AT91R40807 for Audio Decoding Systems

Audio Coding Market

Driven by the need to reduce file size for high-quality audio signals in order to minimize download time for use on the Internet, audio coding technology is now becoming important for an increasingly broad range of applications. The advances made in this technology will result in revolutionary changes in the design and development of personal portable audio systems.

Personal portable audio systems integrate:

- A slot for Flash memory cards to store compressed music files
- A decoder implemented either as a hardwired block, or in software running on a processor
- A link to a PC for downloading music files
- A digital-to-analog converter and the associated analog chain for sound output

As the market grows, so the players are becoming more numerous, the most prominent today being supplied by Diamond, Creative and Samsung. The music industry recognizes the Internet as a powerful distribution channel and a growing number of MP-3 Internet sites have been created.

The most common coding technology used is MP-3, but the market is changing rapidly and new audio standards are emerging. MPEG-AAC and Microsoft WMTA are two serious competitors as they have better results in terms of quality or compression ratio for the same performance requirements. This evolution in standards eliminates the use of hardware decoding solutions that lack the required flexibility.

A key design consideration for these systems is power consumption. Most personal audio systems need to be portable, and so are battery-powered. This forces the developers to optimize the performance/power consumption ratio. The most effective design solution so far is a fully integrated system with a processor that can transfer compressed music files from the PC, download these to Flash memory, decompress the files and transfer the audio data to the analog output chain.

Perhaps the most far-reaching design advantage that has emerged from audio coding technology is the reduction of the data transfer bandwidth needed for the transmission of high precision digital signals. This advance interests, amongst others, the communications market. Today MP-3 decoding has been announced by Ericsson as an integrated function on its next generation of cellular phones, and it is feasible that this kind of decoder will be soon present in communicators, PDAs, automotive audio systems and in many other systems.

AT91
ARM® Thumb® Microcontrollers

Application Note

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The ARM7TDMI - Processing Power for Audio Decompression

The ARM7TDMI™ microprocessor core leads the industry in terms of reduced power consumption, high data transfer and high data processing, and is equipped with basic DSP functions like hardware multiplier and barrel shifter so ARM® Thumb® is a natural contender for this new market opportunity.

Used initially in ASICs, Atmel now offers the ARM7TDMI in Standard Microcontroller Products. ARM® is an industry standard and many companies are using ARM architecture for new product development.

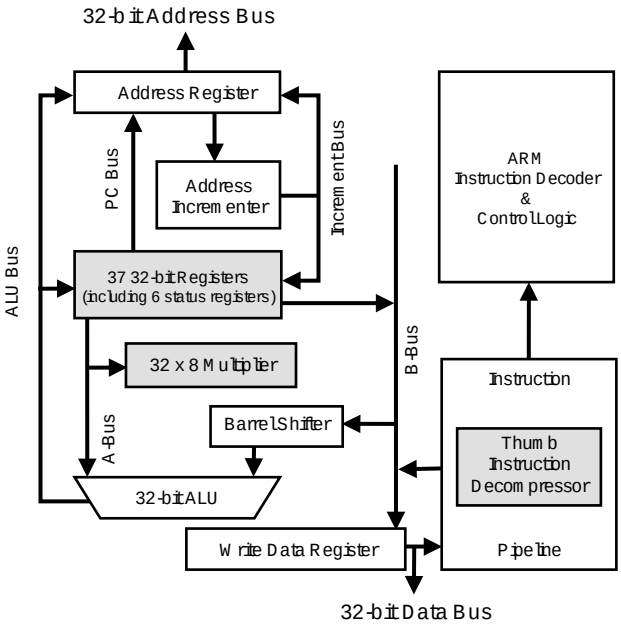
One of the major advantages of the ARM7TDMI is its double instruction set. A highly efficient 32-bit ARM instruction set provides maximum performance. It offers the highest product performance in terms of processing and interrupt latency, and therefore enables the programmer to use software peripherals and digital signal processing algorithms.

The 32-bit ARM instruction set has a Multiply and Accumulate Instruction, generally reserved for DSP devices. It makes complex algorithm processing, such as MP3 and WMTA decompression, possible. Its barrel shifter is used by the scaling operations on digital data.

The high-density 16-bit Thumb® instruction set reduces system cost and power consumption by compressing the code required for system control. Offering an excellent compromise between performance and code size, it permits the integration of new functionality at a low cost.

