# GETTING STARTED MANUAL

# WAVESURFER 400 SERIES

# GETTING STARTED MANUAL

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# Introduction

This brief guide includes important safety and installation information for your WaveSurfer 400 Series oscilloscope along with brief operating procedures to get you started with the basics of operating your oscilloscope.

This manual is available in PDF format in languages other than English on the CD included with your WaveSurfer.

You can change your user interface to be in a language different than English.  To do this, select **Utilities** in the Top (File) Menu, then select **Preferences.  Language** selection is settable in this menu.

The information contained in this guide also appears in greater detail in the on-line **Help** manual. This searchable manual is resident in the scope and also supplied on CD-ROM, shipped with your scope.

# Safety Requirements

This section contains information and warnings 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 safety precautions specified in this section.

## SAFETY SYMBOLS AND TERMS

Where the following symbols or terms appear on the instrument's front or rear panels, or in this manual, they alert you to important safety considerations.

This symbol is used where caution is required. Refer to the accompanying information or documents in order to protect against personal injury or damage to the instrument.
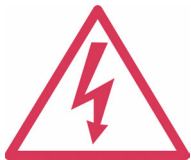
This symbol warns of a potential risk of shock hazard.
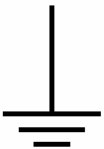
This symbol is used to denote the measurement ground connection.

This symbol is used to denote a safety ground connection.

This symbol shows that the switch is an On/Hibernate switch. When it is pressed, the DSO's state toggles between Operating and Hibernate state. This switch is not a disconnect device. To completely remove power to the DSO, the power cord must be unplugged from the AC outlet after the DSO is placed in Hibernate state.

This symbol is used to denote "Alternating Current."

**CAUTION**

The CAUTION sign indicates a potential hazard. It calls attention to a procedure, practice or condition which, if not followed, could possibly cause damage to equipment. If a CAUTION is indicated, do not proceed until its conditions are fully understood and met.

**WARNING**

The WARNING sign indicates a potential hazard. It calls attention to a procedure, practice or condition which, if not followed, could possibly cause bodily injury or death. If a WARNING is indicated, do not proceed until its conditions are fully understood and met.

**CAT I**

Installation (Overvoltage) Category rating per EN 61010-1 safety standard and is applicable for the oscilloscope front panel measuring terminals. CAT I rated terminals must only be connected to source circuits in which measures are taken to limit transient voltages to an appropriately low level.

## OPERATING ENVIRONMENT

The instrument is intended for indoor use and should be operated in a clean, dry environment with an ambient temperature within the range of 5 °C to 40 °C.

**Note:** Direct sunlight, radiators, and other heat sources should be taken into account when assessing the ambient temperature.

The design of the instrument has been verified to conform to EN 61010-1 safety standard per the following limits:

Installation (Overvoltage) Categories II (Mains Supply

**⚠ WARNING**

The DSO must not be operated in explosive, dusty, or wet/damp atmospheres.

**⚠ CAUTION**

Protect the DSO's display touch screen from excessive impacts with foreign objects.

Connector) & I (Measuring Terminals)

Pollution Degree 2

Protection Class I

**Note:**

Installation (Overvoltage) Category II refers to local distribution level, which is applicable to equipment connected to the mains supply (AC power source).

Installation (Overvoltage) Category I refers to signal level, which is applicable to equipment measuring terminals that are connected to source circuits in which measures are taken to limit transient voltages to an appropriately low level.

Pollution Degree 2 refers to an operating environment where normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected.

Protection Class 1 refers to a grounded equipment, in which protection against electric shock is achieved by Basic Insulation and by means of a connection to the protective ground conductor in the building wiring.

## COOLING REQUIREMENTS

⚠ **CAUTION**

Do not exceed the maximum specified front panel terminal (CH1, CH2, CH3, CH4, EXT) voltage levels. Refer to Specifications for more details.

⚠ **CAUTION**

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

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The instrument relies on forced air cooling with internal fans and ventilation openings. Care must be taken to avoid restricting the airflow around the apertures (fan holes) at the sides and rear of the DSO. To ensure adequate ventilation it is required to leave a 10 cm (4 inch) minimum gap around the sides, front, and rear of the instrument.

⚠️ **CAUTION**

Do not block the ventilation holes located on both sides and rear of the DSO.

⚠️ **CAUTION**

Do not allow any foreign matter to enter the DSO through the ventilation holes, etc.

## AC POWER SOURCE

The instrument operates from a single-phase, 90-264 $V_{rms}$ AC power source at 47-63 Hz, or single-phase 90-132 $V_{rms}$ AC power source at 380-420 Hz.

**Note:**

The instrument automatically adapts itself to the AC line input within the following ranges:

| Voltage Range: | 90 to 264 Vrms | 90 to 132 Vrms |
|---|---|---|

is required because the instrument automatically adapts to line voltage.

Depending on the accessories installed (USB printer, front panel probes, PC port plug-ins, etc.), the instrument can draw up to 180 VA.

| Frequency Range: | 47 to 63 Hz | 380 to 420 Hz |
|---|---|---|

## POWER AND GROUND CONNECTIONS

The instrument is provided with a grounded cord set containing a molded three-terminal polarized plug and a standard IEC320 (Type C13) connector for making line voltage and safety ground connection. The AC inlet ground terminal is connected directly to the frame of the instrument. For adequate protection against electrical shock hazard, the power cord plug must be inserted into a mating AC outlet containing a safety ground contact. Use
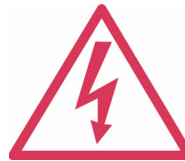
**WARNING**

Electrical Shock Hazard!

Any interruption of the protective conductor inside or outside of the DSO, or disconnection of the safety ground terminal creates a hazardous situation.

Intentional interruption is prohibited.

only the power cord specified for this instrument and certified for the country of use.

The DSO should be positioned to allow easy access to the socket-outlet. To completely remove power to the DSO, unplug the instrument's power cord from the AC outlet after the DSO is placed in Hibernate state.

In Hibernate state the DSO is still connected to the AC supply. The instrument can only be placed in a complete Power Off state by physically disconnecting the power cord from the AC supply. It is recommended that the power cord be unplugged from the AC outlet if the DSO is not being used for an extended period of time.

See On/Hibernate Switch for more information.

**CAUTION**

The outer shells of the front panel terminals (CH1, CH2, CH3, CH4, EXT) are connected to the instrument's chassis and therefore to the safety ground.

## ON/HIBERNATE SWITCH

The front panel On/Hibernate switch controls the operational state of the DSO. This toggle switch is activated by momentarily pressing and releasing it.

There are two basic DSO states: On or Hibernate. In the "On" state, the DSO, including its computer subsystems (CPU, hard drive, etc,) is fully powered and operational. In the "Hibernate" state, the DSO, including computer subsystems, is powered off with the last operational state stored in DSO memory.

Always use the On/Hibernate switch to place the DSO in Hibernate state so that it executes a proper shutdown process to preserve settings before powering itself off.

## CALIBRATION

The recommended calibration interval is one year. Calibration should be performed by qualified personnel only.

## CLEANING

Clean only the exterior of the instrument, using a damp, soft cloth. Do not use chemicals or abrasive elements. Under no circumstances allow moisture to penetrate the
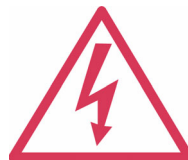
**WARNING**

Electrical Shock Hazard!

No operator serviceable parts inside. Do not remove covers.

instrument. To avoid electrical shock, unplug the power cord from the AC outlet before cleaning.

Refer servicing to qualified personnel.

## ABNORMAL CONDITIONS

Operate the instrument only as intended by the manufacturer.

If you suspect the DSO's protection has been impaired, disconnect the power cord and secure the instrument against any unintended operation.

The DSO's protection is likely to be impaired if, for example, the instrument shows visible damage or has been subjected to severe transport stresses.

Proper use of the instrument depends on careful reading of all instructions and labels.

**⚠ WARNING**

Any use of the DSO in a manner not specified by the manufacturer may impair the instrument's safety protection. The instrument and related accessories should not be directly connected to human subjects or used for patient monitoring.

## VIRUS PROTECTION

Because your scope runs on a Windows-based PC platform, it must be protected from viruses, as with any PC on a corporate network. It is crucial that the scope be kept up to date with Windows Critical Updates, and that anti-virus software be installed and continually updated.

Visit www.lecroy.com/dsosecurity for more information regarding Windows Service Pack compatibility with LeCroy operating software, and related matters.

# When Your Scope is Delivered

## CHECK THAT YOU HAVE EVERYTHING

First, verify that all items on the packing list or invoice copy have been shipped to you. Contact your nearest LeCroy customer service center or national distributor if anything is missing or damaged. If there is something missing or damaged, and you do not contact us immediately, we cannot be responsible for replacement.

**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. 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. LECROY WILL RETURN ALL PRODUCTS UNDER WARRANTY WITH TRANSPORT PREPAID.**

## WARRANTY

**The oscilloscope is warranted for normal use and operation, within specifications, for a period of three years from shipment. 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.**

**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 LeCroy are covered solely by the warranty of the original equipment manufacturer.

## MAINTENANCE AGREEMENTS

We offer a variety of services under the heading of Maintenance Agreements. These give extended warranty and allow you to budget maintenance costs after the initial three-year warranty has expired. Installation, training, enhancements, and on-site repairs — among other services — are available through special supplemental support agreements. Inquire at your LeCroy customer service center or national distributor.

## WINDOWS LICENSE AGREEMENT

LeCroy's agreement with Microsoft prohibits users from running software on LeCroy oscilloscopes that is not relevant to measuring, analyzing, or documenting waveforms.

### End-User License Agreement For Lecroy® X-Stream™ Software

The software in this product is made available under license from LeCroy Corporation. For full details of the End User License Agreement, please refer to the Copyright section in the on-line **Help**.

# Installation and Power Up

## POWER UP

The oscilloscope supports hibernate mode.  By default, your oscilloscope is configured to hibernate when you press the ON/OFF button.

## SOFTWARE

You can find out the scope's software and hardware configuration as follows:

1.  In the tool bar, touch **Utilities**.

2.  In the dialog area, touch **Status**.

## ADDING A NEW OPTION

To add a software option you will need a code to enable the option. Call LeCroy Customer Support to place an order and receive the code.

## RESTORING SOFTWARE

### *Restarting the Application*

Upon initial power-up, the scope will load the instrument application software automatically.

- If you exit the application and want to reload it, touch the shortcut icon on the desktop:

.

- If you minimize the application, touch the appropriate task bar or desktop button to maximize it:

. or 

## *Restarting the Operating System*

If you need to restart the Windows® operating system, you will have to reboot the scope by accessing Shut Down selection from the File Menu to shut down the Scope. Then, the next time the Power ON button is pressed, the oscilloscope will boot up from the SHUT DOWN condition (this will take longer than from normal Hibernate mode).

## HARDWARE CONNECTIONS

*(1) Centronics Port*

*(2) Ethernet Port*

*(3) Mouse*

*(4) Keyboard*

*(5) USB Ports*

*(6) RS-232-C Port*

*(7) External VGA Monitor*

*(8) Line Out*

*(9) Line In*

*(10) Microphone*
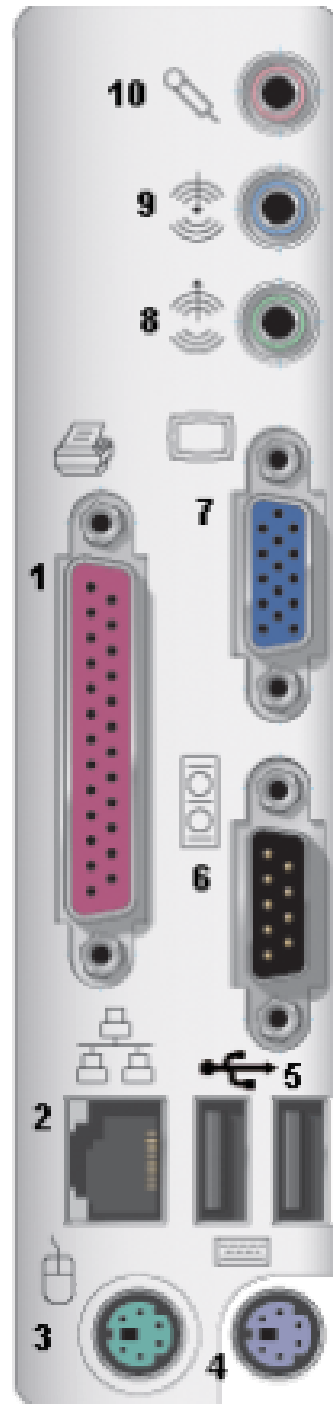
# System Recovery

Your WaveSurfer oscilloscope was designed to operate very reliably for many years.  However, the application software does run on an internal hard drive.  In the event of a hard disk problem, you may need to recover the application software on drive "C:" and/or the user data on drive "D:".  Since WaveSurfer does not have an installed CD-ROM drive, LeCroy has provided a recovery application program that will allow you to recover the application software and user data by accessing a partition on the hard drive. This is very easy to do, if necessary.  Instructions are as follows:

1.  Connect a keyboard and a mouse to the WaveSurfer.
2.  Power the WaveSurfer ON.
3.  As soon as anything (logo, graphic, text) appears on the screen after boot-up, press and hold down the **F4** key.
4.  The FirstWare cME console splash screen displays. Wait about 10 seconds.
5.  The cME console End User License Agreement displays. There are [Accept] and [Decline] buttons at the end of this License Agreement. Click the [Accept] button.
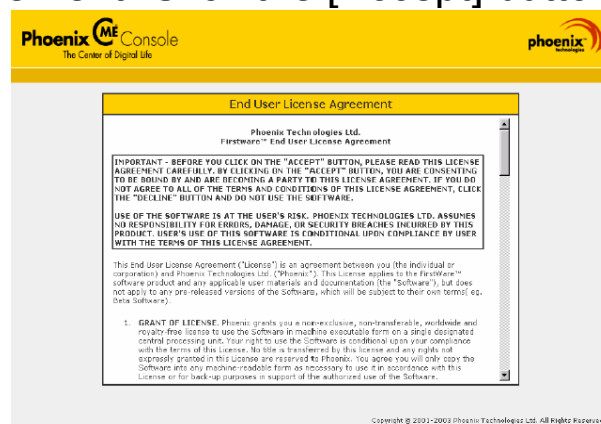
6.  Phoenix cME Console main page displays. Click "Applications".

7. Click Phoenix FirstWare Recover. (If you click "SYSTEM RESTART" button, WaveSurfer will reboot.)
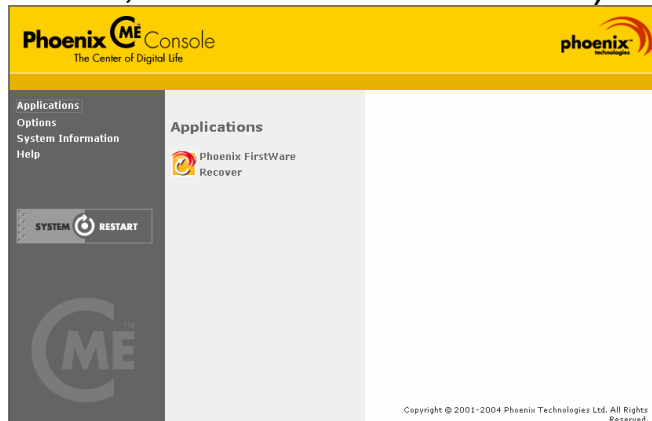
8. Click the LAUNCH button.
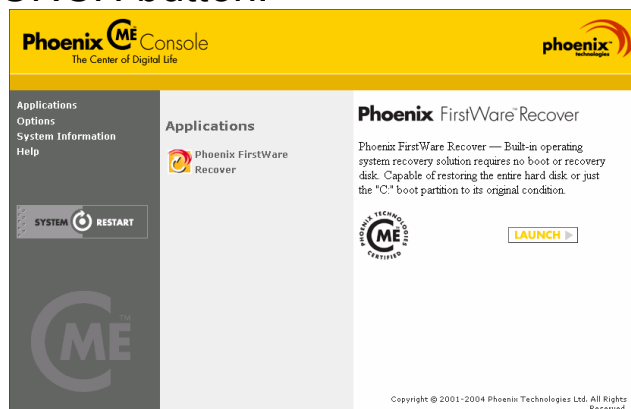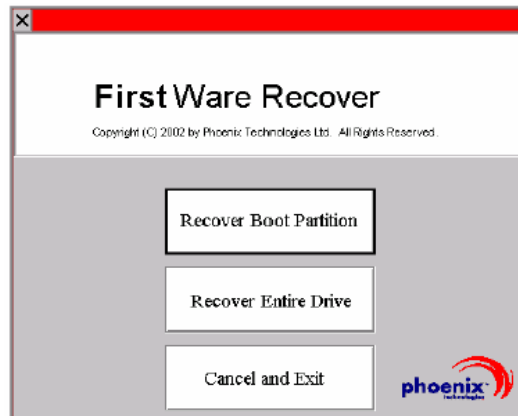
9. The First Ware Recover splash screen displays.

10. Read the license agreement and click [Accept] to proceed.

11. The Select Recover Type screen displays. Select recover option, as defined below:

> **[Recover Boot Partition]** Recovers drive "C:" only. Drive "C:" is the drive that the WaveSurfer application

software is stored on. Drive "D:" is not recovered. (Drive "D:" is USERDATA area of the hard disk.)

**[Recover Entire Drive]** Select this button if you want to recover both the "C:" and "D:" drives of the hard disk (Note: USERDATA will be erased if this option is selected)

**First Ware Recover**

Copyright (C) 2002 by Phoenix Technologies Ltd. All Rights Reserved.

