

HiFi 2 & HiFi EP Audio DSPs

The Proven Audio Architecture—From Mobile to DTV

Product Brief

FEATURES

- Turnkey 24-bit audio for SOC designs
- Supports all popular audio formats
- Low gate count and power
- Audio implementation in:
 - A customizable Xtensa LX core with the HiFi 2 option
 - A customizable Xtensa LX core with the HiFi EP option
- Full matching software tool chain
- Designed into everything from cellular phones to DTV to Blu-ray Disc
- HiFi EP adds advanced optimizations for DTS Master Audio, improved voice pre- & post-processing, and improved cache memory subsystem

BENEFITS

- Programmable support for multiple audio formats
- Proven and pre-packaged, ready to drop into SOC designs
- Over 90 software codecs and audio and voice enhancement packages pre-ported and ready to use, no software porting required
- Reduces silicon area and power consumption
- Uses custom instructions for better code density, fewer cycles
- Uses flexible datapath widths for higher efficiency per cycle
- Uses multiple instructions per cycle for higher efficiency

The Most Popular Audio DSP Architecture

There's a good reason so many top-tier semiconductor companies use Tensilica's HiFi architecture in their products. It works. The HiFi 2 or HiFi EP Audio DSPs are ideal for everything from mobile phones to high-end home entertainment systems.



Tensilica's HiFi Audio DSPs are drop-in solutions for SOC design.

Filling a Wide Range of Audio Requirements

A wide range of electronic devices, from portable music players to Blu-ray Disc players to professional sound reproduction equipment, require the ability to efficiently handle digitally compressed audio. Depending on the type of device and its intended use, it may need to have encode/decode (codec) capability for a large number of different formats, the most popular being MP3 (MPEG-1 layer 3), Dolby Digital (AC-3), AAC (MPEG-2/4 Advanced Audio Coding), WMA (Microsoft Windows Media Audio), DTS, and AMR (Adaptive Multi-rate Speech, 3G standard).

Hardwired audio codecs cannot play multiple standards and can't be changed when standards are extended. General-purpose 32-bit CPUs are very inefficient in both area and power consumption.

Tensilica's HiFi 2 and HiFi EP Audio DSPs provide proven, fully optimized approaches to embedding multiple standards into SOC designs. Both are click-box options for Xtensa LX configurable processors, so you can do additional optimizations if needed.



An Optimized Solution for Audio

The Tensilica HiFi Audio DSPs are optimized solutions for digital audio. They have been extended and optimized by Tensilica to run all the audio formats. They can approach the performance of fixed-gate implementations, while providing the flexibility, time to market, and risk reduction of fixed instruction set RISC processors while simultaneously reducing silicon area and power consumption. Tensilica can provide the codecs listed so you don't have to worry about that development process.

The HiFi Audio DSPs utilize Tensilica's benchmark-breaking Xtensa LX processor technology with custom instructions (better code density, fewer cycles), flexible datapath widths (higher efficiency per cycle), multiple instructions per cycle (VLIW – higher efficiency per cycle), and simultaneous data operations (SIMD – parallelization). A comprehensive Eclipse based software development environment is provided that includes everything from a source code editor, debugger, and ISS to an optimized compiler that provides excellent code density.

Tensilica's HiFi Audio is available two ways:

1. The HiFi 2 Audio DSP—a click-box options for the Xtensa LX processor, so you can do additional optimizations
2. The HiFi EP Audio DSP—a superset of the HiFi 2 Audio DSP with advanced optimizations for DTS Master Audio, improved voice pre- & post-processing, and improved cache memory subsystem.

Whatever HiFi implementation you choose, you can be comfortable that you picked the industry's most popular 24-bit audio solutions. Tensilica's HiFi Audio has been designed into cellular phones, high-end Blu-ray Disc players, and other audio equipment, and is shipping in millions of units each year.

HiFi EP Architecture Enhancements

* HiFi EP includes a novel and unique 32x24 MAC for higher performance at lower power on the popular DTS Master Audio lossless decoder, resulting in a clock rate reduction of almost 35% compared to HiFi 2.

