Cylindrical Dielectric Resonator with Square Patch

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ABSTRACT

Micro strip antenna is very easy to fabricate and analyze, therefore it is very popular. This antenna is design to operate in the frequency range from 4.12GHz to 4.47 GHz , which covers 355 MHz band. These frequency ranges accommodate in the C band in frequency spectrum and radiates circularly polarized wave. C band antenna has greater applications as in wireless local area network (WLAN), where centre frequency is 4.3GHz .Simulation results of cylindrical substrate DRA with square patch is shown in the paper such as return loss, smith chart, radiation pattern. Simulation is performed on CST 2011and HFSS 13. It could be design for possible application in many systems which are wireless system like WLAN if properly scaled to frequency band allowed.

Key words: Dielectric resonator antenna (DRA), gain, grooved substrate, micro-strip antenna, bandwidth, radiation pattern.

INTRODUCTION

In every design of micro strip antenna requires to be small size ,light weight ,low profile ,low cost easy to fabricate and can easily integrated with monolithic microwave circuit (MMIC) in order to fulfill their conditions ,the planer micro strip antenna MSA [1] are considered. For simulation of this cylindrical DRA HFSS 13 and CST microwave studio 2011 is used.

The gain and bandwidth is shown in this paper for cylindrical shaped DRA with square patch using CST and HFSS 13 software. To design DRA micro strip patch antenna with coaxial feed[3] is the main aim of this paper and also to analyses the effect of variation in antenna dimensions such as length, height, radius and substrate parameter such as dielectric constant. Mainly any variation shows effect on band width and beam width. To improve gain and beaming Groove [2] in substrate is used

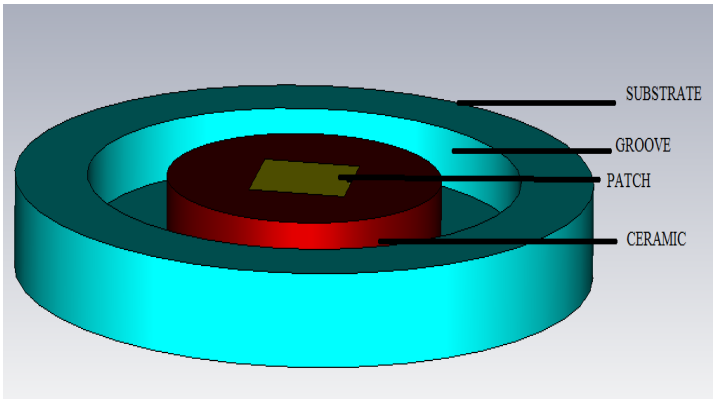

Figure 1. Design of MSA

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A circularly polarized wave has superiority in sensitivity of atmosphere. Therefore it got attention recently. There are two conditions for exciting the circularly polarization [4] first is the phase difference (PD) between the two orthogonal E vector must be approximately 90^0 and second is generated orthogonal E vector must be equal. The polarization is defined as right hand circular polarization (RHCP) and left hand circular polarization (LHCP) by lead and lag by 90^0 phase shift. The characteristic of polarization can be represented by the value of Axial Ratio (AR).

ANTENNA CONFIGURATION AND DESIGN

To design the cylindrical shaped DRA using Taconic CER -10 Ceramic of $\in r$=10 as a substrate. Resonating frequency is 4.3 GHz with height of substrate is 5.6mm.Gain, bandwidth, beam width is calculated using-

