



 SZÉCHENYI
ISTVÁN
UNIVERSITY

 JKK

JÁRMŰIPARI KUTATÓKÖZPONT
RESEARCH CENTER OF VEHICLE INDUSTRY



Egészség
Kultúra
Innováció
A jövő Győrben épül.

SZElectra



RESEARCH CENTER OF VEHICLE INDUSTRY

The Research Center of Vehicle Industry (Járműipari Kutatóközpont – JKK) is an independent research department of Széchenyi István University, Győr. JKK is committed to improving sustainable mobility, focusing on hybrid and electric vehicles and intelligent transport systems.

MAIN SCOPE OF R&D ACTIVITIES

ELECTRIC AND HYBRID DRIVES

- › Research and development of electric machines
- › Vehicle control development
- › Embedded and auxiliary electrical system development
- › Testing and measurement of vehicle drives
- › Fundamental research of magnetic properties related to motor development

MATHEMATICAL SIMULATION AND OPTIMIZATION

MATERIAL SCIENCE RESEARCH

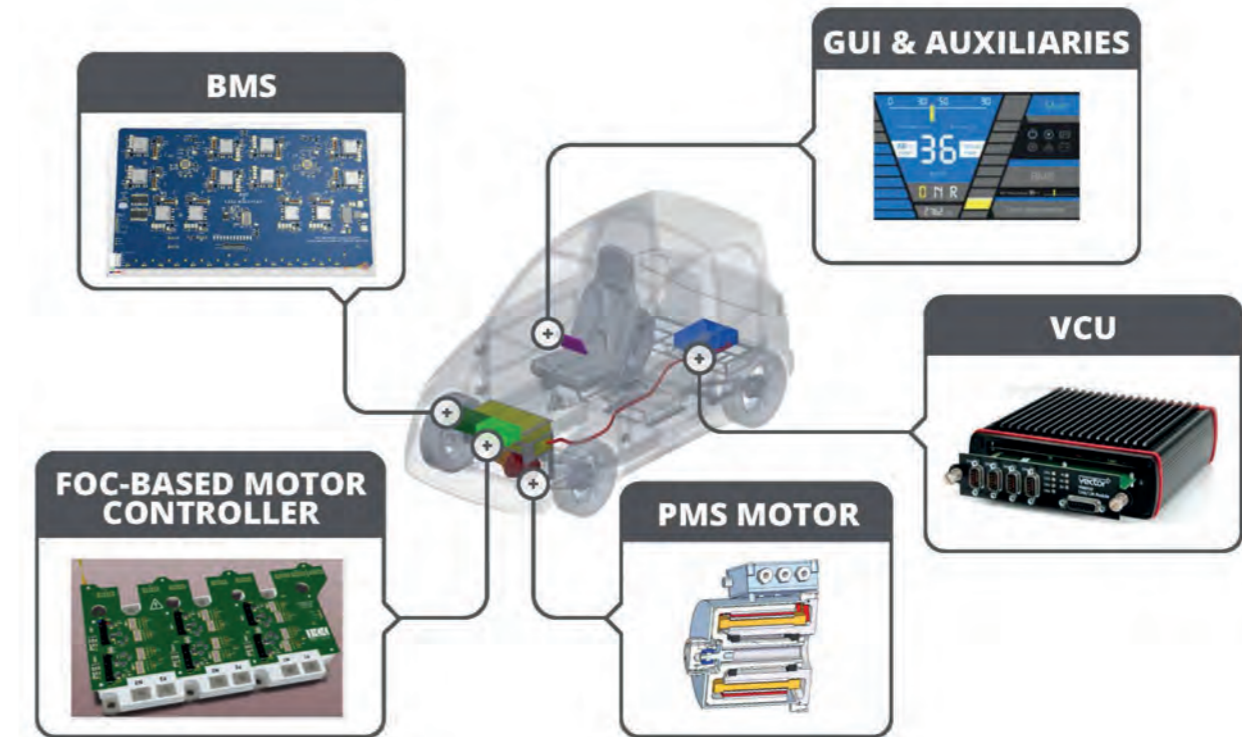
THE MOST IMPORTANT RESEARCH AND DEVELOPMENT PARTNER:

