Digital Filters and Reverb Effect for Live Music and Speech

Team 11: aztEQ

Electrical and Computer Engineering Project

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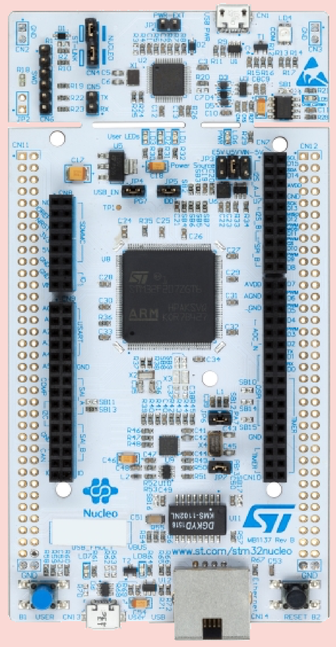
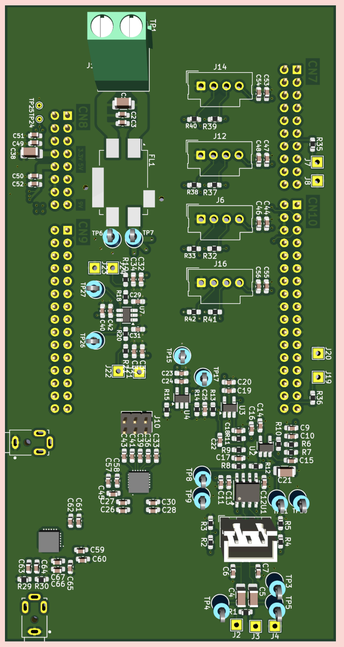
Project Overview

aztEQ is a compact device that manipulates speech from a dynamic microphone connected via XLR or music from a 3.5mm Cable using Digital Signal Processing techniques. The process begins by sampling the connected audio source and converting it to digital audio data for processing. The sampled audio signal is then passed through a series of digital filters that manipulate the frequency content and sound of the audio. Additionally, a network of digital comb and all-pass filters create a digital reverb effect. The user is able to experiment with different sounds and styles by toggling and altering the characteristics of each digital filter using the encoders and pushbuttons.

Hardware



STM32 Nucleo-F767zi



Printed Circuit Board PCB

Key Specifications

Audio Performance:

- 48KHz Sampling Rate
- 16-bit Mono Audio Signal Processing
- Audio Input Range: 20 Hz – 20kHz
- SNR ≥ 60dB @ 1VRMS
- Total Harmonic Distortion ≤ 3%

Digital Signal Processing Capabilities:

- Low Pass, High Pass, Notch, and Peaking Attenuation Filters
- Frequency, Quality Factor, Filter Gain Control, and
- Digital Reverb Algorithm

Input/Output Interfaces:

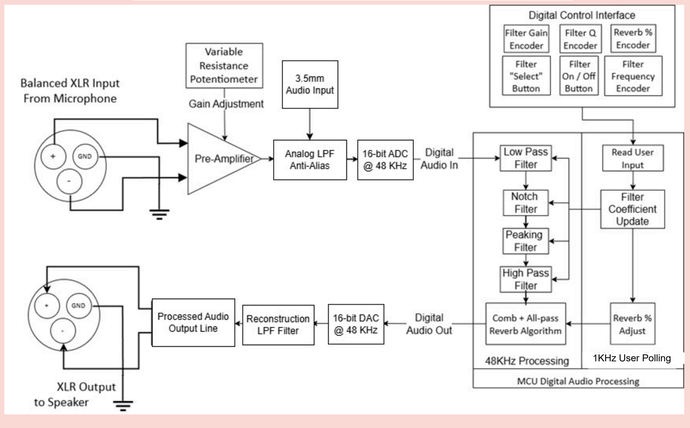
- Inputs: XLR Dynamic Microphone or 3.5mm TRS Jack
- Output: 3.5mm Audio Jack for Consumer Speakers

Power:

- 9VDC Single Supply Using AC-DC Wall Adapter

Final Product

System Level Diagram



Key Technologies

STM32 NUCLEO-F767ZI MCU (Procured Microcontroller):
Interrupt Driven Audio Processing via Direct Memory Access (DMA)
1KHz Polling for User Toggle Buttons and Encoder Control
I2S Serial Audio Interface for ADC and DAC data transfer

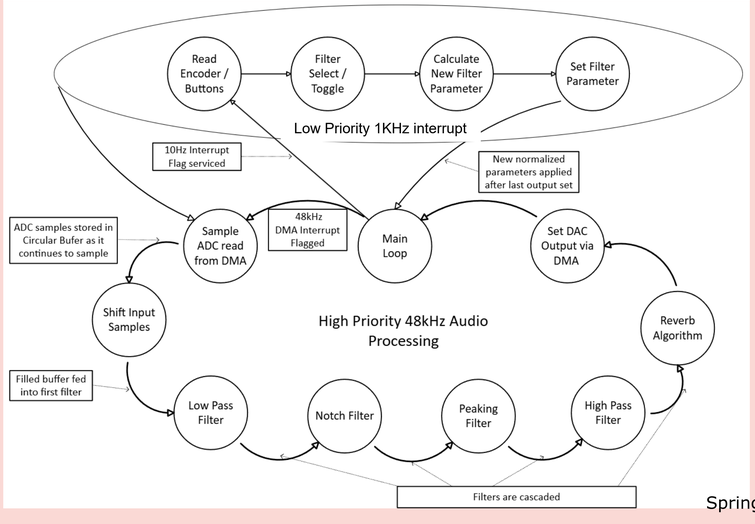
Digital Signal Processing:

- Second-Order IIR Biquad Digital Filters
- Adjustable Filter Response utilizing Encoders and Buttons
- Comb Filter and All Pass Filter Network for Digital Reverb

aztEQ PCB and Hardware

- Single Supply AC Coupled Microphone Amplifier
- Analog to Digital / Digital to Analog Subcircuit
- Quadrature Encoder I/O and Pushbutton Control Interface

Software Operation



Spring 2025