# Four Element Dual Segment Triangular Dielectric Resonator Antenna for Wideband Application

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***Abstract*—In this paper, wideband dual segmented four element triangular dielectric resonator antenna (TDRA) with coaxial probe feed is presented. The input characteristics, the radiation pattern of the proposed antenna on C-band of microwave frequencies using Ansoft HFSS simulation software is also presented.**

***Index Terms*—Triangular dielectric resonator antenna, return loss, input impedance and radiation pattern.**

## I. INTRODUCTION

Dielectric resonators (DRs) are nonmetallic object which functions similar to metallic cavities [1]. It has several attractive features such as small size, low profile, high radiation efficiency, flexible feed arrangement, simple geometry structure, light weight, low cost, a wide range of material dielectric constant which is given more flexibility to the antenna designer [2-4]. Triangular DRA is more compact in size as compare to rectangular and circular disc DRAs [5].

For DRAs, bandwidth enhancement is a major design consideration for practical application. To enhance the bandwidth of DRAs, there are several techniques such as changing the aspect ratio of DRA, varying the dielectric constant of the material, by using multisegments, stacked DRAs and multielement [6], introducing air-gap between ground and DRA [7]. Inserting low dielectric material below the high dielectric material leads to improvement in bandwidth [8].

For monopole type radiation pattern, some studies on DRAs are reported in the literature. The dielectric ring resonator antenna is used for constructing small and compact monopole like radiation pattern has been studied [9]. Multi-element cylindrical DRA and half split hemispherical DRAs have been investigated by Guha et.al [10-11], which shows an enhancement in bandwidth by simulation and measurement. Similarly, four element Rectangular DRA excited with coaxial probe gives 35.25% bandwidth with monopole radiation pattern studied through simulation [12]. Further, for X-Band application three element dual segment TDRA with monopole like radiation pattern has been studied through simulation and experimentally [13].

This paper presents the simulation studies of a four element dual segment triangular DRA (TDRA), which is fed by a 50 Ω coaxial probe and produces a monopole like radiation pattern over a wide bandwidth. The simulation study of the proposed antenna array is carried out using commercially available Ansoft HFSS software. Proposed antenna produces a monopole like radiation pattern over a wide bandwidth having a resonant frequency of 6.87 GHz. The simulated return loss of proposed antenna is compared with the four element TDRA.

## II. THE ANTENNA GEOMETRY

The main reason for taking triangular DRA is that for a given height and resonant frequency, it offers a smaller area than either a cylindrical or rectangular DRA [13]. Thus, it is beneficial for an antenna array design since a larger range of spacing between elements is allowed.

The four element dual segment equilateral triangular DRA (TDRA) shown in Fig. 1 with $a$ = 13.34 mm, $h_1$= 8 mm and $h_2$ = 2 mm which operates at the central frequency of 6.87 GHz. The upper segment of the DRA is designed using a material that has dielectric constant $\boldsymbol{\varepsilon_r}$ = 12 and height $h_1$= 8 mm and the lower segment is designed using Teflon which has a dielectric constant $\varepsilon_r$ = 2.08 and height $h_2$= 2mm; with ground plane of dimensions 50 mm x 50 mm. The elements of the four element dual segment TDRA are centrally excited by a 50Ω coaxial probe which touches the corner edges of all the four elements. The height of the probe above the ground plane for different antenna structures is determined through extensive simulation to obtain minimum return loss at the corresponding resonant frequency. The desired height of the probe is found to be 9 mm for the four element dual segment TDRA.

