

Keysight Technologies

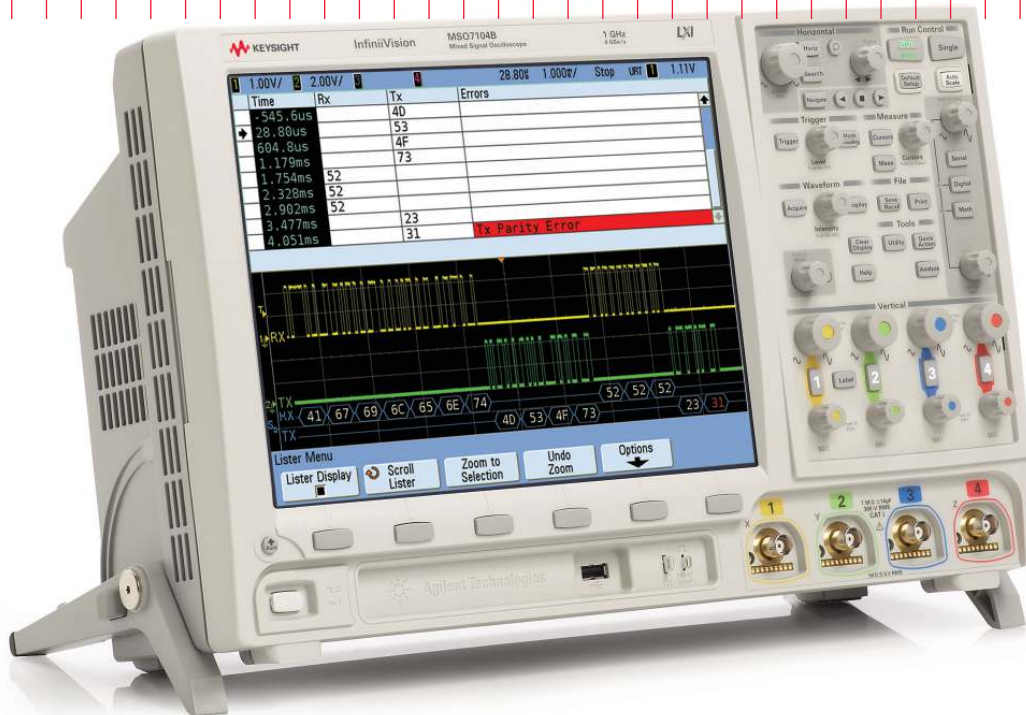
RS-232/UART

Triggering and Hardware-Based Decode (N5457A) for InfiniiVision Oscilloscopes

Data Sheet

Features:

- RS-232/UART serial bus triggering
- RS-232/UART hardware-based protocol decoding
- Real-time frame and error totalize counters



Introduction

Debugging systems that use an RS-232 serial bus can be difficult, unless your scope is capable of triggering on and decoding the RS-232 protocol. Traditional methods of debugging serial buses such as RS-232 include manual bit counting. But this visual technique of counting “1s” and “0s” can be tedious and it is prone to errors.

Keysight Technologies, Inc. serial bus options for InfiniiVision oscilloscopes offer powerful triggering and provide unique hardware-accelerated decoding to help you debug embedded designs with RS-232 and UART serial buses faster. With the industry’s fastest serial decode update rates, you can more easily find and debug random and intermittent errors and signal integrity problems that you could easily miss using other serial bus decode tools.

Other oscilloscope solutions with serial bus triggering and protocol decode typically use software post-processing techniques to decode serial packets/frames. Using these software techniques, waveform- and decode-update rates tend to be slow (sometimes seconds per update), especially when you use deep memory, which is often required to capture multiple packetized serial signals.



Figure 1. Defining the RS232/UART protocol structure

Bus configuration

The RS-232/UART option for Keysight InfiniiVision Series scopes supports a broad range of protocol structures including many RS-422 and RS-485 applications, as shown in Figure 1. Setting up an InfiniiVision Series scope to trigger on and decode your particular RS-232 or UART bus is easy. You can select the following settings:

- Number of bits = 5 to 8
- Parity selection = None, odd, or even
- Baud rate = 1200 b/s up to 2.7648 Mb/s
- Polarity = Idle low or Idle high
- Bit order = LSB out first, or MSB out first

RS-232/UART protocol decoding formats

You can serially decode transmit and receive signals in either binary, hex, or ASCII format. The protocol decode data is always displayed in a time-correlated trace below the captured waveforms. In addition, the decoded data can also be viewed in a tabular format using the "lister" display mode. Figure 2 shows a transmit and receive message decoded in hex format.



