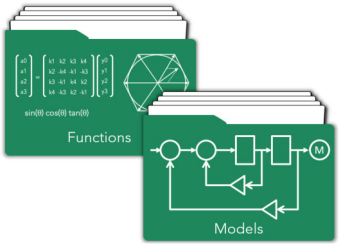
OLEA® LIB Inverter Control



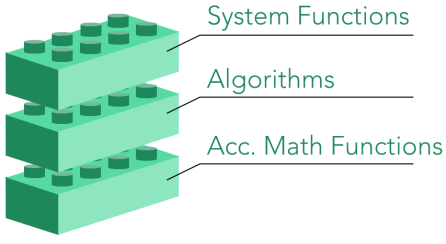
On-the-shelf algorithm contents optimized for OLEA®, boosting application performance with fast time-to-market enablement.

- Cutting edge HEV and EV Inverter control systems
- Configurable and customizable complex algorithms
- x40 computation speed improvement on advanced mathematical and computation functions
- Complete functions design and development in minutes with full integration into OLEA® COMPOSER

Build your own control

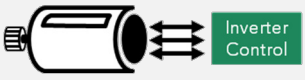
OLEA® LIB is a library of advanced software optimized for OLEA® and dedicated for the control of Hybrid (HEV) and Electric Vehicles (EV). OLEA® LIB is packaged into three levels of integration selectable upon the application needs. Libraries comes as building blocks available as Reference and Target Models Toolbox for MATLAB® Simulink, or as HDL pre-defined blocks, and tuned for best used of AMEC® FLU. Models out of OLEA® LIB are directly usable within OLEA® COMPOSER for MiL simulations and automatic code generation.
By using OLEA® LIB, developer's reduce drastically the time required to optimize algorithm's porting on OLEA® while improving drastically performance, quality and safety of their system.

OLEA® LIB System: Efficient System Functions
OLEA® LIB Algo: Specialized and Enhanced Algorithms
OLEA® LIB Math: Accelerated Mathematical Functions



OLEA® LIB System

Inverter Control (FoC)



OLEA® LIB Algo

- Clarke current transform
- Park current transform
- Decoupling and Flux Weakening
- Inverse Park / Clarke voltage
- Space Vector Modulation PWM
- ID/IQ Regulations
- Motor Speed Regulation
- Tracking loop position estimator
- (Magnetic Resistive, Resolver…)
- Sensorless position estimation (Start-up/
- Low-speed /High speed)
- DC/DC Switching regulation
- AC/DC Switching regulation

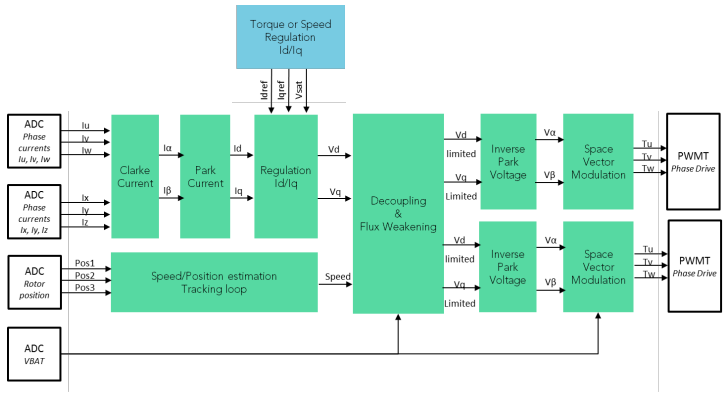
OLEA® LIB Math

- COordinate Rotation DIgital Computer for complex trigonometric operators
- Division operator
- Square Root operator
- Matrix Multiplier
- Proportional Integral Derivate control loop feedback

OLEA® LIB System - Inverter Control Features

Complete Inverter Control function optimized for OLEA® T222 supporting PMSM or WRSM motors based on Field Oriented Control and Space Vector Modulation algorithms.

