Cluster for Application and Technology Research in Europe on NanoElectronics

PROJECT RESULTS

CA310 | Resolving electromagnetic compatibility and reliability issues benefits electric vehicle and automotive and semiconductor industries alike [EM4EM]

This project handled important design challenges with electric and electronic components associated with building electrically operated vehicles. Typically, it deals with electromagnetic compatibility and electromagnetic reliability issues of communication units, which resulted in a significant reduction in electromagnetic emission generated by electric powertrain components.

Designing and developing electrically operated vehicles (EVs) bring with them huge design challenges with electric and electronic components. Electromagnetic compatibility and electromagnetic reliability of communication units, for example, will require a significant reduction in electromagnetic emission generated by the electric powertrain components. What is needed, in short, is for the automotive and semiconductor industries to provide solutions that offer noise immunity in nanoelectronic components and electronic modules.

Holistic approach to electromagnetic compatibility and reliability

Taking a closer look at the technical issues, we see that the close vicinity of high field strength from high-voltage cables and electric motors, and sensitive high-density electronics, requires a holistic approach to electromagnetic compatibility (EMC), respectively electromagnetic reliability (EMR). To complicate things further, the commonly used shielding effect of the car's metal case will disappear due to lightweight designs using carbon fibre cabinets, for example. Furthermore, the introduction of the electric powertrain establishes new voltage and power levels in the vehicles. Therefore, suitable EMC/EMR design and related measures, not previously dealt with in a structured manner, are required.

EM4EM tackled these problems by, firstly, introducing solutions that dealt with noise immunity issues with nanoelectronic components (such as ICs, sensors and power devices) and electronic modules needed in future developments in the automotive and semiconductor industries; and secondly, by introducing methodologies to reduce electromagnetic noise-emission generated by power electronic components, modules and systems, and to increase, on the other hand, the noise immunity of sensor systems. Notably, the project also improved time-to-market and cost efficiency.

Key project results were as follows:

- A new IGBT module design using a symmetric H & L bridge layout demonstrated a further reduction, on the semiconductor level, in noise levels of up to 15 dB at low frequencies (less than 10 MHz);
- A new bulk current injection (BCI) setup for measuring an extended frequency range between 100 kHz and 400 MHz was developed;
- On the component level, a new ringing active control method for PWM driver transistors (based on ringing measurement but without time-consuming calculations based on a fully adaptive algorithm) was developed and tested;
- Innovative new algorithms for tuner integrated EMI (electromagnetic interference) suppression for AM, FM and DAB broadcast services were developed and integrated on a system and vehicle level;
- Most recent measurements show that the SNR was improved by about 10-25 dB. Integration and demonstration activities with a European chip supplier are underway;
- A new measurement methodology to define initial EMR conditions for HEV/PHEV/EV was introduced. A mandatory part was the research on the material level to qualify suitable lightweight materials (like carbon fibre reinforced polymers) for weight reduction, and to ensure electromagnetic shielding behaviour. These are essential for addressing environmental challenges of CO2 emission.

For validation and further exploitation purposes, a set of 26 demonstrators on all four application tiers – semiconductor, component, system and vehicle – were developed to be used in initial products based on EM4EM-developed technology. This included a complete demonstrator based on a test EV called the eBuggy. It consists of real EV components and cables, and offers easy access to all relevant parts of the vehicle. Furthermore, the eBuggy will continue to be available to EV developers to do further investigation and analysis work in a realistic EV environment.

PROJECT CONTRIBUTES TO

- Communication
- Automotive and transport
- Energy efficiency
- Design technology
- Process development
- Manufacturing science

PARTNERS

AUDI AG
Daimler AG
Infineon Technologies AG
Conti-Temic microelectronic GmbH
Robert Bosch GmbH
NXP-Semiconductors Germany GmbH
ZUKEN GmbH
ELMOS Semiconductor AG
Leibniz Universität Hannover
Friedrich Alexander Universitaet Erlangen-Nürnberg
Technische Universität Dortmund
CTU – Czech Technical University Institut of Microelectronic Applications Ltd.
VTT Technical Research Centre of Finland
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COUNTRIES INVOLVED

Germany
Czech Rebublic
Finland

PROJECT LEADER

Jörn Leopold
AUDI AG

KEY PROJECT DATES

March 1, 2013 - March 31, 2015

Centre of expertise and influence

In handling important areas of nanoelectronics development and EMR research, and new methods to improve electrical vehicles and industrial electronic systems, EM4EM not only resolves key technical problems affecting EVs; it will also have some potentially beneficial (commercial) spin-offs. For example, its target to reduce the overall EMR development effort will increase the competitiveness of the European automotive and semiconductor industry on the world market, as will reliable operating-equipment integration, optimisation, safety and robustness, main project objectives. Importantly, the project consortium will also influence other key EV development and production activities and processes, and its drive towards European co-operation will accelerate acceptance and implementation.

Healthy markets

Now, EVs require a huge variety of new electronic functions in propulsion, diagnostics, driver-support, navigation and vehicle-to-grid communications. Taking advantage of these innovative market opportunities requires the special expertise and experience found in semiconductor manufacturers participating in EM4EM. And the trove of project deliverables – including tried-and-tested models, measurement methods and procedures, together with simulation tools and methods – can be used by other European businesses to reduce the time-to-market and costs of EMR-optimised components and systems for EVs. And demonstrators will help third parties integrate these results quickly into new products, helping European industry deal with EV components and systems, and related products.

Project deliverables will also secure and expand European companies in the automotive industry, as well as, preserve – or even increase – employment in Europe and ensure a stable R&D. The market for EV-related products and services – including those deploying EM4EM competence and deliverables – will grow. By 2020, there will be a market for more than 13m electric vehicles requiring multiples of electronic components (compared to today's combustion-engine vehicles), and providing a huge potential for system and semiconductor manufacturer or supplier. Power semiconductors and modules, in particular, will experience a tremendous economic boost in the upcoming years. The semiconductor market for hybrid- and battery-electric vehicles with annual growth rates of 25%, is expected to increase to US$5.5 billion in 2020, reaching about 15% of the overall automotive and semiconductor markets.

And the added-value from electronics in cars will continue to grow steadily, with the share in the value of cars rising to 32% by 2015, thanks to the electrification of the powertrain and cost- and energy-efficient car technologies. In addition, time-to-market will get shorter as productivity from these new technologies kicks in much faster. And, at an annual growth of around 10%, the total automotive-electronics market will stay very attractive in the future.

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