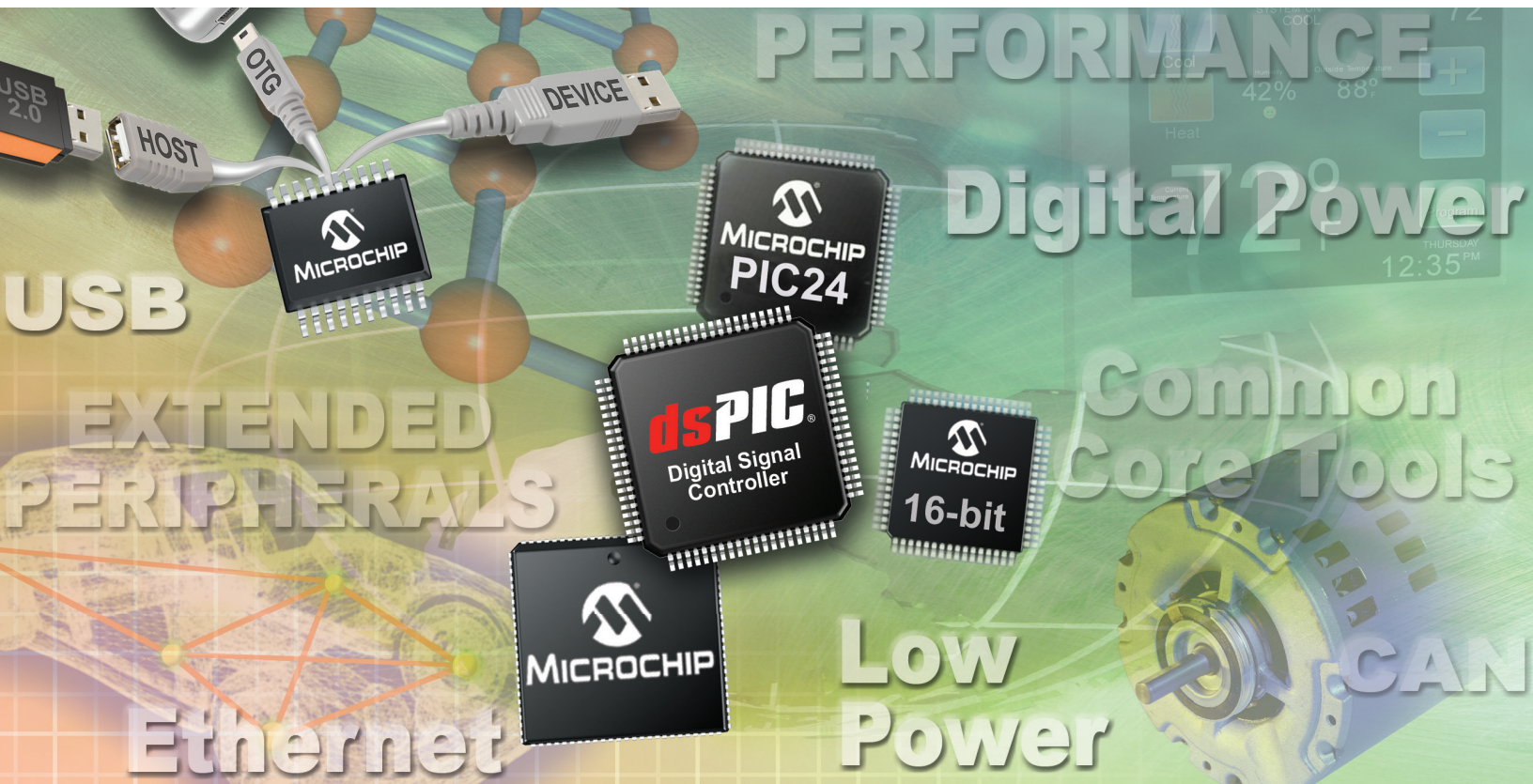




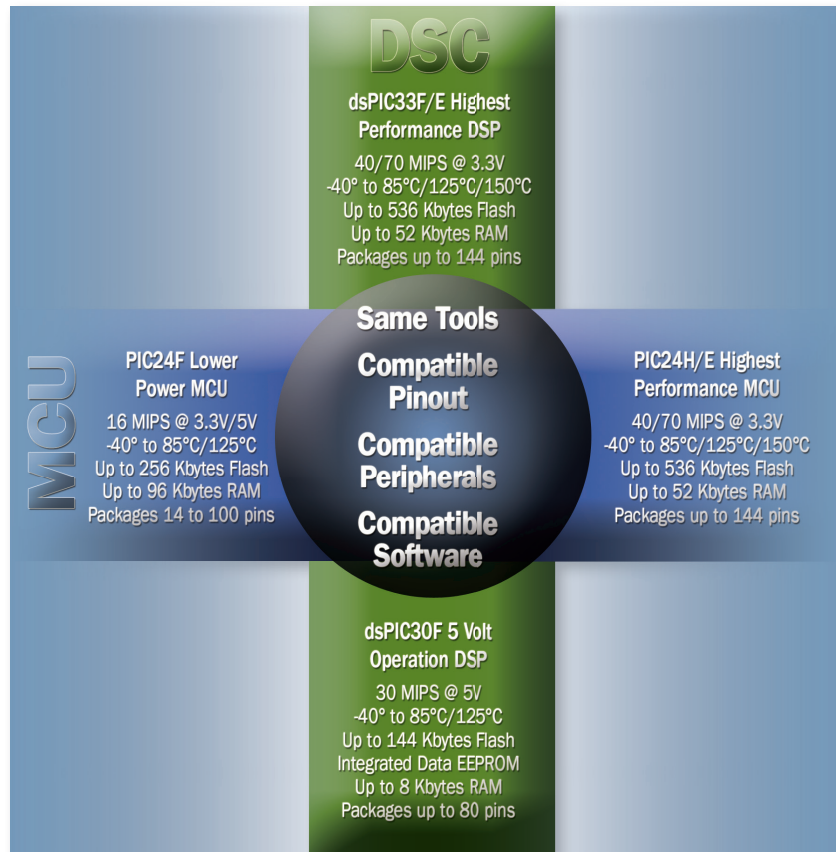
**16-bit Embedded Control Solutions**

*PIC24 Microcontrollers • dsPIC® Digital Signal Controllers*



# 16-bit Embedded Control Solutions

Are you enhancing your product performance and features to increase market share?  
Do you want to achieve an edge over your competition with added connectivity and graphical user interface?  
Do you want to generate more profits by optimizing your design and development costs?  
Microchip's 16-bit embedded control solutions can help you!



Microchip's 16-bit solutions are designed to be a broad platform which can serve your needs now and in the future. If you have designed using our 8-bit PIC® microcontrollers you will be pleased to see that the same MPLAB® Integrated Development Environment used on our smallest 6-pin MCUs and our largest 32-bit PIC32 microcontrollers also supports our 16-bit controllers. Our commitment to peripheral and pinout compatibility has been carried forward to our 16-bit product families. If you are new to Microchip, we offer powerful, low cost development tools, a compatible lineup of products that range from low cost to high performance, and a company dedicated to serving your needs.

Microchip offers two 16-bit Microcontroller (MCU) families plus two 16-bit Digital Signal Controller (DSC) families that offer compatible options across a wide spectrum of price, performance and feature sets.

## Advanced Motor Control with dsPIC® DSCs Portfolio

dsPIC Motor Control DSCs feature a high-performance CPU with motor control peripherals. The silicon solutions are backed up by free software application libraries and motor control algorithms. Low-cost motor control development boards support a wide variety of motors and help you to reduce your design risk and development efforts. Visit [www.microchip.com/motor](http://www.microchip.com/motor) for more information.

## Extreme Low Power Solutions

XLP Technology brings together the circuit and process technologies needed to address today's low power applications. With sleep currents down to 10 nA and industry-leading integration that includes USB OTG, PPS and mTouch™ capacitive sensing, XLP products can help you extend the life of your battery powered application. Visit [www.microchip.com/xlp](http://www.microchip.com/xlp) for more information.

## Speech and Audio for All Embedded Applications

Microchip's 16-bit microcontrollers and digital signal controllers have the performance, peripherals and memory to implement speech and audio applications. A suite of advanced solution libraries have been developed and are available for your application requirements. Visit [www.microchip.com/speech](http://www.microchip.com/speech) for more information.

## Graphics Display Solutions

Graphics displays are gaining popularity in user interface applications and they are easy to add to your application when you use any of Microchip's 16- or 32-bit MCU or DSC devices with PMP. With Microchip's free graphics library and development tools, you can quickly integrate graphics display functions into your application in a single microcontroller. Visit [www.microchip.com/graphics](http://www.microchip.com/graphics) for more information.

# 16-bit Embedded Control Solutions

## Digital Power for Improving the Efficiency and Optimizing the BOM Cost

Implementing advanced software digital control loops for power applications requires a high-performance DSP engine along with specialized peripherals. The dsPIC SMPS Family of DSCs feature a high-performance CPU and rich SMPS peripherals. SMPS peripherals include 4 MSPS 10-bit ADC, 1 nSec Resolution PWM and Analog comparator with 10 nSec response time. Complete reference designs and application solutions from Microchip will help you to get started. Visit [www.microchip.com/power](http://www.microchip.com/power) for more information.

## Enhancing Connectivity to Your Embedded Control Applications

Whether you are considering wired or wireless connectivity, Microchip supports a wide variety of communications protocols with extensive design resources and software libraries. Microchip offers ZigBee® Pro, MiWi™, IrDA® Library stack for wireless connectivity and Ethernet, CAN and USB library stack for wired connectivity. Visit [www.microchip.com/connectivity](http://www.microchip.com/connectivity) for more information.

## High Temperature Rated Devices Qualified to AEC-Q100 Requirements

Several PIC24HJ and dsPIC33FJ devices are rated for operation up to 150°C ambient. These devices provide up to 20 MIPS processing power plus digital signal processing, LIN/ECAN™ connectivity, Motor Control and 10/12-bit ADC performance for stringent automotive and industrial applications. AEC-Q100 Grade 0 (150°C) devices have been released as well. Visit [www.microchip.com/hightemp](http://www.microchip.com/hightemp) for the latest product offering.

## Adding Intelligence To Sensors

dsPIC DSCs and PIC24 MCUs with high performance DSP and 12-bit ADC enable more complex data processing to occur closer to the sensor. These devices are available in small packages and can operate in extended and high-temperature ranges.

### Powerful 16-bit CPU

- Single cycle execution
- Deterministic Interrupt response
- Single cycle bit manipulation
- Single-cycle multiply
- Zero overhead looping
- Fast DMA: no cycle stealing

### Flexible Flash

- High endurance, flexible and secure Flash
- Advanced security features are available
- Program and data storage
- Self-program features

### Integrated DSP

- Look and feel of MCU
- Single cycle 16 × 16 MAC
- 40-bit accumulators
- Dual operand fetches
- Saturation and rounding modes
- Many free libraries and low cost filter design tools

### Innovative Peripherals

- Motor control peripherals
- SMPS peripherals
- Audio peripherals: DAC and I<sup>2</sup>S
- Graphics controller
- CTMU for mTouch technology
- USB OTG
- CAN
- PMP for graphics

### Power Saving Options

- eXtreme Low Power technology
- Deep sleep current as low as 10 nA
- Options to reduce speed or disable CPU
- Application software can alter clock speeds
- VBAT battery backup

### Small Packages

- Packages as small as 5 × 5 mm
- 16-bit MCU with 128 KB Flash in a 6 × 6 mm package
- Peripheral Pin Select allows access to the peripherals needed

## Resources available at [www.microchip.com/16bit](http://www.microchip.com/16bit)

- Product Information
- Application Solutions
- Design Tools
- Web Seminars
- Application Notes & Reference Designs



# Leading 16-bit Performance and Features

## 16-bit Microcontroller (MCU) Portfolio

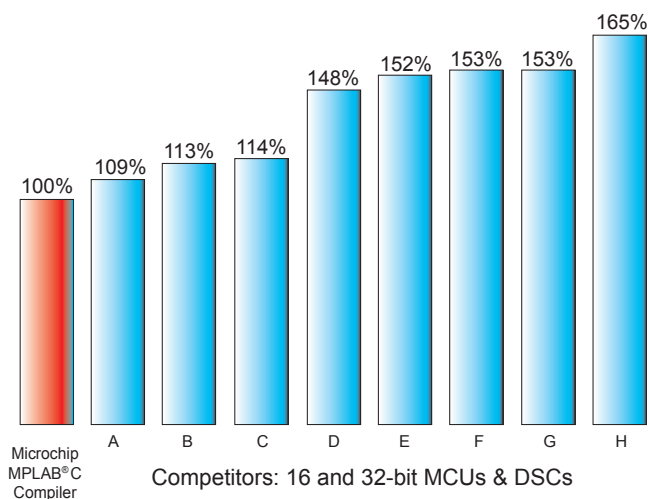
Are costs, performance, low power and smaller packages important considerations for your next design?

PIC24 MCUs offer a variety of peripherals, memory sizes and packaging choices. Microchip offers two compatible Flash-based 16-bit PIC24 MCU families. The 16 MIPS PIC24F family is designed for low power applications. The 40/70 MIPS PIC24H/E MCUs are designed for high performance applications. Both families have the same instruction set, share basic peripherals, have common pinouts and use the same tools for development. The PIC24 families are compatible with dsPIC DSCs for easy migration when additional performance or DSP capability is required.

### PIC24F: Lowest Power 16-bit MCUs

With 16 MIPS performance and an extensive peripheral set, including a graphics controller, USB OTG and capacitive touch sense interface, the PIC24F MCUs are cost-effective for the most demanding 16-bit applications. Serial communication peripherals include up to 4 UARTs, 3 SPI and 3 I<sup>2</sup>C™. With the introduction of XLP Technology, select PIC24F devices have industry leading low power performance with sleep numbers as low as 20 nA and RTCC operation down to 400 nA.

### Relative Code Size (in bytes) for 16-bit Applications



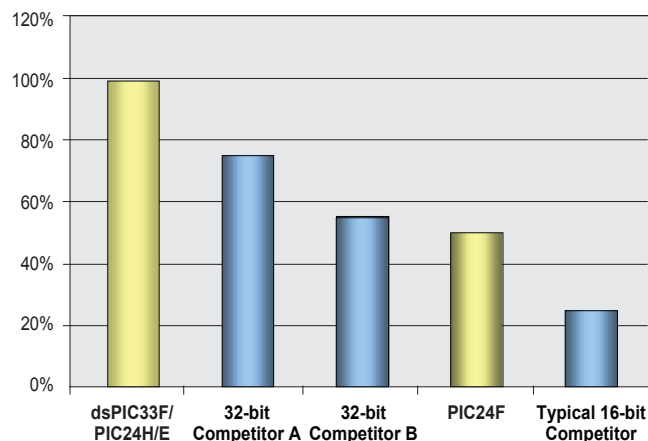
### PIC24H/E: Highest Performance 16-bit MCUs

PIC24 devices offer 40/70 MIPS performance with a combination of large memory and a wide variety of package options. They also includes large Flash in smaller packages (5 × 5 mm). The built-in peripherals include high performance 12-bit ADC and general purpose and motor control 16-bit PWMs. Communication peripherals include up to 2 ECAN modules, 4 UARTs (with IrDA support), 4 SPI, 2 I<sup>2</sup>C and USB OTG. High performance 16 channel Direct Memory Access (DMA) provides better data handling capability optimizing CPU throughput. AEC-Q100-qualified extended (125°C) and high-temperature (150°C) options for industrial and automotive applications are available.

### Optimized C Compiler

Supporting the PIC24 MCU and dsPIC DSC families, Microchip's 16-bit architecture was designed to optimize C language code size. The architecture was co-developed by compiler writers who emphasized the need for an orthogonal instruction set, many general-purpose registers, powerful indirect with offset addressing and a software stack. Now you can achieve leadership code size in applications, helping your project team hit schedule and code size targets. Reduced code size provides the opportunity to use a smaller memory device, spend less time optimizing code size and respond to those marketing requests for "just one more feature."

### Relative Performance/MHz





# Benefits of 16-bit Embedded Control Solutions

## 16-bit Digital Signal Controller (DSC) Portfolio

Does your embedded control application demand performance for advanced motor control, digital power, speech and audio processing? Alternatively, do you want to implement digital filters and FFT algorithms for signal analysis?

dsPIC DSCs offer innovative peripherals and required performance for these needs. Our dsPIC family is a 100% PIC MCU with great math. dsPIC DSCs blend the performance of DSP with the simplicity of an MCU.

### Versatile 5 Volt dsPIC30F DSCs

The 30 MIPS dsPIC30F family is developed for applications that benefit from a wide operating voltage (2.5 to 5.5V), extremely low standby current, integrated EEPROM, and for those that prefer 5V operation due to system considerations.

## dsPIC33F/E: Highest Performance 16-bit MCU with Integrated DSP

The 40/70 MIPS dsPIC33 core is designed to execute and control the high speed precision digital control loops and digital audio and speech processing. The optimized motor control and digital power conversion peripherals include the highest performance ADC, PWMs, USB OTG and analog comparators. A wide variety of memory and package options, audio peripherals, communication peripherals, 15 channel DMA and general purpose peripherals provide flexibility to your high performance embedded control designs. AEC-Q100-qualified extended and high-temperature options for industrial and automotive applications are available.

### Example dsPIC® DSP Performance

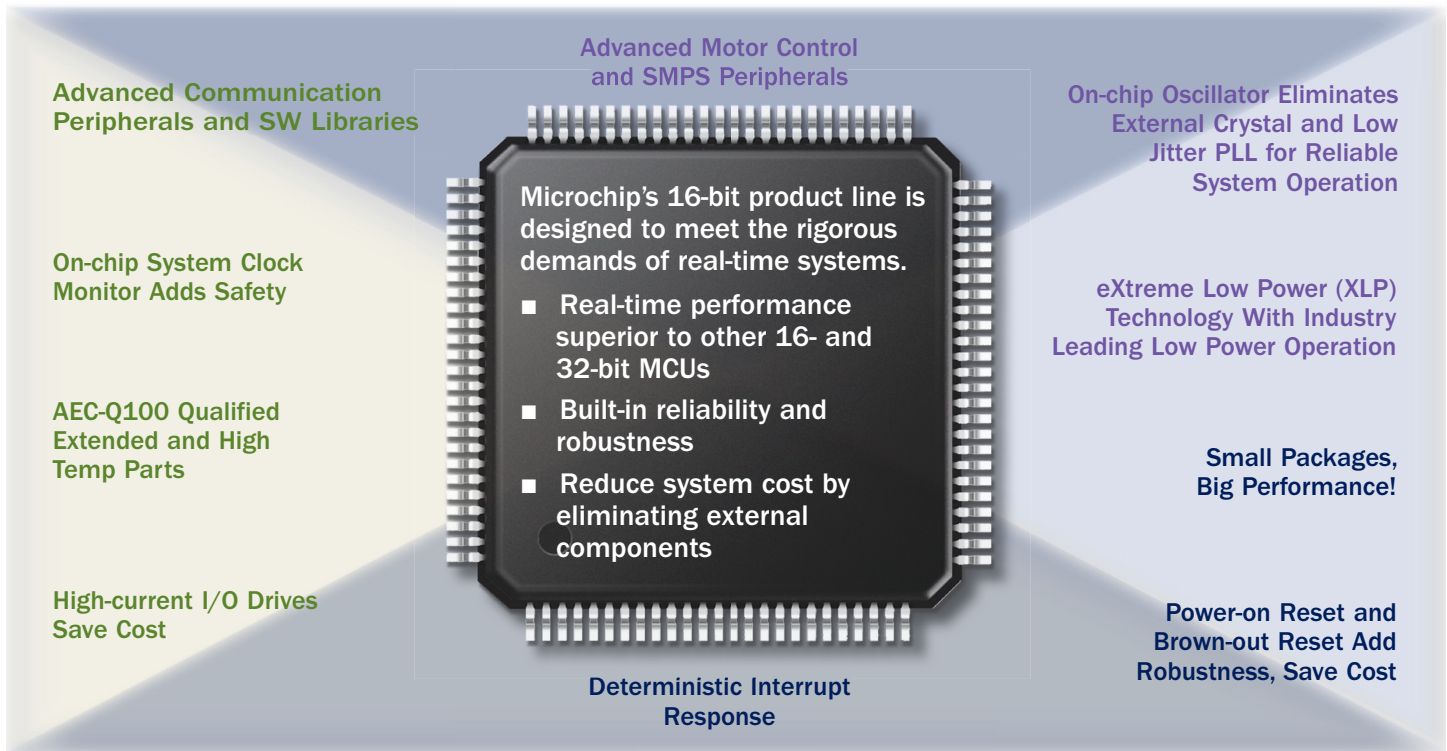
Function	Conditions*	Execution Time @70 MIPS
Complex FFT**	N = 64	55.6 µs
Block FIR	N = 32m M = 32	17.5 µs
Block IIR Canonic	N = 32, S = 4	17.0 µs
Matrix Add	C = 8, R = 8	3.1 µs
Matrix Transpose	C = 8, R = 8	3.4 µs
Vector Dot Product	N = 32	1.7 µs

\*C = # columns, N = # samples, M = # taps, S = # sections, R = # rows

\*\*Complex FFT routine inherently prevents overflow.

