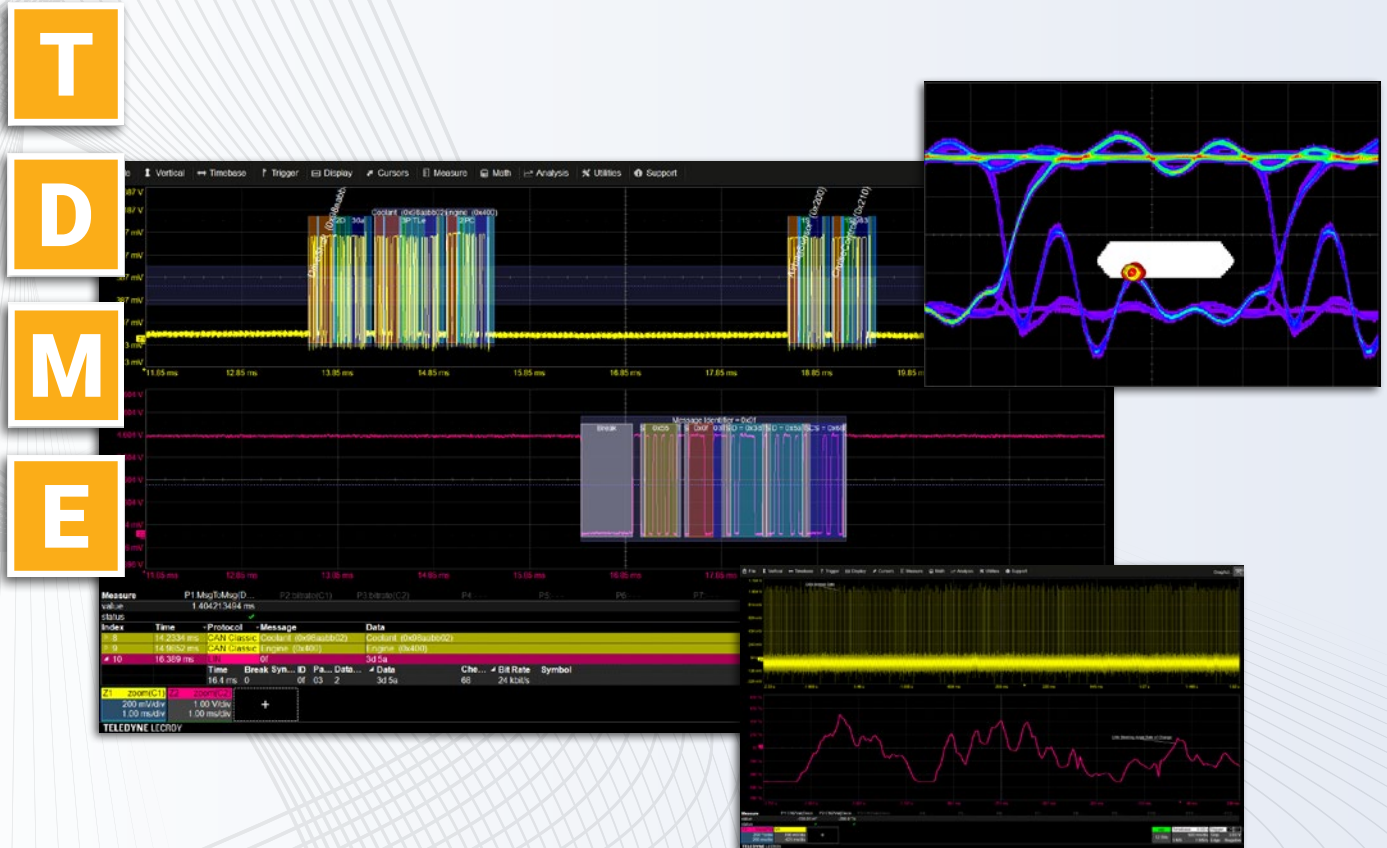
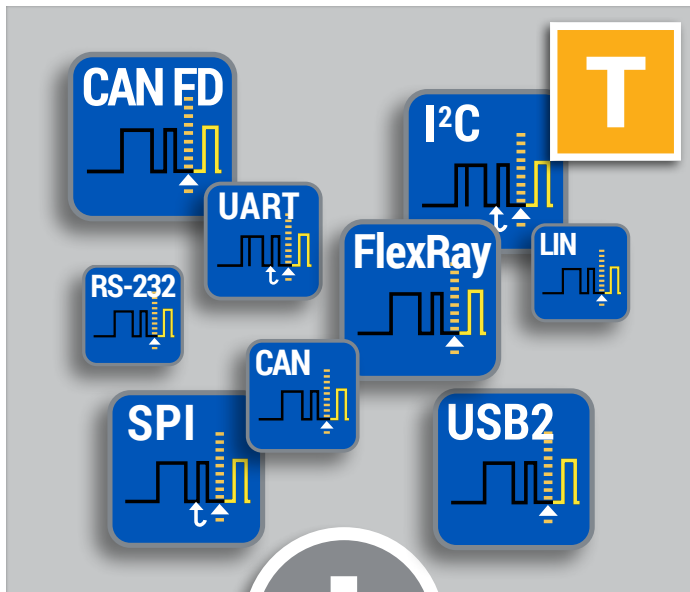


## Comprehensive and Powerful Serial Data Debugging with TDME Options



Teledyne LeCroy offers the widest range and fullest-featured set of serial data debug tools for embedded computing, in-vehicle network, industrial, avionic, sideband/peripheral signals, power management and other applications. Teledyne LeCroy's TDME solutions provide:

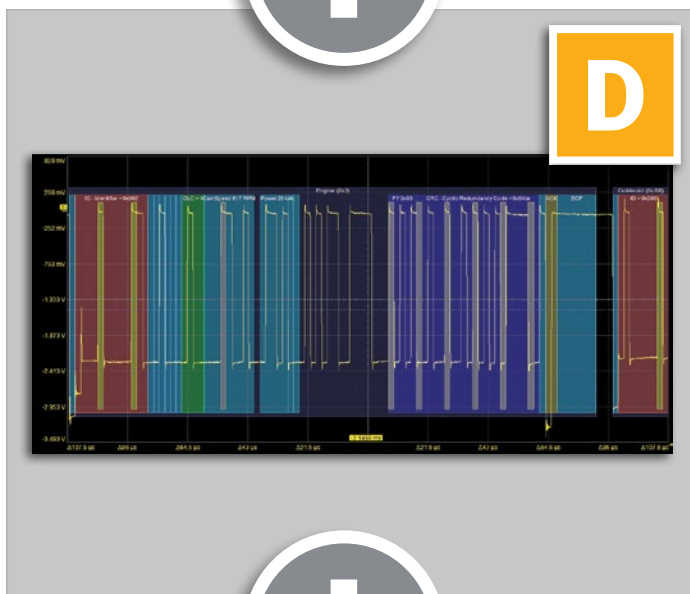
- T** – Most powerful and flexible triggering capabilities
- D** – Most intuitive serial data decoder
- M** – Measure and graph tools for serial data validation efficiency
- E / P** – Eye diagrams, sometimes with enhanced physical layer testing



## Most Powerful and Flexible Serial Data Triggers

Teledyne LeCroy's serial triggers are custom-designed by engineers who have deep knowledge of the standard and contain capabilities that go beyond the basics – isolate rare and unusual events better and debug faster.

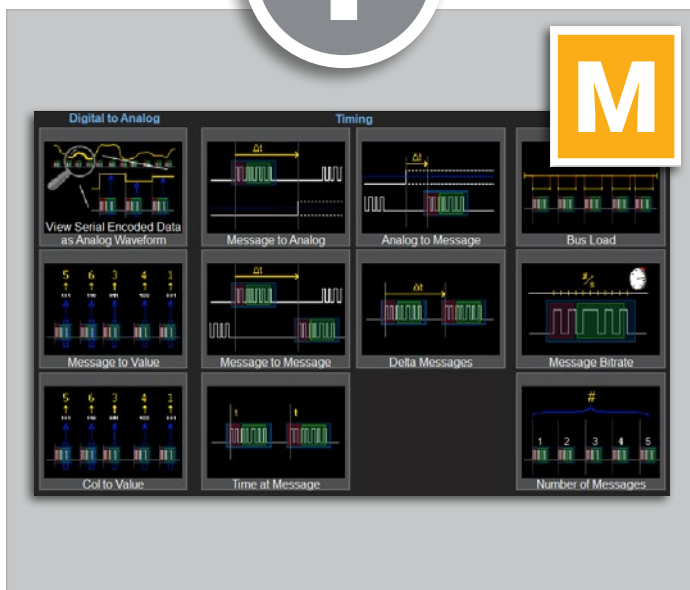
- High Performance
- Flexible Conditional Data Triggering
- Proprietary Protocol Support



## The Most Intuitive Serial Data Decoder

Turn your oscilloscope into a protocol analyzer with decoded protocol information color-coded and transparently overlaid with all data in a single time-interleaved table with advanced search and visualization features.

- Intuitive Color-Coded Serial Decode Overlays
- Advanced Search & Visualization with Real-Time Result
- Interactive Table Summarizes Results



## Extend Your Knowledge with Automated Measurements and Graphing

Teledyne LeCroy's unique measurement and graphing capabilities significantly enhance our trigger and decode capabilities and help you debug and validate faster.

- Automated Timing Measurements Speed Validation
- Serial Data DAC and Graphing Tools
- Bus Status Measurements



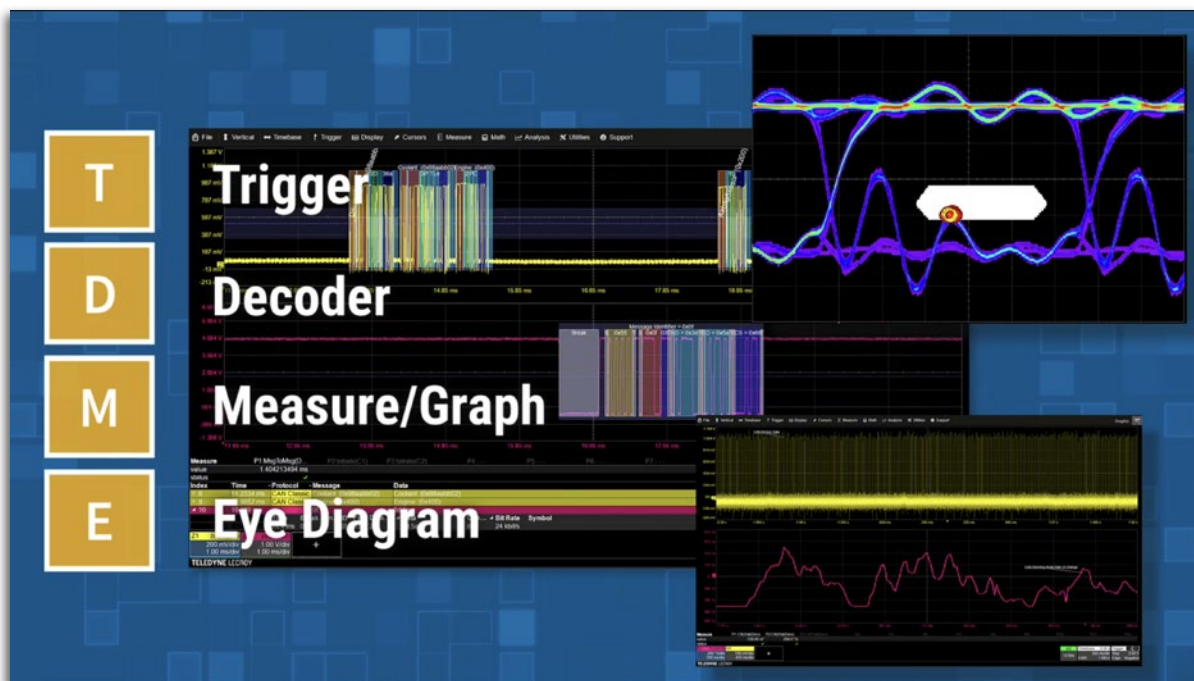
## Eye Diagrams to Visualize and Validate Signal Quality

Eye diagrams are bit-sliced views of the physical layer serial data waveforms. They provide a fast, intuitive way to understand physical layer signal integrity.

- Simple to set up - one button push
- Up to four simultaneous eye diagrams (with eye measurement parameters) may be viewed at one time
- Eye diagram mask testing including mask failure indication and failure locator trace waveform
- Advanced PHY Measurements



## Unique Features That Are Not Available from Any Other Oscilloscope Manufacturer



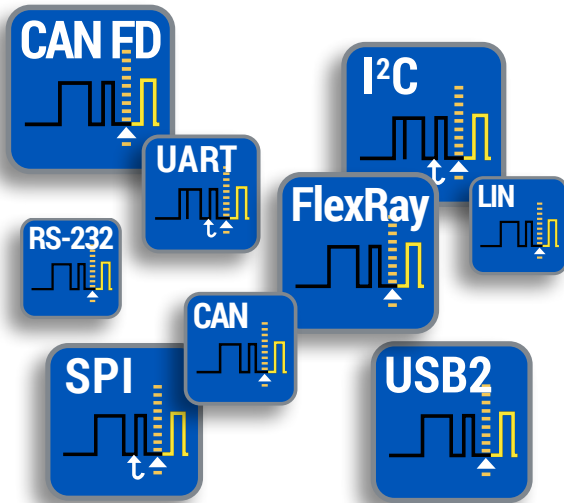
Teledyne LeCroy's triggers and decoders are more powerful and intuitive than others. Serial data DACs with graphing, automated timing and other specialized measurements and bit-sliced eye diagrams provide for faster debugging.

Scan to learn more:  
[teledynelecroy.com/tlme](http://teledynelecroy.com/tlme)



# MOST POWERFUL AND FLEXIBLE SERIAL DATA TRIGGERS

Teledyne LeCroy's serial triggers are custom-designed by engineers who have deep knowledge of the standard and contain capabilities that go beyond the basics – isolate rare and unusual events better and debug faster.



## High Performance

Every serial trigger is designed with extensive knowledge of the underlying protocol and contains unique capabilities to provide high performance. For example:

- Trigger on specific data locations within large memory transactions
- Combine byte sequences into custom message frames for protocol-based triggering
- Apply conditional or symbolic triggering for dynamic message identification
- Define complex transactions for multi-layer communication scenarios

## Flexible Conditional Data Triggering

Teledyne LeCroy serial triggers contain flexible conditional data triggering. Trigger on abnormal values or isolate specific bits in long data streams for faster troubleshooting.

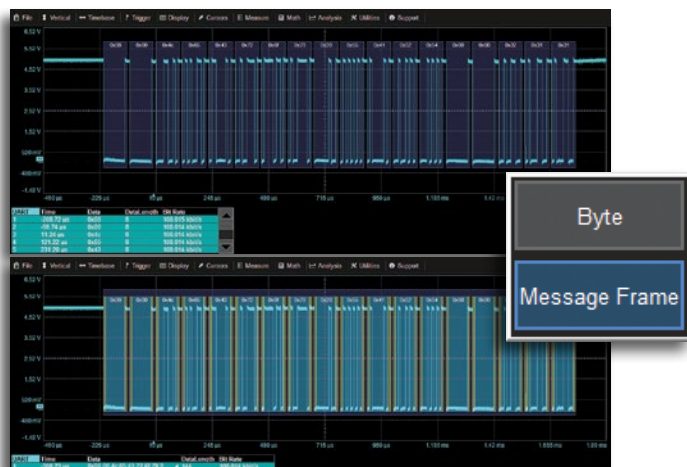
- <, ≤, =, >, ≥, <>, or inside/outside data range conditional setup
- Isolate data in very long byte streams to specific bit locations
- Easily monitor for abnormal events



## Proprietary Protocol Support

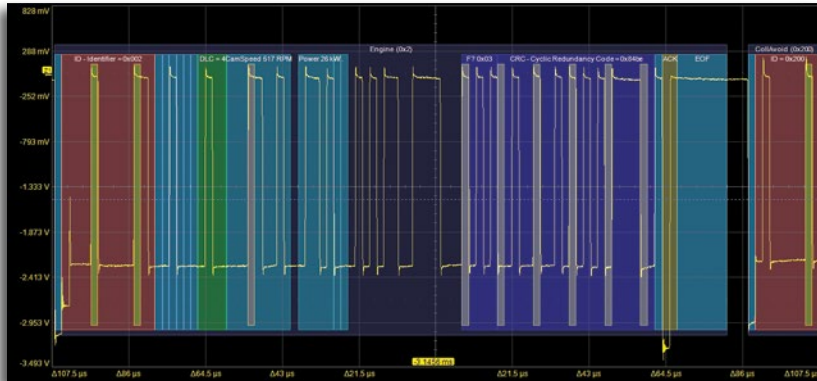
Teledyne LeCroy serial triggers often contain capability to customize the protocol format and setup definition into your exact needs.

- Your UART-based internal standard can have a customized serial trigger
- Configure UART and SPI definitions for multi-byte messages with custom byte formats, message frame structures and message interframe times
- Select CAN and ARINC429 messages symbolically
- Customizable protocol structures for Manchester and NRZ encoded signals



# THE MOST INTUITIVE SERIAL DATA DECODER

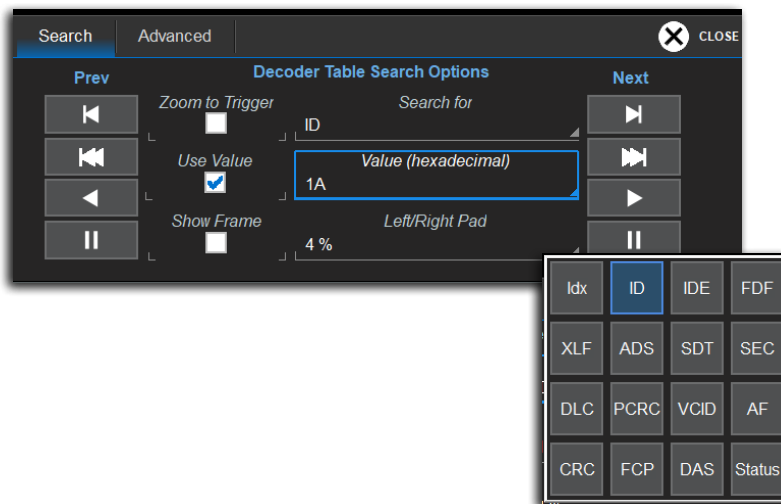
Turn your oscilloscope into a protocol analyzer with decoded protocol information color-coded and transparently overlaid with all data in a single time-interleaved table with advanced search and visualization features.



## Intuitive Color-Coded Serial Decode Overlays

A unique transparent, color-coded overlay makes it easy to correlate signal details with protocol information.

- Overlaid directly on waveform
- Color-coded for different portions of protocol and message frame
- Overlay automatically adjusts as acquisition length or displayed zoom length changes – shows just the right amount of information
- Quickly correlate displayed signals with protocol table information



## Advanced Search & Visualization with Real-Time Result

Navigate long acquisitions using linkable search criteria to find specific messages or quickly jump to the next occurrence of a message.

- Search using a variety of criteria and values
- Create separate zoom trace of searched record
- Display searched record with context in full acquisition

## Interactive Table Summarizes Results

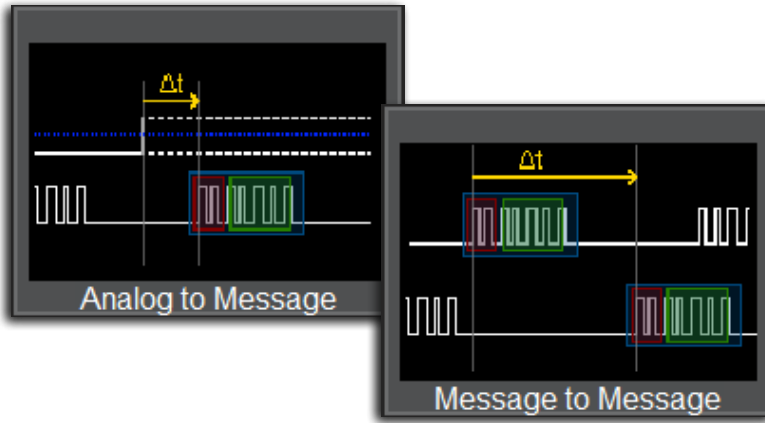
Simultaneously display time-ordered decoded protocol information for up to four different signals in the color-coded table.

| Index | Time       | Protocol | Message           | Data                                                    | CRC    | Status |
|-------|------------|----------|-------------------|---------------------------------------------------------|--------|--------|
| 1 91  | -154.63 ms | 0x00     |                   | 0x00                                                    |        |        |
| 1 92  | -154.54 ms | 0x01     |                   | 0x31                                                    |        |        |
| 1 93  | -154.44 ms | 0x36     |                   | 0x36                                                    |        |        |
| 1 94  | -154.38 ms | 0x34     |                   | 0x34                                                    |        |        |
| 1 95  | -154.32 ms | 0x00     |                   | 0x00                                                    |        | BREAK  |
| 1 96  | -146.73 ms | CAN Std  | Std 0x400         | 6a 6b                                                   | 0x3cc7 |        |
| 1 97  | -144.96 ms | CAN Std  | Std 0x200         | 21                                                      | 0x4409 |        |
| 1 98  | -144.87 ms | CAN Std  | Std 0x210         | 00                                                      | 0x983  |        |
| 1 99  | -137.15 ms | CAN Std  | Std 0x410         | 70 71 72 73 74 75 76 77                                 | 0x3cc7 |        |
| 1 100 | -136.72 ms | CAN Std  | Std 0x400         | 6a 6b                                                   | 0x3cc7 |        |
| 1 101 | -134.88 ms | CAN Std  | Std 0x200         | 21                                                      | 0x4409 |        |
| 1 102 | -134.88 ms | CAN Std  | Std 0x210         | 00                                                      | 0x983  |        |
| 1 103 | -132.54 ms | UART     | Std Ext 0x1000001 | 0x00 90 4c 65 43 72 61 79 20 55 41 52 54 00 00 32 30 38 | 0x3cc7 |        |
| 1 104 | -132.38 ms | CAN Std  | Std 0x410         | 70 71 72 73 74 75 76 77                                 | 0x3cc7 |        |
| 1 105 | -130.88 ms | UART     |                   |                                                         |        | BREAK  |
| 1 106 | -129.82 ms | CAN Std  | Std Ext 0x1000001 | 55 aa                                                   | 0x3cc7 |        |
| 1 107 | -129.78 ms | CAN Std  | Std Ext 0x1000002 | 55 aa 1f                                                | 0x3cc7 |        |
| 1 108 | -126.69 ms | CAN Std  | Std 0x400         | 6a 6b                                                   | 0x3cc7 |        |

- Customize to show only the information of interest and apply a filter to display only specific messages
- Scroll through the table, then touch a message to automatically zoom to it
- Export for offline analysis

# AUTOMATED MEASUREMENTS AND GRAPHING

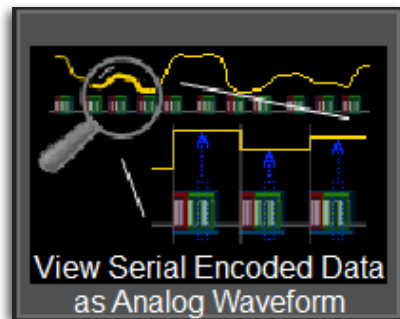
Teledyne LeCroy's unique measurement and graphing capabilities significantly enhance our trigger and decode capabilities and help you debug and validate faster.



## Automated Timing Measurements Speed Validation

Automatically measure cause-effect timing relationships

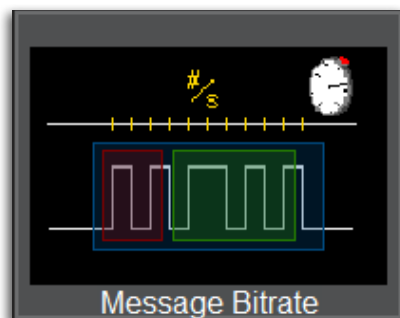
- Measure time between analog signals and messages or between messages
- Acquire statistics, apply pass/fail conditions, understand corner-case conditions.
- Reduce debug time and improve validation efficiency



## Serial Data DAC and Graphing Tools

Digital data is extracted, rescaled to analog values and plotted as a waveform, as if directly probed.

- Resulting waveform is time-correlated to other acquired data
- Specify location of digital data to exact bits, bytes, partial bytes, or data shared across multiple bytes
- Extract protocol table column values for viewing as a waveform or histogram



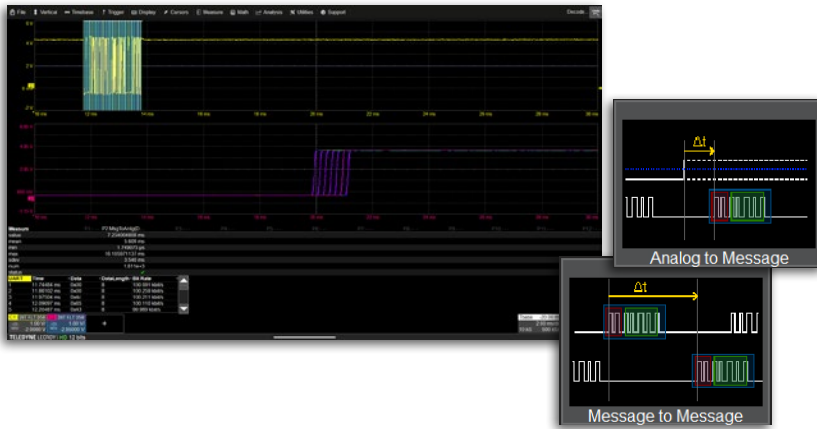
## Bus Status Measurements

Quickly understand protocol bus utilization and overall performance.

- Computes the load of user-defined messages on the bus
- Compute bit rates of user-specified messages
- Count the number of messages matching user definition

# AUTOMATED TIMING MEASUREMENTS

Measure a cause-effect timing relationship with a subsequent analog signal, or vice versa. Automate the measurement and return thousands of values quickly as your system undergoes stress testing under varying operating conditions.



## Analog-to-Message Timing

I2C data packets (top signal) and a control signal (bottom signal) operate with a cause-effect relationship with a defined maximum delay time.

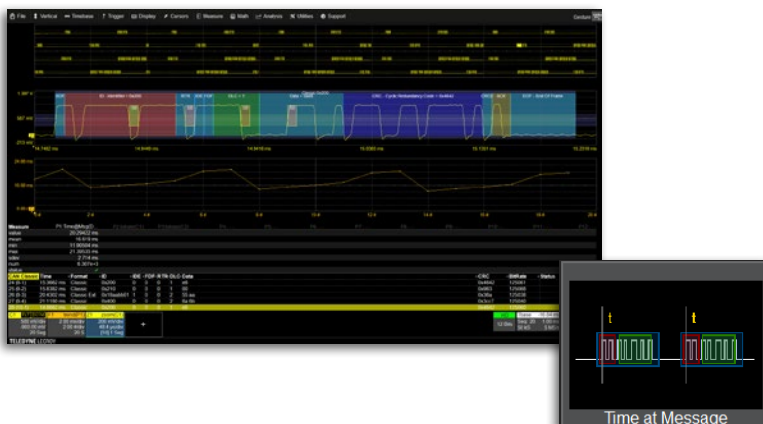
- Yellow (top) waveform is actual acquired I2C digital data
- Blue (bottom) waveform is acquired analog signal that correlates with I2C message
- Timing measurements are calculated and displayed as P1 (message time after trigger), P2 (number of relevant messages acquired) and P3 (time between message and signal)



## Message-to-Message Timing

Automate the measurement of times from one serial data protocol message to another without using cursors or viewing protocol table data.

