Abstract

Objective: This paper suggests a small microstrip antenna with WLAN frequency rejection properties to avoid interference between UWB systems. Methods/Analysis: At initial stage the dimension of suggested antenna are calculated by the available formulae in the literature and then is simulated by HFSS which is based on FEM to get optimized dimensions. The features of the manufactured antenna are checked with E5071C vector network analyser and compared with software generated results for validation. Findings: This antenna comprises of “S” shaped slot etched on the patch of FR4 substrate on front side and ground is having steps on rear. Top and bottom of the substrate is covered with a dielectric material (Teflon) of different dimensions. By proper selection of dimensions of patch and positions of slot on the radiating patch, the broadband property and frequency notching is achieved. The bandwidth of the suggested antenna is found to be 88.7% with operating frequency band from 4.26 GHz to 11.06 GHz and frequency notching range 4.85-5.97 GHz is obtained. It is shown that the shifting of rejected frequency can be observed by altering the size and type of dielectric resonant material. The suggested antenna has a small size of 12 x 18 x 6.6 mm$^3$ and discloses a maximum gain of 4.99 dB. Applications: The suggested antenna can be used to avoid the intervention between UWB systems and other existing systems in the operating frequency range 5-6 GHz.

Keywords: Dielectric Resonant Material, Frequency Notch, Microstrip Feed, Patch Antenna, “S” Shaped Slot

1. Introduction

In recent years printed microstrip patch antennas are gaining more attention because of their advantages like compact structure, easy manufacturing and less cost. But main drawbacks are narrow bandwidth and low gain$^1$. Wide impedance bandwidth with rejected function is obtained by having two steps and a circular slot$^2$, with modified U slot$^3$, with a dual T-shaped strips placed inside the square ring$^4$, using a wing shaped monopole$^5$, with inverted stepped U slot$^6$. A compact dual-band Dielectric Resonator Antenna (DRA) is reported by using a parasitic c-slot fed by a microstrip$^7$, by splitting a rectilinear Dielectric Resonator (DR) and carving notches off the DR$^8$, by using a solid rectangular Dielectric Resonator placed on a vertical ground plane edge$^9$, by using a spiral slot to excite the rectangular DRA for wideband CP$^{10}$, by using a stair-shaped dielectric resonator$^{11}$ and with protruding strips inside rectangular slot$^{12}$.

Most of the reported papers in the literature are having a size more than the suggested antenna. The performance of suggested antenna is also studied as a function of size and type of DR material. The antenna is simulated, fabricated and tested for obtaining the desired return loss and
WLAN Frequency Notched Printed Microstrip Antenna with S Shaped Slot and Dielectric Resonant Material

VSWR characteristics. The simulated results are checked with the investigated ones that prove the accuracy of the suggested antenna. The particulars of suggested antenna are given in the subsequent sections. The main aim of the paper is to show the influence of dielectric resonant material on shifting of notched frequency characteristics.

2. Model and Geometry of the Proposed Antenna

The proposed antenna of dimension \((L_s \times W_s)\) is fabricated on FR4 substrate with dielectric constant of 4.4 along with a dielectric resonant material (Teflon) with dielectric constant 2.1 placed at top and bottom. The antenna consists of “S” shaped slot on the top of the radiating patch and stepped ground on the bottom. The dimensions and shape of the slot are so chosen to get desired frequency notched characteristics. Initially the dimensions of DR material on the top \((L_{dr} \times W_{dr})\) and at the bottom \((L_{br} \times W_{br})\) are chosen to retain the frequency notched properties from 4.85 GHz to 5.97 GHz. The patch and ground is cut at the bottom corners to increase the band width. The type of feed is of microstrip line of having dimensions \((L_f \times W_f)\) with 50 ohms impedance. The layout of proposed antenna is shown in Figure 1 and the designed parameters are given in Table 1.

![Figure 1. Layout of suggested antenna (a) Viewed from front, (b) Viewed from rear and (c) Viewed from side.](image)

Table 1. Design parameters of the proposed antenna

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(L_s)</td>
<td>18 mm</td>
</tr>
<tr>
<td>(L_p)</td>
<td>10 mm</td>
</tr>
<tr>
<td>(W_s)</td>
<td>12 mm</td>
</tr>
</tbody>
</table>

![Table 1](image)

The photograph of the prototype antenna is shown in Figure 2.

![Figure 2. Photograph of the fabricated antenna.](image)

3. Results and Discussion

The proposed frequency notched antenna is simulated using HFSS software based on finite element method. The simulated results are experimentally verified by Agilent E5071C vector network analyser. The detailed information regarding antenna characteristics is discussed in this section. Figure 3 shows the plot of actual and simulated results of return loss versus frequency of the suggested antenna. Figure 4 shows the plot of measured and software generated results of the VSWR versus frequency. Small disagreement between the measured
and simulated results are due to fabrication losses, not measuring in the anechoic chamber and not having smooth finish of dielectric resonant material. The current distribution of the proposed antenna at 4.5 GHz, 7.5 GHz and 10.5 GHz are shown in Figure 5. From Figure 5, it is seen that the maximum current strength is obtained at the edges of feed line and slot lines.

Figure 3. Plot of return loss versus frequency.

Figure 4. Plot of VSWR versus frequency.

Figure 5. Simulated current distributions at (a) 4.5 GHz, (b) 7.5 GHz and (c) 10.5 GHz.

Figure 6 shows the effect of different sizes of dielectric resonant materials on frequency notch characteristics. With increase in the size of DR material, there is a shift of frequency notching towards lower side while the operating frequency remains constant. Figure 7 shows the change of return loss with frequency for different DR materials. We can see a significant change in operating frequency range and frequency notch characteristics with the change of dielectric material. All materials are showing dual band frequency rejection characteristics other than Teflon material.

Figure 6. The variation of return loss with frequency for different sizes of DR patch.

Figure 7. The variation of return loss with frequency for different DR materials.

From Figure 8, it is noticed that the maximum simulated gain is 4.99 dB. The simulated gain of suggested antenna is uniform except in the area of frequency rejection as shown in Figure 8. The E-plane and H-plane

Vol 9 (40) | October 2016 | www.indjst.org

Indian Journal of Science and Technology | 3
radiation patterns at 4.5 GHz, 7.5GHz and 10.5 GHz are shown in Figures 9 and 10 respectively. It is almost dipole like radiation pattern giving omnidirectional characteristics.

Figure 8. Simulated gain total (dB) at (a) 4.5 GHz, (b) 7.5 GHz and (c) 10.5 GHz.

Figure 9. Simulated and measured radiation pattern in E-plane at (a) 4.5 GHz, (b) 7.5 GHz and (c) 10.5 GHz.

Figure 10. Simulated and measured radiation pattern in H-plane at (a) 4.5 GHz, (b) 7.5 GHz and (c) 10.5 GHz.

4. Conclusion

A WLAN frequency notched UWB printed antenna with DR material having an overall size of 18 x 12 x 6.6 mm$^3$ is proposed and the variation of frequency notched characteristics with different sizes of DR materials are discussed. The designed antenna has a wide impedance bandwidth of 88.7% and the radiation pattern in E plane and H plane are almost omnidirectional. Enhancement in the bandwidth is obtained by cutting the patch and ground at the bottom corners. The maximum gain of the proposed antenna is 4.99 dB. We can get the desired range of operating frequency and change in notched frequency by appropriate selection, position and size of DR material.

5. References