## FEATURES

- **Audio decoder system-on-chip**
  - — Allows for support of multiple audio decompression algorithms
  - — Supports MPEG 1, 2, & 2.5 layer 3 audio decoding, including ISO compliant MPEG 1 & 2 layer 3 support for all standard sample rates and bit rates
  - — Supports bit streams with adaptive bit rates
  - — DAI (Digital Audio Interface) providing glueless interface to low power DACs, ADCs, and Codecs
- **Ultra low power consumption for MP3 playback**
  - — 87 mW (typical) for 44.1 kHz samples/sec, 128 kbits/second
  - — 50 mW for 22.05 kHz samples/sec, 64 kbits/second
  - — <1 mW in Standby State
- **ARM720T processor**
  - — ARM7TDMI CPU
  - — 8 kbytes of four-way set-associative cache
  - — MMU with 64-entry TLB (transition look-aside buffer)
  - — Write Buffer
  - — Windows® CE enabled
  - — Thumb code support enabled

*(cont.)*

# Ultra-Low-Power Audio Decoder System-on-Chip

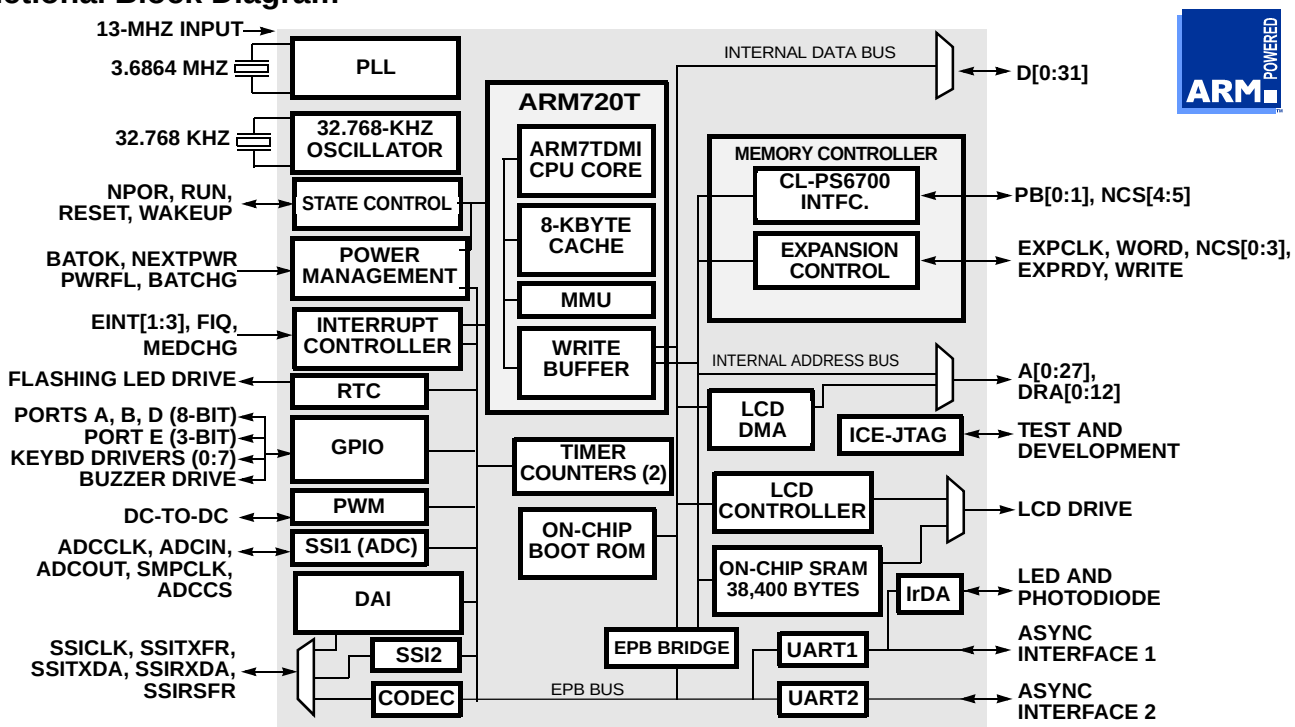
## OVERVIEW

The EP7209 is a complete integrated system on a chip for enabling personal digital audio solutions. It is designed specifically for implementing audio processing algorithms in power sensitive applications. The core-logic functionality of the device is built around an ARM720T embedded processor.

The EP7209 also includes a 32-bit Y2K-compliant Real-Time Clock (RTC) and comparator.

