CAN/LIN Measurements (Option AMS) for Agilent's InfiniiVision Series Oscilloscopes

Data Sheet

Debug the signal integrity of your CAN and LIN designs faster

Introduction

The Agilent Technologies InfiniiVision Series digital storage oscilloscopes (DSOs) and mixed signal oscilloscopes (MSOs) offer integrated serial triggering and hardware-accelerated protocol decoding solutions that give you the tools you need to efficiently and effectively debug your embedded automotive or industrial equipment designs. Option AMS provides extended CAN and LIN triggering and decoding in all four-channel DSOs and MSOs.

Features:

- Integrated serial triggering for testing your CAN and LIN serial buses
- Real-time protocol decode update rates using hardware-accelerated protocol decoding
- Precision differential active probes
- Mixed-signal measurements across analog sensors, serial buses, and digital ECU signals
- Compatible with Segmented Memory option to capture and decode up to 2000 consecutive frames

Agilent Technologies

Enhance your ability to capture random and infrequent error conditions

Other oscilloscope solutions with automotive 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 in today's automotive applications. Agilent's automotive serial bus options are based on hardware technology to provide real-time protocol decode update rates. Hardware-accelerated decoding enhances your ability to capture random and infrequent error conditions so that you can debug your automotive designs faster.

The Agilent CAN/LIN option on InfiniiVision Series scopes 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 you to specify message IDs, data and data length for filtering messages of interest. Triggering on active error frames are also 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 1. 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 captured and displayed an error frame (ERR) color-coded in red – indicating an error caused by a system glitch coupling into the differential CAN signal.

Bus quality and efficiency totalize function

In addition to flagging CAN error frames in real-time, Option AMS also provides real-time CAN bus quality and efficiency measurements. The totalize function provides a complete count of all CAN frames, all active error frames (with %), all overload frames (with %), and a measure of bus utilization (in percent), sometimes called "bus load," as shown in Figure 2. This unique totalize function, which is not available in other oscilloscopes currently on the market, is not related to the scope's acquisition or triggering. In addition, these CAN bus quality measurements are 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. This provides an accurate measure of your CAN system's bus efficiency and quality.

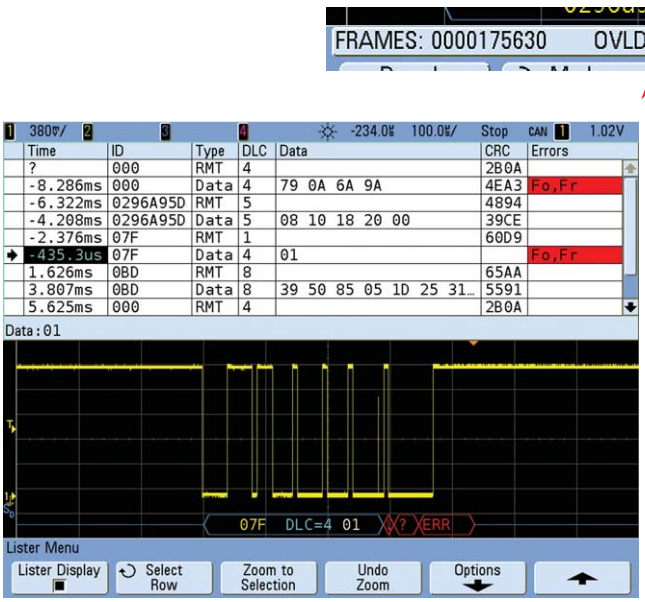


Figure 1. Random errors observed in CAN decode while triggering on data frame ID: $07F_{HEX}$

