Comparison of Return Loss for the Microstrip U-Slot Antennas for Frequency Band 5-6 Ghz

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ABSTRACT - A novel miniature wideband rectangular patch antenna is designed for wireless local area network (WLANs) applications and operating for 5-6 GHz ISM band, and wideband applications. In this paper, comparison is made of the proposed antenna and reference [1] for parameter called return loss. Both of antennas operate on same frequency. The proposed antenna has a good and deep return loss results.

Keywords: Wideband Antenna, Microstrip Patch Antenna, Finite Ground Dimension.

I.INTRODUCTION

Wireless communication has been developed widely and rapidly in the modern world especially during the last two decades. The future development of the personnel communication devices will aim to provide image, speech and data communication at any time, and anywhere around the world. This indicates that future communication terminal antenna must meet the requirements of multiband or wideband to sufficiently cover the possible operating band. Miniature antennas are well desired for wireless communications systems. The most popular among miniature antenna choice is the microstrip patch antenna.

The antenna is the basic element on these communication systems, it is a key component in system performance and size, and it has to simultaneously satisfy three classes of requirements:

i) Geometrical characteristics (small size, light weight, adaptability to actual platform, and non obstructive to the user), ii) Electrical performance (wide bandwidth, radiation properties, high efficiency, reconfigurability, and suitability for diversity), and iii) Manufacturing constraints (low cost, reliability, packaging capabilities). Antenna's performance must also not be degraded by environment as human body, and the design must respect the radiation safety standards.

Microstrip patch antenna is widely considered to be suitable for many wireless applications, even though it usually has a narrow bandwidth [1]. To meet the above requirements, two individually challenging modifications may have to be combined to design a microstrip antenna with wideband operation [1]. Several broad banding techniques for microstrip antennas are widely known, prominent among them are the use of stacked patches or use of parasitic patches. The stacked patch antennas have multilayer structure consisting of several parasitic radiating elements placed one above the other and above the driven element. However this approach has the inherent disadvantage of increased overall thickness and issues related to aligning various layers precisely. The second approach uses patch antenna closely surrounded by parasitic patches. The structure looks like a coplanar parasitic sub array. This approach, although thin, the antenna occupies considerable lateral area.

Wireless communications continues to enjoy exponential growth in the cellular telephony, wireless Internet, and wireless home networking arenas. Wireless networks include wireless local area network (WLAN) for which the IEEE 802.11 group has the responsibility for setting the standards [4]. The most significant technology exists in the ISM bands: 2.4–2.4835 GHz and 5.15–5.825 GHz.

In this paper, we are comparing the two parameter say vswr and return loss factor of the proposed antenna with the reference antenna. Both antenna operates on the same frequency band and there results also studied at the same frequency. Both the design was simulated by the same simulator called high frequency structure simulator.

II. LITERATURE SURVEY

Vedaprabhu et.al proposed a double u-slot patch antenna with dual wideband characteristics. In the proposed work the use of a patch antenna with two u-shaped slots to achieve dual band operation. A thick substrate helps broaden the individual bandwidths. The antenna is designed based on extensive ie3d simulation studies. Microstrip patch antenna is widely considered to be suitable for many wireless applications, even though it usually has a narrow bandwidth.

Vedaprabhu et.al proposed a multifunctional microstrip antenna that was designed, fabricated and experimentally verified for operation in AWS, GSM, WiMAX and WLAN bands. This microstrip patch antenna had two U-shaped slots to achieve the dual wideband operation required to meet these specifications. The dimensions and locations of the U-slots was designed appropriately. The thick substrate used here helps in integrating the antenna with the existing aircraft panel material while achieving wide bandwidths. Experimental results of this single feed antenna indicate that it meets all current requirements for in-cabin wireless communication needs.

Emhemed Alkurbo et.al proposed an rectangular monopole antenna that was printed on a printed circuit board (PCB). The antenna consists of a rectangular patch and a ground plane so that the antenna acts as a planar monopole antenna which is broadband. Broadband planar monopole antennas have all the advantages of the monopole in terms of their cost, and ease of fabrication besides, yielding very large bandwidths. For many applications large bandwidth is required. We have fabricated and tested printed rectangular monopole antennas for wireless application. Basically, the parameters of the presented antenna were the same with a monopole antenna but broadband.

