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E-shaped DRA For Ultra-Wideband Application

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***Abstract*—An Ultra wideband Monopole E-shaped dielectric resonator antenna (DRA) is proposed in this paper. The E-shaped DRA is designed with dielectric constant ε_{DRA} = 10, and excited with monopole in horizontal ground plane. An impedance bandwidth ranging from 4.9 GHz to 11.8 GHz is achieved with efficiency above 94% with similar radiation pattern throughout the band. There are various fields in which ultra wide band frequency has been used such as communications and sensors, radar etc. The gain of the proposed antenna varies from 4.5 to 7.88 dBi over the operating band.**

Keywords-Dielectric resonator antenna (DRA); Ultra wideband(UWB); E-shaped.

I. INTRODUCTION

Dielectric resonator antennas (DRAs) have been subjected to many investigations since their introduction in 1983 [1]. The DRA is useful for high frequency applications where Ohmic losses become a serious problem for conventional metallic antennas. In addition, they offer higher bandwidths and gain when compared with micro strip patch antennas. A hybrid monopole-dielectric resonator antenna (DRA) exhibiting wideband performance was recently introduced [2] and subsequently studies [3] – [10]. The antenna consists of a quarter wave electric monopole around which a E- shaped DRA is placed as shown in Fig.1. The ultra wideband response of this antenna is characterized by two resonances (two minima in the return loss response).

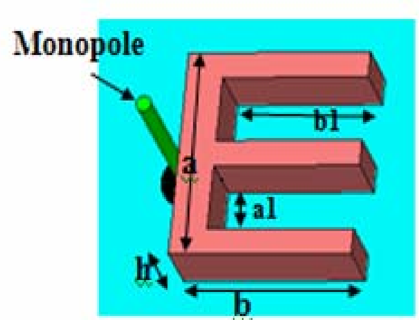


Figure 1. Geometry of E shaped monopole DRA

II. ANTENNA DESIGN & PARAMETRIC STUDY

The geometry of the proposed antenna is shown in Fig.1. The antenna consists of a E- shaped DRA of dimension a=16mm, b=15mm, a1= 5mm, b1=12mm, height h=5.12mm and ε_{DRA} = 10, which is excited by a monopole of length l = 16mm and radius r=0.635mm, both being fitted on a common ground plane of size 50 x 50mm^2. This method has significantly enhances the impedance bandwidth. By carrying out parametric studies over a wide range of frequency like 0 to 12 GHz in this current investigation it has been observed that higher end resonant frequency f_H = 2.41 f_L (f_L is lower end frequency).

First we have done parametric study of return loss characteristics of three designs. First we have studied the return loss characteristics of rectangular shaped DRA on the same ground plane, secondly studied when only the upper part of rectangular DRA is cut and finally we have designed E shaped DRA with same monopole arrangement which is shown in Fig.1. The simulated return loss characteristics of above three designs have been shown in Fig. 2. It has been observed that first resonance occurs at around 5.8 GHz) .

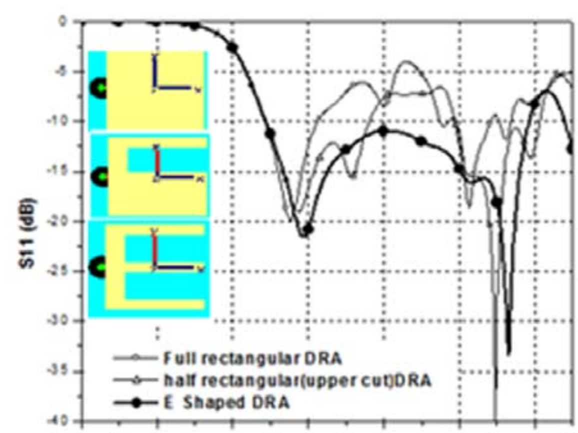


Figure 2. Simulated return loss characteristics of three different designs shown in inset

The DRA excited by the monopole with length 'l', all other parameters being unchanged is parametrically varied to observe its effect on resonance frequency. It is seen from Fig.3 that ultra wideband occurs as monopole length is equal to quarter wavelength i.e. l = λ/4 = 16 mm where λ = c /f_L and f_L = 5.8 GHz lower end resonant frequency.

