Building a low-cost Test Fixture

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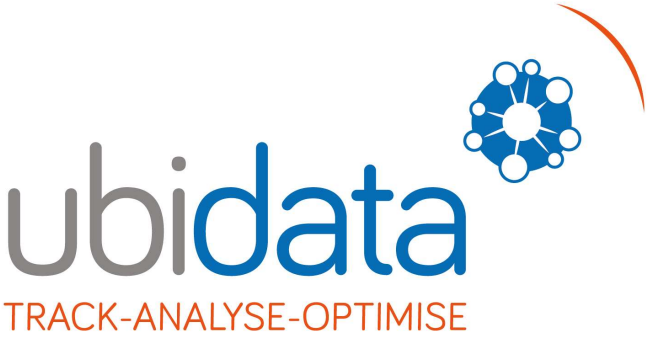
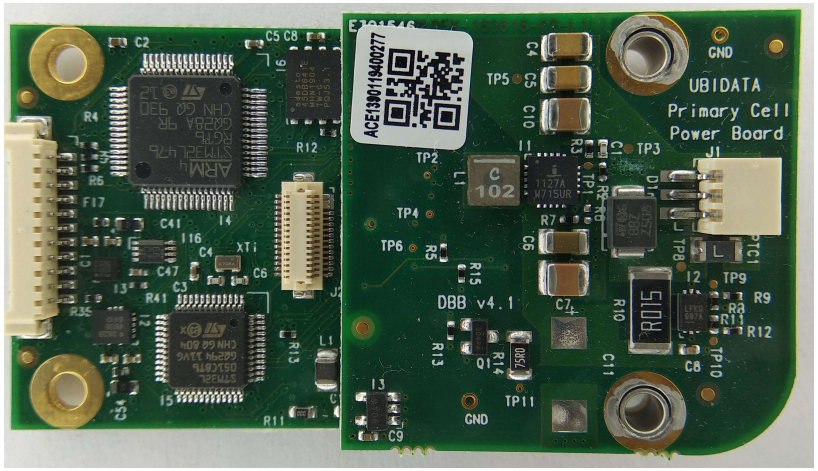


Agenda

- Background
- Motivations
- Architecture
  - Bed of nails
  - Test Controller
  - Flasher
- Conclusions

Background

- Ubidata founded in 2003 in Brussels
- Telematics and mobile logistics solutions
- We design and build our own battery-powered tracking device



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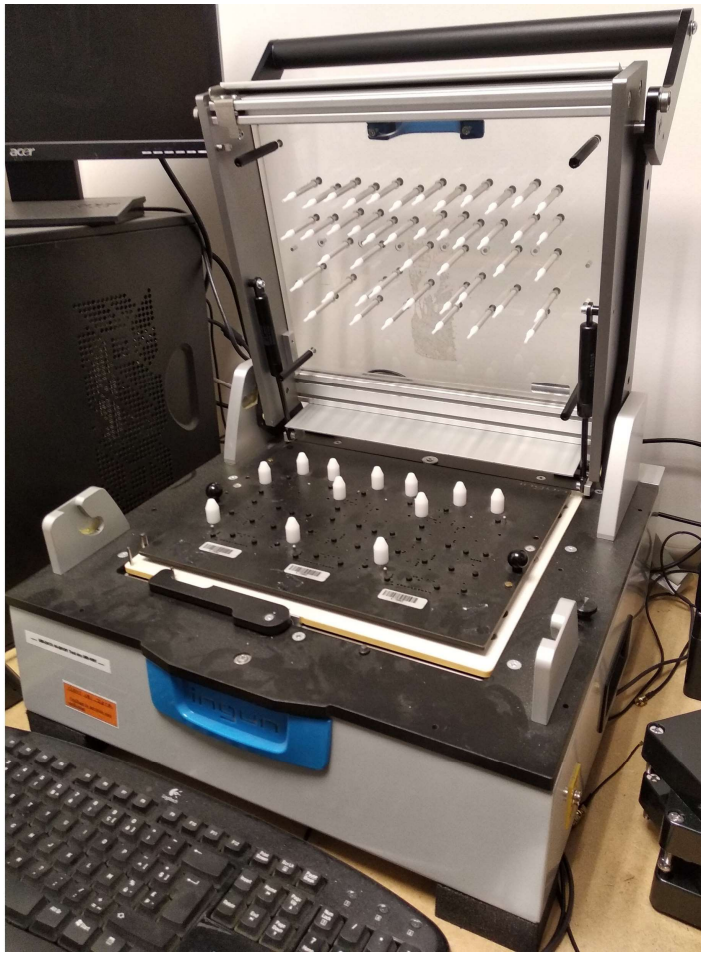
Motivations

