MOTEON GmbH – Introduction
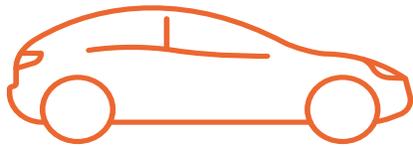
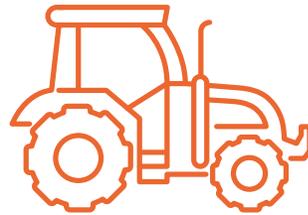MOTEON GmbH   2023

MOTEON at a glance

Founded: 2020

HC: 38 employees

Location: Ilmenau, Thuringia – Germany

EMEA, Americas*

ISO 9001:2015
TISAX

- **The leading expert for motor control system solutions** with years of electronic motor know how

- **Long-term expertise for ARM®-based microcontrollers**

- Expertise in **mechatronics**, **system concept & modeling**, **embedded software** as well as **tools & testing**

- Located at the **industrial cluster for motor control and mechatronic** in *Technology Region Ilmenau Arnstadt*

Competencies	
Mechatronics & System	
Model-Based Design	
MCTRL embedded SW	
Test & Verification (MTB)	
Functional Safety	
MOTIX™ MCU (TLE98xx)	
Other ARM-based µC	

*contract partner need to be located in EMEA or Americas (resource and legal constrains)

MOTEON serves a wide range of automotive, industrial and consumer motor control applications

Areas of expertise
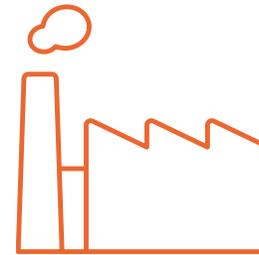
Classical automotive

(Comfort Drive, Pumps & Fans)
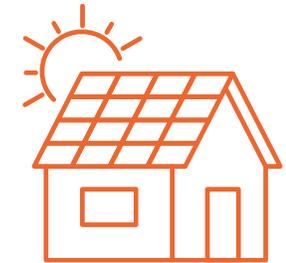
New Mobility

(48V, CAV)

Industrial

(Industrial Drives, Manufacturing, Pumps & Fans)

Smart Home

(Home Appliances, Aircon & Fan)

Regardless of what area we are working in, we focus on a **holistic customer experience** that contributes to a **faster time to market** and **reduced R&D costs.**

End-to-end engineering service offering for motor control applications from software, engineering to testing and tools

Software	Engineering Services	Engineering Tools

Consulting & Training
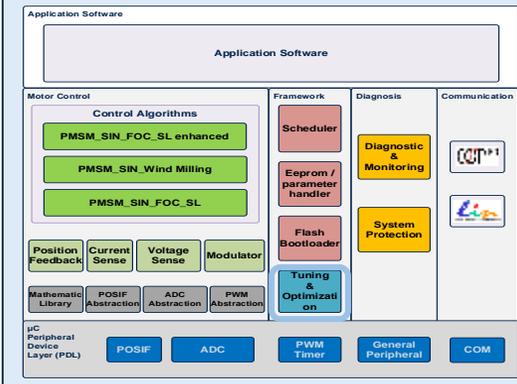
- Feasibility studies
- On-site / remote motor control training

Software Libraries
Software as a Product (SaaP)

- MOTIX™ Motor Control
- Low Level Driver (LLD)
- Motor-SW-Launch Service

MOTIX™ Motor Control Library
FOC Solution
Drive Algorithms
Actuator/ Sensor
Motor Control Abstraction Layer incl. MATH
MOTIX™ Low Level Driver

Software Development

- Customized application software solution

Mechatronic Development

- Design of embedded motors
- Electronics design for system integration
- CFD based thermal simulation

Testing

- Motor identification
- Testing as a Service
- System verification

Tools

- TraceBox
- Motor Analysis Tool

Prototyping – Proof of Concept (PoC)

- PoC for software, electronics, motor and system

Consulting

End-to-end motor control know how to simulate performance and load points as well as root-cause analysis of existing systems

Key features

- Performance assessment: CPU Load, RAM and run-time
- Motor Analysis Tool: torque-speed, target operation points, efficiency analysis
- System simulation (MATLAB plant model simulation)
- Root-cause analysis (motor, inverter, electronic and control method)
- Feasibility analysis of customer specification (compliance matrix)