- Measure gateway latency times from one protocol message to another (e.g. CAN to LIN or low-speed CAN to high-speed CAN)
- Quickly understand bus latency times or arbitration behaviors between two messages
- In the example shown, a CAN message (yellow trace, top, left CAN message) results in a LIN message (magenta trace, bottom) transmission. The CAN-LIN gateway latency is measured as 1.404 ms



## Trigger-to-Message Timing

Measure times between any trigger condition and a specific serial message.

- The oscilloscope is acquiring CAN messages in a segment acquisition mode (yellow trace, top) using a trigger signal on channel 2
- The middle yellow trace (with color-coded decode highlighting) is a zoom of one of the segments in the full acquisition
- Time values from the trigger event to the CAN messages are measured with the Time@Msg measurement parameter and plotted as a Trend over time (F1, orange trace, bottom)

# SERIAL DATA DAC, GRAPHING, AND OTHER TOOLS



Digital data can be extracted from specific locations in the serial data message using the Message to Value measurement parameter - a serial data DAC. This information can then be displayed as a measurement parameter value(s), or it can be viewed as a time-correlated waveform displaying the measurement value over time - as if you were able to probe and acquire it directly.



## CAN Steering Angle Sensor

Vehicle steering wheel angle and rate of change data embedded in CAN is extracted, rescaled to correct units of measure, and plotted as if it were an analog waveform.

- Yellow (top) waveform is acquired CAN digital data (~200 consecutive messages) using an oscilloscope differential probe
- Analog values for steering wheel angle (in degrees) and rate of change (in deg/s) are shown as P1 and P2 measurements
- Magenta (bottom) waveform is plot of extracted analog rate of change values (in deg/s), time-correlated to CAN digital data



## SPI Encoding of ADC

SPI clock (DATA1 digital line, magenta signal in top left) and data signal (DATA0 digital line, blue signal upper left) acquired for 20 ms (thousands of messages). Individual packets are zoomed (yellow signals in lower left).

- SPI digital data is in the protocol table
- F1 (orange signal, right side) is the plot of the extracted SPI digital data
- C3 (blue trace, right side, underneath the F1 orange signal) is the analog reference waveform that was encoded as digital data
- The spikes on the F1 (orange signal) are errors in ADC



## I2S Audio Waveforms

I2S Serial Audio clock (M1, yellow signal at top) and left/right data channels (M2, magenta signal; M3 blue signal at top) are acquired for 50 ms (thousands of messages).

- Left and Right audio channel serial data is plotted as an analog waveform (F1, yellow, left channel; F2, red, right channel; signals at bottom)
- Viewing the digital audio data as an analog waveform helps assess whether there is audio clipping or other anomalous behaviors



## PSI5 Sensor Data

PSI5 data signal (M1, annotated signal at top) is acquired for 200 ms (thousands of messages)

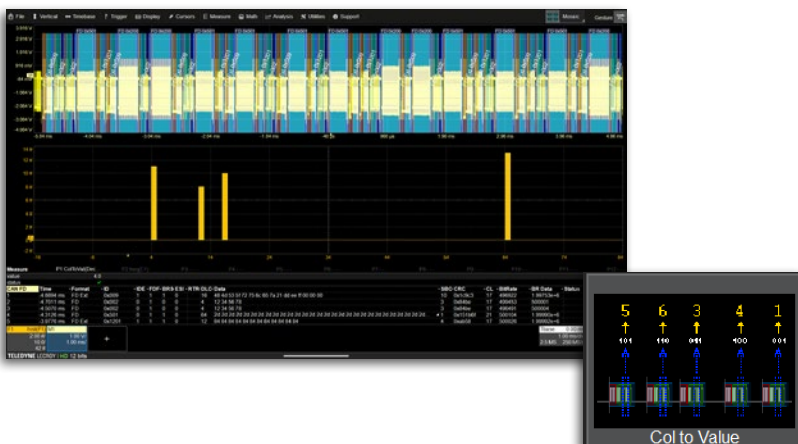
- Middle signal (Z1, yellow) is a zoom of the full acquisition to show just one PSI5 message
- All protocol data is shown in the table at the bottom of the image
- Bottom signal (F1, orange) is a plot of the digital data embedded in the PSI5 messages, time-correlated to the original acquisition



## Column-to-Value Analysis

CAN data (M1, yellow signal at top) is acquired for 10 ms. This example demonstrates using data in the protocol table to evaluate some aspect of system performance.

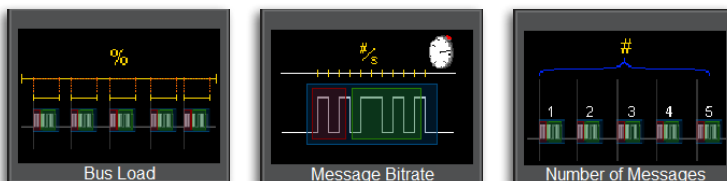
- Data Length Code (DLC – the number of data bytes in each CAN message) is read from the table using the Column-to-Value measurement capability
- Measurement parameter P1 aggregates the table data as a measurement value with min, max, and statistics (42 measured values total)
- All protocol data is shown in the table at the bottom of the image
- Bottom signal (F1, orange) is histogram showing how many packets contain 4, 12, 16, or 64 bytes, enabling quick analysis of data distribution and network behavior



## Bus Load and Bit Rate Analysis

Gain a better understanding of the network communication efficiency, quality and reliability.

- Monitor Bus Load: Identify network congestion and ensure communication efficiency
- Analyze Bit Rate: Verify data transfer speed and timing accuracy for compliance with system requirements
- Optimize Performance: Detect anomalies, prevent delays, and maintain real-time reliability through continuous measurement and analysis



# EYE DIAGRAMS TO VISUALIZE & VALIDATE SIGNAL QUALITY

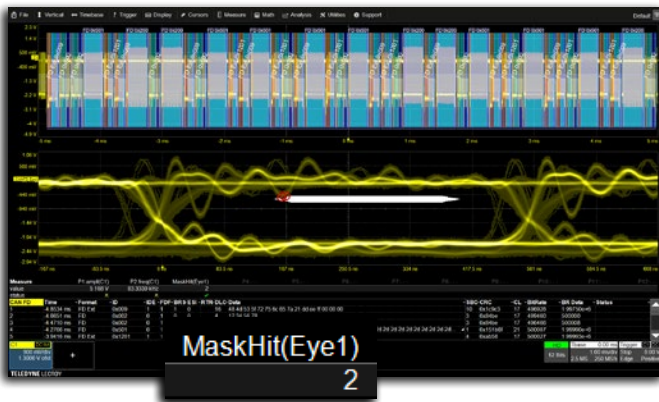
Eye diagrams are bit-sliced views of the physical layer serial data waveforms. They provide a fast, intuitive way to understand physical layer signal integrity and help to identify anomalies.



## Eye Diagrams

Teledyne LeCroy eye diagrams are generated from one long, continuous acquisition of either packetized or streaming data. They may be combined with masks and mask failure indications and eye (opening) parameters.

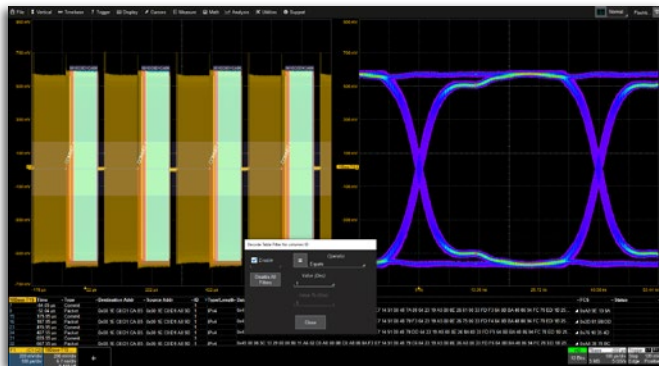
- Simple to set up - one button push
- Up to four simultaneous eye diagrams (with eye measurement parameters) may be viewed at one time
- Eye diagram mask testing including mask failure indication and failure locator trace waveform



## Eye Diagram Mask and Eye Measurements

Compare the eye diagram to predefined limits using an eye diagram mask. Eye diagram parameters and mask failures highlight timing or voltage margin problems.

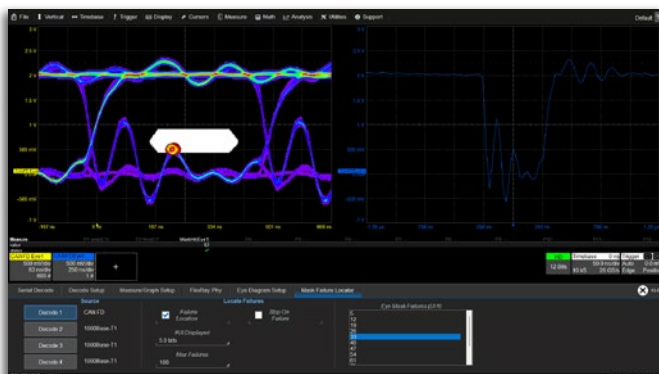
- Perform automated pass/fail test using standard or custom masks
- Visually identifies eye mask margin violations
- Quantify physical layer signal quality applying eye diagram measurements parameters



## Eye Diagram Data Filtering

Combine eye diagrams with data filtering (e.g., messages from a specific node or with a specific ID) to isolate problematic message frames or IDs and accelerate debugging and validation.

- Correlate physical layer issues with protocol-level events for faster root-cause identification and resolution
- Filter messages included in eye diagram by message ID or data value
- Quickly link signal integrity to protocol errors



## Eye Diagram Mask Failure Indication

Root-cause analysis is quickly performed on indicated failures.

- Red circles highlight mask failures for instant visibility
- Interactive failure table enables quick zoom to message or bit for detailed inspection
- Locator links each failure to the exact signal for precise analysis

# ADVANCED PHY TEST MADE SIMPLE

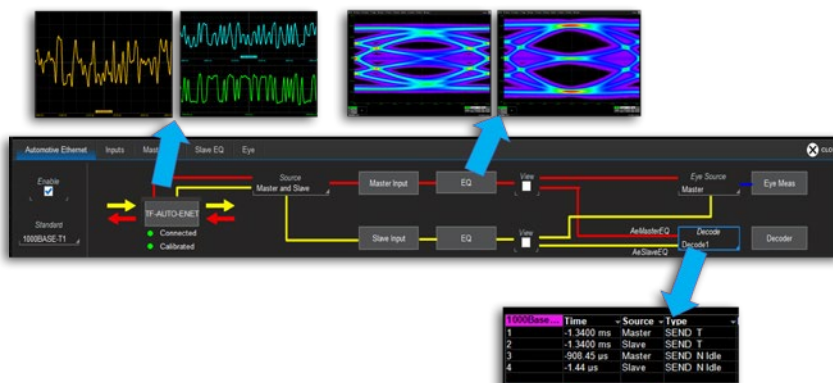
Make accurate PHY measurements according to the specific test definition with advanced eye diagrams, equalization, and specialized tools for precise analysis of complex standards.



## Advanced PHY Measurements

Some standards (e.g., FlexRay, MIPI, USB-PD, DisplayPort AUX) require specific eye diagram and measurement setups. For these standards, Teledyne LeCroy adds standard-specific capabilities and measurements.

- Meet strict eye diagram and measurement requirements for complex standards
- Ensure accurate measurements
- Retains all previously described eye diagram capabilities



## Accurate Automotive Ethernet Analysis

Automotive Ethernet standards, such as 100Base-T1 and 1000Base-T1, require signal equalization to ensure high fidelity PAM3 eye diagrams. Teledyne LeCroy's TDMP solutions for automotive ethernet include capabilities to ensure accurate measurements.

- Integrated equalizers to generate accurate PAM3 eye diagrams
- Accurately simulate real-world receiver behavior
- Provide accurate decoding in real time using equalized signal for master/slave configurations
- Compensate for coupler effects calculations

## Key Features

Set an ACK condition (ACK, NO ACK, Don't Care) in all frame trigger setups

Does not require clock trace to be displayed during decode

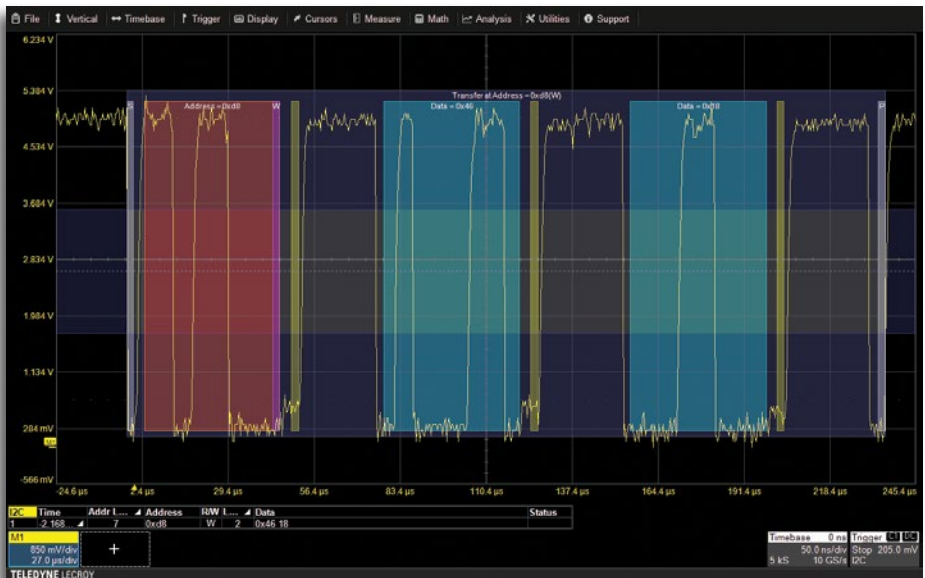
EEPROM read/write 2048 byte trigger capability

Frame Length trigger capability

Address can include a R/W bit, or define as Don't Care

Use analog or digital (MS0) inputs for acquisition and triggering

EXT input may be used for clock signal



| Trigger Type | Setup Format | Address Setup   | Data Pattern Setup | Ack Setup |
|--------------|--------------|-----------------|--------------------|-----------|
| Start        | Binary       | 7 Bits          | In Range of        | X         |
| Stop         | Hex          | 10 Bits         | At Position        | No Ack    |
| Restart      |              | Include R/W Bit | Byte Pos.          | Ack       |
| No Ack       |              | Direction       | Length             |           |
| Addr         |              | Don't Care      | Data Value         |           |
| Addr+ Data   |              |                 | 465BA1             |           |
| Frame Length |              |                 | 465BA9             |           |
| EE PROM      |              |                 |                    |           |

## More Trigger Choices

In addition to typical Start/Stop/ReStart, NoAck, Address and Address+Data triggers, Teledyne LeCroy provides triggering for EEPROM read/writes up to 2048 bytes long and for Frame Length. Address-based triggers permit an additional ACK condition (ACK present, NO ACK present, or DON'T CARE). and selection to include a R/W bit in a 7-bit trigger.

| Trigger Type | Setup Format | Address Setup   | Data Pattern Setup | Ack Setup |
|--------------|--------------|-----------------|--------------------|-----------|
| Start        | Binary       | 7 Bits          | Greater than       | X         |
| Stop         | Hex          | 10 Bits         | At Position        | No Ack    |
| Restart      |              | Include R/W Bit | Byte Pos.          | Ack       |
| No Ack       |              | Direction       | Length             |           |
| Addr         |              | Don't Care      | Data Value         |           |
| Addr+ Data   |              |                 | 54                 |           |
| Frame Length |              |                 |                    |           |
| EE PROM      |              |                 |                    |           |

## More Flexibility for Address-based Triggers

Address-based triggers permit an additional ACK condition (ACK present, NO ACK present, or DON'T CARE). and selection to define the transfer direction as a READ, WRITE or DON'T CARE (using R/W bit in a 7-bit trigger, or R/W Direction selection in a 10-bit trigger).

# SPECIFICATIONS

| I2Cbus TD and I2Cbus TDME            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Source Setup</b>                  | Select Source for Clock and Data.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Format</b>                        | Hexadecimal or Binary. ADDRESS and DATA can be set up with different formats.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Trigger Setup</b>                 | Trigger on START, ReSTART, STOP, Missing ACK, ADDR, DATA, ADDR+DATA, ADDR+DATA FRAME LENGTH, EEPROM DATA TRANSFER                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>ADDRESS Setup</b>                 | Specify one ADDRESS with condition of “=”.<br>7 or 10 bit ADDRESS supported with full Read, Write, or R/W=“Don’t Care” selectability on both 7 and 10 bit ADDRESSES.<br>Choose to Trigger on address values that include/don’t include R/W bit in address value.                                                                                                                                                                                                                                                     |
| <b>DATA Setup</b>                    | ADDRESS+DATA Trigger Type:<br>Hexadecimal: # Data Bytes = 0 to 12. Data can be defined by nibble.<br>Binary: Any combination of 0,1, or X for 1-96 bits<br>Data pattern can be set to start at any location in the 12 Byte / 96 bit sequence.<br>ADDRESS+ DATA FRAME LENGTH Trigger Type: # Data Bytes = 0 to 2047.<br>EEPROM DATA TRANSFER Trigger Type:<br># Data Bytes = 0 to 12. Data can be defined by nibble.<br>Data pattern can be set to start at the beginning of any byte in an up to 2048 byte sequence. |
| <b>DATA Conditions</b>               | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON’T CARE.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>ACK Conditions</b>                | For any ADDR, ADDR+DATA, ADDR+DATA FRAME LENGTH, or EEPROM DATA TRANSFER setup, select an ACK Condition of ACK, NO ACK, and DON’T CARE.                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Bit Rates</b>                     | Full range over I2C specification for Standard, Fast, Fast-Mode Plus, and High-Speed modes. Auto-detected.                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input. Clock may be input to EXT to conserve available analog Channels.                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Format</b>                        | Hexadecimal, Binary, ASCII.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Decode Setup</b>                  | Threshold definition required. Default is to Percent amplitude.<br>Choose to Decode address values including/not including the R/W bit in address value.                                                                                                                                                                                                                                                                                                                                                             |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.<br>Clock channel may be turned OFF and data will still decode (reduces screen clutter)                                                                                                                                                                                                                                                                                                                                                              |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Visual Aid</b>                    | Color Coding for FRAME, START/ReSTART bit, ADDR, R/W, DATA, ACK, NACK, and STOP bit.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                                                                                                                                  |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                           |
| <b>Pattern Search</b>                | Search for Previous or Next ADDRESS, PACKET, or DATA in hexadecimal format.                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| I2Cbus TDME only                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.<br><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                                                 |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger) measurement parameters.<br>Serial Message may be defined by “ID =” (where applicable) and user-defined DATA condition of <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %:</b><br>Serial Message may be defined by “ID =” (where applicable) and user-defined “DATA <=, <, =, >, >=, <>, in range, out of range” in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                                               |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                                                  |

## Key Features

**Supports nearly any type of SPI, including simplified SPI with no Chip Select and SPI DDR**

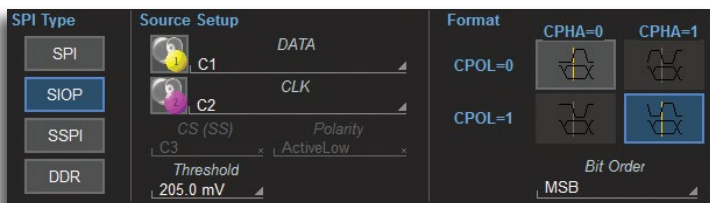
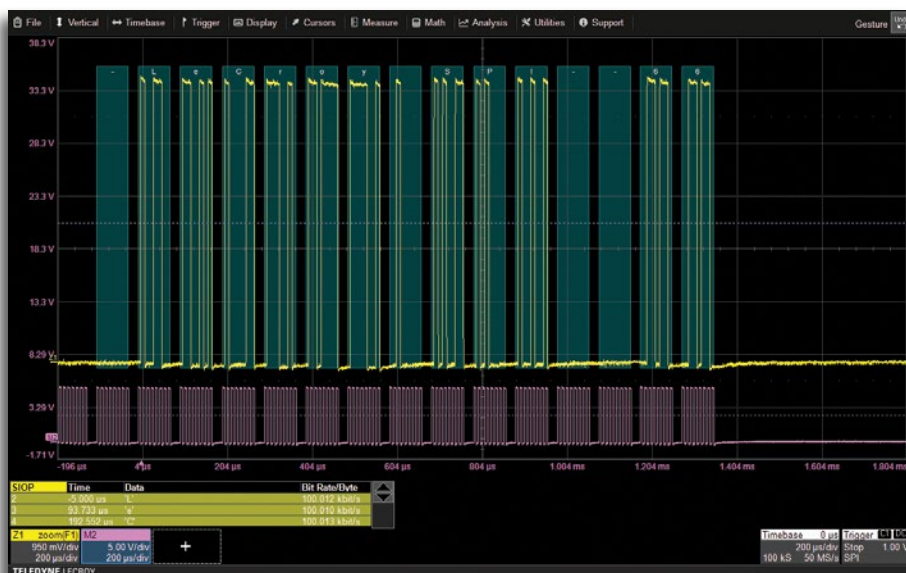
**Interframe message time setup permits Frame definition for support of many proprietary USART-based protocols**

**Flexible Bits/Word Decode Setup**

**Does not require clock trace to be displayed during decode**

**Use analog or digital (MSO) inputs for acquisition and triggering**

**EXT input may be used for clock signal**

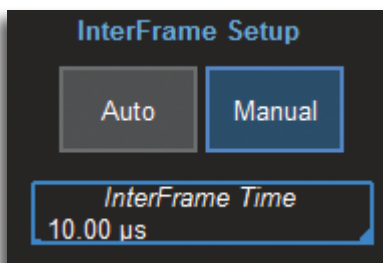


## SPI Triggering When No Chip Select is Present

Most SPI triggers require that a Chip Select signal be present. However, simplified (single-master, single-slave) SPI (also referred to as SSPI or SIOPI) has no Chip Select. Our solution still permits triggering on simplified SPI through use of an Interframe Setup time. In most cases, the AUTO default provides accurate results, but MANUAL selection is also available.

## Interframe Message Time Setup for Proprietary USART-based Protocols

Two line (CLOCK and DATA) serial data signals with proprietary formats are sometimes used. This is commonly known as a USART. Given the flexibility of the setup of our trigger and decoder, it is often possible to use the Interframe Message Time Setup to “packetize” consecutive bytes into one Message Frame, and then trigger on serial data in a particular byte location in the complete multi-byte Frame. Then, SPI-CUSTOM may be used to decode information as a complete Frame instead of individual Bytes.



# SPECIFICATIONS

| SPIbus TD and SPIbus TDME            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Source and Protocol Setup</b>     | Select Source for Clock, Data, and Chip/Slave Select (Chip/Slave Select not required for SIOP or SSPI types).<br>Select SPI Type (SPI, SIOP, SSPI, or SPI-DDR). SPI Type CUSTOM is also available in the decoder.<br>For SPI or SPI-Custom, select CPOL (Clock Polarity 0 or 1) and CPHA (DATA Polarity 0 or 1) (SIOP permits CPOL selection of 0 or 1, but CPHA = 1; SSPI CPOL=1, CPHA=1; SPI-DDR does not have CPOL or CPHA selection). Select DATA = MSB or LSB.<br>Select InterFrame Setup to Auto or Manual.                                                                                                                                                                                                                                                                                      |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Format</b>                        | Hexadecimal or Binary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Trigger Setup</b>                 | Trigger on DATA for any of the five SPI Modes with either MSB/LSB and with or without Slave Select.<br>InterFrame Setup permits user-definition of expected maximum time between clock bits so as to permit triggering with CLOCK and DATA signals in the absence of a CHIP/SLAVE SELECT signal (SIOP or SSPI). Typically, the InterFrame AUTO default of 4x a bit length is sufficient, but this can be set to any value.                                                                                                                                                                                                                                                                                                                                                                             |
| <b>DATA Setup</b>                    | Hexadecimal:<br># Data Bytes = 0 to 12. Data can be defined by nibble.<br>Binary: Any combination of 0,1, or X for 1-96 bits<br><br>Data pattern can be set to start at any location in the 12 Byte / 96 bit sequence.<br><br>InterFrame Time Setup is available for SIOP, SSPI, and SPI-CUSTOM Types. This permits user-definition of expected maximum time between clock bits so as to permit decoding in the absence of a Chip/Slave Select signal. The InterFrame AUTO default of 4x a bit length is typically sufficient, but this can be set to any value up to 10 seconds. It also enables definition of multiple SPI (any Type) byte packets into a single long message package of multiple SPI Data bytes, over which up to 12 Data Bytes can be defined for triggering (as described above). |
| <b>DATA Condition Setup</b>          | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Bit Rates</b>                     | Any, up to 25 Mb/s (typical).<br>Auto-detected from clock signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input. Clock or Chip/Slave Select may be input to EXT to conserve available analog Channels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Format</b>                        | Hexadecimal, Binary, ASCII                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Decode Setup</b>                  | Threshold definition required. Default is to Percent amplitude.<br>Choose to Decode address values including/not including the R/W bit in address value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.<br>Clock channel may be turned OFF and data will still decode (reduces screen clutter)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b># of Decoded Waveforms</b>        | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Visual Aid</b>                    | Color Coding for FRAME, START/ReSTART bit, ADDR, R/W, DATA, ACK, NACK, and STOP bit.<br>Decode information is intelligently annotated based on timebase setting.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Pattern Search</b>                | Search for Previous or Next MESSAGE or DATA Pattern in hexadecimal format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| SPIbus TDME only                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.<br><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                              |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger)<br>Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data.<br>Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %</b><br>Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                             |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                               |



# SPECIFICATIONS

| QSPI TD                              |                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                         |
| <b>Source and Protocol Setup</b>     | Select Source for Clock, Data, and Chip/Slave Select<br>Select QSPI Type (Simple Data SPI, Dual SPI, Quad SPI)<br>For QSPI select CPOL (Clock Polarity 0 or 1) and CPHA (DATA Polarity 0 or 1)<br>Select Address Length (8 - 32), Mode Bits (0,1,2), Dummy Cycles (0 - 32)<br>Select decoding with and without Command. |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                         |
| <b>Format</b>                        | Hexadecimal, Binary, ASCII and Symbolic (Command).                                                                                                                                                                                                                                                                      |
| <b>Trigger Setup</b>                 | Trigger on any of the three QSPI Modes Simple Data SPI, Dual SPI or Quad SPI<br>Trigger on Command, Command & Address or Command & Address & Data<br>Simple Data SPI only Direction: Read, Write or Any.                                                                                                                |
| <b>ADDRESS Setup</b>                 | Hexadecimal (1 -4 byte) or Binary (8 to 32 bit).                                                                                                                                                                                                                                                                        |
| <b>Command Setup</b>                 | Hexadecimal, Binary or Symbolic<br>Symbolic: WRSR, PP, RDSR, WREN, FASTREAD, SE, PP40, PP4IO, READ40, DPE, EN4B, DP, CE, BE, READ4IO                                                                                                                                                                                    |
| <b>DATA Setup</b>                    | Hexadecimal:<br># Data Bytes = 1 to 12. Data can be defined by nibble.<br>Binary:<br>Any combination of 0,1, or X for 1-96 bits<br><br>Data pattern can be any length and can be set to start at any location in the up to 12 Byte / 96 bit sequence.                                                                   |
| <b>DATA Condition Setup</b>          | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE.                                                                                                                                                                                                                                                             |
| <b>Trigger Input</b>                 | Any digital channel of build-in MSO.                                                                                                                                                                                                                                                                                    |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                         |
| <b>Format</b>                        | Hexadecimal, Binary, ASCII, Symbolic (Command).                                                                                                                                                                                                                                                                         |
| <b>Decode Setup</b>                  | Threshold definition required. Default is to Percent amplitude.<br><br>Select CPOL, CPHA, Chip/Slave Select Polarity = ACTIVE LOW or ACTIVE HIGH, Address length = 8 to 32, Mode Bits = 0 to 2, Dummy Cycles = 0 to 32 and decode with and without Command.                                                             |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.<br>Clock and/or Slave Select channel may be turned OFF and data will still decode (reduces screen clutter).                                                                                                                                            |
| <b># of Decoded Waveforms</b>        | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                               |
| <b>Location</b>                      | Overlaid on acquired DATA waveform, on Grid.                                                                                                                                                                                                                                                                            |
| <b>Visual Aid</b>                    | Color Coding for Command, Address, Alt Field, Dummy Cycles and DATA.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                     |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information.                                                                                               |
| <b>Pattern Search</b>                | Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.<br>Search for Previous or Next Idx, Time, Command, Address, ALT ( Mode) Byte and Data .                                                                                                                |

