LeCroy

MS-250
Mixed Signal
Oscilloscope Option

Operator's Manual

August 2007

LeCroy Corporation

700 Chestnut Ridge Road
Chestnut Ridge, NY 10977–6499
Tel: (845) 578 6020, Fax: (845) 578 5985

Internet: www.lecroy.com

© 2007 by LeCroy Corporation. All rights reserved.

LeCroy, ActiveDSO, WaveLink, JitterTrack, WavePro, WaveMaster, WaveSurfer, WaveExpert, and Waverunner are registered trademarks of LeCroy Corporation. Other product or brand names are trademarks or requested trademarks of their respective holders. Information in this publication supersedes all earlier versions. Specifications subject to change without notice.

MS-250-OM-E Rev B
915395-00 Rev A

MS-250 Mixed Signal Oscilloscope Option

SAFETY REQUIREMENTS

This symbol may appear on the product: ⚠

This refers you to additional information contained in the operator's manual. The corresponding information in this manual is similarly denoted.

Before using this product, ensure that its operating environment will be maintained within these parameters:

Temperature:	5 to 40 oC
Humidity:	Maximum relative humidity 80 % (non-condensing) for temperatures up to 31 oC decreasing linearly to 50 % relative humidity at 40 oC
Altitude:	Up to 2,000 m

⚠ **CAUTION**

To avoid personal injury or damage to the MS-250 or any equipment connected to it, review and comply with the following safety precautions.

- **Use only as intended.** The MS-250 hardware is intended to be used only with the LeCroy WaveSurfer or WaveRunner series oscilloscopes. Use of the MS-250 and/or the equipment it is connected to in a manner other than specified may impair the protection mechanisms.

- **Connect and disconnect properly**. Avoid damage to cables thru excessive bending.

- **Do not use in wet/damp or explosive atmospheres.**

- **For indoor use only.** The MS-250 is intended for indoor use and should be operated in a clean, dry, environment.

- **Do not operate with suspected failures.** Do not use MS-250 if any part is damaged. All maintenance should be referred to qualified service personnel.

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

MS-250 Mixed Signal Oscilloscope Option

Cleaning

The outside of the MS-250 hardware should be cleaned with a soft cloth dampened with either deionized / distilled water or isopropyl alcohol. Allow the surface to dry completely before returning the instrument to service.

Use and Maintenance

The MS-250 is a high quality, precision instrument. To maintain accuracy and signal fidelity, mechanical shock should be avoided, as well as damage to the cables through excessive bending. All maintenance and component replacement should be referred to qualified personnel.

DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014:1998

Manufacturer's Name: LeCroy Corporation

Manufacturer's Address: 700 Chestnut Ridge Road
Chestnut Ridge, NY 10977
USA

herewith declare that

Product(s) Name: Oscilloscope Mixed Signal Option
Model Number(s): MS-250

including all their options are in conformity with the provisions of the following EC directive(s), including the latest amendments, and with national legislation implementing these directives:
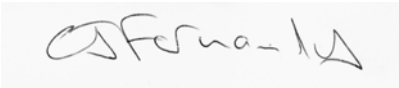
73/23/EEC Low Voltage Directive
89/336/EEC EMC Directive

and that conformity with Council Directive 73/23/EEC is based on

EN 61010-1: 2001   Safety requirements for electrical equipment for measurement control and laboratory use

and that conformity with Council Directive 89/336/EEC is based on

EN 61326: 1997 +A1:1998   EMC requirements for electrical equipment for measurement
    +A2:2001+A3:2003   control and laboratory use

Emissions	EN 55011/A2:2002	Conducted and Radiated Emissions
	EN 61000-3-2/A2:2005	Harmonic Current Emissions
Immunity	EN 61000-4-2/A2:2001	Electrostatic Discharge
	EN 61000-4-3/A1:2003	RF Radiated Electromagnetic Field
	EN 61000-4-4:2004	Electrical Fast Transient/Burst
	EN 61000-4-5/A1:2001	Surge
	EN 61000-4-6/A1:2001	RF Conducted Electromagnetic Field

By: Conrad Fernandes
Vice President, Oscilloscope Division

Place: LeCroy Corporation
700 Chestnut Ridge Road
Chestnut Ridge, NY 10977
USA

Date: May 7, 2007

European Contact:
Your local LeCroy Sales Office or

LeCroy Europe GmbH
Waldhofer Str 104
D-69123 Heidelberg
Germany

Tel: (49) 6221 82700
Fax: (49) 6221 834655

Warning: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

MS-250 Mixed Signal Oscilloscope Option

INTRODUCTION

Overview

The MS-250 Oscilloscope Mixed Signal Option is a powerful solution for the challenge of measuring multiple, mixed signals in a single oscilloscope. An enhancement tool to the LeCroy WaveRunner Xi Series and WaveSurfer Xs Series oscilloscopes, the MS-250 extends their testing range by adding 18 digital channels for display or triggering.

The MS-250 is ideally suited for embedded controller testing where there is a proliferation of analog signals (comparators, voltage sources, sensor/actuator signals, etc.) coincident with digital signals (address or data lines, control signals, or peripheral serial data signals). Users can easily debug signals using standard oscilloscope tools such as cursors, measurement parameters, and zooming.

Both oscilloscopes usable with the MS-250 feature large, bright color displays to facilitate signal viewing, plus all the connectivity and documentation capabilities needed to quickly record and distribute information.

This MS-250 manual assumes that you have a basic understanding of discrete electronics, logic analyzers, and LeCroy oscilloscopes, specifically the LeCroy oscilloscope that the MS-250 system will be used with. Where practical or necessary, detail on specific oscilloscope features is included in this manual.

Warranty

The MS-250 is warranted for normal use and operation, within specifications, for a period of one year from shipment. LeCroy will either repair or, at our option, replace any product returned to one of our authorized service centers within this period. However, in order to do this we must first examine the product and find that the defect is due to workmanship or materials and not due to misuse, neglect, accident, or abnormal conditions or operation.

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 LeCroy representatives, or b) improper connection to incompatible equipment, or c) for any damage or malfunction caused by the use of non-LeCroy supplies.

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. This includes MS-250 specific firmware. Nevertheless, it is supplied without warranty of any kind covering detailed performance. Products not made by LeCroy are covered solely by the warranty of the original equipment manufacturer.

Returning a Product for Service or Repair

If you suspect that you have a problem with the MS-250, you should first contact your local LeCroy service center so that they can ascertain whether this component is defective.

If you need to return a LeCroy product, identify it by its model and serial numbers. Describe the

defect or failure, and give us your name and telephone number. For factory returns, use a Return Authorization Number (RAN), which you can get from customer service. Write the number clearly on the outside of the shipping carton. Return products requiring only maintenance to your local customer service center. Within the warranty period, transportation charges to the service center will be your responsibility.

Products under warranty will be returned to you with transport prepaid by LeCroy. Outside the

warranty period, you will have to provide us with a purchase order number before the work can be

done. You will be billed for parts and labor related to the repair work, as well as for shipping.

You should prepay return shipments. LeCroy cannot accept COD (Cash On Delivery) or Collect

Return shipments. We recommend using air freight.

Technical Support
You can get assistance with installation and operation from your customer service center. Visit the LeCroy Web site at http://www.lecroy.com for the center nearest you.

