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Analysis and Design of C Shaped Microstrip Antenna For Land C Band Application

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Abstract:
In wireless communication system compact antennas are required to minimize the size, hence these requirements can be overcome by microstrip antenna. The present study shows a design of rectangular microstrip antenna by loading rectangular slot in the form of C shape on the patch. The microstrip antenna is designed using slot loading technique, which is resonating at three different frequencies 1.40 GHz, 5.23 GHz and 5.88 GHz. The simulation software High Frequency Structure simulator used to simulate the design. Antenna dimensions of 8x4x0.16cms is fabricated using low cost FR_4 substrate and The antenna is working for triple band between 1.40 GHz to 5.88 GHz with virtual size reduction of 60 %, good return loss, gain and the impedance bandwidth is observed hence it shows the application in C and L band.

***Key Word**: C shaped slot, FR4 Substrate, HFSS and Multiband.*

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I. Introduction

In the field of communication, the role of transmitting and receiving information can be achieved by antennas. Microstrip antenna was first introduced by Decamps. The microstrip antenna is a planar antenna have low cost, compact as compared to the other antennas. But microstrip antenna has some limitation such as single band, low gain and lesser bandwidth etc., Using slot loading, shorting, multilayer are some of the techniques can be adopted to overcome the antenna limitations [1].

A microstrip antenna by loading rectangular slot in the form of Trishul shaped designed shows a wide band covering from 1.61 GHz to 17 GHz frequency [2]. A nearly square microstrip antenna with two half U shaped slots along with rectangular slots are loaded to obtain wideband and also give rise to higher order modes [3]. A compact reconfigurable microstrip antenna resonating at six different bands with good radiation efficiency between 80 % to 96 %. [4]. Another microstrip antenna with chair shaped patch with a defective ground structure in the form of U shaped found highest gain of 11 dB [5]. A C shape strip surrounding the square patch shows a very good efficiency of 78 % with the peak gain of 4.2 dBi and beam width of 90 degree 3dB [6]. Slit loaded microstrip antenna results in dual band in nature with a good return loss and gain. The slit was inclined at an angle 45-degree diagonal to the antenna patch [7]. A dual frequency microstrip antenna obtained by slit cut on the circular patch. Due to the slit cut the offset feed with matched input impedances is observed at TM_{11}, TM_{21} and TM_{02} which results two bands in nature [8]. Using a printed board CNC machine microstrip antenna is fabricated by loading two U shaped slot on the rectangular patch which is resonating at 1.8 GHz, 2.4 GHz and 3.5 GHz with gain of 7 to 9.5 dB [9]. A comparative study is done by adding rectangular, circular and annular ring shaped patch structures on microstrip antenna using cavity model technique two broad side radiating modes are found in rectangular microstrip antenna [10]. By adding a successive rectangular slots of different length with a square stub shows a broad band of 106.92 % [11]. In this proposed work the microstrip antenna is loaded with rectangular slot using FR4 as a substrate. The antenna is simulated using HFSS software which is resulting in triple band in nature with a gain of 6.19 dB and virtual size reduction of 60 % is achieved.

II. Antenna Design

The microstrip antenna is designed for resonating frequency 3.5 GHz to calculate length and width of the patch, substrate and the feed line. The calculated dimensions of microstrip antenna are 8 cms x 4 cms x 0.16 cms using quarter wave transformer feed with a low cost FR4 substrate. The conventional microstrip antenna is resonating at 3.27 GHz with the gain 2.58 dB having return loss of -14.8 dB. Table 1 below shows the dimensions of the basic antenna structure. Figure 1 shows the geometry of conventional microstrip antenna simulated using high frequency structure simulator Ansys software.

