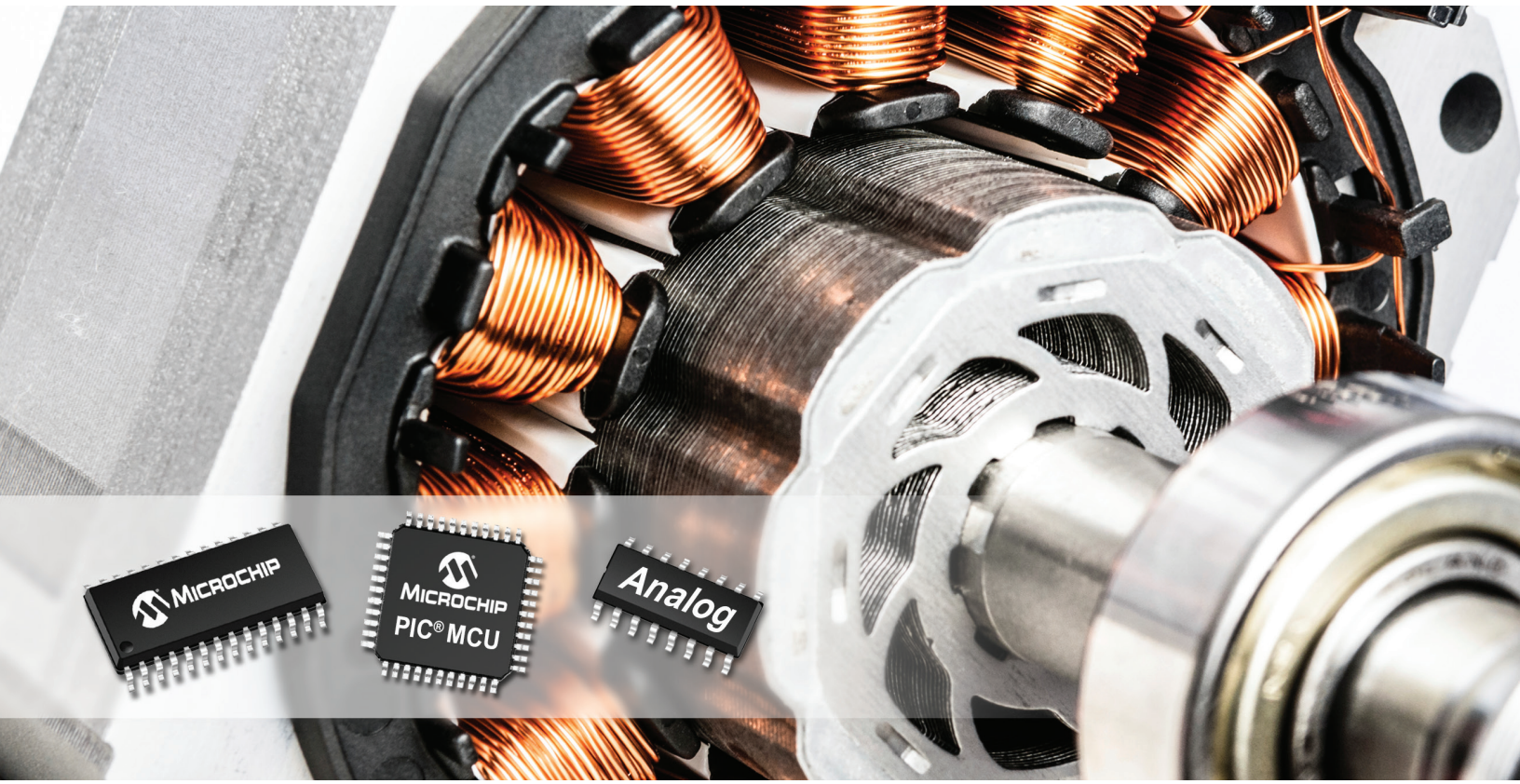
MICROCHIP

Motor Control and Drive Design Solutions



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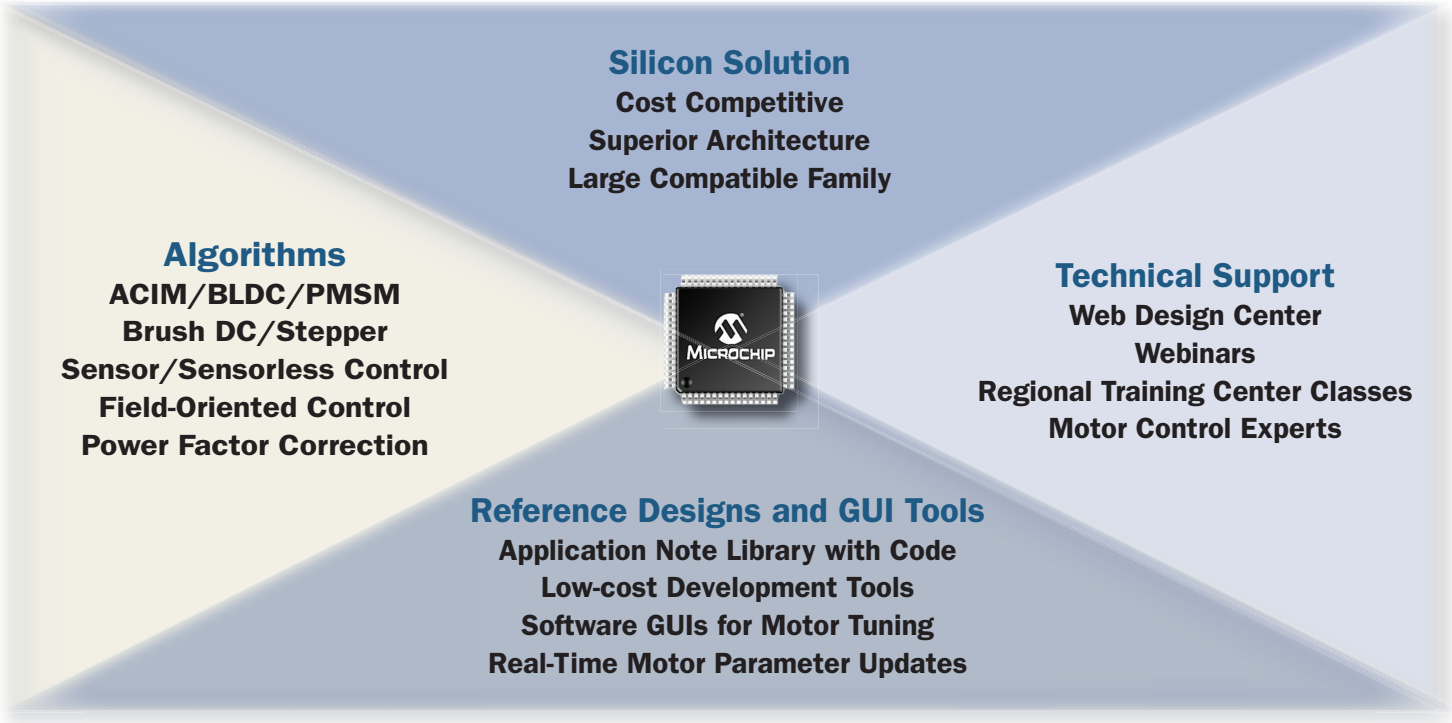
Microchip Motor Control and Drive Solutions



Need Design Assistance?

