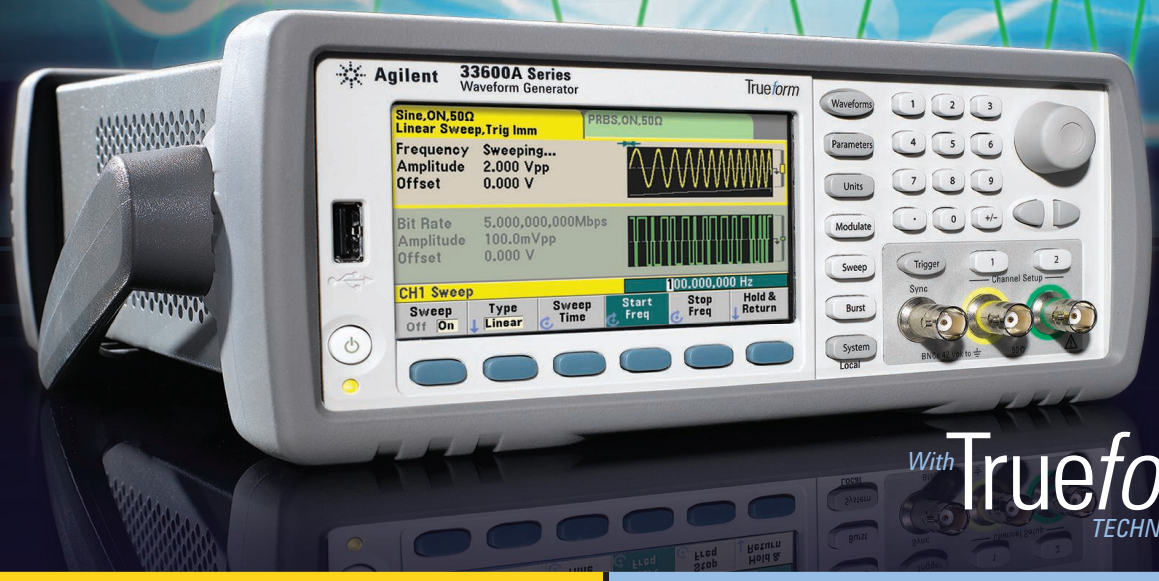
Application Brief

Simulating Signals with the Highest Integrity



With Trueform TECHNOLOGY

Test Challenge Examples:

- Reproducing an arb with designed glitches
- Running arbs at a fast frequency with the same signal from cycle to cycle
- Simulating a complex signal
- Needing the best signal quality possible

How Trueform Can Help:

- Trueform waveform generators are the best in the industry
- Jitter at < 1 ps
- Plays every point as designed without having to force fit a number of samples
- Output voltage with load settings
- None of the weaknesses of DDS (e.g., distorted signals and stretched points)
- 14-bit resolution

A signal source is often needed in test and measurement applications. Whether you are in R&D or manufacturing, a good signal generator is essential for providing signals that are controlled and predictable. Many test and measurement companies offer signal generators based on direct digital synthesis (DDS) that use a fixed clock to simulate your signal. This fixed clock technology adds or reduces points in your signal to meet the fixed clock rate and as a result, may generate a signal that is different than what you designed. In contrast, Trueform waveform generators use a technology that plays every point in your signal exactly as you designed it.

SIMULATING SIGNALS WITH THE HIGHEST INTEGRITY

See our test challenges below to learn how Trueform waveform generators can help you generate accurate signals for all your test needs:

Reproducing an arb with designed glitches

You need to test the robustness of your design. You create a test signal that will really give your design a workout with noise, overshoot, fast voltage spikes, dropouts – every glitch your design might encounter You tried to use a DDS-based waveform generator to output the signal, but noticed that the glitches weren't actually being reproduced as you designed them. That's because DDS-based generators either add or skip points from a signal in order to meet their rigid arb generation rules. Trueform waveform generators don't have the same restrictions and therefore, can reliably reproduce the signal you designed, even the glitches.

