ANALYSIS OF ANNULAR RING SLOT MICROSTRIP ANTENNA FOR MULTIBAND OPERATION

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ABSTRACT

This paper presents a compact interconnected double ring slot [1] antenna operating at 1.151 GHz and 2.766 GHz. The radiating elements of the proposed antenna are composed of a interconnected Double ring slot. The antenna size is very compact (48.51mm ×62.02mm × 1.6mm), and can be integrated easily with other RF front-end circuits. It is demonstrated that the proposed antenna is a dual band antenna with satisfactory radiation characteristics. The simulations are carried out using Zeland IE3D software

Keywords: Double Ring Slot Antenna (ARSMSA), Return Loss, VSWR, Dual Band

I. INTRODUCTION

Recent interest has developed in radiator etched on electrically thick substrates as these antennas are used for high frequency applications. However, microstrip antennas inherently have narrow bandwidth. In many cases, their increased impedance bandwidth is also paid for poorer radiation characteristics. Recent interest in millimeter wave systems and monolithic fabrication, however, has created a need for substrates that are electrically thicker, and/or have high permittivity. Ring slot antennas have been of great interest to many researches and engineers and many related studies have been reported in the open literature. Many characteristics of the ring-slot antenna have been demonstrated [2, 3, and 4]; however, little information on the effects of a finite ground plane on the impedance and radiation characteristics of the ring-slot antennas is presented.

In order to determine the range of validity of these models, and to provide a database of measured data for the testing of improved models, this paper describes the results of a comprehensive set of measurements of interconnected double ring slot microstrip antennas.

II. ANNULAR-SLOT ANTENNA CONFIGURATIONS AND OPERATIONS

For the proposed annular-slot antenna, the first mode is mainly determined by the circumference of the inner and outer slot-rings (in case of multiple slots), and the second mode is mainly determined by the outer circumference. The annular-slot widths and the microstrip feed line parameters also have a significant effect on performance. An approximation is given by [5]:

$$\lambda_{gs}=2\pi R \quad (1)$$

where R is the radius of annular-slot, λ_{gs} is slot guided wavelength where:

$$\lambda_{gs}= \lambda_o\{1.045 - 0.365\ln\varepsilon_r + \frac{6.3(W/h)\ \varepsilon_r^{0.945}}{(238.64 + 100\,W/h)} - [0.148 - \frac{8.81(\varepsilon_r + 0.95)}{100\,\varepsilon_r}]\ \ln(h/\lambda_o)\} \quad (2)$$

he slot antenna is tightly coupled to the coaxial probe and hence, the feed line parameters are key factors. To achieve different dual band characteristics, it is necessary to tune and optimize the slot widths (for multiple rings).

For a single ring, when the mean circumference of the ring is equal to an integral multiple of the guided wavelength, the resonance is established and expressed as [6]:

$$l=2\pi R = n\lambda_{gs}, \text{ for } n= 1, 2, 3 .... \tag{3}$$

zWhere l is the mean circumference of the ring, λ_{gs} is the guided wavelength. The guided wavelength is related to the effective dielectric constant as:

$$\lambda_{gs}=\frac{\lambda_o}{\sqrt{\varepsilon_{eff}}}; \tag{4}$$

Where λ_o is the wavelength in free space, ε_{eff} is the effective dielectric constant. Thus, the resonant frequencies can be represented as:

$$f_n=\frac{nc_o}{l\sqrt{\varepsilon_{eff}}}, \tag{5}$$

for mode n=1, 2, 3 …where c is the speed of light. Equation 1 is applicable for multiple slot ring structure. This equation holds good for the analysis of slot ring (multiple ring) for multiband operation.

III. ANTENNA GEOMETRY AND DESIGN

The geometry of the proposed antenna is shown in Fig.1.The ground plane lies at the bottom side of the antenna with a compact size of 48.51mm × 62.02mm × 1.6mm.The radiation elements of the proposed antenna consist of interconnected double ring slot, operating approximately at operating at 1.151 GHz and 2.766 GHz). The design frequency is taken as 1.5 GHz. The antenna is proposed to design on a glass epoxy material with dielectric constant 4.2 and the thickness equal to 1.6mm. Fig. 1 is the exact figure as designed in Zeland IE3D The other parameters are calculated using [7] and found as: W=62.02mm, h= 1.6mm (assumed), ε_{eff}=3.998, L_{eff}=50.01mm, ΔL=0.75mm and L=48.51mm for ε_r=4.2. For a rectangular microstrip antenna the resonant frequency is given as[8]:

$$f_r = \frac{c}{2(L+\Delta L)\sqrt{\varepsilon_r}} \tag{6}$$

Where length extension (ΔL):

$$\Delta L = 0.412\, h\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)} \tag{7}$$

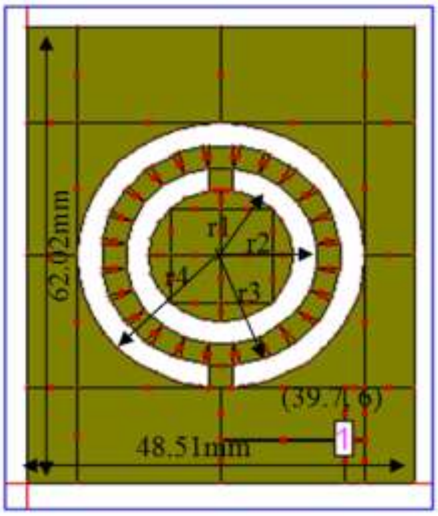

Fig.1: annular ring slot antenna W=62.02mm, h=1.6mm(assumed), ε_{eff}=3.998, L_{eff}=50.01mm, ΔL=0.75mm and L=48.51mm for ε_r=4.2.r1=18mm, r2=15mm, r3=12mm, r4=9mm

IV. SIMULATION AND RESULTS

The simulated return-loss (RL) and VSWR curve for the interconnected double ring slot antenna are shown in Fig. 2 and fig. 3. The substrate with dielectric constant ε_r = 4.2 and thickness h = 1.6 mm is used. A 50Ω coaxial probe is directly feeds at point (39.7, 6). Figure 2 shows the simulated return loss of the proposed slot antenna. The simulated result shows that the resonant frequency located at 1.151 and 2.766 with satisfactory radiation characteristics covering some UWB spectrum.