$$BW = fH - fL$$

$$Beamwidth = \frac{fH - fL}{fc} \times 100\%$$

$$G = er \times D$$

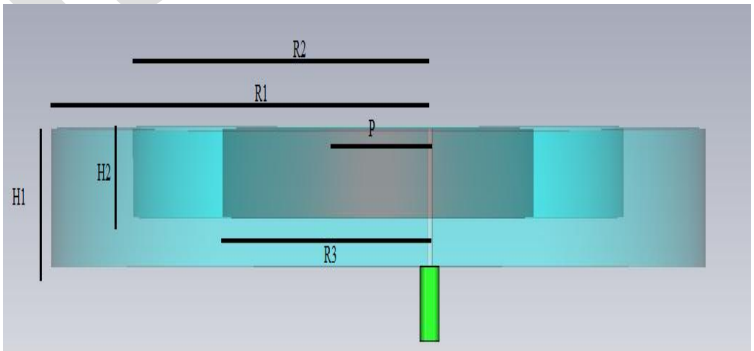


Figure 2. Schematic Diagram of MSA

To design square patch following formulas are used:

Step 1. *Width* (W)

$$w = \frac{c}{2fo\sqrt{\in r + 1}/2}$$

Step 2. *Effective Dielectric Constant* ($\in_{reff}$)

$$\in reff = \frac{\in r + 1}{2} + \frac{\in r - 1}{2}[1 + 12\frac{h}{2}]^{1/2}$$

Step 3. *Effective length* (L_{eff})

$$Leff = \frac{c}{2f0\sqrt{\in eff}}$$

Step 4. *Length extension (ΔL)*

$$\Delta L = 0.412h\frac{(\in eff + 0.3)(\frac{w}{h} + 0.264)}{(\in eff - 0.264)(\frac{w}{h} + 0.8)}$$

Step 5. *Actual length of patch* (L)

$$L = Leff - 2\Delta$$

Square patch is mounted over the grooved substrate of $\in r$=5 .The groove of radius of 21mm, and another substrate of $\in r$=10 is used. Fig(1) & (2) shows the front view and side view respectively .The parameter used are R1,R2,R3,H1,H2 and L ,their values are shown in table no. 1.

R1	R2	R3	H1	H2	P
28	21	13.3	5.6	3.6	4.65

Table no. 1

Where H1 is the height of substrate 1 have $\in r$=-5 , H2 is the height of substrate 2 having $\in r$=10 and R1 and R3 are radius of substrate 1and substrate 2 respectively .P is the length of patch and R2 is radius of ground . There are various feeding techniques which are used in MSA designing [5],[6] for impedance matching .

In the square patch DRA coaxial feeding techniques is used which is most convenient for impedance (Z) matching [7]. Impedance matching is achieved at resonating frequency 4.27GHz by varying the location of coaxial X and Y. The coaxial feeding with coax of length of 3mm and feed of length 8.6 mm is provided. The DRA [8] operates in frequency range from 4.12GHz to 4.47 GH z for bandwidth of 355MHz and its gain is 5.64 dB.

RESULT

All optimized dimensions of the antenna are shown in table no.1 .The return loss of -38 dB is achieved with gain of 5.64 dB and bandwidth 355MHz. The simulated result of two software CST microwave studio 2011 and Ansoft HFSS 13 are likely same. Results are achieved by approximation of design parameters. All simulated results are shown below which are compared and finally CST microwave software studio 2011 are taken in account.

Different parameters of DRA microstrip antenna-

OUTPUT PARAMETERS	
FREQUENCY OF OPERATION	4.27GHz
FEEDING METHOD	coaxial
BANDWIDTH	355MHz
GAIN	5.64dB
SUBSTRATE	$\in r$=5,$\in r$=10

