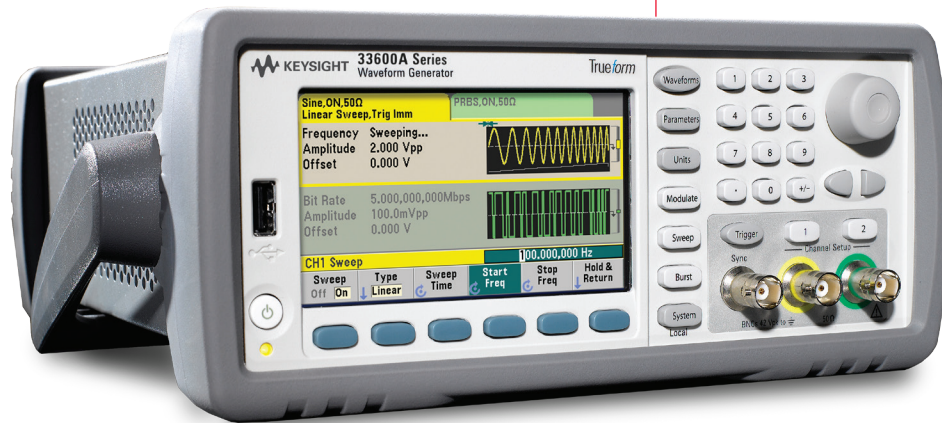


Keysight Technologies

Creating a Differential Signal with a Waveform Generator

Application Brief



Creating a Differential Signal with a Waveform Generator

Test challenge examples:

- Simulating an IC output
- Simulating balance twisted pair outputs
- Simulating a biomedical signal
- Generating an LVDS stimulus signal

How Trueform technology can help:

- Dual channels
- Frequency or amplitude coupling
- Identical or inverted signals between two channels
- Floating outputs up to 42 V
- 1 mVpp to 10 Vpp outputs

Differential signals have many advantages over single-ended signals; namely, fewer timing errors, better signal-to-noise ratio, and better immunity to electromagnetic noise. However, creating a differential signal from previous generation Keysight waveform generators with single-ended outputs is not intuitive or even possible. Trueform waveform generators now make creating a differential signal easier and much more cost effective.

See our test challenges below to learn how Trueform waveform generators can help you create differential signals for a variety of applications:

Simulating an IC output

Test signals are used by engineers to try out their designs. If you are designing analog or digital circuits, or want to reproduce your integrated circuit's output signal, a waveform generator should be your first choice. Using that generator to generate a differential signal; however, might give you second thoughts. Dual-channel Trueform waveform generators can simulate your test signals, even if they are differential. You can capture your signals with an oscilloscope, and then use the Trueform generator to accurately simulate the waveform as a differential signal on your bench. The arbitrary waveforms generated by the Trueform generators output each point without skipping or adding points like DDS-based generators.

Simulating a biomedical signal

When simulating a biomedical signal such as a heart rate to test your equipment, your requirements will include an isolated differential signal and small-amplitude levels. The dual-channel Trueform waveform generators can create small-amplitude, differential signals and do not require an external attenuator. Output levels as low as 1 mV peak-to-peak can be used. The generators even feature a standard cardiac arbitrary waveform in an internal library. Using the 33600A Series Trueform waveform generators, you not only simplify your system design, but also gain the ability to more accurately create versatile test waveforms.

Simulating balanced twisted pair outputs

You need to simulate a balanced, twisted differential pair. The differential pair signals require equal and opposite polarity, and must be tightly timed together. Like any good engineer you want the simulation to be accurate, the development time to be efficient, and the cost to be low. Thanks to the versatility of the Trueform waveform generators, all of your needs can now be met. Dual-channel models make creating a differential pair signal easy, while arb generation tools speed up your development time. Moreover, by adjusting the load impedance setting of the generator to match your load circuit's impedance, you can be assured the amplitude of your waveform will be correct.

