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# Ultra Wide Band RSMA Patch Antenna

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***Abstract—***

***This thesis involves in the creation of a RSMA Patch antenna which is capable of using in the WLAN Application. In this thesis we have adopted the RSMA patch antenna model that is capable of producing Ultra wide band. It can widely use in Access points creation to make point-to-multipoint networks, while remote links are point-to-point. Each of these suggests different types of antennas for their purpose. Nodes that are used for multipoint access will likely use Omni antennas which radiate equally in all directions, or sectorial antennas which focus into a small area. In the point-to-point case, antennas are used to connect two single locations together. Directive antennas are the primary choice for this application.***

***Index terms --- Omni antennas, RSMA Patch, WLAN, WPAN, WBAN, UWB.***

## I. INTRODUCTION

Patch antennas play a very significant role in today's world of wireless communication systems. A Micro strip patch antenna is very simple in the construction using a conventional Micro strip fabrication technique. The most commonly used Micro strip patch antennas are rectangular and circular patch.antennas[1] Dual characteristics, circular polarizations, dual frequency operation, frequency agility, broad band width, feed line flexibility, beam scanning can be easily obtained from these patch antennas.

Wireless communication technology has changed our lives during the past two decades. In countless homes and offices, the cordless phones free us from the short leash of handset cords. Cell phones give us even more freedom such that we can communicate with each other at any time and in any place. Wireless local area network ($WLAN^2$) technology provides us access to the internet without suffering from managing yards of unsightly and expensive cable.

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 computers, 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 technologies.

Wireless personal area networks (WPAN) and wireless body area networks (WBAN) are seen as one of the major fields where such UWB characteristics can be potentially exploited. Antennas play a critical role in the UWB communication systems, since they act as pulse-shaping filters. Dipole antennas have been popular candidates in many systems for their various advantages, such as Light weight, low cost, ease of$fabrication^3$, etc. Normal dipole Antennas are with relatively narrow bandwidth, about 10% for VSWR of 2.This bandwidth problem has limited their application in modern wideband and multi-band communication systems. In addition, nearby objects easily detune the dipoles because of the limited bandwidth of operation. Recently, many monopole and circular shape based planar antennas have been developed for $UWB^4$ communication systems.

The maximum achievable data rate or capacity for the ideal band-limited additive white Gaussian noise (AWGN) channel is related to the bandwidth and signal-to-noise ratio ($SNR^6$) by Shannon-Nyquist criterion [1, 2], as shown in Equation 1.1

$$C=B \log 2(1+SNR) \qquad \textbf{1.1}$$

Where C denotes the maximum transmit data rate[7], B stands for the channel bandwidth.
The length of the rectangular patch antenna, the resonate length, determines the resonate frequency and λ/2 for a rectangular patch in its fundamental mode. In a practical view due to the fringing fields the patch is a bit larger than the theoretical calculated $dimensions^8$.
The length is calculated by the formula[9]

$$L = \frac{0.49\lambda}{\sqrt{\varepsilon r}} \qquad \textbf{1.2}$$

The dimensions of the Micro strip patch antenna i.e. Resonant Length ($L$), width ($w$).
$\lambda_0$ – wave length of the free space, $\lambda_d$– wavelength of the Dielectric medium, $\varepsilon_r$ – dielectric constant.
The width of the patch can be calculated by the formula

$$Width = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad \textbf{1.3}$$

C – The speed of light, $F_r$ – the resonant frequency which is equal to 2.4 GHz.

 

## II. DESIGN CONSIDERATIONS

The step 1 in the design of dimension 2.5 x 1 $mm^2$ and step2 is 4mm on Y-axis and 1 mm on X-axis. The dimensions of third step are kept same as second step. The ground plane is of 32 x 28.1 $mm^2$ is used .The slot present at patch is 3 x 3$mm^2$. The ground plane is modified to enhance the bandwidth of the antenna. The Ground has the first cut of 16 x 2 $mm^2$ and the second cut of 28.1 x 10$mm^2$. The antenna is designed on FR4 substrate with thickness of 1.6 mm and relative dielectric constant of 4.6. The radiator r is fed by a micro strip line of 3 mm width. The distance between the rectangular patch to ground plane printed on the back surface substrate is 1 mm, and the length of truncated ground plane of 11 mm. The excitation is a 50 microstrip line printed on the grounded substrate with lumped port mechanism facilitating in the even excitation for the antenna to radiate[10].

