Printed Antenna for Wireless Applications Operating in ISM band

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ABSTRACT

A compact hexagonal antenna for wireless communication is proposed in this paper. The antenna resonates at 2.45 GHz (ISM) band. The antenna has an overall dimension of only 7.6cm X 5.8cm which shows a good size reduction compared to antennas operating in the WLAN band. The simple design, feeding, and compactness make it easy to be integrated in circuit boards, handheld devices . The simulated output shows that the antenna has a good directivity, gain and bandwidth of 255MHz. The return loss is also is very good. it is around -30 to -40 dB.

Keyword : - *Hexagonal Antenna, ISM band, Microstrip patch*

1. INTRODUCTION

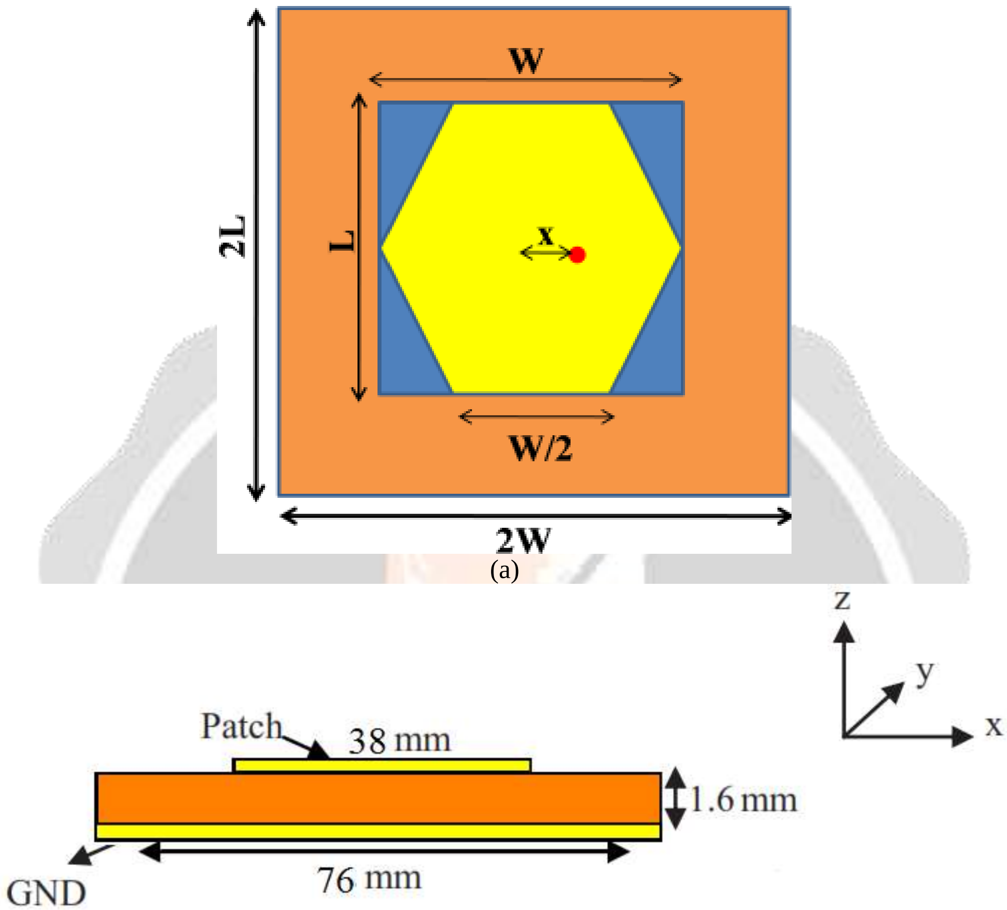
Emerging technology has paved the way for device miniaturization in turn, has led to the need for miniaturization of antennas suitable for these modern devices used in personal communication equipment. Compact antennas are also required for applications such as missiles and other airborne applications where space is limited. The microstrip antennas have recently attracted a lot of attention due to the growing demand for compact antennas for personal communication equipment. It has been shown that loading a rectangular, circular or triangular microstrip patch antenna with a shorting pin can effectively reduce the size of the patch required for a given operating frequency [l-3].

