TELEDYNE LECROY
Everywhereyoulook™

WaveSurfer 4000HD

Oscilloscopes
Getting Started Guide

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Everywhereyoulook™

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WaveSurfer 4000HD Oscilloscopes
Getting Started Guide

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Welcome

Thank you for buying a Teledyne LeCroy product. We're certain you'll be pleased with the detailed features unique to our instruments. This guide is intended to help you set up a WaveSurfer 4000HD oscilloscope and learn some basic operating procedures, so you're quickly working with waveforms.

- See the *MAUI Oscilloscopes Remote Control and Automation Manual* for comprehensive information on remote control of WaveSurfer 4000HD.
- See the *WaveSurfer 4000HD Oscilloscopes Operator's Manual* for detailed information on the operational features of the WaveSurfer 4000HD.

Both manuals can be downloaded from the Oscilloscope Manuals page on our website at: teledynelecroy.com/support/techlib

Introducing WaveSurfer 4000HD

The WaveSurfer 4000HD with HD4096 high definition technology provides 12-bit vertical resolution all the time, delivering unrivaled performance at an unbeatable value.

HD4096 Technology

HD4096 high definition technology consists of high sample rate 12-bit ADCs, high signal-to-noise ratio amplifiers and a low-noise system architecture. Teledyne LeCroy's high definition oscilloscopes (HD) have 16-times more resolution than other oscilloscopes, resulting in waveforms that are cleaner and crisper.

MAUI with OneTouch

MAUI with OneTouch dramatically reduces setup time with revolutionary drag-and-drop actions to copy and change channels, math functions and measurement parameters without lifting a finger.

Advanced Anomaly Detection

The 6-in-1 multi-instrument capabilities, when combined with a fast waveform update rate, create a flexible debug environment that ensures waveform anomalies are quickly detected.

Comprehensive Probe Support

Equipped with the Teledyne LeCroy ProBus interface, the WaveSurfer 4000HD supports over 30 probes in nine different categories, ensuring that the right probe is available for any measurement.

Key Specifications

Detailed specifications are maintained on the product page at **teledynelecroy.com**.

Bandwidth	200 MHz - 1 GHz	
Analog Channels	4 standard	2 interleaved
Memory (per channel)	12.5 Mpts/ch	25 Mpts/ch
Sample Rate (all channels)	2.5 GS/s	5 GS/s
Vertical Resolution	12-bit	
Digital Channels (optional)	16	
Digital Sample Rate	500 MS/s	
Min. Digital Pulse Width	4 ns	
Max. Digital Input Frequency	125 MHz	

Safety

Observe generally accepted safety practices in addition to the precautions specified here.

Symbols

CAUTION of potential damage to equipment, or **WARNING** of potential bodily injury. Refer to manual. Do not proceed until the information is fully understood and conditions are met.

WARNING. Risk of electric shock or burn.

Frame or chassis terminal

Alternating current

Power On/Standby

Operating Environment

Temperature	0 °C to 50 °C
Humidity	Maximum RH 90% (non-condensing) up to 31 °C decreasing linearly to RH 50% at 50 °C
Altitude	Up to 10,000 ft (3,048 m) at or below 30 °C

Power

AC Power	100-240 VAC (±10%) at 50/60 Hz (±10%) or 100-120 VAC (±10%) at 400 Hz (±5%) Automatic AC Voltage Selection
Consumption Nominal	90 W / 90 VA
Maximum*	150 W / 150 VA
Standby	4 W

* Active probes on all channels, all PC peripherals installed.

Measuring Terminal Ratings

Ratings apply to inputs C1-C4 and Ext In.

Maximum Input Voltage	50 Ω coupling ≤ 5 Vrms 1 MΩ coupling ≤ 400 Vpk max. (Peak AC ≤ 10 kHz + DC) derating at 15 dB/decade from 10 kHz to 1.6 MHz, 10 Vpk max. above 1.6 MHz

Measuring terminals have no rated measurement category (CAT) per IEC/EN 61010-1:2010.
Measuring terminals are not intended to be connected directly to supply mains.

Use proper power cord. Use only the power cord shipped with this instrument and certified for the country of use.

Maintain ground. The AC inlet ground is connected to the frame of the instrument. Connect line cords only to outlets with safety ground contacts.

WARNING. Interrupting the protective conductor inside or outside the oscilloscope, or disconnecting the safety ground terminal, creates a hazardous situation. Intentional interruption is prohibited.

Connect and disconnect properly. Do not connect/disconnect probes or test leads while they are connected to a live voltage source.

Observe all terminal ratings. Do not apply a voltage to any input that exceeds the maximum rating of that input. Refer to the markings next to the BNC terminals for maximum allowed values.

Use only within operational environment listed. Do not use in wet or explosive environments.

Use indoors only.

Keep product surfaces clean and dry.

Do not block the cooling vents. Leave a minimum six-inch (15 cm) gap between the instrument and the nearest object. Keep the underside clear of papers and other objects.

Exercise care when lifting and carrying. Unplug the instrument before moving it.

Do not remove the covers or inside parts. Refer all maintenance to qualified service personnel.

Do not operate with suspected failures. Check body and cables regularly. If any part is damaged, cease operation immediately and secure the instrument from inadvertent use.

Front of Oscilloscope

A. Touch Screen Display

B. Front Panel

C. Power On/Off Button

D. Channel Inputs

E. Mixed Signal Interface

F. USB 3.1 Ports

G. Ground and Calibration Terminals

H. Tilting Feet

The capacitive **touch screen display** is the principal viewing and control center of the oscilloscope. See p.10 for an overview of its components.

The **front panel** houses buttons and knobs that control different oscilloscope settings. Operate the instrument using front panel controls, touch screen controls, or a mix that is convenient for you.

The **Power button** controls the operational state of the oscilloscope.

Channels 1–4 are used to input analog signal.

The digital leadset connects to the **mixed signal interface** to input up-to-16 digital lines on oscilloscopes with the Mixed Signal option.

Front mounted **USB 3.1 ports** can be used for transferring data or connecting peripherals such as a mouse or keyboard.

The **Cal Out terminal** is used to compensate passive probes. The **Ground terminal** can be used to ground probes or a wrist strap.

Pull down the flippers on the **tilting feet** for easier benchtop viewing.

Powering On/Off

Connect the line cord rated for your country to the **AC power inlet** on the back of the instrument, then plug it into a grounded AC power outlet. (See Power in “Safety”).

Press the Power button to switch on the instrument and load the oscilloscope software. The LED on the button lights to show the oscilloscope is on. Press it again to switch to Standby power.

⚠ **CAUTION.** Do not power on or calibrate the oscilloscope with a signal attached.

Always use the Power button or the **File > Shutdown** menu option to execute a proper shut down process and preserve settings.

The Power button does not disconnect the oscilloscope from the AC power supply; some “housekeeping” circuitry continues to draw power. The only way to fully power down the instrument is unplug the AC line cord from the outlet.

⚠ **CAUTION**. Do not place the instrument so that it is difficult to reach the power cord in case you need to disconnect from power.

We recommend unplugging the instrument if it will remain unused for a long period of time.

Back of Oscilloscope

A. WaveSource Output

B. Kensington Lock

C. Micro SD Card (removable drive)

D. EXT Trigger Input

E. AUX Output

F. HDMI Port to external monitors

G. Ethernet Port

H. USBTMC Port for remote control

I. USB 2.0 Ports

J. AC Power Inlet

Connecting to External Devices/Systems

See the *WaveSurfer 4000HD Oscilloscopes Operator's Manual* for more detailed instructions on configuring the connections listed below.

WaveSource Waveform Generator

Connect a BNC cable from the **WaveSource output** on the back of the instrument to the signal input device. Go to **Utilities > WaveSource** to configure the output signal.

Note: WaveSource is optional and requires an activated license key.

Trigger Out

To send a trigger pulse to another device, connect a BNC cable from the **AUX output** on the back of the instrument to the other device.

LAN

The instrument is preset to accept DHCP network addressing over a TCP/IP connection. Just connect a cable from the **Ethernet port** on the back panel to a network access device.

Go to **Utilities > Preference Setup > Email** to configure email settings

Remote Control

You can remote control the instrument using TCP/IP over LAN. Be sure the instrument is on the same subnet as the controller.

You can also make the remote connection over USBTMC (with a USB A-B cable) or GPIB (with the optional USB-GPIB adapter). To change the remote control setting from the default TCP/IP, go to **Utilities > Utilities Setup > Remote**.

Also use the Remote dialog to find the instrument's IP address. To configure a Static IP address, touch **Net Connections** on the Remote dialog, then enter the IP address.

Micro SD Card

The **Micro SD card** acts as the oscilloscope's removable hard drive. Use it to store and easily share setup files, waveform trace files, LabNotebooks, and other data. The maximum size SD card supported is 32 Gb.

To remove the card, push in and release. The card should partially pop out, at which point it can be pulled out fully.