Your benefits

- ✓ **Reduction of project risks and threats of redesigns**
- ◎ **Take timely decision for concept idea and project approvals**
- 🔍 **Holistic assessment of entire mechatronic system**
- ↻ **Solutions with minimum impact on design**
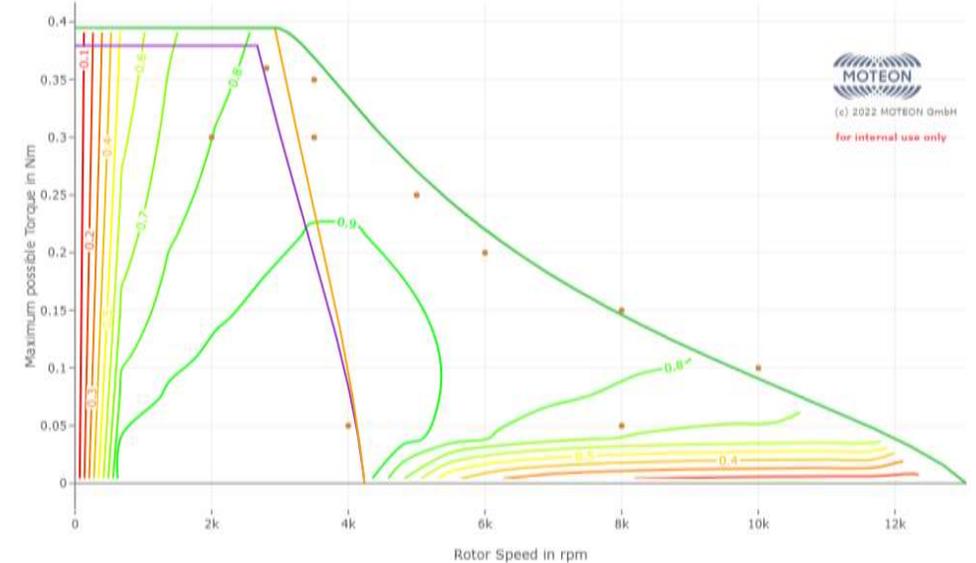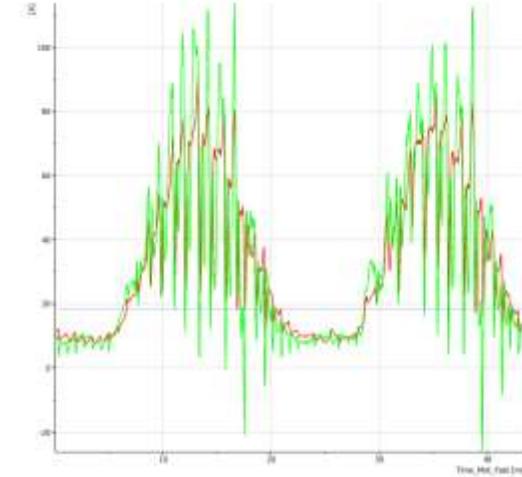
Motor Analysis Tool // Torque-Speed-Characteristic with efficiency lines and target points for different operational modes

Motor Analysis Tool (Infineon Developer Center)

Parameter	Description	Value
name	Motor name	MTN_02_IPM_12T10P
Ld	Inductance of d-axis in H	0.000131
Lq	Inductance of q-axis in H	0.000189
Psi_PM	Permanent Magnet Flux Linkage in Wb	0.003124
R	Phase resistance in Ohm	0.067
p	Pole pair number	5
Unom	Target Supply Voltage in V	12
Is_rated	Maximum rated current in A	16.2

Select a motor: MTN_02_IPM_12T10P

Characteristic Plots:
- ● Operational Modes Plot
- ○ Torque Speed Plot

Make Plot   Generate Report

Motor Analysis Tool - Version 0.2.7

https://softwaretools.infineon.com/tools/com.ifx.tb.tool.motoranalysistool

Hexagons: Torque-Speed-Plots; Target Operational Points; Efficiency Analysis; Thermal Performance Analysis

Online via IDC

Target point callout: speed: 2000.0 rpm; torque: 0.30 Nm; i_d: -2.64 A; i_q: 12.21 A; efficiency: 80.0 %

Plot legend:
- Zero d-Current
- MTPC
- Field Weakening (FW)
- Resistive FW
- Efficiency
- ● Target Points

Maximum possible Torque in Nm (y-axis); Rotor Speed in rpm (x-axis)

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Training –
A few days or one week intensive motor control knowledge leverage

⚙️ **Training**

Remote or on-site professional motor control training customized for your needs and tailored to the level of expertise

Key features

- Physical basics *(generated torque & voltages, B6 bridge operation, terminal voltages)*

- Rotor position detection algorithms *(BEMF, comparator based, ADC, Flux, inductance)*

- Commutation schemes *(FOC, sinus, table based, lead-angel control, stepper)*

- Current measurement/diagnostic techniques

- Motor control phases *(external drive, low-speed, field-weakening or over-modulation)*

