Performance Analysis of Rectangular Patch Antenna using variation in Width of Conducting Patch

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Abstract

A microstrip rectangular patch antenna using different width of the conducting patch is analysed for the various characteristics of the antenna. The antenna is designed at a resonant frequency of 5 GHz. The dielectric substrate used for designed antenna is duroid having a dielectric permittivity of 2.2. It is observed that the gain of the designed antenna gain is enhanced when the width of the patch is reduced. The return loss of the antenna also changes. VSWR of the designed antenna is below 2 .In the designed antenna microstrip feeding is used to energize the antenna. The antenna is observed for the different characteristics such as gain, bandwidth, directivity return loss, and voltage standing wave ratio for different values of the patch width. High Frequency Structure Simulator (HFSS) software is used for the designing and simulation of the antenna.

Keywords - *Microstrip antenna, bandwidth, patch size, voltage standing wave ratio, return loss.*

I. INTRODUCTION

Microstrip patch antennas are mostly used due to its various advantages such as light weight, less volume, low cost, compatibility with integrated circuits, easy to install on the rigid surface. These antennas are used in different communication devices. [1] Microstrip antenna is energized using various feeding techniques such as coaxial feeding, microstrip feeding, aperture coupled feed and proximity coupled feed. Microstrip feeding is the easiest method for energizing the antenna.

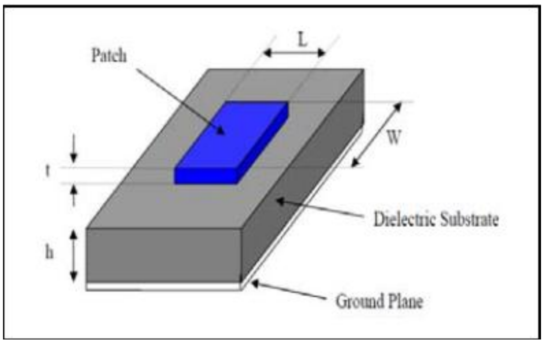

Fig.1 Structure of a Microstrip Patch Antenna

For an efficient patch antenna, practical width that leads to good radiation efficiencies is

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}}$$

The effective dielectric constant of the microstrip patch antenna is calculated using –

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$$

The effective length of the patch is given by-

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

Length extension **(**ΔL) is calculated using following formula -

$$\frac{\Delta L}{h} = 0.412\frac{\left(\varepsilon_{reff}+0.3\right)\left(\frac{W}{h}+0.264\right)}{\left(\varepsilon_{reff}-0.258\right)\left(\frac{W}{h}+0.8\right)}$$

Actual length of the patch is given by-

$$L = L_{eff} - 2\Delta L$$

So by using the above formulas the length and width of the rectangular patch is calculated.

II. ANTENNA DESIGN

The antenna is designed at a resonant frequency of 5 GHz having the following specifications-

Parameter	Value
Frequency	5 GHz
Length of the Patch	19.30 mm
Width of the Patch	23.72 mm
Substrate	Duroid
Substrate Size	35mm×35 mm
Dielectric Constant	2.2
Feeding method	Microstrip Line

Here the designed antenna is analysed for its various characteristics such as gain, bandwidth, return loss, directivity, and radiation pattern by varying the width of the conducting patch. The antenna outputs are observed for the patch width of 23.72, 22.72, and 21.72. Then it is observed that the gain of the antenna and return loss changes when the width of the patch changes.

III. SIMULATION RESULTS

The simulated results for the designed antenna is shown below where the various characteristics of the antenna such as gain, bandwidth, return loss, radiation pattern and directivity is shown-

