

# Design & Simulation of Surface Acoustic Wave (SAW) Filter at 70MHz for Digital Data Transmission

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**Abstract**-The Surface Acoustic Wave(SAW) filter has found wide applications in digital communication due to its linear phase response. The important parameters to design SAW filter are number of fingers, spacing between fingers, their shapes. The SAW filter at 70MHz center frequency having bandwidth of 15% will be designed by using 2-IDT structure. The piezoelectric substrate will be used. The proposed filter will show the insertion loss of 2.5 to 3.5dB . The simulation results will be measured using CST microwave studio .By using remez algorithm in MATLAB frequency response is calculated.

**Key word**-SAW filter, Remez algorithm

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## I. INTRODUCTION

The uses of the RF devices have been increasing day by day. Filters are the most important device in communication channel. Now a days SAW devices are most commonly used in many systems. As SAW filters have many advantages compare to another filter it has been widely used in many communication systems.

The proposed work will be done to design a SAW filter at 70MHz that can be used for digital data transmission as 70MHz which is called the intermediate frequency for all digital communication devices. By using LiNbO<sub>3</sub> as piezoelectric substrate and 2-IDT structure the SAW filter will be designed. The simulation will be done using CST(Microwave Studio).Also the results in MATLAB are shown using Remez algorithm.

## II. DESIGN OF SAW FILTER

Basic design of SAW filter contains IDT structure. Figure 1 shows labeled structure for IDT.

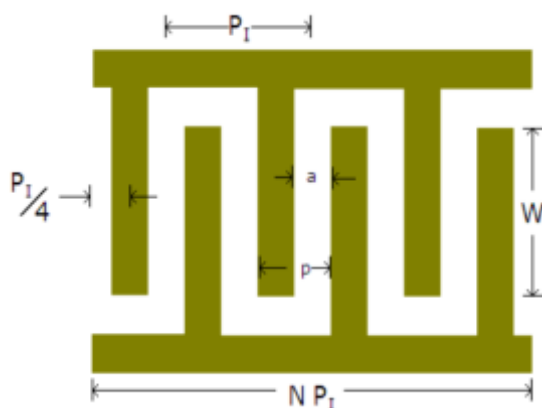


Fig-1 Labeled structure of IDT

Here  $P_1$  is the pitch of the electrodes,  $W$  is the aperture of electrodes and  $N$  is the number of finger pairs,  $h$  is the thickness of metal line will be deposited on substrate, the width of the finger in IDT and space between IDT will be equal to  $P_1/4$ .

### SAW Filter Design:-

1. Specifications
2. Selection of Substrate
3. Selection of Metallization
4. IDT Structure

First of all specifications were selected such as center frequency of 70 MHz, Bandwidth as 15% of the center frequency, Insertion loss of 2.5 to 3.5 dB.

For the selection of piezoelectric substrate the coupling coefficient, temperature coefficient of delay velocity of SAW waves should be taken into account

Number of finger pairs( $n$ )= $\frac{1}{BW}$ ,

Number of finger( $N$ )= $2n+1$ ,

value of pitch( $\Delta$ )= $\frac{\lambda}{2}$ ,

Width of finger= $\frac{\lambda}{4}$ ,

Here the wavelength is dependent on the center frequency and velocity of SAW waves.

Sr No	Parameter	Value
1	Center frequency	70MHz
2	Wavelength	49.82 $\mu\text{m}$
3	Finger pairs	7
5	Value of pitch	24.91 $\mu\text{m}$
6	Width of finger	12.45 $\mu\text{m}$
7	IDT length	348 $\mu\text{m}$
8	Minimum aperture	70.58 $\mu\text{m}$
9	Substrate Length	798 $\mu\text{m}$
10	Substrate Width	108 $\mu\text{m}$

Table-1 parameters for design

Modeling was done using CST microwave studio.



Fig-2 model of SAW filter in CST

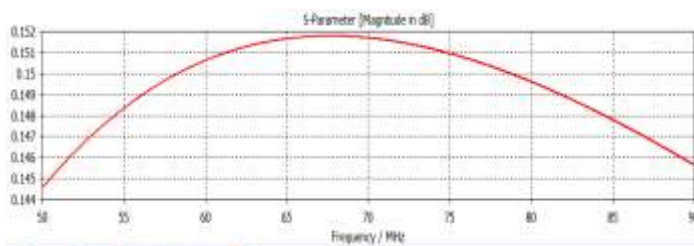


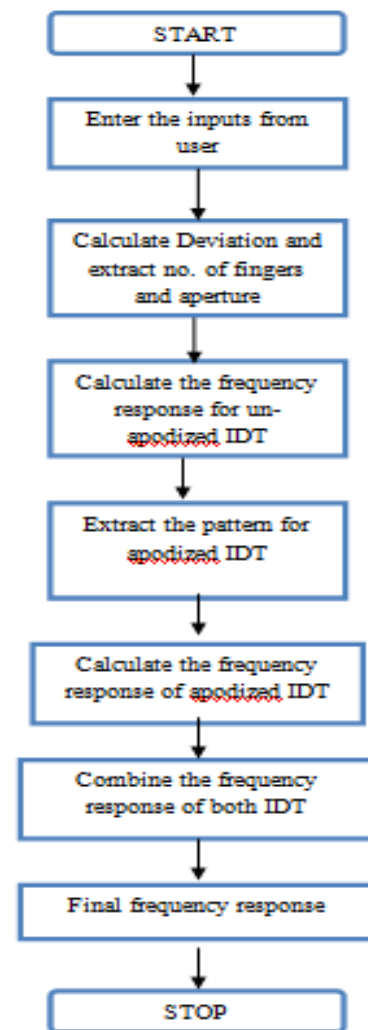
Fig-3  $|S_{21}|$  results for proposed filter

It was giving the appropriate insertion loss but was not able to get sharp cutoff so Remez Algorithm was applied.