- Peripheral support on MOTIX™ µC *(BEMF – comparator, ADC, CCU, current measurement)*

- SW implementation hints *(Architecture, program base structure, timing and interrupts)*

Your benefits

🔍 **Improved knowledge, skills, productivity and employee satisfaction**

🔄 **Build up knowledge and leverage know how for new applications**

Software Libraries accelerate the development at our customer and Software Development provides them a customized solution
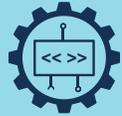
Software Libraries
Software as a Product (SaaP)

Software libraries to PMSM R&D projects
(LLD, hardware abstraction, motor control)

MOTIX™ Motor Control Library
FOC Solution
Drive Algorithms
Actuator/ Sensor
Motor Control Abstraction Layer incl. MATH
MOTIX™ Low Level Driver

Modularized architecture

Software developed acc. to reference specifications

PC-Tools for easy configuration & parameter optimization

Documentation and software integration example
(source code, API, test report, user manual, release note)
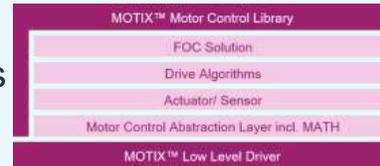
Out of Scope:
- System and application engineering
- System requirement capturing / validation
- Application software
- Parametrization & optimization with own system
- Integration of libraries and mechatronic development

Software Development
Customized Application Software

Application engineering support
(review of hardware, load and motor behavior)

Development according to requirement specification
("Pflichtenheft")

Motor identification & control parametrization

Performance measurement analysis & optimization
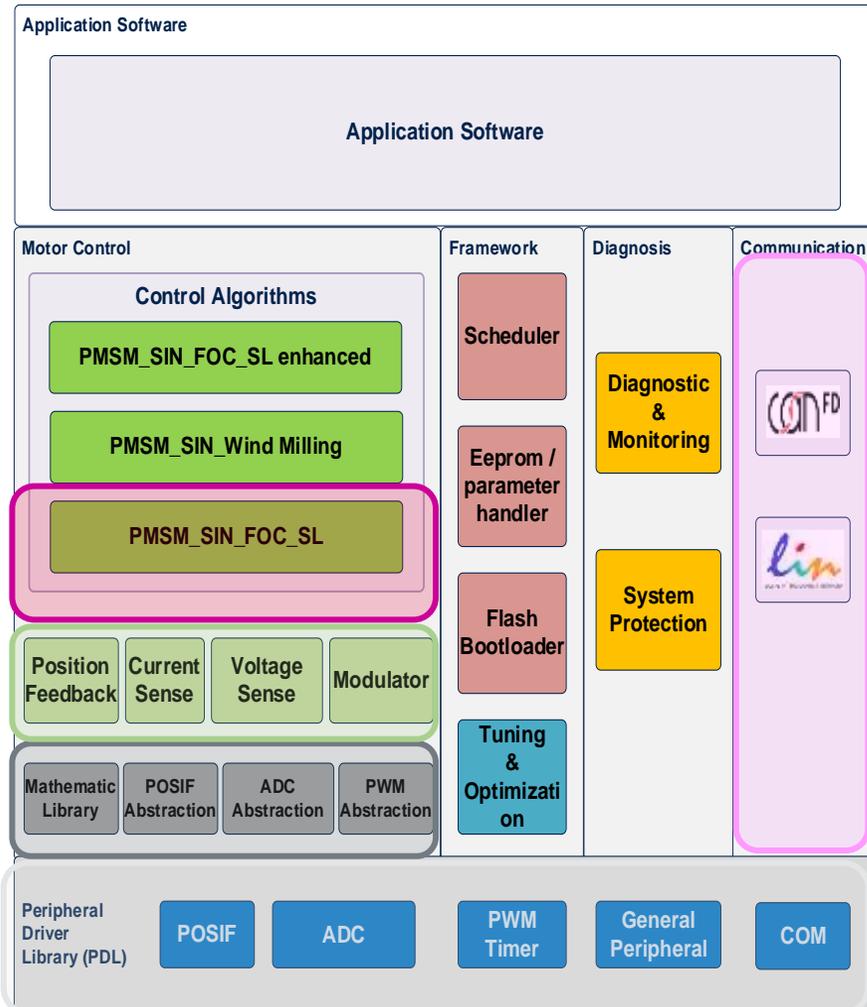
Software integration & system verification

Software optimized for customer system
(selected motor, load and electronics combination)

Library Overview (Released for TLE987x & TLE989x)

FOC Solution
position-sensorless, field-oriented control for (I)PMSM with I/F smooth startup sequence, speed control, current control, fault report, speed pre control, start angle identification, voltage-to-frequency speed control, start-up current ramp

