IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Investigations Of The Dielectric Superstrate Influence On The Circular Microstrip Antenna Parameters

V Saidulu,

Assistant Professor, ECE Department, MGIT, Hyderabad, Telangana State, India

Abstract: Dielectric superstrates influence on main characteristics of circular microstrip patch antenna. The main characteristics of microstrip antennas are resonance frequency, input impedance, bandwidth, beamwidth, gain, VSWR is investigated. The comparative analysis of the microstrip antennas characteristics with superstrate and without it is carried out.

Index Terms **–** Dielectric superstrate, resonant frequency, microstrip antenna.

I. INTRODUCTION

The microstrip antenna is most useful antenna in aircraft, spacecraft, satellite and mobile communications applications because of it is low profile, light weight, low volume antenna and useful in planar and non planar geometry [1-5]. The basic structure of microstrip antenna is consists a radiating patch is one side, ground plane is other side and substrate. The radiating patch is normally copper or gold can available with different shapes such as triangular, rectangular, square, elliptical, U slot and E slot in symmetrical and unsymmetrical models [6-9]. The most common types are rectangular, circular, square patch antennas are used in various communications applications [10-14]. In this paper the effect of superstrate influence on circular microstrip patch antenna (CMPA) parameters are investigated with and without dielectric superstrates and compared their performance.

II. SPECIFICATIONS

The specifications of substrate materials has play very important role in the patch antenna design [15-16]. The selection of substrates and superstrates materials has chosen as appropriate thickness and low loss tangents. The thicker substrate is mechanically strong with improved bandwidth and gain of antenna. However it also increases the weight and surface wave losses [17-18]. The weight and surface wave losses are major limitations in MSA. The low dielectric constant of the substrates are play vital role in the design of the antennas which has increases the fringing fields and radiated powers [19-22]. Keeping all these aspects the Arlon diclad 880 has chosen as the substrate having the permittivity of ϵ_{r1} =2.2 and having the thickness and loss tangent of that substrate is 1.6mm and 0.0009 respectively.. The superstrate materials are used in antenna designs are Arlon AD880, Arlon AD320, FR4 and Arlon AD1000. The thickness of the superstrates materials are 1.6mm, 3.2mm, 1.6mm, 0.8mm respectively.

III. PATCH ANTENNA DESIGN

The circular patch antenna is designed at the resonant frequency of 2.40GHz using Arlon diclad 880 substrate . The specifications of the antenna are shown in Table 1. The prototype of the patch fabricated on Arlon diclad 880 substrate. The cavity model analysis is used for calculating the actual radius and effective radius of the antenna. The designed geometry of the circular patch antenna without superstrate (single antenna) has shown in Fig 1.

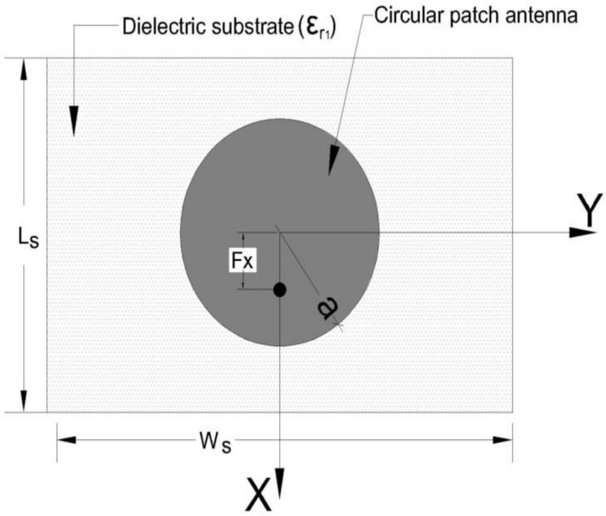

Fig1. Circular patch antenna

The HFSS electromagnetic simulating the software is used for simulate the antenna. In the Fig1, Ls represent the substrate length, Ws is represent the substrate width, Fx is represent the the location of the feed point where the antenna match with free space impedance and a is the actual radius of the circular patch antenna. The design the dimensions of the antenna have shown in Table 1. From the Table, Ls =100 mm, Ws =100mm, Diameter (D) =47.5mm and the Feed point (F) = (5.5mm, 0mm).

