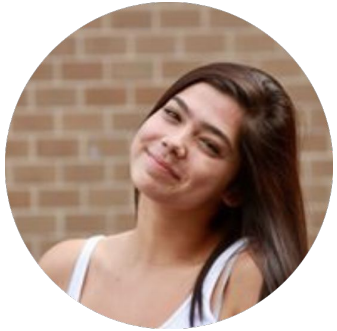
Smart Mug

ECE445 Team#56
Hani Al Majed, Siqi Lu, Srishti Modgil

TEAM PRESENTATION



Srishti Modgil
Senior
Computer Engineering

Siqi Lu
Senior
Electrical Engineering

Hani Al Majed
Senior
Electrical Engineering

Agenda

- Problem, Solution
- Design Overview
- Performance Analysis
- Successes and Difficulties
- Conclusion

1

Problem

Problem

- Maintaining ideal temperature of beverages is challenging
- Impact on taste and enjoyment of the drink
- Existing solutions in the market are expensive, e.g., Ember Mug
- Accessibility issues for average consumers

2

Solution

Solution

- Advanced temperature control system to maintain desired temperature
- Intuitive app interface for setting temperature
- Affordable cost compared to existing solutions
- Eliminates the need for time-consuming and wasteful reheating

Ember Mug²

4.5 (8215) Write a review

$129.95 USD

Pay in 4 interest-free installments of **$32.48** with shop Pay Learn more

Color

Size

14 OZ | 10 OZ

Qty

1 ADD TO CART

Add product protection:

☐ 2-Year Protection Plan $13.99

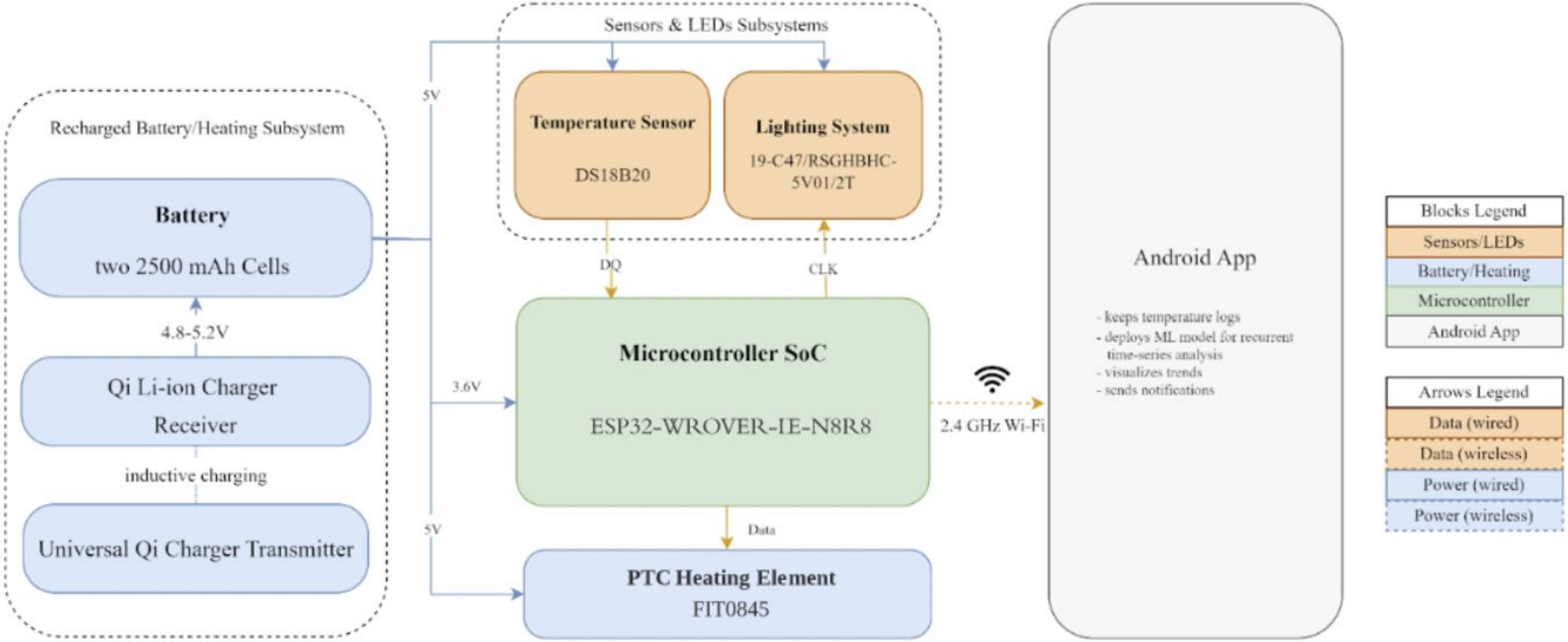
What's Covered? Covered by Clyde

Designed for home or office, the new Ember Mug² does more than simply keep your coffee hot. Our smart mug allows you to set an exact drinking temperature, so your coffee is never too hot, or too cold.

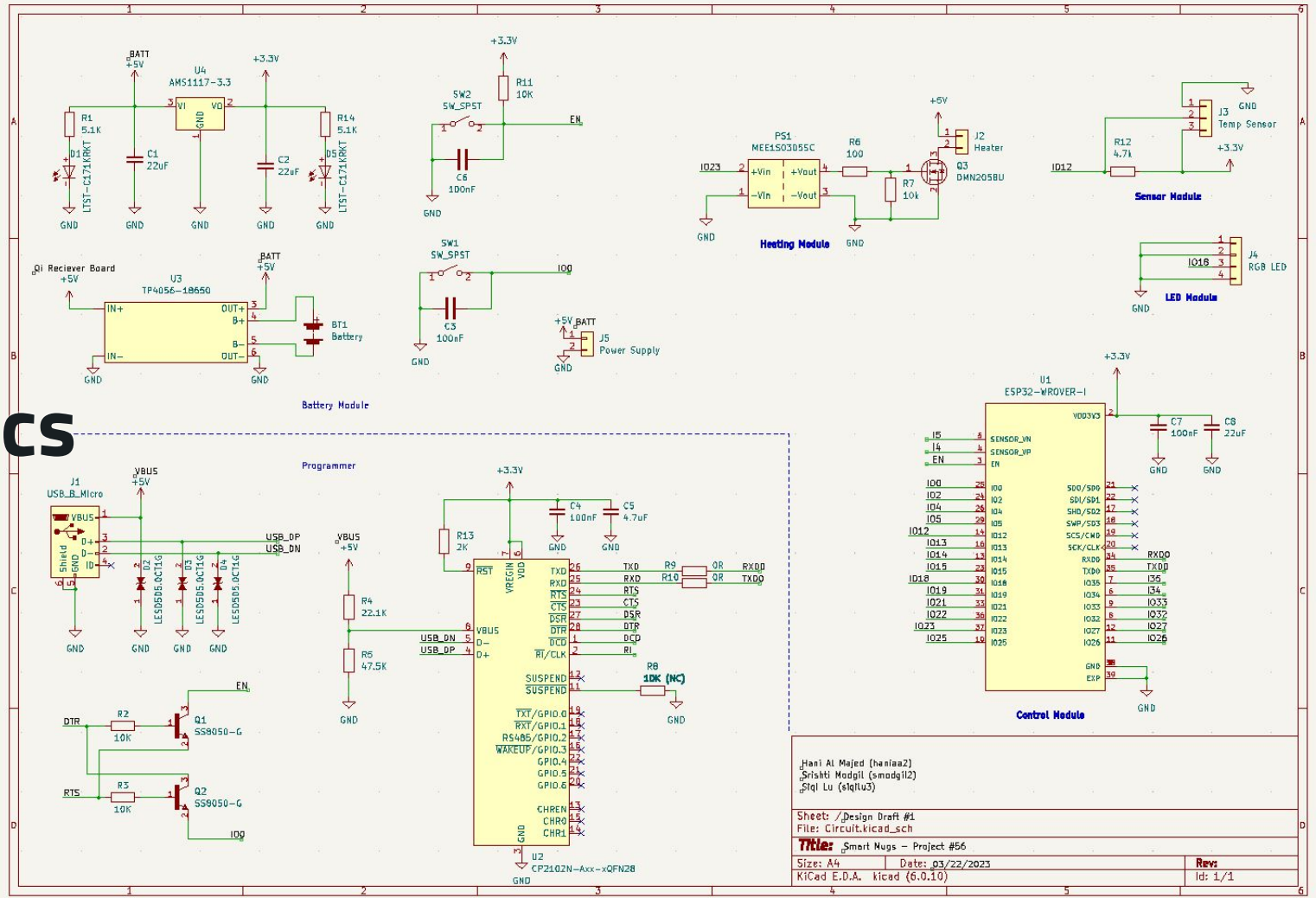
Ember then maintains your chosen temperature for up to 1.5 hours with the Ember Mug² 10 oz and up to 80 minutes with the Ember Mug² 14 oz - so your hot beverage stays perfect. Ember Mug² is safe to hand wash and submersible up to 1 meter in water.

