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Design of Tri Band P Shaped Microstrip Patch Antenna

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Abstract — *This Paper describes the Design of Tri Band P- Shaped Microstrip Patch Antenna which is resonant at 3.5GHz, 6.2 GHz and 11.8 GHz. The Proposed antenna is designed on FR-4 Epoxy substrate with relative permittivity is 4.4. The overall size of the antenna is 18 x 20 mm^2. Antenna is feed by Microstrip feed line and simulated by using ANSOFT HFSS. This antenna operates at S, C and X Band. This antenna is applicable for Wi-Max, long distance Radio Telecommunication, RADAR and Satellite Communication.*

Keywords-*Gain, Return Loss, VSWR, HFSS, Microstrip Patch Antenna*

I. INTRODUCTION

In 21st Century, a radical change has been seen in the field of Wireless communications. Thus the design of antenna has come to contract with this Wireless Application. Microstrip antennas are one of those designs that covered a large portion of the Wireless System such as Bluetooth, Wi-Fi, WLAN, Wi-Max applications. In 1972's Microstrip Antenna was invented by Bob Munson and it had become a great revolution in the field of antenna design.
The MPA are known as low profile antennas. They are easy to use in both planar and non-planar surfaces. They are being used mostly because they are simple and inexpensive to fabricate. These MPAs have a popular frequencies range of above 100 MHz. These patch antennas are fabricated on a dielectric substrate.

Today's communication system demands more gain, wide bandwidth and compactness in size. To avoid use of two different antennas for two frequency bands and to fulfill the demand of leading market there is a need to develop the dual band antennas. Various types of patch structures are available but rectangular, square and circular shape is most frequently used [4].
The Microstrip antenna suffers from some downfalls such as low gain and narrow bandwidth, which can lead to the lower performance of the antenna. To overcome its native limitation of low gain, many techniques have been introduced such as introducing slots, defected ground structures and notches [1]. There has been an ever growing demand, in telecommunication sectors, for antenna designs that possess multiband properties such as verities of application, in aeronautical, maritime field. Many of the communication devices have a multifunction capacity such as radio navigations, satellite information data capture. There are a variety of approaches that have been developed to achieve desirable features of antenna.

II. ANTENNA DESIGN

The geometry and layout of proposed Tri Band P-shape Microstrip Patch Antenna is shown in Figure 1 and Table 1. All the measurements are in mm. The Microstrip Patch Antenna consists of three layers patch, substrate and ground. In this antenna, the substrate selected for the design of the proposed antenna is FR4_epoxy of thickness 1.6 mm and with low permittivity (εr=4.4). The dimensions of the substrate are taken as 18×20×1.6 mm^3 and the size of the ground plane is taken as 18 × 20mm^2. It is the shape of the antenna that makes it possible to resonate at a different range of frequencies.

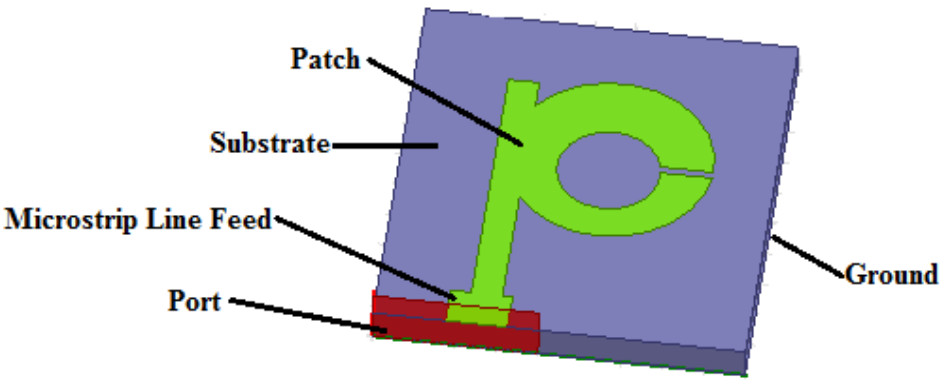

Figure 1. The geometry of Tri Band P Shaped Microstrip patch antenna

Variable	Value
Dimension of Substrate	18mm*20mm
Dimension of ground	18mm*20mm
Substrate material	FR-4
Feeding Technique	Microstrip line feed
Radius of Circle(large)	5
Radius of Circle (Slotted)	2.5

Table 1: Dimensions of Antenna

III. RESULTS AND DISCUSSIONS

The Performance of this proposed antenna is determined by HFSS Software. The analysis is made on Return loss, Gain and VSWR. The antenna shows resonance at three different frequencies. The Simulation Results for the proposed antenna are shown in the figure below. The Return Loss is shown in Figure 3.

