

Square Shaped DRA with Square Patch

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Abstract

A square shaped dielectric resonator antenna has gain of 5.28 dB with bandwidth of 343MHz .It could be developed for possible application in many systems which are wireless system like WLAN if properly scaled to frequency band allowed. Mounted on another square substrate. The groove technique is applied. The result is experimentally investigated with CST studio software 2011 and Ansoft HFSS 13 software. A circularly polarized square DRA is designed at 4.27GHz for C band application as in wireless communication, OFDM and military purpose.

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

Introduction

Micro-strip antenna has many advantages in the field of military as it is light weight, compact size, conformable structure and low cost. Different antennas are designed by using several techniques. DRA got attention this time it has application in wireless hand set and LAN.

Here square shaped DRA with square patch is explained to get bandwidth along with high gain. Along with ceramic substrate $\epsilon_r = 10$, another substrate of $\epsilon_r = 5$ is used in MSA which has square groove in top side. It is well known that the value of Q-factor can be controlled by adjusting the effective dielectric constant [10].

To design a coaxial feed square DRA micro strip patch antenna is the main aim of this paper and analyze the effect of parameter variation such as length ,height and substrate dielectric constant on the bandwidth and gain. This grooved structure of substrate is used to improve antenna gain and beam width.

Antenna Configuration and Design

This design operating from frequency 4.1 GHz to 4.45 GHz therefor Bandwidth (BW) of 343 MHz, Beam width 8.19 % and its peak Gain (G) is about 5.287dB. various formulas are :-

$$BW = fH - fL$$

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

$$G = er \times D$$

To design square patch following formulas are used:
Step 1. Width (W)

$$W = \frac{c}{2fo\sqrt{\epsilon_r + 1/2}}$$

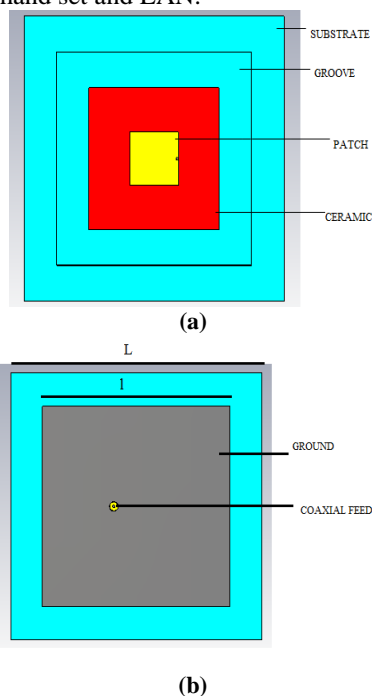


Figure 1. Design of MSA (a) top view & (b) bottom view

Step 2. *Effective Dielectric Constant* (ϵ_{eff})

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

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

$$L_{eff} = \frac{c}{2f_0 \sqrt{\epsilon_{eff}}}$$

Step 4. *Length extension* (ΔL)

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

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

$$L = L_{eff} - 2\Delta L$$

A square shaped DRA is made of ceramic substrate of ϵ_r -10 of height “H1” and side length “D” which is mounted over substrate of ϵ_r -5 which has square groove.

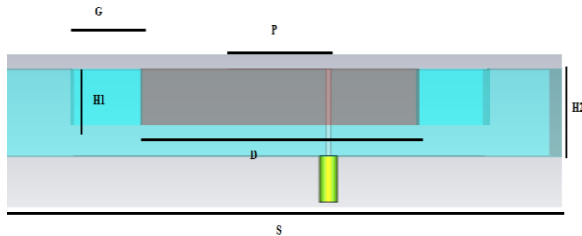


Figure 2. Schematic diagram of DRA MSA

Figure shows the groove of height “H1” is made over substrate of ϵ_r -5 which has height of “H2” and side length “S”. A square shaped patch of length “P” is attached to the ceramic substrate. The ground of length K is placed below the substrate of ϵ_r -5. In this DRA coaxial feeding technique is used which is convenient for impedance (Z) matching .by varying the value of “X” and “Y”. The dimensions of proposed antenna design is shown below in table no.1.

Table no. 1

S	H1	H2	G	D	K	P	X	Y
49.6	3.6	5.6	6.605	24.8	37.21	9.303	4.78	0

Result

The design is simulated by using 2 software which are CST microwave studio 2011 and HFSS13. Simulations result of both software are compared by the diagram shown below. The result of CST 2011 is taken finally.

