TELEDYNE LECROY
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Instruction Manual

Decoder Software and Physical Layer Tests

for MIPI Protocols:

M-PHY
UniPro

MIPI M-PHY Decoders and Physical Layer Tests Instruction Manual

922269 Rev B
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Contents

About This Manual

Teledyne LeCroy offers a wide array of toolsets for decoding and debugging serial data streams. These toolsets may be purchased as optional software packages, or are provided standard with some oscilloscopes.

This manual explains the basic procedures for using serial data decoder software options.

This manual is presented with the assumption that:

- You have purchased and installed one of the serial data products described in this manual.
- You have a basic understanding of the serial data standard physical and protocol layer specifications, and know how these standards are used in embedded controllers.
- You have a basic understanding of how to use an oscilloscope, and specifically the Teledyne LeCroy oscilloscope on which the option is installed. Only features directly related to serial data decoding are explained in this manual.

Teledyne LeCroy is constantly expanding coverage of serial data standards and updating software. Some capabilities described in this documentation may only be available with the latest version of our firmware. You can download the free firmware update from:

teledynelecroy.com/support/softwaredownload

While some of the images in this manual may not exactly match what is on your oscilloscope display—or may show an example taken from another standard—be assured that the functionality is identical, as much functionality is shared. Product-specific exceptions will be noted in the text.

About the Options

Teledyne LeCroy decoders apply software algorithms to extract serial data information from physical layer waveforms measured on your oscilloscope. The extracted information is displayed over the actual physical layer waveforms, color-coded to provide fast, intuitive understanding of the relationship between message frames and other, time synchronous events.

About the M-PHYbus Options

The M-PHYbus D option decodes the lowest physical layers of high-speed, source synchronous interfaces based on the MIPI Alliance specification.

The M-PHYbus DP option adds a complement of physical layer test tools to the decoder. Run 12, simultaneous Clock and/or Data tests selected from a full set of MIPI conformance measurements in High Speed, Pulse Width Modulated, or System Clock Synchronous modes. This advanced set of time-saving measurement and analysis tools shows physical layer measurements and decoded protocol information side-by-side, providing correlation between the physical layer and protocol details. The combination of physical layer test and protocol decode is crucial for quickly determining the root cause of compliance failures.

The UniProbus D and DigRF v4bus D options may be installed on the same instrument as the M-PHYbus software to provide a complete MIPI debug toolset. Viewing the UniPro or DigRF v4 layers next to the time-synchronous physical layer provides a unique view that bus analyzers cannot.

An installation of SDAII or SDAIII is required to run the M-PHYbus D options.

About the UniProbus Decoder Option

The UniProbus D option provides frame- and symbol-level decoding (L1, L1.5, and L2) of MIPI waveforms across four lanes of up- and/or downstream data. Tabular results share the same colorization as the waveform decoding for a highly intuitive view of the signal down to the bit level.

Serial Decode

The algorithms described here at a high level are used by all Teledyne LeCroy serial decoders sold for oscilloscopes. They differ slightly between serial data signals that have a clock embedded in data and those with separate clock and data signals.

Bit-level Decoding

The first software algorithm examines the embedded clock for each message based on a default or user- specified vertical threshold level. Once the clock signal is extracted or known, the algorithm examines the corresponding data signal at the predetermined vertical level to determine whether a data bit is high or low. The default vertical level is set to 50% and is determined from a measurement of peak amplitude of the signals acquired by the oscilloscope. For most decoders, it can also be set to an absolute voltage level, if desired. The algorithm intelligently applies a hysteresis to the rising and falling edge of the serial data signal to minimize the chance of perturbations or ringing on the edge affecting the data bit decoding.

Note: Although the decoding algorithm is based on a clock extraction software algorithm using a vertical level, the results returned are the same as those from a traditional protocol analyzer using sampling point-based decode.

Logical Decoding

After determining individual data bit values, another algorithm performs a decoding of the serial data message after separation of the underlying data bits into logical groups specific to the protocol (Header/ID, Address Labels, Data Length Codes, Data, CRC, Parity Bits, Start Bits, Stop Bits, Delimiters, Idle Segments, etc.).

Message Decoding

Finally, another algorithm applies a color overlay with annotations to the decoded waveform to mark the transitions in the signal. Decoded message data is displayed in tabular form below the grid. Various compaction schemes are utilized to show the data during a long acquisition (many hundreds or thousands of serial data messages) or a short acquisition (one serial data message acquisition). In the case of the longest acquisition, only the most important information is highlighted, whereas in the case of the shortest acquisition, all information is displayed with additional highlighting of the complete message frame.

User Interaction

Your interaction with the software in many ways mirrors the order of the algorithms. You will:

- Assign a protocol/encoding scheme, an input source, and a clock source (if necessary) to one of the four decoder panels using the Serial Data and Decode Setup dialogs.
- Complete the remaining dialogs required by the protocol/encoding scheme.
- Work with the decoded waveform, result table, and measurements to analyze the decoding.

Decoding Workflow

We recommend the following workflow for effective decoding:

1. Connect your data and strobe/clock lines (if used) to the oscilloscope.
2. Set up the decoder using the lowest level decoding mode available (e.g., Bits).
3. Acquire a sufficient burst of relevant data. The data burst should be reasonably well centered on screen, in both directions, with generous idle segments on both sides.

   Note: See Failure to Decode for more information about the required acquisition settings. A burst might contain at most 100000 transitions, or 32000 bits/1000 words, whichever occurs first. This is more a safety limit for software engineering reasons than a limit based on any protocol. We recommend starting with much smaller bursts.

4. Stop the acquisition, then run the decoder.
5. Use the various decoder tools to verify that transitions are being correctly decoded. Tune the decoder settings as needed.
6. Once you know you are correctly decoding transitions in one mode, continue making small acquisitions of five to eight bursts and running the decoder in higher level modes (e.g., Words). The decoder settings you verify on a few bursts will be reused when handling many packets.
7. Run the decoder on acquisitions of the desired length.

When you are satisfied the decoder is working properly, you can disable/enable the decoder as desired without having to repeat this set up and tuning process, provided the basic signal characteristics do not change.

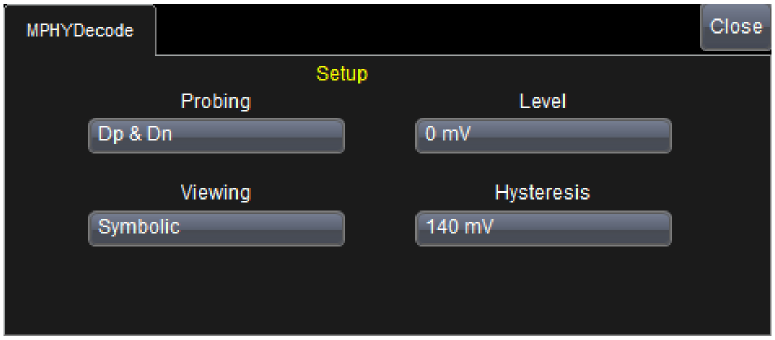
Decoder Setup

Use the Decode Setup dialog and its protocol-related subdialogs to preset decoders for future use. Each decoder can use different (or the same) protocols and data sources, or have other variations, giving you maximum flexibility to compare different signals or view the same signal from multiple perspectives.

Tip: After completing setup for one decoder, you can quickly start setup for the other decoders by using the buttons at the left of the Decode Setup dialog to change the Decode # .

1. Touch the **Front Panel Serial Decode button** (if available on your oscilloscope), or choose **Analysis > Serial Decode** from the oscilloscope menu bar. Open the **Decode Setup** dialog.
2. Select the **data source (Src 1)** to be decoded and the **Protocol** to decode.
3. If required by the protocol, also select the **Strobe** or **Clock** source. (These controls will simply not appear if not relevant.)
4. Define the bit- and protocol-level decoding on the subdialogs next to the Decode Setup dialog.

MIPI M-PHY Decoder Settings



Choose your **Probing** method, one differential probe (Ddiff) or two single-ended probes (Dp & Dn.

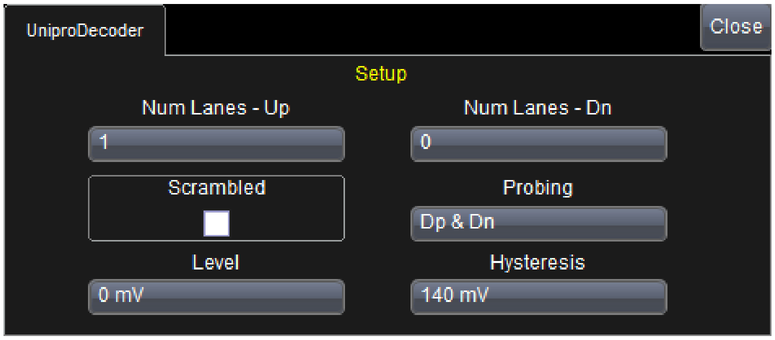
Note: The number of Source selectors on the Decode Setup dialog changes to accommodate your Probing choice. If using two probes, be sure to enter both the Dp and Dn inputs.

