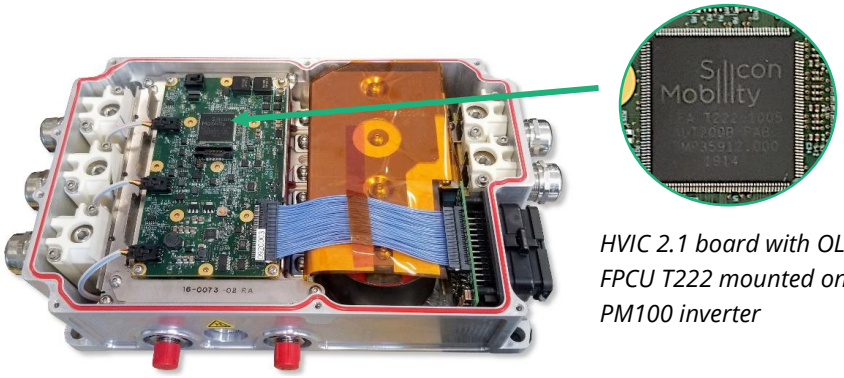
Silicon Mobility with Cascadia Motion show up to 4.6% motor and inverter efficiency improvements by advanced control

Sophia Antipolis, France (July 1st, 2021) – Silicon Mobility, a solution provider of digital control for electrified powertrain of EV/HEV, shows 2% to 4.6% efficiency improvements of inverter and e-motor, compared with industry-standard SVPWM control technique, by using its smarter control.

During the 34th International Electric Vehicle Symposium - EVS34 -, Silicon Mobility in cooperation with Cascadia Motion presented their latest research and development results. In an academic paper presented during one the EVS34 lecture sessions, Silicon Mobility shows the usage of Optimized Pulse Pattern (OPP) modulation to increase the efficiency of the inverter and the permanent magnet synchronous motor (PMSM) by reducing switching losses in the inverter together with copper and iron losses in the electric motor.

The OPP algorithm was implemented using Silicon Mobility's high-performance OLEA® T222 field-programmable control unit, which is dedicated for advanced, safe real-time control of energy conversion in the electric powertrain. The resulting system efficiency was measured on a high-voltage bench using a modified Cascadia Motion's PM100 IGBT-based inverter and a BorgWarner HVH250 production e-motor. The system efficiency is compared with industry-standard SVPWM modulation using comparable Field-oriented Control (FOC) on 8 operating points representing real-world driving loads. As a result, the combined losses of the motor and inverter systems were reduced by 2% up to 4.6% using OPP depending on the motor operating conditions.



HVIC 2.1 board with OLEA® FPCU T222 mounted on PM100 inverter

An advanced software into an advanced integrated circuit

The range of an EV is strongly affected by the efficiency of its powertrain. The energy stored in the battery must be converted into vehicle motion while losing as little as possible energy (resulting in waste heat) in the inverter and motor. While many developments target improving the battery as the main energy storage, and the usage of more efficient wide band gap power devices, Silicon Mobility focuses on further efficiency optimizations by using advanced control solutions with innovative integrated circuit and software.

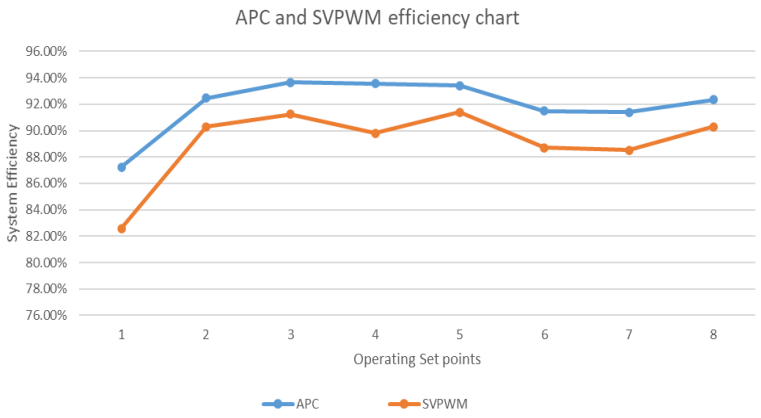
Today, Silicon Mobility is capable, thanks to advanced control algorithms using the power of the OLEA FPCU chip, to significantly reduce energy losses and consequently improve efficiency of the inverter/e-Motor of electric powertrains.

