Analog Devices Finds Sensitive Modulator Development Requires High-Performance Signal Generation

Solution Summary

Challenge	Generate dual 200 MHz sine waveforms with the ability to directly adjust amplitude and phase offset, without adversely affecting IQ modulation sensitivity.
Solution	Tektronix AFG3252 Arbitrary/Function Generator, in combination with a Tektronix TDS8000 Series digital phosphor oscilloscope.
Benefits	The AFG3252 delivers two channels and the ability to generate up to 240 MHz sine waveforms, while the TDS8000 Series offers high-performance signal acquisition. In tandem, the instruments enable Analog Devices engineers to evaluate direct RF conversion at high frequencies to quickly identify and correct phase, amplitude and DC offset voltage imbalances.

A cell phone call or text message may seem effortless and instantaneous to the individuals initiating and receiving the transmission, but the process of getting one person's voice or message to reach the other person is anything but simple. Towering base stations with complex reception, modulation and transmission components are essential ingredients of any cellular or digital radio frequency (RF) communication. These behind-the-scenes cogs enable the processing of a voice or text signal into transferable data, and then pass the data to the appropriate location for conversion back to a meaningful signal and reception by the intended recipient.

A key enabler of this intricate signal chain is Analog Devices, Inc., the worldwide leader in high-performance signal processing solutions. Many of the company's integrated circuits and components help facilitate the broadcast and reception of modern voice and data signals. A notable example is its IQ modulators, which utilize I and Q baseband input signals to modulate an RF carrier that is primed for transmission.

The company recently faced a conundrum when its customers began requesting a high-performance modulator that can handle baseband (sine wave) signals with a bandwidth nearing 200 MHz.

"A modulator is a very sensitive device," said Anthony Mazzei, Senior Product Development Engineer at Analog Devices. "We needed test and measurement equipment that would allow fine adjustment of signal parameters and not adversely affect that level of sensitivity. At the same time, we need to generate up to 200 MHz signals that our device would modulate in the real world, and there was only one test instrument on the market that could meet those specifications."

That instrument was the Tektronix AFG3252 Arbitrary/Function Generator. With two channels and the ability to generate up to 240 MHz sine waveforms, the AFG3252 was the only instrument capable of fulfilling Analog Devices' development and testing needs.

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-Anthony Mazzei, Senior Product Development Engineer, Analog Devices

From Research and Development Supplement to Design and Test Necessity

According to Mazzei, Analog Devices initially acquired and utilized the AFG3252 for supplementary research and development purposes.

“It’s a very affordable instrument, and at first we used it to experiment with different operating scenarios and conditions,” he recalled. “For example, we were using the AFG3252 to see what would happen if we put two continuous signals on the same baseband. We were also using it to test the limits of a signal chain by manipulating the local oscillator interface with a square wave.”

Yet when Analog Devices’ customers started calling for an IQ modulator with more than 100 MHz bandwidth, the AFG3252 took on a much larger role. “Other IQ signal generators on the market can only muster a bandwidth of 20 to 40 MHz, which doesn’t come close to meeting our requirements.” Mazzei said. “The AFG3252, with the capacity to produce two synchronous 240 MHz sine waves as well as fine amplitude and phase control, quickly became a design and test necessity.”

Meeting frequency specifications was only half the challenge, he explained. To assure high signal quality, the I and Q arms of the modulator must be symmetrical with respect to signal gain and phase shift. Without this exactness, performance degradation in the RF spectrum can follow, resulting in spectral impurity and the carrier tone bleeding into the output signal.

Therefore, the equipment used to evaluate and characterize IQ modulation during the design stage must also allow the user to directly adjust amplitude and phase between I and Q signals with fine resolution.

“We need to produce the desired tone, suppress all other harmonics and adjust sine and cosine channels to accurately measure the modulator's IQ imbalance and quadrature,” Mazzei noted. “It’s certainly no small feat, but the AFG3252 delivers.”

He added that the performance and stability of the instrument allow Analog Devices engineers to evaluate IQ modulation at a higher frequency than ever before, and to determine and correct phase, amplitude and DC offset voltage imbalances with greater speed and accuracy.

In conjunction with the AFG3252, Analog Devices is utilizing a Tektronix TDS8000 Series digital phosphor oscilloscope to measure and verify the output signals of its latest IQ modulators. Mazzei indicated this combination of high-performance signal generator and oscilloscope delivers real world data to characterize and validate the performance of its device. In the past, he explained, Analog Devices had to use – and was subsequently constrained by – simulation data as the only measure to describe its high-end modulators’ performance.

“We have always been confident about the capabilities of our modulators, but our customers had to rely on and trust simulation data,” said Mazzei. “We now have bona fide specifications to show the real world capabilities of our new modulation devices.”

With accurate data that proves Analog Devices’ latest IQ modulators are meeting customer demands of 200 MHz performance, the product is selling well and boosting the company’s bottom line. Mazzei claimed his company’s favorite signal generation instrument has also reduced development and equipment costs.

“Not only has the AFG3252 met our performance requirements and expedited our time to market, but it’s also roughly 25 thousand dollars less expensive than the lower frequency instruments we considered,” he said. “The disparity doesn’t make sense, but we’re not complaining.”