cādence®

Tensilica HiFi DSP Family
Configurable processors for audio, voice, and speech processing

Today's audio, voice, and speech processing applications challenge designers to manage a wide breadth of performance and power requirements to create compelling, interactive, and immersive experiences for their customers. The Cadence® Tensilica® HiFi DSP Family for Audio, Voice, and Speech offers a low-energy, high-performance, highly optimized DSP solution that spans the entire spectrum of audio and voice algorithms and end equipment.

Overview

Audio/voice/speech (AVS) processing covers a very wide range of performance- and power-consumption requirements. On one end of the spectrum is the ultra-low-power "wake-on-voice" processing found in many of today's smartphones and wearables. On the other end, building state-of-the-art voice-controlled digital assistants requires advanced audio digital signal processing capabilities to efficiently run neural network-based speech recognition. At the heart of these new AVS innovations is the desire of OEMs to create more compelling, interactive, and immersive experiences with their devices.

Using different processor architectures to handle the breadth of applications in the AVS domain would be very costly in terms of software development and product management. The Tensilica HiFi DSP family for audio, voice, and speech addresses this broad range of requirements, offering low-energy, high-performance processing for the entire spectrum of audio- and voice-processing algorithms and end equipment while maintaining software compatibility across

Figure 1: HiFi DSP Audio and Voice Applications

the portfolio. HiFi DSPs can be found in SoCs across all major markets including mobile, automotive, home audio, television, computing, and gaming (see Figure 1). Whether you are optimizing to increase battery life, save thermal power, or save costs, there is a compelling HiFi DSP that meets your audio requirements.

With over 90 licensees, over 125 partners, and 300 software packages and growing, the HiFi DSP instruction set architecture (ISA) is the #1 DSP architecture for SoC designers.

Tensilica HiFi DSP Family Specifications

ISA Subset Variant		HiFi24 ISA	HiFi32 ISA				
		HiFi Mini	Fusion F1	HiFi 3	HiFi 3z	HiFi 4	HiFi 5
		v24	v32(c)(f)	v32(vf)	v32(vf)	v32(vf)	v32(vf)
VLIW Slots		2	2	3	3	4	5
VLIW Bundle Instruction Sizes		40-bit	40/48-bit	64-bit	40/48/64-bit	48/88-bit	64/128-bit
Fixed-Point MACs per Cycle	32x32	n/a	1	2	2	4	8
	24x24	2	2	4	4	4	8
	32x16	2	2	4	4	up to 8	16
	16x16	2	2 or 4	4	up to 8	up to 8	16
Accumulator		56-bit	64-bit	64-bit	64-bit	64/72-bit	64/72-bit
FPU (optional)		Scalar (Independent) FPU	Integrated Scalar VLIW FPU	Integrated 2-way SIMD VFPU	Integrated 2-way SIMD VFPU	2 integrated 2-way SIMD VFPU	2 integrated 4-way SIMD VFPU
ITU Intrinsic Support		No	Yes				
Circular Buffer Support		None	1	1	1	2	3
Bitstream VLE/VLD Support		Yes	Optional	Yes	Yes	Yes	Yes
User-defined instructions		Limited	Yes	Yes	Yes	Yes	Yes
Other Notes		Includes 32x24 precision MAC	Optional connectivity protocol acceleration				32 MACs/cycle NN MACs (optional) half-precision FPU

ISA Variant Definitions	v24	Base HiFI instruction set, 24-bit and 16-bit data types
	v24e	Enhanced precision 32x24 support, circular buffer
	v32	Superset of v24 with additional operations on 32-bit types
	v32(f)	Single-precision integrated IEEE floating point
	v32(vf)	Single-precision integrated IEEE vector floating point
	v32(c)	Communications protocol acceleration (AES, convolutional encoding,…)

HiFi DSP Family Summary

- HiFi Mini DSP – A superset of the HiFi 2 DSP designed to support lowest area and power for always-listening voice trigger

- HiFi 3 DSP – Most energy-efficient DSP for a broad range of applications in mobile, wearables, home, and automotive applications

- HiFi 3z DSP – Most energy-efficient DSP for object-based audio, super-wideband voice codecs, and neural network-based automatic speech recognition (ASR)

- HiFi 4 DSP – Highest performance HiFi DSP, for object-based audio, digital assistants, front-end processing, and neural network-based ASR

- HiFi 5 DSP – Performance leader for AI speech and audio processing with up to 4X the NN performance and 2X the audio DSP performance of the HiFi 4 DSP. Ideal for digital assistants, infotainment, and other voice-controlled products.

