International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-2S, December 2018

Design of Compact Antenna for Ultra Wide Band Applications

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Abstract--- ***A square ring slot antenna is designed in this research work for Ultra Wide Band (UWB) and RADAR (RAdio Detection And Ranging) applications. The purpose of the slot is to minimize the weight of antenna and also to improve the antenna bandwidth. In this, the slot arms are shaped properly in order to control the isolation and impedance matching. Most of the bands has greater than 20 dB isolation. In this research work, aperture feeding is used for designing the proposed antenna and modified through circular slot arms. For the designed antenna, three dipole resonant frequencies are obtained and these respective frequencies can be used for RADAR applications.***

Keywords: UWB, RADAR, Square Ring Slot Antenna, Aperture Feeding, Proximity Feeding

I. INTRODUCTION

Antenna having the characteristics of Ultra-wide band is more suitable for RADAR and PC peripherals applications. UWB systems are used in indoor and real time applications. Due to high precision and low power consumption, the UWB antennas are mostly used for hospitals. In addition, this consumes less time for broadcasting [1-2]. Ram Krishna et al. designed a antenna which is used for the applications of Imaging and UWB. This slot has identical square ring with rectangular shaped. In this, the antenna characteristics are properly controlled through the shaping of slot arms. In this, the improvement of the impedance bandwidth is obtained as 120% and better isolation [3-7]. Wang et al. developed a slot antenna with stepped impedance (SI). The topologies are utilized in order to model and analyze the resonant condition of this antenna. Through the simulation and analysis, this antenna has validated [8]. Kumar et al. designed a slot antenna with horizontally polarized radiation pattern. Through experiment, the impedance bandwidth obtained for this antenna as 122%. This provides with stable radiation patterns but it produces high frequency distortion [9-13].

Pritam Singh Bakariya et al. designed a patch antenna with proximity coupling for WLAN and Bluetooth applications. This is a V-shaped two layer patch antenna and it has operates on uniform gain and constant radiation pattern. This small size antenna is designed and fabricated in FR4 substrate [14]. Pritam Singh Bakariya et al. designed an antenna along with proximity coupling for Wi-Max applications. This small size antenna is fabricated in FR4 substrate material with 0.8mm thickness and dielectric constant value of 4.4. It has constant gain and better coverage [15].

Minimize the problems faced in the above discussed antennas, the compact size square ring slot antenna is proposed in this research work and it is designed for the applications of UWB and RADAR. This proposed antenna produces more resonant frequencies with better gain. Organization of this paper is described as: Section 2 deals the overview of existing antenna design and proposed antenna design is described in Section 3. Section 4 illustrates the simulated results of the existing and proposed antennas and Section 5 concludes this paper.

II. OVERVIEW OF THE EXISTING ANTENNA DESIGN

Fig.1 shows the top side view of the existing antenna. In this, S1 and S2 indicates the slots and M1, M2, M3 are the micro-strip feed. From this figure, it is observed that this antenna has narrow band. For the improvement of impedance matching, the width of the stub has been increased slightly. In addition, to improve the isolation the slant stub is introduced. Fig.2. shows the bottom view of this existing antenna and it shows the dual band performance. Due to merging of these two bands, large bandwidth is obtained.

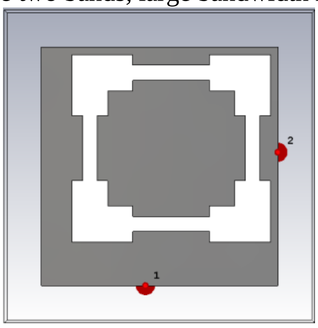

Fig.1 Top side-Ground slot

Manuscript published on 30 December 2018.
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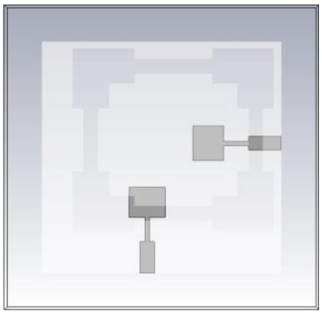

Fig. 2 Bottom side- Microstrip feed

Table 1 Geometric parameters for the existing antenna

Parameters	S1	S2	M1	M2	M3
Length	19.5	17.0	9.0	7.0	8.5
Width	4.2	12.0	3.9	2.4	10.0

Using the parameter values listed in Table1, these resonances are calculated as 4.1 and 7.2GHz, which match fairly with the observed simulated resonances at 3.9 and 7.1GHz. It is seen from Fig.2, the lower edge frequency has slightly decreased while the bandwidth remains almost the same. Isolation is very big problem in slot ring with closed structures. In order to overcome this, the corners are attached with tilted stubs. From the evaluated and measured results, it is revealed that attached stub affects the isolation at higher frequencies and it is optimized to get minimum isolation. This antenna will not show the brevity sake and effects the improvement of reflection coefficient.

