TELEDYNE LECROY
Everywhere**you**look™

WaveSurfer 510
Oscilloscopes
Getting Started Guide

TELEDYNE LECROY
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Oscilloscopes
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Welcome

Thank you for buying a Teledyne LeCroy product. We're certain you'll be pleased with the detailed features so unique to our instruments.
This Getting Started Guide is designed to cover important safety and installation information for your oscilloscope, along with some basic operating procedures so you're quickly working with waveforms.

Contents

INTRODUCTION

WaveSurfer 510 Oscilloscopes

About the WaveSurfer 510 Oscilloscopes

The WaveSurfer 510 combines the MAUI advanced user interface with high performance 10 GS/s hardware, powerful waveform processing, and advanced math, measurement and debug tools to quickly analyze and find the root cause of problems. The large touch screen display makes accessing powerful analysis capabilities fast and easy.

MAUI with OneTouch

MAUI with OneTouch introduces a new paradigm for oscilloscope user experience. Dramatically reduce setup time with revolutionary drag-and-drop actions to copy and setup channels, math functions and measurement parameters without lifting a finger. Use common gestures like pinch, swipe and flick to intuitively interact with the oscilloscope. Quickly enable a new trace or parameter using the "Add New" button, and turn off any trace or parameter with a simple flick of the finger.

Mixed Signal Option

WaveSurfer 510 oscilloscopes are compatible with the Teledyne LeCroy MS-250 and MS-500 mixed signal hardware options. Both offer 18 integrated digital channels and a set of tools designed to view, measure, and analyze analog and digital signals, enabling fast debugging of mixed signal designs. Flexible analog and digital cross-pattern triggering across all 22 channels provides the ability to quickly identify and isolate problems in an embedded system.

Comprehensive Analysis Tools

WaveSurfer 510 has one of the most comprehensive trigger, decode, math, measurement and application toolsets available. Use trend plots to enhance understanding of complex behaviors. WaveScan® Search and Find allows you to search a single acquisition using more than 20 different criteria. History Mode lets you scroll back in time to view previous acquisitions and isolate anomalies. Navigate waveforms in the frequency domain with the Spectrum Analyzer option

New LabNotebook Report Generator

LabNotebook stores the exact state of your oscilloscope in a composite file format that can later be recalled and reviewed, annotated with custom markup, or output to a preformatted report—right on the instrument.

Serial Bus Trigger and Decode

Isolate events using the serial bus trigger and view color-coded protocol information on top of analog or digital waveforms. Timing and bus measurements allow quick and easy characterization of a serial data system.

Specifications

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

Key Specifications	
Bandwidth	1 GHz
Analog Channels	4
Sample Rate (all channels)	10 GS/s
Memory (per channel)	32 Mpts/ch
Digital Channels	up to 36 (with MSO)

Materials List

Check that you have all the parts listed here. Contact Teledyne LeCroy immediately if any part is missing.

- 1 oscilloscope
- 4 passive probes
- 1 AC power cord (rated for country)
- 1 protective front cover
- 1 Getting Started Guide
- 1 Oscilloscope Security Certificate
- 1 Oscilloscope Registration Card
- 1 Calibration Document

General Safety Information

This section contains instructions that must be observed to keep the instrument operating in a correct and safe condition. You are required to follow generally accepted safety procedures in addition to the precautions specified in this section. **The overall safety of any system incorporating this instrument is the responsibility of the assembler of the system.**

Symbols

These symbols appear on the instrument's front or rear panels and in its documentation to alert you to important safety considerations.

⚠️ **CAUTION** of damage to instrument, or **WARNING** of hazard to health. Attend to the accompanying information to protect against personal injury or damage. Do not proceed until conditions are fully understood and met.

⚡ **WARNING.** Risk of electric shock.

⏚ Measurement ground connection.

∿ Alternating Current.

⏻ On/Standby power.

Precautions

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

- **Maintain ground.** This product is grounded through the power cord grounding conductor. To avoid electric shock, connect only to a grounded mating outlet.

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

- **Observe all terminal ratings.** Do not apply a voltage to any input (C1-C4, EXT, AUX, or D0-D36) that exceeds the maximum rating of that input. Refer to the body of the oscilloscope for maximum input ratings.

- **Use only within operational environment listed.** Do not use in wet or explosive atmospheres.

- **Use indoors only.**

- **Keep product surfaces clean and dry.**

- **Exercise care when lifting and carrying.** Always use the built-in carrying handle.

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

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

- **Do not operate with suspected failures.** Inspect all parts regularly and do not use the product if any part is damaged. Cease operation immediately and sequester the instrument from inadvertent use.

Operational Environment

Temperature: 5° to 40° C
Humidity: Maximum relative humidity 90% for temperatures up to 31° C decreasing linearly to 50% relative humidity at 40° C
Altitudes: up to 3,000 m (at < 30° C)

Power and Grounding

The instrument operates from a single-phase, 100 to 240 Vrms (± 10%) AC power source at 50/60 Hz (± 5%) or a 100 to 120 Vrms (± 10%) AC power source at 400 Hz (± 5%). The instrument automatically adapts to the line voltage. Manual voltage selection is not required.

The AC inlet ground is connected directly to the frame of the instrument. For adequate protection against electric shock, connect to a mating outlet with a safety ground contact.

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

Maximum power consumption with all accessories installed (e.g., active probes, USB peripherals, Mixed-Signal input device) is: 375 W.

Power consumption in Standby mode is 15 W.

Cleaning

Clean only the exterior of the oscilloscope using a damp, soft cloth. Do not use harsh chemicals or abrasive elements. Under no circumstances submerge the instrument or allow moisture to penetrate it. Avoid electric shock by unplugging the power cord from the AC outlet before cleaning.

⚠️ **CAUTION.** Do not attempt to clean internal parts.

Calibration

The oscilloscope is calibrated at the factory prior to shipment. Schedule an annual factory calibration as part of your routine maintenance.

WaveSurfer510 incorporates automatic calibration routines to maintain accuracy in between factory calibrations. Go to **Utilities > Preference Setup > Calibration** to select the method used:

Stored Calibration uses cached calibration files to recalibrate the instrument at start-up. As long as the oscilloscope is used at or near sea level within a temperature range of 19-30 °C, this calibration routine should be sufficient to maintain specified performance. The instrument will dynamically recalibrate if the temperature goes outside of the stored calibration range. If you know you will be operating outside this temperature range, do a Calibrate All to minimize recalibration.

Dynamic Calibration recalibrates the oscilloscope at start-up and every time there is a change to any of the acquisition settings that directly affect the performance of the ADCs. When one setup is calibrated at a particular ambient temperature, the calibration is entered in a calibration table and reused for the duration of the session. These calibration entries persist only for a single session; Dynamic Calibration restarts when the instrument is restarted or you change the principal acquisition settings.

