

# Multimode Dielectric Resonator Antenna with a Small Ground Plane

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## Introduction.

Due to their high radiation efficiency and compact design, dielectric resonator (DR) antennas are of considerable interest for modern communication systems that require very small, light-weight and low-cost antenna elements [1-3]. In particular, the multimode dielectric resonator antenna, first introduced in [3], presents a unique opportunity for design of electrically small antennas with controllable radiation pattern and polarization characteristics [4]. The multimode dielectric resonator antennas may be also of interest in design of small antennas, since in the case a mixed TE + TM modes antenna that has a wider theoretical bandwidth limitation [5] can be implemented. Besides, by appropriate phasing of TE and TM modes a unidirectional radiation pattern can be realized thus increasing of the antenna gain by 3 dB. In the present paper a dielectric resonator antenna operating in the mixed TE+TM modes with unidirectional radiation pattern is suggested. The suggested antenna doesn't require an extended ground plane and provides high radiation efficiency with the overall antenna + ground plane dimensions of about  $0.3 \lambda$ . The presented design allows easy integration with solid state devices and it is suitable for photonic emitters [6] since it can easily be made on a semiconductor substrate.

## II. Antenna design

The geometry of a mixed mode dielectric resonator antenna is shown in Fig.1 (a, b). A hemispherical resonator is excited by a linear and ring slots coupled with the CPW for appropriate phasing (Fig. 1(b)). The RF power is supplied to the antenna through a coaxial semi rigid cable. The central conductor of the cable is connected to the central conductor of the CPW as it is shown in Fig. 1 (a,b). The outer conductor of the coaxial cable is connected to the substrate ground plane. In spite of the fact that the substrate thickness was chosen below cutoff, a significant level of spurious radiation from the substrate rim was indicated in computer simulations of the antenna. To suppress this unwanted radiation, the substrate rim was metallized and an additional quarter wave choke was introduced. The dimensions of the feed and position of the DR were optimized for the impedance bandwidth and minimum of cross polarization component. The antenna dimensions and the dielectric constants of the materials used are given in Fig. 1 (a, b) for the operating frequency of 2.37 GHz.

## III. Results

This DRA was simulated using 3D full wave simulator (Ansoft HFSS). The antenna return loss is plotted in Fig. 2. Up to 2.5% in impedance bandwidth (at a level -10 dB) was achieved for an antenna with overall dimensions of about 0.3 wavelength.. The antenna copolar radiation patterns in E and H planes are presented in Fig.3 a) and b), respectively. It was observed a good symmetry of the radiation pattern in E and H planes. The antenna gain of about 5 dB gain and the backward-to-forward radiation ratio of - 15 dB were achieved. The level of cross polarization is less than - 15 dB in the upper hemisphere. The results of computer simulations indicate that the antenna maintains acceptable levels (-15 dB) of cross-polarization up to very low angles of observation.

## Conclusion

The results of this research have shown that the use of multimode dielectric resonator antenna can be utilized to achieve high efficiency DRA having an acceptable bandwidth of 2.5 % with very small ground plane. A substantial improvement in impedance bandwidth for the multimode DR antennas with DR of high permittivity can be also achieved for antennas with circular polarization. The results of the corresponding computer simulations will be presented for discussion.

## References.

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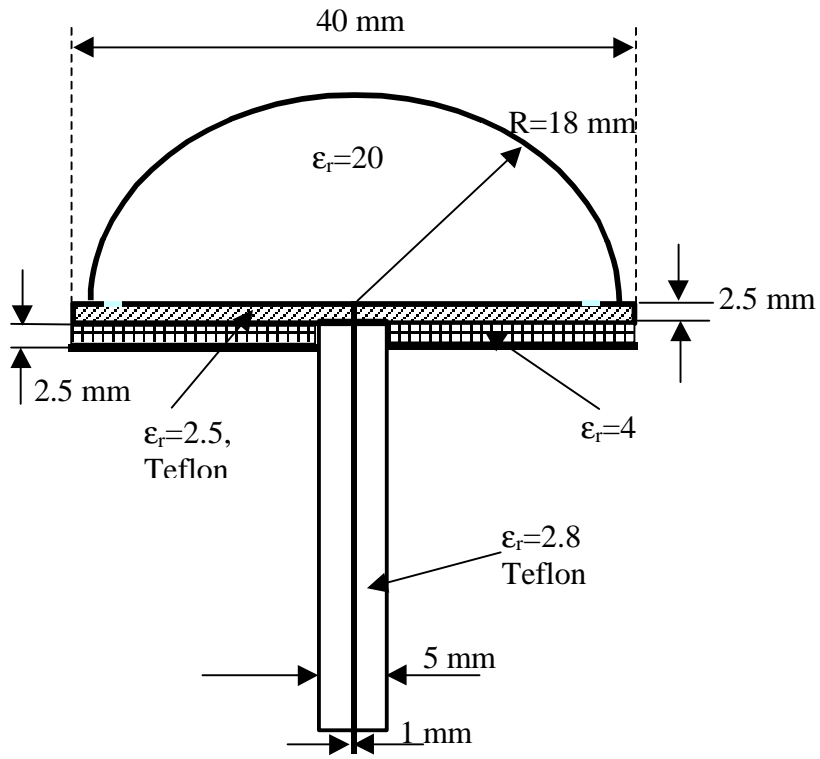


Fig 1 a)

