COSIVU

compact, **s**mart and reliable dr**iv**e **u**nit for commercial electric vehicles

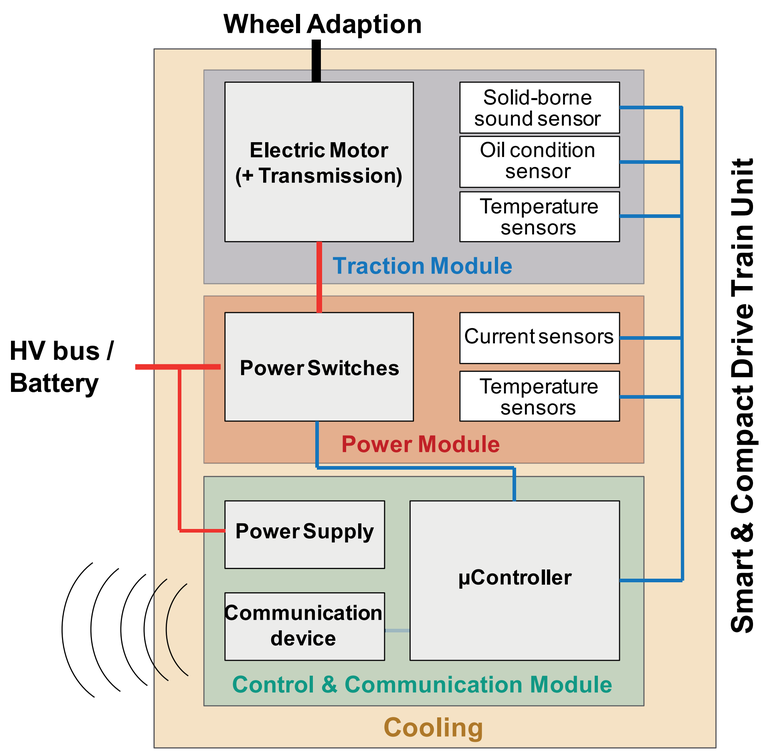
SEVENTH FRAMEWORK PROGRAMME

The project 'COSIVU' aims at new system architectures for drive-train by developing a smart, compact and durable single-wheel drive unit with integrated electric motor, compact transmission, full SiC power electronics (switches and diodes), a novel control and health monitoring module with wireless communication, and an advanced ultra-compact cooling solution.

Project Objectives

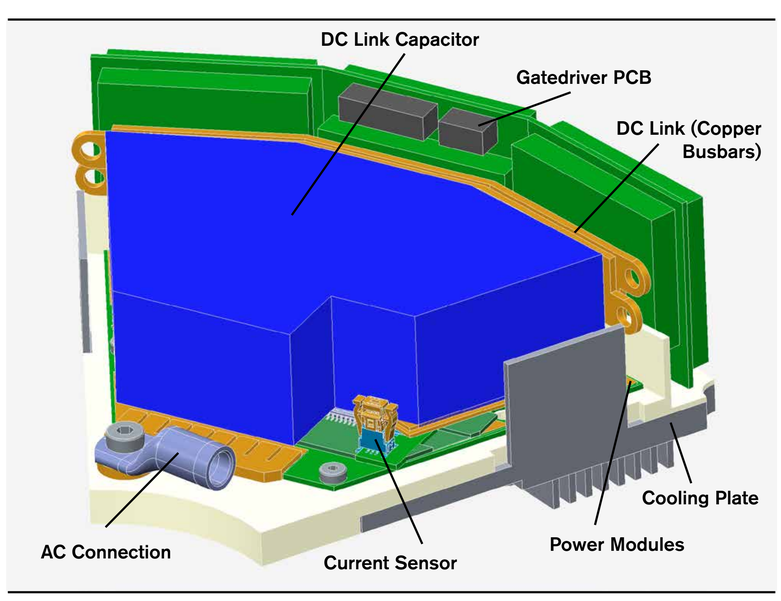
Development of a Compact & Smart Drive for Commercial Electric Vehicles:

- Substitution of the central drive train by compact and smart drives attached to the individual wheels coordinated and controlled by a central computer and wireless communication
- One system package for the wheel motor, its simple transmission, and the inverter modules
- Sensors, signal conditioning, microcontroller, and software for Functional and Health Monitoring of the motor/transmission and the inverters
- Closed loop control based on the sensor signals - at three stages: local (= within the smart drive unit), global short-time and long term (employing the central computer and wireless bi-directional communication)