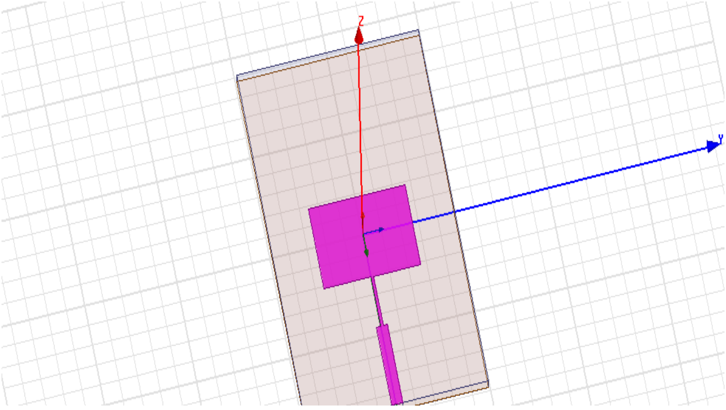


Figure 1: Shows the conventional antenna design

Table 1: Antenna Design Parameters.

Parameters	Dimensions
Width of the patch Wp	2.64 cms
Length of the patch LP	2.04 cms
Width of the substrate Ws	4 cms
Length of the substrate Ls	8 cms
Width of the quarter wave length Wtf	0.05 cms
Length of the quarter wave length Ltf	1.09 cms
Width of the feed Wf	0.3 cms
Length of the feed Lf	2.18 cms

III. Proposed antenna structure

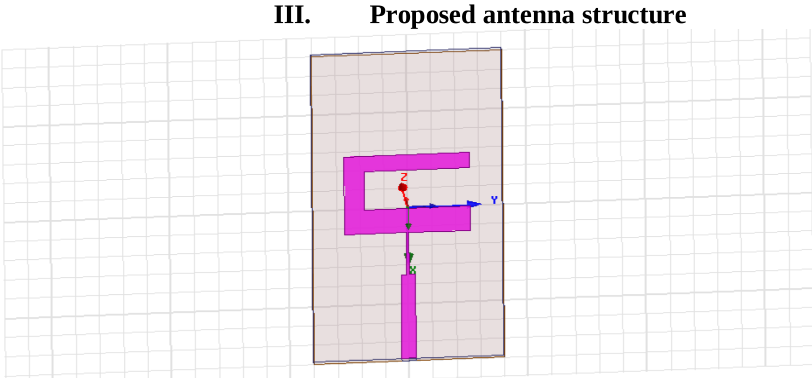


Fig 2. Structure of microstrip antenna with slot width 2.25 cms.

A rectangular slot is loaded on the microstrip patch of length L_1= 1 cms and W_1 = 0.05 cms which results in four bands, resonating at frequencies f_1 = 3.22 GHz, f2 = 6.44 GHz f3 = 7.72 GHz and f4 = 8.40 GHz with a gain of 1.95 dB. The width of the slot is varied in terms of 0.05 cms till 2.25 and the resulted variation in the resonant frequency, gain and virtual size reduction are observed. Figure 2 shows the proposed C shaped microstrip antenna structure. The rectangular slot on the patch shows better size reduction when the slot with is 2.25 cms having multiple bands with highest gain of 6.19 dB. As the width of the rectangular slot is increased the virtual size reduction increased from 8 % to 60 %. The parameters with variation on slot width is tabulated in the table 2.

Table 2: Comparison of parameters with the variation of the slot dimensions.

Sl. No	Slot Dimensions Keeping Ls = 1cms	Frequencies Bands	Virtual Size Reduction VSR	VSWR
01	W_s = 0.5cms	f_1 = 3.22 GHz f_2 = 6.44 GHz f_3 = 8.40 GHz	8%	1.64 1.47 1.63
02	W_s = 1 cms	f_1 = 2.98 GHz f_2 = 5.02 GHz f_3 = 6.15 GHz f_4 = 9.05 GHz	14.85 %	1.65 1.66 1.17 1.13

03	W_s = 1.5cms	f_1 = 2.62 GHz f_2 = 5.02 GHz f_3 = 5.90 GHz f_4 = 9.77 GHz	25.14 %	1.22 1.29 1.50 1.26
04	W_s = 2.0cms	f_1 = 2.23GHz f_2 = 4.82 GHz f_3 = 5.70 GHz f_4 = 9.57 GHz	36.28 %	1.03 1.13 1.59 1.10
05	W_s=2.22cms	f_1 = 1.40 GHz f_2 = 5.23 GHz f_3 = 5.88 GHz	60%	1.40 1.26 1.33

