

Debugging CAN Bus Systems with a Vector CANscope and an Infiniium Mixed-Signal Oscilloscope

Application Note 1498



Figure 1. Vector CANscope recording/triggering hardware module.

Debugging CAN-based systems can be challenging using a scope without CAN trigger capability. Infiniium oscilloscopes do not provide CAN serial bus triggering, which the Agilent 54600 Series provides as standard. However, Agilent Infiniium mixed-signal oscilloscopes (MSOs) used with a third party's CAN trigger and recording solution can be a powerful tool to effectively debug CAN-based systems in less time and with less frustration.

What is CANscope?

CANscope is a CAN triggering and data analysis tool offered by Vector Informatik, Germany. The product, designed for logging and evaluating the CAN signal bus, gives you insight into the physical-layer analysis of various CAN cable effects, bus drivers, terminations and failure modes. CANscope consists of a recording/triggering hardware module and Windows®-based evaluation software. The module is connected to the PC via a RS232 or USB port with variable baud rate up to 115.2 kbps. A 60-cm adapter cable lets you easily connect the CANscope hardware to a CAN bus system.

What is CANscope?

The evaluation software graphically displays the CAN bus signal waveforms on an oscilloscope-like window, and the symbolic information of the signals is listed in a trace window. Selecting an entry in the trace window causes the corresponding section of the display to be highlighted in the oscilloscope window. A time-stamped list of the bit fields (ID RTR, DLC, etc) of the particular message can be dropped down in the trace window. When you select one of these bit fields, the corresponding section of the display window is highlighted.

The powerful triggering capability of the CANscope module combined with multi-channel, deep capture and analysis capabilities of the Infiniium MSO can help you quickly turn on and verify CAN-based mixed analog and digital designs.

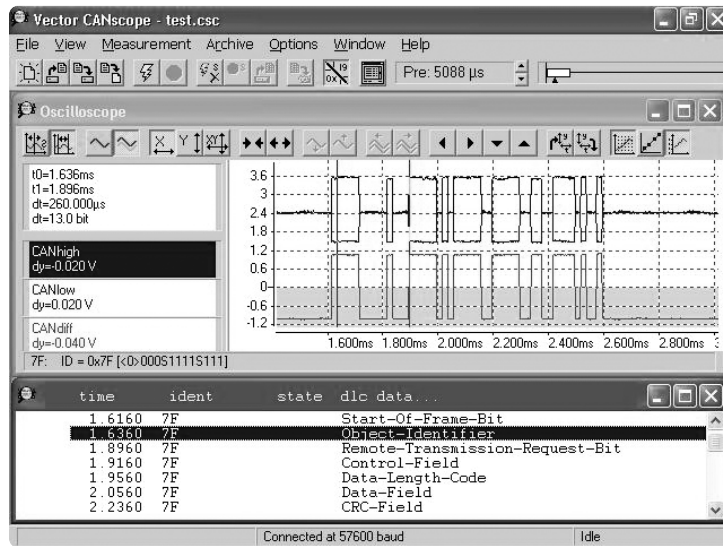


Figure 2. The CANscope software graphically displays the CAN bus signal waveforms in an oscilloscope-like window, and the symbolic information of the signals is shown in a trace window.

How to use CANscope triggering with an Agilent Infiniium MSO

Typically, you install the CANscope software on a PC. However, you can install the software directly on an Infiniium MSO so you can use the MSO's capabilities to solve your debugging problems more effectively. All Infiniium scopes are based on the Microsoft® Windows XP Pro open platform that allows you to run Windows applications inside the scope to add advanced functionality to the scope.

First, install the evaluation software supplied with the CANscope on the Infiniium MSO.

Connect the RS-232 output of the CAN scope hardware module to the serial port on the rear panel of the oscilloscope to transfer the data to the evaluation software. On the module side, there is a BNC trigger output port serving to control other instrument for time-synchronized measurements. At the start of recording, this output is set to low, and if triggering occurs, the output goes high and stays high until the start of the next recording. Connect the trigger output of CANscope to the trigger input of the Infiniium

MSO and set the trigger source of the scope as AUX. Now every time the CANscope is triggered, it simultaneously cross-triggers the MSO.

