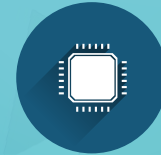


Component

KI-RAM: Intelligent Tire Sensor for Truck and EM Tires



CAD model: Sensor mounted in the tire; the length of the sensor must be adjusted accordingly.

Fast Facts

- Newly developed multi-parameter tire sensor
- Capacitive measurement of tire tread wear
- Integrated pressure and temperature monitoring
- Miniaturized sensor embedded in tire tread
- Cylindrical sensor design, diameter ≤ 6 mm
- Mechanics matched to truck and EM tire loads
- Form factor based on §36 StVZO repair kits

General Description

KI-RAM is a newly developed intelligent tire sensor system for heavy-duty truck and earth mover (EM) tires. The core of KI-RAM is a capacitive sensor element embedded directly in the tire tread. As the tread wears, the active electrode length decreases and the capacitance changes. From this value, the remaining tread depth is determined in real time. In addition to tread wear, the current demonstrator already measures tire pressure and temperature, enabling a comprehensive view of tire condition.

To achieve robust measurements, KI-RAM uses a cylindrical capacitor structure with a maximum diameter of 6 mm. Simulations show that this geometry is largely independent of the complex tire build-up. The electrodes are made from

conductive rubber compounds with mechanical properties similar to the tire, ensuring that the sensor follows abrasion and deformation without degrading. The sensor can be adjusted to accommodate different tread depths; to do this, the sensor is trimmed to the appropriate length after installation.

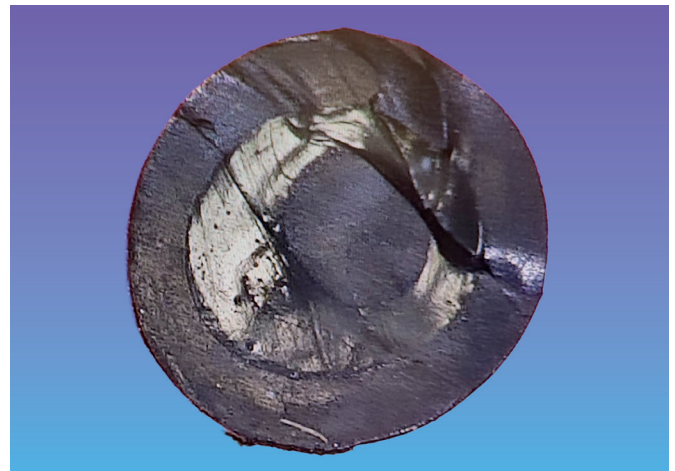
The mechanical design and housing concept are based on approved tire repair kits according to §36 StVZO. This results in a compact, mechanically compatible form factor that can be integrated into heavy-duty tires using established workshop procedures. Together with a dedicated evaluation algorithm, KI-RAM delivers linear, high resolution tread data that shows very good agreement with manual depth gauges in laboratory and field tests, while at the same time providing pressure and temperature data.



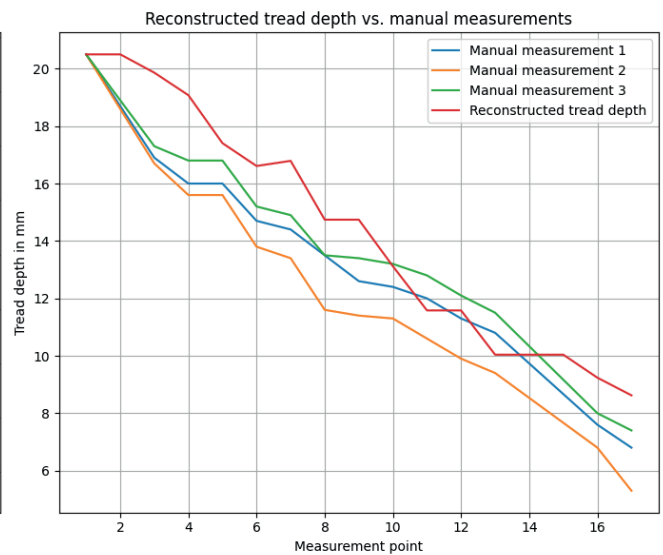
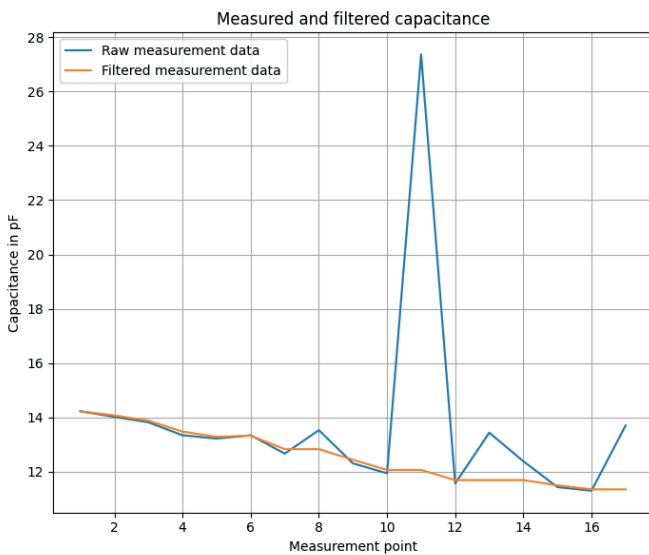
Tread depth sensor ready for installation.

Evaluation algorithm and digital twin

Based on the approximately linear relation between capacitance and electrode length, a compact model computes tread depth from the measured capacitance. Thresholding and exponential moving averaging suppress noise and discard implausible outliers. Via standardized interfaces, KI-RAM data – tread depth, pressure and temperature – can be supplied to higher level digital twin and AI modules, enabling predictive maintenance, optimized fleet operation and data-driven tire lifecycle management.



Cross-section of the sensor element. The inner and outer electrodes and the central insulating layer are visible.



Results from the first field test. On the left are the raw and filtered capacitance measurement data. On the right are the predicted and manually measured tread depths.

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All information contained
in this datasheet is prelimi-
nary and subject to change.
Furthermore, the described
system is not a commercial
product.