TELEDYNE LECROY
Everywhereyoulook™

Operator's Manual

MS-500 Mixed Signal Oscilloscope Option

MS-500

Mixed-Signal Oscilloscope Option

Operator's Manual

January 2013

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 MS 500 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.

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Welcome

Thank you for purchasing a Teledyne LeCroy MS-500.

The MS-500 Mixed Signal Oscilloscope Option is a powerful solution for the challenge of measuring multiple, mixed signals in a single oscilloscope. An enhancement to the Teledyne LeCroy oscilloscopes, the MS-500 extends their testing range by adding 18 or 36 digital channels for display or triggering.

The MS-500 is ideally suited for embedded controller testing where there is a proliferation of analog signals coincident with digital signals. Users can easily debug signals using standard oscilloscope tools such as cursors, measurement parameters, and zooming. Both oscilloscopes compatible with the MS-500 feature large, bright color displays to facilitate signal viewing, plus all the connectivity and documentation capabilities needed to quickly record and distribute information.

The MS-500 and MS-500-36 are identical except the MS-500-36 standard configuration is for 36 channels. The MS-500-36 can be operated in 36 or 18 channel mode for higher performance. The MS-500 is configured as an 18 channel instrument and can be upgraded with an additional lead set to support 36 channels. Both are referred to as MS-500 in this manual.

This MS-500 manual assumes that you have a basic understanding of discrete electronics, logic analyzers, and Teledyne LeCroy oscilloscopes, specifically the model you will use with the MS-500. When necessary, details on specific oscilloscope features are included in this manual.

Contact your nearest Teledyne LeCroy customer service center or national distributor if anything is missing or damaged. We can only be responsible for replacement if you contact us immediately.

Sincerely,

David C. Graef

Teledyne LeCroy Corporation
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.

ELECTROSTATIC DISCHARGE (ESD) HAZARD. Susceptible to damage if anti-static measures are not taken.

DOUBLE INSULATION

Precautions

Connect and disconnect properly.

Do not overload. To avoid electric shock or fire, do not apply any potential to the signal leads that exceeds the maximum rating of the instrument. Refer to Specifications section of the manual for details.

Comply with voltage derating curve. When measuring higher frequency signals, comply with the Voltage vs. Frequency Derating Curve, contained in the Specifications section of the manual.

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 operate with suspected failures. Do not use the product if any part is damaged. Cease operation immediately and sequester the instrument from inadvertent use.

Operating Environment

Temperature: 5 to 40 °C

Humidity: Maximum relative humidity 80% (non-condensing) for temperatures up to 31° C decreasing linearly to 50% relative humidity at 40° C

Altitude: Up to 2,000 m

Cleaning

Clean only the exterior of the instrument 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.

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

Returning a Product for Service or Repair

If you suspect that you have a problem with the MS-500, you should first contact your local Teledyne LeCroy service center so that they can ascertain whether this component is defective.

If you need to return a Teledyne LeCroy product, provide model identification by providing the model name and serial number, 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 are your responsibility.

Products under warranty are then returned to you with transport prepaid by Teledyne LeCroy. Outside the warranty period, you provide us with a purchase order number before the work can be done. You are also billed for parts and labor related to the repair work and shipping.

It is highly recommended to prepay return shipments and use air freight. Teledyne LeCroy cannot accept COD (Cash On Delivery) or Collect Return shipments.

Technical Support

You can get assistance with installation and operation from your customer service center. Visit the Teledyne LeCroy Web site at teledynelecroy.com for the center nearest you.

Staying Up-to-Date

Your MS-500 hardware does not need periodic calibration.

Teledyne 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-500 specific software may be periodically updated. You can download firmware and software updates from the Teledyne LeCroy website.

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. These differences should not affect your understanding of correctly operating the MS-500.

Standard Equipment

MS-500 Standard Hardware

The Standard Hardware consists of the following items:

- Qty. 1 **Mixed Signal Oscilloscope Option** – Provides 18 or 36 channel digital acquisition and triggering.

