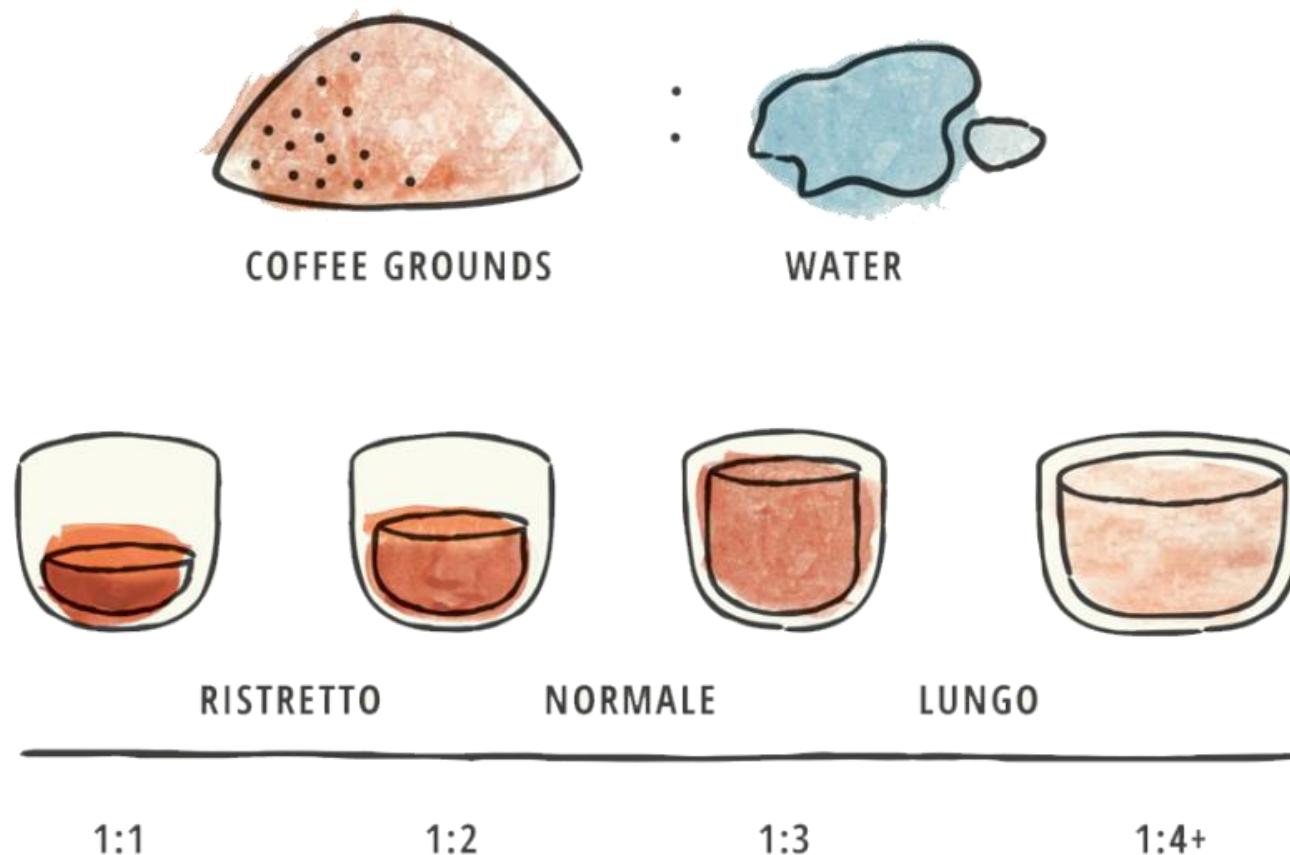


# Hacking Your Coffee Machine

For Fun (and Better Espressos)

# An Espresso, What Else?





# The Variables

- Fresh roasted beans (< 4-6 weeks)
- Coffee grind size
- Extraction time (25-30 seconds)
- Coffee/water ratio
- Water composition and temperature (90-95°C)
- Pressure (9 bars)
  - Too high: strong, bitter coffee
  - Too low: acidic, astringent coffee with low concentration





# My Espresso Machines over the Years



DeLonghi Dedica



Sage Barista Pro



Gaggia Classic Evo  
Eureka Mignon Zero

# and the Upgrades and Accessories [1/2]



Scale



WDT tool  
(Weiss Distribution  
Technique)



Unpressurized  
filter basket

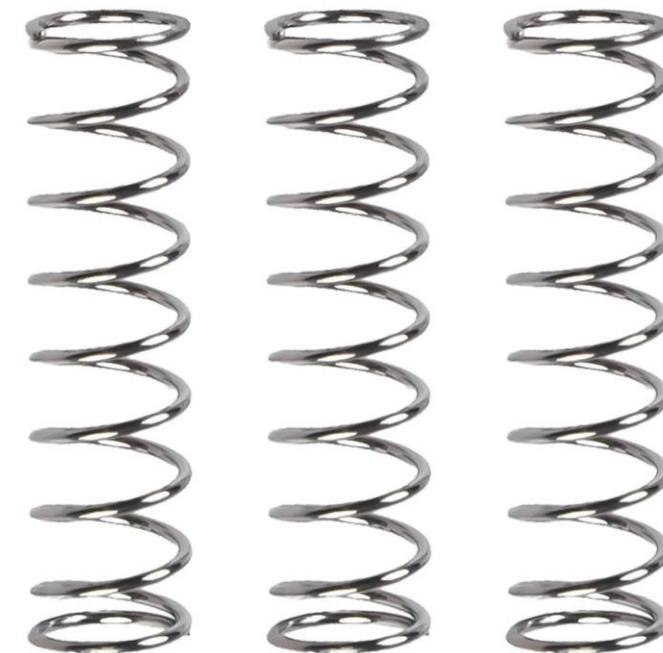


Calibrated tamper

# and the Upgrades and Accessories [2/3]



Bottomless portafilter

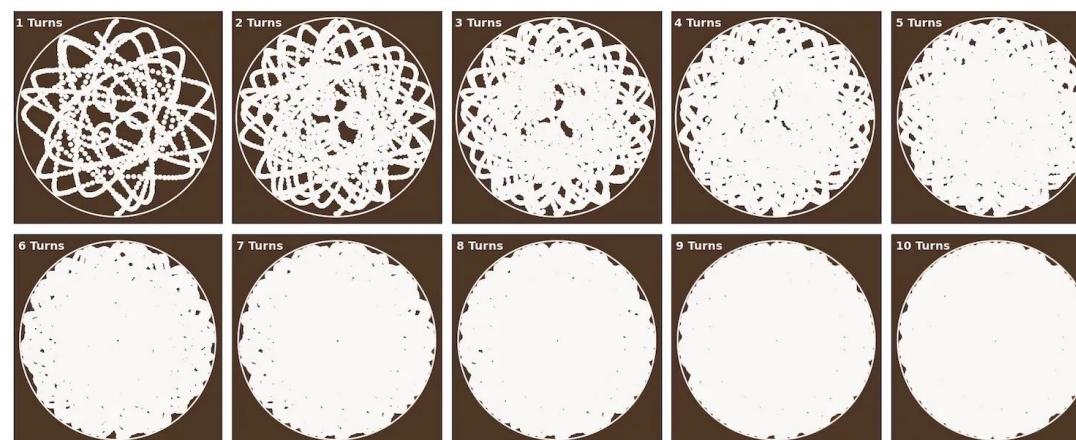


OPV springs  
(Over Pressure Valve)

