

# Charge Distribution and Capacitance Calculation for Generalized Periodic SAW Transducers

## Abstract

Analytic formulae for the surface charge density, electrode charges, and capacitance of generalized periodic SAW transducers with uniform finger spacing (pitch, or period) and constant metallization ratio are derived. The initial electrostatic problem for the finite length transducer is approximated by an auxiliary one with periodic boundary conditions on the surface. In the new electrostatic problem, a SAW transducer containing  $N$  electrodes with arbitrary voltages  $V_i$  is treated as one generalized period of the infinite periodic array derived by subsequential periodic replications of the initial transducer. The closed-form electrostatic solution for one generalized transducer period is deduced using Floquet's theorem, superposition principle, and the known analytic solution for the charge density in a periodic phased array of strips with the same strip voltages and phase progressing uniformly along the infinite array.

It is shown that electrode charges and voltages within one generalized period of  $N$  electrodes are interrelated via closed-form capacitance matrix or pseudo-inverse potential matrix. The general expression for the transducer static capacitance is derived in terms of weighted interelectrode capacitors between nearest neighbor electrodes, next nearest ones and so on. The derived formula for the capacitance is applicable both to uniform as well as to apodized (aperture-weighted) transducers.

The general solution of the "mixed" electrostatic problem is also considered where each electrode is characterized either by its potential or by its charge. The mixed unknown variables (whether charges or potentials) are determined in terms of a priori prescribed known voltages and charges using capacitance or potential matrices. As a special case, the solution for SAW transducers with floating electrodes follows from the general solution by imposing charge neutrality condition on the single floating electrodes or floating sections consisted of several interconnected floating electrodes.

Examples of charge distributions and capacitance calculations for some practical transducers are presented.

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