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Micro-strip Patch antenna designing using multiple arrays

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Abstract - *Antenna is a metallic device for radiating or receiving radio waves, another word can say that antenna is a transitional structure between free space and guided device. A microstrip antenna metallic patch is placed on the ground plane separated using substrate material. For patch antenna, we can use different shapes like rectangular, circular, triangular, or other different shapes that are suitable based on the application. Size shape and structure can be designed as per use. But, it has some disadvantages like contracted bandwidth, lower gain, and low efficiency. Rectangular and circular configurations are basically used due to their agreeable radiation properties, low cross-polarization, low profile, and comfort in planar also in non-planar configuration, which can be mounted on stiff surfaces. Various applications of microstrip antenna like military appliances, satellite communication, handheld radiating devices, GPS antenna, telemetry system, cellphone antenna also other microwave communication applications. A number of single elements arranged in an array fashion for obtaining high gain and high directivity. The proposed work consists of a rectangular Microstrip patch antenna array with EBG structure and without EBG structure. The array is designed for an operating frequency of 2.46 GHz uses two microstrip patch antenna elements and its performance is improved using uniform electromagnetic band-gap (EBG) configuration at 2.50 GHz*

Key Words: **Aperture coupling, 2X1 Array, Bandwidth, Band-gap, Current, Electromagnetic Band-Gap, Gain, Microstrip patch antenna, Microwave frequencies, Patch antenna, VSWR, Reflection coefficient S11**

1. INTRODUCTION

An antenna is a special part of the communication system. An antenna is termed as a metallic device for getting or transmitting radio waves in the RF system. With the appropriate design of the antenna, system requirements can be reduced. Various antenna configurations have been planned. Microstrip patch antenna taken a firm place in the communication system as its attractive features and essentially used in many commercial applications. Unfortunately, it suffers from disadvantages like contracted bandwidth, lower gain, and low efficiency [6][9]. Microstrip antennas are implemented usually in military and industrial applications. It includes a metallic patch with the grounded substrate. It has used in various configurations. Rectangular and circular configurations are basically used due to their agreeable radiation properties, low cross-polarization, low profile, and comfort in planar also in non-planar configuration can be mounted on stiff surfaces. These can be fixed on satellites, military devices, automobiles, and also in handheld devices [9]. A patch excited by a microstrip line feed. Feed arrangement having advantages like it can be etched on the same substrate hence structure remains planer [4]. But disadvantage due to radiation from the feed line, which leads to an increase in the cross-polar level. In addition, the millimeter-wave range and the size of the feed line are proportional to the patch size, leading to increased undesired radiation. For dense substrates, commonly use to achieve gain, both of the above MSA feeding methods have problems [12].

The growth of wireless systems and booming demand for a variety of new wireless applications such as Wireless Local Area Network, it is important to design broadband and high gain antennas to cover a wide frequency range. The design of a required wideband compact size antenna, for the latest microwave applications, is the main challenge [3]. For applications such as high-performance aircraft, satellite, military radar system, mobile radio, and wireless communications, low cost, low profile, compliance, and easy installation and integration of feed networks are the main obstacles .Also, with technological advances, the antenna requirement for more frequencies. i.e. multi-banding is also increasing day by day. Here microstrip patch antenna is the best choice to fulfill all the above requirements [1][2].

Microstrip patch antenna having more advantages like low fabrication cost, supports both, linear as well as circular polarization, as compare to the conventional antennas. Surface wave excitation and narrow bandwidth are some demerits of Microstrip patch antenna. The antenna array can also be used to improve the Gain [4]. Various antenna performance parameters like gain, reflection coefficient, VSWR, Directivity can be controlled by proper feeding technique and location. The inset feed use to exciting line and also terminated by a slot, which length is selected width of 2.8 mm. This feeding method is simple which allows for planer feeding and easy to use with array structure. For input matching, this method is very easy [1]. In most large-scale communication applications, the basic need is to raise the gain with high performance. Consideration can be given to the reorganization of electrical parameters of a particular

