



## Ittiam Low Speed MP3 Encoder (v1.5) on C64x+

### FEATURES

- eXpressDSP™ Algorithm Interface Standard (XDAIS) compliant
- eXpressDSP™ Multimedia Interface (XDM) compliant
- MPEG-2 layer 3 encoding
- Low speed encoding
- Supports encoding up to a speed of 3x
- Validation done on DM6446 and DM6437 only
- Supports all sampling frequencies in the range of 16 kHz to 48 kHz according to MPEG-1/2
- Bit rates 16-320 kbps
- Mono and stereo data support
- C callable interface for encoder
- Re-entrant multi channel implementation
- Efficient scratch memory management with reduced stack requirements
- Constant bit rate (CBR)
- MS stereo
- XDM API with algMoved() support (relocatable tables)

### Unsupported Features

- Intensity stereo
- MPEG 2.5
- Variable bit-rate (VBR)
- Average bit-rate (ABR)
- MPEG-2 layer 1 and layer 2 encoding

### DESCRIPTION

MPEG2 MP3 is a popular audio coding technique recommended by the MPEG committee. MP3 refers to MPEG audio layer 3.

The Ittiam Low Speed MP3 Encoder handles audio signals sampled at the range of 16 kHz to 48 kHz. MPEG1 supports sampling frequencies of 32 KHz, 44.1 KHz and 48 KHz, operating on a frame of 1152 samples. MPEG2 supports the low sampling frequencies (LSFs) of 16 KHz, 22.05 KHz and 24 KHz, operating on a frame of 576 samples, and generating encoded bit streams at 16-320 kbps (depending on the sampling rate).

This data sheet describes the features and performance of the Ittiam Low Speed MP3 Encoder. This codec is designed to run on any TMS320C64x+ based device. Performance data was taken on a C64x+ Cycle Accurate Simulator, and on a TMS320DM6446 processor.

### Product Support

This product was developed and is supported by Ittiam Systems (P) Ltd. For product support, contact:

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## Validation

The MP3 encoder is an informative standard. There is no standard measure or tool for evaluating the quality of the encoder. The encoder produces complex artifacts, which are products of the source material. Taking this into consideration, the test bench for this codec includes the following test types:

- **Bit Stream Compliance:** Ensures the generated bit-stream is in conformance with the specification.
- **Objective Quality Evaluation:** Evaluates audio quality based on the ITU BS.1387 standard.
- **Subjective Quality Evaluation:** Evaluates audio quality based on listening based tests.
- **Artifact Listening Tests:** Evaluates audio quality based on listening tests to ensure the encoder does not produce artifacts.

## Performance Summary

This section describes the performance of the Ittiam MP3 Encoder. The performance summary data was generated using Code Composer Studio version 3.2.39.5, configured for a C64x+ Cycle Accurate Simulator with 0 wait state memory access.

Hardware configuration performance summary data was generated on a DM6446 processor with all data and program memory sections placed in external memory, with a cache configuration of 32 kB L1 P cache, 16 kB L1 D cache, 64 kB L2 cache, and cache thrashed after encoding each frame. MCPS numbers on hardware will vary depending on the I-cache and D-cache size, and with the memory configuration. 09.wav was used for encoding. Program memory does not include code size of the test bench or standard library functions. Data memory should be aligned with the desired byte boundary to meet performance requirements. See the Implementation document for more details on low speed encoding.

**Table 1. Configuration Table**

CONFIGURATION	ID
MPEG2 MP3 Encoder	MPEG2_MP3_ENC_001

**Table 2. CPU Loading on Simulator**

CONFIGURATION ID	SIMULATOR PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)		
	TEST DESCRIPTION	AVERAGE	PEAK
MPEG2_MP3_ENC_001	MPEG2 Layer 3 encode, 44.1KHz, Stereo, 128 kbps	10.76	14.89
	MPEG2 Layer 3 encode, 44.1KHz, Stereo, 192 kbps	12.21	15.35
	MPEG2 Layer 3 encode, 44.1KHz, Stereo, 320 kbps	14.82	21.37

