A Connected E-Shape and U-Shape Dual-Band Patch Antenna for Different Wireless Applications

Md. Mahabub Alam[1] , Md. Suaibur Rahman[2]

Abstract—In this paper, dual operation E-shape and U-shape Patch Antenna feed by transmission line is presented and study the effect of antenna dimensions length (L), width (W) and substrate parameters relative dielectric constant(Er), substrate thickness on radiation parameters of Band width. The proposed antenna is designed on two-layer, one RT/Duroid 6006 laminate substrate and another ground plane with an area of 33 mm by 42 mm. This paper contains designing a Connected E-Shape and U-Shape Dual Band Patch Antenna for different wireless applications except for its narrow band width. The dual operation frequencies are 2.46 GHz and 4.9 GHz. A (-8 dB) bandwidths of return loss S characteristic for the dual band are 13.02 % and 3.28 % respectively. This connected U-shape & E-shape patch antenna is mainly applicable to wireless local area net-works (WLAN).This paper suggests an alternative approach in enhancing the band width of microstrip antenna for the wireless application operating at a dual frequencies 2.46 GHz and 4.9 GHz. The measured results have been compared with the simulated results using software GEMS version-7.0.

Index Terms— E-shape, U-shape, Dual-Band, Patch Antenna, WLAN, Radiation pattern, Laminate, Bandwidth.

1 INTRODUCTION

Stucture of U-shape & E-shape Design microstrip patch antennas have been developed in the past for broadband applications, including 2GHz wireless communication systems[1][2].Recently, authors investigated the application of the connected U-shape & E-shape Design patch antenna to wireless local area net-works (WLAN) operating in the 2.40-2.48 GHz & 5–6 GHz[3] and successfully developed several antennas suitable for high-speed (IEEE 802.11a,54 Mb/s)WLANs and other similar wireless communication systems[4] and satellite band operating in 3.4-4.8GHz[13-14].UWB communication systems use the 3.1-10.6 GHz frequency band, which includes the IEEE 802.11a frequency band(5.15–5.825GHz). A multi U-slot Patch antenna has been reported recently for 5 GHz WLAN [16].Narrow bandwidth in microstrip patch antenna is a disadvantage; However, in recent year, researches have offered several new microstrip patch configurations to increase the bandwidth of the microstrip antenna. These include increasing patch height over ground plane, using a lower permittivity, multilayer. Structure consisting of several parasitic radiating elements with different size above the driven element a stacked patch antenna resulting in a thicker antenna structure [15] also there has been many active research on printed antennas in different shapes. Many designs of single and dual band microstrip patch antenna with triangular, square and circular using E-slots and U-slots have been reported [5-10] also H-shape Patch antenna has been reported in [11,12].

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In this paper, a connected microstrip E-shape and U-shape patch antenna has been designed with over all dimensions 33mm x 42 mm and height of 1.1 mm. A parametric study on the structure is made in-order to obtain the best possible size and position of the connector. Simulation results based on a

2 ANTENNA DESIGN & STRUCTURE

In this paper several parameters have been investigated using GEMS (General Electromagnetic Solver) version 7.
The design specifications for the proposed antenna are:

- The dielectric material selected for the design is RT/Duroid 6006 laminate.
- Dielectric constant 6.15
- Height of substrate (h) = 1.1 mm.

The antenna is fed by 50Ω microstrip line, through a quarter-wavelength transformer for impedance matching. The main advantage of using transmission line feeding is very easy to fabricate and simple to match by controlling the inset position and relatively simple to model. The proposed antenna has one

TABLE I
DIMENSIONS OF THE PROPOSED ANTENNA (UNIT: mm)

L	W	L_h	W_h	L_n
42	33	4	3.5	5
W_n	L_m	W_m	W_c	L_c
20	8	2	5	23

U-shape and one E-shape and one bridge to connect both shape as shown in Fig.1and detail dimensions is given in Table-I Proposed antenna generates dual bands at 2.46 GHz and 4.9 GHz with simulated impedence bandwidth of 13.02% and 3.28%.

