Stacked Coupled Circular Microstrip Patch Antenna for Dual Band Applications

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Abstract— In this paper, the design of stacked coupled circular microstrip antenna is presented for dual frequency operations. The two circular patches are isolated by a substrate. The lower patch is the feed patch and the upper patch is excited by the stacked coupling. The designed antenna is simulated and optimized using CST Microwave Studio simulator. The designed antenna produces two resonances at 3.4233 GHz and 3.7395 GHz. The radiation pattern of the designed antenna is also shown. The designed antenna produces the broadside radiation pattern.

1. INTRODUCTION

For light weight applications, such as in missiles, aircraft, aerospace, mobile handset, etc., microstrip antennas are the most suitable antennas [1, 2]. Microstrip antennas have various advantages and disadvantages over other antennas such as small size, low cost, easy to fabricate, and low gain, narrow bandwidth respectively [3]. In various applications, dual-frequency bands are desirable [4]. Dual-frequency microstrip antennas have the advantages for doubling the system capacity of transmission and reception [5]. In [6], using E-shape patch and U-shape patch, the antenna is designed for dual band applications. The dual operation frequencies are 4.7 GHz and 5.4 GHz. In [7], a dual band microstrip antenna has been proposed; the proposed antenna consists of a microstrip patch with a U-shaped slot that is fed by a broadband electromagnetic coupling probe, known as L-probe. In [8], authors have designed a U-shaped dual frequency microstrip antenna for wireless communication. In [9], the concept of slot loading along with a superstrate is used and the microstrip antenna is designed for dual frequency operation. In [10], authors have presented the cavity-model based simulation tool along with the genetic optimization algorithm for the design of dual-band microstrip antennas. Multiple slots in the patch or multiple shorting strips between the patch and the ground plane are used. The optimization of the positions of slots and shorting strips is performed via a genetic optimization algorithm, to achieve an acceptable antenna operation over the desired frequency bands.

In this paper, stacked coupled microstrip antenna is designed for dual band applications. The designed antenna generates two resonances at 3.4233 GHz and 3.7395 GHz. The radiation and the total efficiency of the designed antenna are 0.9784 and 0.9481 respectively. The organization of the rest of the paper is as follows: The geometrical configuration of the designed antenna is discussed in Section 2. Section 3 discusses the simulated results with discussion. Finally, Section 4 concludes the work.

2. ANTENNA CONFIGURATION

The geometrical configuration of the proposed stacked coupled microstrip antenna is depicted in Fig. 1. Two microstrip circular patches are isolated by the substrate as shown in Fig. 1. The lower microstrip circular patch is the feed patch and excited by the probe feeding technique. The upper circular metallic patch is excited by the coupling. The radius of both patches is 'r'. The thickness, the dielectric constant of the lower and upper substrate are '$H1$', $er1$ and '$H2$', '$er2$' respectively.

Table 1: Dimensions of the proposed antenna.

Radius of upper patch (mm)	Radius of lower patch (mm)	Thickness of upper the substrate (mm)	Dielectric constant of the upper substrate	Thickness of the lower substrate (mm)	Dielectric constant of the lower substrate	Thickness of the upper patch (mm)	Thickness of the lower patch (mm)
15	15	1.4	2.2	1.59	2.2	0.01	0.01

3. RESULTS AND DISCUSSION

The designed stacked coupled circular microstrip antenna is simulated using Finite element based CST microwave studio software. The designed stacked coupled microstrip antenna is optimized

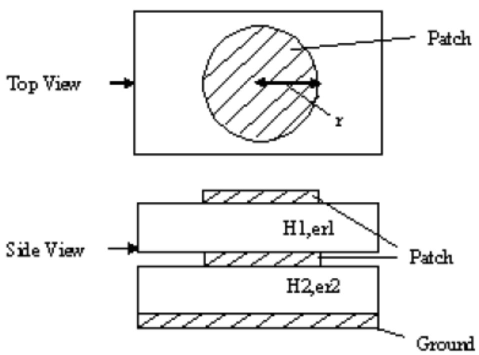


Figure 1: Geometrical configuration of stacked coupled circular microstrip antenna.

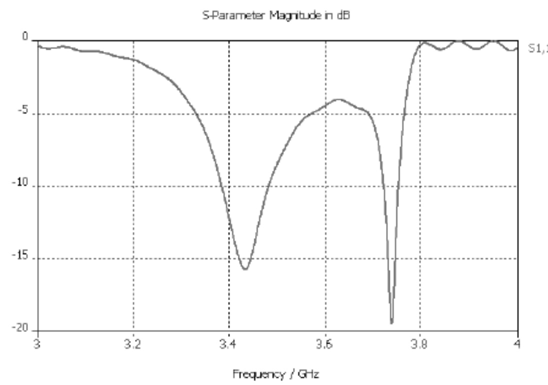


Figure 2: Return loss of the proposed antenna.

