International Journal of Applied Research

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2023; 9(8): 176-180
www.allresearchjournal.com
Received: 13-05-2023
Accepted: 16-06-2023

Shilpi Khare
Research Scholar,
Department of Electronics and Communication Engineering,
Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS),
Prayagraj, Uttar Pradesh
India

Sudhanshu Tripathi
Assistant Professor,
Department of Electronics and Communication Engineering,
Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS),
Prayagraj, Uttar Pradesh
India

Anil Kumar
Assistant Professor,
Department of Electronics and Communication Engineering,
Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS),
Prayagraj, Uttar Pradesh
India

Corresponding Author:
Shilpi Khare
Research Scholar,
Department of Electronics and Communication Engineering,
Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS),
Prayagraj, Uttar Pradesh
India

Designing of ground slotted circular ring patch antenna for X band using ANSYS HFSS Simulator

Shilpi Khare, Sudhanshu Tripathi and Anil Kumar

DOI: https://doi.org/10.22271/allresearch.2023.v9.i8c.11188

Abstract
This paper explains the designing of patch antenna in the shape of circular ring which operates at 2.5 GHz for X band applications. Considering the microstrip line feed technique antenna has been designed with defected ground structure. It has been analyzed keeping in view if its required characteristics, which have been found in agreement with the standard parameters. It has dual band property so it can be use for 10.1 GHz and 11 GHz. The patch is so designed onto a substrate of FR-4 Epoxy so it can be useful in modern and advanced communication systems. Results have been validated with respect to standard norms.

Keywords: Microstrip patch antenna, DGS, circular ring.

Introduction
The fast developing technology in wireless communication requires antenna that are light in weight, small and are cheap. Microstrip antenna comprise of three parts a patch, substrate and ground. The substrate is sandwiched between the radiating patch and ground. The antenna is constructed with help of lithographic technique. Using this IC technique, it became easy to manufacture many necessary devices by different technique on substrate. For some case output attribute of antenna depends on material of substrate and its parameters. The radiating patch can be of any shape i.e. circular, elliptical, rectangular, square, triangular. Most commonly radiating patches being used are rectangular, circular and square as they are easy to fabricate, analyze and radiation characteristics. HFSS is an electromagnetic software used to design and simulate antennas and PCB's. Slots or defects may be periodic and aperiodic made on ground plane for improvement of bandwidth is called defected ground structure. The defects or slots on ground disturbs the flow of current on ground plane which changes property of transmission line. This effectively changes capacitance and inductance by including slot resistance, capacitance and inductance.

Materials and methods
The proposed antenna is designed on HFSS simulator. HFSS is a software design to simulate high-speed, high-frequency electronics i.e.in radar systems, communication systems, satellites, ADAS, microchips, printed circuit boards, IoT products, RF devices. The substrate is of FR-4 material which is high-pressure thermoset plastic laminate grade with good strength to weight ratios, near zero water absorption. The material retain its high mechanical values and electrical insulating qualities in both humid and conditions. These features, along with better fabrication characteristics helps to design a wide variety of electrical and mechanical applications.

