Inductive Position Sensors based on Coupling of Coils on Printed Circuit Boards for Demanding Automotive Applications

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Zusammenfassung

Rotor position feedback is required in many industrial and automotive applications, e.g. for fieldoriented control of brushless motors. Traditionally, magnetic sensors, resolvers or optical encoders are used to measure the rotor position. However, advances in inductive sensing concepts enable a low-cost, high-precision position measurement principle which is robust against magnetic stray fields exceeding 4000 A/m. The operating principle is based on the coupling of a transmitter coil with several receiver coils in the megahertz frequency range. The coils are part of a printed circuit board (PCB) which also comprises circuitry for demodulation and signal processing. The transmitter coil induces eddy currents in an electrically conductive passive coupling element, which provides position-dependent amplitude modulation. The voltage induced in the receiver coils encodes the rotor angle information, typically in quadrature signals. The coupling element requires no rare-earth materials and can be made of stainless steel, for instance. The PCB-based design of the sensor offers considerable flexibility in optimizing its performance. By tailoring the coil geometry and arrangement, accuracy, air gap and overall sensor dimensions can be adjusted to meet a broad range of application-specific requirements. Coil designs can be validated by 3D finite element simulation as well as measurements on a test bench.