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Operator's Manual

MS-250 Mixed Signal
Oscilloscope Option

MS-250 Mixed Signal Oscilloscope Option Operator's Manual

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Introduction

The MS-250 Mixed Signal Oscilloscope Option is a complete system that adds digital acquisition and triggering capabilities to a Teledyne LeCroy oscilloscope.

Once properly connected to the oscilloscope and the device under test, you will be able to use the oscilloscope user interface for the following:

- **Digital Logic Control**: Set the logic threshold and hysteresis for each lead bank, choosing from standard logic families or entering a custom setting.

- **Digital Group Management**: Combine individual digital lines into bus groups to be managed together. Give lines descriptive logical names, regardless of the physical lead number.

- **Digital Analysis**: Display digital signals as single line traces or collapsed bus traces. Many of the same tools available for analyzing analog signals may be applied to digital signals.

- **Digital and Combined Triggering**: Choose to set an acquisition trigger on a digital signal pattern or a combination of conditions using both analog and digital signals.

The MS-250 is ideally suited for embedded controller testing where there is a proliferation of analog signals coincident with digital signals. You can easily debug signals using standard oscilloscope tools such as cursors, measurement parameters, and zooming. Oscilloscopes compatible 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.

Technical Overview

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, but it does not require the user to input a clock.

The USB 2.0 connection downloads the trigger setup from the oscilloscope and uploads digital data from to the oscilloscope.

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While in SINGLE, NORMAL, or AUTO trigger mode, the MS-250 repeatedly samples each digital channel's voltage level. If the voltage is above the threshold, the MS-250 stores a 1 in internal memory; if it is below threshold, a 0 is stored.
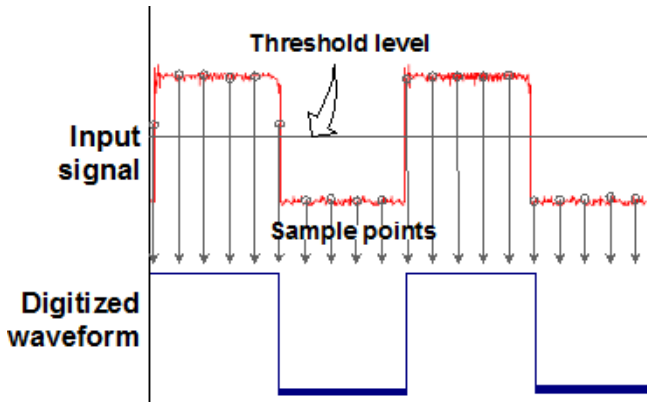
Figure 1. MS-250 sampling.

The MS-250 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 USB 2.0 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 displayed on the oscilloscope 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.

Standard Hardware

The MS-250 is delivered with the following hardware in a carrying case:

Part	Description	QTY
Mixed Signal Accessory	Provides 18-channel digital acquisition and triggering.	1
16" Digital Leadset	Connects the MS-250 to the device under test. The lead set terminates in a 25 mil pin socket. Micro-grippers of various sizes that may be connected to the lead set are available as accessories from Teledyne LeCroy, The lead set is divided into two banks. Each lead is color-coded to the resistor color-coding standard and has an individual ground connection. In addition, there are two common ground leads available for use.	1

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Part	Description	QTY
Bus Cable	1.3 m cable connects the Mixed Signal Accessory to the main oscilloscope unit for timebase synchronization, cross-triggering and power. Includes USB 2.0 cable. 	1
3" Flexible Ground Lead	Lead for grounding individual digital inputs 	5
Ground Extender	Connects to ground port of any digital input and makes a simple signal and ground connection to a 0.1" square pin header. 	20

Accessories

You may purchase these optional accessories separately:

Accessory	Part Number	Description
Digital Leadset	MSO-DLS-18	Additional 16" leadset for inputting lines D0-D17. This can be useful if you have more than one device under test and don't wish to disconnect/reconnect leads.
Large Gripper Probe Set	PK400-1	Large gripper probe set for 0.10 inch (2.54 mm) pin pitch. Includes 10 probes with color-coded leads.
Medium Gripper Probe Set	PK400-2	Medium gripper probe set for 0.04 inch (1.00 mm) pin pitch. Includes 10 probes with color-coded leads.

