

Freescale System Solutions

Motor Control Technologies

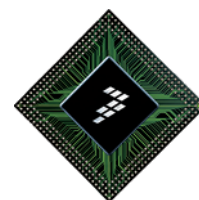




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Freescale Solutions for Motor Control Technologies

Comprehensive 8-, 16- and 32-bit systems with advanced sensor and analog/mixed signal devices

- Freescale offers complete solutions for every motor control application. Our superior portfolio and breadth of devices includes:
- 8-bit microcontrollers (MCUs)
 - 16-bit digital signal controllers (DSCs)
 - 32-bit embedded controllers
 - Acceleration and pressure sensors
 - Analog and mixed signal devices

Freescale delivers solutions that have wide ranging banks of flash and RAM memories, configurable timer options, pulse width modulators (PWMs), and some even offer an enhanced Time Processing Unit (eTPU).

Freescale supports these devices with motor control-related application notes, hardware/software tools, drivers, algorithms and helpful Web links including our motor control Web site at www.freescale.com/motorcontrol. We are dedicated to providing comprehensive system solutions that not only improve motor efficiency but also minimize system updates, development time and maintenance costs.

Freescale provides microcontrollers and development tool solutions for all of your motor control needs.

Freescale Motor Control Solutions
 A full range of products, technology, services and tools

Complexity	Devices	Analog	Sensors	Flash Technology	Hardware and Software Tools: Motor Control Drivers and Algorithms; Design Tools: FreeMASTER, Processor Expert™, QUICKSTART
HIGH	• Power Architecture® MPC5500 family • Power Architecture MPC500 family • ColdFire® family	• eXtreme switch • Power actuation	• Low-g accelerometers		
UPPER-MID	• ColdFire family • 56F8300/8100 digital signal controllers (DSC)	• Motion control • Power management	• Pressure		
MID	• 56F8000/56F800 DSC family • S12X 16-bit family	• QUICCsupply	• E-Field		
LOW	• HCS08 low-voltage, low-power family • RS08 family	• I/O expansion			

Expertise
 Application Notes
 Analog and Sensors

Demos
 Development Tools

MCUs, MPUs and DSCs
 Software and Drivers

Reference Designs
 Online Training

Web Site
 Technical Support

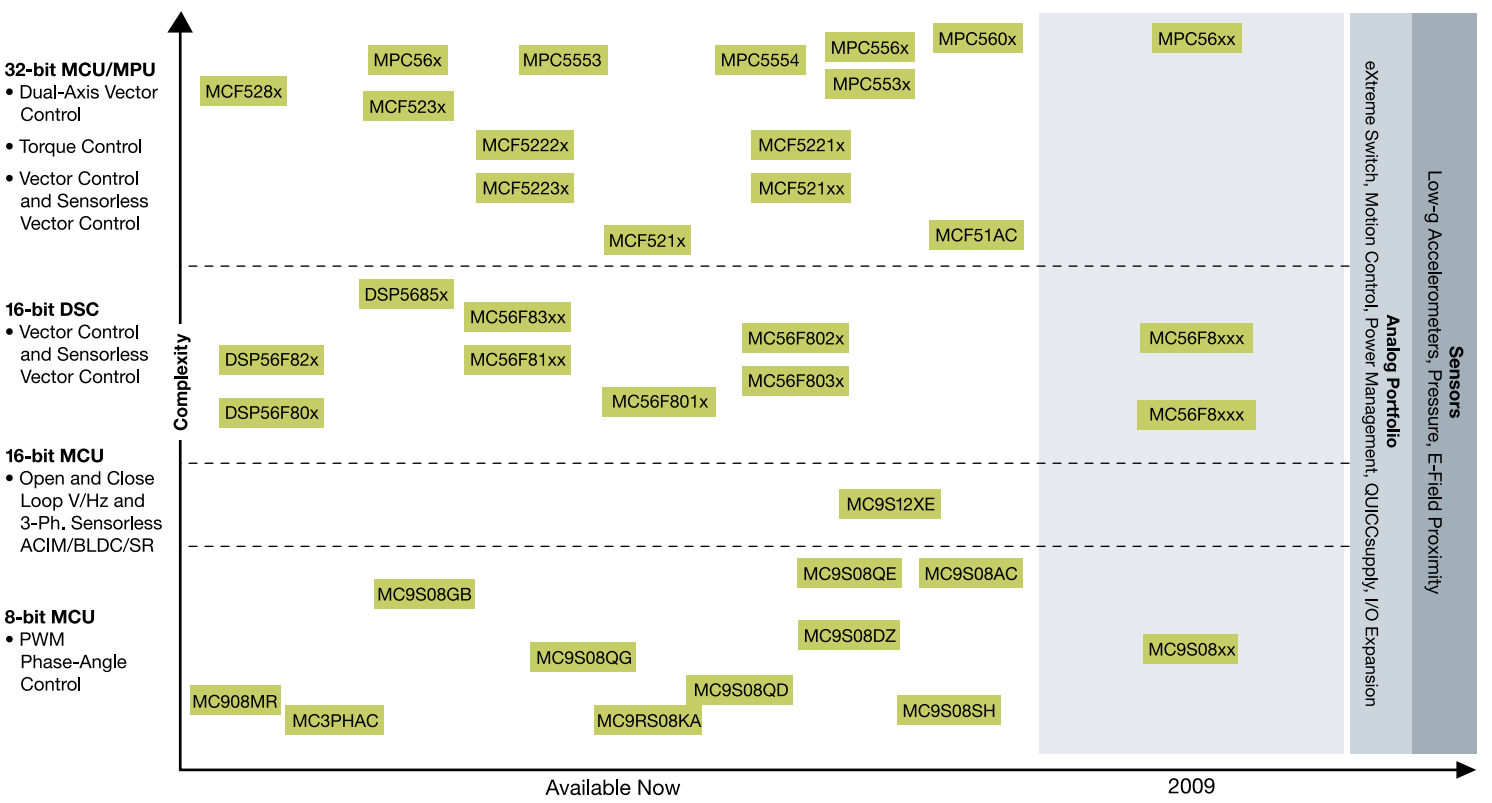
Freescale's Complete Motor Control Solution

A Roadmap for Your Future Design Needs

Intelligent solutions driving new generations of motor control applications

Freescale MCUs, MPUs and DSCs, when coupled with analog/mixed-signal and power integrated circuits, are designed to provide system solutions for motor control, motion control and static load control for an incredible variety of applications.

The product roadmaps demonstrate that new feature integration and software compatibility will continue to drive future generations of embedded motor control solutions.



Motor Control Applications

Motor type/control solution matrix

Technology	Motor Control Applications									
	Refrigeration Compressors	Washers/Dryers	Pumps/Fans/Blowers	Industrial Factory Floor	CNC Tool and Dye, Health Care Scanners	Garage Door Openers	Hand Tools	Kitchen Contertop Appliances	Computers, Office Equipment	Toys
	Universal Motor	8-bit				8-bit	8-bit	8-bit		
	Brush DC Motor					8-bit	8-bit	8-bit		8-bit
	Low-Performance DC Servo				8-bit				8-bit	8-bit
	Switched Reluctance	8-bit	8-bit							
	Stepper Control				8-bit 16-bit				8-bit 16-bit	8-bit
	High-Performance DC Servo			16-bit	16-bit				16-bit	16-bit
	AC Induction Scalar-Slip Control	8-bit	8-bit 16-bit	8-bit 16-bit	8-bit 16-bit		8-bit			
	BLDC Commutated Control	8-bit 16-bit	8-bit 16-bit	8-bit 16-bit			8-bit	8-bit		8-bit
Permanent Magnet AC Field Oriented Control	16-bit	16-bit 32-bit	16-bit 32-bit	16-bit 32-bit	16-bit 32-bit					
AC Induction Field Oriented Control	16-bit	16-bit 32-bit	16-bit 32-bit	16-bit 32-bit	16-bit 32-bit	16-bit				
Technology/Application Match			Good		Moderate		Poor			

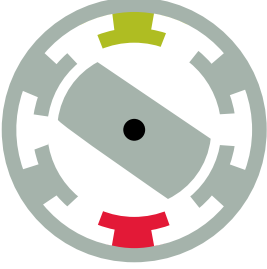
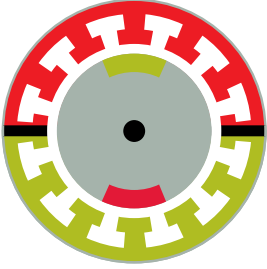
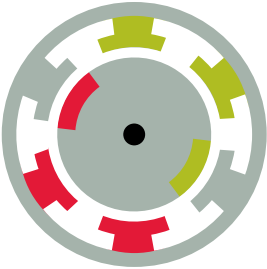
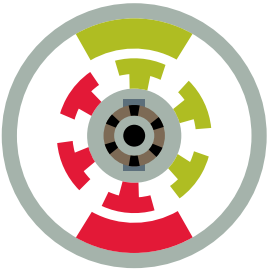
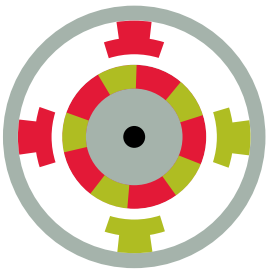
Note: There are numerous possibilities of matches between a technology and an application other than what is shown in this table. This is intended to be a high-level guide, but it is not all-inclusive.

The Broadest Selection of Motor Control Solutions

For multiple electric motor topologies

When designing motor control systems, instruction set efficiency and sophisticated peripherals that are specifically tuned for electric motor control environments provide the greatest performance advantages. Freescale provides comprehensive motor control solutions for virtually all electric motor topologies. In the following pages we feature recommended devices—from 8-, 16- and 32-bit embedded processors to analog/mixed signal power ICs—as well as demonstration boards and reference designs for each electric motor system listed at right.

Freescal has an extremely broad selection of embedded controller solutions for motor control applications. We give you the option to choose the system components that meet your specific electronic motor design needs.



Stepper Motor

Stepper motors are used to produce incremental, noncontinuous motion, and are used primarily for precise position control. Stepper motor application examples and information can be found on pages 6, 7 and 8 of this brochure.

Brushed DC Motor

Permanent magnet DC motor with rotor windings connected via “brushes” to a mechanical commutator. Brushed DC motor application examples and information can be found on page 9.

Brushless DC Motor (BLDC)

BLDC motors have a classic three-phase stator and a rotor with surface-mounted permanent magnets, and are driven by electronically switching the stator winding connections with a rectangular waveform in accordance with rotor position. BLDC application examples and information can be found on pages 10, 11 and 12.

AC Induction Motor (ACIM)

AC induction motors have a classic three-phase stator, and commonly have a “squirrel cage” rotor in which the conductors are shorted together at both ends. ACIM application examples and information can be found on pages 13, 14 and 15.

Permanent Magnet Synchronous Motor (PMSM)

Similar to BLDC motors, permanent magnet synchronous motors have a classic three-phase stator and a rotor with surface-mounted permanent magnets. The construction differs from BLDC motors in they are driven by electronically switching the stator winding connections with a sinusoidal waveform in accordance with rotor position. PMSM application examples and information can be found on pages 16, 17, and 18.

Switched Reluctance Motor

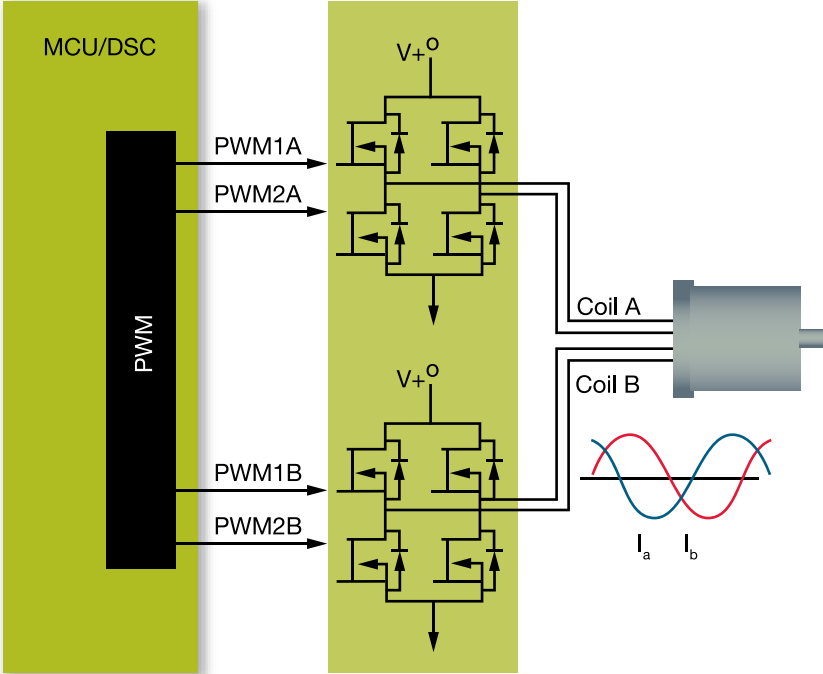
SR motors contain no magnets (mainly stamped metal elements), and are constructed such that both the stator and rotor have salient poles. The motor is driven by a sequence of current pulses applied at each phase, which requires control electronics for operation. SR motor application examples and information can be found on page 19.