Compact Rectangular, circular and triangular microstrip antennas have already been reported in the literature [5, 6]. A shorted Hexagonal microstrip antenna (HMSA) has however, not been investigated as thoroughly as shorted patch antennas of other shapes. A Hexagonal Microstrip Antenna (HMSA) has the advantage that its shape/area can be closely approximated to that of a circle and it can be packed closely together in an array. Also, straight edge of HMSA configuration helps in parasitic coupling with other similar patches for bandwidth improvement which would have become difficult with curved edges of circular microstrip patch antenna. Recently, HMSA and its variations have been reported in the literature and a resonance frequency formulation has been proposed to match with the experimental results [7 – 12].

A single HMSA has been designed, fabricated, simulated and measured results are presented in the next section. The conventional HMSA has also been designed and fabricated and the results for these variations of HMSA have been compared. In [12], a compact configuration of Hexagonal microstrip antenna using multi shorting has been proposed. The area has been shown to reduce by a factor of four for the quarter patch using multi shorting techniques, while maintaining approximately the same resonance frequency as that of conventional HMSA. In this paper, a single shorting pin has been used to reduce the resonance frequency of a given size of hexagonal microstrip patch antenna. The reduction in area for an antenna designed at a given operating frequency using this technique is seen to be almost 10 times as compared to a conventional HMSA

2. ANTENNA DESIGN PARAMETRS

The antenna design parameter equations and its values are given in equations (1) to (5) and Table1. Initially rectangular patch is designed for the ISM band frequency and a hexagonal is formed as shown in figure 1. Along the length direction the patch is divided into 2 halves and along the width direction, the patch is divided into 4 parts. second and third parts of the width are combined together. now. join the center of the length to the joining point of first and second part of the width. similarly repeat on the other side. The obtained patch will be a hexagonal patch. The cross section of the antenna is shown in figure 2. The antenna is fed through coaxial cable.



(a)

(b)

Fig -1: Geometry of the antenna (a) Top view (b) Side View

A. Design Equations

The equations used to design the antenna are given below.
Design Frequency, f_r = 2.45GHz
Substrate material = FR4
Substrate height, h =1.6mm
Substrate permittivity, ε_r=4.4
Patch thickness, t=0.035mm
microstrip width calculation:

$$W = \frac{C}{2f_r\sqrt{\frac{\varepsilon_r+1}{2}}} \qquad (1)$$

Effective permittivity, ε_e:

$$\varepsilon_e = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+\frac{10h}{w}\right]^{-0.5} \qquad (2)$$

Fringing Length, ΔL:

$$\Delta L = \frac{h}{\sqrt{\varepsilon_e}} \tag{3}$$

Effective length of microstrip, L_e:

$$L_e = \frac{C}{2 f_r \sqrt{\varepsilon_e}} \tag{4}$$

Length of microstrip, L:

$$L = L_e - 2\Delta L \tag{5}$$

Table -1: Antenna Parameters

Parameters	Length in mm	Parameters	Length in mm
W	38	ε_e	4.126
L	29	L_e	30.77
h	1.6	ΔL	0.788
ε_r	4.4	x	3

