Research Article *ISSN: 2319-507X*
Mane Puja, IJPRET, 2013; Volume 1(8): 180-188 *IJPRET*

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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DESIGN OF E-SHAPE PATCH ANTENNA FOR WIRELESS APPLICATIONS

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Accepted Date:
27/02/2013

Publish Date:
01/04/2013

Keywords

Bandwidth,
E-shape micro strip patch antenna,
HFSS (High Frequency Structure Simulator) version 13.0 software,
Gain,
Array

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Abstract

The design and simulation presented of E-shape microstrip patch antenna for wireless application. The shape will provide the broad bandwidth which is required in various applications like remote sensing, biomedical application, mobile radio, GPS, bluetooth etc. The antenna design is an improvement from previous research and it is simulated using HFSS (High Frequency Structure Simulator) version 13.0v software. Coaxial feed or probe feed technique is used in the experiment. Parametric study was included to determine effect of design towards the antenna performance. The performance of the designed antenna was analysed in terms of bandwidth, return loss and VSWR. The design was optimized to meet the best possible result. Substrate used was modified epoxy which has a dielectric constant of 4.2. The result shows the wideband antenna is able to operate at 1.59GHz, 2.45 GHz and 2.96 GHz frequency.

INTRODUCTION

In 1953, Deschamps first proposed the concept of printed Microstrip patch antenna. But later it takes around two decades to develop a practical Microstrip antenna. It was designed in 1970s by Munson & Howell [2]. In the last few years printed antennas have been largely studied due to their advantages over other radiating systems in applications such as aircraft, spacecraft, satellite and missiles, where size, weight, cost, performance, ease of installation and aerodynamic profile are major constraint. Because of the booming demand in wireless communication system, microstrip patch antennas have attracted much interest. However, they also have some drawbacks, ranging from narrow bandwidth and low gain. To overcome their inherent limitation of narrow impedance, bandwidth and low gain, many techniques have been proposed and investigated. Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane.

For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable. Since, this provides better efficiency, larger bandwidth and better radiation. An antenna Array is a configuration of individual radiating elements that are arranged in space and can be used to produce a directional radiation pattern. Single-element antennas have radiation patterns that are broad and hence have a low directivity that is not suitable for long distance communications. The radiating pattern of the array depends on the configuration, the distance between the elements, the amplitude and phase excitation of the elements, and also the radiation pattern of individual elements.

Once an array has been designed to focus towards a particular direction [1]. The antenna elements can be arranged to form a 1 or 2 dimensional antenna array. A number of antenna array specific aspects will be outlined; We used 1 dimensional array for simplicity reasons. The overall radiation pattern changes when several antenna elements are combined in an array. The overall radiation pattern results in a certain directivity and thus gain linked through the efficiency with the directivity [1]. Directivity and gain are equal if the efficiency is 100%.

ANTENNA DESIGN

The E-shape microstrip patch antenna has been designed with over all dimensions W (mm) * L (mm). The designing of E-shaped microstrip patch antenna, the resonant frequency 2.45GHz and the dielectric substrate Epoxy resin which has the dielectric constant 4.2 materials is used for simulation. Because it has a good quality to price ratio.

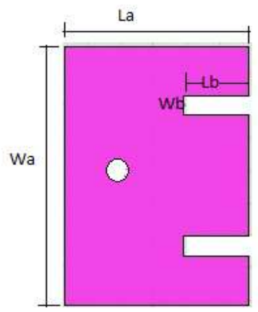

Fig.1. Design geometry of E shape patch antenna

By cutting two symmetrical parallel slots to the rectangular microstrip antenna, it became an E-shape patch. By varying the feed location, the value of resistance was controlled such that it matched the characteristic impedance of the coaxial feed. Bandwidth and gain increases using array.The greatest advantages of the Microstrip antennas is the ease which the Microstrip arrays can be made which is required for high gain to provide increased range, rejection against interference, beam scanning or steering and for some specific radiation pattern. The dielectric constant of the substrate is 4.2 and thickness is 1.6mm.

