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Dielectric Cover Effect on Rectangular Microstrip Patch Antenna Parameters

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Abstract: In this paper the effect of dielectric cover (also called superstrate) which influence on the main characteristics of rectangular microstrip antenna is presented. The antenna main characteristics are including the resonant frequency, gain, bandwidth, beam width, radiation patterns, VSWR and return loss is investigated with and without dielectric superstrate. The antenna is designed at the center frequency of 2.4GHz and simulated using Ansoft electromagnetic simulator named as High Frequency Structure Simulator. When the dielectric superstrate is touching the patch antenna, the resonant frequency is reduced and also which effects on other parameters slightly change their performance. The comparative analysis of the rectangular microstrip patch antenna (RMPA) characteristics with and without it is carried out.

***IndexTerms* - Dielectric superstrate, Patch antenna, Substrate,**

I. INTRODUCTION

The microstrip antennas (MSA) have been used in wireless communication, mobile communication, satellite communication and radar systems in recent years and also used in airborne and spacecraft systems because of low profile and conformal nature [1-5]. The advantages of this antenna are light weight, low cost, and easy to apply Microwave Integrated Circuits (MICs). However, MSA suffers some disadvantages including narrow bandwidth and low gain [6-9]. Many of these applications the dielectric superstrate or it is also called as dielectric cover is required to provide the protection to the antenna from the environmental conditions [10-22]. In this paper the effect of dielectric superstrate influence on the main characteristics of rectangular microstrip antenna is presented. The antenna main characteristics are including the resonant frequency, gain, bandwidth, beam width, radiation patterns, VSWR and return loss is investigated with and without dielectric superstrate. When the dielectric superstrate is touching the patch antenna, the resonant frequency is reduced and also which effects on other parameters. The comparative analysis of the rectangular microstrip antenna (MSA) characteristics with and without it is carried out. The geometry of rectangular microstrip patch antenna is shown in Fig1. The designed frequency 2.40 GHz is widely employed in Bluetooth, WI-Fi applications.