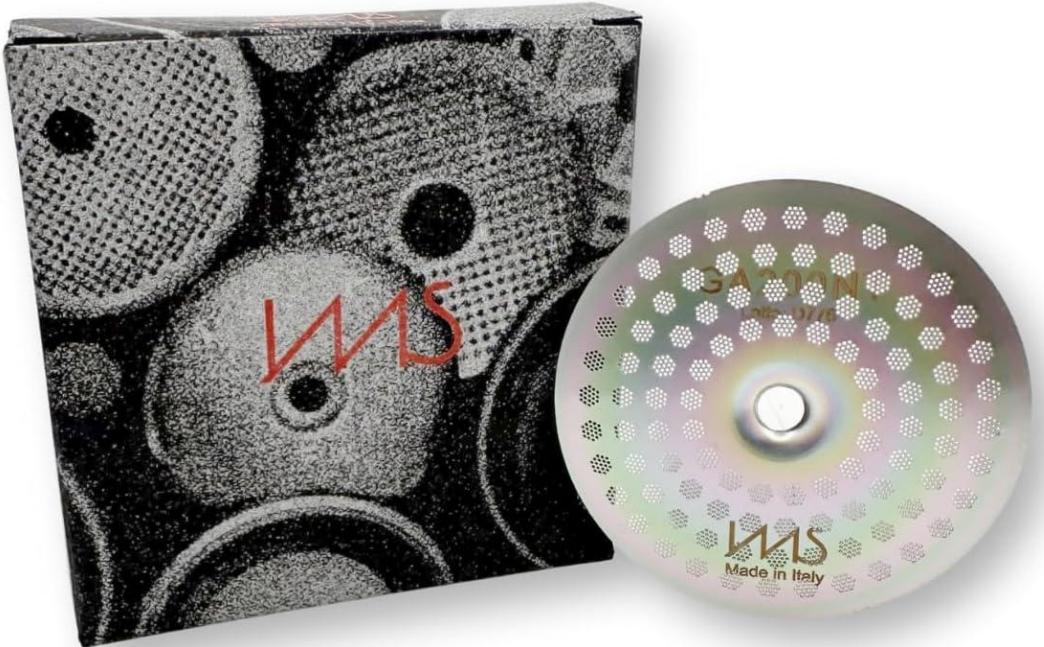
# and the Upgrades and Accessories [3/4]



Umikot  
Planetary Gear  
Spirograph WDT  
tool



# and the Upgrades and Accessories [4/4]



Precision Shower Screen

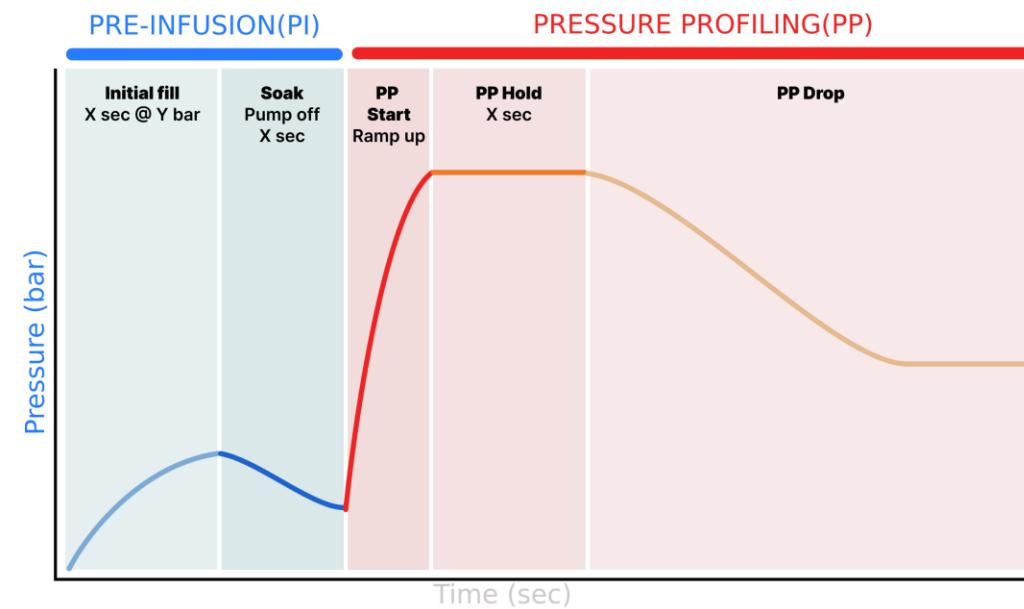


Bluetooth scale



# But Still not Good Enough [...]

- No accurate temperature control (no PID)
- No pre-infusion
- No flow control
- No pressure profiling
- No integrated scale



[https://gaggiuino.github.io/manual/declining\\_pp\\_classic.png](https://gaggiuino.github.io/manual/declining_pp_classic.png)

# Should I Upgrade to a More Decent Machine?



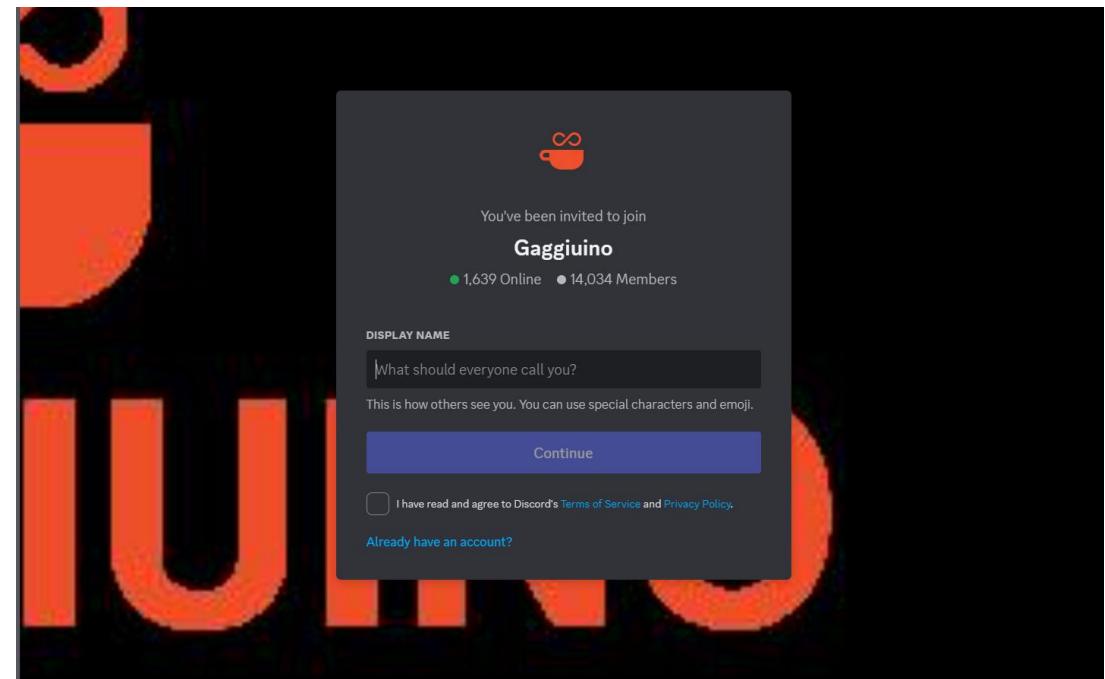
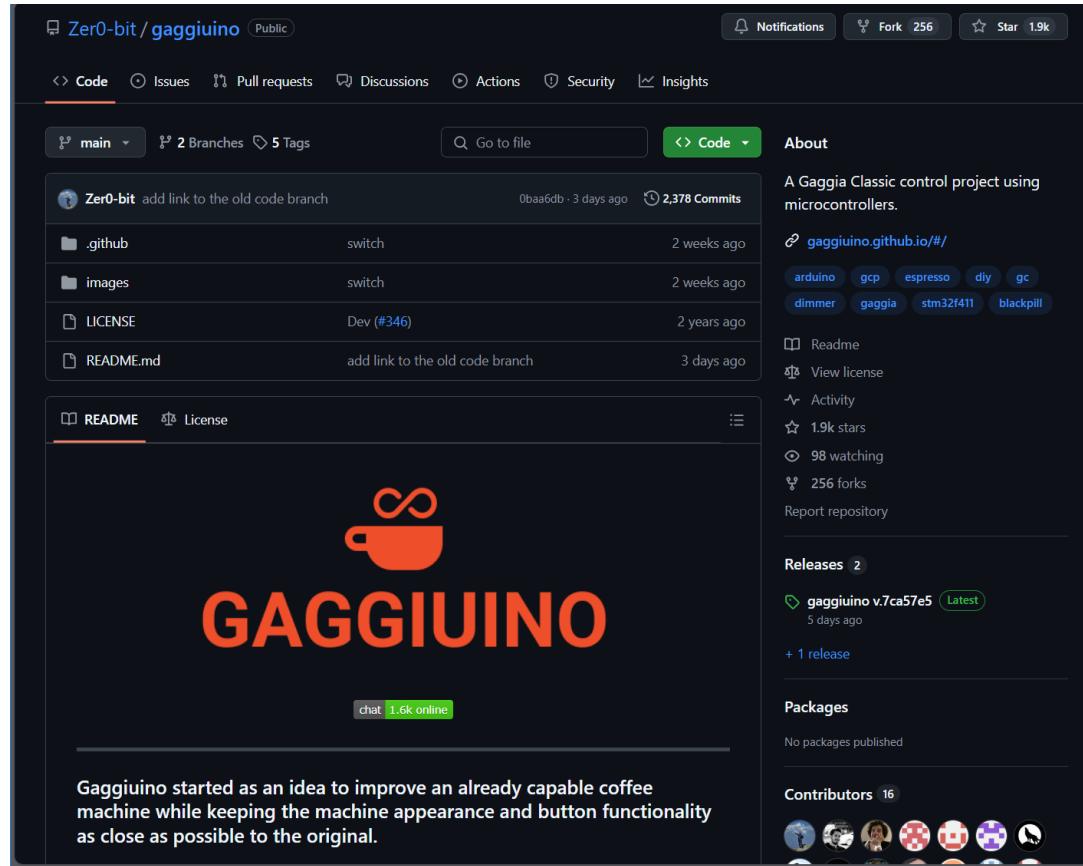
Decent DE1PRO

