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A Wideband H Shape Dielectric Resonator Antenna for Wireless MIMO Systems

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Abstract*— The present work deals with the design of a wideband H- shaped Dielectric Resonator Antenna (DRA) that can be used for wireless MIMO systems. The proposed antenna resonates at a dual band of 6.26 GHz and 15.2 GHz giving an impedance bandwidth of 119%. A 2×2 MIMO system is developed by using the proposed antenna resonating at a dual band of 6.35 GHz and 15.53 GHz with an impedance bandwidth of 119% and a mutual coupling of -21dB and -25 dB at the operating frequencies. The developed antenna system can be widely used for the 4G and WiMAX applications.

Keywords: **Dielectric Resonator Antenna, Coaxial probe, Mutual coupling, Impedance bandwidth.**

I. INTRODUCTION

The Multiple Input Multiple Output **(**MIMO) technology has recently developed as a new technology to achieve very high bandwidth efficiencies and larger data rates in modern wireless communications. The MIMO technology was first studied by the pioneer Foschini [1]. In MIMO technology multiple antennas are placed at the input and output side of a communication system to improve the channel capacities. The multidimensional statistical behavior of the MIMO fading channel and the design parameters of the antennas that are taken at the transmitter and receiver side are responsible for the improvement of data rates [2].

Multiple Input Multiple Output (MIMO) technology is the latest paradigm, where multiple antennas are used at both transmitter and receiver to improve communication performance. It is one of several forms of smart antenna technology. MIMO technology has attracted attention in wireless communications, because it offers significant increase in data throughput, channel capacity [3] and link range without additional bandwidth or increase transmitted power. Because of these properties, M|IMO is an important part of modern wireless communication standards such as IEEE802.11n (Wi-Fi), 4G, 3GPP long term evolution, WiMAX (Wireless interoperability for microwave access) and HSPA (High Speed Packet Access) etc.

The main objective of MIMO systems is that the antennas in the array must provide diverse reception at smaller spacing. When the antennas are closely placed, the electromagnetic waves of different antennas interfere with each other resulting in signal loss. The mutual coupling describes the amount of interference between the elements of the array, and the main objective of any antenna design for a wireless MIMO system is to reduce this mutual coupling. The impact of mutual coupling on capacity of MIMO wireless channels is studied in [4]. The main cause of this mutual coupling is studied in [5] and [6]. In the present work, an H-shaped patch antenna is designed, which is suitable for UWB (Ultra wide band) applications. The designed antenna resonates at a dual band frequency of 6.27GHz and 15.2 GHz, giving an impedance bandwidth of 119%. A two element MIMO system is developed by using the proposed antenna and a mutual coupling of -21 dB and -25 dB is observed between the two antennas for a separation of 10 mm.

II. ANTENNA DESIGN

DRA are nowadays, popular due to their attractive features like high radiation efficiency, low dissipation loss, small size, light weight, and low profile [7]. Moreover, DRAs which posses a high degree of design flexibility, have emerged as an ideal candidate for wide band, high efficiency, and cost-effective applications. Recently more and more Ultra wideband antenna designs have been proposed especially Stacking of two DRAs, DRAs separated by wall, Antenna mounted on a vertical ground plane. The H- shaped dielectric resonator antenna designed in this paper offers more impedance bandwidth compared to a H shaped dielectric resonator antenna fed by microstrip feed [8].

The antenna geometry is shown in Fig.1, which is fed by a coaxial probe. The patch antenna is designed on the ground plane of size 20×20.6 mm^2. The antenna is designed with the following dimensions: The size of DRA is 14mm length and 16.3 mm width and 5 mm thickness with dielectric constant 10.2. Here, the material used for the substrate has a low dielectric permittivity of 1.07 with a thickness of 1mm. The entire antenna system is fed with a coaxial probe of outer radius 1.8 mm and inner radius 0.9 mm at the location (5, 16.3).

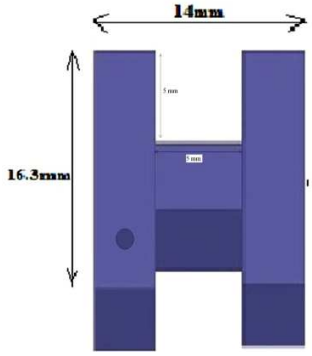

Fig.1. H shaped dielectric resonator antenna

The simulation results of return loss for the H shaped dielectric resonator antenna are shown in the Fig.2. The antenna resonates at a dual band of frequencies 6.26 GHz and 15.2 GHz, with a return loss of -24 dB and -17 dB respectively giving an impedance bandwidth of 119%. Hence

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the proposed shape is much suitable for MIMO systems and WiMAX applications. The above bandwidth is obtained for VSWR ≤1.14. The VSWR plot of the proposed antenna is shown in Fig.3. The radiation patterns at both resonating frequencies are shown in the Fig.4 (a) and 4 (b) respectively. The gain plot is shown in Fig.5.

