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Title of the TRANSCOM 2025 paper

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INTRODUCTION

Backround information & Market Context

Rolling bearing vibration parameters play a crucial role in quality control, directly impacting durability and reliability. Precise vibration measurement enables early defect detection and assessment of technical condition, ensuring proper operation in various applications. This highlights the necessity of advanced calibration systems for vibration sensors to achieve high accuracy and repeatability in measurements.

Problem Statement & Stakeholders

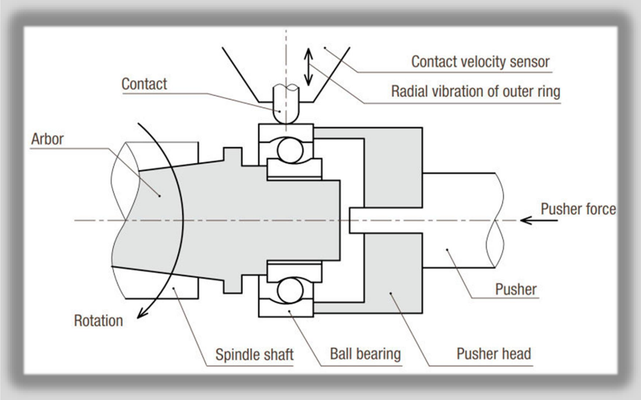
The lack of precise and repeatable calibration systems for rolling bearing vibration transducers creates challenges in ensuring accurate measurement. External interferences, structural stability, signal processing precision, and environmental factors further affect calibration effectiveness. The primary stakeholders include researchers, manufacturers, and industries relying on bearing performance, such as automotive, aerospace, and heavy machinery sectors.

Research Objectives & Expected Impact

This research aims to develop a calibration system for rolling bearing vibration sensors, improving measurement reliability and accuracy. Key components include an exciter, reference transducer, amplifier, digital-to-analog converter, and robust mechanical structures. Future work will focus on refining measurement structures and establishing an uncertainty budget to enhance the system's efficiency and applicability.

MATERIALS, METHODS & IMPLEMENTATION

Industrial rolling bearing vibration measurement system



According to ISO 15242–1:2015:

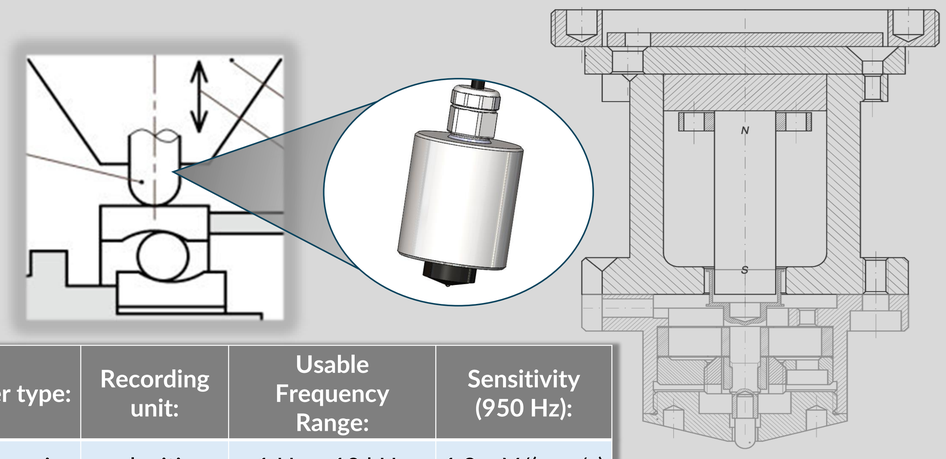
- measurement is realized at a designated location on one of the bearing rings;
- the direction of the sensor (axial or radial) must be determined relative to the reference system;
- the bearing rotates at a specified speed;
- axial loading conditions are precisely defined;
- the signal from the vibration sensor is recorded at a specified time.

ISO 15242-1:2015 allows recording in units of:

- displacements;
- velocities;
- accelerations.

Signal should be presented as velocity as it provides the best resolution over wide frequency range.

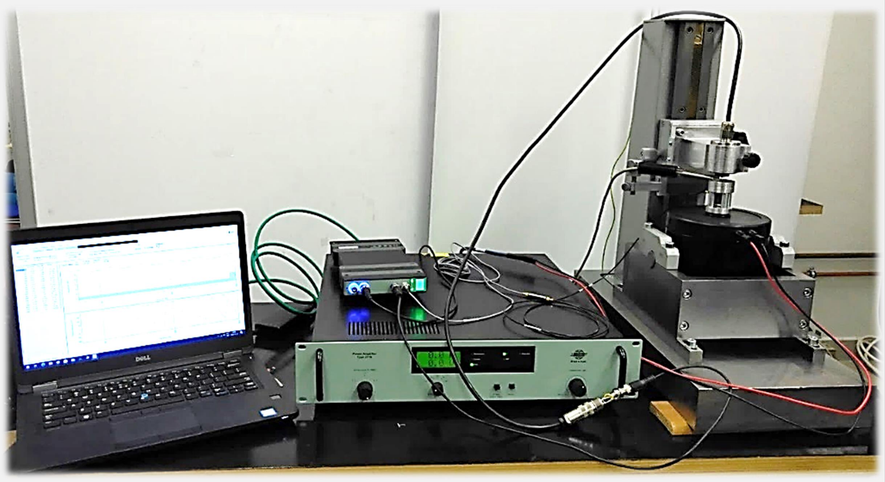
PSV 3 transducer made by Kielce University of Technology



