A Wideband UHF RFID Reader Antenna

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***Abstract*— This paper presents a new wideband RFID reader antenna for UHF application. By applying log periodic antenna theory, the proposed antenna is achieved by employing three loop wire elements and fed by a pair of crisscross feed line. The proposed antenna exhibits wide bandwidth of 25.2 % operating frequency at UHF band from 811 MHz to 1046 MHz. The return loss and radiation pattern of the proposed antenna are presented.**

Keywords- log prioidic; UHF; bandwidth; RFID

I. Introduction

The log periodic antenna was originally proposed in [1]. The log periodic antenna can be in a number of forms. The most common type is the log periodic dipole array (LPDA). The log periodic antennas have been extensively in wireless systems due to its wideband characteristics. Numerous research works on log periodic antennas have been reported in [2-3].

Radio frequency identification technology (RFID) is an automatic identification technology that uses electromagnetic principle to allow target to be detected at a distance. A typical RFID system comprises three components: RFID reader, tag and a host computer. RFID reader allows data communication between tags and host computer. In general, RFID frequency bands exist in four regions: low frequency (125-132.4 kHz), high frequency (13.56 MHz), ultra high frequency (840-960 MHz) and microwave frequency (2.45 and 5.8 GHz).

In recent years, UHF attracts the most attention in RFID application due to its long range and high data rate [4]. Many researches have been reported [5-6] for the UHF application. However the antennas are limited with bandwidth and gain. Moreover, UHF RFID frequency bands vary with countries. Hence, it is desired to introduce a universal RFID reader antenna which is benefited for system efficiency and cost reduction.

Numerous techniques to provide characteristics of wideband antenna have been reported [7-12]. In this paper, a new log periodic antenna with loop elements is proposed. The proposed antenna is formed by a group of loop elements and fed by a pair of crisscross feed line. The proposed exhibits wideband characteristics which meet the requirement of worldwide regulatory UHF band RFID application.

II. Log Periodic Dipole Array (LPDA) Antenna

The design mechanism of log periodic dipole antenna defines the dimension scaling periodically thus the performance is periodic with the logarithm of frequency. Fig. 1 shows a general LPLA.

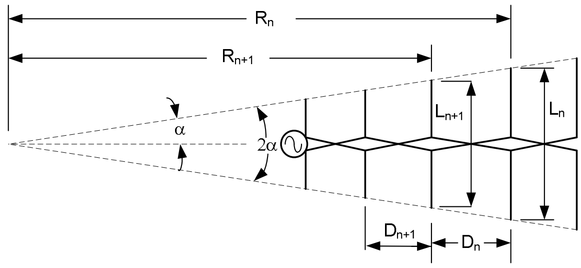


Figure 1. A typical log periodic dipole antenna array

A wedge of enclose vertex angle α bounds of dipole lengths. The scale factor (τ) is defined as

$$\frac{r_{n+1}}{r_n} = \frac{L_{n+1}}{L_n} = \tau \qquad (1)$$

where the ratio of successive element positions (r_n) equals the ratio of successive dipole lengths (L_n).

The spacing factor (σ) of the LPDA is defined as where d_n is the distance between the elements. The angle of apex is calculated by equation. The first step in designing log periodic antenna is the design parameters σ and τ should be selected for a specified directivity. The present design is a log periodic antenna transformed from LPDA antenna. The diameter of the largest loop is determined by

$$L_1 = 2R_1 = \frac{\lambda}{\pi} \qquad (2)$$

III. Antenna Stuctures

The geometry of the proposed design of LPLA is illustrated in Fig. 2. The proposed antenna is fabricated with three loop wire elements with radius of R1, R2, and R3. The three loops are formed with vertex angle of α. The distance between loop elements are defined as d_{12} and d_{23}. A pair of crisscross feed line is located at the antenna feed gap, g. The material of the antenna wires is in copper with diameter of 1.18 mm. A 0.88 mm thickness of card board is employed to form the antenna support. The antenna parameters are simulated and optimized by CST Microwave Studio.

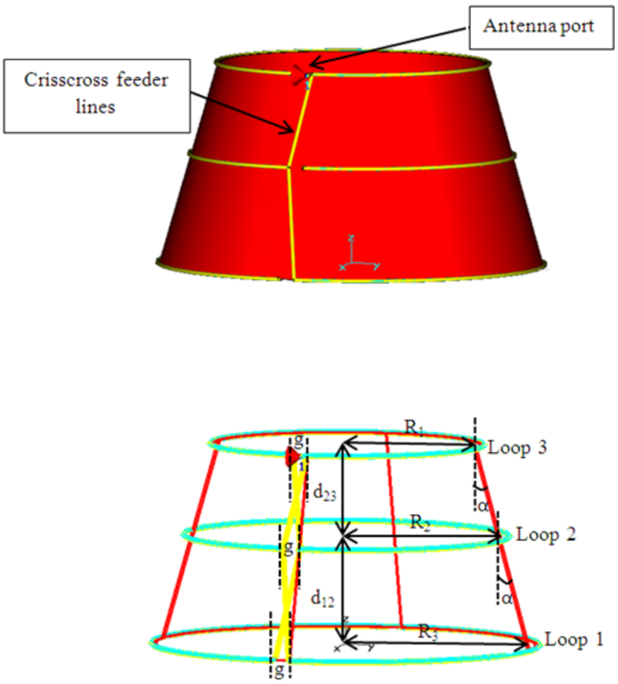


Figure 2. The geometry of the proposed antenna

IV. Result And Discussion

The return loss characteristic of the antenna defined by the proposed parameters in Table I is simulated and the result is illustrated in Fig. 3.

