Design of W-shape Compact Rectangular Microstrip Patch Antenna for Bandwidth Enhancement

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Abstract: - In today's scenario there has been a huge demand for wireless applications . Antennas used in these applications require being low profile, light weight, easily mountable and broad bandwidth. Amongst all these broad bandwidth is the main concern as Microstrip patch antenna has all the features mentioned above except for its narrow bandwidth, which is typically from less than 1% to several percent. This paper introduces an alternative approach in enhancing the bandwidth of the Microstrip patch antenna with promising efficiency for wireless applications. A W-shape Microstrip patch antenna, operating at a particular frequency 2.75 GHz is proposed. A W-shape probe feed antenna with ground plane connected (finite ground) improves the bandwidth to an appreciable 27.27 % in the frequency range of 2.4 GHz to 3.25 GHz. The antenna has been designed and simulated using Commercial Electromagnetic Simulator IE3D V9.0. The enhanced bandwidth, high efficiency, return loss, directivity, gain are achieved for the proposed antenna.

Index Terms: - Bandwidth, directivity, dielectric, antenna efficiency, gain, impedance, microstrip patch antenna, return loss, wideband.

I. INTRODUCTION

The research in wireless communication has spurred the development of extra ordinary range of antennas, each with its own advantage and limitations. Original microstrip antenna configurations have some drawbacks of low efficiency, poor polarization, spurious feed radiation, low power capacity, tolerance problems, narrow bandwidth (3-6%) of the central frequency, its bandwidth is limited to a few percent which is not enough for most of the wireless communication systems nowadays. Broad bandwidth is the main concern as Microstrip patch antenna has all the features like being low profile, light weight, easily mountable except for its narrow bandwidth, typically from less than 1% to several percent. This is one of the problems that researchers around the world have been trying to overcome. Much of the development work in microstrip antennas has thus gone into trying to overcome these problems so as to satisfy increasingly stringent systems requirements. Thus a lot of efforts have resulted in the development of accurate and versatile analytical models of microstrip antenna configurations for the understanding of the inherent limitations of microstrip antennas, as well as for their design and optimization. Thus size reduction and bandwidth enhancement are becoming major design considerations for practical applications of microstrip antennas.
Hence, throughout the years, au-thors have dedicated their investigations to create new designs or modifications to the original antenna in order to produce antenna with wider bandwidths.

A MICROSTRIP ANTENNA (MSA) in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side.The basic configuration of a microstrip antenna is a metallic conducting patch printed on a thin, grounded dielectric substrate. Originally, the element was fed with either a coaxial line through the bottom of the substrate, or by a coplanar micro strip line allows feed networks and other circuitry to be fabricated on the same substrate as the antenna element. The microstrip antenna radiates a relatively broad beam broadside to the plane of the substrate. Thus the micro strip antenna has a very low profile, light weight and can be fabricated using printed circuit techniques which implies that the antenna can be made conformable, and at a very low cost. Other advantages include easy fabrication and easy integration with microwave integrated circuits.

The electromagnetic simulation of the proposed antenna has been carried out using IE3D software of Zeland Software. VSWR, input impedance, return loss, smith chart, directivity, antenna gain, radiating efficiency and radiation pattern etc. can be evaluated using IE3D software.

II. ANTENNA DESIGN SPECIFICATIONS

In this proposed antenna design, formation of W- shape on patch layer gives very effective results in all its radiation parameter along with enhancement in its bandwidth which is our main concern. Fig. 1 shows the proposed W-shape rectangular microstrip patch antenna design. The proposed antenna operates in triple band. In the first band, the antenna operates at resonance frequency f_c = 2 GHz giving 12.5% bandwidth in the frequency range of 1.8 GHz to 2.1 GHz. In second band, the antenna operates at resonance frequency f_c = 2.75 GHz and the proposed antenna design gives enhanced bandwidth with 27.27 % in the frequency range of 2.4 GHz to 3.25 GHz with feed point locations = (-11.575, -12.45). In the third band, antenna operates at resonance frequency f_c = 3.8 GHz giving 19.73 % bandwidth in the frequency range of 3.6 GHz to 4.45 GHz. But keeping in mind the bandwidth concern & other antenna parameters such as return loss, impedance matching, directivity, gain it is suitable if the antenna is made to operate in the second frequency band as it is giving the better results. Hence second frequency band is used. Fig. 2 shows the variation of return loss with frequency of proposed W-shape antenna design. Fig. 3 shows the impedance loci of proposed W-shape antenna. Fig. 4 shows the variation of directivity vs frequency of proposed W-shape antenna. Fig. 5 shows the Antenna & radiating efficiency of proposed W-shape antenna. Fig. 6 shows the gain of proposed W-shape antenna.

