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Design and Analysis of Microstrip Rectangular Patch Antenna using Different Permittivity Substrate

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Abstract: In this paper a microstrip rectangular patch antenna using different permittivity of duroid substrate is designed and analysed. The antenna is designed at a resonant frequency of 5.8 GHz. The dielectric substrate used for antenna designed is duroid having a dielectric constant of 2.2. It is observed that the gain of the designed antenna increases on increasing the relative permittivity of the duroid substrate and decreases on increasing the permittivity of the substrate. The return loss of the designed antenna also decreases on reducing the permittivity of the substrate. Voltage standing wave ratio for the design antenna for different permittivity of the substrate is below 2.The designed antenna is energized using microstrip line feeding technique. The different characteristics of the antenna such as gain, bandwidth, return loss, directivity and VSWR is carried out for different values of the permittivity .The antenna is designed and analysed with the software High Frequency Structure Simulator (HFSS).

Keywords: Microstrip antenna, VSWR, Bandwidth, High Frequency structure simulator.

I. INTRODUCTION

In communication system, Antenna is the main part of wireless communication technology. The antenna is an electrical transducer device that converts the electric current into EM wave while it is used in transmitter and vice versa while used in receiver. Microstrip Patch antennas are attractive due to simple in design, low fabrication cost, light weight and can be used for various applications. A Microstrip Patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. [1]
A microstrip antenna is characterized by its length, width, radiation patterns, gain, input impedance. The length of the antenna is half wavelength in the dielectric. Microstrip antenna is energized by different feeding techniques such as microstrip line feeding, coaxial feeding, proximity coupled feeding, and aperture coupled feeding. From these feeding techniques microstrip feeding is mostly used due to its easy design and fabrication. [2]

Various types of feeding techniques are used for energizing the microstrip antenna such as microstrip feeding, coaxial feeding, proximity coupled feeding. Microstrip feeding technique is mostly used for energizing the antenna.

II. ANTENNA DESIGN

The antenna is designed at a resonant frequency of 5.8 GHz having the following specifications-

Parameter	Value
Frequency	5.8 GHz
Length of the Patch	16.48 mm
Width of the Patch	20.44 mm
Substrate Size	30mm×30 mm
Substrate	Duroid
Dielectric Constant	2.2
Feeding method	Microstrip Line

The height of the duroid substrate is taken as 1.6 mm. The designed antenna is analysed for the different permittivity values of the duroid substrate.

Various characteristics of the antenna as voltage standing wave ratio, return loss, radiation pattern, directivity and gain is observed for different values of permittivity. The base permittivity for the duroid is taken as 2.2. This permittivity is varied from 2.0 to 2.4 and observed the various characteristics of the designed antenna.

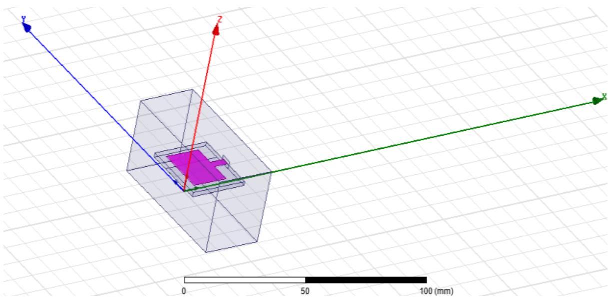

Fig.1 HFSS Design of antenna

III.RESULTS AND DISCUSSION

The designed antenna is simulated for the various values of the dielectric permittivity using software high frequency structure simulator (HFSS).

