Journal of Selected Areas in Microelectronics (JSAM)
Singaporean Journal of Scientific Research(SJSR)
Vol6.No.1 2014 Pp. 48-50
available at:www.iaaet.org/sjsr
Paper Received :05-12-2013
Paper Accepted:25-12-2013
Paper Reviewed by: 1Prof.. S.Soundera Valli 2. Chai Cheng Yue
Editor : Dr. Binod Kumar

Design of Radial EBG-PRS Antenna for Enhanced Gain for WiMax Application

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ABSTRACT

This article presents the simulation based design of a 2-D multiperiod EBG Antenna structure for WiMax application. This paper focus on the Gain enhancement by introducing 2-D multiperiod EBG structure for Microstrip antenna. It is seen that the EBG structure with dielectric material FR4 of dielectric4.4 (Loss tangent 0.02) in proximity can be optimally placed along with patch antenna to increase the gain almost double as compared to the patch antenna without EBG structure. The objective of the paper is to design and study the effect of gap between the patch and the EBG structure on the bandwidth and gain of the antenna. By placing 2-D multiperiod EBG structure on patch antenna, bandwidth from 5.45 to 5.75 GHz with VSWR 2:1 and Gain of 7.21 dB is observed. The gain is found to be stable over the entire frequency band. The results are obtained through simulation byusing Ansoft HFSS^{TM}, a commercially available simulator based on finite element method. The size of a typical near optimum antenna is 66.65 mm × 70.49 mm× 1.57mm with the EBG structure of periodic Circular patch of 5 X 5 can be considered suitable for WiMax application.

Keywords EBG (electromagnetic band gap),FSS(frequency selective surface),PRS(partialy reflective surface),VSWR(voltae standing wave ratio.

I. INTRODUCTION

Microstrip patch antennas have been used widely in satellite communications, aerospace,radars, biomedical applications and reflector feeds, because of their advantages of a low profile, light weight and compatibility with integrated circuits. However, they suffer from disadvantages such as a narrow bandwidth (Less than 5%), low gain (Less than 6dBi) and excitation of surface waves, etc [1].

These disadvantages have limited their applications in many other fields. In order to overcome the bandwidth and less gain disadvantages of microstrip antennas, many techniques have been employed. One such case is uses of EBG structure are conventionally used as focusing devices to enhance the directivity gain of the primary source.

EBG antennas have attracted considerable interest in recent years due to their advantages of high directivity, low side lobes, simple structure and relatively low-profile [2, 3]. Typically these antennas consist of an EBG structure, such as a frequency selective surface (FSS) or partially reflective surface (PRS), placed approximately half a wavelength above a ground plane containing a source antenna.

The exact distance between the EBG structure and the ground plane is determined by the reflection phase of both materials at the operating frequency.

In this article, a 2-D multiperiodic EBG with 5 X 5 circular patch antennas is designed for optimized gain and directive. This article is organized as follows. First, the rectangular patch antenna without EBG structure is designed at operating frequency 5.60 GHz. In Section 2, EBG antenna is used along with basic patch antenna and gain of the entire system is optimized.

Then simulation results are obtained and comparisons are made in Section 3. Conclusions are drawn in Section 4. The motivation of this work is to search for an applicable antenna with high gain at microwave frequencies in WiMax application.

II. PROPOSED ANTENNA DESIGN

A. Patch Antenna

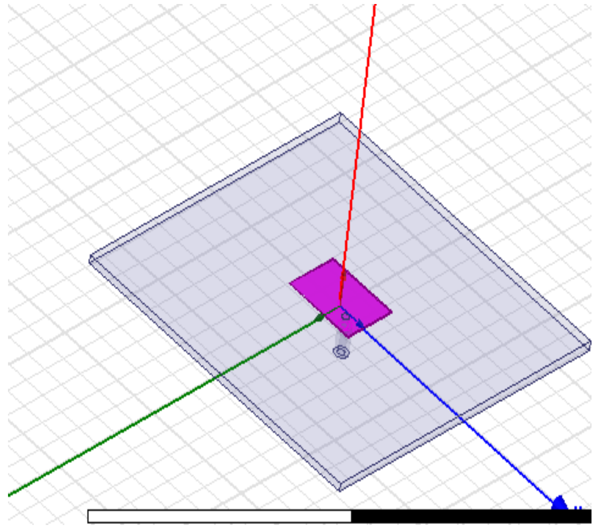

Fig. 1 Patch antenna without EBG structure

First, a planar antenna operating in the frequency range 5.45 - 575 GHz is designed. The prototype is shown in Fig. 1. From the set of available materials FR4 with dielectric constant 4.4 and thickness (h) of 1.57 mm is chosen for use as substrate.