HUNGARIAN ACADEMY OF SCIENCES INSTITUTE FOR COMPUTER SCIENCE AND CONTROL (MTA – SZTAKI)

MAIN ACTIVITIES AT THE RESEARCH CENTER OF VEHICLE INDUSTRY

ELECTRIC VEHICLE DRIVE AND CONTROL SYSTEM RESEARCH AND DEVELOPMENT

This is the most important field of JKK. Further supportive research activities are also related to this area.



RESEARCH ON MATERIAL SCIENCES AND TECHNOLOGY

The JKK performs integrated research in collaboration with the Department of Material Sciences and Technology in the field of automotive materials and manufacturing processes. Its aims are to reduce the weight of the vehicles and simultaneously improve the mechanical properties of the structural components, and support the lightweight construction methods. The main fields of research are as follows:

- › Research of formability characteristics of high strength metal bodywork panels, development of optimized shaping technologies with computer based simulations
- › Applicable polymers, composites, foamed composites and composite foams in automotive industry and the research of recycling these materials.
- › Development of new component manufacturing and rapid prototyping technologies (metal powder die-casting, selective laser sintering - SLS)
- › Research of surface technologies and nanotechnological solutions used in automotive industry.

These activities are backed by modern laboratory infrastructure, which also provides diverse services for external automotive customers of the region.

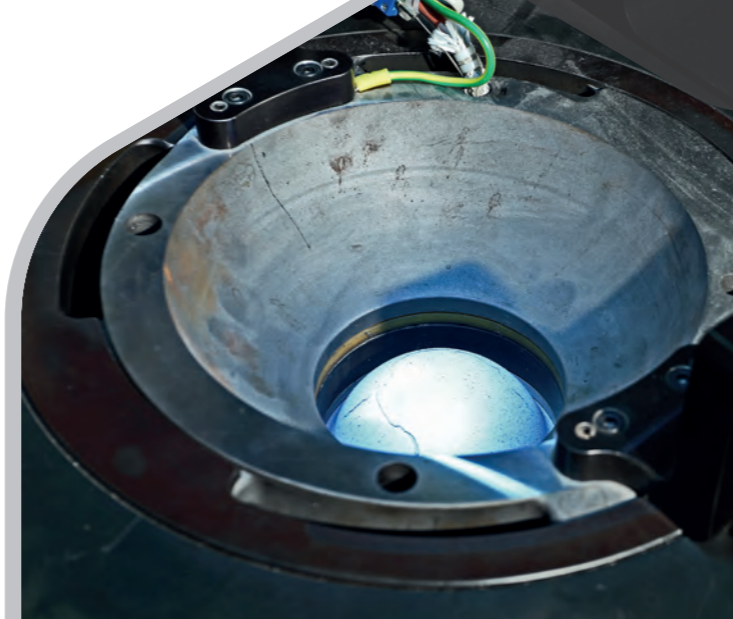
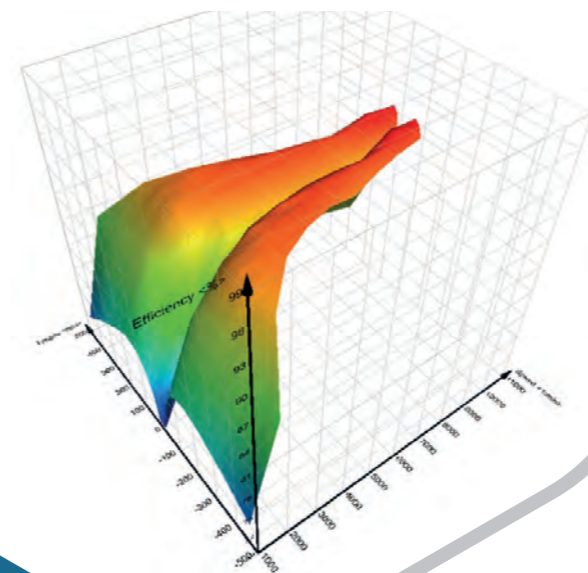
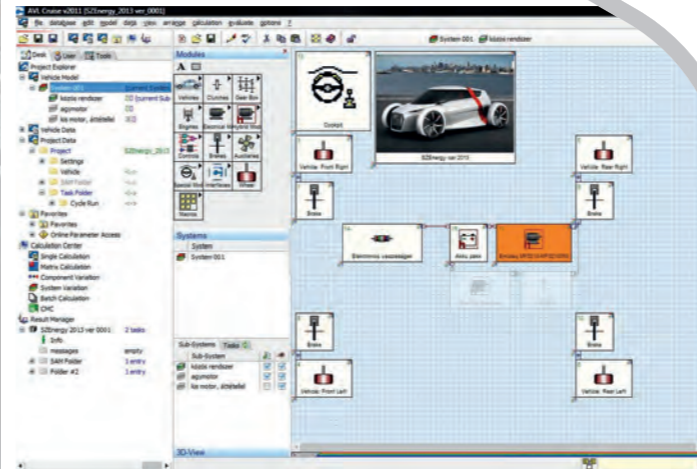