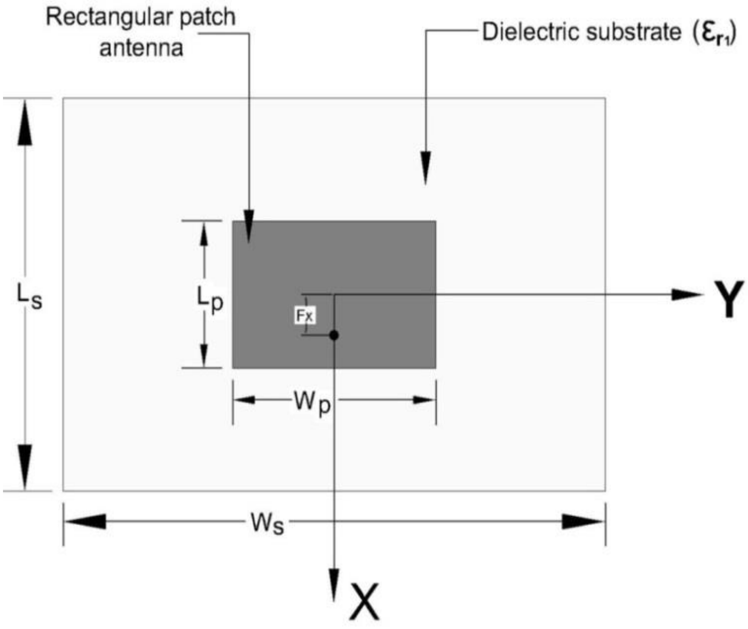


Fig1. Rectangular microstrip antenna

II. SPECIFICATIONS

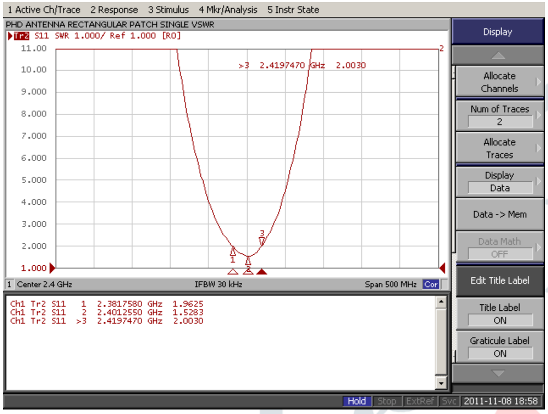
In this work, the antenna is designed at 2.4HGz frequency using Arlon diclad 880 substrate. The dielectric constant of the substrate is $\epsilon_{r1}= 2.2$, the thickness h_1 =1.6mm and the loss tangent of the substrate is very low (Tanδ =0.00009). The dielectric materials such as Arlon 880, Arlon AD 320, FR4 and Arlon AD1000 has chosen as superstrate. The dielectric constant of the superstrate $\in_{r2}$ =2.2, 3.2, 4.4, 10.2 and the thickness of superstrate h_2=1.6mm, 3.2mm, 1.6mm, 0.8mm respectively. All these superstrate materials at zero loss tangent.

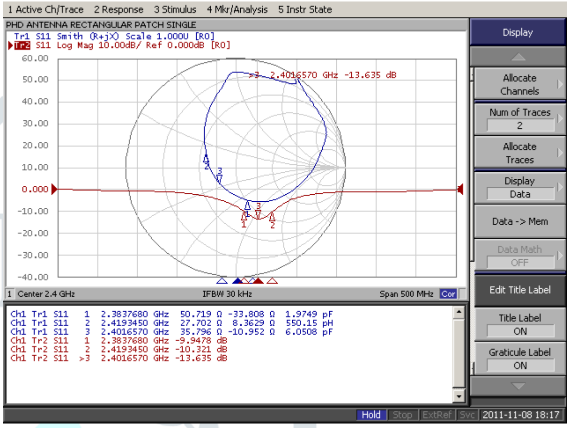
III. PATCH ANTENNA DESIGN

The patch antenna is designed at the resonant frequency of 2.4GHz. The low loss tangent substrate materials are used in the patch antenna design. The name of the substrate material is Arlon AD880, which is having dielectric constant $\in_{r1}$=2.2, h_1 =1.6mm. The transmission line model is used for calculating the patch width W_p, patch length L_P and antenna feed point location F_Y. The patch antennas are fed with coaxial probe feed at a point where the input impedance of the patch is 50 Ω. The location co-ordinates (F_X, F_Y) are found by simulation. By using transmission line model, the geometrical dimension have been calculated. W_s = 100mm, L_s= 100mm, W_P=49.40mm, L_P = 40.30mm, (F_x,F_y) =(0, 10.5)mm.

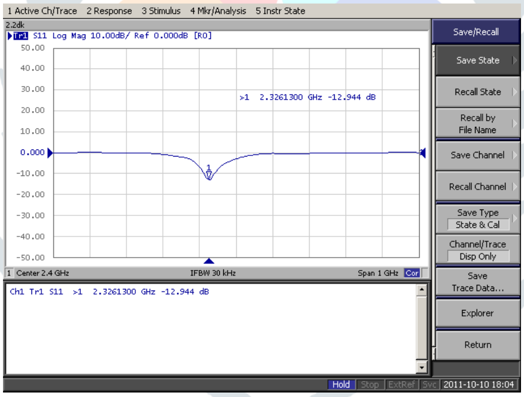
V. EXPERIMENTAL RESULTS

The experimental measured VSWR, return loss and radiation pattern plots are shown in Figs 2 to 7 and also the experimental results as shown in Tables 1 to Table5. The Network Analyzer is used to measure the return loss, VSWR and center frequency and bandwidth. Anechoic chamber is used measure the radiation characteristics.



