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A Navel design of UWB Antenna with multiple slots on patch for 5GHz band notch characteristics

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Abstract: This paper represents a novel UWB antenna with a band elimination characteristic. In order to obtain band elimination characteristic, Multiple Slot inserted in the rectangular patch and I-shaped strip is inserted inside the I-shaped slot on the rectangular patch. The proposed antenna is designed on a GIL GML substrate with thickness of 0.762 mm and relative permittivity (ε_r) of 3.2. The size of our proposed antenna is $26 \times 32\ mm^2$, which results in desirable radiation characteristics. The proposed antenna design with optimal dimensions is fabricated and measured. The measurement shows that return loss is below -10dB within the desired frequency bandwidth from 2.75 GHz to upper 10.8GHz, whereas a notched bandwidth of 5.16 - 5.95GHz is obtained. Far-field radiation patterns and gain of the antenna are also studied in this paper. Good agreement has been found by comparing the results from the measured data and those simulated.

Keywords: Ullra Wide-Band (UWB), Patch, I-shaped slot, Far-field radiation patterns, Return loss.

I. INTRODUCTION

With the definition and acceptance of the Ultra Wide-Band (UWB) technology, there has been considerable research effort put into UWB technology worldwide. According to the federal communication Commission (FCC) Frequency band of 3.1-10.6GHz in 2002 can be used for use in indoor & handheld system application [2]. Ultra Wideband (UWB) technology provides promising solution for future communication system due to excellent immunity to multi path interference, large bandwidth and high speed data rate.

Most important part of UWB communication is UWB antenna because UWB antenna is small in size and with low cost of fabrication and constant attenuation. A good UWB antenna should have ultra wide band width, high radiation efficiency, directional or Omni directional radiation. UWB communication system use the range 3.1-10.6GHz [4] and it include interference by narrow band signal of neighboring RF system such as IEEE 802.11a WLAN having operating frequency range 5.125-5.825GHz [3,5]. So, it is needed to design UWB antenna with band -notch characteristic to avoid interference. The conventional methods to achieve the notched band are cutting a slot on the patch or embedding a quarter wavelength stub within a large slot on the patch, and inserting a slit on the ground [8, 9, 10]. Another way is based on placing parasitic elements near the printed monopole, which play role as a filter to reject limited band.

In this paper we design a miniaturized antenna for UWB system. As we know that the bandwidth of UWB is large so to get interference by bands which lie in this band. In to obtain band elimination characteristic, Multiple Slot inserted in the rectangular patch, and I-shaped strip is inserted inside the I-shaped slot on the rectangular patch.The antenna geometry is introduced in section II. The antenna parameters return loss, radiation characteristics are discussed in section III. Conclusions are given in section IV.

II. THE ANTENNA GEOMETRY

In this UWB antenna design, we begin with the conventional planar rectangular monopole type. As the RF current mainly distributes over lower edge of the main patch and minor on the center region, we can remove this center region of the radiating element without major influence on the antenna performance. The main patch is fed through a 50 Ω Microstrip line.

The antenna is fabricated on GIL GML substrate with a transverse dimension of $26 \times 32\ mm^2$, relative dielectric constant of $\varepsilon_r = 3.2$, a thickness of $0.762\ mm$,and a loss tangent of 0.02. The distance between the radiator and the upper edge of the ground plane is one of the critical factorin wideband impedance matching, therefore has been optimized to be $1mm$. Other dimensions of the proposed antenna are shown in Figure1.

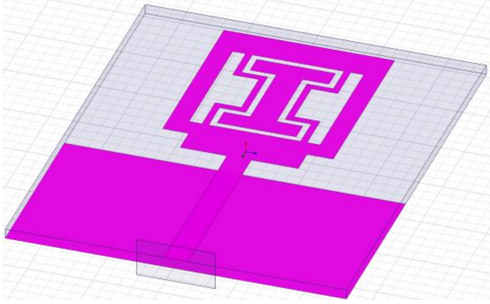

Figure 1(a) The Proposed antenna structure

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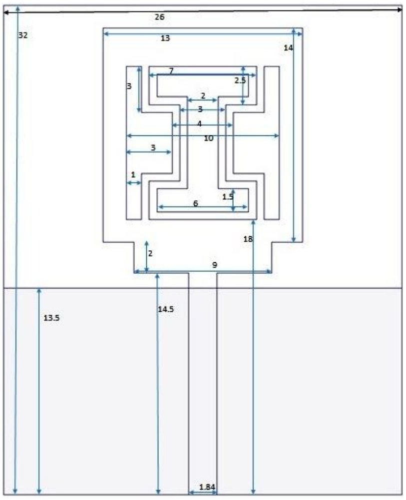

