Motor Control

September 2008

MICROCHIP

Motor Control Design Solutions

www.microchip.com/motor

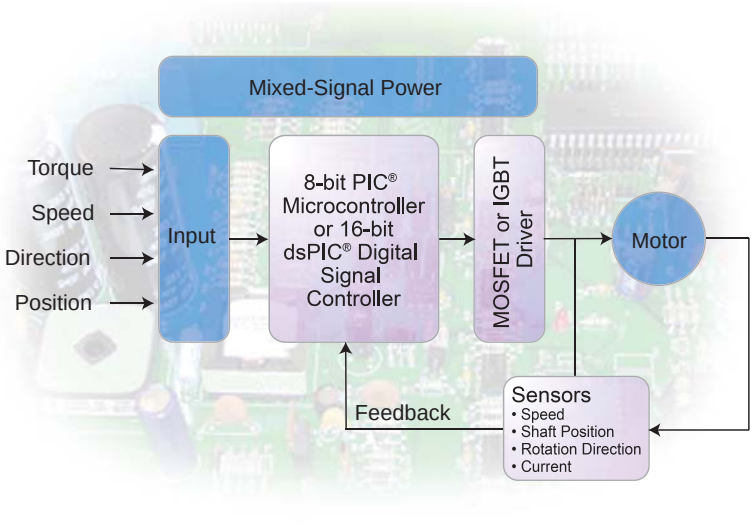
Discover Microchip's Comprehensive Motor Control Solutions

Why chose Microchip for your next motor control design? Our 8-bit Microcontrollers and 16-bit Digital Signal Controllers contain innovative on-chip peripherals designed specifically for motor control. With motor control devices from 8 to 100 pins, we have the perfect part for every application.

Got a tight schedule? We provide free motor control software with application notes and schematics for most motor control algorithms to shorten your development cycle. Our development tools are specifically designed for motor control to promote rapid prototyping of custom applications. We offer technical training classes, web seminars to quickly familiarize engineers with our devices and the latest motor control algorithms.

Microchip can provide these products and resources for motor control applications:

- 8 and 16-bit microcontrollers and digital signal controllers
- MOSFET gate drivers
- Analog and Interface products
- Motor control development tools and reference design hardware
- Motor control algorithms and software
- Motor control training and technical support



Microchip provides everything a motor control design engineer needs: low-risk product development, lower total system cost, faster time to market, outstanding technical support and dependable delivery and quality.

Don't see what you need? Please ask! Just because you don't see it here doesn't mean that it is not available. As a leader in motor control, Microchip is continuously designing new motor control devices and creating new types of motor control support software.

Whole Product Solution

Silicon Solution

Cost Competitive

Superior Architecture

Large Compatible Family

Algorithms

ACIM BLDC PMSM

Brush DC Stepper

Sensor/Sensorless Control

Field-Oriented Control

Technical Support

Web Design Center

Webinars

RTC Classes

Motor Control Experts

Ref. Designs & GUI Tools

Application Note Library with Code

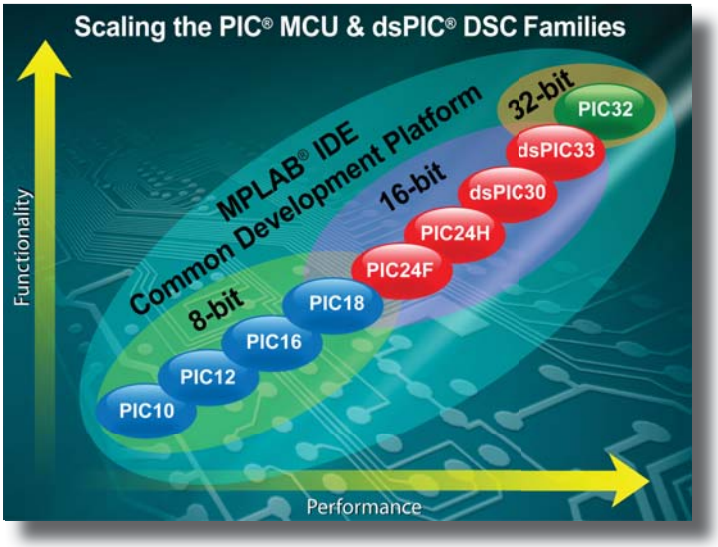
Low-cost Development Tools

Software GUI's for Motor Tuning

Real-Time Motor Parameter Updates

Which MCU or DSC Should You Choose?

Microchip provides many devices that can be used in motor control applications.



Microchip makes many families of MCUs and DSCs, including 8-, 16- and 32-bit solutions. All of these can be used in motor control applications. However, some families contain special motor control peripherals and features as described below. With all of these families, the motor control designer can choose the level of functionality and performance that is required for the application.

PIC10F Microcontroller Family

The 6-pin products of the PIC10F family offer the motor control designer an opportunity to use microcontrollers in applications that have historically been void of such devices. Whether it is cost or space constraints, PIC10F microcontrollers address these concerns by providing a pricing structure that makes them nearly disposable with form factors that can easily be implemented into the most space constrained designs. The ADC, comparator and timer peripherals found in the PIC10F device family can be used to provide a user interface for basic on/off control, speed control and other intelligent motor functions. The PIC10F features include:

- Up to 2 MIPS execution speed
- 2x3 DFN or 6-pin SOT-23 package
- Internal oscillator
- Comparator
- 8-bit ADC

PIC12F and PIC16F Microcontroller Product Family

The PIC12F and PIC16F product families have an 8-bit CPU that can operate at speeds up to 5 MIPS. Device variants in the PIC12F family have 8 pins, while PIC16F variants are offered in 14-pin through 64-pin packages.