- Qty. 1 **16" (40.64 cm) Digital Lead Set** – Interfaces the MS-500 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 Teledyne LeCroy, and may be connected to the lead set. (Qty.2 provided with MS-500-36)

  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 **Teledyne 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 **Operator's Manual**

The MS-500 Software

The standard MS-500 software adds the following capability to the Teledyne LeCroy oscilloscope software dialogs:

- **Analog, Digital and Combination Trigger Modes** – Allows you to choose whether 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-500 Hardware and Software requires no traceable calibration or adjustment. However, the oscilloscope used with the MS-500 does require periodic calibration and adjustment.

Accessories

The following accessories are also available for use with the MS-500.

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

- **MSO-DLS-36 16"** (40.64 cm) Digital Lead Set – An additional 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. Adding this to the MS-500 enables 36 channels. Inputs are labeled D18 – D35

- **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.

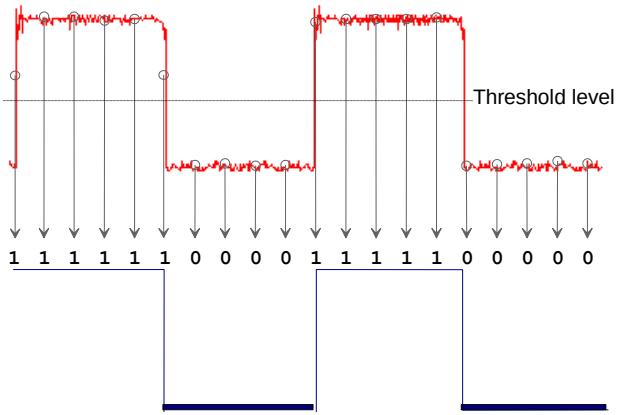
- **MSO-MICTOR** – Mictor Connection cable, 16" (40.64 cm), 36 channel connector.
- **MSO-3M** - Interconnect cable, 16" (40.64 cm) mates with 3M connectors, 2520-6002 and 25205002..

Description of Operation

The various components of the MS-500 Mixed Signal Oscilloscope Option 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-500 is an external device that digitally samples waveform data at up to 2 GS/s (for 500 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-500 repeatedly samples each digital channel's voltage level. If the voltage is greater than the threshold voltage, the MS-500 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 100 mV 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 cancels the acquisition, which leaves the previously acquired data unchanged.

The MS-500 both samples incoming data and searches for trigger conditions.

The USB2.0 cable provides downloading of trigger conditions from the oscilloscope to the MS-500 and uploading of digital data from the MS-500 to the oscilloscope.

Getting Started with the MS-500

Overview

The MS-500 is a complete system that interfaces with 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-500. 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 intuitive connection steps are documented here.

Operation of the specific Teledyne LeCroy 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 MS-500 to the Oscilloscope

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

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

3. Connect the other end of the Teledyne LeCroy Bus cable to the MS-500 and fasten the thumb screws.

4. Connect the other end of the USB2.0 Cable to the MS-500.

5. Connect the Digital Lead Set to the other end of the MS-500 (labeled Digital Inputs, D0 – D17) and fasten the thumb screws. For MS-500-36 repeat this process with the lead set labeled D18 – D35.

NOTE: Each digital line has a ground connection for optimal performance. Two additional ground leads common to the whole lead set are also available.

6. 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 Connection to Oscilloscope and 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.

When your system is connected properly it looks like the following photo:

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

CAUTION. Handle with care! The MS-500 Digital Lead Set connectors are fragile. Pull the connector base, not the wire. Never bend the connectors.

Digital Connections

Channel Groupings

Each 18 channel lead set is divided into two physical groups of 9 and each group is bundled with a plastic separator. When using 36 channels there are 4 groups of 9 leads.

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 intended for easy identification of all 18 digital lines.

