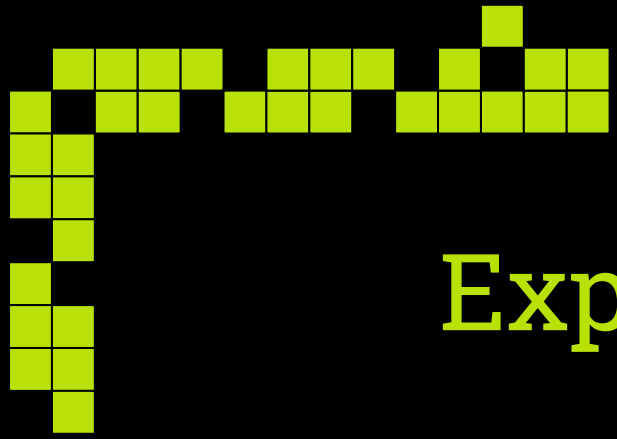


ExploSnake

Team 2

Benjamin Crall
Dmitrii P. Fotin
Evan McClelland
John Michael Mertz

Background

Background

- Problem or Need: What is the problem being solved? Where does it arise?
  - Entertainment and not enough boom in the house or in the workplace.

- Motivation: Why is it important? What is the value of a solution (lives, money, effort, energy saved)?
  - Gives a booming experience after a game.
  - Excites young minds to the great wonders of circuits and engineering.

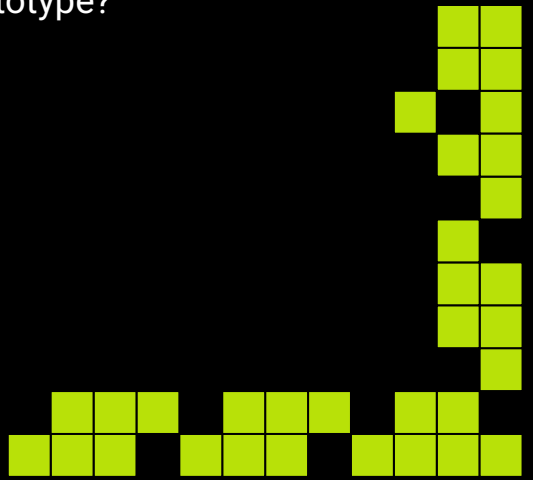
- How is it done today or what other alternatives exist?
  - Online Gaming and virtual simulation.

Approach

- **Concept of operations**: how does your product work? How is it used? What's a typical use case?
  - It is a typical gaming console that plays Snake game; **however**, it creates an explosion after dying or losing the game.

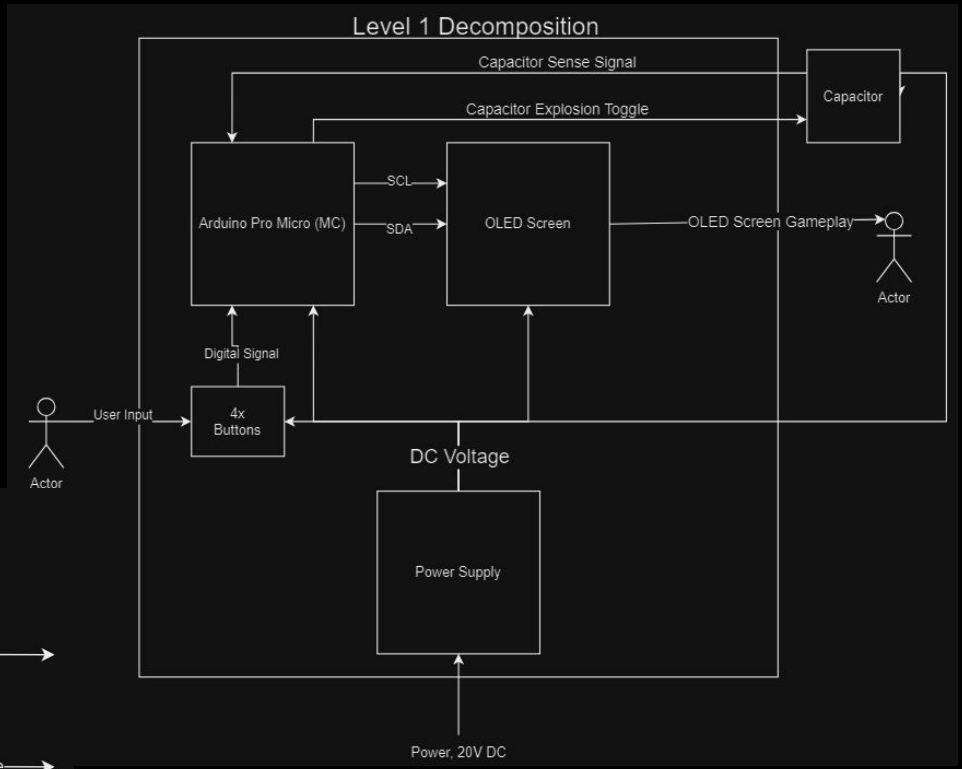
- What is the specific objective of this project? A design? A working prototype?
  - To make a playable & booming design.

