International Journal of Electronics and Communication Engineering (IJECE)
ISSN(P): 2278-9901; ISSN(E): 2278-991X
Vol. 5, Issue 4, Jun - Jul 2016; 1-8

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

A DUAL WIDEBAND STAIR SHAPE MICROSTRIP PATCH ANTENNA FOR C & X BAND

SUSHANT SHARMA[1] & GURPREET KUMAR[2]

[1]Department of Electronics and Communication Engineering, Lovely Professional University, Phagwara, Punjab, India

[2]Assistant Professor, Department of Electronics and Communication Engineering, Lovely Professional University, Phagwara, Punjab, India

ABSTRACT

This paper proposed a compact wideband microstrip patch antenna for C & X band applications to enhanced the bandwidth. The proposed antenna is designed for satellite communication and radar applications in C band (4 - 8 GHz) & X band (8 - 12 GHz). Simulation results shows that the proposed antenna covers a wide bandwidth of 6.59 GHz covering almost the entire C & X band frequency range. There is considerable reduction in overall size, improvement in bandwidth and gain using the proposed patch antenna with DGS. Overall dimensions of the proposed antenna are 32 mm × 32 mm.

KEYWORDS: C & X Band Micro Strip Patch Antenna, Radar, DGS

INTRODUCTION

In recent years as the demands of portable systems have increased, low-profile systems have drawn much interest from researchers. In recent wireless communication systems, dual band as well as single band behavior with good gain is the need. For designing such a low-profile communication systems, the size of the antenna is critical. Micro strip patch antennas are being used in several applications since last few decades and they have been very popular due to their features like low profile, less weight, conformal design, low cost, ease of fabrication and ease of integration into communication systems.[12]

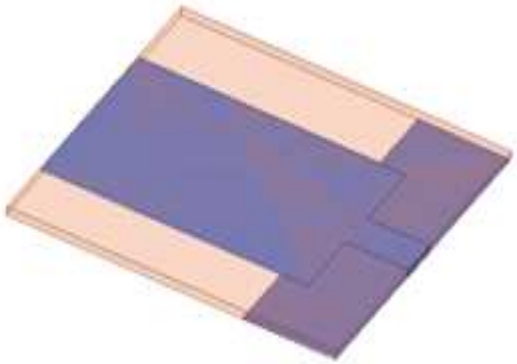
The miniaturization of antenna structure and improvement in its bandwidth can be obtained by using defected ground structure of proper dimensions[1]-[2]. C & X band technologies has been broadly used in various applications because of its high data transmission rate, large bandwidth & long range features. Designing antennas for C & X bands has compelled many researchers to pursue research work in this area and is still a major challenge to equalize these applications [3]. A microstrip patch antenna with circular and rectangular slots was proposed for enhancing bandwidth printed on FR4 substrate material in [1]-[3]. The antenna exhibited bandwidth of about 1.59 GHz as well as average peak gain 7.2dB. On the other hand, the dimension of this antenna was 40 mm × 40 mm[3].

In this paper, a micro strip patch antenna for C & X band applications has been proposed and investigated to increase the bandwidth and reduced size at the same time. The gain bandwidth has been enhanced by using DGS & stair shaped patch. The proposed antenna is compact, having a patch area less than that of a conventional micro strip patch antenna. Overall dimensions of the proposed antenna are 32 mm × 32 mm. There are several bandwidth enhancement techniques also available which are employed in patch design to achieve desired resonance and impedance bandwidth[4]-[9]. Introducing slots, using capacitive coupling are some of the techniques to enhance bandwidth [10]-[13].The Stair case shaped radiating patch help to improve the S11 at desire frequencies. The rest of the paper is organized as follows: Section

II presents the antenna structure and design of the proposed patch antenna. Detailed dimensions of basic patch antenna and proposed antenna are presented in this section. Simulation results are analyzed and discussed in Section III. Section IV gives the conclusion of the paper.