Photo: Károly Matusz



RESEARCH ON ELECTROMAGNETIC PROPERTIES OF ELECTRIC MACHINES

- › Research of the behavior of ferromagnetic materials and their applicability in electric machines
- › Investigation of frequency dependence of magnetic hysteresis, implementation of various measurement configurations
- › Investigation of the Preisach- model and the Jiles-Atherton-model and adjustment of these models for finite element simulations (FEM)
- › Study and implementation of permanent magnet modeling

PRE-DEVELOPMENT OF ELECTRIC MACHINES

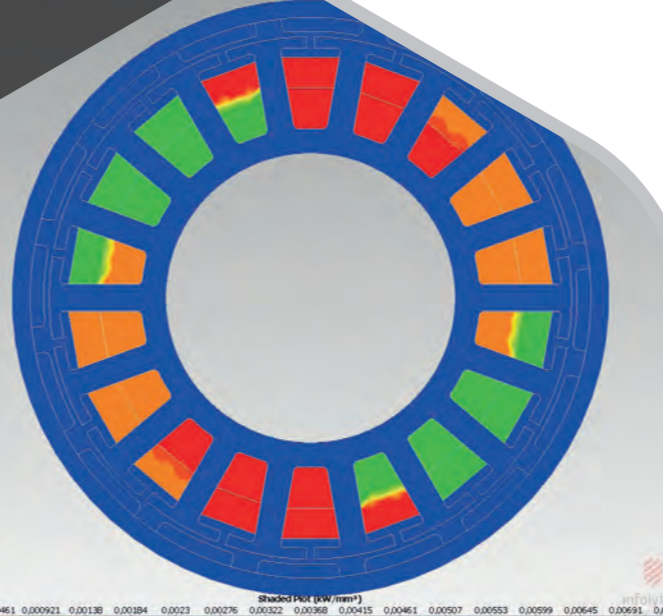
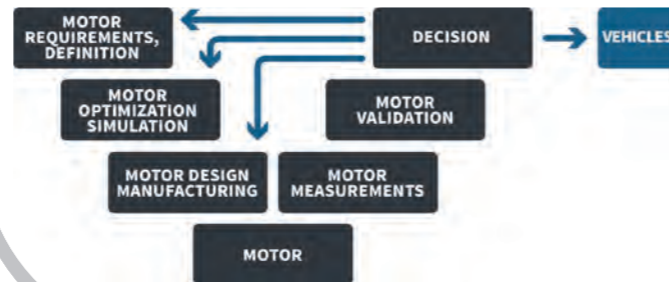
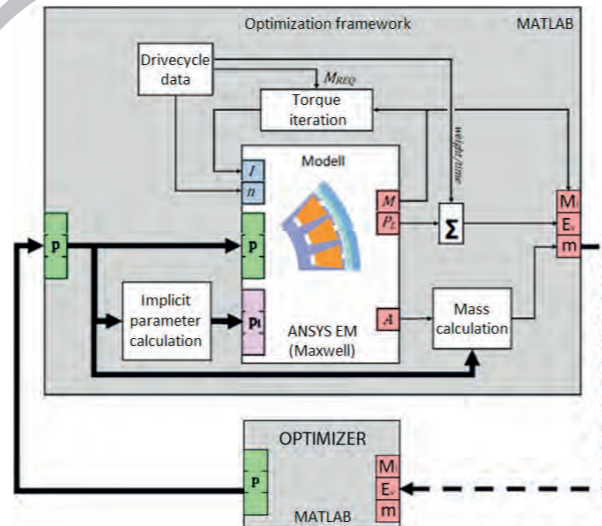
Design requirements of electric machines are determined by different simulation methods. The simulations are based on standard and measured drive cycles.

