JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Circular Patch Microstrip Antenna for UWB Applications

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Abstract- In this paper an Ultra Wideband (UWB) microstrip antenna consisting of a circular monopole patch with stepped feed line, with a 10 dB return loss bandwidth from 3.1 to 10 GHz is proposed. This antenna was designed on FR4 substrate with overall size of 30 x 40 x 1.59 mm3 and dielectric substrate with ε_r = 4.4. This antenna operated at UWB frequency and it designed by using CST Software based on the characteristic impedance for the transmission line model. The parameters like substrate dimension, feed size and ground plane which affect the performance of the antenna in terms of its frequency domain and time domain characteristics are investigated.

Keywords: Microstrip line feed, Microstrip antenna, Partial ground plane, Ultra Wideband Antenna

I. INTRODUCTION

UWB has a number of encouraging advantages that are the reasons why it presents a more eloquent solution to wireless broadband than other technologies. Firstly, according to Shannon-Hartley theorem, channel capacity is in proportion to bandwidth. Since UWB has an ultra wide frequency bandwidth, it can achieve huge capacity as high as hundreds of Mbps or even several Gbps with distances of 1 to 10 meters Secondly, UWB systems operate at extremely low power transmission levels. By dividing the power of the signal across a huge frequency spectrum, the effect upon any frequency is below the acceptable noise floor [2]. A Ultra Wideband technology is defined as a system that occupied over 500MHz of bandwidth or occupy a fractional bandwidth of 20% or greater. Ultra Wideband uses radio modulation technique to achieve a wide bandwidth by transmitting very short pulses (in nanosecond or less) with very low power utilization. This makes Ultra Wide band differs from conventional narrowband systems. Starting 2002, the usage of

unlicensed Ultra Wideband operation was authorised by FFC (Federal Communication Commission) of United States of America (USA) [1]. The interest in UWB seems to be growing exponentially with several researchers exploring RF design, circuit design, system design and antenna design of Ultra Wideband applications.

The objective of UWB technology is to transmit very low power pulses in order to achieve high data rate without any interference to the other

neighboring wireless communications that utilizes part of the UWB band. Antennas dedicated to such applications are not supposed to be multiharmonic but they are required to be wideband. Both frequency and time domain responses must be considered during the design.

Among the UWB antenna designs in the years planar monopole antennas have become one of the considerable candidates for UWB applications owing to the features of low cost, light weight, ease of fabrication and nearly omni-directional radiation pattern. Some of these monopole UWB antennas only cover partial spectrum of the UWB band and some monopole antenna

designs are difficult to integrate. Microstrip patch antenna is one of the most common antennas used in the telecommunication due to their low profile structure. A patch antenna is a narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Photo etching and press machining are the lowest cost technologies made Printed antenna technology is suitable for low cost manufacturing in a mass productions. The advantages of printed microstrip antenna are [2] light weight and low volume, low profile planar configuration which can be easily made conformal to host surface, low fabrication cost, hence can be manufactured in large quantities, supports both, linear as well as circular polarization. Microstrip antenna can be easily integrated with microwave integrated circuits (MICs), and mechanically robust when mounted on rigid surfaces. However, microstrip antennas also have several disadvantages. The disadvantages are narrow bandwidth, low efficiency, low gain, extraneous radiation from feeds and junctions, poor end fire radiator except tapered slot antennas, low power handling capacity and surface wave excitation [3, 4]. In this research, circular patch microstrip with two blocks, stepped microstrip line antenna will be designed to achieve good return loss and constant radiation pattern throughout the UWB frequency. The printed microstrip feed structures perform a matching and phase adjustment providing a higher gain with
little additional cost.

2. ANTENNA GEOMETRY AND SIMULATION RESULTS

A. Antenna Geometry: Fig. 1 illustrates the evolution of the proposed Microstrip Antenna on the Fr4 substrate.

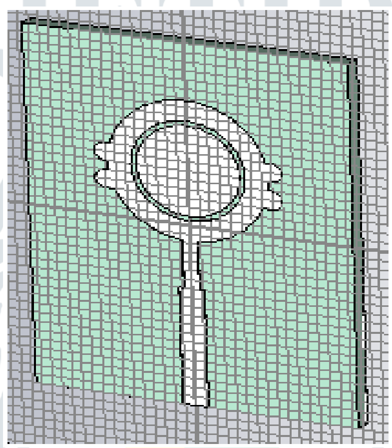

Fig. 1 The proposed Circular Microstrip antenna (a) Simulation Mode

Table I. Antenna Parameters

Sr.No	Description	Value/mm
1	Antenna length	40
2	Antenna width	30
3	Width of the ground plane	20
4	Radius of Circular patch	8.5mm
5	Substrate thickness h	1.59
6	Feed Size (Width)	3
7	Feed Size (Length)	15

B. Impedance Bandwidth

Fig.2 shows the simulated return losses (S parameter) of the proposed antenna. It can be clearly seen that the proposed antenna has a multi-band characteristic in the UWB spectrum. Three resonant frequencies locate at about 3.34GHz, 5.8GHz and 7.7GHz with the return losses reach -40dB, -20dB, and -30dB respectively. The antenna bandwidth that is lower than -10dB occupies from 3.1GHz to 10 GHz. It can operate well in UWB applications. The ground plane size selection is also based on the study presented in [3], [4] on the microstrip slot antennas.

