Comprehensible Open Hardware

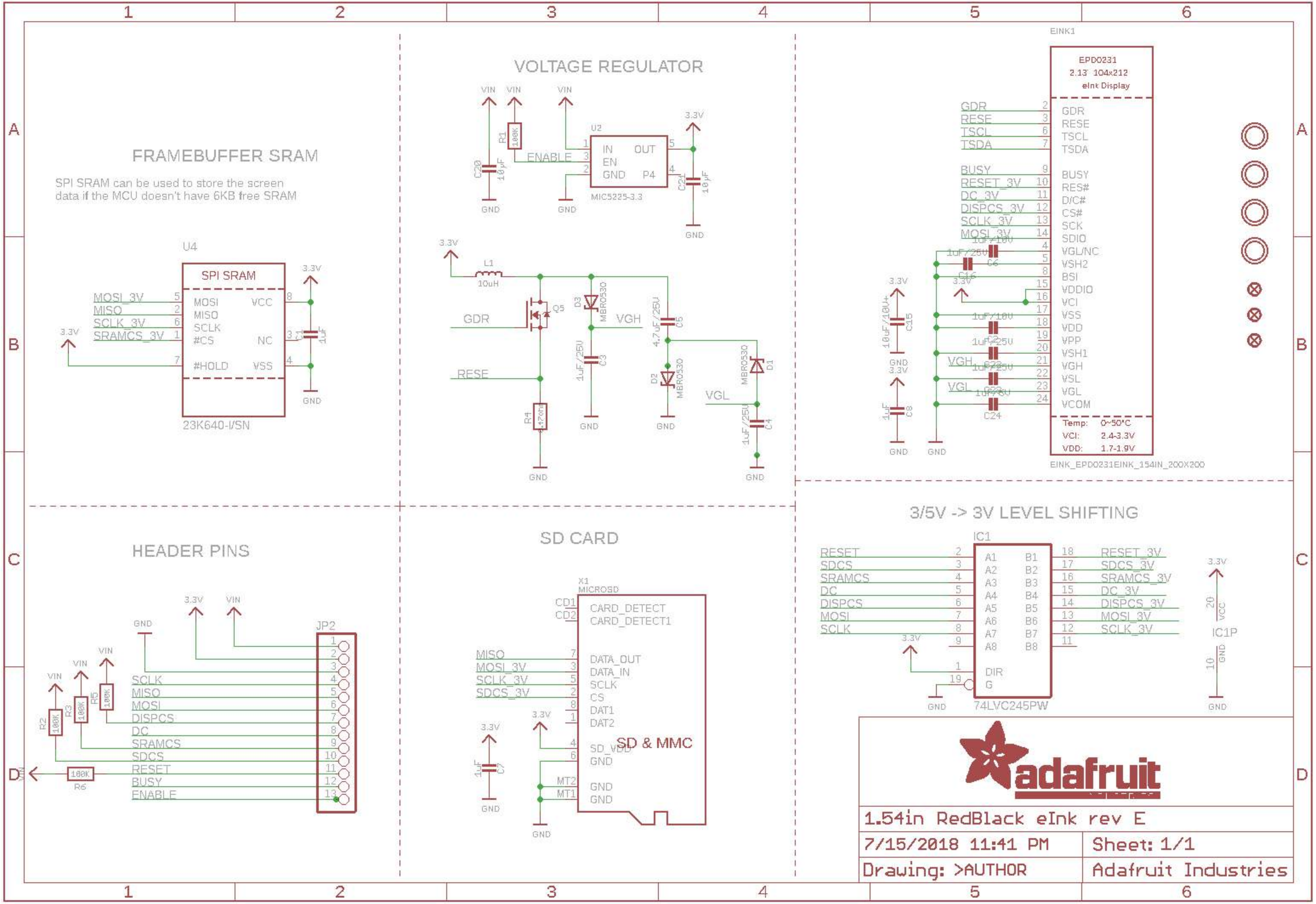
on building the Open Book and friends

Joey Castillo, FOSDEM 2024

About Me

- Technologist in Residence at Cornell Tech in NYC
- I make things under the banner of Oddly Specific Objects
- Background: Journalism, not tech
- Learned by doing and making (and cribbing notes from open source designs)
- **True believer in Open Source Hardware**

The Open Book



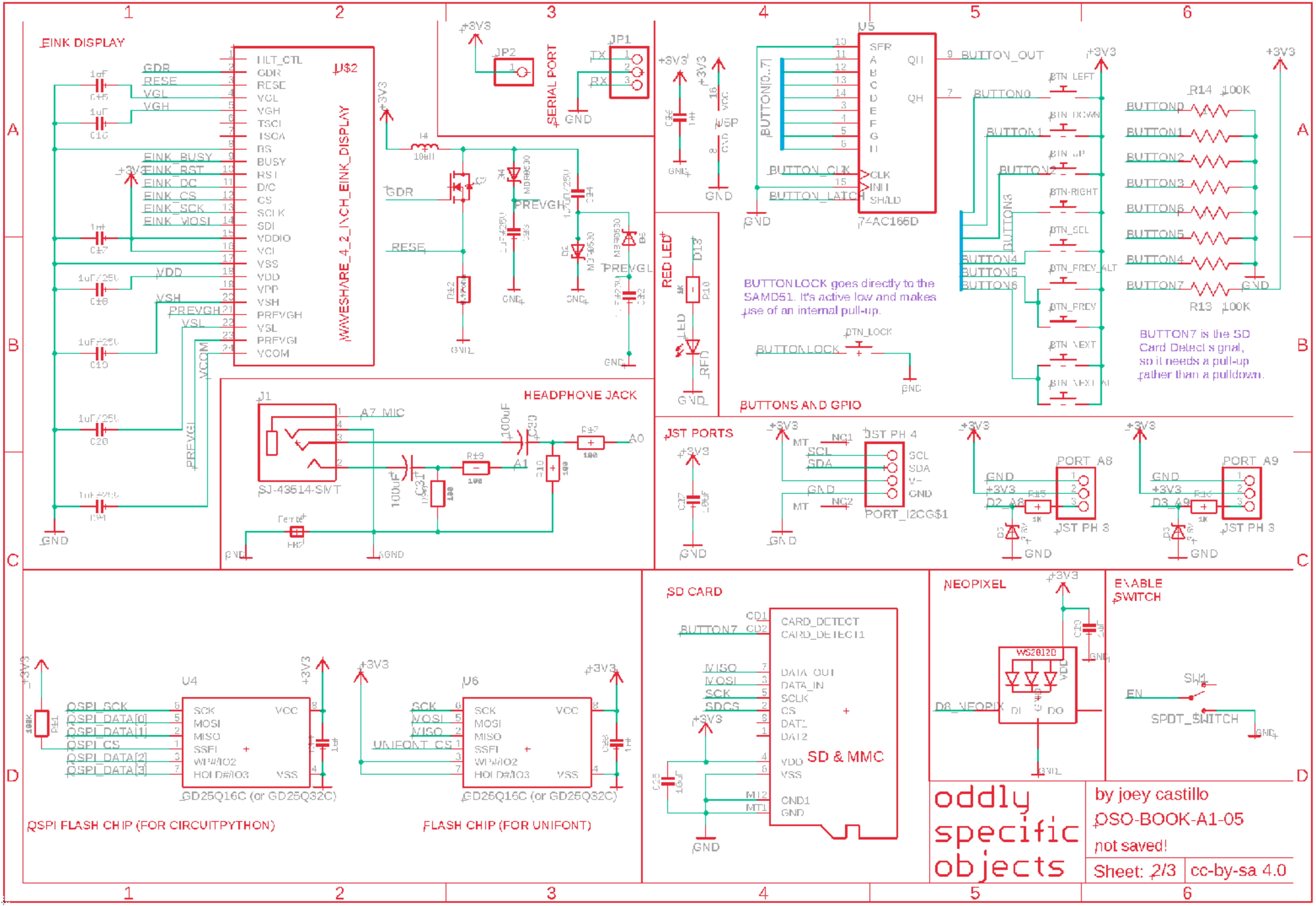
1.54in RedBlack eInk rev E

7/15/2018 11:41 PM

Sheet: 1/1

Drawing: >AUTHOR

Adafruit Industries



BUTTON LOCK goes directly to the SAMD51. It's active low and makes use of an internal pull-up.

BUTTON7 is the SD Card Detect signal, so it needs a pull-up rather than a pulldown.

oddly specific objects

by joey castillo

OSO-BOOK-A1-05

not saved!

Sheet: 2/3

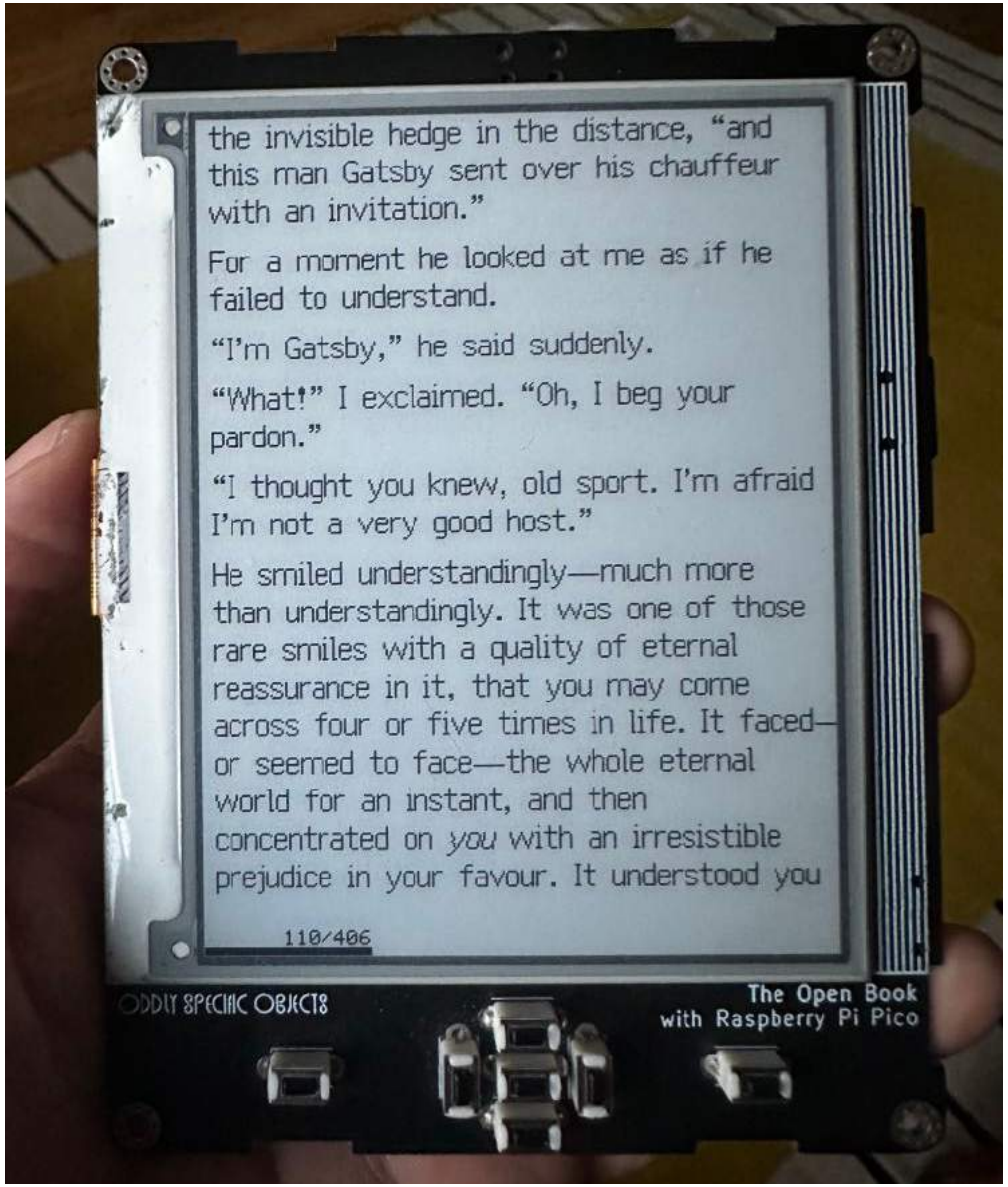
cc-by-sa 4.0

The Open Book
with Raspberry Pi Pico
ODDLY SPECIFIC OBJECTS

The Open Book

Goals

- Function as an open hardware ebook reader



the invisible hedge in the distance, "and this man Gatsby sent over his chauffeur with an invitation."

For a moment he looked at me as if he failed to understand.

"I'm Gatsby," he said suddenly.

"What!" I exclaimed. "Oh, I beg your pardon."

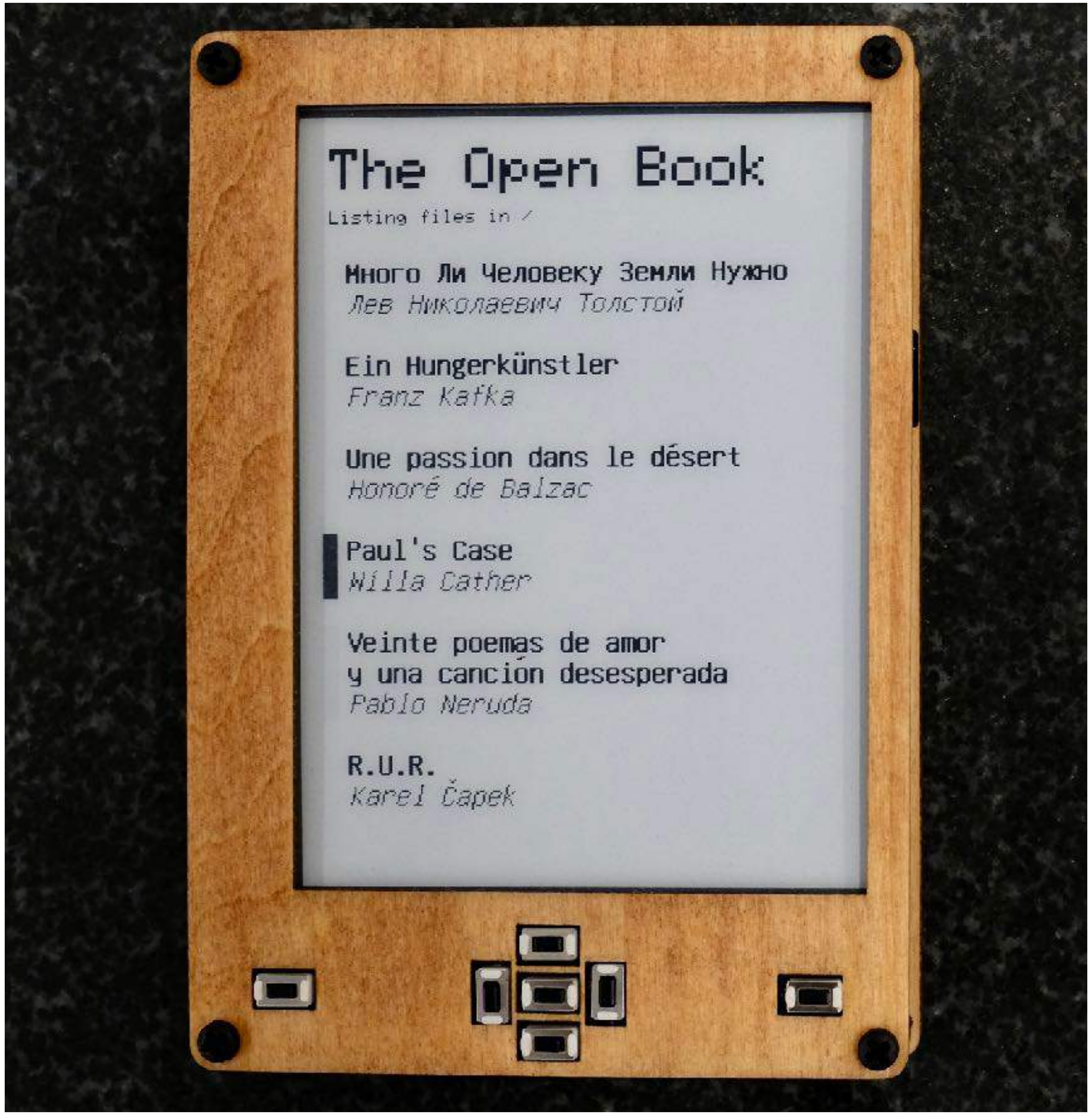
"I thought you knew, old sport. I'm afraid I'm not a very good host."

He smiled understandingly—much more than understandingly. It was one of those rare smiles with a quality of eternal reassurance in it, that you may come across four or five times in life. It faced—or seemed to face—the whole eternal world for an instant, and then concentrated on *you* with an irresistible prejudice in your favour. It understood you

The Open Book

Goals

- Function as an open hardware ebook reader
- Support reading texts in all the languages of the world



The Open Book

Listing files in /

Много Ли Человеку Земли Нужно
Лев Николаевич Толстой

Ein Hungerkünstler
Franz Kafka

Une passion dans le désert
Honoré de Balzac

Paul's Case
Willa Cather

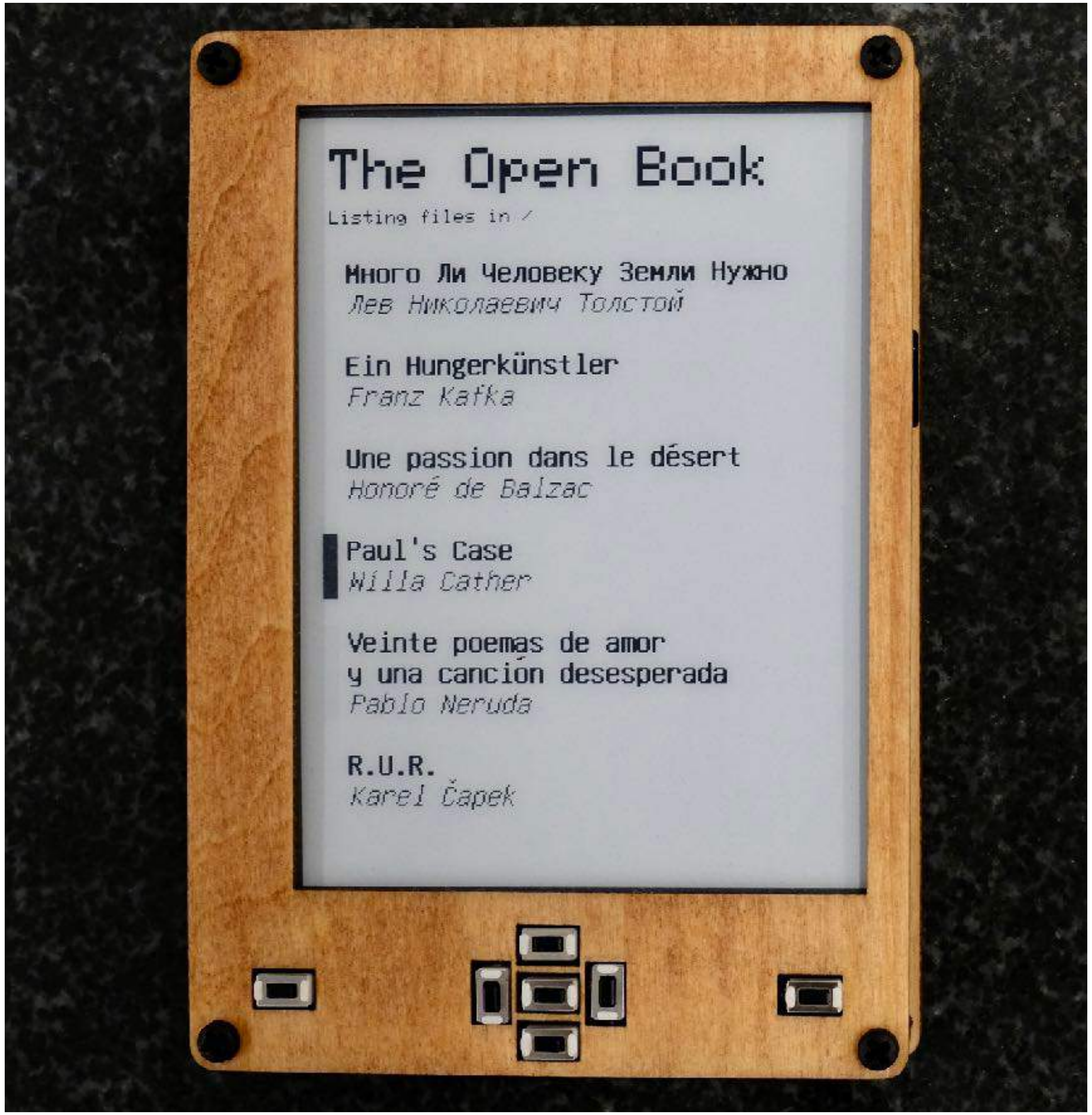
Veinte poemas de amor
y una canción desesperada
Pablo Neruda