III. DESIGN OF PROPOSED SQUARE RING SLOT ANTENNA

Fig. 3 shows the top side view of this proposed antenna. In this, the slots and microstrip feed are labeled as S1, S2 and M1, M2, M3 respectively. Similar to existing antenna, this has narrow band with adjustable stub for impedance matching. The geometrical view of this antenna is graphically shown in Fig.4 and it has similar antenna characteristics of existing antenna. Through simulation results, the bandwidth of the antenna is 3.4–12GHz obtained.

Using the parameter values listed in Table 2 and radius of the circular slot listed in Table 3, these resonances are calculated as4.1and7.2GHz,which match fairly with the observed simulated resonances at 3.9 and 7.1GHz. In this, the lower edge frequency has slightly decreased while the bandwidth remains almost the same. From the simulated result, it is observed that the isolation varied with respect to the length of the stub.

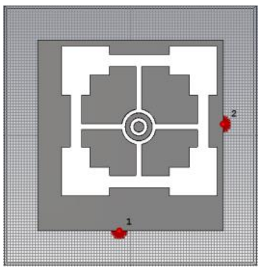

Fig. 3 Top side-Ground slot

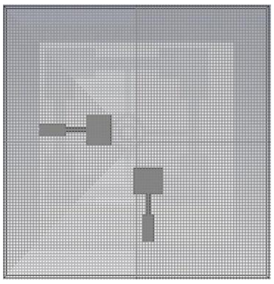

Fig. 4 Bottom side-Microstrip feed

Table 2 Geometric parameters for proposed antenna

Parameters	A	S1	S2	M1	M2	M3
Length	9	19.5	17.0	9.0	7.0	8.5
Width	2	4.2	12.0	3.9	2.4	10.0

Table 3 Radius of the circular slots

Circle	Inner Radius	Outer radius
Circle-1	1	4
Circle-2	4	7

IV. RESULTS AND DISCUSSIONS

For the simulation of 3D electromagnetic (EM) high frequency components, CST Microwave Studio (CST MWS) plays the powerful tool and it offers unparalleled performance. This is the best and first choice in technology leading R&D departments.

4.1. Simulation results for Existing Antenna

Using CST Microwave Studio, the existing antenna is designed then fabricated with required specifications. The simulated parameters are shown in Figs.5 (a-e) and it is measured.

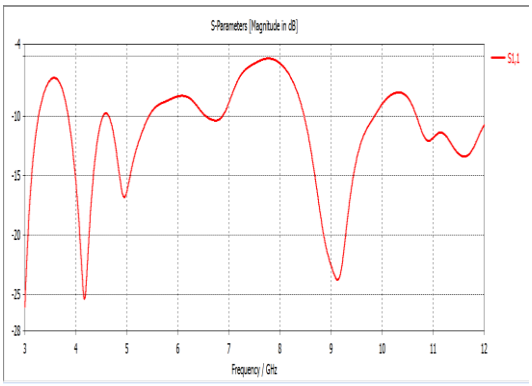

Fig 5(a) Simulated Return Loss

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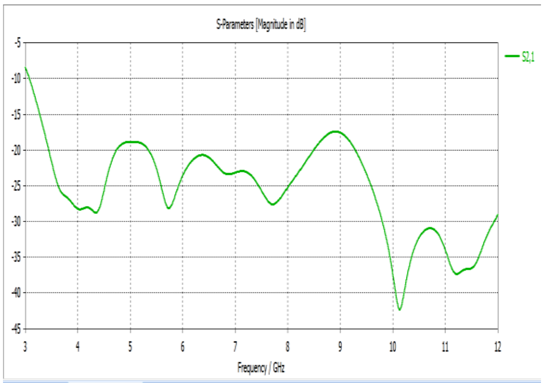

Fig 5(b) Simulated Coupling

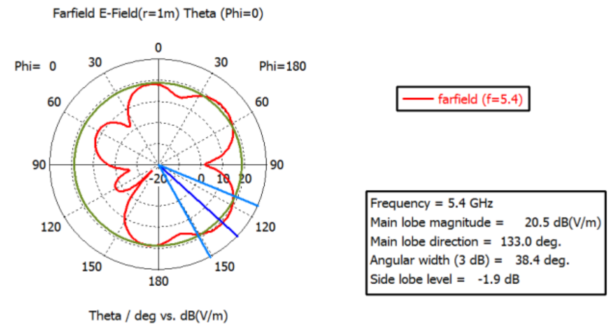

Fig 5(c) Farfield E-Field (phi=0)

