

CLAMS - The Quest for Portability and Audio

Forth Day 2024

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Previously on CLAMS

The original concept - early 2022

- ▶ Forth for the Electro-Smith Daisy Seed
 - ▶ <https://electro-smith.com/products/daisy-seed>
 - ▶ Microcontroller board designed for digital music
 - ▶ ARM Cortex-M7 MCU, running at 480MHz
 - ▶ Hardware floating point and DSP instructions
 - ▶ 64MB of SDRAM for up to 10 minute long audio buffers
 - ▶ 8MB external flash
 - ▶ Stereo audio output - 96kHz / 24-bit audio hardware
 - ▶ No WiFi or Bluetooth
 - ▶ \$29.95US quantity one
 - ▶ Available in various packaged modules
 - ▶ User interface and synthesis both done in Forth

Revised concept - early 2023

- ▶ Forth for the Raspberry Pi Pico (WH)
 - ▶ <https://www.raspberrypi.com/documentation/microcontrollers/pico-series.html>
 - ▶ Microcontroller board designed for general applications
 - ▶ Dual-core ARM Cortex-M0+, running at 133 Mhz
 - ▶ Co-processor for division, interpolation and I/O
 - ▶ No floating point or DSP instructions
 - ▶ 262KB RAM
 - ▶ 2 MB flash
 - ▶ No SD card
 - ▶ No audio hardware, I2S audio expansion packs available
 - ▶ 2.4 GHz WiFi and Bluetooth
 - ▶ \$7.00 US
 - ▶ User interface and synthesis both done in Forth

Stepping up a level - what does a digital synthesizer need?

- ▶ Accurately-timed PCM samples
- ▶ Digital-analog conversion for recording / performance
- ▶ A user interface for the composer / performer

Previous concepts problem 1: Lack of portability:

- ▶ Need to hand-port Forth to individual MCUs
- ▶ Other desirable boards:
 - ▶ Raspberry Pi Zero 2 W
 - ▶ (<https://www.raspberrypi.com/products/raspberry-pi-zero-2-w/>)
 - ▶ Teensy 4.1
 - ▶ (<https://www.pjrc.com/store/teensy41.html>)
 - ▶ ESP32-S3, -C3 and -C6
 - ▶ (<https://www.espressif.com/en/products/socs/esp32>)

Previous concepts problem 2: Limited audio capability

- ▶ Limited audio capability
 - ▶ Only built-in DAC or I2S audio is practical in Forth
 - ▶ Other desirable interfaces:
 - ▶ Class-compliant USB audio and MIDI
 - ▶ Bluetooth audio and MIDI
 - ▶ Specs too complex for easy Forth implementation

CLAMS - The New Design

Arduino or Linux for portability

- ▶ Target MCU boards all have Arduino support
- ▶ Raspberry Pi Zero 2 W has Linux support
- ▶ I2S audio is supported on all boards
 - ▶ DAC is either onboard or expansion hardware
- ▶ Bluetooth audio is supported on boards with hardware
- ▶ USB MIDI is supported on all boards
- ▶ USB audio is supported on Teensy and Zero 2 W
 - ▶ Others in alpha testing

Shore Pine Sound Systems AMY synthesizer

- ▶ Open source on GitHub (shore pine sound systems 2024a)
- ▶ Highly portable - written in C
- ▶ Has Arduino library
- ▶ Has a Python interface for both Linux and MCUs
- ▶ Handles synthesis and I2S audio
- ▶ Very capable synthesizer - saves me months of Forth coding!
- ▶ Heart of the Tulip Creative Computer (shore pine sound systems 2024b)

Forth base: C3

C3 Forth

- ▶ Open source on GitHub (Christopher Curl 2024a)
- ▶ Token-threaded Forth written in C/C++
- ▶ Runs on Linux (native), Raspberry Pi Pico and Teensy 4.1 (Arduino)
- ▶ Under active development
- ▶ Well-documented

Bonus Forth content - C4!

- ▶ Open source on GitHub (Christopher Curl 2024b)
- ▶ Uses concepts from Tachyon Forth and colorForth
- ▶ Arduino support in progress!

Road map - Tasks mostly in Priority Order

Integrate C3 and AMY on Raspberry Pi Zero 2 W

- ▶ Development cycle is easier on Linux
- ▶ Linux USB audio and MIDI are well understood
- ▶ Many supporting software tools available
- ▶ Total hardware cost is \$54.00US
- ▶ <https://vilros.com/products/vilros-raspberry-pi-zero-w-2-port-n-play-ready-to-use-kit>

Make an album

- ▶ Adding AMY synthesizer has shortened development time
- ▶ The dogfooding process will hone the Forth user interface

Integrate C3 and AMY on Pico I2S

- ▶ Backporting of album to small system will stress-test the system

Integrate C3 and AMY and USB audio on Teensy 4.1

- ▶ Teensy has no native I2S / DAC hardware
- ▶ Teensy does have native USB audio and MIDI in Arduino
- ▶ More powerful MCU than the Pico

Add CLAMS to Experimental Music Toolbox

- ▶ Another project of mine
- ▶ Open source on GitHub (AlgoCompSynth by znmeb 2024)
- ▶ Collection of open source tools for experimental music

Longer range

- ▶ Electrosmith Daisy port
- ▶ ESP32 port
- ▶ USB MIDI
- ▶ USB audio on non-Teensy boards

Back Matter

CLAMS on the web

- ▶ GitHub: <https://github.com/AlgoCompSynth/CLAMS>
- ▶ blog: <https://www.algocompsynth.com/#category:CLAMS>
- ▶ this presentation: <https://github.com/AlgoCompSynth/CLAMS/blob/main/presentations/CLAMS-quest.pdf>

Me on the web

- ▶ Mastodon: <https://ravenous.club/@AlgoCompSynth>
- ▶ LinkedIn: <https://www.linkedin.com/in/znmeb>
- ▶ Bandcamp: <https://algocompsynth.bandcamp.com>

References

AlgoCompSynth by znmeb. 2024. “Experimental Music Toolbox on GitHub.” <https://github.com/AlgoCompSynth/Experimental-Music-Toolbox>; AlgoCompSynth by znmeb.

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