Connector Colors

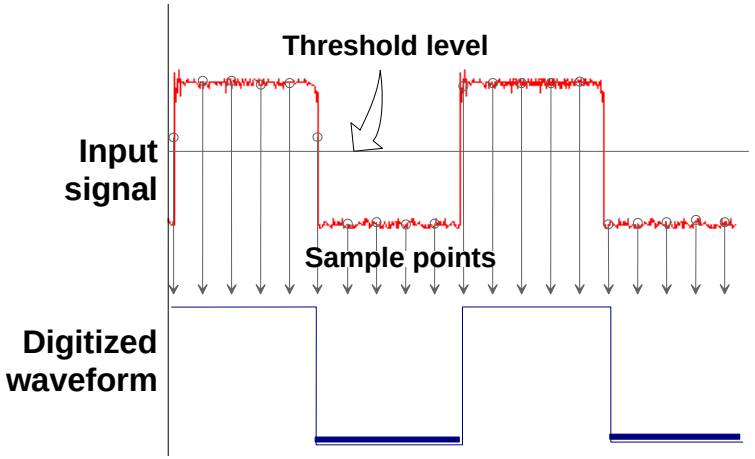
The wires in each color group use 9 repeating colors. The color sequence corresponds to the resistor color code making it easier to know the digital line number without having to look at the label.

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. Teledyne 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

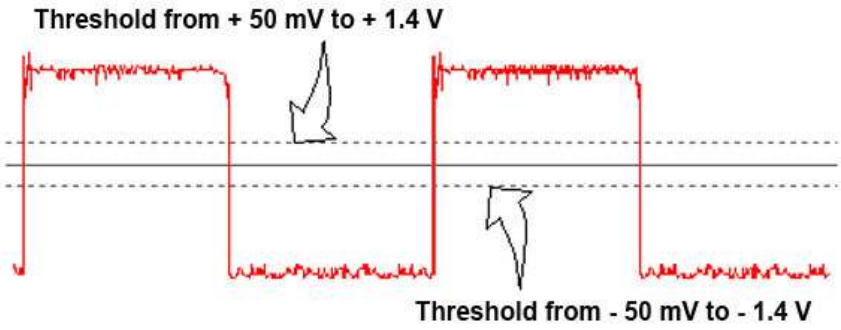
The threshold level determines how the input signal is interpreted. The threshold level can be set in either the Digital Grouping Setup or Pattern Trigger Setup dialogs (it is the same setup, but is in two different places for operator convenience). Input voltages less than the threshold are converted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



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-500 will not operate. However, the MS-500 *can* support a signal as low as 100 mV only if the input signal's quality is adequate.



Accessing the MS-500 Toolset

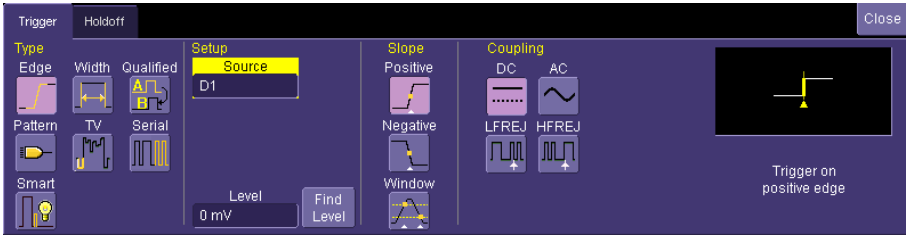
MS-500 trigger and digital line display tools are easily accessible in a variety of ways. The MS-500 option adds additional dialogs (menus) to the existing oscilloscope. These dialogs are defined as:

- **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 the 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-500 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-500 Digital Trigger

The addition of the MS-500 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.

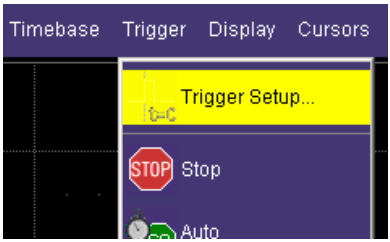
When the MS-500 is connected to the oscilloscope, the trigger type defaults to Pattern Trigger, and the Pattern Trigger tab is automatically displayed on the oscilloscope display dialog. If desired, touch the **Close** button to not display the dialog.

For convenience, 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.

Other ways to access the MS-500 Trigger dialogs include:

- Touching the Trigger trace descriptor label. If the MS-500 is connected to the oscilloscope, the dialog defaults to the Digital Trigger tab. Follow the previous instructions to select either an Analog or Digital trigger.

- Touching **Trigger → Trigger Setup** on the menu bar. Then select either an Analog or Digital trigger (as required).



