Power Feeding to RFID Tags Within Specific Distance and Transponder Control Signal

Kengo Ueyama, Akitoshi Ito, Yukio Iida, and Noriaki Muranaka
FSC, and Dept. of Electric and Electronic Eng., Faculty of Engineering Science
Kansai University, Japan

Abstract—We are proposing the method of supplying driving power of the RFID tag containing transponder control signal by the electro-magnetic field besides the communication signal. From this viewpoint, we are also proposing power supplying method to RF tags within specific distance using two antennas. In the method, we use two properties: (1) The intensity of the electromagnetic field from two loop antennas sharply decreases depending on the distance, and (2) the supplied-signal phase difference sharply changes at a position $1/(2\pi)$ of the wavelength. We used transmitting resonance-type antennas composed of capacitor of 1 pF and the five turns coil of 30 cm in diameter, and receiving antennas composed of variable capacitor from 10 pF to 120 pF and the card-type coil with five turns. The amplitude is 10 V at the transmitting side, and the resonance-frequency is about 17.6 MHz. Under this condition, we were able to drive an IC-encoder-chip of 2 V and 0.3 mA within the distance up to 70 cm. Next, we proposed the ball-type antenna to induce only magnetic fields mainly.

1. INTRODUCTION
The RFID (Radio Frequency Identification) technology [1] has been rapidly attracted attention in recent years, and its applications for various purposes have been considered. In these circumstances, we have thought that the applicability of the RFID technology would be highly improved by supplying power to RFID tags using a method different from a signal communication [2]. Meanwhile, new method of wireless energy transfer has been reported [3]. We proposed the new system to supply power to RFID tags within a restricted transmission distance using two small loop antennas before [4]. In this paper, we now report the problem on using this system and the solution.

2. DEMONSTRATION
We report methods and results of the demonstration.

- We used a loop antenna for the power transmitting antenna and card type antenna. Each parameter of these antennas is shown in Table 1.
- Figure 3 shows the card-type antenna with DC rectification circuit and the resistance 7 kΩ that in equivalent circuit of IC chip.
- We measured the rectified Voltage of IC chip (7 kΩ) on the card.

![Figure 1: Power-transmitting antenna and a power-receiving antenna.](image1.png)

![Figure 2: Distance characteristics of the phases of $H_{r1}$, $H_{\theta2}$ and $E_{\phi2}$ fields.](image2.png)
Variations in DC voltage versus the distance are shown in Figure 4.

As a result, we were able to drive an IC-encoder-chip of 2 V and 0.3 mA within the distance up to 70 cm. And we could also achieve power feeding of 0.3 V to same one within the distance up to 100 cm.

![Figure 3: Card-type antenna.](image1)

![Figure 4: DC Rectified voltage for distance r.](image2)

Table 1: Parameters of the transmitting and receiving antennas.

<table>
<thead>
<tr>
<th>Antenna Type</th>
<th>Capacitor [pF]</th>
<th>Resonance-freq. [MHz]</th>
<th>Size [cm]</th>
<th>Turn [times]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop antenna</td>
<td>1</td>
<td>17.6</td>
<td>30 (diameter)</td>
<td>5</td>
</tr>
<tr>
<td>Card-type antenna</td>
<td>10 ~ 120</td>
<td>17.6</td>
<td>6 (length) 5.5 (width)</td>
<td>5</td>
</tr>
</tbody>
</table>

(20 Vp-p at the Oscillator)

3. BALL ANTENNA

We need the antennas which emit stronger magnetic fields to various directions. So we propose a ball antenna to induce only magnetic fields mainly. We explain the ball antenna shown in Figures 5 and 6.

- We select the sphere of C-60 structure. We fix four loop antennas to the surface of the ball. These loop antennas are connected serially.
- We put excitation loop on the xy plane around the ball.

We perform the experiments to compare a ball antenna with a loop antenna.

- Each parameter of these antennas is shown in Table 2.

![Figure 5: The ball antenna.](image3)

![Figure 6: Structure of the ball antenna.](image4)
The results are shown in Figure 7. We can emit both magnetic field $H_r$ and $H_\theta$ to various direction except upper side of the ball. There is room for correction in the way to excite the ball antenna.

![Figure 7: The field intensity characteristics of the ball antenna at distance $r$.](image)

Table 2: Parameters of the transmitting antenna.

<table>
<thead>
<tr>
<th></th>
<th>Capacitor [pF]</th>
<th>Resonance-freq. [MHz]</th>
<th>Size [cm]</th>
<th>Turn [times]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball antenna</td>
<td>10 $\sim$ 70</td>
<td>21.5</td>
<td>30 (diameter)</td>
<td>5</td>
</tr>
</tbody>
</table>

(20 Vp-p at the Oscillator)

4. CONCLUSIONS

We proposed the ball antenna could emit magnetic field elements $H_r$ and $H_\theta$ to various directions. Based on the results, we can develop the ball antenna and the new power supply system in which the maximum distance from the transmitting unit to RFID tags can be restricted effectively.

ACKNOWLEDGMENT

This work was supported by “Academic Frontier” Project for Private Universities: Matching Fund Subsidy from MEXT, 2007-2011. The computations for this research were performed by the Large-Scale Computer System at the Osaka University Cyber media Center.

REFERENCES