

Multiband Circularly Polarized Microstrip Patch Antenna

Krishan Gopal Sharma

¹Institute of Technology and Management

Abstract—In this paper, Ultra wideband circular Microstrip patch antenna is proposed. Over years, great interest was focused on microstrip antennas for their small volumes, low profiles, good integration, low costs and good performance. With the continuous growth of wireless communication service and the constant miniaturization of communication equipment, there are higher and higher demands for the volume of antennas, integration and working band. This paper presents A circular polarized (CP) Circular microstrip antenna with triple band for wireless communications system application which are suitable for the 2.6-GHz, 3.7-GHz and the 5-GHz triple-band operations. These systems may include various combinations of Bluetooth, WiMAX (Worldwide Interoperability for Microwave Access) and wireless local-area network (WLAN). A circular microstrip patch antenna is designed to operate at 2.6(GHz) with circular polarization, a U slot is inserted thereafter in the original patch to generate the second resonant at 5.4 (GHz). Another C-slot is inserted thereafter to generate the 3.7 (GHz) third band. The C slot insertion effect on the original patch is examined, first arc length effect on the return loss and axial ration is examined in order to get the optimum length, and then the arc orientation effect also is examined to find out the best orientation to place the arc. This design has several advantages as the total antenna volume can be reused, and therefore the overall antenna will be compact. The design is verified through both numerical simulations and measurement of a fabricated prototype. The results confirm good performance of the single and multiband antenna design.

Keywords: Triple Band, Dual band, Circular Polarization Antenna (CPA), Circular Microstrip Patch Antenna (CMPA).

I. INTRODUCTION

Wireless communications have been developed widely and rapidly in the modern world. Especially during the last two decades. The future development of the personal communication devices will aim to provide image, speech and data communications at any time, and anywhere around the world. This indicates that the future communication terminal antennas must meet the requirements of multi-band or wideband to sufficiently cover the possible operating bands. However, the difficulty of antenna design increases when the number of operating frequency bands increases. In addition, for miniaturizing the wireless communication system, the antenna must also be small enough to be placed inside the system. However, in order to transmit and receive more information large bandwidths are required, and bandwidth enhancement is currently a popular research area. The aim of this thesis is to design a Multiband circular polarized Microstrip patch antenna for wireless

communication systems and study the effect of various antenna parameters like patch length (L), width (W), substrate parameters relative dielectric constant, truncated corners, substrate thickness etc. Here, coaxial feed method is used to excite the patch antenna.

Communication between humans was first by sound through voice. With the desire for slightly more distance communication came, devices such as drums, then, visual methods such as signal flags and smoke signals were used. These optical communication devices, of course, utilized the light portion of the electromagnetic spectrum. It has been only very recent in human history that the electromagnetic spectrum, outside the visible region, has been employed for communication, through the use of radio. One of humankind's greatest natural resources is the electromagnetic spectrum and the antenna has been instrumental in harnessing this resource.

Microstrip antennas as in fig 1 are very attractive because of their low profile, low weight, conformal to the surface of objects and easy production. A large number of microstrip patches to be used in wireless applications have been developed [1–3]. Various shapes such as square, rectangle, ring, disc, triangle, elliptic, etc. have been introduced [4–7].

