

# DESIGN AND INVESTIGATION OF DIFFERENT STRUCTURE OF DIELECTRIC RESONATOR ANTENNA

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**Abstract-** Objective of this study is to enhance radius of curvature of return loss, input impedance & explore SWR and radiation pattern. Hollow CDRA has been used instead of single-element CDRA to achieve the above mentioned goal. The impedance bandwidth of a high permittivity hollow cylindrical dielectric resonator antenna excited by micro-strip lines was significantly improved by modifying the feed geometry. The main idea of the present study is to upgrade the bandwidth of the dielectric resonator Antenna. A new hollow cylindrical dielectric antenna above the ground plain is proposed here. The matching bandwidth is 4.45-5.85 GHz and maximum radiation gain are 5.37 dB at 5.045GHz. The 10 dB return loss bandwidth enhance 12% to 27.75% (4.45-5.85GHz) without much affecting the gain and other radiation properties of antenna. The performance of the dielectric resonator antenna is simulated by electromagnetic simulator CST Microwave Studio.

**Index Term-** Dielectric Resonator Antenna (DRA), matching bandwidth, hollow cylindrical dielectric antenna (HCDRA), S11- parameter and impedance bandwidth (IBW).

## I. INTRODUCTION

Antenna is the one type of the conductor through which an RF current is flowing. Any conductor that can intercept an RF field can be an antenna .An antenna is a transducer (sensor), which converts electric power into radio waves, and vice versa. Wireless Communication is impossible without Antenna. Antennas are essential components of all equipment that uses radio waves. For Example, radio broad-leaved, broad-leaved television, two-way radio communications receivers, radar, cell phones, and satellite telephone communications, as well as other devices such as garage door openers, wireless

microphones, Bluetooth enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise. In transmission, a radio transmitter supplies an oscillating radio frequency electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). Reciprocity Theorem says that, "antenna's properties are the same, whether it is used for transmitting or receiving."

## II. TYPES OF ANTENNA

According to their applications and technology available, antennas generally fall in one of two categories:

**1)Omni directional;** - which receive or radiate equal power or electromagnetic wave in all directions. Omni directional antenna oriented vertically is widely used for non-directional antennas on the surface of the earth because they radiate equally in all horizontal directions.

**2) Directional** ;- - which receive or radiate electromagnetic wave in particular directions. It provides increased performance over dipole antenna when a greater concentration of radiation in a certain direction is desired. For long and medium wavelength frequencies , tower arrays are used in most cases as directional antennas

**3)Wire antenna;**- wire antenna is used in automobiles , buildings , shape , aircraft and space craft's. In this antenna also classify in other three types 1. Dipole 2. Circular loop 3. Helix

**4)Aperture antennas;**- this antenna are very useful for aircraft and space craft application because they can be easily mounted on the body of these vehicles. In this antenna also classify in other three types 1. Pyramidal Horn 2. Conical Horn 3. Rectangular Waveguide

**5)Array Antenna;**- Specific direction than can be achieved by an only one element. Arrangement of radiating elements in a linear, planner or in any other

geometric. In this antenna also classify in other three types 1. Yagi- Uda array 2. Aperture array 3. Slotted-waveguide array.

**6) Reflector antennas;-** it is used in long distance communication of signals parabolic and casse grain reflector antenna . It can be used to transmit signals to millions of miles.

**7) Lens antenna;-** geometric optics that lenses are used to collimate incident divergent energy and to prevent it from spreading in undesired directions. By choosing appropriate material and shape of the lenses. They can be used to transform various forms of divergent energy in to plane waves. Mostly used at very high frequencies

### III. DESCRIPTION OF THE DRA

The dielectric resonator antenna (DRA) has long been of interest because of many advantages such as its small size ,low cost, light weight, reasonable bandwidth, and ease of excitation[7], [2]. It also has the advantages of no conductive and surface wave losses. Dielectric resonator antenna consists of dielectric materials. Dielectric patch also called as dielectric resonators (DRs) and there one side of the substrate and has a ground plane (metal) on the other side [1], [2]. The dielectric constant of the DRAs can vary from 2 to 100. Mainly three shapes of The dielectric resonators i.e. circular, rectangular and triangular, hollow but rectangular shape is generally used because the design and analysis of rectangular shape is comparatively easy [3], [4].the DRA has a much wider impedance bandwidth ( $\sim 10\%$  for dielectric constant  $\epsilon_r \sim 10$ ) As compared to the patch antenna. This is because the DRA radiates through the whole DRA surface except the ground part Where's the patch antenna radiates only through two narrow radiation slots, [1]. However, many characteristics of the Patch antenna and DRA are common because both of them behave like resonant cavities. the relative permittivity  $\epsilon_r$  of the substrate should be low ( $\epsilon_r < 2.5$ ), to enhance the fringing fields that account for the radiation. However, as per the performance requirements, the value of the dielectric constant of the substrate may vary and can be of some greater value (say 4.4). Sometimes if we increase the dielectric constant or relative permittivity of the substrate or the dielectric resonators (DRs) there is chance to increase the performance of the antenna, but materials which having a higher dielectric constant values may or may not be available for fabrication There

are a number of effective excitation methods that can be used for DRAs. the resonant frequency and -factor can be tuned by varying the height/width/length and dielectric constant. Some of the examples are the coaxial probe, aperture-coupling with a microstrip feed line, aperture-coupling with a coaxial feed line, direct microstrip feed line, co-planar feed, soldered-through probe, slot line, strip line, proximity coupled microstrip feed, conformal strip, and dielectric image guide feed[1], [5], [6].

