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.

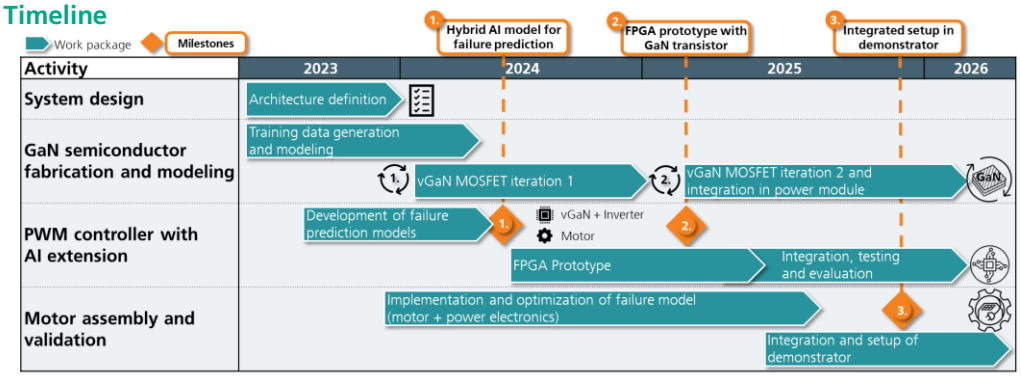
### Technical advantages

- 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

### Timeline





### Contact and further information

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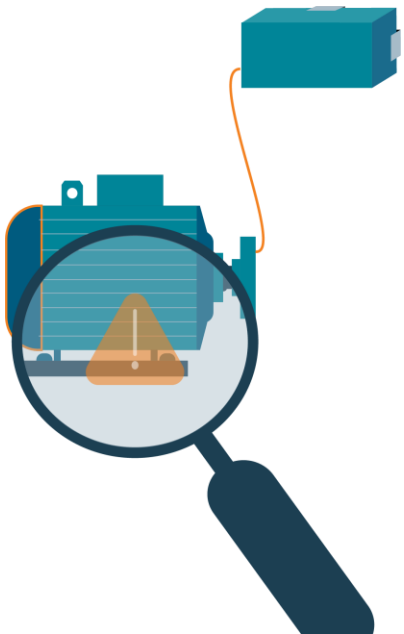
**Info sheet**

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## Motor controller with embedded AI

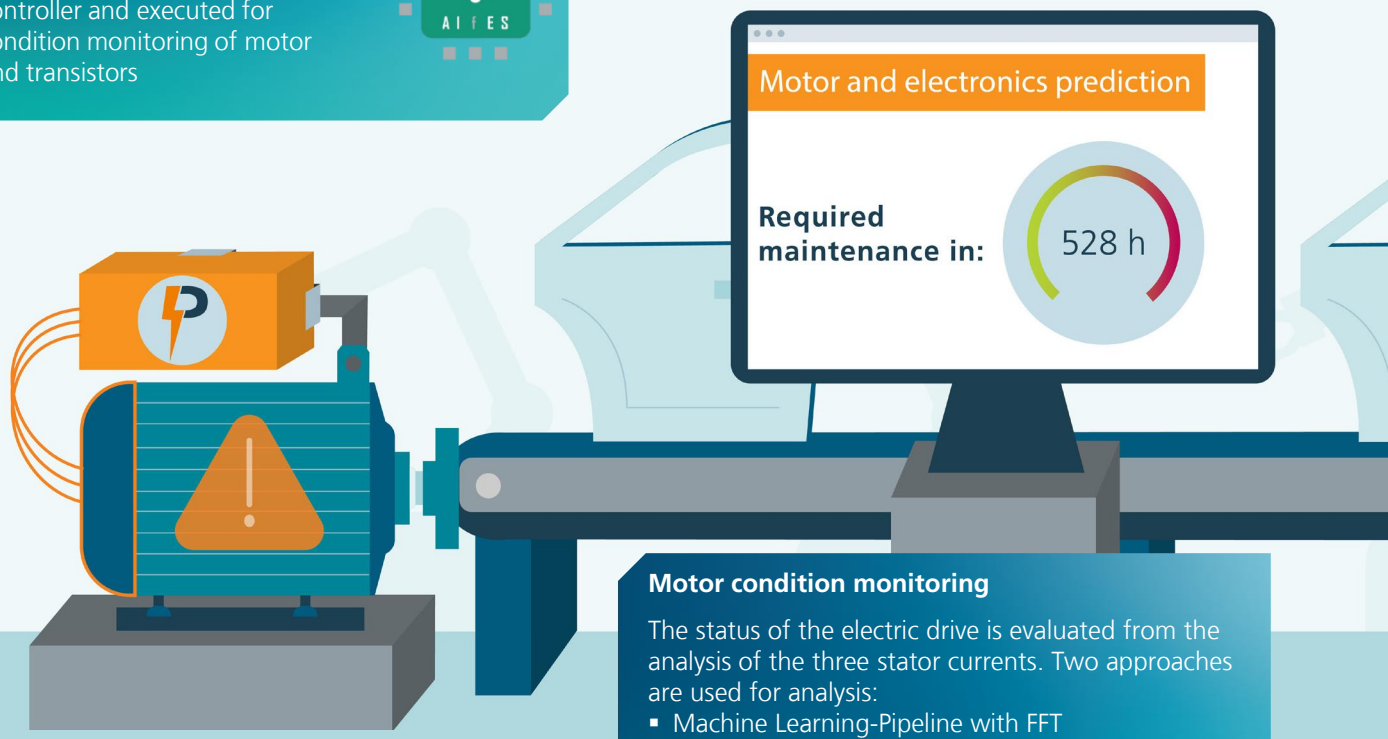
- AI-based failure detection models are implemented on a domain-specific RISC-V control SoC combined with highly efficient GaN power transistors to form a motor driver
- With the open-source AI software framework AIfES (Artificial Intelligence for Embedded Systems) memory-optimized AI models are ported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

AIRISC

AIfES

## Application fields

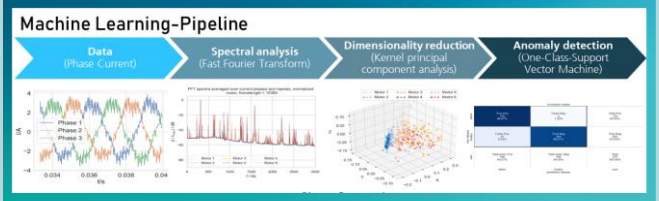
- Efficient and fail-safe industrial drives such as conveyor drives and pumps
- Electric mobility from automotive to drones and electric aircrafts
- Point-of-Load converters for data centers
- Safe cobots and mobile medical robots with longer battery life
- Efficient and predictive PV inverters




## Motor condition monitoring

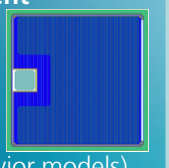
The status of the electric drive is evaluated from the analysis of the three stator currents. Two approaches are used for analysis:

- 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)



## Inverter condition monitoring

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