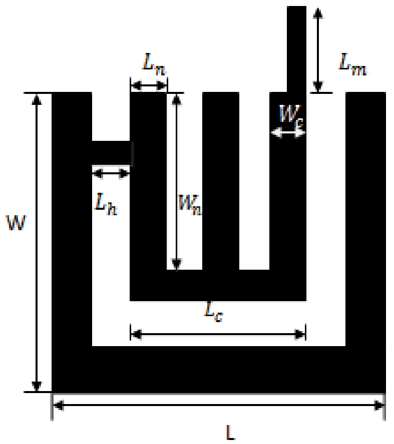

Fig.1: Structure of U-shape & E-shape Design

3. Antenna Design Procedure

This section describes the approach of designing a patch antenna using connected set of U-slot and E-slot techniques to adapt the structure to the desired interest operating frequency. The proposed antenna consists of a ground plane, a printed patch and a microstrip feeding line. The most important parameters that affect the antenna performance, such as impedance bandwidth, gain and efficiency are described in this section.

Moreover, the rapid development in the field of Land Mobile Telephony as well as in the field of Wireless Local Area Networks (WLANs) demands devices capable to operate in more than one frequency bands. So a printed antenna is designed-with intend to conform to multiple communications protocols, for example the IEEE 802.11b/g, in the band 2.5 GHz.

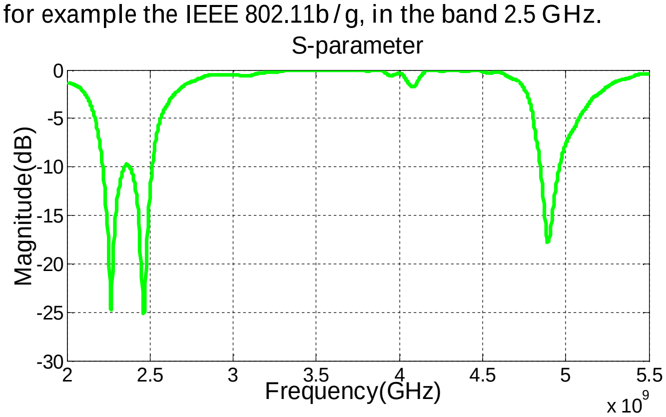

Fig.2: Return loss Simulation result of E-Shape & U-Shape Design

A connected microstrip E-shape and U-shape patch antenna has been designed with over all dimensions 33mm x 42 mm and height of 1.1 mm. Dual operation E-shape and U-shape Patch Antenna feed by transmission line is presented. In the following Fig.2 we analysis the return loss and then analysis the improved bandwidth using this connected set of E-shape & U-shape.

3.1 The Effect of Changing Width (W_h)

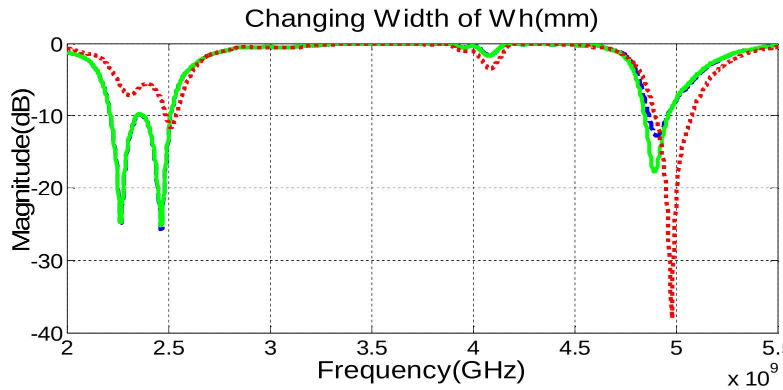

Fig.3: The variation of the (W_h) parameter on the return loss response

TABLE II

Bridge Width(W_h)	Return loss	Magnitude(dB)
2.5mm	2.462 GHz & 4.9GHz	-25.7dB&-12.77dB
3.5mm	2.464 GHz & 4.9GHz	-25.19 dB & -17.78 dB
4.5mm	2.516 GHz & 4.875 GHz	-11.64 dB & -38.06 dB