Motor Control Drive Algorithms
I/f, V/f, FOC : PI current controller, dq-decoupling, DC link voltage limitation with D axis prioritization, Flux estimator,
Start angle estimator: identify the rotor position in standstill

Actor Sensor Lib
Modulator

Hardware Abstraction Layer
µC/board abstraction, Math function, scaling, trigonometric

Low Level Driver (LLD)
µC low level driver + tool support

COM
Process communication stack and protocols 3rd party COM-stack

Facilitate initiation of series development by employing professional software parameterization for customer's electronics and motor

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Motor-SW-Launch Service

Professional launch service in 5-steps to verify design of electronics, identify motor parameters, simulation target-operation-points and parametrize software for testing

Key features

- Electronics Review
- Motor parameter identification
- Motor Analysis Tool: simulation of torque-speed, target operation points and efficiency
- Professional software parametrization
- Motor performance measurement incl. CPU usage & runtime

Your benefits

- 🔍 **Understand system performance** and which algorithms are needed to reach ToP
- 🎯 **Saving weeks of work** during initialization phase
- 🔄 **Avoid trial/error** in parametrization for unknown motors
- 💡 **Identifying design issues** in early phase of project

Electronics Review

Motor identification

Motor Analysis

Software Parametrization

Performance Test
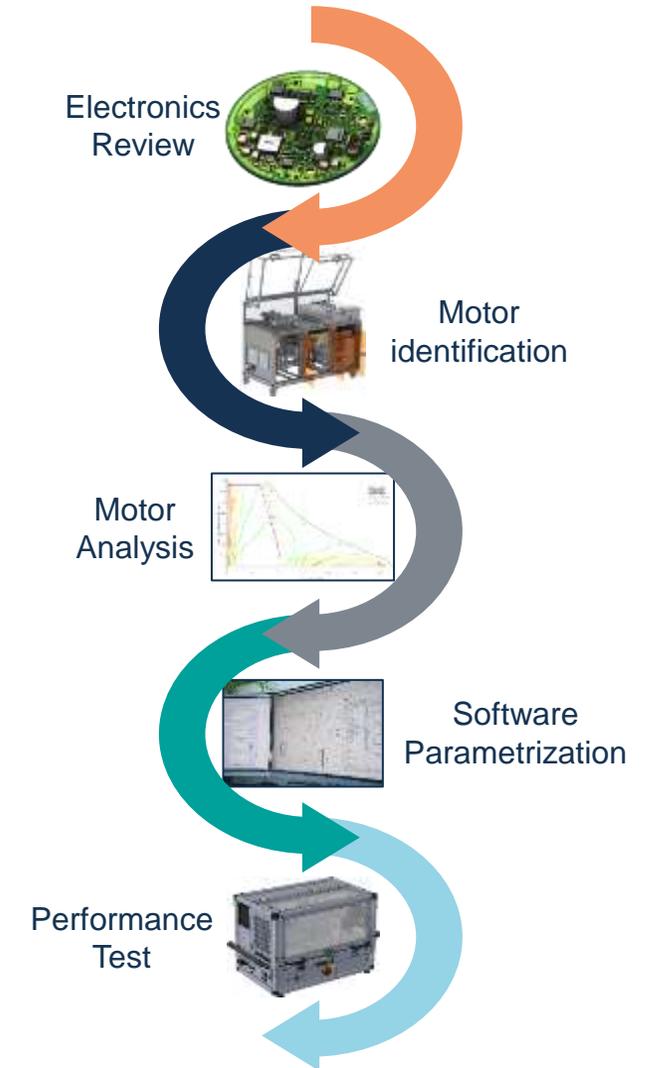
Prototyping -
Rapid prototyping via proof of concept to achieve OEM nomination

⚙ Prototyping

Proof of Concept (PoC) for embedded software, electronics, motor and mechatronic system

Key features

- Target cost development
- PCB design & component selection
- Embedded software demo code for evaluation
- Prototype production (up to 100 PCB or 10 motors)
- Test and evaluation of design, functionality and performance on test bench / lab

Your benefits

- ✓ **Achieve B-sample nomination** from OEM
- 🔍 **Low financial risks** before committing to a full-scale development
- ◎ **Faster time-to-market** by quickly test and evaluation of the concept
- 🔍 Identifying and addressing design issues **reduces development costs**

Mechatronic System Development -
# Efficiently integrate function and volume

Optimized system solution

Architecture based system development to optimize the system design and cover the associated system requirements

Key features

- Functional analysis
- Functional system architecture design
- Technical system architecture design
- System specification