R.U.R.
Karel Čapek

The Open Book

Goals

- Function as an open hardware ebook reader
- Support reading texts in all the languages of the world
- Be affordable, accessible and DIY’able



```
The Open Book
Listing files in /

Много Ли Человеку Земли Нужно
Лев Николаевич Толстой

Ein Hungerkünstler
Franz Kafka

Une passion dans le désert
Honoré de Balzac

Paul's Case
Willa Cather

Veinte poemas de amor
y una canción desesperada
Pablo Neruda

R.U.R.
Karel Čapek
```

My Library

3.49 V

Много Ли Человеку Земли Нужно

ألف ليلة وليلة

孫子兵法

Οδύσσεια

The Weary Blues

Little Women

The Sun Also Rises

Paul's Case

The Gun

The Picture of Dorian Gray

The Great Gatsby

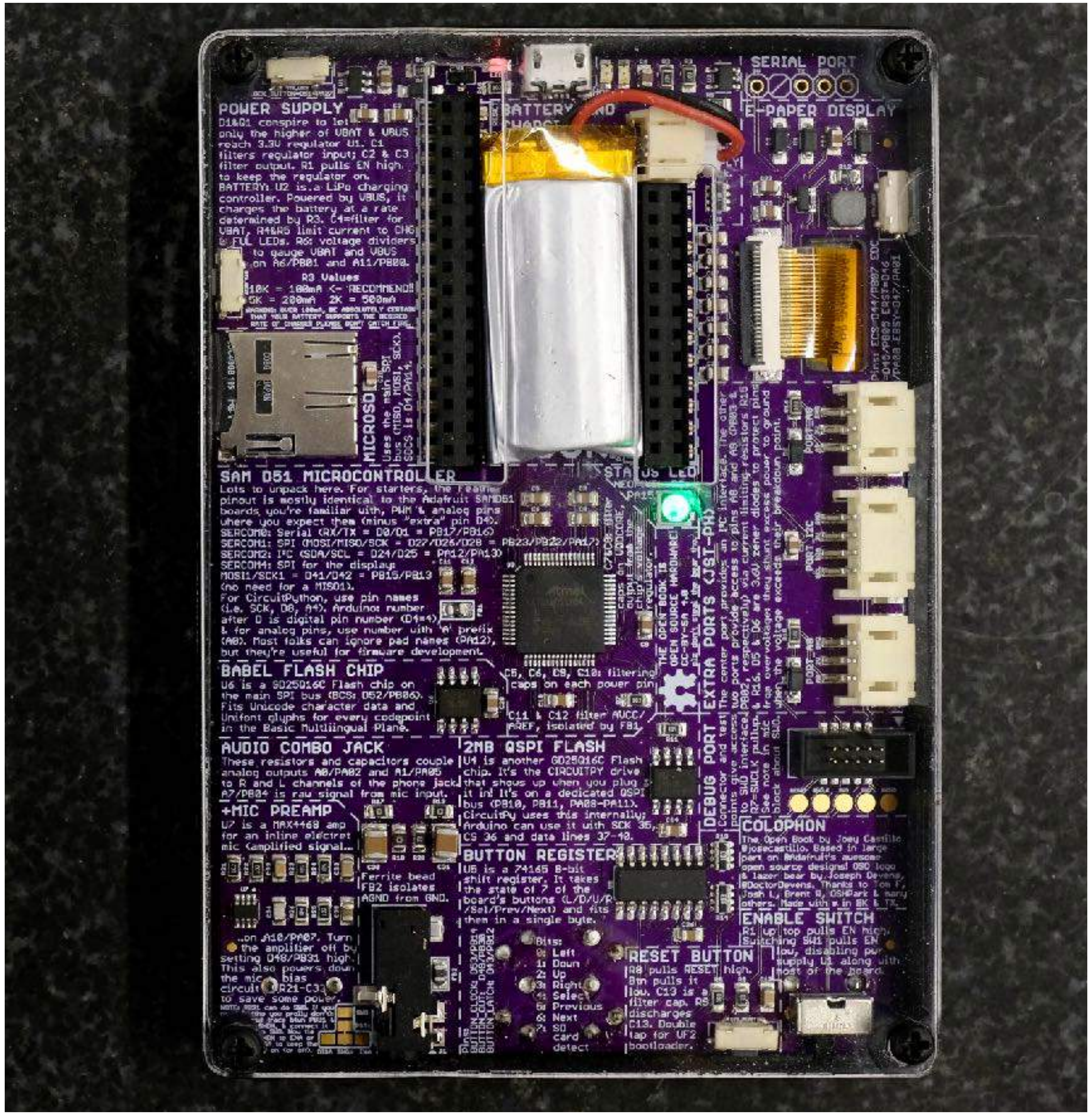
The Machine Stops

Frankenstein

The Open Book

Goals

- Function as an open hardware ebook reader
- Support reading texts in all the languages of the world
- Be affordable, accessible and DIY’able
- **Be understandable by the person who builds and uses it**



POWER SUPPLY

D1&Q1 conspire to let only the higher of VBAT & VBUS reach 3.3V regulator U1. C1 filters regulator input; C2 & C3 filter output. R1 pulls EN high to keep the regulator on.

BATTERY: U2 is a LiPo charging controller. Powered by VBUS, it charges the battery at a rate determined by R3. C4=filter for VBAT, R4&R5 limit current to CHG FUL LEDs. R6: voltage dividers to gauge VBAT and VBUS on A6/PB01 and A11/PB00.

R3 Values

10K = 100mA <- RECOMMEND!!
5K = 200mA 2K = 500mA

WARNING: OVER 100mA, BE ABSOLUTELY CERTAIN THAT YOUR BATTERY SUPPORTS THE DESIRED RATE OF CHARGE!! PLEASE DON'T CATCH FIRE.

MICROSD

Uses the main SPI bus (MISO, MOSI, SCK). SDCS is D4/PA14.

SAM D51 MICROCONTROLLER

Lots to unpack here. For starters, the Feather pinout is mostly identical to the Adafruit SAMD51 boards you're familiar with, PWM & analog pins where you expect them (minus "extra" pin D4).

SERCOM0: Serial (RX/TX = D0/D1 = PB17/PB16)
SERCOM1: SPI (MOSI/MISO/SCK = D27/D26/D28 = PB23/PB22/PA17)
SERCOM2: I²C (SDA/SCL = D24/D25 = PA12/PA13)
SERCOM4: SPI for the display:
MOSI1/SCK1 = D41/D42 = PB15/PB13
(no need for a MISO1).

For CircuitPython, use pin names (i.e. SCK, D8, A4). Arduino: number after D is digital pin number (D4=4), & for analog pins, use number with 'A' prefix (A0). Most folks can ignore pad names (PA12), but they're useful for firmware development.

C7&C8: filter caps on VDDCORE, output from the chip's voltage regulator.

STATUS LED

NEOPIXEL=D8=PA15

THE OPEN BOOK IS OPEN SOURCE HARDWARE!
CC-BY-SA 4.0
plz don't steal the bear tho.

A PORTS (JST-PH)

nter port provides an I²C interface. The other ts provide access to pins A8 and A9 (PB03 & espectively) via current limiting resistors R15 D5 & D6 are 3.6V zener diodes to protect pins ervoltage: they shunt excess power to ground e voltage exceeds their breakdown point.

BABEL FLASH CHIP

POWER SUPPLY
D1&Q1 conspire to let only the higher of VBAT & VBUS reach 3.3V regulator U1. C1 filters regulator input; C2 & C3 filter output. R1 pulls EN high to keep the regulator on.
BATTERY: U2 is a LiPo charging controller. Powered by VBUS, it charges the battery at a rate determined by R3. C4=filter for VBAT, R4&R5 limit current to CHG & FUL LEDs. R6: voltage dividers to gauge VBAT and VBUS on A6/PB01 and A11/PB00.
R3 Values
10K = 100mA <- RECOMMEND!!
5K = 200mA 2K = 500mA
WARNING: OVER 100mA, BE ABSOLUTELY CERTAIN THAT YOUR BATTERY SUPPORTS THE DESIRED RATE OF CHARGE!! PLEASE DON'T CATCH FIRE.
LOCK_BUTTON=D51/PA27
BATTERY AND CHARGING
ODDLY SPECIFIC OBJECTS
THE OPEN BOOK
SERIAL PORT
3V TX GND RX
E-PAPER DISPLAY
Pins: ECS=D44/PB07
=D45/PB05 ERST=D
/PA00 EBSY=D47/
MICROSD
FUL CHG

“The Dr. Bronner's of PCB Design”

But, why?

The Problem

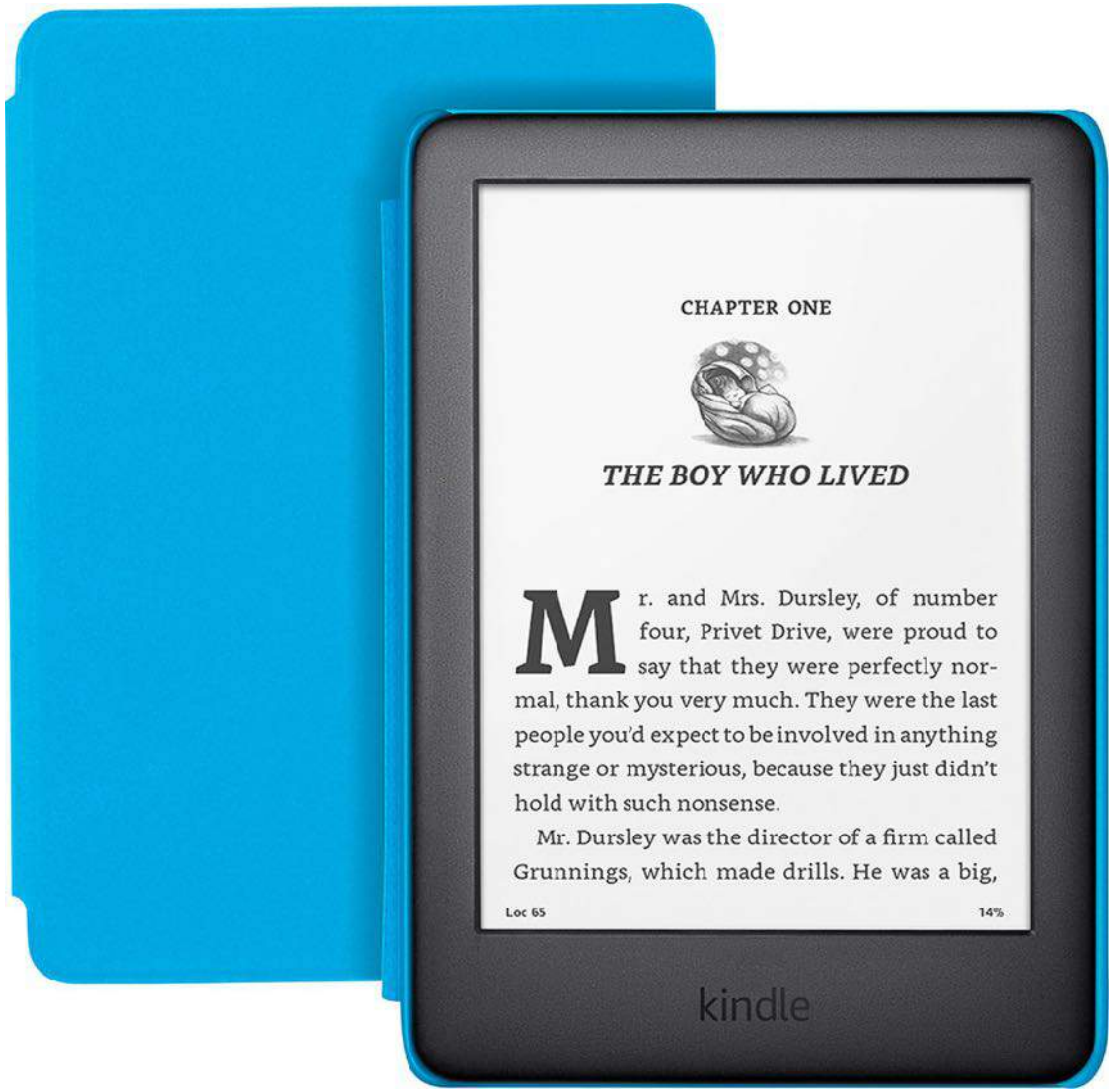
Closed tech fails users

- Who does the technology empower?

The Problem

Closed tech fails users

- Who does the technology empower?



CHAPTER ONE

THE BOY WHO LIVED

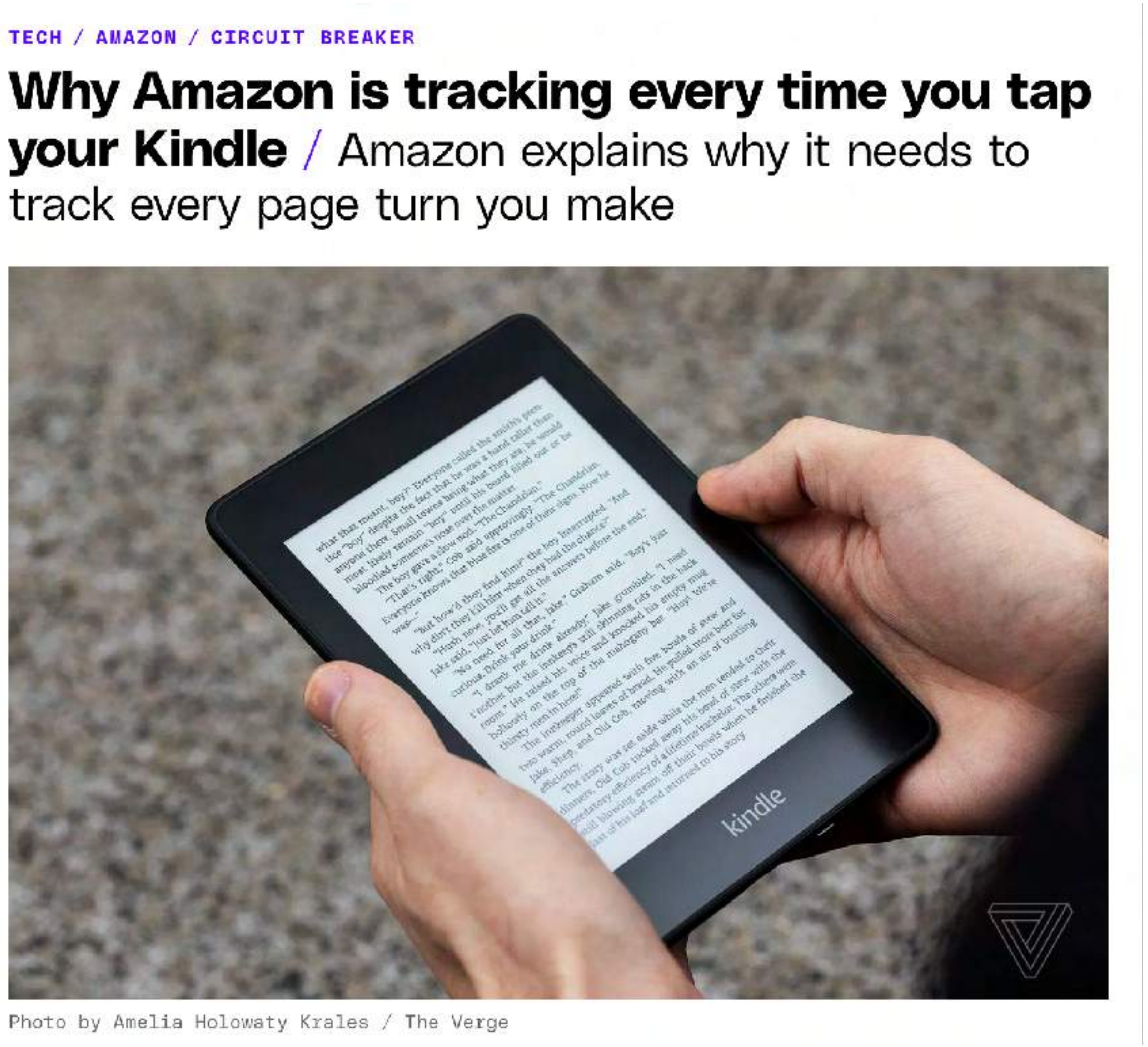
Mr. and Mrs. Dursley, of number four, Privet Drive, were proud to say that they were perfectly normal, thank you very much. They were the last people you'd expect to be involved in anything strange or mysterious, because they just didn't hold with such nonsense.

Mr. Dursley was the director of a firm called Grunnings, which made drills. He was a big,

The Problem

Closed tech fails users

- Who does the technology empower?



TECH / AMAZON / CIRCUIT BREAKER

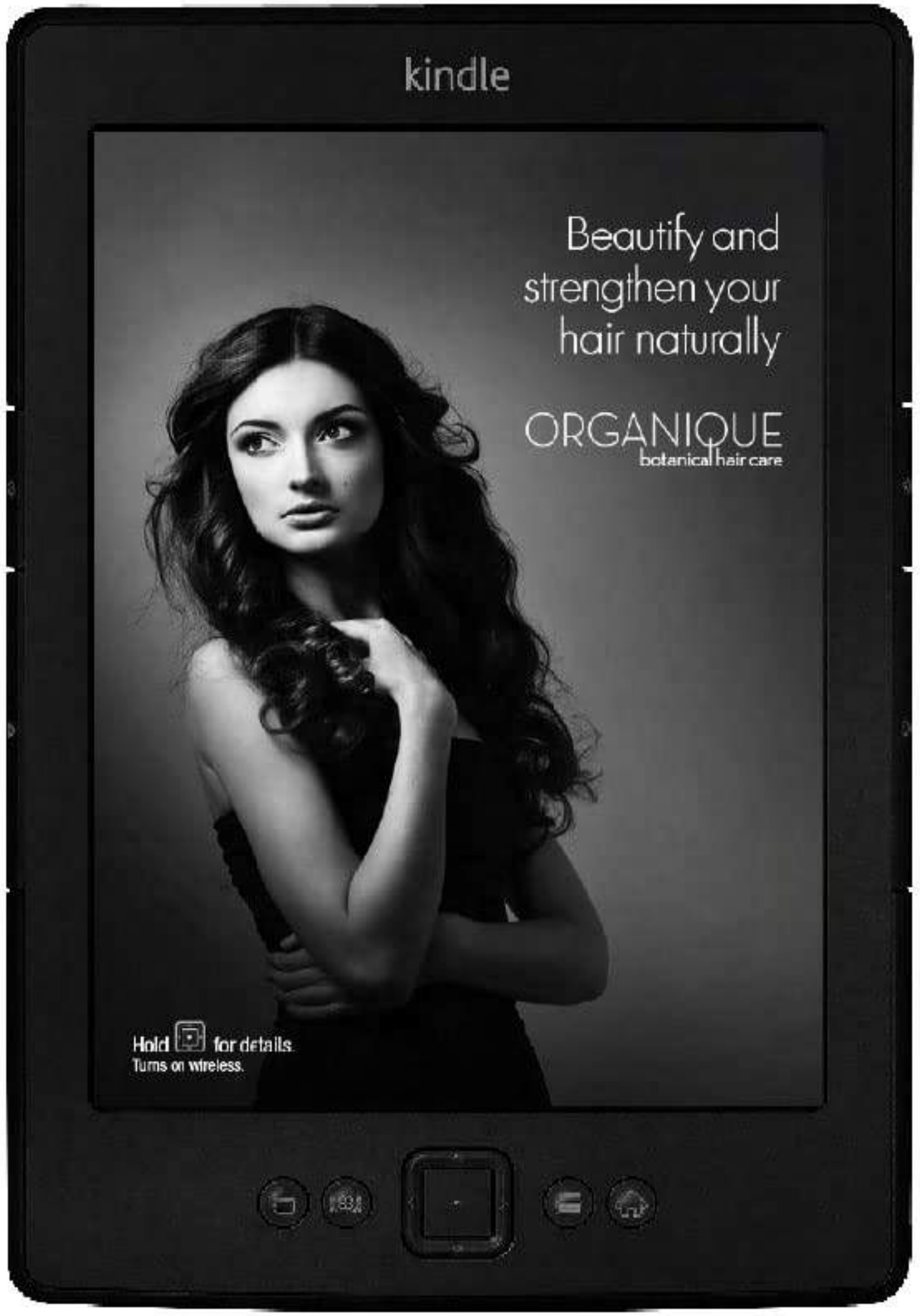
Why Amazon is tracking every time you tap your Kindle / Amazon explains why it needs to track every page turn you make

Photo by Amelia Holowaty Krales / The Verge

The Problem

Closed tech fails users

- Who does the technology empower?