Some variants in the PIC16F family have one or more Enhanced Capture Compare PWM Peripheral (ECCP) modules. The ECCP module is optimized for controlling ½ bridge or H bridge motor drive circuits. It can also be used to steer PWM control signals among 4 output pins for BLDC motor commutation or stepper motor control. The PIC12F and PIC16F device families have these features for low-cost motor control applications:

- Up to 5 MIPS execution speed
- One or more Enhanced Capture Compare PWM (ECCP) modules
- Comparator with input multiplexer
- 8-bit or 10-bit ADC
- Internal RC Oscillator
- Internal 5V Shunt Regulator

PIC18F Microcontroller Product Family

The PIC18F product family also has an 8-bit CPU and offers extended performance over the PIC16F device family. The PIC18F device family can operate at speeds up to 12 MIPS and has a hardware multiplier for faster calculation of control algorithms. There are variants in the PIC18F family with specialized motor control peripherals, including a 3-phase motor control PWM peripheral and a quadrature encoder interface (QEI). Other PIC18F variants have the ECCP module found on the PIC16F device family. Source code developed for the PIC16F device family can be easily migrated to the PIC18F family. Devices with the motor control PWM module are well suited for variable speed 3-phase motor applications, while devices with the ECCP module are useful for brush DC and stepper motor applications. The PIC18F family has these features useful for 8-bit motor control applications:

- Up to 12 MIPS execution speed with hardware multiplier
- Motor Control PWM Module with up to 8 Outputs
- Motion Control Feedback Module for Quadrature Encoders
- One or more Enhanced Capture Compare PWM (ECCP) modules
- 10-bit ADC with up to 200 ksps sample rate
- Up to 3 Internal Comparators

16-bit Product Family with Advanced Peripherals

Advanced Motor Control often does not require DSP but benefits greatly from the DSP resources found on the dsPIC® Digital Signal Controllers (DSCs). For example, our sensorless field-oriented control algorithm makes use of the single cycle MAC with data saturation, zero overhead looping and barrel shifting to achieve stunning performance.

dsPIC® 16-bit Digital Signal Controller Product Family

- Large family of code and pin-compatible Flash devices
  - The dsPIC30F device family offers 5V or 3.3V operation and are available in 28, 40, 64 and 80-pin packages
  - The dsPIC33F device family provides 3.3V operation and are available in 20, 28, 44, 64, 80 and 100-pin packages
  - Easy to migrate between family members
  - Facilitates low-end to high-end product strategy
  - Flash program memory for faster development cycles and lower inventory cost
- High Speed 16-bit CPU with Complier-efficient architecture
  - 40 MIPS operation dsPIC33F (30 MIPS operation on dsPIC30F)
  - Modified Harvard architecture for simultaneous data and program access
  - 16 x 16-bit general purpose registers for efficient software operations
  - Optimized for C code by design with industry-leading efficiency
- Built-in DSP engine enables high speed and precision PID control loops
  - Full featured DSP engine with two 40-bit accumulators for multi-loop PID control
  - Dual data fetches for single-cycle MAC instruction support
  - Hardware barrel shifter and single-cycle multiplier
  - Saturation support, rounding modes, circular buffer and modulo addressing modes for shorter control loops
- Direct-Memory Access (DMA) (many dsPIC33F devices)
  - Peripherals automatically store/retrieve data from RAM without stealing cycles from the CPU
- Single supply voltage rails eliminate extra voltage regulator circuits
- Precision High Speed Internal Oscillator eliminate external crystal
- Comprehensive System Integration Features
  - Up to 4 Kbytes of Data EEPROM (dsPIC30F) for non-volatile data storage
  - High current sink/source I/O pins: 25 mA/25 mA (dsPIC30F), 4 mA/4 mA (dsPIC33F)
  - Flexible Watchdog Timer (WDT) with on-chip low-power RC oscillator for reliable operation
  - Power-on Reset (POR), Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
  - Fail-Safe clock monitor operation detects clock failure and switches to on-chip low power RC oscillator
  - Programmable code protection
  - In-Circuit Serial Programming™ (ICSP™)
  - Selectable Power-Saving modes – Sleep, Idle and Alternate Clock modes; Doze mode (dsPIC33F)
  - Programmable Low-Voltage Detection (PLVD) (dsPIC30F)
  - Programmable Brown-out Reset (BOR)
  - Industrial and extended temperature ranges
  - Codeguard™ Security helps eliminate loss of IP

Advanced On-chip Peripherals

Microchip's 16-bit dsPIC Digital Signal Controllers (DSC's) provide on-chip peripherals to design high-performance, precision motor control systems that are more energy efficient, quieter in operation, have greater range and an extended life.

- Motor Control PWM Module (MCPWM)
  - Dedicated time base with up to 8 PWM outputs
  - Up to 4 complementary pairs for 3-phase control
  - Independent output mode for BLDC Control
  - Edge and Center-aligned Modes for quieter operation
  - Programmable Dead-Time Insertion with separate turn-on and turn-off times
  - Programmable A/D trigger for precise sample timing
  - Up to 2 fault inputs to shutdown PWMs
  - Multiple time bases (i.e., supports motor control and PFC)
- High-speed analog-to-digital converter (ADC)
  - Up to 16 channels, 10-bit resolution, 1.1 Msps (1 µs) high speed conversion rate
  - Up to 4 sample and hold circuits for simultaneous sampling capability for all 3 phases
  - Flexible sampling and conversion modes with 16 result registers
  - Monotonic with no missing codes
- Up to 2 Quadrature Encoder Interfaces (QEI) for shaft encoder inputs
  - Programmable digital noise filters on input pins for robustness against noise
  - Full encoder interface support: A, B, Index and Up/Down
- Up to 2 Comparators
  - 20 ns response time for rapid response
  - Programmable voltage reference
- 12-bit A/D converter (up to 0.5 Msps operation)
- Up to eight Input Capture, Output Compare, Standard PWM channels
- Communication peripherals including UART, SPI, I^2C™ and CAN

