

# Printed Antenna for HF- and UHF-RFID Tag

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**Abstract** - The dual-band tag antenna designed for HF-RFID (13.56MHz) and UHF-RFID (920-925 MHz) applications along Thailand standard is proposed. The overall dimension of the tag antenna has the size of a credit card in order to implement the RFID for the highway tracking and tolls systems. The tag antenna is designed on FR-4 substrate with 0.3 mm thickness. To achieve the dual band operation, the designed tag antenna structure is based on the loop (spiral coil) and the meander-line structure with T-matching technique for HF-RFID and UHF-RFID technologies, respectively.

**Index Terms** — Dual band RFID, HF-RFID, UHF-RFID, Tag Antenna

## I. INTRODUCTION

The demands of Radio Frequency Identification (RFID) systems have been rapidly growth in both the business world and daily life [1-2]. In general, the RFID system is used in many applications such as retail store, logistics, people identification, animals products and many others. Due to the growing of RFID technology, the tag antenna design becomes one of the interesting research topics. The RFID technologies are generally distinguished into four frequency ranges; i.e., low frequency (125-134.2 kHz), high frequency (13.56 MHz), ultra high frequency (433, 860-960 MHz) and microwave frequency (2.45, 5 GHz). Furthermore, the UHF operating frequency band is different in each region and the operating frequency band of Thailand is from 920 MHz to 925 MHz

This paper presents the tag antenna designed for dual band RFID [3-4] applications. The HF-RFID tag antenna is constructed using the loop antenna [5] (spiral coil) and the turn of the loop is used as the matching structure. To design the UHF-RFID tag, the meander-line structure [6] is use to increase the electrical length. The proposed dual-band antenna can be applied for both long range communications (UHF band) and short range communications (HF band) in a single antenna.

## II. TAG ANTENNA STRUCTURE

The tag antenna configuration is presented in Fig. 1. The photograph of the prototype antenna is shown in Fig. 2. The HF antenna parameters are  $L = 84$  mm,  $W = 54$  mm,  $C_1 = 0.5$  mm,  $H = 10$  mm and  $S = 1$  mm. The UHF antenna parameters are  $W_1 = 40$  mm,  $L_{11} = 40$  mm,  $L_s = 18$  mm,  $W_s = 18$  mm,  $L_m = 17$  mm,  $W_m = 12$  mm,  $C_2 = 1$  mm and  $C_3 = 2$  mm. The dimension of the feeding ports are  $L_{g1} = 0.985$  mm

and  $W_{g1} = 0.794$  mm for HF-RFID antenna and  $L_{g2} = 4$  mm and  $W_{g2} = 4$  mm for UHF-RFID antenna. The antenna is designed on the FR4 substrate ( $\epsilon_r = 4.3$  and height = 0.3 mm) with copper thickness of 0.05 mm. The HF tag antenna is connected to SIC5600 IC chip [7] with the capacitor of 23.5 pF at 13.56 MHz and the UHF tag antenna is connected to NXP G2XL IC chip [8] with the impedance of  $15.88 - j148.82 \Omega$  at the 922.5 MHz.

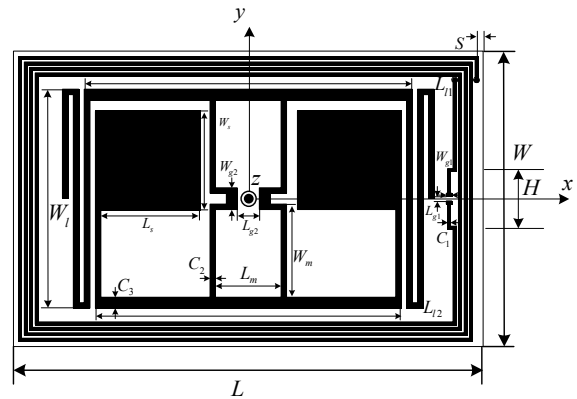


Fig. 1. The proposed tag antenna structure.

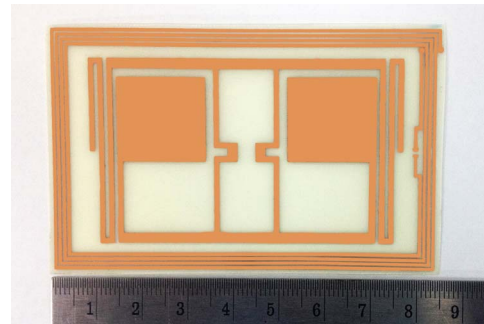


Fig. 2. The photograph of the tag antenna.

## III. SIMULATED AND MEASURED RESULTS

### A. HF-RFID Tag Antenna

The simulated inductance of the proposed HF tag antenna is  $6.134 \mu\text{H}$  and the measured inductance is  $3.143 \mu\text{H}$ .

### B. UHF-RFID Tag Antenna

#### 1. Reflection

The reflection coefficient or  $|S_{11}|$  (dB) of the proposed tag antenna is illustrated in Fig. 3. It is obvious that the simulated and measured  $|S_{11}|$  (dB) are less than -10 dB covering the frequency range from 919.72 to 925.12 MHz

and from 917.5 to 925.5 MHz, respectively. This is qualified for the operating frequency of UHF-RFID according to Thailand standard (920-925 MHz).

