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Design And Performance Analysis Of Multibeam Antenna

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Abstract: In this paper the performance analysis of a multibeam antenna is presented. Now a days applications need different operating frequency antennas in single substrate. Multibeam antenna is capable of transmitting and receiving signals in all direction. Multibeam antenna is constructed using multiple array pattern. Each array is operating at different frequency. The frequency of [2.4-2.5] GHz for Wi-Fi and[5.3-5.7]GHz for WLAN. We designed the multibeam antenna for two different application. Design of multibeam antenna improves the directivity of the antenna. A directivity of 9.263 dBi is achieved which is a very high value.

Index Terms: multibeam antenna, patch, sectoral radiation pattern, Electromagnetic band-gap (EBG) structure

I. INTRODUCTION

MULTIBEAM antennas are widely used in several applications ranging from communications up to radars .In this framework, this letter is aimed at validating a sub arraying strategy where the array can simultaneously receive the signals on different channels when the antenna is used in reception, while only one pattern at each time can be generated in transmission. ELECTROMAGNETIC band-gap (EBG) materials are periodic structures that can control the propagation direction of electromagnetic waves. In the antenna domain, EBG structure is constructed by placing high impedance in ground plane. It is used to avoid the interference of radiation from one antenna to another antenna. By increasing the dimensions of the central core, we can obtain a sectoral antenna, where the electromagnetic field will be evanescent around the core, providing a sectoral radiation pattern Fig. 1.

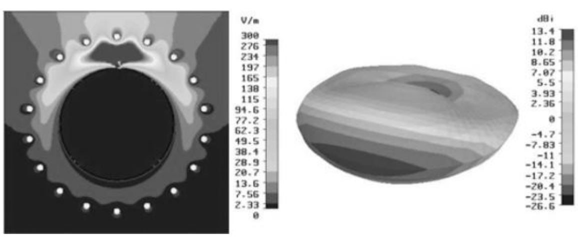

Fig.1.Electromagnetic field distribution and 3D radiation pattern of the sectoral antenna.

Generally, this type of antenna is composed of a thin metallic core acting as a ground plane and surrounded by a EBG structure. An excitation source is positioned between the EBG and the metallic core. A significant enhancement of the excitation source directivity is achieved. Theme of our work is to use the omni directional antenna to design a multibeam antenna for Wi-Fi [2.4-2.5] GHz and WLAN[5.3-5.7] GHZ applications by using multiple array pattern structures.

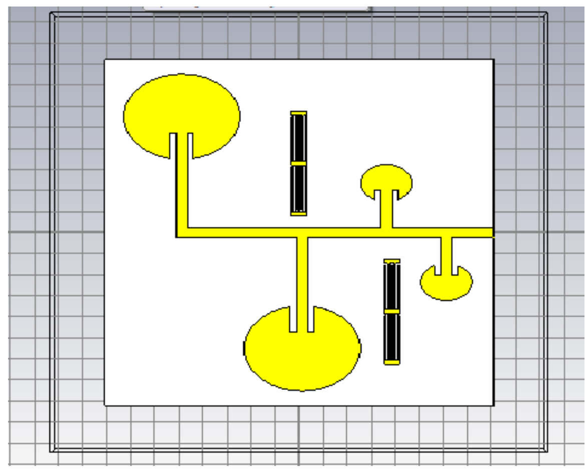

Fig.2 Multibeam Antenna structure.

II. PRINCIPLE OF THE MULTIBEAM ANTENNA

In the omni directional antenna case, the central metallic core has a small diameter. It must be need when employing different antennas in single substrate. Fig.2. Cylindrical EBG structures have also been used to conceive other types of antennas, like omni directional ones. The multibeam antenna can be obtained by adding multiple excitation sources.

III. ANTENNA DESIGN AND SIMULATION

A.Antenna Design

The required antenna is vertically polarized and must produce 4 beams directivity of 9.263 dBi.

B.Design of multibeam antenna

The design of multibeam antenna is a monopole structure and patch is circular.

IV. STRUCTURE OF THE ANTENNA WITH FOUR BEAMS

Planar and microstrip antennas technology has been the most rapidly developing topic and has become a favorite subject of research by many academicians, researchers and engineers throughout the globe. Just like an artist but

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with an extra understanding on how an antenna works, a plane piece of substrate materials with a thin copper laminates on one or both sides of the substrate gives the designers the freedom to come out with unlimited antenna designs, including methods to improve their performance. It has evolved from academic novelty to commercial reality in the past several decades and is still undergoing monumental developments due to driving factors such as newer requirements set by the latest standards, technologies, government rules and regulations and most importantly, the increasing demands of multifunctional telecommunication devises by users and markets around the globe.EBG structures seem simple to construct but actually are complex structures and difficult to characterized through analytical methods and, what more to say when integrated with array antenna structures. In this work, an advanced full wave simulator is used to design and with the substantial advancement in the computational of electromagnetic (EM) waves tools, the progress and contribution to the rapid development of novel antenna designs has been made easier and faster compared to a decade ago. Analyzing the planar/microstrip antennas and EBG structures, including the marriage between both of them could be carried out easily, numerically.

