Using a Scope's Segmented Memory to Capture Signals More Efficiently

Application Note 1573

Introduction

In many applications, such as radar, pulsed lasers, and applications that employ packets of serial data, short bursts of signal activity are interspersed with relatively long periods of signal inactivity. Some oscilloscopes have a feature called "segmented memory" (sometimes known as sequential single shot memory), which can help you capture more of the active signal information. Oscilloscopes with segmented memory, such as the Agilent Infiniium scopes (8000 Series and DSO80000 Series), store information only during the active bursts or pulses; they store no information during the inactive periods. Because valuable memory "real estate" is not used during the inactive periods, you can capture more of the critical signal activity. This feature also means file sizes are smaller, which makes it easier to store waveform files.

The Agilent DSO/DSA90000 Series features the industry's fastest intersegment time of 2.5 µs for ≤6 GHz models, along with the largest number of segments: 131,072 segments for ≤6 GHz models when ordered with 1 G acquisition memory option 01G.

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Segmented Memory to Capture Signals More Efficiently

Radar example

A radar system produces bursts of RF signals. The frequency during each burst is about 4-GHz with a duration of 9-µs. The repetition rate of the bursts is 1-KHz (1-ms cycle time). We decide to sample at 20-GSa/s, which is 5 times the sine wave frequency in each burst, thus easily satisfying the Nyquist criterion. Using the optional 2-M sample memory in the Agilent DSO80000 Series scopes and sampling at 20-GSa/s, we can capture only one burst before running out of acquisition memory using this scope's conventional real-time sampling mode. The total time captured in one acquisition (trigger) is

1/(20 GSa/s) X 2 Msamples = 100 µs

Using the DSO80000's segmented memory sampling mode, we can optimize the available acquisition memory to capture many more bursts without missing any bursts in a sequence. The available memory for each segment depends on the number of segments set. In this case we want to capture 200-K samples per segment; this is just enough to capture an entire burst within each segment:

1/(20 GSa/s) X 200 K = 10 µs

With this memory depth, we can capture up to 256 segments. In this example the scope is set up to capture 100 segments, as shown in Figure 1. To center the captured burst within the segment, we set the horizontal reference to the left edge and the delay to slightly negative.

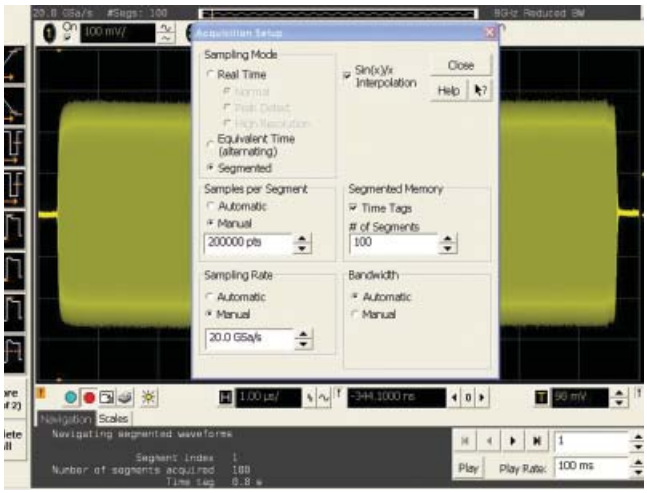

Figure 1. Segmented memory setup controls

When we press the **RUN** key, all the segments are acquired and then the first segment is shown, scaled to the initial time base settings, as shown in Figure-2. By clicking on the right and left arrows in the navigation pane, we can step through all of the captured segments. Or by typing in a segment number we can skip directly to any desired segment, as shown in Figure 3. Here we also see the time tag value, which is the time between this segment's trigger and the first segment trigger. In this case, the 7th segment is captured about 6-milliseconds after the first.

