# Pattern Reconfigurable Conical Dielectric Resonator Antenna with Parasitic Elements

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***Abstract* - A novel conical dielectric resonator antenna (DRA) with tunable radiation pattern has been proposed. The antenna adopts one type of conical dielectric resonator (DR) and arc-shaped coplanar waveguide ground, which has the potential to achieve wideband characteristic. The operating frequency range of the antenna is 1550MHz (8.96-10.51 GHz) or 1340MHz (9.53-10.87 GHz). Some parasitic elements with two pairs of switches are printed on the two opposite sides of the conical DR at the bottom layer. By controlling the switches ON or OFF, the lengths of parasitic strips change in a way of reflector and director of Yagi antenna, which makes the proposed DRA work at three modes with different radiation pattern characteristic.**

***Index Terms* —Dielectric resonator antenna(DRA), conical dielectric resonator, pattern reconfigurable, Yagi antenna.**

## 1. Introduction

Pattern reconfigurable antennas have great advantages for mobile and satellite communications because the controllable radiation pattern can enable diversity, avoidance of noise sources, sensibility of signal and improve beam steering capability of phased array systems. The Yagi antenna has been usually used to design the pattern reconfigurable antenna, featuring characteristics like simple structure, wideband and endfire radiating pattern[1][2].

Dielectric resonator antenna(DRA) has received much attention in recent years owning to some striking characteristics such as low dissipation loss, high radiation, light weight and no metal loss[3]. Recently considerable attention has been paid by researchers to achieve reconfigurable characteristic for DRA. Some frequency agile and polarization tunable DRAs for different application scenarios have been realized and reported[4]-[6]. However, there are little study and scarce literature on patter reconfigurable DRA[7]. Some novel enhancement techniques for reconfigurable DRA are on the way.

In this paper, a novel reconfigurable pattern conical dielectric resonator antenna fed by coplanar waveguide integrated with parasitic elements has been proposed. By optimizing parameters of the geometry for the antenna, the parasitic elements with switches play a role of director or reflector just as in Yagi antenna. Moreover, it combines the higher mode characteristic of conical dielectric resonator and the good impedance of arc-shaped coplanar waveguide ground.

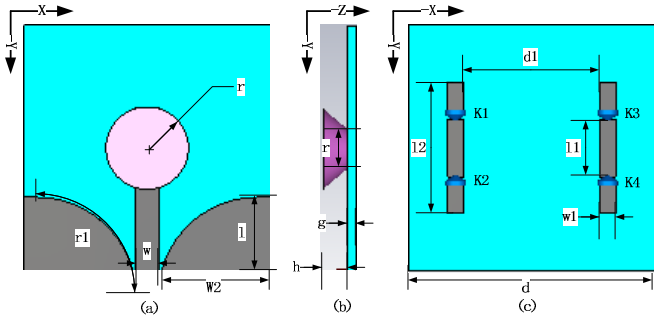


Fig.1. Configuration of the proposed pattern reconfigurable DRA Antenna: (a)front view, (b)side view, (c)bottom view.

## 2. Antenna Configuration

Fig.1 shows the configuration and parameters of proposed pattern reconfigurable conical dielectric resonator antenna. The antenna is fabricated on a piece of dual metal layer substrate of thickness 1mm and dielectric constant of 3.48. The top layer has a conical dielectric resonator of dielectric constant 10.2 fed by coplanar waveguide. This arc-shaped coplanar waveguide ground and conical DR are conductive to broaden the bandwidth. The bottom layer is composed by dual dumb-bell-shaped parasitic elements with four switches K1, K2, K3 and K4. The concept is to change the lengths of strips so as to vary the pattern maximum radiation direction. The basic idea of the proposed pattern reconfigurable DRA is similar to planar Yagi antenna's, whose DR is as driver and parasitic elements as director or reflector. As in the classic Yagi antenna, there is need to optimize the parameters of driver, director and reflector, and the spacing between any two elements for a proper design with the desired effect on the radiation pattern. The whole dimension of the pattern reconfigurable DRA is 30mm×30mm×4.037mm and all the optimized parameters are archived at Table 1.