Figure 2. InfiniiVision Series scopes provide flexible RS-232/UART decoding formats including binary, hex, and ASCII.

Figure 3 shows the same message decoded in a color-coded ASCII format. Note the red "1" character at the end of this important message. Red is an indication that a parity error was detected for that particular byte.

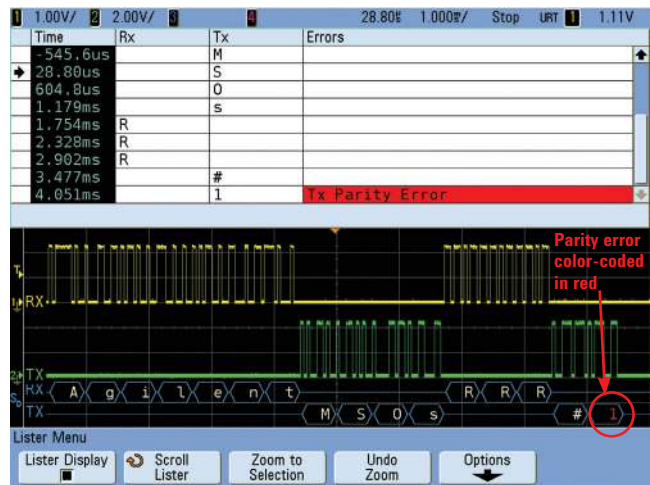


Figure 3. Color-coded ASCII decoding makes reading a transmitted or received message much easier.

And with Keysight's 7000B Series oscilloscope, you can also easily search and navigate within the protocol lister display to find and mark particular events of interest with direct time-correlation to the waveform display.



Triggering

Figure 4 shows the available selections for triggering on RS-232/UART transmit and receive signals, including triggering on either receive or transmit parity errors.

In addition to being able to trigger on specific transmit or receive bytes, this scope's "burst trigger" mode allows you to specify to trigger on the "Nth" byte within a burst of data bytes that satisfies the data entry.

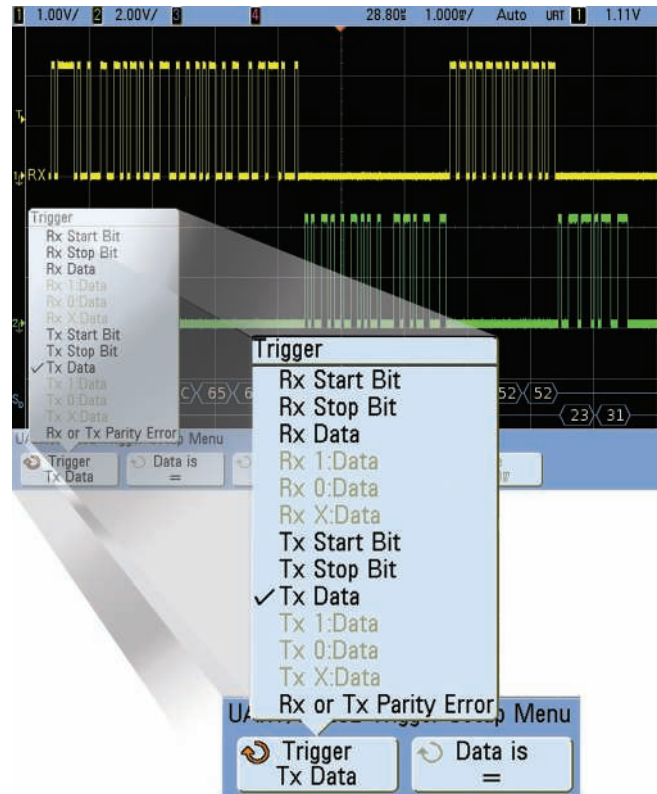


Figure 4. Flexible triggering options enables you to trigger on specific RS-232/UART receive or transmit strings.