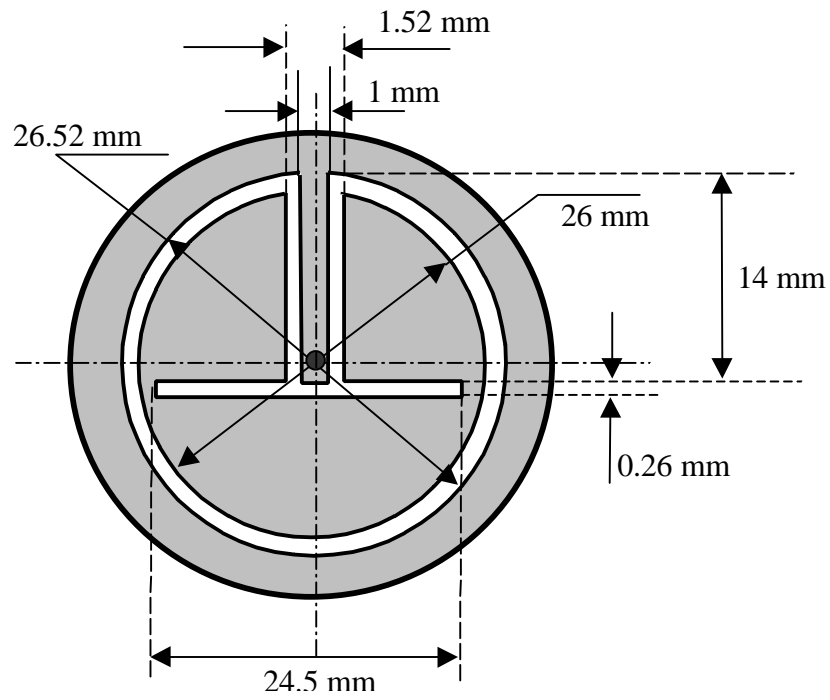


Fig.1 b)

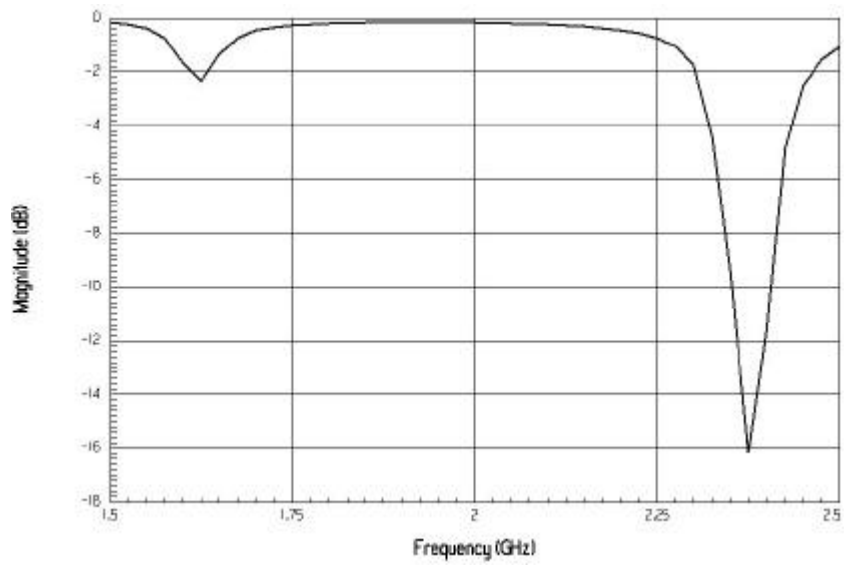
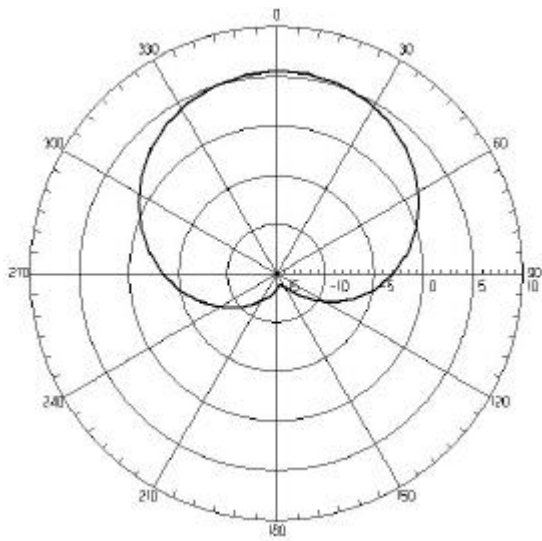
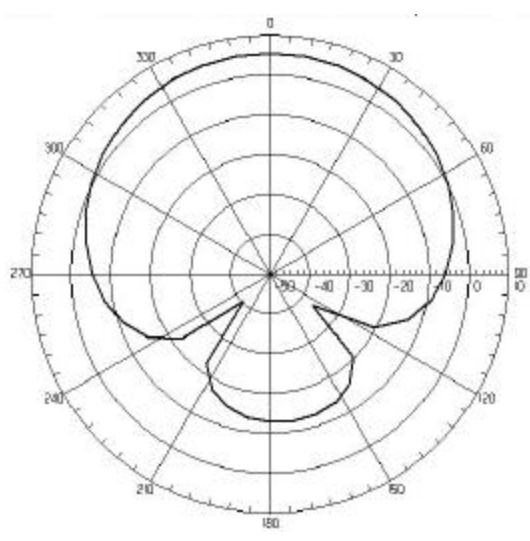


Fig. 2



a)



b)

Fig.3