Two manual calibration routines can be used to recalibrate immediately before sensitive measurements or when there is a significant change of environmental characteristics that could affect the performance of the ADCs:

Calibrate Current State calibrates at the current vertical and horizontal settings. This calibration takes 5 seconds but is valid for only this setup at the current temperature ±2.5 °C.

Calibrate All calibrates all possible combinations of vertical and horizontal settings. This calibration is valid for the current temperature and takes about four to five hours. Perform it when the ambient temperature is stable from the time of calibration to the time of operation. We recommend that you run Calibrate All when:

• The instrument is operating outside the 19-30 °C range and the operating temperature changes while outside that range. Calibrate All is only valid for ± 2.5 °C of the last calibration temperature when operating outside of the 19-30 °C range.

• The instrument is moved to a new operating environment.

• It has been six months since the previous manual calibration.

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

Support

Online Documentation

Online Help is available by selecting Support > Dynamic Help from the oscilloscope display menu bar. You can also select Support > OneTouch Help for a demonstration of MAUI with OneTouch.

Teledyne LeCroy publishes a free Technical Library on its website. Manuals, tutorials, application notes, white papers, and videos are available to help you get the most out of your Teledyne LeCroy products.

The *WaveSurfer 510 Oscilloscopes Operator's Manual* can be downloaded from **teledynelecroy.com/support/techlib** under Manuals > Oscilloscopes. This .PDF document contains more extensive procedures for operating your oscilloscope than are found here.

The Datasheet published on the product page contains the detailed product specifications.

Technical Support

Registered users can contact their local Teledyne LeCroy service center to make Technical Support requests by phone or email. For a list of offices, visit **teledynelecroy.com/support/contact**.

You can also submit Technical Support requests via the website at **teledynelecroy.com/support/techhelp**.

SET UP

WaveSurfer 510 Oscilloscopes

The Front of Your Oscilloscope

A Touch Screen Display

B Front Panel

C Built-in Stylus Holder

D Power Button

E Channel Inputs

F EXT Input

G Aux Output

H USB 2.0 Port

I Ground and Calibration Output Terminals

J LBUS Interface

K Tilting Feet

The **touch screen display** is the principal viewing and control center of the oscilloscope. See "Touch Screen Display" on p.16 for an overview of its components and capabilities.

The **front panel** houses buttons and knobs that control different oscilloscope settings. Operate the instrument using front panel hard controls, touch screen soft controls, or a mix of both that is convenient for you. See "Front Panel" on p.26 for more information.

The **built-in stylus holder** stores a stylus that can be used with the touch screen display.

The **Power button** turns on the oscilloscope. See "Powering On/Off" for more information about shutting down.

Channels 1–4 are signal inputs to the oscilloscope; **Ext** is for inputting an external trigger.

Aux Out connector sends device trigger enabled, trigger out, or pass/fail output to another device

Ground and calibration output terminals are used to compensate passive probes. WaveSurfer 510 oscilloscopes are compatible with the included passive probes and all Teledyne LeCroy ProBus active probes that are rated for the oscilloscope's bandwidth. Probe specifications and documentation are available at **teledynelecroy.com/probes.**

If you have purchased a Mixed-Signal option, use the **LBUS interface** to connect the MS-250 or MS-500 device to the oscilloscope.

The Side of Your Oscilloscope

A   **HDMI Port** (1) for external monitor

B   **DisplayPort Port** (1) for external monitor

C   **USB 3.1 Ports** (4)

D   **Ethernet Ports** (2) for LAN connection or remote control

E   **Audio In/Out**: Mic and Speaker

Connecting

After start up, configure the oscilloscope as described below to support physical connections to the oscilloscope inputs/outputs. See the *WaveSurfer 510 Oscilloscopes Operator's Manual* for detailed instructions.

LAN

WaveSurfer 510 accepts DHCP network addressing. Connect an Ethernet cable from the LAN port on the side panel to a network access device. Go to **Utilities > Utilities Setup > Remote** and select TCPIP to obtain a network connection and IP address.

To assign the oscilloscope a static IP address, open **Net Connections** from the Remote dialog and use the Windows networking dialogs to configure the device address.

Printer

WaveSurfer 510 supports USB printers that are compatible with the Windows OS installed on the oscilloscope. Connect the printer to any host USB port, then go to **File> Print Setup** to configure printer settings.

Audio/USB Peripherals

Connect the device to the appropriate port. These connections are "plug-and-play". Use the Windows control panel to make adjustments. Choose **File > Minimize** to go to the Windows desktop.

Remote Control

To use TCPIP or LXII, connect from the LAN port on the side panel to the controller. Go to **Utilities > Preference Setup > Remote** to configure remote control.

External Monitor

WaveSurfer 510 supports WQXGA monitors with up to 2560x1600 resolution. Connect the monitor cable to the DisplayPort output on the side of the instrument (you can use a convertor if the cable has a different interface). Monitors using the HDMI interface are also supported. Configure display settings using the Windows control panel. Be sure to configure the oscilloscope as the first monitor.

To use the Extend Grids feature, configure the second monitor to extend, not duplicate, the oscilloscope display. If the external monitor is touch screen enabled, the software user interface can be controlled through touch on the external monitor.

Note: The oscilloscope touch screen uses Fujitsu drivers. Because of potential conflicts, external monitors with Fujitsu drivers cannot be used as touch screens, only as displays.

Auxiliary Output

Connect a BNC cable from Aux Out on the front of the instrument to the other device. Go to **Utilities > Utilities Setup > Aux Output** to configure the output signal.

The Back of Your Oscilloscope

A   **Built-in Carrying Handle**

B   **AC Power Inlet** for the AC line cord

C   **Kensington Lock**

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 and Grounding on p.5).

Press the **Power button** on the front to switch on the instrument.

⚠ **CAUTION.** Do not change the instrument's Windows® Power Options from the default Never to System Standby or System Hibernate modes.

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

Use the **File > Shutdown** menu bar option to switch "off". Pressing the Power button again will execute a shutdown, but we do not recommend doing this as it does not allow the Windows operating system to shut down properly, and memories and setup panels will not be saved.

The Power button and File > Shutdown do 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 quickly disconnect from AC power.

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

Language Selection

To change the language that appears on the display, go to **Utilities > Preference Setup > Preferences** and make your **Language** selection. Restart the oscilloscope software after the language is selected.