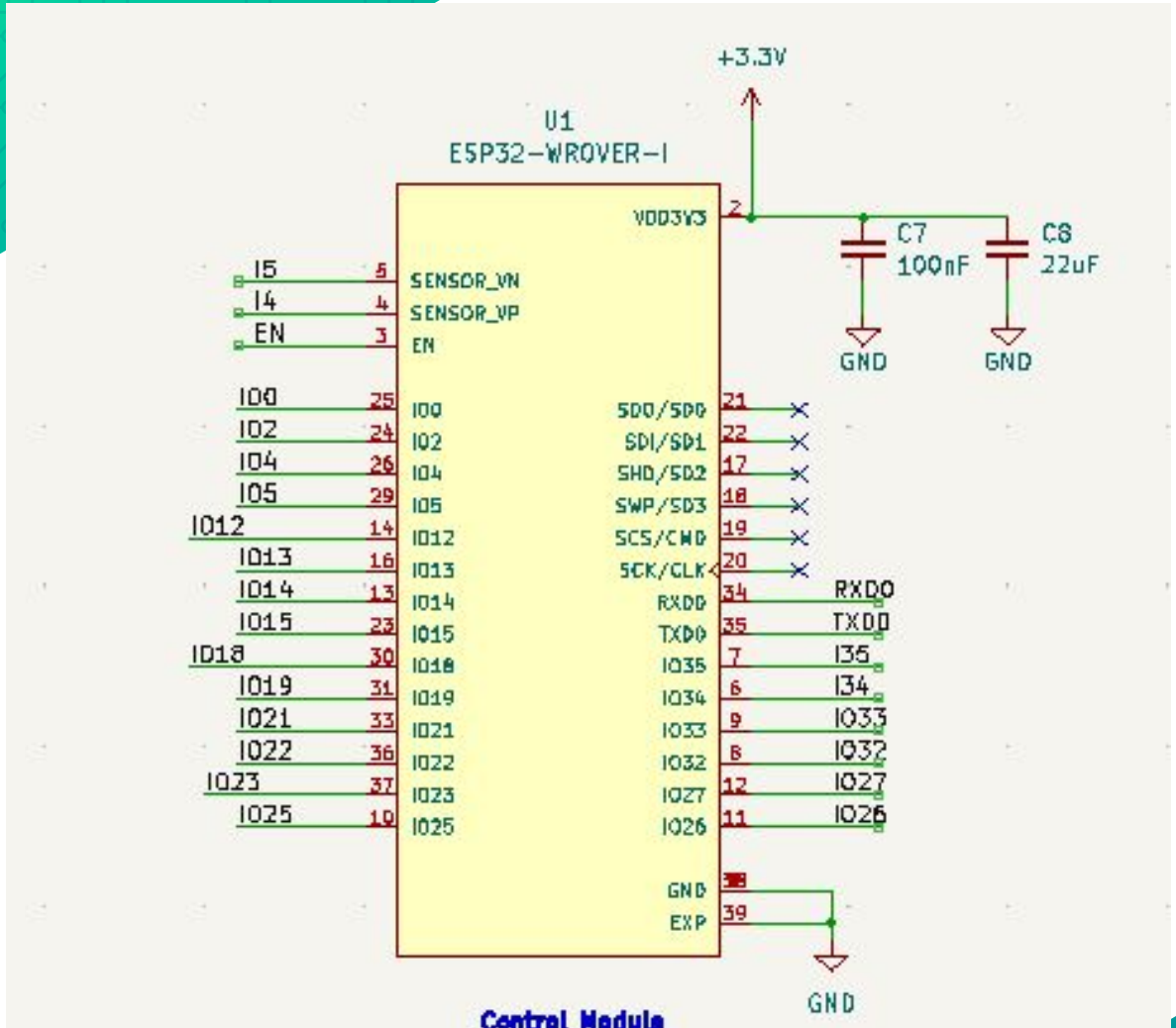
3

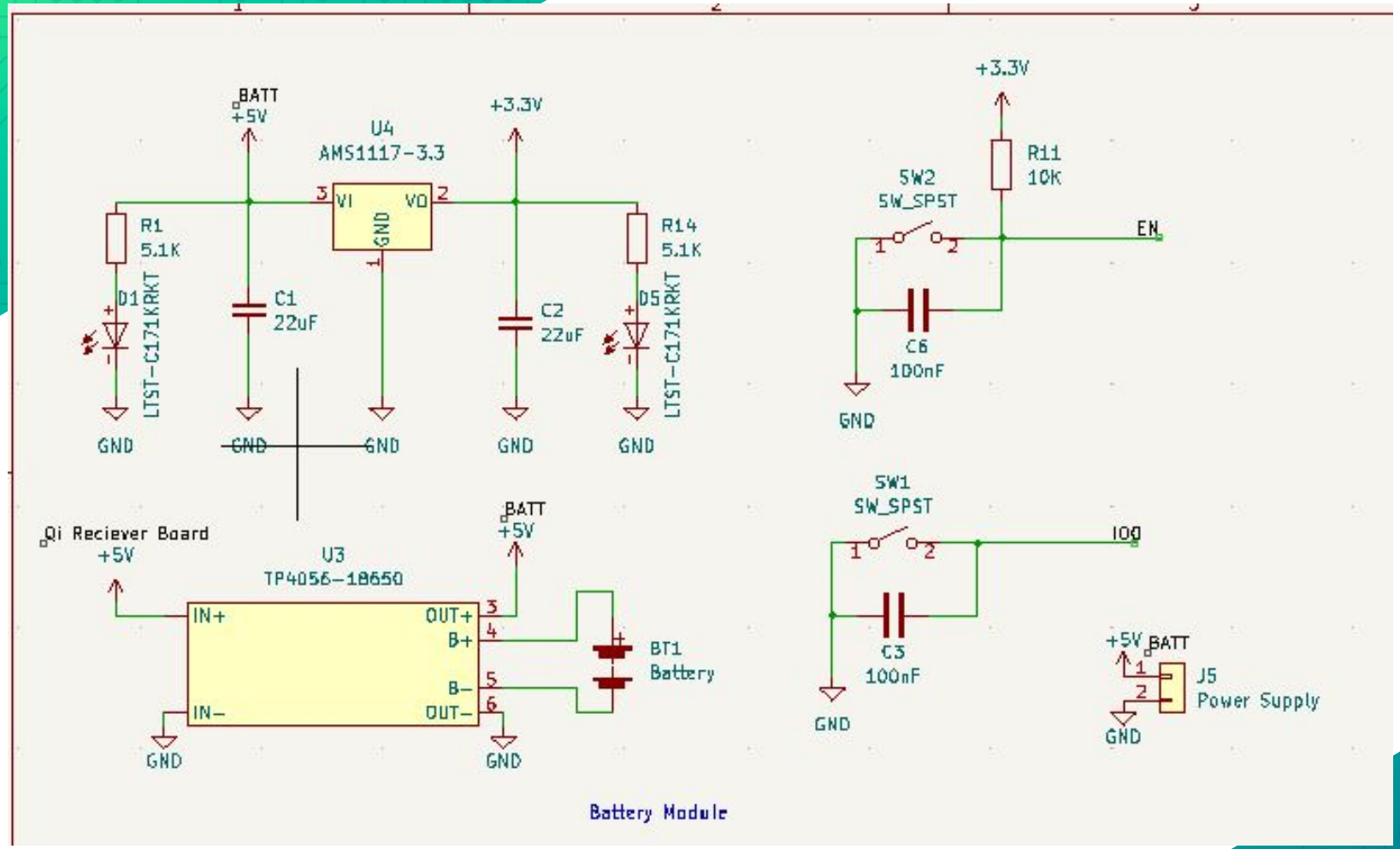
Design Overview

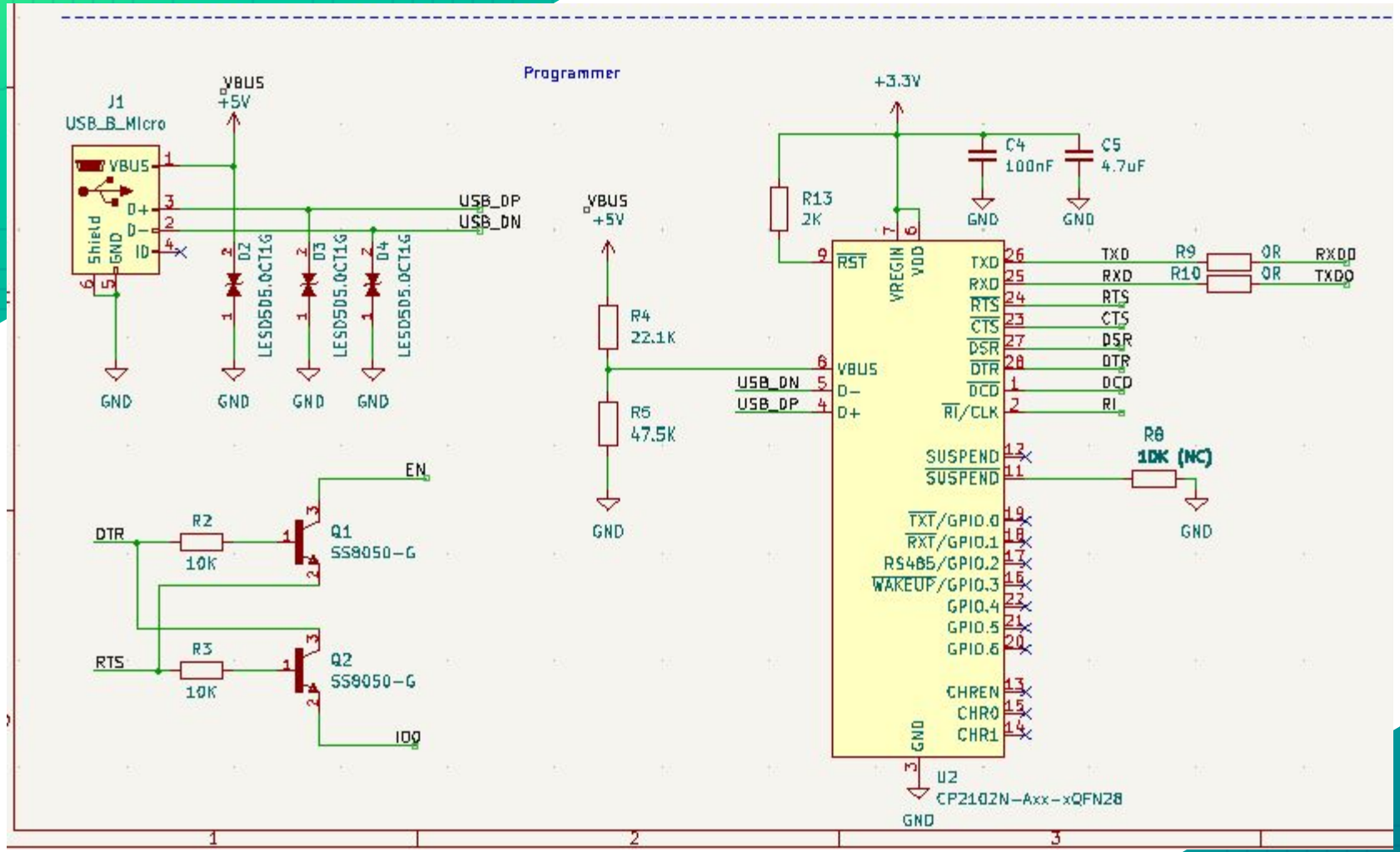

Sensors & LEDs Subsystems
Temperature Sensor
DS18B20
Lighting System
19-C47/RSGHBHC-5V01/2T
Recharged Battery/Heating Subsystem
Battery
two 2500 mAh Cells
4.8-5.2V
Qi Li-ion Charger Receiver
inductive charging
Universal Qi Charger Transmitter
5V
3.6V
5V
DQ
CLK
Microcontroller SoC
ESP32-WROVER-IE-N8R8
Data
PTC Heating Element
FIT0845
2.4 GHz Wi-Fi
Android App
- keeps temperature logs
- deploys ML model for recurrent time-series analysis