III. RESULTS AND DISCUSSION

The measurements have been carried out for typical cases. The results are discussed below

i. Superstrate with $\epsilon_{r2}= 2.2$ *and* h_2 *=1.6 mm.*

The performance analysis of with and without superstrate having the dielectric constant $\epsilon_{r2}= 2.2$, h_2 =1.6 mm on the characteristics of the circular patch antenna have been investigated experimentally. The result of VSWR and input impedance and radiation patterns are shown in Figs 2 to 5. The comparison of with and without superstrate analysis of resonant frequency, bandwidth, gain, beam-width, input impedance, radiation patterns in VP and HP and also the return loss which is shown in Table1. From the Figs 2 to 5 and Table 1, it can observed that the resonant frequency is decreased to 2.37GHz from 2.40GHz, the bandwidth is decreased to 0.030GHz from 0.040GHz and also gain is decreased to 4.80db from 6.70dB for the superstrate dielectric constant $\epsilon_{r2}= 2.2$ and for other superstrates dielectric constants $\epsilon_{r2}= 3.2, 4.8$ and 10.2 as shown in Table1.

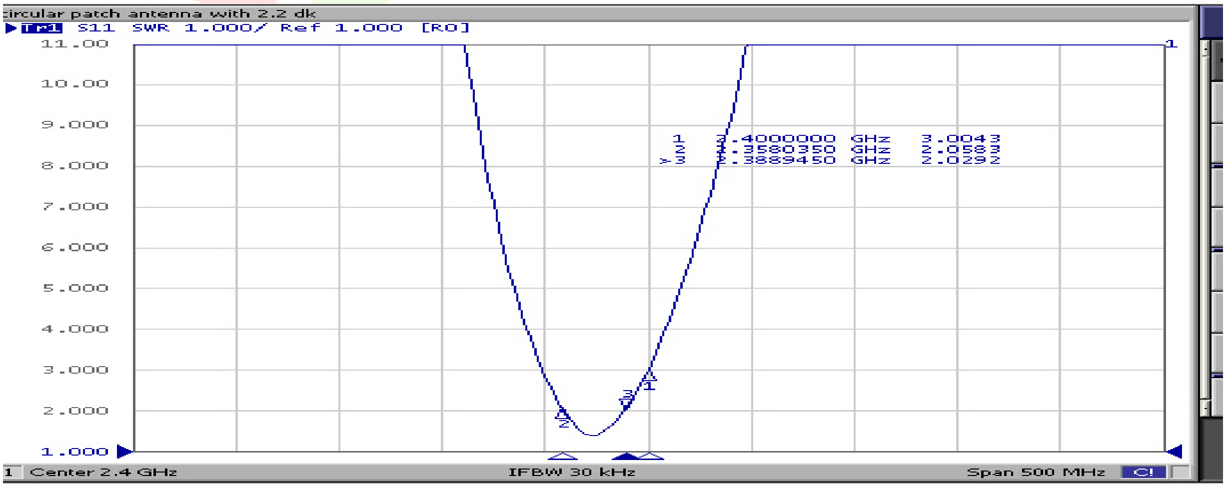

Fig.2 VSWR for circular microstrip patch antenna for $\epsilon_{r1}= 2.2$ without dielectric superstrate at frequency of 2.4 GHz.

