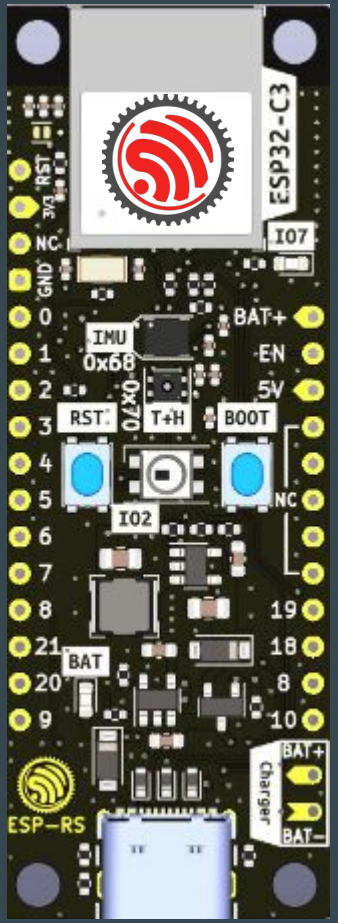
Faster Rust Embedded development with Wokwi for ESP32



2023-06-03
AeroRust - Plovdiv

Juraj Michálek - Espressif Systems

Espressif System

Espressif Systems (688018.SH) is a public multinational, fabless semiconductor company established in 2008, with offices in China, the Czech Republic, India, Singapore and Brazil.

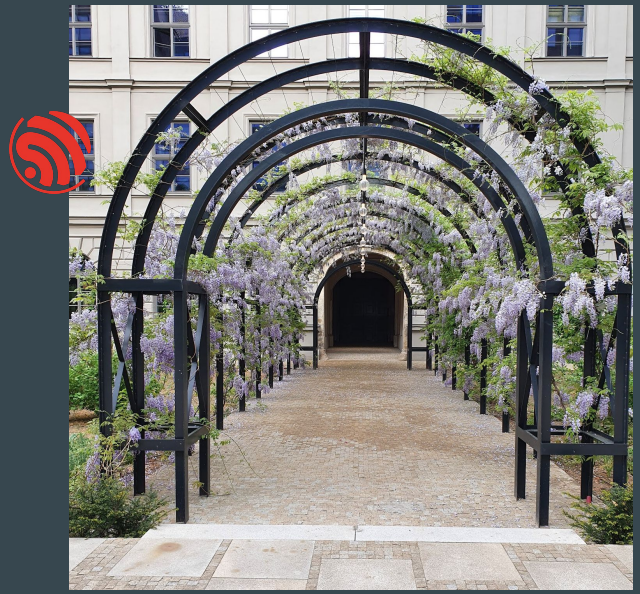
ESP8266 - WiFi

ESP32, ESP32-S - Xtensa cores

ESP32-C, ESP32-H series - RISC-V cores

Open source: https://github.com/espressif

Espressif in Brno



Near Main train station

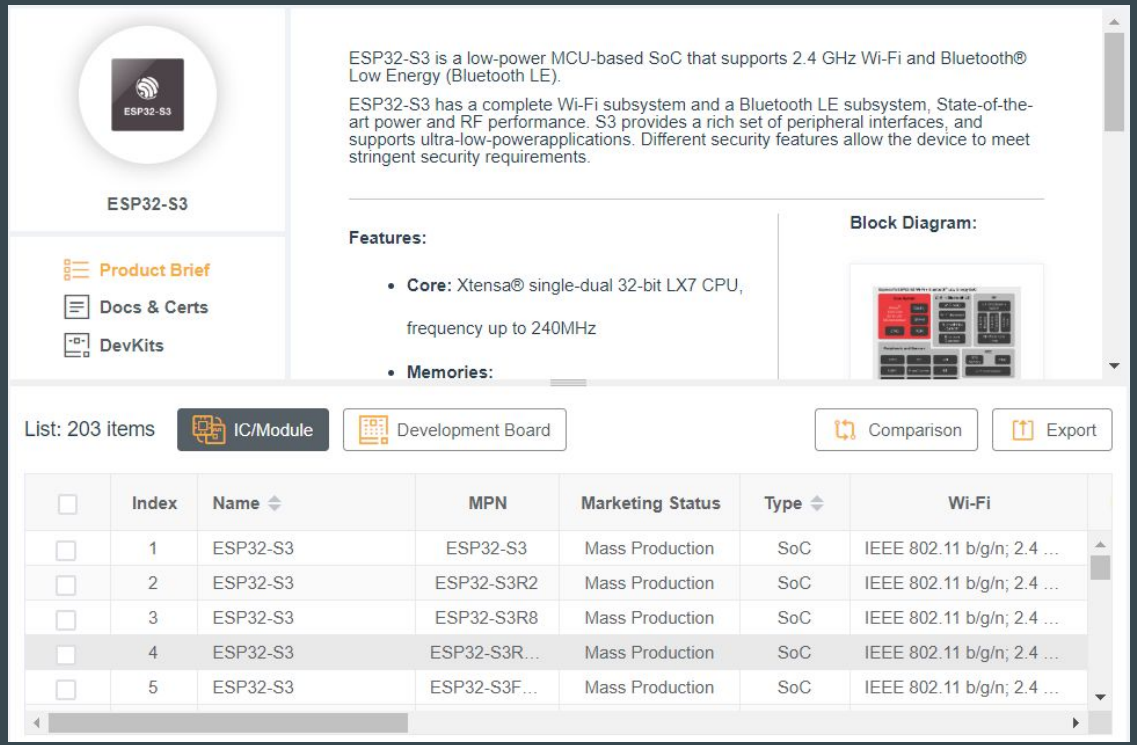
Espressif Systems (Czech) s.r.o.

Přízova 3, 602 00 Brno

Czechia, Europe

Many chips, many boards - quick help

https://products.espressif.com/



OSes and integration and Rust

no_std a.k.a. bare metal with Rust - https://github.com/esp-rs/esp-hal (minimalistic)

ESP-IDF (OS based on FreeRTOS) - https://github.com/esp-rs/esp-idf-hal

Zephyr - https://zephyrproject.org/

- EDC22 Day 1 Talk 10: Applications of Asymmetric Multiprocessing with ESP32 Devices - including Rust on one core - https://youtu.be/oble9ObAqxM

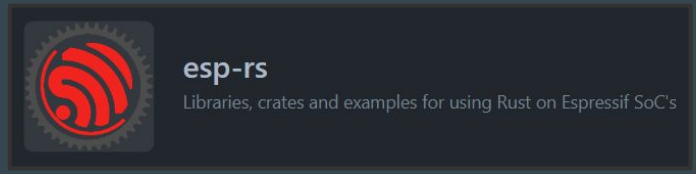
NuttX - https://nuttx.apache.org/ (as app, Linux-like OS)

SVD files: https://github.com/espressif/svd

Programming languages

Active support by Espressif teams

- C/C++
  - most common choice - https://github.com/espressif/esp-idf
- Rust
  - recommended for new design evaluation - https://github.com/esp-rs
  - security and memory guaranties of Rust
  - multi-target Xtensa, RISC-V, plus WASM, desktops or mobile
- Arduino - Maker choice
  - Arduino IDE 2.x
  - note: check the license for production