Your benefits

- ✓ **Verification** of the **requirements coverage**
- **Identification** of **system functions and related system requirements**
- **Development** of the **target system design** (avoid over-engineering)
- **Optimized** function and volume **integration**
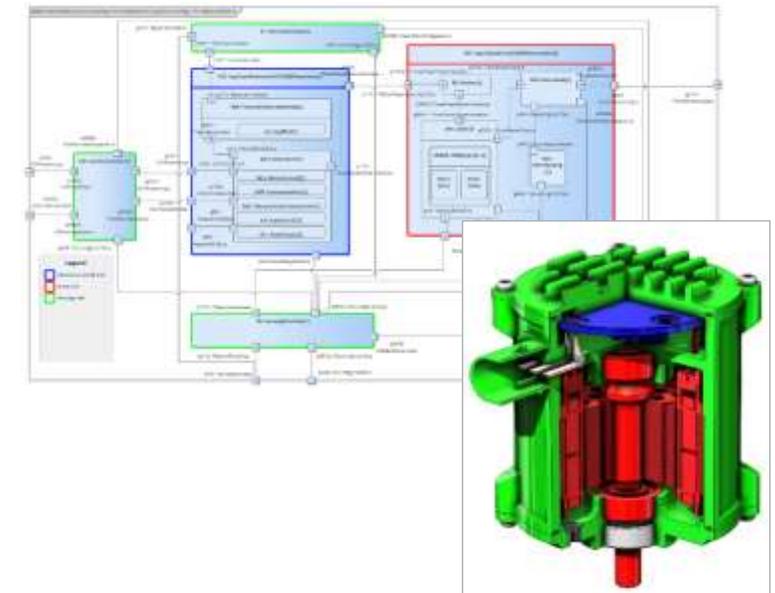
## Concept, design, analysis and motor samples

Concept and design of application-specific motor topology, considering cost efficient magnet material selection and manufacturing of prototypes

Key features

- FEM design of permanentmagnet synchronous motor (PMSM), brushless direct current (BLDC)
- FEM design of synchronous reluctance motors (SRM)
- Evaluation of the best suited motor topology (number of pole pairs, coils, magnetic material)
- Analyzing and benchmarking of existing motors
- Manufacturing of prototyping motors for fast development and test purposes

Your benefits

- ✓ Optimized **mechatronic design approach**
- **Identifying efficiency bottlenecks** in the magnetic circuit, **maximizing material utilization**
- Best suited motor design for application allows **minimized series costs**
- Design data set as starting point for **industrialization**
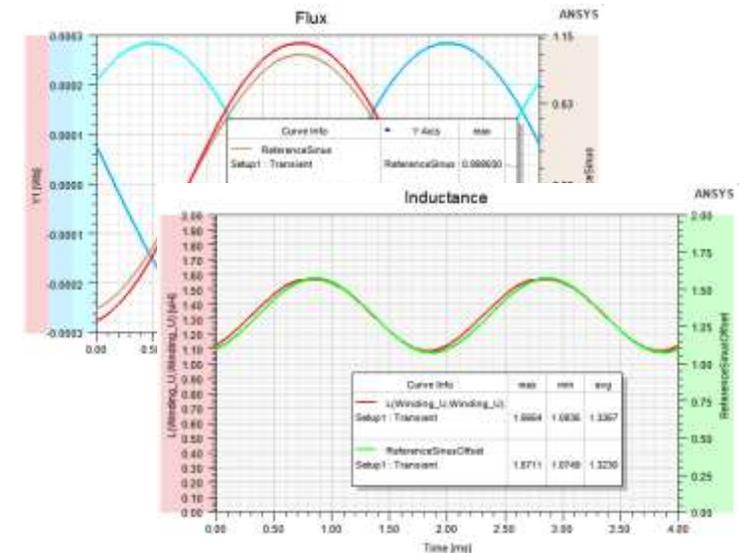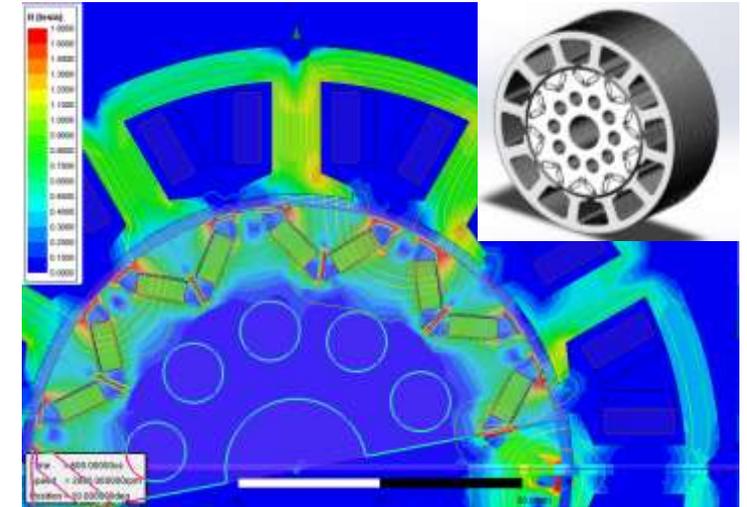
Mechatronic Development - Application-specific electronics design for system integration

