



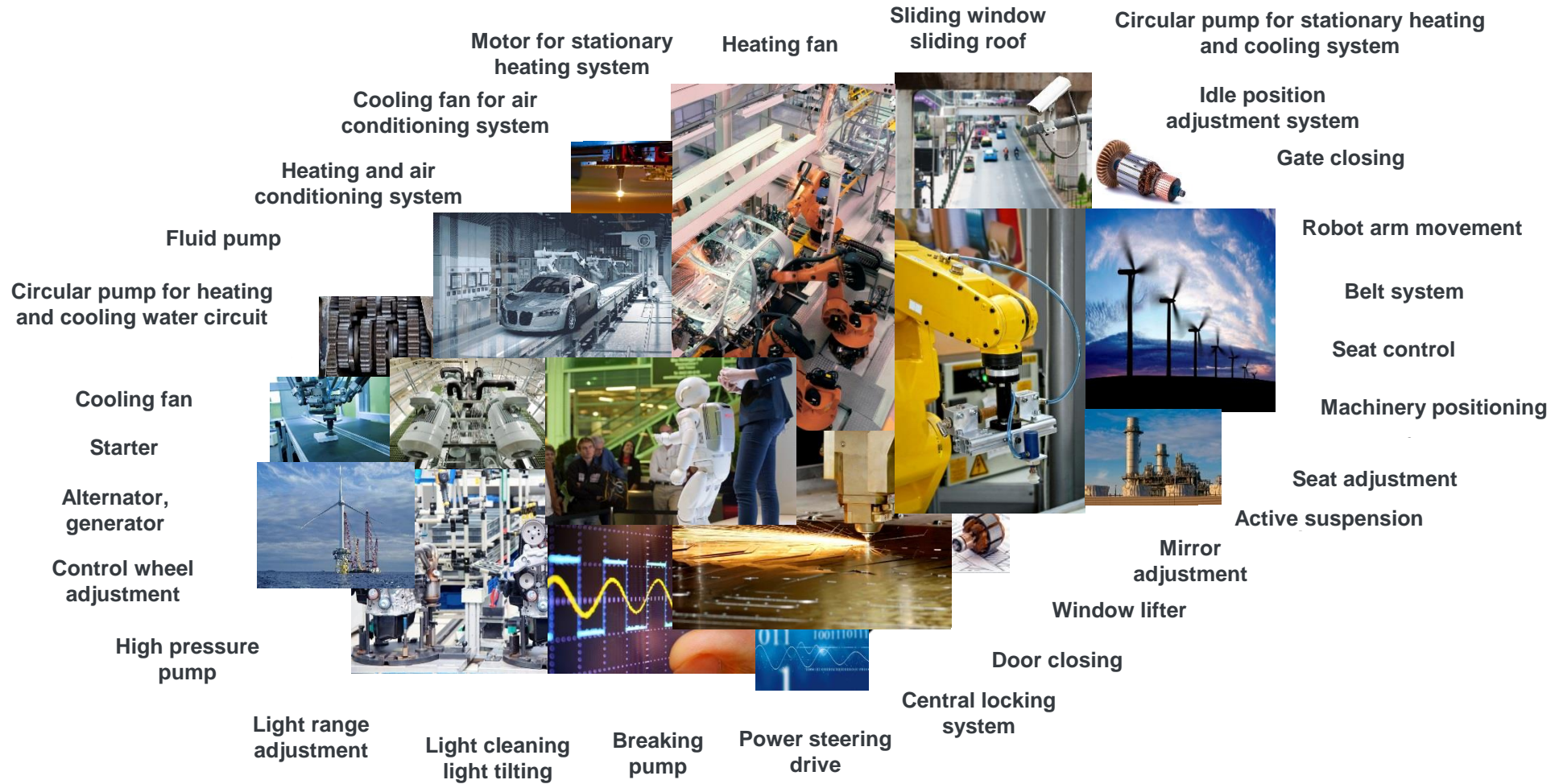
# Ultra-Reliable Microcontrollers

## Automotive & Industrial

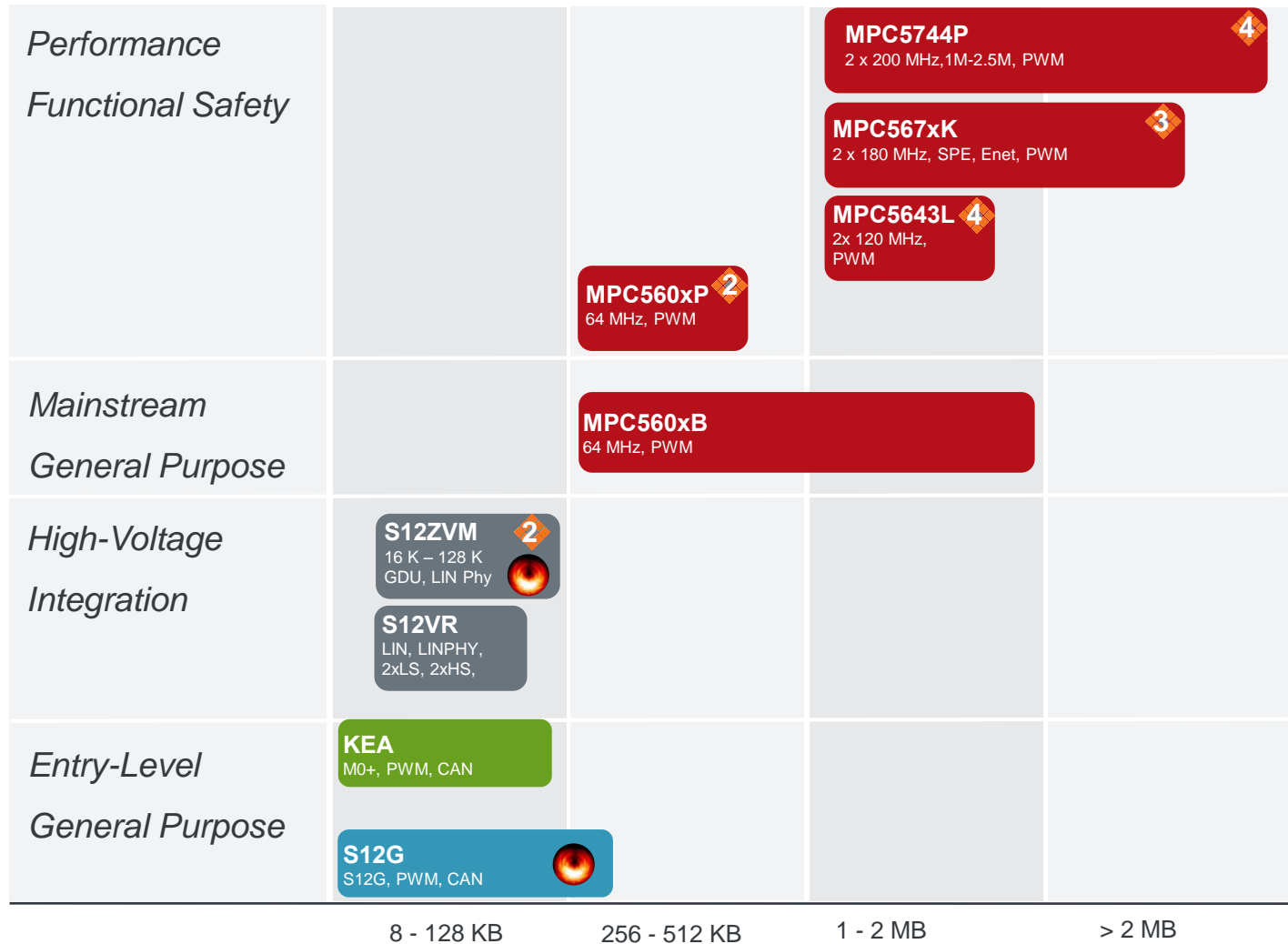
### Motor Control Sales Guide



# Electric Motors Volume Increasing, Size Decreasing



# Ultra-Reliable Motor Control Portfolio



## Key Features:

5 V, robust to ESD/EMC, high temperature  
Best-in-class reliability and quality  
Functional safety and security



## Application Examples

Power steering, door module, seat module, fluid pump, fan, HVAC, window lift, module positioning, sliding doors...

