ISSN (e): 2250 – 3005 || Vol, 05 || Issue, 01 || January – 2015 ||
International Journal of Computational Engineering Research (IJCER)

Analysis of Circular Patch Antenna Embeded on Silicon Substrate

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ABSTRACT:
This paper presents the effect of changing the substrate thickness and path diameter on a circularly polarized linearly feed micro-strip antenna. The base is fabricated with silicon substrate having di-electric permittivity value as 9. The antenna we have simulated is having the centre frequency of 1.227ghz which makes it suitable even for gps satellite communication. The parameters we will be dealing here mainly are total gain, substrate thickness and patch diameter and its subsequent effect on radiation pattern.
KEYWORDS: *Antenna, silicon, gain, patch, diameter, substrate, thickness*

I. INTRODUCTION

Microstrip antennas, also called patch antennas, are very popular antennas in the microwave frequency range because of their simplicity and compatibility with circuit board technology. The circular patch has similar traits to the rectangular patch regarding gain, beam position and efficiency. Circular patch antennas are usually manufactured by etching the antenna patch element in a metalised dielectric substrate. Larger antennas are sometimes constructed by bonding metal cut-outs to a bare substrate.The pin-fed patch, which is simple to construct, is fed by making a circular hole in the substrate and ground plane and bringing the centre conductor of a coaxial connector or cable into ohmic contact with the patch at an appropriate point. The point of contact depends mainly on the required centre frequency and input impedance, typically 50 Ω, but also on the suppression of higher order resonant modes. Fringing fields act to extend the effective diameter of the patch. Thus, the diameter of the half-wave patch (dominant TM11 mode) is usually less than a half wavelength in the dielectric medium. The electric fringing fields are responsible for radiation. Fringing fields act to extend the effective diameter of the patch. Thus, the diameter of the half-wave patch (dominant TM11 mode) is usually less than a half wavelength in the dielectric medium. The electric fringing fields are responsible for radiation.

II. IMPEDANCE CHARACTERISTICS

The circular patch has an impedance bandwidth ranging from 0.3% to 15%. It is usually operated near resonance to obtain a real-valued input impedance. The position of the feed determines the input resistance of the patch. While the input resistance can be determined quite accurately by the position of the pin, the inductive reactance caused by the pin may affect the input match considerably when the substrate is electrically thick.

III. RADIATION CHARACTERISTICS

The dominant mode radiation pattern is a single lobe with maximum in the direction normal to the plane of the antenna

IV. SIMULATION PROCESS

The simulation has been carried in six different stages. In all the stages the relative permittivity of silicon layer has been kept constant to provide the uniformity during entire simulation. in first three steps substrate thickness have been varied with patch diameter constant and in remaining three substrate thickness has been varied keeping the patch diameter constant. The parameters of different stages have been provided in tabular form followed by the graph and respective radiation pattern

Tabulation of parameters for various step of simulation

Step	Substrate Thickness (mm)	Patch Diameter (mm)	Relative Permittivity
1	1.217	23.63	9
2	3.210	23.63	9
3	3.255	23.63	9
4	2.66	23.26	9
5	2.66	23.88	9
6	2.66	24.00	9

