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RESEARCH ARTICLE

A compact N-shaped multiband microstrip patch antenna design for wireless application

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Abstract

In this paper, a compact N-shaped multiband microstrip patch antenna is designed using Finite Element Method (FEM) based simulator HFSSv.13 software. The proposed antenna is designed using FR-4 epoxy substrate having dielectric constant of 4.4 and thickness of 1.6mm. The results of proposed antenna has been analyzed and discussed in terms of impedance bandwidth, input impedance and radiation characteristics. The antenna can efficiently support 4 different bands with their center frequencies as 1.70 GHz, 2.38GHz, 3.82GHz and 5.06GHz, coming under the bands of different wireless applications such as GSM, Bluetooth, WLAN/WiFi, WiMAX-II and some defense applications such as radio navigation. The desired band shift is further obtained by introducing a rectangular notch.

Introduction:-

In recent years, wireless communications have gained prominence over the wired networks due to its ability to link to variety of electronics devices used in daily life. Mobility of devices and its interconnect is one of the major constituents of the development of wireless communication systems. Compactness of devices, its cost and ease of integration with other devices are major parameters of consideration and microstrip antennas fall into the category of such devices [1-7].

The primary disadvantage of the simple rectangular microstrip patch antennas is its narrow band frequency response and mostly not covering the entire frequency band of a single application [8-9]. Hence there is a need to develop new techniques to enhance multiband capabilities for modern wireless communication systems to cover more frequency bands to support many applications using a single antenna. Now a day's demand for multiband terminal antenna that is capable of receiving multiple services introduced by different wireless technology networks such as GSM which operates at 1800 MHz, WiMAX, operating at 3.5 GHz and WLAN, which falls under ISM band at frequencies 2.4 GHz, 5.2 GHz and 5.8 GHz, has increased. These designs have replaced the need of multiple antennas for different wireless bands with a single antenna covering multiple bands.

Design and characterization:-

The geometry of the proposed N-shaped microstrip patch antenna is shown in Figure 1. The proposed antenna is designed on FR-4 epoxy dielectric substrate with relative permittivity of 4.4 and thickness of 1.6mm. The optimal geometrical parameters of the proposed antenna is obtained by using Ansoft's-3D full wave electromagnetic simulator HFSS which is based on Finite Element Method (FEM). The N shape patch is obtained by cutting two triangular shaped notches on rectangular patch. The final shape is obtained by cutting a rectangular notch on the N-shape patch. The geometrical parameters specifications of the proposed antenna are shown in Table 1. The RF power is fed to the radiating element (patch) by using the coaxial feed technique. In this technique the inner conductor of the coaxial feed connector passes through the dielectric and is soldered to the radiating patch, whereas the outer shield is connected to the ground plane. The antenna is designed to work at multiple frequencies, at the resonant frequencies of (1.7 GHz, 2.38 GHz, 3.82GHz and 5.06 GHz). 1.7GHz is be used for GPS and GSM

applications, 2.4 GHz for Bluetooth application, 3.82 GHz for WiMAX-II applications and 5.06 GHz for ISM band applications.

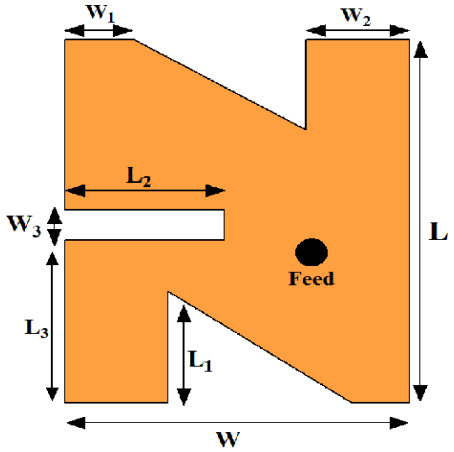


Fig.1: Geometry of proposed antenna

Table 1. Antenna Specifications

Parameter	Value
L	32mm
W	29mm
L_1	11mm
W_1	2.2mm
L_2	16mm
W_2	6.5mm
L_3	12mm
W_3	3mm
height of substrate (h)	1.6mm
Permittivity of substrate (ϵ_r)	4.4

Results and discussion:-

The proposed antennas have been simulated using finite element based electromagnetic simulator HFSSv.13 (High-frequency structure simulator) software. The simulated return loss and VSWR of the proposed antenna are shown in Figure 2 and 3. It is clearly seen that four resonant frequencies at 1.70 GHz, 2.38GHz, 3.82GHz and 5.06 GHz are excited with good impedance matching. The operating bands are 1.67 - 1.72 GHz, 2.36 - 2.42 GHz, 3.75 - 3.86 GHz and 4.87 - 5.15 GHz. These bands are used for different wireless applications, like GSM 1800 MHZ, Bluetooth, WLAN/WiFi, WiMAX-II and some defence applications such as radio navigation. Simulated values of VSWR as shown in fig. 3 are 1.38 at 1.70 GHz, 1.30 at 2.38 GHz, 1.15 at 3.82 GHz and 1.04 at 5.06 GHz, which well around unity.