V SIMULATION RESULTS

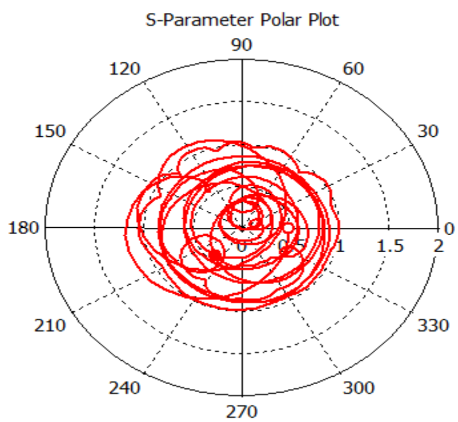

Fig.3 S-Parameter Polar Plot for Multibeam Antenna

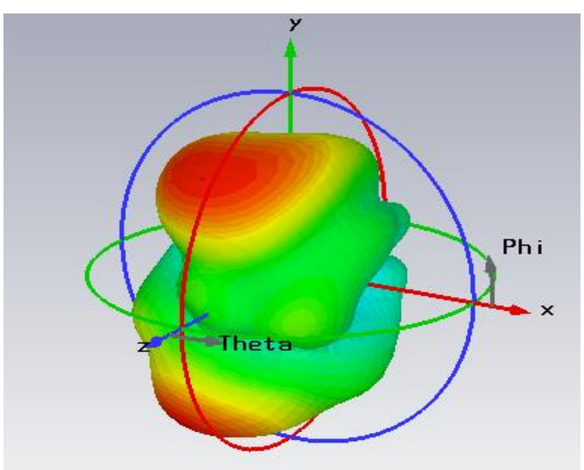

Fig. 4 Farfield patteren of the antenna

Fig.3 shows the S- parameter plot for designed antenna. Which shows the antenna radiation in all of the direction in the space. Fig. 4 shows the simulated patterns of the equivalent waveguide model multibeam antenna at all 4 ports input. The entire insertion loss of the equivalent waveguide feeding network is about 0.9 dB.

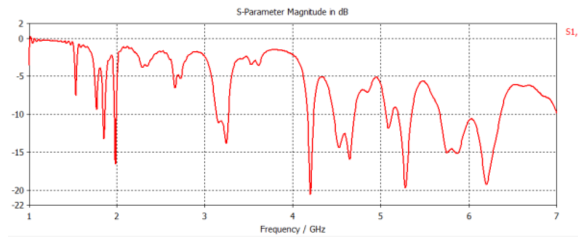

Fig.5. Measured and simulated radiation pattern at 2.44 GHz in the H-plane

VI EXPRIMENTAL RESULTS

A vector network analyzer is utilized to measure the reflection coefficient. Unused ports are terminated by broadband matching loads through SMA connectors. The radiation patterns of the antenna are tested with a microwave antenna test system in an anechoic chamber.

