A Slotted Multiband Microstrip Antenna in Compact Size For the Ultra-Wideband (UWB) Applications

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Abstract- **Nowadays the evolution in wireless systems engineering needs the growth of the low-profile antennas which are effective to maintaining the constant performance over the spectrum of frequencies. In this paper, we presented a Slotted Multiband microstrip antenna in compact size for the UWB applications. This paper explains the compact size Slotted Multiband microstrip antenna for the UWB applications along with the detailed study. Everyone knows that today's everywhere used wireless communication because it is compact, easy to install, light weight and inexpensive. The initial frequency band characteristics is obtained in the microstrip patch antenna at 2.525 GHz which is utilized for the wireless communication and to reduce the WiMAX disturbance from 3.3GHz to 3.8GHz, a slot carved was utilized into the patch. The other band characteristics are accomplished in this paper by employing a defective microstrip structural band that is introduced in the feed line of the microstrip to minimize the WLAN interference from 5.15GHz to 5.825GHz. Microstrip patch antenna has many UWB applications such as medicinal, radar imaging etc. In this paper the proposed antenna contains of parameters, fundamental characteristics.**

Keywords* — *Slotted Multiband Microstrip antenna, Return Loss, Gain, UWB applications, Parameters.

I. INTRODUCTION

For radiating or receiving the electromagnetic wave an antenna is used. There are different shapes and sizes of antenna are available, and all kinds of antenna work on the same electromagnetic principle. The compact antennas are designed for personal wireless communication devices. The satellite communication has grown the demand for compact antennas which have reliable transmission. From the past many years, the Microstrip patch antenna has the ability to works in the growth of wireless local area networks at research organizations because it is compact and inexpensive [1],[2]. Wireless communications and microwave applications are used the patch antenna which is also called planar antennas. The patch antennas are fabricated into planar or linear arrays very easily by using photolithographic techniques. Microstrip patch antennas are popular because of their structure which is compact; it is used the lightweight metal stamped or machine parts and also used the printed circuit technology for the low manufacturing cost. Mostly the microstrip patch antennas are used in arrays. Many types of patterns and polarizations can be designed through microstrip antennas; that is depending on the use of radiating element shape and the excited mode.

In recent years because of the transmission of signal in a large bandwidth with a low energy the ultra-wideband (UWB) system have received an eye of the population. There are some important application areas of the ultra-wideband systems are mobile and satellite communication, radar imaging, biomedical imaging, and multimedia streaming [1-5]. According to the (FCC) federal Communications Commission has been permitted the utilization of 3.1-10.6 GHz frequency range for the implementations of low power emitting for some further studies of the ultra-wideband systems [3]. In wireless communication generally utilized the Microstrip patch antennas because of its multiple advantages. Some advantages like the patch antennas are small in size, low profile, cheap cost and light in weight and also it has the capability of inclusion into the arrays. The antennas have been easily integrated to wireless channels of the (LTE) long term evolution is used to improve the speed of cellphones, (WLAN) wireless local area network and (Wi-MAX) Worldwide interoperability for microwave access protocols and ultra-wideband systems because to these advantages. However, some wireless communication like WiMAX from 3.3GHz to 3.8GHz and WLAN from 5.15GHz to 5.825GHz employ narrow bands that conflict with UWB systems. Several methods for designing band notched antennas have been investigated by several researchers [4-5]. The capacity to use a single antenna to cover several frequency bands which gives multiband antennas an edge beyond single and dual band antennas in considerations of design and operation. Fractal antenna arrays, like the Sierpinski arrays and the Kotch arrays, are

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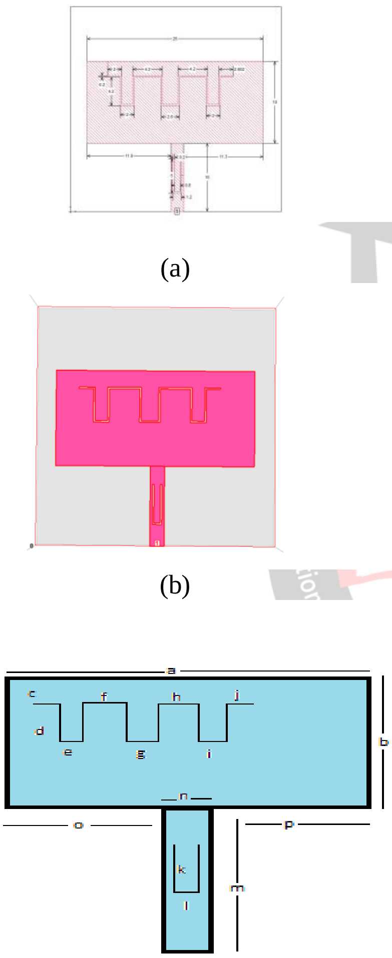
implemented as well to improve multiband functions, as according to studies [6-7].