Fig.3 shows the simulation results of the E-shape and U-shape based on the variations value of W_h. When we use width of the bridge 3.5 mm then bandwidth will increase but returnloss will decrease. As resultant returnloss magnitude of the 3.5mm width is higher than the 2.5mm width.Therefore choosing the width of 3.5 mm will give the best response.

3.2 The Effect of Substrate height (h)

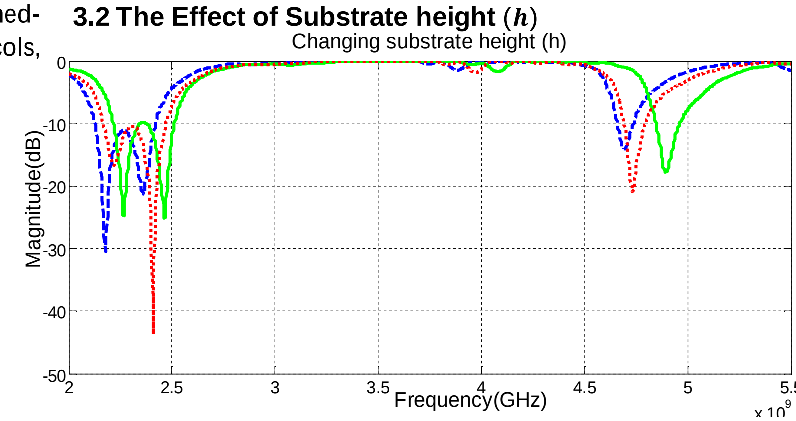

Fig.4: The variation of the of substrate height (h) on the return loss response

TABLE III

Substrate height(h)	Return loss	Magnitude(dB)
1mm	2.3 GHz & 4.693 GHz	-30.52 dB & -14.05 dB
1.1mm	2.464 GHz & 4.9GHz	-25.19 dB & -17.78 dB
1.2mm	2.41 GHz & 4.734 GHz	-43.64 dB & -20.9 dB

Fig.4 shows the simulation results of the E-shape and U-shape based on the variations value of substrate height (h). It is clear from the figure that the magnitude of return loss will increase for the values of the substrate height 1, 1.1&1.2.

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But if Substrate height (h) is 1.1 mm then bandwidth will increase not only for 2.46GHz but also for 4.9 GHz.So, choosing the value of the substrate height of 1.1mm will give the best response.

3.3 The Effect of changing position of the Width (W_h)

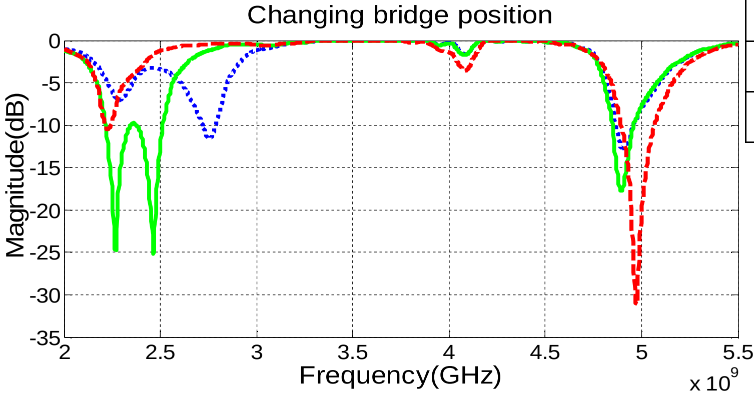

Fig.5: The variation of the position of the width (W_h) on the return loss response

TABLE IV

Position of the width	Return Loss	Magnitude(dB)
Y=16mm	2.751 GHz & 4.9 GHz	-11.64 dB&-12.96 dB
Y=17mm	2.464 GHz & 4.9 GHz	-25.19 dB & -17.78 dB
Y=18mm	2.228 GHz & 4.973 GHz	-10.54 dB &-31.16 dB

Fig.5 shows the simulation results of the E-shape and U-shape based on the variations of the position of the width (W_h). It is clear from the figure that the position of the width is y=17mm then bandwidth will increase but returnloss will decrease.So, choosing the value of the position of the width of y=17mm will give the best response.

