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Comparison Analysis of Rectangular and Circular Patch Microstrip Antennas with Dielectric Superstrates

V. Saidulu[1*], K.Srinivasa Rao[2], K.Kumarswamy[3], P.V.D.Somasekhar Rao[4]

[1]Department of Electronics and Communication, MGIT,Hyderabad, AP, India,
saiduluvadtya@gmail.com.

[2] Department of Electronics and Communication, VIF, Hyderabad, AP, India

[3]Department of Electronics and Communication, BIET,Hyderabad, AP, India

kumaraswamy.kks@gmail.com

[4]Department of Electronics and Communication,JNTUH,Hyderabad,AP,India

ABSTRACT:

In this paper compared the characteristics of coaxial probe fed rectangular and circular patch microstrip antenna with and without Superstrates. The antenna designed at frequency of 2.4GHz(ISM band) and formulated using transmission line and cavity model analysis. In this paper experimentallyinvestigated the effect of dielectric Superstrates onthe parameters such as bandwidth, beam-width, gain, resonant frequency, input impedance, return-loss and VSWR etc. Experimental measured results shows that when placing the Superstrateabove the substrate the antenna parameter will be changed and 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 reactancewhich are increased as Superstrate become thick and its $\epsilon_r$increases.

Key words: Bandwidth, Dielectric superstrates, Microstrip patch antenna, Resonant frequency

Abbreviations:VSWR = Voltage Standing Wave Ratio, HPBW = Half Power Beam-width, BW = Bandwidth, RP = Rectangular Patch, CP = Circular Patch.

1. INTRODUCTION

Microstrip antenna consists of radiating patch on the one side of the dielectric 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[2].The different way of methods on the rectangular, circular patch microstrip antennas is investigated by many researchers [2] - [15] and [20] –[22]. Among them Radome or Superstrate were studied by few researchers [2]-[15]. The dielectrics Superstrate or Radome to protects the patch from climatic conditions and environmental hazards and improve the antenna performance [7]. Among the few researchers [4], [5], 6] have investigated the input impedance of rectangular and circular patch with dielectric Superstrate (Radome). 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 rectangular and circular microstrip patch antenna based on the transmission line and cavity model analysis. The effect of dielectric Superstrates thickness investigated experimentally on the parameters such as Bandwidth, Beam-width, Gain, Resonant frequency, Input impedance, Return loss and VSWR etc. The obtained experimental results shows that the resonant frequency will be shifted to lower side by placing Superstrate above substrate, while other parameters 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 reactancewhich are increased as Superstrate become thick and its $\epsilon_r$increases.

2. ANTENNA SPECIFICATION AND SELECTION OF SUBSTRATE MATERIALS

The geometry of a coaxial probe fed rectangular and circular patch microstrip antennas is shown in Figure 1, Figure 2 and Figure 5.The antenna under investigation the rectangular patch antenna width (W) = 49.4mm, length (L) = 40.3mm and feed point location (F) = 10.5mm and circular patch antenna with diameter (D) = 47.1mm, feed point location (F) = 5.5mm. The antenna designed center frequency is 2.4GH and fabricated on Arlon diclad 880 dielectric substrate, whose dielectric constant ($\in_{r1}$) is 2.2, loss tangent ($\tan\delta$) 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 rectangular, circular patch microstrip antenna is shown the Table 1 and Table 2. The selection of substrate materials play important role for antenna design. Dielectric substrate of appropriate thickness and loss tangent is chosen for designing the 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 ($\tan\delta$) increases the dielectric loss and therefore reduce the antenna performance. The low dielectric constant materials increase efficiency, bandwidth and better for radiation.

