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Design and Analysis of Two Half-Ring and Half Circular Patch Antenna for Dual passband Applications

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Abstract: *In the present work we have designed a two half-ring with half circular microstrip patch antenna for C-band applications. In the literature survey, some of the researchers has reported the rectangular, circular, triangular, ring microstrip antennas. But in these designs, the gain is limited and return loss is not upto the mark.To overcome these we have considered a two half-ring with half circular patch microstrip antenna at 4.1GHz and 6.5GHz with moderate return loss and gain.*

I. Introduction

In Advanced wireless communications, Designing compact antenna with optimum Gain and return loss at multiple frequencies for C band applications is essential and challenging [1-4].There has been many dual frequency antenna designs which are of conventional shapes and these designs were complex. Dual frequency can be generated by many techniques like adding slots, notching and stubbing patch. It can also be developed by two dipoles in which resonating frequency is distorted by other similar band frequencies [5-7]. Various attempts has been made to increase the gain but complementary defects are seen in the other parameters of the designed antenna, same is the case with the return loss too. So, this work proposes a completely different frame work of microstrip patch design which is of high gain with optimized return loss and free from interference issues making this antenna efficient [8-12].

Proposed antenna is a concentric half ring design which has two rings and a half circular patch. Two rings and the half circle patch are connected by a copper strip which is fabricated into the patch. The analysis has carried out with different dielectric materials. The data is presented in the results. These are very much useful in broadband applications at dual frequency operations.

II. Design of two half ring and half circular patch antenna

The design is done based on the mathematical support of the circular patch antennas as this is a peculiar shape proposed. This antenna is designed on a simulation tool where different parameters like return loss and gain are measured. The formula to calculate the radius of the circular patch.

$$R_e = \frac{1.8142\,c}{2\pi f\,\sqrt{\varepsilon_r}} \qquad (1)$$

where R_e is the effective radius of the circular microstrip antenna,f is the resonant frequency, and ε is the dielectric constant of the substrate ,the physical radius is not same as the effective radius due to fringing, the effective patch looks larger than the physical patch, So, Correction factor is included. The physical radius of the patch is

$$a1 = \frac{R_e}{\sqrt{1+\frac{2h}{\pi R\,\varepsilon_r}\left[\ln\left(\frac{\pi R}{2h}\right)\right]+1.7726}} \qquad (2)$$

h is the height of the substrate, and R is the physical radius of the circular patch. $R_e$calculated can be used to calculate R. Dielectric constant of the material is 2.2 where it is fabricated on RT/Duroid material.The height of the substrate is 3mm.

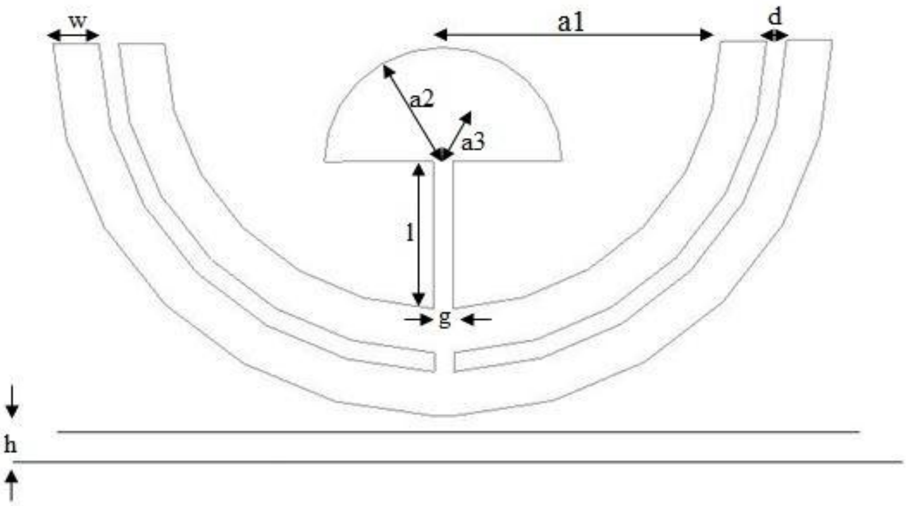

Fig. 1 two half ring and half circular patch antenna
a1=69.8mm,a2=29.8mm,g=4.9mm,w=11.5mm,a3=6.9mm,h=3.0mm

Proposed antenna is shown in fig. 1, fed with a contacting probe feed. Feed location is selected within the boundaries of the patch where the input impedance matching is done at 50Ω.It also decreases spurious radiations caused at the edge of the patch.

