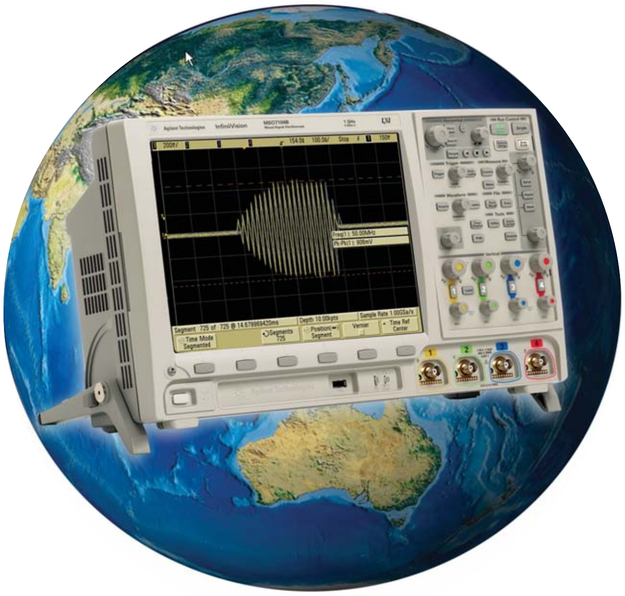

Agilent Technologies N5454A Segmented Memory Acquisition for Agilent InfiniiVision Series Oscilloscopes

Data Sheet

Capture more signal detail with less memory using segmented memory acquisition

Features:

- Optimized acquisition memory
- Capture up to 2000 successive waveform segments
- Fast re-arm time
- Down to 250 ps time-tag resolution
- Segments include all analog and digital channels of acquisition
- Segments include serial bus decoding

Agilent Technologies

Introduction

If the signals that you need to capture have relatively long idle times between low-duty-cycle pulses or bursts of signal activity, then the segmented memory option for Agilent's InfiniiVision Series oscilloscopes can optimize your scope's acquisition memory, allowing you to capture more selective signal details with less memory. With segmented memory, the scope's acquisition memory (up to 8 M points) is divided into multiple smaller memory segments. This enables your scope to capture up to 2000 successive single-shot waveforms with a very fast re-arm time — without missing any important signal information.

After a segmented memory acquisition is performed, you can easily view all captured waveforms overlaid in an infinite-persistence display and quickly scroll through each individual waveform segment. And with a minimum 250 picosecond time-tagging resolution, you will know the precise time between each captured waveform segment. Common applications for this type of oscilloscope acquisition include high-energy physics measurements, laser pulse measurements, radar burst measurements, and packetized serial bus measurements.

Even in applications that don't actually require segmented memory acquisition to optimize memory, using segmented memory acquisition on Agilent's InfiniiVision oscilloscopes can enhance post-analysis navigation through low-duty-cycle signals, burst signals, and serially packetized signals. And Agilent's InfiniiVision Series oscilloscopes are the only scopes in the industry that not only provide segmented memory acquisitions simultaneously on all analog channels (up to four analog channels) and logic channels (up to 16 digital channels) of acquisition, but they also are the only scopes that provide hardware-based serial decoding on packetized serial data for each captured waveform segment.

High-energy physics and laser pulse applications

Segmented memory acquisition in an oscilloscope is commonly used for capturing electrical pulses generated by high-energy physics (HEP) experiments, such as capturing and analyzing laser pulses. With segmented memory acquisition, the scope is able to capture every consecutive laser pulse (up to a maximum of 2000 pulses), even if the pulses are widely separated.

Figure 1 shows the capture of 300 successive laser pulses with a pulse separation time of approximately 12 µs and an approximate pulse width of 3.3 ns. All 300 captured pulses are displayed in the infinite-persistence gray color, while the current selected segment is shown in the channel's assigned color (yellow for channel 1). Note that the 300th captured pulse occurred exactly 3.62352380 ms after the first captured pulse, as indicated by the segment time-tag shown in the lower left-hand region of the scope's display. With the scope sampling at 4 GSa/s, capturing this amount of time would require more than 14 Megapoints of conventional acquisition memory. If these laser pulses were separated by 12 ms, the amount of conventional acquisition memory to capture nearly 4 seconds of continuous acquisition time would be more than 14 Gigapoints. Unfortunately, there are no oscilloscopes on the market today that have this much acquisition memory. But since segmented memory only captures a small and selective segment of time around each pulse while shutting down the scope's digitizers during signal idle time, Agilent's InfiniiVision scopes can easily capture this much information using just 8 Megapoints of memory.