Advanced Motor Control Applications

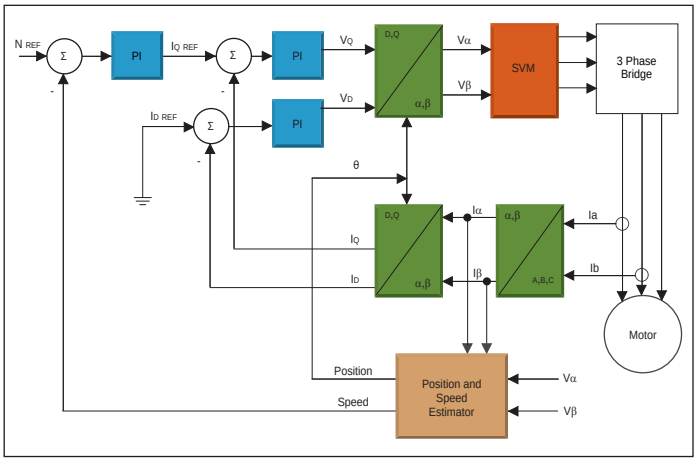
Are you considering moving to brushless motors or sinusoidal control, eliminating costly sensors or adding PFC?

Let Microchip show you how to save energy, reduce noise and cost, improve torque response and reliability.

FOC Sensorless PMSM or ACIM

Are you looking for top of the line dynamic torque response and efficiency, and the lowest system cost motor control solution? Take a look at Microchip's dsPIC sensorless Field Oriented Control (FOC) AN1078 (PMSM) and AN1162 (ACIM) application notes. The dsPIC DSC provides a very cost effective solution to this complex algorithm.

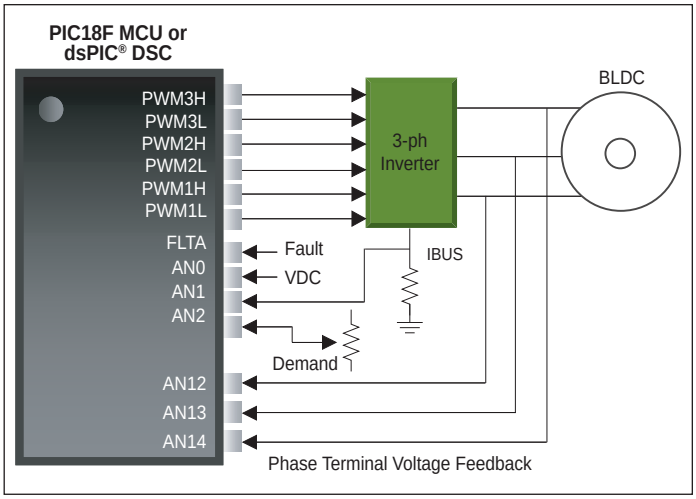
The dsPIC DSC's 10-bit A/D module samples the motor voltage and currents. Clarke and Park transformations transform the A/D information to feed two PI loops controlling torque and flux. Motor speed and position are determined by an estimator which models the motor. The outputs of the PI loops are transformed using Space Vector Modulation to control the Motor Control PWM Module's PWM outputs. Sinusoidal (180°) outputs provide smoother, quieter motor operation.



BLDC Sensorless

Want to eliminate your Hall-Effect sensors and cabling cost by going sensorless? Take a look at Microchip's PIC18F MCU or dsPIC DSC sensorless BLDC solutions. Application notes AN970/AN991/AN992 (Sensorless BEMF), AN1083 (Sensorless Filtered BEMF) and AN1160 (Sensorless Filtered BEMF with Majority Detect) provide details. FIR Filtering of the BEMF and/or using Majority Detect can help with high-speed motors or motors with distorted BEMF signals.

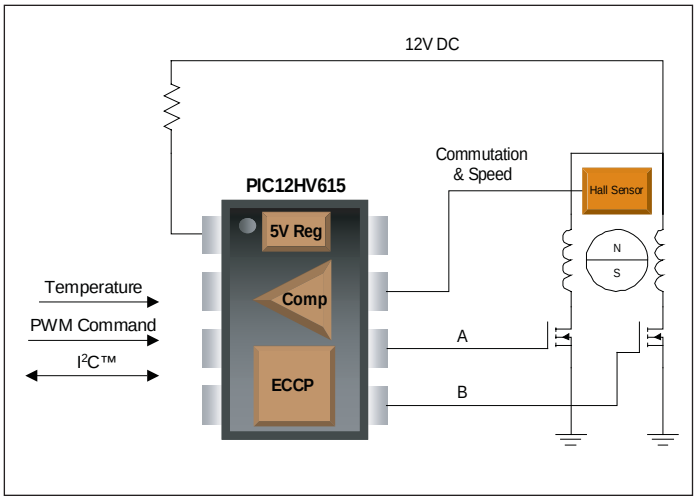
The PIC18 MCU's or dsPIC DSC's A/D samples the motor phase voltages. From the voltages, the CPU determines the rotor position and drives the motor control PWM module to generate trapezoidal output signals for the 3-phase inverter circuit.



Brushless Fan Control

Need a highly integrated fan controller with a customizable speed/temperature profile? Take a look at Microchip's PIC12HV and PIC16HV devices.

The PIC12HV and PIC16HV devices have a built-in 5V regulator and on-chip comparator to save system cost. The rotor position is determined by a Hall-Effect sensor connected to the on-chip comparator. The Enhanced Capture Compare PWM (ECCP) Module uses this feedback information to drive the motor by steering the PWM signal to the appropriate motor phase. Temperature sensor inputs can be used to create a unique fan speed profile and the application can provide digital status information to a host device.