1 cycle = 14.29 nanoseconds @ 70 MIPS

**Designed for real-time control, Microchip's 16-bit DSCs and MCUs offer high performance, innovative features, outstanding reliability, robustness and reduced system cost.**



# 16-bit Product Features Overview

## CPU, Systems & Memory

### Operating Range PIC24F

- DC to 16 MIPS
- V<sub>DD</sub> range: 1.8 to 5.5V
- Ind. (–40° to 85°C) Ext. (–40° to 125°C)

### Operating Range PIC24H/E & dsPIC33F/E

- DC to 40/70 MIPS
- V<sub>DD</sub> range: 3.0 to 3.6V
- Ind. (–40° to 85°C) Ext. (–40° to 125°C) High-Temp (–40° to 150°C)

### Operating Range dsPIC30F

- DC to 30 MIPS
- V<sub>DD</sub> range: 2.5 to 5.5V
- Ind. (–40° to 85°C) Ext. (–40° to 125°C)

### High Performance CPU

- Single cycle execution (most instructions)
- C compiler optimized instruction set
- 16-bit wide data path
- 76 base instructions: mostly 1 word/1 cycle
- 16 16-bit general purpose registers
- Software stack
- 16 × 16 signed fractional/integer multiplier
- 32/16 and 16/16 divide
- 40-stage barrel shifter
- DSC additions (dsPIC30 & dsPIC33):
  - Adds 8 base DSP instructions
  - Two 40-bit accumulators with rounding and saturation options
  - Single core combines MCU and DSP features
  - Adds Modulo and Bit-reverse address modes

### System Management

- Flexible clock options:
  - Primary external clock, crystal, resonator
  - Secondary lower power 32 kHz oscillator
  - Internal RC: fast or low power
  - Integrated low jitter PLL (PLL sourced by ext. and int. clock sources)
- Programmable power-up timer
- Oscillator start-up timer/stabilizer
- Watchdog Timer with its own RC oscillator
- Clock switching/fail-safe clock monitor

### Interrupt Controller

- 5 cycle fixed latency
- Up to 118 interrupt sources, up to 5 external
- 7 programmable priority levels
- 4 processor exceptions and software traps

### Power Management/V<sub>BAT</sub> Battery Backup

- Switch between clock sources in real-time
- Programmable power-on reset start up
- Programmable High/Low-Voltage Detect (HLVD)
- Programmable brown-out reset
- Idle, Sleep and Deep Sleep modes with fast wake up

### On-chip Flash, Data EEPROM and RAM

- Flash program memory: up to 512 KB
- Auxiliary Flash memory: up to 24 KB
- Data EEPROM
  - dsPIC30F: up to 4 KB
  - PIC24F: up to 512B
- Data RAM: up to 96 KB

## Peripherals

### Digital I/O

- Peripheral Pin Select (PPS)
  - Remap digital I/O
  - Support most digital peripherals
- Up to 122 programmable digital I/O pins
- Wake-up/Interrupt-on-change on up to 52 pins
- High current sink/source

### Communication Modules

- 3-wire SPI: up to 3 modules
  - Framing supports I/O interface to simple codecs
  - I<sup>2</sup>C™: up to 3 modules
  - Full multi-master and Slave mode support
  - 7-bit and 10-bit addressing
- UART: up to 4 modules
  - Interrupt-on-address bit detect
  - Wake-up on Start bit from Sleep mode
  - 4-character TX and RX FIFO buffers
  - LIN and IrDA support
- USB OTG\*
  - Internal Boost Regulator requires minimal external components
  - Separate 3.3V regulator
  - Transparent RAM buffer interface
- Codec interface module
  - Supports I<sup>2</sup>S and AC97 protocols

### Timers/Capture/Compare/PWM

- Timer/counters: up to nine 16-bit timers
  - Can pair up to make 32-bit timers
  - 1 timer can run as real-time clock
- Input capture: up to 16 channels
  - Capture on rising, falling or both edges
  - 4-deep FIFO on each capture
- Output compare: up to 16 channels
  - Dedicated timer
  - Single or dual 16-bit compare mode
  - 16-bit glitchless PWM mode

### Auxiliary Functions

- LCD Segment Driver:
  - 60 Segment × 8 Common Driver
- Graphics Controller Features:
  - 3x graphics hardware acceleration units
  - Color look-up table with up to 256 entries
  - Direct interface to monochrome, C-STN, TFT, OLED
- Parallel Master Slave Port (PMP/PSP):
  - 8-bit Parallel IO, highly configurable
  - Communicates with external data memory, communications peripherals, LCDs

- Supports 8-bit or 16-bit data
- Supports 16 address lines
- Hardware Real-Time Clock/Calendar (RTCC):
  - Provides clock, calendar and alarm functions
- Programmable CRC generator
- Charge/Time Measurement Unit (CTMU)
  - Capacitive Touch Sense Keypad I/F
  - Provides 1 ns resolution time measurements

### Hardware DMA PIC24F/H/E & dsPIC33F/E

- Up to 15 channel DMA between RAM and peripherals

### Analog Subsystems

- On-chip high speed op amps
  - High bandwidth op amps designed for motor control and general purpose applications
- Analog comparators (up to 4):
  - Programmable reference
- Audio DAC:
  - 2 ch. 16-bit 100 ksp/s
  - Differential output
- 10-bit ADC:
  - PIC24F: 500 ksp/s, 1 module
  - PIC24FJXXMC: 1.1 Msps, 1 module
  - dsPIC30F: 1 Msps, 1 module
- 12-bit ADC:
  - PIC24F: 200 ksp/s 1 module
  - dsPIC30F: 200 ksp/s 1 module
- 10-/12-bit ADC (user selectable):
  - Available on PIC24H/E and dsPIC33F/E
  - 10-bit: 1.1 Msps, 4 S&H
  - 12-bit: 500 ksp/s, 1 S&H
  - Some devices have 2 modules
- Common ADC features:
  - Buffered output or DMA
  - dsPIC30F & PIC24F: up to 24 channels auto scanning
  - PIC24H/E & dsPIC33F/E: up to 32 channels auto scanning

### Motor Control Peripherals

- Motor Control PWM: up to 14 outputs
  - Up to 7 duty cycle generators
  - Independent or complementary mode
  - Programmable dead time settings
  - Edge or center-aligned PWMs
  - Manual output override control
  - Up to 10 fault inputs
  - ADC samples triggered by PWM module
- Quadrature encoder interface module
  - Up to 2 modules
  - Phase A, Phase B and index pulse input
- High current sink/source

### Switch Mode Power Peripherals

- 10-bit ADC Up to 4 Msps, Up to 6 sample and holds
- PS PWM, 1 nS duty cycle resolution
- Analog comparators
  - Programmable reference

\*Device, Embedded Host, On-The-Go

# PIC24F MCU Family

## 16 MIPS, Low Cost/Low Power (non-XLP Devices)

The PIC24F family is ideal for cost-sensitive applications or applications migrating from 8-bit designs for a boost in performance or memory. In addition to a wide range of general purpose peripherals the PIC24F families include nanoWatt XLP low power technology, USB OTG, a Charge Time Measurement Unit (CTMU) for capacitive touch sense and a PMP that allows easy interface to a graphical user interface.

Device	Pins	I/O Pins	Flash (KB)	RAM (KB)	Graphics	Timer	Capture	Output Compare/PWM	RTCC	ADC 10-bit 500 Ksps	Analog Comparators	UART	SPI	I <sup>2</sup> C™	PMP	PPS	CTMU	USB OTG	JTAG	Package Code
PIC24FJ16GA002	28	21	16	4	-	5	5	5	✓	1 ADC, 10 ch	2	2	2	2	✓	✓	-	-	✓	ML, SO, SP, SS
PIC24FJ16MC101	20	15	16	2	-	5	3	8	✓	1 ADC, 6 ch	3	1	1	1	-	✓	✓	-	-	SS, SO, P
PIC24FJ16MC102	28/36	21	16	2	-	5	3	8	✓	1 ADC, 8 ch	3	1	1	1	-	✓	✓	-	-	ML, SO, SP, SS, TL
PIC24FJ32GA002	28	21	32	8	-	5	5	5	✓	1 ADC, 10 ch	2	2	2	2	✓	✓	-	-	✓	ML, SO, SP, SS
PIC24FJ32MC101	20	15	32	2	-	5	3	8	✓	1 ADC, 6 ch	3	1	1	1	-	✓	✓	-	-	SS, SO, P
PIC24FJ32MC102	28/36	21	32	2	-	5	3	8	✓	1 ADC, 8 ch	3	1	1	1	-	✓	✓	-	-	ML, SO, SP, SS, TL
PIC24FJ32MC104	44	35	32	2	-	5	3	8	✓	1 ADC, 14 ch	3	1	1	1	-	✓	✓	-	-	ML, TL, PT
PIC24FJ64GA002	28	21	64	8	-	5	5	5	✓	1 ADC, 10 ch	2	2	2	2	✓	✓	-	-	✓	ML, SO, SP, SS
PIC24FJ16GA004	44	35	16	4	-	5	5	5	✓	1 ADC, 13 ch	2	2	2	2	✓	✓	-	-	✓	ML, PT
PIC24FJ32GA004	44	35	32	8	-	5	5	5	✓	1 ADC, 13 ch	2	2	2	2	✓	✓	-	-	✓	ML, PT
PIC24FJ64GA004	44	35	64	8	-	5	5	5	✓	1 ADC, 13 ch	2	2	2	2	✓	✓	-	-	✓	ML, PT
PIC24FJ64GA006	64	53	64	8	-	5	5	5	✓	1 ADC, 16 ch	2	2	2	2	✓	-	-	-	✓	PT
PIC24FJ64GA106	64	53	64	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	-	✓	PT, MR
PIC24FJ64GB106	64	52	64	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT
PIC24FJ64GA110	100	53	64	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	-	✓	PT, MR
PIC24FJ128DA106	64	52	128	24	✓	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, MR
PIC24FJ128DA206	64	52	128	96	✓	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, MR
PIC24FJ128GA006	64	53	128	8	-	5	5	5	✓	1 ADC, 16 ch	2	2	2	2	✓	-	-	-	✓	PT
PIC24FJ128GA106	64	53	128	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	-	✓	PT, MR
PIC24FJ128GB106	64	52	128	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, MR
PIC24FJ128GB206	64	52	128	96	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, MR
PIC24FJ256DA106	64	52	256	24	✓	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, MR
PIC24FJ256DA206	64	52	256	96	✓	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, MR
PIC24FJ256GA106	64	53	256	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	-	✓	PT, MR
PIC24FJ256GB106	64	52	256	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, MR
PIC24FJ256GB206	64	52	256	96	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, MR
PIC24FJ64GA008	80	69	64	8	-	5	5	5	✓	1 ADC, 16 ch	2	2	2	2	✓	-	-	-	✓	PT
PIC24FJ64GB108	80	68	64	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT
PIC24FJ128GA008	80	69	128	8	-	5	5	5	✓	1 ADC, 16 ch	2	2	2	2	✓	-	-	-	✓	PT
PIC24FJ128GA108	80	69	128	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	-	✓	PT
PIC24FJ128GB108	80	68	128	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT
PIC24FJ256GA108	80	69	256	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	-	✓	PT
PIC24FJ256GB108	80	68	256	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT
PIC24FJ64GA010	100	85	64	8	-	5	5	5	✓	1 ADC, 16 ch	2	2	2	2	✓	-	-	-	✓	PF, PT
PIC24FJ64GB110	100	84	64	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT
PIC24FJ128DA110	100	84	128	24	✓	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, BG
PIC24FJ128DA210	100	84	128	96	✓	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, BG
PIC24FJ128GA010	100	85	128	8	-	5	5	5	✓	1 ADC, 16 ch	2	2	2	2	✓	-	-	-	✓	PF, PT
PIC24FJ128GA110	100	85	128	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	-	✓	PT
PIC24FJ128GB110	100	84	128	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT
PIC24FJ128GB210	100	84	128	96	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, BG
PIC24FJ256GA110	100	85	256	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	-	✓	PT
PIC24FJ256GB110	100	84	256	16	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT
PIC24FJ256GB210	100	84	256	96	-	5	9	9	✓	1 ADC, 16 ch	3	4	3	3	✓	✓	✓	✓	✓	PT, BG

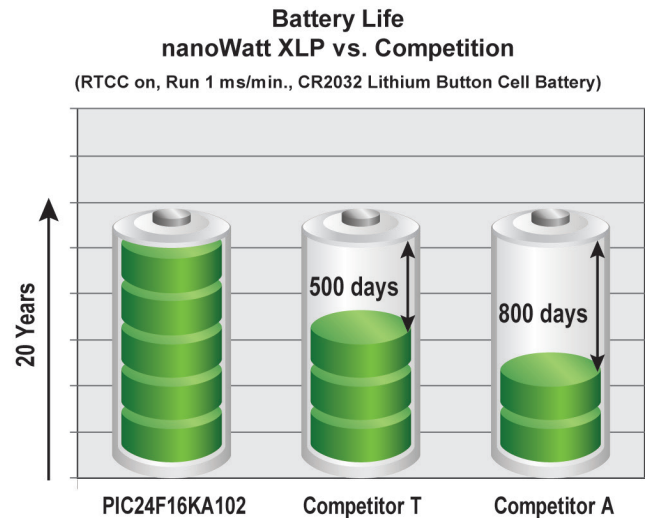


# PIC24F MCU Family

## XLP eXtreme Low Power MCUs

As more electronic applications require low power or battery power, energy conservation becomes paramount. Today's applications must consume little power, and in extreme cases, last up to 15-20 years, while running from a single battery. To enable applications like these, products with Microchip's nanoWatt XLP Technology offer the industry's lowest currents for Sleep, where extreme low power applications spend 90%-99% of their time. Benefits of XLP Technology:

- Sleep currents down to 10 nA
- Brown-out Reset down to 45 nA
- Watchdog Timer down to 200 nA
- VBAT and Real-Time Clock/Calendar down to 400 nA
- Active current down to 150 µA/MHz



## PIC24F MCU Devices with NanoWatt XLP Technology


Microchip products with nanoWatt XLP Technology offer the industry's lowest currents for Sleep, where extreme low power applications spend more than 99% of their time. Visit [www.microchip.com/XLP](http://www.microchip.com/XLP) for more XLP product information.

Device	Pins	I/O Pins	Flash (KB)	RAM (KB)	EEPROM (Bytes)	Timer	Capture	Output Compare/ PWM	RTCC	ADC	Comparators	LCD Setpoints	UART	SPI	I <sup>2</sup> C™	PMP	PPS	CTMU	USB OTG	JTAG	Deep Sleep	Package Code
PIC24F04KA200	14	12	4	0.5	-	3	1	1	-	7 ch, 10-bit	2	-	1	1	1	-	-	✓	-	-	✓	P, ST
PIC24F04KL100	14	12	4	0.5	-	3	2	2	-	-	1	-	1	1	1	-	-	-	-	-	-	P, ST
PIC24F08KL200	14	12	8	0.5	-	3	2	2	-	7 ch, 10-bit	1	-	1	1	1	-	-	-	-	-	-	P, ST
PIC24F04KL101	20	17	4	0.5	-	3	2	2	-	-	1	-	1	1	1	-	-	-	-	-	-	P, SS, SO, MQ
PIC24F04KA201	20	18	4	0.5	-	3	1	1	-	9 ch, 10-bit	2	-	1	1	1	-	-	✓	-	-	✓	P, SO, SS, MQ
PIC24F08KL201	20	17	8	0.5	-	3	2	2	-	12 ch, 10-bit	1	-	1	1	1	-	-	-	-	-	-	P, SS, SO, MQ
PIC24F08KL301	20	18	8	1	256	4	3	6	-	-	2	-	2	2	2	-	-	-	-	-	-	P, SS, SO, MQ
PIC24F08KL401	20	18	8	1	512	4	3	6	-	12 ch, 10-bit	2	-	2	2	2	-	-	-	-	-	-	P, SS, SO, MQ
PIC24F08KA101	20	18	8	1.5	512	3	1	1	✓	9 ch, 10-bit	2	-	2	1	1	-	-	✓	-	-	✓	P, SO, SS, MQ
PIC24F16KL401	20	18	16	1	512	4	3	6	-	12 ch, 10-bit	2	-	2	2	2	-	-	-	-	-	-	P, SS, SO, MQ
PIC24F16KA101	20	18	16	1.5	512	3	1	1	✓	9 ch, 10-bit	2	-	2	1	1	-	-	✓	-	-	✓	P, SO, SS, MQ
PIC24F16KA301*	20	18	16	2	512	5	3	3	✓	9 ch, 12-bit	3	-	2	2	2	-	-	✓	-	✓	✓	SP, SS, SO
PIC24F32KA301*	20	18	32	2	512	5	3	3	✓	9 ch, 12-bit	3	-	2	2	2	-	-	✓	-	✓	✓	SP, SS, SO
PIC24F08KL302	28	24	8	1	256	4	3	6	-	-	2	-	2	2	2	-	-	-	-	-	-	SP, SS, SO, ML, MQ
PIC24F08KL402	28	24	8	1	512	4	3	6	-	12 ch, 10-bit	2	-	2	2	2	-	-	-	-	-	-	SP, SS, SO, ML, MQ
PIC24F08KA102	28	24	8	1.5	512	3	1	1	✓	9 ch, 10-bit	2	-	2	1	1	-	-	✓	-	-	✓	P, SO, SS, MQ
PIC24F16KL402	28	24	16	1	512	4	3	6	-	12 ch, 10-bit	2	-	2	2	2	-	-	-	-	-	-	SP, SS, SO, ML, MQ
PIC24F16KA102	28	24	16	1.5	512	3	1	1	✓	9 ch, 10-bit	2	-	2	1	1	-	-	✓	-	-	✓	P, SO, SS, MQ
PIC24F16KA302*	28	24	16	2	512	5	3	3	✓	10 ch, 12-bit	3	-	2	2	2	-	-	✓	-	✓	✓	SP, SS, SO, ML
PIC24F32KA302*	28	24	32	2	512	5	3	3	✓	10 ch, 12-bit	3	-	2	2	2	-	-	✓	-	✓	✓	SP, SS, SO, ML
PIC24FJ32GA102	28	21	32	8	-	5	5	5	✓	10 ch, 10-bit	3	-	2	2	2	✓	✓	✓	-	✓	✓	SP, SO, SS, ML
PIC24FJ32GB002	28	21	32	8	-	5	5	5	✓	10 ch, 10-bit	3	-	2	2	2	✓	✓	✓	✓	✓	✓	SP, SO, SS, ML
PIC24FJ64GA102	28	21	64	8	-	5	5	5	✓	10 ch, 10-bit	3	-	2	2	2	✓	✓	✓	-	✓	✓	SP, SO, SS, ML
PIC24FJ64GB002	28	21	64	8	-	5	5	5	✓	10 ch, 10-bit	3	-	2	2	2	✓	✓	✓	✓	✓	✓	SP, SO, SS, ML
PIC24FJ32GA104	44	35	32	8	-	5	5	5	✓	10 ch, 10-bit	3	-	2	2	2	✓	✓	✓	-	✓	✓	PT, ML
PIC24FJ32GB004	44	35	32	8	-	5	5	5	✓	10 ch, 10-bit	3	-	2	2	2	✓	✓	✓	✓	✓	✓	PT, ML

\*Device is available in both 1.8V to 3.6V and 2.0V to 5.5V variants.

