International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-10 Issue-6, March 2022

# Simulation and Experimentation Analysis of Dielectric Covers on Square Patch Antenna in Wireless Communications

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***Abstract:*** ***In this paper the different dielectric covers affects on square patch antenna is investigated and compared their performance. The square patch antenna is designed at 2.4GHz with arlon diclad 880 substrate. The dielectric constant of substrate is 2.2 and thickness of substrate is 1.6mm. The different dielectric covers or superstrates are used whose dielectric constants are 2.2, 3.2, 4.8 and 10.2. The patch antenna is simulated using Ansoft electromagnetic simulator such as HFSS. The effect of dielectric cover at height (H) =0 on patch antenna, the result is the performance of antenna is slightly decreased and as increase the height of the dielectric cover above the patch performance antenna is slightly increases as increases height of the dielectric cover above the patch, but at optimum height, performance of the cover results which is same the antenna without dielectric cover. The uses of dielectric covers are used to providing protections from physical damage, rain and snow and also protecting the antenna from physical heat and other environmental hazards. This antenna designed specifications and frequency 2.4GHz is used in wireless applications.***

***Keywords: Antenna Resonant Frequency, Dielectric Cover, Radiation Patterns, Gain, Bandwidth Etc.***

## I. INTRODUCTION

Microstrip antenna is a high frequency microwave antenna and is a broadband antenna operated at microwave frequency range. The microstrip antennas can be used in high performance of aircraft, spacecraft, military, radar, satellite, missile, mobile communications, and wireless communications and also used in highspeed automobile applications [1-4]. The characteristics of square patch antenna are low profile and conformable nature due to this antenna can be used in planar and non planar geometrical surfaces [5-6]. These antennas are available in different shapes, such as rectangular, circular, square, triangular [7-14] etc. In this paper the effect of different superstrates or dielectric covers with different heights and different thickness are investigated and compared their performance with and without superstrates or covers.

Manuscript received on 28 February 2022.
Revised Manuscript received on 26 March 2022.
Manuscript published on 30 March 2022.
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## II. ANTENNA SPECIFICATIONS

The different substrates materials are used for designing of square patch at the frequency range of 2.4GHz. The specifications of substrates and dielectric cover materials as shown in Tables I and II [7-9]. The square patch antenna is designed at 2.4GHz with arlon diclad 880 substrate. The dielectric constant of substrate is 2.2 and thickness of substrate is 1.6mm. The different dielectric covers or superstrates are used whose dielectric constants are 2.2, 3.2, 4.8 and 10.2. These materials are having low tangent losses more stability with stand temperatures.

**Table 1: The specifications of substrate**

| **Dielectric substrate** | **Arlon diclad 880** |
|---|---|
| Dielectric constant($\epsilon_{r1}$) | 2.2 |
| Thickness of substrate ($h_1$) mm | 1.6 |
| Loss Tangent (Tanδ) | 0.0009 |

**Table II: Specifications of dielectric covers**

| **Specifications** | **Arlon AD880** | **Arlon AD380** | **FR4** | **Arlon AD100** |
|---|---|---|---|---|
| Dielectric constant($\epsilon_{r2}$) | 2.2 | 3.2 | 4.8 | 10.2 |
| Loss tangent ($Tan\delta$) | 0.0009 | 0.003 | 0.02 | 0.0035 |
| Thickness ($h_2$) (mm) | 1.6 | 3.2 | 1.6 | 0.8 |

## III. ANTENNA DESIGN

The transmission line model analysis is used for calculation of various dimensions patch antenna such as substrate width (Ws), length of substrate (Ls), patch width (Wp), patch length (Lp) and feed point where input impedance matched with free space impedance [10-14]. The design dimensions of antennas are patch width (Wp) =40.30mm, Patch length (Lp) =40.30mm, substrate width (Ws) =81.30mm, substrate length (Ls) =70.30mm and and the antenna feed point locations is obtained by numerical equations i.e is on X-axis, the feed point, Fx =10mm and on Y-axix, the feed point Fy =0mm. The square patch designed antenna is shown in Fig.1. substrates materials are used for designing of square patch at the frequency range of 2.4GHz. The specifications of substrates and dielectric cover materials as shown in Tables I and II [7-9]. The square patch antenna is designed at 2.4GHz with arlon diclad 880 substrate. The dielectric constant of substrate is 2.2 and thickness of substrate is 1.6mm. The different dielectric covers or superstrates are used whose dielectric constants are 2.2, 3.2, 4.8 and 10.2.

