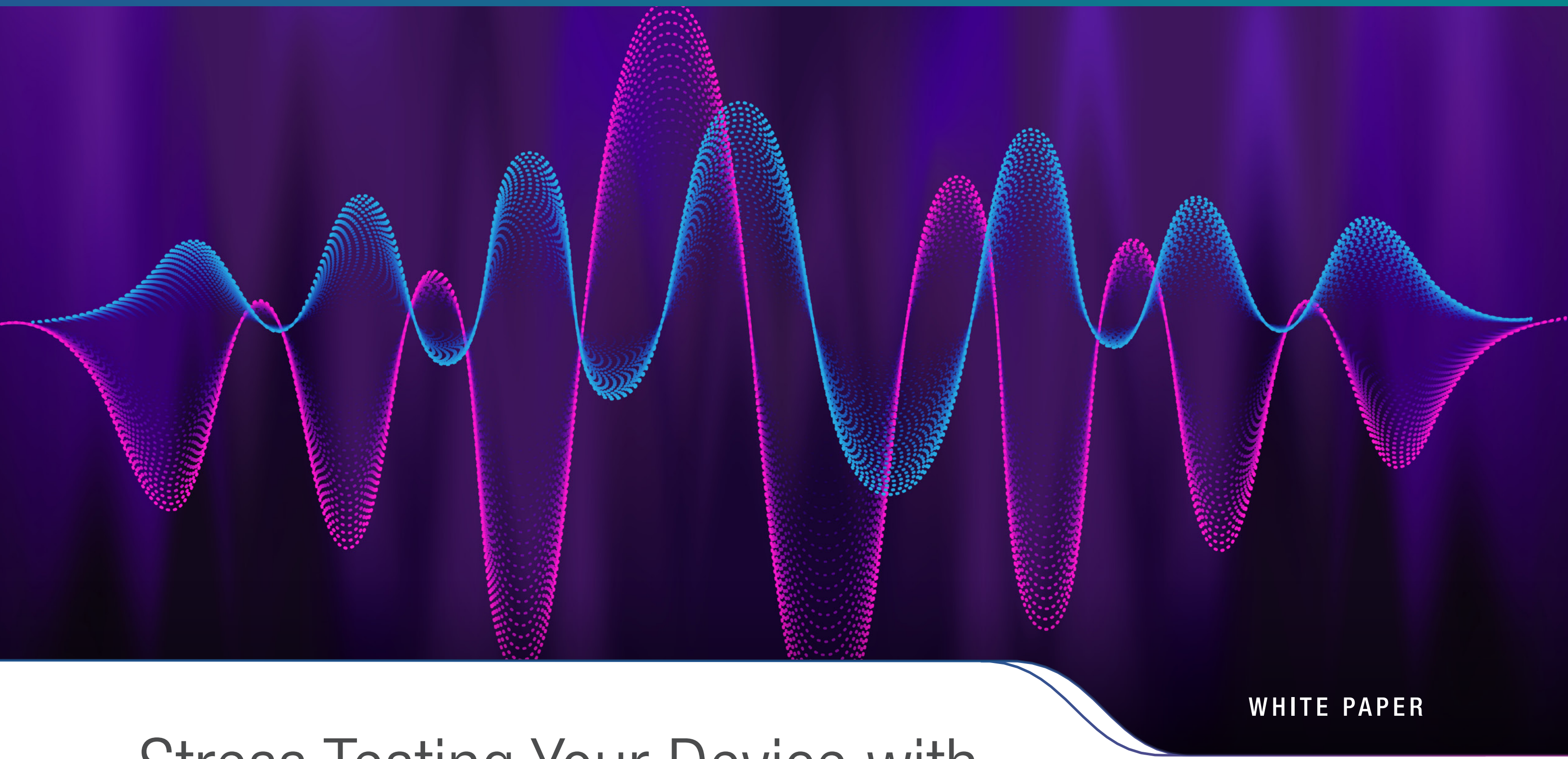

Stress Testing Your Device with Simulated Waveforms

> You can stress test your devices using the Keysight True*form* Series 33500B and 33600A waveform generators to simulate real-world, nonideal conditions on your signals. The True*form* Series 33500B and 33600A waveform generators provide an easy-to-use and best-value solution for generating high-quality waveforms.

Introduction

Digital components and circuits must be able to withstand a certain amount of noise and jitter in clock and data signals to ensure the reliable operation of your device. If they do not, the result could be communication errors or system failures.

Noise, jitter, cross talk, and reflections can cause signal distortions. Transient signal spikes can appear to be valid clocks, or the receiving system might misinterpret data. Such effects cause system failures. The design must minimize distortions to ensure accurate and reliable operation. Therefore, engineers need to stress their devices with these kinds of distortions during design, validation, and production.