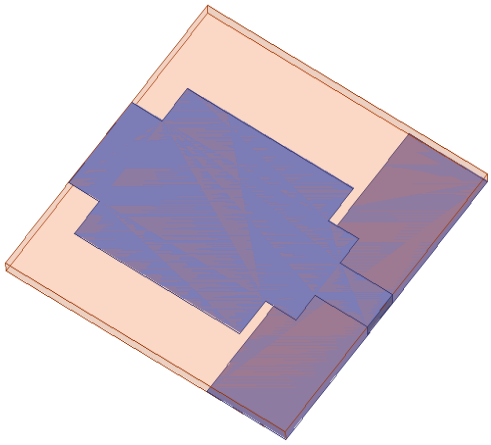
ANTENNA STRUCTURE & DESIGN

The design and Configuration of the proposed antenna is described here. Figure 1 shows 3D view of the proposed micro strip patch antenna in HFSS. All simulations were performed using Ansoft's HFSS software which is a finite element method electromagnetic solving software program. This makes geometry changes to the model easy and effortlessly. In its basic form, a micro strip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. Substrate Material: Roger RT/ Duroid 5880 having relative permittivity of 2.2, loss tangent 0.0009. Dimension: 32 x 32 mm with 0.8 mm thickness is used. The antenna comprises of two step stair shape on the top patch and reduced ground plane. Microstrip feed line is used to excite the proposed antenna. The dimensions of the feed line is optimized as per the lowest resonant frequency. The two step stair shape is helpful to obtain the better return loss value at the two resonant frequencies. The dimensions of the stair shapes are taking for better optimum results. The 3D design of basic patch and the stair shaped antennas is shown in Figure 1.



(a)

Figure 1: 3D View (a) Basic Patch Antenna



(b)

Figure 1: 3D View (b) Proposed Antenna with One Stair Shape Geometry

The detailed dimension of the proposed antenna with labeling is given below along with table 1 in Figure 2

Table 1: Detailed Dimensions of the Proposed Antenna

Parameter	Value (mm)
Length of Ground plane	32
Width of Ground Plane	32
Length of Top Patch	26
Width of Top Patch	18
Thickness of Substrate	0.8
Length of feed strip	6
Width of feed strip	4