Staying Up-to-Date
Your MS-250 hardware does not need periodic calibration.

LeCroy offers state-of-the-art performance by continually refining and improving the instrument's capabilities and operation. We frequently update both firmware and software during

service, free of charge during warranty. Therefore, MS-250 specific software may be periodically updated. You can download firmware and software updates from the LeCroy web-site.

Since software is continuously updated, the dialog boxes and menus you see in your program may be slightly different than what is shown in this manual. The difference should not be enough to affect your understanding of the operation of the MS-250.

MS-250 Mixed Signal Oscilloscope Option

STANDARD AND ACCESSORY EQUIPMENT

The MS-250 Standard Hardware

The Standard Hardware consists of the following items:

- Qty. 1 **Mixed Signal Oscilloscope Option** – Provides 18 channel digital acquisition and triggering.

    Qty. 1 **16" (40.64 cm) Digital Lead Set** – Interfaces the MS-250 to the device under test. The lead set terminates in a 25 mil pin socket. Micro-gripper probes of various sizes are available as accessories from LeCroy, and may be connected to the lead set.

    The lead set is divided into two groups. Each lead within the group is color-coded (to resistor color-coding standard) and has an individual ground connection. In addition, there are two common ground leads available for use.

- Qty. 1 **LeCroy Bus Cable** – 1.3m cable to connect Mixed Signal Hardware to main oscilloscope unit, includes USB2.0 cable. This connection provides timebase synchronization, cross-triggering and power.

- Qty. 5 **3" Flexible Ground Lead –** Lead for grounding individual digital inputs (Qty. 10 for MS-500-36)

- Qty. 20 **Ground Extender –** Connect to ground port of any digital input and make a simple signal and ground connection to a 0.1" square pin header. (Qty. 40 with MS-500-36)

- Qty. 1 **Carrying Case**Qty. 1 **Quick Reference Guide**

- Qty. 1 **Quick Reference Guide**
- Qty. 1 **Operator's Manual**

The MS-250 Software

The standard MS-250 software adds the following capability to the LeCroy oscilloscope software dialogs:

- **Analog, Digital and Combination Trigger Modes** – Allows you to choose whether you want to set an analog trigger condition, a digital trigger condition or a pattern consisting of analog and digital signals.

- **Digital Trigger** – Allows a digital trigger condition to be set from within the oscilloscope using an easy-to-understand interface.

- **Digital Channels** – Provides a standard, general purpose setup for defining the digital channels and displaying digital lines.

- **Digital Threshold Setup** – Provides the means to define a logic threshold for digital trace calculation.

The MS-250 Hardware and Software requires no traceable calibration or adjustment. However, the oscilloscope that is used with the MS-250 does require periodic calibration and adjustment.

Accessories

Various accessories are also available to use with the MS-250. These are listed below:

MS-250 Mixed Signal Oscilloscope Option

- **MSO-DLS-18 16" (40.64 cm) Digital Lead Set** – An additional standard digital lead set. This might be convenient to have if you have more than one device under test and do not wish to disconnect/reconnect your cables to use the MS-500 on different DUTs. Inputs are labeled D0 – D17

- **PK400-1** – Large gripper probe set for 0.10 inch (2.54 mm) pin pitch. Includes 10 probes with color-coded leads.

- **PK400-2** – Medium gripper probe set for 0.04 inch (1.0 mm) pin pitch. Includes 10 probes with color-coded leads.

- **PK400-3** – Small gripper probe set for 0.008 inch (0.2 mm) pin pitch. Includes 10 probes with color-coded leads.

- **MSO-MICTOR** – Mictor Connection cable, 16" (40.64 cm), 36 channel connector

MSO-3M - Interconnect cable, 16" (40.64 cm) mates with 3M connectors, 2520-6002 and 25205002

MS-250 Mixed Signal Oscilloscope Option

DESCRIPTION OF OPERATION

The various components of the MS-250 Mixed Signal Option Oscilloscope acquire and store digital data, trigger on digital patterns, interface the external module to the oscilloscope, and provide a user friendly interface for control and interpretation of data.

The MS-250 is an external device that digitally samples waveform data at up to 1 GS/s (for 250 MHz digital signals). Unlike a logic analyzer, it operates only in a Timing Analysis mode, so it requires 4x oversampling to determine the correct digital edge position, and does not require the user to input a clock.

While in SINGLE, NORMAL, or AUTO trigger mode, the MS-250 repeatedly samples each digital channel's voltage level. If the voltage is greater than the threshold voltage, the MS-250 stores a '1' in internal memory. Otherwise, a '0' is stored.
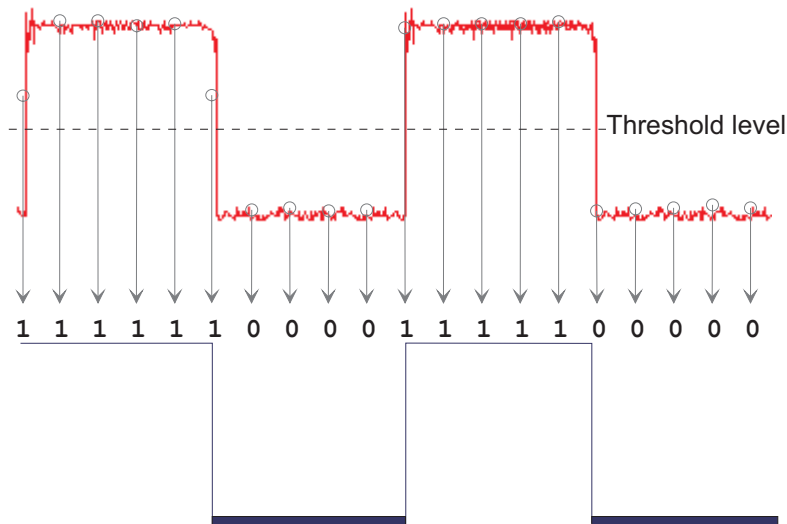
The minimum high voltage level is user definable by the hysteresis control up to 1.4 V above the threshold. The maximum low voltage level is user definable by the hysteresis control up to 1.4 V below the threshold. The minimum signal swing is 100 mV. The *indeterminate range* of 50 mV around the threshold voltage level is the level below which the MS-500 will not operate. However, the MS-500 *can* support a signal as low as 100mV only if the input signal's quality is adequate.

The MS-500 keeps sampling its inputs until the oscilloscope is put into STOP trigger mode. Data is stored in a 50 Mpt internal memory that is periodically transferred to the oscilloscope via the USB2.0 cable. If the oscilloscope is triggering in SINGLE or NORMAL trigger mode, data is acquired and transferred only when the trigger condition is satisfied. The captured data is then displayed on the oscilloscope grid in a time-aligned fashion.

In any trigger mode (AUTO, NORMAL, SINGLE), pressing STOP trigger will cancel the acquisition, which leaves the previously acquired data unchanged.

The MS-250 both samples incoming data and searches for trigger conditions.

The USB2.0 cable provides downloading of trigger conditions from the oscilloscope to the MS-250, and uploading of digital data from the MS-250 to the oscilloscope.

