Admittance Calculation for Periodic SAW Transducers

Abstract

This lecture focuses on the calculation of periodic SAW transducer admittance. The SAW transducer admittance accurately accounts for both acoustic radiation conductance and susceptance in the quasi-static approximation (i.e. neglecting interelectrode SAW reflections). For calculation, the author introduces the concept of a nodal admittance matrix of a SAW transducer. First, self- and mutual elemental nodal admittances of a periodic SAW transducer with uniform aperture are deduced in the closed-form. Physical meaning of the elemental admittances is explained.

Next, given the closed-form nodal admittance matrix and transducer electrode voltages, an analytic expression for the admittance of a SAW transducer with uniform aperture and arbitrary polarity sequence of electrodes is derived. Admittance of the aperture-weighted (apodized) SAW transducer is found by applying this equation to an arbitrary intersection of an apodized transducer and then closed-form integration over the entire transducer aperture.

In particular, within model constraints applied, acoustic admittance of the aperture-weighted SAW transducer is a weighted sum of the nodal interelectrode admittances, with weights given by the effective apertures. Effective apertures are defined as the total overlaps for all the nearest electrodes, next nearest ones, and so on, respectively. They are frequency-independent and depend only on the SAW transducer topology (apodization).

Furthermore, the author applies a special summation technique for the apodized periodic SAW transducers with a fixed pitch and metallization ratio. The summation takes into account periodic properties of the nodal admittance matrix allowing to convert two-dimensional summation into one-dimensional one. As a result, computation time is drastically reduced if compared to the wide-spread aperture channelizing technique.

Moreover, the full periodic SAW transducer admittance (comprising both conductance and susceptance) is given by the Fourier transform of a set of effective apertures. Assumed for the set of the effective apertures to be determined a priori, acoustic admittance calculation takes no more time than frequency response calculation of a SAW transducer, in the quasi-static approximation.

Furthermore, the Fast Fourier Transform (FFT) can be effectively applied to calculate the admittance characteristic in the wide frequency range for the narrowband SAW transducers with the large number of electrodes.

The method is quite general and can be generalized to capacitively-weighted, polarity-weighted, multi-phase, and other periodic SAW transducers having the central frequency away from the synchronous frequency.

Finally, the results of admittance calculation for apodized SAW transducers with split (double) fingers are presented which agree well with the measured admittance characteristics.

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