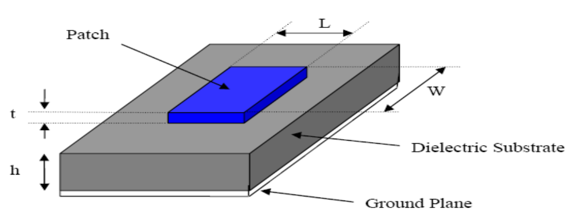


Figure 1: Schematic of rectangular patch microstrip antenna

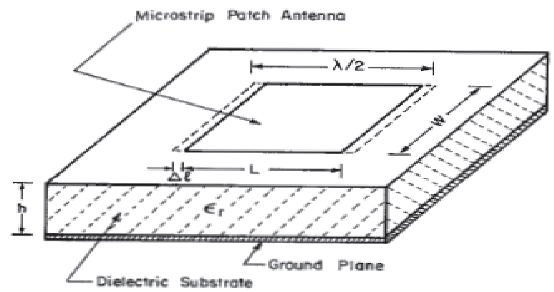


Figure 2: Rectangular microstrip patch antenna geometry

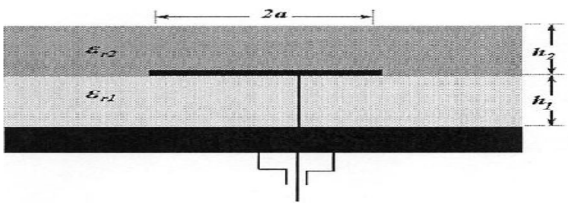


Figure 3: Microstrip antenna with Superstrate geometry

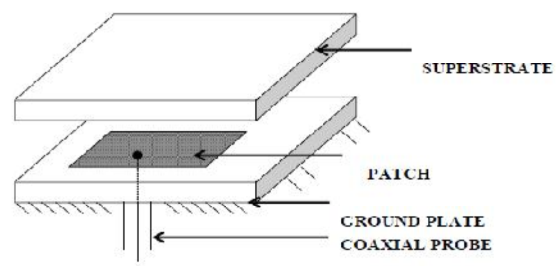


Figure 4: Structure of rectangular patch with substrate and dielectric Superstrates.

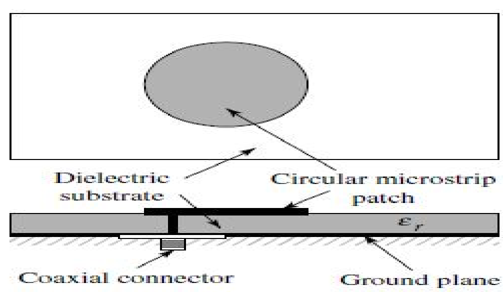


Figure 5: Geometrical structure of circular patch antenna

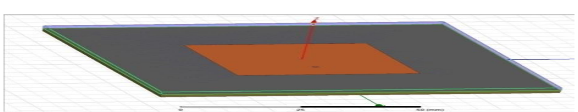


Figure 6: Structure of rectangular patch with Superstrate

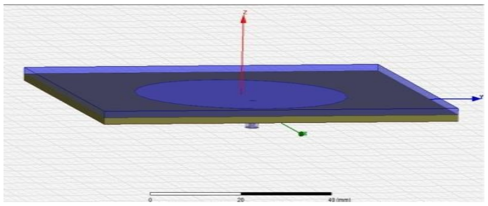


Figure 7: Circular patch antenna with Superstrate

3. DESIGN OF RECTANGULAR AND CIRCULAR PATCH ANTENNA:

The patch antenna can be designed at 2.4GHz using transmission line and cavity model and fabricated on substrate, whose dielectric constant($\in_{r1}$) is 2.2.The substrate and superstrate dimension is 100×100mm for designing of patch antennas. The rectangular patch antenna width (W) =49.4mm, length (L) =40.3mm and feed point location (F) is X=0, Y=10.5mm, calculated using equation (4), (5) and (7). The circular patch antenna diameter (D) =47.1mm can be calculated using equation (8).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 4 to Figure 7. 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 rectangular patch antenna

The effective dielectric constant has values in the range of $1 < \in_{reff} < \in_r$,for most applications. Where the dielectric constant of the substrate is much greater than the unity ($\in_r \gg 1$), the value of $\in_{reff}$ will be closer to the value of the actual dielectric constant $\in_r$ of the substrate [18].