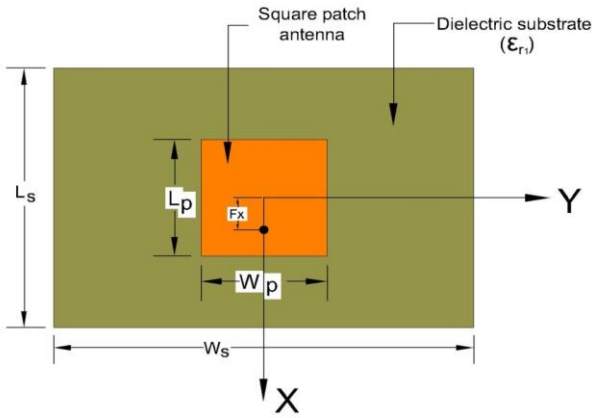



**Fig. 1: Square patch antenna**

## IV. RESULTS AND DISCUSSION

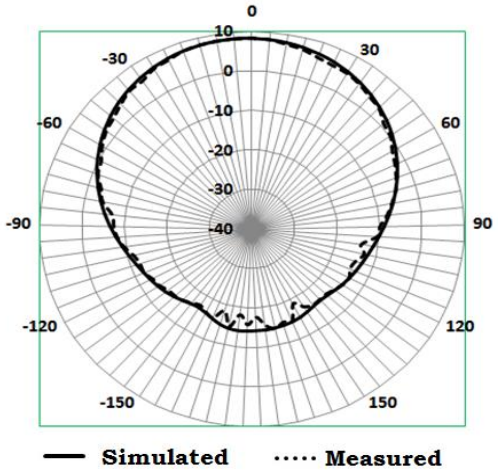



**Fig2. Measured and Simulated Of E-Plane Radiation Pattern**

The return loss plot of proposed square patch antenna is shown in Fig.2, It is observed in this plot the antenna designed frequency is 2.4GHz and resonant at center frequency of 2.4GHz only. The simulated and experimental result shows that the value of return loss is -24.94dB, VSWR is 1.12 and BW is 0.040GHz.he return loss and VSWR is good. The plot of antenna return loss with dielectric covers which is shown in Fig.3. It is observed from Fig.3 the antenna resonant frequency decreased from 2.4GHz to 2.35GHz. The E-pane and H-plane radiation patterns of antennas with and without cover is shown in Fig.4 The simulated and measure results of all the dielectric covers at different heights as shown in Table III.

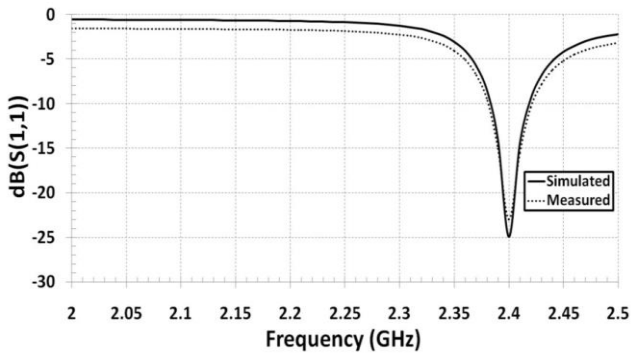



**Fig.2. The return loss Single Patch Antenna Without Dielectric Cover**

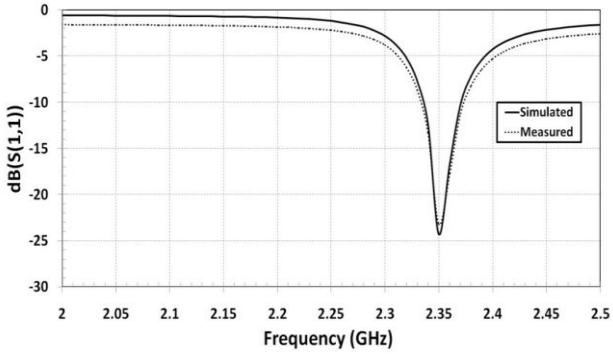
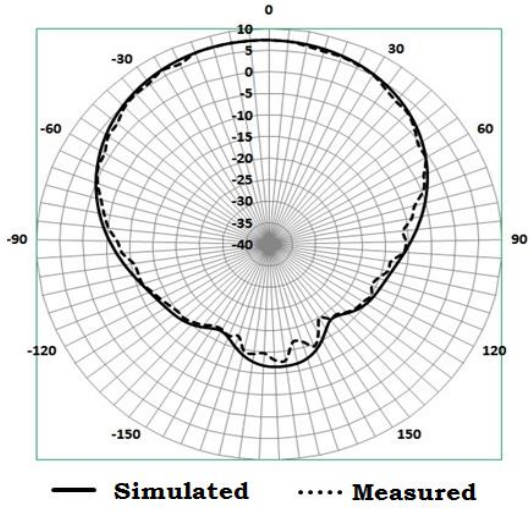