[de1xl\\_v13.jpg \(1200×775\) \(decentespresso.com\)](https://decentespresso.com)

# The Solution



# The Community [1/2]



[GitHub - Zer0-bit/gaggiuino: A Gaggia Classic control project using microcontrollers.](#)

# The Community [2/2]



[https://www.youtube.com/watch?v=V4pTFCGVlmQ&ab\\_channel=LanceHedrick](https://www.youtube.com/watch?v=V4pTFCGVlmQ&ab_channel=LanceHedrick)



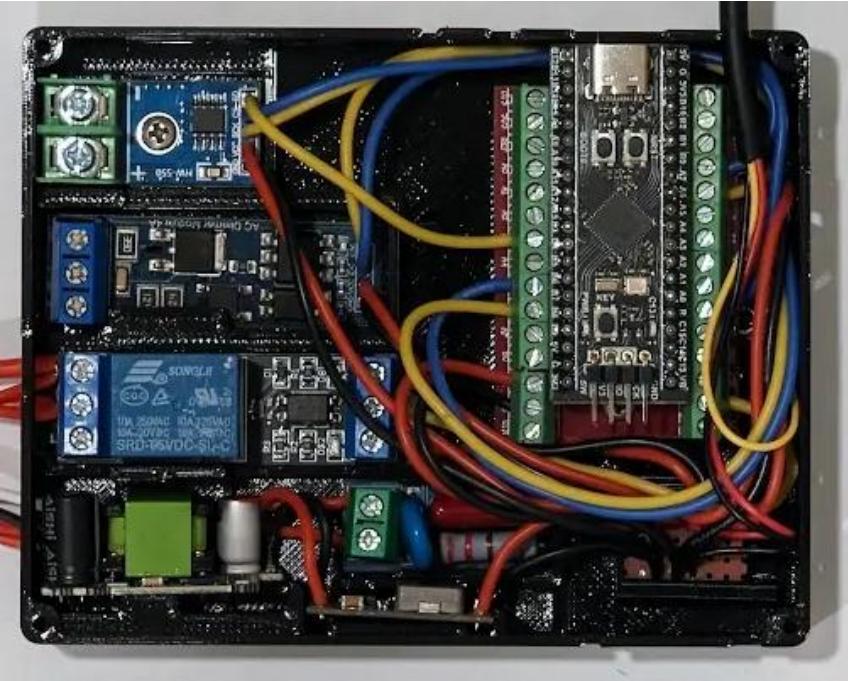
# The Project

- Custom PCB with a **STM32F411** microcontroller
- Brew thermostat replaced by a **thermocouple** to monitor the temperature of the heater
- **Solid-state relay (SSR)** to control the heater
- **Pressure transducer** to monitor the pressure between the pump and the heater
- **Dimmer** to control the pump
- **Touch screen** to interact with the UI (Nextion 2.4")



<https://i.ytimg.com/vi/kIRqOU4PDok/maxresdefault.jpg>

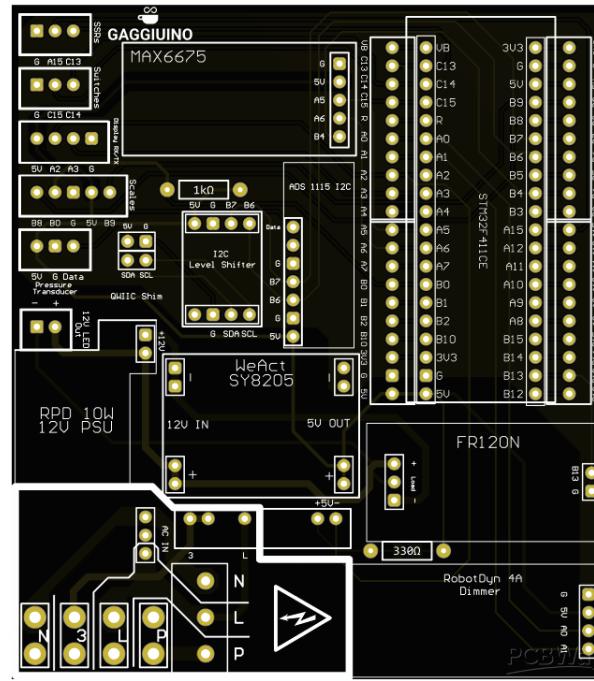
# The PCB



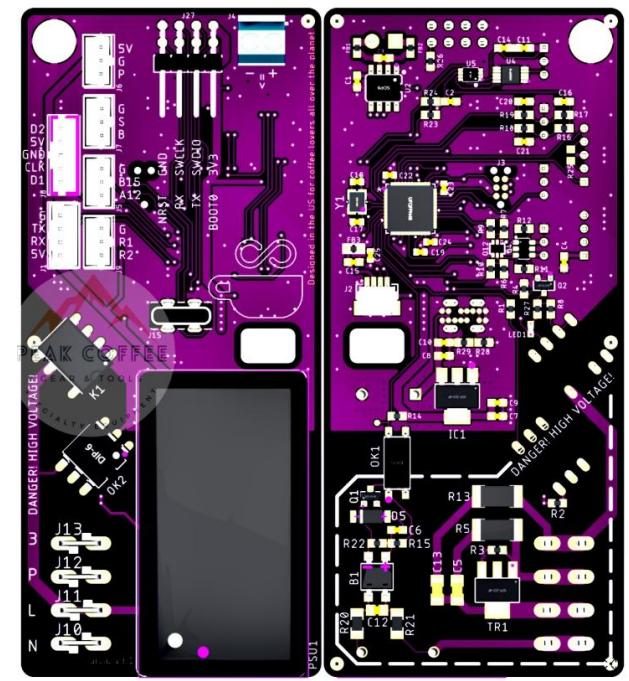
Lego build

<https://www.printables.com/model/269394-gaggiuino-component-housing/comments/632135#preview>  
[1552307530058.png \(645×728\) \(pcbwayfile.s3.us-west-2.amazonaws.com\)](https://www.printables.com/model/269394-gaggiuino-component-housing/comments/632135#preview)

