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Design and Fabrication of CPW fed Dual band antenna for WiMAX and WLAN applications

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Abstract*: A Coplanar Waveguide (CPW) fed patch antenna is proposed for dual band operation. The 50 Ω CPW transmission line of width 3mm is used to excite patch. The ground plane, fed line and radiating patch are on one side of FR4 substrate. The dielectric constant and thickness of FR4 substrate are 4.4 and 1.6mm respectively. The proposed antenna has dimensions of 50x50mm^2.The proposed antenna generates two frequency bands one in 3.28GHz -3.73GHz with bandwidth of 450 MHz and second band in 5.54GHz – 5.94GHz with bandwidth of 400 MHz . The first frequency band is suitable for WiMAX (Worldwide Interoperability for microwave access) and second frequency band is suitable for WLAN (wireless local area network).The proposed antenna generates same frequency bands with improved return loss when triangular slot is created in patch. The proposed antenna is simulated using High Frequency structure Simulator (HFSS).Simulated and measured results shows good agreement with each other.

Keywords*: Coplanar Waveguide, Dual band, WLAN, WiMAX, HFSS

I. INTRODUCTION

Recently antenna with multiband operation is very popular to support various modern wireless communication systems [1].For these reason multiband antennas are designed with various configurations [2].Many applications in wireless communication, such as WLAN (Wireless Local Area Network), require dual or multi-frequency operation that meets the standards of 2.4GHz/5.2GHz/5.8GHz [3] and the World Interoperability for Microwave Access (WiMax) operating at 3.5GHz WiMAX IEEE 802.16 (3.4–3.6 GHz) [4].Many techniques have been developed to achieve dual band operations. In [5] dual band operation is achieved by including U slot and fork like structure. Dual band can be obtained with patch having S shape slot [6], CPW fed rectangular patch with two slots [7], circular ring patch [8], circular patch with shorting pin [9].

The proposed antenna comprises of rectangular patch with two vertical slots on both sides of patch which gives dual band operation. The substrate used is FR4 having dielectric constant of 4.4 and thickness of 1.6mm. The proposed antenna is fed by coplanar waveguide. There is a triangular slot in patch to improve return loss of dual band operation. Simple structure, light weight and low cost are main advantages of proposed antenna. The proposed CPW fed dual band antenna generates two frequency bands one is 3.28GHz -3.73GHz and second is 5.54GHz – 5.94GHz. The proposed antenna has percentage impedance bandwidth of 45% for first band and 40% for second band.

II. ANTENNA DESIGN

This section introduces the design of the proposed antenna. First the rectangular patch antenna is designed based on the design equation. The antenna is fed with inset feed transmission line. Material used for proposed antenna is FR4 having thickness 1.6 mm and dielectric constant of 4.4 [5]-[6]. Figure 1 shows the simulated and fabricated CPW fed dual band antenna structure. The proposed antenna is designed on commercially available FR4 substrate. Substrate has length and width of 50x50mm^2 with thickness of 1.6mm, loss tangent 0.025 and dielectric constant 4.4. Pentagonal cut is created in ground plane. Rectangular patch is placed over pentagonal cut.

There is triangular slot in patch. The proposed antenna consists of following design parameters: Substrate length L=50mm, substrate width W=50mm, l1=13mm, w1=4.12mm, l2=19mm, w2=10mm, r1=4.17mm, feed_w =3mm, W_s=6 mm, a=15mm. A 50Ω CPW transmission line is used to feed the antenna to provide good execution over all the bands, which consists of a signal strip with width of feed_w, connected at centre with SMA (Sub-Miniature version A) connector at the end of the CPW feed line.

