# Design of dual band Flexible Microstrip Patch Antenna for WLAN/X-band applications

Pendli Pradeep[1] P.Sri Harsha[2], S.Kusuma Tejaswini[3], B.Sreni[4]
Assistant Professor[1], UG students[2,3,4]
Electronics and communication engineering, Sreenidhi Institute of Science Technology, Yamnampet, Ghatkesar, Hyderabad, Telangana501 301, India

***Abstract*—** In this paper, a dual band flexible patch antenna presented for WLAN and X-band applications. The proposed antenna consists of truncated rectangular patch and defected ground structure. A 50 ohm microstrip line is used to feed the antenna. The size of proposed antenna is 25mm x 25mm. polyethylene terephthalate (PET) substrate is used in this design with relative permittivity value 3, loss tangent 0.008 and thickness is 0.14mm. The antenna design and simulation carried out by ansys HFSS which is based on Finite Element Method (FEM). The proposed flexible antenna operates at 2.45 GHz and 11.3 GHz with high gains 6.2 dB and 6 dB respectively. The bandwidth covers 2.4 GHz to 2.5 GHz for WLAN applications and 10 GHz to 11.6 GHz for X-band applications. The proposed thin and flexible antenna shows stable characteristics and which is suitable for WLAN and X-band applications

Keywords- Flexible patch antenna, Microstrip patch antenna, rigid structure, substrate, Microstrip line, Poly ethylene terephthalate (PET), High Frequency Structure Simulator (HFSS).

## I. INTRODUCTION

An antenna is a crucial device which is used for communication purposes for transmitting and receiving signals through different mediums like air, vacuum etc, WLAN (wireless local area network) is a widespread technology in the present world. It is considered to be a low cost and reliable approach for high speed data connectivity. The antenna proposed in this paper is a flexible microstrip patch antenna which is simple to design and fabricate. These antennas are light in weight, ultra-thin and occupy very low space so it is easy to carry and easy to install. The proposed design consists of a substrate named polyethylene terephthalate (PET) upon which a conducting layer (patch) and below it a ground is introduced or fabricated. These flexible antennas are very useful in wireless applications like WLAN and X-band implementations and have a high efficiency. The frequency range covered is 2.4-2.5Ghz for WLAN and 10-11.6GHz X-band applications. In previous works the substrates used are polyimide [2], liquid crystal polymer (LCP), polyethylene terephthalate (PET), textile, dielectric liquid. Among all these we considered PET because of its low loss tangent value of 0.008.

In paper [1], describes about the design of two ultra-thin flexible printed monopole antennas. One antenna is a single band antenna which operates at 2.4GHz frequency and the other is a dual band antenna which operates at 2.5GHz and 5.2GHz. The substrate used is Kapton polyimide substrate. In paper [2], presented a novel approach of designing a UWB antenna which is printed on a 70 micrometer thick polyimide substrate .Unequal height ground planes and CPW feeding are used to increase the bandwidth of the antenna. It is observed that good bandwidth is found when the antenna is flat or bent in shape. In this paper [3], a natural rubber substrate is used for flexibility of the antenna. The antenna was observed to be of a dumbbell shape for even current distribution. A minimum return loss of -30dB was observed. In this paper [4], a 3-D printed flexible MPA using a tile array substrate was designed using 2 kinds of materials to utilize the advantages of both types. The first material was NinjaFlex, it has amazing flexible and mechanical properties and the second one is ABS, it has optimal RF properties. This paper [5], introduces a simple rectangular patch antenna with tiny slots on the patch and negligible substrate thickness to get max gain and it works at a frequency of 2.4GHz. It has a high efficiency for transmission and reception of signals. Observed min return loss is -12.5dB. This paper [6], gives a detailed study about different substrates which can be used for flexible patch antennas and their properties. It even gives a detailed explanation of fabrication techniques which are used in the past and present, and even which can be used in the future. In this paper [7], a flexible antenna with rubber substrate and a defected ground structure (DGS) design was explained. It is used for WBAN applications. Because of the use of DGS a 7.5% increment in gain was observed. This paper [8], uses Teflon and PTFE glass as the flexible substrate as they tend to forcibly retract to its original dimensions after deformation. These antennas designed using different substrates are adequate to be applied for medical, wearable and wireless applications. About Omnidirectional pattern is discussed in paper [9]. The effect of slot antenna discussed in paper [10] and paper [11] presents X-band applications.