When the MSO is triggered, you can move from the CANscope software screen to the Infiniium scope display so you can begin to make the sophisticated measurements you need or proceed with your debugging process.

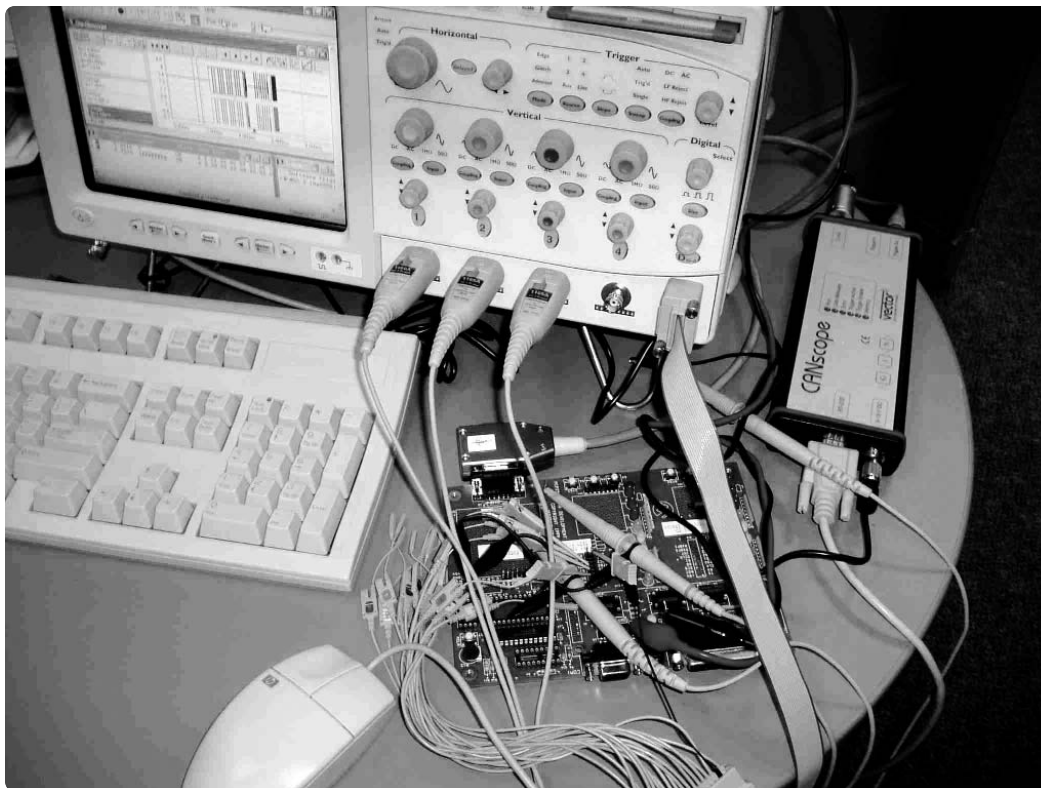


Figure 3. Infiniium MSO with DUT and CANscope triggering module.

Advantages of using the CANscope and Infiniium MSO combination

More channels – A CAN bus usually consists of two differential signal wires, CAN_H and CAN_L, but there are cases where you want to see the interaction between CAN signals and other digital or analog signals of interest. For example, you might want to examine the control lines between a CAN controller and a system processor while monitoring the CAN bus lines. CANscope allows you to capture two CAN signals. Using an Infiniium MSO combined with CANscope, you may be able to capture and view up to 4 analog and 16 digital signals of interest to figure out the detailed correlation between CAN bus and other related signals.

More memory and sampling for higher-quality acquisition – CANscope can acquire data with up to 32 MSa/s sampling rate and 32k samples of memory, but occasionally you need a higher sampling rate to adequately see the details in a high-speed CAN transmission with high resolution. For instance, to capture a whole frame of message running at 50 kb/sec, you will need a 10-ms time window to see one complete message frame, and at that time scale, the sampling rate is only 3 MSa/s when measured with the CANscope module. However, with up to 16 MB of MegaZoom deep memory and 4 GSa/s sampling on the Infiniium MSO, the MSO can easily and quickly capture and analyze long serial streams, always with high resolution. MegaZoom deep memory gives you the ability to look at relatively faster CAN signals and correlate those with slow analog signals such as the signals coming in from an A/D sensor input. See Figure 5.

