Pi Shape Slot Loaded Patch Antenna for Wi-Max Applications

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ABSTRACT

Microstrip patch antennas are strong candidates for use in many wireless communication applications. This paper proposes the use of patch antenna with pi-shaped slot to achieve dual band operation in WiMAX standard. A thick substrate helps broaden the bandwidths at two resonant frequencies. The slot loaded patch antenna resonates at 2.54 GHz and 3.45 GHz frequencies. It has been developed to be used in future Wi-max technology. The simulated bandwidths are 4.01% and 11% at 2.54 GHz and 3.45 GHz respectively. The return losses for these dual bands are -20dB and -16.77 dB respectively.

Keywords: Wi-max Antenna, Impedance Bandwidth, CST Microwave Studio, Pi-slot patch

1. INTRODUCTION

Recent technologies enable wireless communication devices to become physically smaller in size. Antenna size is obviously a major factor that limits miniaturization. With the rapid growth of the wireless mobile communication technology, the future technologies need a very small antenna and also the need of multi-band antenna is increased to avoid using two antennas and to allow video, voice and data information to be transmitted simultaneously. There is an increase demand for multi-wide and wide-band antennas that can be easily integrated with the communication system. To meet the above requirements, microstrip antenna is one of the best candidates. These antennas are low profile, conformable to planer and non planer surface, simple and inexpensive to manufacture using modern printed circuit technology, mechanically robust when mounted on rigid surfaces, compatible with MMIC designs, and when the particular patch shape and mode are selected; they are very versatile in terms of resonant frequency, polarization, pattern and impedance. In addition by adding the load between patch and ground plane such as pins, adaptive elements with variable resonant frequency, impedance, polarization and pattern can be designed. These advantages of microstrip patch antenna (MPA) make them popular in many applications requiring a low profile antenna. The major drawback of microstrip antenna is their narrow impedance bandwidth [1].

Wireless local area network (WLAN) and Worldwide Interoperability for Microwave Access (Wi-MAX) technology is most rapidly growing area in the modern wireless communication [2]. This gives users the mobility to move around within a broad coverage area and still be connected to the network. This provides greatly increased freedom and flexibility. For the home user, wireless has become popular due to ease of installation, and location freedom. Naturally, these applications require antennas. This being the case, portable antenna technology has grown along with mobile and cellular technologies. It is important to have the proper antenna for a device. The proper antenna will improve transmission and reception, reduce power consumption, last longer and improve marketability of the communication device.

In this paper, a pi slot loaded double band microstrip patch antenna for Wi-Max applications is designed and simulated using CST Microwave Studio. The proposed patch antenna resonates at 2.54 GHz and 3.45 GHz frequencies.

2. ANTENNA DESIGN

In this paper several parameters have been investigated using CST Microwave Studio software. The geometry of pi-slot loaded patch antenna is shown in figure-1. The design specifications for patch antenna are:

Substrate permittivity (ε_r) = 2.33

Substrate thickness (h) = 8 mm.

Length of patch (L) = 30 mm.

Width of patch (W) = 26 mm.

Feed point location = (0, 2.5)

Dimension of ground ($L_g x W_g$) = 90x80 mm^2

The slot dimensions are:

a = 20 mm.

b = 17 mm.

c = 3 mm.

d = 12 mm.

Where a, b and c are shown in figure-1.

The width of each slot is 2mm.

The antenna structure is fed with a co-axial probe (50 Ω). The inner and outer radius of co-axial probe is 1.5 mm and 3 mm respectively.

