INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 1)
Available online at: www.ijariit.com

Design and optimization of dual band antenna with DGS for IoT applications

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ABSTRACT

This Paper Proposes a Microstrip antenna to work on 2.4 GHz in Industrial, Scientific and Medical (ISM) band for the Internet of things (IOT) applications. Printed circuit board (PCB) antennas are commonly used in commercial and medical applications because of its small size, low profile, and low cost. The antenna performance has been further compared by developing a defect on the ground of the same antenna. The performance of the antenna is characterized by the shape, dimension and location of the defected ground structure at a specific position on the ground plane. The proposed antenna was simulated and analyzed using CST Microwave Studio Suite Software.

Keywords— *Micro-strip antenna, Defected ground structure, Printed circuit*

1. INTRODUCTION

Microstrip antenna has been studied extensively over the past years because of its low profile, lightweight, low cost and easy fabrication. They are extremely compatible for embedded antennas in handheld portable wireless devices such as cellular phones, pagers etc. These low profile antennas are also useful in aircraft, satellite and missile application, where size, weight, cost, ease of installation and aerodynamic profile are a strict constraint. For example, in a medical application, data is shared with patients and medical professionals through IoT; therefore, a better consultancy can be provided and medical cost can be lowered. [1]. In the network layer, wireless parts including antenna and RF front-end circuits become the main challenges for IoT development [2,3]. But microstrip antenna suffers from drawbacks like narrow bandwidth and low gain. While using a microstrip patch antenna, the losses occur in radiation due to surface waves causing a decrease in the antenna efficiency, gain and bandwidth.

Therefore a technique known as the defected ground structure has been used to improve the antenna parameters. In DGS, some of the ground is etched away in different shapes. This will disturb the shielded current distribution depending upon the shape and dimension of the defect. Due to this defect, shielded current distribution influences the input impedance and current flow of the antenna. The excitation and electromagnetic propagation through the substrate layer can also be control by DGS. Microstrip antenna with DGS improves return loss and provides higher bandwidth overcoming the limitations of the conventional microstrip patch antenna. DGS design is also used for the reduction of harmonics and cross polarization [6,7]. DGS can be integrated onto the ground plane of such an antenna in order to improve the radiation, besides not requiring an additional circuit for implementation. DGS is widely used in microwave devices to provide compactness and effectiveness. In this paper, first an ordinary microstrip antenna has been designed to resonate on 2.4 GHz and then a defect is developed on the ground of the same antenna by keeping other dimensions as constant. A comparative study with DGS and without DGS has also been done.

2. ANTENNA DESIGN

The dimensions of the antenna were calculated as per the standard equations [4]. The antenna has been designed with FR-4 substrate having a dielectric constant as 4.4. The size of the substrate is 57.21x 48.62x1.6 mm. The ground plane size is 57.21x48.62 mm and copper has been used for this. The length of the microstrip feed line is 9.6 mm and width is 5.2mm [5]. The patch size is 38.5x28.7 mm. The size of both the slots on the ground is 2.5x15 mm.

Table 1: Parameters Specification

Parameters	Dimension
GND Size	57.21x48.62 mm
Two Slot Size(on ground)	2.5x15 mm
Substrate Size	57.21x48.62x1.6 mm
Microstrip feed	5.2x9.6 mm
Patch Size	38.5x28.7 mm

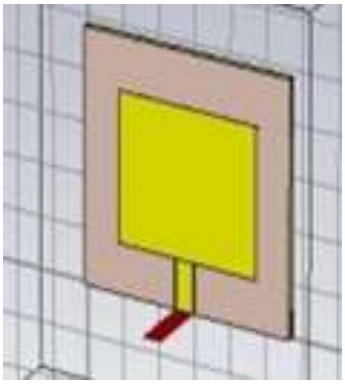

Fig. 1: MPA structure (Top View)

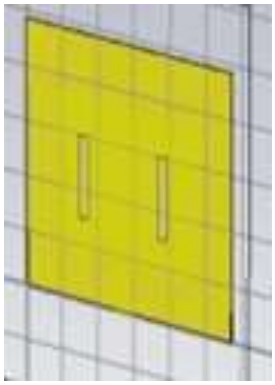

Fig. 2: DGS (Bottom View)

Table 2: Comparison of Parameters

Parameters	Ground Without DGS	Ground with DGS
Return loss	-14.5 dB	14.8 dB(2.4 GHz) and -26 dB(3 GHz)
Bandwidth	50 MHz	59.5 MHz(2.4 GHz) and 53 MHz(3GHz)
Gain	4.0	4.2

3. RESULT

The designed antenna was first simulated without having any defect on the ground. The return loss obtained is -14.5 dB on 2.4 GHz as shown in figure 1. The bandwidth is 50 MHz. Then the antenna was simulated after the introduction of defects on the ground. The antenna is now resonating on two frequencies. The result in fig.4 shows that return loss is now 14.8 dB on 2.4 GHz and -26 dB on 3 GHz. The bandwidth on 2.4 GHz is 59.5 MHz and 53 Mhz on 3 GHz. The directivity of the antenna is 6.42 dB at φ= 03° with a half power beam width of 91.7°.

A comparative study of antenna parameters is shown in table 2.