$$W/h > 1$$

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

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 $\in_{reff}$ and the width-to-height ratio [18]

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

The effective length of the patch is now

$$L_{eff} = L + 2\Delta L \quad (3)$$

For an efficient radiator, a practical width that leads to good radiation efficiencies is [18]

$$W = \frac{1}{2f_r\sqrt{\mu_0\in_0}}\sqrt{\frac{2}{\in_r+1}} = \frac{\vartheta_0}{2f_r}\sqrt{\frac{2}{\epsilon_{r+1}}} \quad (4)$$

The actual length of the patch can now be determined by

$$L = \frac{1}{2f_r\sqrt{\in_{reff}}\sqrt{\mu_0\in_0}} - 2\Delta L \quad (5)$$

The conductance of the patch can be represented as [18]

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

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

$$Z_{in} = \frac{1}{Y_{in}} = R_{in} = \frac{1}{2G_1} \quad (7)$$

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

3.2. Designequations 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 [18]

$$a = \frac{F}{\left\{1+\frac{2h}{\pi\varepsilon_r F}\left[ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\right\}^{1/2}} \quad (8)$$

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

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 [18]

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

Hence, the resonant frequency for the dominant TM_{110}^{Z} is given by [18]

$$(f_r)_{110} = \frac{1.8412 v_o}{2\pi a_e \sqrt{\varepsilon_r}} \quad (10)$$

Where vo is the velocity of light

3.2 Superstrate (Radome) effects:

When rectangular and circular patch microstrip antenna with the dielectric Superstrates or Radom is shown in Figure 3 to Figure 7. The characteristics of antenna parameters change as a function of the dielectric Superstrate layer. The properties of a rectangular and circular 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].

$$\frac{\nabla f_r}{f_r} = \frac{\sqrt{\epsilon_e} - \sqrt{\epsilon_{eo}}}{\sqrt{\epsilon_e}} \quad (11)$$

If $\epsilon_e = \epsilon_{eo} + \nabla\epsilon_e$ and $\nabla\epsilon_e \leq 0.1\ \epsilon_{eo}$, then

$$\frac{\Delta f_r}{f_r} = 1/2 \frac{\Delta\epsilon_e / \epsilon_{eo}}{1 + 1/2\, \Delta\epsilon_e / \epsilon_{eo}}$$

Where,

ϵ_e = Effective dielectric constant with dielectric superstrte

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

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

Δf_r =Fractional change in resonance frequency

f_r =Resonce frequency

4. RESULT AND ANALYSIS

4.1 Experimental measurement:

The impedance characteristics were measured by means of HP 8510B network analyzer is shown in Figure 8. The radiation pattern measurements were performed in the anechoic chamber by the use of automatic antenna analyzer.

Figure 8: Fabricated microstrip antenna measurements

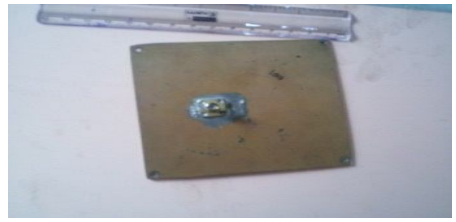


Figure 9: Fabricated Porto type rectangular patch with feed point location

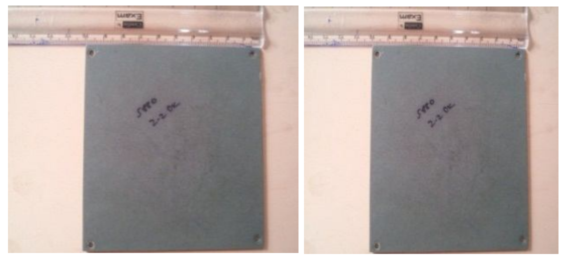


Figure 10: Dielectric substrate ($\in_{r1}$) is 2.2 and superstrate materials($\in_{r2}$) is 2.2

