TELEDYNE LECROY
Everywhereyoulook™

Getting Started Manual

WaveSurfer® MXs-B Oscilloscopes

WaveSurfer® MXs-B
Series Oscilloscopes

Getting Started Manual

January, 2013

700 Chestnut Ridge Road
Chestnut Ridge, NY, 10977-6499
Tel: (845) 425-2000
Fax: (845) 578 5985
teledynelecroy.com

Warranty

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

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

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

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

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Welcome

Thank you for purchasing a Teledyne LeCroy product. This Operator's Manual includes important safety and installation information for your WaveSurfer Oscilloscope, along with operating procedures for capturing, viewing, and analyzing waveforms.

This WaveSurfer Manual is organized in the following manner:

- Hardware (physical features) and Basic Controls
- Viewing Waveforms, includes instructions on setting up the Display
- Vertical and Horizontal Settings, Sampling Modes, and Triggering
- Analyzing Waveforms using parameter Measurements, Math functions, and Reference Waveforms
- Saving and Recalling oscilloscope setups, waveforms, .CSV files, and waveform images. This section also provides procedures to recall factory settings.
- Reference section including certification and contact information.

When oscilloscope is delivered, verify that all items on the packing list or invoice copy have been shipped to you. Contact your nearest Teledyne LeCroy customer service center or national distributor if anything is missing or damaged. If you do not contact us immediately, we cannot be responsible for replacement. Contact us for support if you have any difficulties using the product. You can also refer to additional support materials at teledynelecroy.com.

We truly hope these materials provide increased comprehension when using Teledyne LeCroy's fine products.

Sincerely,

David C. Graef

Teledyne LeCroy
Vice President and Chief Technology Officer

Safety Instructions

This section contains instructions that must be observed to keep the instrument operating in a correct and safe condition. You are required to follow generally accepted safety procedures in addition to the precautions specified in this section.

The overall safety of any system incorporating this instrument is the responsibility of the assembler of the system.

Symbols

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

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

WARNING. Risk of electro-shock.

Measurement ground connection.

Safety (protective) ground connection.

Alternating Current.

Precautions

- **Use proper power cord**. Use only the power cord shipped with this instrument and certified for the country of use.
- **Maintain ground**. This product is grounded through the power cord grounding conductor. To avoid electric shock, connect only to a grounded mating outlet.
- **Connect and disconnect properly**. Do not connect/disconnect probes or test leads while they are connected to a voltage source.

- **Observe all terminal ratings**. Do not apply a voltage to any input (C1, C2, C3, C4 or EXT) that exceeds the maximum rating of that input. Refer to the front of the oscilloscope for maximum input ratings.
- **Use only within operational environment listed**. Do not use in wet or explosive atmospheres.
- **Use indoors only**.
- **Keep product surfaces clean and dry**.
- **Do not block the cooling vents**. Leave a minimum six-inch (15 cm) gap between the instrument and the nearest object. Keep the underside clear of papers and other objects.
- **Do not remove the covers or inside parts**. Refer all maintenance to qualified service personnel.
- **Do not operate with suspected failures**. Do not use the product if any part is damaged. Obviously incorrect measurement behaviors (such as failure to calibrate) might indicate impairment due to hazardous live electrical quantities. Cease operation immediately and sequester the instrument from inadvertent use.

Operating Environment

Temperature: 10 to 40 °C.

Humidity: Maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C (or at the upper operational temperature limit).

Altitude: Up to 10,000 ft (3,048 m) at or below 25 °C.

Cooling

The instrument relies on forced air cooling with internal fans and vents. Take care to avoid restricting the airflow to any part of the oscilloscope. Around the sides and rear, leave a minimum of 15 cm (6 inches) between the instrument and the nearest object. At the bottom, the oscilloscope feet (up or down) provide adequate clearance.

CAUTION. Do not block oscilloscope vents. Always keep the area

beneath the oscilloscope clear of paper and other items.

The instrument also has internal fan control circuitry that regulates the fan speed based on the ambient temperature. This is performed automatically after start-up.

Cleaning

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

CAUTION. Do not attempt to clean internal parts. Refer to qualified service personnel.

Power

Power Consumption

The instrument operates from a single-phase, 100 to 240 V_{rms} (+/-10%) AC power source at 50/60 Hz (+/-5%), or single-phase 100 to 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 (front panel probes, PC port plug-ins, etc.), the instrument can draw up to 340 W (340 VA) max – all 4 channel models and 290 W (290 VA) max – all 2 channel models.

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

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

Standby Power

The  Power (Standby) button controls the operational state of the oscilloscope. Press the button to switch the instrument On or into Standby mode (Off). Always use the Power button or the **File > Shutdown** menu option to execute a proper shut down process and preserve settings before powering down.

Powering off does not disconnect the oscilloscope from the AC power supply. The only way to fully power down the instrument is to shut down then unplug the AC power cord from the outlet.

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

When Your Oscilloscope 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 Teledyne 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.

Maintenance Agreements

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

Software

Find out the oscilloscope's software and hardware configuration by choosing **Utilities → Status** from the menu bar.

Adding a New Option

New software options can be added after purchasing a code and then enabling the option on the oscilloscope. Call Teledyne LeCroy Customer Support to place an order and receive the code.

Restarting the Application

Upon initial power-up, the oscilloscope loads the instrument application software automatically.

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

- If you minimize the application, touch the desktop icon to maximize it:

Rebooting the Oscilloscope

If you need to restart the Windows® operating system, you must reboot the oscilloscope by pressing the power switch, and then turning the power back on after a ten-second wait.

Windows® License Agreement

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

Basic Controls

Front Panel

The WaveSurfer MXs-B front panel is designed to allow you to operate basic oscilloscope functions without having to open software dialogs. Use the Horizontal and Vertical controls as you would for any other oscilloscope. This topic provides descriptions of the various controls.

Vertical Controls

Vertical Controls are multiplexed for each channel. The lighted channel button indicates which channel the controls are *active* for.

Turn channels ON by pressing the corresponding channel button.

Channels are made **active** by pressing the channel button again.

Turn channels OFF by pressing the channel button (activating it), and then pressing again to turn it OFF.

When a channel is active, its descriptor label changes appearance.

Inactive Channel

Active Channel

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

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

Horizontal Controls

Set up the timebase by using the front panel **Horizontal** controls, just as for analog oscilloscopes. The WaveSurfer MXs-B oscilloscope allocates memory as needed to maintain the highest sample rate possible for the timebase setting.

The WaveSurfer MXs-B oscilloscope can acquire in either Real-Time up to 5 GS/s per channel, Random Interleaved Sampling (RIS, up to 50 GS/s), or Roll mode (up to 5 MS/s).

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

At long time/division settings, the oscilloscope defaults to Roll mode operation so the signal shown on the screen are not delayed by the long acquisition time. Maximum sample rate in Roll mode operation is 5 MS/s.

Trigger Controls

Stop	Cancels the capture in Auto, Normal, or Single trigger mode
Auto	Triggers the oscilloscope after a time-out, even if the trigger conditions are not met.
Normal	Triggers the oscilloscope each time a signal is present that meets the conditions set for the type of trigger selected.
Single	Arms the oscilloscope to trigger once (single-shot acquisition) when the input signal meets the trigger conditions set for the type of trigger selected. If the oscilloscope is already armed, it forces a trigger.
Setup	Displays the Trigger setup screen.

AutoSetup Button

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

Measure, Zoom, and Math Quick Buttons

Measure – Press once to open the measure dialog. Press again to close the dialog.

QuickZoom  – Press once to create zooms of all displayed channels. Press again to unzoom.

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

Cursor Knobs and Buttons

The WaveSurfer MXs-B oscilloscope has dedicated dual cursor knobs for cursor control. Cursors always default to a *relative* state (two cursors ON).

Knobs – Rotate to adjust cursor position. If Cursors are OFF, rotating either knob turns Cursors ON. At this point, push in the button to set it as the default position.

Type Button – Pressing the Type button once turns Cursors ON to Horizontal (Time) measurements. Pressing the button again changes it to Vertical (Amplitude) measurements. Pressing it a third time turns the Cursors OFF.

Adjust Knob

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

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

Print Button

This button can be programmed to print the screen to a file, a printer, or the clipboard. It can also send the file as an e-mail attachment. Select the instrument and format it under the **Utilities** → **Hardcopy** dialog.

Clear Sweeps

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

Touch Screen

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

Intensity/Acquisition Mode

The **INTENSITY** knob adjusts the brightness of your trace. Pushing the button toggles between WaveStream fast-viewing mode (indicator lamp on) and real-time mode (lamp off).

Probe and Signal Connection Interfaces

Teledyne LeCroy WaveSurfer MXs-B oscilloscopes contain probe interfaces that provide a complete measurement solution from probe tip to oscilloscope display. All probe interfaces permit automatic recognition of connected probes. For active single-ended and differential voltage probes and current probes, these interfaces upload data regarding the attenuation, offset and units from the probe EEPROM's.

The Teledyne LeCroy WaveSurfer MXs-B oscilloscopes include ProBus probe interfaces. The ProBus interface offers both 50 Ω/1 MΩ input impedance and provides probe power and control for a wide range of probes such as high impedance passive probes, high impedance active probes, current probes, high voltage probes, and differential probes.

Probe Calibration

The passive probe supplied with your WaveSurfer MXs-B oscilloscope is calibrated for the WaveSurfer MXs-B input impedance. If using other passive probes with your WaveSurfer MXs-B oscilloscope, be sure to calibrate them using the 1 kHz square wave signal available on the AUX OUT terminal *before* using them for signal measurements.

Teledyne LeCroy offers a variety of other passive and active probes for use with your WaveSurfer MXs-B Series oscilloscope. Visit teledynelecroy.com for specifications and ordering information.

Current Probes	Available from 30 A to 500 A.
Active Probes	Single-ended to >1 GHz.
Differential Probes	Differential from 15 MHz to >1 GHz.
Passive Probes	The PP009 and PP011 passive probes guarantee full instrument bandwidth at the probe tip. Other passive probes can be used with performance limitations.
High Voltage Probes	For measuring up to 20 kV.

Passive Probe Compensation

Passive probes must be compensated to flatten overshoot. This is accomplished by means of a trimmer at the connector end of the probe.

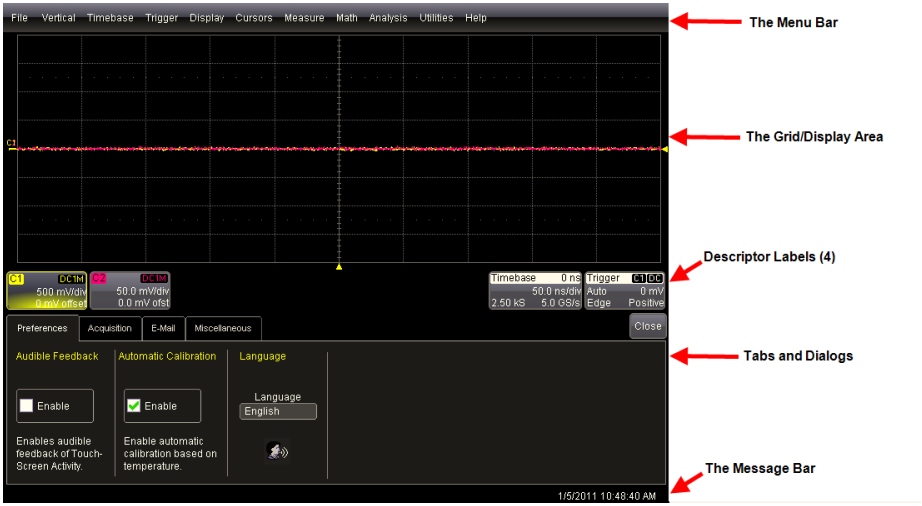
Attach the connector end of your passive probe to any channel.

Connect the probe end to the CAL output connector at the front of the oscilloscope. Ground the probe.

Adjust the trim pot at the connector end of the probe until the square wave is as flat as possible.

Display Dashboard

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



Menu Bar

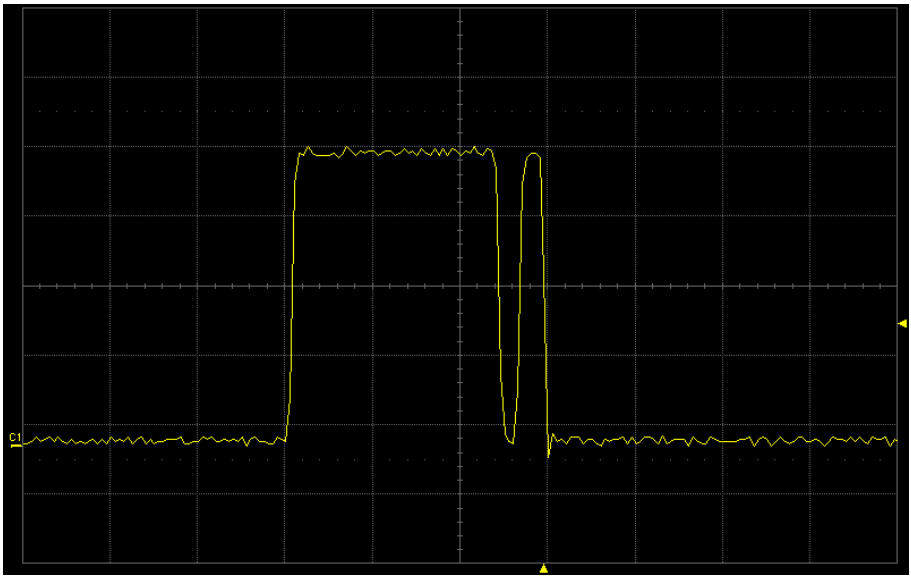
The top menu bar provides access to various software dialogs. It is very similar to the File menu on any Windows program. For common oscilloscope operations, you don't need to use the top menu bar (since you can access most dialogs from the Front Panel or from the Descriptor Labels). However, it is the only way to access setup or other dialogs for the following:

- Display Setup
- Save or Recall Waveform
- Save or Recall Setups
- Print Setup
- Vertical (Channel), Horizontal, or Trigger Status
- Memory (Reference Waveform) Setup
- Pass/Fail Setup
- Utilities and Preferences Setup

At the right-hand end of the top menu bar is an Undo button.

This button appears after the AutoSetup front panel button is pressed, and after Zooming. If you want to perform an Undo operation, it must be the very next operation after you perform the Autosetup or Zoom operation.

