

# An overview of bearing voltages and currents in rail transportation traction motors

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Cite this as: Yao LI, Lin QIU, Yongjian ZHI, Zifan GAO, Jien MA, Jian ZHANG, Youtong FANG, 2022. An overview of bearing voltages and currents in rail transportation traction motors. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 24(3):226-242.

<https://doi.org/10.1631/jzus.A2200180>

# Traditional Bearing Currents

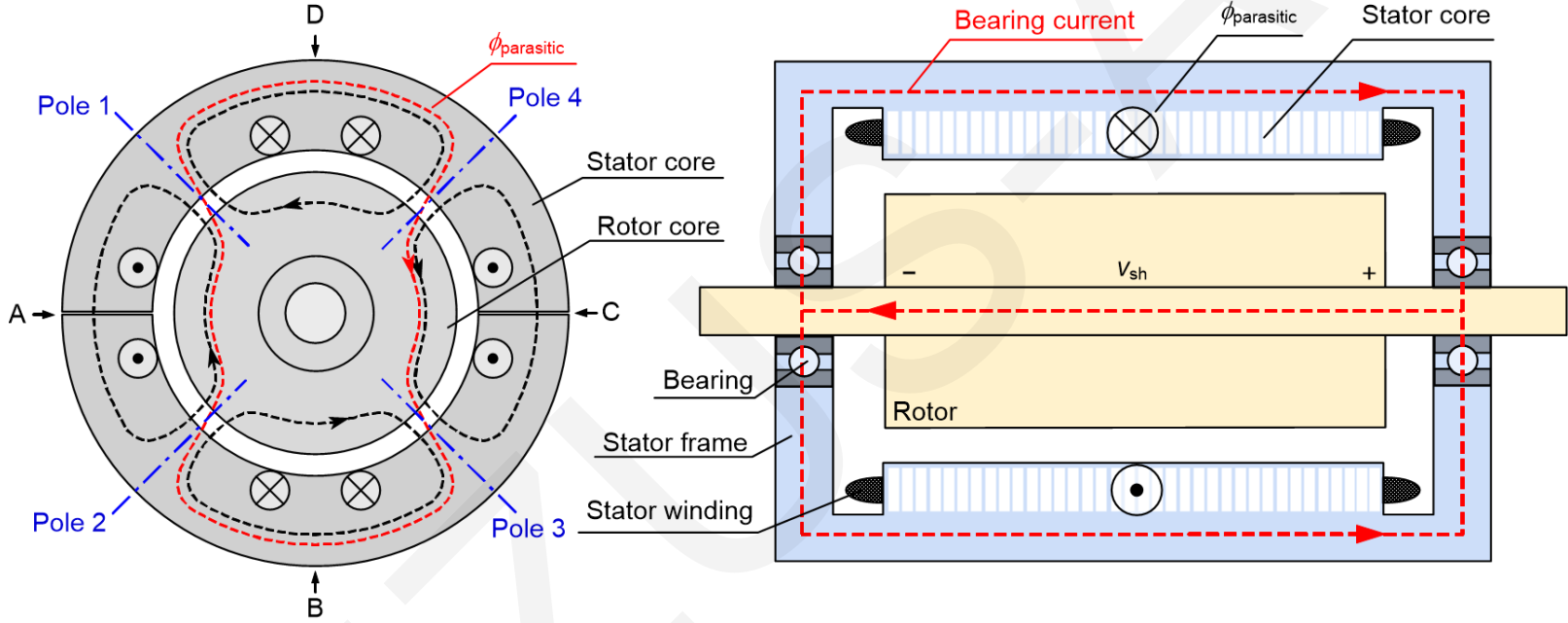


Fig. 1. Bearing currents due to magnetic asymmetries.