Recover Boot Partition

Recover Entire Drive

Cancel and Exit

phoenix

12. Read the license agreement and click [Accept] to proceed.

13. The following dialog box is displayed. Click the [Yes] button.
    - When you selected [Recover Boot Partition], the dialog message is "This operation will permanently overwrite the contents of your boot partition. Are you sure that wish to continue?"
    - When you selected [Recover Entire Drive], the dialog message is "This operation will permanently overwrite the contents of your entire drive. Are you sure that wish to continue?"
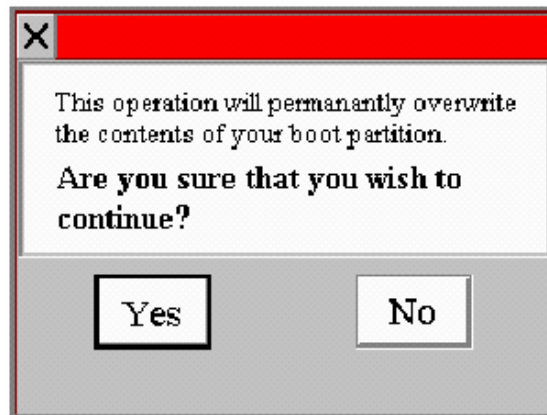
14. The recovery starts, and the FirstWare Progress screen displays. No further selections are required. The recovery takes about 10 minutes.



15. When the recovery is completed, Windows will start automatically. No message or dialog box will display.
16. When you selected [Recover Entire Drive] at step 11, CheckDisk will run after the Windows splash screen.
17. After "Welcome" screen, FBReseal dialog box will display. Click the [OK] button. Windows will restart automatically.

# Probes

## OVERVIEW

The PP007 supplied with your WaveSurfer is calibrated for the WaveSurfer input impedance.  If you use other passive probes with your WaveSurfer, you should make sure that you calibrate them using the 1 kHz square wave signal available on the AUX OUT terminal before using them for signal measurements.

LeCroy offers a variety of other passive and active probes for use with your WaveSurfer 400 Series scope. Visit www.lecroy.com for specifications and ordering information.

| | |
|---|---|
| **Current Probes** | Available from 15A to 500A. |
| **Active Probes** | Single-ended to >1 GHz. |
| **Differential Probes** | Differential from 15 MHz to >1 GHz. |
| **Passive Probes** | The PP007-WS is the passive probe that guarantees full instrument bandwidth at the probe tip.  Other passive probes can be used with performance limitations. |
| **High Voltage Probes** | For measuring up to 20 kV. |

# Using the Front Panel Controls

## FRONT PANEL BUTTONS AND KNOBS
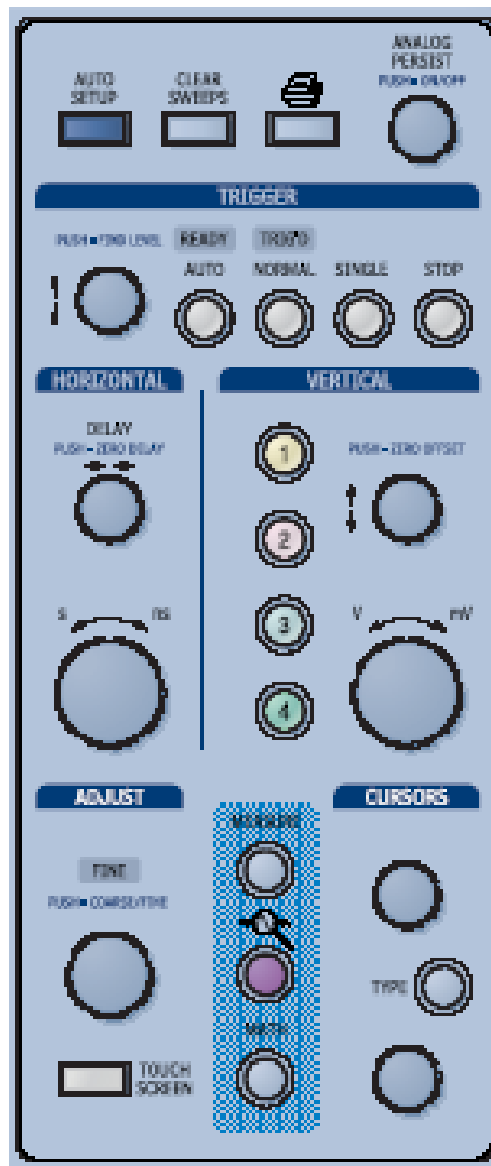
The WaveSurfer front panel is designed to allow you to operate basic oscilloscope functions without having to open software

menus. Use the Horizontal and Vertical controls as you would for any other oscilloscope.  The various controls are described below.

## VERTICAL CONTROLS
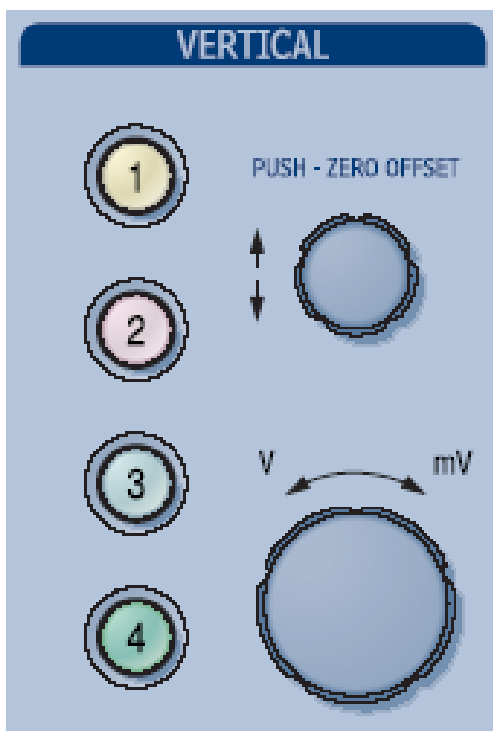
Vertical Controls are multi-plexed for each channel. The lighted channel button indicates which channel the controls are *active* for.

- To turn a channel ON, simply press the channel button.

- To make a channel *active,* simply press the channel button.

- To turn a channel OFF, press the channel button to make it active, then press it again to turn it OFF.

When a channel is *active*, the Descriptor Label changes from this

C1  AC1M
100 mV/div
0.0 mV offset  to this

C1  DC50
50.0 mV/div
0.0 mV offset

When a channel is turned OFF, the next channel in sequence will become the active channel.

# W A V E S U R F E R   4 0 0   S E R I E S

If no front panel channel buttons are lit, it either means that no channels are turned ON, or that a Math, Zoom, or Memory trace is active.  In that case, the vertical offset and sensitivity knobs adjust the vertical position and vertical scale of the Math, Zoom, or Memory (Reference Waveform) trace.

## HORIZONTAL CONTROLS
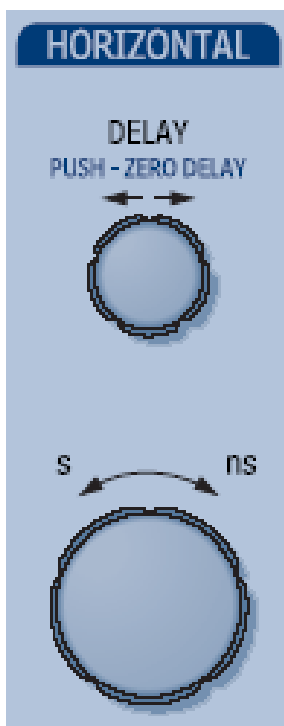
Set up the timebase by using the front panel **Horizontal** controls, just as for analog scopes.  The WaveSurfer will allocate memory as needed to maintain the highest sample rate possible for the timebase setting.

### *Acquisition Mode*

The WaveSurfer can acquire in either Real-Time (up to 2 GS/s), Random Interleaved Sampling (RIS, up to 50 GS/s), or Roll Mode (up to 100 kS/s)

At certain very low time/division settings, the oscilloscope will default to RIS mode of operation to maintain the highest sample rate.

At certain very high time/division settings, the oscilloscope will default to Roll mode of operation so that display of the signal on the screen is not delayed by the long acquisition time.  Maximum sample rate in Roll mode of operation is 100 kS/s.

## Combining of Channels

Channels are automatically combined to maintain the highest sample rate possible in Real-Time mode. The highest sample rate is double the 4-ch sample rate. This process is called Interleaving. Memory is also doubled during interleaving, allowing for longer acquisitions. Channels 1 and 2 interleave, as do channels 3 and 4. Therefore, if you are using two channels and want the maximum sample rate, connect them accordingly. The basic rule is to choose either channel 1 or 2 for your first input, and either channel 3 or 4 for the second input.

When you combine channels, uncombined channels like EXT BNC remain available for triggering, even though they are not displayed.

## TRIGGER CONTROLS
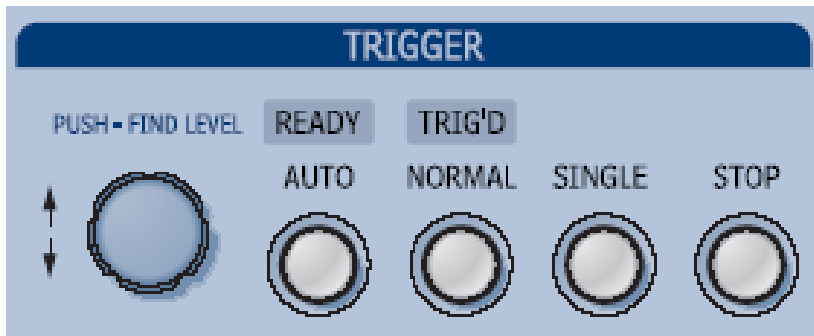


| STOP | Cancels the capture in Auto, Normal, or Single trigger mode |
|---|---|
| AUTO | Triggers the scope after a time-out, even if the trigger conditions are not met. |
| NORMAL | Triggers the scope each time a signal is present that meets the conditions set for the type of trigger selected. |
| SINGLE | Arms the scope to trigger once (single-shot acquisition) when the input signal meets the trigger conditions set for the type of trigger selected. If the scope is already armed, it will force a trigger. |

## AUTOSETUP BUTTON
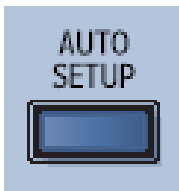
Automatically sets timebase, trigger, and sensitivity to display a wide range of repetitive signals.

## MEASURE, ZOOM, AND MATH QUICK BUTTONS
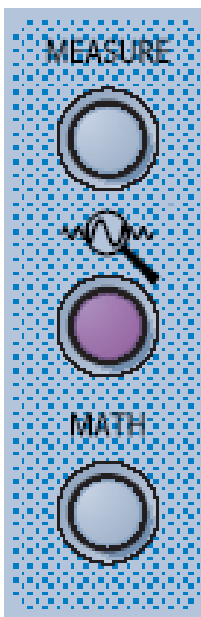
**Measure** – Press once to open the measure menu. Press again to close the menu.

**QuickZoom** ( ) – Press once to create zooms of all displayed channels. Press again to UnZoom.

**Math** – Press once to turn on the Math trace, and display the Math Setup menu. Press again to close the menu.

# WAVESURFER 400 SERIES

## CURSOR KNOBS AND BUTTONS
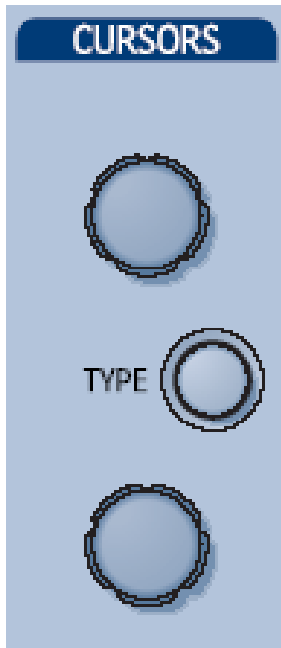
WaveSurfer has dedicated dual cursor knobs for cursor control. Cursors always default to a "relative" state (two cursors ON).

- Knobs – Rotate to adjust cursor position. If Cursors are OFF, rotating either knob will turn Cursors ON. Push to set to default position

- Type Button – Pressing the Type button once will turn Cursors ON to Horizontal (Time) measurements. Pressing again will change to Vertical (Amplitude) measurements. Pressing a third time will turn Cursors OFF.

## ADJUST KNOB

The adjust knob can be used to make adjustments to a value when a menu is open and the selected control has a yellow highlight.

Push the knob in to toggle between coarse and fine adjustments.

## PRINT BUTTON

This button can be programmed to print the displayed screen to a file, a printer, the clipboard, or sends it as an e-mail attachment. Select the device and format it in the Utilities Hardcopy dialog.

## ANALOG PERSISTENCE
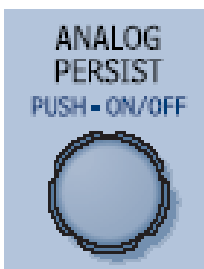
The analog Persistence feature helps you display your waveform and reveal its idiosyncrasies or anomalies for a repetitive signal. Use Persistence to accumulate on-screen points from many acquisitions to see your signal change over time. Press the knob to turn persistence ON to "Analog" mode, press again to view "Color-graded" mode, and press again to turn OFF. Rotate the knob to adjust the saturation of the persisted waveforms.

## CLEAR SWEEPS

Clears data from multiple sweeps (acquisitions) including: persistence displays, parameter (measurement) statistics, and averaged traces.

## TOUCH SCREEN

The Touch Screen lighted pushbutton indicates if the oscilloscope touch screen is operational.  If the button is lighted, the touch screen is ON.  If the button is not lighted, the touch screen is turned OFF.  The button toggles between these two states.

# Understanding Display Information

WaveSurfer's display contains valuable information about the current settings of your Vertical (channel), Horizontal (Timebase) and Trigger controls. In addition, there are many shortcuts that are available by using the touch screen capability of your display to quickly access information or to open menus.

Top Menu Bar

Grid Area

Descriptor Labels

Message Bar
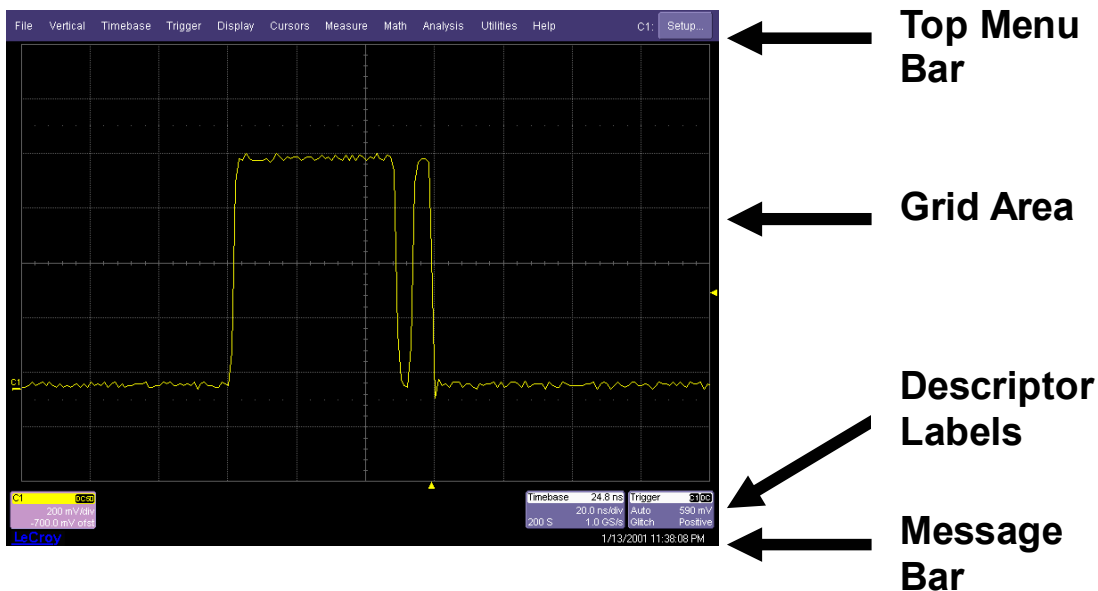
## TOP MENU BAR ("FILE" MENU)

The Top Menu Bar provides access to various software menus. It is very similar to the "File" menu on any Windows program. For common oscilloscope operations, you will not need to use the Top Menu Bar, since you can access most menus from the Front Panel or from the Descriptor Labels. However, it is the only way to access setup or other menus for the following:

- Display Setup

- Save or Recall Waveform

- Save or Recall Setups

- Print Setup

- Vertical (Channel), Horizontal, or Trigger Status

- Memory (Reference Waveform) Setup

- Pass/Fail Setup

- Utilities and Preferences Setup

- Help Access

At the right end of the Top Menu Bar is an Undo button  . This button will appear after the AutoSetup front panel button is pressed, and after Zooming is performed. If you want to perform an Undo operation, it must be the very next operation after you perform the Autosetup or Zoom operation.