- Functional testing at the end of the assembly line
- Run self-test on each PCB
- Program production firmware

- Small form factor:
  - PCB: 67 mm x 36 mm
  - Test points: ø 0.6 mm, spacing 1.27 mm

Motivations

Standard test fixture (€€€)



Can we build something cheaper with off-the-shelf components?

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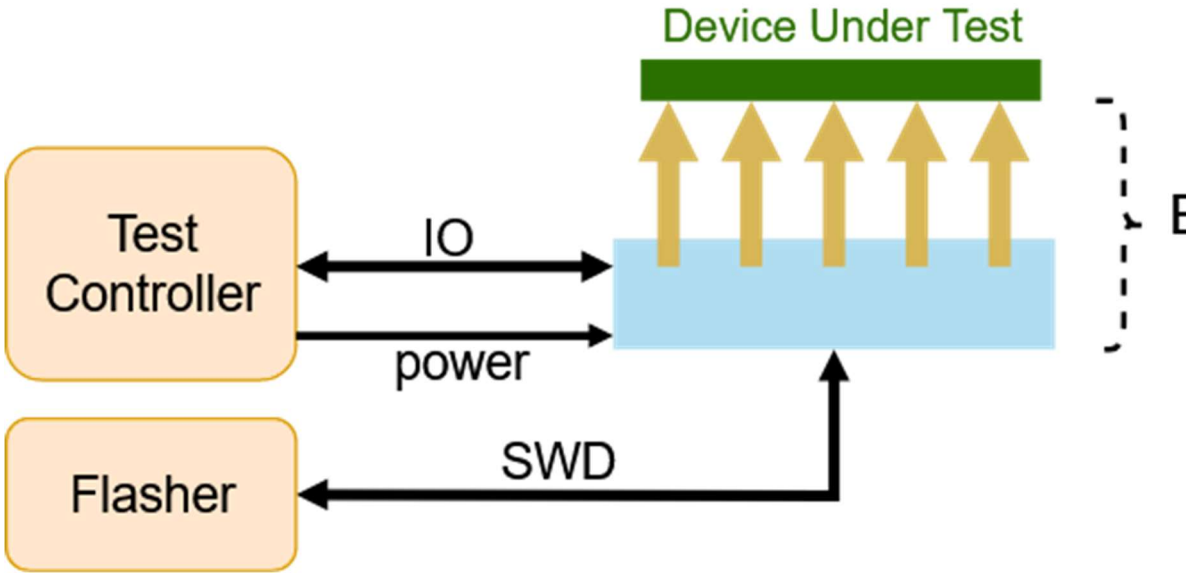
Architecture

- Bed of nails: custom PCB + soldered test probes
- Test controller: Raspberry Pi Zero
- Flasher: OpenOCD

