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Towards Self-powered Smart Sensors in Hydraulic Motors

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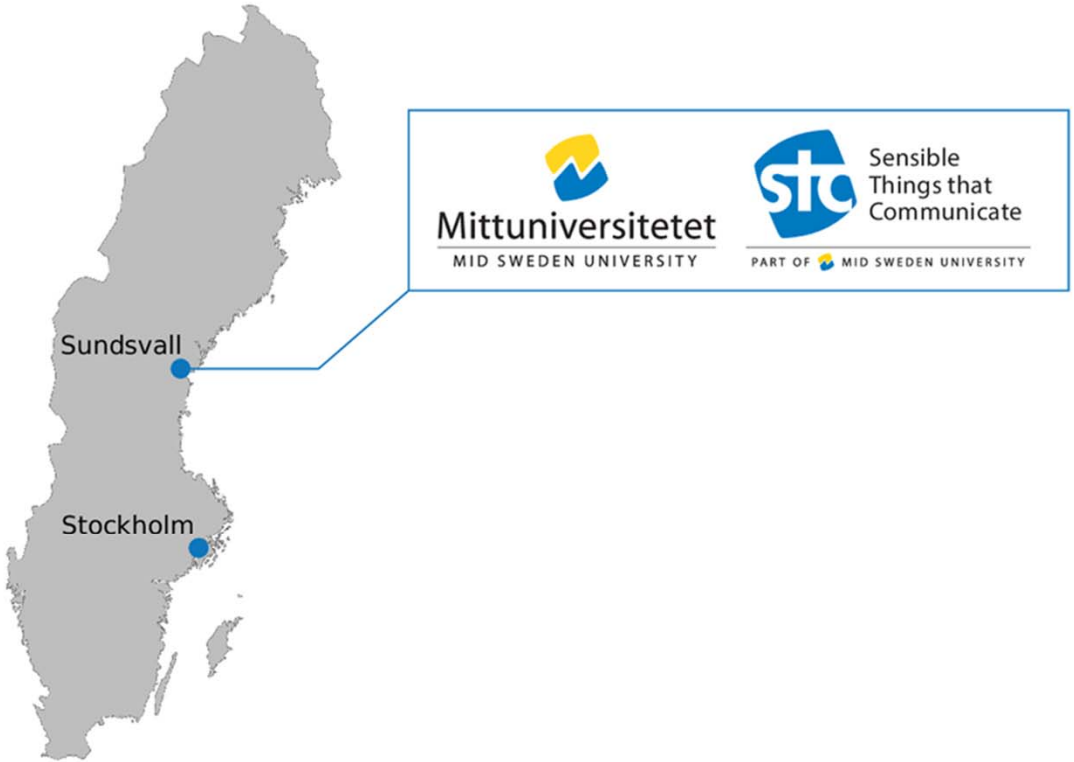
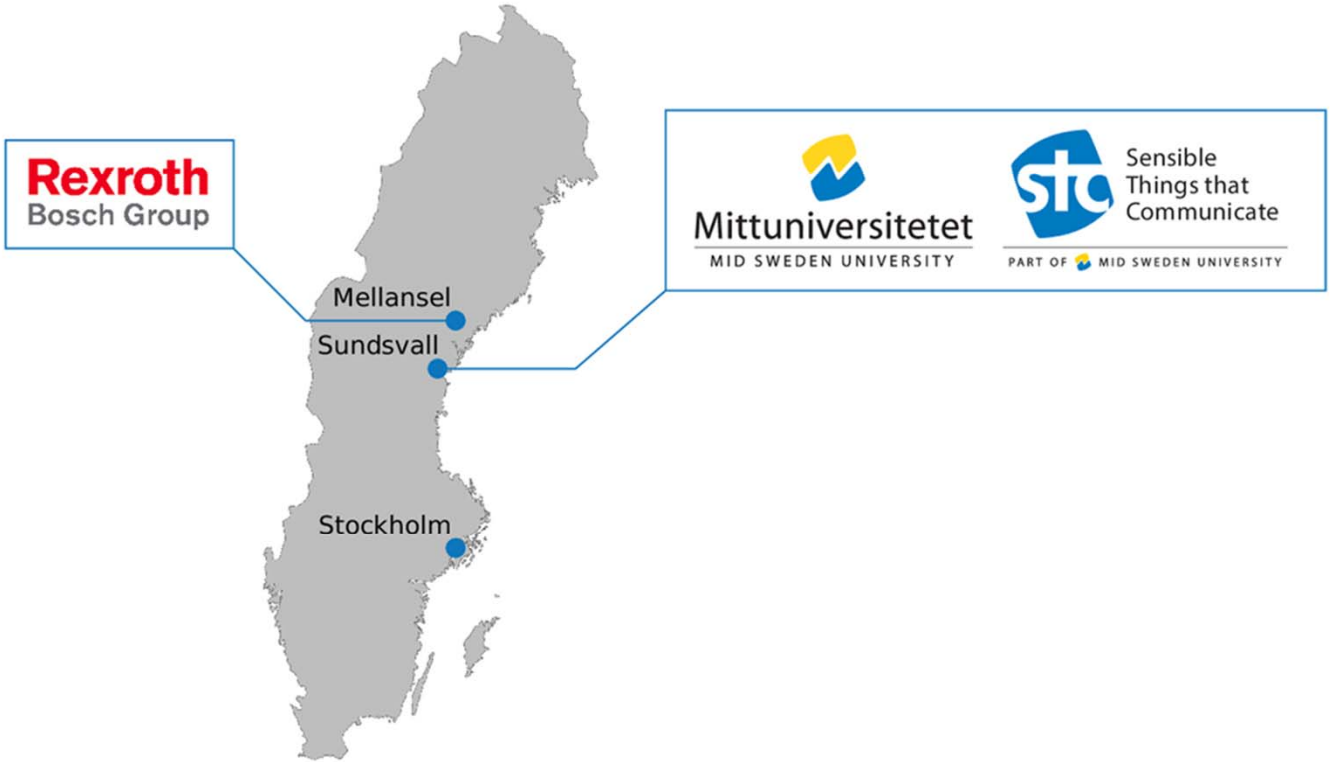
Sebastian Bader