Transducer type:	Recording unit:	Usable Frequency Range:	Sensitivity (950 Hz):
electrodynamic	velocities	1 Hz ÷ 10 kHz	1,8 mV/(mm/s)

RESULTS

Vibration Sensor Calibration System



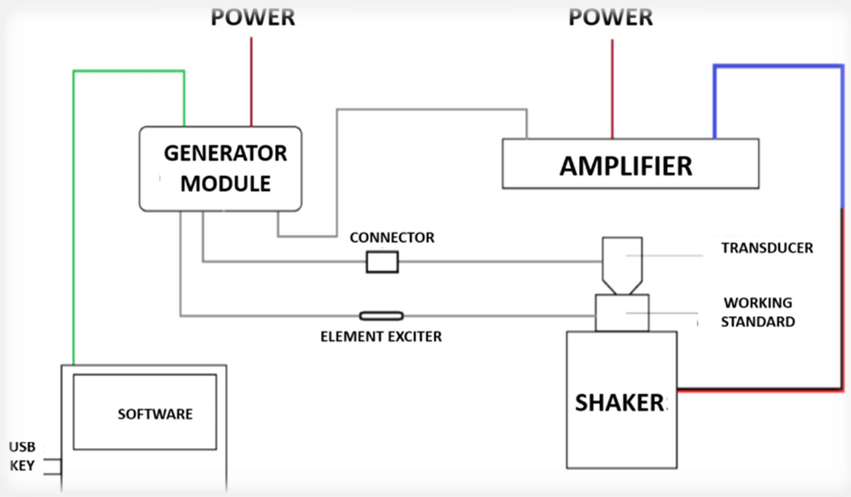
Components of the measuring system:

- Base
- Sensor holder
- Exciter
- Reference sensor
- Signal transmitter
- Amplifier
- Computer with software
- Calibrated sensor

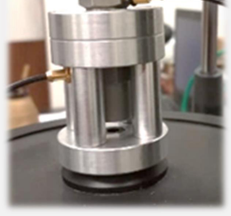
Tests in the frequency range from 50 Hz to 10 kHz

- random amplitude generation 400 Hz – 20 kHz
- generate sinusoidal signal over the entire range for any frequency
- max amplitude - displacement (peak to peak) up to 8 mm
- max amplitude– velocities *(peak) up to 1,65 mm/s*

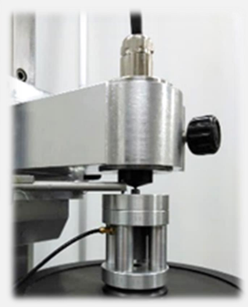
Schematic of the electrical connection



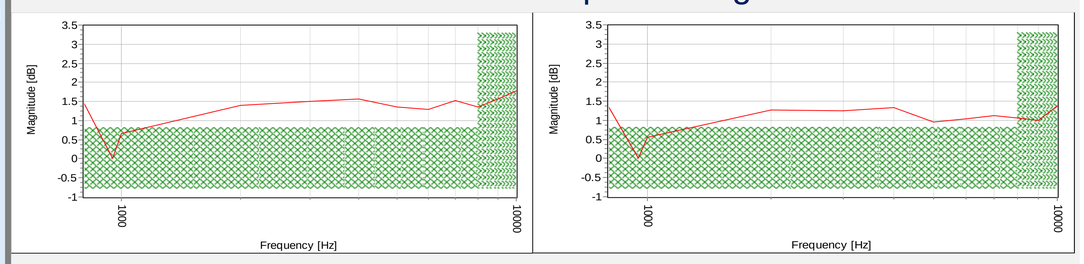
The setup for calibration process of the working standard transducer



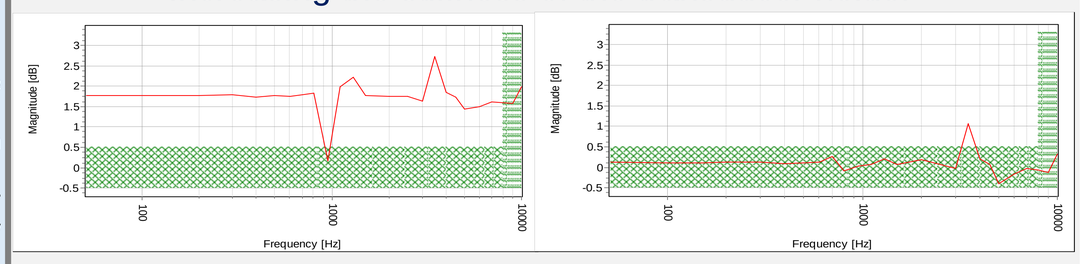
The setup during calibration process



Variable sensor positioning



Increasing the stiffness of the transducer holder



The measurement results are presented in the form of a graph of the difference in signals relative to a reference sensor. The plot shows the limit of acceptability according to ISO 15242.

ISO 15242 - Transducer Requirements and Missing Data

CONCLUSION & IMPLEMENTATION PATH

The article provides a detailed description of the measurement setup and the influence of individual components on the results of calibration tests. It is equally important to understand the influence of internal stimuli generated by the measurement system itself. The article highlights that precise monitoring of these factors allows better understanding and control of the measurement process, which is essential for obtaining accurate and repeatable results.
As part of the further development of the measurement setup, it is planned to establish an uncertainty budget. This will allow a detailed identification of all sources of measurement error and their impact on the results. In addition, it is planned to develop measurement structures that will allow more accurate and reliable monitoring of the technical condition of rolling bearings.

ACKNOWLEDGEMENTS

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