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Modeling and Design of Annular Ring Microstrip Antenna

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ABSTRACT

This paper presents modeling of annular patch antenna. The S and Z parameters of an Annular patch Microstrip antenna are investigated and optimization. The optimization is performed by varying the inner and outer radius of annular Ring. The impedance and radiation characteristics of annular patch antenna are examined and compared. It is able to achieve a return loss less than -36 dB and VSWR < 2.

Keywords

Return loss, annular patch, Impedance, Microstrip antenna, resonant frequency, dielectric material, VSWR, patch radius.

1.INTRODUCTION

Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low-profile and light weight properties. Therefore they are extremely compatible for embedded antennas in handheld wireless devices. Some of their principal advantages are Light weight, low volume, Low fabrication cost, Easy to mount, low profile, conformal, Linear and circular polarization ,easy to implement by position of feed, dual frequency use possible, solid state devices easily integrated [1]. The Microstrip patch antenna can be used in many applications. Microstrip patch antennas are very popular due to their numerous advantages [2]. In this class of antennas, the annular ring Microstrip antenna (ARMA) has received considerable attention [3]–[5]. When operated in the fundamental TM mode, the size of the ARMA is smaller than that of the circular or rectangular patch for a given frequency. In application to array designs, this allows the antenna elements to be more densely packed, thereby reducing the grating-lobe problem [5].

Antenna miniaturization plays a vital role in the design of global positioning systems and modern personal wireless systems. Many techniques have been reported to reduce the patch antenna size, such as a square-ring patch fed by a Microstrip line, the use of cross and bent slots embedded in the radiating patch [7–9] and the use of a slot in the ground plane [10].

In this paper an experimental characterization of S and Z parameters as function of inner and outer patch radius is examine with keeping other parameters are constant.

Modeling Of Annular Microstrip Antenna

Two models commonly used for analyzing microstrip patch antenna are the Transmission Line model and Cavity model.

The patches are printed on substrate, of permittivity $e_r = 5.8$ and thickness h = 2.87 mm with infinite ground plane consideration. To check the performance of annular patch various simulations have been done. First, we was check the effect of variation in inner radius of slot, for that the outer patch radius maintained fixed at 11.8 mm. Secondly, we consider the Inner radius fixed at previous best result and then change the outer radius of patch. Modeling of Annular patch Microstrip antenna is shown in figure 1. By making fractional changes in inner and outer radius of patch, the effect on various parameters can be studied. The proposed patch antenna is designed for 2.4 to 3.2 GHz operation to measure S and Z parameters.

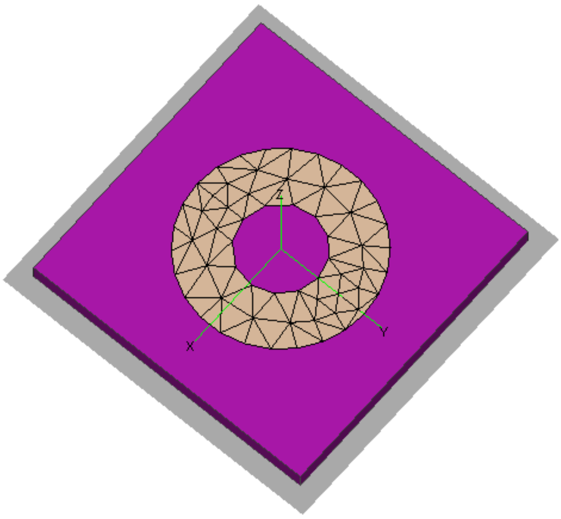

Figure 1- Model of Annular patch Microstrip Antenna

1. Simulation and Result

The proposed antenna is simulated using CADFEKO 6.0. For an initial design, considering the above said parameters with varying Diameter.

Case I: Change in inner radius of annular Ring patch Antenna.

In this type of Annular Microstrip antenna the effect of variation in inner radius of slot was checked with outer patch radius fixed at 11.8 mm and remaining parameters maintained at fixed level. Table-1 shows the measured parameters for various values of inner radius. By making fractional changes in inner radius of patch, the effect on various parameters can be studied.

