

CONDITION MONITORING OF A GRINDING MACHINE - REALIZATION OF A "SENSING GRINDING SPINDLE" BY INTEGRATED SENSORS



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www.i4m-tech.de

OBJECTIVE • Wireless integration of radio sensors in a grinding spindle of a machine tool to measure vibrations and forces occurring during the grinding process

PERIOD • 2021 / 2022

CHALLENGES

- Extremely small installation space (30 x 5 x 5-8,5) mm
- Battery charging without retooling the machine
- Resistance of electronics to high temperatures (85°C)
- Wireless data transmission from the inside of the machine / through the seal
- Electromagnetic interference from the additional eroding process and the spindle drive

REALIZATION

- Integration of a wireless measuring system in four tiny recesses of a grinding spindle
- Development of a board for data acquisition (DAQ) and data transmission with integrated MEMS 6-DoF-IMU for the measurement of accelerations, rotation rates and temperature (16 bits, up to 6,5 kHz sampling rate) as well as for the connection of 4 semiconductor strain gauge full bridges (24 bits, up to 1,5 kHz sampling rate)
- Development of a power management board for connection of the rechargeable battery
- At downtime of the machine: autonomous connection of a voltage source via a stylus for charging the Li-Ion battery with high charging power (2 minutes battery charging for 8 minutes runtime, max. 80 minutes)
- Wireless data transmission via board-integrated antenna per 2.4 GHz radio link to a nemi Connect receiver module

ADVANTAGES

- Structure-integrated measurement of condition data of an autonomous machine tool
- Mapping of sensitive properties by integrated sensors in the machine tool
- Reliable wireless data transmission even through seal and housing of the machine tool
- Energy supply concept suitable for series production
- Autonomous, fast battery charging during short machine downtimes
- High measurement data quality / low noise due to energy supply via rechargeable battery



Charging Contact



Telemetry Board



Power Management Board



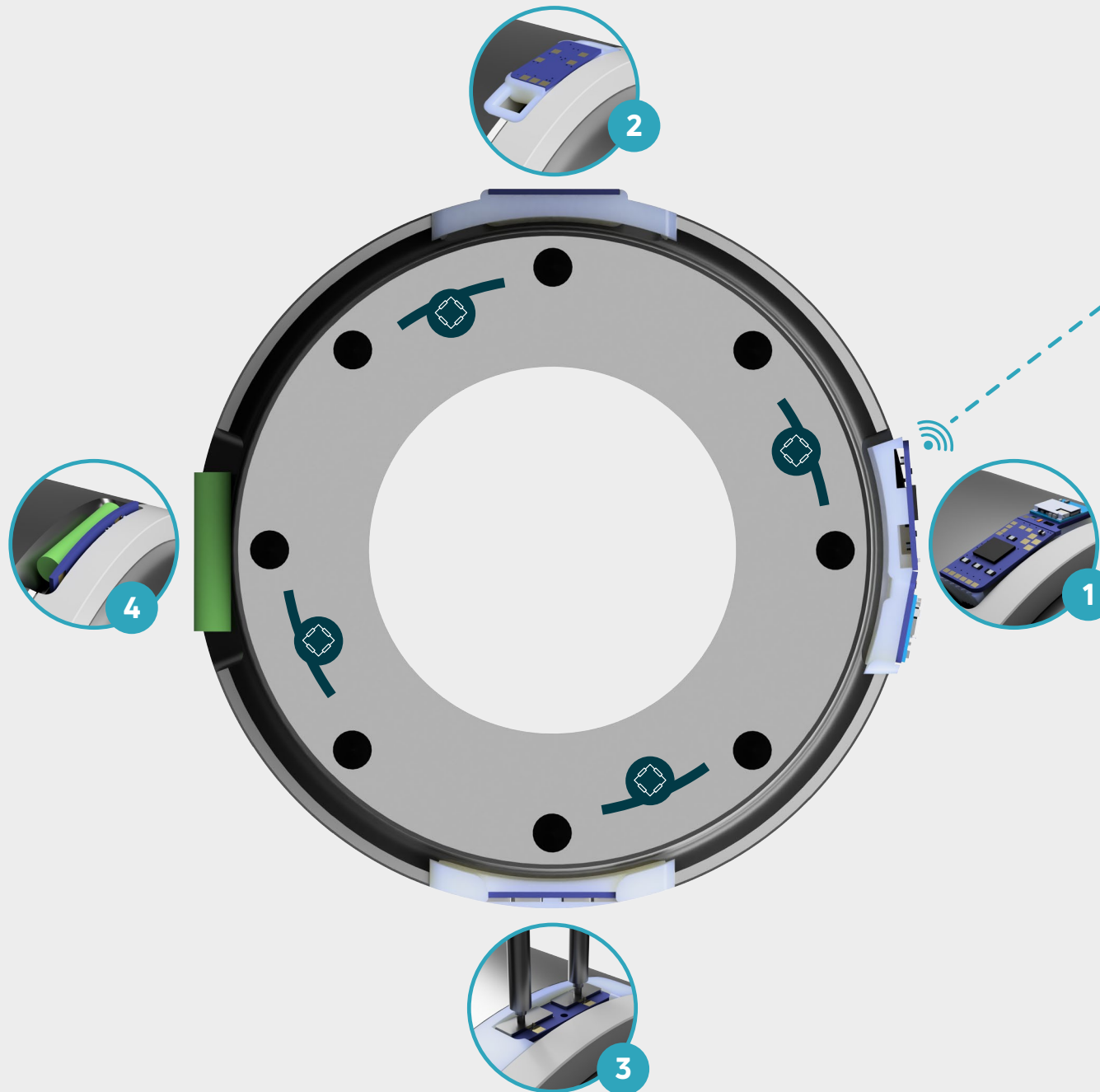
Li-Ion-Akku







„Within a very short time, i4M technologies designed, developed and manufactured a fully functional, wireless telemetry system for the condition monitoring of a tool grinding machine. The telemetry system is very small, battery-powered and fully integrated into the grinding spindle. The system reliably transmits from a machine tool. This solution enables structural integration of sensor technology on rotating machine components, so that process forces can be detected close to the point of action and additional cost-intensive measurement technology components can be dispensed with. I also particularly liked the uncomplicated and goal-oriented cooperation with the team.“

M.Sc. Henning Buhl

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4x DMS Full Bridge
 24 bits, up to 1.5 kHz sampling rate
- 1 Telemetry Board**
 - Integrated MEMS 6-DoF-IMU (accelerations, rotation rates and temperature), 16 bits, up to 6.5 kHz sampling rate
 - Connection of 4 strain gage full bridges
 - On-Board 64 MHz Cortex M4F with DSP for Edge Computing Capabilities
- 2 Power Management Board**
 - Charging and battery protection circuitry
- 3 Battery Charging Contact**
 - Charging with high current during process standstill times
 - 2 minutes battery charging for 8 minutes runtime, max. 80 minutes
- 4 Li-Ion battery**
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nemi Link 2400
 i4M's radio technology in the 2,4 GHz frequency band, Range up to 20 m
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nemi Connect
 Data receiver for connection to PC
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Data transmission via USB