# MICROCHIP

## Motor Control Design Solutions



16-bit dsPIC® Digital Signal Controllers

Analog

8-bit PIC® Microcontrollers
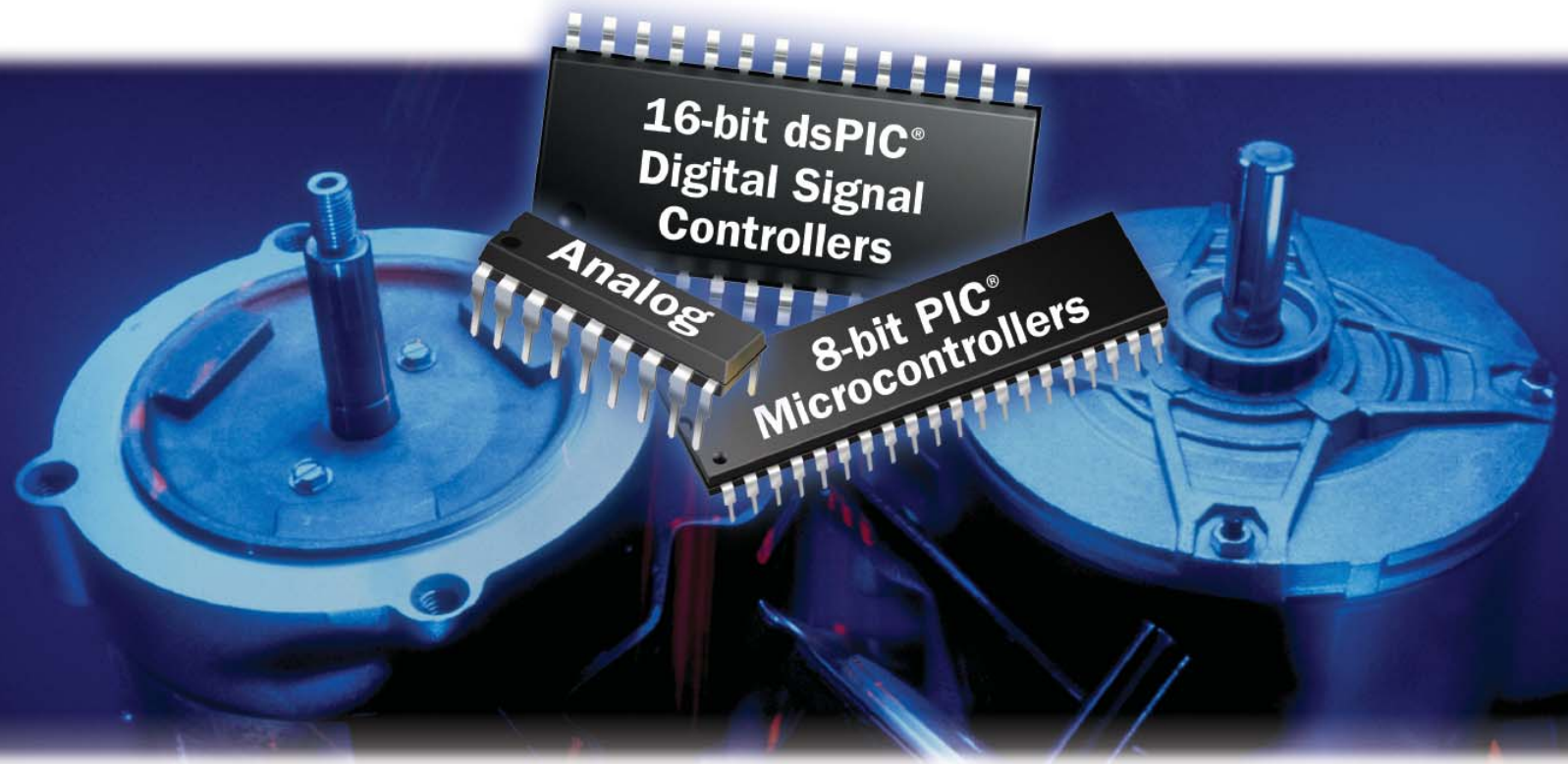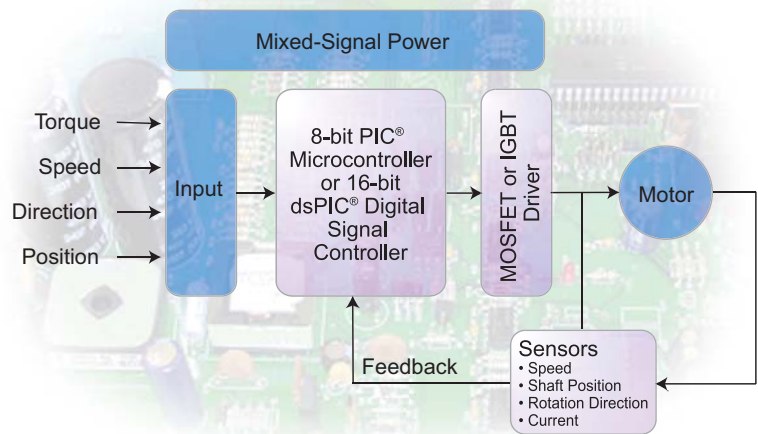
# Motor Control Design Solutions