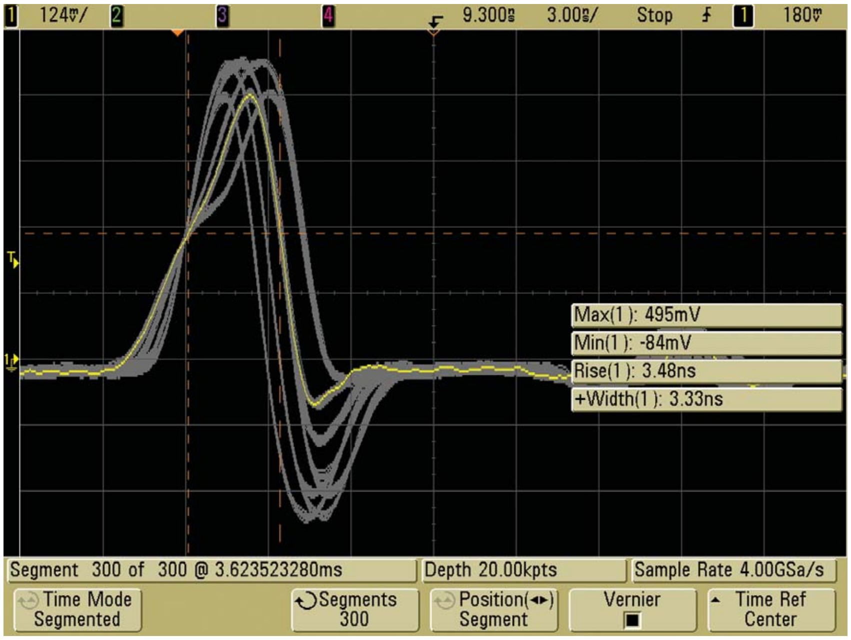

Figure 1: Segmented memory acquisition captures 300 consecutive laser pulses for analysis.

A similar high-energy physics application involves the measurement of energy and pulse shapes of signals generated from subatomic particles flying around an accelerator ring (particle physics). Assuming that sub-atomic particles have been slung around a 3-km accelerator ring at a speed approaching the speed of light (299,792,458 meters/sec), electrical pulses generated at a single detector at one location along the 3-km ring would occur approximately every 10 µs. With segmented memory, you can easily capture, compare and analyze successive pulses generated by the subatomic particles with precise time-tagging.

Radar and sonar burst applications

Engineers often require segmented memory acquisition mode in an oscilloscope when they measure radar and/or sonar bursts. Figure 2 shows an example where we captured 725 consecutive 50-MHz RF burst signals using an Agilent InfiniiVision scope's segmented memory acquisition mode. Engineers often need to compare sent and received signals and compare signal degradation from echo signals. These types of RF burst applications also require precise time-tagging in order to accurately compute distances. Distance and time between bursts can often be very long, for example, when you are analyzing satellite communications. If a satellite is located 100 miles in space away from an Earth transmitter/receiver station, a radar echo time (more than 200 miles round trip) would be approximately 1.07 ms. Using the 50-MHz RF burst shown in Figure 2, you could easily capture 725 consecutive bursts separated by 1.07 ms using segmented memory. Capturing this much time (775 ms) using conventional oscilloscope acquisition at 1 GSa/s would require nearly 1 Gigapoints of acquisition memory. But with the segmented memory option in Agilent's InfiniiVision Series oscilloscopes, capturing this amount of signal data can be accomplished with just 8 Mega points of acquisition memory.

