VARIOUS TYPES AND POLARIZATIONS OF RFID ANTENNAS

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Abstract

Linear, dual and circular polarized UHF Radio Frequency Identification (RFID) tag antennas have been designed. Various parameters have been varied to analyze the characteristics of the proposed antennas. A dipole, dual polarized crossed dipole, fractal dual polarized crossed dipole and planar spiral antennas are designed and analyzed.

1. Introduction

Radio Frequency Identification (RFID) has been very popular in many applications: logistics, security systems, animal tracking, transportation, manufacturing process control, and etc. [1]. RFID system consists of a reader, transponder (tag) and computer connected to the reader. The reader has an antenna. It transmits modulated electromagnetic field, which powers up the tag and sends the data to the tag. The tag has an antenna and a microchip attached to the feeding point of the antenna. The tag gets all the required energy from carrier signal of reader. The tag sends a coded signal back to the reader using the tag antenna at UHF frequencies based on backscattering. The tag antenna reflects back a part of the energy received from the reader. References [3-5] introduce a method to power up the tag. The method uses a rectifying Schottky detector diode circuit that converts microwave energy into DC. The rectified or DC part of the energy is used to power up the electronics in a passive tag chip. A tag antenna should have following characteristics:

- small enough to be attached to any size of product,
- omni directional beam pattern,
- matched polarization to recognize signal with any physical orientation,
- high gain to communicate with the reader with an obstacle and
- matched impedance with the impedance of the chip on the tag

UHF RFID antennas of various shapes are introduced [6-14]. Meander line antenna [6], folded dipole [7], inverted F [8] and folded strip line of RFID antennas are introduced [9]. References [10-11] introduce electromagnetic band gab (EGB) antennas for RFID tag and reader. EGB antenna is attached to metal object. A dual-polarized C band (5.8GHz) RFID antenna also shown in [12]. Dual polarized

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high gain 2x2 arrays for 5.8GHz and 2.4GHz bands are introduced. The two elements are Rx antennas and the other two are Tx antennas. Two Wilkinson power dividers are used for Tx and Rx [13]. A beam-scanning with low side-lobe pattern is also used as a RFID reader antenna as shown in [14]

2. RFID Antennas and Results

UHF RFID antennas of various shapes and polarizations are simulated. According to ISO18000-6, the UHF RFID band is 860~960MHz. Since the center frequency of the band is around 910MHz, the antennas are designed at fc=910MHz. A dipole, crossed dipole, fractal crossed dipole antennas are simulated. The parametric research of each antenna has been done. The length, width, gab and dielectric constant are varied. The relationship between the parameters and characteristics of the antennas is found.

Parameters of a dipole strip antenna are shown in Figure 1. Parameters, length (L), width (w=0.1~1 cm), gab (g=0.1~0.6 cm) and height (h=1~3 cm) are controlled. One of the best designs has L=13.68, g=0.1, w=0.1, h=2 cm and Er=2.2. The null of S11 at 910MHz is about -45dB deep, and impedance is 49.98-1.59j ohm as shown in Figures 3 and 4. The impedance of antenna can be matched with the impedance of the chip. The bandwidth is about 92MHz as shown in Figure 3. When L, h and g are increased and the other parameters are fixed, the fc is decreased as expected. When the width, w, is increased from 0.1cm to 1cm, the center frequency, fc, is increased from 910MHz to 930MHz. The center frequency, fc, is not increased much when w is wider than 0.55cm. The bandwidth is also increased when width is increased. Changing dielectric constant does not change the characteristics of the antenna since the antenna shape is strip line dipole.

