

Tensilica Fusion G DSP Family

Multi-purpose, fixed- and floating-point DSP with exceptional out-of-the-box performance

The scalable Cadence® Tensilica® Fusion G DSP Family includes two high-performance, general-purpose, fixed-and floating-point vector processors: the Fusion G3 DSP and the Fusion G6 DSP. This easy-to-program DSP family, with its highly advanced auto-vectorizing compiler and optimized DSP library, provides exceptional out-of-the-box performance for both DSP and control code. Its comprehensive instruction set, along with extensive integer and floating-point data type support, make it ideal for compute-intensive signal processing applications in automotive, consumer, mobile, internet of things (IoT), and industrial applications.

Overview

As devices strive to become smarter, they need to interact more extensively with the world around them. This includes continuously innovating with newer and more sophisticated algorithms to process real-world sensor or derived data. The rapid cycle of innovation is more easily enabled by the high-performance Fusion G DSP Family, with its rich and orthogonal instruction set and high-precision fixed- and floating-point data types. Software development is simplified with programming in C/C++, an auto-vectorizing compiler, and an extensive DSP software library, all courtesy of the mature Cadence Tensilica Xplorer® integrated development

environment. Further gains in performance may be achieved with the simple addition of application-specific instructions that seamlessly integrate with the DSP's instruction set and are fully supported by the optimized C/C++ compiler and SDK.

The Fusion G DSP Family features an 11-stage, 4-slot very long instruction word (VLIW) pipeline and scales with single-instruction multiple-data (SIMD) data paths. The Fusion G3 DSP supports 4-way vectorization for 32-bit integer types and single-precision floating-point. The Fusion G6 DSP doubles the performance with 8-way vectorization. Further levels of vectorization are also

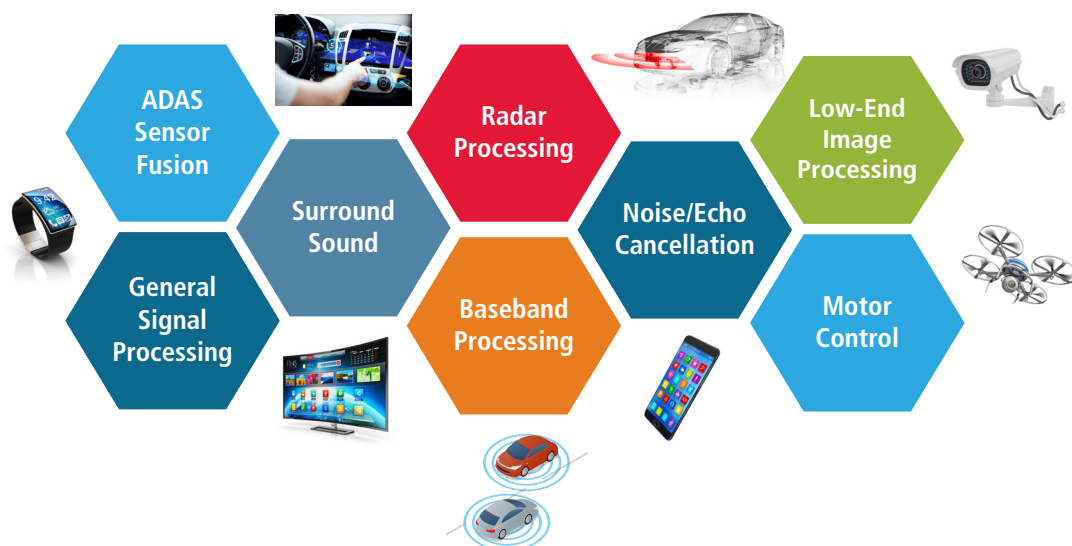
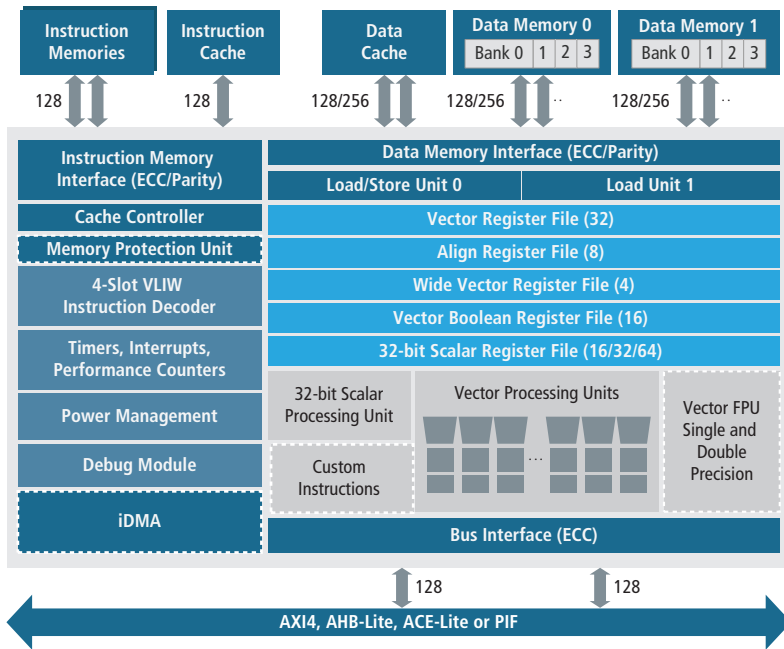


Figure 1: Fusion G DSP Family Application Examples



Features	Fusion G3	Fusion G6
VLIW		
4-slot, 128-bits wide	✓	✓
SIMD Vector Width	Vector Elements	
16-bit fixed point	8	16
32-bit fixed and floating point	4	8
Data Path Width	Bits	
LD/ST, vector register files	128	256
Data cache/memories (4 banks)	128	256
Instruction cache/memories	128	128
Fixed-Point Compute	MACs	
16*16-bit	8	16
32*32-bit	4	8
Floating-Point Compute	FMA/MACs, ADDSUB	
Single-precision VFPU	4	8
Double-precision VFPU	2	4

Figure 2: The Fusion G DSP Family block diagram

supported with native 8-, 16-, 32-, and 64-bit data types. Dual load-store and load units, coupled with vector and wide accumulation vector register files ensure maximum data throughput for the computational units.