IV. Results and Discussion

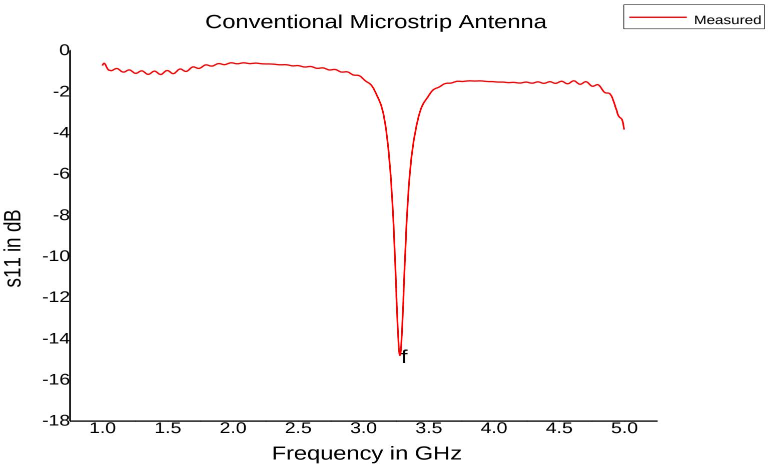
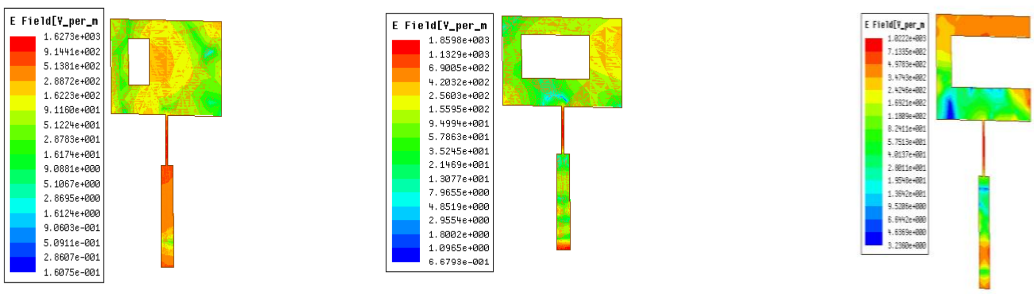


Figure 3: Frequency versus s11 graph for basic antenna.

The above graph shows the return loss of conventional microstrip antenna. The simulated antenna resonating at 3.37 GHz with -14.8 dB return loss and When the rectangular slots are loaded the current distribution path increases more in case of w = 2.2 cms (III Iteration) as compared with the I and II Iterations slot widths and is observed in the figure a b and c.



(a) I iteration (b) II Iteration (c) III Iteration

Figure 4: Current Distribution at width of rectangular slot (a) 0.05cms (b) 1.5 cms and (c) 2.25 cms

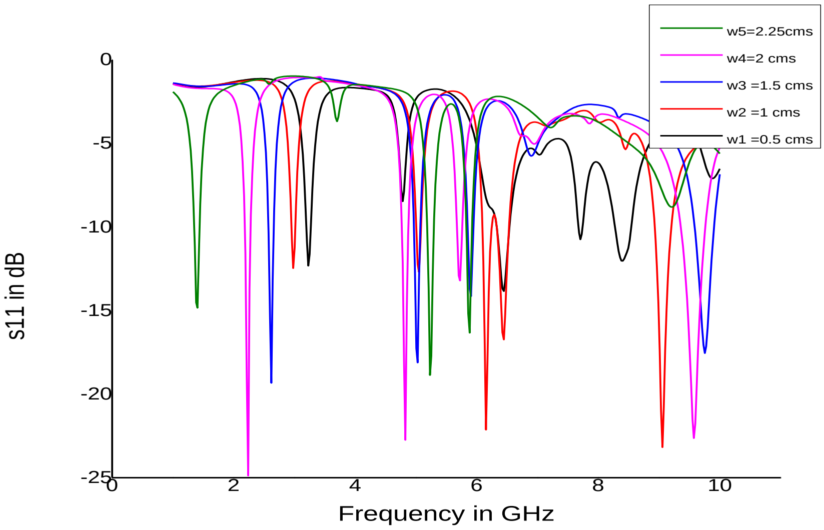


Figure 5: Frequency versus S11 plot for different width of the slots

In the Figure 5 it is observed that slot loaded microstrip patch antenna resonating at different frequency with the variation of slot width. The resonant frequency is reduced from 3.5 GH to 1.40 GHz in case of width is equal to 2.2 cms. The proposed antenna is resonating at three different frequencies f_1 = 1.40 GHz, f_2 = 5.23 GHz and f_3 = 5.88 GHz with the return loss -14.79 dB, -18.62 dB and -15.42 dB having impedance bandwidth BW_1 = 6.42 % GHz, BW_2 = 2.10 % and BW_3 = 1.89 % respectively.

