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UHF Near-Field Wireless Power Transfer, Application To RFID System

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Wireless power transfer (WPT) was first introduced by Nicolas Tesla in 1904. Since then, numerous studies were carried out on theoretical aspects as well as on their practical uses. Recently, WPT was used in several applications such as high power transfer at low frequencies, especially for powering electrical vehicles where huge amount of power is required. On the other hand, for smart devices, the required power is much less important, but the transfer efficiency must be high. Indeed, in many applications the devices are fully passive and their power feeding is solely based on WPT methods[1].

Nowadays, there is a great industrial interest to develop new systems relaying highest power possible provided by RF sources in UHF domain wirelessly, such as radio frequency identification, inside a closed volume. The latter allows to store and to protect electronics and communication circuits from electromagnetic interferences. In this work, we describe the performances of a practical relay system consisting of a series of aligned metallic post placed over a metallic plane. The input and output power ports are monopole antennas respectively placed at second and penultimate position within the series of posts. Such a system transfers the power of an RFID reader from a fixed station to a mobile one wirelessly. The mobile station is a metallic closed volume containing solely passive equipments: antennas and RFID tags. Those inner antennas are fed with coaxial cables that pass through the volume's boundary. Outside of it, the coaxial cables are connected to the output port of the series of post while the RFID reader is connected to the input port. The ground plane of the post series is discontinued in its middle allowing the mobile station to move freely. Connection is established when the series of post is aligned and when the ground plane gap is smaller than a fixed value, 2 cm in the present case. This is of great interest for applications where mobility is required without the need of batteries. The metallic closed volume could be, for example, a mobile cabinet, a suitcase, etc.

The idea of the WPT system comes from the Yagi-Uda antenna. In fact, its high directivity is obtained thanks to its reflector dipoles and numerous directive dipoles that concentrate electric field around them. So, we can imagine a Yagi-Uda antenna in the near-field like an unbounded waveguide. Putting two Yagi-Uda antennas face-to-face creates a longer waveguide with an input port, the radiating dipole of the transmitting antenna, and an output port, the radiating dipole of the receiving antenna. The system can easily be split between two adjacent directive dipoles.

In this study, we evaluate an important indicator of a WPT: the power transmission efficiency defined as the maximum power transfer of the RF energy from the source to the receiver. Since receiving (R_x) and transmitting (T_x) antennas are identical, efficiency of the system only depends on insertion loss ($S_{21} = S_{12}$), reflection loss ($S_{11} = S_{22}$), and cable losses. However, cable losses are inherent to material quality and to the length of the cables. For cables of 0.3 m long, losses are typically of the order of 0.1 dB. Thus, in the present study, those losses were neglected.

By optimizing the geometrical size of the relay antenna with Ansoft HFSSv16.0, both T_x and R_x antennas are perfectly impedance-matched with the feeding circuit and the load impedance respectively when they are face-to-face (separation gap of 2 cm). Results show that the system operates from 845 MHz to 870 MHz (return loss lower than -10 dB) which is compatible with the ETSI UHF RFID band (866~868MHz). Furthermore, high PTE (80%) is achieved, which is sufficient to activate RFID tags inside the closed metallic volume. Experimental results obtained with a proof-of-concept prototype agree with simulations. This validates the concept of WPT for reading tags inside closed metallic enclosure. More results will be given at the conference.

1. M. Fantuzzi, A. Costanzo, S. Tedjini, and P. Lemaitre-auger, "Low-Cost UHF Near-Field Power Transmission for RFID Applications," *47th Eur. Microw. Conf. EuMC 2017*, pp. 212–215, 2017.