ROTATIONAL SPEED SENSOR FOR SERVO DRIVES BASED ON EDDY CURRENTS

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The paper deals with the improvement of the dynamic performance in high speed servo drives with a robust position sensor. The target is achieved with an additional inexpensive and robust sensor for direct and accurate speed measurement. A second advantage of the additional speed sensor is the ability to get a redundant speed information from the drive for fault protection in safety related positioning applications.
The suggested sensor is depicted in **Fig. 1** and works on an inductive basis.

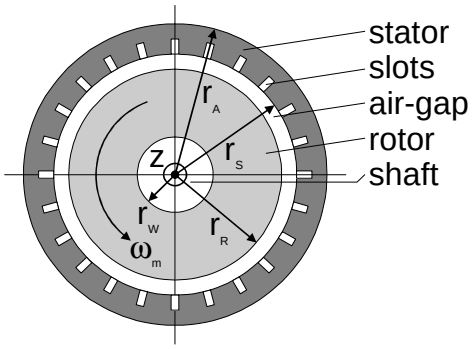

Fig. 1: Cross-sectional view of suggested sensor

Basically the sensor resembles a small two-phase induction machine. One phase is used for AC excitation. The second phase is arranged with a 90° electrical phase shift and picks up the magnetic field of the eddy currents in the rotor. The rotor is ironless. At small speeds this signal with excitation frequency has a magnitude fairly proportional to the rotational speed of the drive.
For the investigation and a reliable prediction of the desired sensor properties, a two-dimensional analytical model has been developed and discussed in the paper. It is based on the vector potential method and a wave approach for stator surface current density and the other field quantities. The equations are evaluated aiming at the analytical representation of the sensor speed constant in terms of geometry, material properties and excitation frequency. The results show a large linear term and a small portion causing either a slight degressive or a progressive characteristic. By a proper choice of parameters, a good linearity and an almost negligible temperature influence can be obtained. Measured results obtained with a prototype show a very good agreement with the theory and validate the applied method.
Based on the theoretical findings, a prototype was built and tested, **Fig. 2**. The stator fits into a mounting ring with an outer diameter of 36.5 mm. The rotor consists of solid brass.

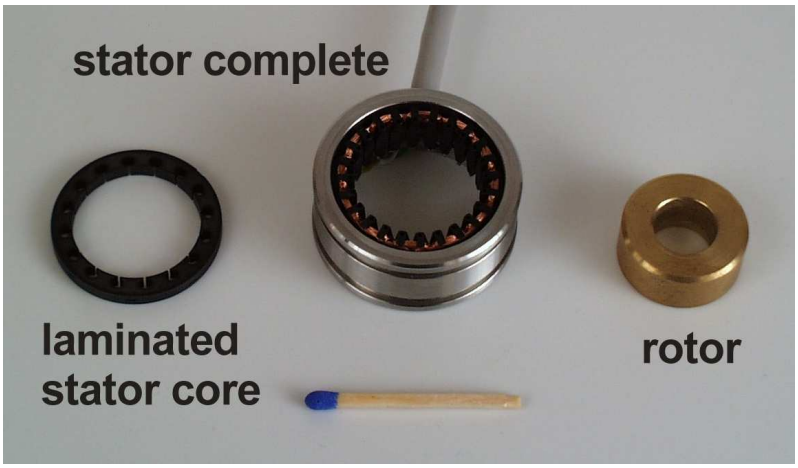

Fig. 2: Sensor prototype

The sensor primary is excited with 10 kHz. The bandwidth has been determined to 4.3 kHz. A comparison of the calculated and the measured output voltage is given in **Fig. 3**.

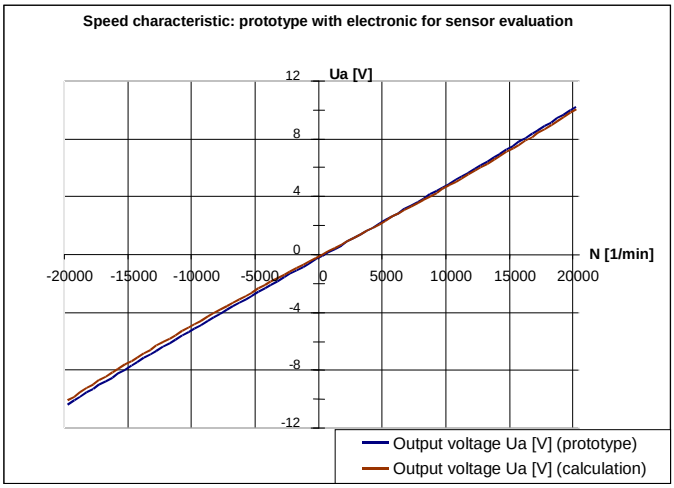

Fig. 3: Speed characteristic prototype compared with calculation

The suggested principle represents a robust and versatile speed sensor for the application in high dynamic AC drives and is capable to improve the behaviour of servo drives with resolver. In combination with a synchronous motor, running up to ± 20,000 rpm, and a digital servo amplifier, a speed resolution of up to 1/16 rpm was achieved.