Accessory	Part Number	Description
Small Gripper Probe Set	PK400-3	Small gripper probe set for 0.008 inch (0.2 mm) pin pitch. Includes 10 probes with color-coded leads.
Mictor Cable	MSO-MICTOR	Mictor Connection cable, 16" (40.64 cm), 36 channel connector
Interconnect Cable	MSO-3M	Interconnect cable, 16" (40.64 cm), mates with 3M connectors 2520-6002 and 2520-5002.

Connecting the Mixed Signal Device

Connecting the Unit

To connect the Mixed Signal accessory to your oscilloscope:

1. Connect the Bus Cable to the LBUS connector on the oscilloscope. Be sure the head is turned so that the positioning wedge fits into the groove at the top of the connector. Fasten the thumb screws.

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

3. Connect the other end of the Bus Cable to the MS-250. Again, be sure to align the wedge and the groove. Fasten the thumb screws.

4. Connect the other end of the USB 2.0 Cable to the MS-250.

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5. Connect the Digital Leadset to the Digital Inputs D0 – D17 connector on the opposite end of the MS-250 and fasten the thumb screws.

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

Connecting Digital Leads

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

Each 18-channel lead set is divided into two physical banks of 9 leads, and each bank is bundled with a plastic separator.

Each lead bank (D0-D7, D8-D15, etc.) will share the same Logic Family (or custom logic Threshold), regardless of how the individual lines are assigned to digital bus groups.

The leads in each bank 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.

The standard terminations on the digital leadset 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.

Digital Logic Setup

Threshold Level

The threshold level determines how the input signal is interpreted. Input voltages below the threshold are converted to 0/Low, while input voltages above it are converted to 1/High.
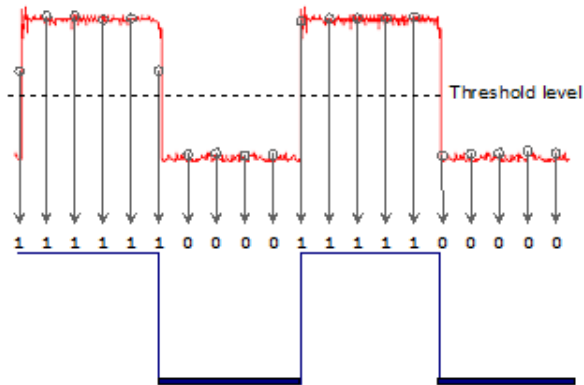
Figure 2. Threshold level determines high-low of digital waveform.

To set the logic threshold:
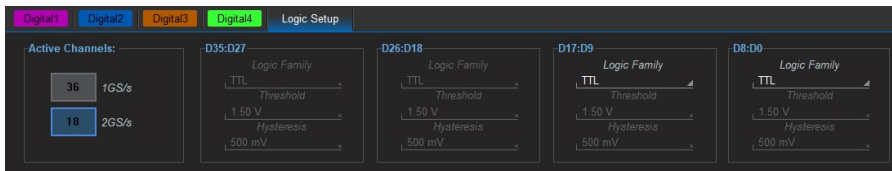
1. Choose **Vertical > Digital 1 Setup** to display the Digital*n* dialogs. Open the **Logic Setup** tab.

2. For each available lead bank, Touch **Logic Family** and either chose one of the standard families or User Defined.

    TTL circuits use a threshold voltage level of 1.58 V. ECL circuits use a threshold voltage level of -1.39 V.

3. If you chose User Defined, enter a custom **Threshold** and **Hysteresis**. Custom threshold levels can be set between −10.0 V and +10.0 V.

Minimum Voltage (Hysteresis)

You can define the minimum high and low voltage levels using the **Hysteresis** controls. Hysteresis can help prevent false determinations on variable signals. Hysteresis can be set up to 1.4 V above or below 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.
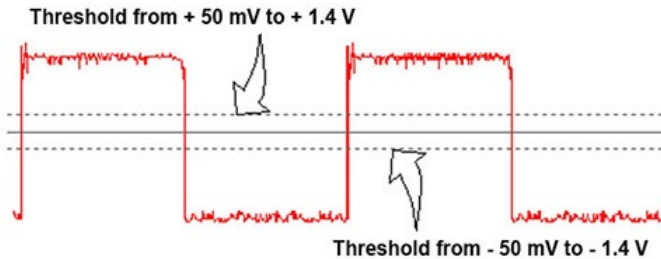
Figure 3. Use hysteresis minimums to prevent false determinations.

