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RESEARCH ARTICLE

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PERFORMANCE INVESTIGATION OF ANNULAR RING MICROSTRIP ANTENNA

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ABSTRACT

In this paper, analysis of "Annular Ring Microstrip Antenna" is presented. A computer simulation of the antenna is performed by using the IE3D software and the s-parameters of the antenna are measured. By using the annular ring antenna the equation for input impedance, radiation patterns, high impedance bandwidth, VSWR, return loss have been studied.

Annular Ring Microstrip antenna has a large bandwidth compared to other conventional type of microstrip antenna. Radiation in annular ring microstrip antenna is offer outer and inner edges. Details of radiation mechanism have been studied, and the analysis of two layer annular ring microstrip antenna is based on expansion of cavity model approach.

Keywords: Annular Ring MSA, IE3D,

INTRODUCTION

Bergman and Schultz first studied the ring type structure in 1955 as a traveling wave mode is relatively antenna. Mink, [19] studied the behavior of the microstrip ring. It was found that for a ring resonator, the resonant frequency of the lowest order mode could be much lower than a circular disk of approximately the same size. Wu and Rosenbaun [13] present a mode chart for different modes of the annular ring. The microstrip ring structure has also been used as resonator for dispersion measurement of lines and as radiator in medical application. [16]. Theoretical analysis of the resonant frequency and input impedance characteristics for TM_{11} and TM_{12} modes in ring structure have been given by Ali, Chew, and Kong [22].

Annular microstrip antenna has a large bandwidth compared to the other conventional type of microstrip antenna [19].Radiation in ring microstrip antenna is from outer and inner edges. Details of radiation mechanism are shown in following section. Lower order modes of annular ring microstrip still suffer by having relatively narrow bandwidth and reduced radiation efficiency,[16] .On other hand the TM_{12} Modes of the annular ring microstrip antenna have found to improve characteristic, [20, 21, and 23]. W. C. Chew [20] has predicted that TM_{12} modes is superior to TM_{11} for radiation purpose, he along with Ali and J.A Kong [21] made detailed study of annular microstrip antenna and predicted that the bandwidth of TM_{11} modes is very narrow while that of the TM_{12} modes is relatively wide and the launching efficiency of the TM_{12} modes is highly sensitive to the feed position .While the behaviors of the TM_{11} modes virtually independent of the feed position.

Theoretical Consideration

The patch geometry of a microstrip ring antenna and the coordinate system used are shown in figure1.

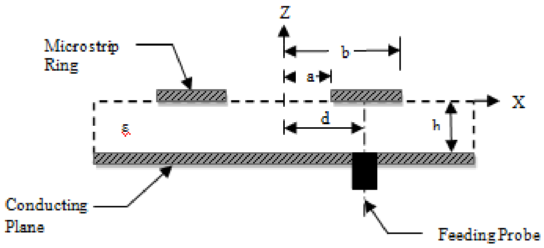


Figure1. Geometry of annular ring microstrip antenna

The ring is printed in one side of a copper clad and the copper left on the other side to behave as a ground plane. The two layer antenna has a driven patch and parasitic patch. The lower patch feed by coaxial cable, so it is known as driven patch. The upper patch is proximity coupled with the lower patch, so it is known as parasitic patch. The parasitic patch and driven patch have same inner radius and outer radius. The upper patch and driven patch height is h_1 and lower patch thickness is h_2. The second patch dielectric thickness is double of the first patch because of same dielectric used in both patches the second patch is kept on the first patch. Since electromagnetic energy feed is given in the antenna, therefore inductive and capacitive coupling both are considered here because the component of an inductance and capacitance represent magnetic and electric energy stored in the field below the patch. Equivalent circuit is calculated for parallel combination because the parasitic patch placed upon driven patch.

Design of Annular Ring Patch Antenna

Design Parameters for Annular Ring Patch

For designing Annular ring microstrip patch most essential parameters are as follows:

The resonant frequency selected for design is 2.9GHz.

Dielectric constant of the substrate (ε_r)is 4.2

Height of the dielectric substrate (h) is 1.6mm.

Following steps will be taken to design the antenna:

Step 1: Calculating the effective inner radius (a_e)

For the design of the antenna, the desired value of a_e at the operating frequency f_r is first obtained by the equation as

$$a_e = \frac{8.794}{f_r\sqrt{\varepsilon_r}}\,cm \quad (f_r \text{ in GHz}) \qquad (1)$$

Step 2: Calculate the actual inner radius (a)

With the help of the effective radius, the radius a can be obtained as

$$a = \frac{a_e}{\left\{1+\frac{2h}{\pi\varepsilon_r a_e}\left[\ln\left(\frac{\pi a_e}{2h}\right)+1.776\right]\right\}^{1/2}} \qquad (2)$$

Step 3: Calculate the actual outer radius (b)

With the help of actual inner radius a, outer radius can be find as

b/a = 2

i.e. b = 2a (3)

Step 4: Calculate the effective dielectric constant (ε_{eff})

The following equation gives the effective dielectric constant as

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2}+\frac{\varepsilon_r-1}{2}\left(1+\frac{10b}{w}\right)^{-1/2} \qquad (4)$$

Step 5: Design parameters for Annular ring patch

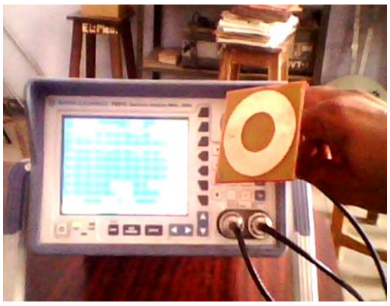
For designing the ARMSA, following parameters are used

