Design and Analysis of a Compact Ultra Wide Band Coaxial Probe Feed Microstrip Patch Antenna

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ABSTRACT
This paper deals with a new compact ultra-wideband (UWB) antenna using coaxial probe feed technique by introducing some slots in square patch of 20mm X 20 mm. The proposed antenna is designed to operate from 1.82 to 3.72 GHz with the centre frequency at 2.20 GHz. Size reduction of 83% is also achieved in this paper. Theoretical investigations have been done by Ansoft® designer software.

Keywords
Microstrip Patch, Ultra wide band, Return loss, slots, coaxial probe feed.

1. INTRODUCTION
Microstrip antennas are increasingly finding applications in microwave communication system as they are light weight, have planar configuration and inexpensive to fabricate. For many years, ultra-wide band (UWB) antennas have had many applications in communication systems with broadband and spread-spectrum features in radar systems [1].

Patch antennas are extensively used in wireless communications because of the following features: light weight, low cost, and ease of fabrication. As a drawback, it is well known that the bandwidth of patch antennas is narrow. Thus, many attempts have been made to widen the bandwidth of printed antennas [2]. In this paper an ultra wide band antenna design has been shown which overcomes the limitation of narrowband by some slot loading technique. A slot antenna is of major importance because of its simple structure. Slot loaded patch antennas have attracted much attention in recent years due to their capability of realizing various functionalities. For example, a square Patch antenna with a slot along the diagonal direction can realize circular polarization with a single feed [3]. Slots are also used to tune the resonant frequencies of antennas [4]. Antenna size can be reduced by properly incorporating slots to make the electric current path mender [5]. As the slot loading technique is simple and effective in enhancing the impedance bandwidth of Microstrip antennas compared to other techniques available in the literature, an effort is made to enhance the impedance bandwidth of rectangular Microstrip array antenna by using slot loading technique [3].

2. ANTENNA DESIGN

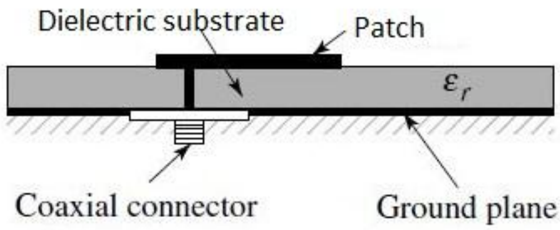

Fig 1: Coaxial probe feed Microstrip antenna

Antenna design has been done on a glass PTFE substrate with dielectric constant 2.4 and thickness of 1.6 mm, which is sandwiched between the ground plane and the patch as shown in fig 1. Here signal is feed through a coaxial connector as shown in fig 1.

The design of the proposed antenna is shown in figure 2. Different slots has been loaded in the 20 mm X 20 mm square copper patch and in the 60 mm X 60 mm ground plane also. Here signal is fed to radiating patch by using coaxial probe feed technique as shown in fig. 1. This is very common technique used in Microstrip antenna. Inner conductor of coaxial connector extends through the dielectric and soldered to the radiating patch, Where as the outer conductor is connected to the ground plane.

