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Low Loss, Wide Band, Phase Linear, Sharp Cut-off Filters Using Unidirectional IDT with Phase Shifters

位相器構造一方向性すだれ状電極を用いた位相直線,
広帯域角形,低損失フィルタの解析

Yusuke Satoh† and Kazuhiko Yamanouchi (Tohoku Institute of Technology)
佐藤悠介†，山之内和彦（東北工大 工）

1. Introduction

In order to obtain the high performance Surface Acoustic Wave (SAW) devices, it is very important for the intrerdigital transducer (IDT) to be made the unidirectional ones (UIDT) together with SAW materials. Especially mobile communication and UWB communication systems require the phase linear, wide band, low-loss filters at GHz-ranges.

Many types of unidirectional transducers are proposed:

(1) UIDT with Multi-phase shifters, (a) Three Phase UIDT [1], (b) Group Type 90°-Phase shifter UIDT [2],

(2)Internal reflection type UIDT [3] and grating reflection type UIDT,

(3) Single phase UIDT using the anisotropy of substrate [4],

(4) Floating electrode reflection type UIDT[5], etal.

Low-loss, wide band, phase linear, sharp cut-off filters using dispersive UIDT and tapered UIDT with internal reflections are proposed [6]. Above filters are some difficulties of fabrication process of UIDT and low-loss properties.

In this papers, UIDT filters with multi-phase shifter using the tapered and dispersive IDT[7],[8] with low-loss, wide band, phase linear, sharp cutoff are described. Especially, group type 90° phase shifter UIDTs have the good properties obtained by using the only one inductor operating as a phase shifter and matching circuit.

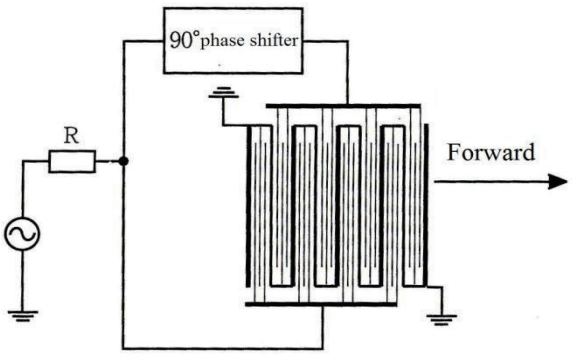

Fig.1 Group type unidirectional IDT (N4-I).

2. New configuration with the tapered UIDT and dispersive UIDT with phase shifter and calculation results

Figure 1 shows the normal type of GUIDT with the 90° phase shifters of pair number of N=4 and group number of I (N-4-I). N-type has the λ width earth electrode for obtaining the in-phase between each group. The earth electrode of λ is eliminated by using the λ/6 width of electrode, called in new types (NN-4-I), as shown in Fig.2. In this case, high efficient UIDT with no spurious forward wave can be obtained, as shown in Fig.3, calculated by the equivalent circuit model.

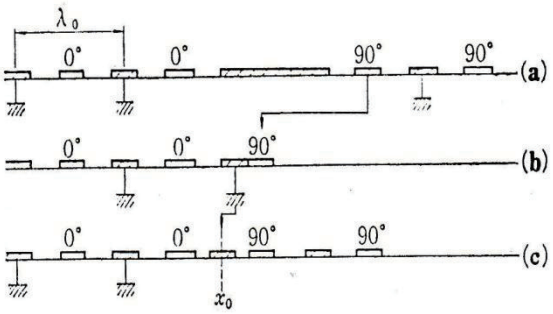

Fig. 2 Explanation of elminating earth electrodes, λ_0.

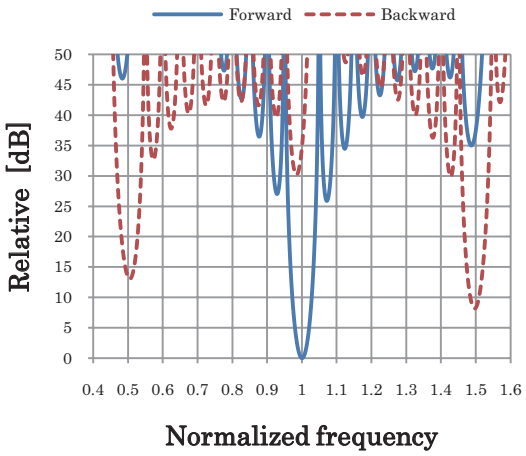

Fig.3 Frequency characteristics of GUIDT (NN-2-I-10)

yamasaw@tohtech.ac.jp

The tapered IDTs (shown in Fig.4) are applied for Group type UIDTs.

