Section 1. Introduction

HIGHLIGHTS

This section of the manual contains the following major topics:

PIC24F 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 PIC24F devices.
>
> Please consult the note at the beginning of the specific 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 microcontrollers (MCUs) and analog semiconductors. The company's focus is on producing products that meet the needs of the embedded control market. Microchip is a leading supplier of the following products:

- 8-bit general purpose microcontrollers (PIC® MCUs)
- 16-bit and 32-bit MCUs
- dsPIC® 16-bit Digital Signal Controllers (DSCs)
- Specialty and standard nonvolatile memory devices
- Security devices (KEELOQ®)
- 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 sales office or downloaded from the Microchip web site (www.microchip.com).

1.2 MANUAL OBJECTIVE

This manual describes the PIC24F device family of 16-bit MCUs. It explains the PIC24F device family architecture and operation of the peripheral modules, but does not cover the specifics of each device in the family. Refer to the specific device data sheet for details such as:

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

The code examples are provided throughout this manual. These examples sometimes need to be written as device-specific as opposed to family-generic, though such code examples are valid for most of the PIC24F device families. Some modifications may be required for devices with variations in register file mappings.

1.3   DEVICE STRUCTURE

Each part of the PIC24F MCU 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 consists of the basic features that are essential to an MCU. The sections of this manual related to the CPU core include:

• CPU
• Data Memory
• Program Memory
• Interrupts
• Data EEPROM
• CPU with Extended Data Space

1.3.2   System Integration

The system integration consists of the core set of modules and features that tie the CPU core and peripheral modules into a single operational unit. The system integration features also provide these advantages:

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

The following sections of the manual discuss the PIC24F system integration functions:

• Oscillator
• High-Level Integration with Programmable HLVD
• Oscillator with 500 kHz Low-Power FRC
• Power-Saving Features with Deep Sleep
• Reset with Programmable BOR
• Reset
• Watchdog Timer (WDT)
• Power-Saving Features
• Flash Memory Programming
• High-Level Device Integration (Configuration and Voltage Regulation)
• Programming and Diagnostics

1.3.3 Peripherals

The PIC24F devices have many peripherals that allow the device to interface with the external world. The following peripherals are discussed in this manual:

- I/O Ports with Peripheral Pin Select (PPS)
- Parallel Master Port (PMP)
- Timers
- Input Capture
- Output Compare/Pulse-Width Modulation (PWM)
- Universal Asynchronous Receiver/Transmitter (UART)
- Serial Peripheral Interface (SPI)
- Inter-Integrated Circuit™ (I^{2}C™)
- Real-Time Clock and Calendar (RTCC)
- Programmable Cyclic Redundancy Check (CRC) Generator
- 10-Bit A/D Converter
- Dual Comparator
- Comparator Voltage Reference
- Motor Control Pulse-Width Modulation (PWM)
- Charge Time Measurement Unit (CTMU)
- Comparator with Blanking
- Charge Time Measurement Unit (CTMU) with Threshold Detect
- USB On-The-Go (OTG)
- Input Capture with Dedicated Timer
- 32-Bit Programmable CRC
- Enhanced Parallel Master Port (EPMP)
- Graphics Controller Module (GFX)
- 10-Bit A/D Converter with 4 Simultaneous Conversions
- Scalable Comparator Module

1.3.4 Memory Technology

The PIC24F devices use enhanced Flash program memory technology. This allows program memory to be electrically erased or programmed under software control during normal device operation.

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 programmer
• Product evaluation boards

For a full description of each of Microchip's development tools, refer to **Section 34. "Development Tool Support"**. As new tools are developed, the latest data sheets and user guides can be obtained from the Microchip web site (www.microchip.com) or from a 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 lists other sites that may be useful references.

1.5 STYLE AND SYMBOL CONVENTIONS

Throughout this manual, certain style and font format conventions are used to indicate specific distinctions for the affected text. Table 1-1 lists these conventions and the MCU industry symbols, and non-conventional word definitions/abbreviations used in this manual. This table defines the symbols, terms and typographic conventions used in this manual.

Table 1-1: Document Conventions

Convention	Description
Symbol and Term Conventions:	
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 BSET) or a sequence of instructions.
: (colon)	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.
< >	Specifies a bit location or range of locations within a particular register or field of similarly named bits. For example, PTCON<2:0> specifies the range of the 3 Least Significant bits of the register, PTCON.
MSb, LSb	Most Significant bit and Least Significant bit.
MSB, msw, LSB, lsw	Most Significant Byte, most significant word, Least Significant Byte and least significant word.
0xnn	Designates the number 'nn' in the hexadecimal number system. This convention is used in code examples, and is equivalent to the notation 'nnh' used in text. For example, 0x13 is equivalent to 13h.
Font Conventions:	
Arial Font	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 Font	Within text, this font is used for contrast with the standard text font and specifically denotes the following: • An instruction set mnemonic or assembler code fragment. • The binary value of a bit, range of bits or a register. • The logical state of a digital signal. Within code examples, this font is used exclusively to denote an assembly language or high-level language instruction sequence.
Times New Roman Font (Italic)	The standard font for mathematical expressions and variables.
Graphic Conventions:	
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, or when used in a table or figure, it is located at the bottom of the table or figure.

1.5.1 Electrical Specifications

Throughout this manual, there are references to electrical specifications and their parameter numbers. Table 1-2 provides the parameter numbering convention for the PIC24F device families. A parameter number represents a unique set of characteristics and conditions that are consistent between every data sheet, though the actual parameter value may vary from device to device.

This manual describes a family of devices, and therefore, does not specify the parameter values. Refer to the **"Electrical Characteristics"** section in the specific device data sheet to determine the parameter values for a specific device.

Table 1-2: 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 third-party sources, offer additional documentation that can assist in your development with PIC24F device-based applications. The following lists contain the most common documentation, but other documents may also be available. Please check the Microchip web site (www.microchip.com) for the latest published technical documentation.

1.6.1   Microchip Documentation

The following PIC24F documentation is currently available from Microchip. Many of these documents provide application-specific information that gives actual examples of using, programming and designing with PIC24F MCUs.

1. *"16-Bit MCU and DSC Programmer's Reference Manual"* (DS70157)

    The programmer's reference manual provides detailed information about the programmer's model and instruction set for 16-bit MCUs and DSCs. The PIC24F instruction set is a subset of the 16-bit MCU and DSC instruction set. A description of each instruction and syntax examples are provided in this manual.

2. *PIC24F Data Sheets*

    The data sheets contain device-specific information, such as pinout and packaging details, electrical specifications and memory maps.

3. *PIC24F Programming Specifications*

    The programming specifications contain detailed descriptions of, and electrical and timing specifications for, the programming process. Both In-Circuit Serial Programming™ (ICSP™) and Enhanced ICSP are described in detail.

1.6.2   Third-Party Documentation

Several third-party documents about Microchip PIC24F device families are available. Microchip does not review these documents for technical accuracy, but these references may be helpful for understanding the operation of devices. The Microchip web site has information on these third-party documents.

1.7   REVISION HISTORY

Revision A (January 2007)

This is the initial released version of this document

Revision B (May 2011)

This revision includes the following updates:

- Updated the lists in the following sections:
  - **Section 1.3.1 "Central Processing Unit (CPU) Core"**
  - **Section 1.3.2 "System Integration"**
  - **Section 1.3.3 "Peripherals"**
- Updated **Section 1.5 "Style and Symbol Conventions"**
- Removed **Section 1.5.1 "Document Conventions"**
- Updated **Section 1.6.1 "Microchip Documentation"**
- Changes to formatting and text were incorporated throughout the document

NOTES:

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."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

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