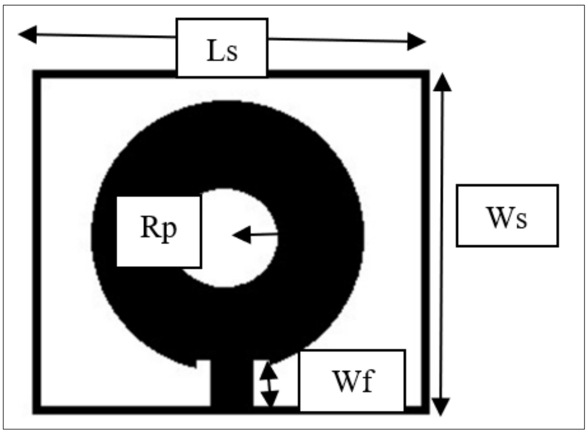

Fig 1: Top view of antenna

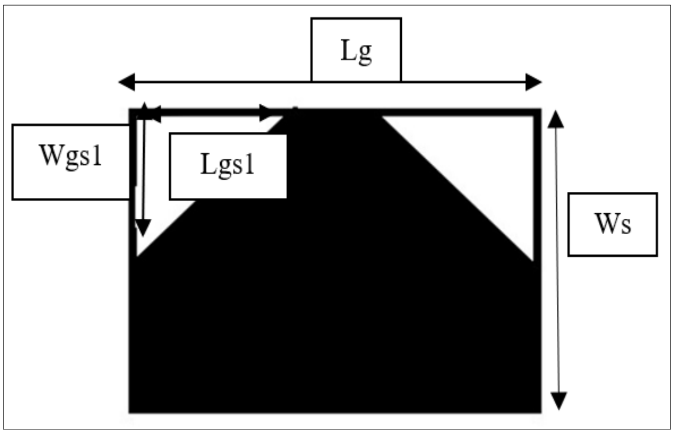

Fig 2: Ground view of antenna

Following table shows the designed antenna parameter with dimensions used in this work.

Table 1: Dimensions of Designed Antenna

Parameters	Dimensions(mm)
Length of substrate (Ls)	68
Width of substrate (Ws)	65
Thickness of substrate (Ts)	1.6
Length of ground (Lg)	68
Width of ground (Wg)	65
Radius of patch (Rp)	30
Length of feed (Lf)	2.5
Width of feed (Wf)	5
Length of ground slot1 (Lgs1)	20
Width of ground slot1 (Wgs1)	20
Length of ground slot2 (Lgs2)	23
Width of ground slot2 (Wgs2)	16.25

Results

a) **Return Loss:** Return loss is loss in signal power due to reflection in signal when there is discontinuity in transmission line. In other term if all the power was transferred to the load, then return loss will be infinite. It is usually expressed in decibels.

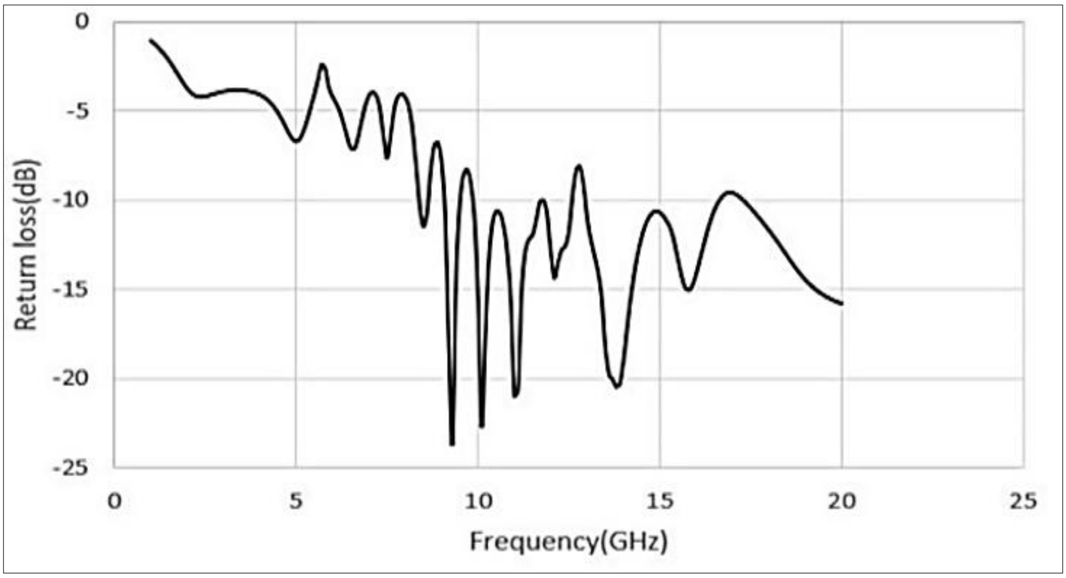

Fig 3: Return loss vs frequency

b) **VSWR:** The VSWR is characterized as maximum and minimum voltage ratio along transmission line. This has real value which is positive. The value generally lies between 1 to 2.

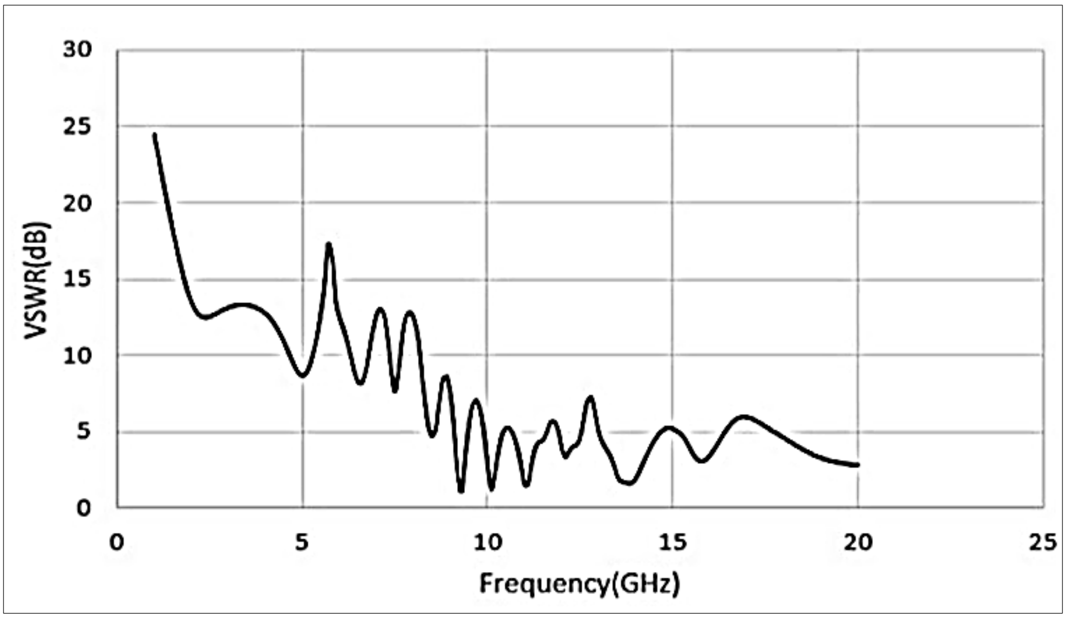

Fig 4: VSWR vs frequency

c) **Gain:** Gain is characterized as product of directivity and efficiency. It indicates how powerful a signal can be transmitted or received in a specific direction by an antenna. Gain is evaluated in dB.

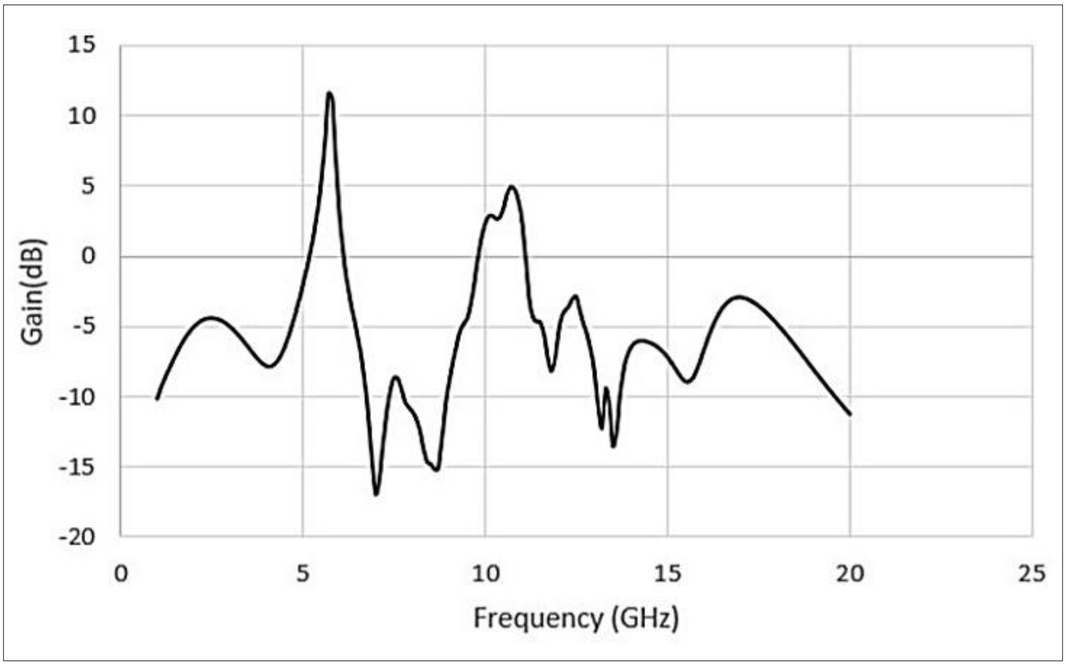

Fig 5: Gain vs frequency

d) **Directivity:** Directivity is defined as concentration of radiation pattern of antenna in a specific direction. It is expressed in dB. When directivity is high the beam radiated by antenna will be more focused and will travel longer. Directivity of omni directional antenna is 1 (0 dB).

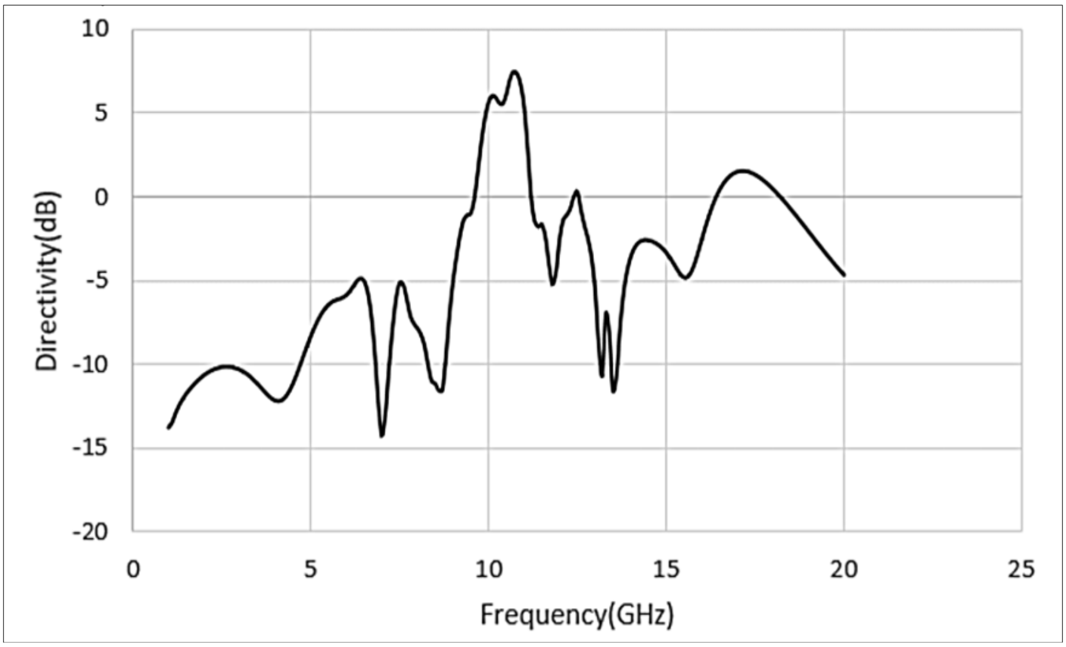

Fig 6: Directivity vs frequency

e) **Radiation Pattern:** The term radiation pattern is a graphical picture of the radiation properties of the antenna. It is expressed by 3-D graph or polar plots. It is basically plot of electrical field strength of waves emitted by that antenna at various angles.

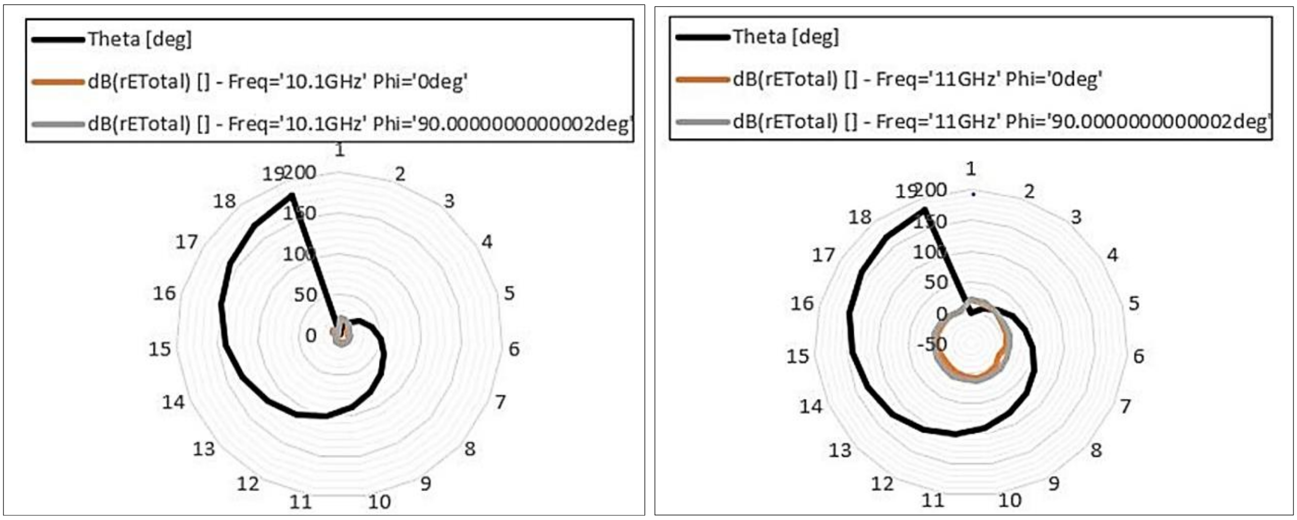

Fig 7: Radiation pattern at frequencies 10.1 and 11 GHz

Discussion

As per results this shows at two range of frequencies a suitable return loss and gain can be obtained from this designed antenna which is applicable for X band.

Table 2: Antenna Result at Various Frequencies

	10.1GHz	11GHz
Return loss (dB)	-22.6	-20.9
VSWR (dB)	1.2	1.5
Gain (dB)	2.8	2.5
Directivity (dB)	6.0	5.4

Conclusion

From the above table it can be shown that at frequency of 10.1 GHz,11 GHz a good gain of antenna can be achieved and return loss is also very good with feasible directivity and VSWR. This paper shows a defected ground circular ring patch antenna with microstrip line feed. Radius of patch has been kept 30mm. This antenna is suitable for weather monitoring, air traffic control, maritime vessel traffic control, defence tracking, and vehicle speed detection. X band is applicable for modern radars. Its shorter wavelengths permit for higher resolution imagery from high-resolution imaging radars for identifying target.

Acknowledgement

Author is very much thankful to Department of Vaugh Institue of Agricultural Engineering and Technology (VIAET), SHUATS College, Prayagraj, for helping me in this work. I would also thanks to HOD of my Electronics and Communication department for his constant guidance and extensive support to encourage for this work.