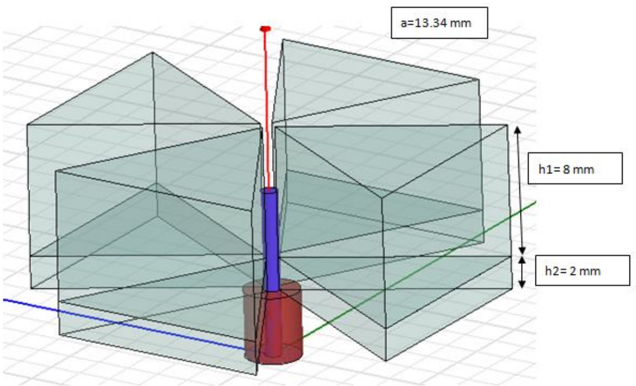


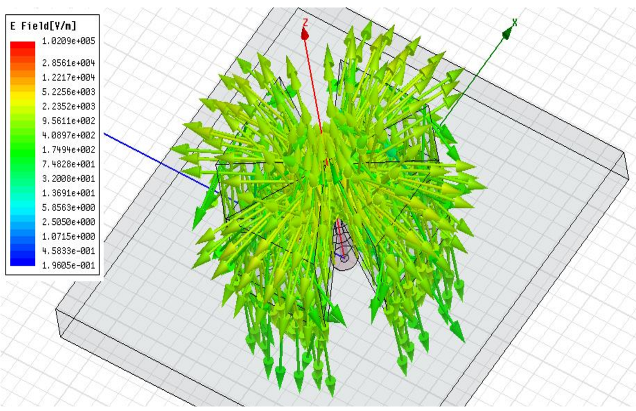

**Fig. 1** Four Element Dual SegmentTDRA

## III. RESULTS AND DISCUSSION

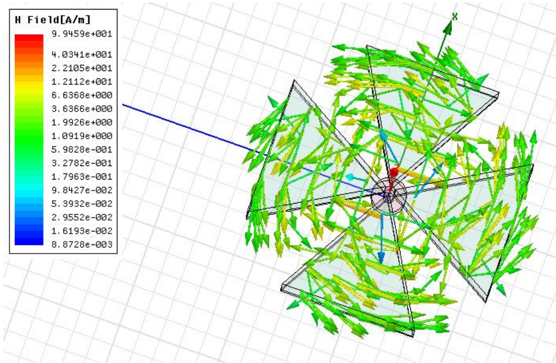
### A. *Near Field Distribution*

The simulation study of the near field distribution in the proposed DRA has been carried out at 6.87 GHz using the Ansoft HFSS software. When three elements are simultaneously excited using 50 Ω coaxial probe as shown in Fig. 3, the composite electric and magnetic field distributions in the 3D plane look like those shown in Fig. 3. It is apparent from Fig. 8 that the coaxial probe excites $TM_{10-1}$ Dominant mode fields in the antenna elements. Also it can be observed that the electric field component face their counter vectors and thus cause no radiation along the broadside direction.

The resultant electric field is polarized along the z-direction and thus it leads to a vertically polarized radiation surrounding the radiating structure like a quarter wave electric monopole. Since the elements of the antenna composite TDRA structure effectively produces identical radiation fields at 6.87 GHz, uniform monopole-type pattern can be achieved over the full matching bandwidth.




(a)




(b)

**Fig. 3** Near field distribution in proposed TDRA (a) E-Field (b) H-Field

### B. *Return Loss and Input Impedance Curves*

The simulation study of return loss and/or input impedance versus frequency characteristics of the single element and three element TDRAs have been carried out using Ansoft HFSS software.

The simulation results for the return loss of proposed antenna for different values of probe height are shown in Fig. 4. From Fig. 4 it can be observed that the minimum return loss at the corresponding resonant frequency is obtained at a probe height of 9 mm.

The simulation values for the return loss of proposed antenna is shown in Fig. 5. From Fig. 5 , it can be seen that the proposed antenna has the wider bandwidth (= 27.5%). It is also clear that the proposed TDRA has the resonant frequency of 6.87 GHz and covers the frequency range from 5.94 GHz to 7.83 GHz .

Fig. 6 shows the simulated results of the input impedance versus frequency of proposed TDRA. From Fig. 6 it can be observed that the simulated value of input resistance of the proposed TDRA at the resonant frequency is found to be 50.87 Ω, which is close to 50 Ω impedance of the feeder.