# High Frequency Bearing Currents

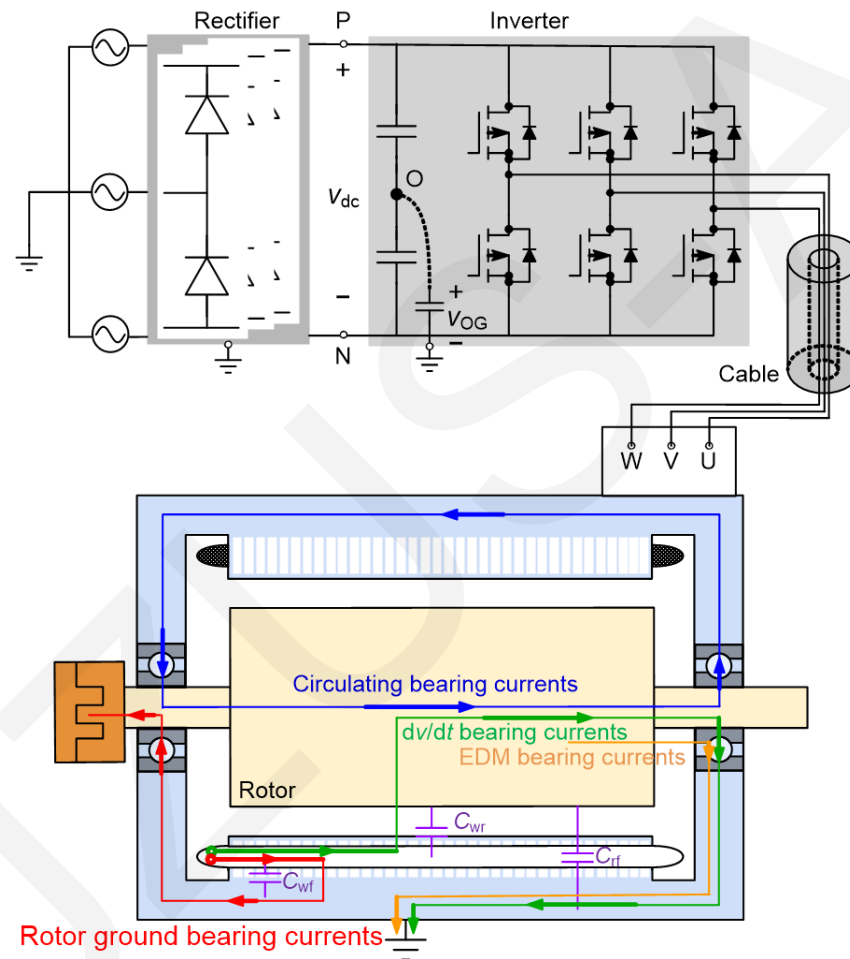
