Two Element Cylindrical Dielectric Resonator Antenna Array with Annular Shaped Microstrip Feed

Gourab Das  
Department of Electronics Engineering  
Indian School of Mines  
Dhanbad, India  
E-mail: gourabecehit@gmail.com

Ravi Kumar Gangwar  
Department of Electronics Engineering  
Indian School of Mines  
Dhanbad, India  
E-mail: ravi8331@gmail.com

Abstract— In this paper, design and simulation of a two element wideband cylindrical Dielectric Resonator Antenna Array with annular shaped microstrip feed is presented for wireless application. Simulation result shows that the proposed antenna achieves wide impedance bandwidth from 4.4 GHz to 6.35 GHz covering complete 5.0 GHz wireless band. The proposed antenna provides the appreciable gain and better radiation throughout the impedance bandwidth.

Keywords— CDRA Array; microstrip feed; wireless.

I. INTRODUCTION

Recently interest has increased in the study of Dielectric Resonator Antenna for their small size, low cost, low profile, ease of excitation and absence of conductor. Due to zero inherent conduction loss and high efficiency DRAs are far superior to microstrip-patch antennas [1]-[4].

In many cases, desired specification such as high gain, high directivity, high efficiency, and directional radiation pattern cannot be achieved with a single DRA of any shape. So DRA Array with appropriate element spacing and modified feed arrangement can be used to provide desired specification[5]-[7]. A number of excitation method such as coaxial probe feed, aperture coupling feed, coplanar waveguide feed, dielectric image guide feed, direct microstrip line feed are used to excite DRA. Among the various excitation methods annular shaped microstrip feed is used for wideband application [8].

In this paper we present a two element CDRA Array with annular shaped microstrip feed for wireless application. The proposed array covers 5.0 GHz WiMAX and WLAN bands. The design methodology and detail results of the proposed DRA Array are discussed in this paper. In section II CDRA Array geometry is discussed clearly. In section III simulation results and discussion have been presented.

II. ANTENNA STRUCTURE

The geometry of the annular-shape microstrip feed with a cylindrical dielectric resonator antenna (DRA) array is presented in Fig. 1. Fig. 1(a) shows the top view of the proposed geometry with the annular microstrip feeding structure. The panoramic view of the proposed cylindrical dielectric resonator antenna is shown in Fig. 1(b). Alumina Ceramic ($\varepsilon_r=9.8$) is used to fabricate Dielectric Resonator. The CDRA has been placed on a substrate having dielectric constant ($\varepsilon_r=4.4$) with 1.6mm thickness.

Fig 1. Geometry of the proposed antenna  
(a) top view (b) panoramic view

The prototype of the annular shape parallel microstrip feed network is shown in the Fig 2. In this proposed feeding network architecture only two quarter wave impedance transformers are used to transform impedances efficiently for two element array. This reduces number of discontinuities in the circuit and comparatively more power would transfer to the feeding arms.
Fig 2. Annular shape parallel microstrip feed network

Table I. Dimension of the various design parameter of the proposed antenna

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Parameter</th>
<th>Dimension Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of the substrate ($L_s$)</td>
<td>70mm</td>
</tr>
<tr>
<td>2</td>
<td>Width of the substrate($W_s$)</td>
<td>52.76mm</td>
</tr>
<tr>
<td>3</td>
<td>Height of the substrate($h$)</td>
<td>1.6mm</td>
</tr>
<tr>
<td>4</td>
<td>Radius of the DRA($r_1$)</td>
<td>6.2mm</td>
</tr>
<tr>
<td>5</td>
<td>Height of the DRA($h$)</td>
<td>4mm</td>
</tr>
<tr>
<td>6</td>
<td>Distance between two DRA($L$)</td>
<td>41.5mm</td>
</tr>
<tr>
<td>7</td>
<td>Length of the Partial ground Plane($W_p$)</td>
<td>31mm</td>
</tr>
<tr>
<td>8</td>
<td>Distance between the center of the DR and inner portion of the annular feed($r_2$)</td>
<td>7mm</td>
</tr>
<tr>
<td>9</td>
<td>Width of the 50Ω microstrip line</td>
<td>3.09mm</td>
</tr>
<tr>
<td>10</td>
<td>Width of the 70Ω microstrip line</td>
<td>1.96mm</td>
</tr>
<tr>
<td>11</td>
<td>Width of the 100Ω microstrip line</td>
<td>0.71mm</td>
</tr>
</tbody>
</table>

III. RESULTS AND DISCUSSIONS

Cylindrical DRA array with annular shaped microstrip feed network simulated using Ansoft HFSS simulation. The variation in return loss versus frequency for proposed array is shown in Fig. 3. From Fig. 3 it can be observed that the proposed antenna shows the wide bandwidth of 36.2% at center frequency 5.37GHz. It is also observed that array resonate at two resonant frequencies. One resonant frequency occurs at 5.0 GHz due to microstrip feed and other resonant frequency occurs at 6.0 GHz due to cylindrical DRA. The wideband characteristics are obtained due to the resonances of both microstrip feed and the DRA. When the microstrip feed is in resonance, the dielectric resonator acts as a high permittivity load and provides wideband characteristics [8].

The surface current distribution for proposed array is shown in Fig. 4 at 5.0 and 6.0 GHz. It has been observed from Fig. 4 that the first resonant frequency at 5.0 GHz occur due to the microstrip feed and the second resonant resonance frequency occur at 6.0 GHz due to the cylindrical DR.

Fig 3. Simulated input reflection coefficient S11(dB) of the proposed antenna

Fig 4. Simulated surface current distribution of proposed cylindrical DRA array with annular- shaped microstrip feed. (a) 5.0 GHz. (b) 6.0 GHz.
Figs. 5 and 6 show the simulated co- and cross polarized radiation patterns in xz-, xy-, and yz-planes at the frequencies of 5 GHz and 6 GHz, respectively. From Fig. 5 it is observed that almost omnidirectional and monopole type radiation pattern at xz-plane and yz-plane. From Fig. 6 we find that almost omnidirectional radiation pattern at xz-plane and xy-plane. It is also observed that almost monopole type radiation pattern at 6.0 GHz in yz-plane.

Fig. 7 shows the simulated gain versus frequency of the proposed DRA Array, from fig. 7 it has been observed that the antenna give maximum gain 6.2 dBi at 5 GHz frequency.

Fig. 5. Simulated Radiation pattern of proposed antenna. (a) XZ-Plane, (b) XY-Plane and (c) YZ-Plane at 5GHz.
**IV. CONCLUSION**

In this paper a two CDRA Array with annular shaped microstrip feed is presented for wireless application. The proposed DRA Array consist of two cylindrical dielectric resonator of same sized which are excited by annular shaped microstrip line in corporate feeding technique. The simulated result shows that the designed antenna covers frequency range from 4.4 GHz to 6.35 GHz which cover several important application bands in wireless communication system.

**References**