Digital Trace Groups

These dialogs provide the ability to define up to 4 different groups of digital signals, and associate from 1-36 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 by touching **Vertical** on the menu bar, and select one of the four Digital traces.

This turns the Digital trace ON and opens the corresponding dialog box.

If the Digital trace is already ON, the trace descriptor label is highlighted and you can configure the setup dialog for that Digital trace.

The Digital trace descriptor labels 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)

Digital Trace Group Setup

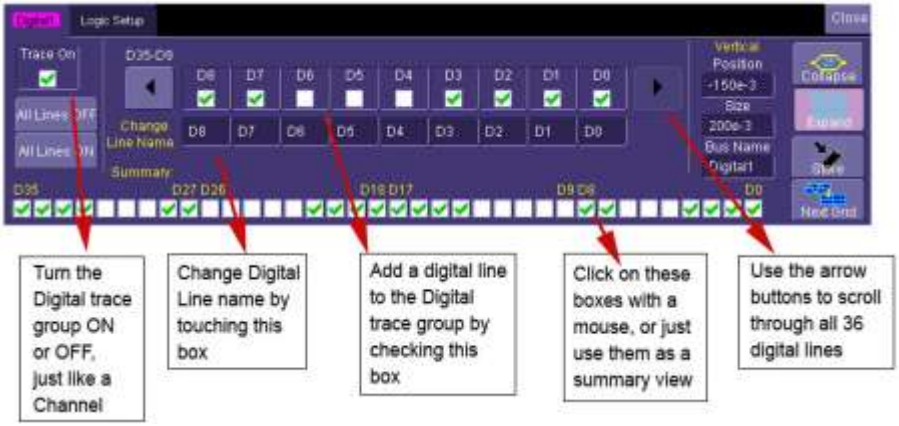
Digital trace groups are very similar to analog channels – they can be turned ON or OFF, they can be increased in size, and they can be positioned on the grid. You can also store them as waveform files. In software, they are accessed through the same Vertical dialog as analog channels. Cursors and most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

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 1-36 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

The following image shows the Digital trace group dialog with an overview of its operation:

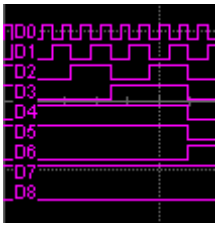


Provides a method to quickly turn all digital lines in the Digital trace group OFF or ON. The default is for all digital lines to be ON. As lines are turned OFF, they automatically resize to take up more of the grid and be easier to see.

There are no dedicated front panel controls for Digital line position or size. However, you can touch these controls twice and enter in a unit-less 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 activate the Digital trace group by touching the trace descriptor label once and then using the front panel channel controls (V/div and Offset) to adjust the position and size.

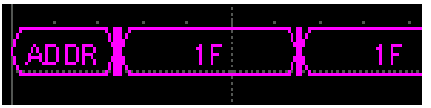
You can view a group of digital traces as individual lines (Expand mode), like this:



Or collapsed into a bus (Collapse mode), like this:

Just select the appropriate button to get the view that you want.

You can rename the collapsed bus for easier identification from the oscilloscope grid. For instance, if we were to name Digital1 as **ADDR**, it would appear as follows on the grid:

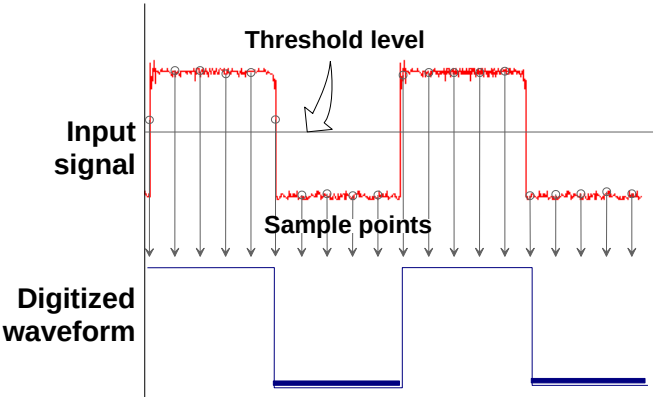


Where ADDR appeared on the far left side of the grid. Very long bus names can be used, but the longer the name; the more bus data is obscured.