antenna. Another path by a congregation of transmitting elements in geometrical and an electrical arrangement formation of new antenna configuration due to multi-elements called as an array for directive antenna [11], a field from the array are added constructively to the needed directions and canceled in the other space. For transmitting as well as receiving the radio waves, multiple antennas are connected together and act as a single antenna called an antenna array. The radio waves radiated by each individual antenna combine and adding together as per their design. hence increase in the power radiated at the desired direction, and reduce transmission of power in other directions.by this way side lobe of the radiation pattern can be reduced and front lobe power is improved.

By using arrays we can improve signal strength, directivity, reduction in side lobes. Also, we can obtain a high signal to noise ratio. Due to arrays, we can obtain high gain and better performance by eliminating power wastage. Electromagnetic has gained a lot of attraction among investigators due to its civil and defense applications. Microstrip patch antennas are popularly used today due to their merits of lighter weight, less volume, lower cost, easy to install, and easily compatible with integrated circuits[12]. In a communication system, some applications require a smaller configuration of microstrip antenna to make it suitable for that application. For the last four years, significant improvement in the configurations of microstrip patch antennas has been presented so different aspects or methods have come forward to fulfill this purpose.

An idea of SIW rises from the microstrip and waveguide. Most microstrip antennas designed with multiple patches in various structural two-dimensional array [8]. The antenna is usually connected to the transmitter or receiver through foil micro strip transmission lines. The radio frequency current is feed also in receiving antennas the received signal is generated between the antenna and ground plane [7]. Microstrip antennas have much appreciated in recent years due to its thickness that can attract users towards it, defense appliances like aircraft and missiles where this antenna fit properly and securely, and the possibility of adding active devices such as microwave integrated circuits to the antenna itself to make active antennas [10].

Microstrip antennas are cost-efficient due to simple two dimensional physical geometry. Due to their size antenna can directly tied to the wavelength at the resonant frequency like UHF and high frequency. From the signal patch antenna we can get maximum directive gain near about 6-9 dBi. Using Lithographic techniques it is comparatively easy to print an array of patch on large single substrate. Microstrip patch arrays comparatively can provide much higher gains as single patch at additional charge [4]. At another side phase adjustment and matching also performed with printed microstrip structure, in the same operations that form the radiating patches.

This type of array patch antennas is an easy way to make phase array of antenna using dynamic beam forming property [11][2]. Also in additional patch antennas are having ability to have polarization diversity. Patch antennas can easily be designed which having vertical, horizontal, right hand circular (RHCP) also left hand circular (LHCP) polarizations, by applying multiple feed points, as well as single feed point with asymmetric patch structures [14]. Due to the unique property of patch antennas they used in many types of various communication applications with rise in requirements [13]. EBG (Electromagnetic Band-Gap) structure is used to enhance the gain in simple microstrip patch array antenna. EBG structures are defined as artificially design structure which having identical substructure components joined together which help to the propagation of electromagnetic waves in the desired frequency band for all incident angles and all polarization states EBG antenna is an excellent candidate for several applications due to its high gain and good polarization purity [5]. EBG improves the radiation or gain patterns also decreases the noise or losses in transmissions [13][14]. Circular, hexagonal, square, uniplanar defect ground structures (DGC), and Co-Planer Waveguide (CPW) fractals are the main types of planer EBG structures.