# PIC24F MCU Family

## PIC24F MCU Devices with NanoWatt XLP Technology (Continued)

Device	Pins	I/O Pins	Flash (KB)	RAM (KB)	EEPROM (Bytes)	Timer	Capture	Output Compare/PWM	RTCC	ADC	Comparators	LCD Setments	UART	SPI	I <sup>2</sup> C™	PMP	PPS	CTMU	USB OTG	JTAG	Deep Sleep	Package Code
PIC24FJ64GA104 	44	35	64	8	–	5	5	5	✓	10 ch, 10-bit	3	–	2	2	2	✓	✓	✓	–	✓	✓	PT, ML
PIC24FJ64GB004 	44	35	64	8	–	5	5	5	✓	10 ch, 10-bit	3	–	2	2	2	✓	✓	✓	✓	✓	✓	PT, ML
PIC24F16KA304* 	44/48	38	16	2	512	5	3	3	✓	10 ch, 10-bit	3	–	2	2	2	–	–	✓	–	✓	✓	PT, ML, MV
PIC24F32KA304* 	44/48	38	32	2	512	5	3	3	✓	10 ch, 10-bit	3	–	2	2	2	–	–	✓	–	✓	✓	PT, ML, MV
PIC24FJ64GA306 	64	53	64	8	–	5	7	7	✓	10 ch, 10-bit	3	240	4	2	2	✓	✓	✓	–	✓	✓	PT, MR
PIC24FJ128GA306 	64	53	128	8	–	5	7	7	✓	10 ch, 10-bit	3	240	4	2	2	✓	✓	✓	–	✓	✓	PT, MR
PIC24FJ64GA308 	80	69	64	8	–	5	7	7	✓	10 ch, 10-bit	3	368	4	2	2	✓	✓	✓	–	✓	✓	PT
PIC24FJ128GA308 	80	69	128	8	–	5	7	7	✓	10 ch, 10-bit	3	368	4	2	2	✓	✓	✓	–	✓	✓	PT
PIC24FJ64GA310 	100	85	64	8	–	5	7	7	✓	10 ch, 10-bit	3	480	4	2	2	✓	✓	✓	–	✓	✓	PT, PF, BG
PIC24FJ128GA310 	100	85	128	8	–	5	7	7	✓	10 ch, 10-bit	3	480	4	2	2	✓	✓	✓	–	✓	✓	PT, PF, BG

\*Device is available in both 1.8V to 3.6V and 2.0V to 5.5V variants.

# PIC24E MCU General Purpose Family

## Up to 70 MIPS, Highest Performance MCU

Microchip's PIC24E general purpose microcontroller family features the highest speed core (up to 70 MIPS) with excellent performance and code density. It offers superior ADC performance, enhanced CAN communication, easier graphic display interface through 8-bit parallel master port and up to 15 DMA channels for extensive data movement. These devices are available in various packages and with extended (125°C) temperature option.

Device	Pins	I/O Pins	Flash (KB)	RAM* (KB)	DMA # ch	Timer 16-bit	Input Capture	Output Compare/PWM	ADC 10/12-bit† 1.1/0.5 Msps	Analog Comparators	Op Amps	USB OTG	UART	SPI	I <sup>2</sup> C™	PMP	PPS	RTCC	ECAN™	JTAG	CTMU	Pkg Code
PIC24EP32GP202	28	21	32	4	4	5	4	4	6 ch	1+2**	2	–	2	2	2	–	✓	–	–	✓	✓	SP, SO, SS, MM
PIC24EP32GP203◊	36	25	32	4	4	5	4	4	8 ch	1+2**	2	–	2	2	2	–	✓	–	–	✓	✓	TL
PIC24EP32GP204	44	35	32	4	4	5	4	4	9 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	TL, ML, PT
PIC24EP64GP202	28	21	64	8	4	5	4	4	6 ch	1+2**	2	–	2	2	2	–	✓	–	–	✓	✓	SP, SO, SS, MM
PIC24EP64GP203◊	36	25	64	8	4	5	4	4	8 ch	1+2**	2	–	2	2	2	–	✓	–	–	✓	✓	TL
PIC24EP64GP204	44	35	64	8	4	5	4	4	9 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	TL, ML, PT
PIC24EP64GP206	64	53	64	8	4	5	4	4	16 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	MR, PT
PIC24EP128GP202	28	21	128	16	4	5	4	4	6 ch	1+2**	2	–	2	2	2	–	✓	–	–	✓	✓	SP, SO, SS, MM
PIC24EP128GP204	44	35	128	16	4	5	4	4	9 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	TL, ML, PT
PIC24EP128GP206	64	53	128	16	4	5	4	4	16 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	MR, PT
PIC24EP256GP202	28	21	256	32	4	5	4	4	6 ch	1+2**	2	–	2	2	2	–	✓	–	–	✓	✓	SP, SO, SS, MM
PIC24EP256GP204	44	35	256	32	4	5	4	4	9 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	TL, ML, PT
PIC24EP256GP206	64	53	256	32	4	5	4	4	16 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	MR, PT
PIC24EP256GU810	100	83	280†	28*	15	9	16	16	2 A/D, 32 ch	3	–	1	4	4	2	1	✓	1	2	✓	–	PF, PT, BG
PIC24EP512GP806	64	53	536†	52*	15	9	16	16	2 A/D, 24 ch	3	–	–	4	4	2	1	✓	1	2	✓	–	MR, PT
PIC24EP512GU810	100	83	536†	52*	15	9	16	16	2 A/D, 32 ch	3	–	1	4	4	2	1	✓	1	2	✓	–	PF, PT, BG
PIC24EP256GU814	144	122	280†	28*	15	9	16	16	2 A/D, 32 ch	3	–	1	4	4	2	1	✓	1	2	✓	–	PL, PH
PIC24EP512GU814	144	122	536†	52*	15	9	16	16	2 A/D, 32 ch	3	–	1	4	4	2	1	✓	1	2	✓	–	PL, PH
PIC24EP512GP202◊	28	21	512	48	4	5	4	4	6 ch	1+2**	2	–	2	2	2	–	✓	–	–	✓	✓	SP, SO, SS, MM
PIC24EP512GP204◊	44	35	512	48	4	5	4	4	9 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	ML, PT
PIC24EP512GP206◊	64	53	512	48	4	5	4	4	16 ch	1+3**	3	–	2	2	2	–	✓	–	–	✓	✓	MR, PT

†Flash size is inclusive of 24 Kbytes of auxiliary Flash

\*RAM size is inclusive of 4 Kbytes of DMA RAM

\*\*Op amps can be configured as comparators

◊See [www.microchip.com](http://www.microchip.com) for availability

# PIC24E MCU Motor Control Family

## Up to 70 MIPS, High Performance Motor Control MCU

Microchip's PIC24E motor control family of microcontrollers features a high speed core (up to 70 MIPS) with excellent performance and code density. These MCUs enable the design of motor control systems that are more energy efficient, quieter in operation, have a great range and extended life. They can be used to control brushless DC, permanent magnet synchronous, AC induction and stepper motors.

Device	Pins	I/O Pins	Flash (KB)	RAM* (KB)	DMA # ch	Timer 16-bit	Input Capture	Output Compare	MC PWM	QEI	ADC 10/12-bit† 1.1/0.5 Msps	Analog Comparators	Op Amps	USB OTG	UART	SPI	I <sup>2</sup> C™	PMP	PPS	RTCC	ECAN™	JTAG	CTMU	Pkg Code
PIC24EP32MC202	28	21	32	4	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
PIC24EP32MC203◊	36	25	32	4	4	5	4	4	6	1	8ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	TL
PIC24EP32MC204	44	35	32	4	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	TL, ML, PT
PIC24EP64MC202	28	21	64	8	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
PIC24EP64MC203◊	36	25	64	8	4	5	4	4	6	1	8 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	TL
PIC24EP64MC204	44	35	64	8	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	TL, ML, PT
PIC24EP64MC206	64	53	64	8	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	MR, PT
PIC24EP128MC202	28	21	128	16	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
PIC24EP128MC204	44	35	128	16	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	TL, ML, PT
PIC24EP128MC206	64	53	128	16	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	MR, PT
PIC24EP256MC202	28	21	256	32	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
PIC24EP256MC204	44	35	256	32	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	TL, ML, PT
PIC24EP256MC206	64	53	256	32	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	MR, PT
PIC24EP512MC202◊	28	21	512	48	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
PIC24EP512MC204◊	44	35	512	48	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	ML, PT
PIC24EP512MC206◊	64	53	512	48	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	MR, PT

\*\*Op amps can be configured as comparators

◊See [www.microchip.com](http://www.microchip.com) for availability



# PIC24H MCU General Purpose Family

## 40 MIPS, High MCU Performance

Microchip's PIC24H general purpose microcontroller family features the highest 16-bit MCU performance and excellent code density. The PIC24H family offers CAN communication, superior ADC performance, easier graphic display interface through 8-bit parallel master port and extensive data movement through DMA channels. PIC24H devices are available in small packages with scalable memory and extended (125°C) and high temp (150°C) options.

Device	Pins	I/O Pins	Flash (KB)	RAM (KB)	DMA # ch	Timer 16-bit	Input Capture	Output Compare/PWM	ADC 10/12-bit† 1.1/0.5 Msps	Analog Comparatos	UART	SPI	I <sup>2</sup> C™	PMP	PPS	RTCC	CAN	JTAG	Pkg Code
PIC24HJ12GP201	18	13	12	1	–	3	4	2	1 ADC, 6 ch	–	1	1	1	–	✓	–	–	–	P, SO
PIC24HJ12GP202	28	21	12	1	–	3	4	2	1 ADC, 10 ch	–	1	1	1	–	✓	–	–	✓	SP, SO, ML, SS
PIC24HJ32GP202*	28	21	32	2	–	3	4	2	1 ADC, 10 ch	–	1	1	1	–	✓	–	–	✓	SP, SO, MM
PIC24HJ32GP302	28	21	32	4	8	5	4	4	1 ADC 10 ch	2	2	2	1	1	✓	1	–	✓	SO,SP, MM
PIC24HJ64GP202	28	21	64	8	8	5	4	4	1 ADC 10 ch	2	2	2	1	1	✓	1	–	–	SO,SP, MM
PIC24HJ64GP502*	28	21	64	8	8	5	4	4	1 ADC 10 ch	2	2	2	1	1	✓	1	1	✓	SO,SP, MM
PIC24HJ128GP202	28	21	128	8	8	5	4	4	1 ADC 10 ch	2	2	2	1	1	✓	1	–	–	SO,SP, MM
PIC24HJ128GP502*	28	21	128	8	8	5	4	4	1 ADC 10 ch	2	2	2	1	1	✓	1	1	✓	SO,SP, MM
PIC24HJ16GP304*	44	35	16	2	–	3	4	2	1 ADC 13 ch	–	1	1	1	–	✓	–	–	✓	PT, ML
PIC24HJ32GP204*	44	35	32	2	–	3	4	2	1 ADC 13 ch	–	1	1	1	–	✓	–	–	✓	PT, ML
PIC24HJ32GP304	44	35	32	4	8	5	4	4	1 ADC 13 ch	2	2	2	1	1	✓	1	–	✓	PT, ML
PIC24HJ64GP204	44	35	64	8	8	5	4	4	1 ADC 13 ch	2	2	2	1	1	✓	1	–	✓	PT, ML
PIC24HJ64GP504*	44	35	64	8	8	5	4	4	1 ADC 13 ch	2	2	2	1	1	✓	1	1	✓	PT, ML
PIC24HJ128GP204	44	35	128	8	8	5	4	4	1 ADC 13 ch	2	2	2	1	1	✓	1	–	✓	PT, ML
PIC24HJ128GP504*	44	35	128	8	8	5	4	4	1 ADC 13 ch	2	2	2	1	1	✓	1	1	✓	PT, ML
PIC24HJ64GP206A	64	53	64	8	8	9	8	8	1 ADC, 18 ch	–	2	2	1	–	–	–	–	✓	PT, MR
PIC24HJ64GP506A	64	53	64	8	8	9	8	8	1 ADC, 18 ch	–	2	2	2	–	–	–	1	✓	PT, MR
PIC24HJ128GP206A	64	53	128	8	8	9	8	8	1 ADC, 18 ch	–	2	2	2	–	–	–	–	✓	PT, MR
PIC24HJ128GP306A	64	53	128	16	8	9	8	8	1 ADC, 18 ch	–	2	2	2	–	–	–	–	✓	PT, MR
PIC24HJ128GP506A*	64	53	128	8	8	9	8	8	1 ADC, 18 ch	–	2	2	2	–	–	–	1	✓	PT, MR
PIC24HJ256GP206A*	64	53	256	16	8	9	8	8	1 ADC, 18 ch	–	2	2	2	–	–	–	–	✓	PT, MR
PIC24HJ64GP210A	100	85	64	8	8	9	8	8	1 ADC, 32 ch	–	2	2	2	–	–	–	–	✓	PT, PF
PIC24HJ64GP510A	100	85	64	8	8	9	8	8	1 ADC, 32 ch	–	2	2	2	–	–	–	1	✓	PT, PF
PIC24HJ128GP210A	100	85	128	8	8	9	8	8	1 ADC, 32 ch	–	2	2	2	–	–	–	–	✓	PT, PF
PIC24HJ128GP310A	100	85	128	16	8	9	8	8	1 ADC, 32 ch	–	2	2	2	–	–	–	–	✓	PT, PF
PIC24HJ128GP510A*	100	85	128	8	8	9	8	8	1 ADC, 32 ch	–	2	2	2	–	–	–	1	✓	PT, PF
PIC24HJ256GP210A	100	85	256	16	8	9	8	8	1 ADC, 32 ch	–	2	2	2	–	–	–	–	✓	PT, PF
PIC24HJ256GP610A*	100	85	256	16	8	9	8	8	2 ADC, 32 ch	–	2	2	2	–	–	–	2	✓	PT, PF

†PIC24H devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 Sample and Hold) or 500 kpsps 12-bit ADC (1 Sample and Hold)

\*Parts available with high temperature options

# dsPIC33E DSC Product Family

## 70 MIPS Motor Control and General Purpose Family

Microchip's dsPIC33E motor control family of digital signal controllers (DSCs) features a high speed dsPIC DSC core (Up to 70 MIPS ) with integrated DSP and enhanced on-chip peripherals. These DSCs enable the design of high-performance, precision motor control systems that are more energy efficient, quieter in operation, have a great range and extended life. They can be used to control brushless DC, permanent magnet synchronous, AC induction and stepper motors. These devices are also ideal for high-performance general purpose applications.

Device	Pins	I/O 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	Analog Comparators	Op Amps	USB OTG	UART	SPI	I <sup>2</sup> C™	PMP	PPS	RTCC	ECAN™	JTAG	CTMU	Pkg Code
dsPIC33EP32MC202	28	21	32	8	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
dsPIC33EP32MC502	28	21	32	4	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP32GP502	28	21	32	4	4	5	4	4	0	0	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP32MC203◊	36	25	32	4	4	5	4	4	6	1	8 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	TL
dsPIC33EP32MC503◊	36	25	32	4	4	5	4	4	6	1	8 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	TL
dsPIC33EP32GP503◊	36	25	32	4	4	5	4	4	0	0	8 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	TL
dsPIC33EP32MC204	44	35	32	4	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	TL, ML, PT
dsPIC33EP32MC504	44	35	32	4	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	TL, ML, PT
dsPIC33EP32GP504	44	35	32	4	4	5	4	4	0	0	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	TL, ML, PT
dsPIC33EP64MC202	28	21	64	8	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
dsPIC33EP64MC502	28	21	64	8	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP64GP502	28	21	64	8	4	5	4	4	-	-	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP64MC203◊	36	25	64	8	4	5	4	4	6	1	8 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	TL
dsPIC33EP64MC503◊	36	25	64	8	4	5	4	4	6	1	8 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	TL
dsPIC33EP64GP503◊	36	25	64	8	4	5	4	4	-	-	8 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	TL
dsPIC33EP64MC204	44	35	64	8	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	TL, ML, PT
dsPIC33EP64MC504	44	35	64	8	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	TL, ML, PT
dsPIC33EP64GP504	44	35	64	8	4	5	4	4	-	-	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	TL, ML, PT
dsPIC33EP64MC206	64	53	64	8	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	MR, PT
dsPIC33EP64MC506	64	53	64	8	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	MR, PT
dsPIC33EP64GP506	64	53	64	8	4	5	4	4	-	-	16 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	MR, PT
dsPIC33EP128MC202	28	21	128	16	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
dsPIC33EP128MC502	28	21	128	16	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP128GP502	28	21	128	16	4	5	4	4	0	0	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP128MC204	44	35	128	16	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	TL, ML, PT
dsPIC33EP128MC504	44	35	128	16	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	TL, ML, PT
dsPIC33EP128GP504	44	35	128	16	4	5	4	4	0	0	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	TL, ML, PT
dsPIC33EP128MC206	64	53	128	16	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	MR, PT
dsPIC33EP128MC506	64	53	128	16	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	MR, PT
dsPIC33EP128GP506	64	53	128	16	4	5	4	4	0	0	16 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	MR, PT
dsPIC33EP256MC202	28	21	256	32	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	-	✓	✓	SP, SO, SS, MM
dsPIC33EP256MC502	28	21	256	32	4	5	4	4	6	1	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP256GP502	28	21	256	32	4	5	4	4	-	-	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP256MC204	44	35	256	32	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	TL, ML, PT
dsPIC33EP256MC504	44	35	256	32	4	5	4	4	6	1	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	TL, ML, PT
dsPIC33EP256GP504	44	35	256	32	4	5	4	4	-	-	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	TL, ML, PT
dsPIC33EP256MC206	64	53	256	32	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	-	✓	✓	MR, PT
dsPIC33EP256MC506	64	53	256	32	4	5	4	4	6	1	16 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	MR, PT
dsPIC33EP256GP506	64	53	256	32	4	5	4	4	-	-	16 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	MR, PT
dsPIC33EP256MU806	64	51	280†	28*	15	9	16	16	8 ch	2	2 A/D, 24 ch	3	-	1	4	4	2	✓	✓	1	2	✓	-	MR, PT
dsPIC33EP256MU810	100	83	280†	28*	15	9	16	16	12 ch	2	2 A/D, 32 ch	3	-	1	4	4	2	✓	✓	1	2	✓	-	PF, PT, BG
dsPIC33EP256MU814	144	122	280†	28*	15	9	16	16	14 ch	2	2 A/D, 32 ch	3	-	1	4	4	2	✓	✓	1	2	✓	-	PL, PH
dsPIC33EP512MC806	64	53	536†	52*	15	9	16	16	8 ch	2	2 A/D, 24 ch	3	-	-	4	4	2	✓	✓	1	2	✓	-	MR, PT
dsPIC33EP512GP806	64	53	536†	52*	15	9	16	16	-	-	2 A/D, 24 ch	3	-	-	4	4	2	✓	✓	1	2	✓	-	MR, PT
dsPIC33EP512MU810	100	83	536†	52*	15	9	16	16	12 ch	2	2 A/D, 32 ch	3	-	1	4	4	2	✓	✓	1	2	✓	-	PF, PT, BG
dsPIC33EP512MU814	144	122	536†	52*	15	9	16	16	14 ch	2	2 A/D, 32 ch	3	-	1	4	4	2	✓	✓	1	2	✓	-	PL, PH
dsPIC33EP512GP502◊	28	21	512	48	4	5	4	4	0	0	6 ch	1+2**	2	-	2	2	2	-	✓	-	1	✓	✓	SP, SO, SS, MM
dsPIC33EP512GP504◊	44	35	512	48	4	5	4	4	0	0	9 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	ML, PT
dsPIC33EP512GP506◊	64	53	512	48	4	5	4	4	0	0	16 ch	1+3**	3	-	2	2	2	-	✓	-	1	✓	✓	MR, PT

†Flash size is inclusive of 24 Kbytes of auxiliary Flash

\*RAM size is inclusive of 4 Kbytes of DMA RAM

\*\*Op amps can be configured as comparators

◊See www.microchip.com for availability

# dsPIC33F DSC Product Family

## General Purpose Family

The dsPIC33F general purpose digital signal controllers offer the performance of DSP with the simplicity of an MCU. The 40 MIPS dsPIC33F core is designed to execute digital filter algorithms, high speed precision digital control loops and digital audio and speech processing. A wide variety of memory and package options, audio peripherals, communication peripherals, DMA and general purpose peripherals provide flexibility to high performance embedded control designs.