MS-250 Mixed Signal Oscilloscope Option

GETTING STARTED WITH THE MS-250

Overview

The MS-250 is a complete system that interfaces to the oscilloscope in a number of ways that make it easier to do the following:

- Set analog, digital and combination triggers.

- View all analog and digital signal information on the oscilloscope grid, with all signals time-correlated.

All setup is done in the user-friendly oscilloscope dialogs – it is not required to leave the oscilloscope software to run the MS-250. All normal oscilloscope tools (cursors, measurement parameters, etc.) are available for use with the digital signals.

There are physical connections that must be made to ensure proper operation, but the connection is intuitive and is documented below.

Operation of the WaveRunner or WaveSurfer oscilloscope is not covered in this manual. Reference the on-Line Help or Getting Started Manual for each oscilloscope for complete information on analog triggering, display of analog signals, front panel operation, etc.

Connecting the MS-250 System to the Oscilloscope

Connect the MS-250 System to the Oscilloscope as follows:

1. Connect the LeCroy Bus Cable to the LeCroy Bus connector on the side of the oscilloscope and fasten the thumb screws

2. Connect the USB 2.0 cable (attached to the LeCroy Bus cable) to any of the side mounted USB ports on the oscilloscope
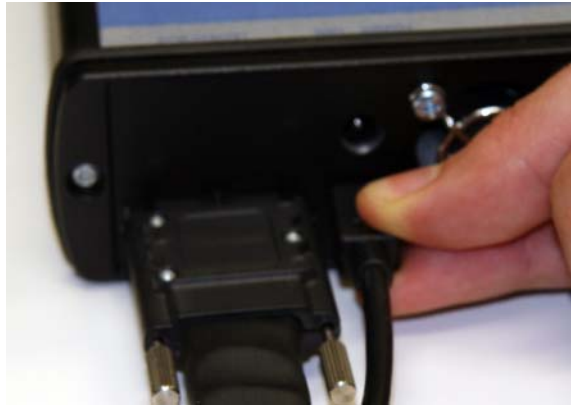

3. Connect the other end of the LeCroy Bus cable to the MS-250 and fasten the thumb screws.

MS-250 Mixed Signal Oscilloscope Option

4. Connect the other end of the USB2.0 Cable to the MS-250.

5. Connect the Digital Lead Set to the other end of the MS-250 where it is labeled Digital Inputs, D0 – D17 and fasten the thumb screws.

6. Note that each digital line has a ground connection for optimal performance. Two additional ground leads are also available. Using the shortest possible ground lead is always recommended.

   Connect the Digital Leads to the digital lines you wish to observe (using accessory micro-grippers, as necessary or desired).

7. Turn on power to the oscilloscope and wait for the oscilloscope application to begin.

Verifying Proper MS-250 Connection to your Oscilloscope and the Device Under Test

If you are concerned that your digital signals aren't being displayed correctly, it is a good idea to check by viewing the digital signals one at a time with an analog channel. This can point out errors in your connection or in your logic threshold setup.

The Complete System Connection

When your system is completely connected, it will look like the photo that follows:

It is usually easiest to debug digital line connection or display problems by viewing the digital information on an analog channel to confirm it's presence, then working back through the sequence above to determine where the connection or display error is.

Digital Connections

Handle with care!

> ⚠️ **The MS-250 Digital Lead Set connectors are fragile. Pull the connector base, not the wire. Never bend the connectors.**

Channel Groupings

Each 18 channel lead set is divided into two physical groups of 9 and each group is bundled with a plastic separator.

MS-250 Mixed Signal Oscilloscope Option

Note: The grouping you assign to the digital lines in the software interface can be different than the physical grouping of digital lines. The physical grouping is for easy identification only of all 18 digital lines.

Connector Colors

The wires in each color group use 9 repeating colors

The color sequence corresponds to the resistor color code to make it easy to know the digital line number without having to look at the label.

Standard Output Connection
The standard terminations on the digital lead sets can be pushed directly onto 25-mil pins. MicroGrippers or NanoGrippers may also be used to probe the test circuit's pins. LeCroy provides a selection of small, medium, and large grippers for various pitch sizes. A more complete selection of adapter probes is available for most chips from Emulation Technology Inc., Yamaichi Inc., and other manufacturers.

Threshold Levels

The threshold level determines how the input signal is interpreted. The threshold level can be set in either the Digital Grouping Setup or Pattern Trigger Setup dialogs (it is the same setup, but is in two different places for operator convenience). Input voltages less than the threshold are converted to '0'. Input voltages greater than the threshold are converted to '1'.

Threshold level

Input signal

Sample points

Digitized waveform
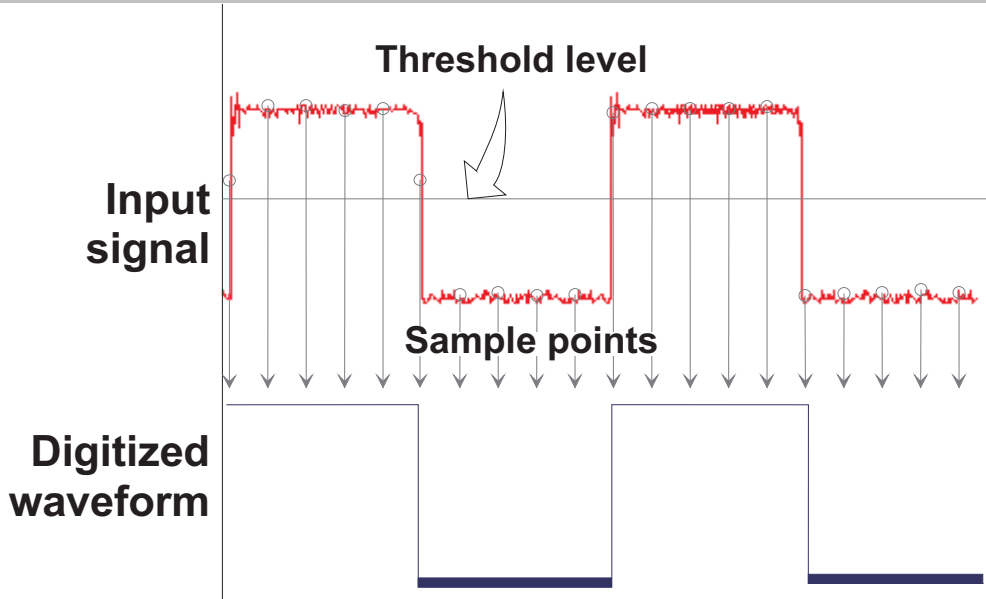
The threshold levels can be set between –10.0 V and +10.0 V. TTL circuits use a threshold voltage level of 1.58 V. ECL circuits use a threshold voltage level of -1.39 V. Other threshold settings are available in the setup dialog.

Minimum voltage swing

The minimum high voltage level is user definable by the hysteresis control up to 1.4 V above the threshold. The maximum low voltage level is user definable by the hysteresis control up to 1.4 V below the threshold. The minimum signal swing is 100 mV. The *indeterminate range* of 50 mV around the threshold voltage level is the level below which the MS-250 will not operate. However, the MS-250 *can* support a signal as low as 100 mV only if the input signal's quality is adequate.

