Asymmetrical Slotted Ultra Wideband Antenna

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1. Abstract

This paper presents an asymmetrical slotted ultra wideband (UWB) antenna. This proposed antenna uses a couple of L and U slot to broader the bandwidth. Truncated ground plane is also used to control the antenna's impedance matching. Those both slots were designed by investigating the behaviour of current distribution of the patch antenna. The total antenna's dimension is 30 mm x 30 mm and fed by microstrip line. Both simulated and measured results have shown a good return loss with respect to -10 dB and nearly omni-directional pattern.

2. Introduction

In recent years, more interests have been put into wireless personal area network (WPAN) technology worldwide. The future WPAN aims to provide reliable wireless connections between computer, portable devices and consumer electronics within a short range. Furthermore, fast data storage and exchange between these devices will also be accomplished. This requires a data rate which is much higher than what can be achieved through currently existing wireless technology. UWB technology has been designed and developed in order to meet this demand. The UWB antennas are essential for providing wireless wideband communications based on the use of very narrow pulses on the order of nanoseconds, covering a very wide bandwidth in the frequency domain, and very short distances at very low power densities.

Research works on UWB antennas have been reported in many literatures [1-7]. Inserting a slot into radiator patch antenna is a technique applied to improve the impedance matching, especially at higher frequency [6-7]. In this paper, the effect of slot to the antenna performance was investigated especially for the asymmetrical coupling slot. The UWB antenna was designed by adding the coupling slot of L and U into pentagonal antenna. Their current behaviour was observed. It is shown that by properly design the slot width and length of those couple slot, without degrading their performance, a broad bandwidth can be obtained.

3. Antenna Geometry

Figure 1 shows the proposed antenna structure printed on the FR4 substrate of $\varepsilon_r = 4.6$. The pentagonal antenna is vertically installed above a ground plane (l_{grd}) of 11 mm. The optimum feed gap (h) to the ground plane is found to be 1.5 mm. The dimension of substrate is chosen to be 30 x 30 mm^2 (W_{sub} x L_{sub}) in this study. Antenna has a pentagonal patch with a width (w) of 15 mm and a length (l) of 12 mm. This shape is as variation of rectangular shape with bevel techniques. The couple slots are designed very carefully by studying the current flow distribution which will give input impedance improvement. The slot size of the proposed antenna is listed in Table 1. The slot width is 0.5 mm in order to improve the bandwidth above 10 GHz.

3.1 Current Distribution

The L and U slotted antenna with current distribution at 3, 6, and 9 GHz is presented in Figure 2. It is shown that the vertical current is most concentrated near to the slots edges for all frequency range. It is also noticed that, the current distribution is less on the area between both slots without degrading its performance. This current distribution was simulated by using Zeland FDTD simulation software.

4. Impedance and Pattern Bandwidth

The simulated and measured return loss is shown in Figure 3. The measured return loss is slightly shifted to the simulated one, but they still cover 2.5 GHz to 10.1 GHz as what the UWB required. From the simulation, the U slot improves the upper dip resonance of 10.3 GHz and the L slot improves the lower dip resonance of 5.3 GHz. The coupling of both slots has shown a very good return loss below -10 dB. The length of L slot is 14.5 mm approximately equal to 0.25χ at 5.3 GHz, and the length of U slot is 11.5 mm approximately equal to 0.4χ at 10.3 GHz. In addition, since the antenna is fed by a micro-strip line, misalignment can result because etching is required on both sides of the dielectric substrate. The alignment error results degradation to the antenna performance.

Figure 4 shows the simulated and measured E and H planes for 4 GHz, and 5.8 GHz. The results show that the radiation patterns are changing as the frequency increases. The H planes show a good omni directional for both frequency ranges. The E-planes are relatively broad and slightly distorted at 5.8 GHz.

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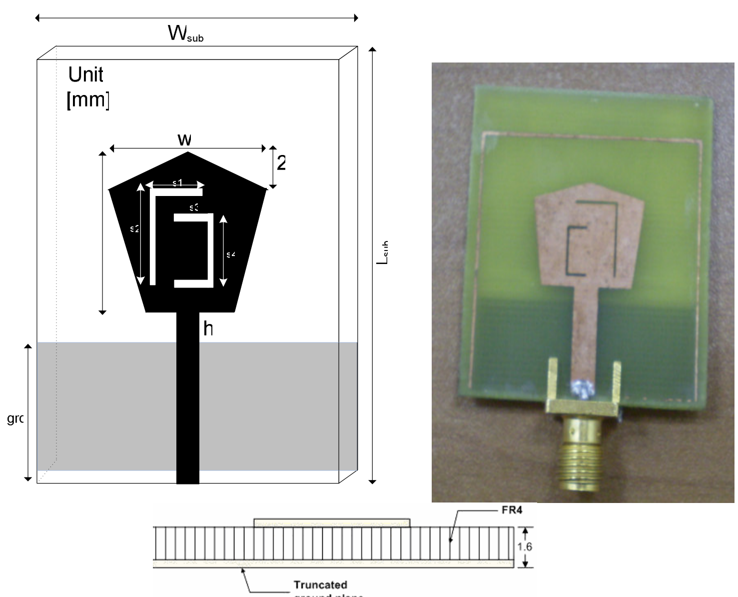


