TELEDYNE LECROY
Everywhereyoulook™

SENT	Time	Sync	Tick	Msg	Stat	b0	b1	b2	b3	D0	D1	ID	Data	CRC	RMS	Pause P	S	Status
82	7.9642 ms	82.38 µs	1.47 µs	Message 82: 8 Nibbles 2 Words	0	0	0	0	0	2914	3476			0	27 ns	118.0 µs	0	
83	8.3878 ms	82.38 µs	1.47 µs	Message 83: 8 Nibbles 2 Words	4	0	0	1	0	2917	2708			9	21 ns	125.4 µs	0	
84	8.8113 ms	82.32 µs	1.47 µs	Message 84: 8 Nibbles 2 Words	4	0	0	1	0	2919	2196			15	23 ns	106.2 µs	0	
85	9.2348 ms	82.38 µs	1.47 µs	Message 85: 8 Nibbles 2 Words	4	0	0	1	0	2921	1684			0	23 ns	97.43 µs	0	
86	2.88189 ms			*+4b Msg 1 = 114								1	114	7				
87	9.6584 ms	82.34 µs	1.47 µs	Message 87: 8 Nibbles 2 Words	8	0	0	0	1	2923	1172			6	15 ns	119.5 µs	0	
88	10.082 ms	82.32 µs	1.47 µs	Message 88: 8 Nibbles 2 Words	0	0	0	0	0	2924	916			15	19 ns	104.8 µs	0	
89	10.505 ms	82.36 µs	1.47 µs	Message 89: 8 Nibbles 2 Words	4	0	0	1	0	2927	148			10	17 ns	103.3 µs	0	
90	10.929 ms	82.38 µs	1.47 µs	Message 90: 8 Nibbles 2 Words	0	0	0	0	0	2929	3716			9	17 ns	104.8 µs	0	
91	11.352 ms	82.39 µs	1.47 µs	Message 91: 8 Nibbles 2 Words	0	0	0	0	0	2931	3204			15	20 ns	112.2 µs	0	

SENTbus

Trigger,
Decode,
Measure/Graph,
Eye Diagram

Instruction Manual

SENTbus TDME Instruction Manual

November 2025
sent-tdme-im.pdf

Contents

About This Manual

This manual explains the basic procedures for using serial data trigger and decode software options for Teledyne LeCroy oscilloscopes. There are also sections pertaining to the measure, graph and eye diagram capabilities of TDME options. It is assumed that you have a basic understanding of the serial data physical layer specifications, and how to use the oscilloscope on which the option is installed. Only features specific to this product are explained in this manual.

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

Some capabilities described may only be available with the latest version of our MAUI® software. Updates are available from the software download page at teledynelecroy.com under Oscilloscope Downloads > Firmware Upgrades.

Introducing SENTbus TD and TDME

The Teledyne LeCroy SENTbus TD and TDME options are tools aimed at decoding SENT (Single Edge Nibble Transmission) and SENT SPC (Short PWM Code) streams emitted by various sensors. The decoder supports the 2008, 2010 and 2016 SENT specifications.

The SENTbus trigger and decode (-TD) option enables you to decode and filter SENT and SENT SPC serial data streams by frame IDs, data patterns, CRCs, Master Trigger Pulse lengths, or protocol errors in . You can also trigger acquisition upon the occurrence of selected SENT protocol errors; start of the next slow channel, fast channel or any type of message; and IDs or data patterns within slow or fast channel messages. Conditional filtering at different levels enables you to target the trigger to a single message or a range of matching data.

When displayed on oscilloscopes or in MAUI® Studio remote oscilloscope software, the decoded information overlays the actual physical layer waveforms, color-coded to provide fast, intuitive understanding of the relationship between message frames and other time-synchronous events.

Note: The current trigger implementation supports only SENT, not SENT SPC.

The SENTbus trigger, decode, measure/graph and eye diagram option (-TDME) adds a set of measurements designed for serial data analysis and protocol-specific eye diagram tests to the standard trigger and decoder capabilities. See Measuring for instructions on using the measure and graphing capabilities. See Eye Diagram Tests for instructions on using the eye diagram tests.

Note: If you have installed other -DME or -TDME options, the dialogs for Measure/Graph and Eye Diagram creation will appear when the decoder is open. They may or may not appear "grayed out." We do not guarantee the correct operation of the functionality unless it is explicitly supported by the installation of a TDME option for this protocol.

Serial Trigger

"T" options provide advanced serial data triggering in addition to decoding. The serial data trigger scrutinizes the data stream in real time to recognize "on-the-fly" the user-defined serial data conditions. When the desired pattern is recognized, the oscilloscope takes an acquisition of all input signals as configured in the instrument's acquisition settings. This allows decode and analysis of the signal being triggered on, as well as concomitant data streams and analog signals.

Note: The trigger and decode systems are independent, although they are seamlessly coordinated in the user interface and the architecture. It is therefore possible to use the serial trigger without displaying the decoded acquisition, or to decode acquisitions made without using the serial trigger.

Requirements

Serial trigger options require the appropriate hardware (please consult support), an installed option key, and the latest firmware release. See Serial Trigger Inputs for supported input channels and devices.

Restrictions

The serial trigger operates on only one protocol at a time. It is therefore impossible to express a condition such as "trigger on CAN frames with ID = 0x456 followed by LIN packet with Adress 0xEBC."

Low-speed serial trigger is not supported on LabMaster series models, only decode, measure and eye diagrams. Some low-speed serial triggers are not supported on WaveMaster models. See the Serial TDME Datasheet for support by option.

Serial Trigger Inputs

	Analog	Digital
SENT	Any channel or Ext In	Any group or line, using digital leadset with built-in MSO only. HDA125 and external MS250/MS500 are not supported.

SENT Trigger Set Up

To access the serial trigger dialogs:

- Touch the Trigger descriptor box or choose **Trigger > Trigger Setup** from the Menu Bar.
- Touch the **Serial** Type button, and the **SENT** Standard button.

Then, working from left to right, make the desired selections from the SENT dialog.

Source Setup

In **SRC 1 (Data)**, select the data source input channel.

Use the **Threshold** control to adjust the vertical level for the trigger.

Physical Layer and Protocol Settings

Enter the **Tick Time** of the input signal.

Enter a **Tick Time Tolerance** (in percent). This defines how the CAL pulse is filtered with respect to the Tick Time. For example, if a Tick Time of 3 µs is set with a tolerance of 10%, the CAL pulse is expected to be 56 * 3 µs ± 10%, therefore 168 µs ± 10%.

Enter the number of **Nibbles** in one Word (default is 8).

Check **Pause Pulse** if using a Pause Pulse as per the 2010 specification, section 5.2.6.

Check **New CRC** if performing CRC computation as per the recommendations of the 2010 specification, section 5.4.2.2. Otherwise, the trigger will follow the guidelines of the 2008 specification, section 5.4.2.1 (Legacy).

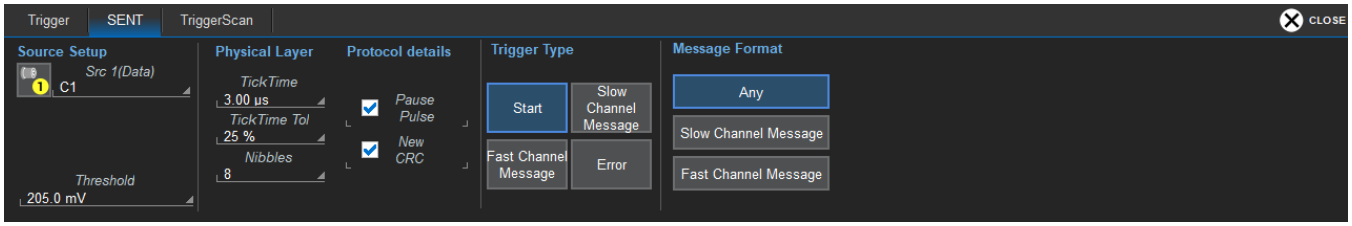
Trigger Type

Choose the type of event on which to trigger:

- **Start** of the selected message type.
- **Slow Channel Message** or **Fast Channel Message** data pattern. Enter the pattern as shown below.
- **Protocol Error**.

Start Trigger

Choose to trigger on the Start of **Any Message**, the next **Slow Channel Message** or the next **Fast Channel Message**.



Slow/Fast Channel Trigger

First choose to enter and display values in **Binary** or **Hex**(adecimal) format. The selection propagates throughout the entire trigger setup. Toggling between formats does not result in loss of information, but will transform the appearance of values.

For Fast Channel Messages, enter the **Status Nibble** value.

For Slow Channel Messages, choose whether to test **Short Serial Message**(s) or **Enhanced Serial Message**(s) of **4** or **8 Bits**, then enter the frame **ID** value.

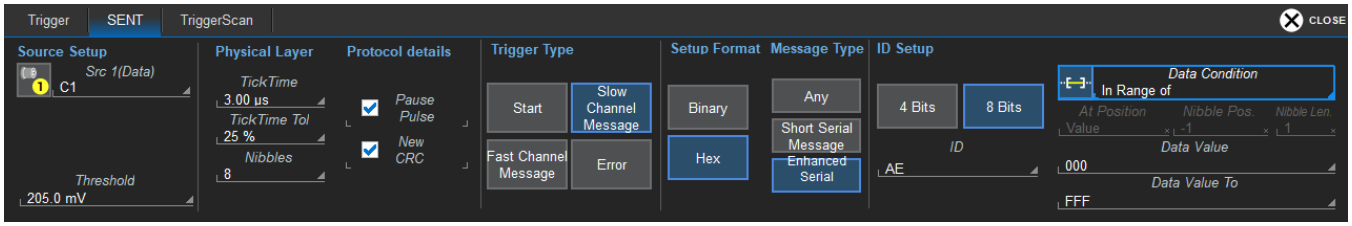
Use **Data Condition** (Boolean operator) and **Data Value** together to specify the data pattern upon which to trigger. The pattern is assumed to begin at the 0 (i.e., first) data byte in the message. If this is not desired, then add preceding or trailing wildcard (X) nibbles to the pattern.

To specify a range of values that may fire the trigger, choose In Range or Out Range. When setting a range, enter the start value in Data Value and the stop value in **Data Value To**.

Note: When more than one data byte is entered, the data is treated as Most Significant Byte (MSB) First. In Hexadecimal format, data must be entered as full bytes even though the minimum acceptable entry is a nibble. If less than a full byte is entered, wildcards (XX) precede the pattern values entered.

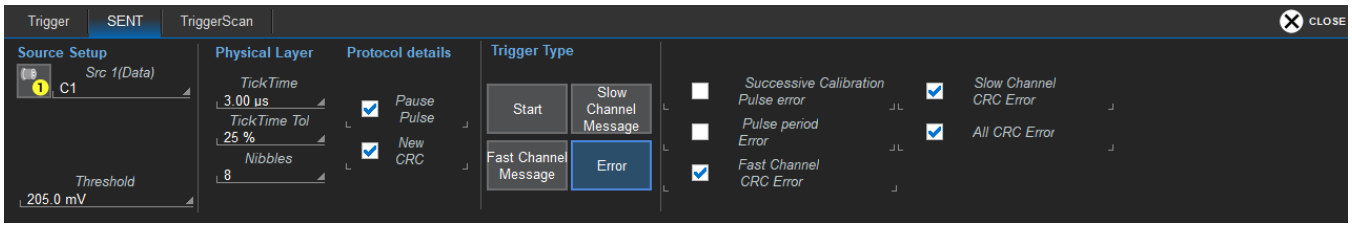
Use an **At Position** of Value (instead of the default "Don't Care") to mark a specific **Nibble Pos**(ition) in the Data field the matching Data Value must occupy. You can select any position up to the maximum valid for that protocol, starting with Byte 0 (the first data byte).

Nibble Length defaults to the length, in nibbles, of the pattern set in Data Value. If the length is changed to a lesser value, the start of the Data Value is truncated by the number of bytes equal to the difference. If the length is increased, wildcards (XX) equal to the difference are appended to the beginning of the value.



Error Trigger

The Error trigger fires whenever a protocol error of the selected type is found. Select all the error types you wish to trigger upon.



Using the Decoder with the Trigger

A key feature of Teledyne LeCroy trigger and decode options is the integration of the decoder functionality with the trigger. While you may not be interested in the decoded data per se, using the decoded waveform can help with understanding and tuning the trigger.

Stop and Look

Decoding with repetitive triggers can be very dynamic. Stop the acquisition and use the decoder tools such as Search, or oscilloscope tools such as TriggerScan, to inspect the waveform for events of interest. Touch and drag the paused trace to show time pre- or post-trigger.

Optimize the Grid

The initial decoding may be very compressed and impossible to read. Try the following:

- Increase the height of the trace by *decreasing* the gain setting (V/Div) of the decoder source channel. This causes the trace to occupy more of the available grid.
- Change your Display settings to turn off unnecessary grids. The Auto Grid feature automatically closes unused grids. On many oscilloscopes, you can manually move traces to consolidate grids.
- Close setup dialogs.

Use Zoom

The default trigger point is at zero (center), marked by a small triangle of the same color as the input channel at the bottom of the grid. Zoom small areas around the trigger point. The zoom will automatically expand to fit the width of the screen on a new grid. This will help you to see that your trigger is occurring on the bits you specified.

If you drag a trace too far left or right of the trigger point, the message decoding may disappear from the grid. You can prevent "losing" the decode by creating a zoom of whatever portion of the decode interests you. The zoom trace will not disappear when dragged and will show much more detail.

Saving Trigger Data

The message decoding and the result table are dynamic and will continue to change as long as there are new trigger events. As there may be many trigger events in long acquisitions or repetitive waveforms, it can be difficult (if not impossible) to actually read the results on screen unless you stop the acquisition. You can preserve data concurrent with the trigger by using the **AutoSave** feature.

- AutoSave Waveform creates a .trc file that copies the waveform at each trigger point. These files can be recalled to the oscilloscope for later viewing. Choose **File > Save Waveform** and an Auto Save setting of **Wrap** (overwrite when drive full) or **Fill** (stop when drive full). The files are saved in D:\Waveforms.
- AutoSave Table creates a .csv file of the result table data at each trigger point. Choose **File > Save Table** and an Auto Save setting of **Wrap** or **Fill**. The files are saved in D:\Tables.

