Microstrip Line Fed RDRA with Improved Bandwidth

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***Abstract*— A hybrid dielectric resonator antenna structure is presented with enhanced impedance bandwidth. The proposed antenna uses a DRA element of permittivity 10.2. The impedance bandwidth is improved by inserting an open ended microstripline resonator (MSR). Proposed antenna shows a moderate gain of 5dBi and a broadside radiation characteristic. The DRA is presented for wireless applications at 7GHz.**

***Keywords*— hybrid, DRA, enhanced bandwidth, microstrip-line resonator (MSR)**

I. Introduction

Recently, dielectric resonator antennas (DRAs) have extensively drawn attention in modern wireless communication systems due to their many attractive features [1], such as high radiation efficiency, low ohmic loss, small size and wide impedance bandwidth as compared to microstrip antenna and great potential to work with different models. The bandwidth of a DRA is determined by its physical dimensions and the relative permittivity of the dielectric material used. The DRA with wide-band characteristics are obtained by using the stacking method [2]. A dielectric coating is used outside the DRA to enhance the bandwidth [3], [4]. Another resonating mode is generated and successfully merged with the DRA mode to achieve the enhanced bandwidth [5].In this paper, a hybrid structure is proposed to attain improved bandwidth. The hybrid structure can be considered as a combination of basic rectangular dielectric resonator antenna and another radiating structure. This arrangement can create two different radiating modes at the frequencies corresponding to their sources. For the proposed design, an open ended half wave microstripline resonator (MSR) is used to generate an auxiliary resonating mode. The auxiliary mode is effectively merged with the DRA mode to enhance the impedance bandwidth. The simulated reflection parameters and radiation characteristics are presented for the microwave applications at upper 6/7 GHz band.

II. Antenna Configuration

The proposed dual mode hybrid antenna is shown in Fig.1. It consists of a basic RDRA and an open ended microstripline resonator (MSR). The RDRA element is fed by an aperture on the ground plane of a 50Ω microstripline (W_m=1.8mm) on a substrate of permittivity 3.2 and a height h_{sub} of 0.762mm. The substrate has an area of 50x50mm^2 with full ground plane with an aperture. The RDRA's dimensions are calculated and obtained as: a=7mm, b=15mm and h=5mm [6]. This RDRA is designed for the resonating frequency of 7 GHz. The optimized dimensions of the aperture are l_s= 7mm and w_s = 1.1mm. The center of the aperture coincides with that of the RDRA. The feed line is extended from the center of the aperture up to a length of s=6.4mm. This extended length is used as a tuning stub for impedance matching of the slot to the line. This RDRA is optimized for (f_1) 6.8 GHz. Another resonating mode is generated by inserting an open ended MSR which is half wavelength long at its (f_2) resonating frequency; f_2 is 7.2 GHz for this design. This auxiliary mode is fully independent and can be inserted at any desired frequency with proper consideration of its coupling with the main structure. In this design a gap coupling is used between the extended microstripline and the open ended MSR, the optimized dimensions for the design are g=0.2mm and L_o=11.8mm at 7.2 GHz. The material used for the RDRA in the proposed design is Rogers RT 6010 with a permittivity of 10.2.

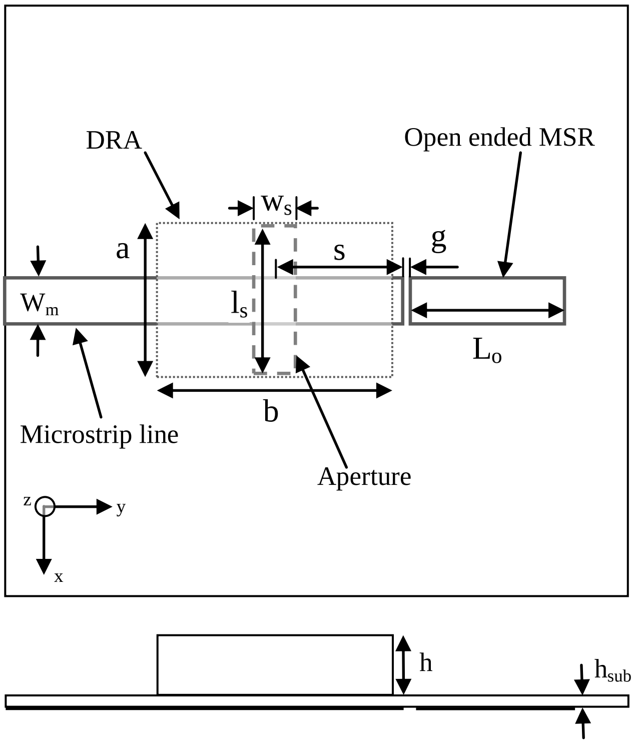


Fig. 1 Proposed Hybrid DRA

III. Simulation Results

Full wave EM simulator software is used for the analysis of the proposed design. In Fig. 2, simulated return loses are compared for both designs; when only RDRA is present (DRA mode) and when open ended MSR is embedded with the structure (MSR mode). It can be seen that insertion of auxiliary mode is not disturbing the basic DRA mode while total bandwidth is enhanced. Fig. 3 shows the effect of varying the length L_o. The length is properly chosen to achieve the maximum (-10dB) impedance bandwidth.