Device	Pins	I/O Pins	Flash (KB)	RAM* (KB)	DMA # ch	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	Codec Interface	ADC 10/12-bit† 1.1/0.5 Msps	16-bit Audio DAC	Analog Comparators	UART	SPI	I <sup>2</sup> C™	PMP	PPS	RTCC	CAN	JTAG	Pkg Code
dsPIC33FJ12GP201	18	13	12	1	-	3	4	2	-	1 ADC, 8 ch	-	-	1	1	1	-	✓	-	-	-	PSO
dsPIC33FJ12GP202	28	21	12	1	-	3	4	2	-	1 ADC, 10 ch	-	-	1	1	1	-	✓	-	-	✓	SO, SP, ML, SS
dsPIC33FJ16GP101	20	15	16	1	-	5	3	8	1	1 ADC, 6ch	-	3	1	1	1	-	✓	1	-	-	SS, SO, P
dsPIC33FJ16GP102	28/36	21	16	1	-	5	3	8	1	1 ADC, 8ch	-	3	1	1	1	-	✓	1	-	-	ML, SO, SP, SS, TL
dsPIC33FJ32GP101	20	15	32	2	-	5	3	8	1	1 ADC, 6ch	-	3	1	1	1	-	✓	1	-	-	SS, SO, P
dsPIC33FJ32GP102	28/36	21	32	2	-	5	3	8	1	1 ADC, 8ch	-	3	1	1	1	-	✓	1	-	-	ML, SO, SP, SS, TL
dsPIC33FJ32GP104	44	35	32	2	-	5	3	8	1	1 ADC, 14ch	-	3	1	1	1	-	✓	1	-	-	ML, TL, PT
dsPIC33FJ32GP202	28	21	32	2	-	3	4	2	-	1 ADC, 10 ch	-	-	1	1	1	-	✓	-	-	✓	SO, SP, MM
dsPIC33FJ32GP302	28	21	32	4	8	5	4	4	1	1 ADC 10 ch	-	2	2	2	1	1	✓	1	-	✓	SO, SP, MM
dsPIC33FJ64GP202	28	21	64	8	8	5	4	4	1	1 ADC 10 ch	-	2	2	2	1	1	✓	1	-	✓	SO, SP, MM
dsPIC33FJ64GP802*	28	21	64	16	8	5	4	4	1	1 ADC 10 ch	2 ch	2	2	2	1	1	✓	1	1	✓	SO, SP, MM
dsPIC33FJ128GP202	28	21	128	8	8	5	4	4	1	1 ADC 10 ch	-	2	2	2	1	1	✓	1	-	✓	SO, SP, MM
dsPIC33FJ128GP802	28	21	128	16	8	5	4	4	1	1 ADC 10 ch	2 ch	2	2	2	1	1	✓	1	1	✓	SO, SP, MM
dsPIC33FJ16GP304	44	35	16	2	-	3	4	2	-	1 ADC, 13 ch	-	-	1	1	1	-	✓	-	-	✓	PT, ML
dsPIC33FJ32GP204*	44	35	32	2	-	3	4	2	-	1 ADC, 13 ch	-	-	1	1	1	-	✓	-	-	✓	PT, ML
dsPIC33FJ32GP304	44	35	32	4	8	5	4	4	1	1 ADC 13 ch	-	2	2	2	1	1	✓	1	-	✓	PT, ML
dsPIC33FJ64GP204	44	35	64	8	8	5	4	4	1	1 ADC 13 ch	-	2	2	2	1	1	✓	1	-	✓	PT, ML
dsPIC33FJ64GP804	44	35	64	16	8	5	4	4	1	1 ADC 13 ch	2 ch	2	2	2	1	1	✓	1	1	✓	PT, ML
dsPIC33FJ128GP204	44	35	128	8	8	5	4	4	1	1 ADC 13 ch	-	2	2	2	1	1	✓	1	-	✓	PT, ML
dsPIC33FJ128GP804*	44	35	128	16	8	5	4	4	1	1 ADC 13 ch	2 ch	2	2	2	1	1	✓	1	1	✓	PT, ML
dsPIC33FJ64GP206A	64	53	64	8	8	9	8	8	1	1 ADC, 18 ch	-	-	2	2	1	-	-	-	-	✓	PT, MR
dsPIC33FJ64GP306A	64	53	64	16	8	9	8	8	1	1 ADC, 18 ch	-	-	2	2	2	-	-	-	-	✓	PT, MR
dsPIC33FJ64GP706A	64	53	64	16	8	9	8	8	1	2 ADC, 18 ch	-	-	2	2	2	-	-	-	2	✓	PT, MR
dsPIC33FJ128GP206A	64	53	128	8	8	9	8	8	1	1 ADC, 18 ch	-	-	2	2	1	-	-	-	-	✓	PT, MR
dsPIC33FJ128GP306A	64	53	128	16	8	9	8	8	1	1 ADC, 18 ch	-	-	2	2	2	-	-	-	-	✓	PT, MR
dsPIC33FJ128GP706A*	64	53	128	16	8	9	8	8	1	2 ADC, 18 ch	-	-	2	2	2	-	-	-	2	✓	PT, MR
dsPIC33FJ256GP506A*	64	53	256	16	8	9	8	8	1	1 ADC, 18 ch	-	-	2	2	2	-	-	-	1	✓	PT
dsPIC33FJ64GP708A	80	69	64	16	8	9	8	8	1	2 ADC, 24 ch	-	-	2	2	2	-	-	-	2	✓	PT
dsPIC33FJ128GP708A	80	69	128	16	8	9	8	8	1	2 ADC, 24 ch	-	-	2	2	2	-	-	-	2	✓	PT
dsPIC33FJ64GP310A	100	85	64	16	8	9	8	8	1	1 ADC, 32 ch	-	-	2	2	2	-	-	-	-	✓	PT, PF
dsPIC33FJ64GP710A	100	85	64	16	8	9	8	8	1	2 ADC, 32 ch	-	-	2	2	2	-	-	-	2	✓	PT, PF
dsPIC33FJ128GP310A	100	85	128	16	8	9	8	8	1	1 ADC, 32 ch	-	-	2	2	2	-	-	-	-	✓	PT, PF
dsPIC33FJ128GP710A*	100	85	128	16	8	9	8	8	1	2 ADC, 32 ch	-	-	2	2	2	-	-	-	2	✓	PT, PF
dsPIC33FJ256GP510A	100	85	256	16	8	9	8	8	1	1 ADC, 32 ch	-	-	2	2	2	-	-	-	1	✓	PT, PF
dsPIC33FJ256GP710A*	100	85	256	30	8	9	8	8	1	2 ADC, 32 ch	-	-	2	2	2	-	-	-	2	✓	PT, PF

†dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 Sample and Hold) or 500 kbps 12-bit ADC (1 Sample and Hold)

\*Parts available with high temperature options



# dsPIC33F DSC Product Family

## Motor Control and Power Conversion Family

Microchip's 16-bit dsPIC33F motor control family of Digital Signal Controllers (DSCs) provide high performance 16-bit MCUs with integrated DSP and on-chip peripherals. These DSCs enable the design of high-performance, precision motor control systems that are more energy efficient, quieter in operation, have greater range and an extended life. These motor control DSCs can be used to control brushless DC, permanent magnet synchronous, AC induction and stepper motors. These devices are also ideal for switched mode power supplies and power factor correction applications.

Device	Plins	I/O Plins	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	Analog Comparators	Op Amps	UART	SPI	I <sup>2</sup> C™	PMP	PPS	RTCC	CAN	JTAG	Pkg Code
dsPIC33FJ12MC201	20	15	12	1	-	3	4	2	4+2 ch	1	1 ADC, 4 ch	-	-	1	1	1	-	✓	-	-	-	SO, P, SS
dsPIC33FJ12MC202	28	21	12	1	-	3	4	2	6+2 ch	1	1 ADC, 6 ch	-	-	1	1	1	-	✓	-	-	✓	SO, SP, ML, SS
dsPIC33FJ16GP101	20	15	16	1	-	5	3	8	6 ch	-	1 ADC, 6ch	3	1	1	1	-	✓	✓	-	-	✓	SS, SO, P
dsPIC33FJ16GP102	28/36	21	16	1	-	5	3	8	6 ch	-	1 ADC, 8ch	3	1	1	1	-	✓	✓	-	-	✓	ML, SO, SP SS, TL
dsPIC33FJ32GP101	20	15	32	2	-	5	3	8	6 ch	-	1 ADC, 6ch	3	1	1	1	-	✓	✓	-	-	✓	SS, SO, P
dsPIC33FJ32GP102	28/36	21	32	2	-	5	3	8	6 ch	-	1 ADC, 8ch	3	1	1	1	-	✓	✓	-	-	✓	ML, SO, SP SS, TL
dsPIC33FJ32GP104	44	35	32	2	-	5	3	8	6 ch	-	1 ADC, 14ch	3	1	1	1	-	✓	✓	-	-	✓	ML, TL, PT
dsPIC33FJ32MC202*	28	21	32	2	-	3	4	2	6+2 ch	1	1 ADC, 6 ch	-	-	1	1	1	-	✓	-	-	✓	SO, SP MM
dsPIC33FJ32MC302	28	21	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	21	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	21	64	16	8	5	4	4	6+2 ch	2	1 ADC 6 ch	-	2	2	2	1	1	✓	1	1	✓	SO, SP MM
dsPIC33FJ128MC202	28	21	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	21	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	35	16	2	-	3	4	2	6+2 ch	1	1 ADC, 9 ch	-	-	1	1	1	-	✓	-	-	✓	PT, ML
dsPIC33FJ32MC204*	44	35	32	2	-	3	4	2	6+2 ch	1	1 ADC, 9 ch	-	-	1	1	1	-	✓	-	-	✓	PT, ML
dsPIC33FJ32MC304	44	35	32	4	8	5	4	4	6+2 ch	2	1 ADC 9 ch	-	2	2	2	1	1	✓	1	-	✓	PT, ML
dsPIC33FJ64MC204	44	35	64	8	8	5	4	4	6+2 ch	2	1 ADC 9 ch	-	2	2	2	1	1	✓	1	-	✓	PT, ML
dsPIC33FJ64MC804*	44	35	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	35	128	8	8	5	4	4	6+2 ch	2	1 ADC 9 ch	-	2	2	2	1	1	✓	1	-	✓	PT, ML
dsPIC33FJ128MC804*	44	35	128	16	8	5	4	4	8 ch	2	1 ADC 9 ch	2 ch	2	2	2	1	1	✓	1	1	✓	PT, ML
dsPIC33FJ64MC506A*	64	53	64	8	8	9	8	8	8 ch	1	1 ADC, 16 ch	-	-	2	2	2	-	-	-	1	✓	PT, MR
dsPIC33FJ64MC706A	64	53	64	16	8	9	8	8	8 ch	1	2 ADC, 16 ch	-	-	2	2	2	-	-	-	1	✓	PT, MR
dsPIC33FJ128MC506A*	64	53	128	8	8	9	8	8	8 ch	1	1 ADC, 16 ch	-	-	2	2	2	-	-	-	1	✓	PT, MR
dsPIC33FJ128MC706A*	64	53	128	16	8	9	8	8	8 ch	1	2 ADC, 16 ch	-	-	2	2	2	-	-	-	1	✓	PT, MR
dsPIC33FJ64MC508A	80	69	64	8	8	9	8	8	8 ch	1	1 ADC, 18 ch	-	-	2	2	2	-	-	-	1	✓	PT
dsPIC33FJ128MC708A	80	69	128	16	8	9	8	8	8 ch	1	2 ADC, 18 ch	-	-	2	2	2	-	-	-	2	✓	PT
dsPIC33FJ64MC510A	100	85	64	8	8	9	8	8	8 ch	1	1 ADC, 24 ch	-	-	2	2	2	-	-	-	1	✓	PT, PF
dsPIC33FJ64MC710A	100	85	64	16	8	9	8	8	8 ch	1	2 ADC, 24 ch	-	-	2	2	2	-	-	-	2	✓	PT, PF
dsPIC33FJ128MC510A	100	85	128	8	8	9	8	8	8 ch	1	1 ADC, 24 ch	-	-	2	2	2	-	-	-	1	✓	PT, PF
dsPIC33FJ128MC710A*	100	85	128	16	8	9	8	8	8 ch	1	2 ADC, 24 ch	-	-	2	2	2	-	-	-	2	✓	PT, PF
dsPIC33FJ256MC510A	100	85	256	16	8	9	8	8	8 ch	1	1 ADC, 24 ch	-	-	2	2	2	-	-	-	1	✓	PT, PF
dsPIC33FJ256MC710A*	100	85	256	30	8	9	8	8	8 ch	1	2 ADC, 24 ch	-	-	2	2	2	-	-	-	2	✓	PT, PF

†dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 Sample and Hold) or 500 kbps 12-bit ADC (1 Sample and Hold)  
\*Parts available with high temperature options

# dsPIC33F DSC Product Family

## SMPS and Digital Power Conversion Family

Implementing high speed precision digital control loops for power conversion applications requires a high-performance DSP engine along with specialized Switch Mode Power Supplies (SMPS) peripherals. Microchip's 16-bit dsPIC33F SMPS DSCs provide on-chip peripherals specifically designed for high-performance, digital power supplies. SMPS peripherals include high speed PWM, ADC and analog comparators. The dsPIC33F SMPS family supports applications such as, AD-DC and DC-DC conversion, induction cooking, UPS, inverter, intelligent battery chargers, power factor correction, HID lighting, fluorescent lighting, LED lighting and motor control applications. SMPS and digital power conversion devices are offered in 40 MIPS and 50 MIPS versions. Please see [www.microchip.com](http://www.microchip.com) for availability.

Device	Pins	I/O Pins	Flash (KB)	RAM (Bytes)	Timer 16-bit	DMA # ch	Input Capture	Output Compare/ Standard PWM	PS PWM	QEI	ADC -10-bit† 2/4 Msps	10-bit DAC o/p	Analog Comparators	UART	SPI	I <sup>2</sup> C™	ECAN™	JTAG	Pkg Code
dsPIC33FJ06GS001	18/20	13	6K	256	2	-	-	0	4	-	1 ADC, 6 ch, 2 S&H	-	2	-	-	1	-	✓	SO, SS, P
dsPIC33FJ06GS101	18	13	6	256	2	-	-	1	4	-	1 ADC, 6 ch, 3 S&H	-	-	1	1	1	-	-	SO
dsPIC33FJ06GS101A	18/20	13	6	256	2	-	-	1	4	-	1 ADC, 6 ch, 3 S&H	-	-	1	1	1	-	✓	SO, SS, P
dsPIC33FJ06GS102	28	21	6	256	2	-	-	1	4	-	1 ADC, 6 ch, 3 S&H	-	-	1	1	1	-	✓	SO, MM, SP
dsPIC33FJ06GS102A	28/36	21	6	256	2	-	-	1	4	-	1 ADC, 6 ch, 3 S&H	-	-	1	1	1	-	✓	SO, SS, MM, SP TL
dsPIC33FJ06GS202	28	21	6	1K	2	-	1	1	4	-	1 ADC, 6 ch, 3 S&H	1	2	1	1	1	-	✓	SO, MM, SP
dsPIC33FJ06GS202A	28/36	21	6	1K	2	-	1	1	4	-	1 ADC, 6 ch, 3 S&H	1	2	1	1	1	-	✓	SO, SS, MM, SP TL
dsPIC33FJ09GS302	28/36	21	9	1K	2	-	1	1	6	-	1 ADC, 8 ch, 3 S&H	1	2	1	1	1	-	✓	SO, SS, MM, SP TL
dsPIC33FJ16GS402	28	21	16	2K	3	-	2	2	6	-	1 ADC, 8 ch, 4 S&H	-	-	1	1	1	-	✓	SO, MM, SP
dsPIC33FJ16GS502	28	21	16	2K	3	-	2	2	8	-	2 ADC, 8 ch, 6 S&H*	1	4	1	1	1	-	✓	SO, MM, SP
dsPIC33FJ16GS404	44	35	16	2K	3	-	2	2	6	-	1 ADC, 8 ch, 4 S&H	-	-	1	1	1	-	✓	ML, PT, TL
dsPIC33FJ16GS504	44	35	16	2K	3	-	2	2	8	-	2 ADC, 12 ch, 6 S&H*	1	4	1	1	1	-	✓	ML, PT, TL
dsPIC33FJ32GS406	64	53	32	4K	4	-	4	4	12	1	1 ADC, 16 Ch, 5 S&H	-	-	2	2	2	-	✓	PT,MR
dsPIC33FJ32GS606	64	53	32	4K	4	-	4	4	12	2	2 ADC, 16 Ch, 6 S&H*	1	4	2	2	2	-	✓	PT,MR
dsPIC33FJ64GS406	64	53	64	8K	4	-	4	4	12	1	1 ADC, 16 Ch, 5 S&H	-	-	2	2	2	-	✓	PT,MR
dsPIC33FJ64GS606	64	53	64	9K	4	4	4	4	12	2	2 ADC, 16 Ch, 6 S&H*	1	4	2	2	2	1	✓	PT,MR
dsPIC33FJ32GS608	80	69	32	4K	4	-	4	4	16	2	2 ADC, 18 Ch, 6 S&H*	1	4	2	2	2	-	✓	PT
dsPIC33FJ64GS608	80	69	64	9K	4	4	4	4	16	2	2 ADC, 18 Ch, 6 S&H*	1	4	2	2	2	1	✓	PT
dsPIC33FJ32GS610	100	85	32	4K	4	-	4	4	18	2	2 ADC, 24 Ch, 6 S&H*	1	4	2	2	2	-	✓	PT, PF
dsPIC33FJ64GS610	100	85	64	9K	4	4	4	4	18	2	2 ADC, 24 Ch, 6 S&H*	1	4	2	2	2	1	✓	PT, PF

\*4 Msps devices

# dsPIC30F DSC Product Family

## General Purpose Family

The 30 MIPS dsPIC30F family is developed for applications that benefit from a wide operating voltage (2.5 to 5.5V), extremely low standby current, integrated EEPROM and for those that prefer 5V operation due to system considerations. The variants with Codec interfaces are well suited for speech and audio applications.

