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Design and Analysis of Triple-Band Inverted F-slot Microstrip Patch Antenna

Swaraj Panusa
University College of Engineering
RTU, Kota (Rajasthan), India

Mithilesh Kumar
University College of Engineering
RTU, Kota (Rajasthan), India

ABSTRACT
Microstrip patch antennas are strong candidates for use in many wireless communications applications. Microstrip patch antennas are also highly preferable for multiband as well as for the WiMAX application. In this paper, a multi-band H-slot microstrip patch antenna for Worldwide Interoperability for Microwave Access (WiMAX) is presented. The radiation performance such as VSWR, return loss, radiation pattern and gain of the antenna are simulated using Ansoft HFSS, fabricated and then presented. This antenna has a simpler structure than other antennas designed for realizing multi-band characteristics which is just composed of a coaxial feed line, a substrate, and a ground plane. Radiating patch lies on the FR4_epoxy substrate which is having dielectric constant 4.1 and height 1.5mm. Coaxial feeding technique is used to feed the antenna with 50 ohm impedance. This proposed antenna enhances the maximum return loss of -17.79 dB at 5.55 GHz, -24.16 dB at 6.55 GHz and -25.55 dB at 7.40 GHz frequencies. Computer simulated results showing the VSWR value lesser than two for the frequency range of 5.40-5.60 GHz, 6.45-6.22 GHz and 7.35-7.50 GHz. Simulated and fabricated results are very much similar.

Keywords
Triple-band; Microstrip Patch Antenna; F-Slot; WiMAX; WLAN; Radiation pattern.

1. INTRODUCTION
Communication can be broadly defined as the transfer of information from one point to another. Communication between human beings was first done through voice. With the desire to increase the distance of communication, devices such as Drums, signal flags and smoke were used. It has been of recent in human history that the electromagnetic spectrum, outside the visible region has been employed for communication, through the use of Radio. One of the greatest human scientific evolutions is the emergence of electromagnetic spectrum and antenna has been instrumental in harnessing the resource [1]-[4]. Antenna plays a very important part in any wireless communication systems. Complexity is reduced and the performance of the receiver is enhanced by the well-designed antenna. Based on the application and the operating frequency of the antenna, the dimension, type and the configuration of the antenna will be chosen. In modern wireless communication systems, multiband antenna has been playing a very important role for wireless service requirements [5]-[9].

Microstrip patch antennas are highly preferable for multiband as well as for the WiMAX and WLAN application. Microstrip patch antenna is very important for antenna designer because of its advantage such as low cost, simple configuration, ease of fabrication, mechanically rugged and compatibility with integrated circuits. Microstrip patch antennas are well suited for high frequency applications because the size of the antenna depends on wavelength and resonant frequency. Microstrip patch antennas are highly preferable for multiband as well as for the WiMAX application [10]-[19].

In this paper, a triple band inverted F-slot microstrip patch antennas for WiMAX application is design and analyses. Further fabrication is performed by using MIC technology. The antenna covers three frequency bands of 5.40-5.60 GHz, 6.45-6.62 GHz and 7.35-7.50 GHz.

2. ANTENNA DESIGN
Substrate selection is the first practical step in designing a patch antenna. FR4_epoxy (dielectric constant =4.1 and height = 1.5 mm) is used as substrate to design, simulate and fabricate the proposed triple band inverted F-slot microstrip patch antenna. To feed the proposed microstrip patch antenna a coaxial probe of characteristic impedance 50 ohm is used. The study of varies parameters summarizes the relationship between antenna dimension and its associated effect on antenna performance. The antenna dimensions obtained after necessary tuning on single antenna element are shown in table 1.

Table 1. Dimensions of the proposed inverted F-slot microstrip patch antenna

Parameter	*L*	*W*	*Ls*	*Ws*	*a*	*b*	*yf*
Units (mm)	34	27	28.25	12	2	2	5.5

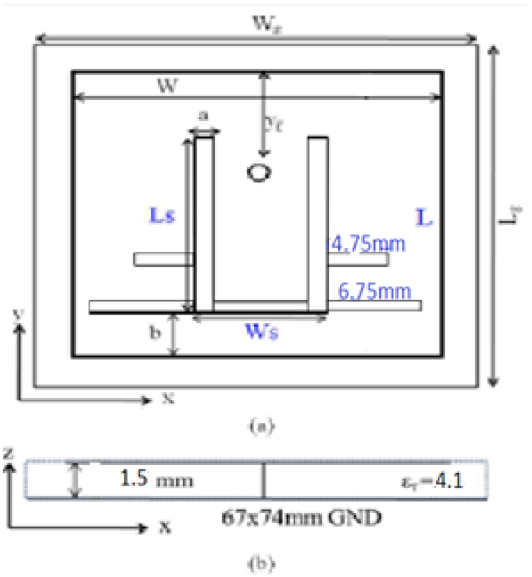


Fig 1: Geometry of the proposed inverted F-slot microstrip antenna: (a) top view (b) side view