To replace the card, push it into the slot until you hear it click.

Note: When using the oscilloscope selectors, the Micro SD card is labeled Storage Card, while a removable USB drive is labeled USB Disk.

USB Peripherals

Connect the device to one of the host **USB ports** on the front or back of the instrument after start up. Most USB connections are "plug-and-play". If the device is not recognized, try reconnecting it.

External Monitor

WaveSurfer 4000HD supports external monitors with 1280 x 800 resolution. Connect the monitor to the **HDMI Port** on the back of the instrument. The connection is "plug-and-play" and does not require any further configuration on the oscilloscope.

Printer

WaveSurfer 4000HD supports PictBridge-compliant printers. Connect to any **USB 2.0 port**. Go to **File > Print Setup** to configure printer settings.

Probes

WaveSurfer 4000HD oscilloscopes are compatible with the included passive probes and most Teledyne LeCroy **ProBus** active probes that are rated for the oscilloscope's bandwidth. Probe specifications and documentation are available at **teledynelecroy.com/probes.**

Digital Leadset

Delivered with the purchase of the Mixed Signal probe option, the **digital leadset** enables input of up-to-16 lines of digital data. Lines can be organized into two logical groups representing different buses and renamed appropriately.

The digital leadset features two digital banks with separate threshold controls, making it possible to simultaneously view data from different logic families.

Each flying lead has a signal and a ground connection. A variety of ground extenders and flying ground leads are available for different probing needs. To achieve optimal signal integrity, connect the ground at the tip of the flying lead for each channel used in measurements. Use either the provided ground extenders or ground flying leads to make the ground connection.

To connect the leadset to the oscilloscope, push the connector into the mixed signal interface below the front panel until you hear a click.

To remove the leadset, press in and hold the buttons on each side of the connector, then pull out to release it.

Front Panel

Most of the front panel controls duplicate functionality available through the touch screen display. They are covered in more detail in the Basics section and in the *WaveSurfer 4000HD Oscilloscopes Operator's Manual.*

Shortcut buttons arranged across the top of the front panel give quick access to commonly used functions.

The **Touch Screen button** enables or disables touch screen functionality.

The **Save/User button** can be configured to perform your choice of function: save LabNotebooks, waveforms or setups to file; clear sweeps, etc. See the *Operator's Manual* for instructions.

When cursors are turned off, the Cursor knobs act as the **Adjust knobs**. The Adjust indicator will be lit when this is the case. They raise/lower the value when a data entry field is selected, or raise/lower trace intensity when a waveform is selected. Pushing the Adjust knobs returns settings to the default value.

All the knobs on the front panel function one way if turned and another if pushed like a button. The first label describes the knob's principal "turn" action; the second label describes its "push" action.

Many front panel buttons light to indicate which functions and traces are active. The labels for Trigger, Horizontal, Vertical and Cursors/Adjust will light in the color of the trace that is currently associated with these knobs. An indicator will light between the Horizontal and Vertical knobs when they are controlling a math function, zoom, or memory trace (instead of a channel), and an indicator with light when the acquisition trigger is armed and ready.

Touch Screen Display

The entire display is a capacitive touch screen. Use your finger or a capacitive stylus (not included) to touch, double-touch, touch-and-drag, or draw a selection box. Many controls that display information also work as “buttons” to access other functions. If you have a mouse installed, you can click anywhere you can touch to activate a control; in fact, you can alternate between clicking and touching, whichever is convenient.

A. Menu Bar

B. Grid

C. Trigger Level Indicator

D. Channel Descriptor Box

E. Trigger Time Indicator

F. Cursor

G. Timebase and Trigger Descriptor Boxes

H. Cursor Readout

I. Setup Dialogs

A drop-down **menu bar** lets you access set up dialogs and other functions. All functionality can be accessed through the menu bar.

The **grid** displays the waveform traces. You can adjust the brightness of the grid lines to make other objects more visible, or even make them invisible. **Axis labels**, which are controlled separately, mark the values represented by each division of the grid.

Trigger level (vertical axis) and **trigger time** (horizontal axis) indicators appear on the grid when a trigger is set, color-coded to match the source.

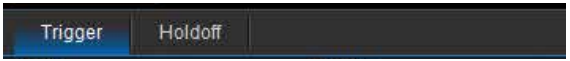
Cursors show where measurement points have been set. Touch-and-drag cursor indicators to quickly reposition the measurement point. Vertical cursor readout appears on the Channel descriptor box; Horizontal cursor readout appears below the Timebase and Trigger descriptor boxes.

Channel (C1-C4), Zoom (Z1-Z8), Math (F1-F2), Memory (M1-M2), and Digital (Digital1-Digital2, with MSO option) **trace descriptor boxes** appear immediately below the grid and summarize current settings for each open trace. Touch the descriptor box to open the corresponding set up dialog.

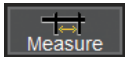
Timebase and Trigger descriptor boxes appear at the right of the display. Timebase and Trigger settings only apply to channel traces. Touch the descriptor box to open the corresponding set up dialog.

Dialogs appear at the bottom of the display for entering set up data. The top dialog will be the main entry point for the selected function.

For convenience, related dialogs appear as a series of tabs behind the main dialog. Touch the tab to open the dialog.

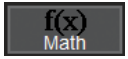


The **Action toolbar** on the main Channel, Math, and Memory dialogs offers shortcuts to common actions so you don't have to leave the underlying dialog. Actions always apply to the active (highlighted) trace.



Apply measurement parameters to the trace

Display a zoom of the trace



Apply math functions to the trace

Open serial data decoder dialogs (if options installed; else disabled)

Copy the trace to internal memory (e.g., C2 to M2)

Scale the trace to fit the grid

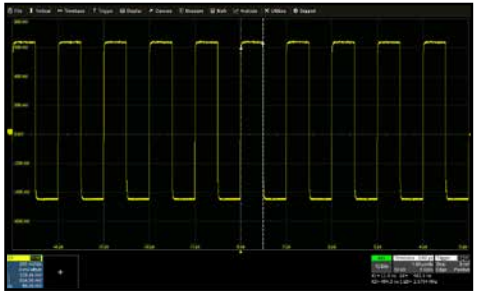
Apply a custom label to the trace

Changing the Display

To modify the touch screen display, choose **Display > Display Setup** from the menu bar and make your selections from the Display dialog.

Grid Mode

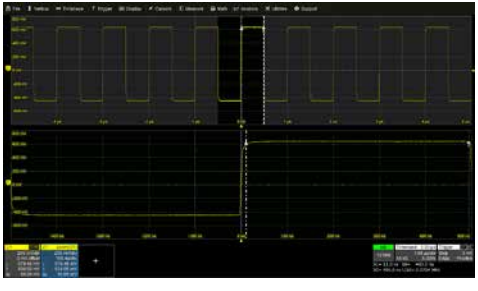
A grid is 8 Vertical divisions representing 4096 Vertical levels and 10 Horizontal time divisions. The current scale is shown at each division.



8 Vertical Divisions

4096 Vertical Levels

The grid area can contain multiple grids, each representing the full number of Vertical levels, so vertical precision is always maintained.



4096 Vertical Levels

4096 Vertical Levels

Auto grid mode enabled by default. Auto adds a new grid for each new type of trace—(analog) channel, zoom, or math function—and closes the grid when no longer needed. All traces of the same type appear on the same grid.

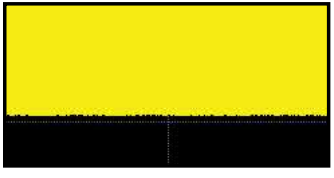
You can also choose to display all traces on a **Single** grid, or one of the **XY** grid modes that combine an XY trace with the time traces.

Line and Intensity

Grid Intensity makes the grid lines dimmer or brighter relative to the trace. It can be set to 0 to remove any visible graticule.

You can turn on/off the **Axis Labels** that show the value currently represented by each Vertical and Horizontal division of the grid.

When more data is available than can actually be displayed, **Trace Intensity** helps to visualize significant events by applying an algorithm that dims levels that occur less often than a given percent of time



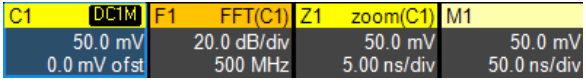
With Intensity 100%

With Intensity 40%

Working With Traces

Trace Descriptor Boxes

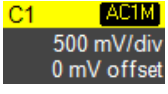
Channel (C1-C4), Zoom (Z1-Z8), Math (F1-F2), Memory (M1-M4) and Digital (Digital1-Digital2) descriptor boxes appear along the bottom of the grid when a trace is turned on. Descriptor boxes summarize, activate, arrange and configure the traces they represent.



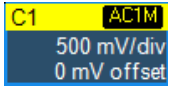
Active vs. Inactive Trace

Although several traces may be open and appear on the display, only one at a time is *active*. This is true for all traces, regardless of the type. All actions apply to the active trace until another is selected.