The Fusion G DSP Family is built on the configurable Xtensa LX 32-bit scalar processor, with flexible memory and I/O subsystems, an optional integrated DMA controller (iDMA), and optional memory protection unit (MPU). The high performance, low power, and small footprint make the Fusion G DSP Family ideal for highly integrated, embedded SoC designs with single or multicore processors running real-time control and DSP applications.

Fusion G DSP Family Features and Benefits

- General-purpose, fixed- and floating-point processor with exceptional out-of-the-box performance
- Extensive ISA with instructions and operations for multiple signal-processing applications
- Quick and easy performance for many signal-processing applications, with support for a wide range of data types from 8- to 64-bit
- Implements a 4-way VLIW and 128/256-bit SIMD architecture (for Fusion G3/G6 DSPs) delivering multiple operations per cycle
- Optional IEEE 754-compliant single- and double-precision vector floating-point unit (VFPU) with four 32-bit single-precision floating-point MACs for the G3 and eight for the G6

- Peak performance of up to 16/32 GFLOPS (for Fusion G3/G6 DSPs) at 1GHz
- Half-precision conversion operations are available to save memory when storing floating-point data
- Complete memory subsystem with support for instruction and data caches and instruction and data local memories (implemented as ROM or RAM), all with optional ECC and parity support
- Optional integrated DMA controller for efficient data transfers to and from system memory
- Optional memory protection unit
- Configurable external bus interface supports AXI4, AXI3, ACE-Lite, and AHB-Lite interface standards with optional ECC support
- Optimized auto-vectorizing compiler for exceptional out-of-the-box performance
- M-way vector programming support, based on 32-bit vector elements for seamless code portability across the Fusion G DSP Family
- Extensive software DSP library with over 550 signal-processing tasks and functions
- Simple and powerful instruction-set extensibility for customer-specific instructions using TIE

Key Fusion G DSP Family Features

Specification	Fusion G3 DSP	Fusion G6 DSP
Load/store	Dual 128-bit load/store and 128-bit load units	Dual 256-bit load/store and 256-bit load units
Instruction lengths (bits)	128, 64, 24, 16	
VLIW	128 bits wide, 2- or 4-issue slots	
SIMD	2/4/8/16-way for integer, 2/4-way for floating point	4/8/16/32-way for integer, 4/8-way for floating point
Data formats	8/16/20/32/40/64/80 real integer, 32/64 real and complex floating-point	
Vector register files	32 entries x 128-bit, 4 entries x 320-bit (wide data)	32 entries x 256-bit, 4 entries x 640-bit (wide data)
ALU operations/cycle	2, 4, 8, 16 for 64, 32, 16, 8-bit	4, 8, 16, 32 for 64, 32, 16, 8-bit
Multiply bit width	8 x 8, 16 x 16, 32 x 32, 64 x 64	
MACs/cycle	1, 4, 8, 16 for 64, 32, 16, 8-bit	2, 8, 16, 32 for 64, 32, 16, 8-bit
16-bit complex MAC throughput	2 per cycle	4 per cycle
Guard bits	4/8/16-bit on 16/32/64 types (utilizing 20/40/80-bit accumulators)	
Aligning load	Available in either of two slots	
Addressing modes	Post-increment, reverse, circular, and general	
Floating-point configuration options	IEEE-754 compliant, single-precision vector floating-point or single- and double-precision vector floating-point	
Floating-point operations	Vector MAC, FMA, ADDSUB, ALU, and type conversion, including to/from half-precision	
MAC/FMA/ADDSUB per cycle	2, 4 for double, single-precision floating-point	4, 8 for double, single-precision floating-point
Division/reciprocal/RSQRT	Included in ISA: integer division and floating-point division/reciprocal/RSQRT	
Vector-programming support	M-way, 32-bit based	
FFT acceleration	ADDSUB included for 2X FFT speedup (fixed- and floating-point)	
Image processing	Scatter gather and histogram	
Vector predication	ALU, MAC, LOAD/STORE, etc.	
DMA support	Integrated DMA controller option and support for external DMA controller	

Toolchain and Design Flow

The Fusion G DSP Family is delivered with a complete set of software tools, including:

- High-performance C/C++ compiler with automatic bundling and vectorization to support the VLIW and SIMD capabilities
- Linker, assembler, debugger, profiler, and graphical visualization tools
- Comprehensive cycle-accurate instruction set simulator (ISS), which allows you to quickly simulate and evaluate performance
- Fast, functional instruction-accurate TurboXim simulator achieves speeds that are 40X to 80X faster than the ISS for efficient software development and functional verification when working with large systems or lengthy test vectors
- Xtensa Modeling Protocol (XTMP) for system modeling in C and Xtensa SystemC (XTSC) for system modeling in SystemC® provide for full-chip simulations. The pin-level XTSC model offers co-simulation of the SystemC model at the pin level for fast, cycle-accurate system simulations
- All major back-end EDA flows are supported

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



Cadence Design Systems enables global electronic design innovation and plays an essential role in the creation of today's electronics. Customers use Cadence software, hardware, IP, and expertise to design and verify today's mobile, cloud, and connectivity applications. www.cadence.com