2. DESIGNING

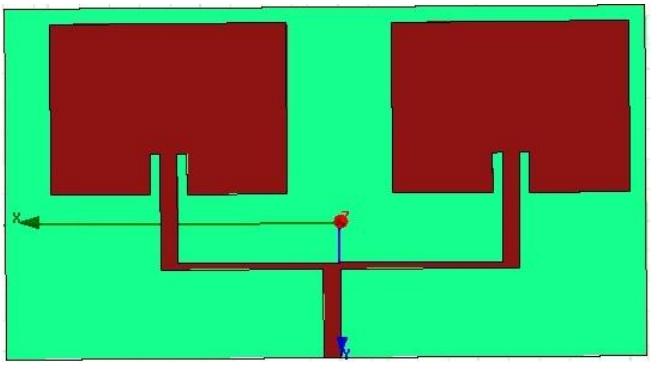

Fig1. Simulated 2X1 microstrip patch antenna design

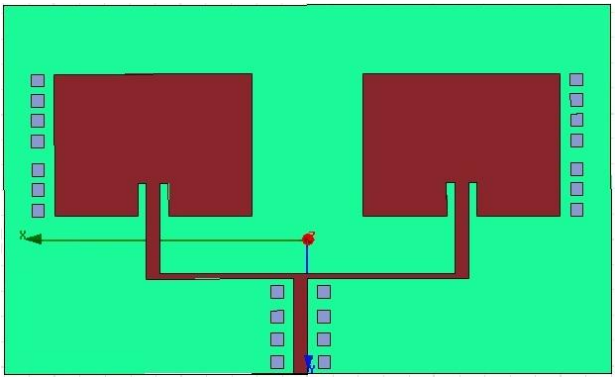

Fig 2. Simulated 2X1 microstrip patch antenna design with EBG

2X1 microstrip patch antenna and 2X1 microstrip patch antenna with EBG structure is designed in HFSS simulation

software to operate at 2.46 GHz and 2.5 GHz respectively, with FR4 epoxy dielectric constant as substrate material. FR4 epoxy dielectric substrate having advantages like economical, thin, loss less over others. The length and width of the patch are 38mm and 29mm respectively. The feed point is 7.5mm from the center of the patch as shown in fig 1 and Fig 2.