Motor Control Application Notes by Motor Type

Motor Type	App. Note	Description
Stepper Motor	AN822	Stepper Motor Micro-stepping with PIC18C452
	AN906	Stepper Motor Control Using the PIC16F684
	AN907	Stepper Motor Fundamentals
Brushed DC Motor	AN696	PIC18CXXX/PIC16CXXX DC Servomotor Applications
	AN893	Low-Cost Bi-directional Brushed DC Motor Control Using the PIC16F684
	AN905	Brushed DC Motor Fundamentals
BLDC and PMSM	AN857	Brushless DC Motor Control Made Easy
	AN885	Brushless DC (BLDC) Motor Fundamentals
	AN899	Brushless DC Motor Control Using PIC18FXX31 MCU's
	AN901	Sensorless Control of BLDC Motor Using dsPIC30F6010
	AN992	Sensorless Control of BLDC Motor Using dsPIC30F2010
	AN957	Sensored Control of BLDC Motor Using dsPIC30F2010
	AN970	Using the PIC18F2431 for Sensorless BLDC Motor Control
	AN1017	Sinusoidal Control of PMSM Motors with dsPIC30F
	AN1083	Sensorless Control of BLDC with Back-EMF Filtering
	AN1078	Dual Shunt Sensorless FOC for PMSM
	AN1160	Sensorless BLDC Control with Back-EMF Filtering Using a Majority Function
	AN1175	Sensorless Brushless DC Motor Control with PIC16
	AN1208	Integrated Power Factor Correction and Sensorless Field-Oriented Control System
AC Induction Motor	AN843	Speed-Control of 3-Phase Induction Motor Using PIC18 Microcontrollers
	AN887	AC Induction Motor Fundamentals
	AN889	VF Control of 3-Phase Induction Motors Using PIC16F7X7 Microcontrollers
	AN900	Controlling 3-Phase AC Induction Motors Using the PIC18F4431
	AN908	Using the dsPIC30F for Vector Control of an ACIM
	AN955	VF Control of 3-Phase Induction Motor Using Space Vector Modulation
	AN967	Bidirectional VF Control of Single and 3-Phase Induction Motor Using Space Vector Modulation
	AN984	Introduction to ACIM Control Using the dsPIC30F
	AN1162	Sensorless Field Oriented Control (FOC) of an ACIM
	AN1206	Sensorless Field Oriented Control (FOC) of an ACIM Using Field Weakening
Other	AN1106	Power Factor Correction on dsPIC® DSC
	AN1229	Meeting IEC 60730 Class B Compliance with dsPIC® DSC

Motor Type/Algorithm Versus MCU Family

Motor Type	Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Stepper Motor	Full and Half-Stepping	AN906 AN907		
	Micro-Stepping		AN822	
Brushed DC Motor	Unidirectional	AN905		
	Bi-directional	AN893		
	Servo Motor	AN696	AN696	
BLDC and PMSM	Sensored	AN857 AN885	AN899	AN957
	Sensored Sinusoidal			AN1017
	Sensorless BEMF	AN1175	AN970	AN901 AN992
	Sensorless Filtered BEMF			AN1083
	Sensorless Filtered BEMF with Majority Detect			AN1160
	Sensorless Dual-Shunt FOC			AN1078
	Sensorless Dual-Shunt FOC with PFC			AN1208
AC Induction Motor	Open Loop V/F	AN887 AN889 AN955 AN967	AN900 AN843	AN984
	Closed Loop Vector Control			AN908
	Sensorless Dual-Shunt FOC			AN1162
	Sensorless Dual-Shunt with Field Weakening			AN1206
Other	PFC			AN1106
	Appliance Class B			AN1229

Product Tables

Op Amps for Motor Control Applications*

Device	Op Amps Per Package	GBWP (MHz)	Operating Voltage Range (V)	Rail-to-Rail	Mid-Supply VREF	Shutdown Pin
MCP6021/22/23/24	1, 2 or 4	10	2.5-5.5	In/Out	MCP6021 MCP6023	MCP6023

MOSFET Drivers for Motor Control Applications*

Device	Configuration	Peak Output Current (A)	Output Resistance (Ohms)	Maximum Supply Voltage (V)
MCP1401/02	Single	0.5	5/8	18
TC1410/11/12/13	Single	0.5-3.0	15/15-2.5/2.5	16
TC4431/2	Single	1.5	10/10	30
TC4451/22	Single	12	2.2	18
TC4467/68/69	Quad	1.2	15/15	18

8-bit PIC® Microcontrollers for Motor Control Applications*

Device	Pins	Flash KB	SRAM Bytes	EE Bytes	Timer 8/16-Bit	Comp	CCP/ ECCP	Motor Control PWM	A/D 10-Bit	Quad Enc	UART	SPI/ I²C™
PIC16F616/ PIC16HV616(1)	14	3.5	128	–	2/1	2	0/1	–	8 ch	No	–	–
PIC16F684	14	3.5	128	256	2/1	2	0/1	–	8 ch	No	–	–
PIC16F737	28	7	368	–	2/1	2	3	–	11 ch	No	1	1
PIC16F747	40/44	7	368	–	2/1	2	3	–	14 ch	No	1	1
PIC16F767	28	14	368	–	2/1	2	3	–	11 ch	No	1	1
PIC16F777	40/44	14	368	–	2/1	2	3	–	14 ch	No	1	1
PIC18F1230	18/20	4	256	128	0/2	3	–	6	4 ch	No	1	–
PIC18F1330	18/20	8	256	128	0/2	3	–	6	4 ch	No	1	–
PIC18F2331	28	8	768	256	1/3	–	2	6	5 ch	Yes	1	1
PIC18F2431	28	16	768	256	1/3	–	2	6	5 ch	Yes	1	1
PIC18F4331	40/44	8	768	256	1/3	–	2	8	9 ch	Yes	1	1
PIC18F4431	40/44	16	768	256	1/3	–	2	8	9 ch	Yes	1	1

Note 1: HV device has on-chip shunt regulator.

