The Magic Jigsaw:

The process of designing
an open music tracker

"Running an Open Source Product Business on Open Source"

Agenda

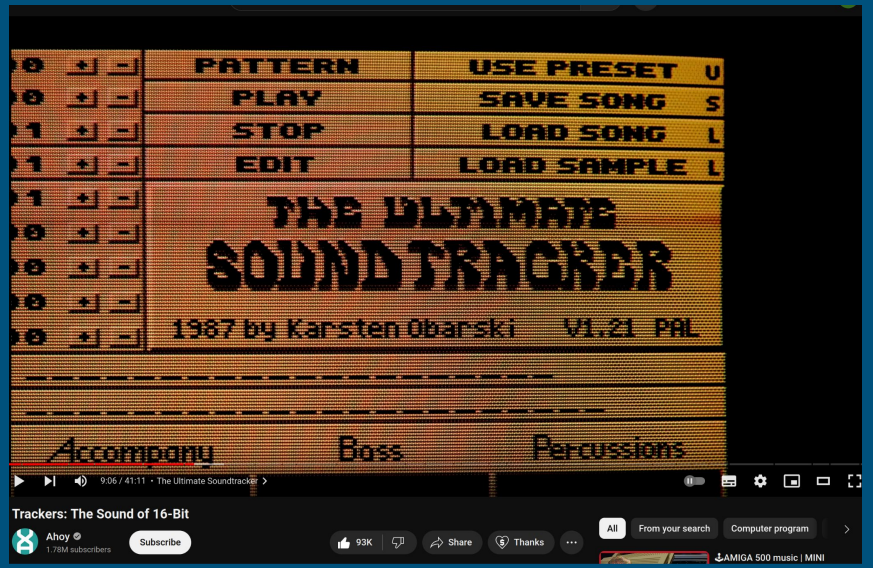
1. **Introduction**
2. **Hardware**
3. **Firmware**
4. **Documentation**
5. **🎉 🎵 Making music! 🎵 🎉**
6. **Everything else**

What is a Tracker ?

Some History (repeating...)

Or what is a Tracker?

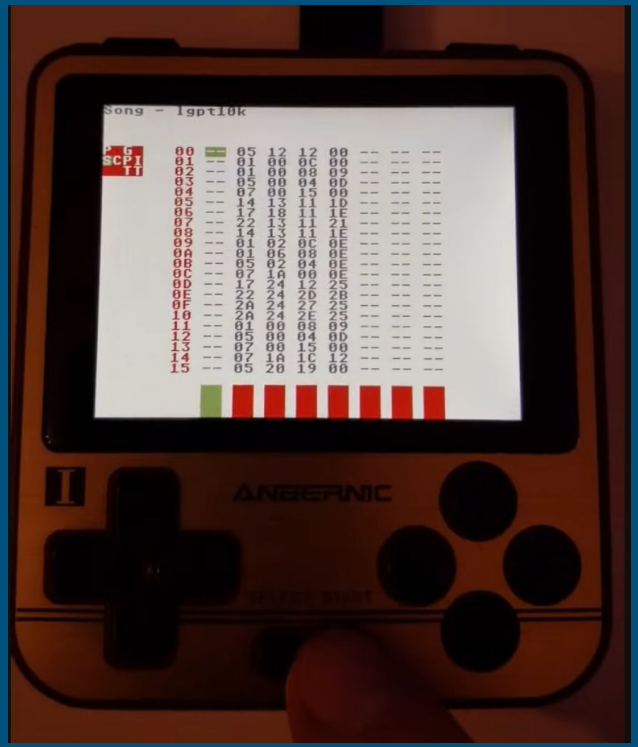
- "Software for composing (sequencing) electronic music"
- Started in 1987 with OG: ***The Ultimate Sound Tracker*** by Carsten Obarski for Amiga 1000
- Gained following for *crack screen* "demo" scene 😱
- [Great video of Tracker history by @Ahoy on Youtube]



Some (not so recent) History

Or what is a **LGPT**?

- Little GP Tracker
- By “Marc Nostromo”: 1st public commit **2014**
- Inspired by **LSDJ** - Tracker app for a Gameboy
- Intended to run on Linux based retro game emulator handhelds
- Still on Github:
  https://github.com/Mdashdotdashn/LittleGPTracker