Figure 2. Display of captured signal

We can expand any segment as needed with the time/div knob to view waveform detail. Figure-4 shows an example where one captured segment has been expanded, along with an automatic frequency

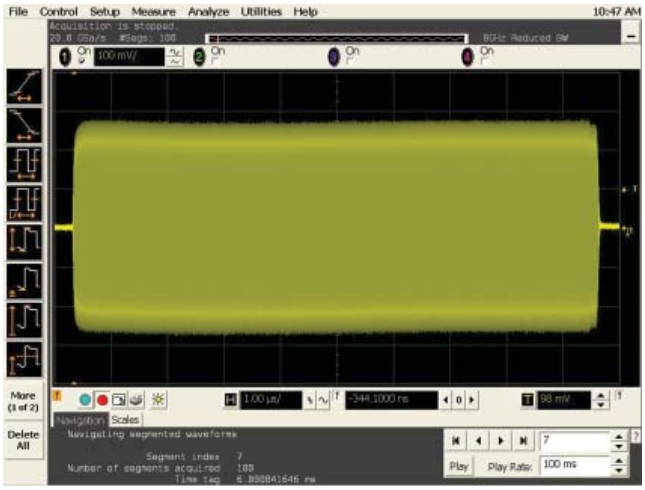

Figure 3. You can use navigation arrows to view other segments

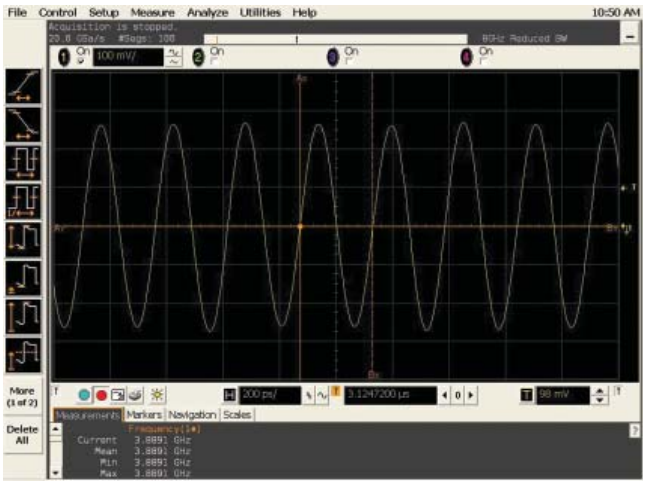

Figure 4. Expanding a segment and measuring frequency

You can also view all the captured segments as a "slide show" or "movie" by clicking the **Play** button and selecting the desired play rate.

To quickly scan through selected segments or navigate to a desired segment out of a large ensemble of segments, you can position the mouse cursor on a wheel mouse over the segment number. Spinning the mouse wheel will then allow you to scan quickly through segments.

Play mode also enables the following features that can be very helpful for analyzing data across multiple segments:

- Waveform histograms allow you to analyze data across multiple segments.
- Measurement statistics lets you gather data across multiple segments.
- Display settings, including infinite persistence and color-graded display, allow you to more easily visualize data across multiple segments.
- The averaging function (**Analyze > Math/FFT > Average**) allows you to view and measure the average value of a waveform across multiple segments.

Pulse-width jitter example

Figure 5 shows a segmented memory acquisition using Agilent's MSO8104A mixed signal oscilloscope. In this screen-shot of 32,000 digital pulses of varying widths, not only can we view all segments overlaid in a color-graded display mode, but we have also performed a statistical pulse-width measurement and a histogram of jitter on these pulses. In addition, we can see from the time tag that the last acquired segment occurred 644.8410088-milliseconds after the first acquired segment.

Figure 5. Segmented acquisition of 32,000 waveforms using the Agilent MSO8104A with measurement statistics and a jitter histogram

Operating Ranges and Limitations

Maximum number of segments and samples per segment

The maximum number of segments available for various sample rates and memory options on the two Infiniium scope families is shown in Tables 1 and 2.

The maximum number of samples per segment is typically the max memory per channel divided by the number of segments rounded up to the next power of 2. For example, when the 8000 Series with option 640 is set to capture 1000 segments, the max samples per segment is about 65.6M/1024 = 64,062.

For the DSO80000 Series scopes, the maximum segment size is 1-M for sample rates ≥5 GSa/sec.

For both scope series the memory is doubled when in 2 channel mode for sample rates ≥4-GSa/sec.

Due to overhead in the acquisition, the maximum samples per segment is reduced when you use a large number of segments (>2048 in DSO80000 Series and >4096 in the 8000 Series).