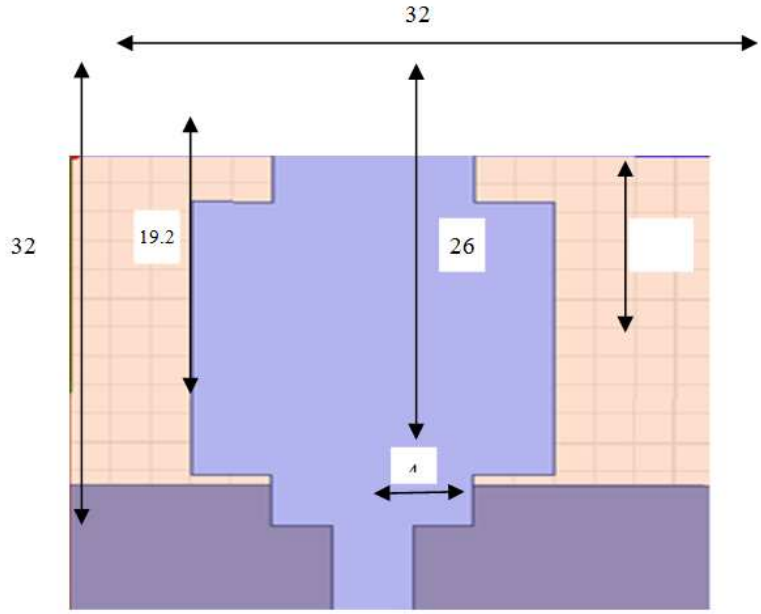


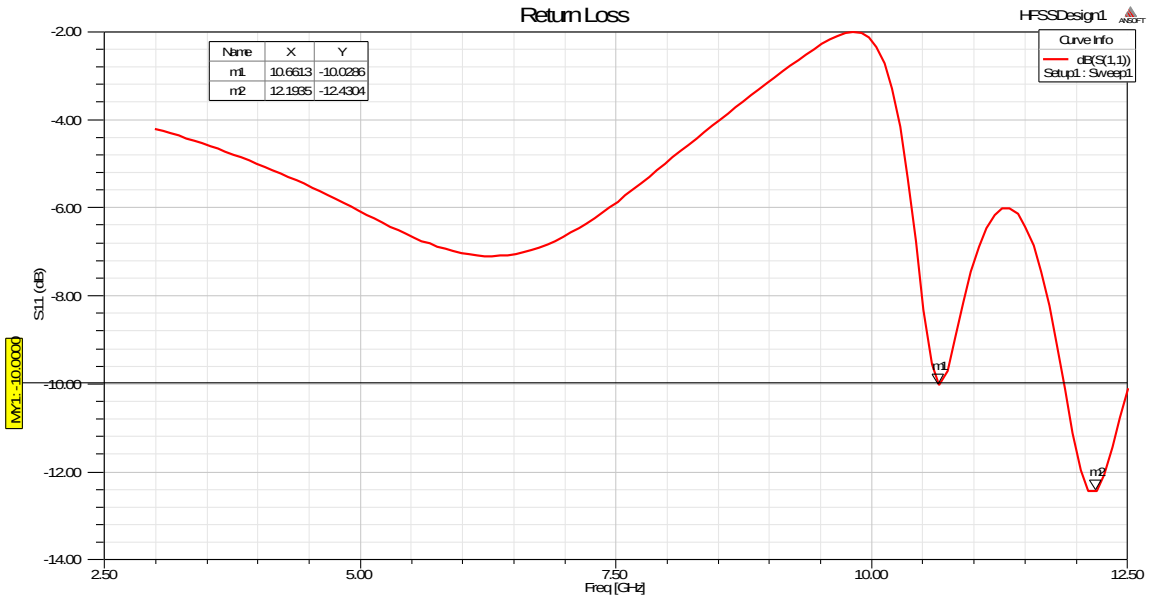
Figure 2: Detailed Dimension of Proposed Stair Shaped Antenna (in Mm)

The complete step wise design of wideband microstrip patch antenna with stair like geometries is given with proper dimensions. Figure 1(a) show the basic patch with defected ground plane. Figure 1(b) show the first modification in radiating patch of stair structure to get the wideband effect in the results. Figure 2 gives the detailed dimensions of all the parameters of the patch antenna with proper labeling.

RESULTS AND DISCUSSION

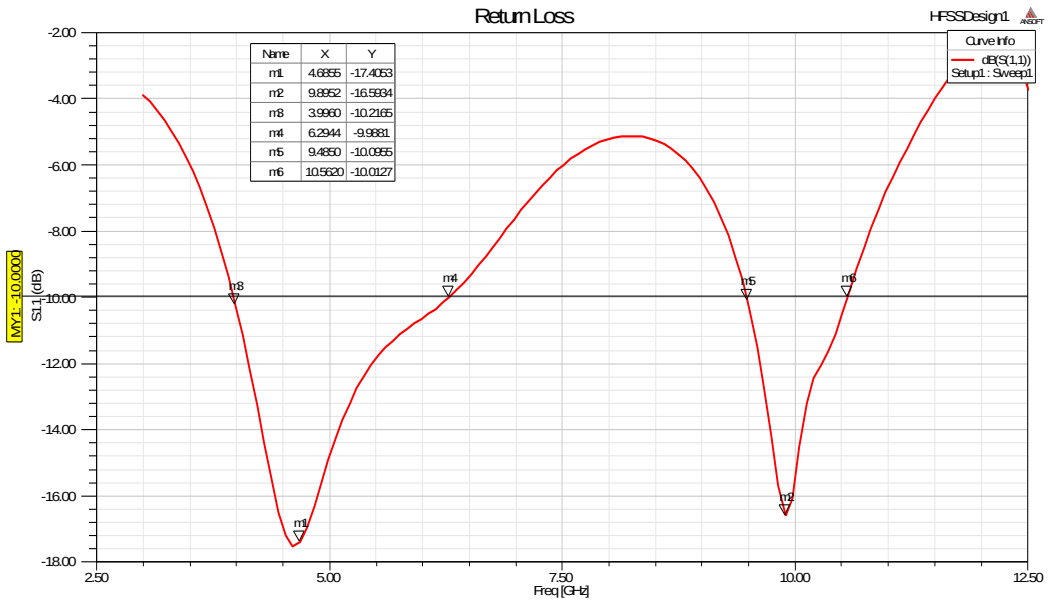
The simulated Return loss of the Basic patch antenna & Proposed antenna with one stair shape & proposed antenna is shown in Figure 3 (a), Figure 3 (b) & Figure 3(c). First of all we design the basic patch antenna the antenna basically radiate at nearly 12.3 GHz with return loss around - 12.2 dB but we cannot use this result for the practical application as the return loss of basic patch antenna is not giving any useful resonance in the frequency range of interest i.e. from 4GHz to 12Ghz. By modifying the shape of the patch into a stair shaped pattern we have observed two resonance peaks as show in Figure 3 (b) which are -17.92 dB and -16.25 dB are obtained at dual resonant frequencies at 4.68 GHz and 9.89 GHz respectively. The value of the return loss with one stair shaped geometry are -17.80 dB and -16.65 dB at resonant

frequencies 4.91 GHz and 9.89 GHz respectively. The radiation pattern of the proposed satellite communication antenna at resonant frequencies is shown in Figure 4. As a result, the radiation pattern of the proposed patch antenna is suitable for C & X band applications. Present patch antenna geometry shows better return loss, better bandwidth coverage and efficient VSWR than conventional microstrip antenna.



