Select Freescale Solutions for Your Application

Find the right device based on your requirements

Overview

Selection of an embedded MCU for motor control applications requires a developer to consider multiple parameters. Nowadays, motor control applications are not dedicated drives for rotating machines but have become complex systems including several interfaces, real-time operating systems, high-performance peripherals and other elements.

Freescale offers MCUs designed for motor control applications that range from low-end to high-end devices covering most performance and peripheral requirements.

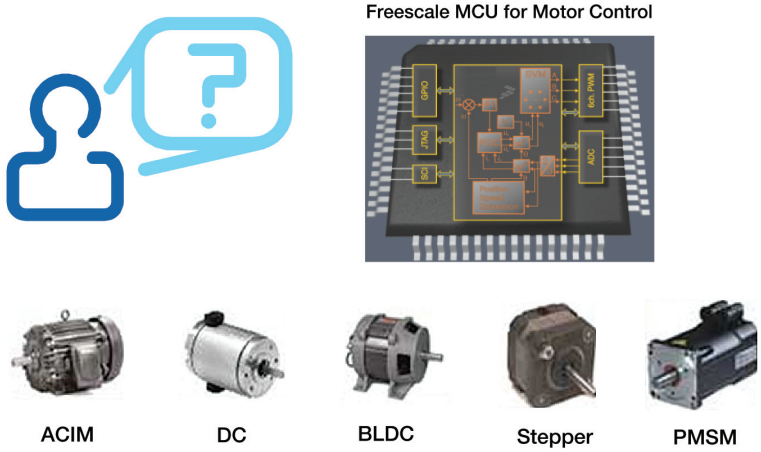
For consumer, industrial and appliance drives, Freescale offers MCUs based on S08, DSC, Power Architecture® technology, and Kinetis MCUs based on ARM® Cortex™-M0+ and Cortex™-M4 cores.

Requirements

The definition stage of a new motor control project is one of the most important parts of the application development process. These parameters should be considered when selecting an MCU:

- Target applications: fan, pump, washer, dryer, servo, general control, industrial control, etc.
- Motor type: PMSM, ACIM, BLDC, SRM, stepper motor
- Required speed or torque accuracy
- Speed/position sensor
  - Mechanical sensor (Hall sensors, quadrature encoder, tacho generator, SinCos)
  - Sensorless
  - Open loop without actual speed feedback
- Control algorithm: BLDC commutation control, sinusoidal scalar control, sinusoidal vector control
- Memory requirements: RAM/ flash space required for specific applications
- Real-time operating system (RTOS)
- Preferred core: 8-, 16- or 32-bit
- Safety standards (i.e., appliance safety IEC60730 standard)

Figure 1: Freescale MCU for Motor Control



Application Complexity

The typical motor control application can be divided into two parts: the motor control algorithms and the application dependent code. The motor control algorithms are almost identical for a certain type of motor and a selected control technique. They do not depend on the application type. On the other hand, the application dependent code is designed individually for a dedicated application and includes user interfaces, communication protocols, safety features and additional state machine functionality.

Complexity of the motor control algorithms can be divided into several segments based on initial requirements. The following segmentation of a typical motor control application defines the main groups which contain a list of peripherals, memory sizes and typical applications as well as MCU cores which are recommended to run certain control algorithms.

1. Very Low-End Segment

Motor types related to this segment are single-phase AC, DC and universal motors. The motor is controlled with low dynamics, such as slow changes in the control loop. The closed loop, if implemented, is usually only one speed loop or the motor is driven in an open loop.

MCU requirements

- CPU speed <= 32 MHz
- Timer with three-phase output PWM capability
- Single ADC
- Comparator
- Package <= 32 pins
- Flash memory 8–32 KB

Freescale S08 MCUs and Kinetis MCUs based on the ARM Cortex-M0+ core are suitable for such applications.

2. Low-End Segment

This segment covers PM synchronous, AC induction and BLDC motors that are used in low dynamic, sensor or sensorless applications.

The MCU core is capable to run the FOC algorithm and the timer is capable of generating three-phase sinusoidal or trapezoidal PWM signals.

MCU requirements

- CPU speed <= 50 MHz
- Timer with three-phase output PWM capability
- Single ADC (with two sample and hold modules for FOC)
- Comparator with DAC
- Package <= 32 pins
- Flash memory 12–32 KB

Freescale MCUs, DSCs and Kinetis MCUs based on the ARM Cortex-M0+ core are suitable for such applications.

3. Middle Segment

The type of application related to this segment is sensorless control of PM synchronous and AC induction motors. The MCU core is sufficient for performing high dynamic, FOC algorithms with optional power factor correction (PFC) routines. The core supports fast mathematical operations (one cycle multiplication) and DSP instructions.

MCU requirements

- CPU speed 50–100 MHz
- Timer with three-phase output PWM capability
- Dual ADC capable parallel sampling
- Comparator with DAC
- Quadrature decoder
- Package 32–64 pins
- Flash memory 32–100 KB

Freescale MCUs, DSCs and Cortex-M4 cores are suitable for such applications.

4. High-End Segment

High-end motor control applications predominantly comprise of PMSM or ACIM high dynamic field-oriented sensorless control and servo drives. The control algorithms are very complex and computed in high precision arithmetic. Control loops can contain an outer position loop that is implemented apart from conventional speed and current controllers. The PFC is required. The MCU performance is capable to control two motors independently.

MCU requirements

- CPU speed: 150+ MHz
- Floating point unit (FPU)
- Timer with three-phase output PWM capability
- 4x fast ADC capable parallel sampling for dual motor control
- Comparator with DAC
- Quadrature decoder
- Ethernet
- Advanced UART
- Package 64–144 pins
- Flash memory 512 KB–2 MB

Freescale MCUs, DSCs, Cortex-M4 and Power e200 cores with FPU are suitable for such applications.

Figure 2: Motor Control Applications

Very Low End	Low End	Middle End	High End
On/Off motors	Pumps	Washers and dryers	Complex industrial drives
Single-phase motors	Residential compressors	Commercial compressors	Dual motor control
Hand and power tools	Fans	Industrial drives	Servo drives
Food processor	Respiratory	HVAC	Military drives

Design Considerations

These additional factors should be considered when selecting an MCU:

- Future system extension: reserved memory space for firmware update
- Device package: pin-to-pin compatible devices enable simple upgrade to a higher performance device when system requirements increase
- Power consumption: MCU for battery supplied applications should have lower power consumption to increase battery life
- On-chip peripherals: analog and digital peripherals can reduce the use of external components like comparators, program gain amplifiers and independent clock source
- Application support: available example applications can speed code development
- Available hardware and software tools using Tower System kits enable the preparation of application code while the final hardware s designed

Conclusion

Choosing the right device for the application is the key factor for a successful design concept. The selection guide, reference designs, hardware and software tools help to simplify the process. For more information, visit **freescale.com/motorcontrol**.

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