

LeCroy

WaveRunner® 6000

Series DSO



Getting Started Manual

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INTRODUCTION.....9

SAFETY REQUIREMENTS 10

Safety Symbols and Terms..... 10

Operating Environment 11

Cooling Requirements 12

AC Power Source 12

Power and Ground Connections..... 12

On/Standby Switch..... 13

Calibration 13

Cleaning 13

Abnormal Conditions..... 14

Virus Protection..... 14

WHEN YOUR SCOPE IS DELIVERED.....15

Check that You Have Everything 15

Warranty..... 15

Maintenance Agreements..... 15

Windows License Agreement..... 15

End-User License Agreement For Lecroy® X-Stream™ Software 16

INSTALLATION23

Hardware Connections 23

SOFTWARE..... 23

Adding a New Option 23

WAVE RUNNER 6000 SERIES

Restoring Software	23
Restarting the Application	23
Restarting the Operating System.....	24
External Monitor.....	24
Writable CD Drive.....	26
USING THE RECOVERY DISK.....	30
PROBES.....	31
FRONT PANEL CONTROLS	32
Front Panel Buttons and Knobs	32
Trigger Knobs:	33
Trigger Buttons:	33
Horizontal Knobs:.....	33
Vertical Knobs:.....	33
Channel Buttons:	34
Zoom Control Knobs:.....	34
Special Features Knobs & Buttons:.....	34
General Control Buttons:	35
ON-SCREEN TOOLBARS, ICONS, AND DIALOG BOXES	36
Menu Bar Buttons	36
Adjust Knob.....	37
Dialog Boxes	37
Alternate Access Methods	37
Mouse and Keyboard Operation.....	37
Tool Bar Buttons	38
TRACE DESCRIPTORS.....	39
TURNING ON TRACES	40
VERTICAL SETTINGS AND CHANNEL CONTROLS.....	42

<i>Adjusting Sensitivity</i>	42
<i>Adjusting the Waveform's Position</i>	42
<i>Coupling</i>	42
TIMEBASE SETUP	44
<i>Combining of Channels</i>	44
To Combine Channels	44
TRIGGERING	45
<i>Simple Triggers</i>	45
Edge Trigger on Simple Signals	45
Controlling Edge Triggering	45
To Set Up an Edge Trigger	46
<i>SMART Triggers</i>	48
DISPLAY FORMATS	49
<i>Display Setup</i>	49
Sequence Mode Display	49
<i>Persistence Setup</i>	50
Saturation Level	50
3-Dimensional Persistence	51
Show Last Trace	51
<i>Zooming Waveforms</i>	51
To Zoom a Single Channel	52
To Zoom by Touch-and-Drag	53
To Zoom Multiple Waveforms Quickly	54
SAVE AND RECALL	55
<i>Saving and Recalling Scope Settings</i>	55
To Save Scope Settings	55
To Recall Scope Settings	55
To Recall Default Settings	55

WAVE RUNNER 6000 SERIES

Saving Screen Images	56
Saving and Recalling Waveforms	56
To Save Waveforms	56
To Recall Waveforms.....	58
PRINTING AND FILE MANAGEMENT	59
Printing	59
To Set Up the Printer	59
To Print.....	59
Adding Printers and Drivers	59
Changing the Default Printer.....	60
Managing Files	60
Hard Disk Partitions	60
UTILITIES	61
Status	61
To Access Status Dialog.....	61
Remote communication	61
To Set Up Remote Communication.	61
To Configure the Remote Control Assistant Event Log.....	62
Hardcopy	62
Printing	62
Clipboard.....	62
File	62
E-Mail	63
Aux Output	64
To Set Up Auxiliary Output	64
Date & Time	64
To Set Time and Date Manually	65
To Set Time and Date from the Internet	65
To Set Time and Date from Windows.....	65
Options	66

Service	66
Show Windows Desktop.....	67
Touch Screen Calibration.....	67
Preferences.....	67
Audible Feedback	67
Auto-calibration	67
Offset Control.....	67
Performance Optimization	68
Offset/Delay Control.....	68
E-mail.....	68
Acquisition Status.....	69
INTRODUCTION TO WAVESHape ANALYSIS.....	70
Parameter Measurements.....	70
Measure Modes	70
Standard Vertical Parameters.....	70
Standard Horizontal Parameters	70
Custom Measurements with My Measure	71
Status Symbols.....	71
WAVEFORM MEASUREMENTS.....	72
Measuring with Cursors	72
Cursor Measurement Icons	72
Cursors Setup	72
Quick Display	72
Full Setup.....	73
PARAMETER ANALYSIS	74
Trend measurements.....	74
Track View.....	74
JitterTrack View.....	74

HISTOGRAMS.....	75
<i>Creating and Viewing a Histogram</i>	75
To Set Up a Single Parameter Histogram	75
To View Thumbnail Histograms	76
Persistence Histogram	76
Persistence Trace Range	77
Persistence Sigma	77
WAVEFORM MATH	78
<i>Math Setup.....</i>	78
<i>Resampling To Deskew</i>	79
To Resample.....	79
<i>Rescaling and Assigning Units.....</i>	79
To Set Up Rescaling	79
<i>Averaging Waveforms</i>	79
Summed vs. Continuous Averaging	79
To Set Up Continuous Averaging	81
To Set Up Summed Averaging	81
<i>Enhanced Resolution (ERES)</i>	82
<i>Waveform Copy.....</i>	82
<i>Waveform Sparser</i>	83
To Set Up Waveform Sparser.....	83
<i>Interpolation</i>	83
To Set Up Interpolation.....	83
<i>FFT Setup</i>	84
ANALYSIS.....	85
<i>Pass/Fail Testing.....</i>	85
Comparing Parameters.....	85
Mask Tests.....	86
Actions	86

GETTING STARTED MANUAL

Setting Up Pass/Fail Testing	87
Setting Up Mask Testing.....	90
CUSTOMIZATION	92
Solutions	92
CUSTOMDSO	94
REMOTE CONTROL OPERATION	95
<i>Standards</i>	95
<i>Program Messages</i>	95
AUTOMATION	96
<i>Standards</i>	96

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Introduction

This brief guide includes important safety and installation information for your WaveRunner 6000 Series oscilloscope along with brief operating procedures to get you started capturing, viewing, and analyzing your waveforms.

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 a On/Standby switch. When it is pressed, the DSO's state toggles between Operating and Standby 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 Standby 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 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.



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.



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.

WAVE RUNNER 6000 SERIES

Cooling Requirements

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, front, 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, 100-240 V_{rms} (+/-10%) AC power source at 50/60 Hz (+/-5%), or single-phase 100-120 V_{rms} (+/-10%) AC power source at 400 Hz (+/-5%).

No manual voltage selection is required because the instrument automatically adapts to line voltage.

Depending on the accessories installed (internal printer, front panel probes, PC port plug-ins, etc.), the instrument can draw up to 425 W (425 VA).

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

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
Frequency Range:	47 to 63 Hz	380 to 420 Hz



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.

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 Standby state.

In Standby 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/Standby Switch for more information.

On/Standby Switch

The front panel On/Standby 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 Standby. In the "On" state, the DSO, including its computer subsystems (CPU, hard drive, etc,) is fully powered and operational. In the "Standby" state, the DSO, including computer subsystems, is powered off with the exception of some "housekeeping" circuitry (approximately 12 watts dissipation).

Always use the On/Standby switch to place the DSO in Standby state so that it executes a proper shutdown process (including a Windows shutdown) to preserve settings before powering itself off. This can be accomplished by pressing and holding in the On/Standby switch for approximately 5 seconds.

Note: To power off, place the DSO in Standby state, then disconnect the power cord.

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



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.



WARNING

Electrical Shock Hazard!

No operator serviceable parts inside. Do not remove covers.

Refer servicing to qualified personnel.

WAVE RUNNER 6000 SERIES

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.

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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.

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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 X-Stream oscilloscopes that is not relevant to measuring, analyzing, or documenting waveforms.

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

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WAVE RUNNER 6000 SERIES

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WAVE RUNNER 6000 SERIES

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8.5 Assignment. This EULA and the rights and obligations hereunder, may not be assigned, in whole or in part by you, except to a successor to the whole of your business, without the prior written consent of LeCroy. In the case of any permitted assignment or transfer of or under this EULA, this EULA or the relevant provisions will be binding upon, and inure to the benefit of, the successors, executors, heirs, representatives, administrators and assigns of the parties hereto.

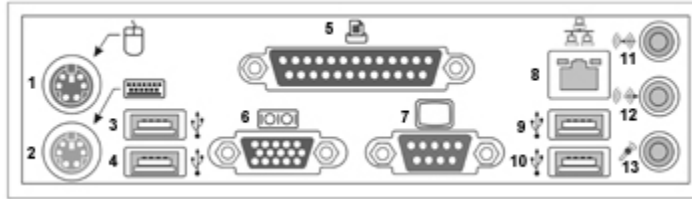
8.6 Notices. All notices or other communications between LeCroy and you under this EULA will be in writing and delivered personally, sent by confirmed fax, by confirmed e-mail, by certified mail, postage prepaid and return receipt requested, or by a nationally recognized express delivery service. All notices will be in English and will be effective upon receipt.

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Installation

HARDWARE CONNECTIONS



(1) Mouse^{}; (2) Keyboard^{*}; (3) USB Port; (4) USB Port; (5) Centronics Port; (6) RS-232-C Port; (7) External VGA Monitor; (8) Ethernet Port; (9) USB Port; (10) USB Port; (11) Line In; (12) Speakers; (13) Microphone*

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.

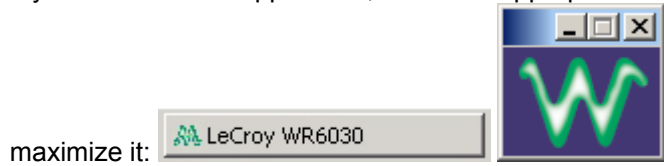
- If you exit the application and want to reload it, touch the shortcut icon on the

desktop:  Start DSO.

^{*} The mouse and keyboard supplied with your scope are USB devices that can be plugged into any available USB connector.

WAVE RUNNER 6000 SERIES

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



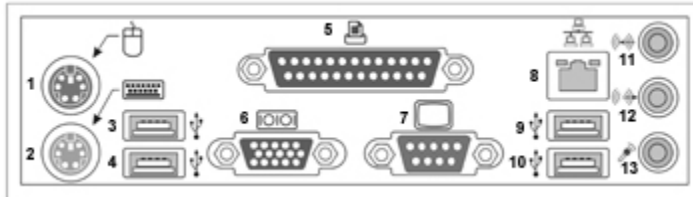
Restarting the Operating System

If you need to restart the Windows® operating system, you will have to reboot the scope by pressing and holding in the power switch for 10 seconds, then turning the power back on.

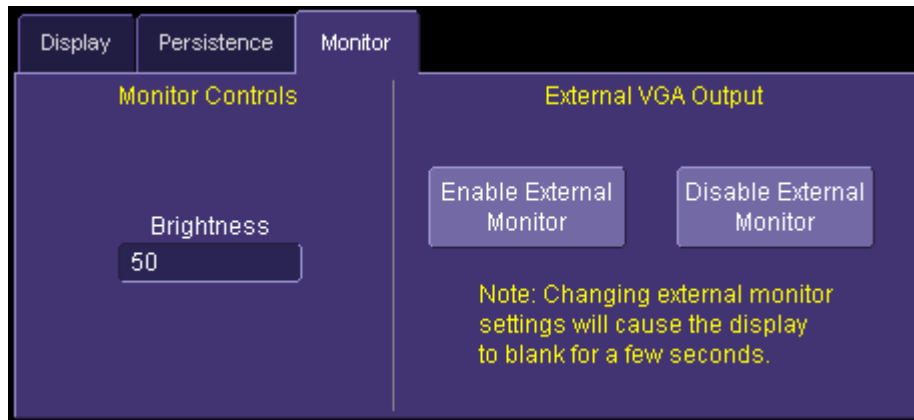
EXTERNAL MONITOR

You can easily add an external monitor to your scope as follows:

1. Connect the external monitor to the VGA port at the rear of the instrument (item 7 in the diagram).



2. Plug in the monitor's power cord, and apply power to the monitor.
3. After boot-up, touch **Display** in the menu bar, then **Display Setup...** in the drop-down menu.
4. Touch the **Monitor** tab of the "Display" dialog:



5. Touch **Enable External Monitor**.

6. Touch inside the **Brightness** field and adjust brightness as necessary.

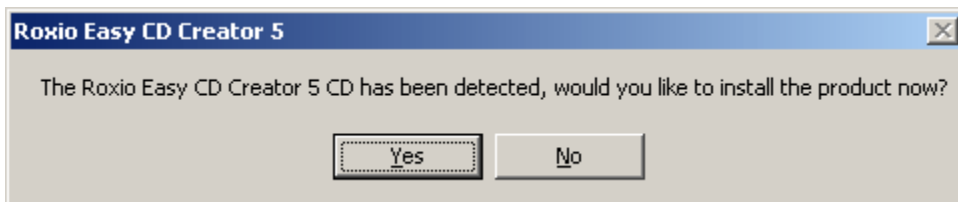
WAVERUNNER 6000 SERIES

WRITABLE CD DRIVE

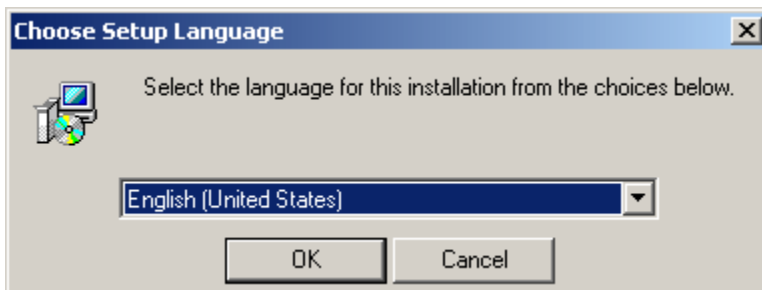
If your scope is equipped with this option, follow these setup instructions to install the software.