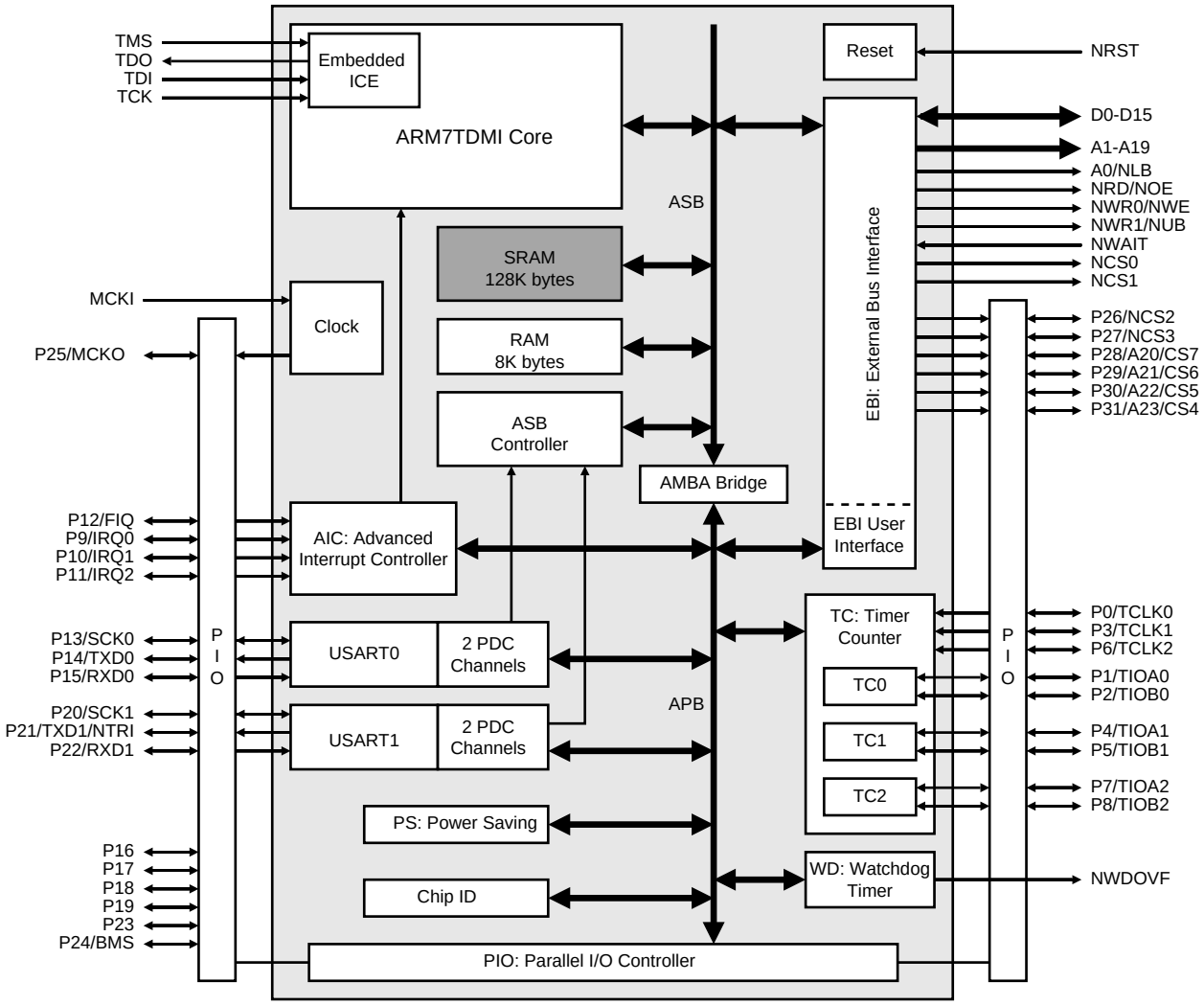
The ARM7TDMI has a 32-bit address bus and a 32-bit data bus, used for both instructions and data. Byte (8-bit), half-word (16-bit), and word (32-bit) signed or unsigned data transfer capabilities aids in data buffer manipulation. This results in an architecture that is particularly well suited for fast data transfer, whatever the buffer size.

The ability to cover a large application spectrum and to perform both simple and complex tasks provides the ARM7TDMI with a real advantage in terms of flexibility at system level integration. The tasks that are not integrated in the hardware can be easily implemented in software. Each task can run only for the short period it is required, then be replaced by another in order to optimize the system hardware resources.



The AT91R40807 - System Level Integration for Audio Decompression

The AT91R40807 is one of Atmel's AT91 ARM Thumb-based microcontroller products. Its combination of a 32-bit ARM7DTMI processor, large on-chip SRAM, an internal 32-bit bus, fast EBI and powerful peripherals enable it to perform all the operations required for audio decompression in a single IC.



