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Bandwidth Enhancement of Dual Patch Microstrip Antenna Array using EBG Patterns on Feedline

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***Abstract*— In this paper, we improve the bandwidth of a dual array patch antenna designed at 14.25 GHz by etching two different patterns that resemble conventional EBG structures on the feedline. The main purpose of the antenna is to have a percentage improvement in bandwidth of an EBG type antenna when compared to a reference antenna. We have termed these patterns as Dummy EBG patterns because these patterns are different from conventional EBG structures but resemble in certain properties and functions to them. These dummy EBG patterns are small and compact in size. It has been shown that a considerable improvement in bandwidth can be achieved.**

Keywords—Electromagneticbandgap(EBG), Antenna Variant-1 , Antenna Variant-2

I. Introduction

Microstrip patch antennas are the most common form of printed antennas. They are popular for their low profile geometry, light weight and low cost. These antennas have many advantages when compared to conventional antennas and hence have been used in a wide variety of applications ranging from mobile communication to satellite, aircraft and other applications [1].

Similarly, electromagnetic bandgap (EBG) structures have attracted much attention in the recent years in the microwave community for its unique properties. These structures are periodic in nature that forbids the propagation of all electromagnetic surface waves within a particular frequency band – called the bandgap – thus permitting additional control of the behavior of electromagnetic waves other than conventional guiding and/or filtering structures. Various compact structures have been proposed and studied on antenna systems. Radiation efficiency and directivity of antennas have been improved using such structures [2]-[3].

In spite of the many advantages that patch antennas have in comparison to conventional antennas, they suffer from certain disadvantages. The major drawback of such antennas is the narrow bandwidth [1].

In this paper, the narrow bandwidth problem of a patch antenna is tackled and solved. A dual array patch antenna is used as a reference antenna and efforts are made to improve its bandwidth by etching the feedline connecting the two patches using EBG type patterns. Three different EBG patterns are introduced in this paper and simulated results confirm a considerable improvement in bandwidth. Also, significance of the position of feedline connecting the twin patches with respect to the bandwidth is studied.

We propose two different types of dummy EBG patterns that are etched effectively on the feedline connecting the two patches of a dual array patch antenna. These dummy EBG patterns are compact and small in size. These patterns resemble conventional EBG structures in certain properties and functions and hence have been termed as dummy EBG patterns. A considerable improvement in bandwidth is observed in antennas having dummy EBG patterns on feedline. Hence, we are able to improve the low bandwidth problem of a patch antenna.

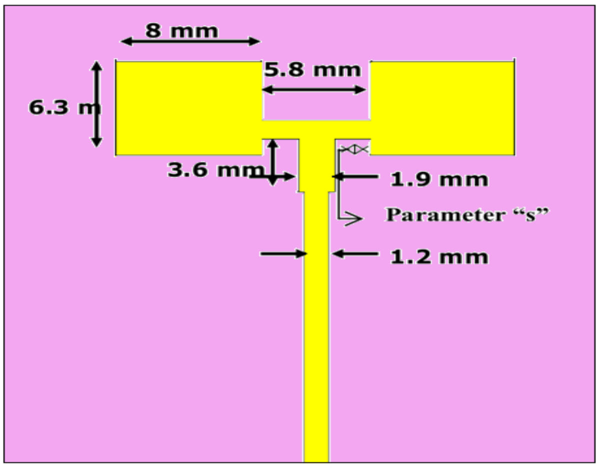

Fig.1 Reference Antenna layout witout EBG pattern

II.ANTENNA STRUCTURE

Reference antenna is the basic antenna that will be used for comparison of different results with the other proposed EBG patterned antennas. The reference antenna is similar to the one examined in [3]. It is a dual array patch antenna with no EBG pattern etched on the feedline connecting the two patches.

The length and width of the reference or the prototype antenna is found to be 8 mm (0.4λ) and 6.3 mm (0.315 λ), respectively. A quarter wave transformer (4/λ) is used for matching purposes whose width is 1.9 mm (0.095 λ) and length is 3.6 mm (0.18 λ). Fig.1 shows the structure of the reference antenna. The dimensions of the antenna are shown in the figure itself. Different variations of this reference antenna are also found by shifting the position of the feedline connecting the two patches to various locations. This is highlighted in Fig.1 by the parameter "s" that we change.