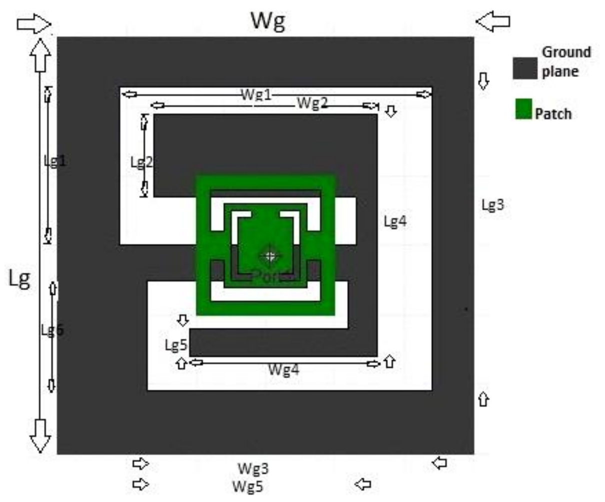

Fig 2: Proposed patch antenna design

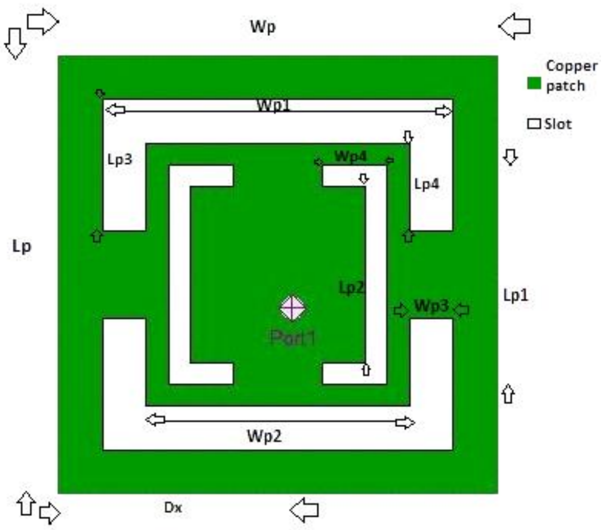

Fig 3: Patch dimensions shown separately

The dimensions of the metallic patch and the ground plane are given in a tabular form in table 1.

Table 1. Dimensions of the patch and the ground plane

Sl. no.	Ground Plane dimensions	Length (mm)	Patch dimensions	Length (mm)
1	Wg	60	Wp	20
2	Wg1	45	Wp1	16
3	Wg2	32	Wp2	12
4	Wg3	41	Wp3	2
5	Wg4	27	Wp4	3
6	Wg5	29		
7	Lg	60	Lp	20
8	Lg1	23	Lp1	10
9	Lg2	12	Lp2	8
10	Lg3	44	Lp3	6
11	Lg4	33	Lp4	4
12	Lg5	4	Dx	11
13	Lg6	15		

3. RESULTS

Return Loss vs. frequency for the proposed antenna using Ansoft Designer Software are analyzed and plotted in Fig-4. This proposed antenna has upper cut off frequency (-10 dB line) at 3.72 GHz and lower cut off frequency (-10 dB line) at 1.82 GHz with centre frequency at 2.20 GHz as shown in fig 4. Thus a wide band width of 1.9 GHz is obtained with this structure which is useful for ultra wide band application in the low frequency profile.

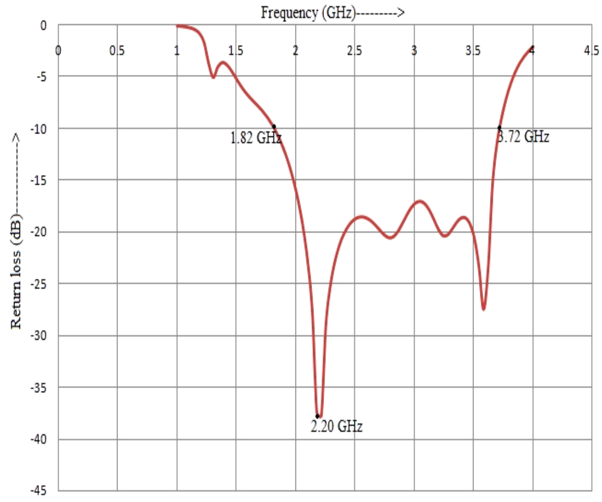

Fig 4: Return loss (dB) V.s frequency (GHz) plot of the proposed patch antenna

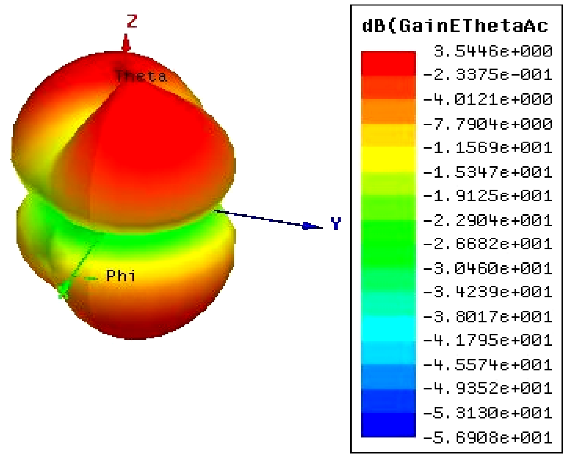

Fig 5: 3D Gain Plot of the antenna at resonant frequency 2.20 GHz

Maximum gain of 3.54 dBi is also achieved with this proposed antenna at the resonating frequency 2.20 GHz shown in fig.5, which is also a good desirable characteristics of an antenna and the radiation pattern at that frequency has been shown in fig 6.