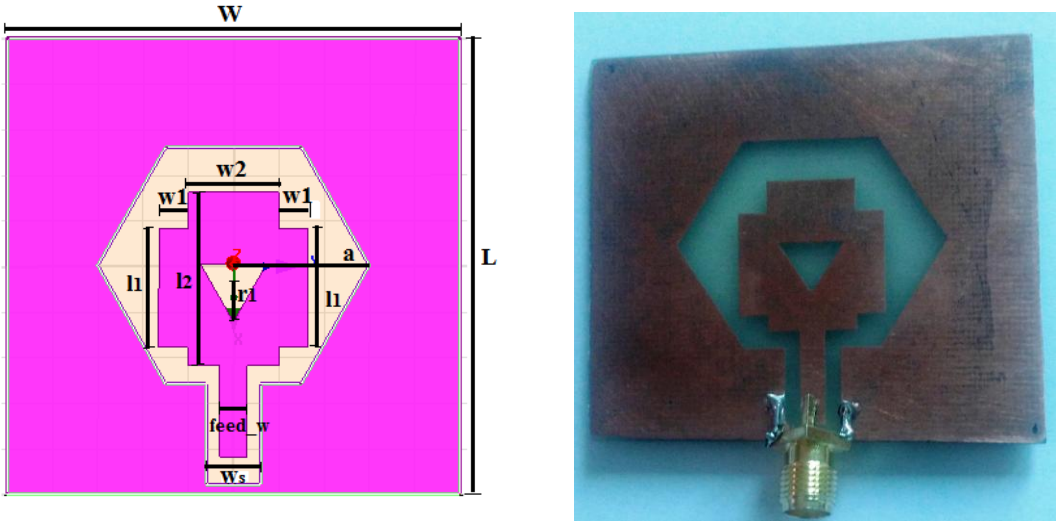

Fig.1. Simulated and Fabricated antenna.

III. PARAMETRIC STUDY

The design and optimization of proposed antenna is performed by using the simulation tool Ansoft HFSS . The effect of change in width and length of rectangular patch are simulated to see the overall effect on design. Variation in slot having length l1 and width w1 is responsible for 5.8 GHz frequency band while slot of length l2 and width w2 is responsible for frequency 3.5 GHz. Figure 2 and Figure 3 show the change in length l1 and width w1which causes change in second frequency band of 5.8 GHz as well as change in return loss. Figure 4 and Figure 5 show the change in length l2 and width w2 which causes change in first frequency band of 3.5 GHz as well as change in return loss. Figure 6 shows the effect of triangular slot created in patch. This triangular slot gives the same dual band frequencies with improved return loss.

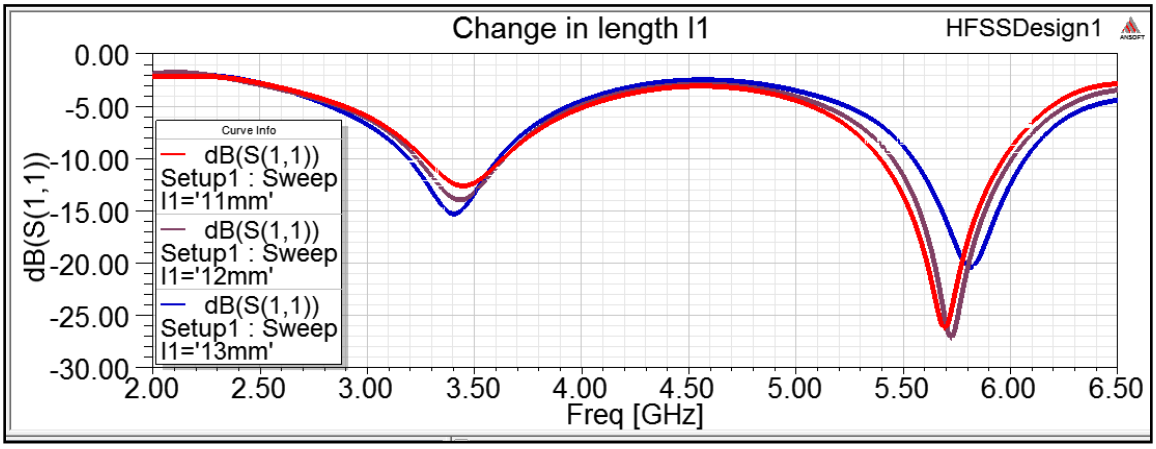

Fig.2. Simulated S_{11} for different value of length l1 with other parameters fixed.

