Design of Wideband Microstrip Antenna for Wireless Applications

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ABSTRACT

Ultra-wideband is a technology for transmitting information spread over a large bandwidth. The design of UWB antenna with high performance is much more challenging design from narrow band antenna. A new approach is proposed to achieve a wide bandwidth by means of cross slot in the patch plane and staircase slot in the partial ground plane. Typically, the designed wide bandwidth antenna produce omnidirectional radiation pattern. The operating frequency of the proposed antenna ranges from 10.2 GHz to 50GHz. The rectangular radiating patch is made of FR4 substrate with dielectric constant 4.3. The designed antenna is suitable for satellite communication, wireless communication, Radar application, microwave imaging, etc. Radiation pattern, gain, VSWR and return loss of the proposed antenna is analyzed using CST software. The designed antenna is fabricated and tested using VNA. The feeding is given to microstrip antenna through SMA connector. The simulated result is in correlated with the measured result.

KEY WORDS: UWB, Microstrip Antenna, Wireless, Radiating.

1. INTRODUCTION

In recent decades, wireless communication and technology is becoming wide popular. The new technologies for wireless communication are emerging day by day to fulfill higher resolution and data rate requirements. In recent years communication is carried out in ultra wideband (UWB) region, where high data transmission rates, low power consumption and simple hardware configuration is achieved. Radio frequency spectrum is ranging from 3 KHz to 300 KHz. Federal Communications Commission (FCC) approved the rules for the commercial use of ultra wide band (UWB) in 2002. The UWB region having frequency ranges of 3.1 to 10.6 GHz (Zhu, 2012; Wu, 2005; Hong, 2007; Peng, 2011; Sung, 2013; Bahadori, 2007; Chen, 2007; Chahat, 2011). Normally the UWB pulses are very short. Because of short duration of UWB pulses, it is easier to produce high data rates. Hence the signal reflections does not overlap also there is no multipath fading of narrow band signals. The Ultra wideband characteristics are suitable for short distance communication, such as PC peripherals. Hence UWB systems tend to be in short-range in indoor applications. Communication can be carried out using UWB region for radio frequency sensitive environment such as hospitals, radar and medical engineering field. Different types of antennas for wide band operation have been studied and implemented for communications and radar systems. The design of ultra wideband is complicated due to its size, cost and simplicity which is to be achieved.

In this design, the microstrip UWB antenna with band notched characteristics is presented. The antenna is designed and fabricated to demonstrate the proposed strategy. The proposed antenna is simulated using CST microwave studio which is the commercial 3-D full-wave electromagnetic simulation software.

Design of microstrip antenna: In this work, the rectangular patch antenna parameters are calculated based on transmission line model analysis (Garg, 2001). Two different types of design are analyzed to achieve wide bandwidth from 10.1GHz to 50GHz.

Design of microstrip antenna with partially grounded rectangular patch –Design I:

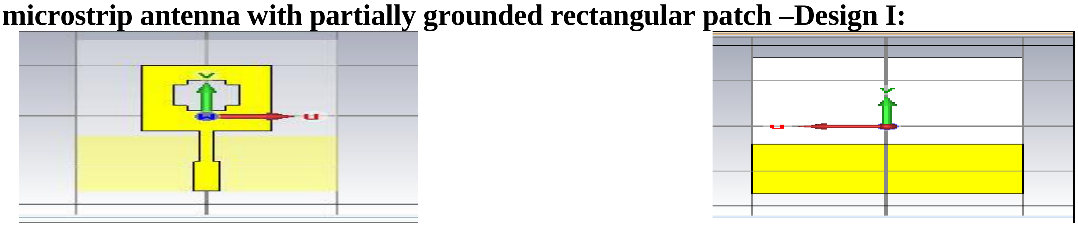

Figure.1. Design I of microstrip antenna (a) Front View (b) Back View

The design 1 as shown in Fig.1, includes rectangular ground and substrate. The patch of the antenna rectangular with modified rectangular cut in the centre. The bottom part of the patch is fed with quarter wave line feed.