These simulations are applied for evaluation of vehicle drivelines in operating conditions. AVL Cruise and MATLAB/Simulink software environments are applied which are capable of rapid modeling and also suitable for integrating other simulation models.

RESEARCH AND DEVELOPMENT OF ELECTRIC MACHINES

This research aims to design electric machines and drive systems which are optimized for certain applications. The optimization procedure minimizes the weight and the energy consumption of the electric drive system (e-motor and optionally attached gearbox). There activities are focused on the development of permanent magnet synchronous machines.

We develop an optimization framework in-house, which determines energy consumption and weight of the drive system using simulation methods. This enables us to minimize consumption and weight of the drive system by changing its properties (for example, we may change the geometrical parameters of the electric machine).



Using this method, design of the electric drive system can be automated. The framework is an open architecture software which is extendable by additional functionalities that allows further criteria to be added to the optimization process. Such criteria may include the thermal and noise properties of electric machines.

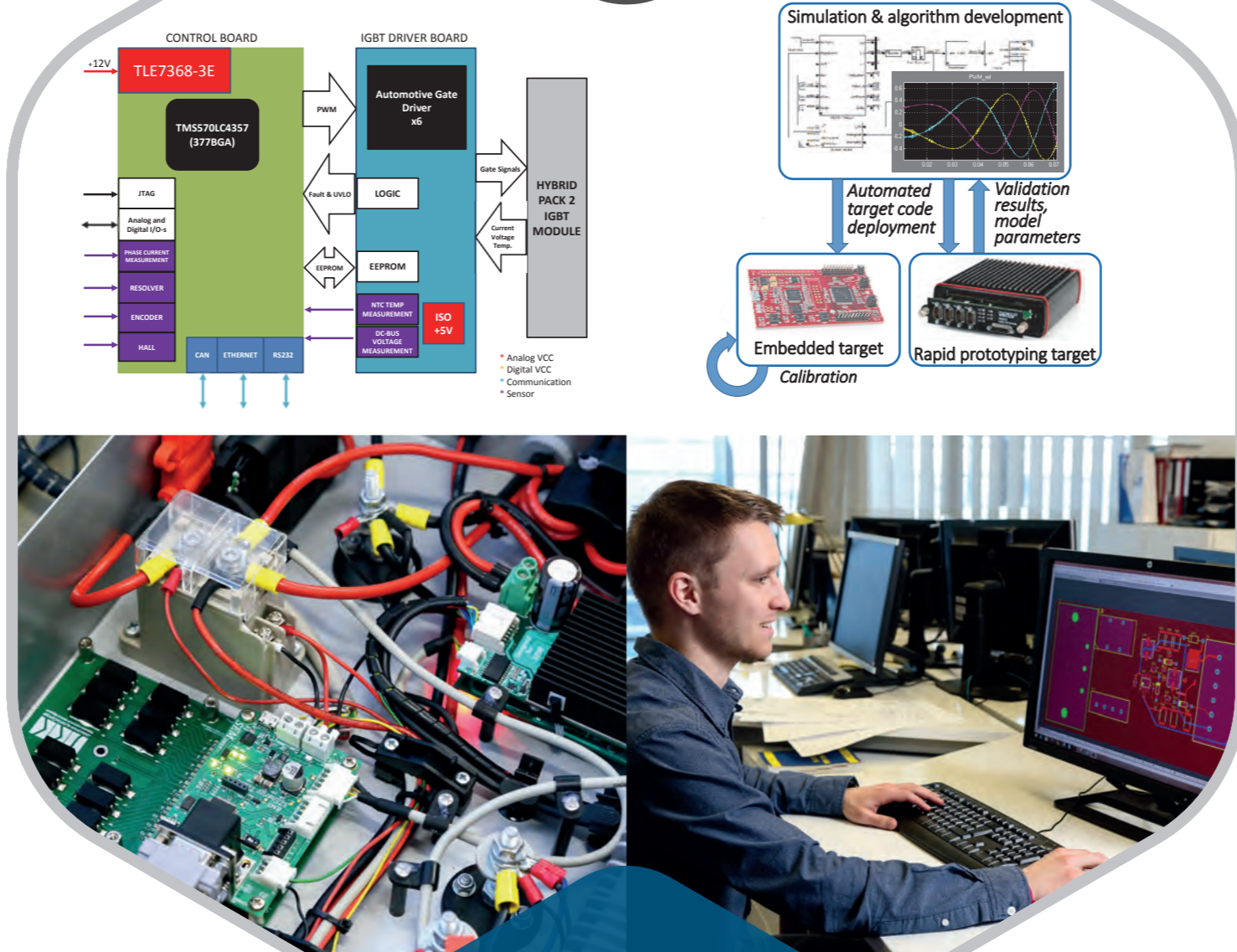
The optimization process defines the main parameters of the electric drive system, which are used for geometric dimensioning, tolerancing and manufacturing of prototypes. Prototypes are tested and validated on the test bench. After successful tests the electric drive system is integrated into its application environment, for example, in a prototype vehicle.



MOTOR CONTROL DEVELOPMENT

The aim of motor control development is to create controller prototypes for R&D purposes which are suitable for powering and testing e-machine prototypes or can be integrated in experimental vehicles.

The developed motor control system is modular, consisting of a microcontroller-based electronic control unit and a power electronics unit. The control electronics unit is universal and the power electronics unit is scalable according to requirements. Different power levels can be realized: 50VDC / 50A, 250VDC / 50A, 400VDC / 1000A.