Digital Group Setup

This procedure organizes the digital lines into groups, which correspond to buses. The lines within a single group can be displayed individually or collapsed into a Bus trace.

You can set up a total of two, distinct groups: Digital1 and Digital2. Each group is designated by its own Digital setup dialog.

Any lines from any lead bank can be combined into a single group, and individual lines can be assigned to as many groups as you wish.
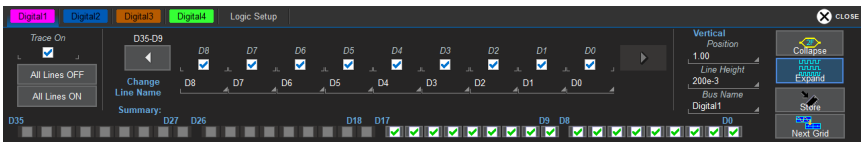
NOTE: While lines can be combined in any way, each lead bank can only have a single logic setup, so be aware of that when choosing lines.

1. Choose **Vertical > Digital 1 Setup** to open the Digital*n* dialogs.

2. Open the dialog for the group you wish to configure (e.g., Digital1).

3. Check the box for each line to be added to the group. If a line is in a bank other than the one displayed, touch the left or right arrow buttons until that bank is shown on the dialog.

   Use the All Lines Off and All Lines On buttons to quickly deselect/select the entire bank.

TIP: Along the bottom of the dialog is an indicator for each line in all the lead banks. As you add lines to the group, the indicator is checked, so you can always see all the lines currently in the group. You can also use these checkboxes to select lines.

Displaying Digital Traces

The **Trace On** checkbox is selected by default, so if you are connected to a live input, you should see digital traces appear as you add lines to the group.

To turn off the trace display, clear Trace On.

⚠️ **CAUTION.** Do not use the All Lines Off or All Lines On buttons to control the display. Doing so will erase your digital group set up. Use the Trace On checkbox to show or hide the traces.

Position Traces

In **Position**, enter the number of divisions (positive or negative) relative to the zero line of the grid where the display begins. The top of the first trace appears at this position.

In **Line Height**, enter the total number of grid divisions each line should occupy. The selected traces (Line or Bus) will appear in this much space.

Individual traces are resized to fit the total number of divisions available. In the example below, each trace takes up one division.

To move the entire group of traces to another grid, touch the **Next Grid** button at the bottom right of the dialog.

Change Trace Style

When Trace On is enabled, digital Line traces show the state of each line relative to the threshold. You can also view a digital Bus trace that collapses all the lines in a group into their Hex values. At the far right of the dialog, choose to either:

- **Expand** the group into individual line traces. The size and placement of the lines depend on the number of lines, the Vertical Position and Line Height settings.

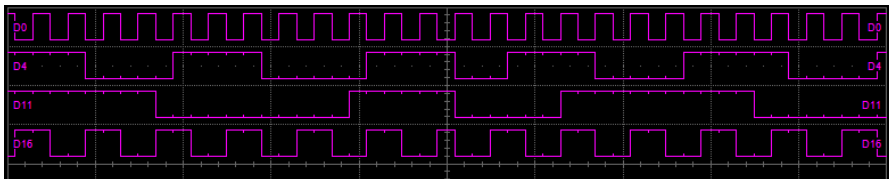- **Collapse** the group into a single bus trace.

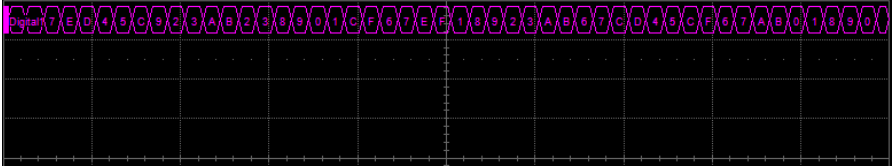*Figure 4. Digital line traces 1 division high starting at position 4 (top of grid).*

Figure 5. Digital bus trace 1 division high starting at position 4.

