

Study on the Effective Loading Method of the Magnetic Sheet for NFC / WPT Dual-Band Antenna

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Abstract - Wireless Power Transfer (WPT) system in accordance with Qi standards and NFC-RFID system is being loaded to the smart phone in recent years. However, the transmission efficiency of WPT system and communication distance of NFC system is greatly deteriorated due to nearby metal objects. To solve this problem, magnetic sheet with high permeability is inserted between these antenna and metal objects. In order to make thickness of these materials thinner, we propose amorphous magnetic sheet. Besides, this amorphous magnetic sheet causes to increase the transmission efficiency and communication distance.

Index Terms — NFC (Near Field Communication), WPT (Wireless Power Transmission), Inductance, RFID (Radio Frequency Identification) tags, Impedance matching

1. Introduction

Wireless Power Transfer (WPT) system in accordance with Qi standards [1], [2] and NFC-RFID system [NFC] are being loaded to the smart phone in recent years. The electromagnetic induction phenomenon caused by metal objects of neighborhood will negatively affect both systems [3]. The reason is that actual electric current on the WPT coil is suppressed by the induction electric current generated on nearby metal objects. To prevent phenomenon, the magnetic thin sheet with high permeability is inserted instead of the air gap between the WPT/NFC dual-band antenna and the metal object. However, the high permeability magnetic sheet has the large magnetic loss as its properties. Therefore, to improve transmission efficiency of the WPT and NFC system, some tact is necessary for the ways of using magnetic sheet insertion. The effectiveness of loss control technique with the transformation of high permeability magnetic sheet is confirmed for the HF-RFID system [4]. It is considered whether these techniques can be applied to the improvement of transmission efficiency for the WPT coil with nearby metal objects. However, in this situation, it is more difficult to control magnetic loss because the quality factor of magnetic sheet depends on the frequency. In general, it needs two or more kinds of magnetic sheet to optimize coil's input impedance at WPT-band (100-205 kHz) and NFC-band (around 13.56MHz). Furthermore, 3 types of positioning procedures for WPT's coil are regulated with Qi standards [1], [2]. Some design admissibility is given for the receiver though the transmitter specification is strictly

regulated in this standard. There are three kinds of transmitter regulation, and the receiver design that adapt to them is important task. The transmitter coil (henceforth expressed as Tx-coil) is divided into two types in Qi standards. The position tolerance type transmitter has a simple planar Tx-coil. On the other hand, the autonomic positioning type transmitter has a guidance magnet at the center of coil for sucking up the receiver coil (henceforth expressed as Rx-coil). However, it is expected that the insertion effect of the magnetic sheet for the efficiency improvement of WPT's Rx-coil is deteriorated by the existence of guidance magnet. Thus, as result, the study about the transmission efficiency in WPT system with the transformation of magnetic sheet is also important like as impedance matching for NFC-systems. The shape optimization technique when only one kind of magnetic sheet is inserted in the stacked WPT/NFC dual-band coil is proposed in this report.

2. Test model and pattern of amorphous sheet

Figure 1 shows a stacked WPT/NFC dual-band coil model that is used in the measurement coil (Fig.1(a)). Also the loss control procedure with the transformation of high permeability magnetic sheet is shown in Fig.1(b) and (c) [4]

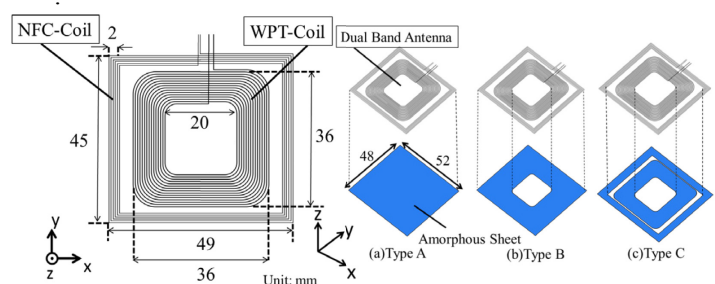


Fig.1 Dual-Band antenna and magnetic sheet loading model.