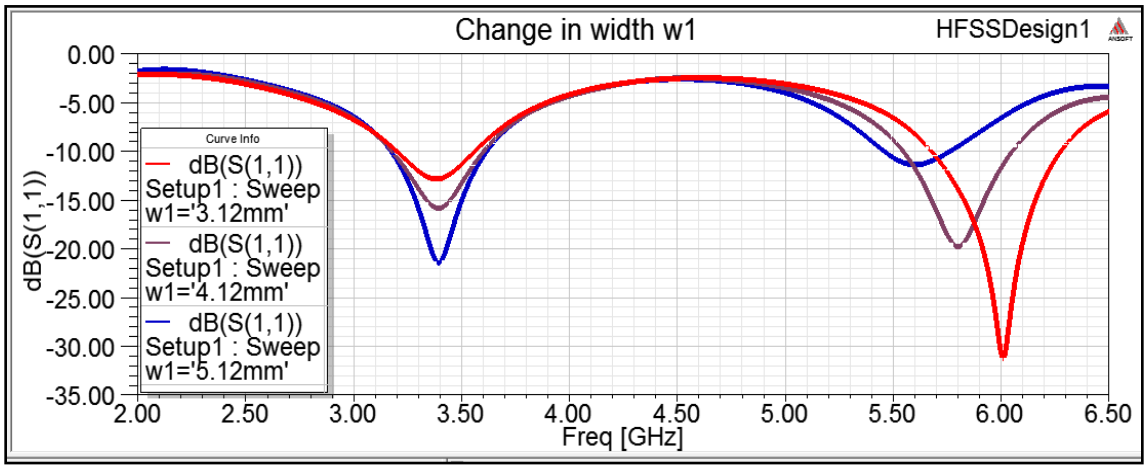

Fig.3. Simulated $S_{11}$for different value of width w1 with other parameters fixed.

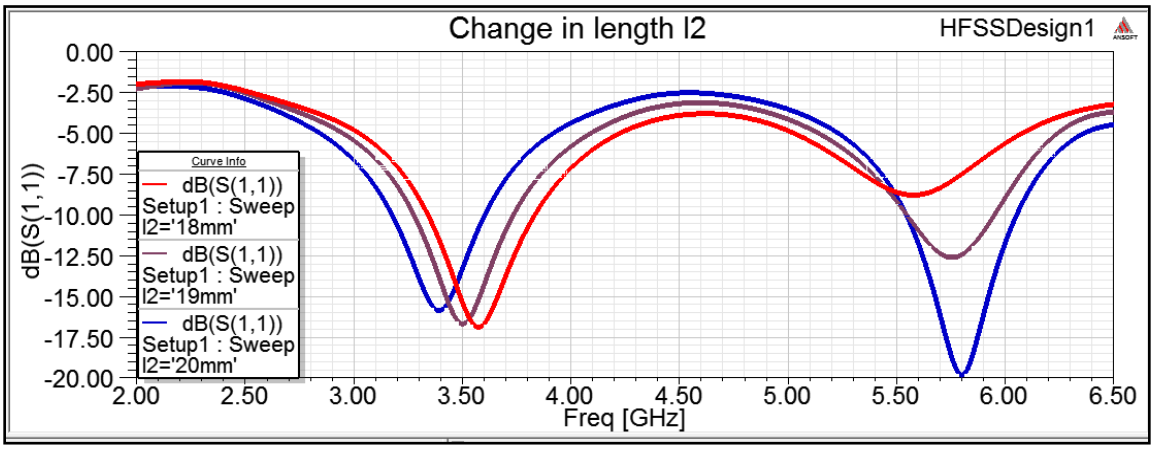

Fig.4. Simulated S_{11} for different value of length l2 with other parameters fixed.

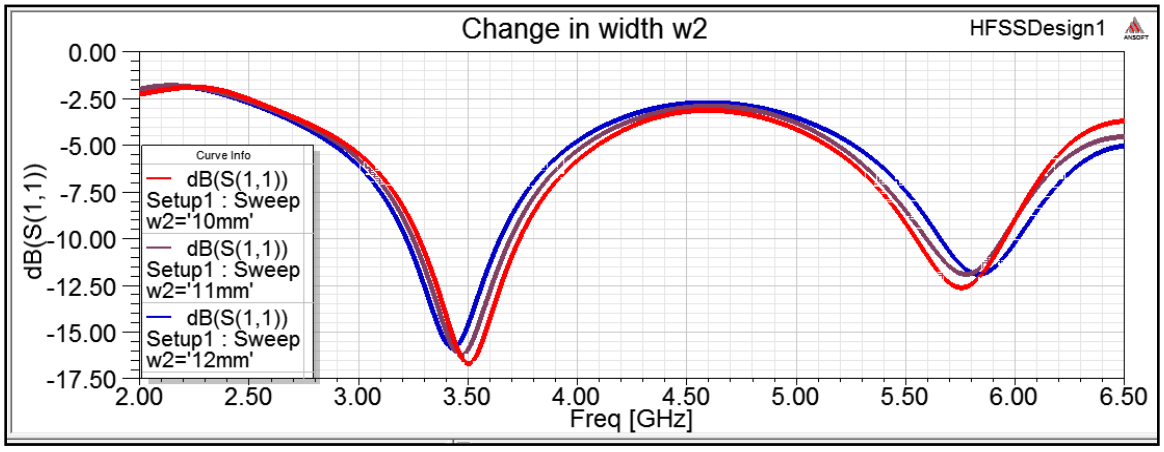

Fig.5. Simulated S_{11} for different value of width w2 with other parameters fixed.