**Table 3. Cycles Information - Profiled on a DM644x DVEVM With Code Generation Tools v 6.0.10**

CONFIGURATION ID	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)(2)(3)</sup>		
	TEST DESCRIPTION	AVERAGE	PEAK
MPEG2_MP3_ENC_001	MPEG2 Layer 3 encode, 44.1KHz, Stereo, 128 kbps	18.87	23.65
	MPEG2 Layer 3 encode, 44.1KHz, Stereo, 192 kbps	20.35	24.13
	MPEG2 Layer 3 encode, 44.1KHz, Stereo, 320 kbps	22.63	28.6

(1) Measured with program memory, stack, and I/O buffers in external memory and with cache configuration: 32KB L1P Cache, 16 KB L1D Cache, and 64KB L2 Cache.

(2) L1 and L2 Cache Invalidation done for every frame.

(3) Measured with frame size= 1152 samples.

**Table 4. Memory Statistics - Profiled with Code Generation Tools v 6.0.10**

CONFIGURATION ID	MEMORY STATISTICS <sup>(1)</sup>				TOTAL
	PROGRAM MEMORY	DATA MEMORY			
		INTERNAL	EXTERNAL	STACK	
MPEG2_MP3_ENC_001	51.5	0.0	47.02	2.6	101.12

(1) All memory requirements are expressed in kilobytes (1 kilobyte = 1024 bytes) and the numbers could vary around 1-2%.

**Table 5. Internal Data Memory Split-Up**

CONFIGURATION ID	DATA MEMORY - INTERNAL <sup>(1)(2)</sup>		
	SHARED		INSTANCE
	CONSTANTS	SCRATCH	
MPEG2_MP3_ENC_001	0	0	0

- (1) Internal memory refers to L1D RAM. All memory requirements are expressed in kilobytes (1 kilobyte = 1024 bytes) and the numbers could vary around 1-2%.
- (2) I/O buffers not included. Some of the instance memory buffers could be scratch.

**Table 6. External Data Memory Split-Up**

CONFIGURATION ID	DATA MEMORY - EXTERNAL <sup>(1)(2)</sup>		
	SHARED		INSTANCE
	CONSTANTS	SCRATCH	
MPEG2_MP3_ENC_001	13.1	15.0	18.92

- (1) All memory requirements are expressed in kilobytes (1 kilobyte = 1024 bytes) and the numbers could vary around 1-2%.
- (2) Does not include I/O buffers.

**Table 7. Co Processor(s) Memory Statistics<sup>(1)</sup>**

CONFIGURATION ID	SEQ DATA MEMORY	SEQ PROG MEMORY	IMX WORKING MEM	IMX IMG BUF	IMX CMD MEM
MPEG2_MP3_ENC_001	0	0	0	0	0

- (1) The encoder does not use co-processors and hence all the values are zero.

## Notes

- I/O Buffers
  - Input Buffer Size = 4608 bytes
  - Output Buffer Size = 2048 bytes
- Total Data Memory for N Non-Pre-Emptive Instances = Constants + Runtime Tables + Scratch + N\*(Instance + I/O buffers + Stack)
- Total Data Memory for N Pre-Emptive Instances = Constants + Runtime Tables + N\*(Instance + I/O buffers + Stack + Scratch)
- Stack also includes the requirement for local variables

## References

- ISO/IEC 11172-3 Information Technology – Coding moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s – Part 3: Audio
- ISO/IEC 13818-3 Information technology – Generic coding of moving pictures and associated audio information – Part 3: Audio
- Ittiam MPEG2 MP3 Encoder on C64x+ Getting Started Guide
- Ittiam LS MP3 Encoder Implementation Document

## Glossary

Term	Description
Constants	Elements that go into .const memory section
Scratch	Memory space that can be reused across different instances of the algorithm
Shared	Sum of Constants and Scratch
Instance	Persistent-memory that contains persistent information - allocated for each instance of the algorithm

## Acronyms

Acronym	Description
DV-EVM	Digital Video Evaluation Module
ISO	International Organization for Standardization
IEC	International Electro-technical Commission
MPEG2	Moving Picture Experts Group-2
MP3	MPEG Audio Layer 3

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