Algorithms and Accuracy Considerations for SAW Sensor based Temperature Measurement

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Wireless sensing with SAW delay line sensors is an emerging topic[1]. Especially remote temperature measurement applications have received significant attention in recent years because of the robustness of these sensors against harsh environmental conditions together with their capability of delivering highly accurate temperature measurements. In this contribution, a comprehensive framework consisting of easily applicable formulas for assessing the achievable temperature estimation accuracy is presented. It is shown that the SAW sensor temperature estimation problem is basically a sinusoidal parameter estimation problem. This enables the application of statistical performance limits like the Cramer-Rao lower bound[2, 3]. From these limits, the key parameters and some trade-offs for designing interrogation systems can be deduced. Influence of amplitude modulation, window functions, etc., have also been investigated.

To give an overview of available algorithms for temperature estimation, both standard frequency estimation and phase estimation based procedures are treated. Furthermore we present an estimator that combines the information encoded in the frequency and in the phase domain[4]. Also, results for temperature tracking based on Kalman filtering are shown.

The impact of often neglected parameters like reflections in between individual reflectors on the SAW tag or phase offsets is discussed. Such disturbances can significantly deteriorate temperature estimation results and lead to strongly biased temperature estimates. Because of the latter imperfections, the necessity to use a calibration for each SAW tag in order to obtain temperature estimates with absolute accuracy in a range below 1°C is finally discussed.

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