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.

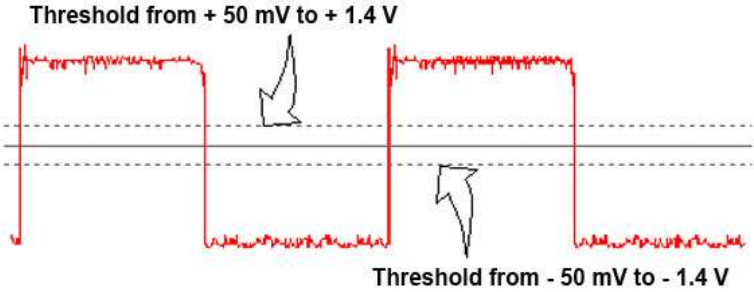
Digital Logic Threshold Setup

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-500 will not operate. However, the MS-500 can support a signal as low as 100 mV only if the input signal's quality is adequate.



The Digital Logic Threshold Setup dialogs are contained in both the Trigger dialogs and in the Digital Setup dialogs. It is important to note that a selection made in one location does affect the value in the other. Up to four different logic levels can be selected: levels can be set for lines D0 to D8, D9 to D17, D18 to D26 and D27 to D35. When connecting your lines, make sure that all lines with like levels are connected to the same set of 9 digital lines.

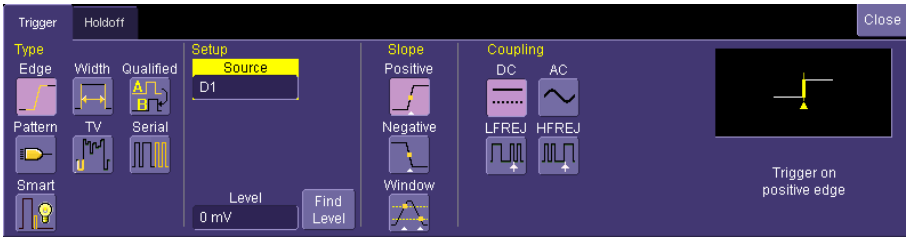
Touch the Logic Setup tab to view the following dialog:

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 are able to define the voltage level. Otherwise, the Voltage Level selection is grayed out.

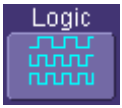
Digital Trigger Setup

When the MS-500 option is loaded onto the oscilloscope, 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 incorporating 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 as follows:



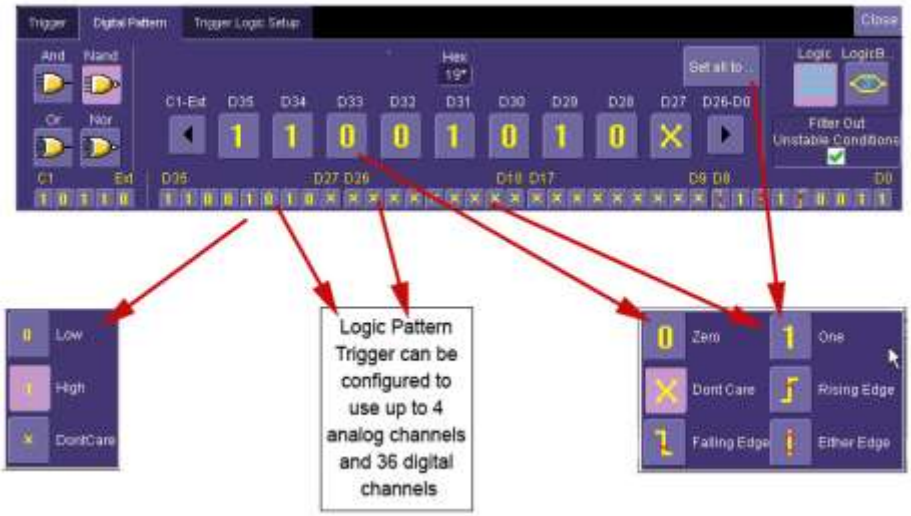
Logic – permits creation of a simple or complex analog/digital cross-pattern trigger condition with a mix of 0, 1, rising edge, falling edge, either edge, or don't care conditions on up to 4 analog channels and 18 digital lines.