**Fig.3. Return loss plot with dielectric cover**




(b)

**Fig.4. Measured and Simulated of H-Plane Radiation Pattern**

**Table III: Comparison of Simulated and Measured Results of Square Patch Antenna Parameters with And Without Dielectric Cover and Also Varying the At Different Height of The Dielectric Covers or Superstrates**

| H (height) | εr 2 | Frequency (GHz) | | Return loss (dB) | | Bandwidth (GHz) | | Gain (dB) | | VSWR | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Simulated | Measured | Simulated | Measured | Simulated | Measured | Simulated | Measured | Simulated | Measured |
| | 1* | 2.40 | 2.40 | -24.94 | -23.00 | 0.040 | 0.041 | 8.90 | 8.90 | 1.12 | 1.15 |
| $H_0$ | 2.2 | 2.35 | 2.35 | -24.30 | -23.20 | 0.031 | 0.032 | 8.74 | 8.60 | 1.13 | 1.15 |
| Hopt/2 | | 2.38 | 2.38 | -21.96 | -21.80 | 0.032 | 0.033 | 8.77 | 8.65 | 1.17 | 1.18 |
| Hopt | | 2.40 | 2.40 | -19.61 | -17.30 | 0.041 | 0.042 | 8.80 | 8.70 | 1.23 | 1.32 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ho | 3.2 | 2.32 | 2.32 | -26.77 | -25.00 | 0.031 | 0.033 | 8.32 | 8.30 | 1.10 | 1.12 |
| Hopt/2 | | 2.37 | 2.37 | -22.12 | -21.84 | 0.033 | 0.034 | 8.49 | 8.45 | 1.18 | 1.19 |
| Hopt | | 2.41 | 2.41 | -17.30 | -16.90 | 0.040 | 0.041 | 8.66 | 8.60 | 1.32 | 1.33 |
| Ho | 4.8 | 2.27 | 2.27 | -25.12 | -23.60 | 0.032 | 0.032 | 7.67 | 7.60 | 1.12 | 1.14 |
| Hopt/2 | | 2.34 | 2.34 | -20.38 | -20.00 | 0.041 | 0.042 | 8.19 | 8.15 | 1.21 | 1.22 |
| Hopt | | 2.41 | 2.41 | -15.64 | -16.40 | 0.041 | 0.042 | 8.71 | 8.70 | 1.40 | 1.36 |
| Ho | 10.2 | 2.12 | 2.12 | -21.34 | -20.50 | 0.022 | 0.023 | 6.44 | 6.40 | 1.19 | 1.21 |
| Hopt/2 | | 2.27 | 2.27 | -16.79 | -16.10 | 0.034 | 0.035 | 7.62 | 7.47 | 1.34 | 1.37 |
| Hopt | | 2.41 | 2.41 | -12.24 | -11.70 | 0.040 | 0.041 | 8.80 | 8.80 | 1.65 | 1.70 |

*without dielectric superstrate

## V. CONCLUSIONS

In this paper the different dielectric covers affects on square patch antenna is investigated and compared their performance. It has been observed that there is a slight degradation in the performance of the antenna when the superstrate is touching the patch antenna (H =0mm). The center frequency is decreased to 2.35GHz from 2.40GHz, bandwidth is decreased to 0.031GHz from 0.040GHz and gain is decreased to 8.74dB from 8.90dB. As compared to without superstrate, the resonant frequency is 2.35GHz (2.08% less), bandwidth is 0.032GHz (21.95%) and gain is 8.60 dB (3.37% less). The frequency 2.4GHz most widely used in ISM band applications.

## ACKNOWLEDGMENT

The author deeply expresses his gratitude to Department of ECE, MGIT, for their encouragement during this work.

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**Dr. V. Saidulu** was born in T.S, INDIA, in 1974. He received his B.Tech in Electronics and Communication Engineering from Nagarjuna University in 1998 and M. Tech in Electronics Engineering (Microwave) from Banaras Hindu University (B.H.U), Varanasi, U.P in 2001 and Ph.D. in Electronics and Communication Engineering (Microstrip Antennas) from NTU Hyderabad in 2016. He worked as an Assistant Professor in the Department of ECE at CBIT from June 2002 to November 2004 and also worked as Assistant Professor in MGIT from November 2004 to June 2006. Currently he is working as an Associate Professor in the Dept. of ECE at MGIT since June 2006 to till date. He published 37 papers in international journals, national and international conferences. His research interests are in the area of Microstrip antennas, Wireless communications and mobile communications.