4.2 Result of rectangular and circular patch antennas without dielectric superstrates:

In order to present the design procedure of antenna achieving impedance matching for the case, the first prototype of the antenna was designed using Arlon diclad 880 substrate resonating at 2.4GHz is shown in Figure 9 and Figure 10 and corresponding the results are shown in Figure 11. The obtained experimental results show that the value of VSWR is 1.466 and Bandwidth is 4.6GHz, the Gain is 4.8dB and half power beam-width is 108.16^0 in horizontal polarization and 105.45^0 in vertical polarization, input impedance is 36.744Ω and return-loss is -8.907dB is shown in Table 5.

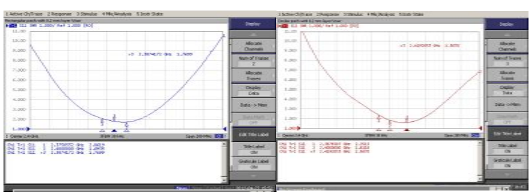
4.2.1 Result of rectangular patch antenna with Superstrate:

The proposed rectangular microstrip patch 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 2.38HGz. The gain varied from 3.3GHz to 6.22 GHz, bandwidth is varied from 2.4GHz to 5.4GHz, half power beam-width (HPBW) is varied from 84.69^0 to 91.50^0 in horizontal polarization, half power beam-width(HPBW) is varied from 67.91^0 to 77.63^0 in vertical polarization, input impedance will be varied from 24.370Ω -j785.85Ω to 47.950Ω -j32..106Ω return loss (RL) is varied from -9.205dB to -11.560dB, VSWR is varied from 1.758 to 3.076 is shown in Figure 12 to Figure 31, corresponding data are tabulated in Table 6 to Table 14.

4.2.2Result of circular patch antenna with Superstrates:

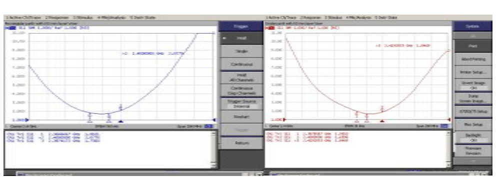
The proposed circular microstrip patch antenna has been analyzed using various thickness of the Superstrates from 0.2mm, 0.5mm, 0.8mm, 1.3mm, 1.5mm, 2.2mm, 2.4mm, 3.2mm and corresponding frequency will be shifted from 2.40GHz to 2.39HGz. The gain varied from 2.87GHz to 5.88GHz, bandwidth is varied from 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 shown Figure 12 to 31, corresponding data are tabulated in Table 6 to Table 14.

5. EXPERIMENTALANALYSIS



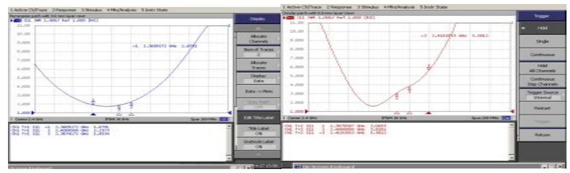
(a) RP (b) CP

Figure 11: Comparison of experimentally measured VSWR plot of rectangular and circular microstrip patch antenna without dielectric Superstrates whose dielectric constant at$\epsilon_{r1} = 2.2$



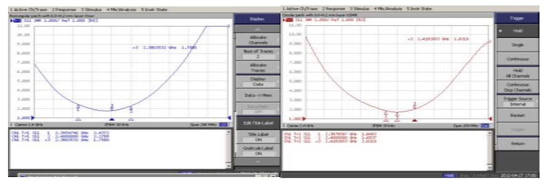
(a) RP (b) CP

Figure 12: Comparison of experimental measured VSWR plot of rectangular and circular patch at Superstrate thickness0.5mm