Department of Electronics Design

STC at Mid Sweden University



STC at Mid Sweden University

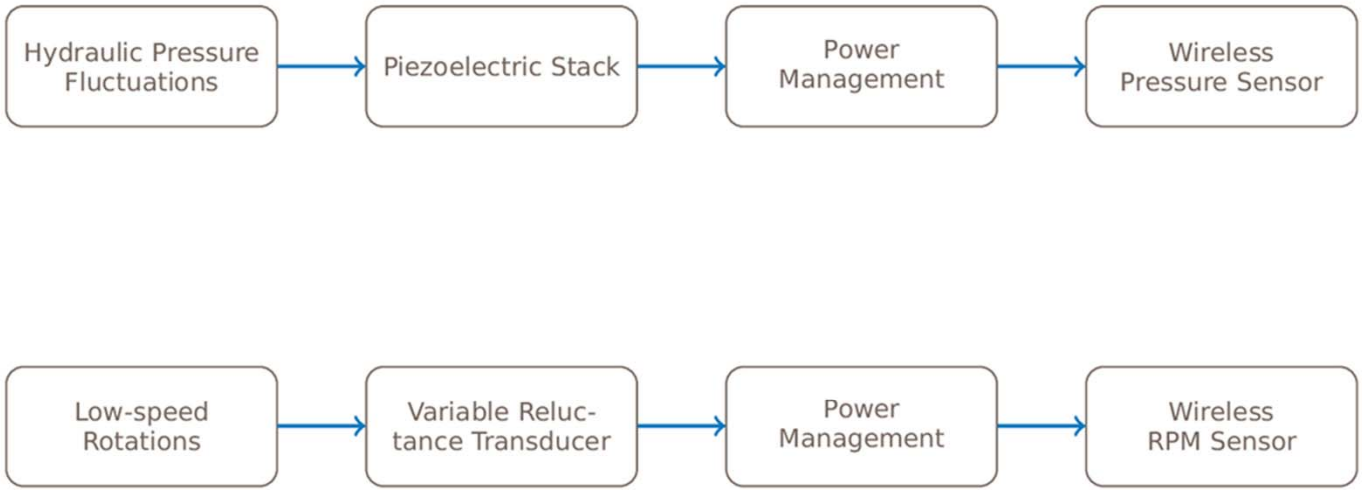


Smart hydraulic motors

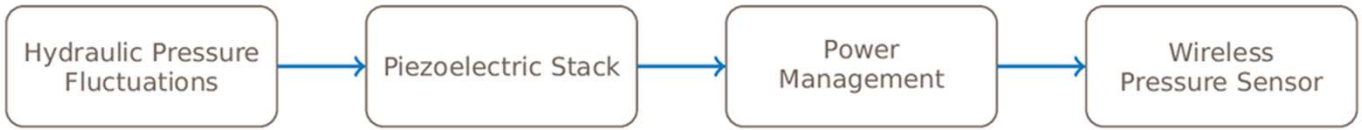
Two EH cases:

- Pressure fluctuations
- Low-speed rotations

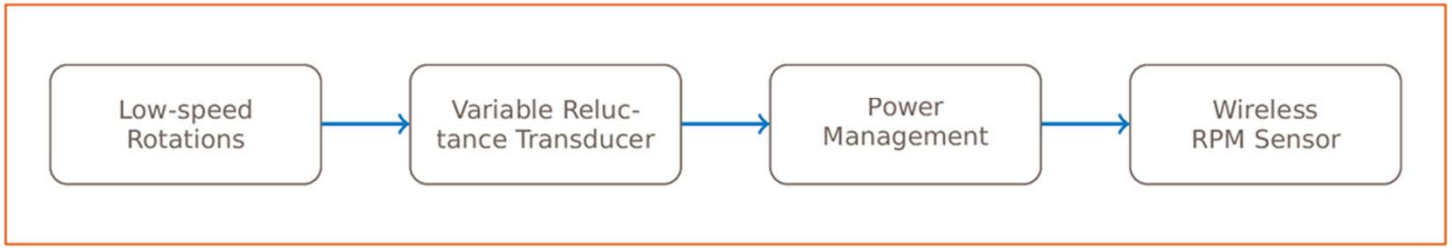
Two cases for self-powered sensors



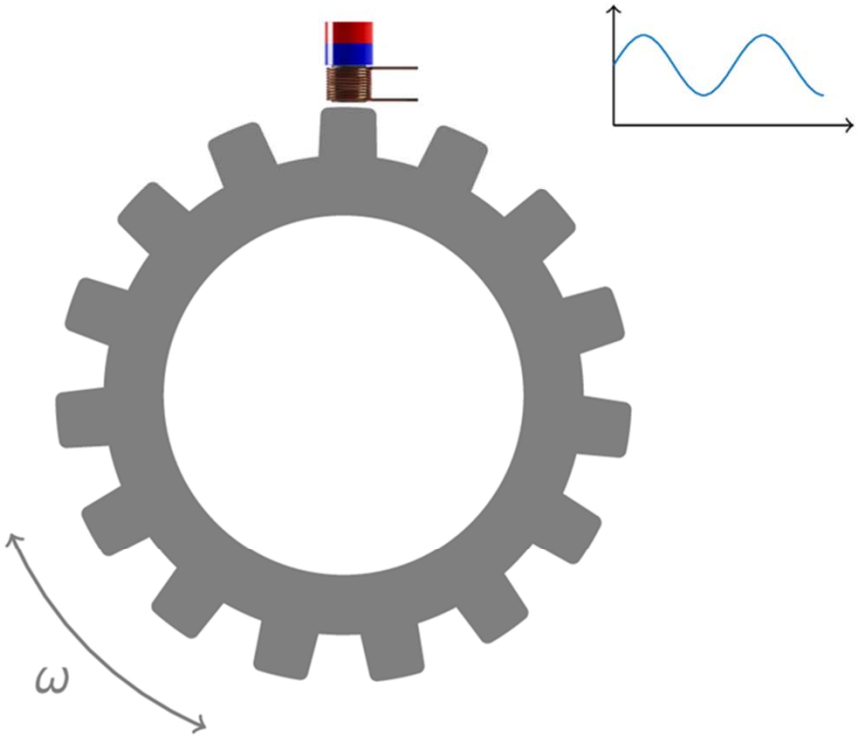
Two cases for self-powered sensors



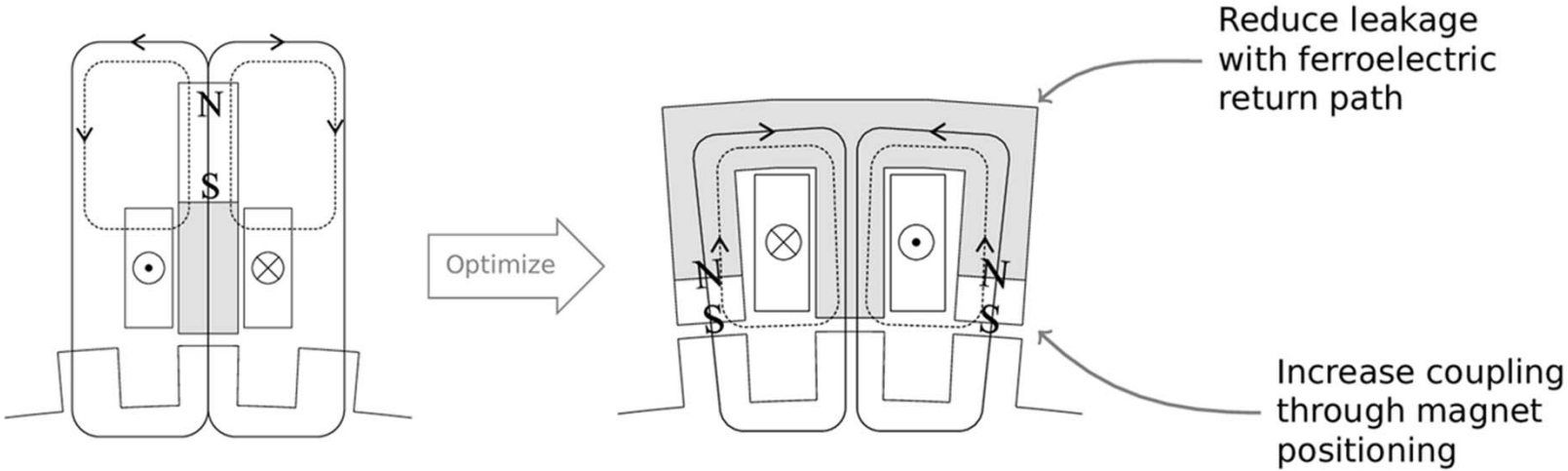
Xiao et al. (2022), Adv. Energy Mater. 12(9)