Some more recent History

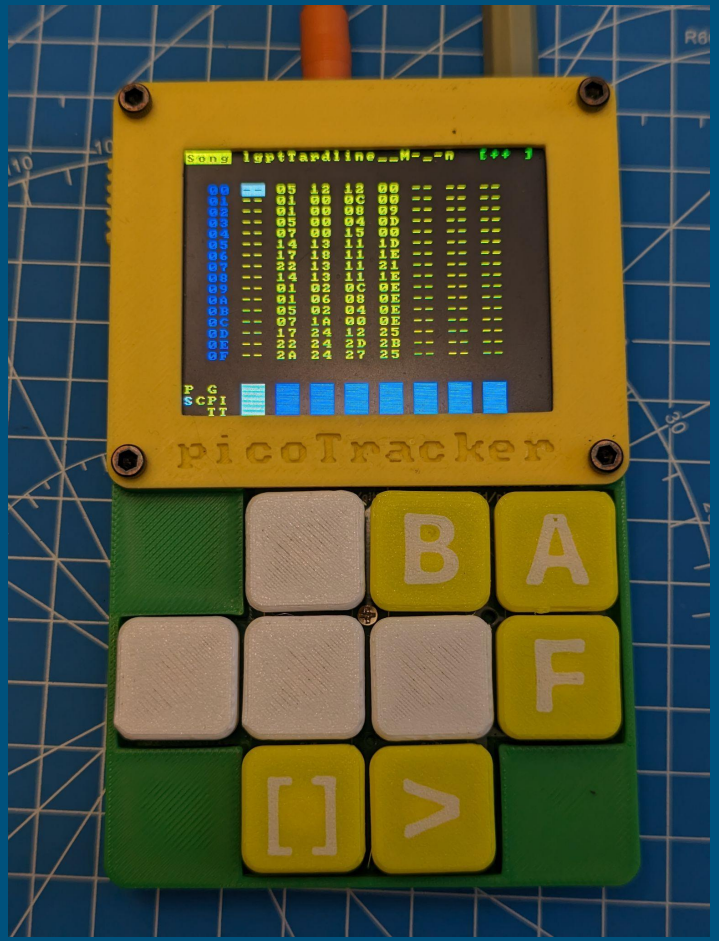
Or what is a **picoTracker**?

- Started in 2023 by **@democloid**
- Uses modified version of LGPT as its firmware
- Runs on a Pi Foundation **RP2040** microcontroller (250kB RAM!!)
- Original “desktop prototype”

Last year at EO24...

The picoTracker!

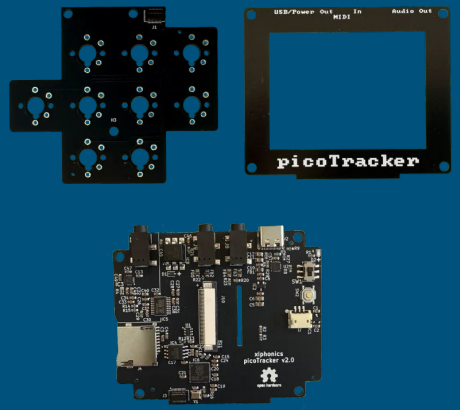
- Fully ***Open*** *Hardware* (PCBs) !
- Fully ***Open*** *Source firmware* !
- Fully ***Open*** 3D printable parts !
- Full ***Open*** src Pico C-SDK !
- **Open** and friendly *community* !



End of last year...

The **picoTracker v2** !!

- Updated PCBs inc new PCB bezel (for sale 😉)
- Build improvements, only soldering switches!
- Improved: LCD, Battery, 2 types switches
- V2 (beta) Firmware!
  2 synths, new features & *lots* of bug fixes
- OG pT v1 PCBs still supported!
- Founded company: *xiphonics inc*
- Still **Open** and friendly *community*



A (little 🤞) later this year...

The **picoTracker+** !!

- Fully assembled device, ready to use
- Upgrades to hardware...

Hardware

Hardware is Hard!

- Schematic and PCB design
- Component selection & sourcing
- Physical enclosure (case) design
- 3D Printing
- Laser etching
- Certification!

Tools of the (embedded) trade

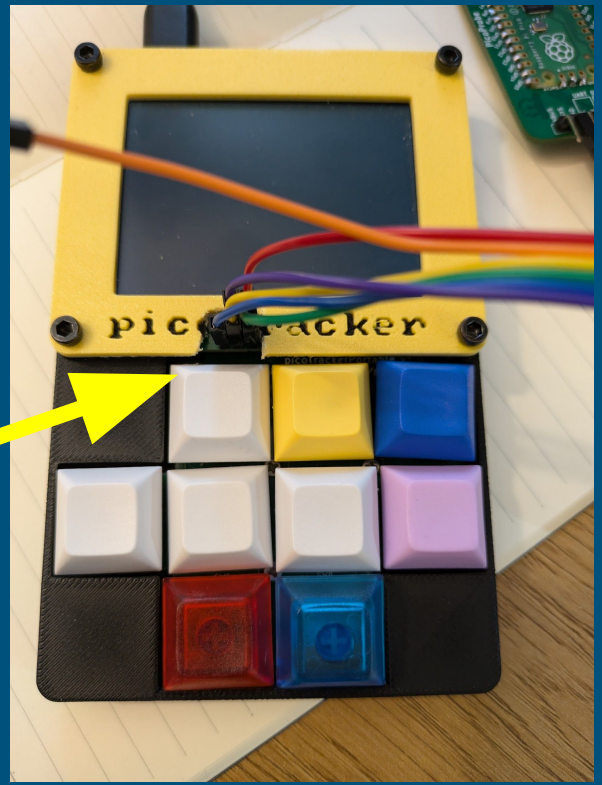
- KiCad (Schematics, PCB layout)
- FreeCad (case design)
- Bambu Studio (3d printer slicer)
- Sigrok PulseView (logic analyser app)
- DSView (fork of PulseView)

