



Lower Bounds on the Performance of Analog to Digital Converters

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This paper deals with the task of finding certified lower bounds for the performance of Analog to Digital Converters (ADCs). A general ADC is modeled as a causal, discrete-time dynamical system with outputs taking values in a finite set. We define the performance of an ADC as the worst-case average intensity of the filtered input matching error, defined as the difference between the input and output of the ADC. The passband of the shaping filter used to filter the error signal determines the frequency region of interest for minimizing the error. The problem of finding a lower bound for the performance of an ADC is formulated as a dynamic game problem in which the input signal to the ADC plays against the output of the ADC. Furthermore, the performance measure must be optimized in the presence of quantized disturbances (output of the ADC) that can exceed the control variable (input of the ADC) in magnitude. We characterize the optimal solution in terms of a Bellman-type inequality. A numerical approach is presented to compute the value function in parallel with the feedback law for generating the worst case input signal. The specific structure of the problem is used to prove certain properties of the value function that simplifies the iterative computation of a certified solution to the Bellman inequality. The solution provides a certified lower bound on the performance of any ADC with respect to the selected performance criteria.

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