

## Design of 2×1 Square Microstrip Antenna Array

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### Abstract

In this paper the design of two element square microstrip antenna array without and with Electromagnetic Band Gap (EBG) structure and square slots is examined. The dielectric used to design the antenna arrays is FR-4 glass epoxy substrate with a dielectric constant of 4.2 and loss tangent of 0.0245. The antenna array designed at a frequency of 6 GHz is resonating at a frequency of 5.55 GHz with a return loss of -29.19 dB. With the introduction of and square patch EBG structure and square slots, the miniaturization produced is 11.53 %. The modified antenna array is producing an overall bandwidth of 20.76%. The antenna arrays have been designed and simulated using Mentor Graphics IE3D simulation software. The antenna arrays designed are useful for WiMax applications.

**Keywords:** Electromagnetic Band Gap Structure, Microstrip Antenna Array, Miniaturization, Square Slot.

### INTRODUCTION

Electromagnetic Band Gap structures are finite and periodic array of dielectric or magnetic cells. When these structures come in contact with electromagnetic waves, they possess distinctive pass and stop bands. Thus an EBG structure acts as a filter in suppressing certain frequencies. Microstrip antennas have become one of the favorites among the researchers. Demand for microstrip patch antennas has been increasing for wireless communication applications. They are the most sought after antennas because of their light weight, planar structure, ease of fabrication and ease of

integration with other devices. Microstrip patch antennas are also called as printed antennas because they can be printed directly on a circuit board. [1-3]

Patch antennas can easily be designed using multiple feed-points or a single feed-point with asymmetric or symmetric patch structures. This unique property allows patch antennas to be used in many types of communications that may have varied requirements. In its basic form a microstrip patch antenna consists of a ground plane on one side of the dielectric substrate which has a radiating patch on the other side. The radiating patch is generally made of conducting material such as copper or gold. The radiating patch and the feed line are photo etched on the dielectric substrate. The radiating patch can take any desired shape. The shape can be rectangular, square, circular, triangular, hexagonal, elliptical or any other configuration. These antennas are used in the frequency range of UHF to millimeter waves. [4-8]

### DESIGN OF ANTENNA ARRAY

The antenna array is designed at a frequency of 6 GHz. It consists of two identical square radiating patches. The length of the side of each radiating patch is 11.36 mm. The length and width of the quarter wave transformer are 6 and 0.5 mm respectively. The length and width of the feed ( $50\Omega$ ) are 6.2 and 3 mm respectively. The antenna array is fed using the corporate feeding technique. The schematic of the conventional antenna array is shown in Fig.1. The distance between the array elements ( $d$ ) is equal to 61 mm. The quarter wave transformer is used to match the impedance of the radiating patch and the feed.

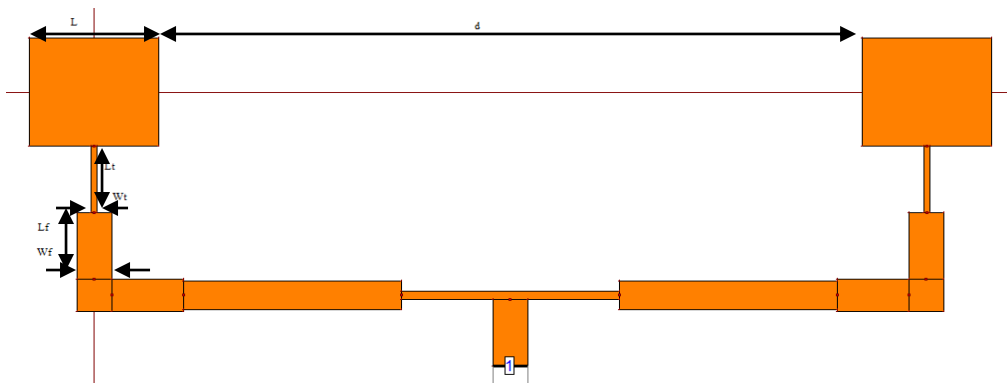


Fig.1. Schematic of conventional Microstrip Antenna Array.

