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# A Novel Compact Band Pass Filter for 2.4 GHz ISM Band Applications

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## Abstract

A novel compact microstrip Band Pass Filter comprising Hewlett-Packard logo shaped patch is proposed in this paper. The filter structure is able to achieve 2.4 GHz central frequency which can be used for Wireless fidelity (WLAN) and the short range devices such as Bluetooth applications. The simulation is performed on CST Microwave Studio. The dielectric substrate used is FR-4 with thickness 1.6 mm. The structure shows good return loss and filter characteristics.

**Keywords:** Bandpass, Hewlett-Packard, WLAN

## 1. Introduction

The mania of integrating 2.4 GHz frequency applications into the electronic products leads to a great interest in making Band Pass Filters (BPF) for such applications. Some design methods include half wavelength resonators[1–4] and a stepped impedance resonator with tapped input-output[5] for designing Band Pass Filters. A dual-mode square slotted microstrip resonator has the advantages of possessing sharper performance and much narrower responses than those of the conventional square patch filter and single mode resonator[6]. However the coupling between resonators is affected by the tapping of asymmetric feed lines[7]. But the spurious suppression[8] can be achieved by using Tapped wiggly-coupled Technique. In[9], a novel compact net-type band pass resonator filter has been presented.

In wireless communication systems, BPFs are being designed and developed as per the requirement of the application devices to get reduced volume and weight of the devices. There are various topologies and design specifications available in the research literature. Designing a compact filter is an ongoing challenge faced by researchers around the world.

In this paper a novel and compact filter structure is presented with letter 'h' and 'p' shaped patches and a defected ground plane. Section 2 discusses the filter structure and detailed dimensions are presented. Section 3 discusses simulated results of the proposed filter. Section 4 presents the conclusion.

## 2. Filter Design

The proposed filter structure is shown in Figure 1. The top view and back view of the filter shows 'h' and 'p' shaped top patch and defected ground plane just beneath the patch. Feed to the patches are provided by two transmission lines. Overall size of the filter is 23 x 12 $mm^2$. The substrate material used is FR4 with dielectric constant of 4.4 and thickness of 1.6 mm.

As shown in Figure 1(c) the feed line for both the patches is 0.2 mm wide, though the feed line for 'p' shaped patch is longer as compared to 'h' shaped patch.

## 3. Simulation Results

The proposed Band Pass Filter design is simulated using commercial EM Simulation CST software. Figure 2 shows return loss and insertion loss plots for the proposed BPF. From the return loss plot (S11) -15 dB bandwidth achieved is from 2.34 GHz to 2.47 GHz. Minimum return

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loss is achieved at 2.41 GHz where its value is -35 dB. The insertion loss at resonance is -8.15 dB.