Stress testing provides valuable insight into the performance of your device under extreme load. Identifying the potential breaking points in your application will allow you to correct them before they become expensive production issues. Engineers must test the limits of their designs to ensure that the products achieve ideal maximum performance and the new hardware meets design specifications across the full range of operations.

This white paper discusses the importance of stress testing and explains how to use a function generator to simulate the waveform and stress test your device.

KEYSIGHT TECHNOLOGIES

Producing Distortion Waveforms

High-speed data throughput is important in digital communications. High-bandwidth electronics require high-frequency clock signals. For the system to function correctly, the signal timing must be accurate. Accurate timing means that the successive rising and falling edges of clock signals must occur at the proper time in each cycle.

When you need to understand the limits of your design, the goal is not to simulate an ideal signal but to simulate a signal with quantitative, nonideal characteristics.

Designers should add distortion waveforms to stress test their devices under nonideal conditions. To do this, add real-world, nonideal characteristics such as DC offsets, broadband noise, narrowband noise, and jitter to the test signal.

Figure 1 shows perfect data or clock signals defined by their rising and falling edges, and the width and the delay of the pulse. The halfway points of the edges define the width and delay.

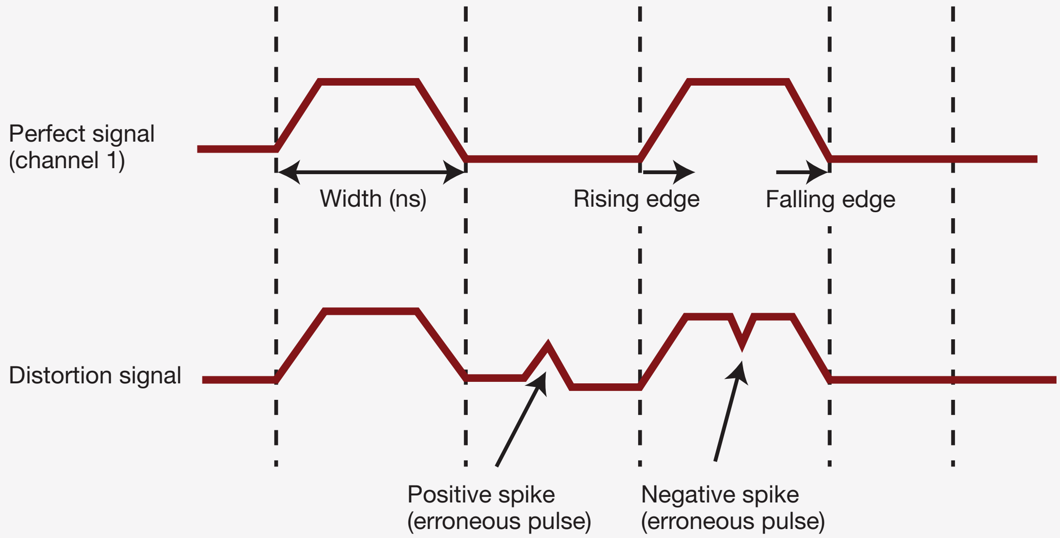

Figure 1. Perfect and distorted signal with clean rising and falling edges

A distorted waveform has either positive or negative spikes added to the perfect signal at a specific place. With a function generator, you can create such distorted waveforms by combining two pulse signals. The first one is a perfect pulse, and the second reflects the distortion.

Figure 2 shows how to define and combine the signals from each channel. The first channel has the perfect signal, including the logic patterns. The second output channel defines the spikes. These can be either positive or negative. Adding the two (the perfect signal plus one of the spikes) produces the distorted signal.

