FPGA Audio Synthesizer

A basic digital audio synthesizer implemented on a Nexys A7 FPGA board. The system generates square wave tones through PWM based on 16 slide switch inputs.

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System Overview

Hardware

Nexys A7 FPGA board with Artix-7 chip

Inputs

16 slide switches select different audio frequencies

Outputs

Audio through 3.5mm jack via PWM signal

Control

Reset button mutes output and resets PWM counter

Project Management

Block Diagram Design

Created functional block diagram to visualize system components

VHDL Development

Implemented synthesizer logic in VHDL

Testing & Simulation

Created testbench and validated with ModelSim

Hardware Implementation

Synthesized and deployed to Nexys A7 FPGA board

Technologies Used

VHDL

Hardware description language for system behavior

Vivado

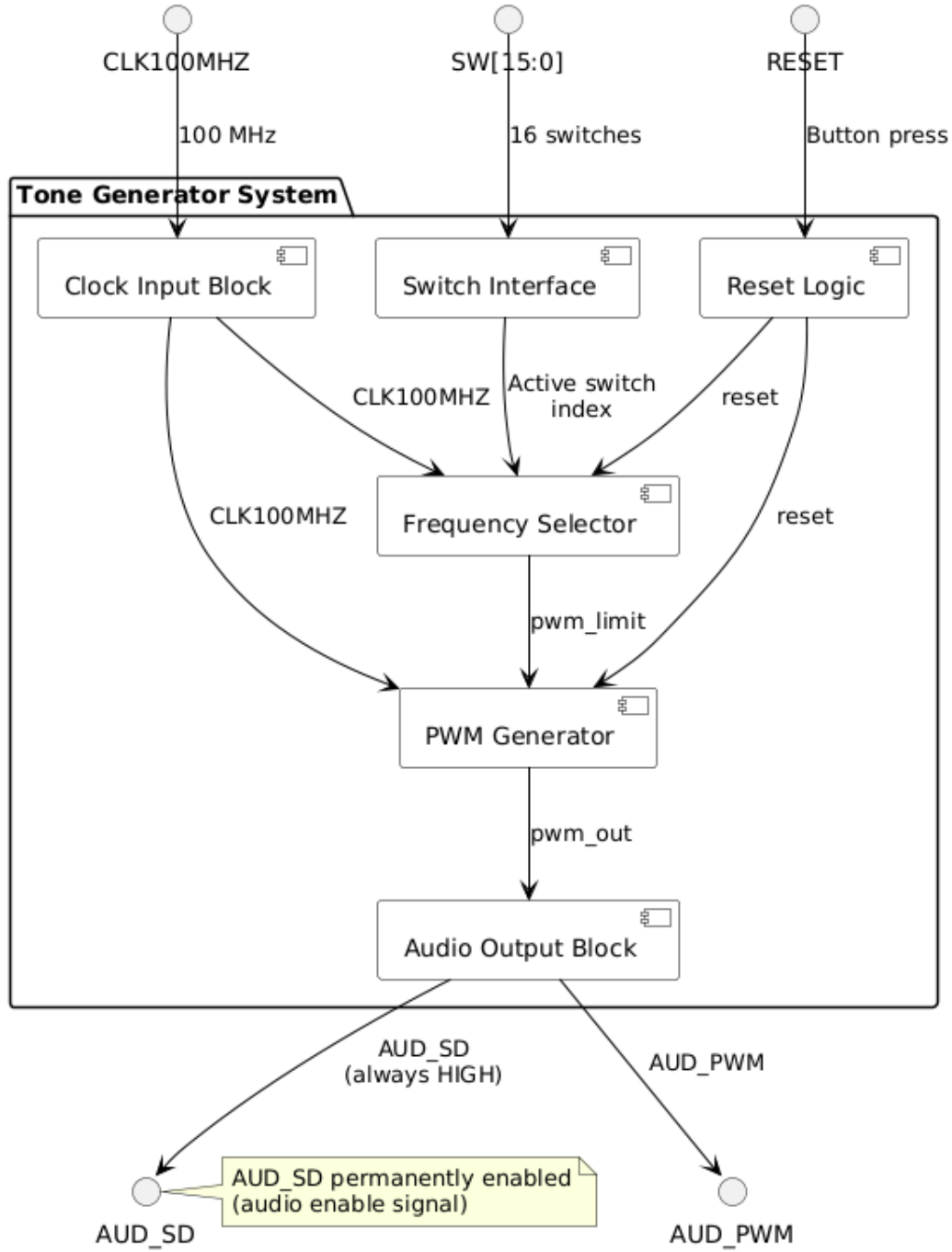
For writing, simulating, synthesizing, and implementing code