# UART AND RS232

## Key Features

**Completely configurable UART-byte structure**

**Customizable Message Frame (multiple bytes in one Frame) for proprietary protocol triggering**

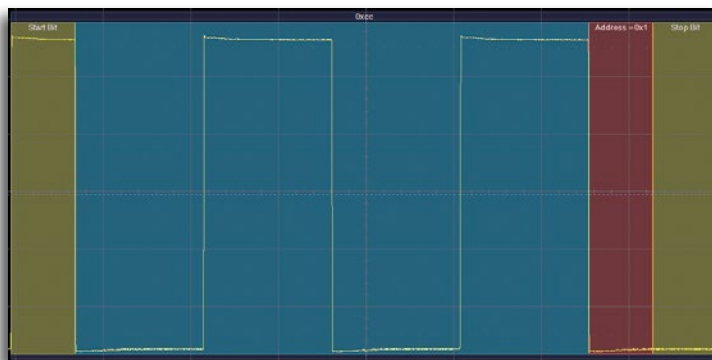
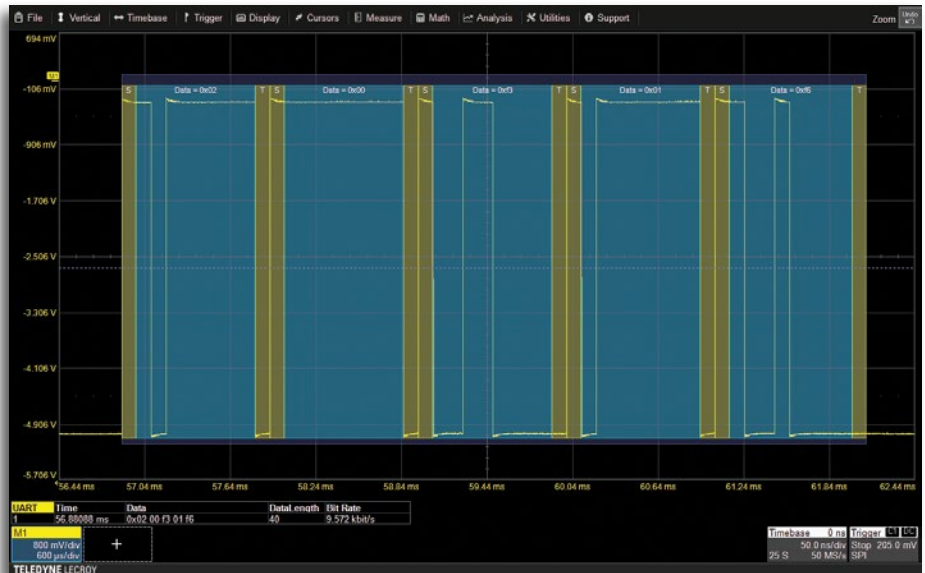
**Supports 9-bit “address” or “wakeup” mode in byte definition (triggering and decoding)**

**Supports up to 16-bit Data words for decoding**

**Binary, Hexadecimal, ASCII or Decimal decoding**

**Polarity either IdleLow or IdleHigh**

**Use analog or digital (MSO) inputs for acquisition and triggering**



## 9-bit “Address” or “Wakeup” Triggering

Most UART triggers assume a maximum of 8 data bits (excluding stop/start and parity bits) in a single byte. However, our solution supports 9-bit data bytes for situations in which a UART protocol is utilized for Address, Wakeup or other communication to another peripheral, preceding the normal serial data byte transmission.

## Interframe Message Time Setup for Proprietary UART-based Protocols

UART byte-based serial data signals with proprietary formats are often used. Given the flexibility of the setup of our trigger and decoder, it is often possible to use the Interframe Message Time Setup to “packetize” consecutive bytes into one Message Frame, and then trigger on in serial data in a particular byte location in the complete multi-byte Frame. Then, the UART decoder may be used to decode information as a complete Frame instead of individual Bytes.



| UART | Time        | Data             | DataLength | Bit Rate     |
|------|-------------|------------------|------------|--------------|
| 1    | 45.12542 ms | 0x40 00 4f 59 71 | 40         | 9.615 kbit/s |
| 2    | 56.88088 ms | 0x40 00 cf 80 6f | 40         | 9.609 kbit/s |
| 3    | 68.68821 ms | 0x40 00 2f 59 09 | 40         | 9.614 kbit/s |
| 4    | 80.45641 ms | 0x40 00 af 80 1f | 40         | 9.621 kbit/s |

# SPECIFICATIONS

| UART-RS232bus TD and UART-RS232bus TDME |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                          |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Definition                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                          |
| Source and Protocol Setup               | For UART:<br>Select Source for Data<br>Select BitRate<br>Select # Data Bits (5-9)<br>Select Parity (Odd, Even, None)<br>Select # Stop Bits (1, 1.5, 2)<br>Select Bit Order (MSB or LSB)<br>Select Polarity (IdleLow or IdleHigh)                                                                                                                                                                                                                                      | For RS-232:<br>Select Source for Data<br>Select BitRate<br>Select # Data Bits (5-8)<br>Select Parity (Odd, Even, None)<br>Select # Stop Bits (1, 1.5, 2) |
| Trigger Capability                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                          |
| Format                                  | Hexadecimal or Binary                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                          |
| Trigger Setup                           | Trigger on DATA or Parity Error                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                          |
| DATA Setup                              | Hexadecimal:<br># Data Bytes = 0 to 12. Data can be defined by nibble.<br>Binary:<br>Any combination of 0,1, or X for 1-96 bits<br>Data pattern can be set to start at any location in the 12 Byte / 96 bit sequence.<br>"Frame" definition permits definition of UART byte packets into a single long message package through a user-defined "Interframe Time" value. In this mode, a 12-bit Data pattern can be defined anywhere in a 2048 UART byte message frame. |                                                                                                                                                          |
| DATA Condition Setup                    | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                          |
| Bit Rates                               | User-defined to any nominal value from 300 b/s to 10 Mb/s                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                          |
| Decode + Search Capability              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                          |
| Format                                  | Hexadecimal, Binary, ASCII                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                          |
| Decode Setup                            | Threshold definition required. Default is to Percent amplitude.<br>Select BitRate, # Data Bits (5 to 16), Parity (NONE, ODD, EVEN),<br># Stop Bits (1 or 2), Bit Order (MSB or LSB), and Polarity (IDLE HIGH or IDLE LOW)<br>(for RS-232, no Bit Order or Polarity setup).<br>Frame definition permits definition of UART byte packets into a single long (decoded) message package through a user-defined "Interframe Time" value.                                   |                                                                                                                                                          |
| Decode Input                            | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                          |
| # of Decodes                            | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                          |
| Visual Aid                              | Color Coding for START Bit, STOP Bit, PARITY Bit, and DATA bytes.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                                                                                                      |                                                                                                                                                          |
| Table Configure, Export Table           | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                            |                                                                                                                                                          |
| Pattern Search                          | Search for Previous or Next ERROR or DATA Byte in hexadecimal format.                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                          |

| UART-RS232bus TDME only                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.<br><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                              |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger)<br>Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data.<br>Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %</b><br>Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                             |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Failure Indication and Location</b>                | "Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                              |

# 10BASE-T1S

## Key Features

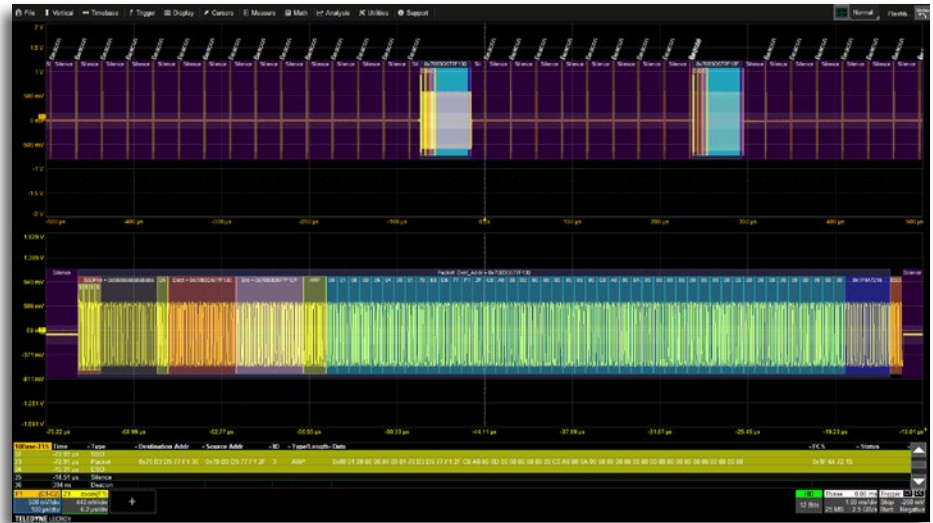
Trigger on Beacon, ID, ID + DATA, Commit/Sync, ESD and CRC-Error

Automatically identifying Node ID simplifies setting up the trigger / decoder

Filtering by node ID and Eye Diagrams identify physical layer issues

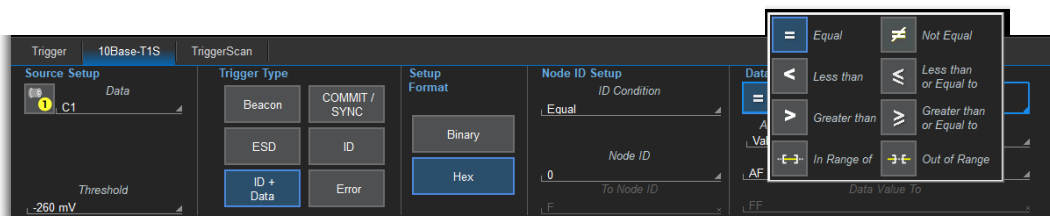
Unique measure/graph capabilities:

- Verify PLCA timing with automated measurements
- Serial DAC - extract digital data and plot it as a waveform



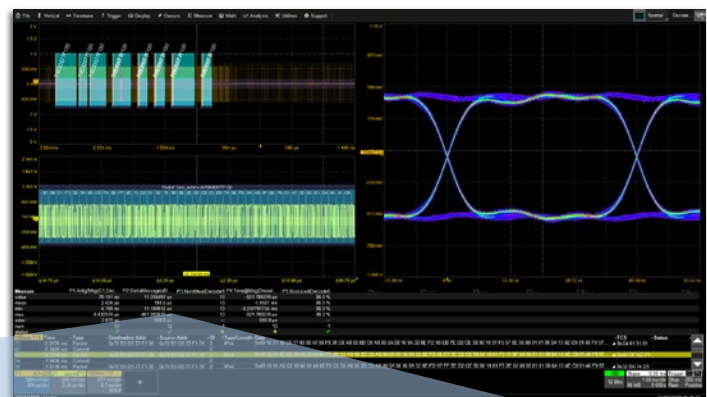
## Comprehensive and Powerful 10Base-T1S Trigger

Capability is provided to permit triggering on Beacon, ID, ID + DATA, Commit/Sync, ESD and CRC-Error. Trigger on Data with full capability to define specific data values or ranges of data values up to 12bytes within the complete data field. The automatic assignment of node ID to MAC address based on analyzing the PLCA cycle simplifies the setting up of the trigger/decoder function.



## Great tools for identifying physical layer issues

The possibility of filtering the decoded data by specific node ID together with the display of eye diagram and the bus specific timing measurements helps to identify problems on the physical layer and in the PLCA cycle.



| Measure | P1:Anlg2Msg(C1,Dec... | P2:DeltaMessages(D... | P3:NumMsg(Decode1) | P4:Time@Msg(Decod... | P5:BusLoad(Decode1) |
|---------|-----------------------|-----------------------|--------------------|----------------------|---------------------|
| value   | 79.151 ns             | 11.208457 µs          | 13                 | -921.789235 µs       | 38.3 %              |
| mean    | 2.626 µs              | 193.0 µs              | 13                 | -1.9507 ms           | 38.3 %              |
| min     | 4.788 ns              | 11.199912 µs          | 13                 | -3.237791734 ms      | 38.3 %              |
| max     | 8.432939 µs           | 461.992070 µs         | 13                 | -921.789235 µs       | 38.3 %              |
| sdev    | 3.870 µs              | 168.8 µs              | —                  | 690.9 µs             | —                   |
| num     | 13                    | 12                    | 1                  | 13                   | 1                   |
| status  | ✓                     | ✓                     | ⚠                  | ⚠                    | ✓                   |

# SPECIFICATIONS

| 10Base-T1S TD and 10Base-T1S TDME    |                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                            |
| <b>Source and Protocol Setup</b>     | Select Source.                                                                                                                                                                                                                                                                                                                             |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>                        | Hexadecimal or Binary.                                                                                                                                                                                                                                                                                                                     |
| <b>Trigger Setup</b>                 | Trigger on Beacon, COMMIT/SYNC, ESD (ESDOK, ESDERR, ESDJAB), ID, ID+DATA and Errors.                                                                                                                                                                                                                                                       |
| <b>ADDRESS Setup</b>                 | Specify Frame ID(s) in Hexadecimal or Binary with condition of <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE.                                                                                                                                                                                                                 |
| <b>DATA Setup</b>                    | Hexadecimal: # Data Bytes = 0 to 12.<br>Binary: Any combination of 0,1, or X for 1-96 bits<br>Data pattern can be up to 12byte (96bit) and can be set to start at any location in the data sequence.                                                                                                                                       |
| <b>DATA Condition Setup</b>          | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE.                                                                                                                                                                                                                                                                                |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input. External MSO not supported.                                                                                                                                                                                                                                                         |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>                        | Hexadecimal or Binary.                                                                                                                                                                                                                                                                                                                     |
| <b>Decode Setup</b>                  | Select Probing Type (Differential Probe, Single-ended Probes)<br>Define level or use Auto Levels.                                                                                                                                                                                                                                          |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                           |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                  |
| <b>Location</b>                      | Overlaid on acquired waveform, on Grid.                                                                                                                                                                                                                                                                                                    |
| <b>Visual Aid</b>                    | Color Coding for Beacon, COMMIT, Preamble, SFD, Destination Address, Source Address, Type/Length, Data, FCS, ESD and Idle.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                  |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns. |
| <b>Pattern Search</b>                | Search for previous or next: Index, Time, Type, Destination Address, Source Address, Type/Length, Data, FCS and Status.                                                                                                                                                                                                                    |

| 10Base-T1S TDME only                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value measurement parameter</b> extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.<br><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                         |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %</b><br>Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                        |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Apply to Zoom, Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                   |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits, Failure Location.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                          |

# OPEN ALLIANCE 3-PIN (OA3P)

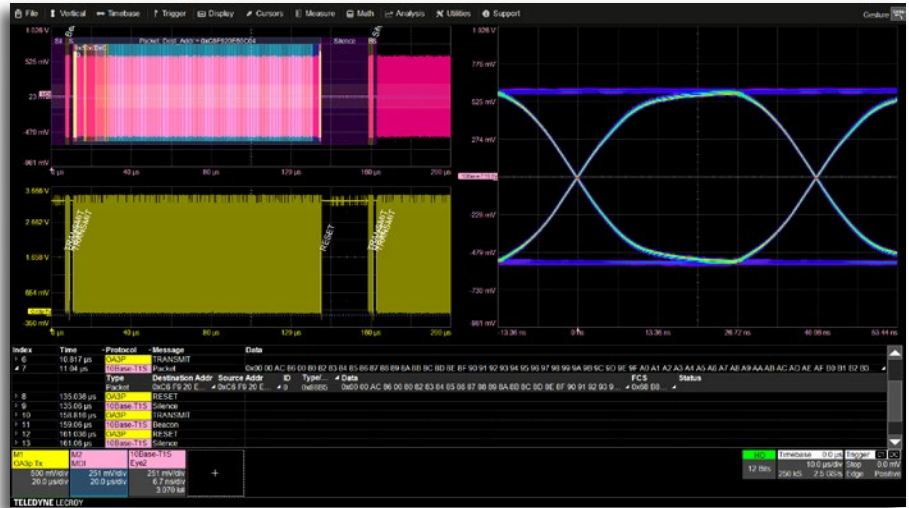
## Key Features

**Trigger and decode Open Alliance 3-pin (OA3p) digital PHY interface to check config, status, and data integrity**

**Inspect received data for MDI signal integrity and interference issues**

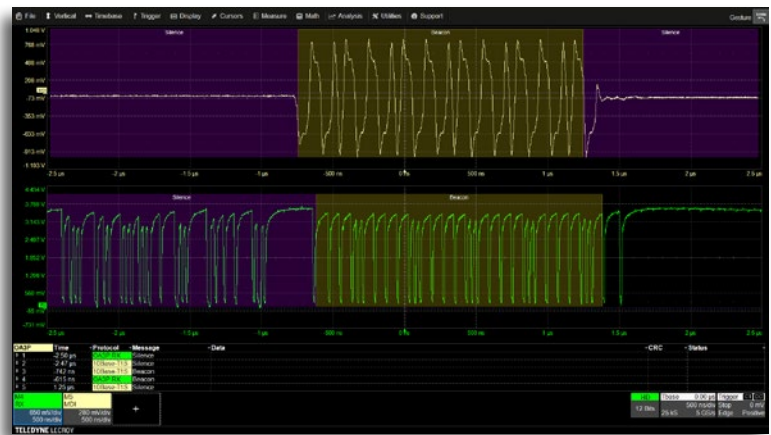
**Monitor commands to assess transceiver status**

**Check MDIO traffic to verify transceiver configuration**



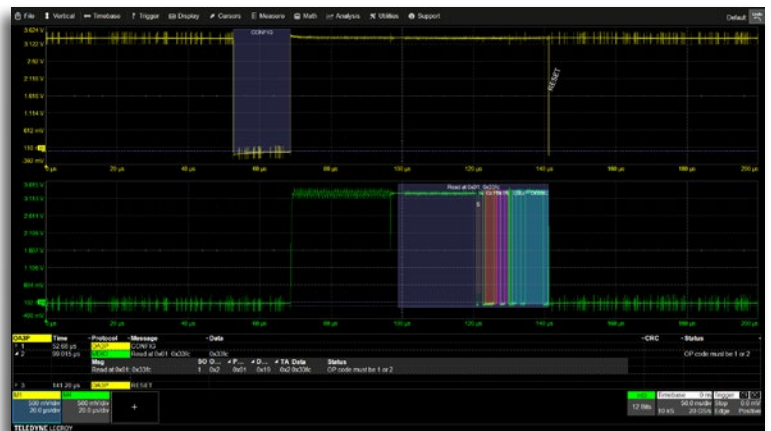
## Accelerate Debug with Correlated Views

Simultaneous decoding on the MDI and OA3p Rx pins tightly correlates protocol activity with the underlying analogue behaviour. This multi-decoder approach makes it easier to detect decoding mismatches, pinpoint signal integrity degradations, and identify interference related issues, ensuring reliable verification of 10BASE T1S link performance in real world conditions.



## Instant Insight into PHY Configuration

MDIO decoding on the OA3p interface provides immediate insight into transceiver behaviour. By tracking configuration commands and status reads, engineers can validate PHY settings, confirm correct operation, and spot configuration related issues early—streamlining debug workflows and boosting confidence in system performance.



# SPECIFICATIONS

| OA3p Trigger and Decode capability (provided in AUTOENET-10M Bundle) |                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                                                    |                                                                                                                                                                                                                                                                                                                               |
| <b>Source Setup</b>                                                  | Select Source,<br>Select Decode (Tx Commands, RX/MDIO, MDI).                                                                                                                                                                                                                                                                  |
| <b>Trigger Capability</b>                                            |                                                                                                                                                                                                                                                                                                                               |
| <b>Trigger Setup</b>                                                 | Trigger on TRANSMIT, RESET, LOWPWRRQ, CONFIG                                                                                                                                                                                                                                                                                  |
| <b>Command Setup</b>                                                 | TRANSMIT: ttxph1Min, ttxph1Max, ttxp/Min, ttxp/Max (5ns - 3ms)<br>RESET: ttxrstMin, ttxrstMax (5ns - 3ms)<br>LOWPWRRQ: ttx/pwMax (5ns - 3ms)<br>TRANSMIT: ttxphMin, ttxphMax, ttxp/Min, ttxp/Max, ttxcfgMax (5ns - 3ms).                                                                                                      |
| <b>Trigger Input</b>                                                 | Any analog Channel or Digital input, or the EXT input                                                                                                                                                                                                                                                                         |
| <b>Trigger Design</b>                                                | Internal to oscilloscope, settable like any other oscilloscope trigger                                                                                                                                                                                                                                                        |
| <b>Decode + Search Capability</b>                                    |                                                                                                                                                                                                                                                                                                                               |
| <b>Decode Setup</b>                                                  | Define Level Type (Percent or Absolute) and Vertical Level (% or V) for TX, RX/Clock MDIO, FD/Data MDIO and MDI Hysteresis Type (Divisions, Percent or Absolute) and Hysteresis Level (div, % or V).                                                                                                                          |
| <b>Decode Input</b>                                                  | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                              |
| <b># of Decodes</b>                                                  | MDI, Tx, Rx or MDIO can be decoded at the same time. Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                |
| <b>Location</b>                                                      | Overlaid on acquired waveform, on Grid.                                                                                                                                                                                                                                                                                       |
| <b>Visual Aid</b>                                                    | Color Coding for OA3p commands (CONFIG, RESET, LOWPWRRQ), Color coding for MDI (same as 10Base-T1S decoder), Color coding for MDIO (same as MDIO decoder), Rx (same as 10Base-T1S decoder)                                                                                                                                    |
| <b>Table Configure, Export Table</b>                                 | Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.<br>Display 1 to 20 rows of decoded information for MDI, Tx, Rx or MDIO decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. |
| <b>Pattern Search</b>                                                | Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.<br>Search for previous or next: Index, Time, Protocol, Message, Data and CRC                                                                                                                                 |

# 100BASE-T1

## Key Features

Easily trigger and debug Link Startup handshaking

Debug link start-up handshaking enables deep system insight

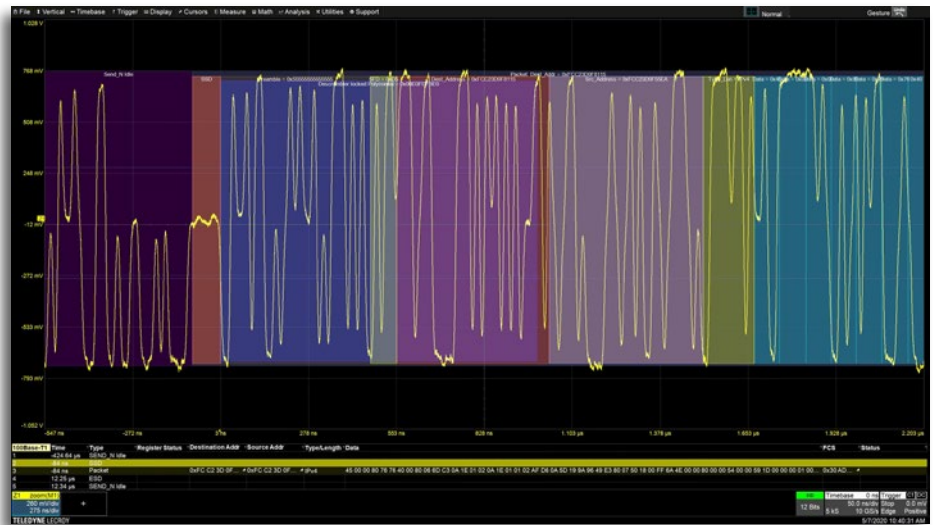
Easily trigger and debug Link Startup handshaking

Identify Link Startup and Packet Errors

Descramble 100Base-T1 Data Packets

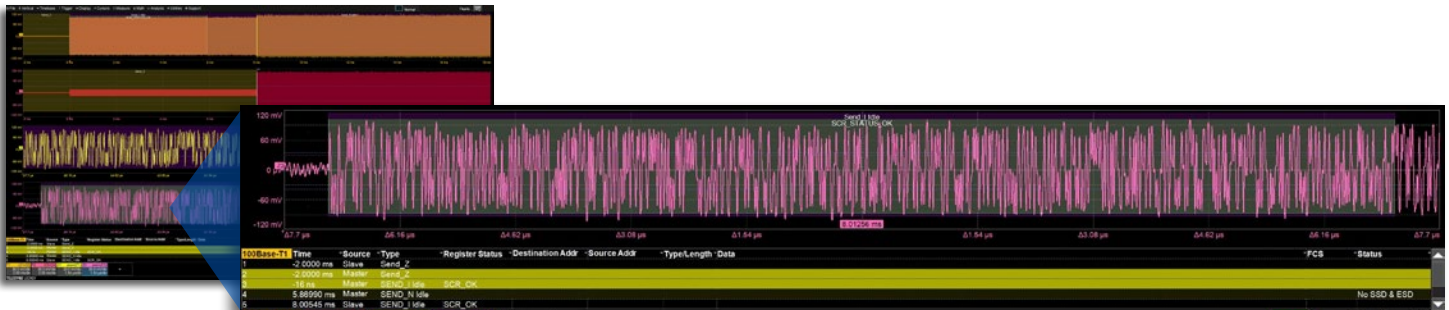
Bidirectional coupler with built-in calibration provides superior signal fidelity

PAM3 Eye Diagram lets characterize system performance



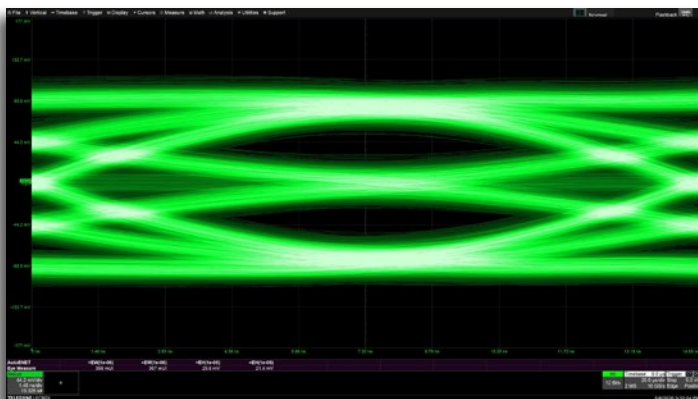
## Debug Link Start-up Handshaking Enables Deep System Insight

Trigger on and decode the link startup handshaking between the Master and Slave. Track where the devices are in the handshaking sequence to determine the cause of a proper link not being established.

