# Analyzing Infiniium Scope Radar Waveforms with Advanced Design System

Connected Solutions
Application Bulletin 1476-2

Introduction

Traditionally, designers used EDA tools and instruments such as oscilloscopes and signal generators from different vendors to generate, capture, and analyze a radar waveform, and struggled to get them to work together. Today's Connected Solutions from Agilent Technologies allow designers to capture RF baseband signals with a high-sampling-rate oscilloscope and analyze these signals in time-domain with Advanced Design System (ADS) software, while maintaining the high sampling rate.

This application bulletin presents a Connected Solution that combines Advanced Design System (ADS) software with an E4438C Vector Signal Generator, and a 54832D Infiniium 4Gs/S sampling scope (all from Agilent Technologies). A Linear FM chirp radar is generated, captured by the scope, and analyzed with ADS to check its linearity. For this application, we generate a Linear FM (LFM) signal in ADS and download it to an Agilent E4438C ESG Vector Signal Generator. The ESG upconverts the baseband signal to 70 MHz and then the Infiniium Oscilloscope acquires the waveform. The waveform is then captured as a .CSV (Comma Separated Variable) file at a 1 Gs/S sampling rate. The .CSV file lists time and voltage data in two columns. At a 1Gs/S time step, centered at 70 MHz, the complex time-domain envelope of the LFM signal can be fully recovered using the Ptolemy simulator in ADS.

Agilent Technologies
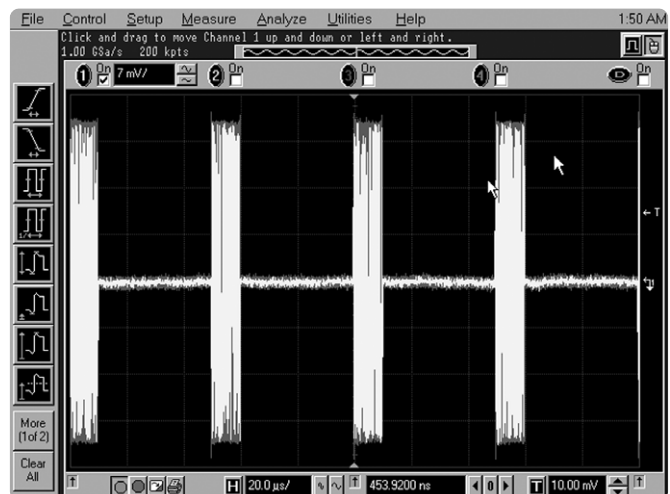
Concept

A built-in PC within the Infiniium platform makes it easy to map Infiniium to another PC Windows environment running ADS. The .CSV file voltage column data is then read by ADS. Using Agilent Ptolemy, the time domain envelope of the LFM can be fully recovered at 1Gs/S time-step, centered at 70 MHz.

LFM Chirp Radar

Figure1 gives a schematic view of signal generation and download into the E4438C Vector Signal Generator.

The LFM characteristics are:
 Pulse Width = 10 uSec
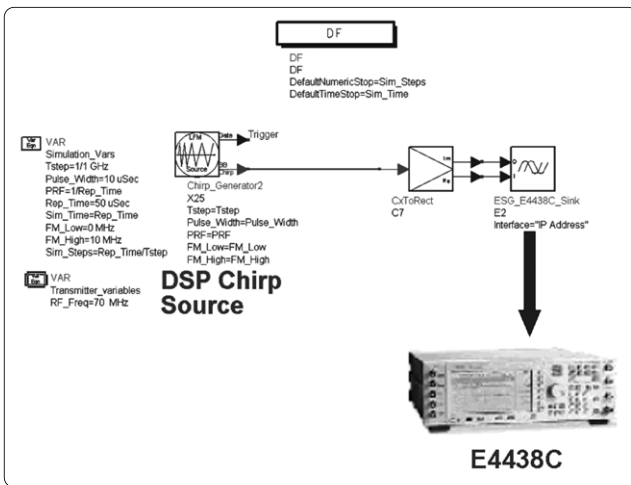 Repetition time = 50 uSec
 FM Low = 0 MHz
 FM High = 10 MHz

Figure 1. The ADS chirp LFM model downloaded to the E4438C Vector Signal Analyzer.