In Section II, presents the detail explanation of proposed flexible antenna design, its geometry and working. In section III, gives detail discussion about antenna parameters like return loss and radiation characteristics and performance of the dual band flexible antennas. Finally conclusion is given in section IV followed by acknowledgement and references.

## II. PROPOSED FLEXIBLE ANTENNADESIGN AND GEOMETRY

The proposed flexible dualband antenna consists of truncated rectangular patch and defected ground structure is shown in figure1 and figure2. The antenna design and simulation carried out by ansys HFSS which is based on Finite Element Method (FEM). A 50 ohm microstrip line is used to feed the antenna. The size of proposed antenna is 25mm x 25mm. polyethylene terephthalate (PET) substrate is used in this design with relative permittivity value 3, loss tangent 0.008 and thickness is 0.14mm. The proposed antenna is suitable for the 2.45 GHz WLAN band and 11.3 GHz X-band applications. The defected ground structure controls the impedance matching and truncated edges of the rectangular patch antenna controls the resonant frequency and bandwidth of the antenna.

To resonate the proposed antenna a two resonant frequencies the dimensions are used as W=25mm, L=25mm, Lf=8.5mm, Wf=2.5mm, Ws=23mm, Ls=16.5mm, L1=11mm, L2=6mm, L3=3.5mm, L4=4mm, L5=2.5mm, L6=2mm, L7=6.5mm, L8=8.5mm, L9=3mm, L10=6.5mm and L11=9mm.

The proposed antenna consist of simple structure and easy to design and fabricate with PET flexible substrate.

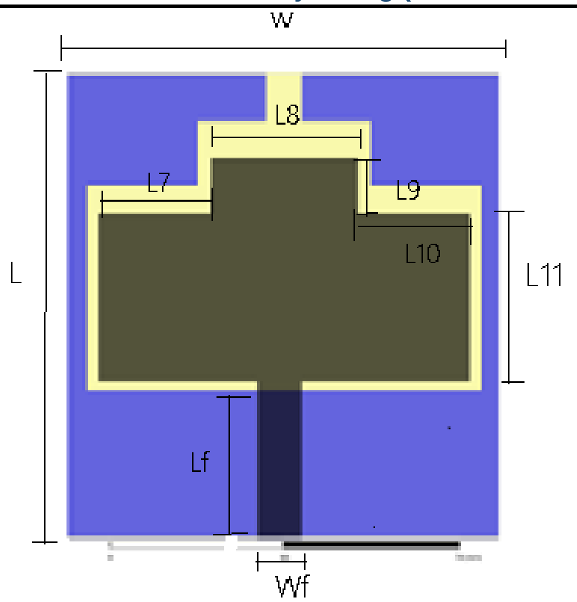


FIG.1. PROPOSED FLEXIBLE PATCH ANTENNA FRONT VIEW

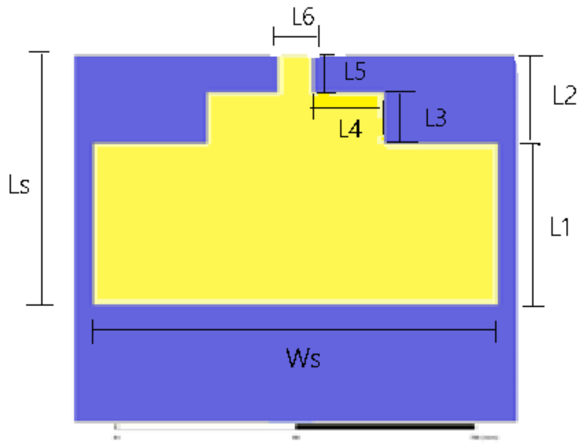


FIG.2. PROPOSED FLEXIBLE PATCH ANTENNA BACK VIEW

## III. RESULTS AND DISCUSSION

The antenna design and simulation carried out by ansys HFSS which is based on Finite Element Method (FEM). The proposed antenna parameters shows the stable antenna parameters at dual bands. The simulated return loss for the antenna is -20 dB at 2.45 GHz, with a -10 dB bandwidth of 100 MHz at one band and -25.5 dB at 11.3 GHz, with a -10 dB bandwidth of 1.64 GHz at other band. The radiating elements are assigned as Perfect Electric Conductors in this design. The return loss plot of the proposed antenna is shown in figure.3