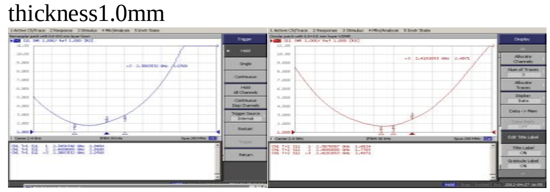
(a) RP (b) CP

Figure 13: Comparison of experimental measured VSWR plot of rectangular and circular patch at Superstrate thickness 0.8mm



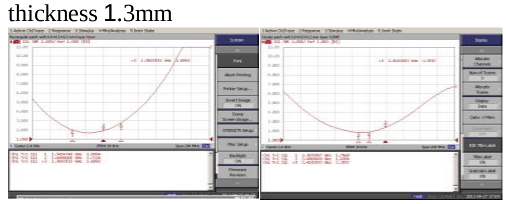
(a) RP (b) CP

Figure 14: Comparison of experimental measured VSWR plot of rectangular and circular patch at Superstrate thickness1.0mm



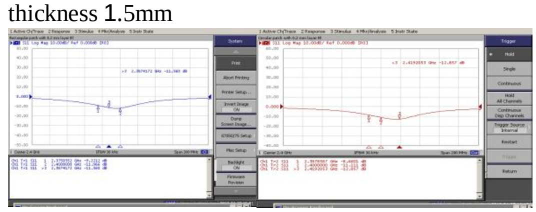
(a) RP (b) CP

Figure15: Comparison of experimental measured VSWR plot of rectangular and circular patch at Superstrate thickness 1.3mm



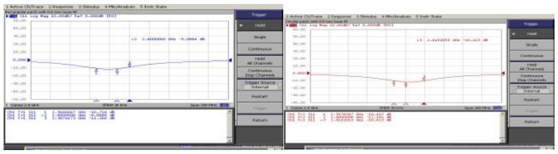
(a) RP (b) CP

Figure16: Comparison of experimental measured VSWR plot of rectangular and circular patch at Superstrate thickness 1.5mm



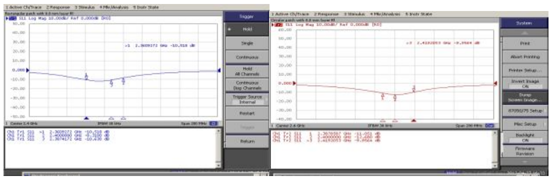
(a) **RP (b) CP**

Figure 17: Comparison of experimental measured return-loss plot of rectangular and circular patch at Superstrate thickness 0.2mm



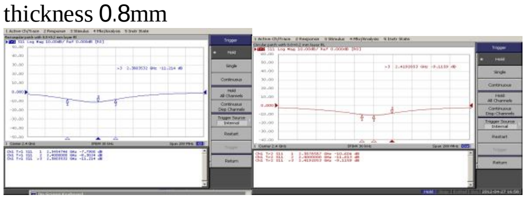
(a) RP (b) CP

Figure 18: Comparison of experimental measured return-loss plot of rectangular and circular patch at Superstrate thickness 0.5mm



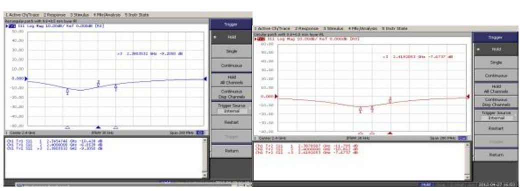
(a) RP (b) CP

Figure 19: Comparison of experimental measured return-loss plot of rectangular and circular patch at Superstrate thickness 0.8mm



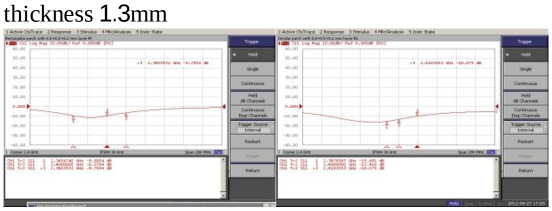
(a) RP (b) CP

Figure 20: Comparison of experimental measured return-loss plot of rectangular and circular patch at Superstrate thickness 1.0mm