Other languages and frameworks

New and noteworthy:

- Ada/Spark - from AdaCore
- Embedded Wizard - DSL and C
- Zig

VM based:

- CircuitPython and MicroPython - Python-like language
- Toit
- Nanoframework - C# language
- Mongoose OS
- Lua
- downside: bigger VM
- upside: more robust, comes with OTA and monitoring

IDE

Supported by Espressif:

- VS Code with Espressif Extension - **great Rust support**
  https://docs.espressif.com/projects/esp-idf/en/stable/esp32/get-started/vscode-setup.html
- Espressif IDE - https://dl.espressif.com/dl/esp-idf/

Supported by JetBrains:

- CLion - https://www.jetbrains.com/clion/ - **great Rust Support**

Supported by SysProgs

- Visual Studio with VisualGDB - https://visualgdb.com/

Supported by TARA Systems

- Embedded Wizard - https://www.embedded-wizard.de/

JET BRAINS

SYSPROGS

Embedded Wizard

GUI Solutions by TARA Systems

Rust language support

Talk: EDC22 Day 1 Talk 7: Rust on Espressif chips - Scott Mabin - DevConf September 2022

https://youtu.be/qeEmJ_-6fPg

Talk: Embedded Rust on ESP32 - Juraj Michálek - Rust Linz November 2022

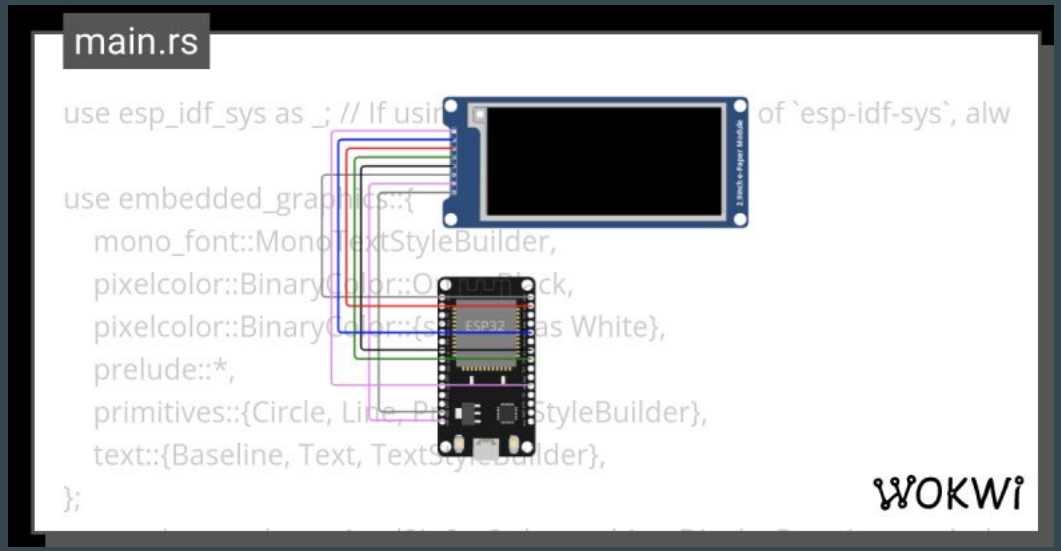
https://youtu.be/OPPPdqoDBQs

wokwi.com/rust

Contribute: https://github.com/wokwi

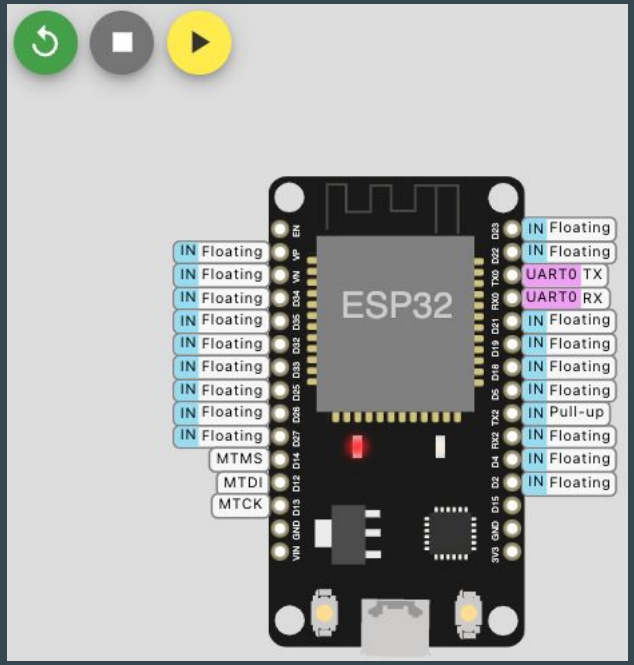
EDC22 Day 1 Talk 9: Your browser is ESP32 - Wokwi - https://youtu.be/TKe4MgD6O8o