### IV. METHODS OF BANDWIDTH ENHANCEMENT

**4.1 Single Dielectric Resonator Antenna;-** The DRA of high permittivity constant has high Q factor and very small bandwidth which can be slightly increased by Single DRA design with Low permittivity that gives compact size with typical bandwidth of about 10%.The coupling is through the microstrip feed [Long S.A. et al(1983)].

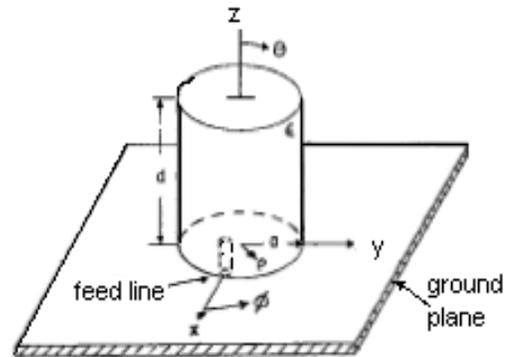


Fig.1 High permittivity Dielectric Resonator Antenna[7]

**4.2 Parasitic DRA;-** The combined effect of DRA and parasitic elements produce wideband operation. The individual BW of DRA is 5.8% while combined the two DRA so at that time BW gets around 17%.The gain is also improved due to parasitic elements. In This technique has main drawbacks of single feed between DRA and parasitic , so low coupling to parasitic elements and no matching network .It has high Volume [Petosa and A. Ittipibon 1998].

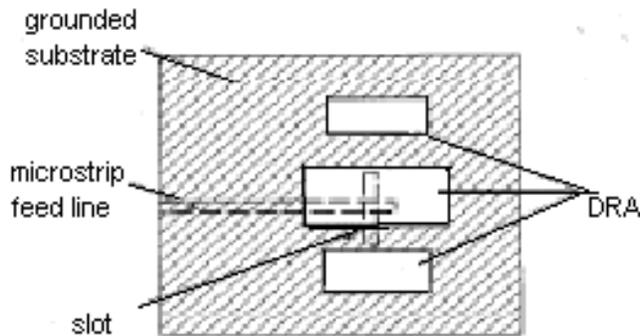


Fig .2 DRA with parasitic elements[1]

**4.3 Multi segment DRA;-** Multi Segment DRA improve the coupling to a micro strip line. Strong Coupling is possible due to high permittivity DRA..Wide bandwidth is achieved by low permittivity DR. In the method High  $\epsilon_r$  DR is inserted below Low  $\epsilon_r$  DR for matching impedance of DRA. This technique can enhance the bandwidth up to 20 %.This method has the limitation of increased volume & weight [aldo petosa(2009)].

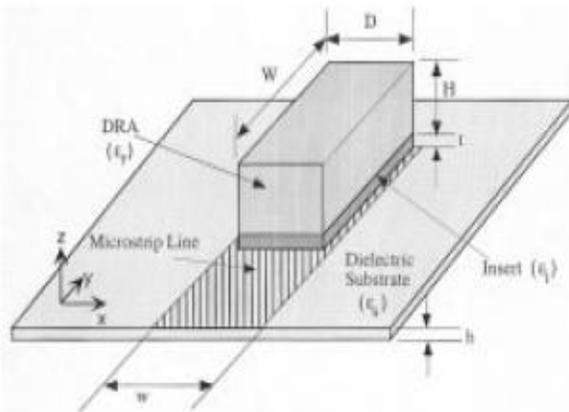


Fig. 3 Multi Segment DRA[7]

**4.4 Introducing gap between ground plane and dielectric resonator antenna;-**By Introducing Gap between ground plane and Dielectric resonator antenna, Q-factor can be effectively reduced and exhibit a broader bandwidth. Bandwidth of around 30 % has been obtained. This method has drawback of large volume and Extra support [G.P. Junker et al 1994].

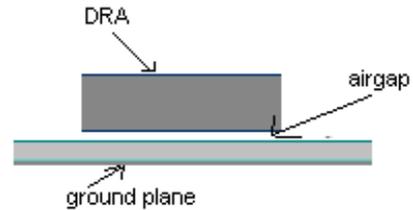


Fig. 4 Dielectric resonator with air gap between ground plane and DRA[10]

### V. ADVANTAGES AND ISSUES

DRA Advantages is they cannot consist the metal parts because it is lossy at high frequency dissipating energy , so these antenna can have lower losses and be more efficient than metal antenna at high microwave and millimeter wave frequency [8].it used in some compact portable wireless device & millimeter wave radar equipment. The size of the DRA can be significantly reduced. No inherent conductor loss in DR.

In DRA some issues are create like Bandwidth enhancement is one of the major design considerations for most practical applications of Dielectric resonator antennas. Micro strip antennas have some limitations compared to dielectric resonator antennas as narrow bandwidth, lower gain, lower power handling capacity etc. For that reason, dielectric resonator antennas are preferred over microstrip and conventional antennas. The conductor loss of metallic antennas becomes severe and the efficiency of the antenna is reduced significantly at these frequencies. But the only loss for a DRA is that due to the imperfect dielectric material, and its value is almost negligible. After the cylindrical DRA has been studied, Long and his colleagues subsequently investigated the rectangular and hemispherical DRAs [3], [4]. Analysis of their resonant modes, radiation patterns, and method of excitation made it clear that these dielectric resonators could be used as antennas and offered a new and attractive alternative to traditional low gain radiators. In the early 1990, emphasis was placed on realizing various analytical or numerical

### VI. CONCLUSION

A new method for improvement the impedance bandwidth of microstrip antennas is proposed. This approach improve the gain of the antenna , as well as

enabling impedance tuning. Optimum rectangular ( $BW > 10\%$ ) and circular ( $BW > 6\%$ ) antenna configurations are demonstrated. These configurations may find applications in wideband phased arrays.

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