## GRID AREA
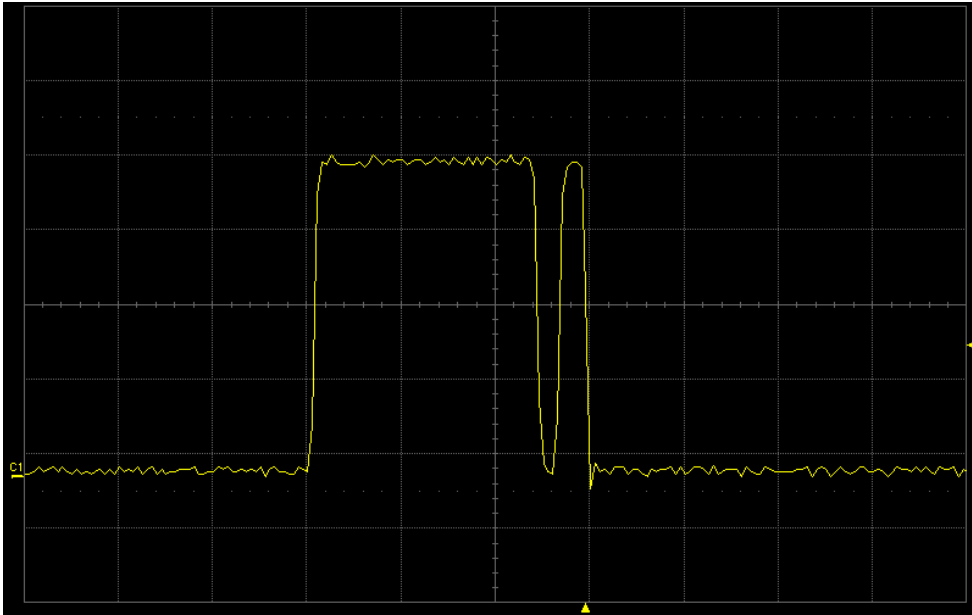


The grid area is divided into 8 vertical divisions and 10 horizontal divisions, just like any other oscilloscope.  There are several indicators on the grid to help you understand the following:

- Trigger Delay setting

- Trigger Level Setting

- Trace Zero Level

These indicators are color-coded to the same color as the channel that the oscilloscope is currently set to trigger on.
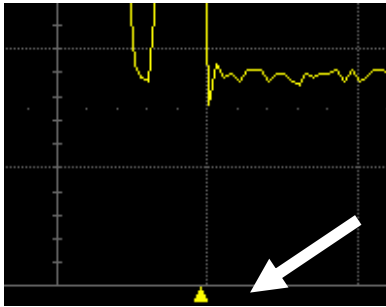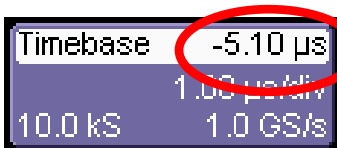
**Trigger Delay Indicator**



The Trigger Delay Indicator is a color-coded triangle that is positioned horizontally on the grid.

Trigger Delay horizontally positions the scope trace on the display so you can observe the signal prior to the trigger time. Delay adjusts the pre- and post-trigger time.
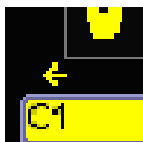


Post-trigger delay is indicated by a color-coded arrow pointing to the left.



All trigger delay values (including post-trigger delay, shown here) are displayed in the Timebase Descriptor Label.

Zero delay is the horizontal center of the oscilloscope display.

To change Trigger Delay, use the front panel Delay knob in the Horizontal Control area.  Rotate the knob to adjust, or push to zero.
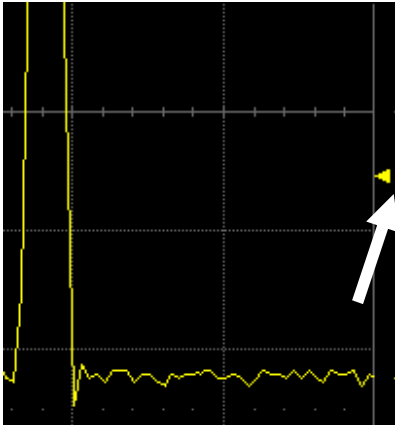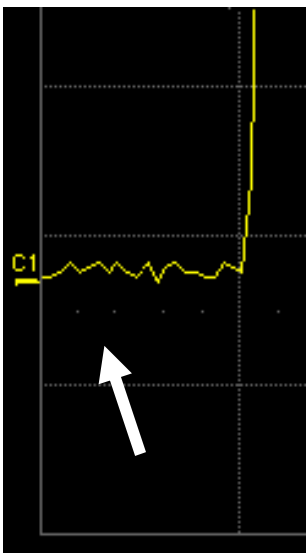
## Trigger Level Indicator

The Trigger Level Indicator is a color-coded triangle that is positioned vertically on the grid.

The solid triangle may also appear with a hollow triangle of the same color. The hollow triangle indicates what the trigger level will be for the next valid trigger.

Note that the Trigger Level Indicator will not be displayed if the triggered channel is not displayed.

To change Trigger Level, use the front panel knob in the Trigger Control area. Rotate knob to adjust, or push to set to 50% of the signal level.

## Zero Level Indicator

The Zero Level Indicator is a color-coded label that is positioned vertically on the grid.

To change the Zero Level, use the front panel Offset knob in the Vertical Control area. Rotate this knob to adjust, or push to set to zero volts. Push again to toggle back to the previous offset setting.

# W AVE S URFER 400 S ERIES

## DESCRIPTOR LABELS

Information is contained in rectangular boxes called Descriptor Labels.  These labels contain status information, and also act as shortcuts to the full menu when you touch them.  Descriptor Labels are displayed only for channels that are turned on.  Timebase and Trigger Descriptor Labels are always displayed.
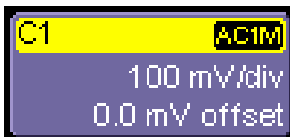
Channel trace labels show the vertical settings for the signal.  The title bar (colored area) of the label shows the Channel number on the far left.  Other information will be indicated in the title bar, as follows:

- Coupling (AC 1M$\Omega$, DC 1M$\Omega$, DC 50$\Omega$, GND)

- Deskew (DSQ) set to non-zero value

- Bandwidth Limiting (BWL) on

- Averaging (AVG) on

Some of these indicators may be abbreviated if several are on at one time.

Touch a Channel Descriptor Label once to make the front panel vertical controls active for that channel.  Touch it again to open the software menu for further adjustment.

If Cursors are ON, cursor information for this channel will appear in this trace label.

| Timebase | 0 ns |
|---|---|
| | 50.0 ns/div |
| 500 S | 1.0 GS/s |
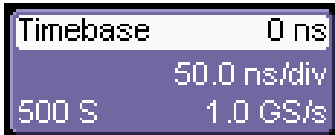
The title bar of the **TimeBase** (Horizontal) label shows the trigger delay setting at the far right. Time per division, Sample Rate, and Number of Samples are indicated below the title bar.

Touch the Timebase Descriptor Label once to open the software menu for further adjustment.

| Trigger | C1DC |
|---|---|
| Stop | 0 mV |
| Edge | Positive |

The title bar of the **Trigger** label shows the triggered channel and the trigger coupling at the far right. Trigger mode (Stopped), Trigger type (Edge), level (0 mV), and slope (Positive) are indicated below the title bar.

Touch the Trigger Descriptor Label once to open the software menu for further adjustment.

Descriptor Labels are also displayed for the Math trace, Zoom traces, and Memory (Reference Waveform) traces. These Descriptor Labels are only displayed when these traces are turned ON. Reference those sections of this manual for information on those descriptor labels.

## MESSAGE BAR

At the bottom of the oscilloscope display is a narrow message bar. The current date and time are displayed at the far right. Status, error, or other messages will also be displayed in this area.

# Multiple Methods to Do the Same Thing

The front panel and display controls provide the most common way to access your oscilloscope's capability. However, the instrument often gives you more than one way to access menus and to enter changes.

## TOP MENU BAR

If you prefer to drive the oscilloscope with the familiarity of Windows, then you might prefer to access menus from the Top (File) Menu Bar. This will open menus at the bottom of the screen where adjustments may be made.

The menu area occupies the bottom one-third of the display. To expand the signal display area, you can minimize each menu by touching the **Close** tab at the right of the dialog box.

In some limited cases, the Top Menu Bar is the only way to access certain functionality, but generally speaking, the most common oscilloscope functionality can be controlled from the front panel.

## MOUSE AND KEYBOARD OPERATION

In the procedures, we focus on using the front panel for common operations, and the touch-screen for making selections. But if you

have a mouse connected to the instrument, you can click on objects instead of touching them. Likewise, if you have a keyboard connected, you can use it to enter data instead of using the virtual keyboard provided by the instrument.

# Displaying Signals, Vertical Setup

## TURNING A CHANNEL ON

1. Connect a signal to a channel (we'll assume you connected to Channel 1 in this example, and that the channel was not already ON).

2. Press the channel 1 button on the front panel to turn on Channel 1. The button lights and the descriptor label for that channel will appear.
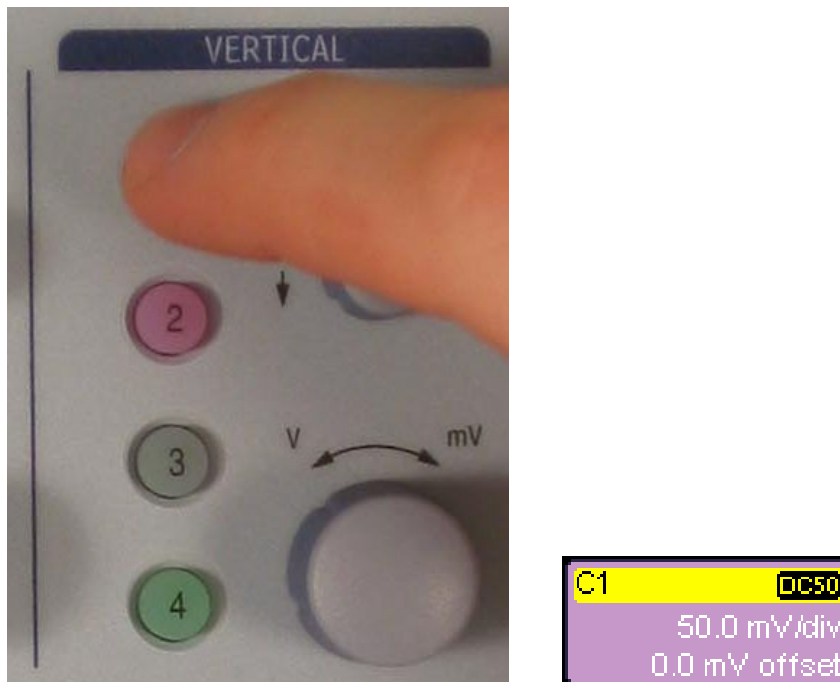


3. If the signal is not on the grid, press the **AUTO** trigger button and adjust **Horizontal** and **Vertical** front panel

controls to adjust the settings to display the signal, or simply press the **AUTOSETUP** button to quickly bring most repetitive signals onto the grid.

4.  If you need to change probe attenuation, coupling, or bandwidth limiting, open the channel setup menu for channel 1 by touching the descriptor label for channel 1 (you will need to press this twice if it is not the active trace)
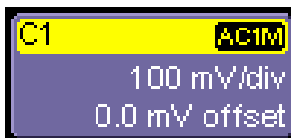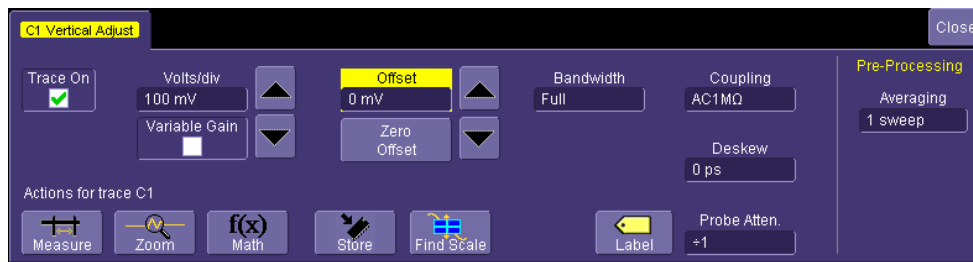


or use the **Vertical-Channel 1 Setup** selection from the Top Menu Bar
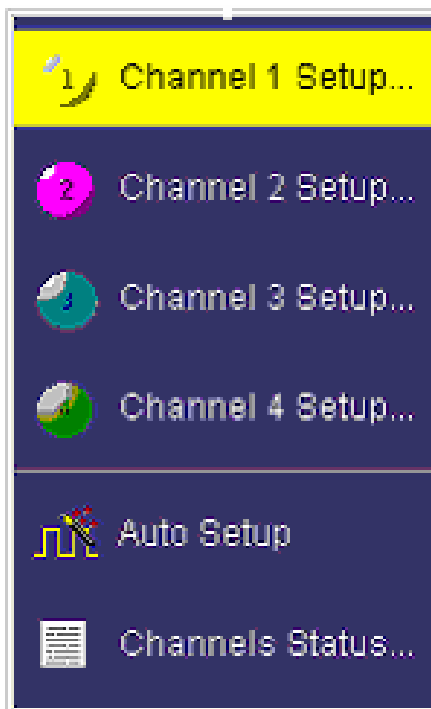


to open the Channel 1 setup menu.

The following menu will appear at the bottom of the display, and the grid area will shorten until this menu is closed (by touching the **Close** button on the upper right hand corner of this menu).



## COUPLING

Your choices of coupling are as follows:

- DC 50 ohm
- GROUND
- DC 1 Mohm
- AC 1 Mohm

To make a coupling selection, touch inside the **Coupling** field and select a coupling mode from the pop-up menu.

**Note:** The coupling choices for a channel will change if a ProBus probe is connected to a channel.

## DESKEW

**Deskew** allows you to compensate for different lengths of cables, probes, or anything else that might cause timing mismatches between signals. Connect all probes to the desired channels, then probe a common signal with each probe and adjust for timing differences using **Deskew**.

## PROBE ATTENUATION

If you use a LeCroy ProBus® compatible active probe, or a probe compatible with Probe Ring, the attenuation will be set automatically by the oscilloscope. If it is not automatically set, select a value here by touching inside the **Probe Atten** field and typing in a value on the pop-up keypad.

## BANDWIDTH LIMITS

You may sometimes want to limit high frequency noise on a very low bandwidth input signal. If this is the case, you can limit the channel bandwidth to less than the full bandwidth of the oscilloscope. Select a different bandwidth by touching inside the **Bandwidth** field and selecting a value from the pop-up menu.
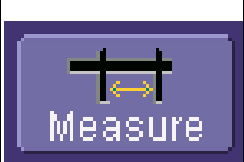
## AVERAGING YOUR SIGNAL

The WaveSurfer allows you the opportunity to continuously average your signal to reduce signal noise and aid in signal evaluation.  If you want to average, select a value here by touching inside the **Averaging** field and entering a value up to 1 million sweeps on the pop-up keypad.

## USING TOOLBAR SHORTCUTS

These toolbar shortcuts can be used to perform specific actions for the channel corresponding to the current setup menu.

For more information on Measure, Zoom, Math, and Memories (Reference Waveforms), reference the chapter for that particular item.

| | |
|---|---|
|  | Opens a Measurement selection pop-up menu.  You can then select up to 6 parameters (measurements) for the active channel from this menu without leaving the Channel Setup menu. The parameter automatically appears below the grid. |
|  | Creates a zoom trace of the channel signal. The zoom trace becomes active, and you can use the Vertical and Horizontal controls to modify its scale and position. |

| | |
|---|---|
| **f(x)** Math | Opens a Math selection pop-up menu. You can then select a math function for the active channel from this menu without leaving the Channel Setup menu. The Math trace is then displayed in its own grid. |
| Store | Copies the channel trace into its corresponding Memory (Reference Waveform) location. For instance, C1 is loaded into M1, C2 is loaded into M2, etc. |
| Find Scale | Automatically performs a vertical scaling that fits the waveform into the grid. |
| Label | Opens a Labeling pop-up menu that allows user-defined labels tied to the waveform. |

# Trigger Setup

## OVERVIEW

The oscilloscope uses many waveform capture techniques that trigger on features and conditions that you define. These triggers fall into two major categories:

- **Edge**  activated by basic waveform features or conditions such as a positive or negative slope, and hold-off

- **SMART Trigger®**  sophisticated triggers that enable you to use basic or complex conditions for triggering.

Use Edge Triggers for simple signals, and the SMART Triggers for signals with rare features, like glitches.

This Getting Started Manual contains information on setting up the Edge Trigger.  Reference the on-line **Help** for information on setting up and using SMART Triggers.

## OVERVIEW OF TRIGGER TERMS
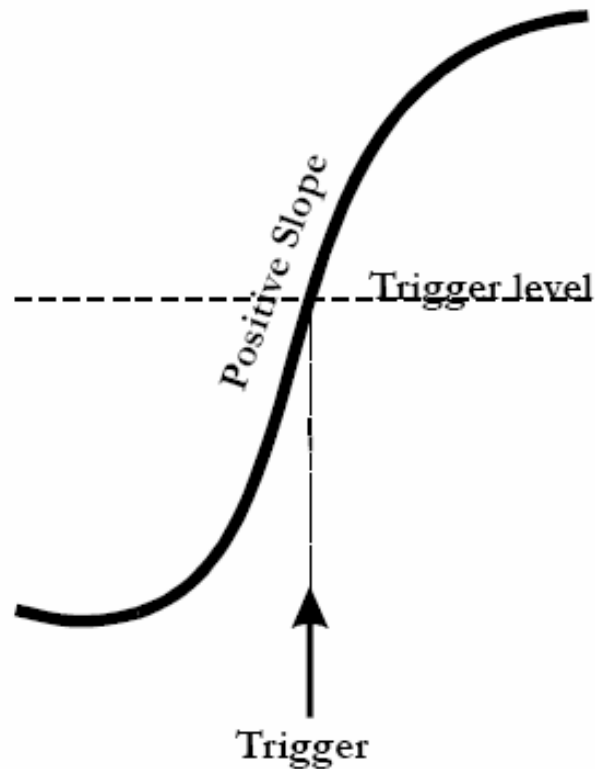


**Trigger Delay** - the amount of time that the oscilloscope trigger is adjusted from a zero value.  You can adjust the oscilloscope's trigger position from 0-100% pre-trigger (left to right on the grid), or from 0-10,000 divisions (in time units) of post-trigger.

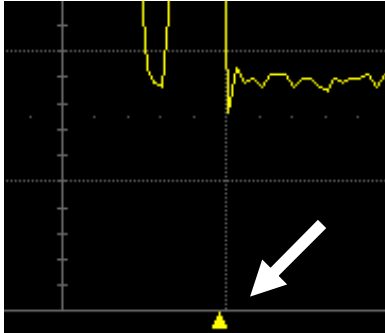**Coupling** – the type of signal coupling at the input of the trigger source.

**Level** – the threshold at which the trigger will occur, specified in volts.

**Slope** – the direction of the trigger voltage transition used for generating a particular trigger.

ISSUED: PRELIMINARY December 2003

## TRIGGER SETUP OVERVIEW

### *Trigger Delay*

The Trigger Delay Indicator is a color-coded triangle that is positioned horizontally on the grid.