Rust + e-Paper + ESP32

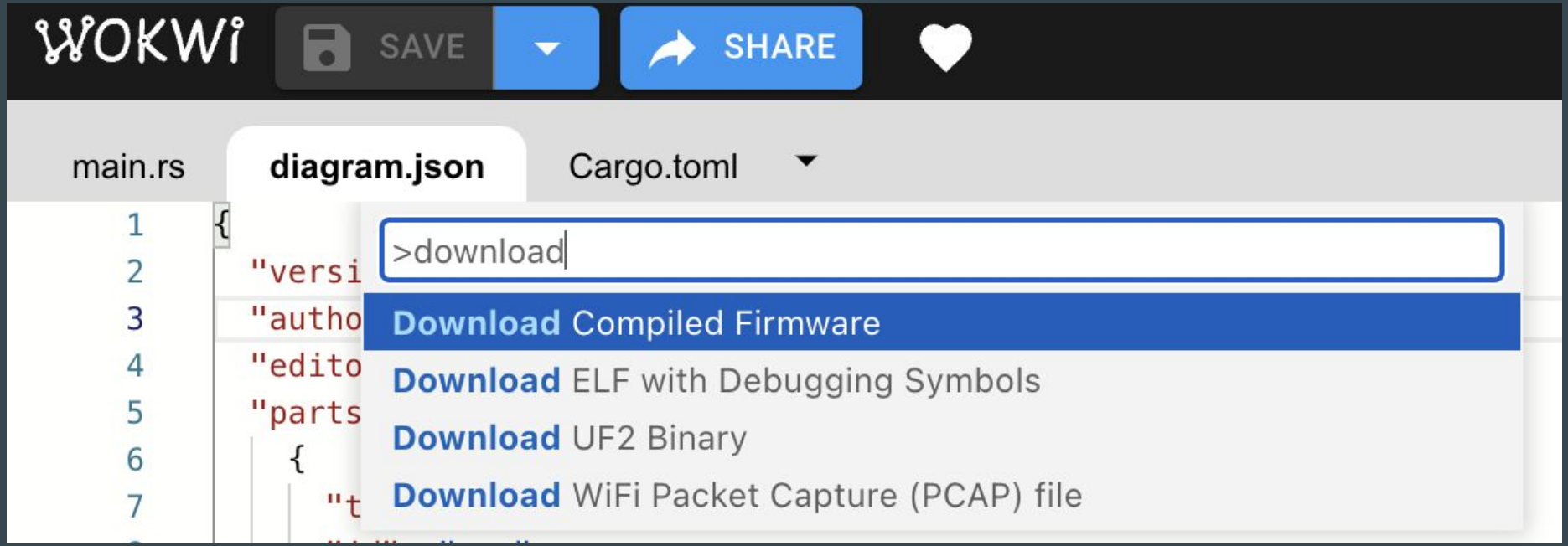


https://wokwi.com/projects/366167936725307393

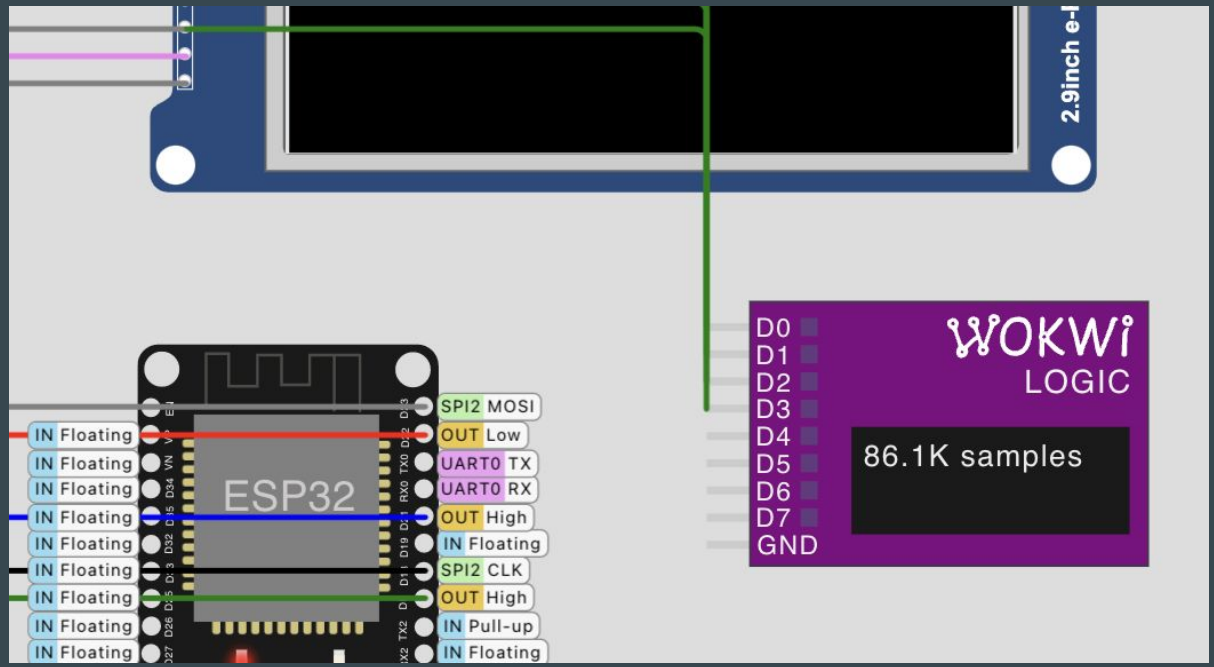
Pause button - see state of GPIOs



Wokwi F1 menu (download binary and many more)