Note: Install the software only in WaveRunner scopes that have CD drive model SM-CD-W224EA installed.

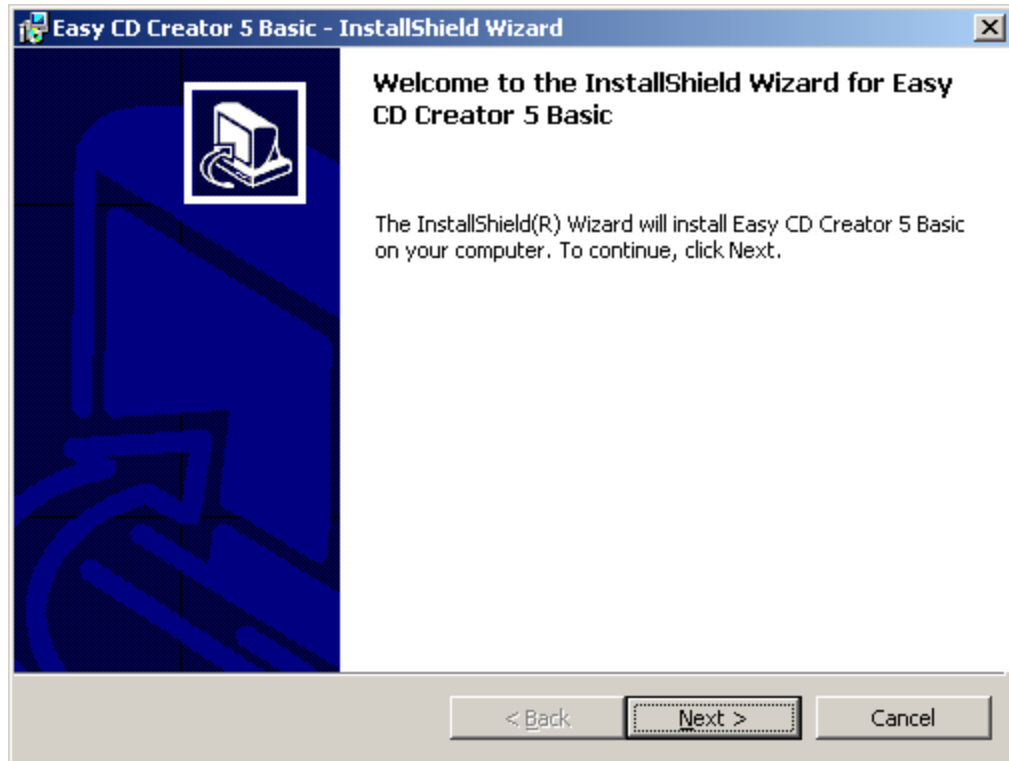
1. Connect a keyboard and mouse to the scope.
2. Load the **Easy CD Creator 5 Basic** installation CD into the CD drive.
3. Click **Yes** to begin installation:



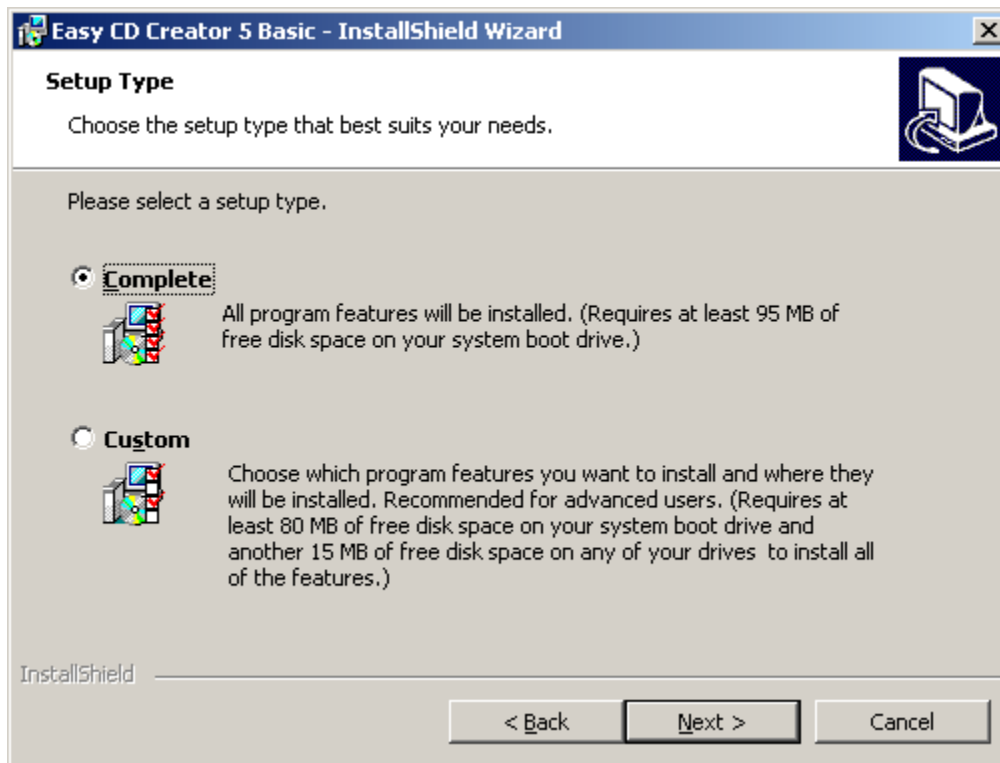
4. Select a language:



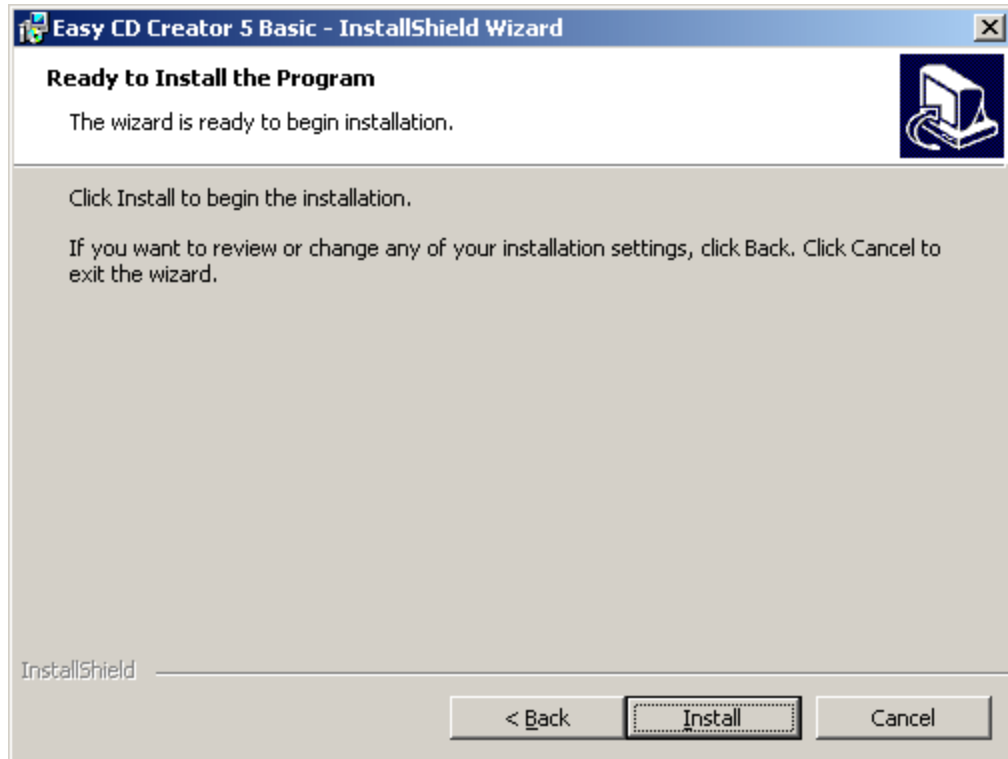
5. Click **Next** when the Wizard appears:



6. Select **Complete** setup:



7. Click **Install**:



8. When installation is completed, the scope will need to be rebooted.
The install Wizard places a shortcut icon on the desktop.

Note: If in the future it is necessary to run recovery software, this **Easy CD Creator 5 Basic** installation software will need to be reinstalled also.

Using the Recovery Disk

Your WaveRunner 6000 Series scope comes with a recovery disk to be used in the event that it becomes necessary to reload the operating software. Instructions for its use are contained on the disk.

Probes

LeCroy offers a variety of passive and active probes for use with your WaveRunner 6000 Series scope. Visit www.lecroy.com for specifications and ordering information.

Current Probes Current Probes measure the current passing through a wire; current probes do not use the "traditional" probing style of placing a tip onto a test point. Rather, a wire is placed inside of the "jaw" of the probe, which then allows the probe to measure the current (in Amps).

Active Probes There are two different types of active probes: "single-ended" and "differential."

Single-ended: A single-ended active probe is associated with measuring voltages at high frequencies. Measurement with an active probe requires a test point and a ground point. The ground (also called earth) acts as a zero reference for the test point measurement.

Differential Probes Differential active probes are like two probes in one. Instead of measuring a test point in relation to a ground point (like single-ended active probes), differential probes measure the difference in voltage of a test point in relation to another test point.

Passive Probes Passive probes measure voltages at lower frequencies (<400 MHz). They have higher input capacitance (input C) and do not need power to operate (unlike active probes). At higher frequencies, higher input capacitance loads the test circuit, attenuating the signal. This is why active probes are used in high frequency applications. Passive probes also measure voltage in reference to ground.

High Voltage Probes These are active single ended probes that are designed to measure high voltages (safely). They measure the voltage in reference to ground.

Front Panel Controls

FRONT PANEL BUTTONS AND KNOBS





The control buttons of the WaveRunner 6000 Series DSO front panel are logically grouped into analog and special functional areas. Analog functions are included in the **Horizontal**, **Trigger**, and **Vertical** groups of control buttons and knobs.

GETTING STARTED MANUAL


Sometimes you may want to change a value without using the numeric keypad. In that case, simply touch once inside the data entry field in the scope dialog area (the field will be highlighted in yellow), then use the **ADJUST** knob to dial in values into the selected field.

By default, the **ADJUST** knob makes coarse adjustments (that is, digits to the left of the decimal point). Push the button in to make fine adjusts (digits to the right of the decimal point). To enter exact values, you can also display a keypad by touching twice inside the data entry field. Then use the keypad to type in the value.


The following table provides an explanation of the front panel buttons and knobs:

Trigger Knobs:	
LEVEL	Selects the trigger threshold level. The Level is indicated in the Trigger descriptor label: 
Trigger Buttons:	
STOP	Prevents the scope from triggering on a signal.
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.
Horizontal Knobs:	
DELAY	Horizontally positions the scope trace on the display so you can observe the signal prior to the trigger time. <i>Delay</i> adjusts the pre- and post-trigger time.
TIME/DIVISION	Sets the time/division of the scope timebase (acquisition system). LeCroy's SMART Memory automatically optimizes the memory and sample rate for maximum resolution.
Vertical Knobs:	
 OFFSET	Adjusts the vertical offset of a channel.