If you wish to also change the language of the Windows operating system:

1. Choose File > Exit to close the oscilloscope application and show the Windows Desktop.

2. From the Windows task bar, choose Start > Control Panel > Clock, Language and Region.

3. Under Region and Language select Change Display Language.

4. Click the Install/Uninstall Languages button.

5. Select Install Language and Browse Computer or Network.

6. Click the Browse button, navigate to D:\Lang Packs\ and select the language you want to install. Follow the installer prompts.

7. After exiting the Control Panel, double-click the Start DSO icon on the desktop to restart the oscilloscope application.

Note: The available languages are: German, Spanish, French, Italian, and Japanese. Other language packs are available from Microsoft's website

Software Activation

The oscilloscope operating software (firmware and standard applications) is active upon delivery.

To purchase a software option, contact your Teledyne LeCroy sales representative. You will receive a license key via email that activates the optional features on the oscilloscope.

To install a license key:

1. Go to Utilities > Utilities Setup > Options.

2. Touch Add Key.

3. Enter the new license key and click OK.

4. Reboot the oscilloscope.

See Software Options on p.40 for information about the available options.

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 the oscilloscope desktop (File > Minimize) or a remote PC, launch the browser and visit the software download page at the URL above.

2. Click the link to Oscilloscope Downloads > Firmware Upgrades.

3. Enter the required model information and account login. If you don't yet have an account, create one now.

4. Follow the instructions to save the installer to a location on the oscilloscope D: drive or a USB storage device.

5. On the oscilloscope, use Windows Explorer to browse to the installer file (xstreamdsoinstaller_x.x.x.x.exe) and double-click it to launch the XStream Setup wizard.

6. Follow the wizard prompts.

7. When installation is complete, power cycle the instrument.

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

USER INTERFACE

WaveSurfer 510 Oscilloscopes

Touch Screen Display

The entire display is a touch screen. Use your finger or the stylus to touch, drag-and-drop, swipe, pinch, and flick. 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 for you.
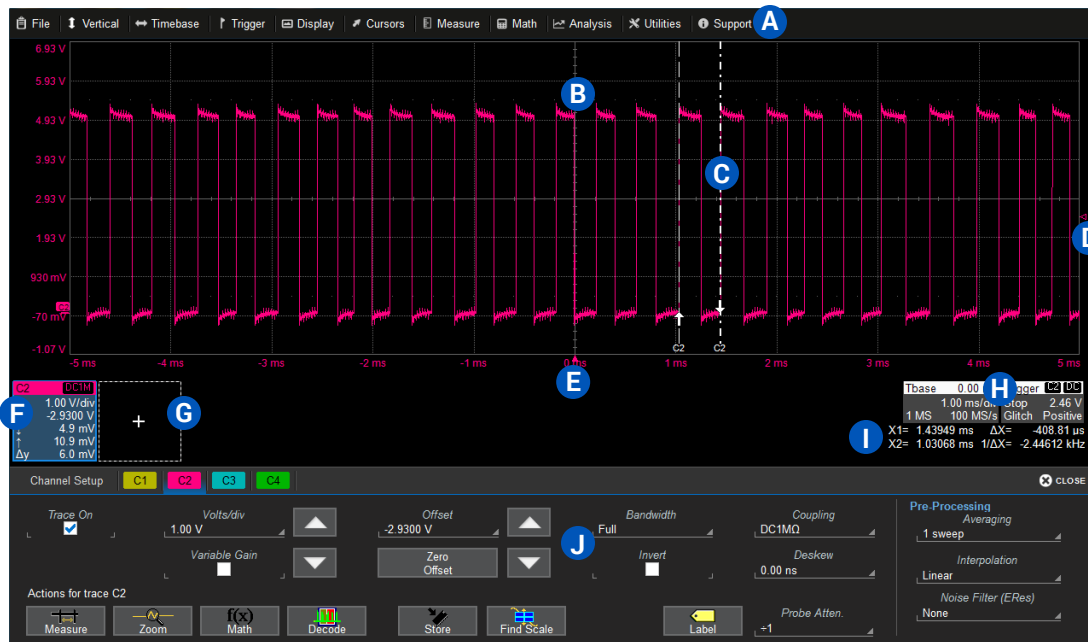
A Menu Bar

B Grid Area

C Cursor Markers

D Trigger Level Indicator

E Trigger Time Indicator

F Trace Descriptor Boxes

G Add New Box

H Timebase and Trigger Descriptor Boxes

I Horizontal Cursor Readout

J Setup Dialogs

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

If an action can be "undone" (such as recalling a setup), a small **Undo button** appears at the far right of the menu bar. Click this to return to the previous oscilloscope display.

The **grid area** displays the waveform traces. It can be configured to show different grid styles.

Cursors show where measurement points have been set. Touch-and-drag cursor indicators to quickly reposition the measurement point. Horizontal cursor readouts appear below the Timebase and Trigger descriptors.

Trigger Level and **Trigger Time** indicators appear at the edge of the grid when a trigger is set, color-coded to match the input.

Trace Descriptor boxes appear along the bottom of the grid area, one for each open trace. They adjust in size and detail as more are opened.

The **Add New box** sits next to the trace descriptor boxes. Use it to turn on new traces or the Measure table. See MAUI with OneTouch on p.21.

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.
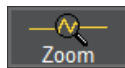
For convenience, related dialogs appear as a series of tabs behind the main dialog. Touch the tab to open the dialog.
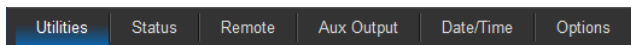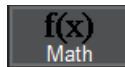
A **toolbar** along the bottom of the main Channel, Math, Memory and Digital dialogs applies common actions so that you don't have to leave the underlying dialog. They always apply to the active (highlighted) trace.
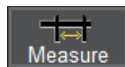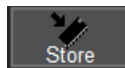
Apply up-to-6 measurement parameters.

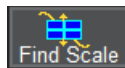Display a zoom of the trace.

Apply a math function to the trace.

Open the Serial Decode dialog.

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

Scale the waveform to fit the grid.

Apply a custom label to the trace.

Changing the Display

The grid is 8 Vertical divisions representing 256 Vertical levels and 10 Horizontal divisions. The value represented by each division depends on the Vertical and Horizontal Scale settings of the traces that appear on it.

8 Vertical Divisions

256 Vertical Levels
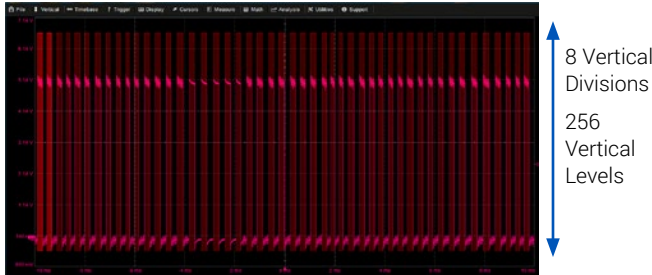
Multi-Grid Display
The grid area can contain multiple grids each representing the full number of Vertical levels.