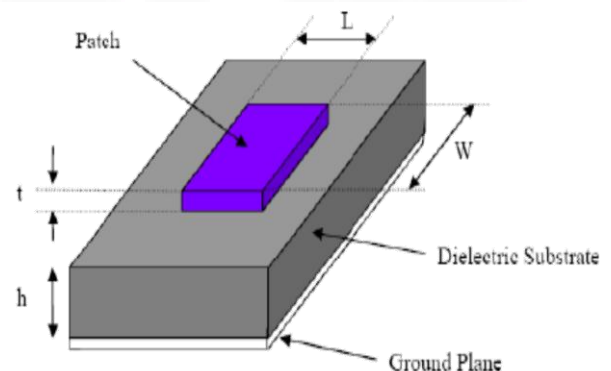


Figure 1: Structure of a Microstrip Patch Antenna

II. ANTENNA CONFIGURATION AND DESIGN

The geometry, parameters, top and bottom views for a prototype of the simple planar circular patch antenna are shown in Figure 2. The antenna consists of circular patch, 50 ohm micro strip line, a probe connector and ground. Circular patch is printed on the top side of the substrate. The planar circular patch is parallel to x - y plane; micro strip line is along the y -axis. The circle of radius R of dimension 5.24 mm is given. The defected ground structure is offered with the slot of 28.1mm X 10 mm.

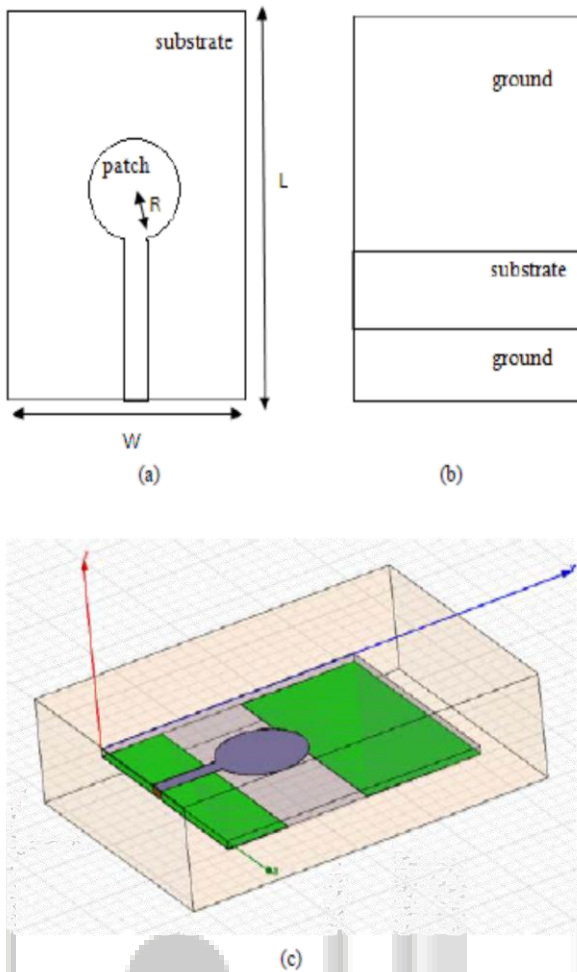


Figure 2: Geometry of circular patch for UWB communication (a)Top View (b) Bottom View (C) Design geometry

III. TRIPLE BAND CIRCULARLY POLARIZED MPA.

Triple-band operations of antenna have presented to satisfy wireless communications system needs. Triple-band antenna can be achieved by several techniques. Firstly one of the most popular techniques of designing multi-band printed antennas based on the "window" concept having frequency band separation of 2:1 or 4:1 whereby windows were cut in a low frequency patch radiators to accommodate high frequency patch antennas. Or Slot loaded circular MPA. As we see several multi band microstrip antennas design have been reported over the years. A simple technique for achieving this has been to load the radiating patch with a slot inside the radiating patch. The triple frequency operation is achieved when the two slots perturb the fundamental resonant frequency of the patch exciting new resonance modes. The resonance frequency of the new modes can be either lower or higher than the original dominant mode with either the same or orthogonal polarization and is strongly dependent on the slot dimensions. According to our Previous presented antenna we are restricted to the C slot technique which is seems the most suitable one to be inserted into our antenna to generate the third frequency band 3.5(GHz). By using a substrate of FR4 ($\epsilon_r = 4.5$) and height ($h = 1.8\text{mm}$) and by using the

same design shown in figure [19] a C-slot with an inner radius of ($a=14\text{ mm}$) and an outer radius of ($b=15.5\text{ mm}$) and arc angle of ($\beta = 180^\circ$) as shown below in figure 3. Simulated return loss result is performed by using commercial software HFSS version-(8.0) they are shown in figure 4.

