Dual-band Dipole Antenna for ISO 18000-6/ISO 18000-4 Passive RFID Tag Applications

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Abstract

In this paper, a slot coupled dipole antenna was presented for dual band passive RFID tag applications. Structures using a slot coupled feed and a resonator are explored to achievable dual band operation. It shows good impedance and radiation characteristics from 860 MHz to 960 MHz (ISO 18000-6) and from 2.40 GHz to 2.50 GHz (ISO 18000-4). The return loss is verified by comparing the calculations and measurements, which show good agreement. Radiation patterns are omni-directional for operation frequencies. Numerical results are calculated using Ansoft HFSS (High Frequency Structure Simulator).

Introduction

Radio Frequency Identification (RFID) of objects or people has become very popular in many services in the industry, distribution logistics, manufacturing companies and goods flow systems [1]. Several frequency bands have been assigned to the RFID applications, such as 125 kHz, 13.56, 910 MHz and 2.45 GHz. At present, most of RFID systems operate in UHF range (typically at 910 MHz) and higher frequencies that utilize free microwave ISM band such as 2.45 GHz are under active development.

In this paper, a novel design of a dual band dipole antenna is presented. It consists of a dipole antenna and a slot coupled structure. By properly selecting a coupled slot on a dipole antenna which covers the band of ISO 18000-6 RFID tag applications, dual band and tunable impedance bandwidth characteristics for ISO 18000-4 RFID tag applications could be achieved. Details of the antenna design and both theoretical and experimental results are presented and discussed.

Antenna Configuration

The configuration of the proposed antenna design is shown in Fig. 1. The antenna

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is symmetrical and its basis is a dipole structure with feed terminals. A coupled slot with lengths of L_2, S_2 and S_3 was placed inside of dipole antenna with length L_1. A numerical simulation [2] shows that the phase difference between the current at the end of dipole antenna (L_1) and that of coupled slot section (L_2) is about 180˚. It shows each section (L_1, L_2) is operated as the approximated half-wave dipole antenna with center feeding [3]. To determine the detailed design parameters for the given structure, the tag antenna was optimized to work at the frequency bands of ISO 18000-4 and ISO 18000-6. The three design goals considered were a suitable impedance bandwidth, omni-directional radiation pattern and simple structure. Optimized design parameters were found with the following dimensions: W=15 mm, L_1=151 mm, L_2=31 mm, W_1=5.5 mm, W_2=5 mm, S_a=S_b=1 mm, S_{feed}=2 mm, S_1=1 mm, S_2=21 mm, S_3=22.5 mm. Antenna parameters used in this paper are S_a (width of coupled slot) and S_2 (length of coupled slot). Based on those parameters the antenna characteristics are calculated and shown in the next section.

Experimental results

Fig. 2 shows calculated and measured return loss characteristics for the fabricated antenna. The measured return loss bandwidth less than -10dB for ISO 18000-6 application is from 840 MHz to 960 MHz and the bandwidth (return loss < -10dB) for ISO 18000-4 application is from 2.33 GHz to 2.51 GHz. The proposed design has sufficient bandwidth to cover the requirement of RFID system in the ISO 18000-6 and ISO 18000-4 standards. Agreement between the experiment and simulation is generally good. Fig. 3 shows return loss characteristics when lengths L_2 and S_a are varied. There are two resonant frequencies, 910 MHz and 2.45 GHz where the return losses are less than about -20 dB. When the lengths of S_2=20 mm and S_a=1 mm, the return loss and band width characteristic are suitable for the applications. Fig. 4 shows radiation pattern at 910 MHz and 2.45 GHz for proposed antenna. Almost the omni-directional patterns in the H-plane are observed.

Conclusion

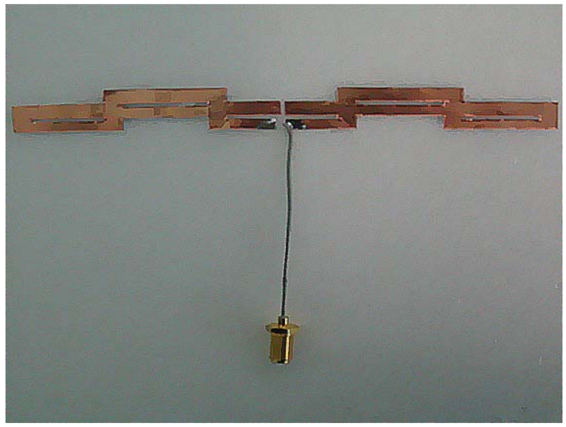
The analysis and design of a slot coupled dipole antenna with dualband performance has been proposed and implemented. With the insert of a coupled slot to the dipole antenna operating at 910 MHz, the proposed antenna can operate at 2.45 GHz. The antenna is simple and symmetrical and has good impedance bandwidth and radiation pattern.

This design is not only suitable for use in ISO 18000-6 (910 MHz) but is also applicable to ISO 18000-4 (2.45 GHz) RFID systems.