II. ANTENNA DESIGN

A. Configuration

The proposed Slotted Multiband antenna is structured by using the substrate material FR-4 (Fire Resistant), and the substrate material constant is 4.9. The height of the material is 1.6(h) mm and the dielectric constant is 4.9 (Ɛr) mm, where all the parameters are absolutely optimized for the better presentation. The proposed microstrip patch antenna has the dimensions 30 mm (Width) × 30 mm (Length). For the simulation of the slotted multiband antenna Sonnet software is utilized. Figure 1(a), (b) &(c) illustrates the geometry, the top view and 3D view of the slotted multiband antenna.



(a) (b) (c)

Figure 1: Geometry of the Multiband Antenna

TABLE 1
DIMENSION OF SLOTTED MULTIBAND MICROSTRIP ANTENNA

Parameters	Value (mm)	Parameters	Value (mm)
a	25	i	2
b	12	j	2.002
c	2	k	5
d	4.2	l	0.8
e	2	m	10
f	4.2	n	1.2
g	2.6	o	11.9
h	4.2	p	11.3

B. Equations for Antenna Designing

The antenna operating dimensions like width and length of patch have been calculated from the given equations:

Width:

$$W = \frac{c}{2fr\sqrt{\frac{\varepsilon r+1}{2}}} \tag{1}$$

Where c= velocity of light in free space,

εr = dielectric constant,

fr = resonant frequency,

W= patch of non-resonant width [7, 8].

Length:

$$L = Leff - 2\Delta L \tag{2}$$

Patch Length Extension:

$$\Delta L = 0.412h\frac{(\varepsilon reff+0.3)(\frac{w}{h}+0.264)}{(\varepsilon reff+0.258)(\frac{w}{h}+0.8)} \tag{3}$$

Effective Length:

$$Leff = \frac{c}{2fr\sqrt{\varepsilon reff}} \tag{4}$$

Effective Dielectric Constant:

$$\varepsilon reff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\ [1+12\frac{h}{w}]^{\frac{-1}{2}} \tag{5}$$

In the above equations, h is the height and w is the width.

III. RESULTS AND DISCUSSION

The proposed slotted multiband antenna is found to be operated at 5 different resonant frequencies 2.525GHz, 4.95GHz, 6.525GHz, 7.0GHz and 9.55GHz respectively. The return loss is -14.56dB at 2.525GHz, -19.07dB at 4.95GHz, -15.17dB at 6.525GHz, -37.83dB at 7.0GHz and -25.49dB 9.55GHz respectively which is shown in figure 2.

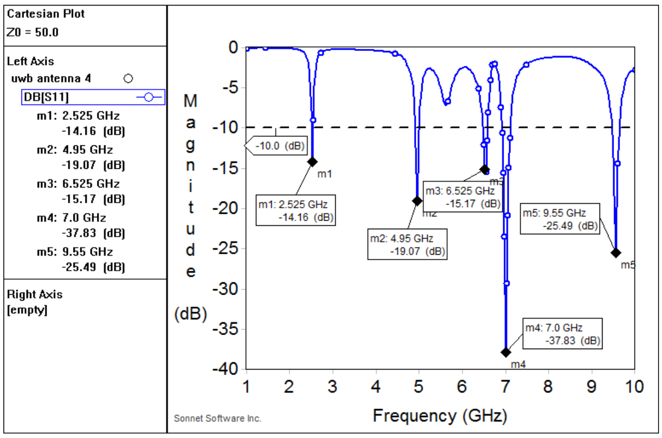


Figure 2: Simulated S11 of Slotted Multiband Antenna

The voltage standing wave ratio (VSWR) is an assessment of how well radio-frequency radiation is delivered from a source of power to a destination via a transmission line.

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Figure 3 illustrates the resulting pattern, which is an oscillating pattern.