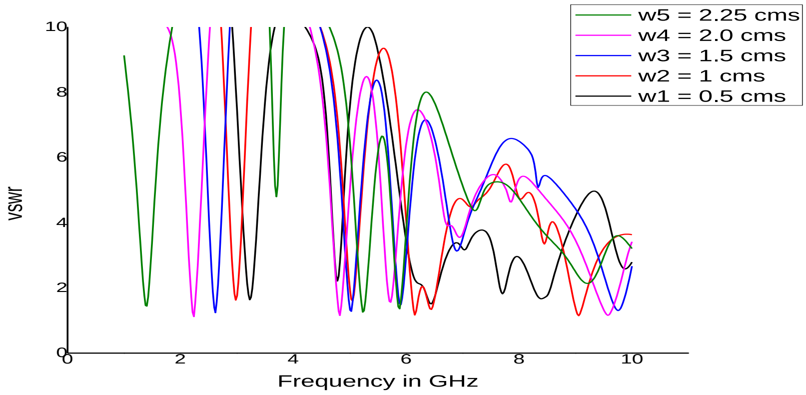


Figure 6: VSWR plot for C Shaped slot.

Figure 6 : VSWR plot. For different slot width variation and for the proposed antenna the VSWR obtained are V1 = 1.40, V2 = 1.26and V3 = 1.33

Table 3: Comparison of parameters with the existing work

Ref. No.	S Parameters in dB	Size Reduction	Gain in dB	Application
[12]	-10.66 dB	53 %	-	GPS
[13]	-15.43 dB	-	7.31	Wi-Fi and Wi-Max
[14]	-21.5 dB	-	4.8	WLAN
[15]	-32.80 dB	-	-	WiMAX, Wi-Fi and WLAN
[16]	-50 dB	-	2.50	Wide Band
[17]	-24.09 dB -23.09 dB	-	6.18 6.18	Wi-Max and WLAN
Proposed	-14.79 dB -18.60 dB -15.42 dB	60 %	6.19	WLAN,IEEE 802.11, military and satellite

Microstrip antenna embedded with C and H shaped slots results in size reduction of 53% and 62 % [12]. A novel microstrip antenna with C shaped patch has high gain of 7.31 dB covers bandwidth about 50% between 1 to 3 GHz frequency [13]. A C and H shaped slots are loaded on the microstrip antenna which is designed at 4.5 GHz frequency using line feed, it is found that C shaped antenna shows better gain and bandwidth as compared with the H shape. Three C shaped microstrip antenna resonating at 2.5 GHz shows bandwidth of 2500 MHz with SWR of 1.04 [15]. An extended C shaped antenna designed gives good bandwidth of 31.1 % with a gain of 2.50 dBi [16]. A unique double C slots loaded on the patch results in the gain of 6.18 Db with dual band in nature [17]. The references antenna gives wide bandwidth and high return loss with good gain but size reduction has not been achieved. But in the proposed antenna a triple band with good return loss as well as size reduction of 60 % having gain of 6.19 dB can be observed as shown in the table 3.

V. Conclusion

C shaped slot loaded microstrip antenna is designed using FR4 substrate. The designed antenna shows triple band in nature as compared with the conventional microstrip antenna. The antenna shows gain of 6.19 dB with virtual size reduction of 60% and having good return loss and impedance bandwidth. The antenna is resonating between 1.40 GHz to 5.88 GHz hence it finds application in WLAN IEEE 802.11, military and satellite application

References

[1]. C.A. Balanis Antenna Theory: Analysis and Design Wiley-Intersicence. 2012.