WAVE RUNNER 6000 SERIES

VOLTS/DIV	Adjusts the Volts/Division setting (vertical gain) of the channel selected.
Channel Buttons:	
1, 2, 3, 4	Turns a channel on or off. These buttons activate the dialog that lets you change the channel's setup conditions including coupling, gain, and offset. They are used also to select multiple grids, to automatically set the gain (Find Scale), or to automatically display a zoom of the signal. Press twice to toggle the trace on and off.
Zoom Control Knobs:	
QUICKZOOM  (toggle switch)	Automatically displays magnified views of up to four signal inputs on multiple grids. With four input signals, the signals are displayed along with four zoom traces, each on its own grid. This button turns off all other traces.
↔ POSITION	Adjusts the horizontal position of a zoom trace on the display. The zoom region is highlighted in color on the source trace. Unlike Delay, the position is not calibrated to the trigger position.
↔ ZOOM	Adjusts the horizontal zoom (magnification factor) of the selected zoom trace.
↑↓ POSITION	Adjusts the vertical position of the selected zoom trace on the display. Unlike Offset, the position is not calibrated to the 0 V reference.
↑↓ ZOOM	Adjusts the vertical zoom (magnification factor) of the selected zoom trace on the display.
Special Features Knobs & Buttons:	
Auto Setup	Automatically sets the scope's horizontal timebase (acquisition system), vertical gain and offset, as well as trigger conditions, to display a wide variety of signals.
CURSORS	These knobs control the placement of the cursors on your waveform. Cursors are activated by selecting Cursors from the menu bar.


GETTING STARTED MANUAL


ANALOG PERSIST	Provides a three dimensional view of the signal: time, voltage, and a third dimension related to the frequency of occurrence, as shown by a color-graded (thermal) or intensity-graded display.
General Control Buttons:	
PRINT SCREEN 	Prints the displayed screen to a file, a printer, the clipboard, or attaches it as an e-mail. You can select the device and format it in the Utilities → Hardcopy dialog.
TOUCH SCREEN (toggle switch)	Activates or deactivates the touch screen.
CLEAR SWEEPS	Clears data from multiple sweeps (acquisitions) including: persistence trace displays, averaged traces, parameter statistics, and Histicons. During waveform readout, cancels readout.

On-screen Toolbars, Icons, and Dialog Boxes


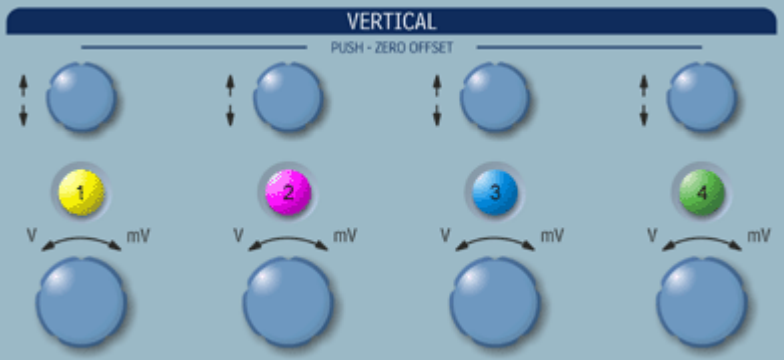

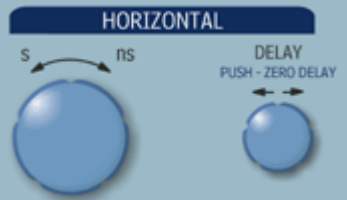
MENU BAR BUTTONS

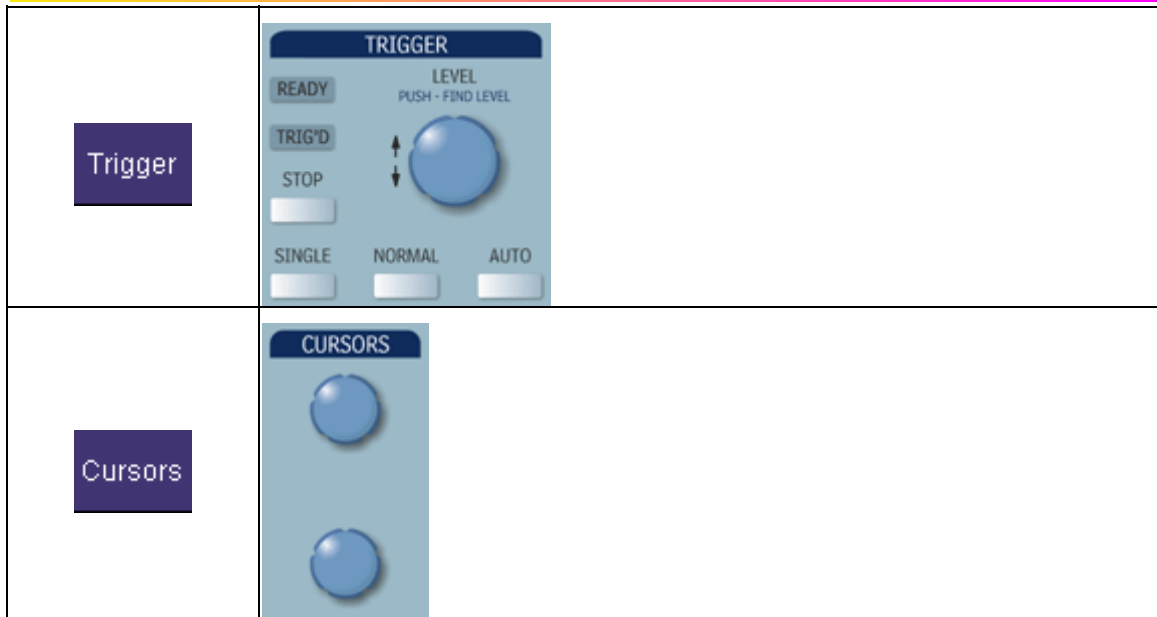
The menu bar buttons at the top of the scope's display are designed for quick setup of common functions. At the right end of the menu bar is a quick setup button that, when touched, opens the setup dialog associated with the trace or parameter named beside it. The named trace or

parameter is the one whose setup dialog you last opened: . This button also

appears as an undo button  after the Autosetup front panel button is pressed. If you want to perform an Undo operation, it must be the very next operation after you perform the Autosetup operation.

Many of the menu bar buttons give you access to the same functions as do the front panel buttons. Refer to this Table of Equivalent Functions.

Display Buttons	Front Panel Push Buttons
	
	



Adjust Knob



The adjust knob can be used to dial in values into a selected control. The selected control is signified by being highlighted in yellow.

Push this button in to toggle between coarse and fine adjustments, i.e., values before and after the decimal point.

DIALOG BOXES

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

ALTERNATE ACCESS METHODS

The instrument often gives you more than one way to access dialogs and menus.

Mouse and Keyboard Operation







In the procedures, we focus on touch-screen operation. 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

WAVE RUNNER 6000 SERIES

connected, you can use it to enter data instead of using the virtual keyboard provided by the instrument.

Tool Bar Buttons

The procedures also focus on the use of the menu bar at the top of the screen to access dialogs and menus. On several dialogs, however, common functions are accessible from a row of buttons that save you a step or two in accessing their dialogs. For example, at the bottom of the Channel Setup dialog, these buttons perform the following functions:

	Calls up the Measure menu. You can then select a parameter from this menu without leaving the Channel Setup dialog. The parameter automatically appears below the grid.
	Creates a zoom trace of the channel trace whose dialog is currently displayed.
	Calls up the Math menu. You can then select a math function from this menu without leaving the Channel Setup dialog. A math trace of the channel whose dialog is currently open is automatically displayed.
	Loads the channel trace into the next available memory location (M1 to M4).
	Automatically performs a vertical scaling that fits the waveform into the grid.
	Automatically moves the channel trace whose dialog is currently open onto the next grid. If you have only one grid displayed, a new grid will be created automatically, and the trace moved.

Another example is these buttons that appear at the bottom of the Measure P_x^\dagger dialogs. Each button opens a menu from which to choose a math trace (F1 to Fx) to display the functions

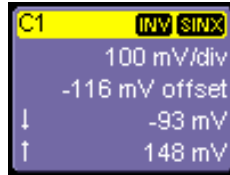


named in the buttons: . By using these buttons you can remain in the Measure dialog to set up other options.

[†] The number of parameters and math traces available depends on the software options loaded on your scope.

Trace Descriptors

Vertical and horizontal trace descriptor labels are displayed below the grid. They provide a summary of your channel, timebase, and trigger settings. To make adjustments to these settings, touch the respective label to display the setup dialog for that function.



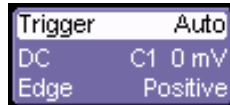
Channel trace labels show the vertical settings for the trace, as well as cursor information if cursors are in use. In the title bar of the label are also included indicators for (SinX)/X interpolation, waveform inversion (INV), deskew (DSQ), coupling (DC/GND), bandwidth limiting (BWL), and averaging (AVG). These indicators have a long and short form:

AVG	A
SINX	S
INV	I
DSQ	DC
DC	D
Gnd	G
BwL	B

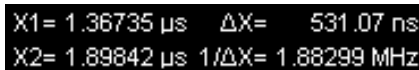
Besides channel traces, math and parameter measurement labels are also displayed. Labels are displayed only for traces that are turned on.



The title bar of the **TimeBase** label shows the trigger delay setting. Time per division and sampling information is given below the title bar.



The title bar of the **Trigger** label shows the trigger mode: Auto, Normal, or Stopped. Below the title bar is given the coupling (DC), trigger type (Edge), source (C1), level (0 mV), and slope (Positive).



Shown below the TimeBase and Trigger labels is setup information for horizontal cursors, including the time between cursors and the frequency.

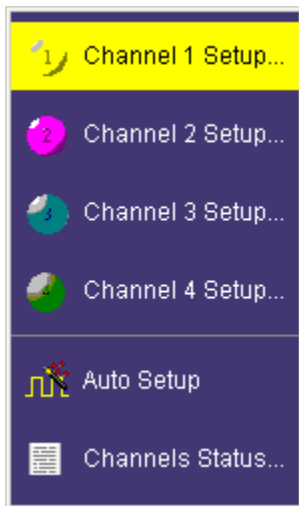
Turning On Traces

1. To turn on a channel trace, on the front panel press a channel select button, such as



, to display the trace label for that input channel. While this turns on the trace, it leaves the current dialog displayed.

If you want to also display the vertical setup dialog for the channel trace, touch the **Vertical** menu bar button, then select the channel from the drop-down menu:



2. To turn on a math function trace, touch **Math** in the menu bar, then **Math Setup...** in the drop-down menu. Touch the **On** checkbox for the trace you want to activate.
3. You can also turn on traces for math functions, parameters, and memory traces without leaving the **Vertical Adjust** dialog by touching the icons at the bottom of the Vertical Adjust dialog:



Whenever you turn on a channel or math trace via the menu bar at the top of the screen, the dialog at the bottom of the screen automatically switches to the vertical setup or math setup dialog for that selection. You can then configure your traces.

GETTING STARTED MANUAL

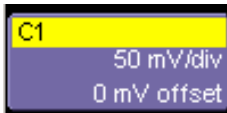
The channel or math trace number appears in the tab of the appropriate dialog, signifying that all controls and data entry fields are dedicated to the selected trace:



Vertical Settings and Channel Controls

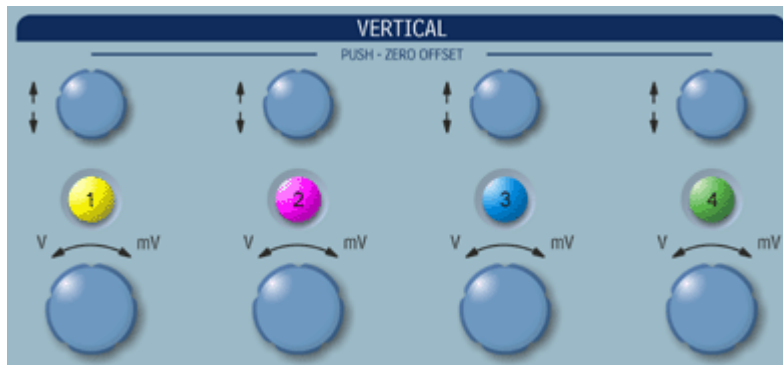
ADJUSTING SENSITIVITY

1. Touch **Vertical** in the menu bar, then **Channel 1** in the drop-down menu.
2. Touch inside the **Trace On** checkbox to display the trace.
3. Turn the volts per division knob for the selected channel. Or you can touch inside the **Volts/Div** field and type in a value using the pop-up keypad. A third way is to use the up/down arrows.
4. The voltage that you set is displayed in the **Volts/Div** field and in the trace descriptor label:



ADJUSTING THE WAVEFORM'S POSITION

Turn the vertical offset adjust knob directly above the channel button whose waveform you want to move vertically. Or you can touch inside the **Offset** field and type in a value on the pop-up keypad. To set the vertical offset to zero, press the vertical offset adjust knob for the channel you want to adjust:



COUPLING

Your choices of coupling are as follows:

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

GETTING STARTED MANUAL

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

Timebase Setup

Set up the timebase by using the front panel **Horizontal** controls, just as for analog scopes.