Trigger Delay horizontally positions the scope trace on the display so you can observe the signal prior to the trigger time. Delay adjusts the pre- and post-trigger time. Pre-trigger delay is adjustable from 0-100%
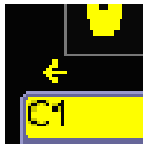
Post-trigger delay is indicated by a color-coded arrow pointing to the left. Post-trigger delay is adjustable from 0-10,000 divisions (calculated in time).
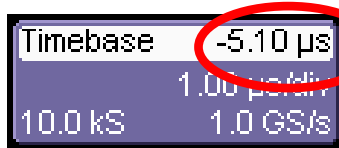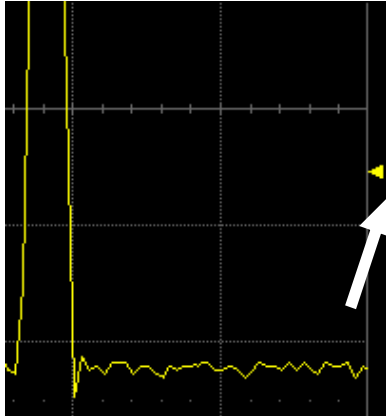
All trigger delay values (including post-trigger delay, shown here) are displayed in the Timebase Descriptor Label.

Zero delay is the horizontal center of the oscilloscope display.

To change Trigger Delay, use the **Delay** front panel knob in the Horizontal Control area. Rotate knob to adjust, or push to zero.

*Trigger Level Indicator*

The Trigger Level Indicator is a color-coded triangle that is positioned vertically on the grid.

The solid triangle may also appear with a hollow triangle of the same color. The hollow triangle indicates what the trigger level will be for the next valid trigger.

**Note:** The Trigger Level indicator will not be displayed if the triggered channel is not displayed.
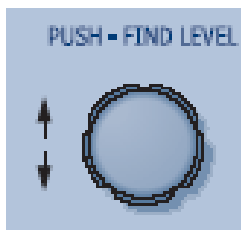
To change Trigger Level, use the front panel knob in the Trigger Control area. Rotate knob to adjust, or push to set to 50% of the signal level.

Trigger level is specified in volts and remains unchanged when you change the vertical gain settings or offset.
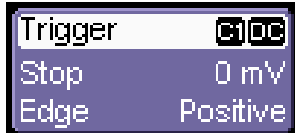
The amplitude and range of the trigger level are limited as follows:

- ± 5 screen divisions with a channel as the trigger source

- ± 0.5 V with EXT as the trigger source

- ± 5 V with EXT/10 as the trigger source

- None with LINE as the trigger source (zero crossing is used).

## *To Set Up an Edge Trigger*

1. Touch the Trigger Descriptor Label

   | Trigger | C1 DC |
   |---------|-------|
   | Stop | 0 mV |
   | Edge | Positive |

   at the bottom right of the display.  Or, in the Top Menu Bar, touch **Trigger**, then select **Trigger Setup.**

   In either case, the following menu will appear at the bottom of the display.

   Make sure that "**Edge Trigger**" is highlighted, and not "**SMART Trigger**"

2.  Touch inside the **Trigger On** field and select an input from the pop-up menu:

**C1** through **C4** are abbreviations for Channel 1 through Channel 4.

**Ext** and **Ext/10** allow you to trigger on the External Input of the oscilloscope. **Ext** input is +/-0.5V.  **Ext/10** input is +/-5.0V.

**Line** is for triggering on the Positive or Negative excursion of the AC power line (not available when using battery or DC input power).

**Pattern** (Logic Pattern) can be used as a source during several of the SMART Triggers (but not for Edge Trigger).

3. Touch inside the **Coupling** field and select a trigger coupling. **Coupling** refers to the type of signal coupling at the input of the trigger circuit. You can choose from these coupling types:
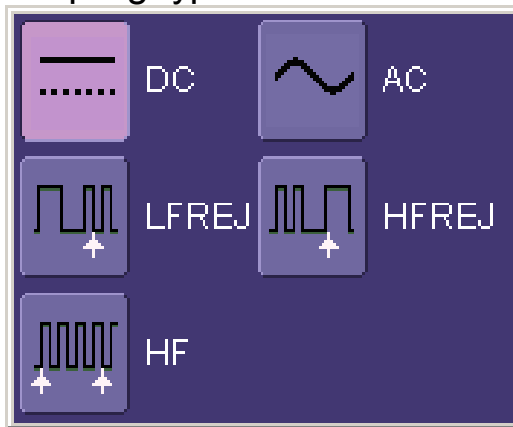


**DC** – All the signal's frequency components are coupled to the trigger circuit for high frequency bursts or where the use of AC coupling would shift the effective trigger level.

**AC** – The signal is capacitively coupled. DC levels are rejected, and frequencies below 50 Hz are attenuated.

**LFREJ** - The signal is coupled through a capacitive high-pass filter network, DC is rejected and signal frequencies below 50 kHz are attenuated. For stable triggering on medium to high frequency signals.

**HFREJ** - Signals are DC coupled to the trigger circuit, and a low-pass filter network attenuates frequencies above 50kHz; used for triggering on low frequencies.
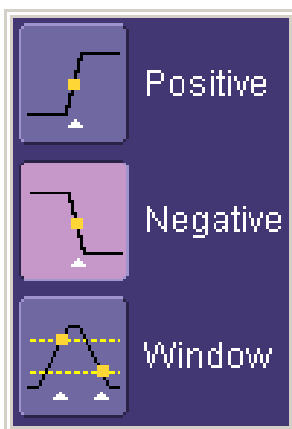
**HF** - Use only when needed for triggering on high-frequency repetitive signals. HF is automatically overridden and set to AC when incompatible with trigger characteristics such as those of SMA RT Trigger.

4.  Change the trigger **Level** by adjusting the front panel trigger level knob.
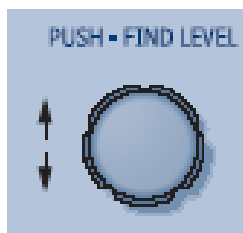


5.  Touch inside the **Slope** field and select a trigger Slope:



**Positive** and **Negative** slope refer to the direction of voltage change that you want to trigger on.

**Window** defines a region whose boundaries extend above and below the selected trigger level. A trigger event will occur when the signal leaves this window region in either direction and passes into the upper or lower region (see figure below).  The next trigger will occur when the signal again passes into the window region.
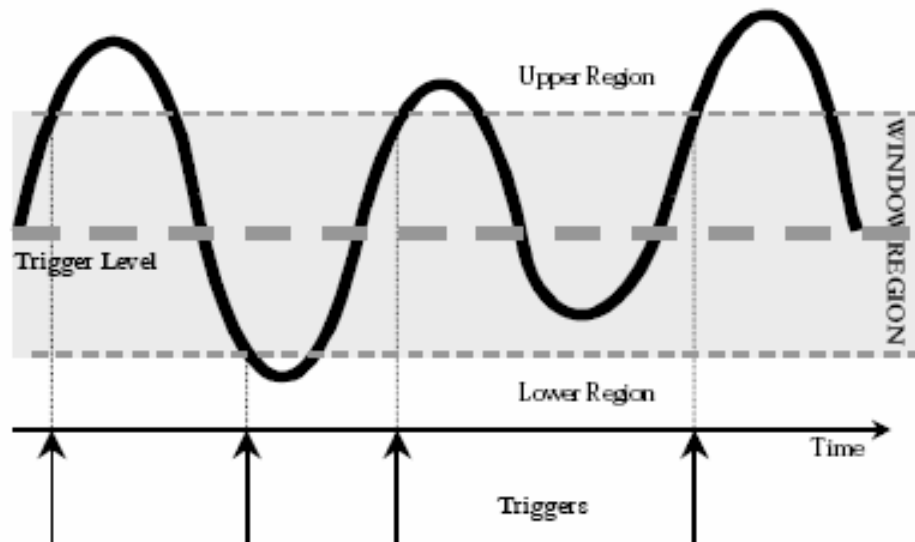
*Explanation of Window trigger operation*

## Trigger Holdoff

Holdoff is an optional, additional condition of Edge trigger.  It can be set either as a period of time or as an event count.  Holdoff disables the trigger circuit for a given period of time or events after the last trigger occurred.

Events are the number of occasions on which the trigger condition is met. The trigger will again occur when the holdoff has elapsed and the edge trigger's other conditions (for level, slope, etc.) are met.

Use holdoff to obtain a stable trigger on complex, but repetitive, waveforms.  For example, if there is a signal with multiple edges prior to the edge you wish to trigger on, you could set the holdoff to equal the number of edges preceding the desired triggering edge.  Refer to the on-line **Help** for more information about setup for holdoff.

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## SMART TRIGGERS

The WaveSurfer contains a number of SMART Triggers that allow you to apply more intelligence to your trigger.  Reference the on-line **Help** for further information on how to set up and use these SMART Triggers.
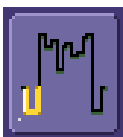
### *Standard SMART Triggers*
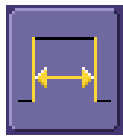
**Width Trigger** allows you to define a positive- or negative-going pulse width bounded by a voltage level, above or below which a trigger will occur. Or you can specify a pulse width and voltage range, within or outside of which a trigger will occur.
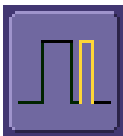
**Glitch Trigger** is a simpler form of Width trigger. Use Glitch trigger when you want to define a fixed pulse-width time or time range only. Glitch trigger makes no provision for voltage levels or ranges.

**Logic Trigger** enables triggering on a logical combination (pattern) of five inputs: CH1, CH2, CH3, CH4, EXT. You have a choice of four Boolean operators (AND, NAND, OR, NOR), and you can stipulate the high or low voltage logic level for each input independently.
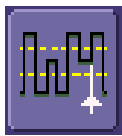
**TV Trigger** - Provides stable triggering on standard or custom composite video signals. Use them on PAL, SECAM, or NTSC systems.
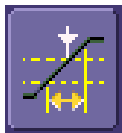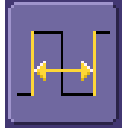
## Optional SMART Triggers

These triggers are available in the WaveSurfer Advanced Trigger Package:

**Runt Trigger** is used to capture pulses that fall within a user defined amplitude range.

**Slew Rate Trigger** is used to capture signals that have a specific rate of increase or decrease, within defined limits.

**Interval Trigger** is used to capture intervals that fall short of, or exceed, a given time limit. In addition, you can define a width range to capture any interval that is itself inside or outside the specified range.
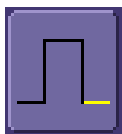
**Dropout Trigger** is used essentially for single-shot applications— usually with a pre-trigger delay. Use it whenever your signal disappears for a set period of time. The trigger is generated at the end of the timeout period following the "last" trigger source transition.
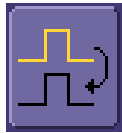
**Qualified Edge Trigger** is an edge-qualified trigger that allows you to use one signal's positive or negative transition to qualify a second signal, which is the trigger source. For Qualify trigger, you specify the time or number of events after the transition when you want the trigger to occur.

**Qualified State Trigger** is a level-qualified trigger which requires that the qualifying signal remain above or below a specified voltage level for a trigger to occur.  It differs from Qualified Edge Trigger in that the signal must remain above or below the set level, and not just temporarily go above or below the set level.

# Measuring with Cursors

## OVERVIEW

Cursors are important tools that aid you in measuring signal values. Cursors can be moved around on the waveform to identify specific voltage and time values on the waveform. Use cursors to make fast, accurate measurements and to eliminate guesswork.

The cursor controls contain two dedicated cursor knobs and a **Type** button. The **Type** button turns cursors ON (if they are not already ON), then toggles between **Horizontal (Time)** cursors, **Vertical (Amplitude)** cursors, and **OFF**. If an FFT Math trace is ON, a **Horizontal (Frequency)** selection will be added to the toggle list.

When cursors are ON, they provide measurements for every waveform displayed. The lone exception is when a Math FFT is ON, which requires a selection of **Horizontal (Frequency)** for cursors to be placed on that waveform. To locate cursors on a Zoom waveform, simply move the cursors into the zoomed part of the original channel signal.
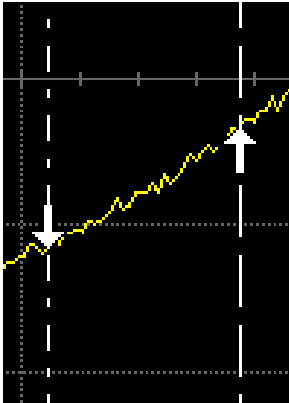
## TURNING CURSORS ON



Cursors will automatically turn on when you rotate either of the two cursor knobs. Or, you can press the **Type** button to turn cursors ON, then toggle through the various cursor types.
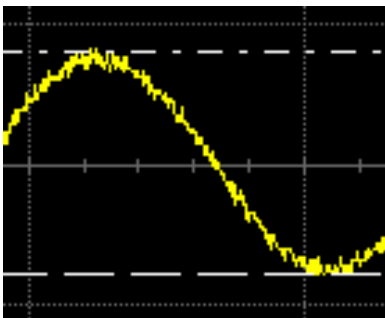
# WAVESURFER 400 SERIES

## CURSOR TYPES

### *Horizontal (Time)*

Horizontal (Time) cursors are moved horizontally along the waveform. Place them at a desired location along the time axis to read the signal's time and amplitude information at the selected location
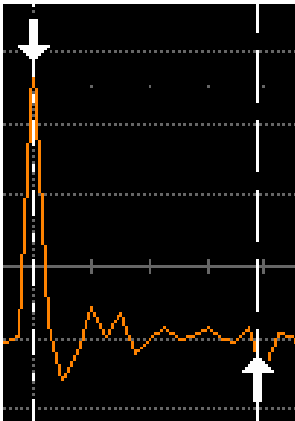
### *Vertical (Amplitude)*

Vertical cursors are lines that you move vertically on the grid to measure the amplitude of a signal.

## *Horizontal (Frequency)*

**Horizontal (Frequency)** cursors are moved horizontally along the FFT Math trace. Place them at a desired location along the frequency axis to read the signal's frequency and amplitude at the selected location.

## *Changing Cursor Type*

Pressing the **Type** button between the cursor knobs will toggle the Cursors from one type to another, and ultimately to **OFF**, without requiring a cursor setup menu to be opened.
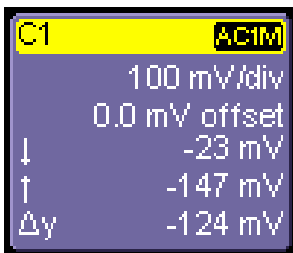
## *Tracking Cursors*
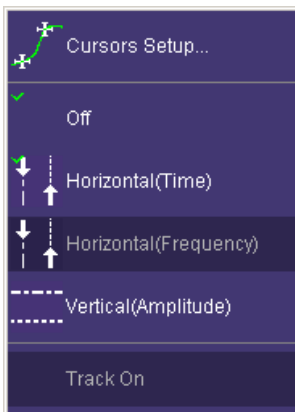
If you wish for cursors to move in unison when you adjust their position, select the **Track** item in the **Cursors** Top Menu Bar pull-down menu to enable cursor tracking.

## READING WAVESURFER CURSOR INFORMATION

Cursor information is displayed in two different places on the WaveSurfer display.

### *Descriptor Labels*

The Descriptor Labels for Channels, and Math, Zoom, and Memory traces contain both absolute and relative amplitude (voltage) cursor information.

### *Cursor Table*

The cursor table underneath the Timebase and Trigger Descriptor Labels appears when **Horizontal (Time)** or **Horizontal (Frequency)** cursors are turned on.  This table contains the common absolute and relative information for the two cursors, and frequency information (if Horizontal cursors are selected).

If the display is in XY Mode, XY cursor information will be located underneath the XY display.

# Measuring with Parameters

## OVERVIEW

Parameters are pre-programmed measurements that eliminate the need to set up cursors for standardized measurements, like rise time, fall time, peak-peak amplitude, etc.  Use them to automatically calculate many attributes of your waveform.  You can make common measurements on one or more waveforms, and display up to six parameter measurements at one time.  You can also display statistics for your measurements, or apply "gating" to the measurement area.

The WaveSurfer uses pre-defined algorithms to determine the top, base, 10% level, etc. of the waveform in order to make automatic measurements.  These algorithms are in accordance with IEEE standards.

If, for some reason, a parameter is unable to be calculated correctly, a warning symbol will be shown underneath the measurement so that you know to proceed with caution.

In WaveSurfer, some parameter measurements (like Mean) produce a single value for all the data between the measure gates.  Others (like Rise Time) are always calculated for every value in an acquisition.  However, the **value** displayed is always the last value in the acquisition.  Use statistics if you desire more information about the distribution of measurements in the acquisition.