256 Vertical Levels

256 Vertical Levels
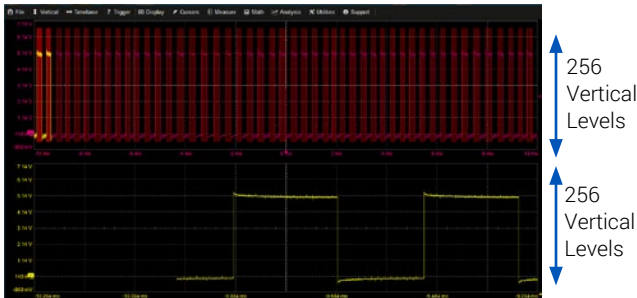
By default, the oscilloscope has the **Auto** grid mode enabled. Auto adds a separate grid for channels, zooms, and math functions/memories. Other grid modes show all traces on a **Single** grid, or incorporate an **XY** plot into the regular display.

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

Extended Display
If you have a second monitor connected, select **Extend Grids on 2nd Monitor** from the Display dialog, then choose a grid style from the Extended Display pop-up menu. Both displays will share this grid style.

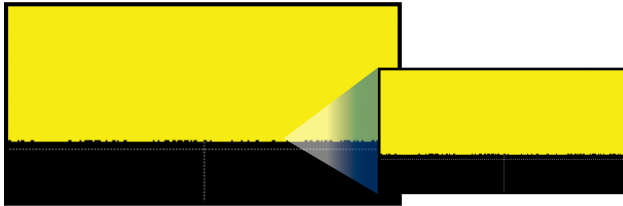*Oscilloscope with an extended display.*

Line and Intensity

The trace style can be set to a series of separate sample **Points** or a continuous vector **Line**.

Grid Intensity makes the grid lines dimmer or brighter relative to the trace.

When more data is available than can actually be displayed, **Trace Intensity** helps to visualize significant events by applying an algorithm that dims less frequently occurring samples. The front panel **Intensity button** sets the Adjust knob to control the trace intensity setting.

Trace with Intensity 100%
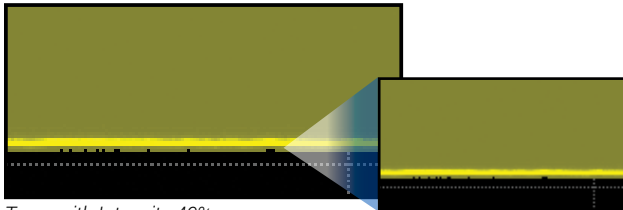
Trace with Intensity 40%.

Using WaveStream

WaveStream provides a vibrant, intensity graded display with a fast update rate to closely simulate the look and feel of an analog oscilloscope. WaveStream is most helpful with signals that have jitter or other anomalies, or for applying a visual check before creating an advanced trigger or WaveScan setup to locate an unusual event.

To apply WaveStream, touch the Timebase descriptor to open the Timebase dialog, and select **WaveStream Sampling Mode**.
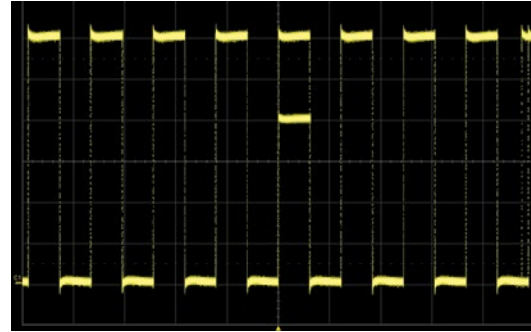
Trace in WaveStream Display Mode

Working With Traces

Trace Descriptor Boxes

Channel (C1-C4), Zoom (Z1-Z8), Math (F1-F8), Memory (M1-M4), and Digital (Digital1-Digital4, on -MS models) descriptor boxes appear along the bottom of the grid area when a trace is turned on. Descriptor boxes summarize, activate, arrange, and configure the traces they represent.

Trace Context Menu

The trace context menu is a quick way to apply math, measurements, or labels to traces. To open the context menu, right-click with your mouse or touch-and-hold on the trace descriptor box until a white circle appears, then release.

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.

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

Active. *Controls will work for this trace.*

Adjusting

On setup dialogs, many entries can be made by selecting from the pop-up menu that appears when you touch a control. But 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.
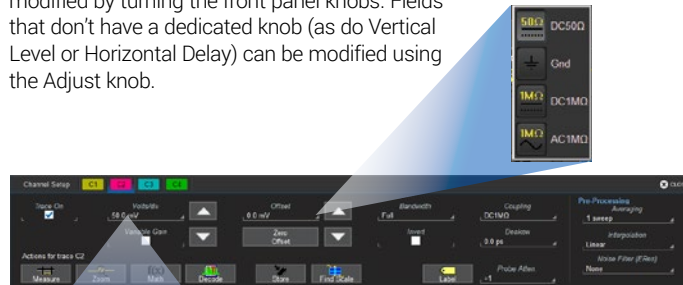
If you have a keyboard installed, you can type entries in an active (highlighted) data entry field. Or, you can touch again, then "type" the entry by touching keys on the virtual keypad or keyboard.

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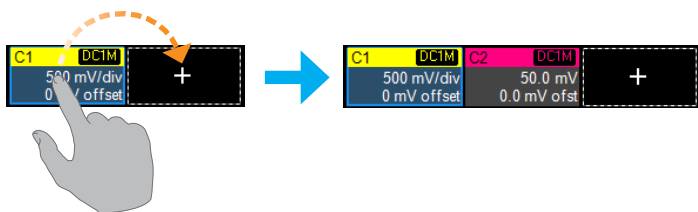
If there is no descriptor box of the desired type on the screen to drag, touch the Add New box and choose the trace type from the pop-up menu.