Threshold from + 50 mV to + 1.4 V

Threshold from - 50 mV to - 1.4 V
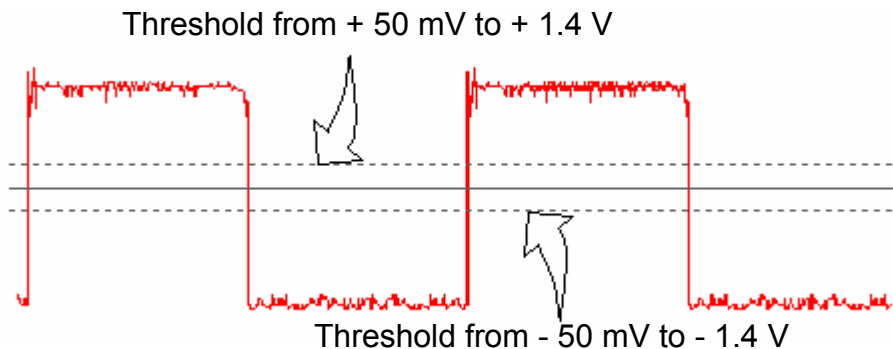
MS-250 Mixed Signal Oscilloscope Option

Basic Oscilloscope Operation

For information on using the oscilloscope to view analog signals, reference your oscilloscope on-line Help system.

ACCESSING THE MS-250 OSCILLOSCOPE MIXED SIGNAL OPTION TOOLSET

Overview

MS-250 trigger and digital line display tools are easily accessible in a variety of ways. The MS-250 option adds additional dialogs (menus) to the existing oscilloscope. These dialogs are defined below:

- Digital setup – allows set up of the Digital lines and definition/display of parallel buses. These dialogs are roughly analogous to the analog Channel setup dialogs in terms of how they are accessed and how they operate in software. However, there are no dedicated front panel controls for digital channels as there are with analog channels.

- Logic Setup – allows setup of the logic threshold value that defines the digital trace.

When the MS-250 is connected to the oscilloscope, these dialogs are conveniently accessed with just one or two touches of the screen, making adjustment fast and easy.

Oscilloscope Analog Trigger and MS-250 Digital Trigger

A standard WaveRunner or WaveSurfer oscilloscope only allows analog triggering. The addition of the MS-250 option adds enhanced triggering; the digital channels are now available in the oscilloscope trigger menu as trigger sources.
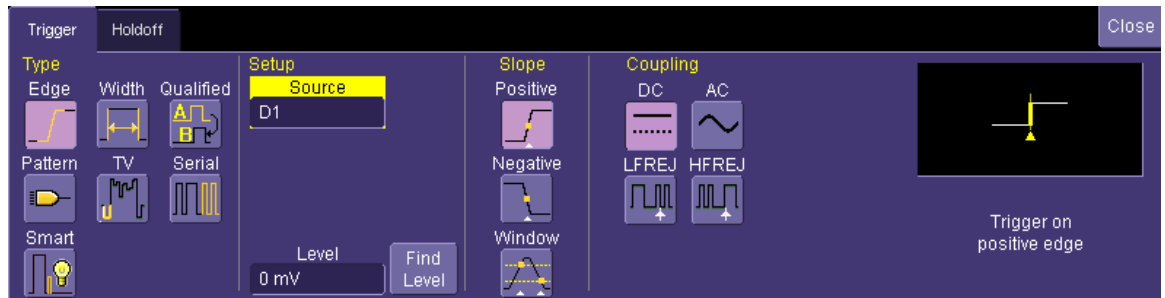
To operate the oscilloscope with a normal analog trigger, simply open the trigger dialog, and then select one of the oscilloscope channels as the source. For more information on setting up an Analog trigger, consult your oscilloscope on-line Help or Getting Started Manual.

When the MS-250 is connected to the oscilloscope, the trigger will default to Pattern Trigger, and the Pattern Trigger tab will automatically be displayed on the oscilloscope display. If you don't wish for it to be displayed, you can simply touch "Close" to close the dialog.

As a convenience to the operator, the Digital Logic Setup dialog is displayed in both the Trigger dialogs and the Digital dialogs. Logic Setup is where you can set the crossing threshold for determining whether the logic level is a 1 or a 0.

MS-250 Mixed Signal Oscilloscope Option

Other ways to access the MS-250 Trigger dialogs are listed below:

1. Touch the Trigger descriptor button. If the MS-250 is connected to the oscilloscope, the dialog will default to the Digital Trigger tab. Follow the instructions above to select either an Analog or Digital trigger.

2. Touch Trigger in the menu bar, and select Trigger Setup. Then select either an Analog or Digital trigger (as required).
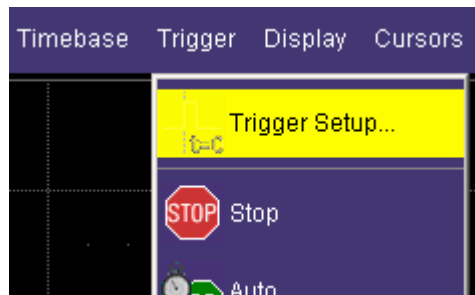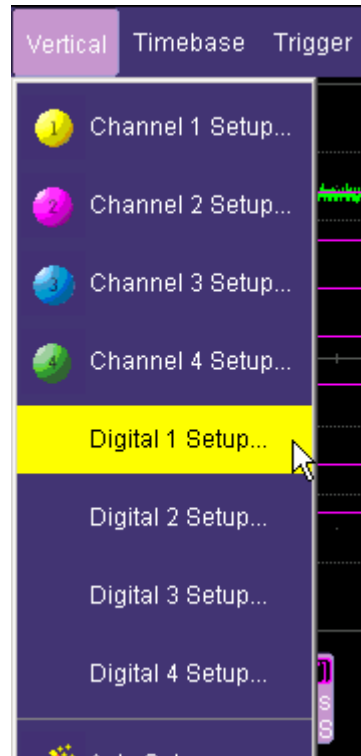

Digital Trace Groups

These dialogs provide the ability to define up to 2 different groups of digital signals, and associate from 1-18 digital lines with each group. Digital lines may be associated with more than one group. As a group, the signals can be resized, repositioned, named, stored to memory, collapsed into a bus trace/value, or moved to a different grid (WaveRunner Xi Series only).

You can access these dialogs at any other time by following the instructions below:

1. Touch Vertical in the menu bar, and select one of the four Digital traces. This will turn the Digital trace ON, and open the dialog box for that Digital trace.

2. If the Digital trace is already ON (i.e., the background color is solid), you can configure the setup dialog for that Digital trace.

3. The Digital descriptor boxes contain information about the Digital Sample Rate (top line), the maximum number of digital samples (bottom line) and the number of channels in the grouping (top right).

