Z8FMC16100 Series of Flash MCUs

Motor Control Library
Class B Compliant

Product Brief

PB020302-0207

ZiLOG's Motor Control (MC) Library v2.0.0 is a Class B compliant software and available as a part of ZiLOG's Z8 Encore! MC™ based Z8FMC16100 Series of Flash MCUs. This Library provides well-defined APIs and header files to design a motor control application for the following motor types:

• 3-phase Brushless DC (BLDC) Motor

• 3-phase AC Induction Motor

Until now, Vector Control has been the domain of Digital Signal Processors (DSPs), Digital Signal Controllers (DSCs) for 32-bit and 16-bit MCUs. Motor Control Library is designed to run on 8-bit Z8FMC16100 Series of MCUs, thus providing a cost-effective solution with minimum lead time, for the motors used in consumer goods.

Product Block Diagram

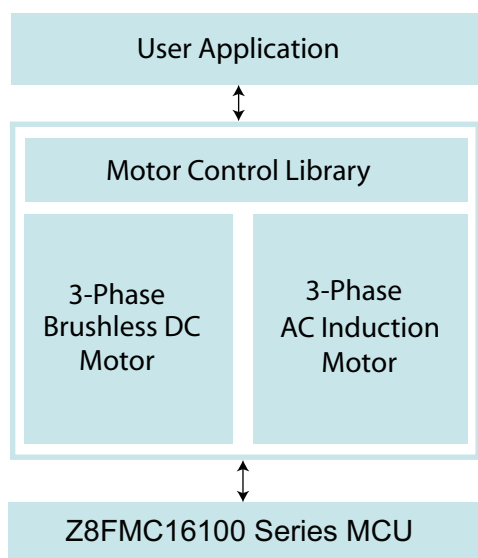Figure 1 illustrates the block diagram of MC Library v2.0.0.

Figure 1. MC Library Block Diagram

Product Highlights

Key features of MC Library includes:

• IEC 60730-1 Class B compliancy

• Speed and direction control

• Fault response

• Constant speed mode and constant torque mode of operation

• BLDC control mode utilizes back-EMF sensing Phase Locked Loop (PLL) approach

• AC Induction Motor utilizes Vector Control approach

• Communication through ZiLOG's Panel Class B GUI (only for AC Induction Motor)

• Utilizes integrated operational amplifier of Z8FMC16100 MCU

• The MC Library also provides APIs for the following:

  – I^2C communication with Digital-to-Analog Converter (DAC) for debugging (only for AC Induction Motor)

  – Retrieving voltage, current, and speed of the motor useful for remote monitoring and control

IEC 60730-1 Class B Compliant Software

The MC Library v2.0.0 follows the International Electrotechnical Commission (IEC, www.iec.ch) Class B standards. Class B software detects fault in the appliance and provides exception handling to prevent any unintended operation in the appliance due to the fault. Thus, many household appliances (for example, microwave oven, washing machine etc.) use Class B software.

The Class B compliancy of MC Library enables fault detection for following system components:

- CPU Register
- Program Counter
- Random Access Memory (RAM)
- Flash Memory
- Clock Frequency
- Interrupt
- Analog Input (for example, voltage, current, etc.)

The above components are tested periodically for faults. If a fault is detected, the motor is brought to a stop to prevent any unintended operation resulting from the fault.

Speed and Direction Control

The MC Library APIs configure the speed and direction of the motor. The monitoring APIs help to monitor, debug, and interface the motor control application with other applications. The following parameters are monitored:

- ADC values of DC bus voltage and bus current
- Temperature
- Set-speed
- Motor's direction of rotation

Fault Response

If a fault is detected, the library contains code for exception handling which asserts a specific flag and stops the motor.

Communication Through Panel Class B GUI

The AC Induction Motor Vector Control module receives commands through a Panel Class B GUI. Based on the input, the motor speed is controlled.

I^{2}C Communication with DAC

The MC Library APIs allows I^{2}C communication with DAC, which in turn measures the motor parameters on Cathode Ray Oscilloscope (CRO) or is used for debugging.

Constant Speed Mode and Constant Torque Mode of Operation

The MC Library consists of Proportional Integral (PI) loop which operates by maintaining constant speed or constant current depending on the user input when configuring the library. This provides the flexibility to run the motor either in torque mode or speed mode.

BLDC Control Mode Utilizes Back-EMF Sensing PLL Approach

The MC Library utilizes the PLL based approach for locking to the back-EMF signal during startup phase. This eliminates the need for initial placement of the rotor in a specific position. It also reduces the jerky movement of the motor during startup or direction reversal.

AC Induction Motor Utilizes Vector Control Approach

Vector Control approach decouples the orthogonal component of current in induction motor into magnetizing current and torque producing current. Thus, each component can be controlled individually providing higher efficiency, fast response, and low-operating costs.