Store Display

To store the entire group and display setup to an internal memory, touch the **Store** button at the far right of the dialog. You can recall this setup to the grid in the future by choosing Math > Memory Setup and selecting Trace On for the respective memory.

Renaming Digital Lines

Each line can be given a unique name to make the dialogs more intuitive.

1. Touch the **D*n* button** immediately below the D*n* selection checkbox (the words "Change Line Name" appear at the far left of the row).

2. Use the virtual keyboard that appears on the touch screen to enter a new name. When finished, click **OK**.

3. The new line name now appears on the D*n* button, instead of the original line number. The number remains over the checkbox.

NOTE: The number of letters that appear will depend on the resolution of your oscilloscope display. Keep names short so lines are easily identifiable.

Digital Triggering

To access the Trigger setup dialogs, do one of the following:

- Choose **Trigger > Trigger Setup** from the menu bar

- Press the **front panel Trigger Setup** button

- Touch the **Trigger descriptor box**

The main Trigger dialog contains the trigger type selections. Other controls will appear depending on the trigger type selection.

The trigger condition is summarized in a preview window at the far right of the Trigger dialog. Refer to this to confirm your selections are producing the trigger you want.

Setting Up a Pattern Trigger

Pattern is the default trigger when the Mixed Signal accessory is connected to the oscilloscope, as these users generally wish to find and trigger upon digital logic patterns.

However, a Pattern trigger can also be set on a user-defined pattern of High or Low voltage levels in analog channels (including the External Trigger input), or a combination of digital and analog patterns when Mixed Signal capabilities are available.

Digital Pattern

On the Trigger dialog, select **Pattern** trigger type. Open the Digital Pattern dialog to display the controls.
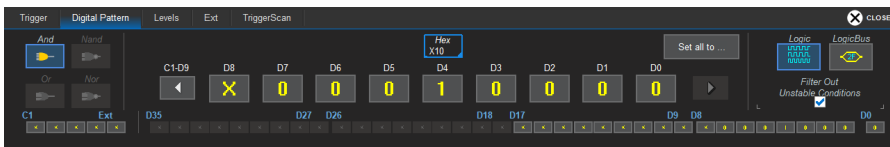
1. Open the **Digital Pattern** dialog.

2. At the far right of the dialog, choose either **Logic Bus** or **Logic**.

   The Logic Bus method simplifies pattern set up by utilizing digital groups and logic you have already defined on the Digital Setup dialogs. A digital pattern is set on a single bus (group) manually or

by applying a hexadecimal value, while the remaining lines are disabled ("Don't Care").

If you have not yet set up digital groups, you can set a digital pattern line by line using the Logic method. All available lines remain active for selection.

3. Optionally, deselect **Filter Out Unstable Conditions**. This filter ignores short glitches that last less than 3.5 ns.

4. If using Logic Bus, touch **Source** and select the digital group. Any lines that are not in this group will now be disabled.

5. To manually set the digital logic pattern, either:

- Enter the hexadecimal value of the pattern (in **Hex** or **Value**). Lines will take a logical 1, 0, or X ("Don't Care") according to the pattern. Disabled lines will remain X.

- Touch the **D*n* button** for each active line, then select whether it must be High or Low compared to the logic threshold. Depending on your selection, a logical 1 (High) or 0 (Low) now appears on the dialog. Leave X selected for any line you wish to exclude from the pattern. Use the Left and Right Arrow buttons to display lines in other digital banks.

  Alternatively, you may set edge conditions on any line. Touch the D*n* button and choose the edge. Edge conditions always assume a logical OR in the overall trigger criteria.

6. If you have not already set a logic threshold, open the **Levels dialog** and select a **Logic Family** for each digital bank from which you've selected lines. To set a custom logic threshold, choose Logic Family User Defined, then enter the **Threshold** voltage and **Hysteresis**.

NOTE: Digital lines inherit the Logic Setup made when defining digital groups. However, you can change the logic threshold on the Levels dialog, as well. The two settings are linked; they will always reflect whatever was last selected on either dialog. Logic thresholds can only be set per lead bank, not individual line.