TABLE I. Design Specification of the Proposed Antenna

R1 (mm)	63
R2 (mm)	53
R3 (mm)	44.5
d_{12} (mm)	34
d_{23} (mm)	28.5
g	5
α	16.5

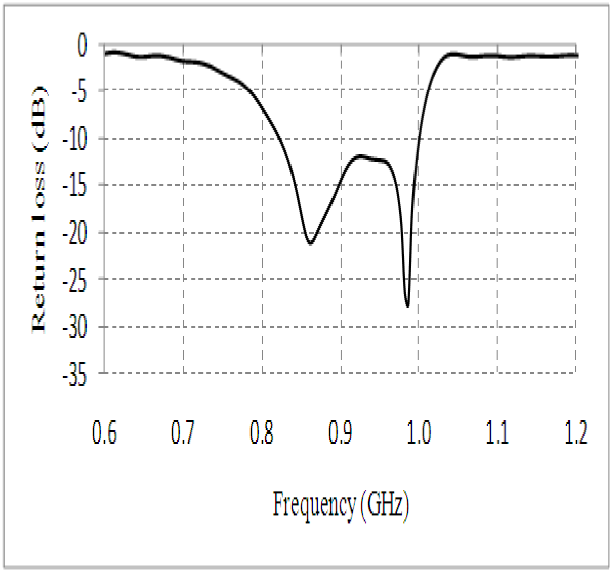


Figure 3. Magnitude of S11 versus frequency

The bandwidth of the proposed antenna is characterized from 10 dB return loss. The simulated result for UHF bandwidth of 235 MHz (from 811 MHz to 1046 MHz) is demonstrated. Therefore, it is sufficient to meet the requirement of worldwide regulatory UHF RFID band application.

Fig. 4 shows the simulated return loss of different radius sizes of Loop 1 with R1. The impedance bandwidth is shifted to lower frequency as the radius of Loop 1 increases.

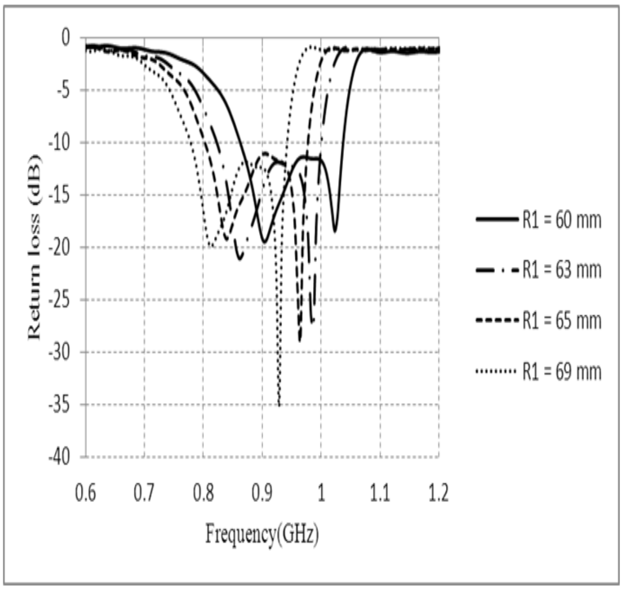


Figure 4. Effect of loop radius versus broadband frequencies

Fig. 5 shows the graph of simulated gain of the proposed antenna. The proposed antenna offers a gain of 7-7.7 dB within the universal UHF RFID bandwidth. The peak antenna gain is about 7.61 dB.