Device	Pins	Flash Memory (Kbytes)	RAM (Bytes)	EEPROM (Bytes)	Timer 16-bit	Input Capture	Output Compare/Standard PWM	Codec Interface	ADC 12-bit 200 ksp/s	Flash Security Segments	UART	SPI	I <sup>2</sup> C™	CAN	Pkg Code
dsPIC30F3014	40/44	24	2048	1024	3	2	2	–	13 ch, 1 S/H	1	2	1	1	–	P, PT, ML
dsPIC30F4013	40/44	48	2048	1024	5	4	4	AC97, I <sup>2</sup> S	13 ch, 1 S/H	3	2	1	1	1	P, PT, ML
dsPIC30F5011	64	66	4096	1024	5	8	8	AC97, I <sup>2</sup> S	16 ch, 1 S/H	3	2	2	1	2	PT
dsPIC30F6011A	64	132	6144	2048	5	8	8	–	16 ch, 1 S/H	3	2	2	1	2	PF, PT
dsPIC30F6012A	64	144	8192	4096	5	8	8	AC97, I <sup>2</sup> S	16 ch, 1 S/H	3	2	2	1	2	PF, PT
dsPIC30F5013	80	66	4096	1024	5	8	8	AC97, I <sup>2</sup> S	16 ch, 1 S/H	3	2	2	1	2	PT
dsPIC30F6013A	80	132	6144	2048	5	8	8	–	16 ch, 1 S/H	3	2	2	1	2	PF, PT
dsPIC30F6014A	80	144	8192	4096	5	8	8	AC97, I <sup>2</sup> S	16 ch, 1 S/H	3	2	2	1	2	PF, PT

## Sensor Family

The dsPIC30F Sensor family products have features designed to support high-performance, cost-sensitive and space-constrained applications. Offered in packages as small as 6 × 6 mm and with pin counts as low as 18 pins.

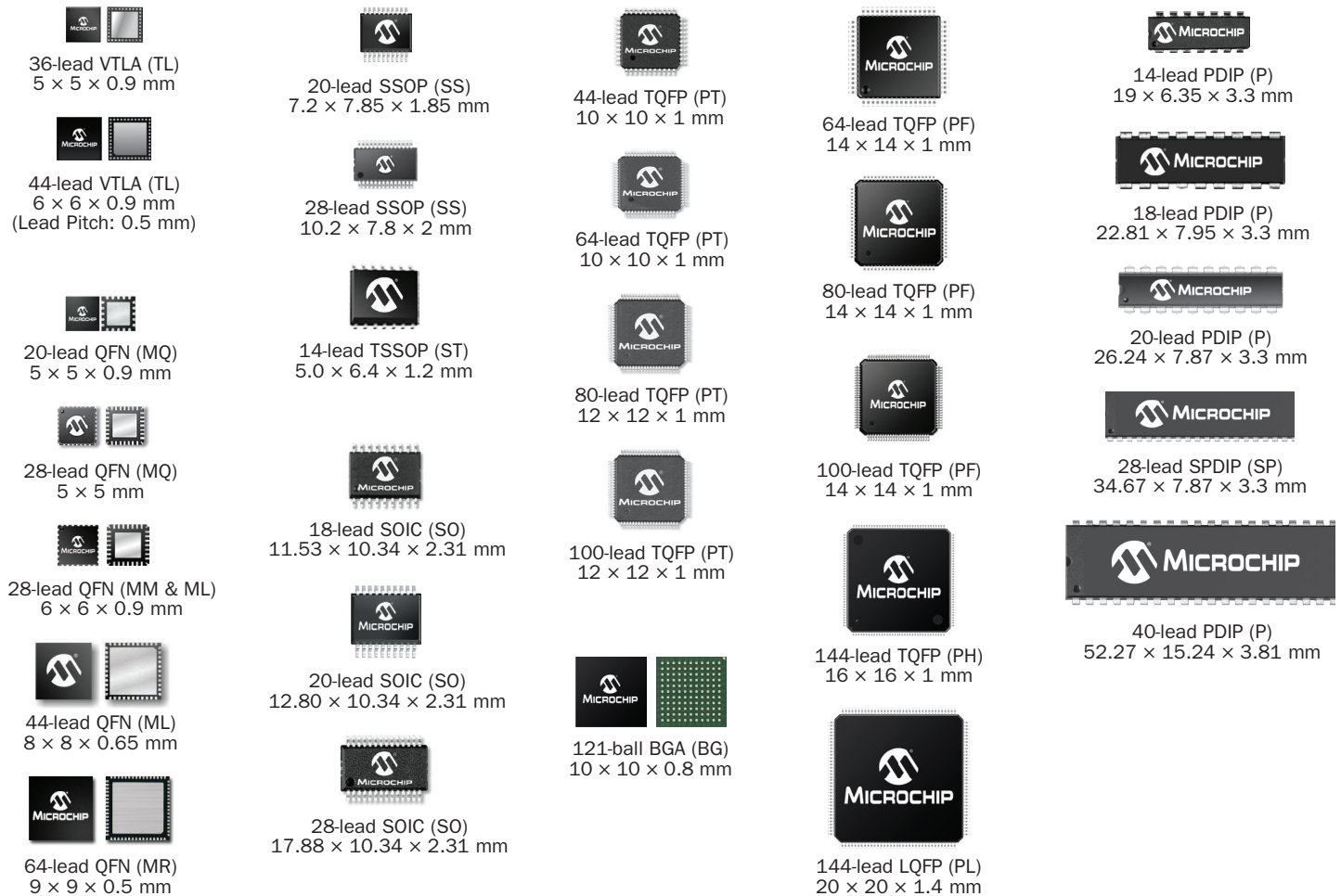
Device	Pins	Flash Memory (Kbytes)	RAM (Bytes)	EEPROM (Bytes)	Timer 16-bit	Input Capture	Output Compare/Standard PWM	ADC 12-bit 200 ksp/s	UART	SPI	I <sup>2</sup> C™	I/O Pins (Max.)	Pkg Code
dsPIC30F2011	18	12	1024	–	3	2	2	8 ch, 1 S/H	1	1	1	12	P, SO, 28-pin ML
dsPIC30F3012	18/44	24	2048	1024	3	2	2	8 ch, 1 S/H	1	1	1	12	P, SO, 44-pin ML
dsPIC30F2012	28	12	1024	–	3	2	2	10 ch, 1 S/H	1	1	1	20	SP, SO, 28-pin ML
dsPIC30F3013	28/44	24	2048	1024	3	2	2	10 ch, 1 S/H	2	1	1	20	SP, SO, 44-pin ML

## Motor Control and Power Conversion Family

This dsPIC30F family supports motor control applications, such as brushless DC, single- and 3-phase induction and switched reluctance motors. These are also ideal for UPS, inverter and power factor correction applications.

Device	Pins	Flash Memory (Kbytes)	RAM (Bytes)	EEPROM (Bytes)	Timer 16-bit	Input Capture	Output Compare/Standard PWM	Motor Control PWM	QEI	ADC 10-bit 1 Msps	Flash Security Segments	UART	SPI	I <sup>2</sup> C™	CAN	Pkg Code
dsPIC30F2010	28	12	512	1024	3	4	2	6 ch	✓	6 ch, 4 S/H	1	1	1	1	–	SP, SO, MM
dsPIC30F3010	28/44	24	1024	1024	5	4	2	6 ch	✓	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	✓	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	✓	9 ch, 4 S/H	1	2	1	1	–	P, PT, ML
dsPIC30F4011	40/44	48	2048	1024	5	4	4	6 ch	✓	9 ch, 4 S/H	1	2	1	1	1	P, PT, ML
dsPIC30F5015	64	66	2048	1024	5	4	4	8 ch	✓	16 ch, 4 S/H	1	1	2	1	1	PT
dsPIC30F6015	64	144	8192	4096	5	8	8	8 ch	✓	16 ch, 4 S/H	3	2	2	1	1	PT
dsPIC30F5016	80	66	2048	1024	5	4	4	8 ch	✓	16 ch, 4 S/H	1	1	2	1	1	PT
dsPIC30F6010A	80	144	8192	4096	5	8	8	8 ch	✓	16 ch, 4 S/H	3	2	2	1	2	PF, PT

# 16-bit Packages



## Terms and Definitions

ADC	Analog-to-Digital Converter	PPS	Peripheral Pin Select
CTMU	Capacitive Time Measurement Unit	PWM	Pulse Width Modulator
DAC	Digital-to-Analog Converter	QEI	Quadrature Encoder Interface
DMA	Direct Memory Access	RTCC	Real-Time Clock Calendar
ECAN	Enhanced Controller Area Network	SPI	Serial Peripheral Interface
I <sup>2</sup> C	Inter-Integrated Circuit	UART	Universal Asynchronous Receiver Transmitter
JTAG	Joint Test Action Group	USB OTG	Universal Serial Bus On-The-Go
PMP	Parallel Master Port		

# World Class Development Tools

## MPLAB Integrated Development Environment (IDE)

Microchip's 16-bit controllers are supported by MPLAB Integrated Development Environment. MPLAB IDE is a FREE development environment that is common to all Microchip 8-, 16- and 32-bit products, making it possible to use across many of your designs. When combined with Microchip's PICkit™ 3 In-Circuit Debugger, you can get started with a complete development tool chain for as little as \$44.95.

All of Microchip's MCU and DSC tools operate cohesively under the MPLAB IDE umbrella. The powerful and easy-to-use MPLAB IDE has all of the advanced edit/build/debug features you would expect from a 32-bit debug environment. MPLAB IDE integrates not only software, but all of Microchip's hardware tools and many third party tools. Key features of MPLAB IDE include:

- Project build and management
- Flexible watch windows
- Mouse over variable inspection
- MATLAB Device Blocks for MPLAB IDE (for dsPIC30 and dsPIC33 DSCs)
- Full feature code editor with color context
- Source level debug in ASM and C
- Searchable trace buffers
- Version control integration
- Real-time data monitoring

## Available for MPLAB IDE

### Assembler/Linker/Librarian

The MPLAB ASM30 is a full-featured macro assembler. User defined macros, conditional assembly and a variety of assembler directives make the MPLAB ASM30 a powerful code generation tool.

### MPLAB SIM Software Simulator

The MPLAB 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.

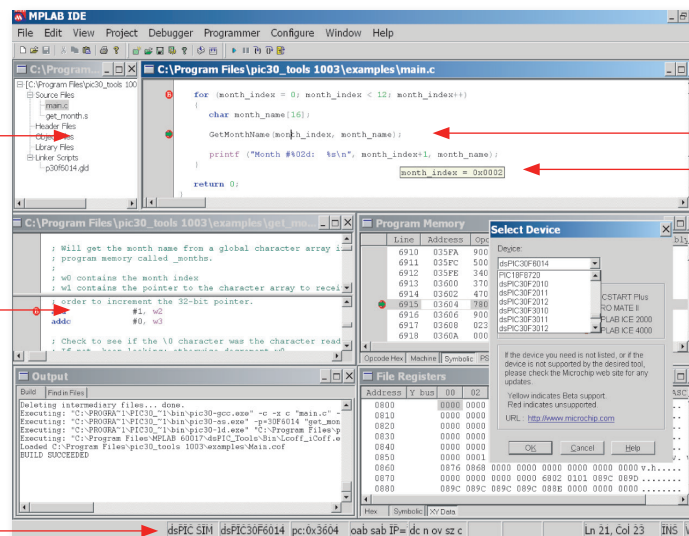
### MATLAB/Simulink Device Blocks for dsPIC DSCs

The Microchip Device Blocksets for MATLAB Simulink provide a set of interface-compliant configuration and run-time peripheral blocks for the dsPIC30 and dsPIC33 DSCs. Complete applications can be created in the form of a MATLAB/SIMULINK model using blocksets provided by Microchip and Simulink. C code for the application will be generated. These blocksets are compatible with the MATLAB plug-in available in MPLAB IDE.

Powerful Project Manager handles multiple projects and all file types

Color-keyed editor makes source code debug easier

Status bar updates on single step or run



Set break/trace points with a click of the mouse

Simply move your mouse over a variable to view or modify

Fully customizable watch windows to view and modify registers and memory locations



# World Class Development Tools

## MPLAB X IDE

### Universal and Integrated Tool Set

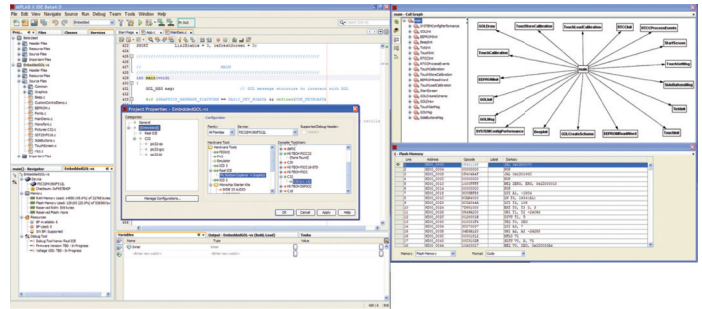
MPLAB X IDE is a single, universal graphical user interface for Microchip and third party software and hardware development tools. It is the industry's only IDE to support an entire portfolio of 800+ 8-bit, 16-bit and 32-bit PIC MCUs, dsPIC DSCs and memory devices.

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.

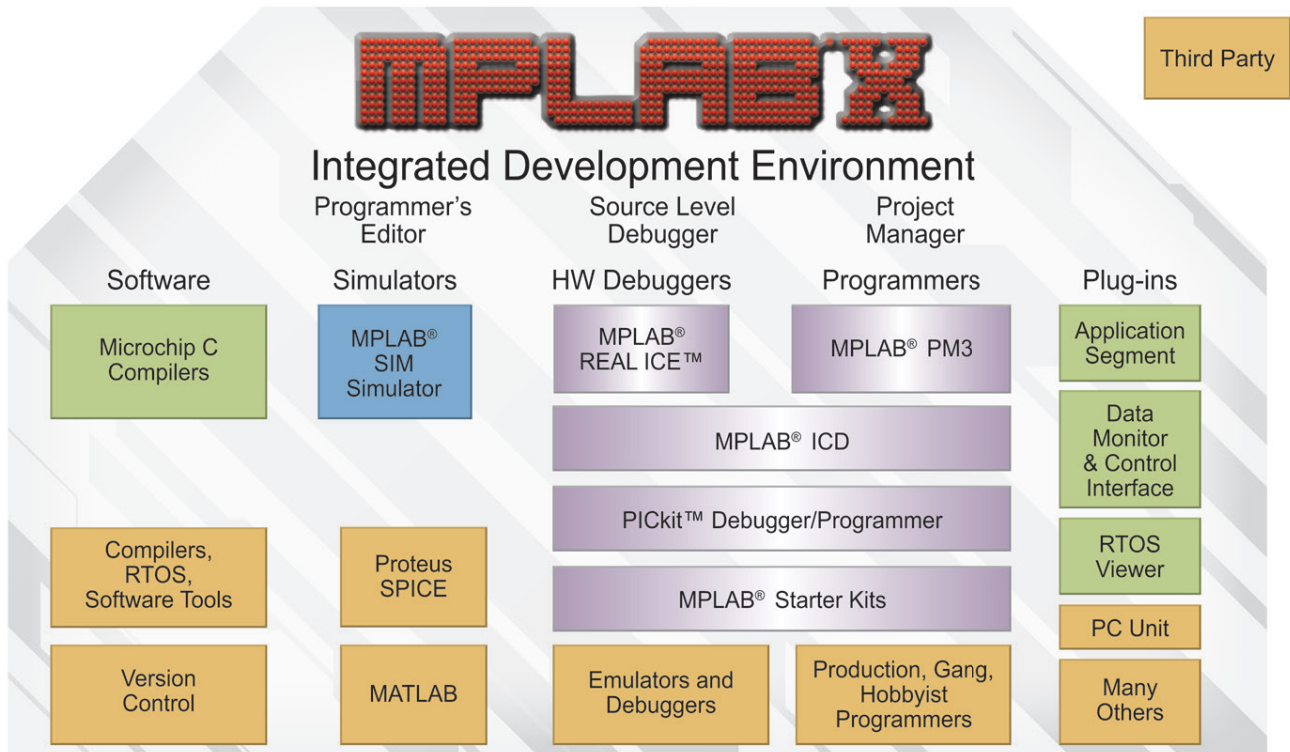


### Open-Source Platform

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



# World Class Development Tools

## Popular C Compilers

### MPLAB C Compilers

Microchip's MPLAB C compilers are full-featured, ANSI compliant high-performance tools tightly integrated with MPLAB IDE. Source level debugging allows single stepping through C source code and inspecting variables and structures at critical points in the code. Integration with MPLAB IDE means there is a single, consistent environment to write code and to debug with the free MPLAB SIM simulator or with MPLAB in-circuit debuggers and emulators.

Code can be programmed into the target using the hardware debuggers or with Microchip's device programmers. Compiler switches and linker customizations are done within MPLAB IDE to provide a full graphical front end to these powerful compilers. Editing errors and breakpoints instantly switch to the corresponding lines in source code. Watch windows show data structures with defined data types, including floating point.

### MPLAB C Compiler for PIC24 MCUs and dsPIC DSCs

The MPLAB C Compiler for PIC24 MCUs and dsPIC DSCs includes a complete ANSI C standard library, including string manipulation, dynamic memory allocation, data conversion, timekeeping and math libraries. The MPLAB C Compiler has a powerful code optimizer; other 16-bit MCUs generate as much as 165 percent larger code for the same application.

## Math Libraries

### dsPIC DSP Library




The dsPIC DSP Library provides a set of speed optimized functions for the most common digital signal processing applications. In total, 49 functions are supported by the DSP Library. It is part of the 16-bit Language Tools Libraries. The DSP Library provides significant performance savings over equivalent functions coded in "C" and allows developers to dramatically shorten their development time. The functions are callable from both 'C' and Assembly.

### Fixed Point Math Library for PIC24 MCUs and dsPIC DSCs

The I/Q Fixed Point Math Library provides a set of speed optimized functions for the most common digital signal processing applications. This library provides significant performance savings over equivalent functions coded in C and allows developers to dramatically shorten their development time. The I/Q math library includes over 65 general-purpose functions composed of 28 functions supporting Q15 math and thirty seven functions supporting Q16 math. The IQ math functions are callable from both 'C' and Assembly.

### Floating Point Math Library for PIC24 MCUs and dsPIC DSCs

The IEEE-754 Compliant Floating Point Math Library is the compiled version of the math library that is distributed with the highly optimized, ANSI-compliant MPLAB C Compiler. It contains advanced single and double-precision floating-point arithmetic and trigonometric functions from the standard C header file <math.h>. The library delivers small program code size and data size, reduced cycles and high accuracy.

Library	Features
 Peripheral Driver Library	This library provides over 300 C utility functions.
 Math Libraries: Standard, Floating-Point & Fixed-Point	<ul style="list-style-type: none"><li>■ ANSI C standard functions</li><li>■ IEEE-754 compliant floating point math Support for both single and double-precisions</li><li>■ I/Q math for fixed point numbers Support for both 1.15 and 16.16 formats</li></ul>
 DSP Algorithm Library	This extensive DSP building block library is fully optimized in assembly code for execution speed.



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

[www.microchip.com/compilers](http://www.microchip.com/compilers)

# General Purpose Development and Evaluation Tools

## Debuggers, Emulators and Programmers

### PICKit 3 In-Circuit Debugger (PG164130)



The MPLAB PICKit 3 allows debugging and programming of PIC MCUs and dsPIC DSCs Flash microcontrollers at a most affordable price point using the powerful graphical user interface of the MPLAB Integrated Development Environment (IDE).

### MPLAB ICD 3 In-Circuit Debugger/Programmer (DV164035)



The MPLAB ICD 3 In-Circuit Debugger/Programmer is a powerful, low-cost development tool. Running under MPLAB IDE, MPLAB ICD 3 can debug ASM or C source code, watch and modify variables, single step and set breakpoints.

### MPLAB REAL ICE In-Circuit Emulation System (DV244005)



The MPLAB REAL ICE In-Circuit Emulator is Microchip's next-generation emulation and debugging system. This system provides a powerful in-circuit emulation platform for easy and rapid application development and debugging. The emulation is performed using special hardware logic on the target device itself, eliminating the need for a separate emulator device.

### MPLAB PM3 Device Programmer (DV007004)



MPLAB PM3 Device Programmer is a full-featured, production quality universal device programmer. Using interchangeable socket modules, the MPLAB PM3 supports virtually all programmable devices from Microchip. MPLAB PM3 has improved programming time for many devices and offers a built-in interface for robust In-Circuit Serial Programming™ (ICSP™).