The AT91R40807 offers the following features:

- Advanced System Bus, 32-bit wide running on the Master Clock for maximum bandwidth.
- Advanced Peripheral Bus, 32-bit wide double-cycle access without clock to minimize the power consumption.
- 8K bytes of integrated system memory, mapped at address 0x0, to handle dynamic vectors for ARM exceptions. Accessed via the 32-bit bus without wait state, it is ideally suited for stack allocation or data and/or code relocation for critical algorithms.
- Large 128K-byte, 32-bit single-clock cycle access SRAM, enabling the device to reach 30 MIPS at 33 MHz making it highly suitable for high-performance MP-3 or WMTA audio decoding. The ARM machine code runs out of this large SRAM without wait state, and data access is single-cycle. This is a great advantage for software that needs a deterministic interrupt latency time or that has to run as fast as the processor is able. This memory bank makes the AT91R40807 the ideal platform for memory-hungry software peripherals and DSP algorithms.
- Integrated Advanced Interrupt Controller and an Atomic Interrupt Control System integrated on the peripherals, particularly suited for real time operation. Both minimize the interrupt latency time of the ARM core, and enable modular and fully independent interrupt handling.

- ASB Controller and Peripheral Data Controller channels that optimize data transfer between the serial peripherals and the internal or external memory. Dedicated to each peripheral, the PDC channels are easy to program and reduce the ARM core overhead for peripheral data buffer handling.
- Power Saving Module that creates an Idle Mode for the ARM core, switching off its clock until the next interrupt and enabling it to deactivate unused peripherals, thus reducing power consumption to a strict minimum at any time.

AT91-based Audio Decoding System

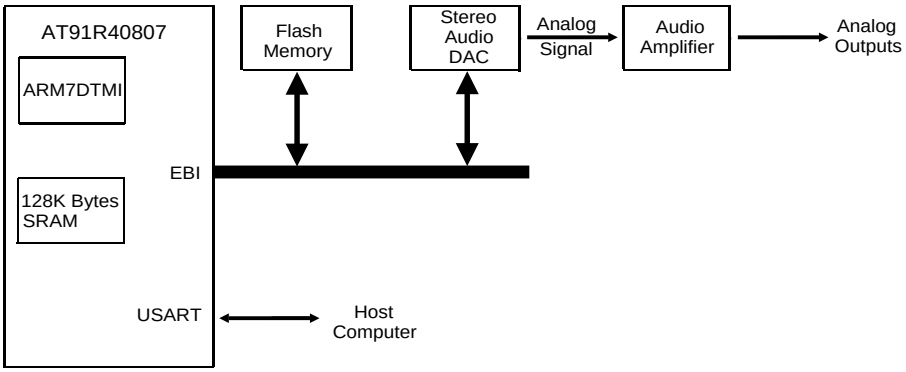
The AT91R40807 ARM7TDMI-based microcontroller architecture is well adapted for audio data coded in up to 24 bits. It has certain DSP capabilities and delivers high performance with minimal system power consumption when running from on-chip memory. It is particularly well-suited for audio decoding systems under the optimum conditions of running 32-bit ARM instructions and accessing data without wait state. These conditions are what the AT91R40807 offers when both program and data are allocated or relocated in its large internal SRAM. An audio decoder solution based on a single AT91R40807 microcontroller is a perfect alternative to high-power DSP and small microcontroller or application specific hardware. It reduces the number of components and minimizes system cost.

MP-3 and MPEG-AAC decoders are proposed as software IPs by ARM for the ARM7TDMI. Microsoft has also ported its WMTA technology to the ARM7TDMI.

For MP-3 the ARM7TDMI has to be clocked at 29 MHz, with 27K bytes of program and 21K bytes of data for a sample rate of 48KHz. This is the peak requirement for a 320K bits/sec stream. MPEG-AAC has to be clocked at 22.7 MHz, with 54K bytes of program and 18K bytes of data. The WMTA decoder offered by Microsoft also requires a 22.7 MHz clock, with 37.4K bytes of program and 19.7K bytes of data.

These speeds are well within the limits of the AT91R40807, which is capable of running at up to 40MHz. Associated with a parallel stereo audio digital-to-analog converter, and Flash memory devices, the AT91R40807 provides the best solution for an integrated Personal Portable Audio System. The Power Saving module ensures maximum performance for minimum power consumption, giving the AT91R40807 an advantage over other products.

It is easy to integrate the AT91R40807 into a product, as an independent module to decode audio signals. In this case, the algorithm is downloaded after the reset and executed in parallel with the main processor, which is freed to perform all other decoding system tasks. Maximum flexibility is possible as users select the decoding algorithm to be downloaded, depending on the decoding system used.



Audio Decoding System Development Tools

The above solution can be easily evaluated using an AT91EB01 equipped with an AT91R40807; the on-board memories (128K bytes of flash and 256K bytes of SRAM) are used only for boot and download sequences.

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