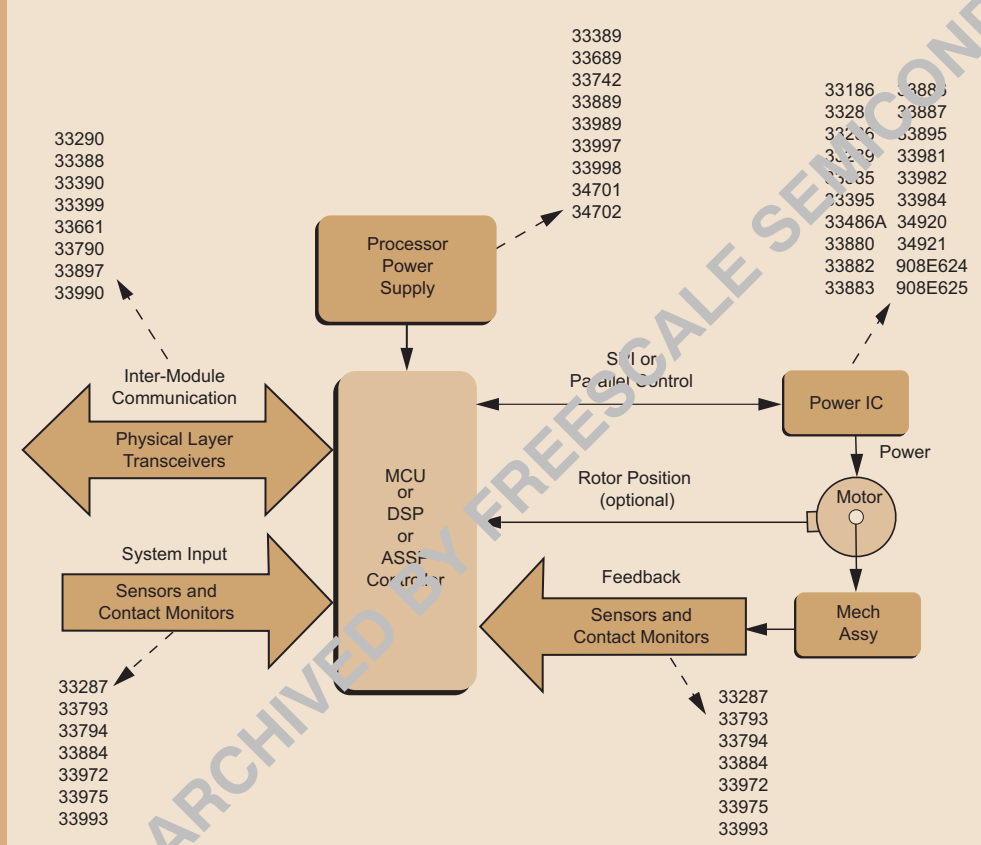# Motor Control

Overview

Motor control is the function of regulating the speed, rotation, and torque of a motor whose application requires constant duty.

Typical applications would include fans/blowers, pumps, compressors, electric boats, electric wheel chairs, golf carts, electric scooters, treadmills, conveyors, winches, and power tools.

Key Benefits

> Provides integrated motor, motion, and static load control system solutions

> Interface easily with most MCU and DSP products

> *SMARTMOS*™ technology enables protection and performance functions to be monolithically built within the power IC silicon

> Freescale offers a selection of power actuation, power management, physical interfaces, and contact monitor products.

MOTOR CONTROL BLOCK DIAGRAM

33389
33689
33742
33889
33989
33997
33998
34701
34702

33290
33388
33390
33399
33661
33790
33897
33990

33186   33885
3328   33887
33215   33895
33119   33981
33135   33982
33395   33984
33486A   34920
33880   34921
33882   908E624
33883   908E625

Processor Power Supply

Inter-Module Communication

Physical Layer Transceivers

System Input

Sensors and Contact Monitors

33287
33793
33794
33884
33972
33975
33993

MCU or DSP or ASSP Controller

SPI or Parallel Control

Rotor Position (optional)

