

Quad Cortex Magic Sound Box Powered by SHARC+ DSPs

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State-of-the-art emulations of your favorite music gear with unprecedented accuracy and unbelievably natural dynamic response.

Neural DSP develops technology to advance the state-of-the-art in the music industry by at least two decades an order of magnitude earlier. With this very ambitious goal, **Quad Cortex**, the most powerful floor modeler on the planet, was born. With 2 GHz of programmable digital signal processor (DSP) performance from its quad-core **SHARC+** architecture, this ludicrous amount of processing capacity provides limitless sound design possibilities.



Figure 1. Quad Cortex floor modeler.

Enabling Creativity

The main goal of Quad Cortex was to provide a platform in which musicians have enough sonic and routing options to be creative without any limitations. On the surface, the product had to look simple and clean, with an intuitive and fun to use graphical user interface (GUI) that abstracts system implementation complexity from the end user.

Therefore, it was all about the Neural DSP engineering team working through the hardware and software design challenges so that users can reap the benefits of maximum optionality and versatility, while keeping the experience extremely clean, simple, and enjoyable.

Power and Ease of Use

In music devices, users must almost always choose between power and simplicity. Neural DSP's main challenge was to create a product that was powerful enough for the most demanding musicians in the world, while being simple and intuitive enough for absolute beginners. Therefore, ease of use, scalability, programmability, power efficiency, and deterministic low latency audio processing capabilities were critical.

There was only one road that these challenging criteria could lead Neural DSP down: Analog Devices' SHARC+ DSP product offerings. SHARC+ technology, as described by the audio engineering industry, is the gold standard in professional audio (pro audio). The convenience of having ultra-powerful multicore system-on-a-chip (SoC) product variants made the solution very appealing. Neural DSP quickly realized that it was possible to build a very powerful system around a single device or a combination of easy to scale devices, which is simply great when it comes to accelerating the systems architecting process.

ADSP-SC58x and ADSP-2158x Multicore Processor Series

The **ADSP-SC58x and ADSP-2158x processor series** (hereafter referred to as ADSP-SC589) are members of the SHARC+ family of products. Multicore SHARC+ and Arm® SoCs deliver high performance, deterministic low latency audio processing capabilities for advanced real-time automotive, consumer, and professional audio market segments. The ADSP-SC589 processor is based on the dual SHARC+ single-instruction multiple-data (SIMD) core and the Arm Cortex®-A5 core. These 32-bit/40-bit/64-bit floating-point processors are optimized for high performance audio/floating-point applications with large, on-chip, static random access memory (SRAM), multiple internal buses that eliminate input/output (I/O) bottlenecks, a feature-rich audio peripheral set, and a wide variety of control and connectivity options, as depicted in the block diagram in Figure 2.

Quad Cortex architecture is based on two ADSP-SC589 devices, resulting in a quad SHARC+ core setup for signal processing, which translates into 2 GHz of programmable DSP performance—plenty of horsepower!

Accelerating System Performance Through Hardware Filter Blocks

In addition to the high performance floating-point cores and large on-chip memory—which make them ideally suited for the implementation of low latency audio signal processing algorithms and the storage of large audio data buffers—SHARC+ processors feature dedicated hardware accelerator engines, such as a high performance fast Fourier transform (HP FFT) and finite/infinite impulse response (FIR/IIR) blocks.

Quad Cortex impulse response-based speaker simulation leverages the on-chip FIR hardware accelerator, freeing up the SHARC+ cores for additional parallel computations, resulting in enormous core millions of instructions per second (MIPS) savings. Also, the FIR block is great for antialiasing purposes,

