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A lossy, one-dimensional, linear systems model for piezoelectric transducers containing opposing zones of polarization

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Inversion layer transducers (ILT), consisting of two or more active, piezoelectrically opposed regions along their thickness direction, have attracted considerable interest in the recent past, due to the potential for wide bandwidth and even harmonic sensitivity. However, design and manufacture of such ILT devices are not straightforward due to the large number of degree of freedom involved. This paper presents the development of a lossy, computationally efficient analytical model to design ILT configuration.
The mathematical formulation for a generalized linear systems model, applicable to arbitrary ILT configurations is presented. The model describes multiple active and passive layers, including zones of variable piezoelectric polarization, matching layers and bondlines. The model is extended further to include mechanical wave absorption in both the active transducer element and the propagating channel, and the effect of such frequency dependant loss on the operational characteristics of an ILT device is reported.
Several simulation results are shown to demonstrate the feasibility of the approach together with a comparisonal analysis to conventional finite modeling techniques and experimental evaluations. The results indicate clearly that such approximate analytical techniques can be used effectively to design optimal ILT configurations.