Logic Bus – permits creation of a digital trigger that corresponds to a hexadecimal bus value for up to 18 digital bits.

Filter Out Unstable Conditions – Use this filter to ignore short glitches in logic state triggers that last less than 3.5ns. If the box is unchecked all logic states are shown. This filter is enabled by default

Logic Pattern Trigger Setup

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



Select a value for any of the digital lines by touching the existing value (using either your finger or a mouse), opening the pop-up menu with a list of choices, and then selecting one of the choices. Alternatively, you can set

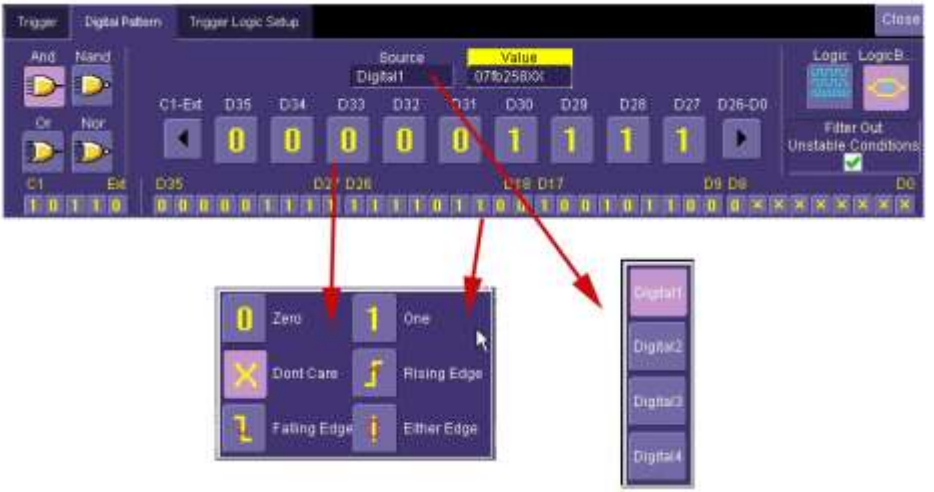
a hex value by byte (or view what the resulting hex value conversion). Touch the arrow buttons to scroll to the next group of eight digital lines. Note that you may set a digital line to any value in the Logic trigger setup even if it is not defined as part of a Digital group.

PLEASE NOTE THE FOLLOWING:

- 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.
- You can set multiple digital lines to different edge conditions. However, the edge conditions are always grouped in an OR trigger condition.

Logic Bus Trigger Setup

The Logic Bus Trigger setup dialog is shown as follows:



The Logic Bus trigger dialog is very similar to the Digital Logic trigger dialog. The main difference is that you must select a Digital source (Digital1, Digital2, Digital3, or Digital4). In addition, only those bits that are defined as part of that Digital group can 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 located on both the **Trigger** and **Digital Setup** dialogs. It is important to note that a selection made in one location does affect the value in the other. Four different logic levels can be selected. One level can be set for each of the four groups D0 to D8, D9 to D17, D18 to D26, and D27 to D35. When connecting your lines, make sure all lines with like levels are connected to the same set of 9 digital lines

Touch the **Logic Setup** tab to view the following dialog:

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, voltage level can be defined. Otherwise, the Voltage Level selection is 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 allow you to characterize your DUT's performance. The number and type of these tools change depending on the Teledyne Leroy oscilloscope you are using and what other software options are loaded on your instrument. The tools 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 to view the signal with enough detail. This is a good method for single-shot / single measurements.

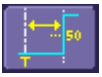
NOTE : When Horizontal (Time) cursors are ON, the hexadecimal bus values for each Digital trace group appear on the Digital trace descriptor label.