Generating a LVDS stimulus signal

Do you need help generating a Low-Voltage Differential Signaling (LVDS) output test signal? Such signals are typically implemented as constant current 3.5-mA signals that terminate into a 100- to 120-ohm load. With Trueform waveform generators, you can now simulate LVDS signals even though waveform generators are typically constant voltage instruments. All you have to do is change the generator's load setting to match your load impedance (see additional details below). With up to 120-MHz of bandwidth and voltage settings ranging from 1 mVpp to 20 Vpp (into high impedance loads), Trueform waveform generators are ideal for helping you reproduce the signals you need.

Easy creation of differential signals

In the simplest terms, a differential signal is made up of a pair of wires devoted to a single signal. One path is at a higher potential than the other. Trueform waveform generators have dual-channel isolated outputs that are referenced to the outer shell. In order to combine the two channels into a single differential output, you must connect the two common connections (the connector shells) of each channel. The middle pin (signal pin) of one channel is used as the high signal path of the differential signal, while the signal pin of the other channel is used as the inverse return path. You can connect the connector shells to a cable shield if you would like additional shielding or a ground connection.

With the Trueform waveform generators (both the 33500B Series and 33600A Series dual-channel units), it is easy to mirror the two signals to create a differential signal. Simply use the inverted tracking capability enabled when the generator is in Dual-Channel Operation mode. This mode may be activated from either the Channel 1 or Channel 2 Output menu.

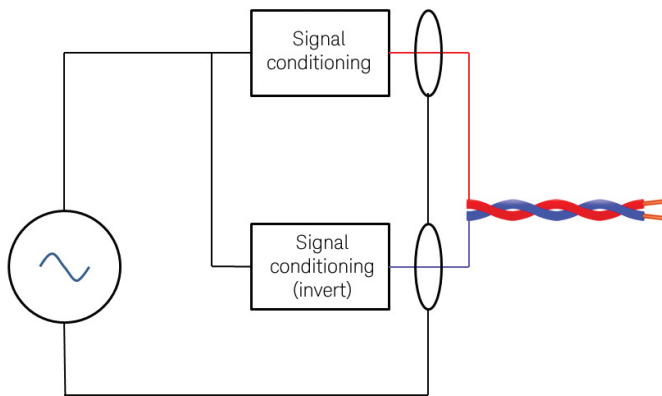


Figure 1. Differential signal block diagram.

The Inverted tracking mode causes Channel 2 to be a mirror image of the signal from Channel 1, which is exactly what you need for a differential signal. Once you have this enabled, all you have to do is set up your signal on Channel 1. It will then be automatically inverted on Channel 2, creating your differential signal.

Table 1. 33500B/33600A dual-channel Trueform waveform generators

33500B Series Dual-channel models	33600A Series Dual-channel models
33510B (20 MHz)	33612A (80 MHz, Arb)
33512B (20 MHz, Arb)	33622A (120 MHz, Arb)
33520B (30 MHz)	
33522B (30 MHz, Arb)	

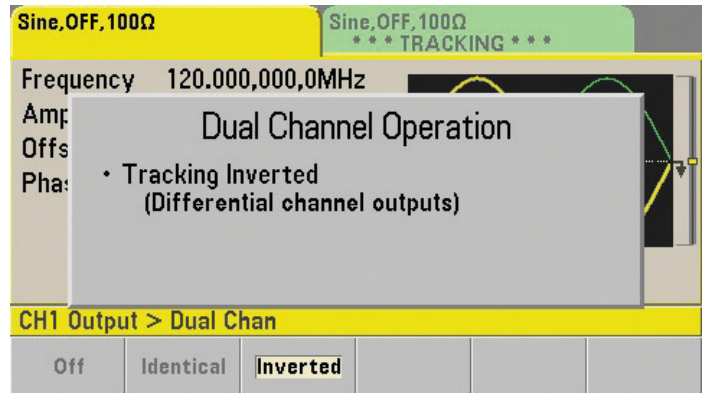


Figure 2. Channel tracking menu.

Measurement tip:

Don't forget to set the load impedance of your output channels. Doing so will enable the generator to accurately determine the voltage output to match your load impedance. Go to **Channel 1 > Output Load** to enter your circuit's load impedance.

Reproduce differential signals from your design

Reproducing the actual signal from your design can help you isolate your test circuit. Using a Trueform waveform generator to perform this task offers a number of key benefits, including the ability to change your signal's frequency, amplitude and offset. With Trueform generators' arb reproduction capability, even glitches from your design are reproduced accurately.