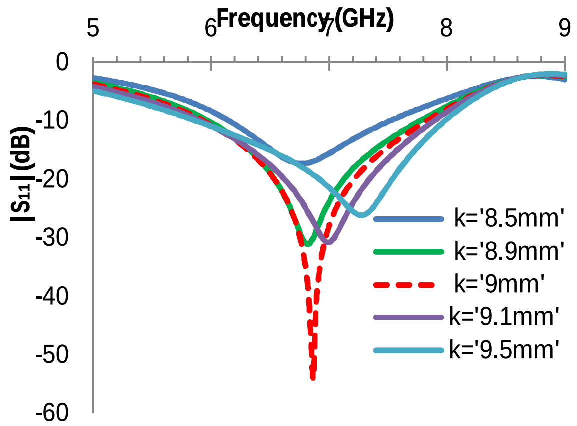



**Fig. 4** Plot of Frequency versus $|S_{11}|$ for different probe heights (k)

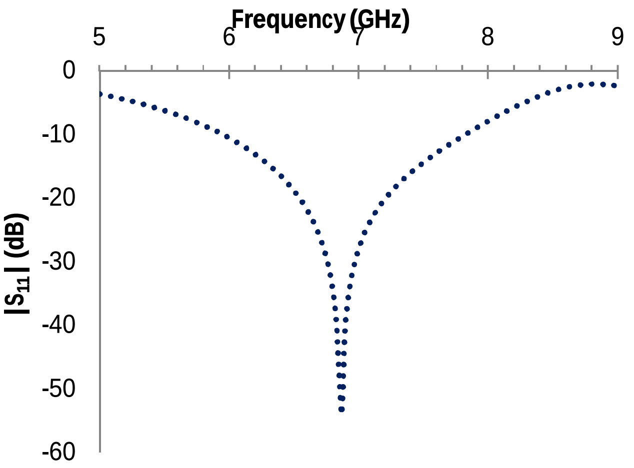



**Fig. 5** Simulated $|S_{11}|$ versus Frequency of proposed TDRA

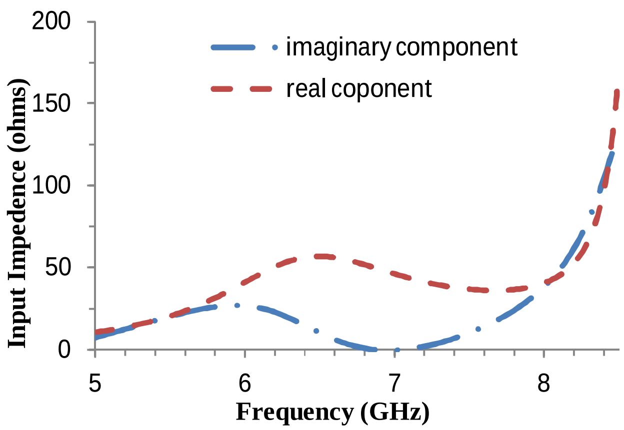



**Fig. 6** Simulated input impedance of proposed TDRA

*C. Far Field Distribution*

The radiation pattern of the proposed DRA is simulated using Ansoft HFSS software. The simulated radiation pattern of the proposed DRA is shown in Fig. 7. It can be observed from Fig. 7 that no radiation is obtained along the broadside direction of the antenna because of counteracting E-field distribution in x-y plane within the elements of the antenna.

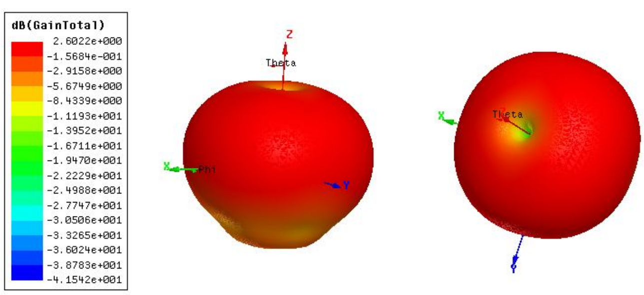



**Fig. 7** Simulated Radiation Pattern

## IV. CONCLUSION

In this paper, a wideband four element dual segment TDRA has been studied through simulation using Ansoft HFSS software. From the study it is inferred that the bandwidth of the proposed antenna has been found to be 27.5% and provide a monopole type of radiation pattern. The results obtained may be useful for designing and developing antennas for subsurface communication, geophysical exploration, biomedical telemetry, and for mobile terrestrial and aerospace communication systems.

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