

# Agilent 33500 Series Waveform Generators Dual-Channel Operation

## Technical Overview

The Agilent 33522A dual-channel waveform generator allows you to output waveforms on both channels independently. This allows you to flexibly drive a device under test (DUT) in many common situations. However, some applications require you to combine two signals on one channel; for example, you may wish to add noise to a sine wave. Other applications may require signals that are related to each other in some way. For example, you may wish to simulate two clock signals, where one clock's frequency is a multiple of the other's.

The Agilent 33522A includes features for meeting these kinds of application challenges and more. You can use these features from the front panel softkey menus or via the Standard Commands for Programmable Instruments (SCPI) programming language.

To use these features from the instrument's front panel, press the channel output key above either channel's output connector. Then press **More > Dual Channel** on the softkey menu. The menu shown in Figure 1 appears, showing the current state of dual-channel features. Dual-channel operations are disabled in the factory default state.

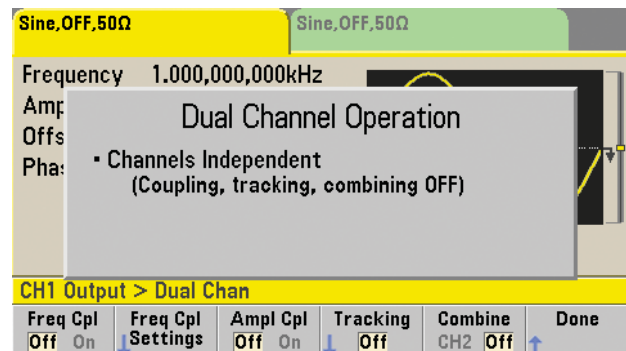


Figure 1. You can access the 33522A waveform generator's dual-channel settings via the softkey menu. The Dual Channel Operation menu allows you to adjust settings for frequency coupling, amplitude coupling, tracking and combining waveforms.



## Frequency Coupling

Frequency coupling allows you to specify that one channel's frequency must be related to the other channel's frequency either by a ratio (multiplying) or an offset (adding). One common use of this would be to simulate a device with two clocks whose timing is related by a frequency ratio. Frequency coupling is enabled by the first softkey in the Dual Channel Operation menu.

For example, suppose channel 1 has a frequency of 20 MHz. If you specify a ratio of 1.35 on channel 1's Dual Channel Operation menu, the frequency on channel 2 will be 27 MHz. If you then change the frequency on channel 1 to 16 kHz, the frequency on channel 2 will automatically change to 21.6 kHz. If your frequency coupling is set to Offset, a 100 kHz offset will set channel 2's frequency to a value 100 kHz above channel 1's frequency.

In both cases (ratio and offset), changing channel 2's frequency will change channel 1's frequency to maintain the specified offset or ratio.

The SCPI commands associated with frequency coupling are shown below.

## Amplitude Coupling

Amplitude coupling ensures that the amplitudes and offsets on both channels are the same. When amplitude coupling is enabled, a change to either channel's amplitude or offset will cause a change in the other channel's amplitude or offset. Amplitude coupling is the third softkey in the Dual Channel Operation menu.

You may implement amplitude coupling with or without frequency coupling, and the front panel display uses a blue asterisk (\*) to indicate coupled parameters, as shown in Figure 2.

The following SCPI command enables or disables amplitude coupling.

```
[SOURce[1 | 2]:]VOLTage:COUPlE[:STATe] {ON | 1 | OFF | 0}
```

[SOURce[1   2]:] FREQUency:COUPlE[:STATe] {ON   1   OFF   0}	Coupling enabled or disabled
[SOURce[1   2]:]FREQUency:COUPlE:MODE {OFFSet   RATio}	Type of coupling used when STATe is ON
[SOURce[1   2]:] FREQUency:COUPlE:OFFSet <frequency>	Frequency added when MODE is RATio
[SOURce[1   2]:]FREQUency:COUPlE:RATio <ratio>	Multiplier used when MODE is OFFSet

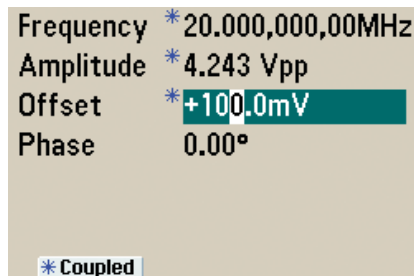


Figure 2. On the 33522B waveform generator's front panel display, a blue asterisk (\*) indicates coupled parameters.

## Tracking

Tracking means that one waveform is exactly the same shape as another, though possibly a mirror image. Tracking, which is configured under the fourth softkey in the Dual Channel Operation menu, has three modes:

- Off – no tracking
- Identical – the two channels have the same output (Figure 3)
- Inverted – the two channels are inverses of each other (Figure 4)

You cannot use tracking with frequency coupling or amplitude coupling. Turning tracking on (identical or inverted) turns coupling off, and turning coupling on (frequency or amplitude) turns tracking off.

The SCPI syntax for this command is `[SOURce[1|2]:]TRACk {OFF|ON|INVerted}`, where ON is equivalent to the front panel **Identical** softkey. Note that the optional [1|2] in the SOURce keyword specifies which channel is to be tracked (default, channel 1).

## Combine

The combine feature adds the two channel outputs on a single channel. In Figure 5, a 15 kHz ramp wave with 50% symmetry on channel 2 is combined with a 1 kHz sine wave on channel 1. Both the sine wave and the ramp wave are configured for 100 mVpp output, so the resulting combined wave has an amplitude of 200 mVpp. The combine feature is the fifth softkey in the Dual Channel Operation menu.

The combine feature can be used with frequency coupling or amplitude coupling, but it may not be used at the same time as tracking.

The SCPI syntax for this command is `[SOURce[1|2]:]COMBine:FEED {CH1|CH2|NONE}`. The optional [1|2] in the SOURce keyword specifies which channel shows the combined output (default, channel 1). The parameter after the word FEED should always be the opposite channel of the SOURce keyword channel (or NONE).



Figure 3. Tracked waveforms with the same output



Figure 4. Tracked waveforms that are inverses of each other

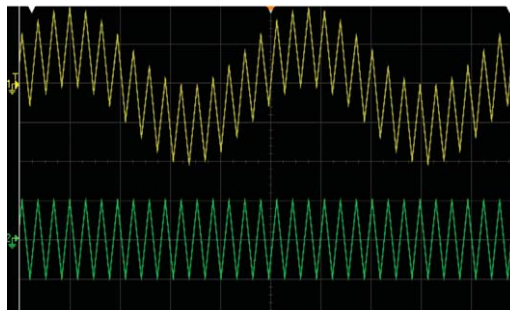


Figure 5. The combine feature adds two channel outputs on a single channel.

## Summary

You can use the dual-channel waveform generator's frequency coupling, amplitude coupling, tracking, and combine features to meet the needs of several complex applications. You can use these features either from the front panel or from SCPI, and you can use these features simultaneously, except in situations where the very definition of one of the features precludes use of the others.



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