III. Results and Discussions

Performance of antenna at different distances in step size of 5mm for Fr4 epoxy material of dielectric constant of 4.4 is compared in the figure1.It is understood that the 5mm distance between the antennas has the minimum return loss at desired frequencies of 4.1Ghz and 6.5Ghz.The gain is high as peak gain is 3.01 dB at 4.1 GHz and 4.14 dB at 6.5 GHz. The parameters are tabulated in the table 1

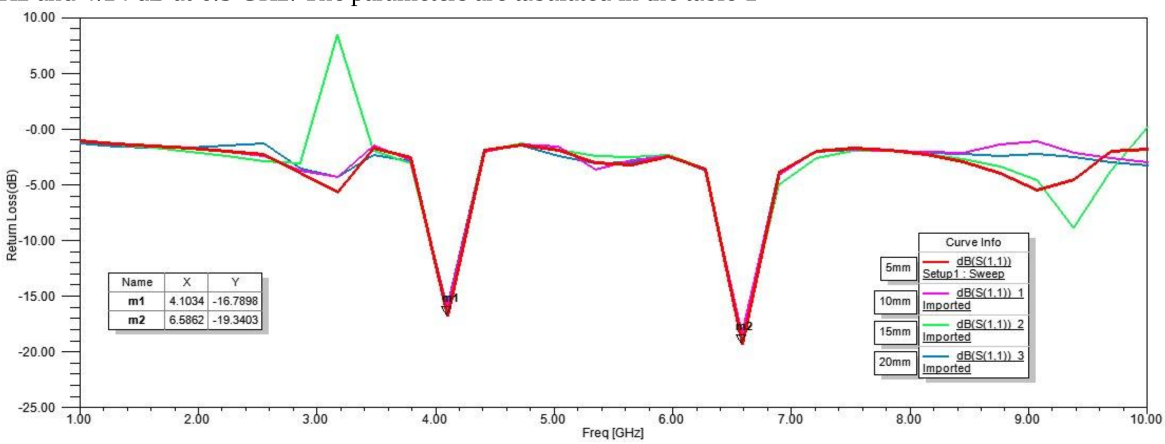

Fig 2 return loss vs frequency of two ring patch antenna for fr4 epoxy with different distance

Table 1 Frequency and Gain for Two Ring Patch Antenna With FR4 Epoxy

FR4-Epoxy ($\varepsilon_r = 4.4$)	5mm		10mm		15mm		20mm	
Frequency(GHz)	4.1	6.5	4.1	6.5	4.1	6.5	4.1	6.5
Gain(dB)	3.08	4.14	2.87	4.35	2.81	4.35	2.5	4.66

Performance of antenna at different distances in step size of 5mm for RT-Duroid material of dielectric constant of 2.2 is compared in the figure3.The gain is high as peak gain is 10.05 dB at resonating frequency 5.6 GHz. Return loss at different distances between the rings of antenna are compared in figure. The gain at different distances between the rings is tabulated to compare the variation of gain in the table 2

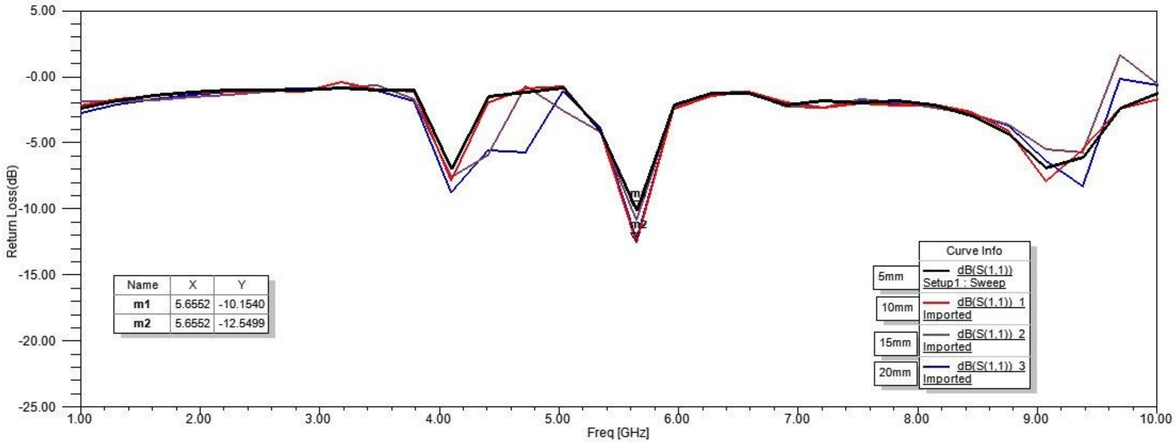

Fig 3 return loss vs frequency of two ring patch antenna for RT-Duroid with different distance