Touch a trace or its descriptor box to activate it and bring it to the *foreground*. When the descriptor box appears highlighted in blue, front panel controls and touch screen gestures apply to that trace. Axis labels and front panel controls will take on the color of the active trace.



Inactive. *Controls will not work for this trace.*



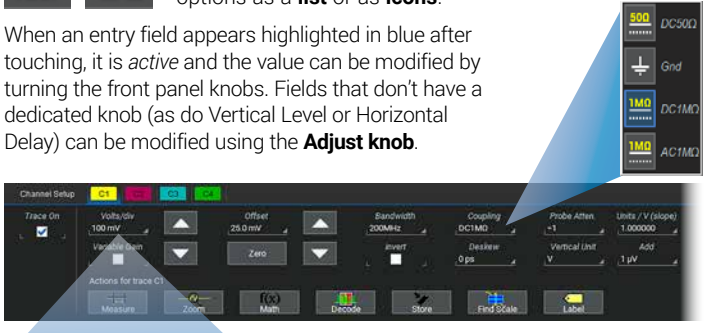
Active. *Controls will work for this trace.*

Adjusting Setups

On setup dialogs, many entries can be made by selecting from the pop-up menu that appears when you touch a control.

On some pop-up menus, you can choose to display options as a **list** or as **icons**.

When an entry field appears highlighted in blue after touching, it is *active* and the value can be modified by turning the front panel knobs. Fields that don't have a dedicated knob (as do Vertical Level or Horizontal Delay) can be modified using the **Adjust knob**.



If you have a keyboard installed, you can type entries in an active (highlighted) data entry field. Or, you can touch again, then "type" the entry by touching keys on the **virtual keypad** or keyboard.

To use the virtual keypad, touch the soft keys exactly as you would a calculator. When you touch OK, the calculated value is entered in the field.

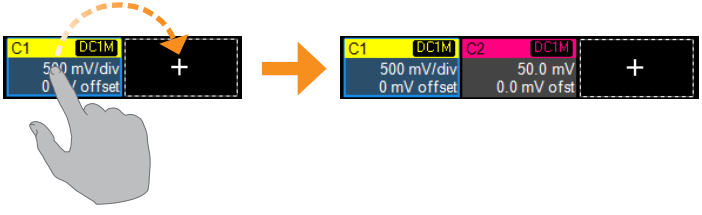
MAUI with OneTouch

Touch and drag can be used to create and change setups with one touch. Just as you change the display by using the setup dialogs, you can change the setups by moving different display objects. Use the setup dialogs to refine OneTouch gestures to precise values.

As you drag-and-drop, valid targets are outlined with a white box. When you're moving over invalid targets, you'll see the "Null" symbol (Ø) under your finger tip or cursor.

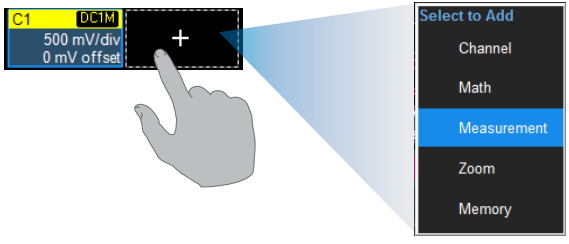
Turn On

To turn on a new channel, math, memory, or zoom trace, drag any descriptor box of the same type to the **Add New ("+") box**. The next trace in the series will be added to the display at the default settings. It is now the active trace.



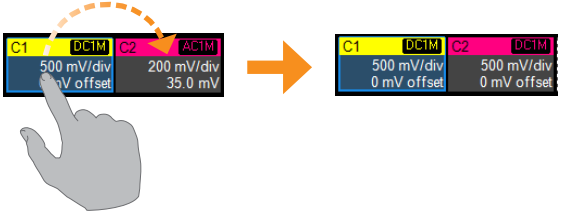
If there is no descriptor box of the desired type on the screen to drag, touch the Add New box and choose the trace type from the pop-up menu.

To turn on the Measure table when it is closed, touch the Add New box and choose Measurement.

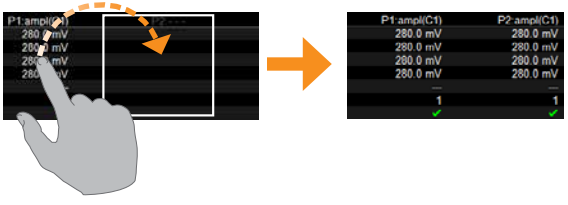


Copy Setups

To copy the setup of one trace to another of the same type (e.g., channel to channel, math to math), drag-and-drop the source descriptor box onto the target descriptor box.

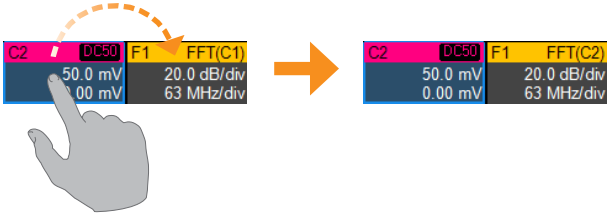


To copy the setup of a measurement (P*n*), drag-and-drop the source column onto the target column of the Measure table.

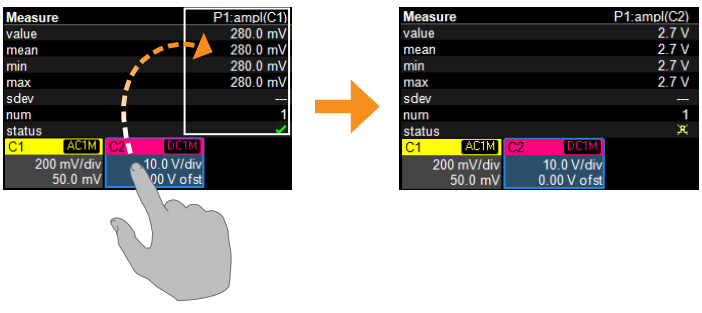


Change Source

To change the source of a trace, drag-and-drop the descriptor box of the desired source onto the target descriptor box. You can also drop it on the Source field of the target setup dialog.

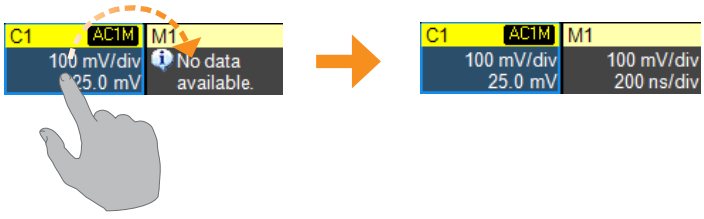


To change the source of a measurement, drag-and-drop the descriptor box of the desired source onto the parameter (P*n*) column of the Measure table.



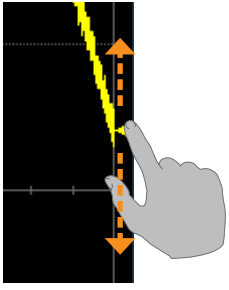
Store to Memory

To store a trace to internal memory, drag-and-drop its trace descriptor box onto the target memory (M*n*) descriptor box.

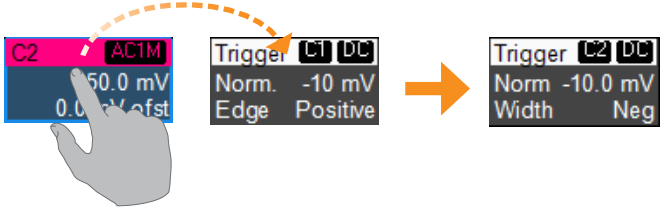


Change Trigger

To change the trigger level, drag the Trigger Level indicator to a new position on the Y axis. The Trigger descriptor box will show the new voltage Level.



To change the trigger source channel, drag-and-drop the desired channel (C*n*) descriptor box onto the Trigger descriptor box. The trigger will revert to the last trigger set on that channel.

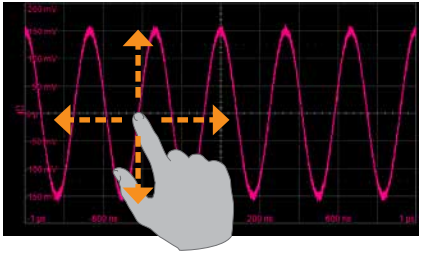


Scroll

To scroll long lists of values or readout tables, swipe the selection dialog or table in an up or down direction.

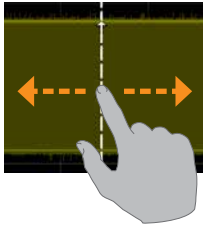
Pan

To pan a trace, activate it to bring it to the forefront, then drag the waveform trace right/left or up/down. If it is the source of any other trace, that trace will move, as well.

