DESIGN AND ANALYSIS OF U-SHAPED SLOT MICROSTRIP PATCH ANTENNA AT MULTIPLE FREQUENCIES

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Abstract: In this paper, U-shaped slot micro strip patch antenna is designed which operates at the multiple frequencies of 7.5 GHz [1] and 4.9 GHz. This antenna has the capability of wide bandwidth and for dual band applications. The substrate used for making antenna is FR4_epoxy. This substrate has a relative permittivity of 4.4 and having a dielectric loss tangent of 0.02 [2]. In this project gain, directivity, return loss, rectangular plot, and radiation pattern are the parameters of U-shaped slot micro strip patch antenna which are analyzed and simulated. All multifarious parameters of the antenna are scrutinized and simulated on HFSS.

Keywords: *U-shaped slot micro strip patch antenna; High-frequency structural simulator; Bandwidth enhancement; Dual band; Multiple frequencies; Antenna parameters.*

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I INTRODUCTION

Since last two decades U-shaped slot micro strip patch antenna is taking too much attention in different applications like wireless etc. These types of antennas are growing rapidly in the market because of their extensive usage in different fields like mobiles and satellite communications.

The fringing fields are present between the edges of the path and the ground plane. Because of these fringing fields, the radiations are emitted by the micro strip patch antennas. Besides this, different type of antennas are present in the market in which printed antennas are taking much attention because these antennas have less size, light weight and of low cost [1].

The development of antennas began in the late 1970's. Huynh and Lee proposed the concept of U-slot micro strip type patch antennas in 1995 [3]. The biggest drawback of micro strip patch antennas using in the market is to have slender bandwidth [4] and squat gain. It was introduced afterward that U-shaped slot micro strip patch antenna increases the bandwidth of simple micro strip antennas [5]. These U-shaped slot micro strip patch antenna can be premeditated for applications using wideband in it. It can also be designed for applications having a dual and triple band in it [6]. It is also used in those applications which have less and widespread ratio of frequency [7]. The U-shaped slot micro strip patch antenna has the ability to reconfigure frequency [8].

II WORK GOALS

The micro strip antennas have low bandwidth and gain. In this project, the U-shaped slot is acquainted with in the micro strip antenna which suggestively augmented the bandwidth and gain of it. The antenna which is designed by using the substrate FR4_epoxy is dual band and works on two important multiple frequencies. It gives two different gains and directivity at two different multiple frequencies on which it is premeditated to work. In this project, radiation pattern is analyzed as well as return loss is measured which tells us how much power is transmitted by the antenna. The parameters which are analyzed is simulated on high frequency structural simulator (HFSS).

This antenna can be installed in mobiles, satellite communication. It can also be used as WLAN & Wireless Radio band.

III ANTENNA GEOMETRIES

The main parts of U-shaped slot micro strip patch antenna comprising of the radiating patch, coaxial connector, dielectric substrate, and ground plane. The radiating patch is present on the upper side of the dielectric substrate while

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ground plane is present on the down side of it. The patch which is present on the upper side is fed with the feed probe or a feed line. Conducting materials like copper or gold are usually used for making the radiating patch as shown in figure 1.