3.4 The Effect of Changing of substrate dielectric constant (ε_r)

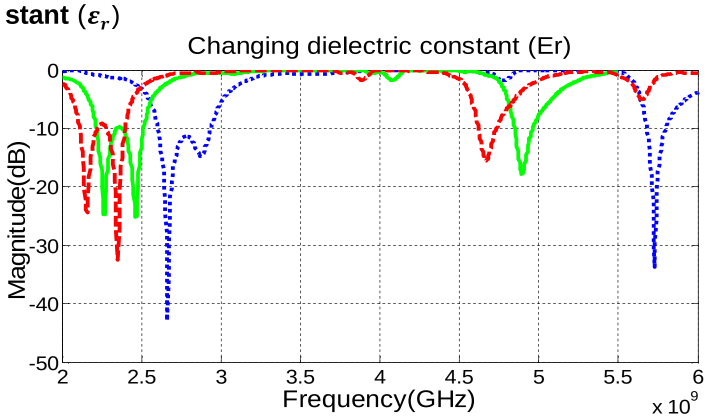

Fig.6: The variation of the of substrate dielectric constant (ϵ_r) on the return loss response

Fig.6 shows the simulation results of the E-shape and U-shape based on the variations value of substrate dielectric constant (ϵ_r). Here choosing the value of dielectric constant 6.15 then impedance bandwidth is increased for both 2.46 GHz and 4.9 GHz.So, choosing the dielectric constant of 6.15 will give the exact response.

TABLE V

Dielectric Constant(Er)	Return loss	Magnitude
4.4	2.664GHz& 5.728GHz	-42.87 dB & -33.7 dB
6.15	2.464 GHz & 4.9GHz	-25.19 dB & -17.78 dB
6.8	2.3 GHz & 4.668GHz	-32.41 dB &-15.46 dB

