Electromagnetically Coupled Dual Port, Dual Band, Octagonal Patch Antenna

Binu Paul, S.Mridula, C.K.Aanandan, K.Vasudevan and P.Mohanan

Centre For Research in Electromagnetics and Antennas

Department of Electronics, Cochin University of Science and Technology

Kochi – 682 022, INDIA

e-mail: drmohan@ieee.org

ABSTRACT

In this paper, a dual port, dual frequency, dual polarized, octagonal shaped Microstrip patch antenna, suitable for GPS (1.565 GHz – 1.585 GHz) and PCS (1.85 GHz – 1.99 GHz) applications is discussed experimentally and theoretically. The proposed antenna configuration is characterized by good impedance bandwidth, gain, isolation between two ports and broad radiation patterns.

INTRODUCTION

The recent boom in wireless communication industry, especially in the area of cellular telephony and wireless data communication, has led to the increased demand for multi band antennas [1]. In such applications the issues to be addressed are, wide bandwidth and gain, while striving for miniature geometry. Thus, there arises an immediate need for a low-cost, compact, highly reliable, integrated antenna capable of multi-band operation. Dual Polarization is a desirable feature of multi-function antennas used in mobile communication equipments [2].

ANTENNA GEOMETRY

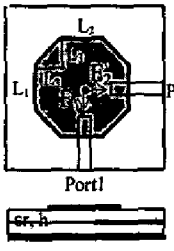

Figure.1.
Antenna Geometry
L_1= 30 mm, L_2 = 20 mm
L_3 = 9 mm
ε_r = 4.28, h=1.6 mm
Feed length = 25 mm
Feed offset
F_1= 13 mm, F_2 = 7 mm

The geometry of the dual band octagonal patch antenna is shown in Figure.1. The dimensions of the patch and feed suitable for GPS/PCS frequency bands are optimized through simulation using IE3D software and trimmed experimentally. The two ports of the antenna are energized electromagnetically using two orthogonal 50 Ω microstrip lines. The antenna and the feed lines are fabricated on a substrate of dielectric constant ε_r = 4.28 and thickness h = 1.6 mm.

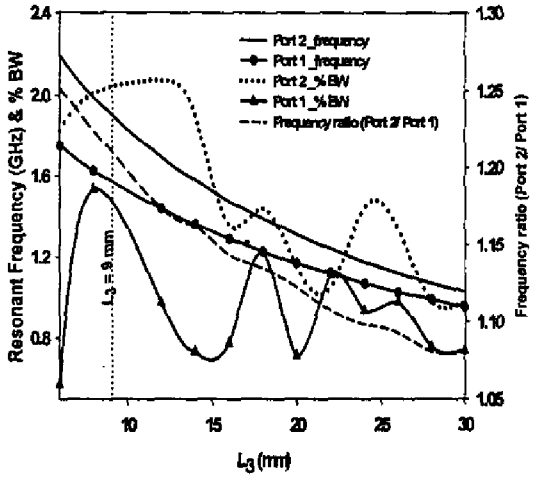

Figure.2
Variation in reflection characteristics with L_3

The resonant frequency bands of the octagonal patch antenna can be finely tuned by the dimension L_3. Figure.2. illustrates the variation in the resonant frequency and % bandwidth of the two operating bands with respect to the dimension L_3, obtained through simulation. The desired operating frequency in both the bands, displaying good

0-7803-8964-6/05/$20.00 ©2005 IEEE

bandwidth characteristics are obtained when L_3 = 9 mm. As L_3 is varied from 6 mm to 30 mm, the resonant frequency of the two ports exhibit a variation from 1.75 GHz to 0.95 GHz and 2.19 GHz to 1.0275 GHz respectively.

RESULTS

The properties of the proposed antenna configuration is measured experimentally using HP 8510C Network Analyser. The reflection and isolation characteristics for varying feed lengths are shown in Figure.3. The feed length =25 mm is found to excite the desired resonant frequency in both the operating bands with reasonably good bandwidth isolation. The proposed antenna when excited by the 25 mm feed, offers 2.8 % and 2.7% impedance bandwidth in the two operating bands centred at 1.6 GHz and 1.9 GHz respectively.