For additional timebase setups

1. Touch **Timebase** in the menu bar, then **Horizontal Setup...** in the drop-down menu. The "Horizontal" dialog appears.
2. Touch inside the **Time/Division** data entry field and enter a value using the pop-up numeric keypad, or use the up/down arrows to adjust the value.
3. Touch inside the **Delay** data entry field and type in a value, using the pop-up keypad. Touch the **Set To Zero** button to set the delay to zero.

COMBINING OF CHANNELS

Channels can be combined to increase sample rate, memory, or both in order to capture and view a signal in all its detail. When you combine channels, uncombined channels like EXT BNC remain available for triggering, even though they are not displayed.

Note: While channels can be combined on any WaveRunner 6000 Series model to increase memory, sample rate can only be increased on 1 GHz and 2 GHz bandwidth models.

In 2-channel operation, channels 2 and 3 are active. In Auto operation, you can use channel 1 or 2, and channel 3 or 4. On the paired channels the maximum sampling rate is doubled and the record length is greatly increased:

Ch 1 & Ch 3	10 GS/s
Ch 1 & Ch 4	10 GS/s
Ch 2 & Ch 3	10 GS/s
Ch 2 & Ch 4	10 GS/s

As you can see, sampling can be maximized to 10 GS/s for any combination of two channels, except a combination of channels 1 and 2, or channels 3 and 4, which yield 5 GS/s. 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.

Refer to Acquisition Modes in the specifications for maximum sample rates.

To Combine Channels

1. In the menu bar, touch **Timebase**; the "Horizontal" setup dialog opens.
2. Under **Active Channels**, touch 4, 2 or Auto. The maximum sample rate is shown alongside each button.

Triggering

SIMPLE TRIGGERS

Edge Trigger on Simple Signals

The instrument 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.

Controlling Edge Triggering

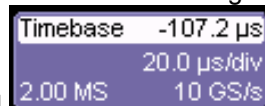
Horizontal: Turn the Delay knob in the HORIZONTAL control group to adjust the trigger's horizontal position. Or, touch inside the **Delay** field in the timebase setup dialog and enter a value, using the pop-up keypad.



The trigger location is shown by a marker below the grid



Post-trigger delay is indicated by a left-pointing arrow below-left of the grid



value is given in the title line of the **TimeBase** label below-right of the grid.



Vertical: Turn the **LEVEL** knob in the TRIGGER control group to adjust the trigger's vertical threshold.

Turn this knob to adjust the level of the trigger source or the highlighted trace. Level defines the source voltage at which the trigger will generate an event: a change in the input signal that satisfies the trigger conditions.

WAVERUNNER 6000 SERIES

Alternatively, in the "Trigger" dialog, you can touch inside the **Level** field and type in a value, using the pop-up numeric keypad. To quickly set a level of zero volts, touch the **Zero Level** button directly below the **Coupling** field.

An arrow on the left side of the grid shows the threshold position. This arrow is only visible if the trigger source is displayed.

To Set Up an Edge Trigger


1. In the menu bar, touch **Trigger**, then select **Trigger Setup...** from the drop-down menu.





2. Touch the **Edge** trigger button under the **Trigger** tab.
3. Touch inside the **Trigger On** field and select an input from the pop-up menu:



4. Touch inside the **Level** data entry field . In the pop-up numeric

keypad, enter a value in millivolts or use the up/down buttons  to increase or decrease the value in increments of 1 mV. Or, touch one of the preset value buttons:





5. Select the holdoff by touching the **Time** or **Events** buttons  . Using the



pop-up numeric keypad, enter a value and specify the unit of time



up/down buttons   to increase or decrease the time value in increments of 200 ps. Or, touch one of the preset value buttons.

6. Choose **Positive** or **Negative** slope



SMART TRIGGERS

SMART Triggers are defined as follows:

Width



One of LeCroy's 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



Another of the SMART Triggers, 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.

Interval



While Glitch trigger performs over the width of a pulse, Interval trigger performs over the width of an interval the signal duration (the period) separating two consecutive edges of the same polarity: positive to positive or negative to negative. Use interval trigger 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 an Exclusion trigger by interval.

Qualify



The Qualify trigger is an edge-qualified SMART 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.

State



The State trigger is a level-qualified SMART Trigger which requires that the qualifying signal remain above or below a specified voltage level for a trigger to occur. For State trigger, you specify the time or number of events after the signal has gone above or below the voltage level when you want the trigger to occur.

Dropout



Used primarily in single-shot applications, and usually with a pre-trigger delay, Dropout trigger can detect lost signals. The trigger is generated at the end of the timeout period following the last trigger source transition. You can select a timeout period from 2 ns to 20 s.

Logic

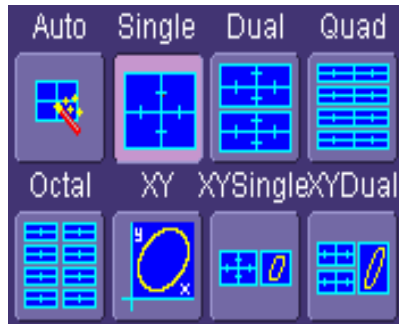


Logic trigger enables triggering on a logical combination (pattern) of five inputs: CH1, CH2, CH3, CH4, EXT. You have a choice of four Boolean operators (AND, NAND, OR, NOR), and you can stipulate the high or low voltage logic level for each input independently.

Display Formats

DISPLAY SETUP

1. In the menu bar, touch **Display**; then touch **Display Setup** in the drop-down menu.
2. Touch one of the **Grid** combination buttons. **Autogrid** automatically adds or deletes grids as you select more or fewer waveforms to display.



3. Touch inside the grid **Intensity** data entry field and enter a value from 0 to 100 using the pop-up keypad.
4. Touch the **Grid on top** checkbox if you want to superimpose the grid over the waveform. Depending on the grid intensity, some of your waveform may be hidden from view when the grid is placed on top. To undo, simply uncheck **Grid on top**.
5. Touch the **Axis labels** checkbox to permanently display the values of the top and bottom grid lines (calculated from volts/div) and the extreme left and right grid lines (calculated from the timebase).



6. Choose a line style for your trace: solid **Line** or **Points**.

Sequence Mode Display

To a set up Sequence Mode display, you must first have selected **Sequence** trigger mode in the Timebase "Horizontal" dialog. You must also have entered a **Num Segments** value.

1. In the menu bar, touch **Display**; then touch **Display Setup** in the drop-down menu.
2. Touch inside the **Display Mode** field and select a display mode from the pop-up menu.
3. Touch inside the **Num seg displayed** field and enter a value, using the pop-up keypad.

WAVE RUNNER 6000 SERIES

The maximum number of segments that can be displayed is 80.

4. Touch inside the **Starting at** field and enter a value.

Note: The maximum value that you can enter for **Starting at** depends on the **Num Segments** value you entered in the "Timebase" dialog. It also depends on the **Num seg displayed** value you entered here in the "Display" dialog. For example, if you had entered a value of 500 in **Num Segments**, and a value of 10 in **Num seg displayed**, the maximum value you can enter as a starting segment is 491 so that 10 segments can be seen.

PERSISTENCE SETUP

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. The instrument persistence modes show the most frequent signal path "three-dimensionally" in intensities of the same color, or graded in a spectrum of colors.

Saturation Level

The Persistence display is generated by repeated sampling of the amplitudes of events over time, and the accumulation of the sampled data into "3-dimensional" display maps. These maps create an analog-style display. User-definable persistence duration can be used to view how the maps evolve proportionally over time. Statistical integrity is preserved because the duration (decay) is proportional to the persistence population for each amplitude or time combination in the data. In addition, the instrument gives you post-acquisition saturation control for a more detailed display.



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

The information in the lower populations (for example, down at the noise level) could be of greater interest to you than the rest. The Analog persistence view highlights the distribution of data so that you can examine it in detail.

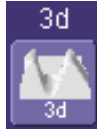
You can select a saturation level as a percentage of the maximum population. All populations above the saturation population are then assigned the highest color intensity: that is, they are saturated. At the same time, all populations below the saturation level are assigned the remaining intensities. Data populations are dynamically updated as data from new acquisitions is accumulated.



Color mode persistence, selected by touching **Color**, works on the same principle as the Analog persistence feature, but instead uses the entire color spectrum to map signal intensity:

violet for minimum population, red for maximum population. A saturation level of 100% spreads the intensity variation across the entire distribution; at lower saturation levels the intensity will saturate (become the brightest color) at the percentage value specified. 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.

3-Dimensional Persistence



By selecting **3d**, you can create a topographical view of your waveform from a selection of shadings, textures, and hues. The advantage of the topographical view is that areas of highest and lowest intensity are shown as peaks and valleys, in addition to color or brightness. The shape of the peaks (pointed or flat) can reveal further information about the frequency of occurrences in your waveform.

The instrument also gives you the ability to turn the X and Y axes of the waveform through 180° of rotation from -90° to +90°.

Show Last Trace

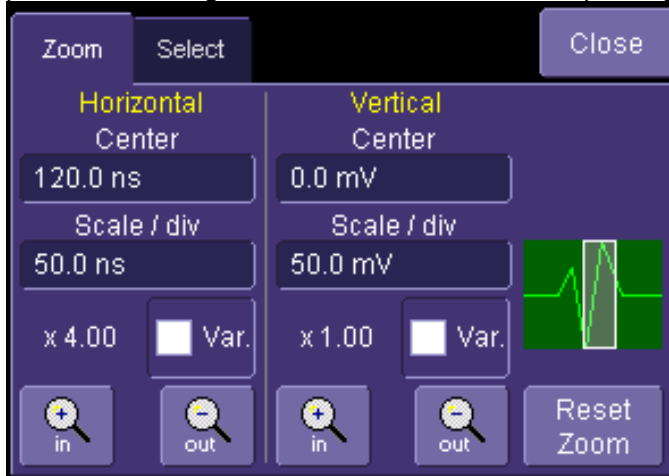
For most applications, you may not want to show the last trace because it will be superimposed on top of your persistence display. In those cases turn off **Show Last Trace** by touching the checkbox. However, if you are doing mask testing and want to see where the last trace is falling, turn **Show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

ZOOMING WAVEFORMS



The Zoom button appears as a standard button at the bottom of the channel "Cx Vertical Adjust" setup dialog if you want to create a math function zoom trace of your input waveform. On the other hand, you can zoom a memory or math function non-zoom trace directly without having to create a separate zoom trace. For such traces, a zoom control mini-dialog is

provided at the right of each math trace "Fx" setup dialog:



The front panel "QuickZoom" button creates multiple zooms, one for each displayed input channel.

At any time, you can also zoom a portion of a waveform by touching and dragging a rectangle around any part of the input waveform. The zoom trace will size itself to fit the full width of the grid. The degree of magnification, therefore, will depend on the size of the rectangle that you create.

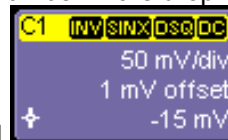
When you zoom a waveform, an approximation of the zoomed area will appear in a thumbnail



icon in the "Zoom" dialog. The "Zoom" dialog appears alongside the math setup dialog when Zoom is the math or memory function selected.

To Zoom a Single Channel

1. In the menu bar, touch **Vertical**; then touch a channel number in the drop-down menu.



Alternatively, you can just touch the channel trace label for a displayed channel.



2. Touch at the bottom of the "Cx Vertical Adjust dialog." A zoom math trace

(one of F5 to Fx The number of math traces available depends on the software options loaded on your scope.) will be created of the selected channel.

3. To vary the degree of zoom, touch the newly created Fx trace label. The setup dialog for the math function opens, and the zoom control dialog appears at lower-right. It shows the current horizontal and vertical zoom factors.
4. If you want to increase or decrease your horizontal or vertical zoom in small increments, touch the **Var.** checkbox to enable variable zooming. Now with each touch of the zoom



control buttons, the degree of magnification will change by a small increment. To zoom in or out in large standard increments with each touch of the zoom control buttons, leave the **Var.** checkbox unchecked. To set exact horizontal or vertical zoom factors, touch inside the Horizontal **Scale/div** data entry field and enter a time-per-div value, using the pop-up numeric keypad. Then touch inside the Vertical **Scale/div** field and enter a voltage value.

