COMPARISON THE CHARACTERISTICS OF CIRCULAR AND SQUARE PATCH MICROSTRIP ANTENNAS WITH SUPERSTRATES

V. Saidulu[1*], K. Srinivasa Rao[2], P. V. D. Somasekhar Rao[3]
[1]Department of Electronics and Communication, MGIT, Hyderabad, AP, India
[2] Department of Electronics and Communication, VIF, Hyderabad, AP, India
[3]Department of Electronics and Communication, JNTUH, Hyderabad, AP, India

ABSTRACT

This paper focused on the comparison characteristics of Circular and Square patch microstrip antennas with dielectric Superstrate (Radome) and without dielectric Superstrates. The proposed antennas fed with coaxial probe at a point where the input impedance is 50Ω, and antennas designed at frequency of 2.4GHz(ISM band), antenna behavior is explained through parameter study using Finite Element Method based EM - Simulator HFSS software (High Frequency Structure Simulator). The Circular and Square patch microstrip antenna have been formulated using transmission line analogy and cavity model. In this paper experimentally measured various characteristics of Circular and Square patch microstrip antennas with and without dielectric Superstrates and compared the performance. The antenna characteristics such as resonant frequency, Bandwidth, Beam- width, Gain, Input impedance, Return –loss and VSWR etc. Experimentally studied that the effect of microstrip patch antenna with and without dielectric Superstrate. The effect of microstrip patch antenna with dielectric Superstrates which result in, antenna resonant frequency will be shifted lower side, while other parameters have slight variation in their values. In particular, the resonant frequency increases with the dielectric constant of the Superstrates thickness. In addition, it has also been observed that return loss and VSWR increases, however bandwidth and gain decreases with the dielectric constant of the Superstrates thickness. Impedance characteristics are that both input impedance and the reactance which are increased as Superstrate become thick and its $\in_r$ increases.

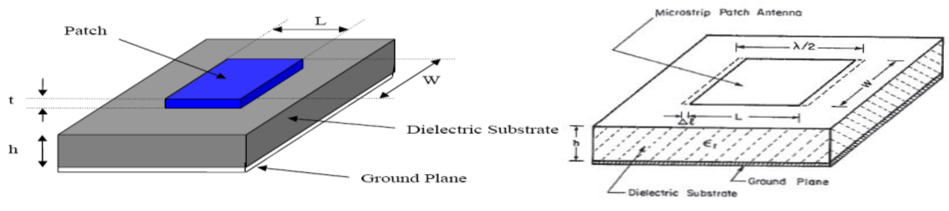
KEYWORDS: *Microstrip patch antenna, Dielectric Superstrates, Bandwidth, Resonant frequency etc.*

I. INTRODUCTION

Microstrip antenna consists of radiating patch on the one side of the substrate having the ground plane on other side. The major advantages are light weight, low profile, conformable to planar and non-planer surfaces and easy to fabricate. The antenna is suitable for high speed vehicles, aircraft's, space crafts and missiles because of low profile and conformal nature of characteristics [1], [2], [3]. The dielectrics Superstrate protects the patch from climatic conditions and environmental hazards and improve the antenna performance [7]. The researchers [3], [4], [5], 6] have investigated the input impedance of circular and square patch with dielectric Superstrate (radome). The different way of methods on the circular and square patch microstrip antennas is investigated by many researchers. K.M.Luk et al, [8] have reported the investigation of the effect of dielectric cover on a circular microstrip patch antenna. The resonant frequency of patch is decreased while bandwidth is slightly varied. Hussain.A et al, [9] have been discussed the microstrip antenna performance covered with dielectric layer. He found the simulated results which show that the antenna resonant frequency is reduced as the dielectric layer thickness is increased; however the gain is decreased as dielectric layer thickness is increased. R.K.Yadav et al, [10] have been observed that the resonant frequency lowers and shift in resonant frequency increases with the dielectric constant of the Superstrates, in addition, it has also been observed that return –loss and VSWR increase, however bandwidth and directivity decreases with the dielectric constant of the Superstrates. Hussein Attia et al, [11], He discussed that a microstrip patch antenna can be designed to achieve the highest possible gain when covered with a Superstrate at proper distance in free space. The transmission line analogy and cavity model are used to deduce the resonance conditions required to achieve the highest gain. Samer Dev. Gupta et al, [12] he discussed the design of multi dielectric layer based on different thickness and permittivity of the Superstrate layer has significant effect in gain and efficiency. The proper choice of thickness of substrate and Superstrate layer, which significantly increase in gain. Mohammed Youness et al, [13], have discussed a parametric study of rectangular microstrip antenna at frequency ranging from 0.6 to 0.8 THz with and without Superstrate. The matching bandwidth and maximum radiation gain obtained .But they have not studied thoroughly the effect of Superstrates on the patch antenna by varying various thickness and dielectric constants. We have been designed the square and circular microstrip patch antenna based on the transmission line and cavity model of analysis. The substrate and Superstrate material as same dielectric constant. The effect of dielectric Superstrates thickness with and without experimentally investigated on the parameter such as bandwidth, beam-width, gain, resonant frequency, input impedance, return loss and VSWR etc. The obtained results shows that the resonant frequency will be shifted to lower side by adding Superstrate above substrate, while other parameter have slight variation in their values. In particular, the resonant frequency increases with dielectric constant of the Superstrates. In addition, it has also been observed that the return loss and VSWR increase, however bandwidth and gain decreases with the dielectric constant of the Superstrates. Impedance characteristics are that both input impedance and the reactance which are increased as Superstrate become thick and its $\in_r$ increases.