Nabil Srifi et.al proposed an A novel miniature wideband rectangular patch antenna is designed for wireless local area network (WLANs) applications and operating for 5-6 GHz ISM band, and wideband applications. The proposed antenna gives a bandwidth of 4.84 to 6.56 GHz for S11<-10dB. The antenna has the dimensions of 20 mm by 15 mm by 0.8 mm on FR4 substrate. Rectangular slot and step have been used for bandwidth improvement. The proposed antenna design and performances are analysed by using Ansoft High Frequency structure Simulator (HFSS) and CST Microwave Studio. In this paper, we proposed a novel miniature wideband rectangular patch antenna for 5 to6GHz applications. The proposed antenna can operate from 4.8 to 6.6 GHz making it suitable for wideband applications. The frequency band of this antenna covers the entire 5.15-5.825 GHz ISM band.

III. ANTENNA DESIGN ANALYSIS

The geometry of the reference antenna is showed in Fig.1. It consists of a printed rectangular patch antenna on FR4 substrate of thickness 0.8 mm and a relative permittivity 4.4. The substrate has a length of L=20 mm and the width of W=15 mm. The dimensions of the partial conducting ground plane are 15mm×7 mm. The excitation is launched through a 50 Ohm microstrip feed line, which has the length 8mm and the width 1.5mm.

In this paper, rectangular slot on the radiator element and rectangular step have been used for bandwidth improvement, in order to cover the entire 5-6GHz band, and make the antenna suitable for 5 to 6 GHz applications.

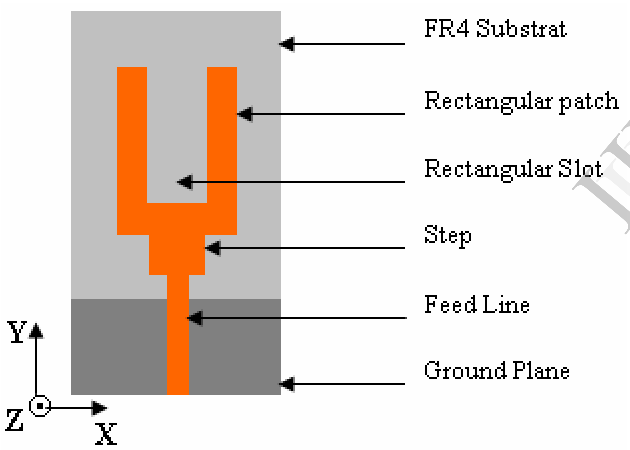

Fig 1. Reference Antenna With Slot and With Step [4]

Table 1 : Dimension of Reference Antenna

FR4 Substrate (mm)	15 * 20 * 0.8
Rectangular Patch (mm)	7 * 8
Rectangular Slot (mm)	3 * 6
Step (mm)	3 * 2
Feed Line (mm)	1.5 * 8
Ground Plane (mm)	15 * 7

The geometry of a single patch antenna using u-slot with different finite ground dimension feed by microstrip feed line can be shown in Figure 2. The patch antenna is constructed on same dielectric substrate. The patch antenna is realized on FR 4 substrate and having a relative permittivity (ε_r) = 4.98, substrate of thickness (***h***) = 1.6 mm and loss tangent (***tan***δ) = 0.09 and the microstrip feed line is realized on the same substrate layer.

Table 2: Dimension of Proposed Antenna

FR4 Substrate (mm)	30 * 30 * 1.6
Dielectric Constant	4.4
Tangent loss	0.01
Rectangular Patch	12.5 * 16
Ground Plane	30 * 8