Feedback

Sensors and Contact Monitors

Power IC

Power

Motor

Mech Assy

33287
33793
33794
33884
33972
33975
33993

freescale™

semiconductor

Freescale Ordering Information[Note]

Part Number	Product Highlights	Additional Information
DSP56F803	80 MHz, 40 MIPS, CAN, SCI, SPI, ADC, PWMs, Quadrature Decoder, Quad Timer; 31.5 K Program Flash; 512 K Program RAM; 4K Data Flash; MCU-Friendly Instruction Set; OnCE for Debug; On-Chip Relaxation Oscillator; 2 K BootFLASH; External Memory Expansion; Up to 16 GPIO Available in a 100-Pin LQFP	www.freescale.com
DSP56F805	80 MHz, 40 MIPS, CAN, SCIs, SPI, ADC, PWMs, Quadrature Decoder, Quad Timer; 31.5 K Program Flash; 512 K Program RAM; 4 K Data Flash; 2 K Data RAM; MCU-Friendly Instruction Set; OnCE for Debug; On-Chip Relaxation Oscillator; 2 K BootFLASH, External Memory Expansion; Up to 32 GPIO Available in a 144-Pin LQFP	
DSP56F807	80 MHz, 40 MIPS, CAN, SCIs, SPI, ADCs, PWMs, Quadrature Decoder, Quad Timer; 60 K Program Flash; 2 K Program RAM; 8 K Data Flash; 4 K Data RAM; MCU-Friendly Instruction Set; OnCE for Debug; On-Chip Relaxation Oscillator; 2 K BootFLASH; External Memory Expansion; Uup to 32 GPIO Available in a 160-Pin LQFP and 160 MAPBGA.	
MC33186	150 mΩ H-Bridge	www.freescale.com/analog
MC33285	Dual High-Side TMOS Driver	
MC33286	Dual High-Side TMOS Driver	
MC33287	Contact Monitoring and Dual Low-Side Protected Switch	
MC33289	Dual High-Side Switch for Inductive Loads, 2 x 40 mΩ	
MC33290	Serial ISO-9141 K-Line Interface	
MC33385	Quad Low-Side Switch (250 mΩ $R_{DS(ON)}$)	
MC33388	Fault Tolerant CAN Interface	
MC33389	System Basis Chip with Low-Speed CAN	
MC33390	Serial Link ISO-9141 Bus Transceiver	
MC33395	Three-Phase Bridge Pre-Driver	
MC33399	Local Interconnect Network (LIN) Physical Layer	
MC33486A	Dual High-Side Switch for H-Bridge	
MC33661	e-LIN–Enhanced Physical Interface (Local Interconnect Network)	
MC33689	System Basis Chip with Enhanced LIN Physical Interface	
MC33742	System Basis Chip with Enhanced High-Speed CAN	
MC33790	2-Channel DSI Physical Interface for Bus Masters	
MC33793	DSI Slave for Remote Sensing	
MC33794	Electric Field Imaging Device	
MC33880	Configurable Eight Output SPI Controlled Switch (1.0 Ω $R_{DS(ON)}$)	
MC33882	Six Output Switch (0.3 Ω $R_{DS(ON)}$) with SPI and Parallel Input Control	
MC33883	H-Bridge Pre-Driver	
MC33884	Switch Monitor Interface	
MC33886	H-Bridge Driver (5.2 A)	
MC33887	H-Bridge Driver with Sleep Mode (5.2 A)	
MC33889	System Basis Chip with Low-Speed Fault Tolerant CAN	
MC33895	Quad H-Bridge with LIN Transceiver	
MC33897	Single-Wire CAN Transceiver	
MC33972	22 Input Multiple Switch Detection Interface with Suppressed Wake-Up	
MC33975	22 Input Multiple Switch Detection Interface with Higher Wetting Current	

Note: Search on the listed part number.

