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Bandwidth Enhancement of MHD Antenna for Wireless Applications

Faizan Hameed[1], Rajesh Parihar[2]

Student of CBS Group of Institute, Jhajjar[1]

Assistant Professor and HOD ECE, CBS Group of Institute, Jhajjar[2]

Abstract: In this Paper Dielectric Resonator Antennas (DRAs) have received lots of attention in the last two decades due to several attractive characteristics such as high radiation efficiency, light weight, and low profile. There is also increasing challenges for the design of high bandwidth and multi-bands antennas which can be achieved using MHD Antennas for high speed and reconfigurable applications in wireless communication. In this work the objective is to design and develop a cylindrical MHD antenna with circular patch and two annular rings. Magneto-hydrodynamics (MHD) Antenna is a Fluid based Antenna in which the fluid resonator provides excellent coupling of RF energy into fluid. Fluid resonator volume, chemical properties, electric field and magnetic fields are the factors of resonant frequency, gain and return loss. The proposed antenna shall be tuned in the wide band of frequency range between 7.9 – 27 GHz.

Key Words: MHD, DRAs, isolation, coupling etc.

I. INTRODUCTION

The word magneto hydro dynamics (MHD) is derived from magneto – meaning magnetic field, hydro –meaning liquid, and dynamics meaning movement. The field of MHD was initiated by Hannes Alfvén in 1942 and later in 1970, Ting and King determined that the conducting fluid can oscillates under the influence of electromagnetic field conditions. This conducting fluid can be used as one of the element of antenna at microwave frequencies. An antenna based on the MHD principle using hybrid approach in which a Dielectric Fluid Resonator in combination with circular patch and annular rings is presented. The feed given to this antenna is a microstrip feed. The fluid resonator was filled with 'Air' and 'BSTO (Barium Strontium Titanate Oxide) microwave fluid'. The molecules of the fluid oscillate and impact ionization takes place due to which electromagnetic field changes. The circular patch helps the fluid to resonate in the cylindrical shaped fluid resonator. The annular rings used around Fluid resonator provide multi-band operation.

Measurement for Resonant frequency, Return Loss and impedance matching using 40GHz Agilent VNA (Vector Network Analyzer) 5230A has been performed. In addition to above parameters simulations using HFSS have been carried out for S11, Radiation Pattern and Gain. Taking benefit from the advantages of DRAs and the antenna symmetry using hybrid approach, the results shows wideband (7.9-27 GHz) with multiband features and shift of resonant frequencies by changing fluid volume for the proposed Antenna Prototype.

II. ANTENNA CONFIGURATION AND DESIGN

The design methodology started with the investigations of an optimized UWB antenna reported in [6][8][4]. The literature also surveyed regarding reconfigurability in [1][2][3]. The multiband operations using annular rings and patch has been studied from [5][7]. Fig. 1 shows the proposed antenna structure in which a circular patch with two annular rings with a microstrip feed has been designed as per dimensions. The feed is attached to outer annular ring and a hollow cylindrical shaped Propylene Random Copolymer (PPR) pipe was fixed on FR4 glass epoxy substrate onto the circular patch.

For an Annular ring Microstrip Antenna (ARMSA) with inner radius 'a' and outer radius 'b' with b/a=2; and given values of n and εr, solving the characteristic equation for knm the resonant frequency can be determined by using eq.-(1)

The resonant frequency of Fluid MHD antenna for cylindrical shape can be computed by the formula shown below in eq.-(2) for DR (Dielectric Resonator) Antenna, where R/H is axial ratio for lowest TE mode. F_{111} is the fundamental frequency of oscillation and R is radius and H is height of cylindrical DRA[1].

………(2)

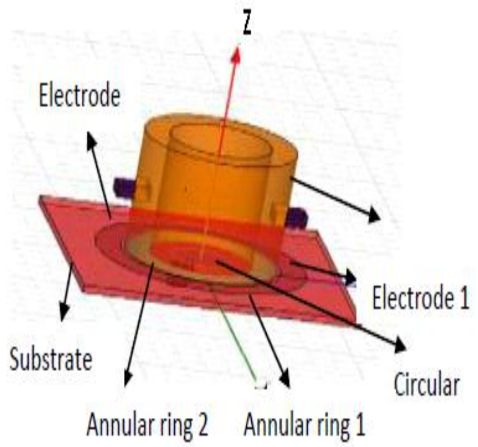

Fig. 1: Proposed Hybrid MHD Antenna (Front View)

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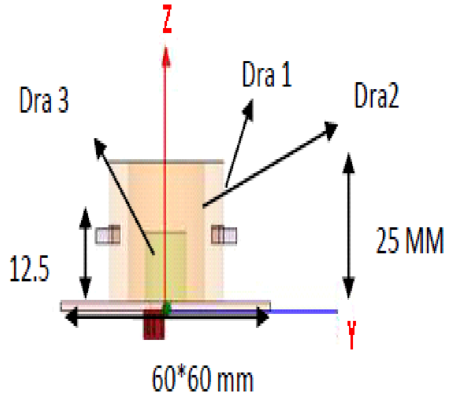

Fig. 2: Proposed Hybrid MHD Antenna (Side View)

III. SIMULATION RESULTS

The proposed antenna with the various ground plane structures is simulated using the commercial software HFSS.

