Bent Loop Antenna for NFC Reader in the Centrifuge Machine

Kamonchanok JANTHONGSRI Patcharathorn POONKATE
Archareeyaporn JANTHARACHA and Supakit KAWDUNGTA†

†Faculty of Engineering, Rajamangala University of Technology Lanna, Chiang Mai, 50300 Thailand

E-mail: †supakitting@rmutl.ac.th

Abstract This paper presents a bent loop antenna for near field communication (NFC) reader in an application of a centrifuge machine. It is operated in the frequency of 13.56 MHz. The loop antenna was designed for transfer data and magnetic energy, respectively, with short range in the same time. The antenna structure is designed as loop and bends around the pole of centrifuge machine. From simulated and measured results, the proposed antenna has $|S_{11}|$ less than -10 dB at 13.56 MHz and it can distribute the magnetic field in *x*, *y* and *z* around the pole. This antenna can be transferred data and power to the tag in 5 cm.

Keyword Bent Loop Antenna, Centrifuge Machine, Near Field Communication (NFC) and Power Transfer

1. INTRODUCTION

Recently, near field communication (NFC) has become a popular field of technology. It is a contactless communication and can transfer both data and supply power. The NFC system consists of NFC reader, reader antenna, and NFC tag or other NFC devices. It is operated based on the principle of inductive coupling at the frequency of 13.56 MHz, which is similar to high frequency radio frequency identification (HF-RFID). The NFC and RFID are compatible with the standards of ISO/IEC 14443 and ISO 15693 at 13.56 MHz. The NFC is employed in many solutions such as access controls, wireless payment and customer check in. [1]. Therefore, there are many research papers, which propose the development of NFC antenna in difference applications especially in smart phone [1]-[4]. In this paper, the NFC system in the centrifuge machine is investigated. The reader antenna is design as a bent loop antenna. It is designed to operate inside the centrifuge machine. The structure of the proposed antenna is a bent loop around the pole of centrifuge machine, and the magnetic field can be distributed in *x*, *y* and *z* axes into the tag at tube lid.

The next section of this paper will be divided as follows. Section 2 presents the structures analysis and system installation. Measured results is shown in Section 3 and conclusion is in Section 4.

2. STRUCTURE ANALYSIS

The centrifuge machine is shown in Fig. 1. It is shown inside of the centrifuge chamber. It consists of a rotor, swing arm rotor, tube and pole. The proposed antenna is installed under the tube and swing arm rotor; the pole is in the middle of loop antenna.

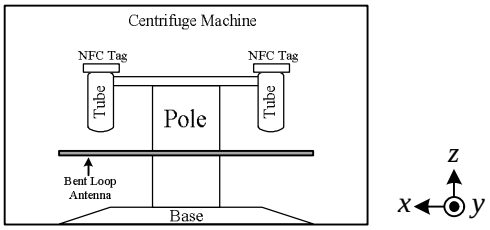


Fig.1. The structure of centrifuge machine inside of chamber.

Consequently, the loop antenna is designed to bent around the pole and rotor as shown in Fig. 2. The proposed antenna consists of bent loop and matching circuit. It is designed on the FR4 substrate (ε_r=4.3) with the thickness of 1.6 mm. Table 1 shows the antenna parameters.

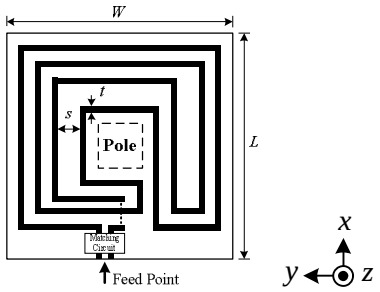


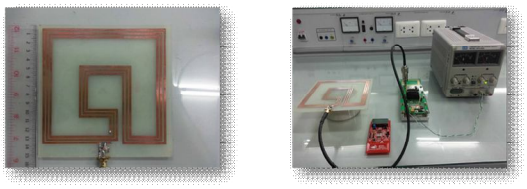
Fig.2. The structure of bent loop antenna.

Table 1 Antenna parameters for bent loop antenna.