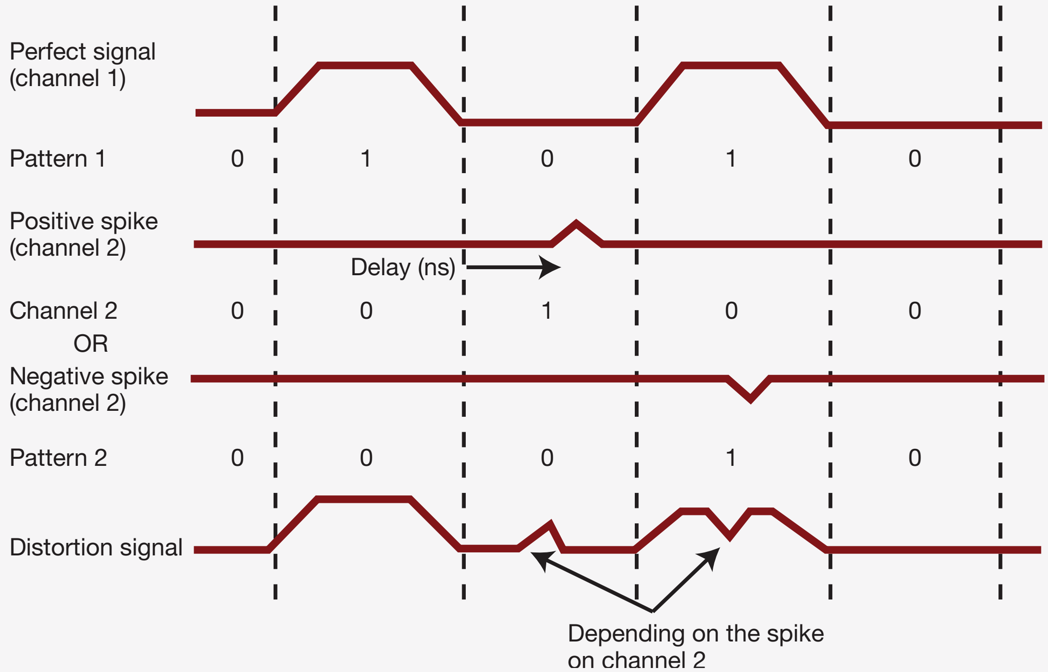

Figure 2. Distortion signal composed of two independent patterns

Generating Waveforms with Jitter or Noise for Stress Testing

Jitter and noise cause misalignment of edges and levels, resulting in data errors. Noise is, by its nature, unpredictable because it can have many causes, from signal interference caused by sudden voltage changes to distortions introduced during transmission. It is important to be able to simulate noise-based malfunctions to identify the additive noise produced by receiving systems, for example.

You should stress devices in different ways by applying distorted waveforms, jitter, or noise. In real-life applications, noise or jitter is an undesired distortion of a signal. For this reason, it is important to add noise or jitter to your test signals to stress test their behavior.

Keysight's True*form* waveform generators have the unique ability to add signals together on a single channel to create an arbitrary waveform. With True*form*, you can create complex multitone signals directly from the front panel. Make sure to use a function generator that can add noise to your signals.

Testing telephony DTMF decoders

We are all familiar with the typical tones telephone systems use. Each time we press a phone key, we hear a tone through the earpiece. The system typically uses these tones to route a call from one location to another. If you listen carefully, you will notice that each tone is actually two frequencies, each a pure sine wave, playing simultaneously. These are dual-tone multi-frequency (DTMF) signals.

The tone you hear is a combination of one low-frequency tone and one high-frequency tone. It is determined by the intersection of the row and column selected by pressing a phone key. See Figure 3. (The A, B, C, and D keys depicted in the figure are not on a standard phone, but they are part of the DTMF push-button phone definition.)

		High frequencies			
		1209 Hz	1336 Hz	1477 Hz	1633 Hz
Low frequencies	697 Hz	1	ABC 2	DEF 3	A
	770 Hz	GHI 4	JKL 5	MNO 6	B
	852 Hz	PQRS 7	TUV 8	WXYZ 9	C
	941 Hz	*	OPER 0	#	D

Figure 3. DTMF keypad frequencies — the sum of one low-frequency and one high-frequency sine wave represents each of the 16 keys (four rows by four columns)

In the telephony world, standards exist for these tones so that all the systems that use them work together gracefully. To ensure that the DTMF decoding electronics in these systems work properly, you must test the decoders by subjecting them to all forms of DTMF generation tones.

Keysight's function / arbitrary waveform generator has a sum function that allows you to add an internally or externally generated signal to the primary signal on a single channel. If the primary signal is a sine wave and the added sum signal is also a sine wave, the combined waveform is exactly what you need to generate and control a DTMF tone for testing decoders. You can easily adjust the amplitude, frequency, and duration of each of the dual tones to the limits specified in the regulatory standard.

Testing a transmission line

It is also important to stress the device with a simulated waveform to test the transmission line. When testing the integrity of a digital transmission system, you need to determine if your system is robust enough to transmit at your data rates. By sending a near-random bitstream through a digital network, you can simulate many conditions and look for weaknesses in your digital transmission system. The industry-accepted method involves using a pseudorandom binary sequence (PRBS) signal to test the integrity of your link. The PRBS signal has random and auto-correlation properties that help determine if your connection is acceptable. You can use a function generator that generates PRBS to simulate or stress test the test signals if your design does not include a source capable of generating this test signal.

Conclusion

Stress testing your devices using a simulated waveform can deliberately induce failures that enable you to analyze the risks at the breaking points. The function generator allows you to test your device by simulating real-world, nonideal conditions on your test signals.

Not all function generators are the same, even though they can generate basic waveforms and advanced waveforms. The Keysight True*form* Series 33500B and 33600A waveform generators provide an easy-to-use, best-value solution for generating high-quality waveforms. Having a stable signal source will provide tremendous benefits for stress testing your device with simulated waveforms.

For more information about the True*form* Series 33500B and 33600A function generators, please go to https://www.keysight.com/my/en/products/waveform-and-function-generators.html.