Stepper Motors

General purpose stepper motor control

- Advantages**
- Precise position control

- Applications**
- Industrial machines
 - Health care scanners
 - Computers
 - Office equipment
 - Toys



Recommended Devices

8-bit MCU: 908JK/JL, 908MR, 908QT/QY, 908QB, 908QC, 908GP, 908GR, 9S08AW, 9S08GB, 9S08GT, 9S08QG, 9S08QD

16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx

32-bit MCU: MCF51AC, MCF521x, MCF523x, MPC56x, MPC55xx

Analog/Mixed-Signal Power ICs

Power Supply: MC34702, MC34717, MC33730

Motor Driver: MC33932, MC34920, MC34921, MC34923, MPC17533, MC33887, MC33899, MC33926, MC33931, MPC17529, MPC17531, MM908E626

Application Notes

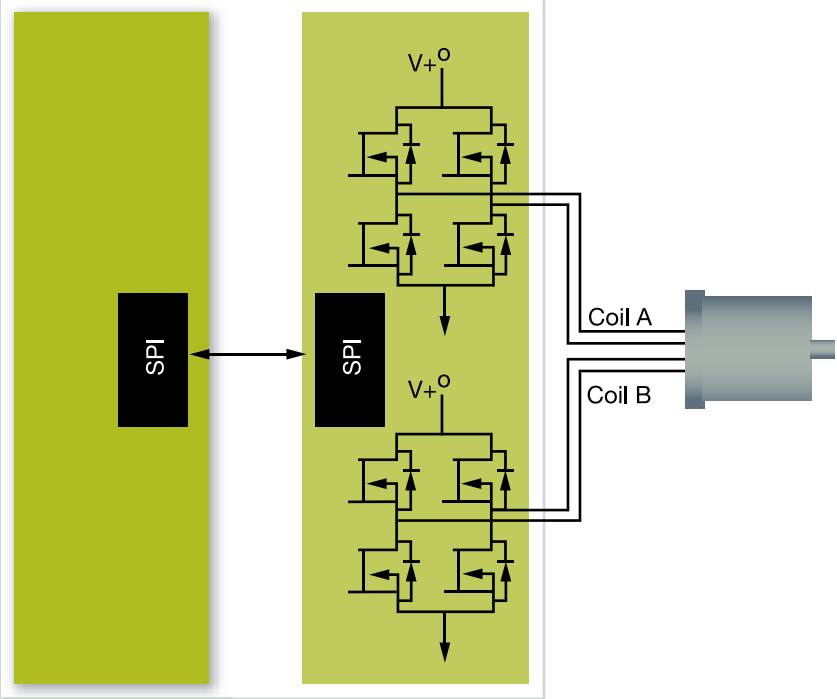
- | | |
|--------|---|
| 32-bit | AN2353 The Essentials of the Enhanced Time Processing Unit |
| | AN2848 Programming the eTPU |
| | AN2869 Using the Stepper Motor (SM) eTPU Function |

Stepper Motors

Intelligent power

- Advantages**
- Precise position control

- Applications**
- Industrial machines
 - Health care scanners
 - Computers
 - Office equipment
 - Toys



Reference Designs

- | | |
|----------------------|---|
| RD68HC908LHID | LIN-bus HID Lamp Leveling Stepper Motor Control Using the Freescale 908E625 |
|----------------------|---|

Recommended Devices

8-bit MCU: 9S08E6xx

Analog/Mixed Signal Power ICs

Motor Driver: MM908E621, MM908E625, MM908E626

Stepper Motors

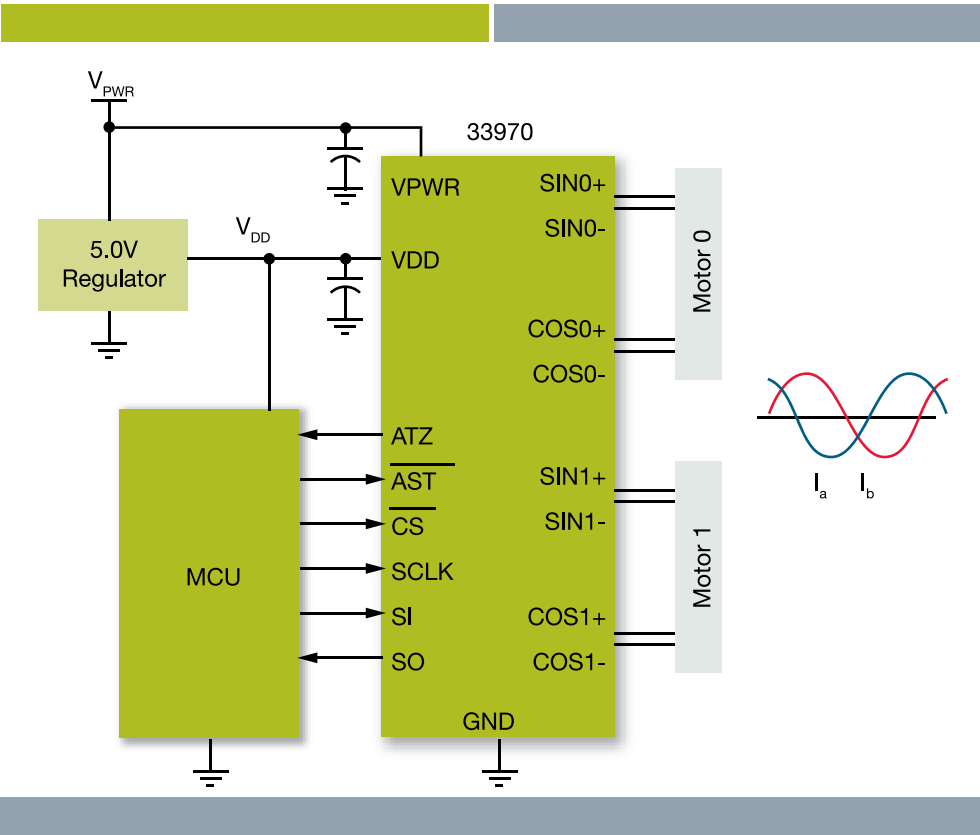
Micro-stepped gauge drivers

Advantages

- Precise position control

Applications

- Industrial machines
- Health care scanners
- Computers
- Office equipment
- Toys



Recommended Devices

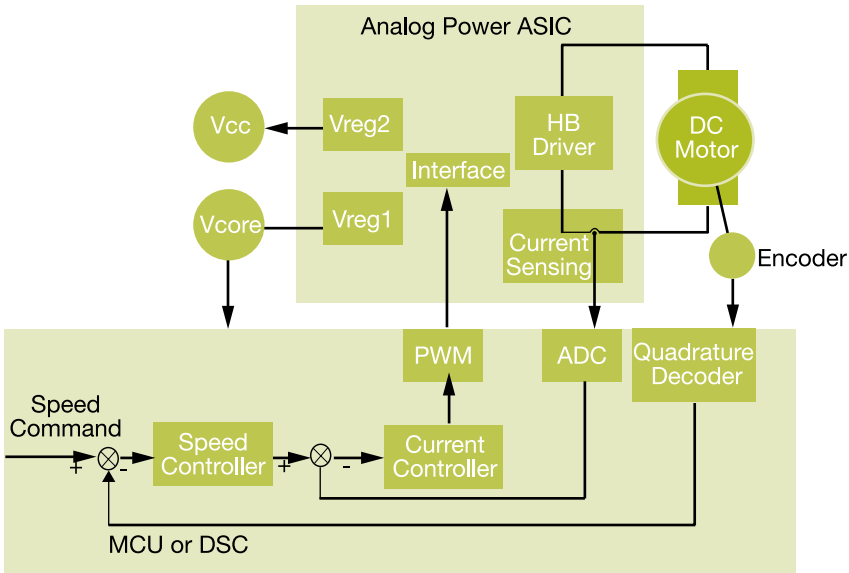
Analog/Mixed-Signal Power ICs: MC33970, MC33976, MC33977, MC33991

Application Notes

- 32-bit **AN2353** The Essentials of the Enhanced Time Processing Unit
- AN2848** Programming the eTPU
- AN2869** Using the Stepper Motor (SM) eTPU Function

Brushed DC Motor

Dual feedback loop control



Application Notes

- 32-bit **AN2955** DC Motor with Speed and Current Closed Loops, Driven by eTPU on MCF523x AN2955SW
- AN2958** Using the DC Motor Control eTPU Function Set (Set 3)
- AN3008** DC Motor with Speed and Current Closed Loops, Driven by eTPU on MPC5554 AN3008SW

Advantages

- Cost-effective control topology
- High-precision speed, torque control and position loop can be added

Applications

- Robots
- Traction control
- Servo systems
- Automotive
- Office equipment
- Toys
- Industrial machines

Recommended Devices

8-bit MCU: 908MR, 9S08GB, 9S08AC

16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx

16-bit MCU: S12XE

32-bit MCU: MCF51AC, MCF521x, MCF523x, MPC56x, MPC55xx

Analog/Mixed-Signal Power ICs

Power Supply: MC34702, MC34717, MC33730, MC34923

Motor Driver: MPC17510, MPC17529, MPC17531, MPC17533, MC34920, MC34921, MC33926, MC33887, MC33899, MC33931, MC33932

Brushless DC Motor (BLDC)

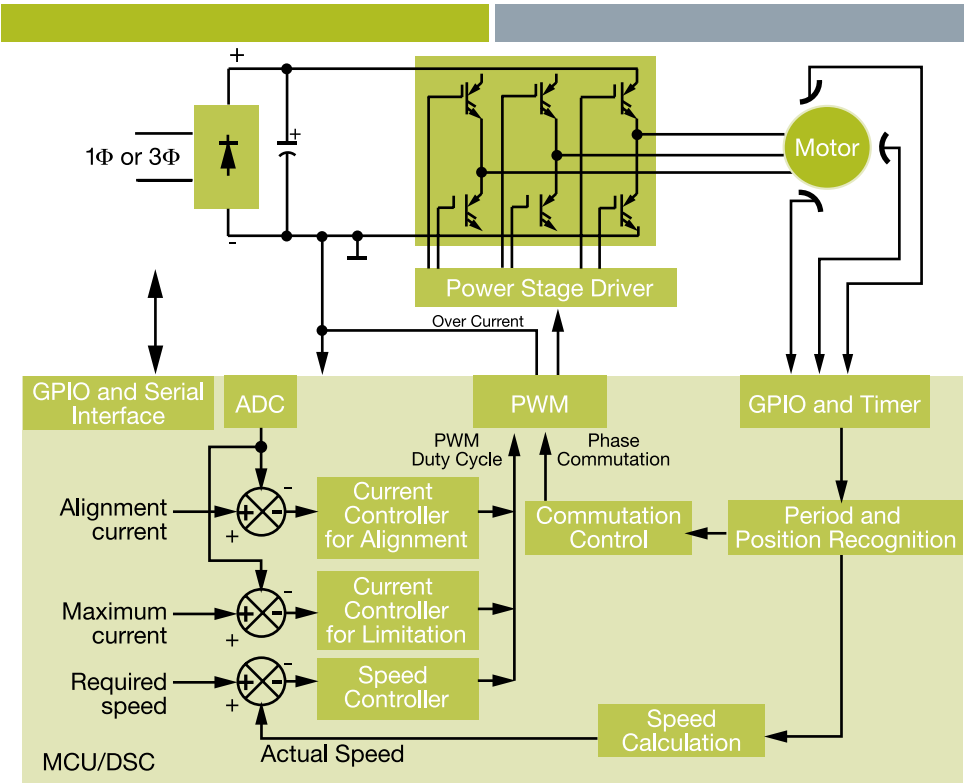
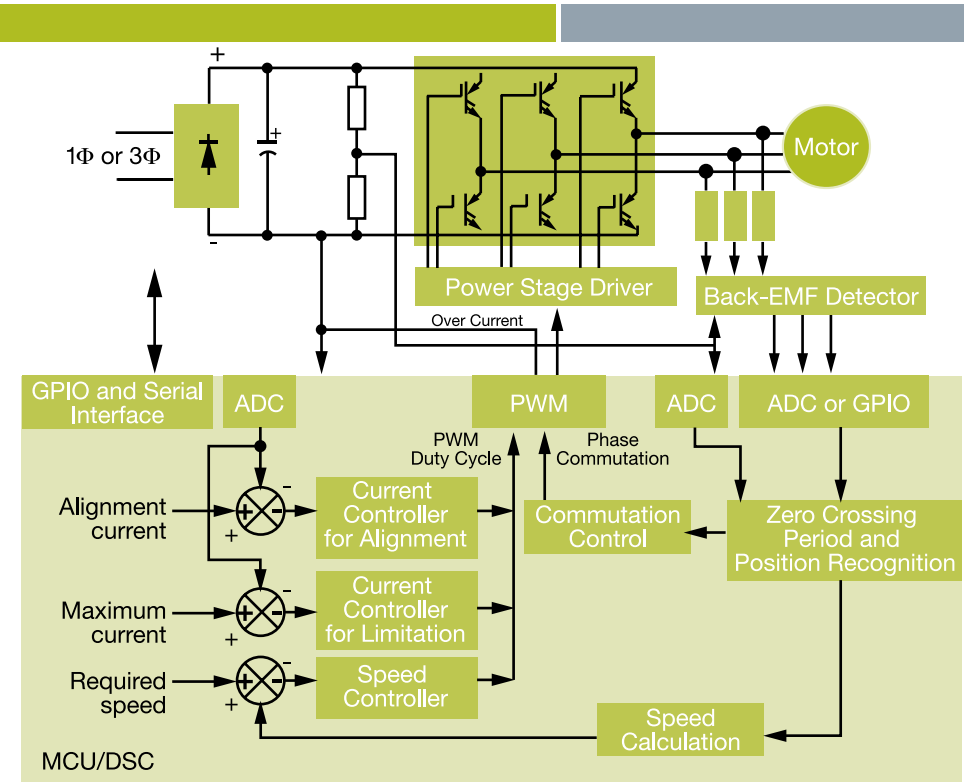
Sensorless back EMF/Hall sensor

Advantages

- Enables bi-directional operation with fast torque response
- Low noise, high efficiency
- Removes the position sensor
- Cost-effective control topology
- Speed and torque control

Applications

- Industrial control
- Large appliances
- HVAC
- Compressors
- Blowers
- Toys
- Pumps
- Health care equipment



