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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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MICROCHIP COMPACT MP3 DECODER LIBRARY USER'S GUIDE

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® X IDE online help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before you use the Microchip Compact MP3 Decoder Library. Items discussed in this Preface include:

- Document Layout
- Conventions Used in this Guide
- Warranty Registration
- License Agreement
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the Microchip Compact MP3 Decoder Library with the PIC32 family of devices. The document layout is as follows:

- **Chapter 1. "Introduction"** – This chapter provides an overview of the Microchip Compact MP3 Decoder Library.
- **Chapter 2. "Library Resources"** – This chapter describes the resources available for the Microchip Compact MP3 Decoder Library.
- **Chapter 3. "Application Programming Interface (API)"** – This chapter outlines how the API functions provided in the Microchip Compact MP3 Decoder Library can be included in your application software via the Application Programming Interface.

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CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
`Plain Courier New`	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
`Italic Courier New`	A variable argument	`file`.o, where `file` can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options] file [options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`

	Represents code supplied by user	`void main (void)`
		`{ ...`
		`}`

Notes	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.	**Note:** This is a standard note box. **CAUTION** **This is a caution note.** **Note 1:** This is a note used in a table.

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Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles you to receive new product updates. Interim software releases are available at the Microchip web site.

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RECOMMENDED READING

This user's guide describes how to use the Microchip Compact MP3 Decoder Library. The following are available and recommended as supplemental reference resources.

PIC32 Family Reference Manual Sections

Family Reference Manual sections are available, which explain the operation of the PIC32 device family architecture and peripheral modules. The specifics of each device family are discussed in the individual family's device data sheet.

MPLAB® XC32 C/C++ Compiler User's Guide (DS51686)

This document details the use of Microchip's MPLAB XC32 Compiler for PIC32 microcontrollers to develop 32-bit applications.

MPLAB® X IDE User's Guide (DS52027)

Consult this document for more information pertaining to the installation and implementation of the MPLAB X IDE software.

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

• **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
• **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
• **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers and other language tools
- **Emulators** – The latest information on the Microchip in-circuit emulator, MPLAB REAL ICE™
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 3
- **MPLAB X IDE** – The latest information on Microchip MPLAB X IDE, the Windows® Integrated Development Environment for development systems tools
- **Programmers** – The latest information on Microchip programmers including the PICkit™ 3 development programmer

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at:
http://www.microchip.com/support

DOCUMENT REVISION HISTORY

Revision A (October 2012)

This is the initial released version of this document.

Revision B (November 2012)

In this revision, the Performance and Resource Consumption for Microchip Compact MP3 Decoder Library table was updated (Table 2-1).

Chapter 1. Introduction

Thank you for purchasing the Microchip Compact MP3 Decoder Library, which can be used with Microchip's PIC32 family of devices, and provides the ability to decode MP3 audio.

1.1 MP3 OVERVIEW

MP3 is a compression format for storing digital audio data. It is an audio codec that has the capability to compress the original audio source with minor loss in sound quality. The higher the compression ratio, the lower the quality. Therefore, there is a balancing act between file size and audio quality. With the right combination, MP3 encoded data can provide very high quality audio.

One of the advantages of MP3 audio is that it can be separated into segments. Each segment is independent and may be decoded or played. This feature makes it a very attractive scheme for streaming audio.

MP3 encoding uses psychoacoustic principles. This is a catch-all term for the way sound is perceived psychologically and physiologically by humans. The human ear can nominally hear sounds in the range of 20 Hz to 20,000 Hz, although with age the higher frequencies may be inaudible. One of the principles applied in encoding is to limit the high frequency information, especially at low bit rates. The threshold of sound perception varies with frequency. A low level sound at high frequencies may be inaudible or may add little to the musical experience. In some situations, an otherwise clearly audible sound can be masked by another sound of higher intensity.

The MP3 encoder evaluates the perceptual experience loss to the listener by analyzing various such phenomena and makes a qualitative judgment based on the chosen compression rate (bit rate). Alternatively, you may choose a Variable Bit Rate (VBR) and the encoder makes a decision on the bit rate for every frame based on the amount of information that is contained.

The task of the decoder is to take the compressed data and produce the decompressed audio on a frame-by-frame basis.

1.2 MICROCHIP MP3 IMPLEMENTATION

Table 1-1 shows the different audio layers that use the `.mp3` file type. The Microchip Compact MP3 Decoder Library implements the MPEG-1, Audio Layer III, which has been approved in the ISO/IEC 11172-3 standard.

TABLE 1-1:   MP3 DECODER SUPPORT MATRIX

Encoding Format	Layer I	Layer II	Layer III
MPEG-1 (Fs = 32, 44.1, 48 kHz)	No	No	Yes
MPEG-2 (Fs = 16, 22.05, 24 kHz)	No	No	No
MPEG-2.5 (Fs = 8, 11.025, 12 kHz)	No	No	No

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1.3   MICROCHIP COMPACT MP3 DECODER FEATURES

- Implements MPEG-1, Audio Layer III decoder (ISO/IEC 11172-3)
- Simple user interface – initialize decoder and pass MP3 data
- Optimized C callable APIs
- Assembly optimized implementation for overall performance
- Supported sampling rates:
  - 32 kHz
  - 44.1 kHz
  - 48 kHz
- Supported bit rates (kbps):
  - 32
  - 40
  - 48
  - 56
  - 64
  - 80
  - 96
  - 112
  - 128
  - 160
  - 192
  - 224
  - 256
  - 320
  - Variable Bit Rate (VBR)

Chapter 2. Library Resources

This chapter provides information on the available resources for the Microchip Compact MP3 Decoder Library.

Topics covered include:

• Resources
• Resource Usage

2.1 RESOURCES

Several resources related to the Microchip Compact MP3 Decoder Library are available from Microchip:

• Hex file for the specific hardware resource
• Library binary archive (SW320002-1)
• Library source (SW320002-2)

The Microchip Compact MP3 Decoder Library can be used as a software resource with your hardware, or with many of Microchip's PIC32 family device hardware resources.

Due to many hardware resources, and to conserve space, the related installation and demonstration procedures are not listed in this document.

To locate the related installation instructions and demonstration files and procedures for your hardware, refer to the main Microchip web page for your specific board.

> **Note:** If you are accessing the information for the specific hardware resource from microchipDIRECT, click the **More Info** link to access the main web page for the board.

2.2 RESOURCE USAGE

TABLE 2-1: **PERFORMANCE AND RESOURCE CONSUMPTION FOR MICROCHIP COMPACT MP3 DECODER LIBRARY**

Peak MIPS	Code Size (Kbytes)	Data Size (Kbytes)	
		~29 Total	
		Decoder State (Heap)	10.76
27.1	45.58	I/O Buffers	12
		Stack	5.4

Note: Tested with CD quality 44.1 kHz, 128 kbps encoded data.

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Chapter 3. Application Programming Interface (API)

This chapter describes the Application Programming Interface (API) to the Microchip Compact MP3 Decoder Library. The prototype declaration of the API functions, the state buffer used, and the buffer sizes for the audio are located in the header file, `MP3Decoder.h`.

3.1 PIC32 MP3 DECODER API FUNCTIONS

This section lists and describes the following three API functions that are available in the Microchip Compact MP3 Decoder Library:

- MP3GetStateSize
- MP3Initialize
- MP3Decode

MP3GetStateSize

Description

This function gets the size of the MP3 state buffer. Based on the return value, the application allocates the required memory for the MP3 Decoder state. If dynamic memory allocation (malloc) is not used, this function need not be called and the MP3 Decoder state buffer shall be statically defined at compile time with the size of the MP3 Decoder state structure.

Prototype

```
unsigned short int MP3GetStateSize(void);
```

Arguments

None.

Return Values

Size of MP3 Decoder state structure size.

MP3Initialize

Description

This function initializes the MP3 Decoder state with the default values.

Prototype

```
BOOL MP3Initialize ( void *state );
```

Arguments

`*state`   Pointer to the allocated state memory

Return Values

TRUE/FALSE

MP3Decode

Description

This function decodes a frame of MP3 data.

Prototype

```
BOOL MP3Decode (void *state, unsigned char *inBuff, unsigned short
int inSize, unsigned short int *used, MP3_FORMAT *format, unsigned
char *outBuff, unsigned short int *outSize);
```

In the following example, `MP3_FORMAT` is the following structure:

```
typedef struct
{
    unsigned short int bitRate;
    unsigned short int sampleRate;
    unsigned char bitsPerSample;
    unsigned char channels;
}
```

Arguments

`*state`	Pointer to the allocated state memory
`*inBuff`	Pointer to input buffer that contains the encoded bit stream
`inSize`	Number of valid bytes in the input buffer
`*used`	Pointer to the number of bytes consumed in the current frame
`*format`	Pointer to the channel information structure
`*outBuffer`	Pointer to output buffer that contains decoded PCM samples
`*outsize`	Pointer to the number of valid bytes in the output buffer

Return Values

TRUE/FALSE

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Appendix A. License Agreement

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