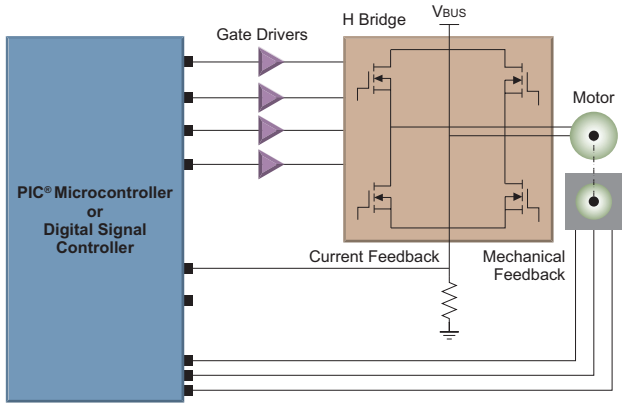
Visit www.microchip.com/partners for a directory of third party consultants and designers that can help with your motor control application.

Table of Contents

Brushed DC Motors

Brushed DC Motor Control

Brushed DC motors are easy to control because speed and torque are proportional to the applied voltage/current. The rotor is heavy due to windings on the armature, more inertia makes it more difficult to start/stop. Heat is generated in windings on the rotor and is more difficult to remove.



Brushed DC Motor Application Notes

Algorithm	App Note
PIC18CXX/PIC16CXXX DC Servomotor Applications	AN8696
Low-Cost Bi-directional Brushed DC Motor Control Using the PIC16F684	AN893
Brushed DC Motor Fundamentals	AN905

Brushed DC Motor Training

Class Title	Language	Recording Date	Duration
Brushed DC Motor Basics	English	09/18/2008	14 min.

Brushed DC Motor Development Tools

F1 BDC Motor Add-On (DM164130-6)

The BDC Motor Add-On is a simple development accessory that plugs directly into the F1 LV Evaluation Platform and incorporates all the components necessary to implement Brushed DC motor control. Key features include two MOSFET half bridge circuits, motor current limit adjustment, debug header, and pin header connector for the motor and power supply.

MTS2916 Dual Full-Bridge Stepper Motor Driver Evaluation Board (ADM00308)

The MTS2916A Dual Full-Bridge Stepper Motor Driver Evaluation Board demonstrates the capabilities of the MTS2916A to control both windings of a bipolar stepper motor. The board also demonstrates the capabilities of controlling two brushed DC motors.

Recommended Products for Brushed DC Motor Control

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™
PIC10F322	6	0.896	64	–	2/0	–	–	2	3 ch 8-bit	–	–	–
PIC12F615/PIC16HV615(1)	8	2	64	–	2/1	1	1	–	4 ch	No	–	–
PIC12F752F	8	1.75	64	–	2/1	2	1	–	4 ch 10-bit	–	–	–
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	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1
PIC18F45K20	40/44	32	1536	256	1/3	2	1/1	–	14	–	1	1
PIC18F46K20	40/44	64	3936	1024	1/3	2	1/1	–	14	–	1	1
PIC18F1330	18/20	8	256	128	0/2	3	–	6	4 ch	No	1	–
PIC18F2431	28	16	768	256	1/3	–	2	6	5 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.

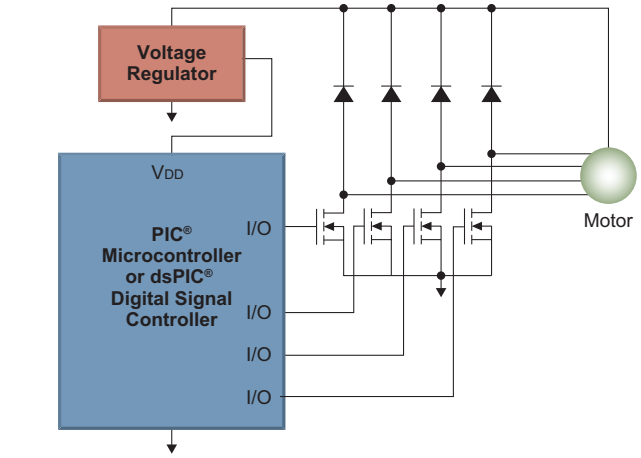
Device	Motor Type	Input Voltage Range (V)	Output Current (mA)	Control Scheme	Temp. Operating Range (°C)	Features	Packages
MTS62C19A	One Bipolar Stepper Motor or Two DC Motors	10.0 to 40.0	750	Direct PWM Input, Current Limit Control, Microstepping	–40 to +105	Overt emperature Protection, Under Voltage Protection, Dual Full Bridge Motor Driver, Microstepping, Pin-compatible with ST L6219	24-pin SOIC
MTS2916A	One Bipolar Stepper Motor or Two DC Motors	10.0 to 40.0	750	Direct PWM Input, Current Limit Control, Microstepping	–40 to +105	Over temperature Protection, Under Voltage Protection, Dual Full Bridge Motor Driver, Microstepping, Pin-compatible with Allegro UDX2916 and A4970	24-pin SOIC