Simulating a complex signal

The custom signal you designed is very complex with many points and very fast transitions that are absolutely critical. Naturally, you would expect that when you use your arbitrary waveform generator the output signal would be exactly as you had designed. Unfortunately, your DDS-based waveform generator isn't able to recreate the fast characteristics that you put into your design. This is not just a bandwidth issue, rather, it is fundamental to the design of the DDS-based generator. In fact, it doesn't even look like the same signal from cycle to cycle. Trueform waveform generators can simulate even the most complex signals. The 33600A Series has 1 GSa/s sample rates and can reproduce your signals **exactly with revolutionary patented technology.**

Running arbs at a fast frequency with the same signal from cycle to cycle

With traditional DDS-based arbitrary waveform generators not every individual point is ensured to play as designed. DDS technology provides a good approximation of designed arbitrary waveform signals, but can skip and/or repeat points of the waveform in an unpredictable way. This can lead to additional jitter or severe distortion in the case of faster frequencies. Even worse, the distortion can be different from cycle to cycle, leading to a non-repetitive waveform and, that distortion will be different at different frequencies. Trueform waveform generators' patented technology ensures that every point of your arbitrary signal is generated exactly as you designed. The arbitrary waveform will be more accurate, have less than 1 ps of jitter, and present less distortion than DDS.

Needing the best signal quality possible

If you are looking for a waveform generator, you will want one that generates the highest signal quality to handle your present and future needs. Trueform waveform generators' sine waves offer 5x better harmonic distortion than other generators. Jitter performance on the 33600A Series is an incredible 200x better than DDS-based generators. Moreover, if you are creating custom arbitrary waveforms, Trueform waveform generators are the only instruments in this class capable of playing each and every point of your waveform as you designed it, at any frequency you choose. No compromises. Trueform waveform generators offer three different output filters (Normal, Step, None) that can be used to optimize your output. Their performance rivals that of much more expensive Point-Per-Clock (PPC) based generators. With up to 120-MHz bandwidth and up to 1 GSa/s, the Trueform waveform generators offer versatility and performance at a DDS-class competitive price.

Trueform versus DDS

Waveform generators output the desired waveform by stepping through the waveform data points. Because DDS generators have a fixed sample clock, if they output one unique point for each sample clock, you would only be able to output one frequency. When a slower frequency is needed, the generator needs to use many clock cycles to output a single point and will repeat points. When a fast frequency is needed and the generator can't output all of the points in waveform memory, it will skip over some points. The faster the frequency, the more points are skipped and looks less like the original signal. Furthermore, DDS generators use internal algorithms to determine which points are skipped. These algorithms put a priority on phase of the signal, which results in signals that don't necessarily skip the same samples in every cycle.

Trueform waveform generators use exclusive technology that allows waveforms to be expressed with the same shape, regardless if the signal is 1 Sample/s or the maximum rate of 1 GSamples/s. Designers working with complex waveforms can use Trueform generators to generate signals with complex modulation and abnormalities (within the constraints of physics). Digital waveforms with transients and pulses can be reproduced with the same characteristics every time. By comparison, DDS-based arbitrary waveforms will sometimes distort your signal from cycle to cycle.

Figure 1 shows an example of the same signals at the same frequency but on two different generators. Channel 1 (yellow) is measuring a DDS-based generator; channel 2 (green) is measuring a Trueform waveform generator. Notice that the DDS channel is missing characteristics and the signal is different from cycle to cycle. The Trueform generator waveform clearly shows there are three small bumps in the signal. The small bump in the DDS-based signal is distorted and is sometimes missed altogether.

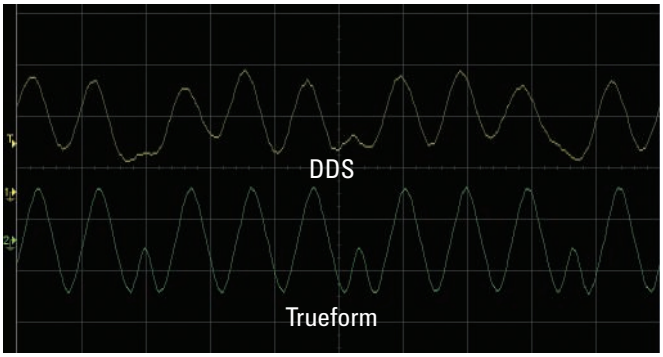


Figure 1. *Two signals at the same frequency measured using different waveform generators.*

One other benefit of the Trueform generators' architecture is the jitter. Cycle to cycle jitter is specified for the 33600A Series at less than 1 ps, for all waveforms including arbitrary, sine, and square waves. That's about 200 times less jitter than DDS-based generators. **Figure 2** shows a screen shot from a signal source analyzer. A signal source analyzer is one of the few instruments that can measure jitter at less than 1 ps (although it is measuring RMS jitter). The analyzer is measuring a 40-MHz sine wave signal with less than 800 fsec of jitter.

