Reader Systems for Delay-Line based SAW Sensors: Modeling and Performance Analysis

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In modern industrial applications sensors based on surface acoustic wave technology achieve excellent results where other sensor types fail due to harsh environmental conditions. Besides the quality of the SAW sensor itself, the design of the interrogation unit has significant impact on the achievable performance of the entire measurement system. Therefore, in this contribution we introduce a comprehensive modeling approach for delay-line based SAW sensor systems, treating both – hardware as well as signal processing aspects.

We focus on the design of reader units operating in the frequency domain[1,2], namely frequency-stepped continuous-wave radar devices. Here we demonstrate the interaction of hardware specific factors, such as transceiver characteristics and noise contributions, as well as interrogation parameters, such as sweep bandwidth and number of samples acquired in the baseband stage. These parameters define the signal to noise ratio, which allows to predict the achievable accuracy for the measurement results. The presented system model is fully parametric and calculates this important quality indicator by means of closed form expressions. With this toolset the designer is capable of identifying bottle-necks within the system configuration, it furthermore enables the realization of neatly specified and therefore cost efficient reader designs. Moreover the developed models provide valuable information on the expected measurement statistics[3], which can be used, e.g., for prediction of code error probability in ID applications or measurement uncertainty in sensor applications.

The performance and capabilities of the developed modelling technique are shown on a system design example as well as practical measurement results, using a novel multichannel 2.45 GHz ISM band SAW reader system[4].

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