Application Notes

8-bit	AN2356 Sensorless BLDC Motor Control on MC68HC908MR32 Software Porting to Customer Motor AN2355 Sensorless BLDC Motor Control on MC68HC908MR32 Software AN1858 Sensorless Brushless DC Motor Using the MC68HC908MR32 Embedded Motion Control AN1853 Embedding Microcontrollers in Domestic Refrigeration Appliances AN2396 Servo Motor Control Application on a Local Area Interconnect Network (LIN) DRM086 Sensorless BLDC Motor Control Using MC9S08AW60
Development System	AN1913 3-Phase BLDC Motor Control with Sensorless Back-EMF ADC Zero Crossing Detection Using DSP56F80x AN1914 3-Phase BLDC Motor Control with Sensorless Back EMF Zero Crossing Detection Using DSP56F80x AN1961 3-Phase BLDC Motor Control with Quadrature Encoder Using 56F800/E DRM078 3-Phase BLDC Drive Using Variable DC Link Six-Step Inverter DRM070 3-Phase BLDC Motor Sensorless Control using MC56F8013/23
16-bit	
32-bit	AN2892 3-Phase BLDC Motor with Speed Closed Loop, Driven by eTPU on MCF523x AN2892SW AN2948 Three 3-Phase BLDC Motors with Speed Closed Loop, Driven by eTPU on MCF523x AN2948SW AN2954 BLDC Motor with Speed Closed Loop and DC-Bus Break Controller, Driven by eTPU on MCF523x AN2954SW AN2957 BLDC Motor with Quadrature Encoder and Speed Closed Loop, Driven by eTPU on MCF523x AN2957SW AN3005 BLDC Motor with Quadrature Encoder and Speed Closed Loop, Driven by eTPU on MPC5554 AN3005SW AN3006 BLDC Motor with Hall Sensors and Speed Closed Loop, Driven by eTPU on MPC5554 AN3006SW AN3007 BLDC Motor with Speed Closed Loop and DC-Bus Break Controller, Driven by eTPU on MPC5554 AN3007SW

Reference Designs

Sensorless Back EMF	
RD68HC908BLDCZC	Sensorless BLDC Motor Control Using the MC68HC908MR32
RDDSCSENSORLESSBLDC	3-Phase Brushless DC Motor Sensorless Control Using 56F801X
RDDSCSNSLESSBLDCAW60	3-Phase BLDC Motor Sensorless Control Using MC9S08AW60
RDDSP56F8BLDCAZC	3-Phase BLDC Motor Control with Sensorless Back-EMF ADC Zero Crossing Detection Using 56F80X or 56F8300 Digital Signal Controllers
Hall Effect Feedback	
RD56F801XBLDCHS	3-Phase BLDC Motor Control with Hall Sensor Using 56F801X Digital Signal Controllers
RD68HC908BLDCHS	3-Phase BLDC Drive Control with Hall Sensors
RDDSP56F8BLDCHS	3-Phase BLDC Motor Control with Hall Sensor Using 56F80X or 56F8300 Digital Signal Controllers
RD68HC908BLDCFPC	MC68HC908QT2 BLDC Fan for PCs Reference Design
RD68HC908NGCD	High-Voltage BLDC Drive for Domestic Appliances Using the MC68HC908MR8
RDDSC3PHBLDCINV	3-Phase BLDC Drive using DC/DC Inverter on MC56F8013
RDHC908BLDCF	Low-Power BLDC Drive for Fans Using the MC68HC908QY4 MCU

Recommended Devices

8-bit MCU: 908MR, 9S08AC, 9S08GB, 9S08QD, 9RS08KA
16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx
16-bit MCU: S12XE
32-bit MCU: MCF51AC, MCF521x, MCF523x, MPC56x, MPC55xx
Analog/Mixed-Signal Power ICs
Power Supply: MC34702, MC34717, MC33730
Motor Driver: MC33927, MC33937, MC34923

Brushless DC Motor (BLDC)

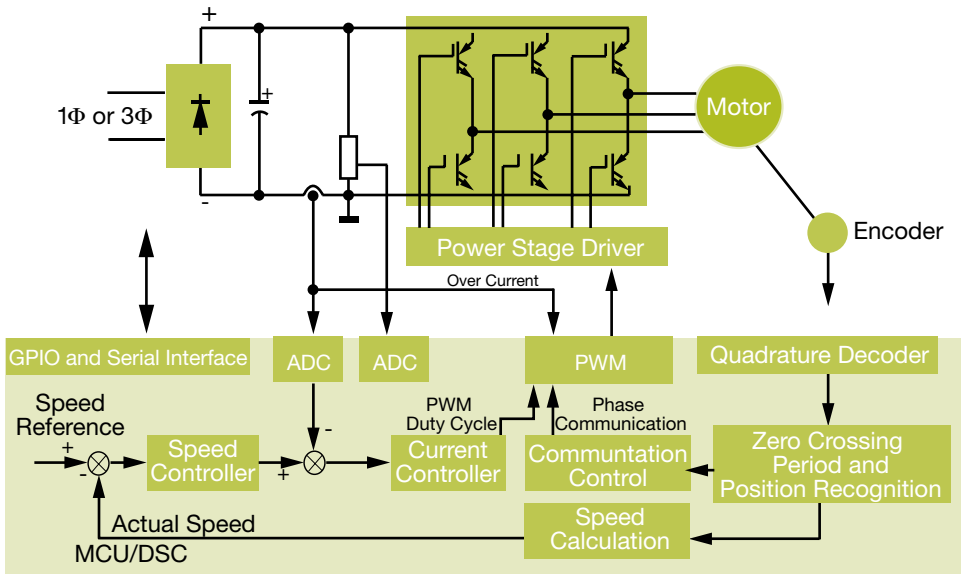
Encoder

Advantages

- Enables bi-directional operation with fast torque response, low noise and high efficiency
- High precision speed
- Torque control
- Position loop can be added

Applications

- Robots
- Traction control
- Servo systems
- Office equipment
- Sewing machines
- Fitness machines/treadmills
- Toys
- Industrial machines



Recommended Devices

8-bit MCU: 908MR, 9S08AC, 9S08GB

16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx

16-bit MCU: S12XE

32-bit MCU: MCF51AC, MCF521x, MCF523x, MPC56x, MPC55xx

Analog/Mixed-Signal Power ICs

Power Supply: MC34702, MC34717, MC33730

Motor Driver: MPC17533, MC34923, MC33937, MC33927

Application Notes

- 8-bit
- AN2356** Sensorless BLDC Motor Control on MC68HC908MR32 Software Porting to Customer Motor
 - AN2355** Sensorless BLDC Motor Control on MC68HC908MR32 Software
 - AN1858** Sensorless Brushless DC Motor Using the MC68HC908MR32 Embedded Motion Control
 - AN1853** Embedding Microcontrollers in Domestic Refrigeration Appliances
 - AN2396** Servo Motor Control Application on a Local Area Interconnect Network (LIN)
 - DRM086** Sensorless BLDC Motor Control Using MC9S08AW60

- Development System
- 16-bit
- AN1913** 3-Phase BLDC Motor Control with Sensorless Back-EMF ADC Zero Crossing Detection Using DSP56F80x
 - AN1914** 3-Phase BLDC Motor Control with Sensorless Back EMF Zero Crossing Detection Using DSP56F80x
 - AN1961** 3-Phase BLDC Motor Control with Quadrature Encoder Using 56F800/E
 - DRM078** 3-Phase BLDC Drive Using Variable DC Link Six-Step Inverter
 - DRM070** 3-Phase BLDC Motor Sensorless Control Using MC56F8013/23

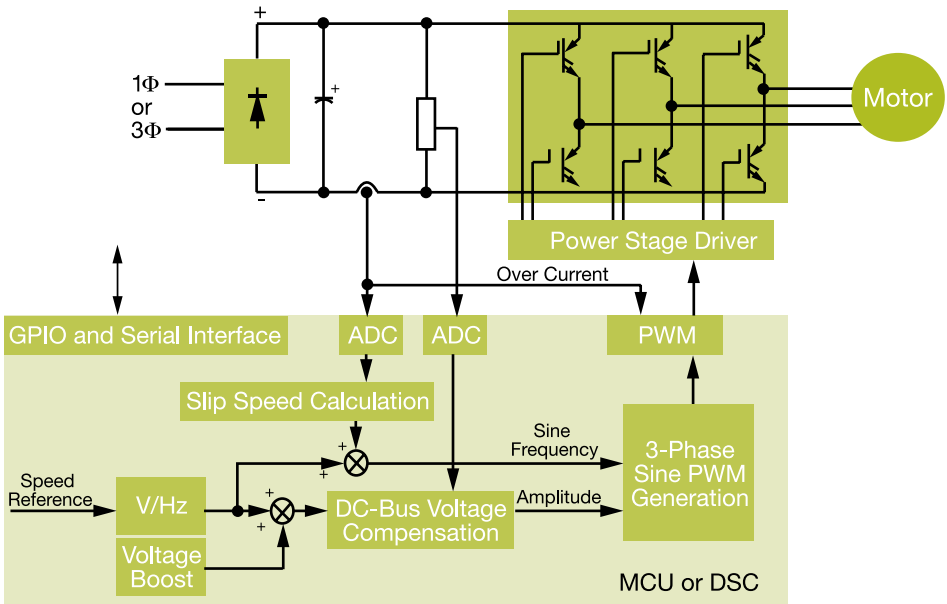
- 32-bit MCU
- AN2892** 3-Phase BLDC Motor with Speed Closed Loop, Driven by eTPU on MCF523x AN2892SW
 - AN2948** Three 3-Phase BLDC Motors with Speed Closed Loop, Driven by eTPU on MCF523x AN2948SW
 - AN2954** BLDC Motor with Speed Closed Loop and DC-Bus Break Controller, Driven by eTPU on MCF523x AN2954SW
 - AN2957** BLDC Motor with Quadrature Encoder and Speed Closed Loop, Driven by eTPU on MCF523x AN2957SW
 - AN3005** BLDC Motor with Quadrature Encoder and Speed Closed Loop, Driven by eTPU on MPC5554 AN3005SW
 - AN3006** BLDC Motor with Hall Sensors and Speed Closed Loop, Driven by eTPU on MPC5554 AN3006SW
 - AN3007** BLDC Motor with Speed Closed Loop and DC-Bus Break Controller, Driven by eTPU on MPC5554 AN3007SW

Reference Designs

RDDSP56F8BLDCE 3-Phase BLDC Motor Control with Encoder Using 56F80X or 56F8300 Digital Signal Controllers

AC Induction Motors (ACIM)

3-phase ACIM with V/Hz open-loop control with PFC



Application Notes

- 8-bit
- AN2154** Cost-Effective, 3-Phase, AC Motor Control System with Power Factor Correction Based on MC68HC908MR32
 - AN1857** 3-Phase, AC Motor Control System with Power Factor Correction Based on MC68HC908MR32
 - AN1664** Cost-Effective 3-Phase AC Motor Control System Based on MC68HC908MR32
 - AN1590** High-Voltage Medium Power Board for 3-Phase Motors
 - AN2149** Compressor Induction Motor Stall and Rotation Detection Using Microcontrollers
 - AN1853** Embedding Microcontrollers in Domestic Refrigeration Appliances

- 16-bit
- AN1918** Indirect Power Factor Correction for 3-Phase AC Motor Control with V/Hz Speed Open Loop Application
 - AN1930** 3-Phase AC Induction Motor Vector Control
 - AN1958** 3-Phase AC Motor Control with V/Hz Speed Closed Loop Using the 56F800/E
 - AN1942** DSP56F80x Resolver Driver and Hardware Interface
 - DRM092** 3-Phase AC Induction Vector Control Drive with Single-Shunt Current Sensing
 - AN3234** Washing Machine Three-Phase AC Induction Motor Drive

Advantages

- Enables bi-directional operation with fast torque response
- Simple cost-effective control topology
- Controls both motor and PFC by single MCU
- Targeted for modest applications accepting low-precision speed control
- High efficiency
- Precise speed control
- Enables indirect torque control
- Tolerant of motor parameters fluctuation

Applications

- Large appliances
- HVAC
- Blowers, fans
- Pumps
- Lifts, cranes, elevators
- Conveyors
- Frequency inverters
- Industrial controls
- Treadmills
- Industrial compressors
- Universal inverters

Recommended Devices

8-bit MCU: 908MR, 9S08AW, 9S08GB, 9S08QD

16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx

32-bit MCU: MCF51AC, MCF521x, MCF523x, MPC56x, MPC55xx

AC Induction Motors (ACIM)

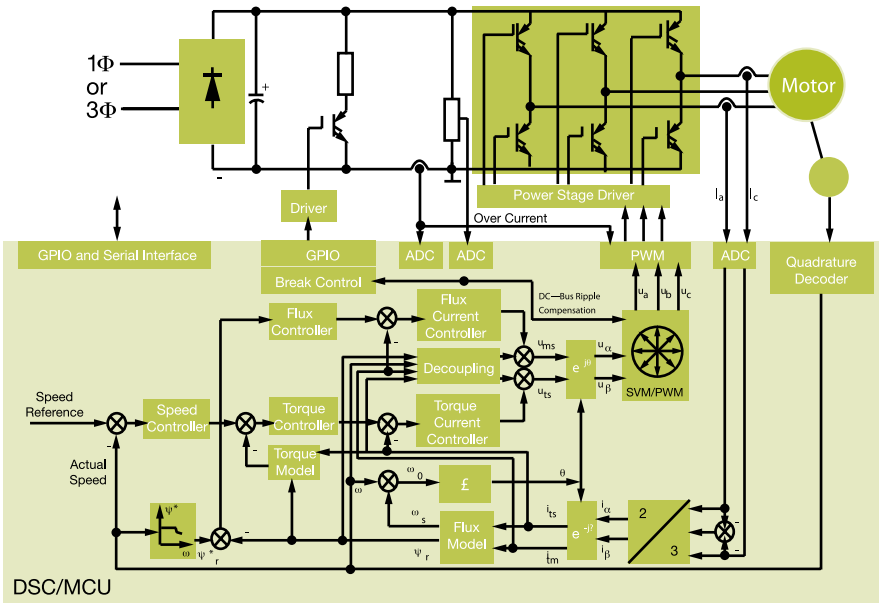
3-phase ACIM with field oriented control (sensored feedback)

Advantages

- Very high-precision speed/torque control
- Suitable for drives with high dynamic requirements
- Highly efficient

Applications

- Large appliances
- HVAC
- Blowers
- Fan, pumps
- Industrial controls
- Lifts, cranes, elevators
- Universal inverters
- Conveyors



