

HiEFFICIENT

Highly EFFICIENT and reliable electric drivetrains based on modular, intelligent and highly integrated wide-bandgap power electronics modules

Challenges and objectives

HiEFFICIENT aims for a resource-efficient and decarbonized transportation system, supported by using highly reliable and integrated wide-bandgap technologies in electronic power circuits and systems of electrified vehicles and charging infrastructures. The HiEFFICIENT objectives address

- the integration of wide-bandgap power electronics from component to system level achieving a volume reduction of 40%,
- efficiencies greater than 98% and a reduction of losses by 50%, and
- an increase in reliability towards 20% longer lifetime.

Therefore, novel System-in-Package (SiP) and System-on-Chip (SoC) concepts as well as Printed Circuit Board (PCB) integration technologies have been investigated to reduce the volume and increase the efficiency. Another focus was on enhancing reliability for power electronics hardware by means of new control and sensing concepts for power modules and developing a comprehensive Prognostic Health Management (PHM) framework.

Technical goals

New WBG devices

- 100 V SoC on GaN-on-SOI
- 650 V SoC on GaN-on-poly-AlN
- 100 V SiP half-bridge

New Integration concepts

- High-voltage SiC and GaN embedding in the PCB with enhanced lifetime

Advanced cooling concepts

- Microfluidic 2-phase cooling

Enhancements in reliability

- Hybrid DD-PoF model
- Mission-profile-oriented reliability assessment tool for optimized design for reliability
- Active thermal control concepts to minimize thermal cycling
- Non-invasive junction-temperature measurement with high bandwidth
- Mission-profile-oriented lifetime test system

Expected impact

HiEFFICIENT is driven by 6 industrial use cases, covering inverters, flexible on- and multi-use off-board chargers, multi-purpose DC/DC converters and test systems for electrified vehicles. Significant impact is achieved as follows

- Highly compact eDrive components with a power density increase of 40% and an efficiency >98%
- Power modules with significantly increased lifetime (up to factor 50)
- Highly dynamic and compact automotive testing solutions for the next generation of electrified vehicles
- Hybrid data-driven and physics of failure PHM approach
- New control strategies to reduce thermal cycling as well as switching losses of power semiconductor devices

Additionally, the partners performed more than 200 dissemination activities, including >65 publications and >10 tutorials and webinars.



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Additional information

The consortium is an excellent combination of 31 well-known European industrial companies and research institutes located along the entire value chain, from semiconductors industry to OEMs. The project started in 2021 and comes to an end 2024, having a budget of 42 MEUR.