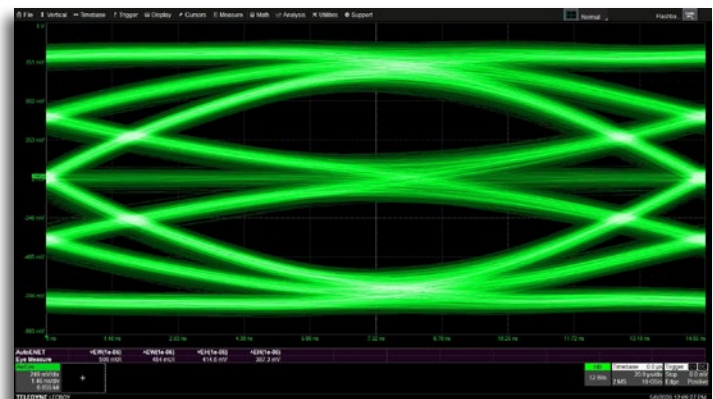


## Enhanced Signal Separation Provides Superior Signal Fidelity

The TF-AUTO-ENET separates bi-directional link traffic to independently view signals from the Master and Slave. The software enhances the directivity of the directional couplers in real time, providing superior signal fidelity compared to other directional coupler approaches. Together with the features of the PAM3 eye diagram, it is the ideal tool to find signal integrity problems in real world systems.



Before



After software enhancement to improve the directivity.

# SPECIFICATIONS

| 100Base-T1 TD and 100Base-T1 TDMP    |                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                            |
| <b>Source and Protocol Setup</b>     | Select Source(s) for Master and/or Slave.                                                                                                                                                                                                                                                                                                  |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                            |
| <b>Trigger Setup</b>                 | Trigger on Master or Slave Start-up Sequence.                                                                                                                                                                                                                                                                                              |
| <b>Trigger Input</b>                 | Any analog Channel or the EXT input.                                                                                                                                                                                                                                                                                                       |
| <b>Trigger Design</b>                | Internal to oscilloscope, settable like any other oscilloscope trigger.                                                                                                                                                                                                                                                                    |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>                        | Ternary symbols or Descrambled bits (Hexadecimal).                                                                                                                                                                                                                                                                                         |
| <b>Decode Setup</b>                  | Integrated CTLE, FFE and DFE equalizer. Parameter can be set separately for Master and Slave (100Base-T1 TDMP only).                                                                                                                                                                                                                       |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, any Digital trace and output from CTLE, FFE and DFE equalizer.                                                                                                                                                                                                                                   |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                  |
| <b>Location</b>                      | Overlaid on acquired waveform, on Grid.                                                                                                                                                                                                                                                                                                    |
| <b>Visual Aid</b>                    | Color Coding for Packet, SSD, ESD, Preamble, SFD, Destination Address, Source Address, Type/Length, Data, FCS, Descrambler Locked Polynomial, and Idle. Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                        |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns. |
| <b>Pattern Search</b>                | Search for previous or next: Index, Time, and Type, Register Status, Destination Addr, Source Addr, Type/Length, Data, FCS and Status.                                                                                                                                                                                                     |

| 100Base-T1 TDMP only                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion. <b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                            |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %</b> . Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                         |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Setup</b>                                          | PAM3 Eye Diagram and Eye Contours. Source could be Master or Slave calculated from the physical layer signal or from the output of the CTLE, FFE and/ or DFE equalizer.<br>Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.<br>Eye Contours can be selected from 10e-3 up to 10e-9.                                                                                                                                                                                                                                     |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, Symbol rate, # of Symbols, Mean Levels and RMS levels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

# 1000BASE-T1

## Key Features

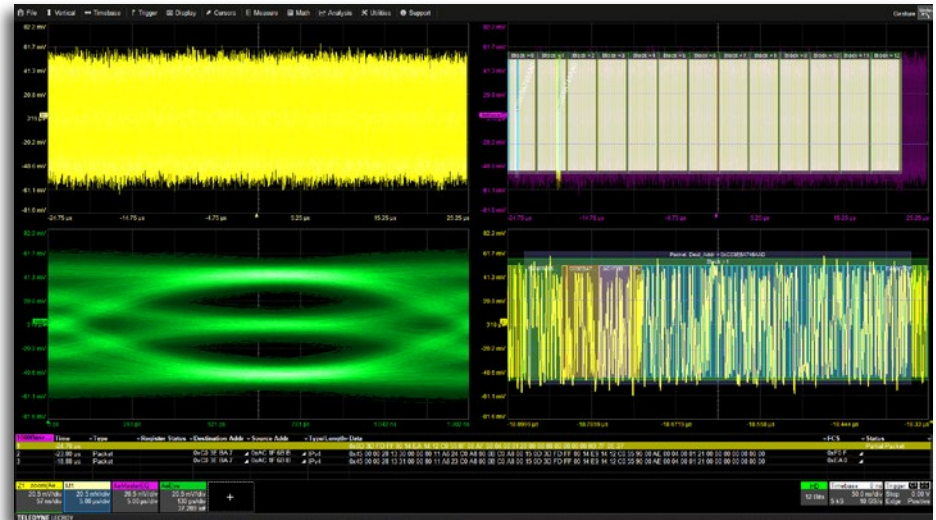
Integrated equalizer shows real receiver behavior and improves decoding of real-world signals

Bidirectional coupler with built-in calibration provides superior signal fidelity

Debug link start-up handshaking enables deep system insight

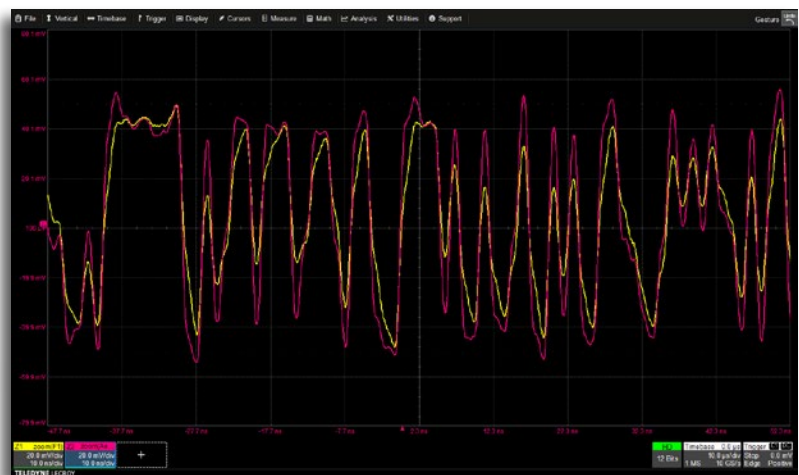
PAM3 Eye Diagram lets characterize system performance

Automatic timing measurements supports latency monitoring



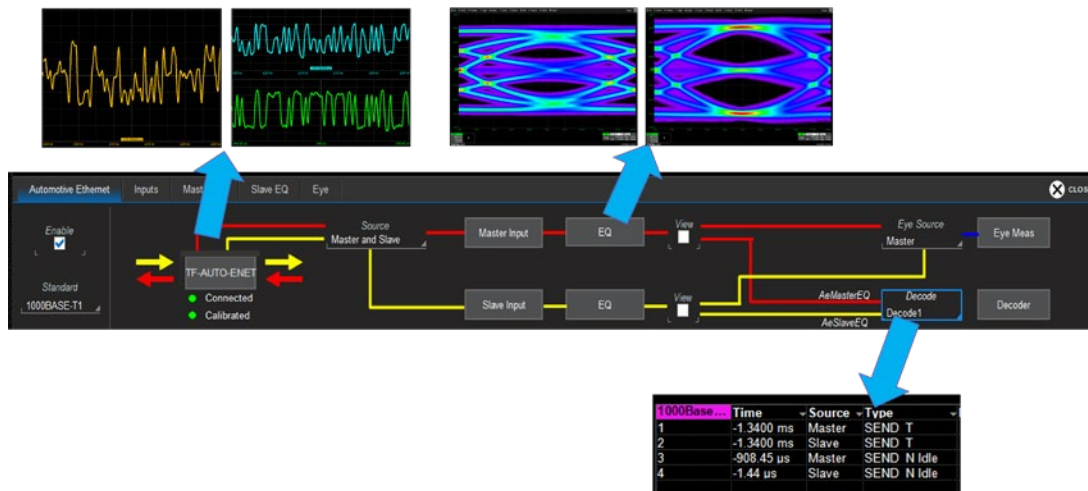
## The Only Decoder And Debugger For Real World Signals

The equalizers integrated into the software gives the ability to decode real-world signals (yellow) and allows to simulate real receiver behavior (purple). The parameters can be set separately for master and slave. Together with the possibility of compensation for the effects of the bi-directional coupler, the conditions in real systems can be reproduced.



## Combine Trigger & Decoder with Measure and Debug Tools

A single tool that connects the entire signal processing flow, from input through equalizer functions to the final output to the eye diagram display and/or decoder. This enables a complete analysis, simplifies the settings, and provides an ideal overview.



# SPECIFICATIONS

| 1000Base-T1 TD and 1000Base-T1 TDMP  |                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                           |
| <b>Trigger Input</b>                 | Any analog Channel or the EXT input                                                                                                                                                                                                                                                                                                       |
| <b>Trigger Design</b>                | Internal to oscilloscope, settable like any other oscilloscope trigger                                                                                                                                                                                                                                                                    |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                           |
| <b>Format</b>                        | Ternary symbols or Descrambled bits (Hexadecimal)                                                                                                                                                                                                                                                                                         |
| <b>Decode Setup</b>                  | Integrated CTLE, FFE and DFE equalizer. Parameter can be set separately for Master and Slave.                                                                                                                                                                                                                                             |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, any Digital trace and output from CTLE, FFE and DFE equalizer.                                                                                                                                                                                                                                  |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                 |
| <b>Location</b>                      | Overlaid on acquired waveform, on Grid.                                                                                                                                                                                                                                                                                                   |
| <b>Visual Aid</b>                    | Color Coding for Packet, SSD, ESD, Preamble, SFD, Destination Address, Source Address, Type/Length, Data, FCS, Descrambler Locked Polynomial, and Idle<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform                                                                      |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns |
| <b>Pattern Search</b>                | Search for previous or next: Index, Time, and Type, Register Status, Destination Addr, Source Addr, Type/Length, Data, FCS and Status                                                                                                                                                                                                     |

| 1000Base-T1 TDMP only                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion. <b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                            |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %.</b> Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                          |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Setup</b>                                          | PAM3 Eye Diagram and Eye Contours. Source could be Master or Slave calculated from the physical layer signal or from the output of the CTLE, FFE and/ or DFE equalizer. Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%. Eye Contours can be selected from 10e-3 up to 10e-9.                                                                                                                                                                                                                                           |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, Symbol rate, # of Symbols, Mean Levels and RMS levels                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

# CAN, CAN FD, CAN FD LIGHT, AND CAN XL

## Key Features

**Supports all versions of CAN: Classic CAN, CAN FD, CAN FD Light and CAN XL with SIC and FAST mode up to 20 Mbit/s**

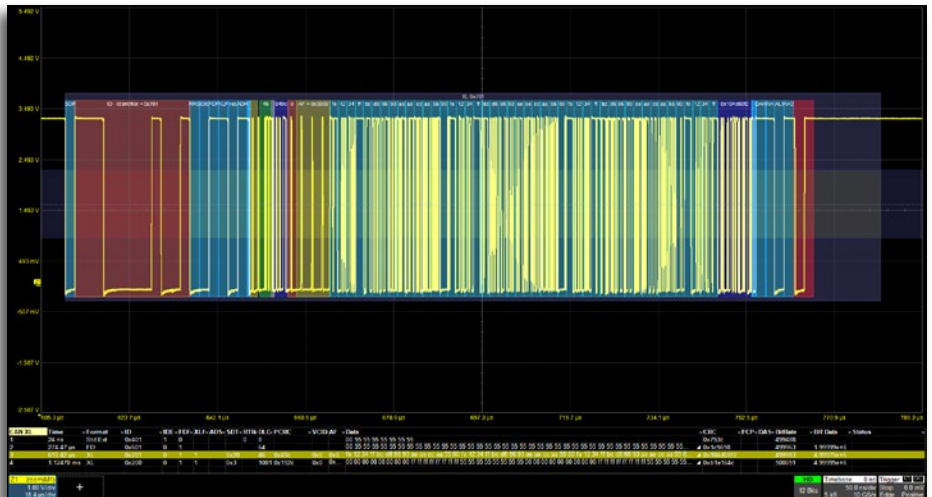
**Symbolic trigger setup, decode, and data extraction and graph setup using (customer-supplied) DBC or ARXML file**

**Error-frame red color decode highlight**

**DATA trigger pattern setup can be less than full bytes/nibbles and can be spread across bytes**

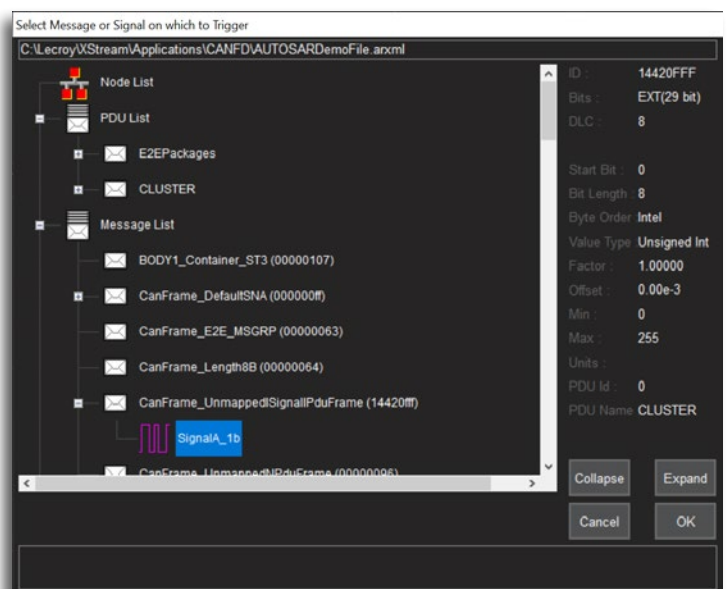
**Conditional ID definition (<, <=, =, >, >=, <=, IN RANGE, OUT of RANGE)**

**Supports 29-bit GM CAN Priority ID, Source ID, Parameter ID trigger and decode**



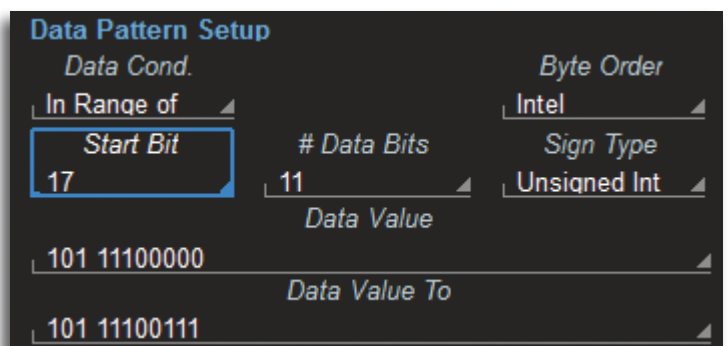
## Symbolic (DBC & ARXML) File Support

CAN, CAN FD, CAN FD Light and CAN-XL decode options support use of a customer-supplied DBC or ARXML file for signal selection for triggering and CAN to Value serial data DAC setup. Additionally, the decode annotation is in Symbolic format as well, with complete message and signal structures described.



## Trigger Flexibly Across Data Bytes

CAN remains the most used vehicle serial data bus. Many vehicle bus software architectures are very message dense, and data for a single message is spread across multiple data bytes. The hexadecimal and measurement toolsets permit isolation of specific bit-level data patterns in one or more data bytes, e.g., data location in bits 17-28 in data bytes 3, 4, and 5. This provides significant advantages in isolating the exact information or behavior you need. Symbolic message/signal setup is even simpler.



# SPECIFICATIONS

| CAN FDbus TD<br>CAN XL TD                |  | CAN FDbus TDME Symbolic<br>CAN XL TDME Symbolic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
|------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Definition                               |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Protocol Setup                           |  | CAN FDbus and CAN XL Select Source. Select Nominal BitRate for CAN FDbus and CAN XL select Data BitRate.<br><b>CAN FDbus:</b> Select Frame Type (EDL) Any(X), CAN Standard (0), or CAN FD (1). Select ISO FRAME, and BR Select (BRS) Any(X), Normal(0), or FD(1).<br><b>CAN XL:</b> Select Frame Type Any, Classic CAN, CAN FD, CAN FD Light or CAN XL. Select CAN-XL FAST and BR Select (BRS) Any(X), Normal (0), FD(1).                                                                                                                                                                        |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Trigger Capability                       |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Format                                   |  | <b>CAN FDbus:</b> Hexadecimal or Binary for ID and Data<br><b>CAN XL:</b> Hexadecimal or Binary for ID, Data and VICD.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | <b>CAN FDbus:</b> Symbolic, Hexadecimal or Binary for ID and Data<br><b>CAN XL:</b> Symbolic, Hexadecimal or Binary for ID, Data and VICD .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| Trigger Setup                            |  | <b>CAN FDbus:</b> Trigger on ID, ID+DATA, REMOTE, ERROR or ALL (Data, Remote, or Error Frame) frames.<br><b>CAN XL:</b> Trigger on ID, ID+DATA, REMOTE, ERROR, SDT, VCID or ALL (Data, Remote, or Error Frame) frames.<br>Set Requested (Bit) Sampling Point from 20 to 90% (Basic) or set values for Prop Seg, Phase_Seg1, Phase_Seg2, and SJW for (Advanced) independently for Nominal Bit Time, FD Bit Time and XL Bit Time.                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| ID Setup                                 |  | <b>Hexadecimal or Binary:</b><br>Specify STD (11-bit), EXT (29-bit) or Any; ID(s) with condition of <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DONT CARE.<br>Supports triggering when both 11-bit and 29-bit IDs are present on the bus.                                                                                                                                                                                                                                                                                                                                                    |  | <b>Symbolic:</b><br>Specify a Message to trigger on using customer supplied DBC or ARXML data base file. Choose from list sorted by Node, Message, or Signal.<br><b>Hexadecimal or Binary:</b><br>Specify STD (11-bit) or EXT (29-bit) ID(s) with condition of <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DONT CARE.<br>Supports triggering when both 11-bit and 29-bit IDs are present on the bus.                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| DATA Setup                               |  | <b>Hexadecimal:</b> # Data Bytes = 0 to 24 Data bytes can be defined by nibble.<br><b>Binary:</b> Any combination of 0,1, or X for 1-96bits.<br>Data pattern can be any length and can be set to start at any location in the up to 512 (CAN & CAN FD) or 16384(CAN XL) bit sequence. Byte Order Intel or Motorola format, Signed or Unsigned Data.                                                                                                                                                                                                                                              |  | <b>Symbolic:</b> Message+Signal with Signal value set in scaled units as defined in customer supplied DBC/ARXML database file.<br><b>Hexadecimal:</b> # Data Bytes = 0 to 24 Data bytes can be defined by nibble.<br><b>Binary:</b> Any combination of 0,1, or X for 1-96bits.<br>Data pattern can be any length and can be set to start at any location in the up to 512 (CAN & CAN FD) or 16384(CAN XL) bit sequence. Byte Order Intel or Motorola format, Signed or Unsigned Data.                                                                                                                                                                                                                                                                                                                                                                  |  |
| DATA Cond. Setup                         |  | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DONT CARE (not available for bitrates >15Mb/s).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Error Frame Setup                        |  | Select any combination of All Error Frames, Stuff Bit Errors, CRC Mismatch Errors, Stuffbit Counter Error, or Stuffbit Counter Parity Error<br>CAN XL : Form, Ack, PCRC Preface, FCP Format and FCRC Frame CRC (not available for bitrates >15Mb/s).                                                                                                                                                                                                                                                                                                                                             |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Remote Frame Setup                       |  | Supported for ID. Capability identical to ID Condition Setup (not available for bitrates >15Mb/s).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Bit Rates                                |  | <b>Nominal Bit Rate:</b> 10, 25, 33.333, 50, 83.333, 100, 125, 250, 500 kb/s, or 1 Mb/s pre-defined nominal values, or user-defined to any nominal value from 10 kb/s to 1 Mb/s for Classic CAN, CAN FD and CAN XL and from 10 kbit/s to 8 Mbit/s for CAN FD Light<br><b>Data Bit Rate FD:</b> 0.5, 1.0, 1.5, 2.0, 5.0, 8.0, or 10 Mb/s pre-defined nominal values, or user-defined to any nominal value from 0.5 to 10 Mb/s.<br><b>Data Bit Rate XL:</b> 0.5, 1.0, 1.5, 2.0, 5.0, 8.0, 10, 12, or 20 Mb/s pre-defined nominal values, or user-defined to any nominal value from 0.5 to 20 Mb/s. |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Trigger Input                            |  | Any analog Channel or Digital input, or the EXT input.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Decode + Search Capability               |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Format                                   |  | Hexadecimal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  | Symbolic (Message and Signal level) or Hexadecimal. Symbolic decode requires user-provided DBC orARXML database file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| Decode Setup                             |  | Threshold definition required. Default is to Percent amplitude.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Decode Input                             |  | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| # of Decode Wfms                         |  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Location                                 |  | Overlaid on acquired waveform, on Grid.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Visual Aid                               |  | <b>Hexadecimal:</b> Color Coding for FRAME, ID, IDE, RTR, SRR, RRS, FDF, XLFRes/ Res-XL, BRS, ESI/ADS, SDT, SEC, DLC, SBC, PCRC, VCID, AF, DATA, CRC, PCRC, FCP, DAS, ACK, STUFF BITS, BIT INDEX and ERRORs. Error Frames are decoded whenever possible, with uncorrupted portions decoded to Identify Type. In all cases, decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                           |  | <b>Symbolic:</b> Color Coding for FRAME, ID, IDE, RTR, SRR, RRS, FDF, XLFRes/ Res-XL, BRS, ESI/ADS, SDT, SEC, DLC, SBC, PCRC, VCID, AF, DATA, CRC, PCRC, FCP, DAS, ACK, STUFF BITS, BIT INDEX and ERRORs. Includes textual Message name, physical Signal value with units, and decode ARXML PDU ID and name. Error Frames are decoded whenever possible, with uncorrupted portions decoded to Identify Type.<br><b>Hexadecimal:</b> Color Coding for FRAME, ID, IDE, RTR, SRR, RRS, FDF, XLFRes/ Res-XL, BRS, ESI/ADS, SDT, SEC, DLC, SBC, PCRC, VCID, AF, DATA, CRC, PCRC, FCP, DAS, ACK, STUFF BITS, BIT INDEX and ERRORs. Error Frames are decoded whenever possible, with uncorrupted portions decoded to Identify Type. In all cases, decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform. |  |
| Table Configure, Export Table            |  | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                                                                       |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Pattern Search                           |  | CAN FDbus: Search for Previous or Next Index, ID, IDE, DLC, DATA, and STATUS<br>CAN XL: Search for Previous or Next Index, Idx, ID, IDE, FDF, XLF, ADS, SDT, BRS, ESI, DLC, PCRC, VCID, AF, CRC, FCP, DAS, CL, or STATUS.                                                                                                                                                                                                                                                                                                                                                                        |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| CAN FDbus Symbolic, CAN XL Symbolic only |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Measure / Graph Capability               |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Serial Data                              |  | <b>Message to Value measurement parameter</b> extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion. <b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                                                        |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Digital-to-Analog Conversion (DAC)       |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Timing Measurements                      |  | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger) Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements.                              |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Bus Status Measurements                  |  | <b>Number of Messages, Message Bit Rate, Message Bus Load %</b> Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                                                       |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Eye Diagram Capability                   |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Setup                                    |  | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%. Apply to Zoom, Auto Scale.                                                                                                                                                                                                                                                                                                                                                                   |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Eye Parameters                           |  | Eye Height, Eye Width, (Number of) Mask Hits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Eye Mask                                 |  | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use. A variety of standard CAN masks are also provided.                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Failure Indication and Location          |  | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |

## Key Features

The most comprehensive oscilloscope-based FlexRay solution

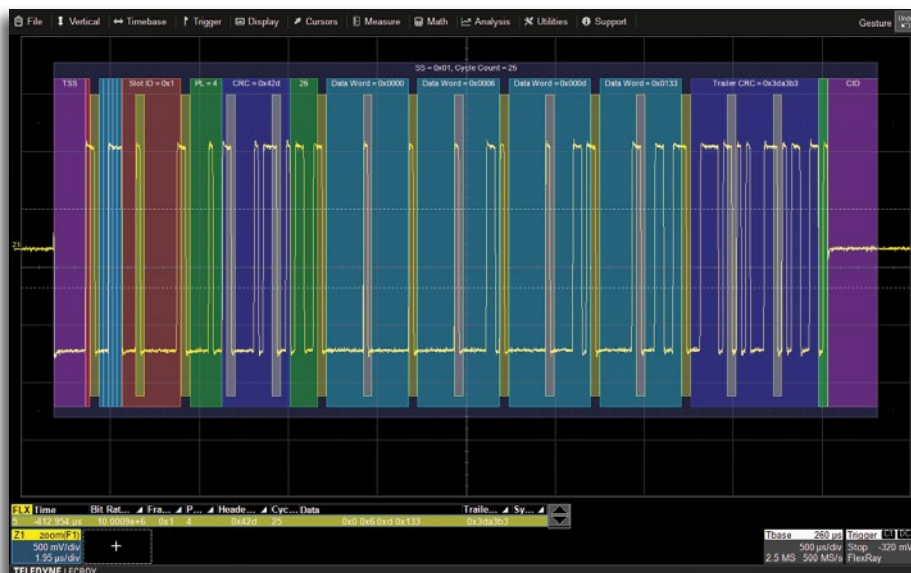
Supports triggering for:

- Frame ID (Static and Dynamic)
- Frame Cycle Count
- Frame Qualifiers
- Symbols
- Errors

Physical Layer Measurements

- Propagation Delay
- Asymmetric Delay
- Truncation
- Jitter
- SI Voting

Supports 2.5, 5 and 10 Mb/s signals



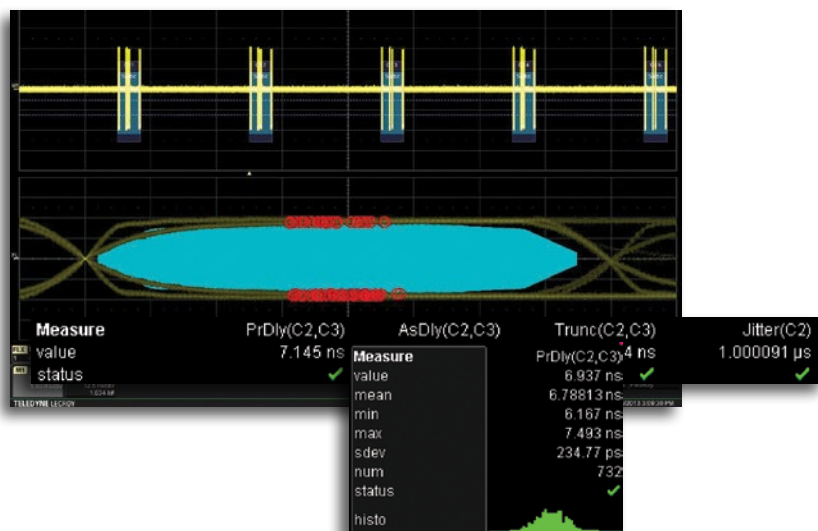
| Trigger Type                                                                | Setup Format                     | Frame ID Setup Condition                                                            | Cycle Count Condition                                                                                                 | Frame Qualifiers Payload Preamble                                                                                                        |
|-----------------------------------------------------------------------------|----------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <div>TSS (Start)</div> <div>Frame</div> <div>Symbol</div> <div>Errors</div> | <div>Binary</div> <div>Hex</div> | <div>In Range of</div> <div>Value</div> <div>3A5</div> <div>To</div> <div>3B7</div> | <div>Equal</div> <div>Value</div> <div>25</div> <div>To</div> <div>63</div> <div>Repetition Factor</div> <div>8</div> | <div>One</div> <div>Null Frame</div> <div>Zero</div> <div>Sync Frame</div> <div>One</div> <div>Startup Frame</div> <div>Don't Care</div> |

## Extensive Triggering Capabilities

Triggering on the complex FlexRay protocol is made easy. Set up a simple TSS (Start) symbol trigger with a single button press or trigger on any part of a FlexRay frame including ID, Cycle Count, Cycle Repetition Factor, and Frame Qualifier. FlexRay defined Symbols and Errors can also be incorporated into the trigger making it as simple or advanced as necessary. Conditional triggering can be set to trigger on any range of Frame IDs or Cycles.

