Dielectric Resonator Antenna Loaded with Monopole Antenna

Inderpreet Kaur
Asst. Prof. MJPRU Bareilly,
amitoj.ekas@gmail.com

Neha Khan
StudentM.Tech SRMS, CET, Bareilly

Padamlata
Student M.Tech, IFTM Univ Moradabad,.

Sumit
Student Member IEEE MJPRU, Bareilly

Abstract- *A DRA loaded with monopole antenna is proposed in the present work. The metal cap is used to cover the monopole antenna top as well as top of DRA. These designing increase the operative frequency of the antenna. The antenna system resonates at 4.4 GHz. The simulation results of return loss, VSWR, gain and radiation pattern are presented.*

Keywords- DRA, Bandwidth, Return loss

I. INTRODUCTION

The DRA is an open resonating structure, fabricated from a low loss microwave dielectric material. Dielectric resonators (DR's) have proved themselves to be ideal candidates for antenna applications by virtue of their high radiation efficiency, flexible feed arrangement, simple geometry, small size and the ability to produce different radiation pattern using different modes[1]. Feeding techniques like probe feed, aperture slot, microstrip line and coplanar line can be used with the DRAs, which enables them for integration with microwave printed technology. Additionally, DRA's avoid some limitations of the patch antenna including the high conductor losses at millimeter-wave frequencies, sensitivity to tolerances, and narrow bandwidth. DRA's of cylindrical, hemispherical and rectangular shapes are most widely used and investigated. The rectangular shape is much easier to fabricate and one or more dimensional parameters are available as additional degrees of freedom for the design Impedance bandwidth varies over a wide range with resonator parameters. It can be as small as a few percent with high εr material or over 20 % with small εr in conjunction with certain geometries and resonant modes. Different far field radiation patterns are supported. For a given DRA geometry, the radiation pattern can be made to change by exciting different modes.

Dielectric resonator antennas (DRA) offer the following attractive features:

- The dimension of a DRA is of the order of $\frac{\lambda_0}{\sqrt{\epsilon_r}}$, where λ_0 is the free-space Wavelength and ϵ_r is the dielectric constant of the resonator material. Thus, by Choosing a high value of ϵ_r($\epsilon_r \approx 10 - 100$), the size of the DRA can be significantly reduced.
- There is no inherent conductor loss in dielectric resonator. This leads to high radiation efficiency of the antenna. This feature is especially attractive for millimeter (mm) wave antennas, where the loss in metal fabricated antennas can be high.

  DRAs offer simple coupling schemes to nearly all transmission lines used at microwave and mm-wave frequencies. This makes them suitable for integration into different planar technologies.

The coupling between a DRA and the planar transmission line can be easily controlled by varying the position of the DRA with respect to the line. The performance of DRA can therefore be easily optimized experimentally. The operating bandwidth of a DRA can be varied over a wide range by suitably choosing resonator parameters. For example, the bandwidth of the lower order modes of a DRA can be easily varied from a fraction of a percent to about 10% or more by the suitable choice of the dielectric constant of the resonator material.

- Each mode of a DRA has a unique internal and associated external field distribution.

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DRS Loaded with monopole: The monopole loaded with dielectric resonator antenna (DRA) has found important application as broad band antenna. A very interesting word on the on the guidelines for the design of this antenna was presented in recent literature. The broadband characteristics of the hybrid antenna both in transmit and receive mode as EMI sensor in frequency domain. There has been considerable interest on the studies of different loaded and dielectric resonator antennas for their wideband characteristics.

II. ANTENNA DESIGN

The DRA is designed to operate in the TMo1 mode which has a circular symmetric modal field pattern similar to that of a short monopole antenna. The bandwidth of monopole antenna can be significantly extended by The addition of the ring DRA, as The monopole and the ring DRA Are both centered about the same axis, and the monopole simultaneously function as a Quarter wavelength radiator and as a feed for the DRA. .The monopole is designed to operate toward the lower end of the spectrum, while the DRA operates toward the upper end .For wideband operation two resonant frequencies are chosen so that a minimum return loss of 10 db is maintained over the operating bandwidth.

- The monopole antenna height (t) is chosen o be one- quarter wavelength at the lowest frequency(f_l) of the desired frequency band.that is , $t=\lambda_l/4$, where λ_l is the wavelength corresponding to frequency f1.also a thin diameter is chosen for the monopole:

  $0.008\lambda \leq d \leq 0.016\lambda$
- The spacing (s) between the monopole and inner DRA radius(b) is also chosen to be a small fraction of wavelength :

  $0.013\lambda \leq s \leq 0.016\lambda$

- The resonant frequency (f_h) of the TM01δ mode of the DRA should be chosen approximately 2.5 times the resonance frequncy f_l , guidelines for the DRA dimensions are :

  $b=d/2+s$

  $a=b/0.3$

  $0.4\lambda \leq h \leq 0.5\lambda$
- Finally the dielectric constant for the DRA can be determined using :

  $\varepsilon r=(\pi/2h)^2 \ +(4.71/a)^2 \ / \ (2\pi f_{h/c})^2$

Where c is the speed of light.