**SETTING UP PARAMETER(S)**
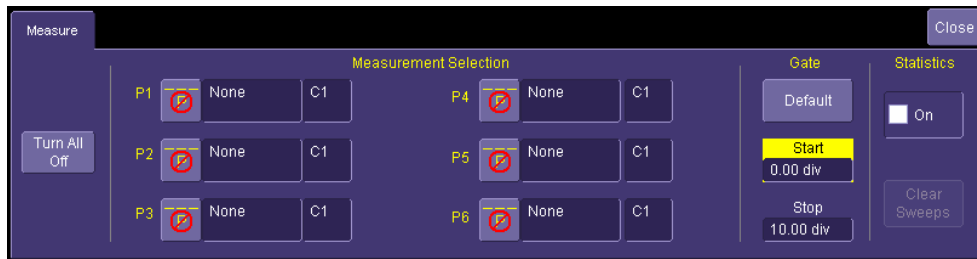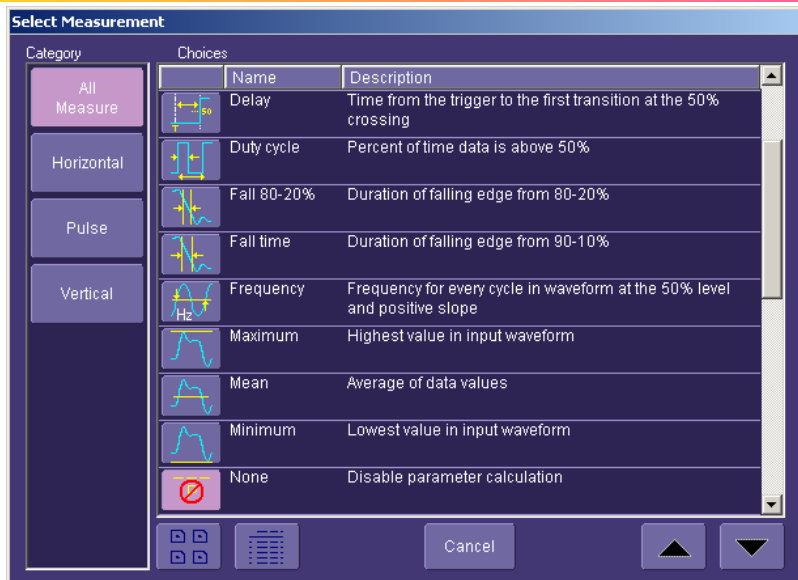
1.  Press the Measure front panel button



Or, in the Top Menu Bar, touch **Measure**, then select **Measure Setup.**

In either case, the following menu will appear at the bottom of the display.



2.  The default status is that parameters are OFF, and all are undefined ("None"). Touch either the **icon** or touch in the **None** area to bring up the **Select Measurement** menu:

Touch any of the icons to select the measurement that you desire.  Scroll down through the list using the slider bar on the right side of the pop-up menu.

3.  Once the parameter is selected, it will appear on the display underneath the grid, as shown below:
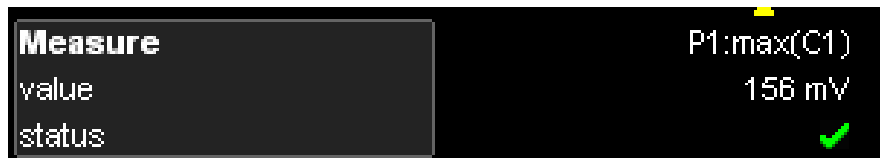


4.  The channel source will default to C1.  Touch inside the **Source** field to select a different source (either a channel, a math function, a memory, or a zoom).

5.  Add additional parameter measurements to the display by selecting other parameters (labeled as P1 through P6) as described above.

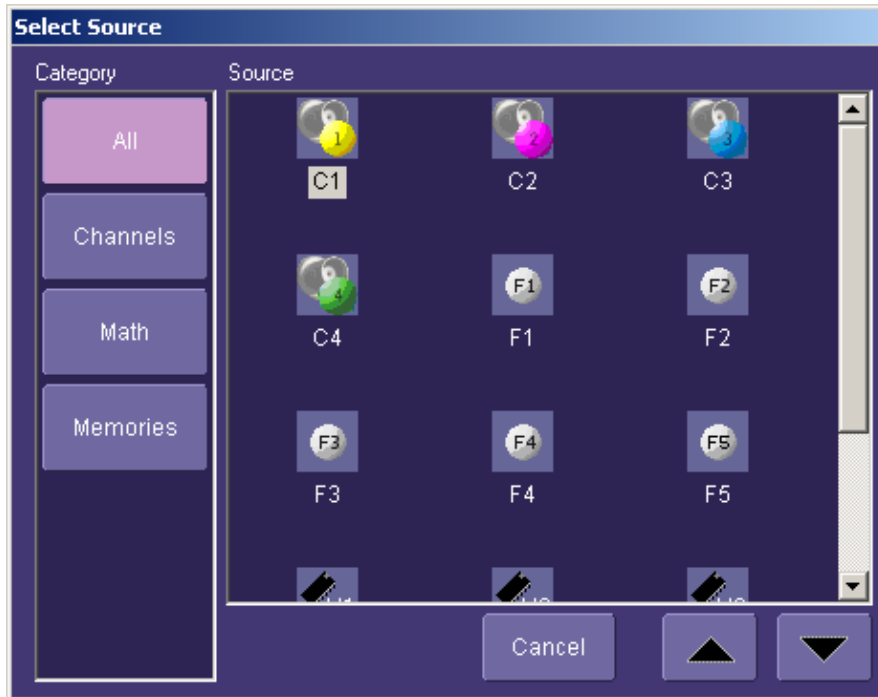6.  Close the measure menu by either pressing the front panel **Measure** button again, or touching **Close** on the on-screen menu.

## UNDERSTANDING PARAMETER DISPLAYS

### *The Parameter Display Format*

Understanding the information in the parameter displays is easy. The table below explains what each abbreviation means, following the parameter display from left to right, and top to bottom.

The format is **Px:Name(source)** with value and status contained below:

| | |
|---|---|
| **P1, P2, P3, P4, P5, P6** | The number of the parameter measurement. "P" means Parameter. Each parameter is uniquely identified. |
| **Name** | In the example in step 3 (above), **max** is the parameter name, short for maximum. A brief definition of each parameter is included in the measurement selection dialog box. |
| **(souce)** | The source can be a channel (Cx), a zoom trace (Zx), a math trace (Math), or a memory (reference waveform) (Mx) |
| **value** | The last measured value in the acquisition. |
| **status** | An indication of whether the parameter was calculated correctly. A ✔ means that the measurement was performed correctly. Reference the table below for information on other status symbols. |

### *Status Symbols*

Below each parameter appears a symbol that indicates the status of the parameter, as follows:

| | |
|---|---|
| ✔ | A green check mark means that the scope is returning a valid value. |

| | |
|---|---|
|  | A crossed-out pulse means that the scope is unable to determine top and base; however, the measurement could still be valid. |
|  | A downward pointing arrow indicates an underflow condition (signal below the grid area). |
|  | An upward pointing arrow indicates an overflow condition (signal above the grid area). |
|  | An upward-and-downward pointing arrow indicates an underflow and overflow condition (signal below and above the grid area). |

## PARAMETER GATES (WINDOWS)



Sometimes you might want to have a parameter measurement on a specific portion of your signal, and ignore all other portions. When this is the case, you can use Measure **Gate.** Measure **Gate** is controlled in the Measure menu, and is set in grid divisions.

To set the gate, touch the **Start** field to highlight the control yellow, and then use the adjust knob to adjust the location of the start gate.  Repeat for the **Stop** gate.  Measure gates will remain on the display as long as the **Start** gate is not equal to 0 divisions, and the **Stop** gate is not equal to 10 divisions.

## MEASUREMENT STATISTICS

After you add a parameter measurement, you can look at statistics of that parameter measurement, and acquire an understanding of how that measurement changes with time.

To view measurement statistics, check the box next to **On** under **Statistics** in the **Measure** menu.  If a measurement is displayed, statistics will now also be displayed (as shown below).

| Measure | P1:freq(C1) |
|---------|-------------|
| value | 3.00300 MHz |
| mean | 3.0000024 MHz |
| min | 2.97619 MHz |
| max | 3.02480 MHz |
| sdev | 6.1486 kHz |
| num | 21.830e+3 |
| status | ✓ |

Statistics will continue to accumulate with each additional trigger until **Clear Sweeps** (either on the front panel or in the measure menu) is pressed, or a control (e.g. Volts/Div) is changed.

Most statistical values (mean, minimum, max, standard deviation) are self-explanatory.   **Num** is the number of measurements in the statistical sample.  **Value** and **Status** are defined in Understanding Parameter Displays (above).

## TURNING OFF PARAMETERS

You can turn all parameters OFF by touching the **Turn All Off** button in the Measure menu.  This will also redefine all the parameter definitions to NONE.

# Zooming Your Channels

## OVERVIEW

LeCroy offers extremely powerful, yet simple to use, zooming capability in the WaveSurfer.  The large, bright 10.4" display with touch screen lends itself very well to quickly creating zooms, and being able to see how they relate to the original channels.

There are a number of different ways to zoom in a WaveSurfer:

- **Drawing a box** around the area to be zoomed, using either your finger or a mouse/pointing device.

- Using the front panel **QuickZoom** button.

- Using the software toolbar **Zoom** button that is in the Channel menu.

The operating behavior for all three methods is basically the same, with some minor differences.

In all cases, the zoomed channels are displayed in a separate half-height grid at the bottom of the display (separate from the channels). If you also have a Math trace displayed when you zoom, there will be three grids on the display, each one-third height.

The zoomed traces are nearly the same color as the original channel traces to make comparison easy.  The zoomed area is shown in white on the original channel trace.  All zooms share a common horizontal zoom scale and position.  Each zoom has an independent vertical zoom capability.  All zooms are calculated to 16-bit vertical resolution.  Therefore, you can vertically scale the zoom traces and still maintain very high resolution when viewing signal detail.

## CREATING ZOOMS

There are three ways to create zooms of your channels.

### *Touch Screen Zooming*
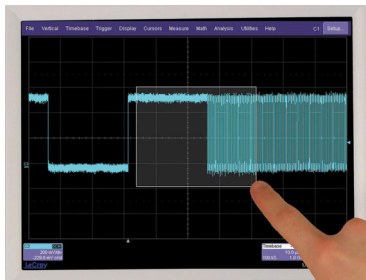
You can "draw a box" around the area that you wish to zoom simply by dragging your finger, fingernail, or pointing device around the area of the waveform that you want to zoom.
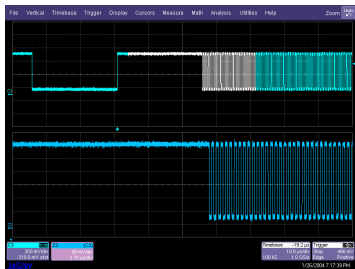
If there is only one channel ON when you draw a box, the zoom will be created instantly. If more than one channel is ON, you will be prompted for which channels you want to zoom.

To UNDO your zoom, touch the **UNDO** button in the upper right corner of the display.

You can also use touch screen zoom to change the zoom scale of an existing Zoom, Math, or Memory (reference waveform) trace.

## Front Panel QuickZoom Button
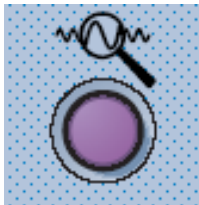
Press the front panel **QuickZoom** button.

Zoom traces will be created for all of the channels currently displayed.
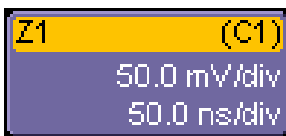
To turn off a Zoom trace individually, touch the Zoom descriptor label twice to open the Zoom trace menu, then uncheck the ON checkbox.

To UNDO your zoom at any time, simply press the front panel QuickZoom button again.

**Note:** If you turn a channel ON while the QuickZoom is displayed, the new channel will not be zoomed.

## Toolbar Zoom

Press the Toolbar **Zoom** button in the Channel Toolbar located in the Channel menu.

A Zoom trace will be created for that channel only.

To UNDO your zoom, press the **UNDO** button in the upper right corner of the display.

## ZOOM DESCRIPTOR LABEL

When a Zoom trace is ON, there is a descriptor label on the display for it, much like for the channels, math trace, and memories (reference waveforms).

```
Z1          (C1)
      50.0 mV/div
      50.0 ns/div
```

- The top line contains information about the Zoom trace (in this case, it's a Zoom of Channel 1).

- The 2$^{nd}$ line contains vertical scaling information.

- The 3$^{rd}$ line contains horizontal scaling information.

If the descriptor label is shaded differently (as shown below), then the Zoom trace is ACTIVE, which means that the Horizontal and Vertical front panel controls are set to adjust that specific zoom trace, and not any of the channels. In this case, the scale and position of the Zoom trace can be changed by adjusting the horizontal and vertical controls on the front panel.

```
Z1          (C1)
      50.0 mV/div
      50.0 ns/div
```

Note that the Horizontal scales and position is the same for all Zoom traces, but Vertical scale and position can be adjusted individually.

If the Zoom trace is not ACTIVE, and you wish to make it ACTIVE, simply touch the descriptor label once and it will become active. Touch the descriptor label again, and it will open the Zoom trace menu.
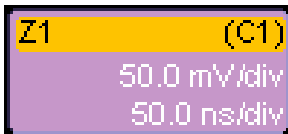
> **Note:** When a Zoom trace is active, no channel buttons will be lighted, which tells you that a Zoom trace may be currently active.

## ADJUSTING ZOOM SCALE AND POSITION

### *Using Front Panel Controls*

It is easy to adjust your Zoom trace scale and position.  WaveSurfer multiplexes the Vertical and Horizontal Front Panel controls to control the zoom scale and position.  This is done automatically after you have created the zoom trace, and remains this way until you make a Channel, Math trace, or Memory (reference waveform) active.

If the Zoom trace you wish to adjust is not active, touch the Descriptor Label once to make it active.
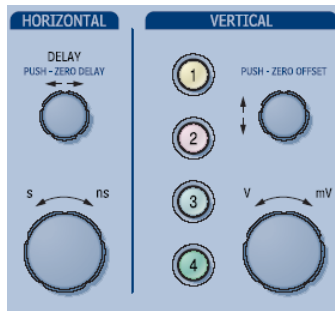
Then use the front panel horizontal and vertical controls to adjust position and scale.  The operation of the knobs will feel natural.  Use the table below as a guide.

**Note:** When a Zoom trace is active, no channel buttons will be lighted, which tells you that a Zoom trace may be currently active.

| Panel Control | Zoom Control Action |
| --- | --- |
| Delay | Zooms horizontal position |
| Timebase | Zooms horizontal scale |
| Offset | Zooms vertical position |
| Gain / Sensitivity | Zooms vertical scale |
| Push – Zero Delay | Resets horizontal zoom to 10:1 scale, and resets to default horizontal position |

| Push – Zero Offset | Resets vertical zoom to 1:1 scale, and resets to default vertical position |
|---|---|

## *Using Zoom Menu Controls*
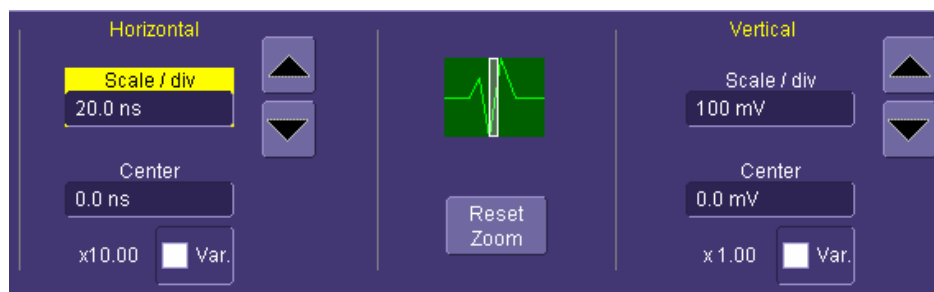
You can also use the Zoom menu controls to adjust zoom.
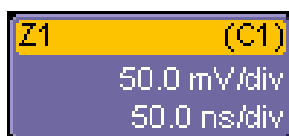


Touch the descriptor label twice to open the Math Menu.

Then use the software zoom controls to change the horizontal and vertical position and scale.
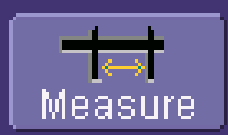
Note that horizontal scale adjustments always apply to all waveforms.



## USING TOOLBAR SHORTCUTS

These toolbar shortcuts can be used to perform specific actions for each Zoom trace.

| | |
|---|---|
| **Measure** | Opens a Measurement selection pop-up menu.  You can then select a parameter (measurement) for the Zoom trace from this menu without leaving the Zoom Setup menu. The parameter automatically appears below the grid. |
| **Store** | Loads the Zoom trace into its corresponding Memory (Reference Waveform) location (for instance, Z1 is stored into M1, Z2 is stored into M2, etc.). |
| **Label** | Opens a Labeling pop-up menu that allows you to create labels tied into the waveform. |

# Using The Math Trace

### OVERVIEW

Math allows you to perform simple and complex mathematical calculations on your signal, or on a zoom or memory (reference waveform). The oscilloscope can be operating in any acquisition mode (Real-Time, RIS, or Roll Mode) when Math is created.

Math traces are defined with an Operator and a Source. Examples of Operators include Add, Subtract, Multiply, Divide, and FFT. Sources are channels, zoom traces, or memories (reference waveforms). Some Operators require two sources, and some only one source. The oscilloscope shows how many sources you need to define when you choose the Operator.

Math is always displayed in a separate half-height grid at the bottom of the display, separate from your other traces. This makes it easier to interpret Math information if the math scale is different from the channel scales. If you also have Zoom traces displayed when you turn the Math trace ON, there will be three grids on the display, each one-third height.

Each Math trace can also be zoomed without setting up a separate zoom trace. This reduces a step, and gives you more capability to understand the exact feature of interest without having to create another trace. Simply use the zoom controls in the Math menu, or use the Vertical and Horizontal controls for position and scale change in both axes when the Math trace is active.
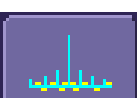
One powerful feature about WaveSurfer Math traces is that they are calculated to 16-bit vertical resolution. Therefore, you can vertically zoom the Math trace and still maintain very high resolution when viewing the zoomed trace.