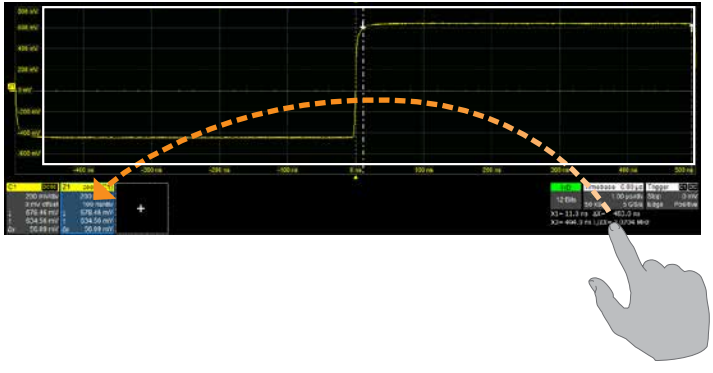


Position Cursors

To change cursor measurement time/level, drag cursor markers to new positions on the grid. The cursor readout will update immediately.



To place horizontal cursors on zooms or other calculated traces where the Horizontal Scale has forced cursors off the grid, drag the cursor readout from below the Timebase descriptor to the trace descriptor box. The cursors are set at the 2.5 and 7.5 divisions of the grid. Cursors on the source traces adjust position accordingly.



Vertical

Vertical controls adjust analog traces along the Y axis. Traces represent eight Vertical divisions of the source signal at the selected number of volts or amperes per division. The zero level is at the center grid line unless you add positive or negative Offset. The front panel V/div knob also controls the Vertical Scale of zoom, math, and memory traces.

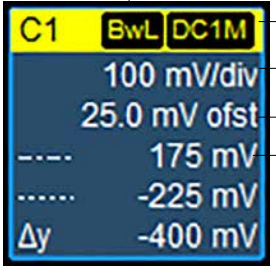
From the Front Panel

Turn on/activate trace and open setup dialog.

Raise/lower **Offset** from zero. Push to return to zero Offset.

Raise/lower **Volts/div**. Push to toggle between coarse and fine scale adjustments.

Channel Descriptor Box



Pre-Processing Summary List (changes from default state)

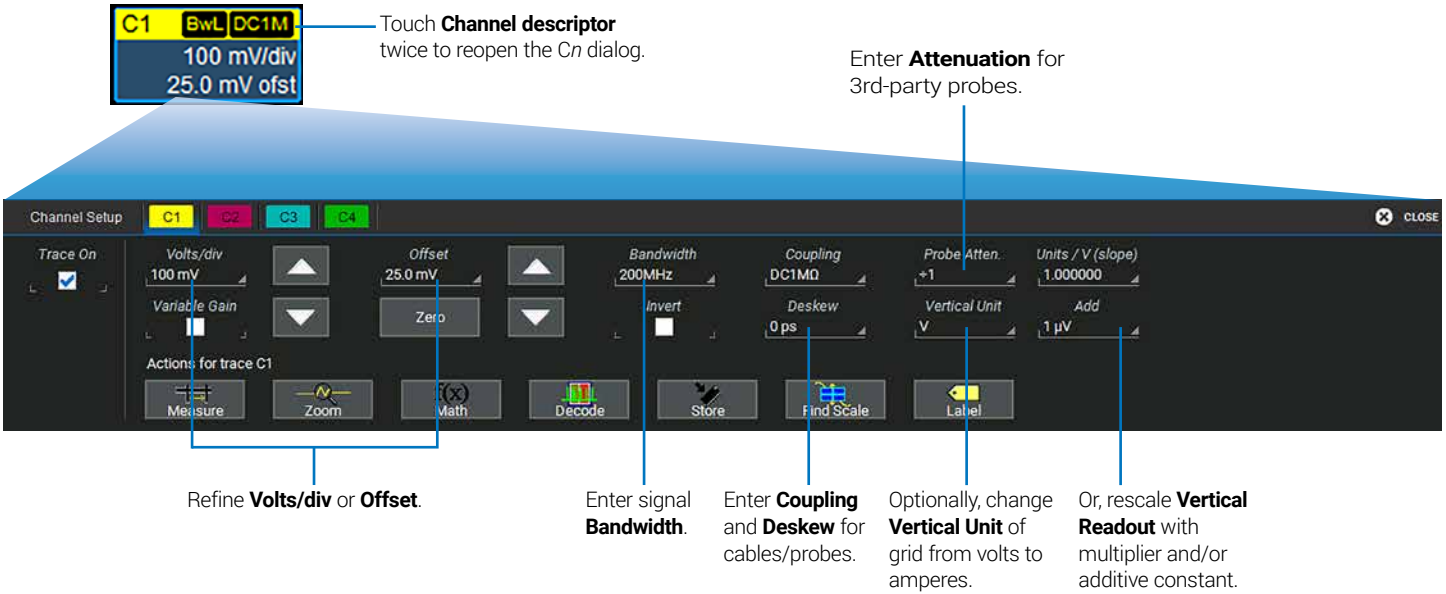
Coupling

Volts/div (Gain)

Offset

Vertical Cursor Positions (when cursors on)

From the Touch Screen



Digital

On instruments with the Mixed Signal Oscilloscope option, Digital selections are added to the Vertical menu, and the front panel Vertical knobs control active Digital line and bus traces.

From the Front Panel

Turn **Offset** to raise/lower group **Vertical Position**, the top of lowest bit relative to center.

Turn on/activate digital traces.

Turn **Volts** to raise/lower **Group Height**, the total Vertical divisions occupied by group.

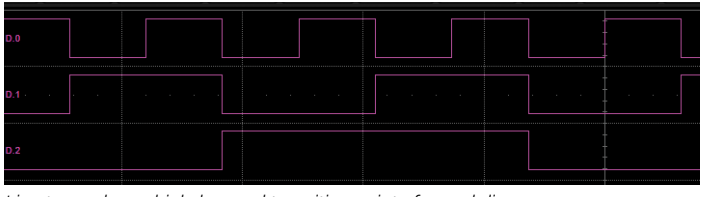
Digital Descriptor Box

Digital Lines in Group

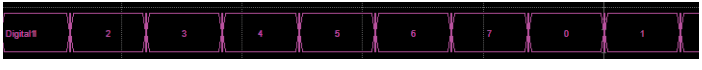
Digital Sample Rate

Digital Memory

Digital Display Modes



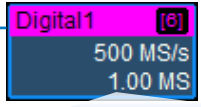
Line trace shows high, low and transition points for each line.



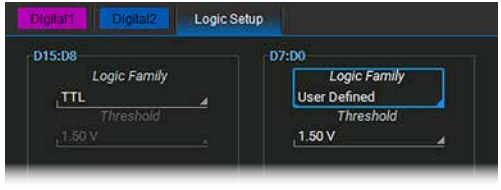
Bus trace collapses lines into hex values.

From the Touch Screen

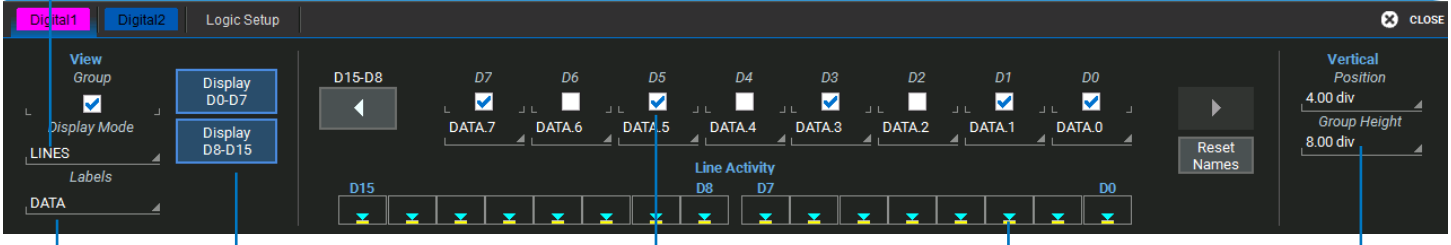
Touch **Digital descriptor** twice to open Digital*n* dialog.



On the Logic Setup tab, choose a standard **Logic Family**, or enter a custom **Threshold**. Separate controls allow you to set different values for each lead bank.



Choose a **Display Mode** of digital lines, bus trace or both.



Optionally, choose a new **Label** for the lines. Select Custom to enter unique names.

Use **Display buttons** to switch between lead banks as you select lines.

Use checkboxes to select the **lines in the group.**

Optionally, enter a unique **line name** in the field beneath.

Line Activity Indicators show the state of each digital line: high, low, or transitioning.

Enter trace **Vertical Position** and **Group Height** in divisions.

