Integrated VCO ADC

UCSB Capstone Project | Senseeker Engineering Inc.

Senseeker Engineering Inc. provides silicon IP, IC and image sensor design and systems engineering all targeted at the unique needs of the scientific and infrared image sensor community. We specialize in the design of digital imaging sensors and readout integrated circuits for hybrid image sensing arrays. We are located in the Santa Barbara, CA, area amid the west coast's hub of infrared and scientific image sensor companies. For more information visit Senseeker.com.

Project Description

With the advancement of IC technology, digital systems offer many advantages to their analog counterparts. However, the world we live in is analog. The need for a wide range of analog to digital converters (ADCs) to process sensor data has never been greater. At Senseeker, and in the industry as a whole, ADCs are a key technology employed in advanced sensors with integrated processing and functionality.

As CMOS processing technology continues to scale, the design of high-performance analog circuits, like ADC's, becomes increasingly challenging. Often, this results in analog circuits that do not exhibit power and area scaling like their digital counterparts. The Voltage-Controlled Oscillator (VCO) ADC is a topology that addresses the analog scaling issue by using circuit blocks created almost entirely of digital circuits to perform analog functions. Many of the sub-circuits of the ADC can be synthesized from Hardware Design Language (HDL) code, enabling rapid design prototyping.

This project will allow students the opportunity to get hands on experience with a mixed-signal design. Students will become familiar with standard figures of merit for these ADCs and characterize their own design using IEEE standards. Ultimately, we feel this project is an excellent introduction into the world of mixed-signal integrated circuit design without having to first master transistor-level design and may be a strong addition to the students' knowledge and future careers.

Project Objective

We propose creating a VCO ADC design that can be implemented with discrete breadboard components on the front end, and with a digital FPGA backend. Students will create a functional ADC and test their design using IEEE standards 1241-2010. The ADC should have greater than 10 bits of resolution and over 9 bits of effective resolution (aka Effective Number of Bits or ENOB). Sample rate is less important since this is a discrete implementation, but if possible should approach 100s of ksps or into the low Msps.

Project Deliverables

ADC hardware
Datasheet with design specifications and lab measurements to include as many of the following as possible: Resolution, Power Consumption, Offset and Gain Error, Transfer Function, INL, DNL plots taken using the Histogram Method, Noise Transfer Function, SNDR, ENOB and SFDR.

Preferred Student Qualifications

Experience in analog and digital design
Experience with HDL code

Assets Available to Students

Engineers at Senseeker Engineering Inc. available for guidance and assistance
Assistance in getting access to test electronics