## Development of application electronics for fast functional samples

Design of application-specific electronics on functional sample level and manufacturing of prototypes for target system integration

Key features

- Schematic and PCB design
- Application-specific component selection
- Thermal and electrical simulations to validate the design
- Generation of production data and manufacturing of prototypes with EMS
- Electronics initial testing

Your benefits

- ✓ Basis for **price indication** for series production
- Identifying and addressing design issues **reduces development costs**
- **Early integration** of the electronics in the target system
- Design data set as starting point for **industrialization**
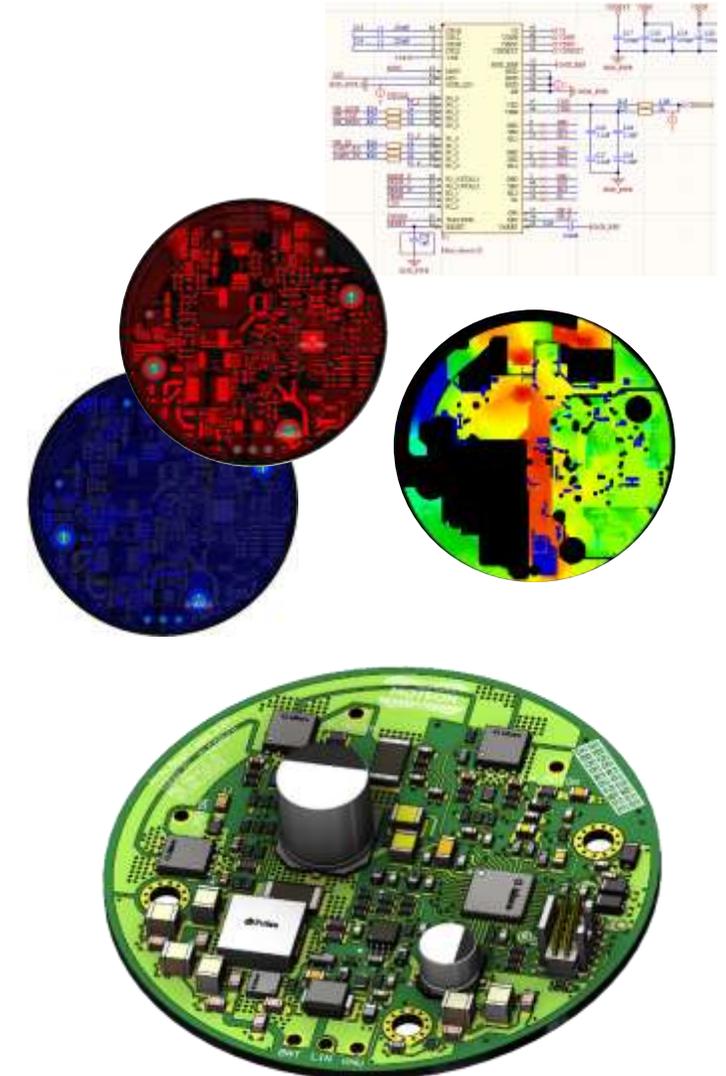
Thermal Simulation as a Service - Early detection of potential design weaknesses

**CFD based thermal simulation to support the system design process**

Mechanical design investigation with the assistance of CFD (Computational Fluid Dynamics) flow simulations enable early detection and optimization of critical thermal paths.

Key features

- Determination of power losses for motor and electronics based on model-based simulations (Matlab)
- Processing of extensive electronics models (Altium Designer) including detailed electrical losses for electrically conductive components and paths
- Simulation of time-dependent heat transfer and dynamic load behavior
- Simulation under realistic environmental and load conditions (consider free/forced convection and radiation)
- Possibility of further processing of results in an FEM strength analysis