Caution: If you have frequent triggers, it is possible you will eventually run out of hard drive space. Choose Wrap only if you're not concerned about files persisting on the instrument. If you choose Fill, plan to periodically delete or move files out of the directory.

Serial Decode

The methods described here at a high level are used by all Teledyne LeCroy serial decoders, differing only slightly for signals with an embedded clock and separate clock and data signals.

Bit-level Decoding

The first software algorithm examines the embedded clock based on a default or user- specified vertical threshold level. Once the clock signal is extracted, the algorithm examines the traffic to determine whether a data bit is high or low. The default High and Low levels are automatically determined from a measurement of the amplitude of the signals acquired by the oscilloscope. Alternatively, they can be manually set by the user. The algorithm intelligently applies a hysteresis to the rising and falling edge of the serial data signal to minimize the chance of perturbations or ringing on the edge affecting the data bit decoding.

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

Logical Decoding

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

Message Decoding

Finally, another algorithm applies a color overlay with annotations to the decoded waveform to mark the transitions in the signal. Decoded message data is displayed in tabular form below the grid. Various compaction schemes are utilized to show the data for the duration of the acquisition, from as little as one serial data message acquisition to many thousands. In the case of long acquisitions, only the most important information is highlighted, whereas with the shortest acquisition, all information is displayed with additional highlighting of the complete message frame.

User Interaction

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

- Assign a protocol/encoding scheme and data sources to one of the four decoder panels on the Serial Data and Decode Setup dialogs. Each decoder can utilize different protocols or data sources, or have other variations, giving you maximum flexibility to compare different signals or view the same signal from multiple perspectives.
- Complete the remaining subdialogs required by the protocol/encoding scheme. Once there is an acquisition in buffer, you will see a result table and an annotation overlay on the waveform trace showing the decoded data.
- Work with the annotated waveform, result table and other functionality to analyze the decoding.

Decoding Workflow

We recommend the following workflow for effective decoding:

1. Set up the decoder using the lowest level decoding mode available, but do not yet enable it.
2. Acquire at least one complete transmission reasonably well centered on screen in both directions, with generous idle segments on both sides.

   Note: See Failure to Decode for more information about the required acquisition settings.

3. Stop acquisition, then enable the decoder. It will operate on the acquisition in buffer.
4. Zoom in on one decoded message to verify that transitions are being correctly decoded. Tune the decoder settings as needed to produce a satisfactory decoding.
5. Once you are correctly decoding in one mode, continue making small acquisitions of five to eight transmissions and run the decoder in higher level modes.
6. Finally, run the decoder on acquisitions of the desired length.

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

Serial Decode Dialog

Choose **Analysis > Serial Decode** to access the serial decoder dialogs.

The Serial Decode dialog is best used to turn on/off decoders after they've been fully configured on the Decode Setup dialog. You cannot make all required decoder settings here.

- To turn on decoders, on the same row as Decode *N*, check **On**. If there is a valid acquisition, a result table and annotated waveform will appear.
- To turn off decoders, deselect the On boxes individually, or touch **Turn All Off**.

Note: If you change the **Protocol** to decode, the last settings configured for that protocol will be resumed.

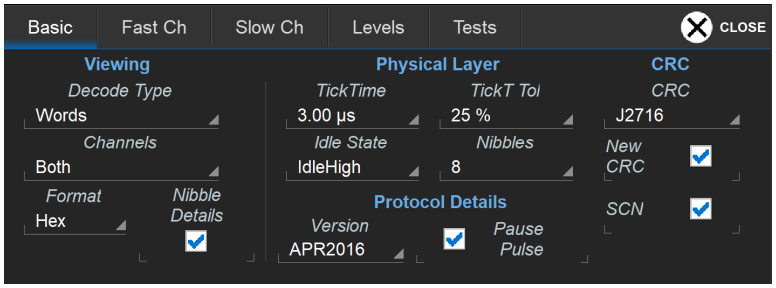
If the decoder supports data search, use the **Search** button to open the Zoom dialogs. Enter search criteria on the Search subdialog to the right of each Z*n* dialog.

Decoder Set Up

Use Decode Setup and its subdialogs to configure decoders.

1. Choose **Analysis > Serial Decode** from the oscilloscope menu bar.
2. On the Serial Decode dialog, enable the decoder by checking **On** next to the decoder number. This may be done any time, although we recommend having an acquisition in buffer before enabling the decoder.
3. Click the **Setup** button at the end of the row to open the Decode Setup dialog.
4. Select the highest-level **Protocol** to be decoded and the inputs (sources). The Protocol selection will influence the remainder of the set up.

SENT Basic Subdialog



Select a **Decode Type** of Nibbles or Words. A separate row will appear in the result table for each nibble or word.

Choose to decode Fast Only, Slow Only, or Both **Channels**.

Choose the **Format** in which to show results: Hex(adecimal) or Dec(imal) .

Check **Nibble Details** if you wish to view the raw nibble values before rounding. Values are normally rounded off to the nearest whole number. This selection will insert an individual row for each nibble in the message beneath the word decoding in the SENT result table.

Enter the **Tick Time**—time in seconds between a nibble of value N and a nibble of value N+1.

Set a **Tick Time Tol(erance)**. This defines how the CAL pulse is filtered with respect to the Tick Time. For example, if a Tick Time of 3 µs is set with a tolerance of 10%, the CAL pulse is expected to be
56 * 3 µs ± 10%, therefore 168 µs ± 10%.

Indicate where the **Idle State**(opposite of the pulse direction) lies , IdleLow or IdleHigh.

Enter the number of **Nibbles** that make up a word, from 5 to 8 (8 is the default).

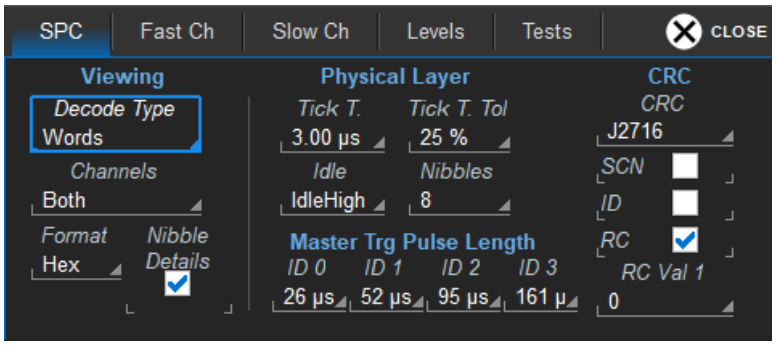
Choose the **Version** of the protocol used in the decoded signal.

The algorithm expects a **Pause Pulse** as per the 2010 section 5.2.6 definition. The Pause Pulse follows the CRC of message N and precedes the CAL pulse of message N+1. Check this box to decode the Pause Pulse.

Select the **CRC** type in use. If you are using the Jan 2010 or April 2016 protocol version, also select which of the following to include in the CRC computation:

- **New CRC**—the CRC computation will be performed as per the 2010 or 2016 recommended implementation.
- **SCN**—the Status and Communication Nibble is used.

SENT SPC Subdialog



In addition to the SENT Basic settings described above, enter the Master Trigger Pulse Length(s) that initiate the transfer of data from up to four sensors in ID 0 through ID 3. This will enable you to decode and filter transmissions from particular sensors. You need only enter those pulse lengths that are in use; any that are not found in the stream are ignored, so you can leave them as is.

In addition to the CRC type and SCN use, also select whether to use:

- ID—Identifier (0 - 3) of the sensor sending the message, matching the MTP length you entered on the dialog.

  Note: If you wish to decode sensor IDs, be sure to assign each a unique MTP both in the decoder and in your system design. If you interrogate two sensors with pulses of the same length, the software will decode the response, but the message will fail the CRC check when you have chosen to decode ID, as well.

- RC—Rolling Counter identifying the (virtual) sequence number of a message from a given sensor. This field is used primarily for tuning the decoder, ensuring that the CRC is being properly computed. To use it, check the box, then enter an RC Val(ue) starting from 0 until any CRC error messages in the decoder table disappear.

Fast Channel Subdialog

The Fast Channel dialog will appear if you selected a Decode Type of “Words” and Channels is set to either “Fast” or “Both.”

The SENT protocol specifies four user-defined data fields, D0 through D3. Each of these can be used to present the content of the message payload as it was programmed. Select each that you wish to decode, then specify the payload interpretation.

Filter Dx Errors removes potentially incorrect D0-D3 values from the result table when an error occurs in the SENT message so that they cannot be used by downstream processes such as graphs and measurements. If you would prefer to see the error data in the table, deselect this box.

Interpretation of Offset defines the units in which the message Offset is entered: Bits, Nibbles or High Speed nibbles. Select Bits only when there is a need to save bits so that more information can be compacted into the relatively short message. Select High Speed only when decoding High Speed SENT.

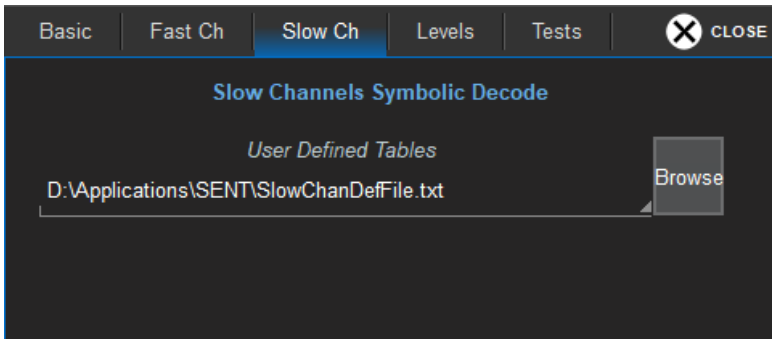
Check Active to decode the corresponding user-defined data field.

In Offset, enter the number of Bits, Nibbles, or High Speed Bits that constitute the message offset (i.e., the position from which to start decoding content).

Enter the number of Nibbles in the payload.

Select whether data is presented in LSN or MSN Order.

Slow Channel Subdialog



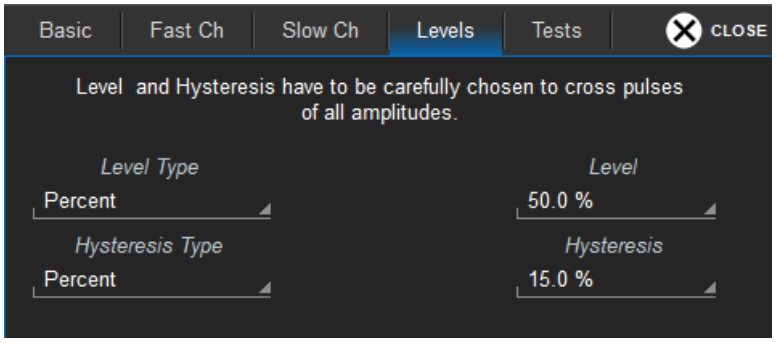
The Slow Channel dialog will appear if you selected a Decode Type of "Words" and Channels is set to either "Slow Only" or "Both." The Slow Only option takes a single data value from each of 16 or 18 SENT message packets and builds a Slow Channel result, displayed on the decoder result table.

A plain text Slow Channel Definition File (SCDF) is used to decode this data into a more meaningful presentation of the assimilated slow channel data. It is expected that different sensors will require different SCDF files. See SCDF File Structure for formatting instructions.

On the Slow Channel dialog, select the User Defined Tables field and Browse to the SCDF file to use for this purpose.

Tip: To simplify uploading a new SCDF file, first copy it to oscilloscope directory D:\Applications\Sent.

Levels Subdialog



Enter the vertical **Level** used to determine the edge crossings of the signal. This value will be used to determine the bit-level decoding.

Optionally, enter a **Hysteresis** band value. For guidelines, see Setting Level and Hysteresis.

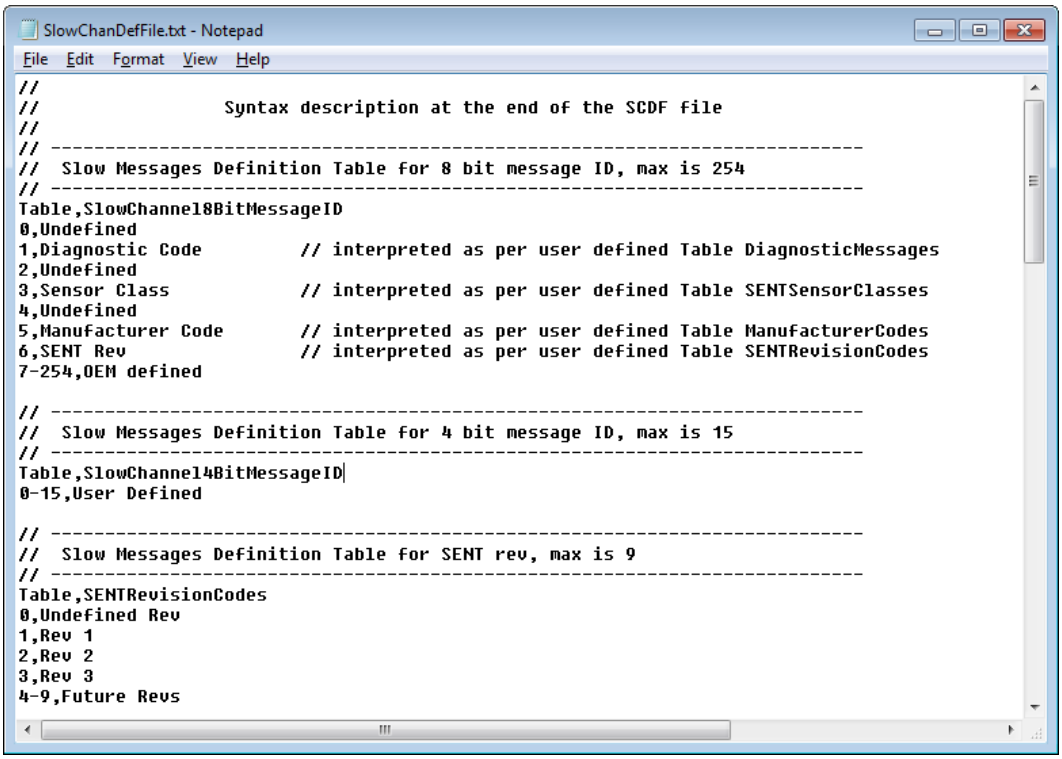
Tests Subdialog

The Test dialog enables you to apply any of four SAE test criteria (the text on the dialog describes the test). Select each test to apply, then enter the value that completes the statement. Results are shown in the decode table as a text message in the Status column and a Numerical output in the S column.