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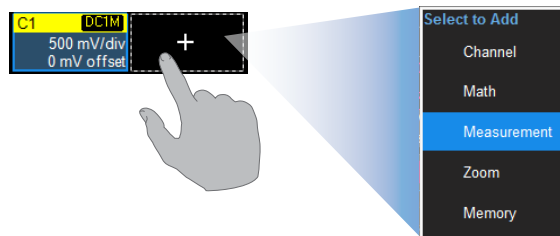
Copy Setups

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*x*), drag-and-drop the source column onto the target column of the Measure table. You can do the same for a qualifier (Q*x*) on the Pass/Fail readout table.
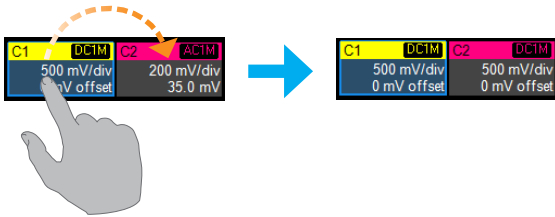
Change Source

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.
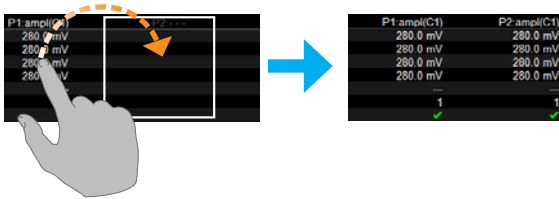
To change the source of a measurement, drag-and-drop the descriptor box of the desired source onto the parameter (P*x*) column of the Measure table. You can do the same to a qualifier (Q*x*) on the Pass/Fail readout table.
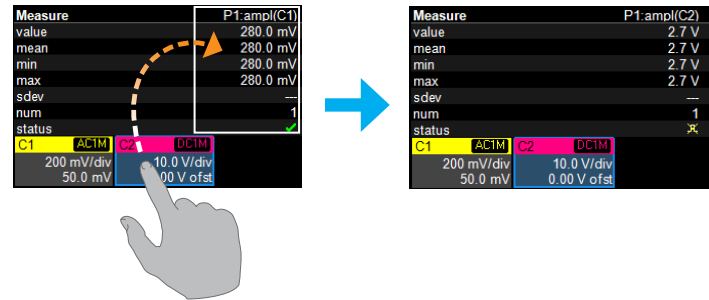
Position Cursors

To change cursor measurement time/level, drag cursor markers to new positions on the grid. The cursor readout will update immediately.
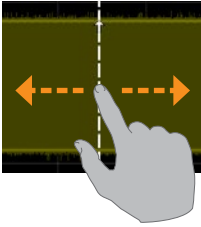
To place horizontal cursors on zooms or other calculated traces where the Horizontal Scale has forced cursors off the grid, drag the cursor readout from below the Timebase descriptor to the grid where you wish to place the cursors. The cursors are set at either the 5 (center) or 2.5 and 7.5 divisions of the grid. Cursors on the source traces adjust position accordingly.
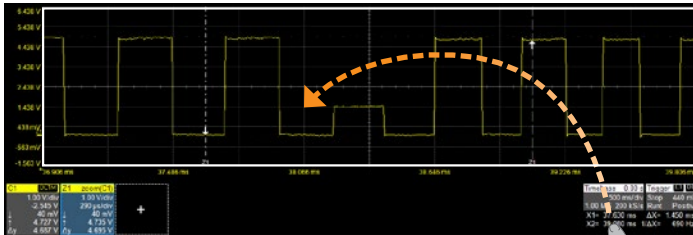
Change Trigger

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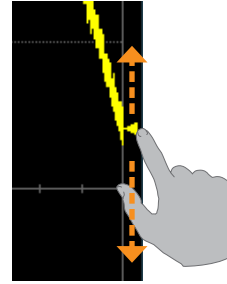
To change the trigger source channel, drag-and-drop the desired channel (C*x*) descriptor box onto the Trigger descriptor box. The trigger will revert to the last trigger set on that channel.
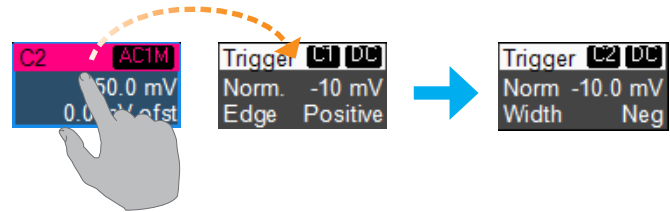
Store to Memory

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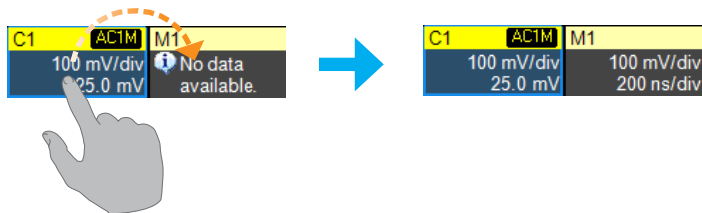
Scroll

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.

To pan at an accelerated rate, swipe the trace right/left or up/down.
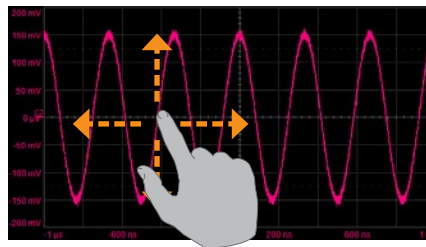
Zoom
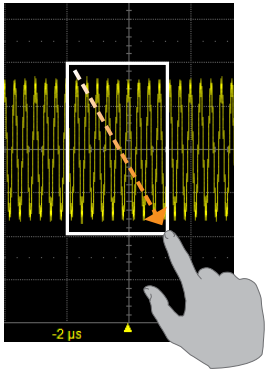
To create a new zoom trace, touch then drag diagonally to draw a selection box around the portion of the trace you want to zoom. Touch the Zx descriptor box to open the zoom factor controls and adjust the zoom exactly.
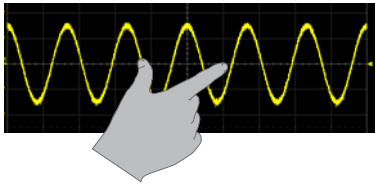
To "zoom in" on any trace, unpinch two fingers over the trace horizontally.
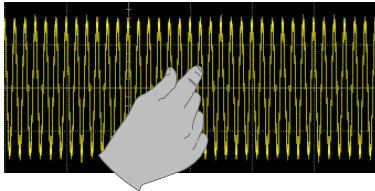
To "zoom out" on any trace, pinch two fingers over the trace horizontally.

Turn Off

To turn off a trace, flick the trace descriptor box toward the bottom of the screen.
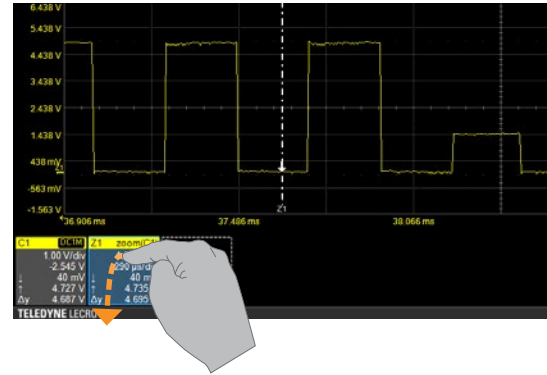
Front Panel

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 510 Oscilloscopes Operator's Manual*. Below are some special front panel controls.