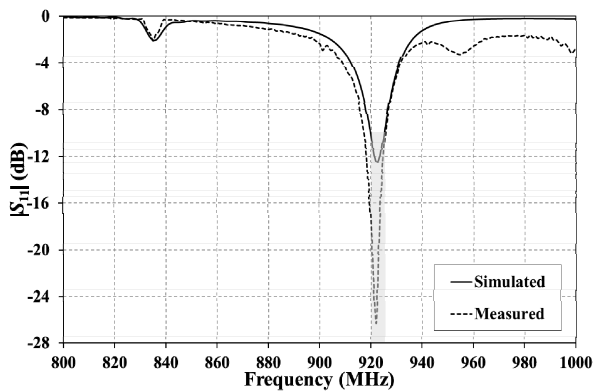


Fig. 3. Simulated and measured  $|S_{11}|$  (dB) versus frequency.

## 2. Impedance

Fig. 4 illustrates the impedance of the proposed tag antenna. The simulated and measured impedance of the tag antenna are  $72.74 + j167.61 \Omega$  and  $59.12 + j129.9 \Omega$ , respectively. The results show the effectively matching between the tag antenna and IC chip.

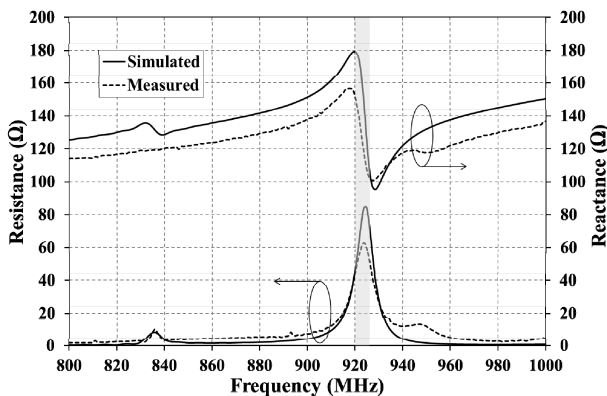


Fig. 4. Simulated and measured impedance versus frequency.

## 3. Radiation Pattern

Fig. 5 illustrates the simulated and measured radiation pattern. It is seen that the radiation pattern of the proposed tag antenna is omnidirectional. The vertical half-power beamwidth from the simulation and measurement are  $92^\circ$  and  $124^\circ$ , respectively. The azimuth pattern from the simulation is completely circle whereas that from the measurement has maximum ripple of less than 3 dB.

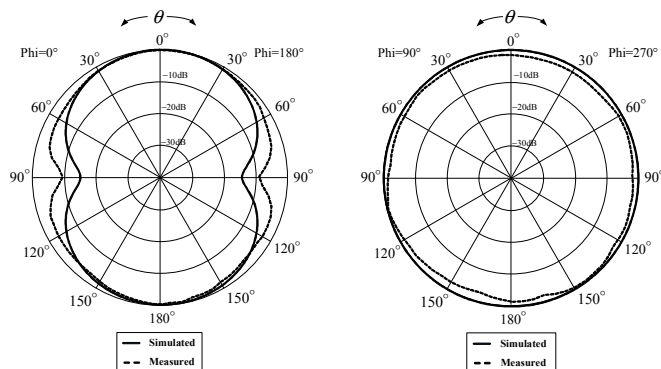


Fig. 5. Simulated and measured radiation pattern in principal planes.

## 4. Gain

Fig. 6 shows the antenna gain at the boresight direction of the proposed tag antenna. The measured antenna gain is 0.62 dBi at the center frequency (922.5 MHz).

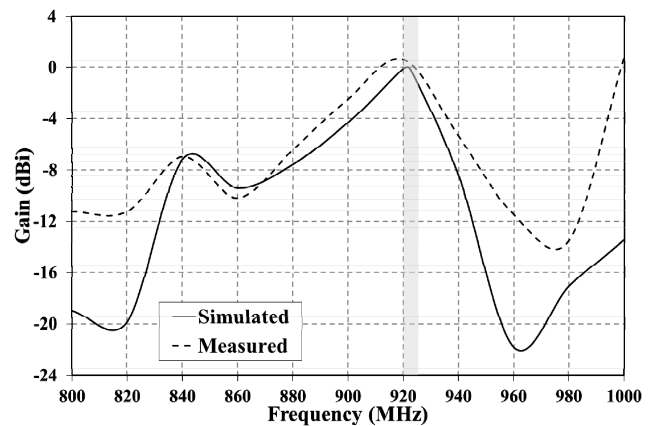


Fig. 6. Simulated and measured gain versus frequency.

## IV. CONCLUSION

The dual band tag antenna designed for HF-RFID (13.56 MHz) and UHF-RFID (920-925 MHz) is presented in this paper. The proposed tag antenna has the compact size with the dimension of  $8.4 \text{ cm} \times 5.4 \text{ cm} \times 0.3 \text{ mm}$  fabricated on FR-4 substrate. The simulated and measured results are obtained and shown. The antenna radiates the omnidirectional pattern. From the measurement, the maximum read range (UHF-RFID) of the tag antenna is about 5 m. It is apparent that the proposed antenna can be applied for the actual applications.

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