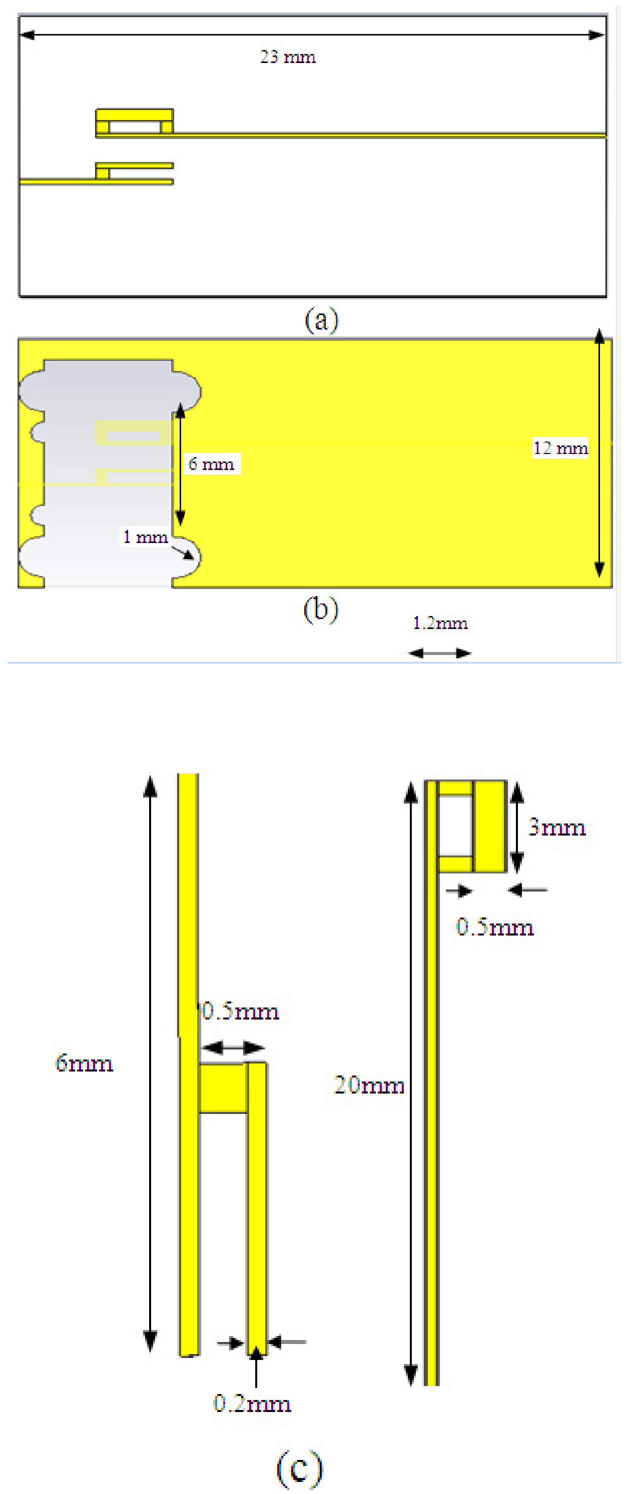


**Figure 1.** Detailed dimensions of proposed Band Pass Filter (a) Top View, (b) Back View and (c) 'h' and 'p' patches.

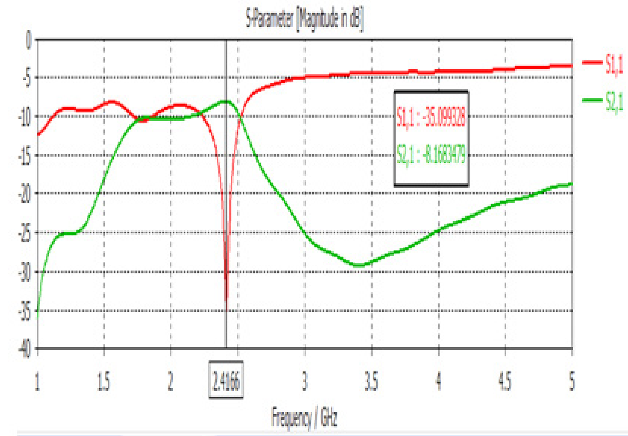


**Figure 2.** Simulated return loss (S11) and insertion loss (S21) plot.

Figure 3 shows the group delay of the signal which it takes when it propagates between the ports. The group delay through the proposed BPF is less than 1.1 ns over the pass band of the filter. This value of the group delay is very small while receiving the signal at the output port.

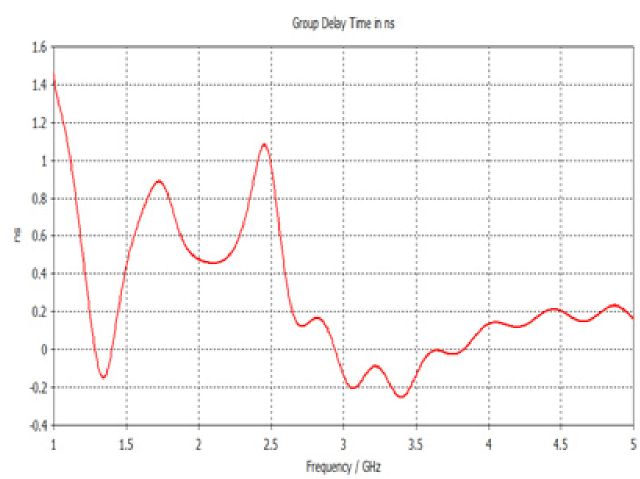


**Figure 3.** Simulated group delay plot.

## 4. Conclusion

A novel compact Band Pass Filter is designed and presented in this paper which is letter 'h' and 'p' shaped and defected ground plane. The proposed design is advantageous in WLAN/Bluetooth applications due to its simple planar structure, compactness, very low group delay, low insertion loss in pass band.

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