4. RADIATION PATTERN

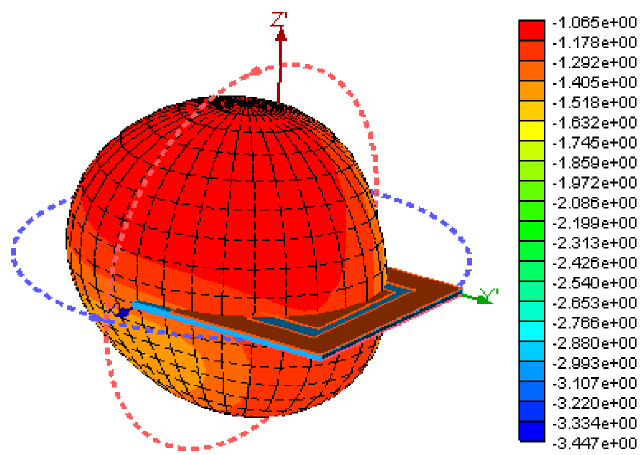

Fig.7: Gain at 2.46 GHz in 3D view

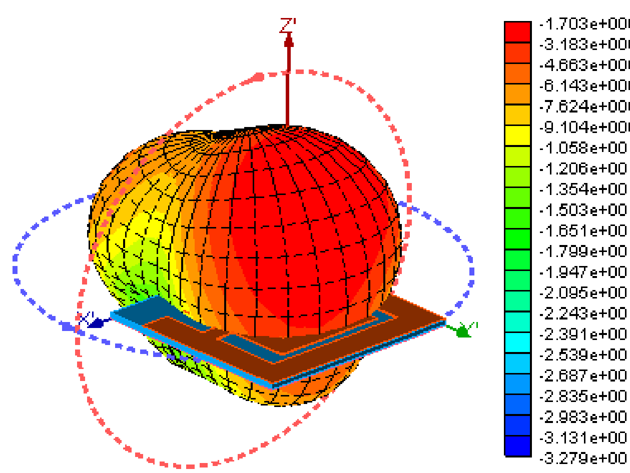

Fig.8: Gain at 4.9 GHz in 3D view

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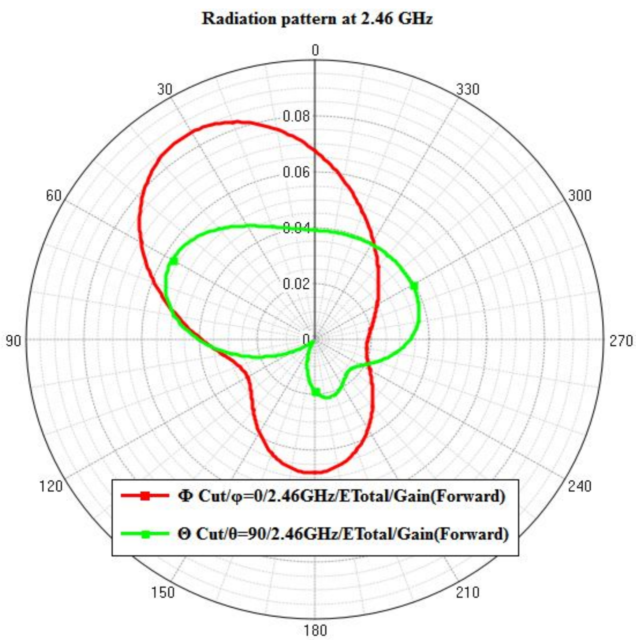