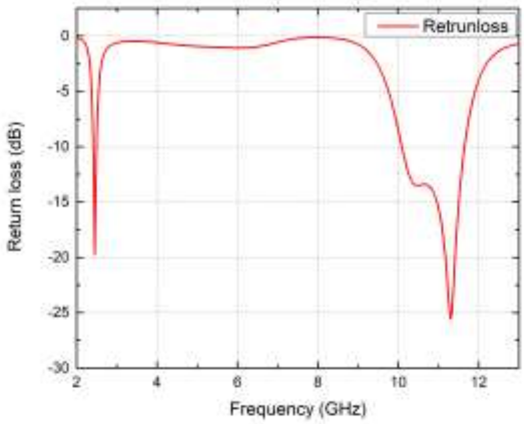


**FIG.3.** S11 Vs FREQUENCY PLOT

The figure.4 shows 2D radiation pattern in elevation plane (E-plane) and azimuthal plane (H-plane) in far field region. This result shows the total radiation power is almost omni-directional pattern. The antenna achieved a gain of 6.2 dB at 2.45 GHz.

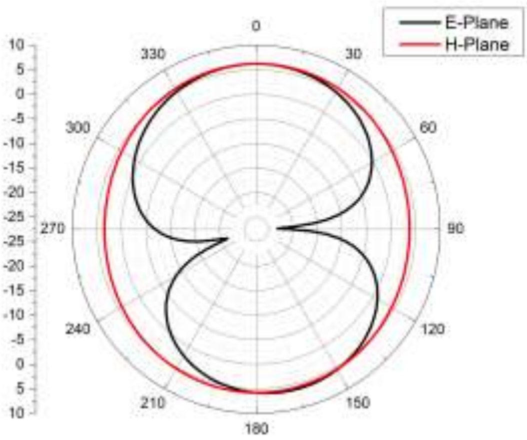


**FIG.4.** RADIATION PATTERN PLOT AT 2.45GHz

The figure.5 shows 2D radiation pattern in elevation plane (E-plane) and azimuthal plane (H-plane) in far field region. This result shows the total radiation power is almost omni-directional pattern except in some other directions. The antenna achieved a gain of 6 dB at 11.3 GHz.

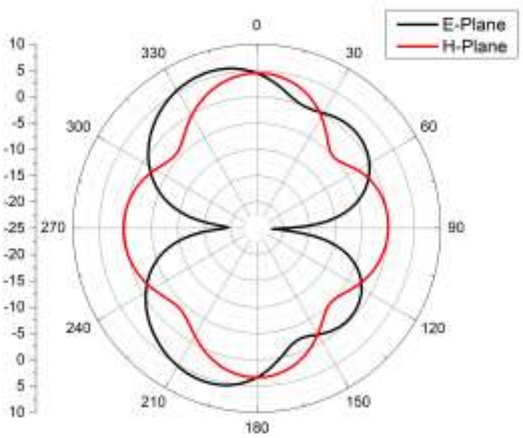


**FIG.5.** RADIATION PATTERN PLOT AT 2.45GHz

The proposed dualband flexible antenna shows sufficient antenna characteristics at WLAN and X-band applications. The important characteristics of proposed dual band flexible antenna shown in table.1.

TABLE NO.1 ANTENNA CHARACTERISTICS

| Frequency(GHz) | $S_{11}$(dB) | Gain(dB) | Bandwidth (MHz) |
|---|---|---|---|
| 2.45 | -20 | 6.2 | 100 |
| 11.3 | -25.5 | 6 | 1640 |

## IV. CONCLUSION

A dual band flexible patch antenna presented for WLAN and X-band applications with truncated rectangular patch and defected ground structure polyethylene terephthalate (PET) substrate is used in this design with relative permittivity value 3, loss tangent 0.008 and thickness is 0.14mm. The antenna design and simulation carried out by ansys HFSS which is based on Finite Element Method (FEM). The proposed dual band flexible antenna operates at 2.45 GHz and 11.3 GHz with high gains 6.2 dB and 6 dB respectively. The bandwidth obtained 100 MHz for WLAN applications at 2.45 GHz and 1.64 GHz for X-band applications at 11.3 GHz. The proposed thin and flexible antenna shows stable characteristics and which is suitable for WLAN and X-band applications

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