The Problem

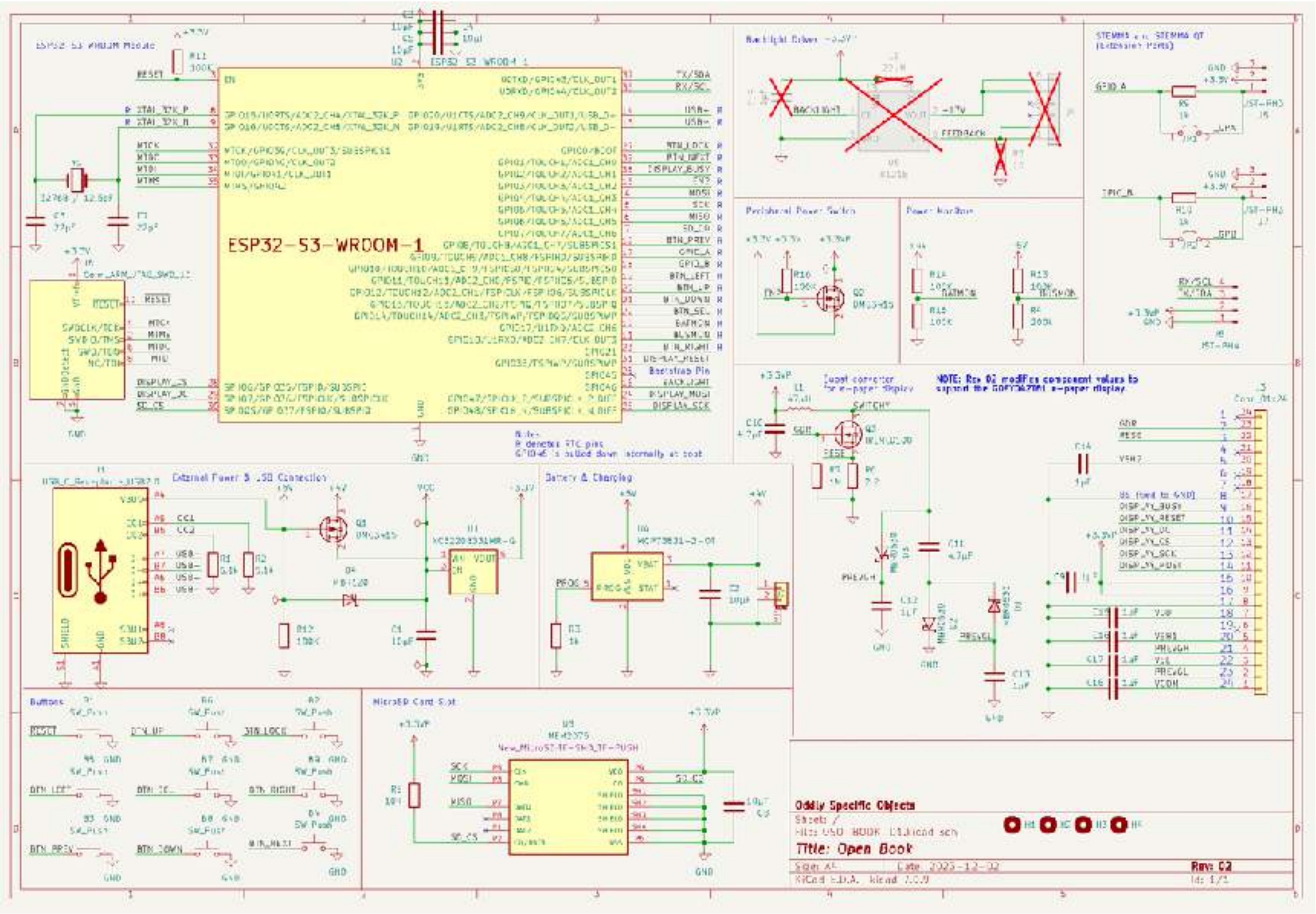
Closed tech fails users

- Who does the technology empower?
- Who does the technology diminish and disempower?
- **Why does the technology get to do this?**
- What can we do about it?

One Solution

Make it comprehensible

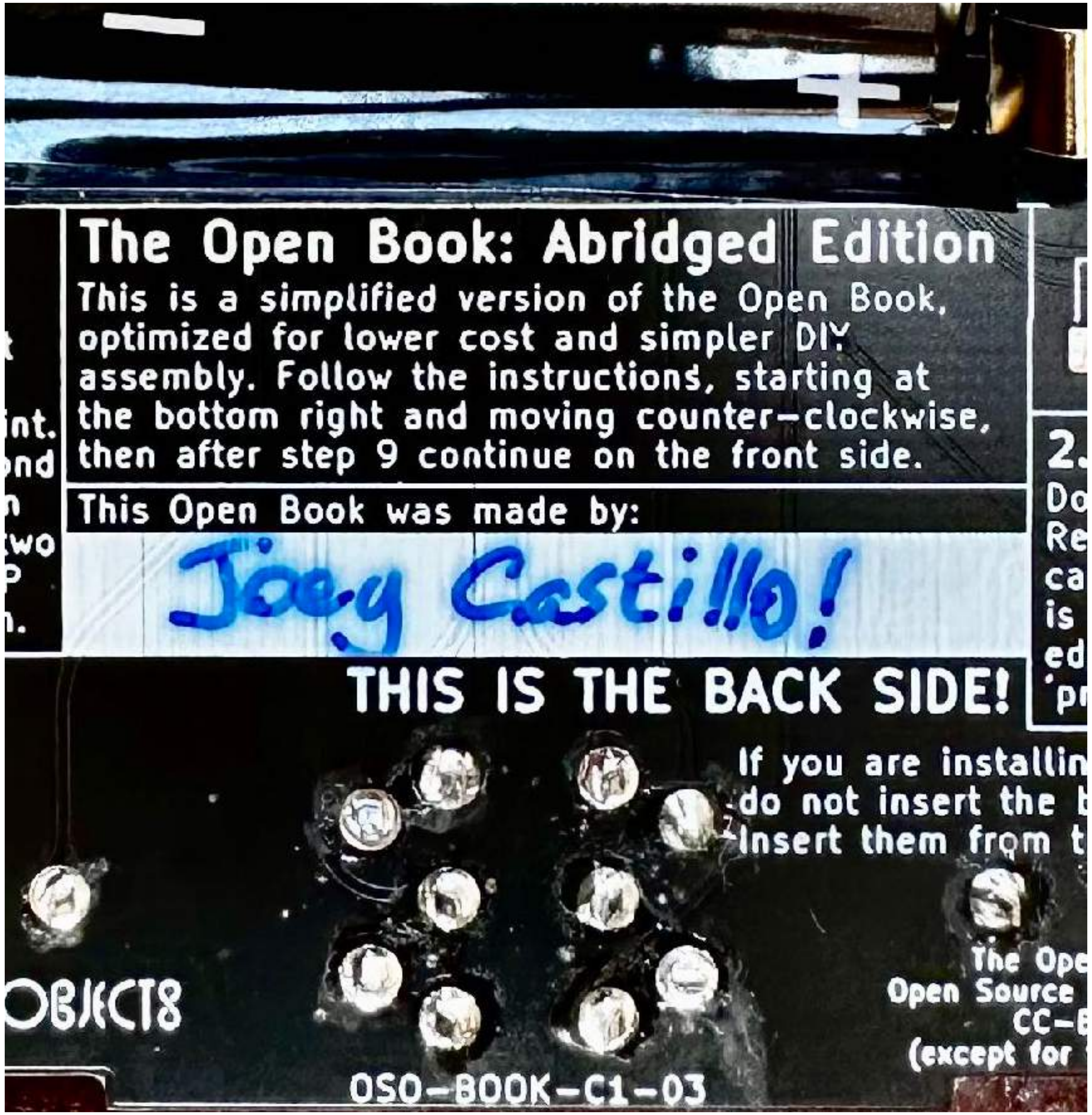
- Design well documented open hardware…
- …that people can build on their own and understand, at least in broad strokes…
- …to teach them that they don't have to accept technology that wasn't made with their best interests at heart.



One Solution

Make it comprehensible

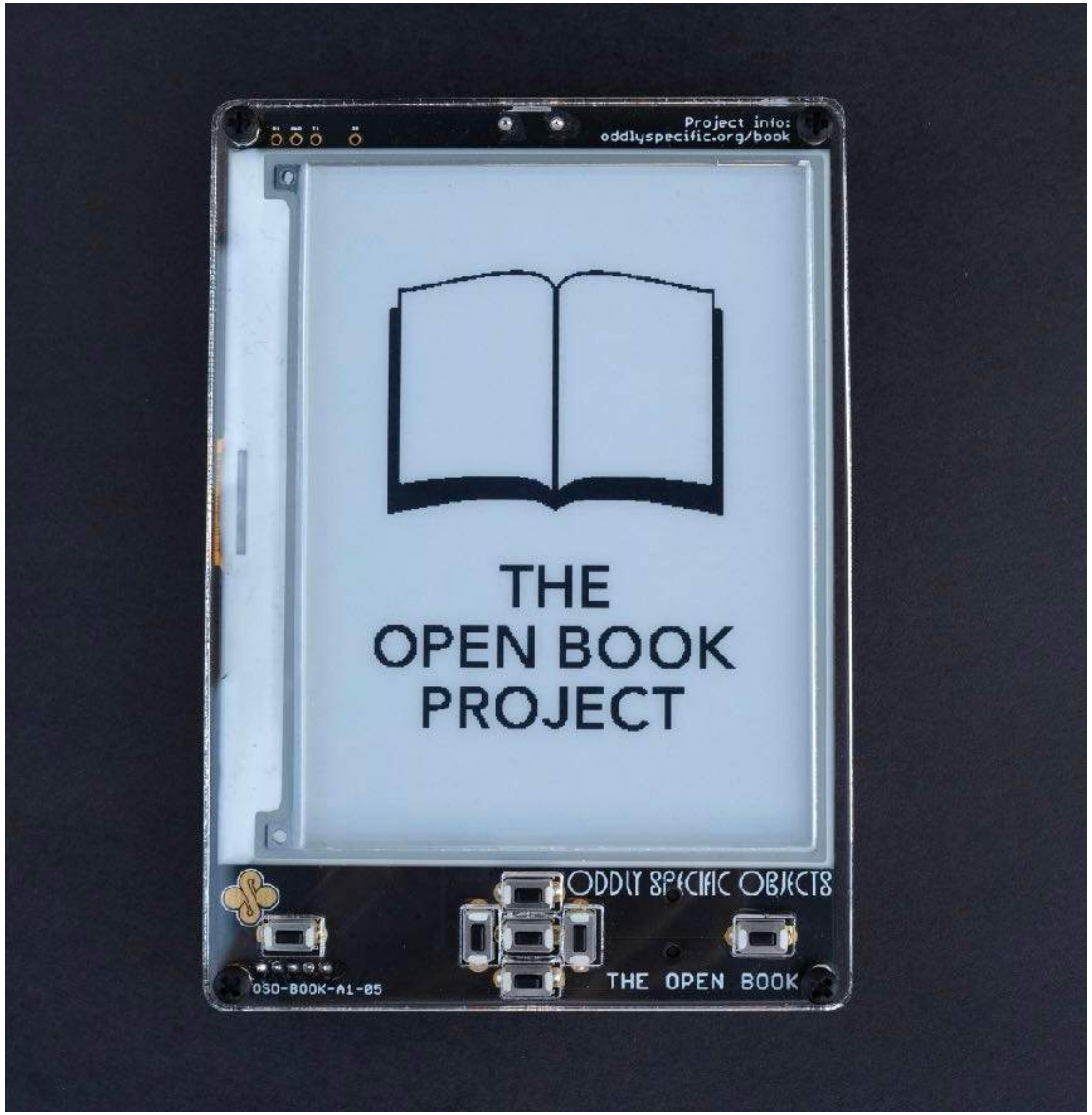
- Design well documented open hardware…
- …that people can build on their own and understand, at least in broad strokes…
- …to teach them that they don't have to accept technology that wasn't made with their best interests at heart.


The Open Book: Abridged Edition
This is a simplified version of the Open Book, optimized for lower cost and simpler DIY assembly. Follow the instructions, starting at the bottom right and moving counter-clockwise, then after step 9 continue on the front side.
This Open Book was made by:
Joey Castillo!
THIS IS THE BACK SIDE!
If you are installin
do not insert the
Insert them from t
OBJECT8
The Ope
Open Source
CC-
(except for
OSO-BOOK-C1-03

One Solution

Make it comprehensible

- Design well documented open hardware…
- …that people can build on their own and understand, at least in broad strokes…
- …to teach them that they don't have to accept technology that wasn't made with their best interests at heart.



> “The point of open source is not to ritualistically compile our stuff from source. It’s the awareness that technology is not magic: that there is a trail of breadcrumbs any of us could follow to liberate our digital lives.”

- **Bunnie Huang, “On Liberating My Smartwatch From Cloud Services”**
  https://www.bunniestudios.com/blog/?p=5863

So, what are those breadcrumbs?

Three Sets of Breadcrumbs

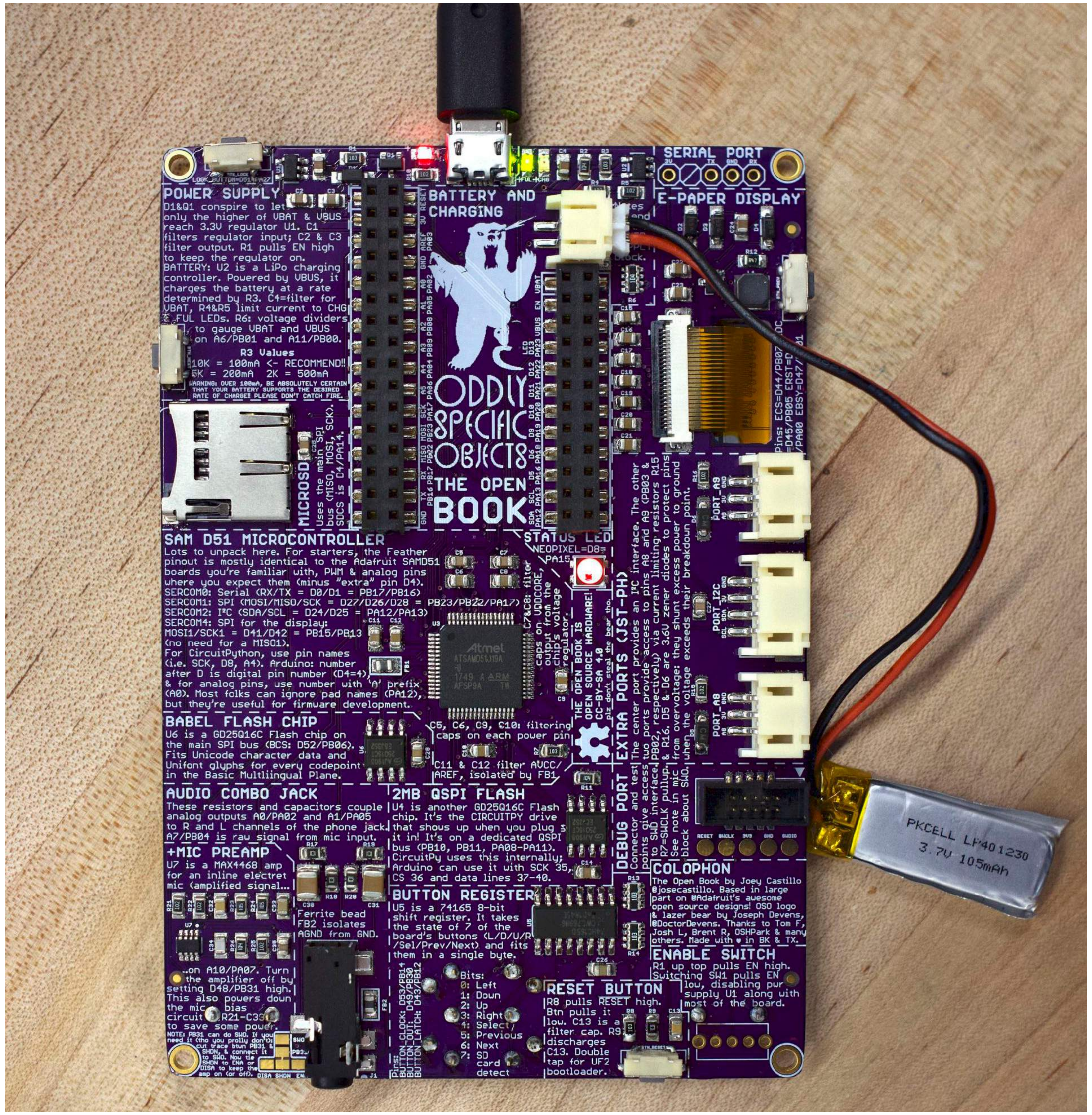
Different trails for different contexts

- Explaining how it works.
- Explaining how to build it.
- Explaining how to use it and hack it.

This trail leads to…

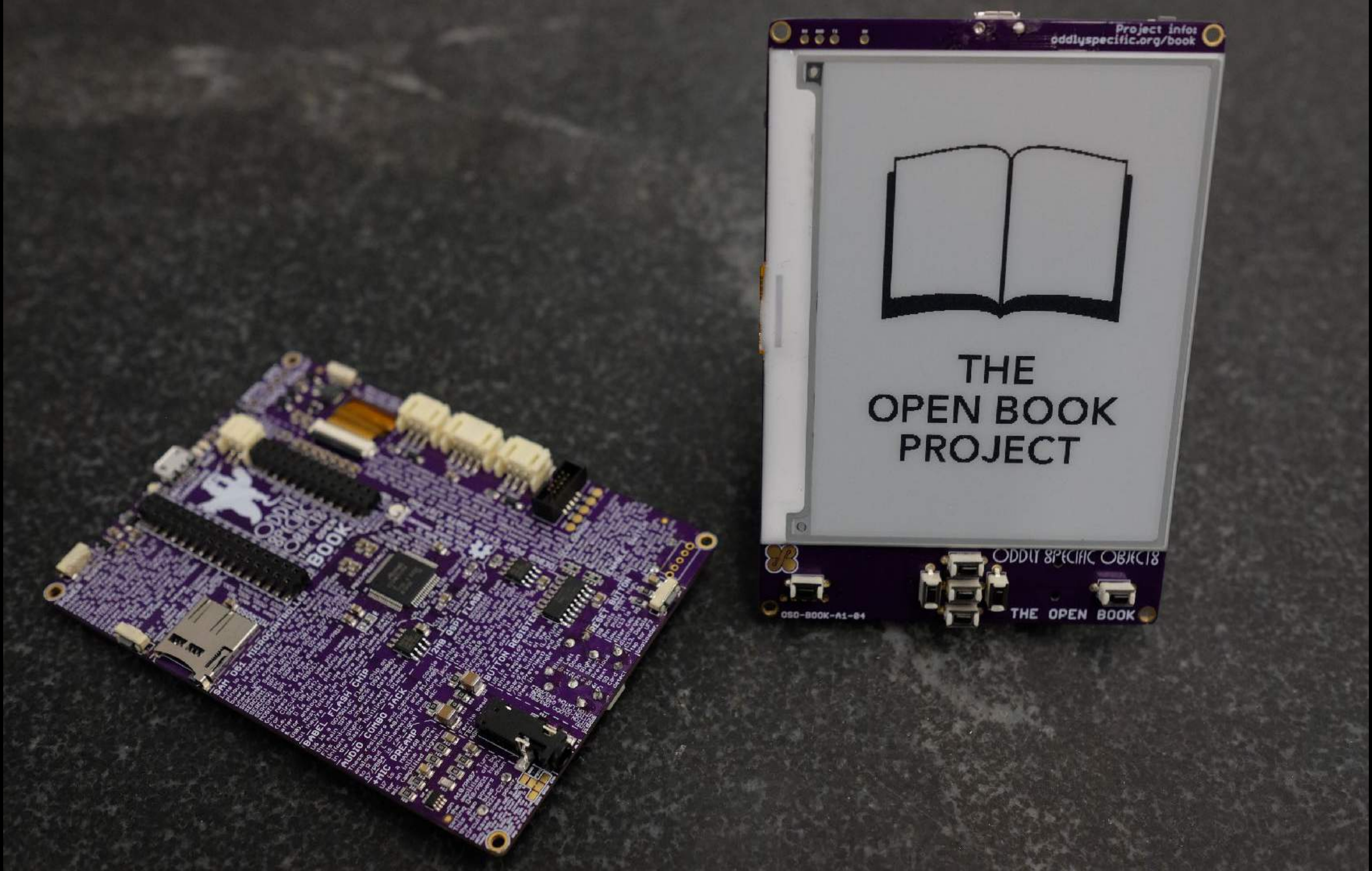
Understanding how it works?