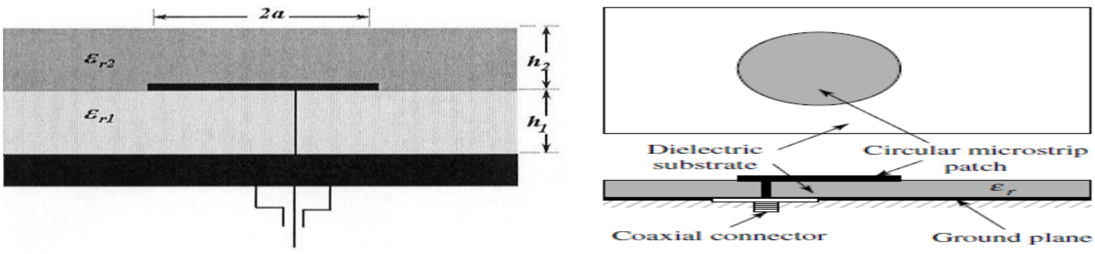
II. ANTENNA SPECIFICATION AND SELECTION OF SUBSTRATE MATERIALS

The geometry of a coaxial probe fed, circular and square patch microstrip antenna is shown in Figure 1, Figure 2. The antenna under investigation the square patch antenna have width and length (W×L) = 33.6mm and feed point location (F) = 10.0mm, the circular patch antenna have diameter (D) = 47.1mm, feed point location (F) = 5.5mm. The antennas designed center frequency is 2.4GHz is shown in Table 1 and Table 2, fabricated on Arlon diclad 880 dielectric substrate, whose dielectric constant($\in_{r1}$) is 2.2, loss tangent(tanδ) is 0.0009, thickness (h_1) is 1.6mm and substrate dimension is 100mm×100mm. The Superstrate material can be used same as substrate with same specification in the design of circular and square patch microstrip antenna is shown the Table 3 and Table 4. The selection of substrate materials play important role for antenna design is shown in Table 3 and Table 4. Dielectric substrate of appropriate thickness and loss tangent is chosen for designing the circular and square patch microstrip patch antenna. A thicker substrate is mechanically strong with improved impedance bandwidth and gain [10]. However it also increases weight and surface wave losses. The dielectric constant ($\in_r$) is play an important role similar to that of the thickness of the substrate. A low value of $\in_r$ for the substrate will be increase the fringing field of the patch and thus the radiated power. A high loss tangent (tanδ) increases the dielectric loss and therefore reduce the antenna performance. The low dielectric constant materials increase efficiency, bandwidth and better for radiation.



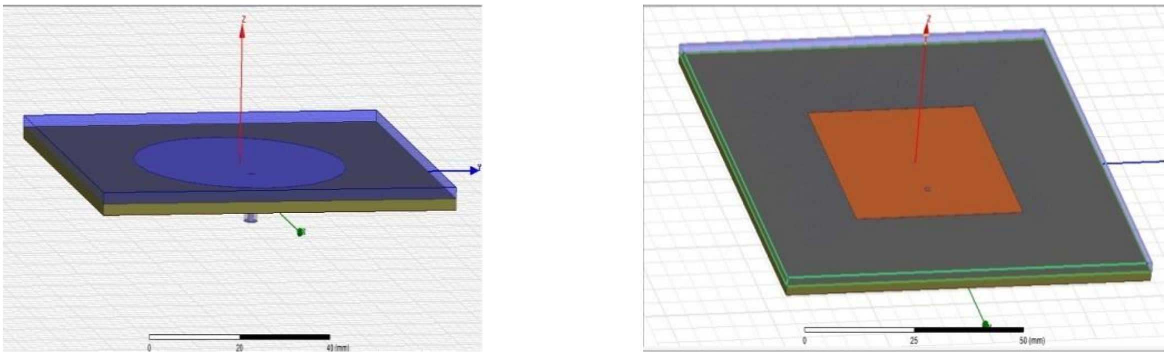
(a) Square patch antenna **(b)** Square patch with dimension.