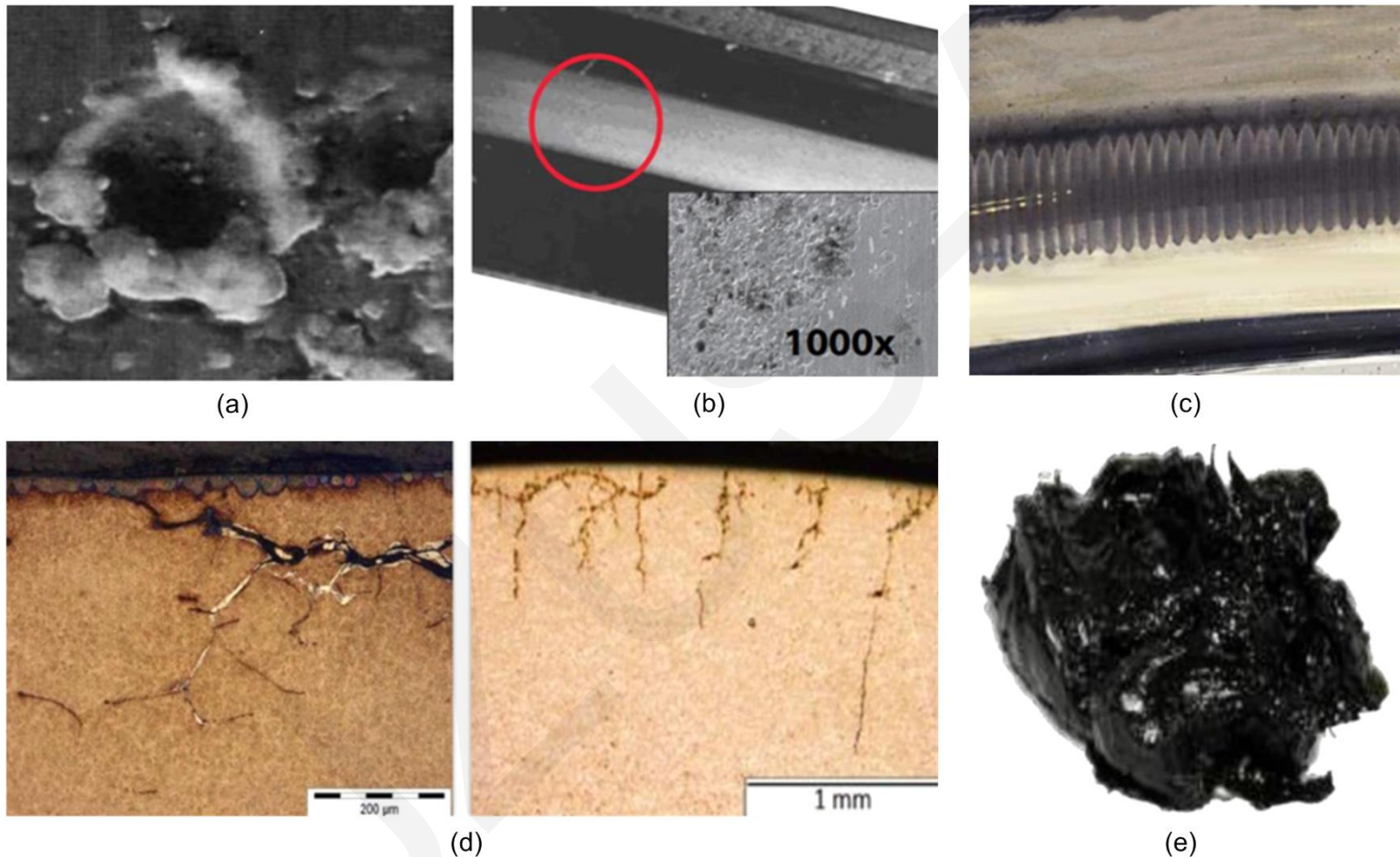


