IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 19, Issue 1, Ver. IV (Jan.-Feb. 2017), PP 134 -138
www.iosrjournals.org

Rectangular Microstrip Antenna for S and L - Band Frequency

Ipsita Samal[1], Sudhansu Sekhar Khuntia[2]
[1]*(Department of Electronics & Communication Engineering, Gandhi Engineering College, India)*
[2]*(Department of Electronics & Communication Engineering, Gandhi Institute For Technology, India)*

Abstract: *Light profile, low weight, low cost fabrication, enhanced patch area reduction with improved bandwidth and gain are the key characteristics for the antenna designed for wireless communication applications under S and L band frequency spectra. Microstrip patch antenna (MPA) suits the features mentioned except for its narrow bandwidth and low gain. This paper experimentally investigates an approach to achieve enhanced patch area reduction (of 23 %) without increasing the complexity of MSA too much with improved impedance bandwidth, gain for applications such as WiMax services, UK fixed satellite services, aeronautical mobile application, maritime mobile services covering the microwave frequency range from 3 - 4 GHz. Experimental results of return loss, impedance bandwidth, radiation pattern, Smith chart characteristics and gain are discussed and presented.*
KeyWord*:Microstrip antenna, dual frequency, patch area reduction, WiMax, maritime mobile services, antenna gain .*

I. Introduction

Wireless communication systems cannot be imagined without an antenna and is one of the most vital and critical components for effective communication without wire.A well designed antenna can improve the overall performance of the wireless communication along with relaxing system requirements. The effective communication between wireless networks do not rely only on the efficient wireless equipments, such as, signal conditioning devices, transmitters and receivers etc., but also on the efficient antennas. Hence, MPA have found enormous potentiality (in its effectiveness) for their use in wireless communications systems due to several advantages such as low profile, conformability, low cost fabrication and ease of integration with the feed networks. While dealing with Gigahertz frequencies, such antenna finds a unique position in terms of design, manufacturing, and can be fabricated on the printed circuit board, which reduces the transmission line length between wireless devices and antenna significantly making it compact.

In recent times, antenna researchers have been concentrating on the slotted patch antennas which can provide improved bandwidth, gain with enhanced patch area reduction [1] - [3]. In design [4], wherein a triangular microstrip antenna fed through probe feeding technique, with 1Ω chip resistor loaded at one triangular tip with a high- permittivity ceramic superstrate achieved 5.65 % patch area reduction, with acceptable impedance bandwidth of 5.8 %. Hence, this paper investigates an approach with dual band property of MPA having achieved enhanced patch area reduction with improved bandwidth and gain. Such MPA is designed and fabricated on low cost FR4 material for use in applications under S and L band frequency spectraIndia.

II. Antenna Design Feature

The basic slotted Inverted Patch - Rectangular Microstrip Antenna (SIP-RMA) is designed for 3.85 GHz. The rectangular probe-fed patch is selected due to its ease of analysis and it is commonly used. The patch is excited with the 50Ω SMA connector. A FR4 dielectric superstrate having copper cladding thickness of 30 m thick is used. At lower frequencies, a thicker copper cladding is chosen because it is generally less expensive than a thinner cladding. Thin claddings are required only where dimensional tolerances are critical, for example at high frequencies or where narrow lines are used, because etching accuracy is of the order of the copper thickness [5]. An electrodeposited copper was chosen, since the surface roughness is not an important consideration at this frequency. The antenna dimensions are calculated and the equations that were used in the design are as mentioned in [6]-[9]. The calculated results serve as the starting parameters for the experimental analysis and the optimized configuration of this design is then used to fabricate the antenna.

Figure.1 depicts a view of proposed SIP-RMA, with width W = 23.28 mm and length L = 17.76 mm is supported by a FR4 dielectric superstrate with a dielectric permittivity of ϵ_r = 4.4 and thickness h = 1.66 mm, with air filled dielectric substrate ϵ_o
≈ 1 with a thickness of Δ = 8.5 mm is sandwiched between the superstrate and ground plane. An Aluminium plate with the dimension Lg = Wg = 40 mm having thickness of h1
=1 mm is used as a ground plane. The fabricated patch and the ground plane were fixed firmly together with plastic spacers along the four corners of the antenna.