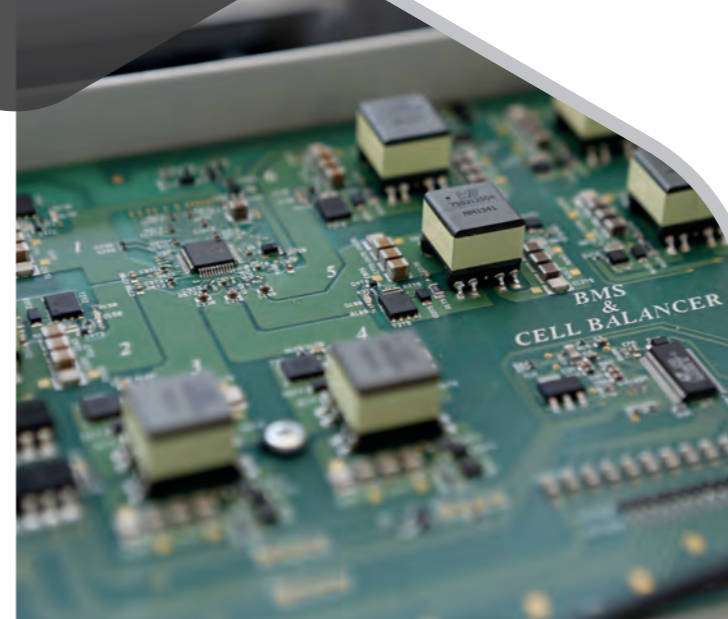
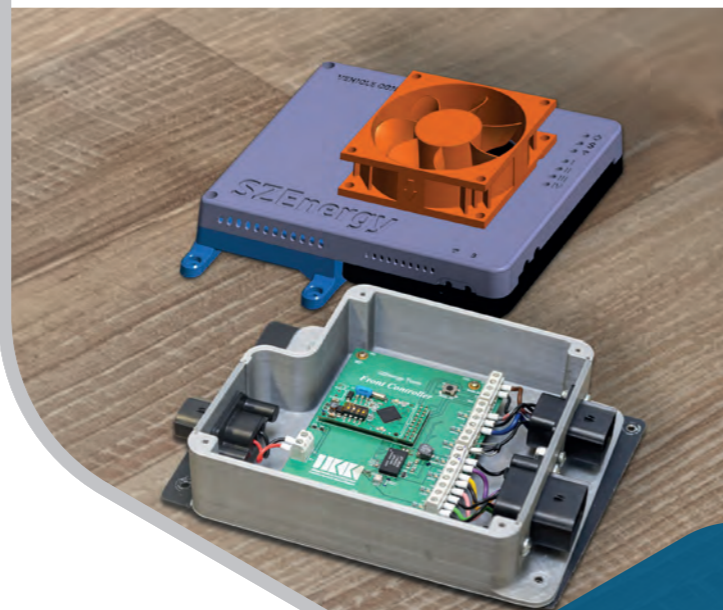
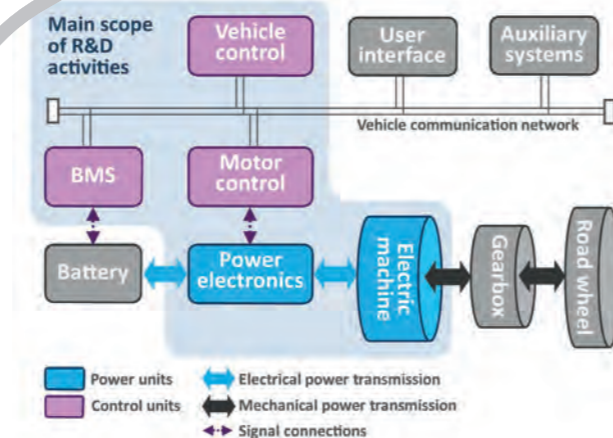
The control electronics unit is based on the Texas Instruments TMS570 microcontroller family which is suitable for safety-critical automotive embedded applications too.

We develop the application software using model-based development methods. The field-oriented current control algorithm, which controls the electric machine, has been implemented in MATLAB/ Simulink environment where we can verify its correct operational behaviour too. After the functions are verified by simulations, we generate the target code using automated methods and integrate it into the embedded system. Finally, we validate and test the motor controller on test benches.

VEHICLE CONTROL UNIT R&D

The aim of vehicle control systems development is to implement embedded systems, which can help to control the vehicles. The development is focused on driveline control functions and include algorithms, software and hardware improvements. The vehicle control algorithms are developed in MATLAB/Simulink environment using model-based design methods based on vehicle simulations. The development of hardware, additional software and communication system (CAN network) is done in such a way that an open, flexible and universal hardware and software platform is provided for future developments. These R&D activities are performed in cooperation with the Hungarian Academy of Sciences Institute for Computer Science and Control.

Our team recently initiated a research project on autonomous vehicles, where we express strong interest to involve fellow researchers.



DEVELOPMENT OF ENERGY STORAGE SYSTEMS

For in-vehicle electric drive systems a well-suited energy source is needed. Thus, development of low voltage and removable battery packages is also ongoing.

The goal is to develop the housing, charging and discharging control system (48V 12 Ah and 40 Ah nominal capacities) and removable battery pack for prototype vehicles. The in-house developed battery management system (BMS) may perform active or passive cell balancing.