A. When Width of the Patch is 23.72

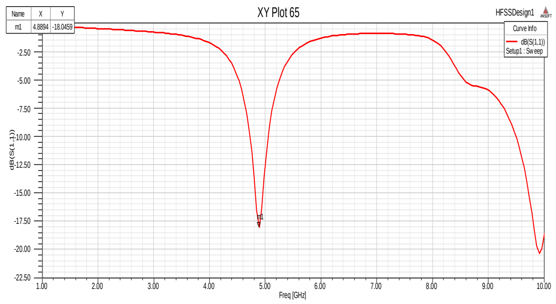

Fig.2 Return Loss of the Antenna

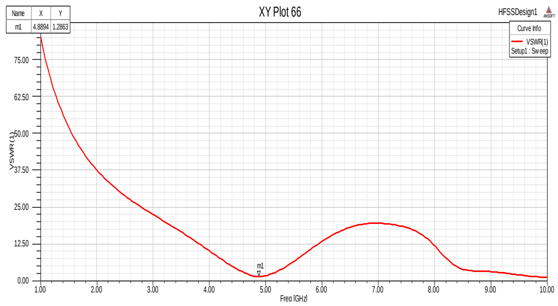

Fig.3 VSWR of the Antenna

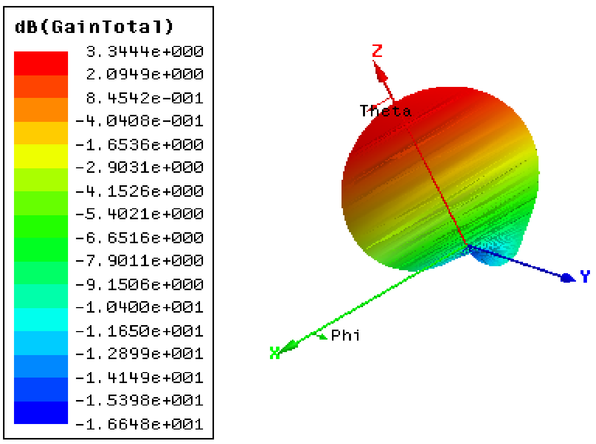

Fig.4 Gain of the Antenna

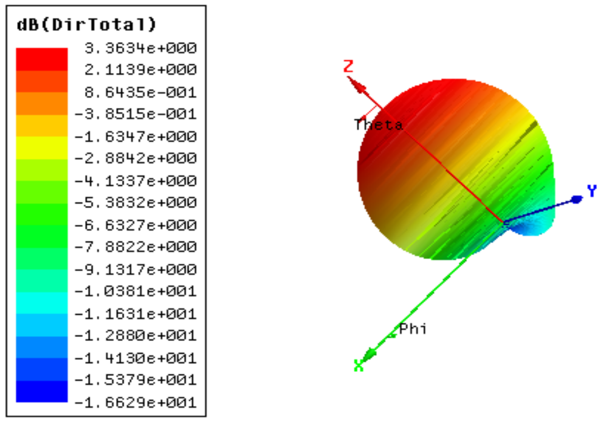

Fig.5 Directivity of the Antenna

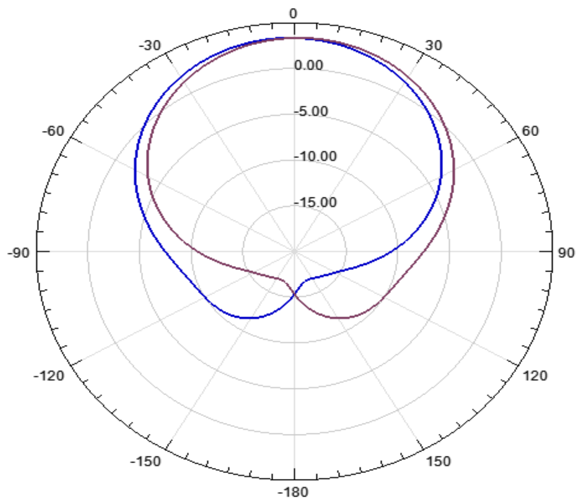

Fig.6 Radiation Pattern of the Antenna

B. When Width of the Patch is 22.72

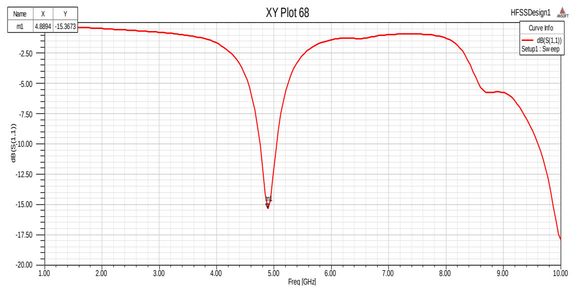

Fig.7 Return Loss of the Antenna

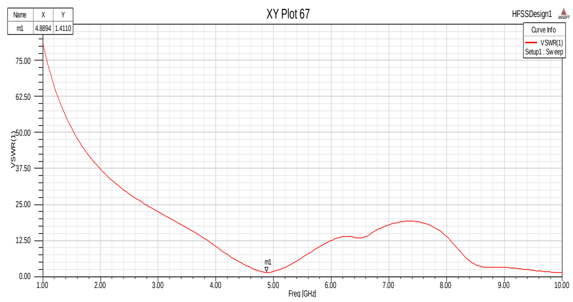

Fig.8 VSWR of the Antenna

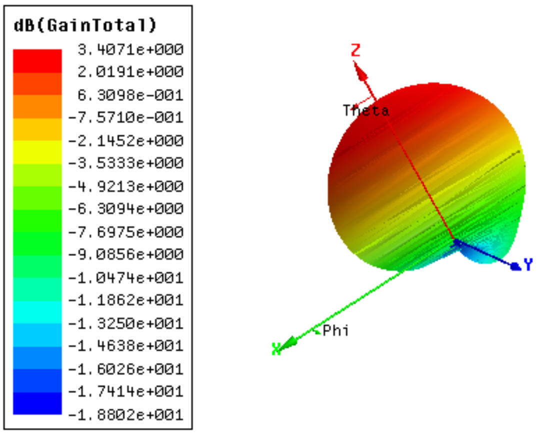

Fig.9 Gain of the Antenna

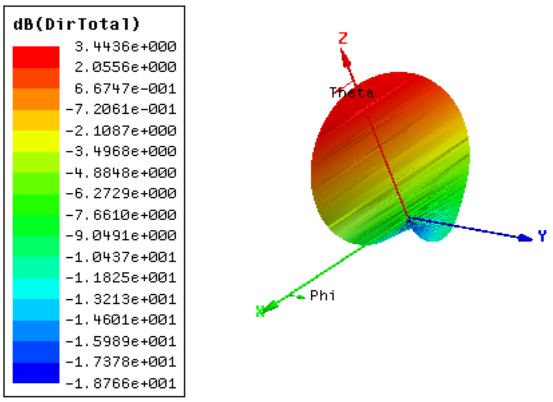

Fig.10 Directivity of the Antenna

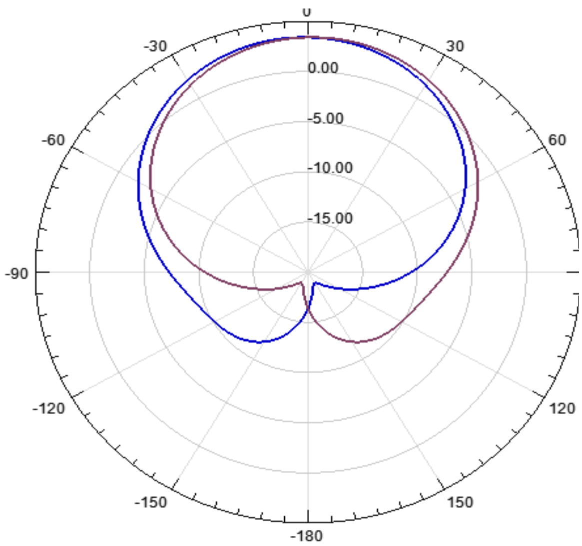