Sr. No.	Inner radius (mm)	Resonant Freq. f_r (GHz)	Return Loss dB	B.W. (MHz)	Impedance Z=(R + jX) Ω. at frequency 'f_r'	VSWR
1	5	8.78	-27.16	182	52.84+j2.82	1.07
2	5.2	8.882	-24.45	203	54.22+j3.12	1.10
3	**5.3**	**8.847**	**-26.86**	**204**	**53.52+j2.43**	**1.07**
4	5.4	8.845	-26.74	200	53.82+j3.32	1.09
5	5.5	8.844	-26.21	200	53.82+j2.53	1.09
6	5.6	8.813	-22.88	181	54.91+j4.5	1.13
7	6	8.817	-22.38	195	55.89+j3.81	1.15
8	8	8.65	-23.27	163	44.94-j5.36	1.14

Table 1 - Measured parameters for various inner patch radiuses

With outer radius = 11.8 mm, the computational result of return loss as a function of frequency is obtained at – 10 dB as shown in figure 2. To optimize the parameter the value of inner radius was changes and then, respective return loss was observed.

At inner radius = 5.3 mm corresponding R_L = -26.86 dB was found at the frequency = 8.847 GHz, where impedance value is Z= (53.52 + j 2.43) Ohm as shown in figure 3. Further increase in inner radius changes the value of R_L. The variation in the inner radius produced changes in resonant frequency and also in return loss as shown in figure-4

The VSWR obtained 1.07 at inner radius = 5.3 mm which is close to ideal value as shown in figure-5.

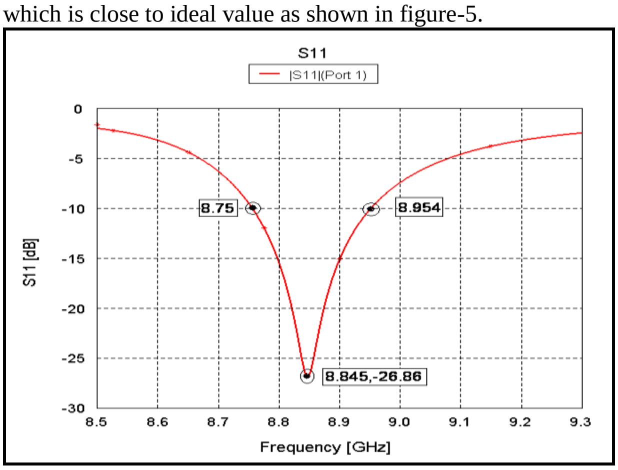

Figure 2- Return loss parameter for Inner radius = 5.3 mm, Return loss RL = -26.86 dB