The geometry of single E-shape microstrip antenna [5] as shown in figure 1. All the dimensions such as patch length, width, slot length, slot width are shown in table I for the optimized E-shaped patch antenna. In many applications radiation energy required is not achievable using single element. So this antenna uses multiple elements in definite pattern leads to increase in radiation energy. This increase in radiation energy is due to the addition of radiation energy from individual element.

TABLE I. Design Specifications

Parameter	Label	Dimensions (mm)
Main Patch	Wa	40
	La	28
slot	Wb	3
	Lb	10
Substrate		

ISSN: 2319-507X
IJPRET

Height	H	1.6
	W	120
Ground	L	70

By using linear array as 3 elements of E shapes and two E shapes are rotated. New electromagnetically coupling fed low profile broadband high gain E-shaped microstrip antennas (MSA) were proposed for high speed wireless applications.

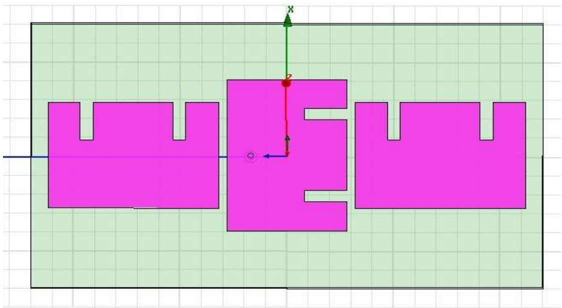

Fig. 2: E shape array Antenna in HFSS

To validate this concept, a single antenna element and a sub-array were designed, built and measured. The E shape array antenna [4] is shown in fig.2. Compared to other available E-shaped MSA designs, the proposed design avoid using vias or pins. Therefore, it greatly reduces cost and errors in fabrication, especially in a large array.

This E shape array not only increases the bandwidth and the gain of the antenna, but also provides necessary mechanism protection for the radiation element as well.

III. RESULTS AND DISCUSSION

If the antenna is mismatched, then not all the available power from the transmission line is delivered to the antenna. This loss is called as return Loss. The return loss of single E shape is -27.80dB and Voltage standing wave ratio (VSWR) is obtained as 1.0 at the resonant frequency 2.45GHz.

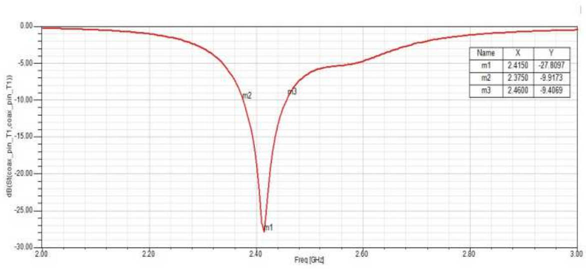

Fig. 3: Return Loss for the single E shape Antenna

The software used to model and simulate the Microstrip patch antenna is HFSS 13.0v [6].The software is based on FEM method, in this method large structures are converted into number of triangular, pyramidal or trapezoidal shape structure for ease of analysis. Here by using array we get multiband frequencies used for different applications.

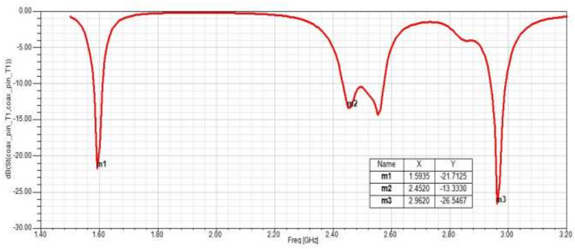

Fig. 4: Simulated Return Loss for E shape array Antenna

The return loss for center frequency 2.45GHz it is found to be -16.61dB as shown in fig.4.

