trigger
A trigger mode in which the oscilloscope triggers based on how fast the pulse edge increases (rises) between an upper and lower threshold. The edge of the pulse may be positive, negative, or both. The oscilloscope starts to trigger on slow pulse edges faster than that in a user-defined scale.

Shape
The direction of a point on a waveform. You can calculate the direction by computing the sign of the ratio of change in the vertical quantity (V) to the change in the horizontal quantity. The two values are steep and flat.

Statistical measurement
An automated measurement that is derived from color-coded waveform data and is based on histogram computed at the crossing levels. A statistical measurement can be selected only in color-coded display mode.

Tek Secure
This feature allows all waveform and setup memory locations (except memory locations are reserved for the factory setup). Then it checks each location to verify setup. This feature helps to ensure that the waveform is user-friendly and reliable for research or development projects.

Time base
The set of parameters that you define the time and horizontal axis structure of a waveform record. The time base determines when and how long to acquire stored waves.

Threshold trigger
A trigger mode in which triggering occurs if the oscilloscope does NOT find a pulse, as specified polarity and level, within the specified time period.

Trace
The visible representation of an input signal or combination of signals, whether it is a waveform.

Trace Expression
The definition of what the trace displays. It can include one or more channels combined arithmetically and modified by functions.

Trigger
An event that starts a waveform record. It results in acquisition and display of the waveform.