Part Number	Product Highlights	Additional Information
MC33981	High-Frequency, High Current, Self-Protected 4.0 mΩ $R_{DS(ON)}$ High-Side Switch	www.freescale.com/analog
MC33982	Self-Protected 2 mΩ Switch with Diagnostic and Protection	
MC33984	Self-Protected 4 mΩ Switch with Diagnostic and Protection	
MC33986	Intelligent High-Current Quad High-Side Switch (024 Heater)	
MC33989	System Basis Chip with High-Speed CAN	
MC33990	Serial Link J-1850 Bus Transceiver	
MC33993	22 Input Multiple Switch Detection Interface	
MC33997	3.3/5.0 V Switching Power Supply	
MC33998	2.6/5.0 V Switching Power Supply	
MC34701	Dual Output Power Supply Switching (1.5 A)	
MC34702	Dual Output Power Supply Switching (3.0 A)	
MC34920	Quad H-Bridge Motor Driver	
MC34921	Power System Control IC	
MC56F8300 Family	60 MHz, 60 MIPS, Up to 576KB Flash, 36KB RAM and Off-Chip Memory, SCI, SPI, ADC, PWM, Quadrature Decoder, Quad Timer, *FlexCAN*™, GPIO, COP/Watchdog, PLL, MCU-Style Software Stack Support, JTAG/OnCE for Debug, Temperature Sensor	www.freescale.com
MM908E624	Integrated Triple High-Side Switch with Embedded MCU and LIN Serial Communication for Relay Drivers	
MM908E625	Integrated Quad Half H-Bridge with Power Supply, Embedded MCU, and LIN Serial Communication	
RD68HC908ACIMDTC	3-Phase AC Induction Motor Drive with Dead Time Distortion Correction Using the 68HC908MR32	
RD68HC908ACIMVHD	3-Phase AC Induction Motor Drive with Tachogenerator Using the MC68HC908MR32	
RD68HC908BLDCHS	3-Phase BLDC Drive Control with Hall Sensors	
RD68HC908BLDCZC	Sensorless BLDC Motor Control Using the MC68HC908MR32	
RD68HC908SVPMD	Sine Voltage Powered 3-Phase Permanent Magnet Synchronous Motor with Hall Sensors	
RDDSP56F8ACIMVHD	3-Phase ACIM Volt Per Hertz Control Using 56F80X	
RDDSP56F8ACVCD	3-Phase AC Induction Motor Vector Control Using 56F805	
RDDSP56F8BLDCAZC	3-Phase BLDC with Sensorless Back-EMF ADC Zero Crossing Detection Using 56F805	
RDDSP56F8BLDCHS	3-Phase BLDC Motor Control with Hall Sensors Using 56F805	
RDDSP56F8BLDCZC	3-Phase Sensorless BLDC Motor Control with Back-EMF Zero Crossing Detection Using 56F805	
RDDSP56F8MSDE	3-Phase PM Synchronous Motor Control with Quadrature Encoder Using 56F805	
RDDSP56F8MTVC	3-Phase PM Synchronous Motor Torque Vector Control Using 56F805	
RDDSP56F8SRDE	3-Phase Switched Reluctance Motor Drive Control with Encoder Using 56F805	
RDDSP56F8SRDHS	3-Phase SR Motor Control with Hall Sensors Reference Design	
RDDSP56F8SRDS	3-Phase SR Motor Sensorless Control Reference Design	
RDHC08ACIM	PWM Control of the Single-Phase AC Induction Motor Using the MC68HC908QT4 MCU	
RDMC3PHAC	General Purpose 3-Phase AC Industrial Motor Controller Reference Design	

Note: Search on the listed part number.

Design Challenges

There are several different kinds of motors used in continuous duty applications, including brushless DC motors, brush-commutator permanent magnet DC motors, series wound field motors, switched reluctance motors, and AC induction motors. The system engineer must not only choose the right kind of motor for the mechanical task, but also choose the appropriate control loop schema which encompasses both the mechanical and electrical time-variant response of the system. The "tuning" of this control loop is often performed in the design of the drive electronics. The design variables are made more numerous by the fact that each different type of motor has a unique set of requirements for the drive electronics. Further complicating the requirements of the drive electronics is the fact that electrical motors, by their inductive nature, are prone to produce EMI, RFI, and destructive high-energy transients. The design of the drive electronics must prevent EMI and RFI while withstanding transient overvoltage and overcurrent conditions, and stall current surges.