## Powerful Physical Layer Test

FlexRay eye diagram mask test overlays all the bits on FlexRay signal in an eye diagram with user-selected masks. Trigger on a specific Frame ID or range of IDs, or filter one long acquisition specific IDs, and show only those messages in the eye diagram. Supports SI Voting. Key timing parameters like Propagation Delay, Asymmetric Delay, Truncation and Jitter help you understand how signals propagate along the channel. Use statistics and histicons for deeper insight.



# SPECIFICATIONS

| FLEXRAYbus TD and FLEXRAYbus TDMP    |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Source and Protocol Setup</b>     | Select Source. Select BitRate.<br>Select FlexRay Channel A or Channel B.                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>                        | Hexadecimal or Binary for Frame ID.<br>Decimal for Cycle Count.                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Trigger Setup</b>                 | Trigger on TSS (Start), Frame ID, Cycle Count, Symbols, and Errors                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>FRAME Setup</b>                   | Specify Frame ID(s) in Hexadecimal or Binary with condition of <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE.<br>Specify Cycle Count from 0 to 63 with condition of <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE. Specify Repetition Factor as 1, 2, 4, 8, 16, 32, or 64.<br>Specify various Frame Qualifiers (Payload Preamble, Null Frame, Sync Frame, and Startup Frame) as 0, 1, or X (don't care).                         |
| <b>DATA Setup</b>                    | Hexadecimal:<br># Data Bytes = 0 to 8. Data can be defined by nibble.<br>Binary:<br>Any combination of 0,1, or X for 1-64 bits<br>Data pattern can be any length and can be set to start at any location in the up to 8 Byte / 64 bit sequence.                                                                                                                                                                                                            |
| <b>Error Setup</b>                   | Trigger on any combination of the following errors:<br>Frame Start Sequence (FSS) Error – triggers when the logic high time between the TSS and the first byte is too long. Byte Start Sequence (BSS) Error – triggers anytime the BSS pattern is not seen between bytes where expected.<br>Frame End Sequence (FES) Error – triggers when the FS is not seen after the last byte.<br>Header CRC Error, Payload CRC Error (select Payload Channel A or B). |
| <b>Symbol Trigger</b>                | Trigger on any combination of the following:<br>Channel Idle Delimiter (CID) Symbol, Collision Avoidance Symbol (CAS) and/or Media Access Test Symbol (MTS), or Wakeup Pattern (WUP)                                                                                                                                                                                                                                                                       |
| <b>Bit Rates</b>                     | 2.5, 5, or 10 Mb/s pre-defined nominal values, or user-defined nominal values in 1 Mb/s increments                                                                                                                                                                                                                                                                                                                                                         |
| <b>Trigger Input</b>                 | Any analog Channel or the EXT input.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>                        | Hexadecimal, excepting Cycle Count (Decimal)                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Decode Setup</b>                  | Threshold definition required for High and Low levels. Default is to Absolute (in volts) amplitude. Select Channel (A or B).                                                                                                                                                                                                                                                                                                                               |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                                                                                                                                           |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                  |
| <b>Visual Aid</b>                    | Color Coding for FRAME, TSS, CID, FSS, Frame Qualifiers, Slot ID, Payload Length, Header CRC, Cycle Count, Data, BSS, Payload CRC and FES.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                  |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                 |
| <b>Pattern Search</b>                | Search by Previous or Next Frame, Next ID (hexadecimal format), or Next Error Frame.                                                                                                                                                                                                                                                                                                                                                                       |

| FLEXRAYbus TDMP only                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion. <b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                            |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %.</b> Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                          |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Eye Parameters</b>                                 | FlexRay PHY: Supports SI Voting (ON or OFF). With SI Voting ON, with voting selection for Positive Bit Length, Negative Bit Length (or both), and Filtered Input is possible. With SI Voting OFF, Any combination of Propagation Delay, Asymmetric Delay, Frame TSS Length Change, or Jitter.<br>Eye Diagram: Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                           |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use. Standard FlexRay TP1, TP1 Bus Driver, TP11, and TP11 Active Star are also provided.                                                                                                                                                                                                                                                                                                                                                     |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                          |

## Key Features

LIN 1.3, 2.x and J2602 support

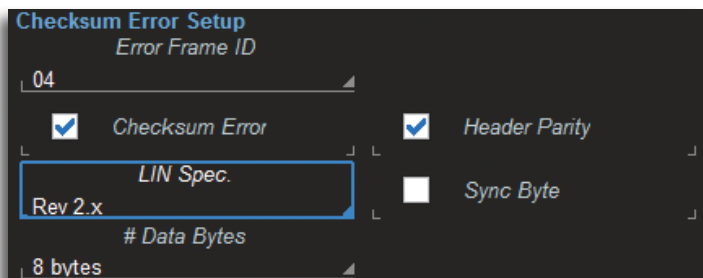
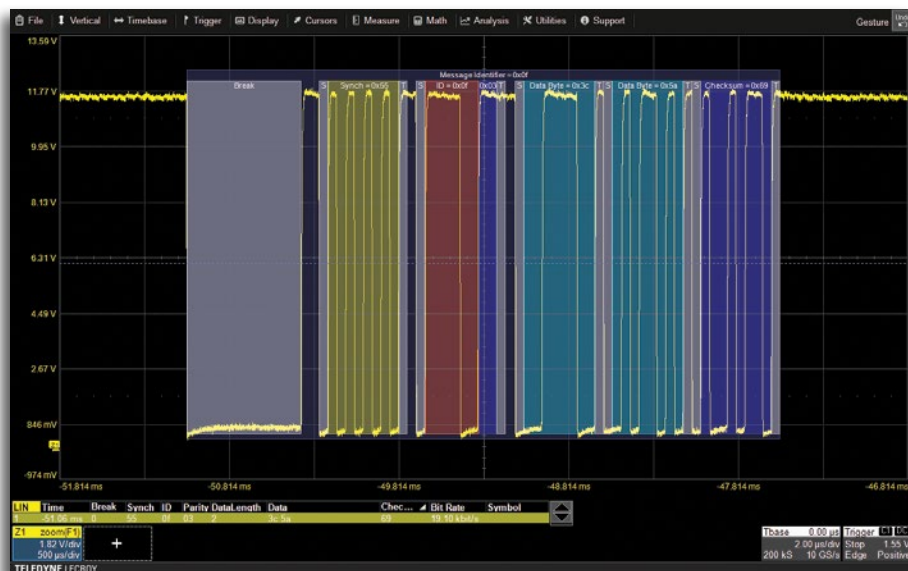
Break (Start of Message), ID, ID+DATA, and Error Frame triggers

Error-frame red color decode highlight

Error-frame trigger can include some or all of Checksum, Header Parity, or Sync Byte types.

Conditional ID definition (<, <=, =, >, >=, <>, IN RANGE, OUT of RANGE)

Supports decode of buses with mixed LIN version traffic

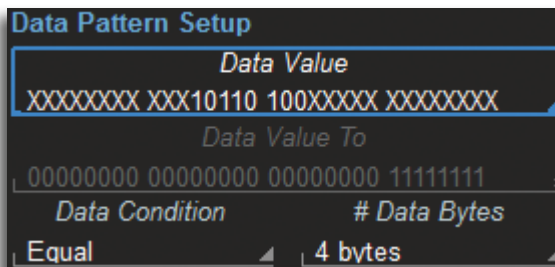


## Flexible Error Frame Trigger

Select to trigger on any combination of Checksum, Header Parity, or Sync Byte error frame types. Additional, Checksum Error allows further definition for Frame ID, LIN Version, and Number of Data Bytes.

## Trigger Flexibly Across Data Bytes

Many vehicle bus software architectures are very message dense, and data for a single message is spread across multiple data bytes. Our LIN trigger and measurement toolsets permit isolation of specific bit-level data patterns in one or more data bytes, e.g., data location in bits 18-26 in data bytes 2 and 3. This provides significant advantages in isolating the exact information or behavior you need.



# SPECIFICATIONS

| LINbus TD and LINbus TDME            |                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                            |
| <b>Source and Protocol Setup</b>     | Select Source. Select BitRate.                                                                                                                                                                                                                                                                                                             |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>                        | Hexadecimal or Binary                                                                                                                                                                                                                                                                                                                      |
| <b>Trigger Setup</b>                 | Trigger on (Sync) Break (Start of Message), Frame ID, Frame ID+DATA, Error Frame (Any combination of Checksum, Header Parity, or Sync Byte error frames)                                                                                                                                                                                   |
| <b>ADDRESS Setup</b>                 | Specify one ADDRESS with condition of <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE.                                                                                                                                                                                                                                          |
| <b>DATA Setup</b>                    | Hexadecimal:<br># Data Bytes = 0 to 8. Data can be defined by nibble.<br>Binary:<br>Any combination of 0,1, or X for 1-64 bits<br>Data pattern can be any length and can be set to start at any location in the up to 8 Byte / 64 bit sequence.                                                                                            |
| <b>DATA Condition Setup</b>          | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE                                                                                                                                                                                                                                                                                 |
| <b>Error Setup</b>                   | Select any combination of Checksum Error, Header Parity, or Sync Byte types.<br>Checksum Error Setup for Frame ID, LIN version, and # Data Bytes                                                                                                                                                                                           |
| <b>Bit Rates</b>                     | 1.2, 2.4, 4.8, 9.6, 10.417, 19.2 kb/s pre-defined nominal values, or user-defined to any nominal value from 300 b/s - 40 kb/s.                                                                                                                                                                                                             |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input.                                                                                                                                                                                                                                                                                     |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>                        | Hexadecimal, Binary                                                                                                                                                                                                                                                                                                                        |
| <b>Decode Setup</b>                  | Threshold definition required. Default is to Percent amplitude.<br>Select BitRate. Select LIN version (1.3, 2.x, J2602, ALL). Decodes LIN messages on busses with mixed LIN versions                                                                                                                                                       |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                           |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                  |
| <b>Visual Aid</b>                    | Color Coding for FRAME, BREAK, START/STOP bits, SYNCH bits, ID, ID Parity, DATA, CRC.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                       |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns. |
| <b>Pattern Search</b>                | Search by Previous or Next Frame, Next ID (hexadecimal format), or Next Error Frame.                                                                                                                                                                                                                                                       |

| LINbus TDME only                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.<br><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                              |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger)<br>Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data.<br>Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %</b><br>Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                             |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                               |

## Key Features

**Supports SENT and SENT SPC**

**Decodes Frames as Nibbles or Words**

**Supports Fast and Slow Channel Decode and Analysis**

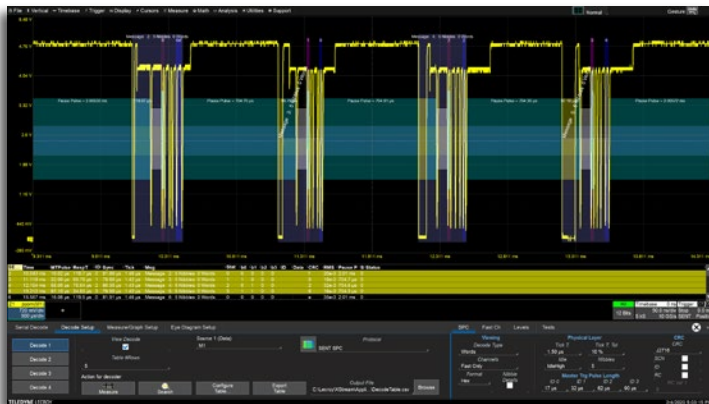
**Extract and plot embedded SENT data**

**SAE Compliance Test Support**



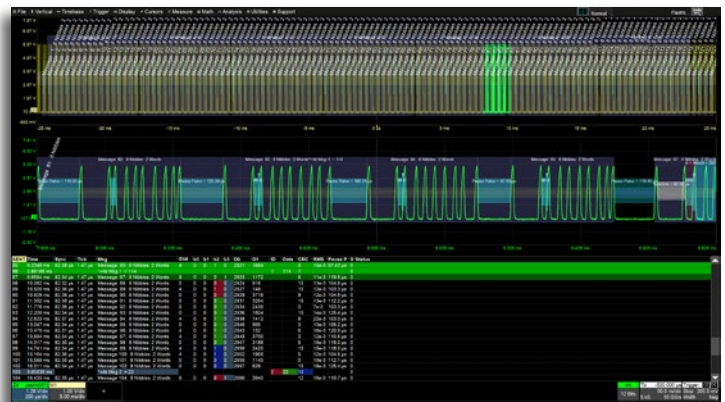
## Debug and Characterize SENT SPC

Define up to 4 MTP lengths to analyze up-to-four “slave” sensors on the same wire. Use the column to value parameter to verify the stability of the MTP over time and correlate sensor activity to other signals in the system.



## Fast and Slow Channels

Define up to 4 fast channels, specifying the numbers of nibbles and offset of each data word independently. The color-coded decode table shows how slow channel bits are distributed over the Fast Messages.



# SPECIFICATIONS

| SENTbus TD and SENTbus TDME          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Source and Protocol Setup</b>     | Select Source.<br>SENT: Select SENT FEB 2008, JAN 2010, and APR 2016 versions or SENT SPC.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Format</b>                        | Hexadecimal or Binary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Trigger Setup</b>                 | Trigger on Start of Frame (Any, Slow Channel Message, or Fast Channel Message), Slow Channel ID+DATA (Any, Short Serial Message, or Enhanced Serial Message), Fast Channel ID+DATA, or Error (Any combination of Successive Calibration Pulse Error, Pulse Period Error, Fast Channel CRC Error, Slow Channel CRC Error, All CRC Error).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Slow Channel ID</b>               | Specify one Slow Channel ID 4 or 8 bit ID in Hexadecimal or Binary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>DATA Setup</b>                    | Data Value: Data can be defined in Hexadecimal (any combination of 0-F for defined number of nibbles or selected message type) or Binary (any combination of Any combination of 0,1, or X for defined number of nibbles or selected message type)<br>Fast Channel: Define nibble length (up to 6 nibbles) and nibble position (from 0 to 5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>DATA Condition Setup</b>          | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input. External MSO not supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Trigger Design</b>                | Internal to oscilloscope, settable like any other oscilloscope trigger.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Format</b>                        | Hexadecimal or Decimal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Decode Setup</b>                  | <b>SENT and SENT SPC:</b> Viewing: Decode Type (Nibbles or Words), Nibble Details (On/Off); Physical Layer: Tick Time (400 nsec to 3 msec), Tick Time Tolerance (1% to 50%), Idle State (High or Low), Nibbles (3 to 9); Protocol Details: SENT Version (FEB 2008, JAN 2010, or APR2016), New CRC (On/Off), Pause Pulse (On/Off); Channel Selection: Fast Only, Slow Only or Both; Levels and Hysteresis: Percent or Absolute; For decode in "Words", "Fast Channels" has four fields available for Payload Interpretation (D0, D1, D2, or D3), includes controls to define Offset, Nibble and Order (MSB or LSB). For decode in "Words", "Slow Channels" has control for User Defined Tables, entered via a TXT file, allowing symbolic decode on Slow Channels.<br><b>SENT SPC:</b> Master Trigger Pulse Length: Define Length for up to four IDs (4 to 500 us); CRC: Version (J2716, Infineon, Method O, Method E), include Status and Communication Nibbles (SCN), ID, and Rolling Counter (RC). |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Visual Aid</b>                    | <b>SENT and SENT SPC:</b> Color Coding for overall SENT Packet, Synchronization Pulse, Status and Communication Nibble, Reserved for Application Status, Serial Data Message Bits, Data Nibbles, CRC, and Pause Pulse. For Slow Channels, Bit Level Annotation.<br><b>SENT SPC:</b> Color Coding for Master Trigger Pulse and Sensor Response Time. Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Pattern Search</b>                | <b>SENT and SENT SPC</b> When decoder set for "Nibbles", search for any of the following: Idx, Time, Sync, Tick Time, Message, Nibbles, RMS, Pause Pulse, and Status. When decoder set for "Words", search for Idx, Time, Sync, Tick, Message, Stat, b0, b1, b2, b3, D0, D1, D2, D3, CRC, RMS, ID, Data, Pause Pulse, and Status.<br><b>SENT SPC</b> When decoder set for "Nibbles" or "Words", search for any of the following: Master Trigger Pulse, Response Time, and ID Mux.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| SENTbus TDME only                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion. <b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                            |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %.</b> Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                          |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                          |

## Key Features

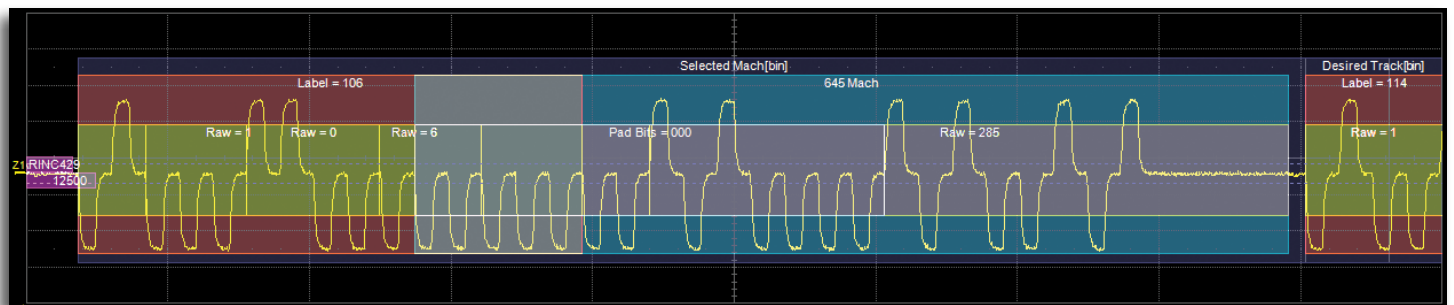
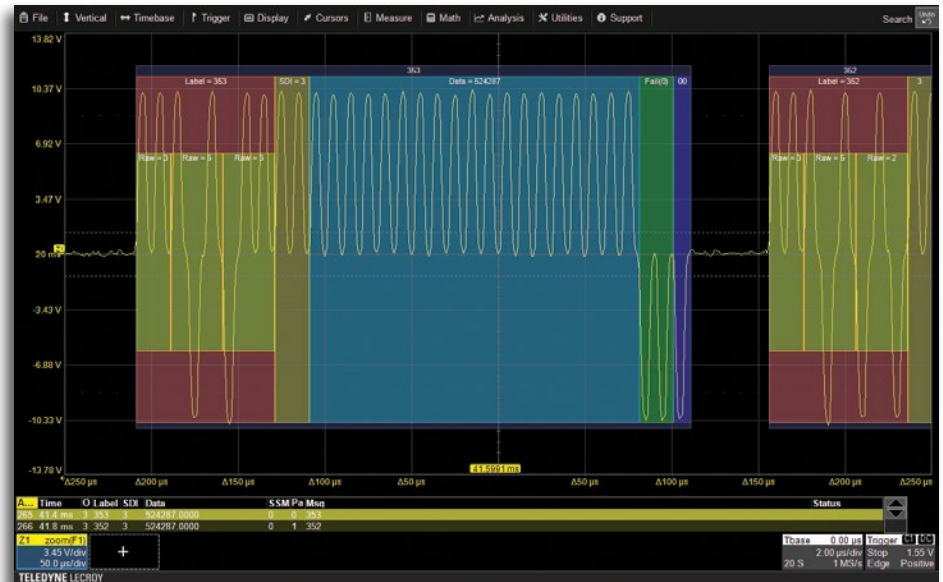
**Symbolic decode with user-provided ULDF database file**

### Decode Viewing Control Selection

- 8+24
- 8+2+19+2+1
- User-defined

### Decode Annotation includes:

- Frame
- ID
- Label
- Raw Bits
- SDI
- Data
- SSM
- Parity
- Symbolic Message and Symbols



## Symbolic Decode Transparent Overlay

A unique and powerful way to view decoded data. Using a user-provided ULDF file, the label and equipment ID fields can be displayed in an intuitive and easy to interpret way. The ULDF Label file is a Comma Separated Variable (CSV) file that contains the ARINC429 token definitions. Any text editor can be used to create or modify the Label file, and there is no limitation as to how many signals can be defined for a given Label. Here, the specified converted data is Selected Mach = 645 Mach.

## Symbolic Decode Protocol Table

Symbol data is then displayed in the protocol table. Quickly view valuable information for each ARINC 429 word, such as Label, SDI, Data, SSM, Parity, and Symbolic Message.

| Data         | SSM Pa Msg           | Symbols       | Bits/Resol... | Pad |
|--------------|----------------------|---------------|---------------|-----|
| 645 Mach     | Selected Mach[bin]   | 12 / 1.000000 | 0             |     |
| 17.6 Degrees | Desired Track[bin]   | 12 / 0.050000 | 13            |     |
| 550 mDegrees | VS/FPA Val[bin]      | 12 / 0.050000 | 6             |     |
| 96 None      | TACAN Control[bin]   | 12 / 1.000000 | 0             |     |
| 0.0 m        | Metric Altitude[bcd] | 4 / 0.250000  | 0             |     |
| 30.0 kg/m2   | Appr Loc[bcd]        | 4 / 0.250000  | 0             |     |
| 5.0 kg/m2    | DD5[bcd]             | 4 / 0.250000  | 0             |     |
| 1.01e+3      | Spare[bin]           | 10 / 1.000000 | 464           |     |
| 63 —         | Spare[bin]           | 10 / 1.000000 | 507           |     |

# SPECIFICATIONS

| ARINC429Bus DSYMBOLIC and ARINC429Bus DMESYMBOLIC |                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                                 |                                                                                                                                                                                                                                                                                                                                            |
| <b>Source and Protocol Setup</b>                  | Select Source. Select BitRate.                                                                                                                                                                                                                                                                                                             |
| <b>Decode + Search Capability</b>                 |                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>                                     | Hexadecimal or Symbolic+Hexadecimal. Symbolic decode requires user-provided ULDF database file                                                                                                                                                                                                                                             |
| <b>Decode Setup</b>                               | Threshold definition required for High and Low levels. Default is to Absolute (in volts) amplitude. Select Viewing Control (8+24, 8+2+19+2+1, or User-defined).                                                                                                                                                                            |
| <b>Decode Input</b>                               | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                           |
| <b># of Decodes</b>                               | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                  |
| <b>Visual Aid</b>                                 | Color coding for Frame, ID, Label, Raw Bits, SDI, Data, SSM, Parity.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                        |
| <b>Table Configure, Export Table</b>              | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns. |
| <b>Pattern Search</b>                             | Search for Previous or Next IDX, Time, OctalDigits, Label, SDI, Data, SSM, Parity, Msg, or Status                                                                                                                                                                                                                                          |

| ARINC429Bus DMESYMBOLIC only                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <p><b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.</p> <p><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.</p>                                                                                    |
| <b>Timing Measurements</b>                            | <p><b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger)</p> <p>Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition &lt;=, &lt;, =, &gt;, &gt;=, &lt;&gt;, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data.</p> <p>Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements.</p> |
| <b>Bus Status Measurements</b>                        | <p><b>Number of Messages, Message Bit Rate, Message Bus Load %</b></p> <p>Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA &lt;=, &lt;, =, &gt;, &gt;=, &lt;&gt;, in range, out of range" in any location in up to 2048 bits of data.</p>                                                                                                                                                                                                                                                                                                                                 |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Failure Indication and Location</b>                | <p>Mask Failure Indication ON or OFF (ON = indicated with a red circle).</p> <p>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.</p>                                                                                                                                                                                                                                                                                                                                                                                     |

## Key Features

### Most comprehensive MIL-STD-1553 oscilloscope trigger available

- Transfers
- Command Words
- Data Words
- Status Words
- Error Words
- Response Times
- Intermessage Gap Times

### Conditional ADDRESS definition

(<, <=, =, >, >=, <>, IN RANGE, OUT of RANGE)

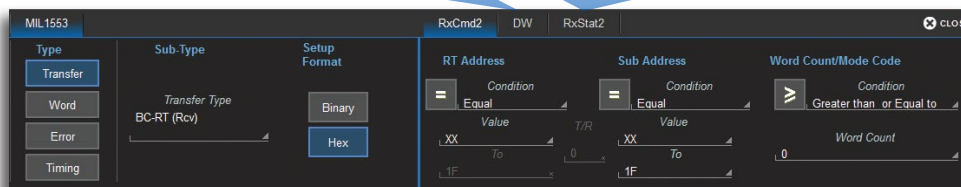
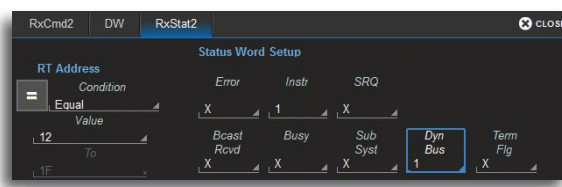
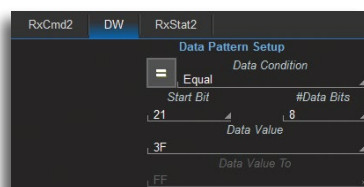
Completely isolate a specific RT Address, Sub Address, Data Value, and Mode Code

Support for MIL-STD-1553 versions A and B



## Highly Flexible and Powerful Triggering

The MIL-STD-1553 trigger can be configured at the transfer or word level to provide the right level of triggering. In addition, error triggers are able to locate the cause of protocol errors at either the transfer or word level. Word level triggering allows conditional RT Address and Sub Address entry.