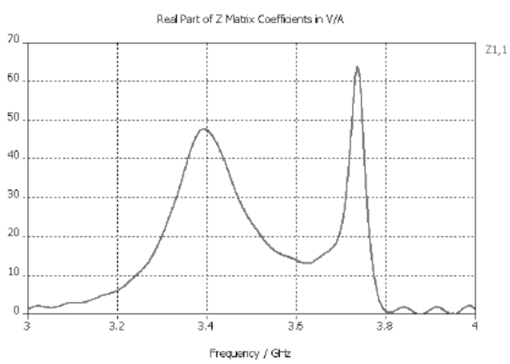


Figure 3: Real part of the input impedance.

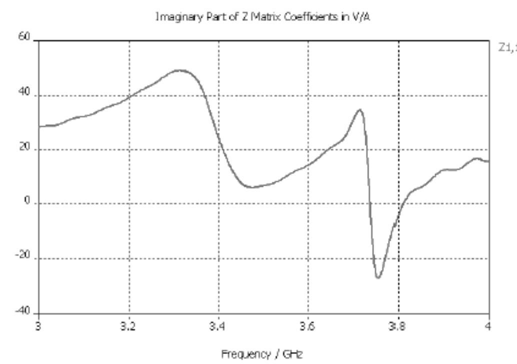
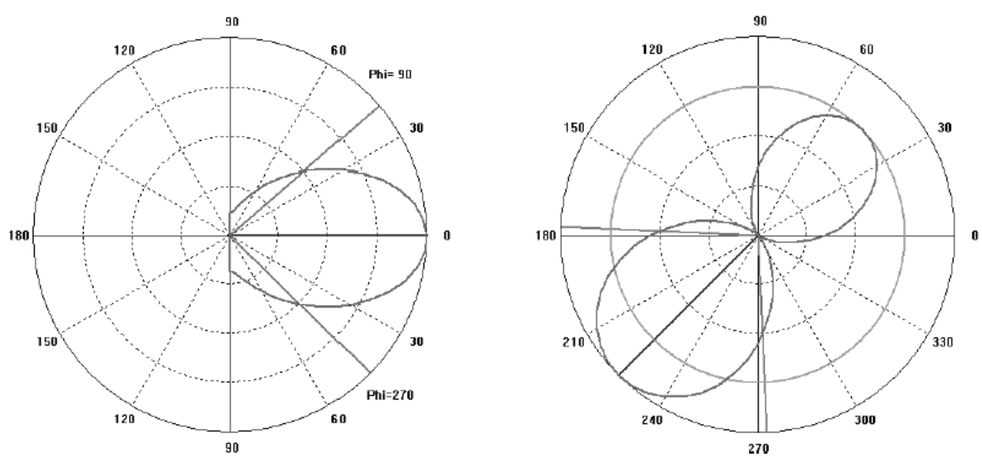
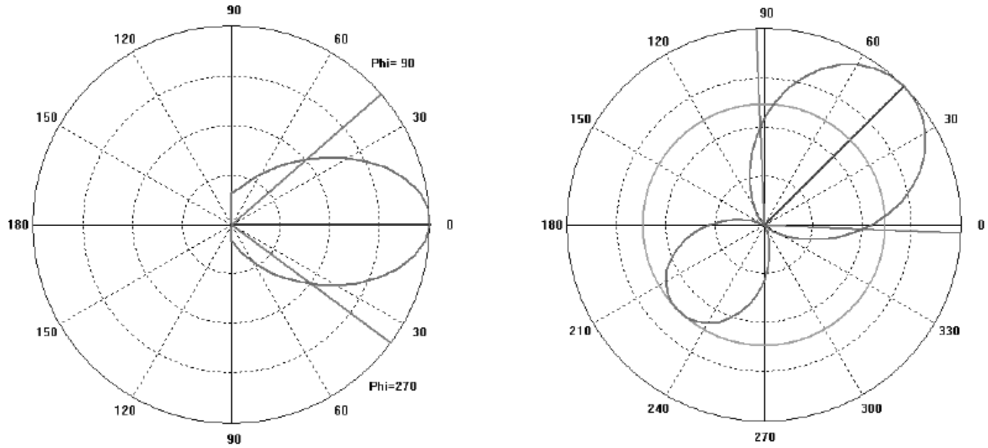


Figure 4: Imaginary part of the input impedance.