Figure 1: The Geometry of L and U Slotted UWB Antenna

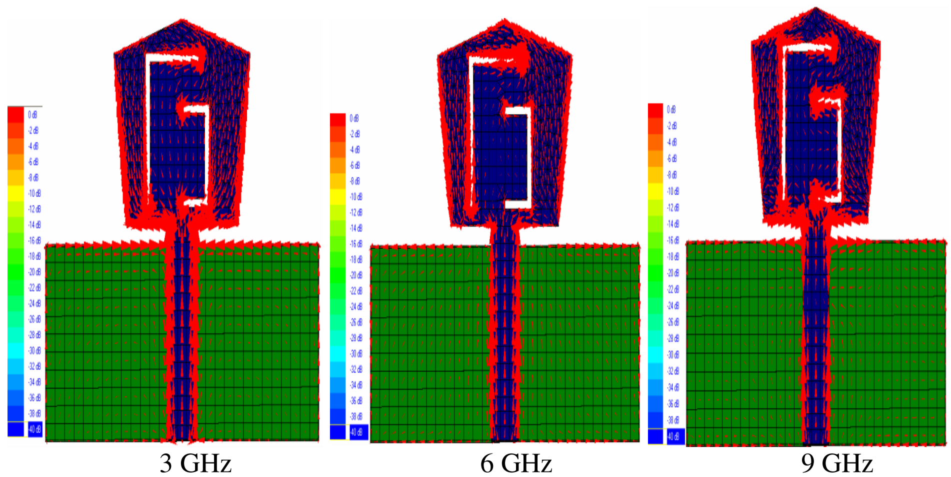


Figure 2: Current Distribution for L and U Slotted UWB Antenna

Table 1: Dimension of L and U Slot

Description	L and U slots	
	Symbol	Size [mm]
Slot length	Is1	6
	Is2	9
	Is3	3
	Is4	6.5

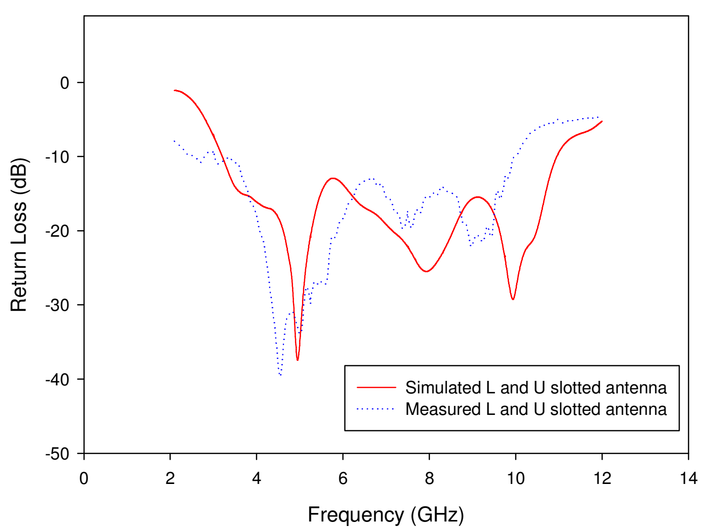
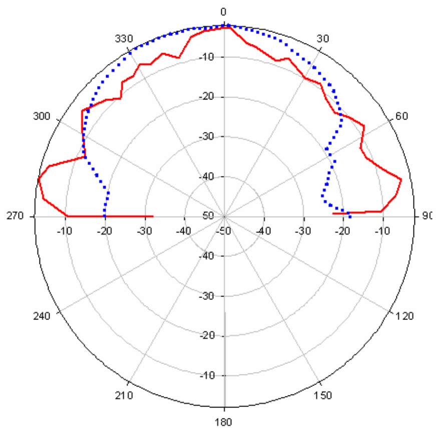
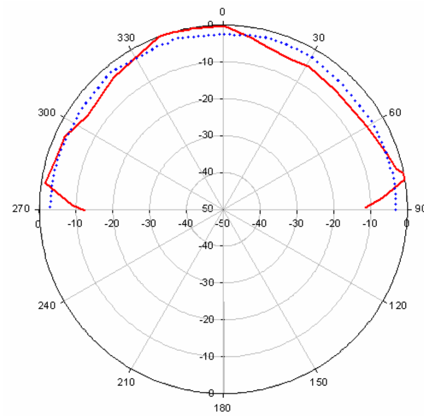


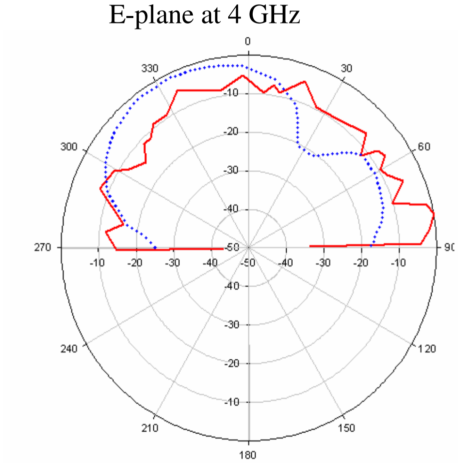
Figure 3: The Measured and Simulated Return Loss for L and U Slotted UWB Antenna



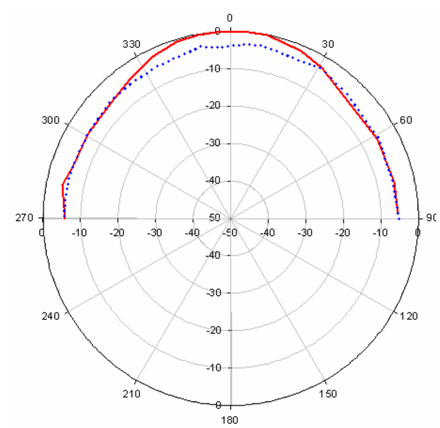
E-plane at 4 GHz



H-plane at 4GHz



E-plane at 5.8 GHz



H-plane at 5.8 GHz

Figure 4: The Measured (solid) and Simulated (dotted) Radiation Pattern for L and U Slotted UWB Antenna

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