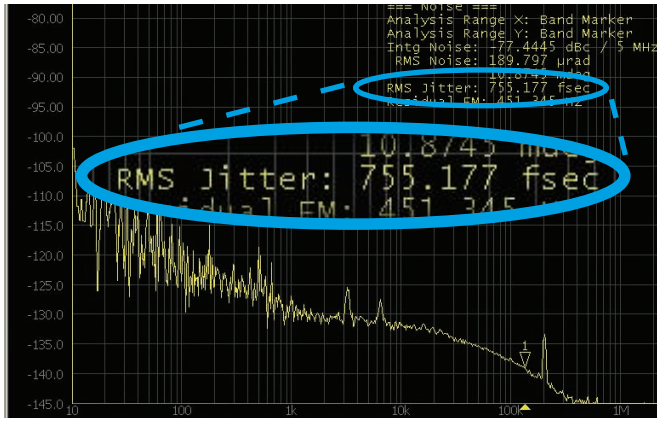


Figure 2. *Signal source analyzer measurement screen.*

As another visual example, we created a sample arbitrary waveform to illustrate the points that are skipped by DDS generators. **Figure 3** shows a basic square wave with seven aberrations, each with less amplitude than the previous one. At 1 kHz, both the DDS signal (yellow) and the Trueform waveform generator signal (green) reproduce all seven aberrations quite well.

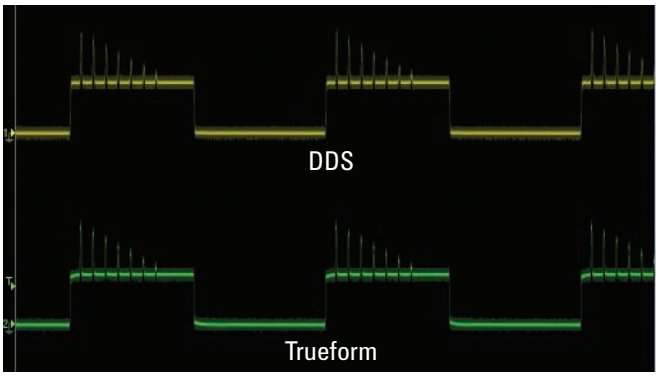


Figure 3. *Same arb at 1 kHz.*

Measurement Tip:

Even if you are looking for a simple sine wave generator, the 33600A Series waveform generators, with their minimal distortion (<0.03% THD), can help clean up your signals.

However, if we bump the frequency of the arb to 2 MHz, we can see that the yellow DDS signal is now missing the first three aberrations (**Figure 4**). The green Trueform signal is still generating all seven points. At even higher frequencies, the aberrations can be played only intermittently, have varying amplitudes, or even all disappear from the DDS-based generator.

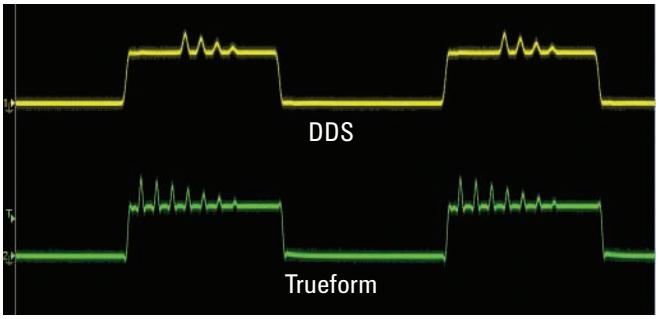


Figure 4. *Missing points at 2 MHz.*

Measurement Tip:

Arbitrary waveforms can be affected by the shape of the output filter. For digital waveforms on the 33600A Series, use the "No" filter path for sharper edges. This limits your sample rate to 250 MSa/s so that the analog output hardware can keep up.

Measurement Tip:

Generating arbitrary files is as easy as creating a .csv file in your own design tool. You can then import the .csv file into a Trueform waveform generator with your choice of I/O. Don't forget about capturing your hardware's signal with a scope and then reproducing it on a Trueform waveform generator.

Summary

For decades DDS technology has been used by waveform generators. It offered good signal quality at a low cost, especially when compared to Point-Per-Clock (PPC) generators which can be more than 10x the cost of a DDS generator. However, with Trueform waveform generators, Agilent has improved on the jitter, signal integrity and ability to output every point in your designed arbitrary waveform. All that performance is offered at the same price range as DDS based generators.

See the True*form* waveform generator test challenge web site for additional topics such as:

- Generating a waveform with many points
- Effortlessly couple or synchronize two signals on a waveform generator
- Using a waveform generator to generate a PRBS signal
- Creating a differential signal with a waveform generator
- Be more efficient designing and using your arbitrary waveforms

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

Published in USA, April 8, 2014
5991-3989EN

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