The dimensions (all in mm) of the proposed design are as follows:

1. Top Surface =1.6
2. Dielectric constant =4.4
3. Loss tangent =0.02
4. Length of the patch =30
5. Width of the patch =30
6. Length of the ground =45
7. Width of the ground =45

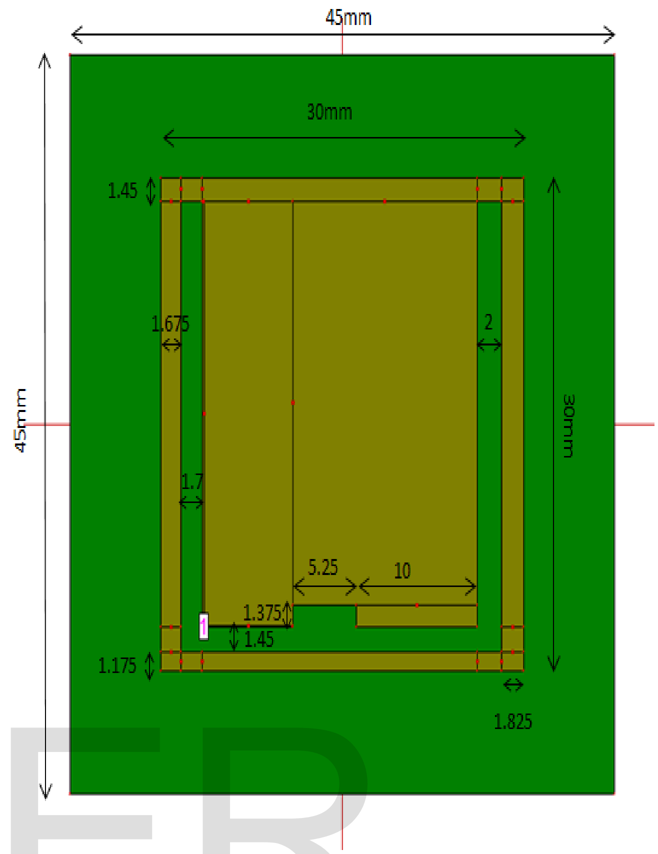

Fig. 1: Proposed W-shape rectangular microstrip patch antenna design (all dimensions in mm).

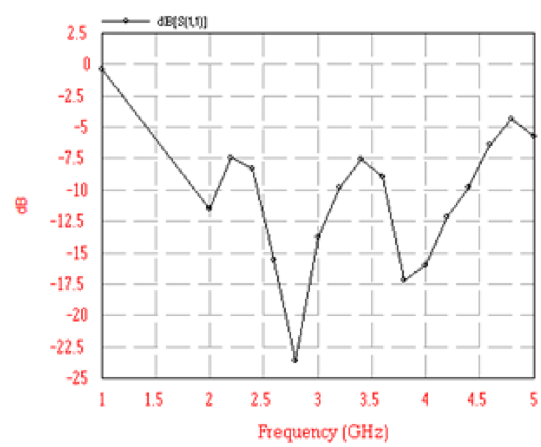

Fig. 2: Variation of return loss with frequency of proposed W-shape antenna.

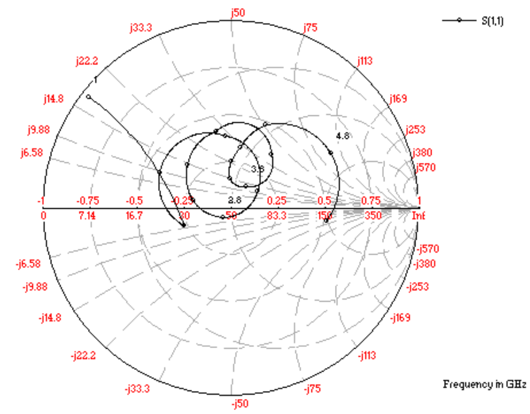

Fig. 3: Impedance Loci of proposed W-shape antenna.

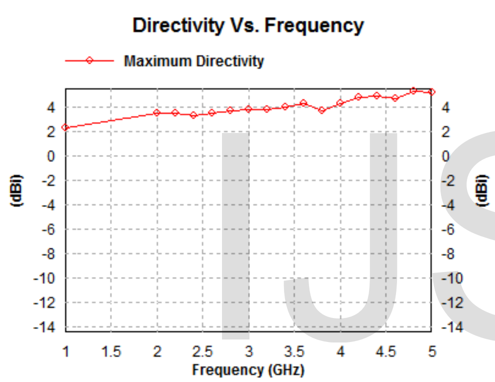

Fig. 4: Directivity vs. Frequency of proposed

W-shape antenna.