Figure 5 shows the frequency characteristics of the tapered GUIDT filters with the band width of 15% (divided channel number of 7, NN-2-I-15, using the rectangular models. Good frequency characteristics with flat wide band and sharp cut off are obtained.

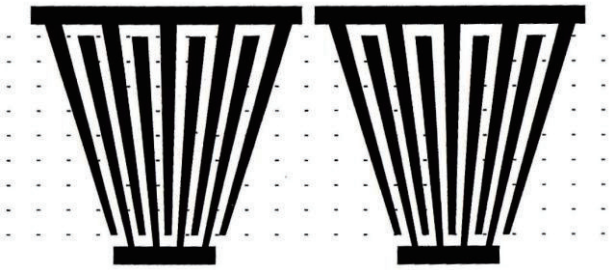

Fig.4 Tapered IDT.

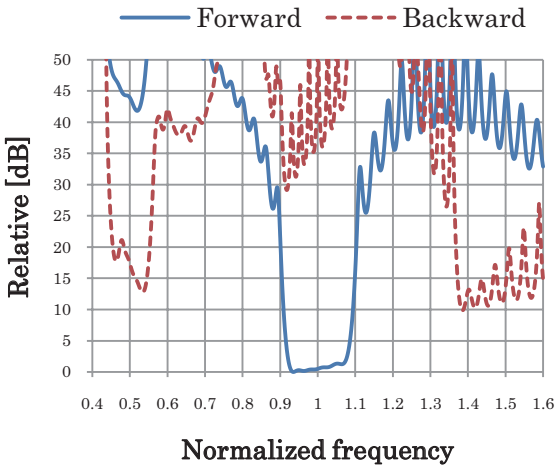

Fig.5 Frequency characteristics of tapered GUIDT (NN-2-I-15, channel number 7)

The dispersive IDTs (shown in Fig.6) are applied for Group type UIDTs.

Figure 7 shows the frequency characteristics of dispersive GUIDT filters with the band width of 30% (NN-2-I-100, using the rectangular models. Good frequency characteristics with flat wide band and sharp cut off are obtained.

Tapered and dispersive GUIDTs require a meander line type of earth electrode for single step photo-lithography. However we can obtain the GUDIDT without the meander line using the dielectric thin film layer for cross-over electrodes.

Also, GUIDT can be obtain by using the only one inductor operating as matching and 90° phase shift.

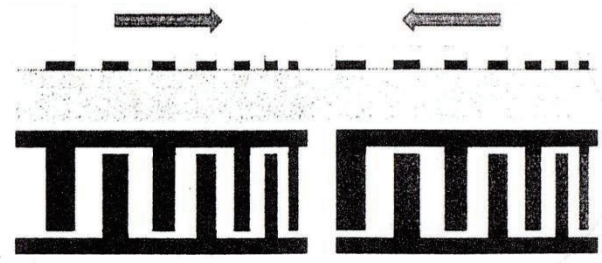

Fig.6 Dispersive IDT with linear phase.

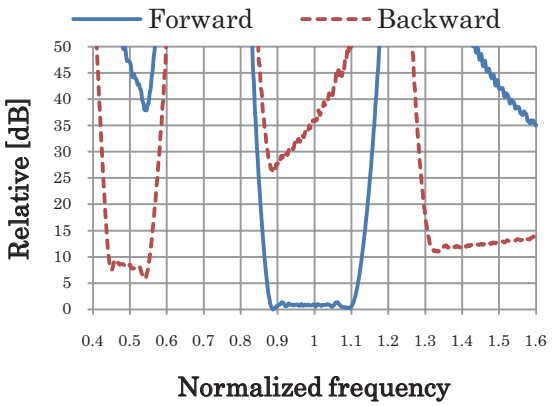

Fig.7 Frequency characteristics of dispersive GUIDT(NN-2-I-100, BW=30%)

Conclusion: We proposed the low Loss, wide Band, phase Linear, sharp cut-off filters Using Unidirectional IDT with Phase Shifters. Good frequency characteristics are obtained. We are now taking the fabrication of devices and measuring of filters.

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