[https://i0.wp.com/www.peakcoffee.cc/wp-content/uploads/2023/06/IMG\\_4089.jpeg?resize=768%2C881&ssl=1](https://i0.wp.com/www.peakcoffee.cc/wp-content/uploads/2023/06/IMG_4089.jpeg?resize=768%2C881&ssl=1)

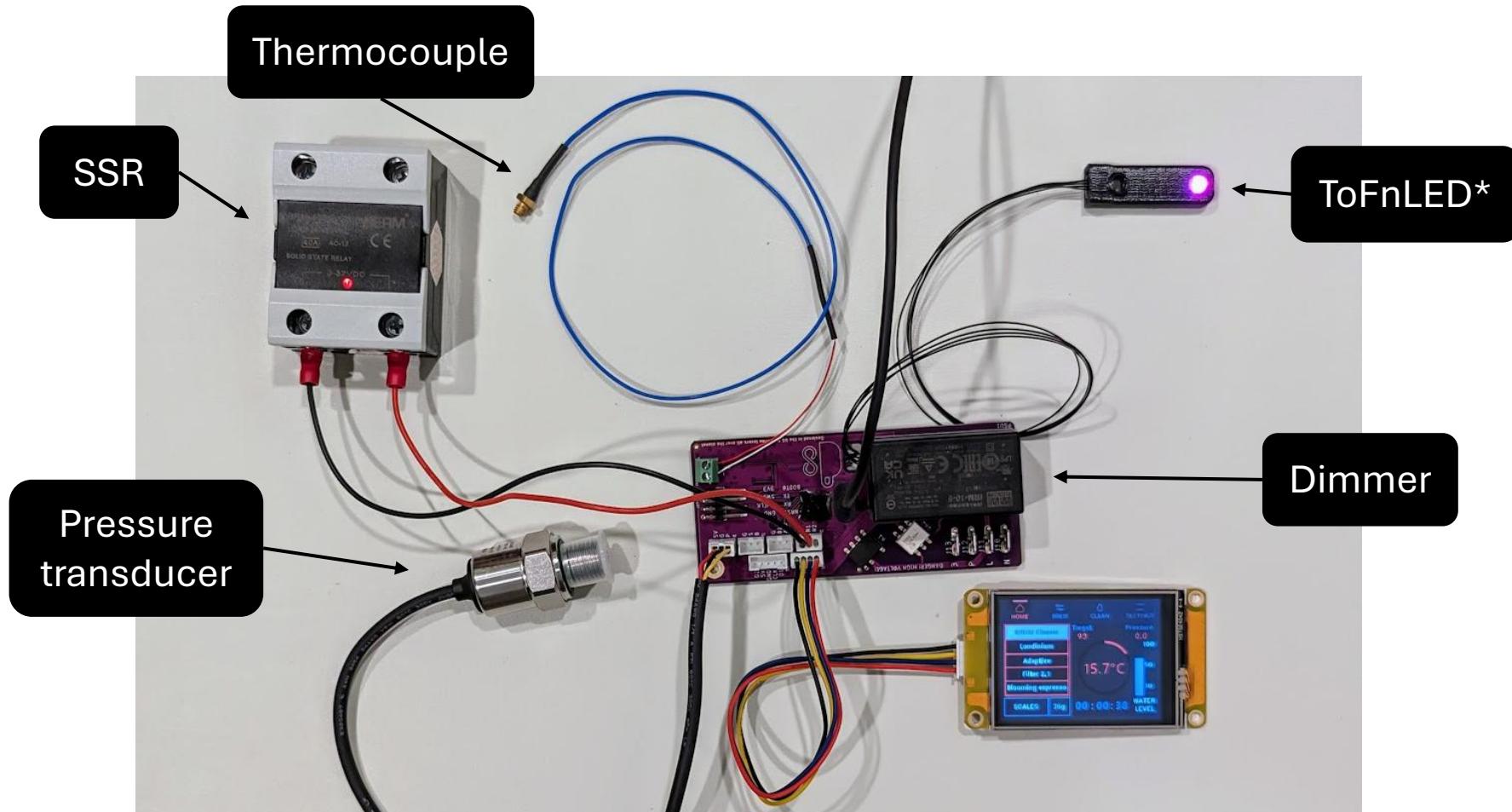


PCBv3/3.1



New PCBv4 with  
STM32U585

# The Electronic Components



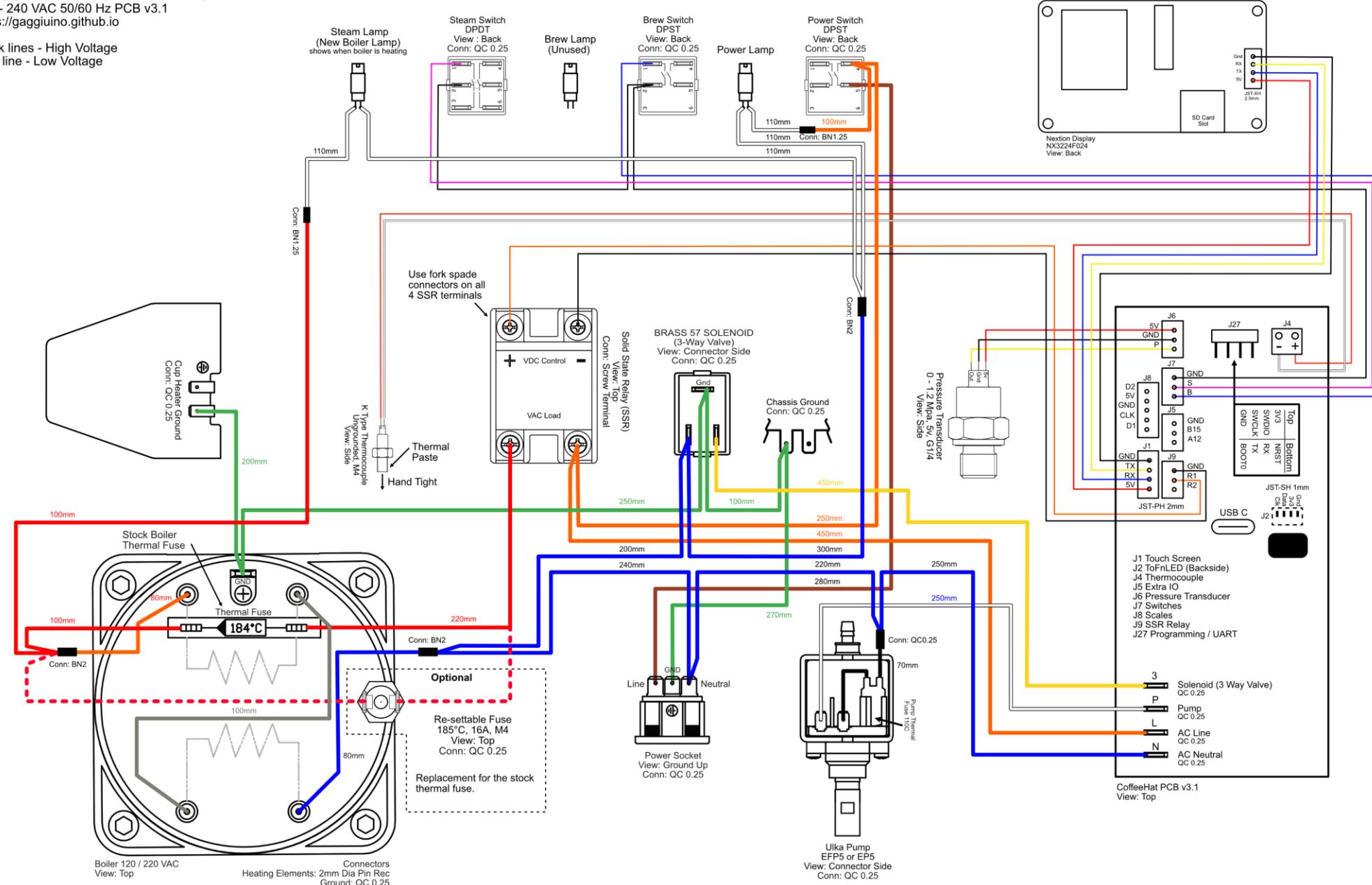
<https://github-production-user-asset-6210df.s3.amazonaws.com/117388662/32800507-836fe705-8835-40f8-af33-fc063a7d09b0.png>