MS-250 Mixed Signal Oscilloscope Option
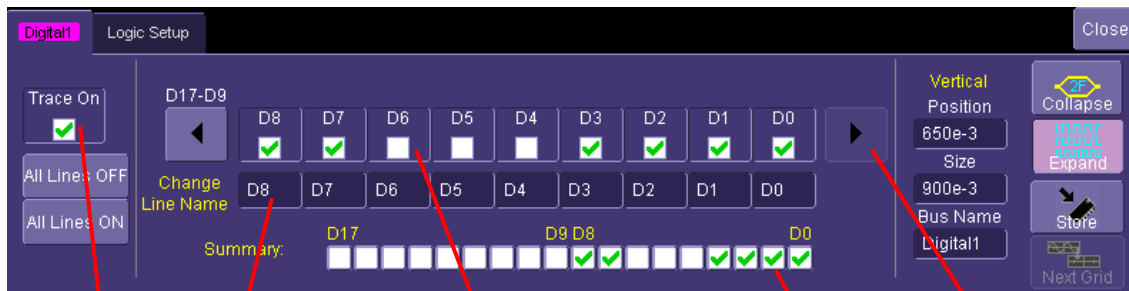
DIGITAL TRACE GROUP SETUP

Digital trace groups are very similar to analog channels – they can be turned ON or OFF, they can be increased in size, and they can be positioned on the grid. You can also store them as waveform files. In software, they are accessed through the same Vertical dialog as analog channels. Cursors and most timing measurements work with Digital traces also.

Notable differences include the lack of sampling information in the trace data, and the lack of dedicated front panel controls (though some front panel controls double as position and size controls when the Digital trace group is active).

However, Digital trace groups have capability far beyond that of an analog channel. Each Digital trace group can consist of 1-18 digital lines. You can create up to four Digital trace groups, and each digital line can be used in as many or as few groups as desired. You can choose to display the group of digital lines as individual digital traces (one per line), or as a "collapsed" bus with bus data values calculated on screen within the bus trace. Since there are so many digital lines, Digital lines or buses can be renamed so that it is easier to keep track of the multitude of digital signals on the screen.

Digital Trace Group Dialog

Below is the Digital trace group dialog with an overview of its operation:
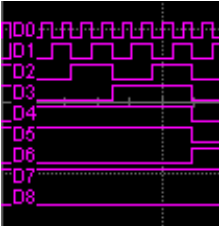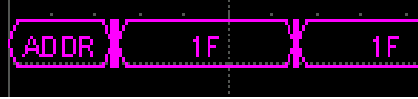
Additional capability is described in the table below:

|	
All Bits OFF All Bits ON	Provides a method to quickly turn all digital lines in the Digital trace group OFF or ON. The default is for all digital lines to be ON. As lines are turned OFF, they will automatically resize to take up more of the grid and be easier to see.
Vertical Position 650e-3 Size 900e-3	There are no dedicated front panel controls for Digital line position or size. However, you can touch these controls twice and enter in a unitless value for position and size using the pop-up keypad. Or you can touch them once, and use the front panel adjust knob to adjust the value. Another way is to make the Digital trace group "active" by touching the descriptor box once Digital1　　[18] 1.0000 GS/s 100.000 kS and then using the front panel channel controls (V/div and Offset) to adjust the position and size.
Collapse Expand	You can view a group of digital traces as individual lines (Expand mode), like this: D0 D1 D2 D3 D4 D5 D6 D7 D8 Or collapsed into a bus (Collapse mode), like this: Digital1　05　18　1D　05 Just select the appropriate button to get the view that you want.
Bus Name Digital3	You can rename the "collapsed" bus so as to more easily identify it when it is on the oscilloscope grid. For instance, if we were to name Digital1 as "ADDR", it would appear as follows on the grid:

	Where ADDR appeared on the far left side of the grid. Very long bus names can be used, but the longer the name, the more bus data will be obscured.
	You can store a Digital trace group to memory, or move it to another grid, just like you would a Channel. These controls function identically for Channels and Digital trace groups.
	Note: WaveSurfer does not have the Next Grid capability.

Digital Logic Threshold Setup

Overview

The threshold level determines how the input signal is interpreted. The threshold level can be set in either the Digital Setup or Digital Trigger Setup menus (it is the same setup, but is in two different places for operator convenience). Input voltages less than the threshold are converted to '0'. Input voltages greater than the threshold are converted to '1'.
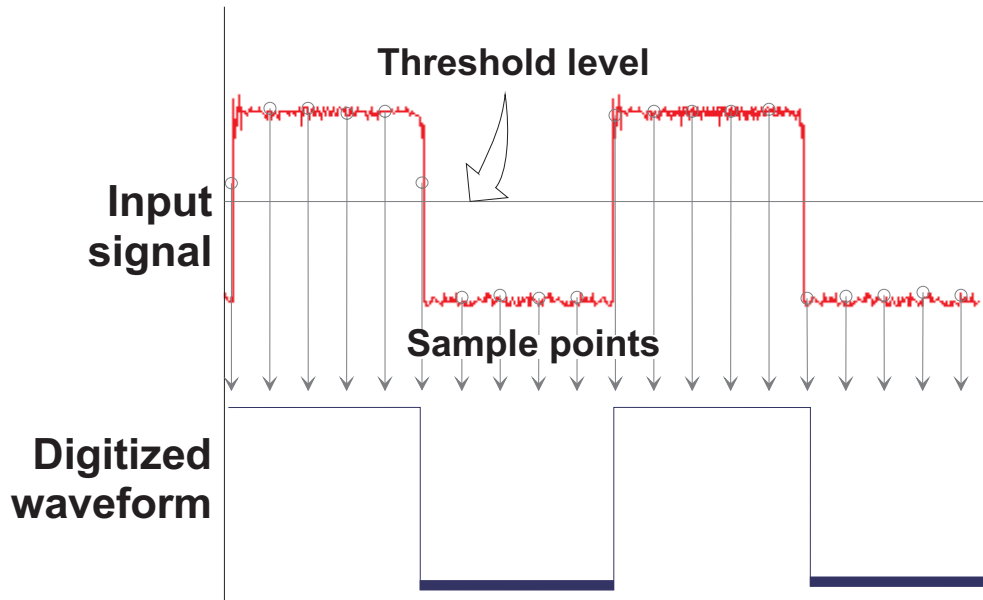
The threshold levels can be set between -10.0 V and +10.0 V. TTL circuits use a threshold voltage level of 1.58 V. ECL circuits use a threshold voltage level of -1.39 V. Other threshold settings are available in the setup dialog.

The minimum high voltage level is user definable by the hysteresis control up to 1.4 V above the threshold. The maximum low voltage level is user definable by the hysteresis control up to 1.4 V below the threshold. The minimum signal swing is 100 mV. The *indeterminate range* of 50 mV around the threshold voltage level is the level below which the MS-250 will not operate. However, the MS-250 *can* support a signal as low as 100 mV only if the input signal's quality is adequate.

Threshold from + 50 mV to + 1.4 V
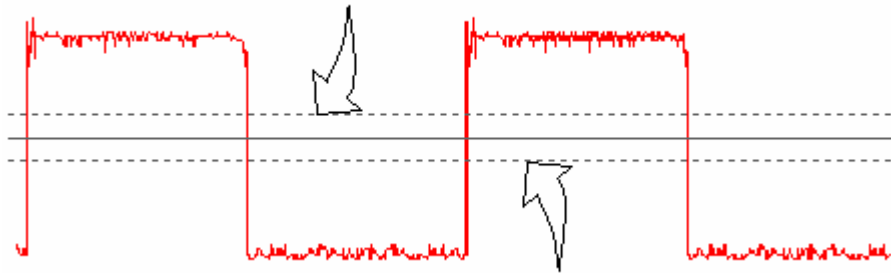
Threshold from - 50 mV to - 1.4 V

Digital Logic Setup

The Digital Logic Threshold Setup dialogs are contained in two places: in the Trigger dialogs and in the Digital Setup dialogs. A selection made in one location will affect the value in the other location. Two different logic levels can be selected: one level can be set for lines D0 to D8, and a different level can be set for lines D9 to D17. When connecting your lines, make sure that all lines with like levels are connected to the same set of 9 digital lines.