Horizontal (Timebase)

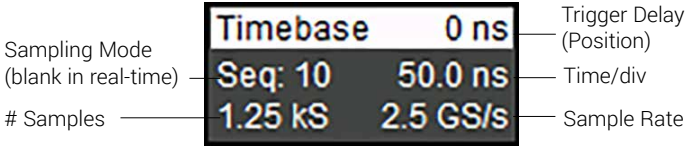
Horizontal controls adjust traces along the X axis. Analog traces usually represent one acquisition of the source signal for 10 divisions of the selected Time per division. The trigger event is shown at the center of the grid, unless you add positive or negative Delay time. The front panel Time knob also controls the Horizontal Scale of zoom, math and memory traces, allowing you to "zoom in" to see more detail or "zoom out" to see the bigger picture.

From the Front Panel

Raise/lower trigger **Delay**. Push to remove Delay.

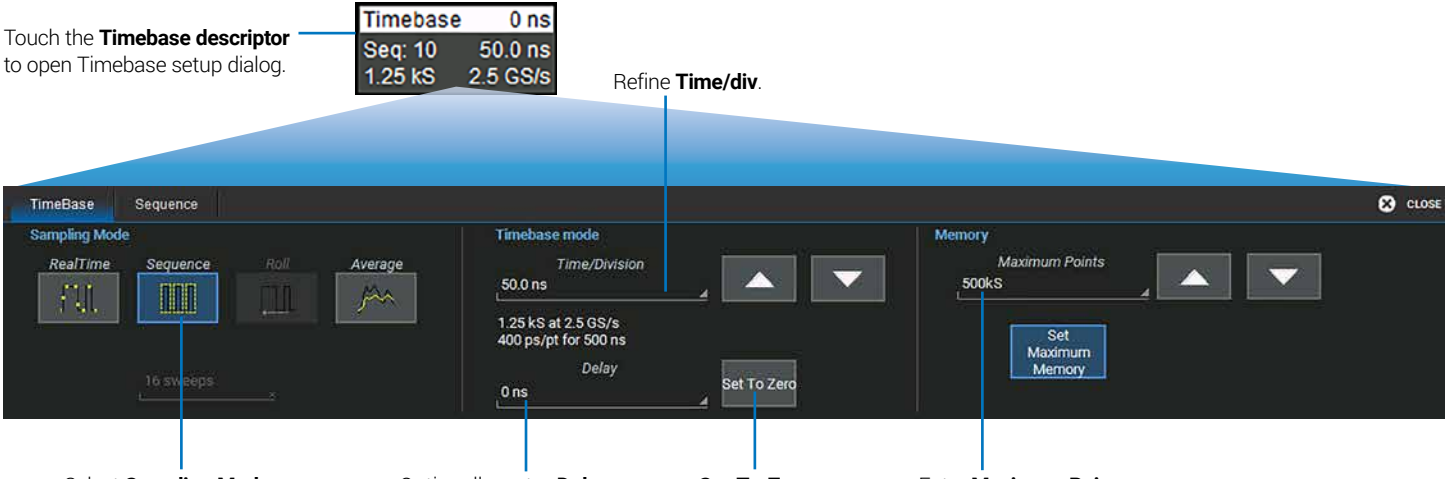
Raise/lower **Time/div**. Push to toggle between coarse and fine scale adjustment of Math functions and Memories.

Timebase Descriptor Box



From the Touch Screen

Touch the **Timebase descriptor** to open Timebase setup dialog.



Select **Sampling Mode**.

When Average, also enter the number of **Sweeps**.

Optionally, enter **Delay**, (negative) time before or (positive) time after trigger event to show.

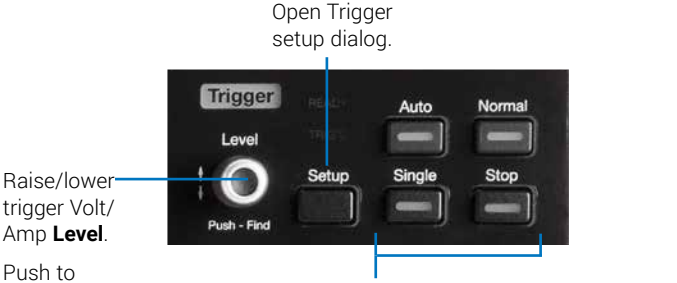
Set To Zero removes Delay.

Enter **Maximum Points** of memory to use in acquisition. Default is the maximum available.

Triggers

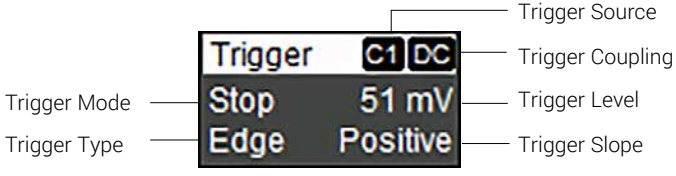
Triggers tell the oscilloscope when to perform an acquisition. The acquisition starts as soon as the trigger is armed *and* all trigger conditions are met, unless postponed by a Holdoff count of time or number of trigger events. Triggers are described at more length in the *WaveSurfer 4000HD Oscilloscopes Operator's Manual*.

From the Front Panel



Select **Trigger Mode**:
Auto – trigger after set time if no valid trigger.
Normal – trigger repeatedly when conditions met.
Single – trigger once when conditions met.
Stop – stop acquisition.

Trigger Descriptor Box



Trigger Indicators

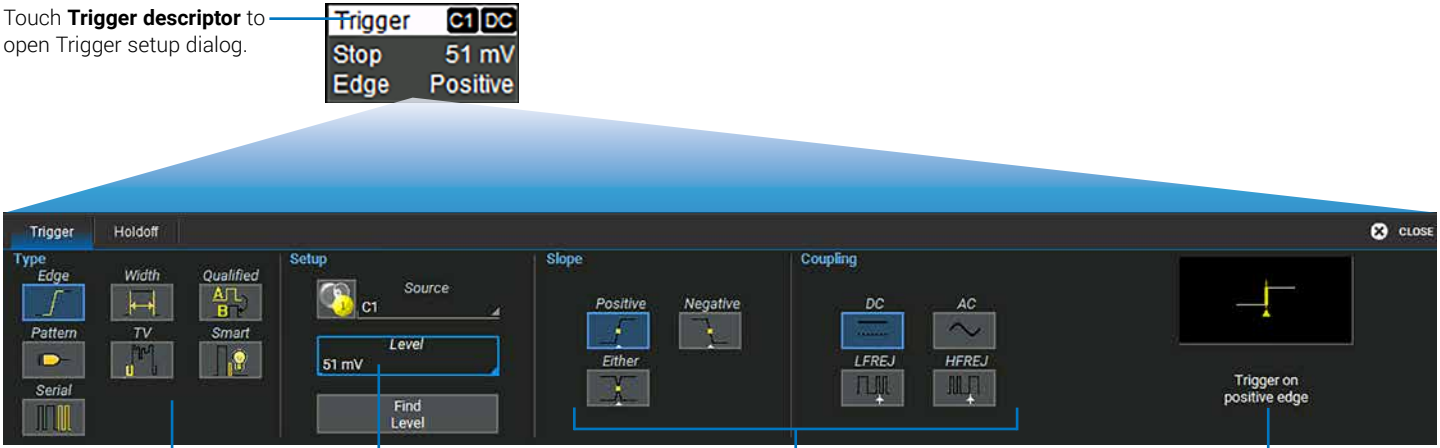
Level

Position

Pre/Post-Trigger – appears at corner of grid when trigger point is no-longer visible.

From the Touch Screen

Touch **Trigger descriptor** to open Trigger setup dialog.



Choose trigger **Type**.

Choose trigger **Source** and set trigger **Level**, or **Find Level** based on mean of the input signal.

Set other **conditions**, such as **Slope** and **Coupling** (vary by trigger type).

Icon summarizes the trigger selections.

Zoom

Zoom traces display a magnified portion of another trace. Any type of trace can be zoomed, allowing you to see the source at the original Timebase at the same time as the Zoom "close up."

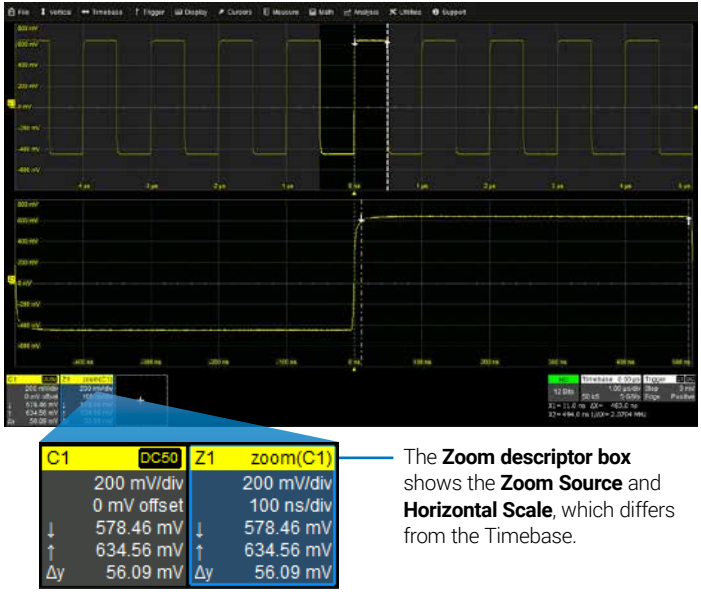
From the Front Panel

Adjust **Horizontal Scale** to change zoom magnification.