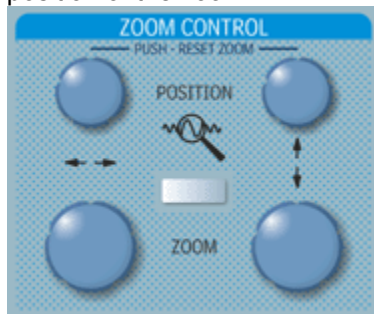
5. To reset the zoom to x1 magnification, touch **Reset Zoom** in the dialog or press the front



panel zoom button

To Zoom by Touch-and-Drag

1. Touch and drag a rectangle around any part of an input channel waveform, math trace, or memory trace. If you have more than one trace displayed, a pop-up "Rectangle Zoom Wizard" will appear.
2. If more than one trace is displayed, touch the "Source" tab and select a trace to act on.
3. Touch the "Action" tab and select **Create a New Zoom Trace**. For channel traces, select **Update Acquisition Settings** if you do not want to create a new zoom, but just want to update acquisition settings. For math function traces, you will be offered the choice of creating a new zoom trace or modifying the current trace.
4. Touch the **Zoom** tab and select a math function trace to display the zoom.
5. Turn the front panel **Zoom Control** position knobs to adjust the vertical and horizontal position of the zoom:




WAVE RUNNER 6000 SERIES

6. Turn the front panel Zoom knobs to control the boundaries of the zoom.

To Zoom Multiple Waveforms Quickly



Press the QuickZoom button  on the front panel. Math function traces **F1** to **F4** will be used to create a zoom of each displayed input channel waveform. Each zoom will be displayed in its own grid.

To Turn Off Zoom

1. Touch the math function trace label for the zoom you want to turn off.
2. Touch the **Trace On** checkbox to delete the check mark and disable the zoom trace.

Save and Recall


SAVING AND RECALLING SCOPE SETTINGS

You can save or recall scope settings to or from hard disk, floppy disk, or LAN location.


To Save Scope Settings

1. In the menu bar, touch **File**; then touch **Save Setup...** in the drop-down menu. Or, press the Save/Recall front panel button, then touch the "Save Setup" tab.
2. To **Save To File**, touch inside the **Save Instrument Settings** data entry field and use the pop-up keyboard to enter the path to the destination folder. Or touch **Browse** to navigate



to the destination folder. Then touch  below the data entry field. To save to folder **Internal Setups** on the scope's hard drive, touch inside a **SetupX** data entry field



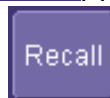
and use the pop-up keyboard to enter a file name. Touch  alongside the data entry field. The file is deposited in **D:\Internal Setups**, and the current date is displayed above the field.

To Recall Scope Settings

1. In the menu bar, touch **File**; then touch **Recall Setup...** in the drop-down menu.
2. To **Recall From File**, touch inside the **Recall panels from file** data entry field and use the pop-up keyboard to enter the path to the source folder. Or touch **Browse** to navigate



to the source folder. Then touch . To recall settings from folder **D:\ Internal**



Setups on the scope's hard drive, touch  alongside the file you want to recall.

To Recall Default Settings

1. In the menu bar, touch **File**; then touch **Recall Setup...** in the drop-down menu.



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

WAVE RUNNER 6000 SERIES

SAVING SCREEN IMAGES

You can send images to a hard copy printer or to storage media. Both types of output are done from the same dialog.

1. In the menu bar, touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
2. Touch the **Hardcopy** tab.
3. Touch the **File** button.
4. Touch inside the **File Format** field and select a file type.
5. Under **Colors**, touch the **Use Print Colors** checkbox if you want your waveforms to print in color with a white background. A white background saves printer toner.
6. Touch inside the **Directory** field and type in the path to the directory where you want the image stored, using the pop-up keyboard. Or you can touch the browse button and navigate there.
7. Touch inside the **File Name** field and type in a name for your image, using the pop-up keyboard.
8. Under **Include On Print**, touch the **Grid Area Only** checkbox if you do not want to include the dialog area in the image.
9. Touch the **Print Now** button.

SAVING AND RECALLING WAVEFORMS

To Save Waveforms

1. In the menu bar, touch **File**; then touch **Save Waveform...** in the drop-down menu.



2. In the "Save Waveform" dialog, touch the **Save To** button.
3. Touch inside the **Source** field and select a source from the pop-up menu. The source can be any trace; for example, a channel (C1C4), math function (F1F4), or a waveform stored in non-volatile RAM (M1M4).
4. Touch inside the **Trace Title** data entry field if you want to change the default name of your waveforms. Use the pop-up keyboard to type in the new name.

Note: You can change the name but not the sequence number.

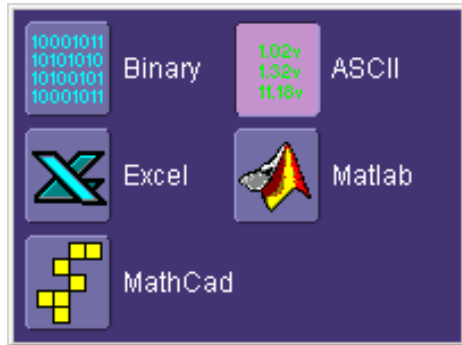


CAUTION

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. For example, if you want to use waveform name "XYZ32" but it is not preceded by waveforms XYZ0 through XYZ31, the waveform will be renumbered with the next available number in the sequence. If you need to use a number in your waveform's

name, it is recommended that you append an alpha character at the end of the number : "XYZ32a" for example.

1. If you are saving to file, touch the **Data Format** field and select a format type from the pop-up menu:



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.

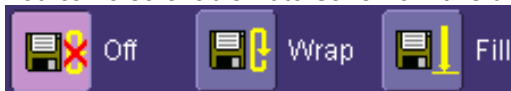
2. Touch the **Browse** button for the **Save file in directory** field and browse to the location where you want the file saved. The file name is assigned automatically and is shown below the field.



3. Touch

Auto Save

You can also enable Auto Save from this dialog by touching one of the Auto Save buttons



: **Wrap** (old files overwritten) or **Fill** (no files overwritten).

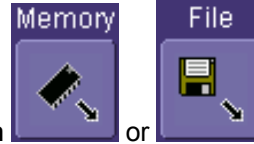


If you select Fill, you can quickly use up all disk space on your hard disk.

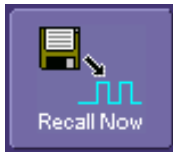
WAVE RUNNER 6000 SERIES

To Recall Waveforms

1. In the menu bar, touch **File**; then touch **Recall Waveform...** in the drop-down menu.



2. In the "Recall Waveform" dialog, touch the **Recall From** button.
3. If you selected **Memory**, touch inside the **Source** field and select a memory location: **M1** to **M4**.
4. If you selected **File**, touch inside the **Destination** field and select a memory location in which to store the file.
 - a. Touch inside the **Show only files** field and select an area to limit the search to: channels, math functions, or memory.
 - b. 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.
 - c. Touch inside the **Next file will be recalled from** data entry field and enter the path, using the pop-up keyboard. Or touch the **Browse** button to navigate to the file.



5. Touch

Printing and File 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 2000 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.

WAVE RUNNER 6000 SERIES

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**.

MANAGING FILES

Use the instrument's utilities to create waveform files on optional floppy disk, internal hard drive, or network drives.

Hard Disk Partitions

The instrument's hard disk is partitioned into drive **C:** and drive **D:**. Drive C: contains the Windows operating system and the instrument application software. Drive D: is intended for data files.

Utilities

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 limited to TCPIP and GPIB.

Note: GPIB is an option and requires a GPIB card to be installed in a card slot at the rear of the scope.

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 2000 network setup menu.

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 a GPIB or 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) or **GPIB** (general purpose interface bus). If you do not have a GPIB card installed, the GPIB selection will not be accessible.
4. If you are using GPIB, set a GPIB address by touching inside the **GPIB Address** data entry field and enter an address.
5. Press the **Net Connections** button; the Windows **Network and Dial-up Connections** window appears.
6. 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.

HARDCOPY

Printing



Refer to Printing under "File Management" (page 59).

Clipboard



This selection prints to the clipboard so you can paste a file into another application (like MS Word, for example).

To Print from 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.

File



Choose **File** if you want to output the screen image to storage media such as floppy drive or hard drive. When outputting to floppy disk, be sure to use a preformatted disk.

To Print to 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.

E-Mail



The instrument also gives you the option to e-mail your screen images, using either the MAPI or SMTP protocols. Before you output to e-mail from the Utilities dialog, you first have to 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.

WAVE RUNNER 6000 SERIES

AUX OUTPUT

In addition to a calibration signal, the following signals can be output through the AUX OUTPUT connector:

	Square Wave
	Trigger Out -- can be used to trigger another scope
	DC level -- a reference level
	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.
	Aux Output Off -- turns off the auxiliary output signal

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. If you simply want a 1 kHz, 1 V square wave, touch the button so labeled.
4. If you want a specialized output, touch one of the buttons under **Use Auxiliary Output For**.
5. Touch inside the **Amplitude** data entry field and enter a value, using the pop-up numeric keypad. If you want a TTL level signal, touch the **TTL Level** checkbox. The **Amplitude** field will accordingly become unavailable.
6. If you selected Square Wave, touch inside the **Frequency** data entry field and enter a value, using the pop-up keypad. You can set a value from 5.0 Hz to 5 MHz.
7. 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.

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.

To Set Time and Date from the Internet

The Simple Network Time Protocol (SNTP) is used.

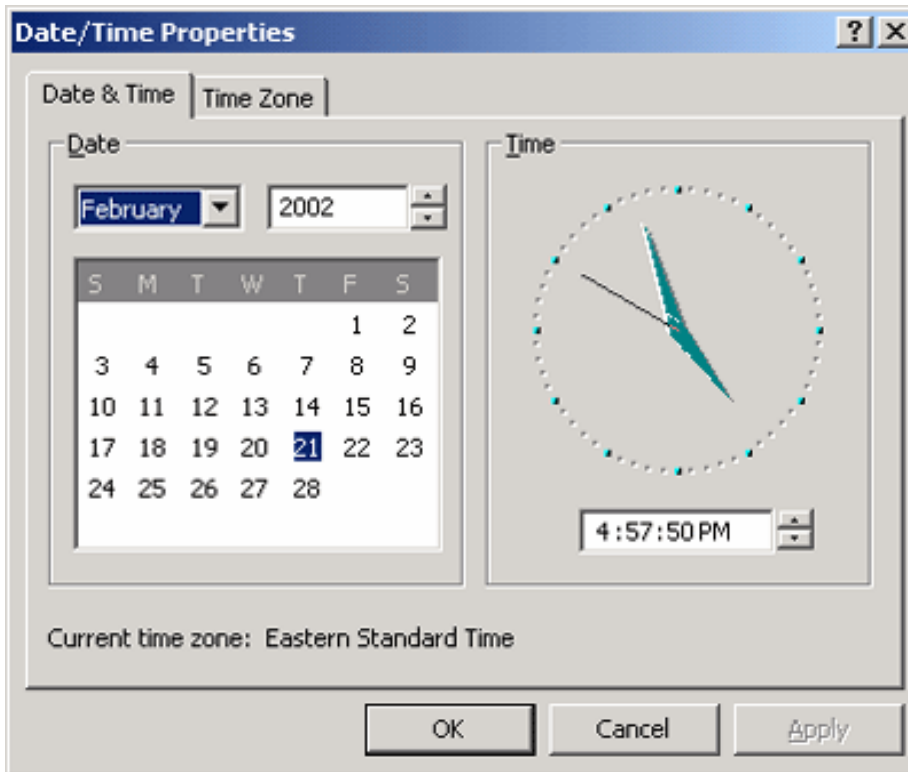
1. Ensure that the scope is connected to the Internet through the LAN connector at the rear of the scope.
2. In the menu bar touch **Utilities**, then **Utilities Setup...** in the drop-down menu.
3. Touch the **Date/Time** tab.
4. Touch the **Set from Internet** button.

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.



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 JTA2, add performance to your instrument. This added performance is seen in the new math functions or parameters that you can choose from when doing Measure or Math setups.

SERVICE

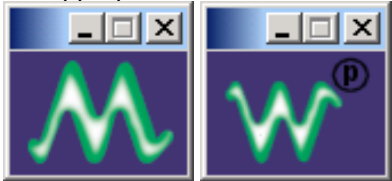


This button provides access to service dialogs, which are for the sole use of LeCroy service personnel. A security code is required to gain access.

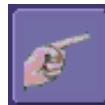
SHOW WINDOWS DESKTOP



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 appropriate 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.

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

WAVE RUNNER 6000 SERIES

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.

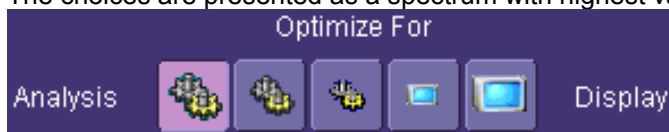
Note: Regardless of whether you select **Volts** or **Div**, the "Offset" shown in the channel setup dialog always indicates volts. However, when **Div** is selected for the Offset Control, the offset in volts is scaled proportional to the change in gain, thereby keeping the division on the grid constant.

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.