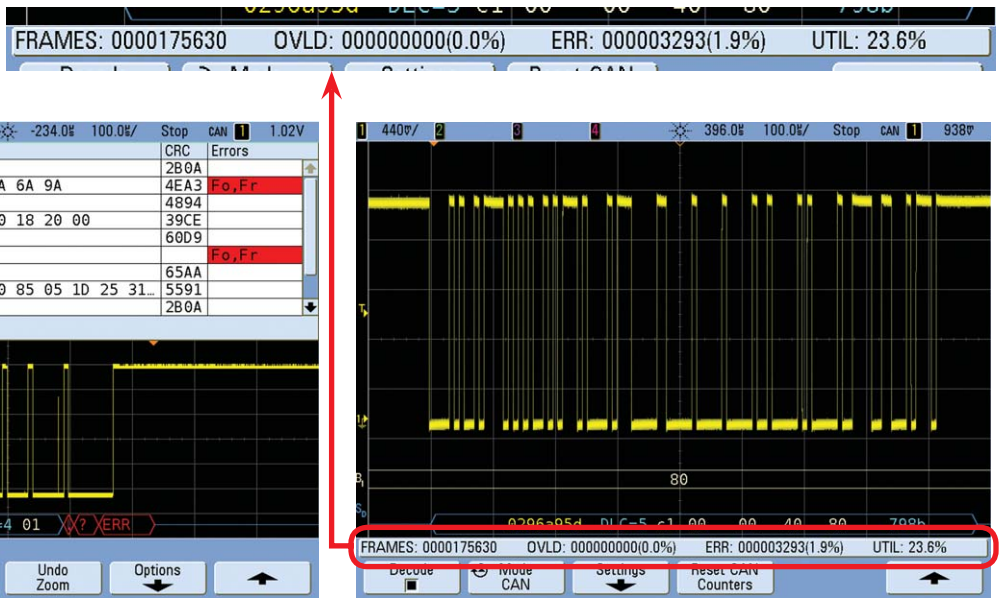


Figure 2. Real-time totalize functions provide CAN bus efficiency and quality measurement statistics.

Segmented Memory captures more frames

The Segmented Memory Option for Agilent's InfiniiVision series oscilloscopes can optimize your scope's acquisition memory allowing you to capture more CAN and/or LIN frames using less memory. Segmented memory acquisition optimizes the number of packetized serial communication frames that can be captured consecutively by selectively ignoring (not digitizing) unimportant idle time between frames. And with a minimum 250 picosecond time-tagging resolution, you will know the precise time between each frame.

Figure 3 shows a CAN bus measurement with the scope setup to trigger on CAN error frames. Using this triggering condition with the segmented memory acquisition mode turned on, the scope easily captures 1000 consecutive CAN error frames for a total acquisition time of 127.3 seconds. After acquiring the 1000 segments/CAN error frames, we can easily scroll through all frames individually to look for physical layer issues that may be inducing these errors.

Agilent' s InfiniiVision series oscilloscopes are the only scopes on the market today that can not only acquire segments of up to four analog channels of acquisition, but also capture time-correlated segments on digital channels of acquisition (using an MSO model), along with hardware-based serial bus protocol decoding.