In **Viewing**, choose to view the extracted data in **Binary**, **Hex**(adecimal), **Symbolic**, or **Symbolic 10b** format.

Enter the voltage **Level** used to determine the edge crossings of the signal.

In **Hysteresis**, enter the amount the signal may rise or fall without affecting bit transition as a voltage value. This can help to stabilize the decoding on noisy signals.

UniPro Decoder Settings



Enter the **Num**(ber of) **Lanes - Up** and **Num**(ber of) **Lanes - Dn**.

Note: The total number of lanes is four (4). The number you may select in each field depends on your probing method. The software will enforce this limit.

Select **Scrambled** if the signal is scrambled.

Choose your **Probing** method, either one differential probe (Ddiff) or two single-ended probes (Dp & Dn).

Note: The number of Source selectors on the Decode Setup dialog changes to accommodate your Probing choice. If using two probes, be sure to enter both the Dp and Dn inputs.

Enter the voltage **Level** used to determine the edge crossings of the signal.

In **Hysteresis**, enter the amount the signal may rise or fall without affecting bit transition as a voltage value. This can help to stabilize the decoding on noisy signals.

Failure to Decode

Three conditions in particular may cause a decoder to fail, in which case a failure message will appear in the first row the the summary result table, instead of in the message bar as usual:

- **Under sampled**. If the sampling rate (SR) is insufficient to resolve the signal adequately based on the bit rate (BR) setup or clock frequency, the message "Under Sampled" will appear. The minimum SR:BR ratio required is 4:1. It is suggested that you use a slightly higher SR:BR ratio if possible, and use significantly higher SR:BR ratios if you want to also view perturbations or other anomalies on your serial data analog signal.
- **Too short acquisition**. If the acquisition window is to short to allow any meaningfull decoding, the message “Too Short Acquisition” will appear. The minimum number of bits required varies from one protocol to another, but is usually between 5 and 50.
- **Too small amplitude**. If the signal’s amplitude is too small with respect to the full ADC range, the message “Decrease V/Div” will appear. The required amplitude to allow decoding is usually one vertical division.

In each case, the decoding is turned off to protect you from incorrect data. Adjust your acquisition settings accordingly, then re-enable the decoder.

Note: It is possible that several conditions are present, but you will only see the first relevant message in the table. If you continue to experience failures, try adjusting the other settings.

Serial Decode Dialog

To first set up a decoder, go to the Decode Setup dialog. Once decoders have been configured, use the Serial Decode dialog to quickly turn on/off a decoder or make minor modifications to the settings.

To turn on decoders:

1. Touch the **Front Panel Serial Decode button** (if available on your oscilloscope), or choose **Analysis > Serial Decode** from the oscilloscope menu bar to access the Serial Decode dialog.
2. On the same row as the **Decode #**, check **On** to enable the decoder.

   As long as On is checked (and there is a valid acquisition), a result table and decoded waveform appear. The number of rows of data displayed will depend on the **Table#Rows** setting (on the Decode Setup dialog).
3. Optionally, modify the:
   - **Protocol** associated with the decoder.
   - **Data (Source)** to be decoded.

To turn off decoders: deselect the On boxes individually, or touch **Turn All Off**.

Reading Waveform Annotations

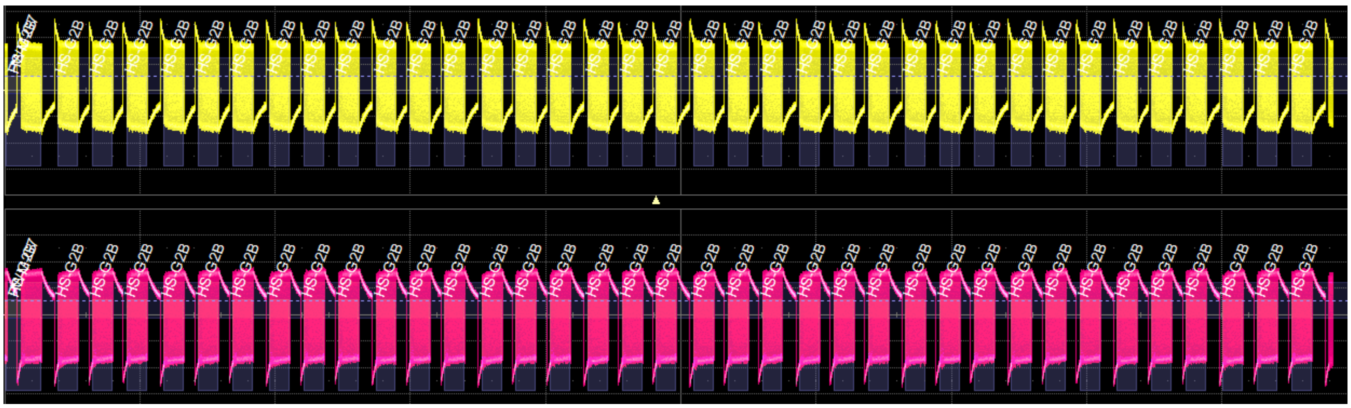
When a decoder is enabled, an annotated waveform appears on the oscilloscope display, allowing you to quickly read the results of the decoding. A colored overlay marks significant bit-sequences in the source signal. The overlay contains annotations corresponding to the Header/ID, Address, Labels, Data Length Codes, Data, CRC, Parity Bits, Start Bits, Stop Bits, Delimiters, Idle segments, etc. Annotations are customized to the protocol or encoding scheme.

The amount of information shown on an annotation is affected by the width of the rectangles in the overlay, which is determined by the magnification (scale) of the trace and the length of the acquisition. Zooming a portion of the decoder trace will reveal the detailed annotations.

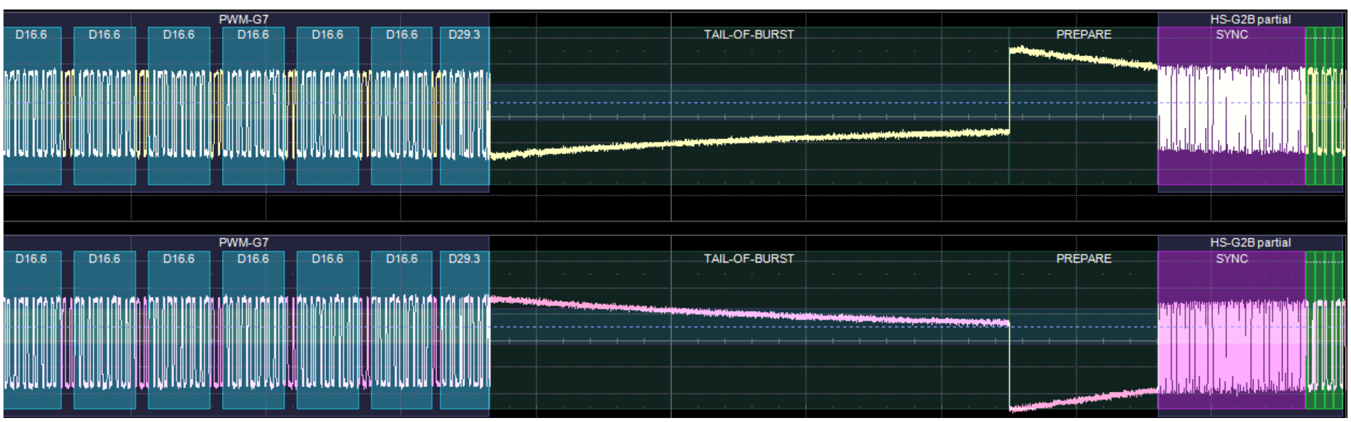
MIPI M-PHY Waveform Annotations

Annotation	Overlay Color (1)	Text (2, 3)
Message burst	Navy Blue (behind data fields)	<Message ID>
Prepare sequence	Dark Green	PREPARE
Sync sequence	Purple	SYNC
Control bits	Green	<Marker>
Payload Data	Aqua Blue	<byte> (e.g., D.16.6)
Tail-of-Burst	Dark Green	TAIL-OF-BURST

1. Combined overlays affect the appearance of colors.
2. Text in brackets < > is variable. The amount of text shown depends on your zoom factors.
3. Data values are shown in Symbolic, Binary, or Hexadecimal format depending on your Viewing selection.



