Keysight Technologies
I²C and SPI Protocol
Triggering and Decode
For Infiniium 9000 and S-Series Oscilloscopes

Data Sheet
Lower-speed serial bus interfaces such as I\textsuperscript{2}C (inter-integrated circuit) and SPI (serial peripheral interface) are widely used today in electronic designs for chip-to-chip communication. In many designs these serial buses tend to provide content-rich points for debug and test. However, since these protocols transfer bits serially, using a traditional oscilloscope has limitations. Manually converting captured 1's and 0's to protocol requires significant effort, can't be done in real-time, and includes potential for human error. In addition, traditional scope triggers are not sufficient for specifying protocol-level conditions.

Extend your scope capability with I\textsuperscript{2}C and SPI Triggering and Decode application. This application makes it easy to debug and test designs that include I\textsuperscript{2}C or SPI protocols using your Infiniium oscilloscopes.

- Set up your scope to show I\textsuperscript{2}C or SPI protocol decode in less than 30 seconds.
- Get access to a rich set of integrated protocol-level triggers.
- Save time and eliminate errors by viewing packets at the protocol level.
- Use time-correlated views to quickly troubleshoot serial protocol problems back to their timing or signal integrity root cause.

This application is available in the following license variations.
- Fixed to an oscilloscope
- Floating license
- Server-based license
- Transportable license

Easily debug and test designs that include I2C or SPI protocols using your Infiniium oscilloscopes

30 Second SPI or I\textsuperscript{2}C Setup
Configure your oscilloscope to display protocol decode in under 30 seconds. Use “Auto Setup” to automatically configure sample rate, memory depth and threshold and trigger levels.

Support for both analog and digital channels
Acquire serial buses using any combination of scope or digital channels. Using digital channels on MSO models preserves analog channels for viewing other time-correlated signals.

Easy to find
Turn decode on/off via the “Serial Decode” button on the front of the instrument or in the “Setup” menu. View decode embedded on the waveform display or in the protocol viewer listing window. (See pages 4-5)
I\textsuperscript{2}C and SPI protocol triggering and searching

Get access to a rich set of integrated protocol level triggers. The application includes a suite of configurable protocol-level trigger conditions specific to I\textsuperscript{2}C and SPI. When serial triggering is selected, the application enables special real-time triggering hardware inside the scope.

Hardware-based triggering ensures that the scope never misses a trigger event when armed. This hardware takes signals acquired using either scope or digital channels and reconstructs protocol frames. It then inspects these protocol frames against specified protocol-level trigger conditions and triggers when the condition is met.

I\textsuperscript{2}C Trigger Setup
Choose a combination of address, read/write, address acknowledge and data values for I2C triggers.

Payload editor
Use the payload editor to specify data values word by word. Operators give additional triggering flexibility.

SPI Trigger Setup
Quickly access protocol triggering via the scope’s trigger menu. Specify SPI trigger in HEX, binary, or decimal up to 200 bits.

Quickly find occurrences
Quickly move to next occurrence of a specified event. Jump to the next or previous occurrence of the specified event.

Post-acquisition searching
Search acquired protocol listing using a menu that is identical to the trigger menu.
SPI protocol decode with precise time-correlation between waveforms and listing

The Keysight Technologies, Inc. SPI protocol viewer includes correlation between the waveforms and the selected packet. The selected packet, highlighted blue row in the listing, is time-correlated with the blue line in the waveform display. Move the blue tracking marker in time through waveforms and the blue bar will automatically track in the packets window. Or, scroll through the packet viewer and highlight a specific packet. The time-correlation tracking marker will move to the associated point in the waveform.

SPI decode embedded in waveform area

Utilize the oscilloscope waveform area to display decode information. For SPI, minor ticks indicate clock transitions and major ticks show the beginning and end of each word in the serial packet.

Full screen SPI listing

Fill the entire display with compact protocol information using the full screen listing. The protocol viewer window shows the index number, time stamp value, and data content for each serial packet in the list. Scroll though all decoded serial packets to find events of interest or errors in the transmission. Data in the listing window can be saved to a .csv or .txt file for off-line analysis or documentation.