Prototyping & Test devices

- Bambu Studio (prop hardware, open src slicer)
- Bus Pirate (fully open hardware/firmware)
- DreamLab Logic Analyser (sort of open hardware, open source client software - fork of Sigrok Pulseview)
- Rigol Oscilloscope (prop hardware, prop firmware on Android)
- tinySA (prop hardware, open source firmware)
- TEM Cell (open source design)

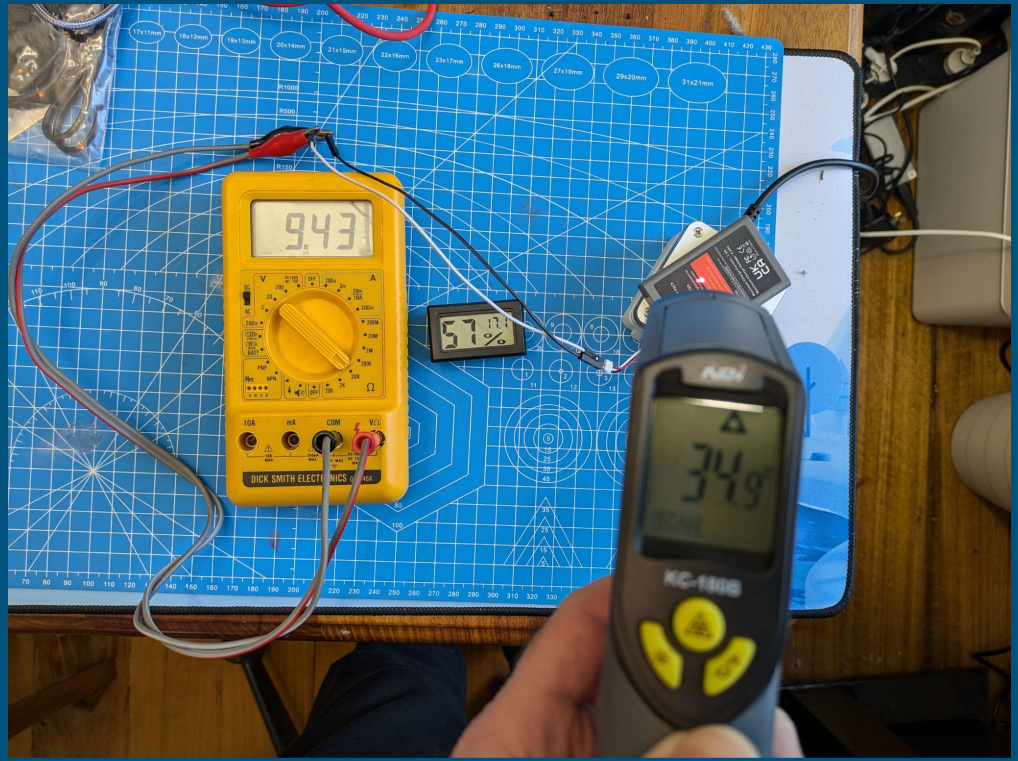
Lots of corn starch...