Recommended Devices

16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx

32-bit MCU: MCF521x, MCF523x, MPC56x, MPC55xx

Application Notes

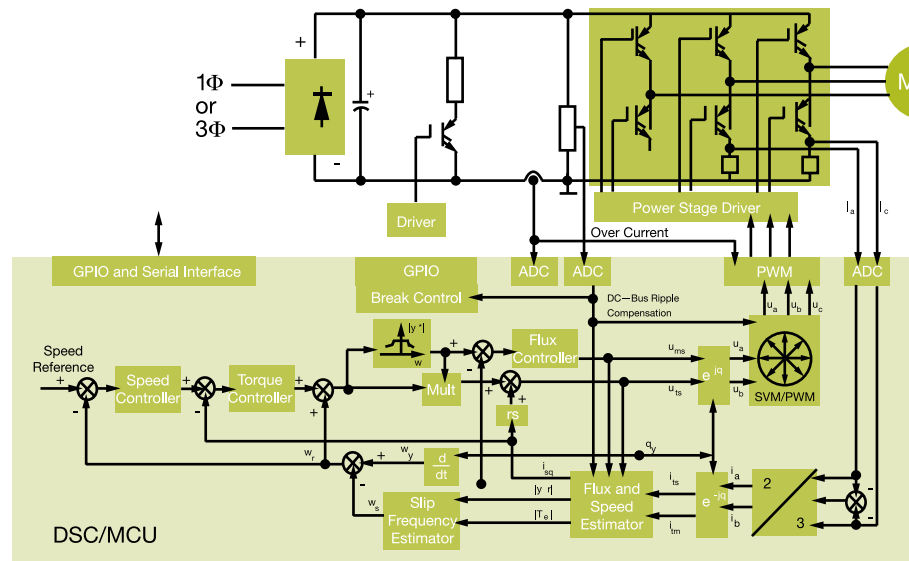
- 8-bit
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 - AN1958** 3-Phase AC Motor Control with V/Hz Speed Closed Loop Using the 56F800/E
 - AN1942** DSP56F80x Resolver Driver and Hardware Interface
 - DRM092** 3-Phase AC Induction Vector Control Drive with Single-Shunt Current Sensing
 - AN3234** Washing Machine Three-Phase AC Induction Motor Drive

Reference Designs

- RDDSCACIMVC** 3-Phase AC Induction Vector Control Drive with Single-Shunt Current Sensing
- RDDSP56F8ACVCD** 3-Phase AC Induction Motor Vector Control Using 56F80X or 56F8300 Digital Signal Controllers

AC Induction Motors (ACIM)

3-phase ACIM with sensorless field oriented control



Application Note

- 8-bit
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 - DRM092** 3-Phase AC Induction Vector Control Drive with Single-Shunt Current Sensing
 - AN3234** Washing Machine Three-Phase AC Induction Motor Drive

Reference Designs

- RD56F801XACIM** Design of an ACIM Vector Control Drive Using the 56F801X

Advantages

- High-precision speed/torque control
- Suitable for drives with high dynamic requirements
- Removal of speed sensor

Applications

- Large appliances
- Industrial compressors
- Water pumps
- Construction machinery
- Universal inverters
- HVAC

Recommended Devices

16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx

32-bit MCU: MCF521x, MCF523x, MPC56x, MPC55xx

Permanent Magnet Synchronous Motors (PMSM)

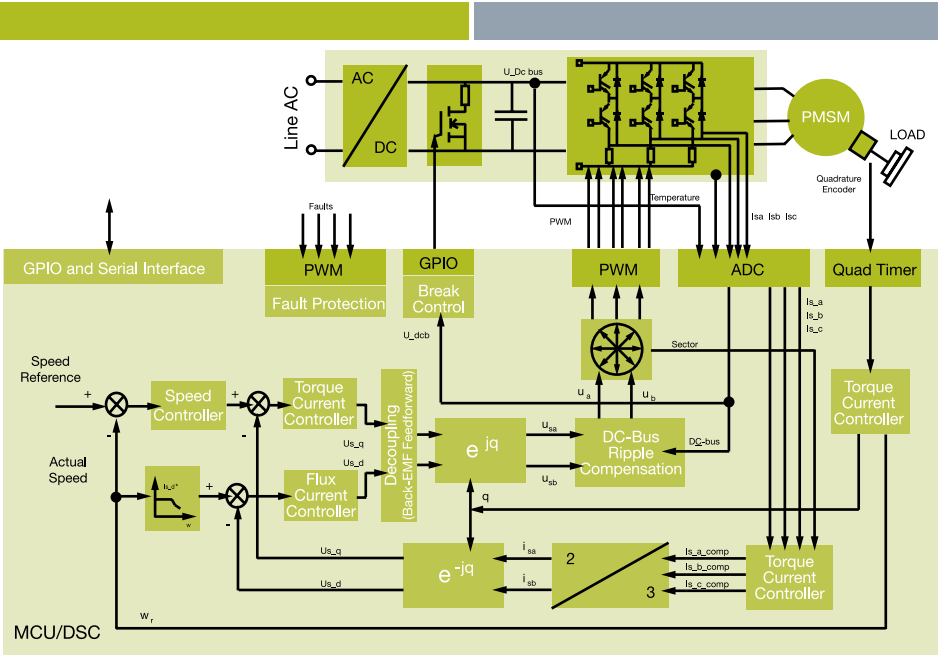
Sensored field oriented control

Advantages

- Exceptionally low noise operation
- Outstanding drive efficiency
- Precise speed/torque control

Applications

- Robotics
- Elevators
- Servo drivers
- Traction systems
- Industrial motion control
- Automotive



Recommended Devices

16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx

32-bit MCU: MCF521x, MCF523x, MPC56x, MPC55xx

Application Notes

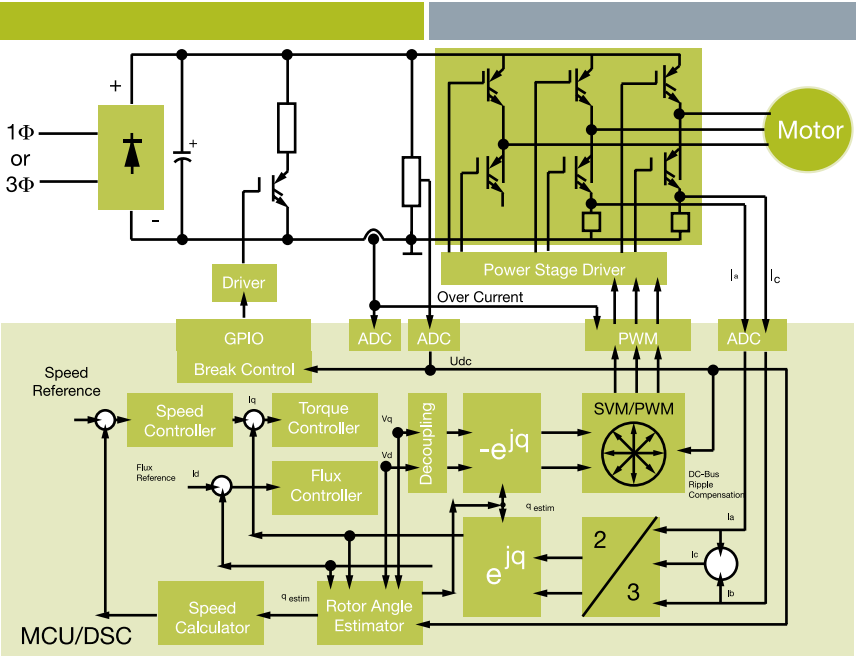
- 8-bit **AN2357** Sine Voltage Powered 3-Phase Permanent Magnet Motor with Hall Sensor
AN2149 Compressor Induction Motor Stall and Rotation Detection Using Microcontrollers
AN1853 Embedding Microcontrollers in Domestic Refrigeration Appliances
AN2396 Servo Motor Control Application on a Local Area Interconnect Network (LIN)
DRM036 Sine Voltage Powered 3-Phase Permanent Magnet Synchronous Motor with Hall Sensors
- 16-bit **AN1931** 3-Phase PM Synchronous Motor Vector Control
AN1942 DSP56F80x Resolver Driver and Hardware Interface
DRM102 PMSM Vector Control with Single-Shunt Current-Sensing Using MC56F8013/23
DRM099 Sensorless PMSM Vector Control with a Sliding Mode Observer for Compressors Using MC56F8013

Reference Designs

RD56F8300EMB	Electro-Mechanical Braking Using 56F8300 Digital Signal Controllers
RD56F8300EPAS	Electronic Power Assisted Steering (EPAS) with 56F8300 Digital Signal Controllers
RD56F8300FRBBW	FlexRay Brake-By-Wire Using 56F8300 Digital Signal Controllers
RDDSP56F8PMSDE	3-Phase PM Synchronous Motor Control with Quadrature Encoder Using 56F80X Digital Signal Controllers
RDDSP56F8SMTVC	3-Phase PM Synchronous Motor Torque Vector Control Using 56F80X or 56F8300 Digital Signal Controllers

Permanent Magnet Synchronous Motors (PMSM)

Low speed sensorless sinusoidal field oriented control



Application Notes

- 8-bit **AN2357** Sine Voltage Powered 3-Phase Permanent Magnet Motor with Hall Sensor
AN2149 Compressor Induction Motor Stall and Rotation Detection Using Microcontrollers
AN1853 Embedding Microcontrollers in Domestic Refrigeration Appliances
AN2396 Servo Motor Control Application on a Local Area Interconnect Network (LIN)
DRM036 Sine Voltage Powered 3-Phase Permanent Magnet Synchronous Motor with Hall Sensors
- 16-bit **AN1931** 3-Phase PM Synchronous Motor Vector Control
AN1942 DSP56F80x Resolver Driver and Hardware Interface
DRM102 PMSM Vector Control with Single-Shunt Current-Sensing Using MC56F8013/23
DRM099 Sensorless PMSM Vector Control with a Sliding Mode Observer for Compressors Using MC56F8013

Advantages

- Low-noise operation
- High drive efficiency
- High-precision speed/torque control
- Suitable for drives with high dynamic requirements
- Removal of speed sensor

Applications

- Appliances
- HVAC
- Compressors
- Blowers
- Industrial motion controls

Recommended Devices

16-bit DSC: MC56F80x, MC56F80xx, MC56F83xx

32-bit MCU: MCF521x, MCF523x, MPC56x, MPC55xx

Permanent Magnet Synchronous Motors (PMSM)

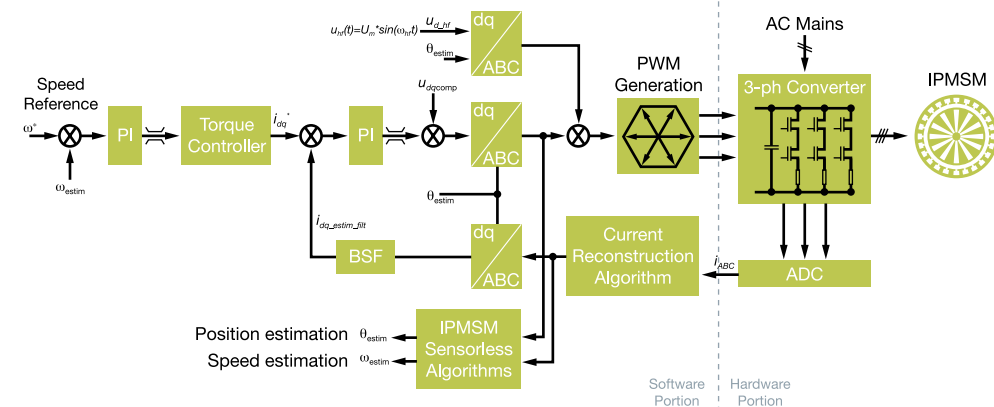
Sensorless sinusoidal field oriented control with zero speed torque capability

Advantages

- Low-noise operation
- High drive efficiency
- High-precision speed/torque control
- Suitable for drives with high dynamic requirements
- Removal of speed sensor

Applications

- Appliances
- HVAC
- Compressors
- Blowers
- Industrial motion controls



Recommended Devices

16-bit DSC: MC56F80x, MC56F80xx,
MC56F83xx

32-bit MCU: MCF521x, MCF523x,
MPC56x, MPC55xx

Analog/Mixed Signal Power ICs

Motor Driver: MC33927, MC33937

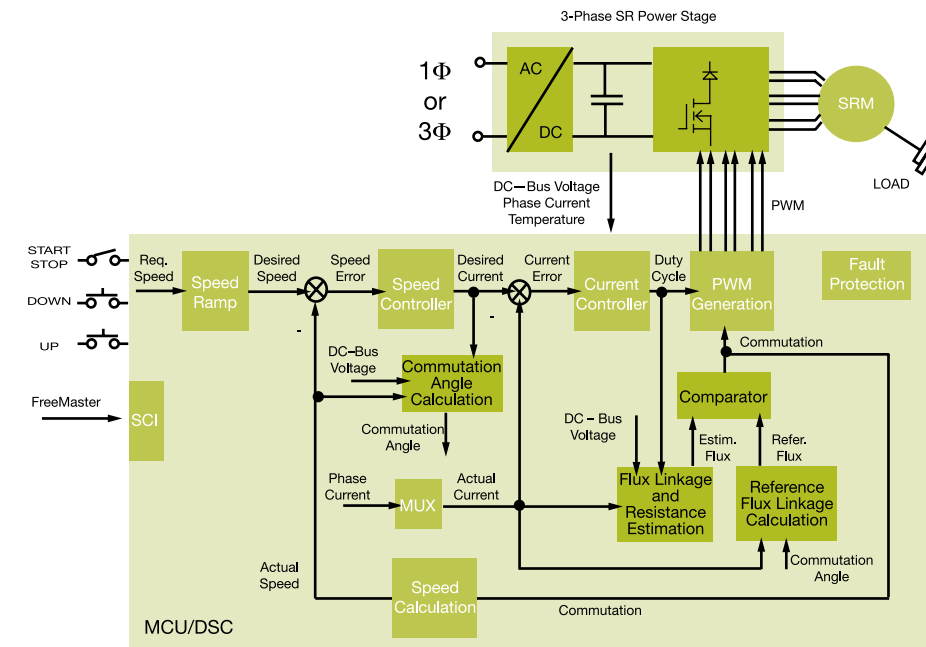
Application Notes

8-bit	AN2357 Sine Voltage Powered 3-Phase Permanent Magnet Motor with Hall Sensor
	AN2149 Compressor Induction Motor Stall and Rotation Detection Using Microcontrollers
	AN1853 Embedding Microcontrollers in Domestic Refrigeration Appliances
	AN2396 Servo Motor Control Application on a Local Area Interconnect Network (LIN)
	DRM036 Sine Voltage Powered 3-Phase Permanent Magnet Synchronous Motor with Hall Sensors