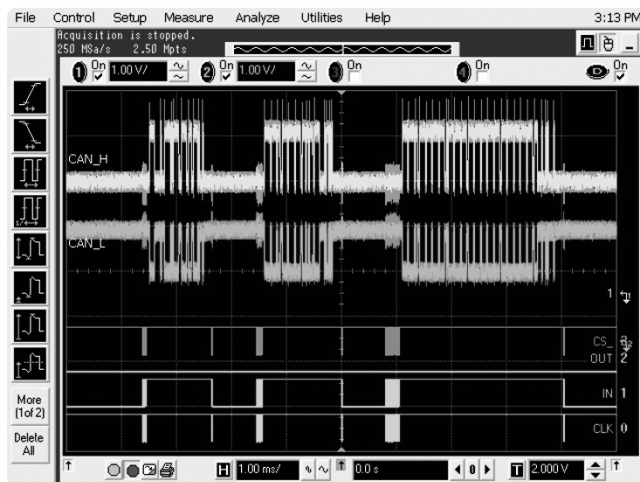


Figure 4. Here the scope triggers on a specific CAN message ID while monitoring the SPI bus signals with digital channels on the MSO.

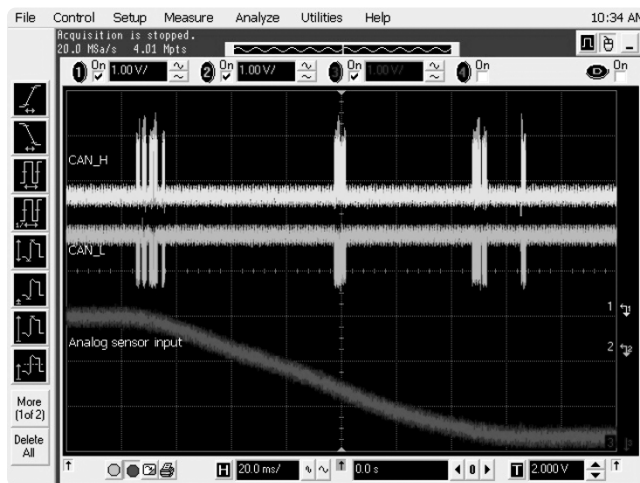


Figure 5. MSO's MegaZoom deep memory and high sample rate allow you to easily capture and analyze long serial streams time-correlated with slow analog signals.

Advantages of using the CANscope and Infiniium MSO combination (continued)

Latency measurement using trigger signals generated from the CANscope module – Using the trigger output signals generated from the CANscope as the trigger input source of the MSO, you can trigger on and measure the time between messages that meet your CAN trigger specification. This time range could indicate an error condition or it could be a system response specification. In Figure 6, the scope is set to trigger only when the rebroadcast of a particular frame (ID=0) occurs outside the expected cycle of 850 msec.

More insight – Take advantage of Infiniium analysis features for getting more insight. Infiniium scopes offer extensive measurement, math and analysis features that help you obtain better insight into what's going on in the CAN design. Analysis features you can use during the CAN debugging process include eye diagrams, FFTs, timing measurements and jitter analysis.

Conclusion

The Agilent Infiniium MSO, used in conjunction with Vector's CANscope module, is a powerful CAN design and debug tool that lets you view time-correlated CAN messages and other analog and digital signals. The powerful triggering capability of the CANscope module combined with multi-channel, deep capture and analysis capabilities of the Infiniium MSO can help you quickly turn on and verify CAN-based mixed analog and digital designs.