### III. REMEZ ALGORITHM

The Remez algorithm is the method which is used for design of FIR filter. It is also called as Remez exchange algorithm. It was founded in 1934 by evgeny vekovlevich. Remez algorithm uses two methods for designing

1. The window method
2. The weighted-chebyshev method



Flowchart for remez Algorithm

Step-1 For creating this first we need to specify the number of samples, sampling frequency, cutoff frequency, passband ripple and stopband attenuation

Step-2 After specifying the specifications deviation will be calculated and from that using remez order function number of fingers, aperture and center frequency were calculated, after that using that number of frequency the amplitude or we can say that pattern for IDT can be calculated.

Step-3 By using the fourier transform method the frequency response for that IDT can be obtained.

Step-4 Next the apodization pattern for another IDT will be calculated and same the frequency response for this IDT will be calculated.

Step-5 After that response of both this IDTs were merged and final response will be calculated.

By taking 24 fingers for un-apodized IDT calculated the frequency response of unapodized IDT.

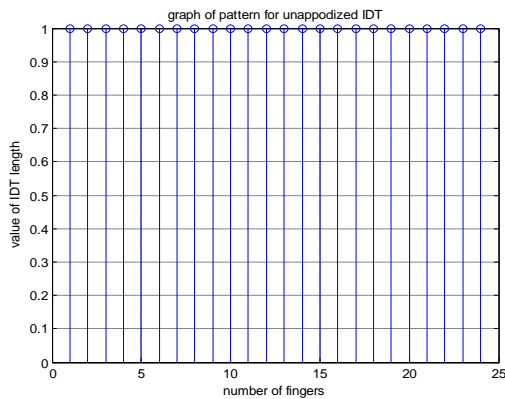


Fig-4 IDT pattern for unapodized IDT

For this pattern fingers were taken having unity overlapping. There is no change in their overlapping. Fingers were assumed to be placed at same spacing and having same width. After that the fourier transform for this IDT was calculated.

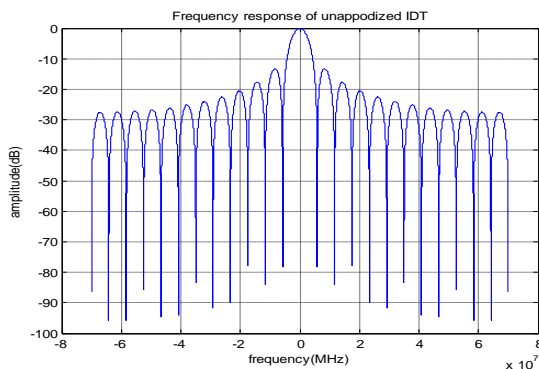


Fig-5 Frequency response of unapodized IDT

There were 87 fingers extracted for apodized IDT. It shows the pattern for apodized IDT which is similar to sinc function.

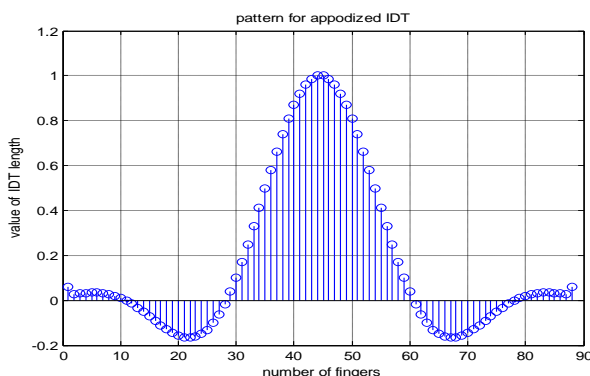


Fig-6 IDT pattern for apodized IDT

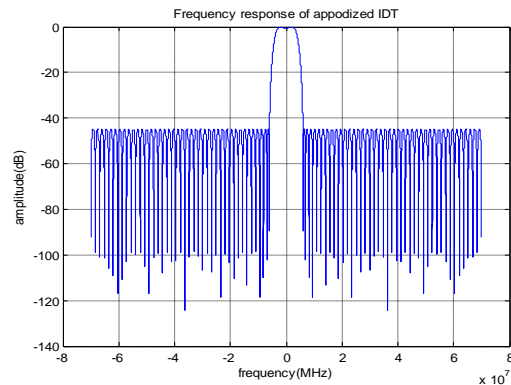


Fig-7 Frequency response of apodized IDT

As the frequency response is dependent on impulse response here the IDT pattern is in sinc form so got the frequency response as flat. Finally the frequency response of both IDTs were combined and it shows the appropriate response

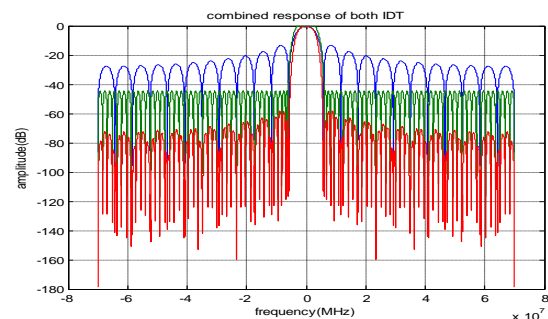


Fig-8 Combined response of both IDT

#### IV. CONCLUSION

The function of SAW filter mostly depends on the IDTs such as number of finger pairs in IDT, Spacing between IDT, pattern of IDT(Apodization). By varying number of fingers or even using weighting withdrawal technique we can achieve proper frequency response for any filter.

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