- visualizes trends
- sends notifications
Blocks Legend
Sensors/LEDs
Battery/Heating
Microcontroller
Android App
Arrows Legend
Data (wired)
Data (wireless)
Power (wired)
Power (wireless)

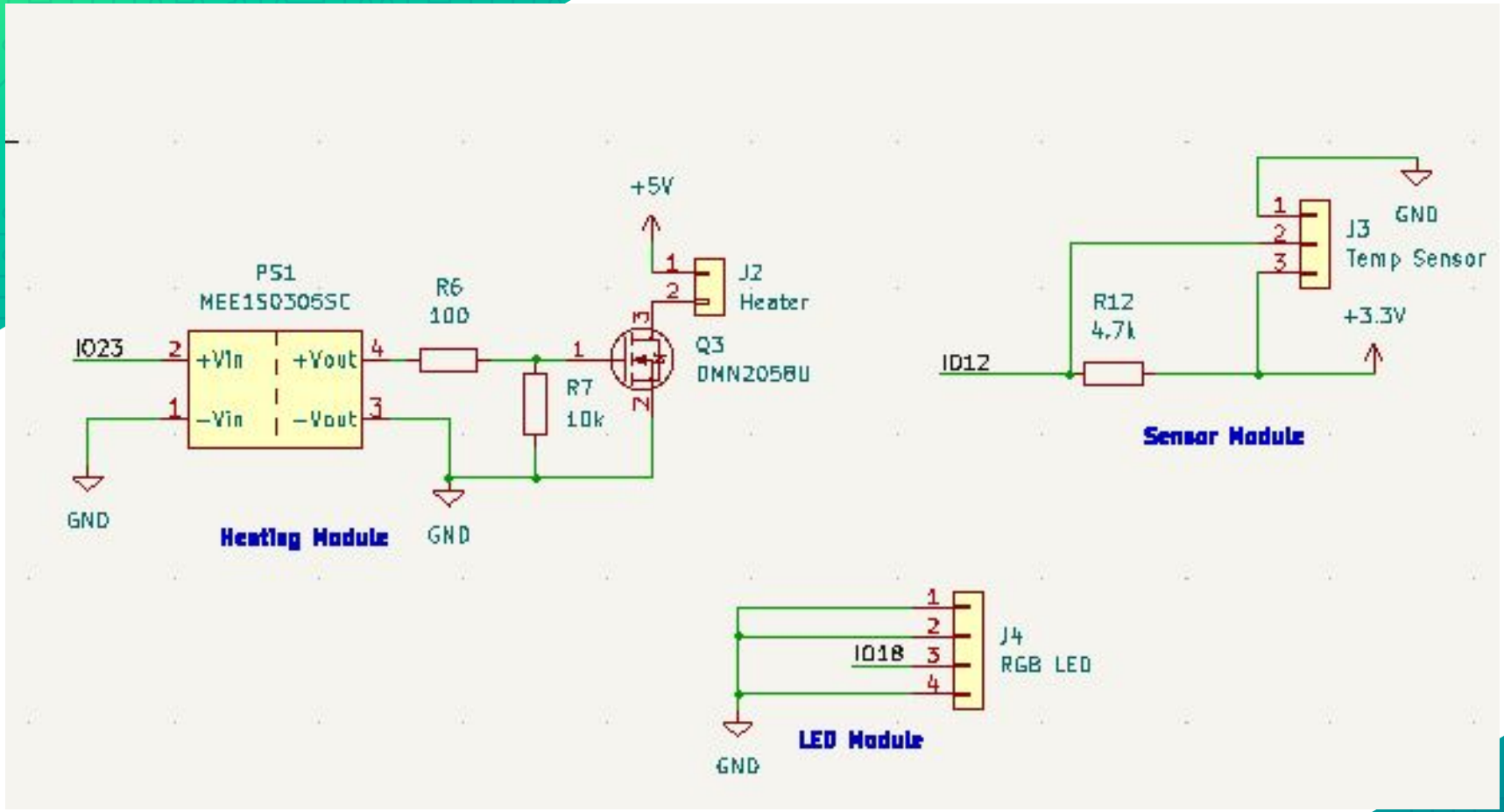
Schematics


Battery Module
Heating Module
Sensor Module
LED Module
Programmer
Control Module
Power Supply
Hani Al Majed (hanlaa2)
Srishti Modgil (smodgil2)
Siqi Lu (siqilu3)
Sheet: /Design Draft #1
File: Circuit.kicad_sch
Title: Smart Mugs – Project #56
Size: A4
Date: 03/22/2023
KiCad E.D.A. kicad (6.0.10)
Rev:
Id: 1/1