IV. C – SLOT EFFECT

The C- slot insertion has some effect on the original patch parameters performance, one of the main affected parameter was the return loss axial ratio. Which changes according to the arc length of the c slot and the orientation angle of the C-slot itself,

A. Effect of C-Slot Length Polarization of the First Frequency.

The C- slot insertion has some effect on the original patch parameters performance, one of the main affected parameter was the axial ratio also. Which changes according to the arc angle (β) of the C-slot itself, we examined these different angles which produce different arc length to see it's effect as shown in figure 4 and we found that the range of angles ($\beta = 170^\circ$ to $\beta = 200^\circ$) have the best axial ration performance as shown in figure 5.

B. Effect of C-Slot Length on Return Loss of Triple Band Frequency.

An important parameter is the return loss of the low and high frequency band, where the arc length of the C-slot has a direct effect on the return loss, since by changing the arc angle we can get a different length of the same arc radius therefore, we tried a sweep range of arc angles to get arcs with different lengths to examine the effect of the C-slot arc length as shown in figure 6 on the return loss of the first and third frequency and find out the optimum arc length at angle of ($\beta = 200^\circ$) to get the best performance on the return loss of both first and third frequency in addition to return loss of our new second band as shown in figure 7 and 8.

C. Effect of C-Slot Orientation on Return Loss of Triple Band Frequency.

The C-slot orientation has on the original patch affected the patch parameters performance, one of the main affected parameter was the return loss of both low and high frequency. Which changes according to the orientation angle (α) of the C-slot itself, we examined these orientation angles effect as shown in figure 9 and we found that ($\alpha = -10^\circ$ & $\alpha = 0^\circ$ & $\alpha = +10^\circ$) angles have the best return loss performance on the first and third frequency as shown in figure 8 and on the second frequency on figure 11.

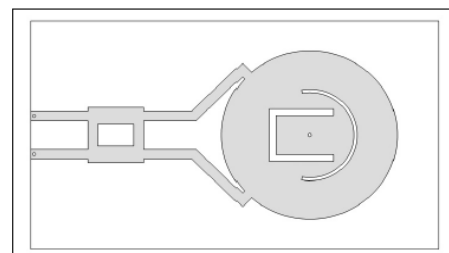


Figure 3: CMPA Configuration with integrated power divider, inserted U slot and C Slot

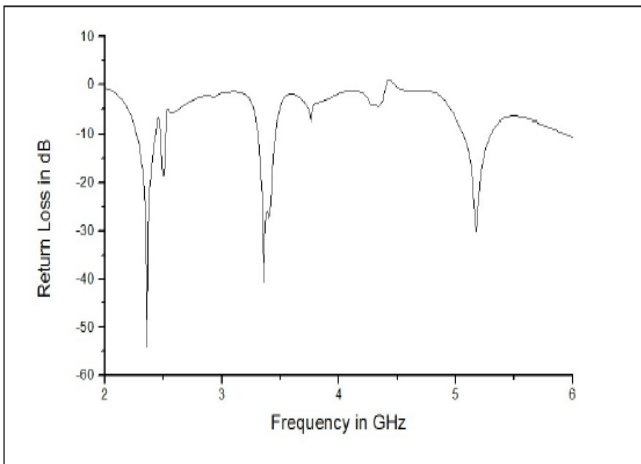


Figure 4: Simulated return loss of the triple band of CMPA configuration in figure 3

