Design of Robust and Flexible On-chip Analog-to-Digital Conversion Architecture

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Abstract
This dissertation presents a comprehensive design and analysis framework for system-on-a-chip analog-to-digital conversion design. The design encompasses a broad class of systems, which take advantage of system-on-a-chip complexity. This class is exemplified by an interferometric photodetector array based bio-optoelectronic sensor that is built and tested as part of the reported work. While there have been many discussions of the technical details of individual analog-to-digital converter (ADC) schemes in the literature, the importance of the analog front-end as a pre-processor for a data converter and the generalized analysis including converter encoding and decoding functions have not previously been investigated thoroughly, and these are key elements in the choice of converter designs for low-noise systems such as bio-optoelectronic sensors. Frequency domain analog front-end models of ADCs are developed to enable the architectural modeling of ADCs. The proposed models can be used for ADC statistically worst-case performance estimation, with stationary random process assumptions on input signals. These models prove able to reveal the architectural advantages of a specific analog-to-digital converter schemes quantitatively, allowing meaningful comparisons between converter designs. The modeling of analog-to-digital converters as communication channels and the ADC functional analysis as encoders and decoders are developed. This work shows that analog-to-digital converters can be categorized as either a decoder-centered design or an encoder-centered design. This perspective helps to show the advantages of nonlinear decoding schemes for oversampling noise-shaping data converters, and a new nonlinear decoding algorithm is suggested to explore the optimum solution of the decoding problem. A case study of decoder-centered and encoder-centered data converter designs is presented by applying the proposed theoretical framework. The robustness and flexibility of the resulting analog-to-digital converters are demonstrated and compared. The electrical and optical sensitivity measurements of a fabricated oversampling noise shaping analog-to-digital converter circuit are provided, and a sensor system-on-a-chip using these ADCs with integrated interferometric waveguides for bio-optoelectronic sensing is demonstrated.

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control systems, data computing, data transmission and information processing. Figure below shows the input/output relationship of an ADC. Input and output definitions of an Analog to Digital converter. Analog to digital converter. Usually transducers are also used to convert the Analog to digital conversions are dependant on the system voltage. Because we predominantly use the 10-bit ADC of the Arduino on a 5V system, we can simplify this equation slightly: If your system is 3.3V, you simply change 5V out with 3.3V in the equation. Resources and Going Further. Doing analog digital conversions is a great thing to learn! Now that you have an understanding of this important concept, check out all the projects and sensors that utilize analog to digital conversion. Some varieties of accelerometers and gyroscopes have analog outputs that must be read in on an ADC to get usable values. In electronics, an analog-to-digital converter (ADC, A/D, or A-to-D) is a system that converts an analog signal, such as a sound picked up by a microphone or light entering a digital camera, into a digital signal. An ADC may also provide an isolated measurement such as an electronic device that converts an input analog voltage or current to a digital number representing the magnitude of the voltage or current. Typically the digital output is a two's complement binary number that is proportional to the