Real-time frame/byte totalizer

In addition to flagging parity errors, InfiniiVision's RS-232/UART option also provides a real-time totalizer/counter of transmitted and received frames/bytes, as shown in Figure 5. In addition, the option allows you to count parity error bytes and see a percent readout that gives an indication of the quality of your serial bus. This totalize function, which is not available in other oscilloscopes currently on the market, is independent from the scope's acquisition or triggering. In addition, this RS-232/UART byte counter is not affected by either the oscilloscope's acquisition window or scope dead-time. Totalize counts run continuously, even when the scope's acquisition is stopped.

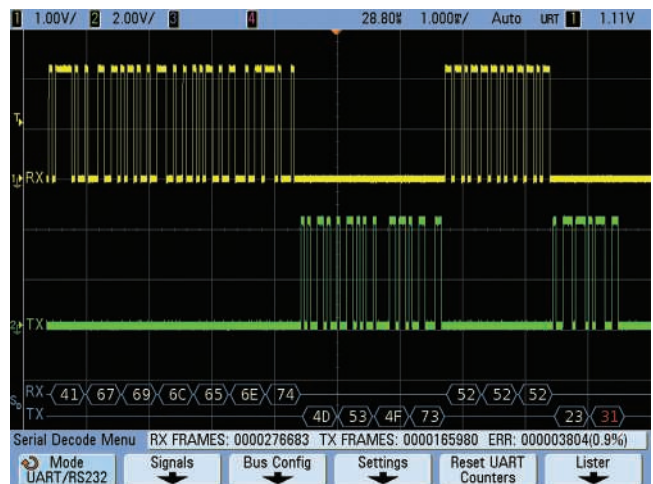


Figure 5. InfiniiVision's real-time totalizer counts all received and transmitted bytes/frames, along with all parity errors.

Segmented memory captures more frames

The segmented memory option for Keysight's InfiniiVision Series oscilloscopes can optimize your scope's acquisition memory, allowing you to capture more RS-232/UART signals using less memory. Segmented memory acquisition optimizes the number of packetized serial communication frames/bytes that can be captured consecutively by selectively ignoring (not digitizing) unimportant idle time between frames. And with a minimum 250 picoseconds time-tagging resolution, you will know the precise time between each frame.

Figure 6 shows an RS-232/UART measurement with the scope set up to trigger on a receive start-bit condition. Using this triggering condition with the segmented memory acquisition

mode turned on, the scope easily captures 500 consecutive bursts of serial communication for a total acquisition time of 11.5 seconds. After acquiring the 500 segments, we can easily scroll through all frames individually to look for any anomalies or errors.

Keysight's InfiniiVision Series oscilloscopes are the only scopes on the market today that can acquire segments on up to four analog channels of acquisition, capture time-correlated segments on digital channels of acquisition (using an MSO model), and perform hardware-based serial bus protocol decoding.