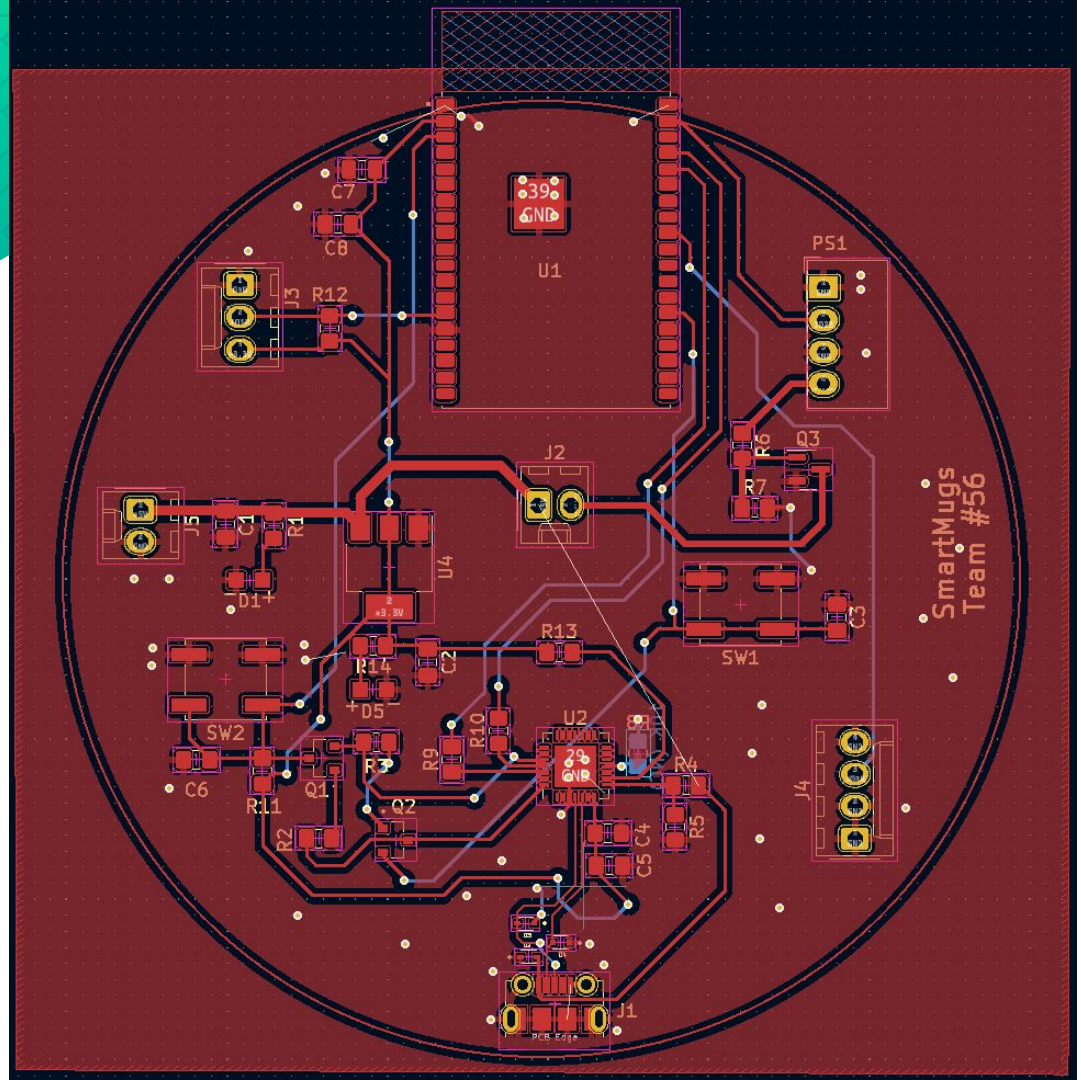

+3.3V
U1
ESP32-WROVER-I
VDD3V3
2
C7
100nF
C8
22uF
GND
GND
I5
5
I4
4
EN
3
SENSOR_VN
SENSOR_VP
EN
I00
25
I02
24
I04
26
I05
29
I012
14
I013
16
I014
13
I015
23
ID18
30
I019
31
I021
33
I022
36
I023
37
I025
10
I00
I02
I04
I05
I012
I013
I014
I015
I018
I019
I021
I022
I023
I025
SDO/SD0
21
SDI/SD1
22
SHD/SD2
17
SWP/SD3
18
SCS/CMD
19
SCK/CLK
20
RXD0
34
TXD0
35
I35
7
I34
6
I033
9
I032
8
I027
12
I026
11
SDO/SD0
SDI/SD1
SHD/SD2
SWP/SD3
SCS/CMD
SCK/CLK
RXD0
TXD0
I35
I34
I033
I032
I027
I026
GND
38
EXP
39
GND
Control Module


BATT
+5V
U4
AMS1117-3.3
+3.3V
VI
VO
GND
R1
5.1K
D1
LTST-C171KRKT
C1
22uF
C2
22uF
R14
5.1K
D5
LTST-C171KRKT
GND
+3.3V
R11
10K
SW2
SW_SPST
EN
C6
100nF
SW1
SW_SPST
100
C3
100nF
+5V
BATT
J5
Power Supply
Qi Reciever Board
+5V
U3
TP4056-18650
IN+
IN-
OUT+
B+
B-
OUT-
BT1
Battery
Battery Module


Programmer
J1
USB_B_Micro
VBUS
+5V
Shield
GND
ID
D+
D-
USB_DP
USB_DN
D2
D3
D4
LESD5D5.0CT1G
GND
+3.3V
C4
100nF
C5
4.7uF
R13
2K
R4
22.1K
R5
47.5K
RST
VREGIN
VDD
VBUS
TXD
RXD
RTS
CTS
DSR
DTR
DCD
RI/CLK
R9
R10
0R
RXDO
TXDO
R8
10K (NC)
SUSPEND
TXT/GPIO.0
RXT/GPIO.1
RS485/GPIO.2
WAKEUP/GPIO.3
GPIO.4
GPIO.5
GPIO.6
CHREN
CHR0
CHR1
U2
CP2102N-Axx-xQFN28
EN
DTR
RTS
R2
R3
10K
Q1
Q2
SS8050-G
IO0


+5V
PS1
MEE1S0305SC
R6
100
IO23
+Vin
+Vout
-Vin
-Vout
J2
Heater
Q3
DMN2058U
R7
10k
GND
Heating Module
GND
GND
J3
Temp Sensor
R12
4.7k
+3.3V
ID12
Sensor Module
IO18
J4
RGB LED
LED Module
GND

PCB


C7
C8
U1
PS1
J3
R12
J2
R6
Q3
R7
J5
C1
R1
U4
D1
SmartMugs
Team #56
R13
C3
SW1
R14
C2
D5
SW2
U2
R10
R9
R3
R4
C6
R11
Q1
Q2
J4
R2
C5
C4
R5
J1

Video Demonstration

Description	Manufacturer	Quantity	Extended Price	Link
Wireless power Li-ion charger Receiver compliant with Qi (WPC) with RT1650 Chip	Adafruit	1	$14.95	Link
Universal Qi Wireless Charging Transmitter	Adafruit	1	$26.95	Link
TP4056 Type-C USB 5V 1A Battery Charger Module Charging Board with Dual Protection Functions	Adafruit	1	$8.99	Link
PTC HEATING ELEMENT - 5V 100C	DFRobot	2	$5.00	Link
Panasonic NCR18650B 3400mAh 4.9A Battery	Panasonic	2	$8.99	Link
Battery Holder (Open) 18650 2 Cell SMD (SMT) Tab	Eoutstanding	1	$8.99	Link
ESP32-WROVER-IE-N8R8	HiLetgo	1	$3.60	Link
USB - micro B USB 2.0 Receptacle Connector 5 Position Surface Mount, Right Angle; Through Hole	Molex	1	$1.01	Link
5.6V 18.6V 5V Bi-Directional SOD-523 ESD Protection Devices ROHS	LRC	3	$0.02	Link
25V 300mW 120@100mA,1V 1.5A NPN SOT-23 Bipolar Transistors - BJT ROHS	Jiangsu Changjing Electronics Technology Co., Ltd.	2	$ 0.0197	Link
LDO Voltage Regulators 800mA & 1A LDO	Texas Instruments	1	$3.07	Link
USB Interface IC USBXpress - USB to UART Bridge QFN20	Silicon Labs	1	$4.66	Link
Tactile Switches 6.0X8.35MM R/A 160G	E-Switch	2	$0.44	Link
Programmable Resolution	Analog	1	$7.78	Link
1-Wire Digital Thermometer	Devices Inc./Maxim Integrated			
Addressable Lighting - 1 LED Serial Red, Green, Blue (RGB) 1.80mm L x 1.80mm W	Everlight Electronics Co Ltd	1	$0.92	Link
Red LED		4	$1.12	Link
5.6V 18.6V 5V Bi-Directional SOD-523 ESD Protection Devices ROHS	LRC	3	$0.79	Link
Total			$97.30	

Cost table

$ 97.30

vs.

$129.95

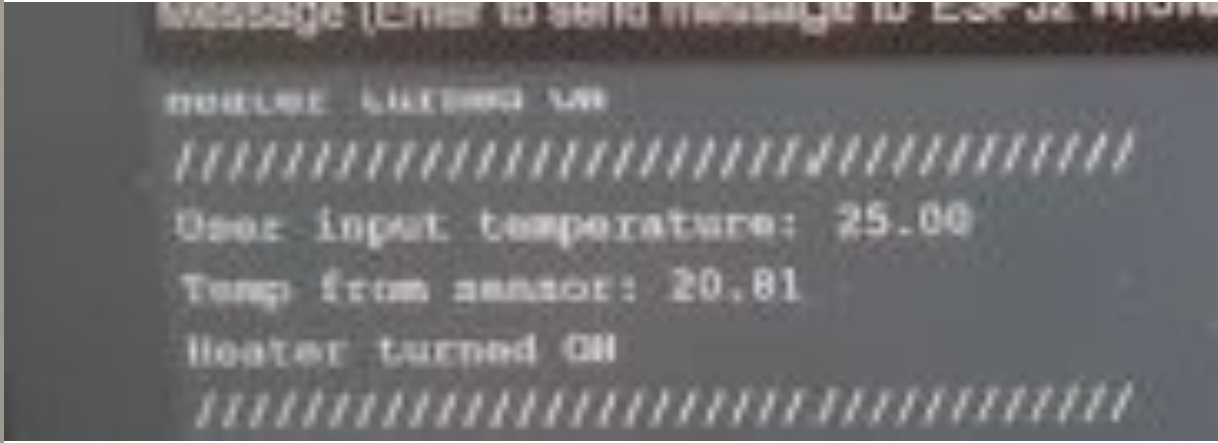
CHEAPER!

