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Design and Analysis of UWB Microstrip Patch Antenna

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Abstract

In this project we have proposed a CPW-Fed Microstrip patch antenna which is specially designed for UWB applications. Antenna rectangular slot is considered for this design. CPW is the feeding comprising of a side-plane conductor as ground and a center strip carrying the signal. This slot works as a radiator. The bandwidth of proposed antenna resides in the band of UWB specified by FCC for commercial use range from 3.1 GHz to 10.6 GHz. But we have excluded a small range of bandwidth approximately 5.1-6 GHz which is the bandwidth for WLAN signals so that this antenna works fluently in the ultra-wide band gap without any interference in WLAN frequencies. First, a conventional rectangular slot antenna is designed and then the rectangular shape is modified by a self-inverted configuration to achieve higher bandwidth. To improve the gain and efficiency, modification has been done. Primary aim throughout this project tenure was to achieve maximum S - parameter frequencies below -10 db in order to get best efficiency. The antenna was designed and simulated using Zeland IE3D for the results of return loss, gain, efficiency, radiation pattern (2D & 3D),current view in the antenna, total field and s - parameter. All the modifications of the design were also done on the same software.

Keywords

Ultrawide Band, Microstrip Antenna ,Geometry, Analysis, Results, Zealand IE 3 D.

1. Introduction

In recent years, microstrip patch antennas are becoming attractive for use in wireless communication systems [1-8] including ultra wideband (UWB) [9-13] systems due to their attractive merits of simple structure and low profile Ultra-wideband communications is fundamentally different from all other communication techniques because it employs extremely narrow RF pulses to communicate between transmitters and receivers. UWB technology can be widely used in ground penetrating radars, high data rate short wireless local area communications, parking radars, and other military applications. Recently, it has been demonstrated that a patch monopole antennas are promising candidates for the UWB applications. But it needs the improvement of impedance matching over the desired frequency. Various techniques to improve the matching over the desired band have been proposed. These include the use of feed gap optimization, bevels, ground plane shaping, multiple feeds, and offset feeding techniques. Planar monopole antennas are able to radiate bi-directional radiation patterns with larger bandwidths. Patch can take various configurations such as rectangle, circular, diamond etc. Coplanar waveguide (CPW) feeding is supposed to be better candidates because of their simple configuration, manufacturing advantages, repeatability and low cost.

CPW-fed slot antennas shave been studied extensively [4-5]. The electric field lines in the two CPW apertures excite the two slots of the antenna and the radiated field of the antenna is linearly polarized along the width of the slot. In this paper, the design of a CPW -fed monopole patch antenna is proposed, where the patch is of diamond shape.

Here, the bandwidth of the antenna is defined as the frequency range in which the return loss of the antenna is –10 dB. The bandwidth of this microstrip patch antenna is more than twice that of CPW -fed microstrip rectangular slot antenna. Analysis of the proposed antenna is done using the IE3D simulation software.

2. Coplanar Waveguide Feed Structure

Feed line is one of the important components of printed antenna structure. One type of feed line that is becoming popular apply to printed antenna is coplanar waveguide structure. The coplanar waveguide was proposed by C.P. Wen in 1969. A coplanar waveguide structure consists of a median metallic strip of deposited on the surface of a dielectric substrate slab with two narrow slits ground electrodes running adjacent and parallel to the strip on the same surface. This transmission line is uniplanar in construction, which implies that all of the conductors are on the same side of the substrate.

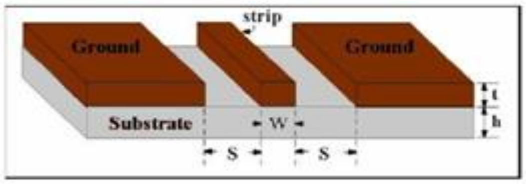

Figure 1: Structure of Coplanar Waveguide Feed

They have many features such as low radiation loss, less dispersion, easy integrated circuits and simple configuration with single metallic layer, and no via holes required. The CPW fed antennas have recently become more and more attractive because of its some more attractive features such as wider bandwidth, better impedance matching, and easy integration with active devices or monolithic microwave integrated circuits. Etching the slot and the feed line on the same side of the substrate eliminates the alignment problem needed in other wideband feeding techniques such as aperture coupled and proximity feed.