Touch the Logic Setup tab to view the dialog shown below:

You can select various Logic Families, or select User Defined and define a custom threshold crossing. Touch inside the Logic Family selection to view a selection list.

MS-250 Mixed Signal Oscilloscope Option

|	
TTL	ECL
CMOS 5V	CMOS 3.3V
CMOS 2.5V	PECL 5V
LVDS	User Defined

If you select User Defined, then you will be able to define the voltage level. Otherwise, the Voltage Level selection will be grayed out.

DIGITAL TRIGGER SETUP

Overview

MS-250 Mixed Signal Oscilloscope Option has a very powerful and flexible Digital trigger, but it is also very easy to set up for basic triggering. Connecting the MS-250 to your circuit is described in the preceding chapters. This is a requirement in order to be able to digitally trigger.

When the MS-250 option is loaded onto the oscilloscope, an additional trigger capabilities are added to the normal oscilloscope trigger. These new trigger capabilities permit you to select digital lines as the sources for your oscilloscope triggers such as Edge, Width, Glitch, Interval and Dropout. Other triggers can work as combination triggers incoproating analog and digital triggering capabilities. These triggers are Qualified (A-B Event Trigger) and Logic Pattern Trigger.
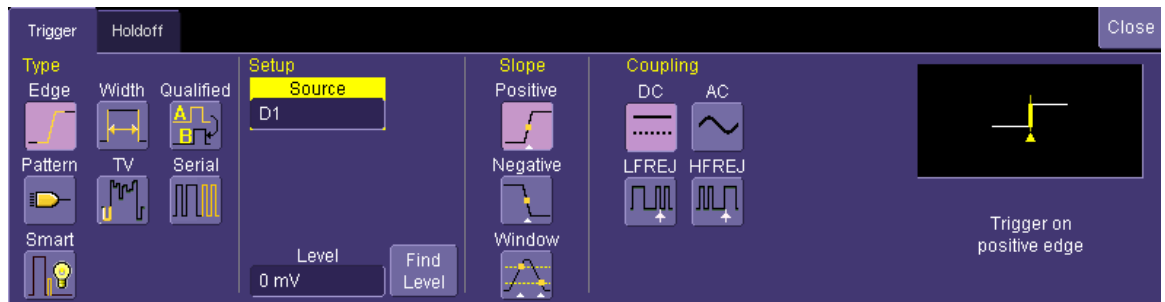
Creating a Pattern Trigger

There are two different ways to trigger digitally. They are listed below:

Logic	**Logic** – permits creation of a simple or complex analog/digital cross-pattern trigger condition with a mix of 0, 1, rising edge, falling edge, either edge, or don't care conditions on up to 4 analog channels and 18 digital lines.
LogicBus	**Logic Bus** – permits creation of a digital trigger that corresponds to a hexadecimal bus value for up to 18 digital bits.

Logic Pattern Trigger Setup

The Logic Pattern Trigger dialog, with detail on some of the setup conditions, is shown in the images that

MS-250 Mixed Signal Oscilloscope Option

follow:
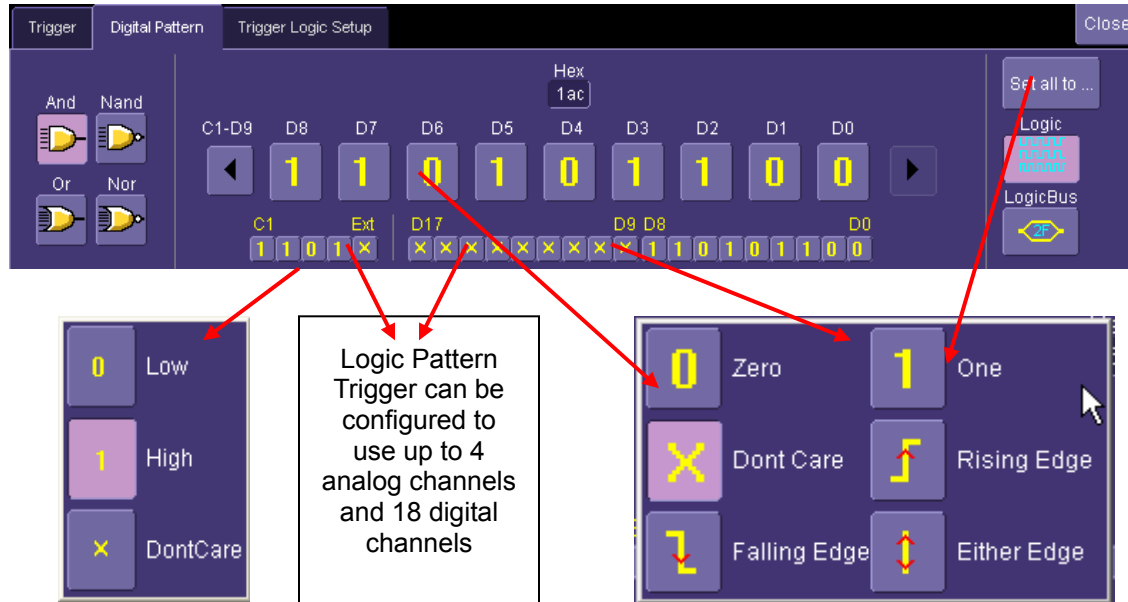
To select a value for any of the digital lines, touch the existing value (using your finger, or use a mouse pointer) to open the pop-up menu with a list of choices, and select one of the choices. Alternatively, you can set a hex value by byte (or view what the resulting hex value is). Touch the arrow buttons to scroll to the next group of eight digital lines. Note that you may set a digital line to any value in the Logic trigger setup even if it is not defined as part of a Digital group.

Note: You may set a digital line to any value in the Logic trigger setup even if it is not defined as part of a Digital group.

Note: You can set multiple digital lines to different edge conditions. However, the edge conditions will always be grouped in an OR trigger condition.