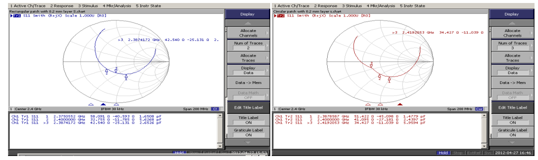
(a) RP (b) CP

Figure 21: Comparison of experimental measured return-loss plot of rectangular and circular patch at Superstrate thickness 1.3mm



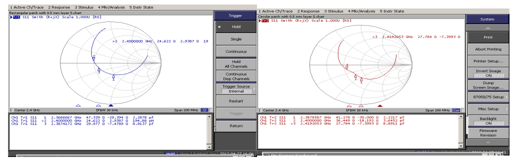
(a) RP (b) CP

Figure 22: Comparison of experimental measured return-loss plot of rectangular and circular patch at Superstrate thickness 1.5mm



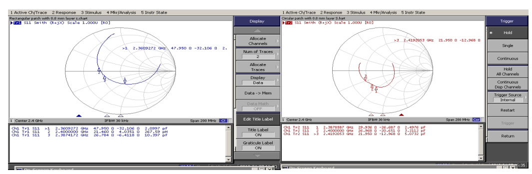
(a) RP (b) CP

Figure 23: Comparison of experimental measured input impedance plot of rectangular and circular patch at Superstrate thickness 0.2mm



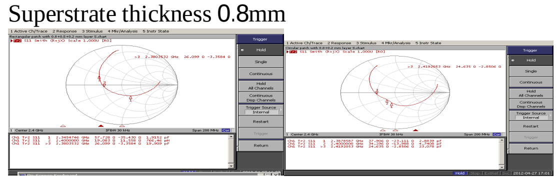
(a) RP (b) CP

Figure 24: Comparison of experimental measured input impedance plot of rectangular and circular patch at Superstrate thickness 0.5mm



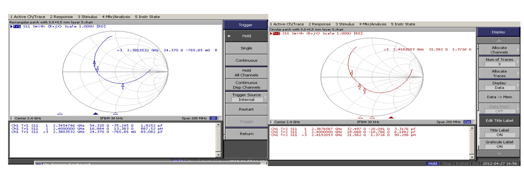
(a) RP (b) CP

Figure 25: Comparison of experimental measured input impedance plot of rectangular and circular patch at Superstrate thickness 0.8mm



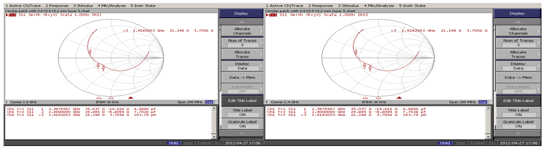
(a) RP (b) CP

Figure 26: Comparison of experimental measured input impedance plot of rectangular and circular patch at Superstrate thickness 1.0mm



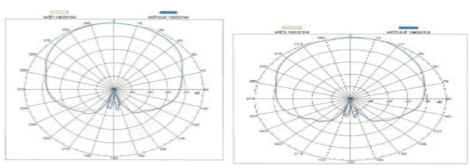
(a) RP (b) CP

Figure 27: Comparison of experimental measured input impedance plot of rectangular and circular patch at Superstrate thickness 1.3mm



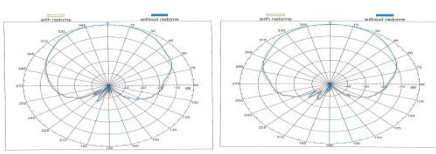
(a) RP **(b) CP**

Figure 28: Comparison of experimental measured input impedance plot of rectangular and circular patch at Superstrate thickness 1.5mm



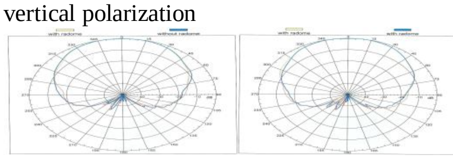
(a) RP **(b) CP**

Figure 29: Comparison offar field radiation pattern with and without Superstrate (radome) at 0.2mm thickness in horizontal polarization