Fan Managers for Motor Control Applications*

Device	Description	Typical Accuracy (°C)	Maximum Accuracy @ 25°C (°C)	Maximum Temperature Range (°C)	Vcc Range (V)	Maximum Supply Current (µA)
TC642	Fan Manager	Note 1	Note 1	-40 to +85	3.0 to 5.5	1,000
TC647B	Fan Manager	Note 1	Note 1	-40 to +85	3.0 to 5.5	400
TC670	Predictive Fan Fault Detector	N/A	N/A	-40 to +85	3.0 to 5.5	150

Note 1: These devices use an external temperature sensor. Accuracy of the total solution is a function of the accuracy of the external sensor.

dsPIC30F Motor Control and Power Conversion Family

Device	Pins	Flash Memory Kbytes	RAM Bytes	EEPROM Bytes	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	Motor Control PWM	Quadrature Encoder	ADC 10-bit 1 Msps	CodeGuard™ Security Segments	UART	SPI	I²C™	CAN	Package Code
dsPIC30F2010	28	12	512	1024	3	4	2	6 ch	Yes	6 ch, 4 S/H	1	1	1	1	–	SP, SO, MM
dsPIC30F3010	28/44	24	1024	1024	5	4	2	6 ch	Yes	6 ch, 4 S/H	1	1	1	1	–	SP, SO, 44-pin ML
dsPIC30F4012	28/44	48	2048	1024	5	4	2	6 ch	Yes	6 ch, 4 S/H	1	1	1	1	1	SP, SO, 44-pin ML
dsPIC30F3011	40/44	24	1024	1024	5	4	4	6 ch	Yes	9 ch, 4 S/H	1	2	1	1	–	P, PT, ML
dsPIC30F4011	40/44	48	2048	1024	5	4	4	6 ch	Yes	9 ch, 4 S/H	1	2	1	1	1	P, PT, ML
dsPIC30F5015	64	66	2048	1024	5	4	4	8 ch	Yes	16 ch, 4 S/H	1	1	2	1	1	PT
dsPIC30F6015	64	144	8192	4096	5	8	8	8 ch	Yes	16 ch, 4 S/H	3	2	2	1	1	PT
dsPIC30F5016	80	66	2048	1024	5	4	4	8 ch	Yes	16 ch, 4 S/H	1	1	2	1	1	PT
dsPIC30F6010A	80	144	8192	4096	5	8	8	8 ch	Yes	16 ch, 4 S/H	3	2	2	1	2	PF, PT

*These tables represents a sampling of device solutions recommended for motor control design. Microchip's broad portfolio of 8-bit microcontrollers, 16-bit digital signal controllers, analog and interface products, serial EEPROMs and related development systems contains hundreds of products that could potentially be used for motor control design, depending upon the application requirements.

Product Tables (Continued)

dsPIC33F Motor Control and Power Conversion Family

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	MC PWM	QEI	ADC 10-/12-bit* 1.1/0.5 Msps	16-bit DAC	Analog Comparators	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	Pkg Code
dsPIC33FJ12MC201	20	12	1	–	3	4	2	4+2 ch	1	1 ADC, 4 ch	–	–	2	1	1	1	–	–	0	SO, P, SS
dsPIC33FJ12MC202	28	12	1	–	3	4	2	6+2 ch	1	1 ADC, 6 ch	–	–	2	1	1	1	–	–	0	SO, SP, ML
dsPIC33FJ32MC202	28	32	2	–	3	4	2	6+2 ch	1	1 ADC, 6 ch	–	–	2	1	1	1	–	–	0	SO, SP, MM
dsPIC33FJ32MC302	28	32	4	8	5	4	4	6+2 ch	2	1 ADC 6 ch	–	2	–	2	2	1	1	1	–	SO, SP, MM
dsPIC33FJ64MC202	28	64	8	8	5	4	4	6+2 ch	2	1 ADC 6 ch	–	2	–	2	2	1	1	1	–	SO, SP, MM
dsPIC33FJ64MC802	28	64	16	8	5	4	4	6+2 ch	2	1 ADC 9 ch	–	2	–	2	2	1	1	1	1	SO, SP, MM
dsPIC33FJ128MC202	28	128	8	8	5	4	4	6+2 ch	2	1 ADC 6 ch	–	2	–	2	2	1	1	1	–	SO, SP, MM
dsPIC33FJ128MC802	28	128	16	8	5	4	4	6+2 ch	2	1 ADC 6 ch	–	2	–	2	2	1	1	1	1	SO, SP, MM
dsPIC33FJ16MC304	44	16	2	–	3	4	2	6+2 ch	1	1 ADC, 9 ch	–	–	2	1	1	1	–	–	0	PT,ML
dsPIC33FJ32MC204	44	32	2	–	3	4	2	6+2 ch	1	1 ADC, 9 ch	–	–	2	1	1	1	–	–	0	PT,ML
dsPIC33FJ32MC304	44	32	4	8	5	4	4	6+2 ch	2	1 ADC 9 ch	–	2	–	2	2	1	1	1	–	PT, ML
dsPIC33FJ64MC204	44	64	8	8	5	4	4	6+2 ch	2	1 ADC 9 ch	–	2	–	2	2	1	1	1	–	PT, ML
dsPIC33FJ64MC804	44	64	16	8	5	4	4	6+2 ch	2	1 ADC 9 ch	2 ch	2	–	2	2	1	1	1	1	PT, ML
dsPIC33FJ128MC204	44	128	8	8	5	4	4	6+2 ch	2	1 ADC 9 ch	–	2	–	2	2	1	1	1	–	PT, ML
dsPIC33FJ128MC804	44	128	16	8	5	4	4	6+2 ch	2	1 ADC 9 ch	2 ch	2	–	2	2	1	1	1	1	PT, ML
dsPIC33FJ64MC506	64	64	8	8	9	8	8	8 ch	1	1 ADC, 16 ch	–	–	3	2	2	2	–	–	1	PT
dsPIC33FJ64MC706	64	64	16	8	9	8	8	8 ch	1	2 ADC, 16 ch	–	–	3	2	2	2	–	–	1	PT
dsPIC33FJ128MC506	64	128	8	8	9	8	8	8 ch	1	1 ADC, 16 ch	–	–	3	2	2	2	–	–	1	PT
dsPIC33FJ128MC706	64	128	16	8	9	8	8	8 ch	1	2 ADC, 16 ch	–	–	3	2	2	2	–	–	1	PT
dsPIC33FJ64MC508	80	64	8	8	9	8	8	8 ch	1	1 ADC, 18 ch	–	–	3	2	2	2	–	–	1	PT
dsPIC33FJ128MC708	80	128	16	8	9	8	8	8 ch	1	2 ADC, 18 ch	–	–	3	2	2	2	–	–	2	PT
dsPIC33FJ64MC510	100	64	8	8	9	8	8	8 ch	1	1 ADC, 24 ch	–	–	3	2	2	2	–	–	1	PT, PF
dsPIC33FJ64MC710	100	64	16	8	9	8	8	8 ch	1	2 ADC, 24 ch	–	–	3	2	2	2	–	–	2	PT, PF
dsPIC33FJ128MC510	100	128	8	8	9	8	8	8 ch	1	1 ADC, 24 ch	–	–	3	2	2	2	–	–	1	PT, PF
dsPIC33FJ128MC710	100	128	16	8	9	8	8	8 ch	1	2 ADC, 24 ch	–	–	3	2	2	2	–	–	2	PT, PF
dsPIC33FJ256MC510	100	256	16	8	9	8	8	8 ch	1	1 ADC, 24 ch	–	–	3	2	2	2	–	–	1	PT, PF
dsPIC33FJ256MC710	**100**	**256**	**30**	**8**	**9**	**8**	**8**	**8 ch**	**1**	**2 ADC, 24 ch**	–	–	**3**	**2**	**2**	**2**	–	–	**2**	**PT, PF**

*dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 S&H) or 500 ksps 12-bit ADC (1 S&H).

Development Systems

Microchip offers a number of development boards and advanced development tools that demonstrate the capabilities of its motor control silicon solutions. These tools work with Microchip's MPLAB® ICD 2 In-Circuit Debugger (DV164005) to download, program and debug application software. Our systems make it easy to customize the software for specific motors.

PICDEM™ MCLV Development Board (DM183021)

The PICDEM MCLV development board is intended for low-voltage (up to 48V), Brushless DC (BLDC) applications. The board provides a low-cost method for users to evaluate and develop motor control applications using Microchip's 28-pin PIC18FXX31 and dsPIC30F motor control products. A 18-pin translator board (AC162078) is also available and allows the PIC18F1330 to be installed on the PICDEM MCLV board.

dsPICDEM™ MCLV Development Board (DM330021)

The dsPICDEM MCLV development board is intended for low-voltage BLDC applications up to 48 volts at 10 amps. It provides a low-cost method for users to evaluate and develop motor control applications using dsPIC33F motor control products via a Plug In Module (PIM) or 28-pin SOIC socket. Serial interfaces include: RS-232C, CAN, LIN and USB (for RTDM). Feedback support includes: Hall-Effect Sensors, Shaft Encoder and three shunt resistors.

Visit www.microchipdirect.com to order any of the development systems shown here.

Advanced Development Tools

A 3-phase High Voltage Power Module and MC1 Motor Control Development Board are shown.

This high-performance modular system provides a method for quick prototyping and validation of various motor types. The tools give you the flexibility to select the appropriate control board and power modules to meet your needs.

A 3-phase Low Voltage Power Module with Explorer 16 Board, Motor Control Interface Board and a Hurst Motor are shown.

Based on the Microchip MCU family that you want to design with, select one of the control board options from the table below:

dsPICDEM™ Motor Control Development System Control Board Options	
dsPIC30F Design	dsPICDEM MC1 Motor Control Development Board (DM300020)
dsPIC33F Design	Explorer 16 Development Board (DM240001) dsPIC33FJ256MC710 Plug-In-Module (MA330013) Motor Control Interface PICtail™ Plus Daughter Board (AC164128)

Next, select a power module based on the voltage and power requirements of the motor you want to control.

dsPICDEM™ Motor Control Development System Power Module Options	
Line Powered Application up to 240V AC, 800W	dsPICDEM MC1H 3 Phase High Voltage Power Module (DM300021)
DC Powered Application up to 48V DC, 600W	dsPICDEM MC1L 3 Phase Low Voltage Power Module (DM300022)

Motors for Development

You can provide your own motor for application development work or purchase one of these:

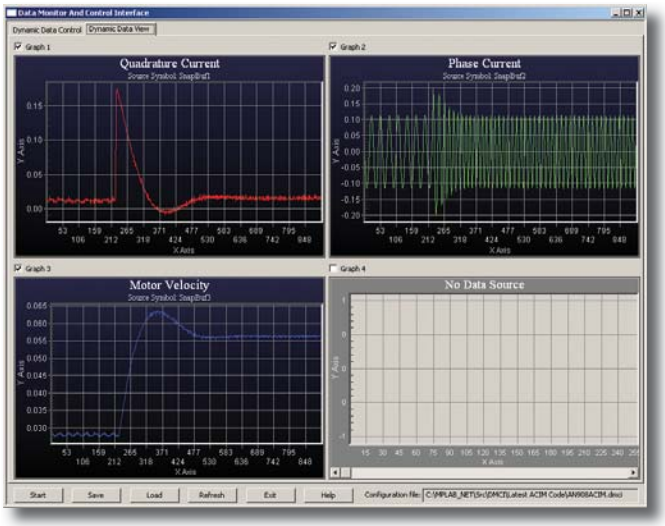
- AC300020 – 24V brushless DC motor
- AC300021 – 208V, 1/3 HP 3-phase AC induction motor

Motor Control Tuning GUIs

These software plug-in tools included with MPLAB® IDE assist with the development of motor control applications:

- **AN901 BLDC Tuning Interface** – Provides a graphical method to configure the motor parameters associated with the AN901 application.
- **AN908 ACIM Tuning Interface** – Provides a graphical method to adjust the control loop parameters associated with the AN908 application.
- **Data Monitor and Control Interface (DMCI)** – Provides a graphical method to input and adjust software motor parameters. Plots can be used to show a time history of control variables so that the motor dynamic response can by analyzed. This tool is useful for tweaking software parameters and visualizing historical data during debug sessions.
- **Real-Time Data Monitor (RTDM)** – Make a change to a software parameter and see the effect immediately without stopping the motor. A serial USB or UART cable supports bi-directional data transfers between the host PC and the MCU/DSC.