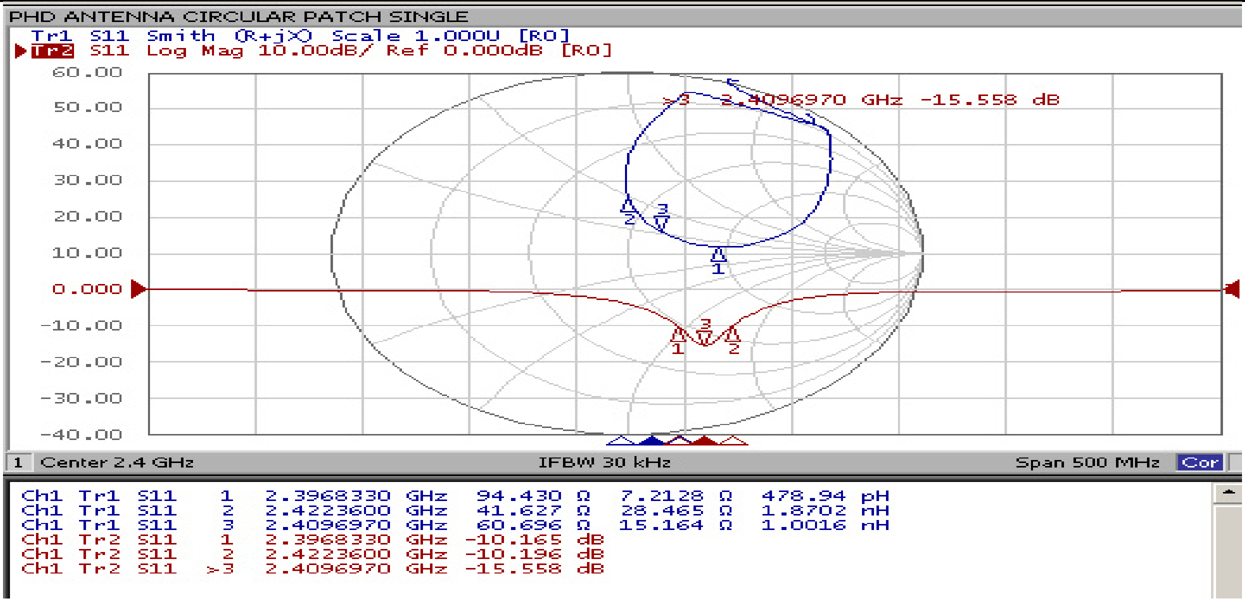

Fig.3 Input impedance for circular microstrip patch antenna for ϵ_{r1}= 2.2 without dielectric superstrate at frequency of 2.4 GHz.

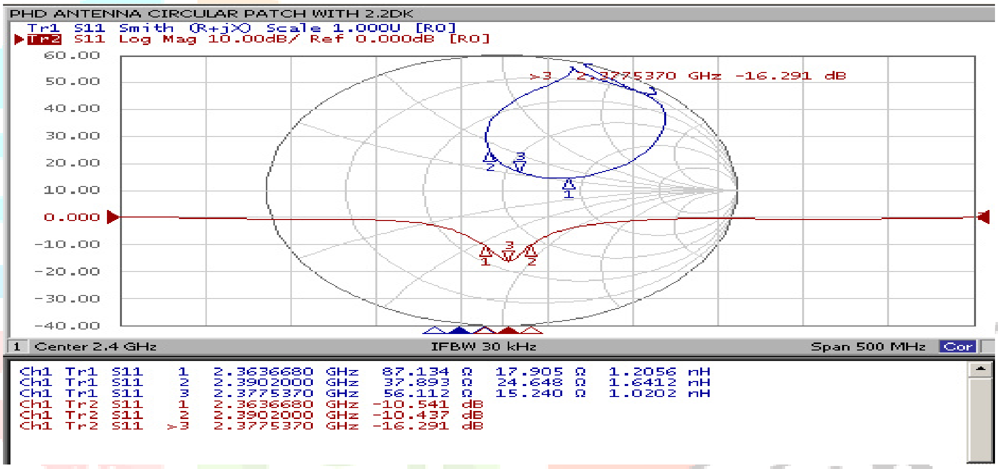

Fig.4 Input impedance for circular microstrip patch antenna for ϵ_{r2}= 2.2 with dielectric superstrate at frequency of 2.4 GHz.