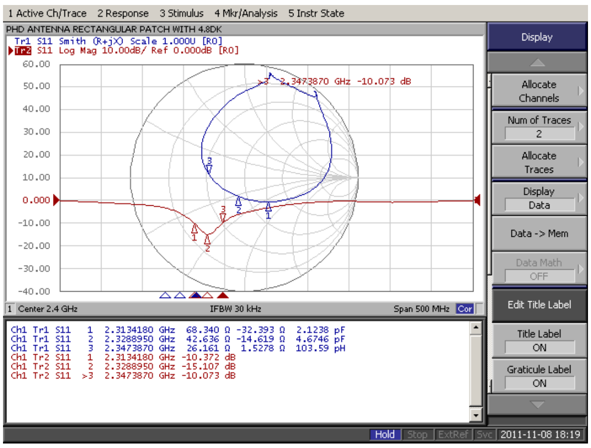


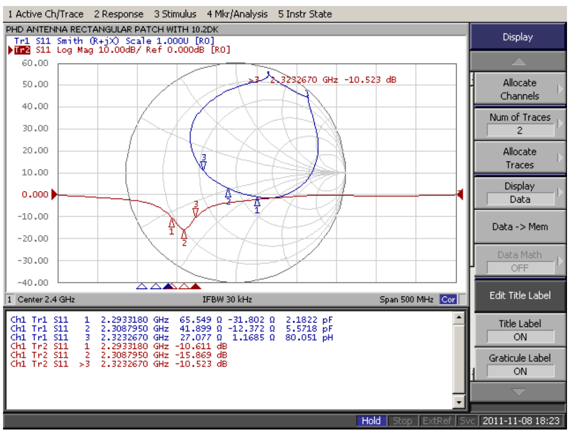
(a) VSWR $\in_{r1}$ =2.2 (b) Input impedance $\in_{r1}$ =2.2



(c)Return loss $\in_{r1}$ =2.2

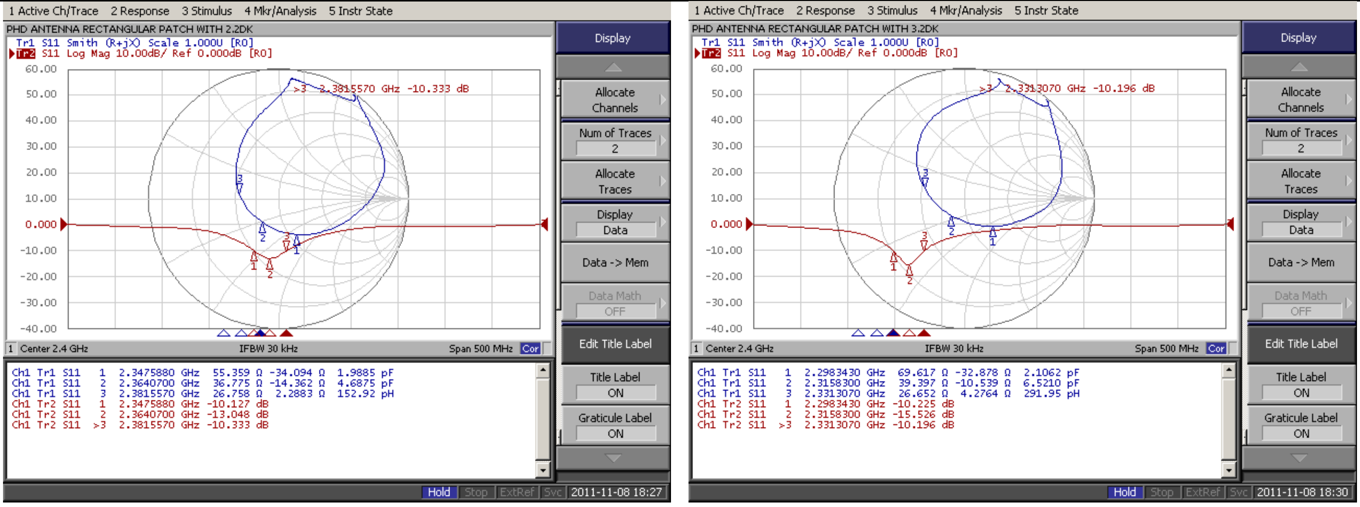
Fig.2 VSWR, Input impedance and RL of RMPA (without superstrate)





