



Smart Amplifier

Audio DSP on XCORE.AI

ELECOMP Capstone Design Project 2024-2025

Sponsoring Company:

XMOS Ltd.

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Bristol, BS1 2LZ
United Kingdom
<http://www.xmos.com>

Company Overview:

XMOS is a fabless semiconductor company, headquartered in Bristol in the UK.

Our mission is to change the way systems are deployed on silicon – disrupting system-on-chip economics and time to market by enabling embedded software engineers to create custom SoC solutions simply by loading software onto our uniquely flexible and accessible hardware platforms.

Technical Director:

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Project Motivation:

XMOS processors are well suited for AI, DSP, and control processing, and the company has strong brand recognition in the high-end audio market. Most of our existing applications involve some combination of ADC/DAC/USB audio streams and DSP. With this project we would like to see if we can remove the DAC from the equation in order to create a lower cost solution with tighter control over the output sound from the DSP subsystem. This project will also speak to the ease of use of Audioweaver from DSP Concepts; if the ABO is achieved, then a team of students will have created a prototype audio product in just 7 months.

Anticipated Best Outcome:

To achieve the ABO the team must:

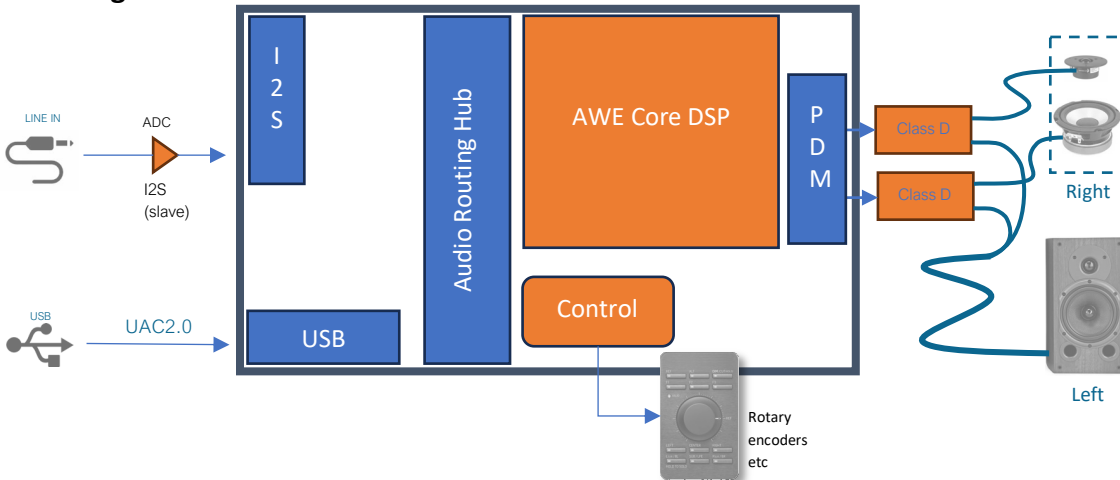
- Implement a Class D amplifier with software control from an xcore
- Accept input from an instrument (or microphone)
- Implement DSP on xcore.ai
- (Bonus) guitar that never needs tuning
- (Bonus) autotune for vocals

Project Details:

Overall system concept:

The system will process an input audio stream and output that stream as a pulse-width modulated signal, suitable for driving a class D amplifier. The amplifier should drive a loudspeaker element, and ideally all analog and digital hardware would be contained in an enclosure that looks like a guitar or PA amp. The signal processing can all be done using Audioweaver from DSP Concepts, which should allow the team to directly apply concepts learned in ELE313 and ELE314 without writing any code.

Block Diagram:



Hardware/Electrical Tasks:

- Evaluate and test class D amplifier / loudspeaker combinations
- Design whole circuit from analog in -> analog out (using multichannel audio board as reference)
- Create PCB and enclosure
- Design test plan
- Assist with algorithm development

Firmware/Software/Computer Tasks:

- Prototype whole system using:
 - o Multichannel audio board
 - o Audio weaver
 - o Built in DAC
 - o Powered speaker
- Modify firmware to:
 - o Account for channels in / out
 - o Accommodate selected ADC
 - o Replace DAC with Class D
 - o Replace I2S output with PWM output
- Lead algorithm development



Composition of Team:

1 Electrical Engineer & 1 Computer Engineer

Skills Required:

Electrical Engineering Skills Required:

- PCB design
- Strong electronics background
- Mechanical / music background (desired)
- Familiar with oscilloscope / logic analyzer (desired)

Computer Engineering Skills Required:

- Signal processing background
- C/C++ experience
- Ability to learn new software tools / simulation environments
- Musical background (desired)

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

By removing the need for a DAC in a standard analog audio product this project will demonstrate additional cost savings that result from choosing to develop your DSP product on xcore.ai. This, when combined with the implied ease of use, and the novel nature of the end product will increase the perceived value of the xcore.ai platform for many potential end customers.

Broader Implications of the Best Outcome on the Company's Industry:

Software defined hardware will allow audio equipment manufacturers to use a single electronic design to service multiple end products by only changing firmware / DSP designs. Additionally, new features can be rolled out to existing products with a simple USB firmware update. Finally, Audio weaver will allow domain experts in acoustics / music to design and tune products with hardware in the loop, without specialized knowledge of electronics or software design.