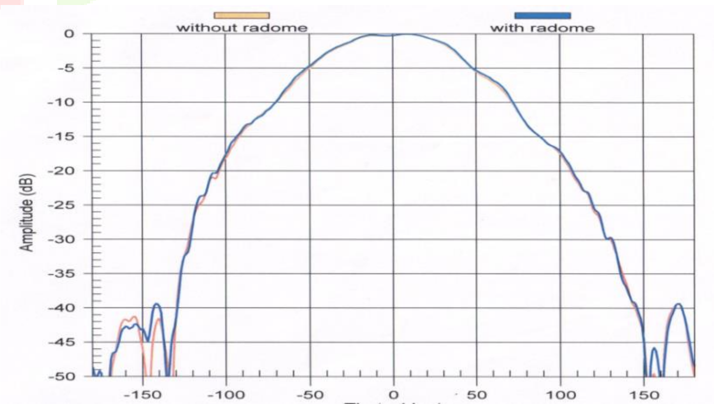

Fig. 5 Far field radiation patterns for circular microstrip patch antenna for ϵ_{r2}= 2.2 without and with dielectric superstrate in Vertical Plane at 2.40GHz

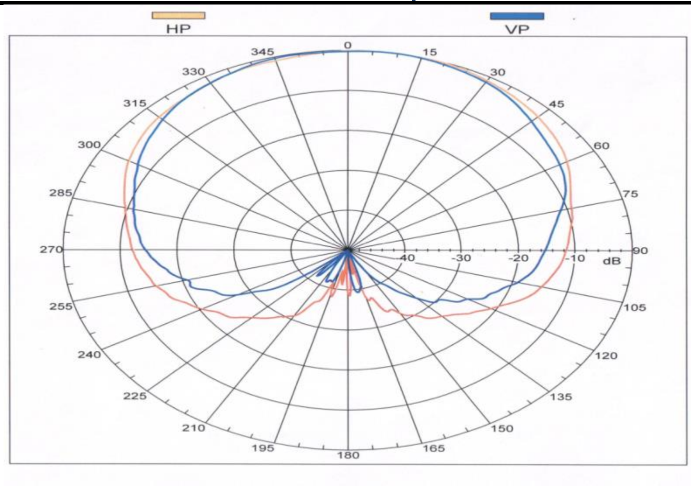

Fig 5: Far field radiation pattern circular microstrip patch antenna with and without dielectric superstrates for dielectric constant for ϵ_{r2}= 2.2 in horizontal polarization at 2.4GHz

Table 1: Comparison of experimental results of antenna characteristics

ϵ_{r2}	f_r (GHz)	*Gain(dB)*	*BW(GHz)*	*HPBW(HP),Deg*	*HPBW(VP),Deg*	*Input Impedance (Ω)*	*Return - loss(dB)*	*VSWR*
2.2*	**2.40**	**6.70**	**0.030**	**98.77**	**90.01**	35.75+j23.955	**-15.55**	**2.03**
2.2	**2.37**	**4.80**	**0.030**	**90.13**	**79.39**	56.11+j15.240	**-16.29**	**2.02**
3.2	**2.32**	**4.50**	**0.022**	**90.13**	**79.39**	54.98+j25.653	**-12.29**	**1.97**
4.8	**2.34**	**1.44**	**0.027**	**90.13**	**70.39**	52.19+j20.997	**-13.83**	**2.05**
10.2	**2.34**	**1.50**	**0.025**	**90.13**	**79.39**	35.75+j23.955	**-10.09**	**2.01**

*** Without dielectric superstrate**

IV. CONCLUSION

The effect of dielectric superstrates influence on the characteristics of circular patch antennas, the characteristics such as resonance frequency, bandwidth, beam width, gain, radiation patterns, input impedance, return loss and VSWR is investigated with and without dielectric superstrates. The comparative analysis of the microstrip antenna with dielectric superstrates and without it is carried out experimentally. From the Table 1, it can observed that the resonant frequency is shifted to lower side (ie is decreased) when the dielectric superstrates touching to the patch antenna. All the characteristics slightly effect their performance when patch covered with dielectric superstrates. At high dielectric constant the gain and bandwidth is decreased. The obtained results indicate that the VSWR and return loss increases, BW decreases for different dielectric constant of the superstrates. From the observation the low dielectric constant materials has provide better impedance matching.

V. ACKNOWLEDGEMENTS

The authors deeply express their gratitude to Department of ECE, Mahatma Gandhi Institute of Technology, for giving permission and their encouragement for carried out this work.