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A. **When permittivity is 2.2:**

When permittivity of the dielectric substrate is 2.2, the simulation results for the different antenna characteristics are shown below:

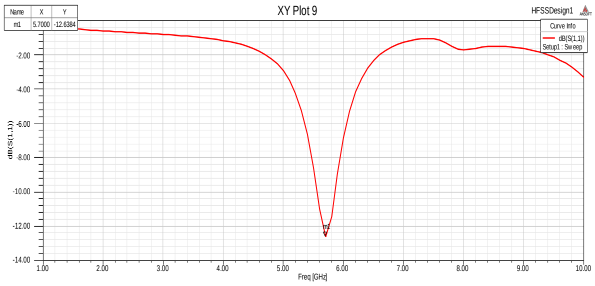

Fig.2 Return loss of the antenna

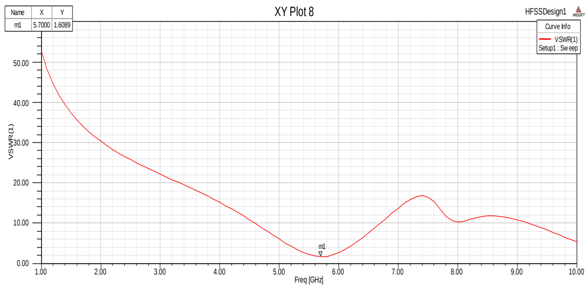

Fig.3 VSWR of the antenna

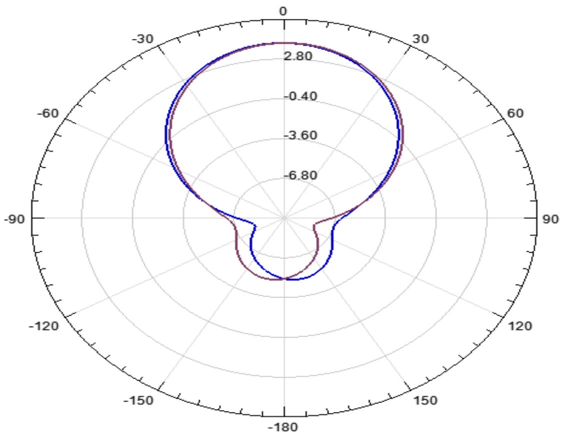

Fig.4 Radiation Pattern of the antenna

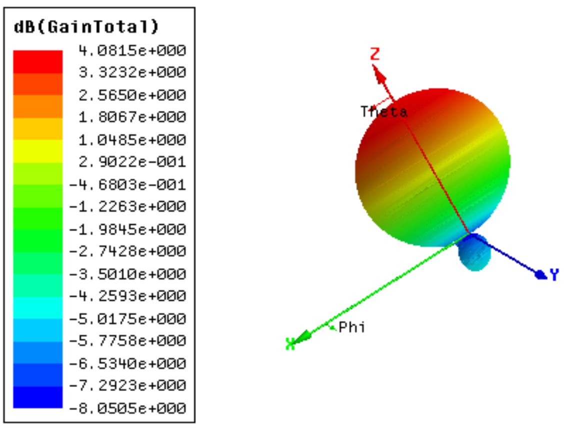

