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# A Compact Novel Microwave Liquid Crystal Tunable Band-pass Filter

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**Abstract:** In this paper, a nematic liquid crystal is used to design a compact tunable band-pass filter at microwave band. The structure and the principles of tunable filters with nematic liquid crystals are analyzed. According to simulation results of the transmission property, it shows that the proposed liquid crystal tunable filter keeps the many advantages of the conventional tunable filter and has better passband performance. The simulated and measured results show that the proposed tunable filter has additional advantages of being continuously tunable, miniaturizable, and having low processing costs and low tuning voltage. Therefore, it has shown greater potentials for modern wireless communication systems.

**Keywords:** Band-pass filter; compact; microwave; liquid crystal; tunable

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## 1. Introduction

In recent years, according to the rapid development of modern wireless communication, high spectrum efficiency has become increasingly prominent. Therefore, tunable microwave devices are required to raise the utilization rate of frequency resources, and the tunable filter is one of the key devices. The liquid crystal tunable filter has been received widespread attention due to its miniaturizability, fast tuning, wide tuning range, light weight, low tuning voltage and good linearity.

Present tunable techniques mainly include ferroelectric material tuning, variable diode tuning and radio frequency (RF) micro-electromechanical systems (MEMS) tuning. First, Yttrium Iron Garnet (YIG), which is a ferroelectric material, has many advantages, but slow tuning speed and large volume [1-4]. Many properties of Barium Strontium Titanate (BST), which is also a kind of ferroelectric materials, are in the middle level. But it has poor linearity, high density and high tuning voltage (up to 30 V) [5, 6]. Second, the tuning speed of diode is fast. But it has a complex bias voltage circuit and poor linearity [7, 8]. Third, RF MEMS has less tuning ratio and higher cost [9, 10]. In conclusion, new materials and new methods are required to develop higher performance tunable filters. The liquid crystal has offered an effective way to achieve this.

This letter presents a compact microwave tunable filter, based on nematic liquid crystal.

## 2. Design of Tunable Filter

### 2.1. Liquid Crystal

The liquid crystal materials have developed rapidly in recent years. The field-induced nematic liquid crystal tuning is a novel tuning method. It has a lot of advantages, such as good linearity, low cost, convenient control and light weight, etc. The nematic liquid crystal that can be applied to key

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