The far-field radiation patterns for the proposed N-shaped multiband microstrip patch antenna are also examined. The comparison of co-polarization and cross polarization of E-plane and H-plane polarization radiation pattern are shown in figure 4, 5, 6 and 7 for 1.7GHz, 2.38GHz, 3.82GHz and 5.06GHz frequencies respectively. The cross polarization is low compared to co polarization so that the stable omnidirectional radiation pattern is achieved at the desired resonance frequencies (1.7 GHz, 2.38GHz, 3.82GHz and 5.06 GHz).

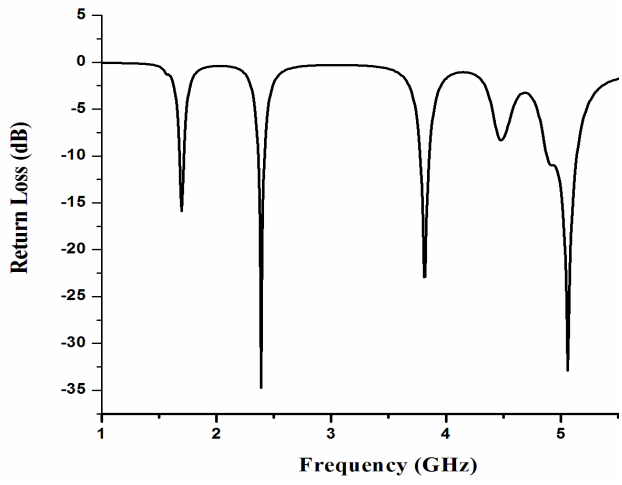


Fig.2: Return loss of proposed antenna

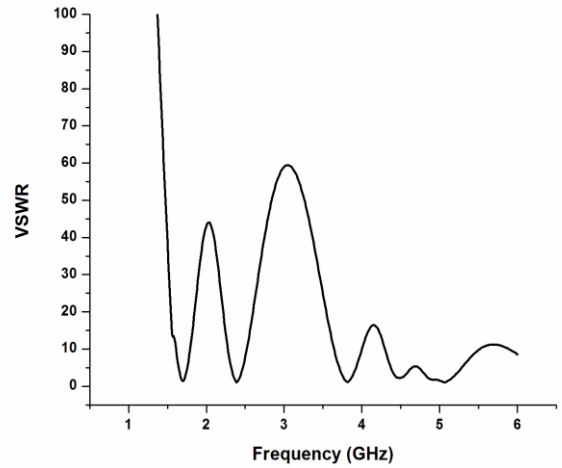
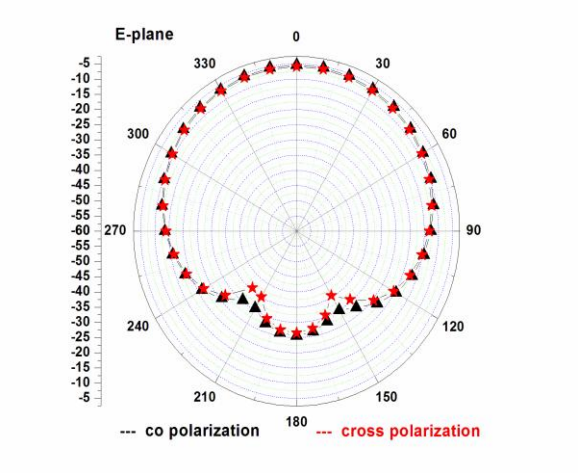
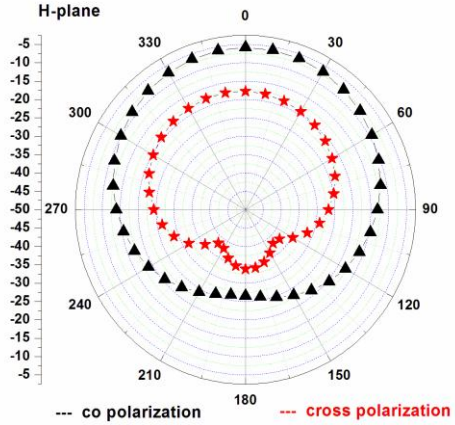