Your benefits

- ✓ **Verification of the cooling concept** based on the mechanical system design
- 🔍 **Identification of thermal path weaknesses** still in the design phase
- ◎ **Efficient optimization** by means of targeted design adaptation
- ⚛ **Direct processing of CAD models** possible without time-consuming simplification
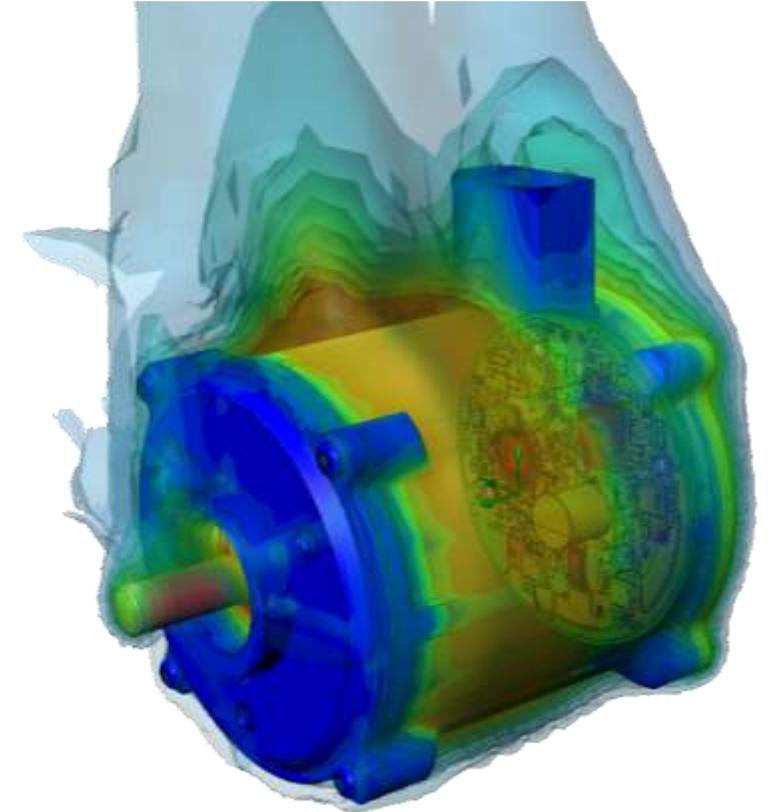
Mechatronic Development -
In-house development and prototyping of system demonstrators

Integration of mechanics, motor, electronics and software into functional samples and system demonstrators

Full in-house mechatronic system development and prototyping capability as well as customer-specific adaption of subcomponents

Key features

- In-house design and prototyping of custom housings and mechatronic components with focus on structure and connection technology for sample systems
- Integration of new electronics into existing customer products as proof-of concept or functional sample for integration tests
- Custom test bench adaption to facilitate measurements of customer-provided systems/motors

Your benefits

- ✓ **Early proof-of-concept, in-house verification** of mechatronics design
- **Evaluation of thermal / electrical / mechanical performance** with real-world data
- **Flexible customer-specific adaption** of subcomponents in existing systems
- **Sample manufacturing** with external partners in case of industrialization topics
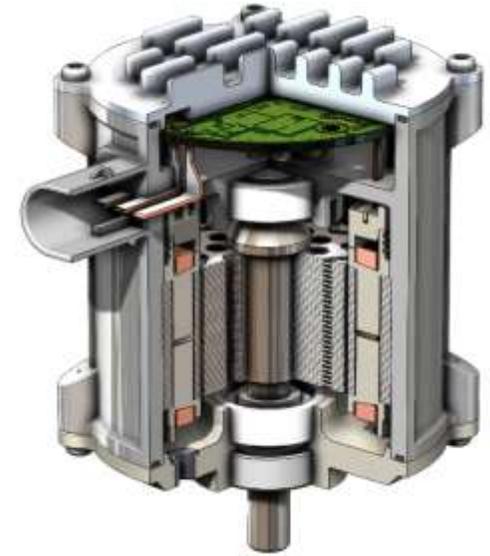
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**Reproducible automated testing for system verification**

Automated Testing & Verification Services
Rapid verification if system and validation of embedded software

Key features

- Emulating load profiles torque = f(speed, position)

- High speed and accuracy of real physical signals and software variables timestamped (50µs)

- Automated Test Report Generation

- Real Time Industrial Motion Controller for load control

- Identification of motor parameters

Your benefits

- ✓ **Rapid verification** of MCTRL algorithms & signal analysis

- Identification of bugs throughout development phase **decrease project risks/costs**

- Efficient parametization to avoid trial & error and **reducing time-to-market**

- **Reproduceable validation** of software adaptions within hours with improved test coverage