* To address the increasingly demanding requirements in mobile and VoIP applications for better immunity to background noise and speakerphone mode quality, new instructions have been added to accelerate voice pre- and post-processing for noise cancellation and beam forming microphones. These instructions also provide better general DSP capabilities.

* The cache memory subsystem is enhanced with an integrated predictive prefetch unit to significantly improve performance in SOC designs with large external memory latencies.

Audio Codecs

Tensilica offers audio packages for HiFi Audio, so these functions can be integrated into an SOC design with no additional codec software development required.

AMR Wideband Plus decoder: implements the AMR wideband plus decoding that adds stereo support and higher sampling rates to the AMR-WB standard and is fully compliant with the 3GPP specifications for the AMR-WB+ codec.

AMR Wideband Plus encoder: implements the AMR wideband plus encoding that adds stereo support and higher sampling rates to the AMR-WB standard and is fully compliant with the 3GPP specifications for the AMR-WB+ codec.

DAB/MP2: implements MPEG-1 and MPEG-2 Layer 1 and Layer 2 stereo decoding, supporting Digital Audio Broadcast.

DAB+: implements HE ACC by Dolby for Digital Audio Broadcast (DAB+) decoding for digital radio with support for Parametric Stereo (PS) and SBR and is fully compliant with ETSI TS 102.

Digital Radio Mondiale (DRM) Decoder: implements HE AAC by Dolby for DRM decoding for digital radio with support for SBR and is fully compliant with ETSI and ITU specifications.

Dolby® Digital AC-3 decoder: implements the complete Dolby Digital AC-3 audio decoder with multichannel 5.1 decoding. It supports all standard down-mix modes and the full range of bit and sample rates.

Dolby Digital Compatible Output Encoder (DDCO): implements Dolby Digital Compatible Output (DDCO) 5.1-channel encoding for the design of next generation HD technologies in Blu-Ray Disc and HD-DVD products.

Dolby Digital Consumer Encoder (DDCE): implements the Dolby Digital Consumer Encoder (DDCE), supporting 1, 2 and 5.1-channel encoding over the full range of bit and sample rates for the design of consumer devices.

Dolby Digital Plus Decoder: implements up to 7.1 channel decoding of the Dolby Digital Plus (DD+, Enhanced AC3, or E-AC-3) codec standard specified by Dolby Laboratories.

Dolby Digital Plus decoder-converter: implements the complete Dolby Digital Plus decoder with multi-channel 5.1 and 7.1-channel decoding as well as the Dolby Digital converter for compatibility with existing Dolby Digital 5.1 receivers. It supports all standard down-mix modes and the full range of bit and sample rates.

Dolby MS10 decoder: implements the Dolby MS10 Multistream decoder, supporting decode of Dolby Digital Plus, Dolby Pulse, Dolby Digital, HE-AAC and all AAC bitstreams.

Dolby Pro Logic II/IIx decoder: implements the Dolby Pro Logic II/IIx decoding which processes any high quality stereo signal source into 7 output – five separate full frequency channels (left, center, right, left surround and right surround) plus one low-frequency-effects (deep bass) channel.

Dolby TrueHD decoder: implements the Dolby TrueHD decoder, a lossless audio coding technology designed for the design of next generation HD technologies in Blu-ray Disc products where the quality of the programming demands playback accuracy that is bit-for-bit identical to the original performance. It is also capable of decoding MLP lossless DVD-Audio (DVD-A) content.

Dolby Volume: implements a consistent playback volume level across all sources and content. It includes loudness-domain signal processing and auditory scene analysis to correct source and content level differences.

DTS DMP decoder: implements the decoding of popular DTS content by creating a stereo mix-down and provides a DTS 5.1 digital bit-stream to external home theater systems.

DTS Broadcast decoder: incorporates all the functionality of the DMP package and extends this to target DTS 5.1 core content delivered over traditional cable, satellite, terrestrial and IP networks. It also supports infrastructures such as video-on-demand, IPTV and managed networks.

DTS-HD Master Audio: implements DTS technologies for Blu-ray Disc and other high end consumer audio applications. The DTS-HD MA codec suite consists of the DTS-HD, DTS Express, DTS Transcoder, DTS Neo:6 SDKs and DTS-HD Post Processing. The codec suite provides up to 7.1 discrete channels of sound that are bit-for-bit identical to a master soundtrack.

