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A Method for Input Impendence Matching of PIFA based on Meander Line Antenna

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***Abstract* – Meander line antenna (MLA) is designed for biomedical band antenna because their low profile and relative high efficiency. This work present a new methods of impedance matching on meander line antenna. In this design has proposed a Planar Inverted-F Antenna (PIFA) short pin structure design, based on a meander line shaped on 433 MHz which is ISM band. According to this method, the resonant characteristics of MLA are related to their physical dimension such as meander height, width number of folds, their positions and overall length of the structure. The antenna has been test with the Vector Network Analyzer and the resonance frequency is measured at 431 MHz, with a meander of 5.5 turns and matching meander 7.5 turns. The best return loss for the antenna is 28dB (measured) with a gain of -3.3 dBi.**

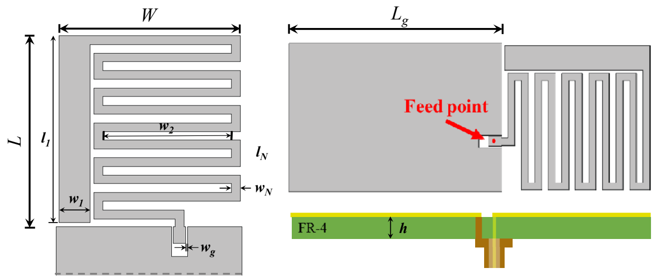
***Index Terms* — Meander line antenna, planar inverted-F antenna, ISM band, UHF RFID.**

I. Introduction

Ultra high frequency (UHF) on Radio Frequency Identify (RFID) on remote control of device has become the trend in public life, instrument control, and biomedical application even in an implantable device now day. [1] Considered ISM band frequency 433 MHz, the wavelength are very large, as compared to the size of antenna. In general, the meander line radiator is designed to achieve low profile and compact antenna size in probable device application. [2-3] In this paper, a coplanar waveguide (CPW) fed low profile monopole antenna is proposed. Meander line monopole radiator is designed to reduce the total size of proposed antenna. However, the high radiation efficiency of the proposed is increased and promoted by radiator design. Thus, the methods of meander shaped matching were design and measure at 433 MHz which is on ISM band frequency.

II. Antenna Structuration

A FR-4 (h = 0.8 mm, $\square_r$ = 4.4, tanδ = 0.02) PCB substrate with singled side metal is used. The structure and parameters of the proposed antenna is shown in Fig.1. The main structure of the proposed antenna is including a meander line radiator and a modified ground plane. A meander line shaped is designed and used in the reference antenna with width W = 33 mm, and length L = 35 mm for N_1 = 7.5 turns. Each turn's width is w_N = 1.59 mm, w_2 = 22.82 mm, l_N = 4.77 mm, and the matching shaped in the end of MLA has length l_1 = 34.09 mm, width w_1 = 6 mm, overall length is 329.92 mm. As shown in Fig.1(b), the red spot is feeding point fed by a CPW and easily integrated in a PCB. Where the ground plane width is 34 mm, length L_g = 50 mm.



(a) Reference Antenna (b) Side View

Fig. 1. The structure of the reference antenna.

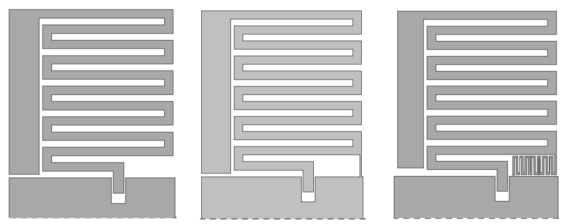
III. Antenna Design

A. Planar inverted-F antenna design

Fig. 2 shows the developing process of the proposed antenna. First, a meander line monopole radiator with several turns (N_1) is designed with quarter-wavelength to resonant at 433 MHz. This structure is called the Reference Antenna. The Fig. 2b shows type I antenna within the short pin¸ where it has width 0.3 mm and length 4.68 mm. The short pin is similar as a shunting inductor circuit thus the Type I antenna can be considered as a PIFA antenna.

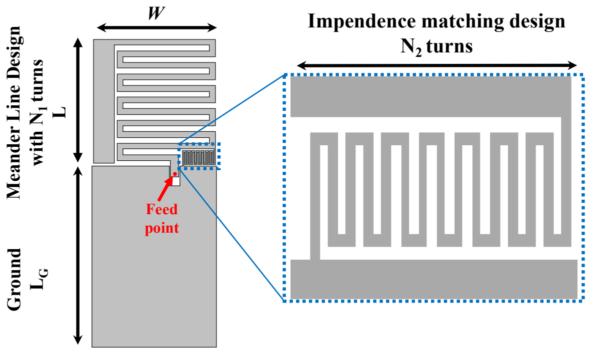
B. Meander Matching Design

The short pin is designed and modified with several turns (N_2) is shown in Fig. 2c. The turns N_2 is dominates the inductance of input impedance. This structure is called type II antenna. The design of sort pin at the first turn's impedance matching can make the profile miniaturized and high return loss. Fig. 3 shows the meander line matching design, where N_2 is the turns; each turns width and length is 0.3 mm and 4 mm respectively. The turns of matching N_2 can be calculate by simulation methods, to make the reference antenna with any type of meander turns N_1, which is corresponded to difference frequency.