Pico probing

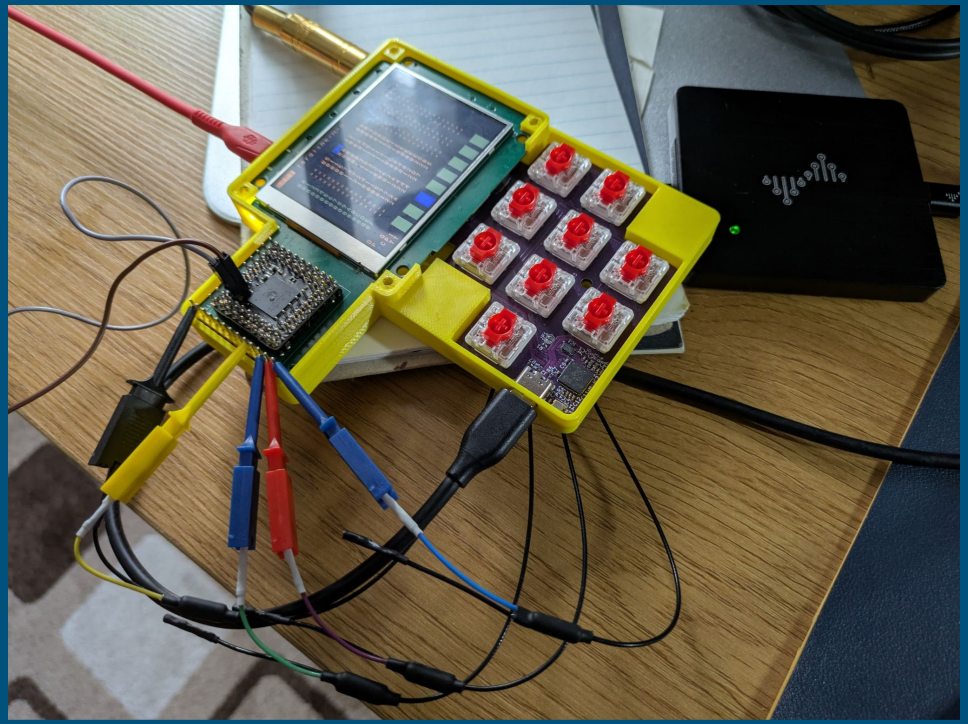


Pico probing a better way

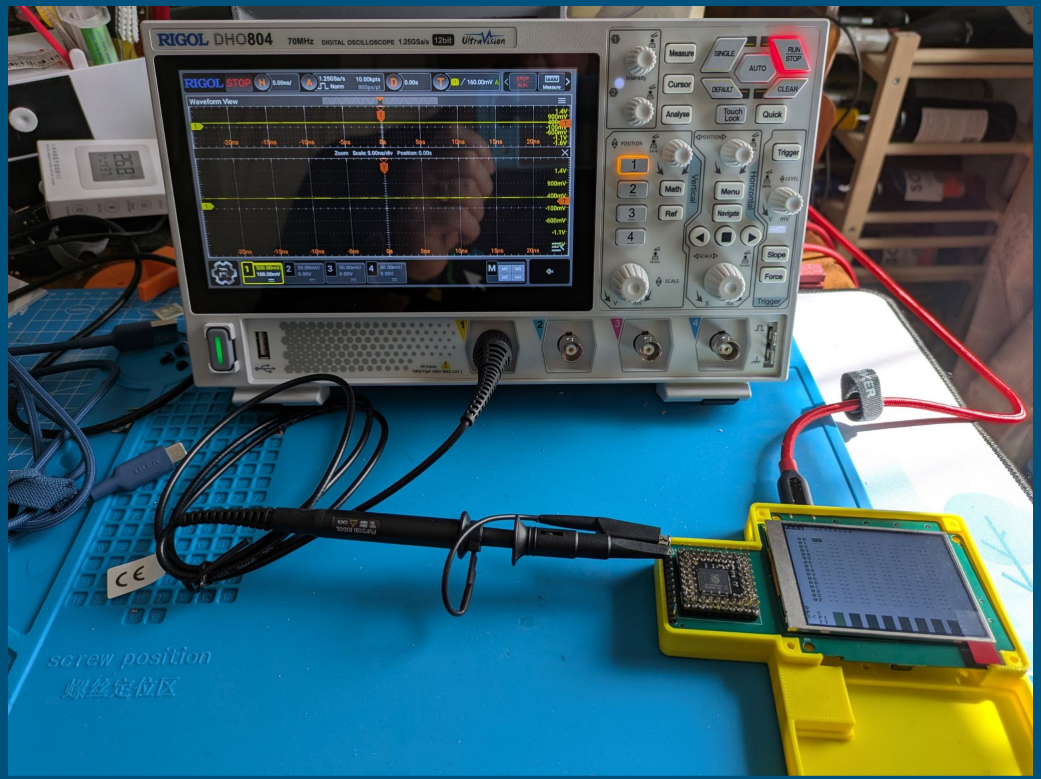
Low tech too



It's all perfectly logically

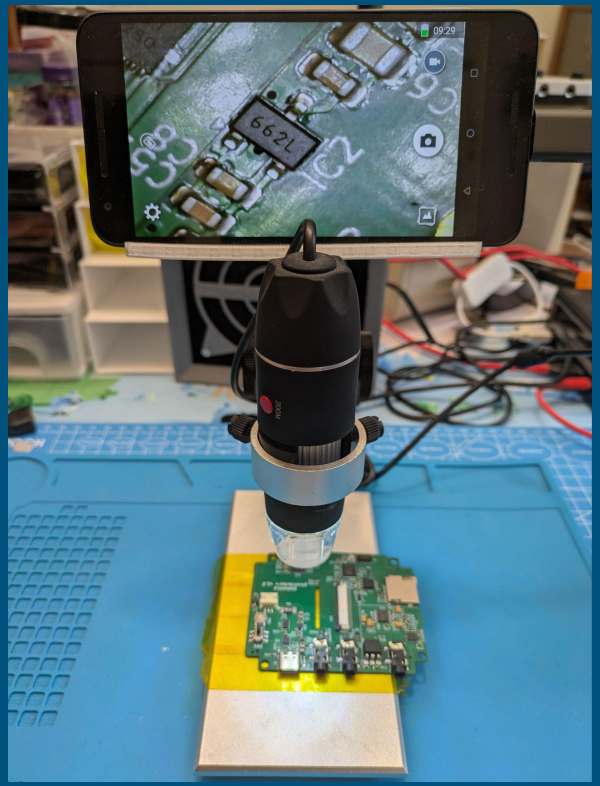


Scoping things out



Tiny Things...

