

MotorBrain – “Nanoelectronics for Electric Vehicle Intelligent Failsafe PowerTrain”

ENIAC Project, 2011 – 2014, addressing SUB-PROGRAMME 2, 4 Semiconductor, Automotive, Industrial, Avionic

Project and consortium presentation: The project is run under the auspices of ENIAC JU - a public-private partnership focusing on nanoelectronics. The overall objective is to develop sustainable drive train technologies and control concepts / platforms for inherently safe electric vehicle (EV) *powertrains*. The project focuses on significant steps ahead in terms of:

- Overall energy efficiency of EV powertrains shall be improved by 20% (from currently 60% to 72%).

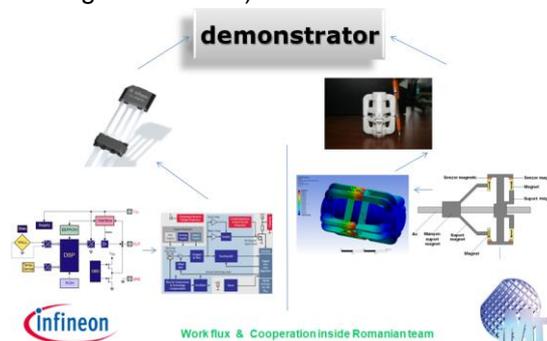
- Development of novel, intrinsically failsafe electrical powertrain concepts and passive components comprising high efficiency torque-dense motors fully integrated with power converters and storage systems for modularity, compactness, reliability and low cost with improved recyclability and less dependency on rare-earth magnets.

- Innovative EV architectures, and sensing and microcontroller concepts / platforms capable of achieving intrinsic fail-safe behaviour of the powertrain and energy management in order to enhance the overall reliability and safety of EVs: Safety will be improved through redundancy by using multi-core ECUs (on the macro level) through distributed control using intelligent sensors. Intelligence will be enhanced through embedded software in a highly distributed control system, taking into account the interaction between hardware and software within the physical environment (i.e. the propulsion and energy management systems, respectively).

The project will address the challenging research on power and high voltage electronic systems as well as smart miniaturized systems up to the subsystems, systems and vehicle demonstrators, encompassing the full supply chain of electric drives for EVs.

The consortium comprises 30 partners from 9 countries: Infineon Technologies AG (coordinator, dr. Reiner Jon), Volkswagen AG, OFFIS Institute for Information Technology, University for Applied Sciences Amberg-Weiden, Technical University Dresden (ILK), Seuffer GmbH, Infineon Austria, AIT Austrian Institute of Technology GmbH, FH Joanneum, AVL List GmbH, Siemens AG, ZF Friedrichshafen AG, Brno University of Technology, Institut mikroelektronických aplikací s.r.o., Centro Ricerche Fiat S.c.p.A., STMicroelectronics srl, Politecnico di Torino, Kemet Electronics Italia, ROBOX, Istituto P.M. s.r.l, Infineon Romania, IMT-Bucharest, Green Power Technologies S.L., Universidad de Sevilla, Höganäs AB, QinetiQ Ltd, The University of Sheffield, NXP Semiconductors BV, TNO, Egston System electronics Eggenburg GmbH.

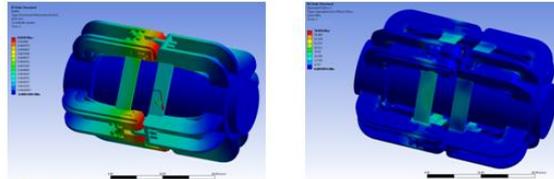
Role of the Romanian team: The Romanian team comprises IMT-Bucharest (National responsible) and Infineon Technologies Romania (Supply Chain SC6 responsible). Its role is to devise, design and make a demonstrator of a torque sensor (IMT-Bucharest) by using magnetic field sensors (designed and realized by Infineon Technologies Romania).



As results, we mention: a) torque sensor based on the magnetic field → devised, simulated and realized in beta version (polymer); b) torque sensor based on optical signal → devised and simulated, it can “amplify” the torque angle; c) torque sensor based on nanostructures → devised, preliminary simulations made that show an extremely high accuracy (0,1 % and better). Current work is performed toward the realization of the metal version for use on a real system (car).

The torque sensor based on the magnetic field has the following specifications:

- Accuracy: 1 %
- Redundancy: 4 sensors are considered
- It discriminates between torque and other mechanical solicitations
- It compensates for: a) angular acceleration (confused with torque); b) magnetization variation (temperature, mechanical stress); c) effect of external magnetic fields
- Is resistant to centrifugal forces (up to 10.000 rpm with a safety factor of at least 3).



ANSYS simulation of the torque sensor behaviour under the action of centrifugal force at 10.000 rpm. Left: radial displacement; Right: von Mises stress.



Beta version of the torque sensor (sensing part) made by Rapid Prototyping

First experimental tests on the polymer model are successful

Research infrastructure used within the project: The infrastructure used comprises items purchased during the run of several national research projects (case of IMT) under Programmes such as „CEEX”, „Capacities”, „Partnerships” and is formed by software programmes (ANSYS MultiPhysics, COMSOL, MATLAB – Simulink, SolidWorks), respectively technology equipments (3D Printer SLS EOS Formiga P100). As regards Infineon Technologies Romania, they used software packages (MATLAB – Simulink, COSIDE SystemC IDE, Infineon proprietary Inway, Microsoft Visual Studio) as well as characterization tools from the in-house laboratory.

Human resources involved in the project: The IMT team comprises 4 researchers (3 physicist – 1 with PhD plus 1 engineer), while the Infineon Technologies Romania team comprises 4 researchers (4 engineers), plus the support team.

Results impact with respect to scientific community and Romanian society: The first impact is represented by the increase of the visibility of the Romanian researchers at the European level. On the other hand, results can be applied to different fields where torque measurement is necessary (motors, wind turbines, heavy-duty machines having high torque, etc.). The aim is to optimize the respective machines in order to ensure a better efficiency and a firmer approach towards environment-friendly systems. Such sensors can be applied in the national economy, for example by Softronic SA (producer of electric traction machines at Craiova).

Integration of the Romanian team within international research networks: The Romanian team was invited to join another ENIAC project that is now under evaluation. Contacts have been established by IMT project leader with some of the new consortium partners for entering in Horizon2020 projects. On the other hand, discussions are now under way for collaborations in other European projects with some of the partners of the consortium.