Table 2

RT-Duroid ($\varepsilon_r = 2.2$)	5mm	10mm	15mm	20mm
Frequency(GHz)	5.6	5.6	5.6	5.6
Gain(dB)	7.8	7.49	6.58	10.05

Frequency and Gain Table for RT-Duroid Two Ring Patch Antenna

Performance of antenna at different distances in step size of 5mm for Neltec material of dielectric constant of 2.55 is compared in the figure 4 .The gain is high as peak gain is 9.88dB at frequency 3.4 GHz. Return loss at different distances between the rings of antenna are compared in figure. The gain at different distances between the rings is tabulated to compare the variation of gain in the table3

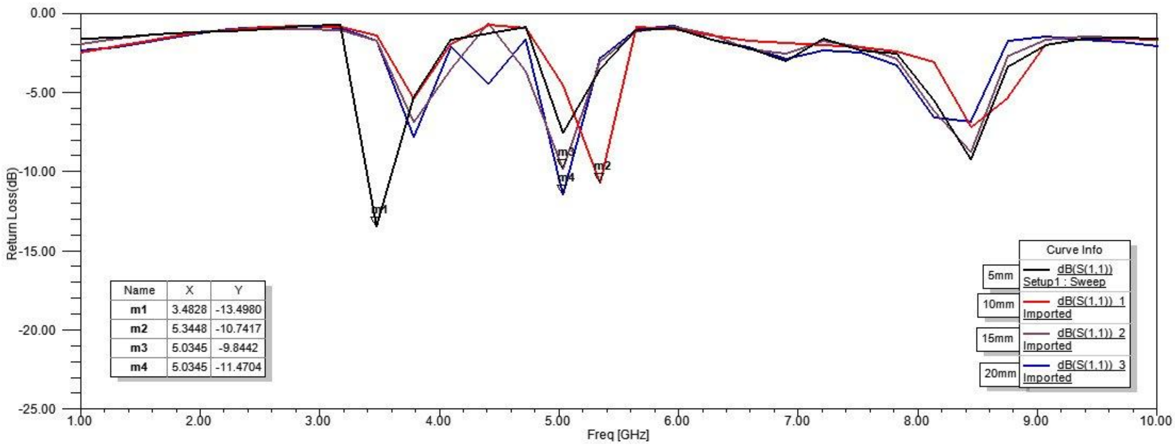

Fig 4 return loss vs frequency of two ring patch antenna for Neltec with different distance

Table 3 Frequency and Gain Table for Neltec Two Ring Patch Antenna

Neltec ($\varepsilon_r = 2.55$)	5mm	10mm	15mm	20mm
Frequency(GHz)	3.4	5.03	5.03	5.0
Gain(dB)	9.88	7.98	7.24	5.9

After analysis of performance comparison of antenna at different distances between the rings with different materials, the optimum performance of antenna is simulated for specific applications. The main parameter of the antenna which is return loss plot s11 plot),the characteristics of the return loss are studied.