3. Geometry of UWB Patch Antenna

The antenna geometry is shown in Fig.2. The total length of the antenna L is 29 mm and the width of antenna W is 33mm. This antenna designed on Glass Epoxy substrate with dielectric constant 4.36, .

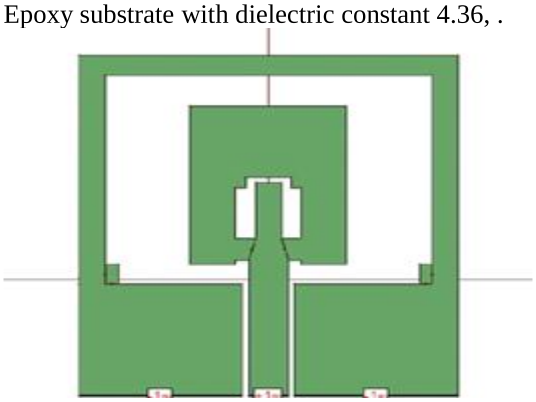

Figure 2: Microstrip Patch Geometry

4. Simulated and Measured Results

For the proposed antenna design, IE3D simulation software is used, which is full wave electromagnetic simulation software for the microwave and millimeter wave integrated circuits. The primary formulation of the IE3D software is an integral equation obtained through the use of Green's function. The simulation using IE3D, takes into account, the effect of co-axial SMA connector, by which the antenna was fed. The best performance of the antenna was obtained after a large number of simulations where dimensions of the self-inverted stepped slot are varied to achieve the maximum bandwidth (in terms of impedance bandwidth and gain) of the antenna.

The simulated radiation patterns are shown in Fig.3, Fig.4, Fig.5 at different frequencies over the band. The radiation patterns remain same over the band. The simulated antenna efficiency and return loss of the slot antenna are shown in Fig.6 and Fig.7 respectively.