(a)

(b)

Fig 2: Hardware of the proposed F-slot microstrip patch antenna (a)top view (b)bottom view

3. EXPERIMENTAL RESULTS AND DISCUSSION

In this section, first of all the simulation and analysis is done for the proposed triple band inverted F-slot microstrip patch antenna by Ansoft HFSS. From these simulation results, the parametric studies are carried out. Further we fabricate this designed inverted F-slot antenna using MIC technology and results are measured with the help of Agilent vector network analyzer E5071C ENA series (300 KHz-20 GHz).

The prototype of the proposed antenna in Fig. 1 was fabricated and investigated experimentally. A photo of the proposed antenna prototype is shown in Fig. 2. The antenna overall size is 67mm x 74mm x 1.5mm. The proposed antenna have impedance matching better than -10 dB return loss for frequency range of 5.40-5.60 GHz, 6.45-6.62 GHz and 7.35-7.50 GHz respectively. Fig. 3 shows the current distribution in the patch of the proposed antenna. Fig. 4 shows that the antenna have the maximum return loss of -17.79 dB at 5.55 GHz, -24.16 dB at 6.55 GHz and -25.55 dB at 7.40 GHz. From Fig. 4 we can easily compare our simulated and measured results. Fig. 5 shows the VSWR value lesser than 2 for the frequency range of 5.40-5.60 GHz, 6.45-6.62 GHz and 7.35-7.50 GHz respectively. Fig. 5 we can easily compare our simulated and measured VSWR. By seeing both Fig. 4 and Fig. 5 we get that our simulated and measured result are very much same and good enough for wireless applications. Fig. 6 shows the simulated 2D radiation pattern at 5.55 GHz, 6.55 GHz and 7.40 GHz frequency respectively. Fig. 7 shows the simulated 3D radiation pattern at 5.55 GHz, 6.55 GHz and 7.40 GHz frequency respectively, having maximum gain of 2.23, 4.19 and 2.72 at 5.55 GHz, 6.55 GHz and 7.40 GHz frequency respectively.

