Octagonal patch antenna for WiMax Applications

Vinita Mathur, Parul Tyagi, Neha Singh

Abstract— In this manuscript microstrip feed patch antenna is designed for S band applications. The structure is suitable from 2.2 to 4GHz. The octagonal shape is taken and squares are added that makes it a wing like structure. The proposed antenna is designed on FR4 substrate board of dimensions 50x55x1 mm^3. All the simulations are performed using CST Microwave Studio. The current distribution and radiation patterns of proposed model are also presented in this paper.

Index Terms— octagonal patch, S-band, square patch, CST Microwave Studio.

1 INTRODUCTION

Microstrip patch antennas are most frequently used in wireless communication systems due to their benefits in terms of low manufacturing cost, light weight, compact size and easily integrated to microwave circuits. Patch antennas have capability to work in dual and multiple frequency bands. Present scenerio of wireless communication system required compact and multiple band antenna design. Since much system are operating at multiple frequency range, requiring dual and triple band antenna for various applications such as WLAN, WiMAX, RFID, satellite communication, etc. Presently, many printed monopole antenna are proposed. Serve for wireless applications to cover the wireless standards for Wireless local area network (WLAN: 2.4–2.48, 5.15–5.35, and 5.75–5.825GHz) and worldwide interoperability for microwave access (WiMAX: 3.4– 3.69 GHz) are two among the available wireless standards which allow interconnections of devices for communication [1].

However, the major drawback of this type of antenna is narrow bandwidth. To overcome this problem several techniques are proposed, such as increasing thickness of the substrate, introducing parasitic elements, defected ground structures, introducing slots and modifying the shape of patches [1-3]. Few of the antenna are introduced by implementing various shape of strips and slots for wireless communications. Many other antennas are proposed with the compact size or simple [4-6].

However, reducing antenna height gives rise to a decrease in bandwidth and this effect is independent of the technology used. In fact, the narrow bandwidth characteristic of microstrip antennas cannot meet the continuously increasing bandwidth demand of most modern multiband systems [7-10].

2 ANTENNA DESIGN

The proposed antenna geometry is compact and simple. The proposed patch antenna is microstrip fed as shown in Fig. 1. This antenna consists of octagonal patch with rectangles added which give it a wing like structure. The antenna is designed on FR-4 substrate (relative dielectric constant 4.4). With the dimension of 55X50X1 mm^3. Dimensions of the proposed patch are shown in Table 1.

Table 1 Dimensions of patch

L	W	W_f	L_f	r	ε
55	50	2	31	8	4.4

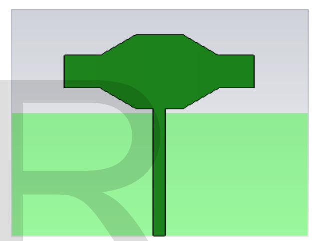

Fig. 1 Proposed Patch

3 RESULTS AND DISCUSSION

Various types of printed monopole antennas are considered for wireless applications, such as square, circular, elliptical, pentagonal, hexagonal, octagonal etc. Out of these octagonal shaped monopole antennas are considered here for designing and analysis.

The change in S11 with effect in the height of the substrate is shown in Fig. 2. Substrate is important for the mechanical strength of the antenna. It is used for degraded electric properties as the surface wave formed on the dielectric extract a portion of total power for space waves. From Figure it is analyzed that better results are observed at h2 = 1 mm. Therefore the substrate thickness taken is h2 = 1 mm.

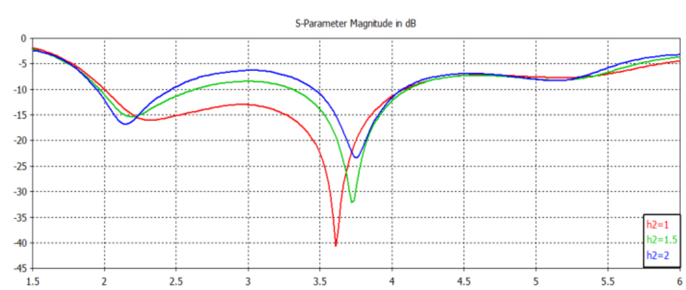

Fig. 2. Comparison of variation of S_{11} with frequency of patch antenna for different substrate thickness

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Fig. 3. shows the effect of the reflection coefficient of the suggested structure by using two different substrates commonly used in the market. However, the estimated bandwidth has been obtained for use of FR4 material. Since it is easily available and less expensive.

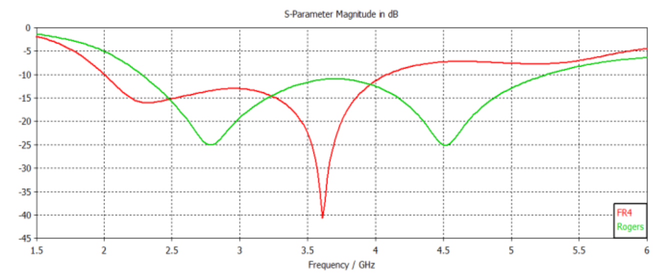

Fig. 3. Comparison of variation of $S_{11}$with frequency of patch antenna for different substrate material

The reflected power and loss of signal is very less when proper matching is done, i.e. at feed = 2 mm as observed from the Fig. 4. The antenna is excited through a simple microstrip line feeding of the length Lf and width Wf. A 50 X semi miniature connector is used on the tip of the feed line to feed the power