Return Loss-

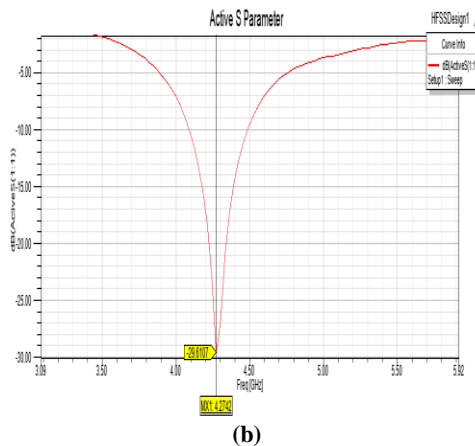
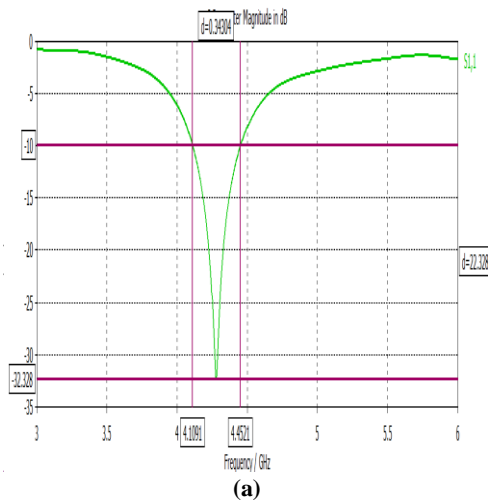
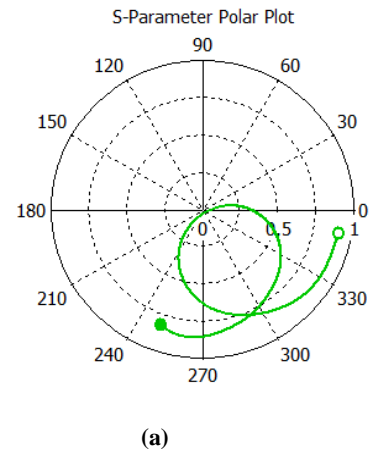


Figure 3. (a) CST microwave studio2013, (b)HFSS13

Polar Plot-



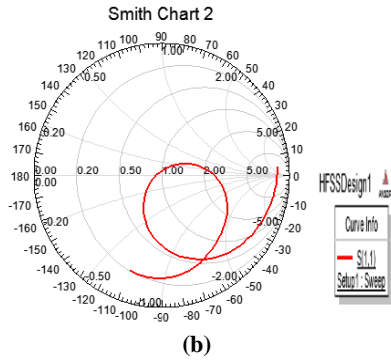
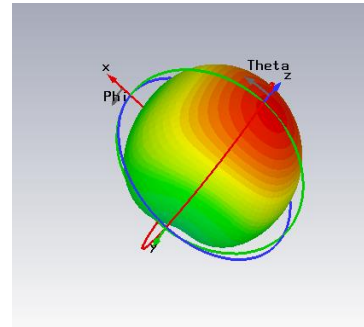


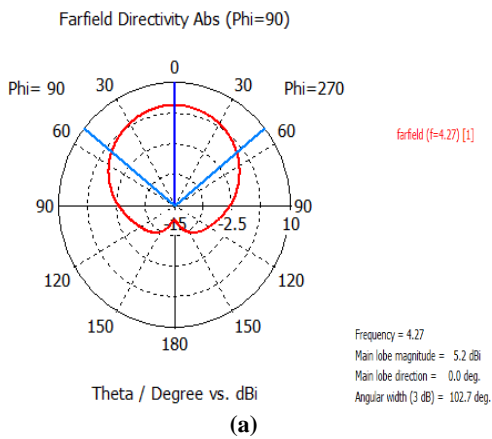
Figure 4. Polar plot (a) CST microwave studio2013, (b) HFSS1

Farfield-

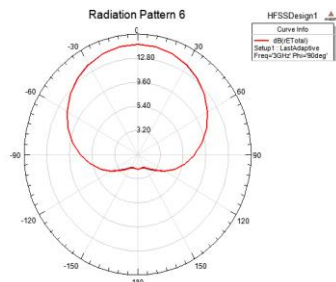


(a)

E-Field-

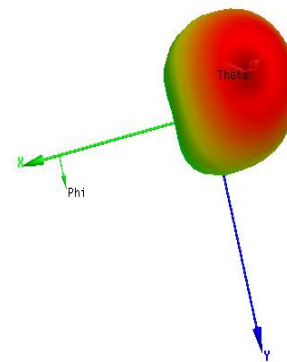


(a)



(b)

Figure5. E-field & (a) CST microwave studio2013,(b) HFSS13



(b)

Figure 6. (a) CST microwave studio-2011 & (b) HFSS-13

By varying the parameters, suitable return loss S11 is achieved as result. This antenna works on the broad side radiation of the band. Some of the values are optimized and some them are fixed .By varying some parameter in this design impedance matching is achieved, which is for achieving the return loss s11 and other result too.

The above figure shows the return loss curve in which CST microwave studio 2011 as well as hfss 13 shows same nature of simulated curve .Both results are approximately same .The centre frequency achieved 4.27 GHz of -32dB return loss. The simulated results shows the highest gain of 5.287 dB and band width of 343 MHz .

PARAMETERS	
BANDWIDTH	343MHz
BAEMWIDTH	8.19%
GAIN	5.287dB
SUBSTRATE	ϵ_r -5, ϵ_r -10
FEEDING METHOD	coaxial

Conclusion

The new square shaped DRA with square patch can be easily manufactured it is very convenient for commercial use. Rigidity is provided by using groove technique. Square patch is used with square DRA to create electric field. The gain which is achieved in C band is very attractive feature of antenna. This antenna is compatible for OFDM and military purpose. This antenna could be developed for possible application in many systems which are wireless system like WLAN if properly scale to frequency band allowed.

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