

Design of RFID Antenna for 2.45GHz Applications

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Abstract—In this paper, we propose a new design of compact planar antenna with a π -shaped shorted structure. The antenna which operates at 2.45 GHz is designed and fabricated respectively. The influences of geometric parameters of this kind of planar antennas on the resonant frequency, bandwidth and gain are also discussed. We use IE3D software to design planar antennas and choose the better parameters to manufacture planar antenna. The novel design proposed antenna here with the size of 27mm×10mm has resonant frequency of 2.45 GHz, bandwidth of 135MHz, return loss of -39.68dB and gain of 0.766dBi. The fabricated antenna is suitable for radio frequency identification (RFID) applications at 2.45GHz.

Keywords— π -shaped; compact planar antenna; RFID

I. INTRODUCTION

In recent years, the radio frequency identification (RFID) systems have become very popular in supply chain management, service industries and security applications etc. A basic RFID system contains three primary components: tag, reader and host computer. The tag provides the object tracking data. The reader collects the information from the tag and communicates it to the network. Antenna is a key component of the RFID system. It enables tag and reader to exchange the signals. There are several frequency bands used in RFID applications, such as 125 KHz, 13.56 MHz, 433.92MHz, 869 MHz, 902~928 MHz, 2.45GHz and 5.8GHz [1]. The design of tag antenna tends to be compact size, lower cost and convenience in use. Several structures of RFID antennas had been proposed, such as meander line, CPW-fed, and aperture-coupled patch etc. [2-5].

In this study, a novel planar antenna with π -shaped shorted structure is proposed. By means of simulation using IE3D software, the suitable geometric parameters for the planar antenna are chosen for RFID antenna at 2.45GHz. The proper size of the patch is designed for compact size requirement. Therefore, a novel planar antenna with size of 27mm×10mm is presented in this paper.

II. THE ANTENNA DESIGN

The configuration of the proposed antenna is depicted in Fig.1. Its structure is based on a one-layer FR4 dielectric substrate which has permittivity of 4.4. We adjust the geometric parameters L and W to observe the variations about the resonant frequency, bandwidth and gain of the

planar antenna. The π -shaped shorted structure was used to excite the centre frequency. The 50 Ω SMA connector was adopted for testing.

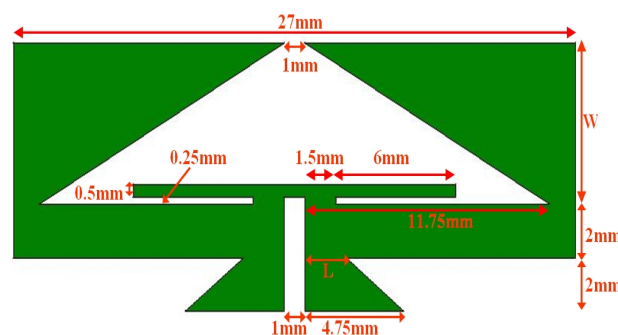


Figure 1. Geometry of proposed planar antenna.

III. THE SIMULATIONS

The characteristics of the proposed antenna were simulated by means of using IE3D software. The simulated curves of return loss against frequency for varying L of the proposed antenna with W=6mm is shown in Fig.2. It can be seen that the proposed antenna with L=2mm shows the best

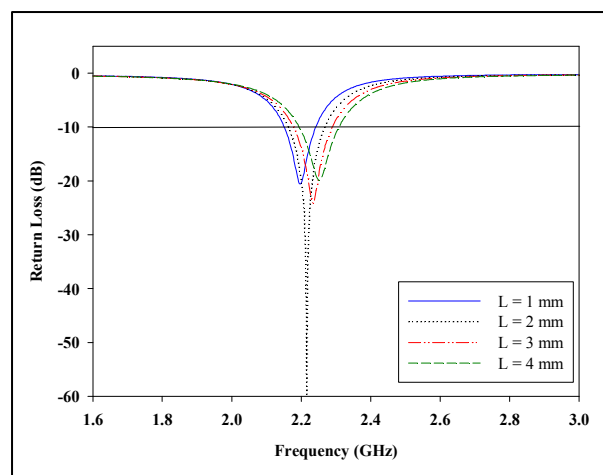


Figure 2. Simulated curves of return loss against frequency for varying L of the proposed antenna with W=6mm.