Fig. 2. Bearing currents due to inverter operation.

# Electrical Bearing Failure Modes



**Fig. 3. Bearing currents failure modes. (a) pitting; (b) frosting; (c) fluting; (d) white etching cracks; (e) grease degradation**

# Equivalent Circuit Model

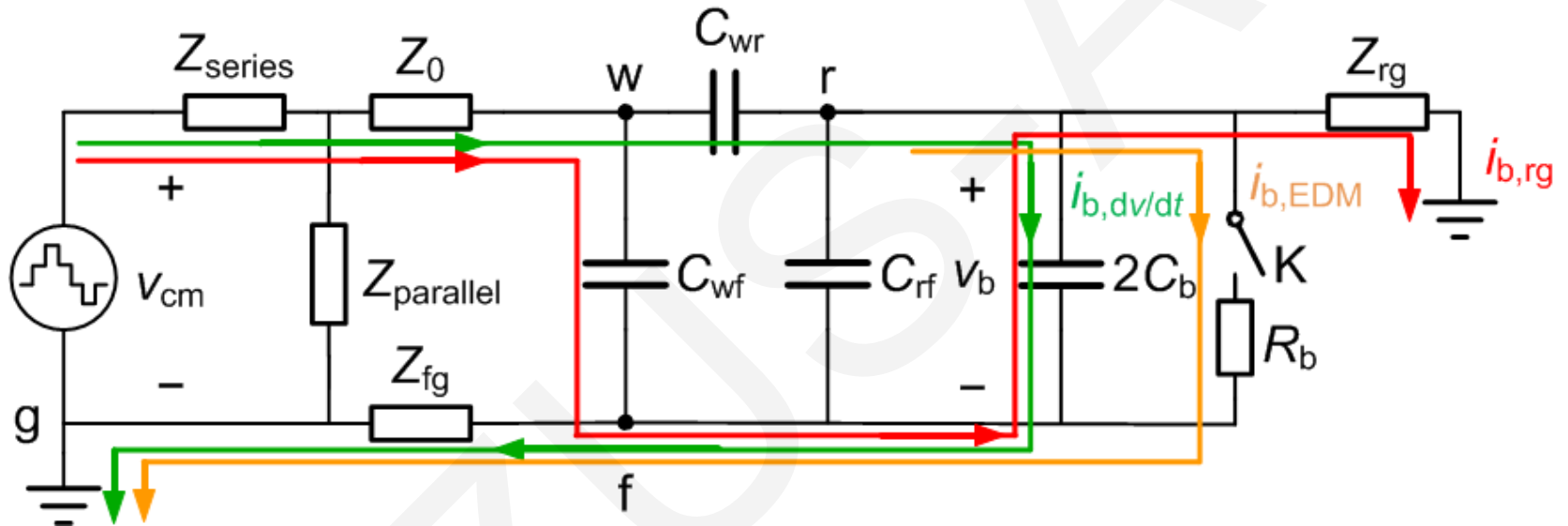


Fig. 4. Non-circulating bearing currents

# Metro Traction System

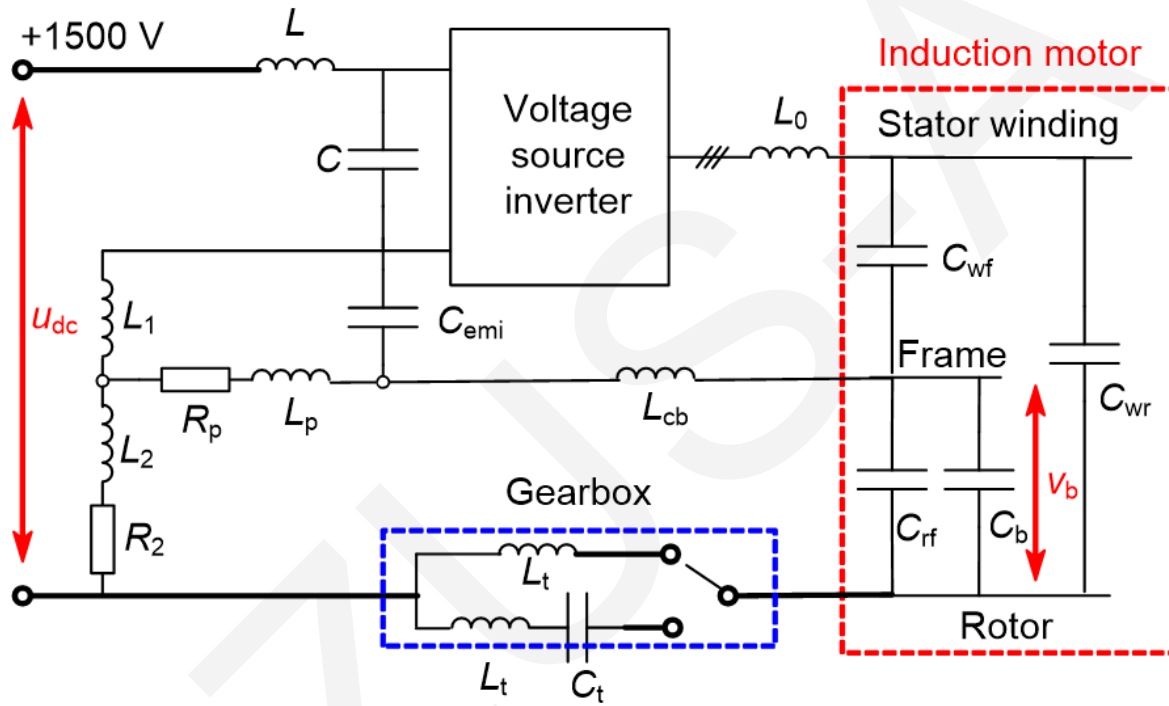
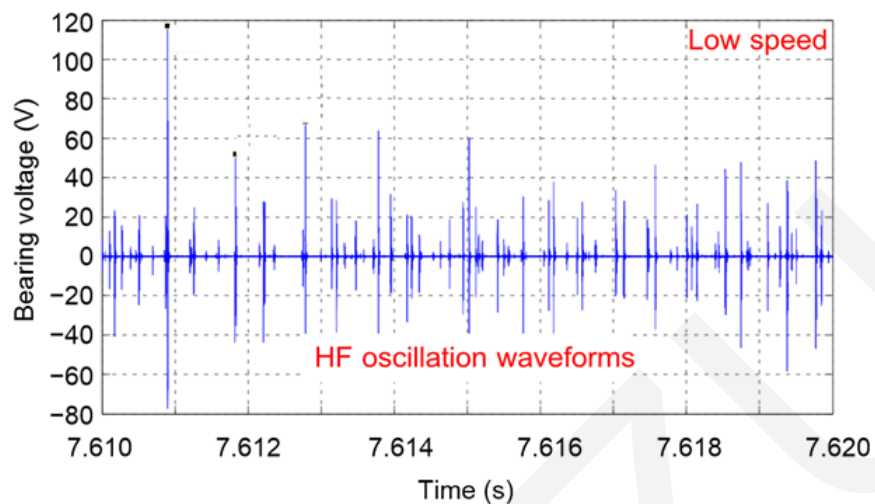
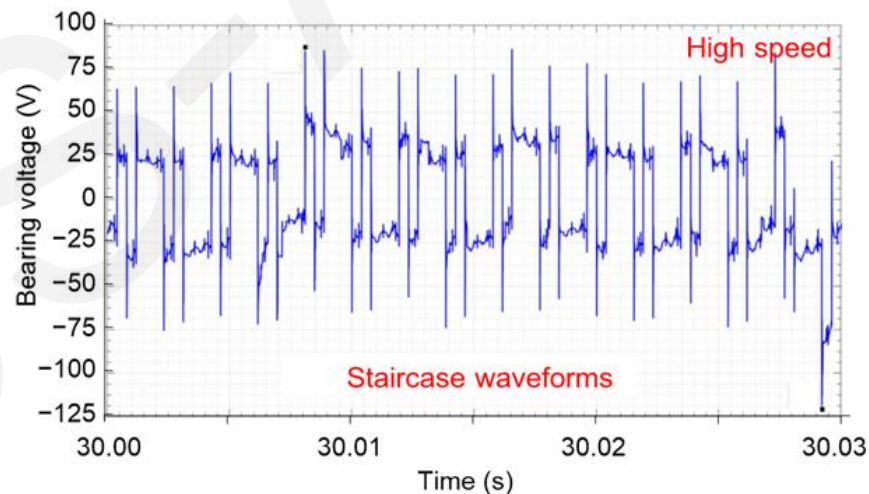


Fig. 5. Equivalent circuit model of metro traction system.

# Measured Rotor Grounding Bearing Voltage



(a) Low-speed waveform



(b) High-speed waveform

**Fig. 6. Measured bearing voltage waveforms of a metro project.**

# Conclusions

- The premature electrical failure of bearings has become a critical issue that has for decades restricted the lifetime of electric motor-based traction systems. In this study, an overview of electrical bearing failures in rail transportation has been presented.
- Related facets such as CM voltages, bearing electrical failure modes, generation and composition of bearing voltages and currents, modeling of bearing currents, and determination of coupling capacitances have been discussed to obtain a comprehensive and systematic perspective on the phenomena.
- On this basis, feasible ways to solve the problem are summarized, and a case study is presented to illustrate the research procedure recommended for the systematic investigation of inverter-induced bearing currents in rail transportation.