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Dual Band Band Pass Filter using Dumble shaped Defective Ground Structure for Wi max Technology

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Abstract

In this paper A Dual-band BPF with parallel-coupling feed and ring resonators is designed and simulated. Parallel coupling feed, results in good coupling between input and output and good isolation between frequency bands by generating deep zero between passband. Ring resonator make filter as dual-band by shifting higher order resonating modes to desired frequency range. Filter response results in two frequency bands 3.4-3.7 GHz and 5.6-6.3 GHz covered in S and C band respectively. Some applications of these bands are mobile communication, Radio astronomy, space research and aeronautical radio navigation. 2 Compact size (16×16×0.589mm), Small group delay (<0.35 nanosecond), large attenuation in stop band (larger than 20db till 16GHz), higher 3dB FBW (11.47% and 29.87%), small insertion loss, large return loss in pass band are some advantageous factors of proposed filter design. Simulation is done using CST microwave studio 2011.

Keywords: Dual BPF; DGS; Scattering Matrix; CST Microwave studio

1. Introduction

Need of multiband and multi-service devices are increasing drastically, some dual-band bandpass filters (BPF) [1-7] are analyzed here. In [1] Stacked-loop structure employed to create two transmission pathways to input signal and each of them with dual-mode resonators outcome in two passbands. But filter have two layer substrates structure that make fabrication tough. In [2-3], different Interdigital, meander shapes slots are utilized to defect, ground layer and vias between patch and ground layer exercised for tight coupling. Reference [3] has small size but not that much good insertion loss and return loss. In [4], dual-band BPF using SIR and DGS has first-class frequency selectivity but still its size is comparatively larger than this design. Further modified SIR and DGS structures employed in [5-7].with slow-wave characteristics by etching a DGS on the ground plane [9]. There are also different techniques other than DGS such as Photonic Band Gap (PBG). PBG is known to provide rejection for certain frequency bands. However due to its complex parameters that can affect the band gap makes it difficult to be used for microwave applications [7]. In [5], the use of DGS had improved the band-pass filter response significantly. By using a triangular head geometry with some other parametric variations, the pass band had increased. The frequency resonance was also affected by the position of the triangle. The frequency resonance tends to vary with different positions of the DGS. The lumped inductors are realised through the dumbbell DGS slots. A triangular DGS slot provides sharper transition region as compared to the square and dumbbell DGS of same area of the slot-heads.

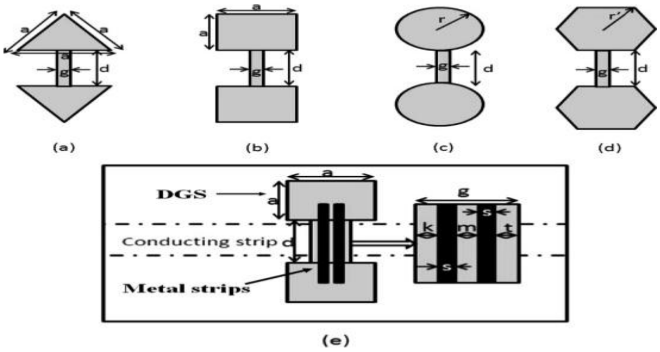

Figure 1: Various DGS shapes: (a) Arrow head (b) A square open loop with slots in the middle (c) Dumbbell shaped (e) Hexagon shaped

Three parallel DGS structures are used in this design. Defected ground structure is the etched out areas in the ground plane. DGS changes the shield current distribution through the ground plane. The shield current in turn changes the transmission line characteristics such as line capacitance and inductance. Hence the DGS circuit is used as the LC equivalent circuit.

In this paper, dual band pass coupled resonator filters with same DGS shape and with different feed line configuration is designed and simulated to operate at a center frequency of 5.4GHz and are suitable for WLAN applications The performance of the filters is investigated with simulation results using commercial CST microwave studio software filter Design.

2. Design of Dual Band Pass Filter

Figure 2 shows the existing topology of the dual-band bandpass filter [6]. An ideal response of BPF shown in Figure 3 without any DGS. It shows that a deep and sharp rejection region outside of the symmetrical passband resulting in a dual-band response. [5,6]The center frequency, fo, acts as the reference frequency and it is situated in between the two passbands. For the other two passbands, the Centre frequency is denoted as f1 and f2, resulting in three transmission zeros that will ensure a good selectivity between the frequencies.[4,7]The dual-band bandpass filter layout is presented in Figure 4 where parallel-coupled lines are coupled to quarter wavelength transmission lines.

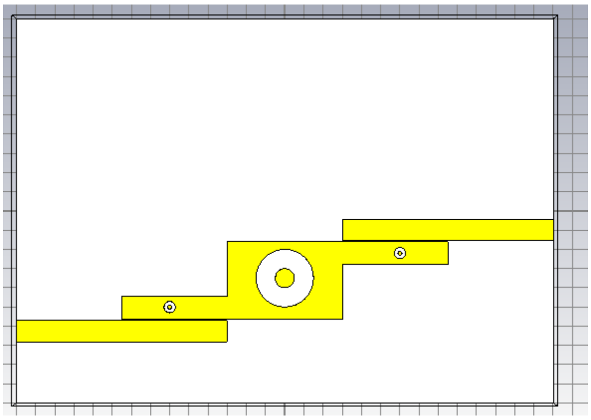

Figure 2: Proposed topology of the dual-band bandpass filter [2]