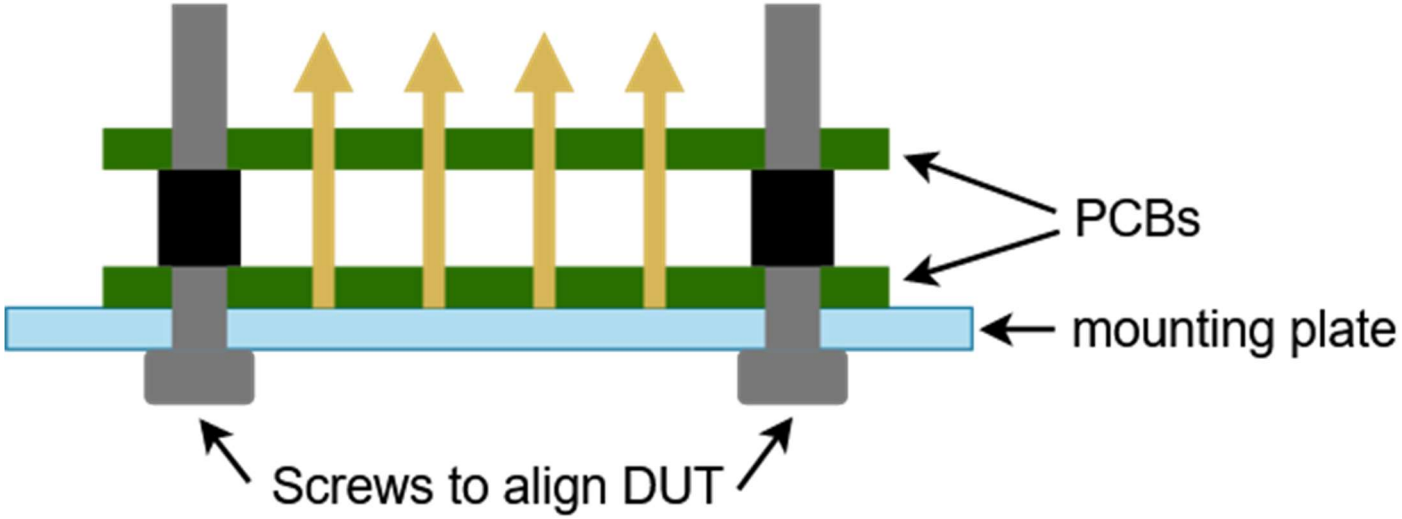


Bed of nails

Custom PCB to:

- align the Device Under Test over the probes
- connect test points to larger header

PCB designed with KiCad



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Bed of nails

Step 1: schematics

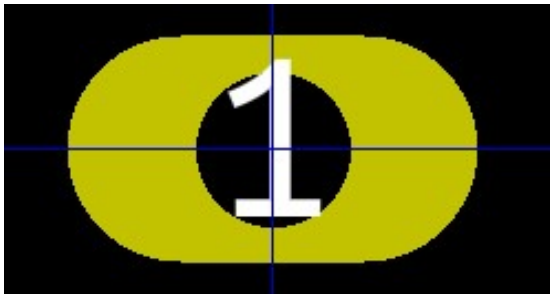
- wire test probes to a larger connector

Bed of nails

Step 2: create custom footprint for probe

Constraints:

- manufacturer's capability:
  - pad to pad spacing
  - annular ring size
- Test points spacing
- Probe diameter