Fig.5 Gain of the antenna

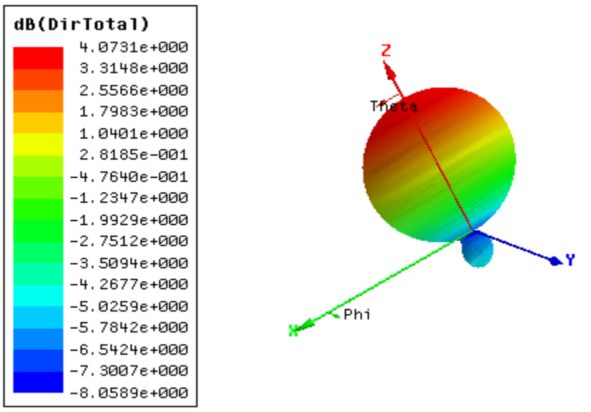

Fig.6 Directivity of the antenna

B. **When permittivity is 2:**

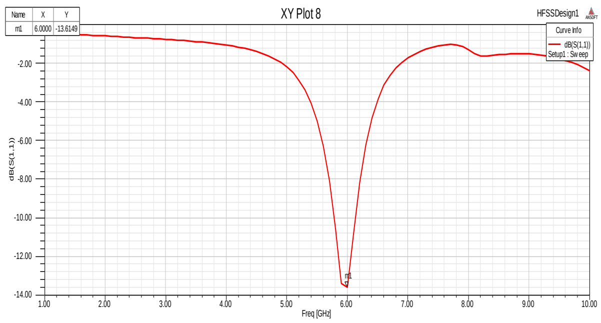

Fig.7 Return loss of the antenna

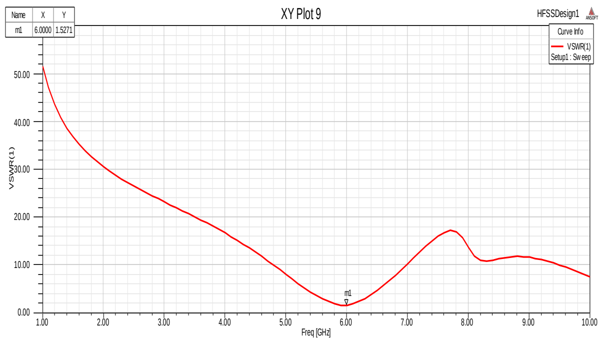

Fig.8 VSWR of the antenna

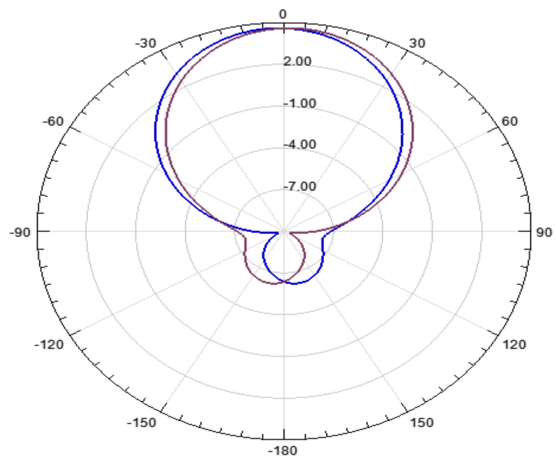

Fig.9 Radiation Pattern of the antenna

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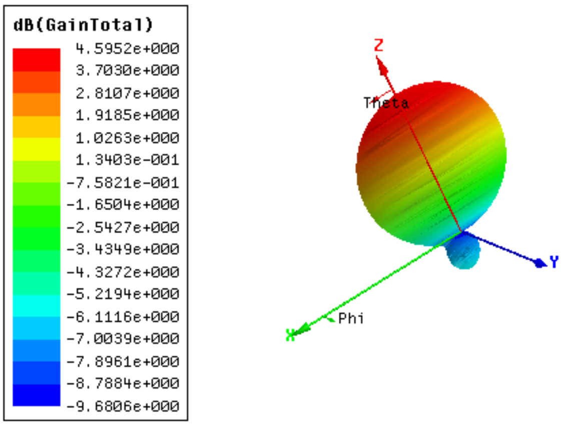