Microchip Technology offers a broad product portfolio that provides a complete system solution for your stepper motor, brushed DC motor, AC induction motor, variable speed brushless DC motor and switched reluctance motor applications. With our sophisticated development systems and technical documentation, Microchip makes it easy for designers of all experience levels to complete a high-performance, electronic motor control design quickly and cost effectively. Only Microchip provides everything a motor control design engineer needs: low-risk product development, lower total system cost, faster time to market, outstanding technical support and dependable delivery and quality.



## Microchip's Recommended Solutions for Motor Control Designs*

| Motor Type | 8-bit PIC® Microcontrollers | 16-bit dsPIC® Digital Signal Controllers | MOSFET Drivers | Fan Managers | Analog Peripherals | Development Tools |
|---|---|---|---|---|---|---|
| Stepper | PIC16F684 PIC16F716 PIC16F7X7 | dsPIC30F5015 | TC141X TC442X TC446X | — | -MCP606, MCP616, MCP6021 Op Amps -TC913X Auto-Zeroed Op Amps -TC7652 Chopper Op Amp -TC74, TC1047A, TC6501 Temperature Sensors -TC102X, TC654X Voltage Comparators | -Motor Control Graphical User Interface -dsPICDEM™ Motor Control Development System |
| Brushed DC | PIC16F684 PIC16F716 | dsPIC30F2010 | TC141X TC442X | TC642 TC647B TC670 | -MCP606, MCP616, MCP6021 Op Amps -TC913X Auto-Zeroed Op Amps -TC7652 Chopper Op Amp -TC74, TC1047A, TC6501 Temperature Sensors -TC102X, TC654X Voltage Comparators | -Motor Control Graphical User Interface -TC642EV Fan Controller Evaluation Kit -dsPICDEM Motor Control Development System |
| AC Induction | PIC16F7X7 PIC18F1X30 PIC18FXX31 | dsPIC30F2010 dsPIC30F3011 dsPIC30F5015 dsPIC30F6010 | — | — | -MCP606, MCP616, MCP6021 Op Amps -TC913X Auto-Zeroed Op Amps -TC7652 Chopper Op Amp -TC74, TC1047A, TC6501 Temperature Sensors -TC102X, TC654X Voltage Comparators | -Motor Control Graphical User Interface -PICDEM™ MC Development Board -dsPICDEM Motor Control Development System |
| Variable Speed Brushless DC | PIC18F1X30 PIC18FXX31 | dsPIC30F2010 dsPIC30F3011 dsPIC30F5015 dsPIC30F6010 | TC141X TC442X | TC642 TC647B TC670 | -MCP606, MCP616, MCP6021 Op Amps -TC913X Auto-Zeroed Op Amps -TC7652 Chopper Op Amp -TC74, TC1047A, TC6501 Temperature Sensors -TC102X, TC654X Voltage Comparators | -Motor Control Graphical User Interface -PICDEM MC/PICDEM MC LV Development Boards -TC642EV Fan Controller Evaluation Kit -dsPICDEM Motor Control Development System |
| Switched Reluctance | PIC18F1X30 PIC18FXX31 | dsPIC30F2010 dsPIC30F3011 dsPIC30F5015 dsPIC30F6010 | TC141X TC442X | — | -MCP606, MCP616, MCP6021 Op Amps -TC913X Auto-Zeroed Op Amps -TC7652 Chopper Op Amp -TC74, TC1047A, TC6501 Temperature Sensors -TC102X, TC654X Voltage Comparators | -Motor Control Graphical User Interface -dsPICDEM Motor Control Development System |

