More Application, Information, and Pricing available at:

250 Technology Way
Rocklin, CA 95765

sales@testworld.com
1-855-200-TEST (8378)

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TDS6000B & TDS6000C Series Digital Storage Oscilloscopes Quick Start User Manual

www.tektronix.com
071-1643-02

Tektronix

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Contacting Tektronix

Tektronix, Inc.
14200 SW Karl Braun Drive
P.O. Box 500
Beaverton, OR 97077
USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit www.tektronix.com to find contacts in your area.

Warranty 2

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

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This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

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

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

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

The inputs are not rated for connection to mains or Category II, III, or IV circuits.

Connect the probe reference lead to earth ground only.

Power Disconnect. The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

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

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

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

Wear Eye Protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

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

Terms in this Manual

These terms may appear in this manual:

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

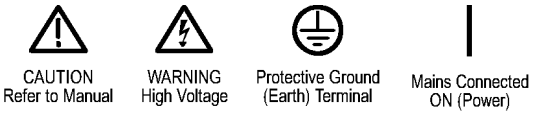
CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and Terms on the Product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

The following symbols may appear on the product:



Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment Recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.

The symbol shown below indicates that this product complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Mercury Notification. This product uses an LCD backlight lamp that contains mercury. Disposal may be regulated due to environmental considerations. Please contact your local authorities or, within the United States, the Electronics Industries Alliance (www.eiae.org) for disposal or recycling information.

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive. This product is known to contain lead, cadmium, mercury, and hexavalent chromium.

Preface

This manual describes the installation and operation of TDS6000B and TDS6000C Series Instruments. Basic operations and concepts are presented in this manual. For more detailed information see the online help on your instrument. The following instruments are supported by this manual:

- TDS6124C
- TDS6154C
- TDS6604B
- TDS6804B

Key Features

TDS6000B and TDS6000C Series instruments can help you verify, debug, and characterize electronic designs. Key features include:

- 12 GHz bandwidth and 40 GS/s real time sampling rate, TDS6124C
- 15 GHz bandwidth and 40 GS/s real time sampling rate, TDS6154C
- 8 GHz bandwidth and 20 GS/s real time sampling rate, TDS6804B
- 6 GHz bandwidth and 20 GS/s real time sampling rate, TDS6604B
- Enhanced Bandwidth capability that, when enabled, applies Digital Signal Process (DSP) filters that can extend the bandwidth and flatten the passband. Enhanced Bandwidth provides a matched response across enabled channels when they are at maximum sample rate.
- Record lengths up to 64,000,000 samples, depending on model and option
- Up to 2.5% DC vertical gain accuracy
- Four input channels (each with 8-bit resolution), auxiliary trigger input and output
- Sample, envelope, peak-detect, high-resolution, waveform database, and average acquisition modes
- Full programmability, with an extensive GPIB-command set and a message-based interface
- Trigger types include edge, logic, pulse (may be logic qualified), selectable for both A and B trigger events. Window trigger mode triggers as the trigger source passes into or out of a defined window. Triggers can be logic qualified. Setup and hold trigger mode triggers when a logic input changes state inside of the setup and hold times relative to the clock. Trigger jitter is less than 1 ps RMS (typical). You can typically trigger on a glitch or pulse of less than 100 ps in width.
- Powerful built-in measurement capability, including histograms, automatic measurements, eye pattern measurements and measurement statistics
- A large 10.4 inch (264.2 mm) high resolution XGA color display that supports color grading of waveform data to show sample density
- MultiView Zoom to view and compare up to four zoom areas at a time. Lock and manually or automatically scroll up to four zoom areas
- An intuitive, graphical user interface (UI), with online help that is built in and available on screen
- Internal, removable disk storage

- Wide array of probing solutions
- Customizable MyScope control windows

Documentation

Additional information is available through a variety of sources. Review the following information for the location of different types of information available for this product.

To read about	Use these documents
Installation and Operation (overviews)	Read the Quick Start User Manual for general information about how to put your instrument into service and maps of the user interface controls.
In-Depth Operation and User Interface Help	Access online help from the Help button or Help menu for information on virtually all controls and elements on screen. Online help includes detailed instructions for using instrument functions. (See page 9, *Accessing Online Help*.)
Programmer Commands	Quickly remind yourself of the syntax of a GPIB command, and copy the command if desired. The programmer guide is on the product software CD.
Analysis and Connectivity Tools	Various connectivity and analysis tools are available on your instrument. For more information, see the Getting Started with OpenChoice™ Solutions Manual.

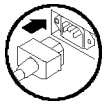
Conventions Used in this Manual

The following icons are used throughout this manual.

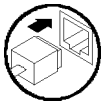
Sequence Step

Front panel power

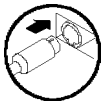
Connect power



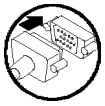
Network



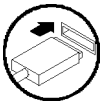
PS2



SVGA



USB



Install Your Instrument

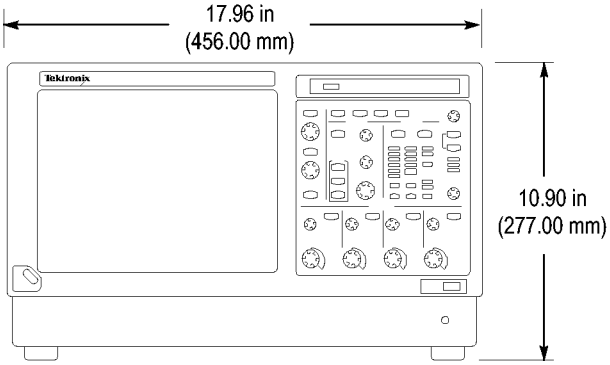
Unpack the instrument and check that you received all items listed as Standard Accessories. Recommended accessories and probes, instrument options, and upgrades are listed in the online help. Check the Tektronix Web site (www.tektronix.com) for the most current information.

Standard Accessories

Accessory		Tektronix part number
TDS6000B and TDS6000C Digital Storage Oscilloscopes Quick Start User Manual		—
TDS6000B & TDS6000C Product Software CD		020-2647-xx
Operating System Restore CD		020-2512-xx
Optional Applications Software CD and Documentation Kit		020-2450-xx
Getting Started with OpenChoice Solutions Kit		020-2513-xx
Online Help (part of the application software)		—
Performance Verification (a pdf file on the Product Software CD)		—
Programmer Online Guide (files on the Product Software CD)		—
NIST, Z540-1, and ISO9000 Calibration Certificate		—
Four TekConnect-to-SMA adapters		TCA-SMA
Mouse, optical		119-7054-xx
Keyboard, mini		119-7083-xx
Front Cover		200-4653-xx
Accessory Pouch		016-1441-xx
Probe Calibration and Deskew Fixture, with instructions		067-0405-xx 067-0484-xx
Nero OEM Software CD		063-3781-xx
Power Cord	North America (Option A0)	161-0104-00
	Universal Euro (Option A1)	161-0104-06
	United Kingdom (Option A2)	161-0104-07
	Australia (Option A3)	161-0104-05
	240 V North America (Option A4)	161-0104-08
	Switzerland (Option A5)	161-0167-00
	Japan (Option A6)	161-A005-00
	China (Option A10)	161-0306-00
	No power cord or AC adapter (Option A99)	—

Operating Requirements

1. Place the instrument on a cart or bench, observing clearance requirements:
   - Top: 0 in (0 mm)
   - Left and right side: 3 in (76 mm)
   - Bottom: 0 in (0 mm) standing on feet, flip stands down
   - Rear: 0 in (0 mm) on rear feet
2. Before operating, ensure that the ambient temperature is between +50 °F to +113 °F (+10°C to +45 °C).

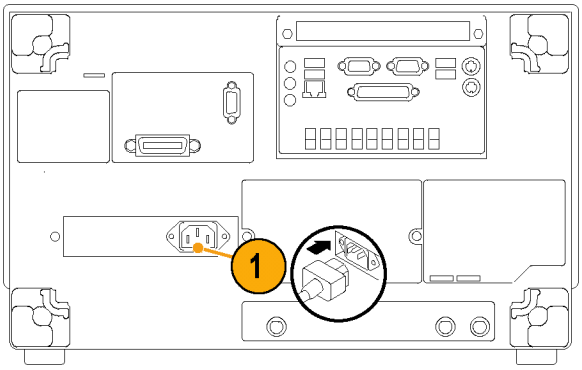


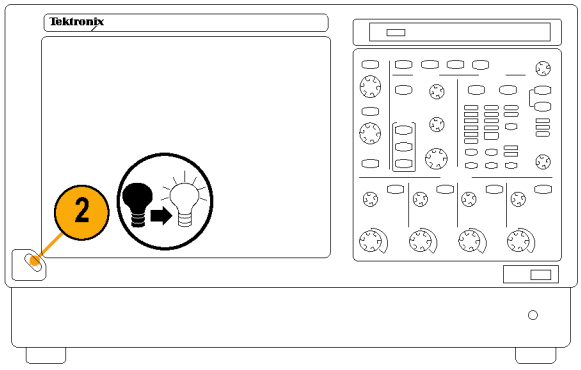
CAUTION. *To ensure proper cooling, keep the bottom and sides of the instrument clear of obstructions.*

Powering On the Instrument

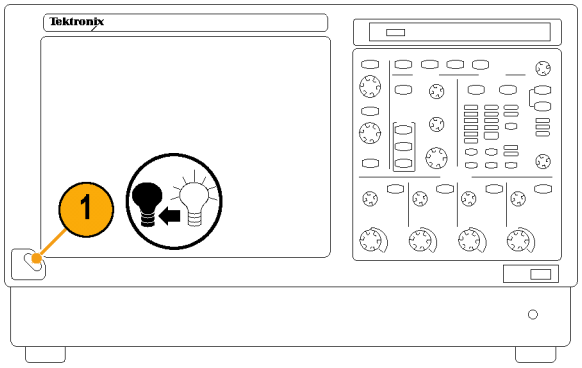
Power Supply Requirements

Source voltage and Frequency	Power Consumption
100–240 V_{RMS} ±10%, 50–60 Hz or 115 V_{RMS} ±10%, 400 Hz	≤ 500 W

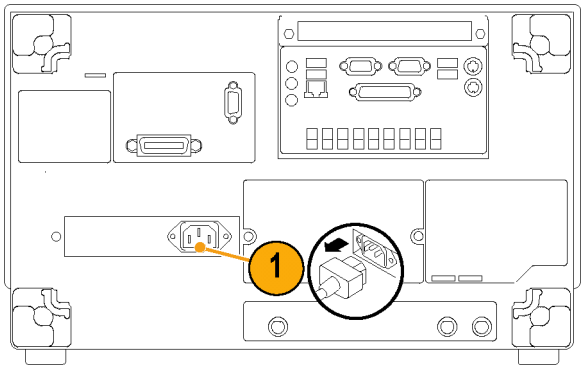




Powering Off the Instrument

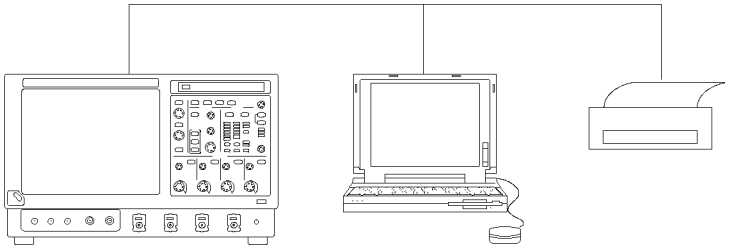


Removing the Power



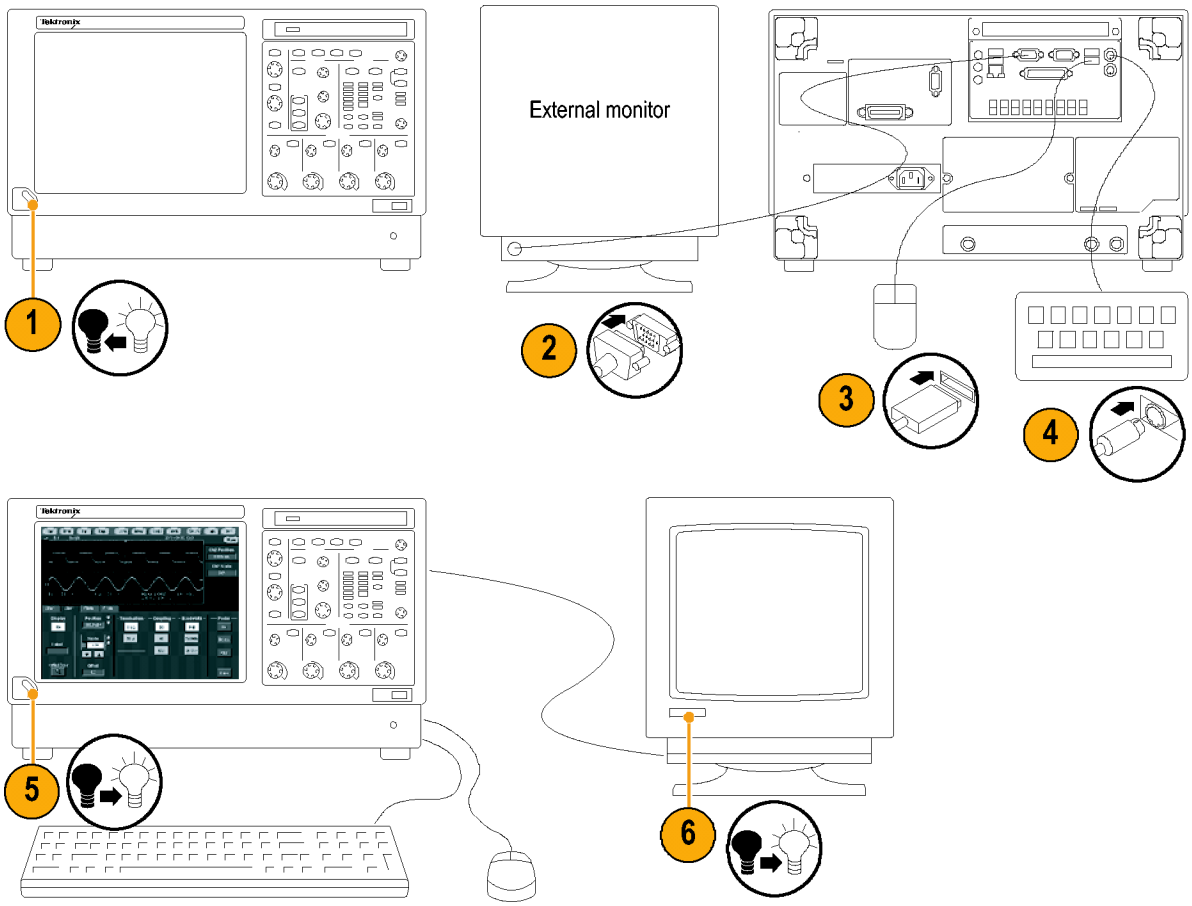
Connecting to a Network

You can connect your instrument to a network for printing, file sharing, internet access, and other functions. Consult with your network administrator and use the standard Windows utilities to configure the instrument for your network.

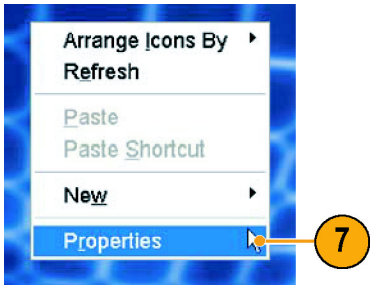


Adding a Second Monitor

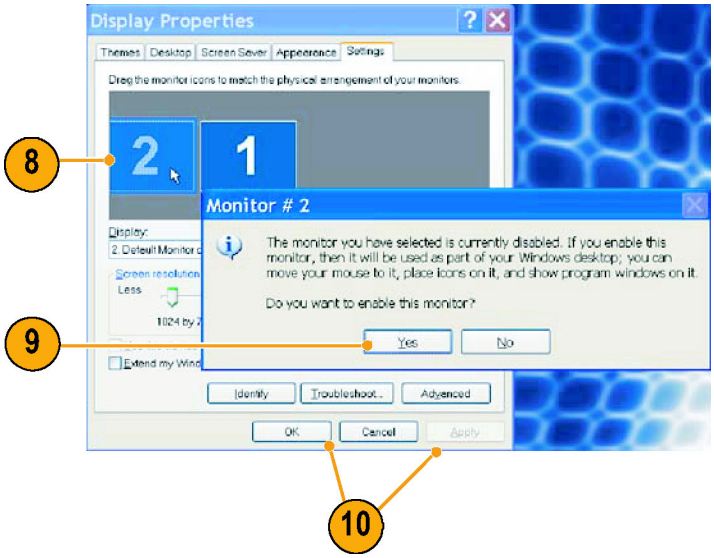
You can operate the instrument while using Windows and installed applications on an external monitor. Follow the procedure below to set up a dual monitor configuration.



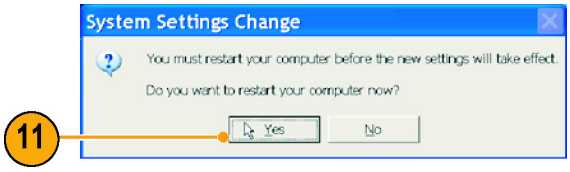
7. In the Windows desktop, right-click the mouse, and then select **Properties.**



8. Select the **Settings** tab. Click on the grayed out external monitor (2) in the display box, and drag it to the left of monitor 1.
9. Select **Yes** when you are prompted to enable the new monitor.
10. Click **Apply**, and then click **OK**.

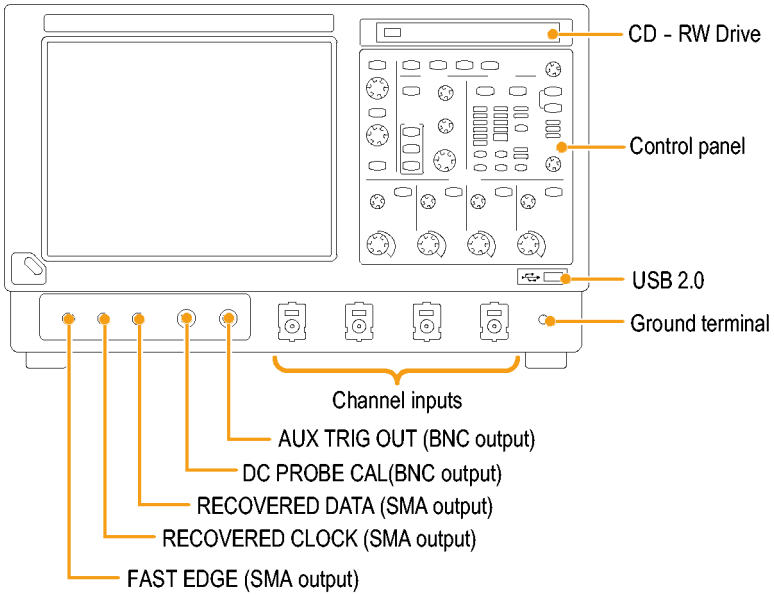


11. Click **Yes** to restart your instrument.

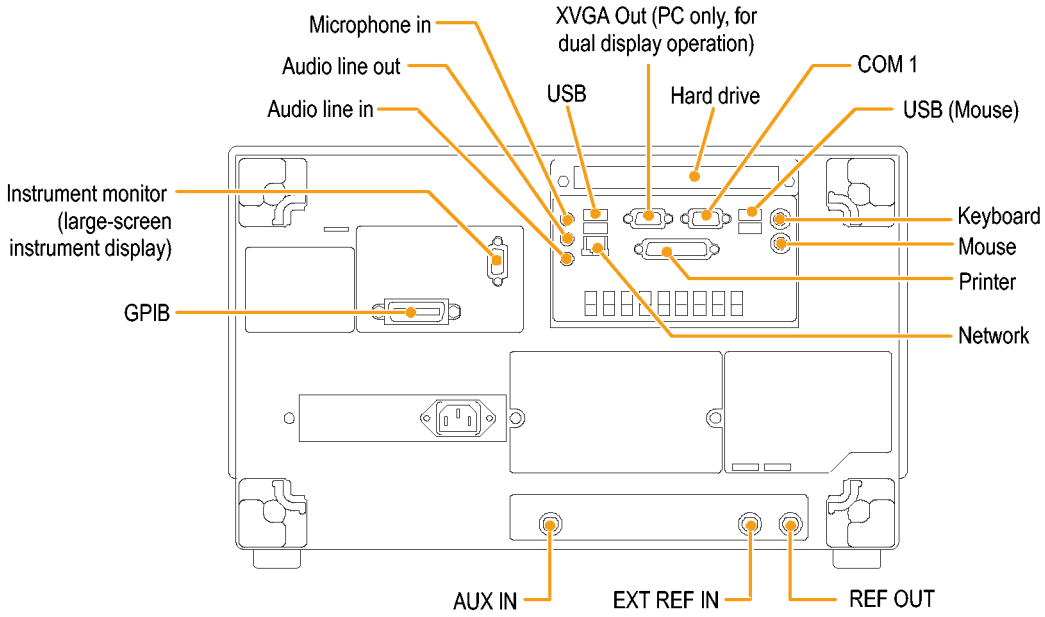


Getting Acquainted with Your Instrument

Front Panel



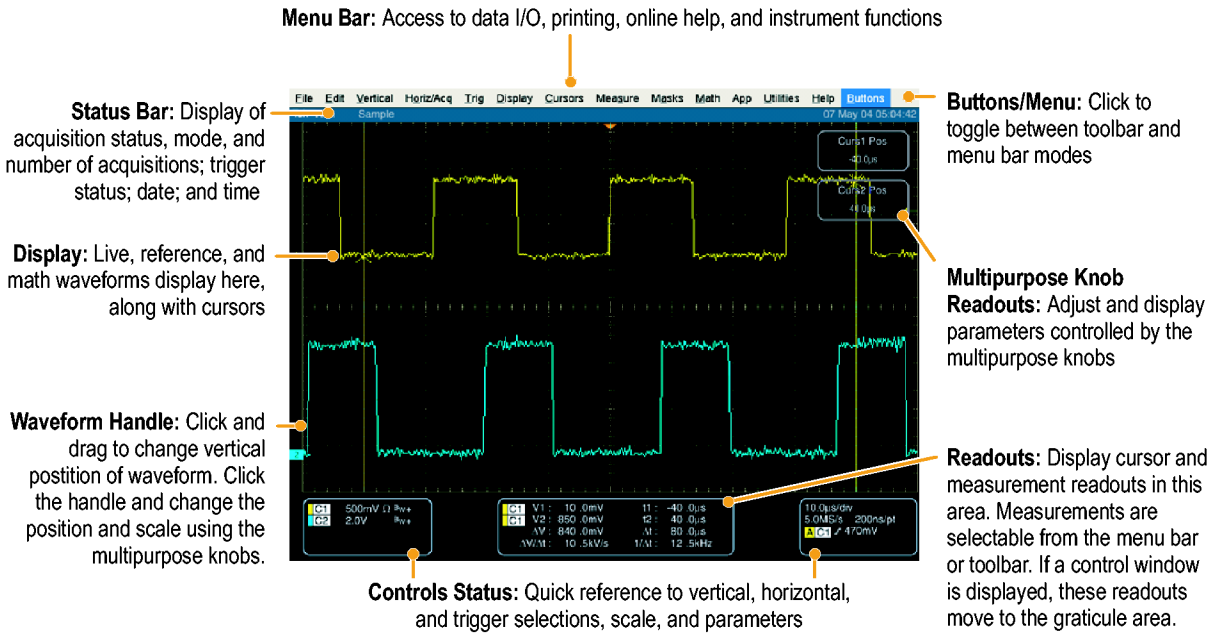
Side and Rear Panels

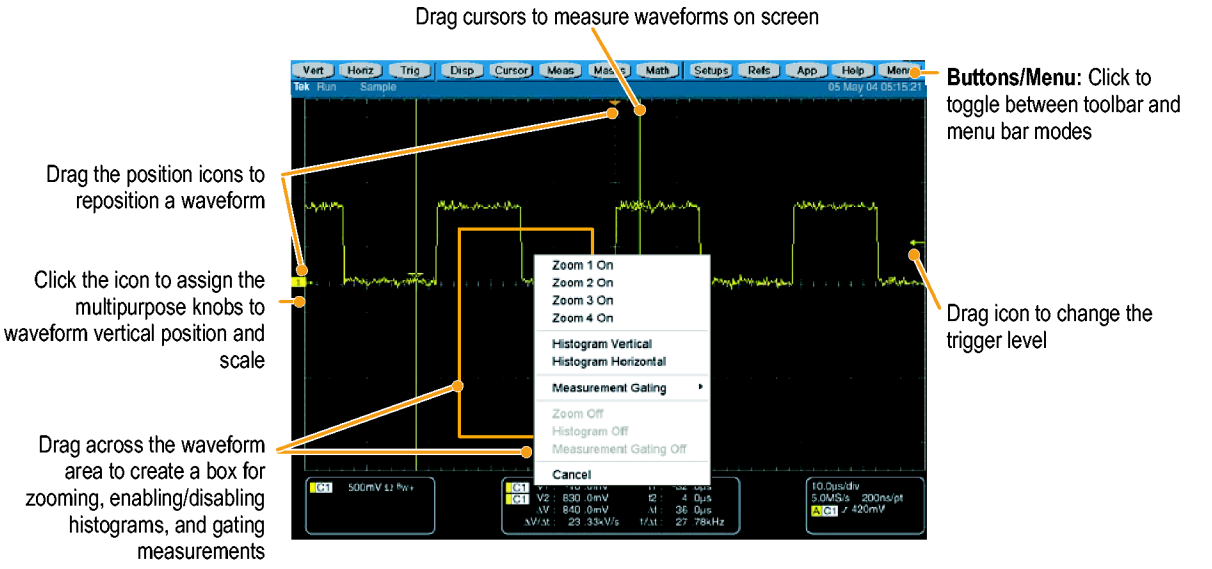


NOTE. *Plug USB devices directly into the USB connectors on the instrument to improve reliability rather than connecting the devices serially. If the instrument front panel and /or touch screen do not respond, press the On/Standby switch for 5 seconds to cycle power.*