Figure 1: Schematic of Square patch antenna



(a) Schematic of Superstrate **(b)** Schematic of Circular patch antenna

Figure 2: Circular microstrip antenna with Superstrate geometry



(a) Circular microstrip patch antenna with Superstrate **(b)** Square microstrip patch antenna with Superstrate

Figure3: Schematic of circular and square microstrip patch antenna

III. DESIGN OF CIRCULAR AND SQUARE PATCH ANTENNA

The patch antenna can be designed at 2.4GHz using transmission line and cavity model and fabricated on substrate, whose dielectric constant(ϵ_{r1}) is 2.2.The substrate and superstrate dimension is 100×100mm for designing of patch antennas. The square patch antenna which have width and length (W×L) =36.5mm and feed point location (F) is X=0, Y=10.0mm is calculated (4), (5) and (7). The circular patch antenna which have the Diameter (D) =47.1mm can be calculated (9).The feed point location (F) is X=5.5mm is calculated using trial and error method. The coaxial probe feeding is given to a particular location of the point where input impedance is approximately 50 Ω is shown in Figure 3. The main advantages of the feeding technique are that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and also has low spurious radiation.

3.1 Design equation of square patch antenna

The effective dielectric constant has values in the range of $1 < \epsilon_{reff} < \epsilon_r$. Where the dielectric constant of the substrate is much greater than the unity ($\epsilon_r \gg 1$), the value of ϵ_{reff} will be closer to the value of the actual dielectric constant ϵ_r of the substrate [2].

$$W/h > 1$$

$$\epsilon_{ref} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2} \quad (1)$$

The dimensions of the patch along its length have been extended on each end by distanceΔL, which is a function of the effective dielectric constant ϵ_{reff} and the width-to-height ratio [2]

$$\frac{\Delta L}{h} = 0.412\frac{(\epsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\epsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)} \tag{2}$$

The effective length of the patch is now

$$L_{eff} = L + 2\Delta L \tag{3}$$

For an efficient radiator, a practical width that leads to good radiation efficiencies is [2]

$$W = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{\epsilon_r+1}} = \frac{\vartheta_0}{2f_r}\sqrt{\frac{2}{\epsilon_r+1}} \tag{4}$$

The actual length of the patch can now be determined by

$$L = \frac{1}{2f_r\sqrt{\epsilon_{reff}}\sqrt{\mu_0\epsilon_0}} - 2\Delta L \tag{5}$$

The conductance of the patch can be represented as [2]

$$G_1 = \begin{cases} \frac{1}{90}\left(\frac{W}{\lambda_0}\right)^2 & W \ll \lambda_0 \\ \frac{1}{120}\left(\frac{W}{\lambda_0}\right) & W \gg \lambda_0 \end{cases} \tag{6}$$

The total input admittance is real, the resonant input impedance is also real, or

$$Z_{in} = \frac{1}{Y_{in}} = R_{in} = \frac{1}{2G_1} \tag{7}$$

$$R_{in} = \frac{1}{2(G_1 \pm G_{12})} \tag{8}$$

3.2 Design equations circular patch antenna

Based on the cavity model formulation, a design procedure is outlined which leads to practical designs of circular microstrip patch antennas for the dominant TM_{110}^{Z} mode. The procedure assumes that the specified information includes the dielectric constant of the substrate (ε_r), the resonant frequency (f_r) and height of the substrate h.

3.2.1 Circular patch radius and effective radius:

Since the dimension of the patch is treated a circular loop, the actual radius of the patch is given by [1]

$$a = \frac{F}{\left\{1+\frac{2h}{\pi\varepsilon_r F}\left[ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\right\}^{1/2}} \tag{9}$$

Where $F = \frac{8.791\times10^9}{f_r\sqrt{\varepsilon_r}}$

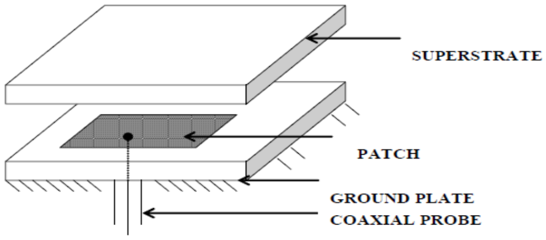
Equation (9) does not take into considerations the fringing effect. Since fringing makes the patch electrically larger, the effective radius of patch is used and is given by [1]

$$a_e = a\left\{1 + \frac{2h}{\pi\varepsilon_r}\left[ln\left(\frac{\pi a}{2h}\right) + 1.7726\right]\right\}^{1/2} \tag{10}$$

