Contactless Power and Data Transfer for Multiple Nonlinear Loads

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Abstract

An inductive power and data transfer for multiple non linear loads is designed. Loads that are distributed across some distance are considered. For example, such loads are adjustable speed drives that are found in factory automation and intra-logistic. The physical properties of the power and the data transfer are modeled via COMSOL. Lumped parameters are deduced from magnetostatic calculations and used with equivalent circuits for system studies. Here we use the magnetic field physics of the AC/DC Module. Specific operating conditions are investigated with FEM coupled to network calculations. This is facilitated with the 3D- coil feature of the recent COMSOL version in conjunction with the circuit feature. Furthermore the heating of selected components is considered were the heat transfer module is applied together with the AC/DC Module. A schematic view of the setup is given in Figure 1. The power feed consists of a controlled H-bridge with a variable operating frequency [Mora]. This feed is inductively coupled to a distributed winding that acts as a short circuit turn. The loads are supplied via couplers from the distributed winding [Glei]. Power couplers consist of Ferrite E-cores with yoke [Glei] [Schm]. We use separate couplers and a separate winding for the data transfer as indicated in Figure 1. This data transfer winding is directly attached to the power winding and interference is a massive since voltage levels for the power and data transfer differ by a factor of 100. The especially designed OFDM modulation uses a bandwidth of app. 600 kHz. The parameters for the equivalent circuit as given in Figure 2 are deduced from the fluxes that are calculated from 3D- magneto-statics. Care was taken to resolve the air gaps between the E -Core and yoke as depicted in Figure 3. These calculations are carried out for the data and power transfer. A simplified model is used to calculate the power and data transfer coupling using quasi-static 3D-FEM together with the circuit formulation. A test stand has been set up to validate the system behavior and check the model calculations. The test stand consists of a 65 m long line that acts as the distributed winding. It is driven by a H-bridge in the frequency range of 20-70 kHz. Loads are frequency inverter driven motors with power of a few hundred watts. These drives are controlled via the contact less data transfer.

Reference

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Figures used in the abstract

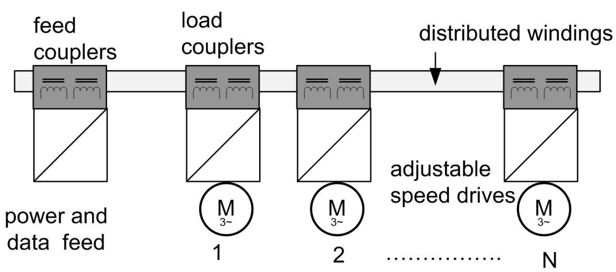

Figure 1: Schematic system overview.

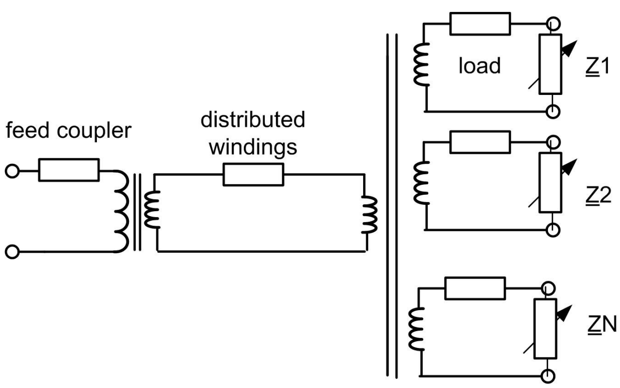

Figure 2: Equivalent circuit for power and data transfer.

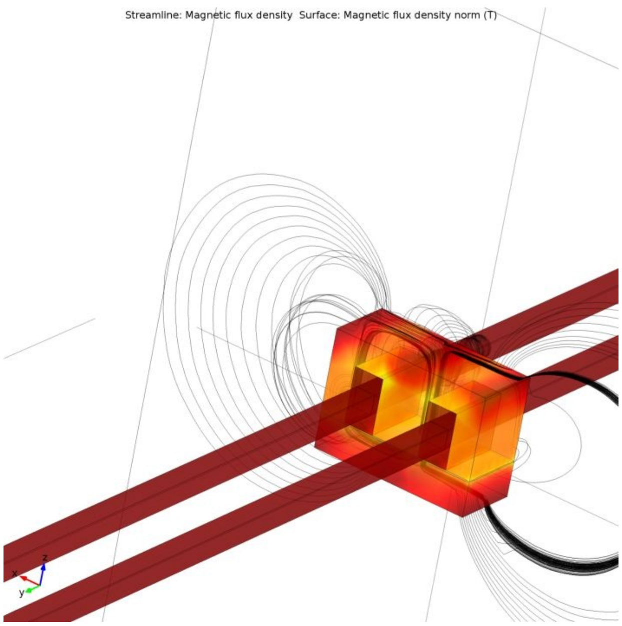

Figure 3: Magnetic field distribution at load.