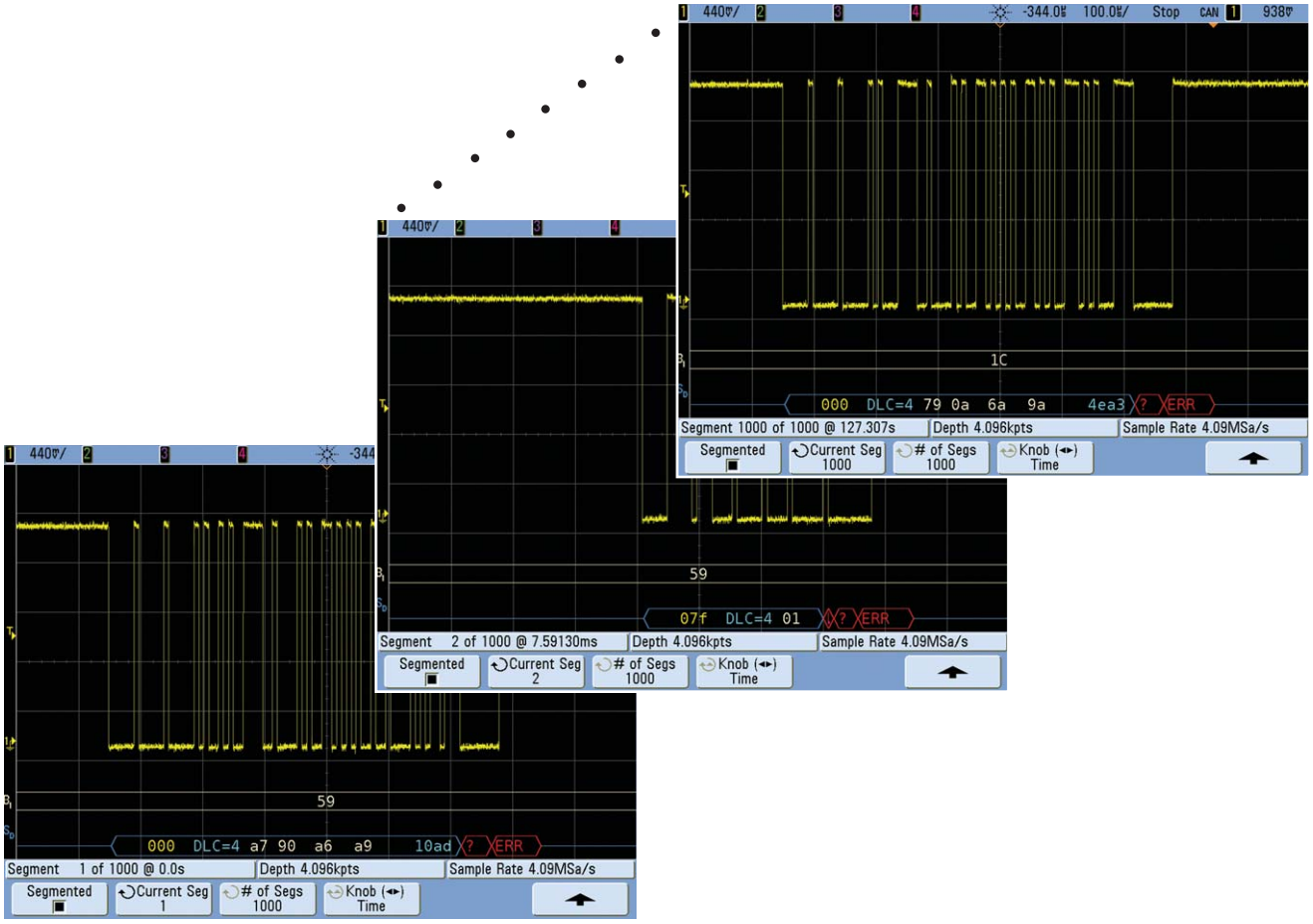


Figure 3. Capturing 1000 consecutive decoded CAN frames using segmented memory.

Probe automotive signals with precision – even in environmental chambers

Signal integrity measurements on CAN differential signals require differential active probing. Agilent offers a range of differential active probes for various bandwidths and dynamic range applications. For the most accurate measurements in automotive embedded systems, Agilent recommends the 1130 Series InfiniiMax active probes for either single-ended or differential applications. This family of active probes comes with a variety of interchangeable, passive probe heads for various probing use-models including browsing, solder-in, and socketed applications (see Figure 4).

Figure 4. Agilent 1130 Series differential active probes with interchangeable passive probe heads

Automotive embedded designs must often be tested under simulated extreme conditions in environmental chambers. These extreme conditions may include testing ECUs and differential serial buses, such as CAN, at temperatures exceeding 150 degrees Celsius. Unfortunately, the active circuitry in today's typical active probes cannot tolerate temperatures exceeding 55 degrees C. However, with the unique electrical and physical architecture of the 1130 Series InfiniiMax active probes, the Extreme Temperature Cable Extension Kit (N5450A) can be used to extend and displace the probe's active amplifier to be outside of an environmental chamber (see Figure 6). With this configuration, InfiniiMax' passive probe heads can be connected to test points within the chamber with temperatures ranging from –55 to +155 degrees C.