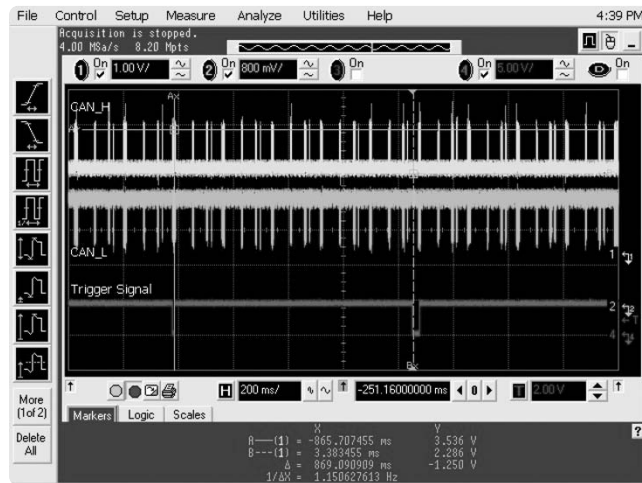


Figure 6. Using CANscope with an MSO, you can trigger on and measure the time between messages.

Glossary

CAN (Controller Area Network) a simple, two-wire differential signal bus. CAN buses operate in noisy environment with a high level of data integrity.

MSO mixed-signal oscilloscope digitizing oscilloscopes that have a larger number of channels than usual for looking at both analog and digital signals. MSOs typically have two or four analog channels and at least 8 bits of vertical resolution. There are usually 16 digital channels but they typically have only 1 bit of vertical resolution.

Appendix A

CANscope features and specs

Trigger on	Standard CAN2.0A and extended CAN2.0B message IDs
	Standard (11-bit) and extended (29-bit) IDs supported. Triggering occurs at the end-of-frame field of the CAN message. Message ID is bit-wise ORed with the acceptance mask to allow for trigger on groups of ID's or to determine if the message is relevant to that particular node.
	CAN Errorframe
	CAN level or wire detect of the low-speed transceiver
	Voltage level. A trigger is initiated if the voltage at a CAN line (CAN_H or CAN_L) exceeds the upper or lower limit or the difference between the two voltages exceeds an upper or lower limit value. This is more like a scope edge trigger.
	By the CANscope evaluation software (software trigger)
	Signal on external trigger input port (BNC input)
Supports the CAN in automation (CiA) recommended baud rates up to 1 Mbaud	
Supports connection to system under test via CiA standard DB9 connector and pinouts	
Full access to CANdb Databases (DBC files)	Trigger messages can be selected symbolically out of the database.
	Signals and messages are displayed symbolically with their physical values in the trace and the oscilloscope window.
Electrical specs of trigger/recording module	ISO 11898-24 V Compliant.
	The CAN_H, CAN_L lines can swing from ± 40 V.
	1 kSa – 32 kSa (2 k – 64 kB) buffer size (memory depth)
	160 kSa/s – 32 MSa/s sampling rate
	Min timing resolution: 32 nsec
	Vertical resolution: 8 bits, 20 mV for 0.5 V range
	Trigger Output High: 2.4 V min, Low: 0.6 V min
Measurement mode: Single shot, Continuous, Autotrigger	

Appendix B

Infiniium MSO features and specs

The Agilent 5483xD Series mixed-signal oscilloscopes uniquely combine the detailed signal analysis of a 2- or 4-channel high-performance scope with the 16-channel timing measurements of a logic analyzer, plus the benefits of fast, usable and affordable MegaZoom deep memory. The increased channels, deep memory and Windows XP open system of a MSO can help you debug today's complex designs containing CAN serial buses more efficiently than you could do with a traditional 2- or 4-channel DSO.



Figure 7. Agilent 5483xD series mixed signal oscilloscope

600 MHz or 1 GHz bandwidth

Integrated 2- or 4-channel scope and
16-channel logic analyzer

Up to 4 GSa/s sample rate

Up to 4 Mpts memory standard; up to
128 Mpts optional

Windows XP Pro open system

Advanced probing solutions

Related Literature

Publication Title	Publication Type	Publication Number
<i>Infiniium 54850 Series Oscilloscopes and 1130 Series Probes</i>	Data Sheet	5988-7976EN
<i>Infiniium 54830 Series Mixed-Signal Oscilloscopes</i>	Data Sheet	5988-3788EN
<i>Debugging CAN-Based Designs More Efficiently with an Agilent 54600 Series Mixed-Signal Oscilloscope and a N2758A CAN Trigger Module</i>	Application Note 1492	5989-0726EN
<i>Debugging Serial Bus Systems with a Mixed-Signal Oscilloscope</i>	Application Note 1395	5988-5997EN

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/scope-apps

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