(A) **Auto Setup** turns on and configures all channels with a signal attached. The edge trigger level is set to the signal mean.

(B) **Default Setup**, on the other hand, returns all channels to the factory default settings.

(C) The **Print** button captures the screen and handles it according to your Print setting (print to file on USB drive, create LabNotebook entry, etc.). It can be set to capture only the grid rather than the full screen.

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

(E) **Clear Sweeps** resets math and measurement counters.

(F) The front panel **Adjust** knob changes the value in a highlighted data entry field when turned. Pushing the Adjust knob toggles between coarse (large increment) or fine (small increment) adjustments when the knob is turned.

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, while the second describes its "push" action.

Many front panel buttons light to indicate the function is active.

BASICS

WaveSurfer 510 Oscilloscopes

Vertical

These controls adjust the channel trace along the Y axis.

From the Front Panel

A Press to turn on/activate analog trace.

B Turn to raise or lower Offset (analog) or Vertical Position (digital). Push to return to zero.

C Turn to raise or lower Vertical Scale (analog) or Group Height (digital). Push to adjust with more precision.

Channel Descriptor Box

Pre-Processing Summary List (changes from default state)

Coupling

Gain Setting

Offset Setting

Sweeps Averaged / Segment

Vertical Cursor Positions

Analog Traces From the Display

A Drag another channel descriptor to the Add New box, or touch the Add New box and choose Channel.

B Touch the new descriptor box to open the C*x* setup dialog.

C Change Vertical settings.

OR

Drag and drop any other channel descriptor onto the new descriptor to copy the setup.

Digital Traces From the Display

A Choose Vertical > Digital # Setup.

B Touch Digital descriptor to open the Digital dialog.

C Open Digital dialog to configure each active group (1-4).

D Touch checkboxes to select the lines in the group. Use arrows to switch between banks.

E Choose to display expanded line traces or collapsed bus trace.

F Modify display by setting Vertical Position (top of lowest bit relative to center) and Group Height (vertical space occupied by group) in divisions.

G Choose a standard Logic Family, or enter custom values for Threshold and Hysteresis. Separate controls allow you to set different values for each bank.
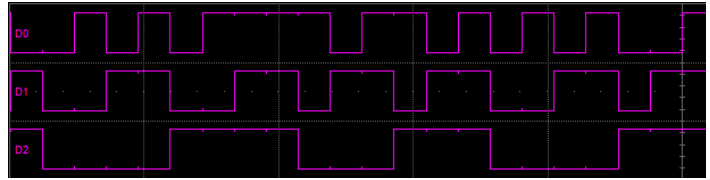
Expanded trace shows high, low and transition points for each line.
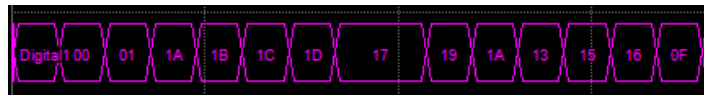
Collapsed trace collapses bus into hex values.

Digital Descriptor Box

— # Digital Lines in Group

— Digital Sample Rate

— Digital Memory

Horizontal (Timebase)

These controls adjust the trace along the X axis.

From the Front Panel

A Turn to increase or decrease trigger Delay. Push to return Delay to zero.

B Turn to raise or lower Horizontal Scale (Time/div). Push to adjust scale with more precision on math, memory, or zoom traces.

From the Display

A Touch the Timebase descriptor box to open the Timebase dialog.

B Touch button to select a Sampling Mode.

C Enter Time/Division.

D Enter optional Delay time, or use the button to Set To Zero.

E Select number of Active Channels to increase/decrease available number of sample points.

Timebase Descriptor Box

Trigger Delay (Position)

Sampling Mode (blank in real-time)

Time/div

Samples

Sample Rate

Triggers

Triggers tell the oscilloscope when to perform an acquisition. Available trigger types are described at more length in the *WaveSurfer 510 Oscilloscopes Operator's Manual.*

From the Front Panel

A Press to open the Trigger setup dialog.

B Press to control acquisition processing:
Auto – trigger after a preset period if there is no valid trigger.
Normal – trigger repeatedly whenever all conditions are met.
Single – trigger once when all conditions are met.
Stop – stop acquisition.

C Turn to raise or lower trigger voltage Level. Push to find a level.

D READY lights when trigger armed; TRIG'D lights when trigger fired.

Trigger Descriptor Box

Trigger Source

Trigger Mode

Trigger Type

Trigger Coupling

Trigger Level

Trigger Slope
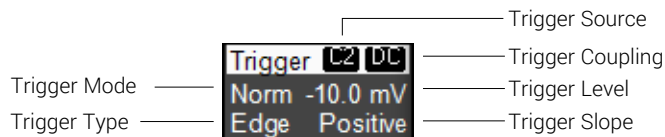
From the Display
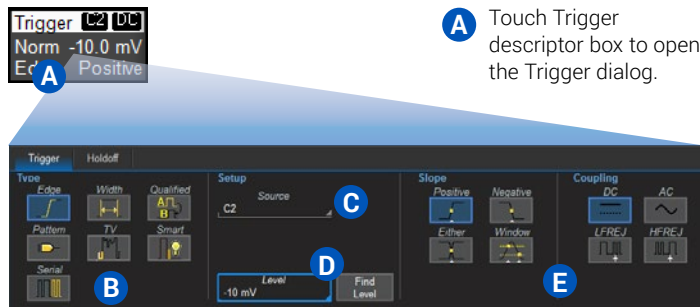
A Touch Trigger descriptor box to open the Trigger dialog.

B Touch to choose trigger Type.

C Touch to choose Source channel, or drag the channel descriptor box onto the Source field.

D Touch to set Trigger Level (V) or let software automatically Find Level.

E Make any other settings required by the trigger type, such as Coupling and Slope.

Trigger Indicators

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

Cursors

Cursors set measurement points on a trace. There are five preset cursor types, each with a unique appearance on the display: Horizontal (Time), Horizontal + Vertical, Vertical (Amplitude), Horizontal (Frequency), and Horizontal (Event). These are described in more detail in the *WaveSurfer 510 Oscilloscopes Operator's Manual*.

From the Front Panel
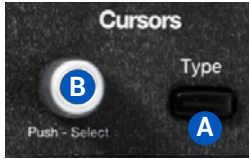
A Press to apply cursor. Continue pressing to cycle through all cursor types.