Grid Area

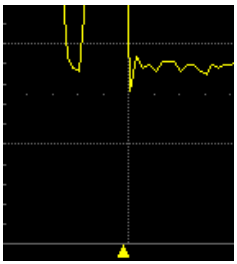


The grid area is divided into 8 vertical divisions and 10 horizontal divisions. There are several indicators on the grid to help you understand the following:

- Trigger Delay setting
- Trigger Level Setting
- Trace Zero Level

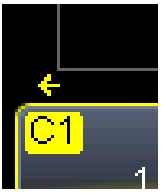
These indicators are color-coded to the same color as the channel that the oscilloscope is currently set to trigger on.

Trigger Delay Indicator



The trigger delay Indicator is a color-coded triangle that is positioned horizontally on the grid.

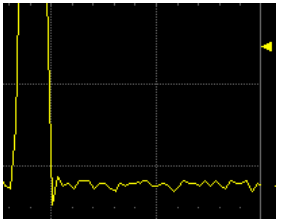
Trigger delay horizontally positions the oscilloscope trace on the display so you can observe the signal prior to the trigger time. It adjusts the pre- and post-trigger time.



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

All trigger delay values (including post-trigger delay, shown here) are displayed in the timebase descriptor label.

Trigger Level Indicator

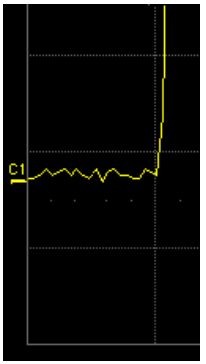


The trigger level Indicator is a color-coded triangle that is positioned vertically on the grid.

In Stop trigger mode, the solid triangle also appears with a hollow triangle of the same color if the level is changed at that time. The hollow triangle indicates what the trigger level is for the next valid trigger.

The trigger level indicator is not shown if the triggering channel is not displayed.

Zero Level Indicator



The zero volts level indicator is a color-coded label that is positioned vertically on the grid.

Change the zero level by using the front panel **OFFSET** knob in the VERTICAL control area. Rotate this knob to adjust, or push to set to zero volts. Push again to toggle back to the previous offset setting.

Descriptor Labels

Information is contained in rectangular boxes called descriptor labels. These labels contain status information, and also act as shortcuts to the full dialog when you touch them. Channel descriptor labels are displayed only for channels that are turned on. Timebase and trigger descriptor labels are always displayed.

Channel trace labels show the vertical settings for the signal. The title bar (colored area) of the label shows the channel number on the far left.

Other information is indicated on the title bar, as follows:

- Coupling (AC 1MΩ, DC 1MΩ, DC 50Ω, GND)
- Deskew (DSQ) set to non-zero value
- Bandwidth Limiting (BWL) ON
- Averaging (AVG) ON
- Interpolation
- Inversion
- Probe attenuation
- Enhanced Resolution (ERES) ON

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

Touch a channel descriptor label once to make the front panel vertical controls active for that channel. Touch it again to open the software dialog for further adjustment.

If cursors are ON, cursor information for this channel appears on this trace label.

The title bar of the **TimeBase** (Horizontal) label shows the trigger delay setting at the far right. Time per division, sample rate, and number of samples are indicated below the title bar.

Touch the timebase descriptor label once to open the software dialog for further adjustment.

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

Touch the trigger descriptor label once to open the software dialog for further adjustment.

Descriptor labels are also displayed for the math trace, zoom traces, and memory (reference waveform) traces. These descriptor labels are only displayed when their traces are turned ON.

Message Bar

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

Alternative Access Methods

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

Top Menu Bar

If you prefer to drive the oscilloscope with the familiarity of Windows, you might prefer to access dialogs from the menu bar at the top of the display. This opens dialog boxes at the bottom of the screen, where adjustments can be made.

The dialog area occupies the bottom one-third of the display. Expand the signal display area by minimizing each dialog by touching the **Close** tab at the right of the dialog box.

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

Mouse and Keyboard Operation

In the procedures, we focus on using the front panel for common operations, and the touch screen for making selections. But, if you have a mouse connected to the instrument, you can click on objects instead of touching them. Likewise, if you have a keyboard connected, you can use it to enter data instead of using the virtual keyboard provided by the instrument.

Turning on Channels and Traces

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

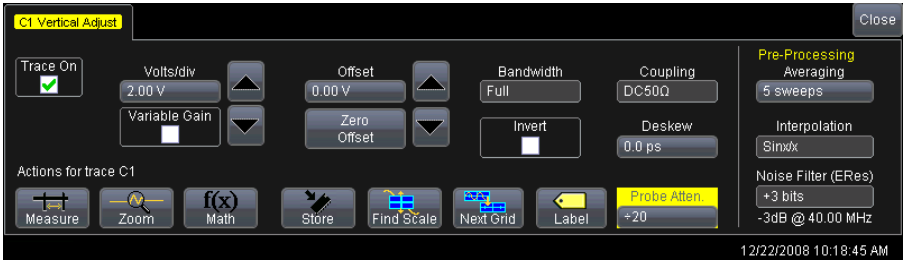
Press the channel 1 button on the front panel to turn on channel 1. The button lights and the descriptor label for that channel are shown.

If the signal is not on the grid, press the **AUTO** trigger button and adjust **Horizontal** and **Vertical** front panel controls to adjust the settings and display the signal, or simply press the **AUTOSETUP** button to quickly bring most repetitive signals onto the grid.

If you need to change probe attenuation, coupling, or bandwidth limiting, open the channel setup dialog for channel 1 by touching the descriptor label for channel 1. Press this button twice if it is not the active trace.

Or, use the **Vertical → Channel 1 Setup** selection from the menu bar to open the channel 1 setup dialog.

At this point, the following dialog is shown at the bottom of the display, and the grid area shortens until this dialog is closed (by touching the **Close** button on the upper right hand corner of this dialog).



Vertical Setup

Coupling

Coupling choices are as follows:

- DC 50 Ω
- GROUND
- DC 1 MΩ
- AC 1 MΩ

Select coupling by touching inside the **Coupling** field and choosing a coupling mode from the pop-up menu.

NOTE: The coupling choices for a channel change if a ProBus probe is connected to a channel.

Deskew

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

Probe Attenuation

If you use a Teledyne LeCroy ProBus compatible active probe, or a probe compatible with Probe Ring, the attenuation is automatically set by the oscilloscope. If it is not automatically set, select a value here by touching inside the **Probe Atten** field selecting a value from the pop-up menu.

Bandwidth Limiting

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

Averaging Your Signal

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

Interpolation Settings

Linear interpolation, which inserts a straight line between sample points, 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 wave shapes, especially when the sample rate is 3 to 5 times the system bandwidth.

Noise Filtering (ERES)

The instrument's enhanced resolution feature improves vertical resolution by a fixed amount for each filter. This real increase in resolution occurs whether or not the signal is noisy, or your signal is single-shot or repetitive. The signal-to-noise ratio (SNR) improvement you gain is dependent on the form of the noise in the original signal. The enhanced resolution filtering decreases the bandwidth of the signal, filtering out some of the noise.

Using Shortcut Toolbar

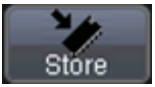
These shortcut buttons can be used to perform specific actions for the channel corresponding to the current setup dialog.

For more information on Measure, Zoom, Math, and Memories (Reference Waveforms), refer to the section dealing with that subject.

Opens a Measurement selection pop-up menu. You can then select up to 6 parameters (measurements) for the active channel from this menu without leaving the Channel Setup dialog. The parameter automatically appears below the grid.

Creates a zoom trace of the channel signal. The zoom trace becomes active, and you can use the Vertical and Horizontal controls to modify its scale and position.

Opens a Math selection pop-up menu. You can then select a math function for the active channel from this menu without leaving the Channel Setup dialog. The Math trace is then displayed in its own grid.



Copies the channel trace into its corresponding Memory (Reference Waveform) location. For instance, C1 is loaded into M1, C2 is loaded into M2, etc.

Automatically performs a vertical scaling that fits the waveform into the grid.

Opens a Labeling pop-up menu that allows user-defined labels tied to the waveform.

TimeBase

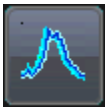
Timebase Setup and Control

Set up the Timebase by using the front panel **Horizontal** controls or the Timebase menu bar, trace descriptor label and dialog box.

1. Touch **Timebase → Horizontal Setup** on the menu bar. The **Timebase** dialog is shown.
2. Touch inside the **Time/Division** data entry field and enter a value.
3. Touch inside the **Delay** data entry field and enter a value.

Sampling Modes

Depending on your timebase, the following sampling modes are available:

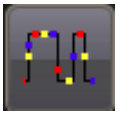


WaveStream Mode - This fast viewing mode provides brightness-graded intensity with a decay time similar to the action of phosphor on an analog screen. WaveStream mode operates at up to 10 GS/s with an update rate up to 22,000 waveforms/second for better capture of higher frequency abnormal events.

Real Time Mode - A single-shot (real time) acquisition is a series of digitized voltage values sampled on the input signal at a uniform rate.

Sequence Mode - In sequence mode, the complete waveform consists of a number of fixed-size segments acquired in single-shot mode

Roll Mode - This mode is invoked automatically for slow acquisitions when the time per division is 100 ms/div or greater. Roll mode samples at 5 MS/s (depending on memory availability).



RIS Mode - Random Interleaved Sampling is an acquisition technique that allows effective sampling rates higher than the maximum single-shot sampling rate. It is used on repetitive waveforms with a stable trigger

Single-shot Sampling Mode

Basic Capture Technique

A single-shot acquisition is a series of digitized voltage values sampled on the input signal at a uniform rate. It is also a series of measured data values associated with a single trigger event. The acquisition is typically stopped a defined number of samples after this event occurs: a number determined by the selected trigger delay and measured by the timebase. The waveform's horizontal position (and waveform display in general) is determined using the trigger event as the definition of time zero.

You can choose either a pre- or post-trigger delay. Pre-trigger delay is the time from the left-hand edge of the display grid forward to the trigger

event, while post-trigger delay is the time back to the event. You can sample the waveform in a range starting well before the trigger event up to the moment the event occurs. This is 100% pre-trigger, and it allows you to see the waveform leading up to the point at which the trigger condition was met and the trigger occurred. (The instrument offers up to the maximum record length of points of pre-trigger information.) Post-trigger delay, on the other hand, allows you to sample the waveform starting at the equivalent of 10,000 divisions after the event occurred.

On fast timebase settings, the maximum single-shot sampling rate is used. But for slower timebases, the sampling rate is decreased and the number of data samples maintained.

The relationship between sample rate, memory, and time can be simply defined as:

$$Capture\ Interval = 1/Sample\ Rate\ X\ Memory$$

and

$$Capture\ Interval/10 = Time\ Per\ Division$$

Sequence Sampling Mode – Working with Segments

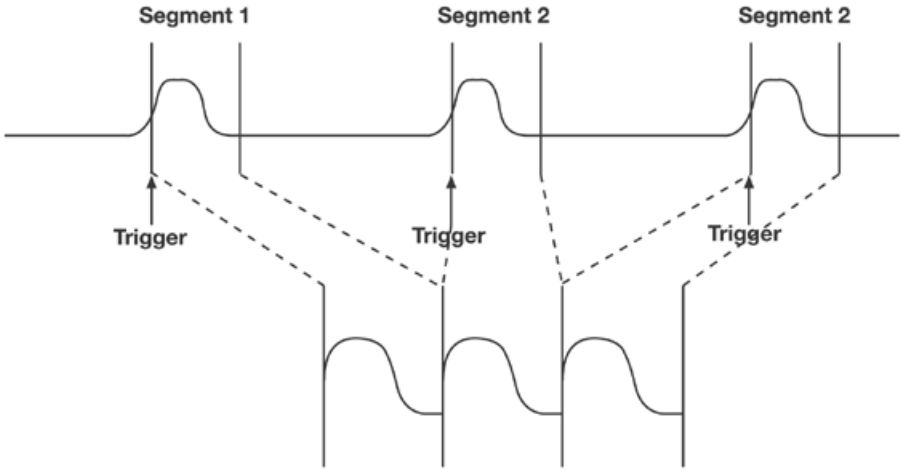
Using Sequence Mode, you can store up to 15,000 triggered events as segments into the oscilloscope's memory. This is ideal when capturing many fast pulses in quick succession or when capturing few events separated by long time periods. The instrument can capture complicated sequences of events over large time intervals in fine detail, while ignoring the uninteresting periods between the events. You can also make time measurements between events on selected segments using the full precision of the acquisition timebase.

Sequence mode offers a number of unique capabilities:

- You can acquire up to four channels simultaneously.
- You can minimize dead time between trigger events for consecutive segments.
- You can view time stamps for acquisitions.
- You can zoom segments or used them as input to math functions.

- You can combine sequence mode with an advanced trigger to isolate a rare event, capture all instances over hours or days, and view/analyze each afterwards.
- You can use Sequence mode in remote operation to take full advantage of the instrument's high data-transfer capability.

In Sequence mode, the complete waveform consists of a number of fixed-size segments acquired in single-shot mode (see the instrument specifications for the limits). The oscilloscope uses the sequence timebase setting to determine the capture duration of each segment as 10 x time/div. With this setting, the oscilloscope uses the desired number of segments, maximum segment length, and total available memory to determine the actual number of samples or segments, and time or points. For more information on sequence sampling mode, see **Working with Sampling Modes**.

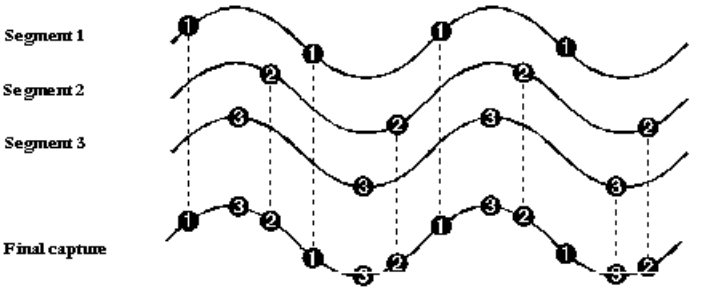


How the instrument captures segments

RIS Sampling Mode - For Higher Sampling Rates

RIS (Random Interleaved Sampling) is an acquisition technique that allows effective sampling rates higher than the maximum single-shot sampling rate. It is used on repetitive waveforms with a stable trigger. The maximum effective RIS sampling rate is achieved by making multiple single-shot acquisitions at maximum real-time sample rate. The bins thus acquired are positioned approximately 20 ps (50 GS/s) apart. The process of acquiring these bins and satisfying the time constraint is a random one. The relative time between ADC sampling instants and the event trigger provides the necessary variation.