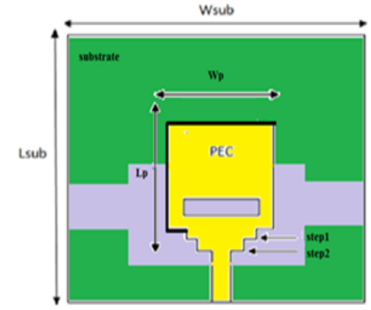

Figure 1.1 Design Dimensions.

The dimensions of the antenna are tabulated in the below table and we can observe the value and the corresponding dimension. It gives the detailed view on the understanding of the geometry of the patch antenna.

Table 1.1 Details of the geometry of the antenna.

| Units | mm |
|---|---|
| Solution frequency | 7.5GHz |
| Step 1 | 2.5×1 |
| Step 2 | 4×1 |
| Substrate thickness | 1.6 |
| Substrate dimension along x | 32 |
| Substrate dimension along y | 28.1 |
| Patch dimension along x | 15 |
| Patch dimension along y | 12 |
| Feed line | 3×3 |

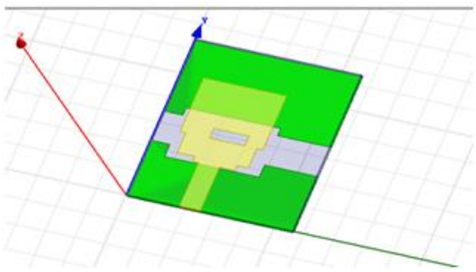
Figure 1.2 Geometric View of the Antenna.

## III. RESULTS

**Return Loss:** This was the plot representing the characteristics of return loss in dB versus the frequency in GHz. From this plot we can notice that the operating frequency is 7.55GHz.

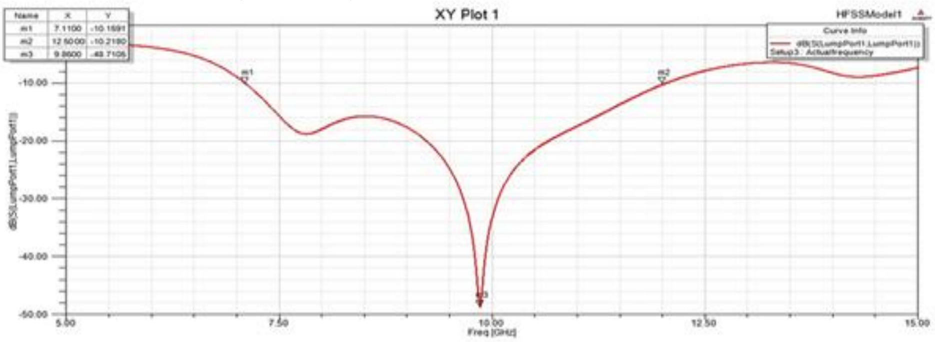

Figure 1.3Rectangular plot of return loss versus frequency with markers representing operating frequencies of the antenna.

 

From the above rectangular plot we can observe the bandwidth BW = $F_H - F_L$.
BW = 12.50 -7.11 = 5.39GHz. which is used at ultra wide band applications.
**Radiation pattern:** The below shown radiation patterns are observed at three different operating frequencies of 7.55Ghz,

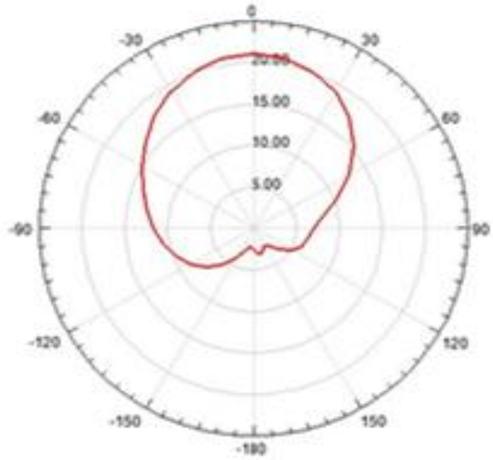


Figure 1.4: Radiation pattern for frequency 7.55GHz.