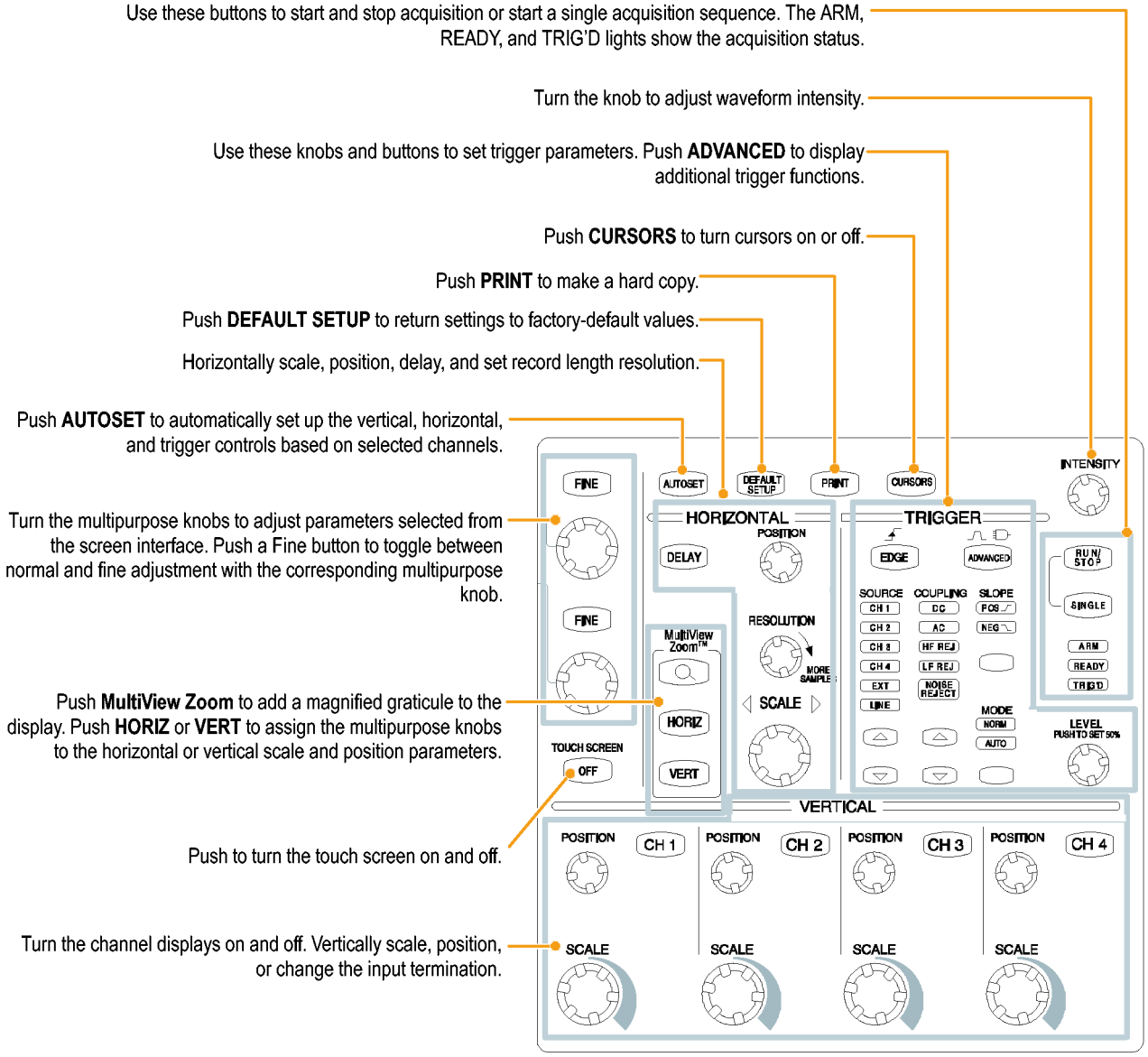
Interface and Display

The menu bar mode provides access to commands that control all of the instrument features and functions. The toolbar mode provides access to the most common features.





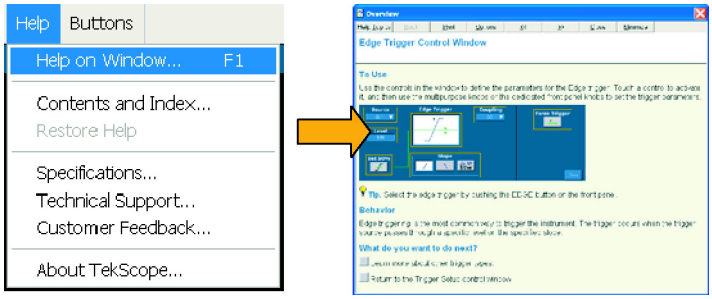
Control Panel



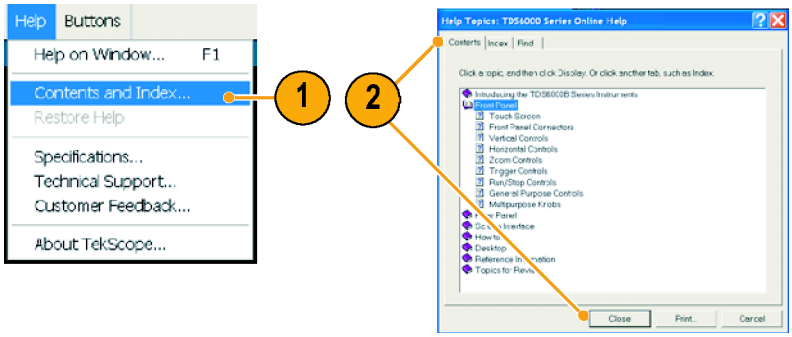
Accessing Online Help

In-depth information is available in the online help on all the features of your instrument.

To access context-sensitive help on the current setup, select **Help > Help on Window...** or press **F1**.

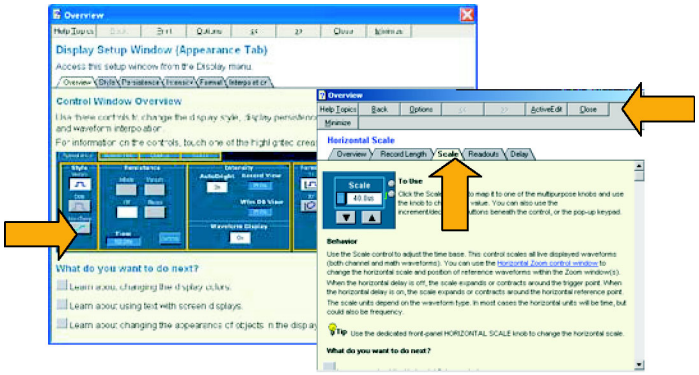


1. To access any topic in the help system, select **Help > Contents and Index...**.
2. Use the Contents, Index, or Find tab to select the topic, and then click **Display**.



To navigate within the help system you can:

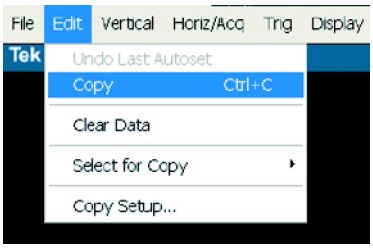
- Click an outlined control shown in the help window to receive more specific information about the control.
- Click a tab in a help window to navigate between the Overview and specific topics.
- Click **Minimize** in a help window to move help out of the way so you can operate the instrument.
- Click **Restore Help** to see the last help topic again.



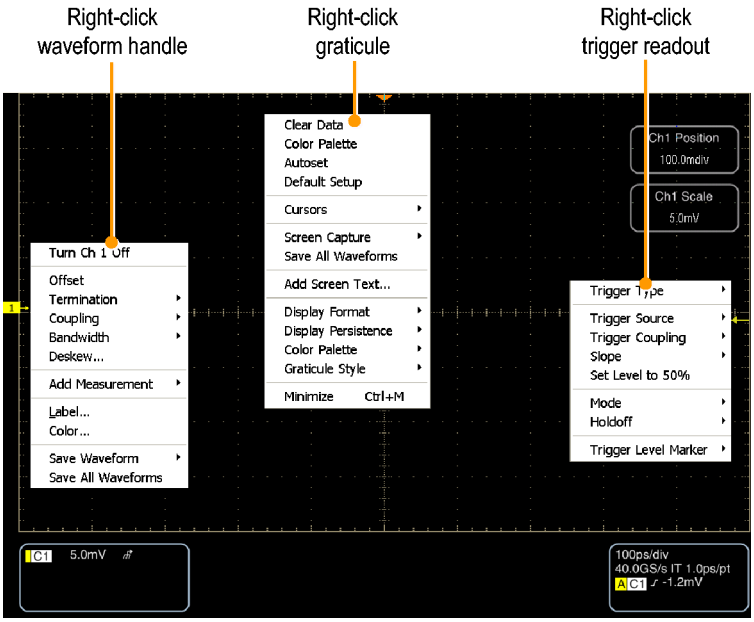
Accessing Menus and Control Windows

You can access menus and control windows using the following techniques:

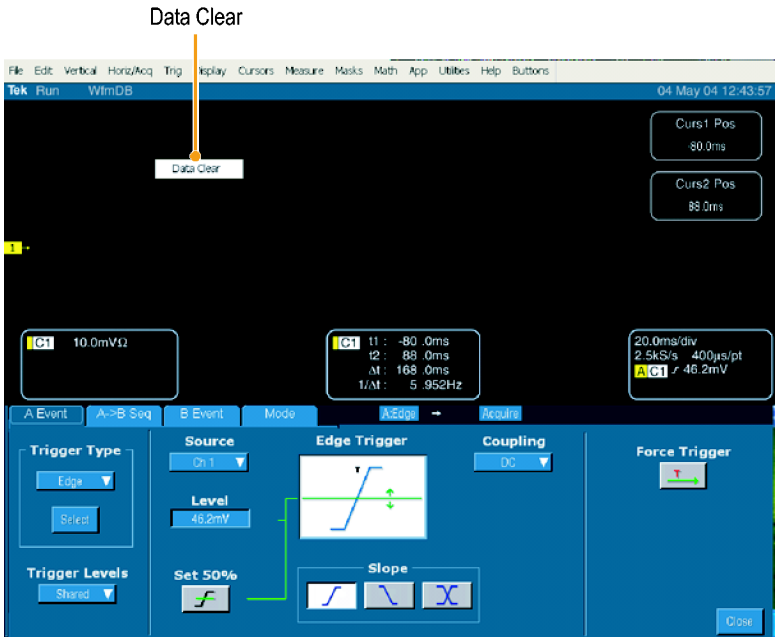
- Click a menu, and then select a command.



- For a shortcut menu, right-click anywhere in the graticule or on an object. The shortcut menu is context sensitive and varies with the area or object where you right-clicked. Some examples are shown in the figure at right.



- For a shortcut to clear data, right-click anywhere in the graticule. Move the cursor to highlight the Clear Data text, and left click to clear the data.



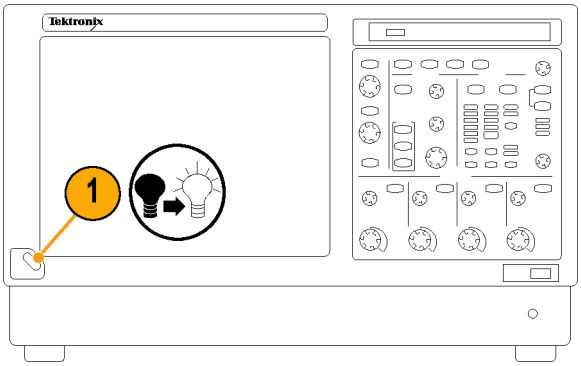
- In the toolbar mode, click a button to quickly access a setup control window. (See page 7.)

Inspect Your Instrument

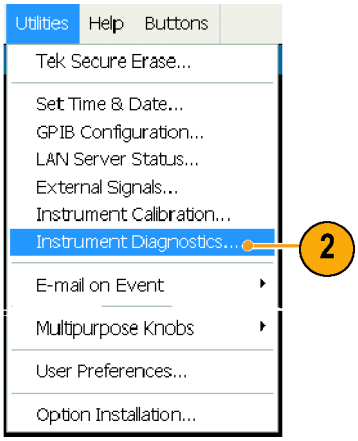
Use the following procedures to verify the functionality of your instrument.

Verify Internal Diagnostics Pass

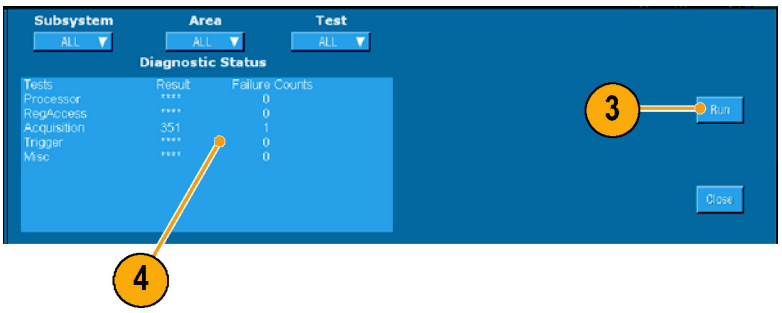
1. Prerequisites: instrument powered on for 20 minutes.



2. Select **Instrument Diagnostics...**.



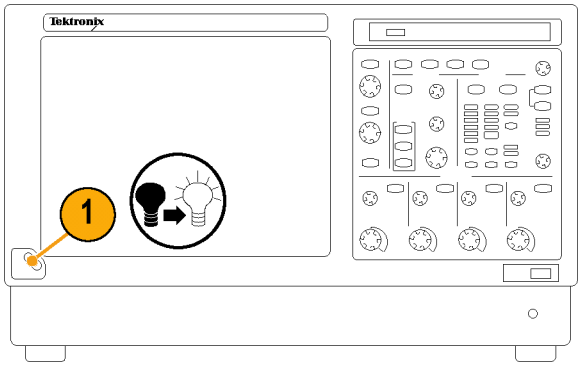
3. Click **Run**. The test results appear in the diagnostics control window.
4. Verify that all tests pass. If diagnostic failures occur, contact your local Tektronix service personnel.



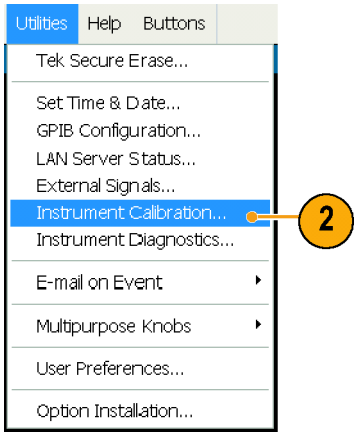
Signal Path Compensation

Use this procedure if the temperature has changed more than 5 °C (9 °F) since the last signal path compensation. Perform the signal path compensation once a week. Failure to do so may result in the instrument not meeting warranted performance levels.

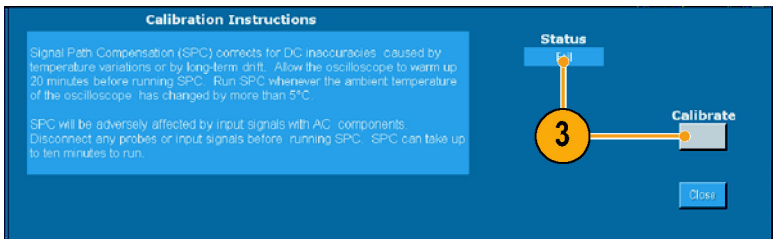
1. Prerequisites: instrument powered on for 20 minutes, and all input signals removed.



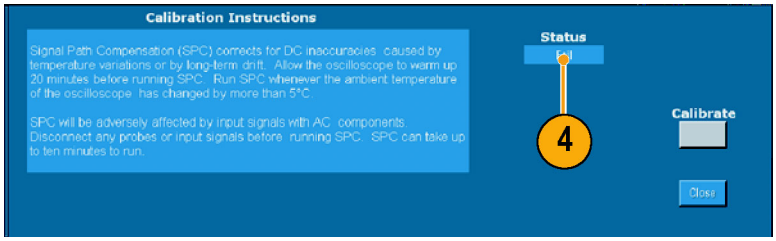
2. Select **Instrument Calibration**.



3. If the status is Warm-up, wait until the status changes to Temp. Then click Calibrate to start the calibration. Calibration may take 10 to 15 minutes.



4. If after calibration the status indicator does not display Pass, recalibrate the instrument, or have the instrument serviced by qualified service personnel.



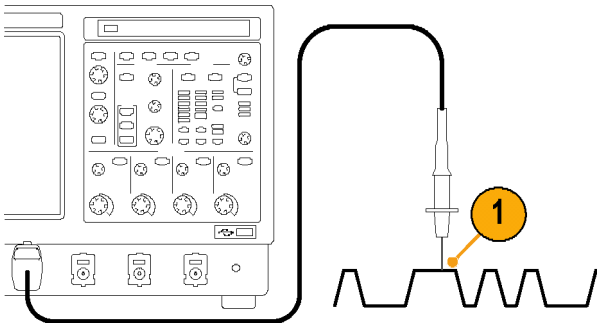
Acquisition

This section contains concepts of and procedures for using the acquisition system. Detailed information is available in the online help.

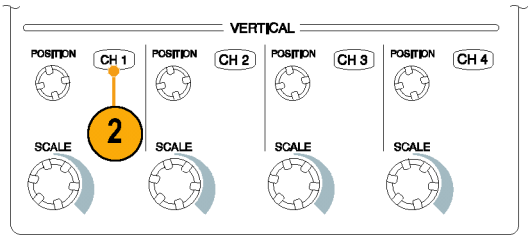
Setting Up Signal Input

Use front-panel buttons to set up your instrument to acquire the signal.

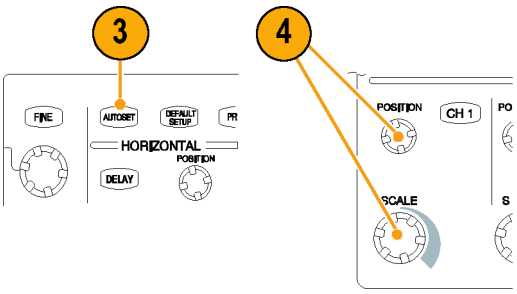
1. Connect the probe to the input signal source.



2. Select the input channel by pushing the front-panel buttons.



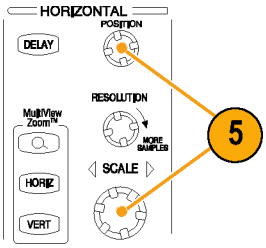
3. Press **Autoset**.
4. Adjust the vertical position and scale using the front-panel knobs.



5. Adjust the horizontal position and scale using the front-panel knobs.

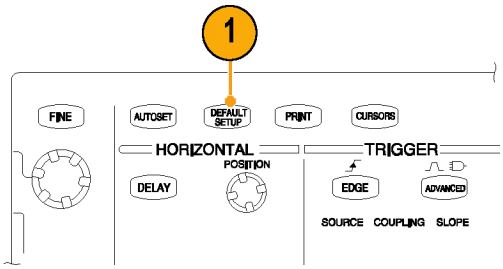
   The horizontal position determines the number of pretrigger and posttrigger samples.

   The horizontal scale determines the size of the acquisition window relative to the waveform. You can scale the window to contain a waveform edge, a cycle, or several cycles.



Using Default Setup

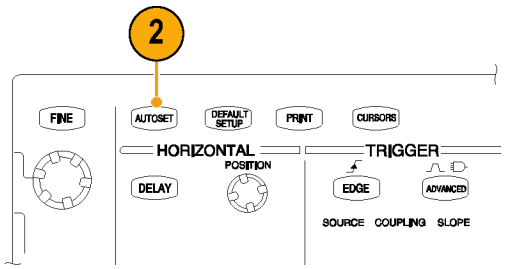
1. To quickly return to the factory default settings, push **DEFAULT SETUP**.



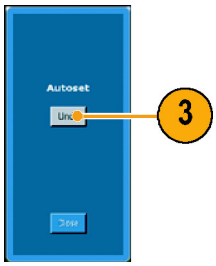
Using Autoset

Use Autoset to quickly and automatically set up the instrument (acquisition, horizontal, trigger, and vertical) based on the characteristics of the input signal. Autoset makes adjustments to the signal such that the waveform displays two or three cycles with the trigger near the midlevel.

1. Connect the probe, and then select the input channel. (See page 15, *Setting Up Signal Input*.)
2. Push the **AUTOSET** button to execute an Autoset.



3. The Autoset Undo control window opens automatically after an Autoset operation. Click **Undo** if you want to undo the last Autoset. Parameters that are not affected by Autoset retain their settings.



Quick Tips

- To position the waveform appropriately, Autoset may change the vertical position . Autoset always sets vertical offset to 0 V.
- If you use Autoset when one or more channels are displayed, the instrument selects the lowest numbered channel for horizontal scaling and triggering. You can individually control the vertical scaling of each channel.
- If you use Autoset when no channels are displayed, the instrument turns on channel one (CH 1) and scales it.
- The Autoset Undo control window remains on the screen until you open another control window. After Autoset Undo closes, you can still undo the last Autoset by selecting the Undo Last Autoset command from the Edit menu. Although the last Autoset is immediately undone, the Autoset Undo control window does not open again.
- You can stop the Autoset Undo control window from opening automatically by changing the User Preferences in the Utilities menu.

Probe Compensation, Calibration, and Deskew

To optimize measurement accuracy, see the instrument online help to perform the following procedures:

- Compensate passive probes
- Compensate the instrument signal path
- Calibrate active probes
- Deskew input channels

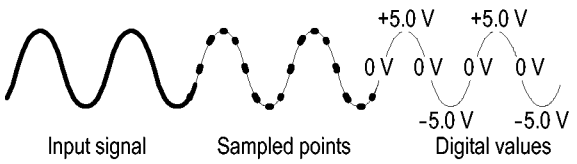
Acquisition Concepts

Acquisition Hardware

Before a signal can be displayed, it must pass through the input channel where it is scaled and digitized. Each channel has a dedicated input amplifier and digitizer. Each channel produces a stream of digital data from which the instrument extracts waveform records.

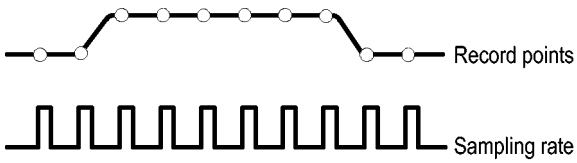
Sampling Process

Acquisition is the process of sampling an analog signal, converting it into digital data, and assembling it into a waveform record, which is then stored in acquisition memory.



Real-time Sampling

In real-time sampling, the instrument digitizes all of the points it acquires using one trigger event. Use real-time sampling to capture single-shot or transient events.



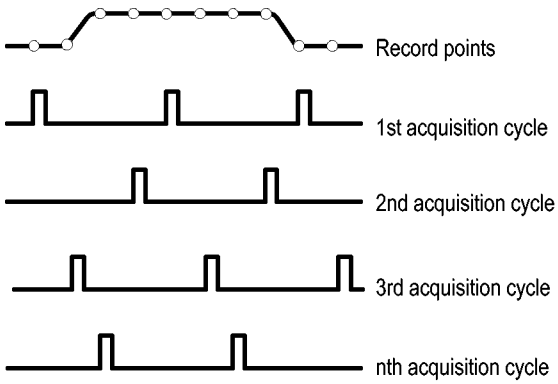
Interpolated Real-time Sampling

In interpolated real-time sampling, the instrument digitizes all of the points it acquires using one trigger event. If the instrument cannot acquire enough samples for a complete waveform at the maximum real-time sample rate, it interpolates. Use interpolated real-time sampling to capture single-shot, transient events, or slow acquisitions.

Equivalent-time Sampling

The instrument uses equivalent-time sampling to extend its sample rate beyond its real-time maximum sampling rate. Equivalent-time sampling is only used if Equivalent Time is selected and the time base is set to a sampling rate that is too fast to create a waveform record using real-time sampling.