Fig.3: VSWR of proposed antenna

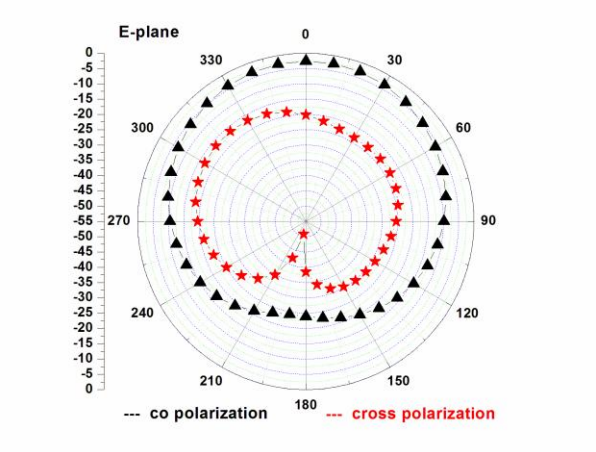


(a)



(b)

Fig.4: Radiation pattern at 1.7GHz band, (a) for of E- plane , (b) for H-plane



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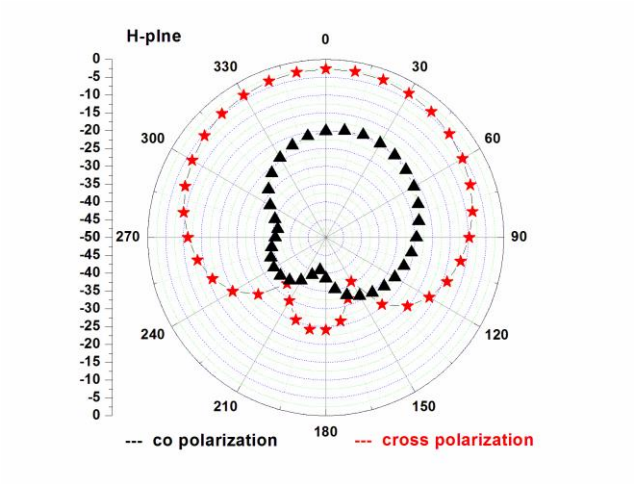
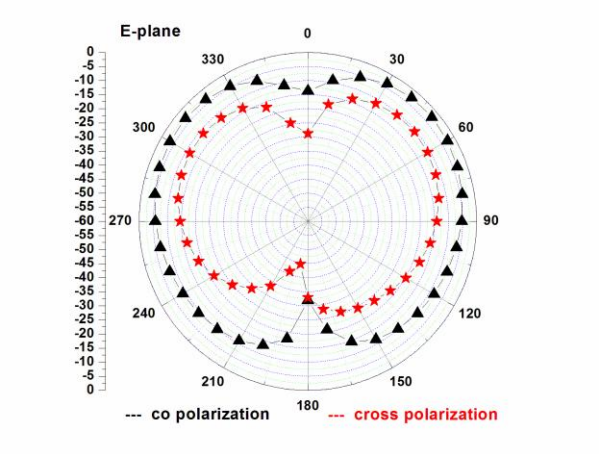


(b)

