COM-Analysis of SAW Devices

Abstract

The coupling-of-modes (COM) approximation is a closed-form technique to model systems with spatially varying properties which is a convenient tool for modelling low-loss SAW filters taking into account interelectrode reflections due to mass-electrical load effect. Basic COM-equations are deduced and applied to the analysis of SAW reflective arrays and transducers. Analytic solution of the reduced system of homogeneous differential equations for reflective grating is considered. Reflection and transduction properties of the reflecting grating are discussed. General solution of the linear system of inhomogeneous differential equations describing an interdigital transducer is considered, with an additional equation containing terminal current flowing into SAW transducer added. Radiation and reception characteristics of a SAW transducer are deduced from which the closed-form mixed scattering matrix (P-matrix) of a SAW transducer is constructed.

COM equations involved in the model are characterized by four independent COM-model parameters, namely, self- and cross-coupling coefficients, SAW excitation function, and static capacitance to be determined a priori. Generally, these COM parameters depend on the frequency, substrate and electrode material, and transducer geometry (metallization ratio, pitch, and metal height). Derivation of COM-parameters from theory or experiment is considered, with their physical meaning explained. Application of the COM method is illustrated by analysis of SAW reflectors, self-matched SAW transducers, long resonant transducers with internal reflections, one- and two-port resonators, and Double Mode SAW (DMS) filters with good agreement between theory and experiment observed.

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