16-bit	AN1931 3-Phase PM Synchronous Motor Vector Control AN1942 DSP56F80x Resolver Driver and Hardware Interface DRM102 PMSM Vector Control with Single-Shunt Current-Sensing Using MC56F8013/23 DRM099 Sensorless PMSM Vector Control with a Sliding Mode Observer for Compressors Using MC56F8013
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Switch Reluctance Motor Drive

Sensorless



Application Notes

16-bit	AN1912 3-Phase Switched Reluctance (SR) Motor Control with Hall Sensors AN1932 3-Phase Switched Reluctance (SR) Sensorless Motor Control DRM100 Sensorless High-Speed SR Motor Drive for Vacuum Cleaners Using an MC56F8013
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Reference Designs

RDDSP56F8SRDE	3-Phase Switched Reluctance Motor Control with Encoder Using 56F80X Digital Signal Controllers
RDDSP56F8SRDHS	3-Phase Switched Reluctance Motor Control with Hall Sensor Reference Design for 56F80X or 56F8300 Digital Signal Controllers
RDDSP56F8SRDS	3-Phase Switched Reluctance Motor Sensorless Control Reference Design Using 56F80X or 56F8300 Digital Signal Controllers

Advantages

- Reliable electronics
- High starting torque
- Removal of position sensor

Applications

- Industrial machines
- Medical scanners
- Computers, office equipment
- Toys
- Food processors
- Vacuum cleaners
- Machine tools
- Large appliances

Recommended Devices

16-bit DSC: MC56F80x, MC56F80xx,
MC56F83xx

16-bit MCU: S12XE

Analog/Mixed Signal Power ICs

Motor Driver: MC33927, MC33937

Power ICs for Motor Control Products

Analog/mixed-signal integrated circuits with SMARTMOS™ technology

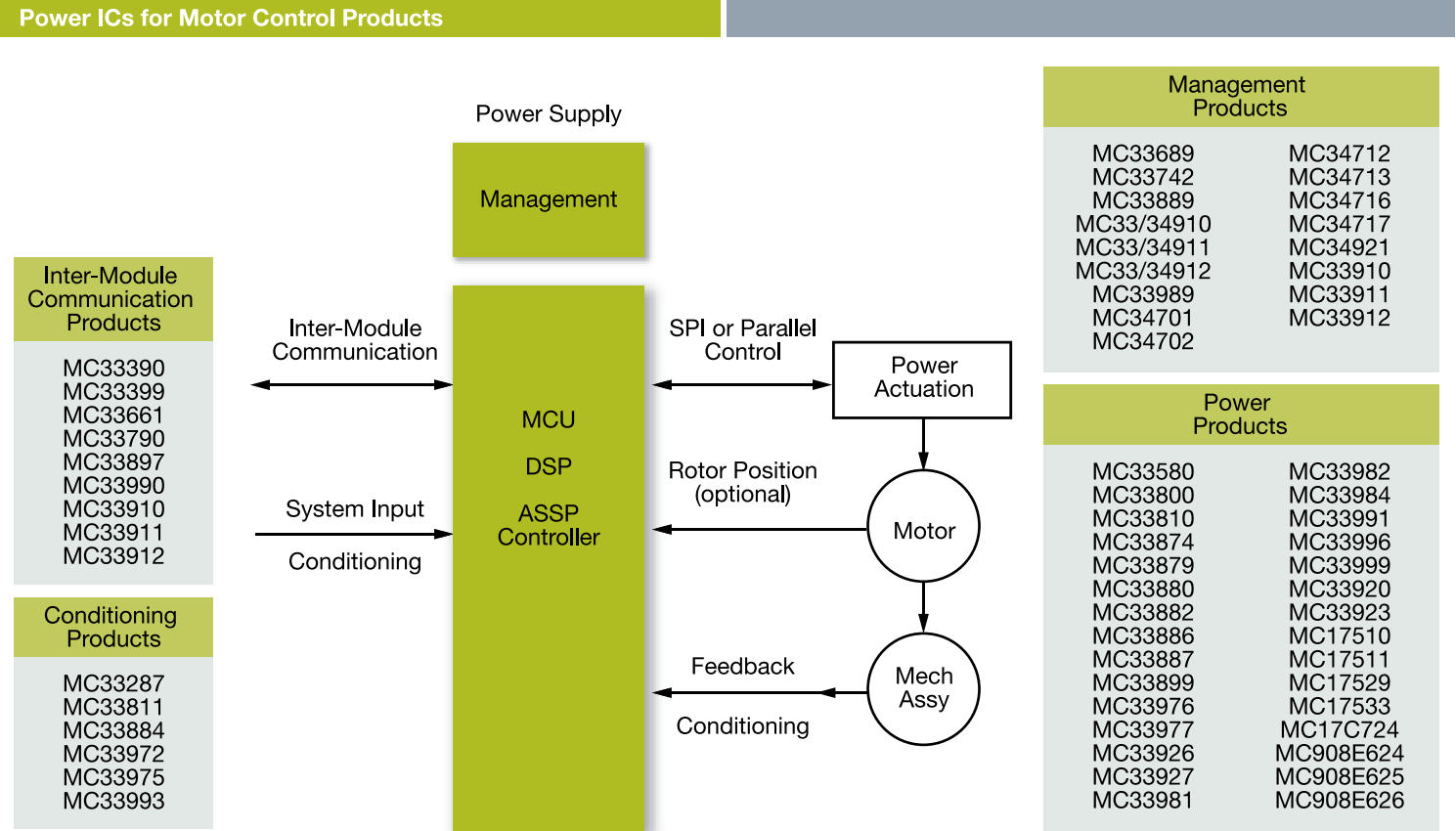
Freescale's analog/mixed-signal and power integrated circuits provide comprehensive electric motor system solutions when coupled with MCUs or DSCs. Freescale's power integrated circuits (ICs) are manufactured using our advanced SMARTMOS™ technology, which enables key protection and performance functions to be monolithically integrated within the power IC silicon. When product designers rely on a printed circuit board loaded with discrete components (and the attendant poor MTBF number), Freescale delivers robust, highly integrated system solutions that provide a long life of reliable and highly functional service.

Product Selector Guide											
Product	Description	Main Characteristics	No. of Outputs	R _{DS(on)} Ω of Each Output	Current Limitation (A)	Current Limitation Standby Max	Protection Features	Control	Status Reporting	Packaging	Status
MC33887	H-bridge driver with sleep mode (5.2A)	130 mw @ 25C, sleep mode, current sense	2	130 mΩhms	6	25 μA	Short circuit, current limit, temp sense	Parallel	One status pin (overcurrent/ overtemp)	20-pin HSSCP 54-pin SOICW	Production
MC34920	0.77W max dual 45V H-bridge DC/ stepper motors with charge pump and dual regulators, device can be paralleled in H-bridge configuration	Dual 45V H-bridge DC/ stepper motor with charge pump and dual regulators	8	1400 mΩhms	2.4 <small>Note</small>	14 mA (n o m)	Overcurrent, undervoltage, overtemp, undervoltage	Serial I/F	System reset on faults	44-pin PLCC	Production
MC34921	Integrated motor drive IC	Dual PWM DC motor drive	4	700 mΩhms	2.5 <small>Note</small>	30 mA	Shoot through undervoltage detect	Serial I/F	n/a	54-pin SOIC 64-pin LQFP	Production
MC34923	Full-bridge PWM motor driver	+/-2.0A @ 45V, 0.27 Ohm RDSOn	2	270 mΩhms	2.0	20 μA	Thermal shutdown with hysteresis, cross-over current protection, undervoltage lockout, programmable PWM off-time	Serial, parallel	n/a	24-pin SOICW	Production
MPC17510	0.45W H-bridge	Single 15V H-bridge with charge pump	2	450 mΩhms	3.0 <small>Note</small>	1.0 mA	Shoot through undervoltage detect	Parallel	Shutdown undervoltage	24-pin TSSOP	Production
MPC17511	1.0A 6.8V H-bridge motor driver IC	Drive DC motors or bipolar step motors	2	460 mΩhms	3.0 <small>Note</small>	1.0 mA	Undervoltage shutdown, cross-conduction suppression	Parallel	n/a	24-pin QFN, 16-pin VMFP	Production
MPC17529	0.7W dual 6.8V with charge pump, 3.3V logic	Dual 6.8V with charge pump	2	700 mΩhms	1.4 <small>Note</small>	1.0 mA	Shoot through undervoltage detect	Parallel	Shutdown undervoltage	20-pin VMFP	Production
MPC17531	0.7W dual 6.8V with charge pump and sleep mode	Dual 6.8V with charge pump	2	700 mΩhms	1.4 <small>Note</small>	1.0 mA	Shoot through undervoltage detect	Parallel	Shutdown undervoltage	20-pin VMFP	Production
MPC17533	0.7W dual 6.8V with external charge pump	Dual 6.8V with external charge pump	2	700 mΩhms	1.4 <small>Note</small>	<200 mA	Shoot through undervoltage detect	Parallel	Shutdown undervoltage	16-pin VMFP	Production

Note: peak current value

Power ICs for Motor Control Products

Analog/mixed-signal integrated circuits as part of robust, highly integrated system solutions



Freescale offers the following analog evaluation boards and modules:

Device P/N	Evaluation Boards and Modules	Device P/N	Evaluation Boards and Modules
MC33399	KIT33399DEVB	MC33975	KIT33975AEWEVBE
MC33661	KIT33661DEVB	MC33984	KIT33984PNAEVB
MC33689	KIT33689DWBEVB	MC33989	KIT33989DWEVB
MC33742	KIT33742DWEVB	MC33996	KIT33996EKEVB
MC33800	KIT33800EKEVME	MC33999	KIT33999EKEVB
MC33810	KIE33810EKEVME	MC34701	KIT33701DWBEVB
MC33880	KIT33880DWBEVB	MC34702	KIT33702DWBEVB
MC33887	KIT33887DWBEVB KIT33887PNBEVB	MC34712	KIT34712EPEVBE
MC33889	KIT33889DWEVB	MC34713	KIT34713EPEVBE
MC33926	KIT33926PNBEVBE	MC34716	KIT34716EPEVBE
MC33927	KIT33927EKEVBE	MC34717	KIT34717EPEVBE
MC33972	KIT33972AEWEVBE	MPC17C724	KIT17C724EPEVBE

Please visit www.freescale.com/analog for more details.



8-bit Microcontroller Motor Control Products

Feature-rich portfolio that meets all of your 8-bit needs

Freescale's 8-bit portfolio includes several low-end devices that provide cost-effective solutions for motor control applications. From flash to ROM, from 1 KB to 60 KB of memory and from tiny 8-pin QFN to 64-pin quad flat packages, the HCS08 and RS08 families are designed to meet all of your 8-bit needs. They feature peripherals, such as 10-bit A/D convertors and multi-channel timers, which make them ideal candidates for low-end motor control applications.

8-bit Product Summary													
Device	Flash	RAM	ADC		Timers					5V IO	Analog Comparator	Communications	Packages
			Channels	Bits	GPT	ESCI	SPI	I ² C	ACMP				
MC3PHAC	—	—	4	10	—	—	6 Output	N/A	—	Y	—	UART	1, 13, 22
MC9S08AC	128 KB	2 KB	16	10	2 x 2-ch. x 16-bit/ 6-ch. x 16-bit	—	See GPT	N	—	Y	—	UART, SPI, I ² C	1, 2, 3, 4, 5
MC9S08DZ	128 KB	8 KB	24	12	2-ch. x 16-bit/ 8-ch. x 16-bit	—	See GPT	N	—	Y	2	UART, CAN, SPI, I ² C	1, 4, 18, 19
MC9S08GB	60 KB	4 KB	8	10	3-ch. x 16-bit/ 5-ch. x 16-bit	—	See GPT	N	—	—	—	UART, SPI, I ² C	4, 5
MC9RS08KA	8 KB	0.25 KB	12	10	2 x 8-bit/2-ch. x 8-bit	—	See GPT	N	—	Y	1	I ² C	6, 7, 8, 9
MC908MR	32 KB	0.75 KB	10	10	4-ch. x 16-bit/ 2-ch. x 16-bit	—	6-ch. x 12-bit	Y	—	Y	—	UART, SPI	5, 23
MC9S08QD	4 KB	0.25 KB	4	10	2-ch. x 16-bit/ 1-ch. x 16-bit	—	See GPT	N	—	Y	—	—	16, 17
MC9S08QG	8 KB	0.5 KB	8	10	2-ch. x 16-bit/ 1 x 8-bit	—	See GPT	N	—	—	1	UART, SPI, I ² C	15, 6, 11, 20, 21
MC9S08SH	32 KB	1 KB	16	10	2 x 2-ch. x 16-bit/ 1 x 8-bit	—	See GPT	N	—	Y	1	UART, SPI, I ² C	11, 12, 13, 14, 15, 16

** HDI = Hardware Deadtime Insertion

8 Bit Development Tool Summary—HCS08/RS08					
Family	Part Numbers	Starter Kit		Advanced Development	
		Demo Board	Software	Evaluation Board Kit	Software
AC	MC9S08AC128/96	DEMOACKIT	CWX-HXX-SE* Compiles up to 32k of object code	DEMOACKIT + DEMOACEX	Options starting at \$395. More options and information at www.freescale.com/codewarrior
	MC9S08AC60/48/32	DEMO9S08AC60E DEMO9S08AC60KIT			
	MC9S08AC16/8	DEMO9S08AC60E DEMO9S08AC16KIT			
DZ	MC9S08DZ128/96/60/32/16	DEMO9S08DZ60		EVb9S08DZ60	
GB	MC9S08GB60/32	M68DEMO908GB60E		M68EVb908GB60E	
KA	MC9RS08KA2/1	DEMO9RS08KA2 USBSPYDER08		EVb9S08DZ60	
	MC9RS08KA8/4	DEMO9RS08KA8 USBSPYDER08			
MR	MC908MR32/16/8	USBSPYDER08			
QD	MC9S08QD4/2	DEMO9S08QD4		—	
		USBSPYDER08			
QG	MC9S08QG8/4	DEMO9S08QG8			
SH	MC9S08SH8/4	DEMO9S08SH8			
	MC9S08SH32/16	DEMO9S08SH32			

* Codewarrior Development Studio for HC(S)08 Special Edition is complimentary and is supplied with all Freescale development tools. Upgrade available to support expanded memory sizes with part number CWP-PRO-NL/FL.