**VSWR**

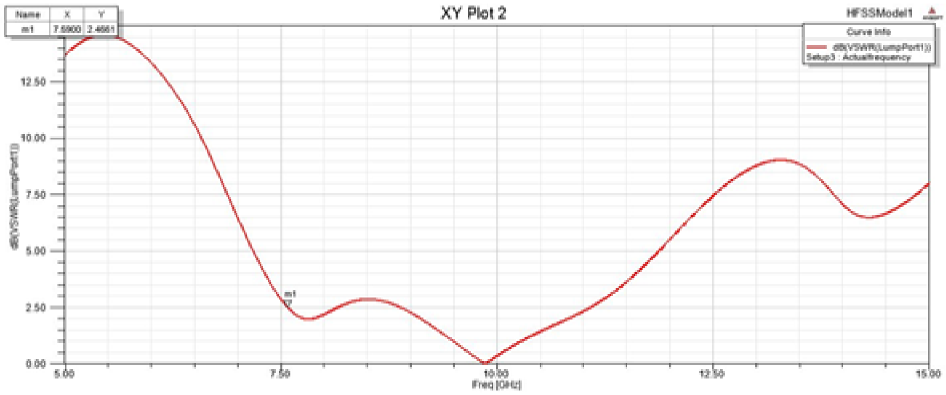


Figure 1.7: Rectangular plot of Voltage Standing Wave Ratio (VSWR) Versus Frequency Characteristics of the Antenna.

The above figure 1.7 is the VSWR for frequency 7.55GHz

VSWR measures the potential of the antenna to radiate. A low VSWR means the antenna is well-matched, but does not necessarily mean the power delivered is also radiated. Figure 1.7 illustrates the VSWR of the Radiator at different frequencies[11].

**DIRECTIVITY**

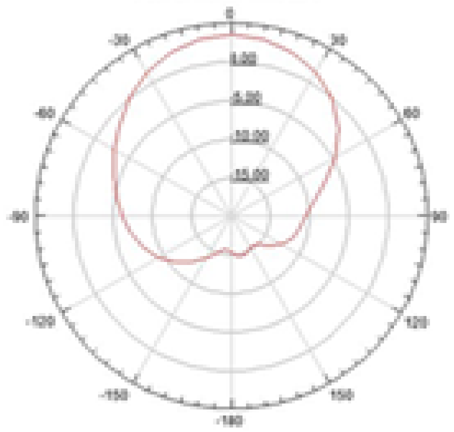


FIG 1.9: Directivity of frequency 7.55GHz.

Directivity of the antenna is the ability of an antenna to radiate in a particular direction with maximum gain in that particular direction, the above plots obtained in the results illustrates that the antenna is capable of radiating the electromagnetic energy in a particular direction.

**3D RADIATION PATTERN**

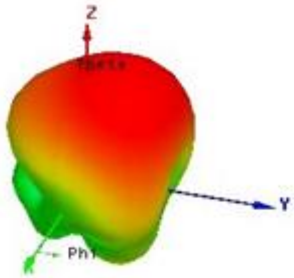


Figure 2.2:3D Radiation pattern forFrequency 7.55GHz.

The above shown result gives a vivid outlook the far field radiation pattern of the antenna. It can be observed that the antenna is capable of producing a highly directive beam as well as the beam of huge band width.

## IV. CONCLUSION

A new ultra wide-band antenna is proposed for WPAN application, the modified RMSA shaped patch antenna is simulated using HFSS13. The proposed antenna has the advantages of small size, easy fabrication and simple construction. The simulated results of the radiation patterns at various frequencies are observed and from the results it had be observed that the designed radiator is observed to produce the wide bandwidth at the operating frequency of 7.55GHz. The proposed antenna for return loss is less than -10 dB and VSWR is nearly 2 have shown that the antenna can be used for ultra wide band application at the operating frequency of 7.5 GHz.

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