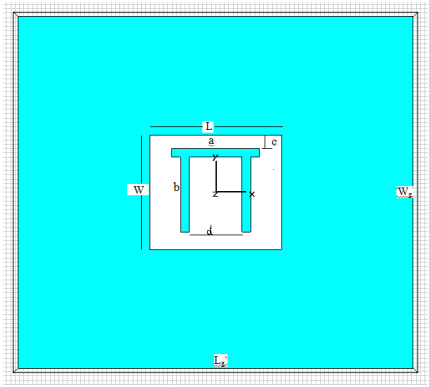

Figure 1(a)

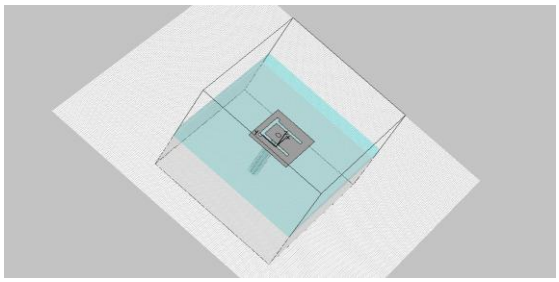

Figure 1(b)

Figure 1 (a): Geometry of pi slot loaded single layer patch antenna
(b): Structural View of Patch Antenna

3. RESULT AND DISCUSSION

The dual band characteristics of the proposed antenna are achieved by incorporating a pi slot. The centre frequencies of these bands are decided by the electrical length of these slots. In addition to other factors, the thick multilayer substrate helps in achieving the required bandwidth [3]. The feed location is moved from the centre of geometry to get the best possible impedance match to the antenna. Simulation studies of proposed antenna reported here are carried out using CST Microwave Studio.

The return loss of the slot loaded patch antenna is shown in figure 2 which shows that it resonates at 2.54 GHz and 3.45 GHz. frequencies. These resonant frequencies give the measures of impedance bandwidth characteristics of the patch antenna [4]. The impedance bandwidth for the proposed antenna is 102 MHz (from 2.497 GHz to 2.599 GHz) for the first band and 382 MHz (from 3.2923 GHz to 3.6751 GHz) for the second band at -10 dB return loss has been achieved. From figure 2 the return loss values at the resonant frequencies f_{r1}=2.54 GHz and f_{r2}=3.45 GHz are -20 dB and -16.77 dB respectively. The achieved values of return loss are small enough and frequencies are closed enough to specified frequencies bands for wi-max applications. These return loss values suggest that there is good matching at the frequency point below the -10 dB region.

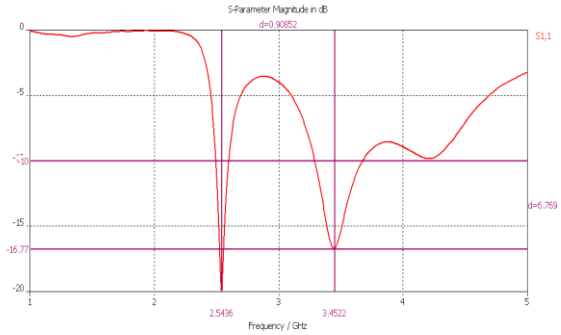

Figure 2: Return Loss verses Frequency graph

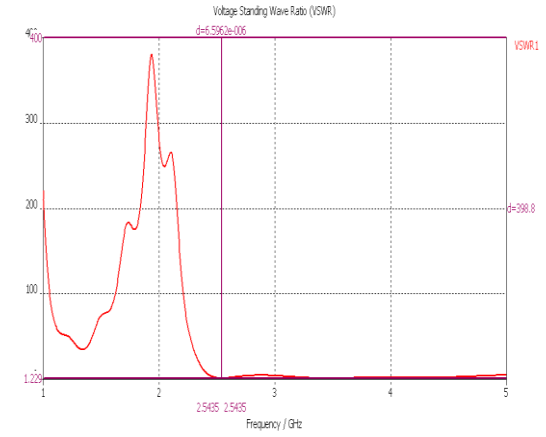

Figure 3: VSWR verses frequency graph

The figure 3 shows the VSWR verses frequency graph for the proposed antenna. The value of VSWR at the two resonating frequencies f_{r1}=2.54 GHz and f_{r2}=3.45 GHz is 1.229 and 1.343 respectively which is below 2. The value of VSWR for both frequency bands is also less than 2 which shows better antenna impedance matching at these two frequency bands.