The return loss versus frequency plot of the conventional antenna array is depicted in Fig.2. The return loss is depicted by the S-parameter  $S_{11}$ .

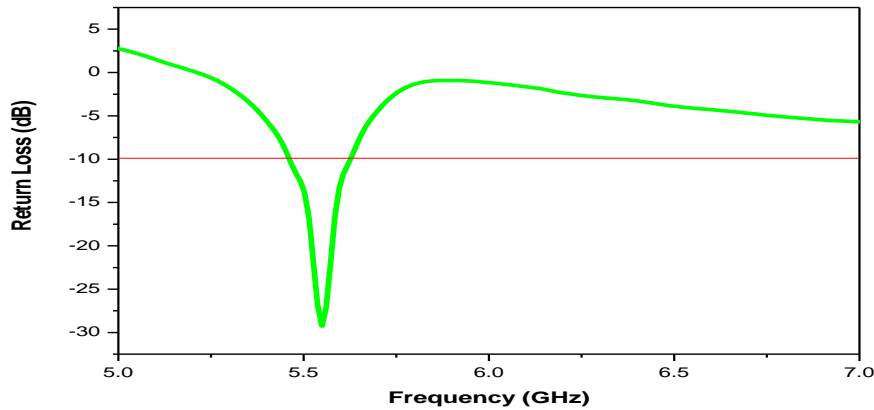


Fig.2. Plot of Return Loss versus Frequency of Conventional Microstrip Antenna Array.

From Fig.2 we see that the antenna array is resonating at 5.55 GHz with a return loss of -29.19 dB. The bandwidth is equal to 157.4 MHz. Bandwidth is calculated by subtracting the lower frequency from the upper frequency at which the return loss crosses the -10 dB value. The bandwidth (%) is equal to 2.39 %.

The conventional antenna array is modified by etching a square slot of dimensions  $4 \text{ mm} \times 4 \text{ mm}$  at the centre of each of the radiating patches and introducing an EBG structure of a matrix of 3 rows and 3 columns of square patch as depicted in Fig.3. The dimensions of each unit cell of the EBG structure employed are  $4 \text{ mm} \times 4 \text{ mm}$ . The distance between the two adjacent cells of the EBG structure is 1 mm. The EBG structure is inserted in between the two antenna elements as shown in Fig.3. The distance between the two antenna elements is maintained the same as in Fig.1.