- Use the silkscreen to narrate what each component is for
- Pros:
  - It could demystify the tech?
- Cons:
  - Hard to really explain it in the space available
  - **Is this the most useful info?**



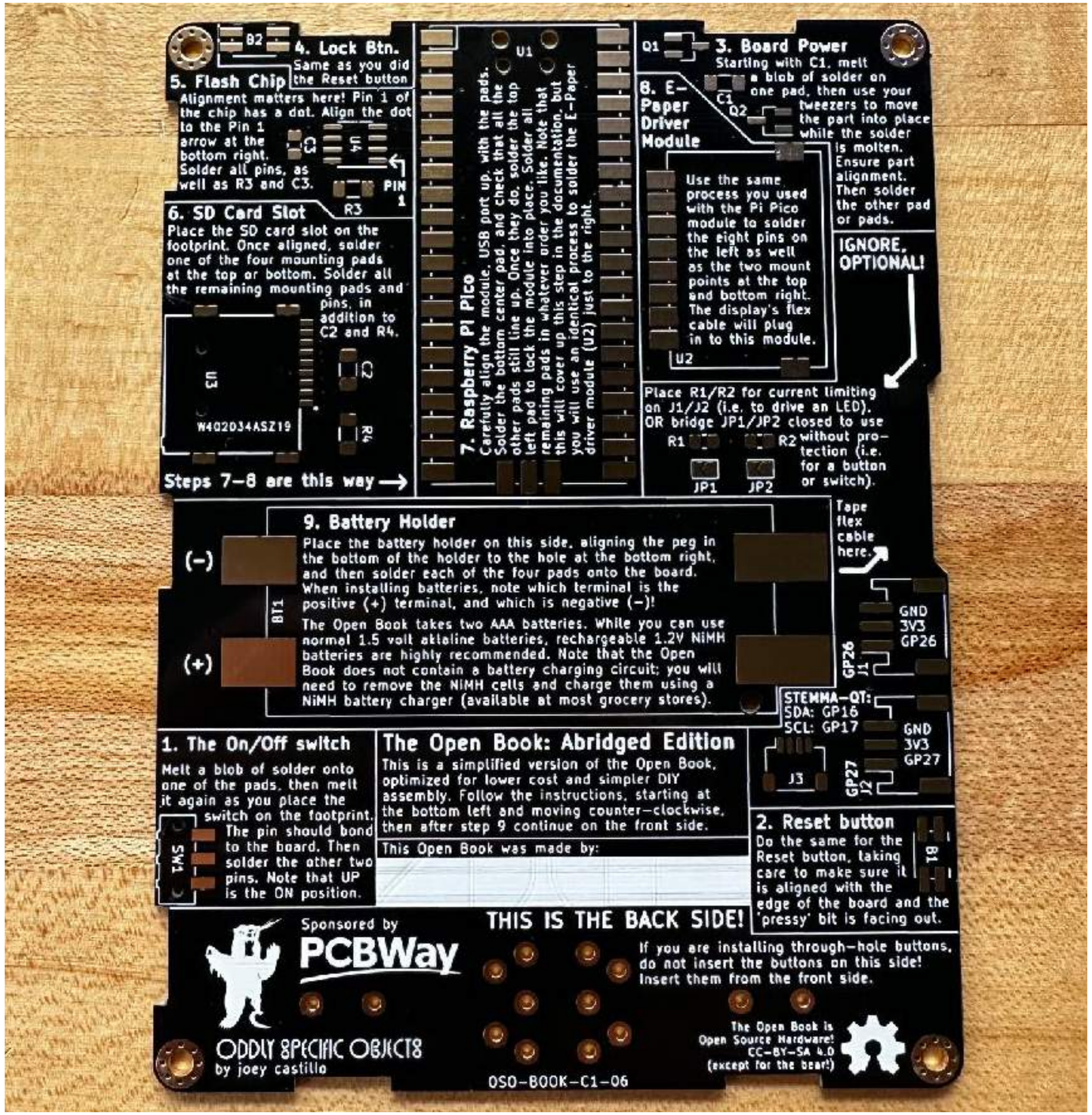
Maybe.

ODDLY SPECIFIC OBJECTS
THE OPEN BOOK
STATUS LED
NEOPIXEL=D8
PA15
BATTERY CHARGING
POWER SUPPLY
R3 Values
10K = 100mA
5K = 200mA
2K = 500mA <- RECOMMEND
MICROSD
SAM D51 MICROCONTROLLER
Lots to unpack here. For starters, the Feather pinout is mostly identical to the Adafruit SAMD51 boards you're familiar with, PWM & analog pins where you expect them (minus "extra" pin D4).
Serial (RX/TX = D0/D1 = PB17/PB16)
SPI (MOSI/MISO/SCK = D27/D26/D28 = PB23/PB22/PA17)
I2C (SDA/SCL = D24/D25 = PA12/PA13)
THE OPEN SOURCE HARDWARE
EXTRA PORTS (JST-PH)
DEBUG PORT
PORT-I2C
PORT-A9
PORT-A8
Atmel
ATSAMD51J19A
C5, C6, C9, C10: filtering caps on each power pin
C12 filter AVCC/ isolated by FB1


Project info:
oddlyspecific.org/book
THE
OPEN BOOK
PROJECT
ODDLY SPECIFIC OBJECTS
OSO-BOOK-A1-04
THE OPEN BOOK
BOOK
SAM D51 MICROCONTROLLER
BABEL FLASH CHIP
AUDIO COMBO JACK
MIC PREAMP
2MB QSPI FLASH
BUTTON RESISTERS
RESET BUTTON

Open Book Abridged

Optimizing for DIY builds



4. Lock Btn. Same as you did the Reset button

5. Flash Chip Alignment matters here! Pin 1 of the chip has a dot. Align the dot to the Pin 1 arrow at the bottom right. Solder all pins, as well as R3 and C3.

6. SD Card Slot Place the SD card slot on the footprint. Once aligned, solder one of the four mounting pads at the top or bottom. Solder all the remaining mounting pads and pins, in addition to C2 and R4.

Steps 7–8 are this way →

7. Raspberry Pi Pico Carefully align the module, USB port up, with the pads. Solder the bottom center pad, and check that all the other pads still line up. Once they do, solder the top left pad to lock the module into place. Solder all remaining pads in whatever order you like. Note that this will cover up this step in the documentation, but you will use an identical process to solder the E-Paper driver module (U2) just to the right.

3. Board Power Starting with C1, melt a blob of solder on one pad, then use your tweezers to move the part into place while the solder is molten. Ensure part alignment. Then solder the other pad or pads.

8. E-Paper Driver Module Use the same process you used with the Pi Pico module to solder the eight pins on the left as well as the two mount points at the top and bottom right. The display's flex cable will plug in to this module.

IGNORE, OPTIONAL!

Place R1/R2 for current limiting on J1/J2 (i.e. to drive an LED). OR bridge JP1/JP2 closed to use without protection (i.e. for a button or switch).

Tape flex cable here.

9. Battery Holder Place the battery holder on this side, aligning the peg in the bottom of the holder to the hole at the bottom right, and then solder each of the four pads onto the board. When installing batteries, note which terminal is the positive (+) terminal, and which is negative (–)!

The Open Book takes two AAA batteries. While you can use normal 1.5 volt aklaline batteries, rechargeable 1.2V NiMH batteries are highly recommended. Note that the Open Book does not contain a battery charging circuit; you will need to remove the NiMH cells and charge them using a NiMH battery charger (available at most grocery stores).

STEMMA-QT:
SDA: GP16
SCL: GP17

1. The On/Off switch Melt a blob of solder onto one of the pads, then melt it again as you place the switch on the footprint. The pin should bond to the board. Then solder the other two pins. Note that UP is the ON position.

The Open Book: Abridged Edition This is a simplified version of the Open Book, optimized for lower cost and simpler DIY assembly. Follow the instructions, starting at the bottom left and moving counter-clockwise, then after step 9 continue on the front side.

This Open Book was made by:

2. Reset button Do the same for the Reset button, taking care to make sure it is aligned with the edge of the board and the 'pressy' bit is facing out.

THIS IS THE BACK SIDE!

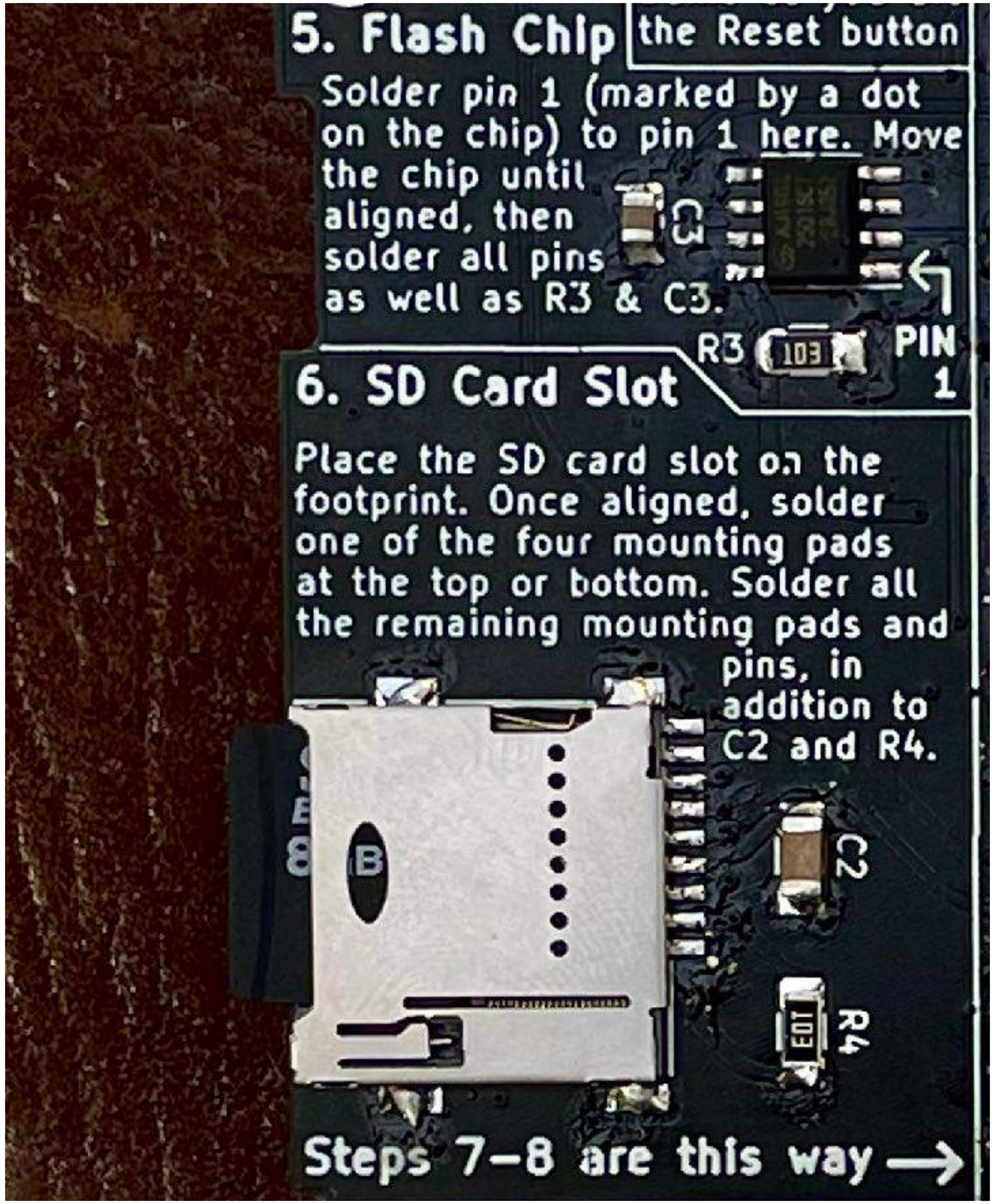
If you are installing through-hole buttons, do not insert the buttons on this side! Insert them from the front side.

The Open Book is Open Source Hardware! CC-BY-SA 4.0 (except for the bear!)

Open Book Abridged

Optimizing for DIY builds

- Larger passives and exposed pins for easier soldering



5. Flash Chip

the Reset button

Solder pin 1 (marked by a dot on the chip) to pin 1 here. Move the chip until aligned, then solder all pins as well as R3 & C3.

6. SD Card Slot

Place the SD card slot on the footprint. Once aligned, solder one of the four mounting pads at the top or bottom. Solder all the remaining mounting pads and pins, in addition to C2 and R4.

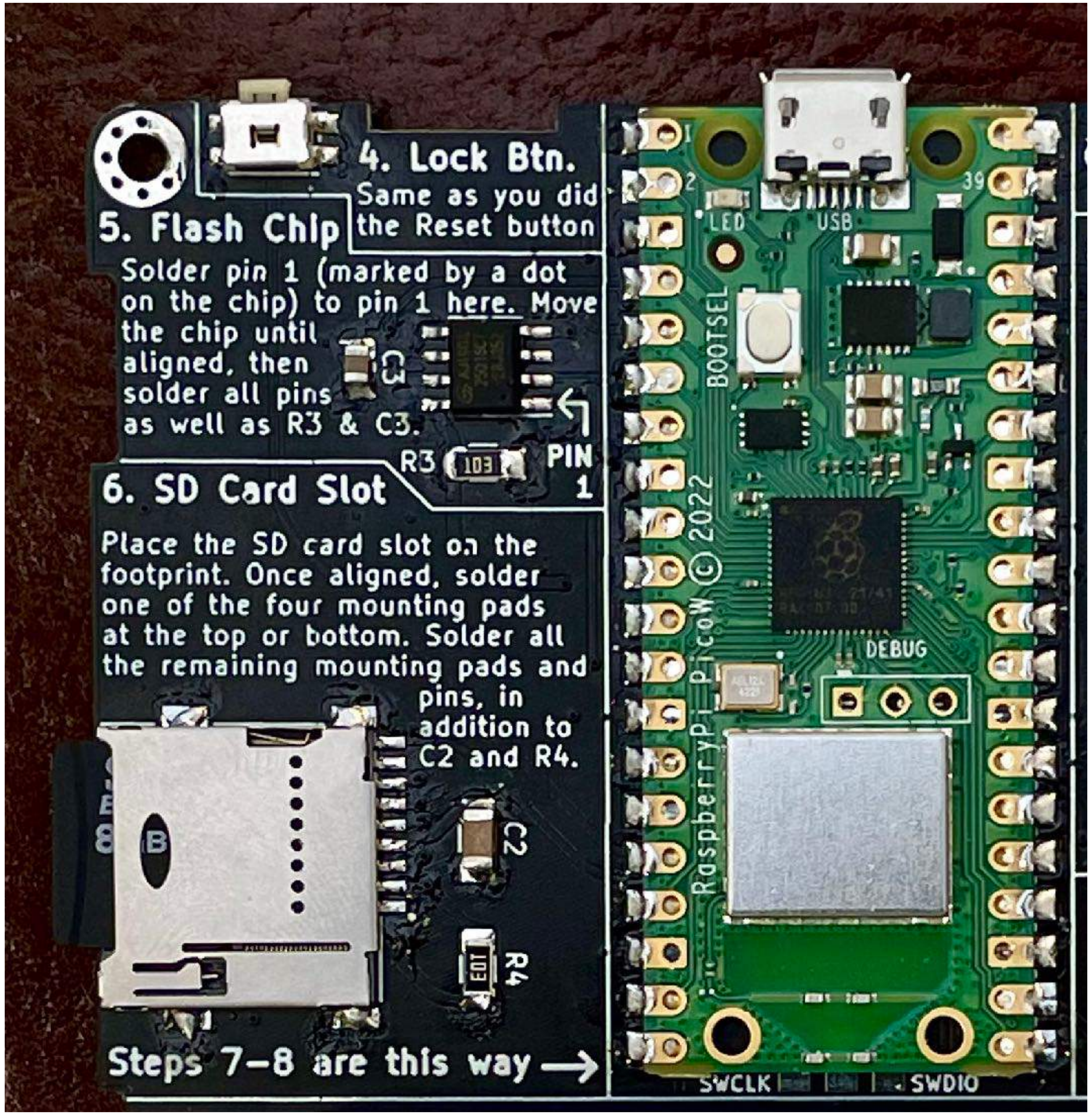
Steps 7–8 are this way →

Open Book Abridged

Optimizing for DIY builds

- Larger passives and exposed pins for easier soldering

- Using a friendly module like the Pi Pico make it easier for folks



4. Lock Btn.
Same as you did the Reset button

5. Flash Chip
Solder pin 1 (marked by a dot on the chip) to pin 1 here. Move the chip until aligned, then solder all pins as well as R3 & C3.

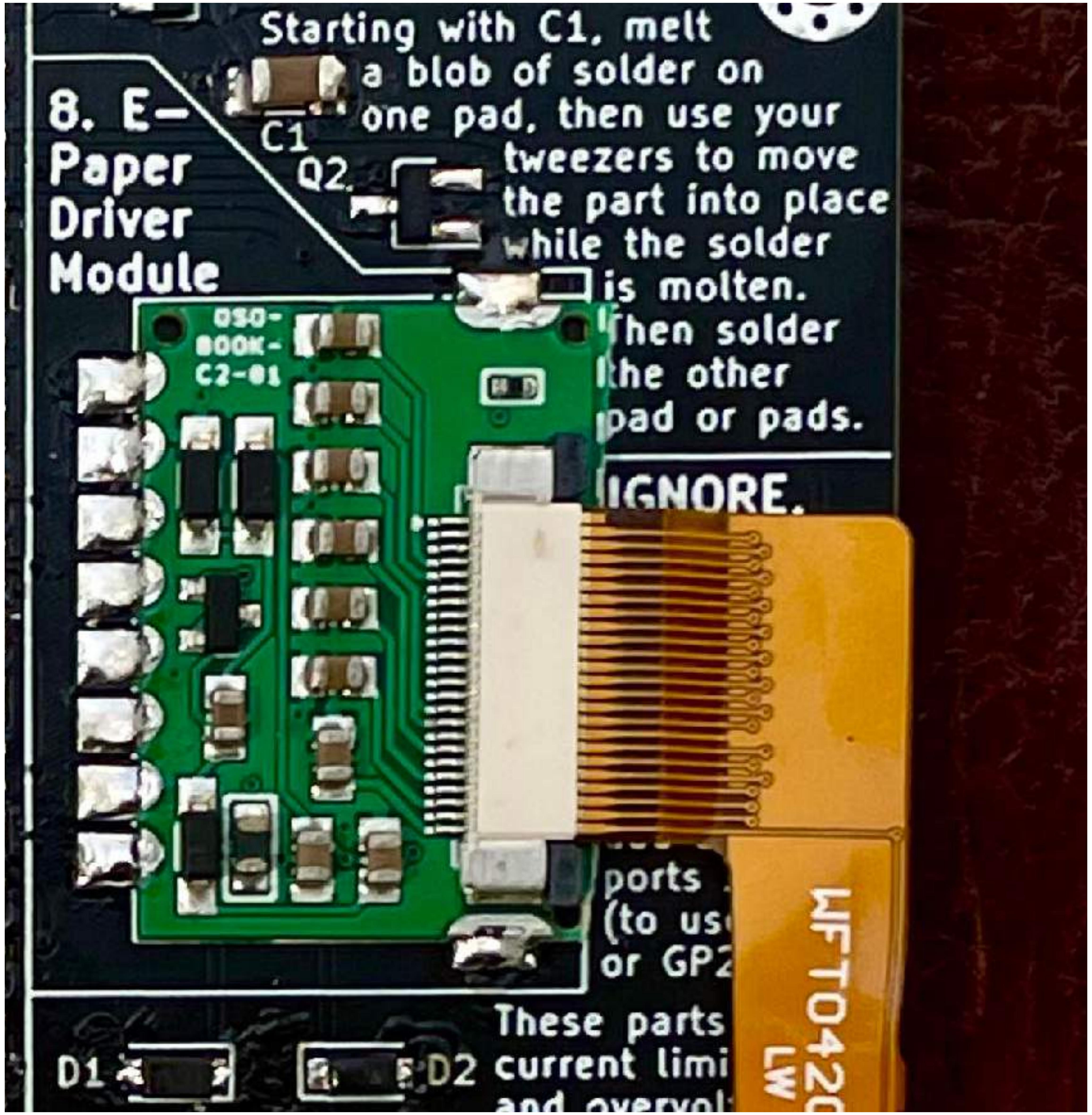
6. SD Card Slot
Place the SD card slot on the footprint. Once aligned, solder one of the four mounting pads at the top or bottom. Solder all the remaining mounting pads and pins, in addition to C2 and R4.