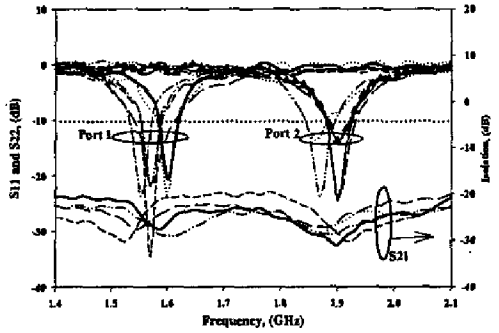

Figure.3. Variation of Return loss at the ports and Isolation between the ports for different feed lengths (25mm feed curves highlighted)

FDTD method is employed to perform the theoretical analysis of the proposed antenna. Conformal FDTD algorithm is applied to model the octagon [3]. Perfect Magnetic Conductor (PMC) wall is applied along the plane of symmetry to reduce the computational domain to half. The direct output of FDTD run is the time domain information, which is then converted appropriately to frequency domain characteristics by applying Fourier transformation.

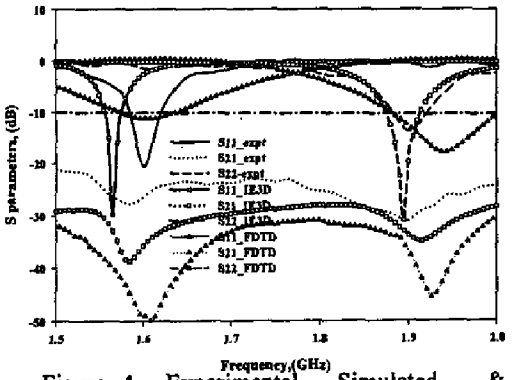

Figure 4 Experimental, Simulated & theoretically computed reflection & isolation characteristics of the antenna.

The FDTD results are compared against the experimental and IE3D™ simulated results [Table 1]. Good agreement is obtained as shown in Figure.4.

		Port 1	Port 2
Expt	Freq (GHz)	1.6	1.9
	Band (GHz)	1.5585-1.62	1.885-1.92
IE3D	Freq (GHz)	1.565	1.895
	% error in freq	+ 2.1	+ 0.26
	Band (GHz)	1.55-1.58	1.875-1.915
FDTD	Freq (GHz)	1.6082	1.9438
	% error in freq	- 0.51	- 2.3
	Band (GHz)	1.5620-1.6487	1.8743-2.01

Table 1. Reflection Characteristics

The influence of the feed length upon the reflection characteristics, studied using FDTD is illustrated in Figure.5.

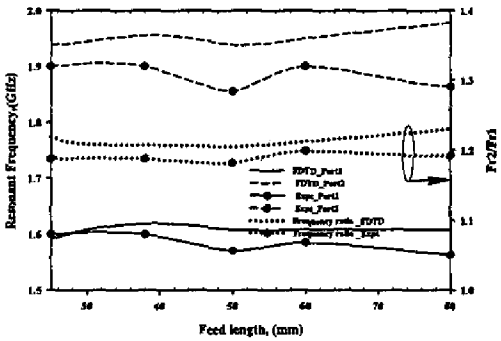

Figure.5. Variation of Resonant frequency and Frequency ratio with feed length

The radiation patterns are shown in Figure.6. The E plane pattern of Port 1 is broader than the H plane pattern. But, the H plane pattern is broader than the E plane pattern in Port 2 [Table.2].

Half Power Beamwidth		Port 1 1.6 GHz	Port 2 1.9 GHz
Expt	E plane	94°	76°
	H plane	26°	88°
IE3D	E plane	105°	80°
	H plane	90°	140°
FDTD	E plane	125°	105°
	H plane	60°	~180°

Table 2. Radiation Characteristics

The antenna exhibits -11.5 dB and -17.5 dB cross-polar levels in the on axis at the centre frequencies of the respective bands.