DEVELOPMENT OF AUXILIARY ELECTRICAL SYSTEMS

USER INTERFACE

We develop user interfaces for prototype vehicles and measurement control systems. These systems run in-house developed software on real-time computers and allow the monitoring of electric drive systems under various operating conditions.

Our custom remote monitoring system (telemetry system) can run real-time tests on experimental vehicles during operation. The system is capable of bidirectional wireless communication (WiFi, 3G) and transmits on-board data to a database server. The received data can be analyzed and interaction with the monitored system is also possible.

CABLE HARNESSES

We develop custom cable harnesses for electrical systems of prototype vehicles.

RESEARCH OF SOLAR CELL APPLICATIONS

JKK also develops solar chargers for vehicle batteries. These activities include the development of assembly, measurement and charge control of solar cells placed on or outside the vehicles.



RESEARCH INFRASTRUCTURE

JKK possesses the necessary infrastructure for its research activities, the main equipment being electric motor test benches. Using these test benches we can verify the operating properties of electric machines by measuring their torque-speed characteristics and efficiency under various load conditions. Due to the modular design of the test benches, electric motors in different type, size and voltage level can be measured. The measurement control system is capable of autonomous operation and it is possible to measure the electric machines according to predetermined drive cycles or real-time simulations.

MEASUREMENT SYSTEM FOR HIGH POWER ELECTRIC MOTORS

- › Maximum power supply voltage: 600 V DC
- › Maximum measurable torque and speed ranges: ± 1000 Nm, ± 12000 rpm
- › Maximum measurable current and voltage ranges: ± 1000 A, ± 1000 V
- › The system is capable of regenerative braking
- › Test bench control and measurement data acquisition is done by a real-time computer which can handle sensor interfaces, run a real-time operating system and in which additional features can be integrated besides the control functions (e.g. real-time simulations).

MEDIUM POWER ELECTRIC MOTOR TEST BENCH

- › Maximum power supply voltage: 48 V DC
- › Maximum measurable torque and speed ranges: ± 100 Nm, ± 6000 rpm
- › Maximum measurable current and voltage ranges: ± 100 A, ± 48 V
- › The system is capable of regenerative braking
- › Test bench control and measurement data acquisition is done by a real-time computer which can handle sensor interfaces, run a real-time operating system and in which additional features can be integrated besides the control functions (e.g. real-time simulations).



LOW POWER ELECTRIC MOTOR TEST BENCH

Suitable for measurement of electric machines under 2 kW power level. Fast, medium accuracy measurement of battery powered electric motors can be performed with maximum 50 V DC power supply voltage. Measurement data acquisition is automatic. Maximum measurable torque is 200 Nm, the highest rotational speed is 5000 rpm.



IN-HOUSE DEVELOPED PROTOTYPE ELECTRIC VEHICLES WITH OPEN ARCHITECTURE

Prototype vehicles built by JKK utilize the previously presented in-house developed custom subsystems like electric machines, control and communication systems and many others. Our vehicles provide open development platforms on which these subsystems can be integrated and validated.

E-VAN

- › Diesel-electric hybrid van with in-house developed 2x30 kW synchronous motors, vehicle control and on-board communication system.
- › Custom lithium-ion battery system with 16 kWh capacity and 400 V nominal voltage which consists of removable battery packages with 50 V nominal voltage.

SZELECTRA (FRONT PAGE)

- › L7e category, battery electric urban vehicle for two persons with custom 15 kW permanent magnet synchronous motor and control system.
- › Custom vehicle control unit and user interface.

SZENERGY - SZELECTRICITY (BACK PAGE)

- › Shell Eco-marathon urban concept, battery electric racecar. Every main subsystem of the car is in-house developed.
- › Permanent magnet wheelhub motor with external rotor, field-oriented motor control system, 48 V 12 Ah nominal capacity removable lithium-ion battery pack, custom vehicle control unit, telemetry, driver assistance system, LIN-O-DC and CAN communication, custom space-frame, carbon body panels.



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SZElectricity