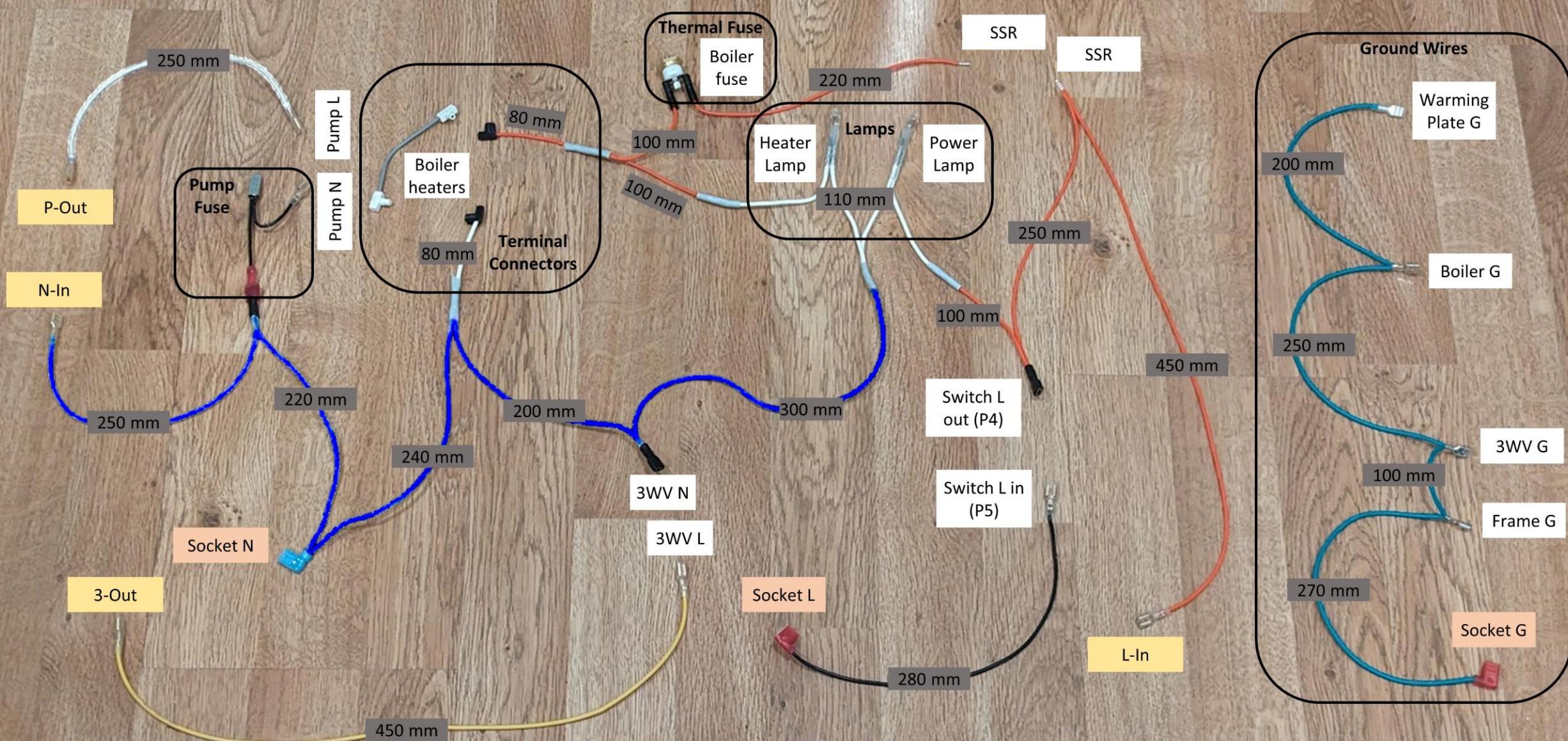
# Gaggia Classic Pro Wiring

220 - 240 VAC 50/60 Hz PCB v3.1

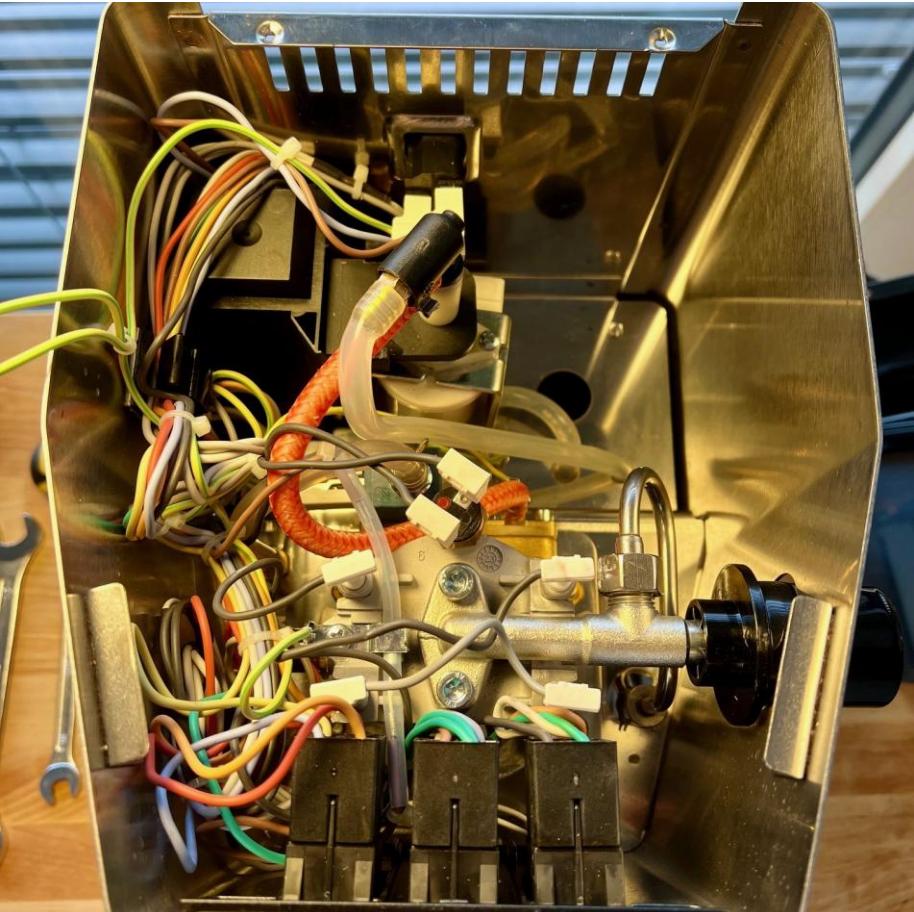
<https://gaggiuno.github.io>

Thick lines - High Voltage  