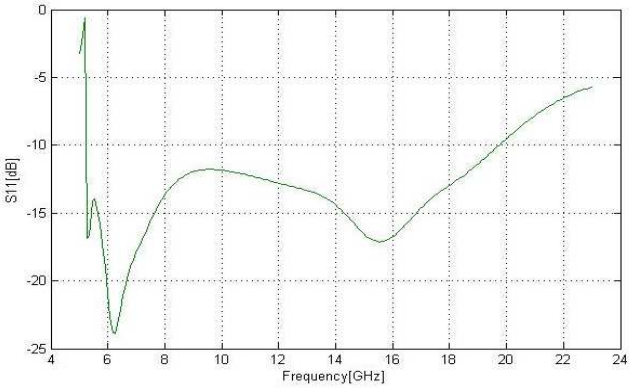


Fig.2. Return loss of H shaped DRA

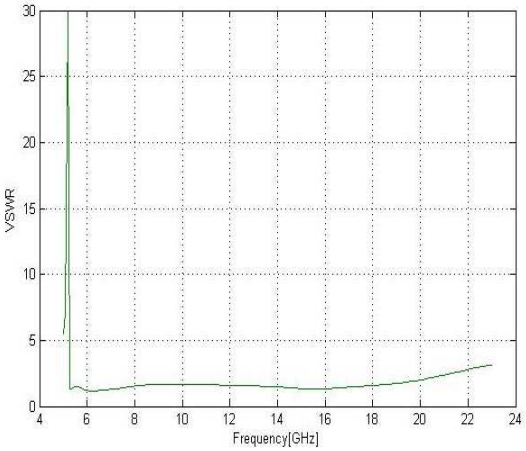
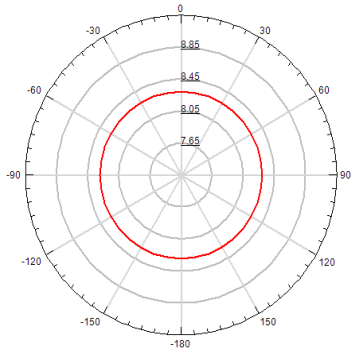
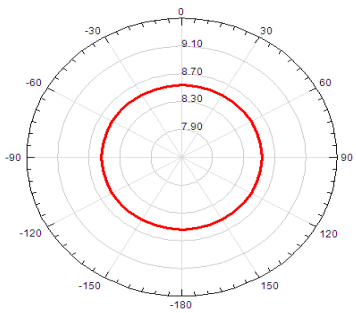


Fig.3. VSWR plot of the proposed Antenna



(a)



(b)

Fig.4. Radiation pattern at (a) 6.26GHz (b) 15.2 GHz

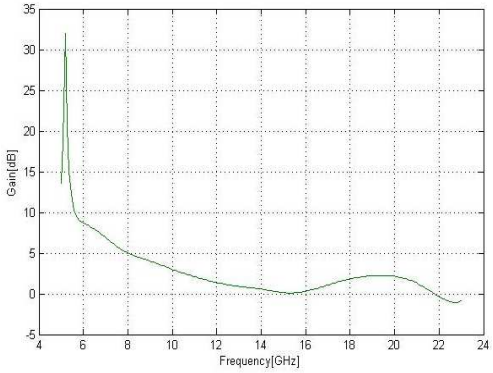


Fig. 5. Gain plot

III. TWO ELEMENT MIMO ARRAY USING THE H SHAPED DRA

In MIMO systems, the major problem faced by the designers is mutual coupling, which arises mainly due to the electromagnetic interactions between the antennas in the array. This problem mainly occurs due to the small spacing between the antennas in the array. The mutual coupling can be minimized by using diversity techniques, which is mentioned in [9] and [10]. Here, a two element MIMO array is designed by using the proposed H shaped patch antenna with a spacing of 10 mm between the two elements. The array is designed on a ground plane of dimensions 54.4×30 mm^2. The geometry of the dielectric resonator antenna MIMO array is shown in Fig.6. The S parameters of the developed MIMO system are shown in Fig.7. The two element array resonates at 6.35 GHz and 15.53 GHz giving the impedance bandwidth of 119%. The corresponding mutual coupling (S_{21}) values obtained at the resonant frequencies are observed as -21 dB and -25 dB. The obtained bandwidth and isolation are adequate for most of the Wi-max applications.

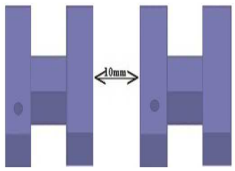


Fig.6. Two element MIMO array

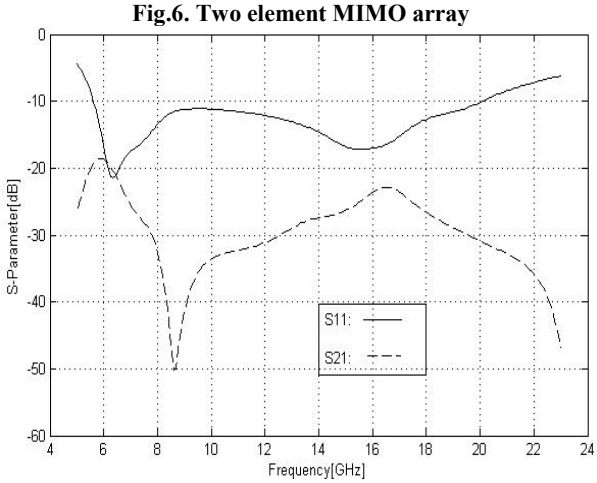


Fig.7. S parameters of MIMO array

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IV. CONCLUSION

In this work, an H shaped dielectric resonator antenna fed by a coaxial probe feed is designed, which can be used for MIMO systems. The proposed antenna resonates at a dual band giving an impedance bandwidth of 119%. A two element MIMO array developed with the proposed antenna gives a mutual coupling of -21dB and -25 dB at the operating frequencies. Hence, the proposed system can be used in many MIMO systems, where higher bandwidth and isolation is desired.

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