Logic Bus Trigger Setup

The Logic Bus Trigger setup dialog is shown below:
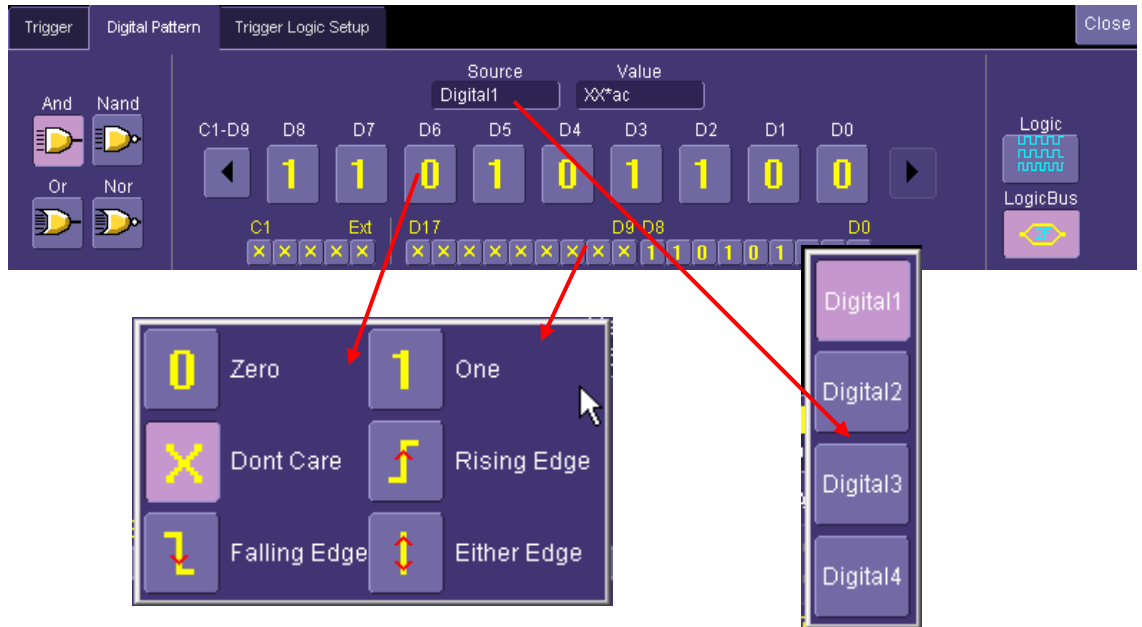
The Logic Bus trigger dialog is very similar to the Digital Logic trigger dialog. The main difference is that you have to select a Digital source (Digital1, Digital2, Digital3, or Digital4). In addition, only those bits that are defined to be part of that Digital group are allowed to be defined in the Logic Bus setup dialog. A hexadecimal data value can be entered directly, or read as a result of the binary setup.

Digital Logic Threshold Setup

The Digital Logic Threshold Setup dialogs are contained in two places ─ in the Trigger dialogs and in the Digital Setup dialogs. A selection made in one location will affect the value in the other location. Two different logic levels can be selected ─ one level can be set for lines D0 to D8 and one for lines D9 to D17. When connecting your lines, make sure that all lines with like levels are connected to the same set of 16 digital lines.

Touch the Logic Setup tab to view the dialog shown below:

MS-250 Mixed Signal Oscilloscope Option

You can select various Logic Families, or select User Defined and define a custom threshold crossing. Touch inside the Logic Family selection to view a selection list.
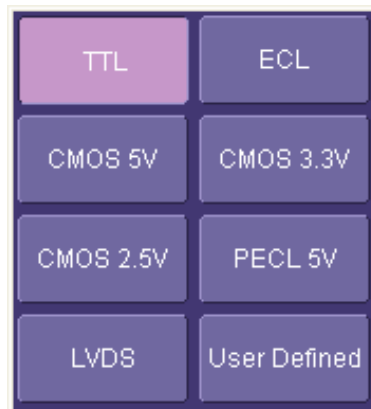
If you select User Defined, then you will be able to define the voltage level. Otherwise, the Voltage Level selection will be grayed out.

# CHARACTERIZE DIGITAL OR MIXED SIGNAL SYSTEM PERFORMANCE

Overview

The oscilloscope contains a number of built-in tools, such as cursors, measurement parameters, statistics, and optional graphical analysis tools that will allow you to characterize your DUT's performance. The number and type of these tools will change depending on whether you are using a WaveRunner or a WaveSurfer oscilloscope, and what other software options are loaded on your oscilloscope. These can be used on the Digital traces and buses just like they are used on any channel.

You may want to use cursors for making single-shot timing measurements, and measurement parameters when you need to accumulate statistical data over many different acquisitions.

Using Cursors

Use horizontal cursors to mark locations on the waveform where the time measurement should be done, then read the cursor values to establish the measurement. As necessary, adjust the timebase or create zooms of the channel(s) and the Digital trace groups so as to be able to view the signal with enough detail. This is a good method for single-shot / single measurements.
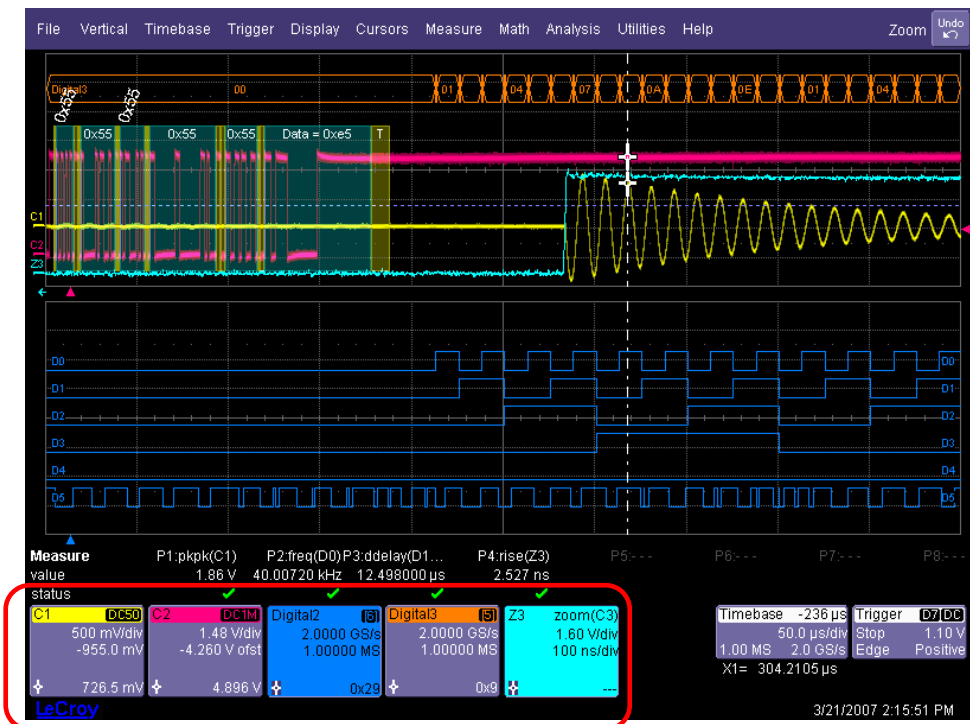
Note that when Horizontal (Time) cursors are ON, the hexadecimal bus values for each Digital trace group will appear in the Digital descriptor box

MS-250 Mixed Signal Oscilloscope Option

This can be useful when trying to measure to a specific bus value.

Using Measurement Parameters

Measurement parameters can be used to make basic timing and other measurements of your digital or mixed-signal system. Basic parameters, such as Delay, Delta Delay, Frequency, Period, Width, and Duty Cycle (not all parameters are available in WaveSurfer) can be used with a digital line as a source.

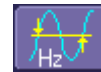**Delay –** Time from the trigger to the first transition at the 50% crossing

Delta Delay – Time between the 50% crossing of first transition of two waveforms

Duty Cycle – Percent of time data is above 50%

Frequency – Frequency of every cycle in a waveform at the 50% level and positive slope

**Period –** Period of every cycle in a waveform at the 50% level and positive slope

Width – Width measured at the 50% level (can be positive or negative slope)

Measurement Gating

Gating is available on each parameter to allow you to set a measurement window that the parameter should be active in. This allows you to eliminate unwanted portions of the acquisition from your measurement.