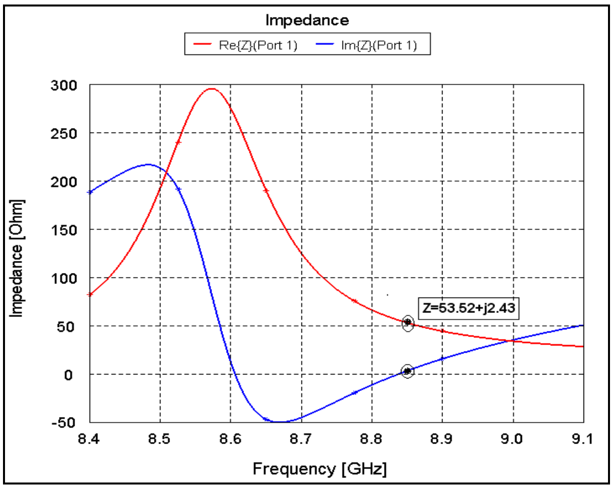

Figure 3 - Z-parameter displays (Real and imaginary) for Inner radius = 5.3 mm

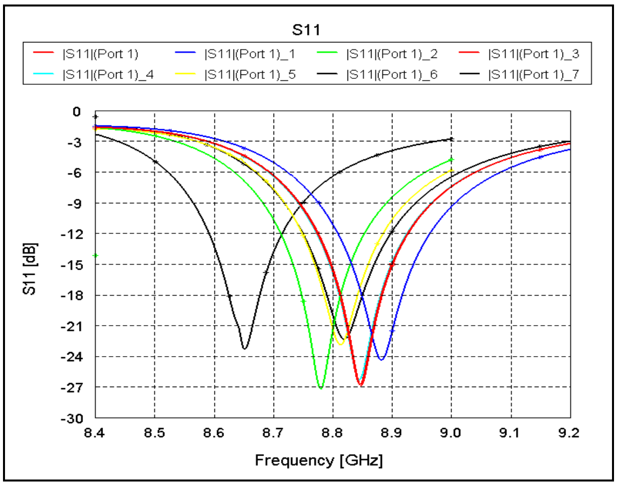

Figure 4- Return loss parameter displays for different Inner radius.

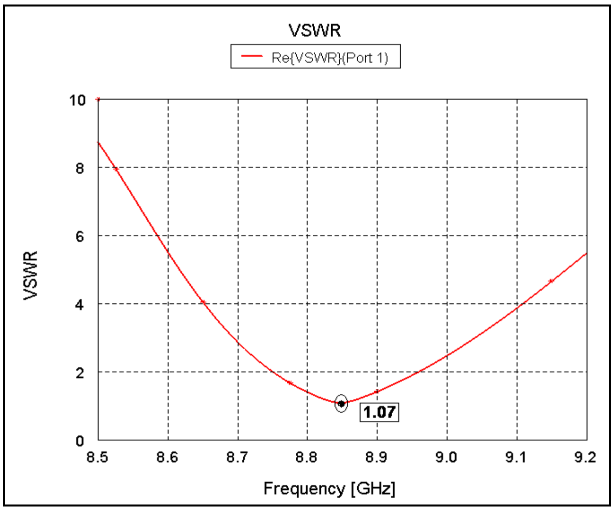

Figure 5-.VSWR parameter displays for Inner radius = 5.3 mm is 1.07.

Case II– Change in size of annular ring (outer Radius of Patch)

Here, the size of antenna is increase (outer Radius of Patch) and then check the effect of variation in inner radius of slot, I select outer patch radius fixed at 20 mm and dielectric constant at 1.1, which is a dielectric constant of foam. The remaining parameters are maintained same as per previous case then check the results with different iteration. Table-2 shows the measured parameters for various values of inner radius. By making fractional changes in inner radius of patch, the effect on various parameters can be studied.

Sr. N.	Inner radius (mm)	Resonance Freq. fr (GHz)	Return Loss (dB)	B.W. (MHz)	Impedance Z=(R + Jx) Ω. at frequency 'fr'	VSWR
1	13.8	5.81	- 41.73	309	50 + j.04	1.02
2	13.9	5.82	- 36.62	322	49.65 - j0.26	1.02
3	14	5.81	- 28.31	319	47.67 – j2.38	1.04
4	14.1	5.79	- 26.39	314	46.91 – j3.3	1.07

Table 2 - Measured parameters for various inner patch radiuses

With outer radius = 20 mm, the computational result of return loss as a function of frequency is obtained at – 10 dB as shown in figure 6. To optimize the parameter the value of inner radius was changes and then, respective return loss was observed.

The best performance of antenna is found at inner Radius 13.9 mm. The return loss characteristics and -10 dB measurement is shown in figure 6, where Bandwidth is maximum. Here, the bandwidth is achieved at 5.54 % of resonance frequency

