PowerCare

Cognitive power electronics with integrated failure prediction

Fraunhofer

PowerCare

Highly efficient motor control with integrated intelligence

Project description

Independence from fossil fuels and the switch to renewable energy sources require extensive electrification of production and mobility. This increases the need for compact, energy-efficient, and reliable power electronics. In PowerCare, novel vertical GaN power semiconductors as well as real-time failure models are developed and used in a motor drive. Here, PowerCare takes a new approach to the monitoring concept by using a miniaturized motor controller with integrated AI-based failure prediction.

Technology

Novel vertical gallium nitride power semiconductors as well as integrated real-time failure models for the inverter and motor.

Technical advantages

- Increased reliability for electric drives: Real-time failure prediction models for GaN transistors and motor integrated in PWM controller
- GaN in inverters: Higher energy efficiency and higher current carrying capacity at higher switching frequencies, smaller passives
- Benefits for drives: Improved power quality for the motors and reduced losses in the motors, especially in the partial load range

Customer benefits

- Innovation of a GaN-based inverter to increase the efficiency of electric motors
- Integrated intelligence in the power module (data analysis with machine learning algorithms) as an enabler for smart maintenance
- RoI increase and system cost savings (passive components) for power modules by fast-switching vertical GaN power semiconductors

Contact and further information

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www.power-care.org

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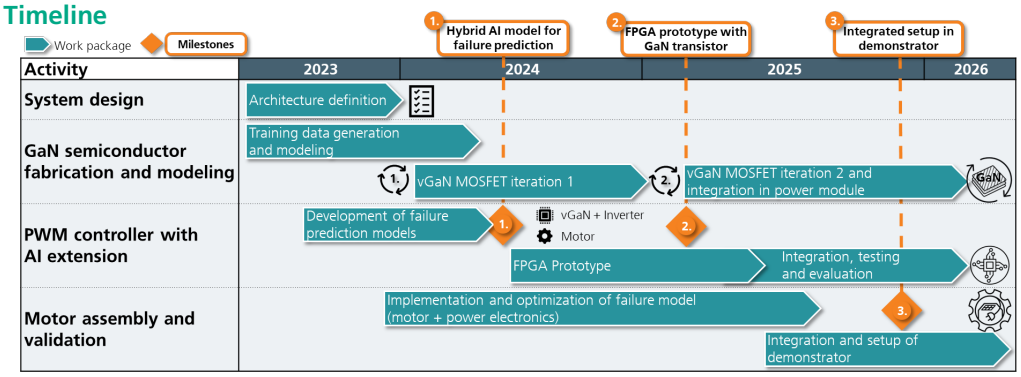
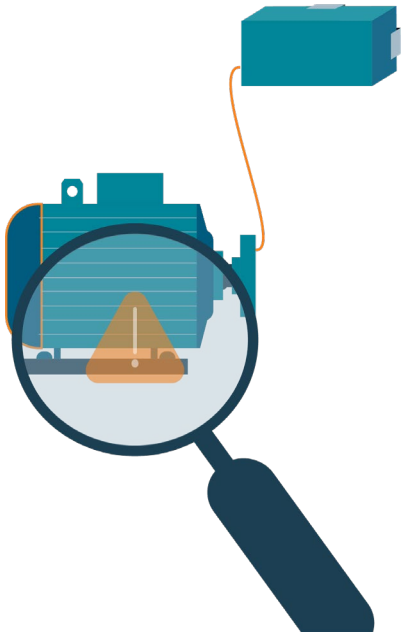
Info sheet

Timeline





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Motor controller with embedded AI