- 32-bit Power Architecture technology®
  - 16-bit S12 MagniV mixed-signal MCUs
  - 32-bit ARM® Cortex®-M0+
  - 16-bit S12G
  - High temp up to 150 °C
- Target Safety Level (ISO 26262/ IEC61508)  
 Level 2 = ASIL-B = SIL 2  
 Level 3 = ASIL-C = SIL 3  
 Level 4 = ASIL-D = SIL 4





# Understand Requirement

## Leading Questions

- What type of application?
- Application / motor voltage & current rating?
- Type of the motor (DC / BLDC / PMSM / SR)?
- Parameters of the motor (number of pole pairs, Rs, Ls)?
- Sensor based or sensorless control?
- Type of position sensor, if any?
- Requested motor behavior (operational & max speed, motor start-up time and other dynamic requirements)?
- Requested speed / torque / position control included in profile?
- Need for any advanced algorithms (field weakening, single shunt current sensing, MTPA, speed reversal sensorless, zero speed sensorless)?





## Application - Product Mapping

# Pumps - DC, BLDC, PMSM Motors



## Recommended Product: S12ZVM

- High voltage analog integrated for space constraint
- Support up to 150 °C ambient, up to 128 K of flash
- Reduce PCB and manufacturing cost

## Alternate product: KEA and S12G

- KEA: Low power ARM® Cortex®-M0+ core for performance and multiple timers, 3 phase sensorless BLDC reference design, up to 128 K of flash
- S12G: S12 16-bit core optimized for general purpose and entry level applications, up to 240 K of flash



Improve efficiency  
Reduce noise and weight



High temperature



Space constraint



LIN and CAN network

# Airflow Systems



## Recommended Product: S12ZVM

- High voltage analog integrated for space constraint
- Provides high gate charge (100 nC) to drive motors up to 1 kW
- Support up to 150 °C ambient, up to 128 K of flash
- Reduce PCB and manufacturing cost

## Alternate product: KEA and S12G

- KEA: Low power ARM Cortex-M0+ core for performance, multiple timers, 3 phase sensorless BLDC reference design, up to 128 K of flash
- S12G: S12 16-bit core optimized for general purpose and entry level applications, up to 240 K of flash



Improve efficiency  
Reduce noise and weight



High temperature



100 to 500 W



LIN and CAN network

# Relay Based Reversible DC Motors

## Recommended Product: S12ZVR

- Integrated LINPHY for PCB reduction
- Capability to drive 2 relay (low side driver), up to 48 K of flash
- Operates directly on 12 V systems
- Directly power sensor, HVI for switch control

## Alternate product: KEA and S12G

- KEA: Low power ARM Cortex-M0+ core for performance, multiple timers, 3 phase sensorless BLDC reference design, up to 128 K of flash
- S12G: S12 16-bit core optimized for general purpose and entry level applications, up to 240 K of flash



Sensor interface



Space constraint



Switch based control



LIN network



# Multi-Motor Applications



## Recommended Product: MPC560xB

- Large memory and package choices, up to 3 M of flash
- Capability to drive multiple DC motors
- Enhanced timers and ADC for precise motor control
- Smart LIN and CAN nodes

## Alternate product: MPC560xP

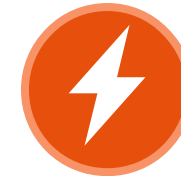
- Optimized MCU with eTimers, high precision PWM and Flexray, up to 512 K of flash.



Drive multiple motors



Certified Software



12 V and 24 V systems



CAN and LIN connectivity

# Safety Systems



## Recommended Product: MPC574xP

- ASIL-D/ SIL 4 functional safety requirement, up to 3 M of flash
- Operate at extended temperature
- LIN CAN Ethernet and Flexray option
- Fast and accurate motor control peripherals

## Alternate product: MPC5643L and MPC560xP

- MPC5643L: ASIL-D/ SIL 4, up to 1 M of flash
- MPC560xP: ASIL-B/ SIL 2, up to 512 K of flash



PMSM for better torque



Drive multiple motors



Safety critical application



Precise, fast and deterministic control



# Enablement

# Complete Solutions for Motor Control



Math & Motor Control Library Set

Motor Control Development Kit

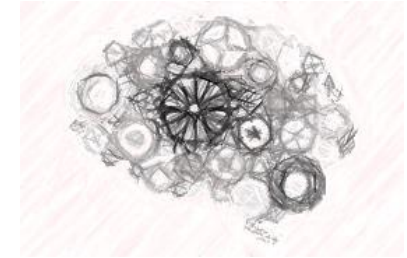
FreeMASTER & Motor Control  
Application Tuning Tools