## MIL-STD-1553 TD and MIL-STD-1553 TDME

| Definition         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Source Setup       | Select Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Trigger Capability |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Format             | Hexadecimal or Binary (Decimal for Word Count).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Trigger Setup      | Trigger on ANY TRANSFER; a COMMAND WORD, STATUS WORD, DATA WORD, or ALL WORDS; an ERROR, a RESPONSE TIME, or an INTERMESSAGE GAP TIME. TRANSFERS may be further qualified by selecting the message type BC-RT, RT-BC, RT-RT, MODE COMMAND, MODE COMMAND & DATA (XMIT), MODE COMMAND AND DATA (RCV), various BROADCASTS (BC-RT(S), RT-RT(S), MODE COMMAND, and MODE COMMAND AND DATA)                                                                                                                                                                                                                                                                                                                                                                            |
| Address Setup      | For COMMAND WORD trigger specify 5-bit Remote Terminal (RT) Address ID(s) or Sub Address(es) with condition of <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE; specify Transmit/Receive bit setting of 0, 1, or X (don't care). For STATUS WORD trigger, specify 5-bit RT Address(es) ID(s) with condition of <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE; Specify Status Word bits as 0, 1, or X (don't care) for Message Error, Instrumentation, Service Request, Broadcast Command Received, Busy, Subsystem Flag, Dynamic Bus Control Acceptance, or Terminal Flag. For any TRANSFER containing an RT Address or Sub Address, setup is identical to that specified above. Settable in Hexadecimal or Binary format in all cases. |

# SPECIFICATIONS

| <b>MIL-STD-1553 TD and MIL-STD-1553 TDME (Cont'd)</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DATA Setup</b>                                     | Data Word Count: In any TRANSFER, specify Data Word Count in decimal format up to 32 data words.<br>DATA WORD or TRANSFER Data Setup (Hexadecimal): # Data Bytes = up to 2 (one Data Word) byte length, settable by nibble.<br>DATA WORD or TRANSFER Data Setup (Binary): Any combination of 0,1, or X for 1-16 bits.<br>Data pattern can be set to start at any location in an up to 2 Byte / 16 bit sequence (in a DATA WORD) or an up to 64 Byte / 512 bit sequence (in a TRANSFER) |
| <b>DATA Condition Setup</b>                           | Data Word Count: <=, <, =, >, >=, or <><br>Data Setup: <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Mode Command Setup</b>                             | TRANSFER MODE COMMANDS and COMMAND WORDS may be qualified by selecting a Mode Code (0 to 31, with description) with a Mode Code condition of <=, <, =, >, >=, or <>.                                                                                                                                                                                                                                                                                                                   |
| <b>Status Setup</b>                                   | In any TRANSFER or STATUS WORD, select 0, 1, or X (don't care) for various Status Word bits. Select for: Message Error, Instrumentation, Service Request, Broadcast Command Received, Busy, Subsystem Flag, Dynamic Bus Acceptance, and Terminal Flag                                                                                                                                                                                                                                  |
| <b>Error Setup</b>                                    | Select one or more Word Level or Transfer Level errors using a check box. Word Level error selection: Invalid Sync, Manchester Error, Idle Error, Parity Error. Transfer Level error selection: Bad Word Count, Address Mismatch, Non-contiguous Data, Sync Error.                                                                                                                                                                                                                     |
| <b>Other Setups</b>                                   | Response Time Setup: Conditional Setup <, >, in range, out of range; Value Setup: 0 to 32.752 microseconds.<br>Intermessage Gap Setup: Conditional Setup <, >, in range, out of range; Value Setup: 0 to 32.752 microseconds.                                                                                                                                                                                                                                                          |
| <b>Bit Rates</b>                                      | 1 Mb/s, pre-defined nominal value                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Trigger Input</b>                                  | Any analog Channel or the EXT input.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Decode + Search Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Format</b>                                         | Hexadecimal, Binary, Decimal (Binary not available for Address).                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Decode Setup</b>                                   | Threshold definition required for High and Low levels. Default is to Absolute (in volts) amplitude. Select Table (Display) Mode (WORD or TRANSFER). Define Response Time and InterMessage Gap Time limits.                                                                                                                                                                                                                                                                             |
| <b>Decode Input</b>                                   | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b># of Decodes</b>                                   | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Visual Aid</b>                                     | Color Coding for Message, Word, Sync bits, RTA Address and SubAddress bits, Receive/Transmit bit, Data Count bits, Data (Payload) bytes and Single-bit Condition Codes, Reserved bits, Response Time Check and Inter-Message Gap Time, and Word and Transfer Level Error Codes.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                         |
| <b>Table Configure, Export Table</b>                  | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                             |
| <b>Pattern Search</b>                                 | Search for Previous or Next Index, Time, Message, Transaction, Type, Summary, Sync, RT Address, T/R, SubAddress, Count, ModeCode, Parity, Response Time, RT Address ACK, Message Error, Inst, SRQ, Reserved, Broadcast Rx, Busy, SubSystem Flag, Dynamic Bus Access, Terminal Flag, Data, IMG, or Status                                                                                                                                                                               |

| <b>MIL-STD-1553 TDME only</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion. <b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                            |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %</b> . Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                         |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Failure Indication and Location</b>                | *Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                         |

# USB 2.0

## Key Features

**Supports USB 2.0 Low, Full, or High speeds (1.x and 2.0)**

**Trigger on USB packet types:**

- Token
- Data
- Handshake
- User-defined

**Transaction triggering support**

**Comprehensive Protocol Error and Bus Event triggering**

**Comprehensive Search by Events, Packets, Transactions or Errors**



| Pattern Type   | Category    | Data Pattern 1 PID | OR | Data Pattern 2 PID | OR          | Data Pattern 3 PID |
|----------------|-------------|--------------------|----|--------------------|-------------|--------------------|
| Packet         | Any Sync    | Any Type           |    | Data0              |             | Data1              |
| Protocol Error | Token       | Compare Type       |    | Compare Type       |             | Compare Type       |
| Transaction    | Data        | Data Length        |    | Data Value         |             | Data Value         |
| Bus Event      | Handshake   | Cmp. Opr.          |    | Cmp. Opr.          | At position | Cmp. Opr.          |
|                | User Define | Any Length         |    | =                  | 24          | =                  |
|                |             |                    |    | Data (1-16 Bytes)  |             | Data (1-16 Bytes)  |
|                |             |                    |    | F54B               |             | 52                 |

## The Most Comprehensive USB Trigger

Full support is provided for triggering on any type of Packet, even User-Defined Packets, with complete flexibility for address, endpoint, split type, hub, port, etc. Trigger on specific Data payloads in specific locations. OR any three Packets in a single trigger condition. Create a USB Transaction trigger with any allowed combination of Token, Data, Handshake, and User-Defined packets. Advanced capability like this is usually only found in a dedicated protocol analyzer!

## Search and Zoom

The powerful search engine of the USB 1.x/2.0 decode package can quickly find an Event, Packet, Transaction, or Protocol Error. Search through a long record of decoded data by entering any of the 45 available search criteria by entering a value or simply finding the next occurrence. For example, search through a long record to find a glitch that is frequently occurring after each EOP.

|          |           |
|----------|-----------|
| Idx      | TransIdx  |
| Time(us) | TransType |
| ItemType | DevAddr   |
| Endpoint | Details   |

# SPECIFICATIONS

| USB2bus TD and USB2bus TDME          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Source and Protocol Setup</b>     | Select for USB Low, Full, or High Speeds (1.x and 2.0).<br>Select Source(s) (one or more, depending on Speed and probing system used).<br>Select D+ and D- Voltage Levels (Low and Full Speeds only)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Format</b>                        | Hexadecimal or Binary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Trigger Setup</b>                 | Trigger on Packet Type (Any, Token, Data, Handshake, or User-Defined), Protocol Error, Transaction (combine any allowable set of Token, Data, Handshake or User-defined Packet together in a Transaction), or Bus Event                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>PACKET Setup</b>                  | <b>Any Packet:</b> Trigger on ANY SYNCH pattern.<br><b>Token Packet:</b> Trigger on ANY Token Packet. Select PREAMBLE/ERR Token Packet. Select SOF Token Packet with specific Frame Number. Select OUT, IN, SETUP, or PING Token Packet with a specific Address and Endpoint, or "don't care." Select SPLIT Special Token Packet with a specific SPLIT TYPE, HUB ADDR, PORT, S(speed/start), E(nd), and ET (for SPLIT type). Select USER-DEFINED. Trigger on any of three Token Packets of any type and trigger on them with an "OR" condition.<br><b>Data Packet:</b> Trigger on ANY Data Packet. Trigger on a single DATA0, DATA1, DATA2, or MDATA Data packet, with settings for Data Payload or Data Length, or trigger on any of up to three Data Packets of any type in an OR condition, with independent setup of Data Payload value or Data Length values.<br><b>Handshake Packet:</b> Trigger on ANY Handshake Packet. Trigger on a specific ACK, NAK, NYET, STALL or ERR Handshake Packet.<br><b>Transaction Packet:</b> Trigger on any USB Transaction - combine any allowable set of Token, Data, Handshake or User-Defined Packet together in a Transaction, and trigger when that set is detected |
| <b>DATA Setup</b>                    | In any DATA PACKET define up to three data conditions with OR logic. Data conditions may be Data Payload Pattern or Data Length for Any, DATA0, DATA1, DATA2, or MDATA types.<br>Data Payload Pattern Setup (Hexadecimal): # Data Bytes = 1 to 16. Data can be defined by nibble. Data Payload Pattern Setup (Binary): Any combination of 0,1, or X for 1-128 bits. Data Payload Pattern start at any location in an up to 128 Byte / 1024 bit sequence.<br>Data Length Setup: Hexadecimal; # Data Bytes = 0 to 1024.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>DATA Cond. Setup</b>              | Data Payload: =, <,>, or DON'T CARE. Data Length: <=, <, >, >=, <>, IN RANGE, OUT OF RANGE, or ANY LENGTH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Error Setup</b>                   | Trigger on any ORed combination of PID/Check Error, CRC5 Error, CRC16 Error, Frame Length Error, Bad Data Toggle Error, or PID0 Error                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Bus Event Setup</b>               | Trigger on any ORed combination of Reset, Resume, Suspend, or Chirp                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Bit Rates</b>                     | Low, Full or High-speed pre-defined values.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Trigger Input</b>                 | USB 1.x and USB 2.0 (Low and Full Speed): Requires two inputs, using any analog Channels or the EXT input<br>USB 2.0 (High Speed): Pre-defined channel, specific to each oscilloscope product line. Input must be with a suitable differential probe.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Format</b>                        | Hexadecimal USB 2.0 Link and Data Layer Protocol Decode                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Decode Setup</b>                  | Select Bus Speed (Low, Full, High). Select Probing Type (One Single-ended Probe, Two Single-ended Probes, Differential Probe).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Visual Aid</b>                    | Color Coding for Transaction, Packet (Handshake, Token, or Data), Control Sequences (Synch bits, PID bits, Check bits, or EOP bits), Device Address, Endpoint, Data Payload, CRC5 or CRC7, Inter-packet Idle, Inter-transaction Idle.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Pattern Search</b>                | Search for Event, Token Packet, Data Packet, Handshake Packet, Transaction Packet, or Protocol Error (45 unique conditions)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| USB2bus TDME only                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion. <b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                         |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %.</b> Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                          |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                               |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle). Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                          |

# DP-AUX (DISPLAYPORT™ AUX CHANNEL)

## Key Features

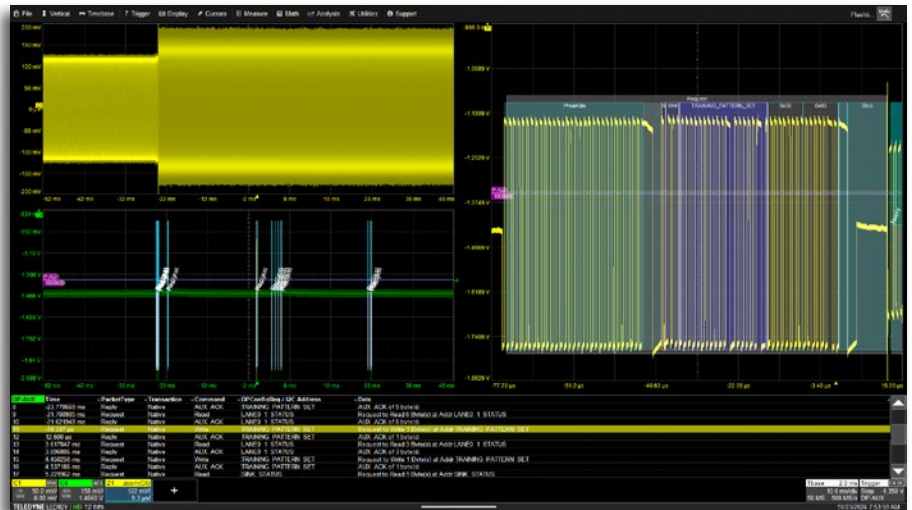
The most comprehensive DisplayPort AUX analyzer solution

DisplayPort 2.0/1.4 and eDP (embedded DisplayPort) Standards

Trigger and Decode DP-AUX Reads/Writes (Native or I2C)

DP-AUX EYE PHY Compliance

USB Type-C system level debug simultaneously with Main Link or USB-PD

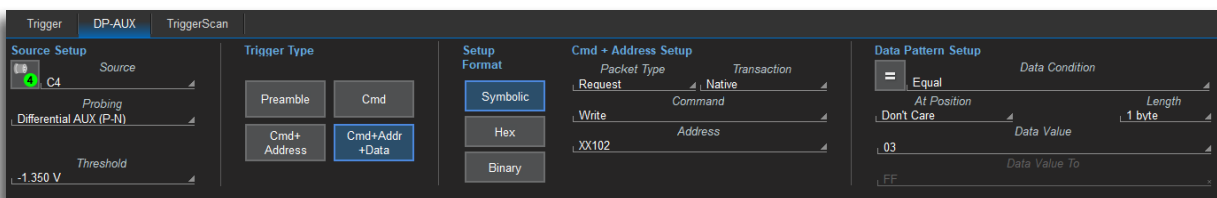


## Interactive Protocol Table

Simply click on the DP-AUX packet of interest in the protocol table to create a zoom window of the waveform with color coded overlay showing the packet type, command, AUX register address, and message details.

## Trigger on any AUX Message (from Preamble to Address + Data)

Triggering of the oscilloscope on DP-AUX channel reads/writes provides unique PHY-logic layer debugging capabilities not found in other oscilloscopes or other AUX analyzers.



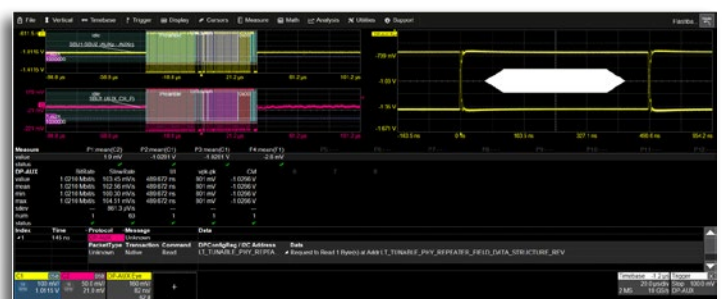
## DisplayPort over USB-C System Level Debug

Use the TF-USB-C-HS or TF-USB-C-SB test coupon fixture and probing solutions for DisplayPort Source/Sink device system integration. For instance, debugging LTTPR timing failures between AUX and Main Link or AUX and 'Alt Mode' Power Delivery messages.



## DisplayPort AUX EYE PHY Compliance

The DisplayPort 2.1 PHY CTS requires DP-AUX EYE diagram measurements on the AUX transmitters on both Sources and Sinks while transmitting 16 SYNC pulses. TDMP decodes the DP-AUX data, makes the required EYE diagram mask and physical layer measurements required for compliance.



# SPECIFICATIONS

| DP-AUX TD and DP-AUX TDMP                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Source and Protocol Setup</b>                                             | Select Source (Decode Input), Protocol (DP-AUX).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Trigger Capability</b>                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Format</b>                                                                | Set Source and Threshold voltage for USB-PD Trigger Source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Comprehensive Trigger selections for debugging link training failures</b> | <b>Trigger Types:</b> Preamble, Command, Command+Address, Command+Address+Data Setup Format: Symbolic, Hex, Binary<br><b>Packet Type:</b> Any, Request, Reply Transaction: Any, I2C, Native<br><b>Command:</b> Any, Write, Read, Write Status Updated Request<br><b>DPCD Address:</b> 5-Byte Hex register address defined in DisplayPort specification<br><b>Data Condition:</b> <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE Data At Position: Don't Care, Value<br><b>Data Length:</b> # of Bytes, Data Value: Hex value based on Data Length. |
| <b>Trigger Input</b>                                                         | Any analog channel, Any MSO digital channel, External.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Decode + Search Capability</b>                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Format</b>                                                                | Hexadecimal or Symbolic DP-AUX Transaction Decode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Decode Setup</b>                                                          | Select Source, View (Hexidecimal or Symbolic), Probing (AUX-P, AUX-N, or Differential), Reply Timeout, and Decode Threshold Levels.                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Decode Input</b>                                                          | Any analog Channel, Memory, Math, or Digital trace.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b># of Decodes</b>                                                          | Up to four buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Location</b>                                                              | Overlaid on acquired AUX Packet waveform, on Grid.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Visual Aid</b>                                                            | Color Coding of Idle, Preamble, Packet Type, Command Type (Read/Write), DP Configuration Register or I2C Address, and Command Register Data, Stop.                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Table Configure, Export Table</b>                                         | Display up to 20 rows of decoded information for up to four different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                     |
| <b>Pattern Search</b>                                                        | Search for previous or next: Index, Packet Type, Command Type, Command, DPCConfigReg/I2C Address.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

| DP-AUX TDMP Only                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), Time@ Message (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Eye Diagram and Physical Layer Test Capability</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Physical Layer Setup</b>                           | DP-AUX Analysis is selected (and enabled) from the Oscilloscope's Analysis menu. Links to DP-AUX serial decoder, performs DP-AUX Physical Layer measurements. Measurements made on selected Zoom packet in decoder or on full acquisition.                                                                                                                                                                                                                                                                                                                     |
| <b>Selectable Physical Layer Measurement</b>          | <b>Measurements defined by the DisplayPort Specification:</b><br>BitRate, Unit Interval, Common Mode Voltage, Slew Rate, Vpk-Pk.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Eye Diagram and Mask Testing</b>                   | Eye Parameters: (Number of) Mask Hits. Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use. Mask Failure Indication ON or OFF (ON = indicated with a red circle). Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                   |

# USB-PD (USB POWER DELIVERY)

## Key Features

The most comprehensive oscilloscope-based USB-PD solution

Supports USB-PD 3.1 - EPR (Extended Power Range) and SPR (Standard Power Range)

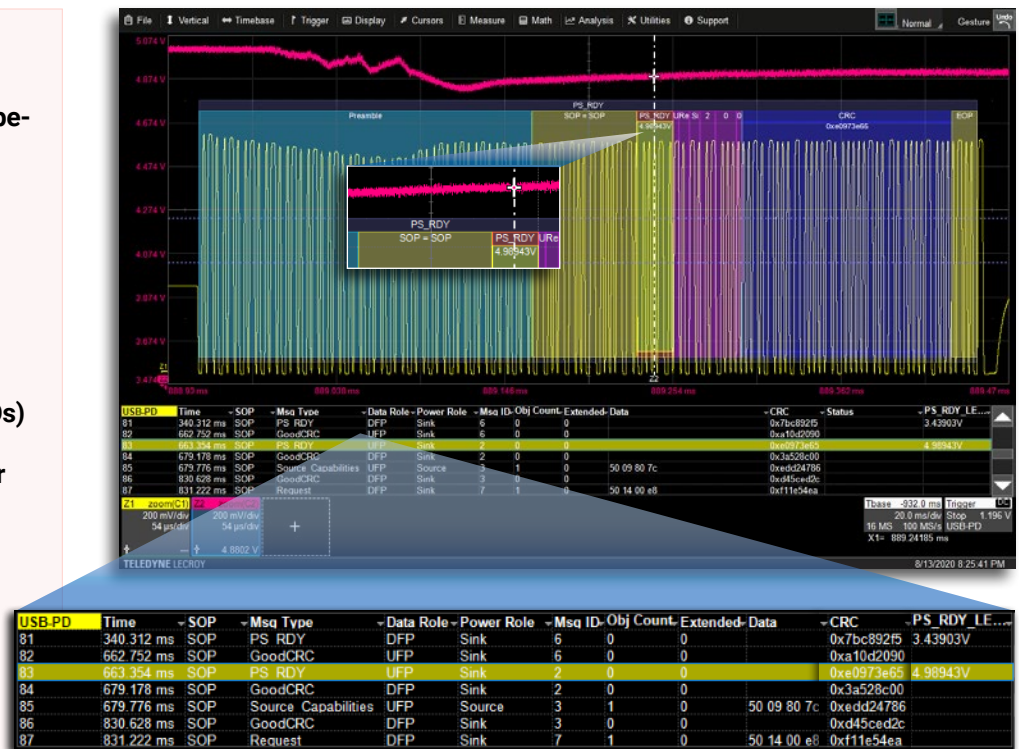
USB-PD Message Triggering

Decode Power Delivery Objects (PDOs)

BMC Eye Diagram and Physical Layer Measurements

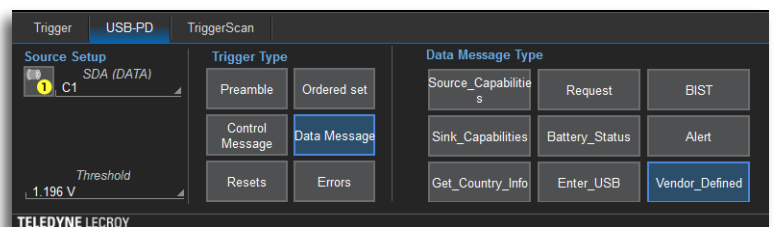
Time Correlate USB-PD with other USB Type-C® connector protocols

Enables USB-PD power supply validation and debug by correlating CC,  $V_{BUS}$  and  $I_{LOAD}$  signals



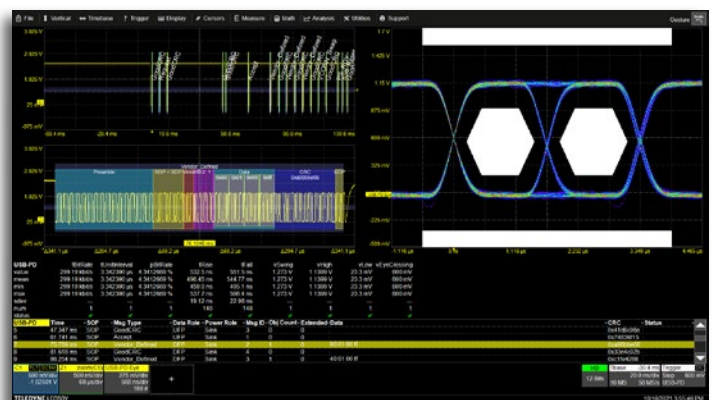
## Comprehensive USB-PD Triggering

Debug power delivery compliance failures by using the same trigger selection types (Preamble, Ordered Set, Control Message, Data Message, Resets, and Errors) as found in the Teledyne LeCroy Voyager USB-PD compliance tester.



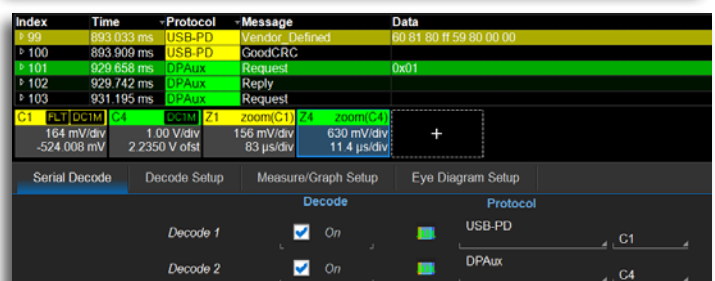
## Eye Diagram and Physical Layer measurements

Debug USB-PD BMC (biphase mark coded) physical layer issues with comprehensive USB-PD Analysis. Select the packet of interest from the decode table, and USB-PD TDMP automatically makes measurements performs transmitter and receiver eye diagram mask testing.



## Time Correlate USB Type-C Protocols

Debug USB Type-C system issues by time correlating USB-PD messages along with other USB Type-C signals such as DP-AUX or USB4-SBU sidebands.