Hence, the resonant frequency for the dominant TM_{110}^{Z} is given by[1]

$$(f_r)_{110} = \frac{1.8412v_o}{2\pi a_e\sqrt{\varepsilon_r}} \tag{11}$$

Where vo is the velocity of light



(a) Microstrip patch with Superstrate

(b) Antenna measurement set up

Figure 4: Measurement setup for Circular and square patch antenna

IV. SUPERSTRATE (RADOME) EFFECTS

When circular and square patch microstrip antenna with the dielectric Superstrate or Radom is shown in Figure 3. The characteristics of antenna parameters change as a function of the dielectric Superstrate layer. The properties of a microstrip antenna with dielectric Superstrate layer have been studied theoretical using the transmission line and cavity model analysis. The resonant frequency of a microstrip antenna covered with dielectric Superstrate layer can be determined when the effective dielectric constant of the structure is known. The change of the resonant frequency by placing the dielectric Superstrate has been calculated using the following the expression [1].

$$\frac{\nabla f_r}{f_r} = \frac{\sqrt{\in_e}-\sqrt{\in_{eo}}}{\sqrt{\in_e}} \tag{12}$$

If $\in_e = \in_{eo} + \nabla\in_e$ and$\nabla\in_e \leq 0.1 \in_{eo}$, then

$$\frac{\Delta f_r}{f_r} = {}^{1}\!/_{2}\,\frac{{}^{\Delta\in_e}\!/_{\in e_o}}{1+{}^{1}\!/_{2}\,{}^{\Delta\in_e}\!/_{\in e_o}}$$

Where,

$\in_e$= Effective dielectric constant with dielectric superstrte

$\in e_o$=Effective dielectric constant without dielectric Superstrate

$\Delta\in_e$= Change in dielectric constant due to dielectric superstrate

Δf_r =Fractional change in resonance frequency

f_r =Resonce frequency

V. EXPERIMENTAL RESULT AND ANALYSIS

5.1 Experimental measurement

The impedance characteristics were measured by means of HP 8510B network analyzer is shown in Figure 4. The radiation pattern measurements were performed in the anechoic chamber by the use of automatic antenna analyzer.

(a) Prototype **(b)** Dielectric substrate **(c)** Dielectric Superstrate

Figure 5: Fabricated Porto type patch, feed point location, dielectric substrate and Superstrate material

5.2 Result of circular and square patch antenna without Superstrate

The obtained results for square patch antenna without Superstrate show that the value of VSWR is 1.466 and Bandwidth is 4.6GHz, the Gain is 4.8dB and half power beam-width is108.16^0 in horizontal polarization and 105.45^0 in vertical polarization, input impedance is 36.24-j8.907 Ω and return-loss is -8.907dB.The corresponding data Table is tabulated is shown in Table 5. The obtained results for circular patch without Superstrate shows that the value of VSWR is 2.034 and Bandwidth is 3GHz, the Gain is 6.7dB, half power beam-width (HPBW) is 98.77^0in Horizontal polarization and 90.01^0 in vertical polarization, input impedance is 35.75+j23.955Ω and return –loss is -15.55dB. The corresponding data table is tabulated in Table 5.

5.3 Result of circular and square patch antenna with Superstrate thickness

5.3.1 Result of circular patch antenna

The proposed antenna has been analyzed using various thickness of the Superstrates from 0.2mm, 0.5mm, 0.8mm, 1.3mm, 1.5mm, 2.2mm, 2.4mm, 3.2mm and corresponding frequency will be shifted from 2.40GHz to 2.39HGz. The gain varied from 2.87GHz to 5.88GHz, bandwidth is varied from 1.2GHz to 3.13GHz, half power beam-width (HPBW) is varied from $84.26^0$to 92.78^0 in horizontal polarization, half power beam-width (HPBW) is varied from $73.02^0$to 79.74^0 in vertical polarization, input impedance will be varied from 21.950Ω -j12.968Ω to 34.427Ω -j11.039Ω return loss (RL) is varied from -7.582dB to -12.857dB, VSWR is varied from 1.567 to 5.581 is based upon the thickness of the Superstrates is shown Figrur7 to Figure 16 corresponding data are tabulated in Table 6.

5.3.2 Result of square patch antenna

The proposed antenna has been analyzed using various thickness of the Superstrates from 0.2mm, 0.5mm, 0.8mm, 1.3mm, 1.5mm, 2.2mm, 2.4mm, 3.2mm and corresponding frequency will be shifted from 2.40GHz to 2.36HGz. The gain varied from 0.47GHz to 3.43GHz, bandwidth is varied from 1.5GHz to 2.6GHz, half power beam-width (HPBW) is varied from $95.41^0$to 105.33^0 in horizontal polarization, half power beam-width (HPBW) is varied from $74.86^0$to 90.20^0 in vertical polarization, input impedance will be varied from 25.387Ω -j16.696Ω to 53.759Ω -j45.307Ω return loss (RL) is varied from -8.286dB to -13.239dB, VSWR is varied from 1.656 to 3.231 is based upon the thickness of the Superstrates is shown in Figure 7 to Figure 16 corresponding data are tabulated in Table 7.

