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Research Article

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Performance Evaluation of Cascaded P-Matrix in Saw Filter

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ARTICLE INFO	ABSTRACT
corresponding Author: **Wazir** Assistant Professor, ECE Department, PMCE, Kami, Sonipat	Surface Acoustic Wave (SAW) filters have been used in electronic devices some physical constraints make the optical tuning and interesting mathematical problem. This paper presents a performance evaluation ofthe two cascaded P-matrices. It uses two Inter Digital Transducer (IDT) i.e. these two matrices after cascading provides the best solution. Each matrix has two parts: transmission and reflector. Each matrix is of 3x3 size and (-1, 1, 0) are the values of each matrix. Hence, 81 combinations are generated by making a every possible pair of two matrices. This cascading is performed for 100 frequency samples. The simulated results clearly indicates that cascading gives better results by using distance formula in every parameter for making of SAW filter.

KEYWORDS: ***SAW, DMS, IDT, STW***

Introduction

A sound wave that propagates along the surface of the solid and is contained within the solid. It uses the piezoelectric effect to turn the input signal into vibrations that are termed back into electrical signals in the desired frequency range.A SAW device relies on the propagation of an acoustic wave across the surface of a piezoelectric material. A comb-like array of electrodes etched on to the surface of the quartz, spaced at the centre wavelength, induces an acoustic wave in the surface of the material. The biggest advantage of quartz is that it is piezoelectric. This means that quartz resonators can directly convert their own mechanical motion into electrical signals. Quartz also has a very low coefficient of thermal expansion which means that quartz resonators can produce stable frequencies over a wide temperature range. When higher stabilities are required, crystal and their driving circuits may be mounted in a crystal oven to control the temperature for very narrow band filters, several crystals are operated in series. Delay line reinforces the desired frequencies as the sound waves flow across the surface of quartz crystal.A similar set of electrodes converts the mechanical signal back to the electrical signal via the piezoelectric effect. The overall effect on the input is attenuation in signal about the center frequency. SAW filters are electromechanical devices, commonly used in radio frequency applications. Electrical signals are converted to a mechanical wave in a device constructed of a piezoelectric crystal; this wave is delayed as it propagates across the device, before being converted back to an electrical signal by further electrodes. The delayed outputs are recombined to produce a direct analog implementation of a FIR filters. SAW filters are limited to frequency up to 3 GHz.

Figure 1: Television signal splitter consisting of a high-pass filter (left) and a low-pass filter (right).

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The antenna is connected to the screw terminals to the left of center. [1] A semiconductor device that is used to filter out desired frequencies. Widely used in mobile phones to filter both RF and IF frequencies, A SAW filter uses the piezoelectric effect to turn the input signal into vibrations that are turned back into electrical signals in the desired frequency range. Two sets of metal electrodes like teeth on a comb are adhered to a quartz crystal and spaced apart (in microns) based on the required frequencies.Piezoelectric materials have the unique ability to convert electrical signals into sound waves that can propagate along the material's surface or through its bulk. The inverse is also possible: Sound waves or mechanical vibrations on the surface or in the bulk of the material can be converted into electrical signals. For converting electrical signals into sound waves, piezoelectric crystals can be used to build structures that resonate within narrowly defined frequency ranges. These structures are ideally suited for highly selective filters in wireless communications systems. The rest of the paper is organized as follows. Section II outlines the literature review of SAW Filter. Sections III describe the complete overview of Surface Acoustic Wave. Proposed algorithm is described in Section IV. Simulated results of minimum distance calculation of SAW Filter are discussed in Section V. The conclusions are given in Section VI.

Related Work

Earlier there are number of techniques applied to solve different or may be the same issue in SAW filters. Each of them having different way of solving problem and with different number of costs and benefits. It is upto the problem whether cost is more effective or the benefits. Problems are classified in two categories i.e. Deterministic or Probabilistic. Deterministic means to go through every solution of the problem while solving it which becomes very difficult for MATLAB to work on it. While, Probabilistic means to find solutions randomly in the search space and to take iterations of it until it reaches up to desirable result. Some of the researches done that may be helpful for the above stated problem are as follows: Priyankaet. al. [2] presents an iterative technique for the same problem. It was a good technique. A number of iterations have been taken to optimize the objective function so that desired frequency response may be retreived. In this technique, in order to find an optimal solution, every solution of the search space was accessed. But, it really becomes very difficult to search iteratively every solution even when the search space is so large. This technique is deterministic which go through every possible solution. However, it is too slow process to go through so many solutions. System may not be able to do so. Secondly, the obtained solution was matched with the desired solution at only single frequency point. By matching the solution at multiple frequency points, the results will be improved. KiyoharuTagawa [8] presents two Evolutionary Algorithms (EAs) i.e. Differential Evolution (DE) and Genetic Algorithm (GA) to the optimization problem. The problem was nearly same. It was to find the desirable structures and designs of balanced SAW filters. The geometrical structures decides the frequency response characteristics of balanced SAW filters. Here, both types of EAs were compared in the quality of solution with same cost. Finally, DE was proved better than GA for providing better results at same computational cost. However, their objective function was having complicated decision of weighting coefficients. So, it is not suitable for multi-objective problem. Gunter [9] presents a generalized p-matrix model for SAW filters. The p-matrix model analyzes the electro-acoustic properties of IDTs and reflector gratings in a SAW filter. Here, he tried to remove the problem of capacitive coupling between neighboring elements of IDT and change electro-acoustic