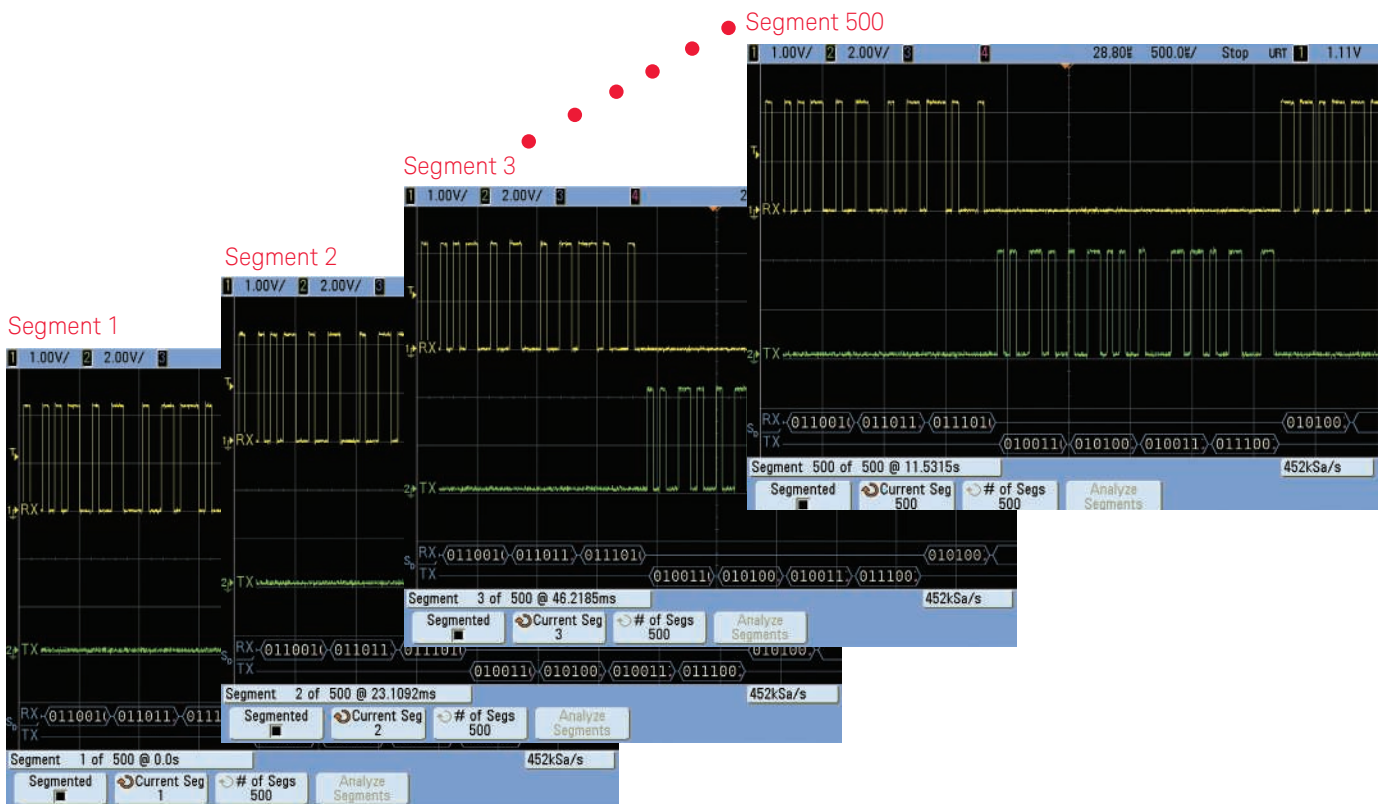


Figure 6. InfiniiVision's segmented memory acquisition mode captures more bytes while using less memory.

Performance characteristics

| Performance characteristics | |
|-----------------------------|--|
| Tx and Rx source | Analog channels 1, 2, 3, or 4 Digital channels D0 – D15 (on MSO models) |
| Bus configuration | |
| Baud rates | 1200 bps up to 2.765 Mb/s (default = 19.2 kb/s) |
| Number of bits | 5 to 9 (default = 8-bits) |
| Parity | None, odd, or even (default = None) |
| Polarity | Idle low or idle high (default = Idle low) |
| Bit order | LSB out first or MSB out first (default = LSB) |
| Triggering | Rx start bit Rx stop bit Rx data Rx 1:data (9-bit format) Rx 0:data (9-bit format) Rx X:data (9-bit format) Rx or Tx parity error Tx start bit Tx stop bit Tx data Tx 1:data (9-bit format) Tx 0:data (9-bit format) Tx X:data (9-bit format) Burst (nth frame within burst defined by timeout) |
| Color-coded decode | |
| Number of decode traces | 2 independent traces (1 for Tx, and 1 for Rx) |
| Data format | Binary, hex, or ASCII-code characters (default = Hex) |
| Data byte display | White characters if no parity error, red characters if parity or bus error |
| Idle bus trace | High or low trace in white (depends on polarity setting) |
| Active bus trace | Byte-delimited bi-level trace in blue if no parity error, red if parity error |
| Totalize/counter function | Total received frames Total transmitted frames Total parity error frames (with percentage) |

Keysight InfiniiVision portfolio

Keysight's InfiniiVision lineup includes 5000, 6000 and 7000 Series oscilloscopes. These share a number of advanced hardware and software technology blocks. Use the following selection guide to determine which best matches your specific needs.