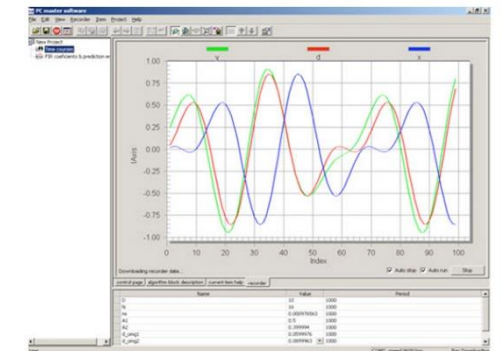
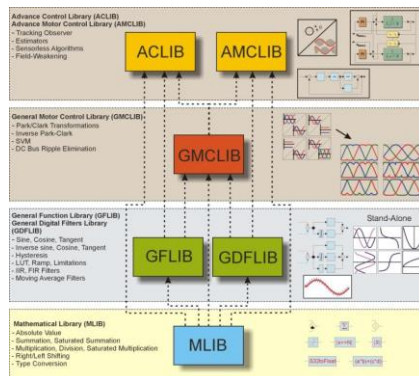
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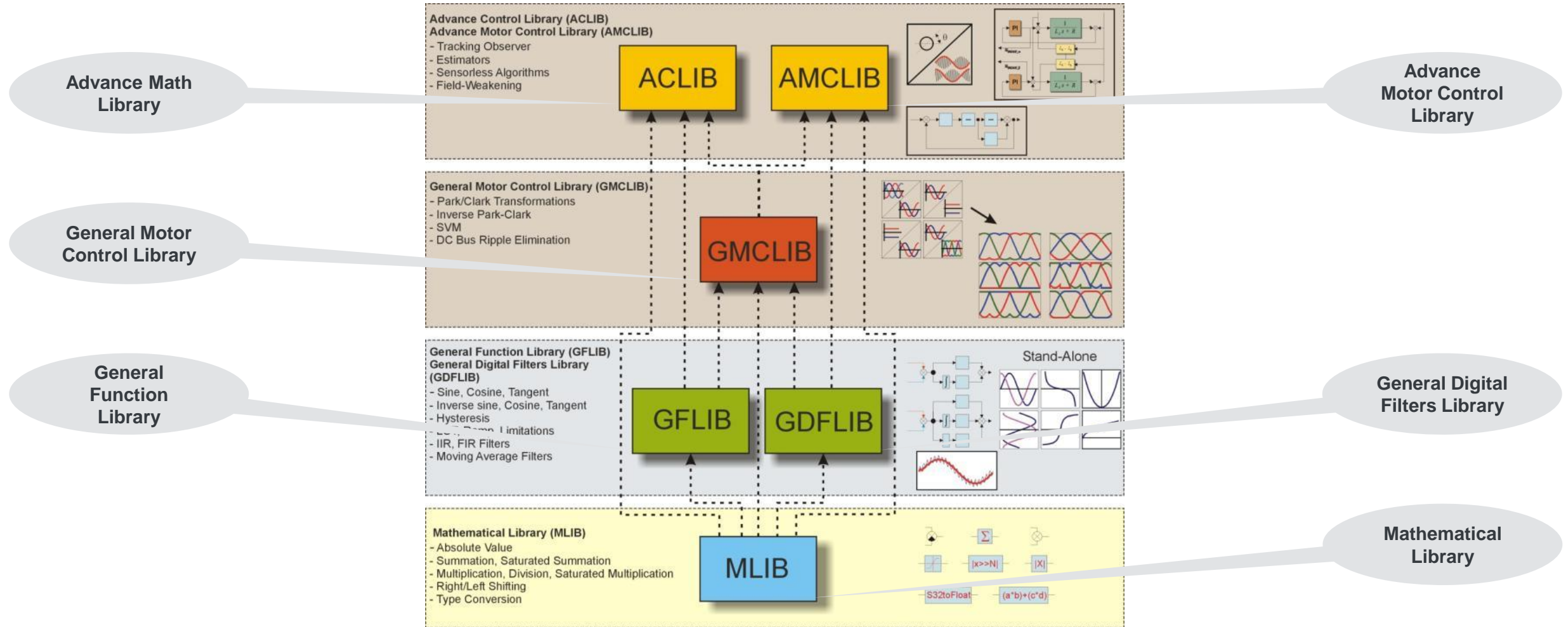