The instrument requires multiple triggers to complete an acquisition. The number depends on the sample rate: the higher the sample rate, the more triggers are required. It then interleaves these segments (in the following graphic) to provide a waveform covering a time interval that is a multiple of the maximum single-shot sampling rate. However, the real-time interval over which the instrument collects the waveform data is much longer, and depends on the trigger rate and the amount of interleaving required.



Roll Mode

Roll mode displays, in real time, incoming points in single-shot acquisitions that have a sufficiently low data rate. The oscilloscope rolls the incoming data continuously across the screen until a trigger event is detected and the acquisition is complete. The parameters or math functions connected to each channel are updated every time the roll mode buffer is updated, as if new data is available. This resets statistics on every step of Roll mode that is valid because of new data.

WaveStream Fast Viewing Mode / Intensity

WaveStream fast viewing mode provides brightness-graded intensity with a decay time similar to the action of phosphor on an analog screen. WaveStream mode operates at up to 5 GS/s with an update rate up to 22,000 waveforms/second for better capture of higher frequency abnormal events.

The **INTENSITY** knob adjusts the brightness of your trace. Pushing the button toggles between WaveStream fast-viewing mode and real-time mode.

Triggering

Overview

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

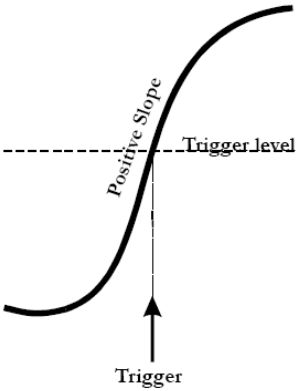
Edge activated by basic waveform features or conditions such as a positive or negative slope, and hold-off

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

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

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

Trigger Terms

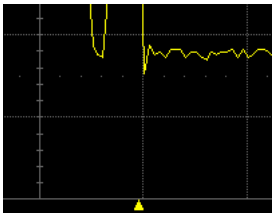


- **Trigger Delay** - the amount of time that the oscilloscope trigger is adjusted from a zero value. You can adjust the oscilloscope's trigger position from 0-100% pre-trigger (left to right on the grid), or from 0-10,000 divisions (in time units) of post-trigger.
- **Coupling** – the type of signal coupling at the input of the trigger source: AC, DC, LFREJ, HFREJ

- **Level** – the threshold at which the trigger will occur, specified in volts.
- **Slope** – the direction of the trigger voltage transition used for generating a particular trigger.

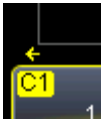
Trigger Setup

Trigger Delay



The trigger delay Indicator is a color-coded triangle that is positioned horizontally on the grid.

Trigger delay horizontally positions the oscilloscope trace on the display so you can observe the signal prior to the trigger time. Delay adjusts the pre- and post-trigger time. Pre-trigger delay is adjustable from 0-100%



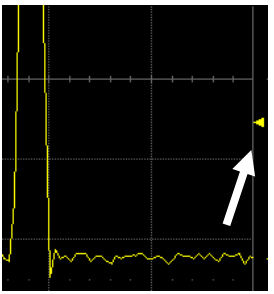
Post-trigger delay is indicated by a color-coded arrow pointing to the left. Post-trigger delay is adjustable from 0-10,000 divisions (calculated in time)

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

Zero delay is the horizontal center of the oscilloscope display.

Change trigger delay by using the **DELAY** front panel knob in the HORIZONTAL control area. Rotate the knob to adjust, or push to zero.

Trigger Level Indicator



The trigger level indicator is a color-coded triangle that is positioned vertically on the grid.

In Stop trigger mode, the solid triangle also appears with a hollow triangle of the same color if the level is changed at that time. The hollow triangle indicates what the trigger level is for the next valid trigger.

NOTE: The Trigger Level indicator is not shown if the triggered channel is not displayed.

Change trigger level using the front panel knob in the Trigger Control area. Rotate the knob to adjust, or push to set to 50% of the signal level.

Trigger level is specified in volts and remains unchanged when you change the vertical gain settings or offset.

The amplitude and range of the trigger level are limited as follows:

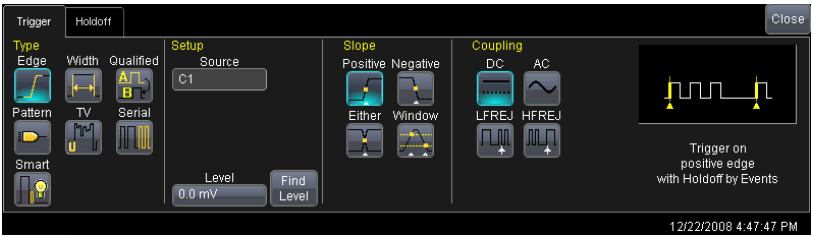
- ± 4.1 screen divisions with a channel as the trigger source
- ± 0.5 V with EXT as the trigger source
- ± 5 V with EXT/10 as the trigger source
- None with LINE as the trigger source (zero crossing is used).

Edge Trigger Set Up

1. Touch the trigger descriptor label at the bottom right of the display.

Or, touch **Trigger →Trigger Setup** on the menu bar.

The following dialog appears at the bottom of the display.



2. Touch inside the **Source** field in the **Setup** section and select an input from the pop-up menu:

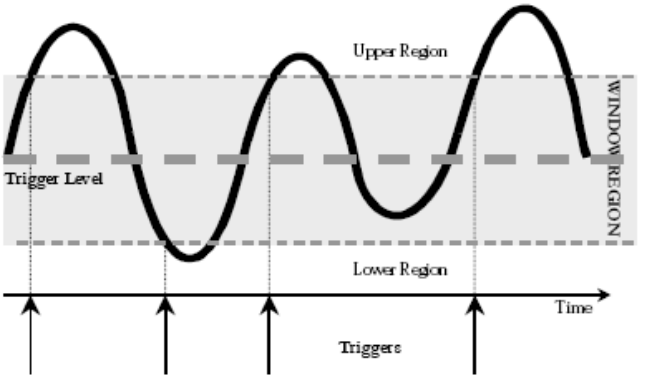
   - **C1** through **C4** are abbreviations for Channel 1 through Channel 4.
   - **Ext** and **Ext/10** allow triggering on the External Input of the oscilloscope. **Ext** input is +/-0.5V. **Ext/10** input is+/-5.0V.
   - **Line** is for triggering on the Positive or Negative excursion of the AC power line (not available when using battery or DC input power).

3. Select a trigger coupling from the **Coupling** section. **Coupling** refers to the type of signal coupling at the input of the trigger circuit. You can choose from these coupling types:

   - DC - All the signal's frequency components are coupled to the trigger circuit for high frequency bursts or where the use of AC coupling would shift the effective trigger level.
   - AC - The signal is capacitively coupled. DC levels are rejected, and frequencies below 50 Hz are attenuated.
   - LFREJ - The signal is coupled through a capacitive high-pass filter network, DC is rejected and signal frequencies below 50 kHz are attenuated. For stable triggering on medium to high frequency signals.
   - HFREJ - Signals are DC coupled to the trigger circuit, and a low-pass filter network attenuates frequencies above 50 kHz (which is used for triggering on low frequencies).

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

5. Select a trigger Slope from the **Slope** s**ection**:
   - **Positive** and **Negative** slope refers to the voltage change direction for triggering.
   - **Window** defines a region whose boundaries extend above and below the selected trigger level. A trigger event occurs when the signal leaves this window region in either direction and passes into the upper or lower region (as follows). The next trigger occurs when the signal passes into the window region.
   - **Either** – Use this selection to trigger when positive or negative voltage change directions occur.



Explanation of Window trigger operation

Trigger Holdoff

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

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

Use holdoff to obtain a stable trigger on complex, but repetitive, waveforms. For example, if there is a signal with multiple edges prior to the edge you wish to trigger on, you could set the holdoff to equal the number of edges preceding the desired triggering edge.

Refer to the **Online Help** for more information about holdoff setup.

Basic Triggers

Edge

Use Edge trigger for simple, repetitive signals. This trigger is activated by basic waveform features or conditions such as a positive or negative slope, and hold-off

Width

Width trigger allows you to define a positive or negative-going pulse width bounded by a voltage level, above or below which a trigger occurs. Or, you can specify a pulse width and voltage range, within or outside of which a trigger occurs.

Qualified

The Qualified (A-B) trigger allows arming of the trigger on Event A and triggering on Event B. If the arming event is a Pattern that occurs once (Pattern) or that occurs and stays satisfied (PatState), then the triggering event can be an Edge, Width, Glitch, or Interval condition. This functionality is identical to Teledyne LeCroy's previous Qualify and State triggers, but presented in a different UI.

Pattern

Pattern trigger enables triggering on a logical combination (pattern) of five inputs: CH1, CH2, CH3, CH4, and 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.

NOTE: When used with an optional Mixed Signal module the pattern trigger supports 18 or 36 digital channels along with the analog oscilloscope channels.

TV

TV triggers provide stable triggering on standard or custom composite video signals. Use them on PAL, SECAM, or NTSC systems. Support for HDTV triggering on 1080i, 1080p, and 720p formats is included. Use CUSTOM setup for other standards.

Serial

Serial trigger allows a serial trigger condition to be set from within the oscilloscope, using an easy-to-understand interface.

NOTE: Teledyne LeCroy offers a wide range of optional serial data triggering capabilities for serial data standards like I^2C, SPI, UART, CAN, LIN, FlexRay, MIL-STD-1553, ARINC 429, MIPI D-PHY, DigRF, USB, and I^2S.

SMART Triggers

SMART Triggers are as follows:

Glitch

Glitch trigger is a simpler form of Width trigger. Use Glitch trigger for defining only fixed pulse-width times or time ranges. 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 falling short of or exceeding 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, i.e. it can be used as an Exclusion trigger by interval.

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,

Runt

The runt trigger is programmed to occur when a pulse crosses a first threshold line and fails to cross a second threshold line before recrossing the first. You can select both voltage thresholds within a time range of 100 ps to 20 s. Other defining conditions for this trigger are the edge (triggers on the slope opposite to that selected) and runt width.

Slew Rate

Slew rate trigger activates a trigger when the rising or falling edge of a pulse crosses two threshold levels: an upper level and a lower level. The pulse edge must cross the thresholds faster or slower than a selected period of time. You can select both thresholds within a range of 2 ns to 20 s.

Serial Trigger and Decode (Optional)

Optional WaveSurfer MXs-B capabilities support triggering and decoding of many serial data protocols. Please refer to the Teledyne LeCroy website for a list of supported standards.

The serial triggers are integrated into the oscilloscope. All serial triggers are selected through the normal oscilloscope trigger menus. Serial data signals are input to the oscilloscope through probes.

Decoding is accessed from the Analysis pull-down menu in the menu bar. The decoding is overlaid on top of the appropriate channel, and is intuitively presented and color-coded for quick understanding. Included is a Search capability for specific messages and a table to display protocol data in summary form underneath the oscilloscope grid.

Accessing Serial Decode Triggers

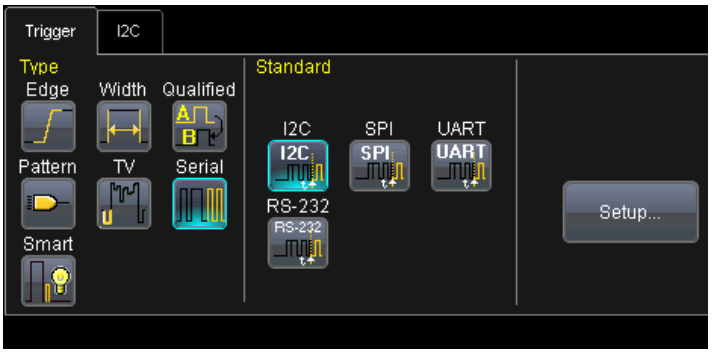
Serial triggers can be accessed in two ways:

- Touch the Trigger Descriptor Box in the lower right hand corner of the oscilloscope display.

OR

- Touch **Trigger → Trigger Setup** from the Menu Bar. On the Trigger dialog, touch **Serial** on the Type section.

Select the appropriate serial trigger. The menu automatically changes to a different tab in the Trigger dialog reflecting the selected standard.



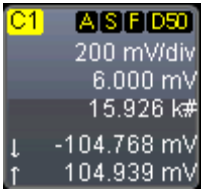
Serial Decode and Decode Setup

These dialogs provide the ability to set the oscilloscope up for protocol decoding of serial data messages, with display of the protocol data overlaid on the signal. They also allow quick and easy access to oscilloscope zooming, searching, table display, and table export.

The serial decode and decode setup dialogs are accessed in any of the following ways:

Touch **Analysis → Serial Decode**... from the menu bar.

The Serial Decode summary dialog is shown and provides access to Decode Setup.



Touch the **Channel or Memory Descriptor Box** to open the respective dialog box, and touch the Decode button in the bottom toolbar.

Touch a **Channel, Memory, or Math trace** to open a pop-up dialog that displays a shortcut to the Decode Setup dialog box

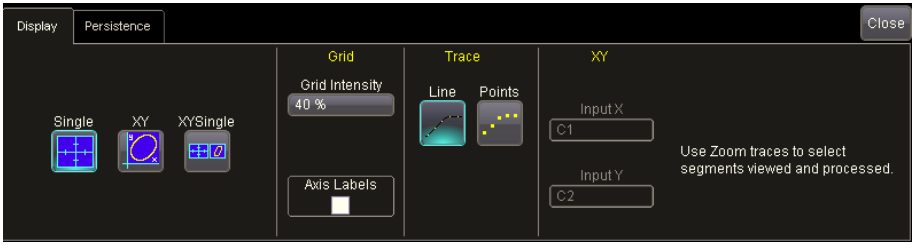
Please refer to the **Low Speed Serial Data Trigger** manual or the **Online Help** on your oscilloscope for Serial Trigger information and details.

Viewing Waveforms

Display Setup

NOTE: Not all grid styles are available on all instruments.

To set up your display, touch **Display →Display Setup** on the menu bar.



Grid Combination Buttons	Touch one of the Grid combination buttons (for example, Single, XY, XYSingle). Autogrid automatically adds or deletes grids as you select more or fewer waveforms to display.
Grid	Touch inside the Grid Intensity data entry field to choose the intensity. 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).
Trace	Choose a line style for your trace: solid Line or Points.

Zooming your Channels

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

There are a number of different ways to zoom in a WaveSurfer MXs-B oscilloscope:

- **Drawing a box** around the zoom area, using either your finger or a mouse/pointing tool.
- Using the front panel **QuickZoom** button.
- Using the software toolbar **Zoom** button in the Channel dialog.

