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Multi-Band U-Slot Microstrip Patch Antenna with Defective Ground Base

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Abstract

In this paper, a multi-band U-slot microstrip patch antenna for wireless application is presented. The antenna has been designed and simulated on FR4 substrate with dielectric constant of 4 and thickness of 1 mm. The dimension of the antenna is 67x74x1mm^3. The simulation and analysis for the proposed multi-beam U-slot microstrip patch antenna is done by using Ansoft HFSS simulation software. The antenna operates at 3.5, 4.77, 6.4, 7.35 and 8.6 GHz frequency bands. The simulated results show that the proposed antenna provides good performance in term of return loss and radiation pattern for wireless applications.

Keywords— Patch antenna; Radiation pattern; U-slot; VSWR.

Introduction

Antennas are important components in communication systems and play a role in transmitting and receiving signals. In modern wireless communication systems, multiband antenna has been playing a very important role for wireless service requirements. Now-a-days, antennas with multiband capabilities have been widely required in satellite and mobile communication systems to meet the growing system complexity. Two techniques have been widely recognized as a viable, cost-effective, and high-speed data connectivity solution, enabling user mobility with the rapid development of the modern wireless communication system, antenna design has turned to focus on wide multiband and small simple structures that can be easy to fabricate. Compact, multiband, low-profile and low-cost antennas are widely used in personal communication devices along with the rapid development of the wireless communication systems.

This rapid increase in communication standards has lead to a great demand for multi-band and broadband antennas with low real estate area, low cost fabrication and ease of integration with feed networks. Therefore, various designs have been proposed in the literature to improve their bandwidth, including the use of thicker substrates, different shape patches and probes, addition of parasitic patches and cutting of slots. Examples of cutting slots include probe-fed U-slot patch antennas, double U-slot patch antenna, double-C patch antennas, and E-shape patch antennas which provide excellent bandwidths. For the past decades, the microstrip, slot, and stacked patch antennas have been used to implement multi-band.

This paper presents the multi-band U-slot microstrip patch antenna cover (3.49-3.51GHz), (4.735-4.78GHz), (6.35-6.45GHz), (7.3-7.4GHz), (8.58 to 8.62 GHz) in the frequency bands for wireless application. The antenna design and simulation has been done using Ansoft HFSS simulation software.

Antenna Design

In this section, the antenna design steps of microstrip slot antenna are presented. Substrate selection is the first practical step in designing a patch antenna. The structure of the proposed microstrip slot antenna in this paper utilizes dielectric material FR4 with dielectric constant of 4 as the substrate with the dielectric loss of 0.02.

The geometry of the proposed antenna is shown in Fig.1 (a) and Fig.1 (b). The dimension of the antenna is 47x54x 1.5mm³.To feed the proposed antenna a coaxial probe of characteristic impedance 50 ohm is used. VSWR less than or equal to 2 or 10dB antenna bandwidth is considered for practical applications. The antenna dimensions obtained after necessary tuning on single antenna element are shown in TABLE 1.