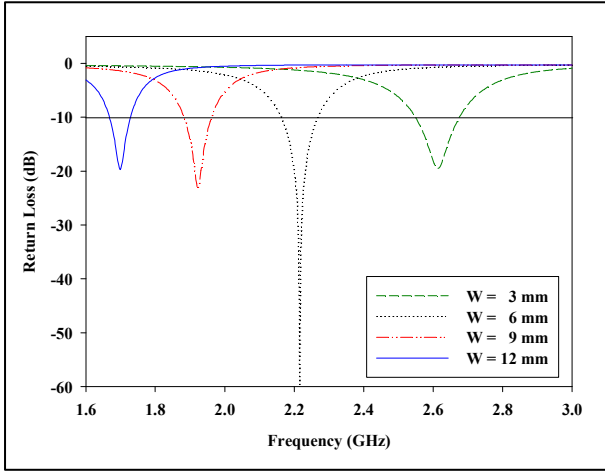


Figure 3. Simulated curves of return loss against frequency for varying W of the proposed antenna with L=2mm.

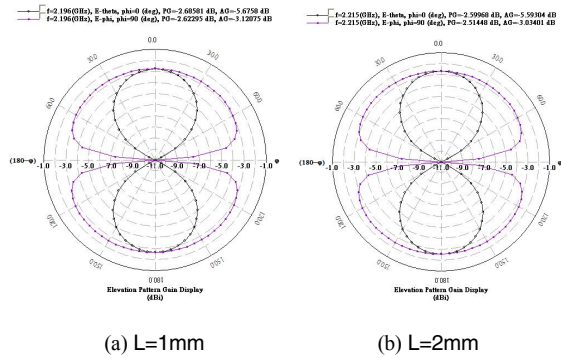


Figure 4. Simulated radiation patterns for varying L of the proposed antenna with W=6mm.

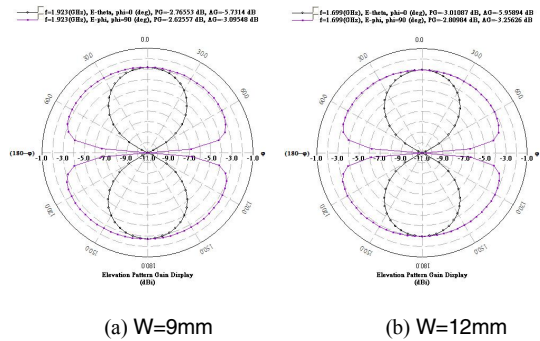


Figure 5. Simulated radiation patterns for varying W of the proposed antenna with L=2mm.

return loss at the centre frequency. Therefore, we fixed L=2mm and changed W of the proposed antenna to observe the variations of return loss. The simulated results are shown in Fig.3. From this figure, it is easy to find that the centre frequency of the proposed antenna is shifted to lower frequency with increasing the value of W. Parts of the

simulated radiation patterns for varying W and L of the proposed antenna are shown in Fig.4 and Fig.5. The simulated results are classified as Table I and Table II. The simulated input impedance versus frequency for varying L and W of the proposed antenna are illustrated in Fig.6 to Fig.9. The input impedances of the proposed antenna obtained from these figures at 2.45GHz are listed in Table III and Table IV. With suitable tuning geometric parameters L and W, the proposed antenna can be designed to match the IC chip of RFID.

TABLE I. SIMULATED RESULTS FOR VARYING L OF THE PROPOSED ANTENNA WITH W=6mm.

L (mm)	Freq (GHz)	R _L (dB)	BW (MHz)	E-plane Gain(dBi)	H-plane Gain(dBi)
1	2.196	-20.58	90	-2.686	-2.623
2	2.215	-59.63	103	-2.600	-2.514
3	2.234	-24.17	109	-2.595	-2.492
4	2.252	-19.93	113	-2.565	-2.444

TABLE II. SIMULATED RESULTS FOR VARYING W OF THE PROPOSED ANTENNA WITH L=2mm.

W (mm)	Freq (GHz)	R _L (dB)	BW (MHz)	E-plane Gain(dBi)	H-plane Gain(dBi)
3	2.612	-19.51	123	-2.636	-2.582
6	2.215	-59.63	103	-2.600	-2.514
9	1.923	-23.31	79	-2.766	-2.626
12	1.699	-19.72	59	-3.011	-2.810

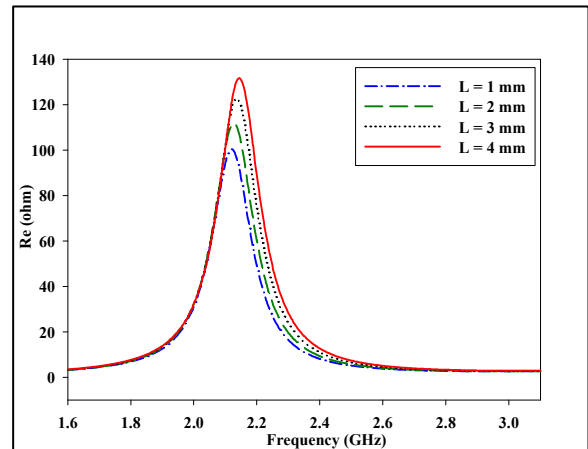


Figure 6. Simulated input resistance vs. frequency plot for varying L of the proposed antenna with W=6mm.