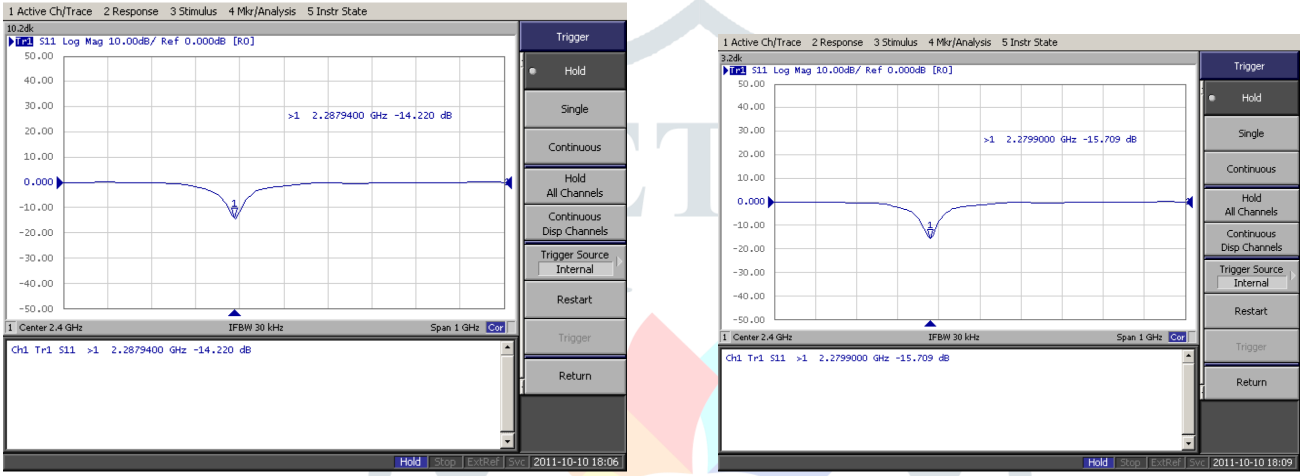
(a) Input impedance $\in_{r2}$ =4.8 (b) Input impedance $\in_{r2}$ =10.2

Fig 3. Input Impedance for RMPA with dielectric constant of the superstrates $\in_{r2}$ =4.8, 10.2



((a) Input impedance ϵ_{r2} =2.2 (b) Input impedance ϵ_{r2} =3.2

Fig4. Input Impedance for RMPA with dielectric superstrates ϵ_{r2} =2.2, 3.2



(aReturn loss ϵ_{r2} =2.2 (b) Input impedance ϵ_{r2} =3.2

Fig5. Return loss for RMPA ϵ_{r2} =2.2, 3.2 (With dielectric superstrate)

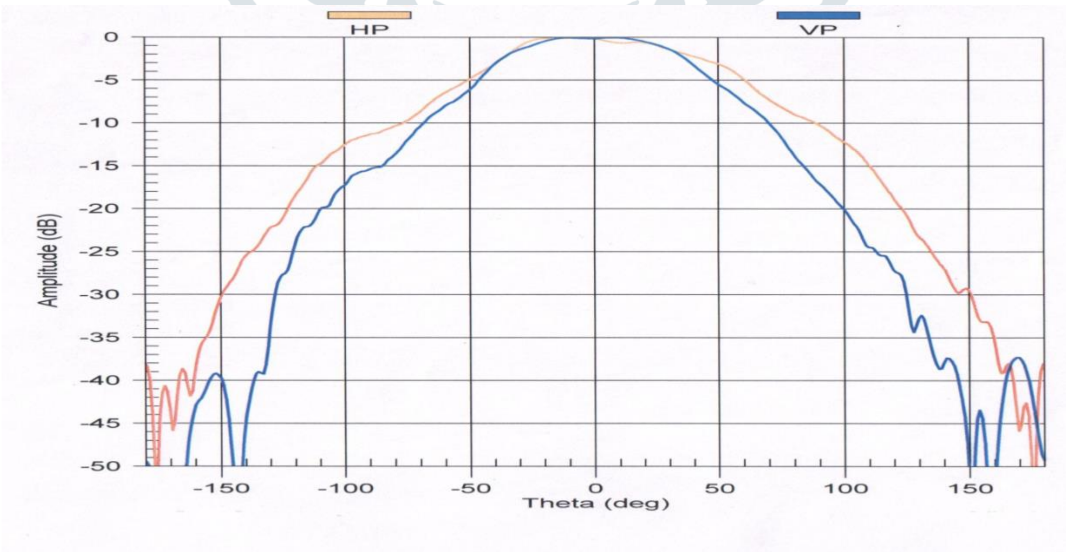


Fig. 6 Experimental measured results of far field radiation patterns for VP and HP at 2.4 GHz.