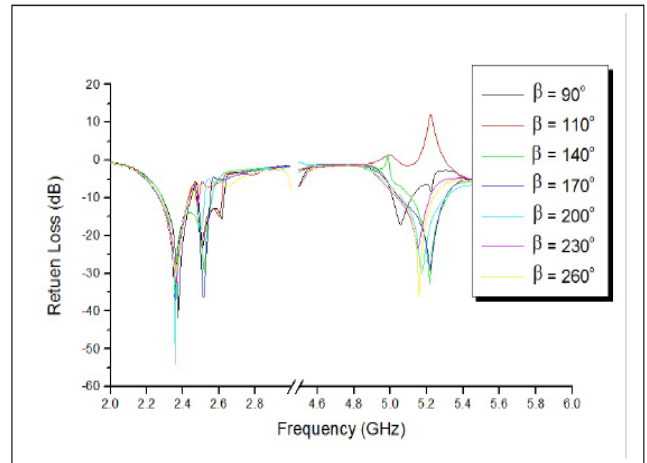


Figure 7: Effect of different C-Slot lengths on return loss of the first and third frequency

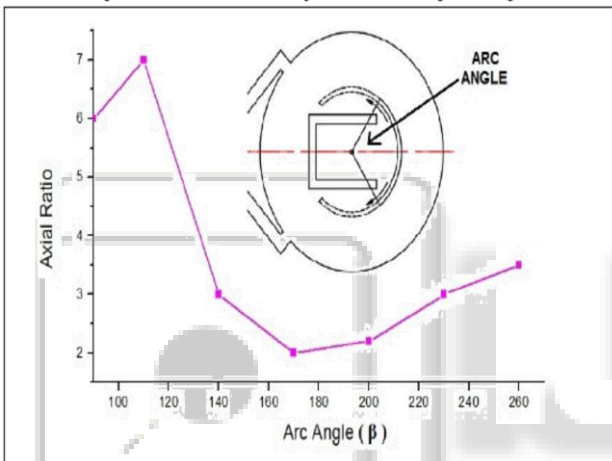


Figure 5: Effect of different C-slot lengths on axial ratio of first frequency 2.4 GHz

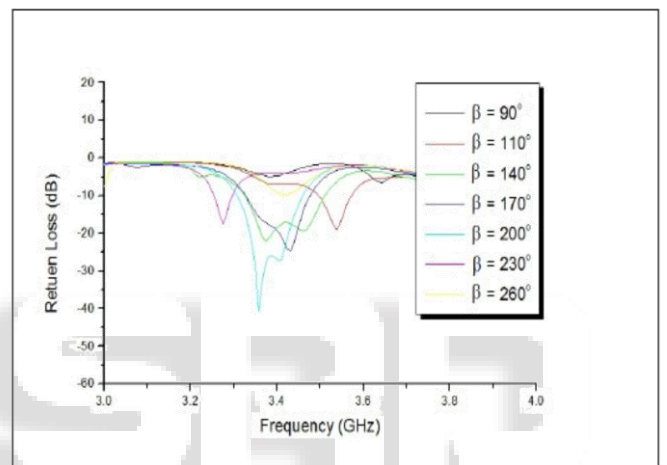


Figure 8: Effect of different C-Slot lengths on return loss of the second frequency 3.5 GHz