4

Performance Analysis

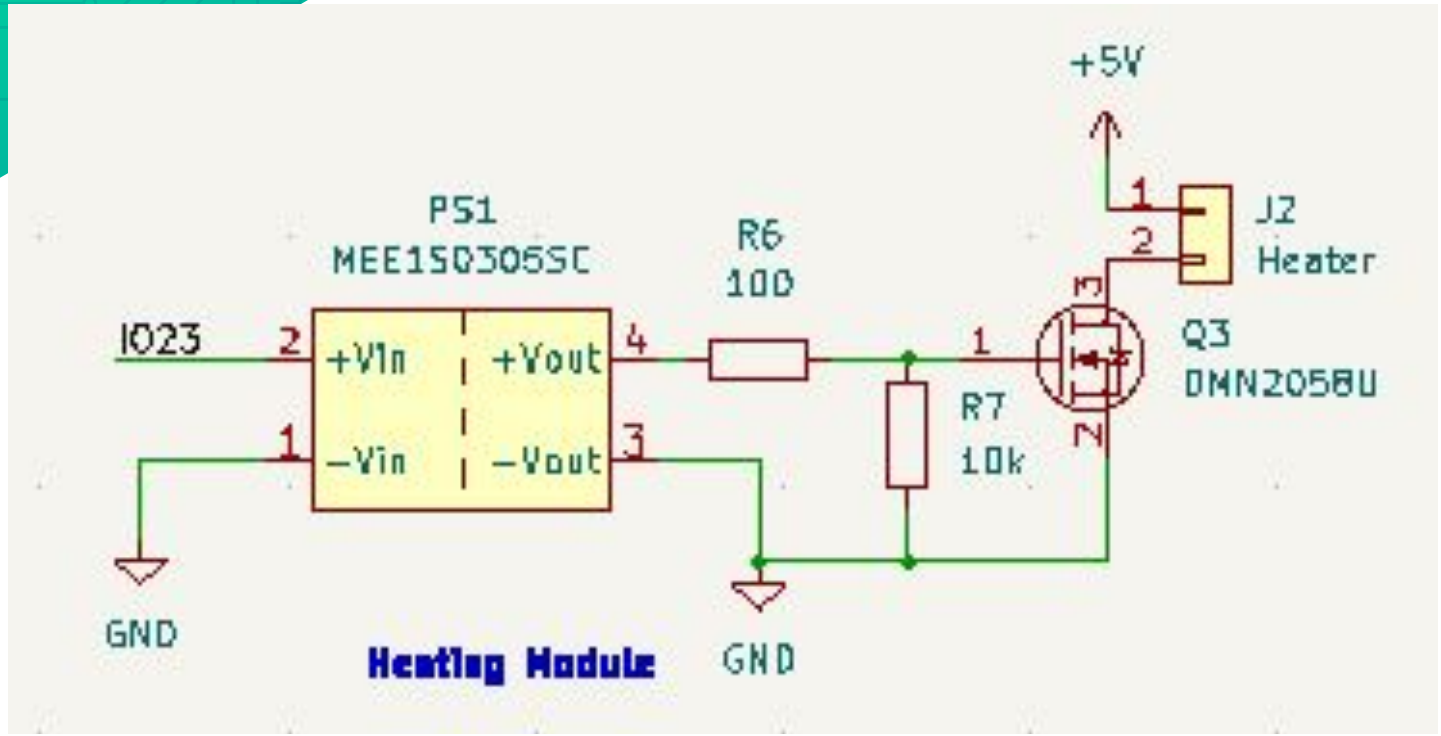
Sensor Subsystem

- Expected:
  - Less than 2% difference with the actual temperature.
  - Detected temperature send to ESP32
- Achieved:
  - Room temperature: 19.44 °C / 67 °F
  - Detected temperature: ~20.50 °C

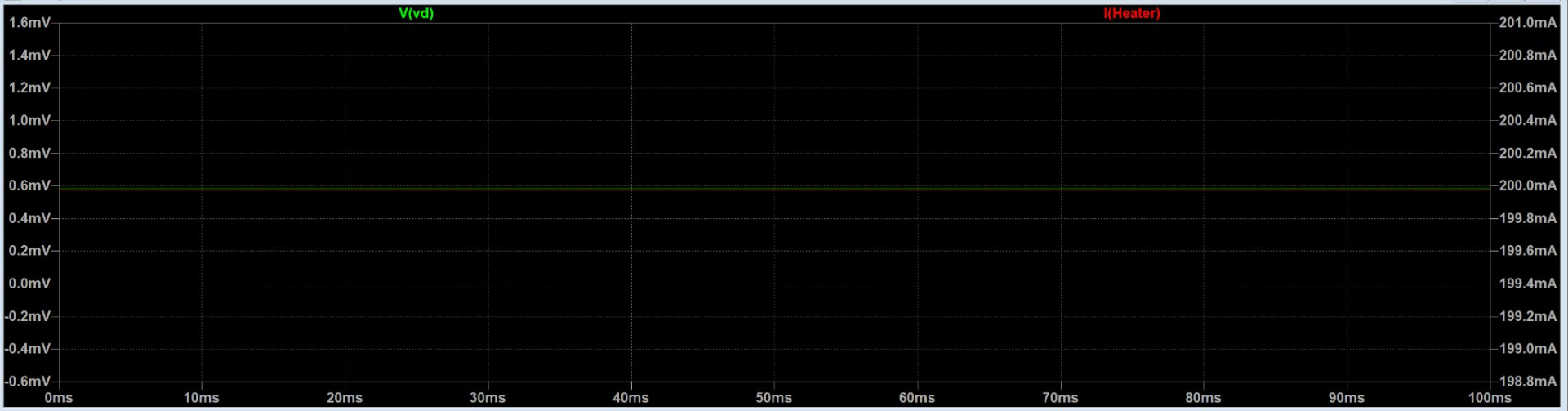

User input temperature: 25.00
Temp from sensor: 20.81
Heater turned ON

Heating Subsystem

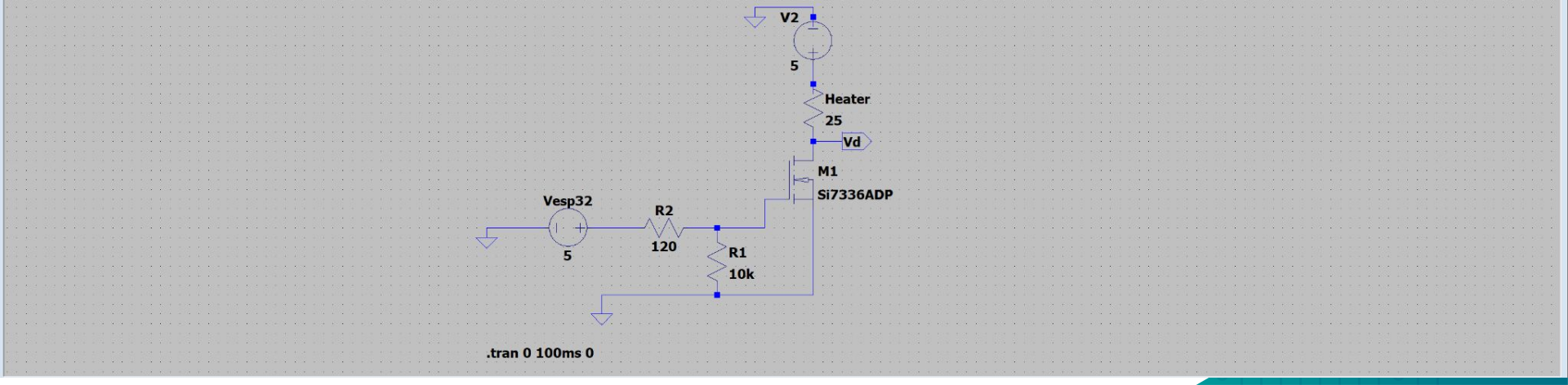
- Expected:
  - Heating element controlled by a GPIO pin of ESP32
  - Heating element heats up liquid in the mug


+5V
PS1
MEE1S0306SC
R6
100
J2
Heater
1023
2
+Vin
+Vout
4
1
Q3
DMN2058U
R7
10k
1
-Vin
-Vout
3
GND
Heating Module
GND