Fig.9: E-plane and H-plane at 2.46 GHz

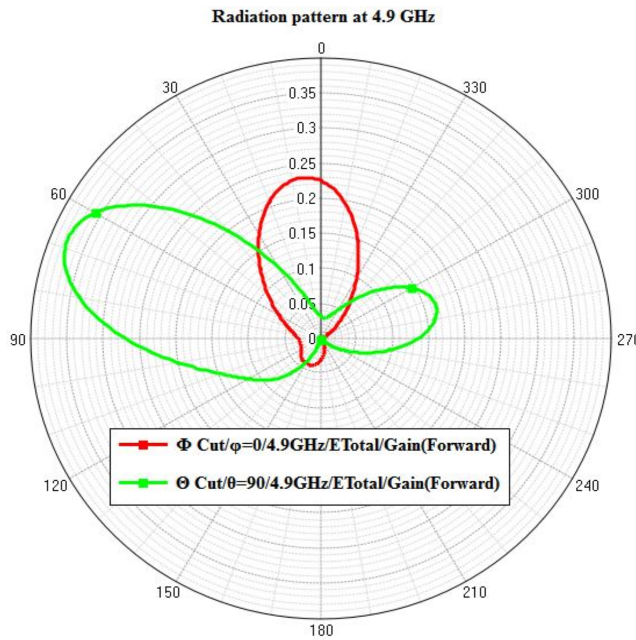

Fig.10: E-plane and H-plane at 4.9 GHz

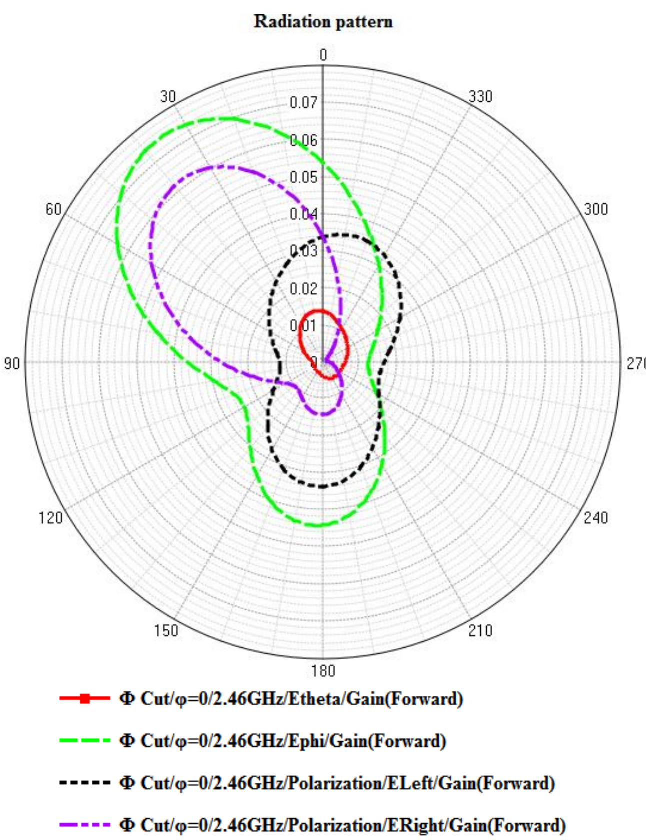

Fig.11: Elevation Pattern of E Right, E left, E theta, E Phi at 2.46 GHz for phi=0 (deg)

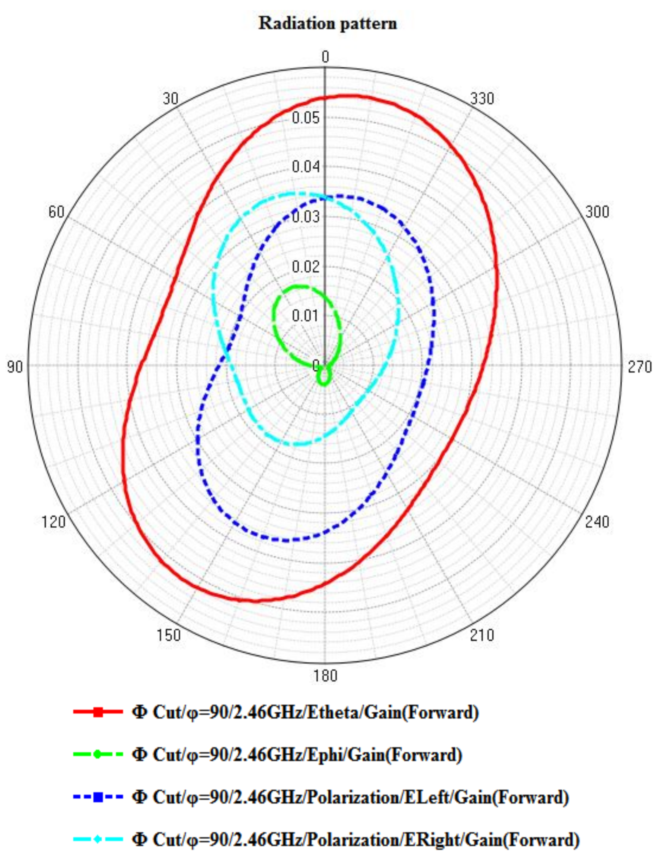

Fig.12: Elevation Pattern of E Right, E left, E theta, E Phi at 2.46 GHz for phi=90 (deg)