Return Loss-

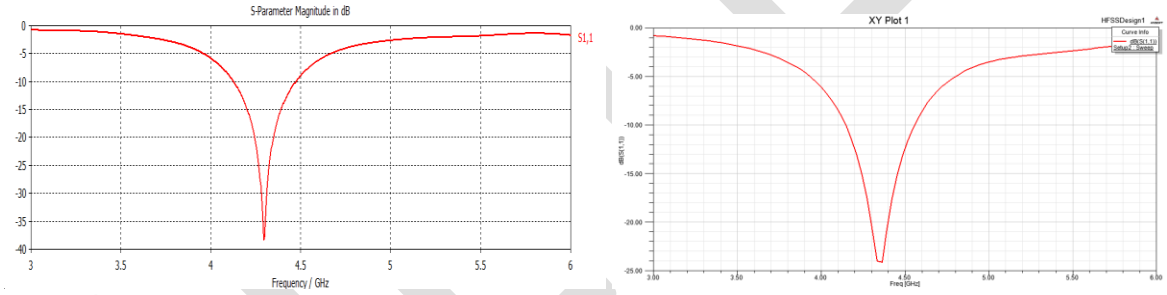
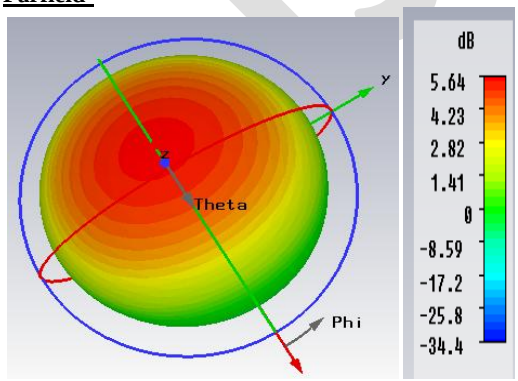


Figure 3. (a) CST microwave studio2013Figure 3 (b) HFSS13

Farfield-



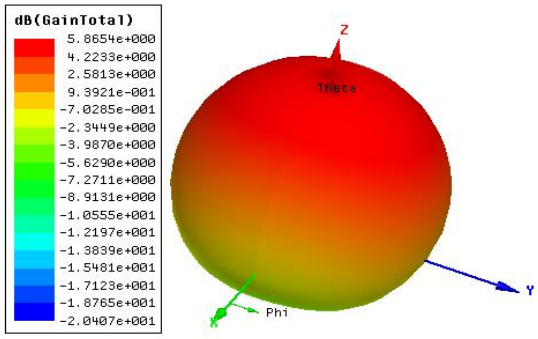
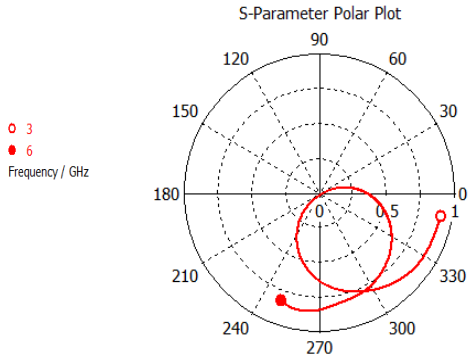


Figure 4. (c) CST microwave studio2013 **Figure 4. (d) HFSS13**

Smith Chart:-



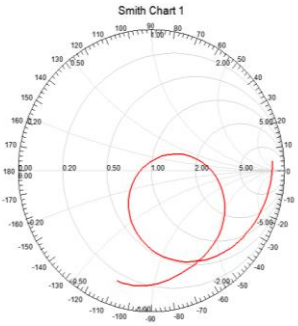


Figure 5. (e) CST microwave studio2013 **Figure 5. (f) HFSS13**

The fig 3 (a) and (b) shows the return loss curve of both software CST 2011 and HFSS 13 which are almost same both respectively. The antenna works on the broad side radiation over the band. Shows the return loss approximately at centre frequency 4.27 GHz. The achieved gain and bandwidth are 5.64 dB and 355 MHz By the variation of 'parameter in antenna design [9] impedance is matched to achieve the Return Loss s11and other result too.

CONCLUSION

Square patch and cylindrical shaped DRA [10] micro strip patch antenna is very easy to fabricate and manufacture .Ceramic is used as substrate material and It is very convenient for commercial use .Groove technology is used here which provide rigidity to MSA. Square patch DRA launches circularly polarized radiation field. This MSA is operates in C band which is attractive feature for antenna. The designed antenna is for high power radio. It transmits over 4.27GHz frequency and is also compatible for OFDM and military purpose too. It has greater application in the wireless system like WLAN.

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