Nexys A7 FPGA

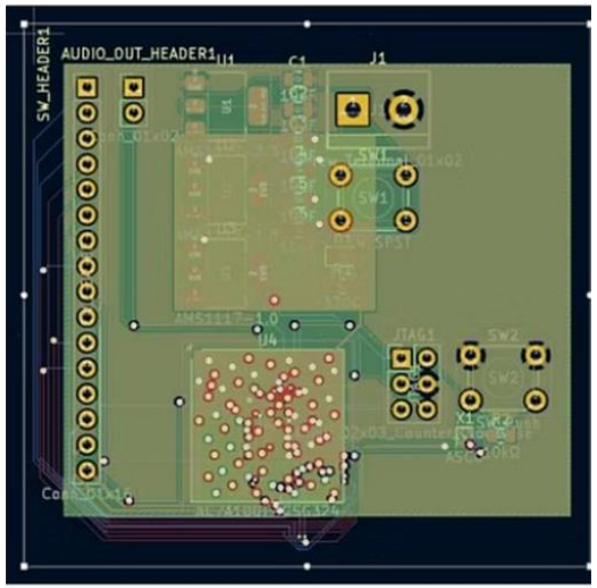
Development board with built-in switches and audio interface

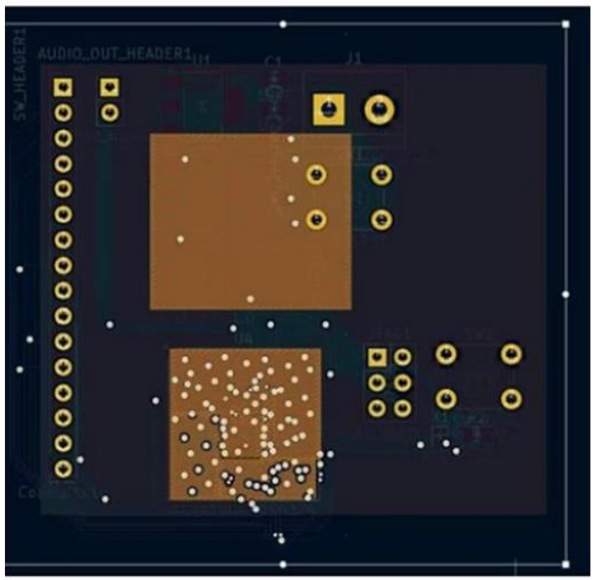
KiCad

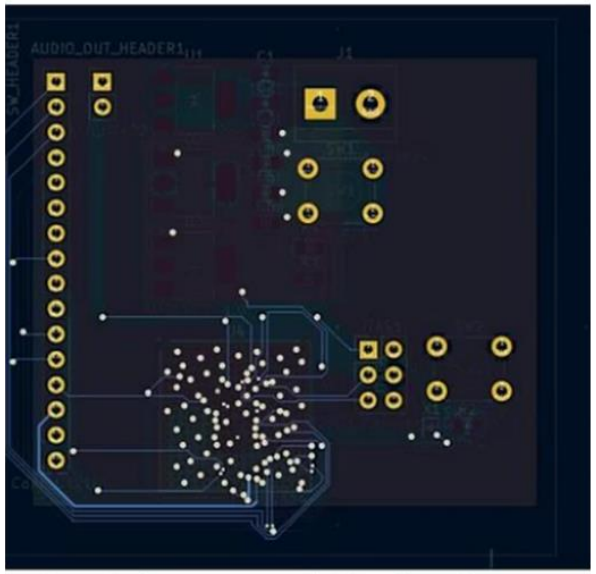
For schematic creation and PCB design

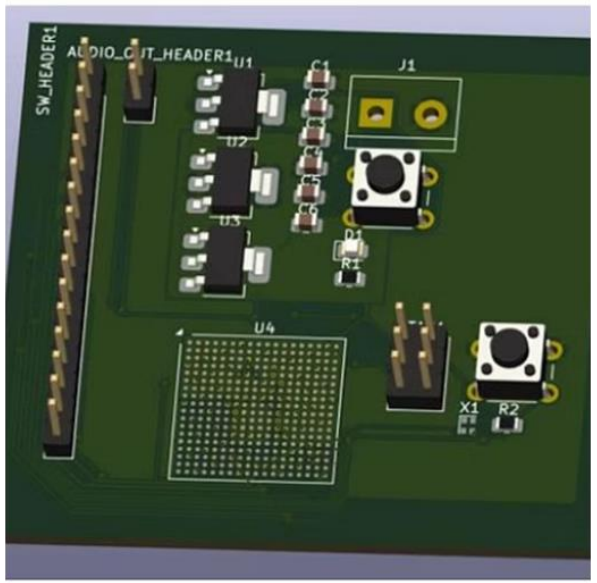

CLK100MHZ
SW[15:0]
RESET
100 MHz
16 switches
Button press
Tone Generator System
Clock Input Block
Switch Interface
Reset Logic
CLK100MHZ
Active switch index
reset
CLK100MHZ
Frequency Selector
reset
pwm_limit
PWM Generator
pwm_out
Audio Output Block
AUD_SD (always HIGH)
AUD_PWM
AUD_SD permanently enabled (audio enable signal)
AUD_SD
AUD_PWM

PCB Design









4-layer PCB design with dimensions 56.5mm × 54.0mm. Manually routed with dedicated power and ground planes.