Fig.5: Radiation pattern at 2.38 GHz band, (a) for of E- plane , (b) for H-plane



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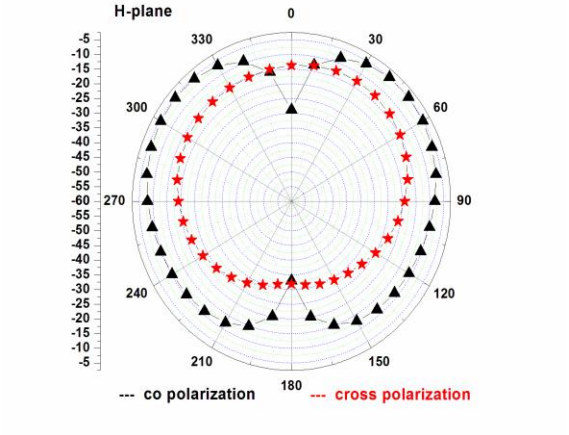
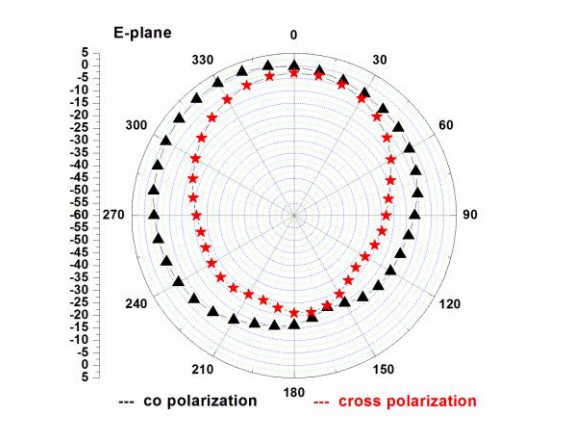
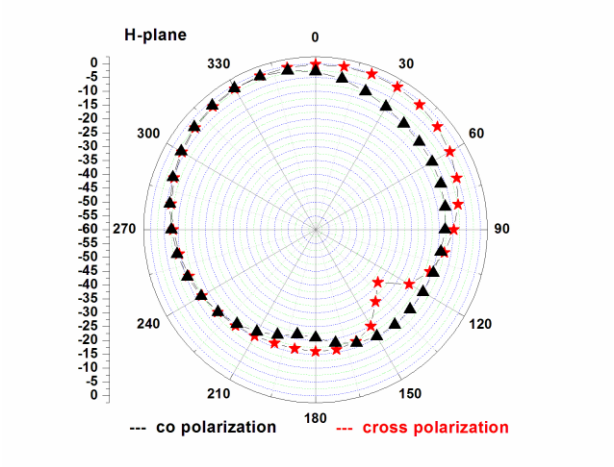


(b)

Fig.6: Radiation pattern at 3.82 GHz band, (a) for of E- plane , (b) for H-plane



(a)



(b)

Fig.7: Radiation pattern at 5.06 GHz band, (a) for of E- plane , (b) for H-plane

Conclusion:-

In this paper, a N-shaped multiband microstrip patch antenna is proposed and investigated. An antenna is designed by two triangular and one rectangular notch and simulated using HFSS. The design is simple and compact and can be easily fabricated and tested. The advantage of the design is that on a single patch four resonating frequencies are obtained which is useful for different applications. The designed antenna is optimized by changing its notch dimension and feed position to provide impedance matching. The results at resonant frequencies of 1.7 GHz, 2.38 GHz, 3.82 GHz, and 5.06 GHz have been optimized. The simulated return loss and the radiation patterns for the center frequencies are plotted. The simulated results suggest that the proposed antenna is useful for different wireless applications.

References:-

[1] K. L. Wong, "Compact and broadband microstrip antennas," Wiley-interscience , Vol. 168, 2004.

[2] M. Samsuzzaman, M. T. Islam and J. S. Mandeep, "Design of a compact new shaped microstrip patch antenna for satellite application," Advances in Natural and Applied Sciences, Vol. 6, pp. 898-903, 2012.

[3] J. K. Ali, "Microstrip-fed printed slot antennas based on hilberttype space- filling curves for wireless communication systems," International Review on Modelling and Simulations, Vol. 3, pp. 672-678, 2010.

[4] M. Samsuzzaman, M. T. Islam and M. R. I. Faruque, "Circularslotted CPW antenna for WiMAX/C band applications," ARPN Journal of Engineering and Applied Sciences, Vol. 8, pp. 581-585, 2013.

[5] M. Samsuzzaman, M. T. Islam, B. Yatim and M. A. M. Ali, "Dual frequency triangular slotted microstrip patch antenna for Ku band applications," Przegląd Elektrotechniczny, Vol. 89, pp. 275-279, 2013.

[6] M. Samsuzzaman, M. T. Islam and M. R. I. Faruque, "Dual-band multi slot patch antenna for wireless applications," Journal of Telecommunications and Information Technology, Vol. 2, pp. 19-23, 2013.

[7] M. Samsuzzaman, M. T. Islam and J. S. Mandeep, "Parametric analysis of a glass-micro fibre-reinforced PTFE material, multiband, patch-structure antenna for satellite applications," Optoelectronics and Advanced Materials – Rapid Communications, Vol. 7, pp. 760-769, 2013.

[8] Ajay Singh and S. C. Gupta, "Review and Survey of Compact and Broadband Microstrip Patch Antenna," International Journal of Computer Applications, Vol. 59, pp. 0975 – 8887, 2012.

[9] C. A. Balanis, "Antenna Theory Analysis and Design," 3rd ed., Hoboken, NJ, Wiley- Interscience , USA, pp. 816, 2005,

[10] Ramesh Garg, Prakash Bhartia, Inder Bahl and Apisak Ittipiboon, "Microstrip Antenna Design Handbook," Artech House, Antennas and Propagation Library, 2001.