(a) (b)

Figure 5: Radiation pattern of the designed antenna at 3.4233 GHz, (a) theta plane, (b) phi plane.



(a) (b)

Figure 6: Radiation pattern of the designed antenna at 3.7395 GHz, (a) theta plane, (b) phi plane.

using CST microwave studio. The dimensions of the optimized simulated model is given in Table 1. The return loss of the designed stacked coupled microstrip antenna is shown in Fig. 2. From this figure, it can be observed that the designed antenna produces two resonances at 3.4233 GHz and 3.7395 GHz. For both resonances the return loss is less than -10 dB, so the designed antenna can be used for both bands. The real and imaginary part of the input impedance of the designed antenna is shown in Fig. 3 and Fig. 4 respectively.

The simulated radiation pattern of the designed antenna for first resonance, i.e., at 3.4233 GHz is shown in Fig. 5. The designed antenna produces broadside radiation pattern. The radiation and the total efficiency is very high, i.e., 0.9764 and 0.9481 respectively. The directivity of the antenna at 3.4233 GHz is 5.073 dB. The simulated radiation pattern of the designed antenna for second resonance, i.e., at 3.7395 GHz is shown in Fig. 6. The designed antenna produces broadside radiation pattern. The radiation and the total efficiency is 0.7960 and 0.7867 respectively. The directivity of the antenna at 3.7395 GHz is 5.563 dB.

4. CONCLUSION

In this paper, a stacked coupled circular microstrip antenna has been designed. The designed microstrip antenna is optimized using FDTD based CST Microwave simulator. The designed stacked coupled microstrip antenna produces two resonances at 3.4233 GHz and 3.7395 GHz respectively. The designed stacked coupled circular microstrip antenna generates broadside radiation pattern. The efficiency of the designed antenna is very high. The radiation efficiency up to 0.9764 and the total efficiency upto 0.9481 is achieved. The designed stacked coupled circular microstrip antenna can be used for dual frequency applications.

REFERENCES

1. Garg, R., P. Bhartia, I. Bahl, and A. Ittipiboon, *Microstrip Antenna Design Handbook*, Artech House Publishers, Boston, London, 2001.
2. Balanis, C. A., *Antenna Theory: Analysis and Design*, Wiley, 2005.
3. Kumar, P., A. K. Singh, G. Singh, T. Chakravarty, S. Bhooshan, S. K. Khah, and A. De, "Numerical computation of resonant frequency of gap coupled circular microstrip antennas," *Journal of Electromagnetics and Applications*, Vol. 21, No. 10, 1303–1311, 2007.
4. Islam, M. T., N. Misran, and A. T. Mobashsher, "Compact dual band microstrip antenna for Ku-band application," *Information Technology Journal*, Vol. 9, No. 2, 354–358, 2010.
5. Shynu, S. V., G. Augustin, C. K. Aanandan, P. Mohanan, and K. Vasudevan, "Design of compact reconfigurable dual frequency microstrip antennas using varactor diodes," *Progress In Electromagnetics Research*, Vol. 60, 197–205, 2006.

6. AbuTarboush, H. F. and H. S. Al-Raweshidy, "A connected E-shape and U-shape dual-band patch antenna for different wireless applications," *The Second International EURASIP Workshop on RFID Technology (EURASIP'08)*, Budapest, Hungary, July 7–8, 2008.
7. Ghalibafan, J., A. R. Attari, and F. H. Kashani, "A new dual-band microstrip antenna with U-shaped slot," *Progress In Electromagnetics Research C*, Vol. 12, 215–223, 2010.
8. Singh, V. K. and Z. Ali, "Dual band U-shaped microstrip antenna for wireless communication," *International Journal of Engineering Science and Technology*, Vol. 2, No. 6, 1623–1628, 2010.
9. Krishna, D. D., M. Gopikrishna, C. K. Aanandan, P. Mohanan, and K. Vasudevan, "Compact dual band slot loaded circular microstrip antenna with a superstrate," *Progress In Electromagnetics Research*, Vol. 83, 245–255, 2008.
10. Ozgun, O., S. Mutlu, M. I. Aksun, and L. Alatan, "Design of dual-frequency probe-fed microstrip antennas with genetic optimization algorithm," *IEEE Trans. on Antennas and Propagation*, Vol. 51, No. 8, 2003.