Decoded waveform. At this resolution, little information appears on the overlay.

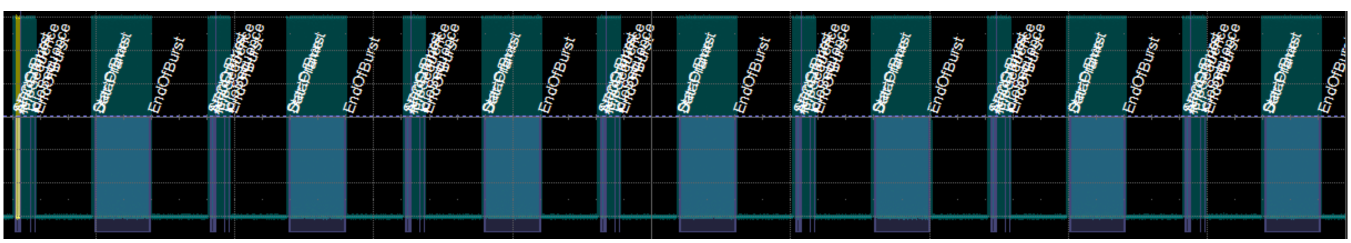


Zoom showing annotation details.

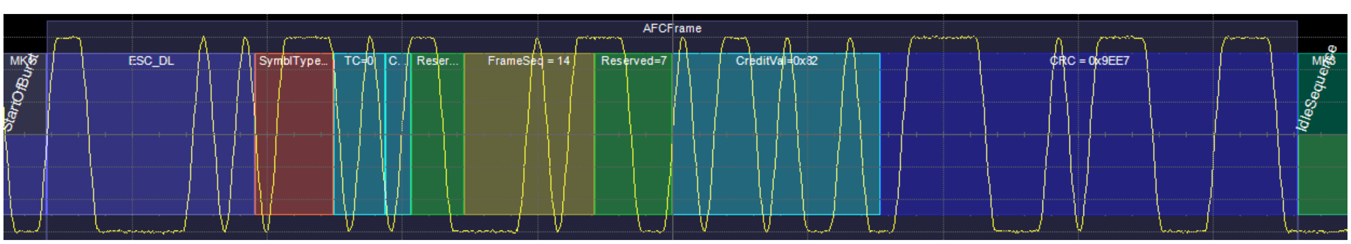
UniPro Waveform Annotations

Annotation	Overlay Color (1) (2)	Text (3)
Frame	Navy Blue (behind other fields)	<Frame Type>
Start of Burst	Violet	MK0 MK1
End of Burst	Violet	MK2
Escaped Data PDU Type	Violet	ESC_<DL | PA>
Symbol Type	Red-Orange	SymbolType=<type>=<number>
End of Frame	Red-Orange	EOF_<Odd=2 | Even=1>
Traffic Class	Cyan	TC = <number>
Credit Value	Blue-green	CReq = <number>
Reserved Bits	Green	Reserved = <number>
Idle Sequence	Green	MK3 FILLER if unscrambled MK3 <symbol> if scrambled
Frame Sequence	Tan	FrameSeq = <number of frame in sequence>
Credit Value	Cyan	CreditVal = <hex code>
Payload Data	Aqua Blue	Data = <hex code>
Cyclic Redundancy Check	Royal Blue	CRC = <hex code>
Skip Sequence Symbol	Purple	SKYPSYM
Protocol Error	Red	<Error type>

1. Combined overlays affect the appearance of colors.
2. Similar colors demarcate boudaries between sub-fields within a UniPro symbol which fall into the same category.
3. Text in brackets < > is variable. The amount of text shown depends on your zoom factors.



Decoded waveform. At this resolution, little information appears on the overlay.



Zoom showing annotation details.

Serial Decode Result Table

By default, a table summarizing the decoder results appears below the grids whenever a decoder is enabled. The result table provides a view of data as decoded during the most recent acquisition, even when the number of bursts are too many to allow legible annotation on the waveform trace.

The table is displayed only when the **View Decode** checkbox is marked on the Decode Setup Dialog *and* a source signal has been decoded using that protocol.

You can export result table data to a .CSV file.

Table Rows

Each row of the table represents one index of data found within the acquisition. Exactly what this represents depends on the protocol and how you have chosen to "packetize" the data stream when configuring the decoder (frame, message, packet, etc.).

Note: For some decoders, it is even possible to turn off packetization, in which case all the decoded data appears on one row of the table.

See Using the Result Table for more information about how to interact with the table rows to view the decoding. Swipe the table up/down or use the scrollbar at the far right to navigate the table.

When multiple decoders are run at once, the index rows are combined in a summary table, ordered according to their acquisition time. The Protocol column is colorized to show which input source resulted in that index.

You can change the number of rows displayed on the table at one time. The default is five rows.

Table Columns

When a single decoder is enabled, the result table shows the protocol-specific details of the decoding. This **detailed result table** may be customized to show only those columns you want displayed.

Enabling two or more decoders switches the display to a combined table. A top-level **summary result table** (which cannot be changed) shows these columns of data for every decoding:

Column	Extracted or Computed Data
Index	Number of the line in the table
Time	Time elapsed from start of acquisition to start of message
Protocol	Protocol being decoded
Message	Message identifier bits
Data	Data payload
CRC	Cyclic Redundancy Check sequence bits
Status	Any decoder messages; content may vary by protocol

When you select the Index number from the summary result table, the detailed results for that index drops-in below it.

MIPI M-PHY Result Table

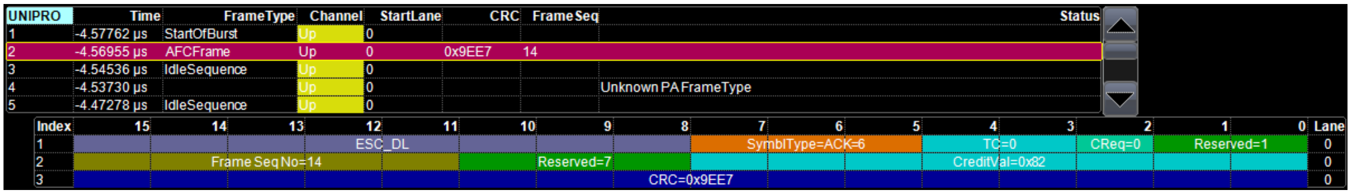
Column	Extracted or Computed Data
Index (always shown)	Number of the line in the table
Time	Time elapsed from start of acquisition to Start of Frame
Msg	Transmission mode and GEAR
Data	Decoded data bytes
BitRate/Msg	Calculated bitrate of the message

MIPI M-P...	Time	Msg	Data	Bit Rate/Msg
1	-9.63901 µs	PWM-G7	D16.6	434.647 Mbit/s
2	-9.61326 µs	HS-G2B		1.699484 Gbit/s
3	-8.84640 µs	HS-G2B		2.912296 Gbit/s

Section of typical MIPI M-PHY detailed result table.

UniPro Result Tables

Two result tables are shown beneath the annotated waveform display.



Typical UniPro detailed result tables showing frame decoding on top and symbol decoding below it.

Frame Table

This table shows a frame-level decoding of the signal. Columns can be hidden by customizing the result table.

Column	Extracted or Computed Data
UniPro (Idx)	Number of the line in the table
Time	Time elapsed from start of acquisition to start of frame
FrameType	Frame type description (e.g., Start of Burst, Data Frame, AFC Frame, Idle Sequence, End of Burst)
Channel	Upstream (Up) or downstream (Down) channel. Up is colored yellow. Down is colored blue.
Start Lane	Lane on which frame started. If there is only one lane, the value is always 0.
CRC	Cyclic Redundancy Check sequence hexadecimal value. A green cell indicates a correct CRC; a red cell indicates an error.
FrameSeq	Sequence number of data link frame
Status	Any errors or other processing messages

Symbol Table

The symbol table shows a decoding of the frame elements and their values as transmitted across all 16 bits of the symbol. The colorization of the table cells matches what is shown on the waveform annotation overlay. This table cannot be customized.

Column	Extracted or Computed Data
Index	Number of the line in the table; also number of the symbol in the frame
(Bits) 15 - 0	Frame element and value transmitted by that bit. Where multiple bits are used to transmit a single element, those cells share the same color. They are the same elements and colors as appear in the waveform decoding.
Lane	The lane on which the symbol was transmitted, 0 to 3

Using the Result Table

Besides displaying the decoded serial data, the result table helps you to inspect the acquisition.