## MPLAB Starter Kits

MPLAB Starter Kits are designed to demonstrate the key features of the device family they represent. In addition to the external circuit needed to support and demonstrate the device, the starter kits include the circuitry necessary to debug and program the MCUs and DSCs. When combined with the MPLAB IDE and the MPLAB C Compiler for PIC24 MCUs or dsPIC DSCs (Evaluation Edition), the starter kit allows designers to gain quick knowledge and experience with 16-bit MCU and DSC products.

### MPLAB Starter Kit for dsPIC Digital Signal Controllers (DM330011)



The MPLAB starter kit for dsPIC Digital Signal Controllers is an excellent low cost platform to evaluate or learn about the dsPIC architecture. It is equipped with the hardware and software necessary to code and debug simple applications and also demonstrates the audio capability of the dsPIC DSC.

### MPLAB Starter Kit for Digital Power (DM330017)



The starter kit allows the user to easily explore the capabilities and features of the dsPIC33F GS Digital Power Conversion family. It is a digitally controlled power supply board that consists of one independent DC/DC synchronous Buck converter and one independent DC/DC Boost converter. Each power stage includes a MOSFET controlled 5W resistive load. The starter kit includes an On-Board Debugger/Programmer.

### MPLAB Starter Kit for PIC24H MCUs (DM240021)



This starter kit is a complete hardware and software kit for exploring the power of PIC24H family of MCUs. The on-board PIC24HJ128GP504 controller is equipped with necessary software to demonstrate accelerometer based sample program with visual display and speech playback.

### MPLAB Starter Kit for PIC24F MCUs (DM240011)



This starter kit is based on the PIC24FJ256GB110 family and is equipped with the hardware and software necessary to demonstrate the USB OTG peripheral and mTouch Capacitive Touch Sense technology.

### dsPIC33E/PIC24E USB Starter Kit (DM330012/DM240012)



These starter kits provide a low-cost modular development system for Microchip's enhanced 16-bit Digital Signal Controllers or High-Performance Microcontrollers (MCUs). It comes with a preloaded demo software for the user to explore the new features of the dsPIC33E DSC family or the PIC24E MCU family.

### Motor Control Starter Kit (MCSK) with mTouch Sensing (DM330015)



This 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 on-board BLDC motor, a user configurable switch and an mTouch slider with LED indicators for speed control. Simply power the board using the included 9V supply and the pre-loaded code begins to execute.



# General Purpose Development and Evaluation Tools

## Development Boards

A variety of hardware development boards are available for the PIC24 MCU and dsPIC DSC, enabling designers to shorten their design cycle. These boards are designed to allow easy connection to an MPLAB ICD 3 In-Circuit Debugger, MPLAB REAL ICE™ In-Circuit Emulator or MPLAB PM3 device programmer. All development boards include documentation and example source code to accelerate your design.

### 16-bit 28-pin Starter Development Board (DM300027)



This low cost development board provides an easy way to get started with any of Microchip's 28-pin 16-bit MCU or DSC devices.

### nanoWatt XLP 16-bit Development Board (DM240311)



The XLP 16-bit Development Board is designed with eXtreme Low Power in mind. Designed as a true platform for low power development, it enables designs with sleep currents as low as 10 nA. The board is suitable for prototyping many low power applications including RF sensors, data loggers, temperature sensors, electronic door locks, metering sensors, remote controls, security sensors, smart cards and energy harvesting. The PICTail™ interface supports Microchip's extensive line of daughter cards for easy evaluation of your next low power application.

### Microstick for dsPIC33F and PIC24H Development Board (DM330013)



The Microstick for dsPIC33F and PIC24H devices is designed to provide designers with an easy to use, economical development environment for 16-bit digital signal controllers and microcontrollers.

### Microstick for 3V PIC24 K-series Development Board (DM240013-1)



Microstick for 3V PIC24F K-series is a flexible, USB powered development platform. It's the perfect solution for those looking to get started with Microchip's lowest cost 16-bit microcontroller families, the PIC24F K-series, for extremely cost sensitive applications.

### Microstick II Development Board (DM330013-2)



Microstick II delivers a low-cost, easy-to-use development platform for Microchip's 16- and 32-bit microcontrollers and digital signal controllers. The USB-powered kit includes an on-board debugger/programmer, a DUT socket for easy device swapping, a user LED and reset button.

### Audio Development Board for dsPIC33E (DM330016)



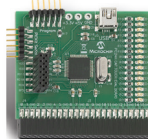
The audio development board features a 70 MIPS dsPIC33E MCU, a 24-bit Wolfson audio codec, a two-inch color LCD, a USB interface and an onboard microphone. Supported by Microchip's free software libraries, the kit provides an ideal solution for the development of iPod music playback, speech and audio recording and playback, as well as MP3 decoding applications.

### LCD Explorer Development Board (DM240314)



This development board supports Microchip's 100-pin microcontrollers with × 8 common segment LCD drivers. The LCD Explorer provides an ideal platform for a customer to evaluate a MCU with a × 8 Common LCD Driver on a 38 segment × 8 common LCD display. PICTail Plus connections allow customers to evaluate the selected MCU in a complex system by adding Microchip's PICTail Plus daughter boards.

### PIC24H mTouch Capacitive Touch Evaluation Board (AC243026)



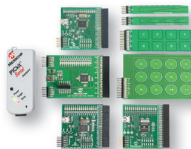
This evaluation board is designed to facilitate the development of capacitive touch-based applications using PIC24H-series microcontrollers. This board is intended to supplement the motherboard portfolio already included in the mTouch Capacitive Touch Evaluation Kit (DM183026-2).

### PIC24FJ256DA210 Development Kit (DV164039)



This low cost development kit is an efficient means to evaluate the features and performance of the PIC24FJ256DA210 with integrated graphics, mTouch and USB. This kit is an ideal platform for new graphical human interface developers. It bundles the PIC24FJ256DA210 Development Board (DM240312), a 3.2" Truly 240x320 TFT Display Board (AC164127-4), three Graphics Display Prototype Boards (AC164139), the MPLAB ICD 3 Debugger with USB Cable (DV164035) and accessories. For those interested in purchasing the kit components, each item can also be purchased separately.

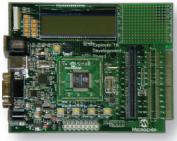
### Enhanced mTouch Capacitive Touch Evaluation Kit (DM183026-2)



This evaluation kit provides a simple platform for developing a variety of capacitive touch sense applications using PIC16F, PIC18F, PIC24F and PIC32 microcontrollers. The diagnostic tool provided allows the user to analyze application-critical information in real-time as it relates to touch sensor behavior.

# Explorer 16 and PICtail Plus Daughter Board

## Explorer 16 Development Board (DM240001/DM240002)



This development board offers an economical way to evaluate Microchip's 16- and 32-bit MCUs, and dsPIC33F DSC families. The combination of versatility and expandability and supporting PICtail

Plus daughter cards allows designer's to evaluate complex software libraries and hardware with minimal time and effort. Features include:

- Processor PIMs (Plug-In Modules)
  - DM240001: two interchangeable PIMs, one each for the PIC24FJ128GA010 and the dsPIC33FJ256GP710 DSC
  - DM240002: features a PIM for the PIC24FJ64GA004 and dsPIC33FJ32GP204

- Alpha-numeric 16 × 2 LCD display
- Interfaces to MPLAB ICD 3 In-Circuit Debugger, REAL ICE In-Circuit Emulator and RS-232
- Includes Microchip's TC1047A high accuracy, analog output temperature sensor
- Full documentation CD includes user's guide, schematics and PCB layout
- Expansion connector to access full devices pin-out and bread board prototyping area
- PICtail Plus connector for expansion boards

## PICtail Plus Daughter Boards

- Allows for the easy addition of complex hardware
- Allows for the easy evaluation of software libraries
- Provides expansion for application specific hardware

Description	Part Number	List Price <sup>(1)</sup>	Devices Supported		
			PIC24F	PIC24H	dsPIC33F
Consumer-band BPSK 7.2 kbps PLM PICtail™ Plus Daughter Board	AC164142	\$249.99	–	–	✓
Wireless PICtail Plus Daughter Board • 2.4 GHz daughter card with the Microchip MRF24J40 transceiver	AC163027	\$39.99	✓	✓	✓
Utility-Band BPSK 6.0 kbps PLM PICtail Plus Daughter Board	AC164145	\$225.00	–	–	✓
ECAN™/LIN PICtail Plus Daughter Board • Two ECAN MCP2551 transceivers • Two LIN MCP2021-330 transceivers	AC163130	\$45.00	–	✓	✓
PICtail Plus Daughter Board for SD/MMC • SPI to SD/MMC interface	AC164122	\$37.99	✓	✓	✓
Ethernet PICtail Plus Daughter Board • Stand Alone ENC24J60 10Base-T Ethernet Controller	AC164123	\$39.99	✓	✓	✓
IrDA® PICtail Plus Daughter Board • IrDA transceiver for IrDA enabled UART	AC164124	\$25.00	✓	✓	✓
Speech Playback PICtail Plus Daughter Board • Adaptive Differential Pulse Code Modulation (ADPCM) speech playback and recording	AC164125	\$45.00	✓	✓	✓
Prototype PICtail Plus Daughter Board • PICtail Plus Expansion Board	AC164126	\$20.00	✓	✓	✓
Graphic PICtail Plus Daughter Board • Enables Graphics display via PMP	AC164127-3	\$154.99	✓	✓	✓
Audio PICtail Plus Daughter Board • Full Duplex Speech and Audio applications	AC164129	\$80.00	–	✓	✓
USB PICtail Plus Daughter Board • USB Device, Host and OTG Expansion	AC164131	\$60.00	✓	–	–
Buck/Boost Converter PICtail Plus Daughter Board • Two independent DC/DC synchronous buck converters • Independent DC/DC boost converter	AC164133	\$89.99	–	–	✓
Thermal/Linear Intelligent Sensor PICtail Plus Daughter Board • Signal input and conditioning for thermocouples and linear sensors • TC1047/1047A Temperature to Voltage Converter	AC164135	\$49.99	–	✓	✓
MCP2515 PICtail Plus Daughter Board • Stand Alone CAN Controller expansion board	MCP2515DM	\$40.00	✓	✓	✓
MCP42XX PICtail Plus Daughter Board • MCP42XX Digital Potentiometer expansion board	MCP42XXDM	\$20.00	✓	✓	✓
MCP4725 PICtail Plus Daughter Board • 12-bit DAC + non-volatile memory	MCP4725DM	\$15.00	✓	✓	✓

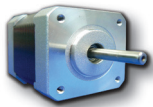
Note 1: List price may change without notice.



# Development Tools for Motor Control Applications

Microchip offers a number of hardware tools to assist in the development of motor control applications. These tools work with Microchip's MPLAB IDE and an in-circuit debugger to download and debug application software. Our systems make it easy to customize the software from our application notes and demo code to run different motors.

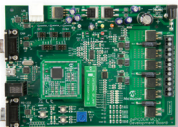
## dsPICDEM™ MCSM Stepper Motor: Motor Control Development Board/Kit (DM330022)/(DV330021)



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 dsPIC33 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. MPLAB ICD 3 In-Circuit Debugger or REAL ICE In-Circuit Emulator is required for programming or debugging operations.

## dsPICDEM MCLV-2 Development Board (DM330021-2)



This development board is intended for low-voltage (up to 48 volts at 10 amps) 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 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 400 volts at 6.5 amps) 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.

## dsPIC33E Dual Motor Control Plug-In Module (PIM) (MA33027)



This Dual Motor Control PIM is designed to facilitate the

development of motor control applications using two motors and one dsPIC33E Digital Signal Controller (DSC). Two Microchip PIM based motor control development boards can be used with this PIM to control two BLDC, PMSM, ACIM or stepper motors. A flexible cable connects the two boards together and routes all signals to the appropriate pins on the dsPIC33E DSC. The configuration of the cable and signals was carefully chosen to support a wide range of dual motor configuration application notes written for the dsPICDEM MCLV, MCHV and MCSM development boards.

## Motor Control Development Systems for dsPIC30F

### PICDEM MC LV Motor Control Development Board (DM183021)



This development board is intended for low-voltage (up to 48V at 2 amps), Brushless DC (BLDC) sensored or sensorless applications. It provides a low-cost board for users to evaluate

and develop applications using Microchip's 28-pin PIC18FXX31 and dsPIC30F motor control devices. An 18-pin translator board (AC162078) is also available and allows the PIC18F1330 to be installed on the board. Feedback support includes Hall-Effect Sensors and Back EMF voltages. MPLAB ICD 3 In-Circuit Debugger or REAL ICE In-Circuit Emulator is required for programming or debugging operations.

### Motors

You can provide your own motor or purchase one of the motors used in our application notes and guaranteed to run, right out of the box:

- AC300024: 2-phase, 8-wire Stepper Motor
- AC300020: 24V BLDC Motor
- AC300022: 24V BLDC Motor with Shaft Encoder
- AC300023: 220V, AC Induction Motor



# Development Tools for Digital Power Applications

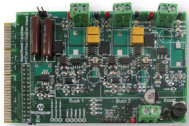
## Platinum Rated 720W AC/DC Reference Design



This reference design demonstrates the flexibility and power of SMPS dsPIC Digital Signal Controllers in switch-mode power supplies. This reference design has a peak efficiency of 94.1% and achieves the ENERGY STAR CSCI Platinum Level. It features a 2-phase

interleaved power factor correction boost converter followed by a 2-phase interleaved two-switch forward converter with synchronous rectification.

## Buck/Boost Converter PICtail Plus Card (AC164133)



A low-cost development platform for dsPIC33FGS SMPS devices, the buck/boost converter PICtail Plus card has two buck stage outputs and one boost stage output. The buck/

boost converter operates from an input supply of +9V to +15V DC. Various performance measures like digital control loop performance of power conversion, dynamic load performance, multi-phase buck and synchronous buck converter operation, parallel operation of two buck converters and multiple output control with a single dsPIC device can be evaluated for dsPIC33FGS SMPS solutions. This board can be used with either the Explorer 16 board or the 16-bit 28-pin starter board and the dsPIC33F SMPS and digital power conversion devices.

## Quarter Brick DC/DC Converter Reference Design



This reference design provides an easy method to evaluate the power, and features of SMPS DSCs in high density quarter brick DC-DC converters for Intermediate Bus

Architectures (IBA). This reference design is implemented using a single dsPIC33F “GS” digital power DSC from Microchip that provides the full digital control of the power conversion and system management functions.

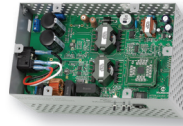
## DC/DC LLC Resonant Converter Reference Design



This reference design operates over a wide input voltage range (350-420V DC) with a nominal input of 400V, providing a 12V DC output, while maintaining high-voltage isolation between the primary and secondary. This reference

design is implemented using a single dsPIC33F “GS” digital power DSCs from Microchip that provides the full digital control of the power conversion and system management functions.

## Digital Power Interleaved PFC Reference Design



High performance power supplies are used in a wide variety of applications ranging from telecommunication equipment, industrial equipment, digital televisions, lighting, air conditioners and

other home appliances. They all need solutions for power factor correction to improve overall efficiency, improve the input power factor, voltage regulation and Total Harmonic Distortion (THD) of the input current. Digital interleaved power factor correction methods provide many benefits over older PFC techniques.

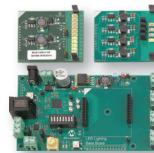
## Digital Pure Sine Wave Uninterruptible Power Supply (UPS) Reference Design



This reference design is based on the dsPIC33F “GS” series of digital power DSCs. This reference design demonstrates how digital power techniques when applied to UPS

applications enable easy modifications through software, the use of smaller magnetics, intelligent battery charging, higher efficiency, compact designs, reduction in audible and electrical noise via a purer sine-wave output, USB communication and low-cost overall bill-of-materials.

## Digital LED Lighting Development Kit



This LED lighting development kit enables designers to quickly leverage the capabilities and performance of the dsPIC33 ‘GS’ DSCs and this reference design to create a 100% digitally controlled ballast function, while including

advanced features such as dimming and color hue control. The dsPIC33 ‘GS’ devices can support an entire system implementation for LED lighting products, including power-conversion circuits, such as AC-to-DC and DC-to-DC conversion, along with functions such as Power Factor Correction (PFC), which are necessary for a complete product and lower overall system cost.

## Grid Connected Solar Micro Inverter Reference Design



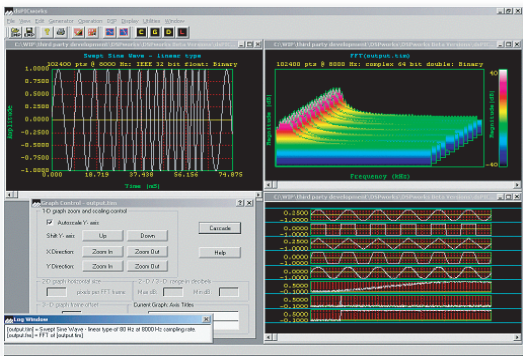
This reference design demonstrates the flexibility and power of SMPS DSCs in grid connected power conversion systems. This reference design works with any PV panel of maximum of 250W

having open circuit voltage between 20V to 52V DC. This reference design will ensure maximum power tracking for PV panel voltage between 25V to 45V DC. Two versions of this reference design are available to support 120V and 230V grid.

Additional information for all reference designs is available at [www.microchip.com/power](http://www.microchip.com/power).

# Develop DSP Algorithms and Debug Application Software: The Easy Way

## dsPICworks™ Data Analysis and DSP Software

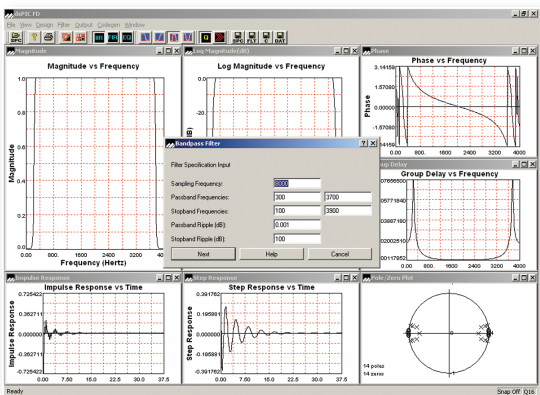


The dsPICworks Data Analysis and DSP Software makes it easy to evaluate and analyze DSP algorithms. You can run a variety of DSP and arithmetic operations and analyze your data in both time and frequency domain.

Key features of the dsPICworks Data Analysis and DSP Software:

- Visually analyze time and frequency domain data
- DSP operations: FFT, convolution, correlation, DCT and filtering
- Waveform synthesis
- Tool generates one-, two- and three-dimensional frequency graphs
- Data import/export options to interface with MPLAB IDE and MPLAB ASM30
- Support for fractional, integer and IEEE floating point data in decimal and hexadecimal notation

## Digital Filter Design Tool



The Digital Filter Design Tool makes designing and analyzing FIR and IIR filters easy. Enter frequency specifications and filter code and coefficients are generated automatically. Graphical output windows provide the desired filter's characteristics.

## Digital Filter Design Lite Tool

Not ready to purchase the whole Digital Filter package? Why not start Lite? The Digital Filter Design Lite Tool includes most of the features of the full-featured version at a fraction of the cost.