Select gating from the Measure dialog by selecting the tab for the appropriate measurement (P1, P2, etc.) and then setting the start and stop for the gate. Reference the oscilloscope's on-line Help for more information on how to set gating.
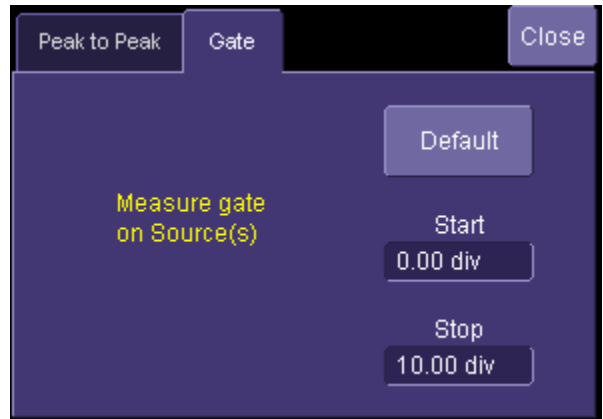
Using Statistics and Graphing

Statistics and Histicons (WaveRunner Xi only) allow you to gather numerical and visual information on the distribution of your various measurements.

You can turn on Statistics and Histicons separately in the Measure dialog. Simply touch the appropriate box to checkmark it and turn it ON; or touch it again to turn it OFF.

In addition, some optional LeCroy programs (WaveRunner 6000 only) add capability to produce larger histograms and trends of your measurement parameters. If you have this capability, then you can access it through the Measurement Parameter setup dialog (the Px tab).

MS-250 Mixed Signal Oscilloscope Option

## ISOLATE AND ANALYZE SIGNAL ACTIVITY

The combination of Analog Triggering, Digital Triggering, Analog Capture, Digital Capture, and normal oscilloscope features is a powerful combination of tools that can make it very easy to find latent HW or SW problems in your circuit. No longer is the oscilloscope a tool just for the hardware engineer. Now the software engineer can also easily visualize the mix of analog and digital signals and relate it to programming code and operation.

Some common mixed signal analysis needs and methods are discussed below:

Capture Long Pre-Trigger Time

LeCroy oscilloscopes are available with optional very long acquisition memory. For instance, for analog channels, the WaveRunner Xi oscilloscope can capture up to 12.5 Mpts on 4 channels, or 25 Mpts on 2 channels. WaveSurfer Xs oscilloscopes can capture up to 10 Mpts on 4 channels The MS-250 option adds 10 Mpts/ch of digital memory. If you wish, all this memory can be 100% pre-trigger, 100% post-trigger, or something in between.

1. Adjust Pre-Trigger and Post-Trigger time by adjusting the Delay knob on the oscilloscope's front panel.

2. Optimize your Sample Rate or Memory Length by accessing the Horizontal Dialog in your oscilloscope and selecting as follows:

    a. WaveRunner Series - either Set Max Memory mode or Fixed Sample Rate mode.

    b. WaveSurfer Series – choose a Max Number of Sample Points

3. Note that you must make sure that your timebase setting and memory length combined do not result in too low of a sample rate, or your analog and digital signals may not be acquired accurately.
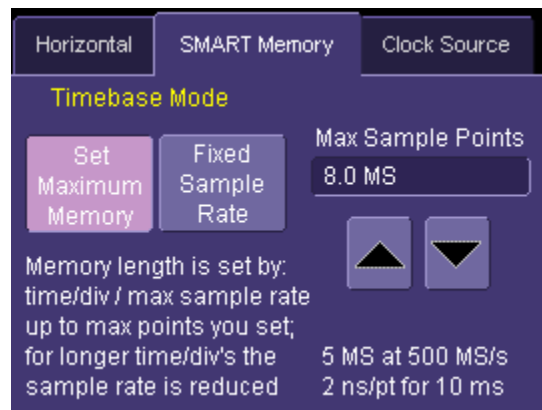
Reference your oscilloscope's on-line Help or Getting Started Manual for more information on these common settings.

Zooming on Your Waveforms

There are a number of ways to zoom a mix of analog and digital signals. The easiest method is to STOP the acquisition and then simply adjust the timebase Time/Div and Delay knobs on the front panel.
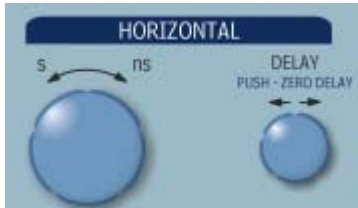
Use the Time/Div knob to change the zoom ratio, and the Delay knob to change the position.

Note: When you adjust timebase to zoom, the position adjustment is limited by the maximum pre-trigger and post-trigger delay adjustment available in your oscilloscope. Reference your oscilloscope manual for specifications for these delays.

You can also zoom by drawing a box with a mouse pointer around the area that you wish to zoom. Follow these steps:

1. Select the area you wish to zoom by "drawing a box" around it with a mouse pointer.

MS-250 Mixed Signal Oscilloscope Option

2. A 2nd grid is created with the zoomed traces. Use either the zoom control knobs (WaveRunner Xi Series) or the Vertical/Horizontal control knobs (WaveSurfer Xs Series) to adjust the vertical and horizontal scale and position. Reference your oscilloscope operator's manual for more information.

Reference your oscilloscope's on-line Help or Getting Started Manual for complete information on zooming.

APPENDIX A – SPECIFICATIONS

Digital Channels	
Number	18
Memory	10 Mpts/Ch
Probe Inputs	100 kΩ || <5.0 pF
Threshold Levels	TTL, ECL, CMOS (2.5, 3.3, 5 V), PECL, LVDS or User Defined.
Sampling Rate	1 kS/s to 1 GS/s
Maximum Input Voltage Range	± 30 V non-destruct (See voltage derating curve on next page)
Minimum Input Voltage Range	±50 mV around the threshold voltage setting
Digital Channel Grouping	4 digital groups can be defined. Each group may use any combination of 18 digital lines. Groups can be displayed as individual lines, or collapsed into a bus view.
Triggering	User selectable analog (i.e., std. oscilloscope trigger) or digital trigger
Digital Trigger	
Setup Type	Logic Pattern or Logic Bus
Logic Setup	Up to 18 digital lines, with any combination of 0, 1, or X (don't care). In addition, a Rising Edge, Falling Edge, or Either Edge condition may also be set (note: multiple edges are OR combined).
Logic Bus Setup	Up to 18 digital lines, defined in hexadecimal format
Accuracy	+/-1 ns
Certifications	CE Approved. Conforms to EN61326-1 and EN61010-1 (Refer to Declaration of Conformity Page for additional details)
Physical	
Pod Dimensions	4.25" x 8.375" x 1.5" (10.8 x 21.2 x 3.8 cm) (W x L x D)
Pod Weight	1.7 lbs (.775 kg)
Complete Kit	18" x 13.25" x 4.25" (45.75 x 33.65 x 10.795 cm) (W x L x D)

MS-250 Mixed Signal Oscilloscope Option

Max. V$_{IN}$ versus Frequency
Note: Max V$_{IN}$ < 30V (DC + Peak AC)

§ § §