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

## Advanced On-chip Peripherals

Microchip offers dedicated families of 8-bit PIC microcontrollers (MCUs) and 16-bit dsPIC digital signal controllers (DSCs) that provide on-chip peripherals to design high-performance, precision motor control systems that are more energy efficient, quieter in operation, have greater range and an extended life:

- High-speed 10-bit analog-to-digital converter (up to 1 Msps operation)
- High-endurance data EEPROM (up to 4 Kbytes)
- Specialized motor control PWM, up to eight channels and four duty cycle generators with flexible modes of operation
- Up to eight Enhanced Capture, Compare, PWM (ECCP) modules
- Quadrature Encoder (Interface or Input Captures)

## Mixed-Signal Power Devices

For advanced, high-voltage, power management technology, turn to an industry leader – International Rectifier (IR). IR's iMOTION™ product portfolio for motor control designs includes Insulated Gate Bipolar Transistors (IGBTs), high-voltage IC drivers, advanced power modules integrating IGBTs with 3-phase IC drivers and Switch Mode Power Supply controllers (SMPSs). The latest integrated inverter modules, in a sleek and compact single in-line package (IRAM family), make IR an excellent choice for the power stage in motor control. For more information, go to www.irf.com.

## Complete Technical Resources for Motor Control Design

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

- Design Flow Charts. Microchip has taken the difficulty out of the motor control design process with this online resource. Starting with the motor control type, users walk through all of the required steps and questions in order to create a high-performance motor control design.

- Applications by Motor Type. This online table captures numerous end applications and their typical motor types for the industrial, automotive, consumer and appliance market segments.

- Technical Documentation. Microchip offers a variety of motor control-related application notes (see partial list to the right), reference designs and other technical documentation to help speed design time. This technical library provides both theory and operation considerations for a variety of motor types.

## Application Notes

*Stepper Motor*

| | |
|---|---|
| AN822 | Stepper Motor Microstepping with PIC18C452 |
| AN906 | Stepper Motor Control Using the PIC16F684 |
| AN907 | Stepper Motors Fundamentals |

*Brushed DC Motor*

| | |
|---|---|
| AN532 | Servo Control of a DC Brush Motor |
| AN696 | PIC18CXXX/PIC16CXXX DC Servomotor Application |
| AN718 | Brush-DC Servomotor Implementation Using PIC17C756A |
| AN893 | Low-Cost Bidirectional Brushed DC Motor Control Using the PIC16F684 |
| AN905 | Brushed DC Motor Fundamentals |

*AC Induction Motor*

| | |
|---|---|
| AN843 | Speed Control of 3-Phase Induction Motor Using PIC18 Microcontrollers |
| AN861 | Smart Air Handler Using ProMPT™ and PIC18F2539 |
| AN887 | AC Induction Motor Fundamentals |
| AN889 | VF Control of 3-Phase Induction Motors Using PIC16F7X7 Microcontrollers |
| AN900 | Controlling 3-Phase AC Induction Motors Using the PIC18F4431 |
| AN908 | Using the dsPIC30F for Vector Control of an ACIM |
| AN955 | VF Control of 3-Phase Induction Motor Using Space Vector Modulation |
| AN967 | Bidirectional VF Control of Single and 3-Phase Induction Motors Using the PIC16F72 |

*Variable Speed Brushless DC Motor*

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|---|---|
| AN857 | Brushless DC Motor Control Made Easy |
| AN885 | Brushless DC (BLDC) Motor Fundamentals |
| AN899 | Brushless DC Motor Control Using PIC18FXX31 MCUs |
| AN901 | Using the dsPIC30F for Sensorless BLDC Control |
| AN957 | Sensored BLDC Motor Control Using dsPIC30F2010 |
| AN970 | Using the PIC18F2431 for Sensorless BLDC Motor Control |

*General*

| | |
|---|---|
| AN894 | Motor Control Sensor Feedback Circuits |
| AN898 | Determining MOSFET Driver Needs for Motor Drive Applications |

# Development Systems

Microchip offers a number of development boards and evaluation kits that demonstrate the capabilities of its motor control silicon solutions. All of the hardware and software is included to control the supported motor types. These tools make it easy to customize the software for specific motors.