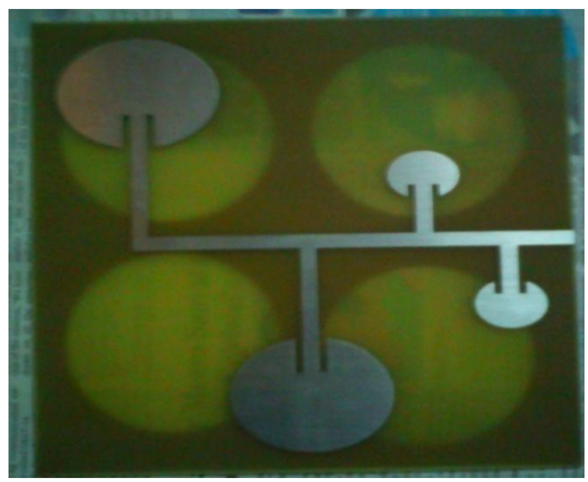

Fig.6 Photograph of the fabricated multibeam antenna

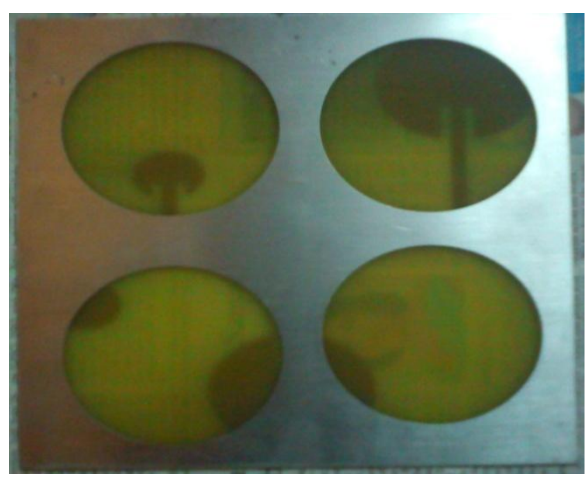

Fig.7 Photograph of the fabricated multibeam antenna EBG

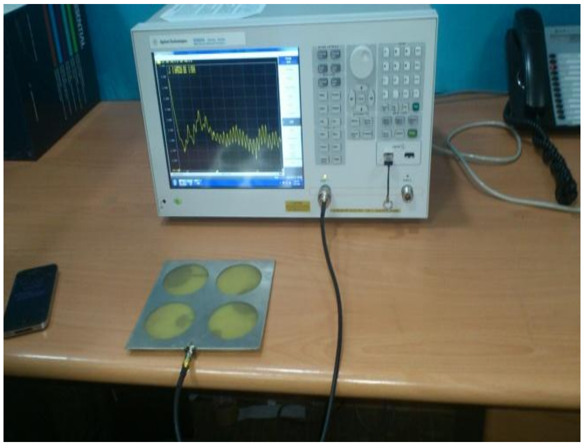

Fig.8 Testing of multibeam antenna array using vector analyzer

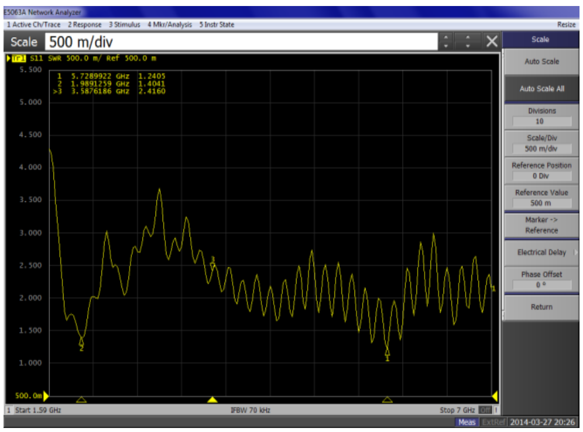

Fig.9 Return loss of the antenna array

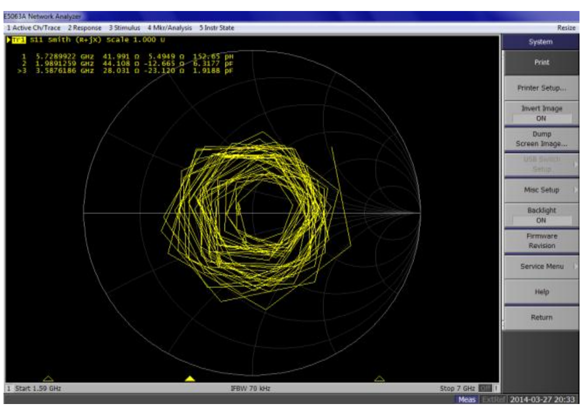

Fig.10 Impedance plot if the antenna array

Fig.6 shows the front view of the fabricated multibeam antenna, Which consists of different frequency in single patch. Fig.7 shows the EBG structure placed in the ground plane of the antenna. Fig.8 shows the interfacing of the designed antenna array with the vector analyzer with help of SMA connector. Fig.9 shows the location of the minimum return loss for designed antenna. It indirectly shows the where the radiating the maximum power. Fig.10 shows the impedance plot for the antenna array. Comparison between simulated and fabricated results

PARAMETERS	SIMULATED OUTPUT	FABRICATD OUTPUT
Directivity	9.263 dBi	9.162 dBi
VSWR (Max)	2-3 and 5.3-6.2	1.9 and 5.7
Return loss (Min)	2-3 and 5.3-6.2	1.9 and 5.7
S-Parameter	In all Direction	In all Direction

The comparison tables shows, there is variation in the Simulated output and the fabricated output. Because of the open air environment. Due to open air environment there will be a ISM band frequency present in the surroundings. So there will be a reduction in parameters compared to the simulated results. To get the perfect simulated results in the fabricated output. The testing must be done in closed air environment.

VII. CONCLUSION

We have presented in this paper, the concept of a multibeam antenna using multiple array pattern. The antenna structure and its components are detailed. Several steps of the design process are described, and predicted performance values obtained by computer simulation are presented. Finally, to validate our simulation results, a protototype of the antenna with four beams is fabricated and characterized. The measured results agreed well with the simulated ones. A low-cost, dual-band, beam-reconfigurable array antenna using simple switching has been designed and evaluated.

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