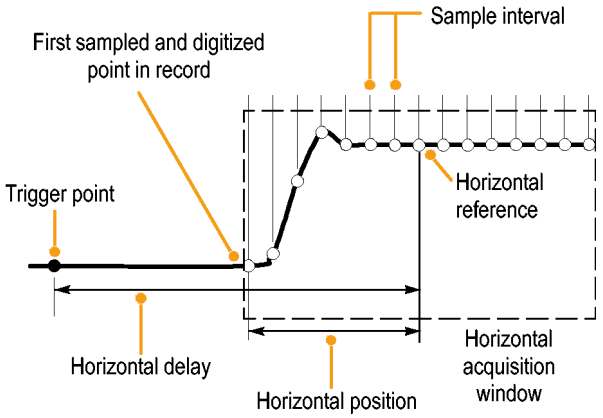
The instrument makes multiple acquisitions of a repetitive waveform to obtain the sample density required for one complete waveform record. Thus, equivalent time sampling should only be used with repetitive signals.



Waveform Record

The instrument builds the waveform record through use of the following parameters:

- Sample interval: The time between sample points.
- Record length: The number of samples required to fill a waveform record.
- Trigger point: The zero time reference in a waveform record.
- Horizontal position: When horizontal delay is off, the horizontal position is a percentage of the waveform record between 0 and 99.9 percent. The trigger point and the horizontal reference are at the same time in the waveform record. For example, if the horizontal position is 50 percent, then the trigger point is in the middle of the waveform record. When horizontal delay is on, the time from the trigger point to the horizontal reference is the horizontal delay.



Interpolation

Your instrument can interpolate between the samples it acquires when it does not have all of the actual samples it needs to fill the waveform record. Linear interpolation computes record points between actual acquired samples by using a straight line fit.

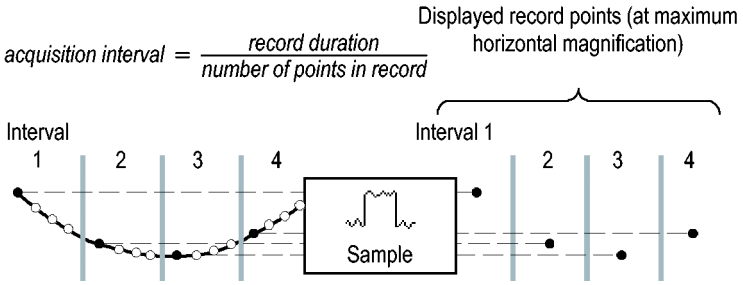
Sin(x)/x interpolation computes record points using a curve fit between the actual values acquired. Sin(x)/x interpolation is the default interpolation mode because it requires fewer actual sample points than linear interpolation to accurately represent the waveform.

Quick Tip

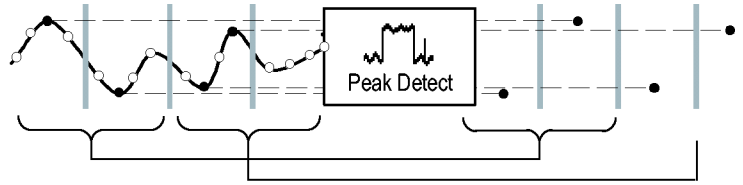
- Use the display style Intensified Samples to intensify the real samples and dim the interpolated samples. (See page 36, *Setting the Display Style*.)

How the Acquisition Modes Work

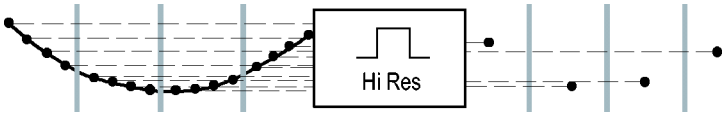
Sample mode retains the first sampled point from each acquisition interval. Sample is the default mode.



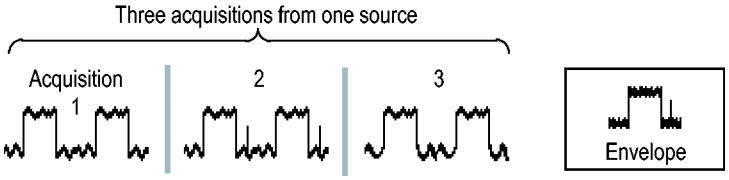
Peak Detect mode uses the highest and lowest of all the samples contained in two consecutive acquisition intervals. This mode only works with real-time, noninterpolated sampling and is useful for catching high frequency glitches.



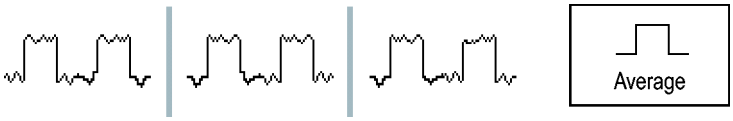
Hi Res mode calculates the average of all the samples for each acquisition interval. Hi-Res provides a higher-resolution, lower-bandwidth waveform.



Envelope mode finds the highest and lowest record points over many acquisitions. Envelope uses Peak Detect for each individual acquisition.



Average mode calculates the average value for each record point over many acquisitions. Average uses Sample mode for each individual acquisition. Use average mode to reduce random noise.

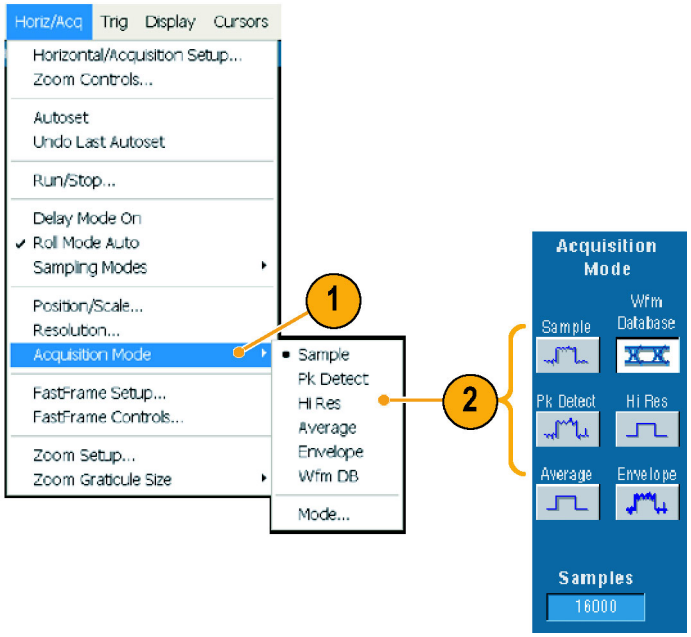


Waveform Database mode is a three-dimensional accumulation of source waveform data over several acquisitions. In addition to amplitude and timing information, the database includes a count of the number of times a specific waveform point (time and amplitude) has been acquired.

Changing the Acquisition Mode

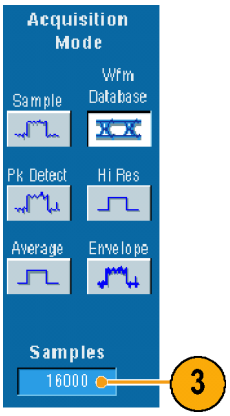
Use this procedure to change the acquisition mode.

1. Select **Horiz/Acq > Acquisition Mode**.
2. To select an acquisition mode, do one of the following:
   - Select an acquisition mode directly from the menu.
   - Click **Mode...,** and then select an acquisition mode.



3. For Average or Envelope acquisition modes, click the **# of Wfms** control, and then set the number of waveforms with the multipurpose knob. For WfmDB mode, click the **Samples** control, and then set the number of samples with the multipurpose knob.

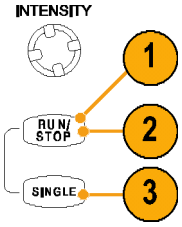
   You can also click the keyboard icon and use the pop-up keypad to set the number of waveforms or samples.



Starting and Stopping an Acquisition

After you have a waveform displayed and the channels that you want to acquire are selected, use the following procedure.

1. Press the front-panel **RUN/STOP** button to start the acquisition.
2. Press the RUN/STOP button again to stop the acquisition.
3. To take a single acquisition, press the **Single** button.

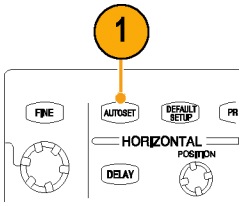


Using DSP Enhanced Bandwidth

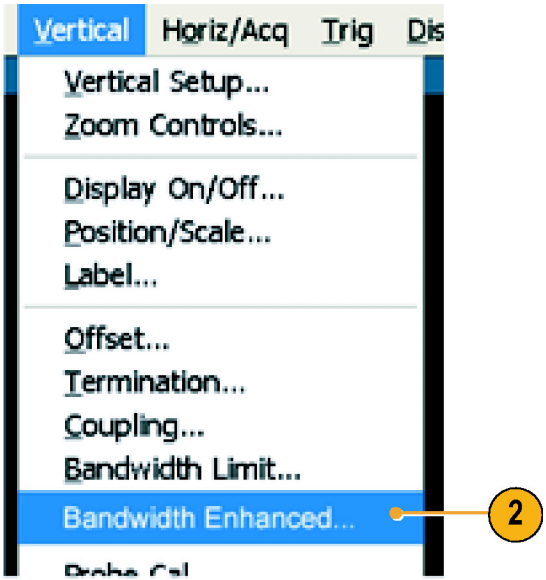
Use the DSP (digital signal processing) enhanced bandwidth for more accurate rise time measurements, to extend the bandwidth, and flatten the passband at the full sample rate (20 GS/s on the TDS6804B and 40 GS/s on TDS6000C instruments). The enhanced bandwidth provides a matched response across enabled channels so you can perform channel-to-channel comparison and differential measurements.

1. Push **AUTOSET** to set the horizontal, vertical, and trigger controls or set the controls manually.

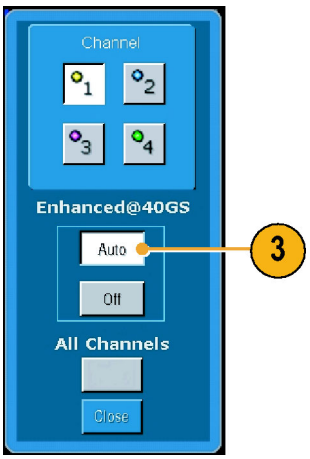
NOTE. *The enhanced bandwidth is 20 GS/s.*



2. Select **Vertical > Bandwidth Enhanced...** .



3. Click Enhance@40GS**Auto**. to turn the enhanced bandwidth on.



The BW+ indicator appears in the vertical readout when the enhanced bandwidth is turned on.

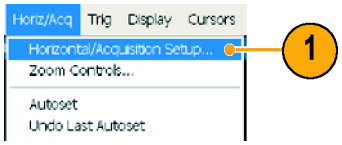
Quick Tips

- The DSP enhanced bandwidth is available on all TDS6000B and TDS6000C instruments except the TDS6604B. The DSP enhanced bandwidth occurs at 20 GS/s for the TDS6804B and 40 GS/s and above for the TDS6000C instruments.
- Use the DSP enhanced bandwidth when your signal have rise times less than 50 ps (TDS6000C instruments) or 100 ps (TDS6804B instruments) or for performing eye pattern compliance testing for signals greater than 5 Gb/s (TDS6000C instruments) or 2.5 GS/s (TDS6804B).
- Turn the DSP enhanced bandwidth off for higher waveform throughput, overdriven signals, and when you prefer to use your own DSP post-processing.

Using Roll Mode

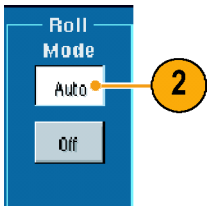
Roll mode gives a display similar to a strip chart recorder for low-frequency signals. Roll mode lets you see acquired data points without waiting for the acquisition of a complete waveform record.

1. Select **Horiz/Acq > Horizontal/Acquisition Setup...**.

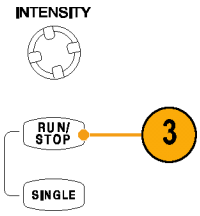


2. If not selected, click the **Acquisition** tab. Click **Auto** to turn on Roll mode.

NOTE. *Roll mode requires Sample, Peak Detect, or Hi Res acquisition mode.*



3. To stop acquisitions in Roll mode:
   - If you are not in Single Sequence, push **RUN/STOP** to stop Roll mode.
   - If you are in Single Sequence, Roll mode acquisitions stop automatically when a complete record is acquired; that is, when the waveform reaches the left edge of the screen.



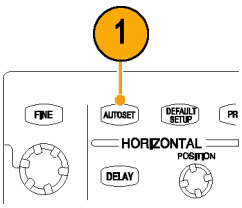
Quick Tips

- Switching to Envelope, Average, or WfmDB acquisition mode will turn off Roll mode.
- Roll mode is disabled when you set the horizontal scale to 40 ms per division or faster.

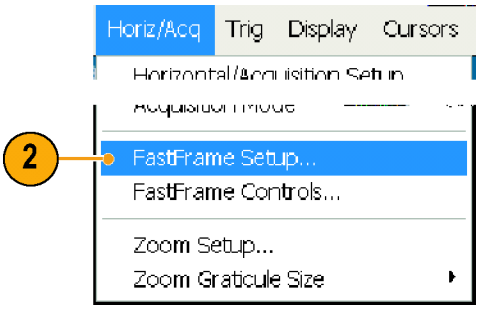
Using FastFrame Mode

FastFrame allows you to capture many trigger events as single records in a larger record, and then view and measure each record individually. Time Stamps display the absolute trigger time for a specific frame and the relative time between triggers of two specified frames.

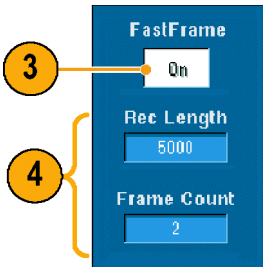
1. Push **AUTOSET** to set the horizontal, vertical, and trigger controls or set the controls manually.



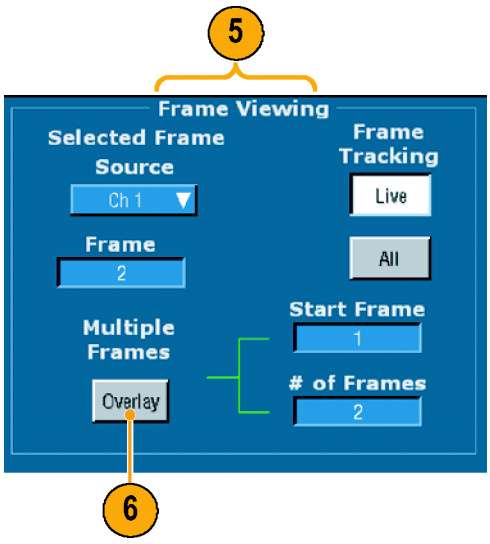
2. Select **Horiz/Acq > FastFrame Setup...** .



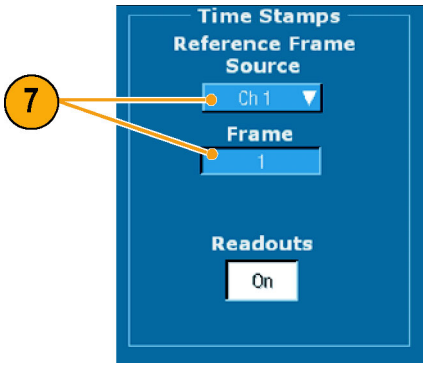
3. Click FastFrame **On**.
4. Select **Rec Length** and **Frame Count**. Then use the multipurpose knobs to set each one. Frame count represents the number of trigger events that will be captured. Record length is the number of samples that will be stored with each trigger event (or frame.) The frame count will be reduced if there is insufficient memory to store all the records.



5. Use the Frame Viewing controls to select the frame that you want to view.
6. To view multiple frames superimposed over each other, select Overlay.



7. Use the Time Stamps controls to select the source for, and frame number of, the reference frame. The reference frame is the starting point when measuring the relative time between two frames.



Quick Tips

- Use FastFrame when you want to preserve the data associated with each trigger event for further analysis or visual inspections.
- Multiple frames are best viewed with the Normal, Green, or Gray color palettes because the dark blue selected frame may be hard to distinguish if you use Temp or Spectral.
- You can quickly set the Selected Frame and Reference Frame for time stamping by selecting **FastFrame Controls...** from the Horiz/Acq menu.
- Use FastFrame when you want to capture multiple events that have long dead times between them that are of no interest to you.

Pinpoint Triggers

The Pinpoint trigger system also comes with a robust suite of advanced trigger types that is usable on both A and B triggers, and it adds Reset capability to reset the trigger sequence if the B event does not occur after a specific number of events or a specific time. Together, these features support capture of events based on the most complex trigger event or sequence of trigger events.

This section contains concepts and procedures for using the trigger system. Detailed information is available in the online help.

Triggering Concepts

Trigger Event

The trigger event establishes the time-zero point in the waveform record. All waveform record data are located in time with respect to that point. The instrument continuously acquires and retains enough sample points to fill the pretrigger portion of the waveform record (that part of the waveform that is displayed before, or to the left of, the triggering event on screen). When a trigger event occurs, the instrument starts acquiring samples to build the posttrigger portion of the waveform record (displayed after, or to the right of, the trigger event). Once a trigger is recognized, the instrument will not accept another trigger until the acquisition is complete and the holdoff time has expired.

Trigger Types

Edge triggers are the simplest and most commonly used trigger type, used with both analog and digital signals. An edge trigger event occurs when the trigger source passes through a specified voltage level in the specified direction (rising or falling signal voltage).

Pulse triggers are special-purpose triggers that are primarily used with digital signals. The following types of pulse triggers are available: Glitch, Runt, Window, Width, Transition, and Timeout.

Logic triggers are special-purpose triggers that are primarily used with digital logic signals. Two of the types, Pattern and State, trigger the instrument based on the Boolean operator you select for the trigger sources. A third type, Setup and Hold, triggers when Data on one trigger source changes state within the setup and hold times that you specify relative to a Clock on another trigger source.

Communication triggers (available only with Option SM) are used on communication signals. Mask testing automatically uses Communication triggers.

The serial pattern trigger (available with Option ST) is a special trigger type used on signals with serial data patterns. Serial triggering is available with A triggers only, and only when the Serial option is present.

Trigger Modes

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

- Normal trigger mode enables the instrument to acquire a waveform only when it is triggered. If no trigger occurs, the last waveform record acquired remains on the display. If no last waveform exists, no waveform is displayed.
- Auto trigger mode enables the instrument to acquire a waveform even if a trigger does not occur. Auto mode uses a timer that starts after a trigger event occurs. If another trigger event is not detected before the timer times out, the instrument forces a trigger. The length of time it waits for a trigger event depends on the time base setting.

Auto mode, when forcing triggers in the absence of valid triggering events, does not synchronize the waveform on the display. The waveform will appear to roll across the screen. If valid triggers occur, the display will become stable.

You can also force the instrument to trigger with an edge trigger by clicking the Force Trigger button on the Trigger Setup control window.

Trigger Holdoff

Trigger holdoff can help stabilize triggering. When the instrument recognizes a trigger event, it disables the trigger system until acquisition is complete. In addition, the trigger system remains disabled during the holdoff period that follows each acquisition. Adjust holdoff to obtain stable triggering when the instrument is triggering on undesired trigger events.

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 other trigger types use DC coupling only.

Horizontal Position

Horizontal position is an adjustable feature that defines where the trigger occurs on the waveform record. It lets you choose how much the instrument 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.

Pretrigger data can be valuable 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 data before the glitch. By analyzing what happens before the glitch, you may uncover information that helps you find the source of the glitch. Alternatively, if you want to see what is happening in your system as a result of the trigger event, make the posttrigger period large enough to capture data after the trigger.

Slope and Level

The slope control determines whether the instrument finds the trigger point on the rising or the falling edge of a signal. The level control determines where on that edge the trigger point occurs.

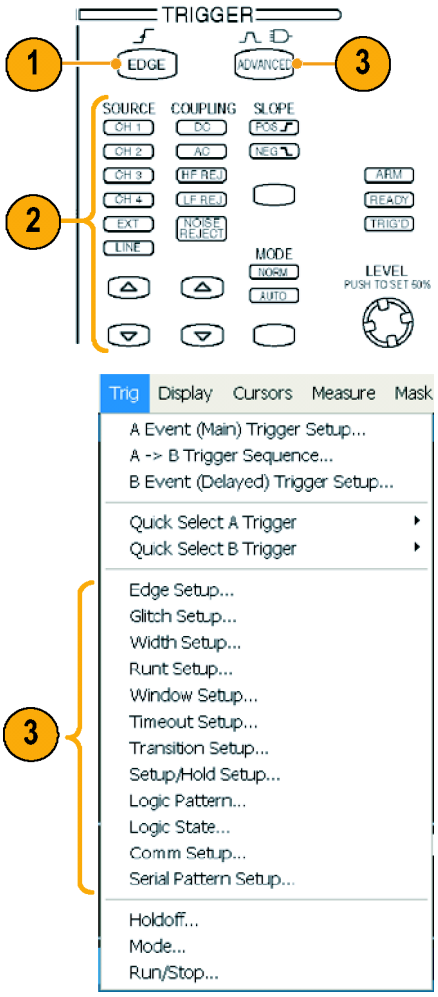
Delayed Trigger System

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 arms the trigger system, and the B trigger event triggers the instrument when the B trigger conditions are met. A and B triggers can (and typically do) have separate sources. The B trigger condition can be based on a time delay or a specified number of events. (See page 33, *Using A (Main) and B (Delayed) Triggers*.)

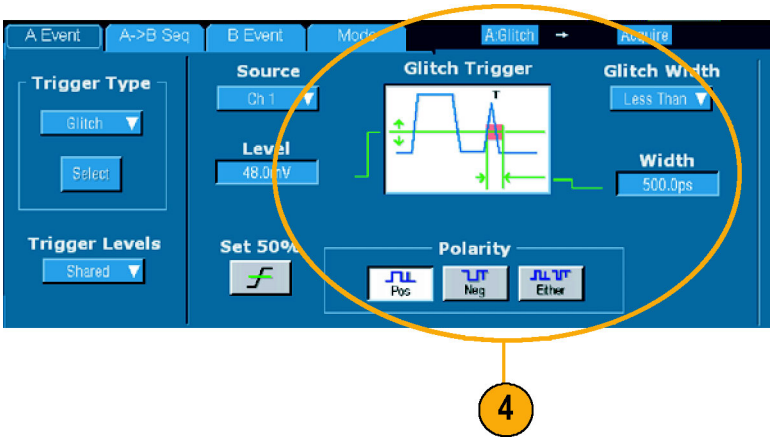
Choosing a Trigger Type

Your instrument allows you to modify basic trigger parameters from the front panel or set up more advanced triggers in the Trigger Setup control window.

1. Push **EDGE**.
2. Set the source, coupling, slope and mode with these front-panel controls.
3. To select one of the other trigger types, do one of the following:
   - Push **ADVANCED**
   - Select a trigger type directly from the Trig menu.



4. Complete the trigger setup using the controls displayed for the trigger type. The controls to set up the trigger vary depending on the trigger type.



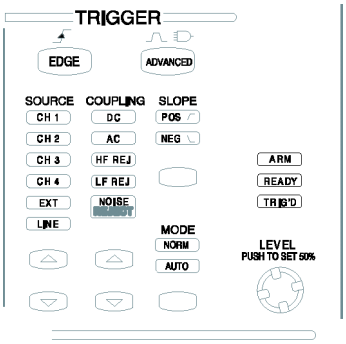
Pinpoint Trigger Selections

Trigger Type		Trigger Conditions
Edge		Trigger on a rising or falling edge, as defined by the slope control. Coupling choices are DC, AC, LF Reject, HF Reject, and Noise Reject.
Glitch		Trigger on a pulse narrower (or wider) than the specified width or ignore glitches narrower (or wider) than the specified width.
Width		Trigger on pulses that are inside or outside a specified time range. Can trigger on positive or negative pulses.
Runt		Trigger on a pulse amplitude that crosses one threshold but fails to cross a second threshold before recrossing the first. Can detect positive or negative runts, or only those wider than a specified width. These pulses can also be qualified by the logical state of other channels (four-channel models only).
Window		Trigger when the input signal rises above an upper threshold level or falls below a lower threshold level. Trigger the instrument as the signal is entering or leaving the threshold window. Qualify the trigger event in terms of time by using the Trigger When Wider option, or by the logical state of other channels using the Trigger When Logic option (four-channel models only).
Timeout		Trigger when no pulse is detected within a specified time.
Transition		Trigger on pulse edges that traverse between two thresholds at faster or slower rates than the specified time. The pulse edges can be positive or negative.
Serial		Trigger on 64-bit serial pattern at data rates up to 1.25 Gb/s (TDS6000B and TDS6000C) and 40-bit serial patterns up to 3.125 Gb/s (TDS6000C only). Requires Option ST.
Pattern		Trigger when logic inputs cause the selected function to become True or False. You can also specify that the logic conditions must be satisfied for a specific amount of time before triggering.
State		Trigger when all of the logic inputs to the selected logic function cause the function to be True or False when the clock input changes state.
Setup/ Hold		Trigger when a logic input changes state inside of the setup and hold times relative to the clock.
Comm		Trigger in conjunction with mask testing on communications codes and standards. The controls work together to define the parameters for the trigger event (available with Option SM).

Checking Trigger Status

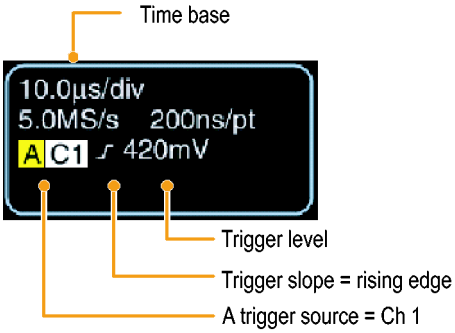
You can check the trigger status from the status lights on the front panel or from the acquisition readout.

