

MP3 Decode for the Blackfin ADSP-BF5xx Processor family

Product Description

MPEG1/2 Layer 3 Audio Decoder, widely known as MP3, is a popular ‘lossy’ decoder used to greatly reduce audio file sizes, while retaining high levels of audio quality faithful to the original uncompressed version.

In addition to MPEG1/2, there is a non-standard version widely known as ‘MPEG2.5’, which supports additional sampling rates. Refer below for additional information.

Product Highlights

The MP3 Decoder has been highly optimised to run on the Analog Devices’ Blackfin processor family. It is a self-contained software module that is fully compliant with ISO/IEC MPEG1/2 compliance specification and rigorously tested & field-proven in commercial application.

It contains a standard C-callable ‘push’ API with the added flexibility of using ‘pull’ (or ‘poll’) by adding light ‘wrapper’ code. The code has been implemented using Instruction and Data cache, and has no dependencies on processor peripherals or registers. This makes system integration much easier.

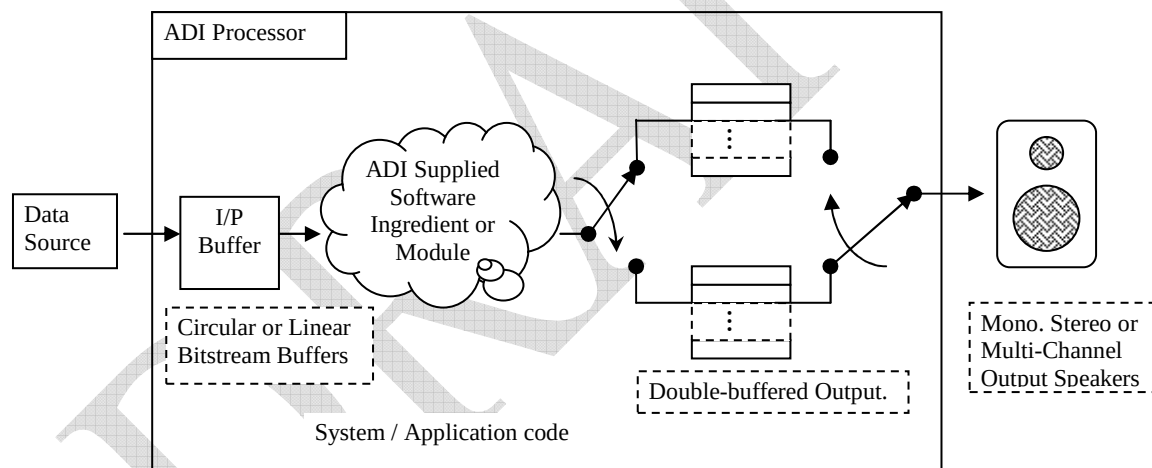


Figure 1 Typical Decoder Application Overview

Executive Summary Table

Code (KiB)	memory	Data RAM (KiB)	Constant Tables (KiB)	Data	MIPS*	
					Average	Peak
24.5		25.5	20.2		21.5	23

- MIPS measured using typical bit rates 128kbps, Fs = 48kHz, optimal memory layout, worst case test vector, running on a BF-533.
- Code compatible across all BF-5xx processors, with silicon anomaly workarounds implemented based on BF-533 Silicon Revision 0.3 and later.
- “Data RAM” for one instance, includes Stack, Scratch, Instance/State, Minimum Input and Output Single Buffers.

- 1 KiB = 1024 Bytes.