Dead time between segments and trigger rates

The dead time between segments on the 7000, 8000 and 80000 Series scopes depends on whether time tags are turned on and the number of channels in use. Turning on time tags increases dead time by ~3 µs. When the sample rate is ≥5 GSa/s on the DSO80000 Series, dead time is also a function of segment size; it increases about 2 ns/sample in 2-channel mode or 4 ns/sample in 4-channel mode. The maximum trigger rate is related to dead time by the equation:

Max trigger rate =
1 / (acquisition time + dead time)

The trigger rate you can achieve with various configurations of Infiniium scope models is shown in Tables 1 and 2. The values shown are with time tags on.

In the DSO/DSA90000 Series, the dead time between segments is always <2.7 us for models with >6 Ghz bandwidth and <2.5 us for models with ≤6 GHz bandwidth

Segmented Memory to Capture Signals More Efficiently (continued)

Operating parameters for Infiniium oscilloscopes

For DSO/DSA90000 Series oscilloscopes:

Minimum intersegment time (the time between the end of the previous acquisition and the beginning of the next acquisition):

91304A / 91204A / 90804A: 2.7 µs

90604A / 90404A / 90254A: 2.5 µs

Maximum number of segments

Model numbers	Acquisition memory (points)	Maximum number of segments
DSO/DSA90254A DSO/DSO90404A DSO/DSO90604A	10M (standard)	2048
	20M (option 20M)	4096
	50M (option 50M)	8192
	100M (option 100)	16384
	200M (option 200)	32768
	500M (option 500)	65536
	1G (option 01G)	131072
DSO/DSO90804A DSO/DSA91204A DSO/DSA91304A	10M (standard)	1024
	20M (option 20M)	2048
	50M (option 50M)	4096
	100M (option 100)	8192
	200M (option 200)	16384
	500M (option 500)	32768
	1G (option 01G)	65536

For DSO/DSA 80000A/B Series oscilloscopes:

Max number of segments	Standard memory		Optional memory	
Sample rate	4-channel mode	2-channel mode	4-channel mode	2-channel mode
40 GSa/s	NA	128	NA	4096
20 GSa/s	64	128	4096	8192
5-10 GSa/s	64	128	8192	8192
<= 4 GSa/s	128	256	16384	16384

Max trigger rate (typical)	1 channel on		2 channel on (2 ch mode)	
Sample rate	1 k pts per segment	10 k pts per segment	1 k pts per segment	10 k pts per segment
40 GSa/s	33 kHz	22 kHz	31 kHz	21 kHz
20 GSa/s	41 kHz	24 kHz	37 kHz	22 kHz
5-10 GSa/s	47 kHz	25 kHz	42 kHz	23 kHz
4 GSa/s	50 kHz	45 kHz	42 kHz	38 kHz
2 GSa/s	50 kHz	43 kHz	42 kHz	36 kHz

Table 1. Agilent DSO80000A/B Series oscilloscopes

Segmented Memory to Capture Signals More Efficiently (continued)

For DSO/MSO 8000 Series oscilloscopes:

Maximum number of segments	
Standard memory	256
Optional 4-Mpts/ch memory (#040)	2,048
Optional 8-Mpts/ch memory (#080)	4,096
Optional 16-Mpts/ch memory (#160)	8,192
Optional 32-Mpts/ch memory (#320)	16,384
Optional 64-Mpts/ch memory (#640)	32,768

Max trigger rate (typical)	1 channel on		2 channel on (2 ch mode)	
Sample rate	1 k pts per segment	10 k pts per segment	1 k pts per segment	10 k pts per segment
4 GSa/s	50 kHz	45 kHz	42 kHz	37 kHz
2 GSa/s	50 kHz	42 kHz	43 kHz	36 kHz

Max trigger rate (typical)	3 channel on		4 channel on	
Sample rate	1 k pts per segment	10 k pts per segment	1 k pts per segment	10 k pts per segment
2 GSa/s	35 kHz	31 kHz	31 kHz	27 kHz

Table 2. Agilent 8000 Series oscilloscopes

Conclusion

You can use your scope's memory to capture much more of the relevant signal activity by using segmented memory. You can also gain additional insight into signal behavior by the use of measurement statistics and histograms across multiple segments.

Related Literature

Publication Title	Publication Type	Publication Number
IInfiniium 80000 Series Oscilloscopes *InfiniiMax II Series Probes*	Data sheet	5989-1487EN
Infiniium 8000 Series Oscilloscopes	Data Sheet	5989-4271EN
Infiniium 90000 Series Oscilloscopes	Data sheet	5989-7927EN

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