Resultant observation

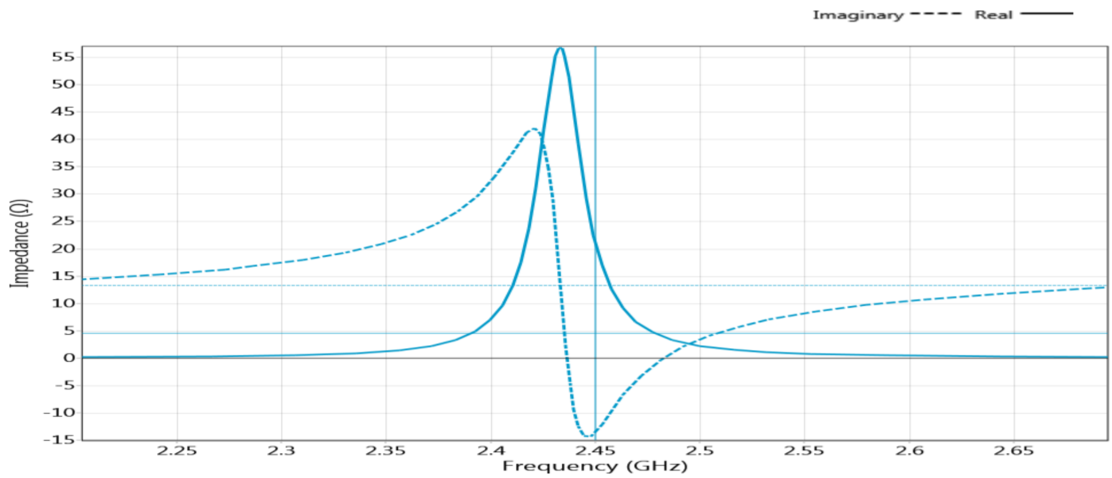

Fig1: Impedance Characteristics for step1

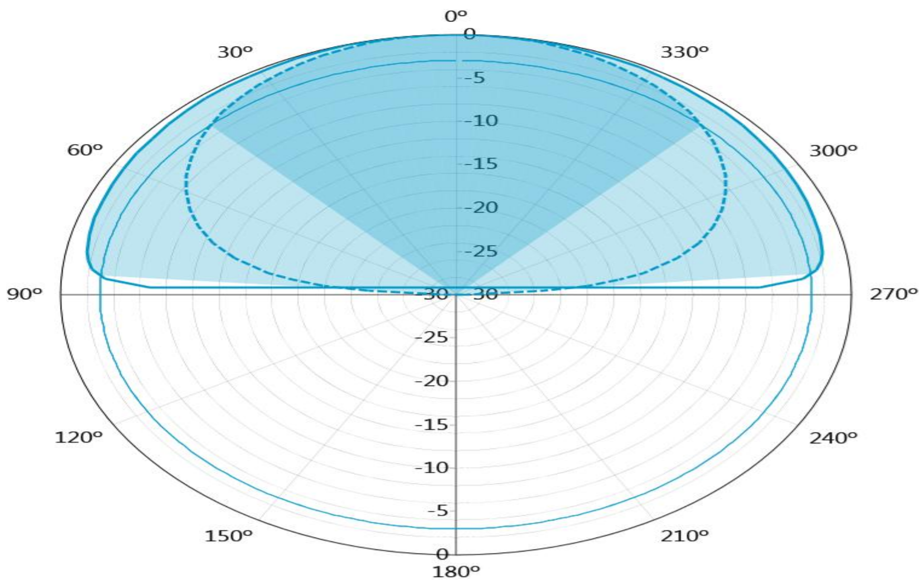

Fig2: Total gain for step 1

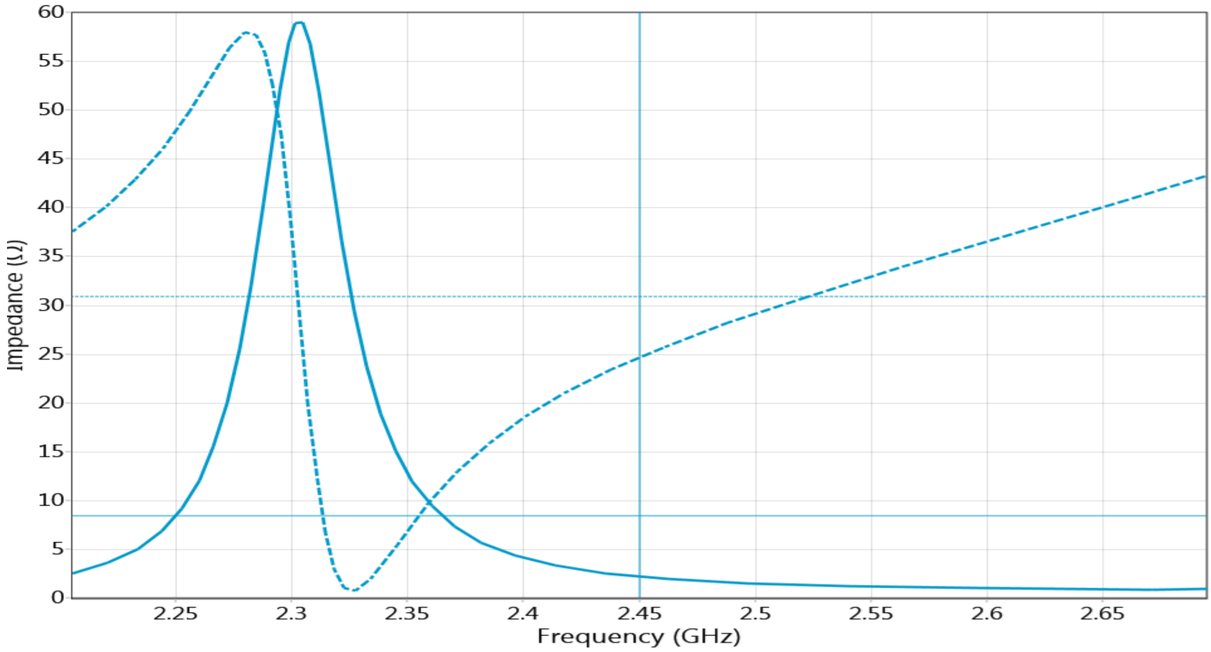

Fig3: Impedance characteristics for step2

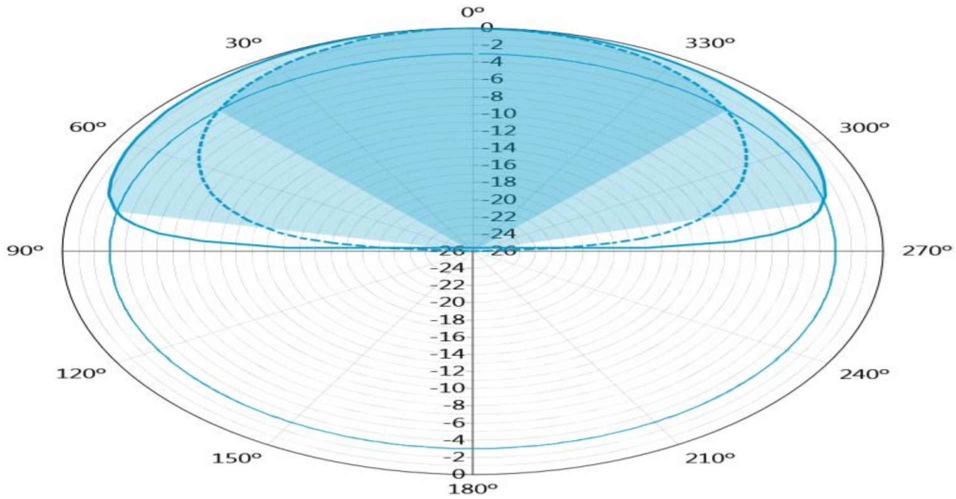

Fig4: Radiation pattern for step 2

