Isolation Enhancement of the Dual Polarized Planar Antenna with Orthogonal Electromagnetic Band-Gap Backed Structure

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***Abstract*—A dual-polarized planar antenna with EBG backed structure fed by microstrip line is proposed. The backed EBG structure is tiled 45 degrees to enhance the isolation between the dual polarized antennas. From the simulated results, the antenna isolation can be improved from 10dB to better that 29dB. Also, the polarization isolation can be improved from 8dB to 18dB with mid ground added and the gain response is more stable as well. The antenna occupies an area of 5.3 ×2 mm^2 for millimeter wave (MMW) application. The planar design makes the antenna easy to integrate with RF circuitry on the same board, especially, in the MMW application.**

***Index Terms*—Dual-polarized, MMW antenna, planar antenna, broadband antenna, EBG backed antenna**

I. Introduction

Various EBG structure has been widely used to enhance the radiation efficiency of the low profiles dipole antennas [1]-[3]. In this article, a dual-polarized planar antenna with EBG backed structure fed by microstrip line is proposed. The backed EBG structure is tiled 45 degrees to enhance the isolation between the dual polarized antennas. From the simulated results, the antenna isolation can be improved from 10dB to better that 18dB. Also, the polarization isolation can be improved from 8dB to 18 dB with mid ground added and the gain response is more stable as well. The antenna occupies an area of 5.3 ×2 mm^2 for millimeter wave application.

II. Design of the Mushroom-like EBG Backed Dual Polarized Antenna

The antenna configuration is illustrated in Fig. 1. Multi-Layer organic (MLO) substrate is employed for the antenna substrate due to its characteristics of low lost and low dielectric constant (ε_r = 3.5). Since low dielectric constant substrate has wider bandwidth and radiation efficiency. The dual polarized monopole antennas with the length 2mm are etched on top layer of the MLO substrate 1 (thickness 60um) and tiled 45 degrees from Y-axis for orthogonal polarization operation. In order to fine tune the input impedance of Port_1 and Port_2, a shorting stub is used and placed between the wideband antennas and 50-Ω feeding line to matching the Port_1 and Port_2 as well. The backed EBG structure composed of a square shape with a length of 0.49mm (about 0.1 λ_0 @ 60GHz) on the top layer of the substrate 2 (thickness is 210um) and a via-hole with diameter 0.15mm between the Top GND and Bottom GND as shown in Fig. 1. The EM simulated tool, HFSS, is used for this work. Fig.2 shows the simulated results of the return loss and the isolation. The S_{11} is solid line with triangle symbol, S_{22} is solid line with circle symbol, and S_{21} is solid line without any symbol. Since Port_1 and Port_2 are symmetric, Fig.2 shows that almost the same return loss performance between Port_1 and Port_2. The 10-dB return loss bandwidth from 56GHz to 75 GHz is obtained. And the isolation between Port_1 and Port_2 is about 10dB.

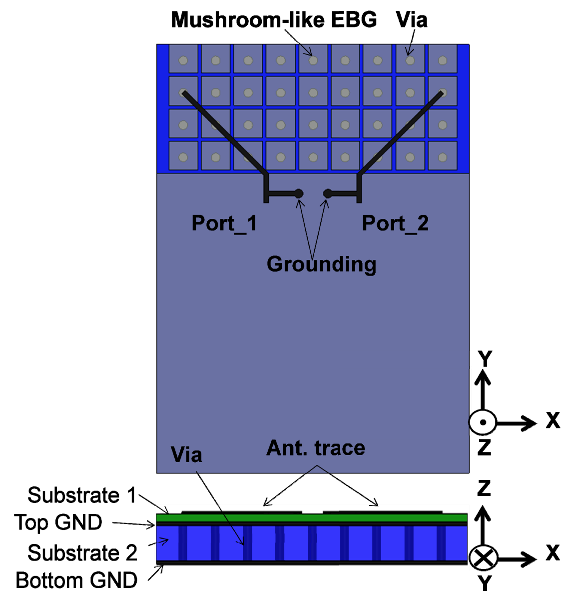


Fig. 1. The configuration of a dual-polarized EBG backed antenna

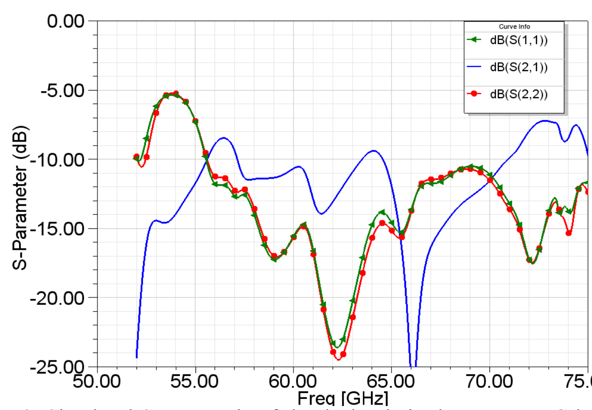


Fig. 2. Simulated S-parametric of the dual polarized antenna EBG backed antenna.

III. Polarization Isolation Enhancement by the Tiled Backed EBG and Mid Ground Added Structure

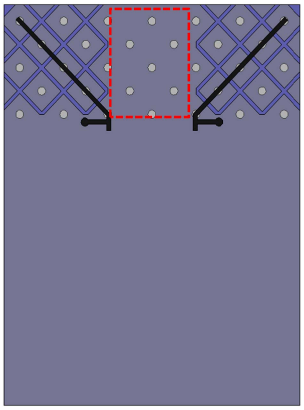


Fig. 4. The configuration of the dual polarized antenna with tiled 45 degrees backed EBG and mid ground added.