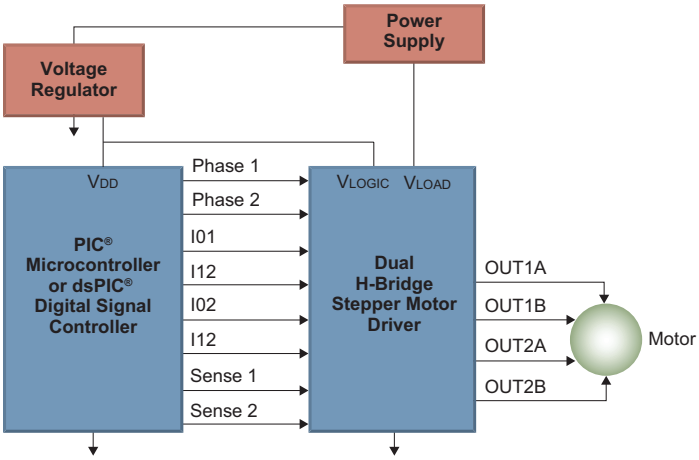
Device	Configuration	Temp. Operating Range (°C)	Peak Output Current (A)	Output Resistance (R_H/R_L) (Max. W @ 25 °C)	Maximum Supply Voltage (V)	Input/Output Delay (t_{D1}, t_{D2}) (ns)	Packages
MCP14700	Dual, Non-inverting	–40 to +125	2	2.5/2.5	5 (V_{DD}), 36 (Boot Pin)	25/25	8-pin SOIC, 8-pin 3 × 3 DFN

Stepper Motors

Stepper Motor Control

Do you need exact position control with great holding torque? If so, then a stepper motor is the best solution. While nearly every MCU or DSC from Microchip can drive a stepper motor, some are better suited for this than others.





Stepper Motor Application Notes

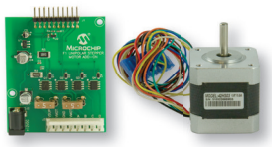
Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Full and Half-Stepping	AN906 AN907	–	AN1307
Micro-Stepping	–	AN822	AN1307

Stepper Motor Training

Class Title	Language	Recording Date	Duration
Stepper Motors Part 1: Types of Stepper Motors	English	09/14/2007	19 min.
Stepper Motors Part 2: Stepper Motor Control	English	09/14/2007	17 min.

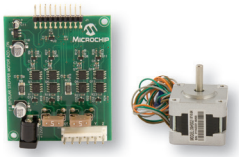
Stepper Motor Development Tools

F1 Unipolar Motor Add-On for the F1 LV Evaluation Platform (DM164130-8)



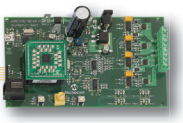
The Unipolar Stepper Motor Add-On is a simple development accessory that plugs directly into the F1 LV Evaluation Platform and incorporates all the components necessary to implement Unipolar Stepper Motor control. Key features include four MOSFET drivers motor current limit, debug header, and pin header connector for the motor and power supply.

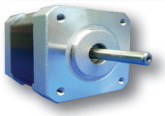
F1 Bipolar Motor Add-On for the F1LV Evaluation Platform (DM164130-7)



The Bipolar Stepper Motor Add-On is a simple development accessory that plugs directly into the F1 LV Evaluation Platform and incorporates all the components necessary to implement Bipolar Stepper Motor control. Key features include four MOSFET half bridge circuits, motor current limit sense, debug header, and pin header connector for the motor and power supply.

dsPICDEM™ MCSM Development Board (DM330022)
dsPICDEM MCSM Stepper Motor Development Board Kit (DV330021)





This development board is intended for low-voltage (up to 80 volts at 3 amps) 2-phase uni-polar or bi-polar stepper motor (4, 6 or 8 wire) applications. It provides a low-cost system for users to evaluate and develop applications using dsPIC33F motor control DSCs via a Plug-In Module (PIM) or 28-pin SOIC socket. A USB serial interface for RTDM is provided. Feedback support includes current and voltage. Demo software to run motors in open-loop or closed-loop with full or variable micro-stepping is provided. A DMCI/RTDM GUI for controlling step commands, motor parameter input and operation modes is included. The kit includes a stepper motor and a 24-volt power supply. PICkit™ 3 Debug Express, MPLAB® ICD 3 In-Circuit Debugger or REAL ICE™ In-Circuit Emulator is required for programming or debugging operations.

MTS2916A Stepper Driver Evaluation Board (ADM00308)

This evaluation board incorporates features through the implementation of push button switches and a variable speed input potentiometer to exercise a stepper motor in Full-Step, Half-Step, Modified Half-Step and Micro-stepping modes.

Stepper Motors

Recommended Products for Stepper Motor Control

Device	Motor Type	Input Voltage Range (V)	Output Current (mA)	Control Scheme	Temp. Operating Range (°C)	Features	Packages
MTS62C19A	One Bipolar Stepper Motor or Two DC Motors	10.0 to 40.0	750	Direct PWM Input, Current Limit Control, Microstepping	–40 to +105	Over temperature Protection, Under Voltage Protection, Dual Full Bridge Motor Driver, Microstepping, Pin-compatible with ST L6219	24-pin SOIC
MTS2916A	One Bipolar Stepper Motor or Two DC Motors	10.0 to 40.0	750	Direct PWM Input, Current Limit Control, Microstepping	–40 to +105	Over temperature Protection, Under Voltage Protection, Dual Full Bridge Motor Driver, Microstepping, Pin-compatible with Allegro UDX2916 and A4970	24-pin SOIC

Device	Max. Input Voltage (V)	Output Voltage (V)	Output Current (mA)	Junction Temp. Range (°C)	Typical Active Current (µA)	Typical Dropout Voltage @ Max. Iout (mV)	Typical Output Voltage Accuracy (%)	Features	Packages
MCP1754	16	1.8, 2.5, 2.7, 2.8, 2.85, 3.0, 3.3, 3.6, 4.0, 5.0	150	–40 to +125	50	300	±2	70 dB PSRR	5-pin SOT-23, 3-pin SOT-89, 3-pin SOT-223, 8-pin 2 × 3 TDFN

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	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1

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

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output/Compare/ Standard PWM	Motor Control PWM Ch	QEI	ADC 10-/12-bit* 1.1/0.5 Msps	16-bit DAC	Analog Comparators	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	Package	Temperature Range***
dsPIC33FJ12MC202	28	12	1	–	3	4	2	6+2 ch	1	1 ADC, 6 ch	–	–	2	1	1	1	–	–	0	SO, SP, ML	I,E
dsPIC33FJ32MC202	28	32	2	–	3	4	2	6+2 ch	1	1 ADC, 6 ch	–	–	2	1	1	1	–	–	0	SO, SP, MM	I,E
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	I,E,H
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	I,E,H
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	I,E,H

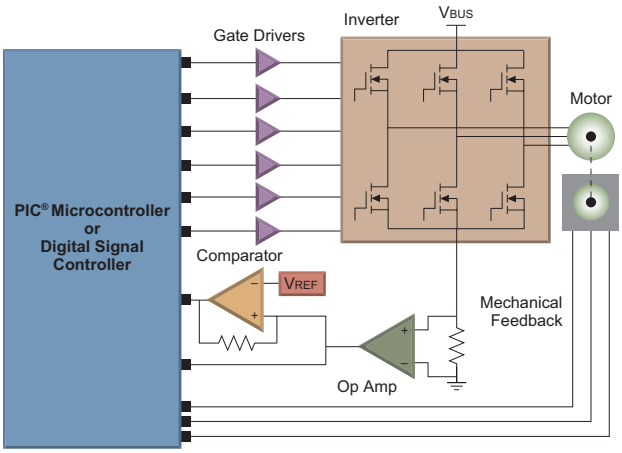
*dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 S & H) or 500 ksps 12-bit ADC (1 S & H).
**A DAC is associated with each analog comparator to set a programmable voltage reference. One DAC output may be selected by software and driven on an external pin.
***I = Industrial Temperature Range (–40°C to +85°C), E = Extended Temperature Range (–40°C to +125°C), H = High Temperature Range (–40°C to +140°C).