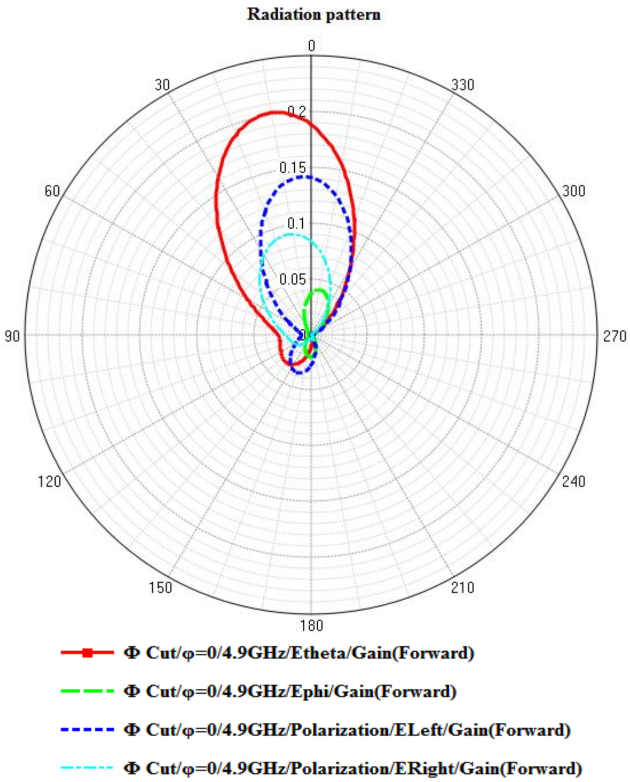

Fig.13: Elevation Pattern of E Right, E left, E theta, E Phi at 4.9GHz for phi=0 (deg)

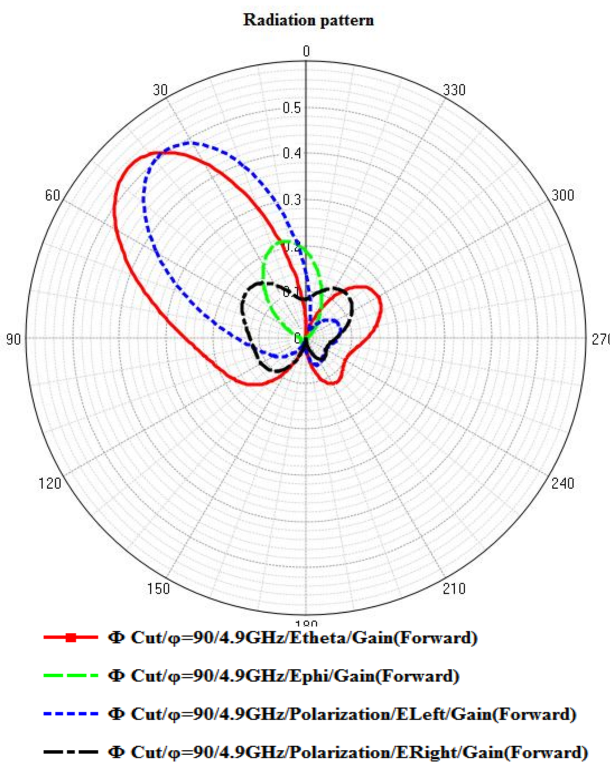

Fig.14: Elevation Pattern of E Right, E left, E theta, E Phi at 4.9 GHz for phi=90 (deg)