## Motor Control Graphical User Interface

The MC-GUI graphical user interface allows users to configure the motor and a wide range of system parameters for a selected motor type, including speed, rotation direction, current, heatsink temperature, fault status and much more. Available at no cost, this Windows® operating system-based software program supports Microchip's motor control demonstration boards to provide a complete solution that helps reduce design time.

## PICDEM™ MC Development Board

The PICDEM MC Development Board (DM183011) gives you everything you need to evaluate Microchip's high-performance PIC18FXX31 8-bit microcontrollers for motor control design. Supporting motors up to 800 Watts, the tool provides total isolation between power and control circuits, enabling users to plug in the MPLAB® In-Circuit Emulator or MPLAB In-Circuit Debugger to the board when high power is connected.

## PICDEM™ MC LV Development Board

The PICDEM MC LV Development Board (DM183021) is intended for low-voltage (up to 48V), Brushless DC (BLDC) applications. The board provides a low-cost method for users to evaluate and develop motor control applications using Microchip's high-performance PIC18FXX31 and dsPIC30F motor control product families.

## dsPIC30F Motor Control Development System

This high-performance modular system provides a method for quick prototyping and validation of various motor types. The tools give you the flexibility to select the appropriate power modules to meet your needs. Start with the dsPICDEM™ MC1 Motor Control Development Board (DM300020) and add the appropriate power module and motor for a complete system:
- dsPICDEM MC1H 3-Phase High-Voltage Power Module (DM300021)
- 3-Phase AC Induction Motor High-Voltage Motor (208/460V) (AC300021)
- dsPICDEM MC1L 3-Phase Low-Voltage Power Module (DM300022)
- 3-Phase Brushless DC Low-Voltage Motor (24V) (AC300020)
- PIC18F4431 Plug-in Module (MA18F4431)

## Other Development Tools

Take advantage of Microchip's world-class development tools for 8-bit PIC microcontrollers and 16-bit dsPIC digital signal controllers, including programmers, emulators, debuggers and additional evaluation kits. Operating under the free MPLAB Integrated Development Environment, Microchip's development systems are easy to use and help reduce design time.

## MOSFET Drivers for Motor Control Applications

| Device | Configuration | Peak Output Current (A) | Output Resistance (Ohms) | Maximum Supply Voltage (V) |
|---|---|---|---|---|
| TC1410/11/12/13 | Single | 0.5-3.0 | 15/15-2.5/2.5 | 16 |
| TC4421/22 | Single | 9 | 1.4 (typ)/1.7 | 18 |
| TC4423/24/25 | Dual | 3 | 5/5 | 18 |
| TC4426A/27A/28A | Dual | 1.5 | 9/9 | 18 |
| TC4467/68/69 | Quad | 1.2 | 15/15 | 18 |