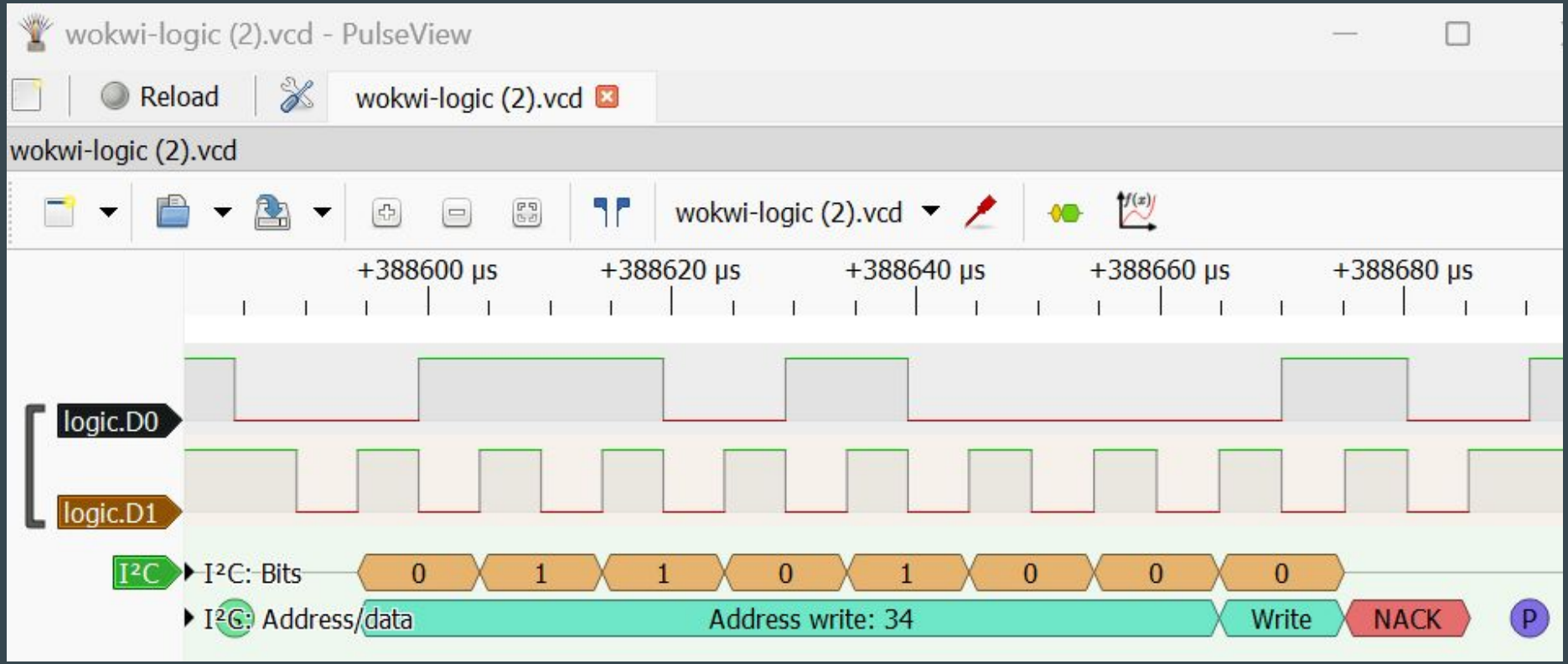


Wokwi Logic Analyzer



Hit Stop to download VCD file for PulseView

Wokwi + PulseView - examples of I2C

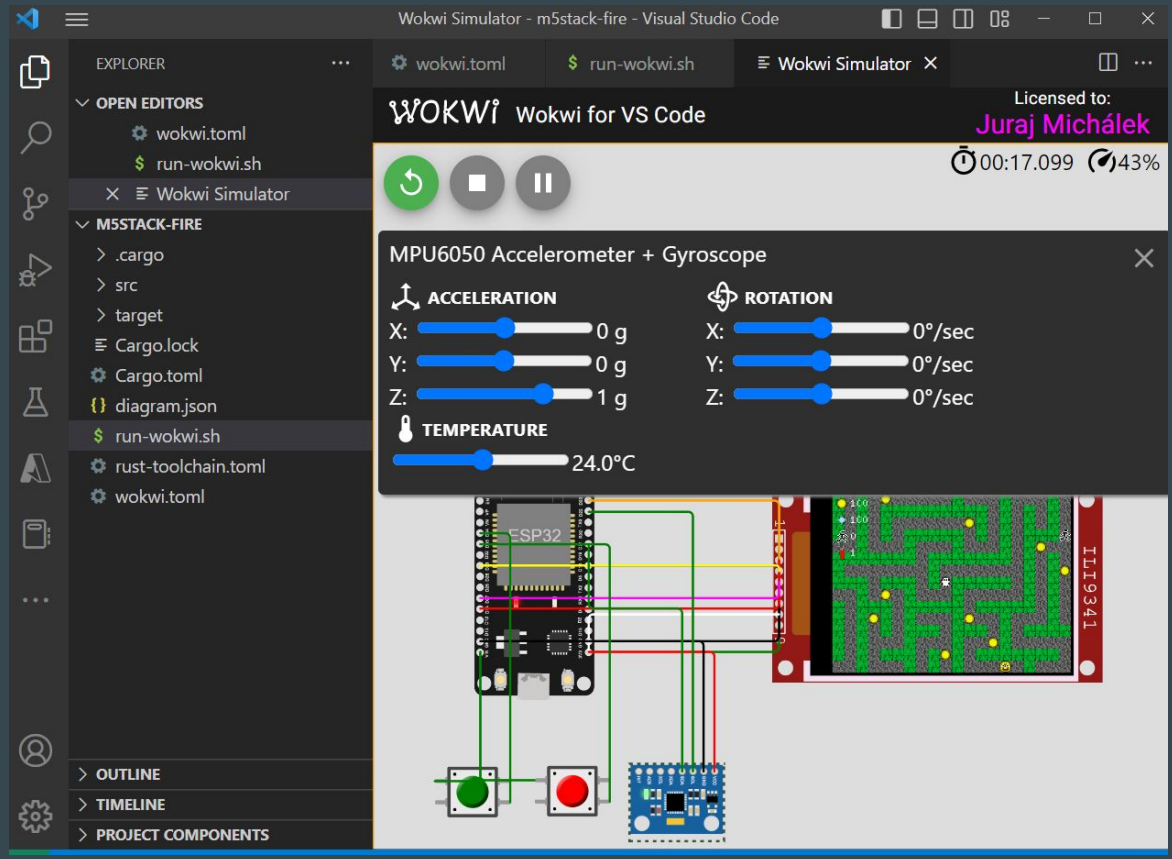


Wokwi - VS Code Plugin

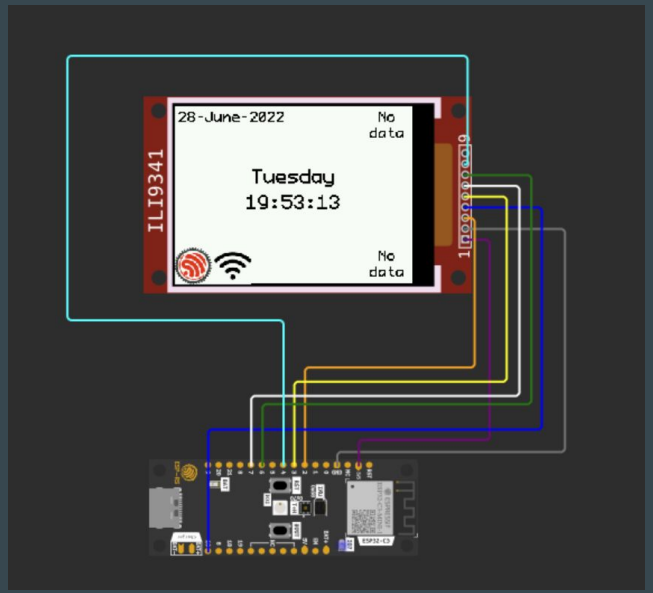
Add wokwi.toml and diagram.json

to your project

CTRL+Shift+P - Wokwi: Start Simulator



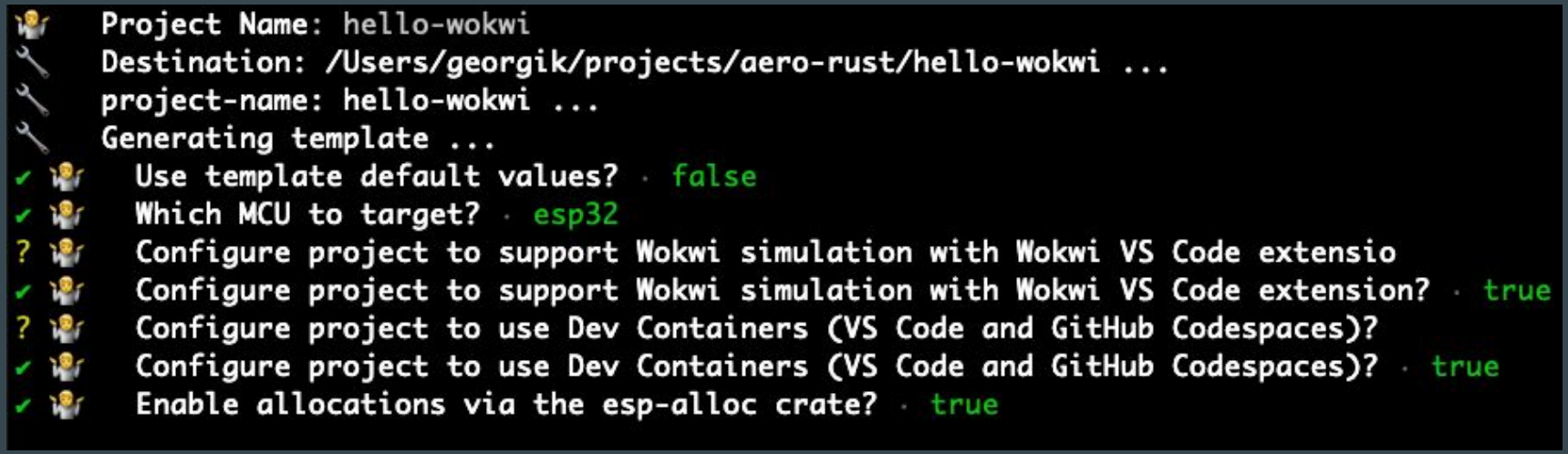
Development containers and Wokwi