Steps 7–8 are this way →

Open Book Abridged

Optimizing for DIY builds

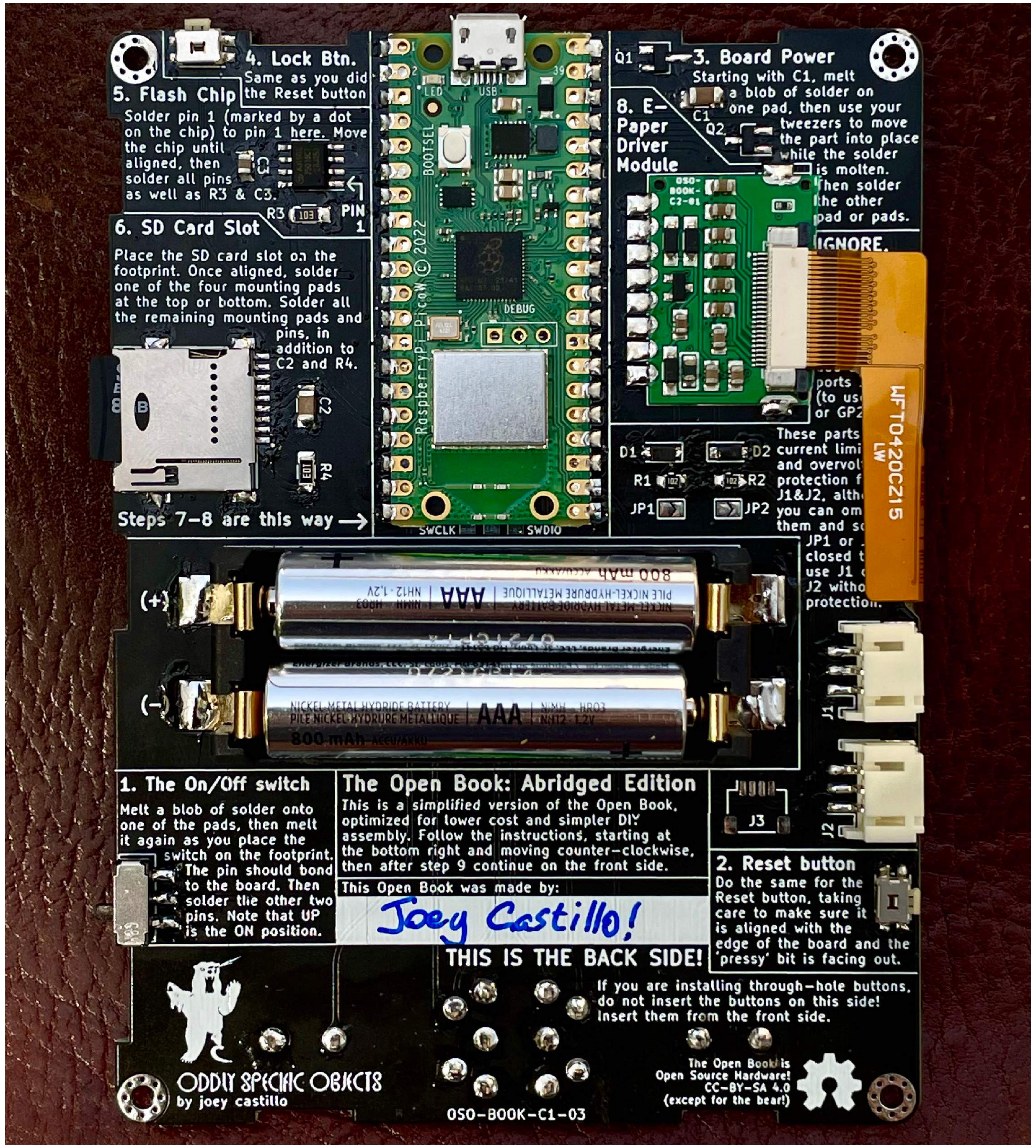
- Larger passives and exposed pins for easier soldering
- Using a friendly module like the Pi Pico make it easier for folks
- Have a fine pitched part? Put it on your own castellated module and PCBA that!


Starting with C1, melt a blob of solder on one pad, then use your tweezers to move the part into place while the solder is molten. Then solder the other pad or pads.
8. E-Paper Driver Module
C1
Q2
OSO-BOOK-C2-01
IGNORE.
ports (to us or GP2
These parts current limi and overvol
D1
D2
WFT042 LW

Open Book Abridged

Optimizing for DIY builds

- Larger passives and exposed pins for easier soldering
- Using a friendly module like the Pi Pico make it easier for folks
- Have a fine pitched part? Put it on your own castellated module and PCBA that!
- **Use the silkscreen for assembly instructions!**



4. Lock Btn.
Same as you did the Reset button

5. Flash Chip
Solder pin 1 (marked by a dot on the chip) to pin 1 here. Move the chip until aligned, then solder all pins as well as R3 & C3.

6. SD Card Slot
Place the SD card slot on the footprint. Once aligned, solder one of the four mounting pads at the top or bottom. Solder all the remaining mounting pads and pins, in addition to C2 and R4.

Steps 7–8 are this way →

3. Board Power
Starting with C1, melt a blob of solder on one pad, then use your tweezers to move the part into place while the solder is molten. Then solder the other pad or pads.

8. E-Paper Driver Module

IGNORE.

ports (to us or GP2

These parts current limi and overvol protection f J1&J2, alth you can om them and s JP1 or closed t use J1 J2 witho protection.

1. The On/Off switch
Melt a blob of solder onto one of the pads, then melt it again as you place the switch on the footprint. The pin should bond to the board. Then solder the other two pins. Note that UP is the ON position.

The Open Book: Abridged Edition
This is a *simplified* version of the Open Book, optimized for lower cost and simpler DIY assembly. Follow the instructions, starting at the bottom right and moving counter-clockwise, then after step 9 continue on the front side.

This Open Book was made by:
Joey Castillo!

THIS IS THE BACK SIDE!

2. Reset button
Do the same for the Reset button, taking care to make sure it is aligned with the edge of the board and the 'pressy' bit is facing out.

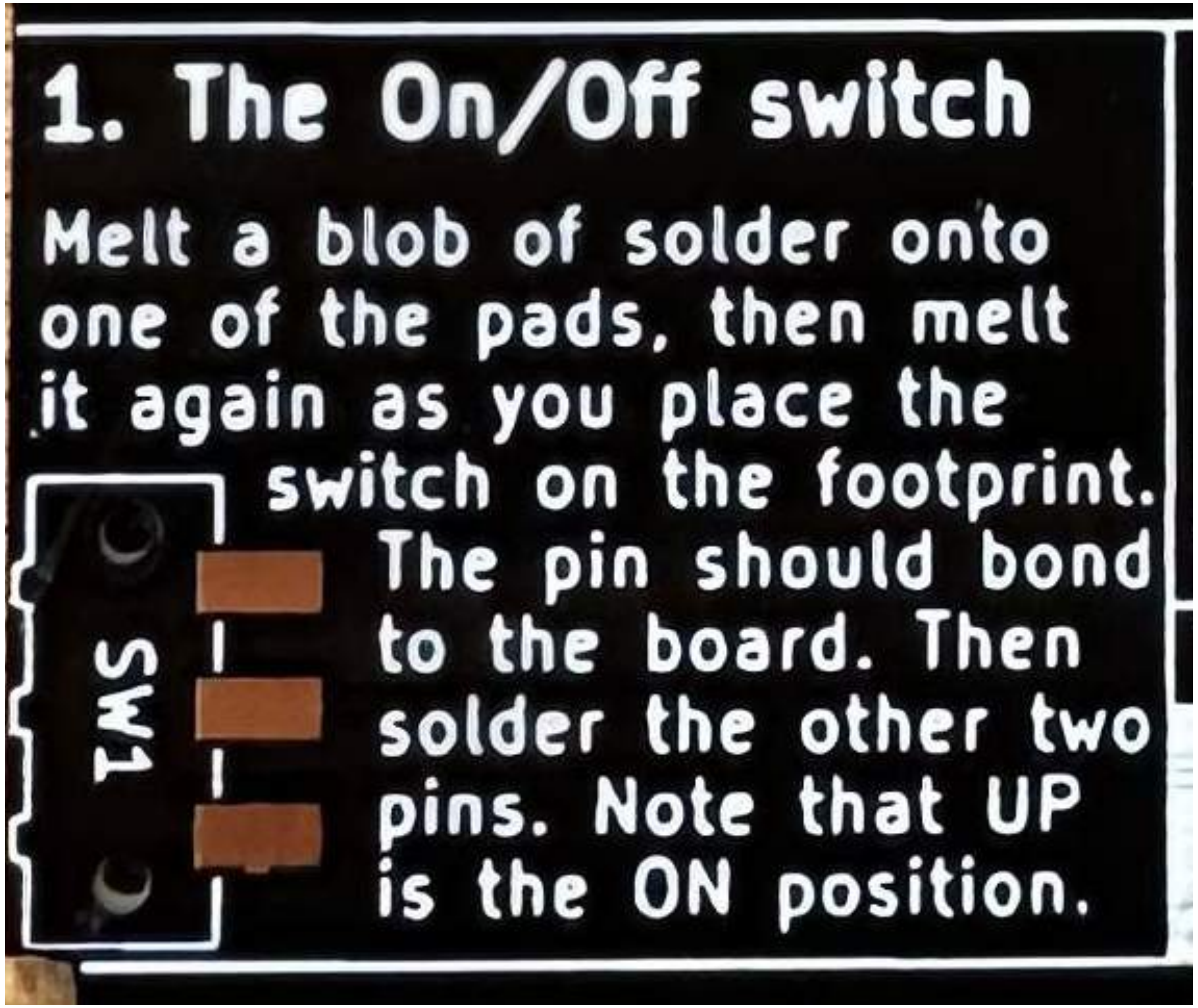
If you are installing through-hole buttons, do not insert the buttons on this side! Insert them from the front side.

The Open Book is Open Source Hardware! CC-BY-SA 4.0 (except for the bear!)

This trail leads to…

Building the device yourself?

- Use the silkscreen for directions to the person building it



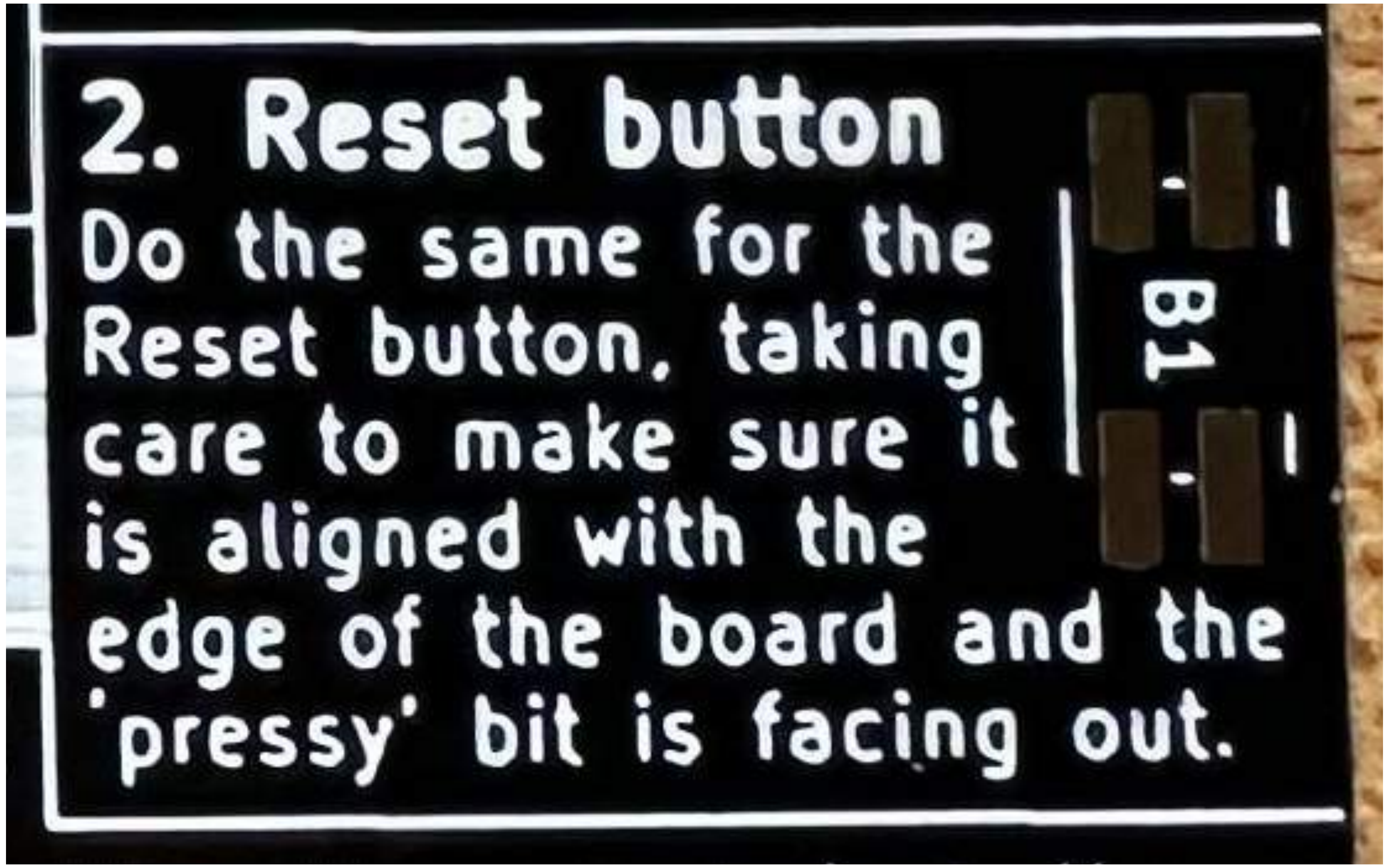
1. The On/Off switch

Melt a blob of solder onto one of the pads, then melt it again as you place the switch on the footprint. The pin should bond to the board. Then solder the other two pins. Note that UP is the ON position.

This trail leads to…

Building the device yourself?

- Use the silkscreen for directions to the person building it



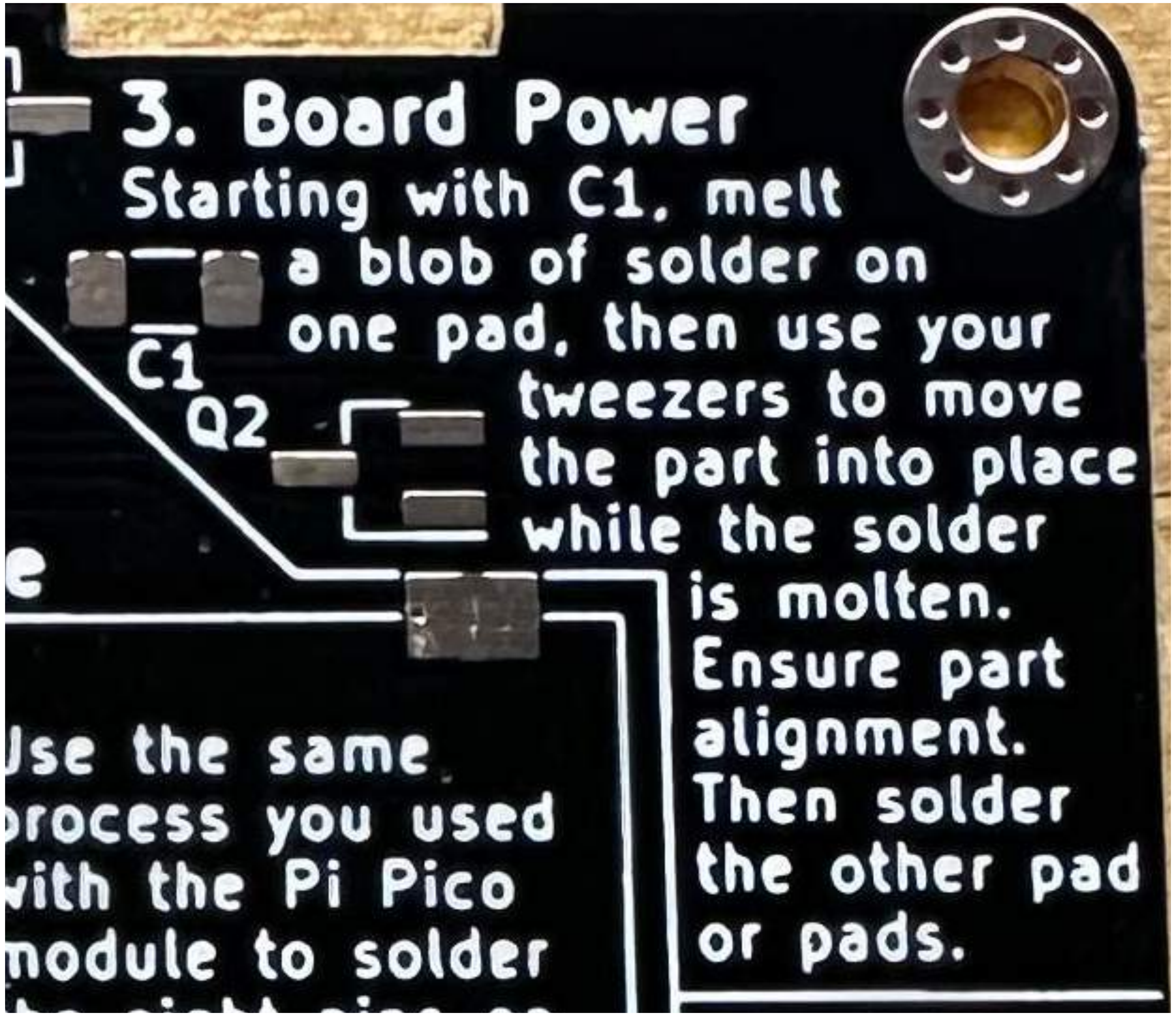
2. Reset button

Do the same for the Reset button, taking care to make sure it is aligned with the edge of the board and the 'pressy' bit is facing out.

This trail leads to…

Building the device yourself?

- Use the silkscreen for directions to the person building it



3. Board Power

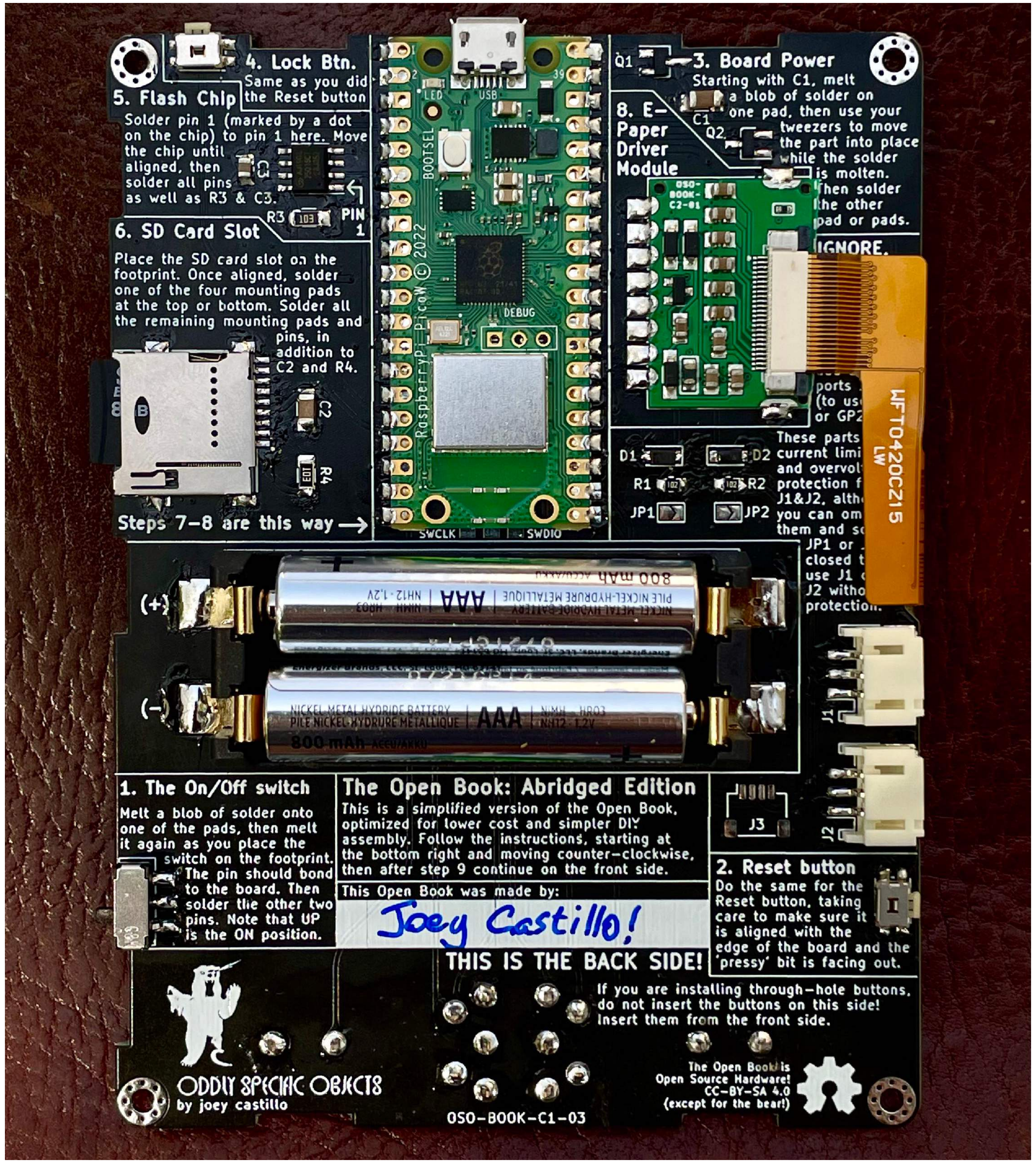
Starting with C1, melt a blob of solder on one pad, then use your tweezers to move the part into place while the solder is molten. Ensure part alignment. Then solder the other pad or pads.