3. SIMULATION

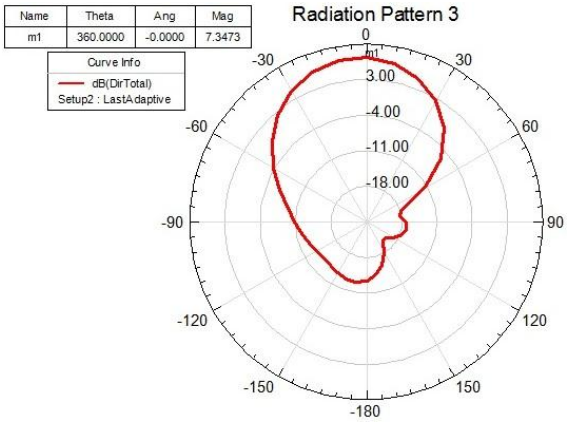

Fig 3. Simulated 2X1 microstrip patch antenna Directivity

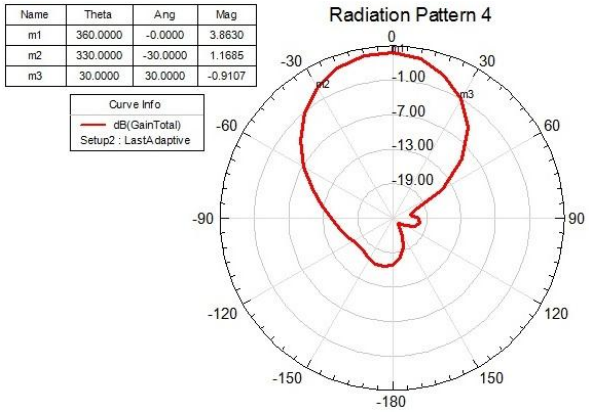

Fig 4. Simulated 2X1 microstrip patch antenna Gain

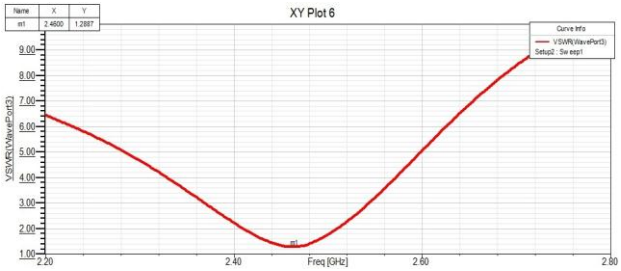

Fig 5. Simulated 2X1 microstrip patch antenna VSWR

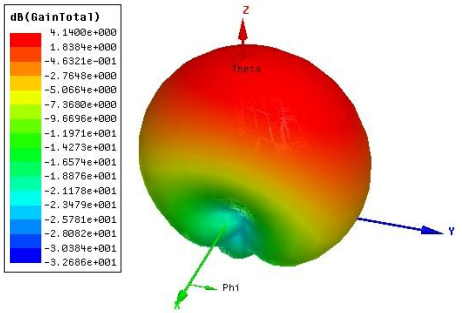

Fig 6. Simulated 2X1 microstrip patch antenna GAIN 3D (Directivity)