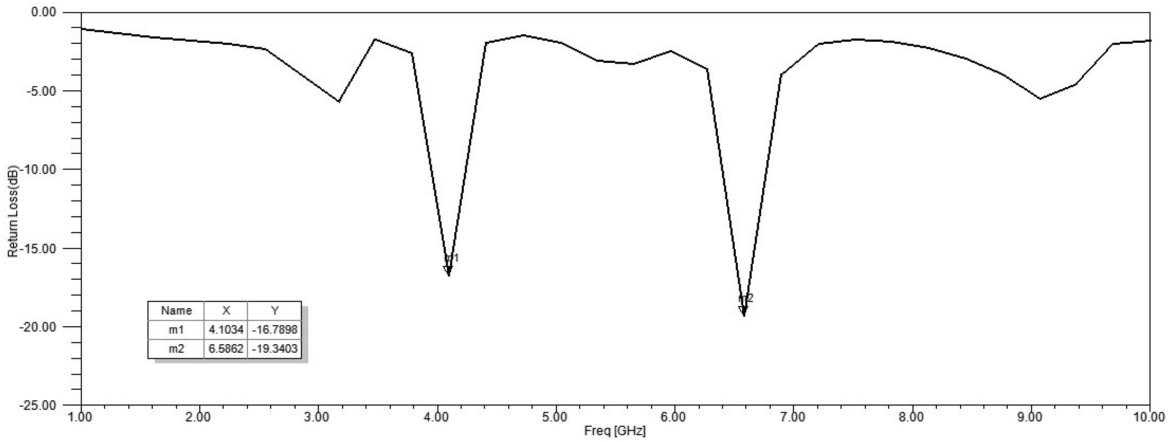

Fig. 5 return loss vs frequency of two ring patch antenna for fr4 epoxy with 5 mm distance

From figure 5, antenna radiates efficiently at 4.1 GHz and 6.5 GHz where. Antenna has a wide bandwidth at each band of frequencies. As the curves are steep at the respective radiating frequencies the antenna suffers a low interference and less losses. The peak gain of the proposed antenna is 3.08 dB at 4.1 GHz and 4.13dB at 6.5 GHz observed in simulated results.

The E-plane and H-plane radiation pattern are shown in fig. with nulling at 90degrees, 270 degrees can be observed. The current distribution of the proposed antenna is analyzed in the figure 6

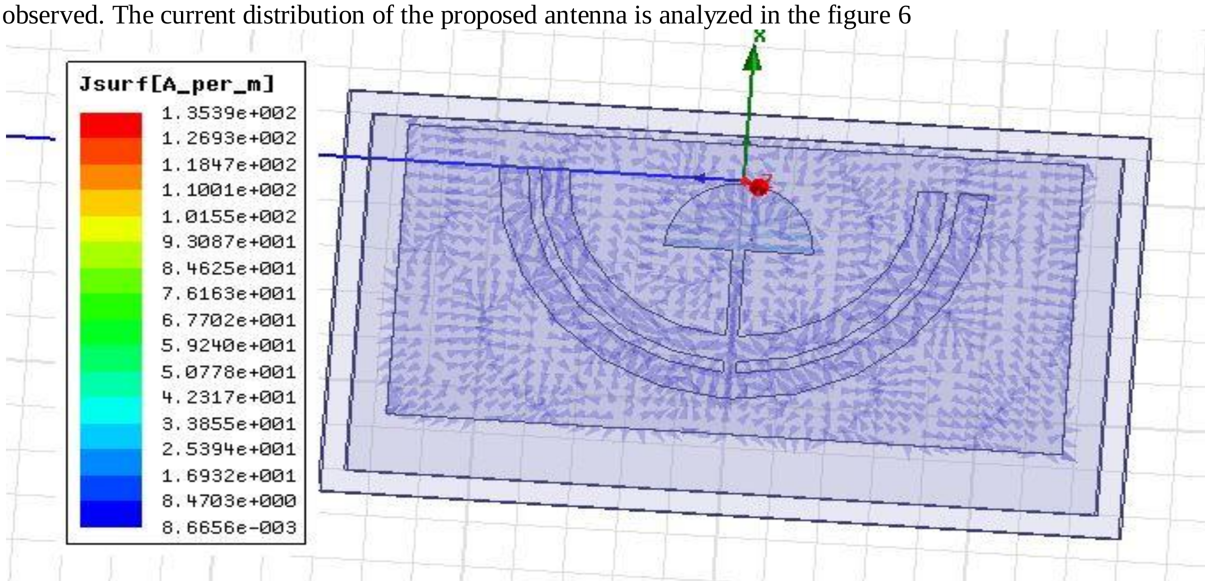

Fig 6 current distribution of two ring patch antenna

Fig 6 shows the current distribution over the surface of the proposed antenna at 4.1 GHz resonant frequencies. A considerable current distribution can be observed for the proposed antenna at resonating frequencies 4.1 GHz and 6.5 GHz. The Directivity observed by the proposed antenna is 6.6dB. The gain of 3.08 dB at 4.1 GHz and 4.14 dB at 6.5 GHz.