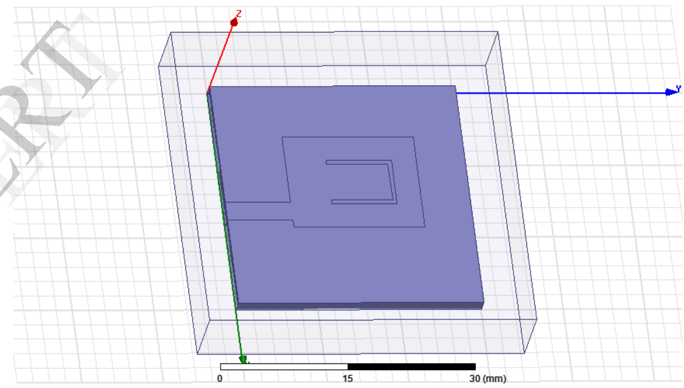

Fig 2: Proposed Antenna

In figure 1, wideband is achieved with the help of rectangular slot and step length on the substrate. While in the figure 2 the wideband is achieved with the help of the u-slop cut on the patch. Both the antenna operates on the same frequency band that is 5-6 GHz.

IV. RESULT DISCUSSION

In this section, the discussion is made on the result of both the antenna. The return loss of the reference antenna is shown is figure 3.

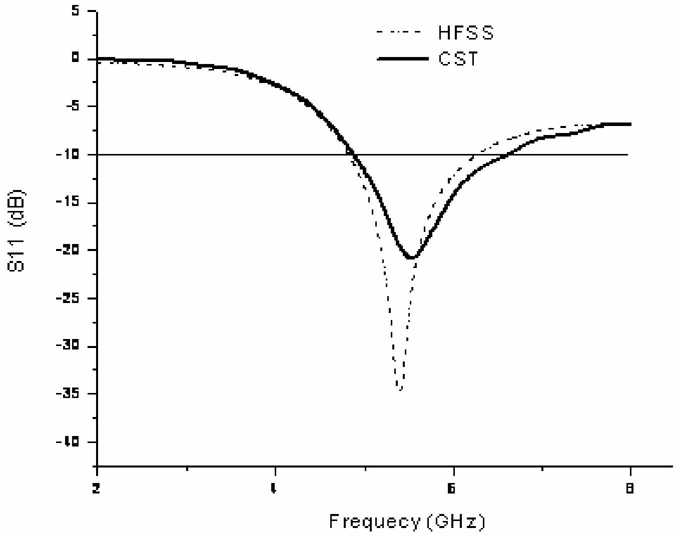

Fig 3: Simulated Result of Reference Antenna

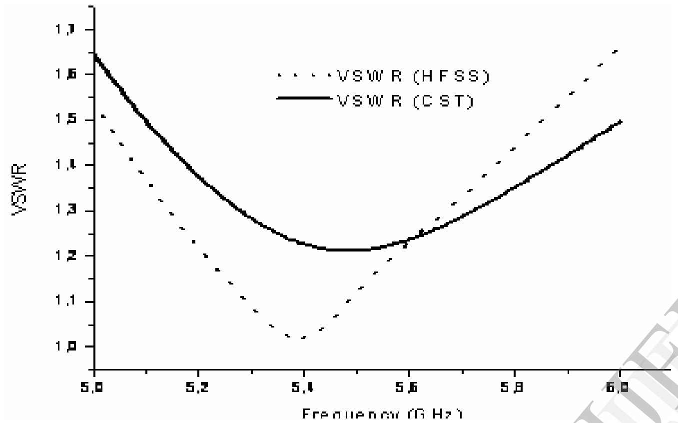

Fig. 4: VSWR Vs Frequency of Reference Antenna

Fig. 3 shows the simulated return loss of the rectangular slotted patch antenna. It is found that the proposed antenna gives a bandwidth for S11<-10dB, of 4.8 to 6.2 GHz. (HFSS) and 4.8 to 6.5 GHz (CST), which covers the entire 5-6 GHz band. Good agreement is obtained between HFSS and CST results. The return loss in case of Hfss is -35 db for the operating frequency 4.8 GHz and in case of CST the result is -20dB for frequency 4.8GHz.

The designed antenna satisfies the voltage standing wave ratio requirement of loss than 2.0 in the frequency range between 5-6 GHz that is shown in figure 4.

The return loss of the proposed antenna is very deep and had a very low value. The return loss is shown in figure 5.