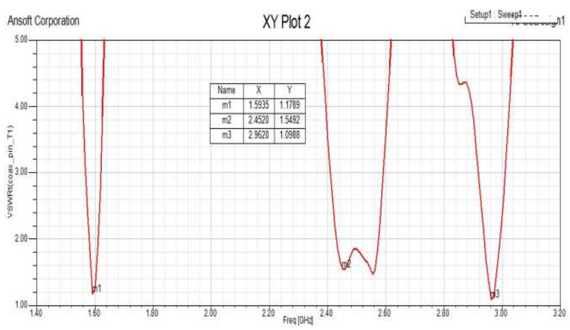

Fig. 5: Simulated VSWR for E shape array Antenna

A standing wave in a transmission line is a wave in which the distribution of current, voltage or field strength is formed by the superimposition of two waves of same frequency propagating in opposite direction. VSWR is the interaction of the reflected waves with forward waves which causes standing wave patterns. Ideally, VSWR must lie in the range of 1 to 2. The VSWR using simulation result is 1.1 which is less than 2 and for centre frequency 2.96GHz respectively as shown in fig.5.

The gain of E-shape array antenna is 2.05dB as shown in fig.6 at frequency 2.45GHz. The directivity obtained as 5.09dB using E shape array which is greater than simple E shape.

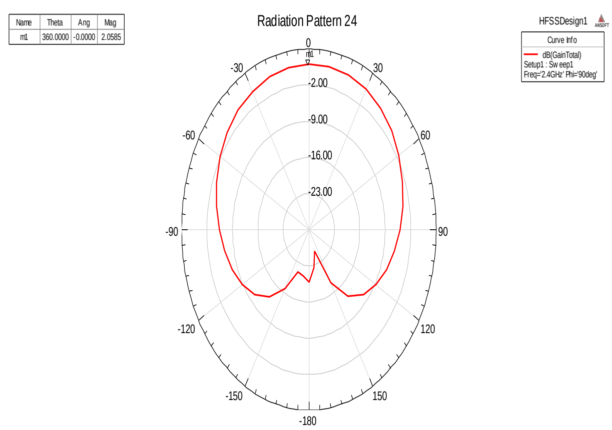

Fig. 6: Gain of E shape array Antenna

In smith chart we can see that in fig.7 whether the antenna feed is perfectly matched or there is no reflection of incident wave. If feed is not perfectly matched energy will be lost & less power will be delivered to antenna. The input impedance of antenna depends on feeding location, probe diameter,probe length.

Parameters	Single E shape	E shape Array
Bandwidth	90MHz	140MHz
Directivity	4.81dB	5.09dB
Gain	1.72dB	2.05dB

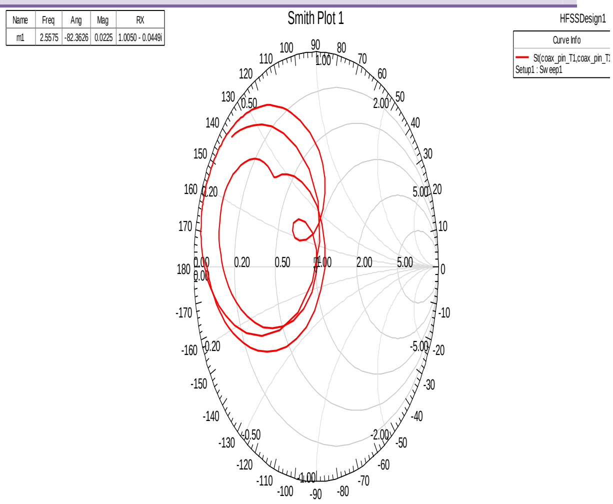

Fig. 7: Smith Chart for E shape array Antenna

The E-field distribution is shown in fig. 8 which shows that the value of red colour is 1.239e+003. The middle shape of E shape shows the maximum radiation.