Freescale Semiconductor Solution

Freescale Semiconductor Solution

Freescale Semiconductor analog/mixed signal and power integrated circuits are designed to provide system solutions for motor control, motion control, and static load control, when coupled with MCUs or DSPs. In addition to being designed for easy interface and communication with most MCU and DSPs, Freescale Semiconductor's *SMARTMOS™* technology also enables the key protection and performance functions to be built monolithically within the silicon of the power IC. Instead of a printed circuit board loaded with discrete components (and a concomitant poor MTBF number) a system solution can be achieved with Freescale Semiconductor products which is highly integrated, robust, and reliable.

Typical Applications:

> Blowers
> Scooters
> Mixers
> Fans
> Electric wheelchairs
> Shredders
> Vacuums
> Electric boats
> Winches
> Pumps
> Conveyors
> Elevators
> Compressors
> Shakers
> Treadmills
> Golf carts
> Vibrators
> Power tools

Loop Control Schema:

> Speed
> Torque/current
> Voltage
> Rotation (CW/CCW)
> None (open loop)

Power Control Schema:

> On/Off
> PWM
> Linear
> Volts/hertz
> Rotating vector
> Phase angle

Motor Types:

> DC brush commutator
> DC 3-phase brushless
> Universal
> AC induction
> Switched reluctance

Development Tools[Note]

Tool Type	Product Name	Vendor	Description	Additional Information
Evaluation Kit	KIT33389DWEVB	Metrowerks	System Basis Chip	www.metrowerks.com
Evaluation Kit	KIT33661DEVB	Metrowerks	LIN Enhanced Physical Interface	
Evaluation Kit	KIT33689DWBEVB	Metrowerks	System Basis Chip with LIN Transceiver	
Evaluation Kit	KIT33889DWEVB	Metrowerks	System Basis Chip with Low-Speed CAN	
Evaluation Kit	KIT33981PNAEVB	Metrowerks	High-Frequency, High-Current, Self-Protected High-Side Switch	
Evaluation Kit	KIT33982PNBEVB	Metrowerks	Protected High-Current High-Side Switch	
Evaluation Kit	KIT33984PNBEVB	Metrowerks	Dual 4 mΩ Intelligent High-Current Self-Protected Silicon High-Side Switch	
Evaluation Kit	KIT33989DWEVB	Metrowerks	System Basis Chip with High-Speed CAN	
Evaluation Kit	KIT33993DWBEVB	Metrowerks	22 Input Multiple Switch Detection Interface	
Evaluation Kit	KIT33997DWEVB	Metrowerks	3.3/5.0 V Switching Power Supply	
Evaluation Kit	KIT33998DWEVB	Metrowerks	2.6/5.0 V Switching Power Supply	
Evaluation Kit	KIT34701EKEVB	Metrowerks	1.5 A Switch-Mode Power Supply with Linear Regulator	
Evaluation Kit	KIT34702EKEVB	Metrowerks	3.0 A Switch Mode Power Supply with Linear Regulator	
Evaluation Kit	KIT908E624DWBEVB	Metrowerks	Integrated Triple High-Side Switch with Embedded MCU and LIN Serial Communication for Relay	
Evaluation Kit	KIT908E625DWBEVB	Metrowerks	Integrated Quad Half H-Bridge with Power Supply, Embedded MCU, and LIN	
Evaluation Kit	KIT908EINTFC	Metrowerks	PC-Interface for MM908Exxx	
Hardware	EVM and other development tools for respective DSCs	Metrowerks	Helps developers simplify and speed development for digital signal processors.	

Note: Search on the listed product name.

Related Documentation[Note]		
Document Number	**Description**	**Additional Information**
BR1569	Analog ICs Integrated Solutions Applications	www.freescale.com
SG187	Analog Automotive Selector Guide	
SG1002	Analog Selector Guide	
Note: Search on the listed document number..		

Notes

Learn More: Contact the Technical Information Center at +1-800-521-6274 or +1-480-768-2130.

For more information about Freescale products, please visit **www.freescale.com**.

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