FLAC decoder: implements the FLAC lossless decoder, supporting up to 7.1 channels, the Subset format and native FLAC and Ogg container format.

MP3 decoder: implements full accuracy MPEG-1, MPEG-2 layer 1/2/3 and MPEG-2.5 layer 3 stereo decoding with support for constant bit rate, variable bit rate and free formats. It is fully compliant with ISO/IEC 11172-4.

MP3 encoder: implements MPEG-1 and MPEG-2 layer 3 stereo encoding with support for joint stereo coding for better efficiency and the constant bit rate format.

MPEG-2 Layer 2 Multi-channel decoder: implements MPEG-2 Layer 2 multi-channel decoding up to 5.1 channels. It includes the full MP3 stereo decoder.

MPEG-2/4 AAC-LC Multi-channel decoder: implements MPEG-4 AAC-LC multi-channel decoding up to 7.1-channels. It supports the full range of bit and sample rates.

MPEG-4 aacPlus v1 Multi-channel decoder: implements MPEG-4 aacPlus v1 multi-channel decoding up to 7.1 channels. It includes support for Spectral Band Replication (SBR) and the full range of bit and sample rates.

MPEG-4 aacPlus v2 Multi-channel decoder: implements MPEG-4 aacPlus v2 multi-channel decoding up to 7.1 channels. It includes support for Parametric Stereo (PS), Spectral Band Replication (SBR) and the full range of bit and sample rates.

MPEG-4 aacPlus v2 decoder: implements aacPlus v2 stereo decoding which includes support for Parametric Stereo (PS) and SBR™ and is compliant with the 3GPP specifications for Enhanced aacPlus.

MPEG-4 aacPlus v2 encoder: implements aacPlus v2 stereo encoding which includes support for Parametric Stereo (PS) and SBR and is compliant with the 3GPP specifications for Enhanced aacPlus.

MPEG-4 aacPlus v1 decoder: implements aacPlus v1 stereo decoding which includes support for Spectral Band Replication (SBR) and is compliant with the 3GPP specifications for Enhanced aacPlus.

MPEG-4 aacPlus v1 encoder: implements aacPlus v1 stereo encoding which includes support for Spectral Band Replication (SBR) and is compliant with the 3GPP specifications for Enhanced aacPlus.

MPEG-2/4 AAC LC decoder: implements MPEG-2/4 AAC stereo decoding compliant with ISO/IEC 13818-4 and 14496-4. It supports the decoding of MPEG-2/4 AAC LC and LC multichannel files as well as the decoding of ADIF, ADTS and RAW file format data streams.

MPEG-2/4 AAC LC encoder: implements MPEG-4 AAC LC and MPEG-2 AAC LC stereo encoding. It supports Constant Bit Rate, Variable Bit Rate, TNS, PNS, Joint Stereo, etc. It also supports ADIF and ADTS encoding formats.

MPEG-4 BSAC decoder: implements MPEG-4 BSAC stereo encoding compliant with ISO/IEC 14496-3 subpart 4. It offers fine grain audio scalability in the range from 16kbps to 64kbps in steps of 1kbps per audio channel and provides error resilience for greatly improved audio quality of a signal transmitted over an error-prone channel such as a wireless network.

Ogg Vorbis decoder: implements stereo decoding of all quality level Ogg Vorbis data streams (0-10) and bit rate peeled streams as specified by the Xiph.Org foundation.

RealAudio 8 decoder: implements RealAudio 8 decoding for low- to mid-bitrates (8-96 kbps) and is fully compliant with the RealAudio 8 specification.

RealAudio 9 decoder: implements RealAudio 9 / MPEG-2/4 AAC stereo decoding compliant with ISO/IEC 13818-4, 14496-4 and the RealAudio 9 specification. It supports the decoding of MPEG-2/4 AAC LC and LC multi-channel files as well as the decoding of ADIF, ADTS and RAW file format data streams.

RealAudio 10 decoder: implements RealAudio 10 / aacPlus v1 stereo decoding which includes support for Spectral Band Replication (SBR) and is compliant with the 3GPP specifications for Enhanced aacPlus and the RealAudio 10 specification.

