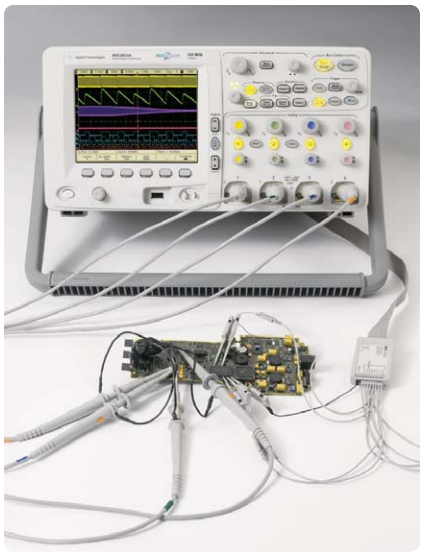
Serial Bus Triggering and Hardware-Accelerated Decode Options (N5423A and N5424A) for Agilent 6000 Series Oscilloscopes

Data Sheet



Find and debug intermittent errors and signal-integrity problems faster

Agilent Technology's triggering and decode options for the 6000 Series oscilloscopes offer hardware-accelerated decode to help you debug I^2C, SPI, CAN and LIN serial buses using the industry's fastest decode update rates. Fast decode update rates enable you to find and debug random and intermittent errors and signal-integrity problems that you could easily miss using other serial bus decode tools.

Lower-speed serial bus interfaces such as I^2C (inter-integrated circuit) and SPI (serial peripheral interface) are widely used today in mixed-signal embedded designs for chip-to-chip communication between EEPROMs, DACs, ADCs, and other peripheral ICs to microcontrollers, microprocessors, and DSPs. For longer-haul serial communication between real-world physical sensors and digital controllers in automotive and industrial applications, serial bus interfaces such as CAN (controller area network) and LIN (local interconnect network) are widely used. Since these protocols transfer many bits of data serially, it can be very difficult to unravel what's happening in an embedded system with conventional scope triggering.

The Agilent 6000 Series oscilloscopes offer integrated serial triggering and hardware-accelerated protocol decoding solutions that give you the tools you need to efficiently and effectively debug your embedded system designs that have serial buses. All Agilent 6000 Series scopes allow you to trigger on the industry's most popular serial bus protocols including I^2C, SPI, CAN, LIN, and USB – making it much easier to isolate particular serial events. The optional N5423A (Option LSS) provides I^2C and SPI decoding, while the N5424A (Option AMS) provides extended CAN and LIN triggering and decoding.

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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.

Agilent's 6000 Series mixed signal oscilloscopes (MSOs) are a perfect fit for verifying and debugging designs that include a combination of analog signals, serial traffic, and higher-speed digital control signals found in today's embedded designs. MSOs provide an integrated way to capture and time-correlate multiple analog, serial, and digital signals of various speeds with deep memory. Agilent offers MSOs with optional serial bus capabilities in various bandwidth models ranging from 100 MHz up to 1 GHz.

N5423A (Option LSS) I^2C/SPI bus triggering and decode

The N5423A I^2C/SPI serial decode option for 6000 Series oscilloscopes is a hardware and software tool that allows you to analyze and troubleshoot physical-layer problems associated with I^2C and SPI serial buses. Combined with the standard I^2C and SPI serial bus triggering and MegaZoom III deep memory offered in Agilent's 6000 Series scopes, the N5423A provides a powerful serial data analysis and troubleshooting solution that decodes specific device addresses, data, IDs, etc., of digitized signals in real-time.

The N5423A I^2C/SPI serial decode option provides responsive, time-aligned, on-screen decode of I^2C and SPI serial buses. Agilent's I^2C and SPI serial bus decode option for 6000 Series 4-channel DSOs and 4+16 channel MSOs is the fastest-throughput oscilloscope solution for triggering on and analyzing I^2C or SPI serial buses.

The I^2C and SPI serial decode option lets you effectively troubleshoot embedded systems. You can easily isolate serial packets to find sources of errors. Using an MSO, you can capture and decode I^2C or SPI data packets and correlate them with other signals in the design, such as digital control signals and analog signals, as shown in Figure 1.