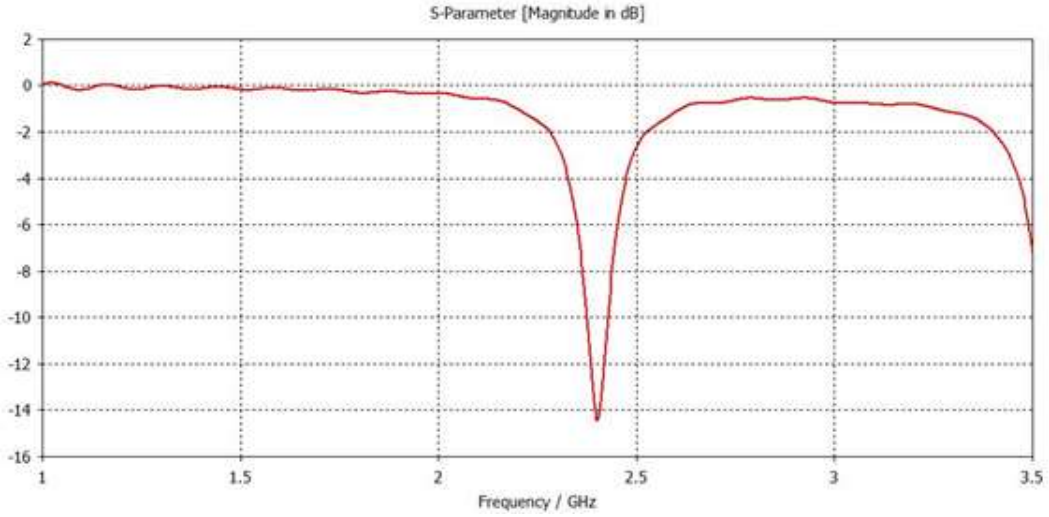

Fig. 3: Graph of return loss vs. frequency (Without DGS)

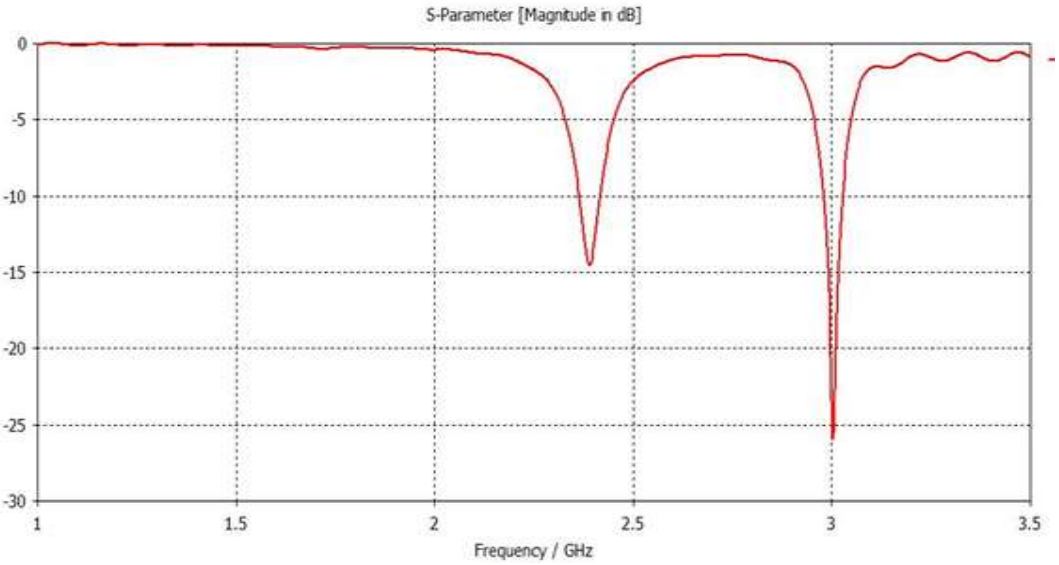

Fig. 4: Graph of return loss vs. frequency (With DGS)

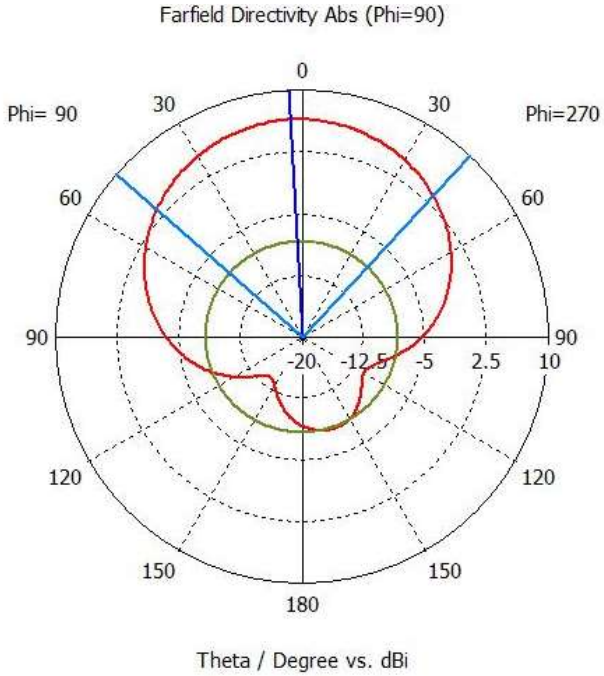

Fig. 5: Radiation pattern of DGS antenna on 2.4 GHz

4. CONCLUSION

The proposed design presents a low profile, low-cost antenna to work for IOT and other applications in WLAN. The comparative study shows that DGS design provides improved parameters of antenna-like bandwidth, gain, return loss and multiband operation. It is a good candidate for the application in devices of blue tooth and ISM band.

5. REFERENCES

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