Brushless DC Motor Control

BLDC Motor Control

Looking for high reliability, high efficiency, and high power-to-size ratio motor? The obvious solution is a Brushless DC (BLDC) motor. It shares many of the same torque and speed characteristics with the brushed DC motor, but without the brushes. Technically it is a Permanent Magnet Synchronous Motor (PMSM), but its name comes from the simple method of commutation and in some cases the stator windings are constructed to match the non-sinusoidal commutation.

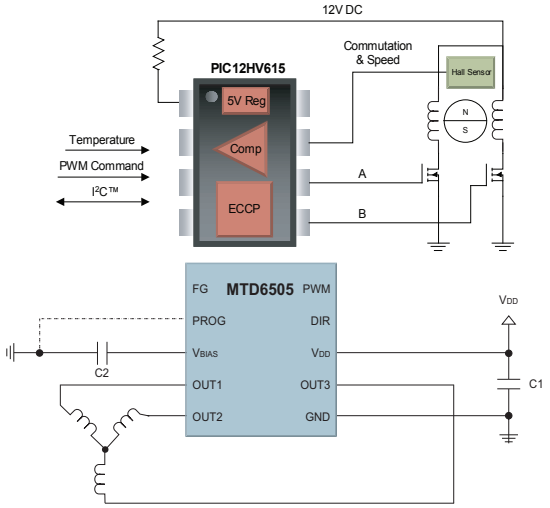
The simpler commutation methods allows the use of a wide range of Microchip products, from 8-bit PIC16 MCUs to MTD650X dedicated BLDC driver chips to dsPIC® digital signal controllers. The device best suited to your application depends on what you are trying to achieve: performance, cost, efficiency, time to market, etc. Microchip has a wide range of application notes and development tools that allow you to get started with your application quickly.



BLDC Fan Motor Control

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

If space or time-to-market is a concern for your next project, Microchip's 3-phase full-wave sensorless drivers for brushless DC (BLDC) motors are the answer. The devices feature 180° sinusoidal drive, high torque output and silent drive. With the adaptive features, parameters and wide range or power supplies, they work standalone or with Microchip's broad range of microcontrollers.



BLDC Application Notes and Tuning Guides

Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Sensored	AN857 AN885	AN899	AN957
Sensored Sinusoidal	–	–	AN1017
Sensorless BEMF	AN1175 AN1305	AN970	AN901 AN992

Algorithm	App Note
Sensorless Filtered BEMF with Majority Detect	AN1160
Sensorless Dual-Shunt FOC with SMO Estimator and Field Weakening	AN1078
Sensorless Dual-Shunt FOC with SMO and PFC	AN1208
Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	AN1292
Sensorless Sing-Shunt FOC with SMO Estimator and Field Weakening	AN1299
Tuning Guide: Sensorless BLDC Control with Back-EMF Filetering Using a Majority Function	AN1160

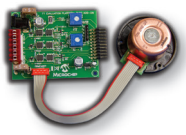
BLDC Training

Class Title	Language	Recording Date	Duration
Sensorless BLDC Motor Control Using a Majority Function	English	04/29/2008	19 min.

Brushless DC Motor Control

BLDC Development Tools

F1 BLDC Motor Add-On (DM164130-2)

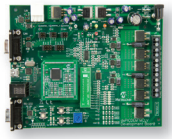


The BLDC Motor Add-On is a simple development accessory that plugs directly into the F1 Evaluation Platform or F1 Evaluation Platform and incorporates all the components necessary to implement Brushless DC motor control. Key features include three MOSFET half bridge circuits, adjustments for zero crossing and current limit of the motor, debug header, and screw terminals for the motor and power supply.

Motor Control Starter Kit with mTouch™ Sensing (DM330015)

The Motor Control Starter Kit with mTouch Sensing is a complete, integrated development platform based on the dsPIC33FJ16MC102. It includes a USB interfaced debugger programmer, a complete drive circuit featuring Microchip's TC4428 dual 1.5A gate drivers, an onboard BLDC Motor, a user configurable switch and an mTouch slider with LED indicators for speed control. Simply power the board using a 9V supply and the pre-loaded code begins to execute.

dsPICDEM MCLV-2 Development Board (DM330021-2)



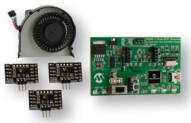
This development board is intended for low-voltage (up to 48V at 10A) BLDC sensored or sensorless applications. It provides a low-cost system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via a Plug-In Module (PIM) or 28-pin SOIC socket. With the MCLV-2 either the internal, on-chip op amps or the external op amps on the MCLV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCLV-2 is fully backwards compatible with the original MCLV and all MC PIMs. Serial interfaces include: RS-232C, CAN, LIN and USB (for RTDM). Feedback support includes Hall- Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual shunt resistors for current. PICkit 3 Debug Express, MPLAB ICD 3 In-Circuit Debugger or MPLAB REAL ICE In-Circuit Emulator is required for programming or debugging operations.

dsPICDEM MCHV-2 Development System (DM330023-2)

This development system is intended for high-voltage (up to 400V at 6.5A) BLDC, PMSM and ACIM sensored or sensorless applications. It provides a low-cost Integrated Power Module (IPM) based system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via a Plug-In Module (PIM) or a 28-pin SOIC socket. With the MCHV-2 either the internal, on-chip op amps or the external op amps on the MCHV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCHV-2 is fully backwards compatible with the original MCHV and all MC PIMs. Isolated serial interfaces include RS-232C and USB (for RTDM). Feedback support includes Hall-Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual current shunt resistors. A PFC circuit is provided to meet regulatory requirements. An isolated built-in debugger (similar to a starter kit programmer/debugger) permits a direct connection with a PC.

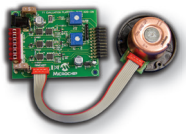
BLDC Fan Control Development Tools

MTD6505 3-Phase BLDC Sensorless Fan Controller Demonstration Board (ADM00345)



The MTD6505 3-Phase BLDC Sensorless Fan Controller Demonstration Board allows the control and monitoring of the MTD6505 device using PC software connected to the board via a USB connection.

F1 BLDC Motor Add-On (DM164130-2)



The BLDC Motor Add-On is a simple development accessory that plugs directly into the F1 Evaluation Platform or F1 Evaluation Platform and incorporates all the components necessary to implement Brushless DC motor control. Key features include three MOSFET half bridge circuits, adjustments for zero crossing and current limit of the motor, debug header, and screw terminals for the motor and power supply.

Recommended Products for Brushless Fan Control

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	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1

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

Brushless DC Motor Control

Recommended Products for Brushless Fan Control (Continued)

Device	Motor Type	Input Voltage Range (V)	Output Current (mA)	Control Scheme	Temp. Operating Range (°C)	Features	Packages
MTD6505	3-Phase Brushless DC Motor	2.0 to 5.5	750	Sensorless Sinusoidal	–40 to +125	180° Sinusoidal Drive, Direction Control, Programmable BEMF Coefficient Range, Current Limitation, Lock-up Recover, Over temperature Protection, Output Switching Frequency at 30 kHz	10-pin 3 × 3 UDFN
MTD6501C	3-Phase Brushless DC Motor	2.0 to 14.0	800	Sensorless Sinusoidal	–30 to +95	180° Sinusoidal Drive, Current Limitation, Lock-up Recover, Over temperature Protection, Output Switching Frequency at 20 kHz	Thermally Enhanced 8-pin SOP
MTD6501D	3-Phase Brushless DC Motor	2.0 to 14.0	500	Sensorless Sinusoidal	–30 to +95	180° Sinusoidal Drive, Current Limitation, Lock-up Recover, Over temperature Protection, Output Switching Frequency at 20 kHz	10-pin MSOP
MTD6501G	3-Phase Brushless DC Motor	2.0 to 14.0	800	Sensorless Sinusoidal	–30 to +95	180° Sinusoidal Drive, Current Limitation, Lock-up Recover, Over temperature Protection, Output Switching Frequency at 23 kHz	Thermally Enhanced 8-pin SOP

Recommended Products for Brushless DC Motors

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	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	Motor Control PWM Ch	QEI	ADC	Analog Comparators	Op Amps	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	USB 2.0	Package	Temperature Range***
dsPIC33EP32MC202	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC502	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC203◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP32MC503◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP32MC204	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL, ML, PT	I,E, H
dsPIC33EP32MC504	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL, ML, PT	I,E, H
dsPIC33EP64MC202	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC502	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC203◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP64MC503◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP64MC204	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC504	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC206	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP64MC506	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP128MC202	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC502	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC204	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC504	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC206	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP128MC506	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP256MC202	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC502	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC204	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC504	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC206	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP256MC506	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC202	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SO, SS, MM	I,E, H
dsPIC33EP512MC502	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SO, SS, MM	I,E, H
dsPIC33EP512MC204	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC504	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC206	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC506	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H

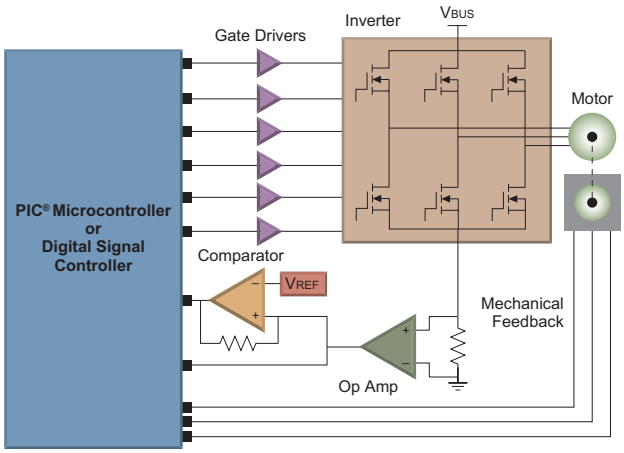
*dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 S & H) or 500 ksps 12-bit ADC (1 S & H).
**Op amps can be configured as comparators.
***I = Industrial Temperature Range (–40°C to +85°C), E = Extended Temperature Range (–40°C to +125°C), H = High Temperature Range (–40°C to +140°C).
◊Check www.microchip.com for availability.

Permanent Magnet Synchronous Motors

PMSM Motor Control

Permanent Magnet Synchronous Motors (PMSM) are brushless and have very high reliability and high efficiency. Due to permanent magnet rotor, they also have higher torque with smaller frame size and no rotor current, of all which are advantages over AC induction motors. With a high power-to-size ratio, PMSMs can help you make your design smaller without the loss of torque.

PMSMs need to be commutated like BLDC motors, but due to the construction of the windings, the waveforms need to be sinusoidal for good performance. This requires more complicated control algorithms and, therefore, a higher performing controller like Microchip's dsPIC digital signal controllers. Microchip offers development tools and applications notes to develop advanced PMSM control solutions like sensorless Field Oriented Control (FOC).



PMSM Application Notes and Tuning Guides

Algorithm	dsPIC® DSC Family
Sensored	AN957
Sensored Sinusoidal	AN1017
Sensorless BEMF	AN901, AN992

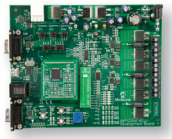
Algorithm	App Note
Sensorless Filtered BEMF with Majority Detect	AN1160
Sensorless Dual-Shunt FOC with SMO Estimator and Field Weakening	AN1078
Sensorless Dual-Shunt FOC with SMO and PCF	AN1208
Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	AN1292
Sensorless Single-Shunt FOC with SMO Estimator and Field Weakening	AN1299
Sensorless Dual-Shunt FOC with SMO Estimator BLDC/PMSM	AN1078
Sensorless Dual-Shunt FOC with PLL Estimator BLDC/PMSM	AN1292
Tuning Guide: Sensorless Single-Shunt FOC with SMO Estimator BLDC/PMSM	AN1299

PMSM Motor Training

Class Title	Language	Recording Date	Duration
Sensorless Field Oriented Control for Permanent Magnet Synchronous Motors	English	03/30/2007	30 min.

PMSM Development Tools

dsPICDEM MCLV-2 Development Board (DM330021-2)



This development board is intended for low-voltage (up to 48V at 10A) BLDC sensored or sensorless applications. It provides a low-cost system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via a Plug-In Module (PIM) or 28-pin SOIC socket. With the MCLV-2 either the internal, on-chip op amps or the external op amps on the MCLV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCLV-2 is fully backwards compatible with the original MCLV and all MC PIMs. Serial interfaces include RS-232C, CAN, LIN and USB (for RTDM). Feedback support includes Hall- Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual shunt resistors for current. PICkit 3 Debug Express, MPLAB ICD 3 In-Circuit Debugger or MPLAB REAL ICE In-Circuit Emulator is required for programming or debugging operations.

dsPICDEM MCHV-2 Development System (DM330023-2)

This development system is intended for high-voltage (up to 400V at 6.5A) BLDC, PMSM and ACIM sensored or sensorless applications. It provides a low-cost Integrated Power Module (IPM) based system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via PIM or a 28-pin SOIC socket. With the MCHV-2 either the internal, on-chip op amps or the external op amps on the MCHV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCHV-2 is fully backwards compatible with the original MCHV and all MC PIMs. Isolated serial interfaces include RS-232C and USB (for RTDM). Feedback support includes Hall-Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual current shunt resistors. A PFC circuit is provided to meet regulatory requirements. An isolated built-in debugger (similar to a starter kit programmer/debugger) permits a direct connection with a PC.

24V 3-Phase Brushless DC Motor (AC300020)

The 24V 3-phase Brushless DC (BLDC) motor with Hall-Effect sensors can be used with the dsPICDEM MCLV-2 development board (DM330021-2).

24V 3-Phase Brushless DC Motor with Encoder (AC300022)

This Brushless DC (BLDC) motor has a 250-line encoder, and can be used with the dsPICDEM MCLV-2 Development Board (DM330021-2).

Permanent Magnet Synchronous Motors

Recommended Products for PMSM Motors

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	Motor Control PWM Ch	QEI	ADC	Analog Comparators	Op Amps	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	USB 2.0	Package	Temperature Range***
dsPIC33EP32MC202	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC502	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC203◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP32MC503◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP32MC204	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL, ML, PT	I,E, H
dsPIC33EP32MC504	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL, ML, PT	I,E, H
dsPIC33EP64MC202	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC502	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC203◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP64MC503◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP64MC204	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC504	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC206	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP64MC506	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP128MC202	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC502	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC204	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC504	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC206	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP128MC506	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP256MC202	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC502	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC204	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC504	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC206	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP256MC506	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC202	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SO, SS, MM	I,E, H
dsPIC33EP512MC502	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SO, SS, MM	I,E, H
dsPIC33EP512MC204	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC504	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC206	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC506	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H

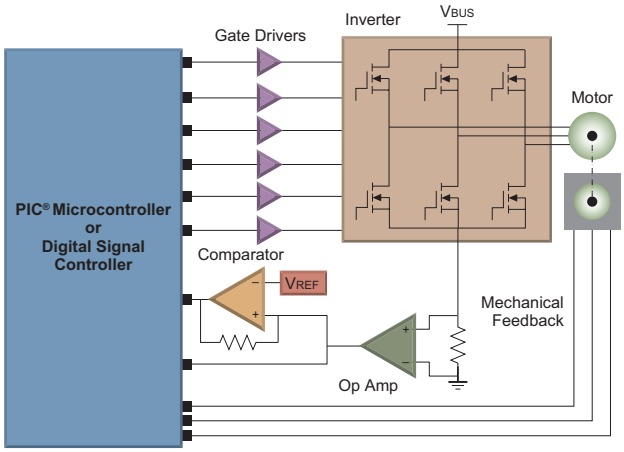
*dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 S & H) or 500 ksps 12-bit ADC (1 S & H).
**Op amps can be configured as comparators.
***I = Industrial Temperature Range (–40°C to +85°C), E = Extended Temperature Range (–40°C to +125°C), H = High Temperature Range (–40°C to +140°C).
◊Check www.microchip.com for availability.

AC Induction Motors

AC Induction Motor Control

The AC Induction Motor (ACIM) is the workhorse of the world. It is the most common motor type, used in everything from consumer products to heavy industry. Its simple design with no brushes makes it highly reliable and also allows it to be manufactured at a low cost. But, it is less efficient than other motors like PMSM, which is partially related to the heat generation in the rotor windings.

The Open Loop Voltage/frequency (V/f) drive technique is tradionally used to control ACIMs. It can be implemented on an 8-bit PIC® MCU. This drive technique is not very efficient, so for applications that need higher efficiency, an advanced control solution like Field Oriented Control can be applied. This requires a high performance controller, like a dsPIC digital signal controller. Hardware and software development solutions are available from Microchip.



AC Induction Motor Training

Class Title	Language	Recording Date	Duration
Sensorless Field Oriented (FOC) Control for AC Induction Motors	English	01/21/2008	23 min.

AC Induction Application Notes

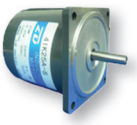
Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Open Loop V/F	AN887 AN889 AN955 AN967	AN900 AN843	AN984
Closed Loop Vector Control	–	–	AN980
Sensorless Dual-Shunt FOC with PLL Estimator	–	–	AN1162
Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	–	–	AN1206

AC Induction Development Tools

dsPICDEM MCHV-2 Development System (DM330023-2)

This development system is intended for high-voltage (up to 400V at 6.5A) BLDC, PMSM and ACIM sensored or sensorless applications. It provides a low-cost Integrated Power Module (IPM) based system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via a Plug-In Module (PIM) or a 28-pin SOIC socket. With the MCHV-2 either the internal, on-chip op amps or the external op amps on the MCHV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCHV-2 is fully backwards compatible with the original MCHV and all MC PIMs. Isolated serial interfaces include RS-232C and USB (for RTDM). Feedback support includes Hall-Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual current shunt resistors. A PFC circuit is provided to meet regulatory requirements. An isolated built-in debugger (similar to a starter kit programmer/debugger) permits a direct connection with a PC.

AC Induction Motor (AC300023)



This compact 3-phase AC Induction Motor has been certified for use with dsPIC33 ACIM motor control application notes in conjunction with the dsPICDEM MCHV-2 Development System (DM330023-2).

Recommended Products for AC Induction Motors

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	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1

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

AC Induction Motors

Recommended Products for AC Induction Motors (Continued)

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	Motor Control PWM Ch	QEI	ADC	Analog Comparators	Op Amps	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	USB 2.0	Package	Temperature Range***
dsPIC33EP32MC202	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC502	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC203◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP32MC503◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP32MC204	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL, ML, PT	I,E, H
dsPIC33EP32MC504	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL, ML, PT	I,E, H
dsPIC33EP64MC202	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC502	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC203◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP64MC503◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP64MC204	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC504	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC206	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP64MC506	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP128MC202	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC502	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC204	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC504	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC206	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP128MC506	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP256MC202	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC502	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC204	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC504	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC206	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP256MC506	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC202	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SO, SS, MM	I,E, H
dsPIC33EP512MC502	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SO, SS, MM	I,E, H
dsPIC33EP512MC204	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC504	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC206	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC506	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H

*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).
**Op amps can be configured as comparators.
***I = Industrial Temperature Range (–40°C to +85°C), E = Extended Temperature Range (–40°C to +125°C), H = High Temperature Range (–40°C to +140°C).
◊Check www.microchip.com for availability.

Application Notes for Motor Control

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
	AN1307	Stepper Motor Control Using the dsPIC® DSC
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 MCUs
	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 With Four Quadrant Control
	AN1078	Dual Shunt Sensorless FOC for PMSM with SMO Estimator and Field Weakening
	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
	AN1292	Dual Shunt Sensorless FOC for PMSM with PLL Estimator and Field Weakening
	AN1299	Single Shunt Sensorless FOC for PMSM with SMO Estimator and Field Weakening
	AN1305	Sensorless 3-Phase Brushless Motor Control with the PIC16FXXX
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	AN894	Motor Control Sensor Feedback Circuits
	AN898	Determining MOSFET Driver Needs for Motor Drive Applications
	AN1106	Power Factor Correction on dsPIC DSC
	AN1229	Meeting IEC 60730 Class B Compliance with dsPIC DSC
	AN1332	Current Sensing Circuit Concepts and Fundamentals

Motor Type/Algorithm Versus MCU Family

Motor Type	Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Stepper Motor	Full and Half-Stepping	AN906 AN907	–	AN1307
	Micro-Stepping	–	AN822	AN1307
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 AN1305	AN970	AN901 AN992
	Sensorless Filtered BEMF with Majority Detect	–	–	AN1160
	Sensorless Dual-Shunt FOC with SMO Estimator and Field Weakening	–	–	AN1078
	Sensorless Dual-Shunt FOC with SMO and PFC	–	–	AN1208
	Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	–	–	AN1292
	Sensorless Single-Shunt FOC with SMO Estimator and Field Weakening	–	–	AN1299
AC Induction Motor	Open Loop V/F	AN887 AN889 AN955 AN967	AN900 AN843	AN984
	Closed Loop Vector Control	–	–	AN980
	Sensorless Dual-Shunt FOC with PLL Estimator	–	–	AN1162
	Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	–	–	AN1206
Other	PFC	–	–	AN1106
	Appliance Class B (IEC 60730)	–	AN1229	AN1229
	Motor Control Sensor Feedback Circuits	AN894	AN894	AN894
	MOSFET Driver Selection	AN898	AN898	AN898
	Current Sensing Circuit Concepts and Fundamentals	AN1332	AN1332	AN1332

World Class Development Tools

MPLAB X IDE

Universal and Integrated Tool Set

MPLAB X IDE is a single, universal graphical user interface for Microchip and third party software and hardware development tools. It is the industry's only IDE to support an entire portfolio of 8-bit, 16-bit and 32-bit PIC MCUs, dsPIC DSCs and memory devices.

MPLAB X supports Microchip's compilers, emulators, debuggers and starter kits, as well as many third-party tools. Moving between all of your favorite Microchip tools and upgrading from software simulators to hardware debugging and programming tools is simple with this IDE's seamless user interface.

Powerful Yet User-Friendly Interface

With complete project management, visual call graphs, a configurable watch window and a feature-rich editor that includes code-completion, context menus and a task navigator, MPLAB X is flexible and friendly enough for new users.

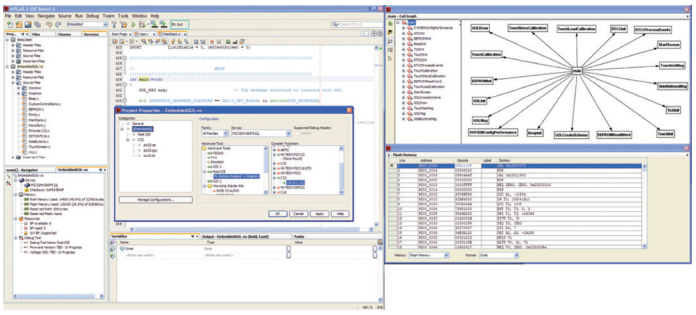
MPLAB X is also fully equipped for the needs of experienced users with the ability to support multiple tools on multiple projects with multiple configurations and simultaneous debugging.

Open-Source Platform

Based on the NetBeans™ Platform, MPLAB X supports a host of free software components and plug-ins from the NetBeans community for high-performance application development customized to your needs. In addition to local file history, MPLAB X is also compatible with revision control plug-ins and Bugzilla.

Cross-Platform

Using MPLAB X IDE, users can run their favorite toolset and develop their next embedded application on Windows®, Linux® or Mac® OS X.



MPLAB XC16 C Compiler for PIC24 MCUs and dsPIC DSCs

The MPLAB XC16 C Compiler includes a complete ANSI C standard library, including string manipulation, dynamic memory allocation, data conversion, timekeeping and math libraries. The compiler has a powerful code optimizer. Other 16-bit MCU compilers generate as much as 165% more code for the same application.

The assembler comes with the MPLAB XC C Compiler and may be used with the compiler or as an assembler. It is a full-featured macro assembler. User-defined macros, conditional assembly and a variety of assembler directives make the assembler a power code generation tool.

FREE Download a full-featured, time-restricted evaluation version of the MPLAB XC16 C Compiler for PIC24 MCUs or dsPIC DSCs from the Microchip web site.