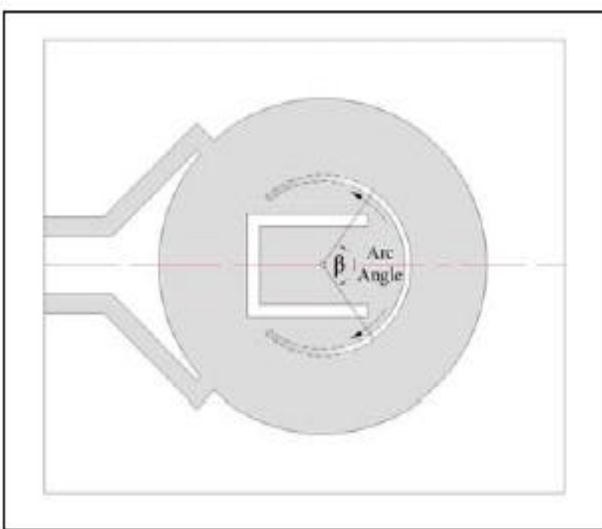


Figure 6: CMPA Configuration with different C-Slot lengths

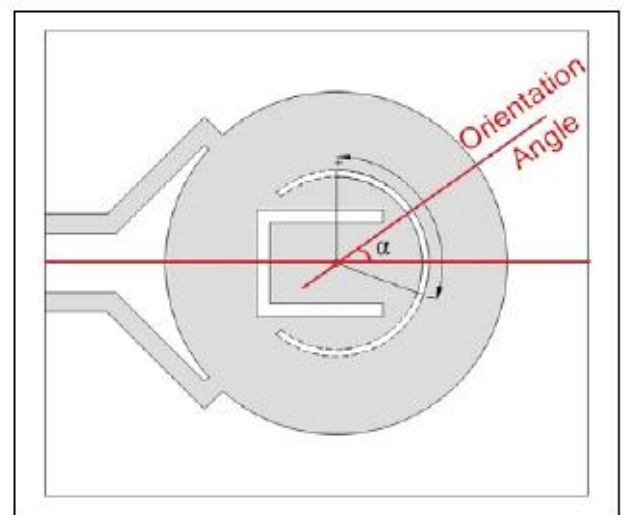


Figure 9: CMPA Configuration with different C-Slot orientation angle α

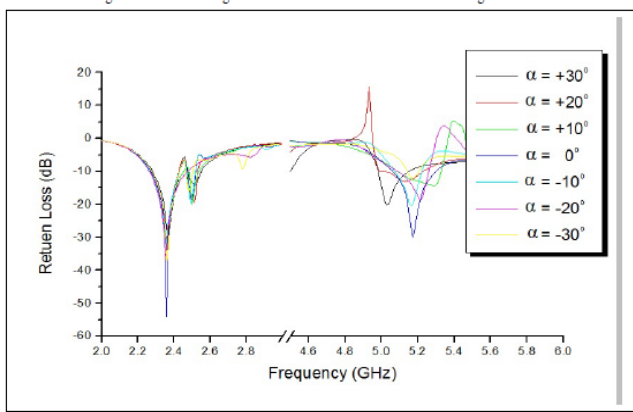


Figure 10: Effect of different C-Slot orientation angle α on return loss of the first and third frequency

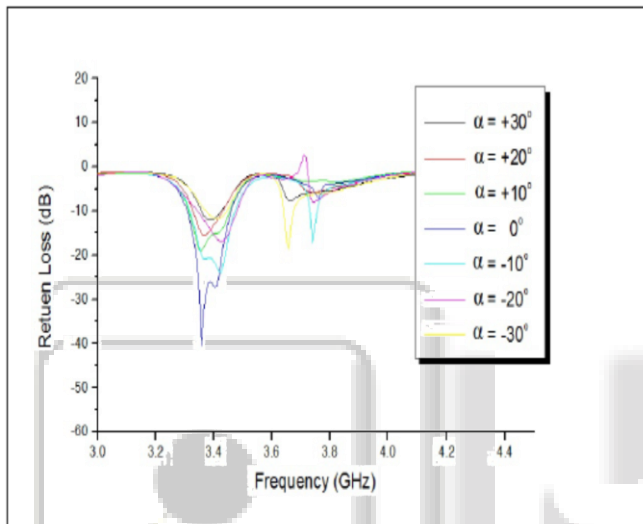


Figure 11: Effect of different C-slot orientation angle α on return loss of the second frequency 3.5 GHz

