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## Section 1. Introduction

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### HIGHLIGHTS

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# dsPIC33F/PIC24H Family Reference Manual

**Note:** This family reference manual section is meant to serve as a complement to device data sheets. Depending on the device variant, this manual section may not apply to all dsPIC33F/PIC24H devices.

Please consult the note at the beginning of the “**Device Overview**” chapter in the current device data sheet to check whether this document supports the device you are using.

Device data sheets and family reference manual sections are available for download from the Microchip Worldwide Web site at: <http://www.microchip.com>

## 1.1 INTRODUCTION

Microchip is a leading provider of PIC<sup>®</sup> microcontrollers (PIC<sup>®</sup> MCUs) and analog semiconductors. The company's focus is on products that meet the needs of the embedded control market.

Microchip is a leading supplier of the following products:

- 8-bit general purpose MCUs
- 16-bit and 32-bit MCUs
- dsPIC<sup>®</sup> 16-bit digital signal controllers (DSCs)
- Speciality and standard nonvolatile memory devices
- Security devices (KEELOQ<sup>®</sup>)
- Application specific standard products

For a listing of the products Microchip offers, request a Microchip Product Line Card. This literature can be obtained from your local Microchip sales office, or downloaded from the Microchip web site ([www.microchip.com](http://www.microchip.com)).

Table 1-1 lists the dsPIC33F/PIC24H 16-bit devices.

**Table 1-1: dsPIC33F/PIC24H 16-bit Devices**

dsPIC33F/PIC24H 16-bit Devices			
dsPIC33FJ64GP206	dsPIC33FJ128MC708	dsPIC33FJ128GP310A	dsPIC33FJ128MC708A
dsPIC33FJ64GP306	dsPIC33FJ128MC710	dsPIC33FJ128GP706A	dsPIC33FJ128MC710A
dsPIC33FJ64GP310	dsPIC33FJ256GP506	dsPIC33FJ128GP708A	dsPIC33FJ256GP506A
dsPIC33FJ64GP706	dsPIC33FJ256GP510	dsPIC33FJ128GP710A	dsPIC33FJ256GP510A
dsPIC33FJ64GP708	dsPIC33FJ256GP710	dsPIC33FJ128MC506A	dsPIC33FJ256GP710A
dsPIC33FJ64GP710	dsPIC33FJ256MC510	dsPIC33FJ128MC510A	dsPIC33FJ256MC510A
dsPIC33FJ64MC506	dsPIC33FJ256MC710	dsPIC33FJ128MC706A	dsPIC33FJ256MC710A
dsPIC33FJ64MC508	dsPIC33FJ64GP206A	PIC24HJ256GP206	PIC24HJ256GP206A
dsPIC33FJ64MC510	dsPIC33FJ64GP306A	PIC24HJ256GP210	PIC24HJ256GP210A
dsPIC33FJ64MC706	dsPIC33FJ64GP310A	PIC24HJ256GP610	PIC24HJ256GP610A
dsPIC33FJ64MC710	dsPIC33FJ64GP706A	PIC24HJ64GP206	PIC24HJ64GP206A
dsPIC33FJ128GP206	dsPIC33FJ64GP708A	PIC24HJ64GP210	PIC24HJ64GP210A
dsPIC33FJ128GP306	dsPIC33FJ64GP710A	PIC24HJ64GP506	PIC24HJ64GP506A
dsPIC33FJ128GP310	dsPIC33FJ64MC506A	PIC24HJ64GP510	PIC24HJ64GP510A
dsPIC33FJ128GP706	dsPIC33FJ64MC508A	PIC24HJ128GP206	PIC24HJ128GP206A
dsPIC33FJ128GP708	dsPIC33FJ64MC510A	PIC24HJ128GP210	PIC24HJ128GP210A
dsPIC33FJ128GP710	dsPIC33FJ64MC706A	PIC24HJ128GP306	PIC24HJ128GP306A
dsPIC33FJ128MC506	dsPIC33FJ64MC710A	PIC24HJ128GP310	PIC24HJ128GP310A
dsPIC33FJ128MC510	dsPIC33FJ128GP206A	PIC24HJ128GP506	PIC24HJ128GP506A
dsPIC33FJ128MC706	dsPIC33FJ128GP306A	PIC24HJ128GP510	PIC24HJ128GP510A

## 1.2 MANUAL OBJECTIVE

This reference manual provides a brief explanation of the dsPIC33F/PIC24H family architecture and operation of the peripheral modules, but it does not cover the specifics of each device family. Refer to the specific device data sheet for more information. The information that can be found in the data sheet includes the following:

- Device pinout and packaging details
- Device memory map
- List of peripherals included on the device, including multiple occurrences of peripherals
- Device-specific electrical specifications and characteristics

## 1.3 DEVICE STRUCTURE

Each part of the dsPIC33F/PIC24H devices can be placed into one of the following groups:

- Central Processing Unit (CPU) Core
- System Integration
- Peripherals

### 1.3.1 Central Processing Unit (CPU) Core

The CPU core pertains to the basic features that are essential to operate the device. The following sections relate to the CPU core:

- **Section 2. “CPU”** (DS70204)
- **Section 3. “Data Memory”** (DS70202)
- **Section 4. “Program Memory”** (DS70203)
- **Section 6. “Interrupts”** (DS70184)

### 1.3.2 System Integration

The system integration features provide the following advantages:

- Decreased system cost, by bringing traditionally off-chip functions into the MCU
- Increased design flexibility, by adding a wider range of operating modes
- Increased system reliability, by enhancing the ability to recover from unexpected events

The following sections discuss the dsPIC33F/PIC24H system integration functions:

- **Section 5. “Flash Programming”** (DS70191)
- **Section 7. “Oscillator”** (DS70186)
- **Section 8. “Reset”** (DS70192)
- **Section 9. “Watchdog Timer (WDT) and Power-Saving Modes”** (DS70196)
- **Section 23. “CodeGuard™ Security”** (DS70199)
- **Section 24. “Programming and Diagnostics”** (DS70207)
- **Section 25. “Device Configuration”** (DS70194)

### 1.3.3 Peripherals

The dsPIC33F/PIC24H devices have many peripherals that allow them to be interfaced to external circuitry. The peripherals are discussed in the following sections:

- **Section 10. “I/O Ports”** (DS70193)
- **Section 11. “Timers”** (DS70205)
- **Section 12. “Input Capture”** (DS70198)
- **Section 13. “Output Compare”** (DS70209)
- **Section 14. “Motor Control PWM”** (DS70187)
- **Section 15. “Quadrature Encoder Interface (QEI)”** (DS70208)
- **Section 16. “Analog-to-Digital Converter (ADC)”** (DS70183)
- **Section 17. “UART”** (DS70188)
- **Section 18. “Serial Peripheral Interface (SPI)”** (DS70206)
- **Section 19. “Inter-Integrated Circuit™ (I²C™)”** (DS70195)
- **Section 20. “Data Converter Interface (DCI)”** (DS70288)
- **Section 21. “Enhanced Controller Area Network (ECAN™)”** (DS70185)
- **Section 22. “Direct Memory Access (DMA)”** (DS70182)

## 1.4 DEVELOPMENT SUPPORT

Microchip offers a wide range of development tools that allow users to efficiently develop and debug the application code. Microchip's development tools are classified into the following categories:

- Code generation tools, compilers, libraries, application maestro software, and so on
- Hardware and software debugging
- Device programming
- Product development boards

For a full description of each of Microchip's development tools, refer to the Microchip web site. As new tools are developed, the latest product briefs and user guides can be obtained from the Microchip web site ([www.microchip.com](http://www.microchip.com)), or from your local Microchip sales office.

Microchip offers other references and support to speed the development cycle. These include:

- Application notes
- Reference designs
- Microchip web site
- Local sales offices with Field Application Engineering (FAE) support
- Corporate support line

The Microchip web site ([www.microchip.com](http://www.microchip.com)) also lists other web sites that may be useful for references.

## 1.5 STYLE AND SYMBOL CONVENTIONS

Throughout the individual family reference manual sections, certain style, format and font conventions are used to indicate specific distinctions to the emphasized text. Table 1-2 lists these conventions, the specific symbols, and non-conventional word definitions and abbreviations.

**Table 1-2: Document Conventions**

Symbol/Term	Description
Set	To force a bit/register to a value of logic '1'.
Clear	To force a bit/register to a value of logic '0'.
Reset	To force a register/bit to its default state. A reset is a condition, in which the device places itself after a device Reset occurs. Some bits will be forced to '0' (such as interrupt enable bits), while others will be forced to '1' (such as the I/O data direction bits).
R-M-W	Read-Modify-Write. This is when a register or port is read, then the value is modified and that value is then written back to the register or port. This action can occur from a single instruction (such as <code>BSET</code> ) or a sequence of instructions.
:	Specifies a range or concatenation of registers/bits/pins. Concatenation order (left to right) usually specifies a positional relationship (MSb to LSb, higher to lower). For example, TMR3:TMR2 indicates the concatenation of two 16-bit registers to form a 32-bit timer value, with the value of TMR3 representing the most significant word of the value.
< > (angle brackets)	Specifies a bit location or range of locations within a particular register or field of similarly named bits. For example, OSCCON<14:12> or COSC<2:0>, specifies the register and associated bits or bit positions.
MSb, LSb	Indicates the Most Significant bit and Least Significant bit.
MSB, LSB	Indicates the Most Significant Byte and Least Significant Byte.
lsw, msw	Indicates the least significant or most significant word in a field of bits.
0xnn	Designates the number 'nn' in the hexadecimal number system. This convention, which is always preceded by 0x, is used in code examples and text. For example, 0x13 is equivalent to 13h.
'bnnn	Designates the binary number 'bnnn'. For example, the designation 'b101 may be used.
<b>Font Conventions:</b>	
Arial	The standard font used for all text, figures and tables within this manual. Other fonts, as described below, are used to set off mathematical and logical expressions, or device instruction code, from descriptive text.
Courier New	Within text, this font is used for contrast with the standard text font and specifically denotes the following: <ul style="list-style-type: none"> <li>An instruction set mnemonic or assembler code fragment</li> <li>The binary value of a bit, range of bits or a register</li> <li>The logical state of a digital signal</li> </ul> Within code examples, this font is used exclusively to denote a programming language or high-level language instruction sequence.
<i>Times New Roman (Italics)</i>	The standard font for mathematical expressions and variables. $FVCO = F_{IN} \times \left( \frac{M}{N1} \right) = F_{IN} \times \left( \frac{(PLLDIV + 2)}{(PLLPRE + 2)} \right)$
<b>Graphic Conventions:</b>	
Note	A Note presents information that we want to re-emphasize, either to help you avoid a common pitfall or to make you aware of operating differences between some device family members. A Note can be in a box, and is located at the bottom of the table, figure, or register.
Register cells	A bit reference that appears in a gray shaded cell of a register, signifies that the bit is either unimplemented (instead of a name, an EM dash (—) is present) or is not relevant to the particular peripheral module.