Antenna Parameter	Description	Physical Size (mm)
W	Width of antenna	141
L	Length of antenna	150
s	Distance between wires	1
t	Thickness of wire	2

3. Measured Results

The prototype antenna is fabricated by FR4 substrate with the thickness of 1.6 mm as shown in Fig. 3(a). The prototype antenna is matching with the RC matching circuit. $|S_{11}|$ is measured by network analyzer (Agilent 8753 ES), which is less than -10 dB at 13.56 MHz as shown in Fig. 4. Then, the prototype antenna measured the performance of transfer data and supply power by the NFC reader, 4W RF amplifier and NFC tag (M24LR04E-R). The performance of the proposed antenna in the principle direction is shown in Fig. 5.



(a) Prototype antenna. (b) Test equipment.

Fig.3. Prototype antenna and test equipment.

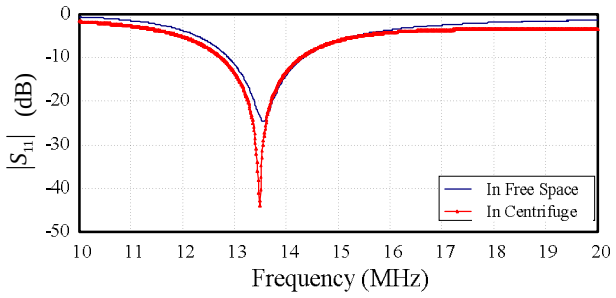
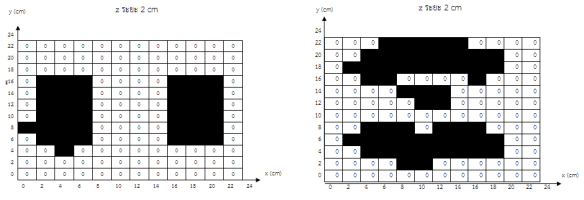
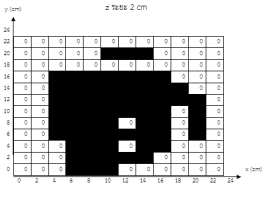


Fig.4. Measured of $|S_{11}|$ for bent loop antenna.



(a) *x*-axis. (b) *y*-axis.



(c) *z*-axis.

Fig.5. Performance of transfer data and supply power at the distance of z = 5 cm.

Table 2 The maximum transfer data and supply power.

Range of transfer data(cm)	Range of transfer supply power (cm)
5.0	5.0

4. Conclusion

The bent loop antenna are designed for NFC reader in the centrifuge machine with size 150 mm x 141 mm. It can be operated in the frequency of 13.56 MHz with $|S_{11}|$ less than -10 dB. From measured result, the proposed antenna can transfer data and supply power to the NFC tag (M24LR04E-R) within 5 cm. It can transfer maximum DC power of 3.25 Vdc. The bent loop antenna is effectively used in the application of centrifuge machine.

5. Acknowledgements

The part of the research was sponsored by Rajamangala University of Technology Lanna under the Project of Hands-on Researcher Small (HRS-1). The research is published creative And community service of Rajamangala University of Technology Lanna. The authors would like to extend deep gratitude to the aforementioned organizations for the financial support, without which this research would not have materialized.

References

[1] S. Soodmand, T. W. C. Brown and A. Gluhak, "Evaluation of HF band NFC/RFID antennas for smart shelf applications" *European Conference on Antennas and Propagation (EuCAP)*, pp. 1895 - 1898, April, 2013.

[2] M.-A. Chung, Y.-L. Chien, L. Cho, P.-H. Hsu and C.-F. Yang, "A dual-mode antenna for wireless charging and Near Field Communication" *IEEE International Symposium on Antennas and Propagation*, pp. 1288 - 1289, July, 2015.

[3] M. A. Chung and C. F. Yang, "Miniaturized NFC antenna design for a tablet PC with a narrow border and metal back-cover" *IEEE Antennas and Wireless Propagation Letters*, pp. 1 - 4, December, 2015.

[4] B. Lee, B. Kim, F. J. Harackiewicz, B. Mun and H. Lee, "NFC antenna design for low-permeability ferromagnetic material" *IEEE Antennas and Wireless Propagation Letters*, vol. 13, pp. 59 - 62, January, 2014.