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A Coin Detection System by Coupled Printed Spiral Inductors

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Abstract: This paper describes a coin detection system using coupled Printed Spiral Inductors (PS-Inductors). In this research, the PS-Inductor is composed of copper foil spiral on the printed board. As an advantages, the PS-Inductor can be made easily and does not need the iron core. The experimental measurement and the theoretical calculation of the inductance of the PS-Inductor are derived. This enables the easily realizable coin detection system using PS-Inductor. In this system, a coin can be identified as changes of the mutual inductance of coupled PS-Inductors. The mutual inductance is investigated by inserting the coin between two PS-Inductors.

Key–Words: Coin detection, Mutual inductance, Printed Spiral Inductor, Combination inductance, Self-inductance

1 Introduction

A lot of spiral shape elements are used for RFID, IC, and so on [1][2]. Especially, the spiral shapes inductors are called spiral-inductor. The spiral inductor which is generated in an IC is often used [3]. The spiral inductor is not only constructed on the chip but also on a printed board. The spiral inductors on the printed board have been easily used as a mutual inductor because the iron core does not need. That is, the mutual inductance can be easily achieved.

In this paper, we propose a novel coin detection system using the mutual inductance changes of coupled printed spiral inductors (PS-Inductors). Since the elemental composition of each coin in the world is unique, the influence of the electro magnetic field generated by two PS-Inductors, strongly depends on the coin type. In other words, the coin can be identified by investigating the mutual inductance changes of two PS-Inductors. The advantage of the proposed method is that this method is better realizable than the conventional coin detection system using the natural frequency of coin that requires the Fourier transform for detection [4]. Moreover, it can be said that the PS-Inductor generated by semicircular wiring pattern in the printed board is fit for the physical characteristic of coins.

The experimental results of various coins suggest that the proposed method can identify coins correctly.

This paper is organized as follows. In Section 2, the evaluation of the inductance of the PS-Inductor is described. The self inductance L is measured and calculated. In Section 3, the coin identification system is proposed. The coin can be distinguished by using the mutual inductance change effected by it. Section 4 shows the experimental methods and results using two coupled PS-Inductors. The coin identification is experimented using two types of PS-Inductors which have different diameter. Finally, in Section 5 the conclusion of this paper are drawn.

2 Printed Spiral Inductor

The PS-Inductor is designed by combining hemicycles. In general, a spiral inductor in an IC is composed of a square wiring pattern that is combination of straight lines.

The circle wiring pattern can provide the high Q value [5]. Therefore, PS-Inductor with circle wiring pattern is decided in this paper. Besides, its physical form suits to form of coins very well. The layout and inductance of PS-Inductor are decided by five parameters as shown in Fig. 1 and Table 1. Also, two types of PS-Inductor α and β are used in this research (see Fig. 2). The PS-Inductors are created by combining semicircular patterns by using cutting machine (see Fig. 3). The length of the conductor shortens toward the center because the conductor rolls the hemicycle from the maximum radius to the center.