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

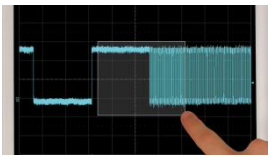
In all cases, the zoomed channels are displayed in a separate half-height grid at the bottom of the display (separate from the channels). If you also have a Math trace showing when you zoom, three grids are then shown on the display, each at one-third height.

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

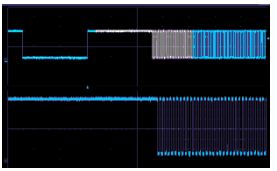
Creating Zooms

There are three ways to create zooms of your channels.

TOUCH SCREEN ZOOMING



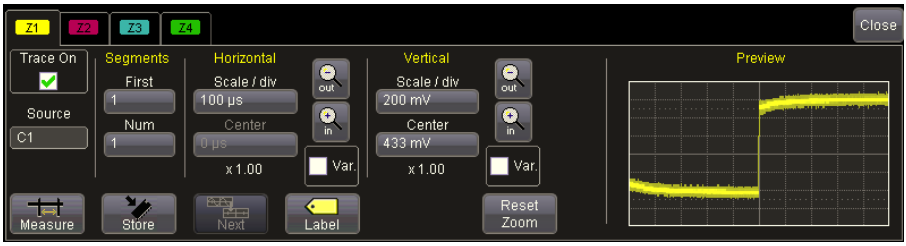
You can draw a box around the area that you wish to zoom simply by dragging your finger, stylus, or mouse pointer around the area of the waveform or waveforms that you want to zoom. Zoom traces are created instantly in a separate grid.



UNDO your zoom by touching the **UNDO** button in the upper-right corner of the display.

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

When you zoom a waveform by this method, a representation of the zoom area appears in a thumbnail Preview in the **Zx** dialog (lower-right).



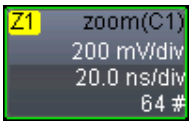
FRONT PANEL QUICKZOOM BUTTON

Pressing the front panel QuickZoom button creates Zoom traces for all channels shown.

Individually turn off a Zoom trace by touching the Zoom **descriptor label**, open the **Zoom trace dialog**, and then **uncheck the ON** checkbox.

UNDO your zoom at any time by pressing the front panel QuickZoom button again.

NOTE: A Zoom is not automatically created for channels turned ON ***after*** QuickZoom is displayed.



TOOLBAR ZOOM

Press the toolbar **Zoom** button in the **Cx Vertical Adjust** dialog for the channel trace you want to zoom. A Zoom trace is created **for the selected channel**.

UNDO your zoom by pressing the **Undo** button in the upper-right corner of the display, or pressing the front panel QuickZoom button again.

Zoom Descriptor Label

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

- The top line contains information about the Zoom trace (in this case, it's a Zoom of Channel 1).
- The 2nd line contains vertical scaling information.
- The 3rd line contains horizontal scaling information.

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

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

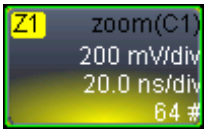
If the Zoom trace is inactive, and you wish to make it active, simply touch the descriptor label once and it becomes active. This also opens the Zoom trace dialog.

NOTE: When a Zoom trace is active, no channel buttons are lit. This indicates that a Zoom trace may be currently active.

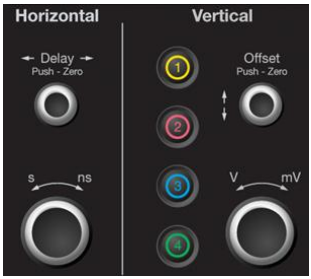
Adjusting Zoom Scale and Position

Using Front Panel Controls

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



If the Zoom trace you wish to adjust is not active, touch the descriptor label once to make it active.

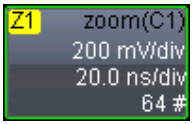


Then, use the front panel horizontal and vertical controls to adjust position and scale. The operation of the knobs feels natural. Use the following table as a guide.

NOTE: When a Zoom trace is active, no channel buttons are lit. This indicates that a Zoom trace may be currently active.

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

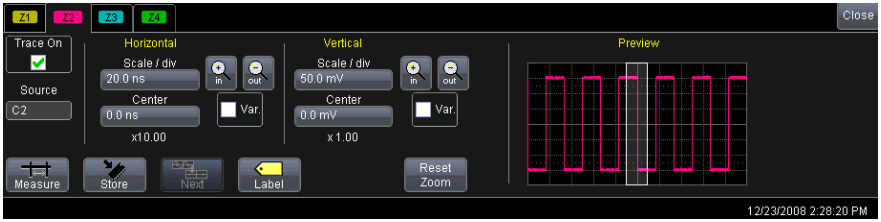
Using Zoom Dialog Controls



You can also use the Zoom dialog controls to adjust zoom. Touch the descriptor label to open the Zoom dialog.

Then use the on-screen zoom controls to change the horizontal and vertical position and scale.

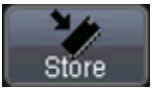
Horizontal scale adjustments always apply to all waveforms.



Using Toolbar Shortcuts

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

Opens a Measurement selection pop-up menu. You can then select a parameter (measurement) for the Zoom trace from this menu without leaving the Zoom Setup dialog. The parameter automatically appears below the grid.



Loads the Zoom trace into its corresponding Memory (Reference Waveform) location (for instance, Z1 is stored into M1; Z2 is stored into M2, etc.).

Opens a Labeling pop-up menu that allows you to create labels tied into the waveform.

Analyzing Waveforms

Measuring with Cursors

Overview

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

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

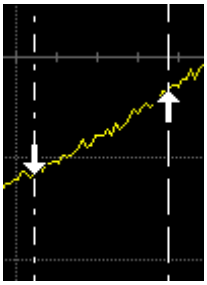
When cursors are ON, they provide measurements for every waveform displayed. The lone exception is when a Math FFT is ON, which requires a selection of **Horizontal (Frequency)** for cursors to be placed on that waveform. Place cursors on a Zoom waveform by moving the cursors into the zoom portion of the original channel signal.

Turning On Cursors

Cursors automatically turn on when either knob is rotated. Or, you can press the **TYPE** button to turn cursors ON, and then toggle through the various cursor types.

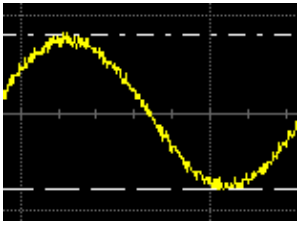
Cursor Types

Horizontal (Time)



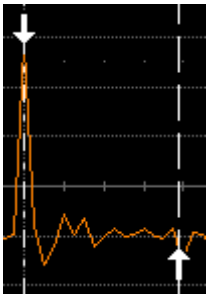
Horizontal (Time) cursors are moved left and right along the waveform. Place them at a desired location along the time axis to read the signal's time and amplitude information at the selected location.

Vertical (Amplitude)



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

Horizontal (Frequency)

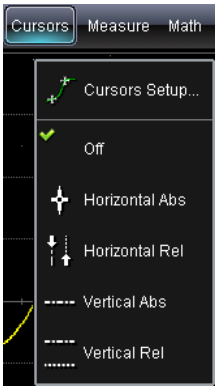


Horizontal (Frequency) cursors are moved left and right along the FFT Math trace. Place them at a desired location along the frequency axis to read the signal's frequency and amplitude at the selected location.

Changing Cursor Type

Pressing the **Type** button between the cursor knobs toggles the Cursors from one type to another, and ultimately to **OFF**, without requiring a cursor setup dialog to be opened.

Tracking Cursors



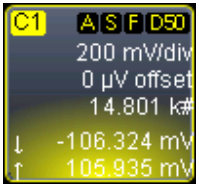
Lock the cursors together by checking the **Track** checkbox on the **Cursors** dialog (**Cursors → Cursor Setup…** from menu bar).

This sets the cursors to move in unison while adjusting their position.

Reading Cursor Information

Cursor information is displayed in two different places on the WaveSurfer MXs-B oscilloscope display.

Descriptor Labels



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

Cursor Table

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

If the display is in XY Mode, XY cursor information is shown underneath the XY display.

Measuring with Parameters

Overview

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

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

If, for some reason, a parameter is unable to be calculated correctly, a warning symbol is shown underneath the measurement. This indicates to proceed with caution.

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

Setting Up Parameter(s)

1. Press the Measure front panel button

   Or, select **Measure** → **Measure Setup** from the menu bar.

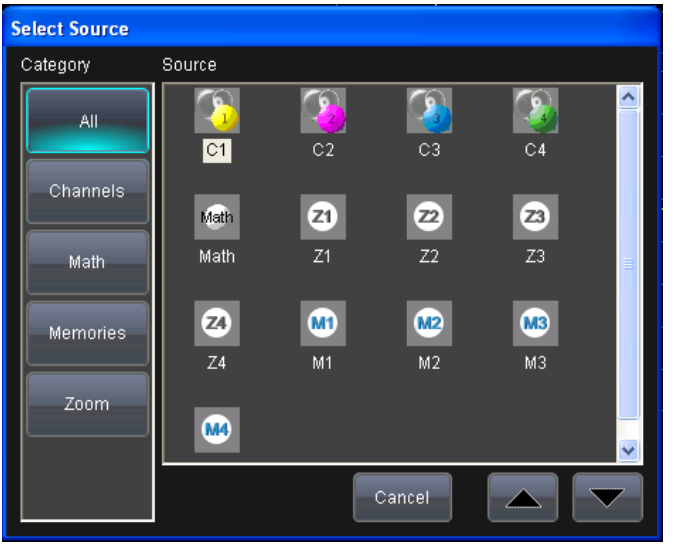
   The following dialog is then shown on the lower display.

2. The default status has parameters turned OFF, and all are undefined (None). Touch either the **icon** or touch in the **None** area to show the **Select Measurement** dialog:

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

   Once the parameter is selected, it appears on the display underneath the grid, as follows:

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



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

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

Understanding Parameter Displays

The Parameter Display Format

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

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

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

Status Symbols

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

A green check mark means the oscilloscope is returning a valid value.

A crossed-out pulse means the oscilloscope is unable to determine top and base. However, the measurement could still be valid.

A downward pointing arrow indicates an underflow condition (signal below the grid area).

An upward pointing arrow indicates an overflow condition (signal above the grid area).

An upward-and-downward pointing arrow indicates an underflow and overflow condition (signal below and above the grid area).

Parameter Gates (Windows)

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

Set the gate by touching the **Start** field to highlight the control (shows in yellow), and then use the adjust knob to dial the location of the start gate. Repeat the same process for the **Stop** gate. Measure gates remain on the display provided the **Start** gate is not equal to 0 divisions, and the **Stop** gate is not equal to 10 divisions.

Measurement Statistics

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

View measurement statistics by checking the box next to **On** under **Statistics** in the **Measure** dialog.

If a measurement is displayed, statistics are also shown (as follows).

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

Statistics accrue with each additional trigger until pressing **Clear Sweeps** (either on the front panel or in the Measure dialog), or changing a control (e.g. Volts/Div).

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

Viewing 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.

Turning Off Parameters

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

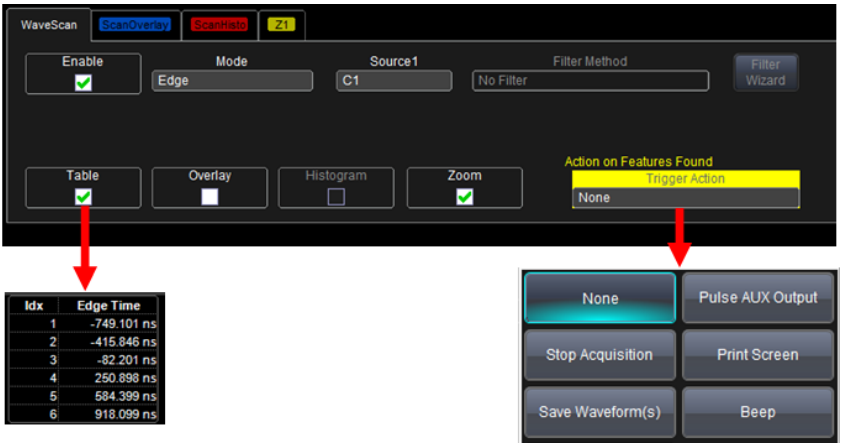
WaveScan™ Advanced Search and Analysis

Introduction to WaveScan

WaveScan enables you to search for unusual events in a single capture, or to scan for an event in many acquisitions over a long period of time. You can select from more than 20 search modes (frequency, rise time, runt, duty cycle, etc.), apply a search condition (slope, level, threshold, hysteresis), and begin scanning in a post-acquisition environment. Since the scanning modes are not simply copies of the hardware triggers, but "software triggers," the capability is much greater.

For instance, there is no “frequency” trigger in any oscilloscope, yet WaveScan allows frequency to be quickly scanned for. You can accumulate a data set of unusual events that are separated by hours or days, enabling faster debugging. The events are time stamped and indexed in a table from which you can select them for viewing individually.

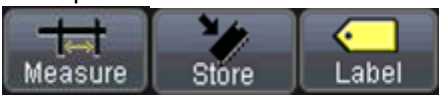
You can also set actions to occur automatically when unusual events are found: stop the acquisition, emit an audible beep, output a pulse, print the screen, or save the waveform.



Signal Views

WaveScan provides distinct views of your signal:

- Source view highlights all occurrences of edges that meet your criteria.
- Zoom view allows you to expand a waveform feature vertically and horizontally; to apply further **processing**; to **store** it, or to apply a descriptive **label** to the feature.



NOTE: The number of grids displayed varies from depending on which views are enabled. WaveScan handles this function automatically

Search Modes

Search modes are used to locate anomalies during acquisition.

- Edge - for detecting the occurrence of edges; selectable slope and level
- Non-monotonic - for detecting threshold re-crosses; selectable slope, hysteresis, and level
- Runt - for detecting pulses that fail to cross a threshold; selectable polarity and thresholds
- Measurement - for filtering and performing parameter measurements

Parameter Measurements

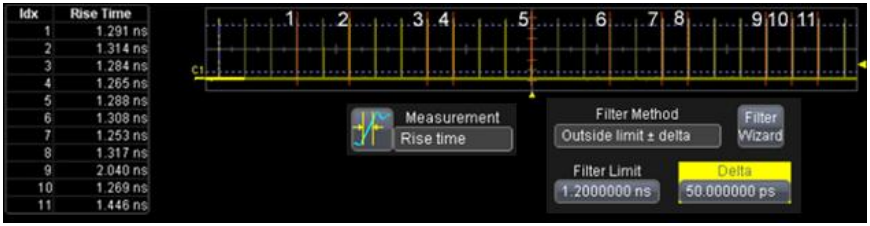
Besides parameter measurements made during acquisition, post-acquisition measurements can also be made. The number of parameters available depends on the options loaded on your instrument. Measurements are made only on the events defined by your filter (search criteria). A Filter Wizard is provided to quickly establish statistical criteria such as ±1, 3, or 5 sigma.