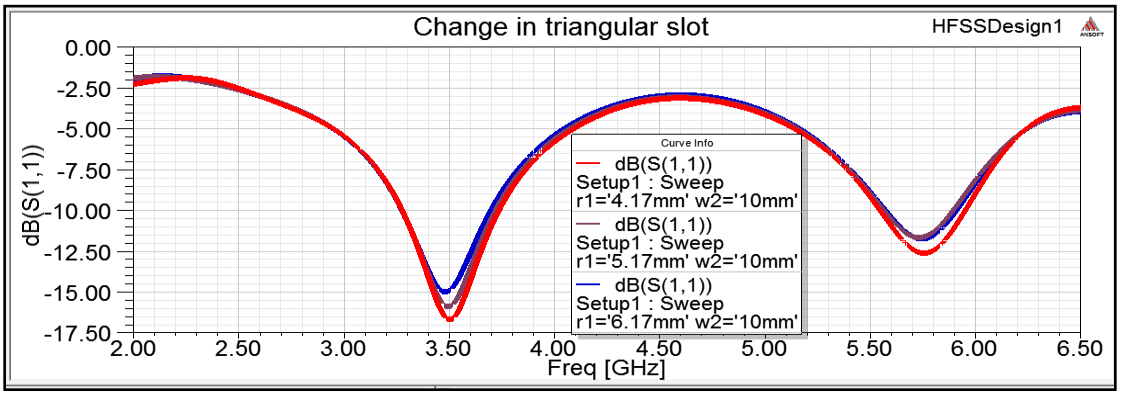

Fig.6. Simulated S_{11} for different value of triangular slot r1 with other parameters fixed.

III. MEASURED RESULT AND DISCUSSION

After the optimizing of the antenna parameters, simulated antenna design was fabricated and tested. The prototype antenna is tested using network analyzer (Agilent N9912A). A photograph of the fabricated antenna is shown in Figure. 1. The Figure 7 shows the comparison between the simulated and measured S_{11} of the proposed antenna. The measured result is having first band of 3.32GHz- 3.98GHz and second band of 5.48GHz-5.7 GHz. The measured results clearly shows that the proposed antenna provides dual bands. From Figure 7, it is clear that the simulated and measured results show a good matching. The small discrepancy is due to the fabrication tolerance. With these measurements, the proposed antenna satisfies the requirements of WLAN and WiMAX applications concurrently.