Zoom & Search

Touching any cell of the table opens a zoom centered around the part of the waveform corresponding to the index. The Z*x* dialog opens to allow you to rescale the zoom, or to Search the acquisition. This is a quick way to navigate to events of interest in the acquisition.

Tip: When in combined table mode, touch any data cell *other than* Index and Protocol to zoom.

The table rows corresponding to the zoomed area are highlighted, as is the zoomed area of the source waveform; the highlight color reflects the zoom that it relates to (Z1 yellow, Z2 pink, etc.). As you adjust the scale of the zoom, the highlighted area may expand to several rows of the table, or fade to indicate that only a part of that Index is shown in the zoom.

When there are multiple decoders running, each can have its own zoom of the decoding highlighted on the combined table at the same time.

Note: The zoom number is no longer tied to the decoder number. The software tries to match the numbers, but if it cannot it uses the next empty zoom slot.

View Details

When viewing a combined table, touch the **Index number** in the first column to drop-in the detailed decoding of that record. Touch the Index cell again to hide the details.

If there is more data than can be displayed in a cell, the cell is marked with a white triangle in the lower-right corner. Touch this to open a pop-up showing the full decoding.

Navigate

In single table mode, touch the **Index column header** (top, left-most cell of the table) to open the Decode Setup dialog. This is especially helpful for adjusting the decoder during initial tuning.

When in combined table mode, the Index column header cell opens the Serial Decode dialog, where you can enable/disable all the decoders. Touch the **Protocol** cell to open the Decode Setup dialog for the decoder that produced that index of data.

Customizing the Result Table

Follow these steps to change what data appears on the detailed result table:

1. Press the Front Panel **Serial Decode button** or choose **Analysis > Serial Decode**, then open the **Decode Setup tab**.
2. Touch the **Configure Table** button.
3. On the **View Columns** pop-up dialog, mark the columns you want to appear and clear those you wish to remove. Only those columns selected will appear on the oscilloscope display.

   Note: If a selected column is not relevant to the decoding selections, the column will not appear in the table.

   To return to the preset display, touch **Default**.
4. Touch the **Close** button when finished.

On some decoders, you may also use the View Columns pop-up to set a **Bit Rate Tolerance** percentage. When implemented, the tolerance is used to flag out-of-tolerance messages (messages outside the user-defined bitrate +- tolerance) by colorizing in red the Bitrate shown in the table.

You may customize the size of the result table by changing the **Table # Rows** setting on the Decode Setup dialog. Keep in mind that the deeper the table, the more compressed the waveform display on the grid, especially if there are also measurements turned on.

Exporting Result Table Data

You can manually export the detailed result table data to a .CSV file:

1. Press the Front Panel **Serial Decode button**, or choose **Analysis > Serial Decode**, then open the **Decode Setup tab**.
2. Optionally, touch **Browse** and enter a new **File Name** and output folder.
3. Touch the **Export Table** button.

Export files are by default created in the D:\Applications\<protocol> folder, although you can choose any other folder on the oscilloscope or any external drive connected to a host USB port. The data will overwrite the last export file saved in the protocol directory, unless you enter a new filename.

Note: When a combined table is exported, a combined file is saved in D:\Applications\Serial Decode. Separate files for each decoder are saved in D:\Applications\<protocol>.

In addition, the oscilloscope Save Table feature will automatically create tabular data files with each acquisition trigger. The file names are automatically incremented so that data is not lost. Choose **File > Save Table** from the oscilloscope menu bar and select **Decodex** as the source. Make other file format and storage selections as you wish.

Searching Decoded Waveforms

Touching the Action toolbar **Search button** button on the Decode Setup dialog creates a 10:1 zoom of the center of the decoder source trace and opens the Search subdialog.

Touching the **any cell** of the result table similarly creates a zoom and opens Search, but of only that part of the waveform corresponding to the index (plus any padding).

Tip: In combined table mode, touch any cell *other than* Index and Protocol to create the zoom.

Basic Search

On the Search subdialog, select what type of data element to **Search for**. These basic criteria vary by protocol, but generally correspond to the columns of data displayed on the detailed decoder result table.

Optionally:

- Check **Use Value** and enter the **Value** to find in that column. If you do not enter a Value, Search goes to the beginning of the next data element of that type found in the acquisition.
- Enter a **Left/Right Pad**, the percentage of horizontal division around matching data to display on the zoom.
- Check **Show Frame** to mark on the overlay the frame in which the event was found.

After entering the Search criteria, use the **Prev** and **Next** buttons to navigate to the matching data in the table, simultaneously shifting the zoom to the portion of the waveform that corresponds to the match.

The touch screen message bar shows details about the table row and column where the matching data was found.

Advanced Search

Advanced Search allows you to create complex criteria by using Boolean AND/OR logic to combine up-to-three different searches. On the Advanced dialog, choose the **Col(umns) to Search 1 - 3** and the **Value** to find just as you would a basic search, then choose the **Operator(s)** that represent the relationship between them.

M-PHY Physical Layer Testing

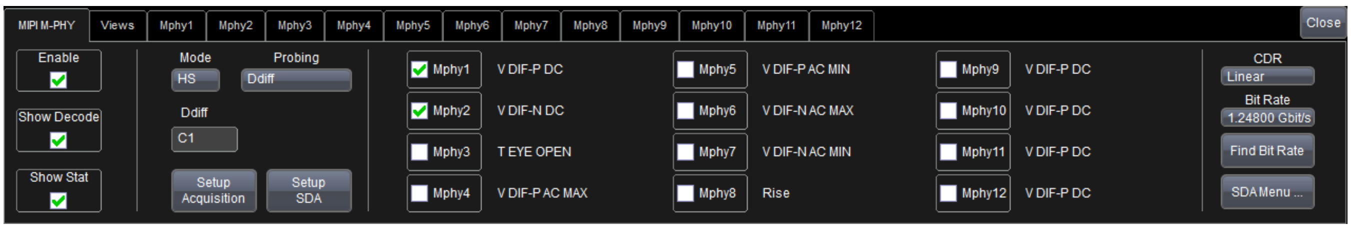
The M-PHYbus DP option enables you to run Transmitter-side (Tx) physical layer tests defined by the MIPI specification concurrent with the waveform decoding. This allows you to gain insight into signal performance that is useful for debugging prior to compliance testing. Tests are available in all categories (electrical, timing, slew rate, etc.) and may be run in High Speed (HS), Pulse Width Modulated (PWM), or System-Clock Synchronous (SYS) modes.

Note: The M-PHYbus DP option requires an installation of the Teledyne LeCroy SDAII or SDAIII option. You will not be able to access the dialogs without it.

To access the M-PHY physical layer tests, choose **Analysis > MIPI M-PHY** from the menu bar.

Define Test Mode and Inputs

To begin physical layer testing, select the test mode in which to run and define the test inputs. The available tests will vary depending on the test mode.



1. From the menu bar, choose **Analysis > MIPI M-PHY**.
2. Select the **Enable** checkbox. This turns on the waveform with the decoding overlay and the test measurement table. To turn off the overlay, deselect **Show Decode**.
3. To add statistics to the M-PHY measurement table, select **Show Stats**. The default table shows only the last calculated measurement.
4. Choose the **Test Mode**: HS (High Speed), PWM (Pulse Width Modulated), or SYS (System-Clock Synchronous).
5. Choose the **Probing** method in use: Ddiff (single differential probe), Dp & Dn (two single-ended probes), or CM (single probe acquiring Common Mode).
6. For each input required by the probing method, select the source channel.
7. Choose a **CDR** (Clock Data Recovery) method of:
   - Linear—best-fit recovered clock to acquired data
   - Filtered—using the second-order JTF function defined in the M-PHY Specification, Section 5.1.2.7, for HS-TX Total Jitter and HS-TX Deterministic Jitter.
   - Short-Term—filtered with the HSTJ-TX(f) highpass filter defined in the M-PHY Specification, Section 5.1.2.7, for HS-TX Short Term Total Jitter.

8. Enter the **Bit Rate** of the bus. If you do not know the bit rate, Choose **Find Bit Rate** to allow the software to calculate a bit rate based on the signal average.

Set Up Acquisition

If you have not already done so, make acquisition settings for the selected input sources. To do this, you may:

- Manually enter the settings on the channel setup dialogs. Use the Vertical menu to access the dialogs. Be sure to also set up the acquisition trigger.
- Use the **Setup Acquisition** button on the MIPI M-PHY dialog. The software makes the following settings:
  - **HS Mode**: channels are set to 200 mV/div, -600 mV offset, and an Edge trigger is applied to the signal.
  - **PWM Mode**: channels are set to 200 mV/div, -600 mV offset, and a Qualified-Pattern trigger is applied to the signal for capturing the ULPS sequence.
  - **SYS Mode**: channels are set to 200 mV/div, -600 mV offset, and a Qualified-Pattern trigger is applied to the signal for capturing the ULPS sequence.