TABLE1: Calculated width, length and feed point location of Square patch antenna.

Type of patch	Width (W),mm	Length (L),mm	Feed Point (F),mm
Square patch antenna	33.6	33.6	10

TABLE2: Calculated dimeter and feed point location of circular patch antenna.

Type of Patch	Diameter(mm)	Feed Point(mm)
Circular patch antenna	47.1	5.5

TABLE3: Specification of dielectric substrate($\in_{r1}$) material used in the design of Circular and Square patch antenna

Dielectric constant(ε_{r1})	Loss tangent(tanδ)	Thickness of the substrate(h_1)
2.2	0.0009	1.6

TABLE4: Specification of dielectric superstrate($\in_{r2}$) material used in the design of Circular and Square patch antenna.

Dielectric constant(ε_{r2})	Loss tangent(tanδ)	Thickness of the substrate(h_2)
2.2	0.0009	1.6

TABLE5: Comparison of experimental result for circular and square patch antennas without dielectric Superstrate at $\in_{r1}$=2.2

	Characteristics	Circular patch antenna	Square patch antenna
2.2	Center frequency(f_r), GHz	2.40	2.40
	Gain(dB)	6.7	4.8
	BW(GHz)	0.030	0.046
	HPBW(HP),Deg	98.77	108.1
	HPBW(VP),Deg	90.01	105.4
	Impedance (Ω)	35.75+j23.955	36.24-j8.9070
	Return-loss(dB)	-15.55	-10.08
	VSWR	2.034	1.466

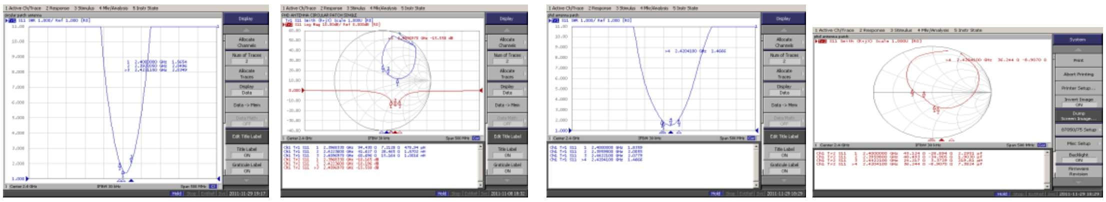
TABLE6: Experimental measured result of Resonant frequency, Gain, Half power beam-width(HPBW), Impedance(IMP), Return loss and VSWR for Circular patch antenna with various dielectric Superstrate thickness

Superstrate thickness ($\in_{r2}$)	Δ_{fr}/f_r (GHz)	Gain(dB)	BW(GHz)	HPBW(HP), deg	HPBW(V), deg	IMP(Ω)	RL(dB)	VSWR
0.2mm	2.41	3.92	0.0121	84.26	77.47	34.427-j11.039	-12.857	1.567
0.5mm	2.419	4.01	0.0313	85.70	73.02	27.784-j7.3993	-10.423	1.846
0.8mm	2.41	3.64	0.0121	84.32	76.99	21.950-j12.968	-9.956	5.581
1.0mm	2.419	5.88	0.0121	88.33	75.49	24.635-j2.8506	-9.11	2.021
1.3mm	2.419	5.29	0.0313	90.0	76.84	21.248-j1.3726	-10.075	2.355
1.5mm	2.419	5.21	0.0121	90.0	76.80	21.58+j3	-7.673	2.497
2.2mm	2.394	2.87	0.0331	89.06	74.51	25.2+j2.3	-10.23	2.521
2.4mm	2.341	3.91	0.0232	92.89	75.84	26.25-j2	-11.20	2.92
3.2mm	2.351	3.29	0.267	92.78	79.34	28.2+j23	-13.43	4.78

TABLE7: Experimental measured result of Resonant frequency, Gain, Half power beam-width(HPBW), Impedance(IMP), Return loss and VSWR for Square patch antenna with various dielectric Superstrate thickness:

Superstrate thickness ($\in_{r2}$)	Δ_{fr}/f_r (GHz)	Gain(dB)	BW(GHz)	HPBW(HP), deg	HPBW(VP), deg	IMP(Ω)	RL(dB)	VSWR
0.2mm	2.40	1.42	0.267	98.16	90.20	25.387-j16.696	-8.286	2.253
0.5mm	2.40	0.93	0.158	99.15	74.86	35.833-j17.566	-12.142	1.656
0.8mm	2.38	1.63	0.158	95.41	77.56	31.468-j19.960	-10.054	1.916
1.0mm	2.369	2.01	0.142	94.20	75.25	53.759-45.307	-10.233	2.206
1.3mm	2.387	1.83	0.0158	105.33	79.72	36.166-j10.869	-12.006	1.670
1.5mm	2.40	2.43	0.0249	107.23	80.56	29.987-j15.292	-10.991	1.786
2.2mm	2.37	3.43	0.0152	98.55	81.07	28.23+j23	-10.234	2.612
2.4mm	2.39	0.74	0.0142	107.56	77.30	29.23-j2.34	-12.231	2.991
3.2mm	2.39	0.47	0.142	102.25	83.61	30.23+j6.2	-13.239	3.231