The antennas were simulated for VSWR and return loss using Zeland IE3D software. A careful simulation study of resonant frequency, bandwidth and return loss of the antenna was undertaken and the results of return loss are presented. The radiation elements of the proposed antenna consist of an interconnected double ring slot, operating at dual frequency.

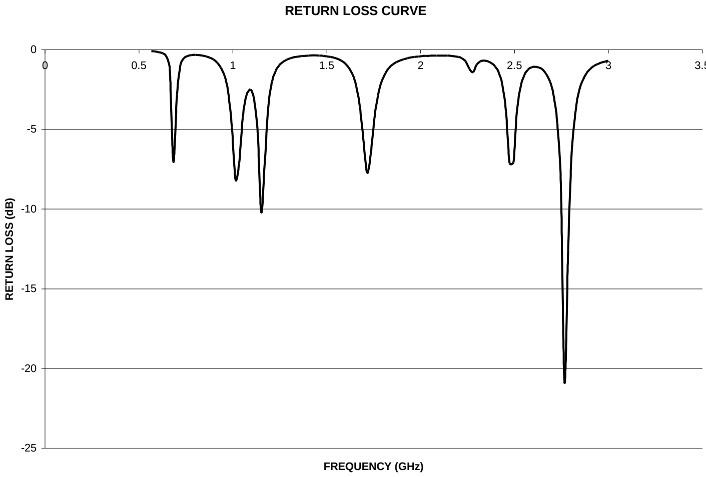

Fig.2: Return Loss Curve for Proposed Antenna

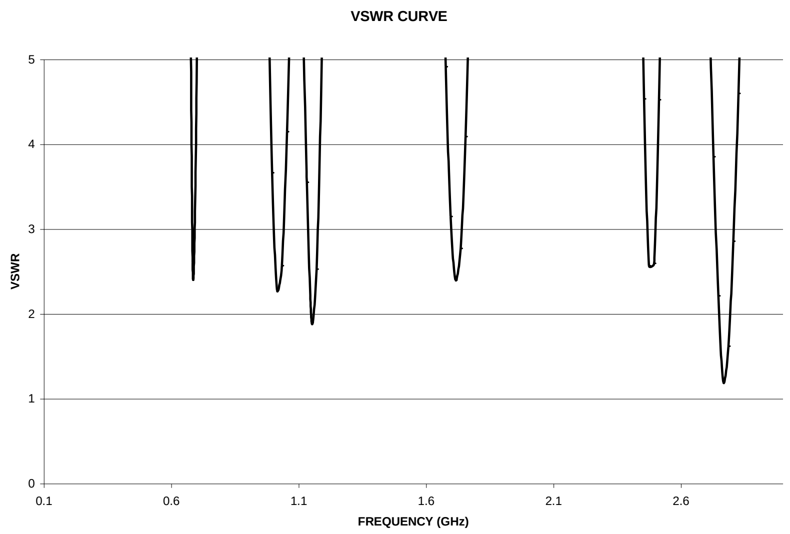

Fig.3: VSWR Curve for Proposed Antenna

Fig. 3 and fig.4 represents VSWR and smith chart respectively. The values of VSWR are taken below 5 only.

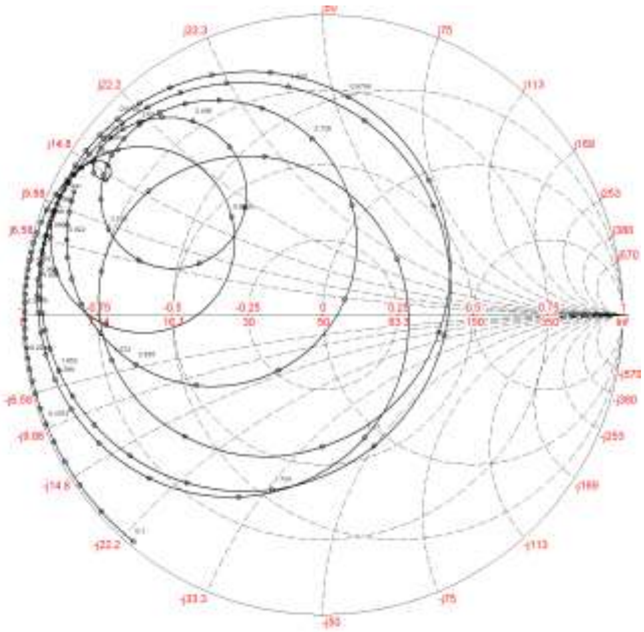

Fig.4: VSWR Curve for Proposed Antenna

V. CONCLUSION

The interconnected double ring slot microstrip antenna has been designed and analyzed in this paper. The structure is smaller in size and easy to fabricate. Its operations cover the applications around center frequencies 1.151 GHz and 2.766 GHz) with satisfactory radiation characteristics for return loss less than -10dB. Simulation results agree with the verified frequency responses and radiation characteristics. In applications, it can be applied to the UWB bands and others applications lying in ultra wide band.

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