https://github.com/playfulFence/esp-clock#dev-containers

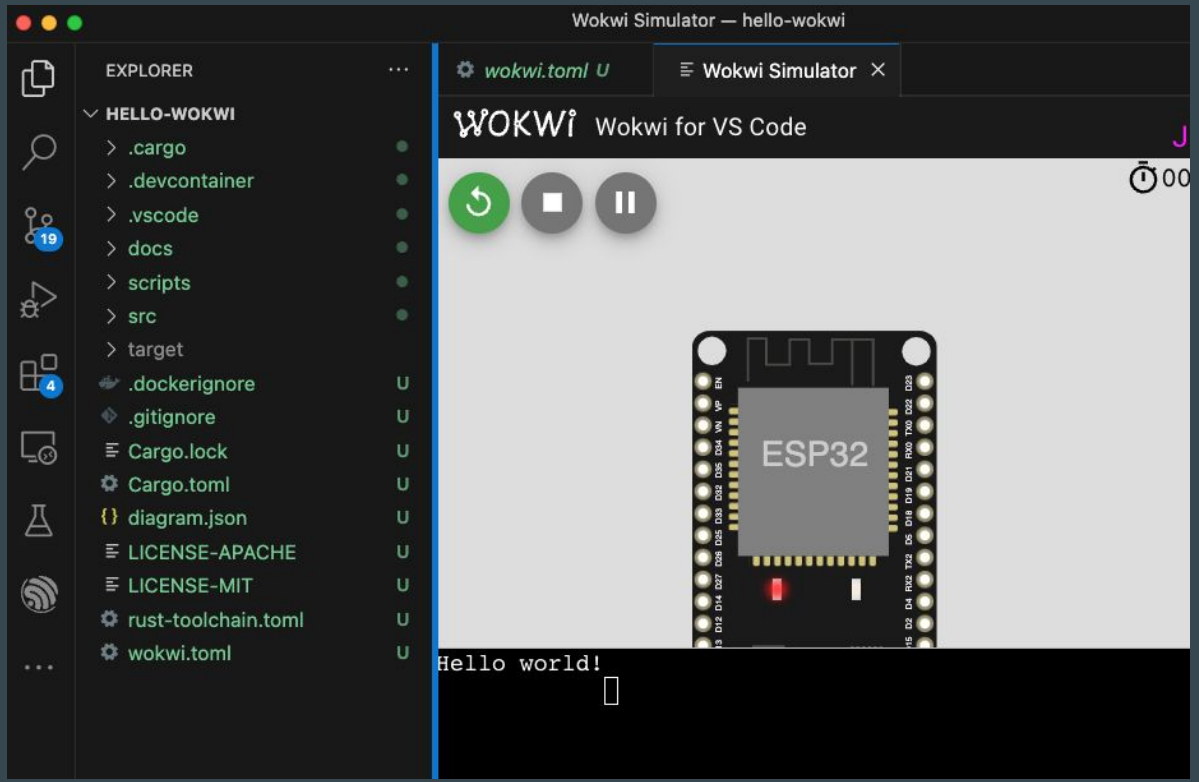
Starting from template

cargo generate -a esp-rs/esp-template

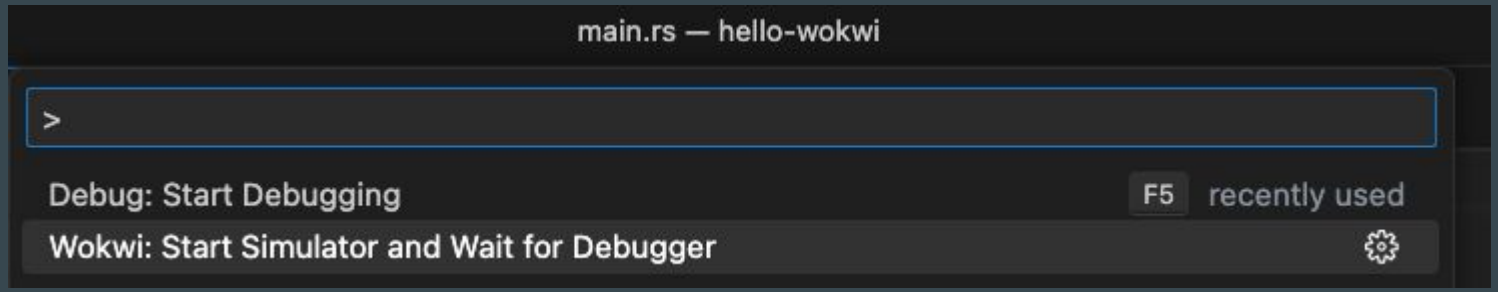


cargo build

Command/CTRL+Shift+P - Wokwi: Start Simulator

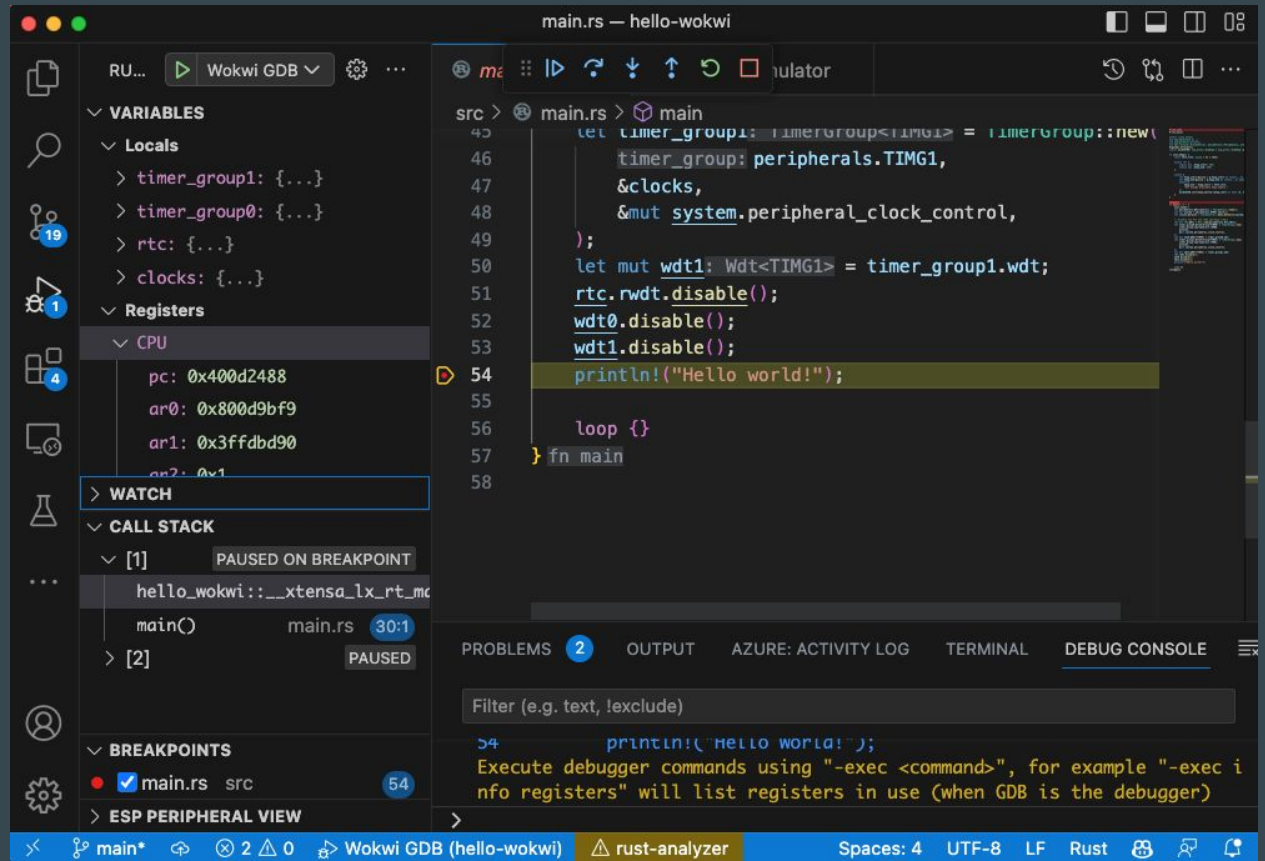


Debugging



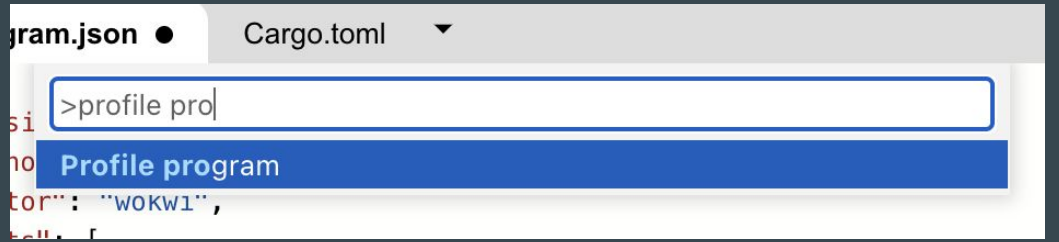
2 steps: simulator, debugger