Create **Quick Zoom** of all open channels.

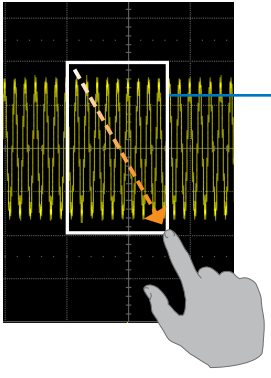
When you use the front panel Zoom button, a new Quick Zoom (Z*n*) is created for every open channel (C*n*), showing a 10x magnification of the source trace.

The un-zoomed portion of the original trace is shaded (grey), so that the zoomed portion is more visible.



The **Zoom descriptor box** shows the **Zoom Source** and **Horizontal Scale**, which differs from the Timebase.

From the Touch Screen

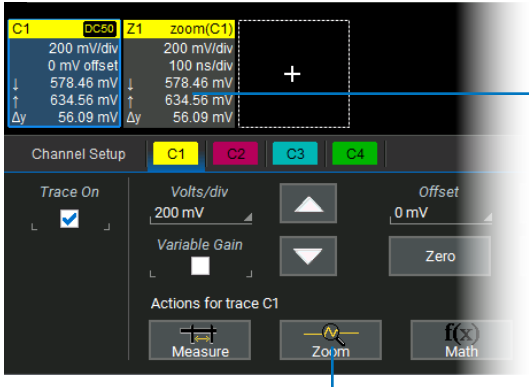


Rectangle Zoom: Drag diagonally to draw a rectangle around part of any source trace you wish to "zoom in" on.

If the source is an acquired trace (e.g., a channel), a new zoom trace (Z*n*) is created; if it's a calculated trace (e.g., Math functions), the trace itself is rescaled. The horizontal region within the box is centered and expanded, while the vertical region is rescaled proportionally.

Use the zoom factor controls on the Z*n*, F*n* or M*n* dialogs to make exact center and scale adjustments.

OR



Touch **Zoom descriptor** to open Z*n* dialog and make other adjustments.

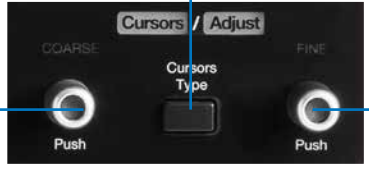
On the source trace setup dialog, touch **Action Toolbar Zoom button** to create a new zoom of just that source trace.

Cursors

Cursors set measurement points on the Vertical or Horizontal axis of a trace (or both).

From the Front Panel

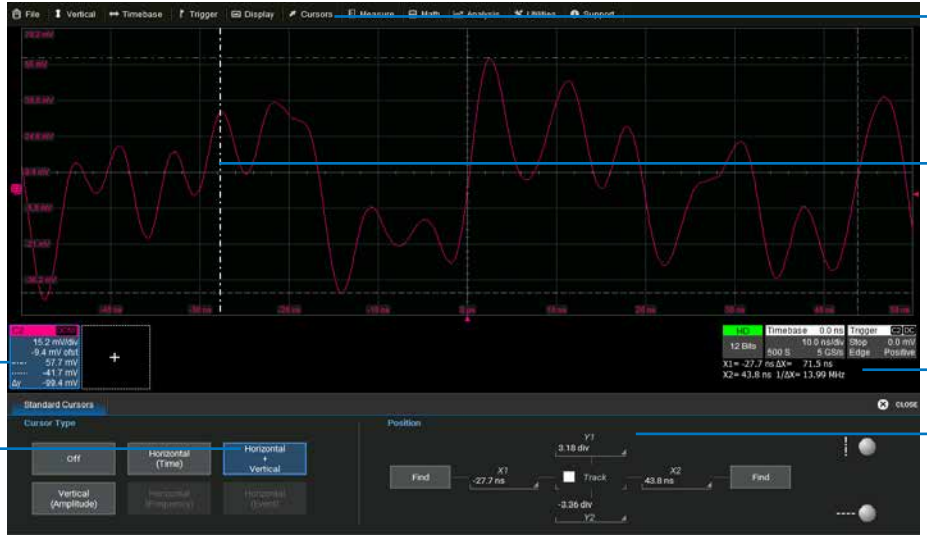
Continue pressing to turn on cursors and cycle through all **Cursor Types**.



Adjust **X1/Y1 cursor position**. Push to select different lines.

Adjust **X2/Y2 cursor position**. Push to select different lines.

From the Touch Screen



Cursors > Cursor Setup opens the Cursor dialog.

Touch-and-drag **cursor** to reposition it.

Vertical readout on descriptor boxes.

Horizontal readout below Timebase.

Choose **Cursor Type**.

Set exact **Position** of each cursor using dialog.

Track moves both cursors together.

Measurements & Statistics

Measurements are waveform parameters that can be expressed as numerical values, such as amplitude or frequency. You can set up-to-six simultaneous measurements on one or more traces and view the active readout in a table below the grid. Statistics can be added to the readout along with histicons, a miniature histogram of the statistical distribution. You can also gate measurements to limit them to a specific portion of the trace or plot the trend of the measurement over time.

Measure > Measure Setup opens the Measure dialog.

Touch **Measure** column to re-open Measure dialog if closed.

Add/remove **Satistics** and **Histicons**.

Clear Sweeps to restart measurements.

Choose **Measurement** and **Source** trace to be measured.

Optionally, enter measurement **Gates in divisions**, or just drag gate markers from edge of grid to set gates.

Math

Math function traces show the result of applying a mathematical operation (e.g., Sum, Product, FFT) to one or more source traces. Operations can be chained by using one math function as a source for the other. The math trace always opens in a separate grid from the source and can be viewed along side it. One important distinction between math functions and measurement parameters is that the result of math is always another waveform, whereas the result of measurement is a number.

Math > Math Setup opens the Math dialog.

Trace units and scale on **Fn descriptor box**.

Math tab to turn on/off function trace. **Fn tab** to set up/change function.

Use **Zoom subdialog** to rescale math trace.

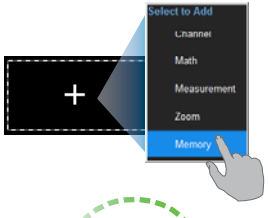
Make other settings on the **function subdialog** (vary by operation).

Choose **Source** trace(s) and **Operator**.

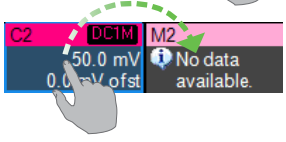
Memories (Reference Waveforms)

Memories are traces stored for reference that can be recalled to the display for comparison with other traces. A memory can be zoomed or measured for continued analysis of historical data. You can store four internal memories (M1-M4). After that, new memories will overwrite previously stored data.

To store a new memory:

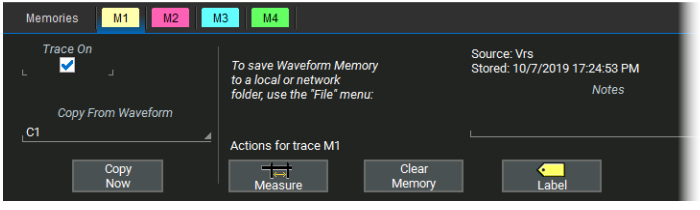


Touch the **Add New** box and choose **Memory** to turn on the next memory trace.



Then, drag the descriptor box of the trace you want stored onto the new M*n* descriptor box.

OR

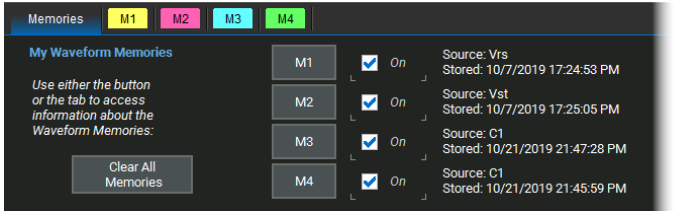


Choose **Math > Memory Setup**. On the M*n* tab, select the trace you want stored in **Copy From Waveform**, then touch **Copy Now**.

Optionally, add **Notes** or **Labels** to the stored memory.

To recall a stored memory:

Choose **Math > Memory Setup**, then check On next to the memory.



Internal memories persist only until the oscilloscope is rebooted. To store memories indefinitely, save them to a trace (.TRC) file by choosing **File > Save Waveform**.

The trace file can later be recalled into one of the internal memories for viewing by choosing **File > Recall Waveform**. Only files saved with the .TRC extension can be recalled.