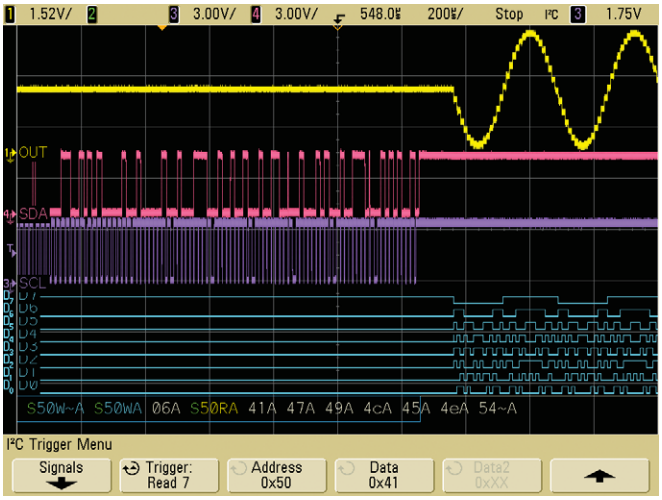

Figure 1. On-screen serial decode of I^2C data packet shown with time-correlated analog and digital waveforms captured by an MSO

N5424A (Option AMS) CAN/LIN bus triggering and decode

CAN and LIN serial buses are used to route electronic signals between subsystems in many of today's automotive and industrial-automation embedded designs. The harsh environment in these applications makes these signals susceptible to signal integrity problems, which can create errors during critical communication cycles. The automotive triggering and real-time decode option for Agilent's 6000 Series oscilloscopes enables you to gain insight into your CAN/LIN-based designs. With hardware-accelerated protocol decoding, the N5424A CAN/LIN option helps you find and debug errors and signal integrity problems faster than you can with other oscilloscope-based solutions on the market today.

The Agilent N5424A CAN/LIN option allows you to trigger on either standard or extended CAN message IDs, including the message ID of a remote transfer request frame. It supports triggering on a data frame, and allows engineers to specify message IDs, data and data length for filtering messages of interest. Triggering on active error frames also is supported.

Decode information for the CAN and LIN buses is time-correlated with each specific digitized packet waveform. To make the information easier to interpret, the decoded serial data is provided in a color-coded format, as shown in Figure 2. With the real-time update of decoded frames, your ability to find random and infrequent signal integrity problems is greatly enhanced. In this particular screen image, we can see that the scope quickly captured and displayed a CRC error color-coded in red – indicating an error frame caused by a system glitch coupling into the differential CAN signal.

In addition to flagging CAN error frames in real-time, the N5424A also provides an error totalize function that indicates the total number of active frame errors encountered while the scope captures CAN frames repetitively.

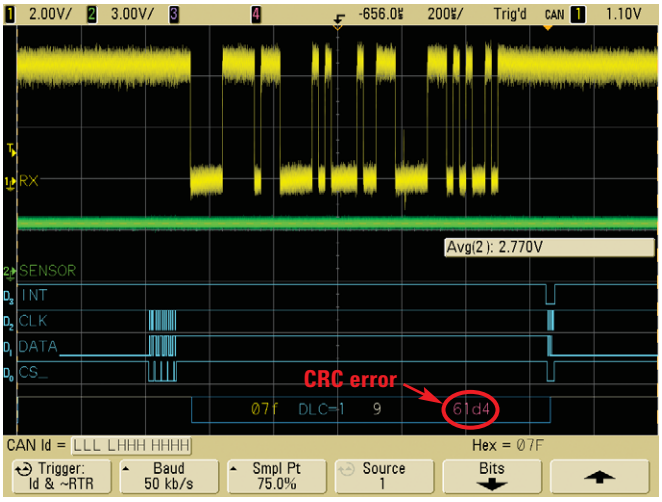

Figure 2. Random errors observed in CAN decode while triggering on data frame ID: $07F_{HEX}$

I^2C Specifications/Characteristics (N5423A or Option LSS)

I^2C source (clock and data)	Analog channels 1, 2, 3, or 4 Digital channels D0 to D15
Max clock/data rate	Up to 3.4 Mbps (automatic)
Triggering[1]	Start condition Stop condition Missing acknowledge Address with no acknowledge Restart EEPROM data read Frame (Start:Addr7:Read:Ack:Data) Frame (Start:Addr7:Write:Ack:Data) Frame (Start:Addr7:Read:Ack:Data:Ack:Data2) Frame (Start:Addr7:Write:Ack:Data:Ack:Data2) 10-bit write
Color-coded, hardware-accelerated decode[2]	Data (HEX digits in white) Read address (HEX digits in yellow) Write address (HEX digits in light-blue) Restart addresses (prefixed with "S" in green) Acknowledges (suffixes "A" or "~A" in the same color as the data or address preceding it) Idle bus (high bus trace in white) Active bus (bi-level bus trace in dark-blue) Unknown/error bus (bi-level bus trace in red)

1 Standard I^2C triggering in all Agilent 6000 Series oscilloscopes
2 Optional I^2C decoding in all 4-channel and 4+16-channel 6000 Series oscilloscopes

SPI Specifications/Characteristics (N5423A or Option LSS)