Sampling Mode

Whenever WaveScan is enabled, the instrument reverts to Real-time sampling mode.

SOURCE VIEW

The top trace on the screen is the source (channel, math, memory) trace. This trace shows all captured edges and highlights those that fit your search criteria. For example, in this figure we are searching for slow rising edges that fall outside a time window:



In this acquisition, WaveScan has located eleven edges that fit the search criteria (filter) of greater than 1.2 ns with a delta of 50 ps. Each of the found edges is highlighted with a red rectangle, and indexed to a table entry at left. Rise time values are also included in the table.

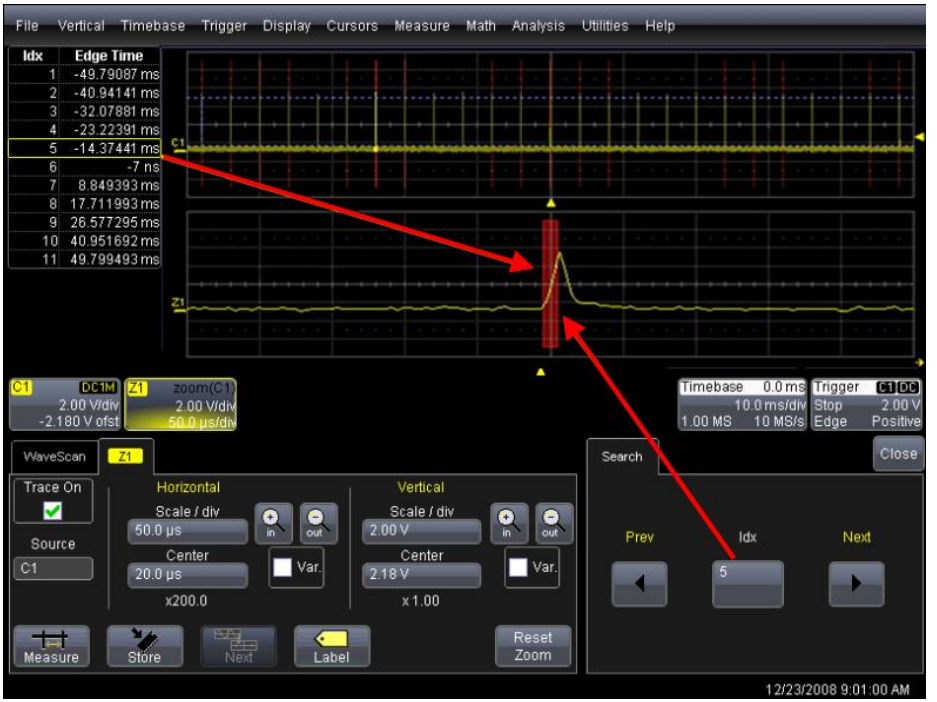
Level Markers

Markers are provided on the source trace to show measurement criteria such as level and thresholds. In the example above, the level markers indicate 10% and 90% for the standard Rise Time parameter measurement.

Level markers are displayed only while the scope is in WaveScan mode. Once the WaveScan **Enable** checkbox is unchecked, the level markers disappear.

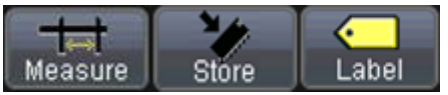
Zoom View

An individual edge can be zoomed by selecting it from the table of found events at the left of the screen. You can also scroll through the table using the **Prev/Next** scroll buttons in the **Search** dialog, or select an event by touching inside the **Idx** field and entering an index number, using the pop-up keypad.



Front panel **Zoom** controls can be used to vary the magnification and position of the zoomed trace. Or, you can use the on-screen **In/Out**buttons.

In Zoom View, you can also apply further processing, store, or apply a descriptive label to the zoom trace.

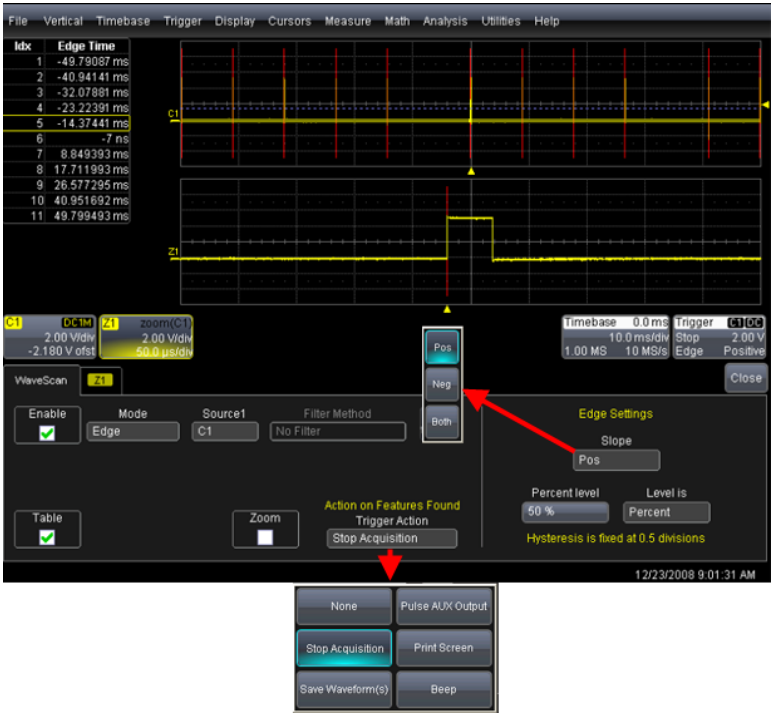


Edge Mode

This search mode locates all edges in an acquisition and presents them time-stamped in a table. You can select positive, negative, or both edges. When the acquisition is stopped, scan filters contained in Measurements mode can be applied to the edges to find specific characteristics.

A level marker, corresponding to 50% in this case, is displayed in the source trace at top.

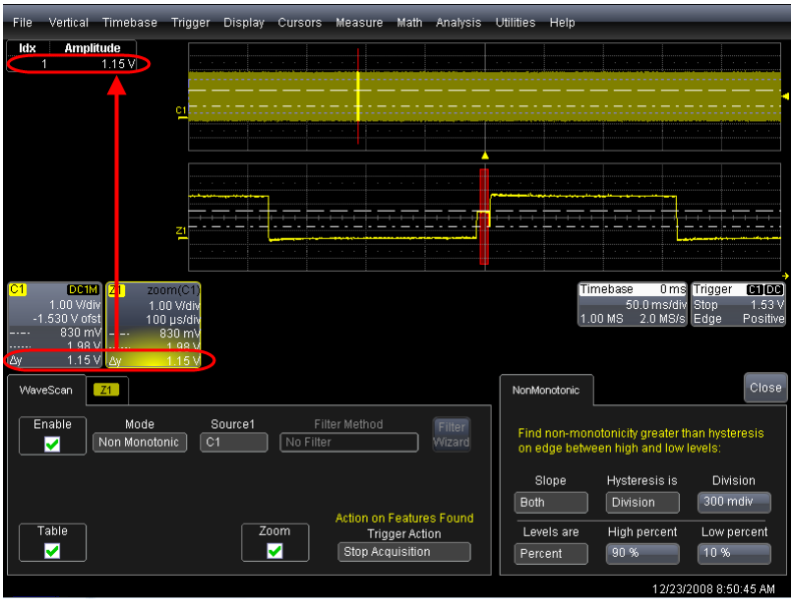
As with other search modes, a trigger action can be set for Edge mode also.



Non-monotonic Mode

The Non-monotonic search mode looks for edges that cross a threshold more than once between high and low levels. All events that meet the criteria of slope, hysteresis, and level are presented in a table and highlighted in the source trace. The value displayed in the table is the difference of the max. and min. of the non-monotonicity.

This can be confirmed with cursors:



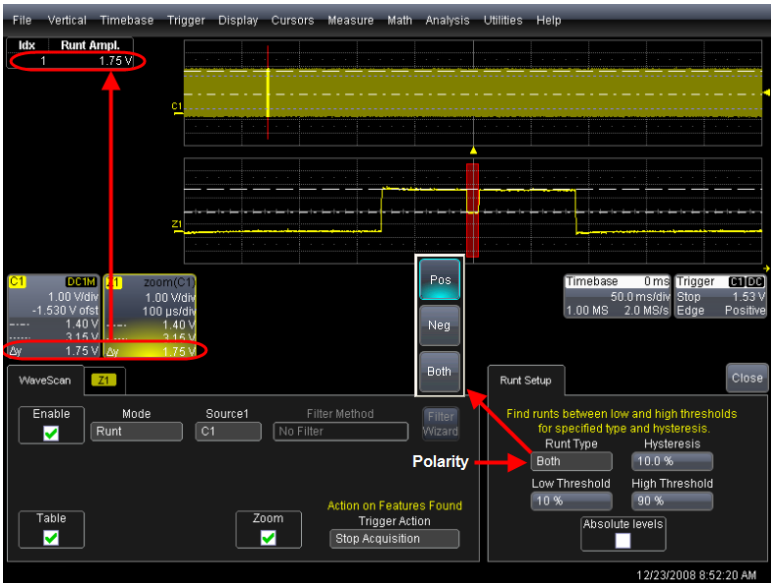
The hysteresis value is used to eliminate noise. A non-monotonicity is detected only when its amplitude is greater than the hysteresis. Therefore, when setting a hysteresis level, set a value that is greater than the amplitude of the noise.

Runt Mode

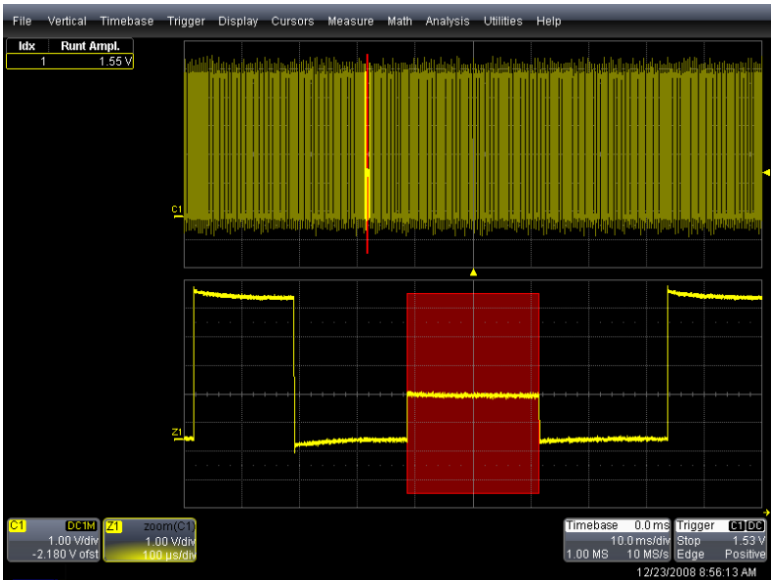
This search mode looks for pulses that fail to transit a given region. You can search for positive-going or negative-going runts, or both. An adjustable hysteresis band is provided to eliminate noise.

In the case of negative-going runt pulses, the value displayed in the table is the difference (delta) of the high level of the signal and the runt amplitude, i.e., where the runt bottoms out.

This can be confirmed by placing cursors on the runt pulse and reading the delta Y value in the trace labels:



In the case of positive-going runt pulses, the value displayed in the table is the absolute value of the amplitude of the runt pulse:



Measurement Mode

This search and scan mode lets you apply filters to your acquisitions to highlight only the features of interest. Post-acquisition, you can apply other filters to the acquisition, or make different parameter measurements on it.

For example, in this acquisition a **Rise** time (10-90%) parameter measurement is applied to fast edges during acquisition. We are interested only in edges with a rise time slower than 37 ns. Therefore, the **Greater Than** filter method is selected, with a value of 37 ns; four edges pass during acquisition:

SCAN FILTERS

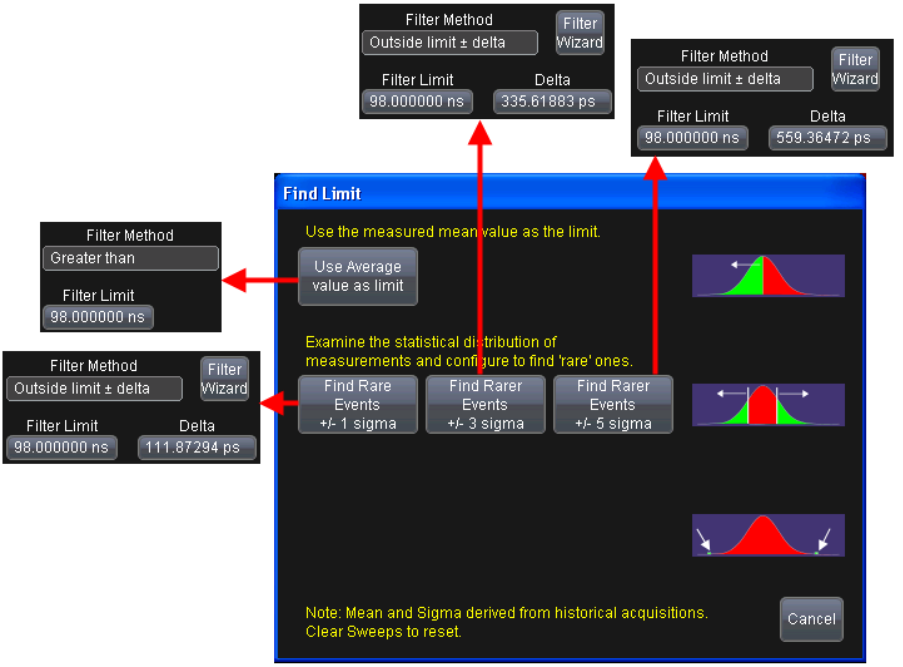
But, now we want to look at fall times greater than 45.5 ns; 3 falling edges from the same acquisition pass this new filter:

You can also decide how anomalous the features located should be by using the **Filter Wizard** to select the average value as the limit, to search for rarest events, or to apply statistical criteria.

FILTER WIZARD

You can decide how anomalous the features searched or scanned for should be by using the average value as the limit, by searching for rarest events, or by applying statistical criteria: ±1, 3, or 5 sigma.

In the following example, there were several slow edges in a repetitive waveform. For each filtering method selectable from the wizard, the rise time used as the filter limit and delta are calculated automatically.