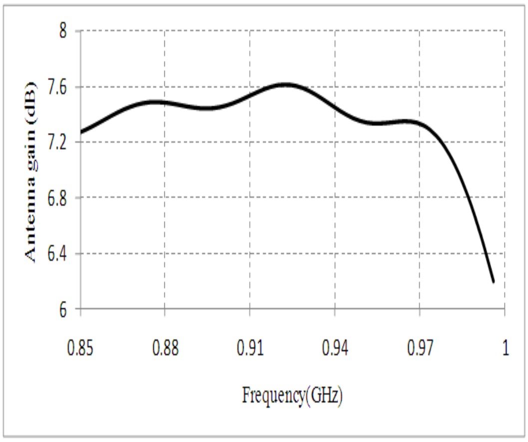


Figure 5. Antenna gain of the proposed antenna

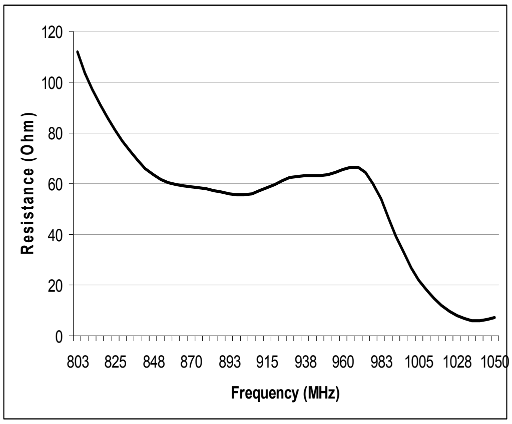


Figure 6. Resistance curve of the proposed antenna

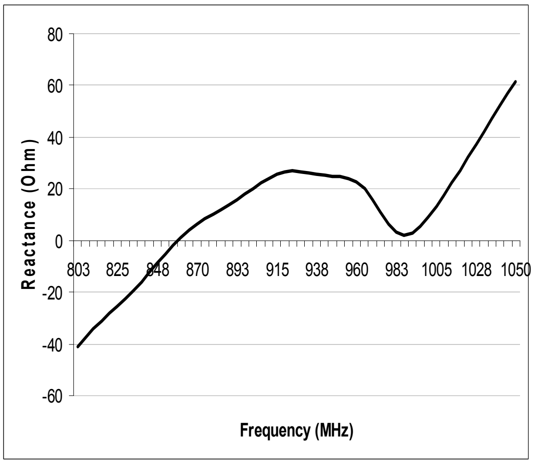
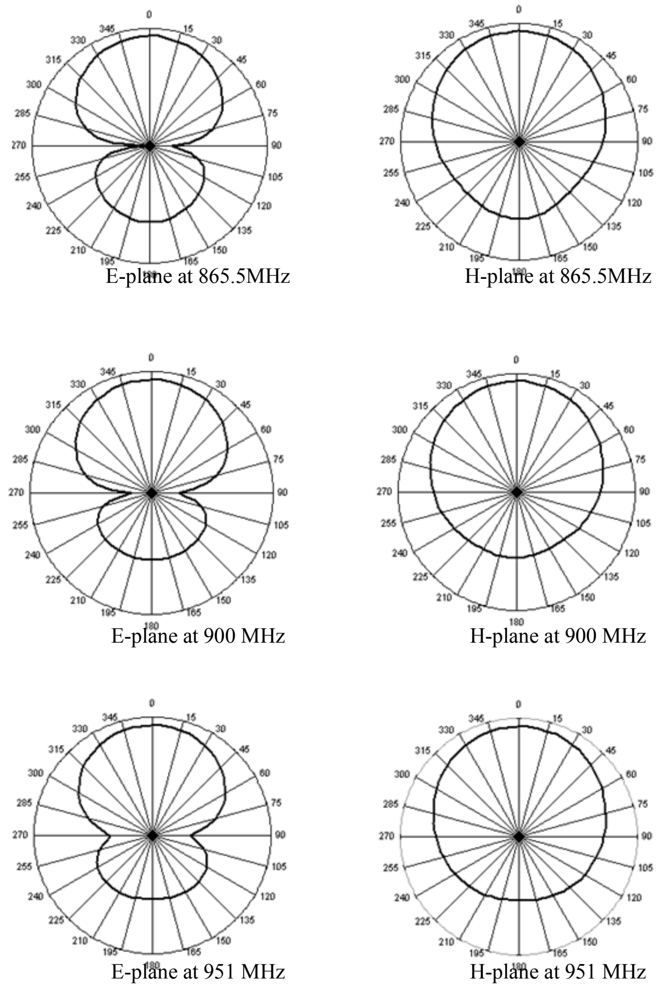


Figure 7. Reactance curve of the proposed antenna

Fig. 6 and Fig. 7 show the simulated resistance and reactance curves of the proposed RFID reader antenna respectively. In the figures, it shows a nearly constant variation desired UHF frequency bands (from 840 to 960 MHz) with both impedance curves to match 50 ohm impedance.

In Fig. 8, the E plane (yz) and H-plane (xz) of the proposed antenna are depicted at three frequencies. The E-plane patterns are directional and constant over the frequencies.



(a) (b)

Figure 8. Radiation pattern (a) E-plane (b) H-plane of the proposed antenna at 865.5MHz, at 900MHz, at 951MHz

V. CONCLUSIONS

A novel wideband UHF log periodic antenna has been achieved. The proposed antenna is sufficient to cover 25.2% bandwidth from 811 MHz to 1046 MHz and a maximum gain of 7.61 dBi. The design results demonstrate the proposed log periodic antenna to offer the characteristics of wide bandwidth and high gain for the UHF RFID application.

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