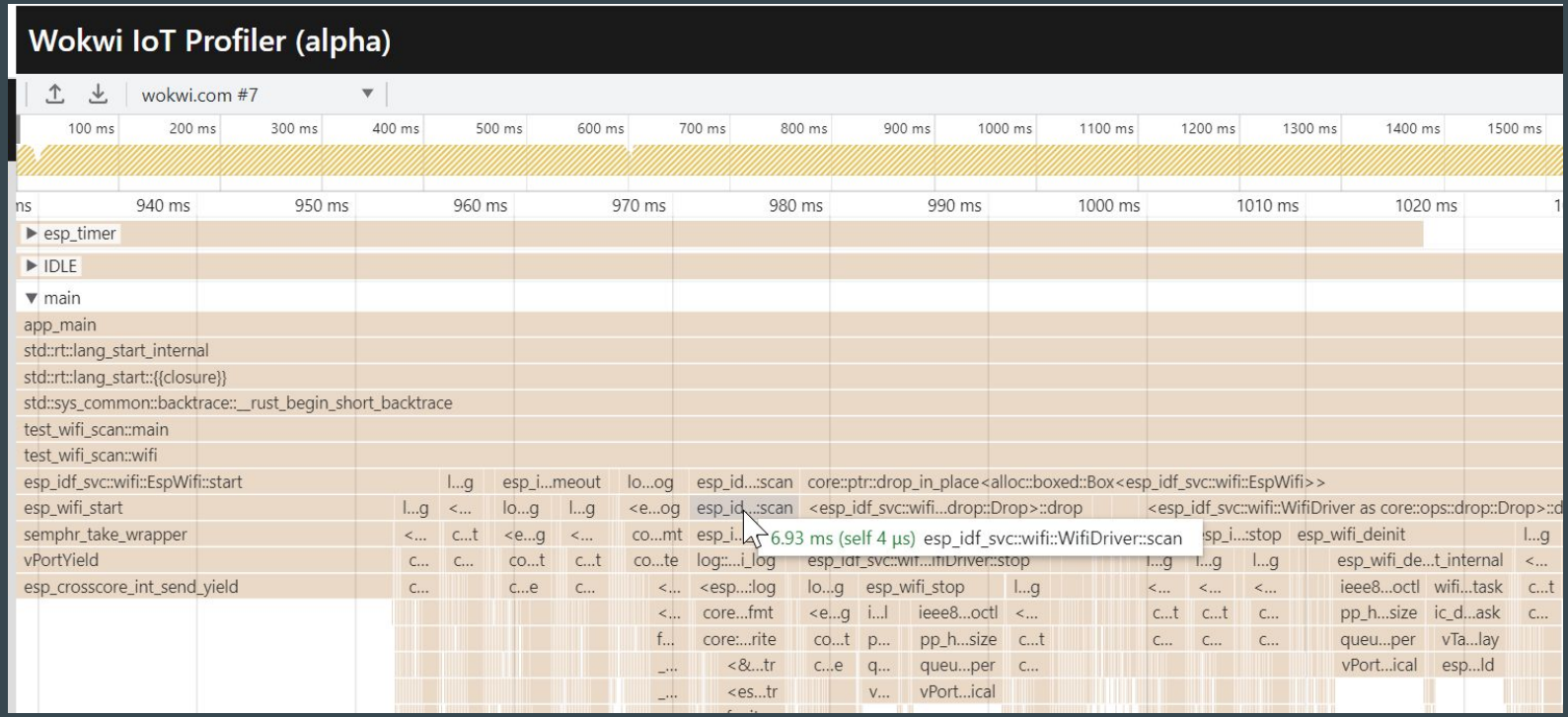
Debugging session with Wokwi



Wokwi Profiler

https://profiler.wokwi.com/



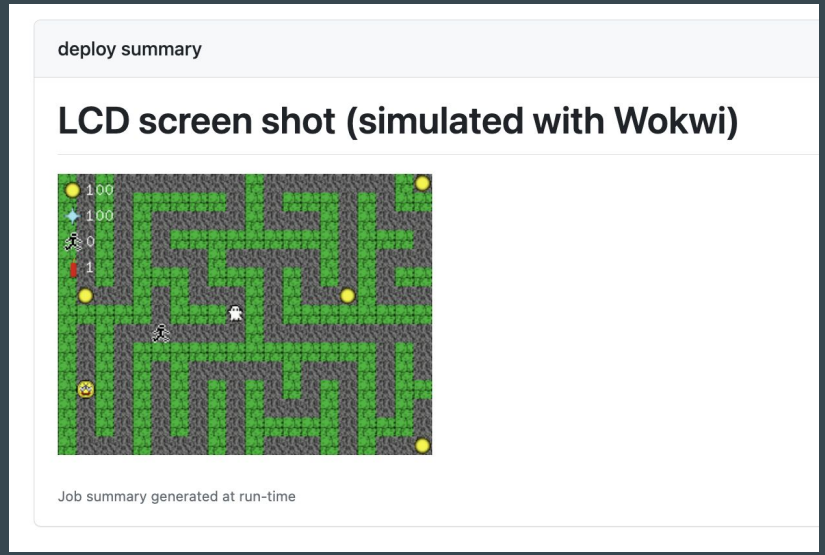


Wokwi CI

https://github.com/wokwi/wokwi-ci-action

Wokwi and CI with screenshot

https://github.com/georgik/esp32-spooky-maze-game/actions/runs/5111553942



Wokwi custom chips

https://docs.wokwi.com/chips-api/getting-started

Implement your own virtual HW.