FILTER METHODS

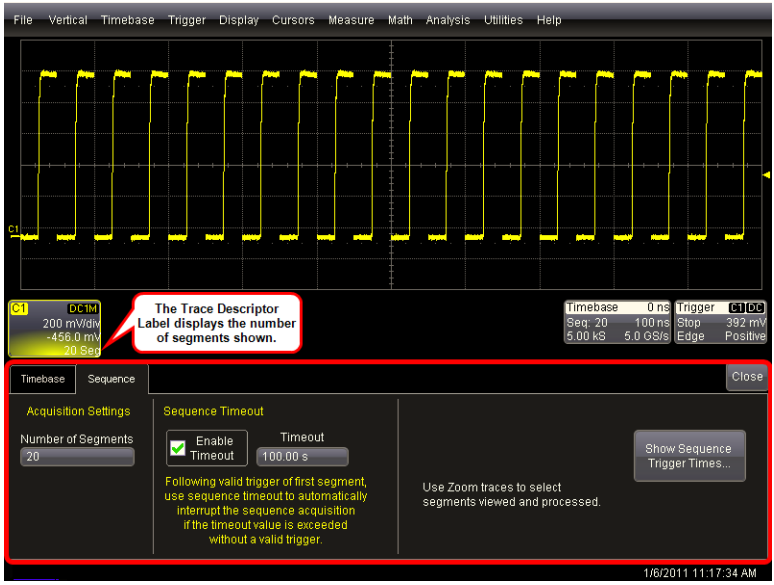
While the Filter Wizard provides a quick way to apply filtering criteria automatically, the **Filter Method** menu and related fields let you manually set up filtering criteria. And unlike the Filter Wizard selections, which are restricted to absolute deltas, the **Filter Method** menu also offers deltas as percentages:

Working with Sampling Modes

Sequence Mode Setup

When setting up Sequence Mode, you define the number of fixed-size segments acquired in single-shot mode (see the instrument specifications for the limits).

The oscilloscope uses the sequence timebase setting to determine the capture duration of each segment. Along with this setting, the oscilloscope uses the number of segments, maximum segment length, and total available memory to determine the actual number of samples or segments, and time or points.



1. Touch **Timebase → Horizontal Setup** on the menu bar.
2. Click the **Sequence** tab.
3. Under **Acquisition Settings**, touch inside the **Number of Settings** data entry field and enter the number of segments you want to display.

NOTE: The number of segments you choose to display can be less than the total number of segments in the waveform. For example, in the pop-up images above, the number of display segments is 10, but the total number of segments entered in the timebase dialog's **Number of Segments** field is 100.

4. Touch the **Enable Timeout** checkbox.
5. Touch inside the **Timeout** data entry field and enter a timeout value.

   NOTE: Use the sequence mode timeout to automatically interrupt the sequence acquisition if the timeout value is exceeded without a valid trigger. The timeout period accounts for instances when a **Number of Segments** miscount occurs for some reason and the oscilloscope waits indefinitely for an unforthcoming segment. During that time, no oscilloscope functions are accessible. By means of a timeout value, however, the acquisition will be completed, the waveform displayed, and control of the oscilloscope returned to the user after the timeout has elapsed.

5. Under **Display Settings**, touch inside the **Display mode** field, and select a sequence mode display from the pop-up menu.
6. Touch the SINGLE trigger front panel button.

   NOTE: Once a single acquisition has started, you can interrupt the acquisition at any time by pressing the **SINGLE** front panel button a second time or by pressing the **STOP** front panel button. In this case, the segments already acquired will be retained in memory.

Zooming Segments in Sequence Mode

You can zoom individual segments easily using the **QUICKZOOM** front panel button. When you zoom, the zoom traces default to Segment 1. Channel descriptors indicate the total number of segments acquired. Zoom descriptors indicate [Seg #] and #Segments in the Zoom.

You can scroll through the segments using **ZOOM** front panel position knob.

1. Touch the front panel **Quickzoom** button.
2. Turn the **ZOOM** front panel position knob to scroll through the segments.
3. To vary the degree of zoom, touch the newly created **Zx** trace label. The setup dialog for the zoom (Z1 to Z4) opens. 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 changes by small increments.

OR

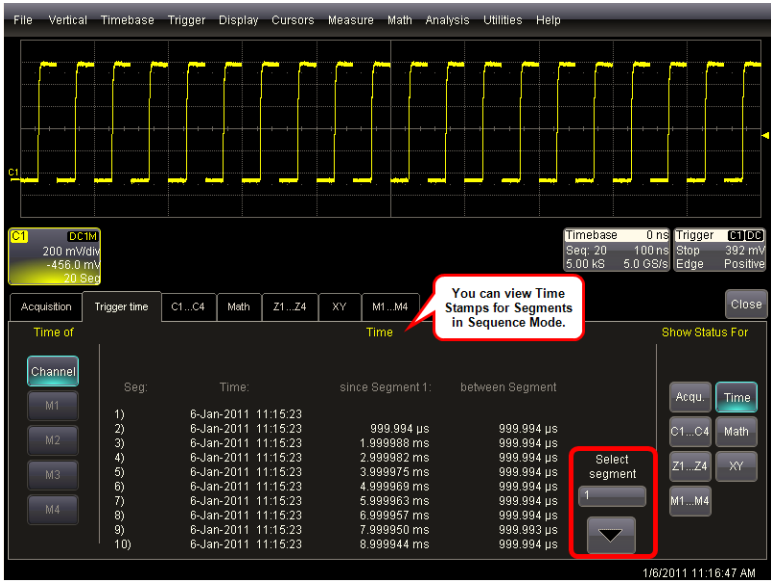
If you want to zoom in or out in large standard increments with each touch of the zoom control buttons, leave the **Var.** checkbox unchecked.

OR

If you want 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.

Viewing Time Stamps

You can view time stamps for each segment. To view time stamps, from the Sequence tab select **Show Sequence Trigger Times**.



Using the Math Trace

Overview

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

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

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

Each Math trace can also be zoomed without setting up a separate zoom trace. This reduces a step, and gives you more capability to understand the exact feature of interest without having to create another trace. Simply use the zoom controls in the Math dialog, or use the Vertical and Horizontal controls for position and scale change in both axes when the Math trace is active.

One powerful feature about WaveSurfer MXs-B Math traces is that they are calculated to 16-bit vertical resolution. Therefore, you can vertically zoom the Math trace and still maintain very high resolution when viewing the zoomed trace.

Description of math functions

The WaveSurfer MXs-B oscilloscope contains several Math operators as standard, plus an FFT function. Descriptions are provided as follows:

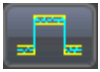
Standard Math

Absolute Value – calculates the absolute value of a waveform.

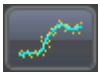
Average – calculates either a summed or continuous average up to 1 million sweeps (user selectable).

Derivative – calculates the derivative of adjacent samples.

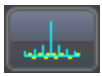
Difference (Subtract) – subtracts two waveforms.



Envelope – calculates highest and lowest vertical values of a waveform at each horizontal value for a given number of acquisitions (sweeps).



Enhanced Resolution (ERES) – noise reduction and smoothing filter specified by number of additional bits.



Fast Fourier Transform (FFT) – computes a power frequency spectrum of an FFT with Rectangular, Von Hann, Flat Topp, Hamming, Blackman-Harris, and Hanning windows, and capability to calculate up to 1 Mpts. Also allows FFT Averaging through use of 2nd Math Operator.

Floor - calculates the lowest vertical values of a waveform at each horizontal value for a given number of acquisitions (sweeps).

Integral – calculates the linearly rescaled integral (with multiplier and adder) of a waveform input.

Invert – inverts the waveform.

Product (Multiply) – Multiplies two waveforms.

Ratio (Divide) – Calculates the ratio of two waveforms.

Reciprocal – calculates the reciprocal of the waveform.

Rescale – allows user-defined rescaling, including user defined units.

Roof - calculates the highest vertical values of a waveform at each horizontal value for a given number of acquisitions (sweeps).

Square – calculates the square of the waveform.

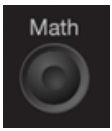
Square Root – calculates the square root of the waveform.

Sum (Add) – Adds two waveforms.

Zoom – Produces a zoom of the input waveform

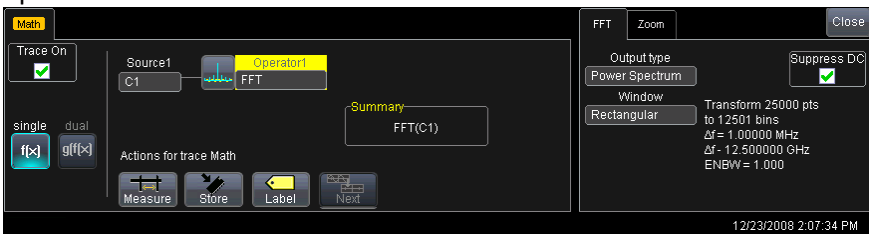
Setting up a Math Trace

1. Press the **Math** front panel button



Or, touch **Math** → **Math Setup…** from the Menu Bar.

The following dialog is shown on the lower display with the Math trace ON and the last selected Math Operator chosen as the current operator.



2. Change the currently defined Operator by touching either the icon or inside the **Operator** area to bring up the following pop-up menu (if you ordered the MathSurfer Advanced Math option, you would have more selections than shown):

3. Touch any of the icons to select the math operator (function) that you desire. Scroll down through the list using the scroll bar on the rights side of the pop-up menu.
4. Once the **Operator** is selected, the pop-up menu closes and the Math trace is re-defined.

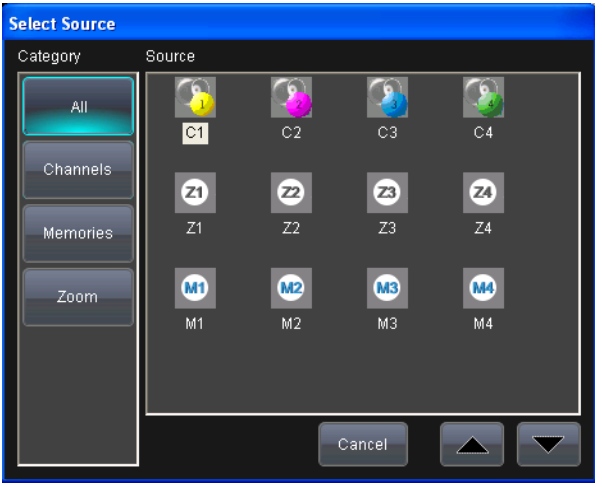
Using Dual Operators

If you have purchased the MathSurfer Advanced Math option (standard on WaveSurfer MXs-A), you can select a second **Operator**. Do this by selecting Dual from the **Single/Dual** button selection.

A second **Operator** is shown. Make changes to it the same way as with the first operator.

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

The channel source defaults to C1. Touch inside the source field to select a different source (a channel, a memory, or a zoom).

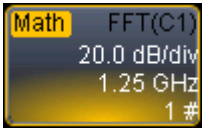


Close the Math dialog by either pressing the front panel **Math** button again, or touching **Close** on the on-screen dialog.

Math Descriptor Label

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

- The top line contains information about how the Math trace is defined (in this case, it's an FFT of Channel 1).
- The 2nd line contains vertical scaling information.
- The 3rd line contains horizontal scaling information.

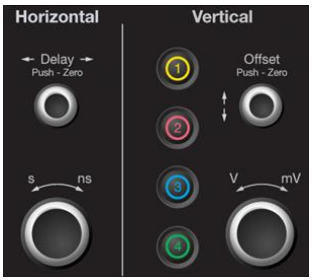


If the descriptor label is a solid color (as follows), then the Math trace is ACTIVE, which means that the Horizontal and Vertical front panel controls are set to adjust the Math trace, and not any of the channels. In this case, the scale and position of the Math trace can be changed by adjusting the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

If the Math trace is not ACTIVE, and you wish to make it ACTIVE, simply touch the descriptor label once and it becomes active and the Math dialog opens.

Zooming Math

Math traces have zoom capability built in, so it is easy to change the scale and position of the Math trace, as required. Zoom the channel as follows:



1. Touch the descriptor label to make it active.

2. Then, use the front panel horizontal and vertical controls to adjust position and scale. The operation of the knobs feels natural. Use the following table as a guide.

NOTE: When Math trace is active, no channel buttons are lit. This indicates that the Math trace may be currently active.

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

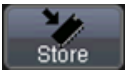
Using Math Dialog Zoom Controls

1. Touch the descriptor label twice to open the Math dialog.
2. Then use the Zoom dialog on the right to change the horizontal and vertical position and scale.

Toolbar Shortcuts

These buttons can be used to perform specific actions for the Math Trace.

Opens a Measurement selection pop-up menu. You can then select a parameter (measurement) for the Math trace from this menu without leaving the Math Setup dialog. The parameter automatically appears below the grid.



Loads the Math trace into its corresponding Memory (Reference Waveform) location (Memory 1, or abbreviated as M1).

Opens a Labeling pop-up menu that allows you to create labels tied to the waveform.

Pass/Fail Testing

Overview

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

Mask Tests

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

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

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

Actions

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

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

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

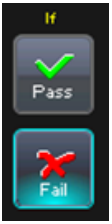
Setting Up Pass/Fail Testing

Touch **Analysis → Pass/Fail Analysis** from the menu bar.

The following dialog is shown on the lower display area.

Select a Source for the mask test.

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



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

If you want to save your waveform automatically, touch the **Save Setup**. This exits the current dialog and opens the **Save Waveform** dialog. Refer to the **Saving and Recalling Signals** section for more details.

Mask Testing Setup

1. From the **Test** dialog (right side of the screen), choose one of the **Test is True when** buttons:

   A selection means (for example, if you select **All In**) the test is False if even a single waveform falls outside the mask.

2. From **Show Markers**, choose whether or not to have mask violations displayed.
3. If you are loading a pre-existing mask, touch the **Load Mask** tab, then the **File** button. You can then enter the file name or browse to its location.
4. If you want to make a mask from your waveform, touch the **Make Mask** tab.
5. Touch inside the **Ver Delta** and **Hor Delta** fields and enter boundary values, using the pop-up numeric keypad.
6. Touch the **Browse** button to create a file name and location for the mask if you want to save it.
7. Touch the **Gate** tab, then enter values in the **Start** and **Stop** fields to constrain the mask to a portion of the waveform. Or, you can simply touch and drag the Gate posts, which initially are placed at the extreme left and right ends of the grid.