Utilizes Integrated Operational Amplifier of Z8FMC16100 MCU

The MC Library APIs utilize the integrated operational amplifier of Z8FMC16100 MCU which converts the current signal to a voltage signal resulting in a simpler hardware design.

Architecture

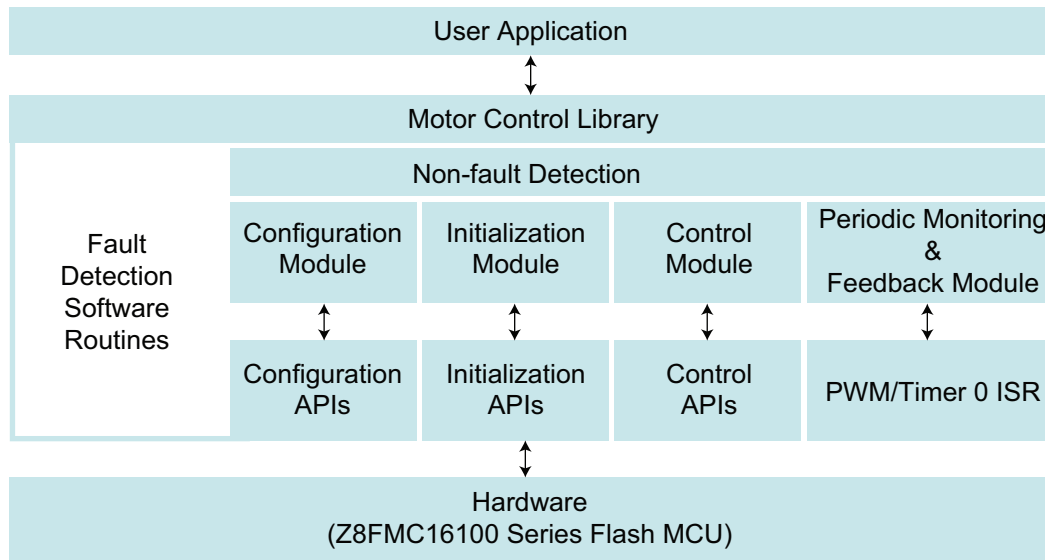Figure 2 illustrates the architecture of MC Library v2.0.0.

User Application
Motor Control Library

Figure 2. Motor Control Library Architecture

MC Library v2.0.0 is divided into the following segments based on their functionality:

- Fault detection
- Non-fault detection

Each segment is briefly described below.

Fault Detection

The fault detection segment consists of software routines that checks for hardware faults (for example, RAM and Flash faults) in the system. If a fault is detected, motor is stopped to prevent any unintended operation.

For fault detection, some tests are performed during startup while other tests are run periodically to detect the run-time faults. For more details on faults, theory of detection, and response to each fault, refer *Implementation of Class B Features White Paper (WP0016)* available for download at www.zilog.com.

Non-Fault Detection

The non-fault detection segment consists of the following modules.

Configuration Module

The configuration module allows you to configure the library with default values and set the motor control operation mode. This module also performs an initial test to detect any fault in RAM or CPU register during startup. If a fault is detected, the motor is brought to a stop to prevent any unintended operation resulting from a fault.

Initialization Module

The initialization module allows you to initialize the on-chip peripherals required to drive motor like operational amplifier, comparator, Timer0 ISR, ADC, and Pulse Width Modulator.

Control Module

The control module allows you to control functional parameters of the motor like speed and direction.

Periodic Monitoring and Feedback Module

Periodic monitoring and feedback module consists routines to monitor the motor condition based on the feedback. Based on the feedback, this module adjusts the PWM duty cycle.

This module also controls the direction switching of the motor and performs periodic tests to detect any fault in system during run time. If a fault is detected, the motor is brought to a stop to prevent any unintended operation resulting from a fault.

Development Tools

MC Library v2.0.0 is supported by ZiLOG Developer Studio (ZDS II v4.10.0) which provides compiling, debugging, and project building capabilities for the quick and efficient development of motor control applications. ZDS II v4.10.0 and related documents are available for free download at www.zilog.com.

Packaging

The MC Library v2.0.0 package is available for Z8FMC16100 MCUs and supplied as a 'C' source library module along with a sample application.

Sample Application

A sample motor control application interfaces with the MC Library APIs to access the on-chip peripherals on Z8FMC16100 Series of MCUs for controlling the BLDC or an AC Induction Motor.

Related Documents

The following documents provide detailed description, function, and usage of MC Library:

- *Motor Control Library Quick Start Guide (QS0056)*—Provides an overview and installation of MC Library.

- *Motor Control Library API Reference Manual (RM0046)*—Provides a comprehensive description of the APIs and enumerations.

- *Motor Control Library User Manual (UM0199)* —Provides the calling sequence of the APIs along with a sample application.

This publication is subject to replacement by a later edition. To determine whether a later edition exists, or to request copies of publications, please visit www.zilog.com.

Feedback

For any comments, detail technical questions, or reporting problems, please visit ZiLOG's Technical Support at http://support.zilog.com.

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