- USB Webcam "microscope"
- Dodgy outdated Android App
- Ancient Android phone
- Works surprisingly ok-ish for *inspection*
- **Latency** is horrible!
  (SMD soldering is... 😱)



Tiny Things Take 2...

- RPI Zero +
- RPI Camera Module v2 +
- Weird aspect ratio LCD (I got off a Kickstarter years ago) +
- Extra long flex cable +
- Metal stand from prev setup +
- My basic Freecad design 3d print

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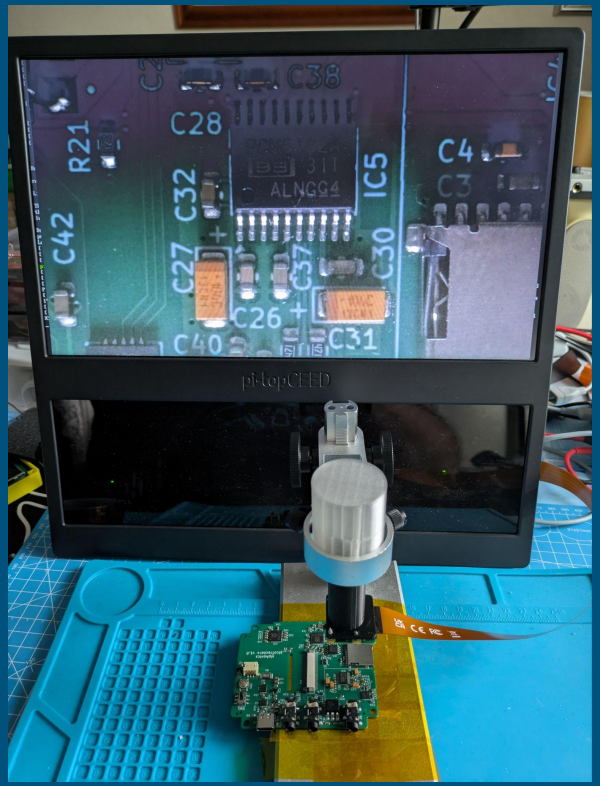
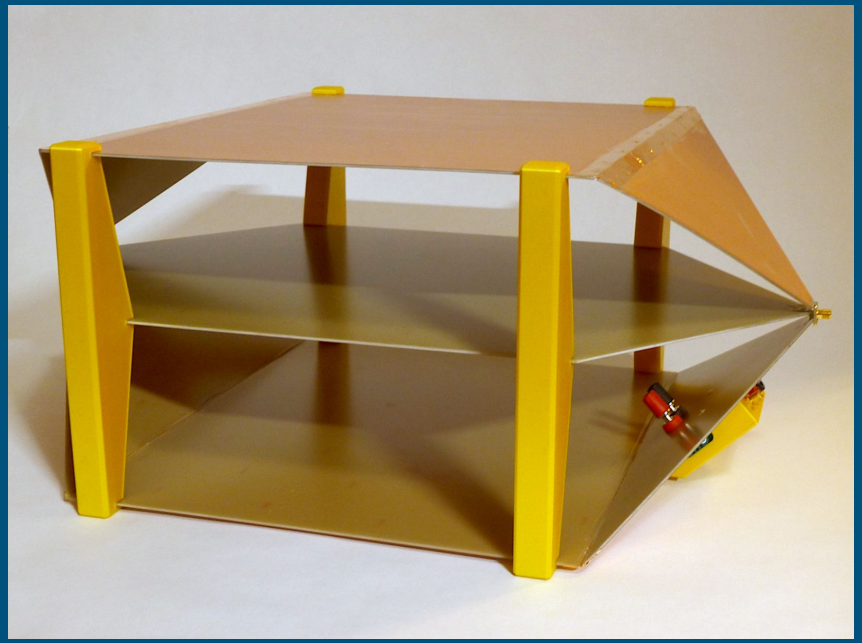
Fantastic setup with **no** latency!



Spectrum Analyser ?!?!