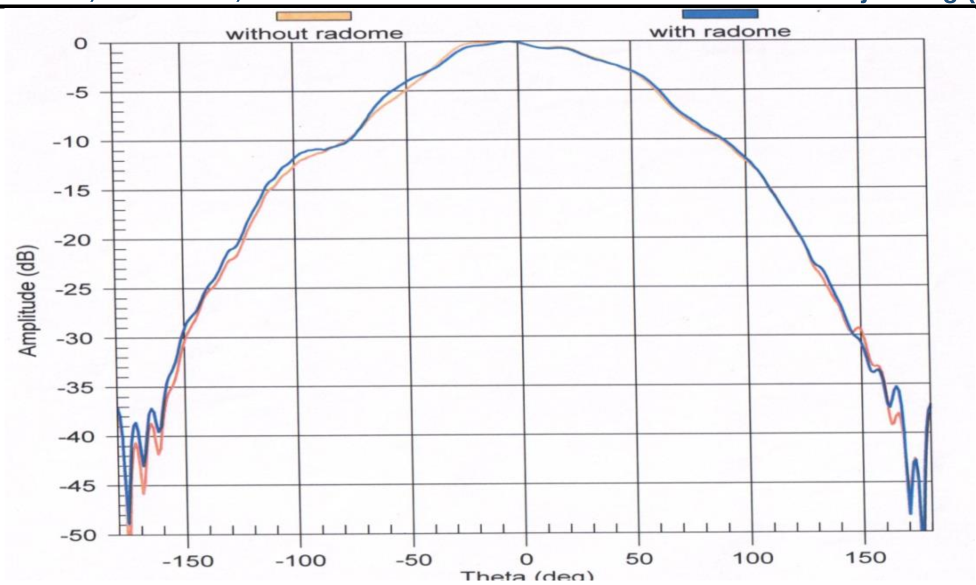


Fig. 7 Experimental measured results of far field radiation patterns for ϵ_{r2}= 2.2 at 2.4 GHz in HP.

Table 1: Results of the rectangular microstrip antenna without superstrate

Dielectric Constant (ϵ_{r1})	Center Frequency (f_0)	Band –Width (BW)	Gain (G)	HPBW (HP)	HPBW (VP)
Arlondiclad 880	2.410501	0.203785	7.3	88.36	90.20

Table 2: Results of the rectangular microstrip antenna with superstrate

Dielectric Constant (ϵ_{r1})	Center Frequency (f_0)	Band-Width (BW)	Gain (G)	HPBW (HP)	HPBW (VP)
2.2	2.390425	0.0094	5.9	88.36	78.73
3.2	2.3106775	0.041965	2.8	88.36	78.73
4.8	2.3307775	0.043975	4.0	88.36	78.73
10.2	2.3217325	0.041965	4.2	88.36	78.73

VI. RESULTS AND DISCUSSION

It is found from the above plots and Table1 and Table 2, there is degradation in the performance of the antenna when the superstrate is touching the patch antenna. The experimental results show that the rectangular patch antenna the measured resonant frequency is decreased to 2.38 GHz, the bandwidth is decreased to 0.0094 GHz and gain is decreased to 4.8dB. The remaining all the parameters with and without dielectric cover has shown in above Tables.

VII. CONCLUSION

The obtained results indicate that return loss and VSWR increases, BW decreases with the different dielectric constant of the superstrates. The value of impedance, return loss and VSWR are minimum, whereas BW is maximum for superstrate having dielectric constant(ϵ_{r2}) is 2.2 and vice versa(ϵ_{r2}).This type of characteristics of antenna has been used in Wireless, Bluetooth and Wi-Fi applicatios most widely used. The frequency 2.4GHz has been employed in this applications.

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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 Satishkumar Sharm “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.