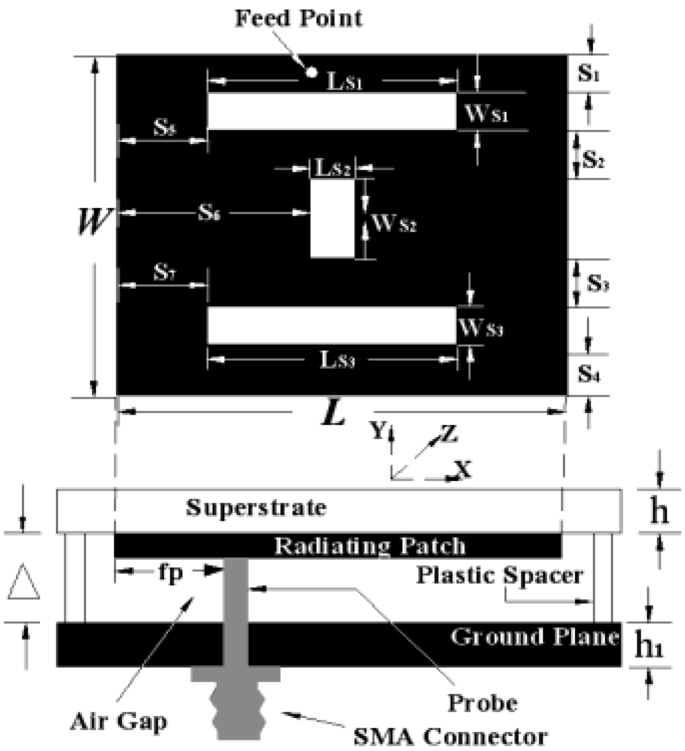

Figure 1 View of SIP-RMA

The Proposed patch antenna is designed to operate in the S- band and L-band frequency range. The artwork of the proposed antennas is carried out using AutoCAD 2008 software package to achieve better precision. The proposed patch integrates two rectangular horizontal slot having lengths Ls1= Ls3 =19.14 mm, and widths Ws1 = Ws3 =4.86 mm and a single rectangular vertical slots with length Ls2 = 0.2 mm and width Ws2 =6.51 mm and spacing maintained between slots are S1 = S4 = 4.17 mm, S2 = S3= 1.01 mm, S5 = S7 = 0.68 mm, S6 = 10.15 mm on the patch. The slots are cut in parallel to the radiating and non-radiating edge of the patch symmetrically with respect to the centerline (x and y-axis) of the patch. The dimensions of the slots are taken in terms λ0, where λ0 is the operating wavelength. The patch is fed by co-axial probe feed along the center line of Y-axis at a distance fp from the top edge of the patch as shown in Figure. 1. The location point of probe on the patch is selected based on the equations as mentioned in [10] along x and y-axis. When the patch is excited by such feed, a charge distribution is established between the ground plane and the underneath of the patch. The underneath of the patch is charged positive and the ground plane is charged negative after excitation by feed. The attractive forces are being setup between the planes i.e., patch underneath and the ground plane. Hence, patch antenna radiate in the due to the fringing fields between the underneath of the patch and the ground plane.

III. Result And Discussion

With the designed frequency of antenna at 3.85 GHz, the experimental results show that the antenna resonates at two distinct operating frequencies excited at 3.22 GHz and 4.31 GHz. The impedance bandwidth over return loss (RL) less than -10dB is measured for S and L band of frequencies. The antenna is tested using a Vector Network Analyzer (Rohde and Schwarz, Germany make ZVK model 1127.8651). The plot showing the variation of return loss (RL) versus frequency (f) of SIP-RMA is in Figure.2. It is clear that, when the multiple slots are cut on the patch and excited through probe fed mechanism, the antenna resonates at a lower fundamental resonance frequency at 3.22 GHz and 4.31 GHz which will result in dual band property compared to the designed frequency. Proposed patch antenna offered 23 % patch area reduction with improvement in impedance bandwidth of 9.40 % (at 3.22 GHz) and 3.70 % (at 4.31 GHz) at a return loss (RL) of – 20.50 dB and – 17.81 dB, with achieved gain of 8.83 dB and 2.62 dB for the proposed antenna.