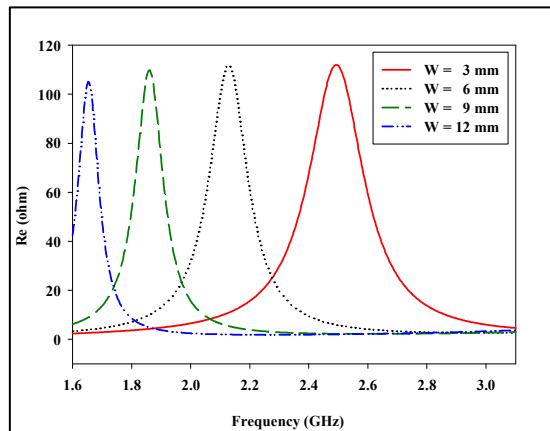


Figure 7. Simulated input resistance vs. frequency plots for varying W of the proposed antenna with L=2mm.

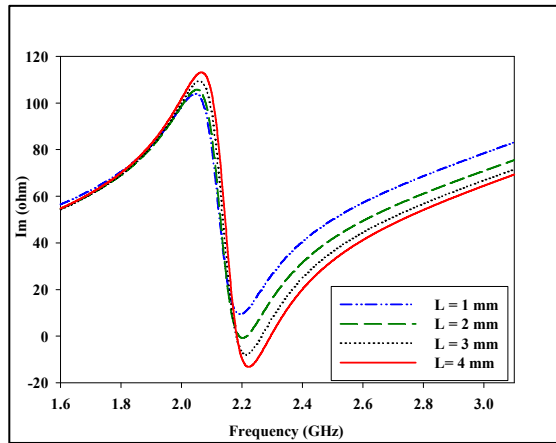


Figure 8. Simulated input reactance vs. frequency plots for varying L of the proposed antenna with W=6mm.

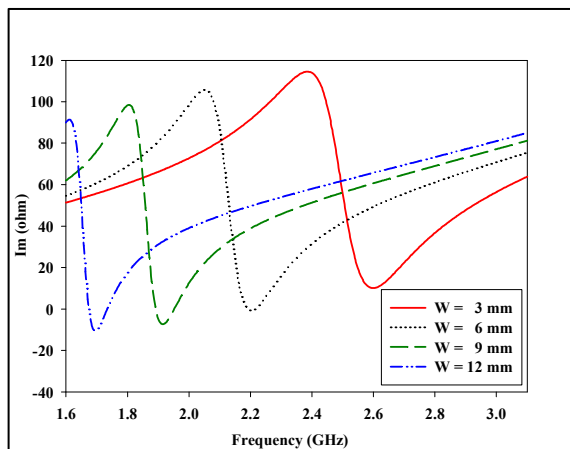


Figure 9. Simulated input reactance vs. frequency plots varying W of the proposed antenna with L=2mm.

TABLE III. SIMULATED INPUT IMPEDANCE FOR VARYING L OF THE PROPOSED ANTENNA WITH W=6mm AT 2.45GHZ

L (mm)	1	2	3	4
Impedance (ohm)	6.31 +j45.62	7.14 +j37.09	8.26 +j31.20	9.47 +j26.77

TABLE IV. SIMULATED INPUT IMPEDANCE FOR VARYING W OF THE PROPOSED ANTENNA WITH L=2mm AT 2.45GHZ

W (mm)	3	6	9	12
Impedance (ohm)	97.66 +j98.19	7.14 +j37.09	2.31 +j53.81	1.97 +j59.95

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The photography of fabricated antennas with the design of Fig.1 is shown in Fig.10. The measured curves of return loss against frequency for varying L of the proposed antenna with W=6mm is illustrated in Fig.11. Fig.12 shows the measured curves of return loss against frequency for varying W of the proposed antenna with L=2mm. From these figures, we observe the trend of simulated and measured results are in good agreement.

Parts of the measured radiation patterns of the proposed antenna are shown in Fig.13. The measured results are listed in Table V and Table VI. The measured 10-dB return loss bandwidth and gain of the proposed antenna are better than the simulated results. The measured centre frequency of the fabricated antenna is shifted to higher frequency range compared with the simulated results. Therefore, it should be carefully designed with tuning the geometric parameters to obtain the resonant frequency. In this article, we choose W=6mm and L=2mm of the proposed antenna shown in Fig.1 to implement the compact planar antenna which can be used in RFID systems at 2.45GHz.