16-bit MCU and Digital Signal Controller Motor Control Products

Specializing in automotive and DSP processing applications, the S12X and DSCs offer superior functionality in a 16-bit package

16-bit digital signal controller (DSC) products—The 56800 core-based family of DSCs combines the processing power of a DSP and the functionality of a microcontroller, with a flexible set of peripherals on a single chip. This creates an extremely cost-effective motor control solution.

MC9S12XE family will deliver 32-bit performance with all the advantages and efficiencies of a 16 bit MCU.

16-bit Product Summary													
Device	Flash	RAM	ADC		Timers					5V IO	Analog Comparator	Communications	Packages
			Channels	Bits	GPT	PIT	PWM	HDI**	TPU				
MC56F801x	16 KB	4 KB	2 x 4-ch.	12	4 x 16-bit	See GPT	6-ch. x 15-bit	Y	—	Y	—	UART, SPI, I ² C	5
MC56F802x	32 KB	4 KB	2 x 8-ch.	12	2 x 4-ch. x 16-bit	3 x 16-bit	6-ch. x 15-bit	Y	—	Y	2	UART, SPI, CAN, I ² C	6
MC56F803x	64 KB	8 KB	2 x 8-ch.	12	2 x 4-ch. x 16-bit	3 x 16-bit	6-ch. x 15-bit	Y	—	Y	2	UART, SPI, CAN, I ² C	6
MC56F8123/8122	32 KB	8 KB	2 x 4-ch.	12	2 x 4-ch. x 16-bit	—	6-ch. x 15-bit	Y	—	Y	—	UART, SPI	6
MC56F8135	64 KB	8 KB	4 x 4-ch.	12	2 x 4-ch. x 16-bit	—	6-ch. x 15-bit	Y	—	Y	—	UART, SPI, CAN, Quad Decoder	7
MC56F8147/8146/8145	128 KB	8 KB	4 x 4-ch.	12	2 x 4-ch. x 16-bit	—	6-ch. x 15-bit	Y	—	Y	—	UART, SPI, Quad Decoder	8
MC56F8157/8156/8155	256 KB	16 KB	4 x 4-ch.	12	2 x 4-ch. x 16-bit	—	6-ch. x 15-bit	Y	—	Y	—	UART, SPI, Quad Decoder	8
MC56F8167/8166/8165	512 KB	32 KB	4 x 4-ch.	12	2 x 4-ch. x 16-bit	—	6-ch. x 15-bit	Y	—	Y	—	UART, SPI, Quad Decoder	8
MC56F8323/8322	32 KB	8 KB	2 x 4-ch.	12	2 x 4-ch. x 16-bit	—	6-ch. x 15-bit	Y	—	Y	—	UART, SPI, CAN, Quad Decoder	6
MC56F8335	64 KB	8 KB	4 x 4-ch.	12	4 x 4-ch. x 16-bit	—	2 x 6-ch. x 15-bit	Y	—	Y	—	UART, SPI, CAN, Quad Decoder	7
MC56F8347/8346/8345	128 KB	8 KB	4 x 4-ch.	12	4 x 4-ch. x 16-bit	—	2 x 6-ch. x 15-bit	Y	—	Y	—	UART, SPI, CAN, Quad Decoder	8, 9
MC56F8357/8356/8355	256 KB	16 KB	4 x 4-ch.	12	4 x 4-ch. x 16-bit	—	2 x 6-ch. x 15-bit	Y	—	Y	—	UART, SPI, CAN, Quad Decoder	8, 9
MC56F8367/8366/8365	512 KB	32 KB	4 x 4-ch.	12	4 x 4-ch. x 16-bit	—	2 x 6-ch. x 15-bit	Y	—	Y	—	UART, SPI, CAN, Quad Decoder	8, 9
MC9S12XE	1024 KB	64 KB	2 x 16-ch.	12	8-ch. x 16-bit	8-ch. x 16-bit	8/4-ch. x 8/16-bit	Xgate	—	Y	—	UART, CAN, SPI, I ² C	1, 2, 3, 4

** HDI = Hardware Deadtime Insertion

DSC Development Tool Summary										
Family	Part Numbers	Starter Kit		Advanced Development						
		Demo Board	Software	Evaluation Board Kit	Software					
56F8000	MC56F8011	DEMO56F8014-EE	CWX-568-SE* Compiles up to 32k of object code	—	Options starting at \$395. More options and information at www.freescale.com/codewarrior					
	MC56F8013	DEMO56F8013-EE								
	MC56F8014	DEMO56F8014-EE								
	MC56F802x/3x	—								
56F8100	MC56F8123/8122	—		CWX-568-SE* Compiles up to 32k of object code		56F8037EVM	Options starting at \$395. More options and information at www.freescale.com/codewarrior			
	MC56F8135					MC56F8367EVME				
	MC56F8147/8146/8145					MC56F8367EVME				
	MC56F8157/8156/8155									
	MC56F8167/8166/8165									
56F8300	MC56F8323/8322					—		CWX-568-SE* Compiles up to 32k of object code	MC56F8323EVME	Options starting at \$395. More options and information at www.freescale.com/codewarrior
	MC56F8335								MC56F8367EVME	
	MC56F8347/8346/8345									
	MC56F8357/8356/8355									
	MC56F8367/8366/8365									

S12X Development Tool Summary					
Family	Part Numbers	Starter Kit		Advanced Development	
		Demo Board	Software	Evaluation Board Kit	Software
XE	MC9S12XEP768/100	DEM09S12XEP100	CWX-HXX-SE* Compiles up to 32k of object code	EVb9S12XEP100	Options starting at \$395. More options and information at www.freescale.com/codewarrior
	MC9S12XEQ512/384				
	MC9S12XET256				
	MC9S12XEG128				

* CodeWarrior Development Studio for S12X Special Edition is complimentary and is supplied with all Freescale S12X development tools. Upgrade available to support expanded memory sizes with part number CWP-PRO-NL/FL.

Package Information			
Number	Type	Size (mm)	Pitch (mm)
1	80 LQFP	14 x 14	0.65
2	112 LQFP	20 x 20	0.65
3	144 LQFP	20 x 20	0.5
4	208 MAPBGA	17 x 17	1.0
5	32 LQFP	7 x 7	0.8
6	64 LQFP	12 x 12	0.5
7	128 LQFP	20 x 14	0.5
8	160 LQFP	24 x 24	0.5
9	160 MAPBGA	15 x 15	1.0

* CodeWarrior Development Studio for 56800 Special Edition is complimentary and is supplied with all Freescale 56800 development tools. Upgrade available to support expanded memory sizes with part number CWP-PRO-NL/FL.

32-bit Microcontroller Motor Control Products

High performance for complex, real-time motor control applications

These 32-bit embedded microcontrollers combine higher performance with increased on-chip functionality to address complex real-time control applications that require more system throughput. Both the ColdFire® family and MPC500 and MPC5500 families built on Power Architecture® technology are capable of fulfilling the most demanding motor control requirements in a wide range of operating environments.

32-bit Product Summary													
Device	Flash	RAM	ADC		Timers					5V IO	Analog Comparator	Communications	Packages
			Channels	Bits	GPT	PIT	PWM	HDI**	TPU				
MCF51AC	256 KB	32 KB	24	12	6	—	2	Y	—	Y	2	I ² C, SPI, CAN	1, 8
MCF521x	256 KB	32 KB	8	12	4-ch. x 32-bit	2 x 16-bit	8/4-ch. x 8/16-bit	N	—	—	—	UART, I ² C, SPI, CAN	1, 2, 3, 4
MCF521xx	128 KB	16 KB	8	12	4-ch. x 32-bit	2 x16-bit	8/4-ch. x 8/16-bit	N	—	—	—	UART, I ² C, SPI, CAN	1, 2, 3, 4
MCF5221x	128 KB	16 KB	8	12	4-ch. x 32-bit	2 x16-bit	8/4-ch. x 8/16-bit	N	—	—	—	UART, I ² C, SPI, CAN, USB	1, 2, 3, 4
MCF5222x	256 KB	32 KB	8	12	4-ch. x 32-bit	2 x16-bit	8/4-ch. x 8/16-bit	N	—	—	—	UART, I ² C, SPI, CAN, USB	1, 2, 3, 4
MCF5223x	256 KB	32 KB	8	12	4-ch. x 32-bit	2 x16-bit	8/4-ch. x 8/16-bit	N	—	—	—	UART, I ² C, SPI, CAN, Ethernet	8, 9, 10
MCF523x	—	64 KB	—	—	4-ch. x 32-bit	4 x 16-bit	See TPU	eTPU	32-ch. eTPU	—	—	UART, CAN, I ² C, SPI, Ethernet	5, 6, 7
MCF5282	512 KB	64 KB	8	10	4-ch. x 16-bit	4 x 16-bit	1 x 16-bit	N	—	Y	—	UART, CAN, I ² C, SPI, Ethernet, USB	7
MPC561/2	—	32 KB	32	10	6 x 16-bit	1 x 16-bit	6 x 16-bit	TPU	2 x 16-ch.	Y	—	UART, CAN, SPI	11
MPC563/4	512 KB	32 KB	32	10	6 x 16-bit	1 x 16-bit	6 x 16-bit	TPU	2 x 16-ch.	Y	—	UART, CAN, SPI	11
MPC565/6	1024 KB	36 KB	40	10	6 x 16-bit	1 x 16-bit	6 x 16-bit	TPU	3 x 16-ch.	Y	—	UART, CAN, SPI	11
MPC5534	1024 KB	64 KB	2 x 40	12	24-ch. x 24-bit	Part of GPT	—	eMIOS/eTPU	32-ch. eTPU	Y	—	UART, CAN, SPI	12, 13
MPC5553	1536 KB	64 KB	2 x 40	12	24-ch. x 24-bit	Part of GPT	—	eMIOS/eTPU	32-ch. eTPU	Y	—	UART, CAN, SPI	12, 13, 14
MPC5554	2048 KB	64 KB	2 x 40	12	24-ch. x 24-bit	Part of GPT	—	eMIOS/eTPU	2 x 32-ch. eTPU	Y	—	UART, CAN, SPI, Ethernet	12, 13, 14
MPC5565	2048 KB	80 KB	2 x 40	12	24-ch. x 24-bit	Part of GPT	—	eMIOS/eTPU	32-ch. eTPU	Y	—	UART, CAN, SPI	13
MPC5566	3072 KB	128 KB	2 x 40	12	24-ch. x 24-bit	Part of GPT	—	eMIOS/eTPU	2 x 32-ch. eTPU	Y	—	UART, CAN, SPI, Ethernet	14

* Specifications listed are for the superset device in each family. Memory sizes, peripherals and communication options vary by device. Please see appropriate data sheet for further information.
** HDI = Hardware Deadtime Insertion

ColdFire Development Tool Summary					
Family	Part Numbers	Starter Kit		Advanced Development	
		Demo Board	Software	Evaluation Board Kit	Software
MCF51ACxxx	MCF51AC256/128	DEMOACKIT	CWX-HXX-SE*	DEMOACKIT / DEMOACEX	Options starting at \$395. More options and information at www.freescale.com/codewarrior
MCF521x	MCF5213/2/1	M5211DEMO	CWX-MCF-SE*	M5213EVBE	
	MCF5216/4	M5282LITEKIT		M5282EVBE	
MCF521xx	MCF52110/52100	M52210DEMO		M52211EVb	
MCF522xx	MCF52211/52210	M52210DEMO		M52211EVb	
	MCF52223/1	—		M52223EVb	
MCF5223x	MCF52235/4/3/1/0	M52233DEMO		M52235EVb	
MCF523x	MCF5235/4/3/2	M5235BCKKIT		M523XEVB	
MCF528x	MCF5282/1/0	M5282LITEKIT		M5282EVBE	
MPC Development Tool Summary					
Family	Part Numbers	Starter Kit		Advanced Development	
		Demo Board	Software	Evaluation Board Kit	Software
MPC55xx	MPC5553	—	CWS-MPC-5500-SE*	MPC5553EVBE	Options starting at \$395. More options and information at www.freescale.com/codewarrior
	MPC5554		Compiles up to 128k of object code	MPC5554EVBE	

CodeWarrior Development Studio Special Edition for all MPC devices is complimentary, and is supplied with all MPC55xx evaluation Boards. This version of CodeWarrior supports object code sizes up to 128 KB. Upgrade available to support expanded memory sizes. For information on these upgrade options, visit www.freescale.com/codewarrior.