See SAE Test Results for more information.

SCDF File Structure

The mechanism used to translate SENT IDs and values is a simple TXT file containing table definitions. The beginning of the SCDF default file installed on every instrument is shown here:



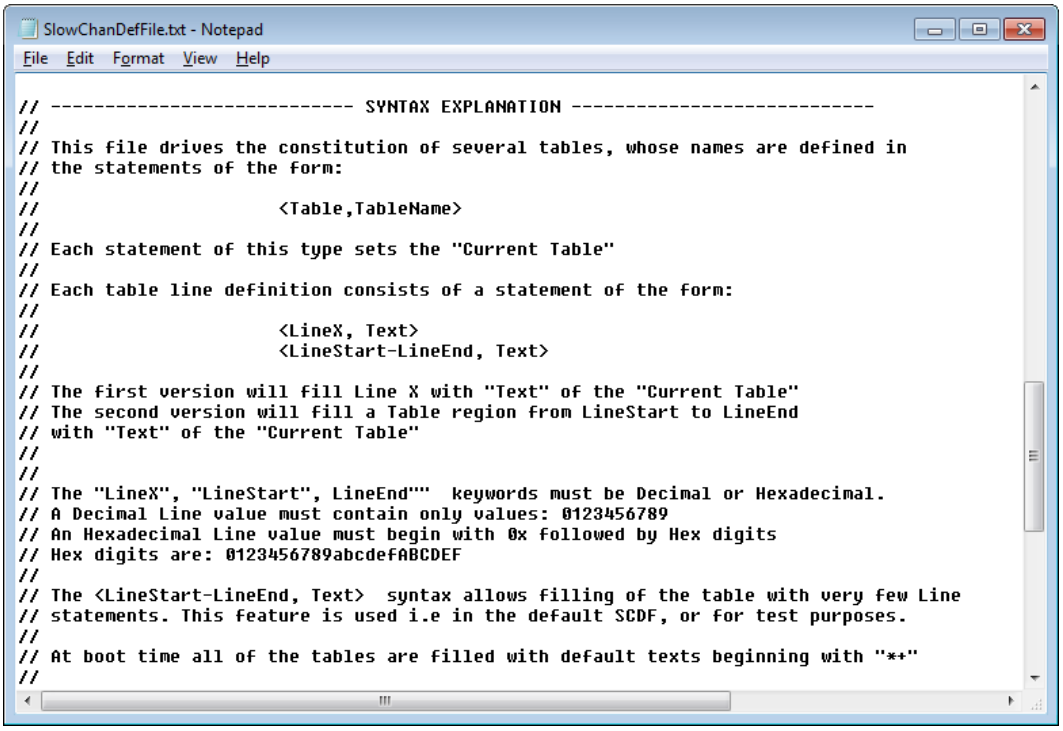
Reserved Names

The SCDF syntax defines several reserved names to identify the auxiliary tables used for:

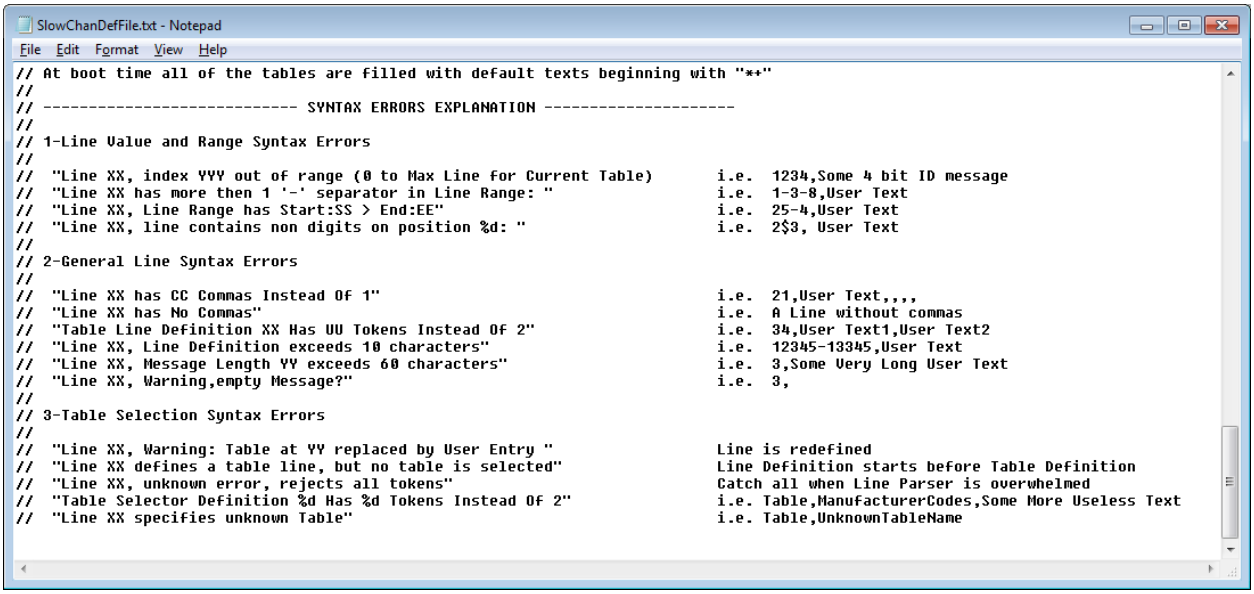
- Table, SlowChannel8BitMessageID, used to interpret the 8 bit message ID
- Table, SlowChannel4BitMessageID, used to interpret the 8 bit message ID
- Table, SENTRevisionCodes, used to interpret the value conveyed by message ID 6
- Table, SENTSensorClasses, used to interpret the value conveyed by message ID 3
- Table, DiagnosticMessages, used to interpret the value conveyed by message ID 1
- Table, ManufacturerCodes, used to interpret the value conveyed by message ID 5

Syntax Errors

The syntax is documented in the file itself as comments toward the end, as well as the syntax errors detected during the parsing.



Parsing errors are listed at the very end of the file. Note that the parsing errors are very useful when beginning to use the SCDF, in order to located syntax errors. The syntax is very strict, in order to keep the parser as simple as possible.



In addition to the SCDF file, parsing errors are always emitted at the bottom of the oscilloscope screen, with the last error overwriting the previous ones. It is therefore advisable to fix the errors as they occur, beginning with the last emitted error, then reload the file and see if any errors are left.

Setting Level and Hysteresis

The **Level** setting represents the logical level for bit transition, corresponding to the physical Low and High distinction. Level is normally set as 50% of waveform amplitude, but can sometimes be set as an absolute voltage (with reference to the waveform 0 level).

Percent mode is easy to set up because the software immediately determines the optimal threshold, but in some cases it might be beneficial to switch to Absolute mode when available:

- On poor signals, where Percent mode can fail and lead to bad decodes
- On noisy signals or signals with a varying DC component
- On very long acquisitions, where Percent mode adds computational load

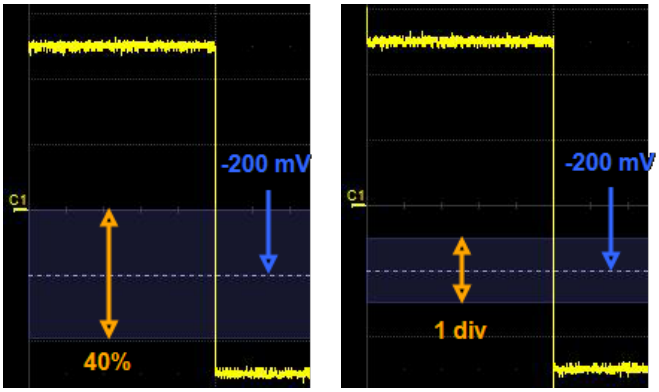
The transition Level appears as a dotted, horizontal line across the oscilloscope grid. If your initial decoding indicates that there are a number of error frames, make sure that Level is set to a reasonable value.

The optional **Hysteresis** setting imposes a limit above and below the measurement level that precludes measurements of noise or other perturbations within this band.

A blue marker around the Level line indicates the area of the hysteresis band. Depending on protocol, the **Hysteresis Type** may be percent amplitude, vertical grid divisions or absolute voltage level.

Observe the following when setting Hysteresis:

- Hysteresis must be larger than the maximum noise spike you wish to ignore.
- The largest usable hysteresis value must be less than the distance from the level to the closest extreme value of the waveform.



Hysteresis set as 40 percent of total waveform amplitude (left) and Hysteresis set as equivalent of 1 grid division (right) around an absolute -200mV Level setting.

Note: Usually, you can set the Level and Hysteresis in different modes. For a few protocols, there is only one option for setting Level or Hysteresis.

Decoding Digital Inputs

While digital lines can be used as sources for most decoders, it is important to make sure that the logic setup for the digital inputs is consistent with the levels set for the decoder and appropriate for the signal.

If you receive a poor decoding when using digital inputs, do the following to troubleshoot.

Assess Signal Levels Using Analog Input

It is good practice to establish the exact signal characteristics using an analog input method prior to using a digital input method.

Connect the signal to an oscilloscope channel (C*n*) and set the amplitude, top and base measurement parameters on it. If the decoder utilizes multiple sources, do this for all signals.

Open the decoder setup dialogs and try decoding the analog signal using the default levels. Adjust Level and Hysteresis according to the measured amplitude until you get a good decoding of the analog signal.

Set Appropriate Logic Levels on Digital Dialogs

When a digital input device is connected to the oscilloscope, setup dialogs for digital groups (Digital*n*) are added to the Vertical menu. Use the Digital*n* dialogs to set the levels used for logic determination by the input device.

Note: Digital1 is turned on by default with all the lines added to the group.

Open the Logic Setup tab and either select a Logic Family that is appropriate to the signal amplitude, or choose User Defined and enter your custom logic Threshold and Hysteresis levels based on what you determined when decoding the analog signal.

Tip: Selecting different Logic Families will display what determination Threshold and Hysteresis values they use on the dialog.

For example, a signal with approximately 1.25 V amplitude, 0 V based, does not match any of the Logic Families but lends itself to a User Defined setup with Threshold at 0.625 V (~50%) and a Hysteresis of 100 mV if the edges are clean.

Continue to adjust your digital group Logic Setup and your decoder Levels in synch until you receive a good digital decoding.

Note: For the MSO Digital Leadset, logic can only be set per digital leadbank, not line by line as on the HDA125. Be sure the lines you use for decoding are all from the same leadbank and set appropriately.

Failure to Decode

Several conditions may cause a decoder to fail, in which case a message will appear in the first row of the summary result table, instead of in the message bar as usual. In these cases, the decoding is turned off to protect you from incorrect data. Adjust your acquisition settings accordingly, then re-enable the decoder.

All decoders will test for the condition Too small amplitude. If the signal's amplitude is too small with respect to the full ADC range, the message "Decrease V/Div" will appear. The required amplitude to allow decoding is usually one vertical division.

If the decoder incorporates a user-defined bit rate (usually these are protocols that do not utilize a dedicated clock/strobe line), the following two conditions are also tested:

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

However, there are no tests for the following, so you will want to pay attention to:

- Poor signal quality. Care must be taken when probing high speed serial data signals (typically with a high bandwidth differential probe). Channel loss, reflections and probe loading can degrade the signal. Its best to probe at the termination of a high speed serial link to minimize probe loading effects and reflections. If the signal has significant channel loss, CTLE/DFE equalizers can be used to improve the quality of the signal being decoded. Use the waveform output by the equalizer as the input to the decoder.
- Incorrect Threshold Levels. Configuring an incorrect threshold level can result in no, incomplete or incorrect decoding. With analog traces, the threshold level can be adjusted after the acquisition but this is not possible with digital waveforms. You must make sure that the appropriate logic levels are configured for digital inputs, as described in the Decoding Digital Inputs, before data is acquired. When troubleshooting, it is best to use analog channels instead of digital channels because of the additional information available.

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

Reading Waveform Annotations

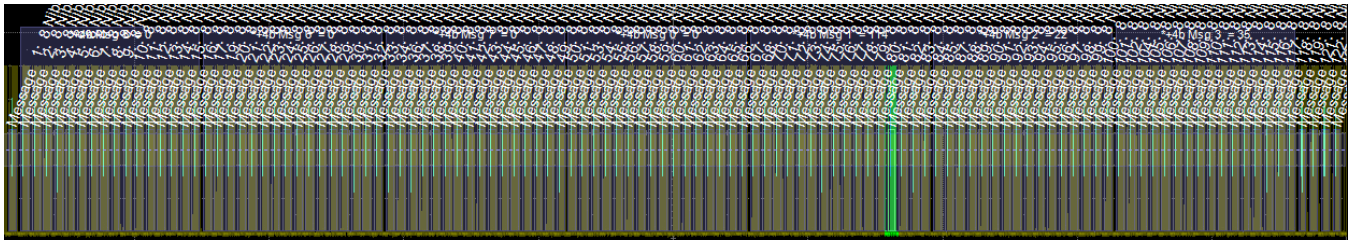
When a decoder has operated successfully on a valid acquisition, an annotated waveform appears on the oscilloscope display, allowing you to quickly see the relationship between the protocol decoding and the physical layer. A colored overlay marks significant bit-sequences in the source signal: Header/ID, Address, Labels, Data Length Codes, Data, CRC, Parity Bits, Start Bits, Stop Bits, Delimiters, Idle segments, etc. Annotations are customized to the protocol or encoding scheme.

