Getting Ultra Wide Band Radio Signals to Hop: TZero Technologies Takes Advantage of Powerful Tektronix Instruments

Solution Summary	
Challenge	Generate, capture and characterize a 528 MHz UWB signal that hops between three radio frequencies for a total modulation bandwidth of 1584 MHz; the test equipment must provide better than -30 dB EVM over this entire bandwidth.
Solution	Tektronix AWG710B Arbitrary Waveform Generator and TDS7000B Series Digital Phosphor Oscilloscope, which offer a powerful combination of high bandwidth, high sampling rate, high precision and sophisticated waveform editing features.
Benefits	The ability to create and characterize high quality hopping UWB signals digitally; flexibility and ease-of-use for utilizing different test approaches and manipulating various dynamics to optimize chip performance.

It's no simple task: Generate, capture and characterize an Ultra Wide Band (UWB) radio signal that hops between three frequency channels in the 3 – 5 GHz spectrum. The task gets considerably more difficult when the signal's error vector magnitude (EVM) – a measure of the overall modulation quality of the signal that accounts for thermal noise, phase noise, nonlinear distortion, hopping and switching transients, IQ imbalance and other signal degradations – must remain significantly better than -19.5 decibels (dB).

Welcome to the world of TZero Technologies, Inc.

The proliferation of wireless technologies and products has created great opportunities for consumer electronics, mobile and PC applications. It has also produced an overcrowded radio frequency (RF) domain.

To accommodate consumer demand and take advantage of the business potential presented by emerging wireless applications, new communications technologies, such as UWB radio, have sprouted as a means to efficiently send large quantities of data through the congested RF spectrum. In addition, new data transmission techniques, including Orthogonal Frequency Division Multiplexing (OFDM) – backed by the WiMedia Alliance – are enabling advanced wireless multimedia networking over UWB frequencies.

TZero is at the forefront of these developments, creating chipsets that utilize MBOA-UWB specifications to provide unsurpassed speed and reliability for state-of-the-art multimedia wireless networks. Using these cutting-edge UWB standards, TZero's chipsets deliver the highest performance, longest reach and highest reliability for home audio and video, handheld devices and PC peripherals.

Achieving such performance and reliability, however, was a highly complex undertaking.

"Hopping is a critical aspect of the MBOA-UWB standard and can be equated to a car's ability to switch lanes or change routes to avoid a traffic jam. It allows the UWB signals to switch frequencies in order to optimize performance and transmission," said Dr. Adam Schwartz, Principal System Architect, TZero Technologies, Inc. "Hopping UWB signals also have a modulation bandwidth that greatly exceeds current test solutions, which presented some overwhelming obstacles in the test and debug phases of chip development."

Fortunately, Tektronix test and measurement equipment enabled TZero to overcome such obstacles. Using Tektronix AWG710B Arbitrary Waveform Generators to produce the signals and Tektronix TDS7000B Series Digital Phosphor Oscilloscopes to acquire and characterize them, TZero was able to successfully test and validate its high performance UWB chips.

According to Dr. Schwartz, the traditional approach of using an analog baseband modulator to create a hopping RF waveform from an arbitrary waveform generator was infeasible. The process introduced too much IQ imbalance resulting in poor EVM.

"Ensuring our chips met the WiMedia/MBOA performance requirements could not be accomplished using traditional approaches. We needed to incorporate the hopping and IQ modulation digitally, which necessitated superlative test equipment," Dr. Schwartz explained. "Tektronix instruments were the only products available that could offer the combination of high bandwidth, high sample rate and high precision we needed."

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–Dr. Adam Schwartz, Principal System Architect, TZero Technologies, Inc.

Boasting a 4.2 GS/s sample rate and the ability to generate signals up to 2.1 GHz, the AWG710B enabled TZero to produce MBOA-UWB hopping signals occupying a total modulation bandwidth of 1584 MHz at an IF frequency. Tzero engineers then up-converted the signals to RF using a standard mixer instead of an IQ modulator. This approach eliminated EVM distortion caused by IQ imbalance of an analog modulator.

Tzero then utilized the powerful TDS7000B Series, which delivers up to 7.25 GHz (typical) true analog bandwidth, down to 43 ps rise time (20% – 80%) and 20 GS/s maximum real-time sample rate, to acquire the RF signals. According to Dr. Schwartz, they exploited the instrument's entire 20 GS/s sampling capability and processed the acquired signals using custom Matlab software to calculate the EVM.

The results were better than expected.

"The MBOA-UWB standard imposes a minimum requirement of -19.5 dB EVM. To accurately measure the EVM of our chips, we needed the test equipment to significantly exceed that mark," noted Dr. Schwartz. "Using Tektronix test and measurement tools, we were able to provide hopping UWB signals in the 3 – 5 GHz range with -34 dB EVM. This exceeded everyone's expectations and allowed us to verify that our chips indeed significantly surpass the MBOA requirement."

TZero Utilizes Instruments' Flexibility and Editing Features in Addition to Sheer Power

In addition to the rare combination of world-class bandwidth and sample rate, TZero is taking advantage of the flexibility and advanced features of the AWG710B and TDS7000B Series.

The editing features of the instruments are particularly useful, according to Dr. Schwartz. With the ability to create and test waveforms in different ways (examples include floating point waveforms and 8-bit pattern files), Tektronix instruments have helped TZero tweak, synchronize and optimize the performance of its complex UWB chips.

The AWG710B comes standard with AXW100 ArbExpress waveform creation and editing software, which allows for easy waveform import from oscilloscopes as well as basic and advanced math waveform creation and edit capabilities. TZero is able to use different test approaches and manipulate various waveform dynamics when characterizing the hopping UWB signals without arduous, complicated setup procedures.

"We're a startup company and always strive to maximize our resources – both human and technological," indicated Dr. Schwartz. "Because they are versatile and easy to use, we get a lot of mileage out of our Tektronix instruments. We use them not only for EVM testing, but also gain testing, frequency response testing, ADC testing and a wide range of other tasks."

Nevertheless, when push comes to shove, Dr. Schwartz is most pleased with the EVM testing of TZero's UWB chipset.

"Producing a 528 MHz UWB signal that hops between three bands is one thing; generating, capturing and characterizing a 528 MHz UWB signal that hops between three bands with an EVM significantly better than -19.5 dB is quite another," he quipped. "To our knowledge, no other company had successfully measured EVM for a WiMedia-UWB signal in hopping mode. We weren't sure it was possible, but Tektronix equipment came through."

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