Fig.10 Gain of the antenna

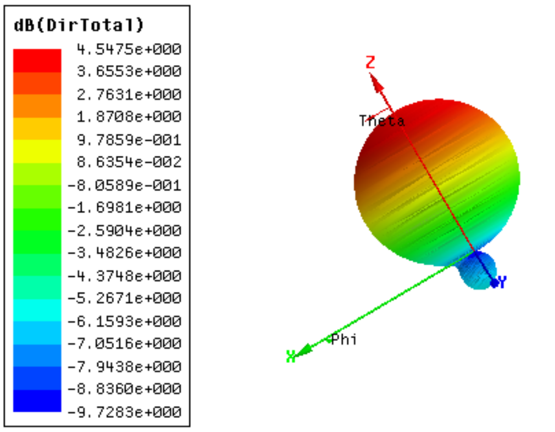

Fig.11 Directivity of the antenna

C. **When permittivity is 2.1:**

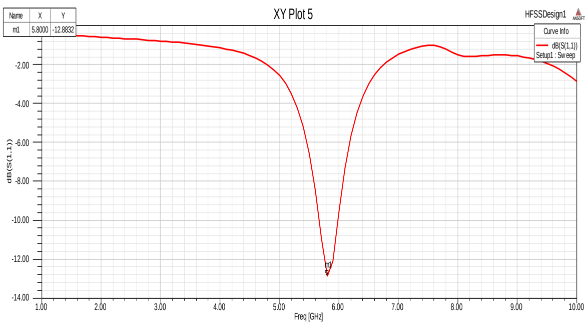

Fig.12 Return loss of the antenna

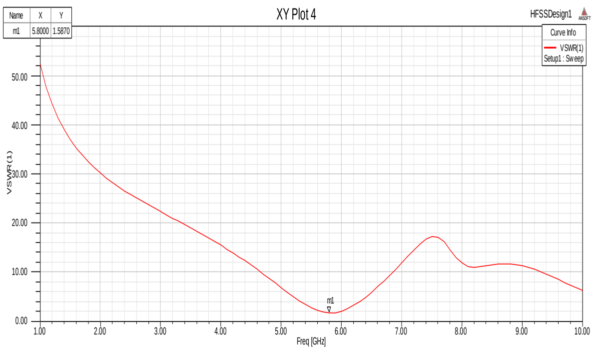

Fig.13 VSWR of the antenna

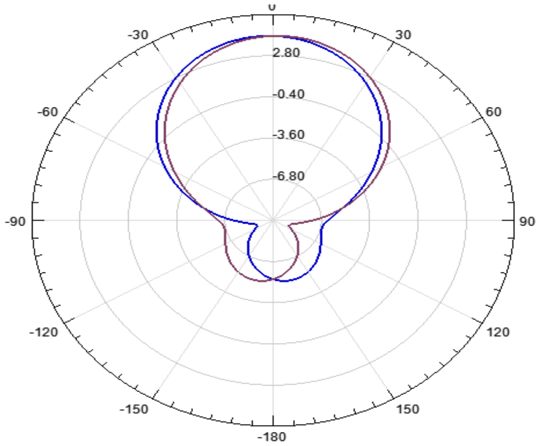

Fig.14 Radiation Pattern of the antenna

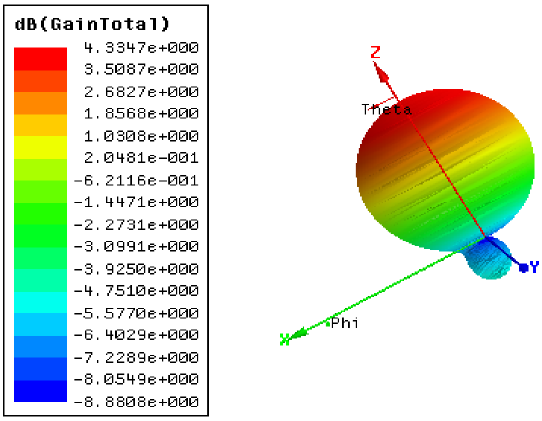

Fig.15 Gain of the antenna

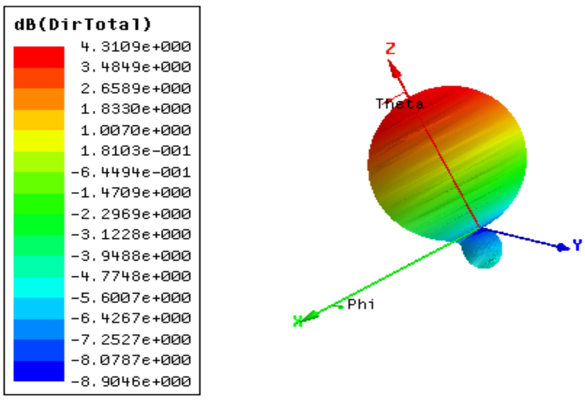

Fig.16 Directivity of the antenna

D. **When permittivity is 2.3:**

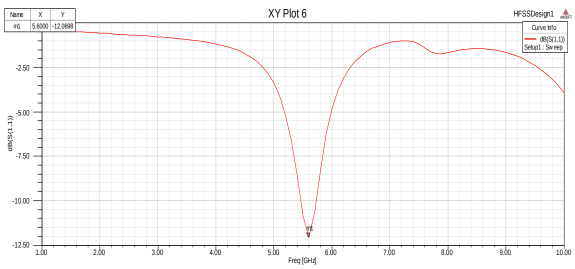

Fig.17 Return loss of the antenna

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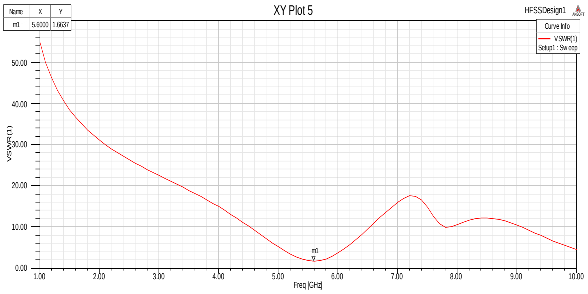