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

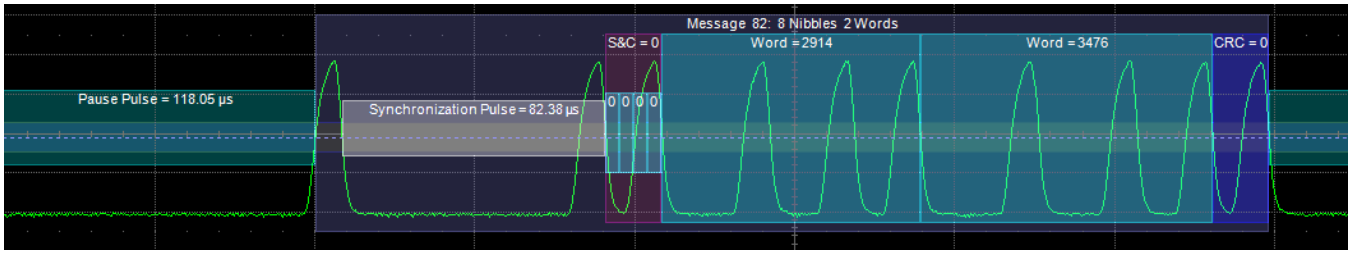
SENT Decoded Waveform Annotations

Annotation	Overlay Color (1)	Text (2) (3)
Message Burst	Navy Blue (behind data fields)	Message <ID>
Pause Pulse	Dark Green	Pause Pulse = <time>
Syncronization Pulse	Grey	Synchronization Pulse = <time>
Status & Communication Bits	Purple	S&C = <value>
Payload Data	Aqua Blue	[Word | Nibble] = <value>
Cyclic Redundancy Check	Royal Blue	CRC = <value>

1. Combined overlays affect the appearance of colors.
2. Text in brackets < > is variable. The amount of text shown depends on your zoom factors.
3. Data values are shown in Nibbles or Words depending on your decoder selection.



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

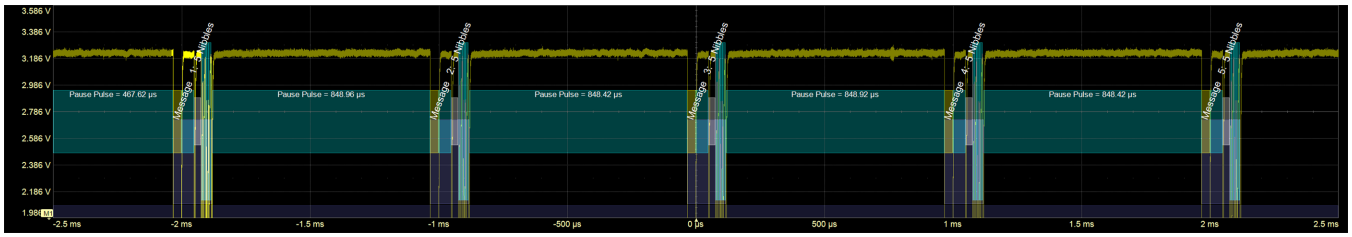


Zoomed waveform annotations, showing decoded data.

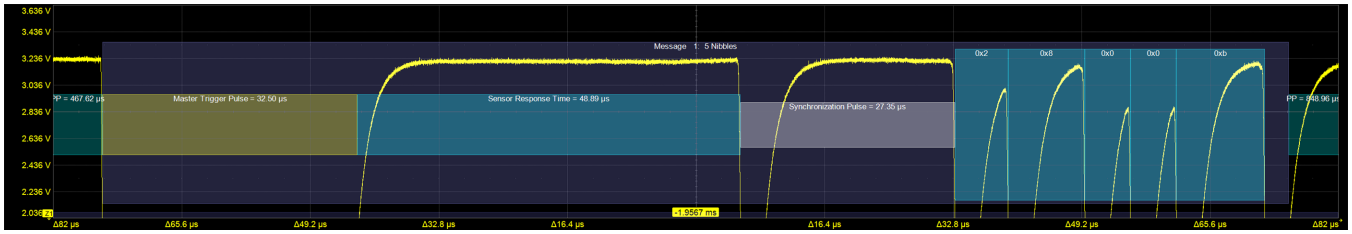
SENT SPC Decoded Waveform Annotations

Annotation	Overlay Color (1)	Text (2) (3)
Message Burst	Navy Blue (behind data fields)	Message <ID>
Pause Pulse	Dark Green	Pause Pulse = <time>
Master Trigger Pulse	Olive	Master Trigger Pulse = <time>
Sensor Response Pulse	Aqua Blue	Sensor Response Time = <time>
Syncronization Pulse	Grey	Synchronization Pulse = <time>
Payload Data	Aqua Blue	[Word | Nibble] = <value>

1. Combined overlays affect the appearance of colors.
2. Text in brackets < > is variable. The amount of text shown depends on your zoom factors.
3. Data values are shown in Nibbles or Words depending on your decoder selection.



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



Zoomed waveform annotations, showing decoded data.

Serial Decode Result Table

When you choose to turn On or to View Decode, provided there is a valid acquisition to decode using that protocol, a table summarizing the decoder results appears below the grids. This result table shows all data decoded during the most recent acquisition, even when there are too many bursts for the waveform annotation to be legible.

Tip: The result table does not have to be visible in order for the decoder to function. Hiding the table can improve performance when your aim is to use the decoding in downstream processes, like measurements.

Table Rows

Each row of the table represents one index of data found within the acquisition. What exactly this represents depends on the protocol and how you have chosen to "packetize" the data stream when configuring the decoder.

When multiple decoders of different protocols are run at once, the rows are interleaved in a summary table, ordered according to their acquisition time. The Protocol column is colorized to match the input source that resulted in that index of data.

Note: The interleaved summary table will default to the lowest common decoding (e.g., hexadecimal if both support that, but only one supports symbolic).

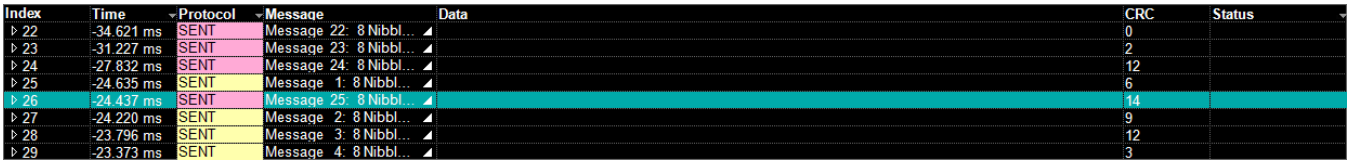
You can change the number of rows displayed on the table at one time. The default is five rows.

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

Table Columns

When a single decoder is enabled, the result table shows the protocol-specific details of the decoding. This **detailed result table** may be customized to show only selected columns. When two or more decoders are enabled, a **summary result table** combining results from all decoders shows these column:

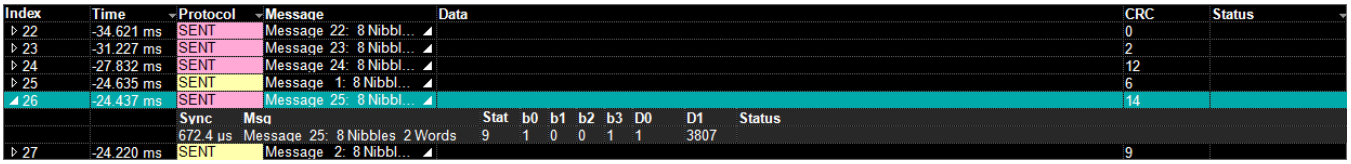
Column	Extracted or Computed Data
Index	Number of the line in the table
Time	Time elapsed from start of acquisition to start of message
Protocol	Protocol being decoded
Message	Message identifier bits
Data	Data payload
CRC	Cyclic Redundancy Check sequence bits (if used)
Status	Any decoder messages; content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



Index	Time	Protocol	Message	Data	CRC	Status
22	-34.621 ms	SENT	Message 22: 8 Nibbl...		0	
23	-31.227 ms	SENT	Message 23: 8 Nibbl...		2	
24	-27.832 ms	SENT	Message 24: 8 Nibbl...		12	
25	-24.635 ms	SENT	Message 1: 8 Nibbl...		6	
26	-24.437 ms	SENT	Message 25: 8 Nibbl...		14	
27	-24.220 ms	SENT	Message 2: 8 Nibbl...		9	
28	-23.796 ms	SENT	Message 3: 8 Nibbl...		12	
29	-23.373 ms	SENT	Message 4: 8 Nibbl...		3	

Example summary result table, with results from different protocol decoders interleaved on one table.

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



Index	Time	Protocol	Message	Data	CRC	Status
22	-34.621 ms	SENT	Message 22: 8 Nibbl...		0	
23	-31.227 ms	SENT	Message 23: 8 Nibbl...		2	
24	-27.832 ms	SENT	Message 24: 8 Nibbl...		12	
25	-24.635 ms	SENT	Message 1: 8 Nibbl...		6	
26	-24.437 ms	SENT	Message 25: 8 Nibbl...		14	
		Sync	Msg	Stat b0 b1 b2 b3 D0 D1 Status		
		672.4 us	Message 25: 8 Nibbles 2 Words	9 1 0 0 1 1 3807		
27	-24.220 ms	SENT	Message 2: 8 Nibbl...		9	

Example summary result table showing drop-in detailed result table.

Exporting Result Table Data

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

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

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

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

The Save Table feature will automatically create tabular data files with each acquisition trigger. The file names are automatically incremented so that data is not lost. From the oscilloscope menu bar, choose **File > Save Table** and select the desired **Decode *N*** as the source.

SENT Result Table

This extracted data appears on a SENT detailed result table. Columns can be hidden by customizing the result table.

Column	Extracted or Computed Data
Index	Number of the line in the table
Time(µS)	Time (in microseconds) relative to the trigger of the beginning of the SENT burst
Sync	Measured length of the synchronization pulse. The pulse width is measured between the two falling edges of the sync pulse, at the intersection of the signal and the Level selected on the Level dialog. Note that a large hysteresis will impact this value.
Tick	Tick Time; value of the sync pulse divided by 56
Msg	Message summary, with the number of transitions, nibbles and words
RMS	Root Mean Square value of the falling edge crossings, usually in nanoseconds
Pause P(ulse)	Time from the end of one burst to the beginning of the next burst
S	Status Bit: 0 when Status is empty (no errors), 1 or greater when errors are reported. The S column can be used with measure, math, and analysis features explained later.
Status	Reported errors and warnings
When decoding Nibbles...	
Nibbles	Number of nibbles
When decoding Words...	
Stat	Value of the status and communication (S&C) nibbles. This value is split into its component bits in the next four columns to help interpret the contents. Component bits are chromacoded for quick reference to their result values in the ID, Data, and CRC columns.
b0-b1	Reserved for special applications
b2	Message data bits (slow channels)
b3	Message start bits
D0 - D3	Message data bits (fast channels)
ID	Result value of 8-bit ID
Data	Result value of 12-bit data
CRC	Value of the CRC (error detection) nibble compared to values of the other nibbles of the message. If it does not match, an error appears in the Status column. It is normal that the first and last messages of a record, when truncated, generate a CRC error.

SENT	Time	Sync	Tick	Msg	Stat	b0	b1	b2	b3	D0	D1	ID	Data	CRC	RMS	Pause P	S	Status
1	-24.635 ms	82.34 µs	1.47 µs	Message 1: 8 Nibbles 2 Words	0	0	0	0	0	2742	2373			6	19 ns	365.6 µs	0	
2	-24.220 ms	82.35 µs	1.47 µs	Message 2: 8 Nibbles 2 Words	8	0	0	0	1	2744	1861			9	26 ns	116.6 µs	0	
3	-23.796 ms	82.33 µs	1.47 µs	Message 3: 8 Nibbles 2 Words	4	0	0	1	0	2747	1093			12	23 ns	100.3 µs	0	
4	-23.373 ms	82.36 µs	1.47 µs	Message 4: 8 Nibbles 2 Words	0	0	0	0	0	2750	325			3	32 ns	101.8 µs	0	
5	-22.949 ms	82.35 µs	1.47 µs	Message 5: 8 Nibbles 2 Words	4	0	0	1	0	2752	3893			15	30 ns	120.9 µs	0	
6	-22.526 ms	82.32 µs	1.47 µs	Message 6: 8 Nibbles 2 Words	0	0	0	0	0	2755	3125			10	19 ns	97.38 µs	0	
7	-22.102 ms	82.34 µs	1.47 µs	Message 7: 8 Nibbles 2 Words	0	0	0	0	0	2757	2613			0	14 ns	110.6 µs	0	
8	-21.679 ms	82.31 µs	1.47 µs	Message 8: 8 Nibbles 2 Words	0	0	0	0	0	2760	1845			10	23 ns	125.3 µs	0	

Section of typical SENT detailed result table.

SENT	Time	Sync	Tick	Msg	Stat	b0	b1	b2	b3	ID	Data	CRC	RMS	Pause P	S	Status
1	-15.696 ms	162.1 µs	2.89 µs	Message 1: 8 Nibbles 0 Words	0	0	0	0	0			6	4e-3	186.5 µs	0	
				Raw Nibble 0 :-0.0005 Δ: -5.403e-04 Δ^2: 2.919e-07												
				Raw Nibble 1 :04.0026 Δ: 2.591e-03 Δ^2: 6.712e-06												
				Raw Nibble 2 :00.9986 Δ: -1.439e-03 Δ^2: 2.071e-06												
				Raw Nibble 3 :06.0000 Δ: -3.816e-05 Δ^2: 1.456e-09												
				Raw Nibble 4 :04.9985 Δ: -1.550e-03 Δ^2: 2.402e-06												
				Raw Nibble 5 :03.0097 Δ: 9.683e-03 Δ^2: 9.377e-05												
				Raw Nibble 6 :12.0039 Δ: 3.850e-03 Δ^2: 1.483e-05												
				Raw Nibble 7 :05.9996 Δ: -3.984e-04 Δ^2: 1.587e-07												
				RMS: 3.877e-03												
11	-14.878 ms	162.1 µs	2.89 µs	Message 11: 8 Nibbles 0 Words	0	0	0	0	0			6	2e-3	16.41 µs	0	
				Raw Nibble 0 :00.0003 Δ: 2.701e-04 Δ^2: 7.293e-08												

SENT result table with nibble details.