- MATLAB / Simulink reference model
- MATLAB / Simuling target model ready for code generation
- Configurable parameters include
  - Variable number of phases
  - Sensor or Sensor-less position estimation
  - Magnetic Resistive, Resolver or Quadrature Sensor Type support
- Diagnostic functions



OLEA® LIB Algorithm Features

Speed Regulation	Speed regulation with D/Q-Axis control: PI regulators with Anti Wind-up. DQ-axis Reference current computation
Torque Control	Torque control with D/Q-Axis reference current computation
Clarke Current	3 to 2 phases or 6 to 2 phases current transformation
Park Current	2 phases current rotation from αβ to DQ framework
Inverse Park Voltage	DQ framework reference voltage transform into αβ voltage space vector
Decoupling & Flux Weakening	DQ-axis Decoupling and flux weakening
Regulation Id/Iq	IDQ regulation from torque set point
Space Vector Modulation	Space Vector Modulation
Position Estimation	Position and speed estimation based on Tracking-loop algorithm
Sensor-Less Position Estimation	Position and speed estimation: for standstill, low-speed and high-speed operating modes

OLEA® LIB Math Features

Operator	Description	Properties	Exec. Cycles	# of Operators
CORDIC (COordinate Rotation DIgital Computer)	• $x \cdot \cos(\theta) - y \cdot \sin(\theta)$ • $y \cdot \cos(\theta) + x \cdot \sin(\theta)$ • $\text{atan}\left(\frac{y}{x}\right)$ • $\sqrt{x^2 + y^2}$ • $x \cdot \cosh(\theta) - y \sinh(\theta)$ • $y \cdot \cosh(\theta) + x \sinh(\theta)$ • $\text{atanh}\left(\frac{y}{x}\right)$ *with* $\frac{y}{x} \in [-0{,}8; 0{,}8]$ • $\sqrt{x^2 - y^2}$ *with* $\frac{y}{x} \in$ [-0,8: 0,8]	• *θ: unsigned 16−bit for angle ∈[0°: 360°]* • *x and y: signed 32−bit fixed point with same fractional bits* • *atan or atanh: unsigned 16−bit angle ∈ [0°: 360°]* • *others: signed 32−bit, fixed point with same fractional bits as inputs*	Resolution in bit + 4	• 6 in parallel • Can be pipelined with PID
Division	A/B= *Quotient with remainder*	• *A and B : signed or unsigned 24 bits* • *Quotient : signed or unsigned 24 bits*	26	• 3 in parallel
Square root	• $\sqrt{R}$ *in unsigned mode* • $\sqrt{\lvert R \rvert}$ *in signed mode*	• *R (Radicant) : signed or unsigned 24 bits* • *Root value: unsigned 24 bits*	2	• 3 in parallel
Matrix Multiplier	• $\begin{bmatrix} r_0 \\ r_1 \end{bmatrix} = \begin{bmatrix} a_0 & a_1 & a_2 & a_3 & a_4 & a_5 \\ a_6 & a_7 & a_8 & a_9 & a_{10} & a_{11} \end{bmatrix} \times \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \\ b_4 \\ b_5 \end{bmatrix}$ • $r_0 = \sum_{i=0}^{iter}(a_i \times b_i \gg Q_f)$ • $r_1 = \sum_{i=0}^{iter}(a_{i+6} \times b_i \gg Q_f)$	• a_n: *signed* 16, 24 *or* 32 *bits* • b_n: *signed* 16, 24 *or* 32 *bits* • Q_f: *Integer* ∈ [0 : 31] • r_n : *signed* 32 *bits* • *iter: iteration number*	Iter + 4	• 3 in parallel • Can be pipelined with a CORDIC
PID (Proportional Integral Derivative controller)	Saturation with Anti-windup: ▪ Back calculation : *if saturation then* $integral_n = K_i \times e_n - K_b\ (pid_{n-1} - pid\_sat_{n-1}) + integral_{n-1}$ ▪ Integral clamping *: if saturation and* $sign(pid_{n-1}) = sign(e_{n-1})$ *then* $integral_n = integral_{n-1}$	• K_p, K_i, K_d, K_b: *signed* 16, 24 *or* 32 *bits* • $P_{in}, P_{in_{ref}}$: *signed* 16, 24 *or* 32 *bits* • SAT_{MAX} , SAT_{MIN}, *Init: signed* 32 *bits* • Q_f = *Integer*∈ [0 : 31]	8	• 6 in parallel • Can be pipelined with another PID

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