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Band Notching UWB Planar Monopole Antenna Using EBG

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Abstract:
A planar monopole UWB antenna with microstrip feed is developed. Two unit cells of electromagnetic band gap [EBG] were added beside the feed line. By adjusting the EBG dimensions, and changing gap between EBG and feed line, any notch frequency can be obtained through the entire UWB frequency band. Antenna structure with different dimensions was examined using HFSS simulator.

Index Terms - UWB antenn; Band notch frequency; EBG.

I. Introduction

The planar monopole is one of the most common UWB antennas due to low profile, low cost, offer wide band width, good radiation characteristics and high radiation efficiency [1]. In UWB antennas band notch is used to avoid interference from narrow band systems [2-14]. The band notch can be obtained through; different slots in radiating patch, slots in feed line, slots in ground plane, and/or parasitic patches. An array of two coplanar circular monopoles with element separation of 25 mm was investigated for Bluetooth, Wi-Fi, Wi-MAX and UWB applications. [15].

In this paper, band notch is obtained using EBG structure. The EBG is placed besides feed line to reject single frequency. The EBG resonant frequency can be tuned by changing the dimensions of patch, and gap between EBG and feed line. Their effect on S_{11} is examined. FEM in frequency domain is utilized to simulate the proposed structure using HFSS, [16].

This paper is divided into three sections. In first section the antenna structure is designed .The effect of different patch dimensions, and gap between EBG and feed line is studied in section 2. The radiation pattern and gain of antenna is presented in the third section.

II. Antenna Design and Simulation

The geometry of the proposed antenna with EBG structure is shown in Fig.1 . FR4 with thickness 1.6 mm, permittivity 4.5 and loss tangent 0.002 is used as the substrate of the proposed antenna. The dimensions of the substrate are B*L. The dimensions of ground plane are B*L_t.

To produce band notch, two square patches are placed besides feed line with dimension w. The gap between EBG and feed line is g. The design parameter of the proposed antenna shown in Table I .

The resonance frequency of the EBG structure is given by:

$$f_r = \frac{1}{2\pi\sqrt{LC}} \qquad (1)$$

The capacitance C , represents the coupling between the EBG and the transmission line. The inductance L is due to the current flowing through via.

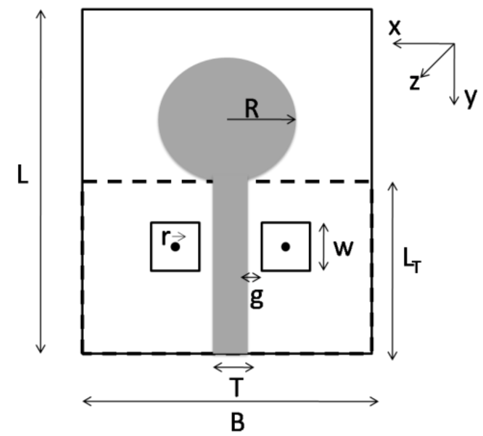

Fig. 1. Geometry of Proposed Antenna with EBG

TABLE I.
THE DESIGN PARAMETER OF THE PROPOSED ANTENNA

Design Parameter	B	L	L_t	T	W	g	R	r
Dimension mm	42	50	20	3	7	0.5	10	0.3

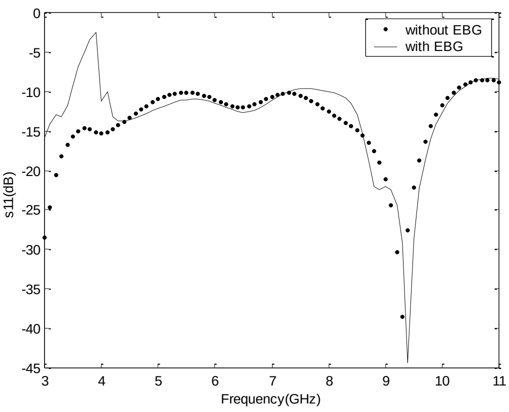

Fig. 2. S_{11} with and without EBG .

As shown in Fig. 2, the planar antenna without EBG has a resonance dip at 9.3 GHz . The doted curve is S_{11} for the structure with EBG (w =7 mm , g = 0.5 mm). There is a notch at 3.8 GHz.

A. Effect of EBG dimensions

The effect of change in the EBG dimensions is analyzed. Fig. 3 shows the return loss variation with frequency for different EBG dimensions. As can be observed, the notch frequency decreases when dimension increases. The resonant frequency is shown in Table II . By adjusting the EBG dimensions, any notch frequency can be obtained through the entire UWB frequency band.