Saving and Recalling Waveforms

Overview

There are several ways to save and recall your signals:

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

Memories (Reference Waveforms)

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

Waveform Data

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

Screen Image

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

Saving and Recalling Memories

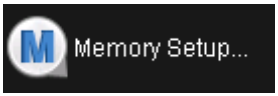
Fastest Way to Store and Display

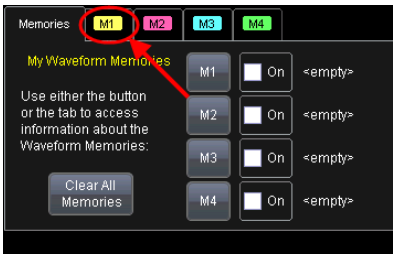
Being able to compare a current acquisition with a reference trace is a very fundamental oscilloscope need. The WaveSurfer MXs-B oscilloscope has made it easy to save a channel, math trace, or zoom trace to a memory location.

Touch the Channel, Math, or Zoom descriptor label twice to open the dialog for the trace that you desire to save to a reference location.

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

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



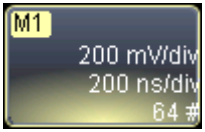


1. Choose **Math → Memory Setup** from the menu bar.
2. Choose a Memory location from the **Memory Setup** dialog. In this example, we'll choose M1.

3. Choose a waveform to save into this memory. In this example, we'll choose to save C1 into this M1 memory location.

   After you've selected the waveform to save into memory, touch **Copy Now**.

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



Using Memory Toolbar Shortcuts

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

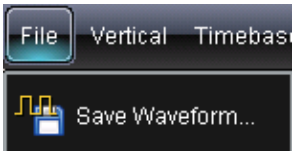
Opens a Measurement selection pop-up menu. You can then select a parameter (measurement) for the Memory trace from this menu without leaving the Memory Setup dialog. The parameter automatically appears below the grid.

Clears the memory of the stored trace.

Opens a Labeling pop-up menu that allows you to create labels tied to the memory.

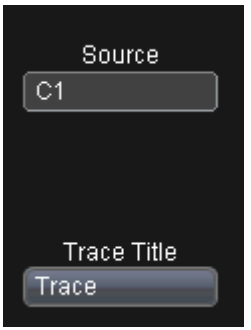
Saving and Recalling Waveform Data

Saving Waveform Data



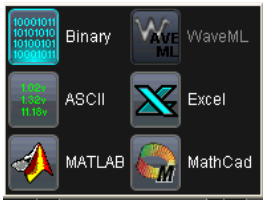
1. Choose **File** → **Save Waveform** from the menu bar.

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



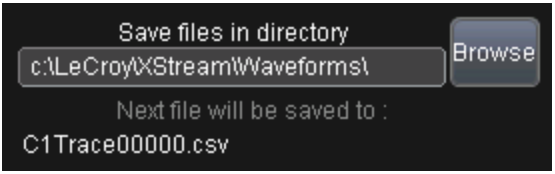
3. Choose a source of the data that you want to save, and choose a file name for the data file.

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



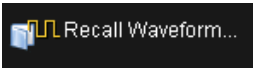
4. Choose a data format. If you select **ASCII** or **Excel**, also touch the **SubFormat** field and select either **Time Data** or **Time & Ampl**. Then touch the **Delimiter** field and select a delimiter character from the pop-up menu: comma, space, semicolon, or tab.

5. Choose a directory and file name to store the file to (this could be a USB memory storage device, or the oscilloscope internal hard drive:

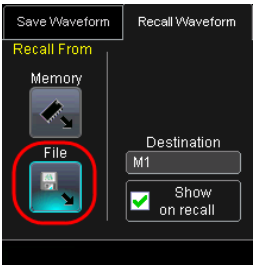


6. Then touch the **Save Now** button in the dialog.

Recalling Waveform Data



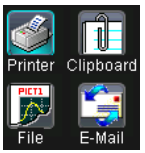
1. Choose **File** → **Recall Waveform** from the menu bar.



2. Choose to recall the Waveform Data from a **File**
3. Touch inside the **Destination** field and select a memory location to store the file into. If you wish, check the **Show on Recall** box to turn the memory ON and display the waveform instantly.
4. Touch 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.

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

Saving Screen Images



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

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

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

Saving the Screen Image to a File

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

1. Touch **Utilities** → **Utilities Setup...** from the menu bar.
2. Touch the **Hardcopy** tab, then the **File** icon.
3. Touch inside the **File Format** data entry field and select a graphic file format from the pop-up menu.
4. Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white background saves printer toner.
5. Touch inside the **Directory** data entry field and type the path to the folder you want to print to, using the pop-up keyboard. Or touch the **Browse** button and navigate to the folder.
6. Touch inside the **File Name** data entry field and enter a name for the display image, using the pop-up keyboard.
7. Touch the **Grid Area Only** checkbox if you do not need to print the dialog area and you only want to show the waveforms and grids.
8. Touch the **Print Now** button, or use the front panel Print button to save the file.

Sending the Screen Image as an E-mail Attachment

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

1. Touch **Utilities** → **Utilities Setup...** from the menu bar.
2. Touch the **Hardcopy** tab, then the **E-mail** button.
3. Touch inside the **File Format** data entry field and select a graphic file format from the pop-up menu.

4. Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white background saves printer toner.
5. Touch the **Prompt for message to send with mail** checkbox if you want to include remarks with the image.
6. Touch the **Grid Area Only** checkbox if you do not need to print the dialog area and you only want to show the waveforms and grids.
7. Touch the **Print Now** button.

Printing the Screen Image to a Printer

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

1. Touch **File** → **Print Setup...** from the menu bar. 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 **Preferences - Color** 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.
7. Touch the **Print Now** button, or use the front panel Print button to print the file.

Saving the Screen Image to a Clipboard

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

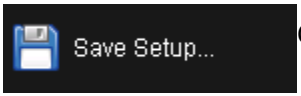
1. Touch **Utilities** → **Utilities Setup...** from the menu bar.
2. Touch the **Hardcopy** tab.
3. Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white background saves printer toner.
4. Touch the **Grid Area Only** checkbox if you do not need to print the dialog area and you only want to show the waveforms and grids.
5. Touch the **Print Now** button, or use the front panel Print button to save the file.

Saving and Recalling Setups

Overview

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

Saving Oscilloscope Settings as a Setup File

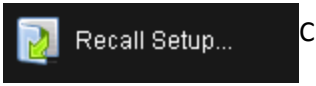


Choose **File** → **Save Setup** from menu bar.

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

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

Recalling Oscilloscope Settings from a Setup File

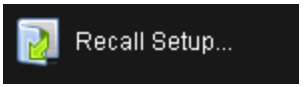


Choose **File** → **Recall Setup** from the menu bar.

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

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

Recalling Default Oscilloscope Settings



Choose **File** → **Recall Setup** from the menu bar.

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

Sharing Data & Communicating

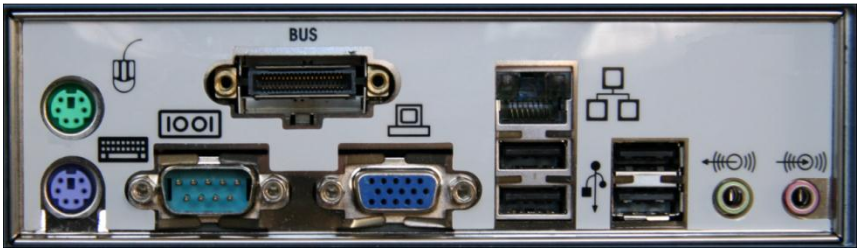
Overview

The WaveSurfer MXs-B oscilloscope provides you with many powerful tools to communicate your results to others and to increase your productivity. Some examples include:

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

The WaveSurfer MXs-B oscilloscope uses WindowsXP, so you are probably aware of the basic philosophy of minimizing the program, saving to directories, and opening other programs on the oscilloscope. This makes it easier to intuitively operate the WaveSurfer MXs-B oscilloscope.

Standard outputs

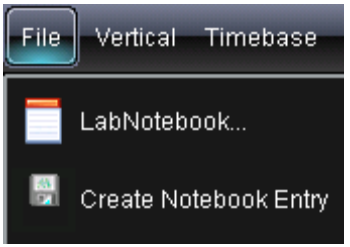


The WaveSurfer MXs-B oscilloscope is standard with the following:

- 100BaseT Ethernet
- Front-Mounted USB port (not pictured)
- Side-mounted USB ports (qty. 4)
- 9-pin serial port
- SVGA output
- Teledyne LeCroy Bus (LBus) Interface

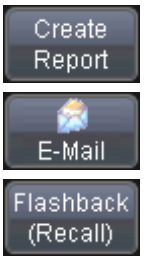
Documenting Your Work Using LabNotebook

The LabNotebook feature simplifies the way waveforms, screen captures, and oscilloscope setup files are saved and documented. LabNotebook also provides an easy way to recall your settings with the Flashback feature. And it lets you create reports, showing your screen images, in pdf, html, or rtf output formats.



LabNotebook entries are easily created by selecting LabNotebook from the File menu, then clicking the **Create** button.

Several annotation tools and colors are then put at your disposal to mark up your waveform. When you click **Done**, your mark-ups and oscilloscope settings are saved together in a database resident on the instrument.



Click the **Create Report** button to generate a hardcopy format that you can save to a network drive or external media. Or click the **E-mail** button to send the report to another location. Use the Flashback feature at any time to recall a Notebook entry, including oscilloscope setup, for further study.

Connecting to a Network

The WaveSurfer MXs-B oscilloscope's standard 10/100 Base-T Ethernet port allows quick and easy connection to a network. Using DHCP (Dynamic Host Configuration Protocol), provided the network does not have a firewall, plug the network cable into the WaveSurfer MXs-B scope's Ethernet port, and a network address is self-assigned.

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

Because your oscilloscope runs on a Windows-based PC platform, it is wise to protect it from viruses, as with any PC on a corporate network. It is

crucial that the oscilloscope be kept up to date with Windows Critical Updates, and that anti-virus software be installed and continually updated.

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

Sending E-mail from the Oscilloscope

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

Controlling and Viewing Remotely

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

All of these programs may be loaded and configured on the WaveSurfer MXs-B oscilloscope as if the WaveSurfer MXs-B was a standard PC.

Accessing the Desktop

You can access the WaveSurfer MXs-B oscilloscope's (Windows) desktop by touching **File → Minimize**. This minimizes the oscilloscope allowing access to other Windows programs like File Explorer, Paint, Internet Explorer, etc.

When minimized, the oscilloscope program appears as a follows in the lower right hand corner of the display. Touch on the icon to maximize the program to full screen size.

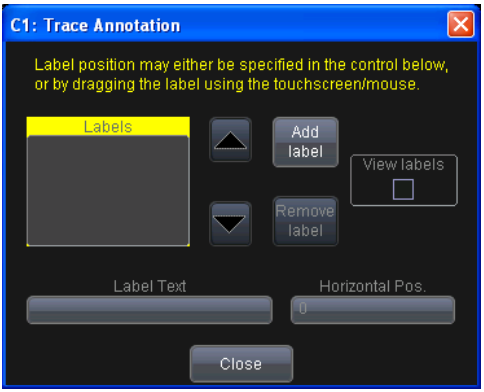
Annotating Image Files / Creating Labels

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

- Label placement adjusts depending on vertical and horizontal adjustments to the trace.
- When a screen image is saved to disk, these labels are part of the screen image.
- By using labels, you eliminate extra work in a separate program.
- Labels contribute to your co-worker or customer understanding of your work.

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

3. Touch the **Add Label** button in the pop-up menu.



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

Saving Data Files and Images

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

Images can be saved by choosing **File** in **Utilities, Hardcopy**, selecting a **File Format**, **File Name**, **Directory** location, etc.), and then pressing the **Print** icon in the dialog or on the front panel.

Please refer to the Saving the Screen Image to a File topic for more information.

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

Creating Reference Waveforms (Memories)

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

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

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

Printing

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

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

Print Management

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

Setting Up the Printer

1. Touch **File** → **Print Setup...** from the menu bar. The Utilities **Hardcopy** dialog opens.

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

   Under **Colors**, touch the **Use Print Colors** checkbox if you want the traces printed on a white background. A white background saves printer toner. Change the printer colors in the **Preference** dialog.

   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.

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

   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.

Printing from the Oscilloscope

2. You can print in one of three ways:
3. Press the printer button on the front panel.
4. Touch **File** → **Print** from the menu bar.
5. 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 oscilloscope.

1. Touch **File** → **Print Setup...** from the menu bar. The Utilities **Hardcopy** dialog opens.
2. In the dialog area, touch the **Printer** icon.

3. Touch the **Add Printer** button. The **Print** screen is then shown.
4. Touch the **Properties** button to change printer properties such as number of copies.

Changing the Default Printer

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

Utilities and Preferences

Overview

The Utilities and Preferences dialogs are accessed from the menu bar's **Utilities** selection. Utilities and Preferences contain setup and other information that doesn't need to be changed or accessed frequently.

Other items are located in the various top menu bar drop-downs.

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

Status

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

To access Status, from the menu bar, choose **Utilities**.

Now, touch the **Status** tab on the **Utilities** dialog.

Remote Communication

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

NOTE: The instrument uses Dynamic Host Configuration Protocol (DHCP) as its addressing protocol. Therefore, it is not necessary to set up an IP address if your network supports DHCP. If it does not, you can assign a static address in the standard Windows network setup dialog. Consult with your IT department. The local firewall may make it difficult for you to do this on your own.

The Remote Control Assistant monitors communication between your PC and oscilloscope 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.

Remote Communication Setup

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

1. Touch **Utilities** → **Utilities Setup...** from the menu bar.
2. Touch the **Remote** tab.
3. Make a **Port** selection:**TCPIP** (transmission control protocol/Internet protocol) is the only supported port at this time.
4. Press the **Net Connections** button. The Windows **Network and Dial-up Connections** screen is shown.
5. Touch **Make New Connection** and use the Windows Network Connection Wizard to make a new connection. Or, touch **Local Area Connection** to reconfigure the oscilloscope's connection if it is already connected to the network.

Configuring the Remote Control Assistant Event Log

1. Touch **Utilities** → **Utilities Setup...** from the menu bar.
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. Export the contents of the event log to an ASCII text file by touching the **Show Remote Control Log** button. The **Event Logs** pop-up is shown. Touch inside the **DestFilename** data entry field and use the pop-up keyboard to provide a file name. Now, touch the **Export to Text File** button.

Aux Output

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

Aux Output Off - turns off the auxiliary output signal

Trigger Out - can be used to trigger another oscilloscope

Trigger Enabled - can be used as a gating function to trigger another instrument when the oscilloscope is ready

Pass/Fail - allows pulse duration setup from 1 ms to 500 ms. Generates a pulse when pass/fail testing is active and conditions are met.