Check the ARM, READY, and TRIG'D front-panel controls to determine the trigger status.



- If TRIG'D is on, the instrument has recognized a valid trigger and is filling the posttrigger portion of the waveform.
- If READY is on, the instrument can accept, and is waiting for, a valid trigger to occur. Pretrigger data has been acquired.
- If ARM is on, the trigger circuitry is filling the pretrigger portion of the waveform record.
- If both TRIG'D and READY are on, a valid A event trigger has been recognized and the instrument is waiting for a delayed trigger. When a delayed trigger is recognized, the posttrigger portion of the delayed waveform will fill.
- If ARM, TRIG'D, and READY are off, acquisitions have stopped.

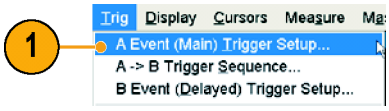
To quickly determine the settings of some key trigger parameters, check the Trigger readout at the bottom of the display. The readouts differ for edge and the advanced triggers.



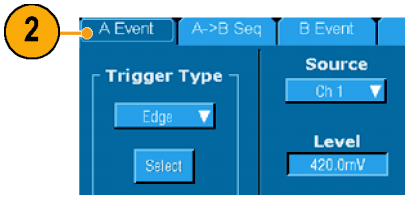
Using A (Main) and B (Delayed) Triggers

You can use the A Event (Main) trigger for simple signals or combine it with the B Event (Delayed) trigger to capture more complex signals. After the A Event occurs, the trigger system looks for the B Event before triggering and displaying the waveform.

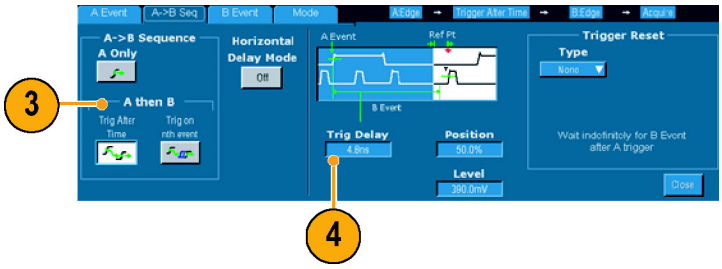
1. Select **Trig > A Event (Main) Trigger Setup...**.



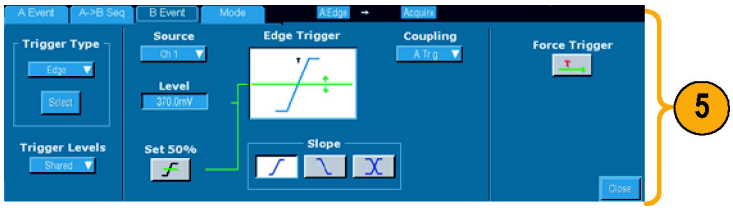
2. Set the A trigger type and source in the A Event tab.



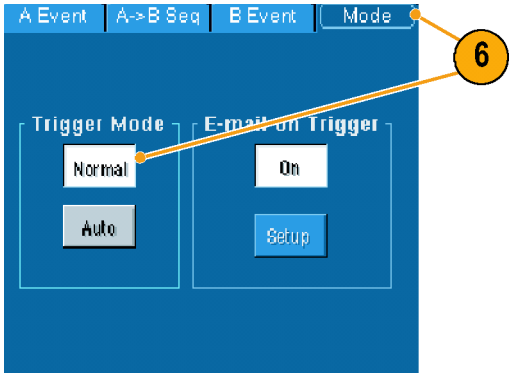
3. Choose a function in the A →B Seq tab.
4. Set the trigger delay time or the number of B events, as appropriate.



5. Set the B trigger characteristics in the B Event (Delayed) tab.

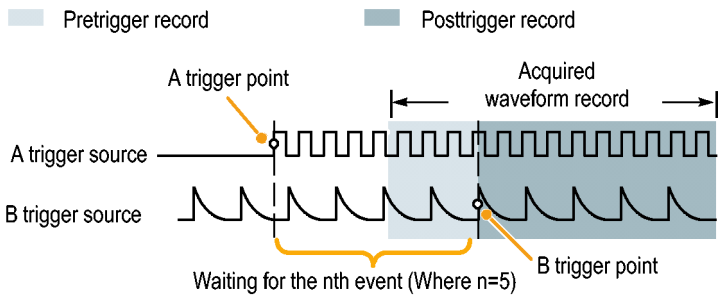


6. Select **Normal** Trigger Mode.



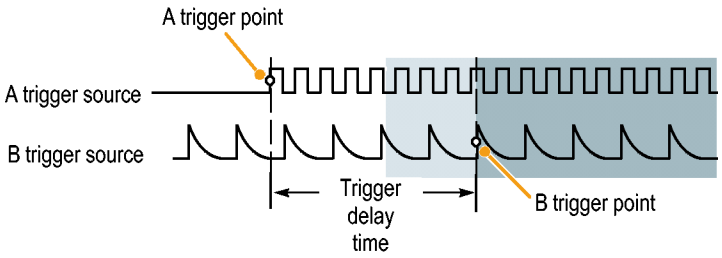
Trigger on B Event

The A trigger arms the instrument. Posttrigger acquisition starts on the nth B event.



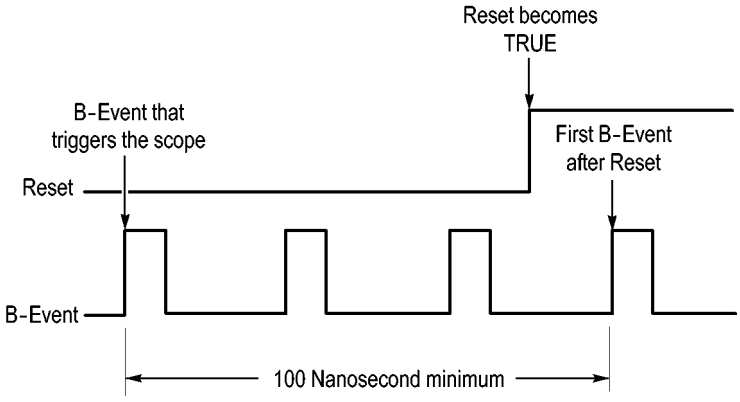
B Trigger After Delay Time

The A trigger arms the instrument. Posttrigger acquisition starts on the first B edge after the trigger delay time.



Triggering with Reset

You can specify a condition to reset the trigger system if it occurs before the B trigger event. When the reset event occurs, the trigger system stops waiting for the B event and returns to waiting for the A event.



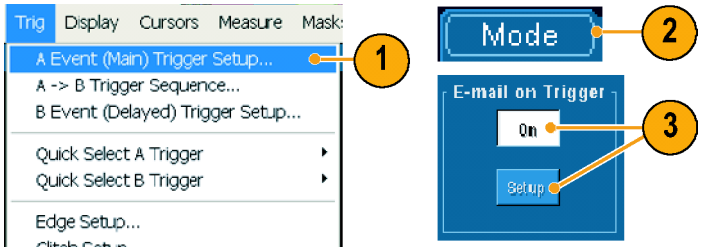
Quick Tips

- B-trigger delay time and horizontal delay time are independent functions. When you establish a trigger condition using either the A trigger alone or the A and B triggers together, you can also use horizontal delay to delay the acquisition by an additional amount.

Sending E-mail on Trigger

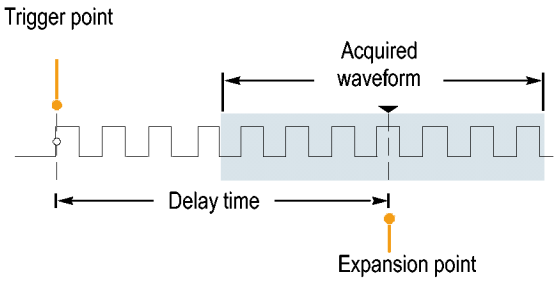
You must configure e-mail on event before performing the following procedure. (See page 65, *Setting Up E-mail on Event*.)

1. Select **Trig > A Event (Main) Trigger Setup...**.
2. Select the **Mode** tab.
3. Under E-mail on Trigger, click **On**, and then click **Setup**. (See page 65, *Setting Up E-mail on Event*.)

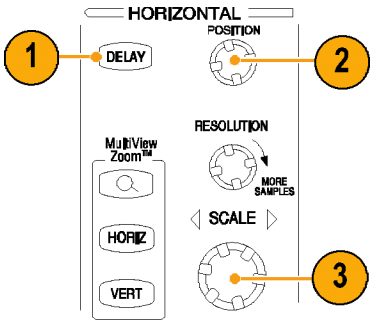


Using Horizontal Delay

Use horizontal delay to acquire waveform detail in a region that is separated from the trigger location by a significant interval of time.



1. Push **DELAY**.
2. 2. Adjust the delay time with the horizontal **POSITION** control, or enter the delay time in the control window.
3. 3. Adjust the horizontal **SCALE** to acquire the detail that you need around the delay expansion point.



Quick Tips

- Use MultiView Zoom and Horizontal Delay together to magnify a delayed acquisition.
- Toggle Horizontal Delay on and off to quickly compare signal details at two different areas of interest, one near the trigger location and the other centered at the delay time.

Display a Waveform

This section contains concepts and procedures for displaying a waveform. Detailed information is available in the online help.

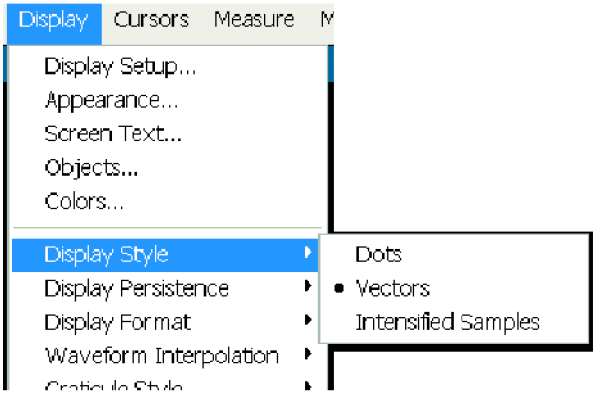
Setting the Display Style

To set the display style select **Display > Display Style,** and then select one of the following styles:

Displays waveforms with lines drawn between record points.

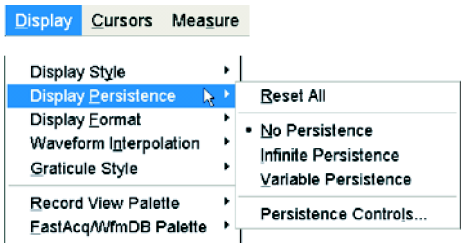
Displays waveform record points as dots on the screen.

Displays the actual samples as intensified dots. Interpolated points are shown in the waveform color.



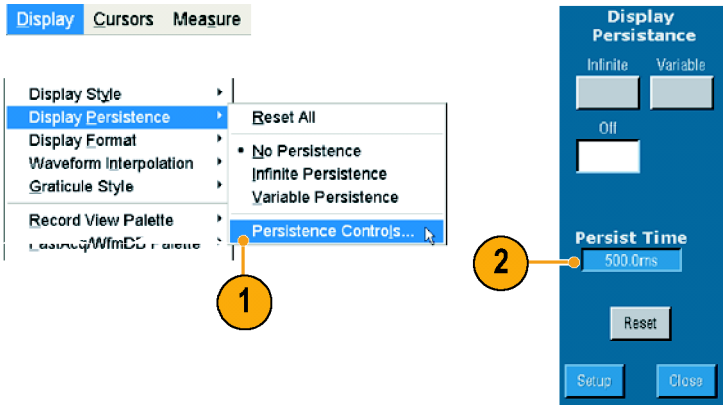
Setting the Display Persistence

Select **Display > Display Persistence**, and then select the type of persistence.



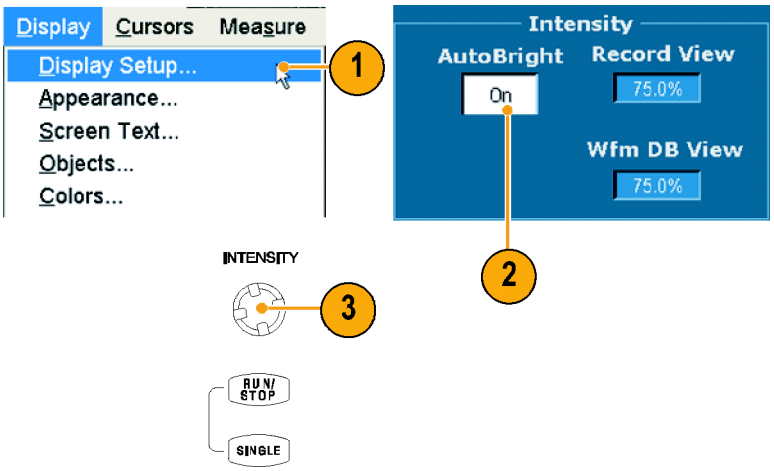
- No persistence shows record points for the current acquisition only. Each new waveform record replaces the previously acquired record for a channel.
- Infinite persistence continuously accumulates record points until you change one of the acquisition display settings. Use for displaying points that may occur outside the normal acquisition envelope.
- Variable persistence accumulates record points for a specified time interval. Each record point decays independently according to the time interval.

1. To set the variable persistence time, select **Display > Display Persistence > Persistence Controls...**.
2. Click **Persist Time**, and then use the multipurpose knobs to set the persistence time.



Using AutoBright

1. Select **Display > Display Setup...**.
2. Turn AutoBright off to simulate the appearance of analog oscilloscope signals.
3. Use the front-panel **INTENSITY** knob to manually adjust the display intensity when AutoBright is Off.



Quick Tips

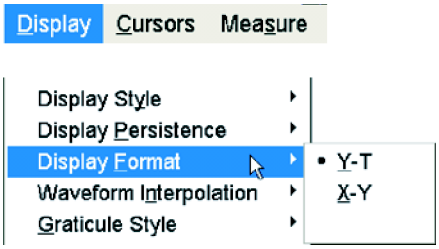
- Turn AutoBright on to make waveforms visible even at low trigger repetition rates.

Setting the Display Format

The instrument can display waveforms in two different formats. Choose the format that best suits your needs.

Select **Display > Display Format**.

- Select **Y-T** format to show a signal amplitude as it varies over time.
- Select **X-Y** format to compare the amplitude of CH 1 (X) and Ch 2 (Y) waveform records point by point.



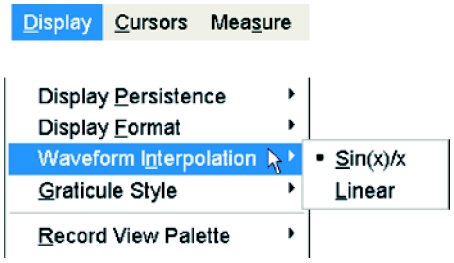
Quick Tips

- XY format is particularly useful for studying phase relationships such as Lissajous Patterns.
- XY format is a dot-only display, although it can have persistence. The Vector style selection has no effect when you select XY format.

Selecting the Waveform Interpolation

Select **Display > Waveform Interpolation**, and then select one of the following:

- Sin(x)/x interpolation computes record points using a curve fit between the actual samples acquired.
- Linear interpolation computes record points between actual acquired samples by using a straight line fit.

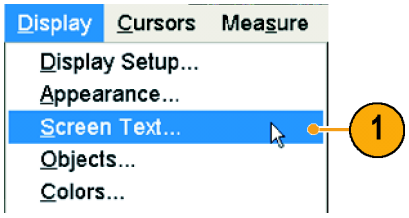


Quick Tips

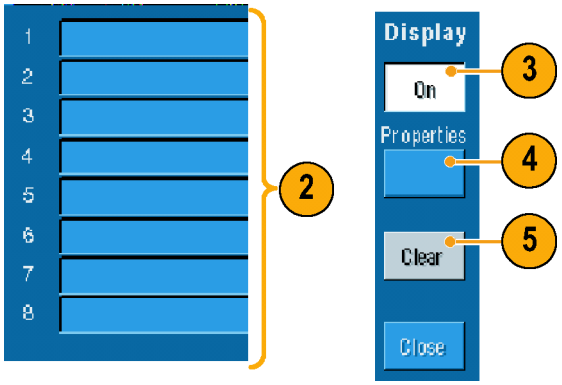
- Sin(x)/x interpolation is the default interpolation mode. It requires fewer actual sample points than linear interpolation to accurately represent the waveform.

Adding Screen Text

1. Select **Display > Screen Text** to access the Screen Text Setup control window.



2. Enter up to eight lines of text to provide notes for screen shots, printouts, or other users.
3. Click **Display** to turn the text display on and off.
4. Click **Properties** to open the Text Properties control window for positioning of the text on the display.
5. Click **Clear** to erase the entire text of the selected line.

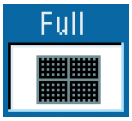


Quick Tips

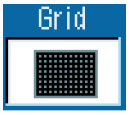
- You can click and drag screen text to reposition it on the screen.

Setting the Graticule Style

To set the graticule style, select **Display > Graticule Style**, and then select one of the following styles:

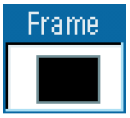


Use for quick estimate of waveform parameters.

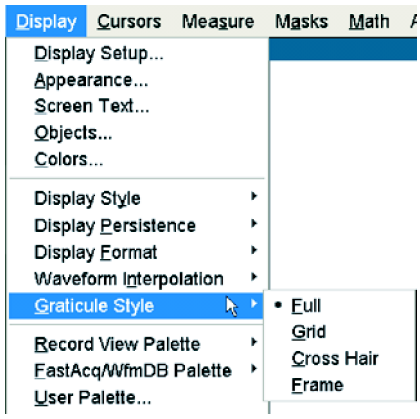


Use for full-screen measurements with cursors and automatic readouts when cross hairs are not needed.

Use for making quick estimates of waveforms while leaving more room for automatic readouts and other data.

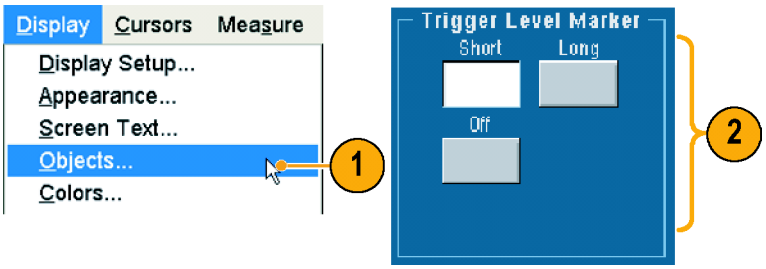


Use with automatic readouts and other screen text when display features are not needed.



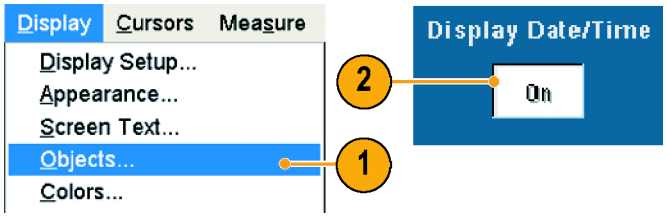
Setting the Trigger Level Marker

1. Select **Display > Objects...**.
2. Select one of the following:
   - **Short** displays a short arrow on the side of the graticule by the active waveform.
   - **Long** displays a horizontal line across the graticule.
   - **Off** turns off the trigger level marker.



Displaying the Date and Time

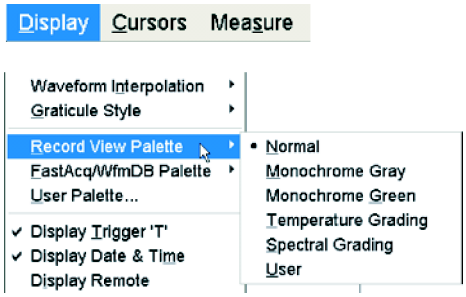
1. Select **Display > Objects...**.
2. Toggle the display of the date and time on the graticule. Use the Utilities menu to set the date and time.



Using the Color Palettes

Select **Display > Record View Palette** or **WfmDB Palette,** and then select one of the following color schemes for the waveform and graticule:

- Normal displays hues and lightness levels for best overall viewing. The color of each channel waveform matches the color of the corresponding front-panel vertical SCALE knob.
- Monochrome Gray displays areas of the waveform with the highest sample density in lighter gray shades. The areas of lowest sample density appear in darker gray shades.
- Monochrome Green displays areas of the waveform with the highest sample density in lighter green shades. The areas of lowest sample density appear in darker green shades. It most closely resembles analog oscilloscope displays.
- Temperature Grading displays areas of the waveform with the highest sample density in red shades. The areas of lowest sample density appear in blue shades.



- Spectral Grading displays areas of the waveform with the highest sample density in blue shades. The areas of lowest sample density appear in red shades.
- User displays the waveform in a customized color that you define by hue, lightness, and saturation.

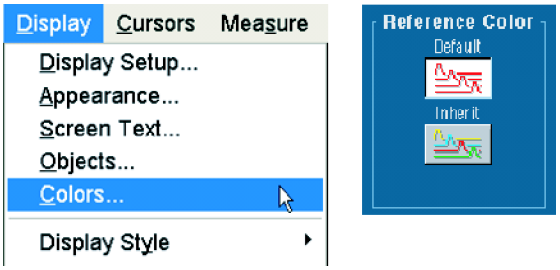
Quick Tips

- Choose one of the color grading palettes in the **Display>Colors** control window to see different sample densities represented in different colors.
- There are two color palettes, one for Record View and one for WfmDB.

Setting the Reference Colors

Select **Display > Colors...** and then select one of the following:

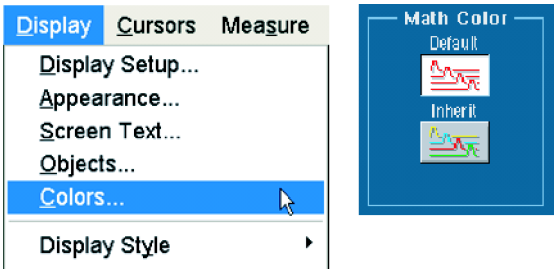
- Default uses the default system color for reference waveforms.
- Inherit uses the same color for the reference waveform as the original waveform.



Setting Math Colors

Select **Display > Colors...** and then select one of the following:

- Default uses the default system color for math waveforms.
- Inherit uses the same color for the math waveform as the waveform the math function is based on.



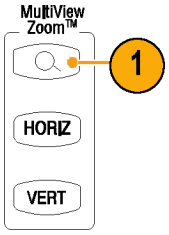
Quick Tips

- The default color for math and reference waveforms are different for each waveform.

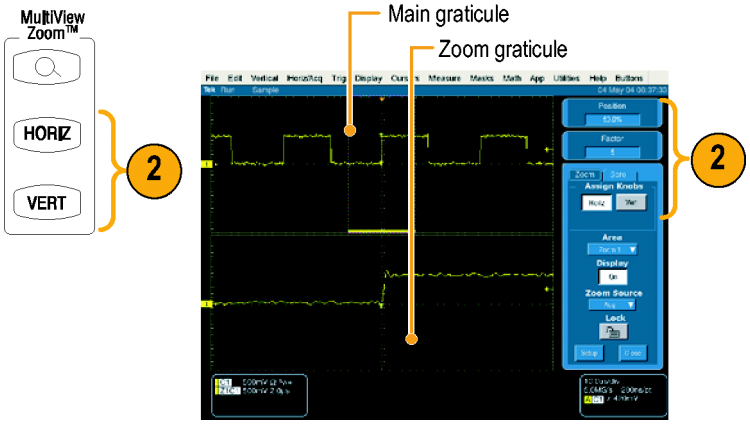
Using MultiView Zoom

Use the MultiView Zoom function to magnify a waveform vertically, horizontally, or in both dimensions. Zoomed waveforms can also be aligned, locked, and automatically scrolled. Scale and Position affect only the display, not the actual waveform data.

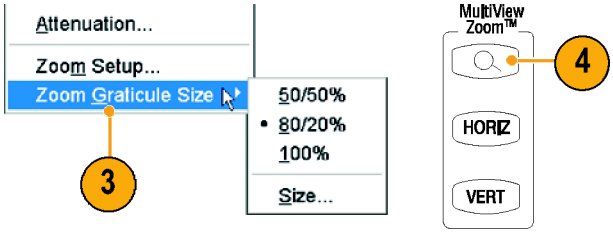
1. Push **MultiView Zoom** to split the screen and add a zoom graticule.



2. Push **HORIZ** or **VERT** to select which axis to magnify in the zoom graticule. Use the multipurpose knobs to adjust scale and position of the magnified waveform.



3. To adjust the zoom graticule size select Zoom Graticule Size from either the Vertical or Horiz/Acq menus.
4. To turn zoom off, push the front-panel button.



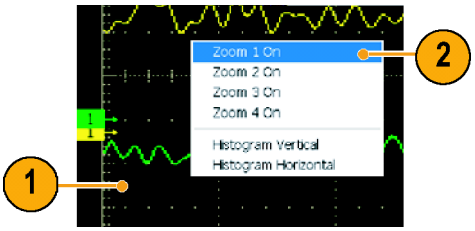
Quick Tips

- You can also use the Zoom Setup menu to change the graticule size of the zoomed waveform.