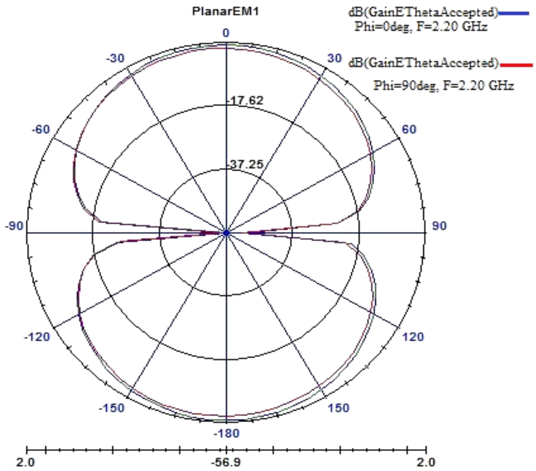

Fig 6: Radiation pattern of the proposed antenna at 2.45 GHz resonating frequency

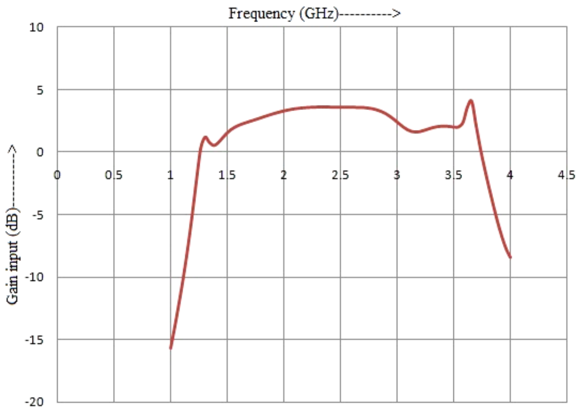

Fig 7: Gain Input (dB) V.s. Frequency (GHz) plot of the proposed antenna

Variation of the antenna input gain (dB) with the entire frequency (GHz) is plotted as shown in fig 7, also variation of VSWR of the proposed antenna with the frequency is shown in fig 8.

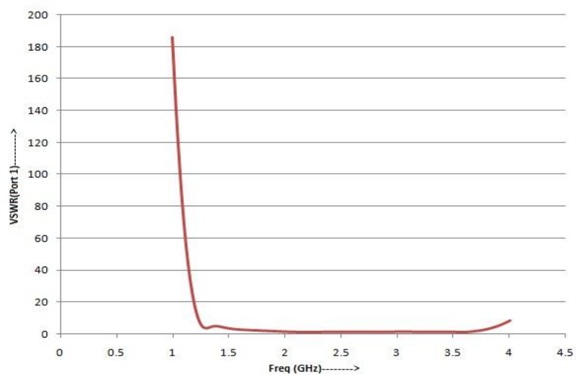

Fig 8: VSWR vs. frequency (GHz) plot of proposed antenna

The details simulation results of the patch antenna with the help of Ansoft Designer software is investigated and given in tabular form in table.1.

Table 2. Simulation Results

Sl. no.	Resonating frequency (GHz)	Bandwidth In MHz	Percentage of Bandwidth	Gain (dB)
1	2.20	1900	86.36	3.54

Size reduction of 83% is obtained by compared to the reference antenna without slot [7].

4. CONCLUSION

In this paper a compact microstrip patch antenna has been designed for wide band application. Moderate gain throughout the entire band has been achieved with this microstrip patch antenna. So, this antenna has wide application in microwave ovens, cordless phone, Bluetooth devices and other appliances uses this band.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] J. Young and L. Peters, A brief history of GPR fundamentals and applications, Proc 6th Int Conf Ground Penetrating Radar, Sendai, Japan, 1996, pp. 5–14.

[2] Katsuki Kiminami, Akimasa Hirata," Double-Sided Printed Bow-Tie Antenna for UWB Communications, IEEE antennas and wireless propagation letters, vol. 3, 2004.

[3] S L Mallikarjun$,* & P M Hadalgi," Single layer modified rectangular microstrip array antenna for multi band and wide band applications", Indian Journal of Radio & Space Physics, Vol 39, June 2010, pp. 156-162.

[4] Maci S, Gentili G B & Avitaoile G, Single-layer dual frequency patch antenna, Electron Lett (UK), 29 (1993) 1441.

[5] Dey S & Mittra R, Compact microstrip antenna, Microwave Opt Technol Lett (USA), 12 (1996).

[6] T.W. Chiou, K.L. Wong," Designs of compact microstrip antennas with a slotted ground plane", In: Proceedings of the IEEE Antenna and Propagation Society International Symposium, Vol. 2, Boston, MA, 2001, pp. 732–735.

[7] Constantine A. Balanis," Antenna theory, analysis and design",pp.817-820.