(a) Reference Antenna (b) Type I (c) Type II

Fig. 2. The develop process of proposed antenna.



(a) Low Profile Antenna (b) Meander Line Matching Design

Fig. 3. The meander line matching design on the shape of short pin.

IV. RESULT AND DISCUSSION

The proposed antenna is designed and simulated with ANSYS HFSS® v.15 and verified in measurement. To verify the simulation result, antenna prototypes were test with an Agilent E5071C network analyzer. Fig. 4 shows the return loss of each type antenna through HFSS simulation, where reference antenna, Type I, Type II, and Type II measure resonance frequency is 423 MHz, 443.3 MHz, 433 MHz, and 431 MHz respectively. The simulation result and measurement is really feet.

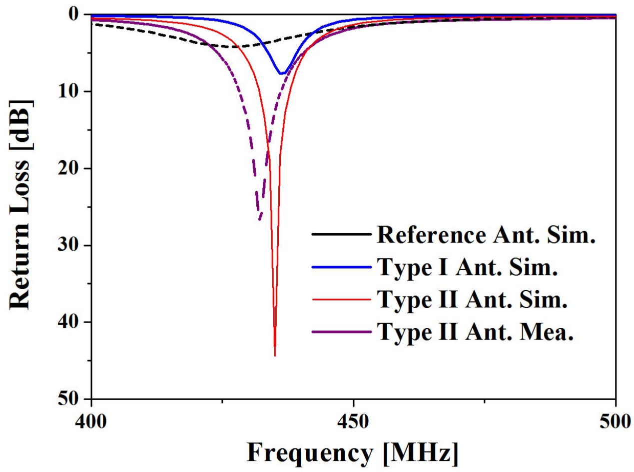


Fig. 4. The simulated and measured return loss of the proposed antenna.

Table I presents the compare of the different resonant frequency of different numbers of the Matching turns (N2). When the number of the matching turns is increased, the resonance frequency is decreased. By adjusting the short pin turns, the input impedance of proposed antenna is matched goes easier and simple.

Fig. 5 is the simulated and measured Smith chart of developing process of the proposed antenna. Fig. 6 shows the simulated 3-D radiation pattern of the Type II antenna at 433 MHz. The max gain of proposed antenna is -3.34 dBi with omnidirectional radiation, and it is relative high gain than same dimension.

TABLE I
MATCHING TURNS COMPARE

Antenna	Numbers of the Matching turns (N_2)	Simulation Result	
		Resonance Frequency [MHz]	Return Loss [dB]
Type I	0	443.6	8.5
Type II	1.5	438.7	12
	3.5	436.5	17
	5.5	434.6	26
	7.5	433.1	45

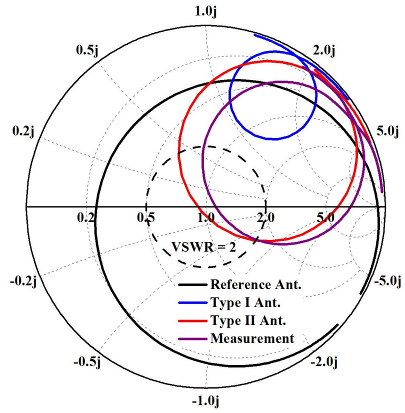


Fig. 5.Simulated Smith chart of the Reference, Type I, Type II, and measured Smith chart of Type II.

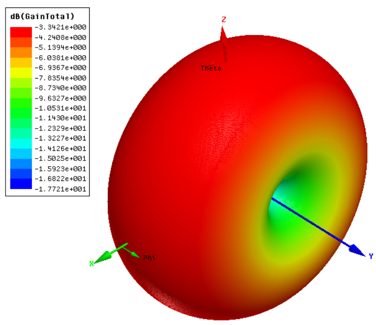


Fig. 6. Simulated 3-D radiation pattern of the Type II antenna.

V. CONCLUSION

A low profile and relativity high gain antenna of ISM band and UHF RFID frequency antenna has been designed. The proposed antenna consist of the monopole radiator, meander shaped matching short pin, and CPW fed methods. The shaped design is a simple and effective approach to reduce the antenna size. The measured resonance frequency is 431 MHz with 20 MHz bandwidth which covered the operation frequency (433 MHz), and has relative high gain -3.34 dBi.

REFERENCES

[1] K. Finkenzeller, *RFID Handbook*. London, U.K.: Wiley, 1999.

[2] Soontornpipit, P.; Furse, C.M.; You Chung Chung, "Design of implantable microstrip antenna for communication with medical implants," *Microwave Theory and Techniques, IEEE Transactions on* , vol.52, no.8, pp.1944,1951, Aug. 2004

[3] Marrocco, G., "Gain-optimized self-resonant meander line antennas for RFID applications," *Antennas and Wireless Propagation Letters, IEEE* , vol.2, no.1, pp.302,305, 2003.