Thin line - Low Voltage

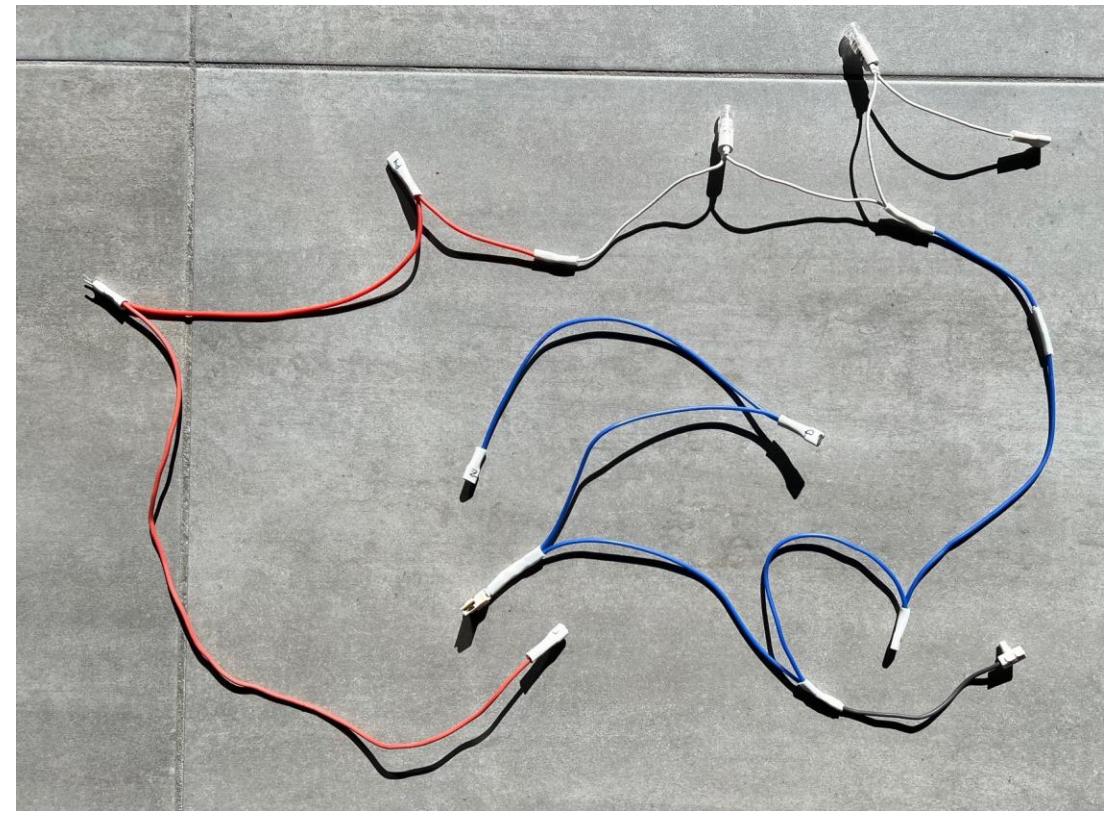




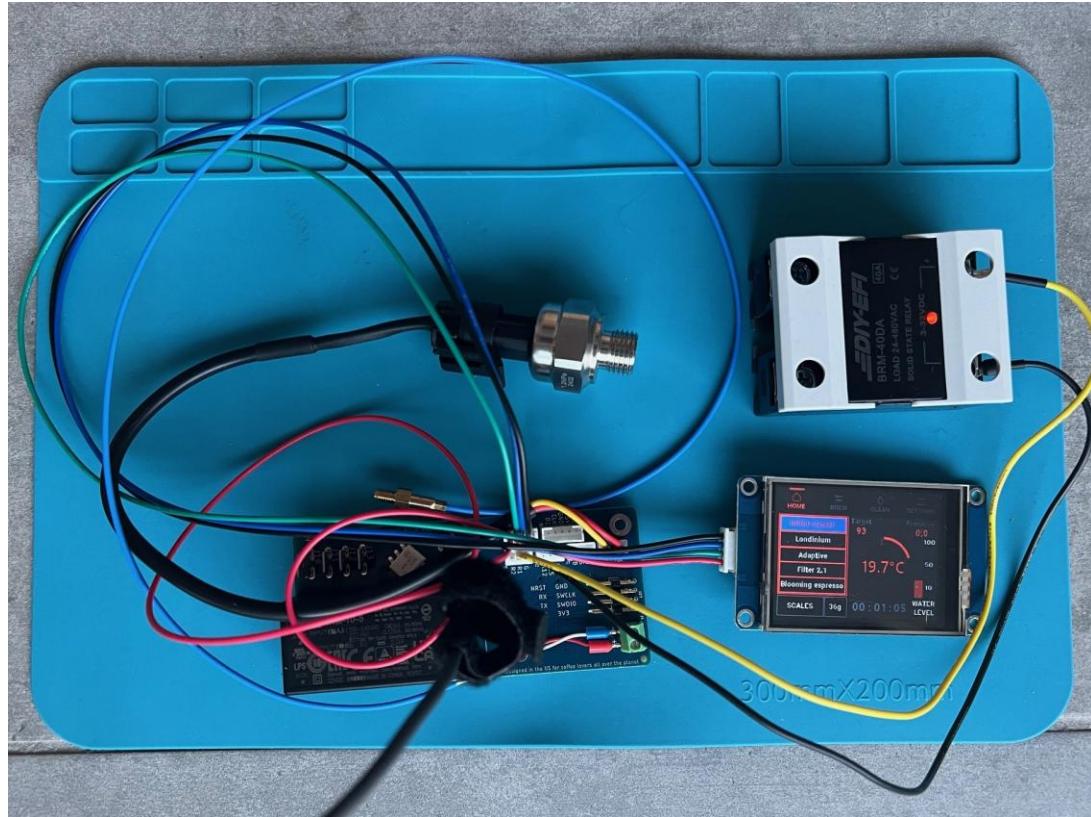
# The (un)Build



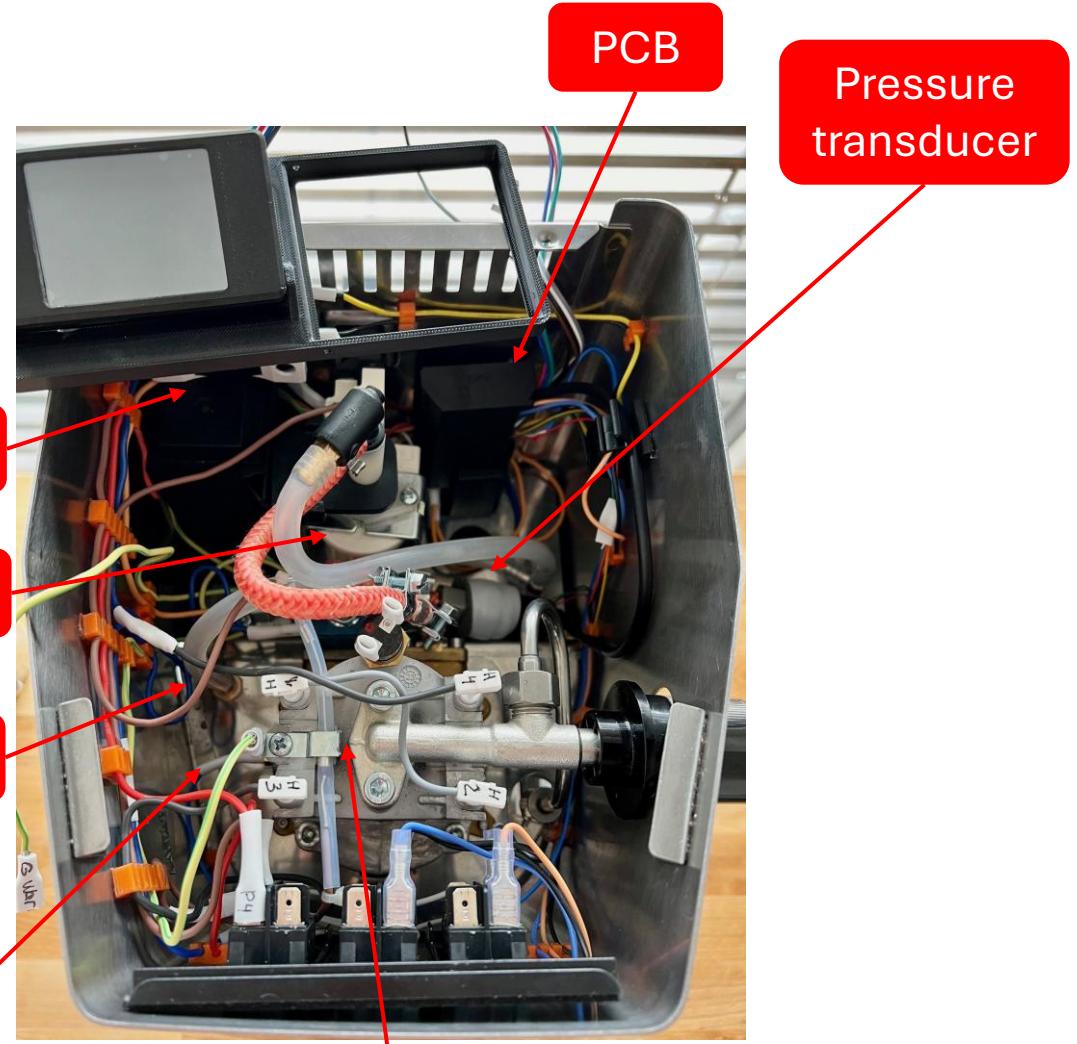
# The Build



# The Build



