Bandwidth Enhancement in Microstrip Rectangular Patch Antenna using Defected Ground plane

Sudarshan Kumar Jain
Assistant Professor (Electronics & Communication)
Jagannath University, Jaipur

***Abstract*— A wide band rectangular microstrip patch antenna using defected ground plane is proposed in this paper. The designed frequency for the antenna is 5 GHz and it has wide bandwidth. Here the bandwidth of the antenna is enhanced significantly using defected ground plane. To provide the defected ground plane to the antenna ground plane of varying width is used. For the designing of the antenna duroid substrate is used having dielectric constant of 2.2. The antenna gain is analyzed for the varying width of the ground plane. The microstrip line feeding method is used to energize the antenna. VSWR value of the designed patch antenna is less than 2. The different characteristics of the antenna such as gain, return loss, bandwidth, directivity, and VSWR is analyzed for varying width of the ground plane. It is observed that the designed antenna using defected ground plane gives a significant increase in bandwidth. The antenna is designed using the software HFSS 13.0.**

***Index Terms*— Microstrip antenna, Resonant Frequency, Microstrip feeding, VSWR, HFSS**

I. INTRODUCTION

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. The conducting patch can be used of any shape but rectangular and circular configurations are the mostly used configuration [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.

II. ANTENNA DESIGN

The antenna is designed and analysed at a resonant frequency of 5GHz for the varying width of ground plane. The duroid substrate is used for the designing of the antenna having dielectric constant of 2.2. The length and width of the antenna is 26.96 mm and 28.36mm respectively.

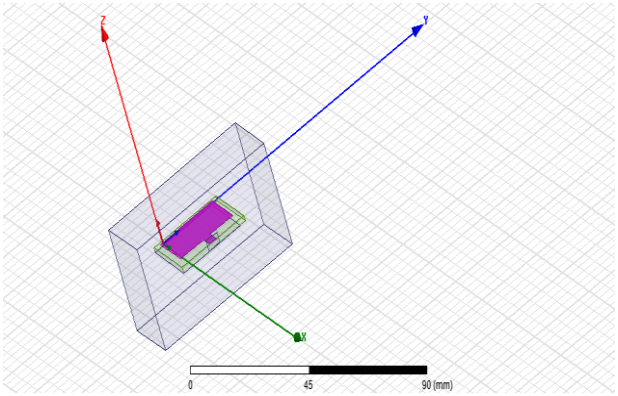

Fig.1 Actual HFSS design

To provide the defected ground plane structure to the antenna varying width ground plane is used. The different characteristics of the antenna such as return loss, gain, bandwidth, directivity, VSWR is analysed for this designed antenna. It is observed that the bandwidth of the designed antenna using defected ground plane is enhanced significantly in comparison to conventional antenna. The return loss of the antenna is also reduced. The antenna design is simulated using High frequency structure simulator software.

III. RESULTS AND DISCUSSION

The designed microstrip wide band rectangular patch antenna is simulated by using the software HFSS (High Frequency Structure simulator). The simulated results for antenna gain, return loss, VSWR, directivity, are observed for the varying width of the ground plane. All the outputs of the designed antenna using defected ground plane and conventional antenna is shown below-

A. *Outputs using Conventional antenna*

As the designed frequency is 5 GHz and dielectric constant for duroid is 2.2 .In the conventional design the dimension of the ground plane is 26.96mm x28.36mm.The return loss, gain, directivity and VSWR curve using conventional antenna is given below.

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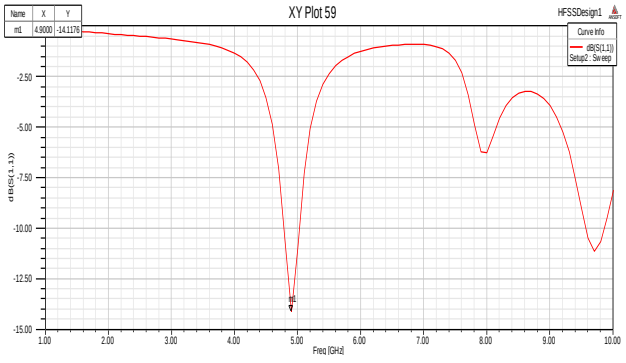

Fig.2 Return loss Vs Frequency

From the Fig.2 it is seen that the return loss is -14.11 dB in the conventional antenna.