Figure 5. The Extreme Temperature Cable Extension Kit (N5450A) allows differential active probing within environmental chambers at extreme temperatures.

When more robust probe point connections are required, the Agilent N2791A 25 MHz differential active probe may be a good low-cost solution for your probing applications (see Figure 5).

Figure 6. Agilent N2791A 25 MHz differential active probe.

Agilent also recommends the SI-200 differential active probe from Sapplive Instruments. For addition including a list of worldwide distributors, so to www.sapplive.com.tw

Figure 7. Sapplive SI-200 differential active probe.

Easily make automotive mixed-signal measurements

Today's automotive designs include a combination of analog, digital, and serial bus signals. The automotive embedded designer often needs to time-correlate signal activity across analog sensors, serial communication, and digital control and I/O signals within ECUs. Agilent InfiniiVision Series MSOs are the perfect fit for verifying and debugging these types of designs. Agilent MSOs that support automotive serial bus applications provide four channels of analog acquisition and up to sixteen channels of logic signal acquisition, as shown in Figure 8.

Figure 8. Mixed-signal measurements in a mix-signal automotive system using an MSO

Battery operation

Evaluating CAN/LIN bus signal fidelity with an "un-tethered" oscilloscope requires a scope that performs CAN and LIN measurements under battery operation. Agilent InfiniiVision MSO6000 series oscilloscopes are the only battery-operated oscilloscopes on the market today that also support CAN and LIN, measurements. In addition to direct internal battery operation, the MSO6000 oscilloscopes can also be powered from an automobile's 12 V battery using an optional power adapter.

Figure 9. Making remote CAN and LIN measurements with Agilent's battery option for InfiniiVision Series scopes.

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 and ERR message in red) Overload frame ("OVRLD" in blue) Idle bus (high bus trace in white) Active bus (bi-level bus trace in dark-blue)
Totalize function	Total frames Total overload frames Total Error frames Bus utilization

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, 10.4 kbs, 19.2 kbs, 115.2 kbs or 625 kbs (user-selectable)
Triggering	Sync break[1] Frame ID ($0X00_{HEX}$ to $0X3F_{HEX}$) Frame ID AND Data
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 digits in red = error) Sync error ("SYNC" in red) $T_{Header\text{-}Max}$ ("THM" in red) $T_{Frame\text{-}max}$ ("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

Option AMS (CAN/LIN) is compatible only with 4-channel DSOs and 4+16 channel MSO models in the InfiniiVision Series oscilloscopes, including the 5000, 6000, and 7000 Series scopes.

If you already own a 4-channel InfiniiVision Series DSO or MSO and would like to upgrade your scope to support CAN and LIN measurements, order the N5424A after-purchase upgrade kit.

Factory-installed option number	User-installed option number	Description
Option AMS	N5424A	CAN/LIN triggering and decode (4 and 4+16 channel models only)
Option LSS	N5423A	I^2C/SPI serial decode option (4 and 4+16 channel models only)
Option 232	N5457A	RS-232/UART triggering and decode (4 and 4+16 channel models only)
Option SND	N5468A	I2S triggering and decode (4 and 4+16 channel models only)
Option SGM	N5454A	Segmented Memory
	N2772A	20-MHz differential active probe
	1130A	InfiniiMax 1.5-GHz differential active probe (probe heads must be ordered separately)
	N5450A	Extreme Temperature Cable Extension Kit for 1130A InfiniiMax probes

