5G MILIMETERWAVE BASESTATION

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ABSTRACT

5G promises ultrafast data connections by opening up new millimeter-wave spectrum enabling high-gain active antenna phased arrays for beamforming. ADI is providing silicon for the entire 5G signal chain from bits to radiation. In this demo, a complete basestation is described with a live demonstration of over-the-air analog beamforming capabilities.

BACKGROUND & PROJECT DESCRIPTION

The 5th Generation of wireless is still being defined by the 3GPP but already ADI is busy with a full signal chain of products from bits to radiation. One of the most significant changes in 5G will be the introduction of millimeter-wave (mmW) spectrum. To achieve higher data rates approaching 1Gbps, more spectral bandwidth must be made available, which can be found far above the sub-6GHz frequencies we traditionally think of as cellular. Initial 5G mmW deployments are focused on 28 and 39GHz. At these wavelengths active antenna arrays with beamforming techniques can be employed to increase the spectral efficiency and SINR per user of the radio link. With beamforming, each user has its own directional beam which adds another dimension of access, spatial diversity, beyond time and frequency.

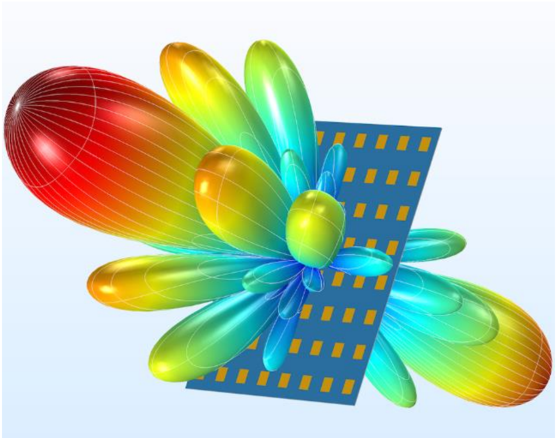

Figure 1: Beamforming with an Active Phased Array Antenna

Figure 1. shows an example phased array antenna. Typical 5G deployments will be rectangular patch antenna arrays made up of smaller sub arrays. Individual antenna elements(patches) are separated by wavelength/2 in the design. A single antenna patch has a nominal gain of 5dB and increases by 3dB each time the number of patches doubles. Since the wavelengths at mmW (10.7mm at 28GHz) are relatively small, large arrays can be constructed achieving highly directional antenna gains as high as 30dB for a 256 element array. In 5G, the antenna becomes so small it can be integrated into the radio itself in what is referred to as Antenna in Package (AiP). Integrating the antenna into the radio is a significant paradigm shift and presents testing and conformance challenges. Historically, basestation radio conformance testing was possible through conducted coaxial cable. Now, Over-The-Air (OTA) techniques are required to fully test the performance and conformance of the radios. Anechoic chambers, which acoustically quiet the RF fields in free-space, allow for antenna characterization, array beamforming calibration, and far-field spectral and modulated conformance testing. Actual beamforming can be done in either the analog or digital domain or in a combination of the two in what is known as hybrid beamforming. Regardless of the beamforming technique, the beam angle is directed by changes in phase of the signal to each antenna element. Changes in amplitude of the signal to each antenna element directly impact side lobe levels.

In order to prepare for ADI's third generation of 5G systems coming in 2018, a prototype 2nd generation system was assembled as a proof-of-concept basestation design. The block diagram of this prototype basestation is shown in **Figure 2**.

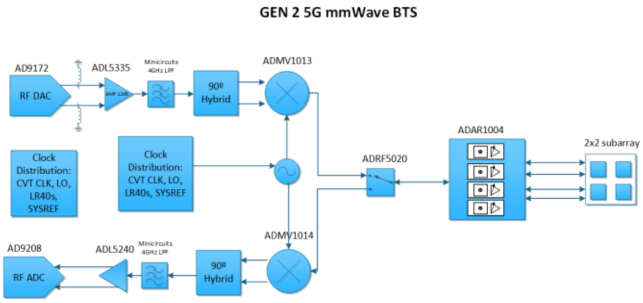

Figure 2. 5G Basestation block diagram with ADI's 2nd generation microwave parts and 28nm RF data converters.

DETAILS OF DEMONSTRATION CONTENTS

In this demonstration, a full 5G basestation is presented with ADI's second generation of microwave products. The Real IF architecture shown in **Figure 3** allows for >1GHz of BW in a mmW band of 28GHz. The baseband radio showcases ADI's latest 28nm RF data converters. For the baseband transmitter the 16-bit, 12GSPS AD9172 RFDAC was chosen, followed by the ADL5335 TxVGA. The ADMV1013, a wideband microwave up-converter translates the baseband 5G signal to the 28GHz spectrum. For the baseband receiver, the 14-bit, 3GSPS AD9208 RF ADC converts the 3GHz IF to digital. This ADC is driven by the ADL5240 VGA. The ADMV1014, a wideband microwave downconverter, translates the mmW spectrum down to baseband. For the mmW front-end, two ADAR1004 beamformer ICs enable the demonstration of analog beamforming for an 8-element linear phase array antenna. This full system is capable of 1.2GHz of un-aliased BW and 20dBm EIRP for small cell deployment.

Beam Directions of -60, -30, 0, +30, and +60 degrees will be demonstrated, highlighting the value of beamforming in regards to per user SINR/EVM and interference mitigation. OTA demodulation of 5G NR waveforms will be demonstrated highlighting wide bandwidth and EVM capabilities.

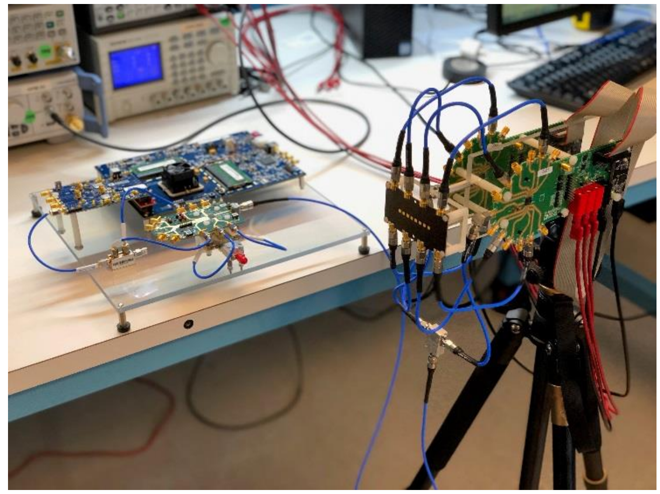

Figure 3. Complete 5G BTS Transmitter with Active Antenna Array showcasing analog beamforming.

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Key Words

5G, Wireless Communications, Basestations, mmW, Beamforming, AD9172, AD9208, Microwave, ADMV1013, ADMV1014, Phased Arrays