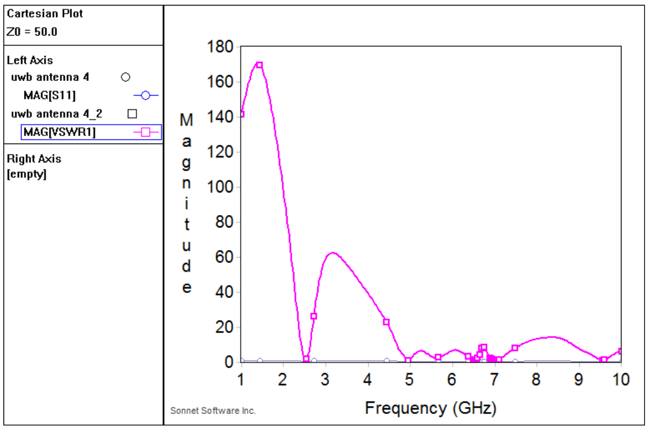

Figure 3: VSWR of Slotted Multiband Antenna

The Schmitt chart is scaled in normalized impedance, normalized admittance, or both in two dimensions on the compound coefficient of reflection plane. The antenna impedance fluctuates with frequency, as shown by the smith chart plot. The Schmitt chart for a Slotted Multiband Antenna for five distinct frequencies is shown in Figure 4.

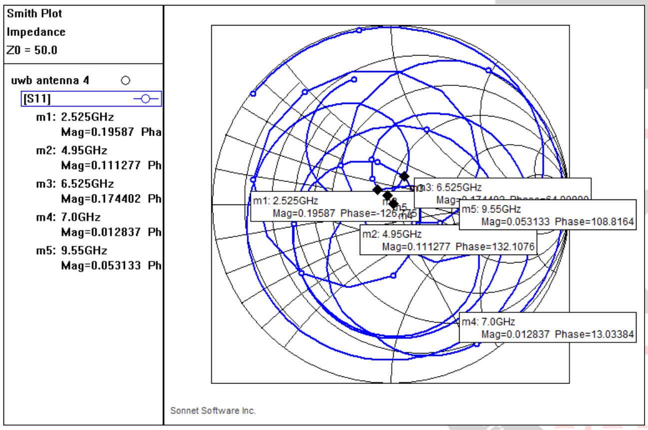

Figure 4: Schmitt diagram of Slotted Multiband Antenna

The simulated current distribution at 5 different resonant frequencies in the antenna by using the SONNET Software is shown in figure5.