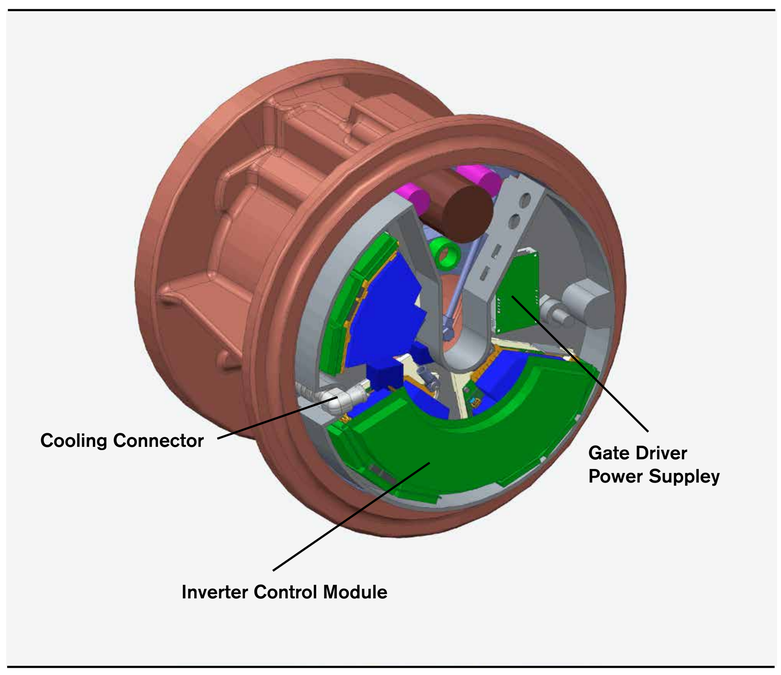
Results

During the first twelve months of the project the COSIVU system architecture concept has been developed and a highly modular packaging concept was chosen for the power stage, using "Inverter Building Blocks" (IBB). The IBB is a mechanically self supporting structure containing an aluminum cooling plate, three Power Modules in parallel, one AC current sensor, one DC link Capacitor and one Gate Driver PCB.



For the IBB, different designs have been evaluated regarding the placement and form factor to find an optimum between the different requirements of the components. Identification and documentation of critical components with respect to reliability and durability has been done as well as collection of input for the reliability model. The Figure above shows the mechanical layout of the IBB.

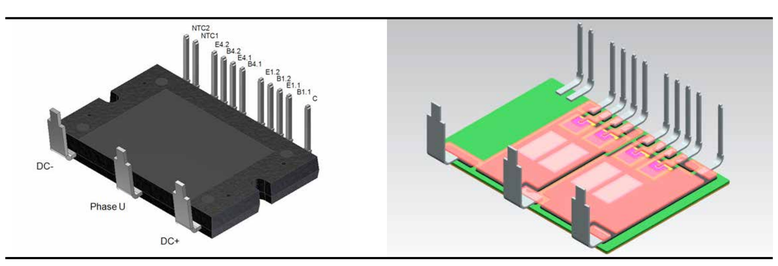
For integration in the wheel motor housing the COSIVU Inverter has been designed to interface with the commercial vehicle wheel motor as shown schematically in the figure below.



The Inverter will be adapted for the passenger car integration for a wheel motor developed within the project: The electromagnetic core for direct drive motor for passenger car application giving continuous torque output of 800Nm and over 90% efficiency even at very low RPMs has been developed by Elaphe. Electric motor control algorithm concepts have also been developed for both applications.

SiC components

SiC BJTs and diodes have been selected and production of packaged SiC devices has started at Fairchild. The double sided cooling concept investigated by Swerea IVF in the project will have the same pin configuration.



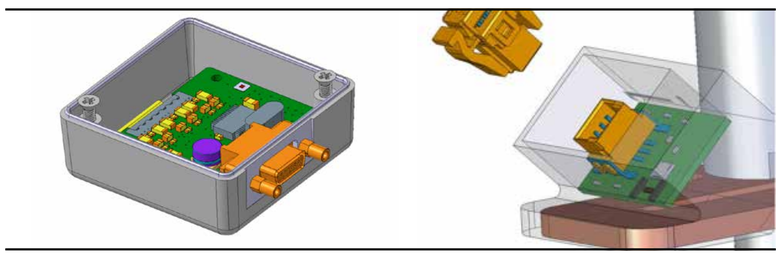
Theoretical design of new driver solutions has been done by TU Chemnitz with the following changes/improvements:

1. Proportional drive
2. De-saturation Detection
3. Zener Charge Pump (against parasitic turn-on)
4. Paralleling

A thermal investigation setup has been designed by Fraunhofer ENAS and Nanotest for the thermal characterization of SiC modules.

Sensors

Hella has delivered the first sample of the solid-borne sound sensor (below left) and also started the development of an advanced oil condition sensor that will be applied to wet brake oil monitoring.



Several space saving current sensor packaging concepts have been designed by Sensitec (above right) and will be evaluated further before final selection

Overview project partners & their main roles	
swerea IVF	Project coordination. Novel heat removal solutions – technology and material development,
VOLVO	Definition of Requirements, providing of In-Wheel motor, functional testing of developed demonstrator
TranSiC FAIRCHILD	1200 V SiC bipolar junction transistors and SiC-based Power modules
HELLA	Health monitoring (solid-borne sound sensor, oil condition sensor), µController programming
SENSITEC	Current sensors (anisotropic magnetoresistive - AMR effect)
elaphe	Overall system integration & optimization (design, prototyping, testing, ...), transfer of COSIVU architecture to an alternative direct drive electric motor version for other vehicle platforms
NANOTEST Berliner Nanotest und Design GmbH	Material characterization (for FE-Simulations), thermal characterization, failure analyses
Fraunhofer	**ENAS:** Electrical & thermo-mechanical reliability assessment, by combining FE-Simulation with accelevated reliability testing **IISB:** Power module system integration, development of gate driver stage
TECHNISCHE UNIVERSITÄT CHEMNITZ	Functional & health monitoring based on thermal impedance spectroscopy and current sensing + dv/dt flank control

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swerea IVF