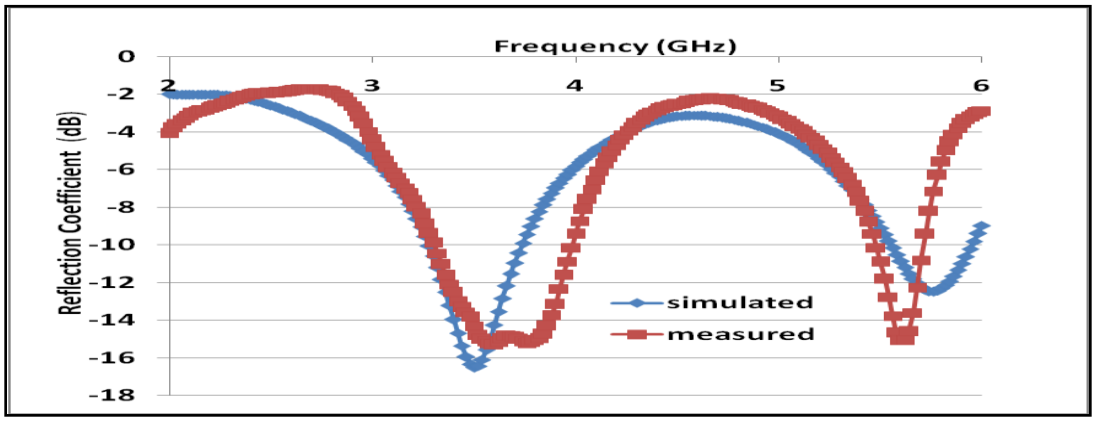

Fig.7. Simulated and measured result of S_{11}

A. Radiation Pattern

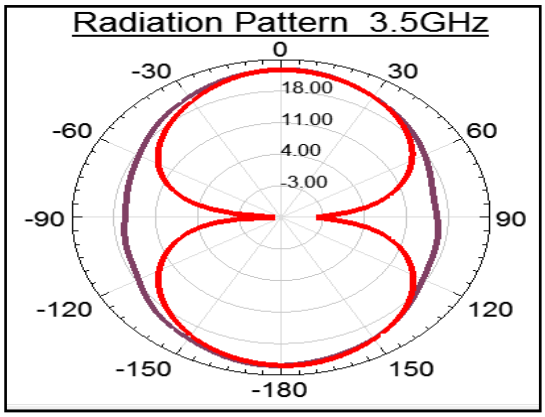

Fig.8. Simulated radiation pattern at 3.5GHz

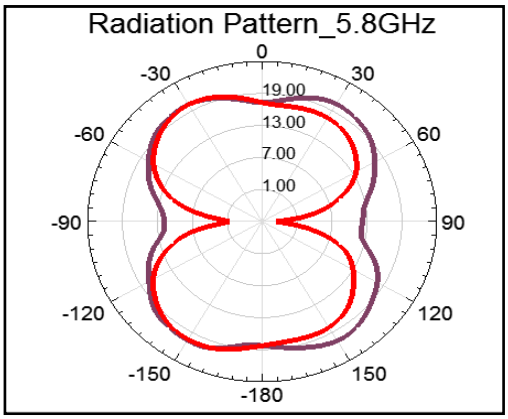

Fig.9. Simulated radiation pattern at 5.8GHz

Figure 8 and 9 shows the radiation pattern for dual band frequencies 3.5 GHz and 5.8 GHz respectively.

B. Gain

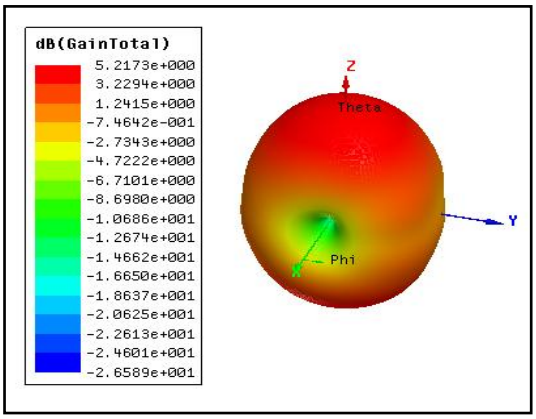

Fig.10. Simulated gain at 3.5GHz

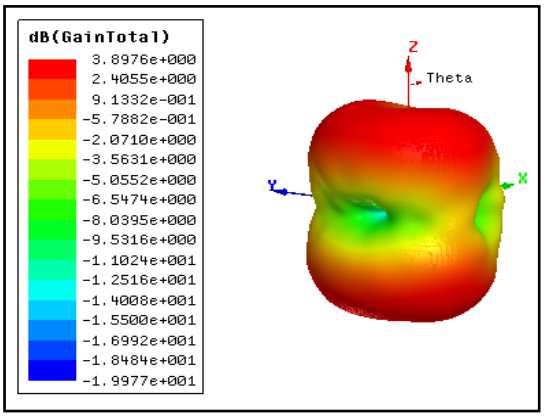

Fig.11. Simulated gain at 5.8 GHz

The measured peak gains for the dual band (Band 1andBand 2) are 5.2173 dB and 3.8976 dB respectively. The gain of the proposed antenna satisfies the need of some wireless applications.

VI. CONCLUSION

The dual band CPW fed patch antenna with triangular slot is designed and fabricated for wireless communication applications. Simulated and measured results shows that the proposed antenna can achieve desired dual bands. A good omnidirectional radiation pattern is also obtained in H-Plane. Finally two operating bands of 3.28GHz - 3.73GHz and 5.54GHz – 5.94GHz are obtained with proposed antenna which is very useful for WiMAX and WLAN applications.

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