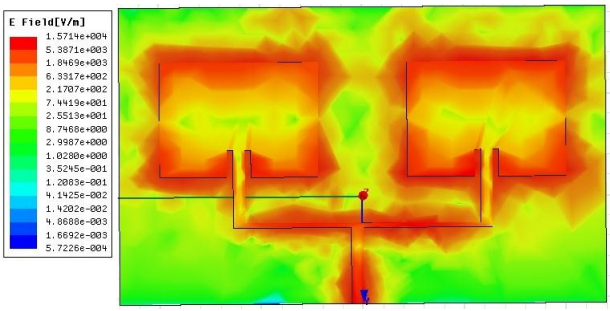

Fig 7. Simulated 2X1 microstrip patch antenna Current

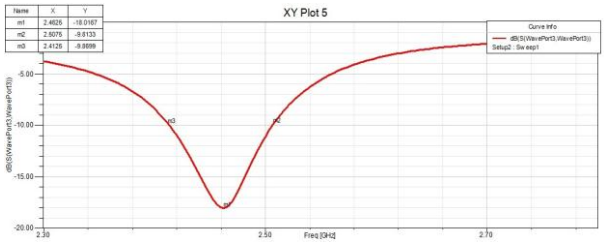

Fig 8. Simulated 2X1 microstrip patch antenna S11

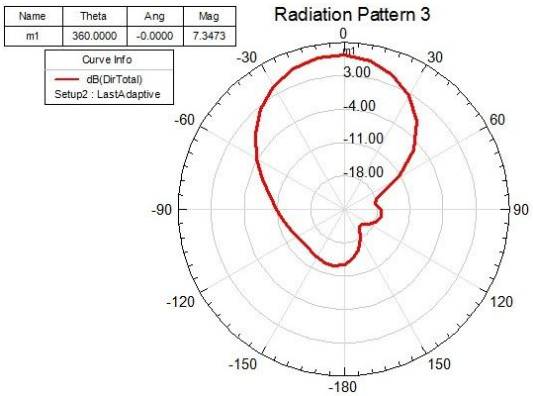

Fig 9 . Simulated 2X1 microstrip patch antenna Directivity with EBG

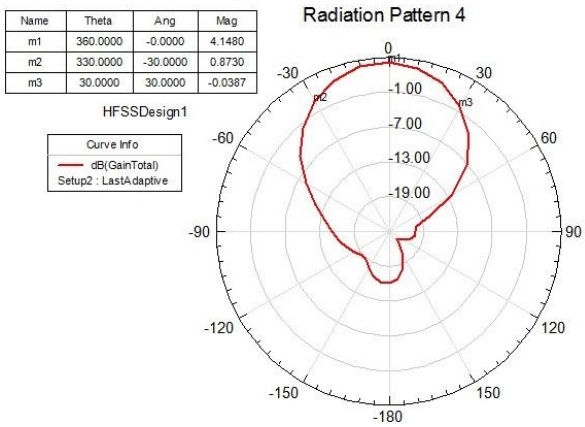

Fig 10. Simulated 2X1 microstrip patch antenna Gain with EBG

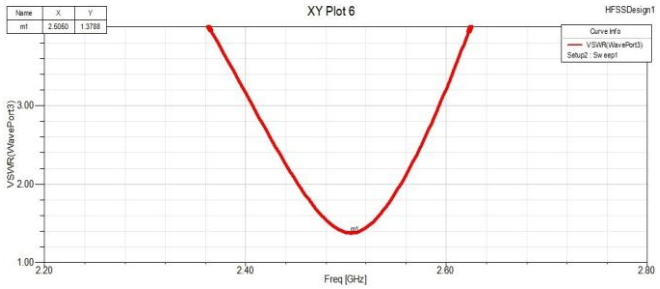

Fig11 . Simulated 2X1 microstrip patch antenna VSWR with EBG

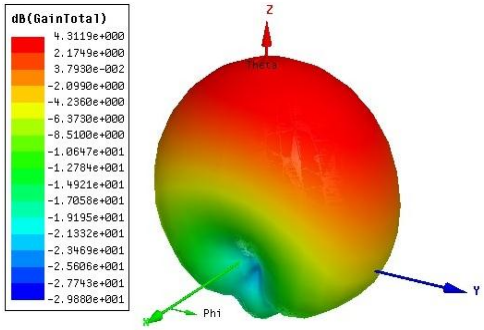

Fig 12. Simulated 2X1 microstrip patch antenna GAIN 3D (Directivity) with EBG

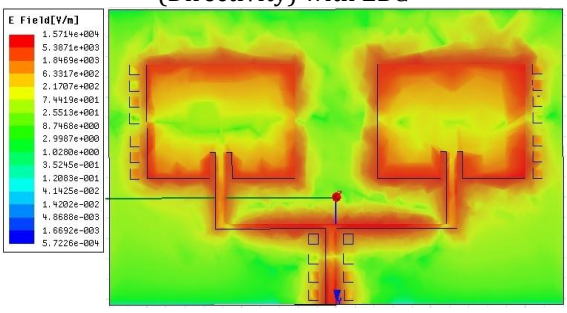

Fig 13. Simulated 2X1 microstrip patch antenna Current with EBG

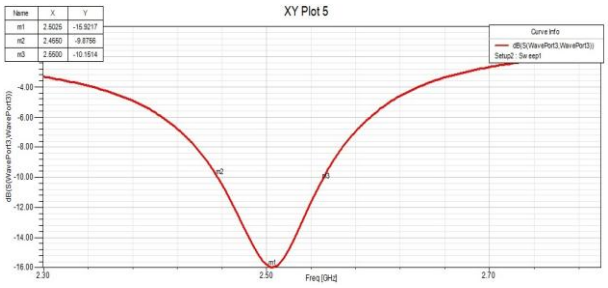

Fig 14. Simulated 2X1 microstrip patch antenna S11 with EBG

Sr.no	Parameter	Simple 2X1	2X1 With EBG
1.	Frequency	2.46GHz	2.5 GHz
2.	VSWR	1.29	1.38
3.	S11	-17.98dB	-15.92 dB
4.	Bandwidth	95MHz	85MHz
5.	Gain	3.86dB	4.15dB
6.	Directivity	7.34	7.64

Fig 15. Comparison of simulation Result

4. CONCLUSION

From the simulation result 2X1 microstrip patch antenna array without EBG structure and 2X1 microstrip patch antenna array with EBG structure by using HFSS simulation software implementation has been completed, hence from the result 2X1 microstrip patch antenna with EBG Structure is giving better performance therefore antenna array can be used for long-distance communication applications.

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