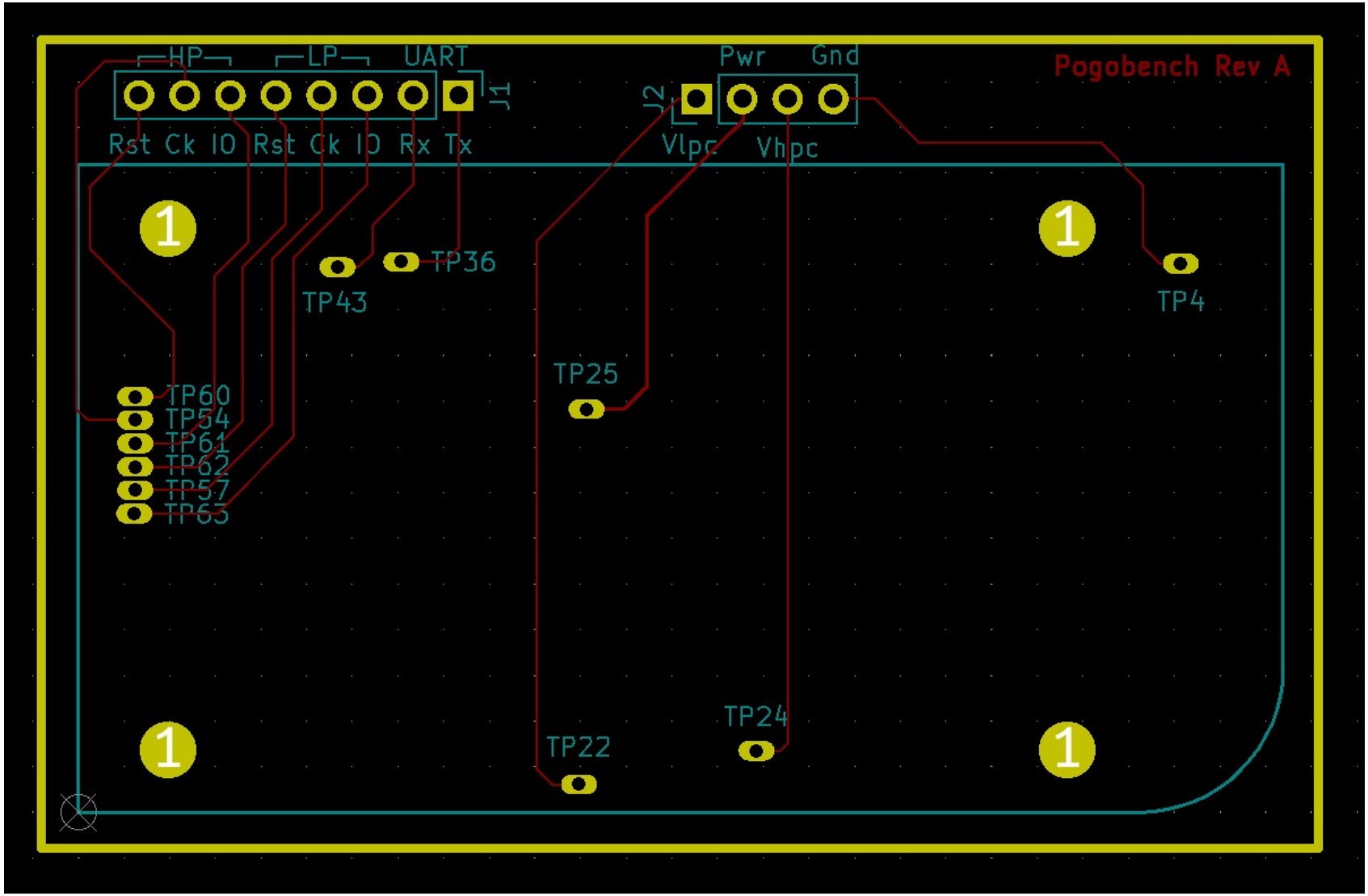
Pad size: 1.1 mm x 2 mm, ø 0.75 mm

Bed of nails

Step 3: PCB layout

- DUT's edges drawn on silkscreen layer
- Test points' coordinates extracted from DUT's gerber files
- Set origin point for the grid on new layout
- Place footprints with:
  - Position Relative To… -> Use Grid Origin