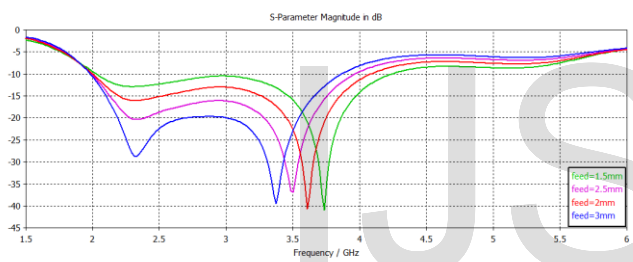

Fig. 4. Comparison of variation of $S_{11}$with frequency of patch antenna with feed thickness

Ground plane dimensions are very significant for antenna. It should be around quarter wavelength ʎ/4. To accommodate the effect of substrate and fractal geometry, the length of the ground has to be optimized. Variations in the dimensions of the ground are made for maximizing impedance bandwidth and minimizing return loss. By choosing ground length as 14.8 mm, it is observed that better results are obtained. The width of the rectangular ground plane (GW) is important because distribution of current is along the x-axis of the ground as shown in Fig. 5. There is an optimal value of width which offers the impedance bandwidth throughout the desired band. This is because the width of the ground behaves like an inductive resonant circuit over which the current is distributed along the X-axis. As the ground width increases or decreases, the inductive reactance also increases or decreases. But at the optimum ground width value, this inductive part is minimized.

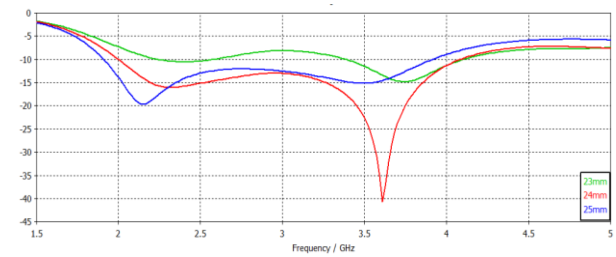

Fig. 5. Comparison of variation of $S_{11}$with frequency of patch antenna with variation of ground length

VSWR is a measure that describes the matching ofimpedance in the antenna to the connecting line it isassociated to. Voltage along the transmission line deter-mines the VSWR. At resonant frequencies, the value isapproximately between 1 and 2 as shown in Figure 6.

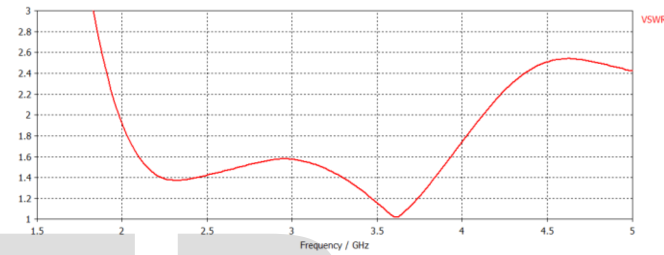

Fig. 6. VSWR of the proposed patch

At the receiver side near constant group delay should be there in UWB range for efficient working of antenna. Fig. 6. shows the graph of group delay of the proposed patch. It is the derivative of the far-field phase concerning the frequency. The straight graph is obtained almost at entire frequency

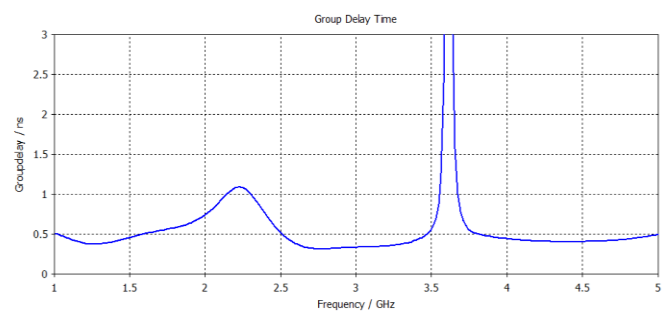

Fig. 6. Group delay of the proposed patch

Fig. 7. shows that the antenna gain values at resonant frequencies are 2.85 dBi, 3.77 dBi respectively.

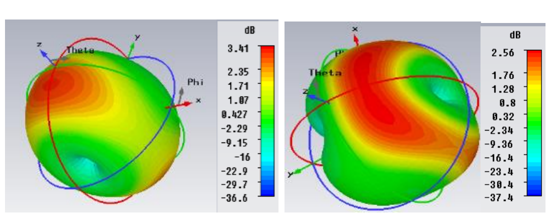

Fig. 7. Radiation pattern at (a) 3GHz (b) 4GHz

Surface current distribution at 3GHz frequency is depicted in Fig. 8.

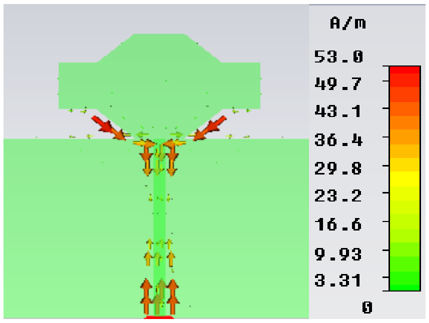

Fig. 8. Surface current distribution at 3GHz

The proposed antenna possess the unique features such as miniaturized size, reduced return loss, simple feeding technique and ease of fabrication with readily available substrate material.

CONCLUSION

A triple-band octagonal shape patch antenna covering WLAN 2.4GHz, WiMAX 3.5-GHz, and WLAN 5.5-GHz bands are evaluated with high gain and stable patterns presented in this paper. The proposed design is compact and simple. Where octagonal shape SRR rings are using as a radiating element. The proposed antenna find wide application in modern multiple wireless applications WLAN /WiMAX.

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