WaveScan

WaveScan Search and Find® enables you to search for unusual events in a single capture, or to scan for a particular event in many acquisitions over a long period of time. A predefined set of scan modes (similar to trigger setups) enable a quick search for events of interest. The results are time stamped, tabulated and can be selected for individual viewing.

Table lists all matching events found in source.

Analysis > WaveScan opens WaveScan dialog.

Colored overlays mark events found on source and zoom traces.

Choose **scan mode** and **source** trace.

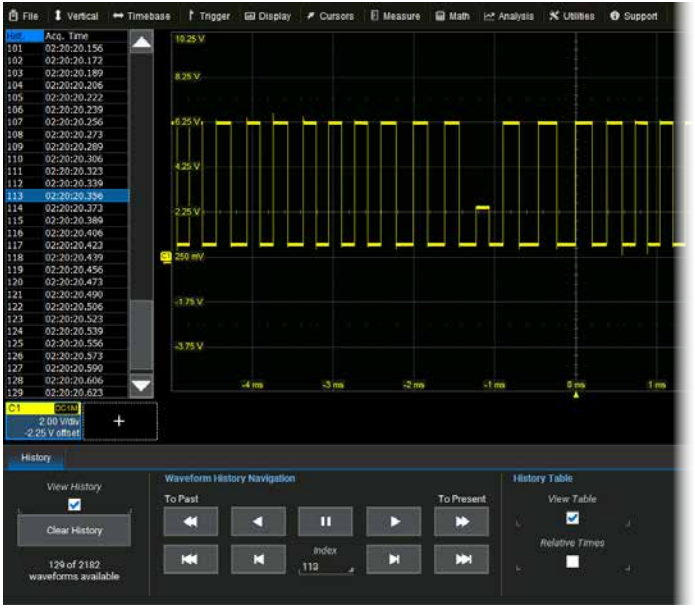
Choose **scan views**.

Use **scan mode subdialog** to fully define search.

Optionally, take **action** when events occur.

History Mode

History Mode allows you to review any acquisition in the oscilloscope's history buffer, which automatically stores all acquisitions until full. Each record is indexed and time-stamped with either the absolute time since the beginning of history or the time relative to where you are in the history. Not only can individual acquisitions be restored to the grid, you can use the A/V controls to "replay" history at varying speeds to capture detailed changes in the waveforms over time. Choose **Timebase > History**.



Pass Fail/Testing

Pass/Fail testing enables you to compare a trace to mask a region and immediately see whether it "passed" or "failed" the test through both a tabular readout and colored display markers. You can preset various actions to occur automatically depending on the outcome of the test. Choose **Analysis > Pass/Fail Setup**.

Saving and Sharing Data

Use the oscilloscope **File menu** options to save and recall data. See the *WaveSurfer 4000HD Oscilloscopes Operator's Manual* for more information on using these features.

LabNotebooks

LabNotebooks are composite files (.LNB) containing setups, waveform data and screen image as they were at the moment of capture. Creating a LabNotebook can be as simple as pressing the Save/User button as you work. Flashback LabNotebooks to restore the oscilloscope to the exact state it was in when the file was saved. Waveforms and tables are displayed as they were for new analyses to be performed.

LabNotebook files can be extracted into their component setup, waveform and screen image files.

Setup, Waveform and Table Data

The current oscilloscope configuration can be saved to internal setup panels or setup (.LSS) files and later recalled.

Waveform data can be stored to trace (.TRC) files and later recalled into memories to restore the waveform display to the screen.

Table data can be saved to either ASCII (.TXT) or Excel (.CSV) files.

When multiple waveforms or tables are displayed, one command saves **All Displayed** to separate, autonamed files.

Screen Captures

The Print function captures an image of the screen, which will then be handled according to your chosen method (sent to a printer, saved to an image file, etc.). You can configure the front panel **Save/User button** to print/save images, while the Screen Image Preferences can be set to open the drawing tools to annotate images before printing/saving, same as with LabNotebooks.

You can also choose **File > Save Screen Image** from the menu bar to generate a screen capture.

File Sharing

If the oscilloscope is networked, LabNotebooks, reports, and other user data files can be emailed directly from the instrument or saved to accessible network devices.

Files can also be transferred to a USB drive through any of the host USB ports. Stored user data files are located on the D: drive (the removable Micro SD card).

Options

These options are available to extend the functionality of a WaveSurfer 4000HD. Once the license key is activated (p.37), they integrate seamlessly with the MAUI application, adding new tools to the oscilloscope menus.

Mixed Signal Oscilloscope Option (WS4KHD-MSO)

The Mixed Signal Oscilloscope option enables mixed analog and digital input and triggering. The digital leadset is delivered with the purchase of this option. See p.8 and p.18.

WaveSource Waveform Generator (WS4KHD-AWG)

The WaveSource Waveform Generator allows you to output multiple types of waveform signals, including arbitrary waveforms, from the WaveSurfer 4000HD. To use it, just connect a BNC cable from the WaveSource output on the back of the oscilloscope to the input device and set up the waveform on the WaveSource dialog. To access WaveSource, press the **front panel WaveSource button**, or choose **Utilities > WaveSource**.

Digital Voltmeter (WS4KHD-DVM)

The Digital Voltmeter is an integrated 4-digit digital voltmeter and 5-digit frequency counter that operates through the probes already attached to the oscilloscope channels. View real-time and statistical (Min., Max., Avg., Range) measurements through a dedicated display that continues even when your triggering system is stopped. To access the Digital Voltmeter, choose **Utilities > Voltmeter**.

Spectrum Analyzer (WS4KHD-SPECTRUM-1)

Spectrum Analyzer simplifies setup and use of the oscilloscope for analyzing frequency-dependent effects. Users familiar with RF spectrum analyzers can start using the FFT with little or no concern about the details of setting up an FFT. To access it, choose **Analysis > Spectrum Analyzer.**

Power Analysis Software (WS4KHD-PWR)

Power Analysis Software provides exceptional ability to measure and analyze the operating characteristics of power conversion devices and circuits. To access it, choose **Analysis > Power Analysis.**

Serial Trigger and Decode Options

Serial trigger and decode options provide added insight when debugging serial data standards. For the most up-to-date list, go to: **teledynelecroy.com/serialdata.**

To access serial trigger and decode functions on the oscilloscope, choose **Analysis > Serial Decode** from the menu bar.

Cleaning

Clean the outside only of the WaveSurfer 4000HD using a soft cloth moistened with water or isopropyl alcohol solution. Do not use harsh or abrasive cleansers. Do not submerge the instrument or allow moisture to penetrate it. Dry the instrument thoroughly before using it.

Backing Up and Sanitizing the SD Card

The Micro SD card acts as the instrument's removeable hard drive, storing user data files such as saved setups, waveforms, LabNotebooks, screen captures, etc.

To back up the contents of the SD card to a USB drive or other external storage device:

1. Connect the device to one of the USB ports.
2. Go to **Utilities > Disk Utilities** and press **Backup**.

To erase the contents of the SD card, go to **Utilities > Disk Utilities** and press **Sanitize**.

Calibration

The WaveSurfer 4000HD is calibrated at the factory prior to being shipped. The calibration is run at 23 °C (± 2 °C) and is valid for temperatures ± 5 °C of the original calibration temperature. Within this temperature range, the instrument will meet all specifications once warmed up.

Warm up the WaveSurfer for at least 20 minutes prior to each use so it can reach a stable operating temperature. Specifications are not guaranteed during the warm up period.

Whenever the oscilloscope is used in an environment ± 5 °C from the original calibration temperature, or when it has been more than one month since the previous calibration, manual calibration is recommended. There are two calibration routines for selection:

Calibrate All calibrates all possible combinations of vertical and horizontal settings at the current temperature. This calibration is valid for the current temperature ± 5 °C and takes about 45 minutes.

Calibrate Current Setting calibrates at the current vertical and horizontal setting. This calibration is valid at this setting only for the current temperature ± 5 °C and takes under 30 seconds.

From the menu bar, choose **Utilities > Preference Setup > Calibration** to run the calibration.

⚠ **CAUTION.** Remove all inputs from the oscilloscope prior to performing calibration.

Schedule factory calibration once per year. Contact your local Teledyne LeCroy office for service.

Firmware Updates

Free firmware updates are available periodically from the Teledyne LeCroy website at **teledynelecroy.com/support/softwaredownload.** Registered users will receive email notification when a new update is released. To download and install the update:

1. From a remote PC, visit our download page and click the link to **Oscilloscope Downloads > Firmware Upgrades**.
2. Select your oscilloscope series and model number.
3. Enter your registration login information, or create a new account.
4. Click the download link, and choose to **Save** the installer to a USB drive.
5. Insert the USB drive into one of the ports on the front of the oscilloscope.
6. Go to **Utilities > Utilities Setup**.
7. On the Utilities dialog, choose **Update Firmware**.
8. Browse to the installer file in the **USB Disk** folder, then select **Upgrade**.
9. When installation is complete, reboot the instrument.