- (A) Magnetic sheet loading case that fit to the outline of the NFC coil
- (B) Magnetic sheet loading case that to cut out a hollow part fit to WPT coil
- (C) Magnetic sheet loading case that completely fit to the NFC / WPT each coil

The system configuration of WPT and NFC measurement system is showed in Fig.2. In this report, the following models are assumed as the WPT and NFC measurement situation;

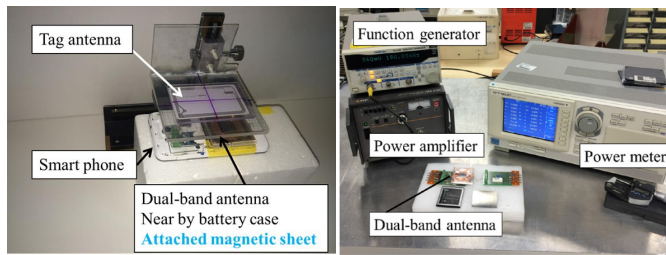
NFC model: In this model, the communication situation between the card type passive tag according to ISO-14443 and the Tx-coil for NFC is evaluated.

WPT model-1: In this model, the transmitter unit that is composed with Tx-coil, sintered ferrite sheet and metal plate is used.

WPT model-2: Tx-coil used by this model is almost the same composition as WPT model-1, though it has a guidance magnet.

In both WPT model-1 and -2, distances between Tx-coil and Rx-coil are kept in 5 mm.

Table I shows the permeability at each frequency band of the amorphous sheet.



(a) NFC-system (b) WPT-system

Fig.2 Measurement set up of NFC and WPT system.

TABLE I PERMEABILITY OF AMORPHOUS

Frequency	Permeability μ'	$\tan\delta$
150 kHz	15000	0.54
13.56 MHz	500	1.6

3. Result and discuss

Figure 3 shows the measurement results of communication distance in NFC measurement model. As results, the expansion tendency of communication distance is observed when the use area of high permeability magnetic sheet like the amorphous sheet is reduced (from 'Type A' to 'Type-C' in Fig.1).

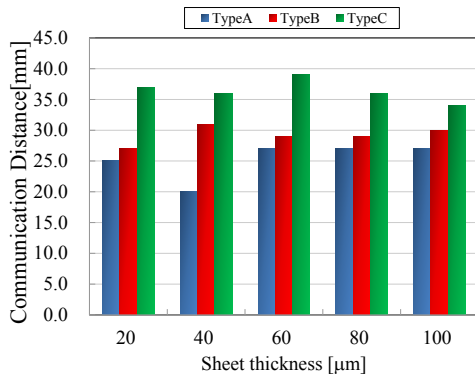


Fig.3 Communication property evaluation for NFC.

Figure 4 shows the measurement results of transmission efficiency as a function of the amorphous sheet thickness in WPT measurement model. In the tendency of Fig.4 (a) and Fig.4 (b), a remarkable difference is confirmed. In WPT model-1, when the amorphous sheet use area is large (as for

Type-A), higher transmission efficiency tendencies are confirmed at all sheet thickness categories. Contrastingly in WPT model-2, when the facing region of amorphous sheet to the guidance magnet is removed (Type-B, for Tape-C), the transmission efficiency rises are confirmed. It is thought that the extension of magnetization saturation on amorphous sheet with the guidance magnet is protected with the inner hole edge of doughnut.

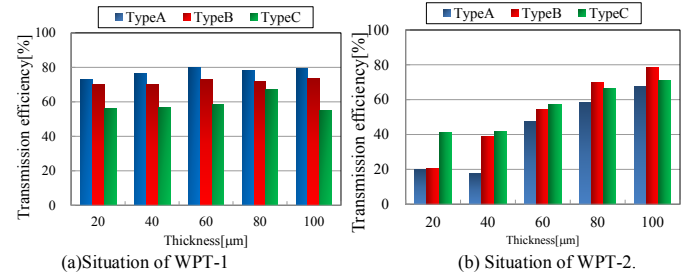


Fig.4 Transmission efficiency evaluation for WPT

As summary, 'Type B' is the most effective loading type for both systems. And it is possible to suppress total thickness of NFC/WPT dual-band antenna.

TABLE II EFFECTIVE LOADING TYPE

	NFC	WPT	
Loading type	C>B>A	WPT-1	WPT-2
		A>B>C	B≧C>A

*A>B>C; Type A is higher performance than Type B or C.

4. Conclusion

In this report, the property improvement technique for the stacked WPT/NFC dual-band coil near metal objects with one kinds of magnetic sheet was verified. As a result, it was confirmed that occasionally the communication distance and the transmission efficiency was improved with reducing the use area of the high permeability magnetic sheet like a amorphous sheet.

It was confirmed that the NFC communication distance improved when the gap was put onto the amorphous sheet between NFC-coil and WPT-coil. In the future, the optimization of magnetic sheet insertion method to the WPT/NFC dual-band coil will be carried out based on above results.

References

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