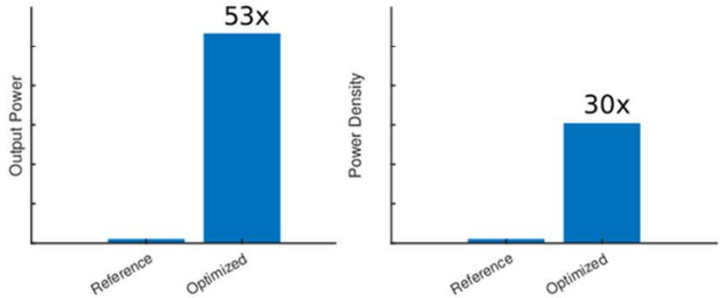


Variable reluctance principle

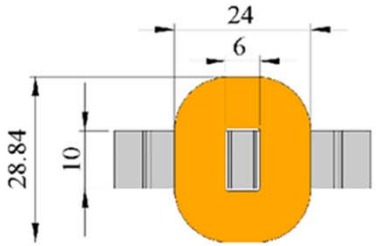


Variable reluctance pickup optimization



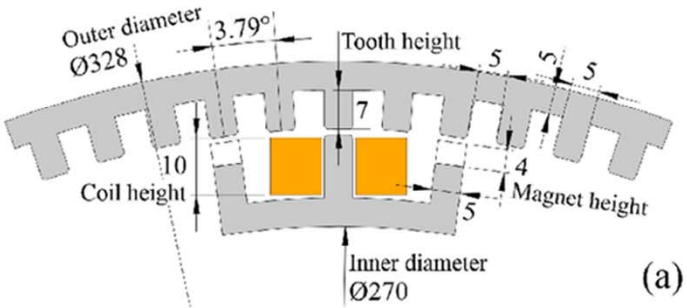


On-rotor m-shaped VREH

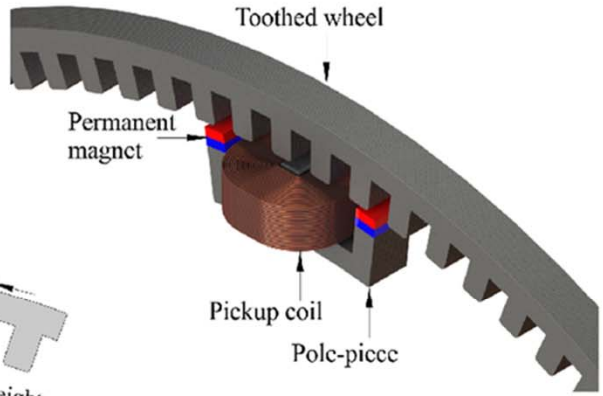


Unit: mm

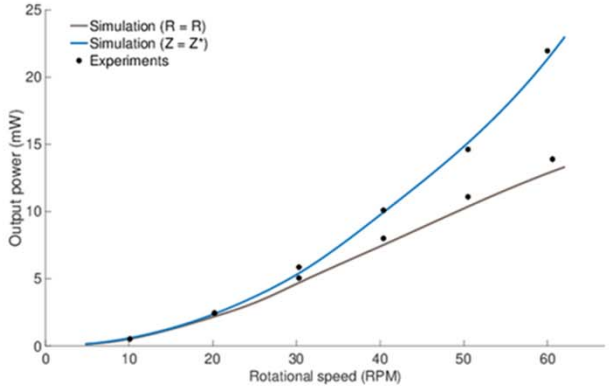
(b)



(a)

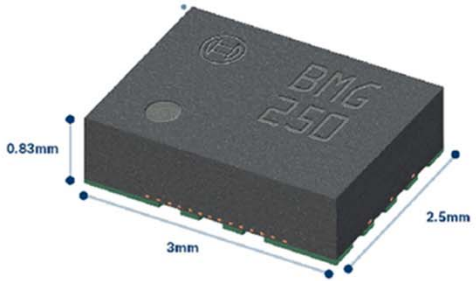


(c)