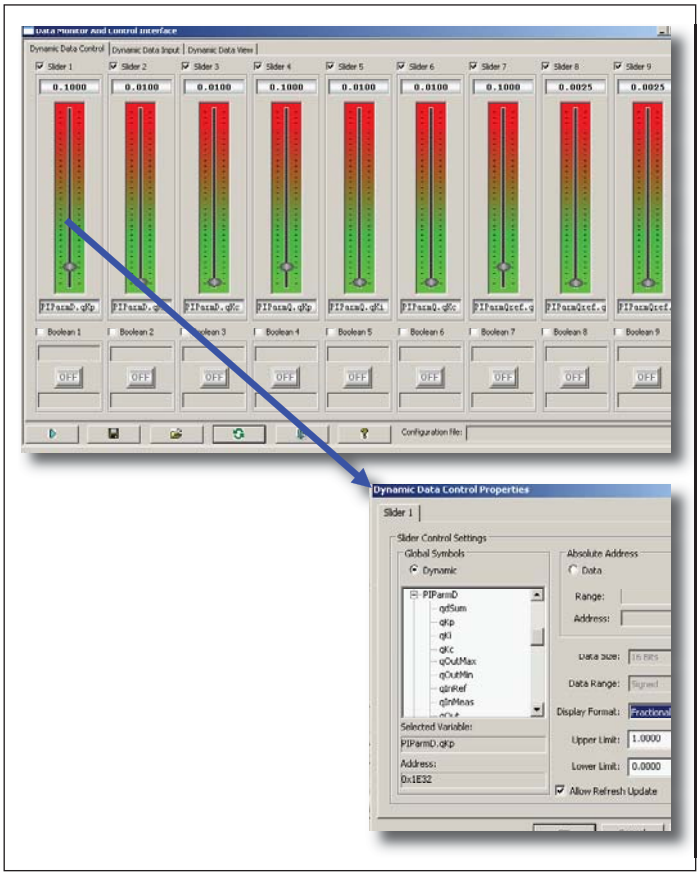
DMCI Graphical Data Display



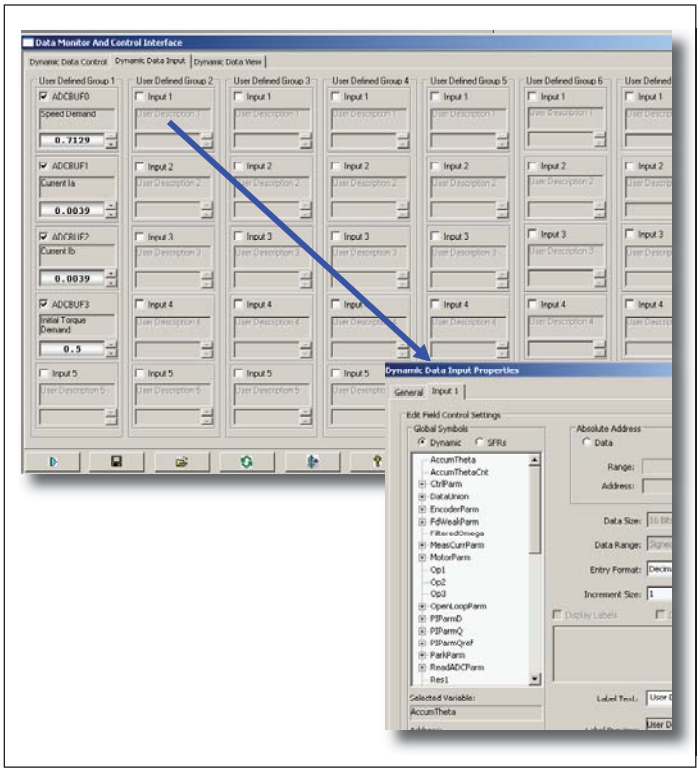
Other Development Tools

Take advantage of Microchip's world-class development tools for 8-bit PIC microcontrollers and 16-bit dsPIC digital signal controllers, including programmers, emulators, debuggers and additional evaluation kits. Operating under the free MPLAB Integrated Development Environment, Microchip's development systems are easy to use and help reduce design time. Software library support that enables motor control applications is available in Microchip's C Compiler tool suites. In addition to peripheral drivers, algorithms are available for Proportional-Interface-Derivative (PID) control and digital filtering.

DMCI Data Input Sliders and Variable Assignment



DMCI Data Input Page and Variable Assignment



Training Solutions

Microchip provides a variety of ways to come up to speed quickly on our 8-bit MCU's and 16-bit dsPIC DSC's, as well as learn how to use them to spin a motor.

Pressed for time? Log on to www.microchip.com/webseminars and download a web seminar on your own schedule. These training modules are just the right size to fit into your busy schedule.

