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SHAPING OF SAW TRANSDUCER PATTERNS BY FREQUENCY-SPACE APODIZATION

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Several new structures of interdigital transducers of surface acoustic waves for shaping prescribed radiation patterns are suggested. Comparison between frequency-space and phase apodization is performed and an analogy between them is drawn. Some types of transducers with compensation of distortions of frequency responses are proposed, and experimental characteristics of the filters are presented.

The signal processing devices for surface acoustic waves (SAW) usually employ a beam with rectangular amplitude profile having high diffraction divergence. The shaping of a smooth SAW beam, sloping down at the edges of the amplitude profile, will make it possible to diminish the diffraction distortion. When dealing with single-mode beams in narrow-aperture structures, we have to shape and process a SAW beam with cosine profile. The shaping of special radiation patterns (RP) with the aid of frequency-space apodization (FSA) permits us to improve selectivity due to the additional possibility of weighting.

Shaping of radiation patterns. Consider the application of FSA for shaping a SAW beam with an arbitrary amplitude profile. Figure 1*a* depicts an interdigital transducer (IDT) used for shaping an arbitrary RP. The IDT includes two electrode-type structures with overlapping electrodes *1* and *2*. The width of electrodes *1* and the distance between adjacent electrodes in the combs *1* and *2* equals $\lambda_0/8$. The width of electrodes *2* in the middle of the IDT aperture is $5\lambda_0/8$, where λ_0 is the SAW length at the middle frequency. Electrodes *1* are tilted, with their inclination direction alternating about the SAW front.

Consider the shaping of a SAW amplitude profile corresponding to an IDT RP. Let us arrange the SAW δ-sources in the center of gaps between electrodes *1* and *2*. Replace two δ-sources, located in the left and right of each electrode *1*, by a single equivalent source arranged along the axial line of this electrode. The frequency dependence of the equivalent source amplitude, as compared with the IDT frequency response (FR), may be neglected. Thus, the equivalent source is also considered the δ-source.

Let us find the resulting amplitude $u(y')$ of surface acoustic waves radiated by two electrodes *1* adjacent to electrode *2*: $u(y') = u_+(y) + u_-(y)$, where the y'–axis is oriented along the axial line of electrode *2*; $u_\pm(y) = 0.5e^{\pm jkx}$ are waves radiated by δ-sources located, respectively, to the left and right of the y'–axis; to make the mathematics easier, the wave amplitude is assumed equal to 0.5; $x = \lambda_0 / 2 - l(y)\,\mathrm{sign}(y)$, $\mathrm{sign}(y) = \begin{cases} 1, & y \ge 0, \\ -1, & y < 0. \end{cases}$ Thus, $u(y') = \cos kx$. At the middle frequency we have $u(y') = \cos k_0 l(y)$, where $k_0 = 2\pi/\lambda_0$. Hence, $l(y) = k_0^{-1} \arccos u(y)$, where $u(y)$ is the prescribed RP, and we assume that $u(y) = u(y')$. The obtained expression dictates the distance $l(y)$ between the axial line of electrode *1* and axial line of its

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