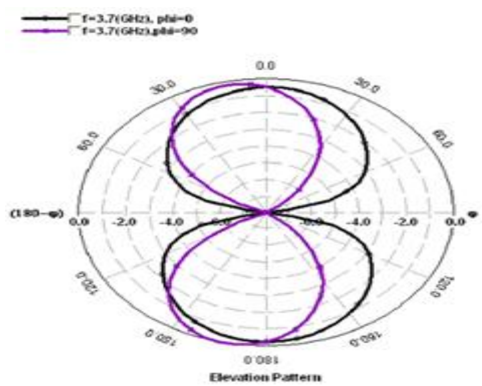

Fig 3: Simulated Radiation Pattern at 3.7 GHz

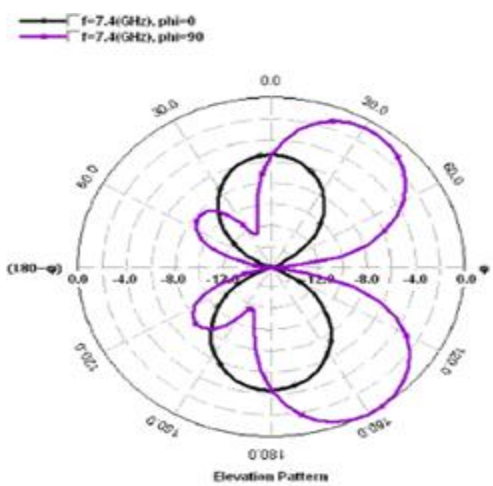

Fig 4: simulated radiation pattern at 7.4 GHz

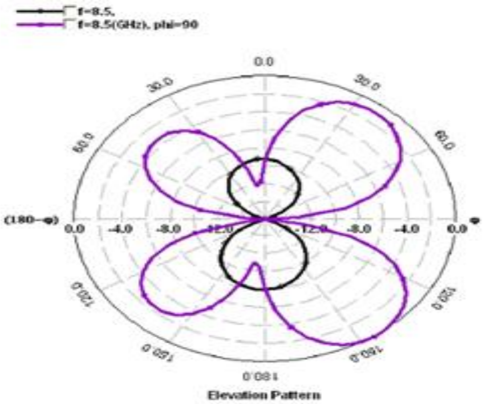

Fig 5: Simulated radiation pattern at 8.5 GHz

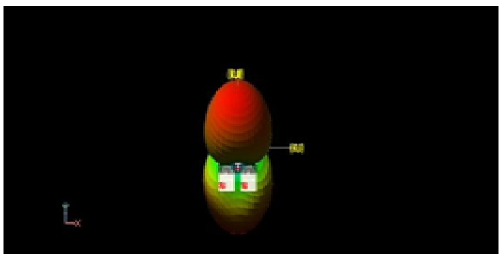

Fig 6: 3D Radiation pattern at 3.7 GHz

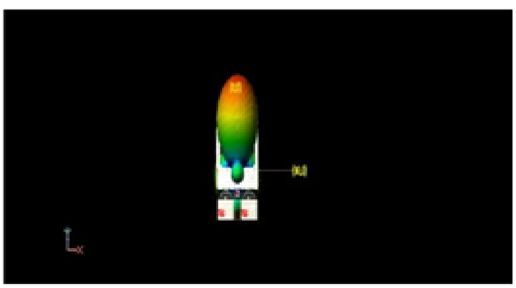

Fig 7: 3D Radiation Pattern at 7.4 GHz

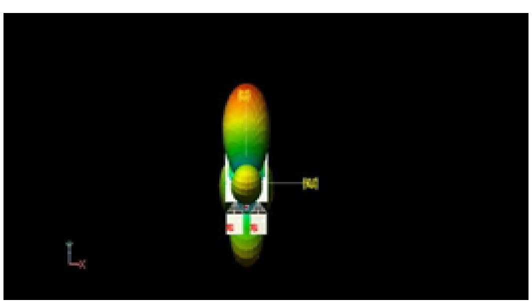

Fig 8: 3D Radiation pattern at 8.5 GHz

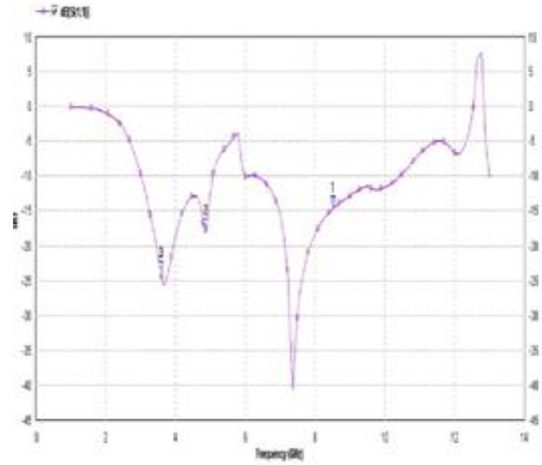

Fig 9: Simulated Return Loss of the Patch Antenna

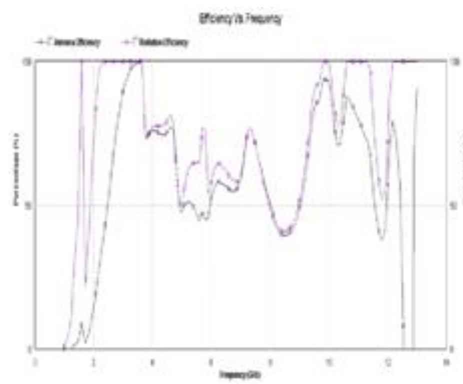

Fig 10: Simulated Antenna and Radiation Efficiency

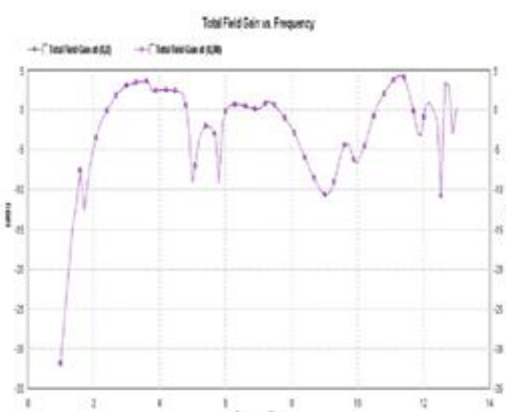

Fig 11: Simulated Total Field Gain of the Patch Antenna

5. Conclusions and Results

A new concept of microstrip patch antenna, for UWB operation, is described here. The patch antenna has 62% bandwidth at the centre frequency of 7.4GHz. The simulated and measured results show that the antenna may be used for the application in UWB communication range of frequencies ranging from 3.1 Ghz to 10.6Ghz with maximum return loss closely to 7.4 Ghz and the frequency band is modified such that it doesn't interfere in WLAN range which is 5 Ghz to 5.9 Ghz and the 3D simulated radiation patterns at 3 different frequencies are also shown and graphs have been provided.

References

[1] J. R. James and P. S. Hall, Handbook of Microstrip Antennas, vol. 1, Peter Peregrinus Ltd., London, 1989.
[2] R Garg, P. Bhartia, I. J. Bahl and A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, 2001.