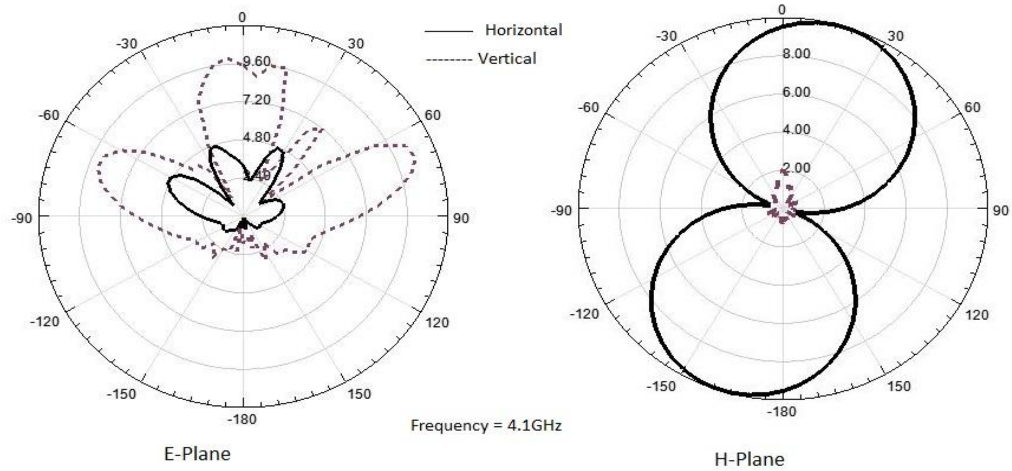

Fig 7 radiation pattern of e-plane and h-plane at 4.1 GHz frequency

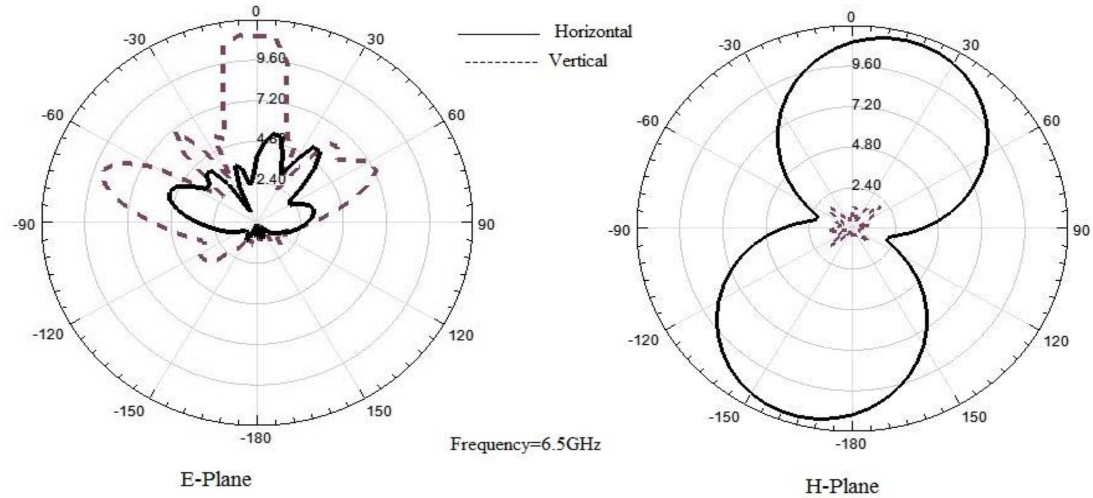

Fig 8 radiation pattern of e-plane and h-plane at 6.5GHz frequency

Fig 7 and fig 8 show the E-Plane and H-plane orientations of the radisation pattern of proposed antenna. Dotted line represent the vertical polarization and the continuous line indicate the horizontal polarization of the proposed antenna. So, from these figures antenna can effectively radiate at horizontal polarization in H-plane.

IV. Conclusion

A New Design of dual frequency concentric half ring and half circular antenna is proposed. It is a High gain antenna with optimum return loss at defined frequencies. As this is a half ring antenna, the net size of the antenna reduces reducing the cost. Antenna operates at dual frequency 4.1 GHz and6.5 GHz. S11 and gain both are good optimum result for a patch antenna to radiate effectively. This antenna is used for Wi-Fi and WLAN applications and ISM applications where 2.4 GHz is a congested band. As antenna radiates at 6.5 GHz, can be useful at C band applications and Defense RADAR Applications.

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