TABLE 1 Dimensions of the proposed U-Slot Microstrip Patch Antenna

Parameters	Units(mm)
L	34
W	27
Ls	25
Ws	12
a	4
b	4.5
yf	5.5

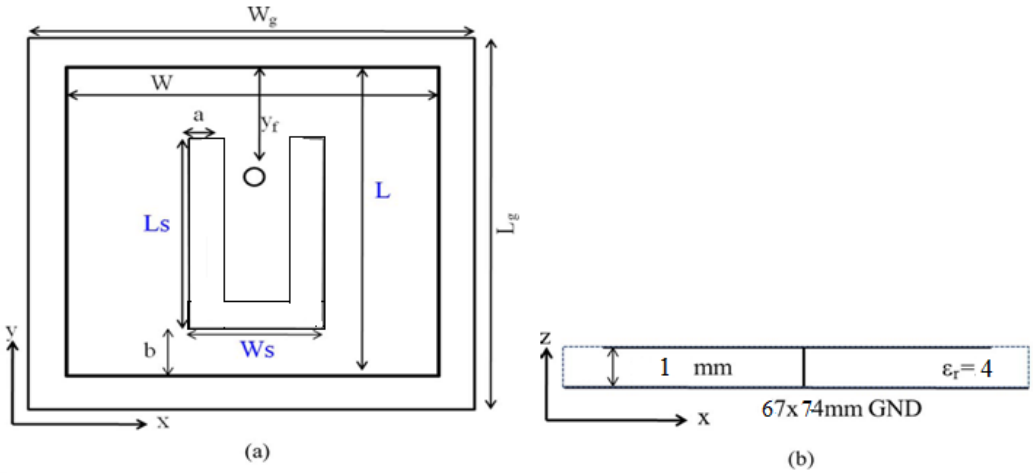


Fig.1.Geometry of the proposed U-Slot Microstrip Patch Antenna: (a) top view; (b) side view

Simulated Results

In this section, the simulation and analysis is done for the proposed multi-beam U-slot microstrip patch antenna by Ansoft HFSS simulation software. From these simulation results, the parametric studies are carried out. In this paper, the return loss, VSWR, and gain are simulated and analyzed. Fig.2. shows the current distribution in the patch of the proposed antenna.The proposed antenna have impedance matching better than-10 dB return loss for frequency range of 3.49-3.51 GHz, 4.735-4.78 GHz, 6.35-6.45 GHz, 7.3-7.4 GHz, 8.58-8.62 GHz respectively. Fig.3. shows that the antenna have the return loss of-11 dB at 3.5 GHz,-12 dB at the 4.75 GHz,-16 dB at 6.4 GHz and-10.5 dB at 7.35 GHz and-13 dB at 8.6 GHz frequency respectively. Fig.5. shows the VSWR value lesser than 2 for the frequency range of 3.49-3.51 GHz, 4.735-4.478 GHz, 6.35-6.45 GHz, 7.3-7.4 GHz, 8.58-8.62 GHz respectively. Fig.5. shows the radiation pattern of the proposed antenna at different frequencies.