SENT SPC Result Table

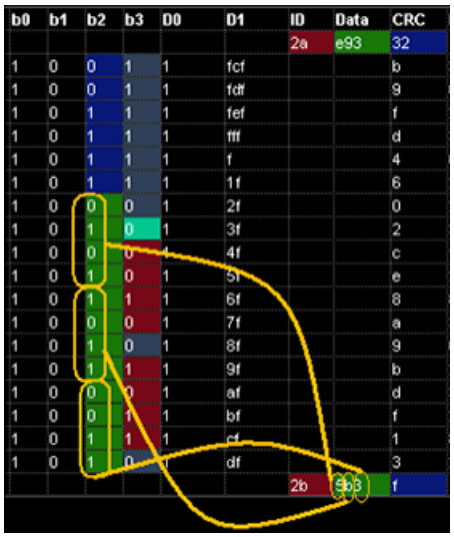
In addition to the columns above, the result table will show the following when decoding SENT SPC:

Column	Extracted or Computed Data
MT Pulse	Measured length of the Master Trigger Pulse (MTP)
RespT	Measured response time from MTP to the sensor response
ID	ID of the sensor sending the message, 0 through 3

SE...	Time	MTPulse	RespT	ID	Sync	Tick	Msg	Nibbles	RMS	Pause P	S	Status
1	-2.0324 ms	32.50 µs	48.89 µs	0	27.35 µs	488 ns	Message 1: 5 Nibbles	2 8 0 0 b	64e-3	467.6 µs	0	
2	-1.0321 ms	32.51 µs	48.83 µs	0	27.34 µs	488 ns	Message 2: 5 Nibbles	2 8 0 0 b	60e-3	849.0 µs	0	
3	-32.439 µs	32.50 µs	48.88 µs	0	27.35 µs	488 ns	Message 3: 5 Nibbles	2 8 0 0 b	62e-3	848.4 µs	0	
4	967.784 µs	32.50 µs	48.88 µs	0	27.34 µs	488 ns	Message 4: 5 Nibbles	2 8 0 0 b	64e-3	848.9 µs	0	
5	1.9675 ms	32.50 µs	48.82 µs	0	27.35 µs	488 ns	Message 5: 5 Nibbles	2 8 0 0 b	66e-3	848.4 µs	0	

SENT SPC detailed result table.

Chromacoding of S&C Bits



In addition to the decoded bit values, the SENT table displays color-coding of Status and Communication (S&C) bits so that it is easy to recognize how they are distributed over 16 or 18 Fast Messages. The resulting bit transmission is shown in the ID, Data, and CRC columns.

Bits	Color Code
Sync pattern	Grey
4-bit or 8-bit ID	Red
12-bit Data	Green
Control bit: When 0, ID is 8-bits and Data 12-bits wide When 1, ID is 4-bits and Data 16-bits wide	Turquoise
4-bit or 6-bit CRC	Blue

SENT Errors

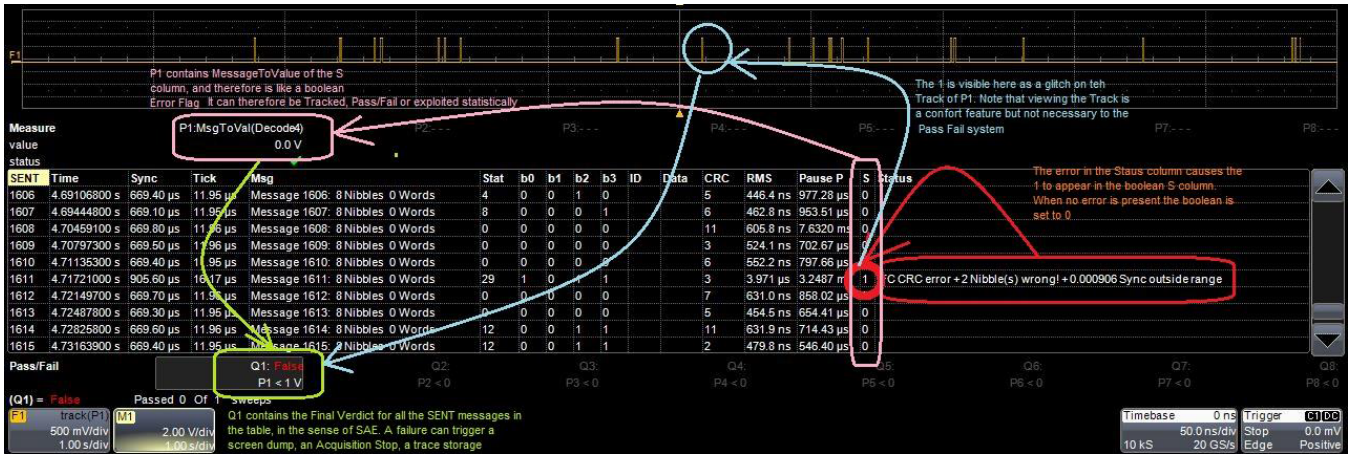
These messages may appear in the Status column of the SENT detailed result table. The corresponding status bit value appears in the S column.

Channel	Error	Status Message	S Value
Fast	Nibble value outside range 0-15	%d Nibble(s) wrong!	1
Fast	Sync outside range ± 25% of Sync computed as 56 * user TickTime	%f Sync outside range	1
Fast	Fast channel CRC error	FC CRC error	1
Slow	Enhanced Slow Message bit 7, 13 or 18 is not 0	B [7|13|18] != 0!	1
Slow	Enhanced Slow Message CRC error	SC(18) CRC Error	1
Slow	Legacy Slow Message CRC error	SC(16) CRC Error	1
Compound Fast	More than *N* in 100 errors	%d 100 messages faulted	2
Compound Fast	More than *N* consecutive errors	%d consecutive messages faulted	3
Compound Fast	Counter error	Counter D%x faulted	4
Compound Fast	CAL > % from prev	Sync faulted	5

SAE Test Results

The results of SAE tests are populated to the Status and S columns of the result table:

- Status shows a description of the error
- S shows 0 if there is no error, 1 or greater when an error appears, making it an error flag that can be tracked statistically or exploited for measurements and Pass/Fail testing.



In the example above:

- A glitch in record 1611 appears as 1 in the S column.
- P1 is MsgToValue set to "pass thru" column S values.
- Pass/Fail test Q1 is set to fail whenever P1 is *not* "less than 1" (P1 < 1 = False), meaning it is not an error free 0. The "fail" could in turn be set up to trigger any number of other actions.

Note: It is not necessary to display the measurement source trace in order for the SAE test results to be used this way.

Using the Result Table

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

Zoom & Search

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

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

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

When there are multiple decoders running, each can have its own zooms of the decoding open at once. In this case, multiple rows of the summary table are highlighted to show which indexes are shown in the zooms. These highlights will be different colors to indicate which rows correspond to each decoder.

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

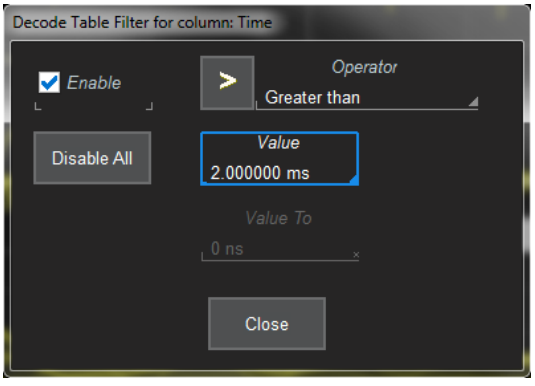
Index	Time	Protocol	Message	Data	CRC	Status
32	-22.102 ms	SENT	Message 7: 8 Nibbl...		0	
33	-21.679 ms	SENT	Message 8: 8 Nibbl...		10	
34	-21.256 ms	SENT	Message 9: 8 Nibbl...		12	
35	-21.042 ms	SENT	Message 26: 8 Nibbl...		8	
36	-20.832 ms	SENT	Message 10: 8 Nibbl...		0	
37	-20.409 ms	SENT	Message 11: 8 Nibbl...		3	
38	-19.985 ms	SENT	Message 12: 8 Nibbl...		6	
39	-19.562 ms	SENT	Message 13: 8 Nibbl...		12	

Filter Results

Columns of data with a drop-down arrow in the header cell can be filtered: 

Touch the column **header cell** to open the Decode Table Filter dialog. Select **Enable** to turn on the column filter; deselect it to turn off the filter. Use the **Disable All** button to quickly turn off multiple filters.

Select a filter **Operator** and enter a **Value** that satisfies the filter condition.

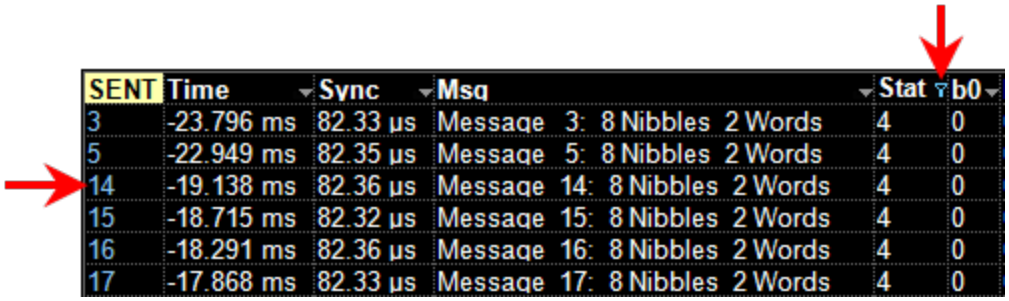


Operators	Data Types	Returns
=, ≠	Numeric or Text	Exact matches only
>, ≥, <, ≤	Numeric	All data that satisfies the operator

Operators	Data Types	Returns
In Range, Out Range	Numeric	All data within/without range limits
Equals Any (on List), Does Not Equal Any (on List)	Text	All data that is/is not an exact match to any full value on the list. Enter a comma-delimited list of values, no spaces before or after the comma, although there may be spaces within the strings.
Contains, Does Not Contain	Text	All data that contains or does not contain the string

Note: Once the Operator is selected, the dialog shows the Value format that may be entered. Numeric values must be within .01% tolerance to be considered a match. Text values are case-sensitive, including spaces within the string.

Those columns of data that have been filtered will have a funnel icon (similar to Excel) in the header cell, and the index numbers will be colorized.



SENT	Time	Sync	Msg	Stat	b0
3	-23.796 ms	82.33 µs	Message 3: 8 Nibbles 2 Words	4	0
5	-22.949 ms	82.35 µs	Message 5: 8 Nibbles 2 Words	4	0
14	-19.138 ms	82.36 µs	Message 14: 8 Nibbles 2 Words	4	0
15	-18.715 ms	82.32 µs	Message 15: 8 Nibbles 2 Words	4	0
16	-18.291 ms	82.36 µs	Message 16: 8 Nibbles 2 Words	4	0
17	-17.868 ms	82.33 µs	Message 17: 8 Nibbles 2 Words	4	0

Example filtered decoder table.

On summary tables, only the Time, Protocol, and Status columns can be filtered.

If you apply filters to a single decoder table, the annotation is applied to only that portion of the waveform corresponding to the filtered results, so you can quickly see where those results occurred. Annotations are not affected when a summary table is filtered.

Also, eye diagrams are modified to represent only the filtered results, which can help to identify exactly which indices of data are the cause of signal integrity problems.

View Details

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

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

Navigate

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

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

Customizing the Result Table

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

Performance may be enhanced if you reduce the number of columns in the result table to only those you need to see. It is also especially helpful if you plan to export the data.

1. On the Decode Setup tab, touch the **Configure Table** button.
2. On the **View Columns** pop-up dialog, mark the columns you want to appear and clear those you wish to remove. Only those columns selected will appear on the oscilloscope display.

   Note: If a column is not relevant to the decoder as configured, it will not appear.

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

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

Searching Decoded Waveforms

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

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

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

Basic Search

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

Optionally:

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

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

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

Advanced Search

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

Decoding in Sequence Mode

Decoders sometimes can be applied to Sequence Mode acquisitions. In this case, the index numbers on the result table are followed by the segment in which the index was found and the number of the sample within that segment: *index* (*segment-sample*).

CAN Std	Time	Format	ID	IDE	RTR	DLC	Data
2 (2-1)	9.72882 ms	Std	0x400	0	0	2	6a 6b
3 (3-1)	19.7527 ms	Std	0x400	0	0	2	6a 6b
4 (4-1)	30.2558 ms	Std	0x400	0	0	2	6a 6b
5 (5-1)	40.1663 ms	Std	0x400	0	0	2	6a 6b
6 (6-1)	49.8284 ms	Std	0x400	0	0	2	6a 6b
7 (7-1)	59.8595 ms	Std	0x400	0	0	2	6a 6b
8 (8-1)	69.8913 ms	Std	0x400	0	0	2	6a 6b
9 (9-1)	80.4032 ms	Std	0x400	0	0	2	6a 6b
10 (10-1)	89.9384 ms	Std	0x400	0	0	2	6a 6b
11 (11-1)	99.9688 ms	Std	0x400	0	0	2	6a 6b

Example filtered result table for a sequence mode acquisition.

In the example above, each segment was triggered on the occurrence of ID 0x400, which occurred only once per segment, so there is only one sample per segment. The Time shown for each index in a Sequence acquisition is absolute time from the first segment trigger to the beginning of the sample segment.

Otherwise, the results are the same as for other types of acquisitions and can be zoomed, filtered, searched, or used to navigate. When a Sequence Mode table is filtered, the waveform annotation appears on only those segments and samples corresponding to the filtered results.

Note: Waveform annotations can only be shown when the Sequence Display Mode is Adjacent. Annotations are not adjusted when a Sequence Mode summary table is filtered, only the result table data.

Multiple decoders can be run on Sequence Mode acquisitions, but in a summary table, each decoder will have a first segment, second segment, etc., and there may be any number of samples in each. As in any summary table, the samples will be interleaved and indexed according to their actual acquisition time. So, you may find (3-2) of one decoder before (1-1) of another. Filter on the Protocol column to see the sequential results for only one decoder.