The **SDA Setup** button will copy the acquisition settings made in MIPI- MPHY to the SDA application.

To quickly access the SDA dialogs, touch the **SDA Menu** button at the far right of the MIPI M-PHY dialog.

Tip: If you exit the MIPI M-PHY dialog to manually make acquisition settings, touch the far left cell of the MIPI M-PHY measurement table to return to the M-PHY dialogs.

Choose Tests and Waveform Views

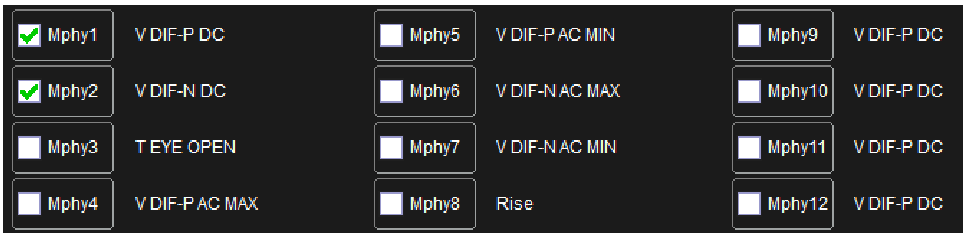
After setting up the acquisition, go on to choose the test measurements and waveform views.

Running PHY Test Measurements

Up to 12 test measurements may be run simultaneously on the acquisition. You choose from among the standard MIPI conformance tests in each category (electrical, Tx, etc.) and configure them for your signal. As with the waveform views, the options will vary depending on the test mode selection.

Enable/Disable Tests

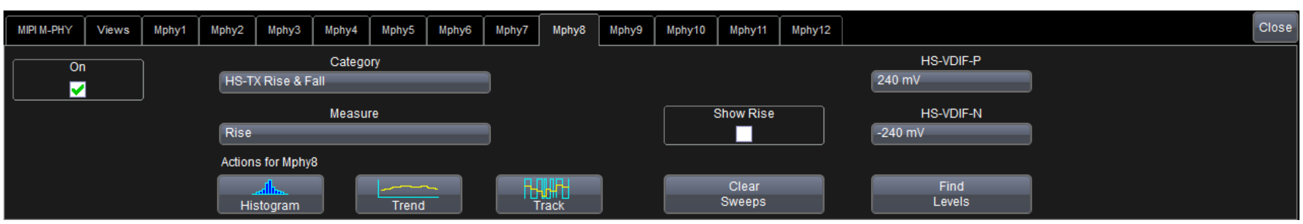
All tests are enabled by default when you select a test mode. If a measurement has been turned off, you can quickly re-enable it by marking its respective checkbox (Mphy#) in the test summary area of the MIPI M-PHY dialog.



Tip: You can also enable/disable measurements from the Mphy# dialogs.

Configure Tests

1. Complete the test mode and input selection on the MIPI-M-PHY dialog.
2. For each of the 12 possible tests, open the Mphy# dialog and make any other settings required for the measurement. These are described with the tests below.



3. Use the Histogram, Track, and Trend buttons on the Mphy# dialog to quickly plot the test measurements on a separate grid.

HS Tests

These tests are available when in HS test mode.

Note: Some tests may not be available depending on your probing method.

HS-TX Electrical Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Description
V DIF-P DC	To verify that the Differential DC Output Voltage Amplitude (VDIF_DC_xx_xx_TX) of the DUT's transmitter is within the conformance limits, for both Large and Small Amplitudes, and for both terminated and unterminated cases.
V DIF-N DC	
T EYE-OPEN	The transmitter eye opening TEYE_TX is defined as the duration in an eye diagram over which the absolute value of the differential HS-TX output signal is larger than the lower limit of VDIF_AC_TX when the HS-TX transmits a test pattern into a reference load RREF. Enter the voltage level at which to measure the Eye width in **Opening Level**. Check **Auto threshold** to automatically calculate the level.
V DIF-P AC MAX	To verify that the Differential AC Output Voltage Amplitude (VDIF_AC_xx_xx_TX) of the DUT's transmitter is within the conformance limits, for both Large and Small Amplitudes, and for both terminated and unterminated cases.
V DIF-P AC MIN	
V DIF-N AC MAX	
V DIF-N AC MIN	

HS-TX Common-Mode Tests

These tests are only available when probing Dp & Dn or CM.

Measure	Description
VCM-TX-PREPARE	To verify that the Common-Mode DC Output Voltage Amplitude (VCM-TX) of the DUT's HS-TX is within the conformance limits, for all combinations of supported Amplitudes, Terminations, LANEs, and HS GEARs.
VCM-TX-TAIL	
VCM-TX	
PSD Margin	To verify that the Common-Mode AC Power Spectral Magnitude of the DUT's HS-TX is below the conformance limit, for Large and Small Amplitudes, in Terminated mode, for all Lanes, for HS-G1.

HS-TX Rise & Fall Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Description
Rise	To verify that the 20%-80% Rise and Fall Times of the DUT's HS-TX are within the conformance limits. Enter the voltage level for **HS-VDIF-P** and **HS-VDIF-N**, or choose **Find Level** to autoset the level.Check **Show Rise/Fall** to turn on the rise time plot.
Fall	

HS-TX Slew Rate Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Description
SR DIF P	To verify the Slew Rate of the DUT's HS-TX is within the conformance limits, for all supported Amplitudes, in Terminated mode. This measurement is also used to verify the Slew Rate Monotonicity and Resolution of the DUT. Enter the voltage level in **HS-VDIF-P** and **HS-VDIF-N**, or choose **Find Level** to autoset the level.
SR DIF N	

HS-TX Skew Tests

These tests are only available when probing Dp & Dn.

Measure	Description
Intra-L Skew	To verify that the Intra-Lane Output Skew of the DUT's HS-TX is within the conformance limits, for all combinations of supported Amplitudes, Terminations, LANEs, and HS GEARs. Enter the transmitter common-mode voltage in **VCM-TX**.

HS-TX Jitter Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Description
Tj	To verify that the Total Jitter (TJTX) and the Short-Term Total Jitter (STTJTX) of the DUT's HS-TX transmitter is within the conformance limits, for all combinations of supported Amplitudes, Terminations, and Lanes. Select a **CDR** of either Filtered (Jitter) or Short-Term (Short-Term Jitter).
Dj	To verify that the Deterministic Jitter (DJTX) and Short-Term Deterministic Jitter (STDJTX) of the DUT's HS-TX transmitter is within the conformance limits, for all combinations of supported Amplitudes, Terminations, and Lanes. Select a **CDR** of either Filtered (Jitter) or Short-Term (Short-Term Jitter).

HS-TX Timing Tests

These tests are only available when probing Ddiff or Dp & Dn.

Name	Purpose
TPULSE	To verify that the Pulse Width (TPULSE_TX) of the DUT's HS-TX transmitter is within the conformance limits, for all combinations of supported Amplitudes, Terminations, and Lanes.
HS Bitrate	To verify that the Frequency Offset (ƒOFFSET_TX) of the DUT's HS-TX transmitter is within the conformance limits.
UI HS	To verify that the measured UIHS value for a given burst or continuous capture corresponds to the inverse of the mean ƒOFFSET-TX value for that burst/capture.
Min foffs	To verify that the minimum, mean, and maximum Frequency Offset (ƒOFFSET-TX) values are within the conformance limits.
Mean foffs	
Max foffs	
THS PREPARE	To verify that the length of the DUT's transmitted HS PREPARE period is consistent with the value indicated by its TX_HS_PREPARE_LENGTH configuration attribute.

PWM Tests

These tests are available when in PWM test mode.

Note: Some tests may not be available depending on your probing method.

PWM-TX Electrical Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Description
V DIF-P DC	To verify that the Differential DC Output Voltage Amplitude (VDIF_DC_xA_xT_TX) of the DUT's PWM-TX transmitter is within the conformance limits, for all combinations of supported Amplitudes, Terminations, Gears, and Lanes.
V DIF-N DC	
V DIF-P AC MAX	To verify that the Differential AC Output Voltage Amplitude (VDIF_AC_xx_xx_TX) of the DUT's transmitter is within the conformance limits, for both Large and Small Amplitudes, and for both terminated and unterminated cases.
V DIF-P AC MIN	
V DIF-N AC MAX	
V DIF-N AC MIN	

PWM-TX Common-Mode Tests

These tests are only available when probing Dp & Dn.