Jse the same rocess you used vith the Pi Pico module to solder

This trail leads to…

Building the device yourself?

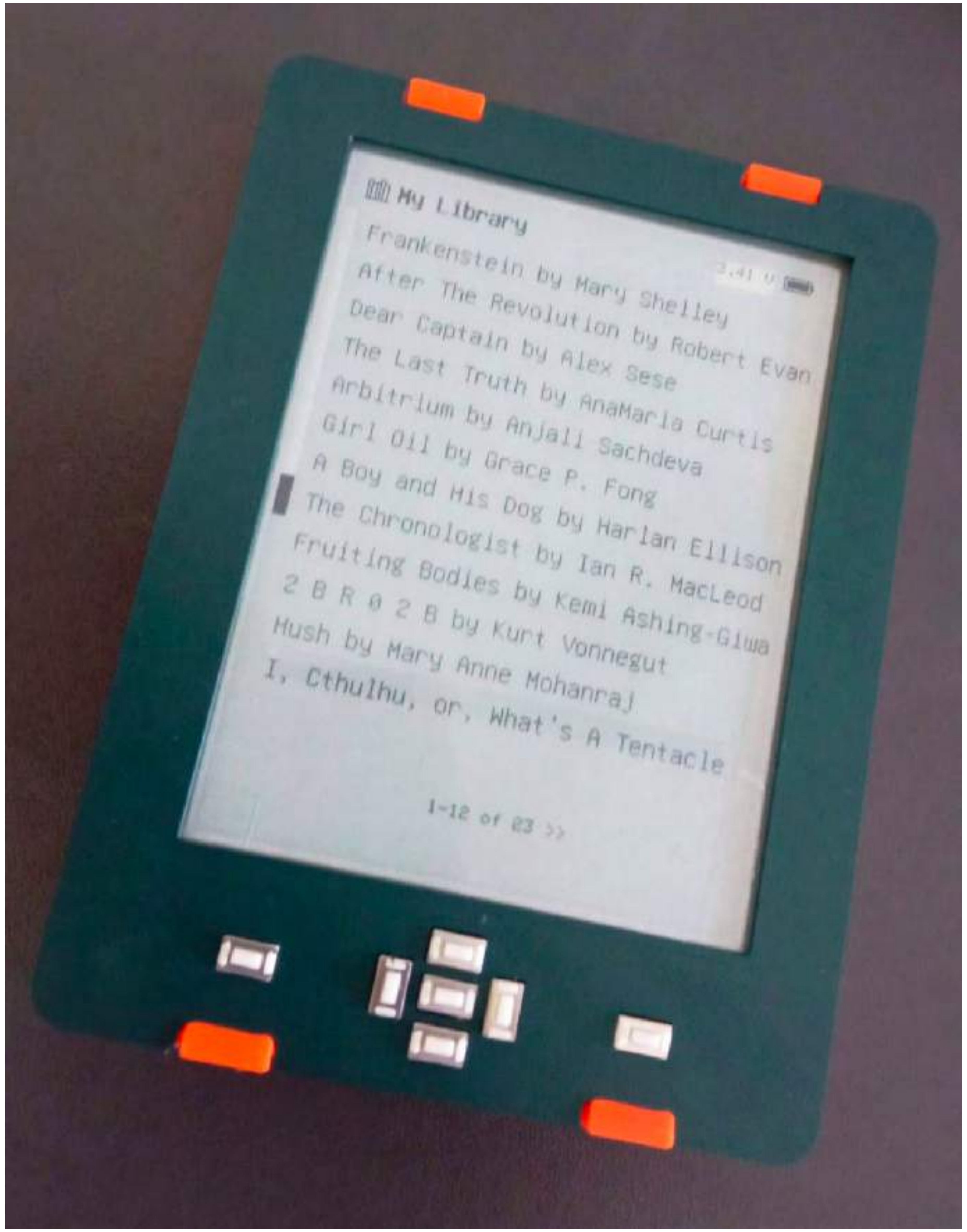
- Use the silkscreen for directions to the person building it
- It’s super effective!


4. Lock Btn.
Same as you did the Reset button
5. Flash Chip
Solder pin 1 (marked by a dot on the chip) to pin 1 here. Move the chip until aligned, then solder all pins as well as R3 & C3.
C3
R3
PIN 1
6. SD Card Slot
Place the SD card slot on the footprint. Once aligned, solder one of the four mounting pads at the top or bottom. Solder all the remaining mounting pads and pins, in addition to C2 and R4.
C2
R4
Steps 7–8 are this way →
BOOTSEL
LED
USB
DEBUG
Raspberry Pi Pico W © 2022
SWCLK
SWDIO
Q1
3. Board Power
Starting with C1, melt a blob of solder on one pad, then use your tweezers to move the part into place while the solder is molten. Then solder the other pad or pads.
C1
Q2
8. E-Paper Driver Module
OSO-BOOK-C2-01
IGNORE.
ports
(to us
or GP2
These parts
current limi
and overvol
protection f
J1&J2, alth
you can om
them and so
JP1 or
closed t
use J1
J2 witho
protection.
D1
D2
R1
R2
JP1
JP2
WFT0420CZ15 LW
(+)
(–)
J1
J2
J3
1. The On/Off switch
Melt a blob of solder onto one of the pads, then melt it again as you place the switch on the footprint. The pin should bond to the board. Then solder the other two pins. Note that UP is the ON position.
The Open Book: Abridged Edition
This is a simplified version of the Open Book, optimized for lower cost and simpler DIY assembly. Follow the instructions, starting at the bottom right and moving counter-clockwise, then after step 9 continue on the front side.
This Open Book was made by:
Joey Castillo!
THIS IS THE BACK SIDE!
2. Reset button
Do the same for the Reset button, taking care to make sure it is aligned with the edge of the board and the 'pressy' bit is facing out.
If you are installing through-hole buttons, do not insert the buttons on this side! Insert them from the front side.
ODDLY SPECIFIC OBJECTS
by joey castillo
OSO-BOOK-C1-03
The Open Book is Open Source Hardware!
CC-BY-SA 4.0
(except for the bear!)

This trail leads to…

Building the device yourself?

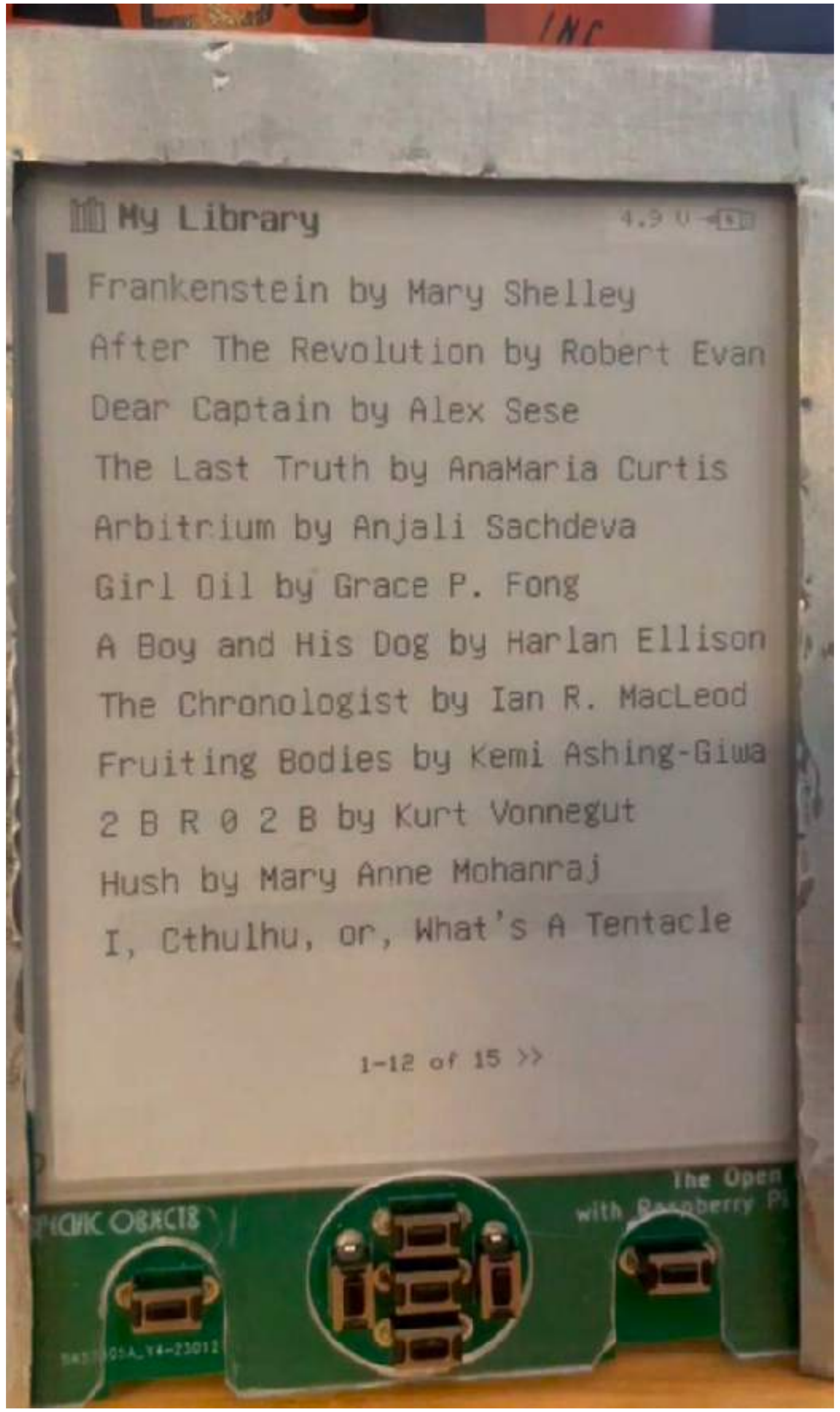
- Use the silkscreen for directions to the person building it
- It’s super effective!


My Library
Frankenstein by Mary Shelley
After The Revolution by Robert Evan
Dear Captain by Alex Sese
The Last Truth by AnaMaria Curtis
Arbitrium by Anjali Sachdeva
Girl Oil by Grace P. Fong
A Boy and His Dog by Harlan Ellison
The Chronologist by Ian R. MacLeod
Fruiting Bodies by Kemi Ashing-Giwa
2 B R 0 2 B by Kurt Vonnegut
Hush by Mary Anne Mohanraj
I, Cthulhu, or, What's A Tentacle
1-12 of 23 >>

This trail leads to…

Building the device yourself?

- Use the silkscreen for directions to the person building it
- It’s super effective!



My Library

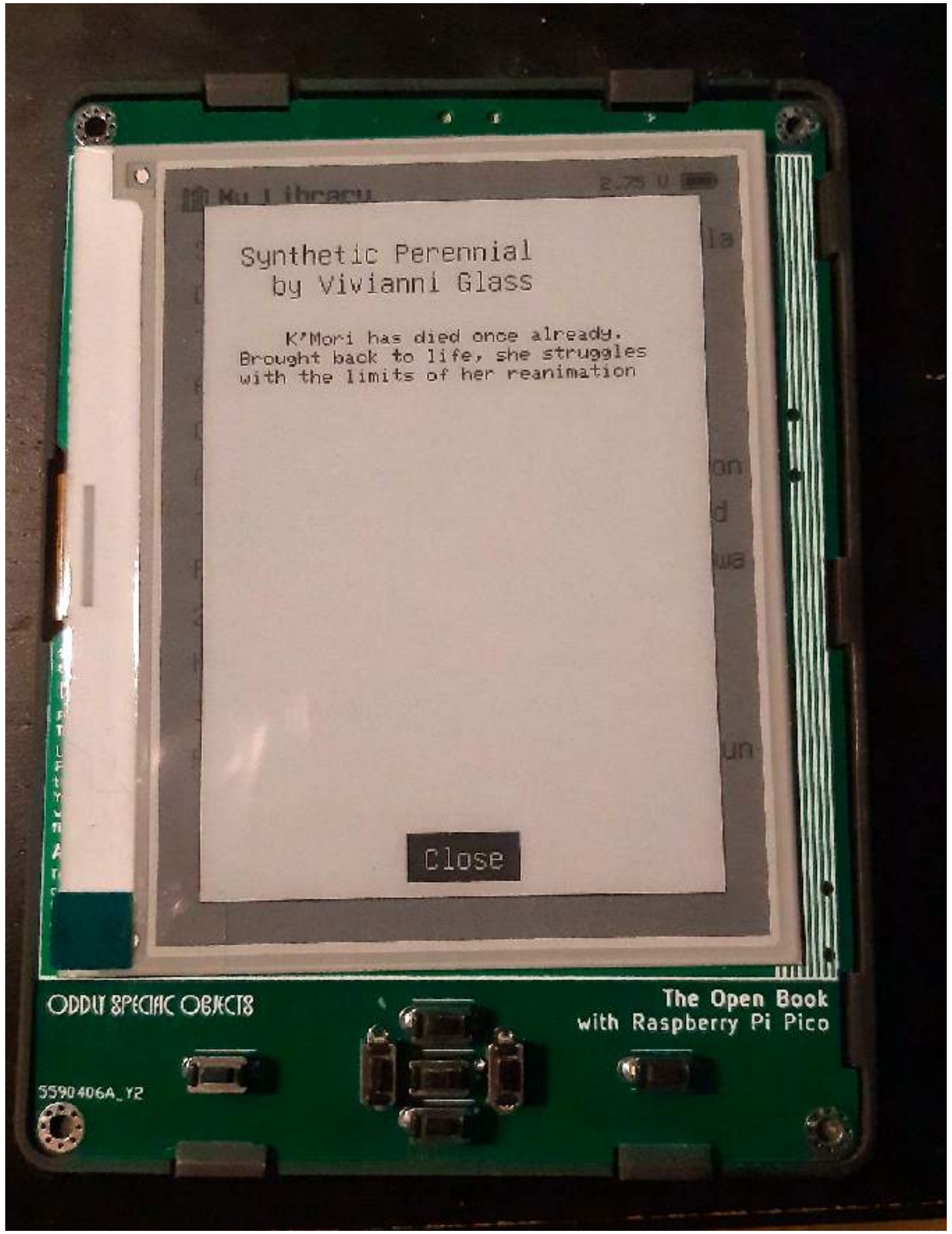
Frankenstein by Mary Shelley
After The Revolution by Robert Evan
Dear Captain by Alex Sese
The Last Truth by AnaMaria Curtis
Arbitrium by Anjali Sachdeva
Girl Oil by Grace P. Fong
A Boy and His Dog by Harlan Ellison
The Chronologist by Ian R. MacLeod
Fruiting Bodies by Kemi Ashing-Giwa
2 B R 0 2 B by Kurt Vonnegut
Hush by Mary Anne Mohanraj
I, Cthulhu, or, What's A Tentacle

1-12 of 15 >>

This trail leads to…

Building the device yourself?

- Use the silkscreen for directions to the person building it
- It’s super effective!



This trail leads to…

Building the device yourself?

- Use the silkscreen for directions to the person building it
- It’s super effective!
- Much likelier to lead to a successful build

This trail leads to…

Building the device yourself?

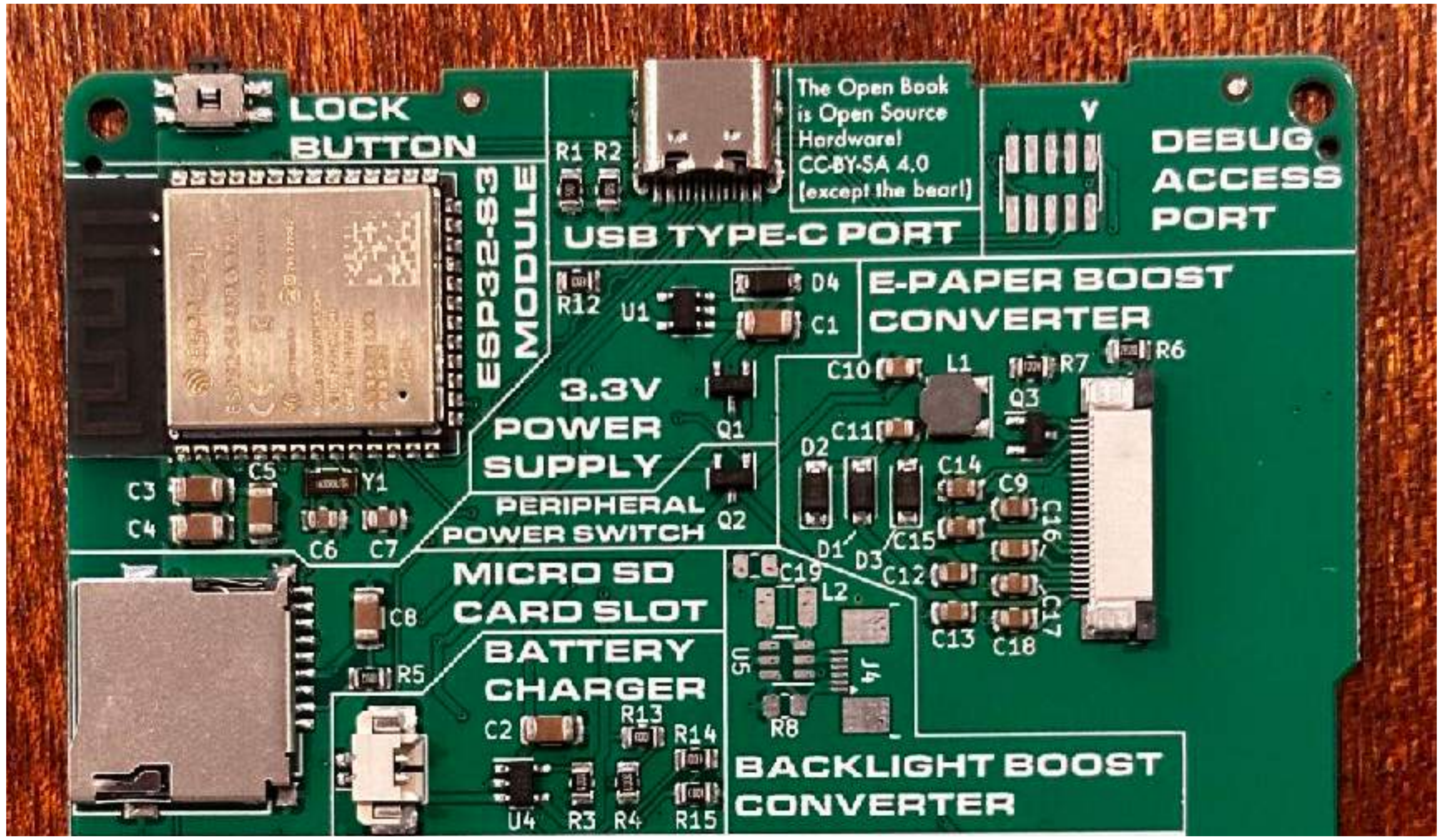
- Use the silkscreen for directions to the person building it
- It’s super effective!
- Much likelier to lead to a successful build

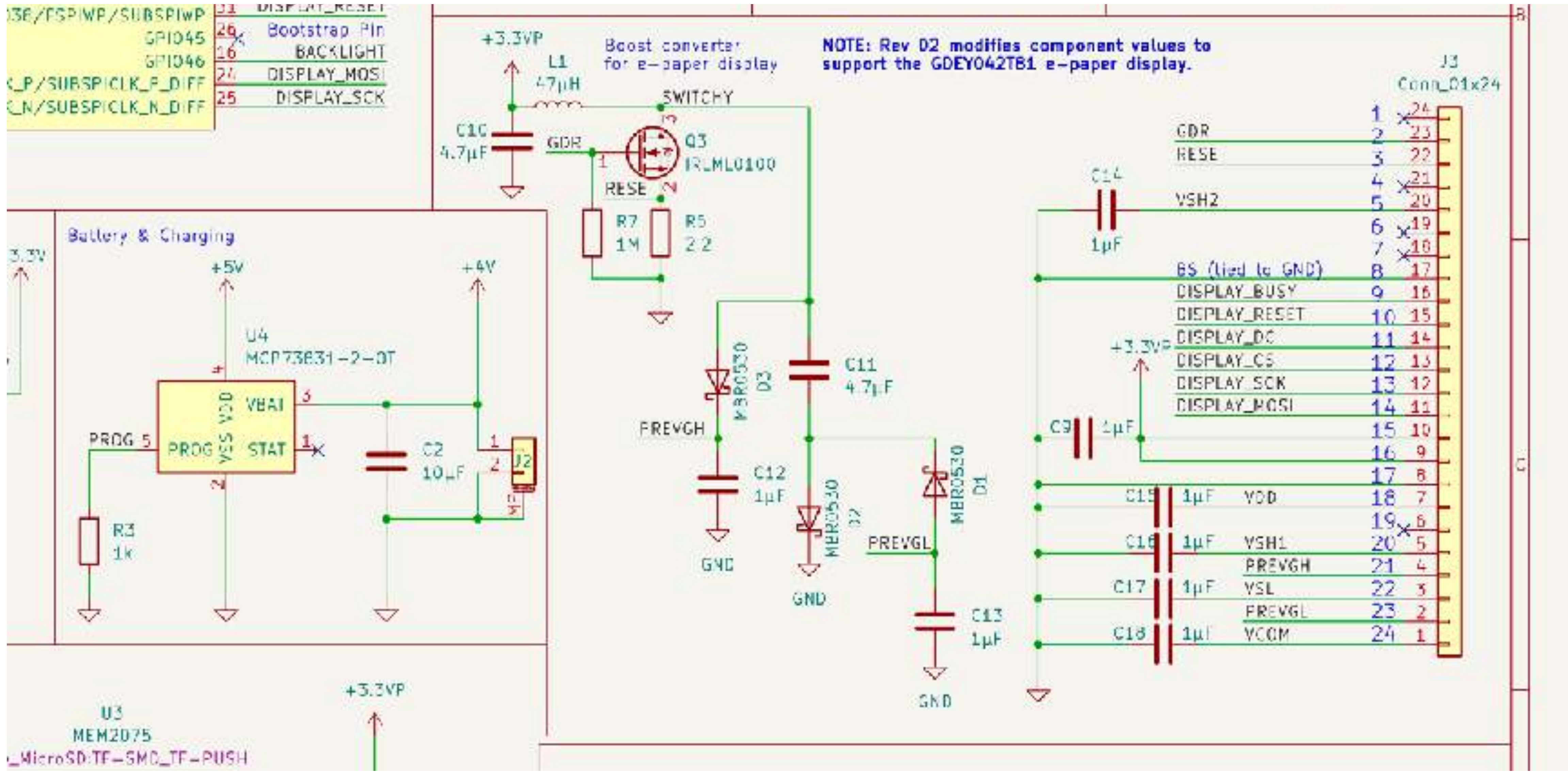
What about self-documenting boards that come preassembled?