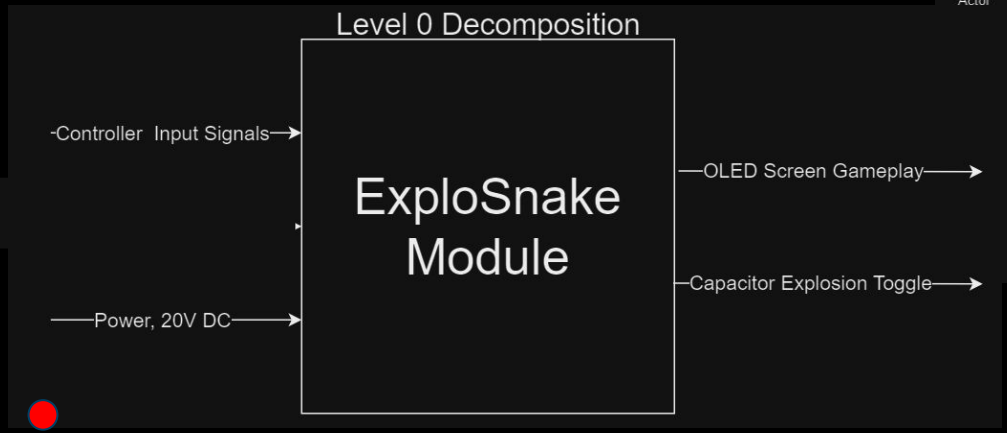
- **Requirements:** What are the requirements?
  - Display the Snake Game
  - Game must be controllable by the User
  - Audible alert that the game is over (Capacitor goes boom).
  - Resettable for another game.