## DESCRIPTION OF MATH FUNCTIONS

WaveSurfer contains several Math operators as standard, plus an FFT function. Additional Math functions are available in the MathSurfer Advanced Math option. Descriptions are provided below:
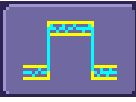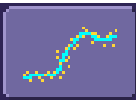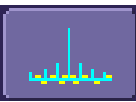
### *Standard Math*

| | |
|---|---|
| — | **Difference** (Subtract) – Subtracts two waveforms |
| × | **Product** (Multiply) – Multiplies two waveforms. |
| ÷ | **Ratio** (Divide) – Calculates the ratio of two waveforms |
| + | **Sum** (Add) – Adds two waveforms |
| | **Fast Fourier Transform (FFT)** – computes a power frequency spectrum of an FFT up to 25 kpts. Contains Rectangular, Von Hann, and Flat Top windows. |
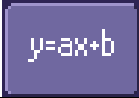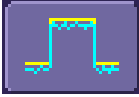
### *MathSurfer Advanced Math*

| | |
|---|---|
| \|y\| | **Absolute Value** – calculates the absolute value of a waveform. |

| | |
|---|---|
| <y>n | **Average** – calculates either a summed or continuous average up to 1 million sweeps (user selectable) |
| dy/dx | **Derivative –** calculates the derivative of adjacent samples |
| | **Envelope** – calculates highest and lowest vertical values of a waveform at each horizontal value for a given number of acquisitions (sweeps) |
| | **Enhanced Resolution (ERES)** – noise reduction and smoothing filter specified by number of additional bits |
| | **Fast Fourier Transform (FFT)** – Adds Hamming, Blackman-Harris, and Hanning windows, and capability to calculate up to 1 Mpts.  Also allows FFT Averaging through use of $2^{nd}$ Math Operator. |
| | **Floor** - calculates the lowest vertical values of a waveform at each horizontal value for a given number of acquisitions (sweeps) |
| ∫ydx | **Integral** – calculates the linearly rescaled integral (with multiplier and adder) of a waveform input |
| -(y) | **Invert** – inverts the waveform |
| 1/y | **Reciprocal** – calculates the reciprocal of the waveform |

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| | |
|---|---|
| y=ax+b | **Rescale** – allows user-defined rescaling, including user defined units. |
| | **Roof** - calculates the highest vertical values of a waveform at each horizontal value for a given number of acquisitions (sweeps) |
| $y^2$ | **Square** – calculates the square of the waveform |
| $\sqrt{y}$ | **Square Root** – calculates the square root of the waveform |

## SETTING UP A MATH TRACE

1. Press the Math front panel button
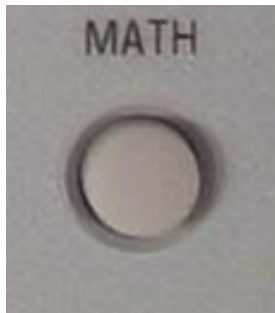
   

   Or, in the Top Menu Bar, touch **Math**, then select **Math Setup…**

   In either case, the following menu will appear at the bottom of the display, the Math trace will turn ON, and the last selected Math Operator will be chosen as the current operator.
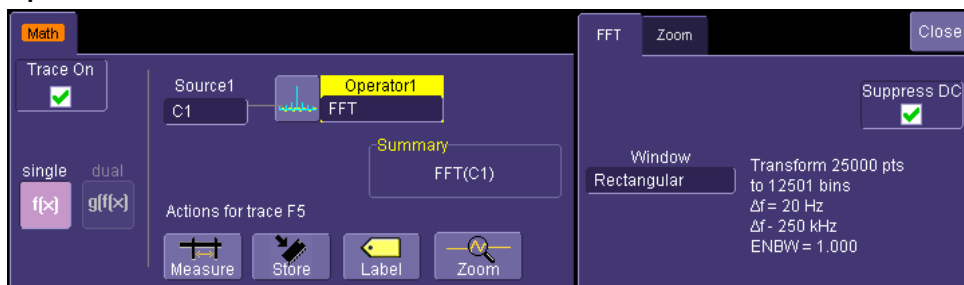
   

2. To change the currently defined Operator, touch either the  icon or touch in the **Operator** area to bring up the following pop-up menu (if you ordered the MathSurfer Advanced Math option, you would have more selections than those shown):
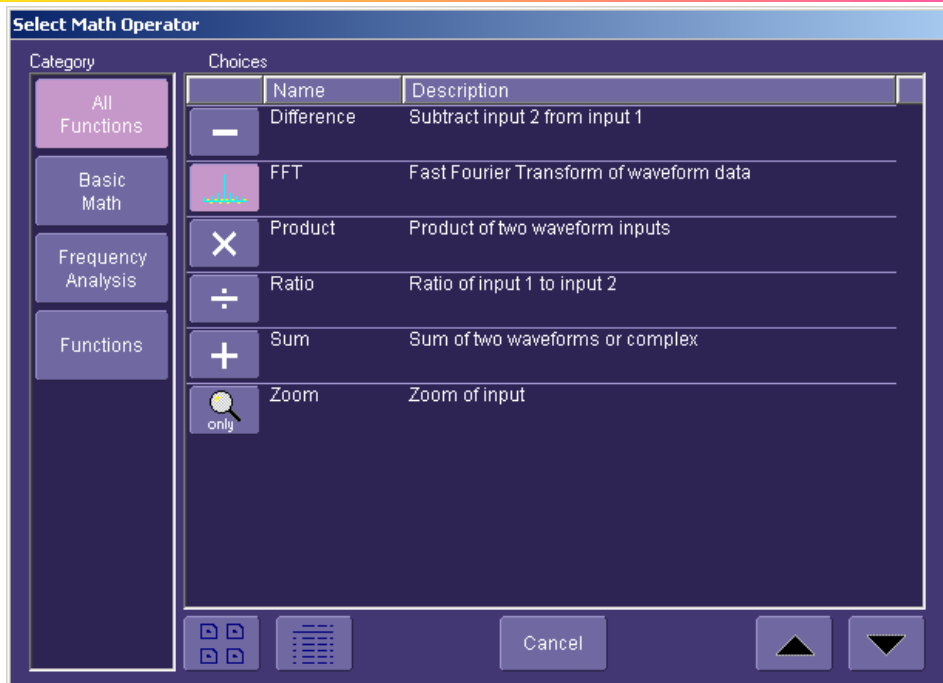
Touch any of the icons to select the math operator (function) that you desire.  Scroll down through the list using the scroll bar on the rights side of the pop-up menu.

3.  Once the **Operator** is selected, the pop-up menu will close and the Math trace will be re-defined.

4.  If you have purchased the MathSurfer Advanced Math option, you will also be able to select a second **Operator.** To do this, select Dual from the **Single/Dual** button selection.

A second **Operator** will appear.  It can be changed like the first.

Two Operators can be helpful in some situations.  For instance, you can compute an FFT, then Average the FFT result over many computations by making the first Operator an FFT and the second operator an Average function.   Or, you can make the second Operator a Rescale function to change units and rescale information for a non-standard calculation.

5.  The channel source will default to C1.  Touch inside the source field to select a different source (either a channel, a memory, or a zoom).
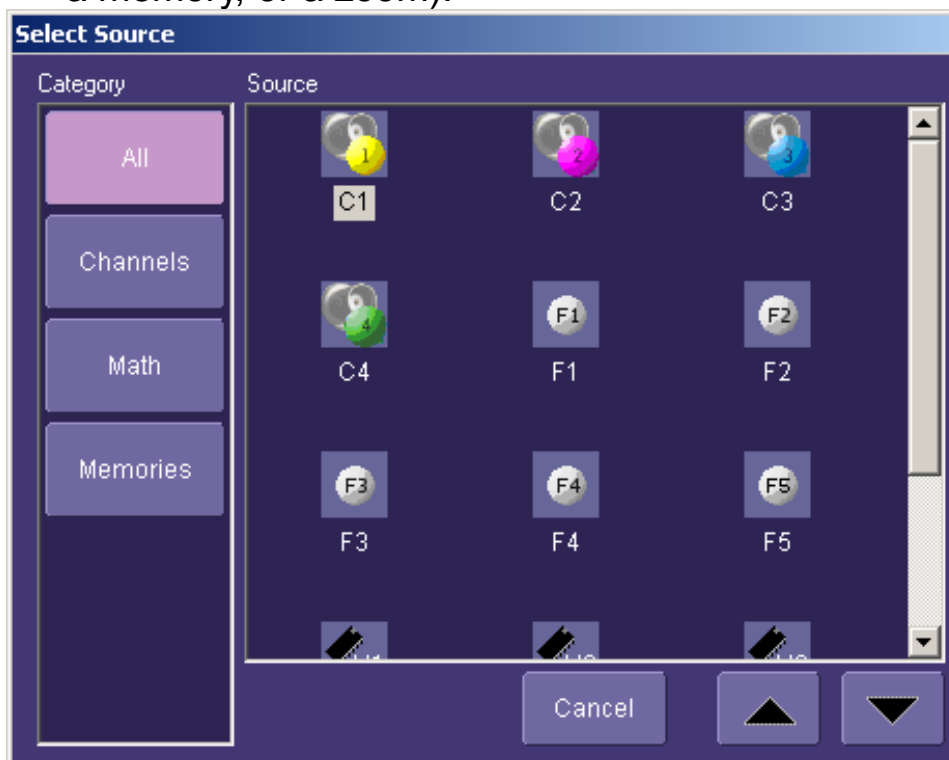
6. Close the Math menu by either pressing the front panel **Math** button again, or touching **Close** on the on-screen menu.

## MATH DESCRIPTOR LABEL

When a Math trace is ON, there is a descriptor label on the display for it, much like for the channels, zooms, and memories (reference waveforms).



- The top line contains information about how the Math trace is defined (in this case, it's an FFT of Channel 1).

- The 2nd line contains vertical scaling information.

- The 3rd line contains horizontal scaling information.

If the descriptor label is shaded differently (as shown below), then the Math trace is ACTIVE, which means that the Horizontal and Vertical front panel controls are set to adjust the Math trace, and not any of the channels.  In this case, the scale and position of the Math trace can be changed by adjusting the horizontal and vertical controls on the front panel.
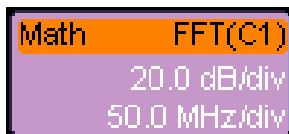


If the Math trace is not ACTIVE, and you wish to make it ACTIVE, simply touch the descriptor label once and it will become active and the Math menu will open.

## ZOOMING MATH

Math traces have zoom capability built in, so it is easy to change the scale and position of the Math trace, as required.  You can zoom in one of two ways:

### *Using Front Panel Controls*

Touch the descriptor label to make it active.
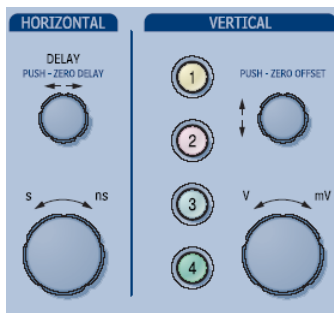
Then use the front panel horizontal and vertical controls to adjust position and scale.  The operation of the knobs will feel natural.  Use the table below as a guide.

**Note:** When Math trace is active, no channel buttons will be lighted, which tells you that the Math trace may be currently active.

| Panel Control | Zoom Control Action |
|---|---|
| Delay | Zooms horizontal position |
| Timebase | Zooms horizontal scale |
| Offset | Zooms vertical position |
| Gain / Sensitivity | Zooms vertical scale |
| Push – Zero Delay | Resets horizontal zoom to 10:1 scale, and resets to default |

| | horizontal position |
|---|---|
| Push – Zero Offset | Resets vertical zoom to 1:1 scale, and resets to default vertical position |

## *Using Math Menu Zoom Controls*
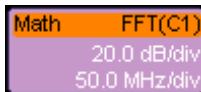
Touch the descriptor label twice to open the Math Menu.

Touch the Zoom button in the Math Menu toolbar.
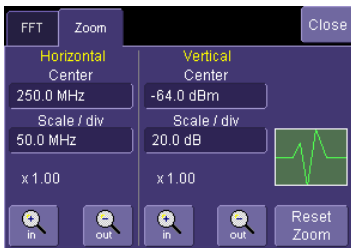
Then use the software zoom controls to change the horizontal and vertical position and scale.

## USING TOOLBAR SHORTCUTS

These toolbar shortcuts can be used to perform specific actions for the Math Trace.
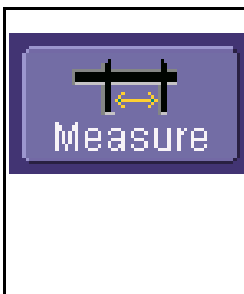
| | Opens a Measurement selection pop-up menu.  You can then select a parameter (measurement) for the Math trace from this menu without leaving the Math Setup menu. The parameter automatically appears below the grid. |
|---|---|

| | |
|---|---|
| **Store** | Loads the Math trace into its corresponding Memory (Reference Waveform) location (Memory 1, or abbreviated as M1). |
| **Label** | Opens a Labeling pop-up menu that allows you to create labels tied to the waveform. |
| **Zoom** | Opens the zoom control tab in the Math menu. |

# Using Analog Persistence

## OVERVIEW

The Analog Persistence feature displays your waveform and reveals its anomalies for a repetitive signal. Use Persistence to accumulate on-screen points from many acquisitions to see your signal change over time. These waveform "points" correspond to display pixels.

The instrument persistence modes display the intensity in either an "analog" view, or graded in a spectrum of colors (with red representing many occurrences, and violet representing fewer occurrences).

Persistence works simultaneously on all waveforms displayed on the WaveSurfer grid.

Basic persistence adjustments can be made using the front panel controls.  Additional persistence adjustments can be accessed by selecting **Display** in the Top Menu Bar, and **Persistence Setup** from the drop-down menu.

## TURNING PERSISTENCE ON
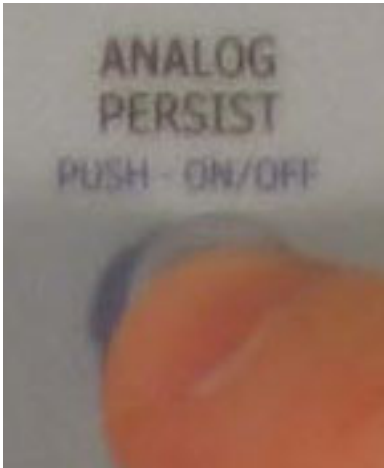


To turn persistence ON, press the front panel **Analog Persistence** knob once. This will turn Persistence ON to Analog mode. Press again to change to Color-Graded mode. Press again to turn OFF.

The default saturation level when first turned ON is 50%, with an infinite persistence time.



Adjust the saturation of the persistence by rotating the knob. If your waveform has very little variation, you may have to adjust the knob quite a bit either clockwise or counterclockwise before you see a persistence view that meets your expectations.

## UNDERSTANDING PERSISTENCE

### *Saturation Level*

The Persistence display is generated by repeated sampling of the waveform over time, and the accumulation of the sampled data into "3-dimensional" display maps, with the third dimension representing the number of occurrences.

You can select a saturation level as a percentage of the maximum population of occurrences. Lowering this percentage causes the pixels to be saturated at a lower population, and makes visible those rarely hit pixels not seen at higher percentages.

All pixels with a population of occurrences above the saturation level are then assigned the highest intensity (representing saturation). At the same time, all populations below the saturation level are assigned the remaining intensities. Data populations are updated in real-time as data from new acquisitions is accumulated.

### *Persistence Time*

The duration of persistence can be used to view how the signal changes over time by adjusting how long the pixel data stays displayed before it is no longer displayed. The persistence duration (decay) is proportional to the persistence population for each number of occurrences (or time combination in the data). Persistence Time can be changed from 0.5s to Infinity from a menu of several pre-defined values.

### Analog Persistence Mode

When you select **Analog** Persistence mode, each trace is assigned a single color. As a persistence pixel map is created, different intensities of that color are assigned to the range between a minimum and a maximum population of occurrences. The maximum population automatically gets the highest intensity, the minimum population gets the lowest intensity, and intermediate populations get intensities in between these extremes.

### Color-graded Persistence Mode
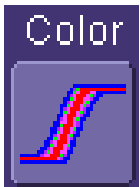
Color-graded Persistence works on the same principle as Analog persistence, but instead uses the entire color spectrum to map signal intensity: violet for minimum population, red for maximum population. Lowering the saturation percentage causes the pixels to be saturated at a lower population, and makes visible those rarely hit pixels not seen at higher percentages.

### Show Last Trace

For most applications, you may not want to show the last trace because it will be superimposed on top of your persistence display. In those cases turn off **Show Last Trace** by touching the checkbox. However, if you are doing mask testing and want to see where the last trace is falling, turn **Show Last Trace** on.

# Saving and Recalling Setups

## OVERVIEW

You can save or recall scope settings to or from hard disk, USB key, or LAN location.  This can be very helpful if you repeat the same types of tasks over and over again, or if you share the scope with many people.

### *To Save Scope Settings as a Setup File*

Choose **Save Setup** from the **File** Top Menu Bar.

Choose to save the Waveform Data as an **Internal Setup** temporary location in RAM or to a **File** on the hard drive or external storage device.

Touch **Save Now** to save the file.

### *To Recall Scope Settings from a Setup File*

Choose **Recall Setup** from the **File** Top Menu Bar.

Choose to recall the Setup from an **Internal Setup** temporary location in
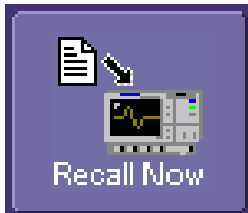
RAM or from a **File** on the hard drive or external storage device.

Touch **Recall Now** to save the file.

*To Recall Default Scope Settings*

Choose **Recall Setup** from the **File** Top Menu Bar.

Touch the button under **Recall Default Setup.**

# Saving and Recalling Signals

## OVERVIEW

There are several ways to save and recall your signals:

- Save your Channel signal, Math trace, or Zoom trace to a Memory location (Reference Waveform).

- Save your Channel signal, Math trace, or Zoom trace as Data.

- Save your Channel signal, Math trace, or Zoom trace as a Screen Image.

### *Memories (Reference Waveforms)*

Memories are saved in non-volatile RAM on the WaveSurfer. Saving to a memory is quick and easy.  It is the ideal way to save data for quick comparison with another waveform.

### *Waveform Data*

Waveform Data is usually saved in a binary or ASCII format (though other formats are available).  The data can be recalled on the same oscilloscope, or transferred to another oscilloscope or other program (like Excel, MATLAB, or Mathcad) for further processing. If recalled on an oscilloscope, it would be recalled in a Memory (reference waveform) trace.