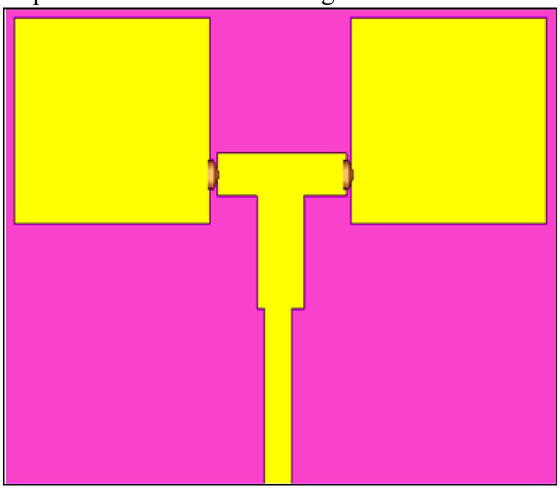

Fig 2 shows the Magnified view of the reference antenna when there is no EBG pattern is introduced.

Two different variations of the reference antenna are designed by etching different EBG patterns on the feedline connecting the twin patches. These variations are termed as antenna variant-1, antenna variant-2. The patch dimensions, substrate thickness and dielectric constant of each of these antenna variants are similar to the reference antenna.

Fig.3 shows the magnified view of the feedline in the fabricated antenna. Note that only a small part of the antenna patches are shown in Fig.4.

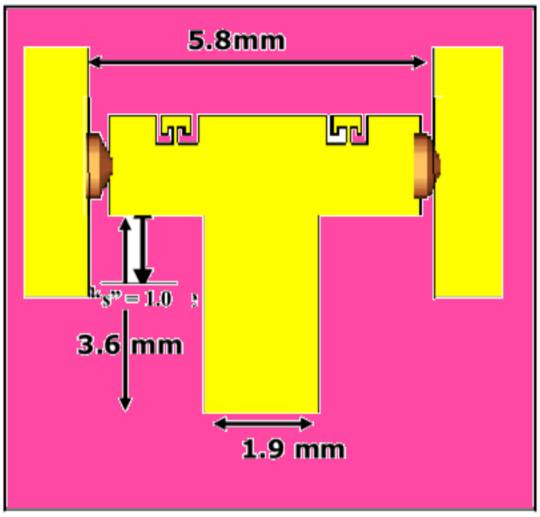

Fig.3 Magnified view of the feedline of antenna variant-1

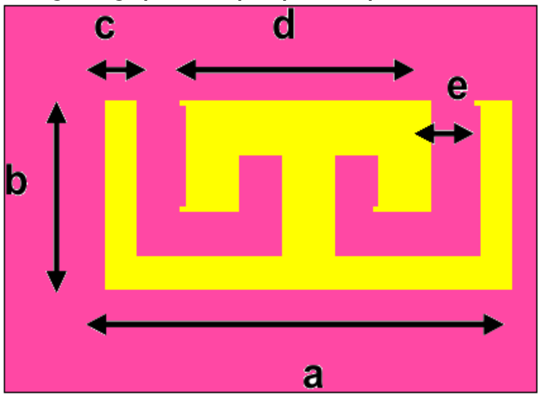

Fig. 4 Single EBG pattern-1 etched on feedline of antenna variant-1

The proposed EBG pattern that has been etched in an array fashion on the feedline of the antenna is shown in Fig 4.

The magnified view of the feedline for antenna variant-2 in Fig 5.

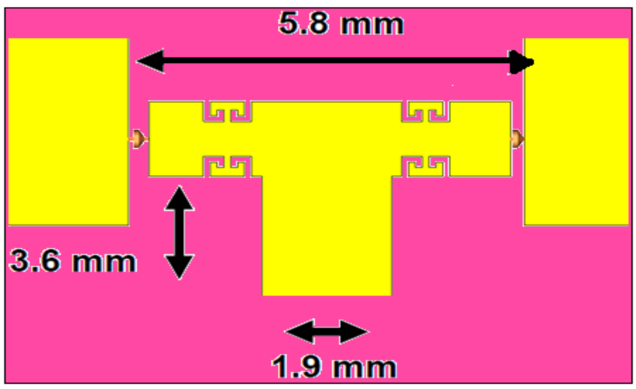

Fig.5 Magnified view of the feedline of antenna variant-2

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III RESULTS AND DISCUSSION

Case 1: Reference antenna: Without EBG with both diode ON

Fig.6 shows the S11 graph of reference antenna when both diodes are ON. The operating frequency is 14.25 GHz. and band width at 10dB is .263 GHz.