Fig.18 VSWR of the antenna

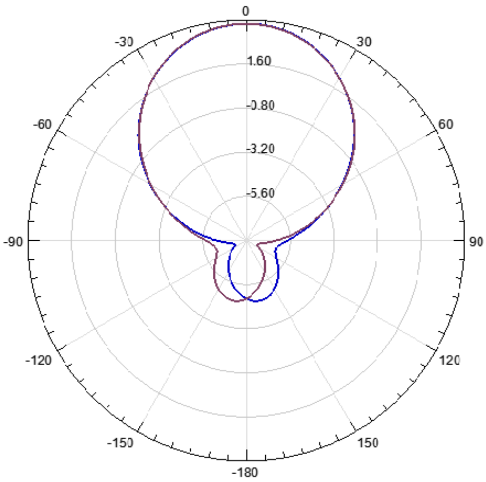

Fig.19 Radiation Pattern of the antenna

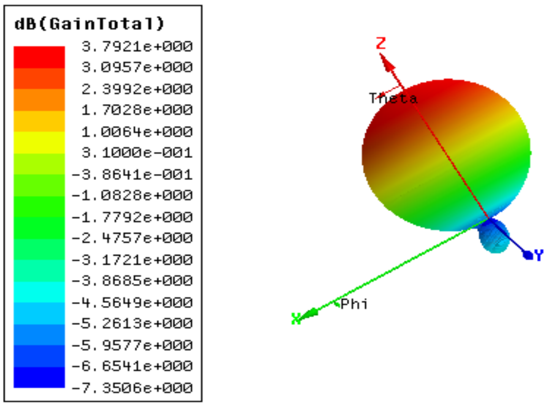

Fig.20 Gain of the antenna

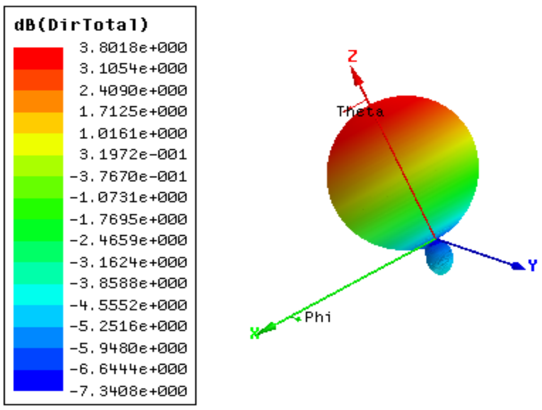

Fig.21 Directivity of the antenna

E. When permittivity is 2.4:

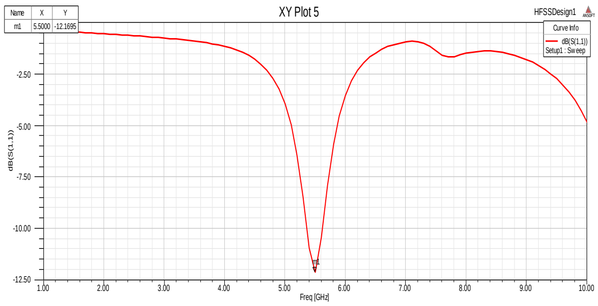

Fig.22 Return loss of the antenna

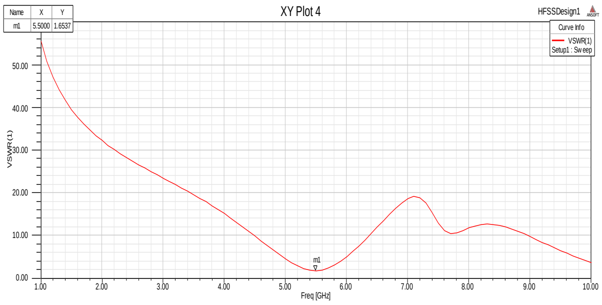

Fig.23 VSWR of the antenna

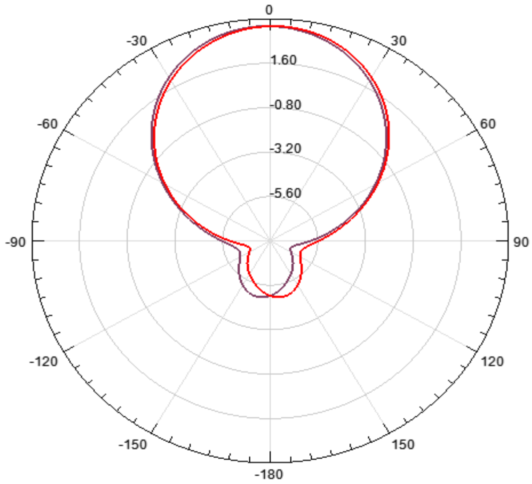

Fig.24 Radiation Pattern of the antenna

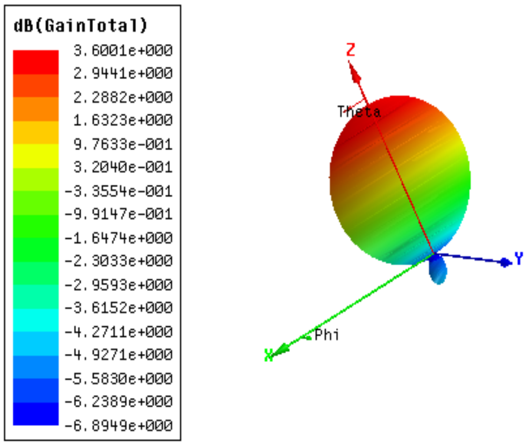

Fig.25 Gain of the antenna

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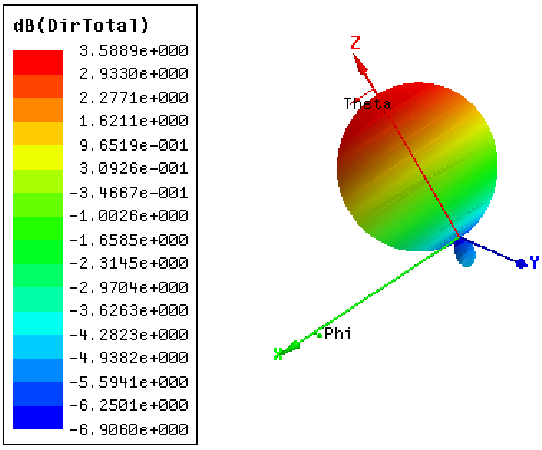

Fig.26 Directivity of the antenna

TABLE I COMPARISON CHART USING DIFFERENT PERMITTIVITY

Permittivity of substrate	Return loss (dB)	Gain (dB)	Directivity (dB)	VSWR
2.0	-13.61	4.59	4.54	1.53
2.1	-12.88	4.33	4.31	1.59
2.2	-12.63	4.08	4.07	1.60
2.3	-12.06	3.79	3.80	1.66
2.4	-12.16	3.60	3.58	1.65

So from the above table it is clear gain and directivity of the antenna is increased when the dielectric permittivity substrate reduces. It is maximum when the permittivity is 2. A return loss of -13.61 dB is achieved for a substrate permittivity of 2. The VSWR of the designed antenna is less than 2.

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