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The Loop Antenna with magnetically coupled parasitic element for Wireless-tag System

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1. Introduction

The recent advance in cost-effective low power electronics and packaging have enabled the wireless tag as a likely substitute for barcodes in industries as access control, parcel and document tracking, distribution logistics automotive system. In these applications data is transferred to local querying system (reader or interrogator) from a remote transponder (tag) including an antenna and a microchip transmitter. The built-in antenna is strongly demanded for wireless tag system. The suitable antenna must have low cost, low profile especially small size whereas the bandwidth requirement is less critical [1].

From these view points, the loop antenna with magnetically coupled parasitic element for wireless tag system is presented in this paper. In order to confirm the basic antenna characteristics of the antenna, the antenna characteristics are analyzed. The electromagnetic simulator based on the Method of Moment (MoM) is used. As results, it has been confirmed how low profile and small size are achieved on the antenna. Low profile is achieved by printing the antenna on the dielectric material. In addition, small size is achieved by coupling the feed element with the parasitic element, which loaded capacitor.

2. Antenna Structure

Antenna model is shown in Fig.1, where the feed and parasitic elements are depicted on the right side and the antenna model designed on the dielectric material is depicted on the left side. The loop antenna is magnetically coupled with the parasitic element, which loaded capacitor. It is consider that the resonance frequency of the antenna is adjusted by changing capacitance. As the parameters of the dielectric material are fixed, the thickness and permittivity of parasitic element are 1.6mm, 4.6 respectively. The parameters of the antenna are a=13mm, b=7mm, m=22mm, n=33mm, C=5pF. The antenna is fed by a coaxial cable. The resonance frequency is 306MHz.

3. Results

3.1 Input Impedance Characteristics

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Fig.3 shows the input impedance characteristics of the antenna. The smith chart is used to explain the input impedance. In the figure, the plot of input impedance shows a loop around 50Ω. Fig.3(b) shows the return loss characteristics for the antenna. The calculated and measured results are compared each other. As can be seen in figure, the calculated and measured results show similar tendency. In addition, the relative bandwidth of the antenna shows the narrow bandwidth characteristics.

3.2 Current and Magnetic Field Distribution

The calculated current distributions of the antenna are shown in Fig.4, where (a) shows the case the antenna is shorted without capacitance and (b) shows the case the antenna is loaded with 5pF capacitance. They are shown at the center frequency f_0 (f_0=306MHz). In the figure, the current distribution is expressed by dB scale. As can be seen in figures, the different current distributions on the antenna elements are shown in both cases. The current distribution is not distributed on the parasitic element in figure (a), whereas is strongly indicated in figure (b).

In addition, the calculated magnetic field distributions are shown in Fig.5, where the antenna is loaded with 5pF capacitance. In figures, the magnetic field is strongly distributed in the inside of feed element. It is considered that the current on the parasitic element is distributed by the magnetic field distributed in the inside of feed element. The parasitic element of the antenna is coupled with the feed element.

3.3 Radiation Patterns

The measured radiation patterns are shown in Fig.6. The radiation patterns are expressed by directivity [dB]. They are shown at the center frequency f_0 (f_0=306MHz). The figures illustrate the radiation patterns at each plane. As can be seen in these figures, the E_ϕ component shows the shape of modified 8 in XZ and YZ plane and omni directional pattern in XY plane.

4. Conclusion

In this study, in order to meet a low cost, low profile and small size, the loop antenna with magnetically coupled parasitic element for wireless tag system has been presented. The antenna characteristics have been analyzed in order to confirm the basic antenna characteristics of the antenna. As results, it has been confirmed that the current on the parasitic element is distributed by the magnetic field in the inside of feed element. The parasitic element of the antenna is coupled with the feed element. Low profile is achieved by printing the antenna on the dielectric material. In addition, small size is achieved by coupling the loop antenna with the parasitic element, which loaded capacitor.

