

Automotive Motor Control Solutions

# 3-phase Sensorless BLDC Motor Control Reference Design using Kinetis KEA128

## Target Automotive Applications

- Heating, ventilation and air conditioning (HVAC)
- Engine cooling fan
- Electric pumps, motor control and auxiliaries
- Transmission and gearbox
- Doors, window lift and seat control

## KEA128BLDCRD Reference Design Features

- 32-bit KEA128 MCU
- MC33937A FET pre-driver
- MC33903D system basis chip
- Sensorless control using back-EMF zero-crossing detection
- DC-bus overvoltage, undervoltage, and overcurrent fault detection
- Application built using the Automotive Math and Motor Control Library Set functions
- FreeMASTER tool for instrumentation/visualization
- Integrated Motor Control Application Tuning (MCAT) tool
- LIN & CAN connectivity support
- OpenSDA debug interface

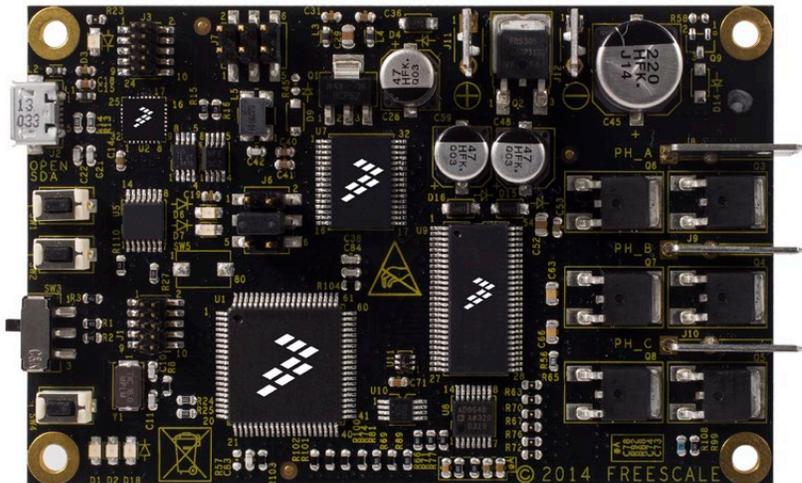
## Overview

The KEA128BLDCRD motor control reference design based on the Kinetis KEA128 32-bit ARM® Cortex®-M0+ automotive MCU represents an example of a 3-phase sensorless brushless DC (BLDC) motor control solution using six-step commutation process, including closed-loop speed control and dynamic motor current limitation.

The overall hardware solution consists of the KEA128 MCU, MC33903 system basis chip, and MC33937A 3-phase field effect transistor pre-driver. This Freescale integrated circuit ecosystem represents a BLDC motor control solution for the 12 V automotive systems.

The motor control application is built upon the algorithm building blocks provided by the Automotive Math and Motor Control Library Set for ARM Cortex-M0+. These include 16-bit and 32-bit fixed point arithmetic based elemental mathematical functions, PI controllers, and digital filters.

## Motor Control Reference Design Hardware



Application data visualization and control is provided by the FreeMASTER run-time debugging tool. Integrated Motor Control Application Tuning (MCAT) tool allows run-time tuning of the application parameters.

### KEA128 Features

- 32-bit ARM Cortex-M0+ CPU core with frequency up to 48 MHz
- 128 KB of flash, 16 KB of SRAM
- One MSCAN and three UARTs with LIN support
- One 12-bit SAR ADC with 16 channels and external trigger control
- 6-channel 16-bit FlexTimer with complementary PWM, dead time insertion, and fault protection
- Two 2-channel 16-bit FlexTimers

### MC33937A Features

- Fully specified from 8.0 to 40 V (covers 12 and 24 V automotive systems)
- Extended operating range from 6.0 to 58 V (covers 12 and 24 V systems)
- Greater than 1.0 A gate drive capability with protection
- Protection against reverse charge injection from  $C_{GD}$  and  $C_{GS}$  capacitances of external FETs
- SPI programmable dead time
- Includes a charge pump to support full FET drive at low battery voltages
- Simultaneous output capability enabled via safe SPI command
- Integrated current-sense amplifier with overcurrent comparator

### MC33903 Features

- 5 or 3.3 V voltage regulator with current, temperature and voltage protection
- One CAN and up to two LIN transceivers
- Advanced SPI, MCU, ECU power supply and critical pin diagnostics and monitoring
- Extremely low quiescent current in low power modes

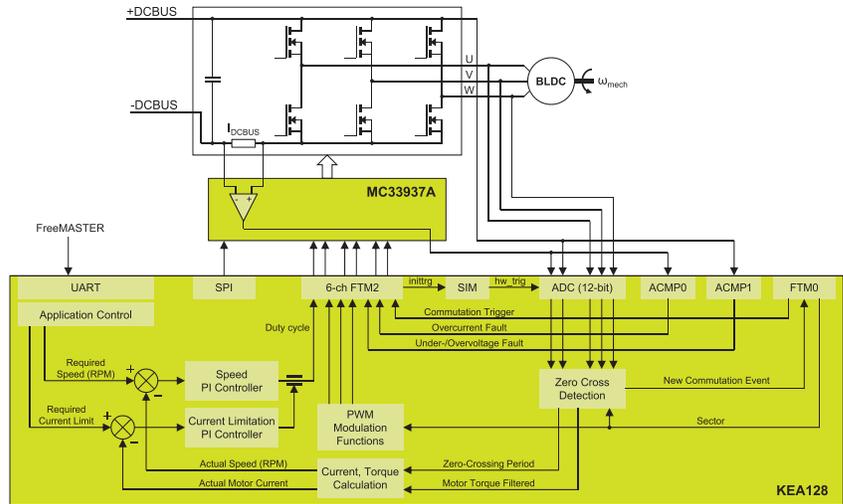
## FreeMASTER Project Page with MCAT GUI



## Software Tools

Name	Web link
Automotive Math and Motor Control Library Set	<a href="http://freescale.com/AutoMCLib">freescale.com/AutoMCLib</a>
FreeMASTER	<a href="http://freescale.com/FREEMASTER">freescale.com/FREEMASTER</a>
Motor Control Application Tuning (MCAT) Tool	<a href="http://freescale.com/MCAT">freescale.com/MCAT</a>
CodeWarrior for Microcontrollers 10.6	<a href="http://freescale.com/CodeWarrior">freescale.com/CodeWarrior</a>

## Six-step Commutation BLDC Motor Control Algorithm Concept



For current information please visit [freescale.com/KEA128BLDCRD](http://freescale.com/KEA128BLDCRD)