

Keysight Technologies

Creating a Solution for Testing Frequency-Hopping Spread Spectrum Devices

Wideband modulation in 60 GHz
communication

Application Note



Overview

In wireless connectivity and communications, frequency-hopping spread spectrum (FHSS) is a technique used to reduce interference, increase transmission security and enhance the efficient use of available bandwidth. FHSS is used in applications such as Bluetooth®, consumer walkie-talkies and military communications.

With this technique the carrier frequency is rapidly changed across a wide range of frequency channels. The transmitter and receiver both know the hopping sequence, and cryptographic keys may be used to protect the sequence. In the case of military communications, additional encryption may be applied to the signals.

During product development or manufacturing, creating a viable FHSS measurement solution often requires two types of instruments:

1. A vector signal generator (VSG) that produces I/Q-modulated signals and upconverts them to microwave frequencies. An external upconverter is typically required if translation to millimeter-wave frequencies is necessary.
2. An arbitrary waveform generator (AWG). If the AWG has two output channels, it can produce a modulating pair of I/Q signals that simulates the required FHSS sequences.

Although AWG capabilities are built into instruments such as the Keysight Technologies, Inc. E8267D PSG vector signal generator, a high-performance external AWG is typically needed to address applications that require extremely fast frequency switching and settling.

Problem

When creating an FHSS testing solution, achieving sufficient performance and repeatability depends on several key characteristics:

- Frequency accuracy
- Switching speed
- Local-oscillator (LO) setting time
- Dwell time
- Duty-cycle off time
- Power level

There are testing solutions that may be considered, however they many lack necessary characteristics. For example, a switched synthesizer typically cannot switch frequencies fast enough or settle on a frequency quickly enough to be a useful approach (Figure 1). A typical, standalone AWG may be capable of producing wideband I/Q signals, however, it cannot cover a wide enough band for high-frequency applications. Consequently, some type of external upconverter is required. The typical AWG also lacks the necessary maximum available playback time for simulated signals, which is a function of the available built-in waveform memory, as well as the built-in sequencing and programming functions.



Figure 1.

Solution

Keysight's application engineering organization helped create a simulation system capable of generating precise signals for testing of FHSS devices and systems. The simulation system generates appropriate test signals that are sent to the receiver side of the device under test (DUT).

A basic diagram of the system is shown in Figure 2. The major elements are:

- Waveform-creation software running on a PC
- A two-channel AWG
- A VSG capable of producing I/Q modulation

The AWG provides the modulating I/Q signal pair and the VSG functions as the upconverter.

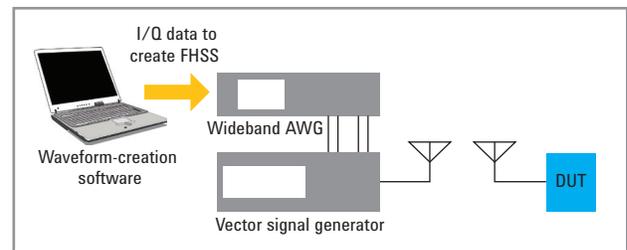


Figure 2. This combination of software and instrumentation provides flexible signal generation that enables accurate, repeatable testing of FHSS devices.

For this test solution, the VSG is an E8267D PSG vector signal generator, which offers frequency coverage up to 44 GHz. It also includes custom I/Q modulation capability with up to 2 GHz RF modulation bandwidth. Working in concert with an external AWG providing the modulating I and Q signals the E8267D functions as the upconverter.¹

The AWG is an Keysight 81180A arbitrary waveform generator with 12-bit resolution up to 4.2 GSa/s. Alternatively an Keysight M8190A AWG can be used. It provides 12-bit resolution up to 12 GSa/s or 14-bit resolution up to 8 GSa/s. Both AWGs can be configured with one or two analog output channels, and each channel can operate in single-ended or differential mode. The M8190A offers longer playback time with up to 2 GSa of waveform memory per channel, advanced programming and sequencing capabilities.