Improving Decoder Performance

Digital oscilloscopes repeatedly capture "windows in time". Between captures, the oscilloscope is processing the previous acquisition. The following suggestions can improve decoder performance and enable you to better exploit the long memories of Teledyne LeCroy oscilloscopes.

Where possible, **decode Sequence Mode acquisitions.** By using Sequence mode, you can take many shorter acquisitions over a longer period of time, so that memory is targeted on events of interest.

Note: For some protocols, the Serial Trigger does not support Sequence Mode acquisitions, although you could still decode Sequence Mode acquisitions made using a different trigger type.

Parallel test using multiple oscilloscope channels. Up-to-four decoders can run simultaneously, each using different data or clock input sources. This approach is statistically interesting because multi-channel acquisitions occur in parallel. The processing is serialized, but the decoding of each input only requires 20% additional time, which can lessen overall time for production validation testing, etc.

Avoid oversampling. Too many samples slow the processing chain.

Optimize for analysis, not display. The oscilloscope has a preference setting (Utilities > Preference Setup > Preferences) to control how CPU time is allocated. If you are primarily concerned with quickly processing data for export to other systems (such as Automated Test Equipment) rather than viewing it personally, it can help to switch the Optimize For: setting to Analysis.

If your goal is downstream processing, turn off tables, annotations, and waveform traces. As long as downstream processes such as measurements or Pass/Fail tests reference a decoder, the decoder can function without actually displaying results. If you do not need to see the results but only need the exported data, you can deselect View Decode, or minimize the number of lines in a table. Closing input traces also helps.

Decrease the number of rows and columns in tables. Only the result table rows and columns shown are exported. It is best to reduce tables to only the essential columns if the data is to be exported, as export time is proportional to the amount of data exchanged.

Measure/Graph

Not supported on WaveSurfer and HDO4000 series oscilloscopes.

The installation of the Measure/Graph package (included with "ME" and "MP" options) adds a set of measurements and plots designed for serial data analysis to the oscilloscope's standard measurement capabilities. Measurements can be quickly applied without having to leave the waveform or tabular views of the decoding.

Note: This capability will only function properly if an "ME" or "MP" option for the protocol decoded is installed, although the dialogs will appear if any Measure/Graph options are installed.

Serial Data Measurements

These measurements designed for debugging serial data streams can be applied to the decoded waveform. Measurements appear in a tabular readout below the grid (the same as for any other measurements) and are in addition to the result table that shows the decoded data. You can set up as many measurements as your oscilloscope has parameter locations.

Note: When working outside the TDME software, measurements appear in the Serial Decode sub-menu of the Measure Setup menu and may have slightly different names. The measurements are made the same.

Measurement	Filters	Description
View Serial Encoded Data as Analog Waveform		Simplified set up of a Message to Value parameter and graph. Performs a Digital-to-Analog Conversion (DAC) of the embedded digital data and displays it as an analog waveform.
Message to Value	ID, Value	Extracts a selected portion of the decoded data to a measurement parameter location, with optional conversion of value. Data may be selected by ID and/or data field position.
Column to Value	Column	Extracts the data in a single column of the result table to a measurement parameter location, with no transformation of value.
Message to Analog	ID, Data, Analog, Column	Computes time from start of first message that meets conditions to crossing threshold on an analog signal. If the analog condition precedes the message condition, no measurement is performed.
Message to Message	ID, Data, Column	Computes time from start of first message that meets conditions to start of the next message that meets conditions.
Time at Message	ID, Data, Column	Computes time from trigger to start of each message that meets conditions.
Analog to Message	ID, Data, Analog, Column	Computes time from crossing threshold on an analog signal to start of first message that meets conditions. If the message condition precedes the analog condition, no measurement is performed.
Delta Messages	ID, Data, Column	Computes time difference between two messages on a single decoded line.
Bus Load	ID, Data, Column	Computes the load of selected messages on the bus (as a percent).
Message Bitrate	ID, Data, Column	Computes the bitrate of selected messages within the decoded stream.
Number of Messages	ID, Data, Column	Computes the total number of messages in the decoding that meet conditions.

Graphing Measurements

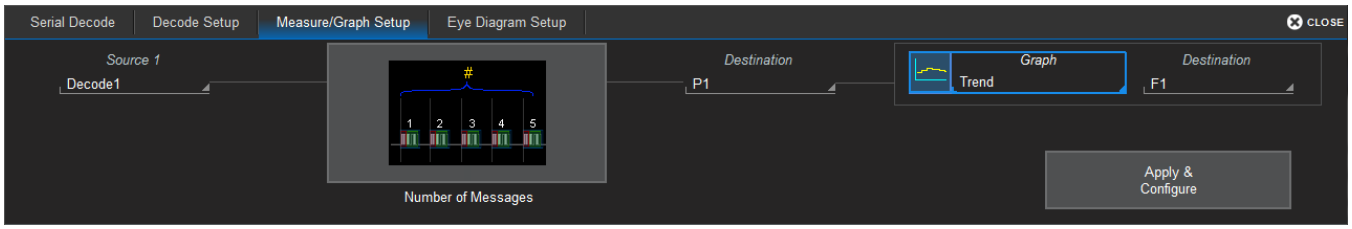
The Measure/Graph package include simplified methods for plotting measurement values as:

- Histogram - a bar chart of the number of data points that fall into statistically significant intervals or bins. Bar height relates to the frequency at which data points fall into each interval/bin. Histogram is helpful to understand the modality of a parameter and to debug excessive variation.
- Trend - a plot of the evolution of a parameter over time. The graph's vertical axis is the value of the parameter; its horizontal axis is the order in which the values were acquired. Trending data can be accumulated over many acquisitions. It is analogous to a chart recorder.
- Track - a time-correlated accumulation of values for a single acquisition. Tracks are time synchronous and clear with each new acquisition. Track can be used to plot data values and compare them to a corresponding analog signal, or to observe changes in timing. A parameter tracked over a long acquisition could provide information about the modulation of the parameter.

To graph a measurement, just select the plot type from the Measure/Graph dialog when setting up the measurement. All plots are Math functions that open along side the deocoding in a separate grid.

Measure/Graph Setup Dialog

Use the Measure/Graph Setup dialog to select the parameter to apply to the decoded waveform while simultaneously graphing the results.



1. Select the Measurement to apply and the Destination parameter (P*n*) to which to assign it.
2. The active decoder is preselected in Source 1, indicating the measurement will be applied to those decoder results; change it if necessary. If the measurement requires it, also select an appropriate Source 2 (such as an analog waveform for comparison).
3. Optionally:
   - Touch Graph to select a plot type. Also select a Destination function (F*n*) for the plot.
   - Touch Apply & Configure to set a filter, gate or other qualifiers on the measurement.

Filtering Measurements

Certain serial decode measurements can be filtered to give results for only rows with specified IDs, data patterns or values in selected columns of data. When the measurement uses multiple sources, each source can have the same or a different filter.

Main

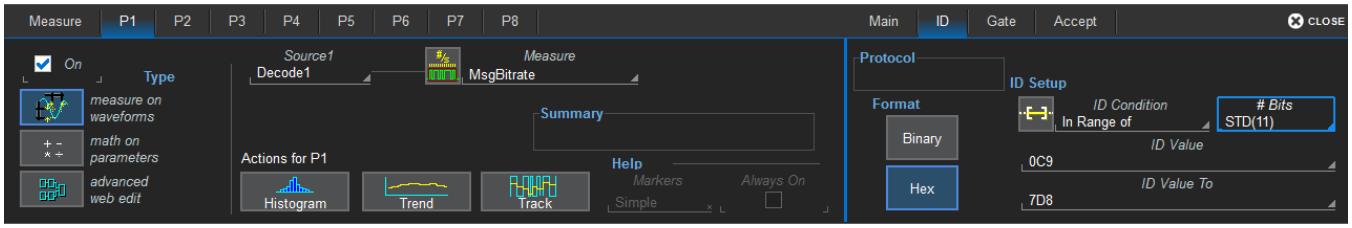
1. After creating a measurement on the Measure/Graph Setup dialog, touch **Apply & Configure**. The touch screen display will switch to the standard Measure setup dialogs for the parameter you selected.
2. From the **Filter** drop-down on the Main subdialog, choose the message elements on which to filter:
   - **Any** displays results for any message (no filter).

     ID restricts the measurement to messages with a specific ID value.
   - **ID + Data** restricts the measurement to messages with extracted data matching the filter.
   - **Col**(umn) restricts the measurement to messages with matching values in the selected result table column(s). It can be applied to timing measurements such as MsgtoMsg and MsgtoAnalog. It allows you to use a column other than ID or Data as the start/end point for the measurement.

     Tip: To make timing measurements on different parts of message frames within the same decoding, choose the same Decode as measurement Source1 and Source2, Column filter both, but choose a different column for Col1 and Col2. See the example below.
3. Set filter conditions on the right-hand subdialogs that appear next to the P*n* dialogs.

ID Filter

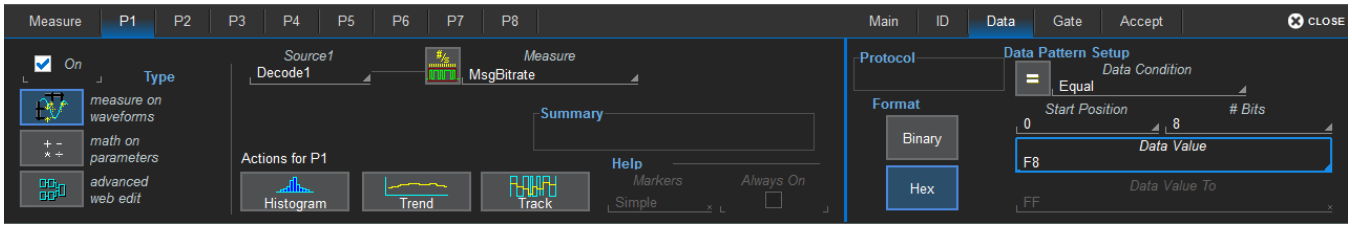
Settings on this dialog may change depending on the protocol.



1. On the **ID subdialog**, choose to enter the ID in **Binary** or **Hex**(adecimal) format.
2. If the field appears, select the **# Bits** used to define the frame ID. (This will change the ID Value field length.)
3. Using the **ID Condition** and **ID Value** controls, create a condition statement that describes the IDs you want included in the measurement. To set a range of values, also enter the **ID Value To**.

   Tip: On the value entry pop-up: use the arrow keys to position the cursor; use Back to clear the previous character (like Backspace); use Clear to clear all characters.

ID + Data Filter

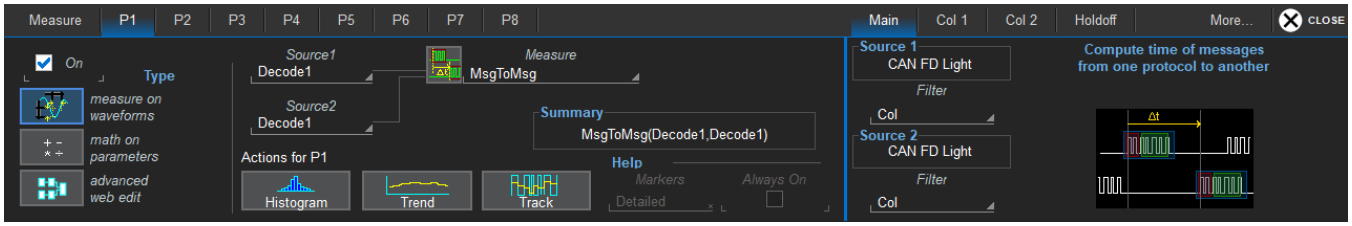


Tip: For a Data only filter, leave the ID subdialog set to ID = ALL.

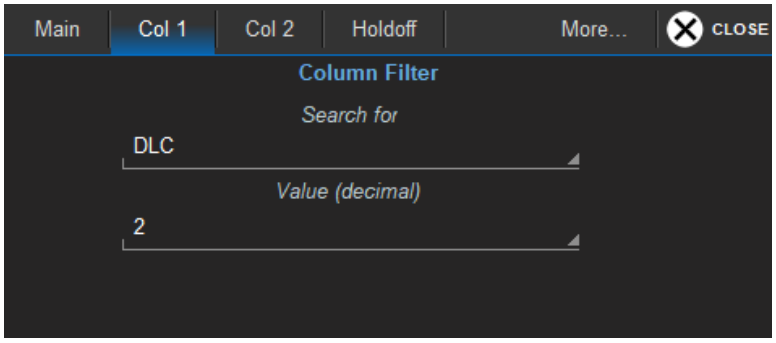
1. On the Data subdialog, choose to enter data in **Binary** or **Hex**(adecimal) format.
2. Create a Boolean **Data Condition** describing the **Data Value(s)** to include in the measurement. Use "X" as a wild card ("Don't Care") in any position where the value doesn't matter.
3. Optionally, enter a **Start Position** within the data field byte to begin seeking the pattern, and the **# Bits** in the data pattern. The remaining data fields positions will autofill with "X".

Note: For MsgtoMsg measurements, the data filter condition is entered twice: first for the Start Message and then for the End Message. The measurement computes the time between finding a match to each condition.

Column Filter



1. On the Measure/Graph Main subdialog, choose the **Filter** type **Col**(umn) for those sources where you want to specify a column of data (i.e., message frame) as the start/end point for a timing measurement.
2. On the **Col 1** and **Col 2** subdialogs, choose the result table columns to **Search for** the **Value**.