Fig. 4 shows configuration of the dual polarized antenna with tiled 45 degrees backed EBG structure. For isolation improvement, the square shape of the EBG is tiled 45degrees from Y-axis as well as the dual planar antennas. For fine tuning the new structure, the length of the square is optimized to 0.54mm and the length of the antenna is optimized to 2.5mm. Since the asymmetric ground plane, the polarization isolation is only about 8dB. To solve this problem, the antenna is designed to be close to the ground plane with a more symmetrical. The dashed line area is the added ground that makes the antenna structure to be more symmetrical. The simulated result of the dual polarized antenna with tiled EBG is shown in Fig.5. The S_{11} is solid line with triangle symbol, S_{22} is solid line with circle symbol, and S_{21} is solid line without any symbol. From the result, it can be easy obtained that the isolation can be improved from 10dB to 29dB at f_0 (60GHz). Also, the isolation is improved in other desired band.

Fig.6 shows the radiated patterns of E-plane (Phi=135° cut) and H-plane (Phi=45°) as Port_1 excited. The co-pol is solid line with circle symbol and the cross-pol is solid line without any symbol. From the results, a peak realized gain about 3.5dBi is obtained. Also, the polarization isolation is about 18dB due to the more symmetric ground plane. The polarization isolation is improved from 8dB to 18dB. Since Port_1 and Port_2 are symmetric, the radiated pattern excited by Port_2 is not shown here for simplify the article.

Fig.7 shows the comparison of the polarization isolation between with and without the mid plane. From the results, it can be shown that the more symmetrical structure will have relatively high polarization isolation.

IV. Conclusion

A dual-polarized planar antenna with EBG backed structure fed by microstrip line is proposed. The backed EBG structure is tiled 45 degrees to enhance the isolation between the dual polarized antennas. From the simulated results, the antenna isolation can be improved from 10dB to better that 29dB. The antenna is designed to be close to the ground plane with a more symmetrical. So that the polarization isolation can be improved from 8dB to 18dB with mid ground added and the gain response is more stable as well. The antenna occupies an area of

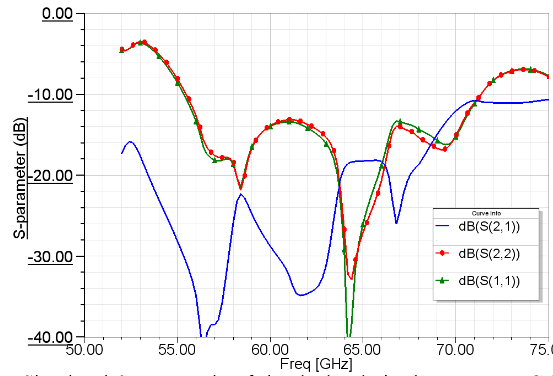
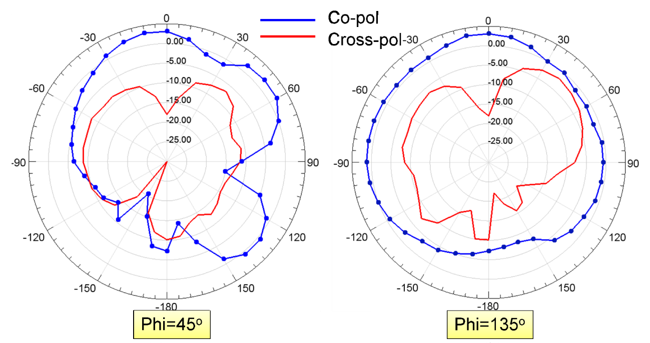


Fig. 5. Simulated S-parametric of the dual polarized antenna EBG backed antenna.



(a) (b)

Fig. 6. Radiated pattern as Port_1 excited @ 60GHz (a) H-plane or Phi=45° cut-plane (b) E-plane or Phi=135° cut-plane

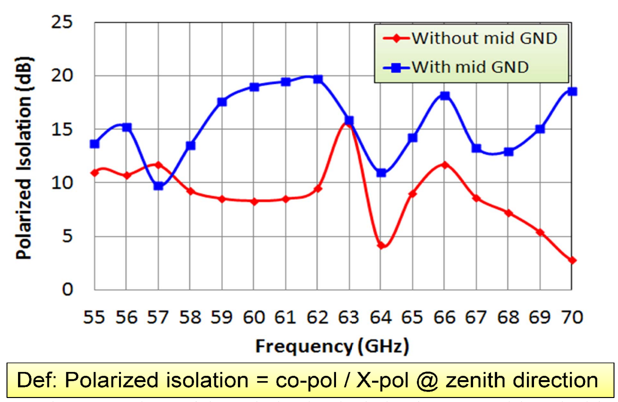


Fig. 7. The comparison of the polarization isolation between with and without the mid plane.

5.3×2 mm^2 for MMW application. The planar design makes the antenna easy to integrate with RF circuitry on the same board, especially, in the MMW application.

References

[1] D. Sievenpiper, L. Zhang, R. F. J. Broas, N. G. Alexopolus, and E. Yablonovitch, “High-Impedance Electromagnetic Surface with a Forbidden Frequency Band,” *IEEE Trans. Microwave Theory and Tech.*, vol. 47, No. 11, pp. 2059-2074, Nov. 1999.

[2] Fan Yang, Y. Rahmat-Samii, “Reflection Phase Characterization of the EBG ground plane for low profile wire antenna applications,” *IEEE Trans. Antennas Propagat.*, vol. 51, pp. 2691-2703, Oct 2003.

[3] Y. F. Lu and Y. C. Lin, “Design and Implementation of Broadband Partially Reflective Surface Antenna,” in *Proc. IEEE Int. Antenna and Propag. Symp.*, 2011, pp. 2250-2253.