Figure 4 shows the simulated radiation pattern of proposed antenna with directivity 6.06 dBi at resonating frequency 2.54 GHz and 8.56 dBi at resonating frequency3.45 GHz.

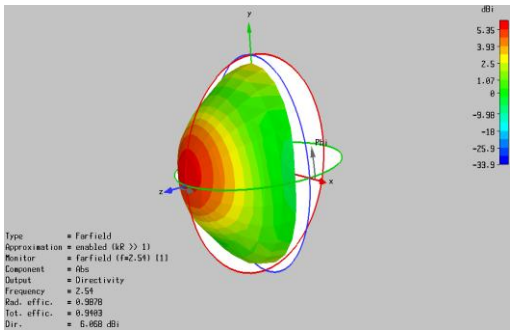

Figure 4(a)

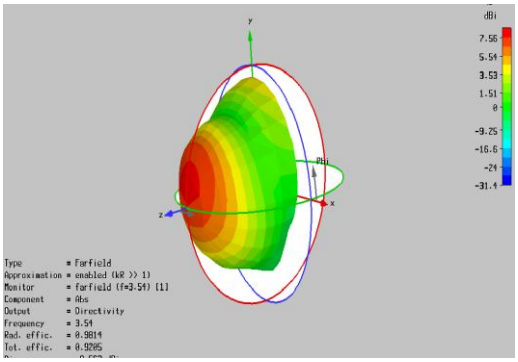

Figure 4(b)

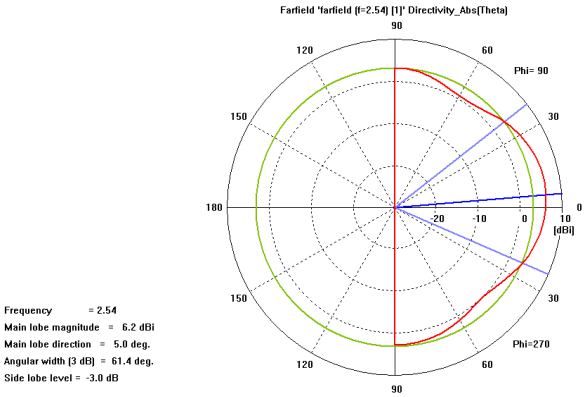

Figure 4(c)

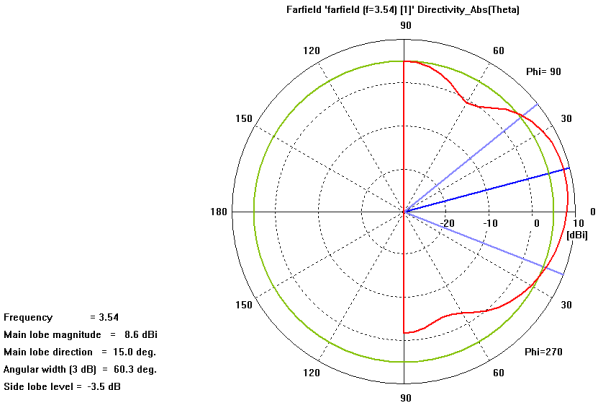

Figure 4(d)

Figure 4: (a) 3-D Radiation Pattern at 2.54 GHz
(b) 3-D Radiation Pattern at 3.45 GHz
(c) Polar plot of Antenna at 2.54 GHz
(d) Polar plot of Antenna at 3.45 GHz

4. CONCLUSION

A pi-slot patch antenna has been designed and simulated using CST Microwave Studio software. This is operating in two bands viz band I (2.497 GHz to 2.599 GHz) and band II (3.2923 GHz to 3.6751 GHz) covering wi-max bands. The return losses for these bands are -20 dB and -16.77 dB respectively. A good radiation pattern results have been obtained which seems to be adequate for the envisaged applications.

5. REFERENCES

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