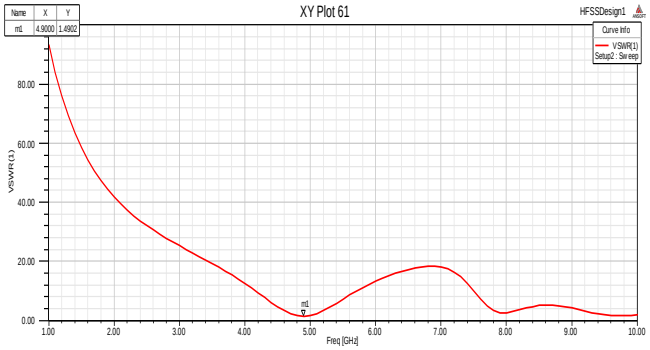

Fig.3 Voltage Standing Wave Ratio

From the above figure it is seen that VSWR is 1.4902

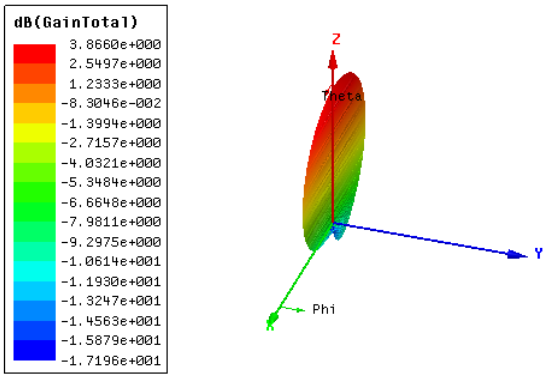

Fig.4 Gain of the Antenna

From the above 3-D polar plot it is seen that the maximum gain of 3.86 dB is achieved with conventional antenna.

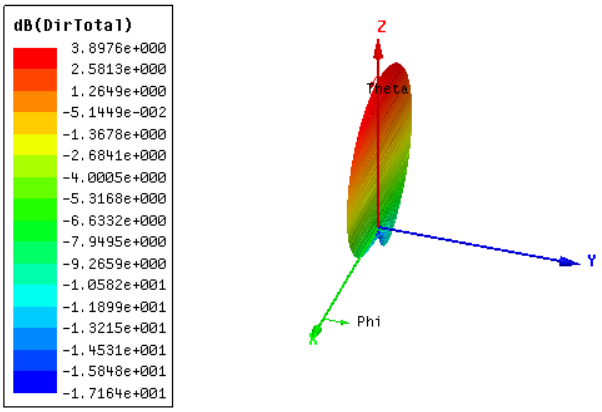

Fig.5 Directivity of the Antenna

The maximum directivity of the antenna is 3.89dB.

B. *Outputs using defected ground structure:*

1. *For width=26mm*

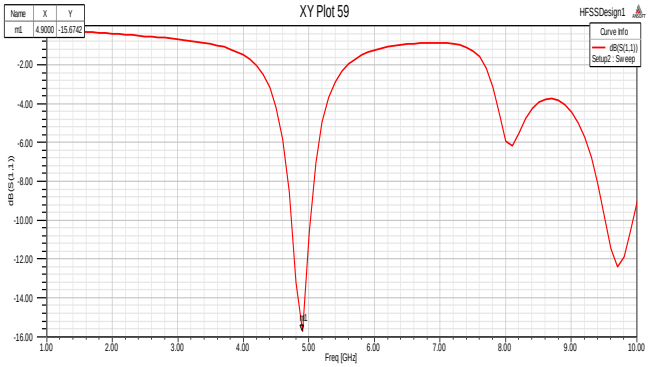

Fig.6 Return loss Vs Frequency

From the Fig.6 it is seen that received return loss < -10dB.The minimum return loss is -15.67 dB.

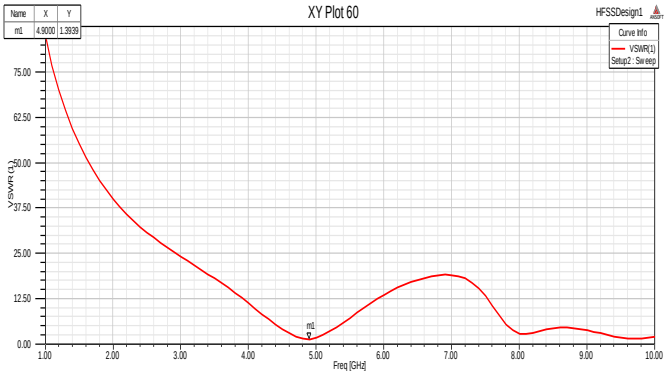

Fig.7 Voltage Standing Wave Ratio

From the above figure it is seen that VSWR is less than 2 and it is 1.3939.

