

Couple or Synchronize Two Signals on a Waveform Generator

Introduction

Engineers often face significant challenges when they need to couple two signals while maintaining a precise phase, amplitude, or frequency relationship. Ensuring that any change to one signal is accurately and instantaneously replicated on the other is a critical but often tedious task. Traditional methods for managing these interdependent signals can be incredibly complex and time-consuming.

Dual-channel Trueform waveform generators offer a powerful solution to this problem. These instruments are specifically designed to simplify the generation and control of two synchronized signals. By providing a built-in mechanism for linking signal parameters, they eliminate the need for manual adjustments and external synchronization circuitry. This capability ensures unparalleled accuracy and ease of use, allowing engineers to focus on their design and testing rather than on the meticulous task of signal management.

This application note explores how Trueform waveform generators help you overcome common test challenges, enabling you to effortlessly couple or synchronize two signals with precision.

#1 I/Q Modulation testing

Generating and testing I/Q (in-phase and quadrature) signals is a common but complex requirement for engineers working with RF components, such as converters or signal conditioning systems. To properly qualify key parameters like I/Q gain imbalance, frequency response, or quadrature error, you need a reliable signal source that can produce precise, synchronized I and Q signals. Traditionally, generating these signals has required significant investment in expensive, specialized equipment and a steep learning curve to master complex software. The process can be time-consuming and prone to errors, which directly impact the accuracy of your test results.

How Keysight Trueform waveform generators overcome this

With up to a 120-MHz bandwidth and superior jitter performance, Two-channel Trueform waveform generators are perfectly suited for simulating a wide range of I/Q signals.

Key features that simplify your workflow include:

- Built-in coupling features: Allow you to easily link the two channels, ensuring the I and Q signals maintain a precise phase and amplitude relationship without manual adjustments.
- Built-in I/Q generation feature: Simplify the process even further, allowing you to quickly move from signal simulation to a high-quality output on the test bench.

#2 Simulating a differential pair signal

Generating a differential pair signal from a standard waveform generator can be challenging because its outputs are typically designed as single-ended signals, which have a single wire and a ground reference. A differential signal, on the other hand, consists of two complementary signals that are 180° out of phase. This configuration is crucial for rejecting external noise and interference.

How Keysight Trueform waveform generators overcome this

Two-channel Trueform waveform generators simplify the creation of differential signals. Unlike traditional generators, you can easily configure these instruments to output perfectly matched or complementary signals. This capability is not just an added feature but a core function, often requiring just a single setting to enable.

With their 14-bit amplitude resolution, Trueform generators provide the high accuracy needed to simulate the subtle nuances of real-world outputs. This ensures that the complementary signals are nearly identical in every way except for their polarity, which is essential for effective noise rejection in your testing.

#3 Generating stimulus and trigger signals

Engineers testing semiconductor devices, such as an RFID receiver IC, need a trigger signal to initiate a test precisely when a specific stimulus signal is applied. The primary challenge is to ensure that these two signals are generated simultaneously and with a perfectly synchronized relationship.

How Keysight Trueform waveform generators overcome this

- Dual-channel synchronization and phase matching: This allows you to generate both signals with a perfect, user-defined timing relationship.
- Amplitude and delay control: You can fine-tune the amplitude and introduce precise delays, giving you complete control over the test setup.
- Simplified workflow: These integrated features eliminate the need for external synchronization circuitry, streamlining your testing process for accurate, repeatable results.

#4 Creating a frequency relationship on two signals

Engineers often need to generate two clock signals with a precise frequency relationship, where one signal's frequency is a fraction or multiple of the other's. While this can be done with two separate generators, maintaining this relationship when varying the frequencies requires significant manual effort or complex programming.

How Keysight Trueform waveform generators overcome this

Trueform waveform generators simplify this task through their dual-channel operation modes. This feature allows you to link the frequencies of both channels, so that any change to one signal's frequency automatically updates the other, maintaining their synchronized relationship. This capability saves significant development time and eliminates the tedious work of manual adjustments.

With up to 120-MHz bandwidth, these generators are versatile enough to support a wide range of applications, from initial design validation to final production testing.

Phase Synchronization and IQ Signal Relationships

Controlling the phase relationship between two channels is essential for applications where precise timing is critical, such as in stimulus-and-trigger setups or IQ signal generation. Trueform waveform generators simplify this process with dedicated features.

- For built-in functions like sine, square, or pulse waves, you can easily synchronize two channels to start at the same time. Simply navigate to [Parameters] > [Phase] > [Sync Internal]. Once synchronized, you can adjust the phase to create a specific delay between the two channels.

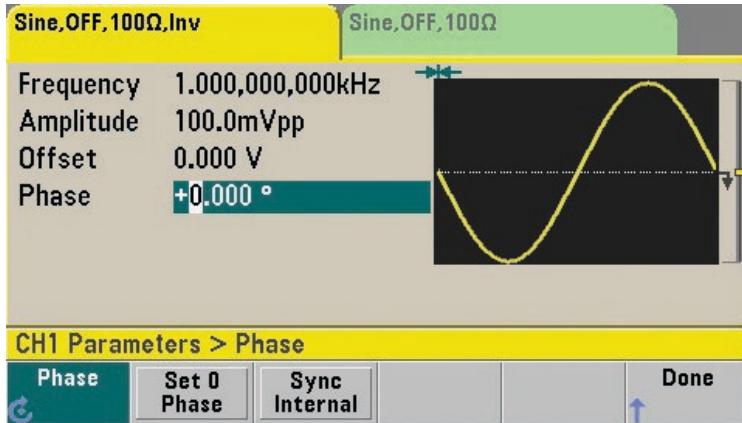


Figure 1. 33600A series' menu for internal phase sync.