ESP32-C6

Main feature: WiFi 6 support - reduced power consumption

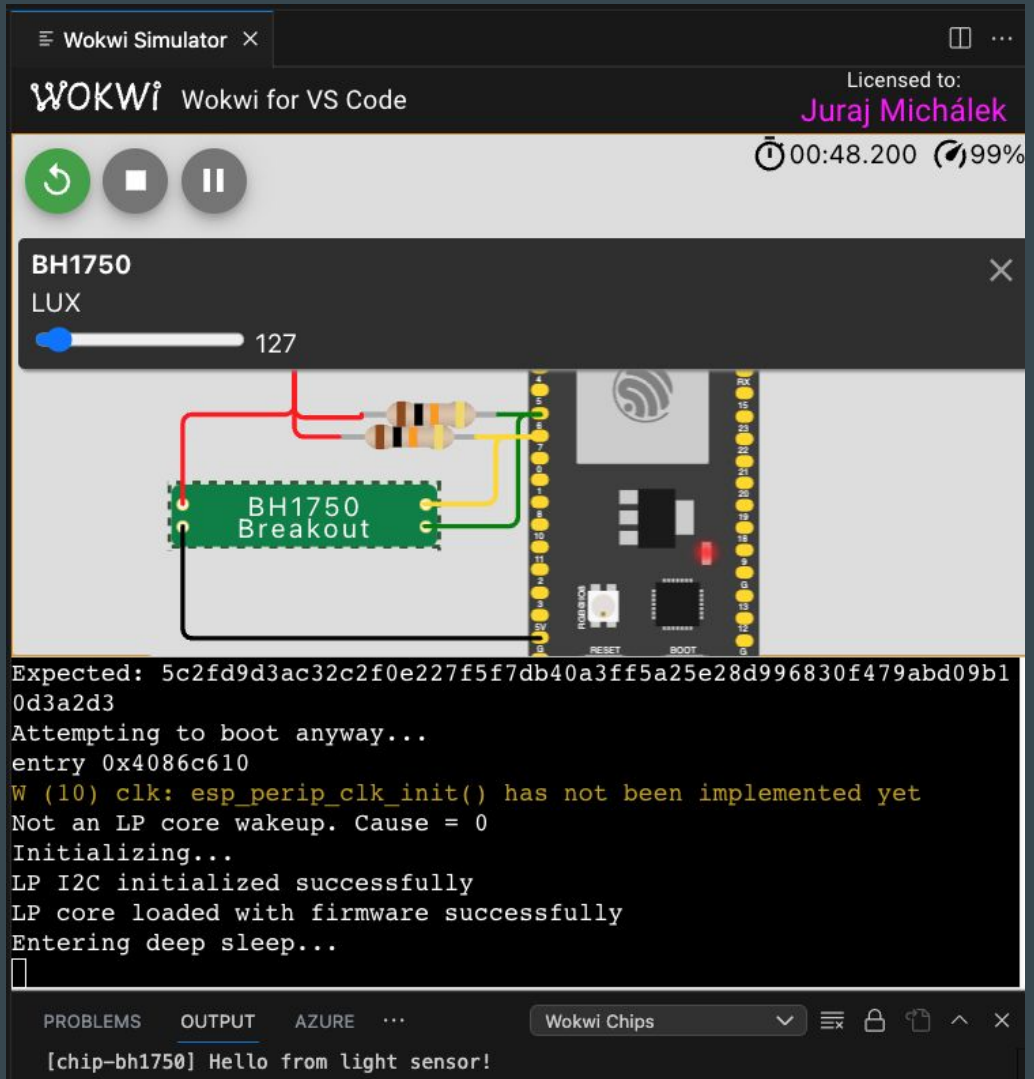
- https://www.youtube.com/watch?v=FA1jqZLig4s

Second important feature:

- Low Power Core - 20 MHz

Wokwi and Low Power Core simulation ESP32-C6

https://github.com/wokwi/esp32c6-i2c-lp



Books

The Rust on ESP Book

- https://esp-rs.github.io/book/

Rust STD Training Embedded for ESP32-C3

Material: https://esp-rs.github.io/std-training/

GitHub: https://github.com/esp-rs/espressif-trainings

Developed by Ferrous Systems, Espressif Systems and Community

ferrous systems

Async with Embassy

Embassy: https://github.com/embassy-rs/embassy

Examples of Embassy on ESP32:

- https://github.com/esp-rs/esp-hal/blob/main/esp32-hal/examples/embassy_hello_world.rs
- https://github.com/esp-rs/esp-hal/blob/main/esp32-hal/examples/embassy_spi.rs
- https://github.com/esp-rs/esp-hal/blob/main/esp32-hal/examples/embassy_wait.rs

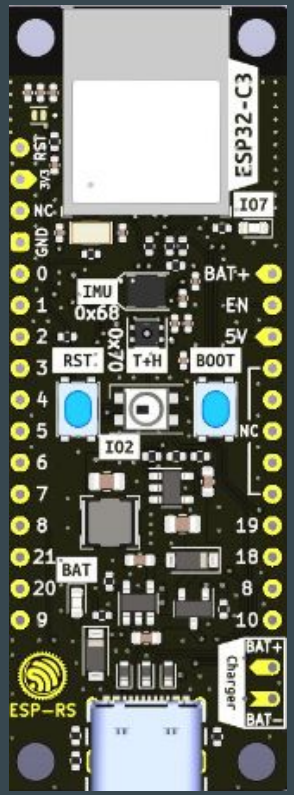
Designing Open Hardware - esp-rust-board