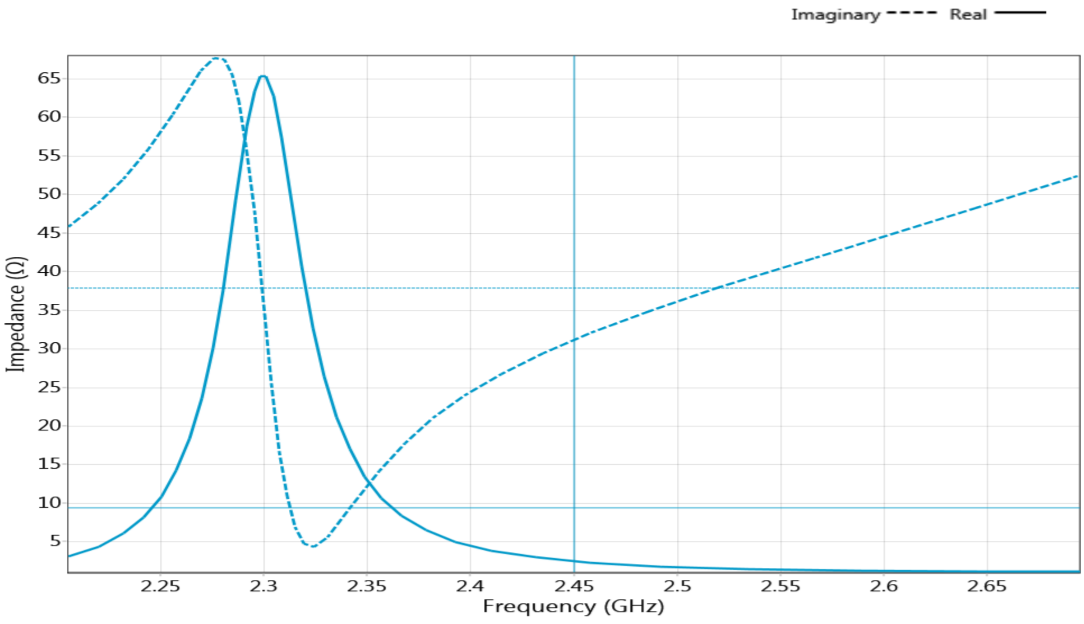

Fig5: Impedance Characteristics for step 3

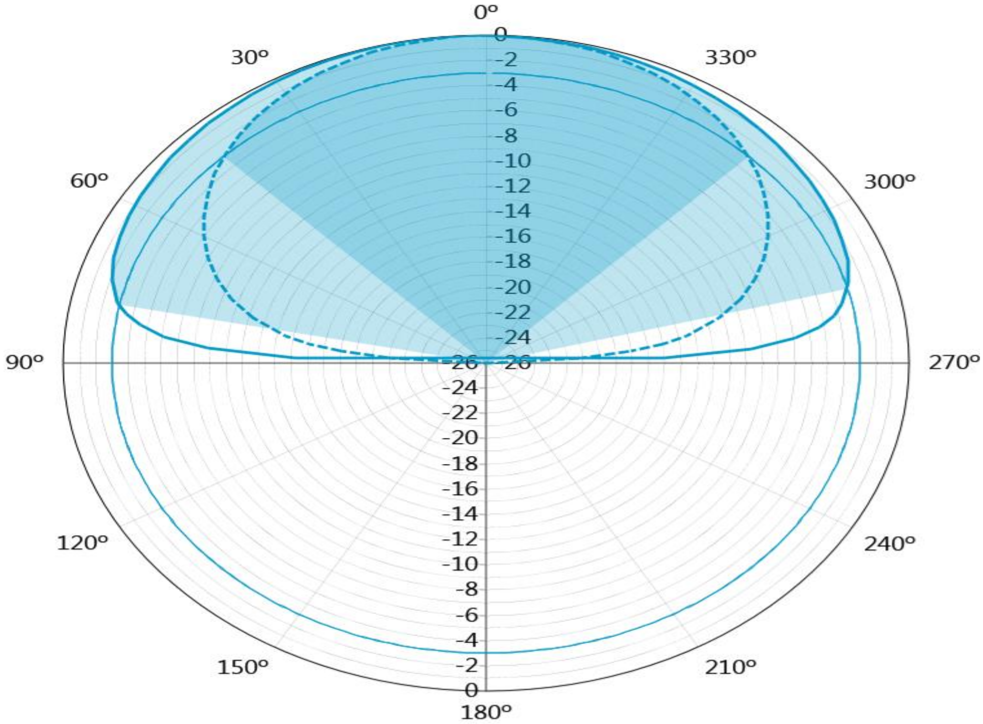

Fig6: Radiation Pattern for step 3

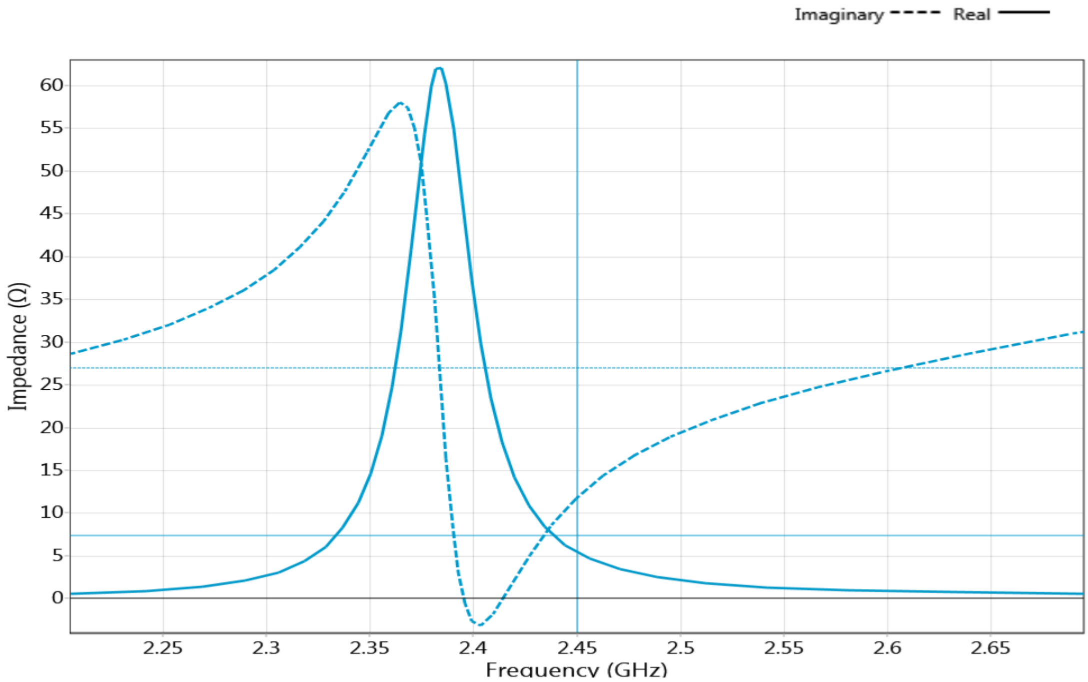

Fig7: Impedance Characteristics for step 4

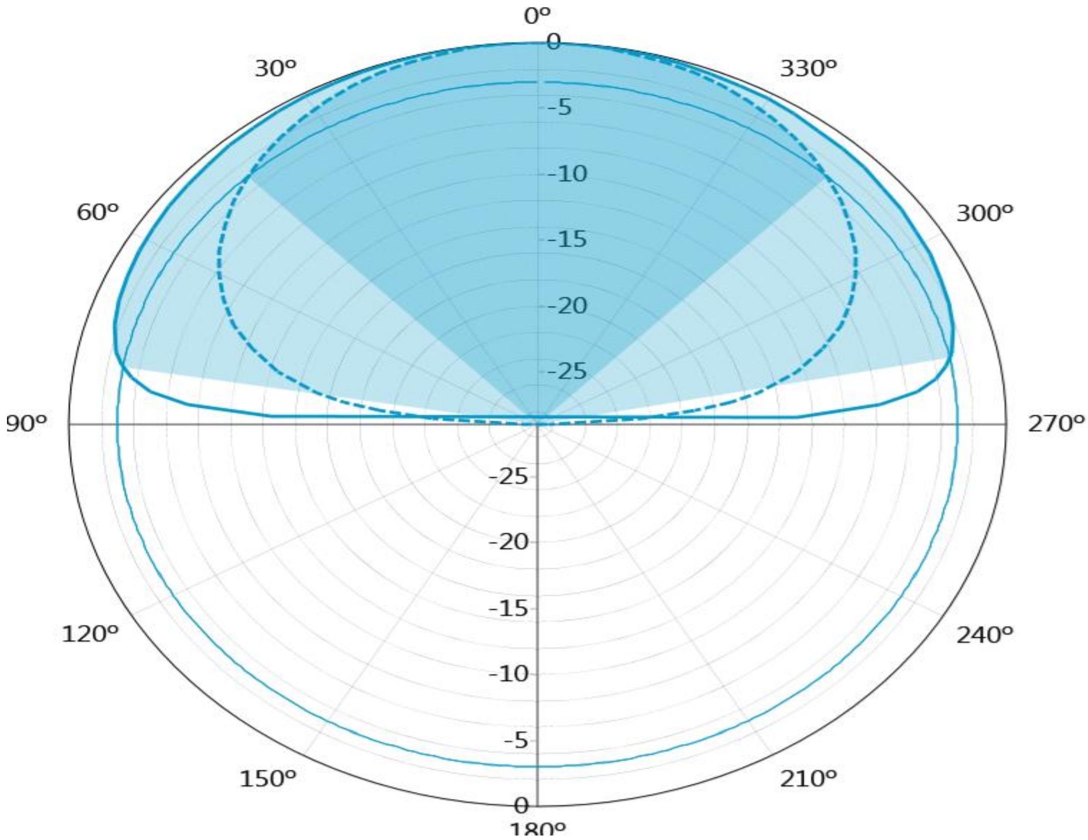

Fig8: Radiation Pattern for step 4

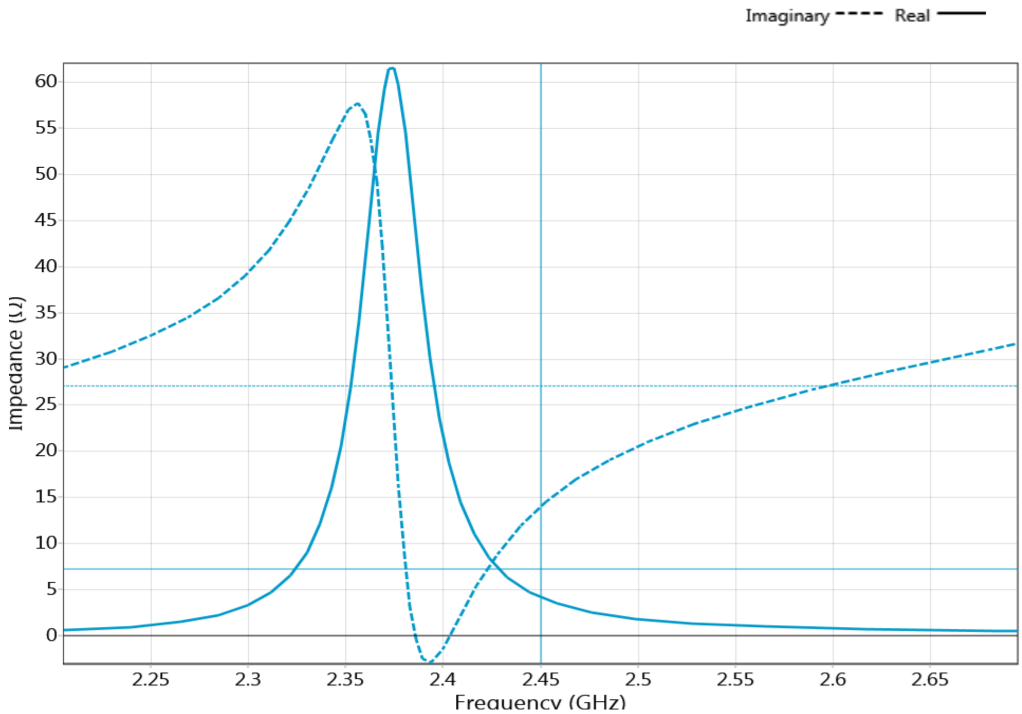

Fig9: Impedance Characteristic for step 5

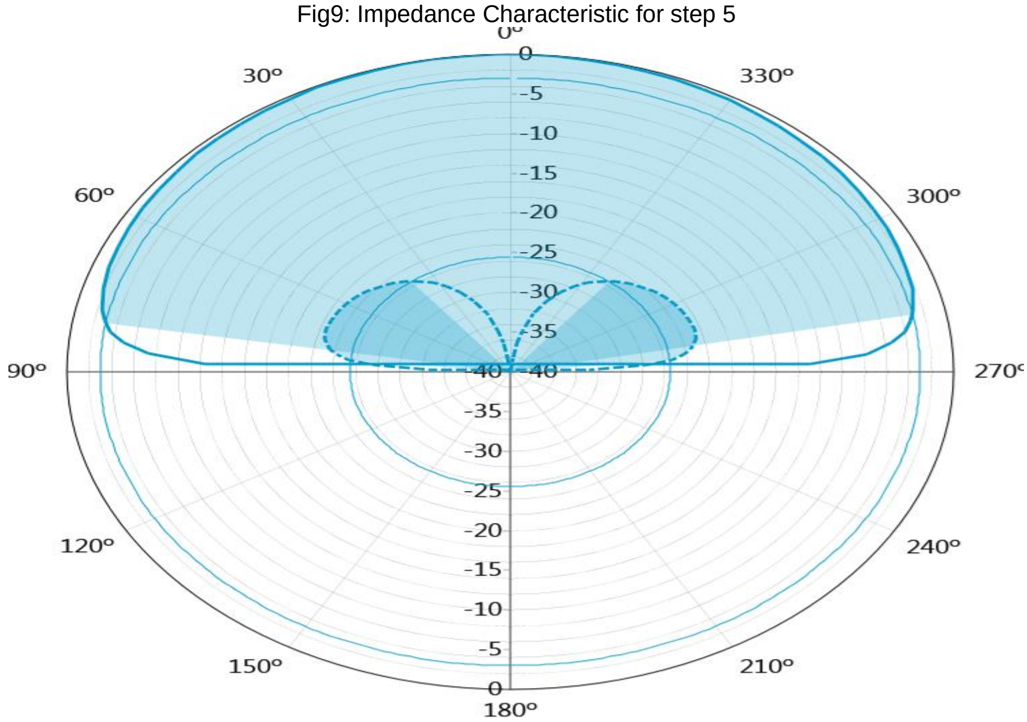

Fig10: Radiation Pattern for step 5

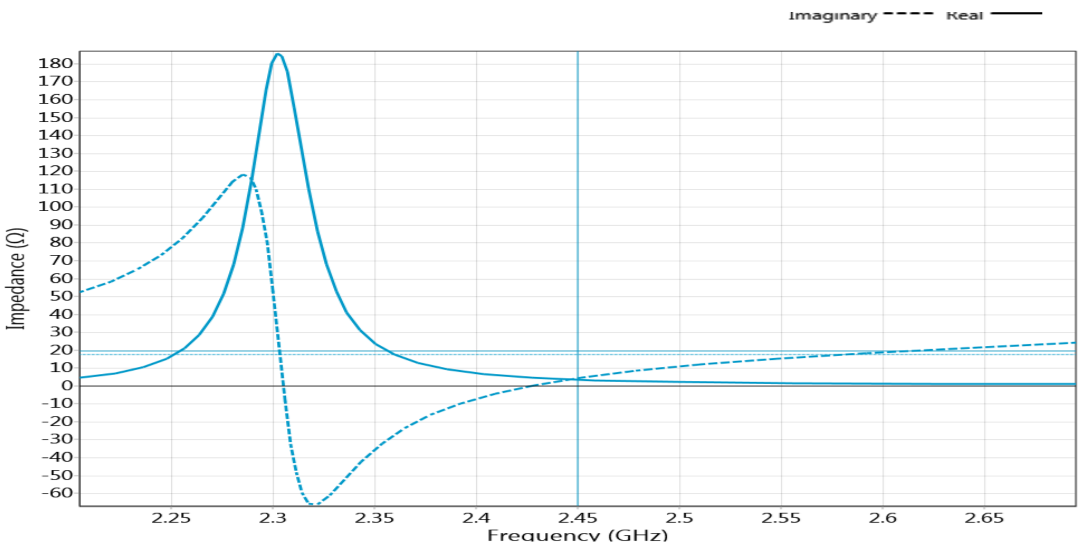

Fig11: Impedance Characteristics for step 6

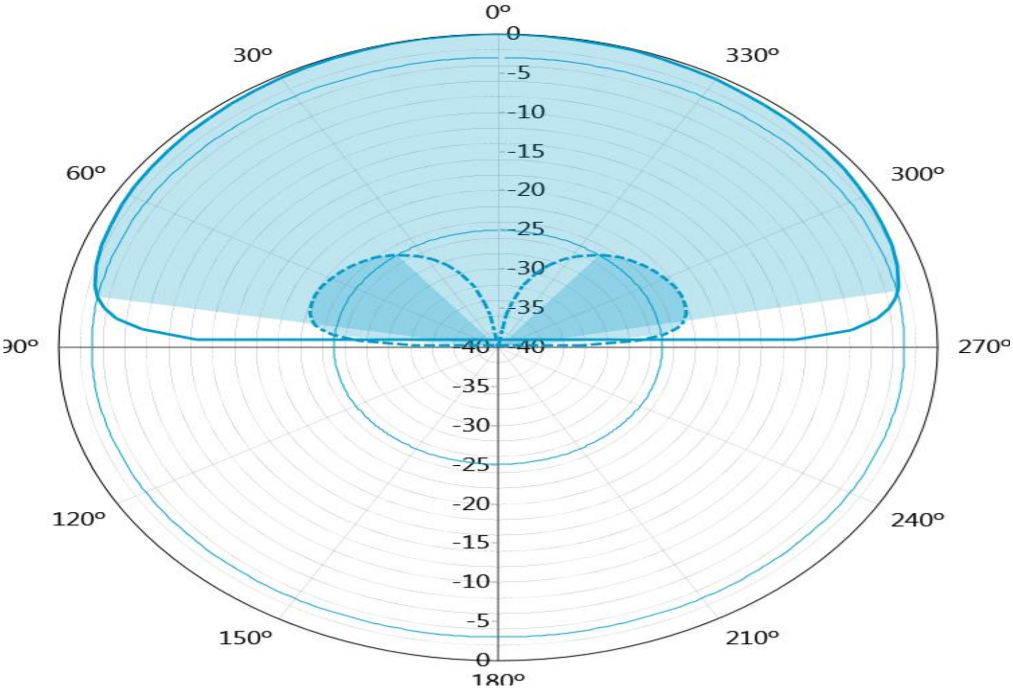

Fig12: Radiation Pattern for step 6

V. RESULT & DISCUSSION

Before discussing the results we have summarized the gain , impedance frequency, for the every above mentioned parameters

Fig	Angle Frequency(Degree)	Gain(DB) @ 2.45Ghz	Real Impedance
1,2	0	3.153	56.86 ohm @ 2.43 Ghz
	90	3.151	
3,4	0	4.507	59.18 ohm @ 2.30 Ghz
	90	4.487	
5,6	0	4.492	65.58 ohm @ 2.5Ghz
	90	4.470	
7,8	0	4.845	62.29 ohm @ 2.384 Ghz
	90	4.837	
9,10	0	4.484	61.70 ohm @ 2.37 Ghz
	90	-17.17	
11,12	0	4.883	186.1 ohm @ 2.37 Ghz
	90	-17.18	

The ideal gain of circular linearly fed patch antenna is 8db maximum from 4dbi which is minimum for wavelength greater $\frac{lambda}{6}$ upto $\frac{lambda}{2}$ and we observe that if we increase substrate thickness in spite of increase in inductive reactance the gain has not decreased and have maintained the minimum level of gain and the result have further improved while we have kept substrate thickness to minimum and have increased the patch diameter though it have affected the resonant frequency but all the gains have been measured at 2.45ghz so the results match the requirement of minimum gain.

VI. CONCLUSION

A high-performance microstrip patch antenna was fabricated on a normal low resistive silicon wafer The fabrication progress was fully compatible with MMCM packaging, without any additional process steps. The antenna resonated with a maximum gain of 4.9dbto minimum gain of 3.153db.

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