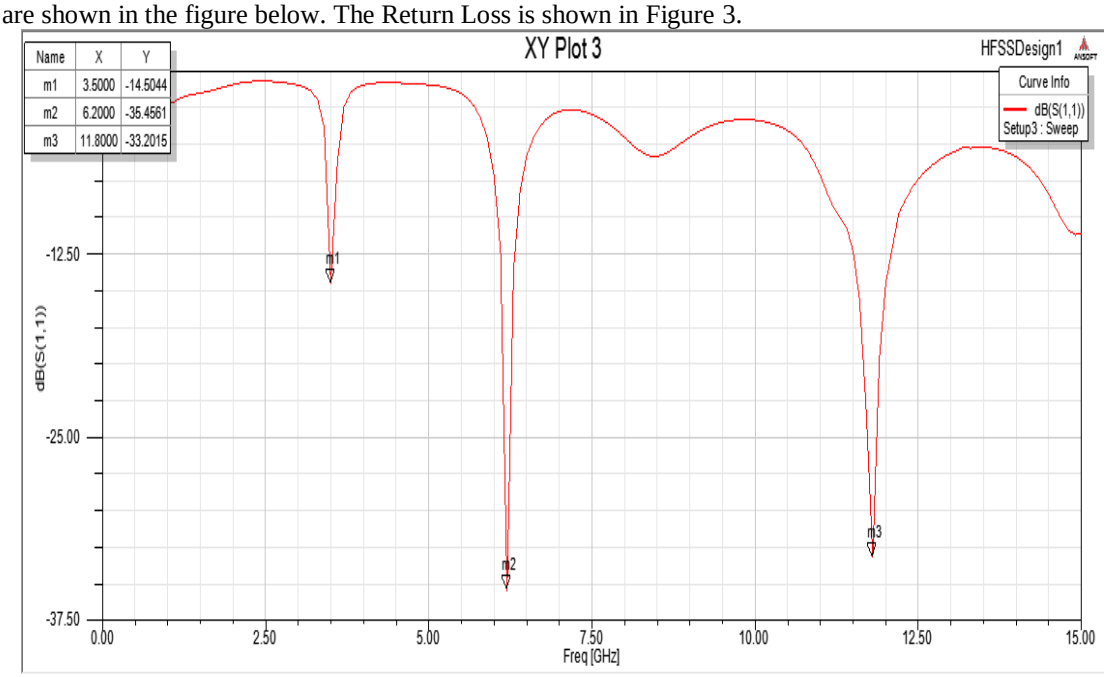

Figure 2: Return loss of the proposed antenna

It is clear from the above figure of the return loss that the propagating wave crosses the -10 dB line three times. The first resonance is found at 3.5 GHz frequency and the return loss is -14.50 dB. The second resonance is found at 6.2 GHz and the return loss is -35.45 dB. In the last, the third resonance is found at 11.8 GHz and the return loss is -33.20 dB. The Simulation Results are well agreed for Wi-Max, long distance Radio Telecommunication, RADAR and Satellite Communication. These resonant frequencies along with their corresponding bands, return loss, gain and VSWR are tabulated below.

Resonant Frequency (in GHz)	Band Covered	Return loss (in dB)	Gain (in dB)	VSWR
3.5	S	-14.50	3.82	1.4
6.2	C	-35.45	3.03	1.03
11.8	X	-33.20	9.37	1.05