Chirp LFM Playback

Figure 2 diagrammatically shows the scope capturing the LFM waveform in .CSV format and bringing it into ADS. ADS then reads the .CVS file as a one-column .TXT file.
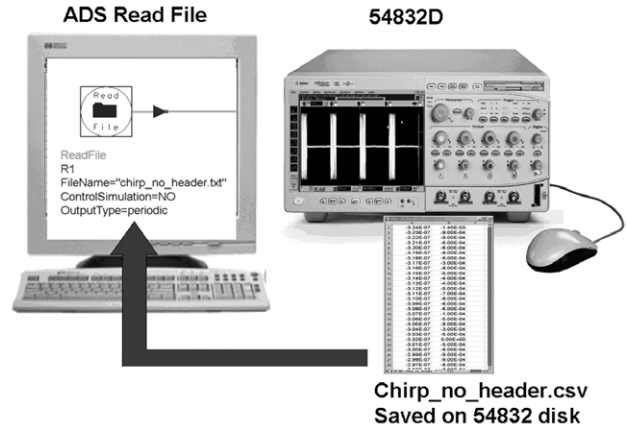

Figure 2. The oscilliscope .CSV file is saved and read back into ADS.

The 54832D Infiniium oscilloscope is capable of sampling input waveforms up to 4 GHz. We chose to sample at 1 GHz because it was high enough to represent the fidelity of the chirp.

Figure 3 shows the ADS simulation setup. ADS converts the waveform into a timed signal with 1 nSec of TimeStep, and it modulates a carrier frequency at 70 MHz. After the appropriate bandpass filtering, the ADS FM demodulator processes the LFM chirp. Finally, the linearity of the chirp is detected.
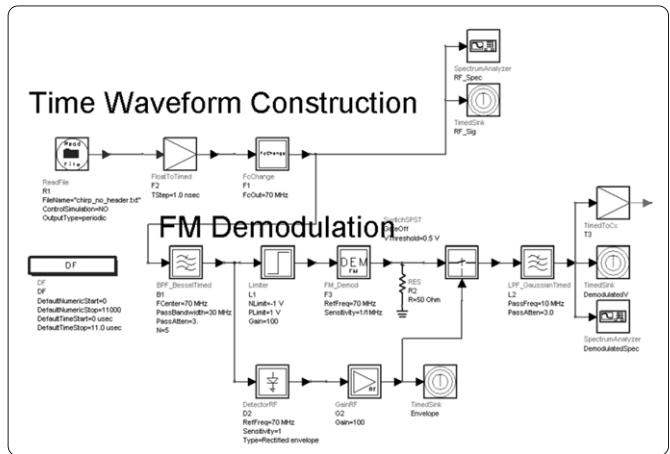

Figure 3. The LFM chirp linearity test setup in ADS.