The simulated results of S-parameters and radiation pattern are obtained in the frequency range of 3-11 GHz and analyzed for isolation and bandwidth performance characteristics.

Bandwidth Characteristics:

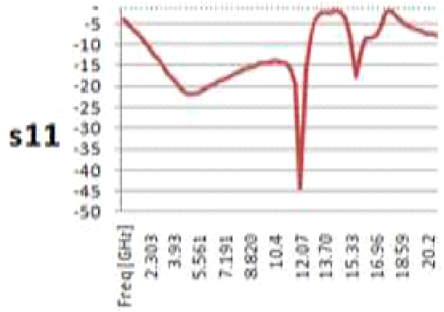

Fig. 3: Return loss without using stacked DRA

In this structure when DRA adding with ε_r =5.7, 10 achieved the bandwidth of this antenna 2.5 to 12.9 GHz and return loss is -45 dB fig. 3.

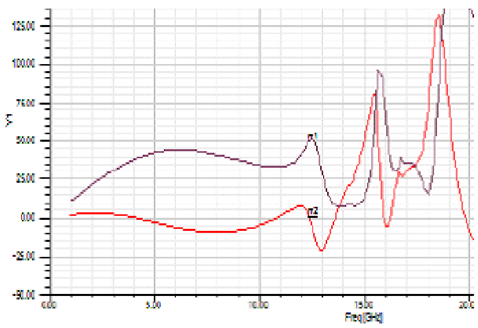

Fig. 4: Impedance Matching

Impedance matching in fig.4 real part m1 is 49.93 and imaginary part m2 is 0.785 so proper impedance matching on 12.4 GHz of resonant frequency.

When complete the structure concentric annular rings embedded DRA then achieve the gain 1.5 dB. Show in figure 5

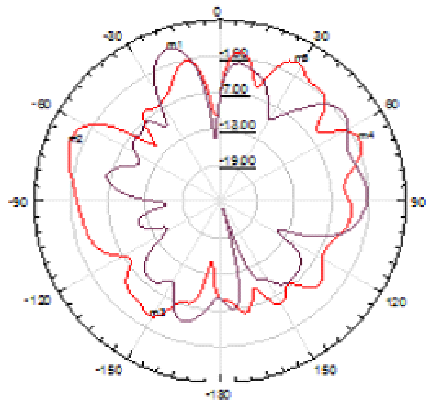

Fig. 5: Radiation Pattern

D.C. bias using in this structure then S_{11}.

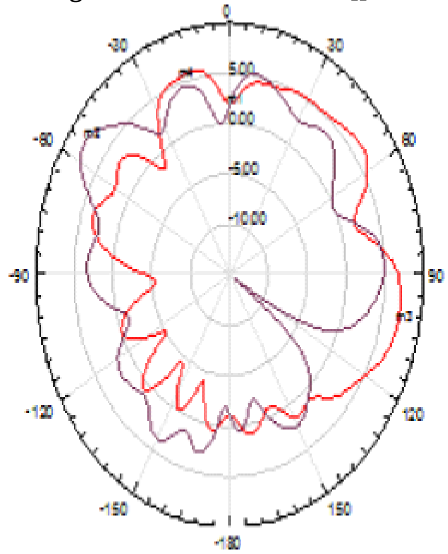

Fig. 6: Radiation Pattern using DC bias

In this figure 6 gain is achieved **7.79 dB.** After ground doing negative and both of electrode assign positive voltage 20v then gain is 9.67 dB in fig. 7

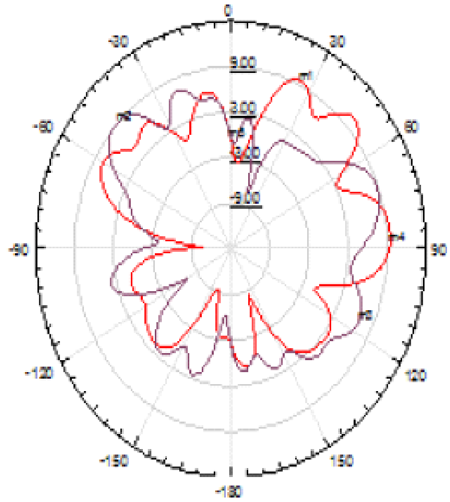

Fig. 7: Radiation Pattern using 20V DC bias

Adding magnetic bias of 2500 T magnetic saturation in this structure then S11 show in figure 8.

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Fig. 8: Return Loss

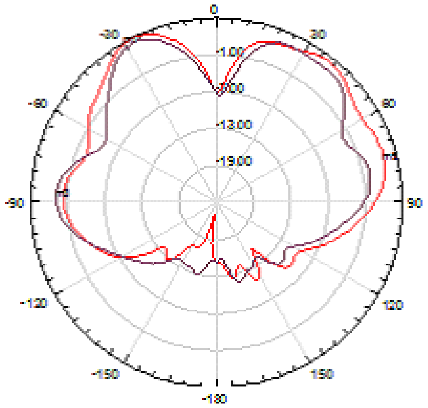

Fig. 9: Radiation pattern with electric and magnetic

IV. CONCLUSION

In this paper impedance, bandwidth higher 10GHZ and with DC bias this bandwidth is 8 GHz but gain improve of 75%.when I given magnetic bias with different magnetic saturation ,they decreases return loss and given effective radiation pattern .Widely application for wireless communication and military, naval, air force applications.

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