- For custom IQ signals, maintaining a 90-degree phase relationship is critical. With Trueform generators, you can load your I and Q arbitrary waveforms (arbs) onto channels 1 and 2, respectively. To ensure they start together and maintain their relationship, set them to initiate at the same time and then press the [SYNC ARBS] button, which is typically found on the second page of the parameters menu.

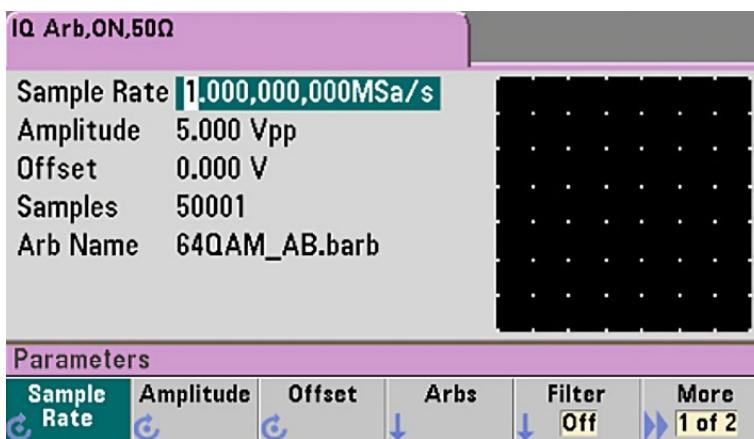


Figure 2. 33500B series' menu for IQ Arb player.

- The 33600A Series Trueform waveform generators provide added flexibility by allowing you to change the units for the phase parameter. You can select your preferred unit — degrees,

radians, seconds, or samples (for arbs) by going to the [Units] menu, which makes it easier to work with different types of applications and calculations.

Measurement tips:

The IQP (IQ Player) for Trueform waveform generators significantly simplifies IQ signal generation. This feature configures and controls both channels as a single, unified instrument, ensuring the phase relationship between the I (in-phase) and Q (quadrature) channels remains within the nominal IQ range.

The IQP streamlines the creation of complex IQ signals, which are essential for testing RF components and systems. By treating the two physical channels as one logical channel, it eliminates the need for manual synchronization and complex programming, accelerating the setup and ensuring signal fidelity. This makes the process much more intuitive, reducing both the financial investment and learning curve typically associated with generating high-quality IQ signals.

Click on [IQ Signal Generation Made Easy](#) to learn more.

Creating Differential Signals

Creating a differential signal is straightforward with Trueform waveform generators due to their inverted tracking capability. This feature, available in dual-channel mode, automatically mirrors the signal from channel 1 onto channel 2, but with an inverted polarity.

This is exactly what is needed for a differential signal, which consists of two identical but opposite-polarity signals. By simply enabling this mode and configuring your desired signal on channel 1, the generator handles the creation of the complementary signal on channel 2, streamlining your test setup.

Click on [Creating a Differential Signal with a Waveform Generator](#) to learn more.

Frequency and Amplitude Coupling

Frequency and amplitude coupling on Trueform waveform generators simplifies the creation and management of two synchronized signals. This capability eliminates the need for manual adjustments and programming to maintain a precise relationship between channels.

Frequency coupling allows you to link the frequency of one channel to the other using either a ratio or an offset. To enable this, simply select the channel's output key, then go to [More] > [Dual Channel]. Once enabled, any change to the frequency on one channel will automatically adjust the other to maintain the specified relationship. For example, if a ratio of 2:1 is set, changing Channel

2's frequency will instantly update Channel 1 to twice that value. This capability saves significant configuration time and ensures the signals remain perfectly synchronized throughout your testing.

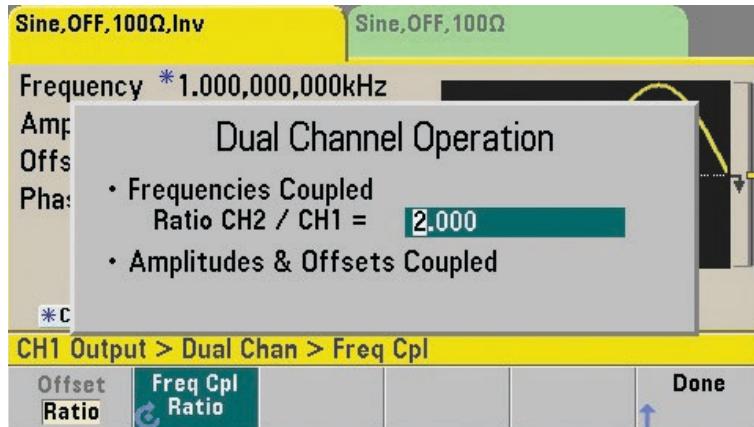


Figure 2. Frequency coupling with the generator in dual-channel operation mode.

Similarly, amplitude coupling ensures that the amplitudes and offsets of both channels are identical. When this feature is active, any change made to the amplitude on one channel is automatically mirrored on the other. This guarantees that your two signals maintain a consistent amplitude relationship, streamlining your test setup and ensuring signal integrity.

Conclusion

Keysight's dual-channel Trueform waveform generators provide a powerful solution for modern engineering challenges by simplifying the generation of complex, multi-channel signals. Whether you need to simulate an IQ signal, a differential signal, or maintain a precise frequency and phase relationship between two signals, these instruments offer an ideal and efficient solution. By leveraging their built-in synchronization and coupling features, the signal generation process becomes faster, more accurate, and far less frustrating, ultimately accelerating your design and test cycles.

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