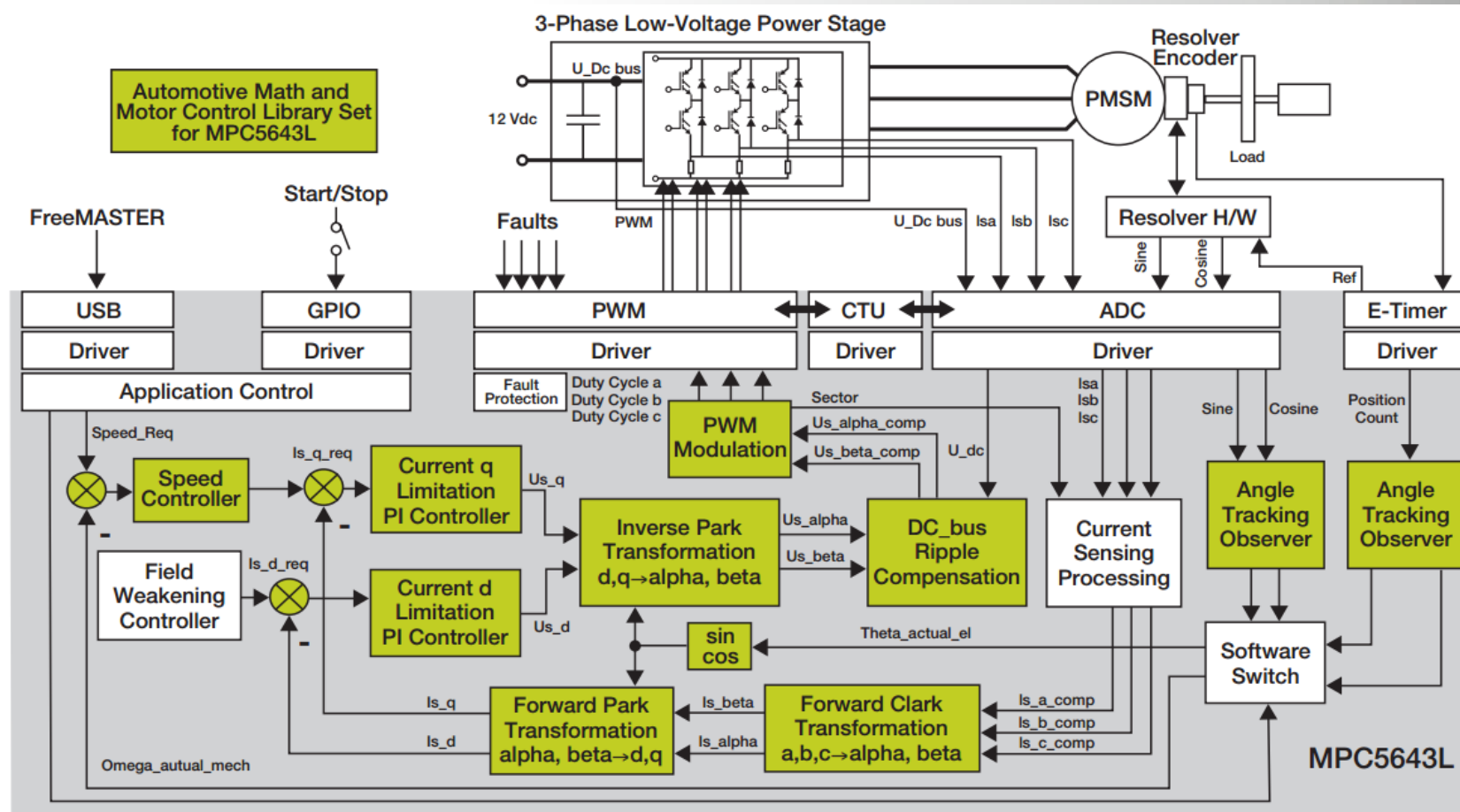
## Enablement - Math and Motor Control Library

# Building Blocks for Motor Control Software





# PMSM Field Oriented Control Example

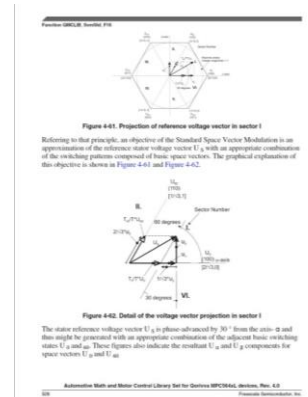


# Find More Info Online

[www.freescale.com/AutoMCLib](http://www.freescale.com/AutoMCLib)

## Features:

- Software details
- Download latest releases
- Extensive documentation
- Theoretical background, examples, description, etc.