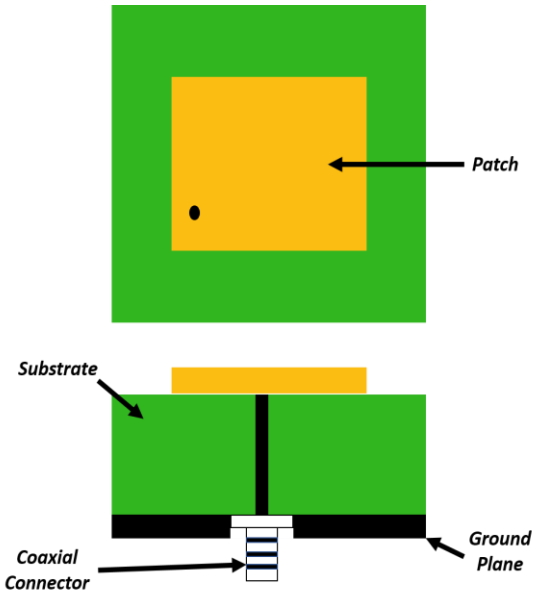

Figure 1 U-shaped slot micro strip patch antenna

This antenna is designed by using the dielectric substrate FR4_epoxy which have a relative permittivity of 4.4 and having a dielectric loss tangent of 0.02 [2]. The dimensions of this substrate are based on the multiple frequencies of 7.5 GHz and 4.9 GHz [1] using probe feed. It consists of a U-shaped slot patch on an RF4_epoxy substrate material. The patch is probe feed. The probe feed consists of two cylinders which are assigned pec material. The whole substrate is placed inside the air box who's each side, except side at z=0, has been assigned radiation boundaries. The wave port excitation has been assigned to the upper side of probe feed cylinder which is in parallel with the patch as shown in figure 2 and 3.

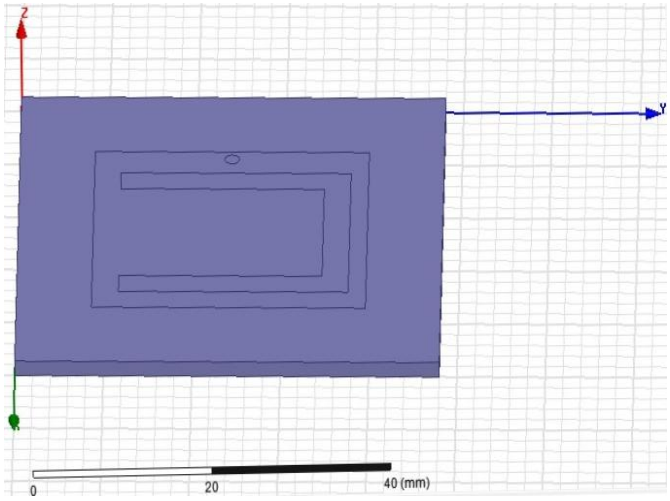

Figure 2 Geometry of U-shaped micro strip patch antenna (Top View)

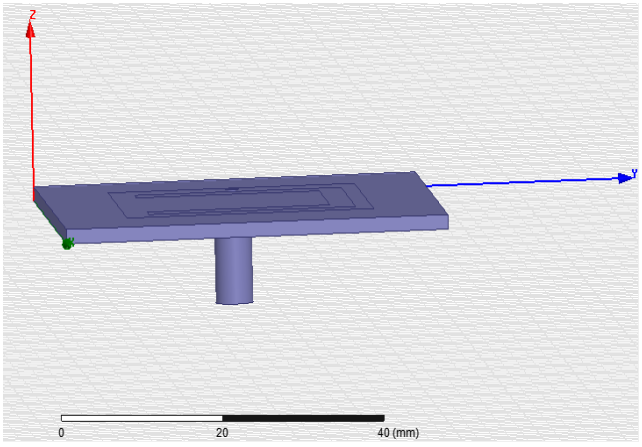

Figure 3 Geometry of U-shaped Micro Strip Patch Antenna (Side View)

The designed parameters of the U-shaped slot micro strip patch antenna are presented in table 1.

Table 1 Designed parameters of U-shaped slot micro strip patch antenna

Operating frequencies	4.9 GHz and 7.5Ghz
Substrate	FR4_Epoxy
Patch (width, length)	(31mm, 29.45mm)
Substrate's Height	1.59mm
Dielectric constant of substrate	4.4
Wave port	2.35 mm
Probe feed (length, radius)	(10.83mm, 0.82mm)
Air box (length, width, height)	(50mm, 48mm, 20mm)
U-shaped slot (width, length)	(3mm, 26mm)

IV SIMULATION RESULTS AND DISSCUSIONS

All the simulations of the antenna are performed on the high-frequency structural simulator (HFSS). The waveform of a rectangular plot of the antenna is shown in figure 4.

