Project Overview

Our 16-channel FM Music Synthesizer connects to MIDI-supported keyboards and applies frequency modulation to the notes being played. A user interface and LCD display allows customization of modulation parameters as well as waveform selection (Sine, Square, Sawtooth, Triangle). The SoC’s processor decodes the MIDI data and the FPGA implements custom RTL to generate and modulate the requested notes. DSP is accomplished using fixed-point arithmetic to balance resources and numerical accuracy. An ADSR (Attack, Decay, Sustain, Release) envelope is applied to both the carrier and modulator signals to create a time-varying FM signal. The digital signal is converted to analog using a 24-bit DAC. A low-pass reconstruction filter is applied to the signal before it is output via a 3.5mm audio jack.

System Process Overview

FM Datapath

\[ A(t)\cos(\omega_c t + cm(t)) \]

- Modulating Signal \(m(t)\)
- Modulating Sensitivity \(c\)
- Tuning Word \(\omega_c\)
- Quadrant Mapper
- Envelope Shaping Function \(A(t)\)
- I2S TX

The Team

Elisha Reece, Tiber Hernandez, Andres Medina, Tharaa Rahhal, Abdul Altawheed, Michael Fallon

Budget: $225

Enclosure

FM Synthesizer on FPGA
By The Synthesizers
Department of Electrical and Computer Engineering

FM Datapath

- ADC/DAC, I2S 11.1%
- Case/Housing 6.7%
- SMD/TH Parts 22.2%
- PCB 6.7%
- MIDI Cables 6.7%
- FPGA 44.4%
- Arduino Uno 2.2%