User's Guide Example

**freescale**

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Freescale Embedded Software and Tools Run-time Software AUTOMATH\_MCL

**AUTOMATH\_MCL: Automotive Math and Motor Control Library Set** UPDATED

**Overview** Documentation Downloads Training & Support

The Automotive Math and Motor Control Library Set is a precompiled software library containing the building blocks for a wide range of motor control and general mathematical applications. It consists of four groups of functions:

- Basic mathematical functions (MLIB) with elementary math functions.
- General trigonometric and basic functions (GFLIB) with basic math, trigonometric, look-up table and controller functions.
- General motor control functions (GMCLIB) with space vector modulation, transformation and motor control specific functions.
- General digital filter functions (GDFLIB) with digital filter functions for signal controlling.

The Automotive Math and Motor Control Library Set is delivered as a precompiled library and provides a highly speed-optimized, intensively tested and easy to use solution for the rapid development of user motor control and general mathematical applications. The Automotive Math and Motor Control Library Set functions interface is included into a single public interface to reduce the number of files required for inclusion by the user application. An integral part of the Automotive Math and Motor Control Library Set are the Matlab/Simulink models of all supported functions to allow modeling of the user application using the Matlab Simulink environment, and extensive user documentation. The Automotive Math and Motor Control Library Set support three major arithmetics: 32-bit fixed-point, 16-bit fixed-point and single precision floating-point.

**Supported Devices**

- Qoriva MPC560x
- Qoriva MPC57xx
- S12ZVM: S12 MagniV Mixed-Signal MCU for BLDC and DC Motor Control

**Featured Documentation**

AMMOCLSFS: Automotive Math and Motor Control Library Set Fact Sheet

**Current Updates and Releases**

MPC560XP\_AMMCLIB\_LIB: Automotive Math and Motor Control Library Set for Qoriva MPC560x

MPC564XL\_AMMCLIB\_LIB: Automotive Math and Motor Control Library Set for Qoriva MPC564xL

MPC567XF\_AMMCLIB\_LIB: Automotive Math and Motor Control Library Set for Qoriva MPC567x