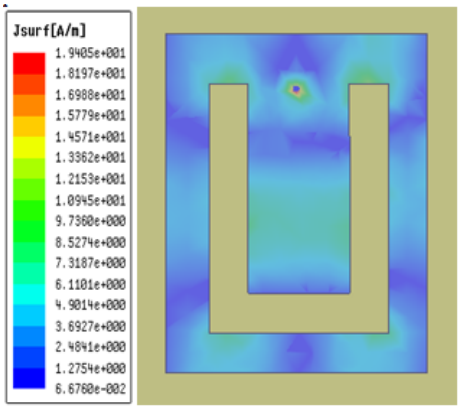


Fig.2. Current distribution of the proposed antenna

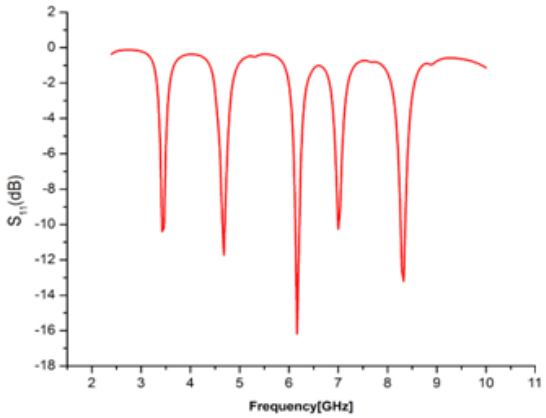


Fig.3. Simulated Return-Loss of the proposed Antenna

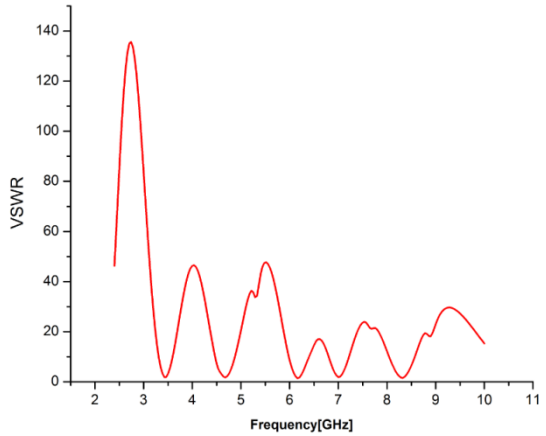
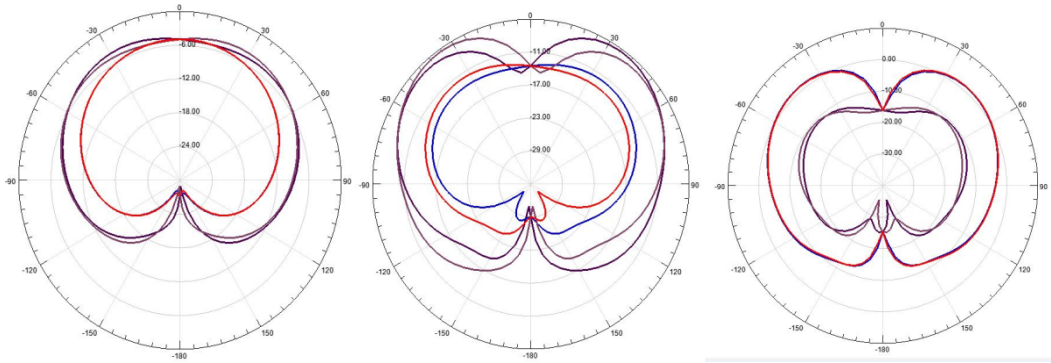
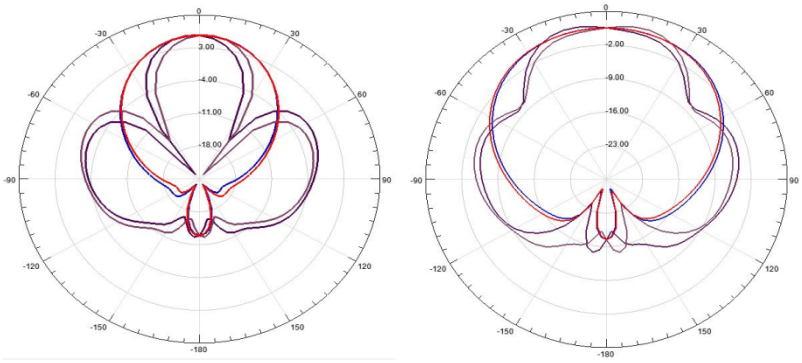


Fig.4. Simulated VSWR plot of the proposed Antenna



(a) (b) (c)



(d) (e)

Fig.5. Radiation Pattern of the proposed antenna at (a)3.5GHz (b)4.77GHz (c)6.4GHz (d)7.35GHz (e)8.6GHz

Conclusion

In this paper a multi-band U-slot patch antenna with a coaxial feed technique has been present. The simulated results of return loss, gain, and radiation patterns have been analyzed using Ansoft HFSS simulation software.. The proposed antenna can be considered to achieve multiband just through etching U-slots on the patch, so it can be much easier to fabricate. The proposed antenna have achieved good impedance matching, stable radiation pattern and satisfied return loss. The measured results show that the obtained impedance bandwidths are.02 GHz (3.49-3.51 GHz), 0.335 GHz (4.735-4.4.78GHz), 0.1 GHz (6.35-6.45 GHz), 0.1(7.3-7.4 GHz), 0.12 GHz (8.58 to 8.62 GHz) respectively, good enough for wireless applications. In addition, the proposed antenna has good radiation characteristics and gains in the multi operating bands, so it can emerge as an excellent candidate for multiband generation of wireless communication.

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