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BRIEF NOTE

NEW DISPERSIVE IDT

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A new structure of interdigital transducer (IDT) of surface acoustic waves is proposed having useful property as concern the overtone frequency response. The proposed transducer utilizes both dispersive aperiodic system of electrodes, and apodization.

Let us consider a chirp signal with a time-duration T and a passband B, $t \in (-T/2, T/2)$

$$h(t) = \sin \phi(t), \qquad \phi(t) = 2\pi\left(f_0 + \frac{B}{2T}\,t\right)t \tag{1}$$

A typical dispersive IDT has its electrodes placed at $x_n = vt_n$ on the substrate surface, where

$$\phi(t_n) = n\pi \tag{2}$$

It is well known that the frequency response of such transducer can be severely spoiled due to the Bragg reflection of SAW from transducer fingers [1]. To avoid that, one may use split fingers applying $\pi/2$ instead of π in Eq. (2). Below we propose yet another method.

Consider the signal $h(t)$ superposed on another chirp pulse h'

$$s(t) = \sin 2\pi\left(f_0 + \frac{B}{2T}\,t\right)t + \sin 2\pi\left(f'_0 + \frac{B'}{2T}\,t\right)t = 2\sin\phi'(t)\cos\phi''(t)$$

$$\phi' = 2\pi\left(\frac{f_0 + f'_0}{2} + \frac{B + B'}{4T}\,t\right)t, \quad \phi'' = 2\pi\left(\frac{f'_0 - f_0}{2} + \frac{B' - B}{4T}\,t\right)t \tag{3}$$

The corresponding dispersive IDT will have electrodes placed accordingly to Eq. (2) but with ϕ' replacing ϕ; the apodization of the transducer is described by cos $\phi''(t_n)$. The local wave-number of strips is $2d\phi'/dx$, $x=vt$ (the factor 2 is the consequence of Eq (2)). Note that applying suitable f'_0, the synchronous Bragg reflection is removed from the DDL passband. This is because the x-dependent local wave number of strips is shifted to $2\pi(f_0+f'_0)/v$ while the Bragg condition requires its value equal double SAW wave number, that is $4\pi f_0/v$.

The advantage of the proposed structure (several others can be deviced in similar manner, generally h' should be a passband signal; if $f'_0=3f_0$ and $B'=3B$, we obtain split fingers, if $B'=-B$, we obtain a dispersive IDT having periodic fingers with apodization [2]) is two-fold

- the above-mentioned reduction of Bragg reflections,
- and additionally if $B'=0$, the introduced passband is of sin x/x shape placed at the chosen frequency f'_0. This spurious passband is easily rejected from the filter passband with help of the properly chosen second IDT of the filter.

This particular case is shown in Fig. 1, where the amplitude response of the sample dispersive IDT was calculated applying $B'=0$ and $f'=f+2B$. The fundamental, and the overtone passbands are shown.

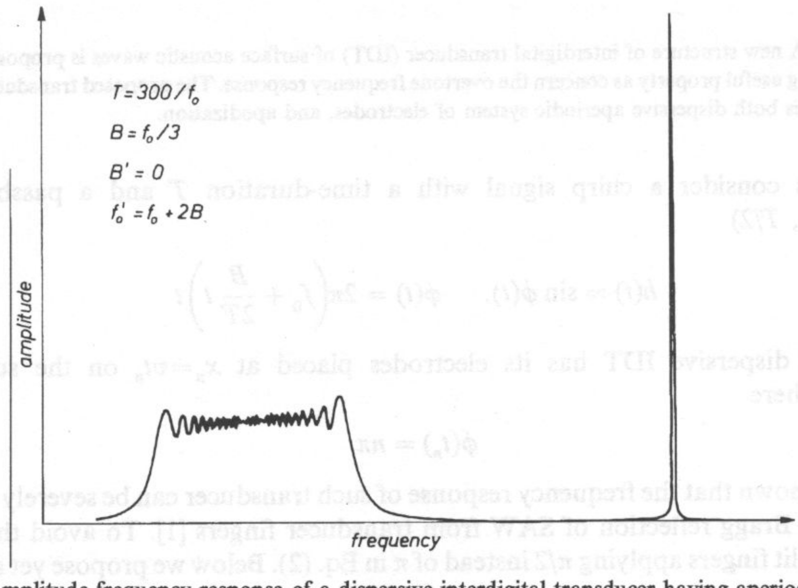

Fig. 1. Amplitude-frequency response of a dispersive interdigital transducer having aperiodic electrodes with apodization.

As concern the theory of the proposed transducer, that presented in [3] can be particularly useful as it allows to analyze nearly periodic electrodes which are the most common cases in dispersive filters.

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References

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[3] E. DANICKI, *Generation and Bragg reflection of SAW in nearly periodic system of elastic metal strips on piezoelectric halfspace*, J. Acoust. Soc. Am., **93**, 116–131 (1993).

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