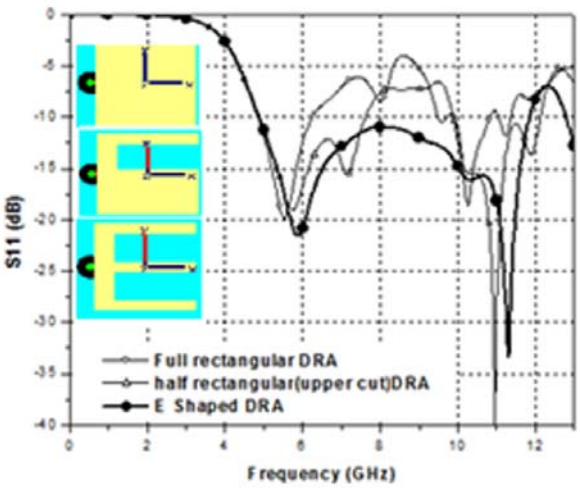


Figure 3. Simulated return loss versus frequency of monopole-fed DRA having variable probe pin length as fig.1

The maximum bandwidth achieved by optimizing the height of DRA. Fig.4. shows the effect of the DRA height ‘h’ on return loss for the proposed DRA. It is seen from the figure that when the height of DRA is 5.12 mm then only maximum broadband could be achieved.

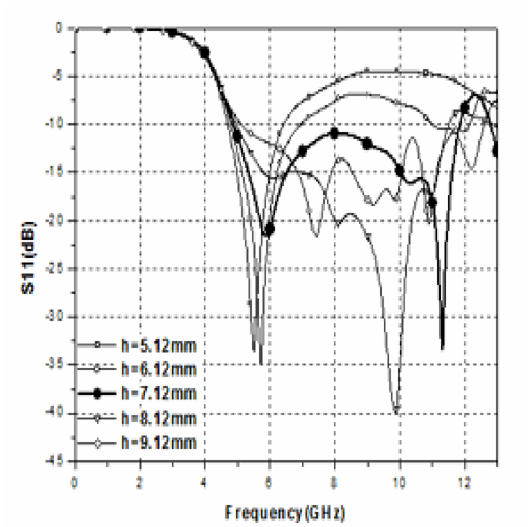


Figure 4. Simulated return loss versus frequency of monopole-fed DRA having Different height of DRA

Another parameter we have studied the comparison of monopole only, E shaped DRA excited with probe pin and E shaped DRA with monopole on the same ground plane. This arrangement is shown in Fig.5., it has been observed that monopole fed DRA gives much better band width as compare to only monopole and only E shaped DRA.

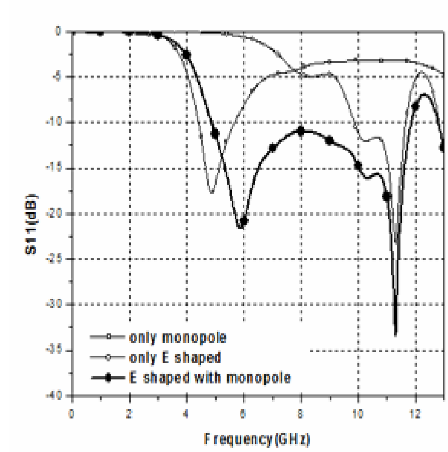


Figure 5. Simulated return loss plot of comparison of only monopole, only E shaped and E shaped with monopole arrangement

III. RESULTS AND DISCUSSION

The proposed antenna is analyzed using CST Microwave StudioTM. From the return loss plot of the antenna as shown in Fig.6 it is seen that the resonance in DRA with monopole is caused by the monopole itself. When this monopole having length of l = λ/4 = 16 mm is loaded by E- shaped DRA ultra wideband occurs which may cause by the combined effect of both monopole and DRA.