Bed of nails



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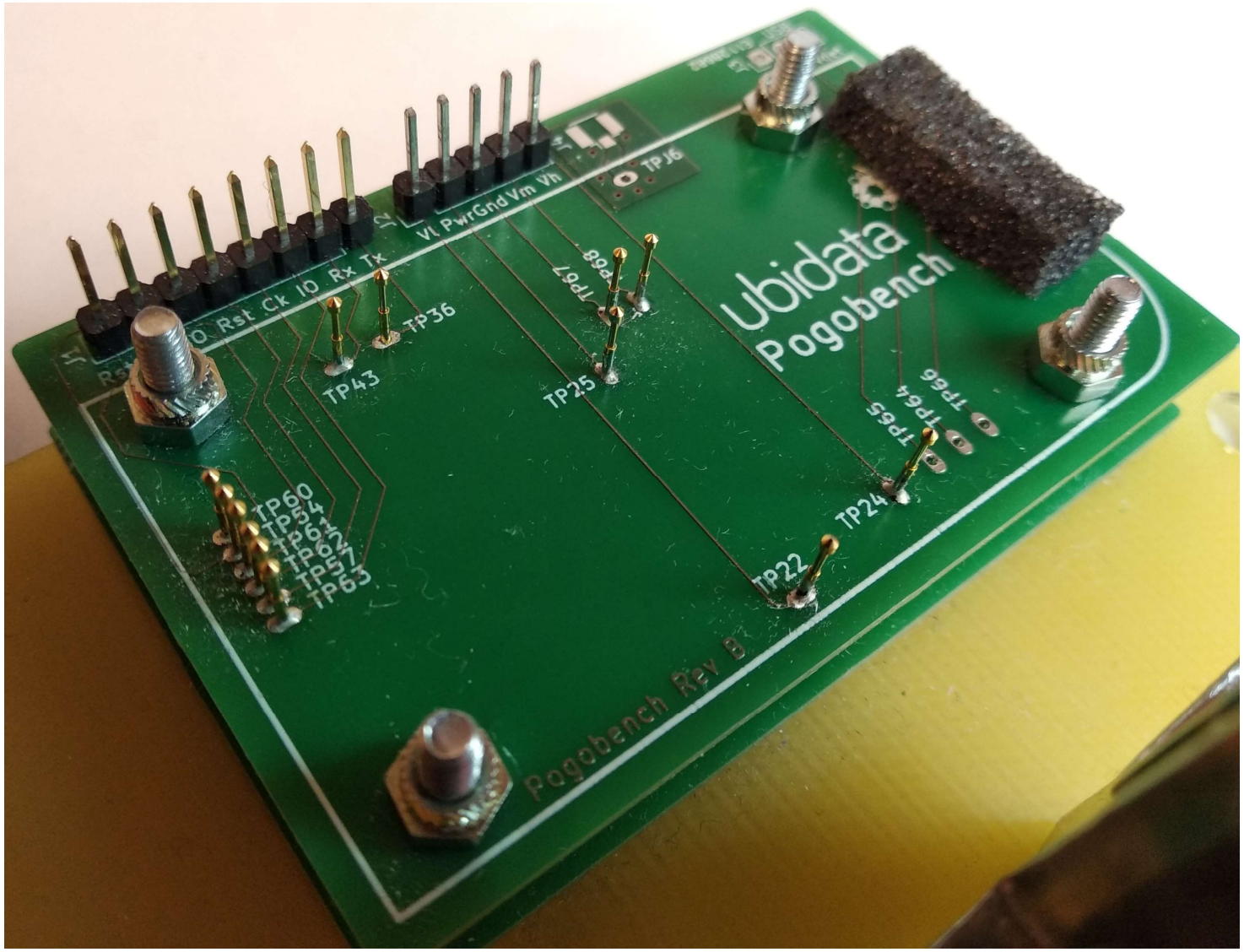
Bed of nails