Measure	Purpose
VCM-TX PREPARE	To verify that the Common-Mode Output Voltage Amplitude (VCM-TX) of the DUT's PWM-TX is within the conformance limits, for all combinations of supported Amplitudes, Terminations, LANEs, and PWM GEARs.
VCM-TX-TAIL	
VCM-TX	

PWM-TX Rise and Fall Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Purpose
Rise	To verify that the Rise and Fall times (TR_PWM_TX and TF_PWM_TX) of the DUT's PWM-TX transmitter are within the conformance limits, for all combinations of supported Amplitudes, Terminations, PWM gears, and Lanes. Enter the voltage level in **PWM-VDIF-P** and **PWM-VDIF-N**, or choose **Find Level** to autoset the level. Check **Show Rise/Fall** to turn on the rise time plot.
Fall	

PWM-TX Timing Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Purpose
PWM Bitrate TPWM-TX	To verify that the Transmit Bit Duration (TPWM_TX) of the DUT's PWM-TX transmitter is within the conformance limits, for all combinations of supported Terminations, PWM gears, and Lanes.
kPWM-TX-b0 kPWM-TX-b1	To verify that the Transmit Ratio (kPWM_TX) of the DUT's PWM-TX transmitter is within the conformance limits, for all Lanes.
MINOR-b0 MINOR-b1	To verify that the PWM-G0 Minor Duration (TPWM_MINOR_G0_TX) of the DUT's PWM-TX transmitter is within the conformance limits, for all Lanes.
TPWM PREPARE	To verify that the length of the DUT's transmitted PWM-PREPARE period is consistent with the value indicated by its TX_LS_PREPARE_LENGTH configuration attribute.

SYS Tests

These tests are available when in SYS test mode.

Note: Some tests may not be available depending on your probing method.

SYS-TX Electrical Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Description
V DIF-P DC V DIF-N DC	To verify that the Differential DC Output Voltage Amplitude (VDIF_DC_xA_xT_TX) of the DUT's HS-TX transmitter is within the conformance limits, for all combinations of supported Amplitudes, Terminations, Reference Frequencies, and Lanes.
V DIF-P AC MAX V DIF-P AC MIN V DIF-N AC MAX V DIF-N AC MIN	To verify that the DUT's HS-TX transmitter meets the requirements for the maximum Differential AC Output Voltage Amplitude (VDIF_AC_xA_xT_TX), for all combinations of supported Amplitudes, Terminations, Reference Frequencies, and Lanes.

SYS-TX Common-Mode Tests

These tests are only available when probing Dp & Dn or CM.

Measure	Description
VCM-TX-PREPARE V DIF-P CM V DIF-N CM	To verify that the Common-Mode Output Voltage Amplitude (VCM-TX) of the DUT's SYS-TX is within the conformance limits, for all combinations of supported Amplitudes, Terminations, LANEs, and Reference Frequencies.

SYS-TX Rise & Fall Tests

These tests are only available when probing Ddiff or Dp & Dn.

Measure	Description
Rise	To verify that the Rise and Fall times (TR_SYS_TX and TF_SYS_TX) of the DUT's SYS-TX transmitter are within the conformance limits, for all combinations of supported Amplitudes, Terminations, Reference Frequencies, and Lanes. Enter the voltage level in **SYS-VDIF-P** and **SYS-VDIF-N**, or choose **Find Levels** to autoset the level. Check **Show Rise/Fall** to turn on the rise time plot.
Fall	

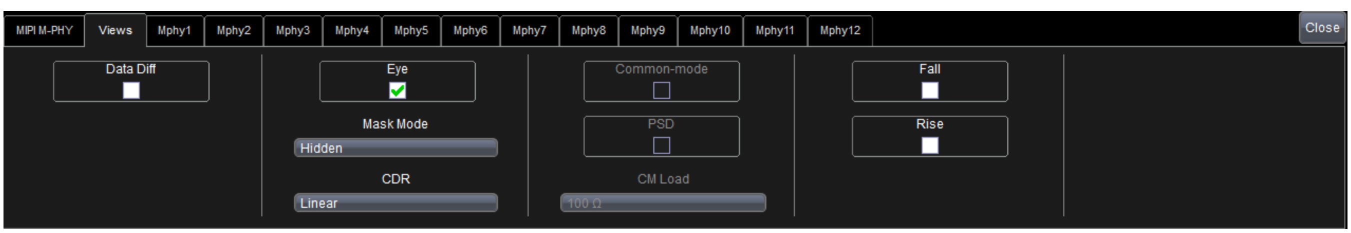
SYS-TX Timing Tests

These tests are only available when probing Ddiff or Dp & Dn.

Name	Purpose
SYS Bitrate	To verify that the Transmit Bit Duration (TSYS_TX) of the DUT's SYS-TX transmitter is within the conformance limits, for all combinations of supported Terminations, SYS gears, and Lanes.
UI SYS	To verify that the Unit Interval (UISYS) of the DUT’s SYS-TX are within the conformance limits, for all supported Reference Frequencies.
Min foffs	To verify that the minimum, mean, and maximum Frequency Offset (ƒOFFSET-TX) of the DUT’s SYS-TX are within the conformance limits, for all supported Reference Frequencies.
Mean foffs	
Max foffs	
TSYS PREPARE	To verify that the length of the DUT’s transmitted SYS-PREPARE period is consistent with the value indicated by its TX_LS_PREPARE_LENGTH configuration attribute.

Waveform Views

The Views dialog enables you to create different types of diagrams and plots required by the MIPI M-PHY test specification. The available selection depends on the test mode in which you are running, so complete the input setup on the main MIPI M-PHY dialog before turning on views.



These alternative views may be displayed in combination with the input traces or each other. Each view selected appears on the touch screen with a dedicated trace descriptor box.

Data Diff View

The Data Diff view shows a calculated differential trace when probing DP & DN.

Data Diff is available in all test modes. On the **Views** dialog, select the **Data Diff** checkbox.

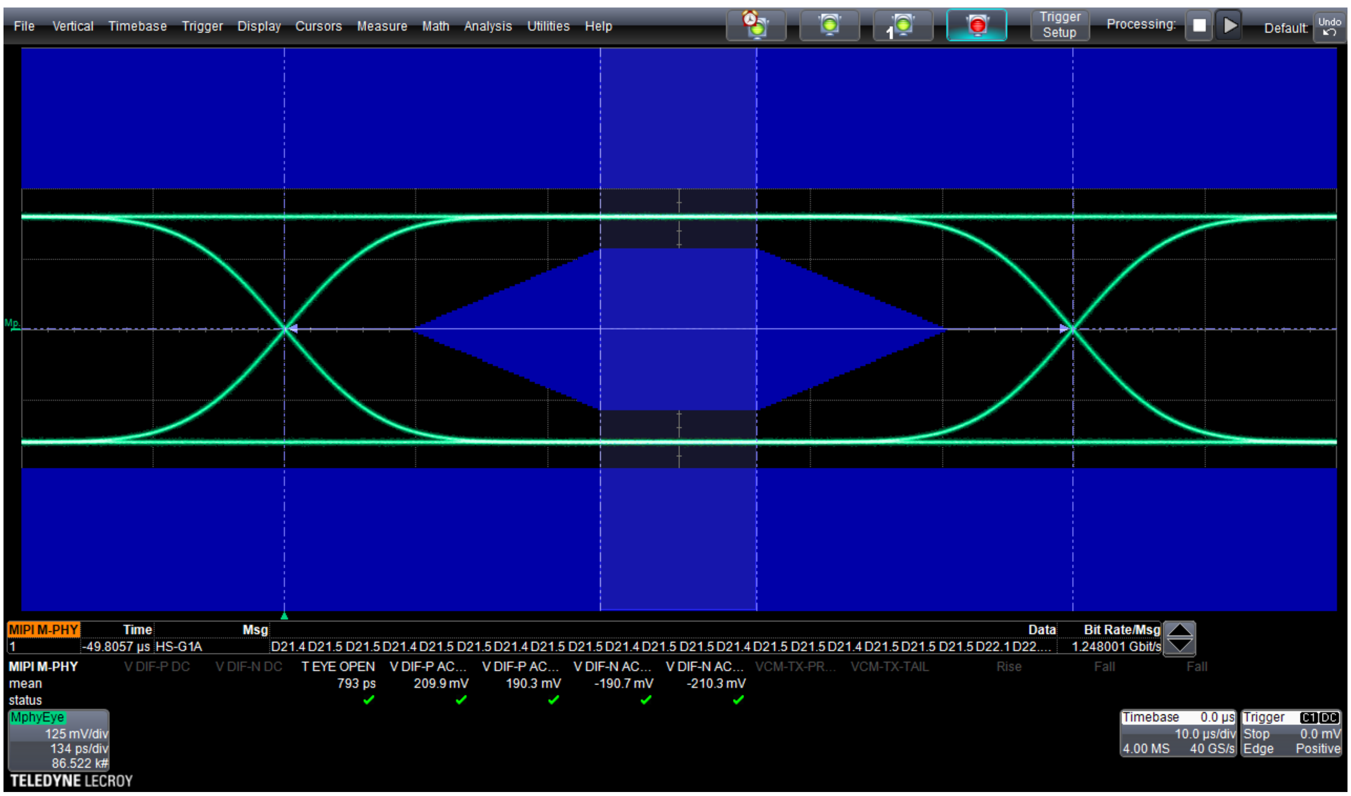
Eye Diagram View

The Eye view constructs an eye diagram by recovering a clock using a second-order PLL (specified in the CTS). The acquired eye is compared to the selected mask.