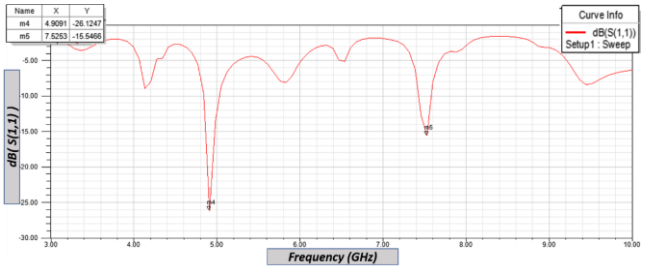

Figure 4 Rectangular plot Waveform of U-shaped slot micro strip patch antenna

Simply, a gain of the antenna describes the direction in which maximum radiation is going. Gain that was achieved at the frequency of 4.9 GHz was 3.4225 dB and that at 7.5 GHz was 5.1809 db. The gain at 4.9 GHz is shown in figure 5 and of 7.5 GHz is shown in figure 6.

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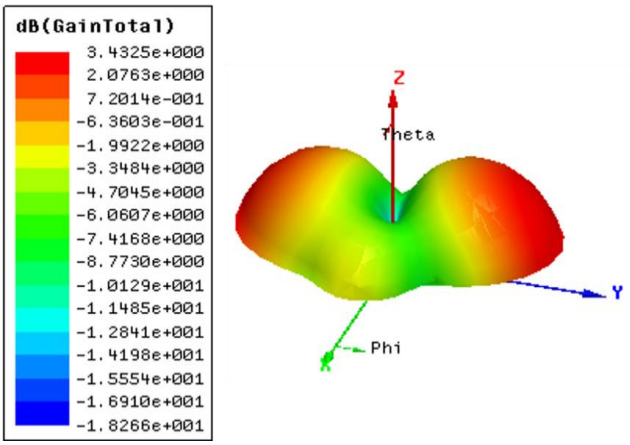

Figure 5 Gain of U-shaped micro strip patch antenna at 4.9 GHz

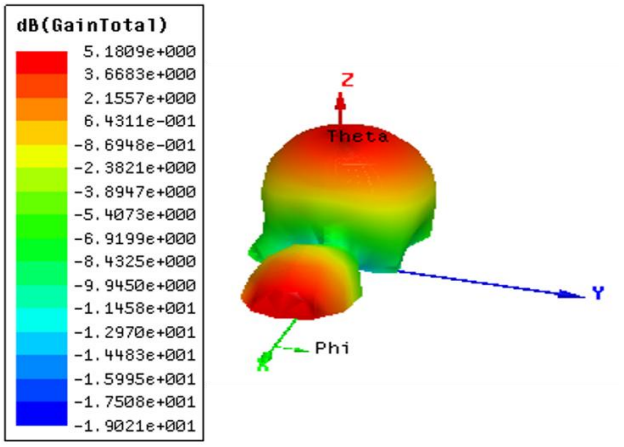

Figure 1 Gain of U-shaped micro strip patch antenna at 7.5 GHz

Directivity tells us the direction associated with the maximum radiation from the antenna. The maximum directivity at the solution frequency of 4.9 GHz is 7.0288 dB and that at 7.5 GHz is 9.6796 db. The directivity at 4.9 GHz is shown in figure 7 and of 7.5 GHz is in figure 8.