Spectrum Analyser - FCC Certification

- ***Pre***-Certification
- Tiny SA
- DIY TEM Cell



Ref: https://github.com/PetteriAimonen/tem-cell

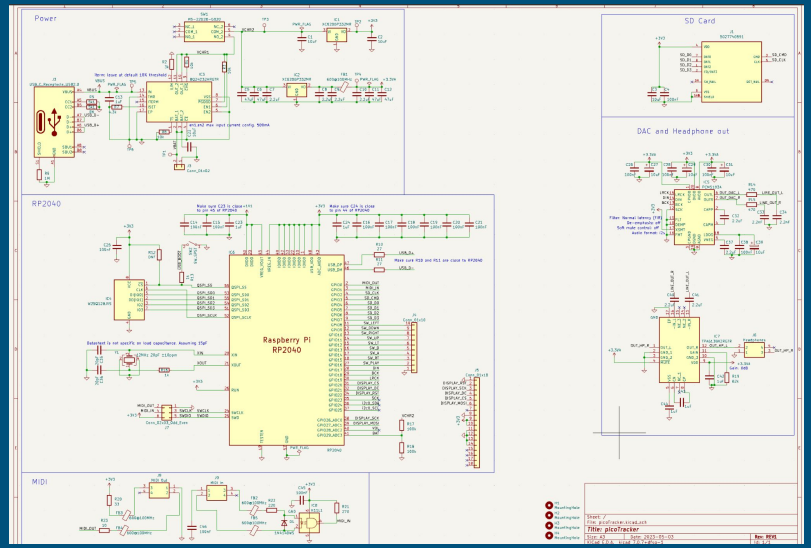
RP2040 ?

- Open source PICO SDK from RPI
- Excellent documentation!
- Great, large community/ecosystem
- Open source 3pp libs: TinyUSB, SDFat

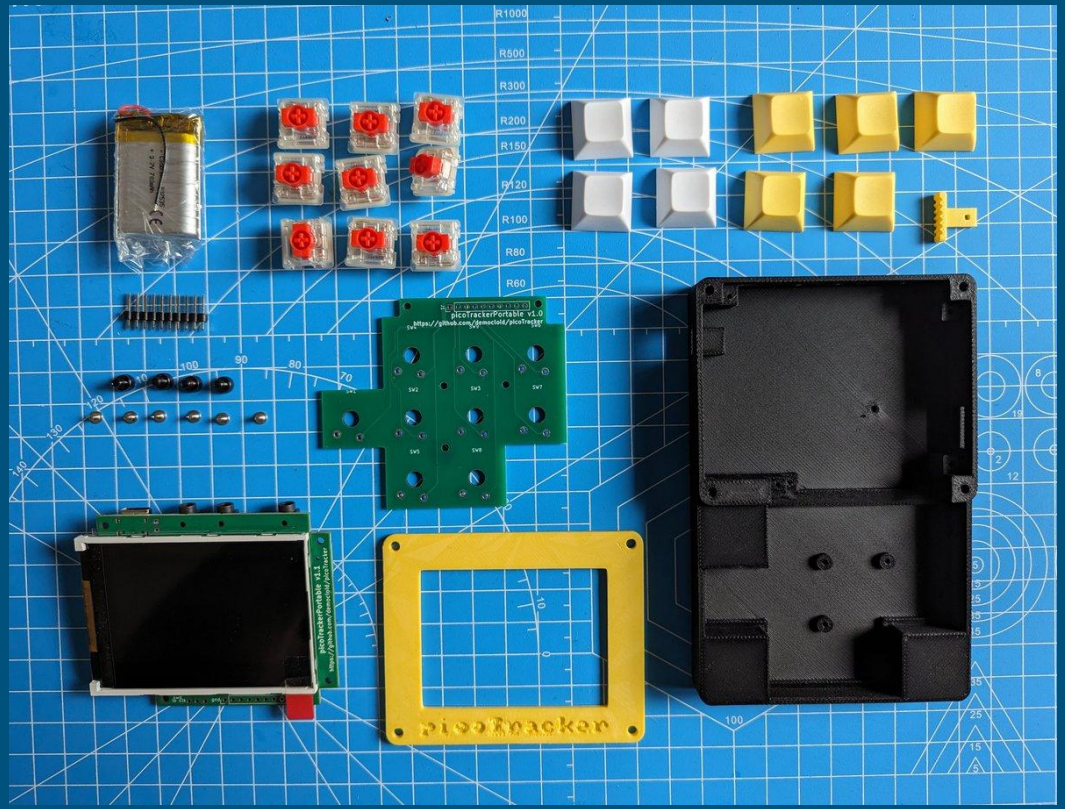
What's inside a picoTracker?

