



ELECTRONICS AND MICROSYSTEMS

CERAMIC-INTEGRATED MINIATURIZED COILS FOR SPEED MEASUREMENT IN TURBOCHARGERS

Dipl.-Ing. Martin Ihle, Dr. Steffen Ziesche, Dr. Uwe Partsch

Eddy-current sensors enable the non-contact detection of path, distance, position, vibrations and speeds in electrically conductive materials. Ceramic multilayer technology (LTCC – low-temperature co-fired ceramics) offers a great platform for integrating bespoke eddy-current-sensing coils into very small assemblies. LTCC-printed and embedded measuring coils can be used in very rough environments at operation temperatures of up to 550 °C.

Together with the Jaquet Technology Group, Fraunhofer IKTS has developed an LTCC coil for measuring the rotational speed in the turbochargers of vehicle engines. Speed measurement is crucial for supplying the engine with the optimum air mass and thus minimizing fuel consumption.

Sensor element layout

A crucial element for its performance is the quality factor of the embedded coil. Thanks to new LTCC manufacturing processes developed at Fraunhofer IKTS, the lateral winding distance of the printed coils could be reduced to 30 μm, which improves the coil's conductivity. At the same time, the metallization thickness was enhanced, reducing the internal resistance. The result was a measuring signal with much less noise and loss. In addition to miniaturization with optimized quality, the integration of a bespoke coil design in LTCC was also a big driver of development. Coils of this type are typically produced as wound coils with a spiral-like shape.

The LTCC double D-coil developed at Fraunhofer IKTS delivers a narrow-band magnetic field thanks to the tailored design and thus a clearer measuring signal on turbocharger blades, for

example on those made of aluminum or titanium. These innovative microcoils in the bespoke LTCC double D-design with optimized quality and an aspect ratio of > 1 (height to width ratio of printed conductor paths) stand out from the current state of the art.

Manufacturing

Because of its optimized sensor properties, the novel LTCC coil technology will be included in the product portfolio of the Jaquet Technology Group for the measurement of turbocharger speed on both passenger cars and trucks.

Services offered

- Development and construction of bespoke LTCC coils (sensors, transformers, etc.)
- Assembly and testing of pre-production series

- 1 Sintered and separated LTCC double-D coil, size compared with matchstick.
- 2 CT scan image of LTCC double-D coil in the sensor head.
- 3 Complete turbocharger speed sensor from Jaquet Technology Group.