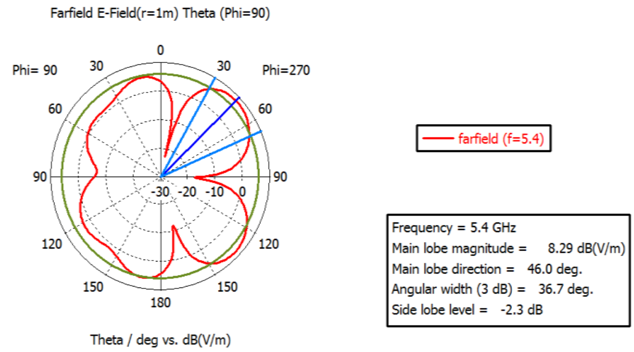

Fig 5(d) Farfield E-Field (phi=90)

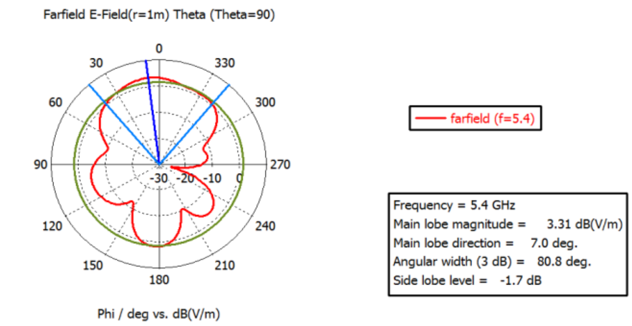

Fig 5(e) Farfield E-Field (Theta=90)

Both ports are considered for simulation and the10-dB impedance band-width is 3.0–12GHz is found from the simulated results. Also, it is found that the radiation pattern matched with the measured value. The obtained patterns are nearly omni directional and in E-plane it has the bell shaped structure. Cross-polar difference for the simulated and measured are obtained for one of the ports along the boresight direction. A margin of is taken in case of the measured value. Also shown in the Figure is the simulated cross-polar difference for an L-shaped slot. It can be observed that addition of the other slot arms resulting in a symmetric ring has increased the cross-polar difference to nearly 20dBi over most of the band. The peak gain (measured and simulated) and radiation efficiency over the operating band for one of the ports. While the peak gain varies between 5–8dBi over the operating band, the efficiency remains above 60%.

4.2. Simulation results for Proposed Antenna

Through CST Microwave Studio, the proposed slot antenna is designed and then simulated with required specifications. Antenna parameters are simulated successfully using above mentioned tool and its results are shown in Fig.6(a-c). From these Figures, it is attained three DIP frequencies which can be used for various RADAR applications. Due to proper section of the slot with feedline, the DIP frequencies are obtained. For the designed antenna, it is attained that three DIP frequencies which can be used for various UWB and RADAR applications.

