Design of Correct Contour/Structure of NFC-Reader-Antenna By FEM Simulation for Automotive Electronics

A. K. Palit[1]

[1]ZF-Lemförder Electronic GmbH, ZF-Friedrichshafen AG. Group, Friedrichshafen, Germany

Abstract

The design of a right contour/structure of the NFC-antenna is presented. The NFC-reader-antenna is applied later to communicate with the NFC-tag (transponder) of a smart phone placed in the phone box of the car. The NFC-reader-antenna with selected contour is printed directly on the PCB and the antenna-PCB is placed under the phone box of the car at the center console. The designed antenna must fulfill certain requirements prescribed by a leading German car manufacturer (OEM). The geometry/shape of phone box and the maximum rectangular area available underneath the phone box are also given. The design of the NFC-reader-antenna should be such that it can read the NFC-tags of different smart phones when latter (smart phone) is placed in the phone box and also from a height of 30 mm above the phone box. Furthermore, at the center of the NFC-antenna/PCB a rectangular empty space must be left to fit the wireless charging unit (WLC) under the phone box. Three inductive coils of the WLC unit drastically reduce the H-field strength of the rectangular NFC-Antenna, and thereby making the center part of the Antenna totally insensitive to the NFC-tag of Smart phone. As per OEM, the minimum H-field strength (measured with Langer Hall-sonde [1]) in the entire phone box and 30 mm above it should be 2.5 A/m. In order to fulfill such requirements different NFC-antenna structures were tested but none of the randomly designed structures could fulfill the OEM's requirements. Hence, computer aided engineering (CAE) approach/FEM simulation was needed to model and simulate the optimal contour of NFC-reader antenna.

Several 3D-models of the NFC-antenna were developed and simulated with COMSOL Multiphysics® software at 13.56 MHz frequency [2]. Single and double layer rectangular/H-shaped antenna of size 15.5 cm x 12.5 cm were selected initially with one or two turns and with inner structure as shown in Figure 1 and 2. The Magnetic Fields interface with IBC and LP were used. All models were simulated in the frequency domain with Lumped Port excitation current of 150 mA flowing through the NFC-reader-antenna. The objective H-field strength was purposefully chosen to be much higher than 2.5 A/m so that during the real measurement of NFC-Antenna (in presence of WLC unit) the H-field of at least 2.5 A/m can be achieved.

Frequency domain simulation generated the H-field due to NFC-Antenna-contour. If the plateau of magnetic field generated is not acceptable owing to less value (Figure 1 and 3), the contour of the NFC is further changed. After a few trials we achieved the desired

(optimal) structure of the NFC-reader-antenna which fulfills the required criteria of 2.5 A/m (Figure 4).

Several antenna contours were simulated. Although, first few simulations did not deliver any satisfactory results, after a couple of trials we could achieve the desired performance from the modified contour of NFC-reader-antenna using COMSOL Multiphysics software.

Reference

[1] Langer Hall-Sonde: Langer EMV-technik H-Feld Messsonde RF-R 400-1, Germany. https://www.langer-emv.de/de/category/nahfeldsonden/19
[2] A. K. Palit, Extraction of 13.56 MHz NFC-Reader Antenna Parameters for Matching Circuit Design, Excerpt from the Proceedings of the 2015 COMSOL Conference in Grenoble, France (2015)

Figures used in the abstract

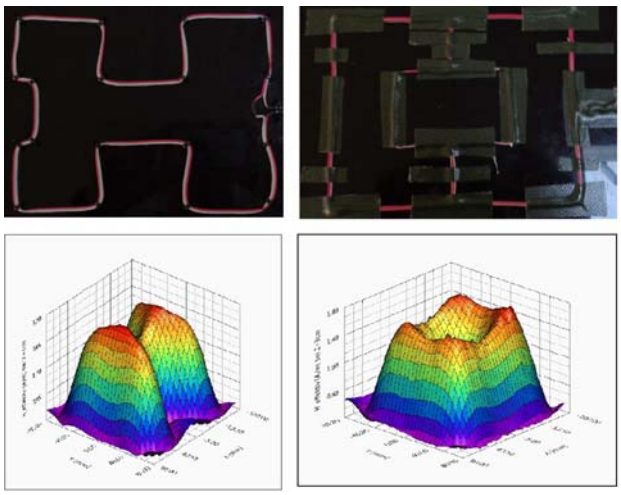

Figure 1: Different contours/structures of NFC-Antenna (top-left & right) and the corresponding H-field measurements with Langer Hall-Sonde (bottom-left & right).

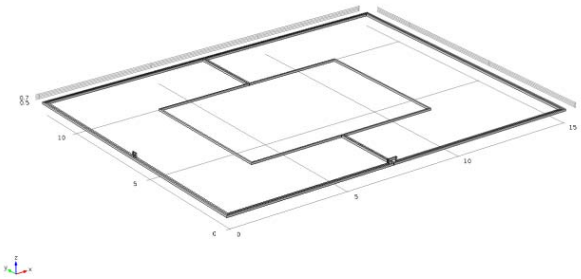

Figure 2: The 3D-model of NFC-Antenna of Fig. 1 (top-right).

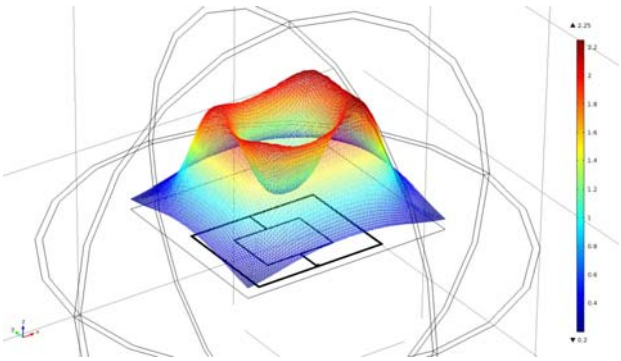

Figure 3: Frequency domain simulation of NFC-Antenna contour of Fig. 2 showing the Hfield.

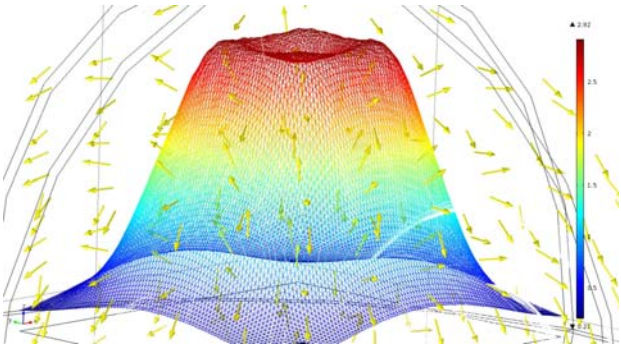

Figure 4: Frequency domain simulation of desired NFC-Antenna-contour producing the Hfield larger than 2.5 A/m.