*(cont.)*

## Functional Block Diagram




CIRRUS LOGIC®
*P.O. Box 17847, Austin, Texas 78760*
*(512) 445 7222 FAX: (512) 445 7581*
*http://www.cirrus.com*

## FEATURES *(cont.)*

- **Dynamically programmable clock speeds of 18, 36, 49, and 74 MHz at 2.5 V**
- **Performance matching 100 MHz Intel® Pentium-based PC**
- **OEM customization**
  - — Integrated ARM720T RISC processor
  - — Up to 25 MHz of CPU processing power available (after digital audio decoding) for custom features such as software EQ or tone control, volume control, spectrum analyzer, random play order, etc.
  - — Allows for control of digital voice recorder function
- **LCD controller**
  - — Interfaces directly to a single-scan panel monochrome LCD
  - — Panel width is programmable from 32 to 1024 pixels in 16-pixel increments
  - — Video frame buffer size programmable up to 128 kbytes
  - — Bits per pixel of 1, 2, or 4 bits
- **Memory controller**
  - — Decodes up to 6 separate memory segments of up to 256 Mbytes each
  - — Each segment can be configured as 8, 16, or 32 bits wide and supports page-mode access
  - — Programmable access time for conventional ROM/SRAM/FLASH memory
  - — Supports Removable FLASH card interface
  - — Enables connection to removable FLASH card for addition of expansion FLASH memory modules
- **38,400 bytes (0x9600) of on-chip SRAM for fast program execution and/or as a frame buffer**
- **On-chip boot ROM for manufacturing support**
- **Integrated DAI interface**
  - — Connects directly to a Crystal® audio DAC
- **27-bits of general-purpose I/O**
  - — Three 8-bit and one 3-bit GPIO port
  - — Supports scanning keyboard matrix
- **SIR (up to 115.2 kbps) infrared encoder/decoder**
  - — IrDA (Infrared Data Association) SIR protocol encoder/decoder
- **DC-to-DC converter interface (PWM)**
  - — Provides two 96 kHz clock outputs with programmable duty ratio (from 1-in-16 to 15-in-16) that can be used to drive a DC to DC converter
- **208-pin LQFP or 256-ball PBGA packages**
- **Full JTAG boundary scan and Embedded ICE support**

## OVERVIEW *(cont.)*

The EP7209 also includes a comprehensive set of integrated peripherals such as an LCD display controller, an audio DAC interface, and a FLASH memory interface. Using the EP7209, a portable audio decoder solution can be built with the addition of an LCD display, an audio DAC, a FLASH memory subsystem, and a small number of additional low cost components.

The EP7209 uses its powerful 32-bit RISC processing engine to implement audio decompression algorithms in software. The nature of the on-board RISC processor and the availability of efficient C-compilers and other software development tools ensures that a wide range of audio decompression algorithms can easily be ported to and run on the EP7209.

The EP7209 uses external memory for storing application code. The use of external memory to support software audio decompression algorithms ensures that the audio decompression system solution can be tailored to the requirements of the application. Software can be placed in a low cost mask ROM for price sensitive applications, or can be placed in external FLASH memory to enable upgradeable systems. The EP7209's 8 kbyte on-board cache and programmable wait state generator ensure that a wide range of memory options can be utilized.

The EP7209 runs a full ISO-compliant MPEG 1, 2, & 2.5 layer 3 audio decompression engine with less than 50% of its available processing capability. This leaves significant processing power available for product differentiation.

### *MPEG 1, 2, & 2.5 Layer 3 Object Code Library*

Cirrus Logic provides an object code library for enabling MPEG 1, 2, & 2.5 layer 3 audio decompression. This library supports the MPEG 1 sample rates of 48 k, 44.1 k and 32 k bits per second; the MPEG 2 sample rates of 24 k, 22.05 k and 16 k bits per second; and the MPEG 2.5 sample rates of 12 k, 11.025 k and 8 k bits per second. In addition to all standard fixed compressed data rates, the MPEG layer 3 object code library also supports decompression of variable bit-rate data streams.

## OVERVIEW *(cont.)*

### Power Management

The EP7209 is designed for ultra-low-power operation. Its core operates at only 2.5 V, while its I/O has an operation range of 2.5 V-3.3 V. Through careful design, Cirrus Logic has achieved extremely low power consumption with the EP7209. This is achieved by using a combination of dynamically adjustable core clock frequencies, low power states utilized during periods of inactivity, and fully static design principles. For example, when decompressing MPEG 1 layer 3 music data with sample rates of 44.1 kHz and 128 kbits/sec, the EP7209 consumes less than 87 mW. At sampling frequencies of 22.05 kHz and 64 kbits/sec, power consumption falls to 50 mW.

### Audio Data Memory Interfaces

The EP7209 connects directly to both on-system FLASH memory and to removable FLASH memory-cards. The generality of the external interface on the EP7209 allows for the use of a wide variety of additional memory types for compressed audio data storage.

### LCD Interface

The EP7209 interfaces directly to a single-scan panel monochrome LCD display. For portable digital audio player applications that require LCDs, a 128 kbyte display buffer is provided.

### Data Download

The EP7209 along with minimal glue logic can connect to a PC through the parallel port. This enables downloading of compressed music or data from a PC to an EP7209-based portable digital audio player.