(Optional): Language English

Category Motor Control

	Title	Language	Recording Date	Duration
Details	Sensorless Field Oriented (FOC) Control for AC Induction Motors	English	01/21/2008	23 min
Details	Stepper Motors Part 1: Types of Stepper Motors	English	09/14/2007	19 min
Details	Stepper Motors Part 2: Stepper Motor Control	English	09/14/2007	17 min
Details	Sensorless Field Oriented Control for Permanent Magnet Synchronous Motors	English	03/30/2007	30 min
Details	dsPIC30F Motor Control PWM Module	English	03/30/2005	20 min
Details	Introduction to Mechatronics and the Mechatronic Design Center	English	02/03/2005	20 min
Details	AC Induction Motor (ACIM) control using the PIC18FXX31	English	01/14/2004	20 min
Details	Brushless DC motor (BLDC) motor control using PIC18Fxx31	English	12/18/2003	20 min

Want to Learn From an Expert?

Log on to www.microchip.com/RTC and sign up for a formal class taught by a Microchip engineer. Many of these classes include hands on motor control development work, so you can learn the theory and then put it into practice. Additional classes are available that cover the device programming and peripheral usage, C language and control techniques that are not specific to motor control.

Class	Hours	Type	Abstract
MCT3201: BLDC Control Techniques	7	Hands On	This workshop class provides a detailed overview of BLDC motor theory and control algorithms. The class also provides an introduction to the dsPIC architecture, and motor control peripherals, along with an in-depth look at Microchip's BLDC Motor Control firmware and Motor Control Graphical User Interface.
COMING SOON **MCT7301: Field Oriented Control of Permanent Magnet Synchronous Motors**	7	Hands On	This workshop class provides a detailed overview of PMSM motor theory and control algorithms. The class also provides an introduction to the dsPIC architecture, and motor control peripherals, along with an in-depth look at Microchip's PMSM Motor Control firmware and Motor Control Graphical User Interface.
COMING SOON **MCT4301: Field Oriented Control of AC Induction Motor**	7	Hands On	This workshop class provides a detailed overview of ACIM motor theory and control algorithms. The class also provides an introduction to the dsPIC architecture, and motor control peripherals, along with an in-depth look at Microchip's ACIM Motor Control firmware and Motor Control Graphical User Interface.

Need Design Assistance?

Visit www.microchip.com/partners for a directory of third party consultants and designers that can help with your motor control application.

Get Started Now!

Microchip makes it easy to add electronic motor control functionality to your embedded design. For access to Microchip's complete motor control design resources, visit the Motor Control Design Center at www.microchip.com/motor. Whether you are a motor control expert or a beginner, this dedicated site provides you with everything you need to complete your motor control design, including:

- **Applications by Motor Type:** This on-line table captures numerous end applications and their typical motor types for the industrial, automotive, consumer and appliance market segments. Users are guided to the appropriate products and software solutions for each type of motor.
- **Technical Documentation:** Microchip offers a variety of motor control-related application notes, reference designs and other technical documentation to help speed design time. This technical library provides both theory and operation considerations for a variety of motor types.

Support

Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. In addition, the following service areas are available at www.microchip.com:

- **Support** link provides a way to get questions answered fast: http://support.microchip.com
- **Sample** link offers free evaluation samples of any Microchip device: http://sample.microchip.com
- **Training** link offers webinars, registration for local seminars/workshops and information on annual MASTERs events held throughout the world: www.microchip.com/training
- **Forum** link provides access to knowledge base and peer help: http://forum.microchip.com

Purchase

microchip DIRECT www.microchipdirect.com

microchipDIRECT is a web-based purchasing site that gives you 24-hour-a-day access to all Microchip devices and tools, including pricing, ordering, inventory and support. You can buy the products you need on an easily opened Microchip line of credit.

Sales Office Listing

AMERICAS

Atlanta
Tel: 678-957-9614
Boston
Tel: 774-760-0087
Chicago
Tel: 630-285-0071
Cleveland
Tel: 216-447-0464
Dallas
Tel: 972-818-7423
Detroit
Tel: 248-538-2250
Kokomo
Tel: 765-864-8360
Los Angeles
Tel: 949-462-9523
Santa Clara
Tel: 408-961-6444
Toronto
Mississauga, Ontario
Tel: 905-673-0699

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Denmark - Copenhagen
Tel: 45-4450-2828
France - Paris
Tel: 33-1-69-53-63-20
Germany - Munich
Tel: 49-89-627-144-0
Italy - Milan
Tel: 39-0331-742611
Netherlands - Drunen
Tel: 31-416-690399
Spain - Madrid
Tel: 34-91-708-08-90
UK - Wokingham
Tel: 44-118-921-5869

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733
China - Beijing
Tel: 86-10-8528-2100
China - Chengdu
Tel: 86-28-8665-5511
China - Hong Kong SAR
Tel: 852-2401-1200
China - Nanjing
Tel: 86-25-8473-2460
China - Qingdao
Tel: 86-532-8502-7355
China - Shanghai
Tel: 86-21-5407-5533
China - Shenyang
Tel: 86-24-2334-2829
China - Shenzhen
Tel: 86-755-8203-2660
China - Wuhan
Tel: 86-27-5980-5300
China - Xiamen
Tel: 86-592-2388138
China - Xian
Tel: 86-29-8833-7252
China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-4182-8400
India - New Delhi
Tel: 91-11-4160-8631
India - Pune
Tel: 91-20-2566-1512
Japan - Yokohama
Tel: 81-45-471- 6166
Korea - Daegu
Tel: 82-53-744-4301
Korea - Seoul
Tel: 82-2-554-7200
Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Malaysia - Penang
Tel: 60-4-227-8870
Philippines - Manila
Tel: 63-2-634-9065
Singapore
Tel: 65-6334-8870
Taiwan - Hsin Chu
Tel: 886-3-572-9526
Taiwan - Kaohsiung
Tel: 886-7-536-4818
Taiwan - Taipei
Tel: 886-2-2500-6610
Thailand - Bangkok
Tel: 66-2-694-1351

1/2/08

MICROCHIP

www.microchip.com/motor

Microchip Technology Inc. • 2355 W. Chandler Blvd. • Chandler, AZ 85224-6199

Microcontrollers • Digital Signal Controllers • Analog • Serial EEPROMs

DS00896F