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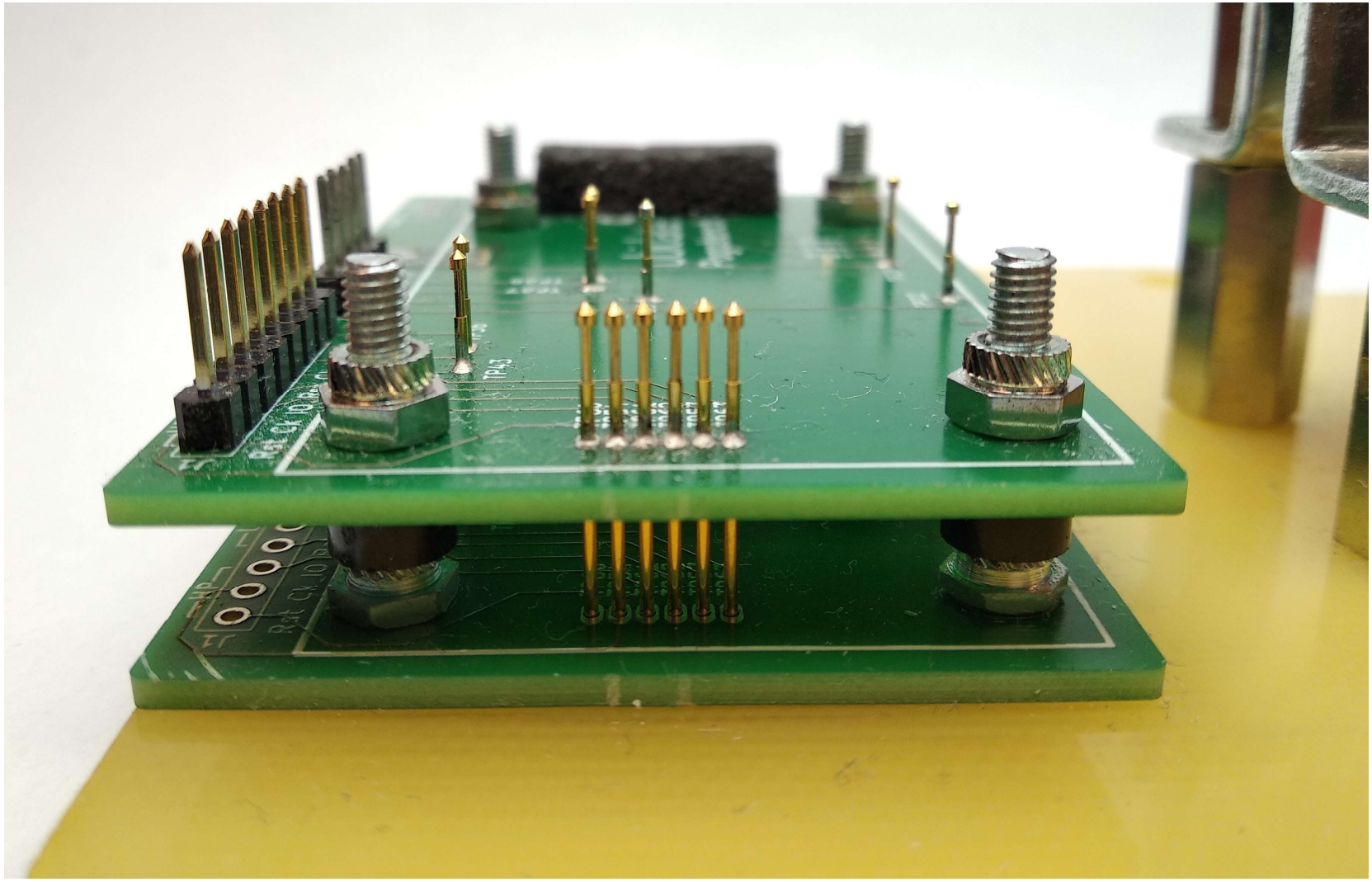
Bed of nails



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Test Controller

- Raspberry Pi Zero running TinyCore
  - Minimal Linux system
  - Runs from RAM
- Test scripts written in Python
- Communicate with DUT via UART

Test Controller

Pimoroni Automation pHAT:

- 1 relay -> Supply power to DUT
- 3 ADCs -> Measure voltage rails

Flasher

- Connect to microcontroller via SWD
- OpenOCD compiled with GPIO bitbang support

```
./configure --enable-sysfsgpio --enable-bcm2835gpio
```