[2]. Apleen Kaur, Jaswinder Kaur, Naveen Kumar," Super Wide-Band Slotted Trishul-Shaped Microstrip Patch Antenna for Wireless Applications", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249-8958, Volume-8 Issue-5, June 2019.

[3]. Venkata A. P. Chavali and Amit A. Deshmukh," Half U slot and rectangular slots are loaded nearly square shaped microstrip antenna for wideband response"Progress In Electromagnetics Research Vol 104, 129-141,2020.

[4]. I.A. Shah, S. Hayat a, A. Basir a, M. Zada , S.A.A. Shah a , S. Ullah a , S. Ullah," Design and analysis of a hexa-band frequency reconfigurable antenna for wireless communication", I.A. Shah et al. / Int. J. Electron. Commun. (AEÜ) 98 (2019) 80–88.

[5]. Sachin Chetal1, Anil Kumar Nayak2 and R. K. Panigrahi3," Multiband antenna for WLAN, WiMAX and future wireless applications", URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019.

[6]. Zhao-Lin Zhang, Kun Wei, Jian Xie, Jian-Ying Li, and Ling Wang," New C-Shaped Parasitic Strip for the Single-Feed Circularly Polarized (CP) Microstrip Antenna Design", Hindawi International Journal of Antennas and Propagation Volume 2019.

[7]. Tilak Sarmah, Pranjal Borah and Tulshi Bezboruah," Design of a Dual-Band Rectangular Microstrip Patch Antenna with Diagonal Slit for Its Use in L- and S-Band Communications", © Springer Nature Singapore Pte Ltd. 2019.

[8]. Aarti G. Ambekar, Venkata A. P. Chavali, Ameya A. Kadam, Amit A. Deshmukh and K. P. Ray," Slit Cut Circular Microstrip Antenna for Multiband Response", © Springer Nature Singapore Pte Ltd. 2020.

[9]. Osama W. Ata∗, Mohammad Salamin, Khaleel Abusabha," Double U-slot rectangular patch antenna for multiband applications", 0045-7906/© 2020 Elsevier Ltd.

[10]. Jayanta Bhattacharya, Sudipta Maity," A Comparative Study between Rectangular, Circular and Annular Ring Shaped Microstrip Antennas", Proceedings of 2020 IEEE Calcutta Conference (CALCON).

[11]. Ramesh kumar verma and Dr. Srivastava,"Bandwidth Improvement Of Stub Loaded Compact Ultra Wide Band Microstip Antenna For C/X Band Application ", wireless personal communication 2021.

[12]. S.V. Saravanan, S. Sindhuja ,Miniaturisation Using Shorting Posts in C-Shaped and H-Shaped Microstrip Patch Antennas for GPS Applications, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7 Issue-5S2, January 2019.

[13]. Anamika Singh, Aadesh Arya & Sanjay Sharma, High Gain of C Shape Slotted Microstrip Patch Antenna for Wireless System, International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11 (2012)

[14]. K.Chandra Sekhararao1 ,Ch.Babu Design Of C-Shape Slot Microstrip Patch Antenna With Line Feed For WLAN Technology, IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 11, Issue 6, Ver. IV (Nov.-Dec .2016).

[15]. Diponkor Dutta, Avijit Hira, Fahim Asjad, and Tarique Ibne Haider, Compact Triple C Shaped Microstrip Patch Antenna for WLAN, WiMAX & Wi-Fi Application at 2.5 GHz,978-1-4799-6399-7/14/$31.00 ©2014 IEEE.

[16]. Dr. D.K.Srivastava, Diwakar Singh , Amit Kumar Gupta and R.K.Prasad, Design and Analysis Of Extended C-Shaped Microstrip Patch Antenna For Wideband Application, Conference on Advances in Communication and Control Systems 2013 (CAC2S 2013)

[17]. Pranaw Kumar, A vdhseh Kumar, Prapti Bhardwaj, Design of Double C-shaped Microstrip antenna for application in UWB region, This full-text paper was peer-reviewed and accepted to be presented at the IEEE ICCSP 2015 conference.

Mamatha A G, et. al. "Analysis and Design of C Shaped Microstrip Antenna For Land C Band Application." *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)* 16(3), (2021): pp: 46-50.