Performance Optimization

You can set up the scope to optimize either calculating speed or display speed. If the display update rate is of primary concern to you, optimize for Display. If acquisition and analysis are more important, optimize for analysis. Optimizing for analysis can be useful when persistence or averaging is used, giving higher priority to waveform acquisition at the expense of display update rate.

The choices are presented as a spectrum with highest values at the extremes:



1. In the menu bar touch **Utilities**; then touch **Preferences** in the drop-down menu.
2. Touch one of the optimization icons.

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.

Introduction to WaveShape Analysis

This section is a brief reference to the basic tools available to perform WaveShape Analysis in the time, frequency, and statistical domains.

PARAMETER MEASUREMENTS

WaveShape Analysis typically begins with the measurement of parameters. Parameter measurement tools determine a wide range of waveform properties. Use them to automatically calculate many attributes of your waveform, like rise time, rms voltage, and peak-to-peak voltage, for example.

There are parameter modes for the amplitude and time domains, custom parameter groups, and parameters for pass and fail testing. You can make common measurements on one or more waveforms.

Measure Modes

The selections for Measure Mode allow you to quickly apply parameters for standard vertical and standard horizontal setups, and custom setups.

Pass and fail parameters can be customized, too. You can accumulate and display statistics on each parameter's average, lowest, highest, and standard deviation.

Standard Vertical Parameters

These are the default Standard Vertical Parameters:

Vertical	Description
mean	Mean
sdev	Standard deviation
max	Maximum
min.	Minimum
ampl	Amplitude
pkpk	Peak-to-peak

Standard Horizontal Parameters

These are the default Standard Horizontal Parameters:






Horizontal	
freq	Frequency
period	Period
width	Width
rise	Risetime
fall	Fall time
duty	duty cycle

Custom Measurements with My Measure

You can choose to customize up to six parameters by touching **My Measure** and then selecting the measurements desired.

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.
	An upward pointing arrow indicates an overflow condition.
	An upward-and-downward pointing arrow indicates an underflow and overflow condition.

Waveform Measurements

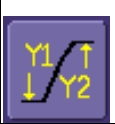


MEASURING WITH CURSORS

Cursors are important tools that aid you in measuring signal values. Cursors are markers — lines, cross-hairs, or arrows — that you can move around the grid or the waveform itself. Use cursors to make fast, accurate measurements and to eliminate guesswork. There are two basic types:

- **Horiz(ontal)** (generally Time or Frequency) cursors are markers that you move horizontally along the waveform. Place them at a desired location along the time axis to read the signal's amplitude at the selected time.
- **Vert(ical)** (Voltage) cursors are lines that you move vertically on the grid to measure the amplitude of a signal.

Cursor Measurement Icons

The **Readout** icons depict what is being measured for each measurement mode.

	<p>Each cursor locates a point on the waveform. The cursor values can be read in the descriptor label for the trace. Use the Position data entry fields at the right side of the dialog to place the cursors precisely.</p>
	<p>This is the difference in Y values. The value can be read in the descriptor label for the trace.</p>
	<p>This gives the slope between cursors.</p>

If there are non-time-domain waveforms displayed, there will also be a menu offering choices of x-axis units: **s** or **Hz**, for example.

CURSORS SETUP

Quick Display

At any time, you can change the display of cursor types (or turn them off) without invoking the "Cursors Setup" dialog as follows:

1. In the menu bar, touch **Cursors**, then **Off**, **Abs Horizontal**, **Rel Horizontal**, **Abs Vertical**, or **Rel Vertical**.
2. The cursors displayed will assume the positions previously set up. If you want to change their position or measurement mode, in the menu bar touch **Cursors**, then **Cursors Setup** in the drop-down menu.

Full Setup

1. In the menu bar, touch **Cursors**, then **Cursors Setup**. The "Standard Cursors" dialog opens.
2. In the dialog area, touch the **Cursors On** check box to display them.
3. Touch one of the **Horizontal** or **Vertical** mode buttons: **Relative** or **Absolute**.
4. If you chose a Relative mode, also touch a readout parameter button: Y position, delta Y, or slope.
5. If you chose a Relative mode, touch inside the **Position 1** and **Position 2** data entry fields and type in a value for each cursor. You can also use the Cursors knobs on the front panel to place the cursors. If you chose an Absolute mode, do the same for your single cursor.
6. If you chose a Relative mode and you would like both cursors to move in unison as you adjust the position, touch the **Track** check box to enable tracking.

Parameter Analysis

TREND MEASUREMENTS

A trend of a measurement parameter is a line graph with a measurement point from each subsequent signal acquisition plotted on the graph.

1. In the menu bar, touch **Measure**, then **Measure Setup...** in the drop-down menu.
2. Touch one of parameter tabs **P1** through **P6**.
3. Touch inside the **Source1** data entry field and select an input waveform from the pop-up menu.
4. Touch inside the **Measure** data entry field and select a parameter from the pop-up menu.
5. Touch the **Trend** button at the bottom of the dialog.

TRACK VIEW

A Track View of a measurement parameter is a unique and specialized graph that is time correlated to the signal being measured. The Track View applies to a single-shot acquisition and plots the variation of a parameter (such as width) for each cycle in time-correlated sequence with the waveform. Track View lets you locate a problematic signal feature including width, period, amplitude, and more.

1. In the menu bar touch **Measure**, then **Measure Setup...** in the drop-down menu.
2. Touch one of parameter tabs **P1** through **P6**.
3. Touch inside the **Source1** data entry field and select an input waveform from the pop-up menu.
4. Touch inside the **Measure** data entry field and select a parameter from the pop-up menu.
5. Touch the **Track** button at the bottom of the dialog.

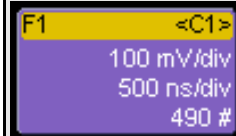
JITTERTRACK VIEW

A JitterTrack View is similar to a Track View but is applicable to a specialized set of timing parameter measurements used to analyze cycle-to-cycle timing variation, including clock jitter, and to aid in tracking the variation to its source. JitterTrack is available with the optional XMAP or JTA2 WaveShape Analysis packages.

Histograms

CREATING AND VIEWING A HISTOGRAM

Note: The number of sweeps comprising a histogram is displayed in the bottom line of the trace descriptor label:



To Set Up a Single Parameter Histogram

From Measure Dialog

1. In the menu bar, touch **Measure**, then **Measure Setup**.
2. Touch the **My Measure** button.
3. Touch one of tabs **P1** through **Px**.
4. Touch inside the **Source1** field and select an input waveform from the pop-up menu.
5. Touch inside the **Measure** field and select a parameter from the pop-up menu.
6. Touch the **Histogram** button at the bottom of the dialog.
7. Touch a math trace in which to place the resulting histogram, then close the pop-up menu.
8. Touch the math trace label for the math trace you just created.
9. In the dialog to the right, touch the Histogram tab.
10. Under "Buffer," touch inside the #Values data entry field and enter a value.
11. Under "Scaling," touch inside the #Bins data entry field and enter a value from 20 to 2000.
12. Touch the Find Center and Width button to center the histogram. Or touch inside the Center, then the Width, data entry fields and enter a value using the pop-up numeric keypad.

From Math Dialog

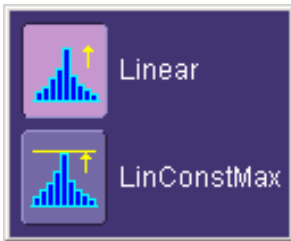
1. In the menu bar, touch **Math**, then **Math Setup**.
2. Touch one of function tabs **F1** through **Fx**. The number of math traces available depends on the software options loaded on your scope.



3. Touch the **Graph** button
4. Touch inside the **Source1** field and select a source from the pop-up menu.
5. Touch inside the **Measurement** field and select a parameter from the pop-up menu.

WAVE RUNNER 6000 SERIES

6. Touch inside the **Graph with** field and select **Histogram** from the pop-up menu.
7. In the dialog to the right, touch the **Histogram** tab.
8. Under "Buffer," touch inside the **#Values** data entry field and enter a value.
9. Under "Scaling," touch inside the **#Bins** data entry field and enter a value from 20 to 2000.
10. Touch the **Find Center and Width** button to center the histogram. Or touch inside the **Center**, then the **Width**, data entry fields and enter a value using the pop-up numeric keypad.
11. Touch inside the Vertical Scale field and select **Linear** or **Linear Constant Max** from the pop-up menu:



A linear histogram will continue to grow as values are accumulated. A linear-constant-maximum histogram will continually rescale itself to remain well within the grid.

To View Thumbnail Histograms

Histicons are miniature histograms of parameter measurements that appear below the grid. These thumbnail histograms let you see at a glance the statistical distribution of each parameter.

1. In the menu bar, touch **Measure**, then one of the Measure Mode buttons: **Std Vertical**, **Std Horizontal**, or **My Measure**.
2. Touch the **Histicons** checkbox to display thumbnail histograms below the selected parameters.


Note: For measurements set up in My Measure, you can quickly display an enlarged histogram of a thumbnail histogram by touching the Histicon you want to enlarge. The enlarged histogram will appear superimposed on the trace it describes. This does not apply to "Std Vertical" or "Std Horizontal" measurements.

Persistence Histogram

You can create a histogram of a persistence display also by cutting a horizontal or vertical slice through the waveform. You also decide the width of the slice and its horizontal or vertical placement on the waveform.

This math operation is different than the "Histogram" math operation and is not affected by **Center** and **Width** settings made there.

To Set Up Persistence Histograms

1. In the menu bar, touch **Math**, then **Math Setup**.
2. Touch one of function tabs **F1** through **Fx** The number of math traces available depends on the software options loaded on your scope.
3. Touch inside the **Source1** field and select a source from the pop-up menu.
4. Touch inside the **Operator1** field and select **Phistogram**  from the **Select Math Operator** menu.
5. Touch the "Phistogram" tab, then touch inside the Slice Direction field and select **Horizontal** or **Vertical** slice from the pop-up menu.
6. Touch inside the **Slice Center** field and enter a value, using the pop-up keypad.
7. Touch inside the **Slice Width** field and enter a value, using the pop-up keypad.

Note: You can use the front panel Adjust knobs to move the **Slice Center** line and the **Slice Width** boundary lines.

Persistence Trace Range

This math operation has a field where you can enter the percent of the persistence trace population to use in creating a new waveform.

Persistence Sigma

This math operation has a field where you can enter a scale, measured in standard deviations, by which to create a new waveform.

Waveform Math

MATH SETUP

This setup mode allows you to quickly apply frequently used math functions.

1. In the menu bar, touch **Math**, then **Math setup...**
2. If there are math functions already assigned to **F1** through **Fx**, touch the checkbox for the function you want to enable. The number of math traces available depends on the software options loaded on your scope.
3. To assign a new math function to a trace, touch the Fx button for that trace, for example



. The math function menu appears.

4. Touch a menu selection; your new function is automatically assigned, with the same setups as were in place for the last function in that Fx position.
5. If you want to change other setup items, like the source waveform, touch the appropriate



Fx tab, for example . The setup dialog for that Fx position appears.






6. Touch the **Single** function button



on the trace, or touch the **Dual** function button to perform math on math.

7. Touch the **Graph** button, then touch inside the **Graph with** field to select a graph mode. The Graph modes are as follows:

	Histogram of the values of a parameter
	Track of the values of a parameter
	Trend of the values of a parameter

RESAMPLING TO DESKEW

Deskew whenever you need to compensate for different lengths of cables, probes, or anything else that might cause timing mismatches between signals. Resample a signal on one channel and adjust it in time relative to a signal on another channel.

To Resample

1. In the menu bar, touch **Math**, then **Math Setup...** in the drop-down menu.
2. Touch a math function trace tab **F1** through **Fx**. The number of math traces available depends on the software options loaded on your scope.
3. Touch the **single** function button.
4. Touch inside the **Source1** field and select a source: channel, math trace, memory location.
5. Touch inside the **Operator1** field and select **Deskew** from the **Functions** category.
6. In the dialog on the right, touch the **Deskew** tab.
7. Touch inside the **Delay by** data entry field and type in a time value, using the pop-up keypad.

RESCALING AND ASSIGNING UNITS

This feature allows you to apply a multiplication factor (a) and additive constant (b) to your waveform: $aX + b$. You can do it in the unit of your choice, depending on the type of application.

To Set Up Rescaling

1. In the menu bar, touch **Math**, then **Math Setup...** in the drop-down menu.
2. Touch a math function trace tab **F1** through **Fx**. The number of math traces available depends on the software options loaded on your scope.
3. Touch the **single** function button.
4. Touch inside the **Source1** data entry field and select a source: channel, math trace, memory location.
5. Touch inside the **Operator1** data entry field and select **Rescale** from the **Functions** category.
6. In the dialog on the right, touch the **Rescale** tab.
7. Touch inside the **First multiply by** checkbox and enter a value for a , the multiplication factor.
8. Touch inside the **then add:** data entry field and enter a value for b , the additive constant.
9. Touch inside the **Override units** checkbox to disregard the source waveform's units, using the pop-up keyboard.