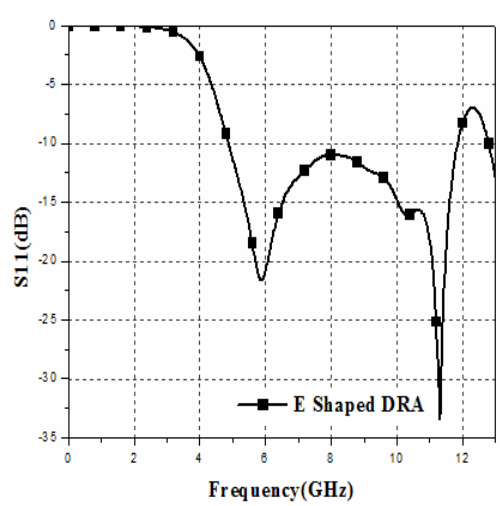
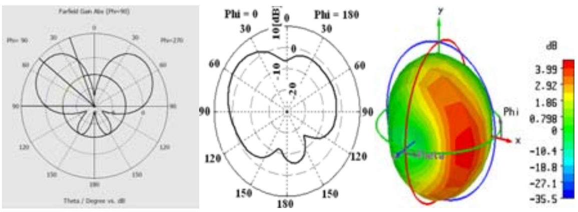


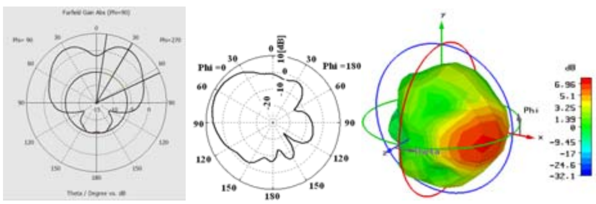
Figure 6. Return loss plot of E shaped DRA with monopole arrangement

The antenna exhibits Omni directional pattern in YZ-plane and XZ-plane at 5.855 GHz and 11.326 GHz frequency as shown in Fig.7 & Fig.8 respectively. Radiation pattern is Omni-directional in XZ and YZ plane. At frequency 5.8 GHz directivity is 5.15 and at 11.32 GHz frequency directivity is 8.34 and we also studied frequencies v/s gain plot which is shown in fig.9. In Fig.7 (c) and fig.8(c), the donut shaped radiation pattern in XY plane indicates the coupling of monopole with the DRA. The peak gain varies from 3.89 to 8.42 dBi within the band. The computed efficiency is found to be above 94%.



(a) (b) (c)

Figure 7. Simulated radiation pattern (a) xz plane (b) yz plane (c) 3D radiation Pattern at 5.8556 GHz.



(a) (b) (c)

Figure 8. Simulated radiation pattern (a) xz plane (b) yz plane (c) 3D radiation Pattern at 11.326GHz

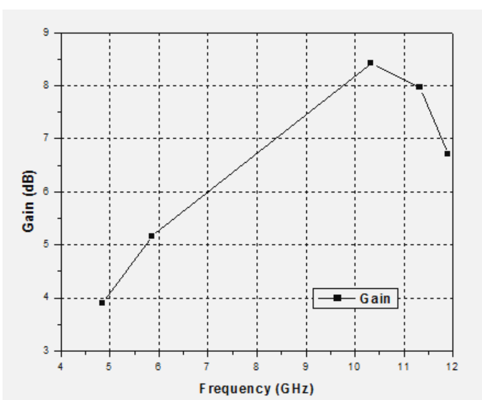


Figure 9. gain v/s frequency plot of proposed antenna

IV. CONCLUSIONS

A ultra wideband Omni-directional DRA has been investigated. The antenna is designed based on the E-shaped DR structure integrated with monopole. Parametric studies are carried out to optimize the structure to achieve the wide bandwidth. The antenna is optimized to achieve a wide impedance bandwidth of 4.92 GHz to 11.8 GHz.

ACKNOWLEDGEMENT

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