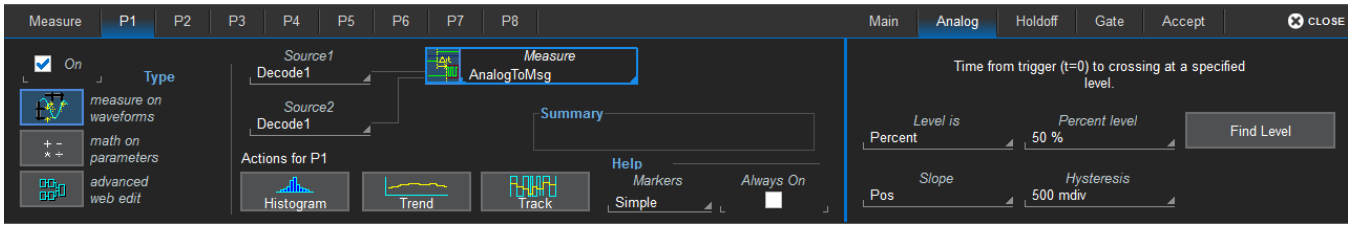
Note: In measurements where both sources are Column filtered, the measurement is made from the first matching value in Col 1 to the first matching value in Col 2.

Analog Filters

The measurements AnalogToMsg and MsgToAnalog allow you to use crossing level and slope to define the event in the Analog waveform that is to be used as the reference for the measurement.

As with the decoder, Level may be set as a percentage of amplitude (default), or as an absolute voltage level by changing **Level Is** to Absolute. You can also use **Find Level** to allow the oscilloscope to set the level to the mean Top-Base amplitude.

A **Slope** and **Hysteresis** selection is also offered. The width of the Hysteresis band is specified in milli-divisions. See Setting Level and Hysteresis for more information on using these controls.



Digital to Analog Conversion

These serial data measurements enable you to take a subset of decoded data (such as sensor data payload) and plot it as a graph. The track of the these measurements is, in effect, a Digital to Analog Converter (DAC) that can display digitally-encoded sensor data as an analog waveform. They are particularly useful for symbolic and higher-level decodings.

Note: Examples shown are taken from CAN decoders, but the functionality works the same for all protocols.

View Serial Encoded Data as Analog Waveform

This is an alternative set up method for Message to Value, which preselects for the Track graph. You can add filters the same as for Message to Value by clicking **Apply & Configure**.

Message to Value

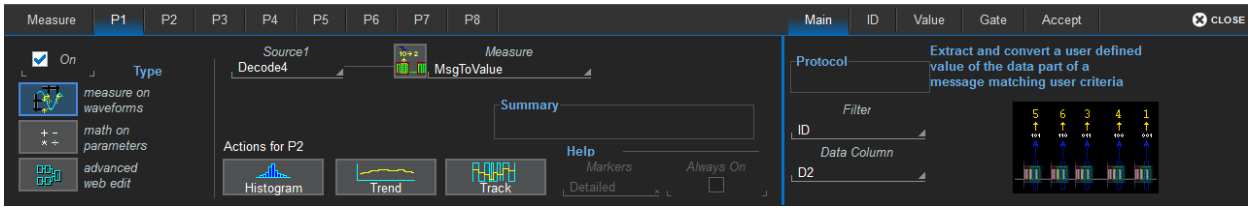
The MsgToValue measurement enables you to graph or test only a subset of a decoder result table. It is aimed at protocols with addressed packets containing varying types of data, like CAN, LIN, MIL1553 and many others. With it, you can filter the table by a particular ID to extract and convert decoded data values via a parameter that can be used for other math or measurement processes, such as the Track function.

Tip: When SAE tests are turned on, the S column of the result table contains the numeric result (status bit) of the tests. Any value 1 through 5 indicates an error. You can configure a parameter with MsgToValue assigned to decoder column S, then set a Pass/Fail test on the occurrence of a particular status in that parameter. See SENT Errors for status values.

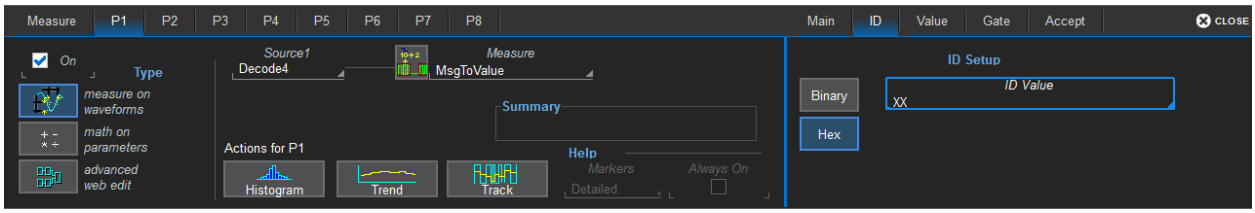
For TDME users, MsgToValue can be assigned to a Source decoder and parameter right on the Measure/Graph Setup dialog. However, MsgToValue requires several filter selections, so it is necessary to select **Apply & Configure** to complete the set up on the Measure set up subdialogs.

continued

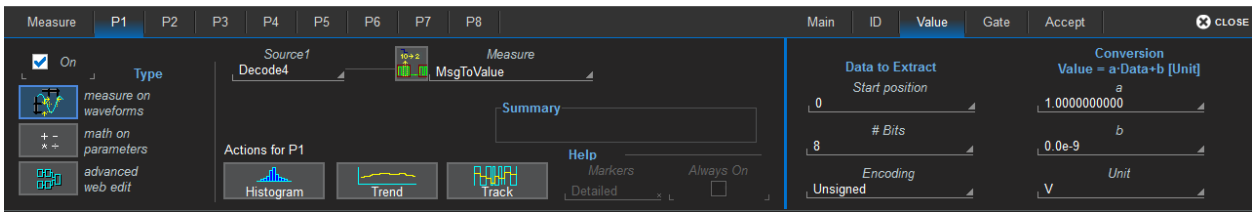
1. Choose whether or not you wish to **Filter** by **ID** or accept **Any** packets, then select the **Data Column**from which to pass values.



2. If you are filtering by ID, enter the desired ID on the ID subdialog.



3. On the Value subdialog, enter the **Data to Extract** and any **Conversion** to be made.



   Follow these steps to define the values to extract:

   a. SYMBOLIC users: touch **Browse DBC/ARXML**. Expand the symbol file, then click on the desired symbol to filter on occurrences of that symbol.

   > Note: This button will not appear if your installation does not support symbolic decoding.

   b. Under Data to Extract, begin by entering the **Start position** and the **# Bits** to extract.

   c. Choose the **Encoding** type if the signal uses encoding, otherwise leave it Unsigned.

   d. Under Conversion, enter the **a. Coefficient** and **b. Term** that satisfy the formula:
   *Value = Coefficient * Raw Value + Term*.

   e. Optionally, enter a **Unit** for the extracted decimal value.

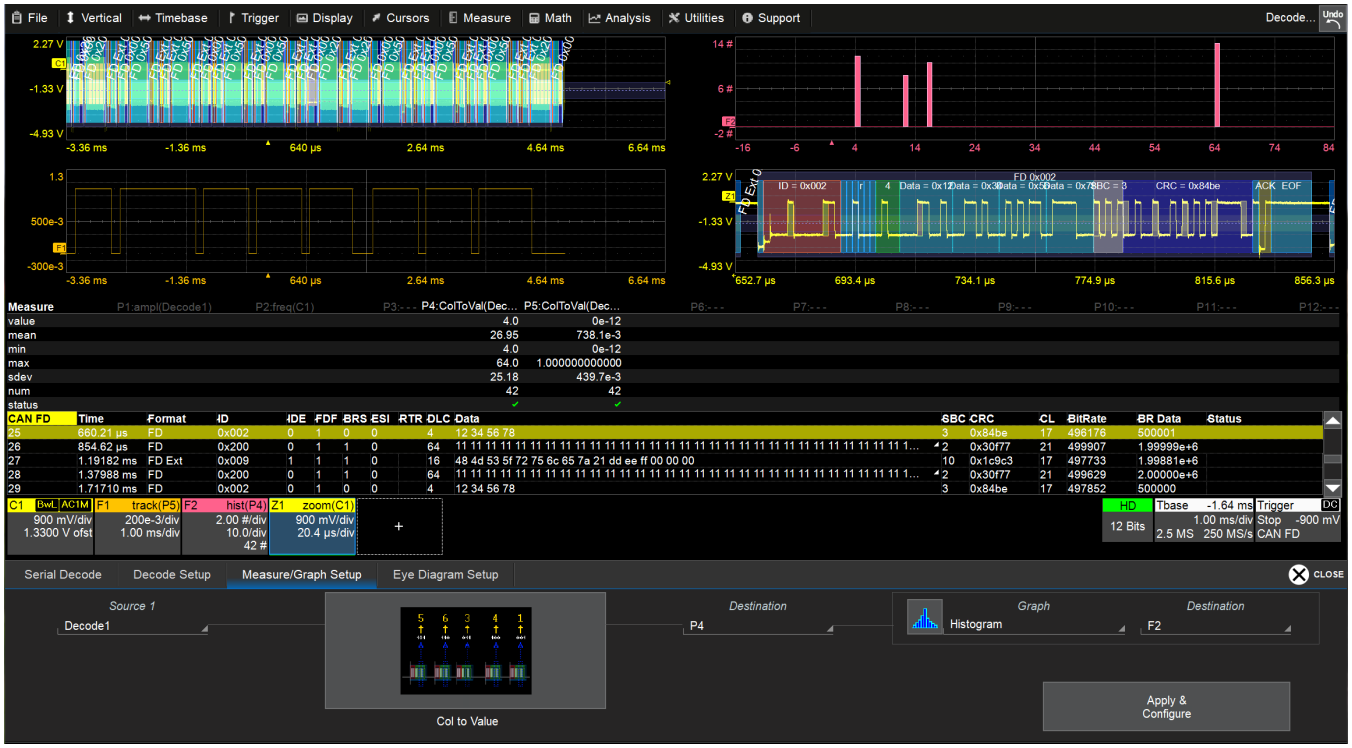
Column to Value

Similar to MsgToValue, ColToValue acts as a special "pass thru" of one column of decoder table values via a parameter configured with this measurement, allowing you to graph, run Pass/Fail tests or perform other calculations on just these values by using the parameter as the source of other functions. It is very similar to using Excel to graph a column of data.

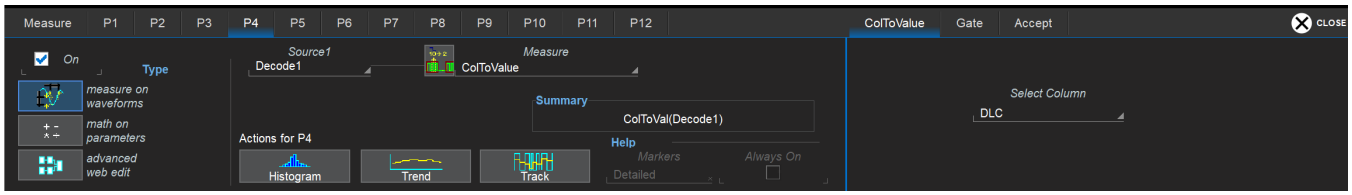
ColToValue acts upon many columns in the table, not just Index or Data. There is no special setup other than the column selection. It is therefore very useful for decodings of continuous data streams that are not "packetized" into separately indexed table rows, or when you want to process values from columns other than Data.

To use this measurement successfully, be sure there is an active decoding. If there is no data in the result table, the Select Column field on the ColToValue subdialog shows "undef", and the selector is inactive. As long as there is data in the table, you should see a selection of those columns populated by the decoder.

In the CAN FD example below, parameters P4 and P5 are both configured with the ColToValue measurement using Source Decode1. P4 is additionally histogrammed (F2), while P5 is tracked (F1).



After beginning to configure the parameter on the Measure/Graph Setup dialog, the **Apply & Configure button** opens the Measure setup ColToValue subdialog, where you **Select (the) Column** whose values are extracted. Parameter P4 is confgured to pass the DLC column data, whereas P5 (not shown) passes the BRS column data. This is the data set that appears in Measure table P4 and P5 and is represented by the F2 and F1 functions that graph the parameters.



Eye Diagrams

Not supported on WaveSurfer and HDO4000 series oscilloscopes.

Eye diagrams are a key component of serial data analysis. They are used both quantitatively and qualitatively to understand the quality of the signal communications path. Signal integrity effects such as intersymbol interference, loss, crosstalk and EMI can be identified by viewing eye diagrams, such that the eye is typically viewed prior to performing any further analysis.

The eye diagram shows all values a digital signal takes on during a single bit period. The bit period (also referred to as unit interval, or UI) is defined by the data clock, whether explicit or extrapolated depending on the protocol. Each pixel in the eye takes on a color that indicates how frequently a signal has passed through the time and voltage represented by that pixel.

The eye can be generated from all transitions in the acquisition or from a "filtered" set of transitions by using the Apply to Zoom feature. With Apply to Zoom, only transitions related to the zoomed (highlighted) table rows are included in the eye diagram.

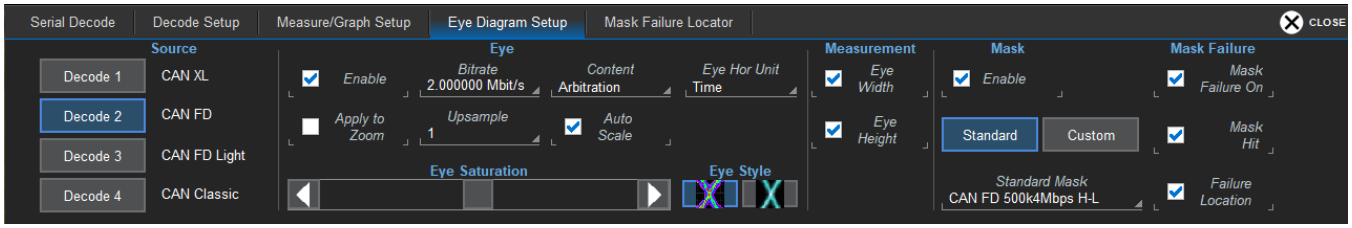
Note: Serial decode eye diagrams show the decoded signal as it has been configured for the result table. They are not persistent, as are eye diagrams generated in some other serial data analysis software; the eye will change from one acquisition to the next and when the result table is filtered.

Our recommended approach to using the eye diagram is to:

- Make single acquisitions with decoder and eye diagram enabled to test both are working correctly.
- Make a normal acquisition with Mask Testing and Stop On Failure enabled (if masks have been defined for the protocol), or with a Pass/Fail test set on one of the eye parameters.