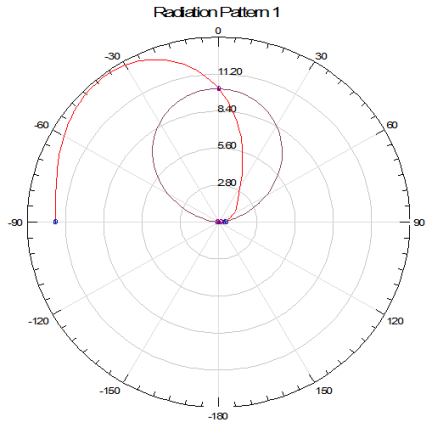
(a)

Figure 3: Simulated Return Loss (a) Basic Patch Antenna



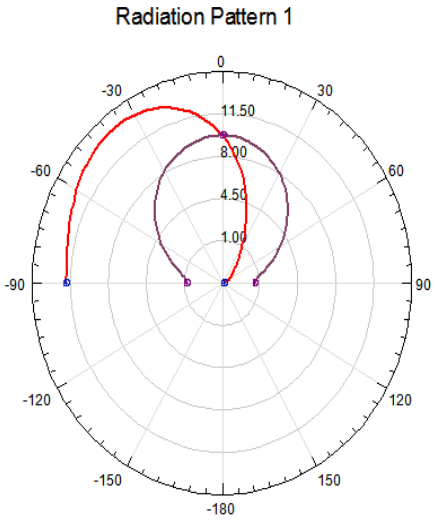
(b)

Figure 3: Simulated Return Loss (b) Proposed with One Stair Shape Geometry



(a)

Figure 4: Simulated Radiation Pattern (a) Basic Patch Antenna



(b)

Figure 4: Simulated Radiation Pattern (b) Proposed Antenna for Phi=0^0 & 90^0

Figure 5 indicates the voltage standing wave ratio (VSWR) of the proposed patch antenna. The assessment of VSWR is below 2 dB that are observed from the given plot clearly. It shows 2.18 dB and 2.26dB VSWR values at resonant frequencies 4.68 GHz and 9.89 GHz respectively. These value is effective for X & C band operation for any satellite communication and we can effectively used in any real operation of satellite communication.