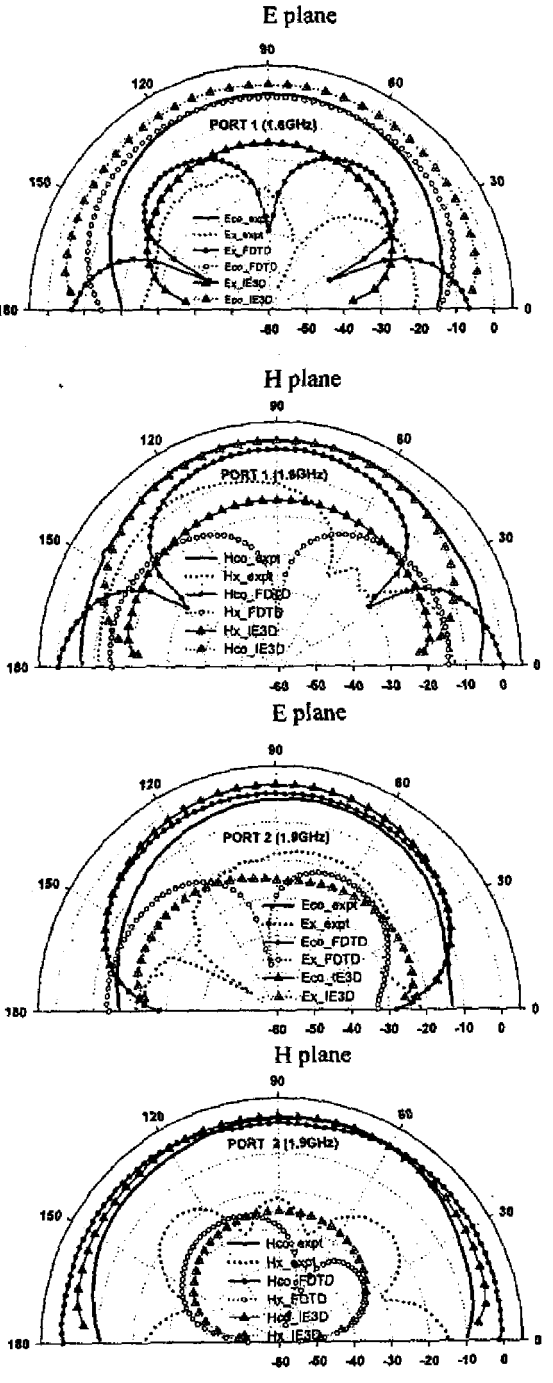

Figure 6. Radiation Patterns

Figure 7 illustrates the gain of the proposed antenna. Moderate gain (+ 0.45 and + 1.35 dB respectively) with respect to standard circular patches is observed at the two ports. The Electric and magnetic field distributions within the patch computed by the FDTD method, corresponds to the TM_{10} mode at 1.6 GHz and TM_{01} mode at 1.9 GHz respectively.

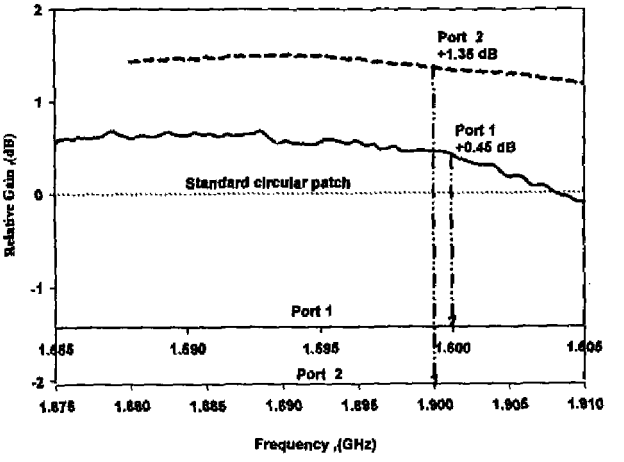

Figure.7. Relative Gain of the Octagonal patch antenna in the respective bands

CONCLUSIONS

A compact antenna suitable for GPS and PCS applications is presented. At 1.6 GHz, there is an area reduction of 15 % and 31 % with respect to circular and rectangular patches. Good reflection and radiation characteristics of the proposed antenna configuration make it highly suitable for a dual band terminal intended for L-band applications.

REFERENCES

1. Zhizhang Chen, Acep D.Ganjara and Xiaomin Chen. 'A dual L antenna with a novel tuning technique for dual frequency applications,' *IEEE Trans. Antennas and Propagation*, vol. 50, no.3, pp. 402-403, March 2002.

2. Binu Paul, S. Mridula, C.K.Aanandan and P.Mohanan, " A new Microstrip Patch Antenna for Mobile Communications and Blue tooth Applications", *Microwave & Optical Technology letters*, Vol.33, No:4, pp. 285 – 286, May 20 2002.

3. Wenhua Yu, Raj Mittra, "A conformal FDTD algorithm for modeling perfectly conducting objects with curve shaped surfaces and edges,"in *Microwave and Opt. Technol. Lett* . vol. 27, no. 2, October 20, 2000, pp 136-138