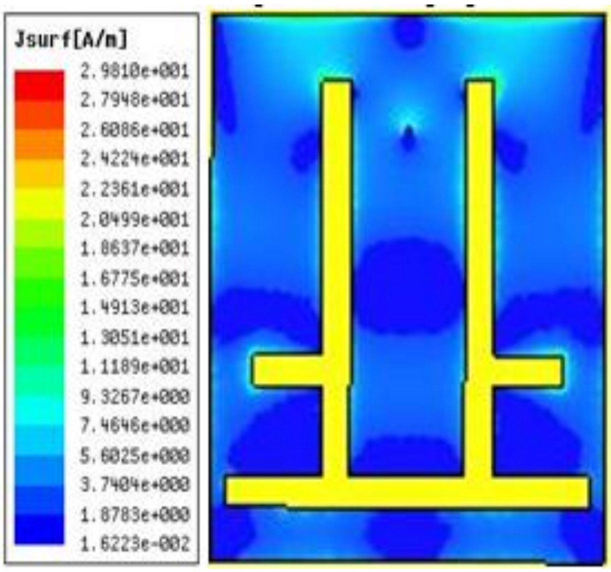


Fig 3: Current distribution in the patch of the proposed antenna

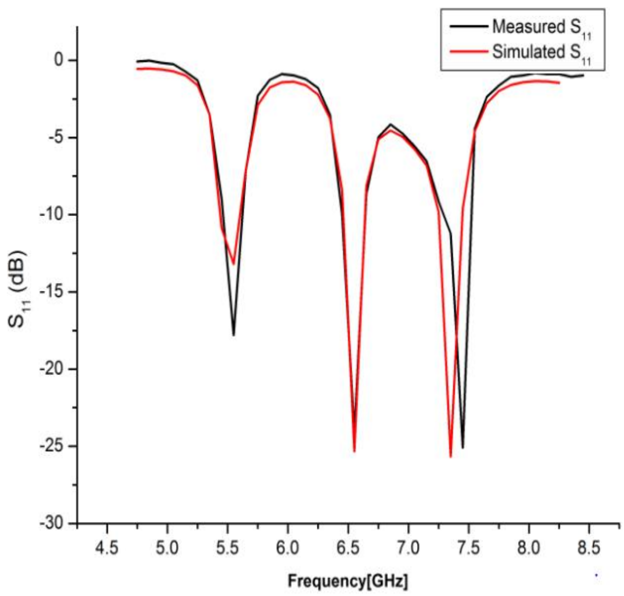


Fig 4: Comparison of simulated and measured return-loss of the proposed antenna

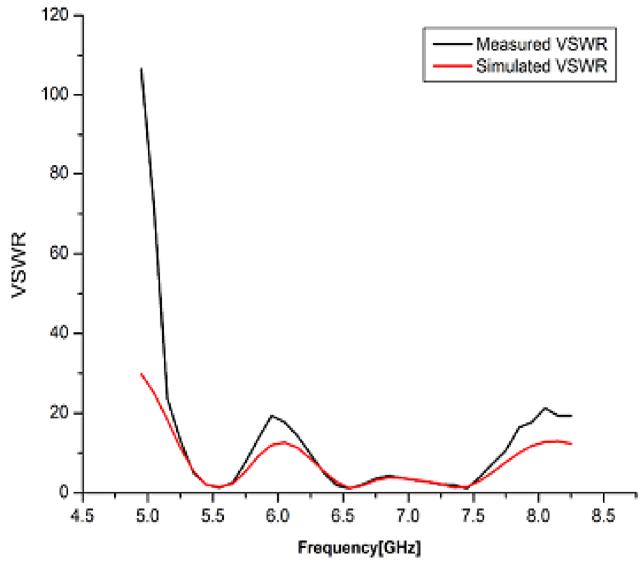
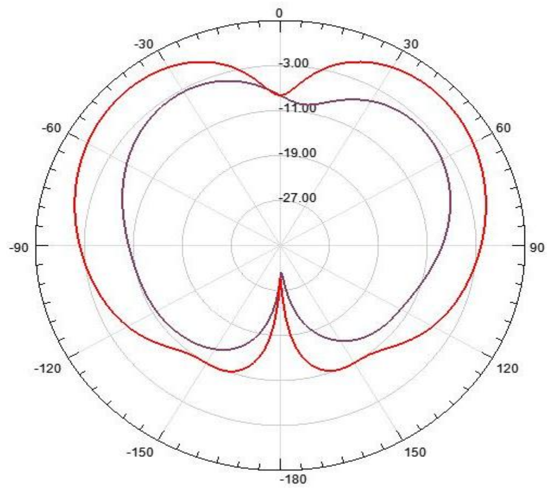
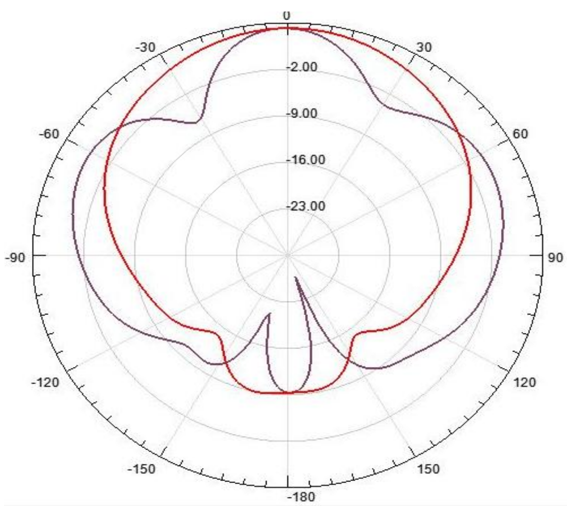


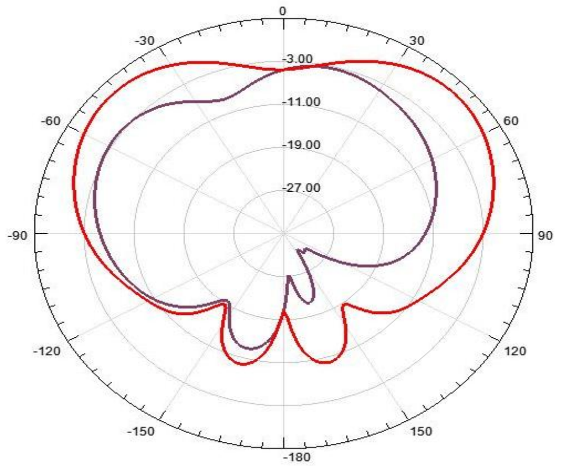
Fig 5: Comparison of simulated and measured VSWR of the proposed antenna