5.4 Experimental measurement plots



(i) VSWR **(ii) Impedance** **(iii) VSWR** **(iv) Impedance**

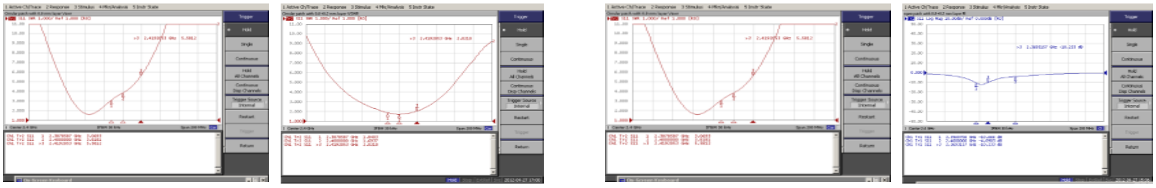
(a) Circular patch antenna **(b)** Square patch antenna

Figure 6: Comparison of experimentally measured VSWR and Input impedance plot of circular and square patch antenna without dielectric Superstrates whose dielectric constant at $\in_{r1}$= 2.2

(i) 0.2mm **(ii) 0.5mm** **(iii) 0.2mm** **(iv) 0.5mm**

(a) Circular patch antenna **(b)** Square patch antenna

Figure 7: Comparison of experimental measured VSWR plot of circular and square patch antenna with dielectric Superstrates thickness 0.2mm and 0.5mm



(i) 0.8mm **(ii) 1.0mm** **(iii) 0.8mm** **(iv) 1.0mm**

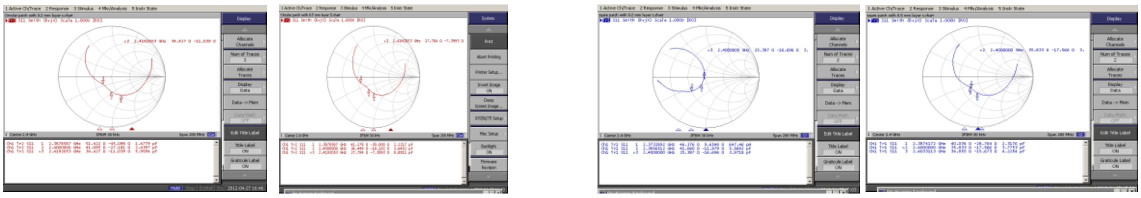
(a) Circular patch antenna **(b)** Square patch antenna

Figure 8: Comparison of experimental measured VSWR plot of circular and square patch antenna with dielectric Superstrates thickness 0.8mm and 1.0mm

(i) 1.3mm **(ii) 1.5mm** **(iii) 1.3mm** **(iv) 1.5mm**

(a) Circular patch antenna **(b)** Square patch antenna

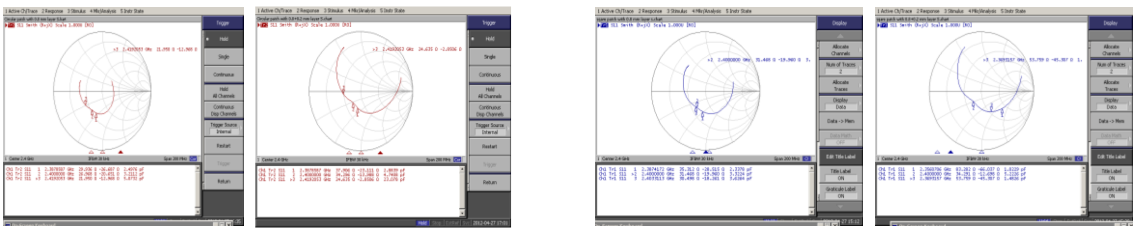
Figure 9: Comparison of experimental measured VSWR plot of circular and square patch antenna with dielectric Superstrates thickness 1.3mm and 1.5mm