AVERAGING WAVEFORMS

Summed vs. Continuous Averaging

For Summed averaging, you specify the number of acquisitions to be averaged. The averaged data is updated at regular intervals and presented on the screen.

WAVE RUNNER 6000 SERIES

On the other hand, Continuous averaging (the system default) helps to eliminate the effects of noise by continuously acquiring new data and adding the new waveforms into the averaging buffer. You determine the importance of new data vs. old data by assigning a weighting factor. Continuous averaging allows you to make adjustments to a system under test and to see the results immediately.

Note: Continuous Averaging is accessible from the channel "Vertical Adjust" dialog under "Pre-Processing," and from the math function menu.

Summed Averaging

Summed Averaging is the repeated addition, with equal weight, of successive source waveform records. If a stable trigger is available, the resulting average has a random noise component lower than that of a single-shot record. Whenever the maximum number of sweeps is reached, the averaging process stops.

An even larger number of records can be accumulated simply by changing the number in the dialog. However, the other parameters must be left unchanged or a new averaging calculation will be started. You can pause the averaging by changing the trigger mode from NORM/AUTO to STOP. The instrument resumes averaging when you change the trigger mode back to NORM/AUTO.

You can reset the accumulated average by pushing the CLEAR SWEEPS button or by changing an acquisition parameter such as input gain, offset, coupling, trigger condition, timebase, or bandwidth limit. The number of current averaged waveforms of the function, or its zoom, is shown in the acquisition status dialog. When summed averaging is performed, the display is updated at a reduced rate to increase the averaging speed (points and events per second).

Continuous Averaging

Continuous Averaging, the default setting, is the repeated addition, with unequal weight, of successive source waveforms. It is particularly useful for reducing noise on signals that drift very slowly in time or amplitude. The most recently acquired waveform has more weight than all the previously acquired ones: the continuous average is dominated by the statistical fluctuations of the most recently acquired waveform. The weight of 'old' waveforms in the continuous average gradually tends to zero (following an exponential rule) at a rate that decreases as the weight increases.

The formula for continuous averaging is

$$\text{new average} = (\text{new data} + \text{weight} * \text{old average}) / (\text{weight} + 1)$$

This is also the formula used to compute summed averaging. But by setting a "sweeps" value, you establish a fixed weight that is assigned to the old average once the number of "sweeps" is reached. For example, for a sweeps (weight) value of 4:

1st sweep (no old average yet): $\text{new average} = (\text{new data} + 0 * \text{old average}) / (0 + 1) =$
new data only

2nd sweep: new average = (new data + 1*old average)/(1 + 1) = 1/2 new data + 1/2 old average

3rd sweep: new average = (new data + 2 * old average)/(2 + 1) = 1/3 new data + 2/3 old average

4th sweep: new average = (new data + 3 * old average)/(3 + 1) = 1/4 new data + 3/4 old average

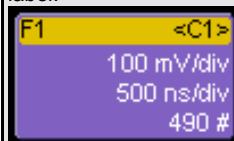
5th sweep: new average = (new data + 4 * old average)/(4 + 1) = 1/5 new data + 4/5 old average

6th sweep: new average = (new data + 4 * old average)/(4 + 1) = 1/5 new data + 4/5 old average

7th sweep: new average = (new data + 4 * old average)/(4 + 1) = 1/5 new data + 4/5 old average

In this way, for sweeps > 4 the importance of the old average begins to decrease exponentially.

Note: The number of sweeps used to compute the average will be displayed in the bottom line of the trace descriptor label:



To Set Up Continuous Averaging

1. In the menu bar, touch **Math**, then **Math Setup...** in the drop-down menu.
2. Select a function tab from **F1** through **Fx**. The number of math traces available depends on the software options loaded on your scope.
3. Touch inside the **Source1** field and select a source waveform from the pop-up menu.
4. Touch inside the **Operator1** field and select **Average** from the **Select Math Operator** menu.
5. Touch the **Average** tab in the dialog to the right of the "Fx" dialog, touch the **Continuous** button.
6. Touch inside the **Sweeps** data entry field and enter a value using the pop-up keypad. The valid range is 1 to 1,000,000 sweeps.

To Set Up Summed Averaging

1. In the menu bar, touch **Math**, then **Math Setup...** in the drop-down menu.
2. Select a function tab from **F1** through **Fx**. The number of math traces available depends on the software options loaded on your scope.
3. Touch inside the **Source1** field and select a source waveform from the pop-up menu.
4. Touch inside the **Operator1** field and select **Average** from the **Select Math Operator** menu.

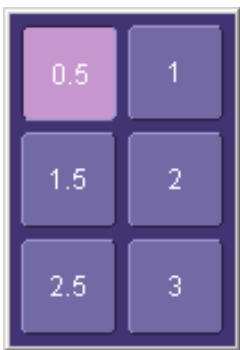
WAVE RUNNER 6000 SERIES

5. Touch the **Average** tab in the dialog to the right of the "Fx" dialog, then touch the **Summed** button.
6. Touch inside the **Sweeps** data entry field and type in a value using the pop-up keypad. The valid range is 1 to 1,000,000 sweeps.

ENHANCED RESOLUTION (ERES)

ERES (Enhanced Resolution) filtering increases vertical resolution, allowing you to distinguish closely spaced voltage levels. The functioning of the instrument's ERES is similar to smoothing the signal with a simple, moving-average filter. However, it is more efficient concerning bandwidth and pass-band filtering. Use ERES on single-shot waveforms, or where the data record is slowly repetitive (when you cannot use averaging). Use it to reduce noise when your signal is noticeably noisy, but you do not need to perform noise measurements. Also use it when you perform high-precision voltage measurements: zooming with high vertical gain, for example.

1. In the menu bar, touch **Math**, then **Math Setup...** in the drop-down menu.
2. Touch a function tab **F1** through **Fx**. The number of math traces available depends on the software options loaded on your scope.
3. Touch inside the **Operator1** data entry field.
4. Select **ERES** from the **All Functions** or **Filter** group of Math functions.
5. Touch the **Trace On** checkbox.
6. Touch the "ERES" tab in the right-hand dialog, then touch inside the **bits** field and make an "Enhance by" selection from the pop-up menu:



WAVEFORM COPY



The **Copy** math function makes a copy of your present waveform in its unprocessed state. While processing may continue on the original waveform, the copy enables faster throughput in some cases by preserving the original data. That is, no calculations need to be undone on the copy before additional math can be calculated.

This benefit of faster throughput, however, comes at the expense of memory usage.

WAVEFORM SPARSER



The Sparse math function **sparse** allows you to thin out an incoming waveform by skipping points at regular intervals, and by starting acquisition at a particular "offset" (point). The **Sparsing factor** specifies the number of sample points to reduce the input waveform by. A sparsing factor of 4, for example, tells the scope to retain only one out of every 4 samples. A **Sparsing offset** of 3, on the other hand, tells the scope to begin on the third sample, then skip the number of samples specified by the sparsing factor (4). In this way, the sample rate is effectively reduced.

For the sparsing factor (interval), you can set a value from 1 to 1,000,000 points. For the sparsing offset you can set a value from 0 to 999,999.

Note: The maximum sparsing offset that can be entered for any sparsing factor equals Sparsing Factor - 1.

To Set Up Waveform Sparser

1. In the menu bar, touch **Math**, then **Math setup...** in the drop-down menu.
2. Touch the tab for the function (F1 to Fx The number of math traces available depends on the software options loaded on your scope.) you want to assign the Sparse operation to.
3. Touch inside the **Source1** field and select an input waveform.
4. Touch inside the **Operator1** field and select **Sparse** from the **Select Math Operator** menu.
5. Touch inside the **Sparsing factor** field and enter a value, using the pop-up keypad.
6. Touch inside the **Sparsing offset** field and enter a value, using the pop-up keypad.

INTERPOLATION

Linear interpolation, which inserts a straight line between sample point, is best used to reconstruct straight-edged signals such as square waves. (Sinx)/x interpolation, on the other hand, is suitable for reconstructing curved or irregular waveshapes, especially when the sampling rate is 3 to 5 times the system bandwidth. The instrument also gives you a choice of Cubic interpolation.

For each method, you can select a factor from 2 to 50 points by which to interpolate (upsample).

To Set Up Interpolation



1. In the menu bar, touch **Math**, then **Math setup...** in the drop-down menu.
2. Touch the tab for the function (F1 to Fx The number of math traces available depends on the software options loaded on your scope.) you want to assign the Interpolate operation to.
3. Touch inside the **Source1** field and select an input waveform.
4. Touch inside the **Operator1** field, then touch the **Filter** button in the **Select Math Operator** menu.
5. Select **Interpolate** from the Filter submenu.
6. Touch the "Interpolate" tab in the mini setup dialog to the right of the main dialog.



7. Touch inside the **Algorithm** field and select an interpolation type.
8. Touch inside the **Upsample by** Upsampling is the factor by which sampling is increased. field and enter a value, using the pop-up numeric keypad, if you want to enter a specific value. Otherwise, use the **Up/Down** buttons to increment the displayed value in a 1-2-5 sequence.

FFT SETUP

1. In the menu bar touch **Math**, then **Math Setup...** in the drop-down menu.
2. Touch a Math function trace button: **F1** through **Fx** The number of math traces available depends on the software options loaded on your scope.; a pop-up menu appears. Select

FFT  from the menu.

3. Touch the **Single**  or **Dual** (function of a function)  button if the FFT is to be of the result of another math operation.
4. Touch inside the **Source1** field and select a channel, memory, or math trace on which to perform the FFT.
5. Touch inside the **Operator1** field: Select **FFT** from the pop-up menu if you selected **Single** function. Select another math function if you selected **Dual** function. Then touch inside the **Operator2** field and select **FFT** from the pop-up menu.
6. In the right-hand dialog, touch the **FFT** tab.

7. Choose whether to **Truncate**[‡]  or **Zero-fill**[§]  the trace display.
8. Touch the **Suppress DC** checkbox if you want to make the DC bin go to zero. Otherwise, leave it unchecked.
9. Touch inside the **Output** type field, and make a selection from the pop-up menu.
10. Touch inside the **Window** field, select a window type.
11. Touch inside the **Algorithm** field and select either **Least Prime**^{**} from the pop-up menu.

[‡] When the FFT transform size does not match the record length, you can truncate the record and perform an FFT on the shorter record. This will increase the resolution bandwidth.

[§] Zero-fill is useful when the source data for the FFT comes from a math operation that shortens the record. This is commonly encountered in filtering operations like enhanced resolution. The missing data points are replaced by data values, whose amplitudes are interpolated to fit between the last data point and the first data point in the record. This guarantees that there is not a first-order discontinuity in the filled data. Since the data at the end of the record is "filled" data, it is advisable to select a weighting window other than rectangular to minimize the effect of the fill on the resulting spectrum.

^{**} The default algorithm is a least primes algorithm that computes FFTs on transform sizes having lengths that can be expressed as factors of $2^N \cdot 5^K$. This is very compatible with the record lengths encountered in the oscilloscope, which are

Analysis

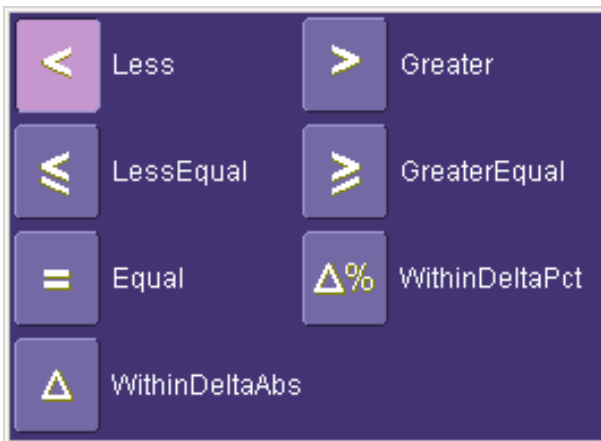
PASS/FAIL TESTING

Comparing Parameters



Each Pass/Fail input (**Qx**) can compare a different parameter result to a user-defined limit (or statistical range) under a different condition.