heating_test.raw

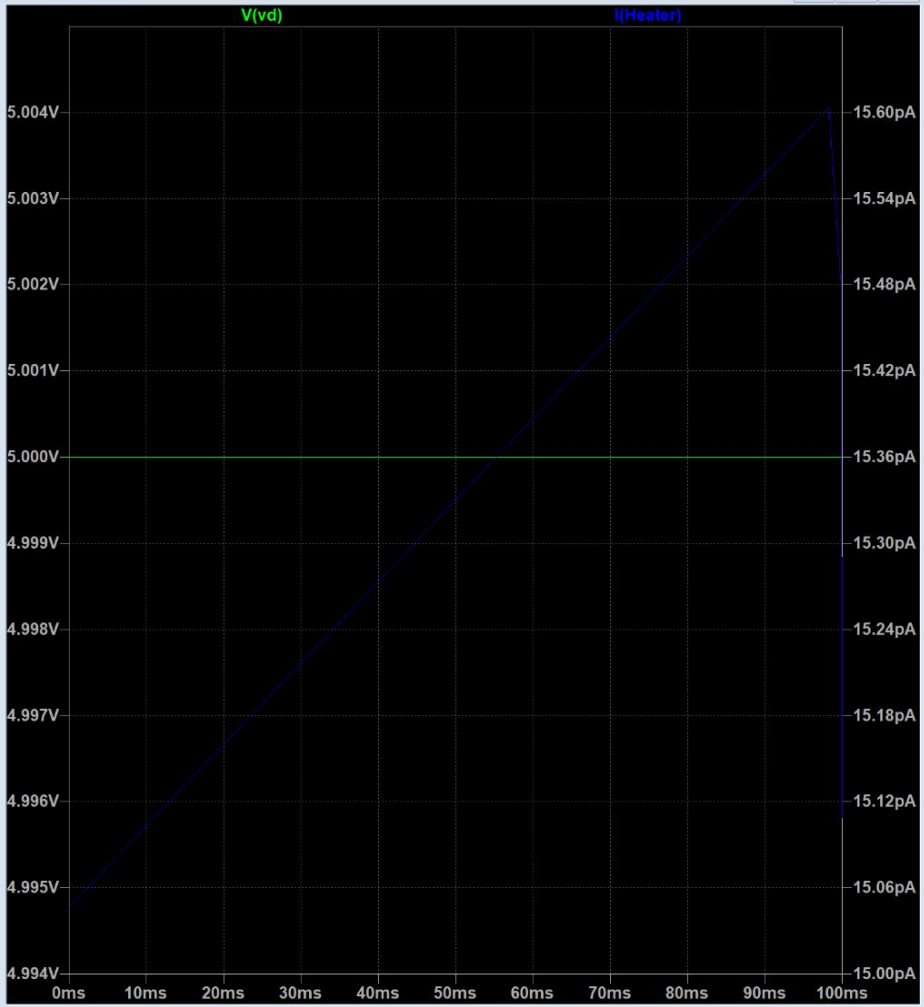


heating_test.asc

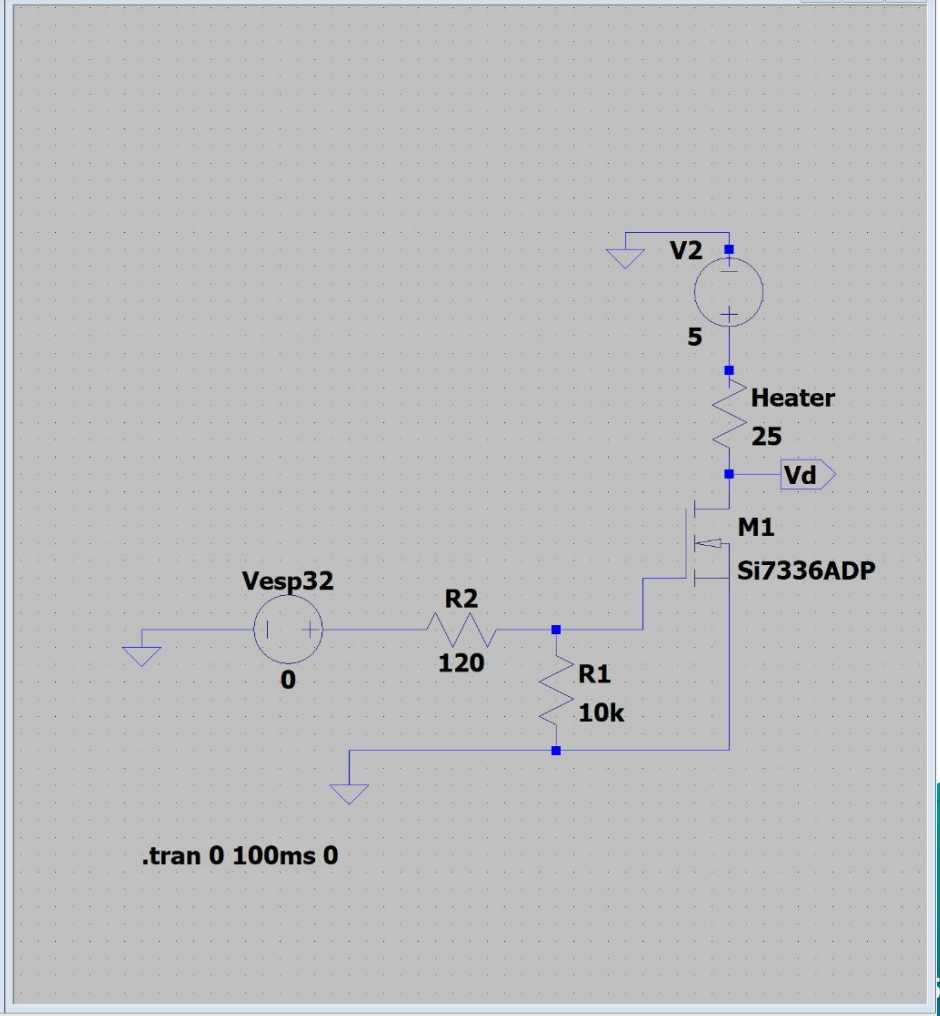


heating_test.asc heating_test.raw

heating_test.raw

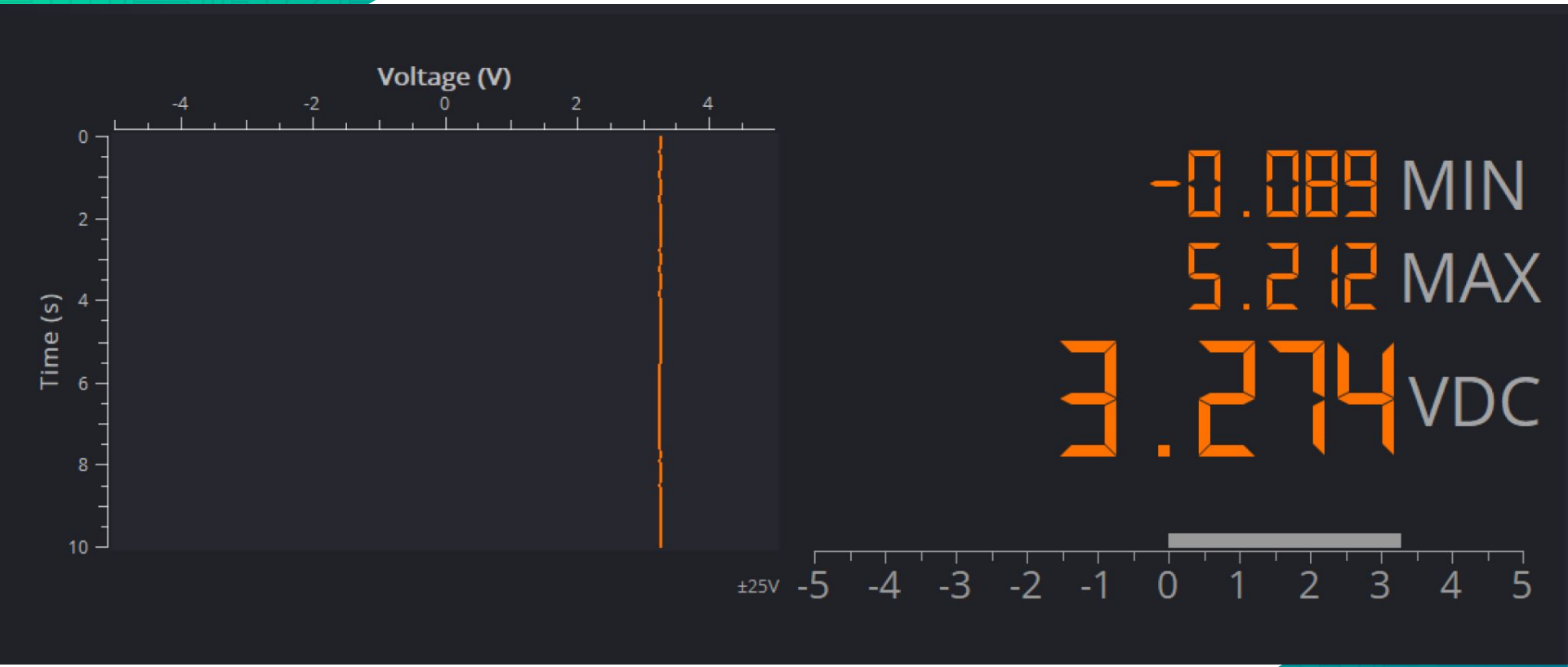


heating_test.asc

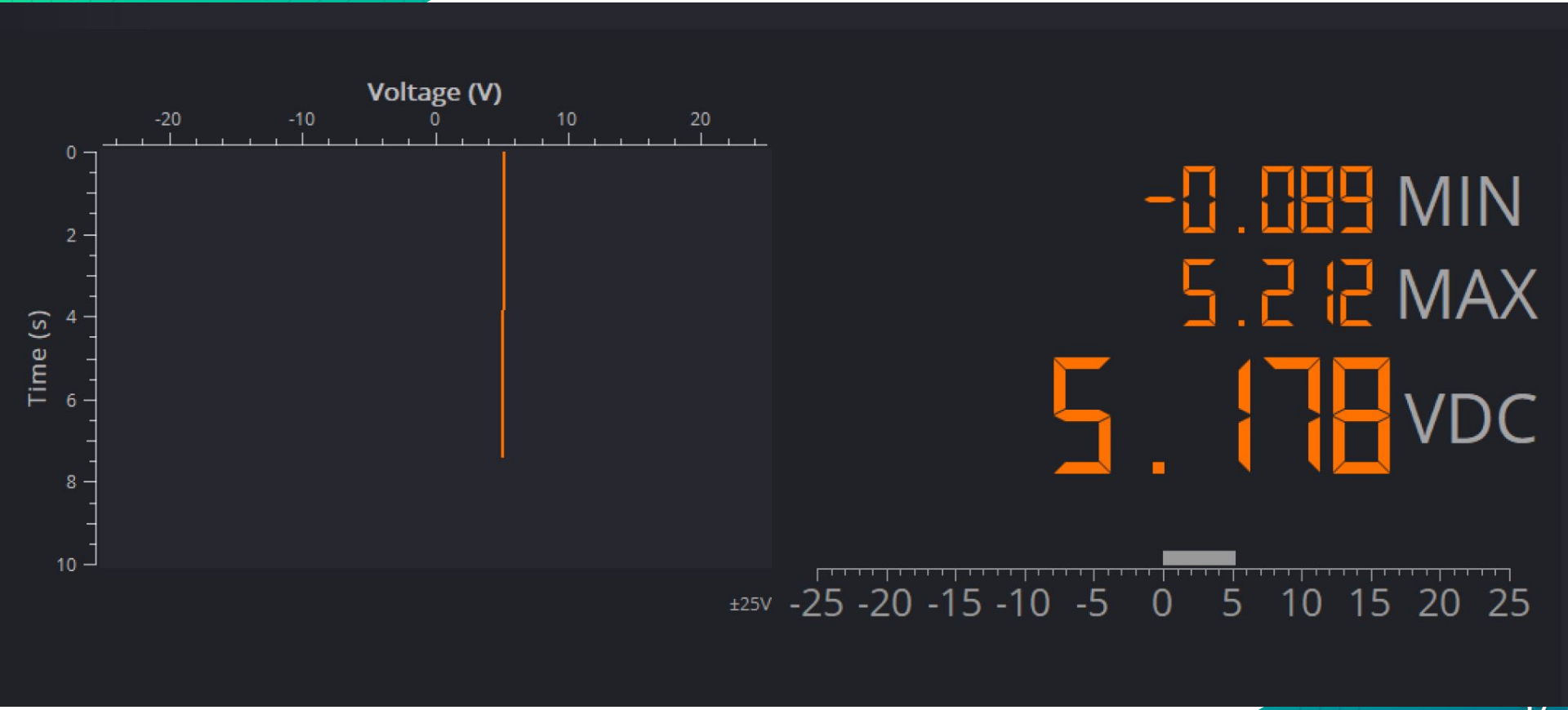


x = 78.57ms y = 5.00272V, 15.5233pA

Achieved: output voltage from GPIO 5