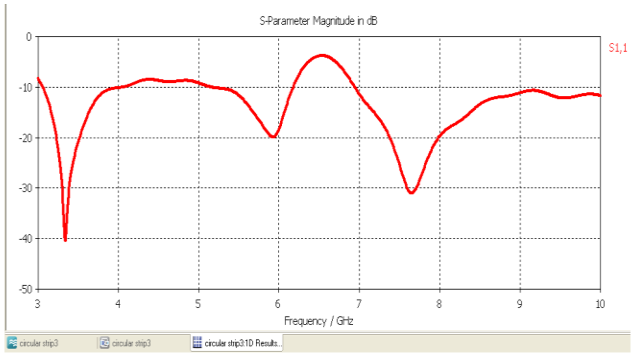

Fig.2.The reflection coefficient (S11, dB) versus frequency (GHz) plot for antenna design.

The VSWR or impedance BW of the microstrip antenna is defined as the frequency range over which it is matched with that of the feed line within specified limits. The BW of the microstrip antenna is inversely proportional to its quality factor *Q* and is given by [5]

$$BW = \frac{VSWR-1}{Q\sqrt{VSWR}}$$

Where VSWR is defined in terms of the input reflection coefficient Γ as:

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

The Γ is a measure of reflected signal at the feed-point of the antenna. It is defined in terms of input impedance *Z*in of the antenna and the characteristic impedance *Z*0 of the feed line as given below:

$$\Gamma = \frac{Zin - Zo}{Zin + Zo}$$

4. Smith Chart Plot

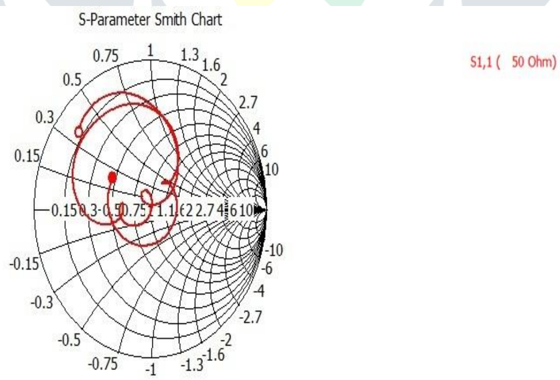

Figure 3:-Smith chart plot (microstrip linefeed) for simulated antenna design

5. Effect of Parameter variation on Antenna Performance*:*

Substrate material Variation: In this case there are comparisons of return loss with the variation in the materials of substrate. In this investigation of effect generally Roger 4003 & Fr4 are considered. From the result it is to be observed that Fr4 provides the min. return loss as compared to the Roger 4003. So Fr4 is considered as a suitable material for the proposed antenna design. With the use of Fr4 as a substrate material the bandwidth increases as shown in figure below:

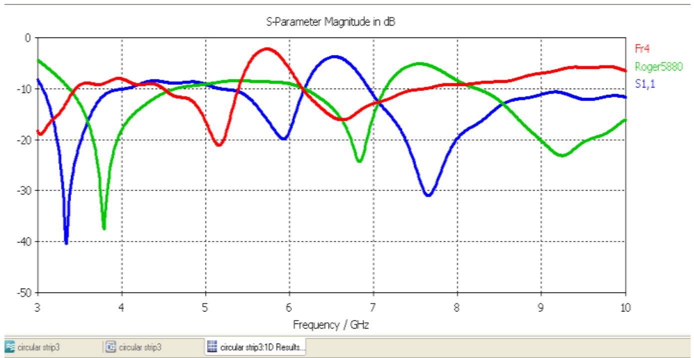

Figure 4: Effect of substrate material on the antenna performance

Substrate permittivity (ε_r) *Variation :* In this case there is comparisons of return loss with the variation in the permittivity of the materials. On decreasing the dielectric constant of substrate , the bandwidth increases as shown in figure below:

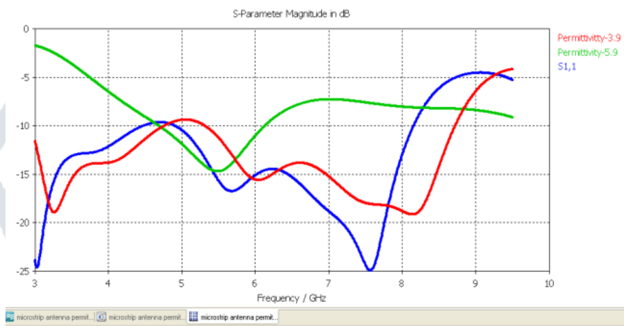

Figure 5 – Effect of substrate permittivity (ε_r) on antenna performance characteristics

Effect of ground size width: On increasing the ground size width, the return loss between the resonant frequencies increases but at a specific value of ground width there is a impedance matching at this value min. return loss is achieved and the proposed antenna provides the effective result.