Figure 1(b) The antenna structure with dimension

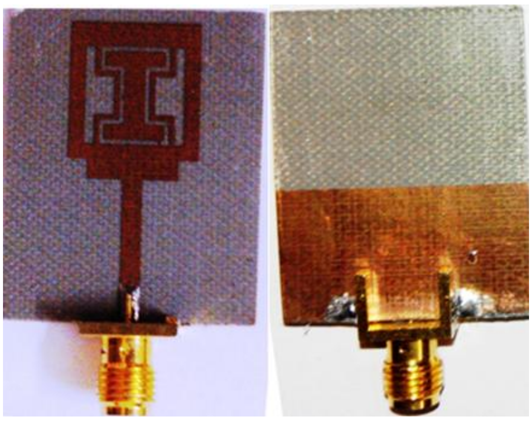

Figure 2: Photograph of prototype, Front and back view.

III. THE ANTENNA PARAMETERS RETURN LOSS, RADIATION CHARACTERISTICS

The prototype of the proposed antenna was fabricated on the low-cost GIL GML substrate, as shown in Figure 2

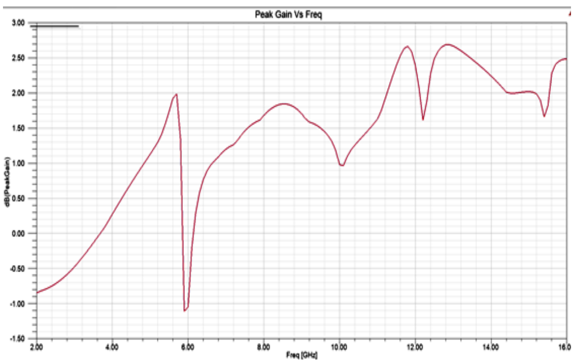

Figure3. Simulated Gain Frequency Response for Proposed Antenna

Figure 3 Gain Vs Frequency plot which shows that the maximum peak gain of the proposed antenna is 2 dB.

Figure 4 shows the measured return loss agrees well with the simulated results, which covers the UWB frequency range (3.1-10.6 GHz) except in 5.16- 5.95 GHz band. The resonance frequency of the antenna can be obtained from the return loss plot from the point at which the return loss is minimum. The minimum return loss is -23.78 dB obtained and the resonance frequency is 7.68 GHz.

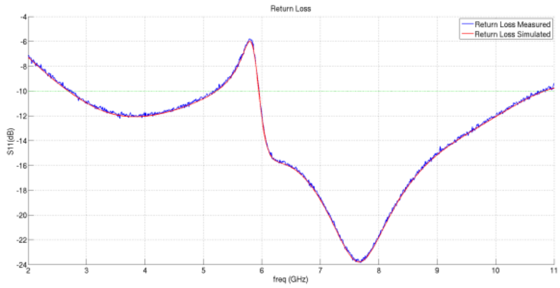

Figure 4: S11 parameter curve for measured & simulated antenna

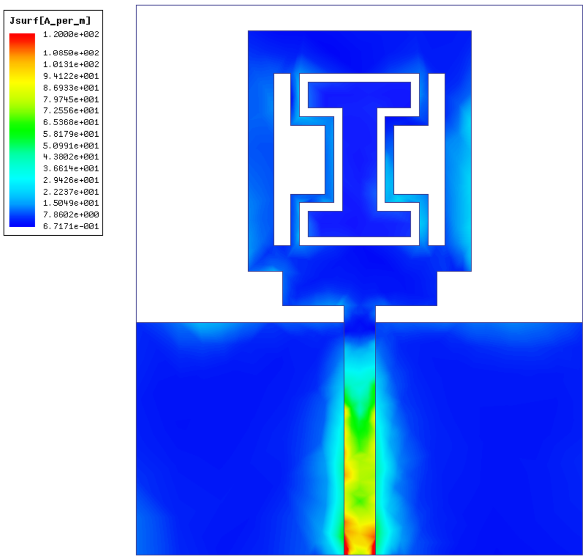

Figure 5(a): The average current density distributions of the proposed antenna at 3.9 GHz