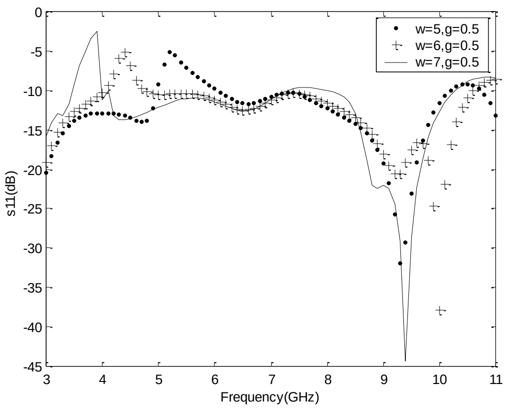

Fig. 3. Effect of different dimensionsof EBG on S_{11} for the proposed antenna

TABLE II.
RESONANT FREQUENCIES OF EBG WITH DIFFERENT DIMENSIONS

EBG Dimension mm	5	6	7
Resonant frequency GHz	5.2	4.3	3.8

B. Effect of Gap Dimensions

Figure 4 shows the variation in the return loss with frequency for different ground gap between EBG and feed line "g" (0.3 mm, 0.4mm, and 0.5mm). Increase in gap shifts the resonant frequency to upper side. The resonant frequency is shown in Table III

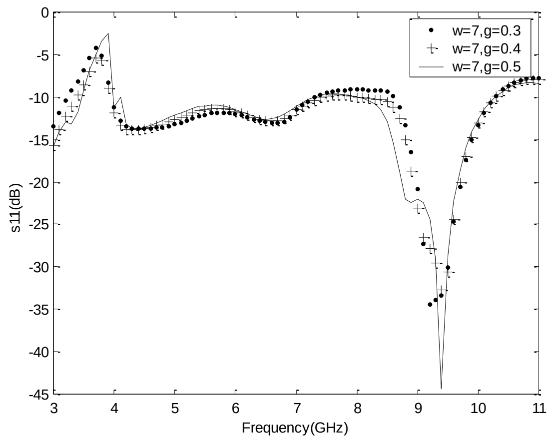

Fig. 4. Effect of different gap on S_{11} for the proposed antenna

TABLE III.
RESONANT FREQUENCIES OF EBG WITH DIFFERENT GAP DIMENSIONS

Gap Dimension mm	0.3	0.4	0.5
Resonant frequency GHz	3.6	3.7	3.8

C. The Radiation Pattern and Gain

The different radiation patterns at different frequencies 5.4, 6.5, and 9.5 GHz for the proposed antenna with EBG are shown in figure 5. It is clear the stability of the radiation pattern throughout the bandwidth. Fig.6 shows the gain versus frequency for the UWB antenna with EBG. The gain is suppressed at the notch frequency.

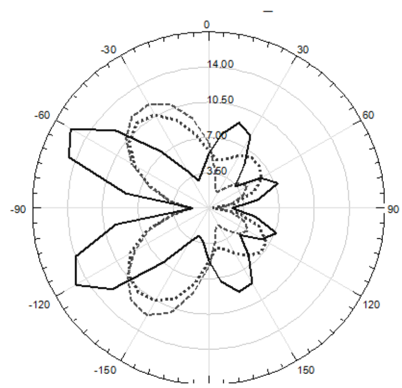

Fig. 5. The Radiation patterns of the UWB antenna loaded EBG (w=7 mm, g=0.5) at different frequencies 5.4GHz (dot), 6.5GHz (dash), 9.5GHz (solid).

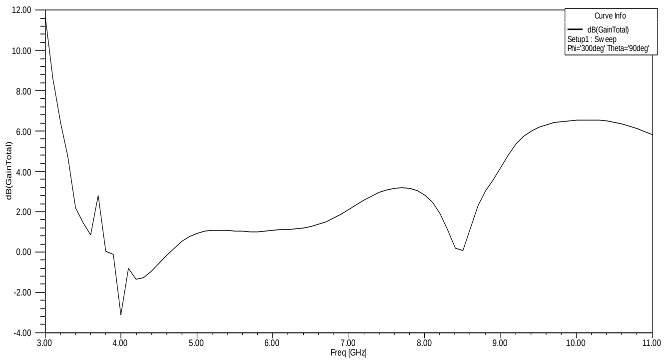

Fig. 6. Gain versus frequency for the UWB antenna with EBG.

III. CONCLUSION

A micro strip UWB planar monopole antenna with EBG to get frequency notch is designed. The effect of varying EBG dimensions on the notch frequency is investigated. The effect on the antenna return loss is examined. The proposed antenna shows reasonable stability of the radiation pattern throughout the operating bandwidth.

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