Low-Power, High-Performance Audio and Voice DSPs

The HiFi DSP ISA is highly optimized for AVS applications. By optimizing more than 200 software packages, the HiFi ISA provides the lowest energy, highest performance DSPs for audio and voice. This performance scales across the entire DSP product family, from the ultra-low-energy 24x24 dual MAC HiFi Mini DSP, to the energy-efficient 24x24 quad MAC HiFi 3 DSP, to the high-performance 32x32 8-way MAC HiFi 5 DSP.

Audio and Voice Software and Ecosystem

OEMs continue to look to AVS as a means to differentiate their products and provide a compelling user experience, adding features such as voice trigger and advanced voice recognition to their products. In the home audio and voice market, this could mean supporting the latest object-based audio decoder or the latest 3-D and AR/VR-positional audio post-processing suites.

By choosing Cadence's HiFi DSP family, SoC designers can ensure that the broadest set of codecs and pre-/post-processing software is immediately available to their customers. Currently more than 300 different software packages are available as part of the largest audio and voice ecosystem for any DSP in the market. This means that all of the newest and most innovative audio and voice IP is always available with HiFi DSPs.

Flexibility

HiFi DSPs are completely configurable, giving the SoC designer control of numerous pre-defined functions and features, including the memory subsystem, debug, floating point, and many others.

In addition to configuration options, the SoC designer can choose to further improve performance and reduce energy for any given application by adding custom instructions and more I/O bandwidth. This is possible because all HiFi DSPs are based upon the Cadence Tensilica Processor Generator, which allows designers to add value through additional customization while remaining completely compatible with the HiFi software ecosystem (see Figure 2).

Ease of Programming

HiFi DSPs offer a key advantage—their simple programming model. Software developers can write audio and voice applications completely in C using efficient, optimized audio and voice instructions, maintaining or surpassing the performance of the same applications built with assembly code.

Cadence Services and Support

- Cadence Tensilica application engineers can answer your technical questions and provide technical assistance and custom training.

- Cadence-certified instructors teach a series of courses on Tensilica IP and bring their real-world experience into the classroom.

- Internet Learning Series (iLS) online courses allow you the flexibility of training at your own computer via the Internet.

- The Cadence Tensilica IP support site gives you 24x7 online access to a knowledgebase of the latest solutions, technical documentation, software downloads, and more at ip.cadence.com/support
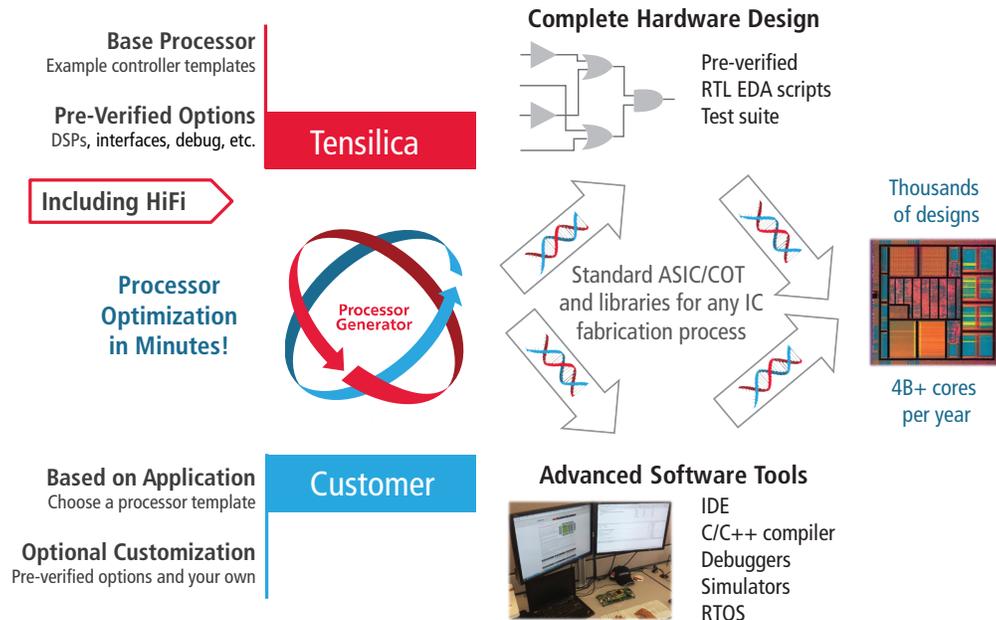

Figure 2: Tensilica Processor Development Flow