## Screen Image

Screen images can be saved in a number of different image formats, and saved to a filename, printed, or sent as an email attachment. Screen images are not actual oscilloscope data, and cannot be recalled into the oscilloscope.

## SAVING AND RECALLING MEMORIES

### *Fastest Way to Store and Display*

Being able to compare a current acquisition with a reference trace is a very fundamental oscilloscope need.  WaveSurfer has made it easy to save a channel, math trace, or zoom trace to a memory location.
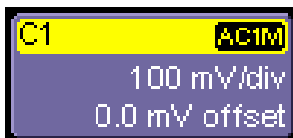
Touch the Channel, Math, or Zoom descriptor label twice to open the menu for the trace that you desire to save to a reference location.

Touch the **Store** button in the toolbar at the bottom of the menu.

The trace will be saved to its corresponding Memory trace (C1 to M1, C2 to M2, etc., Z1 to M1, Z2 to M2, etc., Math to M1) and displayed on the grid. The memory trace will have a descriptor label, a menu, etc. like all other traces. It can even be zoomed and repositioned on the grid.

### *Most Flexible Way to Store and Display*

Choose **Memory Setup** from the **Math** Top Menu Bar.

Choose a Memory location from the **Memory Setup** menu.  In this example, we'll choose M1.

Choose a waveform to copy into this memory.  In this example, we'll choose to copy C1 into this M1 memory location.
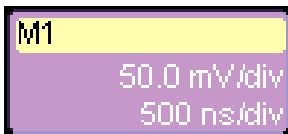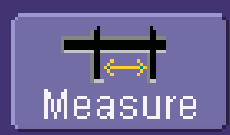
After you've selected the waveform to copy into memory, touch **Copy Now**.

The M1 memory trace will contain the C1 waveform present at the time of copy, the M1 trace will be turned ON, and the descriptor label will be active. The position and scale can be changed with the front panel controls, just like a zoom trace.

## *Using Memory Toolbar Shortcuts*

These toolbar shortcuts can be used to perform specific actions for the Memory Traces.

| | |
|---|---|
| **Measure** | Opens a Measurement selection pop-up menu. You can then select a parameter (measurement) for the Memory trace from this menu without leaving the Memory Setup menu. The parameter automatically appears below the grid. |
| **Clear Memory** | Clears the memory of the stored trace. |
| **Label** | Opens a Labeling pop-up menu that allows you to create labels tied to the memory. |

## SAVING AND RECALLING WAVEFORM DATA

### *To Save Waveform Data*

Choose **Save Waveform** from the **File** Top Menu Bar.

Choose to save the Waveform Data to a **File**

Choose a source of the data that you want to save, and choose a file name for the data file.

⚠ **CAUTION**

**If you use a name that ends in a number instead of a letter, the instrument may truncate the number. This is because, by design, the first waveform is automatically numbered 0, the second 1, etc.**

Choose a data format. If you select **ASCII** or **Excel**, also touch the **SubFormat** field and select either **Time Data** or **Time & Ampl**. Then touch the **Delimiter** field and select a delimiter character from the pop-up menu: comma, space, semicolon, or tab.

Then choose a directory and file name to store the file to (this could be a USB

memory storage device, or the oscilloscope internal hard drive:
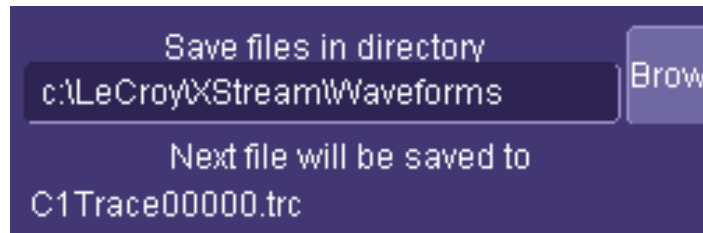
Then touch the **Save Now** button in the menu.

## *To Recall Waveform Data*
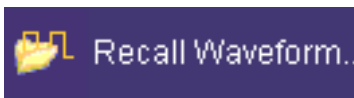
Choose **Recall Waveform** from the **File** Top Menu Bar.

Choose to recall the Waveform Data from a **File**

Touch inside the **Destination** field and select a memory location to store the file into.  If you wish, check the **Show on Recall** box to turn the memory ON and display the waveform instantly.

Touch inside the **Recall files from directory** data entry field and enter the path, using the pop-up keyboard. Or touch the **Browse** button to navigate to the file.



Touch the **Recall Now** button to recall the waveform data file.

## SAVING SCREEN IMAGES
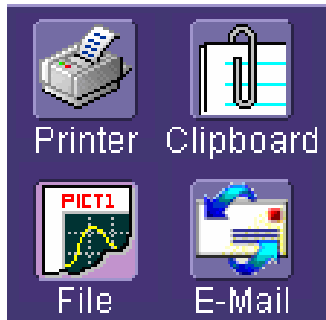
You can send images to a hard copy printer, to storage media (like the internal hard drive or a USB memory stick), as an email attachment, or as a clipboard file for copying into other programs.

You can define the front panel **Print** button to automatically save, print, or email the file with just one button push

You can also annotate (add labels) to your screen images before saving them so as to make your documentation job easier. Use the toolbar Label button to create and add labels independently to each Waveform.

### *Saving the Screen Image to a File*

Choose File if you want to save the screen image to storage media, such as a USB memory stick or the internal hard drive.

To Save the Screen Image to a File

1. In the menu bar touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
2. Touch the **Hardcopy** tab, then the **File** icon.
3. Touch inside the **File Format** data entry field and select a graphic file format from the pop-up menu.
4. Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white

background saves printer toner.

5.  Touch inside the **Directory** data entry field and type the path to the folder you want to print to, using the pop-up keyboard. Or touch the **Browse** button and navigate to the folder.

6.  Touch inside the **File Name** data entry field and enter a name for the display image, using the pop-up keyboard.

7.  Touch the **Grid Area Only** checkbox if you do not need to print the dialog area and you only want to show the waveforms and grids.

8.  Touch the **Print Now** button, or use the front panel Print button to save the file.

*Sending the Screen Image as an Email Attachment*

The instrument also gives you the option to e-mail your screen images, using either the MAPI or SMTP protocols. Before you send an email, you must first be connected to an email server and must set up the e-mail server and recipient address in **Preference Setup**.

To Send E-mail

1.  In the menu bar touch **Utilities**, then **Utilities Setup...** in the

drop-down menu.

2. Touch the **Hardcopy** tab, then the **E-mail** button.

3. Touch inside the **File Format** data entry field and select a graphic file format from the pop-up menu.

4. Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white background saves printer toner.

5. Touch the **Prompt for message to send with mail** checkbox if you want to include remarks with the image.

6. Touch the **Grid Area Only** checkbox if you do not need to print the dialog area and you only want to show the waveforms and grids.

7. Touch the **Print Now** button.

### *Printing the Screen Image to a Printer*

Choose Printer if you want to print the screen image to an external printer

To Print the Screen Image to a Printer

1. In the menu bar, touch **File**, then **Print Setup...** in the drop-down menu. The Utilities **Hardcopy** dialog opens.

2. In the dialog area, touch the **Printer** icon.

3. Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white background saves printer toner. (You can change the printer colors in the **Preference** menu).

4.   Touch inside the **Select Printer** field. From the touch pad pop-up choose the printer you want to print to. Touch the **Properties** button to see your printer setup.

5.   Touch the icon for the layout **Orientation** you want: portrait or landscape.

6.   Touch the **Grid Area Only** checkbox if you do not need to print the dialog area and you only want to show the waveforms and grids.

7.   Touch the **Print Now** button, or use the front panel Print button to print the file.

Also refer to Printing under "Print Management" (page 122).

### Saving the Screen Image to a Clipboard
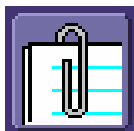
Choose Clipboard if you want to save the screen image to the clipboard so you can paste a file into another application (like MS Word, for example).

To Save the Screen Image to the Clipboard

1.   In the menu bar touch **Utilities**, then **Utilities Setup...** in the drop-down menu.

2.   Touch the **Hardcopy** tab.

3.   Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white

background saves printer toner.

4.  Touch the **Grid Area Only** checkbox if you do not need to print the dialog area and you only want to show the waveforms and grids.

5.  Touch the **Print Now** button, or use the front panel Print button to save the file.

# Sharing Your Data & Communicating with Others

## OVERVIEW

WaveSurfer provides you with many powerful tools to communicate your results to others and to increase your productivity.  Some examples are listed below:

- Email images to co-workers or customers directly from the oscilloscope.
- Allow annotation of image files directly on the oscilloscope.
- Save images and data files to the oscilloscope hard drive or network drive.
- Download images and files quickly to a USB memory stick.
- Create an archive of "perfect" signals for comparison to during board validation (using traces stored on the hard drive).
- Print to any printer.
- Be controlled or viewed from a remote location using off-the-shelf software tools.

WaveSurfer uses WindowsXP embedded, so you are probably aware of the basic philosophy of minimizing the program, saving to directories, and opening other programs on the oscilloscope.  This will make it easier for you to intuitively operate the WaveSurfer.

# WAVESURFER 400 SERIES

## STANDARD OUTPUTS

WaveSurfer is standard with the following:

- 100BaseT Ethernet
- Front-Mounted USB port
- Side-mounted USB ports (qty. 2)
- 9-pin serial port
- 25-pin parallel (Centronics) port
- SVGA output

## CONNECTING TO A NETWORK

WaveSurfer's standard 10/100 Base-T Ethernet port allows quick and easy connection to a network. DHCP (Dynamic Host Configuration Protocol) means that, provided your network doesn't have a firewall, you only need to plug in your network cable to the WaveSurfer's Ethernet port, and a network address will be self-assigned.

If your network has a firewall, your IT department can assist you in connecting to the network using familiar Windows setup routines.

Because your scope runs on a Windows-based PC platform, it is wise to protect it from viruses, as with any PC on a corporate network. It is crucial that the scope be kept up to date with Windows Critical Updates, and that anti-virus software be installed and continually updated.

Visit www.lecroy.com/dsosecurity for more information regarding Windows Service Pack compatibility with LeCroy operating software, and related matters.

## ACCESSING THE DESKTOP
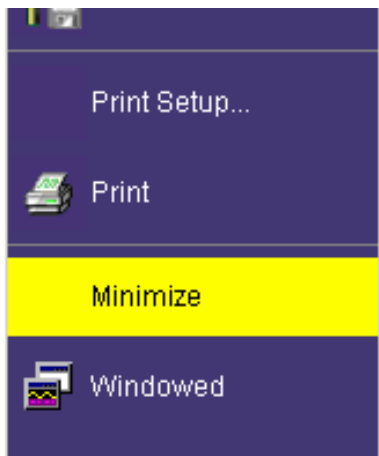
You can access the WaveSurfer's (Windows) desktop by opening the **File** Top Menu Bar and then choosing **Minimize**. This will minimize the oscilloscope and allow you to open other Windows programs, such as Windows Explorer, Paint, Internet Explorer, etc.
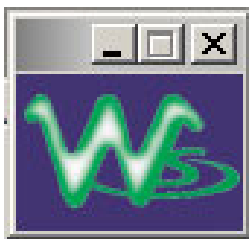
When minimized, the oscilloscope program will appear as a follows in the lower right hand corner of the display. Touch on the icon to maximize the program to full screen size.

## SENDING EMAIL FROM THE OSCILLOSCOPE

It is very easy to send an email of an image directly from the oscilloscope by pressing a single front panel button. Reference the previous section *Sending the Screen Image as an Email Attachment.*

## ANNOTATE IMAGE FILES

Any channel, math trace, zoom trace, or memory (reference waveform) can be "annotated", or labeled.  These labels are attached to the waveform and can be positioned anywhere on the waveform.  Note the following:

- Label placement adjusts depending on vertical and horizontal adjustments to the trace.

- When a screen image is saved to disk, these labels are part of the screen image.

- By using labels, you eliminate extra work in a separate program.

- Labels contribute to your co-worker's or customer's understanding of your work.

To Create a Label on a Waveform

1. Open the menu for the channel, math, zoom, or memory that you want to label.
2. Touch the **Label** button in the toolbar.



3. Touch the **Add Label** button in the pop-up menu.
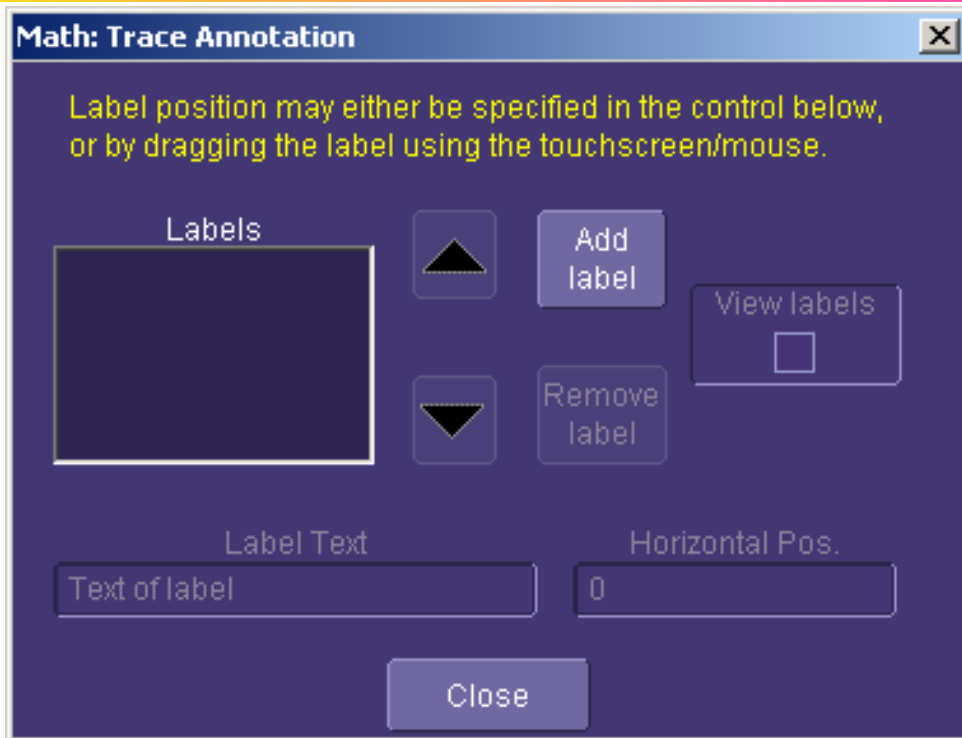
4.  Create **Label Text** by using the pop-up keyboard.  You may also change **Horizontal Position** of each label, **Remove Label**, and turn labels on/off by checking or unchecking the **View Labels** checkbox.

## SAVING DATA FILES AND IMAGES

You can save raw data files by **Choosing File**, **Save Waveform** and choosing data format, locations, etc. before choosing **Save Now**.

Images can be saved by choosing **File** in **Utilities, Hardcopy**, selecting a **File Format**, **File Name**, **Directory** location, etc.), and then pressing the **Print** icon in the menu or on the front panel. Reference *Saving the Screen Image to a File* for more information.

Once saved (on a USB memory stick, USB storage device, or oscilloscope hard drive), the image file can be easily cut and paste into other programs, like Word, Excel, Paint, etc.

## CREATING REFERENCE WAVEFORMS (MEMORIES)

If you wish to compare a waveform to another waveform, you can save them into **Memories**.  Up to 4 memories can be stored in non-volatile RAM at a time.  You can display all 4 memories at once, if desired.

If you wish to store more than 4 waveforms at a time, you can **Save Waveform** Data (accessed from the **File** menu), and then **Recall Waveform** Data (also accessed from the File menu) into a **Memory** trace.

Reference the chapter on **Saving and Recalling Signals** for more information.

## PRINTING

Since WaveSurfer runs on a WindowsXP platform, you can connect any WindowsXP compatible printer to the oscilloscope, following standard Windows setup routines for installing a new printer.

Reference the chapter on **Print Management** for more detailed information.  In addition, there is information on setting the front panel **Print** button in the chapter **Saving and Recalling Signals** section *Printing the Screen Image to a Printer.*

## REMOTE CONTROLLING AND VIEWING

Use Windows NetMeeting, VNC, pcAnywhere, or a similar program to control the oscilloscope remotely or share screen information in real-time with others located anywhere in the world, or just down the hallway.

All of these programs may be loaded and configured on the WaveSurfer as if the WaveSurfer were a standard PC.

# Print Management

The instrument gives you the ability to output files to a printer or plotter, to print to file, or to e-mail your files. Any Windows XP supported printer is supported by your instrument.

**PRINTING**

*To Set Up the Printer*

1.  In the menu bar, touch **File**, then **Print Setup...** in the drop-down menu. The Utilities **Hardcopy** dialog opens.

2.  In the dialog area, touch the **Printer** icon .

3.  Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white background saves printer toner. (You can change the printer colors in the Preference dialog;)

4.  Touch inside the **Select Printer** field. From the touch pad pop-up choose the printer you want to print to. Touch the **Properties** button to see your printer setup.

5.  Touch the icon for the layout **Orientation** you want: portrait or landscape.

6.  Touch the **Grid Area Only** checkbox if you do not need to print the dialog area and you only want to show the waveforms and grids.

*To Print*

You can print in one of three ways:

- Press the printer button on the front panel.
- In the menu bar, touch **File**, then **Print** in the drop-down menu.
- Touch the **Print Now** button in the "Hardcopy" dialog

## *Adding Printers and Drivers*

**Note:** If you want to add a printer driver, the driver must first be loaded on the scope.

1. In the menu bar, touch **File**, then **Print Setup...** in the drop-down menu. The Utilities **Hardcopy** dialog opens.

2. In the dialog area, touch the **Printer** icon .
3. Touch the **Add Printer** button. An MS Windows® window with which to add a printer will open.
4. Touch the Properties button to change printer properties such as number of copies.