(i) 0.2mm **(ii) 0.5mm** **(iii) 0.2mm** **(iv) 0.5mm**

(a) Circular patch antenna **(b)** Square patch antenna

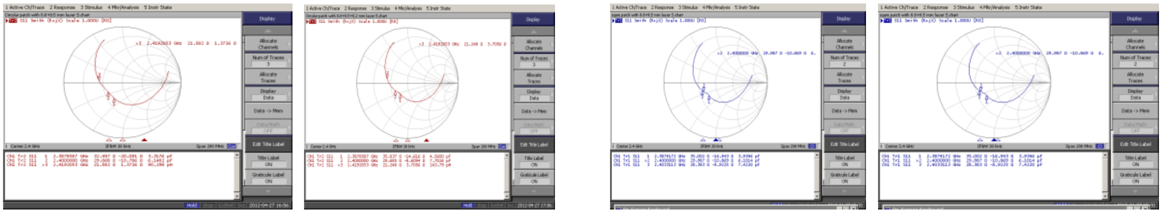
Figure10: Comparison of experimentally measured input impedance plot of circular and square patch antenna with dielectric Superstrates thickness 0.2mm and 0.5mm



(i) 0.8mm **(ii) 1.0mm** **(iii) 0.8mm** **(iv) 1.0mm**

(a) Circular patch antenna **(b)** Square patch antenna

Figure11: Comparison of experimentally measured input impedance plot of circular and square patch antenna with dielectric Superstrates thickness 0.8mm and 1.0mm



(i) **1.3mm** **(ii) 1.5mm** **(iii) 1.3mm** **(iv) 1.5mm**

(a) Circular patch antenna **(b)** Square patch antenna

Figure12: Comparison of experimentally measured input impedance plot of circular and square patch antenna with dielectric Superstrates thickness 1.3mm and 1.5mm

(i) **0.2mm** **(ii) 0.2mm**

(a) Circular patch antenna **(b)** Square patch antenna

Figure13: Comparison of experimental measured far field amplitude radiation pattern plot of circular and square patch antenna pattern with Superstrate (Radome) thickness 0.2mm in horizontal polarization

(i) **1.3mm** **(ii) 1.3mm**

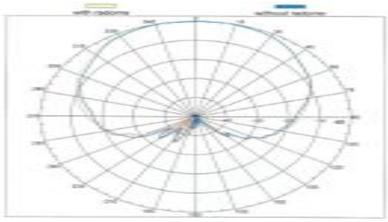
(a) Circular patch antenna **(b)** Square patch antenna

Figure14: Comparison of experimental measured far field amplitude radiation pattern plot of circular and square patch antenna pattern with Superstrate (Radome) thickness 1.3mm in vertical polarization

(i) **2.4mm** **(ii) 2.4mm**

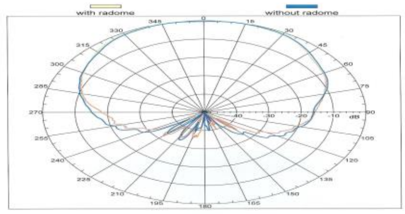
(a) Circular patch antenna **(b)** Square patch antenna

Figure15: Comparison of experimental measured far field amplitude radiation pattern plot of circular and square patch antenna pattern with Superstrate (Radome) thickness 2.4mm in vertical polarization



(i) **3.2mm**

(a) Circular patch antenna



(ii) **3.2mm**

(b) Square patch antenna

Figure16: Comparison of experimental measured far field amplitude radiation pattern plot of circular and square patch antenna pattern with Superstrate (Radome) thickness 3.2mm in vertical polarization

VI. RESULTS AND DISCUSSION

In this paper compared the characteristics such as the resonant frequency, bandwidth, beam –width, gain, input impedance, return loss and VSWR etc. The compared results for both antenna with and without dielectric Superstrates is shown in Figure 6 to Figure 16 and corresponding data is tabulated is shown in Table 5 to Table 7. The data refer the highest gain 6.7dB is obtained for circular patch antenna without Superstrate and with Superstrate 5.88dB at Superstrate thickness 1.0mm is shown in Table 5 and Table 6. The data refer the highest gain 4.8dB is obtained for square patch antenna without Superstrate and with Superstrate 3.43dB at Superstrate thickness 2.2mm. The data refers that the return- loss is first increases with increasing the dielectric constant of the dielectric Superstrate materials and decreases. The band width of microstrip antennas also increases with increasing thickness of dielectric sheet for low dielectric constant materials, and decreases for high dielectric constant materials. The variation of VSWR with different dielectric Superstrate (radome) thickness, as dielectric Superstrate thickness increases, VSWR increases. Increase with high dielectric constant of the Superstrates. From Table Table6 and Table 7 it is also observed that the resonant frequency f_r decreases monotonically with the increase in the superstrate thickness and dielectric constant of the superstrates. The general trend of impedance characteristics is that both input impedance and the reactance are increased as Superstrate become thick and its $\in_r$ increases. The HPBW become narrower or wider depending upon the dielectric constant and thickness of the Superstrates.