Table1 Design parameters of ARMSA

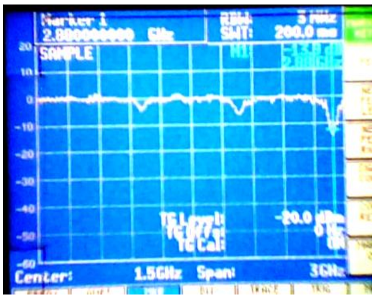
parameters	**Values**
Design frequency	= 2.9GHz
Free space wavelength	= 100mm
Dielectric constant (glass epoxy)	= 4.2
Loss tangent (tanδ)	= 0.02
Thickness of the substrate (h)	= 1.6mm
Inner radius of ring (a)	= 16.6mm
Outer radius of ring (b)	= 33.2mm
Relative permeability of substrate	= μ_r=1
Location of feed point (x,y)	=(24,0)

RESULT AND DISCUSSIONS

(a) Experimental Setup



Spectrum Analyzer Setup



(a) Results

Figure2. Experimental Setup and network analyzer

Experimental setup is shown in figure 2. for the determination of the return loss of the proposed antenna. In this experiment the designed antenna is connected to the SWR Bridge (50Ω, 5-300MHz) are used for the connection of microstrip antenna and the network analyzer. This is attached to the analyzer of range 0-3 GHz. This analyzer determined the return loss of the designed annular ring shape microstrip antenna and demonstrate the return loss versus frequency pattern.

(b) Simulation Result for Return Loss (RL)

For obtaining frequency vs. return loss plot on IE3D EM simulator software, the suitable co-ordinates of each corners of Annular ring shape microstrip are added on EM simulator software and Annular ring shape microstrip antenna is drawn, after simulating a return loss of about -45 dB is obtained which is shown in figure3.

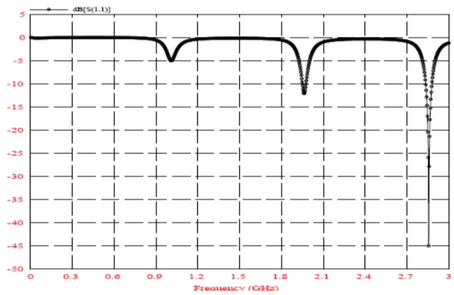


Figure3. Frequency vs. return loss for annular ring shape microstip antenna

(c) Simulation Result for Voltage Standing wave Ratio (VSWR)

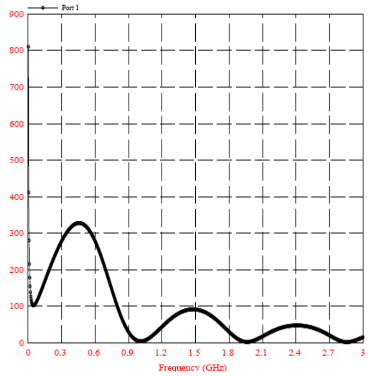


Figure4. VSWR vs. frequency

The plot of frequency vs. real part of input impedance obtained on IE3D is shown in figure 4.

As per our starting inputs, voltage standing wave ratio shown in figure 4 should be less than 2 as per our simulated result is concerned; it gives at frequency 2.9GHz. Result at 2.9GHz is more desirable.

(d) Radiation Pattern Plots

The patterns can be obtained after feeding the required fields of the radiation pattern in 3D is obtained as the following structure as shown in the figure4 from the different angles on the different axis. As the microstrip patch antenna radiates normal to its surface, the elevation pattern for the φ= 0 and θ=90 degrees would be important.

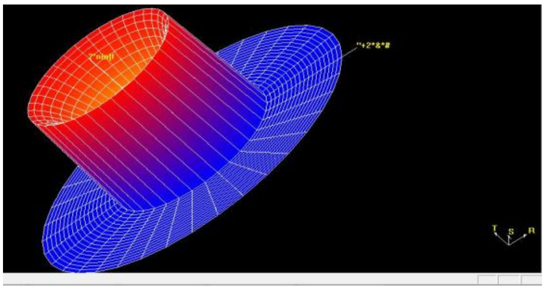


Figure5. 3D view of the radiation pattern (ARMSA-shape)

(e) Measured Result

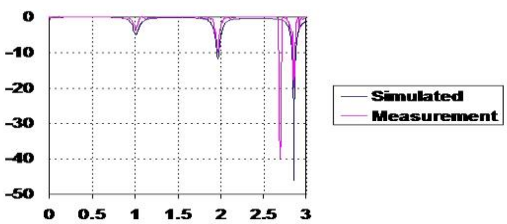


Figure6. Comparison between simulated value & measured value

Graph of the simulated value & measured value are shown in the Figure6. In these graph simulated and measured result are closely matched. Simulated result is -45dB at 2.9GHz resonating frequency and measured result is -40.05dB at 2.7 GHz resonating frequency.

CONCLUSION

We have presented experimental result for annular ring antenna. The input impedance, radiation pattern, bandwidth, VSWR, return loss, resonant frequency, have been studied. From the plot between VSWR and frequency we have studied that the antenna has relative dielectric constant of the dielectric substrate as ε_r =4.2, gives the maximum bandwidth. The substrate of the material of relative permittivity provides the best matching with coaxial feed because lowest value of return loss is shown by the substrate of the material of relative permittivity 4.2, which has a loss tangent of 0.2 at 2.9GHz. Simulation results showed that designed antenna is practically one as it shows its voltage standing wave ratio < 2 at the resonant frequency 2.9GHz and giving return loss -45dB. The result obtained through IE3D software yield compatible with experimental. And it is good to see that the return loss has a negative value in all the cases which states that losses are minimum during the transmission.

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