Moving to PCBA

AKA: not building it yourself

- Arrange components in functional blocks…
- …that match what's in the schematic
- This still gives an overview of "how it works"
- Still: what to do with the rest of the silkscreen?

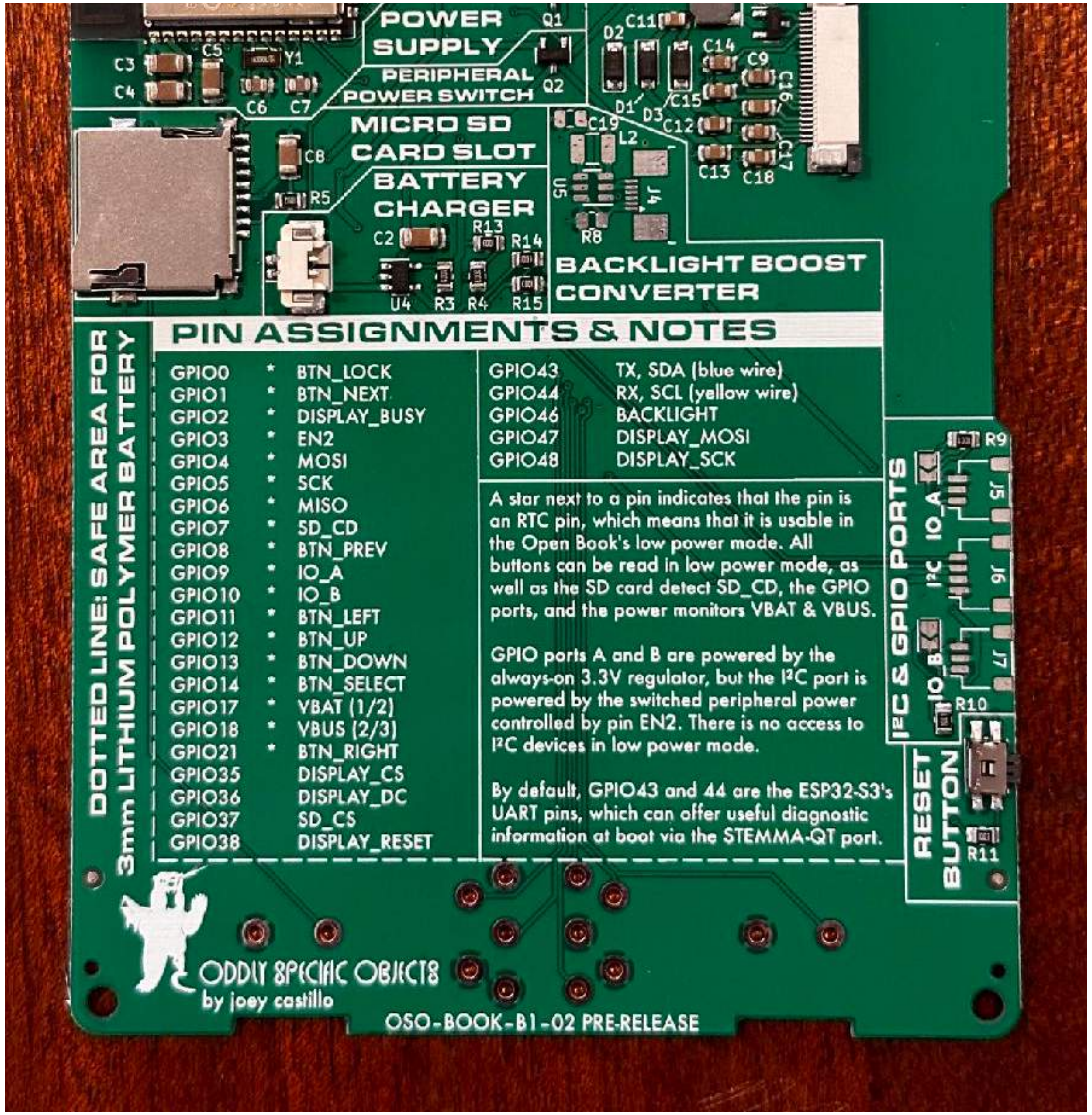

LOCK BUTTON
ESP32-S3 MODULE
R1 R2
USB TYPE-C PORT
The Open Book is Open Source Hardware! CC-BY-SA 4.0 (except the bear!)
DEBUG ACCESS PORT
E-PAPER BOOST CONVERTER
3.3V POWER SUPPLY
PERIPHERAL POWER SWITCH
MICRO SD CARD SLOT
BATTERY CHARGER
BACKLIGHT BOOST CONVERTER
R12 U1 Q1 Q2 D4 C1 C10 L1 R7 R6 Q3 C11 D2 C14 C9 C16 D1 D3 C15 C12 C19 L2 C17 C13 C18 U5 J4 R8
C3 C4 C5 Y1 C6 C7 C8 R5 C2 R13 R14 U4 R3 R4 R15



This trail leads to…

Making use of the device!

- Pin assignments and notes on how to develop for the device!
- True facts: I use this a ton when writing my firmware!
- It’s an affordance both for me and for users of the device.



PIN ASSIGNMENTS & NOTES

GPIO0	*	BTN_LOCK
GPIO1	*	BTN_NEXT
GPIO2	*	DISPLAY_BUSY
GPIO3	*	EN2
GPIO4	*	MOSI
GPIO5	*	SCK
GPIO6	*	MISO
GPIO7	*	SD_CD
GPIO8	*	BTN_PREV
GPIO9	*	IO_A
GPIO10	*	IO_B
GPIO11	*	BTN_LEFT
GPIO12	*	BTN_UP
GPIO13	*	BTN_DOWN
GPIO14	*	BTN_SELECT
GPIO17	*	VBAT (1/2)
GPIO18	*	VBUS (2/3)
GPIO21	*	BTN_RIGHT
GPIO35		DISPLAY_CS
GPIO36		DISPLAY_DC
GPIO37		SD_CS
GPIO38		DISPLAY_RESET

GPIO43	TX, SDA (blue wire)
GPIO44	RX, SCL (yellow wire)
GPIO46	BACKLIGHT
GPIO47	DISPLAY_MOSI
GPIO48	DISPLAY_SCK

A star next to a pin indicates that the pin is an RTC pin, which means that it is usable in the Open Book's low power mode. All buttons can be read in low power mode, as well as the SD card detect SD_CD, the GPIO ports, and the power monitors VBAT & VBUS.

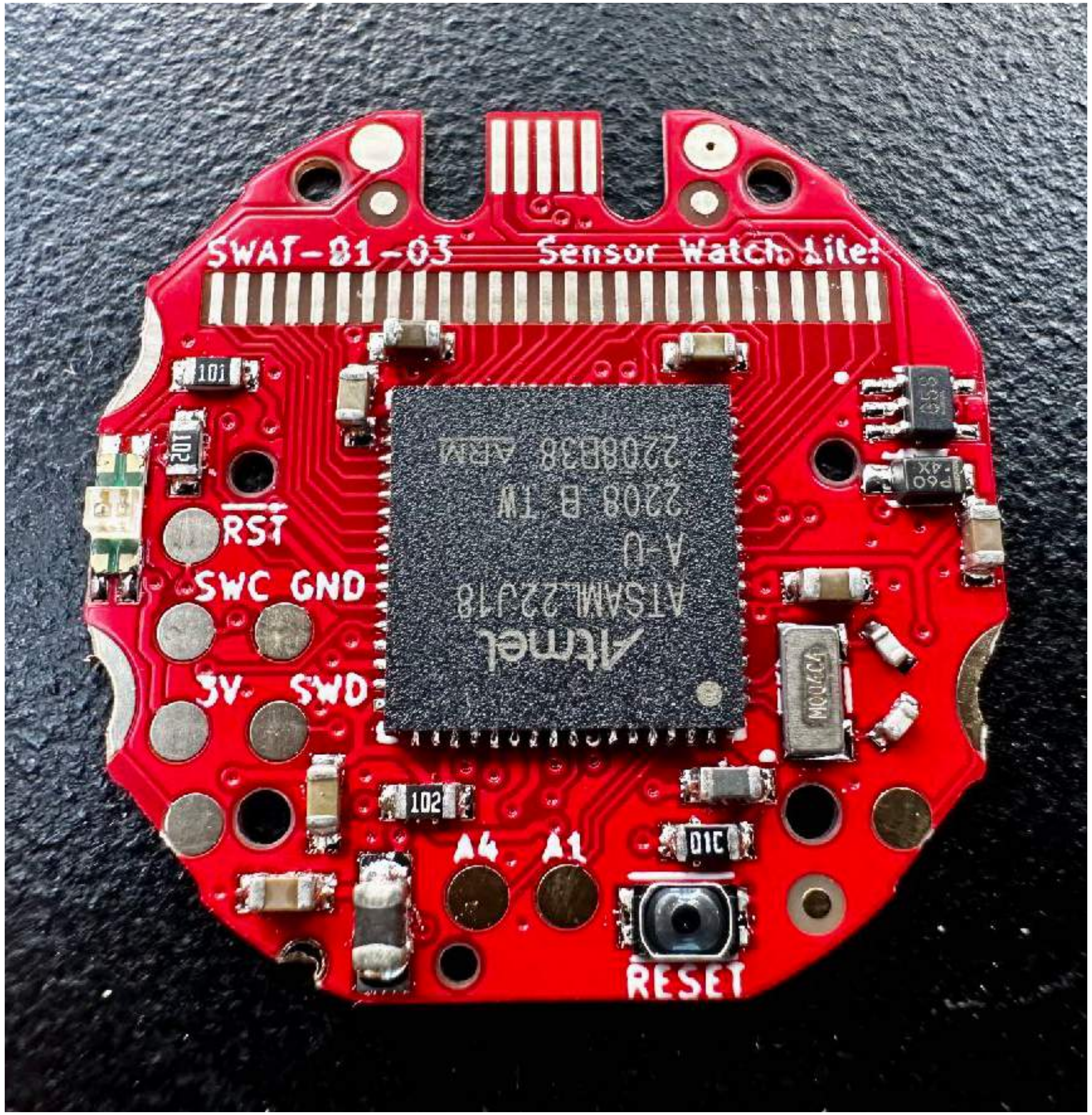
GPIO ports A and B are powered by the always-on 3.3V regulator, but the I²C port is powered by the switched peripheral power controlled by pin EN2. There is no access to I²C devices in low power mode.

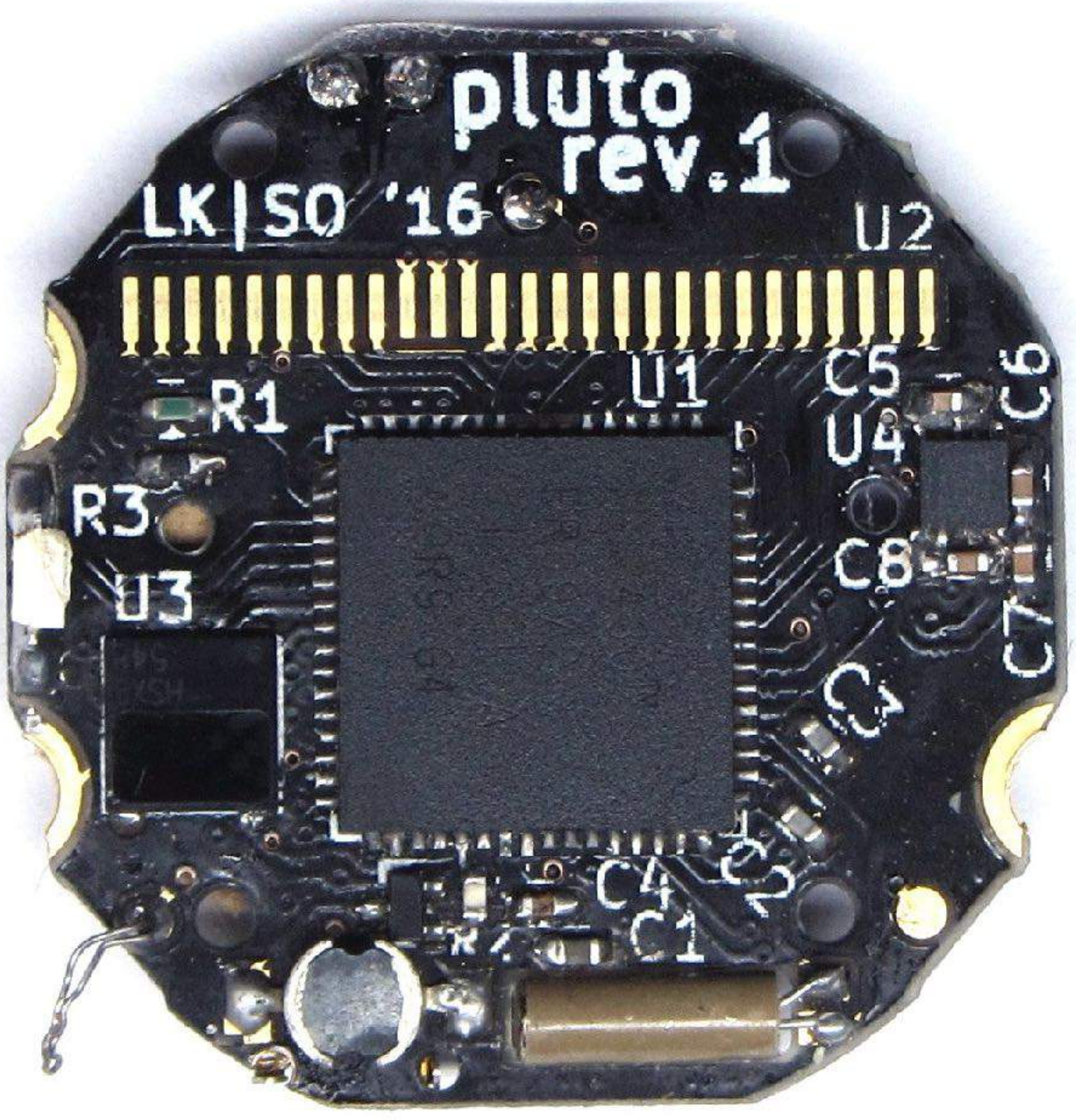
By default, GPIO43 and 44 are the ESP32-S3's UART pins, which can offer useful diagnostic information at boot via the STEMMA-QT port.

This trail leads to…

Making use of the device!

- Pin assignments and notes on how to develop for the device!
- True facts: I use this a ton when writing my firmware!
- It’s an affordance both for me and for users of the device.
- Works on boards of (many?) shapes and sizes.