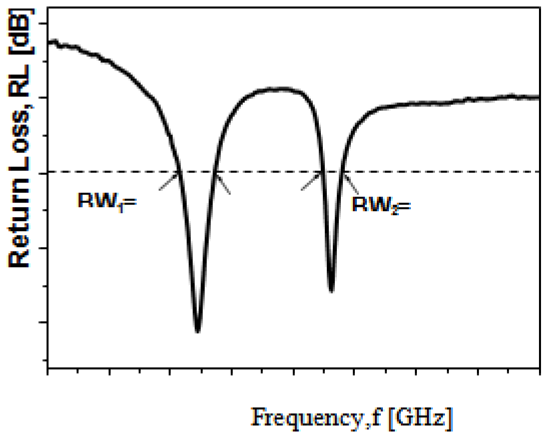

Figure 2 Variation of return loss Vs frequency of SIP-RMA.

The radiation patterns of the proposed antenna at the two operating frequencies are also measured and plotted. For the measurement of radiation pattern, the antenna under test (AUT), i.e., the proposed antenna and standard pyramidal horn antenna are kept in the far field region. The AUT, which is the receiving antenna, is kept in phase with respect to transmitting pyramidal horn antenna. The received power by AUT is measured from 0o to 180o with the rotational motion at steps of 10o each. Notable, it is seen that the antenna displays good broadside radiation patterns with linear polarized characteristics for both the resonating frequencies as shown in Figure 3. The half power beamwidths (HPBWs) of SIP-RMA are is9608o, 13o respectively.

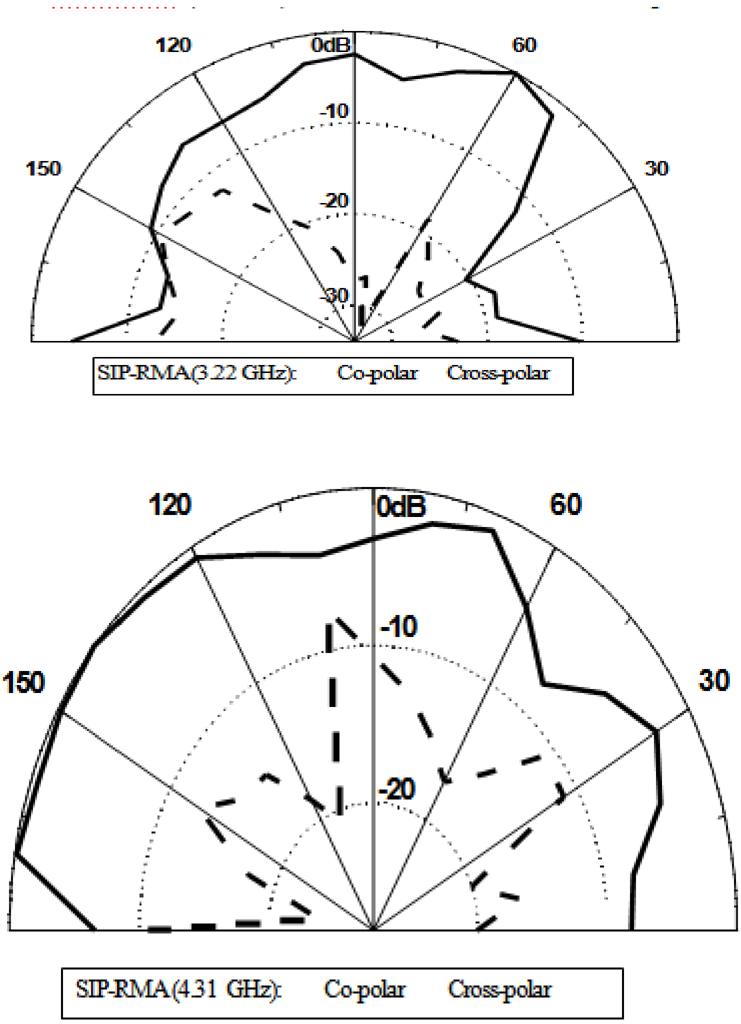

Figure 4 and 5 display antenna gain characteristics and Smith chart showing better input impedance matching behavior with the presence of two loops at the center, validating its lowest resonant dual frequency operation for the proposed antenna respectively. Figure 6 shows the measured VSWR characteristics and is found to be less than 1.5 at two resonant frequencies for the proposed antenna.