REFERENCES

1. I J Bhal and P Bhartia, "Microstrip antennas", Artech house, 1980.
2. Balanis, C.A., Antenna Theory Analysis and Design, John Wiley& Sons.
3. R.Shavit, "Dielectric cover effect on Rectangular Microstrip Antennas array". IEEE Trans. Antennas propagat.,Vol 40,. PP.992-995, Avg.1992.
4. Inder ,Prakash and Stuchly, "Design of Microstrip Antennas covered with a Dielectric Layer. IEEE Trans. Antennas Propagate. Vol.AP-30.No.2, Mar 1992.
5. O.M.Ramahi and Y.T.LO,"Superstrate effect on the Resonant frequency of Microstrip Antennas", Microwave Opt.Technol. Lett. Vol.5, PP.254-257,June 1992.
6. A.Bhattacharyya and T. Tralman, "Effects of Dielectric Superstrate on patch Antennas", Electron Lett., Vol.24, PP.356-358, Mar 1998.
7. R.Afzalzadeh and R.N.Karekar,"Characteristics of a Rectangular Microstrip patch Antenna with protecting spaced Dielectric Superstrate", Microwave Opt. Technol. Lett., Vol.7, PP.62-66, Feb 1994.
8. I J Bahl P. Bhartia, S.Stuchly "Design of microstrip antennas covered with a dielectric layer. IEEE Trans. Antennas Propogat. No. 30, PP. 314-318, Mar 1982
9. Odeyemi KO, Akande, D.O and Ogunti E.O." Design of S-band Rectangular Microstrip Patch Antenna, European Journal of Scientific Research Volume 55, Issue 1, 2011
10. Bernnhard and Tousignant, "Resonant Frequencies of rectangular microstrip antennas with flush and spaced dielectric superstrates", IEEE Trans. Antennas Propagat, Vol.47, no.2, Feb 1999.
11. Hussain, A. Hammus, "Radiation performance evaluation of microstrip antenna covered with a dielectric layer", Eng& Tech Journal, vol.27, 2009.
12. P. Malathi AND Rajkumar "Design of multilayer rectangular microstrip antenna using artificial neural networks" International journal of recent trends in Engineering, Vol.2, no.5, Nov. 2009.
13. P. Malathi and Rajkumar "On the design of multilayer circular microstrip antenna using artificial neural network", International Journal of Recent Trends in Engineering, Vol.2, No.5, Nov. 2009.
14. Christopher J Meagher and SatishkumarSharm "A wide band aperture- coupled microstrip patch antennas employing space and dielectric cover for enhanced gain performance, IEEE Transaction on antenna and propagation, Vol.58, No.9, Sep. 2010.
15. Bahl, I.J, Stuchly, S.S, "Analysis of a microstrip covered with a lossy dielectric, IEEE Trans. Microwave Theory Tech., 28, pp.104-109.1980.
16. AlexopoulosN.G.Jackson, D.R. "Fundamental superstrate (cover) effects on printed antennas, IEEE Trans. Antennas Propagat.32, PP. 807-816.
17. R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon, Microstrip Antenna Design Hand book, Artech House, Canton, MA, 2001.
18. Pozar, D.M, and Schaubert, D.H, Microstrip Antennas, the analysis and design of microstrip antennas and arrays, IEEE Press, New YORK, USA, 1985.
19. James J.R., and Hall P.S, Handbook of microstrip antennas, Peter Peregrinus, London, UK, 1989.
20. R.K.Yadav,R.L.Yadava "Performance Analysis of superstrate loaded patch antenna and Abstain from environmental Effects"International Journal of Engineering science and Tech., Vol.3, no.8, p.p.6582-6591, Aug. 2011.
21. V. Saidulu, K. SrinivasaRao and P.V.D. SomasekharRao, "Studies on the Effect of Dielectric Superstrates on the Characteristics of Rectangular Microstrip Patch Antenna," National Conference on Recent Trends in Science and Technology (NCRTST) at JNTU, Hyderabad, College of Engineering, Nachupally, Krimnagar, ISBN: 978-93-82570-52-3, 25-26, February, 2015, pp. 157-162.
22. V.Saidulu, "Effect of Dielectric Cover Thickness Analysis on Rectangular Microstrip Patch Antenna in Wi-Fi Applications" International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol. 11, Issue. 4 March 2022, pp. 4-7. Published by Blue Eyes Intelligence Engineering and Science Publication.