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

Related literature

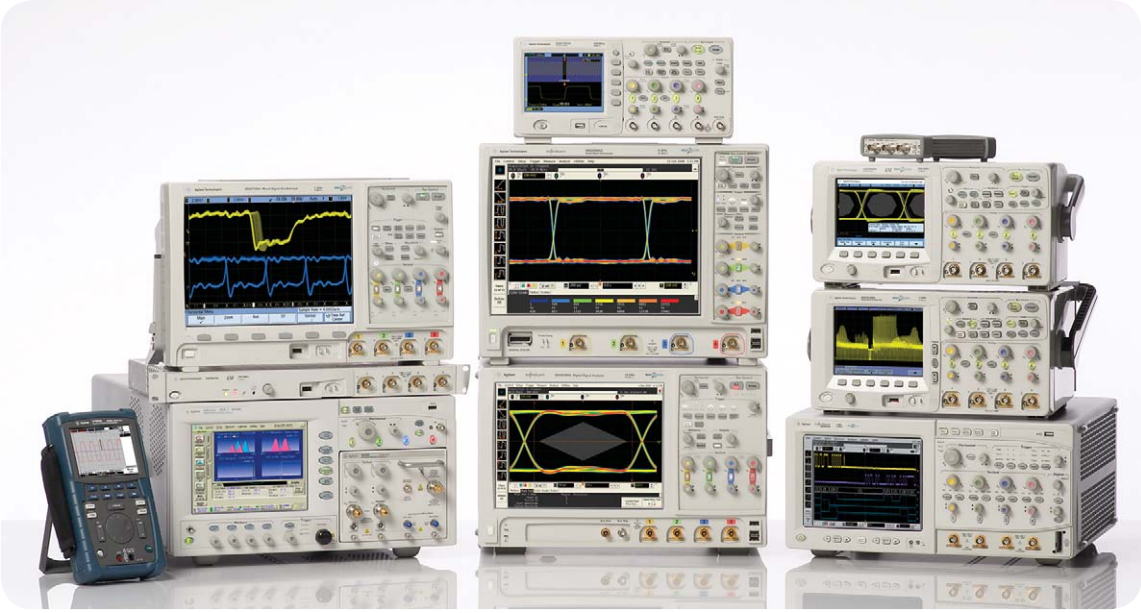
Publication title	Publication type	Publication number
Agilent Technologies Oscilloscope Family Brochure	Brochure	5989-7650EN
Agilent 7000 Series InfiniiVision Oscilloscopes	Data sheet	5989-7736EN
Agilent 6000 Series InfiniiVision Oscilloscopes	Data sheet	5989-2000EN
Agilent InfiniiVision Series Oscilloscope Probes and Accessories	Data sheet	5968-8153EN
I^2C and SPI triggering and hardware-based decode options for InfiniiVision Series Oscilloscopes (N5423A)	Data sheet	5989-5126EN
RS-232/UART triggering and hardware-based decode for InfiniiVision Series Oscilloscopes (N5457A)	Data sheet	5989-7832EN
Segmented Memory Acquisition for Agilent InfiniiVision Oscilloscopes (N5454A)	Data sheet	5989-7833EN
Agilent N5450A InfiniiMax Extreme Temperature Extension Cable Kit	Data sheet	5989-7542EN
Using an Agilent InfiniiVision MSO to Debug an Automotive CAN Bus	Application note	5989-5049EN
Evaluating Oscilloscopes for Best Signal Visibility	Application note	5989-7885EN
Debugging Embedded Mixed-Signal Designs Using Mixed Signal Oscilloscopes	Application note	5989-3702EN
Choosing an Oscilloscope with the Right Bandwidth for your Applications	Application note	5989-5733EN
Evaluating Oscilloscope Sample Rates vs. Sampling Fidelity	Application note	5989-5732EN
Evaluating Oscilloscope Vertical Noise Characteristics	Application note	5989-3020EN
The Extending the Range of Agilent InfiniiMax Probes	Application note	5989-7587EN

To download these documents, insert the publication number in the URL: http://cp.literature.agilent.com/litweb/pdf/xxxx-xxxxEN.pdf

Product Web site

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

www.agilent.com/find/scopes



Agilent Technologies Oscilloscopes

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www.agilent.com/find/CAN-LIN

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Revised: October 1, 2008

Product specifications and descriptions in this document subject to change without notice.

Printed in USA, September 2, 2009
5989-6220EN

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