FAG Sensor Bearings in Electric Car Motors

FAG
Rolling Bearings

Examples from Application Engineering

Publ. No. WL 01 502 EA

For car drives: Water-cooled three-phase AC asynchronous motor from Siemens AG, Bad Neustadt

Photo: Siemens AG

Courtesy: Ford Motor Company

Ford TH!NK City and Fiat Seicento Elettra are among the smallest “exhaust-free” cars on the market today. In terms of range and performance they are at the top of this category.

Siemens AG and FAG worked closely together in developing the drive system. The FAG “sensor bearing” was developed, a deep groove ball bearing with an integrated speed sensor for the most modern electric drive system that can be industrially manufactured today.

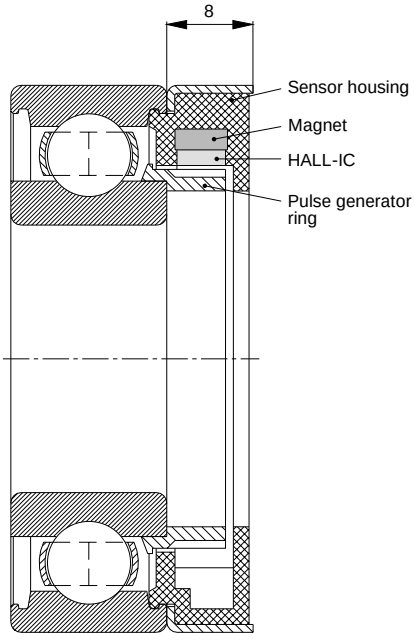
Cars that are equipped with this system already offer the future solution for environmentally friendly transportation for persons and goods in city centres.
Compared to conventional systems, the overall weight of this drive system is small. As an additional advantage, the interior space does not have to be restricted to accommodate the drive system.

The electric drive system in the Ford TH!NK City and Fiat Seicento Elettra is equipped with FAG sensor bearings.

The sensor bearing

Standard deep groove ball bearings with an integrated speed sensor measure both the speed and the sense of rotation of the motor. This information is needed for the inverter which controls the power of the three-phase motor.
For utilization in the drive system of cars the FAG sensor bearings must be designed for:

- speeds of up to 16 000 min^{-1}
- electric field intensities of up to max. 200 V/m
- magnetic field intensities of up to max. 100 mT (milliTesla)
- and temperatures of up to 150 °C



Cross section of a sealed sensor bearing

Technical data

Sensor bearing	FAG 6206C5.H124S Deep groove ball bearing with an integrated speed sensor, characteristics of the catalogue bearing.
Output signals	2 square wave signals with a phase shift of 90°
Number of pulses	64 pulses/revolution
Motor	Three-phase AC asynchronous motor
Max. power	30 kW
Nominal power (continuous power)	15 kW at 2 200 - 9 000 min^{-1}
Max. torque	123 Nm
Nominal torque (continuous torque)	65 Nm at 0 - 2 200 min^{-1}
Nominal voltage	220 Volts

The motor

The motor is a water-cooled three-phase asynchronous motor.
Thanks to the speed signal and to a sophisticated electronic design the motor behaves like a generator when the brake is actuated, which has a positive effect both on the car's fuel economy (the batteries are charged when the car slows down or drives on sloping roads) and on its ergonomic qualities as the cars have a motor brake as drivers are used to from cars with internal combustion engines.
Utilization of these sensor bearings enabled engineers to realize a very compact motor design with a reduced size and weight.
The motor, which is the size of a shoebox, offers an excellent performance. The max. power is 30 kW.
The max. torque is already available when the motor is started. Acceleration from 0 to 50 km/h is possible within less than eight seconds, and top speeds of more than 90 km/h can be reached. Thus these cars perform as well in urban traffic as those with an internal combustion engine.

The frequency transformer (inverter)

As the three-phase motor requires three-phase alternating current it cannot be directly driven by the direct current provided by the batteries. So a vectorial inverter with a torque control system is used.
The inverter constantly compares the speed measured by the sensor bearing with the nominal speed and regulates the motor to the desired speed by adjusting the frequency of the alternating current.

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WL 01 502 EA / 98.5/05/00