

Keysight Technologies

Frequency Agile Complex  
Signal Simulation with the  
Keysight M8190A Arbitrary  
Waveform Generator

Application Note



## Introduction

The Keysight Technologies, Inc. M8190A Arbitrary Waveform Generator (AWG) generates complex, realistic test signals needed for today's sophisticated signal simulation and system test. Whether you're simulating advanced electronic warfare threats, radar target returns or satellite transponders, the M8190A combines powerful modulation with agile frequency switching.

## Problem Statement

Testing radar and electronic warfare designs needs to be as realistic as possible. Pushing the designs to the limit through realistic signal scenarios reduces test costs by minimizing the need for high cost flight-testing.

- Apart from needing high signal fidelity, modulation bandwidth needs are constantly increasing. Traditional signal generators provide the necessary signal purity, but most of them can only offer modulation bandwidths of about 100 MHz.
- In addition, the signals need certain agility, so they can hop within the frequency band.
- But the most critical need to address is the playtime. This needs to be enough to capture complex scenarios, such as the entire flight of an airplane.

## Solution

The M8190A AWG is a versatile signal scenario generator with a unique combination of:

- Frequency agility
- Long playtime

This makes it a key element in test setups that can push radar and electronic warfare designs further. Fourteen bits of vertical resolution make it possible to generate detailed baseband signals. Without compromising the long, baseband playtime, the accurate digital up-conversion option then ensures an excellent IF signal quality, with an intrinsic analog bandwidth of 5 GHz. Higher bandwidth is possible using a mixer with a local oscillator for further up-conversion.

# Test Setup

For this application note we are using signals produced by MATLAB, but there are many different software tools available for creating waveforms, such as Keysight N7620B Signal Studio for pulse building or Keysight W1461 SystemVue radar libraries.

We used a Keysight DSAX96204Q Infinium High-Performance Oscilloscope to analyze the output from the arbitrary waveform generator, because it can handle 63 GHz in real-time, and runs vector signal analyzer software.

## Powerful modulation capabilities and frequency agility provided by the M8190A AWG

The M8190A can perform any kind of modulation, radar chirps, or fast frequency hopping signals.

Highly realistic testing often requires long play time and long signal scenarios. The 2 GSa memory combined with advanced sequencing capabilities allows you to use the memory efficiently and effectively. If the sequence is known, switching from one sample to another one is possible. Direct access to individual memory segments is possible in real time through the dynamic sequence control input, switching time is 2.3  $\mu$ s. Last but not least hopping is possible based on an event input within 26.6 ns (12 G mode).