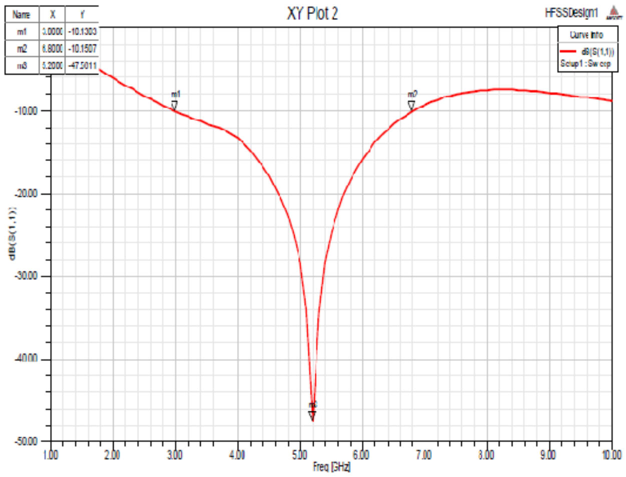

Fig.5: Simulated Result in HFSS

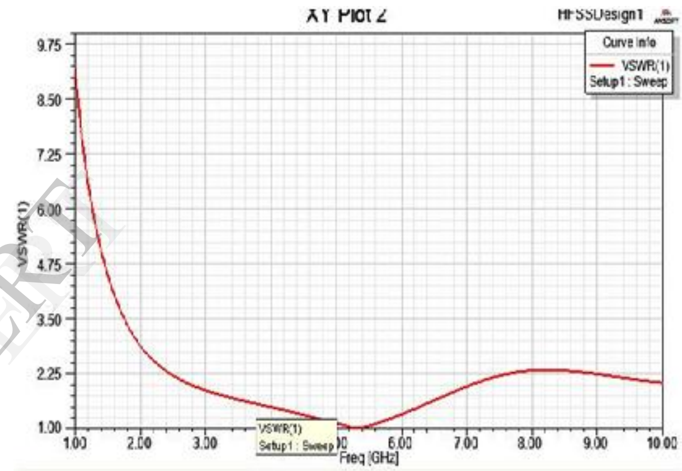

Fig.6: VSWR of Proposed Antenna.

Table 3: VSWR Vs Frequency.

Sr.No.	Frequency	Voltage Standing Wave Ratio
1	4.7	1.915
2	4.8	1.64
3	4.9	1.358
4	5	1.061
5	5.1	0.752

6	5.2	0.43
7	5.3	0.151
8	5.4	0.298
9	5.5	0.640
10	5.6	1.00
11	5.7	1.374
12	5.8	1.752

The Return loss or VSWR is good when the curve has a deep and wide dip, which shows the antenna with good bandwidth. Consequently, the narrower the dip is, the bigger the risk that desired channels would be also reflected away. The proposed antenna is showing acceptable return loss over the entire range in the figure 5. The return loss of -47.56dB is obtained at 5.2GHz respectively.

The performance of the antenna is good that is perfect impedance matching is achieved when the return loss is less than -10 dB. Figure 5 shows the resonance frequencies for the simulation result drop at 5.2 GHz is implemented. The value of the return loss at this frequency is -47.64 dB respectively. The bandwidth of the proposed antenna is 3.8GHz that lies between the frequencies ranging from 3GHz to 6.8GHz. The resonance frequencies can be varied by changing the dimensions of the patch.

V. CONCLUSION AND FUTURE SCOPE

A wideband microstrip antenna with U-slot having finite ground implemented is proposed with the return loss and VSWR of antenna is shown in the result. As it is analyse from the result that it is showing good characteristics to work for many wireless communication applications and it is much better than the reference antenna in study of return loss and VSWR. It is offering return loss to be less than -10 dB for frequency 5.2GHz so support many wireless applications. It also offers wide bandwidth having value 3.8 GHz and VSWR is also less than 2. As it is microstrip antenna its size is small. So requirements for wideband support and small size are met with the proposed antenna.

There are many possibilities for future work on this topic. The antenna was reconfigured for a single frequency using U-slot with finite ground plane however using more cuts in the patch and also implementing switch combinations more frequencies can be tried and achieved.

- Future work that can be done on this work includes:
- Increasing the bandwidth of operation with increased return losses.
- The fabrication of the design in which the RF MEMS switches are designed on the same substrate.

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