Freescale Motor Control Boards

Hardware development kits provide rapid prototyping of motor control applications

Overview

Freescale motor control development boards are intended to support the rapid evaluation and prototyping of a variety of motor control applications using Freescale MCUs.To cover both low- and high-voltage applications Freescale built two motor control development boards:

- Low-voltage Tower System-compatible platform
- High-voltage platform

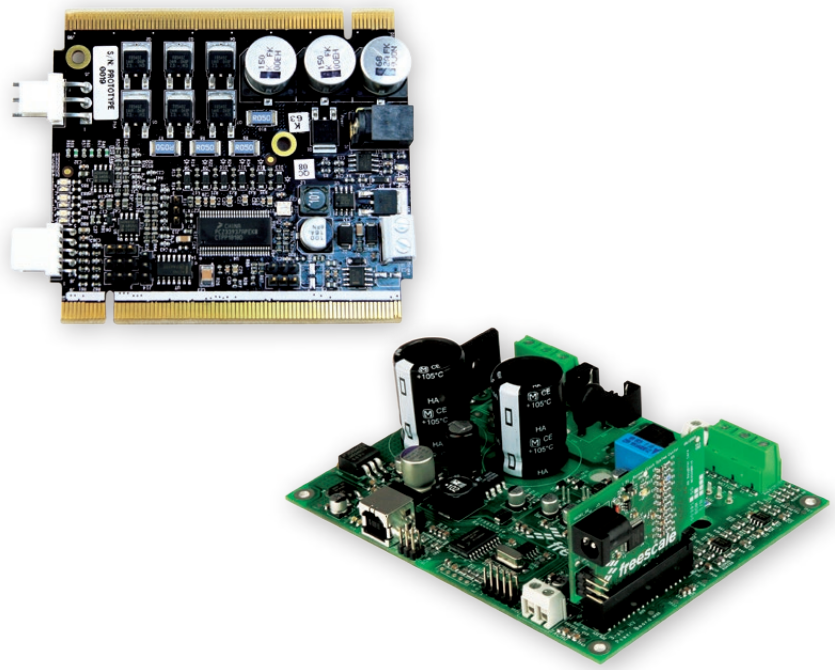
Tower System Three-Phase Low-Voltage Power Stage

The TWR-MC-LV3PH low-voltage three-phase motor control module was designed to provide a Tower System-compatible module for motor control applications. This peripheral module is interchangeable across the development platform and can be used with a variety of existing controller modules.

Three-Phase High-Voltage Power Board

High-voltage applications (supplied from mains) require a different approach of inverter board design due to safety requirements and isolation distances. The Freescale high-voltage power board combines a three-phase inverter and power factor correction stage. The board allows development and prototyping of applications for white goods, industrial and general-purpose drives.

Figure 1: Motor Control Boards



Three-Phase Low-Voltage Tower System Board

The three-phase low-voltage control board (TWR-MC-LV3PH) is a peripheral Tower System module. With one of the available MCU Tower System modules, accommodating a selected MCU, it provides a ready-made, software-development platform for one-third horsepower offline motors. Feedback signals are provided that allow a variety of algorithms to control three-phase PMSM and BLDC motors.

The TWR-MC-LV3PH module features:

- Power supply voltage input 12 to 24 VDC, extended up to 50 V
- Output current up to 8 A
- Power supply reverse polarity protection circuitry
- Three-phase bridge inverter (six MOSFETs)
- Three-phase MOSFET gate driver with overcurrent and undervoltage protection
- Three-phase and DC bus current sensing shunts
- DC bus-voltage sensing
- Three-phase back EMF voltage sensing circuitry
- Low-voltage on-board power supplies
- Encoder/Hall sensor sensing circuitry
- Motor power and signal connectors
- User LED, power-on LED, six PWM LED diodes
- Braking resistor MOSFET

Sets of jumpers located on the board enable configuration setting of analog signals. SPI communication channel and MC33937 driver signal selectors are available through zero-ohm resistors.

The MC33937 provides overcurrent and undervoltage functions, in addition to other functions.

A filtered DC bus current signal is fed into the pre-driver current comparator input. If the current exceeds the adjustable reference value, all six transistors are switched off while a fault bit setting in the status register.

The TWR-MC-LV3PH kit contains a three-phase BLDC motor with Hall sensors LINIX 45ZWN24-40 with parameters:

- Rated voltage of 24 VDC
- Rated speed 4000 RPM
- Rated power 40 W
- Continuous current 2.34 A

The board supports Tower System standards and interface pin-out. However, not all Freescale MCUs are dedicated for motor control applications. The list of recommended Tower System MCU modules that are fully compatible from TWR-MC-LV3PH regarding number of PWMs, ADCs and timer channels is as follows:

- 8-bit
  - TWR-S08PT60
- ColdFire
  - TWR-MCF5441X
- DSC
  - TWR-56F8257
  - TWR-56F8400
- ARM core-based Kinetis MCUs
  - TWR-K40X256
  - TWR-K60N512
  - TWR-K70F120M

Three-Phase High-Voltage Power Board

The three-phase high-voltage power board is a power stage and part of the Freescale embedded motion control series of development platforms. The kit consists of the main board and a selected MCU daughter card. The interface between the card and the main power board provides a 96-pin PCI connector which accommodates all required signals for the three-phase inverter and active power factor correction stage.

The power board is capable to control sensored or sensorless PM synchronous motors, AC induction motors and BLDC motors with the power up to 1 kW. The DC bus voltage is regulated using PFC to the value of 400 VDC which enables generation of three-phase output signals with amplitude up to 230 VAC.

The algorithms for motor control applications required apart from powerful MCUs are also motor analog signals (current, voltage) and a rotor position feedback. The motor position in case of sensorless applications is calculated using a motor model. However, the real position of the rotor is essential at least for initial application tuning. The power board contains interfaces for quadrature decoder, Hall sensors, tacho generator and optional resolver position and speed feedbacks.

The HV power board features:

- Input voltage of 85–250 VAC
- Output current up to 15 A
- Auxiliary power supplies 15 V and 5 V DC from rectified voltage
- Three-phase IGBT power module
- Analog sensing (DCB voltage, DCB current, phase currents, back EMF voltage)
- Motor speed/position sensors interface (encoder, Hall, tacho generator, resolver)
- Hardware overcurrent fault protection
- Active PFC
- Overvoltage comparator with DC-brake resistor interface
- SCI-to-USB optically isolated communication interface

The main component of three-phase inverters is the smart power module (SPM). The high-speed built-in HVIC provides optocoupler-less single supply IGBT gate driving capability that reduces the overall size of the inverter system design. Each phase current of the inverter can be monitored separately due to the divided negative DC terminal.

The platform currently supports key MCUs dedicated for motor control applications:

- MC9S08MP16
- MC56F80xx
- MC56F82xx
- MC56F84xx
- MPC564xL
- K40X256

Availability

The TWR-MC-LV3PH Tower System modules are currently available at **freescale.com** for direct ordering or through distributors. The kit contains three-phase BLDC motor, 24 VDC power supply and the Tower System module. The BLDC example applications are available for Kinetis MCU and DSC platforms.

The kit and application software are available at **freescale.com/Tower.**

The high-voltage power board will be available for ordering in 2013. Currently, the board redesign is in progress as well as mass production preparations. The MCU daughter cards will be available for both Kinetis MCU and DSC platforms.

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