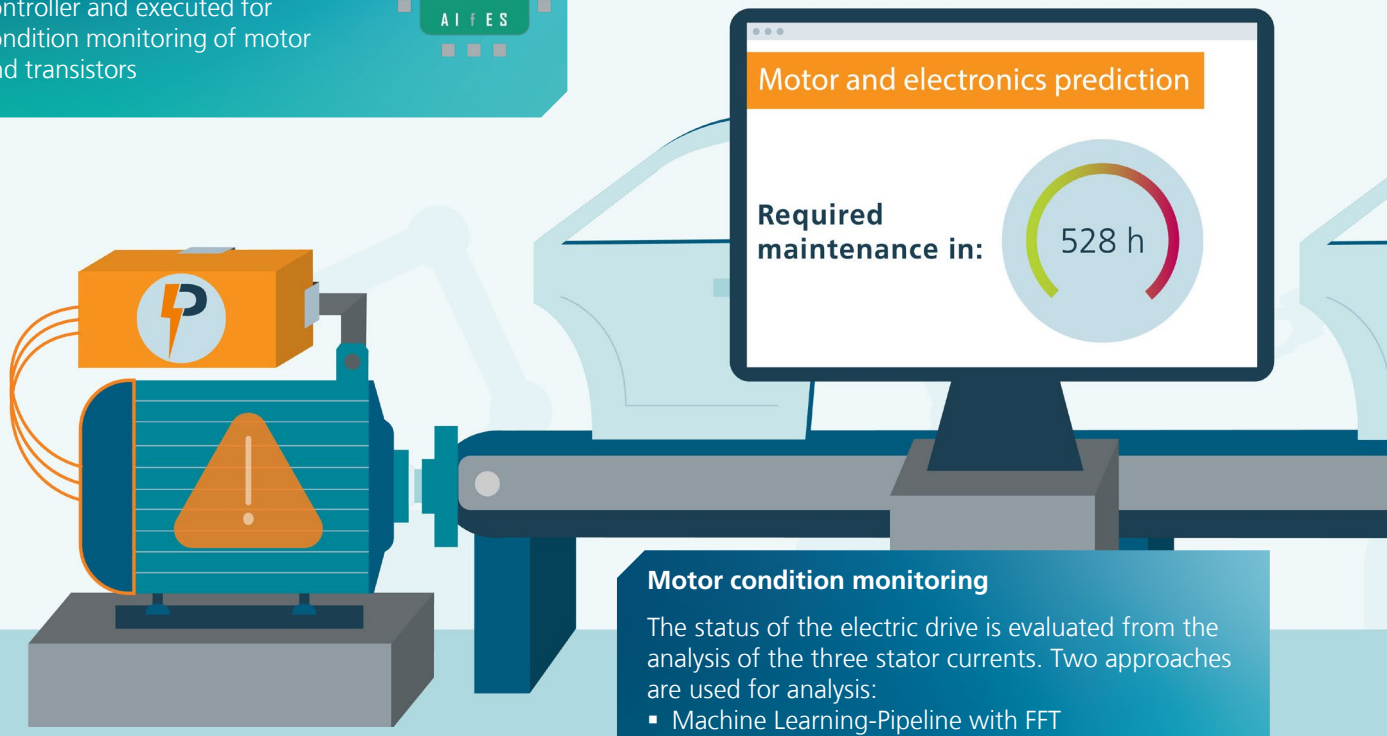
- AI-based failure detection models are implemented on a domain-specific RISC-V control SoC combined with highly efficient GaN power transistors to form a motor driver
- With the open-source AI software framework AIfES (Artificial Intelligence for Embedded Systems) memory-optimized AI models are ported to the motor controller and executed for condition monitoring of motor and transistors

AIRISC

AIfES

Application fields

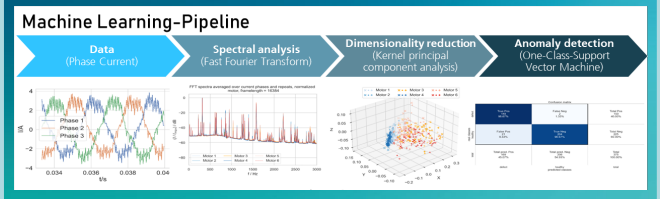
- Efficient and fail-safe industrial drives such as conveyor drives and pumps
- Electric mobility from automotive to drones and electric aircrafts
- Point-of-Load converters for data centers
- Safe cobots and mobile medical robots with longer battery life
- Efficient and predictive PV inverters



Motor condition monitoring

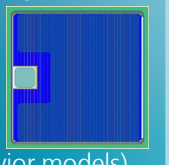
The status of the electric drive is evaluated from the analysis of the three stator currents. Two approaches are used for analysis:

- Machine Learning-Pipeline with FFT
- Deep Learning-Pipeline with explanation



vGaN device and inverter development

- Normally-off trench MOSFET based on 8" GaN-on-QST substrates
- Manufacturing and development of transistors and inverters at Fraunhofer
- Device design, modelling (TCAD, behavior models) and characterization capabilities are continuously being expanded
- Expected Specs: 48 V, >40 A (>600 V / 100 A in parallel development)
- Sample ETA mid 2025



Inverter condition monitoring

- Currently developed based on commercial GaN HEMTs
- Expanded compact models of devices and system level simulation in QSPICE
- Based on phase currents only