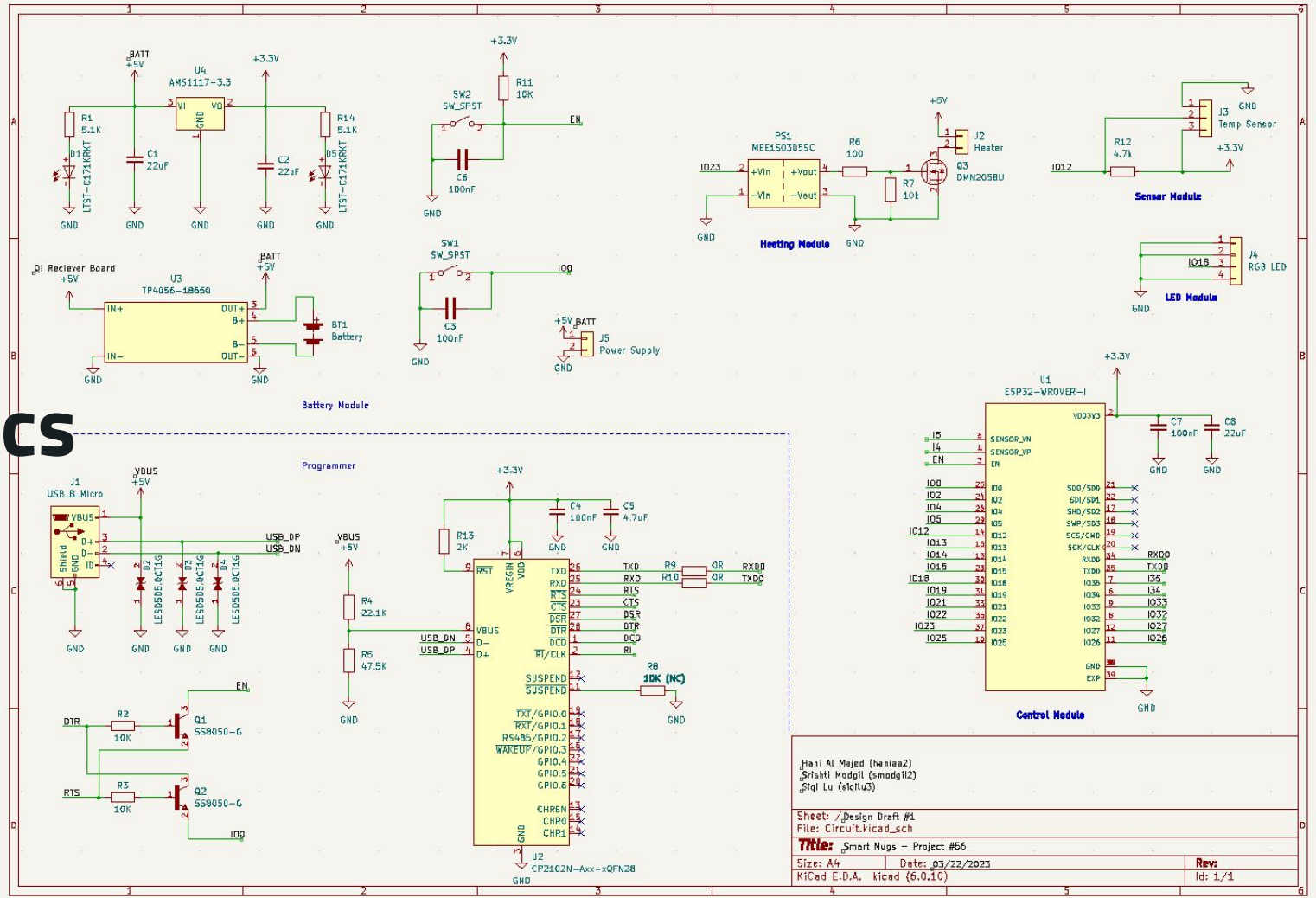
voltage drop through the heating element



5

Successes and Difficulties

Schematics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Heating Module
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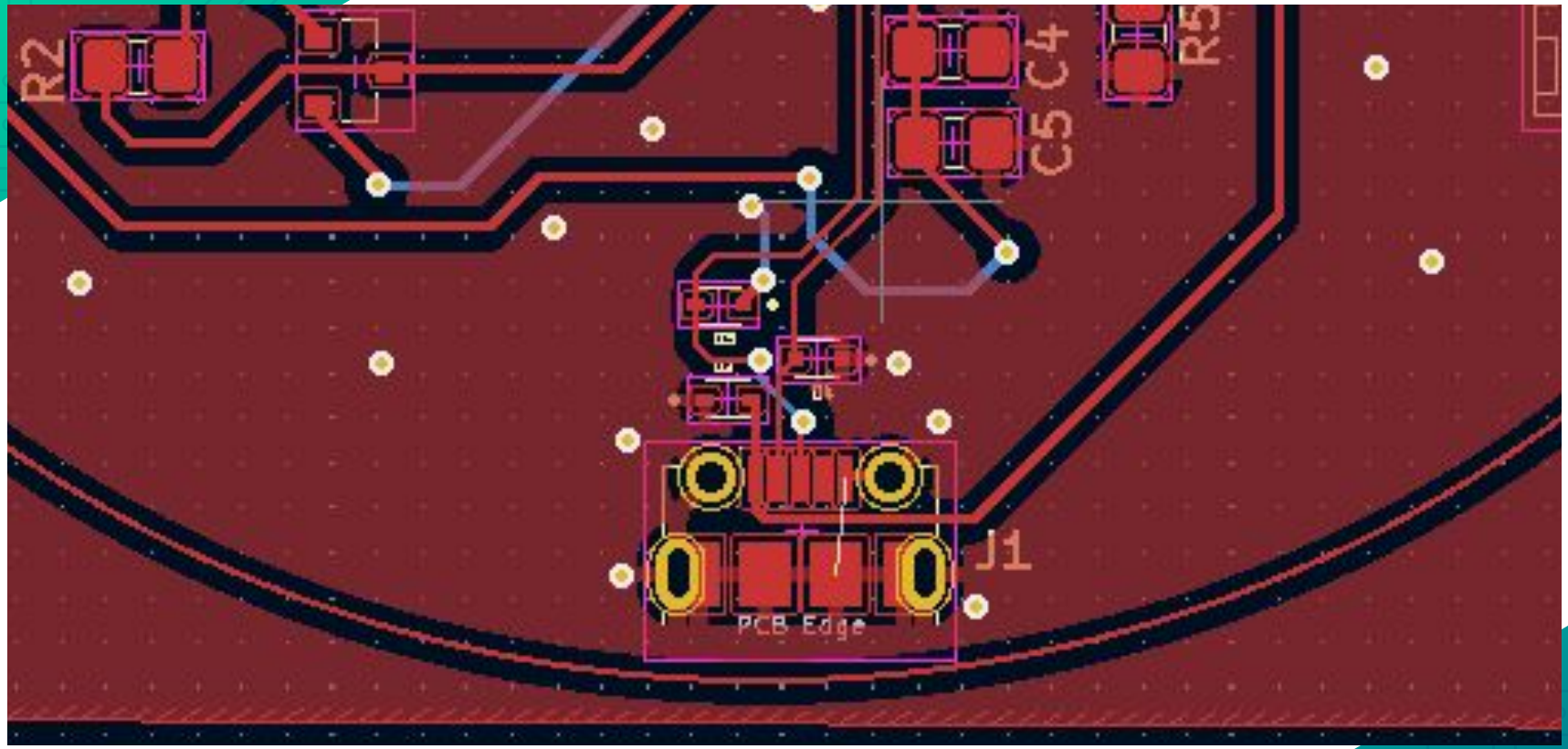
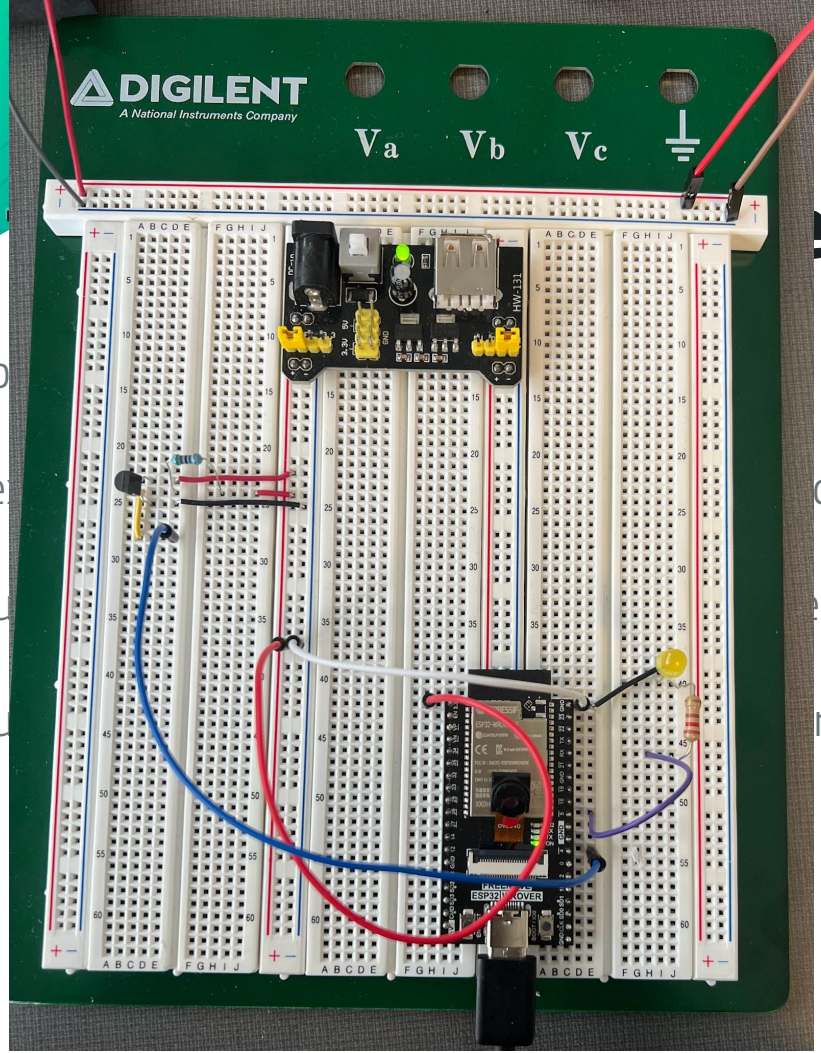
PCB