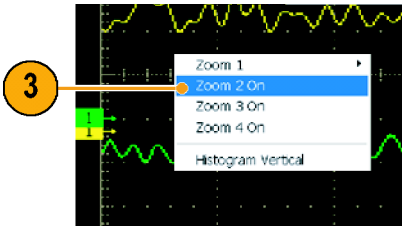
Zooming in Multiple Areas

When you want to view and compare multiple areas of one record at the same time use the following procedure.

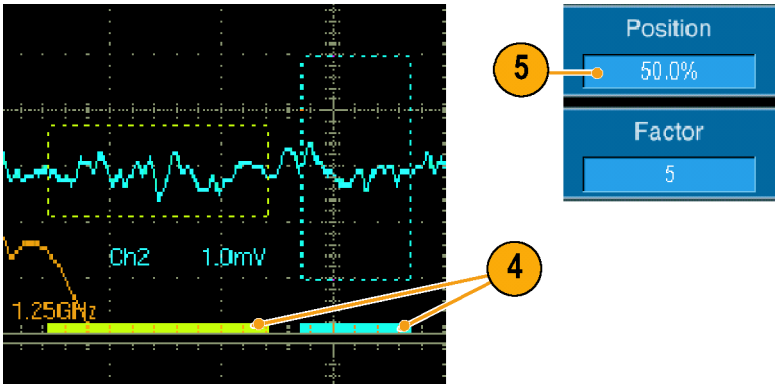
1. Click and drag a box around the area of the waveform that you want to zoom.
2. Select **Zoom 1 On**.



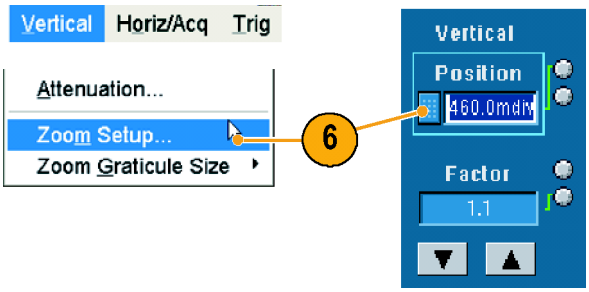
3. Click and drag a box around another area of the waveform that you want to zoom, and then select **Zoom 2 On**.



4. To adjust the zoomed area horizontally, click the horizontal marker below the Zoom box to select the zoomed area.
5. Use the multipurpose knobs to adjust the horizontal position and factor of the selected zoom area.



6. To adjust the zoomed area vertically, select **Vertical > Zoom Setup...** and then use the multipurpose knobs to adjust the Vertical Position and Factor.



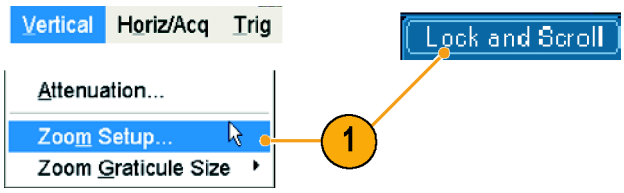
Quick Tips

- To clear the zoom area, click **Position Factor Reset** from the Zoom Setup control window.
- You can turn each zoom display on and off from the Zoom Setup control window.

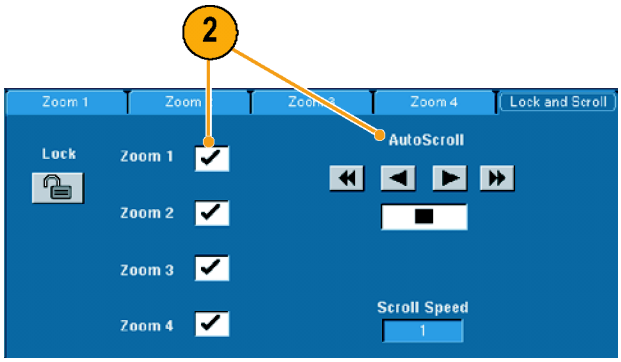
- Push the **MultiView Zoom** button to toggle all zoom displays on and off.
- To reposition the zoomed area horizontally, click and drag the horizontal marker at the bottom of the zoom box.

Lock and Scroll Zoomed Waveforms

1. To use Lock and Scroll select **Zoom Setup...** from either the Vertical or Horiz/Acq menu, and then select the **Lock and Scroll** tab.

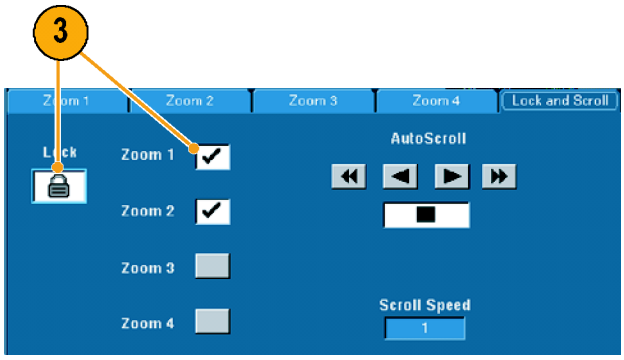


2. To scroll a single zoomed area, click a **Zoom 1-4** button, and then click an Auto Scroll button.



3. To scroll multiple zoomed areas simultaneously, click **Lock,** and then click the **Zoom1-4** buttons that you want to scroll through.

   Locking the zoomed areas locks in their relative horizontal position. Changing the horizontal position of one locked and zoomed area changes them all.



Quick Tips

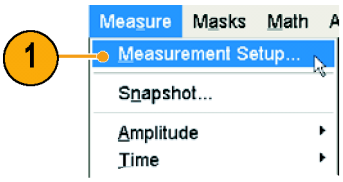
- When multiple zoom areas are selected but not locked, the zoom area with the highest number will autoscroll, while the other zoom areas remain stationary.

Analyzing Waveforms

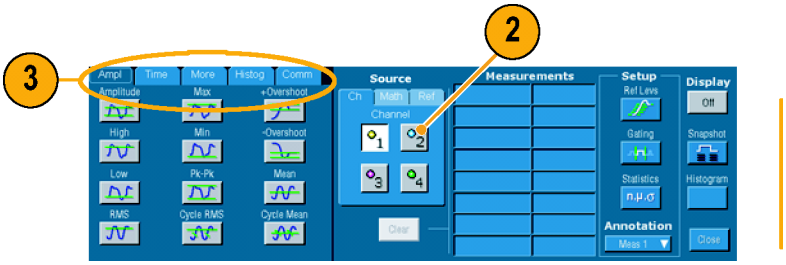
Your instrument features cursors, automatic measurements, statistics, histograms, math, spectral analysis, and advanced pass/fail tests to assist you in analyzing waveforms. This section contains concepts and procedures for analyzing waveforms. Detailed information is available in the online help.

Taking Automatic Measurements

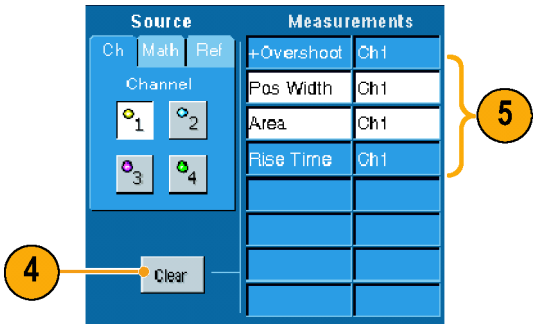
1. Select **Measure > Measurement Setup...** .



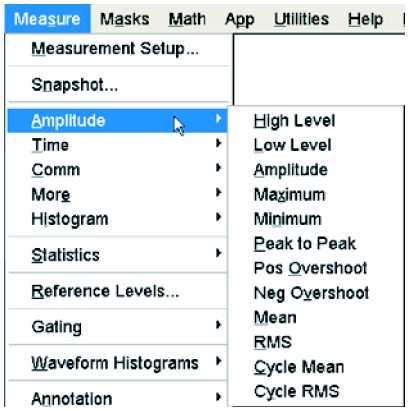
2. Select the channel, math or reference waveform that you want to measure.
3. Using the tabs, select up to 8 measurements in five different categories.



4. To remove the last measurement, click **Clear**.
5. To remove multiple measurements, click and drag to select the measurements, and then click **Clear**.



You can also choose a measurement for the selected waveform directly in the Measure menu. (See page 48, *Automated Measurement Selections*.)



Quick Tips

- In roll mode, measurements are not available until after you stop the acquisition.

Automated Measurement Selections

The following tables list each automated measurement by category: amplitude, time, more, histogram, or communication. (See page 46, *Taking Automatic Measurements*.)

Amplitude Measurements

Measurement	Description
Amplitude	The high value less the low value measured over the entire waveform or gated region.
High	This value is used as 100% whenever high reference, mid reference, or low reference values are needed, such as in fall time or rise time measurements. It can be calculated using either the min/max or histogram method. The min/max method uses the maximum value found. The histogram method uses the most common value found above the midpoint. This value is measured over the entire waveform or gated region.
Low	This value is used as 0% whenever high reference, mid reference, or low reference values are needed, such as in fall time or rise time measurements. It can be calculated using either the min/max or histogram method. The min/max method uses the minimum value found. The histogram method uses the most common value found below the midpoint. This value is measured over the entire waveform or gated region.
RMS	The true Root Mean Square voltage over the entire waveform or gated region.
Max	Typically the most positive peak voltage. Max is measured over the entire waveform or gated region.
Min	Typically the most negative peak voltage. Min is measured over the entire waveform or gated region.
Pk-Pk	The absolute difference between the maximum and minimum amplitude in the entire waveform or gated region.
Cycle RMS	The true Root Mean Square voltage over the first cycle in the waveform or the first cycle in the gated region.
+Overshoot	This is measured over the entire waveform or gated region and is expressed as: Positive Overshoot = (Maximum - High) ¸ Amplitude x 100%.
-Overshoot	This is measured over the entire waveform or gated region and is expressed as: Negative Overshoot = (Low - Minimum) ¸ Amplitude x 100%.
Mean	The arithmetic mean over the entire waveform or gated region.
Cycle Mean	The arithmetic mean over the first cycle in the waveform or the first cycle in the gated region.

Time Measurements

Measurement	Description
Rise Time	The time required for the leading edge of the first pulse in the waveform or gated region to rise from the low reference value (default = 10%) to the high reference value (default = 90%) of the final value.
Fall Time	The time required for the falling edge of the first pulse in the waveform or gated region to fall from the high reference value (default = 90%) to the low reference value (default = 10%) of the final value.
Pos Width	The distance (time) between the mid reference (default 50%) amplitude points of a positive pulse. The measurement is made on the first pulse in the waveform or gated region.
Neg Width	The distance (time) between the mid reference (default 50%) amplitude points of a negative pulse. The measurement is made on the first pulse in the waveform or gated region.
+ Duty Cyc	The ratio of the positive pulse width to the signal period expressed as a percentage. The duty cycle is measured on the first cycle in the waveform or gated region.

Time Measurements (cont.)

Measurement	Description
- Duty Cyc	The ratio of the negative pulse width to the signal period expressed as a percentage. The duty cycle is measured on the first cycle in the waveform or gated region.
Period	The time required to complete the first cycle in a waveform or gated region. Period is the reciprocal of frequency and is measured in seconds.
Freq	The first cycle in a waveform or gated region. Frequency is the reciprocal of the period; it is measured in Hertz (Hz) where one Hz is one cycle per second.
Delay	The time between the mid reference (default 50%) amplitude point of two different waveforms.

More Measurements

Measurement	Description
Area	Area measurement is voltage over time measurement. The area over the entire waveform or gated region in volt-seconds. Area measured above ground is positive; area measured below ground is negative.
Cycle Area	A voltage over time measurement. The measurement is the area over the first cycle in the waveform or the first cycle in the gated region expressed in volt-seconds. The area above the common reference point is positive while the area below the common reference point is negative.
Phase	The amount of time that one waveform leads or lags another waveform, expressed in degrees where 360° comprises one waveform cycle.
Burst Wid	The duration of a burst (a series of transient events) and is measured over the entire waveform or gated region.

Histogram Measurements

Measurement	Description
Wfm Ct	Displays the number of waveforms that have contributed to the histogram.
Hits in Box	Displays the number of points in or on the histogram box.
Peak Hits	Displays the number of points in the largest bin of the histogram.
Median	Displays the middle point of the histogram box. Half of all acquired points within or on the histogram box are less than this value and half are greater than this value.
Max	Displays the voltage of the highest nonzero bin in vertical histograms or the time of the rightmost nonzero bin in the horizontal histograms.
Min	Displays the voltage of the lowest nonzero bin in vertical histograms or the time of the leftmost nonzero bin in the horizontal histograms.
Pk-Pk	Displays the peak-to-peak value of the histogram. Vertical histograms display the voltage of the highest nonzero bin minus the voltage of the lowest nonzero bin. Horizontal histograms display the time of the rightmost nonzero bin minus the time of the leftmost nonzero bin.
Mean	Measures the average of all acquired points within or on the histogram box.
Std Dev	Measures the standard deviation (Root Mean Square (RMS) deviation) of all acquired points within or on the histogram box.
Mean ±1 Std Dev	Displays the percentage of points in the histogram that are within one standard deviation of the histogram mean.

Histogram Measurements (cont.)

Measurement	Description
Mean ±2 Std Dev	Displays the percentage of points in the histogram that are within two standard deviations of the histogram mean.
Mean ±3 Std Dev	Displays the percentage of points in the histogram that are within three standard deviations of the histogram mean.

Communication Measurements

Measurement	Description
Ext Ratio	The ratio of eye top to base. This measurement only works for waveform database or a reference waveform saved in waveform database mode.
Ext Ratio %	The ratio of eye base to top expressed as a percentage. This measurement only works for waveform database or a reference waveform saved in waveform database mode.
Ext Ratio (dB)	The ratio of eye top to base expressed in decibels. This measurement only works for waveform database or a reference waveform saved in waveform database mode.
Eye Height	The measurement of the eye height in volts.
Eye Width	The measurement of eye width in seconds.
Eye Top	The top value used in the extinction ratio measurements.
Eye Base	The base value used in the extinction ratio measurements.
Crossing %	The eye crossing point expressed as a percentage of eye height.
Jitter P-P	The peak-to-peak value for the edge jitter in the current horizontal units.
Jitter RMS	The RMS value of the edge jitter in the current horizontal units.
Jitter 6 Sigma	Six times the RMS value of the edge jitter in the current horizontal units.
Noise P-P	The peak-to-peak value of the noise of the top or base of the signal as specified by you. To ensure accurate noise values, be sure to set the signal type to Eye when measuring an Eye signal.
Noise RMS	The RMS value of the noise of the top or base of the signal as specified by you. To ensure accurate noise values, be sure to set the signal type to Eye when measuring an Eye signal.
S/N Ratio	The ratio of the signal amplitude to the noise of the top or base of the signal as specified by you.
Cyc Distortion	The peak-to-peak time variation of the first eye crossing measured at the Mid Ref as a percent of the eye period.
Q-Factor	The ratio of eye size to noise.

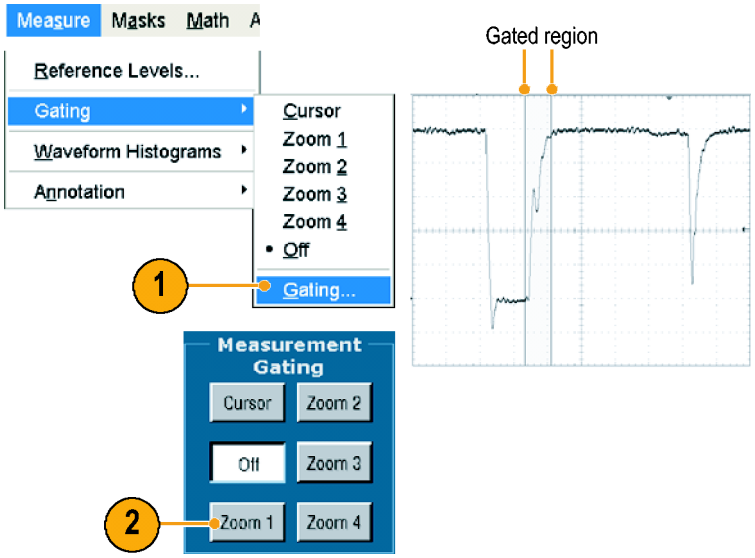
Customizing an Automatic Measurement

You can customize automatic measurements by using gating, modifying measurement statistics, adjusting the measurement reference levels, or taking a snapshot.

Gating

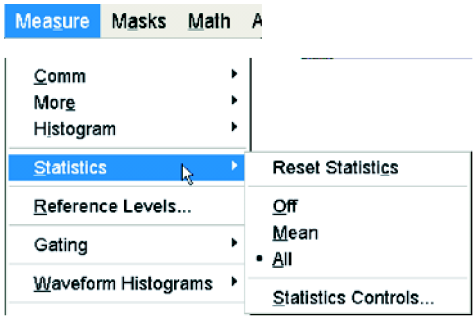
Use Gating to confine the measurement to a certain portion of a waveform.

1. Select **Measure > Gating >Gating ...**.
2. Position the gates by doing one of the following:
   - Click **Cursor** to set the gated area to the area between the cursors.
   - Click **Zoom (1-4)** to set the gated area to the Zoom (1-4) graticule.



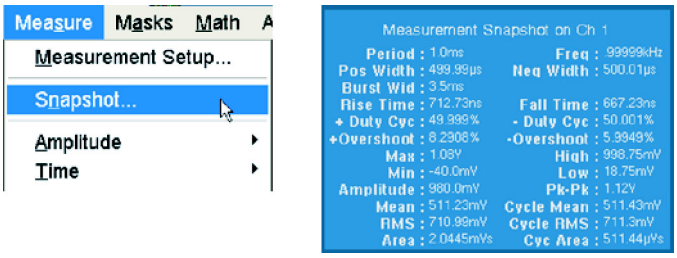
Statistics

Statistics turn on automatically with measurements. Statistics characterize the stability of the measurement. To change the statistics that are displayed, select **Measure > Statistics**, and then select **Mean** or **All**. (All includes min, max, mean, standard deviation, and population.) To remove statistics select **Off.**



Snapshot

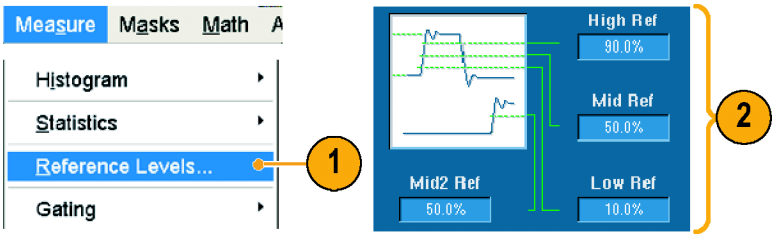
To see a one-time view of all valid measurements, select **Measure > Snapshot**.



Reference Levels

Reference levels determine how time-related measurements are taken.

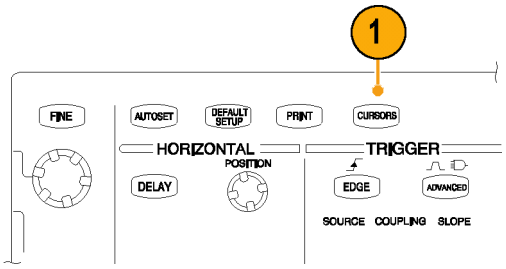
1. Select **Measure > Reference Levels...** .
2. Adjust the measurement reference levels to different relative or absolute values.
   - High and Low reference are used to calculate rise and fall times. The default High reference is 90% and Low reference is 10%.
   - Mid reference is primarily used for measurements between edges such as pulse widths. The default level is 50%.
   - Mid2 reference is used on the second waveform specified in delay or phase measurements. The default level is 50%.



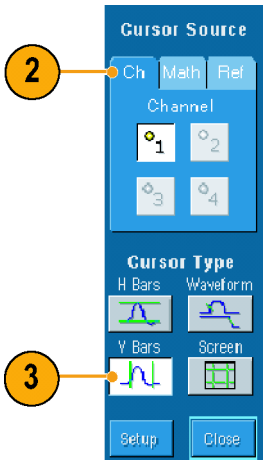
Taking Cursor Measurements

Cursors are an easy tool to use for taking measurements on acquired data.

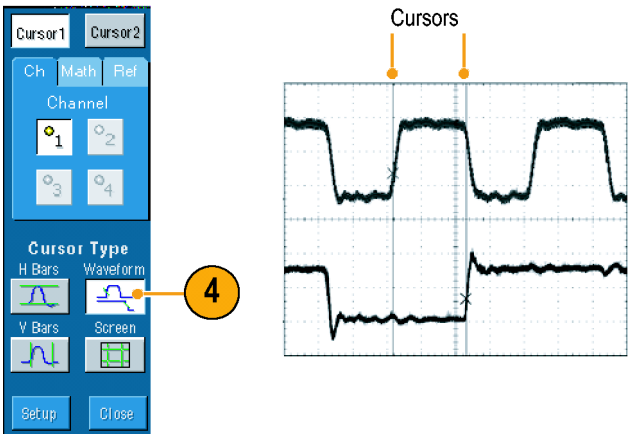
1. Push **CURSORS**.



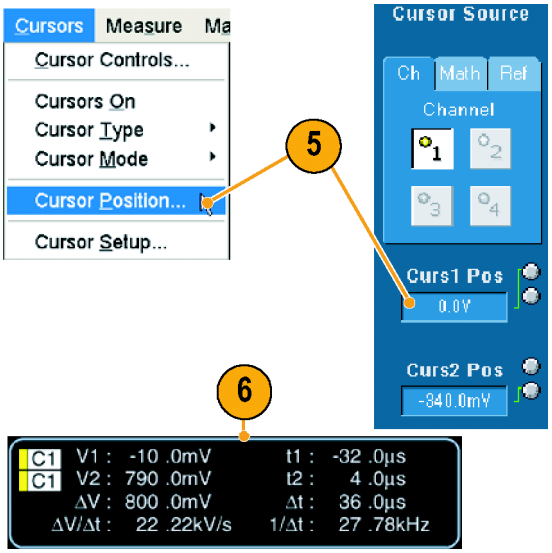
2. Select the Cursor Source.
3. Select a cursor type from one of the following:
   - H Bars measure amplitude (typically in volts or amperes)
   - V Bars measure horizontal parameters (typically time)
   - Waveform and screen cursors measure vertical and horizontal parameters simultaneously. Waveform cursors are attached to the waveform and screen cursors float, unattached to the waveform.



4. If you want to take measurements between two waveforms, select **Waveform**, and then select the waveform source for each cursor.



5. Select **Cursors > Cursor Position...**, and then use the multipurpose knobs to adjust the cursor position.
6. Read cursor measurement results in the display.



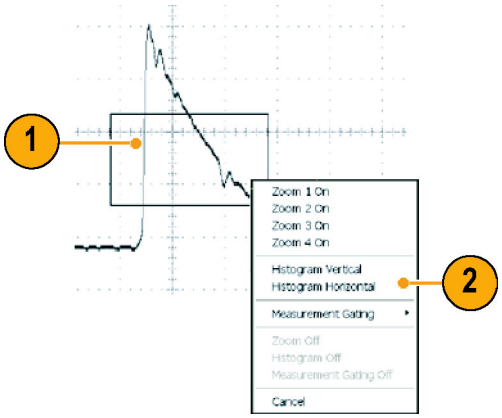
Quick Tips

- Use the Cursor Track Mode to set the cursors to move in tandem. Use the Cursor Independent mode to move the cursors separately.
- If you use the zoom graticule, you can place a cursor directly on a specific waveform point to take precision measurements.
- You can also move cursors by clicking and dragging them to a new position.
- Vertical cursors measure the time from the trigger point to the vertical cursor.

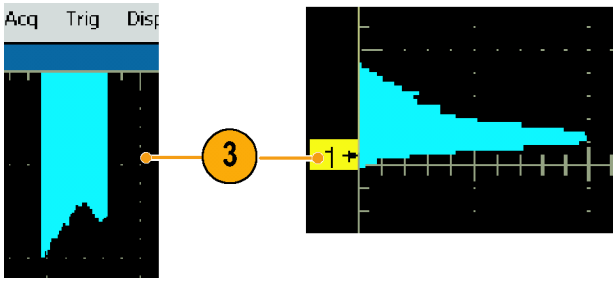
Setting Up a Histogram

You can display either a vertical (voltage) or horizontal (time) histogram. Use histogram measurements to get statistical measurement data for a section of a waveform along one axis. Histograms are not available in FastFrame mode.