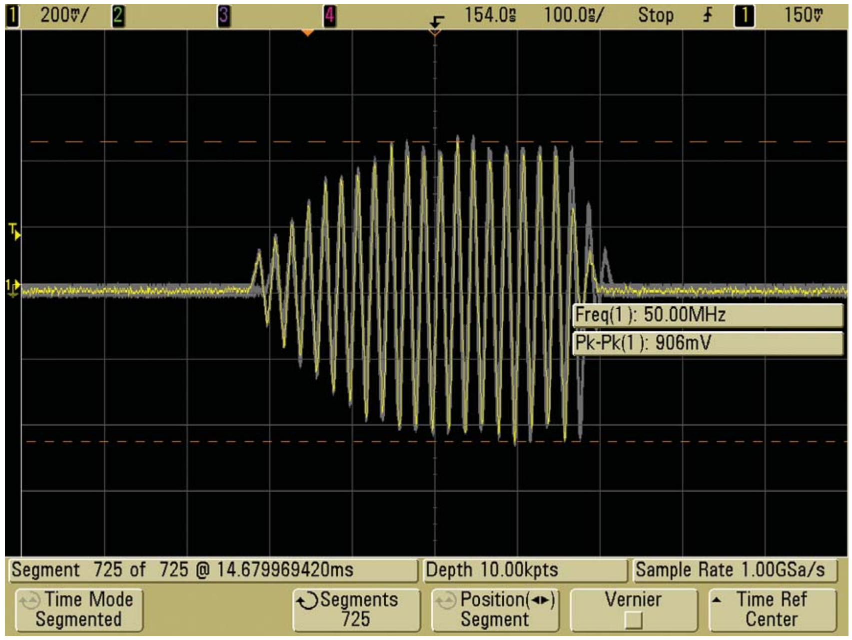

Figure 2: Capturing consecutive RF bursts with precise time-tagging using segmented memory

Mixed-signal and serial bus applications

Serial bus measurements are another application area where segmented memory acquisition is useful. You can optimize the number of packetized serial communication frames that can be captured consecutively by selectively ignoring (not digitizing) unimportant idle time between frames. As mentioned earlier, Agilent' s InfiniiVision Series oscilloscopes are the only scopes on the market today that not only can acquire segments of up to four analog channels of acquisition, but also can capture time-correlated segments on digital channels of acquisition (using an MSO model), along with hardware-based serial bus protocol decoding. The segmented memory option on Agilent's InfiniiVision Series oscilloscopes is compatible with all of the following serial bus triggering and decoding options:

- I²C/SPI (N5423A or Option LSS)
- RS-232/UART (N5457 or Option 232)
- CAN/LIN (N5424A or Option AMS)

To illustrate how segmented memory acquisition can enhance serial bus measurements, we will examine a mixed-signal automotive CAN bus measurement application. Figure 3 shows a CAN bus measurement with the scope set up to trigger on every start-of-frame (SOF) condition. Using this triggering condition with the segmented memory acquisition mode turned on, the scope easily captures