Circui es

- Breadb
- Most e d
  - Su eating subsystem
  - Su re



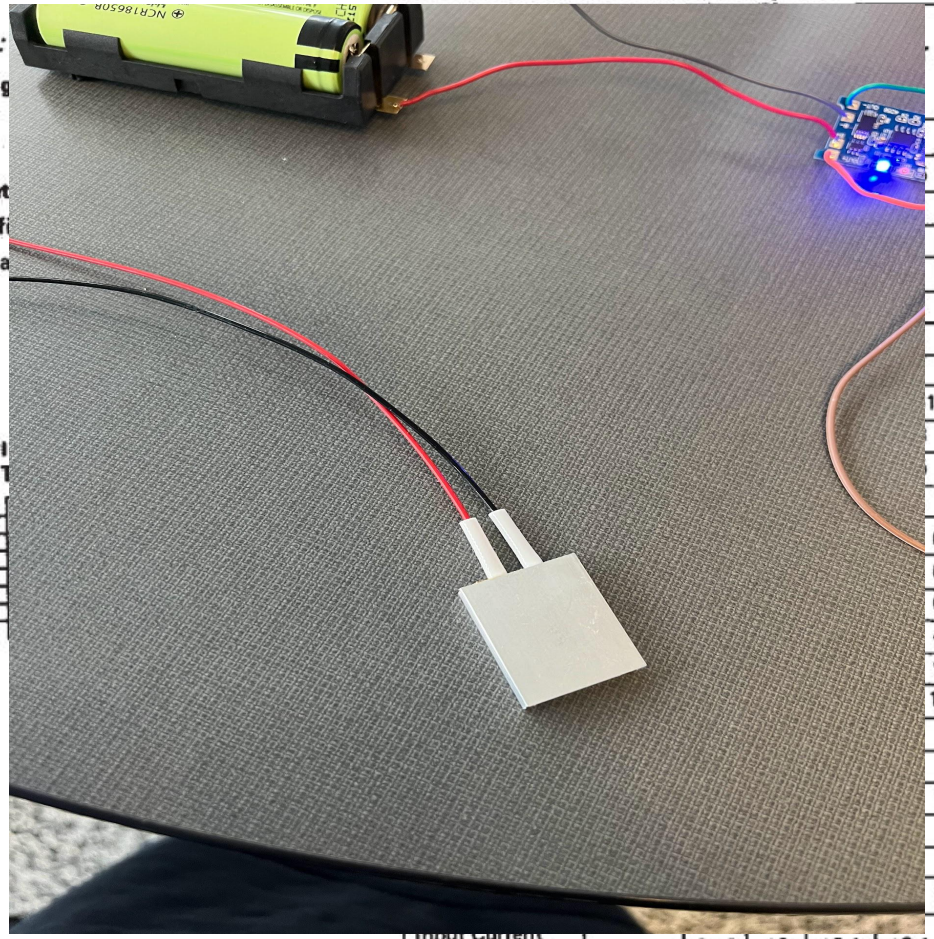
STATIC ELECTRICAL CHARACTERISTICS

Applications:

- Extremely hig
- Shapers
- Inverters
- Threshold det
- Linear amplifi
- Crystal oscilla

TERMI

Q2 (P) DRAIN
Q2 (P) SOURCE
Q2 GATES
Q2 (N) SOURCE
Q2 (N) DRAIN
Q1 GATES
V_{SS}, Q1 & Q2 & Q3 (N)
SUBSTRATES Q1 (N)
SOURCE



		INDICATED TEMPERATURES (°C)						UNITS
					+25			
			+85	+125	Min.	Typ.	Max.	
			7.5	7.5	–	0.01	0.25	µA
			15	15	–	0.01	0.5	
			30	30	–	0.01	1	
			150	150	–	0.02	5	
			0.42	0.36	0.51	1	–	mA
			1.1	0.9	1.3	2.6	–	
			2.8	2.4	3 4	6.8	–	
		1	−0.42	−0.36	−0.51	−1	–	
			−1.3	−1.15	−1.6	−3.2	–	
			−1.1	−0.9	−1.3	−2.6	–	
			−2.8	−2.4	−3.4	−6.8	–	
		0.05			–	0	0.05	V
		0.05			–	0	0.05	
		0.05			–	0	0.05	
		4.95			4.95	5	–	
		9.95			9.95	10	–	
		14.95			14.95	15	–	
		1			–	–	1	V
		2			–	–	2	
		2.5			–	–	2.5	
		4			4	–	–	
		8			8	–	–	
		12.5			12.5	–	–	
Input Current I_{IN} Max.		0,18	18	±0.1	±0.1	±1	±1	–	$\pm10^{-5}$	±0.1	µA

Software: Success

- Responsive and user-friendly front-end
- Integrated the front-end with a real-time NoSQL database
- Configured the ESP32 to connect to a Wi-Fi and database
- Program the ESP32 to receive temperature data from web app
- Communicates with the temperature control loop

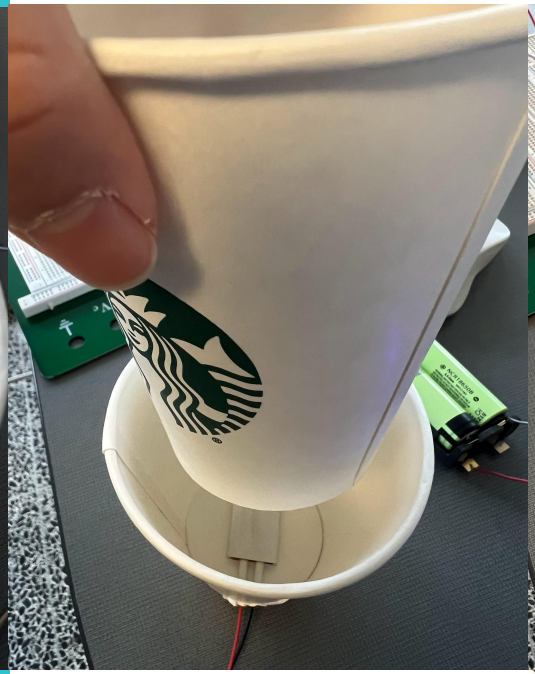
Software: Difficulties

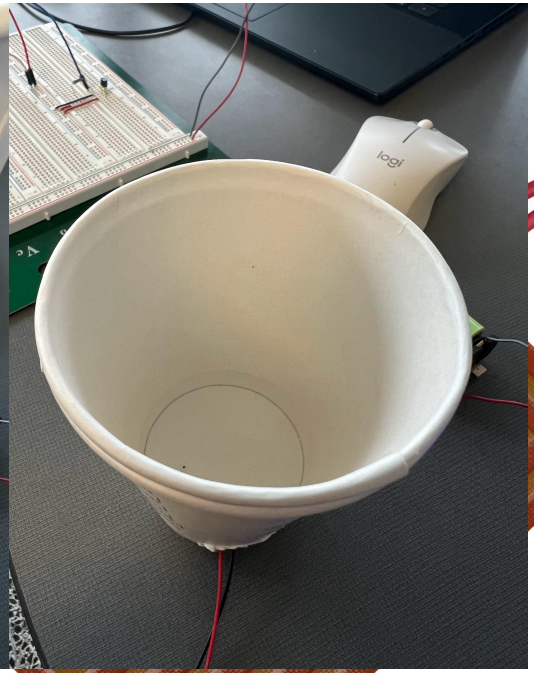
- Switch between a lot of microcontrollers
- Subsystems were not fully integrated
- Resolved most issues

7

Conclusion

Much more than a





	This week	Oct 7 - 13
Drinks	↓ 0	21
Drinks per drinking day	–	5.2
Days under limit	↑ 100%	57%
Sober days	↑ 100%	43%

What we learned this semester

- Program microcontroller
- Connect web app to a real time database
- Connect microcontroller to wifi and to real time database
- Soldering experience
- Got KiCad experience

What we learned this semester

- Real-World Problem Solving
- Interdisciplinary Collaboration
- Project Management
- Lifelong Learning

THANKS!

Any questions?