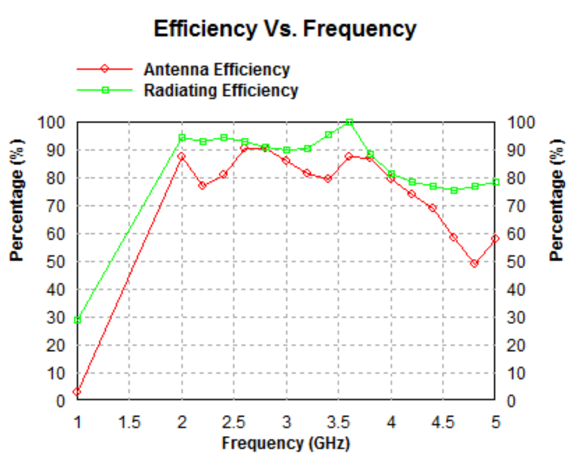

Fig. 5: Antenna & radiating efficiency of proposed W-shape antenna.

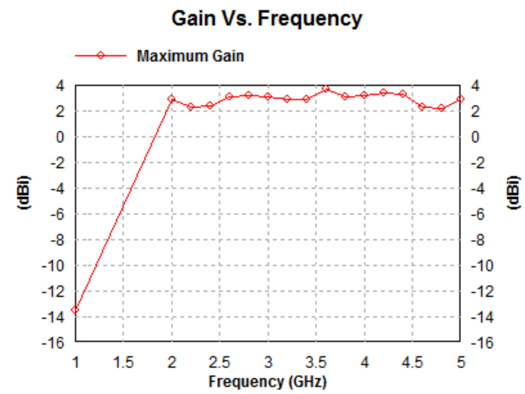

Fig. 6: Gain of proposed W-shape antenna.

III. Result and Discussions

The simulation results of the proposed antenna have been carried out by using IE3D software. The W-shape rectangular microstrip patch antenna of the proposed design gives enhanced bandwidth of **27.27 %** which is very good increment in the bandwidth. After simulating & analyzing all the parameters the antenna is acceptable for various wireless communication applications.

References

[1] Maci, S. and G.B. Gentilli, "Dual Frequency Patch Antenna," *IEEE A P Magazine*, Vol. 39, December 1997, pp. 13-17.
[2] Chen, J.S., and K.L.Wong, "A Single-Layer Dual–Frequency Rectangular Microstrip Patch Using a Single Probe Feed," *Microwave Optical Tech. Letters*, Vol. 11, No. 2, 1996, pp. 83-84.
[3] Deepkumar, M., et al., " Broadband Dual Frequency Microstrip Antennas," *Electronics Letters*, Vol. 32, August 1996, pp. 1531-1532
[4] Alok Agawal, Siddiqui Naushad Ather, Alok kushwaha, P.K Singhal, *Bandwidth enhancement of compact a Microstrip Antennas*, IJARCSEE, Vol-1,Issue-6, August 2012.
[5] Pozar, D.M. and D.H.Schaubert, *Microstrip Antennas: The Analysis and Design of Microstrip Antennas and Arrays, New York: IEEE Press, 1995.*
[6] Milligan, T. A., *Modern Antenna Design*, John Wiley & Sons, Hoboken, New Jersey, 2005.
[7] Garg, R., P. Bhartia, I. Bahl, and A. Ittipiboon, *Microstrip Antenna Design Handbook*, Artech House, Boston, London, 2001.
[8] Wong, K. L., Compact and Broadband Microstrip Antenna, John Wiley & Sones, New York, 2002.
[9] Nakano, H., and K.Vichien, " Dual Frequency Square Patch Antenna with Rectangular Notch," *Electronics Letters*, Vol. 25, August 1989, pp. 1067-1068.
[10] Ray, K. P., S. Ghosh, and K. Nirmala, "Multilayer multi resonator circular microstrip antennas for broadband and dualband operations," *Microwave and Optical Technology Letters*, Vol. 47, No. 5, 489–494, Dec. 2005.

[11] Palit, S.K., A. Hamadi, and D.Tan, "Design of a Wideband Dual-Frequency Notched Microstrip Antenna," *IEEE AP-S Int. Symp. Digest*, 1998, pp. 2351-2354
[12] Ghassemi, N., M. H. Neshati, and J. Rashed-Mohassel, "A multilayer multiresonator aperture coupled microstrip antenna for ultra wideband operations," *Proc. IEEE Applied Electromagnetic Conference 2007*, Kolkata, India, December 19–20, 2007.
[13] Zehforoosh, Y., C. Ghobadi, and J. Nourinia, "Antenna design for ultra wideband applications using a new multilayer structure," *PIER Online*, Vol. 2, No. 6, 544–549, 2006.
[14] Kim, T., J. Choi, and J. S. Jeon, "Design of a wideband microstrip array antenna for PCS and IMT-2000 service,"
[15] *Microwave and Optical Technology Letters*, Vol. 30, No. 4, 261–265, Aug. 2001.
[16] Jazi, M. N., Z. H. Firouzeh, H. Mirmohammad-Sadeghi, and G. Askari, "Design and implementation of aperture coupled microstrip IFF antenna," *PIER Online*, Vol. 4, 61–68, 2008.