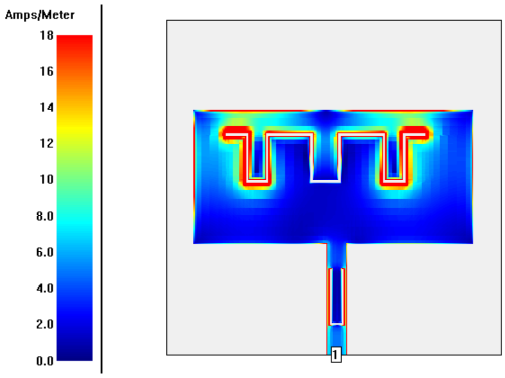

Figure 5.1 Current Distribution at 2.525GHz

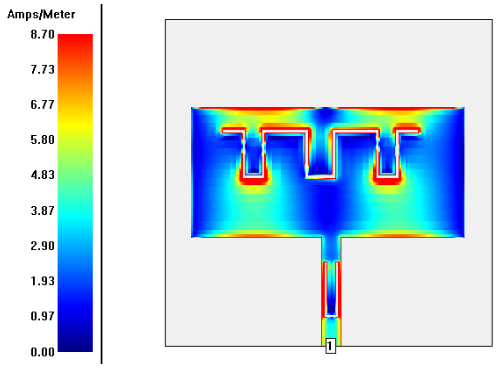

Figure 5.2 Current Distribution at 4.95GHz

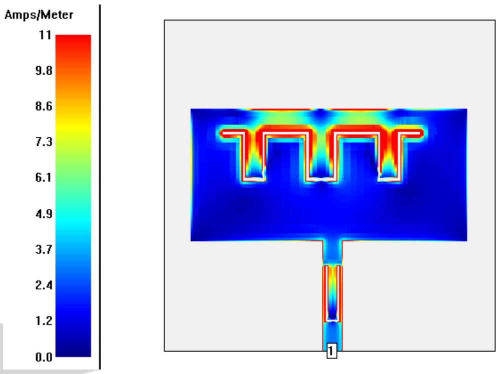

Figure 5.3 Current Distribution at 6.525GHz

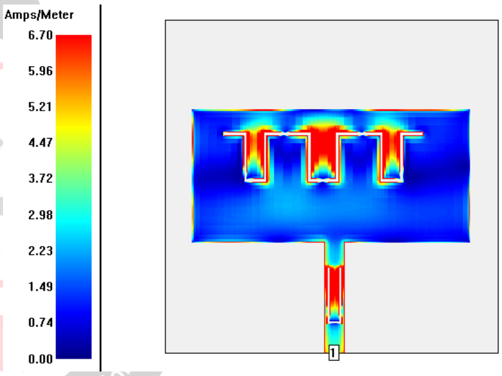

Figure 5.4 Current Distribution at 7.0GHz

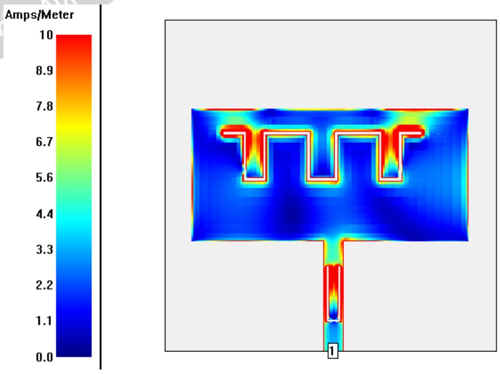

Figure 5.5 Current Distribution at 9.55GHz

In this section simulation outcomes for the S11, far field radiation and current density of the designed antenna are measured and presented. Figures 6 and 7 illustrated the far field radiation patterns, which shows the gain and directive gain at five distinct frequencies 2.525GHz, 4.95GHz, 6.525GHz, 7.0GHz and 9.55GHz respectively.

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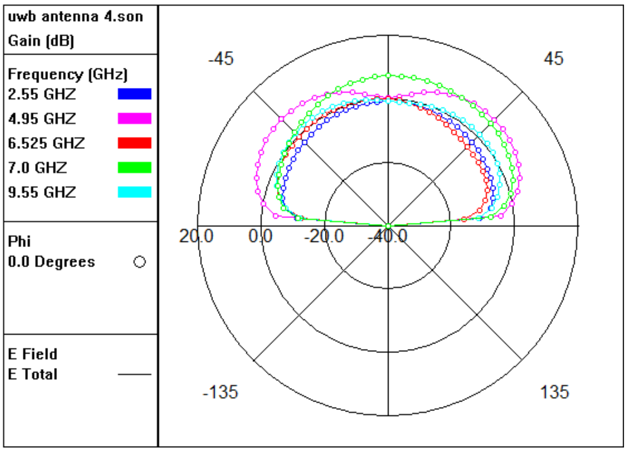

Figure 6: Gain of Slotted Multiband Antenna

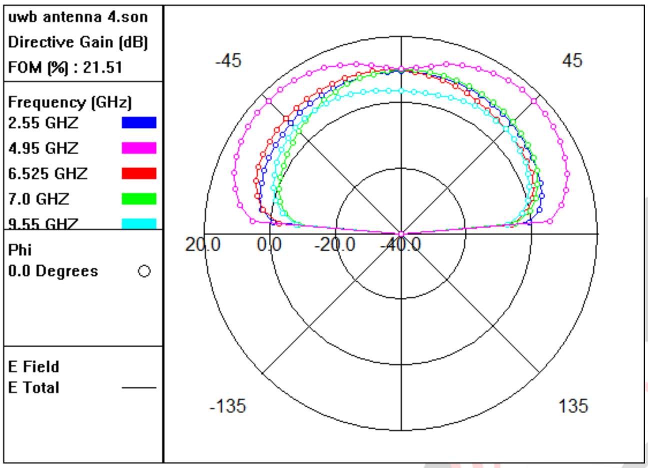

Figure 7: Directive Gain of Slotted Multiband Antenna

TABLE 2
RESULTS OF SLOTTED MULTIBAND MICROSTRIP ANTENNA

S.No.	Frequency (GHz)	Return Loss S11(dB)	Gain (dB)	Directivity Gain (dB)
1.	2.525	-14.56	-0.772	9.455
2.	4.95	-19.07	0.332	10.16
3.	6.525	-15.17	0.089	10.38
4.	7.0	-37.83	7.348	9.971
5.	9.55	-25.49	-0.588	3.525

IV. CONCLUSION

SONNET 12.56 version software was used to create a Slotted Multiband Microstrip Patch Antenna that can operate at 5 distinct frequencies. Simulated results shown by the software. The resonant frequency 2.525GHz, 4.95GHz, 6.525GHz, 7.0GHz and 9.55GHz respectively. The return loss is -14.56dB at 2.525GHz, -19.07dB at 4.95GHz, -15.17dB at 6.525GHz, -37.83dB at 7.0GHz and -25.49dB 9.55GHz respectively. This antenna can be utilized for a variety of UWB applications that run between 3 to 10 GHz, such as WLAN, Wi-Max, Missile Navigation and Wi-Fi. To obtain Slotted Multiband antenna performance, the dimensions of the slots are optimized. The location of the slots does have an influence on the antenna.

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