B Turn to adjust cursor position. Push to select different cursor markers to adjust.

From the Display
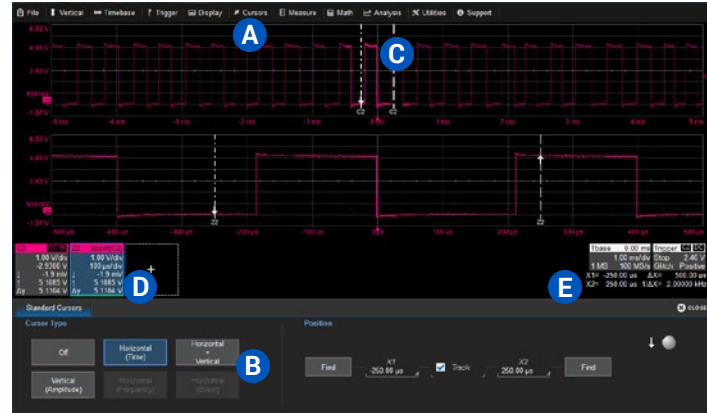
A Choose Cursor > Cursor Setup to open the Cursor dialog.

B Touch to choose Cursor Type.

C Touch-and-drag cursor markers to reposition cursor.

D Vertical Cursor readout appears on descriptor boxes.

E Horizontal Cursor readout appears below Timebase. Drag horizontal readout to zoom traces to place cursors on zoomed area.

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. Statistical measurements 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.

A Touch the Add New box and choose Measure to turn on the Measure table.

B Readout of parameter values. Drag any Px cell to target Px cell to copy the parameter setup.

C Drag trace descriptor to Px cell to change measurement source.

D Use Px controls to select/change measurement.

E Enter position of measurement gate, or drag gate markers from edge of grid. All measurements share the same gate.

F Turn on/off statistics and histicons.

Math

Math traces display the result of applying a mathematical function (e.g., Average, FFT, Histogram) to one or more traces. One important distinction between math functions and measurement parameters is that the result of math is always another waveform trace, whereas the result of measurement is a number.

A To turn on the next math trace in the series, touch the Add New box and choose Math or just drag another math descriptor box to the Add New box.

B Math trace (F1-F2) opens in separate grid from source trace.

C Math descriptor box shows math function and scaling. Touch it to open Function (Fx) setup dialog.

D Use Fx dialog to change function.

E Use Zoom subdialog to rescale math trace, or just pinch/unpinch directly over the trace.

Memories (Reference Waveforms)

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

Internal memories only persist until the oscilloscope is rebooted. To store memories indefinitely, save them to an external file by choosing File > Save Waveform. The file can then be recalled into one of the four internal memories for viewing by choosing File > Recall Waveform. Only memory files saved with the extension .trc can be recalled.

A To recall a stored memory, press the front panel Mem(ory) button to open the Memories dialog, then check On next to M1-M4.
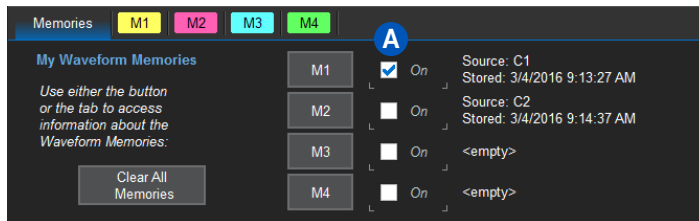
To store a new memory, either:
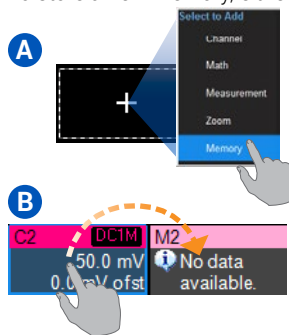
A Touch the Add New box and choose Memory to turn on the next memory trace.

B Drag the descriptor box of the trace you want stored onto the Mx descriptor box.

OR
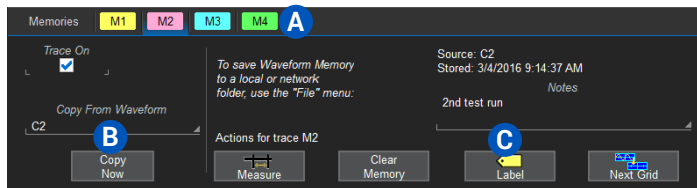
A Open the M1-M4 tab behind the Memories dialog.

B Select the trace you want stored in Copy From Waveform and touch Copy Now.

C Optionally add notes or labels to the stored waveform.

Decode

The **Decode** front panel button is activated when serial trigger and decode software options are installed. Press it to open the serial decode dialogs. Decoders apply software algorithms to extract encoded serial data information from physical layer waveforms measured on your oscilloscope. The extracted information is displayed over the waveforms, color-coded to provide fast, intuitive understanding of the relationship between protocol and signal. Serial triggers fire upon finding complex, user-defined patterns and events in the data stream. Measure/graph and eye diagram options allow you to apply special measurements designed for serial data debugging.

A Set up decoder by selecting inputs and protocol. Make other required settings on the subdialogs.

B View decoding on the colored waveform overlays.

C Touch any cell cell of the result table to zoom that single Index of data.

D When multiples decoders are running, touch the Index cell to drop-in the detailed decoding of that Index. Touch any cell *other than* Index and Protocol to zoom it.

E When there is more data than can fit in a cell, touch the white triangle to pop-up the full decoding.

F Customize the result table or apply user-defined filters to search for events in the decoded waveform.

WaveScan

Press the **WaveScan** front panel button to open the WaveScan dialogs. 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.
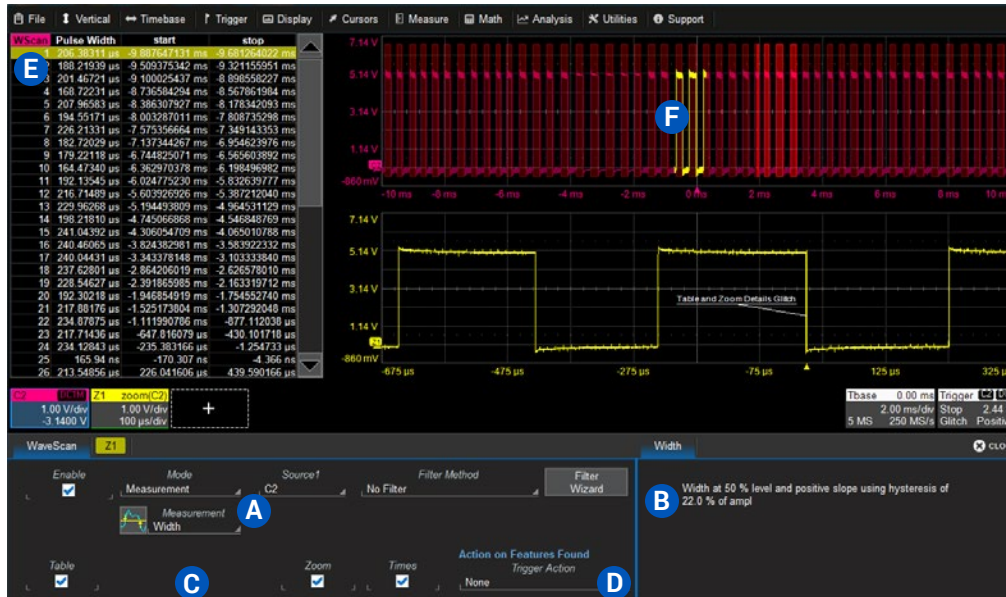
A Choose scan Mode (event to find) and Source waveform to search.