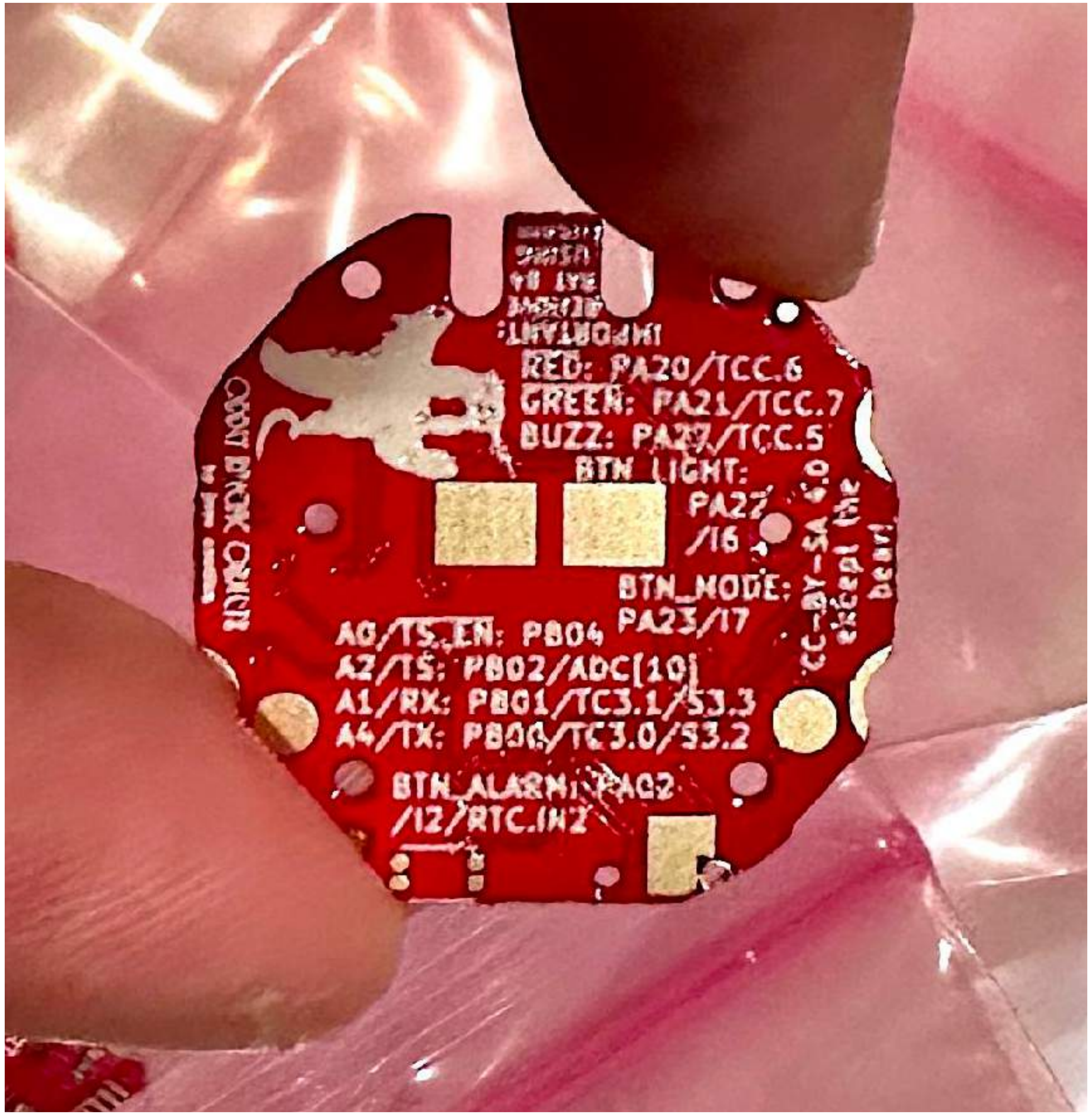



pluto
rev.1
LK|SO '16
U2
U1
C5
C6
R1
U4
R3
C8
U3
C7
C3
C4
C2
C1

This trail leads to…

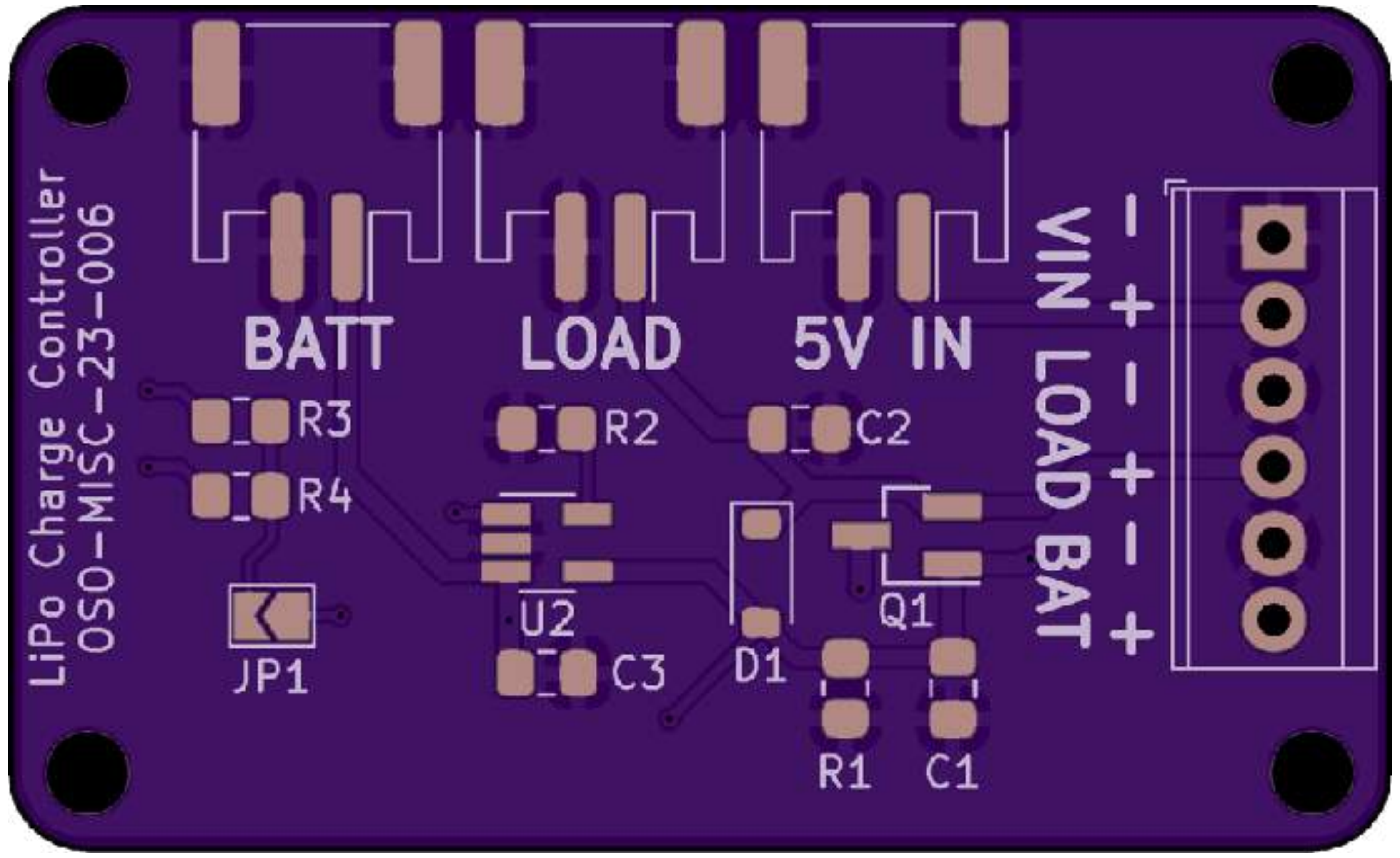
Making use of the device!

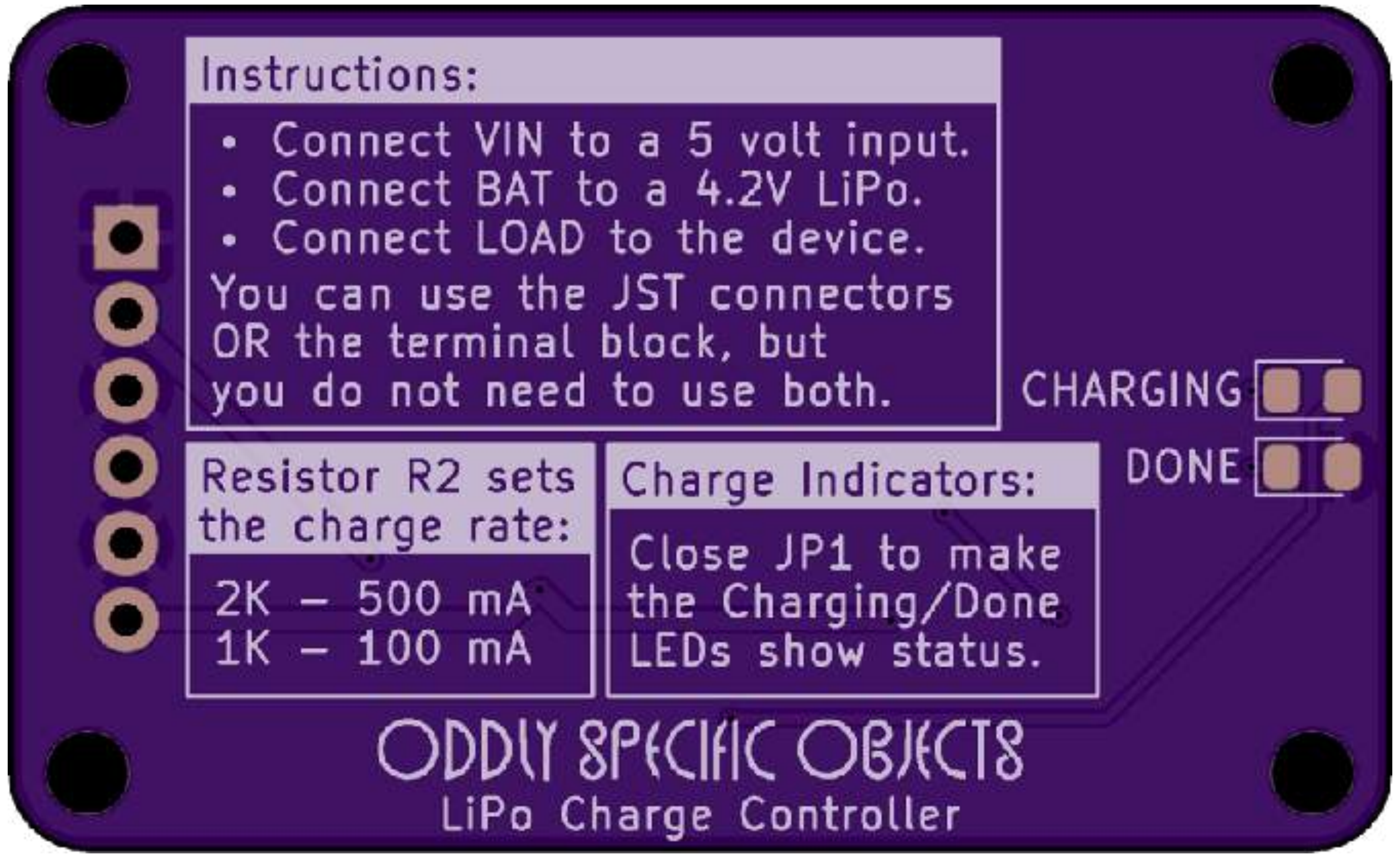
- Pin assignments and notes on how to develop for the device!
- True facts: I use this a ton when writing my firmware!
- It’s an affordance both for me and for users of the device.
- Works on boards of (many?) shapes and sizes.



Self-documenting circuit boards…

- Add immediate context to the hardware you have in hand





Instructions:

- Connect VIN to a 5 volt input.
- Connect BAT to a 4.2V LiPo.
- Connect LOAD to the device.

You can use the JST connectors OR the terminal block, but you do not need to use both.

Resistor R2 sets the charge rate:

2K – 500 mA
1K – 100 mA

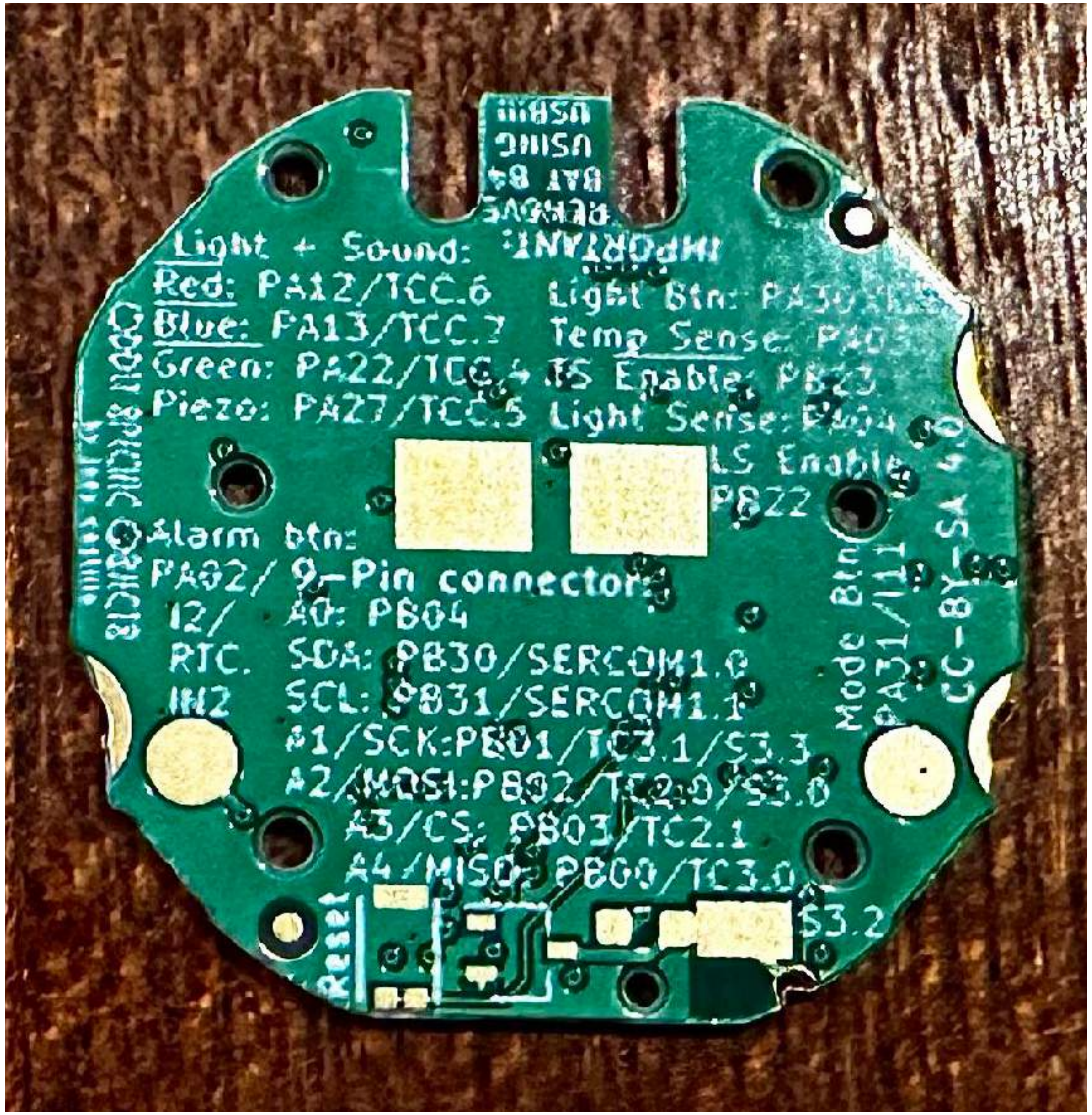
Charge Indicators:

Close JP1 to make the Charging/Done LEDs show status.

ODDLY SPECIFIC OBJECTS
LiPo Charge Controller

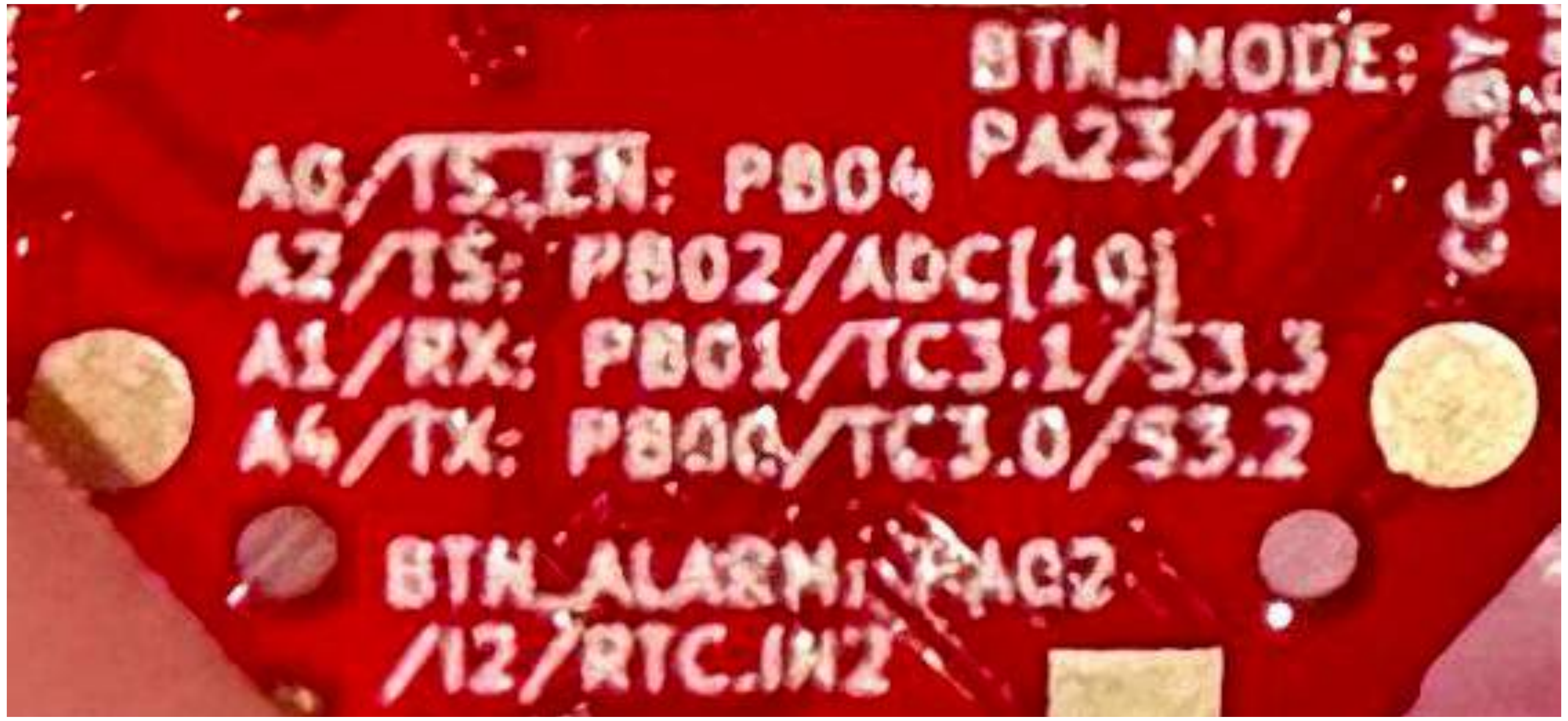
Self-documenting circuit boards…

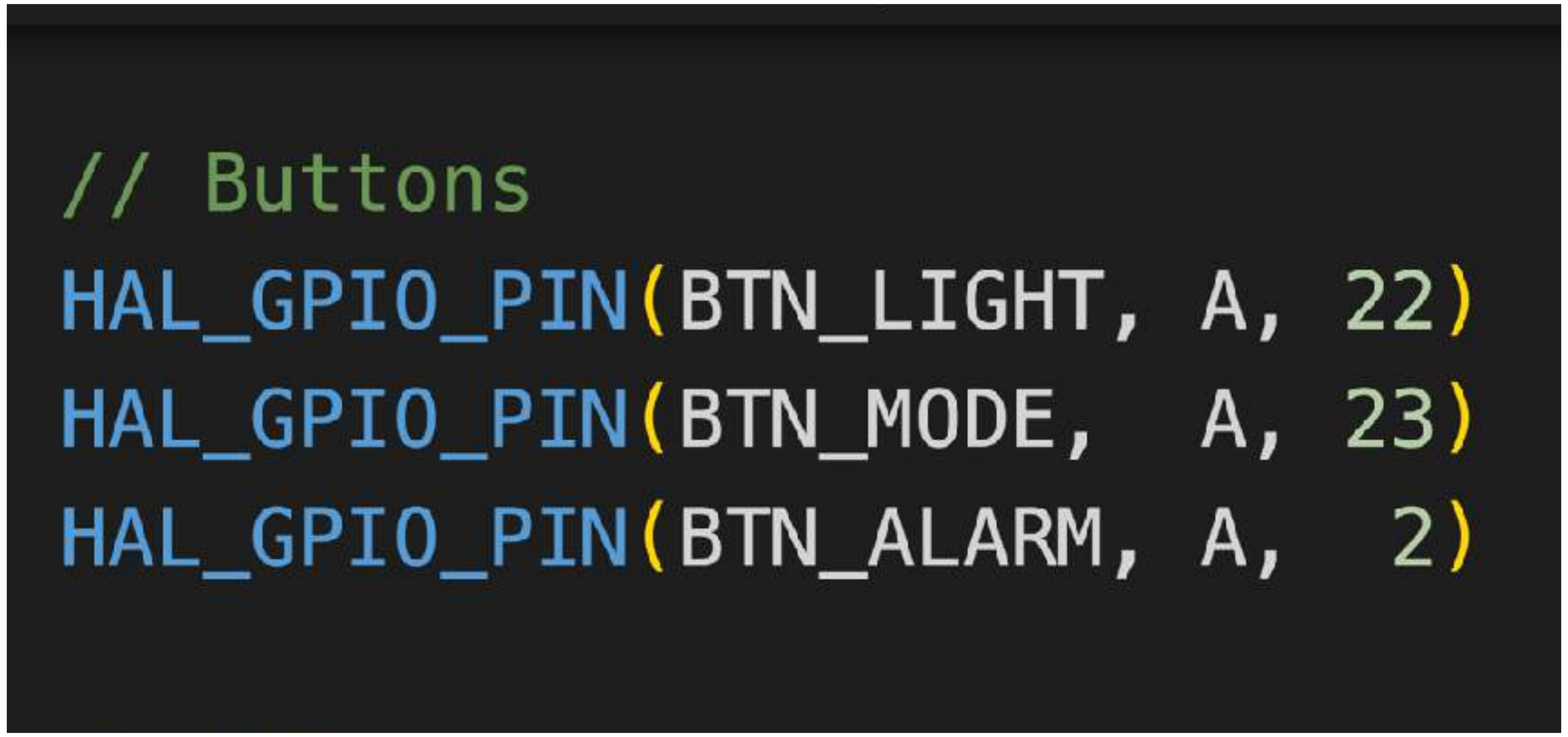
- Add immediate context to the hardware you have in hand
- Create a self-contained artifact
- Are user-hackable by default



Self-documenting circuit boards…

- Add immediate context to the hardware you have in hand
- Create a self-contained artifact
- Are user-hackable by default
- Pairs nicely with code that makes use of the same names





```
// Buttons
HAL_GPIO_PIN(BTN_LIGHT, A, 22)
HAL_GPIO_PIN(BTN_MODE,  A, 23)
HAL_GPIO_PIN(BTN_ALARM, A,  2)
```

ODDLY SPECIFIC OBJECTS
THE OPEN BOOK

Questions to Ask

How can we do even better?

- How do I imagine other people making use of the device?
- What affordances am I offering in the service of those use cases?
- What information would I want to give to a novice user of the device? An advanced user?
- Can I tell the story of the device in a way that makes sense?

Comprehensible Open Hardware

Joey Castillo

Oddly Specific Objects: oddlyspecificobjects.com

The Open Book: theopenbook.is

Sensor Watch: sensorwatch.net

Fediverse: mastodon.social/@joeycastillo