Core of the highly innovative, patented solution lays in the dedicated architecture of the OLEA® FPCU (Field Programmable Control Unit), which enables superior control performance for electric powertrain. Using programmable hardware acceleration for time-critical control loops, depending on the motor's operating conditions, the OLEA® FPCU may apply different types of modulation techniques to provide the optimal modulation for the targeted set point. In addition to Space Vector PWM (SVPWM), the FPCU supports the flexible implementation of generic Angle-based Pulse Control (APC) modulations. One example is Optimized Pulse Patterns (OPP), a modulation technique relying on a set of precisely applied switching (pulse) patterns that are pre-computed offline to optimize system behavior of motor and inverter. Its main purpose is to shape the harmonic signature of the control current in order to reduce iron and copper losses depending on the motor operating conditions.

The published paper explains and illustrates in-depth how the APC modulation properly executes the OPP, how a multicriteria pattern generator tool with scoring and constraints has been developed, the details of the measurement protocol and results.

Result: Up to 4.6% efficiency improvement

- The real-world driving points selected are less than 50Nm in the lower-efficiency region of the map.
- All the measurements have been realized in close-loop at the same average temperature for the inverter and e-motor.
- System efficiency is increased **from 2% up to 4.6%** on these points.
- E-motor and inverter losses **reduction varies from 87W up to 1230W.**



- 3 types of patterns have provided the best results (Ri2, Ripple & THD).

"Any improvement in propulsion system (motor + inverter) efficiency is good as improving motor and inverter efficiency allows a lower cooling system demand and better vehicle range." says Larry Rinehart, Director of Advanced Engineering, Cascadia Motion. "The results from this work indicate a compelling improvement in motor + inverter efficiency. It makes an IGBT-based inverter more competitive compared to a SiC inverter – without the added cost."

"The OPP modulation is supporting the same targets as adjacent work on new power transistor technologies (GaN, SiC), advanced inverter system architecture (multi-stage, multi-level), and advanced torque, current, and magnetic flux control strategies as Model Predictive Control or AI-based control" said Khaled Douzane, VP Products at Silicon Mobility. "They all target to produce a better energy efficiency for the EV/HEV drivetrain. And as the physical approaches for efficiency improvements are different, their practical benefits of each will mostly add on. "

Available immediately

As of today, OLEA® FPCU is the only automotive-qualified System-on-Chip powerful enough to run such a demanding algorithm, while also ensuring the ISO 26262 safety ASIL D level.

APC technology with OPP is available in OLEA® APP INVERTER HE control application for OLEA® FPCU and is available for selected customers.

About Silicon Mobility

Silicon Mobility is a technology leader inventor of the FPCU semiconductor architecture for ultra-fast and critically safe real-time control. Silicon Mobility accelerates all e-mobility transitions in the cleanest, safest, secure, and smartest way. The company designs, develops, and sells flexible, real-time, safe, and open semiconductor solutions for the automotive industry used to increase energy efficiency and reduce pollutant emissions while keeping passengers safe.
Silicon Mobility's products control electric motors, battery, and energy management systems of hybrid and electric vehicles. By using Silicon Mobility's technologies, manufacturers improve the efficiency, reduce the size, weight, and cost of electric motors, and increase the battery range and durability. Its technologies and products accelerate the car's powertrain electrification for OEMs. Silicon Mobility is headquartered in Sophia- Antipolis, France, with a global presence in Germany, Silicon Valley, CA., China, and Japan. For more information, visit: www.silicon-mobility.com

Stay safe

Contact Presse

David Fresneau
Silicon Mobility
Tel: +1 415 513 2426
david.fresneau@silicon-mobility.com