| | Largest display, shallow depth | Optional battery, 100 MHz MSO | Ideal for ATE rackmount applications | Smallest form factor, lowest price |
|-----------------------|---------------------------------------|--------------------------------------|---|---|
| | 7000B Series | 6000A Series | 6000L Series | 5000 Series |
| 100 MHz Bandwidth | ● | ● | ● | ● |
| 300/350 MHz Bandwidth | ● | ● | ● | ● |
| 500 MHz Bandwidth | ● | ● | ● | ● |
| 1 GHz Bandwidth | ● | ● | ● | |
| MSO Models | ● | ● | ● | |
| GPIB Connectivity | | ● | ● | ● |
| Rackmount height | 7U | 5U | 1U | 5U |
| Battery option | | ● | | |
| Display size | 12.1" | 6.3" | 6.3" | |
| Footprint (WxHxD) | 17.9"x 10.9"x 6.8" | 15.7"x 7.4"x 11.1" | 17.1"x 1.7"x 10.6" | 15.2"x 7.4"x 6.9" |



Keysight's InfiniiVision oscilloscope portfolio offers:

- A variety of form factors to fit your environment
- Responsive controls and best signal visibility
- Insightful application software
- Responsive deep memory with MegaZoom III

Ordering information

The N5457A RS-232/UART option is compatible with all 4-channel and 4+16-channel Keysight InfiniiVision Series oscilloscopes (5000, 6000, and 7000 Series scopes). This option is

available as a factory-installed option if ordered as Option-232 along with a specific oscilloscope model, or existing InfiniiVision Series oscilloscope users

can order this option as an after-purchase product upgrade (N5457A).

| Model number – user installed | Option number – factory installed | Description |
|-------------------------------|-----------------------------------|---|
| N5457 | 232 | RS-232/UART triggering and decode (for 4- and 4+16-channel scope models only) |
| N5423A | LSS | I ² C/SPI serial decode option (for 4- and 4+16-channel scope models only) |
| N5424A | AMS | CAN/LIN triggering and decode (for 4- and 4+16-channel scope models only) |
| N5432C | FLX | FlexRay triggering and decode (for 4- and 4+16 channel scope models only) |
| N5468A | SND | I ² S triggering and decode (for 4- and 4+16 channel scope models only) |
| N5469A | 553 | MIL-STD 1553 triggering and decode (for 4- and 4+16 channel scope models only) |
| N5454A | SGM | Segmented memory |

Note that additional options and accessories are available for Keysight InfiniiVision Series oscilloscopes. Refer to the appropriate 5000, 6000, or 7000 Series oscilloscope data sheet for ordering information about these additional options and accessories, as well as ordering information for specific oscilloscope models.

Related literature

| Publication title | Publication type | Publication number |
|---|------------------|--------------------|
| <i>Keysight 7000B Series InfiniiVision Oscilloscopes</i> | Data Sheet | 5990-4769EN |
| <i>Keysight 6000 Series InfiniiVision Oscilloscopes</i> | Data Sheet | 5989-4087EN |
| <i>Keysight 5000 Series InfiniiVision Oscilloscopes</i> | Data Sheet | 5989-6110EN |
| <i>Keysight InfiniiVision Series Oscilloscope Probes and Accessories</i> | Data Sheet | 5968-8153EN |
| <i>Segmented Memory Acquisition (N5454A) for Keysight InfiniiVision Series Oscilloscopes</i> | Data Sheet | 5989-7833EN |
| <i>I²C and SPI Triggering and Hardware-Based Decode (N5423A) for Keysight InfiniiVision Series Oscilloscopes</i> | Data Sheet | 5989-5126EN |
| <i>CAN/LIN Measurements (option AMS) for Keysight's InfiniiVision Series Oscilloscopes</i> | Data Sheet | 5989-6220EN |
| <i>Evaluating Oscilloscope Segmented Memory for Serial Bus Applications</i> | Application Note | 5989-7885EN |
| <i>Evaluating Oscilloscopes for Best Waveform Update Rate</i> | Application Note | 5989-3702EN |
| <i>Evaluating Oscilloscopes to Debug Mixed-Signal Designs</i> | Application Note | 5989-3702EN |
| <i>Using a Keysight InfiniiVision MSO to Debug an Automotive CAN Bus</i> | Application Note | 5989-5049EN |
| <i>Evaluating Oscilloscope Bandwidths for your Applications</i> | Application Note | 5989-5733EN |
| <i>Evaluating Oscilloscope Sample Rates vs. Sampling Fidelity</i> | Application Note | 5989-5732EN |
| <i>Evaluating Oscilloscope Vertical Noise Characteristics</i> | Application Note | 5989-3020EN |

Product Web site

For the most up-to-date and complete application and product information, please visit our product Web site at: www.keysight.com/find/7000



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