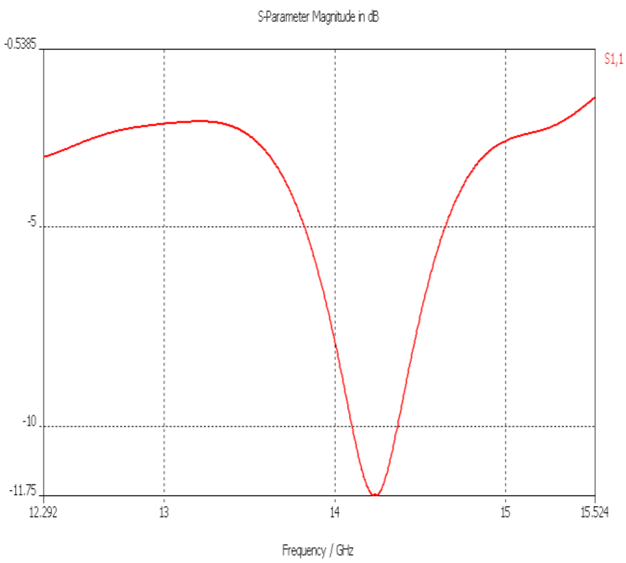

Fig.6 S11 graph of the antenna array when there is no EBG pattern is applied.

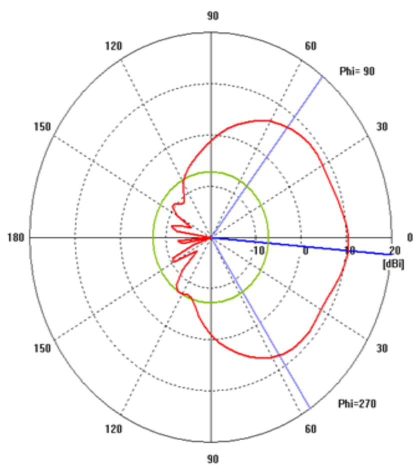

Fig.7 shows the surface current distribution at 14.25 GHz, it is clear from fig. that current is symmetrical on the patches.

From the fig.7 we can observe the farfield pattern of the antenna. The amplitude is 10.4 dBi which is quite good. The maximum radiation pattern is directed along 5 degree and side lobe gain is -17.5 dB.

Case 3 Antenna Variant-1 with EBG pattern with both diodes is ON

From fig.8 s11 can observed, resonating frequency is 14.25 which is equal to the resonance frequency of reference antenna. But the bandwidth of the antenna is increased from the reference antenna. At 10 dB band width of the reference antenna is .263 GHz. In antenna variant-1 band width at 10 dB is .278 GHz.

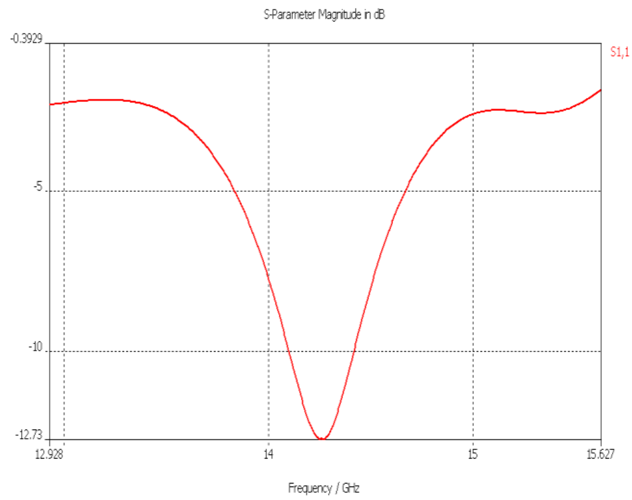

Fig.8 S11 graph of the antenna array antenna variant-1 EBG pattern when both diodes are ON

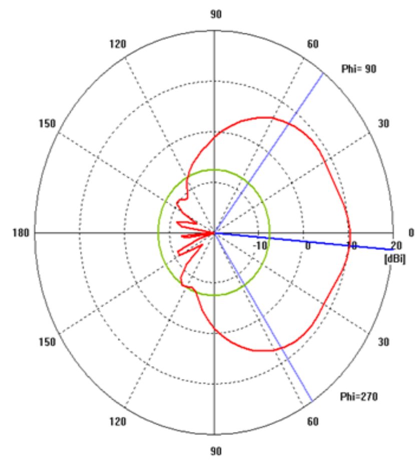

Fig.9 Farfield pattern Abs (Theta) of the antenna array antenna variant-1 EBG pattern when both diodes are ON

From the fig.9 we can observe the farfield pattern of the antenna. The main lobe amplitude is 10.4 dBi which is quite good. The maximum radiation pattern is directed along 5 degree and side lobe gain is -17.8 dB.