- Running on the Pi Zero
- Define pins for SWD in script

Conclusions

Cost comparison

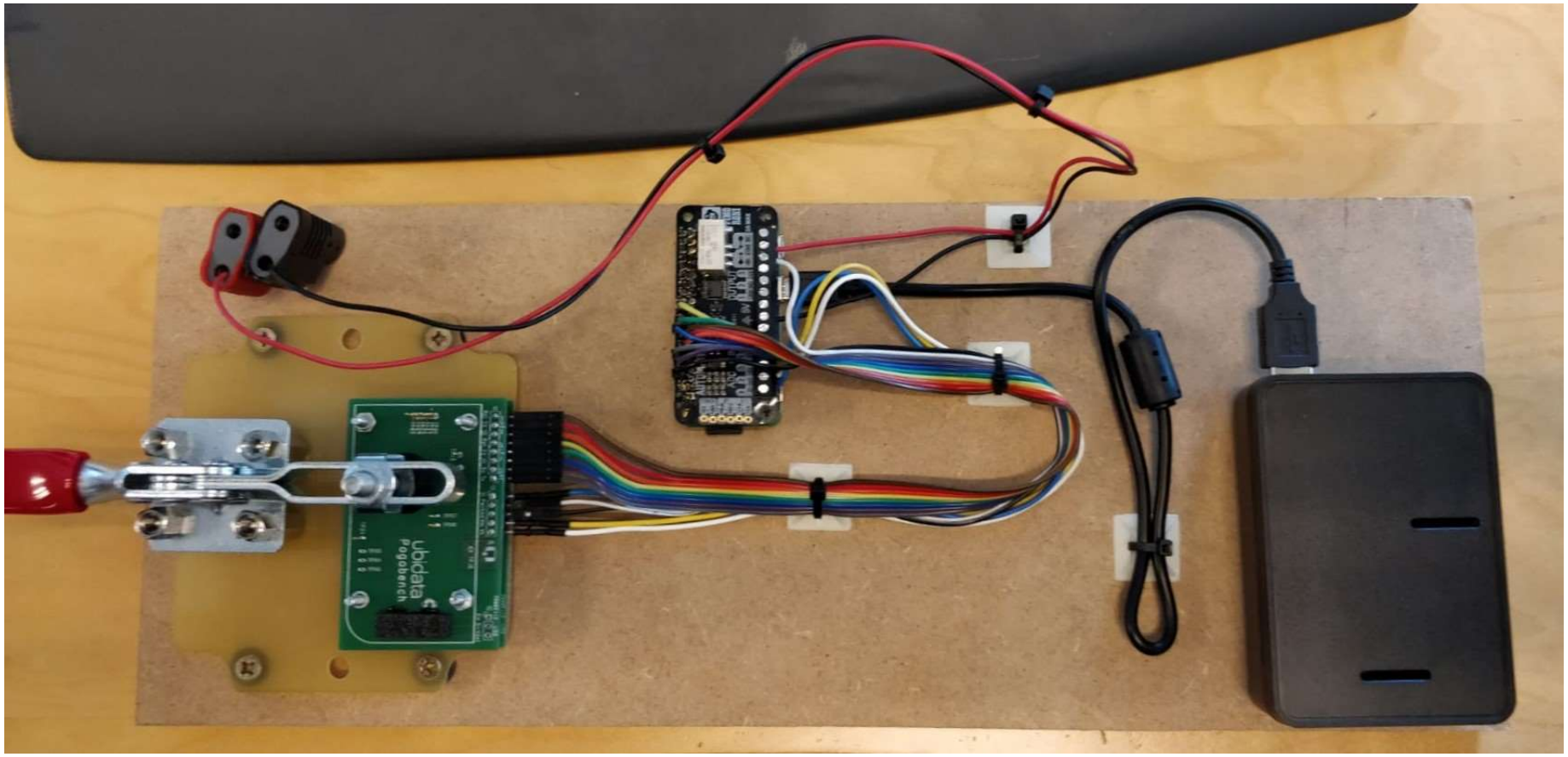
	Standard	Low-cost
Bed of nails	3000 € - 6000 €	2 PCBs: 24 € 13 probes: 18 € Others: 20 €
Test controller	100 €	RPi Zero + pHAT: 25 €
Flasher	2 x 300 €	0 €
Total	**3700 € - 6700 €**	**87 €**

Conclusions

- Cheap
- Robust
- Easy to build/replicate

Limitations: not suited if special probes required (e.g. RF probes)

Assembly



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References

- Test probes P50 series:
  https://be.farnell.com/fr-BE/multicomp/p50-e-120-g/levier-large-point/dp/1568259
- Automation pHAT from Pimoroni:
  https://shop.pimoroni.com/products/automation-phat