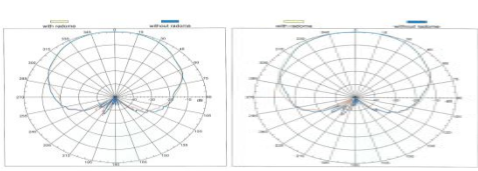
(a) RP **(b) CP**

Figure 30: Comparison of far field radiation pattern with and without Superstrate (radome) at 1.3mm thickness in vertical polarization



(a) RP **(b) CP**

Figure 31: Comparison of far field radiation pattern with and without Superstrate (radome) at 2.4mm thickness in vertical polarization



(a) RP **(b) CP**

Figure 32: Comparison of far field radiation pattern with and without Superstrate (radome) at 3.2mm thickness in vertical polarization

Table 1: Specification of dielectric substrate($\in_{r1}$) material used in the design of patch antenna

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

Table 2: Specification of dielectric superstrate($\in_{r2}$) material used in the design of patch antenna.

Superstrates ($\in_{r2}$)	**Loss Tangent ($Tan\delta$)**	**Thickness of the Superstrates (h_2),mm**
2.2	0.0009	1.6

Table 3: Calculated width, length and feed point of rectangular and circular microstrip patch antennas.

Type of patch	**Width (W),mm**	**Length (L),mm**	**Feed Point (F),mm**
Rectangular patch	49.4	40.3	10.5

Table 4: 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

Table 5: Comparison of experimental result for rectangular, circular and microstrip patch antennas without dielectric Superstrate at $\in_{r1}$=2.2

	Characteristics	**Rectangular patch antenna**	**Circular patch antenna**
2.2	f_r	2.40	2.40
	Gain(dB)	7.3	6.7
	BW(GHz)	0.0201	0.030
	HPBW(HP),Deg	88.36	98.77
	HPBW(VP),Deg	90.20	90.01
	Impedance (Ω)	35.79-j10.952	35.75+j23.955
	Return-loss(dB)	-13.63	-15.55
	VSWR	1.998	2.034

Table 6: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 0.2mm

	Characteristics	**Rectangular patch antenna**	**Circular patch antenna**
0.2mm	$\Delta f_r/f_r$(GHz)	2.387	2.41
	Gain(dB)	4.29	3.92
	BW(GHz)	0.024	0.0121
	HPBW(HP),Deg	90.94	84.26
	HPBW(VP),Deg	70.71	77.47
	Input impedance (Ω)	42.540-j25.131	34.427-j11.039
	Return-loss(dB)	-11.560	-12.857
	VSWR	1.769	1.567

Table 7: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 0.5mm

	Characteristics	Rectangular patch antenna	Circular patch antenna
0.5mm	$\Delta f_r / f_r$(GHz)	2.40	2.419
	Gain(dB)	3.97	4.01
	BW(GHz)	0.033	0.0313
	HPBW(HP),Deg	89.80	85.70
	HPBW(VP),Deg	73.21	73.02
	Input impedance (Ω)	24.622+J2.9387	27.784-J7.3993
	Return-loss(dB)	-9.0884	-10.423
	VSWR	2.077	1.846

Table 8: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 0.8mm

	Characteristics	Rectangular patch antenna	Circular patch antenna
0.8mm	$\Delta f_r / f_r$(GHz)	2.36	2.41
	Gain(dB)	3.85	3.64
	BW(GHz)	0.039	0.0121
	HPBW(HP),Deg	84.77	84.32
	HPBW(VP),Deg	76.88	76.99
	Input impedance (Ω)	47.950-j32.106	21.980-j12.968
	Return-loss(dB)	-10.518	-9.956
	VSWR	1.879	5.581