Component Breakdown

€53.50

Total Unit Cost

Including PCB and components

€50.00

FPGA Cost

Artix-7 XC7A100T-CSG324

€1.50

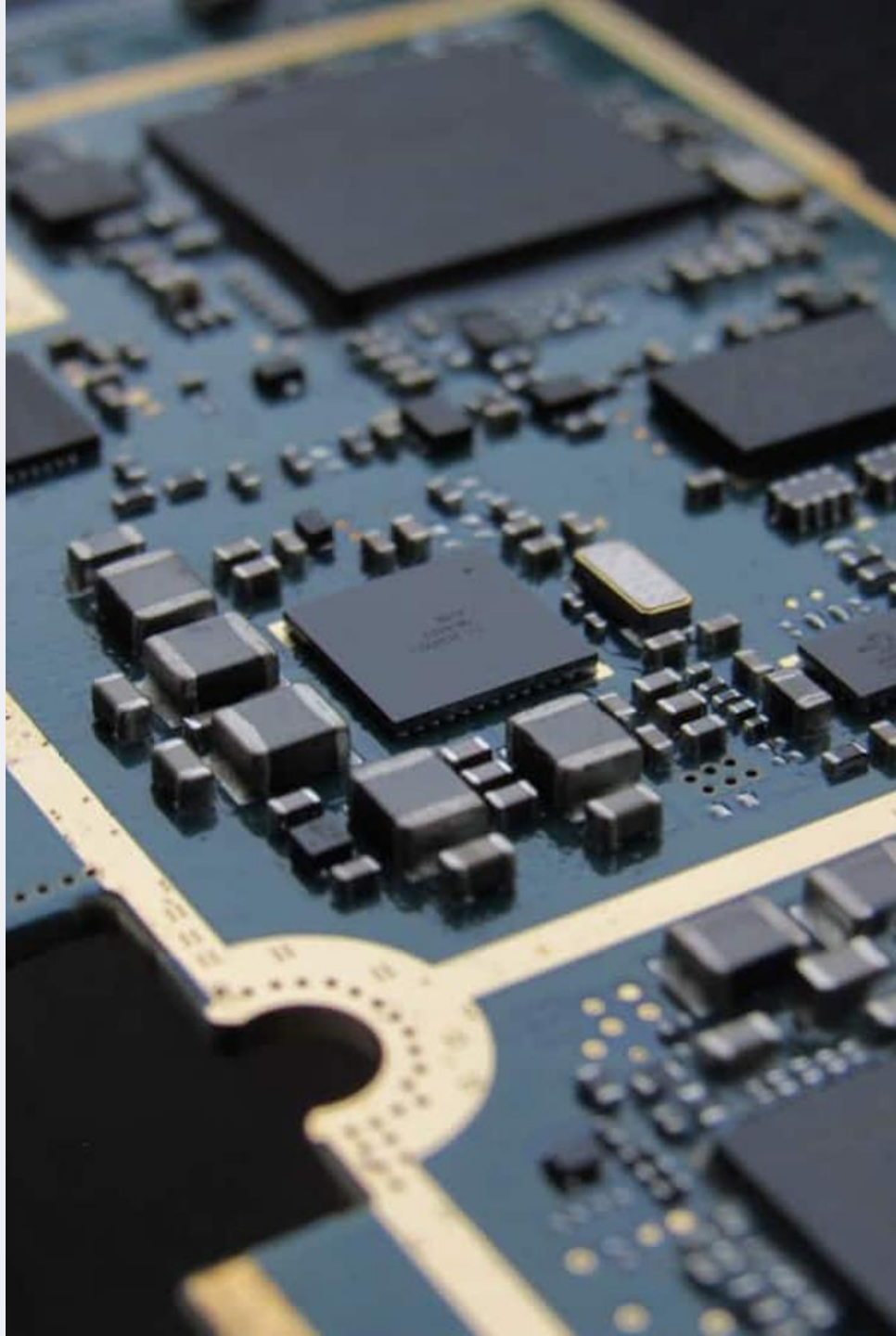
PCB Cost

Per board (4-layer)

€2.00

Other Components

Regulators, capacitors, headers



Results & Conclusion

Successful Implementation

All features working as designed

Verified Tone Generation

16 distinct frequencies via PWM

Complete PCB Design

4-layer board with clean layout

The project successfully implemented a digital audio synthesizer on FPGA hardware with a custom PCB design. All timing constraints were met with no resource overflow.

Live Demonstration: