Designing of Ground Slotted Rectangular Patch Antenna for S and Ku band with use of Ansoft HFSS Simulator

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***Abstract*- This paper focusses at the designing of patch antenna in rectangular shape which is suitable for operating at 2.45 GHz for S and Ku band applications. During the designing of patch antenna using coaxial feed technique which is considered with its defected ground based structure. It is observed and analyzed for its various characteristics of so prepared antenna. The antenna has multiband uses as it may be applied for 3.1 GHz , 16.54 GHz and 17.5 GHz .Its properties are in agreement when validated with standard parameters. The patch is designed onto a substrate of Rogers RT/duroid 5880. The designed antenna may be found as a useful device for modern and advanced communication systems.**

***Index Terms*- Microstrip patch antenna, DGS, coaxial feed**

I. INTRODUCTION

The rapid development in technology requires antenna that are light in weight and are cheap. Microstrip element contain a part of metal located on the ground called microstrip patch which is called substrate that is sandwiched between radiating patch and ground plane. The printed 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. ANSYS 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. In other words defect made on ground effectively changes capacitance and inductance by including slot resistance, capacitance and inductance.

II. ANTENNA

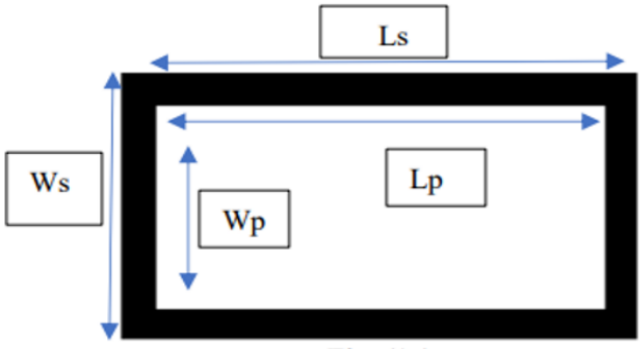

Figure 1: Front view of antenna

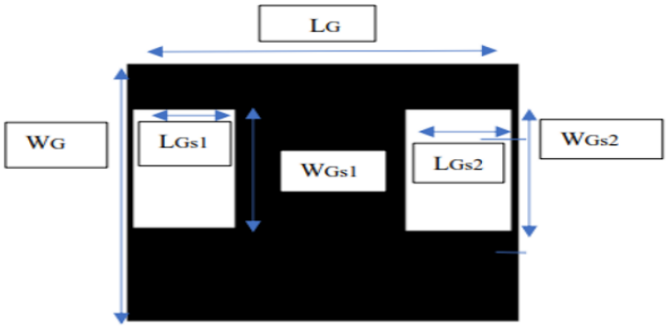

Figure 2: Ground view of antenna

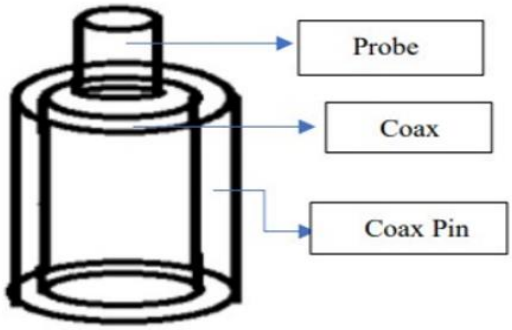

Figure 3: Coaxial feed

Table 1: Antenna Parameter Dimensions

Parameters		**Dimensions (cm)**
Ls	Substrate length	4.76
Ws	Substrate width	3.9
Ts	Substrate thickness	0.16
LG	Ground length	4.76
WG	Ground width	3.9
Lp	Patch length	4
Wp	Patch Width	3
LGS1	Length of ground slot1	1.2
WGS1	Width of ground slot 1	3
LGS2	Length of ground slot 2	1.2
WGS2	Width of ground slot 2	3
Rp	Radius of port	0.4

III. RESULTS AND OBSERVATION

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.

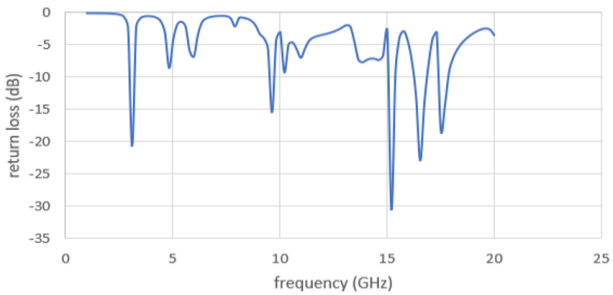

Figure 4: Return loss vs frequency

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.

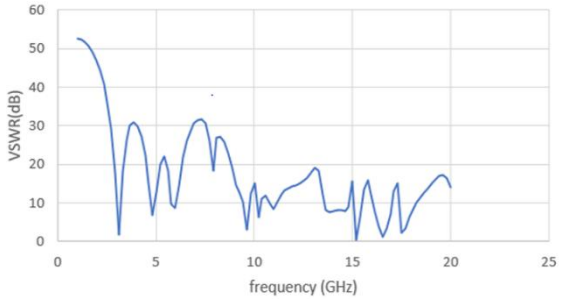

Figure 5: VSWR vs frequency

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.

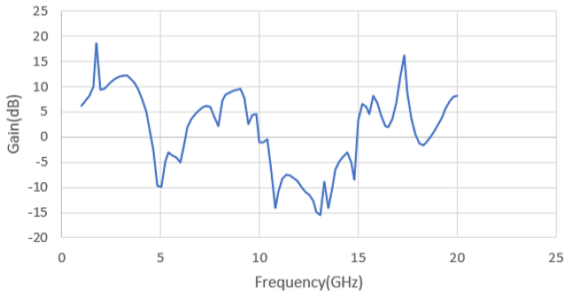

Figure 6: Gain vs frequency

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).

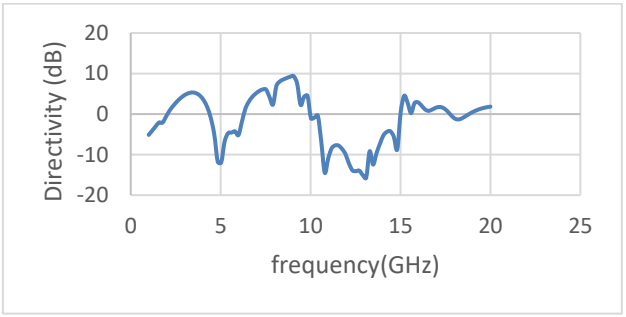

Figure 7: Directivity vs frequency

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.

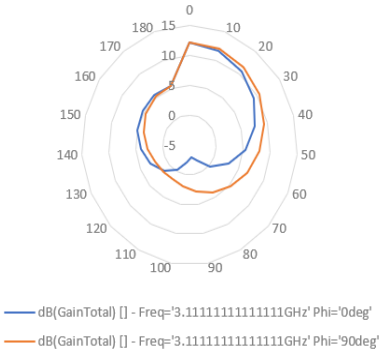

Figure 8: Radiation pattern

IV. DISCUSSION OF ANTENNA AT VARIOUS FREQUENCIES:

Table 2: Antenna Result at Various Frequencies

	3.1GHz	16.54GHz	17.5GHz
Return loss(dB)	-20	-22	-18
VSWR(dB)	1.6	1.2	2.1
Gain(dB)	12	1.9	8.8
Directivity(dB)	4.9	0.7	1.12

As per results this shows that in a single design we can obtain frequencies at different bands for S and Ku band.
Return loss [12] at 4.4 GHz was -28 dB & gain 2.70dB
Proposed antenna at 3.1 GHz was -20.6 dB & gain12.2 dB
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V. CONCLUSION:

From the above table, it can be shown that at frequency of 3.1 GHz,16.5 GHz and 17.5 GHz, a good gain of the designed antenna can be achieved such that the return loss is also very good with feasible directivity and VSWR. Thus this paper describes the designing of a defected ground rectangular patch antenna with coaxial feed and dimensions as described above having size of patch 4 cm x 3 cm and which is suitable for mobile communication, satellite communication, wireless LAN, Bluetooth and radar.

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REFERENCES:

[1] I. Ali and Y. Chang, "Design of dual-band microstrip patch antenna with Defected Ground plane for Modern Wireless Applications", IEEE 82nd Vehicular Technology Conference (VTC2015Fall), September 2015.
[2] I. Chang, B. Lee, "Design of defected ground structures for harmonic control of active microstrip antenna", 10.1109/APS.2002.1016779,vol.2,pp.852-855, February2002.
[3] H. Chiang and W.T. Kam, "Microstrip monopole antenna with enhanced bandwidth using defected ground structure" ,IEEE antennas and wireless propagation letters, vol. 7,pp.532-535, September 2008.
[4] H. Choi, J. Lim and C. Jeong, "A new design of doherty amplifiers using defected ground structure", IEEE microwave and wireless components letters,vol. 16, pp.687-689, December 2006.
[5] J. Costantine, Y. Kabalan, Hajj, M. Rammal, "New multi-band microstrip antenna design for wireless communications", IEEE Antennas and Propagation Magazine, vol. 49, pp. 181-186, December 2007.
[6] A. Deshmukh, P. Mohadikar, K. Lele, G. Panchal, A. Parvez, "PSI shaped ultra-wideband monopole antenna with modified feeding structure",6th International Conference On Advances In Computing & Communications(ICACC),pp.60-66, September 2016.
[7] K. Girase, M. Joshi, "Design of Wideband Monopole Square microstrip patch antenna", International Conference on Communication, Information & Computing Technology (ICCICT), 10.1109/ICCICT.2018.8325886, February 2018.
[8] A. Gautam, S. Verma, "Printed Crescent-Shaped Monopole Antenna with Defected Ground Structure for Wireless Applications",3rd International Conference for Convergence in Technology (I2CT), 10.1109/i2ct2018.8529707,pp.1-5, April 2018.
[9] U. Habib, M. T. Islam , M. R. Ahsan, J. S. Mandeep, N. Misran, "A dual band slotted patch antenna on dielectric material substrate", IEEE Hindawi Publishing Corporation International Journal of Antennas and Propagation, January 2014.
[10] Y. Horii and T. Makoto, "Harmonic Control by Photonic Bandgap on Microstrip Patch Antenna", IEEE microwave and guided wave letters, vol. 9, pp.13-15, February 1999.
[11] W. Houda, T. Khaoula, C. Mondher, " Design of rectangular microstrip patch antenna", 2nd International Conference on Advanced Technologies for Signal and Image Processing,10.1109/ATSIP.2016.7523197,pp.798-803, March 2016.
[12] C. Humberto, C. Fernandes, L. José, S. Almir, "Multi-frequency microstrip antenna using defected ground structures with band-notched characteristics ", XXXV SIMPÓSIO BRASILEIRO DE TELECOMUNICAÇÕES E PROCESSAMENTO DE SINAIS , 10.14209/sbrt.2017.83,pp.62-66, January 2017.
[13] M. Hussein ,Y. Huang , B. Al-Juboori, "A Multi-band High Selectivity Frequency Selective Surface for Ka-Band Applications",10th Global Symposium on Millimeter-Waves, 10.1109/GSMM.2017.7970280,pp.63-65, May 2016.
[14] M. Mehdi , S. Taheri, H. Hassani, A. Nezhad, "UWB printed slot antenna with bluetooth and dual notch bands", IEEE antennas and wireless propagation letters,2011,vol. 10, February 2011.
[15] K. Naik, P. Amala, V. Sri, "Design of concentric circular ring patch with DGS for dual-band at satellite communication and radar applications", Wireless Pers Communication ,201710.1007/s11277-017-5012-7, February 2018.
[16] D. Pozar, "Microstrip Antennas", Proceedings of the IEEE, vol. 80,pp.79-91, January 1992.
[17] F. Raval, Y .Kosta, J. Makwana, A. Patel, "Design & implementation of reduced size microstrip patch antenna with metamaterial defected ground plane", International conference on Communication and Signal Processing, 10.1109/iccsp.2013.6577040,pp.186-190, April 2013.
[18] B. Sharma, G. Parmar, M. Kumar, "Frequency Reconfigurable Microstrip Patch Antenna with Circular Slot for S-Band Application", IEEE International Conference on Computer, Communication and Control, 10.1109/ICRITO.2015.7359343, September 2014.

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[19] S. Golzari, N. Rojhani, N. Amiri, "Multiband Low Profile Printed Monopole Antenna for Future 5G Wireless Application with DGS",IEEE 4th International Conference on Knowledge-Based Engineering and Innovation (KBEI),pp.887-890, December 2017.
[20] E. Sarva ,M. Srinubabu, R.Rao, "A 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) 10.1109/WiSPNET.2016.7566511, March 2016.
[21] A. Skrivervik, M. Bosiljevac, Z. Sipus, "Fundamental limits for implanted antennas: Maximum power density reaching free space", IEEE Transactions on Antennas and Propagation, 10.1109/TAP.2019. 2891697,vol.67,pp.4978-4988, August 2019.

[22] S. Sanzgiri,W. Pottenger ,D. Bostrom, D. Denniston, R. Lee, "Active subarray module development for ka band satellite communication systems", Proceedings of IEEE Antennas and Propagation Society International Symposium and URSI National Radio Science Meeting 10.1109/APS. 1994. 407929,pp.860-863, June 1994.
[23] R. Sowndarya, T. Shanmuganantham, "Design of radome fss antenna for l-band, s-band, c-band and x-band application" , International Conference on Communication and Signal Processing,10.1109/ ICCSP.2019. 8697936,pp.355-359, April 2019.
[24] S. Sodhi, P.Chabra, "Effect and Design of Microstrip Patch Antenna with Defected Ground Structure", International Journal of Engineering Research & Technology ,Vol. 9 ,pp.331-333, February 2020.
[25] L. Tian, Z. Xue, W. Ren, "Stacked tri band microstrip patch antenna", IEEE 5th International Symposium on Electromagnetic Compatibility 10.1109/EMC-B.2017.8260427, October 2017.
[26] S. D Tugonski, S. D Waterhouse, "An aperture coupled stacked patch antenna with 50% bandwidth",IEEE10.1109/ APS.1996.549532, July 1996.
[27] Y. Sung, "Bandwidth enhancement of a microstrip line-fed printed wide-slot antenna with a parasitic center patch", IEEE transactions on antennas and propagation,vol.60,pp.87-93, April 2012.