Table 9: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 1.0mm

	Characteristics	Rectangular patch antenna	Circular patch antenna
1.0mm	$\Delta f_r / f_r$(GHz)	2.380	2.419
	Gain(dB)	5.75	5.88
	BW(GHz)	0.054	0.0121
	HPBW(HP),Deg	88.40	88.33
	HPBW(VP),Deg	77.63	75.49
	Input impedance (Ω)	31.542-j11.772	24.635-2.850
	Return-loss(dB)	-11.214	-9.11
	VSWR	1.758	2.021

Table 10: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 1.3mm

	Characteristics	Rectangular patch antenna	Circular patch antenna
1.3mm	$\Delta f_r / f_r$(GHz)	2.380	2.419
	Gain(dB)	6.12	5.29
	BW(GHz)	0.054	0.0313
	HPBW(HP),Deg	84.69	90.0
	HPBW(VP),Deg	67.91	76.84
	Input impedance (Ω)	24.370-J785.85mΩ	21.982+j1.3726
	Return-loss(dB)	-9.785	-10.75
	VSWR	1.899	2.355

Table 11: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 1.5mm

	Characteristics	Rectangular patch antenna	Circular patch antenna
1.5mm	$\Delta f_r / f_r$(GHz)	2.380	2.419
	Gain(dB)	4.3	5.21
	BW(GHz)	0.054	0.0121
	HPBW(HP),Deg	87.34	90.0
	HPBW(VP),Deg	70.42	76.80
	Input impedance (Ω)	26.099-j3.3584	21.248+j3.7056
	Return-loss(dB)	-9.205	-7.673
	VSWR	3.076	2.497

Table 12: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 2.2mm

	Characteristics	Rectangular patch antenna	Circular patch antenna
2.2mm	$\Delta f_r / f_r$(GHz)	3.345	2.394
	Gain(dB)	3.342	2.87
	BW(GHz)	0.034	0.033
	HPBW(HP),Deg	91.50	89.06
	HPBW(VP),Deg	71.80	74.51
	Input impedance (Ω)	26.099-j3.3584	21.248+j3.7056
	Return-loss(dB)	-9.205	-7.673
	VSWR	3.076	2.497

Table 13: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 2.4mm

	Characteristics	Rectangular patch antenna	Circular patch antenna
2.4mm	$\Delta f_r/f_r$(GHz)	3.322	2.394
	Gain(dB)	3.342	2.87
	BW(GHz)	0.033	0.033
	HPBW(HP),Deg	91.50	89.06
	HPBW(VP),Deg	71.80	74.51
	Input impedance (Ω)	26.099-j3.3584	21.248+j3.7056
	Return-loss(dB)	-9.205	-7.673
	VSWR	3.076	2.497

Table 14: Comparison of experimental result for rectangular, circular and microstrip patch antennas with dielectric Superstrate thickness at 3.2mm

	Characteristics	Rectangular patch antenna	Circular patch antenna
3.2mm	$\Delta f_r/f_r$(GHz)	2.342	2.394
	Gain(dB)	4.47	3.29
	BW(GHz)	0.045	0.033
	HPBW(HP),Deg	91.50	92.78
	HPBW(VP),Deg	71.80	79.34
	Input impedance (Ω)	26.099-j3.3584	21.248+j3.7056
	Return-loss(dB)	-9.205	-7.673
	VSWR	3.076	2.497

6. RESULTS AND DESCUSSION

A comparison of experimental results without dielectric Superstratefor rectangular, circular patch microstrip antenna is presented in Table 5. The data refer the highest gain 7.3dB is obtained for rectangular patch antenna and 6.7dB gain is obtained for circular patch antenna at dielectric constant ($\in_{r1}$) = 2.2. A comparison of experimental results with dielectric Superstrate for rectangular, circular patch of microstrip antenna is presented in Table 6 to Table 14. 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 6 to Table 14 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 which 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.

7. CONCLUSION

The effect of dielectric Superstrate with different dielectric constant on the behavior of rectangular and circular 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 Superstrate with low dielectric constant($\in_{r2}$)= 2.2 is provide better impedance matching, hence has nominal effects and do not disturb much the performance characteristics of the antennas. 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.

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