(a)

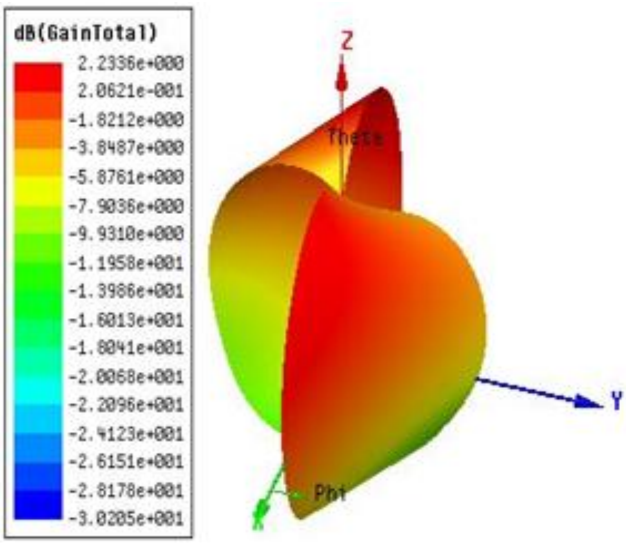


(b)

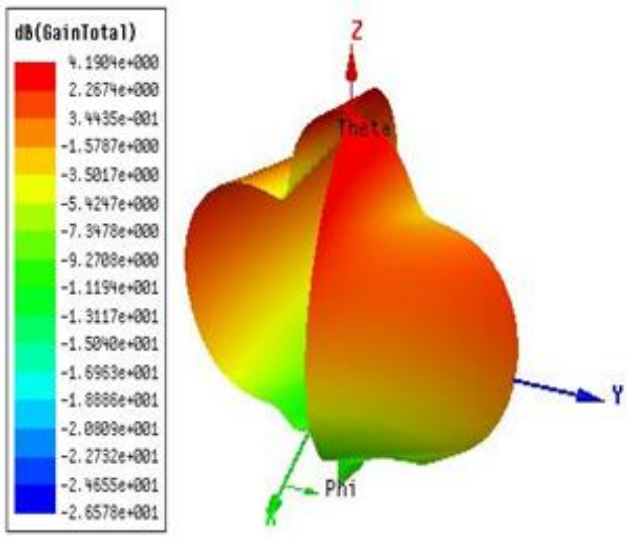


(c)

Fig 6: Simulated 2D Radiation pattern of the proposed antenna at (a) 5.55 GHz (b) 6.55 GHz (c) 7.40 GHz



(a)



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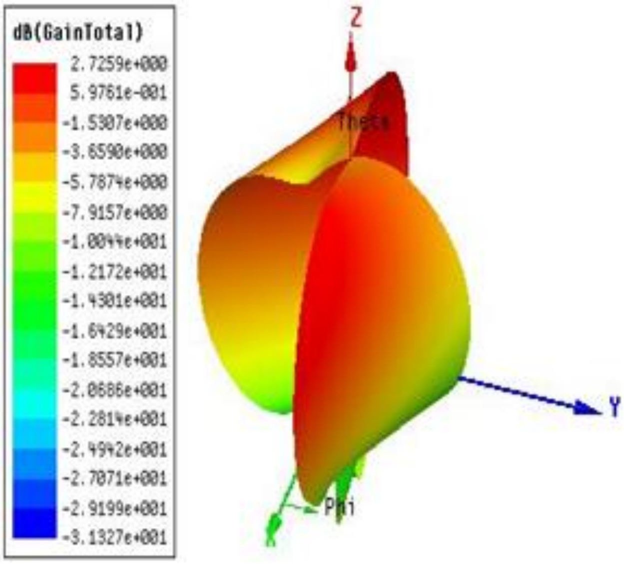

Fig 6: Simulated 3D Radiation pattern of the proposed antenna at (a) 5.55 GHz (b) 6.55 GHz (c) 7.40 GHz

4. CONCLUSION

In this communication a triple band inverted F-slot antenna for WLAN/WiMAX applications is presented. The measured and simulated results show that the obtained impedance bandwidths are from 5.40-5.60 GHz, 6.45-6.62 GHz and 7.35-7.50 GHz respectively, good enough for WLAN and WiMAX applications. In addition, the proposed antenna has good radiation characteristics and gains in its all operating bands, so it can emerge as an excellent candidate for multiband generation of wireless

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