Research Article Impact Factor: 2.275 ISSN: 2319-507X
Sahoo P, IJPRET, 2014; Volume 2 (11): 1-7 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

A NEW COMPACT CIRCULAR SHAPE PHOTONIC BAND GAP FILTER

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Accepted Date: 13/06/2014; Published Date: 01/07/2014

Abstract: In this paper we report on a novel technical approach to the implementation of photonic microwave filters that is based on the circular slab concept by half radius, which depends on whether the reflected wave in phase or reinforce phase , cancel the phase of incoming energy signal inside the circle slab. Simulated evidence is provided of the implementation of filter with wide band gap at higher cut off frequency (17.064 GHz) that shows excellent agreement with results predicted by the theory. This paper represents the design and simulation of wideband bandstop photonic filter using microstrip which is designed to have a center frequency of 17.064 GHz. The filter is designed on a FR-4 substrate having dielectric constant ε_r=4.4 and thickness h=1.6mm. The design and simulation are performed using computer simulation technology software.

Keywords: Photonic band gap (PBG), Circular slab, computer simulation technology software (CST).

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How to Cite This Article:

Sahoo P, Singhal PK; IJPRET, 2014; Volume 2 (11): 1-7

PAPER-QR CODE

INTRODUCTION

Filter is an essential component in modern communication system. Narrow band stop filter (BSF) and wideband Band stop filter is one key component in modern communication system [1, 2]. It plays a greater role of filtering out undesired frequencies and passing the desired signal. Now the implementation of photonic-based filters for the processing of RF, microwave, and millimeter-wave signals brings a number of advantages compared with more-traditional approaches in terms of flexibility, light weight, and immunity to rf interference Considerable research has been carried out to obtain filters that provide wide band rejection [4] at high frequency 17.06 GHz. Wavelength inside the circular slab shown in fig-1. A wave incident on a band-gap material partially reflects off each layer of the structure. The reflected waves are in phase and reinforce one another. They combine with the incident wave to produce a standing wave that does not travel through the material.

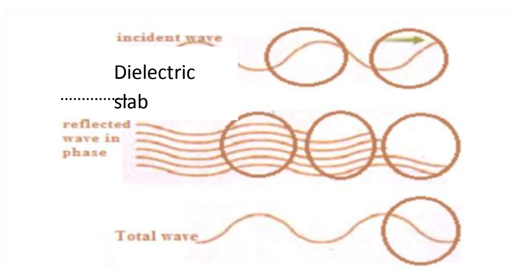

Fig-1 Wavelength in a Circular Cell

DESIGN PROCEDURE

We have started the design procedure with a circle which has inner radius 0.4 mm and outer radius 0.5 mm as shown in fig 1(a). now take twenty one same radius circles for six rows and fifteen columns and intersect by $S_1(x)$ 0.5 mm and S_2 (y) 0.5mm with each other's as shown in fig. 1(b).

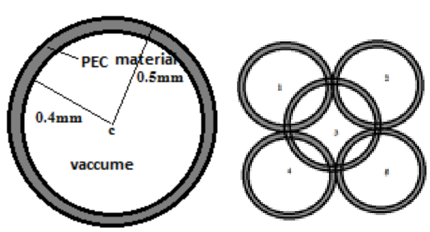

Fig-1(a) Circle with inner radius0.4mm and outer radius 0.5mm from the center (c), Fig-1(b) Structure formation using five circles

PROPOSED FILTER STRUCTURES

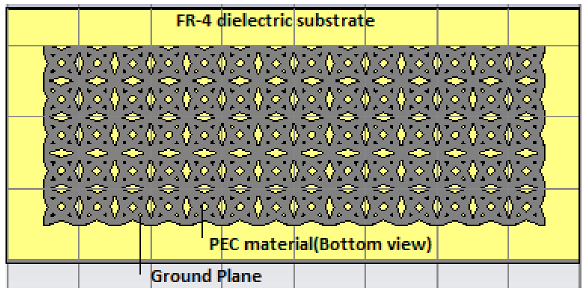

Fig-1(c) Layout of the Proposed photonic band gap filter on a substrate with ε_r=4.4 and h=1.6mm on CST software

TABLE.I. CIRCUIT PARAMETERS FOR THE PROPOSED PBG SECTION

Ground plane	**Dimension**	**5mmx10mm**
	Height	0.638mm
	Material	PEC
PBG Cell	Inner Radius	0.4mm
	Outer Radius	0.5mm
	Dimension of repeated circle	4.3mmx8mm
Substrate	Dielectric Constant ε_r	4.2
	Material	FR-4
	Thickness	1.6mm
Microstrip line	Length	10mm
	Width	2mm
	Height	.038mm
	Material	PEC
	Impedance	50Ω

A simulation study is performed to verify the validity of the above dimensions in millimeter wave. For the simulation purpose we have used CST software [7]. Simulated structure of the desired Photonic band gap filter is shown in fig-1(d) and effect of the variation in width of the microstrip line shown in fig-1(e). All parameters can be calculated by given formulas.