⚠ **CAUTION.** The installation may take several minutes, depending on the length of time since your last update. Do not power down the oscilloscope at any point during the installation process.

Language Selection

To change the language that appears on the oscilloscope touch screen, from the menu bar, choose **Utilities > Preference Setup > Preferences** and make your **Language** selection.

You can also make this selection at power on by touching the Talk icon when it appears at the upper-right of the touch screen.

Reboot the oscilloscope after changing language.

Activating Software Options

To purchase an option (p.35), contact your Teledyne LeCroy sales representative. You will receive a license key via email that activates the optional features on the oscilloscope. To install the key on the oscilloscope:

1. From the menu bar, choose **Utilities > Utilities Setup > Options**.
2. Touch **Add Key**.
3. Enter the new **license key** and click **OK**.
4. Reboot the instrument.

Service

If the WaveSurfer 4000HD cannot be serviced on location, contact your service center for a **Return Material Authorization (RMA)** code and instructions where to ship the product. All products returned to the factory must have an RMA.

Return shipments must be prepaid. Teledyne LeCroy cannot accept COD or Collect shipments. We recommend air freighting. Insure the item you're returning for at least the replacement cost.

Follow these steps for a smooth product return:

1. Remove all accessories from the instrument.
2. Label the unit with:
   - The RMA
   - Name and address of the owner
   - Description of failure or requisite service.
3. Pack the instrument in its original shipping box, if available, or an equivalent carton with adequate padding to avoid damage in transit. Do not include the manual.
4. Mark the outside of the box with the shipping address. Add:
   - ATTN: *<RMA code assigned by Teledyne LeCroy>*
   - FRAGILE
5. **If returning a product to a different country:** contact Teledyne LeCroy Service for instructions on completing your import/export documents.

Service Plans

Extended warranty, calibration, and upgrade plans are available for purchase. Contact your Teledyne LeCroy sales representative or customersupport@teledynelecroy.com to purchase a service plan.

Service Centers

For a complete list of Teledyne LeCroy offices by country, including our sales and distribution partners, visit: **teledynelecroy.com/support/contact**

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Sales and Service:
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Support:
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Warranty

NOTE: THE WARRANTY BELOW REPLACES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. TELEDYNE LECROY SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT OR OTHERWISE. THE CUSTOMER IS RESPONSIBLE FOR THE TRANSPORTATION AND INSURANCE CHARGES FOR THE RETURN OF PRODUCTS TO THE SERVICE FACILITY. TELEDYNE LECROY WILL RETURN ALL PRODUCTS UNDER WARRANTY WITH TRANSPORT PREPAID.

The product is warranted for normal use and operation, within specifications, for a period of three years from shipment. Teledyne LeCroy will either repair or, at our option, replace any product returned to one of our authorized service centers within this period. However, in order to do this we must first examine the product and find that it is defective due to workmanship or materials and not due to misuse, neglect, accident, or abnormal conditions or operation.

Teledyne LeCroy shall not be responsible for any defect, damage, or failure caused by any of the following: a) attempted repairs or installations by personnel other than Teledyne LeCroy representatives; b) improper connection to incompatible equipment; or c) for any damage or malfunction caused by the use of non-Teledyne LeCroy supplies. Furthermore, Teledyne LeCroy shall not be obligated to service a product that has been modified or integrated where the modification or integration increases the task duration or difficulty of servicing the instrument. Spare and replacement parts, and repairs, all have a 90-day warranty.

The instrument's firmware has been thoroughly tested and is presumed to be functional. Nevertheless, it is supplied without warranty of any kind covering detailed performance. Products not made by Teledyne LeCroy are covered solely by the original manufacturer's warranty.

Certifications

Teledyne LeCroy certifies compliance to the following standards as of the time of publication. Please see the EC Declaration of Conformity document shipped with your product for current certifications.

EMC Compliance

EC DECLARATION OF CONFORMITY - EMC

The instrument meets intent of EC Directive 2014/30/EU for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications listed in the Official Journal of the European Communities:

EN 61326-1:2013, EN 61326-2-1:2013 EMC requirements for electrical equipment for measurement, control, and laboratory use. [1]

Electromagnetic Emissions:

EN 55011:2016+A1:2017, Radiated and Conducted Emissions Group 1, Class A [2 3]

EN 61000-3-2:2014 Harmonic Current Emissions, Class A

EN 61000-3-3:2013 Voltage Fluctuations and Flickers, Pst = 1

Electromagnetic Immunity:

EN 61000-4-2:2009 Electrostatic Discharge, 4 kV contact, 8 kV air, 4 kV vertical/horizontal coupling planes [4]

EN 61000-4-3:2006+ A2:2010 RF Radiated Electromagnetic Field, 3 V/m, 80-1000 MHz; 3 V/m, 1400 MHz - 2 GHz; 1 V/m, 2 GHz - 2.7 GHz

EN 61000-4-4:2012 Electrical Fast Transient/Burst, 1 kV on power supply lines, 0.5 kV on I/O signal data and control lines [4]

EN 61000-4-5:2014+A1:2017 Power Line Surge, 1 kV AC Mains, L-N, L-PE, N-PE [4]

EN 61000-4-6:2014 RF Conducted Electromagnetic Field, 3 Vrms, 0.15 MHz - 80 MHz

EN 61000-4-11:2004+A1:2017 Mains Dips and Interruptions, 0%/1 cycle, 70%/25 cycles, 0%/250 cycles [4 5]

[1] To ensure compliance with all applicable EMC standards, use high-quality shielded interface cables.

[2] Emissions which exceed the levels required by this standard may occur when the instrument is connected to a test object.

[3] This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.

[4] Meets Performance Criteria "B" limits of the respective standard: during the disturbance, product undergoes a temporary degradation or loss of function or performance which is self-recoverable.

[5] Performance Criteria "C" applied for 70%/25 cycle voltage dips and for 0%/250 cycle voltage interruption test levels per EN61000-4-11.

European Contact:*

Teledyne GmbH, European Division
Im Breitspiel 11c
D-69126 Heidelberg
Germany
Tel: + 49 6221 82700

AUSTRALIA & NEW ZEALAND DECLARATION OF CONFORMITY – EMC

The instrument complies with the EMC provision of the Radio Communications Act per the following standards, in accordance with requirements imposed by Australian Communication and Media Authority (ACMA):

AS/NZS CISPR 11:2015 Radiated and Conducted Emissions, Group 1, Class A.

Australia / New Zealand Contacts:*

RS Components Pty Ltd.
Suite 326 The Parade West
Kent Town, South Australia 5067

RS Components Ltd.
Units 30 & 31 Warehouse World
761 Great South Road
Penrose, Auckland, New Zealand

* Visit teledynelecroy.com/support/contact for the latest contact information.

Safety Compliance

EC DECLARATION OF CONFORMITY – LOW VOLTAGE

The oscilloscope meets intent of EC Directive 2014/35/EU for Product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements

EN 61010-2:030:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits

The design of the instrument has been verified to conform to the following limits put forth by these standards:

- Mains Supply Connector: Overvoltage Category II, instrument intended to be supplied from the building wiring at utilization points (socket outlets and similar).
- Measuring Circuit Terminals: No rated measurement category. Terminals not intended to be connected directly to the mains supply.
- Unit: Pollution Degree 2, operating environment where normally only dry, non-conductive pollution occurs. Temporary conductivity caused by condensation should be expected.

U.S. NATIONALLY RECOGNIZED AGENCY CERTIFICATION

The oscilloscope has been certified by Underwriters Laboratories (UL) to conform to the following safety standard and bears the UL Listing Mark:

UL 61010-1 Third Edition – Safety standard for electrical measuring and test equipment.

CANADIAN CERTIFICATION

The oscilloscope has been certified by Underwriters Laboratories (UL) to conform to the following safety standard and bears the cUL Listing Mark:

CAN/CSA-C22.2 No. 61010-1-12. Safety requirements for electrical equipment for measurement, control and laboratory use.

Environmental Compliance

END-OF-LIFE HANDLING

The instrument is marked with this symbol to indicate that it complies with the applicable European Union requirements of Directives 2012/19/EU and 2006/66/EC on Waste Electrical and Electronic Equipment (WEEE) and Batteries.

The instrument is subject to disposal and recycling regulations that vary by country and region. Many countries prohibit the disposal of waste electronic equipment in standard waste receptacles. For more information about proper disposal and recycling of your Teledyne LeCroy product, please visit teledynelecroy.com/recycle.

RESTRICTION OF HAZARDOUS SUBSTANCES (RoHS)

Unless otherwise specified, all materials and processes are compliant with RoHS Directive 2011/65/EU in its entirety, inclusive of any further amendments or modifications of said Directive.

Intellectual Property

All patents pertaining to the WaveSurfer 4000HD can be found on our website at:

teledynelecroy.com/patents/

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TELEDYNE LECROY
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