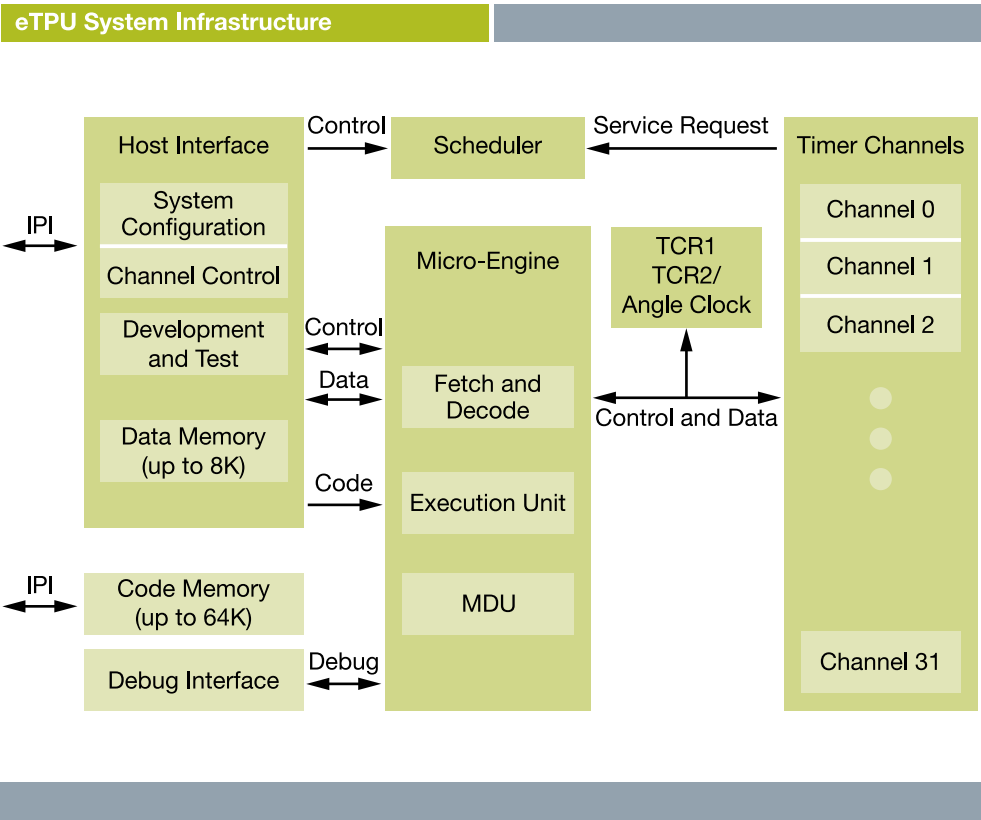
32-bit Microcontroller Motor Control Products

Enhanced time processing unit (eTPU) on the MCF523x and MPC55xx families

The eTPU is a programmable I/O and control module with its own core and memory system dedicated to performing complex timing, control and I/O management functions independently of the main processor.

The eTPU is essentially a microcontroller itself, used in a variety of applications, including general timing functions, serial communications, motor control, custom logic replacement and engine control.

With some applications requiring more than 70 percent of the CPU bandwidth, the eTPU on the MCF523x and MPC55xx is an ideal solution.



eTPU Functions Library										
General Timing and Measurement	General Input-Output (GPIO)	Pulse Width Modulation	Input Capture	Output Compare	Frequency and Period Measurement	Queued Output Match	Synchronized Pulse Width Modulation			
Communications	Serial Periperal Interface (SPI)	UART	UART with Flow Control							
DC Motors	Motor Speed	DC Bus Break Control	Quadrature Decode	Hall Sensor Decode	Analog Sensing	Motor Control PWM	Current Control	Quadrature Decoder	Hall Sensor Decoder	
AC Motors	Motor Speed	DC Bus Break Control	Quadrature Decode	Hall Sensor Decode	Analog Sensing	Motor Control PWM	ACIM Vector	ACIM V/Hz Control	PMSM Vector Control	
Electronic Motors and Controls Supported	CD Open Loop	DC Speed Loop with QD	DC Speed Loop with HD	DC Speed Loop and Current Loop	BLDC with HD Open Loop	BLDC with HD Speed Loop	BLDC with HD Speed and Current Loop	BLDC with QD Open Loop	BLDC with QD Speed Loop	BLDC with QD Speed and Current Loop
	ACIM V/Hz Open Loop with Sine	ACIM V/Hz Open Loop with SVM	ACIM V/Hz Speed Loop with Sine Wave Drive	ACIM V/Hz Speed Loop with SVM	ACIM Torque Vector Control	ACIM Vector Control with Speed Loop	PMSM Torque Vector Control	PMSM Vector Control with Speed Loop		

Freescale provides a free library of eTPU function including C source code, Host C API and detailed application notes. See it all at www.freescale.com/eTPU.

Users may customize library functions and/or develop custom functions using the Byte Craft C Compiler and ASH WARE Simulator.



Motor Control Products

Algorithms and drivers provided by Processor Expert™

Microcontroller Drivers and Algorithms—Available in Processor Expert			
Motor Type	Available Drivers and Algorithms		
Standard Drivers	Timer	PWM	I/O ports
	Flash	SCI	CAN (DSP only)
	ADC	SPI	Position Sensing Encoder (DSP only)
AC Induction	Power factor	Brake control	Board identification
	3-phase waveform generation	V/Hz and PFC	SCI communication routine
	Space vector modulation	PI/PID controllers	Lookup table
	Ramp	Velocity calculation and estimation	
	Switch/push button	Position calculation and estimation	
Brushless DC	BLDC commutation handler with sensor	BLDC with sensors	Switch control
	BLDC commutation handler, sensorless	Ramp board identification	SCI communication routine
	PI/PID controllers	Switch/push button	
	Position calculation and estimation	Velocity calculation and estimation	
	BLDC with zero crossing	Brake control	
Switched Reluctance	SR commutation handler	Switch/push button	Brake control
	SR commutation angle calculation	PI/PID controllers	Switch control
	SR with sensors	Velocity calculation and estimation	Board identification
	SCI communication routine	Position calculation and estimation	
	Ramp	Look-up table	
16-bit Digital Signal Controller Drivers and Algorithms—Available in Processor Expert			
Standard Drivers	ADC	DAC	Quadrature Decoder
	MSCAN	Analog Comparator	PIT
	Flash	GPIO	Interrupt Controller
	PLL	PWM	Quad Timer
	Serial/SCI (also with LIN)	SPI	Posix Timer
	SIM	SSI	TOD
	FlexCAN		
Drivers for off-Chip Peripherals	I ² C	Terminal	Button
	BLDC	LED	Brake
	Codec	EEPROM/Flash (SPI Bus Serial)	Switch
Tools	PC Master	File I/O	JTAG Flash Loader
	FreeMaster	RTOS Support	MicroC/OS-II
Miscellaneous	Serial Boot Loader	Data Structures (FIFO)	Cycle Count
	Stack Check	Test	
Motor Control Algorithms	3-Phase Sine Wave Generation	Clarke/Park Transformation	Space Vector Modulation
	Ramp	D-Q System (2-Phase)	FOC Decoupling
	BLDC Commutation Handler w/Sensors	BLDC Commutation Handler Sensorless-Zero Cross	SR Commutation Handler
	PI/PID Controllers	Velocity Calculation and Estimation	Look-up Table
	Brake Control	Switch Control	Flux Model
	Brushless DC w/Encoder	AC Induction Motors V/Hz Closed Loop	Digital Power Factor Correction
	Wave Generate	Phase Flux Estimation	
	Brushless DC Motors w/Hall Sensor		

Additional Motor Control Application Notes and Reference Designs

Application Notes	
AN1976	Migrating from SDK to Processor Expert
AN1920	DSP56800 Hardware Interface Techniques
AN1926	Production Flash Programming 56F80x, 56F826 and 56F827
AN1933	Synchronization of On-Chip Analog to Digital Converter
AN1935	Programming On-Chip Flash Memories of DSP56F80x DSPs Using the JTAG/OnCE Interface
AN1947	DSP56800 ADC
AN1948	Real-Time Development of MC Applications PC Master Software Visualization Tool
AN1952	Using Program Memory as Data Memory
AN1965	Design of Indirect Power Factor Correction
AN1973	Production Flash Programming
AN1974	56F8300 and 56F8100 ADC
AN1975	Multiple Target Features Using Processor Expert and CodeWarrior
AN3118	Production Flash Programming for the 56F8000 Family
AN3103	56F8000 Clock Generation Guidelines to Ensure Correct Functionality
AN3102	Unique Features of the 56F801x Family of Devices
AN2395	PC Master Software Usage
AN2263	PC Master Software: Creation of Advanced Control Pages
AN2095	Porting and Optimizing DSP56800 Applications to DSP56800E
AN1999	56F8300 Hybrid Controller Used in Control of Electro-Mechanical Brake
AN1994	Start-Up Considerations for 56F8300 and 56F8100 Family Devices
AN1991	Controlling Power Consumption in 56F8300 and 56F8100 Family Devices
AN1983	Software Compatibility Considerations for HCS12, HC16 and 56800/E Devices
AN1980	Using the 56F83xx Temperature Sensor
AN1734	Pulse Width Modulation Using the 16-bit Timer
Reference Designs	
RDHC08ACIM	PWM Control of the Single-Phase AC Induction Motor Using the MC68HC908QT4 MCU
RDDSC56F8xxxPFC	Direct PFC Using the MC56F8013
RD68HC908ACIMDTC	3-Phase AC Induction Motor Drive with Dead Time Distortion Correction Using the MC68HC908MR32
RD68HC908ACIMVHD	3-Phase AC Induction Motor Drive with Tachogenerator Using MC68HC908MR32
RDDSP56F8ACIMVHD	3-Phase ACIM Volt Per Hertz Motor Control Using 56F80X or 56F8300 Digital Signal Controllers
RDMC3PHAC	General-Purpose 3-Phase AC Industrial Motor Controller Reference Design
RD68HC908SVPMD	Sine Voltage Powered 3-Phase Permanent Magnet Synchronous Motor with Hall Sensors

Motor Control Product Development Tools

Hardware and software tools and reference designs that work for you

Start with your idea

Then use Freescale’s Interactive Development Tool Ecosystem to design a development process that fulfills your specific needs.

Begin by selecting software and hardware tools you need to complete your design.

Get your product to market, on time and on budget.

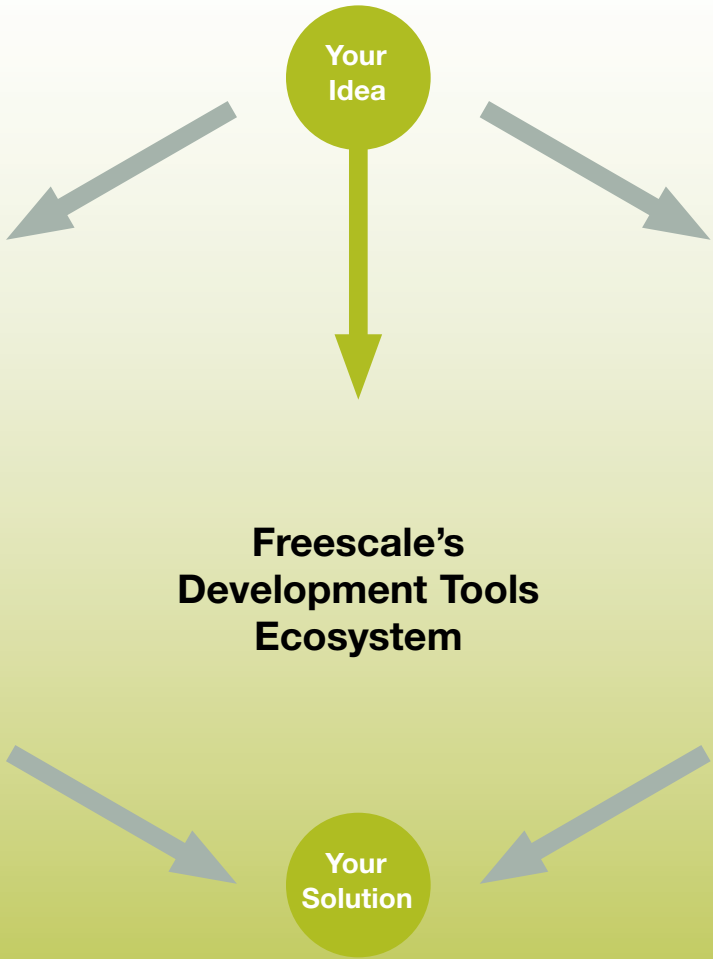


Development Hardware

Demonstration boards (DEMOs) give designers a cost-effective platform to program and debug project application code, with basic I/O functions and I/O headers for easy expandability. It may be all you need for product evaluation before moving to prototyping.

Evaluation boards (EVBs) provide more functionality than demo boards with expanded capabilities. Programmers have the option to either step up to an EVB after initial evaluation on a demo board, or they can start with an EVB and move directly to prototyping.

BDM debug cables like the USB multilink and the open source BDM (OSBDM) are the link between the IDE running on your PC and the target hardware. These interfaces allow full, non-intrusive in-circuit emulation, are and are provided by Freescale and our partners and are integrated in every Freescale Evaluation board. Acquiring one of these standalone cables is essential when designing a custom board.



Development Software

Software development tools, including CodeWarrior Development Studio and other third-party tools, provide a comprehensive set of integrated development environment (IDE) options, as well as other development tools such as debuggers, emulators, RTOSes, stacks and drivers.

Drivers and Stacks provide everything needed to begin using a complex module without spending any time writing module-specific code. Freescale and our Tools Alliance Program partners offer many drivers and stacks for all of our devices.

Freescale offers a comprehensive ecosystem of product development tools that can help you successfully complete your product design. Our extensive library of hardware, software tools and reference designs are designed to enable fast and inexpensive product development. This leads to fast time to market and cost-effective solutions.

- CodeWarrior—The backbone of Freescale’s software development tools is the CodeWarrior Integrated Development Environment (IDE). With compiler, debugger, linker, editor, assembler and other features, the CodeWarrior IDE, makes C/C++ source-level debugging and embedded application development as worry-free as possible. The CodeWarrior tool suite is consistent across all supported platforms, without host-to host incompatibilities.
- Processor Expert—CodeWarrior Development Studios can also come with UNIS Processor Expert, a Rapid Application Design (RAD) component-based application builder and system integration tool. This tool enables component-oriented programming, provides tested, ready-to-use code and delivers instant functionality of generated code. (See table on the next page for a list of algorithms and software examples provided by Processor Expert)

- Freescale software tools include GNU support plus additional development tools from a large network of third-party vendor partners.
- Comprehensive evaluation kits include demo boards, serial cables, quick start guides and CodeWarrior software development tools with Processor Expert. The kits give developers a comprehensive package to develop and evaluate applications using Freescale solutions.

- FreeMASTER is a free and intuitive application development tool for all motor control devices from 8- to 32-bit. This powerful diagnostic and demonstration tool allows real-time debugging and remote control of an application from a user friendly graphical environment running on a PC. FreeMASTER supports: HC(S)08, S12X, DSP66F800, MC56F8300, MC56F8100, MC56F8000, MPC5XXX and ColdFire® families of devices.

