Partial Ground Microstrip Patch Antenna for Ultra-wideband Applications

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Abstract--**In this paper, a compact microstrip UWB antenna with step impedance microstrip line is proposed, where, partial ground technique is used. The antenna consists of a rectangular patch with slits on the top face and a partial ground with slots at the rear end. The antenna with dimension of 34mm X 36mm (L X W) is simulated on Rogers RT/duroid 5870 dielectric with relative permittivity of 2.33. The designed antenna has the capability of operating between 3 GHz to 10.26 GHz with a 7.26 GHz bandwidth. The proposed antenna has Omni-directional radiation pattern on most of the operating band. Feed line used has characteristic impedance of 50 Ω. The proposed antenna is analyzed with HFSS software for UWB applications. Antenna parameters such as return loss and radiation pattern are presented as simulated results.**

Keywords: Ultra wide band, partial ground, bandwidth, slits and slots, HFSS.10

I. INTRODUCTION

ANTENNAS have fundamental importance in the field of wireless communication. With the rapid development and advancement of wireless broadband technologies we require light weight, low cost, and small size antennas. In recent years, a lot of research has been carried out to develop ultra wideband (UWB) antennas [1,3] due to their low cost, simple structure and wide impedance and pattern bandwidth. As the federal communication commission (FCC) prescribed the frequency range of 3.1 to10.6 GHz for commercial ultra-wideband (UWB) communication systems [2,4], many researchers are paying much attention on UWB antennas since FCC has released commercial use of UWB for indoor communication systems [5]. However, there is existing wireless local area network (WLAN) bands [2, 6] and some satellite services at 8 GHz and 11 GHz that may create intrusion with a wideband communication structures operating at 2.9 to 12 GHz. With rapid development of broad operating frequency, one serious challenge is the miniaturization of antennas with broad impedance bandwidth and higher radiation efficiency [7].

In general UWB application antenna requires convenient impedance matching over broad frequency of operation. In recent past, the planar monopole antenna is most widely used for UWB application due to its wide impedance bandwidth, low cost and simple structure [8]. It has become one of the most prominent considerations for UWB applications. Several designs of monopole planar UWB antenna have been proposed. However some of these antennas involve complex parametric calculations and sophisticated fabrication process [9]. At this stage it is utmost necessary to present a relatively more simple but robust design of UWB antenna. In this research paper a simple design is proposed, this design is based on a microstrip rectangular patch. Design parameters like shape of radiator, ground plane as well as feeding structure are optimized to obtain the broadband impedance bandwidth [10, 11].

Microstrip antennas are mainly used in aircraft, spacecraft, satellite and missile applications where small size, low cost, high performance and ease of installation are major constraints. Printed rectangular patch with partial ground technique is presented in this paper. Extensive parametric study of slits in patch and slots in the ground has also been carried out. Increase in overall bandwidth has been observed for effective position of these slits and slots. Details of antenna design and software simulation results are also discussed.

II. DESIGN, ANALYSIS AND OPTIMIZATION

Optimized geometry of the proposed antenna is depicted in Figure 1 as under. In Figure 1, the geometry of the proposed antenna is shown. Dimensions of the microstrip patch, transmission line, and slits in the patch are presented in Table 1. Usually we can adjust the operating frequency of our antenna by selecting the length of the patch; smaller dimension of the patch results in higher resonating frequency and vice versa. Patch antenna is usually known for small bandwidth but different techniques like partial ground, addition of suitable slots in the ground and patch have been developed and studied, resulting in ultra wide bandwidth of antenna. How- ever such UWB antenna often suffers for additional impedance matching and large ground plane system problems. Printed UWB design is essentially an unbalanced design in which electric current is distributed on both radiator and ground plane. Therefore performance of UWB design is greatly affected by the shape of ground plane in terms of radiation pattern [12, 13], impedance bandwidth and resonating frequency of antenna. Such ground planes cause numerous design problems and complexities. However various studies have been made by engineers to reduce this ground plane effect. One of them is the truncation of ground plane to reduce the effect of ground plane on overall performance of antenna [12]. Antenna efficiency in terms of return loss depends upon the impedance matching between patch and transmission feed line. We get more efficient results when both transmission feed and patch have perfect impedance matching. On the other hand substrate material and its height are also very important for radiation pattern, high gain and bandwidth of antenna.