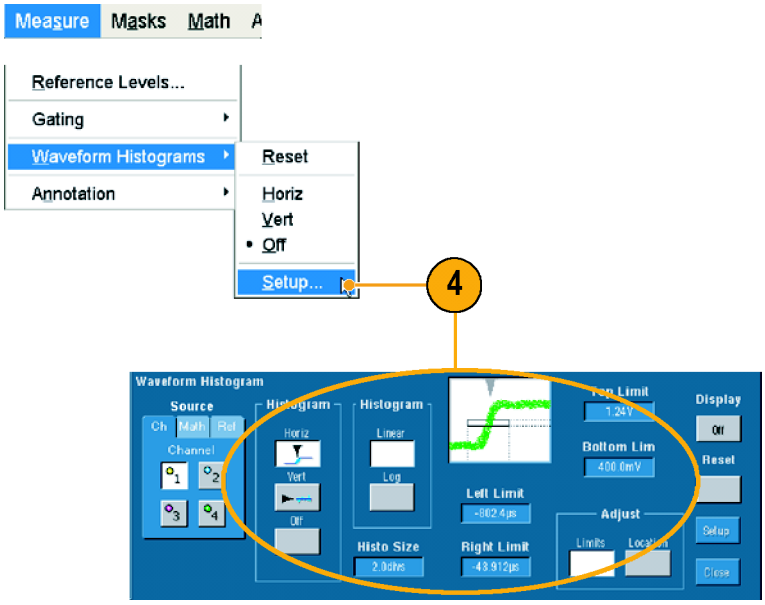
1. Click and drag across the segment of the waveform that you want the histogram to cover. For a horizontal histogram, for example, it is best to make the box wider than it is tall.
2. Select **Histogram Vertical** or **Histogram Horizontal** from the shortcut menu.



3. View the histogram at the top (for horizontal histograms) or the left edge (for vertical histograms) of the graticule.



4. To make adjustments to the histogram scale or the size and location of the histogram box, select **Measure > Waveform Histograms... > Setup...**, and then use the Histogram Setup control window.
5. You can also take automated measurements on histogram data.(See page 46, *Taking Automatic Measurements*.)



Quick Tips

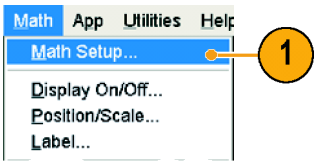
- Use vertical histograms to measure signal noise and horizontal histograms to measure signal jitter.
- Use the click and drag procedure to activate the shortcut menu to turn the histogram display off.

Using Math Waveforms

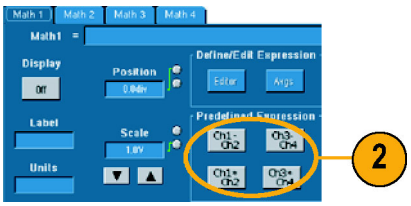
Create math waveforms to support the analysis of your channel and reference waveforms. By combining and transforming source waveforms and other data into math waveforms, you can derive the data view that your application requires.

Use the following procedure for predefined math equations.

1. Select **Math > Math Setup...**.

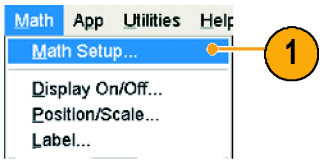


2. Choose one of the predefined math equations.

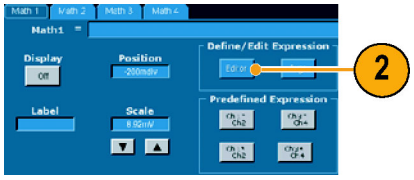


Use the following procedure to build an advanced math waveform expression.

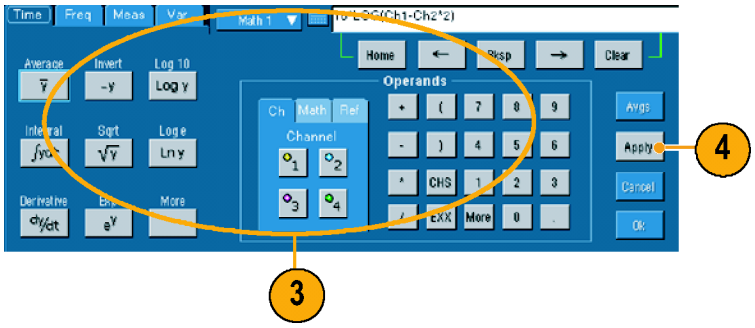
1. Select **Math > Math Setup...**.



2. Click **Editor**.



3. Build your advanced math waveform expression using sources, operators, constants, measurements, variables, and functions.
4. When you have defined the expression to your satisfaction, click **Apply**.



Quick Tips

- Math definitions are not implemented if the sources are not valid.
- Math waveforms can be created from channel, reference, math source waveforms and from measurements.
- Measurements can be taken on math waveforms in the same way as on channel waveforms.
- Math waveforms derive their horizontal scale and position from the sources in their math expressions. Adjusting these controls for the source waveforms also adjusts the math waveform.
- You can magnify math waveforms using MultiView Zoom; use the mouse for positioning the zoomed area.

Spectral Analysis Concepts

Signals may be represented by their characteristics in both the time and the frequency domains. Spectral analysis merges the time domain controls with the frequency domain controls to provide a complete spectral analyzer. Consider the following when using spectral analysis:

- Frequency Domain controls use traditional spectrum analyzer controls to set the center frequency, span, and resolution bandwidth directly.
- Time Domain controls for the acquired waveform set the time duration and the resolution time between samples. You can easily set the required sample rate and record length.
- Gating Controls are the bridge that connects 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.
- Eight different window functions are available to shape the filter response.
- Display log data in dB, dBm, or linear mode. You can display the real or only the imaginary parts of the spectral magnitude. Reference level offset and reference level controls give complete control over the vertical position and offset of the spectrum.
- Display phase data as a function of frequency in radians, degrees, or group delay. You may zero the phase value for magnitudes below a user-defined threshold level to prevent the display from becoming unusable due to random noise.
- You can turn on averaging in the frequency domain for phase and magnitude waveforms.
- Up to four spectral analyzers may be used simultaneously. They may all be assigned to different gates on the same source waveform or to different channel sources. The controls of Math1 and Math2 may be locked, and the controls of Math3 and Math4 may be locked. When controls are locked, turning a control on one analyzer changes the control on the other analyzer to the same value. Other combinations of locking, including all four analyzers, are available using GPIB commands.

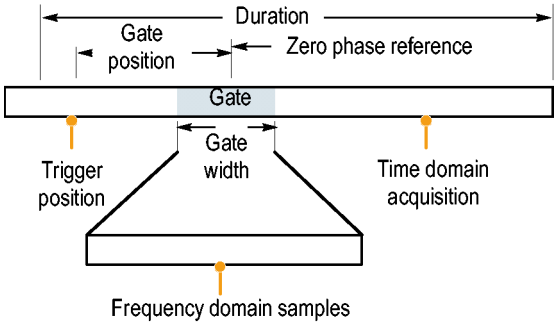
Using the Time Controls

The time domain controls for the spectral waveform are:

- Duration, which selects the time from the beginning to the end of the acquired waveform. Set duration using the record length and/or the sample rate controls.
- Resolution, which determines the time between samples. Duration is kept constant as resolution is changed. Therefore, the Resolution control affects both the sample rate and the record length simultaneously.

Using the Gating Controls

Gating determines which portion of the acquired waveform is transformed into the frequency domain. The gate has a position and a width control. The gate position is the time in seconds from the trigger location to the center 50% position of the gate interval. The position and width units are seconds.



Using the Frequency Controls

The frequency domain controls for the spectral waveform are:

- Span, which is the frequency at the end of the spectral waveform minus the frequency at the beginning of the waveform.
- Center, which is the frequency at the center of the spectral waveform. Center is equal to the start frequency plus one half of the span.
- Resolution bandwidth, which is the 3 dB down bandwidth of the spectral analyzer frequency response to a sine wave input.

Using the Magnitude Controls

Vertical units can be either linear or log. When the spectrum is linear magnitude, the vertical units are the same as the source waveform. When the vertical scale of the magnitude spectrum is set to dB, use the Reference Level Offset to set which vertical position in the magnitude spectrum is zero dB. Setting the vertical scale to dBm sets the Reference Level Offset to a value that is equivalent to 1 mW of power into 50 Ω.

The value of the Reference Level is the magnitude at the top of the display screen. Reference Level does not change the spectral data but Reference Level Offset does. Adjusting the Reference Level Offset causes the spectral waveform to move vertically with respect to the waveform reference marker. This moves the waveform without changing the Reference Level control setting.

Using the Phase Controls

You can set the vertical units to Degrees, Radians, or Group Delay in seconds. Phase is a relative measurement that must have a time domain reference point. The phase value is specified with respect to this phase reference position.

The spectral analyzer produces phase values from -p to p radians or -180 to 180 degrees. However, when you perform impulse response testing and the phase is continuous, then phase values outside these ranges may occur. The spectral analyzer then wraps the data with discontinuities in the display from +180 to -180 degrees. Phase unwrap will display the correct result by unwrapping the phase. Phase unwrap is only valid when the phase spectrum is a continuous function of frequency. Therefore, do not use it when analyzing the harmonic content of the typical repetitive signal.

Random noise in the spectrum may have phase values over the entire range. This could make the phase display unusable. However, you can set the suppression threshold control to a level in dB. The phase of any complex spectral points with a magnitude below this threshold is set to zero.

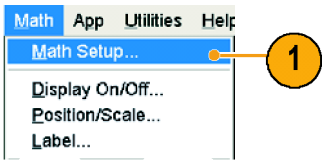
When the phase spectrum is a continuous function of frequency, group delay may be computed. This is true of impulse response testing where an impulse is fed into the system, and the spectrum of the response of the system output is computed.

Group delay measures how well a system passes a signal in terms of phase distortion. Group delay is the derivative of the phase with respect to frequency. This feature is not useful for analysis of harmonic content of signals where the phase response is not continuous.

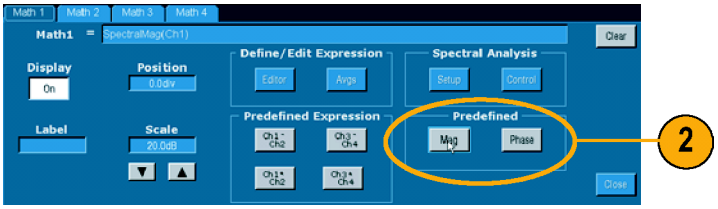
Using Spectral Analysis

Use the following procedure for predefined spectral math expressions.

1. Select **Math > Math Setup...**.

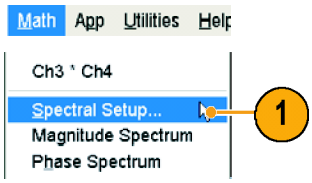


2. Choose one of the predefined spectral math expressions.

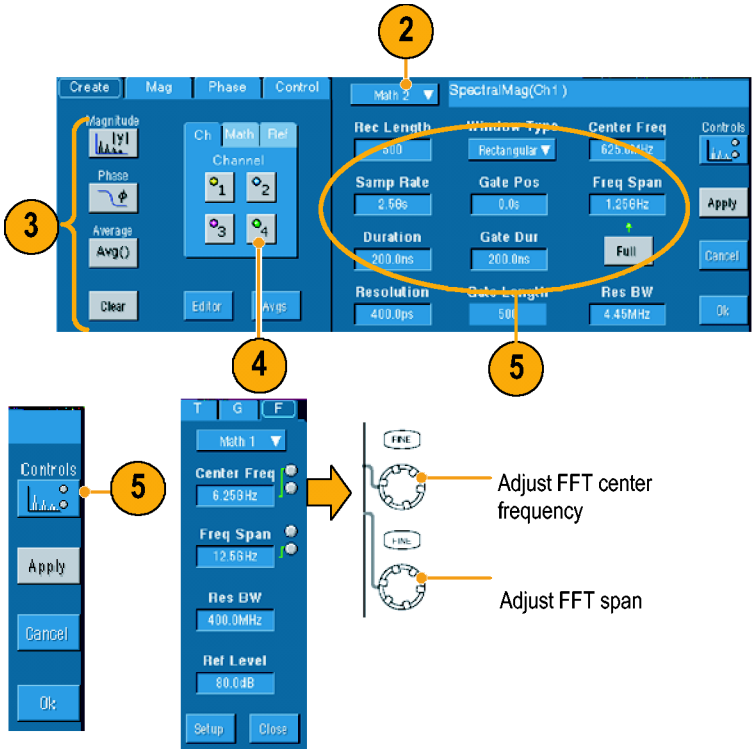


Use the following procedure to build an advanced spectral math expression.

1. Select **Math > Spectral Setup...** .

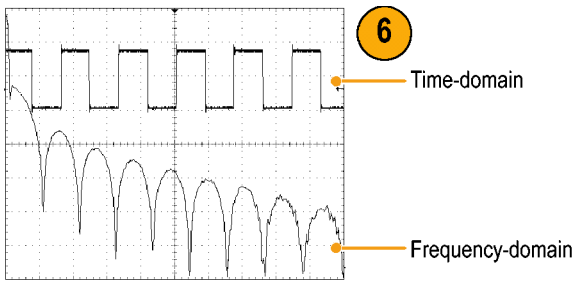


2. Select the math waveform that you want to define.
3. Click the type of spectral waveform that you want to create. To redefine a waveform, click Clear.
4. Select the source waveform.
5. To adjust the spectral waveform do one of the following:
   - Use the controls in the Spectral Setup control window.
   - Click **Controls**, and then use the multipurpose knobs to adjust the spectral waveform.



6. You can view time-domain and frequency-domain waveforms simultaneously.

   Use **Gating** to select only a portion of the time-domain waveform for spectral analysis. (See page 51, *Gating*.)



Quick Tips

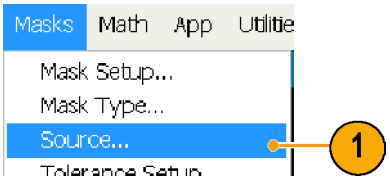
- Sources for spectral math waveforms must be channel or other math waveforms.
- Use short record lengths for faster instrument response.
- Use long record lengths to lower the noise relative to the signal and increase the frequency resolution.

- Different window functions produce different filter response shapes in the spectrum and result in different resolution bandwidths.
- The resolution bandwidth directly controls the gate width. Therefore, the time domain gate markers move as you adjust the RBW control.
- You can 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 transform it back into a time domain trace.

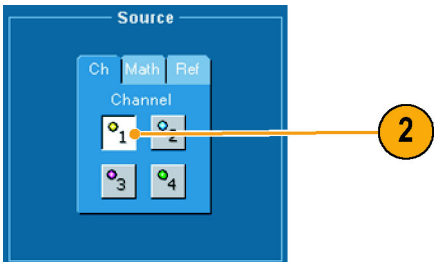
Using Mask Testing

Serial Mask Testing (Option SM) allows you to compare your signal to a predefined template or mask. For the signal to pass the test, it must fall outside the segments defined by the mask. Generally, standards committees such as ANSI define the masks. To perform mask testing do the following:

1. Select **Masks > Source...**.

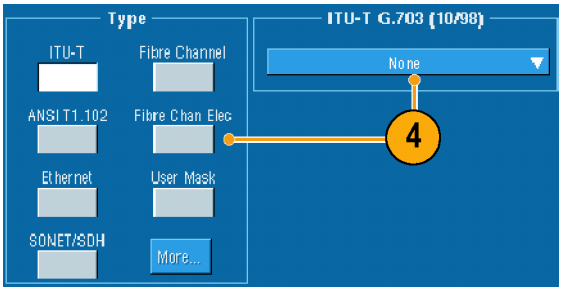


2. Select the signal source.

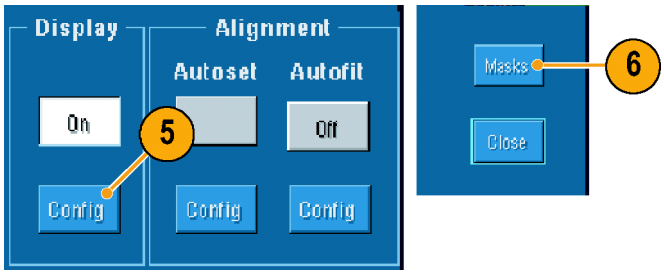


3. Click the **Masks** tab.

4. Select the Type and Standard.



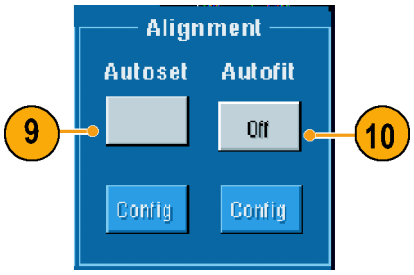
5. Click **Config** to access the Mask Configuration control window, where you can adjust how masks and violations are displayed and how Mask Autoset and Autofit are configured.
6. Click **Masks** to return to the Mask Setup control window.



You can access these controls from the Display Config button or from the Mask Setup control window.

7. Click Lock Mask to Wfm **On** so that the mask tracks changes in the horizontal or vertical settings.
8. Click Hit Count **On** to highlight violations during a mask test.

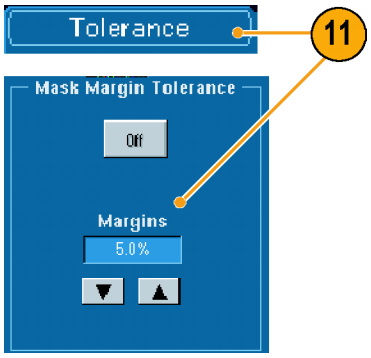
9. Click **Autoset** to automatically align the waveform with the mask based on the characteristics of the input signal.
10. Click **Autofit On** to automatically reposition the waveform after each acquisition to minimize hits.



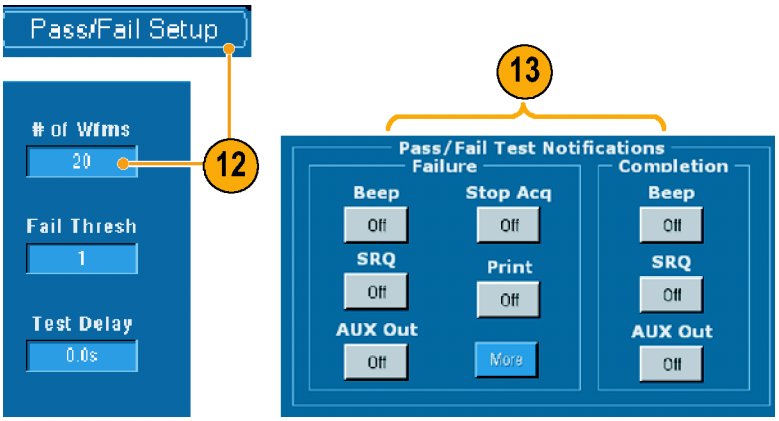
11. Click the **Tolerance** tab, and then set the tolerance.

    Tolerance settings greater than 0% make the mask test harder to pass, settings less than 0% make the test easier to pass.

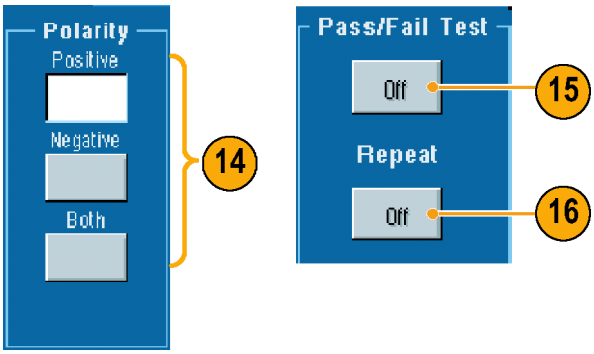
    Use 0% if you want the mask as specified in the standard. Changing the percentage allows you to do margin testing.



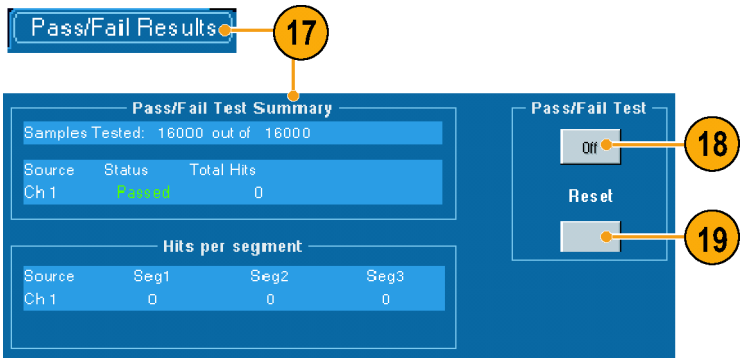
12. Select the **Pass/Fail Setup** tab, and then set up the pass/fail parameters. (When acquisition mode is Waveform Database, the # of Wfms label becomes Samples.)
13. Select your Pass/Fail Test Notifications.



14. Select the polarity you want to test.
15. Click Pass/Fail Test **On** to start the mask test.
16. Click Repeat **On** to run the mask test continuously.



17. Click the **Pass/Fail Results** tab to view the test results.
18. Click Pass/Fail Test **On** to start the mask test.
19. Click **Reset** to reset the totals and clear any violations.

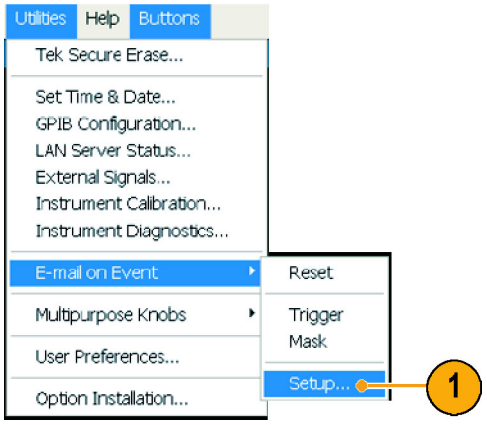


Quick Tips

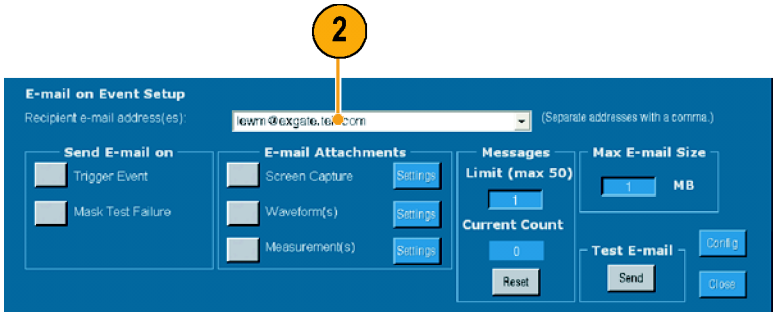
- If the signal is not within the mask, enable Autoset to center the waveform in the mask.

Setting Up E-mail on Event

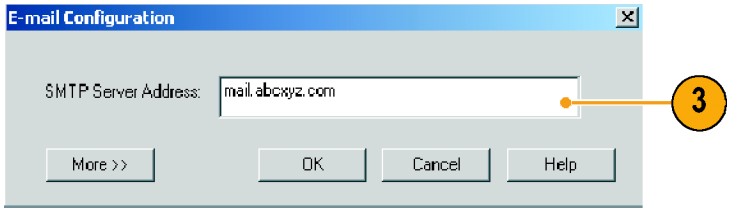
1. Select **Utilities > E-mail on Event > Setup...**.



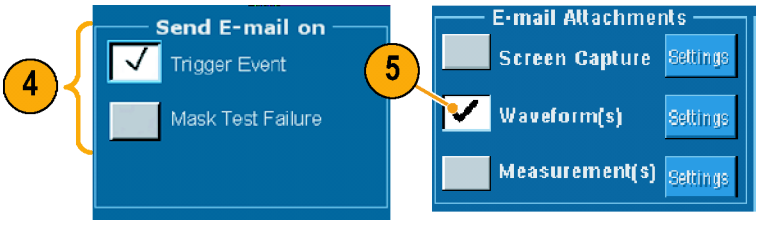
2. Enter recipients' e-mail address(es). Separate multiple entries with a comma. There is a limit of 252 characters in the e-mail address box.



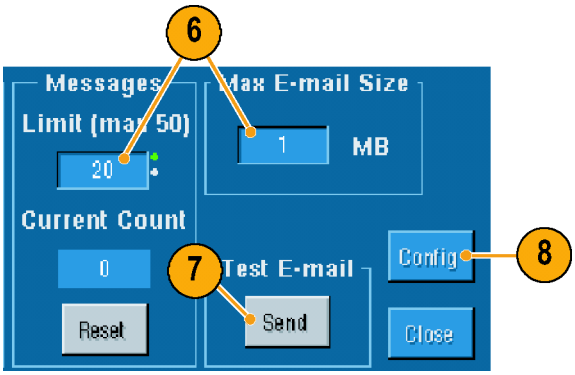
3. Click **Config**, and then enter the SMTP Server Address. Contact your network administrator for the correct address.



4. Select the event(s) for which you want to send an e-mail.
5. To include attachments, select the type of attachment, and then click **Settings** to specify the format.



6. Set the maximum message limit and e-mail size. (Maximum message limit is 50 and maximum e-mail size is 2000 MB). When the maximum message limit is reached, you must click **Reset** to send more e-mails on event.
7. To ensure that you have set up the e-mail addresses correctly, send a test-mail by clicking **Send**. If the recipient does not receive the test e-mail, you may need to adjust the configuration.
8. Click **Config** to access the e-mail configuration dialog box and adjust the configuration.



Quick Tips

- To save attachments to your instrument hard drive, set the maximum message size to zero. The attachments will be saved to the default location C:\TekScope\Images, Waveforms, or Data depending on the type of attachment.