## Fan Managers for Motor Control Applications

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

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

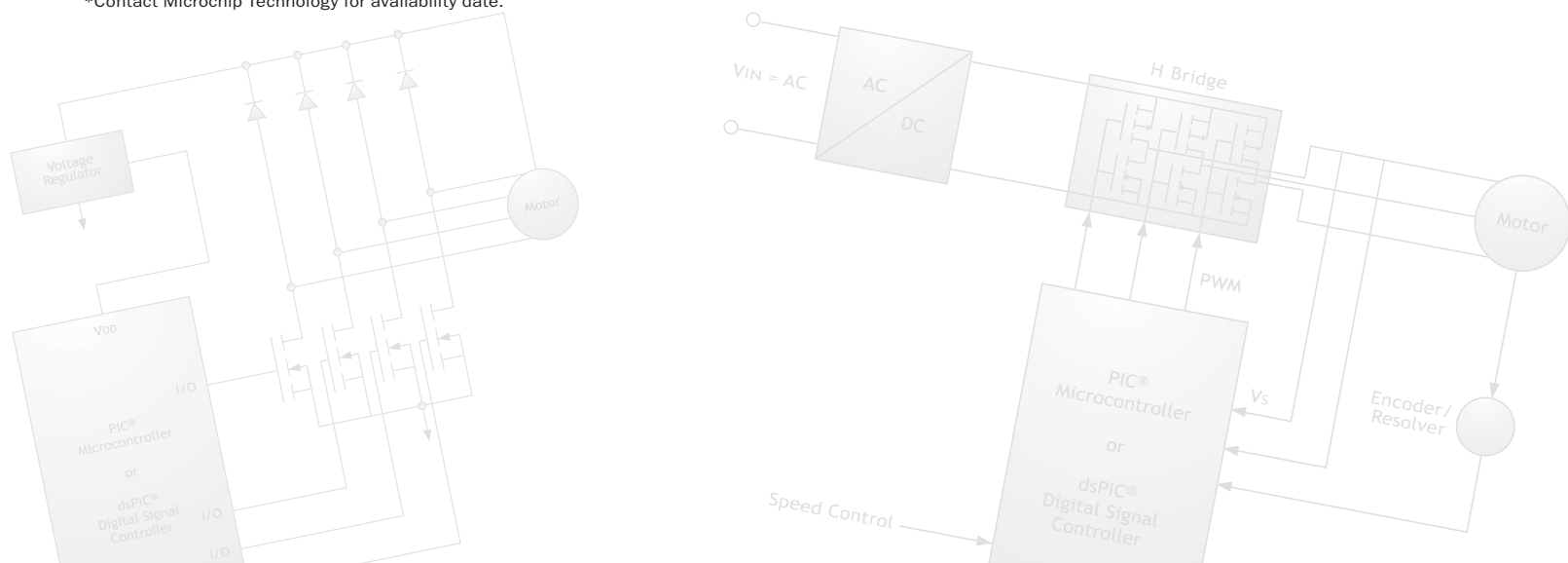## 8-bit PIC® Microcontrollers for Motor Control Applications

| Product | Pins | Flash KB | SRAM Bytes | EE Bytes | Timer 8/16-Bit | Comp | CCP/ ECCP | Motor Control PWM | A/D 10-Bit | Quad Enc | UART | SPI™/ I²C™ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PIC16F684 | 14 | 5.6 | 128 | 256 | 2/1 | 2 | 1 | — | 8 ch | No | — | — |
| PIC16F716 | 18 | 5.6 | 128 | — | 2/1 | — | 1 | — | 4 ch (8-bit) | No | — | — |
| PIC16F737 | 28 | 7 | 368 | — | 2/1 | 2 | 3 | — | 11 ch | No | 1 | 1 |
| PIC16F747 | 40/44 | 7 | 368 | — | 2/1 | 2 | 3 | — | 14 ch | No | 1 | 1 |
| PIC16F767 | 28 | 14 | 368 | — | 2/1 | 2 | 3 | — | 11 ch | No | 1 | 1 |
| PIC16F777 | 40/44 | 14 | 368 | — | 2/1 | 2 | 3 | — | 14 ch | No | 1 | 1 |
| PIC18F1230* | 18/20 | 4 | 256 | 128 | 0/2 | 3 | — | 6 | 3 ch | No | 1 | — |
| PIC18F1330* | 18/20 | 8 | 256 | 128 | 0/2 | 3 | — | 6 | 3 ch | No | 1 | — |
| PIC18F2331 | 28 | 8 | 768 | 256 | 1/3 | — | 2 | 6 | 5 ch | Yes | 1 | 1 |
| PIC18F2431 | 28 | 16 | 768 | 256 | 1/3 | — | 2 | 6 | 5 ch | Yes | 1 | 1 |
| PIC18F4331 | 40/44 | 8 | 768 | 256 | 1/3 | — | 2 | 8 | 9 ch | Yes | 1 | 1 |
| PIC18F4431 | 40/44 | 16 | 768 | 256 | 1/3 | — | 2 | 8 | 9 ch | Yes | 1 | 1 |

*Contact Microchip Technology for availability date.