Advantages of gyroscopic measurement

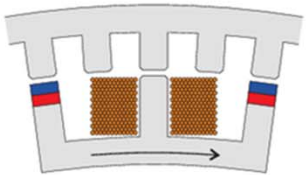
- Inertial measurement (no reference)
- Output proportional to angular speed
- Bandwidth and delays are independent of angular speed
- Very low cost and size



Bosch BMG250

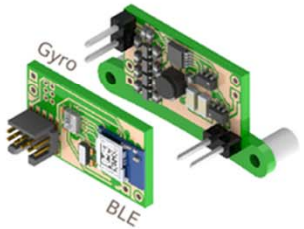
- approx. 6mm^3
- 1.8V - 0.9mA
- 3uA suspend mode
- approx. 2€

Self-powered sensor systems based on EH

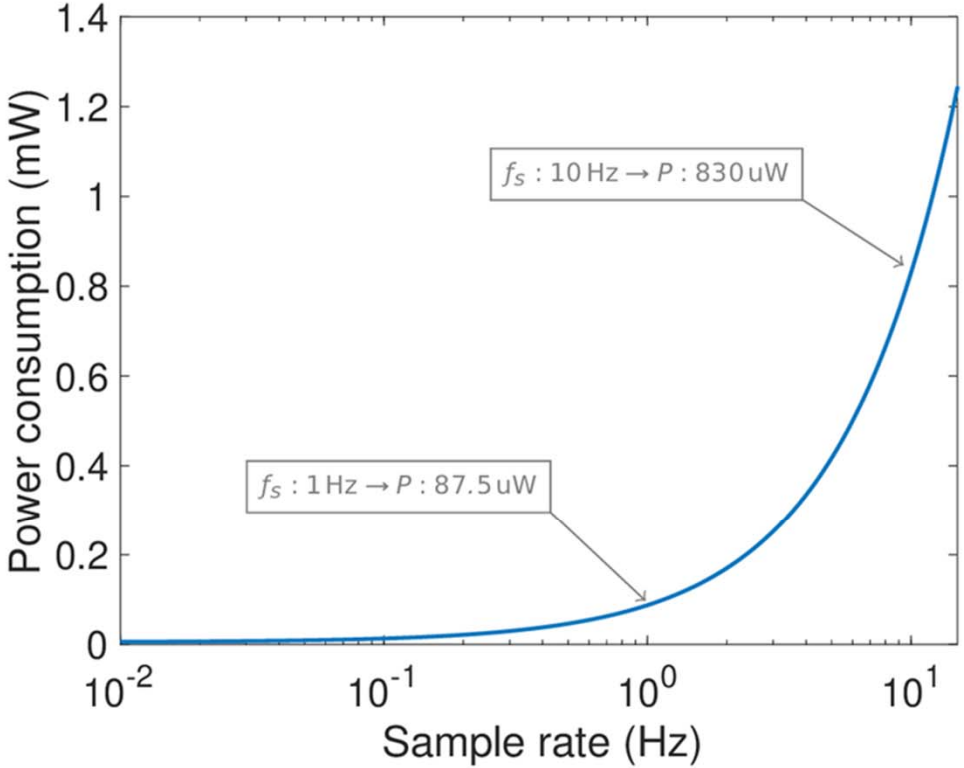


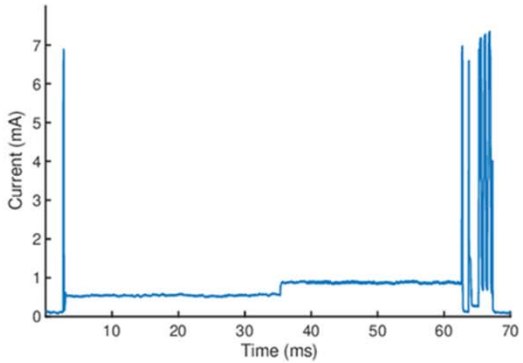
Rectifier

PMIC



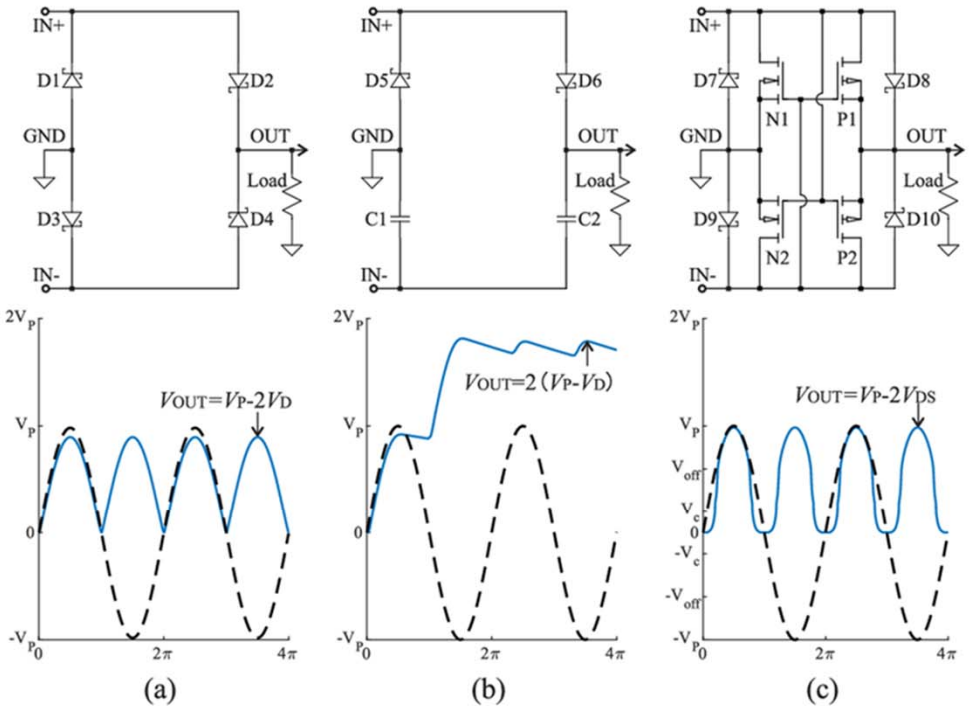
Power requirements



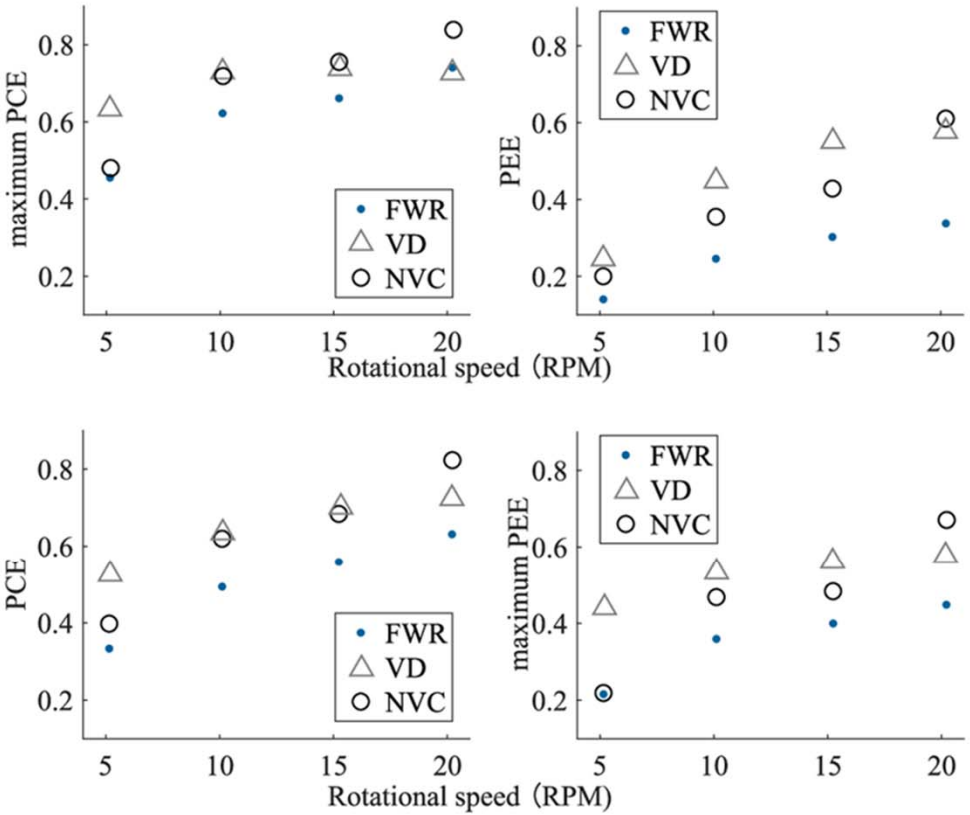


Sample period: 64 ms
Energy consumption: 83 uJ

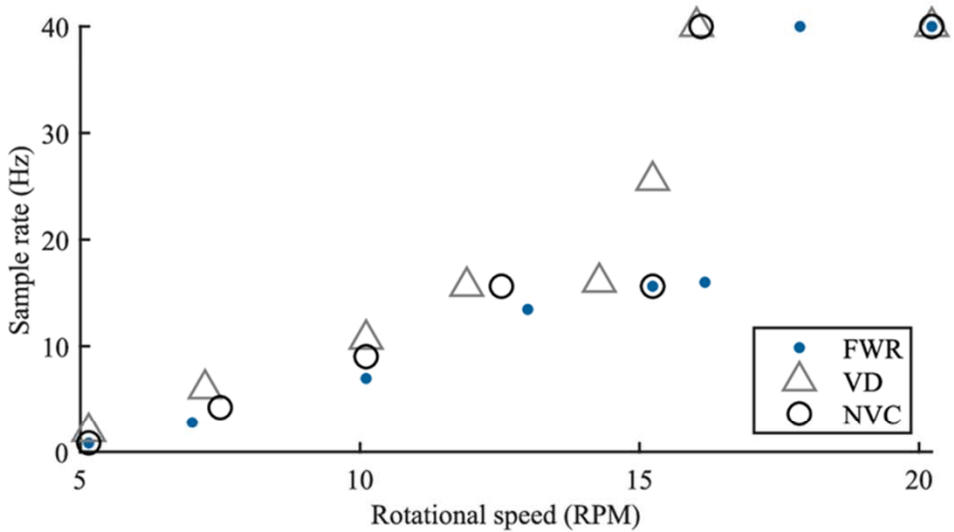
Investigated rectifier alternatives