References

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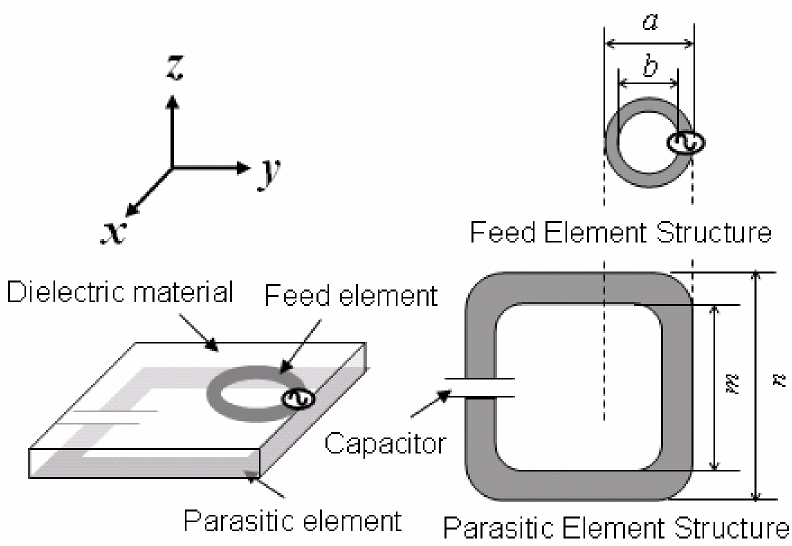


Fig.1 Antenna structure
(a=13mm, b=7mm, m=22mm, n=33mm, C=5pF, f_0=306MHz)

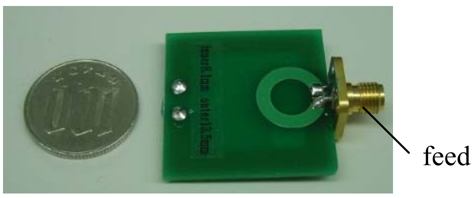
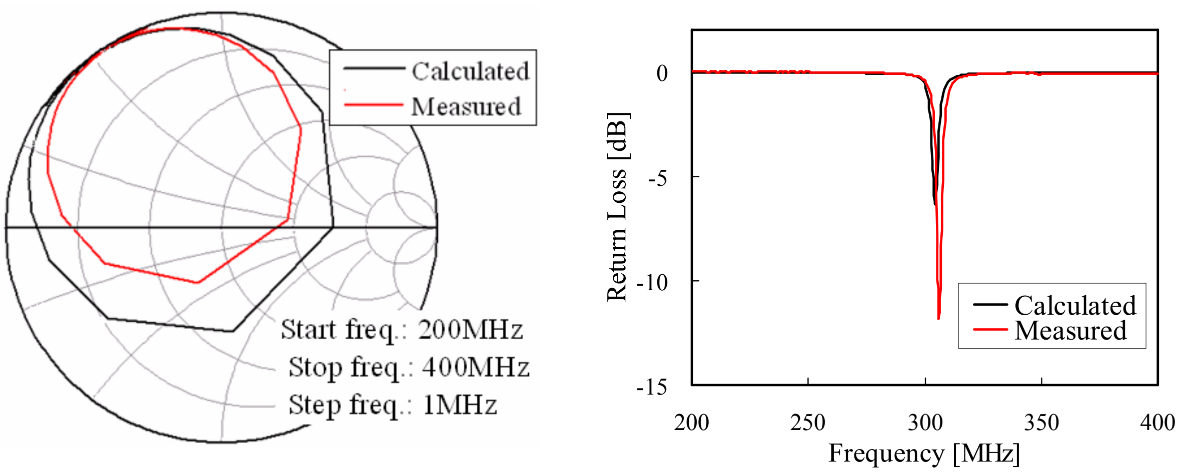