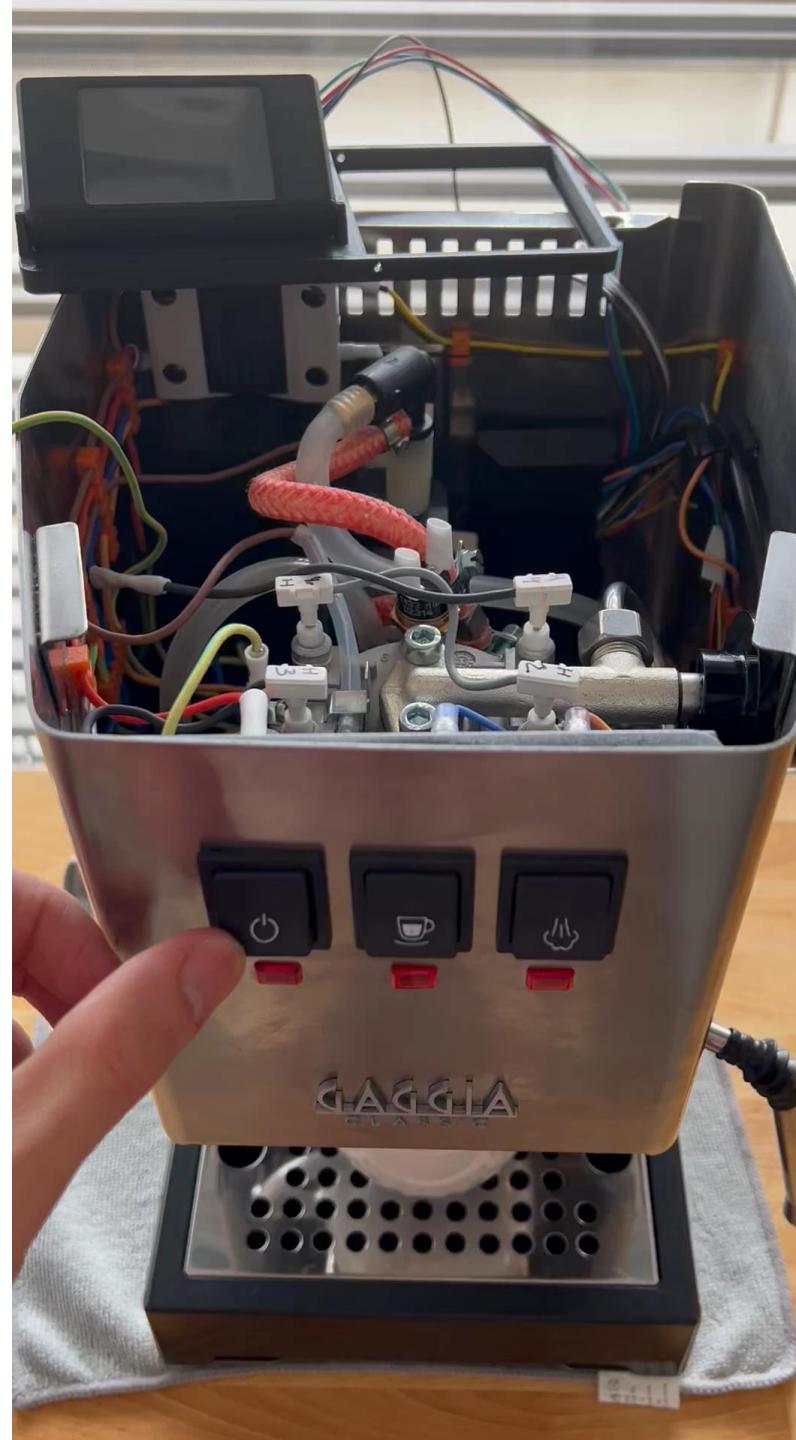
Thermocouple



Heater



#first-start



Nothing Burned ;-)

# Demo

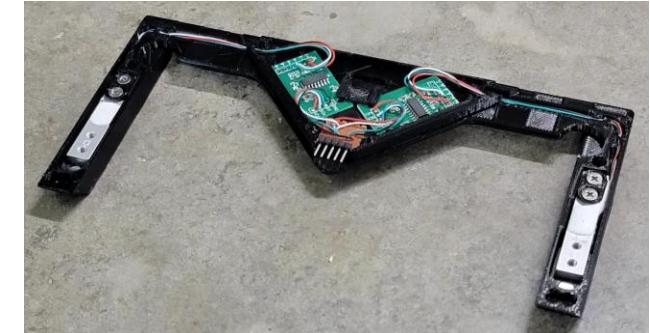
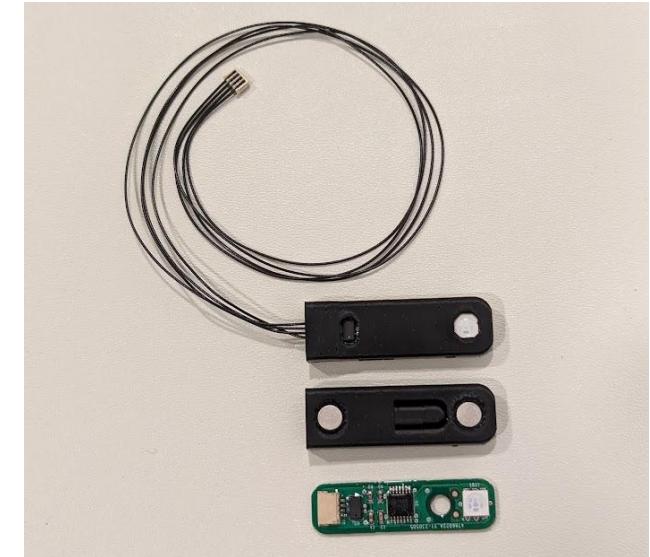
No Live Demo ;-)