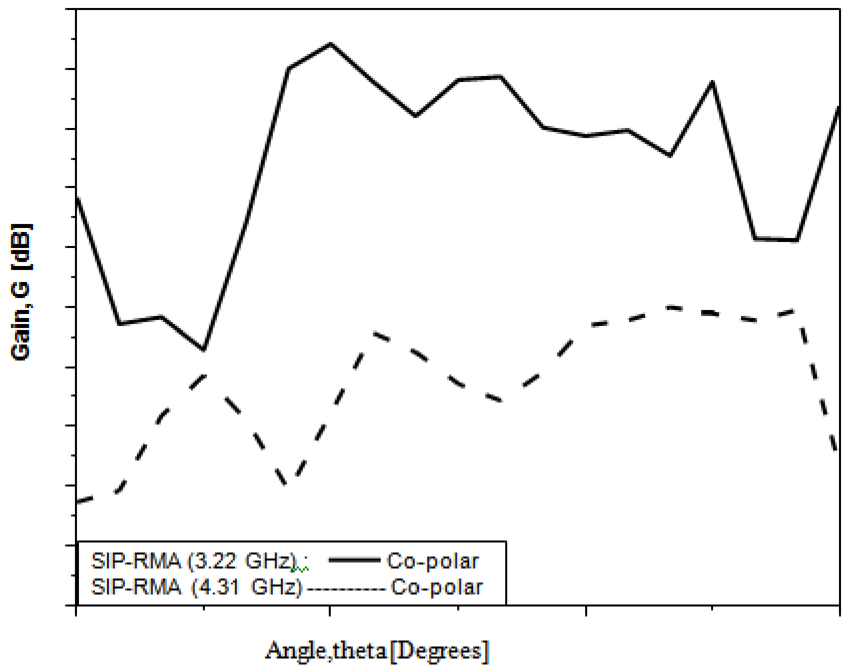

Figure 4 View of gain plot (SIP-RMA).

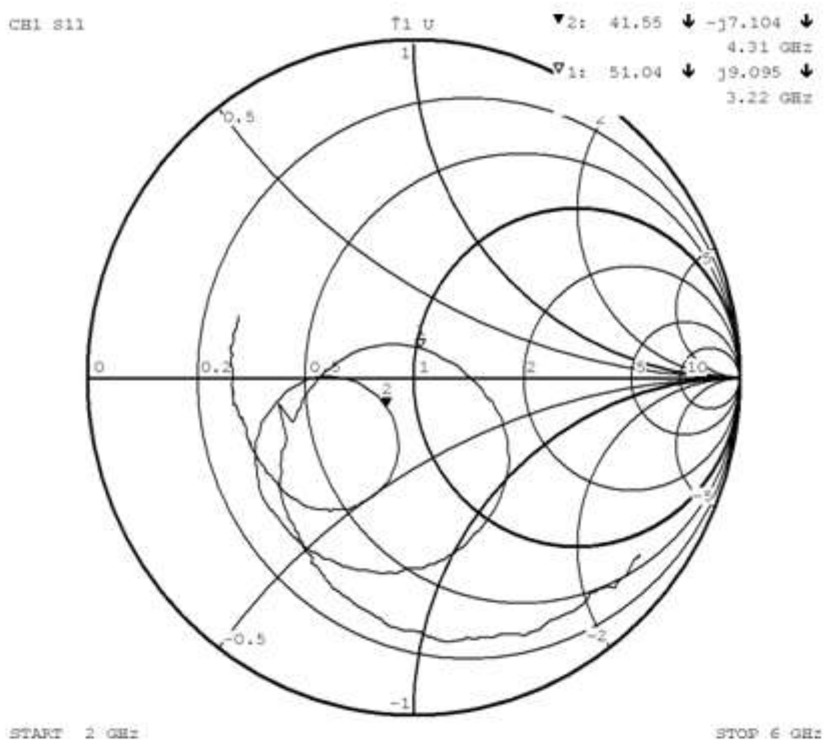

Figure 5 Smith chart characteristics (SIP-RMA).