Table: DRA – Loaded monopole Designs :

Frequency Band(Ghz)	t (mm)	d (mm)	s (mm)	a (mm)	b (mm)	h (mm)	ε_r
2-5	37.5	2.0	1.90	9.5	2.90	16.0	2.5
3-8	25.0	1.3	1.40	6.5	1.95	11.0	18

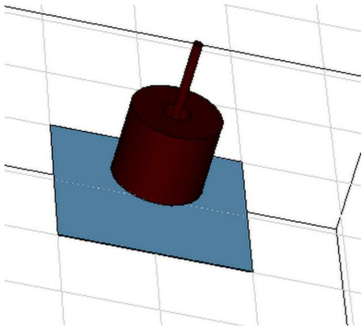

Fig1

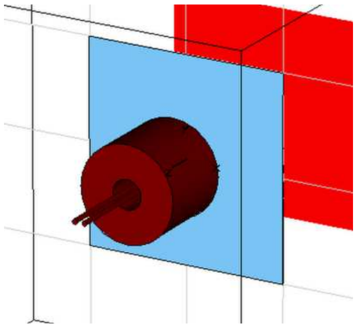

Fig2

III. Results

This experiment work is carried out by varying the number of poles .DRA with dimension (a=9.5mm, b=2.5 mm, g=5.2 mm, εr=25). Monopole in figure 1 with dimension (r=1 mm, h=35.5 mm, εr=25).DR is taken about the centre of the rectangular slot in order to achieve maximum impedance bandwidth. The size and position of the slot are selected in order to improve matching and control resonance frequency. The return loss about -40 db was proposed for the antenna.

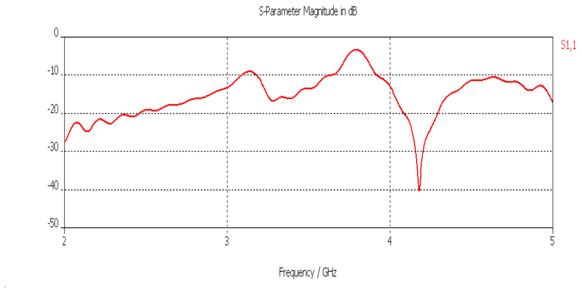

Fig 3: Return Loss for DRA with single Monopole

And the polar plot for monopole

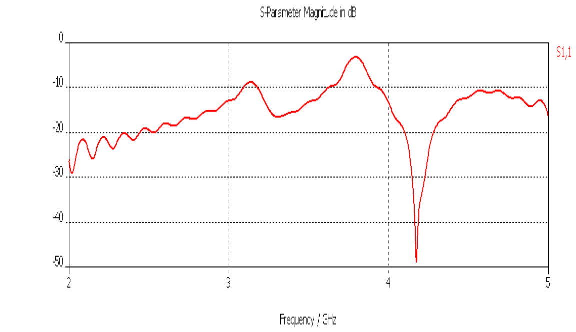

Fig 4: Polar plot for DRA antenna with single monopole

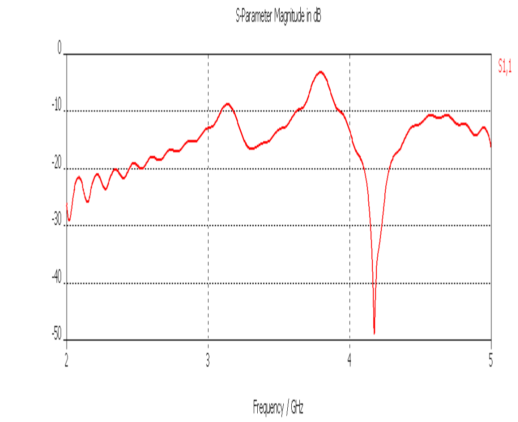

Figure 5: Return Loss for DRA antenna with double Monopoles

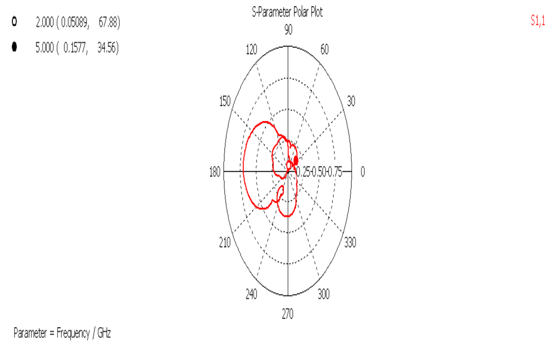

Figure 6: polar Plot for DRA antenna with Double monopole

The X-Y plane co-polar and cross –polar radiation pattern of single monopole and double monopole are measured at their resonant frequencies (2 GHz to 5 GHz) and are shown in figure. With increases in return loss the double monopole DRA antenna exhibit more bandwidth among the proposed antenna. Thus to improve the return loss of the DRA antenna, two monopoles are considered with dimensions(r=1 mm, h=35.5 mm, εr=25).

Conclusion

The presented active antenna is able to cover the 3-5 Ghz wide S band at 4.2 Ghz with a combined monopole antenna and return loss of -40 DB for a DRA loaded with single monopole and 50 DB DRA loaded with double monopole.it provided us with better noise carrier to noise ratio then the DRA loaded with single monopole antenna.

IV. References

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