#first-shot

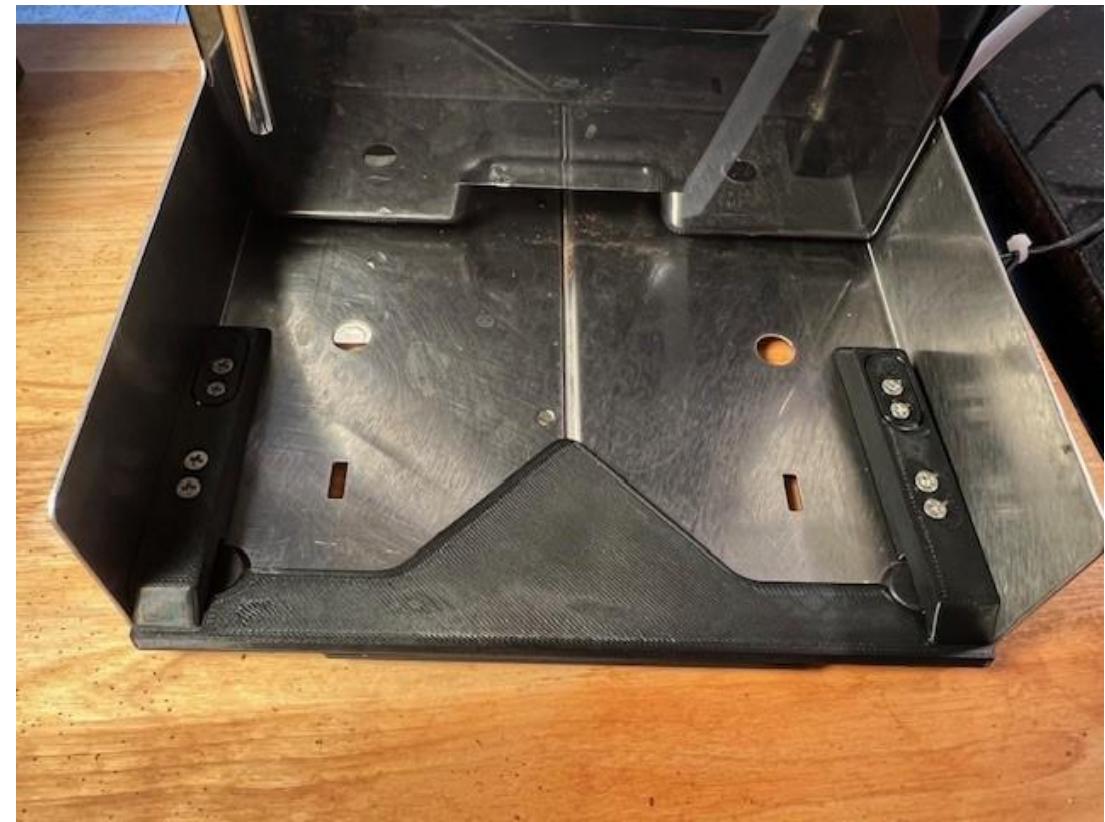
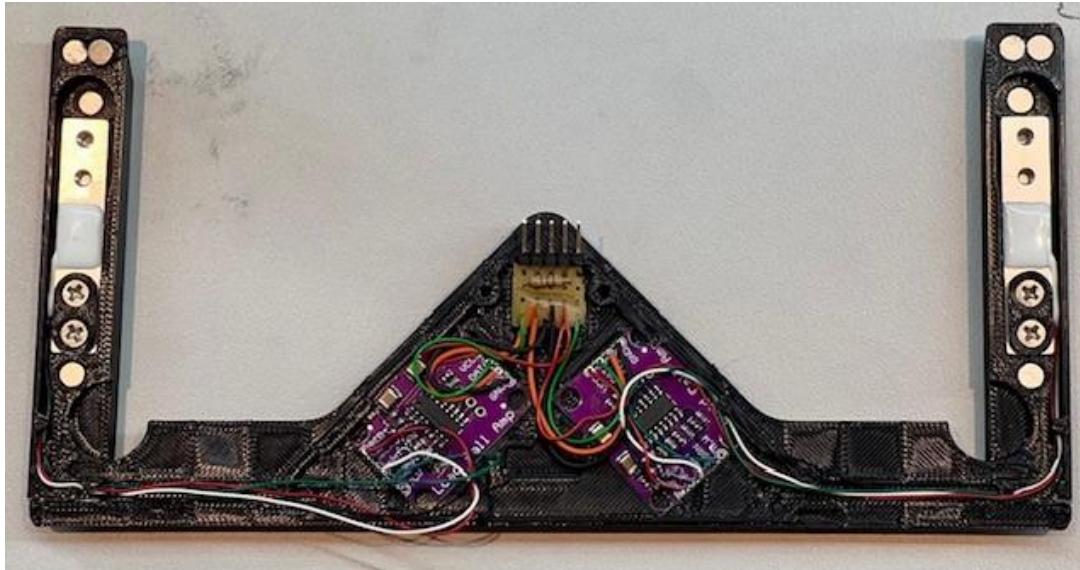
# The Addons and Potential Upgrades

- Time of flight (ToF) sensor to monitor the tank water level
- Hardware scale under the drip tray
- LED under the group head
- Bigger screen with new functionalities (V3)
  - Web server
  - OTA updates
  - Pressure profiles editing and sharing
  - Etc.
- STM32F411 → STM32U585
- New pump tower



<https://user-images.githubusercontent.com/117388662/256652465-c6fe4def-9d61-43f8-9b23-339bb7d53b8b.png>  
[256965387-c217fc32-4cf8-4c89-8a9e-5b96efc188a2.png \(1191×642\) \(user-images.githubusercontent.com\)](256965387-c217fc32-4cf8-4c89-8a9e-5b96efc188a2.png)

# The Hardware Scale



# The New Screen (V3)

4.3" ESP32-S3  
Screen



“must be activated by PeakCoffee or DIY-EFI”

# and UI [1/2]

The image displays three screenshots of a coffee machine's web-based user interface, illustrating its functionality across different sections:

- Home Page:** Shows real-time monitoring of water level (50%) and pressure (0.3bar). A large circular display shows a temperature reading of 89.5°C. The interface includes a timeline graph, a "STOP ON" button, and a scale section with "TARGET TEMP" (93), "SCALE" (0.0), and buttons for "FLUSH" and "DESCALE". A sidebar lists available profiles: IUIUIU Classic, Londinium, Adaptive, Filter 2.1, Blooming espresso, Zer0, and Boiler Off. The top navigation bar includes links for HOME, PROFILES, SETTINGS, and a timestamp (04:40).
- Profiles Page:** Titled "Manage profiles", it lists existing profiles (IUIUIU Classic, Londinium, Adaptive, Filter 2.1, Blooming espresso, Zer0, Boiler Off) and allows creating new ones ("+ NEW") or importing from a file ("IMPORT"). It features a detailed graph of a brewing cycle for the "Zer0" profile, showing temperature over time. Buttons for "EDIT", "DUPLICATE", "EXPORT", and "DELETE" are present at the bottom.
- Machine State Management:** Titled "Machine State Management", this page provides control over various machine parameters. It includes sections for BOILER (Steam Temperature 155), SYSTEM (DreamSteam, Temperature Offset 7), LED, SCALES, and DISPLAY. Under the DISPLAY section, there are advanced settings for HPWR (550), Main Divider (5), and Brew Divider (3). The top navigation bar includes links for HOME, PROFILES, SETTINGS, and a timestamp (05:15).

Web server

# and UI [2/2]



# Last Demo





# Conclusion

- Understanding how coffee machines work
- Introduction to electrical schematics and HV wiring
- Learn more about coffee and how to optimize its extraction
- A fun project, to be recommended to all Gaggia Classic owners (not only)
- Thanks to MHE, TKU and KSU for their help ☺