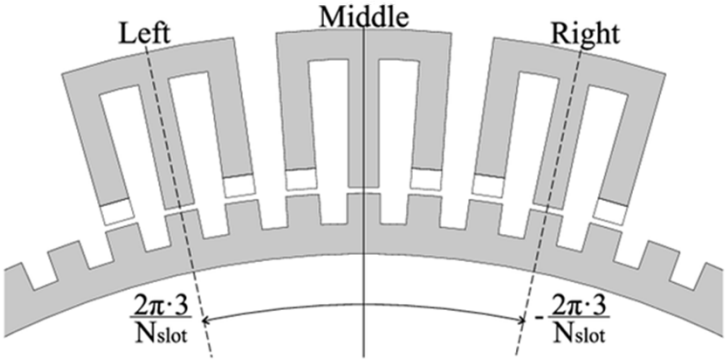
Rectifier performance



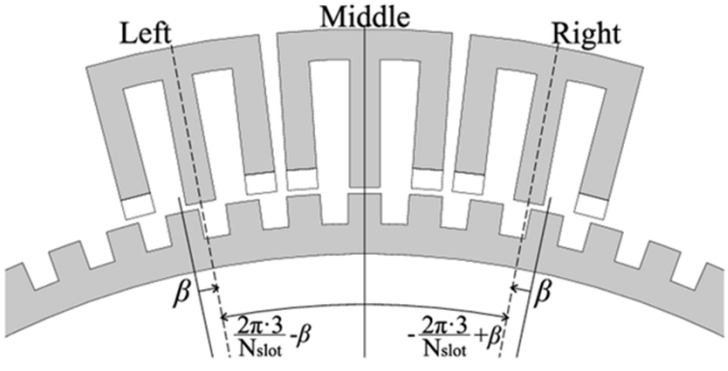
System performance



Phase-shifted pickup units

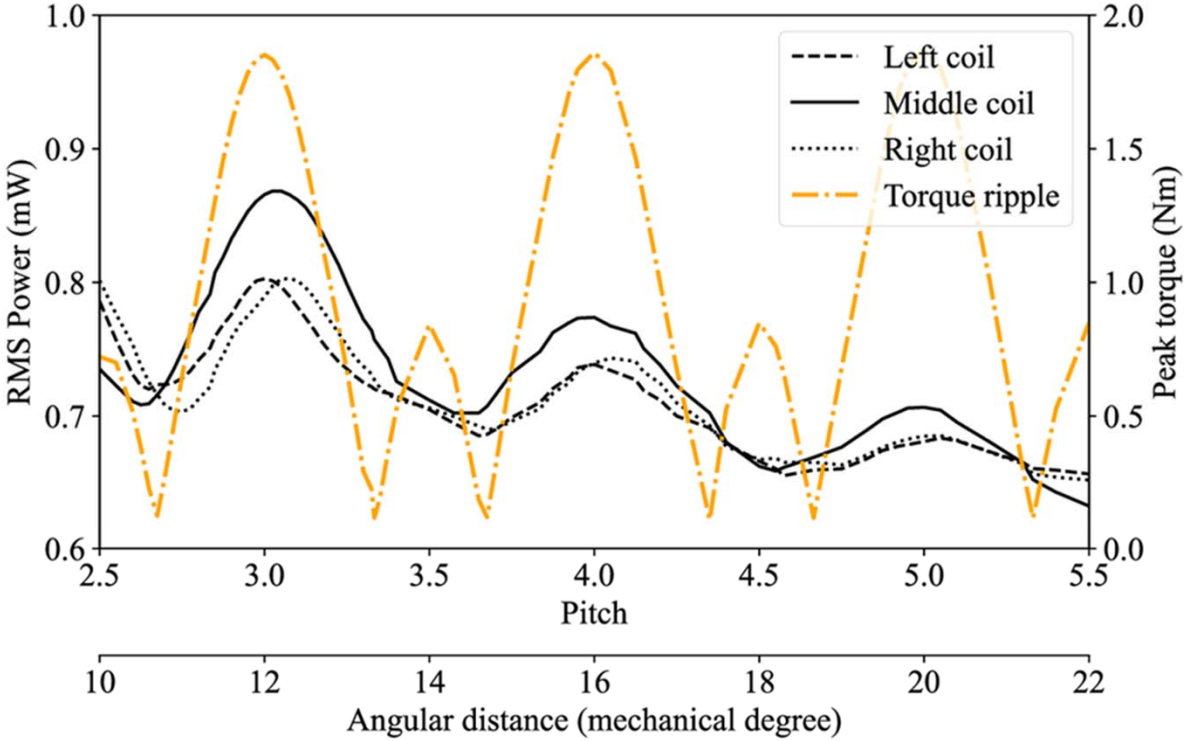


Single phase

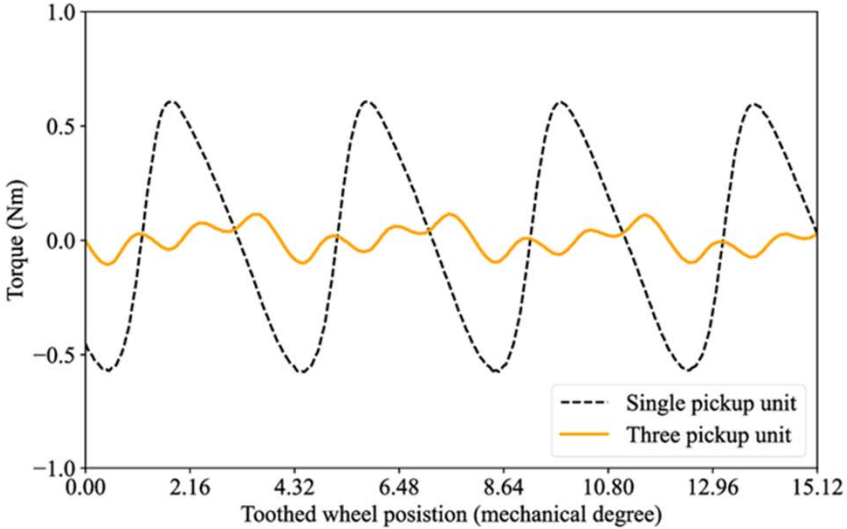


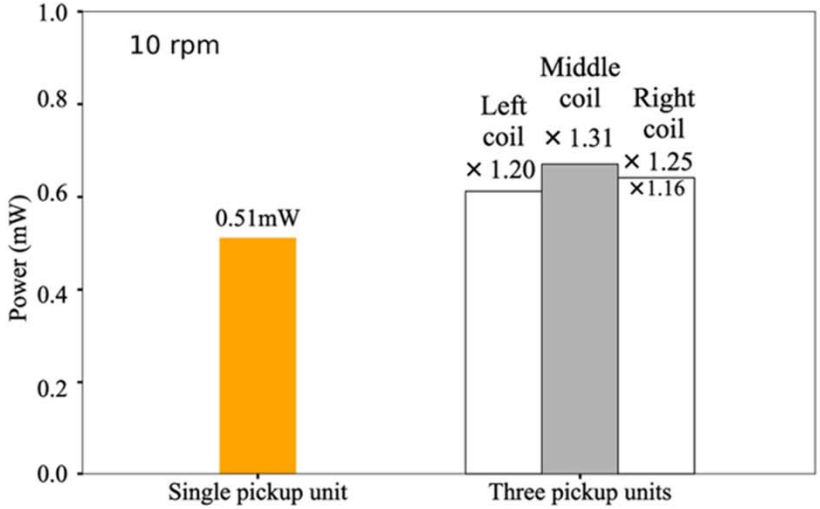
Phase-shifted

Torque and power output



Single-phase vs three-phase torque





Conclusions and next steps

- VREH is suitable for low-speed rotating applications.
- Together with MEMS gyroscopes it enables energy-autonomous, on-rotor RPM sensing.
- Consideration of the entire system chain necessary to optimize performance.
- Three-phase VREH can minimize parasitic effects.

Thank you for your attention!

Contact: sebastian.bader@miun.se