

Design of SPUDT/RSPUDT SAW Filters

Abstract

The lecture reviews basic properties and design principles of SAW filters using **Single Phase Unidirectional Transducers (SPUDT)**. Based on the general properties of the mixed scattering (P-matrix) of a SAW transducer as a three-port reciprocal and lossless network, it is shown that acoustoelectric conversion is related to the transducer short-circuit reflection. A condition of the transducer global directivity is deduced from the condition of the net zero reflection coefficient at the forward (backward) acoustic port of a SAW transducer that includes both mechanical (mass-electrical loading, short-circuit SPUT) and regenerated reflections (transducer terminated by the electrical load). As can be shown, the global directivity condition reduces to the 45° phase shift between the global transduction and reflection centers of a SAW transducer. Local directivity condition applied to each SPUDT elemental cell is discussed.

Three basic types of the SPUDT elemental cells are considered, in particular, 1) **DART** - **D**istributed **A**coustic **R**eflector **T**ransducer, 2) **EWC** - **E**lectrode **W**idth **C**ontrolled Transducer, and 3) Hunsinger's unbalanced split electrode structure. The relative positions of the reflection and transduction centers for the elemental cells of the different types are evaluated by the numeric calculations.

Concept of the reflective SPUDT (RSPUDT) is discussed, with the elemental SPUDT cells generalized to the RSPUDT implementation. Conversion between standard SPUDT cells with positive reflectivity and inversed SPUDT cells with negative reflectivity is considered. Superiority of the RSPUDT design over the conventional SPUDT design is demonstrated by some examples.

Practical aspects of SPUDT design based on the bidirectional split-finger prototype are discussed. Contrary to the conventional bidirectional SAW filters, both the weighted transduction (SAW excitation) and the weighted reflection functions are to be simultaneously synthesized that greatly complicates the synthesis problem of SPUDT SAW filters. A simplified SPUDT synthesis algorithm is discussed which is modification of the auto-correlation technique for synthesis of the weighted reflection function.

The problem of the RSPUDT optimum synthesis is discussed using the Chebyshev non-linear approximation. The general non-linear programming optimization needs to be applied to solve the optimization problem.

SPUDT/RSPUDT SAW filter simulation is discussed using the matrix cascading the elemental cells. The recurrent cascading relations are deduced. The estimated reflection coefficients of the basic SPUDT elemental cells are presented.

SPUDT/RSPUDT design is illustrated by the CDMA SAW filter with the central frequency $f_0=85.38$ MHz. The classical SPUDT design and optimized RSPUDT design are presented and compared. Both filters have good triple transit echo suppression and low insertion loss when properly matched. However, while the CDMA SPUDT SAW filter fits the long SMD package 19 x 5 mm, RSPUDT SAW filter is almost twice shorter die size fitting the 13.3 x 6.5 mm package.

Good correspondence between simulated and measured SPUDT/RSPUDT SAW filter characteristics is observed.

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