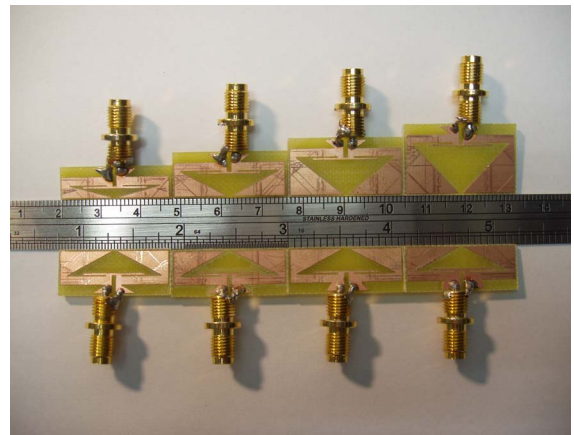


Figure 10. Photography of fabricated antennas with various sizes shown in Fig.1.

V. CONCLUSION

A novel planar antenna with compact size has been presented in this study. The compact size of 27mm×10mm was achieved by using a π -shaped shorted structure. The input impedance of the proposed antenna can be achieved by carefully choosing suitable geometry parameters and match to the IC chip of RFID. The fabricated antenna can be used in RFID systems for the 2.45GHz band.

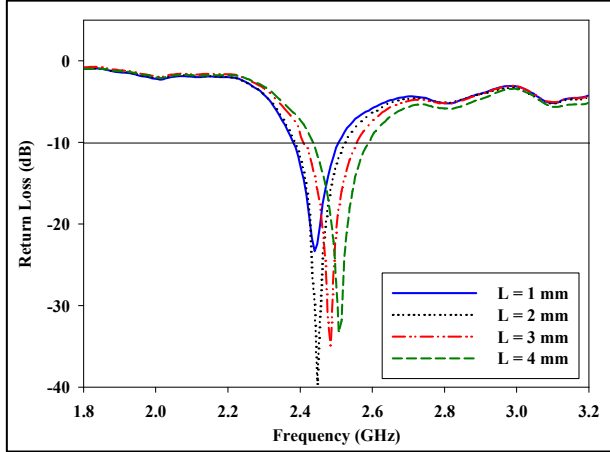


Figure 11. Measured curves of return loss against frequency for varying L of the proposed antenna with W=6mm.

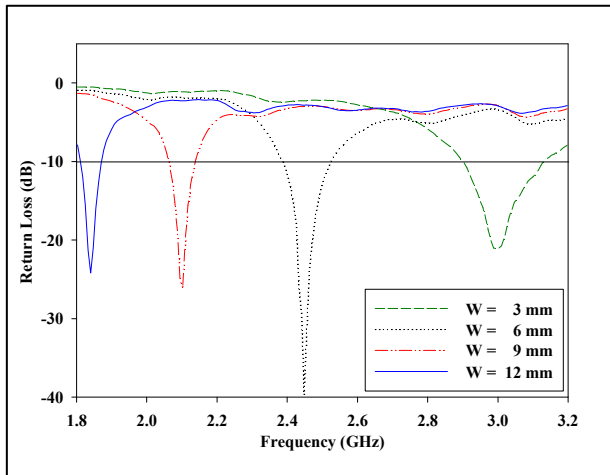
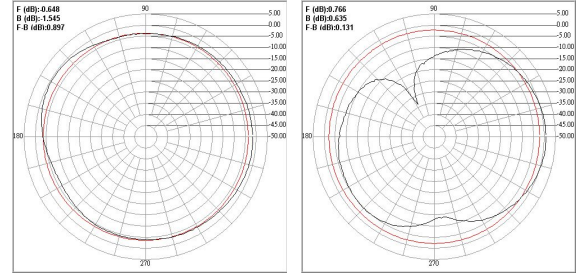


Figure 12. Measured curves of return loss against frequency for varying W of the proposed antenna with L=2mm.



(a) E-plane

(b) H-plane

Figure 13. Measured radiation patterns for the antenna shown in Fig.1 with L=2mm and W=6mm.

TABLE V. MEASURED RESULTS FOR VARYING L OF THE PROPOSED ANTENNA WITH W=6mm.

L (mm)	Freq (GHz)	R _i (dB)	BW (MHz)	E-plane Gain(dBi)	H-plane Gain(dBi)
1	2.44	-23.32	112.5	-1.511	-0.038
2	2.45	-39.68	135.0	-0.648	0.766
3	2.49	-35.21	142.5	-0.647	0.788
4	2.51	-33.29	150.0	-0.219	0.855

TABLE VI. MEASURED RESULTS FOR VARYING W OF THE PROPOSED ANTENNA WITH L=2mm.

W (mm)	Freq (GHz)	R _i (dB)	BW (MHz)	E-plane Gain(dBi)	H-plane Gain(dBi)
3	3.00	-21.09	225.0	-4.216	-6.981
6	2.45	-39.68	135.0	-0.648	0.766
9	2.10	-26.12	67.5	-3.777	-7.350
12	1.84	-24.19	52.5	-8.476	-8.237

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