## 1.5.1 Electrical Specifications

The individual family reference manual sections contain references to electrical specifications and their parameter numbers. Table 1-3 shows the parameter numbering convention for dsPIC33F/PIC24H devices. A parameter number represents a unique set of characteristics and conditions that is consistent between every data sheet, although the actual parameter value may vary from device to device.

To determine the parameter values for a specific device, refer to the “**Electrical Characteristics**” chapter in the specific device data sheet.

**Table 1-3: Electrical Specification Parameter Numbering Convention**

Parameter Number Format	Comment
Dxxx	DC Specification
Axxx	DC Specification for Analog Peripherals
xxx	Timing (AC) Specification
PDxxx	Device Programming DC Specification
Pxxx	Device Programming Timing (AC) Specification

**Legend:** ‘xxx’ represents a parameter number.

## 1.6 RELATED DOCUMENTS

Microchip, as well as other sources, offers additional documentation that can assist in your development with dsPIC33F/PIC24H devices. These lists contain the most common documentation, but other documents may also be available. Please check the Microchip web site ([www.microchip.com](http://www.microchip.com)) for the latest published technical documentation.

### 1.6.1 Microchip Documents

The following documentation is available from the Microchip web site ([www.microchip.com](http://www.microchip.com)). These documents provide application specific information that gives actual examples of using, programming and designing with dsPIC33F/PIC24H devices. Please check the Microchip web site for the latest published technical documents.

- “*16-bit MCU and DSC Programmer’s Reference Manual*” (DS70157)  
This programmer’s reference manual provides detailed information about the dsPIC DSC programmer’s model and instruction set for 16-bit MCUs and DSCs. A description of each instruction, along with syntax examples, are provided in this manual.
- The following data sheets provide a summary of the available dsPIC33F/PIC24H family devices that are best suited for general purpose applications. These documents include device pinouts, memory sizes and available peripherals.
  - “*dsPIC33FJXXXGPX06/X08/X10 Data Sheet*” (DS70286)
  - “*dsPIC33FJXXXMCX06/X08/X10 Data Sheet*” (DS70287)
  - “*dsPIC33FJXXXGPX06A/X08A/X10A Data Sheet*” (DS70593)
  - “*dsPIC33FJXXXMCX06A/X08A/X10A Data Sheet*” (DS70594)
  - “*PIC24HJXXXGPX06/X08/X10 Data Sheet*” (DS70175)
  - “*PIC24HJXXXGPX06A/X08A/X10A Data Sheet*” (DS70592)

### 1.6.2 Third-Party Documentation

There are several documents available from third-party sources. Microchip does not review these documents for technical accuracy; however, these references may be helpful for understanding the operation of Microchip dsPIC33F/PIC24H devices. Please refer to the Microchip web site ([www.microchip.com](http://www.microchip.com)) for related third-party documents.

## 1.7 REVISION HISTORY

### Revision A (May 2007)

This is the initial released version of the document

### Revision B (June 2009)

This revision incorporates the following content updates:

- Added the dsPIC33FJXXXGPX06A/X08A/X10A and dsPIC33FJXXXMCX06A/X08A/X10A families of devices (refer to the second column of the device list in [1.1 “Introduction”](#))
- Changes to the text and formatting were incorporated throughout the document

### Revision C (May 2012)

This revision incorporates the following updates:

- Sections:
  - Re-organized the last paragraph in [1.1 “Introduction”](#) to [1.2 “Manual Objective”](#)
  - Added DS numbers for the sections listed in [1.3.1 “Central Processing Unit \(CPU\) Core”](#) through [1.3.3 “Peripherals”](#)
  - Added [1.5.1 “Electrical Specifications”](#)
  - Updated [1.6.1 “Microchip Documents”](#)
- Tables:
  - Updated the list of dsPIC33F/PIC24H devices in [Table 1-1](#)
- Updated all dsPIC33F references to dsPIC33F/PIC24H in the entire document
- Changes to text and formatting were incorporated throughout the document

NOTES:



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**Note the following details of the code protection feature on Microchip devices:**

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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