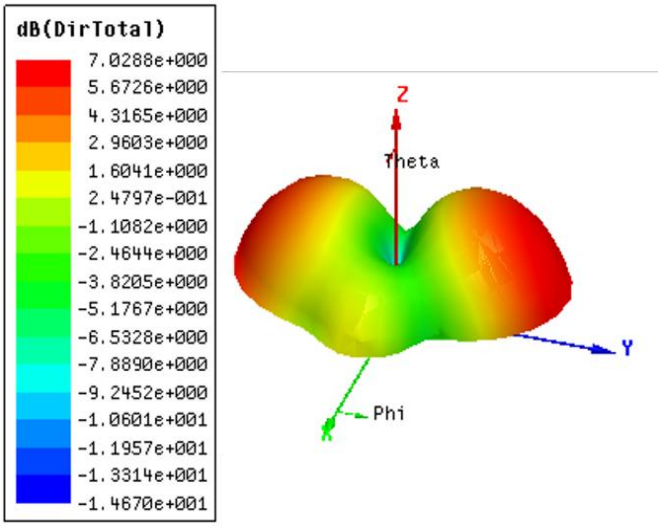

Figure 7 Directivity of U-shaped micro strip patch antenna at 4.9 GHz

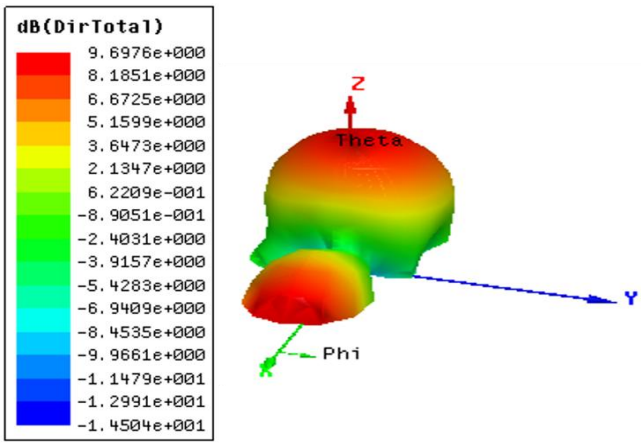

Figure 8 Directivity of U-shaped micro strip patch antenna at 7.5 GHz

The radiation pattern of the U-shaped slot micro strip patch antenna is shown in figure 9.

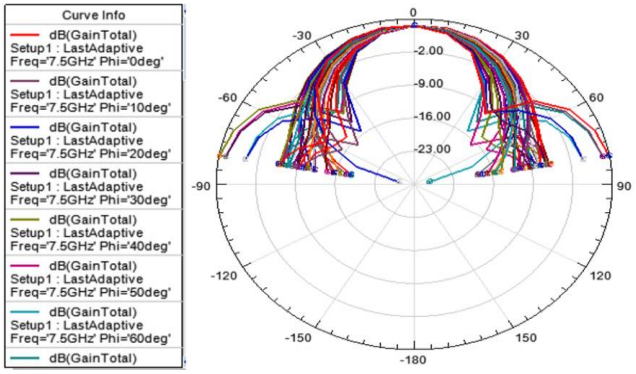

Figure 9 Radiation Pattern of U-shaped slot micro strip patch antenna

Voltage standing wave ratio (VSWR) of the U-shaped slot micro strip patch antenna is shown in figure 10. Which tells us the amount of power transmitted and reflected back from the antenna [1]?

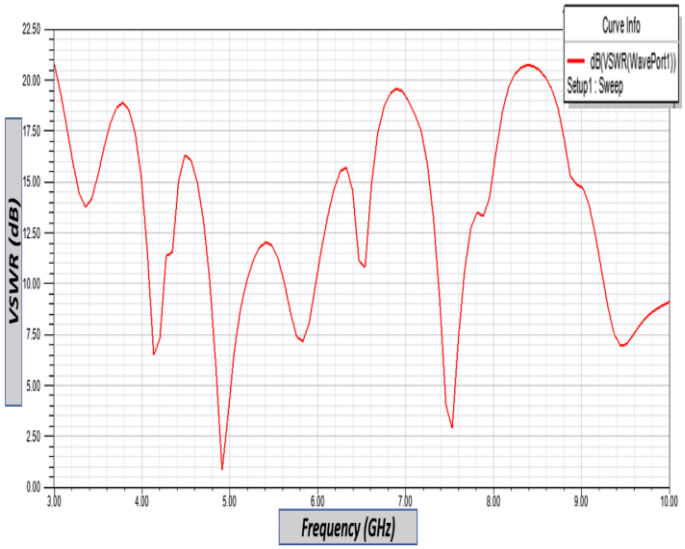

Figure 10 Power reflected from the U-shaped slot micro strip patch antenna

V CONCLUSION

All the results which are scrutinized and simulated on HFSS have obtained accurately by altering the dimensions of the dielectric substrate, radiating patch, and the slot. In this reduction in size and height of dielectric substrate occurred. The size of the patch is also reduced while the size of the slot is increased. With proper dimensions, it is able to achieve the dual band antenna operating at two important multiple frequencies of 7.5 GHz and 4.9 GHz [3] instead of the mono band.

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