TABLE I. DETAILED DIMENSIONS OF THE ANTENNA.

| ***Parameters*** | ***d*** | ***g*** | ***h*** | ***r*** | ***w*** | ***l*** |
|---|---|---|---|---|---|---|
| Value(mm) | 30 | 1 | 3 | 5 | 3 | 9 |
| ***Parameters*** | ***d1*** | ***r1*** | ***w1*** | ***w2*** | ***l1*** | ***l2*** |
| Value(mm) | 16 | 12 | 2 | 8.25 | 7 | 16 |

## 3. Simulation Results and Discussion

In this section, the optimal simulation results of the pattern reconfigurable are presented. The antenna structure is set up and optimized using an electromagnetic simulator named Computer Simulation Technology (CST) 2015. When the switches K1 and K2 are ON, the parasitic element on the positive x-axis acts as reflector and the parasitic element on the negative acts as director only in the case of K3 and K4 OFF. When K3 and K4 are ON, the results are on the contrary. When all the switches are OFF, the elements act as passive parasitic strips and the prototype is a normal DRA monopole.

Fig.2 presents the simulated reflection coefficients S11 under different operation modes. The condition that all switches are ON is not the operation mode. The proposed antenna can work at three modes as indicated in the follow figure within the common impedance bandwidth of 980 MHz (9.53-10.51 GHz). Under the condition of 1550 MHz (8.96-10.51 GHz) , the antenna works at two modes.

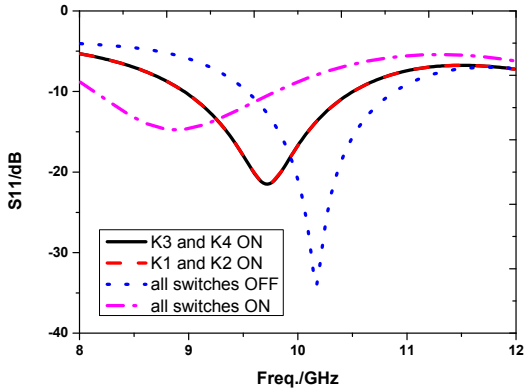


Fig.2. Simulated S11 versus frequency of the antenna

The E-plane radiation patterns of three operation modes at 10 GHz are shown in Fig.3, which proves the design concept of the proposed DRA antenna with switchable pattern property. The main lobe directions are 32° and 136° at similar Yagi antenna mode. Moreover, the pattern can change from directional to bidirectional with all switches OFF.

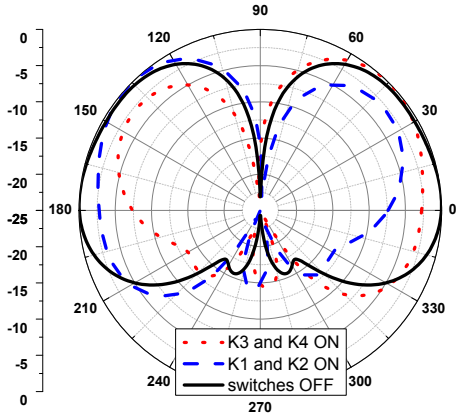


Fig.3. Normalized radiation pattern for the antenna at 10GHz.

Fig.4 shows the maximum gain and radiation efficiency versus frequency for the proposed pattern reconfigurable antenna. The performances of gain in the similar Yagi antenna mode are both higher than monopole mode. When the parasitic elements play a role of director or reflector, the gain will be improved, ranging from 0.53 dB to 1.73 dB. All the values of gain are above 4.33 dB. The antenna reaches higher than 95 percent radiation within all the operation frequency band at all operation modes.

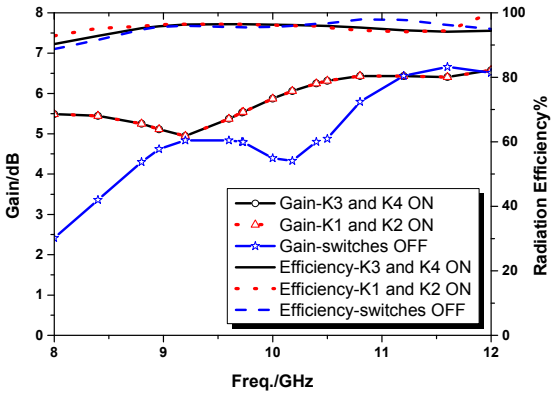


Fig.4. Antenna gain and radiation frequency versus frequency.

## 4. Conclusion

In this paper, a pattern reconfigurable DRA is presented, which adopts a conical DR fed by coplanar waveguide and parasitic elements with two pairs of switches. By changing the switches between ON and OFF, the antenna can achieve three different modes: one bidirectional radiation pattern and two directional radiation patterns. In addition, the proposed antenna has the advantages of well impedance matching, good gain and high efficiency.

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