

Design of Circularly Polarized Unidirectional Antenna using Probe-Excited Circular Ring Antenna above the Square Reflector with Inserted Metallic Slabs

Chuwong PHONGCHAROENPANICH¹, Kittima LERTSAKWIMARN², Rungsinee SUKKAMAT¹,
Nattaset MHUXTONGON¹, Sompol KOSULVIT¹ and Prayoot AKKARAEKTHALIN³

¹Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand

²Faculty of Industrial Technology, Rambhai Barni Rajabhat University, Chanthaburi 22000, Thailand

³Department of Electrical Engineering, King Mongkut's University of Technology North Bangkok, Bangkok 10800, Thailand

Abstract - This paper proposes a circularly polarized unidirectional antenna using a probe excited circular ring with inserted perpendicular slabs above the square reflector for UHF-RFID system. The measured $|S_{11}| \leq -10$ dB covers 884 - 1000 MHz or 12.31% bandwidth, and 3-dB AR bandwidth of 900 - 1000 MHz or 10.53% bandwidth. The maximum gain is 8.35 dBic. The half-power beamwidths in xz - and yz -planes are 66.3 and 66.7 degrees, respectively.

Index Terms — Circular polarization (CP), Circular ring, UHF-RFID, Unidirectional pattern

1. Introduction

The radio frequency identification (RFID) is an automation identification technology that uses radio wave to exchange data between reader and tag attached to an object. It has been widely applied in many manufacturing companies, logistics systems, service industries, government agencies, and public service organizations in the past few years [1].

The antenna design is the key to develop the RFID technology. Generally, the antenna for the RFID reader should be characterized, by high quality circular polarization characteristics and unidirectional pattern. The circular ring excited by probe above the square reflector is a potential candidate [2]. A simple structure and can be designed easily and straightforward is reported [3].

This paper proposes a circularly polarized unidirectional antenna for RFID system. The organization of the rest of this paper as follows: Section 2 presents the proposed antenna configuration. Section 3 describes the simulated and measured results. The concluding are provided in Section 4.

2. Proposed Antenna Configuration

A circularly polarized unidirectional antenna using a probe excited circular ring with inserted perpendicular slabs above the square reflector for RFID system is shown in Fig.1. The antenna is composed of radiator, circular ring, and reflector. The radiator is a linear electric probe with circular brass at the center probe. The electric probe is $\lambda/4$ length in order

to operate at the frequency of 922.5 MHz. The circular ring with inserted perpendicular slabs produces the circular polarization. The square reflector is use to generate the unidirectional pattern.

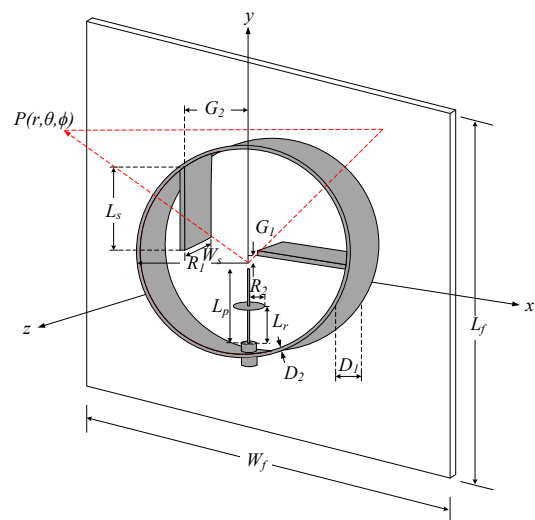


Fig.1 Geometry of the proposed antenna.

In order to verify the frequency response of various characteristics of the proposed antenna, the antenna parameters are varied to determine the optimized dimensions and characteristics such as $|S_{11}|$, AR, gain and HPBW. The antenna dimensions are optimized at the center frequency of 922.5 MHz, as given in Table I.

3. Simulated and Measured Results

Fig.2 depicts the photograph of the fabricated prototype antenna which was designed on copper slab and fed by SMA connector with 50- Ω characteristic impedance. The antenna characteristics based on the geometrical dimensions are tabulated in Table I. Fig.3 illustrates the $|S_{11}|$ as function of frequency. It can be observed that $|S_{11}| \leq -10$ dB can cover

the frequency range from 884 MHz to 1000 MHz. The 3-dB AR bandwidth covers along the frequency range from 900 MHz to 1000 MHz in Fig.4. Fig.5 reveals the radiation patterns in the xz- and yz-planes at the center frequency. The unidirectional pattern with circular polarization is achieved. Fig.6 illustrates the antenna gain versus the frequency.