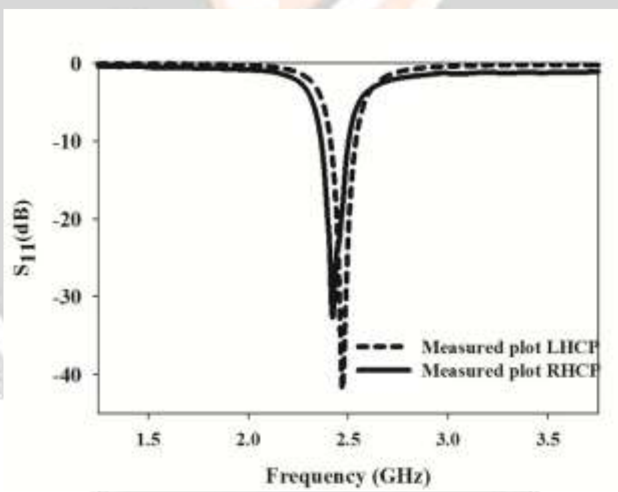


Fig-2: Return loss of the antenna

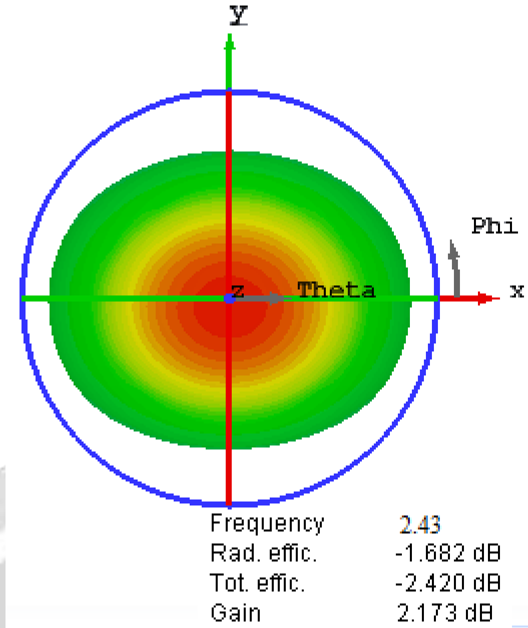


FIG-3: Directivity of the antenna in 3D

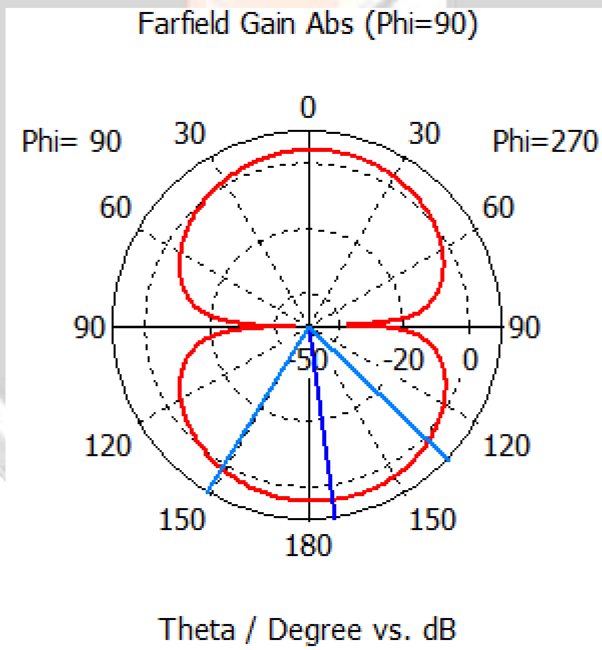


FIG-4: Radiation pattern of the antenna

3. RESULTS AND DISCUSSION

The simulated and experimental results for the return loss of single shorted hexagonal microstrip patch antenna are shown in figure 2. As seen from Figure 2, a hexagonal microstrip patch antenna resonates at 2.45GHz. Figure 3 and figure 4 gives the directivity and radiation pattern of the hexagonal antenna. The fabricated Shorted

Hexagonal Microstrip patch antenna is shown in figure 5. Current path distributions of hexagonal microstrip patch antenna and is shown in figure 6.

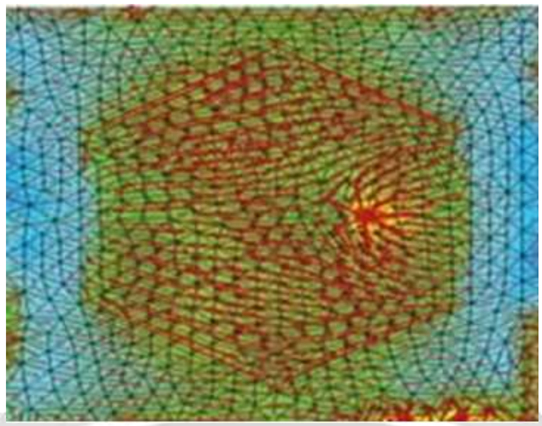


FIG-6: Current path distribution of Hexagonal Antenna

4. CONCLUSIONS

A hexagonal microstrip patch antenna with a single shorting pin at the edge was designed to realize significant reduction in the resonance frequency leading to more than 90% reduction in the size of the antenna and an extremely compact, lightweight design at the desired frequency. Simulated and measured results were shown to be in good agreement with each other. This antenna is useful in applications like mobile handsets, missiles, aircrafts, and other compact systems operating in ISM band having severe space constraints and where size and weight are of major concern.

5. REFERENCES

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