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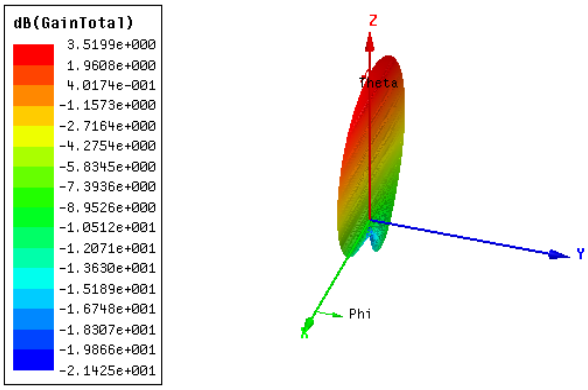

Fig.8 Gain of the Antenna

From the above 3-D polar plot it is seen that the maximum gain of 3.51 dB is achieved for ground plane width of 26mm.

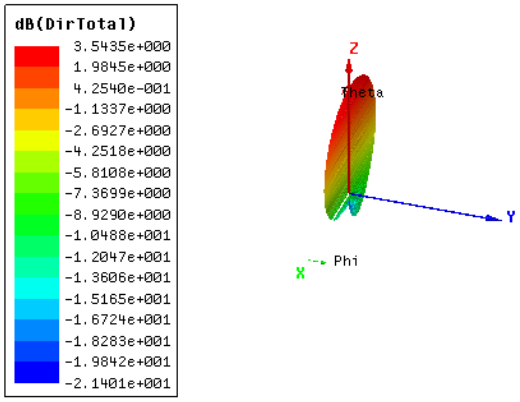

Fig.9 Directivity of the Antenna

The maximum directivity of the antenna is 3.54dB is achieved.

2. *For width=24mm*

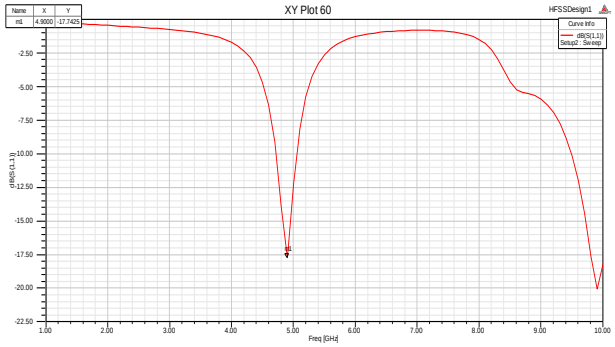

Fig.10 Return loss Vs Frequency

A minimum return loss of -17.74dB is achieved.

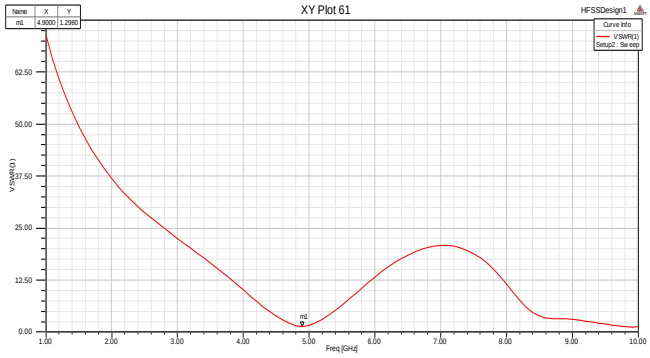

Fig.11 Voltage Standing Wave Ratio

VSWR of the antenna is 1.29 or less than 2.

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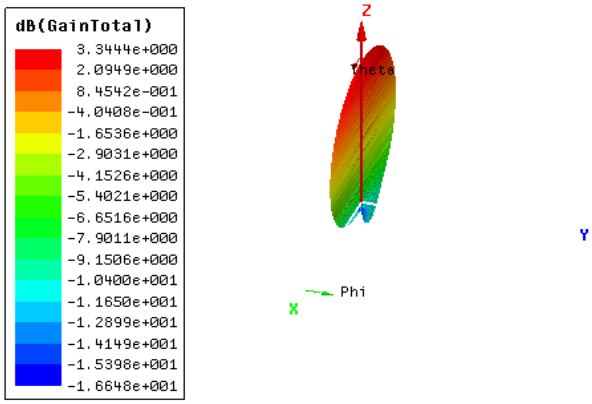

Fig.12 Gain of the Antenna

From the above 3-D polar plot it is seen that the maximum gain of 3.34 dB is achieved.

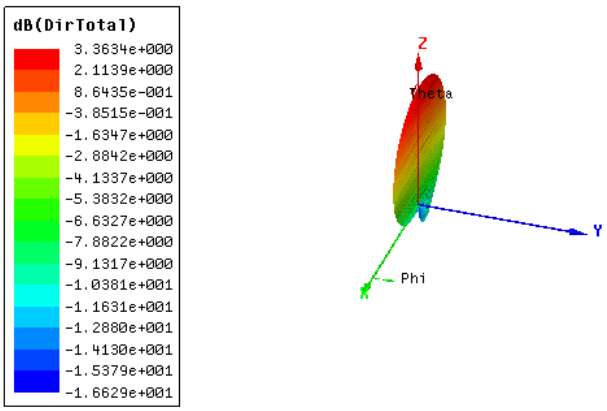

Fig.13 Directivity of the Antenna

The maximum directivity of the antenna is 3.36dB

3. *For width=20mm*

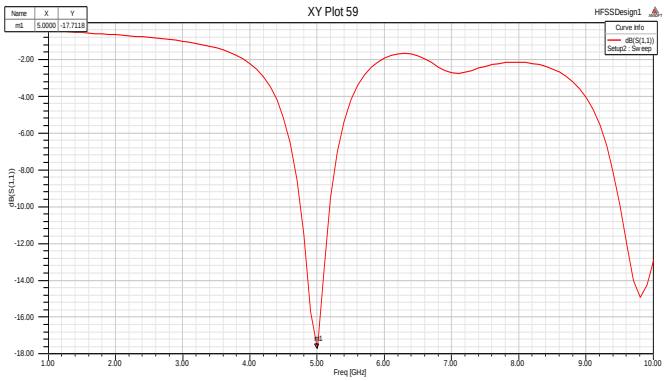

Fig.14 Return loss Vs Frequency

The minimum return loss of the antenna is -17.71dB.

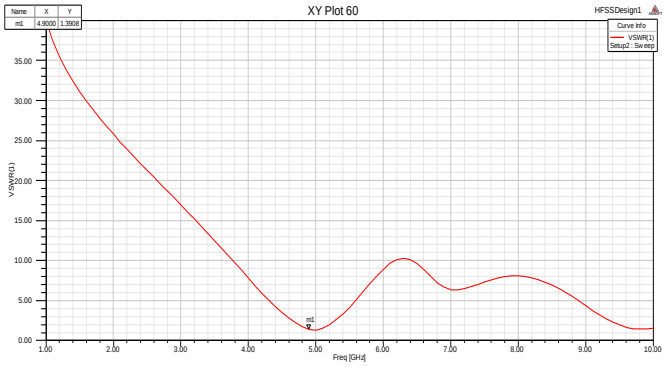

Fig.15 Voltage Standing Wave Ratio

From the Fig.15 it is seen that VSWR is less than 2 and it is 1.39.

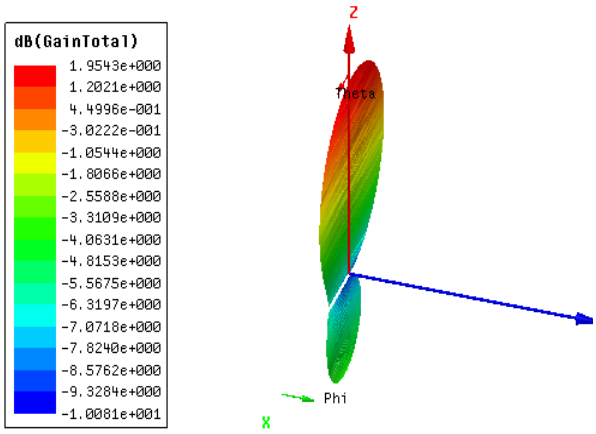

Fig.16 Gain of the Antenna

From the above 3-D polar plot it is seen that the maximum gain of 1.954 dB is achieved.

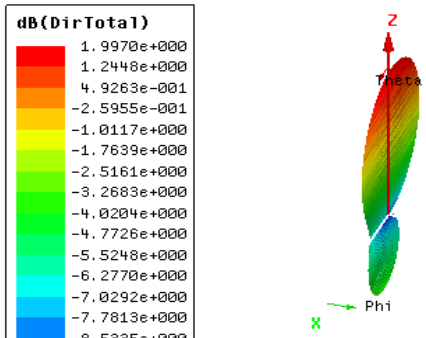

Fig.17 Directivity of the Antenna

4. *For width=18mm*

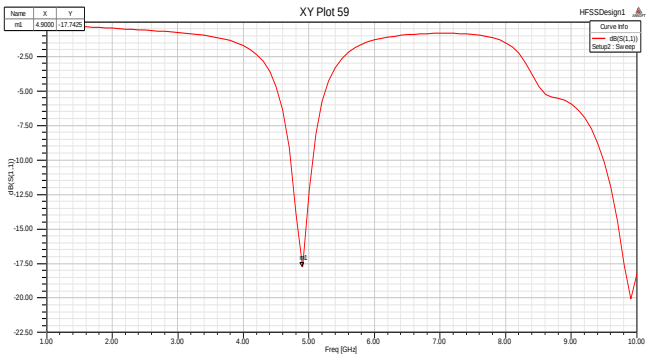

Fig.18 Return loss Vs Frequency

A minimum return loss of -26.72 dB is achieved when poly quartz is used to provide hybrid structure.

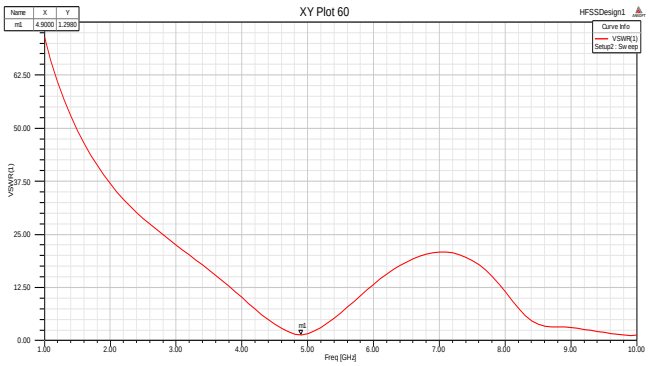

Fig.19 Voltage Standing Wave Ratio

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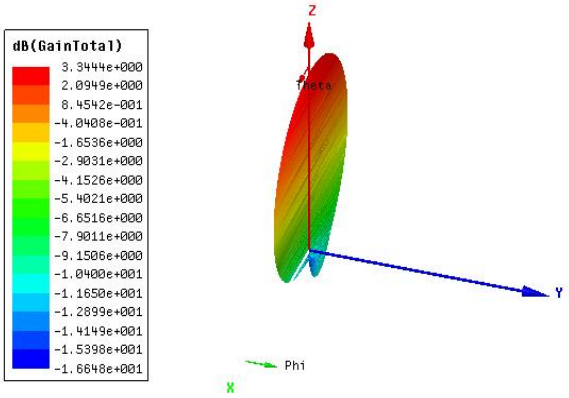

Fig.20 Gain of the Antenna

From the above 3-D polar plot it is seen that the maximum gain of 3.34dB is achieved.

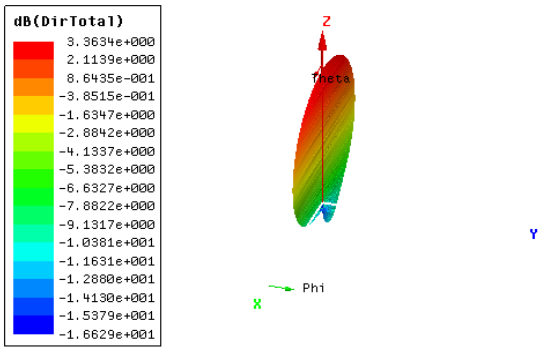

Fig.21 Directivity of the Antenna

5. *For width=16mm*

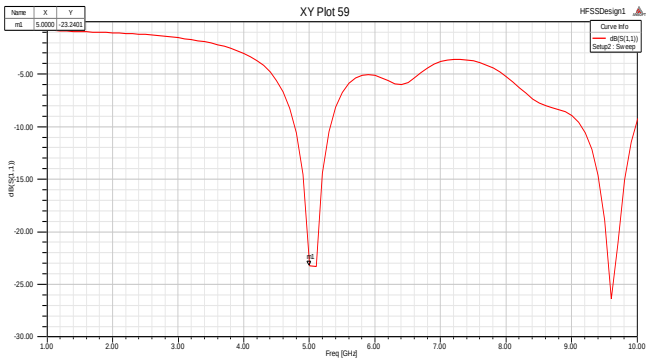

Fig.22 Return loss Vs Frequency

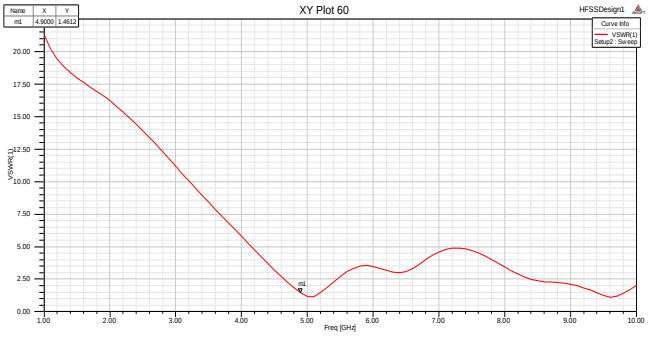

Fig.23 Voltage Standing Wave Ratio

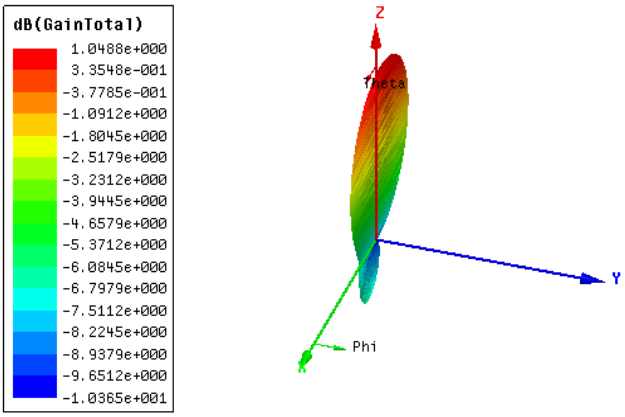

Fig.24 Gain of the Antenna

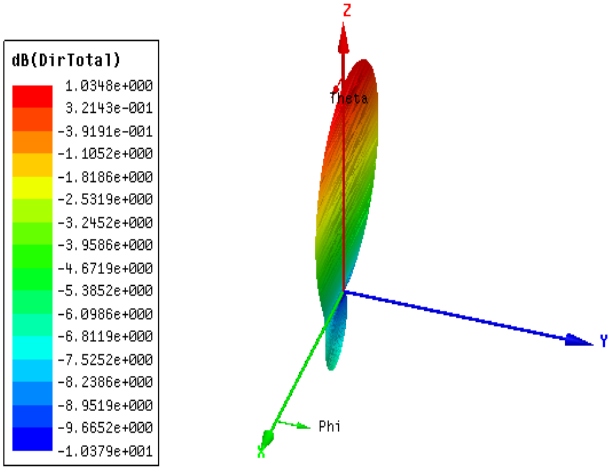

Fig.25 Directivity of the Antenna

TABLE I

COMPARISON CHART OF CONVENTIONAL AND DEFECTED GROUND PLANE STRUCTURE

		R.L (dB)	V	G(dB)	D(dB)	B.W (MHz)
Conventional Antenna		-14.11	1.49	3.86	3.89	
With defected Ground Plane structure	**Ground plane width in mm**					
	26	-15.67	1.39	3.51	3.54	276
	24	-17.74	1.29	3.34	3.36	326
	20	-17.71	1.39	1.95	1.99	442
	18	-26.72	1.29	3.34	3.36	666
	16	-23.24	1.46	1.04	1.03	534

Here R.L= Return Loss
V= Voltage Standing wave ratio
G= Gain in dB
D= Directivity in dB
B.W= Bandwidth in MHz

IV. RESULTS AND DISCUSSION

So the designed rectangular microstrip antenna using defected ground plane has wide band characteristics than the conventional antenna. The designed antenna is analyzed for the different characteristics such as gain, return loss, directivity and voltage standing wave ratio etc. It is observed that the maximum bandwidth for ground plane width of 18 mm is received for constant length for the frequency of 5 GHz. Minimum return loss is -26.72 dB. For the different ground plane width at constant length antenna bandwidth is increased significantly that is shown in table I.

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