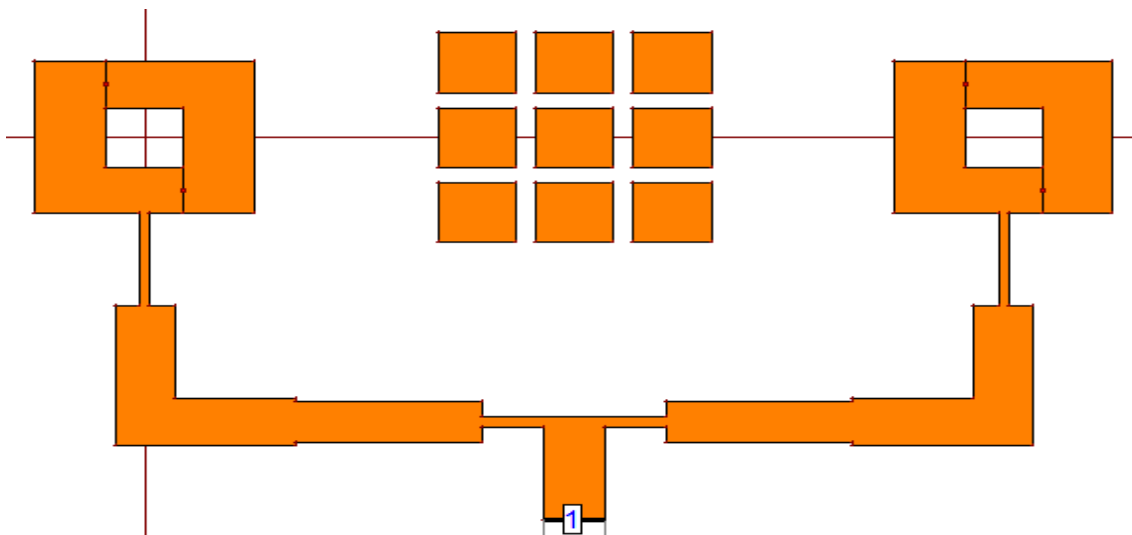


Fig.3. Schematic of Microstrip Antenna Array with EBG and Square Slots.

The proposed antenna array is simulated to obtain the results. The results of the proposed antenna array are depicted in Fig.4.

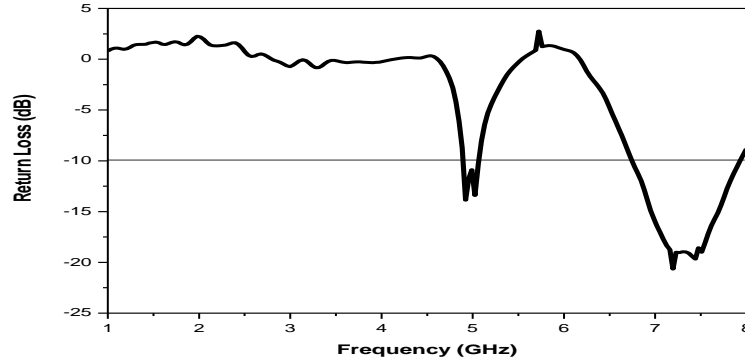


Fig.4. Plot of Return Loss versus Frequency of Microstrip Antenna Array with EBG and Square Slot.

From Fig. 4, we see that with the introduction of square patch EBG structure and square slots the antenna array is resonating at a lesser frequency of 4.91 GHz as compared to 5.55 GHz of the conventional antenna array. This implies miniaturization or virtual size reduction is obtained. The miniaturization obtained is equal to 11.53%. Moreover, the modified antenna array is resonating at two frequencies – 4.91 and 7.17 GHz respectively. This antenna array is having a very good return loss of -13.76 and -20.51dB respectively at the corresponding resonant frequencies.

The bandwidths of the proposed antenna array at the resonant frequencies of 4.91 and 7.17 GHz are 248.53 and 1126.37 MHz respectively. The overall bandwidth (%) is equal to 20.76 %. Hence the proposed antenna array is possessing enhanced bandwidth (%) compared to the conventional antenna array.

From the above study performed the proposed antenna array with square patch EBG structure and square slots has an improved performance in terms of return loss, bandwidth (%) and miniaturization over its counterpart.

## SUMMARY OF RESULTS

Table I depicts the summarized simulated results of the conventional and proposed antenna arrays. This table shows the comparison of the performance parameters of conventional antenna array and proposed antenna array in terms of resonant frequency, return loss and bandwidth.

TABLE I. Summarized Simulated Results.

Parameter	Conventional Antenna Array	Proposed Antenna Array
Resonant Frequency (GHz)	5.55	4.91
		7.17
Return Loss (dB)	-29.19	- 13.76
		-20.51
Bandwidth (MHz)	157.4	248.53
		1126.37
Bandwidth (%)	2.39	20.76

## CONCLUSION

In this paper the antenna arrays have been successfully designed and simulated and the simulation results demonstrate the improved performance parameters of two element antenna array with the incorporation of square patch EBG structure and square slots. The modified antenna array is resonating at two frequencies. In addition to obtaining a miniaturization of 11.73%, the proposed antenna an overall bandwidth of 20.76% compared to the conventional antenna array.

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