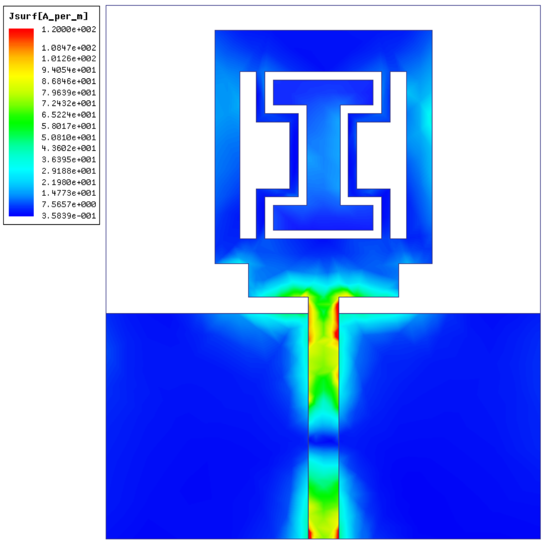

Figure 5(b): The average current density distributions of the proposed antenna at 7.6GHz

The average current density distribution of the proposed antenna at 3.9 GHz and 7.6 GHz frequencies are presented. As observed in Fig. 5(a) and 5(b). It is mainly

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distributed along the Microstrip-line and the edges of the slot for all frequencies.

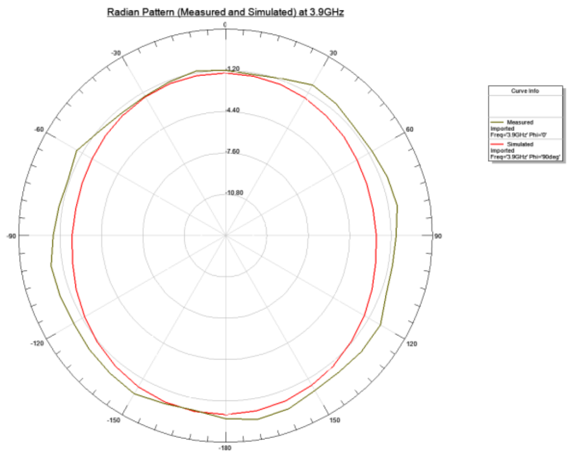

Figure 6(a): Simulated 2D radiation pattern for proposed antennas at 3.9GHz.

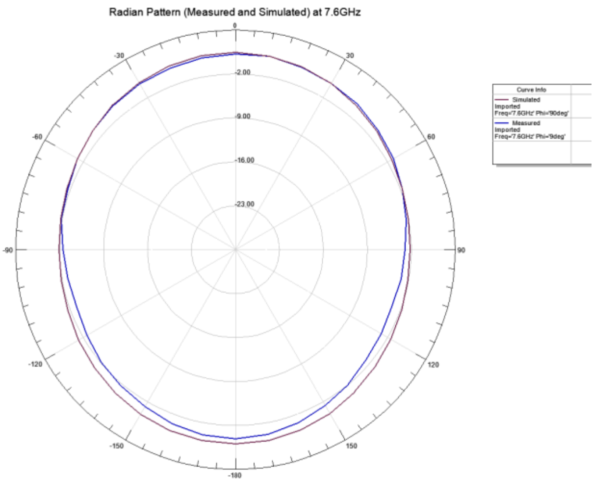

Figure 6(b): Simulated 2D radiation pattern for proposed antennas at 7.6GHz.

Figure 6 (a) and (b) exhibit simulated 2D radiation pattern for proposed antenna. As presented in figureit shows perfect Omni directional radiation pattern at 2.75 to 10.8 GHz frequencies.

IV CONCLUSION

A band-notched ultra wide-band antenna is proposed in this paper. In order to obtain band elimination characteristic, multiple slot inserted in the rectangular patch, and I-shaped strip is inserted inside the I-shaped slot on the rectangular patch. Band-notched characteristics can be controlled by adjusting I-shaped strip parameters. The proposed antenna design with optimal dimensions is fabricated and measured. The measurement shows the return loss is below -10dB within the desired frequency bandwidth from 2.75GHz to upper 10.8GHz, whereas a notched bandwidth of 5.16 -5.95GHz is obtained. Far-field radiation patterns and gain of the antenna are also studied in this paper. Good agreement has been found by comparing the results from the measured data, and those simulated.

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