Table.1. Description and variables of the proposed antenna

Description	Values	Description	Values
Width (w)	20mm	p3	1
Substrate thickness (t)	0.035mm	p4	6
Substrate height (h)	1.6mm	p5	6
Feed size (wf)	2.5mm	p6	3
Variables	Values (mm)	g2	2
p1	13	g3	5
p2	4	g1	4

Design of microstrip antenna with two step cut in ground plane:

Figure.2. Proposed Design II of microstrip antenna (a) Front View (b) Back View

The geometric representation of the proposed system is shown in Fig.2. The description and parameter of the proposed antenna is shown in the table.1. The antenna is simulated with the frequency range of 5GHz to 50GHz. All the parameter analysis is done in CST microwave studio software of version 2010.

2. RESULT AND DISCUSSION

The results and discussion are explained in detail about parametric study of microstrip patch antenna of two different designs in time domain analysis. The study of parameters has been conducted to optimize the antenna design. This study of antenna to be done before fabrication of the antenna can be done.

Parametric analysis of design-I: The reflection coefficient (S11), VSWR, Gain, radiation pattern and E-field and H-field distribution at 11GHz is discussed below.

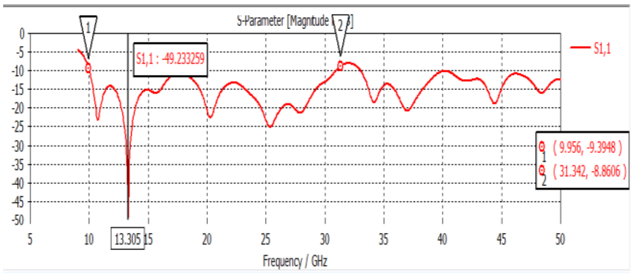

Figure.3. Reflection coefficient (S11) of Design –I

In Fig.3, it is shown that the designed antenna radiates over the entire bandwidth of 9.9GHz to 31GHz with a central operating frequency of 13.305GHz with a maximum return loss. The designed antenna attains a VSWR of below 2.0 in Fig.4, which shows the stability of the antenna over the bandwidth range. In Fig.5, over the entire radiating bandwidth range, the maximum gain of 6.9dB is obtained at a frequency of 13.305GHz.

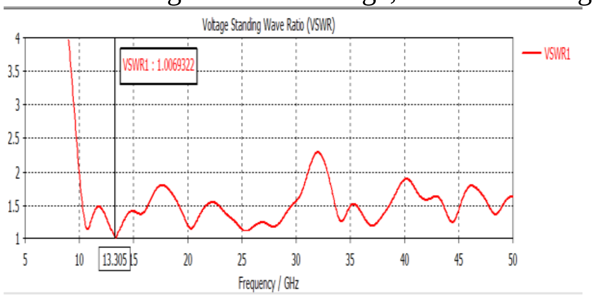

Figure.4. VSWR vs. frequency of Design –I

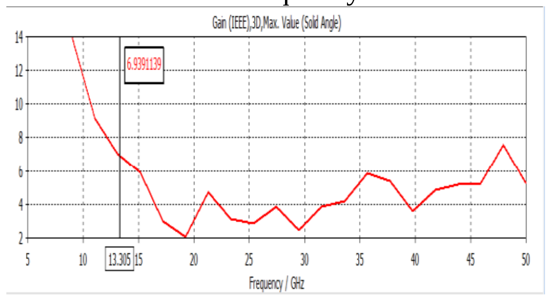

Figure.5. Gain vs. Frequency plot of design I

In order to improve the bandwidth range we go for modifications in the ground plane with step cut and observe the performance.

Parametric analysis of design-II: To further improve the bandwidth and gain performance of the antenna, two steps cut in the ground plane and observe the performance. The effect of modifying the ground plane on S11 parameter is observed. It is seen that when two step cut in the ground plane, the S11 vs frequency curve gets below -10dB completely. It is also observed that for an optimum value of 16.298GHz, the S11 is more deeps with an acceptable return loss Fig. 6. Also maximum frequency range obtained from 10.1GHz to 50GHz.