## 16-bit dsPIC® Digital Signal Controllers for Motor Control Applications

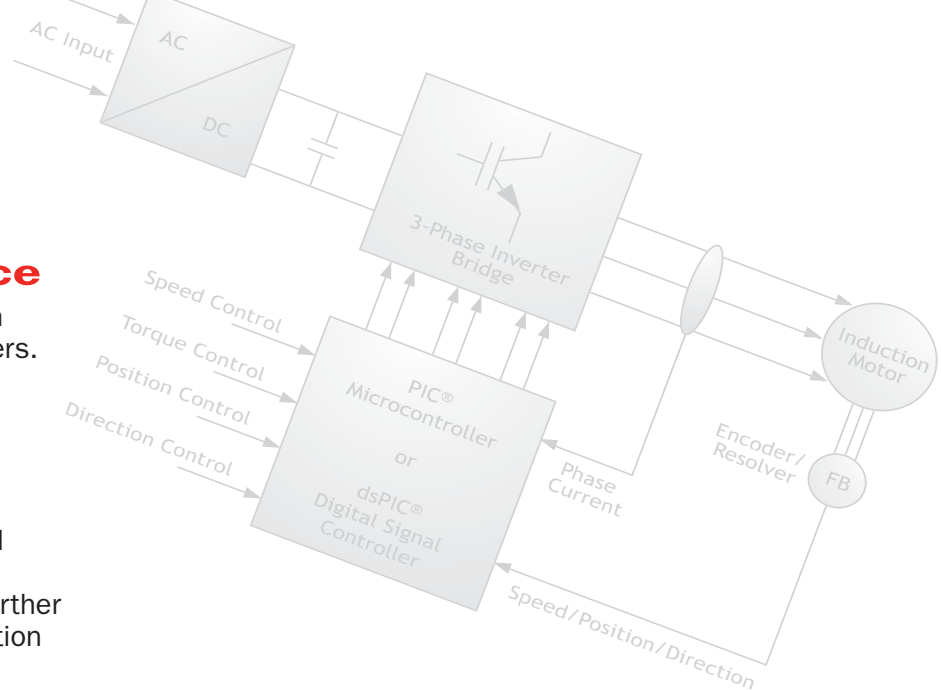| Product | Pins | Flash KB | SRAM Bytes | EE Bytes | Timer 16-Bit | Input Cap | Output Comp/ Std PWM | Motor Control PWM | A/D 10-Bit 500 ksps | Quad Enc | UART | SPI™ | I²C™ | CAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| dsPIC30F2010 | 28 | 12 | 512 | 1024 | 3 | 4 | 2 | 6 | 6 ch | Yes | 1 | 1 | 1 | — |
| dsPIC30F3010 | 28 | 24 | 1024 | 1024 | 5 | 4 | 2 | 6 | 6 ch | Yes | 1 | 1 | 1 | — |
| dsPIC30F3011 | 40/44 | 24 | 1024 | 1024 | 5 | 4 | 4 | 6 | 9 ch | Yes | 2 | 1 | 1 | — |
| dsPIC30F4011 | 40/44 | 48 | 2048 | 1024 | 5 | 4 | 4 | 6 | 9 ch | Yes | 2 | 1 | 1 | 1 |
| dsPIC30F4012 | 28 | 48 | 2048 | 1024 | 5 | 4 | 2 | 6 | 6 ch | Yes | 1 | 1 | 1 | 1 |
| dsPIC30F5015* | 64 | 66 | 2048 | 1024 | 5 | 4 | 4 | 8 | 16 ch | Yes | 1 | 2 | 1 | 1 |
| dsPIC30F5016 | 80 | 66 | 2048 | 1024 | 5 | 4 | 4 | 8 | 16 ch | Yes | 1 | 2 | 1 | 1 |
| dsPIC30F6010 | 80 | 144 | 8192 | 4096 | 5 | 8 | 8 | 8 | 16 ch | Yes | 2 | 2 | 1 | 2 |
| dsPIC30F6015 | 64 | 144 | 8192 | 4096 | 5 | 6 | 6 | 8 | 16 ch | Yes | 2 | 2 | 1 | 1 |

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# Worldwide Sales & Service

At Microchip, we know that it takes more than product specifications to create loyal customers. In addition to a broad product portfolio, we understand the value of a complete design solution. That's why we maintain a worldwide network of sales and support. Our technical support is unmatched with a global network of experienced field application engineers and technical support personnel ready to provide product and system assistance to help you further streamline your design, prototype and production activities.

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