Case 5 Antenna Variant-2 Both Diodes On

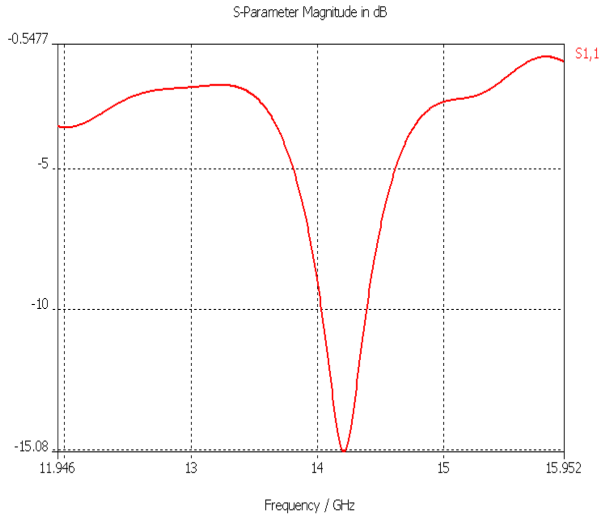

Fig.10 shows the S11 graph of the antenna variant-2 EBG pattern when both diodes are ON

From fig.10 s11 can observed, resonating frequency is 14.25 which is equal to the resonance frequency of reference antenna. But the bandwidth of the antenna is increased from the reference antenna. At 10 dB band width of the reference antenna is .263 GHz. In antenna variant-1 band width at 10 dB is .359 GHz.

IV.COMPARISION BETWEEN REFERENCE ANTENNA, ANTENNA VARIANT-1 AND ANTENNA VARIANT-2

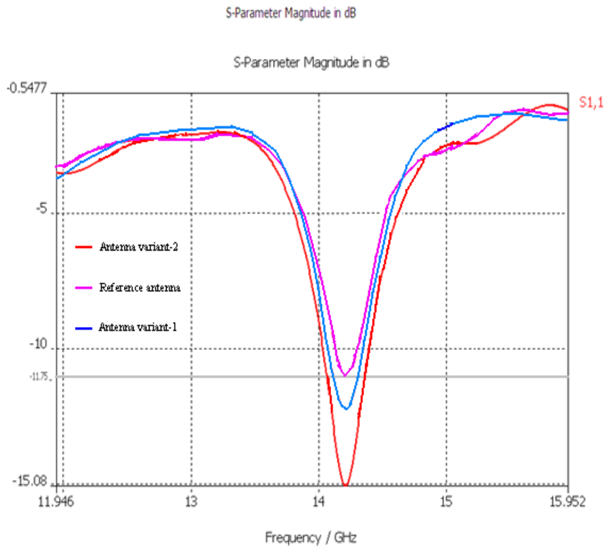

Fig.11 comparison between reference antenna, antenna variant-1 and antenna variant-2 when both diodes are ON.

Fig.11 shows the comparison of S11 graph between reference antenna, antenna variant-1 and antenna variant-2.in this comparison we obtained that in reference antenna operating frequency is 14.25 GHz and band width at 10 dB is .263 GHz .when EBG pattern is introduce in the feed line in antenna variant-1, operating frequency is still same but band width at 10 dB is increased, in antenna variant-1 band width is .278 GHz. But when antenna variant-2 bandwidth is more increased, operating frequency is still same i.e. 14.25 but band width at 10 dB is .359 dB. This is 36% percentage higher than the antenna which has no EBG pattern.

V. CONCLUSION

Thus we have concluded that when EBG pattern is introduce in the antenna structure the band width at the radiating frequency is increased. This also increased the application of the antenna. Designed antenna has band width without EBG pattern at 10 dB is .263 GHz. When EBG pattern is introduced the band width is increased up to 36% from the reference antenna without EBG.

VI. REFRENCE

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He is the author/co-author of 85 Research Papers in refereed Journals, International and National Conferences. He received "First prize best student paper platinum award" in 2009 at the IEEE International conference on Antennas, Propagation and Systems (INAS-2009) held at Johor Bahru, Malaysia from December 3-5, 2009. He is visited Malaysia, Japan, and Germany. He is a Member of the IEEE-Microwave Theory and Techniques Society.