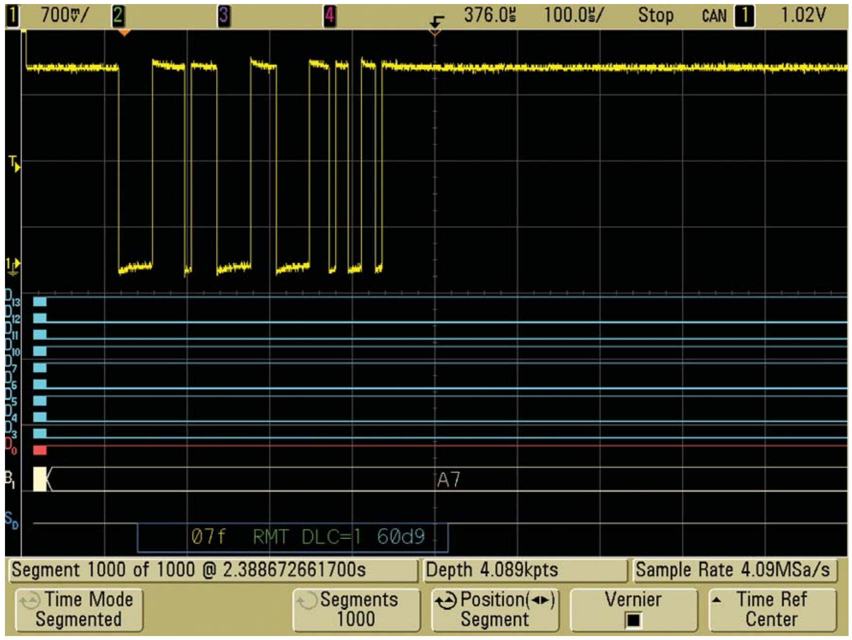

Figure 3: Capturing 1000 consecutive decoded CAN frames using segmented memory.

1000 consecutive CAN frames for a total acquisition time of 2.4 seconds. After acquiring the 1000 segments/ CAN frames, we can easily scroll through all frames individually to look for any anomalies or errors. In addition, we can easily make latency timing measurements between frames using the segmented memory's time-tagging. Also note that in this measurement example, eight time-correlated digital channels were acquired along with the analog CAN signal and decoding.

Mixed-signal and serial bus applications

Figures 4a and 4b show examples of capturing 1000 consecutive remote frames and data frames with the ID code of $07F_{HEX}$. This was accomplished by setting the trigger condition to trigger on either remote or data frames with this specific frame ID. Now we can easily measure the timing latency between each remote transfer request frame with a frame ID of $07F_{HEX}$ and its associated data frame response with the same frame ID. In this measurement example, the latency between segment #1 (remote frame) and segment #2 (data frame) was 4.821 ms. Also note that although not shown, the time-tag on the last captured segment (segment #1000) was approximately 9.5 seconds. Capturing this much time using conventional oscilloscope acquisition memory at this sample rate (~4 MSa/s) would require 38 Megapoints of memory.

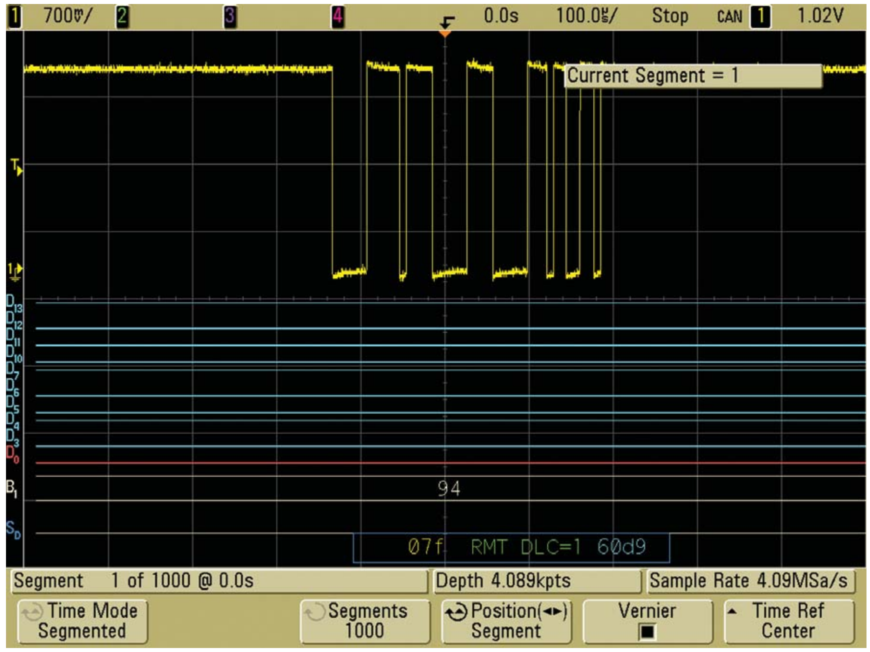

Figure 4a: Remote frame $07F_{HEX}$ captured as segment #1 has a default time-tag of 0.0 s.