The EP7209 can also be connected to industry standard USB slave devices through an external interface. The power of the EP7209 coupled with the 36 MHz external data bus ensures that the EP7209 can support rapid transfer of compressed audio data over a USB interface.

The EP7209 also includes a built-in 115.2 kbps IrDA SIR protocol encoder/decoder that can be used to drive an infrared communication interface to download the data.

### Digital Audio Interface

The EP7209 integrates an DAI interface to enable a direct connection to many low cost, low power, high quality audio converters. In particular, the DAI interface can be used to drive the Crystal CS43L41 / 42 / 43 low power audio DACs and the Crystal CS53L32 low power audio ADC. Some of these devices feature digital bass and treble boost, digital volume control and compressor-limiter functions.

### Packaging

The EP7209 is available in a 208-pin LQFP package and a 256-ball PBGA package.

### System Design

As shown in the system block diagram, simply adding FLASH memory, an LCD, an audio DAC, and some discrete components, a complete low power digital audio player system can be made. (See the following illustration).

## OVERVIEW *(cont.)*

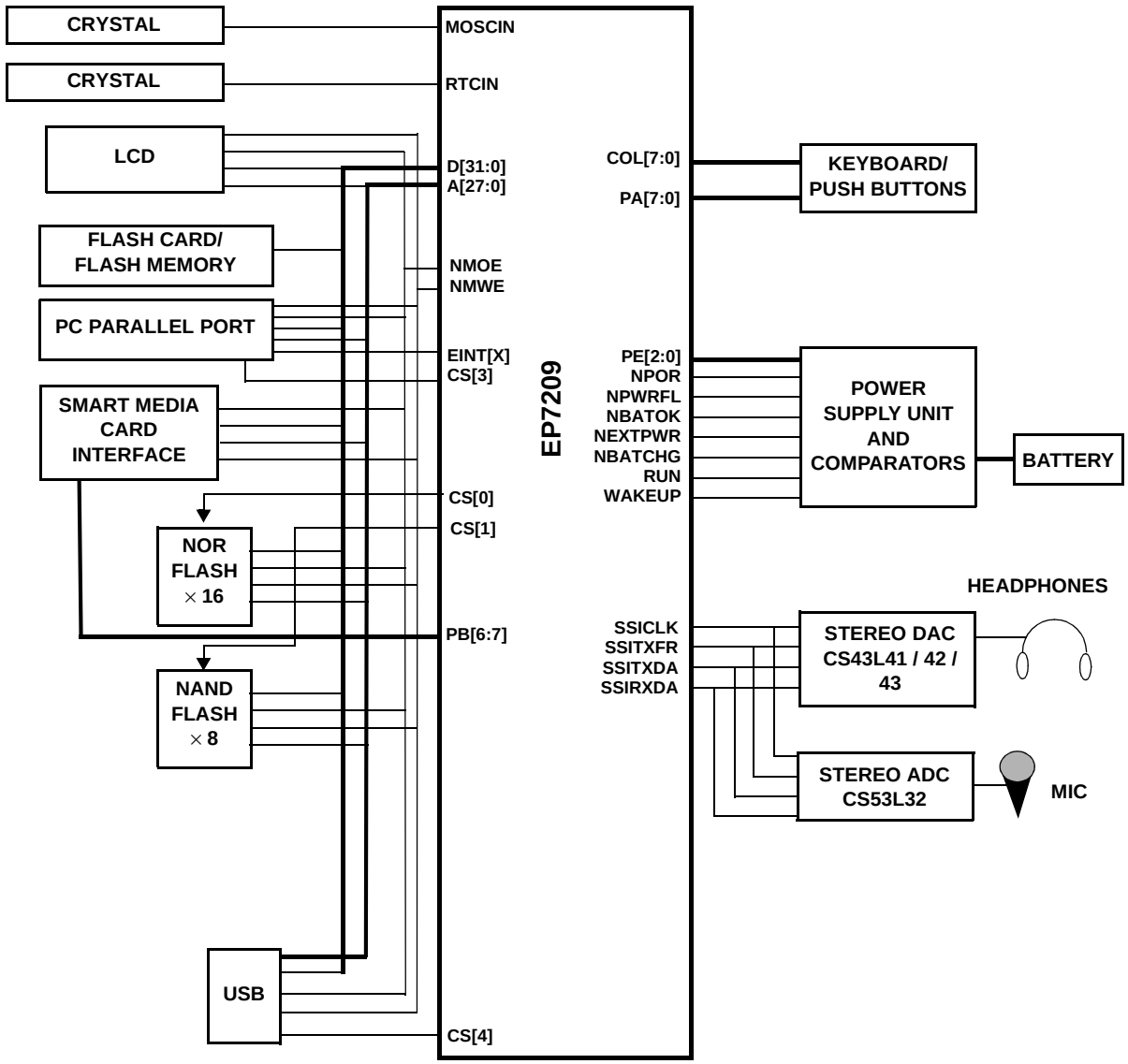



**Figure 1. A Typical EP7209-Based Digital Audio Player Reference**