The patch dimensions have direct influence on the operating frequency and gain. The patch length (L) and width (W) are found to be 11.6 mm and 16.44 mm respectively as shown in Table.1. The patch antenna is fed with a coaxial feeding connected to a point of the patch where the input impedance is 50 ohm.

Table.1 Dimension of Patch Antenna

Elements	L(mm)	W(mm)	h(mm)
Substrate	66.65	70.49	1.57

The HFSS simulator tool is used to build a model for the EBG antenna. The 2-D multiperiodic EBG structure antenna is designed using FR4 dielectric with 5 X 5 rectangular patch of length 6 mm and width 6 mm and above the patch with some gap (g) as shown in Fig. 2.

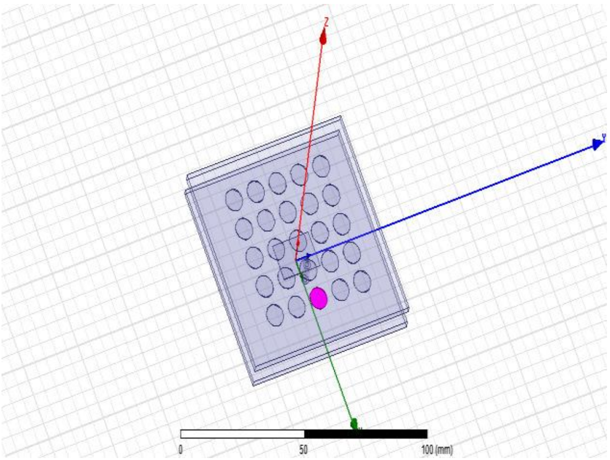

Fig. 2 Patch antenna with EBG structure

IV. SIMULATION RESULTS

A. Patch Antenna without EBG structure.

The designed patch antenna without EBG structure has central frequency of 5.59 GHz and a –10 dB return loss bandwidth of 285 MHz as shown in Fig.3. The other parameters like gain, VSWR, Bandwidth and Bandwidth percentage are obtained as shown in Table.2

Table.2 Different parameters values of Patch antenna without EBG.

BW(MHz)	%BW	VSWR	Gain(dB)
285	5.13	1.94 :	4.33

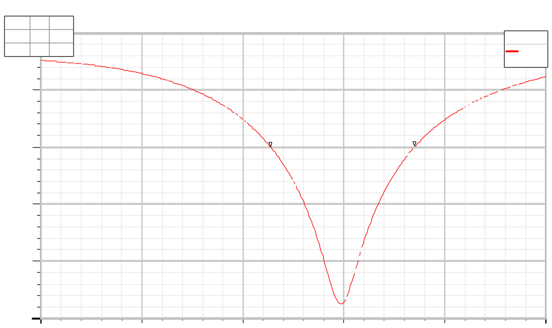

Fig.3 Return Loss of Patch antenna without EBG

B. PATCH ANTENNA WITH EBG STRUCTURE

The designed patch antenna with EBG structure has central frequency of 5.60 GHz and a –10 dB return loss bandwidth of 257.5 MHz as shown in Fig.3. The other parameters like gain, VSWR, Bandwidth and Bandwidth percentage are obtained as shown in Table.3

Table.3 Different parameters values of Patch antenna with EBG

BW(MHz)	%BW	VSWR	Gain(dB)
300	5.35	1.02	7.21

V CONCLUSION

This Paper demonstrates that patch antenna with FR4 substrate and 2-D multiperiod EBG structure made up of FR4 with dielectric constant 4.4 on patch antenna with a distance of 5 mm operating at 5.45-5.75 GHz range applicable for WiMax application. The gain of patch antenna with EBG is around 7.21 dB which is almost 3/4th as compared to patch antenna without EBG structure.

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