Support for 2, 3, and 4-Wire SPI

The application supports 2-, 3-, and 4-wire SPI. Use digital channels on MSO models to preserve analog channels for simultaneously viewing other signals.

Long Time Captures using Segmented Memory

Capture seconds to days of serial protocol. The scope fills memory as each acquisition sees its trigger condition. Segmented memory uses time tags to track time between segment acquisitions.
Quickly move between physical and I2C protocol layer information using the time-correlated tracing marker. Display protocol content using embedded decode in the waveform area, Or, see protocol events in a compact listing format using the industry’s first scope based multi-tab protocol viewer. For I2C minor tick marks indicate clock transitions. Major tick marks indicate sections of the serial packet such as address, acknowledge, and data.

Details tab breaks the packets into easy-to-read textual fields. Hovering shows additional detail.

Payload tab shows data carried by the packet in byte-by-byte HEX and ASCI.

Header tab shows packets in a data book format. Hovering at any field reveals additional detail.

Fill the entire display with compact protocol information. The protocol viewer shows index number, time stamp, and data content for each serial packet. Listing content can be saved to a .csv or .txt file for off-line analysis or documentation. Use search capability to quick navigate through an acquisition.
### I^2C specifications and characteristics

| I^2C source (clock and data) | Analog channels 1, 2, 3, or 4  
|                            | MSO models can additionally use digital channels D0 to D15  
|                            | any waveform memory  
| Max clock/data rate        | Any waveform memory up to 3.4 Mbps (automatic)  
| Auto Setup                 | Automatically configures scope settings for proper I^2C decode and protocol triggering  
| Triggering                 | Start and re-start 7-bit address  
|                            | Start and re-start 8-bit address  
|                            | Start and re-start 10-bit address  
|                            | Start and re-start 11-bit address  
|                            | Specify value for 3 fields choosing between the following  
|                            |  
|                            | Read or write  
|                            | Address (value in HEX or binary)  
|                            | Address acknowledge  
|                            | Data (up to 20 bytes (specify in HEX, binary, ASCII, or decimal)  
|                            | Operators include: = on 8-bit word boundaries.  

### SPI specifications and characteristics

| SPI protocols supported | 2-wire SPI signals:  
|                       | data source and clock source  
|                       | 3-wire SPI signals:  
|                       | data source, clock source, and chip select source  
|                       | 4-wire SPI signals: data source (MOSI), clock source, chip select source, data source (MISO)  
| SPI source (all signals) | Analog channels 1, 2, 3, or 4  
|                          | MSO models can additionally use digital channels D0 to D15  
| Max clock/data rate     | Up to 50 Mbps (automatic)  
| Autoset                 | Automatically configures scope settings for proper SPI decode and protocol triggering  
| Decode word size        | User-selectable from 4 to 32 bits  
| Decode bit order        | User-selectable LSB or MSB  
| Triggering              | Data length up to 200 bits  
|                          | Number of words * word size < 200 bits  
|                          | Number of words selectable up to 50  
|                          | Word size selectable from 4 to 32 bits  
|                          | Data operators include: =, OR  

Ordering information

This application is compatible with all 9000 and S-Series oscilloscope models.

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<tr>
<th>Application software</th>
<th>9000 Series</th>
<th>S-Series</th>
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<tbody>
<tr>
<td>I²C/SPI triggering and decode</td>
<td></td>
<td></td>
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<tr>
<td>Fixed</td>
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<td>Option 007</td>
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<td>N5391B-1FP*</td>
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<td>N5391B-1TP*</td>
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<td>Server-based</td>
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<td>N5435A-006</td>
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<tr>
<td>PC/SPI, RS-232/UART triggering and decode bundle</td>
<td></td>
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<tr>
<td>Fixed</td>
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* Requires Infiniium 5.0 or above

Related literature

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<th>Publication title</th>
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<td>Infiniium 9000 Series Oscilloscopes</td>
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<td>Infiniium 9000 H-Series Oscilloscopes</td>
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