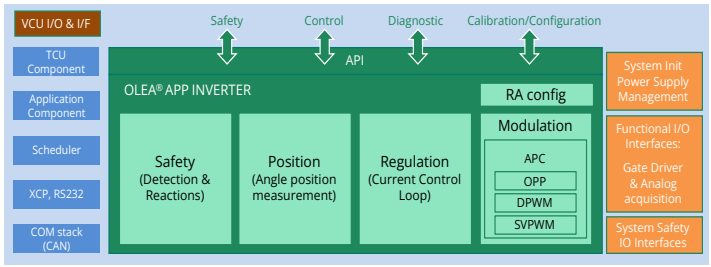
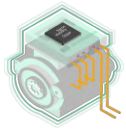
Application software for the control of inverter and e-motor delivering the highest energy efficiency





OLEA® APP INVERTER software modules
OLEA® APP INVERTER software modules subject to adaptation
Optional module specifically developed through engineering service

OLEA® APP - INVERTER HE

- Software **flexibility** and **modularity**
- **Adaptable** for further differentiation
- **Optimized Pulse Pattern** & Adaptive PWM Control
- Short **time to market**
- **ISO 26262 ASIL-C** certified design ready

Advanced control algorithms

OLEA® APP INVERTER HE is a turnkey software application for the control of inverter and electric motor delivering the highest level of energy efficiency and optimized for the OLEA® FPCU.

OLEA® APP INVERTER HE integrates all the necessary functions of a safe torque or speed regulation of electric motor control. The software's architecture is based around a core application that includes unique adaptive algorithms which applies the most suitable control strategy upon requested power, motor angle and speed. OLEA® APP INVERTER HE cuts energy losses into the power switches and into the electric motor while extending the operating range of the e-motor.

OLEA® APP INVERTER HE has several customizable modules to interface any system configuration such as power transistors, gate drivers' type, e-motor topology, position sensor and faults management. The software interface is compliant to AUTOSAR 4.3.

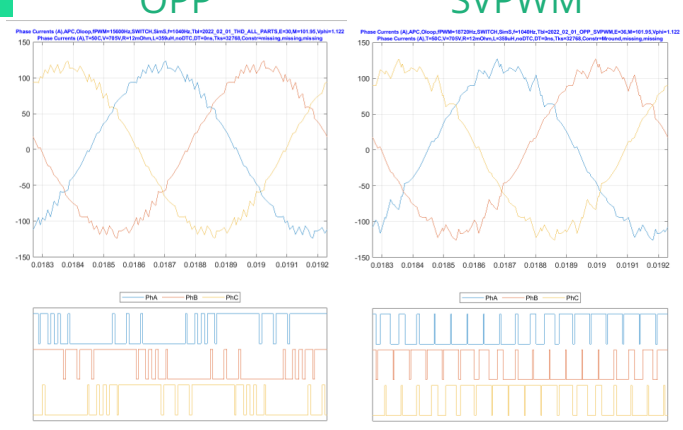
Introducing the OPP technology

OPP modulation is entirely based on the electrical angle rather than conventional time-based modulations such as SVPWM and DPWM. OPP applies a repetitive periodic switching pulse pattern. Phases are shifted relatively from one to another by 2π/3.

This allows to optimize the patterns upon user-chosen cost functions evaluating several criteria independently or all together such as:

- Inverter losses
- THD
- Motor losses
- Minimum NVH, etc.

OPP | SVPWM



Less number of switching, better THD

Advanced Algorithms

- Field Oriented Control (FoC)
- Adaptive PWM Control (APC)
- Space Vector Modulation (SVPWM)
- Optimized Pulse Pattern (OPP)
- Selective Harmonic Elimination (SHE)
- Voltage Phase Compensation (VPC)

Inverter/e-motor Topologies

OLEA® APP INVERTER HE can be customized to control any e-Powertrain system:

- Compatible with all power transistor technologies (MOSFET, IGBT, SiC and GaN)
- Support any e-Motor voltages (<60V and > 60V) .
- Support all types of e-Motor (PMSM, WRSM and more)
- Support all number of pair poles (1, 2, 4, 8 and more)
- Support 3 or 6 phases current acquisition
- Compatible with all types of position sensor (Resolver, Hall-effect)
- Can be interface with external or embedded VCU/TCU

