Chameleon: an Electrical Musical Instrument Platform

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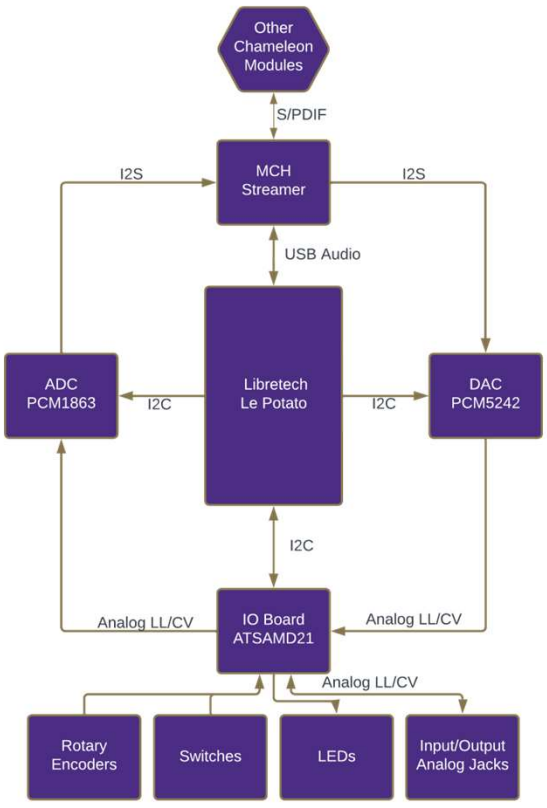
Objectives

- To create an open-source, reprogrammable, digital, modular synthesizer platform that will enable student-created digital signal processing projects using the YASE synthesis engine.
- A Chameleon module will be able to communicate with traditional analog Eurorack modular synthesizers and other digital Chameleon modules.
- To create a lower noise modular synthesis system by using digital sound signals rather than analog ones.
- To Allow UW ECE students to learn digital signal processing techniques through the lens of music production and digital sound synthesis.

Current modular synthesizers are often not open source – making teaching and customization limited.

Fig. 1: Wavefonix W314 Eurorack Synthesizer

System Architecture Block Diagram



Major Components

ADC – PCM1863
- Converts analog audio signals to 24-bit digital I2S audio signals.
- Op-amp buffers to tolerate both 0-10V control voltage signals and 0-1V line level signals.
- 32-bit signal compatibility for future improvements to audio quality.

DAC – PCM5242
- Converts 24-bit digital I2S audio signals to analog audio signals.
- Output pre-amplification gain stage for low signal-to-noise ratio.
- 32-bit signal compatibility for future improvements to audio quality.

I/O Board – ATSAMD21
- Manages the state of rotary encoders, buttons, switches, and LEDs.
- Four analog audio inputs and two analog audio outputs.
- Communicates data to host CPU via the I2C bus.

Transceiver – TOTX/TORX
- To be implemented in the future for inter-Chameleon optical audio transmitting and receiving.
- S/PDIF though TOTX1950A(F) and TORX1950A(F) optical components for near noiseless signal transmission.

Front Panel
- Laser cut acrylic that allows students to customize the look of their module and label the functionality of knobs, switches, and LEDs.
- Matches Eurorack standard for dimensions and mounting hardware.

Testing

- Digilent Digital and Analog Discovery units utilized to test input and output to DAC, ADC, and I/O boards.
- Exhaustive testing of the I/O Board responses to I2C read and write operations.

Results

- 7+ printed circuit boards (PCBs) designed, ordered, and assembled.
- Working transceiver, IO, and ADC boards.
- YASE successfully outputting sound from Le Potato.
- Acrylic mounting board designed and cut.
- Successful I2C communication between Le Potato and peripheral PCBs.
- Successful SMD and thru-hole soldering skills learned. Reflow oven used to successful solder PCBs
- Learned how to use common ECE software tools like Linux, GitHub, and KiCad.

ADC v7 KiCad PCB Schematic

Future Work

- For future work, the chameleon should be able to communicate between units using S/PDIF, so that the devices may send and receive sound data to manipulate.
- Remove the MCH Streamer and use a DIX5242 chip alongside the transceiver unit to send and receive digital audio signals.
- Introduce user interface desktop software to easily configure Chameleon units

Transceiver v1 KiCad 3D render

References

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