- **Automated testing** reduces verification effort by up to 80%
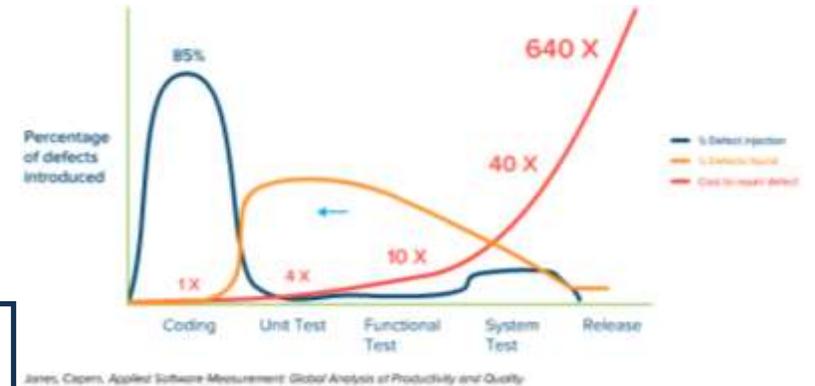
Mobile Motor Test Bench (mMTB) -
The compact way of testing motors and electronics

MCTRL analysis tool with integrated data tracing & debugging

Mobile Motor Test Bench (mMTB)*
Compact motor test bench to **develop and test a variety of motors**

Key features

- Load structure: 1x customer motor with 1x ECU
- DC voltage up to 60 VDC and current up to 50 A with a max power of 1 kW for test objects
- Determine efficiency maps for motors, inverters, and combinations of these components
- Torque up to 1 Nm (peak 2.5 Nm) and speed up to 10,000 rpm
- MOTEON TraceBox integrated

Your benefits

- ✓ **Rapid verification** of MCTRL algorithms & signal analysis
- ⊚ **Root cause analysis** throughout the entire development phase
- ⊛ Compact and robust design **specifically constructed for office use**
- ⚛ **Automated testing** reduces verification effort by up to 80%

*Market availability expected by Q1 2024
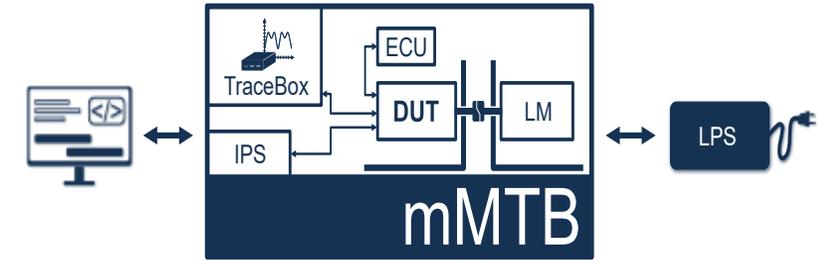
TraceBox -
The easy way of validating motor control software

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⚙ **Software debug & data tracing tool**

TraceBox*
A versatile data acquisition and communication **tool for the development and validation of motor control** (MCTRL) **software** that can be used in conjunction with real target hardware.

Key features

- Data streaming via SPI/UART optimized for low cost microcontroller
- Target communication with various application protocols and interfaces

  lin   CAN FD   EtherCAT.   RS232 COMM   ⟿ USB

- Flashing and debugging via SWD (XMC™ Link functionality)
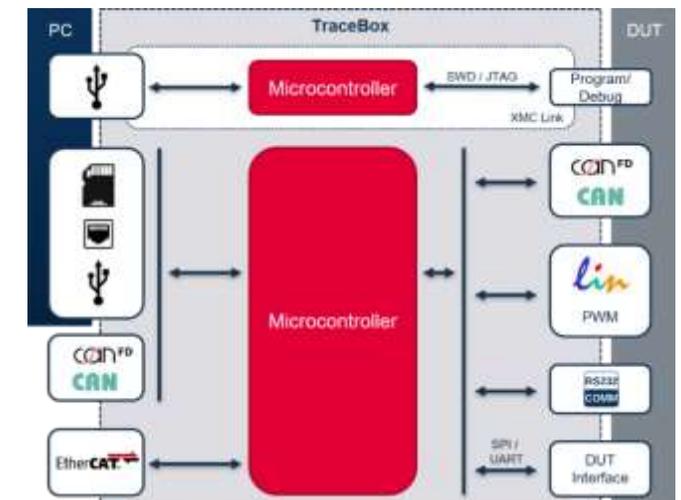- Time synchronization via EtherCAT master in embedded test environments

Your benefits

- ✓ **Verification** of MCTRL algorithms & signal analysis
- 🔍 **Identification** of issues throughout the entire development phase
- 🔍 **Validation** of software adaptions in the ongoing development process
- ⚛ **Direct implementation** in the installed, application-oriented state
- ↻ One **standard device** for various use cases

https://www.moteon.com/tracebox.html

PC — TraceBox — Device Under Test

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www.moteon.com