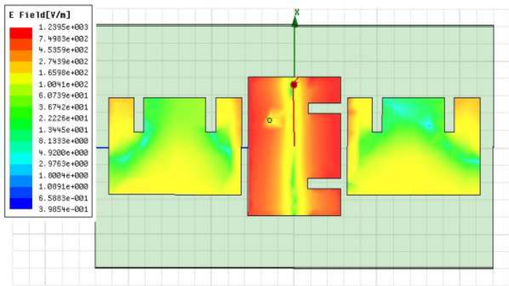

Fig. 8: E-field distribution of E shape array Antenna

TABLE II. Parametric Study

Abovetable II shows the parametric study in which clearly understand that the by using array there is increase in bandwidth and gain. Also radiation pattern changes due to array. The main advantage of this array is that it is used for multiband applications. The specifications of triple band frequencies are shown in table III.

TABLE III. Parametric study of E-Shape Array Antenna

Frequency	1.5GHz	2.45GHz	2.9GHz
Return loss	-22.7dB	-16.5dB	-23.1dB
VSWR	1.15	1.34	1.14
Bandwidth	30MHz	140MHz	90MHz
Gain	0.90dB	2.05dB	0.98dB

The simulated results are nearly matched with fabricated results. The fabricated antenna is tested by using Network Analyser which is having frequency less than 3GHz.

Fig.9. Fabricated E-Shape Array Antenna

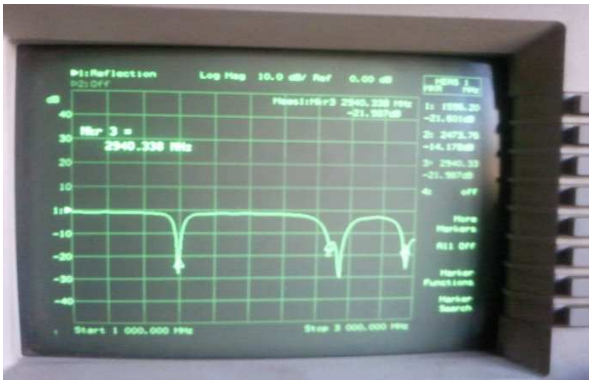

Fig.10. Return Loss of Fabricated E-Shape Array Antenna

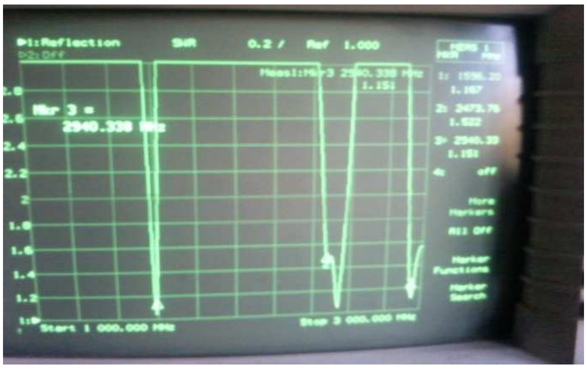

Fig.10. VSWR of Fabricated E-Shape Array Antenna

The fig.9.shows that fabricated antenna. The return loss and voltage standing wave ratio of fabricated antenna is matched with simulated results as shown in fig.10. and fig.11.

CONCLUSION

A low cost and easy to fabricate solution of bandwidth enhancement of E shape patch array antenna is presented. Its bandwidth can be enhanced by using E shape array. The proposed design improves the bandwidth at resonant frequency 2.45GHz.The proposed antenna can be used in wireless communication. By using selection of slot dimensions & positions of feeding point, a desired triple band frequency response & wider BW can be achieved. In E shape array antenna concluded that the bandwidth is better than single E shape antenna.

ACKNOWLEDGMENT

The authors express their thanks to the Prof. S.V. Khobaragade, Prof. Amit Naik and Department of Electronics and Telecommunications Engineering of Dr. Babasaheb Ambedkar Technological University, Lonere for their support.

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