Specifications

Codec Functions	MP3 Decoder
Conformance Standard	International Standard ISO/IEC 11172-4 Part 4, 1992, & ISO/IEC 13818-4 Part 4 Compliance Testing 1994.
Reference Code Revision	ISO/IEC Reference Code 11172-3, MPEG1 MP3, 1993 & ISO/IEC 13818-3, MPEG2 MP3, 1998, Part 3: Audio.
Target Processor	ADSP-BF533; code compatible across the Blackfin Processor Family ADSP-BF5xx.
Framework dependencies	None.
Release format	Object code module with C interface.
Input format	Supports bit streams compliant with MPEG1, MPEG2 and (non-official) MPEG2.5, Layer 3. CBR, VBR and (non-official) ABR. Mono, Stereo, Dual Channel and Joint Stereo.
Output format	Supports up to two channels (Stereo) Interleaved 16-bit PCM (left, right, left, right ...). Only 16-bit PCM output is supported.
Output buffer samples per block	1152 samples/channel for MPEG-1; 576 samples/channel for MPEG-2.
Sample Rate	All sampling frequencies specified by MPEG1 L3 (32, 44.1 and 48kHz); MPEG2 L3 (16kHz, 22.05kHz and 24kHz) and MPEG2.5 L3 (8kHz, 11.025kHz, and 12kHz).
Bit Rate	MPEG1 MP3 standard 32 – 320 kbit/sec, & MPEG2 & (non-official) MPEG2.5, 8 – 160 kbit/s.
Multi-channel	Fully re-entrant and multi-instancing capable.

Features:	
Transport Stream	Raw MPEG-1/2 audio bit stream.
Output Status	Frame information such as sample rate, average & maximum bit rates.
Fast Forward / Rewind	The decoder provides 'hooks' to seek forward or backward to desired position in CBR or VBR streams.
Extended Test Vector Testing	Compliant with ISO/IEC test vectors and additional test vectors generated using several different encoders.
Error Codes	Reports up to 5 unique high level error codes. Such as invalid, or non-supported streams.

Memory & Performance

This section presents the MIPS & memory usage of the decoder and some performance figures based on several common memory configurations. This provides developers with a range of processing requirements and overhead estimates.

System Configuration

The MIPS performance are based on worst case test vectors & expressed as Average and Peak figures. Developers will need to budget MIPS requirements according to system and memory layout conditions.

- 1) Processor used: ADSP-BF533

- 2) CCLK = 532 MHz
- 3) SCLK = 133 MHz
- 4) The minimum input buffer required is 1440 bytes per instance (for bit rates up to 320kb/s).
- 5) The size of the output PCM buffer required is 1152 16-bit words per audio channel per instance. (1 instance of the decoder is used, setup to output 2 channels).
- 6) Heap is not used

Total Memory Usage (Bytes)

<i>Code</i>	<i>C Standard Library</i>	<i>Stack Depth</i>	<i>Scratch</i>	<i>Per Instance</i>	<i>Data Tables</i>	<i>Input Buffer</i>	<i>Output Buffer</i>
24144	0	1500	7788	13108	20216	1440	4608

In a typical system, the input and output buffers must be double-buffered, increasing the memory requirements for the input and output buffers to 2880 and 9216 bytes respectively.

Notes:

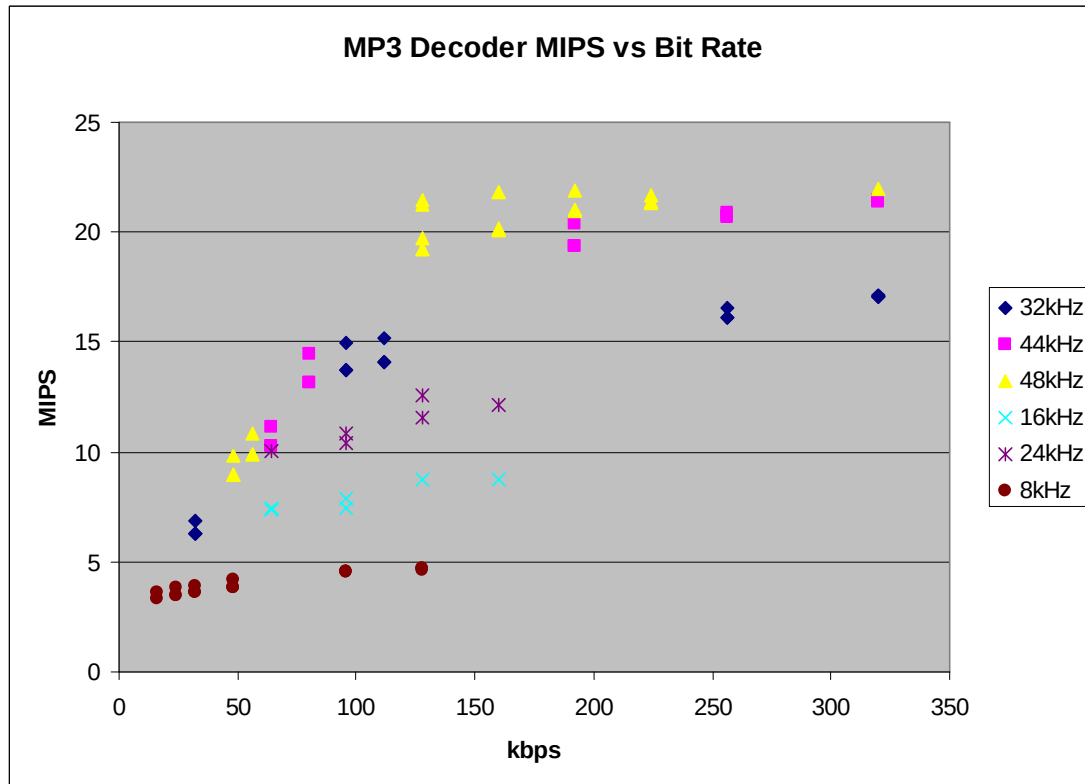
- o The “C Standard Library” memory figures will vary with VisualDSP++ tool versions
- o The “Stack Depth” figures are typical values and may vary with VisualDSP++ tool versions
- o Sizes indicated for input and output buffers are minimum requirements

MIPS

MIPS have been measured using the following placement schemes:

1. Optimal Memory Layout – All code, data and stack were placed in L1 memory with input and output buffer in L3. 16KiB L1 instruction memory was configured as instruction cache and 16KiB of L1 data memory was configured as write-through data cache.
2. Typical memory layout - All code and data were placed in L3 memory including input and output buffer. Stack was placed in L1 data memory. 16KiB L1 instruction memory was configured as instruction cache and 16KiB of L1 data memory was configured as write-back data cache.

<i>Sample Rate (kHz)</i>	<i>Bit Rate (kbps)</i>	<i>Channel Config</i>	<i>Memory Scheme</i>	<i>Avg MIPS</i>	<i>Peak MIPS</i>
8	16	Stereo	1	3.6	4.0
8	32	Stereo	1	3.9	4.3
8	48	Stereo	1	4.2	4.5
16	64	Stereo	1	7.4	8.8
16	96	Stereo	1	7.9	9.7
16	128	Stereo	1	8.8	11.0
32	96	Stereo	1	15.0	16.1
32	112	Stereo	1	15.2	16.9
32	256	Stereo	1	16.6	18.0
44.1	64	Stereo	1	11.1	12.0
44.1	192	Stereo	1	20.3	22.4
44.1	256	Stereo	1	20.9	23.2
48	128	Stereo	1	21.5	23.0
48	128	Stereo	2	27.2	28.5
48	224	Stereo	1	21.7	24.7
48	320	Stereo	1	22	23.4



MIPS Requirement: MIPS required under configuration 1

Notes:

- The MIPS vs. Bit Rate graph above was obtained using a mixture of ISO and ADI test vectors at each sampling frequency and bit rate. The MIPS listed in the table are the worst case average and peak MIPS within this vector set. All ADI test vectors comprise a mixture of speech and music that are indicative of the type of audio encountered in practice.

Deliverables

- o ADSP-BF5xx (Blackfin) library module with a C-callable API (application programming interface) consistent with other ADI software modules
- o C source application example which calls the above library module
- o Real-time demonstration executable running on ADI evaluation boards
- o Documentation, including Application Note and detailed Developer's Guide, with test report made available on request

Availability

This module is available in object code format under the appropriate software license agreements.

Other available software from ADI,

Stereo Codecs: MP3, MPEG-4 AAC and WMA

Multi-channel Audio Codecs: Dolby Digital (AC3) Decoder, Dolby Digital® Consumer Encoder (DDCE), DTS

Video Codecs: MPEG-2, MPEG-4, H.264, JPEG / M-JPEG

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