## *Changing the Default Printer*

1. If you want to change the default printer, minimize the instrument application by touching **File** in the menu bar, then **Minimize** in the drop-down menu.
2. Touch the **Start** button in the task bar at the bottom of the screen.
3. Select **Settings**, then **Printers**.
4. Touch the printer you want to set as the default printer, then touch **File, Set as Default Printer**.

# Pass/Fail Testing

**OVERVIEW**

WaveSurfer's pass/fail testing is designed for basic determination of whether a signal is within an industry-standard or user-defined mask. Several unique views are provided to make it easy to understand when the signal is falling outside of its desired range.

*Mask Tests*

You have the choice to do mask testing by using an existing mask, or by using a mask created from your actual waveform, with vertical and horizontal tolerances that you define. Existing masks can be loaded from a floppy disk or from a network.

You can set your mask test to be True for waveforms All In, All Out, Any In, or Any Out. For example, if you select All In, the test will be False if even a single waveform falls outside the mask.

Masks that you create from your waveform can be confined to just a portion of the trace by use of a measure gate. (See Measure Gate for an explanation of how this feature works.)

*Actions*

You can decide the actions to occur upon your waveform's passing or failing, by selecting one or all of the following:

•   stop

- audible alarm
- print image of display
- emit pulse
- save waveform



The selection **Pulse**  causes a pulse to be output through the Aux Out connector at the front of the scope. This pulse can be used to trigger another scope. You can set the amplitude and width of the pulse as described in Auxiliary Output Signals.

### *Setting Up Pass/Fail Testing*

1. Touch the **Analysis** Top Menu Bar item, then touch **Pass/Fail Analysis**.

   The following menu will appear at the bottom of the display.
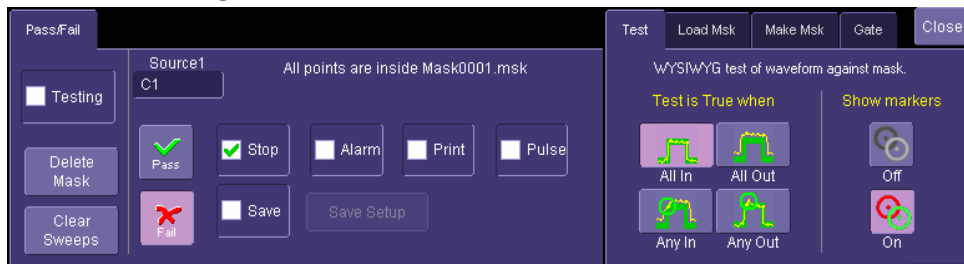
   

2. Select a Source for the mask test.

3. Touch either the **Pass** or **Fail**  button to set the actions to occur upon your waveform's passing or failing the test.

4. Touch the actions you want to occur: stop test, sound alarm, print result, emit pulse, or save the waveform. If you want to have the results printed, be sure that the oscilloscope is connected to a local or network printer. See Printing.

5. If you want to save your waveform automatically, touch the **Save Setup**. This will take you out of the current dialog and will open the "Save Waveform" dialog. See Saving and Recalling Signals.

### *Setting Up Mask Testing*

1. From the "Test" menu on the right-hand side, make a selection in the **Test is True when** group of buttons:



. This selection means, for example, that if you select **All In** the test will be False if even a single waveform falls outside the mask.

2. From **Show Markers**, choose whether or not to have mask violations displayed.

3. If you are loading a pre-existing mask, touch the **Load Mask** tab, then the **File** button. You can then enter the file name or browse to its location.

4. If you want to make a mask from your waveform, touch the **Make Mask** tab.

5. Touch inside the **Ver Delta** and **Hor Delta** fields and enter boundary values, using the pop-up numeric keypad.

6. Touch the **Browse** button to create a file name and location for the mask if you want to save it.

7. Touch the **Gate** tab, then enter values in the **Start** and **Stop** fields to constrain the mask to a portion of the waveform. Or, you can simply touch and drag the Gate posts, which initially are placed at the extreme left and right ends of the grid.

# Utilities and Preferences

## OVERVIEW

The Utilities and Preferences menus are accessed from the Top Menu Bar **Utilities** selection.   Utilities and Preferences contain setup and other information that doesn't need to be changed or accessed frequently.

Other items are located in the various Top Menu Bar drop-downs.

Most of the following entries correspond to labeled tabs on the **Utilities** menu.

## STATUS

The status read-only dialog displays system information including serial number, firmware version, and installed software and hardware options.

### *To Access Status Dialog*

1.  In the menu bar, touch **Utilities**.
2.  Touch the **Status** tab.

## REMOTE COMMUNICATION

The Remote dialog is where you can select a network communication protocol, establish network connections, and configure the Remote Control Assistant log. The choice of communication protocols is currently limited to TCPIP.

**Note:** The instrument uses Dynamic Host Configuration Protocol (DHCP) as its

addressing protocol. Therefore, it is not necessary to set up an IP address if your network supports DHCP. If it does not, you can assign a static address in the standard Windows network setup menu. Consult with your IT department. The local firewall may make it difficult for you to do this on your own.

The Remote Control Assistant monitors communication between your PC and scope when you are operating the instrument remotely. You can log all events, or errors only. This log can be invaluable when you are creating and debugging remote control applications.

### *To Set Up Remote Communication.*

If you are connecting the scope to a network, first contact your Information Systems administrator. If you are connecting the scope directly to your PC, connect an Ethernet cable between them.

1. In the menu bar touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
2. Touch the **Remote** tab.
3. Make a **Port** selection:**TCPIP** (transmission control protocol/Internet protocol) is the only supported port at this time.
4. Press the **Net Connections** button; the Windows **Network and Dial-up Connections** window appears.
5. Touch **Make New Connection** and use the Windows Network Connection Wizard to make a new connection; or, touch Local Area Connection to reconfigure the scope's connection if it is already connected to the network.

### *To Configure the Remote Control Assistant Event Log*

1. In the menu bar touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
2. Touch the **Remote** tab.

3. Touch inside the **Log Mode** data entry field.

4. Select **Off**, **Errors Only**, or **Full Dialog** from the pop-up menu.

5. To export the contents of the event log to an ASCII text file, touch the **Show Remote Control Log** button: the "Event Logs" popup window appears. Touch inside the **DestFilename** data entry field and enter a file name, using the pop-up keyboard. Then touch the **Export to Text File** button.

## AUX OUTPUT

The following signals can be output through the AUX OUTPUT coaxial connector on the back of the WaveSurfer (this coaxial connector is not labeled).

| | |
|---|---|
| | Aux Output Off -- turns off the auxiliary output signal |
| | Trigger Out -- can be used to trigger another scope |
| | Trigger Enabled -- can be used as a gating function to trigger another instrument when the scope is ready |
| | Pass/Fail -- allows you to set a pulse duration from 1 ms to 500 ms; generates a pulse when pass/fail testing is active and conditions are met. |

### *To Set Up Auxiliary Output*

1. In the menu bar, touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
2. Touch the **Aux Output** tab.
3. Touch one of the buttons under **Use Auxiliary Output For**.
4. If you selected Pass/Fail, touch inside the **Pulse Duration** field and enter a value from 1 ms to 500 ms, using the pop-up numeric keypad.

**Note:** The CAL output on the front of the WaveSurfer is always set to a 1V / 1 kHz square wave.

## DATE & TIME

The instrument gives you the choice of manually setting the time and date or getting it from the Internet. If you elect to get the time and date from the Internet, you need to have the scope connected to the Internet through the LAN connector on the rear panel. You can also set time zones and daylight savings time.

### *To Set Time and Date Manually*
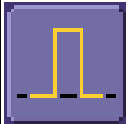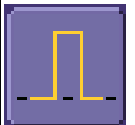
1. In the menu bar touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
2. Touch the **Date/Time** tab.
3. Touch inside each of the **Hour**, **Minute**, **Second**, **Day**, **Month**, and **Year** data entry fields and enter a value, using the pop-up numeric keypad.
4. Touch the **Validate Changes** button.

# W AVE S URFER 400 S ERIES

### *To Set Time and Date from the Internet*

The Simple Network Time Protocol (SNTP) is used.

1. Ensure that the scope is connected to the Internet through the LAN connector at the rear of the scope.
2. In the menu bar touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
3. Touch the **Date/Time** tab.
4. Touch the **Set from Internet** button.

### *To Set Time and Date from Windows*

1. In the menu bar touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
2. Touch the **Date/Time** tab.



3. Touch the **Windows Date/Time** button .
4. Use the **Time & Date Properties** window to configure the time, including time zone.

ISSUED: PRELIMINARY December 2003
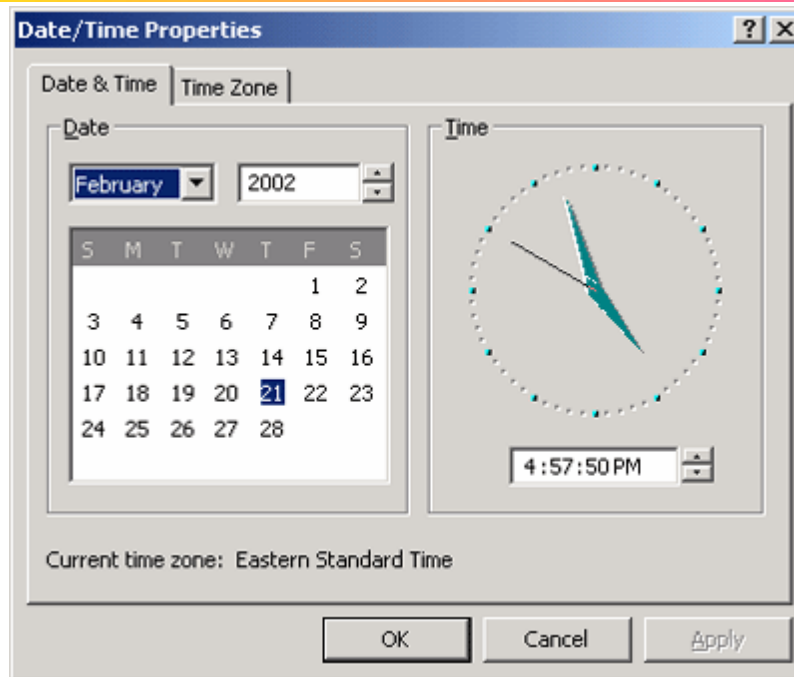
## OPTIONS

Use this dialog to add or remove software options. For information about software options, contact your local LeCroy Sales and Service office, or visit our Web site at http://www.lecroy.com/options.

Options that you purchase, such as **MathSurfer**, add performance to you instrument. This added performance is seen in the new math functions you can choose from when setting up the Math trace.

## SERVICE

This button provides access to service dialogs, which are for the sole use of LeCroy service personnel. A security code is required to gain access.

## SHOW WINDOWS DESKTOP

Touching the **Show Windows Desktop** button in the main "Utilities" dialog minimizes the instrument application to reveal the underlying desktop. To maximize the application, touch the shortcut icon:
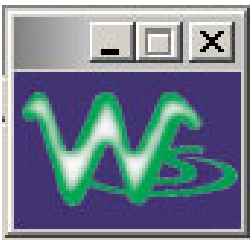
## TOUCH SCREEN CALIBRATION

Touching the **Touch-Screen Calibration** button starts the calibration procedure. During the procedure, you will be prompted to touch the center of a small cross in 5 key locations on the touch screen. Because sufficient accuracy cannot be achieved using your

finger, use a stylus instead for this procedure. The calibration has a ten-second timeout in case no cross is touched.

To avoid parallax errors, be sure to place your line of sight directly in front of each cross before touching it.

# W A V E S U R F E R   4 0 0   S E R I E S

## PREFERENCES

### *Audible Feedback*

You can elect to have audible confirmation each time you touch a screen or front panel control.

1. In the menu bar touch **Utilities**; then touch **Preferences** in the drop-down menu.
2. Touch the "Audible Feedback" **Enable** checkbox so that the scope emits a beep with each touch of the screen or front panel control.

### *Auto-calibration*

You can choose to have your instrument automatically recalibrate itself whenever there is a significant change in ambient temperature. If you do not enable this option, the scope will only recalibrate at startup and whenever you make a change to certain operating conditions.

1. In the menu bar touch **Utilities**; then touch **Preferences** in the drop-down menu.
2. Touch the "Automatic Calibration" **Enable** checkbox.

### *Offset Control*

As you change the gain, this control allows you to either keep the vertical offset level indicator stationary (when **Div** is selected) or to have it move with the actual voltage level (when **Volts** is selected). The advantage of selecting **Div** is that the waveform will remain on

the grid as you increase the gain; whereas, if **Volts** is selected, the waveform could move off the grid.

> **Note:** Regardless of whether you select **Volts** or **Div**, the "Offset" shown in the channel setup dialog always indicates volts. However, when **Div** is selected for the Offset Control, the offset in volts is scaled proportional to the change in gain, thereby keeping the division on the grid constant.

1. In the menu bar touch **Utilities**; then touch **Preferences** in the drop-down menu.
2. Touch the **Offset/Delay** tab.
3. Under **Offset Setting constant in:**, touch either the **Div** or **Volts** button.

## *Local Language*

WaveSurfer can be selected to display a user interface in a wide variety of languages.  Make a selection and WaveSurfer will change language dynamically.

## *Offset/Delay Control*

As you change the timebase, this control allows you to either keep the horizontal offset indicator stationary (when **Div** is selected) or to have it move with the trigger point (when **Time** is selected). The advantage of selecting **Div** is that the trigger point will remain on the grid as you increase the timebase; whereas, if **Time** is selected, the trigger point could move off the grid.

> **Note:** Regardless of whether you select **Time** or **Div**, the "Delay" shown in the timebase setup dialog always indicates time. However, when **Div** is selected for Delay In, the delay in time is scaled proportional to the change in timebase, thereby keeping the division on the grid constant.

1. In the menu bar touch **Utilities**; then touch **Preferences** in the drop-down menu.
2. Touch the **Offset/Delay** tab.
3. Under **Offset Setting constant in:**, touch either the **Volts** or **Div** button.
4. Under **Delay Setting constant in:**, touch either the **Time** or **Div** button.

## *E-mail*

Before you can send e-mail from the scope, it must first be configured.

- In the menu bar touch **Utilities**, then **Preference Setup...** in the drop-down menu.
- Touch the **E-mail** tab.
- Choose an e-mail server protocol: **MAPI** (Messaging Application Programming Interface) is the Microsoft interface specification that allows different messaging and workgroup applications (including e-mail, voice mail, and fax) to work through a single client, such as the Exchange client included with Windows 95 and Windows NT. MAPI uses the default Windows e-mail application (usually Outlook Express). **SMTP** (Simple Mail Transfer Protocol) is a TCP/IP protocol for sending messages from one computer to another through a network. This protocol is used on the Internet to route e-mail. In many cases no account is needed.
- If you chose MAPI, touch inside the **Originator Address (From:)** data entry field and use the pop-up keyboard to type in the instrument's e-mail address. Then touch inside

the **Default Recipient Address (To:)** data entry field and use the pop-up keyboard to enter the recipient's e-mail address.

- If you chose SMTP, touch inside the **SMTP Server** data entry field and use the pop-up keyboard to enter the name of your server. Touch inside the **Originator Address (From:)** data entry field and use the pop-up keyboard to type in the instrument's e-mail address. Then touch inside the **Default Recipient Address (To:)** data entry field and use the pop-up keyboard to enter the recipient's e-mail address.

- You can send a test e-mail text message by touching the **Send Test Mail** button. The test message reads "Test mail from [name of scope's email address]."

## ACQUISITION STATUS

For each general category of scope operation, you can view a summary of your setups. These dialogs are not accessible through the Utilities menu, but are instead accessed from the menu bar drop-down menus. The categories are as follows:

- Vertical -- select **Channels Status . . .** from drop-down menu

- Timebase -- select **Acquisition Status . . .** from drop-down menu

- Trigger -- select **Acquisition Status . . .** from drop-down menu

- Math -- select **Math Status . . .** from drop-down menu

In addition to these dialogs, summaries are also provided for XY setups, memory (M1-M4) setups, and time stamps for sequence mode sampling.

# Remote Control Operation

Refer to the *Remote Control Manual* supplied on CD with your scope for more information.

You can fully control your instrument remotely. The only actions for which you must use the front panel controls are the powering up of the scope and the setting of remote control addresses.

## STANDARDS

LeCroy remote control commands conform to the GPIB IEEE 488.2[*] standard. This may be considered an extension of the IEEE 488.1 standard.

## PROGRAM MESSAGES

You control the oscilloscope remotely using program messages that consist of one or more commands or queries. The program messages you send from the external controller to the WaveSurfer oscilloscope must conform to precise format structures. The oscilloscope will execute all program messages sent in the correct form, but will ignore those with errors.

**WaveSurfer
side panel**

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[*]*ANSI/IEEE Std. 488.2–1987,* IEEE Standard Codes, Formats, Protocols, and Common Commands*. The Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017 USA*

# Automation

Refer to the *Automation Manual* supplied on CD with your scope for more information.

In addition to supporting the familiar ASCII-based "GPIB" remote commands, the WaveSurfer instruments fully support control by Automation interfaces based on Microsoft's Component Object Model (COM). Using COM, the controlling application can run directly on the instrument without requiring an external controller; or, alternatively, it can run using Microsoft's distributed COM standard (DCOM) on a networked computer.

## STANDARDS

Automation is a Microsoft technology, formerly referred to as "OLE Automation," that has primarily been used to enable cross-application macro programming. It is based upon the Component Object Model (COM).

An application that "exposes Automation Objects" is referred to as an "Automation Server." Automation Objects expose "Automation Interfaces" to the controlling "Automation Client." The manual describes these Automation objects and interfaces in detail.

It is important to note that Automation itself is not software language dependent; it can be used from any programming language that supports COM. LeCroy's usage, however, concentrates mainly on the use of Automation from the Visual Basic Script (VBScript) language, primarily because it is easy to use, it is the language that the WaveSurfer uses for setup files, and VBScript interpreter is

installed by default on all WaveSurfer instruments and, therefore, is available without your having to purchase any additional software.

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