The conditions are represented by these comparison operators:

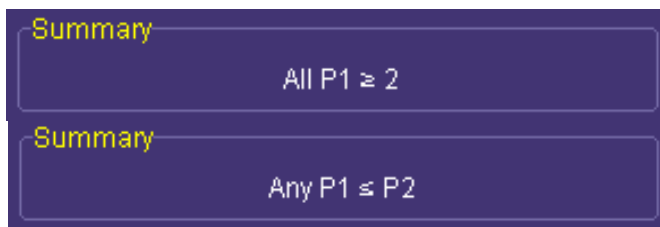


At the touch of a button, test results can also be compared to these standard statistical limits:

- current mean
- mean + 1 SD
- mean + 3 SD

In Dual Parameter Compare mode, your X-Stream scope gives you the option to compare to each other parameter results measured on two different waveforms. You can set your test to be true if Any waveform or All waveforms fit the criterion stipulated by the comparison condition. Your setup is conveniently shown in the Summary box of the **Qx** dialog. For example:

often multiples of 1, 2, 4, 5, or 10. or Power of 2 The other choice is a power of two algorithm where the record lengths are in the form of 2^N . The power of 2 algorithm generally runs faster than the least primes algorithm. The price that is paid is a record length that is not the same as the acquired signal. The power-of-two FFT uses the first 2^N points of the record. For example, if you acquire 500 points in your trace, the power-of-two FFT would only use the first 256 points.



Mask Tests

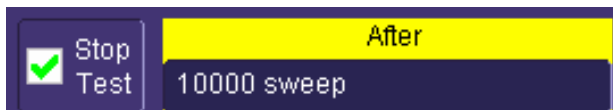


You have the choice to do mask testing by using an existing mask, or by using a mask created from your actual waveform, with vertical and horizontal tolerances that you define. Existing masks can be loaded from a floppy disk or from a network.

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



By touching the **Stop Test** checkbox in the "Actions" dialog, you can set up the test to end after a predetermined number of sweeps that you decide.

You can also decide the actions to occur upon your waveforms' 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.

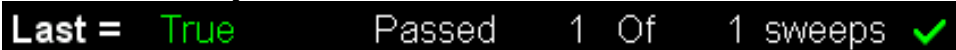
Depending on your scope model, you can configure up to 8 pass/fail conditions. The boolean conditions to determine if your waveform passes are as follows:

All True	All False
Any True	Any False
All Q1 to Q4 Or All Q5 to Q8	Any Q1 to Q4 And Any Q5 to Q8

Setting Up Pass/Fail Testing

Initial Setup

1. Touch **Analysis** in the menu bar, then **Pass/Fail Setup...** in the drop-down menu.
2. Touch the **Actions** tab.
3. Touch the **Enable Actions** checkbox. This will cause the actions that you will select to occur upon your waveform's passing or failing a test.
4. Touch the **Summary View** to enable a line of text



that shows concisely the status of your last waveform and keeps a running count of how many sweeps have passed.

5. Touch inside the **Pass If** field, and select a boolean condition from the pop-up menu.
6. If you want to set up the test to end after a finite number of sweeps, touch the **Stop Test** checkbox. Then touch inside the **After** data entry field and enter a value, using the pop-up numeric keypad.



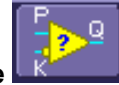
7. Under "If", touch either the **Pass** or **Fail** button to set the actions to occur upon your waveform's passing or failing the test.
8. Under "Then", touch the actions you want to occur: stop test, sound alarm, print result, emit pulse, or save the waveform. If you want to have the results printed and your scope is not equipped with a printer, be sure that the it is connected to a local or network printer. See Printing.
9. 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 Waveforms.

WAVE RUNNER 6000 SERIES

10. Test your Pass/Fail conditions by touching the **Force Actions Once** button. Press the **Clear All** button to quickly uncheck all checkboxes if you want to change your selections.

Comparing a Single Parameter

1. Touch **Analysis** in the menu bar, then **Pass/Fail Setup...** in the drop-down menu.
2. Touch a **Qx** tab; a setup dialog for that position will open.
3. Touch inside the **Source1** field and select a source from the pop-up menu.

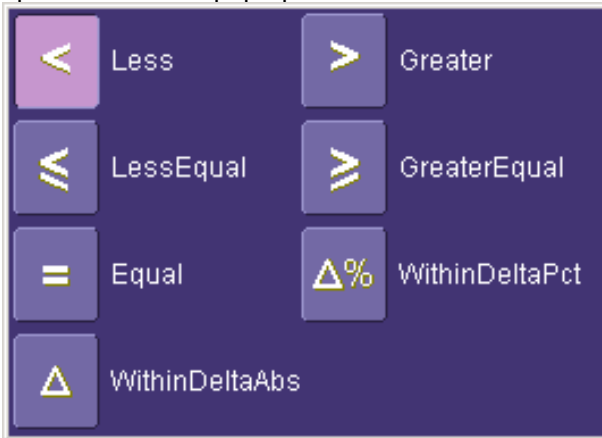


4. Touch inside the **Condition** field in the main dialog and select **ParamCompare**
5. Touch inside the **Compare Values** field and select **All** or **Any** from the pop-up menu:



By selecting **All**, the test will be true only if every waveform falls within the limit that you will set. By selecting **Any**, the test will be true if just one waveform falls within the limit.

6. Touch inside the **Condition** field in the "ParamCompare" mini-dialog and select a math operator from the pop-up menu:

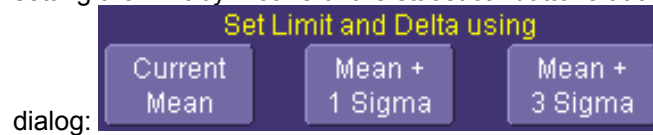


7. Touch inside the **Limit** field and enter a value, using the pop-up numeric keypad. This value takes the dimensions of the parameter that you are testing. For example, if you are



testing a time parameter, the unit is seconds. If you chose either **WithinDeltaPct**

or **WithinDeltaAbs**  from the **Condition** menu, you also have the choice of setting the limit by means of the statistical buttons at the bottom of the "ParamCompare"



Comparing Dual Parameters

1. Touch **Analysis** in the menu bar, then **Pass/Fail Setup...** in the drop-down menu.
2. Touch a **Qx** tab; a setup dialog for that position will open.
3. Touch inside the **Condition** field in the main dialog and select **DualParamCompare**

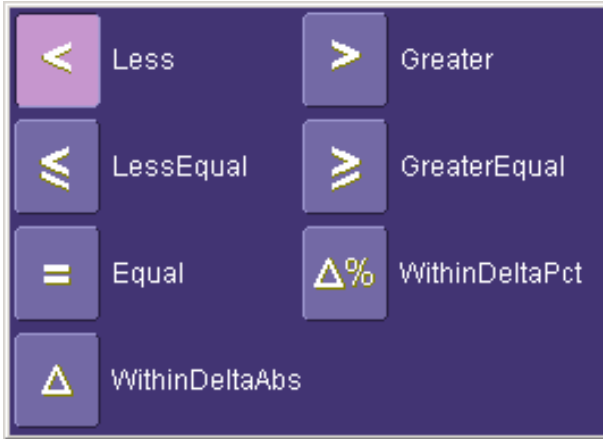


4. Touch inside the **Source1** and **Source2** fields and select a source from the pop-up menu.
5. Touch inside the "ParamCompare" mini-dialog field and select a source from the pop-up menu.
6. Touch inside the **Compare Values** field and select **All** or **Any** from the pop-up menu:



By selecting **All**, the test will be true only if every waveform falls within the limit that you will set. By selecting **Any**, the test will be true if just one waveform falls within the limit.

7. Touch inside the **Condition** field in the "ParamCompare" mini-dialog and select a math operator from the pop-up menu:

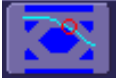


8. Touch inside the **Limit** field and enter a value, using the pop-up numeric keypad. This value takes the dimension of the parameter that you are testing. For example, if you are testing a time parameter, the unit is seconds.

9. If you chose either **WithinDeltaPct**  or **WithinDeltaAbs**  from the **Condition** menu, touch inside the **Delta** field and enter a value.

Setting Up Mask Testing

1. Touch **Analysis** in the menu bar, then **Pass/Fail Setup...** in the drop-down menu.
2. Touch a **Qx** tab; a setup dialog for that position will open.
3. Touch inside the **Source1** field and select a source from the pop-up menu.

4. Touch inside the **Condition** field in the main dialog and select **Mask Test** .
5. From the "Test" mini-dialog, 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.

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

7. 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.
8. If you want to make a mask from your waveform, touch the **Make Mask** tab.
9. Touch inside the **Ver Delta** and **Hor Delta** fields and enter boundary values, using the pop-up numeric keypad.
10. Touch the **Browse** button to create a file name and location for the mask if you want to save it.
11. 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.

Customization

The instrument provides powerful capability to add your own parameters, functions, display algorithms, or other routines to the scope user interface without having to leave the instrument application environment. You can customize the instrument to your needs by using the power of programs such as Excel™, Mathcad™, and MATLAB™, or by scripting in VBS. Whichever method you use, the results appear on the instrument's display together with the signals that you started with. This ability offers tremendous advantages in solving unique problems for a large range of applications, with comparatively little effort from you.

Instrument customization provides these important capabilities:

- You can export data to programs, without leaving the instrument environment.
- You can get results back from those programs, and display them on the instrument, without leaving the instrument application environment.
- Once the result is returned, you can perform additional scope operations, such as measuring with cursors, applying parameters, or performing additional functions on the waveform, in exactly the same way as for a normal waveform.
- You can program the scope yourself.

The instrument does not just provide connectivity with data downloads to other programs. It provides true customizable interaction with these other programs, and allows you to truly customize the scope to do the exact job you want it to do. The advantages to this are many:

- You can use the standard processing power of the instrument to do most of your calculations
- You only need to write the function, parameter, display algorithm, etc. that specifically applies to your need and that the instrument doesn't contain.
- You can view the final result on the instrument display, and use all of the instrument's tools to understand the result.
- You can do additional processing on the result by applying either standard instrument parameters, functions, etc. to the returned result, or even more powerfully, adding chained customized functions. For example, you can do an Excel calculation on a result with a MATLAB function applied to it.

Solutions

Engineers do not buy equipment; they buy solutions. But what solutions can be reached from a set of instrument waveform data? In principle, anything that can be logically derived from those data, given the limitations of signal-to-noise ratio and processing time. Here are some examples of what can be done with a customized instrument:

- Changing the units of a grid to joules, newtons, amps, etc.
- Creating a new waveform by manipulating the data of one or two input waveforms
- Creating a new waveform without using any of the input data
- Creating a new parameter by manipulating the data of one or two input waveforms

- Changing a vertical scale or a horizontal scale from linear to non-linear

You don't have to use all the data from the input waveforms: you can select data from one or more segments, which need not be aligned in the two-input waveforms.

Refer to the on-line Help manual for more information.

CustomDSO

CustomDSO, in its Basic mode, allows you to create DSO setups that can be called by the touch of a single button. The recalled setups can themselves include calls to other setups. A very simple example would be a toggle between two setups. Rings of three or more setups are possible, as are trees, or any other topology that you need. Basic mode also allows you to recall VBScripts that can set up all or part of the scope and do many other things.

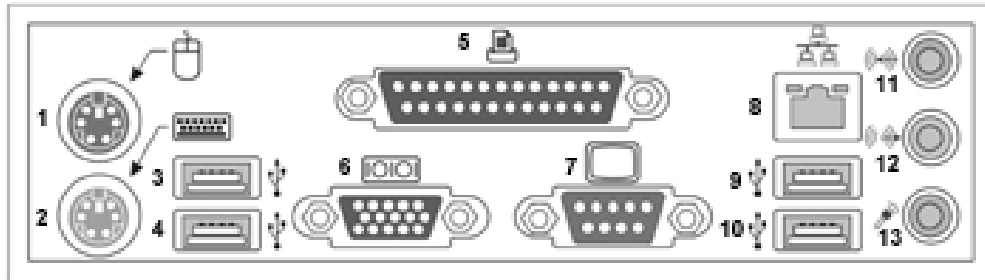
Another more powerful feature is the Plugin, which allows you to add your own ActiveX controls to a setup. These controls are powered by routines written in Visual Basic. With ActiveX controls you can create your own user interfaces to suit your own preferences. A large number of interactive devices are available: button, checkbox, radio button, list box, picture box, and common dialogue box.

Refer to the on-line Help manual for more information.

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 by using either the optional GPIB (General Purpose Interface Bus) port or the LAN communication port on the scope's rear panel, shown below (8). 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.



WaveMaster back panel, including the LAN port (8) used for remote control

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, which deals mainly with electrical and mechanical issues.

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 WaveMaster 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.

^{††}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 remote commands that have been used to control all LeCroy DSOs for many years, all of the Windows-based “X-Stream” 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), which is similar in nature to CORBA, more commonly found in the UNIX world.

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

It is important to note that Automation itself is not 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 for several reasons, including the fact that it is one of the easiest to use. Also, it is the language that X-Stream instruments use for setup files. In addition, the VBScript interpreter is installed by default on all X-Stream instruments and, therefore, is available without your having to purchase any additional software.

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