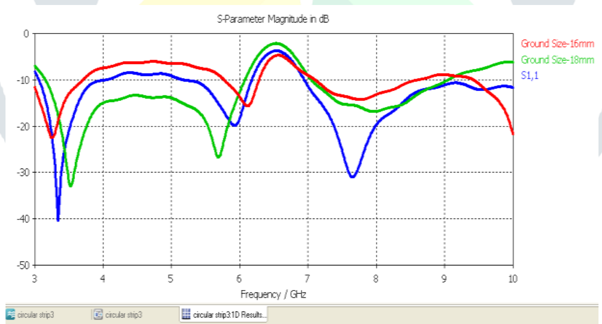

Figure 6: Effect of ground size variation on the antenna performance

Feed width (Wf) Variation : On increasing the feed width (Wf), the bandwidth increases and return loss first increases on increasing feed width and then starts decreasing as shown in figure below:

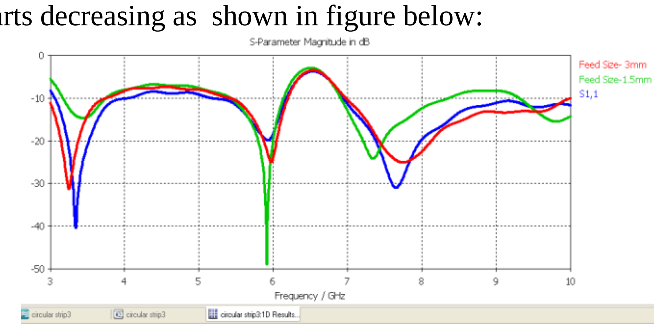

Figure 7– Effect of feed width (ε_r) on antenna performance characteristics

7. CONCLUSION:

In this paper, a planar circular shape microstrip slot antenna is investigated for the impedance matching and radiation pattern characteristics. The antenna can find applications in radar & Space –craft applications. As from the paper, it is observed that because of the various advantages of Microstrip patch antenna like small size, small weight, low fabrication cost, etc, it can be used in the various applications where small size and small weight are major constraints. In this paper, an UWB microstrip patch antenna has been proposed which is dual resonant at frequencies of 3.34GHz and 7.7 GHz respectively with impedance bandwidth of 4.875GHz respectively. The antenna exhibits the return loss (S11) well below -10dB for the frequency range mentioned. The effects of antenna parameters such as patch width, patch step slot dimensions, feed width, ground slotting and substrate permittivity on antenna performance characteristics has been studied and analyzed. The feed size of antenna is inversely proportional to the port impedance. The dimension of the microstrip antenna also has an impact on the antenna performance because the current is mainly distributed along the edge on the radiator. In a broad sense, the ground plane of the antenna design perform operation as an impedance matching circuit, and it tunes the input impedance and hence changes the operating bandwidth with variation of antenna feed size[10].

ACKNOWLEDGMENT

I would also like to thank Er. Krishan Sherdia Assistant Professor at JCDM College of Engineering, Sirsa for their help to provide the basic knowledge about the software CST Software & Antenna concepts.

REFERENCES

[I] Federal Communications Commission, "FCC Part IS-Radio Frequency Devices, Code of Federal Regulation 47 CFR Ch. 1 (10-1-09 Edition)", Section IS.S21, Washington, D.C, 2019.

[2] Balanis, c.A., Antenna Theory: Analysis and Design, John Wiley & Sons, Inc, 2017.

[3] Kumar, G. and Ray, K.P., Broadband Microstrip Antennas, Artech House, Inc, 2013 ..

[4] Garg, R., Bhartia, P., Bahl, 1., Ittipiboon, A., Microstrip Antenna Design Handbook, Artech House, Inc, 2001. [S] (2019) Computer Simulation Technology website. [Online]. Available: http://www.cst.com

[6] M. 1. 1. Ammann, M., "Some techniques to improve small ground plane printed monopole performance," in Antennas and Propagation Society International Symposium. 2017 IEEE, vol. 9

[7] Hossain, 1.; Noghanian, S.; Pistorius, S.; , "A diamond shaped small planar ultra wide band (UWB) antenna for microwave Imaging Purpose," Antennas and Propagation Society International Symposium,2007 IEEE , vol., no., pp.S713-S716, 9-1S June 2019

[8] Sadat, S.; .lavan, S.D.S.; Houshmand, M.; , "Design of a Microstrip square-ring slot antenna filled by an H -shape slot for UWBapplications," Antennas and Propagation Society International Symposium, 2007 IEEE , vol., no., pp.70S-708, 9-IS June 2017

[9] Zhi Ning Chen, Senior Member IEEE & Terence S. P See and Xianming Qing “Small printed UWB Antenna with reduced Ground Plane effect” IEEE transactions on Antenna & Propagation Vol. 55 No. 2, February 2017

[10] Sunil Kumar Rajgopal and Satish Kumar Sharma, Senior Member, IEEE “Investigation on UWB Pentagon Shape Microstrip Slot Antenna for Wirelss Communications” IEEE Transactions On Antenna And Propagation, Vol. 57, No.5, May 2019.