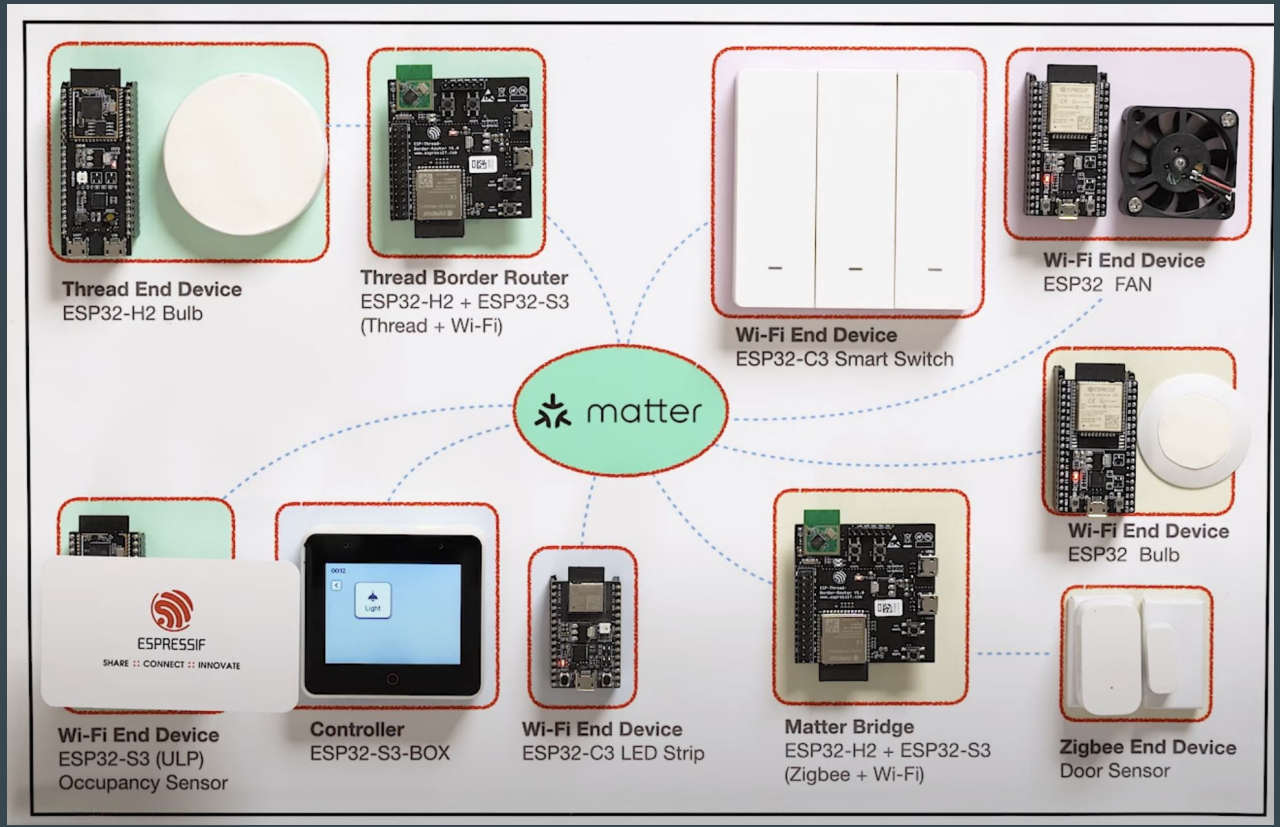
KiCad templates

https://github.com/esp-rs/esp-rust-board

ESP32-C3-DevKit-RUST-1 (available at Mouser, AliExpress)

https://www.espressif.com/en/products/devkits





Espressif's Matter Demo - https://youtu.be/Jr4Lut_NggA

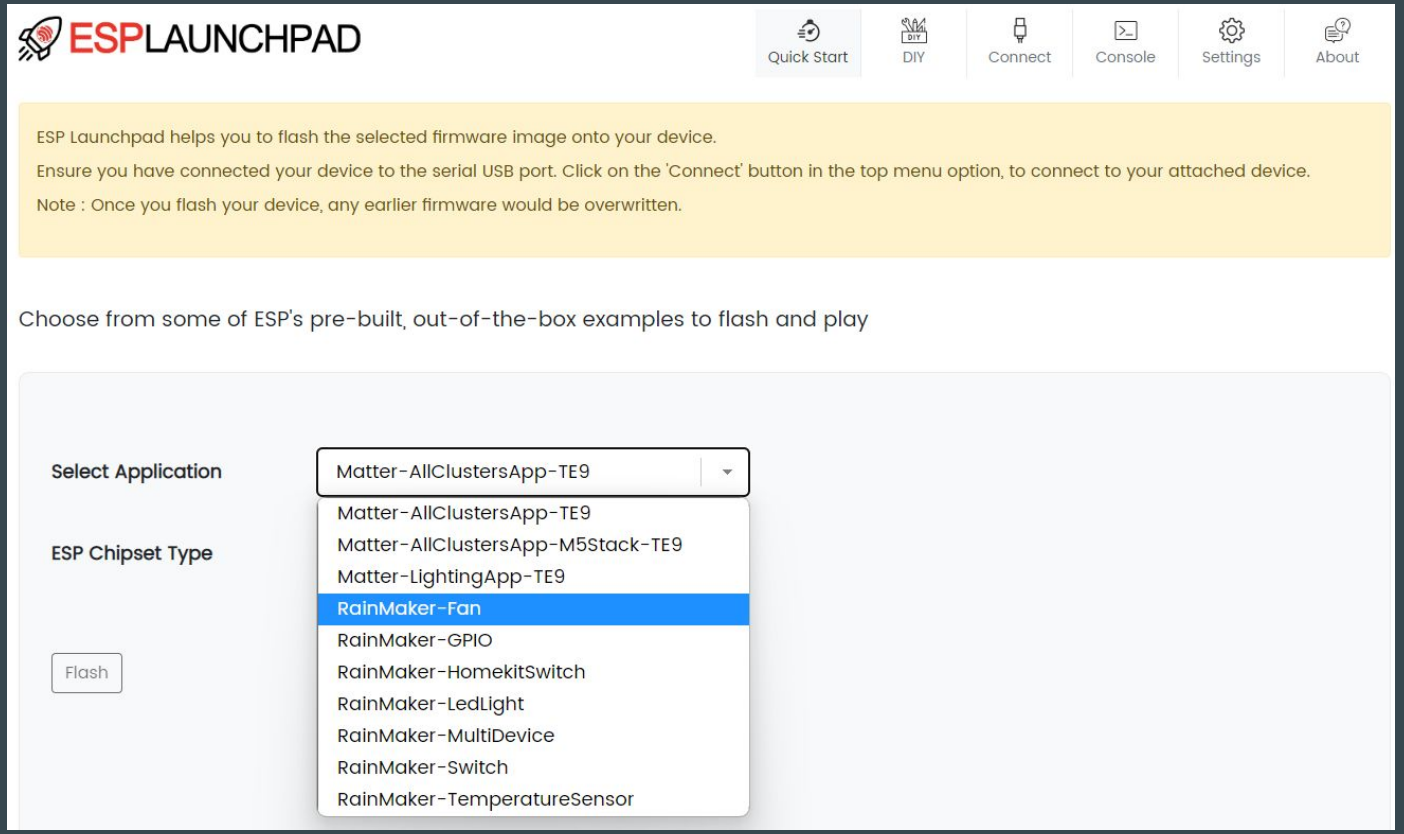
Espressif and Matter

Support for ESP32 is upstream
https://github.com/project-chip/connectedhomeip/tree/master/examples/all-clusters-app/esp32

esp-matter project - https://github.com/espressif/esp-matter

matter-rs - Rust - https://github.com/project-chip/matter-rs

ESP Launchpad - https://espressif.github.io/esp-launchpad/



Multi-target project (PoC) - ESP32 Spooky Maze

Source: https://github.com/georgik/esp32-spooky-maze-game

Idea: sharing business logic in Rust between multiple targets

Demo: https://georgik.rocks/rust-bare-metal-application-for-esp32-desktop-android-and-ios/

Targets: ESP32, ESP32-S2, ESP32-S3, ESP32-C3, M5Stack, Wasm and Desktop

Article: https://georgik.rocks/rust-bare-metal-application-for-esp32-desktop-android-and-ios/

https://github.com/espressif/esp-box

Espressif Developer Conference 2022 - recording

https://www.youtube.com/playlist?list=PLOzvoM7_Knrc6o-n25jYuXRB2T8UKk1NU

Developer Conference 2023 - scheduled for 12-13 September - https://devcon.espressif.com/

Embedded World 2024

Meet us in Nuremberg, Germany

Visit us in Brno

Espressif Systems (Czech) s.r.o.

Přízova 3, 602 00 Brno

Czechia, Europe