**Implemented Algorithms**

- MLIB
- GFLIB
- GMCLIB
- GDFLIB

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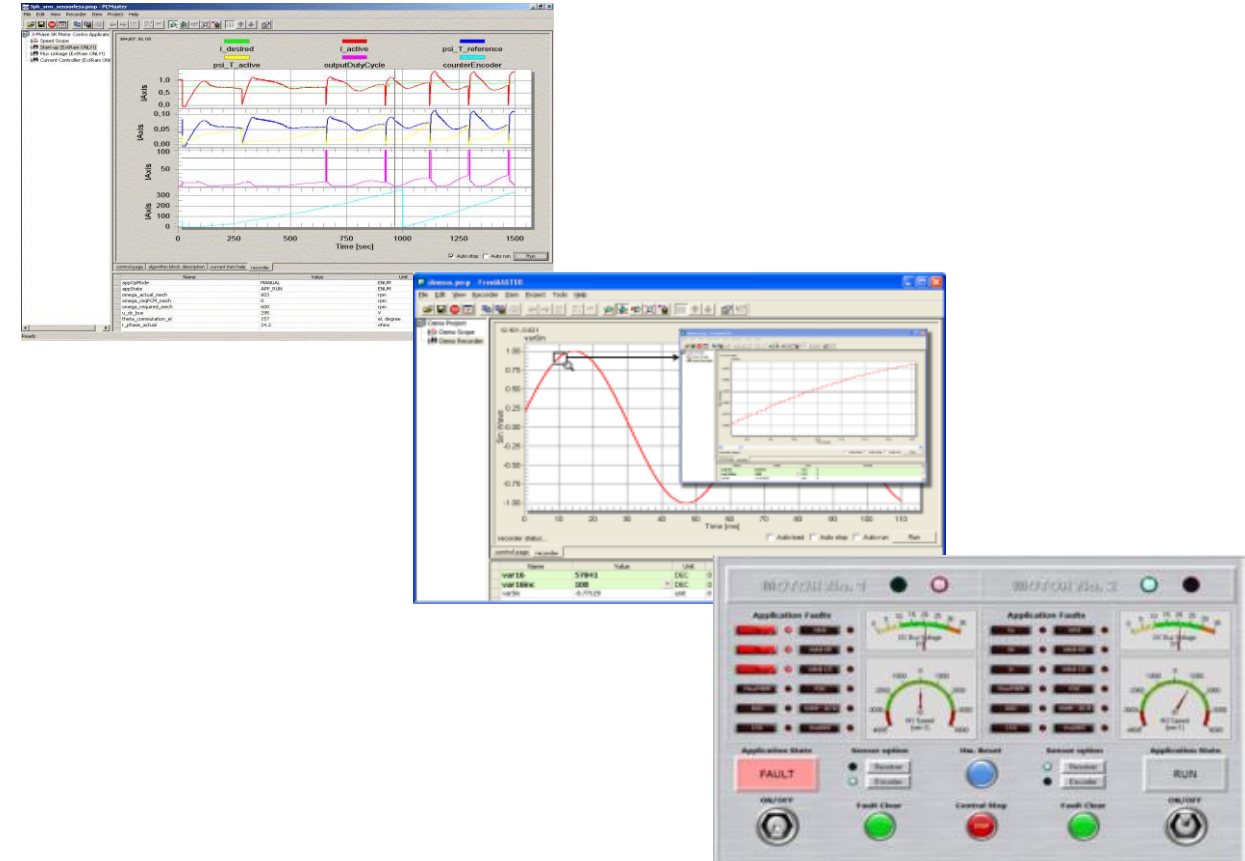


## Enablement - Tools

# FreeMASTER - “Debugger for Real-time Applications”

[www.freescale.com/FreeMASTER](http://www.freescale.com/FreeMASTER)

- **Real-time Monitor Tool**
  - Track your variables
  - Tracing capability
- **Graphical User Interface**
  - Modify variables run-time
- **Demonstration Platform**
  - Design your own dashboard



# MCAT Tool - Makes any Motor Spin

[www.freescale.com/MCAT](http://www.freescale.com/MCAT)

Tool guiding the user step by step to tune the control parameters of their MC application

- Run-time tuning of control parameters
- Generation of header file with resulting parameters