3. Design of proposed dual band pass filter with triangular shaped DGS

The proposed DGS shape for this dual-band bandpass filter is a rectangular shape. The DGS is intended to change the characteristic of the micro-strip line in terms of the line inductance and capacitance [8]. The DGS shape can help to increase the impedance matching that cannot be achieved due to the limits of the micro-strip line width. Figure 7 depicts the DGS structure at various positions on the ground plane in order to find the best position that can maximize the response of the filter. The tested positions are along the centre line and at the four corners of the ground plane. [12,13]The length (l) and width (w) of the DGS are 6.5 mm and 6 mm respectively. The filter is modelled in CST on a Rogers RO5010 substrate which have relative dielectric constant, r = 2.2, substrates thickness, h = 0.589 mm and loss tangent, tan δ = 0.001 as shown in Figure 5. Optimization on the transmission lines and parallel-coupled structures are performed to obtain a perfect matching and the final dimensions are shown in Figure 4. Figure 6 shows the comparison between simulated and measured results of the filter. It can be observed that th e simulated result produces two passbands centred at f1, 3.4 to 3.7 GHz and f2 5.6 to 6.3 GHz, although the measured centred frequencies shifted slightly. Both results are comparable, however the second band differs significantly. It is observed that the measured and simulated S11 are 19.41 dB and 24.93 dB respectively.

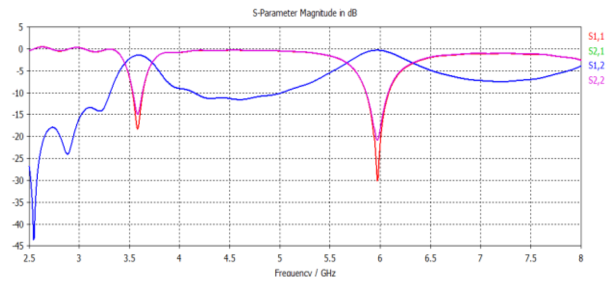

Figure 3: Ideal frequency response of the dual-band bandpass filter [2, 3]

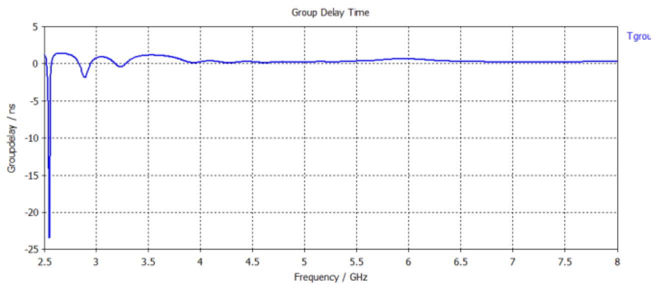

Fig-4 Group Delay vs freq [12,13]

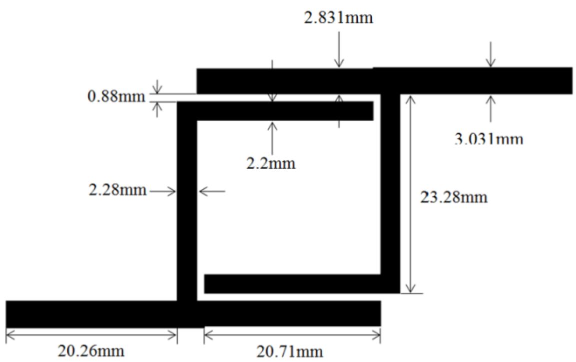

Figure 4: 2 D circuit layout of the dual-band bandpass filter [12]

Overall, the isolation level between the two passbands is more than 20 dB and the insertion losses are around 0.3 dB for both bands. The outer rejection level for the first passband is more than 10 dB with the second passband achieving a much lower value

4. Result Analysis and comparison

This paper designs a dual pass-band filter using arrows shaped DGS and ring resonator. The dual pass-band characteristic is achieved by ring resonator. DGS structure has good frequency selectivity and can be used to adjust the distance among the pass bands. The distance between feed line and ring resonator can be utilized to adjust coupling coefficient. [2, 3]The filter working in WLAN and Wi -MAX frequency bands is eventually designed. Test results show that the return loss in passband is more than 24 dB, ripple in pass band is small.

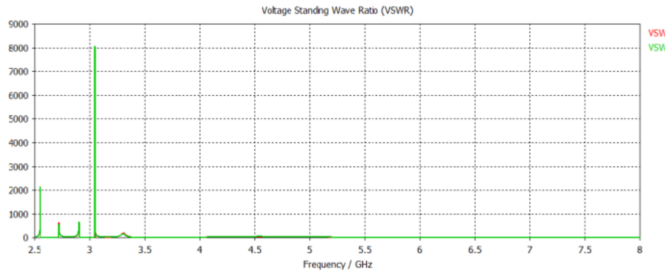

Figure 5 : VSWR VS Frequency Diagram for Dual band BPF

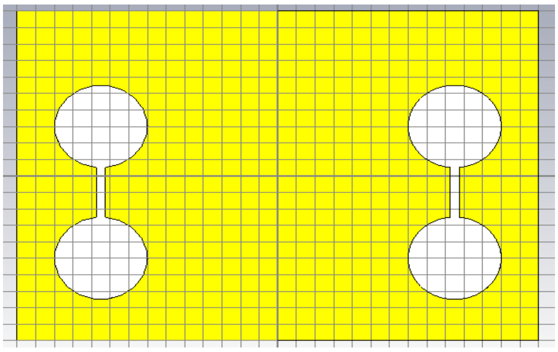

Figure 6 : Doumble shaped DGS Diagram for Dual band BPF

Group Delay is less than 0.35nsec.VSWR in the range of 1.5 in both band. The filter has compact structure and small size, which is suitable for application in wireless network and communication equipment.

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