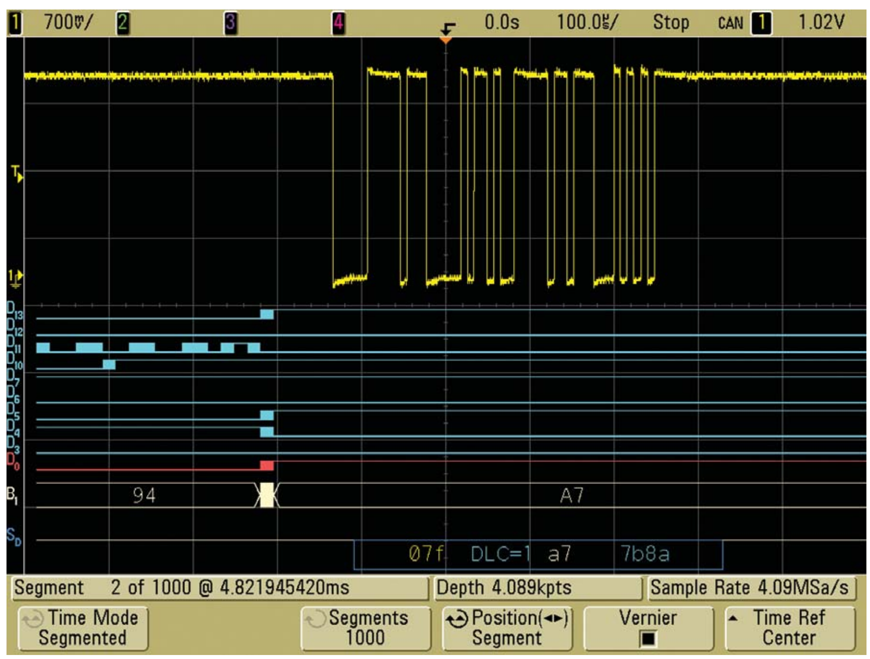

Figure 4b: Data frame $07F_{HEX}$ captured as segment #2 indicates a timing latency of 4.822 ms.

Mixed-signal and serial bus applications (continued)

While scrolling through the various segments/frames, we could see that error frames were occurring randomly. So the next step in this CAN measurement application was to capture and store only error frames. To do this, we set up the scope's triggering to trigger specifically on any occurrence of any error frame, regardless of its ID code. Figure 5 shows how the segmented memory acquisition mode captured 500 consecutive error frames with a total capture time (time-tag of the segment #500) of more than 60 seconds. Capturing this many frames at this sample rate (~9 MSa/s) using conventional oscilloscope memory would require more than 0.5 Gigabyte of acquisition memory. But with the segmented memory option, our InfiniiVision oscilloscope was able to capture more than 60 seconds of selective signal detail using its 8 Megapoints of memory

Once we have captured consecutive CAN error frames, we can easily dial through all of the individual frames to discover why these errors might be occurring. In this measurement example, we can see that segment #471 was an error frame with a data frame ID code of $07F_{HEX}$. After close inspection of the analog waveform associated with this decoded frame, we can now see why the error frame occurred. Note the narrow glitch near the end of this frame.

