Extended post processing for simulation results of FEM synthesized UHF-RFID transponder antennas

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The development and optimization of passive transponders for application in UHF-RFID systems with wide read range is directly correlated to the supply of appropriate antenna designs. On the one hand these antennas must be frequency selective in order to suppress interferences of radio systems in adjacent wave bands. Otherwise the antennas should exhibit enough bandwidth to compensate for tolerances of chip impedance and to account for the influence on impedance from the adjacencies of the antenna. A largely stable use of a passive transponder makes sense in a moderately variable environment only in such a way. The dependences between geometry and impedance qualities of the antenna make the synthesis of suitable antenna structures possible for the fulfilment of the qualification profile under consideration of the at most permitted geometric measurements.

The design process of a transponder antenna for the application in an UHF-RFID system using the Finite Element Method (FEM) allows for the consideration of extended, geometrical complex objects with arbitrary material characteristics in the immediate near-field region. The material specific qualities of these objects generally lead to an influencing of the antenna impedance associated with changes of the resonant frequency, bandwidth and matching between antenna and transponder chip. Recent simulation programmes based on an implementation of the FEM allow for an optimization of the antenna design by the variation of defined geometry parameters of simulation models parameterized correspondingly under consideration of predefined environmental conditions.

This work evaluates the quality of the simulation results of the FEM based simulation programme High Frequency Structure Simulator (HFSS). This product is used as a design tool for the synthesis of plane transponder antennas. Despite the various areas of application which arise by the use of this sophisticated simulation tool limits also exist in the calculation possibilities. For instance it is not possible to calculate the electromagnetic fields outside the simulation model in arbitrarily defined field points or field point areas. Moreover, the quality of the calculation of the surface current distribution of plane antenna structures is insufficient. Therefore a module implemented in MATLAB is introduced that offers extended possibilities for the post processing of HFSS simulation results. A check of the convergence of the electromagnetic field can be carried out in the complete simulation volume by the calculation of the surface currents of the antenna structures examined here. The knowledge of the frequency dependent current distribution forms the base for calculating the electromagnetic fields in arbitrary space points.