The ADS LFM Chirp Linearity Analysis

Figure 4 shows the result of the linearity analysis of the chirp. The top plot displays the actual and theoretical line. The bottom plots show differential frequency deviation and the deviation from a linear trace. It shows the frequency difference between samples, which are 100 steps apart. An ideal, perfectly linear trace would be a straight line at 0.1. Figure 5 shows the output of the demodulation in time and frequency, respectively.
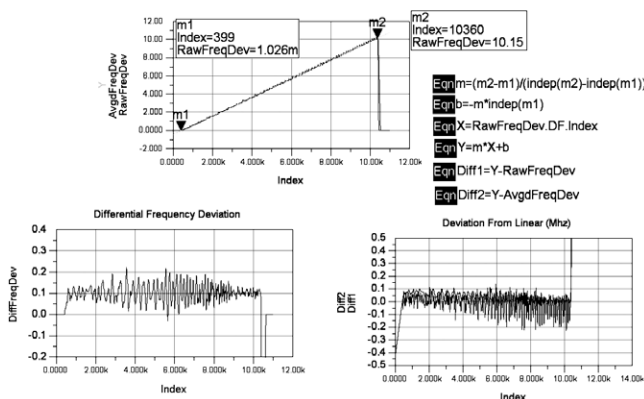
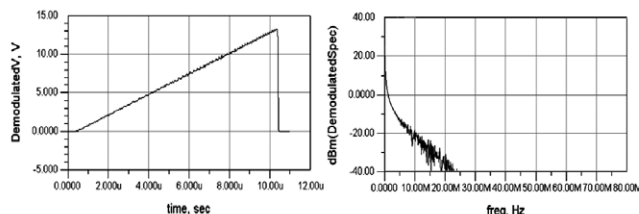**Figure 4. The packet error rate (PER) when Bluetooth interferes with the 802.11g OFDM signal.**

Figure 5. Demodulation output in both time and frequency.

Summary

ADS is a powerful simulation environment that can facilitate the processing of data from Agilent Infiniium oscilloscopes. Through this example we show how a waveform from an LFM chirp radar signal created with an Agilent E4438C Vector Signal Generator is captured by an Infiniium 54832D oscilloscope. The captured waveform is sampled at 4 Gs/S and saved on the oscilloscope's internal PC. The voltage waveform is then read back into ADS and the time-based envelope of the signal can be reconstructed. Analysis of the chirp linearity is a powerful tool for studying the radar waveform.

This example illustrates the flexibility and expandability that ADS simulation provides for test and verification of any signal format. Any RF baseband signal data up to 800 MHz of bandwidth can be captured and analyzed with the Infiniium oscilloscope and ADS.

Required Equipment/Software

E4438C Electronic Signal Generator (ESG) with arb
(Up to 6 GHz frequency range)
54832 Infiniium Oscilloscope (Option 008)

Advanced Design System (ADS)

E5720A/AN Connection Manager
E8900A Design Environment
E8901A Data Display
E8823A Ptolemy Simulator
E8822A Ptolemy fixed-point models (as applicable)
E8874 ADS Wireless LAN Design Library
ADS BER/Application guide

Resources

Agilent EEsof EDA:
www.agilent.com/find/eesof

Agilent Connected Solutions:
www.agilent.com/find/eesof-connectedsolutions
(Application notes and a configuration guide are available at this site)

Agilent infiniium oscilloscopes
www.agilent.com/find/infiniium

Agilent 54800 series oscilloscopes
www.agilent.com/find/54800series
(Performance guides and application notes are available at this site)

Agilent signal generators
www.agilent.com/find/signal_generators
(A selection guide and other literature is available at this site)

For more information about Agilent EEsof EDA, visit:

www.agilent.com/find/eesof

For more information about Agilent Technologies'
connected solutions, visit:

www.agilent.com/find/eesof-connectedsolutions

For more assistance with your test and measurement needs, visit:

www.agilent.com/find/assist

Phone or Fax:

United States:
(tel) 1 800 452 4844

Canada:
(tel) 1 877 894 4414
(fax) (905) 282-6495

China:
(tel) 800 810 0189
(fax) 800 820 2816

Europe:
(tel) (31 20) 547 2323
(fax) (31 20) 547 2390

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Korea:
(tel) (82-2) 2004-5004
(fax) (82-2) 2004-5115

Latin America:
(tel) (305) 269 7500
(fax) (305) 269 7599

Taiwan:
(tel) 0800 047 866
(fax) 0800 286 331

Other Asia Pacific Countries:
(tel) (65) 375-8100
(fax) (65) 6836-0252
Email: tm_asia@agilent.com

Product specifications and descriptions in this document
subject to change without notice.

Agilent Technologies