To recreate your signal, first capture it using an oscilloscope with trace saving features. The 33600A Series Trueform waveform generator recreates signals with 1 GSa/s resolution. Modern Keysight scopes can be used to save your signal to a .csv file. Once saved, a USB thumb drive or the 33600A Series' USB drag and drop feature moves the file to your Trueform waveform generator. You can then import the data in the **Waveforms > Arbs** menu. For a differential signal, the data will be a single channel arb. The process above can then be used to recreate the output as a differential signal.

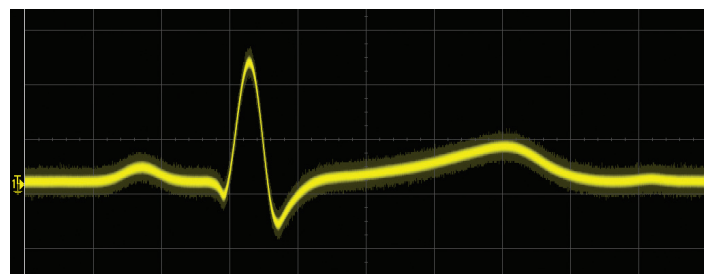


Figure 3. Reproduction of an actual design signal.

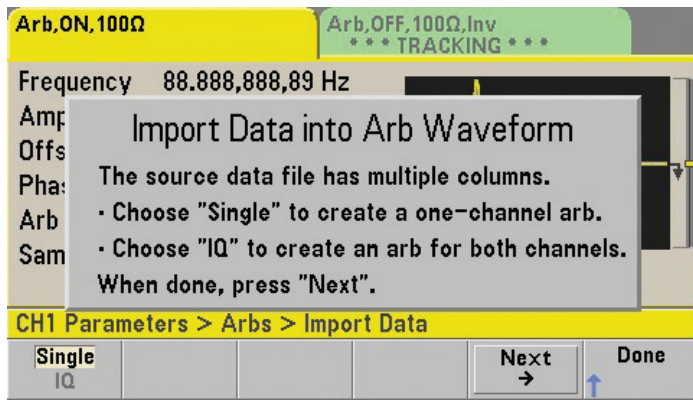


Figure 4. Importing data into an arb waveform.

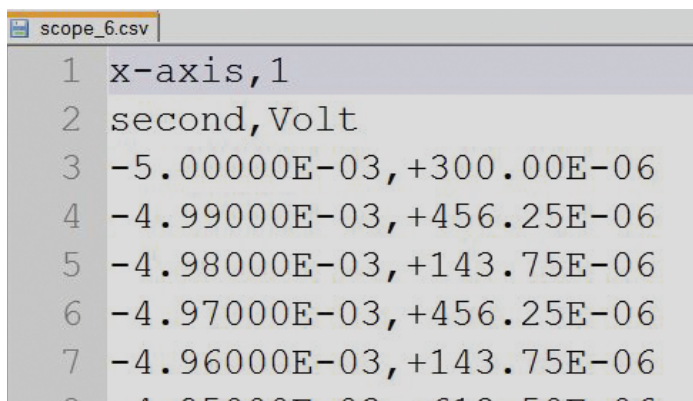


Figure 5. Saving a signal to a .csv file.

Measurement tip:

You can directly output scope trace files if you rename the extension from .csv to .dat files. Trueform waveform generators recognize .dat formats as arb files and can load them without the import data process.

Measurement tip:

If you'd like to design a signal, consider using Keysight's BenchLink Waveform Builder Pro software to build your signals. For more information on the software visit: www.keysight.com/find/33503



Summary

Simulating differential signals can be simple using Trueform waveform generators. You just recreate your own signals with an oscilloscope, capture and then output the data using a Trueform waveform generator. With this process you gain greater flexibility in your signal generation.

See the [Trueform waveform generator test challenge web site](http://www.keysight.com/find/trueformTC) for additional topics such as:

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

www.keysight.com/find/trueformTC

For 33600A Series Trueform waveform generator product information visit www.keysight.com/find/33600A

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