In addition to all of the above, you can test drive our development tools and products through virtual labs and benefit from our motor control tutorials found at Freescale’s Embedded Learning Center.

Specialized Motor Control Development Tools

Accelerate application development and speed time to market

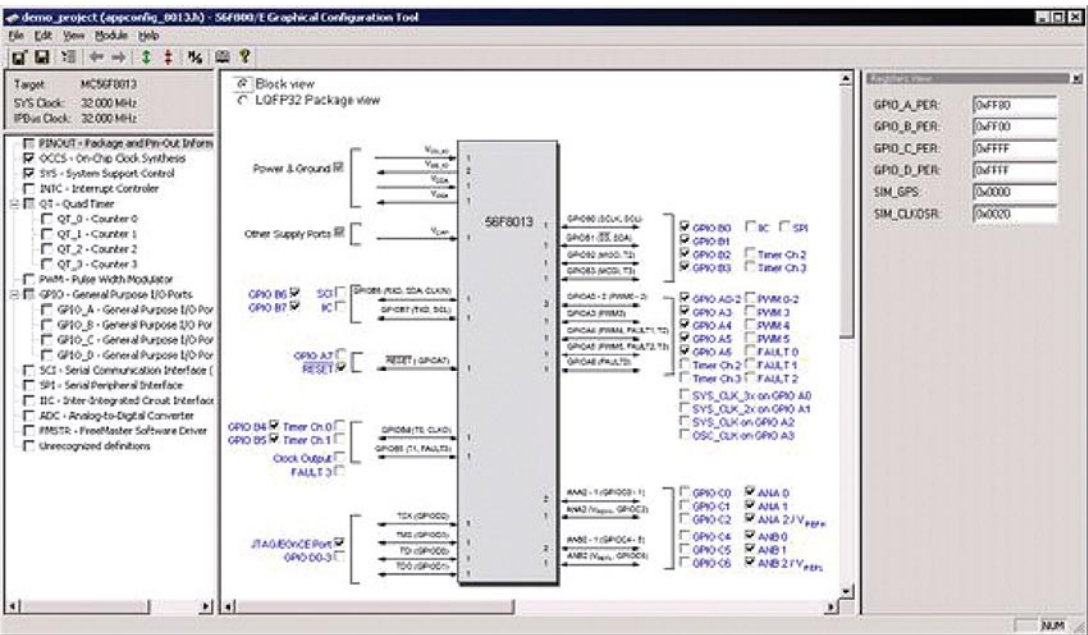
Freescale provides complimentary start-up and diagnostic development tools that are unique to the industry. These are the DSP56800E Quick Start Initialization and Development Tool and the FreeMASTER Real-Time Control and Debugging Tool.

The DSP56800E Quick Start Initialization and Development Tool is a software environment for embedded applications development. It is based on the graphical configuration tool (GCT) and a unified application programming

interface (API)-style of accessing the peripheral modules. The Quick Start toolset helps users to accelerate the application development, to become quickly familiar with the target device and to create real-time applications rapidly and efficiently while retaining complete control over each portion of the underlying hardware.

The DSP56800E Quick Start toolset was specially designed for the real-time applications written in C or mixed

Assembler/C languages where a deterministic behavior and transparent software structure are required. It provides a software infrastructure that allows development of efficient applications that are portable and reusable between devices within the architecture family or even between different architectures. The Quick Start tool complements the other development and initialization tools for Freescale processors like Processor Expert or RAppID.

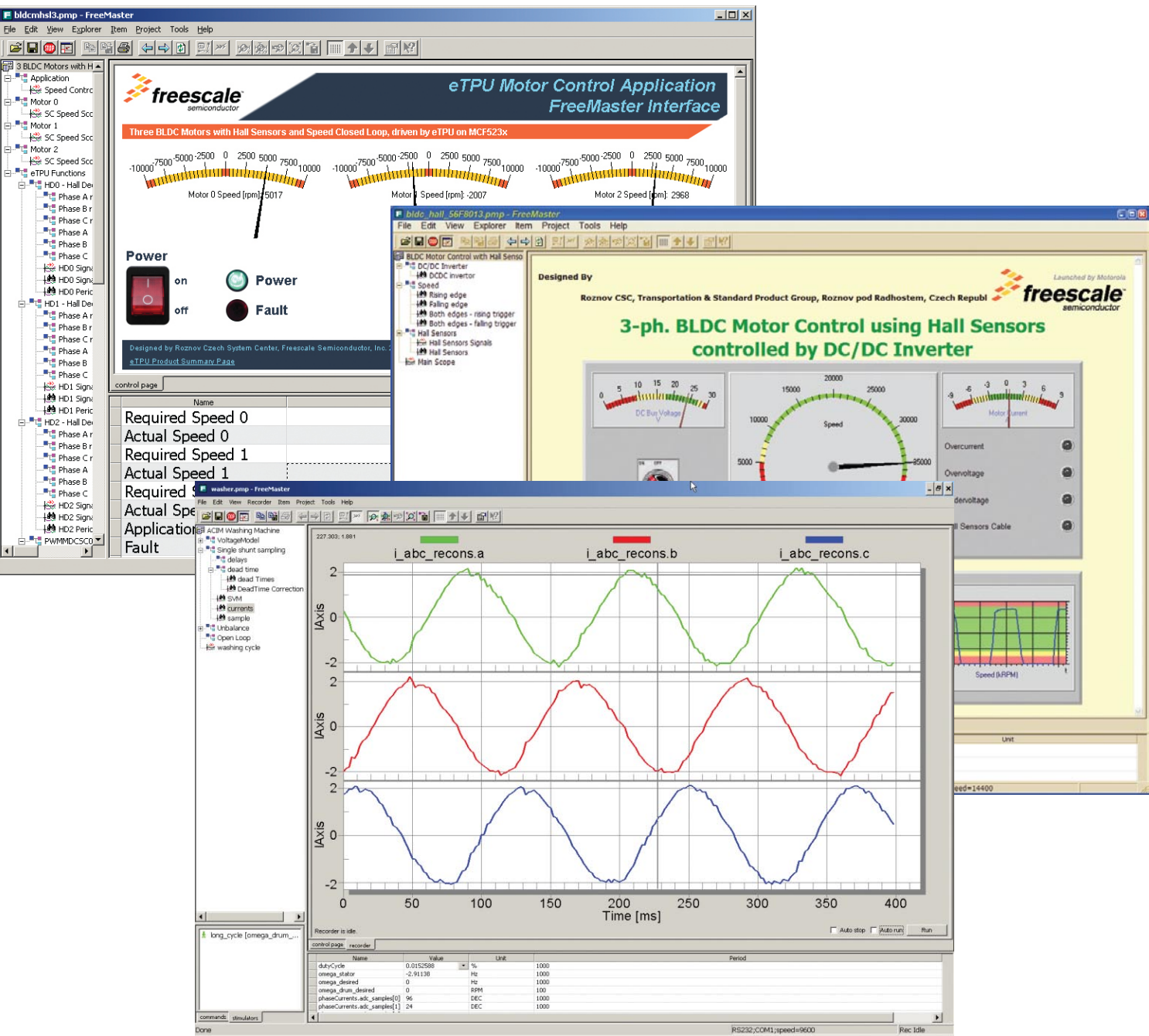


FreeMASTER software (formerly known as PC Master) represents a sophisticated tool with intuitive navigation that can be used in any application development. This tool allows control of an application remotely from a user-friendly graphical environment running on a PC. It also provides the ability to view real-time application variables in both textual and graphical form. FreeMASTER gives you what you need to monitor the

system in real-time, control the embedded application from a PC and demonstrate advanced capabilities of Freescale driven solutions. Designers may take advantage of the versatility and use FreeMASTER for multipurpose algorithms and applications. It may be used for real-time debugging, diagnostics as well as for demonstration, sales and educational purposes.

Below are some examples of interfaces created in FreeMASTER for different motor control applications.

For additional information on these tools, as well as others like Processor Expert and Rappid, please go to www.freescale.com.



Software Library Set for MC56F80XX and MCF51AC Families

Software libraries GFLIB, MCLIB, GDFLIB used to build digital control systems

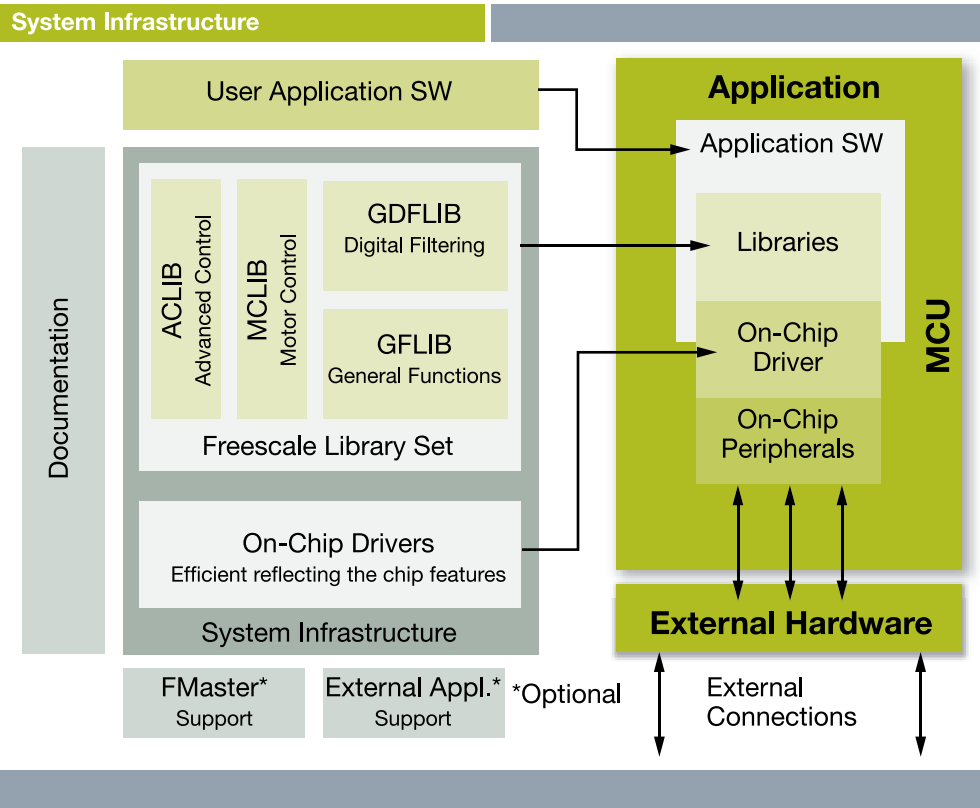
The software libraries for MC56F80XX and MCF51AC families are designed to construct digital control systems for different motor types. The libraries contain software modules implemented in optimized assembly form and having C-callable function interface.

General Function Library (GFLIB) contains math, trigonometric, look-up table and control functions. These software modules are basic building blocks.

Motor Control Library (MCLIB) contains vector modulation, transformation and specific motor related functions to build digitally controlled motor drives.

General Digital Filter Library (GDFLIB) contains filter functions for signal conditioning. Upcoming Advanced Control Library (ACLIB) will contain functions to enable building the variable speed AC motor drive systems with field oriented control techniques without a position or speed transducer.

Individual libraries are delivered in library modules and are intended for use in small data memory model projects. The interfaces to the algorithms included in these libraries have been combined into a single public interface file. This is done to simplify the number of files required for inclusion by application programs. Refer to the specific algorithm sections of user document for details on the software Application Programming Interface (API).



Motor Control Libraries		
General Function Library (GFLIB)	Motor Control Library (MCLIB)	Digital Filter Library GDFLIB
<ul style="list-style-type: none"> Sine, cosine, tangent Inverse sine, cosine, tangent* Two-argument inverse tangent* Signum* 1D look-up table* Hysteresis* Square root Ramp, dynamic ramp Limitation on input signal Proportional-integral (PI) controller of parallel form* Proportional-integral (PI) controller of recurrent form 	<ul style="list-style-type: none"> Clark, inverse clark Park, inverse park Vector limitation DC bus voltage ripple elimination Space vector modulation techniques PM motor decoupling ACIM flux model Angle tracking observer Back EMF observer for PM motor Saliency tracking observer 	<ul style="list-style-type: none"> 1st order IIR filter 2nd order IIR filter* Moving average filter Simplified MA filter*

* Indicates library is available only for MC56F80xx devices.

For more information on these libraries, please contact your Freescale sales representative.

Design Resources—Quick Start

Freescale offers easily accessible products, tools and services to help you speed your product to market

Freescale Fast Track

The companies that win the race to market with new product designs often become market leaders in their industries. Freescale Fast Track helps you win that race, accelerating the development cycle by providing immediate services at every step of the design process. Fast Track opens the door to assistance programs that not only will help you be the first to market but also be the best in market. Below are just a few of our Fast Track services.

Embedded Learning Center provides a wealth of online technical training courses and Webcasts—24 hours a day, 7 days a week—that can bring you up to speed on our latest products, tools and technologies.

DevToolDirect is an easy way to order Freescale development tools, software and third-party design tools directly online for shipment anywhere in the world.

Online Samples Program is simple and straightforward, starting with an “Order Sample” button next to a selected product that begins an easy three-step request process.

Technical Support is available online by our worldwide team of specialists. Your personal data is protected by an e-mail-ID/password combination, and each service request is assigned a number to enable easy follow-up communication.

To access Freescale’s Fast Track services, visit www.freescale.com/fasttrack.

Web Links

Freescale Motor Control Solutions Homepage
www.freescale.com/motorcontrol

Freescale 8-bit Microcontrollers Homepage
www.freescale.com/8bit

Freescale 16-bit DSC Homepage
www.freescale.com/dsc

Freescale 16-bit Microcontrollers Homepage
www.freescale.com/16bit

Freescale 32-bit ColdFire Microcontrollers
Homepage www.freescale.com/coldfire

Freescale Power Architecture Homepage
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Freescale CodeWarrior Software Development Tools
www.freescale.com/codewarrior



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