Setting Up Auxiliary Output

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

NOTE: The CAL output on the front of the WaveSurfer MXs-B oscilloscope is always set to a 1V / 1 kHz square wave.

Setting the Date and 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 oscilloscope connected to the Internet through the LAN connector on the rear panel. You can also set time zones and daylight savings time.

Manually Setting the Date and Time

1. Touch **Utilities** → **Utilities Setup...** from the menu bar.
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.

Setting the Date and Time from the Internet

The Simple Network Time Protocol (SNTP) is used.

Ensure that the scope is connected to the Internet through the LAN connector on the back of the oscilloscope.

1. Touch **Utilities** → **Utilities Setup...** from the menu bar.
2. Touch the **Date/Time** tab.
3. Touch the **Set from Internet** button.

Setting the Date and Time from Windows

1. Touch **Utilities** → **Utilities Setup...** from the menu bar.
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 Teledyne LeCroy Sales and Service office, or visit our Web site at http://teledynelecroy.com/options.

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

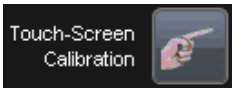
Service

This button provides access to service dialogs, which are for the sole use of Teledyne 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. Maximize the application, by touching the shortcut icon:

Touch-Screen Calibration



Touching the **Touch-Screen Calibration** button starts the calibration procedure. During the procedure, you are prompted to touch the center of a small cross in 5 key locations on the touch-screen. Be sure to use a stylus

for this procedure. Using your finger provides insufficient accuracy. The calibration has a ten-second timeout in case no cross is touched.

Avoid parallax errors by placing your line of sight directly in front of each cross before touching.

Preferences

Audible Feedback

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

- Touch **Utilities** → **Preferences** from the menu bar.
- Touch the Audible Feedback **Enable** checkbox so the oscilloscope 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 oscilloscope only recalibrates at startup and whenever you make a change to certain operating conditions.

- Touch **Utilities** → **Preferences** from the menu bar.
- Touch the Automatic Calibration **Enable** checkbox.

Offset Control

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

- Touch **Utilities** → **Preferences** from the menu bar.
- Touch the **Offset/Delay** tab.
- Under **Offset Setting constant in**: touch either the **Div** or **Volts** button.

Local Language

The WaveSurfer MXs-B oscilloscope can be configured to display a user interface in different languages. Make a selection and the WaveSurfer MXs-B oscilloscope dynamically changes the language shown.

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 remains on the grid as you increase the timebase. 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.

Touch **Utilities** → **Preferences** from the menu bar.

- Touch the **Offset/Delay** tab.
- Under **Offset Setting constant in**:, touch either the **Volts** or **Div** button.
- Under **Delay Setting constant in**:, touch either the **Time** or **Div** button.

E-mail

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

- Touch **Utilities** → **Preference Setup…** from the menu bar.
- 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 oscilloscope's e-mail address]."

Acquisition Status

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

- Vertical - select **Channels Status . . .** from drop-down menu
- Timebase - select **Acquisition Status . . .** from drop-down menu
- Trigger - select **Acquisition Status . . .** from drop-down menu
- Math - select **Math Status . . .** from drop-down menu

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

Remote Control Operation

Refer to the *Remote Control Manual* available at teledynelecroy.com for more information.

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

Standards

Teledyne LeCroy remote control commands conform to the GPIB IEEE 488.2[1] standard. This may be considered an extension of the IEEE 488.1 standard.

Program Messages

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

Automation

In addition to supporting the familiar ASCII-based GPIB remote commands, the WaveSurfer MXs-B oscilloscope instruments fully-support control by Automation interfaces based on Microsoft's Component Object Model (COM).

Using COM, the controlling application runs directly on the instrument. There's no need for an external controller.

The controlling application can also be run using Microsoft's distributed COM standard (DCOM) on a networked computer.

Please refer to the *Automation Manual* available at teledynelecroy.com for more information.

Standards

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

An application exposing *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.

[1]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

It is important to note that Automation itself is not software language dependent. Meaning, it can be used from any programming language supporting COM. Teledyne LeCroy's usage concentrates mainly on the use of Automation from the Visual Basic Script (VBScript) language. This is largely because it is easy to use, it is the language the WaveSurfer MXs-B oscilloscope uses for setup files, and the VBScript interpreter is installed by default on all WaveSurfer MXs-B instruments. So, this is all available without having to purchase any additional software.

System Recovery

Your WaveSurfer MXs-B series oscilloscope was designed to operate very reliably for many years. However, the application software that operates the instrument runs on a Windows platform. The loading or incomplete removal of additional Windows applications may eventually cause problems in the stability of the operating system. In severe cases, it may be necessary to reload the base operating system and oscilloscope application. This can be done by using a recovery routine to restore a clean copy of the image originally installed on the C: drive. Any user or calibration data located on the D: partition is not be affected by the recovery process.

Teledyne LeCroy has provided a recovery application, along with a backup image, in an extra partition on the instrument's hard drive. The recovery process is easy to perform, using the following instructions.

After the recovery procedure is done, you must activate Windows, either by internet connection to Microsoft's Web site or by telephone. For this, you need to provide the Windows Product Key number, which is affixed to the bottom of the oscilloscope.

NOTE: The recovery process produces a replica of the operating system and oscilloscope application software at the revision levels that were current when the oscilloscope was manufactured. Any later revisions of the application software, Windows operating system, and virus scan definition files are not automatically loaded. After completion of the disk image recovery, it is highly recommended that you search the vendors' Web sites to upgrade the individual components to their current revision level.

The current oscilloscope application software can be downloaded directly from the Teledyne LeCroy Web site at teledynelecroy.com.

Since the calibration data for the oscilloscope is stored in the D: drive, the current calibration constants are preserved during the recovery process.

Software Recovery Application

Your oscilloscope is designed to operate reliably for many years. However, the application software operating the instrument runs on a Windows platform. The loading or incomplete removal of additional Windows applications may eventually cause problems in the stability of the operating system. Severe cases may require a reloading of the base operating system and oscilloscope application. This is done using a recovery routine that restores a clean copy of the image originally installed on the C: drive.

NOTE: Any user and calibration data located on the D: partition is not affected by the recovery process.

Teledyne LeCroy provides you with a recovery application and a backup image in an extra partition on the instrument's hard drive. The recovery process is easy to perform using the Recovery Wizard. A .PDF document containing instructions are loaded on the oscilloscope desktop, and are available for download from the technical library at teledynelecroy.com.

After the recovery procedure is done, you must activate Windows, either by Internet connection to Microsoft's Web site or by telephone. Have your Windows Product Key number (located on the rear of the oscilloscope) handy during Widows reactivation.

NOTE: The recovery process produces a replica of the operating system and oscilloscope application software at the current revision levels when the oscilloscope was manufactured. Any further revisions of the application software, Windows operating system, and virus scan definition files are not automatically upgraded. Therefore, after completion of the disk image recovery, it is highly recommended to search vendor Web sites and upgrade the individual components to current revision levels.

The current oscilloscope application software can be downloaded directly from the Teledyne LeCroy website at teledynelecroy.com. Since the calibration data for the oscilloscope is stored in the D: drive, current calibration constants are not overwritten during the recovery process.

Restarting the Application after Recovery

Upon initial power-up, the oscilloscope automatically loads the instrument application software. If you exit the application and want to reload it, touch the shortcut icon on the desktop:

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

Restarting the Operating System

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

Windows Activation

Click Start in the task bar, and then select **All Programs → Activate Windows.** Follow the prompts on the Activate Windows wizard.

NOTE: After Windows Activation is completed, this selection no longer appears on the All Programs menu.

- If you elected to activate by internet, enter the Activation ID (Product Key number on the bottom of the oscilloscope) number when prompted to do so, and then click **Next**. Windows Activation then starts.
- If activating by phone, select the oscilloscope location (country). Then dial the number provided to you over the phone. When asked, verbally repeat the installation ID listed on the screen. Enter the 7-part number given to you in the empty boxes at the bottom of the screen. Click the **Next** button to proceed.

Check the revision levels of the X-Stream software, virus definitions, and Windows updates. Visit the vendors' Web sites and download all necessary updates.

Reference

Certifications

This section contains the instrument's Electromagnetic Compatibility (EMC), Safety and Environmental certifications.

EMC Compliance

EC Declaration Of Conformity - EMC

The oscilloscope meets intent of EC Directive 2004/108/EC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61326-1:2006, EN 61326-2-1:2006 EMC requirements for electrical equipment for measurement, control, and laboratory use. [1]

Electromagnetic Emissions:

CISPR 11:2003, Radiated and Conducted Emissions Group 1, Class A [2 3]

EN 61000-3-2:2006 Harmonic Current Emissions, Class A

EN 61000-3-3/A2:2005 Voltage Fluctuations and Flickers, Pst = 1

Electromagnetic Immunity:

EN 61000-4-2:2001 Electrostatic Discharge, 4 kV contact, 8 kV air, 4 kV vertical/horizontal coupling planes [4]

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

EN 61000-4-4:2004 Electrical Fast Transient/Burst, 1 kV on power supply lines, 0.5 kV on I/O signal data and control lines [4]

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

EN 61000-4-6:2007 RF Conducted Electromagnetic Field, 3 Vrms, 0.15 MHz - 80 MHz [4]

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

1 To ensure compliance with all applicable EMC standards, high quality shielded interface cables should be used.

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

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

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

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

European Contact:

Teledyne LeCroy Europe GmbH
Waldhofer Str 104
D-69123 Heidelberg
Germany
Tel: (49) 6221 82700

AUSTRALIA & NEW ZEALAND DECLARATION OF CONFORMITY – EMC

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

CISPR 11:2003 Radiated and Conducted Emissions, Group 1, Class A, in accordance with EN61326-1:2006 and EN61326-2-1:2006.

Australia / New Zealand Contacts:

Vicom Australia Ltd.
1064 Centre Road
Oakleigh, South Victoria 3167
Australia

Vicom New Zealand Ltd.
60 Grafton Road
Auckland
New Zealand

Safety Compliance

EC DECLARATION OF CONFORMITY – LOW VOLTAGE

The oscilloscope meets intent of EC Directive 2006/95/EC for Product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

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

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

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

- Overvoltage Category II: this refers to equipment intended to be supplied from the building wiring with a nominal supply voltage up to 300V.
- Measurement Category O: this refers to oscilloscope measurement terminals that are not intended to be directly connected to the MAINS supply.
- Pollution Degree 2: this refers to an operating environment where normally only dry, non-conductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment.
- Protection Class I: this refers to grounded equipment, in which protection against electric shock is achieved by Basic Insulation and a connection to the protective ground conductor in the building wiring.

U.S. Nationally Recognized Agency Certification

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

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

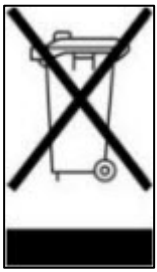
Canadian Certification

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

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

Environmental Compliance

END-OF-LIFE HANDLING



The instrument is marked with this symbol to indicate that it complies with the applicable European Union requirements to Directives 2002/96/EC and 2006/66/EC on Waste Electrical and Electronic Equipment (WEEE) and Batteries.

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

RESTRICTION OF HAZARDOUS SUBSTANCES (ROHS)

This instrument has been classified as Industrial Monitoring and Control Equipment, and is outside the scope of the 2011/65/EU RoHS Directive until 22 July 2017 (per Article IV, Paragraph 3).

ISO Certification

Manufactured under an ISO 9000 Registered Quality Management System. Visit teledynelecroy.com to view the certificate.

Contact Teledyne LeCroy

Teledyne LeCroy Service Centers	
United States and Canada - World Wide Corporate Office Teledyne LeCroy Corporation 700 Chestnut Ridge Road Chestnut Ridge, NY, 10977-6499, USA Ph: 800-553-2769 / 845-425-2000 FAX: 845-578-5985 teledynelecroy.com **Support**: contact.corp@teledynelecroy.com **Sales**: customersupport@teledynelecroy.com	***United States - Protocol Solutions Group*** Teledyne LeCroy Corporation 3385 Scott Boulevard Santa Clara, CA, 95054, USA FAX: 408-727-0800 teledynelecroy.com **Sales and Service**: Ph: 800-909-7211 / 408-727-6600 contact.corp@teledynelecroy.com **Support**: Ph: 800-909-7112 / 408-653-1260 psgsupport@teledynelecroy.com
European Headquarters Teledyne LeCroy SA 4, Rue Moïse Marcinhes Case postale 341 1217 Meyrin 1 Geneva, Switzerland Ph: + 41 22 719 2228 / 2323 /2277 FAX:+41 22 719 2233 contact.sa@teledynelecroy.com applications.indirect@teledynelecroy.com teledynelecroy.com/europe **Protocol Analyzers:** Ph: +44 12 765 03971	***Singapore, Oscillosocpes*** Teledyne LeCroy Singapore Pte Ltd. Blk 750C Chai Chee Road #02-08 Technopark @ Chai Chee Singapore 469003 Ph: ++ 65 64424880 FAX: ++ 65 64427811 ***Singapore, Protocol Analyzers*** Genetron Singapore Pte Ltd. 37 Kallang Pudding Road, #08-08 Tong Lee Building Block B Singapore 349315 Ph: ++ 65 9760-4682
China Teledyne LeCroy Corporation Beijing Rm. 2001 - Office; Rm. 2002 - Service Center Unit A, Horizon Plaza No. 6, Zhichun Road, Haidian District Beijing 100088, China Ph: ++86 10 8280 0318 / 0319 / 0320 FAX:++86 10 8280 0316 **Service:** Rm. 2002 Ph: ++86 10 8280 0245	***Korea*** Teledyne LeCroy Korea 10th fl.Ildong Bldg. 968-5 Daechi-dong, Gangnam-gu Seoul 135-280, Korea Ph: ++ 82 2 3452 0400 FAX: ++ 82 2 3452 0490
Taiwan LeColn Technology Co Ltd. Far East Century Park, C3, 9F No. 2, Chien-8th Road, Chung-Ho Dist., New Taipei City, Taiwan Ph: ++ 886 2 8226 1366 FAX: ++ 886 2 8226 1368	***Japan*** Teledyne LeCroy Japan Hobunsya Funchu Bldg, 3F 3-11-5, Midori-cho, Fuchu-Shi Tokyo 183-0006, Japan Ph: ++ 81 4 2402 9400 FAX: ++ 81 4 2402 9586 teledynelecroy.com/japan

X-Stream Software End-User License Agreement

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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 Teledyne 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.

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700 Chestnut Ridge Road
Chestnut Ridge, NY 10977
USA

teledynelecroy.com