	Filter Design	Filter Design Lite
List Price	\$249	\$29
Low-pass	✓	✓
High-pass	✓	✓
Band-pass	✓	✓
Band-stop	✓	✓
FIR Taps	Up to 513	Up to 64
IIR Taps for LP, HP	Up to 10	Up to 4
IIR Taps for BP, BS	Up to 20	Up to 8
Generate ASM Code	✓	✓
Export MPLAB® IDE	✓	✓
Export to MPLAB C Compilers	✓	✓
32-bit IIR Filter	✓	✓

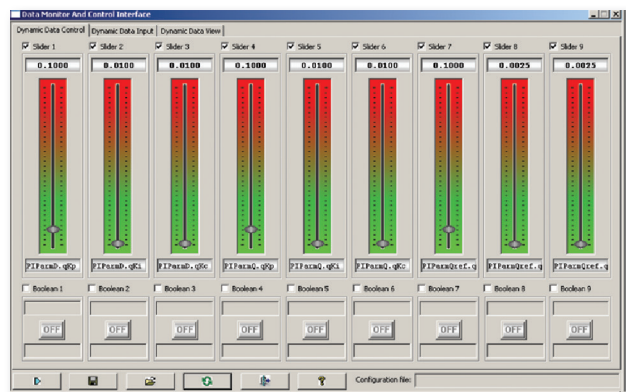
## Data Monitor & Control Interface: A Free MPLAB IDE Plug-in

The Data Monitor and Control Interface (DMCI) provides dynamic access and control of software variables. It is useful for tuning application parameters and viewing run-time application data graphically. Software parameter changes are updated during run-time. Feature highlights include:

- MPLAB project aware: The current device and software variables are recognized automatically by DMCI
- Compiler independent
- Debug tool independent
- Provides effortless graphical analysis of application historical data

## Real-Time Data Monitor (RTDM)

The Real-Time Data Monitor saves development and testing time for embedded control applications. RTDM allows users to make a change to a software parameter and see the effect immediately without stopping the application execution. A serial USB or UART cable supports bi-directional data transfers between the host PC and the MCU/DSC.





# Libraries for Speech and Audio Applications

## Speech Encoding/Decoding Libraries

Three options exist for a variety of speech compression/encoding and decompression/decoding applications:

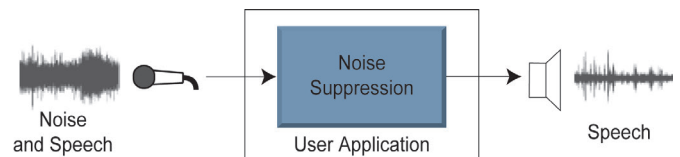
- FREE** ■ The library is an implementation of the ITU-T G.711 standard which uses A-law or  $\mu$ -law companding to achieve 2:1 compression.
- FREE** ■ G.726A is an implementation of the ITU-T G.726 Annex A standard which uses Adaptive Differential Pulse Code Modulation (ADPCM) encoding algorithm. It can achieve up to an 8:1 compression ratio depending on output bit rate selected.
- FREE** ■ Speex is a popular standard in the open source software community which has been adapted for the dsPIC DSC. It uses Code Excited Linear Prediction (CELP) algorithm. It can achieve a 26:1 compression ratio.

Vocoder	Incoming Data Rate (16-bit)	Output Rate	Speech Quality (MOS)	MIPS <sup>(1)</sup>	Flash (KB)	RAM (RB)	Target
G.711	8 kHz	64 kbps	4.3–4.5	1	3	3.6	PIC12/dsPIC® DSC
G.726A	8 kHz	16–40 kbps	4.3–4.5	15	6	4	dsPIC DSC
Speex	8/16 kHz	8–12.8 kbps	3.7–4.2	20/24	24/38	7.6/12	dsPIC DSC

Note 1: Includes both encoder and decoder processing in full duplex.

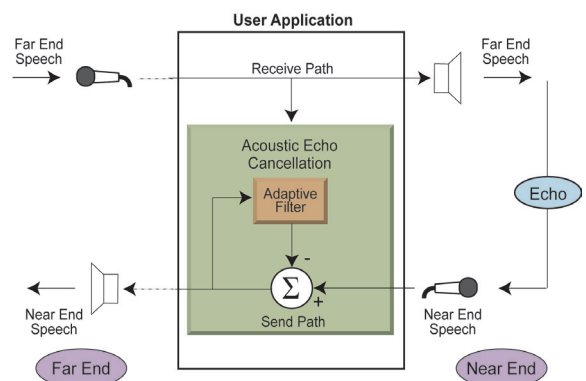
## **FREE** Noise Suppression Library

This application library suppresses the noise interference in a speech signal, such as ambient noise picked up by a microphone while capturing speech. This algorithm is particularly useful for systems such as hands-free phones, speakerphones, intercoms and headsets where an isolated noise reference is not available. The algorithm handles 0–4 kHz audio bandwidth and provides adjustable noise reduction up to 44 dB.



## **FREE** Acoustic Echo Cancellation Library

This library provides a function to eliminate the echo generated in the acoustic path between a speaker and a microphone, such as in a speakerphone or an intercom system. This library is compatible with the G.167 standard and provides 16, 32, 64 or 128 ms echo delays. It handles 0–4 kHz audio bandwidth and provides echo cancellation of 40–50 dB. It also includes some sample rate conversion functions.



## **FREE** Line Echo Cancellation Library

This library provides a function to cancel electrical line echoes caused by 2- to 4-wire conversion hybrids in telephone lines. The library can be used in long distance voice communication applications, especially in links involving satellite networks and intercontinental long haul networks, as well as digital networks, such as Voice over IP (VoIP). This library is compatible with the ITU-T G.168 recommendation. The library can be used for full-duplex operation. It handles 0–4 kHz audio bandwidth (8 kHz sampling of 16-bit speech data).

## **FREE** Equalizer Library

The Equalizer library allows applications to change the tonal properties of a signal by offering an 8-band frequency band amplitude control. The library processes an 8 kHz sampled signal. The library works readily with the rest of Microchip's dsPIC DSC Speech and Audio Processing Algorithms.

## **FREE** dsPIC DSC Automatic Gain Control Library

The dsPIC DSC Automatic Gain Control Library automatically adjusts the amplitude of a speech signal to match a set level. This is useful in speech applications where the distance between the speech source and the microphone is not fixed. The Automatic Gain Control Library can be used readily with Microchip's Speech and Audio Solutions for speech signal pre-processing.

## **FREE** Speech and Audio Fast Forward (SAFF)

The dsPIC DSC Speech and Audio Fast Forward tool provides user's with real-time control of Microchip's Speech and Audio Processing Algorithms as they are running in an embedded system application. This PC GUI tool facilitates code generation and easy tuning of Microchip's Noise Suppression, Acoustic Echo Cancellation, Line Echo Cancellation and Equalizer algorithms in speech and audio applications by simplifying parametric tuning of algorithms.

# Connectivity and Embedded Control Libraries

## **USB On-The-Go Library**

Microchip's USB support consist of a series of application notes with software that demonstrate and support the development of embedded host, peripheral and On-The-Go functions. Specific driver classes include Human Interface Device (HID) class for user interfaces, and Mass Storage Device (MSD) class for memory devices and a Microchip custom device class driver. USB application demos include thumb drive bootloader, mass storage, USB charger and a printer host. PIC18, PIC24F, PIC24E, dsPIC33E and PIC32 MCUs are supported by Microchip's USB Framework. All USB application notes are available free of charge at [www.microchip.com/usb](http://www.microchip.com/usb).

## **Microchip's Free TCP/IP Stack Software (ENC28J60 and ENC624J600 Driver)**

The Microchip TCP/IP Stack is a free suite of programs that provide services for standard TCP/IP-based applications (HTTP server, FTP server, etc.) or it can be used in a custom TCP/IP-based application. The stack is portable across all PIC18, PIC24 and dsPIC products. It contains support for MPLAB C18, HI-TECH PIC18 and MPLAB C Compiler for PIC24 MCUs and dsPIC DSCs.

## **ZigBee PRO Wireless Networking Protocol Stack**

ZigBee PRO is a wireless network protocol specifically designed for low data rate sensors and control Networks. There are a number of applications that can benefit from the ZigBee protocol including building automation networks, home security systems, industrial control networks, remote metering and PC peripherals. ZigBee may be the appropriate solution if your product must interact with other vendor's products on a wireless network. Microchip offers a ZigBee PRO Compliant Platform, ZigBee RF4CE compliant Platform, and ZigBee application profiles.

## **MiWi Wireless Networking Protocol Stacks**

The MiWi and MiWi P2P Wireless Networking Protocols are simple, easy to use protocols designed for low data rate, short distance, low-cost networks. These protocols operate on both the IEEE 802.15.4 and Sub-GHz RF transceivers for Wireless Personal Area Networks (WPANs). The MiWi protocols provide an easy to use alternative for wireless communication. In particular, the MiWi protocols target peer-to-peer, star, or mesh networks with few hops between nodes. The MiWi Protocol stacks are applicable with Microchip's MRF24J40 2.4 GHz Transceiver/modules for IEEE 802.15.4 compliant networks and Microchip's Sub-GHz transceivers.

## **IrDA Standard Stack for Microchip 16-bit MCUs**

The IrDA Standard is a highly popular, inexpensive method for providing wireless point-to-point communication. This free stack coupled with Microchip's 16-bit microcontrollers and DSCs, with their built-in IrDA standard support, provide an inexpensive wireless connection with plenty of computing power left for other tasks.

## **Embedded Control Libraries**

### **Encryption Libraries**

Implement reliable secure applications using the Symmetric and Asymmetric Key Embedded Encryption Libraries. These libraries are both proven and optimized. Library functions can be easily called by your C or assembly code. These libraries and the 256-bit key AES and Triple-DES Libraries are available for a production license fee of \$5.00 from microchipDIRECT.

### **File System for PIC18, PIC24, PIC32 MCUs and dsPIC DSCs**

Microchip's memory disk drive file system interface library brings the ability to transfer and share portable memory devices between an embedded system and a personal computer. Most SD cards, CF cards and MMCs MultiMedia Cards, particularly those sized below 2 gigabytes (GB), use the FAT16 standard. The FAT32 standard can be used to address memory sized between 2 GB and 2 terabytes (TB). This library with complimentary application note (AN1045) provides a method to read and/or write to these storage devices through a microcontroller. The data of these storage devices can be read by a PC, and the data written by a PC can be read by a microcontroller. Most operating systems (i.e., Windows® XP) support the FAT16 and FAT32 file systems.

### **Graphics Library for PIC24 & PIC32 MCUs and dsPIC DSCs**

The Microchip Graphics Library is highly modular and is optimized for Microchip's 16- and 32-bit microcontrollers. The software package includes: full source code, schematics, drivers, documentation and utilities. Graphics Library supports:

- Up to 800x480 (WVGA) resolution
- Up to 16-bit or 65K colors
- 2D and 3D Objects
- Image and Animation
- Resistive touch screen and keypad
- Foreign fonts

### **mTouch Sensing Technology Source Code and Demos**

Microchip's mTouch Sensing solutions provide a free and easy method for designers to add capacitive touch sensing to applications utilizing PIC microcontrollers without the cost of fee-based licensing and royalty agreements. Being a source-code solution further helps engineers quickly integrate touch sensing functionality with their existing application code in a single, standard microcontroller, thus reducing the total system cost associated with current designs.



# Methods and Modules Ready to Use

---

## Methods

### Emulating Data EEPROM for PIC18 and PIC24 MCUs, dsPIC DSCs and PIC32

For devices that do not have on-chip EEPROM, emulating EEPROM with on-chip Flash memory may be an important option. This application note presents an interface similar to an internal data EEPROM, but uses available on-chip Flash memory to improve endurance by a factor as high as 500. (Application Note: AN1095)

### Achieving Higher ADC Resolution Using Oversampling

This application note describes oversampling as a method to add additional bits of accuracy to the 12-bit ADC conversion in a dsPIC DSC. (Application Note: AN1152)

### Bootloader for PIC24 MCUs and dsPIC DSCs

This application note describes a UART-based bootloader for all 16-bit MCU and DSC families. (Application Note: AN1094)

### A Serial Bootloader for PIC24F Devices

This application note describes a UART-based bootloader and includes Microchip's PIC24F Quick Programmer (P24QP) Windows-based graphical programming interface. (Application Note: AN1157)

### Implementing Digital Lock-In Amplifiers Using the dsPIC DSC

Conventionally, lock-in amplifiers use complicated (and expensive) analog circuitry to perform the phase sensitive detection and filtering. However, modern Digital Signal Controllers (DSCs), such as the dsPIC30F and dsPIC33F families, can be used to remove large amounts of the analog circuitry by performing the necessary operations in software. This capability provides a number of additional benefits including increased reliability, resistance to temperature and aging effects, and the ease with which the system can be modified in the field. (Application Note: AN1115)

## Low Power Design Guide

This document seeks to simplify the transition to low-power applications by providing a single location for the foundations of low-power design for embedded systems. The examples discussed in this document will focus on power consumption from the viewpoint of the microcontroller (MCU). (Application Note: AN1416)

## Modules

### Cyclic Redundancy Code (CRC) Module

CRC is one of the most versatile error checking algorithm used in various digital communication systems. This application note illustrates how to use the hardware CRC module on selected 16-bit MCUs and DSCs. Users can program any user-defined generator polynomial into this module for CRC computation. (Application Note: AN1148)

### MATLAB Device Blocks for MPLAB IDE

The Microchip Device Blocksets for MATLAB Simulink provide a set of interface-compliant configuration and run-time peripheral blocks for the dsPIC30 and dsPIC33 DSCs.

Complete applications can be created in the form of a MATLAB/SIMULINK model using blocksets provided by Microchip and Simulink. C code for the application will be generated. These blocksets are compatible with the MATLAB plug-in available in MPLAB IDE. Also provided are many examples in the form of demo models, including a complete BLDC motor control application.

# Power Conversion and Motor Control Application Software

Application Type	Application Solution	AN Number	Description
Brushless DC Motor Control	Sensored BLDC Motor Control	AN957	This application note describes a fully-tested 3-phase BLDC motor control algorithm with 3 Hall-effect sensors.
	Sensorless BLDC Motor Control Using the dsPIC30F of dsPIC33F	AN901	This application note describes how to provide sensorless BLDC motor control with the dsPIC® DSC device.
	Sensorless BLDC Control with Back-EMF Filtering Using a Majority Function	AN1160	This application note describes a sensorless Brushless Direct Current (BLDC) motor control algorithm, implemented using the dsPIC Digital Signal Controller (DSC). The algorithm works by the use of a majority function for digitally filtering the Back-Electromotive Force (BEMF). Each phase of the motor is filtered to determine when to commutate the motor drive voltages.
AC Induction Motor Control	Vector Control of an ACIM Using Optical Encoder	AN908	This application note describes a fully-tested vector, or field oriented, control algorithm for a 3-phase ACIM. The motor currents, torque and velocity are regulated in control loops.
	Introduction to ACIM Control	AN984	This application note describes volts per hertz control of an AC Induction Motor.
	Sensorless Field Oriented Control (FOC) of an AC Induction Motor (ACIM)	AN1162	This application note presents a solution for sensorless Field Oriented Control (FOC) of induction motors using a dsPIC Digital Signal Controller (DSC). The benefits of field oriented control can be directly realized as lower energy consumption, higher efficiency, lower operating costs and reduced cost of drive components.
	Sensorless Field Oriented Control (FOC) of an AC Induction Motor (ACIM) Using Field Weakening	AN1206	This application note presents one solution for sensorless Field Oriented Control (FOC) with Field Weakening (FW) of induction motors using a dsPIC Digital Signal Controller (DSC).
Permanent Magnet Synchronous Motor Control	Sinusoidal PMSM Motor Control	AN1017	This application note provides a fully working and highly flexible solution for using the dsPIC DSC to control a permanent magnet synchronous motor using three hall sensors with sinusoidal voltages.
	Sensorless Field-Oriented Control for PMSM Motors with Field Weakening Using Slide Mode Controller	AN1078	This application note describes how to apply a dsPIC DSC to control a permanent magnet synchronous motor using the field oriented control algorithm. Shunt resistors are used to estimate rotor position.
	Sensorless Field Oriented Control (FOC) of an AC Induction Motor (ACIM) Using Field Weakening	AN1206	This application note presents one solution for sensorless Field Oriented Control (FOC) with Field Weakening (FW) of induction motors using a dsPIC Digital Signal Controller (DSC).
	Sensorless Field Oriented Control (FOC) for a Permanent Magnet Synchronous Motor (PMSM) Using a PLL Estimator and Field Weakening (FW)	AN1292	This application note describes the sensorless FOC algorithm for PMSM motor using a Phase Locked Loop (PLL) position and speed estimators.
	Integrated Power Factor Correction (PFC) and Sensorless Field Oriented Control (FOC) System	AN1208	This application note describes the process of integrating two complex applications: PFC and Sensorless FOC. These applications are implemented on a Permanent Magnet Synchronous Motor (PMSM). In addition, this application note also describes the integration of the algorithms, lists the necessary hardware requirements, and provides the guidelines to optimize the development procedure.
Stepper Motor Control	Single-Shunt Three-Phase Current Reconstruction Algorithm for Sensorless FOC of a PMSM	AN1299	This dsPIC33F application note describes a motor control technique where a single-shunt resistor circuit is used to measure the motor phase current.
SMPS/Digital Power	Stepper Motor Control with dsPIC DSCs	AN1307	This application note describes how to drive a stepper motor with a dsPIC33F motor control family DSC.
	Switch Mode Power Supply (SMPS) Topologies (Part I)	AN1114	This application note explains the basics of different types of SMPS topologies and their applications. The pros and cons of different SMPS topologies are also explained to guide the user to select an appropriate topology for a given application, while providing useful information regarding selection of components for a given SMPS design.
	Switch Mode Power Supply (SMPS) Topologies (Part II)	AN1207	This application note is the second of a two-part series on Switch Mode Power Supply (SMPS) topologies. This series expands on the previous material in Part I, and presents the basic tools needed to design a power converter.
	Offline UPS Reference Design	AN1279	The application note describes the design of an Offline Uninterruptible Power Supply (UPS) using a Switch Mode Power Supply (SMPS) dsPIC Digital Signal Controller (DSC).
	Digital Power Interleaved PFC Reference Design	AN1278	The application note describes the design of a Digital Power Interleaved PFC (IPFC) using a Switch Mode Power Supply (SMPS) dsPIC Digital Signal Controller (DSC).
	Quarter Brick DC-DC Reference Design	AN1335	This application note describes the design of Quarter Brick DC-DC Reference Design using Switch Mode Power Supply (SMPS) dsPIC Digital Signal Controller(DSC)
	DC-DC LLC Resonant Converter Reference Design	AN1336	This application note describes the design of DC-DC LLC Resonant Converter Reference Design using Switch Mode Power Supply (SMPS) dsPIC Digital Signal Controller(DSC)
	Grid Connected Solar Microinverter	AN1338	This application note describes the design of Grid Connected Solar Microinverter Reference Design using Switch Mode Power Supply (SMPS) dsPIC Digital Signal Controller(DSC)
Class B Software	Class B Safety Software Library for PIC MCUs and dsPIC DSCs	AN1229	This application note describes the Class B Safety Software Library routines that detect the occurrence of Faults in a single channel CPU. These routines have been developed in accordance with the IEC 60730 standard to support the Class B certification process.

## Motor Control Tuning Guides

Tuning guides describe the procedure and setup necessary for tuning the Motor control algorithms; they simplify motor control design and optimize solutions.

Description	Tuning Guide
Sensorless Dual-Shunt FOC with SMO estimator BLDC/PMSM	AN1078 Tuning Guide
Sensorless Dual-Shunt FOC with PLL estimator BLDC/PMSM	AN1292 Tuning Guide
Sensorless Single-Shunt FOC with SMO estimator BLDC/PMSM	AN1299 Tuning Guide
Sensorless BLDC Control with Back-EMF Filtering Using a Majority Function	AN1160 Tuning Guide
Stepper Motor Control	AN1307 Tuning Guide

# Resources for Self-paced Learning

## Web Seminars

Microchip offers extensive online resources for designers ranging from downloadable documentation to web seminars (webinars) to online discussion groups. All of these helpful resources are accessible at [www.microchip.com/webseminars](http://www.microchip.com/webseminars) and are updated frequently with the most current information on our products and services.

For more information about additional self-paced learning resources, please visit [www.microchip.com/training](http://www.microchip.com/training).