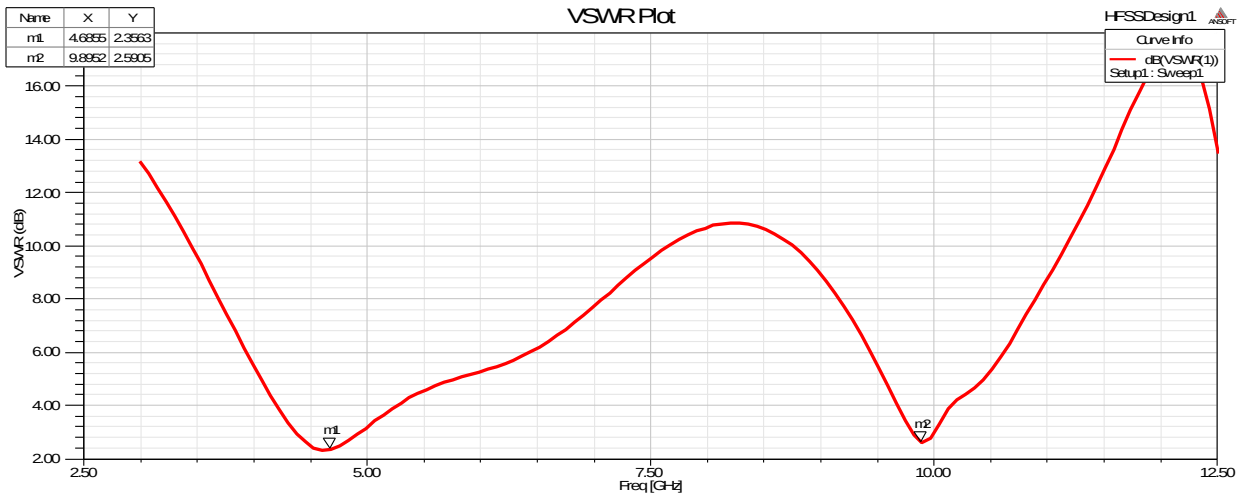


Figure 5: Simulated VSWR Plot of the Proposed Antenna

The given stair shape radiating patch antenna give the desirable and efficient result for two bands X and C. It also serve the basic requirement of high bandwidth as show in above results. The modification in ground plane and the above radiating patch helps to serve application in the domain of satellite communication.

CONCLUSIONS

A compact microstrip patch antenna with reduced size and improved wider bandwidth coverage has been designed and demonstrated in this paper. Simulation results indicate that all the parameters of the proposed microstrip patch antenna has considerably been improved by using DGS and stair case structure in top patch. As compared to the conventional rectangular patch antenna presented in the paper the proposed stair shaped antenna is showing significant improvement in bandwidth, VSWR having the same overall size. Overall dimensions of the proposed antenna are 32 mm × 32 mm. This antenna is suitable for its use in satellite communication systems. The proposed antenna is effectively serve the needs of wideband application system with having huge bandwidth in C & X band.

REFERENCES

1. J. X. Xiao, M. F. Wang, and G. J. Li, “A ring monopole antenna for UWB application,” Microw. Opt. Technol. Lett., vol. 52, no. 1, pp. 179-182, 2010.
2. Naser-Moghadasi, M.; Ebadifallah, E.; Katouli, M.; Sadeghzadeh, R.A.: A compact UWB Microstrip monopole antenna, with periodically defected ground structure. IEICE Electron. Express, 6 (19) (2009), 1402–1407
3. A. Srilakshmi, N.V. Koteswara Rao and D. Srinivasa Rao, “ X band printed microstrip compact antenna with slots in ground plane and patch”, IEEE Conference on recent advances in intelligent computational systems (RAICS), Trivandrum, 2011, pp.851-855.
4. Pan, C.-Y., "Dual wideband printed monopole antenna for WLAN/ WiMAX application", IEEE Antennas Wireless Propag. Letters, 6 (2007), 149–151.
5. Sukhdeep Kaur and Rajesh Khanna, "Design and analysis of stair-shape UWB antenna with flowery DGS", International Journal of Microwave and Wireless Technologies, Volume 7, Issue 01, pp 53 - 60, February 2015.

6. Melo DR, Kawakatsu MN, Nascimento DC and Dmitriev V. A planar monopole UWB antennas with rounded patch and ground plane possessing improved impedance matching. Microwave and Optical Technology Letters 2012; 54(2): 335-338.
7. Y. Sung, “Bandwidth enhancement of a microstrip line-fed printed wide-slot antenna with a parasitic center patch,” IEEE Trans. Antennas Propag., vol. 60, no. 4, pp. 1712–1716, Apr. 2012.
8. S. T. Fan, Y. Z. Yin, B. Lee, W. Hu and X. Yang, "Bandwidth Enhancement of a Printed Slot Antenna With a Pair of Parasitic Patches," in IEEE Antennas and Wireless Propagation Letters, vol. 11, no., pp. 1230-1233, 2012.
9. Hedfi, A.; Hayouni, M., "Band-notched UWB antennas: Recent trends and development," 14th Mediterranean Microwave Symposium (MMS), pp.1,4, 12-14 Dec. 2014.
10. Gupta, S.; Dhillon, S.S.; Khera, P.; Marwaha, A., "Dual Band U-Slotted Microstrip Patch Antenna for C Band and X Band Radar Applications," 5th International Conference on Computational Intelligence and Communication Networks (CICN), pp.41-45, 27-29 Sept. 2013.
11. J. Y. Sze and K. L. Wong, "Bandwidth enhancement of a microstrip line-fed printed wide-slot antenna", IEEE Trans. Antennas Propag., vol. 49, no. 7, pp. 1020-1024, 2001.
12. D.M Pozar and D.H Schaubert Ed., Micrsotrip Antenna, New York, IEEE press.
13. Debatosh Guha, Chandreyee Sarkar, Sumitra Dey, and Chandrakanta Kumar “Wideband High Gain Antenna Realized From Simple Unloaded Single Patch “IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 63, NO. 10, OCTOBER 2015