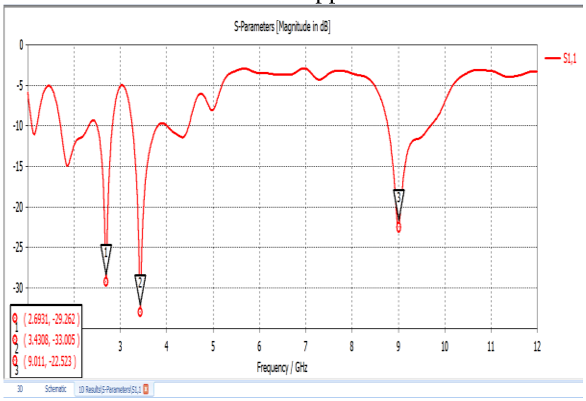

Fig 6(a) Simulated Return Loss

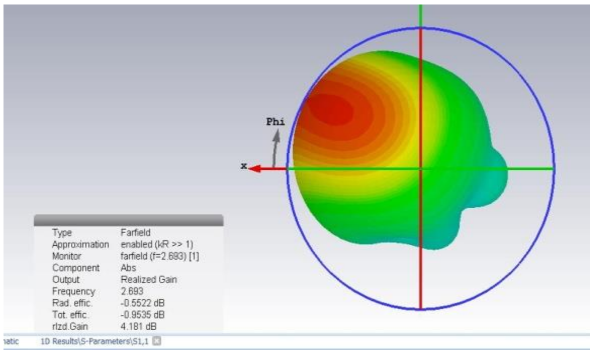

Fig 6(b) Gain at 2.693GHz

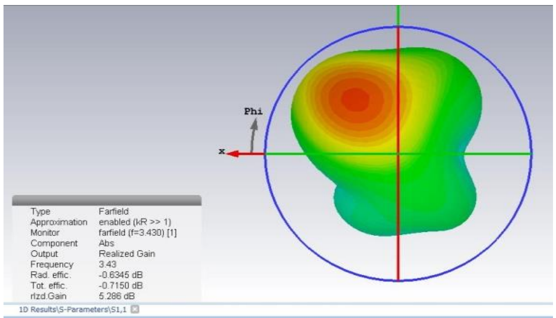

Fig 6(c) Gain at 3.43GHz

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V. CONCLUSION

In this research work, the square ring slot antenna is designed for various specifications and simulated successfully using CST Microwave Studio tool. From the measured and simulated results, there are three DIP frequencies (2.6GHz, 3.4GHz, 9.01GHz) for proposed antenna is found which can be used for RADAR applications such as Air Traffic Control, Marine and RADAR. In addition, the impedance matching is achieved through the proper sectioning of slots and feedline. In future, patch antenna using proximity feeding model will be designed and it is fabricated for UWB applications.

REFERENCES

1. Best S. and Kaanta B.,"A tutorial on the receiving and scattering properties of antennas", IEEE Antennas and Propagation Magazine, vol. 51, no. 5, pp. 26–37, October 2009.
2. Kanesan M., Thiel D.V., and Keefe S.G.O.,"The effect of lossy dielectric objects on a UHF RFID meander line antenna", in the proc. of the IEEE Antennas and Propagation Symposium, July 2012.
3. Kumar R., Khokle R. K., and Ram Krishna R. V. S., "A dual polarized square-ring slot antenna for UWB, Imaging and Radar Applications", IEEE Transactions on Antennas and Propagation, vol. 62, no. 7, pp. 3501–3510, July 2014.
4. Li Y., Zhang Z., Chen W., Feng Z., and Iskander M.F.,"A dual- polarization slot antenna using a compact CPW feeding structure", IEEE Antennas Wireless Propagation Letters,vol.9, pp. 191–194, 2010.
5. Lu J., Kuai Z., Zhu X., and Zhang N.,"A High-Isolation dual-polarization Microstrip patch antenna with quasi-cross-shaped coupling slot", IEEE Transactions on Antennas and Propagation, vol.59, no. 7, pp. 2713–2717, July 2011.
6. Gao S., Li L.W., Leong M.S., and Yeo T.S.,"A broad-band dual polarized Microstrip patch antenna with aperture coupling", IEEE Transactions on Antennas and Propagation, vol.51, no.4, pp.898–900, April 2003.
7. Wei K., Zhang Z., and Feng Z., "Design of a wideband horizontally polarized Omni directional printed loop antenna", IEEE Antennas Wireless Propagation Letters, vol.11, pp.49–52, 2012.
8. Wang C.J.and Chen L.T., "Modeling of stepped impedance slot antenna", IEEE Transactions on Antennas and Propagation., vol. 62, no. 2, pp.955–959, February 2014.
9. Kumar R., Khokle R.K., and RamKrishna R.V.S.,"A horizontally polarized rectangular stepped slot antenna for ultra wide bandwidth with boresight radiation patterns," IEEE Transaction on Antennas and Propagation, vol. 62, no.7, pp. 3501–3510, July 2014.
10. Chacko B. P., Augustin G., and Denidni T. A.,"Uni planar slot antenna for ultra wide band polarization-diversity applications", IEEE Antennas Wireless Propagation Letters, vol. 12, pp. 88–91, 2013.
11. Lee C.H., Chen S.Y., and Hsu P.,"Isosceles triangular slot antenna for broad band dual polarization applications", IEEE Transactions on Antennas and Propagation,vol.57, no. 10, pp. 3347–3351, October 2009.
12. Lee D., Yang H., and Cho Y.,"Design and analysis of tapered slot antenna with 3.5/5.5GHz band-notched characteristics", in the proc. of the Electromagnetic Research, vol. 56, pp. 347–363, 2013.
13. Behdad N. and Sarabandi K., "A multi-resonant single element wideband slot antenna", IEEE Antennas Wireless Propagation Letters, vol.3, pp.5–8, 2004.
14. Pritam Singh Bakariya, Santanu Dwari,"Proximity-Coupled Multiband Microstrip Antenna for Wireless Applications", IEEE Antennas Wireless Propagation Letters, vol.11, pp.139–141, 2015.
15. Pritam Singh Bakariya, Santanu Dwari, "Proximity-Coupled Microstrip Antenna for Bluetooth, WiMAX, and WLAN Applications", IEEE Antennas Wireless Propagation Letters, vol. 11, pp. 144–147, 2015.

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