Analog Pattern
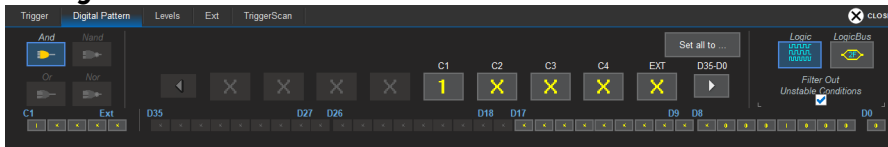
1. To add the analog pattern to the digital pattern, leave your digital pattern as is and skip to step 2.

    To create an analog-only pattern, touch **Set All To...** and select **Don't Care**. This will eliminate any meaningful digital pattern and activate all the Boolean operators.

2. Touch the **Left Arrow** button until the C1-EXT group of inputs is displayed in the main section of the dialog.

3. Touch the **C*n* button** for each input to be included in the pattern, then select whether it must be High or Low compared to the threshold Level you will set.

    Depending on your selection, a logical 1 (High) or 0 (Low) now appears on the dialog. Leave Don't Care ("X") selected for any input you wish to exclude.

    NOTE: Only the AND operator is available when combining analog and digital patterns. If all digital lines were left "Don't Care" (X), all operators would be available.

4. Open the **Levels dialog** and enter the voltage threshold for each input included in the trigger.

5. If you've included EXT as an input, open the **Ext dialog** and enter the **Attenuation**.

Setting Up a Serial Trigger

The Serial trigger type will appear on the Trigger dialog if you have installed serial data trigger and decode options. Select the Serial type, the desired Protocol, then Setup to open the serial trigger setup dialogs.
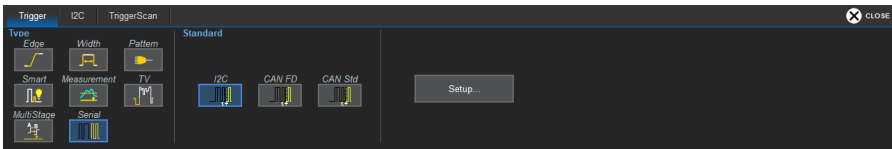
Specific instructions for each protocol are in the trigger and decode manuals at teledynelecroy.com/support/techlib under Manuals > Software Options.

NOTE: Certain software serial triggers can only be input on certain channels; the set up dialog will instruct you which channel to use. More information on the operation of serial pattern triggers can be obtained from the *High-Speed Serial Triggers Instruction Manual*.

Reference

Certifications

For the full list of current certifications, see the EC Declaration of Conformity shipped with your product.

The probe is marked with this symbol to indicate that it complies with the applicable European Union requirements to Directives 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE).

For more information about proper disposal and recycling of your Teledyne LeCroy product, visit teledynelecroy.com/recycle.

The product and its accessories conform to the 2011/65/EU RoHS2 Directive inclusive of any further amendments or modifications of said Directive.

Technical Support

For a complete list of offices by country, including our sales and distribution partners, visit:

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Returning a Product for Service

Contact your local Teledyne LeCroy service center for calibration or other service. If the product cannot be serviced on location, the service center will give you a Return Material Authorization (RMA) code and instruct you where to ship the product. All products returned to the factory must have an RMA.

Return shipments must be prepaid. Teledyne LeCroy cannot accept COD or Collect shipments. We recommend air-freighting. Insure the item you're returning for at least the replacement cost.

1. Remove all accessories from the probe.

2. Pack the probe in its case. If possible, include all tips. Do not include the manual.

3. Pack the case in its original shipping box, or an equivalent carton with adequate padding to avoid damage in transit.

4. Mark the outside of the box with the shipping address given to you by Teledyne LeCroy. Be sure to add the following:

   - ATTN:<RMA code assigned by Teledyne LeCroy>

   - FRAGILE

5. If returning **a probe to a different country:** contact Teledyne LeCroy Service for instructions on completing your import/export documents.

Extended warranty, calibration and upgrade plans are available for purchase. Contact your Teledyne LeCroy sales representative to purchase a service plan.

Warranty

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 product is warranted for normal use and operation, within specifications, for a period of one year 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.

Products not made by Teledyne LeCroy are covered solely by the warranty of the original equipment manufacturer.

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