Application Data	Webinar Topic
Motor Control	Sensorless Field Oriented Control for ACIM Sensorless Field Oriented Control for PMSM Sensorless BLDC Motor Control Using a Majority Function Brushed DC Motor Basics Stepper Motor Control
Speech & Audio	dsPIC® DSC Speech and Audio Solutions A Look at the dsPIC Audio and Speech Starter Kit Audio DAC Peripheral on DSC Devices
Graphics & Display	Graphics LCD System and PIC24 Interface Microchip Graphics QVGA Display Solution Microchip Graphics Library Architecture
Connectivity	TCP/IP Networking CAN Design Considerations Using the IrDA® Standard Protocol
Power Management	Building a dsPIC SMPS System SMPS Components and Their Affects on System Design Control System Design for Power Converters SMPS Topologies, The Buck Converter Switch Mode Power Supply Topologies, the Forward Converter Deep Sleep Mode on Microchip PIC18 and PIC24 Microcontrollers
Capacitive Touch Sense	Introduction to mTouch™ Capacitive Touch Sensing Capacitive mTouch Sensing Solutions: Design Guidelines Overview of Charge Time Measurement Unit (CTMU)
Chip Functionality	Introduction to the PIC24F MCU Introduction to the dsPIC DSC dsPIC DSC Peripherals PIC24F Peripherals Power Management Modes dsPIC DSC Architecture, Addressing Modes, DSP Engine CodeGuard™ Security Overview of Charge Time Measurement Unit Peripheral Pin Select Deep Sleep Mode on Microchip PIC18 and PIC24 Microcontrollers
Tools	dsPIC Development Tools Overview Tutorial on the MPLAB® Starter Kit for PIC24H MCUs Introduction to Microchip SIMULINK Blocksets MATLAB Plug-in for MPLAB IDE
USB	USB On-The-Go Introduction
Sensors	Hardware Conditioning of Sensor Signals

## Microchip Technical Training Centers

With a worldwide network of Technical Training Engineers and certified third-party providers, Microchip makes it easy to enhance your technical skills, in a location that fits your needs: live instruction in our training centers, in virtual classrooms on the internet or at your facility.

Visit the Microchip web site at [www.microchip.com/training](http://www.microchip.com/training) for classes and schedules.



# Development Tools

## Software Development Tools and Operating Systems

Development Tool	Product Name	Description	Part Number	List Price <sup>(1)</sup>	Devices Supported			
					PIC24F	PIC24H/E	dsPIC30F	dsPIC33F/E
Integrated Development Environment	MPLAB® IDE*	Integrated Development Environment	SW007002	Free	✓	✓	✓	✓
	Green Hills Multi	Integrated Development Environment	–	Contact GHS	✓	✓	✓	✓
C Compilers	MPLAB C Compiler for PIC24 MCUs and dsPIC® DSCs	ANSI C compiler, assembler, linker and librarian	SW006012	\$895	✓	✓	✓	✓
	MPLAB C Compiler for PIC24 MCUs	ANSI C compiler, assembler, linker and librarian	SW006014	\$495	✓	✓	–	–
	MPLAB C Compiler for dsPIC DSCs	ANSI C compiler, assembler, linker and librarian	SW006013	\$495	–	–	✓	✓
	Embedded Workbench for dsPIC30F	ISO/ANSI C and Embedded C++ compiler in a professional, extensible IDE, (Windows® NT/2000/Windows XP®) special DSP support included	EWdsPIC 1	Contact IAR	✓	✓	✓	✓
	CCS PCD C-Compiler for PIC24 MCUs and dsPIC DSCs	Command-line C Compiler for Microchip PIC24 MCU and dsPIC DSC families, integrates with MPLAB IDE	SW500021	\$250	✓	✓	✓	✓
Operating Systems	AVIX-RT AVIX	AVIX is an RTOS specifically developed for Microchip's PIC24 MCUs and dsPIC DSCs	–	Contact AVIX	✓	✓	✓	✓
	CMX-Tiny+™ for dsPIC DSCs	Preemptive Real-time Operating System (RTOS) for dsPIC30F	SW300032	\$3000	✓	✓	✓	✓
	CMX-RTX™ for dsPIC DSCs	Fully preemptive Real-time Operating System (RTOS) for dsPIC30F	SW300031	\$4000	✓	✓	✓	✓
	CMX Scheduler™	Multi-tasking, preemptive scheduler for dsPIC30F	–	Free	✓	✓	✓	✓
	Express Logic ThreadX MCU	ThreadX MCU Edition RTOS is a fully preemptive, deterministic, real-time operating system designed for Microchip's PIC24 MCUs.	SW500130	\$5990	✓	✓	–	–
			SW500131	\$5990	–	–	✓	✓
	FreeRTOS.org™	Portable, open source, mini real time kernel	–	Contact freeRTOS.org™	✓	✓	✓	✓
	Lassar Systems AVA	A unique and powerful RTOS designed exclusively for Microchip's PIC24 MCUs and dsPIC DSCs	–	Contact Lassar Systems	✓	✓	✓	✓
	Micrium µC/OS-II	Portable, scalable, preemptive real-time, multitasking kernel	–	Contact Micrium	✓	✓	✓	✓
	osCAN for dsPIC DSC	OSEK/VDX v2.2	–	Contact Vector	–	✓	✓	✓
	Pumpkin's Salvo RTOS	Salvo RTOS is a full-featured multitasking priority-based event-driven RTOS for all Microchip microcontrollers	–	Contact Pumpkin	✓	✓	✓	✓
	RoweBots DSPnano	DSPnano POSIX RTOS is a tiny, fully preemptive, deterministic, real-time operating system designed for Microchip's PIC24 MCUs and dsPIC30/33 processors	–	Contact RoweBots	✓	✓	✓	✓
SEGGER embOS	Real-time operating system for embedded applications	–	Contact SEGGER	✓	✓	✓	✓	
DSP	dsPICworks™	Data analysis and DSP software	SW300023	Free	✓	✓	✓	✓
	Digital Filter Design	Full featured graphical IIR and FIR filter design package for dsPIC30F	SW300001	\$249	–	–	✓	✓
	Digital Filter Design Lite	Graphical IIR and FIR filter design package for dsPIC30F	SW300001-LT	\$29	–	–	✓	✓

Note 1: List price may change without notice.

\*Includes MPLAB ASM30, MPLAB SIM, MPLAB VDI

## Hardware Development Tools

Development Tool	Description	Part Number	List Price <sup>(1)</sup>	Devices Supported			
				PIC24F	PIC24H	dsPIC30F	dsPIC33F
MPLAB® ICD 3	In-Circuit Debugger/Programmer	DV164035	\$219.99	✓	✓	✓	✓
MPLAB REAL ICE™ In-Circuit Emulator	In-Circuit Emulator System	DV244005	\$499.98	✓	✓	✓	✓
	Performance Pak	AC244002	\$159.98	✓	✓	✓	✓
MPLAB PM3	Full Featured Device Programmer, Base Unit	DV007004	\$895	✓	✓	✓	✓
Third Party Programmers	BP Microsystems	–	–	✓	✓	✓	✓
	Data I/O	–	–	✓	✓	✓	✓

Note 1: List price may change without notice.

# Development Tools

## Development Boards and Reference Designs

Development Tool	Description	Part Number	List Price <sup>(1)</sup>	Devices Supported			
				PIC24F	PIC24H/E	dsPIC30F	dsPIC33F/E
Development Tool Starter Kits (Includes Debug Capability)	MPLAB® ICD 3 with Explorer 16 Kit	DV164037	\$299.99	✓	✓	-	✓
	MPLAB Starter Kit for dsPIC® DSCs	DM330001	\$59.98	-	-	-	✓
	MPLAB Starter Kit for PIC24H MCUs	DM240021	\$59.98	-	✓	-	-
	MPLAB Starter Kit for PIC24F MCUs	DM240011	\$59.98	✓	-	-	-
	PIC24E USB Starter Kit	DM240012	\$65.00	-	✓	-	-
	dsPIC33E USB Starter Kit	DM330012	\$65.00	-	-	-	✓
Starter Development Boards	Explorer 16 Development Board	DM240001	\$129.99	✓	✓	-	✓
	dsPICDEM™ 80-pin Starter Development Board	DM300019	\$79.99	-	-	✓	✓
General Purpose Development Boards	dsPICDEM 1.1 Plus General Purpose Development Board	DM300024	\$299.99	-	-	✓	✓
	Microstick for dsPIC33F and PIC24H Development Board	DM330013	\$24.99	-	✓	-	✓
	Microstick II Development Board	DM330013-2	\$34.95	✓	✓	✓	✓
	Microstick for 3V PIC24 K-series Development Board	DM240013-1*	\$34.95	✓	-	-	-
	nanoWatt XLP 16-bit Development Board	DM240311	\$59.99	✓	-	-	-
	Audio Development Board for dsPIC33E	DM330016	149.99	-	-	-	✓
Motor Control Development Boards	Motor Control Starter Kit with mTouch™ Sensing	DM330015	\$89.99	-	-	-	✓
	PICDEM MC LV Development Board	DM183021	\$129.99	-	-	✓	-
	dsPICDEM MCLV-2 Development Board	DM330021	\$199	-	-	-	✓
	dsPICDEM MCHV-2 Development Board	DM330023	\$699	-	-	-	✓
	dsPICDEM MCSM Development Board	DM330022	129.99	-	-	-	✓
	dsPICDEM MCSM Development Kit	DV330021	269.99	-	-	-	✓
	dsPIC33E Dual Motor Control Plug-In Module (PIM)	MA330027	175.00	-	-	-	✓
	dsPICDEM MC1 Motor Control Development Board	DM300020	\$300	-	-	✓	-
	dsPICDEM MC1H 3-Phase High Voltage Power Module	DM300021	\$800	-	-	✓	✓
	3-Phase ACIM High Voltage Motor (208/460V)	AC300021	\$120	-	-	✓	✓
	dsPICDEM MC1L 3-Phase Low Voltage Power Module	DM300022	\$700	-	-	✓	✓
3-Phase BLDC Low Voltage Motor (24V)	AC300020	\$120	-	-	✓	✓	
Graphics Development Boards	PIC24FJ256DA210 Development Kit	DV164039	\$399.99	✓	-	-	-
	PIC24FJ256GA210 Development Board	DM240312	\$89.99	✓	-	-	-
	3.2" Graphics Display Truly 240x320 Board	AC164127-4	\$99.99	✓	✓	-	✓
	WQVGA 4.3" Graphics Display Powertip 480x272 Board	AC164127-6	\$115.00	✓	✓	-	-
	VGA 5.7" Graphics Display Truly 640x480 Board	AC164127-8	\$269.99	✓	✓	-	-
	WVGA 7" Graphics Display Truly 800x480 Board	AC164127-9	\$269.99	✓	✓	-	-
	PIC32 Low Cost Controllerless Graphics Board	AC164144	\$89.99	✓	✓	-	-
	Solomon Systech Graphics Board	AC164127-5	\$69.99	✓	✓	-	-
Epson Graphics Board	AC164127-7	\$119.99	✓	✓	-	-	
LCD Display	LCD Explorer Development Board	DM240314	\$125.00	✓	-	-	-
SMPS Development Board	Buck/Boost Converter PICtail™ Card	AC164133	\$89.99	-	-	-	✓
	LED Lighting Development Kit	DM330014	\$249.00	-	-	-	✓
Capacitive Touch Sense Development Boards	PICDEM Touch Sense 2 Development Kit	DM164128	\$99.99	✓	-	-	-
	Enhanced mTouch Capacitive Evaluation Kit	DM183026-2	\$99.95	✓	-	-	-
	PIC24H mTouch Capacitive Touch Evaluation Board	AC243026	\$24.95	-	✓	-	-

Note 1: List price may change without notice.

\*For use with 3V PIC24 K-series devices



# Development Tools

## Plug-in Modules Supporting Explorer 16 Development and Other Development Boards

A Plug-in Module (PIM) is a daughter board with a PIC MCU or dsPIC DSC soldered on top and header socket strips on the bottom. This method allows for easy swapping of devices onto the various development boards, without having to unsolder and resolder parts. For a complete listing of available PIMs please go to [www.microchip.com/explorer16](http://www.microchip.com/explorer16).

## Software Application Libraries

Application	Application Library	List Price <sup>(1)</sup>	Devices Supported						Part Number
			PIC24F	PIC24H	PIC24E	dsPIC30F	dsPIC33F	dsPIC33E	
Speech, Audio and Communication	dsPIC® DSC Noise Suppression Library	Free	–	–	–	✓	✓	✓	–
	dsPIC DSC Acoustic Echo Cancellation Library	Free	–	–	–	✓	✓	✓	–
	dsPIC DSC Line Echo Cancellation Library	Free	–	–	–	✓	✓	✓	–
	dsPIC DSC Equalizer Library	Free	–	–	–	✓	✓	✓	–
	dsPIC DSC Automatic Gain Control Library	Free	–	–	–	✓	✓	✓	–
	PIC24/dsPIC DSC G.711 Speech Encoding/Decoding Library	Free	✓	✓	✓	✓	✓	✓	–
	dsPIC DSC G.726A Speech Encoding/Decoding Library	Free	–	–	–	✓	✓	✓	–
	dsPIC DSC Speex Speech Encoding/Decoding Library	Free	–	–	–	✓	✓	✓	–
	DTMF Library	–	–	–	–	✓	–	–	
Encryption and Security	dsPIC DSC Symmetric Key Embedded Encryption Library	\$5	–	–	–	✓	✓	✓	SW300050
	dsPIC DSC Asymmetric Key Embedded Encryption Library	\$5	–	–	–	✓	✓	✓	SW300055
	Triple DES/AES Encryption Libraries	\$5	✓	✓	✓	✓	✓	✓	SW300052
DSP and Math	dsPIC DSC DSP Library	Free	–	–	–	✓	✓	✓	Included in MPLAB® C Compiler
	PIC24/dsPIC DSC Math Library	Free	✓	✓	✓	✓	✓	✓	Included in MPLAB C Compiler
	PIC24/dsPIC DSC Fixed Point Math Library	Free	✓	✓	✓	✓	✓	✓	Included in MPLAB C Compiler
Peripherals	PIC24/dsPIC DSC Peripheral Library	Free	✓	✓	✓	✓	✓	✓	SW300021
Graphics	Microchip Graphics Library	Free	✓	✓	✓	–	✓	✓	–
	Graphics Display Designer	Free	✓	✓	✓	✓	✓	✓	–
mTouch™ Capacitive Touch	Capacitive Touch Library	Free	✓	–	✓	–	–	✓	–
Wired and Wireless Connectivity	Microchip TCP/IP Stack Software (ENC28J60/ENC628J600 Driver)	Free	✓	✓	✓	–	✓	✓	SW300024
	Microchip USB Framework	Free	✓	–	✓	–	–	✓	–
	IEEE 802.15.4: MiWi™ and MiWi P2P	Free	✓	✓	P	–	✓	P	–
	IEEE 802.15.4: ZigBee®, ZigBee PRO, ZigBee Smart Energy Profile Suite	Free	✓	✓	P	–	✓	P	–
	IrDA® Stack	Free	✓	✓	✓	–	✓	✓	–
	Bluetooth®	–	–	–	P	–	✓	P	SW500151
File System and Memory	Microchip FAT File System for PIC24 & PIC32 MCUs and dsPIC DSCs	Free	✓	✓	✓	–	✓	✓	SW300027
	Data EEPROM Emulation for PIC18, PIC24 & PIC32 MCUs and dsPIC DSCs	Free	✓	✓	✓	–	✓	✓	–
	SD/MMC	Free	✓	–	✓	–	✓	✓	–
Other	PMBus Stack	Free	–	–	–	–	✓	–	–
	Class B Safety Software Library for PIC® MCUs and dsPIC DSCs	Free	–	–	✓	–	✓	✓	–

Note 1: List price may change without notice  
 \*Software library license up to 5K unites  
 P = Planned to be compatible in the future

# Other Information

## Third Party Contact Information

Company	Phone	E-mail	Website
CMX Systems, Inc.	+1 904 880 1840	cmx@cmx.com	www.cmx.com
FreeRTOS.org™	–	–	www.freertos.org
IAR	+46 18 16 78 00	info@iar.se	www.iar.se
Micrium	+1 954 217 2036	info@micrium.com	www.micrium.com
SEGGER	+49 2103 2878 0	info@segger.com	www.segger.com
Vector Informatik GmbH	+49 711 80670 0	info@vector-informatik.com	www.vector-informatik.com
VOCAL Technologies, LTD	+1 716 688 4675	sales@vocal.com	www.vocal.com
Embedded Code Source	–	–	www.embeddedcodesource.com

## Microchip Quick Web Links

Microchip Software Libraries	<a href="http://www.microchip.com/libraries">www.microchip.com/libraries</a>
Microchip Datasheet Finder Tool	<a href="http://www.microchip.com/datasheets">www.microchip.com/datasheets</a>
Microchip Application Notes	<a href="http://www.microchip.com/applicationnotes">www.microchip.com/applicationnotes</a>
Microchip Advanced Part Selector	<a href="http://www.microchip.com/maps">www.microchip.com/maps</a>
16-bit MCUs and DSCs Home Page	<a href="http://www.microchip.com/16bit">www.microchip.com/16bit</a>
Advanced Motor Control Solutions	<a href="http://www.microchip.com/motor">www.microchip.com/motor</a>
Digital Power Solutions	<a href="http://www.microchip.com/power">www.microchip.com/power</a>
Speech and Audio Solutions	<a href="http://www.microchip.com/speech">www.microchip.com/speech</a>
eXtreme Low Power Solutions	<a href="http://www.microchip.com/xlp">www.microchip.com/xlp</a>
Connectivity Solutions	<a href="http://www.microchip.com/connectivity">www.microchip.com/connectivity</a>

## 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](http://www.microchip.com):

- **Support** link provides a way to get questions answered fast: <http://support.microchip.com>
- **Sample** link offers evaluation samples of any Microchip device: <http://sample.microchip.com>
- **Forum** link provides access to knowledge base and peer help: <http://forum.microchip.com>
- **Buy** link provides locations of Microchip Sales Channel Partners: [www.microchip.com/sales](http://www.microchip.com/sales)

## 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

#### Indianapolis

Tel: 317-773-8323

#### 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

## Training

If additional training interests you, then Microchip can help. We continue to expand our technical training options, offering a growing list of courses and in-depth curriculum locally, as well as significant online resources – whenever you want to use them.

- Technical Training Centers: [www.microchip.com/training](http://www.microchip.com/training)
- MASTERS Conferences: [www.microchip.com/masters](http://www.microchip.com/masters)
- Worldwide Seminars: [www.microchip.com/seminars](http://www.microchip.com/seminars)
- eLearning: [www.microchip.com/webseminars](http://www.microchip.com/webseminars)
- Resources from our Distribution and Third Party Partners [www.microchip.com/training](http://www.microchip.com/training)

### ASIA/PACIFIC

#### Australia - Sydney

Tel: 61-2-9868-6733

#### China - Beijing

Tel: 86-10-8569-7000

#### China - Chengdu

Tel: 86-28-8665-5511

#### China - Chongqing

Tel: 86-23-8980-9588

#### China - Hangzhou

Tel: 86-571-2819-3187

#### 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: 91-80-3090-4444

#### India - New Delhi

Tel: 91-11-4160-8631

#### India - Pune

Tel: 91-20-2566-1512

#### Japan - Osaka

Tel: 81-6-6152-7160

#### 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: 886-3-5778-366

#### Taiwan - Kaohsiung

Tel: 886-7-213-7828

#### Taiwan - Taipei

Tel: 886-2-2508-8600

#### Thailand - Bangkok

Tel: 66-2-694-1351

10/30/12

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

Information subject to change. The Microchip name and logo, the Microchip logo, dsPIC, MPLAB and PIC are registered trademarks and PICDEM, PICtail and mTouch are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. © 2012 Energizer. Energizer and other marks are trademarks owned by Energizer. All other trademarks mentioned herein are property of their respective companies. © 2012, Microchip Technology Incorporated. All Rights Reserved. Printed in the U.S.A. 10/12 DS01032K



  
**MICROCHIP**  
[www.microchip.com](http://www.microchip.com)

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