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excitation and detection of forward and backward propagating SAW. He presents the generalization of the classical p-matrix model that relates outgoing acoustic surface waves and all electric currents to incoming acoustic surface waves and all electric voltages in a general acoustic track. This track may consist of many number of IDTs, reflectors and delay lines. Also, this model may be applied to the tracks with floating fingers. Ventsislavet. al. [10] presents a theoretical that allows one to conduct Coupling-of-Modes (COM) Surface Transverse Wave (STW) loss analysis and estimate the resonator Q from material and layout parameters. There are substantial advantages of STW resonators over conventional SAW resonators. The COM transmission coefficient x11 is derived by Floquet analysis. Its imaginary part is obtained by numerically fitting available experimental data for the Q-factor of particular resonators. It is a measure of STW propagation loss that adds to the electrode. However, the considerations are restricted to real values of transmission and reflection coefficients i.e. x11 and x12. Kathiravan Krishna et.al. [7] presents a simple and effective technique of characterizing a SAW filter in-situ. By SAW resonator, the errors involved in vector measurements are avoided. It is very useful for a fast-paced product development environment where quick insight into SAW impedances is required for CAD & optimization. A simple model offers insight into the Q of the SAW input and output to estimate matchability. The effect of EM interaction on the SAW package is also determined by the resonance method with the matching inductor.

Surface Acoustic Wave

A surface acoustic wave (SAW) is a type of mechanical wave motion which travels along the surface of a solid material. The wave was discovered in 1885 by Lord Rayleigh [1], and is often named after him. Rayleigh showed that SAWs could explain one component of the seismic signal due to an earthquake, a phenomenon not previously understood. These days, these acoustic waves are often used in electronic devices. At first sight it seems odd to use an acoustic wave for an electronicapplication, but acoustic waves have some particular properties that make them very attractive for specialized purposes. And they are not unfamiliar, many wristwatches have a quartz crystal used for accurate frequency generation, and this is an acoustic resonator though it uses bulk acoustic waves rather than surface waves.

Acoustic waves are described by the modeof wave propagation through or on a piezoelectric substrate. Acoustic waves aredistinguished primarily by their velocities and displacement directions; many combinations are possible, depending on the material

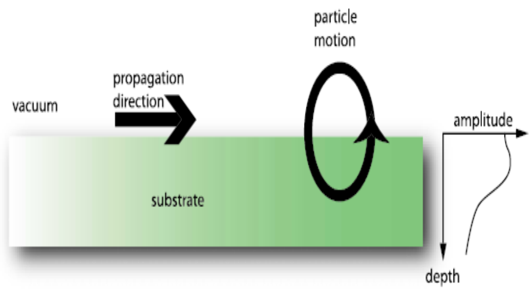

Figure 2. Basic SAW Filter

and boundary conditions. The IDT of each sensor provides the electric field necessary to displace the substrate and thus form an acoustic wave. The wave propagates through the substrate, where it is converted back to an electric field at the IDT on the other side.

Proposed Methodology

In this section, we have to design a flow chart of proposed work. Overall work is simulated in VB & Matlab tool. In staring, two P matrixes is designed with different Matrices formulas.

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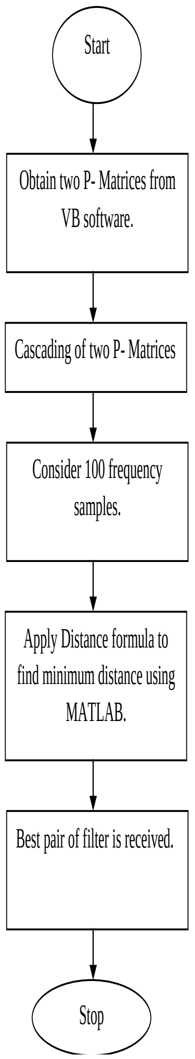

Figure 3. Proposed Methodology

Two matrixes are cascaded with cascading formula to obtained new matrices. The complete signal is sampled into different ways. These signals are sampled at different sampling frequency. 100 samples are obtained from this sampling process. Now, apply distance formula to find minimum distance. This process is repeating 100 times& best filter pair is receive

Result Analysis

In this dissertation the aim of cascading the two P-Matrices is to improve the certain parameters of a SAW filter and to provide the best pair combination from the two P-Matrices with the help of cascading and distance formula.

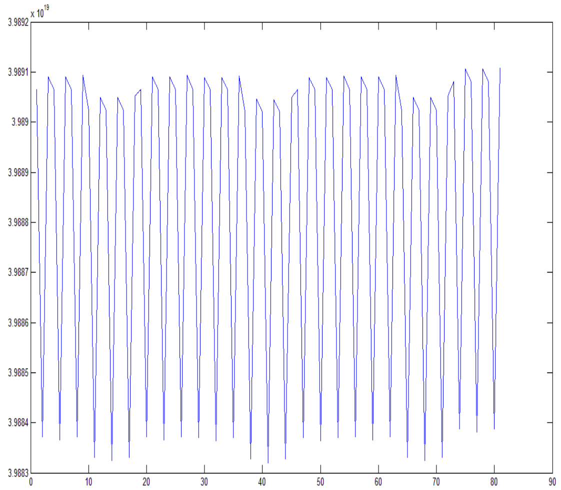

Figure 4: Minimum distance calculation

The basic idea of cascading the two P-Matrices is to obtain the best parameters by choosing the best pair combination among the two P-Matrices.

Conclusion

In the present work, cascading of two P-matrices is performed to obtain the desired response of SAW filter. The two matrixes are of a 3x3 size and each matrix produce a nine pair of combinations, therefore in total 81 combinations are obtained.Each P-matrix contains two parts: transmission and reflection, so each pair has two values i.e. one transmitted value and other is reflected value. The numbers of frequency samples used are 100. After cascading these pairs, 81 combinations are received and with the help of distance formula, one minimum distance is found i.e. desired and best pair of filter is received.

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