The quality factor of the small radiating structures increases due to proximity of grounding surface and high current density hence reduces antenna's impedance bandwidth. Meanwhile high current density results in increase of impedance and joule losses therefore decreasing the antenna gain [13, 14]. Dielectric material with higher permittivity is responsible for degradation of electrical field properties of the antenna as the surface waves produce a part of the total power available for direct propagation on the dielectric surface [1]. In the proposed design these parameters were optimized to get the broadband with high radiation efficiency. The proposed antenna was designed and optimized by HFSS software. Simulated geometry of antenna patch and ground plane is given in Figure 2. For bandwidth enhancement, a number of techniques such as corner truncation, embedding of the slits in the main microstrip rectangular patch and using of partial ground with slits have been used. The positions of the slits and slots in the patch and ground plane at a suitable place have been optimized for maximum bandwidth.

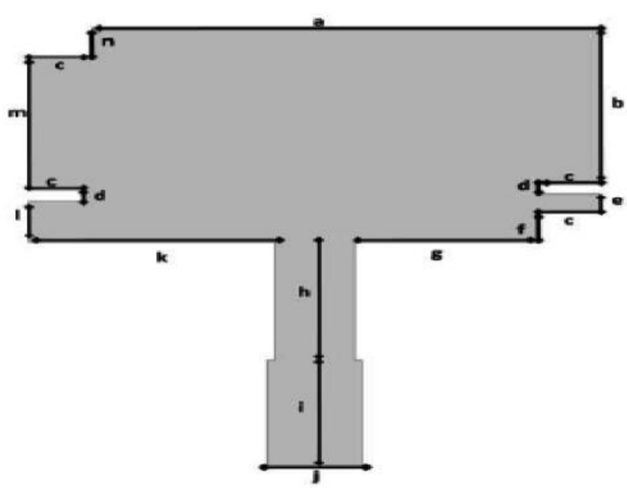

Figure 1. Geometry of the proposed antenna.

TABLE 1: DIFFERENT DIMENSIONS

a	16.0 mm	g	5.7 mm	m	6.8mm
b	7.9mm	h	6.0mm	n	1.5mm
c	2.0mm	i	5.2mm	p	10.0mm
d	0.8mm	j	3.0mm	w	34.0mm
e	1.0mm	k	7.7mm	L	36.0mm
f	2.0mm	l	2.2 mm		

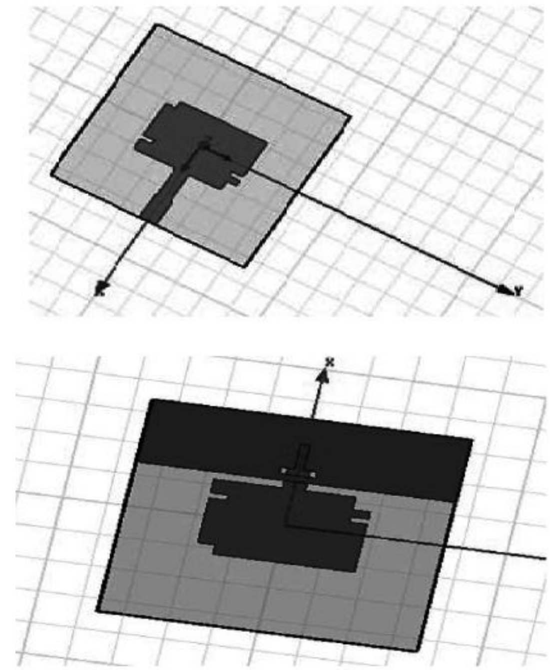

Figure 2. Geometry of patch and partial ground on HFSS.