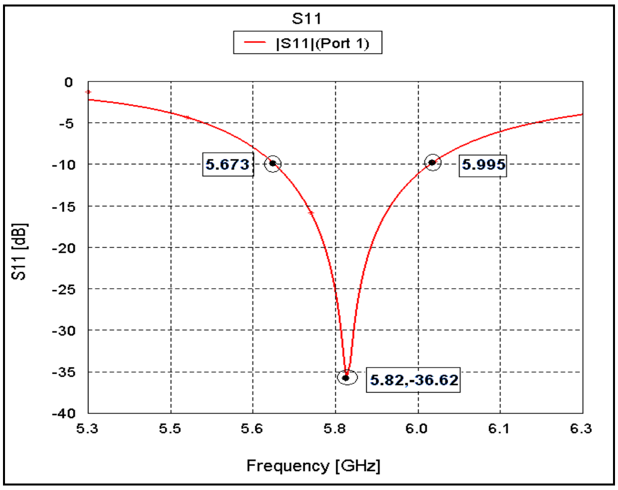

Figure 6 - Return loss parameter for Inner radius = 13.9 mm,
Return loss RL = -36.62 dB

The impedance value found to be Z = (49.65 – j 0.26) Ohm at resonance frequency 5.82 GHz. The Normalize and smith chart for impedance is shown in figure 3.2.21 and 3.2.22 respectively.

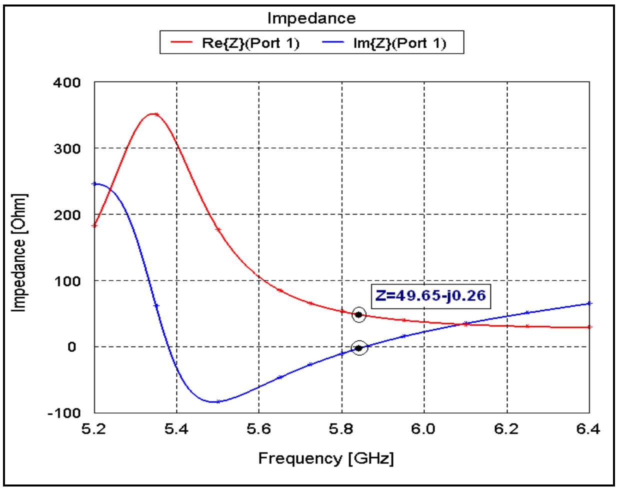

Figure 7-Z-parameter displays (Real and imaginary)

The VSWR obtained is 1.02 at resonance frequency 5.82 GHz, which is < 2 as shown in figure 8. The Characteristics of VSWR is as shown in figure-3.2.23. From the table 2, it is found that the value of VSWR increases with increase in inner patch radius.

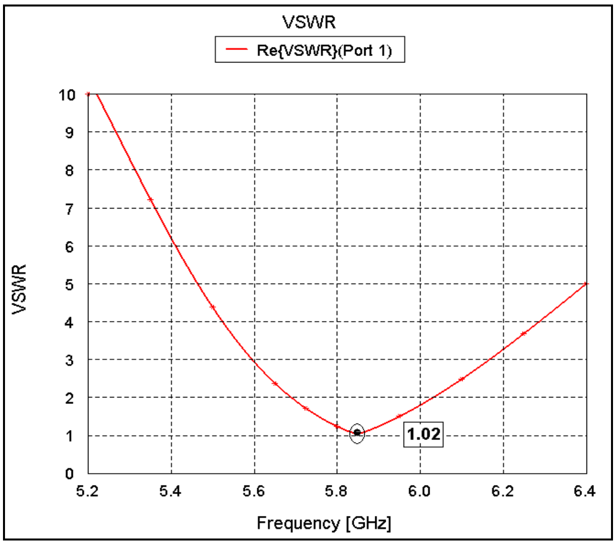

Figure 8 - VSWR Measurement

2. CONCLUSIONS

Two different cases have been studied. In case 1, the relatively wide bandwidth and centre-frequency are not heavily dependent on the feed point position and the antenna provides a convenient match to 50Ω, is easy to fabricate and demonstrates wide manufacturing tolerances. In The annular patch the antenna the Band width is enhanced up to 209 MHz

In case 2, it is found that VSWR value increases with increase in Inner radius of patch. The annular patch the antenna the Band width is enhanced up to 322 MHz which is 5.54 % of resonance frequency. As the size of antenna increases the bandwidth also increases. The directivity of antenna is found to be 2.41.

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