Eye Diagram Setup

Note: Examples shown are taken from CAN decoders, but the functionality works the same for all protocols.



Create Eye Diagram

1. Open the **Eye Diagram Setup** dialog and select the **Decode** for which to create an eye diagram.
2. Under Eye, check **Enable** to display the eye diagram.
3. Enter the **Bitrate** of the section of the decoding to be diagrammed. This should match the Content selection in protocols where there is an option.

4. Select the type of decoded **Content** (e.g., packet type) from which to draw the eye diagram. The eye will be created solely from transitions of that type, without having to manually adjust the Bitrate. The Content choices will vary by protocol.

   Caution: Conflicts can occur if the Content type does not match the table selection when using Apply to Zoom. Zoom only single rows and change Content to match the row zoomed.

5. Choose an **Eye Hor**(izontal) **Unit** of either Time or UI. The eye diagram graticule is redrawn accordingly.
6. To diagram only the zoomed row(s) of the decode result table, check **Apply to Zoom**. Eye measurements will also reflect only this zoomed section.
7. The **Upsample** factor increases the number of sample points used to compose the eye diagram. Increase from 1 to a higher number (e.g. 5) to fill in gaps that can occur when the bit rate is a submultiple of the sampling rate, or the acquisition does not sample a sufficiently large number of UIs.
8. To rescale the eye diagram to fit the entire grid, check **Auto Scale**.
9. Choose an **Eye Style** of either color-graded or analog persistence:

   With **color-graded** persistence  , pixels are given a color based on the pixel's relative population and the selected Eye Saturation. The color palette ranges from violet (lowest) to red (highest).

   Analog persistence  uses relative intensities of the same color.

10. Use the **Eye Saturation** slider to adjust the color grading or intensity. Slide to the left to reduce the threshold required to reach saturation.

Eye Measurements

You can optionally choose to display the **Eye Height** and/or **Eye Width** measurement parameters. The read out will appear in the first open slots of the Measure table, with markers drawn over the eye diagram.

Eye Mask Test

A mask test of the eye diagram is a quick way to verify basic signal integrity. Many standard eye masks have been included for the protocols where masks have been defined. You can also upload custom masks.

1. Set up and display the eye, then under Mask, check **Enable** to turn on eye mask testing.
2. Select to use either a **Standard** or **Custom** mask, then **Browse** to and select your **Mask File**.
3. Optionally, check:
   - **Mask Failure On** to mark the parts of the eye diagram that "hit" the mask. Mask violations appear as red circles where the eye diagram intersects the mask.
   - **Mask Hits** to display the total number of mask violations on the Measure table.
4. To delve deeper into mask hits, check **Failure Location** and use the Mask Failure Locator feature.

Mask Failure Locator

The Mask Failure Locator feature plots a sequence of just those bits that failed an eye mask test. It is essentially a signal "error" waveform

When you select the **Failure Location** box from the Eye Diagram Setup dialog, the Mask Failure Locator dialog is added to the screen, along with the Mask Failure waveform in a new grid. A list of those UIs (by number) that contain failed bits is shown at the right of the Mask Failure Locator dialog in **Eye Mask Failures**, and the failed bits from that UI are marked on the eye diagram with yellow circles, so you can see exactly where on the eye the failure occurred.

In **#UI Displayed**, enter the number of bits (as a decimal) to display at once in the Mask Failure waveform.

Enter the maximum number of UIs to plot on the Mask Failure waveform in **Max Failures**. This helps to create a manageable limit to the plot.

Stop On Failure stops acquisition whenever an eye mask failure occurs. This can help you to more closely examine the eye and the Mask Failure waveform to ascertain when and where failures occurred.

CAN FD mask test with Failure Location on. Yellow markers indicate where the displayed Mask Failure bits are located.

If you select a UI by number from the from the **Eye Mask Failure** list, the Mask Failure waveform shifts to display those error bits from the selected UI. Conversely, if you drag the Mask Failure waveform, the visible UI is highlighted in the list, and the yellow failure markers will shift according to the bits currently displayed.

Note: Mask Failure On marks all mask violation on the eye with red circles. Failure Location marks only those violations related to the UI currently selected/displayed by the Mask Failure plot.

Appendix A: Automating the Decoder

As with all other oscilloscope settings, decoder features such as result table configuration and export can be configured remotely using COM Automation.

Note: The examples shown here were taken from a CAN FD decoding, but all decoder result tables share the same Automation structure.

Configuring the Decoder

The object path to the decoder Control Variables (CVARs) is:

app.SerialDecode.Decode*n*

Where *n* is the decoder number, 1 to 4. All relevant decoder objects will be nested under this. Use the MAUI Browser utility (installed on the oscilloscope desktop) to view the entire object hierarchy.

Accessing the Result Table

The decoder Result Table is a complex matrix with secondary tables nested within some of its cells. The table data can be accessed using the Automation object:

app.SerialDecode.Decode*n*.out.Result.cellvalue(*RowA*, *ColA*)(*RowB*, *ColB*)

Where:

n:= 1 to 4

RowA:= 0 to K (0=Row Index Number)

ColA:= 0 to L (0=Column Header)

RowB:= 0=MeasuredValue, 1=StartTime, 2=StopTime

ColB:= 0 to M

Complicating the matter of accessing the table is that there are two types of cell that may appear in the Result table, Simple Cell and Table Cell, which are accessed in slightly different ways, and that some columns are always hidden from view, yet they are still counted among the columns when querying.

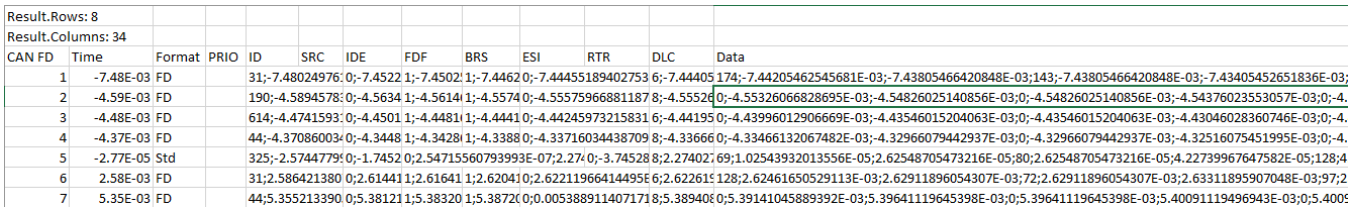
Reading the Structure of the Result Table

In order to successfully access the data, it is necessary to first ascertain how many rows and columns are actually in your decoder result table, and what cell type is used for the column of data you wish to read.

To do this, we have provided the script, ExampleTableSerialDecode.vbs, which by default installs into oscilloscope: C:\LeCroy\XStream\Scripts\Automation\ExampleTableSerialDecode.vbs.

Tip: This script may also be used as a basis for your own remote control programs, or used as is to read decoder table data.

With the decoder table populated, run the script from the oscilloscope (or a PC if you have a remote connection to the oscilloscope). The script will generate the comma-delimited file, ExampleTableSerialDecode.txt, which may be imported into Excel or other spreadsheet software to show the table structure.



Result.Rows: 8												
Result.Columns: 34												
CAN FD	Time	Format	PRIO	ID	SRC	IDE	FDF	BRS	ESI	RTR	DLC	Data
1	-7.48E-03	FD		31;-7.48024976	0;-7.4522	1;-7.4502	1;-7.4462	0;-7.444551894027536			6;-7.44405	174;-7.44205462545681E-03;-7.43805466420848E-03;143;-7.43805466420848E-03;-7.43405452651836E-03;
2	-4.59E-03	FD		190;-4.5894578	0;-4.5634	1;-4.5614	1;-4.5574	0;-4.555759668811877			8;-4.55526	0;-4.553260668286955E-03;-4.54826025140856E-03;0;-4.54826025140856E-03;-4.54376023553057E-03;0;-4.
3	-4.48E-03	FD		614;-4.4741593	0;-4.4501	1;-4.4481	1;-4.4441	0;-4.442459732158316			6;-4.44195	0;-4.43996012906669E-03;-4.43546015204063E-03;0;-4.43546015204063E-03;-4.43046028360746E-03;0;-4.
4	-4.37E-03	FD		44;-4.37086003	0;-4.3448	1;-4.3428	1;-4.3388	0;-4.337160344387098			8;-4.33666	0;-4.33466132067482E-03;-4.32966079442937E-03;0;-4.32966079442937E-03;-4.32516075451995E-03;0;-4.
5	-2.77E-05	Std		325;-2.5744779	0;-1.7452	0;2.54715560793993	E-07;2.274	0;-3.74528			8;2.274027	69;1.025439320135556E-05;2.62548705473216E-05;80;2.62548705473216E-05;4.22739967647582E-05;128;4
6	2.58E-03	FD		31;2.586421380	0;2.61441	1;2.61641	1;2.62041	0;2.622119664144956			6;2.622615	128;2.62461650529113E-03;2.62911896054307E-03;72;2.62911896054307E-03;2.63311895907048E-03;97;2
7	5.35E-03	FD		44;5.355213390	0;5.38121	1;5.38320	1;5.3872(	0;0.005388911407171			8;5.389408	0;5.39141045889392E-03;5.39641119645398E-03;0;5.39641119645398E-03;5.40091119496943E-03;0;5.400

Example spreadsheet after importing ExampleTableSerialDecode.txt.

The first two rows of the imported file will show the total number of rows and columns in the table, in this example 8 rows and 34 columns. This indicates the range of your *RowA* and *ColA* keys.

The third row of the imported file will replicate the column headers of the Result Table (0), with individual records (frames, messages, etc., depending on how you have "packetized" the decoding) appearing in subsequent rows (1-*n*).

Counting from 0 at the far left (Row Index Number), find the column of the data you wish to access. That will be the *ColA* key in your script.

Note: Do not confuse the number/letter of the cells in the imported file with the rows/columns of the Result Table.

Hidden columns (whether hidden by you or the software) must still be counted, so, in the example above, PRIO is column 3, making ID column 4, and so forth. So, if you wished to access the ID of record 6, the first argument of your query would be: (6,4)

Within each column, Simple Cells contain a single value that appears at the specified location in the table. In the above example, columns 0 through 2 are Simple Cells. Simple Cell VBS access syntax is:

vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(*RowA*,*ColA*)'

However, many cells of the Result Table are the Table Cell type, nested tables that may contain multiple "B" columns and always three "B" rows that, when coupled with the column key, each return a different component of the measurement: (0,*ColB*) = MeasuredValue, (1,*ColB*)= StartTime, (2,*ColB*) = StopTime. These cells can be identified by the list of semi-colon delimited values within them. The first three values in the list are Col0, the second three values are Col1, and so forth.

To access Table Cells, the (*RowB*,*ColB*) argument is sent in a second parenthesis, following the A "locators":

vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(*RowA*,*ColA*)(*RowB*, *ColB*)'

Although the image above does now show it, the ID and IDE columns each contain a single-column, three-row nested table. To read the *values* from such columns, you would add the argument (0,0) following your "locators": (*RowA*,4),(0,0) and (*RowA*,6),(0,0) respectively.

Reading the Data column (*RowA*,12) is more complicated, because it contains a *multi-column,* three-row nested table, as indicated by the longer list of values. To access the full Data column value for each record, all *ColB*s must be called by your script.

For example, if these were your decoder results:

CAN FD	Time	Format	ID	IDE	FDF	BRS	ESI	RTR	DLC	Data
1	-7.4822 ms	FD	0x01f	0	1	1	0		6	ae 8f a0 a3 00 06
2	-4.5915 ms	FD	0x0be	0	1	1	0		8	00 00 00 00 00 00 00 00
3	-4.4762 ms	FD	0x266	0	1	1	0		6	00 00 00 00 00 00
4	-4.3729 ms	FD	0x02c	0	1	1	0		8	00 00 00 00 00 00 00 00
5	-27.74 µs	Std	0x145	0	0			0	8	45 50 80 00 00 00 00 00
6	2.58442 ms	FD	0x01f	0	1	1	0		6	80 48 61 44 00 06
7	5.35321 ms	FD	0x02c	0	1	1	0		8	00 00 00 00 00 00 00 00

The following table shows example VBS queries you might add to a remote control program to read data from the decoder result table.

Remote Queries	Returned Value(s)	What Is Read by Query
vbs? 'return=app.SerialDecode.Decode1.out.Result.rows'	8	Number of table rows (incl. header Row 0)
vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(6,0)' vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(6,1)' vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(6,2)'	6 2.58442...E-03 FD	Value in first 3 columns of Row 6, including: Index # in Row 6 Col 0 Time in Row 6 Col 1 Format in Row 6 Col 2
vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(6,12)(0,0)'	128	Data value in ColB0 of Row 6 Col 12
vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(6,12)(1,0)'	2.62461...E-03	StartTime of Data in ColB0 of Row 6 Col 12 (hidden)
vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(6,12)(2,0)'	2.62911...E-03	StopTime of Data in ColB0 of Row 6 Col 12
vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(6,12)(0,1)'	72	Data value in ColB1 of Row 6 Col 12
vbs? 'return=app.SerialDecode.Decode1.out.Result.cellvalue(6,12)(1,1)'	2.62911...E-03	StartTime of Data in ColB1 of Row 6 Col 12 (hidden)

Modifying the Result Table

The CVAR app.SerialDecode.Decode*n*.Decode.ColumnState contains a pipe-delimited list of all the table columns and their current state (visible=on, hidden=off). For example:

app.SerialDecode.Decode1.Decode.ColumnState = "Idx=On|Time=On|Data=On|..."

If you wish to hide or display table columns, send the full string with the state changed from "on" to "off", or vice versa, rather than remove any column from the list.

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Teledyne LeCroy
700 Chestnut Ridge Road
Chestnut Ridge, NY, 10977, USA
teledynelecroy.com

Sales and Service:
Ph: 800-553-2769 / 845-425-2000
FAX: 845-578-5985
contact.corp@teledynelecroy.com

Support:
Ph: 800-553-2769
support@teledynelecroy.com

700 Chestnut Ridge Road
Chestnut Ridge, NY 10977
USA

teledynelecroy.com