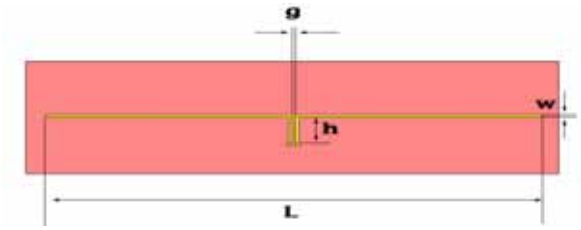

Figure 1. Antenna Parameters

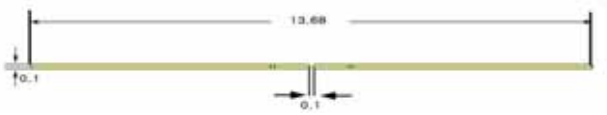

Figure 2. Design of RFID Dipole Antenna

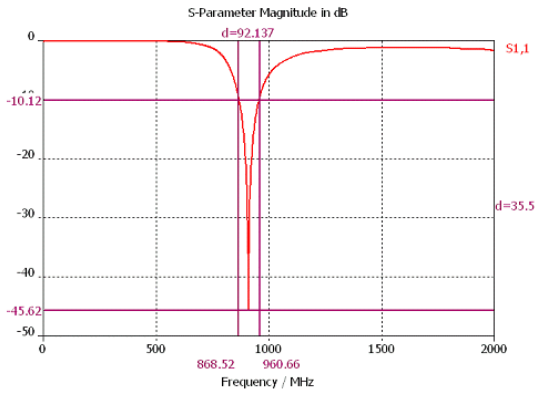

Figure 3. S11 of Dipole Antenna

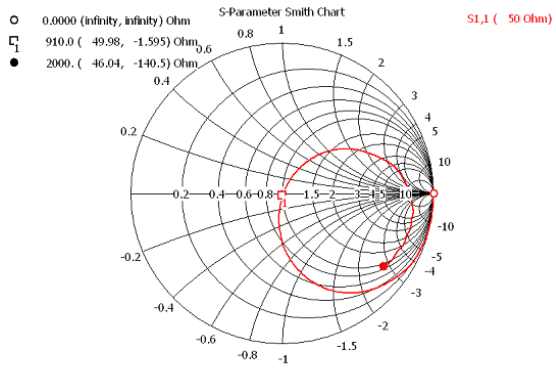

Figure 4. Impedance of Dipole Antenna

A crossed dual polarized dipole antenna has been designed as shown in Figures 5 and 6. Bandwidth of crossed dipole is about 136MHz, which is wider than the dipole antenna as shown in

Figure 2. The size of fractal dual polarized-crossed dipole antenna is about 6mm smaller than that of the dual polarized-crossed dipole antenna. Planar spiral antenna is shown in Figures 9 and 10. Bandwidth of the planar spiral is narrower than that of the dual polarized dipole antenna. The planar spiral can be transformed to a log periodic planar antenna for the future.