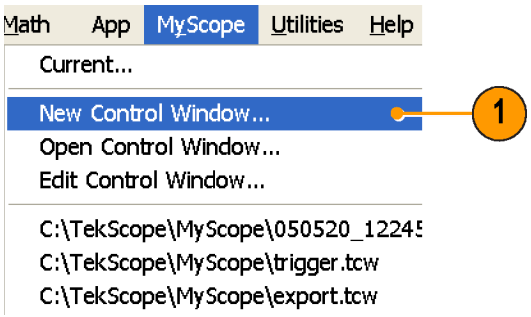
MyScope

MyScope allows you to create custom control windows that include only the controls that you to use regularly. Instead of switching between several control windows, put the controls you use into a custom control window.

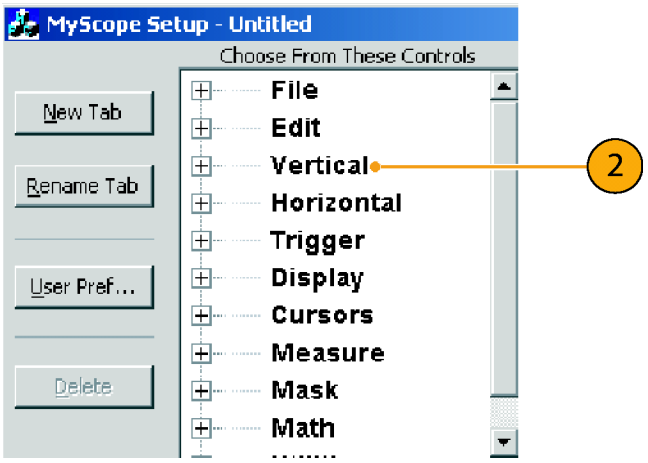
This section contains procedures for creating and using MyScope control windows. Detailed information is available in the online help.

Creating a New MyScope Control Window

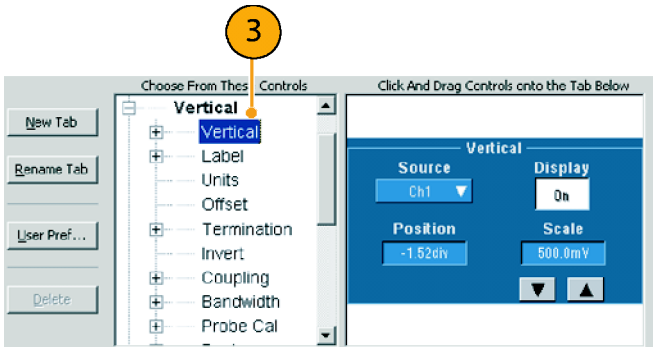
1. Select **MyScope > New Control Window...** .



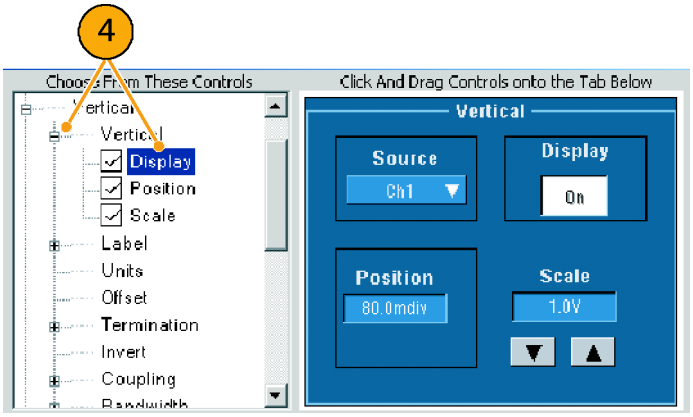
2. Click **+** to expand a category. Controls that can be added to your MyScope control window are contained within each category. The categories match the menu bar to aid you in finding the controls you normally use.



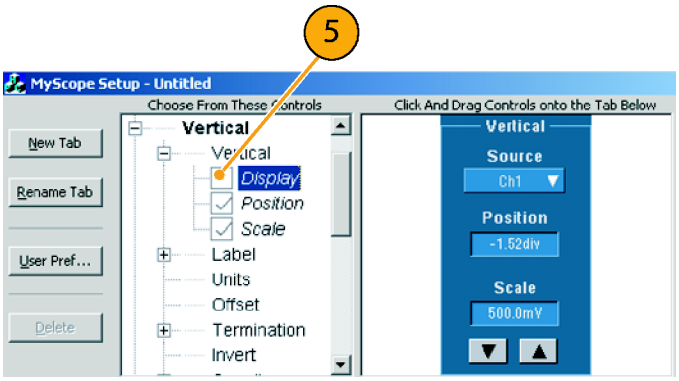
3. Click a control to preview it.



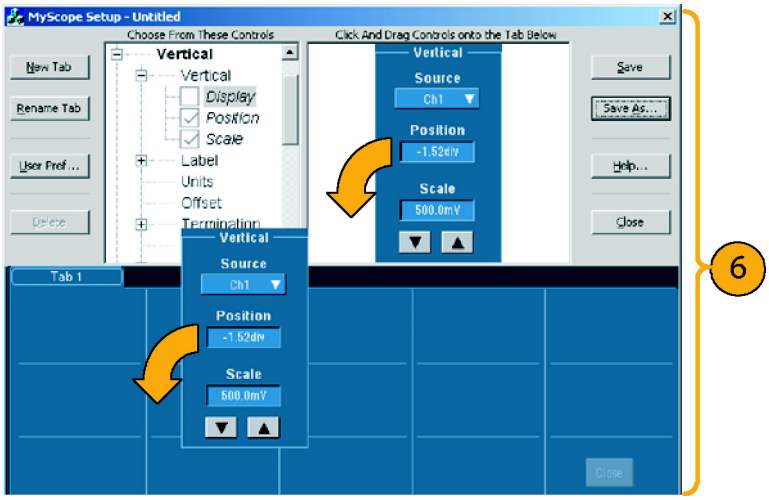
4. Double-click the control or click the **+** to expand the control list. (If there is no +, then the control cannot be customized further.)



5. Clear the check boxes to remove any components you do not want included in the control.



6. Click and drag the control to your MyScope control window. The control will snap to the nearest grid location when you release the mouse. You can change the placement of the control in your MyScope control window by clicking and dragging.



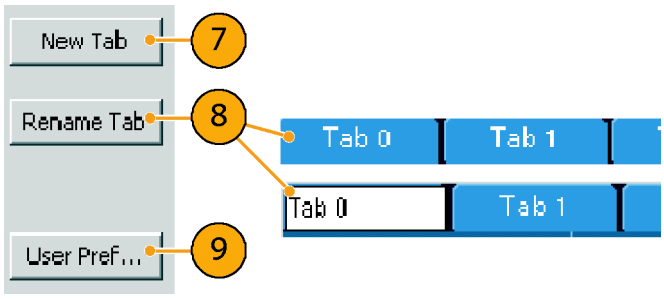
7. Click **New Tab** to add a tab to your MyScope control window. You can have up to eight tabs.

8. To rename a tab do one of the following:

- Click **Rename Tab**
- Double-click the tab

Then type the new name.

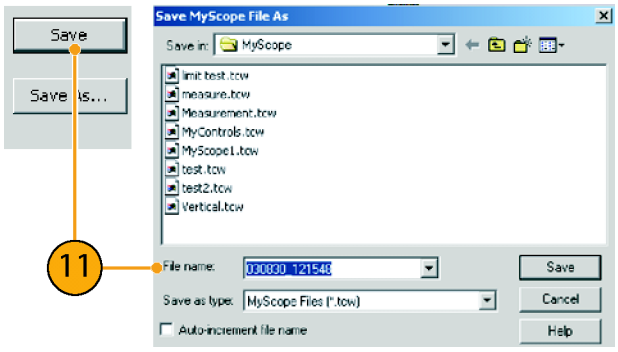
9. Click **User Pref...** to specify user preferences that are loaded with your MyScope control window.



10. To delete controls do one of the following:

- Select a tab, and then click **Delete**. The tab and all of the controls are deleted.
- Select a control, and then click **Delete.** Just the selected control is deleted.

11. Click **Save** , and then enter a name for your MyScope control window, or use the default name.



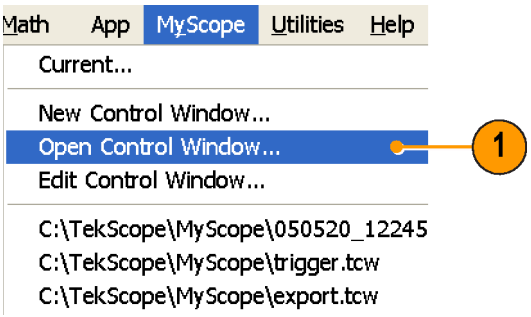
Quick Tips

- To reconfigure a control, click and drag it back to the preview window. Then select or clear the check boxes to include or remove components in the control.
- To change the tab order, click and drag a tab to a new location.
- To delete a control, click and drag it to the upper half of the screen (off of your MyScope control window).

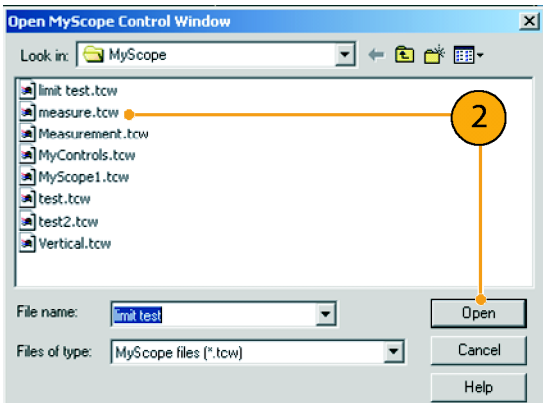
Using MyScope Control Windows

To open a previously defined MyScope control window do the following:

1. Select **MyScope > Open Control Window...** or one of the five most recently used MyScope windows.

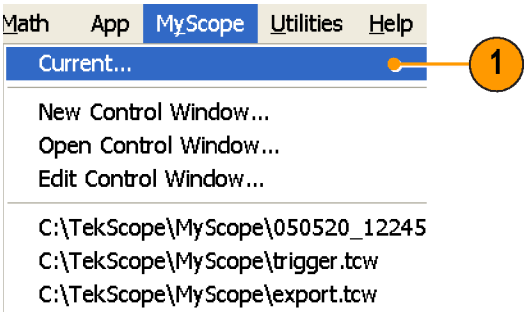


2. Select the MyScope control window you want to use, and then click **Open**.



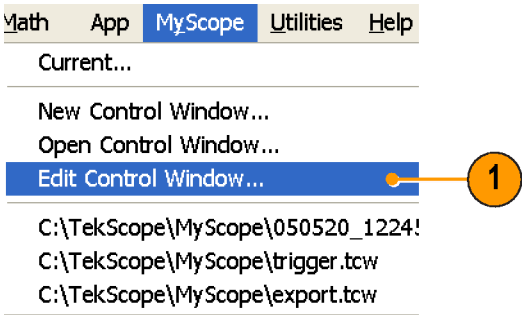
To display the active MyScope control window do the following:

1. Select **MyScope > Current...** or click **MyScope** in the toolbar mode. (Your MyScope control window remains active even when it is not displayed.)

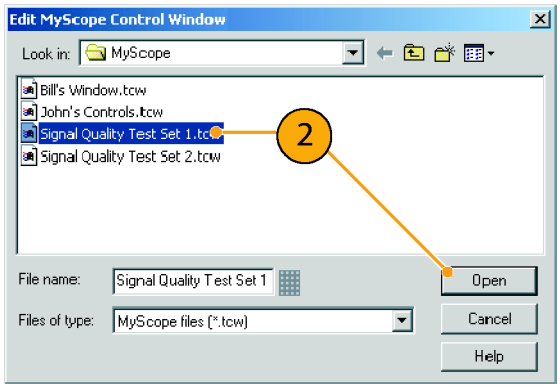


To edit a MyScope control window do the following:

1. Select **MyScope > Edit Control Window...** .



2. Select the control window you want to edit, and then click **Open**.



Quick Tips

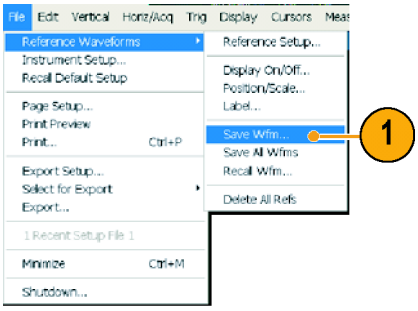
- Some controls function differently in a MyScope control window than they do in the standard control window. For details, see the online help.
- You can copy MyScope control windows (.tcw files) to other TDS/CSA7000B Series instruments.

Managing Data

This section contains procedures for saving and recalling waveforms and setups, and exporting images, waveforms, and measurements. Also procedures are included for using the clipboard and printing from your instrument. Detailed information is available in the online help.

Saving Waveforms

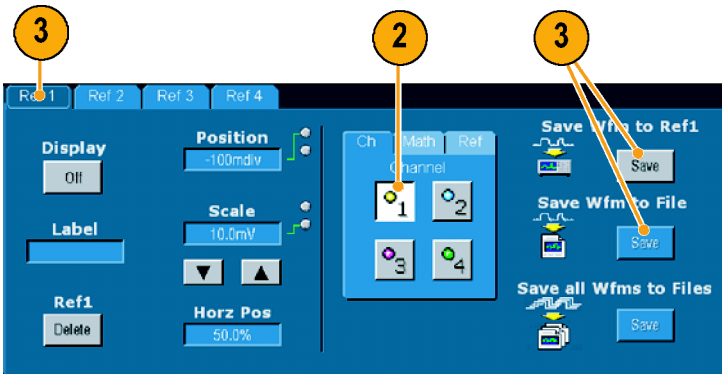
1. To save waveforms, select **File > Reference Waveforms > Save Wfm...**.



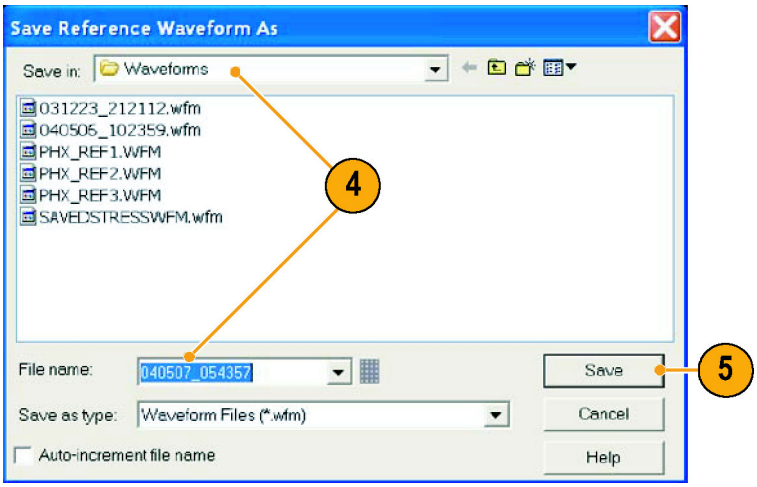
2. Select the source.
3. You can save the waveform as a reference waveform in the instrument memory or as a .wfm file in a Windows directory.

   To save the waveform as a reference, select a Ref 1 through Ref 4 tab, and click Save Wfm to Ref(n) **Save**.

   To save as a .wfm file, click Save Wfm to File **Save**, and select the location where you want to save the waveform.



4. If you are saving as a .wfm file, type in a file name or use the default.
5. Click **Save**.

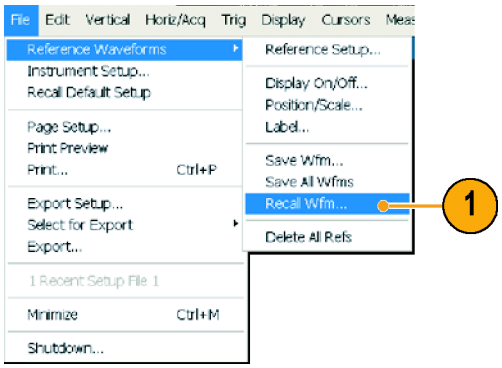


Quick Tips

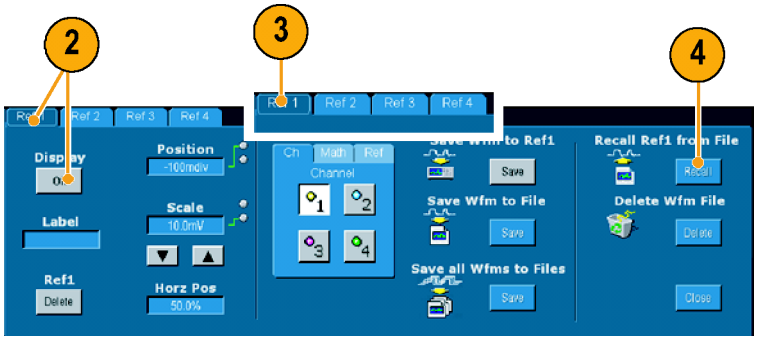
- Select **Auto-increment file name** to save numerous similar waveforms without retyping the entire name.

Recalling Waveforms

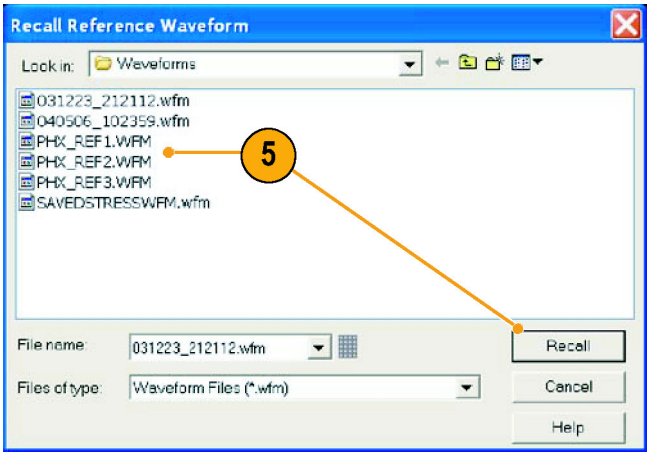
1. Select **File >Reference Waveforms > Recall Wfm...**.



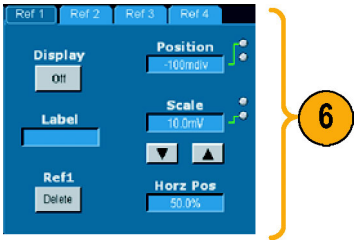
2. To recall a waveform from a reference location, select the reference location of the waveform (Ref 1 through Ref 4). If you want to see the waveform displayed, click Display **On**.
3. To recall a waveform saved in a file, first select a reference location in which to recall the waveform (Ref 1 through Ref 4).
4. Click **Recall**.



5. Browse to the waveform that you want to recall. Click **Recall** to place the selected waveform in reference memory and display the waveform.



6. Use the controls to turn the display on, reposition or label the Reference waveform, change the scale, save or recall.

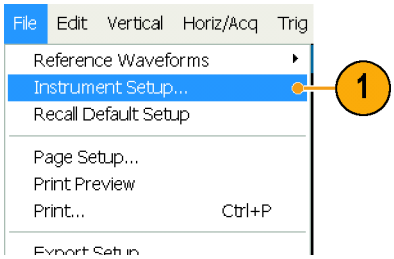


Quick Tips

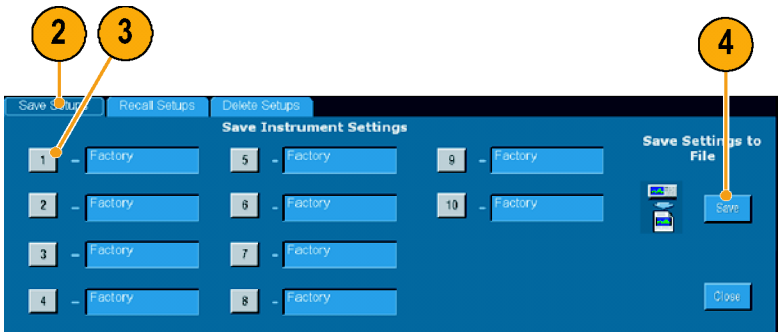
- You can save a number of different file types for external applications, but you can only recall setup (*.set) files and reference waveform (*.wfm) files directly.

Saving Instrument Setups

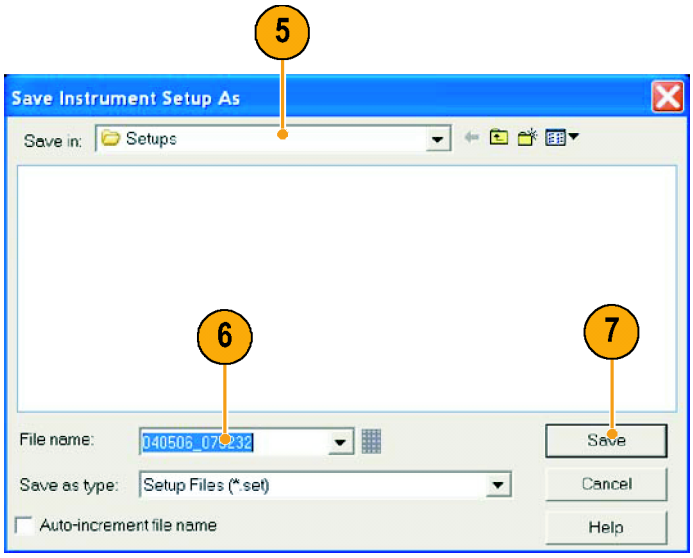
1. Select **File > Instrument Setup...**.



2. If not selected, click **Save Setups**.
3. To save the current setup to the instrument memory, select one of the ten setup storage locations. The default name for the saved setup is User, but you can rename the setup using a keyboard attached to the instrument or the pop-up keyboard.
4. To save a setup to a file in a Windows directory, click **Save**.



5. Select the location where you want to save the setup.
6. Type a file name or use the default name. Using a keyboard attached to the instrument or the pop-up keyboard to enter a filename different from the default name.
7. Click **Save**.

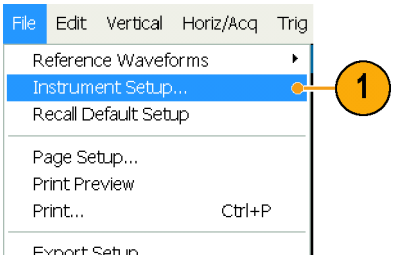


Quick Tips

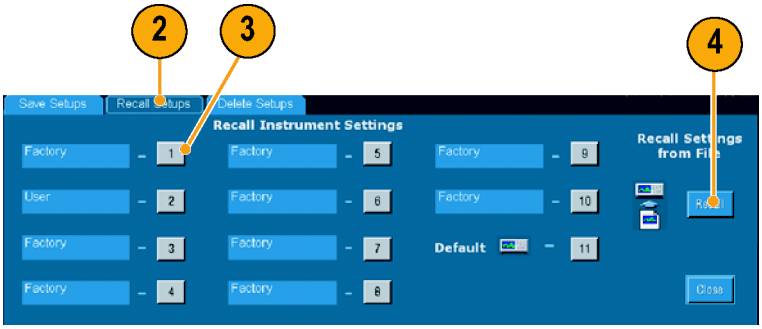
- If the touch screen is enabled, use the pop-up keyboard to label the setups for easy identification.
- Use Auto-increment file name to save numerous similar files without retyping the entire file name.

Recalling Instrument Setups

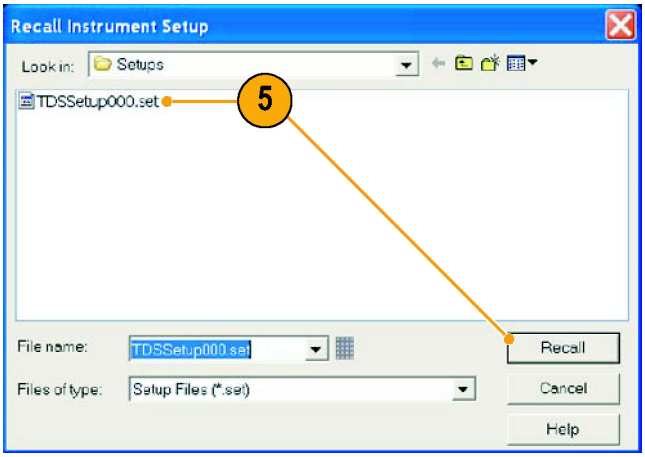
1. Select **File > Instrument Setup...**.



2. Click the **Recall Setups** tab.
3. To recall a setup stored in instrument memory, click one of the ten setups (or the Default setup).
4. To recall a setup saved in a file, click **Recall**.



5. Select the file that you want, and click **Recall**.



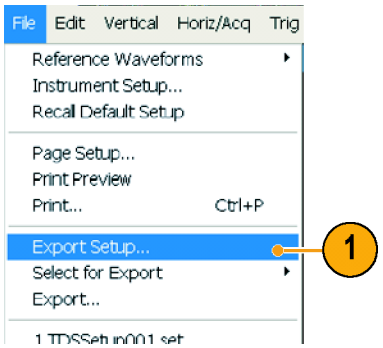
Quick Tips

- You can recall any setup stored on disk and then save it in an internal setup storage location for quicker access.