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

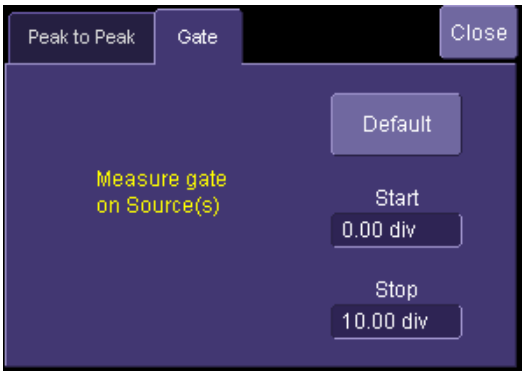
Period – Period of every cycle in a waveform at the 50% level and positive slope

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

Measurement Gating

Gating is available on each parameter so you can set a measurement window in which the parameter should be activated. 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 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 Teledyne LeCroy programs 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)

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. The oscilloscope is no longer a tool only for hardware engineers. Now software engineers can easily visualize the mix of analog and digital signals and relate it to programming code and operation.

Following are some common mixed signal analysis needs and methods.

Zooming 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 of 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.

2. A second grid is created of the zoomed traces. Use either the **Zoom** control knobs or the **Vertical/Horizontal** control knobs 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.

Reference

Certifications

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

EMC Compliance

EC Declaration of Conformity - EMC

The instrument 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.

Electromagnetic Emissions:

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

Electromagnetic Immunity:

EN 61000-4-2:2001 Electrostatic Discharge, 4 kV contact, 8 kV air, 4 kV vertical/horizontal coupling planes [3]

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 [3]

1 Emissions which exceed the levels required by this standard may occur when the leads are connected to a test object.

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

3 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.

European Contact:

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

AUSTRALIA & NEW ZEALAND DECLARATION OF CONFORMITY—EMC

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

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 instrument 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

EN 61010-031/A1:2008 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test.

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)

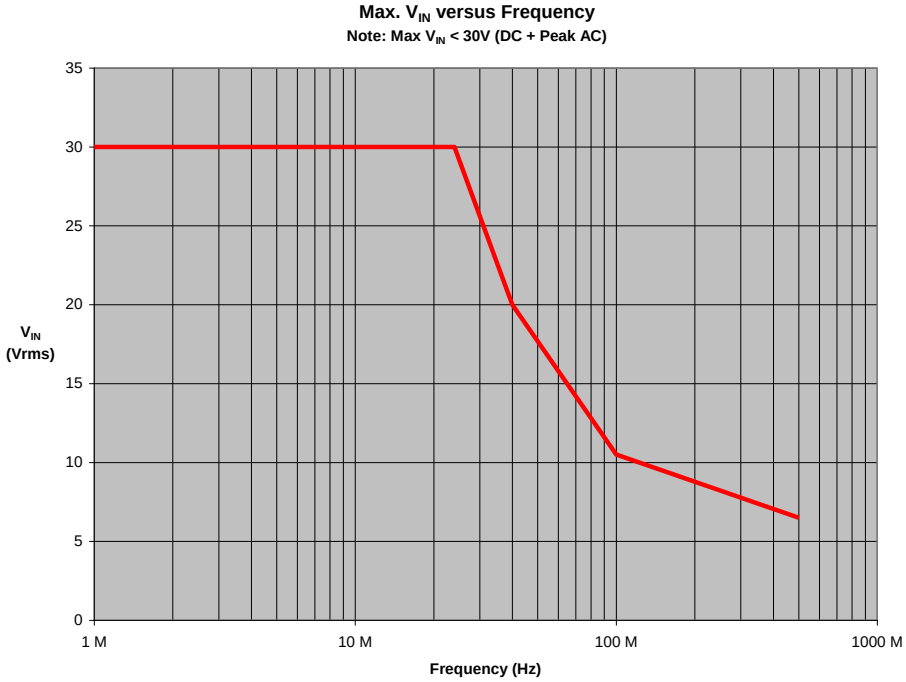
This instrument has been classified as Industrial Monitoring and Control Equipment and is outside the scope of the 2011/65/EU RoHS Directive until 22 July 2017 (per Article 4, Paragraph 3).

Specifications

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)

Digital Channels	
Number	18
Memory	50 Mpts/Ch (25 Mpts/Ch) (10 Mpts/Ch when used with WaveSurfer Xs)
Probe Inputs	100 kW || <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 2 GS/s (1 GS/s maximum sampling rate on 36 channels).
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 36 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 (typical)
Setup Type	Logic Pattern or Logic Bus



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