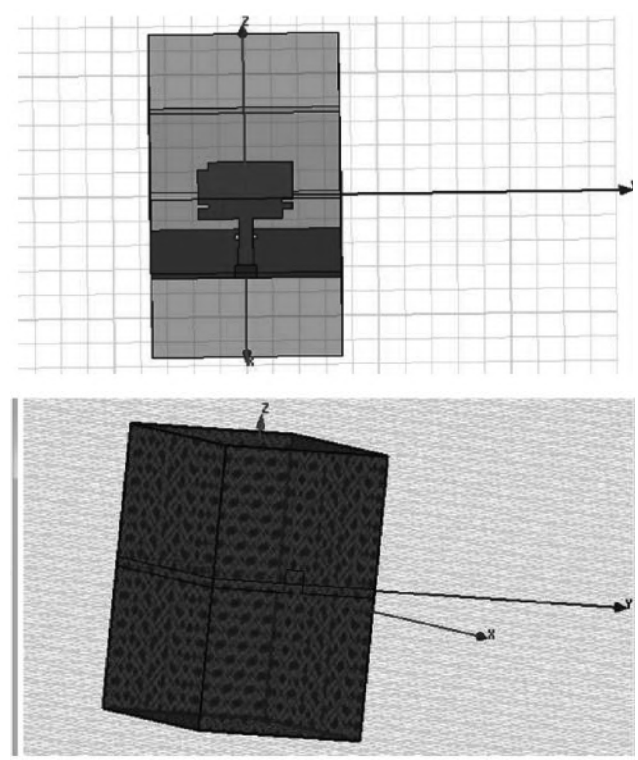

Figure 3. HFSS Design of Antenna.

III. MEASURED RESULTS AND DISCUSION

The optimized antenna is simulated by using HFSS.10 and return loss is measured shown in Figure 4 representing the characteristic bandwidth of 7.26 GHz from 3 GHz to 10.26 GHz. The simulated results are in good agreement with the theoretical results. The 2D simulated radiation pattern of antenna on different operating frequencies is shown in Figure 5. It has been observed that on most of frequency range the antenna radiation pattern is Omni directional due to leakage of radiation by using of partial ground technique. The radiation pattern of the antenna is controlled by the current distribution on the patch and ground for UWB antennas. The Omni directional radiation pattern provides freedom in transmitter and receiver location. The performance of linearly polarized antennas is often described in terms of *E* & *H* plane.