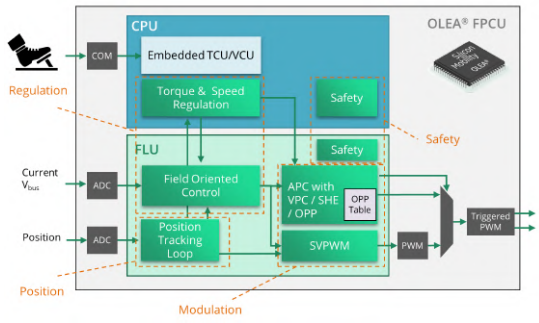
** Compared to WLTP** simulation of state-of -the art FoC, SVPWM and Full Wave algorithms executed on conventional MCU*
*** Worldwide harmonized Light vehicles Test Procedures*

Adaptive PWM control

The APC reduces energy losses of both the inverter and the e-motor power stages, while mitigating Noise, Vibration and Harshness effects. Based on the electrical angle position and the requested power (Torque x Speed), APC orchestrates several advanced algorithms to suppress useless switching events on the inverter and to improve the e-Motor Torque/Speed operating points. These advanced algorithms are:

- Optimized Pulse Pattern (OPP) – Offline and online calculated switching patterns reducing inverter losses including SHE
- Selective Harmonic Elimination (SHE) – Eliminate harmonics to reduce iron losses and NVH effects
- Voltage Phase Compensation (VPC) – Better correct the magnetic angle of the e-Motor to extend its operating range and to better reduce iron and copper losses

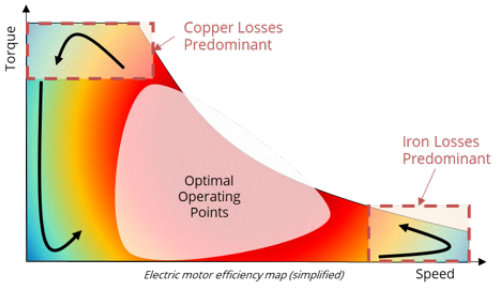
OLEA® APP INVERTER HE implemantion



Impact of algorithms per type of losses:

Losses Type		Algorithms	Impact
Inverter	Switching	APC + OPP + Soft-Switching	Reduction of the losses > 70%
	Conduction and others		
e-Motor	Iron	APC + SHE + VPC	Reduction of the losses > 80%
	Copper	APC + ONR + VPC	Reduction of the losses > 30%

Efficiency Map with OLEA® APP INVERTER HE



Pattern Generation

OLEA® APP INVERTER HE is delivered with an off-line tool to generate the set of patterns optimized for the target system. This tool enables to generate the best patterns among a large multi-dimensional space upon several optimization criteria and parameters.

Optimization criteria

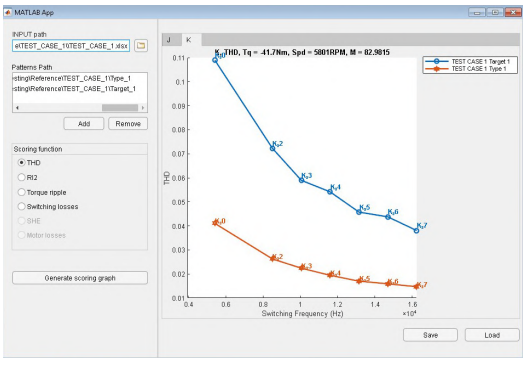
- Scoring functions
- Constraints

System Parameters

- Set points (speed, torque)
- E-motor parameters
- Inverter properties

Output results

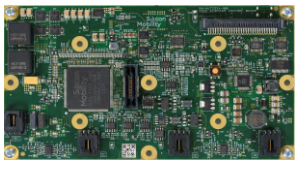
- Set of OPP tables
- Alternative sub-optimal patterns



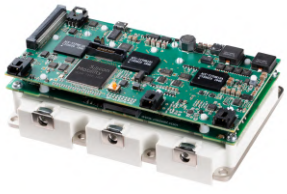
Key deliverables

- Licensable as object code
- Fully featured API for an efficient integration with custom software
- Fast configuration and calibration with OLEA® COMPOSER - T222 e-motor GUI
- OLEA® T222 FPCU Technical Reference Manual, OLEA® COMPOSER – T222 SDK and User's Guides

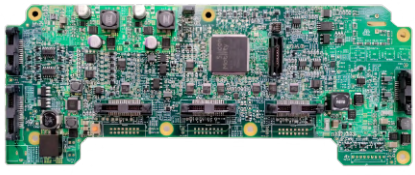
Starter Kit for rapid protoyping



OLEA® COMPOSER – T222 HVIC Starter Kit



SiC inverter platform with CISSOID



300kW SiC Inverter platform with Wolfspeed and Analog Devices

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