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Title:	High-speed torque sensing in car engines by means of SAW resonators
Abstract:	<p>A number of SAW torque sensors have been developed for laboratory testing, automotive and industrial applications. Most of these applications require either measurement of average torque or slowly varying torque so the sensor bandwidth needed is only 1-2 kHz. However, there are applications such as IC engine control that would benefit from considerably faster torque sensors. The paper presents a new high-speed reader for interrogation of the resonant SAW torque sensor that allows achieving more than 8 kHz system bandwidth and some experimental results obtained with this reader on the test rig.</p> <p>The reader is based on a pulsed interrogation of the SAW resonators in the time domain but, unlike the previous one, it does a simultaneous excitation of two of them contained in the differential sensor and a parallel spectral analysis of their response. The significant increase of the system bandwidth is achieved at the expense of doubling the number of components used in the new reader in comparison with the old one. However, a special interrogation algorithm allows almost tripling the speed of interrogation as a result.</p> <p>Simultaneous interrogation of the two resonators causes additional frequency measurement errors associated with a mutual influence of the two strong SAW responses received in a single receiver. A method of error reduction to an acceptable level by means of window functions is proposed. Another source of errors discussed is intermodulation products generated due to nonlinearity of the receiver. In conjunction with aliasing, they can significantly increase non-linearity of the sensor characteristics. Design rules are proposed that allow significant reduction of these errors.</p> <p>The reader has been tested in conjunction with the flexplate torque transducer attached to a crankshaft of an IC engine. Some test results are presented that confirm a possibility of a high-speed measurement of the output engine torque.</p>