Formula for cutoff frequency:

$$f_0 = \frac{f_1 + f_2}{2}$$

Formula for Fractional Band Width

$$FBW = \frac{f_2 - f_1}{f_0}$$

Formula for calculating Band Width

$$BW = f_2 - f_1$$

For W/h ≤ 1;

$$\varepsilon re = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left(1 + 12\frac{h}{w}\right)^{-0.5}$$

For W/h>1;

$$\varepsilon re = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left(1 + 12\frac{h}{w}\right)^{-0.5} + 0.4\left(1 + \frac{w}{h}\right)^{2}$$

Guided Wavelength

$$\lambda g = \frac{300}{f(ghz)\sqrt{\varepsilon re}}$$

RESULTS AND DISCUSSION

The simulated results of the proposed photonic band gap filter structures are shown in figure 1(d) and figure 1(e) respectively. From the graph, it is clear that the center frequency is found to be 17.064 GHz and insertion loss (S_{21}) –50.071629dB and the bandwidth 12.117 GHz which is nearly 71.04% of the center frequency.Fractional bandwidth is 0.7266 by using equation.

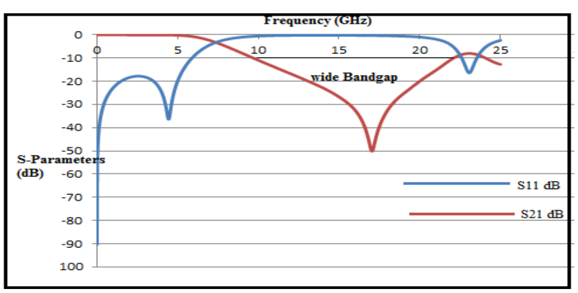

Fig-1(d) S11 & S12 (dB) versus frequency GHz of the circular photonic band gap filter measured using CST software for microstrip width 10mm.

Effect of the position of the transmission line

The effect of the position of the transmission line with respect to the PBG ground plane is studied. When the transmission line was just above the center of PBG structures in the ground plane, the S_{12} characteristics showed reasonable width and depth in the stop band. As the transmission line got shifted towards the Centre of the PBG structure the stop band depth and width are found to decreases as shown in Fig-1(e)

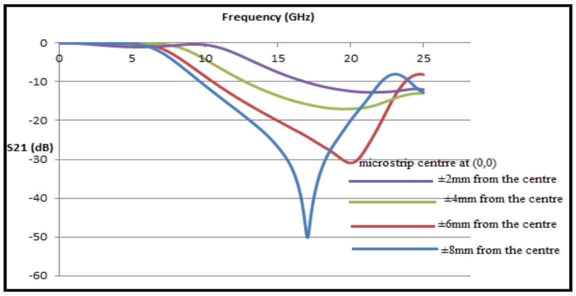

Fig-1(e) frequency vs. transmission coefficients for different width of microstrip line

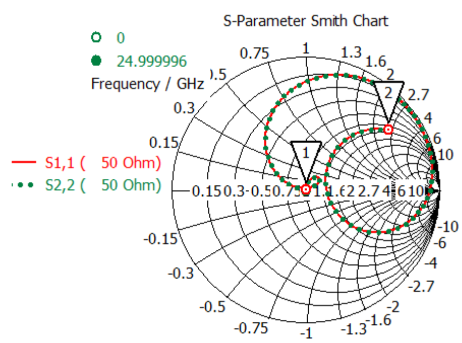

Fig-1(g) Smith chart of the proposed photonic band gap filter

Figure 1(g) shows the stability of the filter at 25GHz. point 1 indicated total impedance (50, 0.411083) Ω at 0 frequency/GHz and point 2, (60.738, 127.39) Ω at 25 GHz for both S_{11} and S_{12}.

CONCLUSION

In this paper a new design structure of photonic band gap filter has been discussed that can be used as a band stop filter. The circular photonic filter proposed in this paper covers the band width extending from L-band to S-band applications [6]. PBG can be used with couplers, hybrid rings, coupled microstrip line band pass filters etc. in future PBG can be used to make tunable filters by implementing BST as the host material. Wideband band stop filters are important components in microwave applications. It rejects higher harmonics and imitative pass bands. Complete band gap can be achieved by extending the perforations in three dimensions for PBG structures. The structure of the new proposed circular photonic band gap filter paper has compact size, highly stable, and wide stopband as well as it provides good performance. Both simulated insertion and return loss show excellent agreement with the calculated values for the prototype band stop filter.

ACKNOWLEDGMENT

The authors express their sincere thanks to MITS College of Engineering and Technology. The measurement facility provided by Dr. P. K. Singhal of Madhav Institute of Technology and Science, Gwalior (M.P, India) is gratefully acknowledged

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