Polar ADC and Down Converter

NRAO TECH TRANSFER

A Completely New Breed of Analog-to-Digital Converters

Most autonomous products require sensors to become situationally aware. Our concept consists of a mixed-signal IC that develops a completely new breed of analog-to-digital converters. This ADC converts the inherent bandpass nature of all radio signals (navigation, surveillance and communications) into an asset, by digitizing their amplitude and phase directly from the antenna, removing the need for any down-conversion, and operating at a sampling frequency equal to the signal bandwidth.

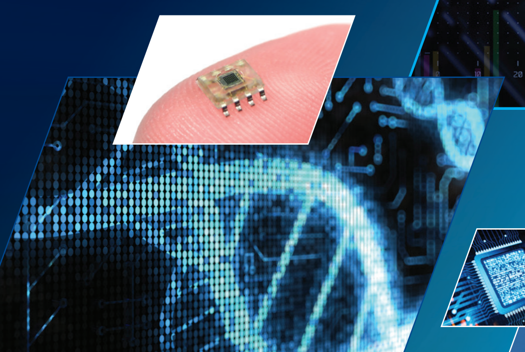
The envisioned ADC can be used in any receiver with a bandpass sensor. Nonetheless, we are targeting only radio receivers at this moment. Our initial objective for this program is to develop a wideband ADC partially covering the SHF band (which spans from 3 to 30 GHz), on a best effort basis. Similarly, the targeted sampling frequencies are about a few gigahertz.

One of the key benefits of the Polar ADC And Down-Converter, or P-$(ADC)^2$, is a reduction of the size, weight, and power (SWaP) requirements of the receiver. This is achieved through two key innovations: Firstly, the receiver no longer requires an analog downconverter and all its associated hardware, such as the local-oscillator circuitry and the frequency mixer. And secondly, the P-$(ADC)^2$ requires less internal circuitry than a traditional ADC, as the signal phase can be extracted with no reference voltage, hence reducing the number of comparators.

A second improvement of the P-$(ADC)^2$ is an increase in the digitized bandwidths, in part because it operates at a sampling frequency equal to the signal bandwidth, regardless of the maximum frequency component of the input signal. Ideally, the antenna would match this bandwidth increase and the entire radio spectrum of

Applications

- Direct RF Sampling
- Software Defined Radio
- Ultra Low Power
- Autonomous Products



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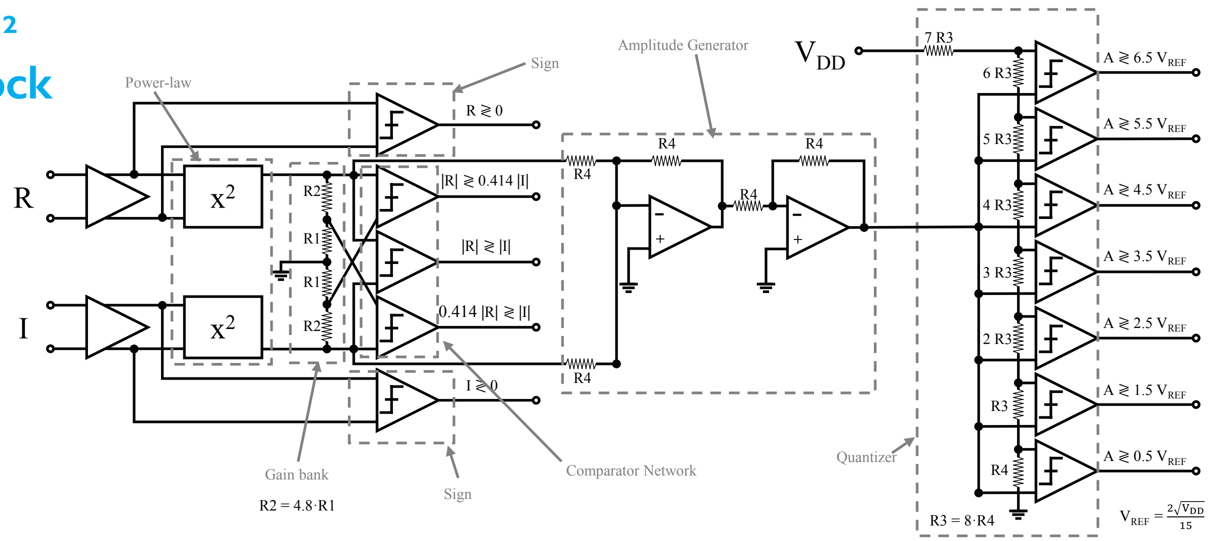
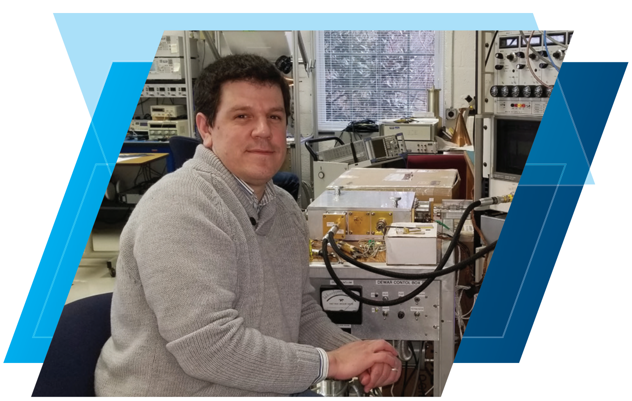
P-(ADC)² Core Block Diagram



interest can be digitized using a single antenna and the P-(ADC)². That will be a game-changing technology dramatically decreasing at once the overall SWaP requirements of all radio systems the autonomous product employs, and the very first true realization of the software defined radio concept (True SDR).

Finally, an additional benefit may derive from working with polar coordinates as opposed to Cartesian ones (or I and Q components). The implementations of many of the initial receiver tasks are simpler when the received signal is represented in polar coordinates, such as a carrier tracking circuit or an automatic gain control. With the P-(ADC)² there is no need for converting IQ components into amplitude and phase at the first stages of the digital signal processor, which could result into the use of a smaller DSP.

The Inventor



Omar A. Yeste Ojeda, PhD, is a Research Engineer at the NRAO Central Development Laboratory. He develops very large scale integration signal processing solutions for future world-class radio astronomy facilities, such as the next generation ALMA and ngVLA instruments. The central signal processor of such facilities performs exascale digital signal processing tasks in real-time and crunches through terabits of data per second from each of the hundreds of steerable antennas. Dr. Ojeda leverages his background in electronic warfare, radar imaging (ISAR/SAR) and avionics, to develop world-class autonomous signal processing core technologies.

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