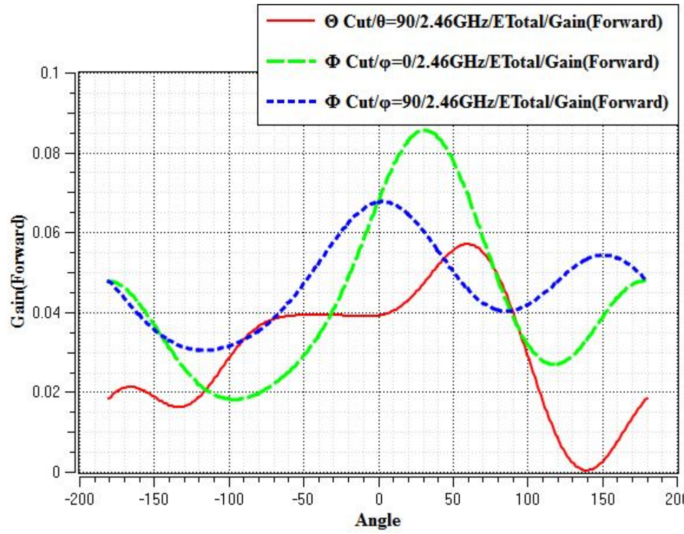

Fig.15: Simulated gain in 2D view of connected e-shape and u-shape at 2.46 GHz

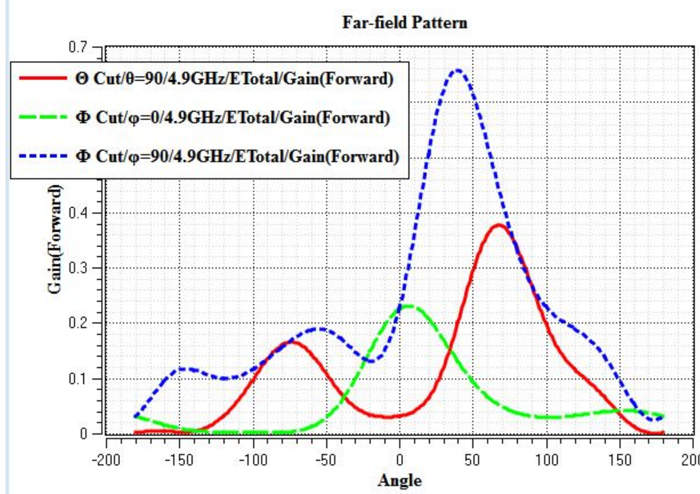

Fig.16: Simulated gain in 2D view of connected E-shape and U-shape at 4.9 GHz

5. CONCLUSION

Connected E-shape and U-shape patch antenna is investigated and successfully simulated in this paper, the simulated return loss and the radiation pattern showed well performance for the dual band at 2.46 GHz and 4.9 GHz, the impedance bandwidths for the dual band are 13.02 % and 3.28 %. The design shows suitable characteristic for dual-band operations. Using this Connected E-shape and U-shape patch antenna, bandwidth can be improved at two different frequencies at 2.46 GHz and 4.9 GHz for different wireless LAN application. It can be concluded from the above results that, designing a proper feed network and impedance matching are very important parameters in microstrip patch antenna design. Also choosing a proper position for terminating the feed line affects the overall performance of the antenna. Different types of feed methods affect the performance of an antenna.

In this paper, microstrip line feed is chosen. In the future study we would like to look at how other types of feed network will affect the performance of microstrip antennas as compared to the microstrip line feed. In this paper bandwidth is not too much at 4.9 GHz.The performance of bandwidth will be increased by using Proximity Coupled Feed.

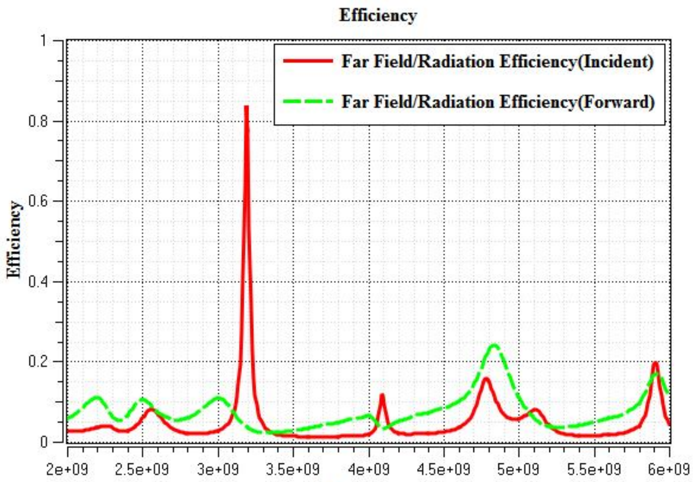

Fig.14: Radiation efficiency of connected E-shape and U-shape MSA

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