# SPECIFICATIONS

| USB-PD TD and USB-PD TDMP                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Source and Protocol Setup</b>                      | Select Channel Source for CC1/CC2 Signals.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Trigger Capability</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Format</b>                                         | Set Source and Threshold voltage for CC1/CC2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Trigger Setup</b>                                  | <p><b>Comprehensive Trigger selections equivalent to the Teledyne LeCroy Voyager USB PD Compliance Tester for debugging compliance failures:</b></p> <p>Trigger on Preamble, Ordered Set, Control Message, Data Message, Resets, or Errors with selections for each as follows:</p> <p><b>Ordered Sets:</b> SOP, SOP', SOP", SOP'_Debug, or SOP"_Debug.</p> <p><b>Control Messages:</b> GoodCRC, PS-RDY, VCONN_Swap, Not_Supported, Get_Country_Codes, GotoMin, Get_Source_Cap, Wait, Get_Source_Cap_Extended, Get_Sink_Cap_Extended, Accept, Get_Sink_Cap, Soft_Reset, Get_Status, Reject, DR_Swap, Data_Reset, FR_Swap, Ping, PR_Swap, Data_Reset_Complete, or Get_PPS_Status.</p> <p><b>Data Message:</b> Source_Capabilities, Sink_Capabilities, Get_Country_Info, Request, Battery_Status, Enter_USB, BIST, Alert, Vendor Defined</p> <p><b>Resets:</b> Soft Reset, Data Reset, or Cable Reset.</p> <p><b>Errors:</b> 5b Symbol Error, Ordered Set Error, CRC Error, EOP Error, Reserved Message Error, Invalid Message Error, or Packet Length Error.</p> |
| <b>Trigger Design</b>                                 | Internal to oscilloscope, settable like any other oscilloscope trigger.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Decode + Search Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Format</b>                                         | Hexadecimal or Binary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Decode Setup</b>                                   | Source Setup for CC1/CC2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Decode Input</b>                                   | Any analog Channel, Memory, Math, or Digital trace.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b># of Decodes</b>                                   | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Location</b>                                       | Overlaid on acquired DATA waveform, on Grid.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Visual Aid</b>                                     | Color Coding of Message Type, Preamble, SOP, Data Role (UFP/DFP), Power Role (Source/Sink), EPR/SPR (Source/Sink) Capabilities, Msg ID, Obj Count, Extended, Data, CRC, and EOP. Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Table Configure, Export Table</b>                  | Display 1 to 20 rows of decoded information for up to four different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Pattern Search</b>                                 | Search for previous or next: Index, Time, SOP, Msg Type, Data Role, Power Role, Msg ID, Obj Count, Extended, Data, CRC, Status. Advanced search of a combination of up to the three Table Columns using AND/OR operation and specified Values.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| USB-PD TDMP Only                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Definition</b>                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Source and Protocol Setup</b>                      | <p>Typical Setup for USB-PD Specific Measurements:</p> <p>Select Channel Source for CC1 or CC2 Signals (required)</p> <p>Select Channel Source for Vbus Signal (required for VBUS@PS_RDY Measurements)</p> <p>Select Channel Source for Iload Signal (optional)</p> <p>Select Channel for other side band protocols such as DP-AUX, USB4-SBU (UART), or other</p> <p>Alt Modes (required if time correlating with USB-PD).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>USB-PD Specific Measurements</b>                   | PS_RDY_Level - Measures VBUS@PS_RDY.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Timing Measurements</b>                            | <p><b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), Time@Message (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition &lt;=, &lt;, =, &gt;, &gt;=, &lt;&gt;, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Eye Diagram and Physical Layer Test Capability</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Physical Layer Setup</b>                           | USB-PD Analysis is selected (and enabled) from the Oscilloscope's Analysis menu. Links to USB-PD serial decoder, performs Physical Layer and BMC Eye Diagram tests. Eye and Measurements made on selected Zoom packet in decoder or on full acquisition.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Selectable Physical Layer Measurements</b>         | <p><b>Measurements defined by the USB-PD Specification:</b></p> <p>BMC Common Parameters: fBitRate, tUnitInterval</p> <p>BMC Transmitter: pBitRate, tRise, tFall, vHigh, vLow, vSwing, SymbEncod</p> <p>BMC Eye: vEyeCrossing</p> <p>Vbus: PS_RDY_LEVEL</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>VBUS@PS_RDY Measurement</b>                        | Appears in Measurements as PS_RDY_LEVEL is enabled in Decode Setup menu. It Measures Vbus on a separate channel when PS_RDY message occurs on the CC line. Result is displayed in Measurement Table, Decode Overlay, and Decode Table.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Eye Diagram Setup</b>                              | Select BMC Eye (ONE, ZERO, or BOTH). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Eye Parameters</b>                                 | Automatic measurement of Unit Interval (tUnitInterval) for Eye Diagram clock recovery and Eye Mask Hits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Eye Mask</b>                                       | <p><b>USB-PD Standard or Custom Mask Selection:</b></p> <p>USB-PD Standard: BMC Transmitter Mask, BMC Receiver Masks (Neutral, Sourcing, Sinking)</p> <p>Custom: Modify standard masks or create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Failure Indication and Location</b>                | <p>Mask Failure Indication ON or OFF (ON = indicated with a red circle).</p> <p>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

# USB4 SIDEBAND (SB) CHANNEL

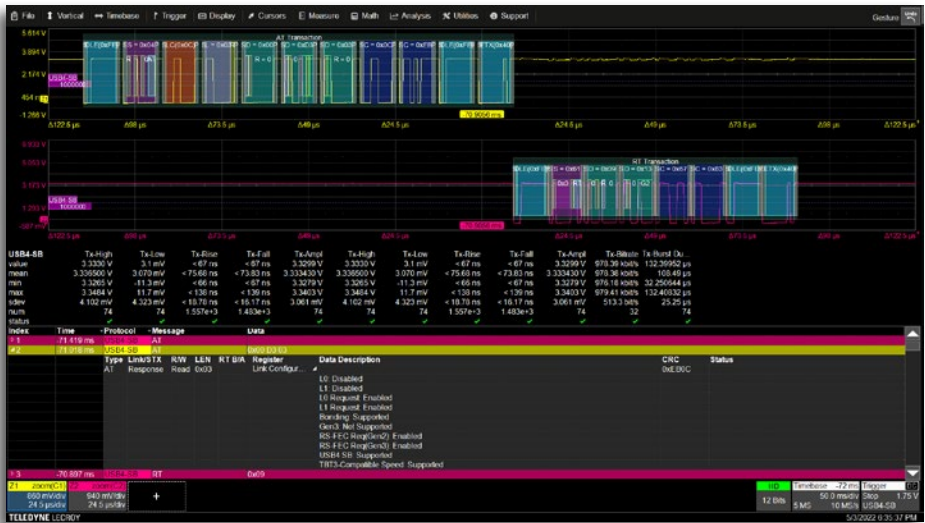
## Key Features

**Trigger on USB4® Thunderbolt™ Sideband Link Management Events**

**Decode Link (LT), Admin (AT), and Re-timer (RT) Transactions on SB-TX and SB-RX**

**Use standalone or with USB4bus DME for USB4 PHY-Logic Layer Debug**

**USB4 and Thunderbolt Sideband PHY Compliance Measurements**

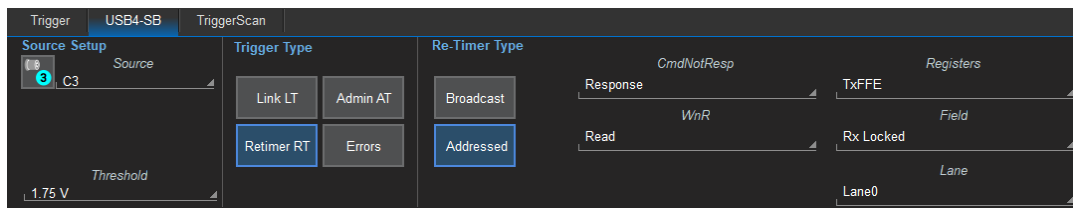


## Analyze SB-Tx and SB-Rx using Interactive Protocol Table

Simply click on the USB4-SB packet of interest in the protocol table to create a zoom window of the waveform with color coded overlay showing the packet type, command, register address, and message details.

## Trigger and Decode USB4 the Sideband

Setup the USB4-SB trigger to capture specific events during link training and the decode table to validate sideband link management transactions between devices are conformant to the USB4 specification.



## Use standalone or with USB4bus DME software for PHY Logic Layer Debug

Use TF-USB-C USB High-speed and Sideband Test Coupon Fixtures with a wide range of oscilloscopes to capture USB4 sideband Tx and Rx signals using passive probes or with DH Series differential probes to capture the full USB4 bus including sideband signals and high-speed data. The TF-USB-C enables the only solution to trigger on USB4-SB signals and simultaneously capture high-speed data up to 20Gb/s on a live link, allowing the user to validate PHY link layer training on USB4 and Thunderbolt Transmitters, Re-timers, or Active Cables.



TF-USB-C-HS USB4 High Speed and Sideband Test Coupon



# SPECIFICATIONS

| USB4-SB TD and TDMP                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Source and Protocol Setup</b>     | Select Source(s).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Format</b>                        | Set Source and Threshold voltage for SBU4-SB Trigger Source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Trigger Setup</b>                 | <b>Comprehensive Trigger selections for debugging link training failures:</b><br><b>Trigger Types:</b> Link (LT), Address (AT) and Retimer (RT) Transactions, with selectable Register values:<br><b>Link (LT):</b> LSE Symbol (Resume, Fail, Lroff, Gen2, Gen3, Resume2, or Any), Lane (Lane0, Lane1, Any)<br><b>Admin (AT):</b> CmdNotResp (Command, Response, Any); <b>Command/Response:</b> (Read, Write, Any), <b>Read:</b> (Vendor ID, Product ID, Opcode, Metadata, Link Config, TxFEE, SB Chan Ver, Data, Any); <b>Write:</b> (Opcode, Metadata, TxFEE, Data, Any); <b>TxFEE Field:</b> (Request Done, Tx Active, Any); <b>Lane:</b> (Lane0, Lane1, Any)<br><b>Retimer (RT):</b> (Broadcast, Addressed); <b>Broadcast;</b> <b>Addressed:</b> CmdNotResp (Command, Response, Any); <b>Command/Response:</b> (Read, Write, Any); <b>Read:</b> (Vendor ID, Product ID, Opcode, Metadata, Link Config, TxFEE, SB Chan Ver, Data, Any); <b>Write:</b> (Opcode, Metadata, TxFEE, Data, Any); <b>TxFEE Field:</b> (Request Done, Tx Active, Any); <b>Lane:</b> (Lane0, Lane1, Any). |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input. External MSO not supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Format</b>                        | Hexadecimal or Binary (Decode of register values listed in Trigger Setup above).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Decode Setup</b>                  | Define Source as: SBTX, SBRX, or 'SBTX and SBRX'.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Decode Input</b>                  | Any analog Channel, Memory, Math, or Digital trace.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Location</b>                      | Overlaid on acquired DATA waveform, on Grid.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Visual Aid</b>                    | Color Coding of Message Type, Preamble, SOP, Data Role (UFP/DFP), Power Role (Source/Sink), Msg ID, Obj Count, Extended, Data, CRC, and EOP. Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Pattern Search</b>                | Search for previous or next: Index, Time, SOP, Msg Type, Data Role, Power Role, Msg ID, Obj Count, Extended, Data, CRC, Status. Advanced search of a combination of up to the three Table Columns using AND/OR operation and specified Values.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| USB4-SB TDMP Only                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.                                                                                                                                                                                                                               |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Eye Diagram and Physical Layer Test Capability</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Physical Layer Setup</b>                           | USB4-SB Analysis is selected (and enabled) from the Oscilloscope's Analysis menu. Links to USB4-SB serial decoder, performs USB4 and Thunderbolt Physical Layer measurements. Measurements made on selected Zoom packet in decoder or on full acquisition.                                                                                                                                                                                                                                                                                                        |
| <b>Selectable Physical Layer Measurements</b>         | <b>USB4 and Thunderbolt Physical Layer Tx Measurements:</b> VHigh, VLow, Rise Time, Fall Time, Amplitude, Bitrate, Burst Duration.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Eye Diagram and Mask Testing</b>                   | <b>Eye Parameters:</b> Eye Height, Eye Width, (Number of) Mask Hits. Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use. Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br><br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                 |

# SMBUS

## Key Features

Supports triggers on standard SMBus Command Protocols with or without PEC

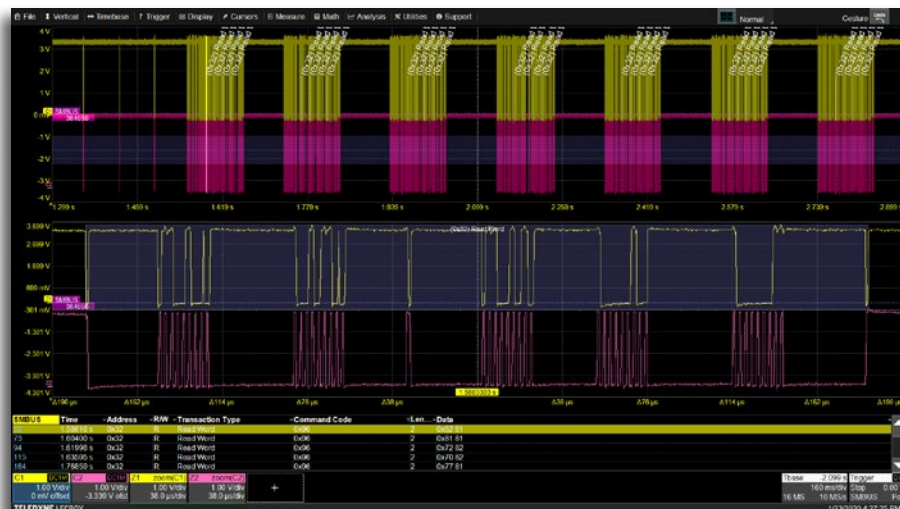
Trigger support for ARP, SMBALERT#, and PEC errors

Trigger and Decode unaffected by Clock Stretching

Provides for complex triggering with defined Address, R/W (direction), Command Code, and Data.

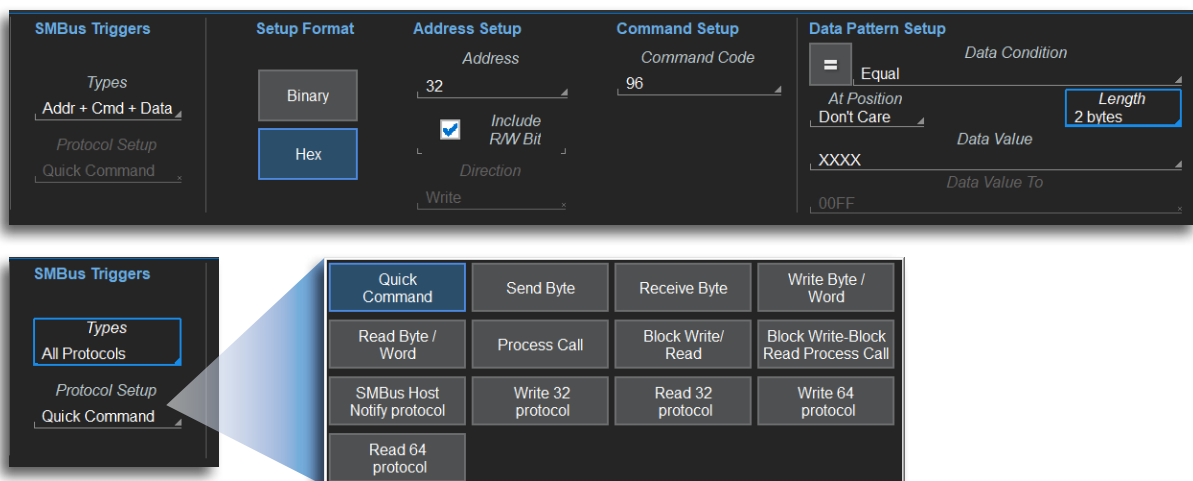
Conditional data definition (<, <=, =, >, >=, <>, INRANGE, OUT of RANGE).

Use analog or digital (MSO) inputs for acquisition and triggering.



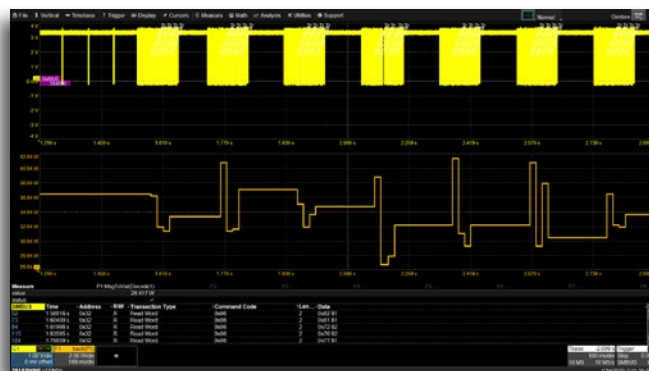
## Comprehensive and Powerful SMBus Trigger

Capability is provided to trigger on any standard SMBus Command Protocol, ARP Command, and also on user-defined command protocols, with full capability to define specific data values or ranges of data values.



## Extract Data from user-defined Command Code readouts and Plot it as a Waveform

SMBus data readouts are difficult to understand by reviewing hexadecimal values in a table. The SMBus TDME option provides ability to extract digital data from a defined data location in specific messages and convert them to analog values that are then plotted to resemble an analog waveform.



# SPECIFICATIONS

| SMBus TD and SMBus TDME              |                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Source and Protocol Setup</b>     | Select Source for Clock and Data                                                                                                                                                                                                                                                                                                                                             |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Format</b>                        | Hexadecimal or Binary. ADDRESS and DATA can be set up with different formats.                                                                                                                                                                                                                                                                                                |
| <b>Trigger Setup</b>                 | Trigger on START, STOP, RESTART, No ACK, Read Protocols, Write Protocols, Quick Command, Send Byte, Receive Byte, Write Byte/Word, Read Byte/Word, Process Call, Block Write/Read, Block Write-Block Read Process Call, SMBus Host Notify protocol, Write 32 protocol, Read 32 protocol, Write 64 protocol, Read 64 protocol, ARP, ADDR, ADDR+CMD+DATA, SMBALERT#, PEC Error |
| <b>ADDRESS Setup</b>                 | Specify one ADDRESS with condition of "=".<br>7 bit ADDRESS supported with full Read, Write, or R/W="Don't Care" selectability on 7 bit ADDRESSES.<br>Choose to Trigger on address values that include/don't include R/W bit in address value.                                                                                                                               |
| <b>DATA Setup</b>                    | Custom Trigger Type:<br>Hexadecimal: # Data Bytes = 0 to 12. Data can be defined by nibble.<br>Binary: Any combination of 0,1, or X for 1-96 bits. Data pattern can be set to start at any location in the 12 Byte / 96 bit sequence.                                                                                                                                        |
| <b>DATA Conditions</b>               | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE.                                                                                                                                                                                                                                                                                                                  |
| <b>ACK Conditions</b>                | For any ADDR or ADDR+CMD+DATA setup, select an ACK Condition of ACK, NO ACK, and DON'T CARE.                                                                                                                                                                                                                                                                                 |
| <b>Bit Rates</b>                     | Full range over SMBus specification for 100 kHz Class, 400 kHz Class, and 1 MHz Class SMBus. Auto-detected.                                                                                                                                                                                                                                                                  |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input. External MSO not supported.                                                                                                                                                                                                                                                                                           |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Format</b>                        | Hexadecimal, Binary                                                                                                                                                                                                                                                                                                                                                          |
| <b>Decode Setup</b>                  | Threshold definition required. Default is to Percent amplitude.<br>Choose to Decode address values including/not including the R/W bit in address value.                                                                                                                                                                                                                     |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace. Clock channel may be turned OFF and data will still decode (reduces screen clutter).                                                                                                                                                                                                                        |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                    |
| <b>Visual Aid</b>                    | Color Coding for Command Protocols as well as START/ReSTART, ADDR, R/W, DATA, ACK, NACK, and STOP bits.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                       |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                   |
| <b>Pattern Search</b>                | Search for previous or next: Index, Time, Address, R/W, Command Code, Length, Data in hexadecimal format.                                                                                                                                                                                                                                                                    |

| SMBus TDME only                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.<br><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                         |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger). Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %:</b><br>Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                       |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                          |

## Key Features

Support for SMBus and PMBus

Select command categories and auto-fill numeric data formats

Trigger on hex or analog values (i.e., 5 V)

Custom configuration file

Conditional data definition (<, <=, =, >, >=, <>, In Range of, Out of Range)

Use analog or digital (MS0) inputs for acquisition and triggering



## Trigger on Extracted Analog Values

Whether you want to trigger when the output voltage is 5 V, device temperature is 30°C, or it's 7 ms after a pin enables, enter the analog value and let the software do the rest. Also supports all standard SMBus trigger types.

The screenshot shows the Command Setup and Data Pattern Setup dialog boxes for the READ VOUT command. The Command Setup dialog has "READ VOUT" selected. The Data Pattern Setup dialog has "Equal" selected, with "Type" set to "Linear\_16u", "Value" set to "5.00000", and "Exp(R)" set to "-13". The Symbol File is set to "C:\LeCroy\XStre...\PMBusConf.conf".

The screenshot shows the Command Setup and Data Pattern Setup dialog boxes for the READ TEMPERATURE 1 command. The Command Setup dialog has "READ TEMPERATURE 1" selected. The Data Pattern Setup dialog has "Equal" selected, with "Type" set to "Linear\_11s", "Value" set to "30.00000", and "Exp(R)" set to "0". The Symbol File is set to "C:\LeCroy\XStre...\PMBusConf.conf".

The screenshot shows the Command Setup and Data Pattern Setup dialog boxes for the TON DELAY command. The Command Setup dialog has "TON DELAY" selected. The Data Pattern Setup dialog has "Equal" selected, with "Type" set to "Linear\_11s", "Value" set to "7.00e-3", and "Exp(R)" set to "-9". The Symbol File is set to "C:\LeCroy\XStre...\PMBusConf.conf".

## Automatically set up device commands and numeric data formats

Your power management device can support all of the 256 PMBus commands or a subset. Select a custom configuration file and numeric data formats are pre-filled, no complex calculations required. Everything is decoded and presented in an easy-to-read format.



# SPECIFICATIONS

| PMBus TD and PMBus TDME                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Source and Protocol Setup</b>                      | Select Source for Clock and Data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Trigger Capability</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Format</b>                                         | Hexadecimal or Binary. ADDRESS and DATA can be set up with different formats.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Trigger Setup</b>                                  | Trigger on value being monitored (Volts, temperature, time, etc.) by selecting specific command set (Memory, On/Off, Output Voltage, Configuration, Warning/Faults, Sequencing, Status, Telemetry, Inventory, Mfg Ratings, Others). Numeric data format gets automatically filled from configuration file.<br>Trigger on any SMBus packet - START, STOP, RESTART, No ACK, Read Protocols, Write Protocols, Quick Command, Send Byte, Receive Byte, Write Byte/Word, Read Byte/Word, Process Call, Block Write/Read, Block Write-Block Read Process Call, SMBus Host Notify protocol, Write 32 protocol, Read 32 protocol, Write 64 protocol, Read 64 protocol, ARP, ADDR, ADDR+CMD+DATA, SMBALERT#, PEC Error |
| <b>ADDRESS Setup</b>                                  | Specify one ADDRESS with condition of "=".<br>7 bit ADDRESS supported with full Read, Write, or R/W="Don't Care" selectability on 7 bit ADDRESSES.<br>Choose to Trigger on address values that include/don't include R/W bit in address value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Command Setup</b>                                  | Specify one 8-bit COMMAND with condition of "=".<br>8-bit value can be in Binary, Hexadecimal, or Symbolic. Symbolic command can be default or defined in customer configuration file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>DATA Setup</b>                                     | Custom Trigger Type:<br>Symbolic: Enter value being monitored (voltage, temperature, time, etc.) in decimal. Numeric data format gets automatically filled from configuration file.<br>Hexadecimal: # Data Bytes = 0 to 12. Data can be defined by nibble.<br>Binary: Any combination of 0,1, or X for 1-96 bits. Data pattern can be set to start at any location in the 12 Byte / 96 bit sequence.                                                                                                                                                                                                                                                                                                          |
| <b>DATA Conditions</b>                                | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE. Selection options vary based off command category chosen.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>ACK Conditions</b>                                 | For any ADDR or Custom setup, select an ACK Condition of ACK, NO ACK, and DON'T CARE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Bit Rates</b>                                      | Full range over SMBus specification for 100 kHz Class, 400 kHz Class, and 1 MHz Class PMBus. Auto-detected.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Trigger Input</b>                                  | Any analog Channel or Digital input, or the EXT input. External MSO not supported. Clock may be input to EXT to conserve available analog Channels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Decode + Search Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Format</b>                                         | Hexadecimal, Symbolic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Decode Setup</b>                                   | Threshold definition required. Default is to Percent amplitude.<br>Choose to Decode address values including/not including the R/W bit in address value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Decode Input</b>                                   | Any analog Channel, Memory or Math trace, and any Digital trace.<br>Clock channel may be turned OFF and data will still decode (reduces screen clutter)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b># of Decodes</b>                                   | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Visual Aid</b>                                     | Color Coding for START/ReSTART, ADDR, R/W, DATA, ACK, NACK, and STOP bits.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Table Configure, Export Table</b>                  | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Pattern Search</b>                                 | Search for previous or next: Index, Time, Address, R/W, Command Code, Length, Data in hexadecimal format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| PMBus TDME only                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.<br><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                                                                                                                                                                  |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger) Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements.                                                                                                                                           |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %:</b><br>Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## Key Features

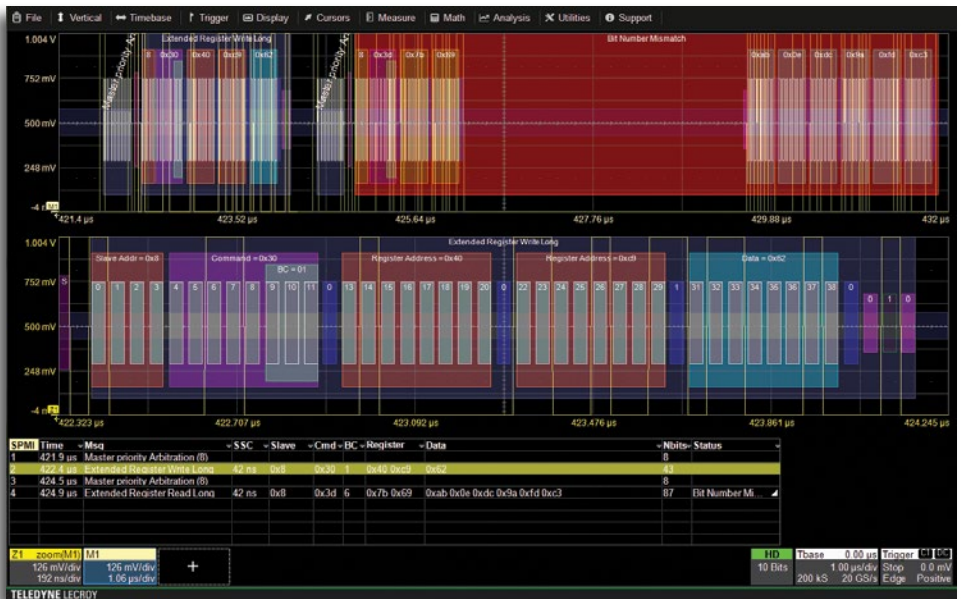
Trigger and Decode Commands, Command Sequences and Error Frames

User-defined Command Frame/Sequence – trigger on non-standard frames.

Conditional data definition (<, <=, =, >, >=, <>, INRANGE, OUT of RANGE).

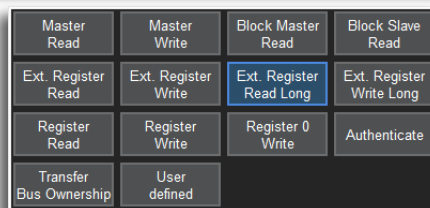
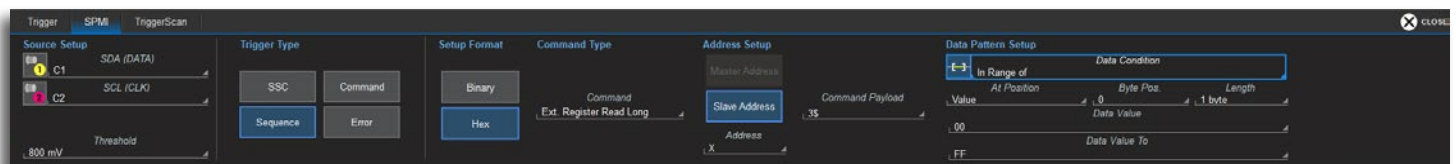
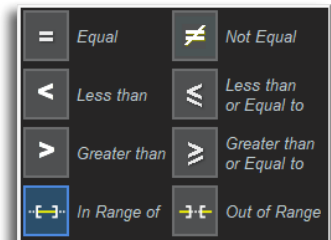
Use analog or digital (MSO) inputs for acquisition and triggering.

Full arbitration sequence support and for all sequences with pauses.



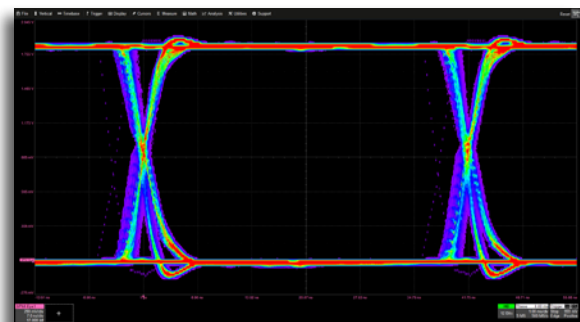
## Comprehensive and Powerful SPMI Trigger

Capability is provided to permit triggering on any MIPI-defined allowable command sequence, and also on user-defined command sequences, with full capability to define specific data values or ranges of data values.



## Eye Diagrams Identify Physical Layer Issues

Quickly create an eye diagram to intuitively show bit transitions and physical layer signal quality. In this 10 ms acquisition, it is easy to assess the signal quality and find the irregular bit transitions (faint purple lines).