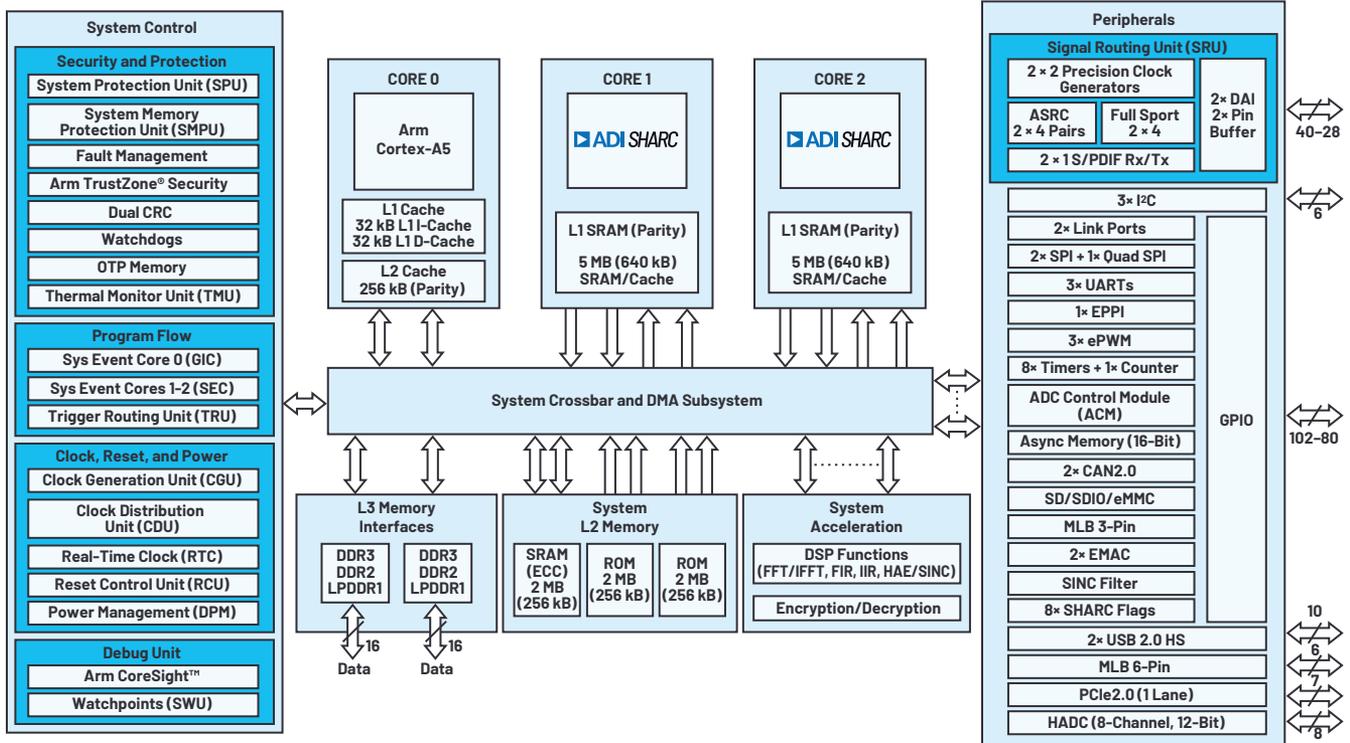


Figure 2. ADSP-SC58x SHARC+ processor block diagram.

which is another big need when models of ultrahigh gain, nonlinear systems, such as guitar amplifiers, are required.

Furthermore, the on-chip hardware cryptography engine enables a wealth of security features such as secure booting, IP code authentication, confidentiality, decryption, and encryption, all of which are key requirements for guaranteeing secure product deployment, while protecting manufacturers' intellectual property (IP), an increasing concern in today's pro audio market.

Superb Sub-3 ms Audio Processing Latency

The SHARC+ SoC architecture features high speed direct memory access (DMA) channels and large internal SRAM memory blocks (L1 and L2), which enabled the implementation of efficient on-chip and off-chip intercore communication protocols. Similarly, its feature-rich peripheral set, such as the byte-wide link ports for audio and high speed data exchange between the two on-board ADSP-SC589 devices, combined with the 2-wire interface (TWI)—I²C, for musical instrument digital interface (MIDI) and diagnostics—resulted in a very impressive low latency of less than 3 milliseconds!

