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Big Type D Energy

Microcontrollers for Audio Applications

Introduction

Any modern day speaker must be able to take input from multiple sources and output clean sound. The most common solution to this problem is an embedded microcontroller or series of microcontrollers capable of decoding the audio streams, analog to digital conversion, high frequency sampling and front panel control. In addition to sound quality, battery powered speakers must also consider the power consumption of these microcontrollers. This technical review briefly summarized some commercially available microcontrollers for audio applications.

Commercial Microcontrollers

Given the demands associated with modern-day high-quality audio streams it is more cost effective to use a dedicated microcontroller for decoding. [1] Decoders typically have a sampling rate of 48 kHz or 96 kHz. The processing and memory requirements of maintaining 96 kHz sampling rate are not conducive to a portable battery powered speaker and the benefits of a higher sampling rate are minimal. [4] Texas Instruments (TI) produces a cost effective digital audio processor capable of 48 kHz sampling. The TAS3204 is capable of analog and digital input and output and boasts four channel digital input and output. The price of this processor is $10.41 and would require the additional purchase of a front panel controller.

Analog Devices produces a competing chip that is primarily used in Bluetooth headsets and headphones because of its ability to run off of minimal power. [3] The ADAU1777 takes 4 inputs and produces 2 outputs and is capable of filtering, level control and mixing. This device is only capable of outputting 2 channel, stereo audio. The Analog devices design is priced at under $4 and offers an additional mounting board for $137.00 [2].

Technology in Microcontrollers

Encoded Signal

Depending on the quality, uncompressed music files can take up gigabytes of space [4]. This is problematic for storage and transfer so the vast majority of music is digitally compressed or encoded. When it is time for the audio signal to be played it must first be decoded and converted into an analog signal before it is able to be passed to speakers and listened to. The primary way this is done is through PCM [7]. PCM or pulse code modulation is the way in which analog signals are stored in digital form. This is accomplished through sampling. The PCM signal can come in several different forms including left justified, right justified, I2C, MP3 etc. [1].

Decoding

A music quality microcontroller must be able to detect what form the signal is in and what frequency it was sampled at in order to accurately recreate the signal for playback. If this is done correctly the signal is considered lossless. Meaning a perfect recreation of the initial signal was accomplished. In order to accept both analog and digital signals a decoder must have both an analog to digital converter (ADC) and a digital to analog converter (DAC). These two will operate at the same clock frequency in order to ensure a lossless signal is converted [6]. A decoder will first collect 8 data bits and look for the repeating pattern of ones and zeros placed there by the encoder. This pattern will inform the decoder of the frequency at which the incoming signal is recorded at. [8] The decoder's clock will then adjust to synchronize with the incoming signal. Some less expensive codecs such as the Analog Devices chip can only read a certain type of encoding while the Texas Instruments chip is able to determine which of several encoding is used and decode each accordingly. Once the signal is decoded it is then passed to one or several amplifiers that drive speakers that play the signal audibly.

Implementation in Music Quality Sound Systems

Given the large variety of devices that output sound, a modern-day receiver must be able to accept different inputs with different encodings and seamlessly convert each of them into a playable analog signal [1]. Also necessary is the ability to change volume, mix and equalize. This requirement deems an additional front panel input necessary and potentially an LCD display for user interface. With this in mind the user must acquire a codec that is capable of supporting multiple input methods as well as input from other sources for sound manipulation as well as outputting to an amplifier for sound. Producers of audio equipment must find or create microcontrollers that are compatible with each other to make a product that is functional, easy to use and cost sensitive.

Citations

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