SPI source (clock, data, chip select)	Analog channels 1, 2, 3, or 4 Digital channels D0 to D15
Max clock/data rate	Up to 25 Mbps (automatic)
Triggering[1]	4- to 32-bit data pattern during a user-specified framing period Framing period can be a positive or negative chip select (CS or ~CS) or clock idle time (timeout)
Color-coded, hardware-accelerated decode[2]	Data (hex digital in white) Unknown/error bus (bi-level bus trace in red) Number of clocks/packet ("XX CLKS" in light-blue) Idle bus (outside of a packet = white) Active bus (bi-level bus trace in dark-blue)

1 Standard SPI triggering in all Agilent 6000 Series oscilloscopes
2 Optional SPI decoding in all 4-channel and 4+16-channel 6000 series oscilloscopes

CAN Specifications/Characteristics (N5424A or Option AMS)

CAN source	Analog channels 1, 2, 3, or 4
Baud rates	10 kbps up to 1 Mbps (user-selectable)
Triggering	Start-of-frame (SOF)[1] Remote frame ID (RMT) Data frame ID (~RMT) Remote or data frame ID Data frame ID and data Error frame ID length: 11-bits or 29-bits (extended)
Color-coded, hardware-accelerated decode	Frame ID (HEX digits in yellow) Remote frame (RMT in green) Data length code (DLC in blue) Data bytes (HEX digits in white) CRC (HEX digits in blue = valid, hex digits in red = error) Error frame (bi-level bus trace in red) Totalize active error frames ("XXXXXX ERR" in red) Overload frame ("OVRLD" in blue) Idle bus (high bus trace in white) Active bus (bi-level bus trace in dark-blue)

1 Standard CAN triggering in all Agilent 6000 Series oscilloscopes

LIN Specifications/Characteristics (N5424A or Option AMS)

LIN source	Analog Channels 1, 2, 3, or 4 Logic Channels D0 - D15
LIN standards	LIN 1.3 or LIN 2.0
Signal types	LIN Single-ended Tx Rx
Baud rates	2400 bps, 9600 bps, or 19.2 kbps (user-selectable)
Triggering	Sync Break[1] Frame ID ($0X00_{HEX}$ to $0X3F_{HEX}$)
Color-coded, hardware-accelerated decode	Frame ID (6-bit hex digits in yellow) Frame ID and optional parity bits (8-bit hex digits in yellow) Data bytes (hex digits in white) Lin 2.0 check sum (hex digits in white) Lin 1.3 Check Sum (hex digits in blue = valid, hex digit in red = error) Sync error ("SYNC" in red) $T_{Header-Max}$ ("THM" in red) $T_{Frame-max}$ ("TFM" in red) Parity error ("PAR" in red) LIN 1.3 wake-up error ("WUP" in red) Lin 1.3 idle bus (high bus trace in white) Active bus (bi-level bus trace in dark-blue)

1 Standard LIN triggering in all Agilent 6000 Series oscilloscopes

Ordering information

The N5423A (I^2C and SPI) and N5424A (CAN and LIN) are compatible with the 6000 Series oscilloscopes 4-channel DSOs and 4+16-channel MSOs only. These serial triggering and decode products are available as factory-installed options (Options LSS and AMS), or existing 6000 Series users can order them as an after-purchase product (N5423A and N5424A).

Model	Description
N5423A (or Option LSS)	I^2C/SPI serial bus decode option
N5424A (or Option AMS)	CAN/LIN serial bus trigger and decode option
DSO6014A	4-channel 100-MHz DSO
DSO6034A	4-channel, 300-MHz DSO
DSO6054A	4-channel, 500-MHz DSO
DSO6104A	4-channel, 1-GHz DSO
MSO6014A	4+16 channel, 100-MHz MSO
MSO6034A	4+16 channel, 300-MHz MSO
MSO6054A	4+16 channel, 500-MHz MSO
MSO6104A	4+16 channel, 1-GHz MSO

Related Literature

Publication Title	Publication Type	Publication Number
Agilent 6000 Series Oscilloscopes	Data sheet	5989-2000EN
Agilent 6000 Series Oscilloscope Probes and Accessories	Data sheet	5968-8153EN
Using an Agilent 6000 Series MSO To Debug an Automotive CAN Bus	Application note	5989-5049EN
Debugging Embedded Mixed-Signal Designs Using Mixed Signal Oscilloscopes	Application note	5989-3702EN
Debugging Serial Bus Systems with a Mixed Signal Oscilloscope	Application note	5988-5997EN
Why Oscilloscope Waveform Update Rates are Important	Application note	5989-2002EN

Product Web site

For the most up-to-date and complete application and product information, please visit our product Web site at:
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