Fig.2 Measured antenna model



(a) Smith Chart (b) Return Loss characteristics

Fig.3 Input impedance characteristics

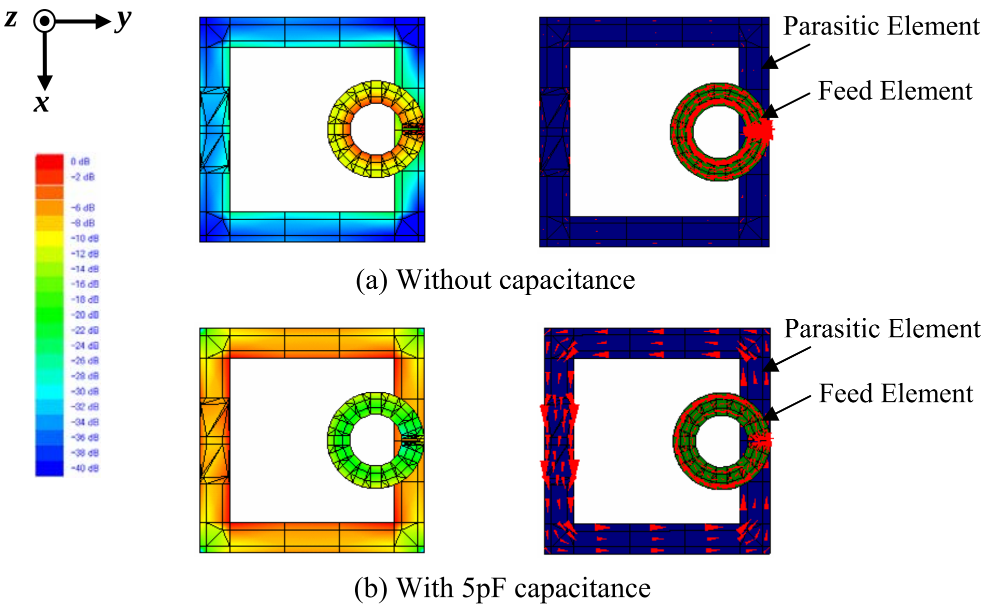


Fig.4 Current distribution (f_0=306MHz)

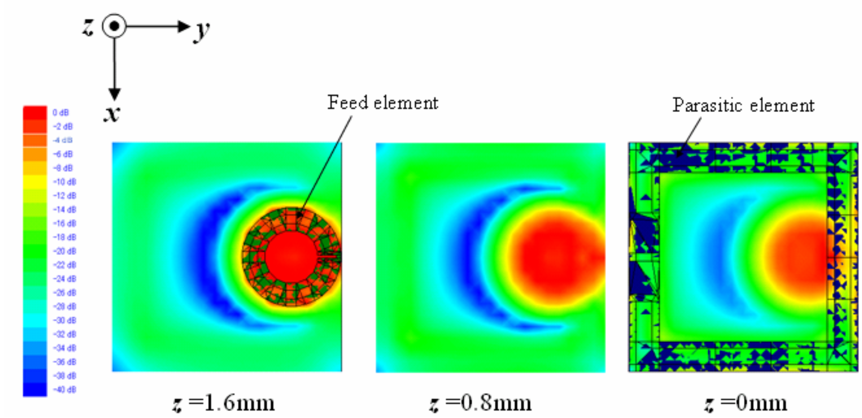


Fig.5 Magnetic field distribution (f_0=306MHz)

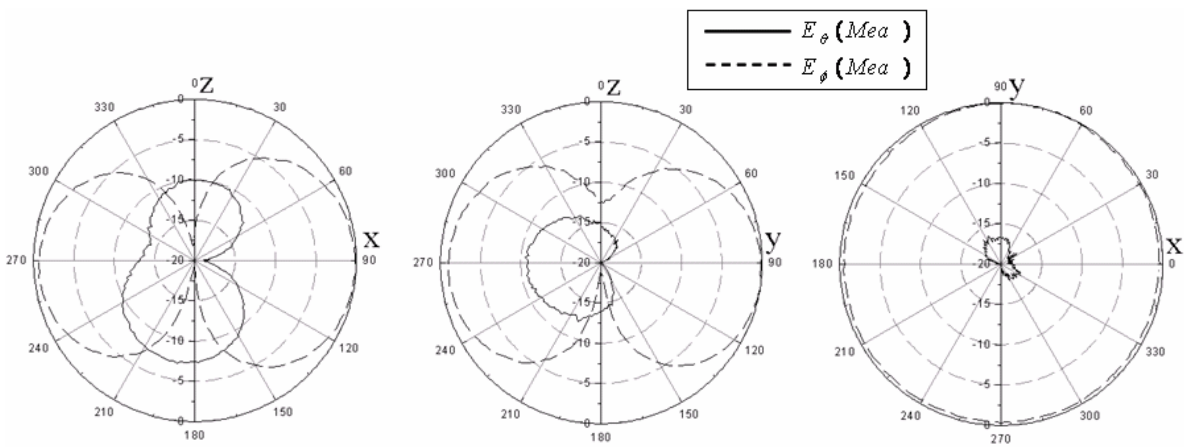


Fig.6 Radiation Patterns (f_0=306MHz)