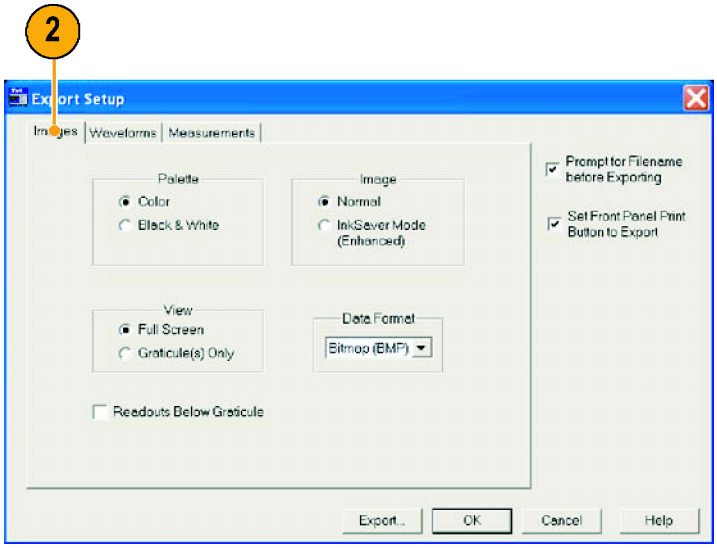
Exporting Data

You can export image, waveform, and measurement data to a file for use with other applications.

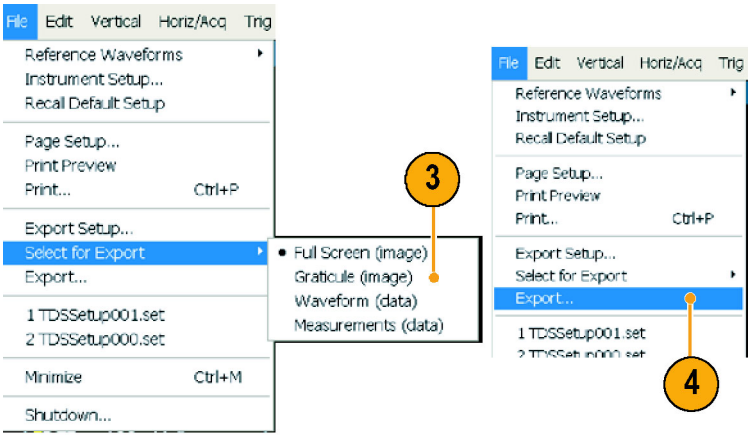
1. To set the output content and format for images, waveforms, and measurements, select **File>Export Setup...**.



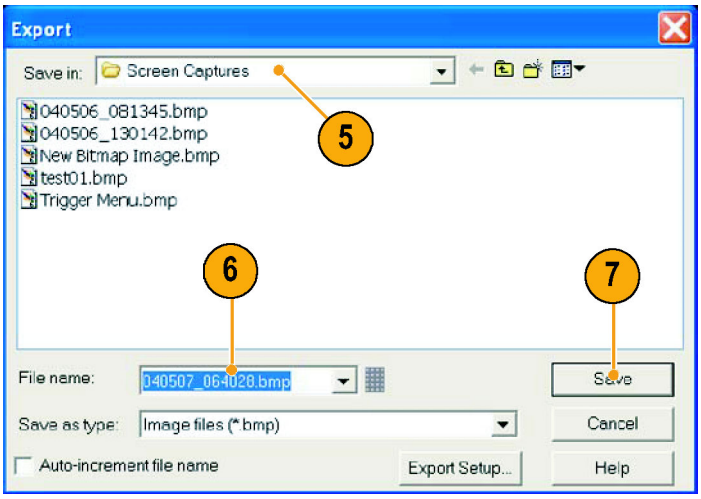
2. Click the tab for the type of data you will be exporting, and set up the characteristics and features that you want.



3. Select **File > Select for Export** , and then select the type of data that you want to export.
4. Select **File > Export...**.



5. Select the location to save the exported data.
6. Type in a name for the file or use the default name, and then select a file type.
7. Click **Save**.



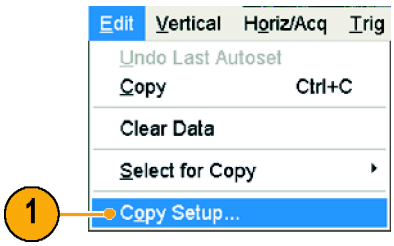
Quick Tips

- To quickly save multiple screen captures, select **Set Front Panel Print Button to Export** in the Export Setup dialog box, and then click OK. You can now export data by pushing the front panel Print button.
- Use Auto-increment file name to save numerous similar files without retyping the entire file name.

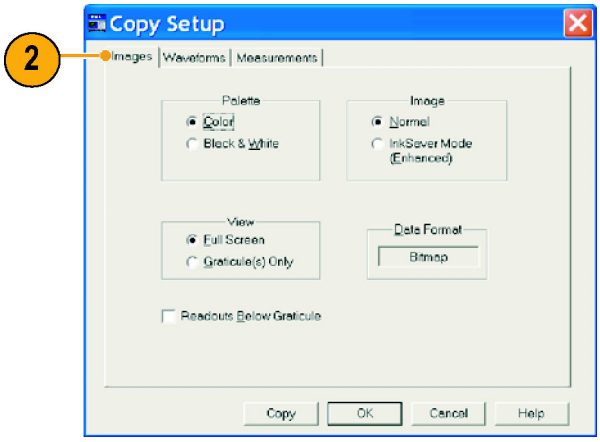
Copying Your Results to the Clipboard

Use the following procedure to set the output content and format for images, waveforms, or measurements to be copied to the Microsoft clipboard.

1. Select **Edit > Copy Setup...**.

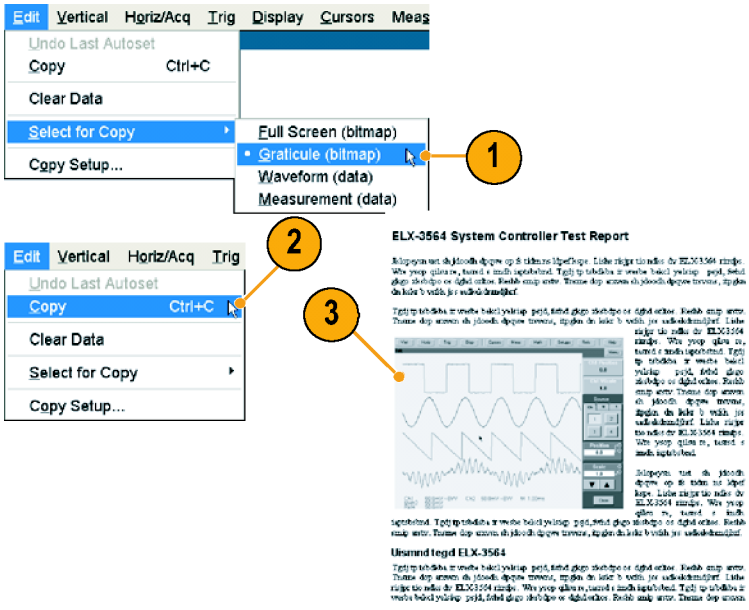


2. Click the **Images**, **Waveforms**, or **Measurements** tab, and then select the desired options.



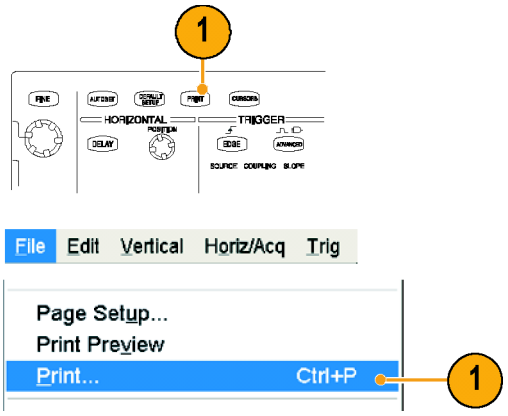
To copy images, waveforms, or measurements use the following procedure:

1. Select the item that you want to copy. That item is now available to copy to the clipboard.
2. Select **Edit > Copy** or press **Ctrl + C**.
3. Press **Ctrl + V** to paste the item into a Windows application.



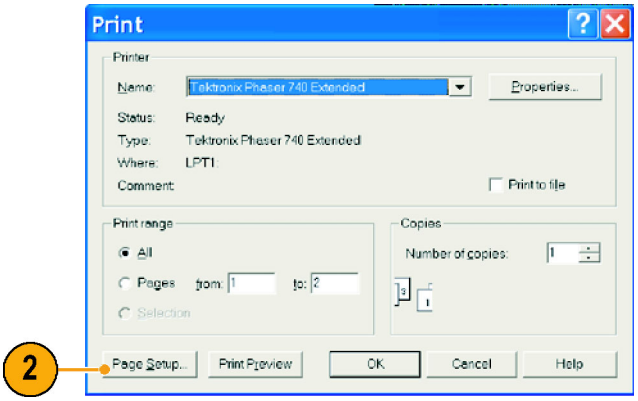
Printing a Hard Copy

1. To print a hard copy to an attached printer, do one of the following:
   - Push **PRINT**.
   - Select **File > Print**. If necessary, you can make changes to the page orientation in the Page Setup dialog box.

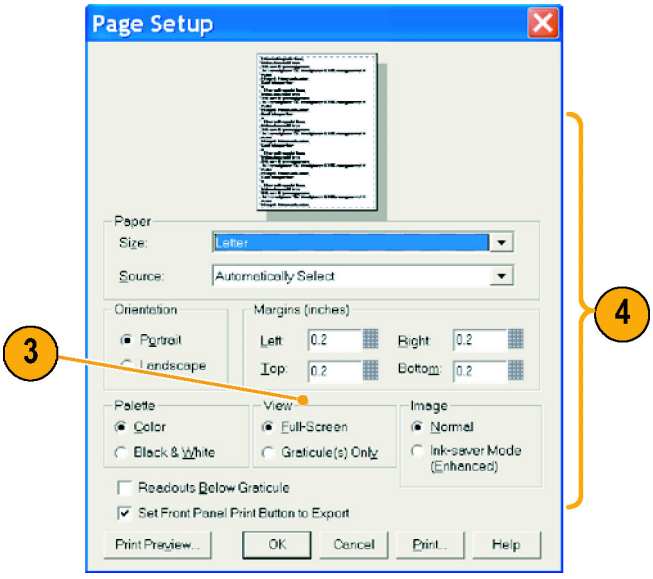


Your Print and Page Setup dialog boxes will depend on the printer you are using.

2. Click **Page Setup...**.



3. Select either **Full-Screen** or **Graticule(s) Only**.
4. Select the printing parameters depending on the type of printing.

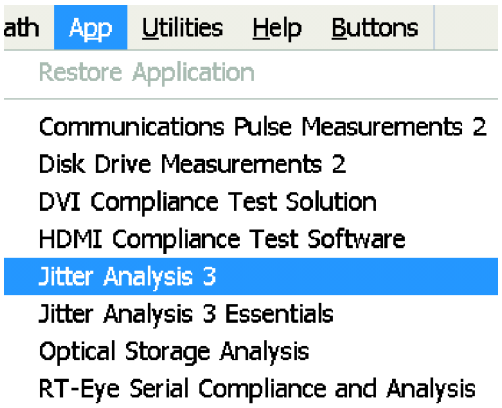


Run Application Software

The Optional Application Software CD contains free five-time trials of optional application software that you can install on your instrument. These applications provide application-specific measurement solutions. Some examples are described below. Additional packages may be available. Contact your Tektronix representative or visit our Web site at www.tektronix.com for more information.

- Use **TDSJIT3 Advanced** or **TDSJIT3 Essentials** Jitter Analysis Software to characterize timing performance. Analyze jitter on contiguous clock cycles using single-shot acquisitions.
- Use **TDSRTE** Real Time Eye Measurement Software to perform serial data compliance and analysis. These are compliance modules for many serial standards.
- Use **TDSHT3** HDMI Compliance Test Software to verify conformance to HDMI standards and test specifications (CTS).
- Use **TDSDVI** Compliance Test Solution Software for DVI physical layer compliance testing.
- Use **TDSDDM2** Disk Drive Measurement Software to measure disk drive signals according to IDEMA standards.
- Use **TDSDVD** Optical Storage Analysis and Measurement Software for automatic amplitude and timing measurements, providing you with the flexibility to modify signal processing blocks to maximize design performance.
- Use **TDSET3** to perform 10/100/1000 Base-T Ethernet compliance testing.
- Use **TDSUSB2** to characterize USB2 signals including mask testing and parametric testing.
- Use **TDSCPM2** for mask and measurements compliance testing for ITU-T G.703 and ANSI T1.102 communications standards.
- Use **TDSPWR3** Power Measurement Software to quickly measure and analyze power dissipation in power supply switching devices and magnetic components.
- Use **TDSPTD** Protocol Trigger and Decode Software to trigger and decode 8 B/10 B data on high-speed serial or data protocols. Protocol triggering up to 3.125 GS/s is available on TDS6000C instruments with Option ST. The decode feature is available on all models.

Follow the instructions provided with the application software to install it. To run the software, select **File > Run Application** and then select the application.



Application Examples

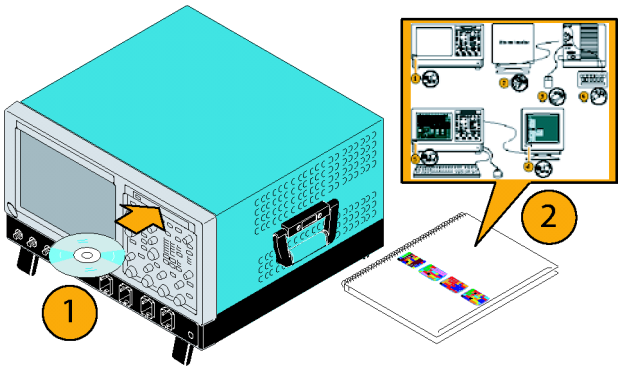
This section contains ways to use your instrument in common troubleshooting tasks, procedures for using your instrument with a Tektronix logic analyzer and extending the use of your instrument.

Using the Extended Desktop and OpenChoice Architecture for Efficient Documentation

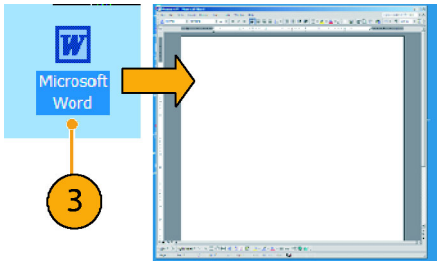
Engineers often need to document their lab work for future reference. Instead of saving screen shots and waveform data to a CD or USB memory device, and then generating a report later, try using the OpenChoice architecture to document your work in real time.

To make your instrument the center of your design and documentation process, use the following procedure.

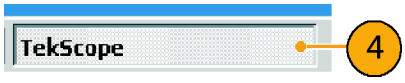
1. Load Microsoft Word or Excel on your instrument.
2. Connect a second monitor. (See page 4, *Adding a Second Monitor*.)



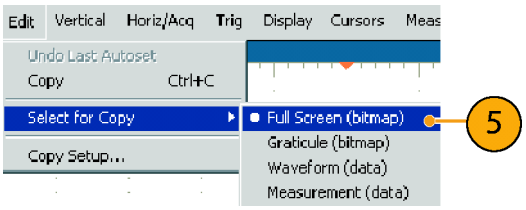
3. Open Microsoft Word, and then drag the Word window onto the extended desktop.



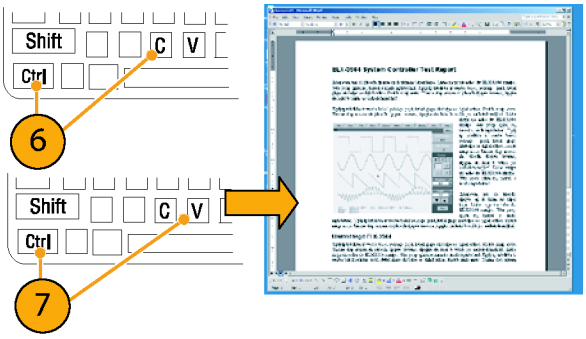
4. Click **TekScope** to restore the instrument application.



5. Select **Edit > Select for Copy > Full Screen (bitmap)**.



6. Press **Ctrl+C**.
7. Click in the Word document wherever you want to place the screen shot, and then press **Ctrl+V**.



Quick Tips

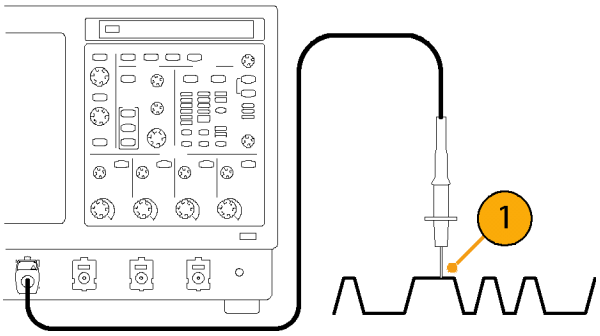
- The oscilloscope comes with a variety of OpenChoice software tools designed to ensure maximum efficiency and connectivity to the rest of your design environment.

Using Acquisition Memory to Efficiently Capture Multiple High Resolution Events

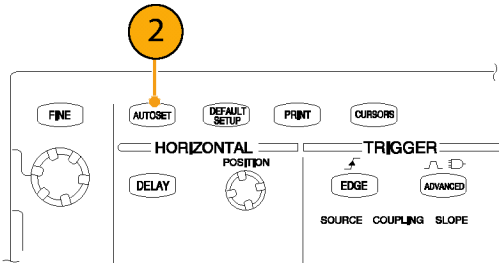
The record length of an instrument indicates how many sample points the instrument can acquire and store in a single acquisition, while the sample rate determines how closely in time these samples are taken. If you set the oscilloscope to run at the maximum sample rate, then the total time window acquired will be much shorter than if you chose a slower sample rate. In other words, in normal operation the oscilloscope can either acquire a shorter period of signal activity with high resolution or a much longer period of signal activity with lower resolution.

Some applications, such as capturing laser or radar pulses, require that the instrument capture multiple events over a long period of time with very high resolution. This example shows you how to use FastFrame to acquire such signals. For this example, we are looking at a laser pulse that fires every 1-2 seconds but is only a few nanoseconds wide. We want to capture 50 consecutive pulses and compare the wave shape of all 50 pulses.

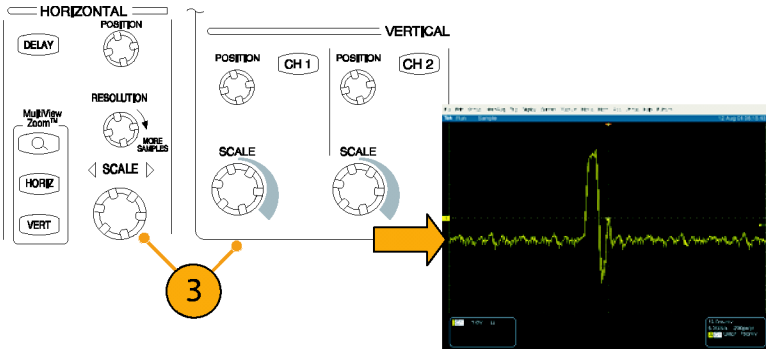
1. Acquire the desired signal on CH1.



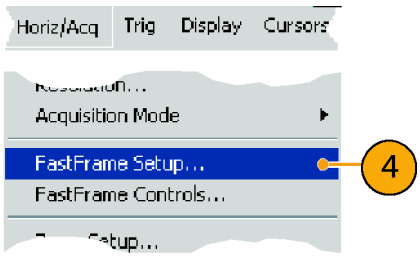
2. Push **Autoset**.



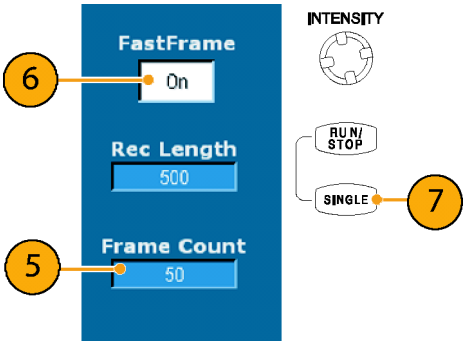
3. Use the horizontal and vertical controls to display one occurrence of the event of interest.



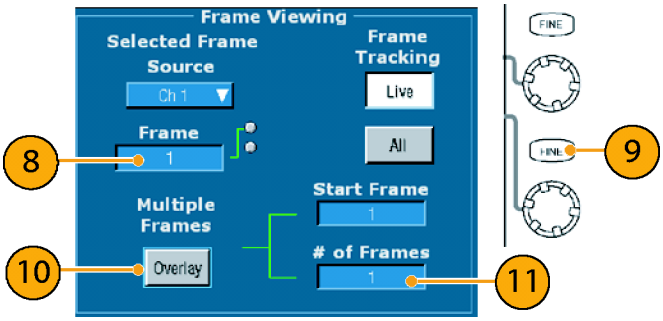
4. Select **FastFrame Setup...**.



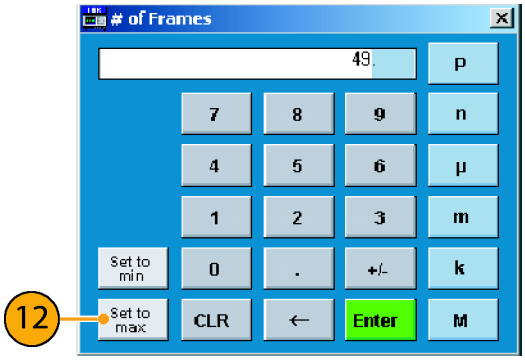
5. Set Frame Count to 50.
6. Click FastFrame **On**.
7. Push **Single** to acquire one set of 50 events. When the oscilloscope is done acquiring, all the trigger status lights will go out and the number of acquisitions specified will readout above the graticule.



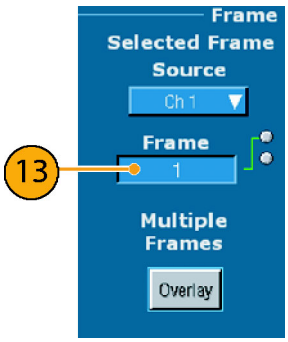
8. Click **Frame**, and then use the multipurpose knob to scroll through the frames.
9. Press **Fine** to scroll one frame at a time.
10. Select **Overlay**.
11. Click **# of Frames**, and then click the **keypad icon**.



12. Click **Set to Max,** and then **Enter**. All the frames are overlaid with the currently selected frame shown in blue. (See screen capture below.)



13. To continue comparing frames, click **Frame,** and then use the multi-purpose knobs to scroll as in steps 8 and 9.



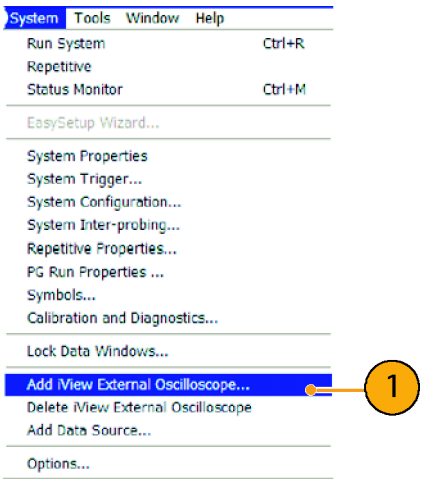
Correlating Data Between a Tektronix Oscilloscope and Logic Analyzer

Today almost every design is a high-speed design with fast clock edges and data rates. For these designs, you need to see the analog characteristics of high-speed digital signals in relation to complex digital events in the circuit. iView is your window into the digital and analog world. The iView capability seamlessly integrates and automatically time-correlates data from Tektronix logic analyzers and oscilloscopes, so you can transfer analog waveforms from the oscilloscope to the logic analyzer display with the click of a mouse. View time-correlated analog and digital signals side-by-side and pinpoint the source of elusive glitches and other problems in moments.

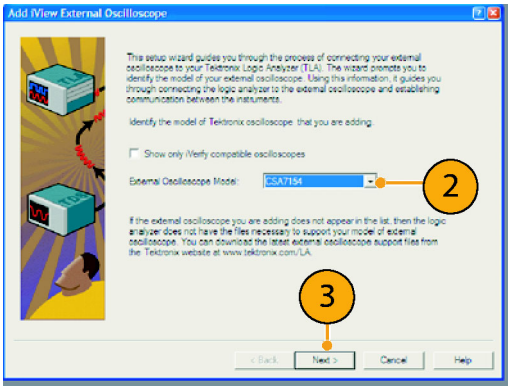
The iView External Oscilloscope Cable allows you to connect your logic analyzer to a Tektronix oscilloscope, enabling communication between the two instruments. The Add External Oscilloscope wizard, which is available from the TLA application System menu, will guide you through the process of connecting the iView cable between your logic analyzer and oscilloscope.

A setup window is also available to assist you in verifying, changing, and testing the oscilloscope settings. Before acquiring and displaying a waveform, you must establish a connection between your Tektronix Logic Analyzer and oscilloscope using the Add External Oscilloscope wizard.

1. Select **Add iView External Oscilloscope...** from the logic analyzer System menu.



2. Select your model of oscilloscope.
3. Follow the on-screen instructions and then, click **Next**.
4. See your Tektronix Logic Analyzer documentation for more information on correlating data between the logic analyzer and the oscilloscope.



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