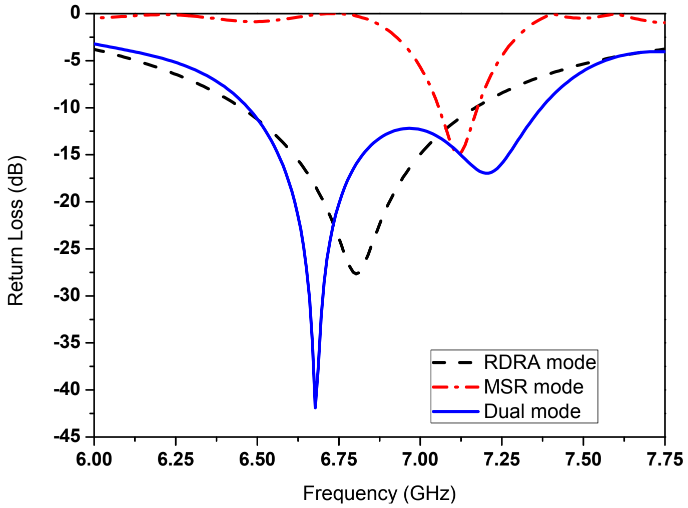


Fig. 2 Return loss of proposed antenna

The radiation pattern is also simulated at 6.8 GHz and 7.2 GHz and found broadside and omnidirectional respectively. The -3dB beamwidth (θ_{-3dB}) is improved from 91.6° to 95.5° in x-z plane, Fig. 4. Table 1 summarizes the improved parameters of the hybrid structure with a slightly dropped gain.

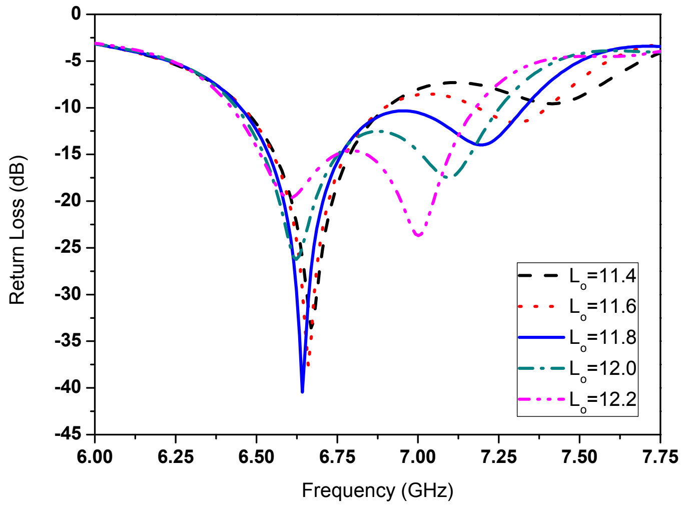
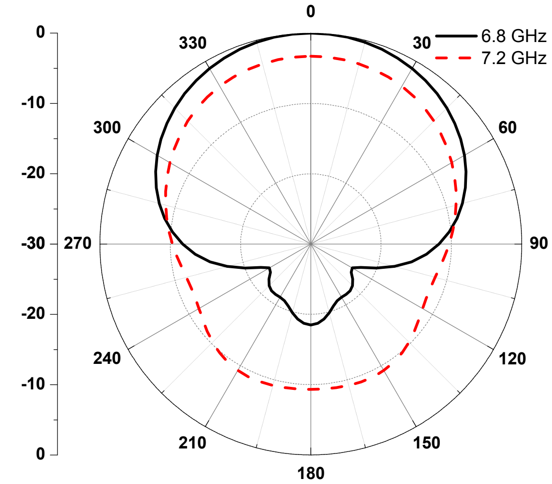


Fig. 3 Return loss variation with MSR length

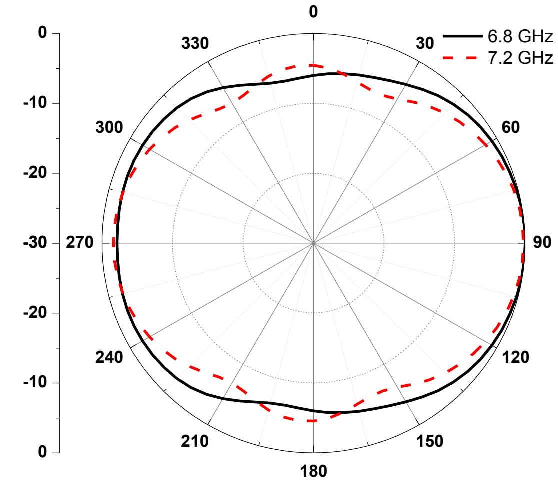
TABLE I

Simulation results of the antennas at 6.8 GHz

Structure	Impedance Bandwidth (MHz)	Centre Frequency (GHz)	FBW (%)	θ_{-3dB} x-z plane (degrees)	Gain (dBi)
RDRA	718	6.81	10.54	91.6	5.3
Hybrid	900	6.92	13.00	95.5	5



(a)



(b)

Fig. 4 E-field pattern of the proposed antenna in (a) x-z plane (b) x-y plane

IV. CONCLUSIONS

A new hybrid structure is explored and shown that an open ended MSR can be used as a capable auxiliary mode generator; when it is strongly coupled to the basic DRA structure. A microstrip gap is used to couple the two radiators. The proposed structure is very simple and feasible to fabricate to achieve a dual mode wide band characteristic. Contrary to other approaches, such as stacking different DRAs together, the proposed structure uses only one single DRA radiating element.

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