SBC Bluetooth decoder: implements the low complexity sub band coding decoding for Bluetooth voice, audio and video applications and is fully compliant with the SBC specification in the Bluetooth Advanced Audio Distribution Profile (A2DP).

SBC Bluetooth encoder: implements the low complexity sub band coding encoding for Bluetooth voice, audio and video applications and is fully compliant with the SBC specification in the Bluetooth Advanced Audio Distribution Profile (A2DP).

WMA decoder: implements decoding of high-, mid-, and low-rate WMA data streams as well as the decoding of ASF data streams and is fully compliant with Microsoft WMA test specifications.

WMA encoder: implements encoding of high-, mid-, and low-rate WMA data streams as well as the encoding of ASF data streams and is fully compliant with Microsoft WMA test specifications.

WMA 10 Pro decoder: implements Microsoft's Windows Media Audio 10 Professional decoder supporting profiles that include everything from full-resolution 24-bit/96 kHz audio in stereo, to 5.1- or 7.1-channel surround sound, to highly efficient mobile capabilities at 24 Kbps to 96 Kbps for stereo, and 128 Kbps to 256 Kbps for 5.1-channel sound.

WMA 10 Pro Lossless decoder: incorporates all of the functionality of the WMA 10 Pro decoder and also supports lossy profiles that include everything from full-resolution 24-bit/96 kHz audio in stereo, to 5.1- or 7.1-channel surround sound, to highly efficient mobile capabilities at 24 Kbps to 96 Kbps for stereo, and 128 Kbps to 256 Kbps for 5.1-channel sound.

Voice Codecs

AMR narrowband speech codec: implements AMR narrowband speech decoding and encoding and is fully compliant with the 3GPP specifications for the AMR NB codec.

AMR wideband speech codec: implements AMR wideband speech decoding and encoding (G.722.2) and is fully compliant with the 3GPP specifications for the AMR WB codec.

G.729AB speech codec: implements G.729AB speech decoding and encoding which includes support for Discontinuous Transmission (DTX), Voice Activity Detection (VAD), Comfort Noise Generation (CNG) and Silence Insertion Descriptor (SID). It is fully compliant with the ITU specifications for the G.729 standard with Annexes A and B.

GSM EFR speech codec: implements the speech codec standard specified in 3GPP TS 46.051 V9.9.9 (2009-12). It is used to coding of speech at 8 KHz, 12.2Kbps for GSM.

GSM-FR speech codec: implements the speech codec standard specified in 3GPP TS 46.010 V9.0.0 (2009-12). It is used to coding of speech at 8 KHz, 13Kbps for GSM.

GSM-HR speech codec: implements the speech codec standard specified in 3GPP TS 46.002 V9.0.0 (2009-12). It is used to coding of speech at 8 KHz, 5.6Kbps for GSM.

Third Party Solutions

Acoustic Technologies: provides SoundClear brand of patented full-duplex communication, echo cancellation, noise elimination, and music enhancement solutions enabling significant advancements in mobile and hands-free audio quality.

AM3D: provides 3D and special effects for mobile phones and portable music players. Both AM3D's Zirene® audio enhancement and Diesel Power Mobile™ 3D audio game engine are available.

Arkamys: implements Arkamys' digital audio solutions for portable devices, in-car audio, and home entertainment.

QSound microQ™ : implements QSound's microQ audio components – a MIDI wavetable synthesis engine with a scalable sample set, a multi-channel stereo mixer, a wide range of processes to control frequency response, dynamics and spatial enhancements, as well as full 3D positional audio for games.

Sensory: implements Sensory's TrulyHandsfree™ Voice Control for speech activation in noisy environments. It provides a voice trigger capability on a local device that can communicate via the cloud to enable complex voice searches and text-to-speech for data retrieval.

SPIRIT DSP: delivers optimized, high quality digital audio and voice software packages. The SPIRIT Voice Engine brings high quality real-time wideband voice and video to next generation VoIP equipment. The SPIRIT audio software package includes MP3, AAC, AAC+ v1, AAC+ v2, BSAC, SBC and WMA, complete with add-ons like EQ, sample rate converter, dynamic range control and mixer.