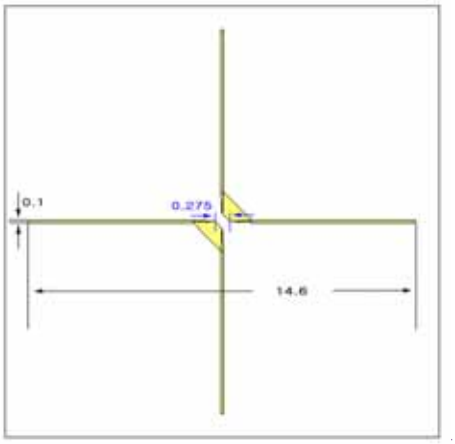

Figure 5. Crossed Dipole

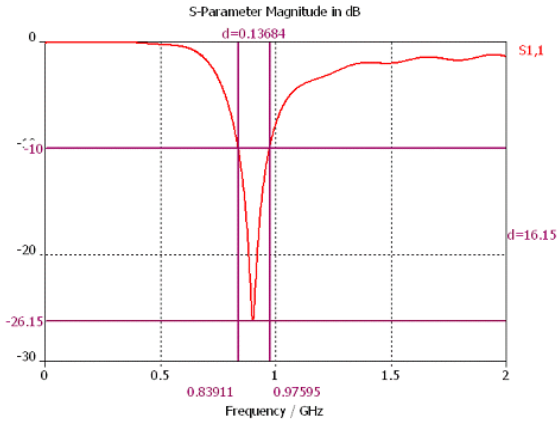

Figure 6. S11 of Crossed Dipole

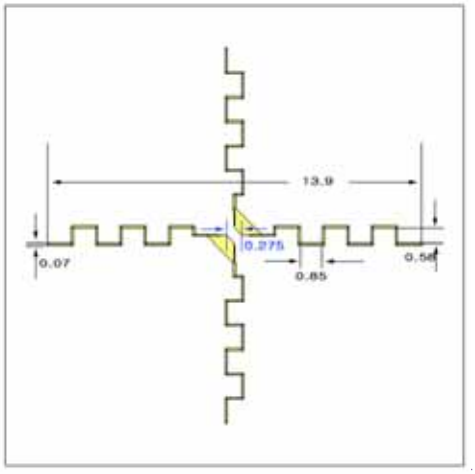

Figure 7. Fractal Crossed Dipole

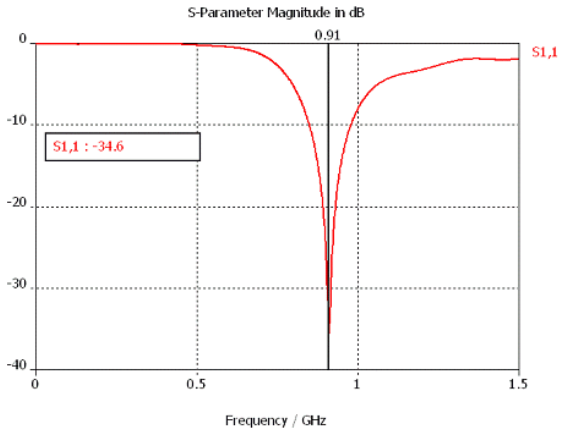

Figure 8. S11 of Fractal Crossed Dipole

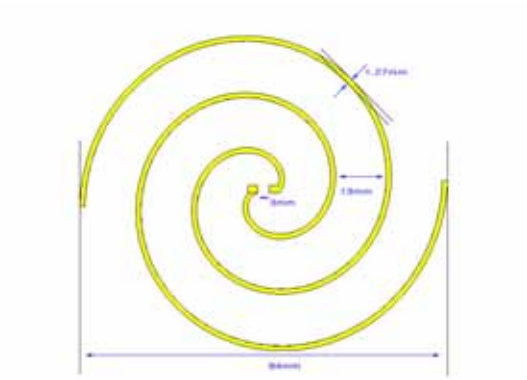

Figure 9. Planar Spiral Antenna

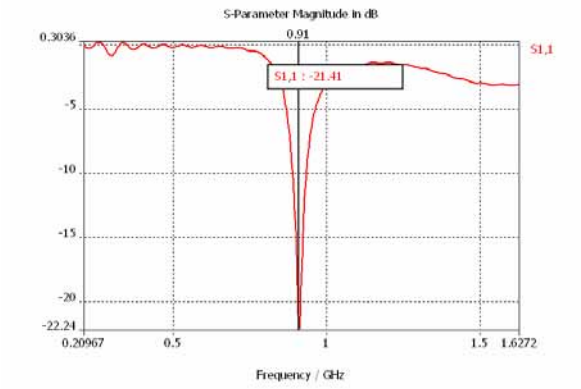

Figure 10. S11 of Planar Spiral

4. Conclusion

Most recent RFID related references are reviewed, and some RFID tag antennas are designed.

Dipole, crossed and fractal crossed dipole antennas and planar spiral RFID antennas are designed at UHF band 860~960MHz, fc=910MHz. Parameters of all antennas are studied for the future design of RFID antennas.

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