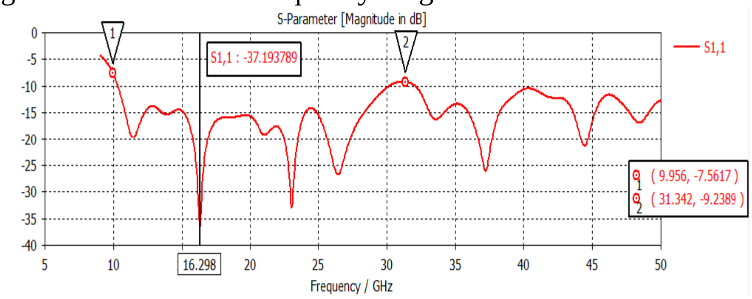

Figure.6. Reflection coefficient of design II

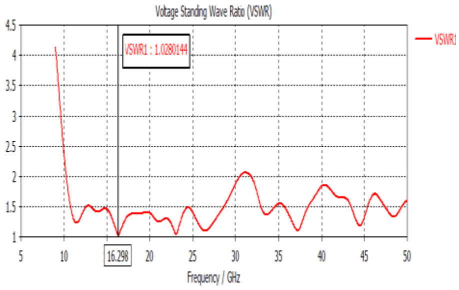

Figure.7. VSWR plot of design II

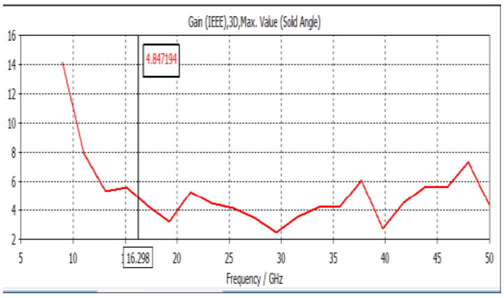

Figure.8. Gain vs Frequency plot of design II

The gain and VSWR of the designed antenna with step cut in the ground plane is obtained as 7.5dB at 47.5GHz and below 2.0 which shows that it is effective than the previous design is shown in Fig.7 and Fig.8. By the above two design, a wider bandwidth which is more applicable for radar applications.

Measured Result: The fabricated structure of the proposed antenna is shown in fig.9. The measured return loss is shown in Fig. 10. By obtaining the testing result we conclude that the theoretical and practical values remain the same. Also the simulated and the tested result match the expected bandwidth range.

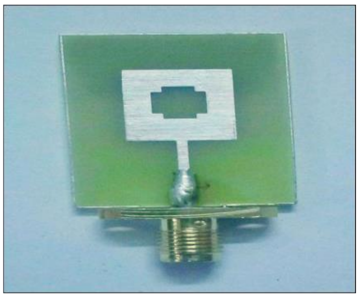

Figure.9. Structure of the fabricated antenna

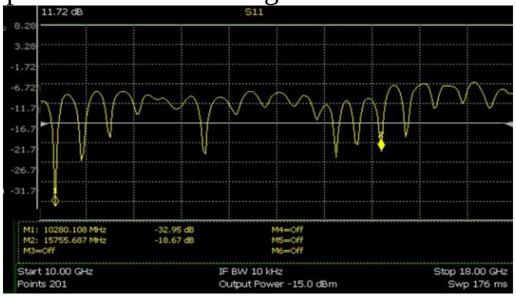

Figure.10. Measured return loss of the proposed antenna Design II

3. CONCLUSION

In the proposed work, an wide band microstrip antenna with modified ground plane introducing two step cut is designed. The operating bandwidth of the antenna is improved by introducing rectangular slots on the patch and step cut in the ground. With all these modifications, the antenna operates over the frequency band of 10.1 GHz from 50GHz with a return loss of -35 dB. Further the gain of the antenna is improved to 7.5dB by introducing these modifications. The designed antenna is fabricated and tested using VNA.

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