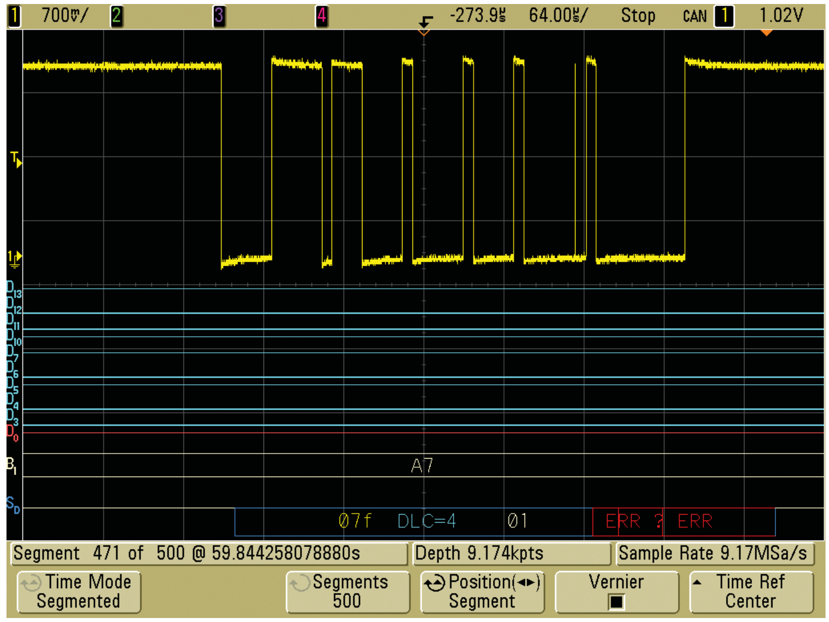

Figure 5: Segmented memory captures 500 consecutive CAN frames over a 60-second time span.

Performance characteristics

Compatible scope models	All DSO/MSO 7000 Series oscilloscopes All DSO/MSO 6000A Series oscilloscopes All DSO/MSO 6000L Series oscilloscopes All DSO5000 Series oscilloscopes
Segment source	Analog channels 1 and 2 (on two-channel DSO models) + Analog channels 3, and 4 (on four-channels DSO models) + Digital channels D0 – D15 (on MSO models) + Serial decode (on four-channel models with serial decode options)
Number of segments	1 to 2000 (6000 and 7000 Series) 1 to 250 (5000 Series)
Minimum segment size	500 points (+ Sin(x)/x reconstructed points on faster timebase settings)
Re-arm time	8 μs (minimum time between trigger events)
Maximum sample rate	4 GSa/s (on 1-GHz and 500-MHz bandwidth models) 2 GSa/s (on 300-MHz and below bandwidth models)
Time-tag resolution	Down to 250 ps (on 1-GHz and 500-MHz bandwidth models) Down to 500 ps (on 300-MHz and below bandwidth models)

Ordering Information

The N5454A segmented memory option is compatible with all Agilent InfiniiVision Series oscilloscopes (5000, 6000, and 7000 Series scopes). This option is available as a factory-installed option if ordered as Option-SGM along with a specific oscilloscope model, or existing InfiniiVision Series oscilloscope users can order this option as an after-purchase product upgrade (N5454A).

Model number – user installed	Option number – factory installed	Description
N5454A	SGM	Segmented memory
N5423A	LSS	I2C/SPI serial decode option (4 and 4+16 channel models only)
N5424A	AMS	CAN/LIN automotive triggering and decode (4 and 4+16 channel models only)
N5457	232	RS-232/UART triggering and decode (4 and 4+16 channel models only)

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 Agilent literature

Publication title	Publication type	Publication number
Agilent 7000 Series InfiniiVision Oscilloscopes	Data sheet	5990-4769EN
Agilent 6000 Series InfiniiVision Oscilloscopes	Data sheet	5989-2000EN
Agilent 5000 Series InfiniiVision Oscilloscopes	Data sheet	5989-6110EN
Agilent InfiniiVision Series Oscilloscope Probes and Accessories	Data sheet	5968-8153EN
I2C and SPI triggering and hardware-base decode for Agilent InfiniiVision Series Oscilloscopes (N5423A)	Data sheet	5989-5126EN
CAN/LIN Measurements (Option AMS) for Agilent's InfiniiVision Series Oscilloscopes	Data sheet	5989-6220EN
Evaluating Oscilloscopes for Best Waveform Updates Rates	Application note	5989-7885EN
Evaluating Oscilloscopes to Debug Mixed-Signal Designs	Application note	5989-3702EN
Using an Agilent InfiniiVision MSO to Debug an Automotive CAN Bus	Application note	5989-5049EN
Evaluating Oscilloscope Bandwidths 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
Evaluating Oscilloscope Segmented Memory for Serial Bus Applications	Application note	5990-5817EN

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/7000

Agilent InfiniiVision Portfolio

Agilent'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.

7000 Series	6000A Series	6000L Series	5000 Series
			
Largest display, shallow depth	**Optional battery, 100 MHz MSO**	**Ideal for ATE rackmount applications**	**Smallest form factor, lowest price**

Bandwidth	**7000 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"

Agilent'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 Mega*Zoom* III

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