Eye diagramming is available when running in HS or SYS test mode. On the **Views** dialog, select the **Eye** checkbox.

A selection of standard eye diagram mask tests are available. A red overlay marks those areas where the eye intersects the mask, showing a "fail." Choose the **Mask Mode** and a **CDR** (Clock Data Recovery) method of:

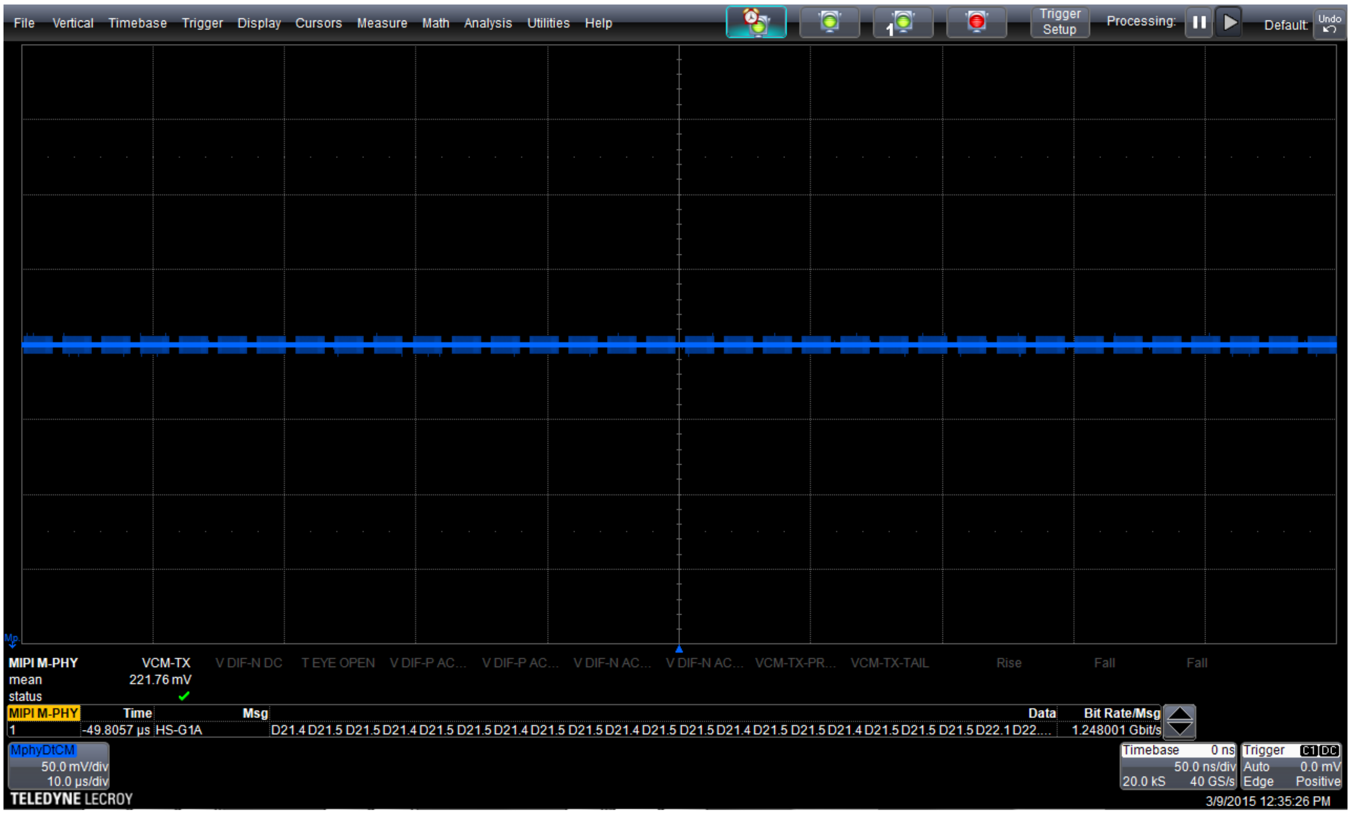
- Linear—best-fit recovered clock to acquired data
- Filtered—using the second-order JTF function defined in the M-PHY Specification, Section 5.1.2.7, for HS-TX Total Jitter and HS-TX Deterministic Jitter.
- Short-Term—filtered with the HSTJ-TX(f) highpass filter defined in the M-PHY Specification, Section 5.1.2.7, for HS-TX Short Term Total Jitter.



Common Mode View

The Common Mode view shows the calculated common mode signal. You cannot generate this view when probing DDiff.

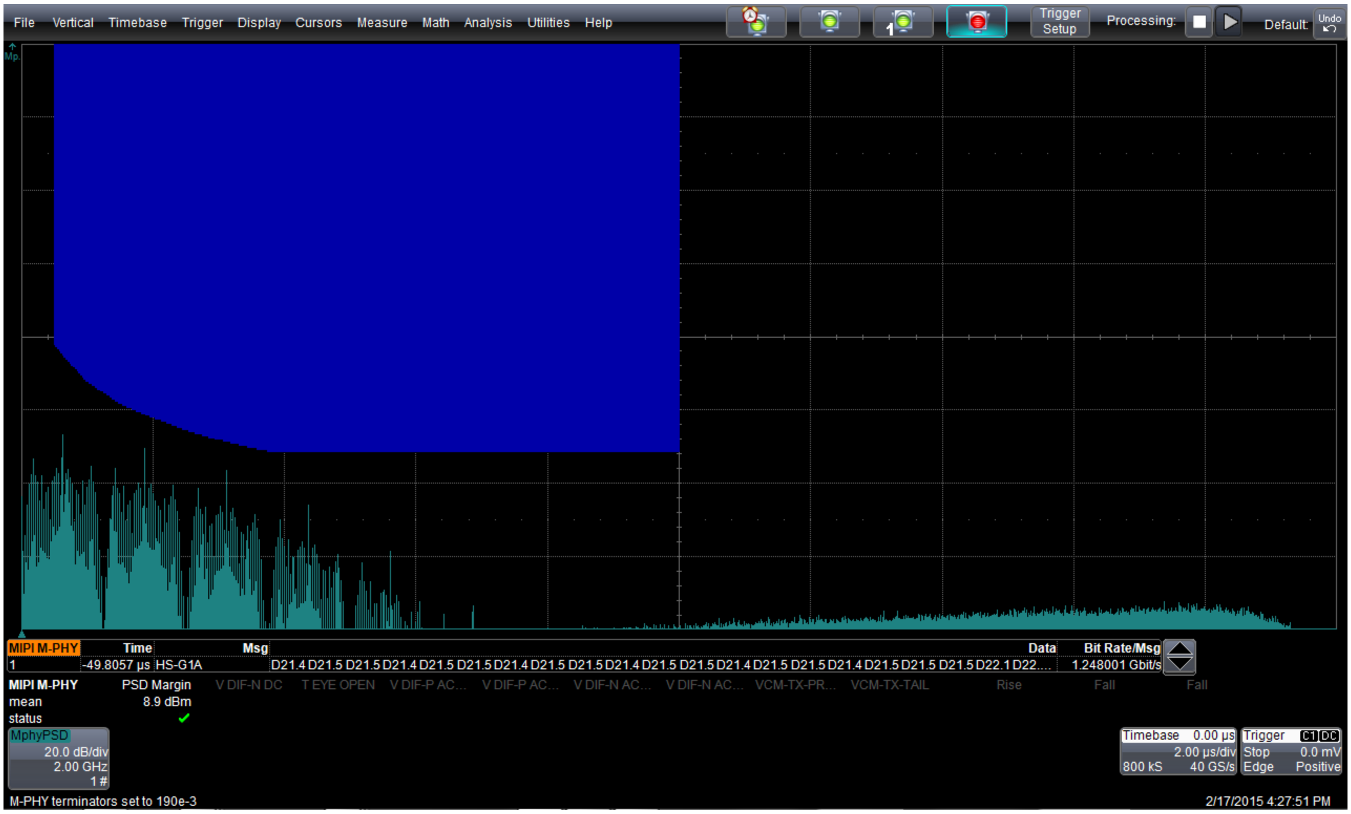
Common Mode is available in all test modes. On the **Views** dialog and select the **Common-mode** checkbox.