VII. CONCLUSIONS

The effect of dielectric Superstrate with different dielectric constant on the behavior of circular and square patch of microstrip antennas reveals that the Superstrate affects not only the resonance frequency but also effects on other parameters such as gain, bandwidth, beam width, VSWR and return-loss. In particular, the resonance frequency is shifted to lower side. 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 0.2mm thickness for square patch antenna and 0.5mm thickness for circular patch antenna

ACKNOWLEDGEMENTS

Author wishes to acknowledge the invaluable help and of Mr. M.Balachary, Scientist 'G' and Head of Antenna Wing, DLRL, Hyderabad who helped greatly offering the experimental measurement work at DLRL and also thanks to K.Kumaraswamy for their keen interest in this work.

REFERENCES

[1]. J Bhal and P Bhartia, "Microstrip antennas", Artech house, 1980
[2]. Balanis, C.A., Antenna Theory: Analysis and Design, John Wiley& Sons.
[3]. Inder Prakash, Stuchly " Design of Microstrip Antennas Covered with Dielectric layer", IEEE Trans. Antennas Propagate. Vol.A.P-30, NO.2, March 1992.

[4]. O.M.Ramahi, Y.T.LO, " Superstrate effect on the Resonant frequency of Microstrip Antennas", Microwave Opt. Technol. Lett. Vol.5, p.p. 254 – 257, June 1992.
[5]. A. Bhattacharyya, T. Tralman, " Effects of Dielectric Superstrate on patch Antenna", Electron Lett. Vol.24. p.p. 356 -358, March 1998.
[6]. R. Afzalzadeh, R.N.Karkar, " Characteristics of a Rectangular Microstrip patch Antenna with protecting spaced Dielectric Superstrate", Microwave Opt. Technol. Lett. Vol.7, p.p.62 -66, February 1994.
[7]. I.J.Bahl P. Bhattia, S.Stuchly, " Design of Microstrip Antennas covered with a Dielectric Layer", IEEE Trans. Antennas Propagat. No.30, p.p. 314 – 318, March 1982.
[8]. K.M.Luk, w.Y.Tam, C.L.Yip ,"Analysis of a Circular microstrip antennas with Superstrate", IEE proceeding, vol. 136, p.p. 261 – 262, June 1989.
[9]. Hussain A. Hammas, Radiation Performance Evaluation of Microstrip Antenna Covered with a Dielectric Layer", Eng. & Tech. Journal, vol. no.7.p.p.1280 – 1286, 2009.
[10]. R.K.Yadav, R.L.Yadava, " Performance Analysis of Superstrate Loaded Patch Antenna and Abstain from Environmental Effects", International Journal of Engineering Science and Technology, vol.3, no.8, August 2011.
[11]. Hussein Attia, L. Yousefi, and O. Ramahi, " High Gain Microstrip Antennas Loaded with High Characteristic Impedance Superstrates", IEEE, P.P.1258 – 1261, 2011.
[12]. Samir Dev Gupta, Amit Singh. " Design and Analysis of Multi dielectric Layer Microstrip Antenna With varying Superstrate Layer Characteristics", International Journal of Advances in Engineering& Technology, vol.3, Issue1, p.p. 55-68, March 2012.
[13]. Mohammed Younss, Acharaf, YacoubDiallo, Ahmed EI Moussaoui and Noura Aknin, "Study of a Microstrip A ntenna with and without Superstrate for Terahertz Frequency", International Journal of Innovation and Applied Studies, p.p. 1-3, 2013

AUTHORS BIOGRAPHY

V. Saidulu, was born in A.P, INDIA, in 1974.He received the 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 pursuing Ph.D in Microstrip Antennas. He worked as Assistant Professor from June 2001 to November 2006 and working as an Associate Professor from November 2006 to till date in Electronics and Communication Engineering. He has published 11 papers in journals and conference. His research interests Microstrip antennas, wireless communication and Mobile Communication.

K. Srinivasa Rao, was in Hyderabad, A.P, INDIA, in 1948. He received his B.E in ECE, in the year 1970 and M.E. in ECE in the year 1973 from college of Engineering, Osmania University, Hyderabad, A.P. He worked as senior scientist in Defence Electronics Research Laboratory, Hyderabad from 1974 – 78 and as Lecturer in ECE Dept., College of Engineering, O.U. from 1978 – 83. He worked as Associate Professor in ECE Dept., CBIT, O.U. from 1983 – 88. He worked as Senior Scientist in NERTU, O.U. from 1988 – 90 and carried out his research work in the area of Microwaves. He received his Ph.D. degree in the year 1995. He was promoted as Professor, ECE in CBIT in 1995 and worked there from 1995 – 97 and 2000 – 2008. He worked as Professor and Head, Dept. of ECE, VNRVJIET, Hyderabad, A.P. from 1977 – 2000. After receiving as Professor, ECE in CBIT in 2008, he has been working in various Private Engineering Colleges and presently he is working as Professor in ECE, VIF College of Engineering, JNTUH, and Hyderabad.