Table 2: Return Loss, Gain and VSWR of the proposed antenna

Figure 3: 3D Polar Plot gain of proposed antenna at 3.5 GHz

Figure 4: 3D Polar Plot gain of P-Shaped MPA at 6.2 GHz

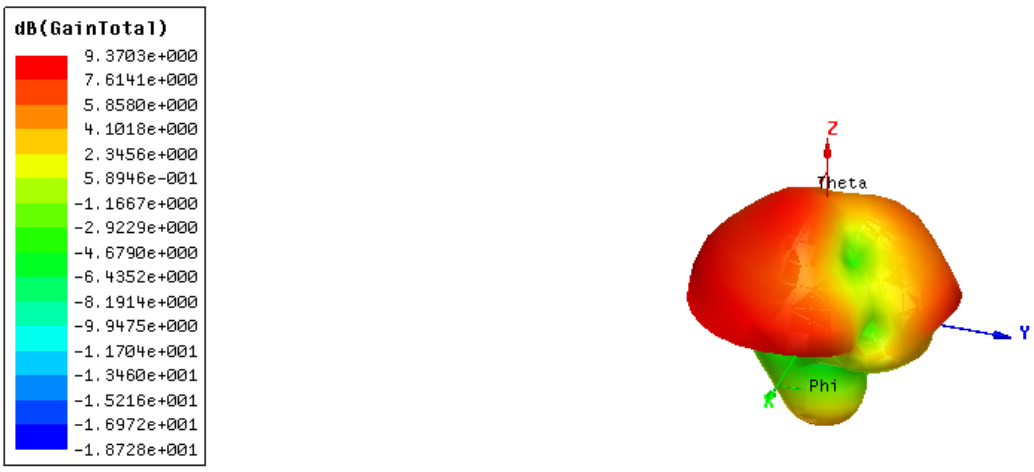

Figure 5: 3D Polar Plot gain of P-Shaped MPA at 11.8 GHz

Antenna gain is a term that describes how much power is transmitted in the direction of an isotropic source. The antenna gain should be more than 3 dB for a best antenna. Antenna has gain 3.82, 3.03 and 9.37 at three resonant frequencies that is 3.5 GHz , 6.2 GHz and 11.8 GHz respectively.

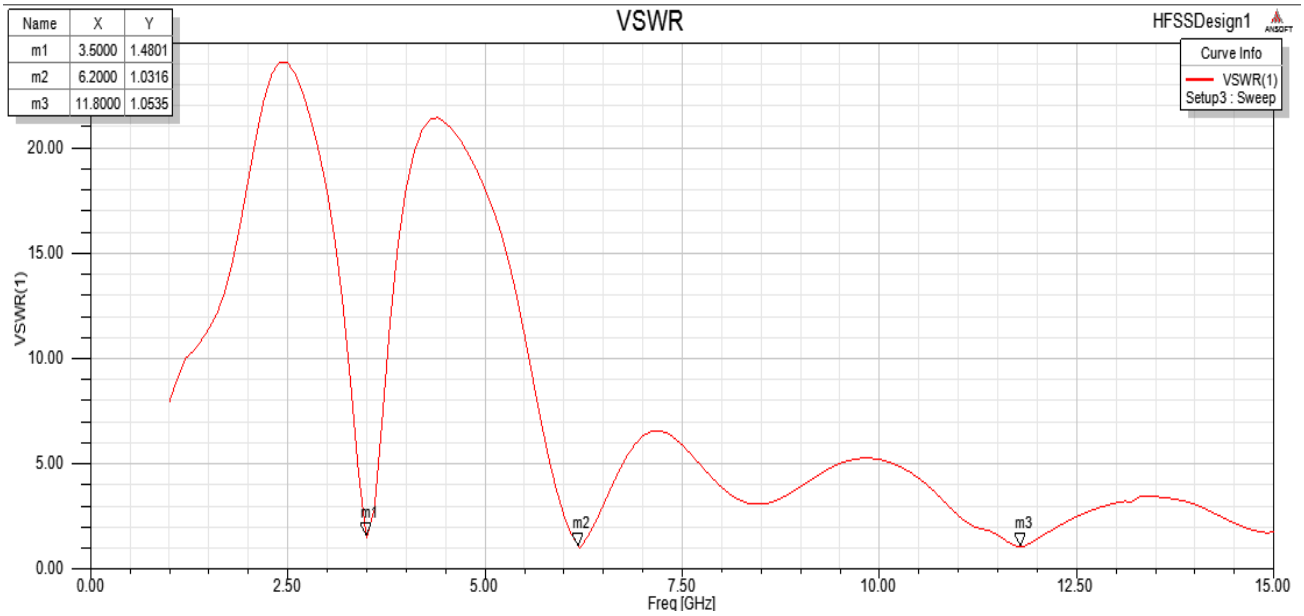

Figure 6: Voltage Standing Wave Ratio of the proposed antenna

Voltage Standing Wave Ratio is measure of reflection occur. VSWR is a ratio of Voltage maxima to voltage minima and must be less than two. This antenna has VSWR of 1.4, 1.03 and 1.05 at constituting frequencies. The Figure 6, indicating the good matching conditions.

IV. CONCLUSION

A Tri Band P Shaped Microstrip Patch Antenna has been designed to resonant at three frequencies 3.5 GHz, 6.2 GHz and 11.8 GHz with satisfactory results. The antenna is designed by using FR-4 epoxy Substrate with 1.6 mm of thickness. For this antenna, resonant frequencies are obtained in S, C and X band. The Return loss, Gain and VSWR of the tri band P Shaped Antenna is presented in the paper.

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