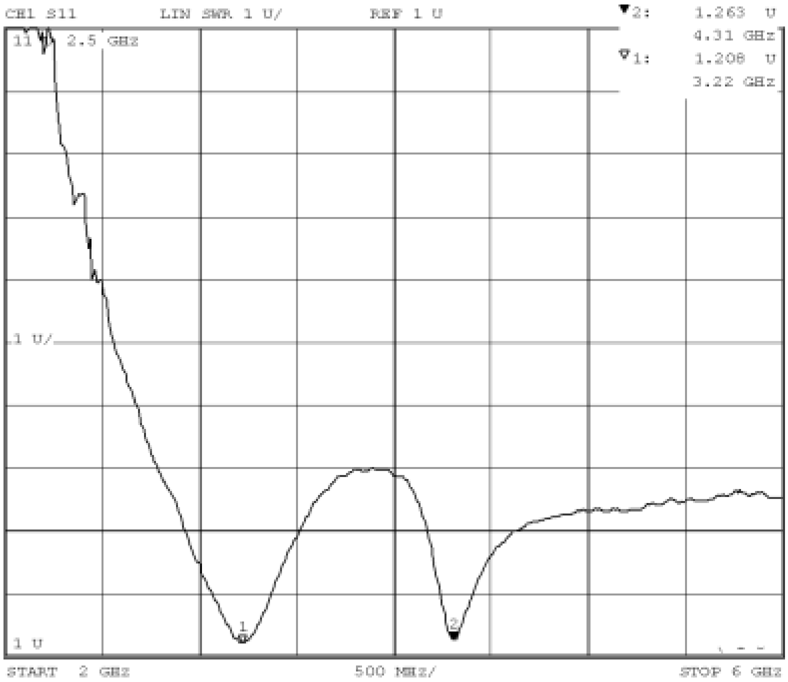

Figure 6 Measured VSWR characteristics.

IV. Conclusion

In this study, a new approach is employed to achieve dual band property covering S and L band microwave frequency range. It is verified that patch with the pair of slots makes the antenna reduced in its overall size. Results show that the proposed antenna achieves 23 % of patch area reduction with improvement in impedance bandwidth of 9.40 %, and a gain of 8.83 dB with broadsided radiation pattern. Proposed antenna finds application in WiMax operating in the frequency range of 3.3 – 3.6 GHz, and in UK fixed satellite services application, aeronautical mobile application and maritime mobile services (3 – 4 GHz).

References

[1]. Gao, S. C., L. W. Li, and M. S. Leong (2002), "Small dual- frequency micro- strip antennas," IEEE Transactions on Vehicular Technology, Vol. 51, No. 1, pp.28-36.

[2]. Lu, J.-H. (2003), "Broadband dual-frequency operation of circular patch antennas and arrays with a pair of L-shaped slots," IEEE Transactions on Antennas and Propagation, Vol. 51, No. 5, pp. 1018- 1023.

[3]. Guo, Y.-X., I. Ang, and M. Y. W. Chia (2003), "Compact internal multi- band antennas for mobile handsets," IEEE Antennas and Wireless Propagation Letters, Vol. 2, pp.143-146.

[4]. Cheng-shong H (1999), "Gain enhanced broadband microstrip antenna", Proc.Natl.Sci.Counc.Roc(A),Vol.23, No.5, pp. 609-611.

[5]. T. S. Laverghetta (1996), Practical Microwaves, Prentice Hall, Englewood Cliffs, N.J.Kumar G., Ray K.P (2003), Broadband Microstrip Antennas, ArtechHouse, Inc, London.

[6]. Nirun, K., N. Chalermpol, and T. Taspong (2001), "Parametric study of the rectangular microstrip antenna with an air gap," R&D Journal, Vol. 24, No. 2, King Mongkut's University of Tech-nology Thonburi, 131-142, Bangkok.

[7]. Jackson, D. R. and N. Alexopoulos (1991), "Simple approximate formulas for input resistance, band- width and effciency of a resonant rectangular patch," IEEE Transactions on Antennas and Propagation, Vol. 39, No.409.

[8]. Balanis, C. A., Antenna Theory: Analysis and Design (2005), John Wiley & Sons, Inc, USA.

[9]. Kara, M., "The Resonant frequency of Rectangular Microstrip Antenna Elements with various substrate thickness" (1996), Microwave opt. Technical lett., Vol.12, pp.234 – 239