The required I/Q signal pairs are created using MATLAB from The MathWorks.² MATLAB creates mathematically ideal test waveforms with customized patterns and sequences for FHSS simulation and testing. These waveforms are downloaded into AWG memory for playback into the I/Q inputs of the PSG.

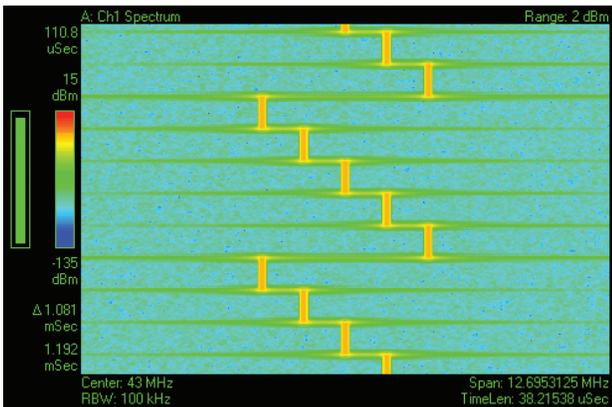


Figure 3. With near-zero settling time, the COTS system enhances the testing of FHSS devices during development and on the production line.

Results and Benefits

This combination of commercial, off-the-shelf (COTS) equipment and software enables the creation of essentially “ideal” baseband signals with near-zero settling time (Figure 3). Those signals are accurate in terms of both time and frequency, ensuring precise control of test patterns and accurate characterization of device performance.

In R&D, this level of performance is especially beneficial in the development of advanced FHSS receivers. Any signals created during product development can be easily reused within an automated test system on the production line. In manufacturing, the suggested configuration also provides the speed and repeatability needed for cost-effective testing.

Conclusion

The configuration presented here provides a fast, flexible solution for testing receivers used in FHSS systems. It demonstrates how linking a signal generator, arbitrary waveform generator and MATLAB simplifies signal creation. The combination of software elements and high-performance instrumentation is scalable and reconfigurable to address other technologies, as well as future projects.

Related information

- Data sheet: Keysight 81180A 4.2 GSa/s arbitrary waveform generator, publication 5990-5697EN
- Data sheet: Keysight E8267D PSG vector signal generator, publication 5989-0697EN
- Data sheet: Keysight M8190A 12 GSa/s arbitrary waveform generator, publication 5990-7516EN
- MATLAB information: Please visit www.mathworks.com/products/matlab and www.keysight.com/find/matlab

1. Requires Option 016, wideband external I/Q inputs.

2. Software similar to MATLAB can also be used.

myKeysight

myKeysight

www.keysight.com/find/mykeysight

A personalized view into the information most relevant to you.



www.axiestandard.org

AdvancedTCA® Extensions for Instrumentation and Test (AXIe) is an open standard that extends the AdvancedTCA for general purpose and semiconductor test. Keysight is a founding member of the AXIe consortium.



www.lxistandard.org

LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Keysight is a founding member of the LXI consortium.



www.pxisa.org

PCI eXtensions for Instrumentation (PXI) modular instrumentation delivers a rugged, PC-based high-performance measurement and automation system.



Three-Year Warranty

www.keysight.com/find/ThreeYearWarranty

Keysight's commitment to superior product quality and lower total cost of ownership. The only test and measurement company with three-year warranty standard on all instruments, worldwide.



Keysight Assurance Plans

www.keysight.com/find/AssurancePlans

Up to five years of protection and no budgetary surprises to ensure your instruments are operating to specification so you can rely on accurate measurements.



www.keysight.com/quality

Keysight Electronic Measurement Group
DEKRA Certified ISO 9001:2008
Quality Management System

Keysight Channel Partners

www.keysight.com/find/channelpartners

Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/M8190

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	0800 000154
Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-05-23-14)