SRS audio enhancement technologies: implements SRS TruSurround HD™, TruSurround XT™, WOW XT, WOW HD™ and Xspace 3D™.

For Digital Radio

Designers of digital radio systems can use Tensilica's HiFi 2 Audio DSP to run all of the decoders required throughout the world for digital radio. Tensilica's HiFi2 Audio DSP supports all of the terrestrial and satellite standards: DAB, DAB+, HD Radio, DRM, and XM Radio.

Tensilica supports all the worldwide standards:

HD-Radio - Available now from iBiquity Digital

DAB - Available now with the HiFi 2 MP3 decoder

DAB+ - Available now, certified by Dolby

DRM - Available now, certified by Dolby

XM-Satellite - Available from XM Satellite

T-DMB (BSAC audio) - Available now with the HiFi 2 BSAC decoder

ISDB - Available now with AAC, HE-AAC decoders

For Home Entertainment: Blu-ray, DTV, STB, A/V Receivers

The HiFi Audio DSOs are ideal for Blu-ray Disc DTV, set-top boxes and high-end home theater receiver SOCs. HiFi Audio offers significant cost and time savings with a huge list of pre-ported audio codecs and a programming model that easily enables full development in C.

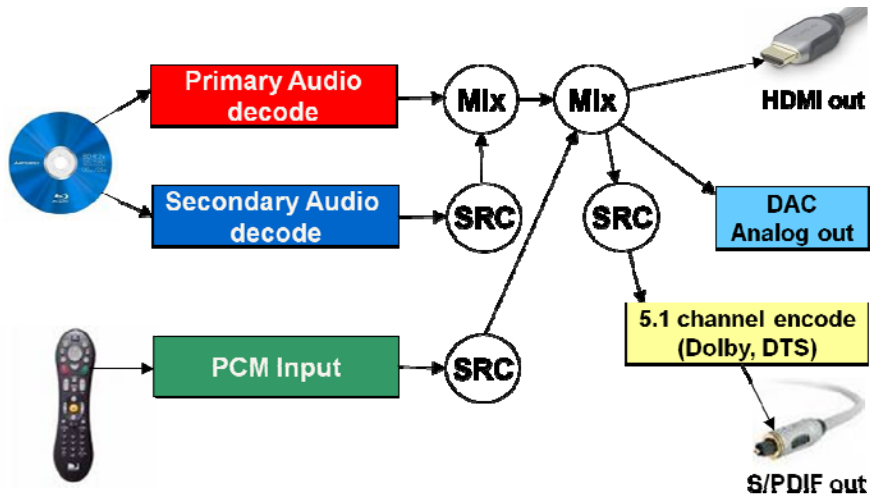
HiFi EP's architectural enhancements significantly improve DTS Master Audio decoding and tolerance to high external memory latency. With HiFi EP, single-core Blu-ray Disc SOCs can easily be implemented in 65GP with additional MHz to spare for other audio functions.

Blu-ray Disc unleashes a new level of entertainment in the home with up to 7.1 channel audio, and video that surpasses the quality of standard DVDs by up to 6x. New features include Second-

ary Audio to support interactive content and director's commentary, higher resolution compressed audio streams for enhanced audio reproduction, and lossless audio formats that provide bit-for-bit identical reproduction of the original studio master in up to 7.1 channels.

New codecs have been developed and introduced by Dolby and DTS to support these audio capabilities - Dolby Digital Plus, Dolby TrueHD, DTS-HD High Resolution Audio and DTS-HD Master Audio. The combination of increased codec complexity and support for simultaneous Secondary Audio decoding and mixing of decoded Primary and Secondary and effects audio has resulted in a huge step function increase in signal processing compared to the DVD standard.

HiFi Audio meets the challenge with extremely efficient implementations of all the mandatory and optional Dolby and DTS codecs, enabling the development of area and power efficient single audio DSP core-based Blu-ray Disc SOCs.