B Refine scan settings (if needed).

C Select different views of the results: event table with/without time stamps, scan overlay, zoom trace, or all.

D Take action when an event is found, such as sending a pulse or sounding an alarm.

E Result table lists found events. Touch an event to zoom it on the grid.

F Color overlays mark the events on the source trace.

History Mode

The **History** front panel button puts the instrument into History Mode. History Mode allows you to review any acquisition saved in the oscilloscope's history buffer, which automatically stores all acquisition records until full. Not only can individual acquisitions be restored to the grid, you can "scroll" backward and forward through the history at varying speeds to capture details and changes in the waveforms over time. Each record is indexed and time-stamped, and you can choose to view the absolute time of acquisition or the time relative to where you are in the history.

A Choose to display Table with/without Relative Time stamps.

B Use the Auto Play buttons and the slider bar at the bottom of the dialog to "replay" the history. This is a useful way to find events of interest.

C When you find something of interest, Pause to freeze the display and select the Index row of the table to see the details.

Saving and Sharing Data

Use the oscilloscope **File menu** options to save and recall data. See the *WaveSurfer 510 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 Print button as you work. Recall 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 measurements and analyses to be performed.

LabNotebook files can be edited, annotated and exported into a preformatted HTML, .RTF, or .PDF report. They can also 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 front panel Print button captures an image of the screen, which will then be handled according to your chosen Print method (sent to a printer, saved to an image file, etc.). Before printing or saving the capture, use the drawing tools, same as LabNotebooks, to annotate the image.

You can also use the touch screen File menu to Save Screen Image.

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.

Software Options

These are just some of the options available to enhance the performance of a WaveSurfer 510.

Spectrum Analyzer Software (WS510-SPECTRUM) simplifies setup and use of the oscilloscope for analyzing frequency-dependent effects. It allows users who are familiar with RF spectrum analyzers to start using the FFT with little or no concern about the details of setting up an FFT.

Power Analysis Software (WS510-PWR) provides exceptional ability to measure and analyze the operating characteristics of power conversion devices and circuits, such as device power switching, control loop modulation, and line power harmonics.

Electric-Telecom Pulse Mask Test (WS510-ETPMT) performs automated compliance mask tests on a wide range of electrical telecom standards.

Many **Serial Trigger & Decoder Options** provide added insight when debugging serial data. For the most up-to-date list of options, visit teledynelecroy.com/serialdata.

REFERENCE

WaveSurfer 510 Oscilloscopes

Service

Contact your local Teledyne LeCroy service center for calibration or other service.

Returning a Product

If the product cannot be serviced on location, the service center will give you a **Return Material Authorization (RMA)** code and instruct you 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 device. Do not include the manual.

2. Pack the product in its case, surrounded by the original packing material (or equivalent).

3. Label the case with a tag containing:
• The RMA
• Name and address of the owner
• Product model and serial number
• Description of failure or requisite service

4. Pack the product case in a cardboard shipping box with adequate padding to avoid damage in transit.

5. Mark the outside of the box with the shipping address given to you by Teledyne LeCroy; be sure to add the following:

• ATTN: <RMA code assigned by Teledyne LeCroy>
• FRAGILE

6. **If returning a product to a different country:**

• Mark the shipment as a **Return of US manufactured goods for warranty repair/recalibration.**

• If there is a cost for the service, list the cost in the Value column and the original purchase price **For insurance purposes** only.

• Be very specific about the reason for shipment. Duties may have to be paid on the value of the service.

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**

Teledyne LeCroy
700 Chestnut Ridge Road
Chestnut Ridge, NY, 10977, USA
teledynelecroy.com

Sales and Service:
Ph: 800-553-2769 / 845-425-2000
FAX: 845-578-5985
contact.corp@teledynelecroy.com

Support:
Ph: 800-553-2769
customersupport@teledynelecroy.com

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 55011:2010, Radiated and Conducted Emissions Group 1, Class A [2] [3]

EN 61000-3-2/A2:2009 Harmonic Current Emissions, Class A

EN 61000-3-3:2008 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/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/A1:2010 Electrical Fast Transient/Burst, 1 kV on power supply lines, 0.5 kV on I/O signal data and control lines [4]

EN 61000-4-5:2006 Power Line Surge, 1 kV AC Mains, L-N, L-PE, N-PE [4]

EN 61000-4-6:2009 RF Conducted Electromagnetic Field, 3 Vrms, 0.15 MHz - 80 MHz

EN 61000-4-11:2004 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 LeCroy Europe GmbH
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 11:2011 Radiated and Conducted Emissions, Group 1, Class A.

Australia / New Zealand Contacts:*

RS Components Pty Ltd.	RS Components Ltd.
Suite 326 The Parade West	Units 30 & 31 Warehouse World
Kent Town, South Australia 5067	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 to Directives 2012/19/EU and 2013/56/EU 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)
This instrument and its accessories conform to the 2011/65/EU RoHS2 Directive.

ISO Certification
Manufactured under an ISO 9000 Registered Quality Management System.

Warranty

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 oscilloscope 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 or 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 oscilloscope. Spare and replacement parts, and repairs, all have a 90-day warranty.

The oscilloscope'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 warranty of the original equipment manufacturer.

Intellectual Property

All patents pertaining to the WaveSurfer 510 can be found on our website at:

teledynelecroy.com/patents/

Windows License Agreement

The WaveSurfer 510 Series oscilloscope software runs on the Windows operating system. Teledyne LeCroy's agreement with Microsoft prohibits users from installing third-party software on WaveSurfer 510 oscilloscopes that is not relevant to measuring, analyzing, or documenting waveforms.

TELEDYNE LECROY
Everywhere**you**look™