Determination of NFC-Antenna Operating Distance By COMSOL Multiphysics® Simulation of Planar Transformer Modeling

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Abstract

Although the Near Field Communication (NFC) concept has been developed for the short distance communication between the NFC-reader antenna and transponder/Tag, yet the requirements of different Automotive OEMs vary drastically. For instance, for the keyless entry into the car based on capacitive type sensor in door handle project which consists of a rectangular NFC-reader antenna of size 80mm x 20mm OEM requirement is that aforementioned antenna must be capable of communicating with the authorized driver's smart-phone/smart card from a distance of 4-5 cm when the latter is properly aligned with the car's door handle. However, fulfillment of such technical specification for the aforementioned car door handle project is greatly dependent on the shape, size, Geometry and mechanical structure of car's door handle and also on the NFC-antenna of smart phone. After the design of NFC-antenna this operating distance is experimentally determined. In many cases, actual NFC-antenna operating distance is much lower than the technical specification and this can be either due to improper antenna matching circuit or improper antenna-contour design. Antenna matching circuit design can be verified both by RF-simulation and VNA-measurement of antenna together with matching circuit. However, there is no theoretical rules with which one can predict/guarantee this operating distance before the actual hardware/NFC-antenna prototype is developed. It is just known that operating distance of NFC-antenna is mostly dependent on the diagonal/size of the NFC-antenna. Larger the NFC-reader-antenna size longer the operating distance is and vice versa. But for a particular geometry of the NFC-antenna what should be the maximum operating distance, this is not known in priori. This makes a confusion both for the OEM and also for the electronic designer. In order to resolve this issue theoretically or, by simulation approach COMSOL Multiphysics® based modeling technique has been proposed to determine the theoretical operating distance of the NFC-reader-antenna when the latter communicates with some selected reference Tags.

Since the communication between the NFC-reader antenna and some selected Reference Tag is possible only when smart tag receives sufficient power/voltage-signal from the reader antenna through the coupled reader-antenna coil and Tag-antenna coil through air core, this situation is nothing but a transformer principle where both windings are essentially planar coils.

With this objective, two planar-coils geometries are drawn which are separated vertically in the air with a distance (dz). One planar coil of size 60mm x 20mm with six-turns are

implemented directly on the PCB and a reference tag of size 30mm x 25mm with six-turns are implemented. This gives rise to a planar transformer. Simulation was carried out in frequency domain at 13.56 MHz frequency and parameter sweep of dz was performed with a step of 10 mm. If a preassigned power/voltage-signal is induced in the reference-tag-antenna through transformer coupling from a certain maximum vertical distance, it is taken as possible maximum-distance. In the Magnetic Fields physics interface, Impedance Boundary Condition and Lumped-Port have been used for both reader-antenna-coil and reference-tag-antenna coil.

Figures used in the abstract

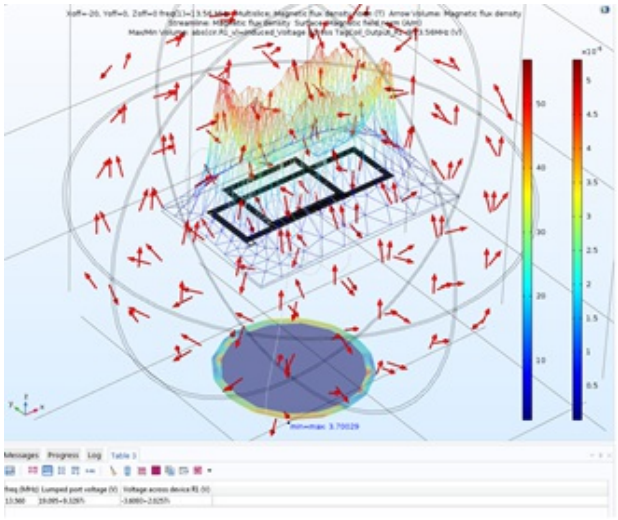

Figure 1: Induced Voltage & Coupled H-Field at the Reference Tag-coil.