PSD View

The PSD view displays the common-mode spectrum. The blue mask represents the spectral limit line below which the samples should fall. You cannot generate this view when probing DDiff.

PSD is available only in High Speed mode. On the **Views** dialog, select the **PSD** checkbox, then enter the load impedance in **CM Load**.

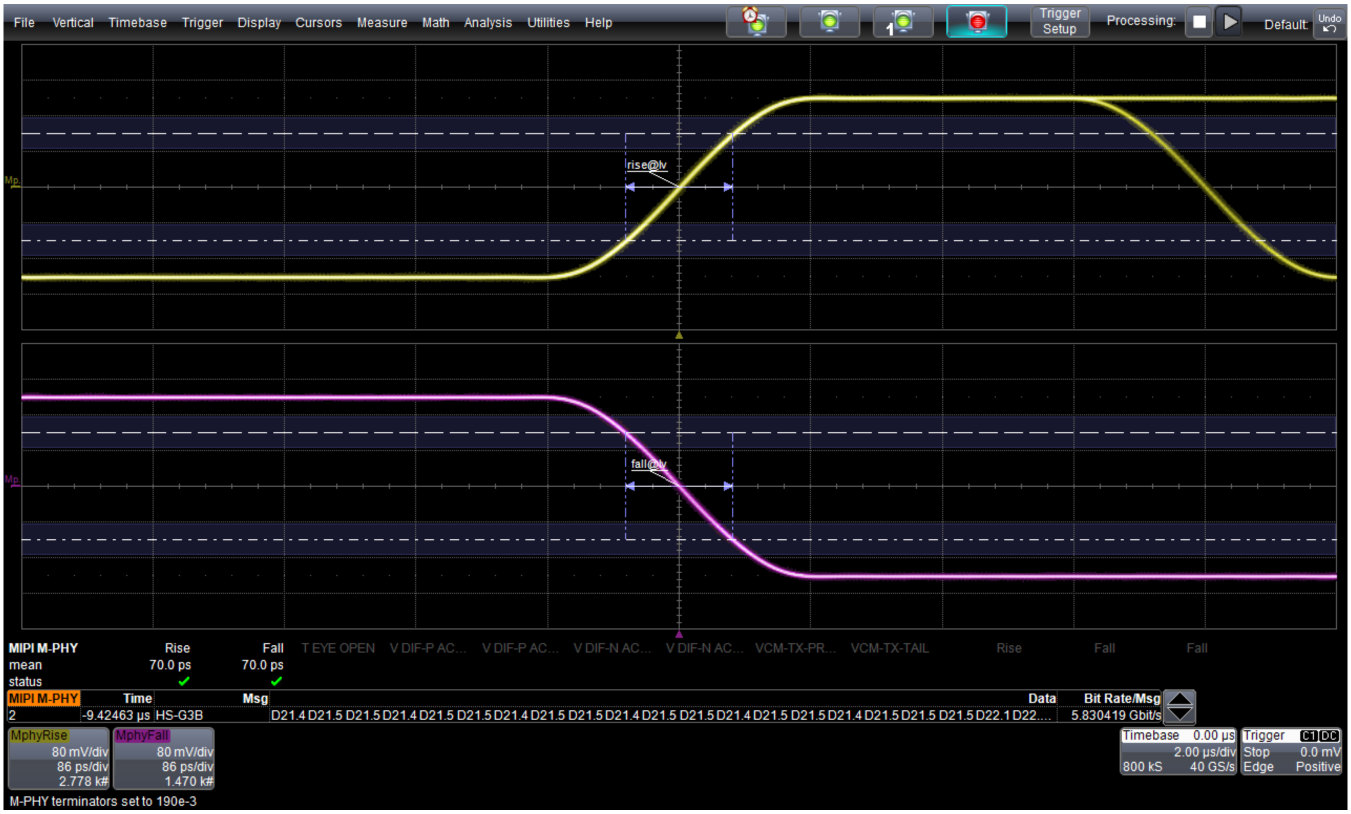


Rise and Fall Views

The Rise view plots the averaged rising-edge signal used to calculate TR-HS-TX.

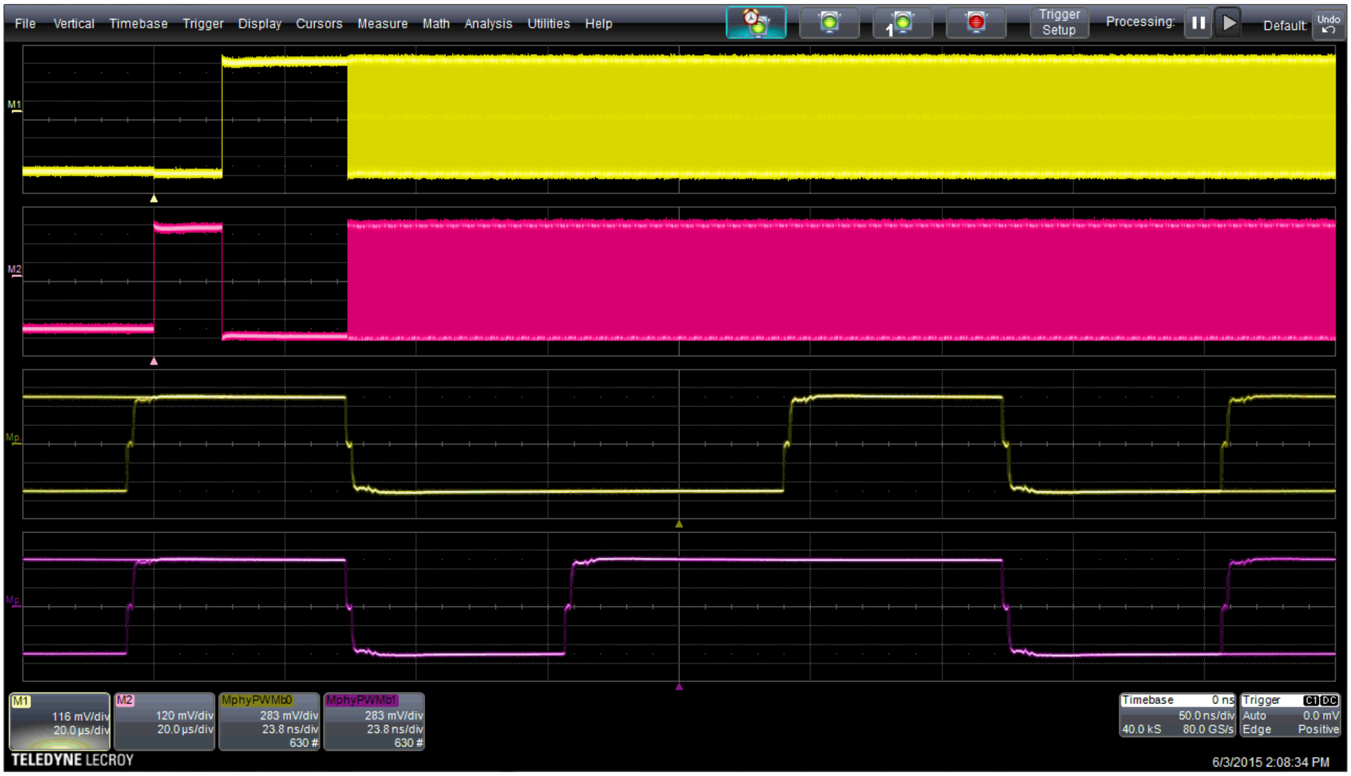
The Fall view plots the averaged falling-edge signal used to calculate TF-HS-TX.

Rise and Fall are available in all test modes. On the **Views** dialog, select the respective checkbox.



PWM b0 and PWM b1 Views

The PWM views generate a persistance trace of a b0 or b1 bit.



PWM views are available only in PWM test mode. On the **Views** dialog, select the **PWM b0** or **PWM b1** checkbox.

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