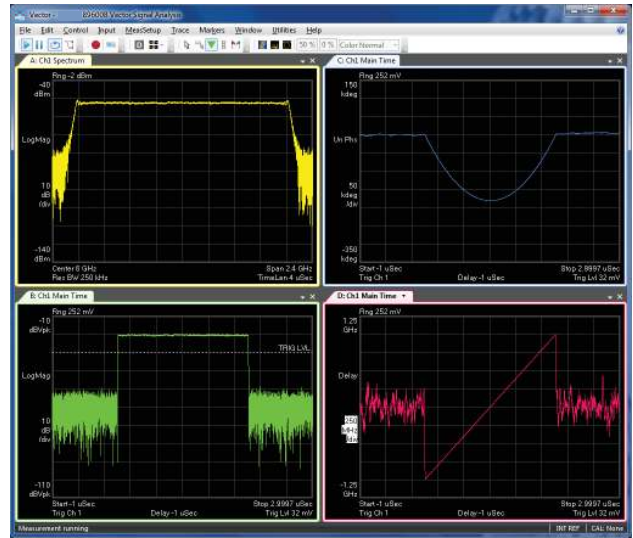


Figure 1. 2.4 GHz chirp at 6 GHz

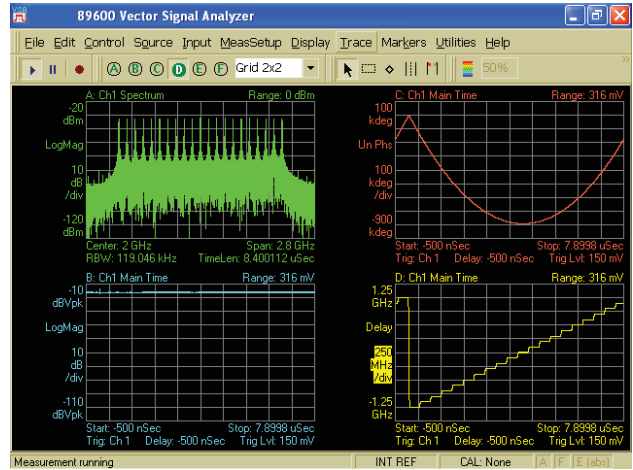


Figure 2. Switching between frequencies in a 2 GHz bandwidth, in under 500 ps

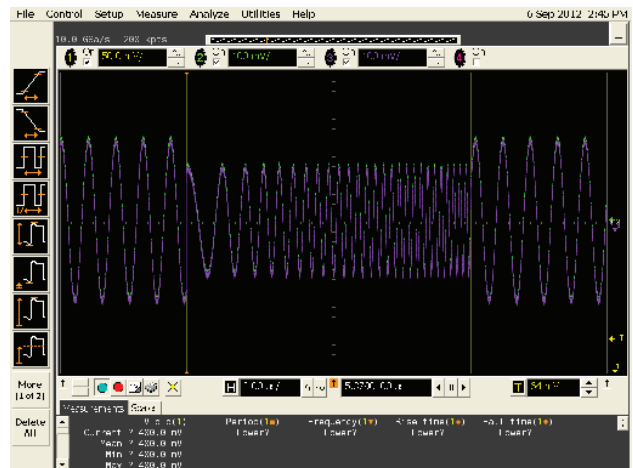


Figure 3. Fast changing signals such as GHz pulses, combined with slow changes such as an antenna scan, for example, 15 RPM

## Long playtime

The M8190A comes with 2 GSa memory per channel. At a sampling rate of 12 GSa/s this would result in a playtime of 1/6 s. This is obviously not enough for most applications. Instead of adding memory, effective memory use helps. Therefore, as well as producing excellent baseband signals, the M8190A uses digital up-conversion to intermediate frequency to dramatically increase the effective memory size. Apart from avoiding any distortion, such as in-band images or carrier feed-through, Keysight's implementation of the digital up-conversion helps by:

- Separating the frequency and amplitude from the pulse shape. This compresses the quantity of data significantly.
- Setting the phase of the waveform separately. The phase information does not need to be stored in the waveform.

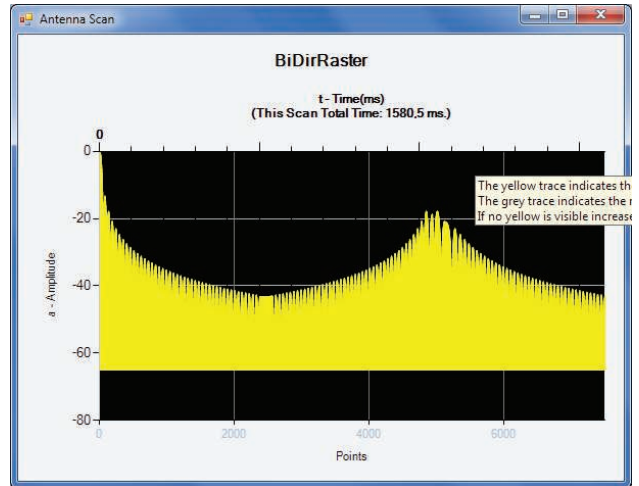


Figure 4. Antenna scan

Table 1. Digital up-conversion memory management and its impact.

Implementation	Impact	Gain in playtime
Phase coherence handled by Keysight proprietary ASIC	No memory needed for phase information	From < 1 s to several seconds
Store only low bandwidth I/Q sample data, rather than IF samples	Only needs 1/3 to 1/48 the amount of memory	From seconds to minutes
Amplitude and frequency can be stored independently of the waveform	Waveform only needs to be stored once	From minutes to hours

Depending on the waveform and the parameters up to 1 million times more playtime is possible.

## Summary

Fast, frequency-agile signal simulation needs precise signal generation in the baseband, as well as at intermediate frequencies. Fast frequency changes are important for hopping within the band. But the most important requirement is long playtime. The M8190A addresses the needs with:

- 14 bit vertical resolution
- 5 GHz analog bandwidth
- 2 GSa memory per channel
- Digital up-conversion for best IF signal quality
- Digital up-conversion to extend the playtime up to 1 million times.

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