[3] F. Yang, X-X Zhang, X. Ye and Y. Rahmat-Samii, "Wide-band E-shaped patch antennas for wireless communications", IEEE Trans. Antennas and Propagation,, Vol. AP-49, pp. 1094– 1100, 2001.
[4] K. L. Wong, Compact and Broadband Microstrip Antennas, Wiley, 2002.
[5] G. Kumar, and K. P. Ray, Broadband Microstrip Antennas, Artech House, Boston, 2003.
[6] E. S. Angelopoulos, A. Z. Anastopoulos, D. I. Kaklamani, A. A. Alexandridis, F. Lazarakis and K. Dangakis, "Circular and elliptical CPW -fed slot and microstrip-fed antennas for ultrawideband applications", IEEE Antennas and Wireless Propagation Letters, Vol. 5, pp. 294 – 297, 2006.
[7] J.-J. Jiao, G. Zhao, F.-S. Zhang, H.-W. Yuan, and Y.- C. Jiao "A broadband CPW-FED T-Shape slot antenna", Progress In Electromagnetics Research, PIER 76, pp. 237-242, 2007.
[8] J. S. Roy, and M. Thomas, "Design of a circularly polarized microstrip antenna for WLAN", Progress In Electromagnetic Research, PIER M, Vol. 3, pp. 79 – 90, 2008.
[9] K.Y. Yazdandoost, and R. Kohno, "Ultra wideband antenna", IEEE Communications Magazine, Vol. 42, No. 6, pp. S29 - S32, June 2004.
[10] Y.-L. Chen, C.-L. Ruan, and L. Peng, "A novel ultra- wideband bow-tie slot antenna in wireless communication systems", Progress In Electromagnetics Research Letters, Vol. 1, pp. 101- 108, 2008.
[11] M. Naghshvarian-Jahromi, "Compact UWB bandnotch antenna with transmission -line-fed", Progress in Electromagnetics Research B, Vol. PIERB 3, pp. 283 - 293, 2008.
[12] J. Ghosh and J. S. Roy, "Design of a wideband microstrip antenna", Journal of Electromagnetic Waves and Applications, JEMWA, Vol. 22, pp. 2379-2389, 2008.

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