Basics of IF SAW Filter Design

Abstract

Basic properties of linear- and nonlinear-phase periodic SAW transducers with a constant period (pitch) and constant metallization ratio (duty factor) are considered in the quasi-static approximation, i.e. neglecting interelectrode reflections. It is shown that a SAW transducer frequency response can be represented as the product of the array factor and element factor. The former is basically responsible for the passband shape of the bandpass frequency response, whereas the latter is the wideband frequency-dependent function that accounts for the metallization ratio and describes harmonic behavior of the response in the wide frequency range. SAW transducers are classified with respect to their symmetry type, sampling rates in the time and frequency domains, and even/odd number of electrodes. Symmetry properties of the magnitude and phase response are discussed.

Basic properties of the array and element factors are discussed in details. The difference between overlap- and finger-length weighted (apodized) SAW transducers is explained in terms of their element factors. Advantages and disadvantages of each weighting method are discussed and practical recommendations on how to correctly apply overlap- and finger-length weighting are given. It is shown that the element factor results in the distortion (slant) of the passband magnitude response that might be significant for wide-band SAW transducers. In most practical cases, the passband distortion of the frequency response due to the element factor is negligible and the quasi-static model can be approximated with good accuracy by the impulse model, with the frequency response and transducer tap weights related via Fourier transform. In other words, SAW transducer frequency response is approximated by the array factor only which is virtually a trigonometric polynomial.

Properties and limitations of the impulse model are considered for linear- and nonlinear-phase SAW transducers. It is shown that the array factor can be equivalently represented in the frequency, time, or Z-transform domains. The equivalence and interrelation of these three basic forms of the frequency response representation is discussed, with trigonometric basis function properties in time and frequency domains considered. Properties of the Z-transform are discussed, with Z-transform roots classified with respect to their phase characteristics and partial contributions to an overall SAW transducer frequency response.

Passband and stopband properties of the Z-transform roots are considered. Methods of the reduction of the number of parameters to describe frequency response without sacrificing approximation accuracy are suggested.

The lecture material is illustrated with design and modelling examples.

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