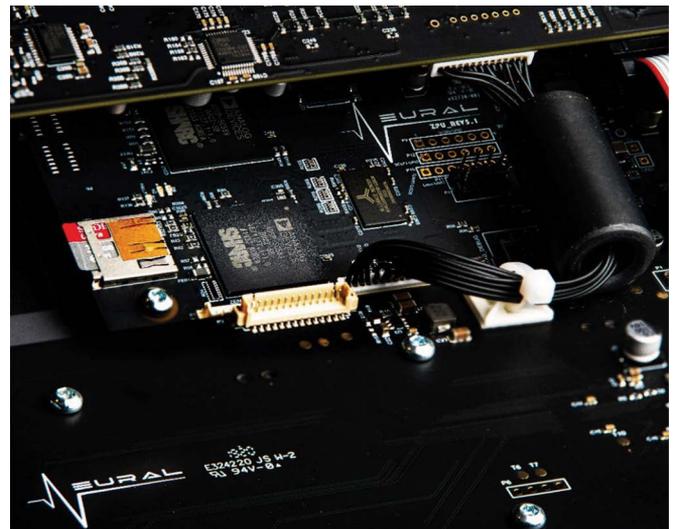


Figure 3. Quad SHARC+ multichip and multicore architecture.

Integrated Heterogenous Cores Architecture

The Quad Cortex floor modeler features a massive 7" multi-touch display. A powerful parametric equalizer (EQ) gives users absolute control with amazing ease at their fingertips. Whereas the SHARC+ DSP cores are fully focused on advanced audio processing, the integrated on-chip Arm Cortex-A5 core hosts a Linux® operating system used as the main controller of the product, with the user interface (UI) running on top of it.

Additionally, an Audio Class 2 compliant device is managed through the device USB interface—again, hosted by the same Arm core. This makes the ADSP-SC589 integrated heterogenous cores a perfect complement to the dedicated control and connectivity functions of the Arm core, leaving the computationally intense audio effects processing to the SHARC+ DSP floating-point engines.



Figure 4. A 7" multi-touch display powerful parametric EQ.

Neural Capture and Artificial Intelligence

Among many of the high end audio processing features, the Neural DSP Quad Cortex architecture supports capturing, sharing, and downloading a musician's favorite rigs' sounds. Equipped with unique biomimetic artificial intelligence (AI) technology, Quad Cortex can learn and replicate the sonic characteristics of any physical amplifier, overdrive, and cabinet with unprecedented accuracy.

Unlike any other, the Neural DSP sophisticated neural network algorithm perceives sound akin to human perception, making it a fabulous natural-sounding capture solution. This process, which is borderline deep learning, is quite computationally intensive. All four available SHARC+ DSP cores, largely based on their exceptionally powerful floating-point processing capabilities, are leveraged to make this process extremely time efficient.

Light Compact Unique Design

But it is not all about its unprecedented accuracy and unbelievably natural dynamic response. Quad Cortex is also an ultra-compact, modern, and light aluminum unibody. This product uses a proprietary design that allows its footswitches to be used as knobs. All of this combined not only makes Quad Cortex roughly twice as powerful as its closest competitor, but also half the weight and less than a third of the size, enabled by SHARC+ technology's compact and integrated SoC solution. ADSP-SC589 multicore processors come in a compact 19 mm × 19 mm, 529-ball BGA package.

The Quad Cortex SHARC+ project was born as a part of a challenging but entertaining journey. Image rendering for a responsive UI, training neural networks with DSP cores, implementing optimized audio algorithms, developing a cloud platform for wireless preset sharing, and performing firmware updates represent a few of the many challenges faced during the development and creation of this groundbreaking device. Needless to say, it has taken dozens of people years to

put this amazing product together, but both Neural DSP and Analog Devices truly believe that it has resulted in a best-in-class piece of pro audio equipment that will help musicians be more creative and inspired than ever!

References

[Quad Cortex Product Page](#). Neural DSP Technologies, 2020.

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