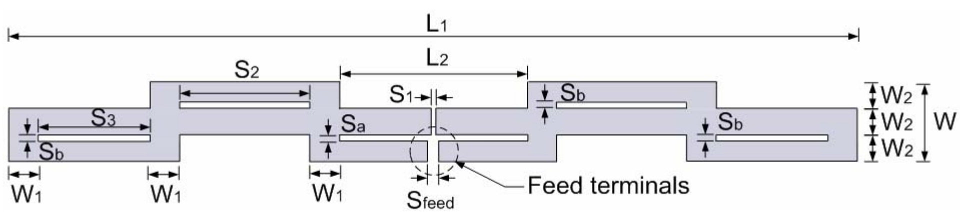
References

[1] K. Finkenzeller, "RFID Handbook", Wiley, England, 1999

[2] Ansoft High Frequency Structure Simulator (HFSS), Ver. 10.0, Ansoft Corporation
[3] W. L. Stutzman, "Antenna Theory and Design", Wiley, America, 1998



(a) overall view



(b) dimension

Figure 1. Structure of the proposed passive RFID tag antenna

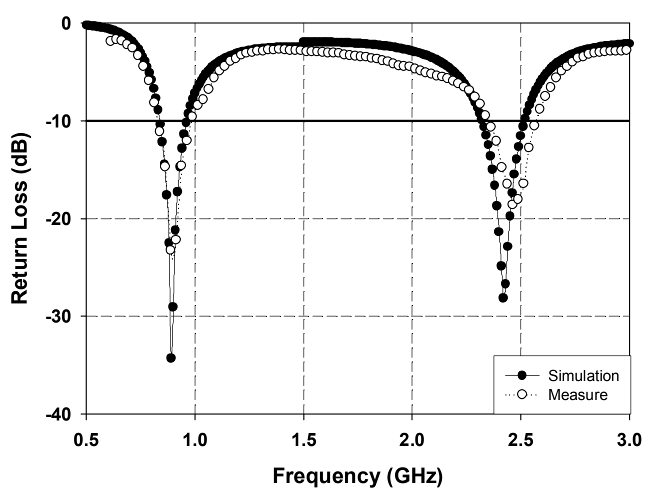
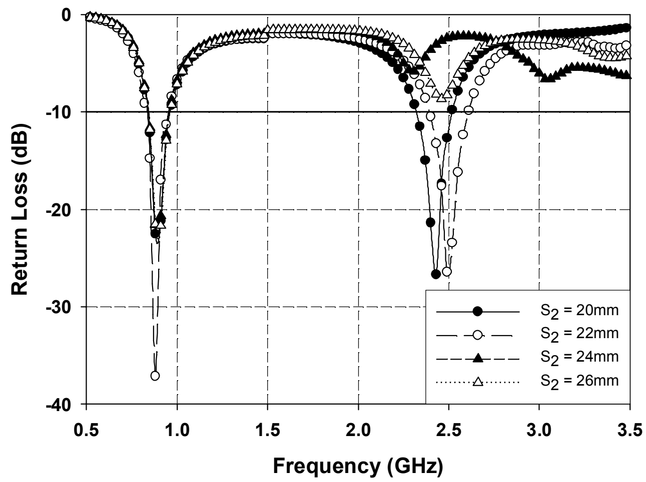
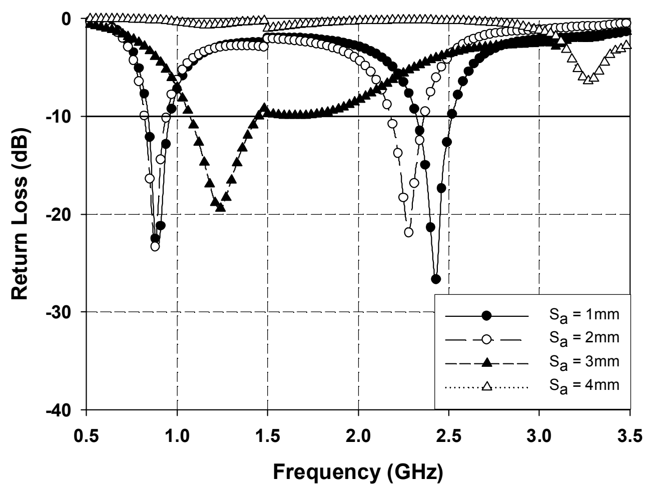


Figure 2. Calculated and measured return loss of the proposed antenna

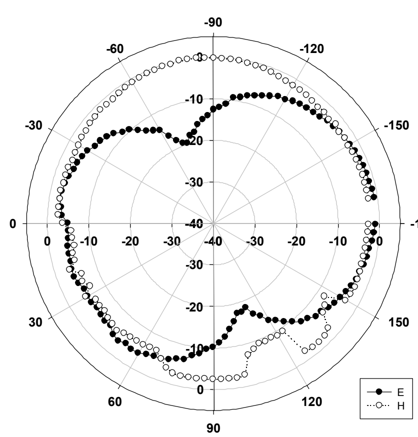


(a)

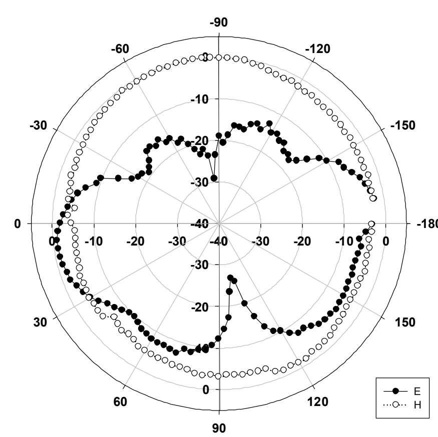


(b)

Figure 3. Calculated return loss with varied parameters: (a) S_2 and (b) Sa



(a) ISO 18000-6 (910 MHz)



(b) ISO-18000-4 (2.45 GHz)

Figure 4. Measured far-field radiation pattern