TABLE I
Proposed Antenna Geometrical Dimensions

Parameter	Dimension (mm)	Parameter	Dimension (mm)
R_1	75	D_1	25.5
R_2	5	D_2	1.5
L_p	75	G_1	16.5
L_r	10	G_2	29.5
L_s	65	L_f	250
W_s	25.5	W_f	250

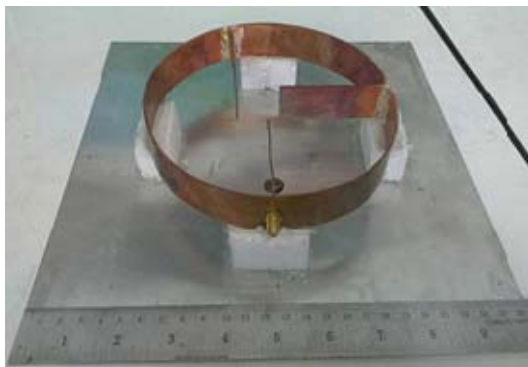


Fig.2 Photograph of the fabricated prototype of the proposed antenna.

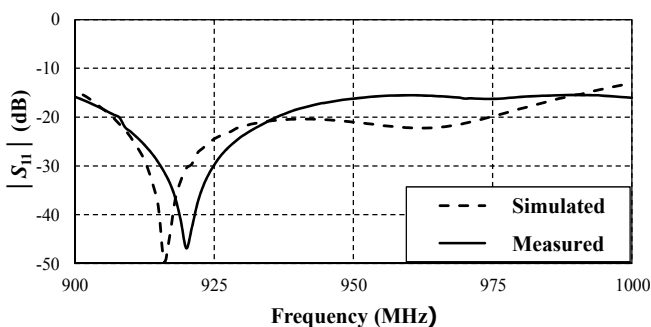


Fig.3 Simulated and measured $|S_{11}|$ as function of frequency.

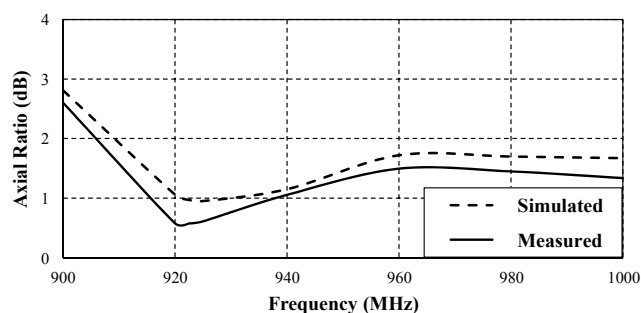


Fig.4 Simulated and measured AR as function of frequency.

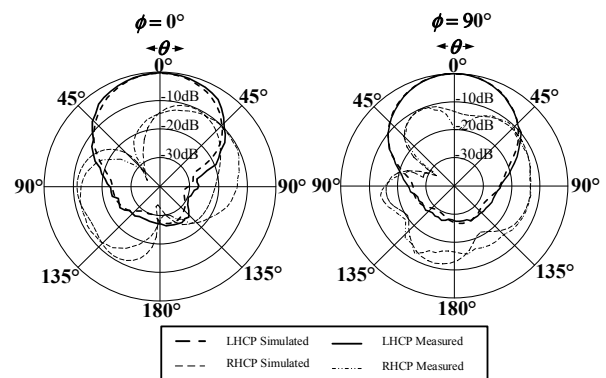


Fig.5 Radiation patterns in the xz- and yz-planes at the center frequency.

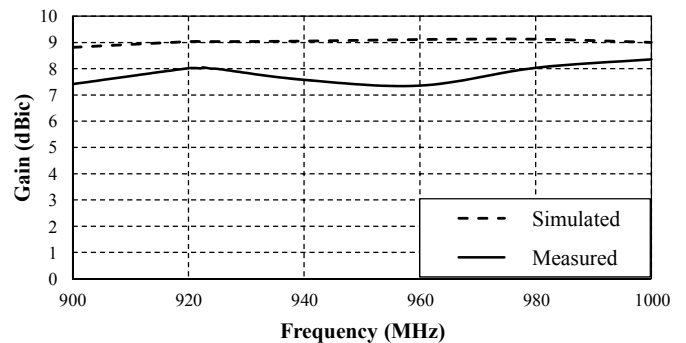


Fig.6 Simulated and measured gains as function of frequency.

4. Conclusion

The UHF-RFID reader antenna radiating circular polarization has been characterized. The measured result shows that $|S_{11}| \leq -10$ dB covers the frequency range of 884 - 1000 MHz. The 3-dB AR bandwidth of the antenna is 900 - 1000 MHz. The half-power beamwidths (HPBW) in xz- and yz-planes are 66.3 and 66.7 degrees, respectively. The achieved gain is 8.05 dBic at the center frequency. The antenna size is appropriate for UHF-RFID reader following national standard.

Acknowledgment

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