On the custom PCB:

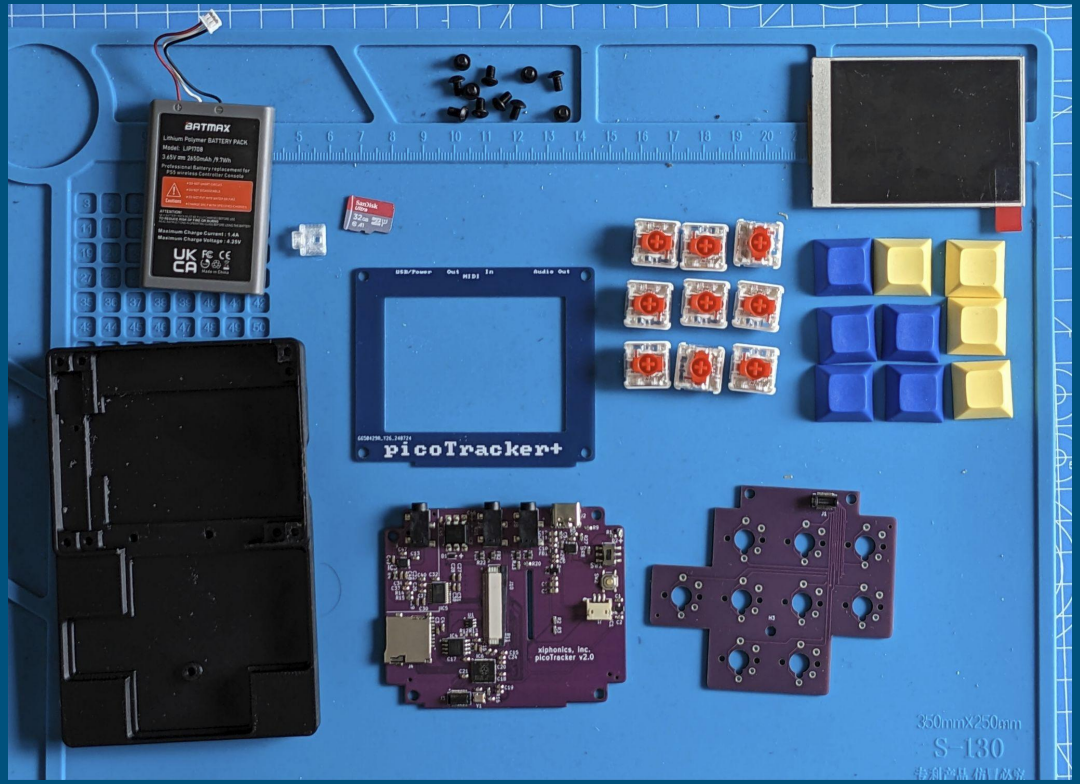
- RP2040
- 16MB Flash
- SPI for LCD
- PCM5100 DAC, Amp
- SD Card socket
- Battery charger circuit
- TRS sockets, MIDI Optocoupler, USB socket, passives, etc.



What’s inside a picoTracker?



What’s inside a picoTracker v2?



What’s inside a picoTracker+?

What’s inside a picoTracker+?

RP2350

Firmware

Building the firmware

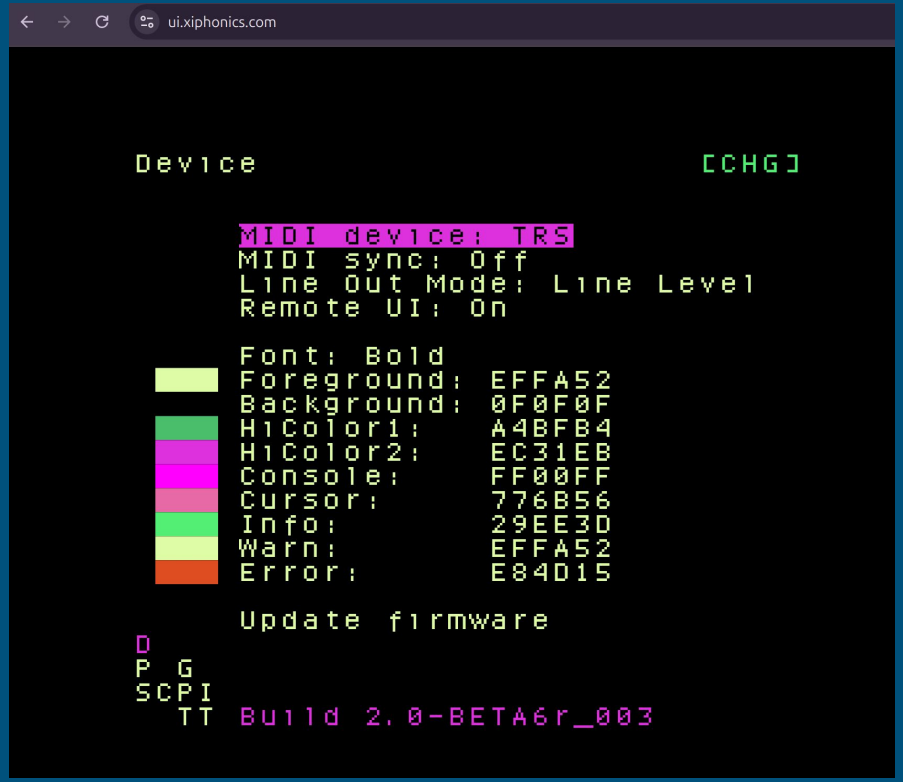
- RPI Foundation PICO C SDK
- CMake
- Ninja, Python
- GCC 12.3 (arm-none-eabi)