Blu-ray Disc Audio—The Most Demanding Consumer Audio System

Worst Case HiFi 2/EP Performance on Blu-ray Disc Algorithms

Audio Function	Worst Case Performance on HiFi 2	Worst Case Performance on HiFi EP
Primary Audio: DTS Master Audio 24.5 Mbps 5.1 192 KHz	175 MHz	115 MHz
Secondary Audio: DTS-LBR (DTS Express) 256 kbps 5.1 kHz decoding	63 MHz	61 MHz
Upsample, mixing, post-processing	48 MHz	45 MHz
Downsample, Downmix, S/PDIF Output: DTS/AC-3 5.1 48 KHz encoding	76 MHz	75 MHz
Subtotal (ideal memory)	362 MHz	296 MHz
Allowance for cache/bus latency	100 cycles memory delay	100 cycles memory delay
Total	541 MHz	380 MHz

HiFi 2 & HiFi EP Audio DSPs

Specifications

Audio Codecs	Clock Rate Re-quired* (MHz)	Code Size - ROM (KB)	Table Size - ROM (KB)	RAM** (KB)	I/O Buffer - RAM (KB)
AMR Wideband Plus Stereo Decoder (48 Kbps, 48 KHz)	29	87	70	44	46
AMR Wideband Plus Stereo Encoder (48 Kbps, 48 KHz)	77 (LC)	122	72	152	31
DAB+ Stereo Decoder (128 Kbps, 48 KHz)	13	77	40	58	19
DAB/MP2 Stereo Decoder (48 KHz, 192 Kbps)	6.6	10	3.8	9.3	6.5
Digital Radio Mondiale (DRM) Stereo Decoder (24 Kbps, 48 KHz)	41	130	86	53	11
Dolby Digital (AC-3) Decoder, 5.1 (384 and 448 Kbps, 48 KHz)	27	21	7.7	17	10
Dolby Digital (AC-3) Consumer Encoder (DDCE), Stereo	19	39	6.8	49	14.5
Dolby Digital (AC-3) Consumer Encoder, 5.1 ch. (640 Kbps, 48 KHz)	60	39	7.7	95	38.5
Dolby Digital (AC-3) Compatible Output Encoder, 5.1 ch. (640 Kbps, 48 KHz)	60	39	7.7	95	38.5
Dolby Digital Plus Consumer Decoder, 7.1 ch.	63	45	22	152	52
Dolby Digital Plus Consumer Decoder-Converter, 5.1 ch.	43 (Decoder)	55	23	97	36 (PCM) 4(AC-3)
	52 (Converter)				
	70 (Both)				
Dolby MS10 Decoder, MS10-DDT (5.1 ch main + 5.1 ch assoc. + DDCE + post processing)	223	135	41	374	161
Dolby MS10 Decoder, MS10-DDT (5.1 ch. Main + 2 ch. Assoc. + DDCE + post processing)	156	135	41	374	161
Dolby Pro Logic II, 5.1 ch. (48 KHz)	13	7.8	2.8	9	4
Dolby Pro Logic IIX, 7.1 ch. (48 KHz)	15	8.6	3.2	9	5
Dolby TrueHD Decoder, 7.1 ch. (9.6 Mbps, 48 KHz)	48	13	5.4	16	8.9
Dolby Volume, 2 ch. (48 KHz)	11	50	17	39	36
Dolby Volume, 5.1 ch. (48 KHz)	25	50	17	39	36
DTS Core Decoder, 5.1 ch. (48 KHz)	24	39	115	86	19
DTS Broadcast 5.1 ch. (1.536 Mbps, 48 KHz)	33	46	120	87	40
DTS DMP 5.1 ch. (1.536 Mbps, 48 KHz)	24	39	115	86	19
DTS-HD SDK (Master Audio, 96/24, ES, Hi Resolution, Core) for Blu-ray Disc, AVR (192 KHz, 5.1 ch)	175 (HiFi 2) 115 (HiFi EP)	195	160	710	79
DTS Express SDK for Blu-ray Disc, AVR	63	50	20	55	9
DTS Transcoder SDK for Blu-ray Disc, AVR					
(with 192->48 KHz downsampling)	76	22	45	49	52
(No downsampling, inputs Fs <= 48 KHz)	61	22	45	49	15
DTS Neo:6					
SDK for Blu-ray Disc, AVR (48 KHz, 2ch -> 7ch)	44	25	11	48	2.5
48 KHz, 2ch -> 3ch (for ES Matrix)	30	25	11	48	2.5
DTS-HD PP (DRC, Dialnorm, Downmixing, Primary-Secondary Mixing, Sec Upsampling)	48	70	15	29.5	19
FLAC, 2 ch. (44.1 KHz, 16-bit PCM)	5.3	13	2.6	7.8	variable
FLAC, 7.1 ch. (96 KHz - 16-bit PCM)	23	13	2.6	7.8	variable
MP3 Stereo Decoder (128 Kbps, 44.1 KHz)	5.7	21	15	20	6.5
MP3 Stereo Decoder (320 Kbps, 44.1 KHz)	6.9	21	15	20	6.5
MP3 Stereo Encoder (128 Kbps, 44.1 KHz)	26	47	14	40	6.5
MP3 Stereo Encoder (320 Kbps, 44.1 KHz)	30.2	47	14	40	6.5
MPEG-2 Layer 2 Decoder, 5.1 ch. (1,066 Kbps, 48 KHz)	30	35	15	59	18
MPEG-4 aacPlus v2 Stereo Decoder (48 Kbps, 48 KHz)	19	71	33	52	18
MPEG-4 aacPlus v2 Stereo Decoder (64 Kbps, 48 KHz)	20	71	33	52	18
MPEG-4 aacPlus v2 Stereo Encoder (48 Kbps, 48 KHz)	34	128	41	124	9.5
MPEG-4 aacPlus v2 Stereo Encoder (64 Kbps, 48 KHz)	34	128	41	124	9.5
MPEG-4 aacPlus v1 Stereo Decoder (64 Kbps, 48 KHz)	19	63	31	47	18
MPEG-4 aacPlus v1 Stereo Decoder (128 Kbps, 48 KHz)	20	63	31	47	18
MPEG-4 aacPlus v1 Decoder, 7.1 ch. (192 Kbps, 48 KHz)	72	63	31	141	70
MPEG-4 aacPlus v1 Stereo Encoder (64 Kbps, 48 KHz)	51	123	41	100	9.5
MPEG-4 aacPlus v1 Stereo Encoder (128 Kbps, 48 KHz)	53	123	41	100	9.5

* Average MHz required for single-cycle memory. 1 MHz = 1 MCPS

** RAM includes persistent, scratch and stack

HiFi 2 & HiFi EP Audio DSPs

Audio Codecs	Clock Rate Required* (MHz)	Code Size - ROM (KB)	Table Size - ROM (KB)	RAM** (KB)	I/O Buffer - RAM (KB)
MPEG 2/4 AAC LC Stereo Decoder (128 Kbps, 48 KHz)	8.1	34	20	18	5.5
MPEG 2/4 AAC LC Stereo Decoder (320 Kbps, 48 KHz)	11	34	20	18	5.5
MPEG-4 AAC LC Decoder, 7.1 ch. (576 Kbps, 48 KHz)	34	34	20	66	38
MPEG-2/4 AAC LC Stereo Encoder (128 Kbps, 48 KHz)	38	74	27	50	9.5
MPEG 2/4 AAC LC Stereo Encoder (320 Kbps, 44.1 KHz)	44	74	27	50	9.5
MPEG-4 BSAC Stereo Decoder (64 Kbps, 44.1 KHz)	25	33	24	33	10
MPEG-4 BSAC Stereo Decoder (128 Kbps, 48 KHz)	45	33	24	33	10
Ogg Vorbis Stereo Decoder (128 Kbps, 44.1 KHz)	12	28	19	86	16
Ogg Vorbis Stereo Decoder (320 Kbps, 44.1 KHz)	17	28	19	86	16
RealAudio 8 Stereo Decoder (96 Kbps, 44.1 KHz)	9.6	8.2	32	23	6.2
RealAudio 9 Stereo Decoder (128 Kbps, 44.1 KHz)	8.1	34	20	18	5.5
RealAudio 10 Stereo Decoder (64 Kbps, 44.1 KHz)	19	63	31	46	18
SBC Bluetooth Stereo Decoder (512 Kbps, 48 KHz)	7.7	5.1	2.5	4.6	1
SBC Bluetooth Stereo Encoder (512 Kbps, 48 KHz)	7.8	6.5	2	6.8	1
WMA Stereo Decoder (22 Kbps, 22 KHz)	12	29	52	52	12
WMA Stereo Decoder (128 Kbps, 44.1 KHz)	11	29	52	52	12
WMA Stereo Decoder (320 Kbps, 48 KHz)	15	29	52	52	12
WMA Stereo Encoder (128 Kbps, 44.1 KHz)	49	127	105	167	41
WMA 10 Pro Decoder (2 ch, 128 Kbps, 44.1 KHz)	11	230	152	245	256
WMA 10 Pro Decoder (7.1 ch, 768 Kbps, 48 KHz)	115	230	152	245	256
WMA 10 Pro Lossless Decoder (2 ch, 1.58 Mbps, 44.1 KHz)	97	252	152	415	256
WMA 10 Pro Lossless Decoder (7.1 ch, 5.59 Mbps, 48 KHz)	187	252	152	415	256

Voice Codecs	Clock Rate Required* (MHz)	Code Size - ROM (KB)	Table Size - ROM (KB)	RAM** (KB)	I/O Buffer - RAM (KB)
AMR Narrowband Speech Codec (5.15 Kbps)	18	63	31	13	3.6
AMR Wideband Speech Codec (8.85 Kbps)	29	63	27	18	3
G.729AB Speech Codec (8 Kbps)	14	36	6	7.9	0.8
GSM-EFR Speech Codec (12.2 Kbps)	21	48	23	13	0.7
GSM-FR Speech Codec (13 Kbps)	2.7	12	1	3.5	0.7
GSM-HR Speech Codec (5.6 Kbps)	15	58	16	10	0.7

3rd Party Audio	Clock Rate Required* (MHz)	Code Size - ROM (KB)	Table Size - ROM (KB)	RAM** (KB)	I/O Buffer - RAM (KB)
Acoustic Technologies	Contact A.T.		www.acoustictech.com		
AM3D Zirene Audio Enhancement and Diesel Power Mobile 3D	Contact AM3D		www.am3d.com		
Arkamys Audio Enhancement Software	Contact Arkamys		www.arkamys.com		
Audyssey Sound Correction Technology	Contact Audyssey		www.audyssey.com		
QSound Qvoice, microQ (MIDI, 3D positional, effects)	Contact QSound		www.qsound.com		
Sensory TrulyHandsfree Voice Control	Contact Sensory		www.sensory.com		
SRS StudioSound HD, TruSurround HD, WOW-XT and Xspace 3D	Contact SRS Labs		www.srslabs.com		

* Average MHz required for single-cycle memory. 1 MHz = 1 MCPS

** RAM includes persistent, scratch and stack

Power Savings

Through a combination of significantly lower power per MHz and architectural optimization of the 24-bit HiFi Audio DSP instruction set, the HiFi Audio Engine delivers dramatic improvements in energy efficiency that lead to increased battery life for portable and wireless applications. Based on TSMC's 40 nm LP process and a minimal HiFi 2 configuration, power is as low as 21 μ W/MHz dynamic and 7.5 μ W static. Decoding a typical MP3 file at 5.7 MHz requires only 0.13 mW of total power.

Simplified Programming

A key advantage of the HiFi Audio DSP is its simple programming model. Because of the efficiency of the optimized audio and voice instructions, software developers can port audio and voice codecs completely in C while maintaining or surpassing the performance of assembly on other DSP and CPU architectures.

Lower Gate Count

Through careful engineering and by fully exploiting the features of the Xtensa LX architecture, Tensilica was able to implement the HiFi 2 Audio DSP ISA in approximately 45K gates. A minimal configuration, including the Xtensa LX processor, is approximately 67K gates.

Performance to Spare

Because of the efficiency of the HiFi Audio architecture, the HiFi Audio DSPs require only a fraction of the available MHz to perform the audio decoding and encoding functions. Targeting high performance applications, the HiFi Audio DSP can support speeds greater than 900 MHz in TSMC 45GS, 600 MHz in TSMC 65GP, and 500 MHz in TSMC 40LP, leaving lots of headroom for other control, media and signal processing tasks.

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