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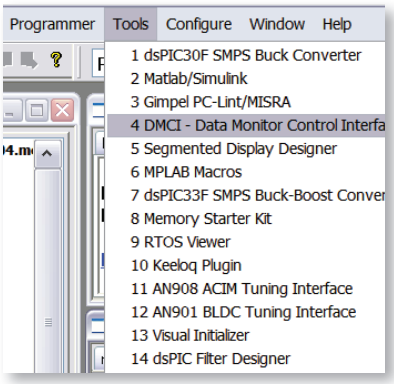
Available for MPLAB X IDE

FREE MPLAB X SIM Software Simulator

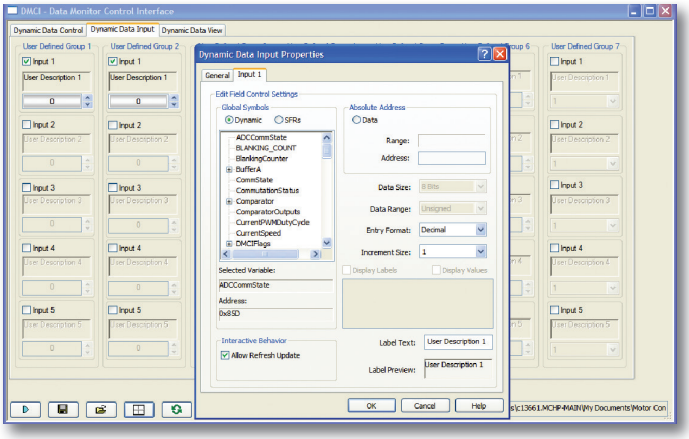
The MPLAB X SIM Software Simulator is a full-featured, cycle-accurate software simulator. In addition to simulating the CPU and the instruction set, it also supports key peripherals.

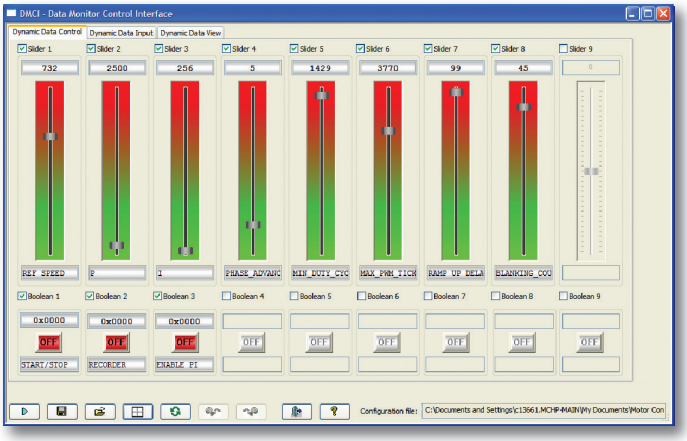
Motor Control Tuning GUIs

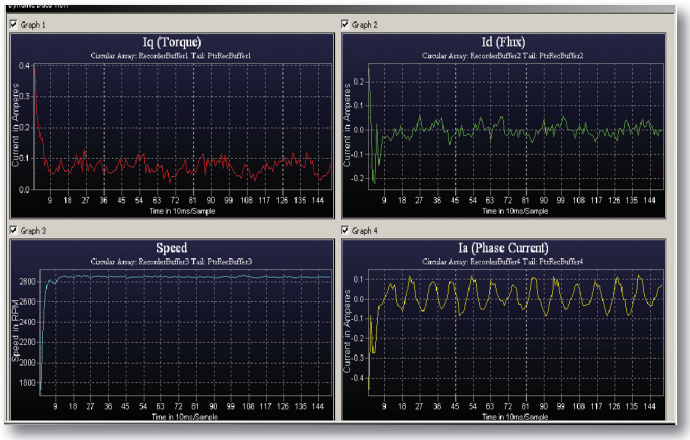
These software plug-in tools included with MPLAB X IDE assist with the development of motor control applications:

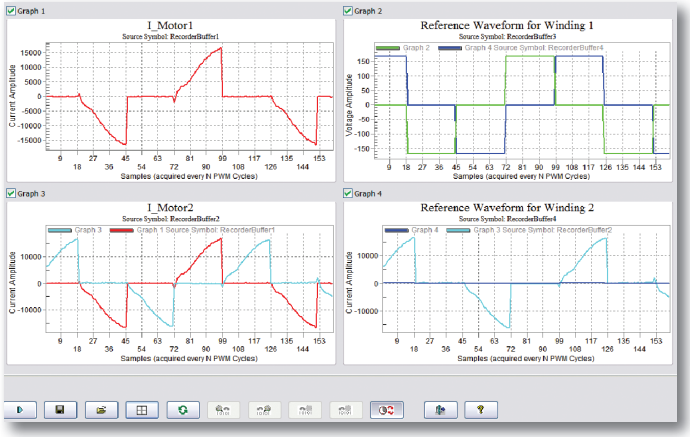


- **Data Monitor and Control Interface (DMCI):** Provides a customizable GUI to input and adjust software motor parameters using sliders and switches. Four customizable output plots can be used to show a graphical history of control variables so that the motor dynamic response can by analyzed. This tool is useful for tweaking software parameters and visualizing historical data during debug sessions. Most motor control application note software comes with a setup file to automatically configure DMCI for the application.

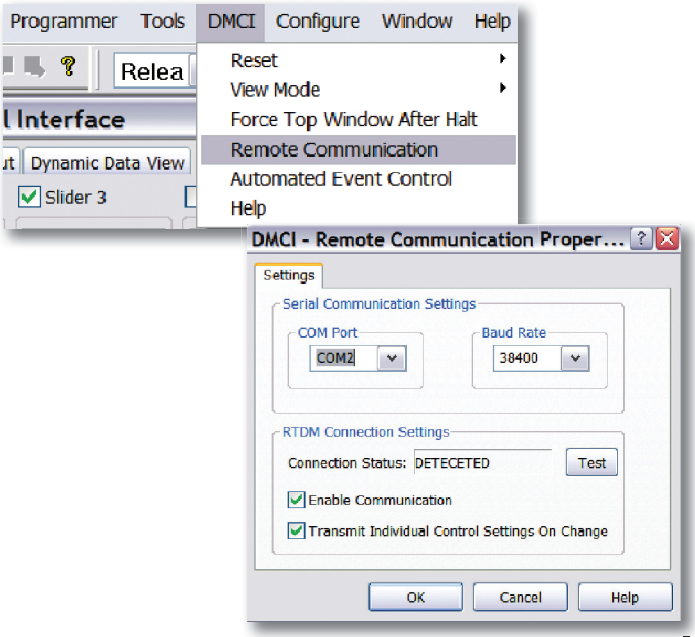








- **Real-Time Data Monitor (RTDM):** Make a change to a software parameter and see the effect immediately without stopping the motor. A serial USB or UART cable supports bi-directional data transfers between the host PC and the MCU/DSC. This is configured within DMCI and most motor control application note software comes with a setup file to automatically configure RTDM for the application.



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