Debugging the firmware

- Micropython
- GDB + OpenOCD + SWD (eg. picoprobe)
- Logic Analyser (Sigrok Pulseview, DSView)

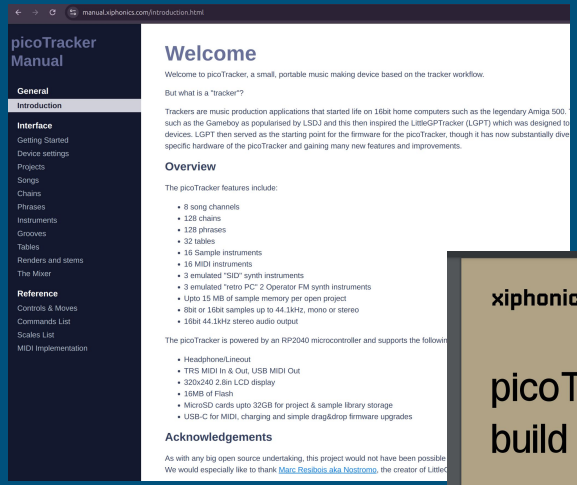
Remote UI Webapp

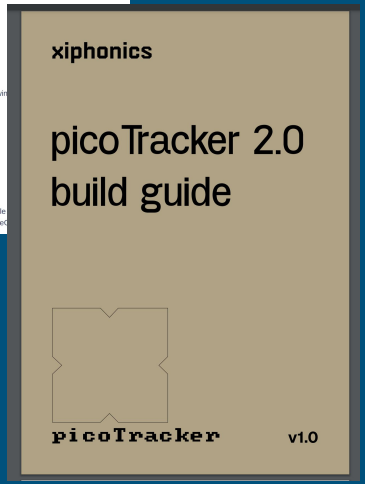
- Flutter *prototype* as Linux native app
- Flutter **release** build as **Webapp**
- Github Pages + Actions (deploy static web assets)



Documentation!

- picosite
  (custom static site generator) for User Manual
- Inkscape
  (PDF Build Instructions, packaging assets)





Tools of other trades

- Markdown (readme, dev docs)
- Github Actions + Github Pages (user manual deploy)
- Audacity (Build Guide Video)
- Shotcut (Build Guide Video)

Non-Free Tools 😢

- GitHub for git remote, issues, PRs, CI, hosting
- Discord (community, chat)
- Google Docs, Sheets, Slides (admin)
- Shopify (online shop, website hosting)

The *Really* Fun Part!
Making Music!

Making music!

What can the Picotracker do?

- **8 mono** track sequencer
- Sequencer: **128** Chains with **128** Phrases,
  16 Steps/Phrase
- **32** Instruments: **16** samples, **16** MIDI, **3** SID, **3** OPAL
- ~**15 MB** flash space for samples per project
- FX Commands (Filters, Volume, etc)
- **32** “Tables”
- 8 or 16bit samples up to 44.1kHz, mono or stereo
- 16bit/44.1kHz/Stereo audio output

Making music!

What can the Picotracker do?

- **MIDI In & OUT TRS & USB**
- ***Big feature*** of picoTracker vs LGPT handhelds!
- Works great with MultiTimbral Synths!

The tracker workflow

MTV! Making music videos!

- Remote UI via Flutter **RemoteUI** Webapp
- Record with OBS
- Edit with Shotcut

Jamming


PICOTRACKER V2:
PLUGIN SYNTHS,
MIDI IN/OUT
FOR $50 TO $75
picoTracker

The joys of everything else...

The joys of being open!

- At least **3** case designs so far
- At least **2** hardware remixes
- **1** platform port (ESP32)
- **2** PCB remixes
- **3** contributors of PRs
- **~150** members in Discord server
- **3** YouTube channels with videos about the picoTracker

The joys of *shipping!*

- picoTracker v2 PCBs!
- Firmware v2 ! (Beta)

Contributing!

https://github.com/xiphonics/picoTracker

- /issues/new

- /docs/CONTRIBUTING.md
- /docs/DEV.md

Future plans (the big todo list!)

- ~~Synths!! (tinysynth?, OPAL?, CSID?, Braids?)~~
- ~~MIDI OUT, MIDI USB, MIDI Chords~~
- MIDI IN, MIDI controllers
- Mixer screen (per channel VU meters etc)
- More audio features: ADSR, LFOs, “DJ filter”, etc
- More commands: random, chance, delay etc
- **Lots** more in GitHub Issues…
- What will ***YOU*** build? 🙂

Participate!

xiphonics.com

💙💙💙

@RickyTinez on YT

Share the love, share the knowledge, knowledge is power, peace!

Thank you!

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