Fig.11 Radiation Pattern of the Antenna

C. When Width of the Patch is 21.72

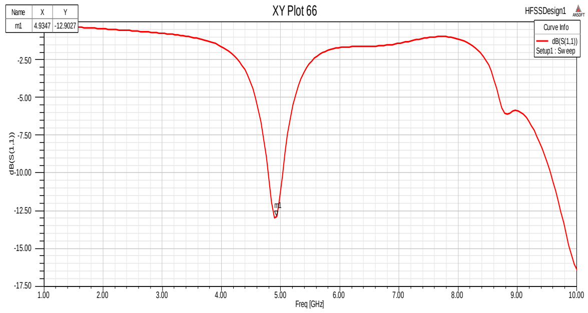

Fig.12 Return Loss of the Antenna

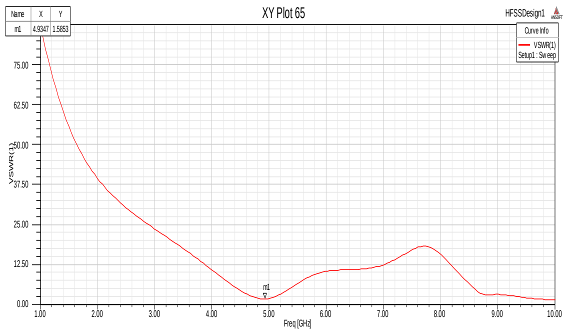

Fig.13 VSWR of the Antenna

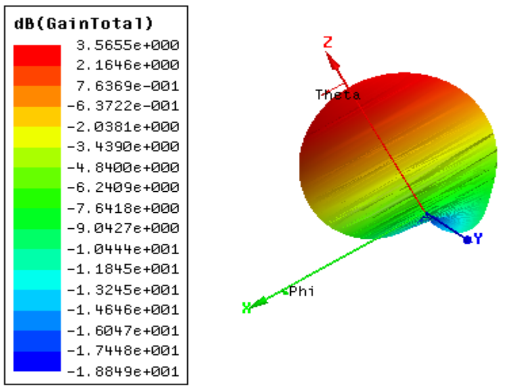

Fig.14 Gain of the Antenna

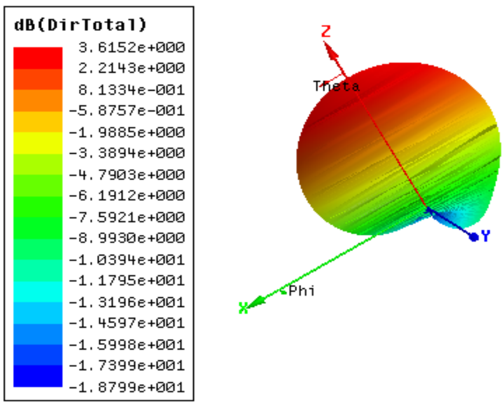

Fig.6 Directivity of the Antenna

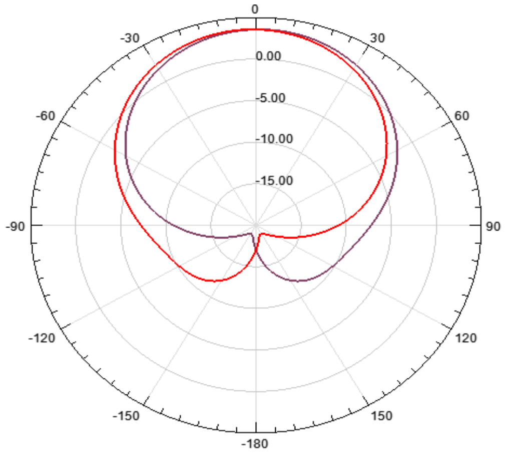

Fig.15 Radiation Pattern of the Antenna

Table I : Comparison Chart using Different width of Conducting Patch

Width of Conducting Patch	Return loss (dB)	Gain (dB)	Directivity (dB)	VSWR
23.72	-18.05	3.34	3.36	1.28
22.72	-15.36	3.40	3.44	1.41
21.72	-12.90	3.56	3.61	1.58

IV. CONCLUSIONS

So it is clear from the above output characteristics of the designed antenna that the antenna gain increases as the width of the patch decreases. The directivity of the antenna also increases. The voltage standing wave ratio of the designed antenna is below 2.

REFERENCES

[1] Constantine A. Balanis, Antenna Theory, Analysis and Design,3rd edition, A John Wiley & Sons, Inc. , Publication, 2005.

[2] Zhu Yongxiang, Chen Jianjun, SongXuerui, Cao Hongxi, "The Design Study of the Wide Bandwidth and High Gain RFID Microstrip Patch Antenna", Third IEEE International Conference on Intelligent System Design and Engineering Applications-2013.

[3] Sudarshan Kumar Jain, "Design and analysis of rectangular microstrip antenna using slotted substrate structure to minimize fabrication" International Journal of Engineering Trends and Technology, volume 9, 2014