# SPECIFICATIONS

| SPMibus TD and SPMibus TDME          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Source and Protocol Setup</b>     | Select Source for Clock and Data.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Format</b>                        | Hexadecimal or Binary                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Trigger Setup</b>                 | Trigger on SSC, Command (Reset, Sleep, Shutdown, Wakeup), Command Sequence (Master Read, Master Write, Block Master Read, Block Slave Read, Extended Register Read, Extended Register Write, Extended Register Read Long, Extended Register Write Long, Register Read, Register Write, Register 0 Write, Authenticate, Transfer Bus Ownership, User-defined), or Errors (OR any combination of Command Parity Error, Acknowledgement Error, Data Parity Error, Frames Error). |
| <b>DATA Setup</b>                    | Command Sequence Trigger Type:<br>Hexadecimal: # Data Bytes = 0 to 16. Data can be defined by nibble.<br>Binary: Any combination of 0,1, or X for 1-128 bits"                                                                                                                                                                                                                                                                                                                 |
| <b>DATA Condition Setup</b>          | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Bit Rates</b>                     | Any, up to 26 Mb/s. Auto-detected from clock signal.                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input. External MSO not supported                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Format</b>                        | Hexadecimal, with selection for Bit Viewing (Index or State).                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Decode Setup</b>                  | Threshold definition required. Default is to Percent amplitude.<br>Choose to Decode address values including/not including the R/W bit in address value.                                                                                                                                                                                                                                                                                                                      |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.<br>Clock channel may be turned OFF and data will still decode (reduces screen clutter).                                                                                                                                                                                                                                                                                                                      |
| <b># of Decoded Waveforms</b>        | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Visual Aid</b>                    | Color Coding for FRAME, ARBITRATION SEQUENCE, COMMAND SEQUENCE, ARBITRATION/COMMAND BITS, SEQUENCE START CONDITION (SSC), SLAVE ADDRESS, COMMAND, BYTE COUNT CODE (BC), REGISTER ADDRESS, PAYLOAD DATA, PARITY BITS, BUS PARK CYCLE, ACK/NACK, and PROTOCOL ERROR<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                              |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                    |
| <b>Pattern Search</b>                | Basic search for Previous or Next INDEX, TIME, MESSAGE (value), SSC, SLAVE (id), COMMAND, BYTE COUNT CODE, REGISTER, DATA (value), NBITS, or STATUS. Advanced search allows complex criteria using boolean and/or logic to combine up to three different searches.                                                                                                                                                                                                            |

| SPMibus TDME only                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion. <b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                       |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger) Serial Message may be defined by "ID =" (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %</b><br>Serial Message may be defined by "ID =" (where applicable) and user-defined "DATA <=, <, =, >, >=, <>, in range, out of range" in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                       |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                         |

## Key Features

**Supports triggers in SDR, HDR-DDR, and Legacy I2C operating modes**

**Provides triggering in “ANY” supported operating mode**

**Provides for complex triggering with defined Address, R/W (direction), Common Command Code, and Data.**

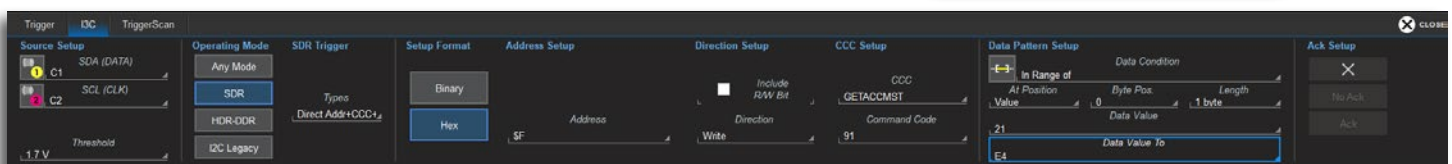
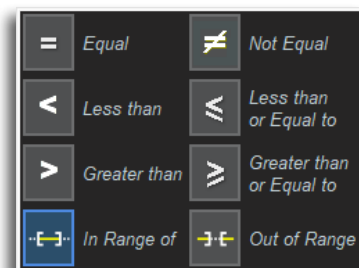
**Conditional data definition (<, <=, =, >, >=, <>, INRANGE, OUT of RANGE).**

**Use analog or digital (MSO) inputs for acquisition and triggering.**



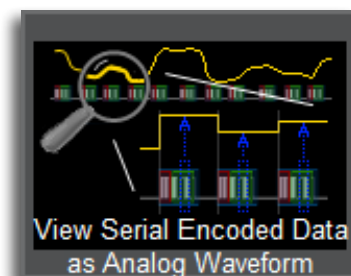
## Comprehensive and Powerful I3C Trigger

Capability is provided to permit triggering on any MIPI-defined allowable command sequence, and also on user-defined command sequences, with full capability to define specific data values or ranges of data values.



## Extract Digital Sensor Data and Plot it as a Waveform

Embedded digital sensor data can be difficult to understand by reviewing hexadecimal values in a table. The I3Cbus TDME option provides ability to extract digital data from a defined data location in specific I3C messages and convert them to analog values that are then plotted to resemble an analog waveform.



# SPECIFICATIONS

| I3Cbus TD and I3Cbus TDME            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Source Setup</b>                  | Select Source for Clock and Data.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Format</b>                        | Hexadecimal or Binary. ADDRESS and DATA can be set up with different formats.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Trigger Setup</b>                 | Select from operating modes to trigger on the following:<br>SDR: Start (S), Stop (P), Restart (SR), Direct Frame, Broadcast Frame, SDR Frame Length, Direct Address + CCC + Data, Broadcast Address + CCC + Data, SDR Errors<br>HDR-DDR: Enter, Exit, Restart, Frame Length, Address + Cmd + Data, Preamble, Errors<br>I2C Legacy: START, ReSTART, STOP, Missing ACK, ADDR, DATA, ADDR+DATA, ADDR+DATA FRAME LENGTH, EEPROM DATA TRANSFER<br>Any Mode: Start (S), Stop (P), Restart (SR), Frame Length, Any Address + Data, Any Errors |
| <b>ADDRESS Setup</b>                 | Specify one ADDRESS with condition of “=”.<br>7 or 10 bit ADDRESS supported with full Read, Write, or R/W=“Don't Care” selectability on both 7 and 10 bit ADDRESSES.<br>Choose to Trigger on address values that include/don't include R/W bit in address value.                                                                                                                                                                                                                                                                       |
| <b>DATA Setup</b>                    | Direct Address + CCC + Data, Broadcast Address + CCC + Data, ADDRESS+DATA, Any Address + Data, and HDR-DDR Address + Cmd + Data<br>Trigger Types:<br>Hexadecimal: # Data Bytes = 0 to 12. Data can be defined by nibble.<br>Binary: Any combination of 0,1, or X for 1-96 bits<br>Data pattern can be set to start at any location in the 12 Byte / 96 bit sequence.                                                                                                                                                                   |
| <b>DATA Conditions</b>               | <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>ACK Conditions</b>                | For any Direct Address + CCC + Data, Broadcast Address + CCC + Data, HDR-DDR + Cmd + Data, Addr + Data, or Any Addr + Data setup, select an ACK Condition of ACK, NO ACK, and DON'T CARE.                                                                                                                                                                                                                                                                                                                                              |
| <b>Bit Rates</b>                     | Full range of speeds for I3C specification for SDR, HDR-DDR, and I2C legacy operation modes.                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input. External MSO not supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Format</b>                        | Hexadecimal, Binary, ASCII                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Decode Setup</b>                  | Threshold definition required. Default is to Percent amplitude.<br>Choose to Decode address values including/not including the R/W bit in address value.                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Decode Input</b>                  | Any analog Channel, Memory or Math trace, and any Digital trace.<br>Clock channel may be turned OFF and data will still decode (reduces screen clutter).                                                                                                                                                                                                                                                                                                                                                                               |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Visual Aid</b>                    | Color Coding for FRAME, START/ReSTART bit, ADDR, R/W, DATA, ACK, NACK, and STOP bit.<br>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.                                                                                                                                                                                                                                                                                                                                    |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                             |
| <b>Pattern Search</b>                | Search for Previous or Next ADDRESS, PACKET, or DATA in hexadecimal format.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| I3Cbus TDME only                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measure / Graph Capability</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Serial Data Digital-to-Analog Conversion (DAC)</b> | <b>Message to Value</b> measurement parameter extracts and converts a specified portion of the data in an up to 2048 byte data/payload in the serial message and displays it as an analog decimal value. Supports different data encoding formats, message filtering to specific IDs, and complete re-scaling with unit conversion.<br><b>Serial DAC Waveform</b> plots the converted digital-to-analog data as a waveform time-correlated to other acquisition data, and view the change in data over time.                                                           |
| <b>Timing Measurements</b>                            | <b>Message to Analog, Analog to Message, Message to Message, ΔMessage Time</b> (identical message on same decoder), <b>Time@Message</b> (time from trigger)<br>Serial Message may be defined by “ID =” (where applicable) and user-defined DATA with condition <=, <, =, >, >=, <>, IN RANGE, or OUT OF RANGE in any location in up to 2048 bits of data. Analog Signal may be defined by Slope (pos, neg), Level (abs or %) with Hysteresis setting. Holdoff may be set on the Analog Signal by either Time or Events (up to 1000) to preclude unwanted measurements. |
| <b>Bus Status Measurements</b>                        | <b>Number of Messages, Message Bit Rate, Message Bus Load %:</b><br>Serial Message may be defined by “ID =” (where applicable) and user-defined “DATA <=, <, =, >, >=, <>, in range, out of range” in any location in up to 2048 bits of data.                                                                                                                                                                                                                                                                                                                         |
| <b>Eye Diagram Capability</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Setup</b>                                          | Create up to four simultaneous Eye Diagrams (one per Serial Decoder) of the physical layer signal(s). Eye Style selectable as color- or analog-persisted. Eye Saturation adjustable from 0 to 100%.                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Eye Parameters</b>                                 | Eye Height, Eye Width, (Number of) Mask Hits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Eye Mask</b>                                       | Create a custom Mask using the free Teledyne LeCroy MaskMaker software utility. Store custom masks for later recall and use.                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Failure Indication and Location</b>                | Mask Failure Indication ON or OFF (ON = indicated with a red circle).<br>Mask Failure Location trace waveform displayed and interactive with Eye Mask failure table. Supports STOP trigger on Mask Failure.                                                                                                                                                                                                                                                                                                                                                            |

# NRZ-MANCHESTER

## Key Features

User definable protocol trigger and decoding of Manchester and NRZ encoded buses

Supports decoding of continuous data streams using flexible synchronization

Flexible decoding of buses with bit rates up to 60 Gb/s

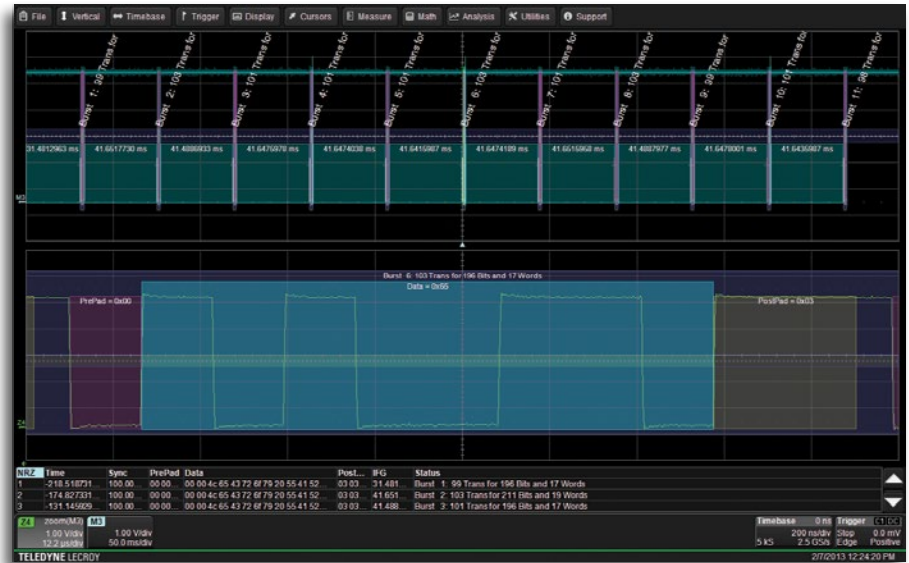
Configurable word and packet grouping for custom protocol definition

Flexible CRC calculation support

Intuitive color-coded decode is overlaid directly on physical layer waveform

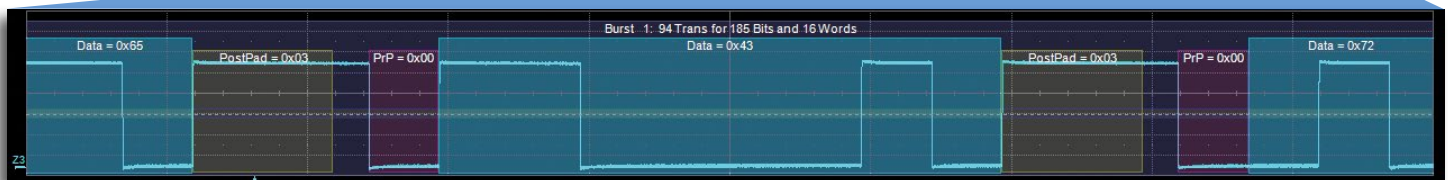
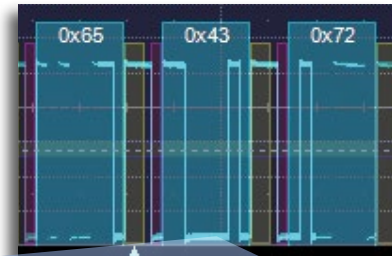
Convenient table display with quick "zoom to message" capability

Search feature quickly identifies



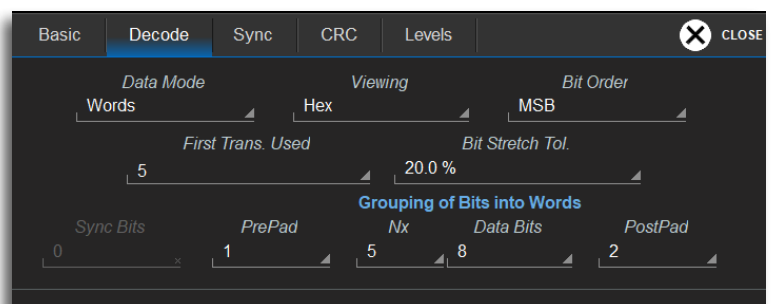
## Flexible, User-Definable Protocol Decoding

The NRZ-Manchester TD option offers a generic NRZ and Manchester decoder for troubleshooting and analyzing the physical layer of NRZ or Manchester coded signal. It expands the trigger and decoder with customizable configuration of the protocol structure that has to be decoded and makes any NRZ and Manchester-based data signal decoding to a seamless, effortless process.



## Configurable Grouping for Custom Protocol Definition

Define the number of sync bits, header or pre-amble bits, data bits and footer or CRC bits to build a custom protocol decoder for a proprietary bus or decode Manchester or NRZ based industry standard buses like PSI5, DALI, LONworks, and proprietary NRZ protocols.



# SPECIFICATIONS

| NRZ-Manchester TD                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Source Setup</b>                  | Select Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Trigger Capability</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Format</b>                        | Hexadecimal or Binary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Trigger Setup</b>                 | <p>Trigger on Start of Frame (SOF), Data and Error (only for Manchester). Select BitRate (10 bit/s to 31.25 Mb/s), Idle State (Idle Low, Idle High, Dont Care), Idle Polarity (NRZ: Low=0 or Low=1; Manchester Falling=0, Falling=1).</p> <p>Encoding NRZ: Standard, NRZ-M, NRZ-S.</p> <p>Encoding Manchester: Standard, Differential Bi-Phase Mark, Differential Bi-Phase Space, Modified Miller.</p> <p>Frame definition permits definition of byte packets into a single long (decoded) message package through a user-defined "Timeout Definition" in Bits (1-100) or Seconds (100ps - 10s). First Transition Used (0 - 400), Bit Stretch Tolerance (0 - 100 %), Sync Bits (0-1000), Grouping of Bits into Words: PrePad Bits (0 - 32), Data Bits (1 - 32), Number of Data Packets (Nx 0 -100), Data Bits (1-32), PostPad Bits (0 - 32).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>DATA Setup</b>                    | <p>DATA Trigger Type:</p> <p>Hexadecimal: # Data Bytes = 0 to 12. Data can be defined by nibble.</p> <p>Binary: Any combination of 0,1, or X for 1-96 bits.</p> <p>Data pattern can be set to start at any location in the 12 Byte / 96 bit sequence.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>DATA Conditions</b>               | Data Setup: <=, <, =, >, >=, <>, IN RANGE, OUT OF RANGE, or DON'T CARE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Error Setup</b>                   | Manchester Only: Under Speed Error, Over Speed Error                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Bit Rates</b>                     | 10bit/s - 25 Mbit/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Trigger Input</b>                 | Any analog Channel or Digital input, or the EXT input                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Decode + Search Capability</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Format</b>                        | Hexadecimal, Binary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Decode Setup</b>                  | <p>Threshold definition required. Default is to Percent amplitude.</p> <p>Select BitRate, Idle State (Idle Low, Idle High, Dont Care), Idle Polarity (NRZ: Low=0 or Low=1; Manchester Falling=0, Falling=1).</p> <p>Encoding NRZ: Standard, NRZ-M, NRZ-S.</p> <p>Encoding Manchester: Standard, Differential Bi-Phase Mark, Differential Bi-Phase Space, Modified Miller.</p> <p>Frame definition permits definition of byte packets into a single long (decoded) message package through a user-defined "Timeout Definition" in Bits (1-100) or Seconds (100ps - 10s).</p> <p>First Transition Used (0 - 400), Bit Stretch Tolerance (0 - 100 %), Sync Bits (0-1000), Grouping of Bits into Words: PrePad Bits (0 - 32), Data Bits (1 - 32), Number of Data Packets (Nx 0 -100), Data Bits (1-32), PostPad Bits (0 - 32).</p> <p>In Extended Mode: Using synchronization for continuous data streams: Manual, Auto.</p> <p>Has Preamble (111...,000...,custom - custom could be in hex or binary); Has Start Pattern (hex or binary); Has End Pattern (Hex or Binary).</p> <p>CRC verification: Start Idx Mode (Manual, Auto), End Idx (Manual, Auto), Polynome Length (1-64), Polynome, Polynome Seed, Invert Output, Data Start Idx (0-1000), Data End Idx (0-1000), CRC Start Idx (0-1000), CRC End Idx (0-1000).</p> |
| <b>Decode Input</b>                  | <p>Any analog Channel, Memory or Math trace, and any Digital trace.</p> <p>Clock channel may be turned OFF and data will still decode (reduces screen clutter).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b># of Decodes</b>                  | Up to 4 buses may be decoded at one time. In addition, zooms can be displayed (with decoded information).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Visual Aid</b>                    | <p>Color Coding for Idle, timeout, Prepad, Data, PostPad. Decode information is intelligently annotated based on timebase setting.</p> <p>Decode information is intelligently annotated based on timebase setting, and overlaid on acquired waveform.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Table Configure, Export Table</b> | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Pattern Search</b>                | Display 1 to 20 rows of decoded information for up to 4 different protocols or decodes in time order in a single table. Displayed information includes Index, Timestamp, and other various protocol-specific information. Table permits scrolling, touch to zoom, export to .csv file, and special display of long data or other patterns. Search for Index, Time, Time Out, Idle, Message, Prepad, Data, Postpad, Status. Selection available for use of defining decimal or hexadecimal search value with Data mode = Words.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

# COMPATIBILITY

|                         |                                                                                                             | WaveSurfer 4000HD       | HDO4000A    | WaveRunner 8000HD<br>WaveRunner 9000 |                                                  |
|-------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------|-------------|--------------------------------------|--------------------------------------------------|
| Embedded Computing      | I <sup>2</sup> C                                                                                            | EMB bundle              | EMB bundle  | EMB bundle                           |                                                  |
|                         | SPI                                                                                                         |                         |             |                                      |                                                  |
|                         | UART-RS232                                                                                                  |                         |             |                                      |                                                  |
|                         | QSPI <sup>2</sup>                                                                                           | –                       | –           | TD                                   |                                                  |
|                         | USB 2.0 HSIC                                                                                                | –                       | –           | D                                    |                                                  |
| Automotive + Industrial | 10Base-T1S                                                                                                  | –                       | TD          | AUTOENET-10M<br>Bundle               | AUTOENET-10M-<br>1G BUNDLE                       |
|                         | OA3p                                                                                                        | –                       | –           |                                      |                                                  |
|                         | 100Base-T1                                                                                                  | –                       | –           |                                      |                                                  |
|                         | 1000Base-T1                                                                                                 | –                       | –           |                                      |                                                  |
|                         | CAN                                                                                                         | CAN FD                  | AUTO bundle | IVN-Classic Bundle TD                | IVN-Classic Bundle TD<br>IVN Classic Bundle TDME |
|                         |                                                                                                             | CAN FD Light/<br>CAN XL | –           |                                      |                                                  |
|                         | FlexRay                                                                                                     | AUTO bundle             |             |                                      |                                                  |
|                         | LIN                                                                                                         |                         |             |                                      |                                                  |
| SENT                    | –                                                                                                           |                         |             |                                      |                                                  |
| Avionics                | ARINC 429                                                                                                   | –                       | D Symbolic  | D Symbolic,<br>DME Symbolic          |                                                  |
|                         | MIL-STD-1553                                                                                                | –                       | TD          | TD,<br>TDME                          |                                                  |
|                         | SpaceWire                                                                                                   | –                       | D           | D                                    |                                                  |
| Peripherals             | Ethernet (10/100Base-T)                                                                                     | –                       | D           | D                                    |                                                  |
|                         | USB 2.0                                                                                                     | –                       | D           | TD,<br>TDME                          |                                                  |
|                         | DisplayPort AUX                                                                                             | –                       | TD          | TD,<br>TDMP                          |                                                  |
|                         | USB-PD (Power Delivery)                                                                                     | –                       | TD          | TD,<br>TDMP                          |                                                  |
|                         | USB4-SB (Sideband)                                                                                          |                         | TD          | TD,<br>TDMP                          |                                                  |
| Power Mgmt              | SMBus                                                                                                       | –                       | TD          | TD,<br>TDME                          |                                                  |
|                         | PMBus                                                                                                       | –                       | TD          | TD,<br>TDME                          |                                                  |
|                         | SPMI                                                                                                        | –                       | TD          | TD,<br>TDME                          |                                                  |
| MIPI                    | C-PHY                                                                                                       | –                       | –           | D,<br>DP <sup>1</sup>                |                                                  |
|                         | D-PHY                                                                                                       | –                       | D           | D,<br>DP <sup>1</sup>                |                                                  |
|                         | DigRF 3G                                                                                                    | –                       | D           | D                                    |                                                  |
|                         | DigRF v4                                                                                                    | –                       | D           | D                                    |                                                  |
|                         | I <sup>3</sup> C                                                                                            | –                       | TD          | TD,<br>TDME                          |                                                  |
| Other                   | Audio (I <sup>2</sup> S, LJ, RJ, TDM)                                                                       | TD                      | TD          | TD,<br>TDG                           |                                                  |
|                         | NRZ-Manchester                                                                                              | –                       | TD          | TD                                   |                                                  |
| Notes                   | 1 – Available on some bandwidth models only.<br>2 – QSPI TD (D excluded) Trigger needs installed MSO option |                         |             |                                      |                                                  |

|                         |                                                                                                             | HDO6000B                                         |                        | WavePro HD                                       |                        | WaveMaster 8000HD                                |                        |
|-------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------|------------------------|--------------------------------------------------|------------------------|--------------------------------------------------|------------------------|
| Embedded Computing      | I <sup>2</sup> C                                                                                            | EMB bundle                                       |                        | EMB bundle                                       |                        | EMB bundle                                       |                        |
|                         | SPI                                                                                                         |                                                  |                        |                                                  |                        |                                                  |                        |
|                         | UART-RS232                                                                                                  |                                                  |                        |                                                  |                        |                                                  |                        |
|                         | QSPI <sup>2</sup>                                                                                           | TD                                               |                        | TD                                               |                        | TD                                               |                        |
|                         | USB 2.0 HSIC                                                                                                | D                                                |                        | D                                                |                        | D                                                |                        |
| Automotive + Industrial | 10Base-T1S<br>OA3p                                                                                          | AUTOENET-10M Bundle                              | AUTOENET-10M-1G BUNDLE | AUTOENET-10M Bundle                              | AUTOENET-10M-1G BUNDLE | AUTOENET-10M Bundle                              | AUTOENET-10M-1G BUNDLE |
|                         | 100Base-T1                                                                                                  |                                                  |                        |                                                  |                        |                                                  |                        |
|                         | 1000Base-T1                                                                                                 |                                                  |                        |                                                  |                        |                                                  |                        |
|                         | CAN<br>CAN FD<br>CAN FD Light/<br>CAN XL                                                                    | IVN-Classic Bundle TD<br>IVN Classic Bundle TDME |                        | IVN-Classic Bundle TD<br>IVN Classic Bundle TDME |                        | IVN-Classic Bundle TD<br>IVN Classic Bundle TDME |                        |
|                         | FlexRay                                                                                                     |                                                  |                        |                                                  |                        |                                                  |                        |
|                         | LIN                                                                                                         |                                                  |                        |                                                  |                        |                                                  |                        |
|                         | SENT                                                                                                        |                                                  |                        |                                                  |                        |                                                  |                        |
| Avionics                | ARINC 429                                                                                                   | D Symbolic,<br>DME Symbolic                      |                        | D Symbolic,<br>DME Symbolic                      |                        | D Symbolic,<br>DME Symbolic                      |                        |
|                         | MIL-STD-1553                                                                                                | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        |
|                         | SpaceWire                                                                                                   | D                                                |                        | D                                                |                        | D                                                |                        |
| Peripherals             | Ethernet (10/100Base-T)                                                                                     | D                                                |                        | D                                                |                        | D                                                |                        |
|                         | USB 2.0                                                                                                     | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        |
|                         | DisplayPort AUX                                                                                             | TD,<br>TDMP                                      |                        | TD,<br>TDMP                                      |                        | TD,<br>TDMP                                      |                        |
|                         | USB-PD (Power Delivery)                                                                                     | TD,<br>TDMP                                      |                        | TD,<br>TDMP                                      |                        | TD,<br>TDMP                                      |                        |
|                         | USB4-SB (Sideband)                                                                                          | TD,<br>TDMP                                      |                        | TD,<br>TDMP                                      |                        | TD,<br>TDMP                                      |                        |
| Power Mgmt              | SMBus                                                                                                       | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        |
|                         | PMBus                                                                                                       | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        |
|                         | SPMI                                                                                                        | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        |
| MIPI                    | C-PHY                                                                                                       | D,<br>DP <sup>1</sup>                            |                        | D,<br>DP <sup>1</sup>                            |                        | D,<br>DP <sup>1</sup>                            |                        |
|                         | D-PHY                                                                                                       | D,<br>DP <sup>1</sup>                            |                        | D,<br>DP <sup>1</sup>                            |                        | D,<br>DP <sup>1</sup>                            |                        |
|                         | DigRF 3G                                                                                                    | D                                                |                        | D                                                |                        | D                                                |                        |
|                         | DigRF v4                                                                                                    | D                                                |                        | D                                                |                        | D                                                |                        |
|                         | I <sup>3</sup> C                                                                                            | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        | TD,<br>TDME                                      |                        |
| Other                   | Audio (I <sup>2</sup> S, LJ, RJ, TDM)                                                                       | TD,<br>TDG                                       |                        | TD,<br>TDG                                       |                        | TD,<br>TDG                                       |                        |
|                         | NRZ-Manchester                                                                                              | TD                                               |                        | TD                                               |                        | TD                                               |                        |
| Notes                   | 1 – Available on some bandwidth models only.<br>2 – QSPI TD (D excluded) Trigger needs installed MSO option |                                                  |                        |                                                  |                        |                                                  |                        |

#### Customer Service

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Teledyne LeCroy oscilloscopes and probes are designed, built, and tested to ensure high reliability. In the unlikely event you experience difficulties, our digital oscilloscopes are fully warranted for three years and our probes are warranted for one year. This warranty includes:

- No charge for return shipping
- Long-term 7-year support
- Upgrade to latest software at no charge

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