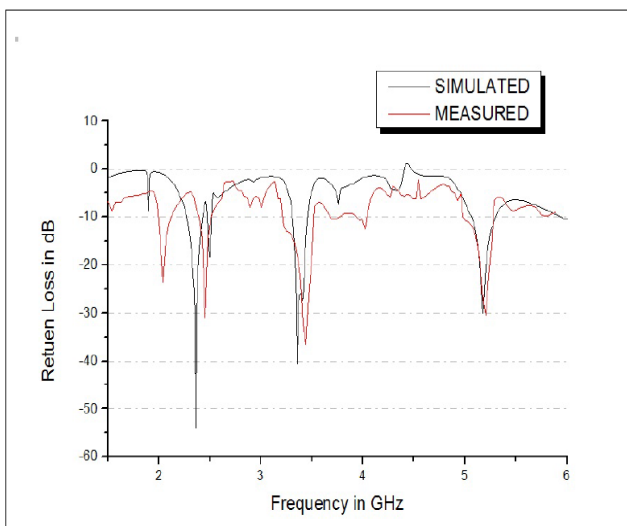


Figure 12: Simulated and measured result of return loss for the triple band antenna configuration

V. CONCLUSION

circular micro strip patch antenna is designed to operate at 2.6 (GHz) with circular polarization, a U slot is inserted thereafter in the original patch to generate the second resonant at 5.4(GHz). Another C-slot is inserted thereafter to generate the 3.7 (GHz) third band. The C-slot insertion effect on the original patch is examined, first arc length effect on the return loss and axial ration is examined in order to get the optimum length, and then the arc orientation effect also is examined to find out the best orientation to place the arc. The design is verified through both numerical simulations and measurement of a fabricated prototype The results confirm good performance of the triple bands antenna design as shown in figure 12.

REFERENCES

- [1] R. L. Li, B. Pan, T. Wu, J. Laskar, and M. M. Tentzeris "A Triple-Band Low-Profile Planar Antenna for Wireless Applications" December 15, 2008, IEEE Xplore
- [2] M. Ben Ahmed, M. Bouhorma, F.Elouaai, A.Mamouni "Design of New Multi Standard Patch Antenna GSM/PCS/UMTS/HIPERLAN for Mobile Cellular Phones" European Journal of Scientific Research, ISSN 1450-216X Vol.32 No.2 (2009), pp.151-157
- [3] R. K. Gupta "Printed TRI-BAND Monopole Antenna Structures For Wireless Applications" Issue 2, Vol I, Apr 2010
- [4] R. L. Li, B. Pan, T. Wu, J. Laskar, and M. M. Tentzeris "A Triple-Band Low-Profile Planar Antenna for Wireless Applications" December 15, 2008, IEEE Xplore
- [5] M. Ben Ahmed, M. Bouhorma, F.Elouaai, A.Mamouni "Design of New Multi Standard Patch Antenna GSM/PCS/UMTS/HIPERLAN for Mobile Cellular Phones" European Journal of Scientific Research, ISSN 1450-216X Vol.32 No.2 (2009), pp.151-157
- [6] R. K. Gupta "Printed TRI-BAND Monopole Antenna Structures For Wireless Applications" Issue 2, Vol I, Apr 2010
- [7] M. A. S. Alkanhal "Composite Compact Triple- Band Microstrip Antennas" Progress In Electromagnetics Research, PIER 93, 221 {236, 2009
- [8] Mohammed Y. M. Yousef, Abdelhamid Gaafar, Abdelaziz A. Abdelaziz "Dual Band Circularly Polarized Microstrip Patch Antenna For Wi-Fi Applications" July 2010, NGMAST'10 Conference Publishing Services (CPS) and IEEE Xplore. (Accepted-in Press)
- [9] D. Krishna, M. Gopikrishna, C. K. Aanandan "Compact dual band slot loaded circular microstrip antenna with a superstrip" Progress In Electromagnetic Research, PIER 83, 245-255, 2008.F
- [10] E. Wang, J. Zheng, Y. Liu "A novel dual-band patch antenna for WLAN communication" Progress in Electromagnetic Research C, Vol. 6, 93-102, 2009.
- [11] Thomas, K.G. Sreenivasan, M. "A simple dual-band microstrip-fed Printed antenna for WLAN applications" Microwaves, Antennas & Propagation, IET, June 2009.