**CAN-based monitoring system for spindle bearings**

Schaeffler’s Spindle-Sense monitoring system reduces downtimes and increases utilization of machine capacity. The variant C-A1 outputs the measurements via CAN.

The main spindle is crucial to the performance capability of the complete machine tool. It is at the heart of the machine and largely defines the achievable cutting capacity, surface quality, and precision. In turn, the spindle bearing support is one of the most heavily loaded components because it must transmit machining forces precisely at very high speeds for long periods of time and the risk of collisions can never be ruled out. It therefore comes as no surprise that the majority of machine tool downtimes can be traced back to defective spindles, particularly as a result of collisions and continuous, undetected overloads. In milling operation, for example, the combination of high radial loads, long tool protrusions, and high speeds leads to particularly high loads and unfavorable kinematic conditions on the spindle bearing in the vicinity of the tool. These unfavorable and in some cases impermissible loads occur because operators have hitherto not had a suitable tool, with which they could monitor borderline loads on spindle bearings. Schaeffler has now solved this problem with its new Spindle-Sense monitoring system.

**Ready for volume production**

The first production-ready SRS sensor ring units, including radial and axial measuring ring, with an inside diameter of 70 mm is available for customers to test in practical applications to coincide with EMO 2019. Additional sizes with inside 80-mm and 100-mm diameter will be available at the end of the year. All units have a standard width of 16 mm. The scope of delivery includes an SST setup service tool, with which the product can be parameterized and put into operation.

The sensor system integrated into the spindle bearing measures the displacement of the spindle shaft under load in a very high resolution and in five spatial directions – three translational and two rotatory. The sensor ring transmits an electrical warning signal to the machine’s control system if the deflections measured on the rolling elements exceed a specific threshold, which is set individually for every spindle and machine type. The threshold is based on an assessment of operation-related bearing parameters such as pressure, spin/roll ratio, and cage pocket clearance, into which Schaeffler has integrated its many years of expertise in rolling bearings.

All of the software and the required algorithms are integrated into the 16-mm sensor ring. No further components are required for the system. The system is locally functional and transmits an individual warning signal to the machine’s control system, which makes the following applications possible:

- Detecting a crash (collision): The sensor technology is capable of signaling an overload at a digital output within two milliseconds. This allows serious subsequent damage to be minimized or even prevented through fast deactivation of the drive.
- Long-term protection for machine tool spindles: In practice, continuous mechanical spindle bearing overloads are not immediately identified. In contrast, the monitoring system immediately triggers a warning signal when the overload is parameterized accordingly. The operator can adjust their machining program right after the first manufactured part and reduce the spindle load by using a new tool or modified cutting values, or by employing a more suitable tool type. The operator thus achieves lower and less numerous peak loads, and thus benefits from a longer spindle operating life with fewer machine tool downtimes, which ultimately means more production time and reduced repair costs.

Variant C-A1 outputs the measured radial and axial displacements including tilting via CAN network. Machine tool and spindle manufacturers can use these displacement values to develop analysis tools for optimizing the utilization of spindle capacity, e.g. by visualizing the deflection collective measured by the sensor ring as a load collective. For the first time ever, the machine operator will know the degree to which the spindle capacity in each

![Figure 1: The spindle bearing monitor system comprises distance sensors (1), an evaluation unit (2), and the cable with CAN connectivity (3) (Source: Schaeffler)](image)
New Solutions for your Custom CAN FD Application

PCAN-MicroMod FD

New product line with CAN FD interface and I/O functionality

The PCAN-MicroMod FD is a small plug-in board which provides a CAN FD connection and enhanced I/O functionality for the integration into your hardware. An evaluation board facilitates the development of your custom solution.

The module is configured with a Windows software via the CAN bus and then operates independently. In addition to simple I/O mapping to CAN messages, function blocks are also available for processing the data.

Besides the evaluation board, the PCAN-MicroMod FD will also be available ready-to-use mounted on small motherboards that provide peripherals for specific applications.

PCAN-MicroMod FD:
- 8 analog inputs
- Measuring range unipolar 0 to 3 V
- Resolution 12 bit, sample rate 1 kHz
- Selective configuration of up to 16 devices in a CAN bus
- Voltage supply 3.3 V
- Dimensions: 33 x 36 mm
- Extended operating temperature range from -40 to 85 °C (-40 to 185 °F)

PCAN-MicroMod FD Evaluation Board:
- CAN bus connection via D-Sub, 9-pin
- Switchable CAN termination of 120 Ohm
- Pick-offs for all plug-in board pins
- Low-side switches for digital outputs
- DIP switches for status change of the digital inputs
- Protected digital inputs
- LEDs for digital inputs and outputs
- 4 potentiometers for analog inputs
- Soldering fields for individual additional wiring
- RS-232 connection with V.24 levels
- Firmware upload via CAN, USB, RS-232
- Reset button for restarting the board
- 5 V supply via Micro-USB or supply unit
- Board 100 x 102 mm with rubber feet
The machining process is being utilized as a percentage with a high level of accuracy and thus be able to adjust the machining process even more precisely in terms of capacity utilization and operating life for each machine: This means that harmful overloads are prevented despite maximum spindle loads. Safe operation in the limit range allows the operator to increase their productivity and also to benefit from longer spindle operating life and less frequent machine downtimes.

The measured displacements that are outputted via CAN can also be used for zero point compensation. This makes it possible to produce the same quality with larger cutting values or higher quality with unmodified cutting values. The monitoring of the maximum displacement can also be used for quality assurance.

**Electronic versus mechanical overload system**

In comparison with mechanical, i.e. passive overload systems, the introduced monitoring system does not just protect the spindle in the event of a collision, it is also a revolutionary system for safely maximizing the utilization of the spindle capacity. For the first time, machine manufacturers can now offer their customers a tool for increasing productivity, machine availability, and quality.