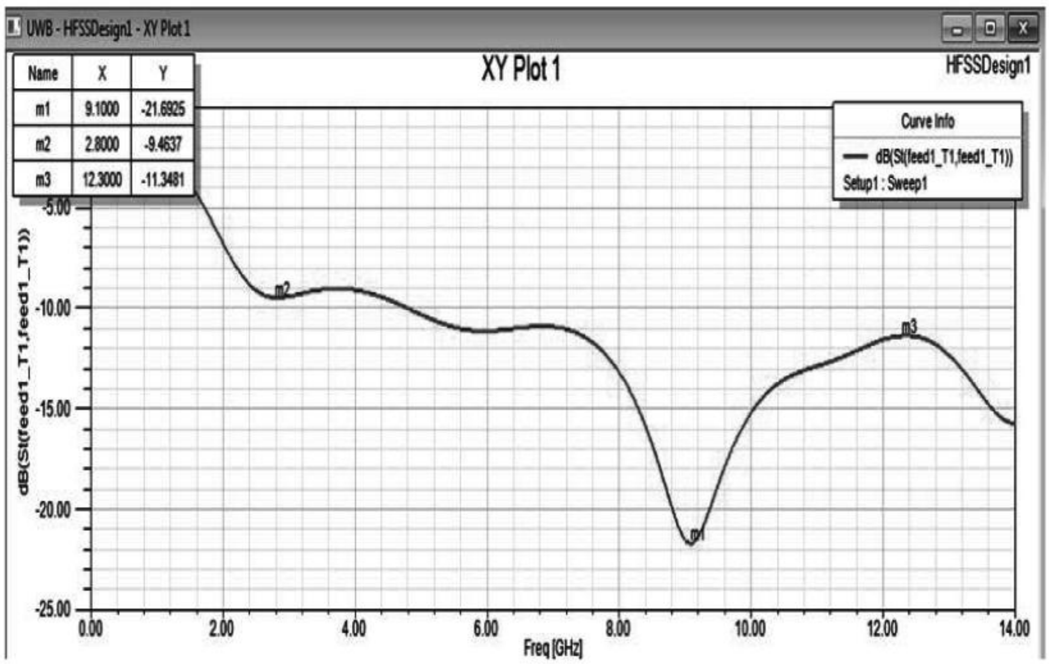

Figure 4. Return loss HFSS Result.

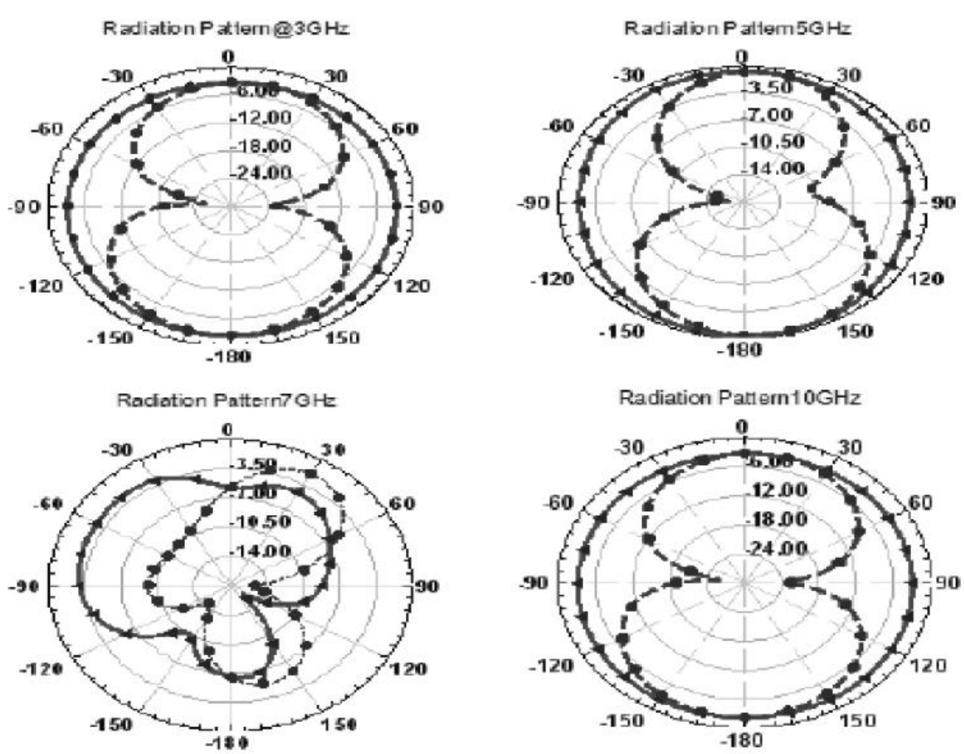

Figure 5. Radiation Pattern of proposed antenna.

V. CONCLUSION

In this paper we have presented UWB antenna which is capable of supporting large bandwidth. Excitation of antenna is made through the wave port. By adding suitable slits and slots in the patch and ground, improvement in the bandwidth is achieved. By variation of the ground plane and patch size, a significant impedance bandwidth has been realized. So it can be considered as a key parameter for return loss and bandwidth enhancement.

IV. REFERENCES

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