References

1. Rashmitha R, Niran N, Abhinandan A, Mohammed A. Microstrip Patch Antenna Design for Fixed Mobile and

Satellite 5G Communications. Proceedings of the Third International Conference on Computing and Network Communications (2019), Science Direct, Procedia Computer Science. 2020;171:2073-2079.
2. Sodhi S, Chabra P. Effect and Design of Microstrip Patch Antenna with Defected Ground Structure. International Journal of Engineering Research & Technology. 2020;9:331-333.
3. Parasuraman S, Yogeeswaran S, Ramesh G.P. Design of Microstrip Patch Antenna with improved characteristics and its performance at 5.1GHz for Wireless Applications. IOP Conf. Series: Materials Science and Engineering 925 (2020) 012005,2020:1-8.
4. Skrivervik A, Bosiljevac M, Sipus Z. Fundamental limits for implanted antennas: Maximum power density reaching free space.IEEE Transactions on Antennas and Propagation, 10.1109/TAP.2019.2891697; c2019 Aug. p. 4978-4988.
5. Sowndarya R, Shanmuganantham T. Design of radome fss antenna for l-band, s-band, c-band and x-band application Inter. Conference on Communication and Signal Processing; c2019. p. 355-359. 10.1109/ICCSP.2019.8697936.
6. Kishore N, Upadhyay G, Tripathi VS, Prakash A. Dual band rectangular patch antenna array with defected ground structure for ITS application. International Journal of Electronics and Communications (AEU). 2018;96:228-227.
7. Naik K, Amala P, Sri V. Design of concentric circular ring patch with DGS for dual-band at satellite communication and radar applications. Wireless Pers Communication; c2018. 201710.1007/s11277-017-5012-7.
8. Girase K, Joshi M. Design of Wideband Monopole Square microstrip patch antenna. International Conference on Communication, Information & Computing Technology (ICCICT); c2018. 10.1109/ICCICT. 2018.8325886.
9. Gautam A, Verma S. Printed crescent-shaped monopole antenna with defected ground structure for wireless applications. 3rd Inter. Conference for Convergence in Technology (I2CT); c2018. p. 1-5. 10.1109/i2ct2018.8529707.
10. Golzari S, Rojhani N, Amiri N. Multiband low profile printed monopole antenna for future 5G Wireless Application with DGS. IEEE 4th International Conference on Knowledge-Based Engineering and Innovation (KBEI); c2017 Dec. p. 887-890.
11. Khandelwal MK, Kanaujia BK, Dwari S, Kumar S, Gautam AK. Analysis and design of dual band compact stacked Microstrip patch antenna with defected ground structure for WLAN/WiMax applications. International Journal of Electronics and Communications (AEU). 2015;69(1):39-47.
12. Guha D, Biswas M, Antar Y. Microstrip Patch Antenna with defected ground structure for cross polarization Suppression. IEEE Antennas and wireless propagation letters. 2005;4:455-458.
13. Garg M, Singh N. Rectangular Microstrip Patch Antenna. International Journal of Computer Science and Technology. 2015;6(4):253-257.
14. Khan WM, Gulhane SM. Related review on microstrip patch antennas. International Journal of Industrial Electronics and Electrical Engineering. 2015;3(1):12-15.
15. Sung Y. Bandwidth enhancement of a microstrip line-fed printed wide-slot antenna with a parasitic center patch. IEEE transactions on antennas and propagation. 2012;60:87-93.
16. Mehdi M, Taheri S, Hassani H, Nezhad A. UWB printed slot antenna with Bluetooth and dual notch bands. IEEE antennas and wireless propagation letters. 2011;10:255-258.
17. Kumar M, NathV. Analysis of low mutual coupling compact multi-band microstrip patch antenna and its array using defected ground structure. Engineering Science and Technology, an International Journal. 2016;19(2):866-874.
18. Deshmukh A, Mohadikar P, Lele K, Panchal G, Parvez A. PSI shaped ultra-wideband monopole antenna with modified feeding structure.6th International Conference On Advances In Computing & Communications (ICACC); c2016. p. 60-66.
19. Sharma B, Parmar G, Kumar M. Frequency Reconfigurable Microstrip Patch Antenna with Circular Slot for S-Band Application. IEEE International Conference on Computer, Communication and Control; c2014. 10.1109/ICRITO.2015.7359343.
20. Sarva E, Srinubabu_M, Rao RA. New 3-shape slot microstrip patch antenna with tapered step defected ground structures for wireless communication applications. IEEE International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET); c2016. 10.1109/WiSPNET.2016.7566511.
21. Tian L, Xue Z, Ren W. Stacked tri band microstrip patch antenna, IEEE 5th International Symposium on Electromagnetic Compatibility; c2017. 10.1109/EMC-B.2017.8260427.
22. Sung YJ, Kim M, Kim YS. Harmonics reduction with defected ground structure for a micro strip patch Antenna. IEEE antennas and wireless propagation letters. 2003;2:111-113.