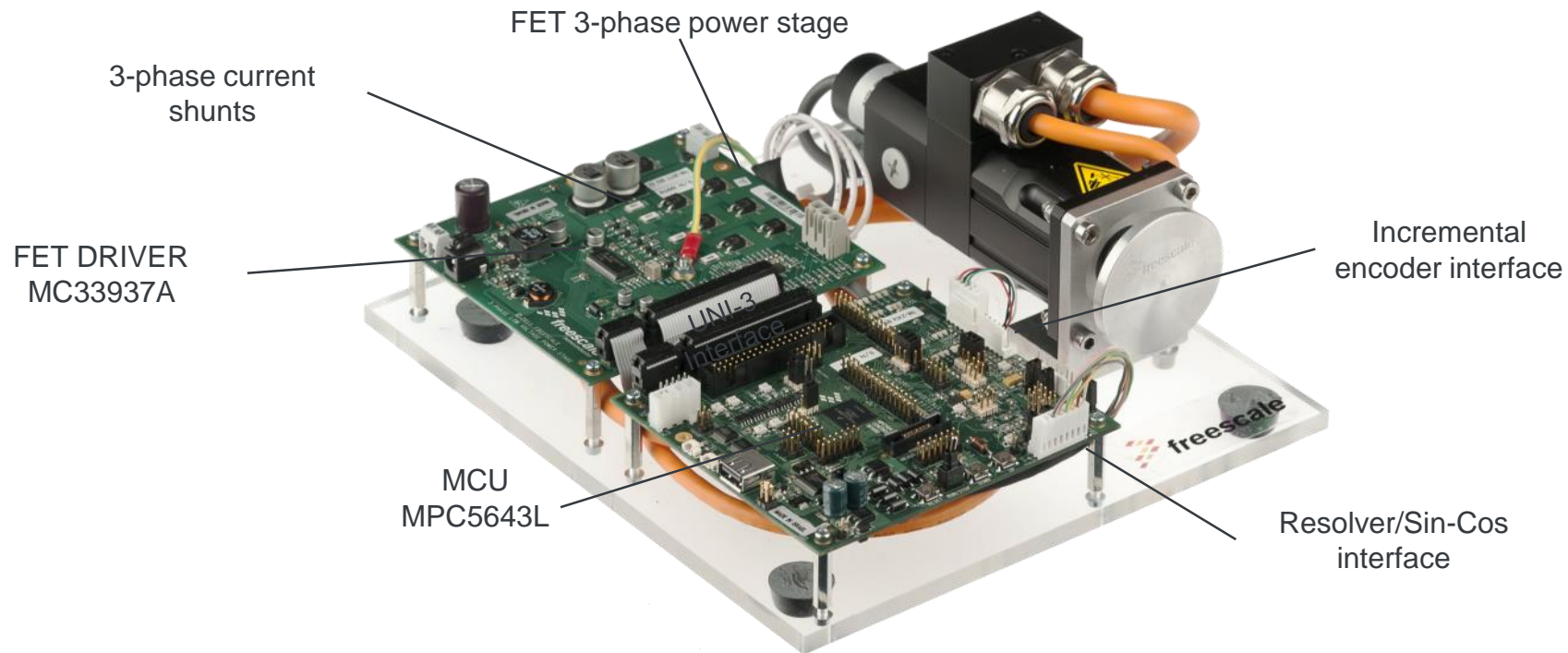


# Enablement - Motor Control Reference Development Kits



# Spin a Motor Within Minutes with MC Development Kit

- [www.freescale.com/AutoMCDevKits](http://www.freescale.com/AutoMCDevKits)



PMSM with  
resolver/encoder

+

MC33937A  
3-phase  
low voltage  
power stage

+

MPC5643L  
controller board

# Many Motor Control Development Kits



	Product Type	Product features	Motor/ Application Type
<b>KEA128BLDCRD</b>	ARM Cortex M0+ 128 K flash	48 MHz, CAN and LIN, 12-bit ADC 16 ch	3-phase Sensorless BLDC
<b>MTRCKTDBN5643L</b>	Power, ASIL D, 1 M flash	120 MHz, Dual core, Flexray, CAN and LIN, FPU	Dual 3-phase Sensorless BLDC
<b>MTRCKTDPS5643L</b>	Power, ASIL D, 1 M flash	120 MHz, Dual core, Flexray, CAN and LIN, FPU	Dual 3-phase PMSM
<b>MTRCKTSBN5604P</b>	Power, ASIL B, 512 K flash	64 MHz, Flexray, CAN and LIN	3-phase Sensorless BLDC
<b>MTRCKTSBN5606B</b>	Power, 1 M Flash	64 MHz, high number of CAN and LIN	3-phase Sensorless BLDC
<b>MTRCKTSBN5643L</b>	Power, ASIL D, 1 M flash	120 MHz, Dual core, Flexray, CAN and LIN, FPU	Single 3-phase Sensorless BLDC
<b>MTRCKTSBNG128</b>	S12, 128 K Flash	50 MHz, CAN and LIN	3-Phase Sensorless BLDC
<b>MTRCKTSBNZVM128</b>	S12Z, high-voltage analog, 128 K	100 MHz, LIN-PHY, Gate Driver Unit	3-phase Sensorless BLDC
<b>MTRCKTSPS5604P</b>	Power, ASIL B, 512 K flash	64 MHz, Flexray, CAN and LIN	3-phase PMSM
<b>MTRCKTSPS5643L</b>	Power, ASIL D, 1 M flash	120 MHz, Dual core, Flexray, CAN and LIN, FPU	3-phase PMSM



# Summary

Find a true reference platform at [freescale.com/AutoMCDevKits](https://freescale.com/AutoMCDevKits)



## HARDWARE

Multiple development kits and reference designs with complete schematics



## SOFTWARE and LIBRARIES

Application software source code available for all kits, e.g. 6 steps communication control for BLDC motors, vector control - FOC for PSM motors; math and motor control library objects at no-cost



## TOOLS

FreeMASTER & MCAT user interface to ease application visualization and control with extensive documentation





[www.Freescale.com](http://www.Freescale.com)