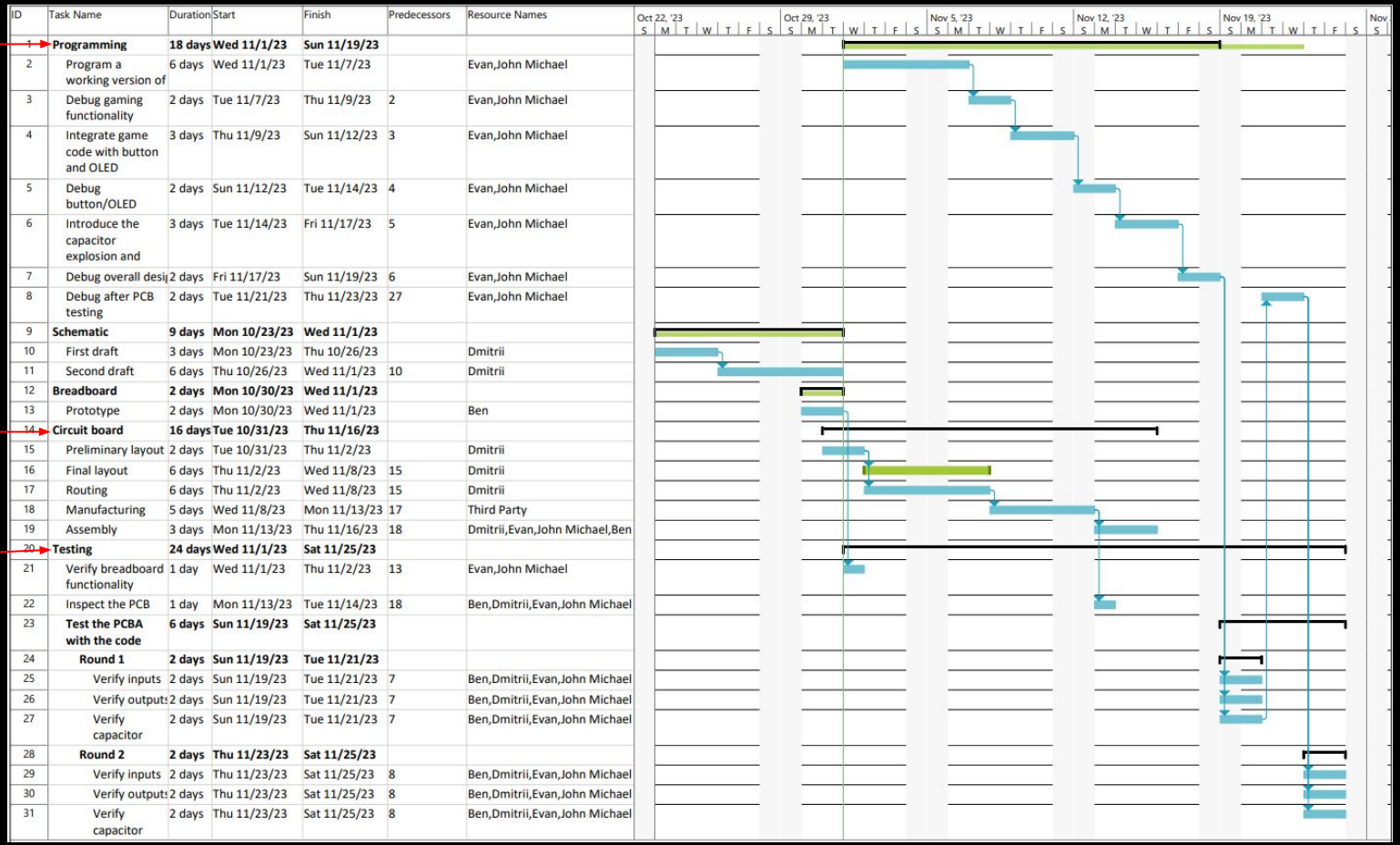


Design

Design Overview







ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Programming**	**18 days**	**Wed 11/1/23**	**Sun 11/19/23**		
2	Program a working version of	6 days	Wed 11/1/23	Tue 11/7/23		Evan,John Michael
3	Debug gaming functionality	2 days	Tue 11/7/23	Thu 11/9/23	2	Evan,John Michael
4	Integrate game code with button and OLED	3 days	Thu 11/9/23	Sun 11/12/23	3	Evan,John Michael
5	Debug button/OLED	2 days	Sun 11/12/23	Tue 11/14/23	4	Evan,John Michael
6	Introduce the capacitor explosion and	3 days	Tue 11/14/23	Fri 11/17/23	5	Evan,John Michael
7	Debug overall desi	2 days	Fri 11/17/23	Sun 11/19/23	6	Evan,John Michael
8	Debug after PCB testing	2 days	Tue 11/21/23	Thu 11/23/23	27	Evan,John Michael
9	**Schematic**	**9 days**	**Mon 10/23/23**	**Wed 11/1/23**		
10	First draft	3 days	Mon 10/23/23	Thu 10/26/23		Dmitrii
11	Second draft	6 days	Thu 10/26/23	Wed 11/1/23	10	Dmitrii
12	**Breadboard**	**2 days**	**Mon 10/30/23**	**Wed 11/1/23**		
13	Prototype	2 days	Mon 10/30/23	Wed 11/1/23		Ben
14	**Circuit board**	**16 days**	**Tue 10/31/23**	**Thu 11/16/23**		
15	Preliminary layout	2 days	Tue 10/31/23	Thu 11/2/23		Dmitrii
16	Final layout	6 days	Thu 11/2/23	Wed 11/8/23	15	Dmitrii
17	Routing	6 days	Thu 11/2/23	Wed 11/8/23	15	Dmitrii
18	Manufacturing	5 days	Wed 11/8/23	Mon 11/13/23	17	Third Party
19	Assembly	3 days	Mon 11/13/23	Thu 11/16/23	18	Dmitrii,Evan,John Michael,Ben
20	**Testing**	**24 days**	**Wed 11/1/23**	**Sat 11/25/23**		
21	Verify breadboard functionality	1 day	Wed 11/1/23	Thu 11/2/23	13	Evan,John Michael
22	Inspect the PCB	1 day	Mon 11/13/23	Tue 11/14/23	18	Ben,Dmitrii,Evan,John Michael
23	**Test the PCBA with the code**	**6 days**	**Sun 11/19/23**	**Sat 11/25/23**		
24	**Round 1**	**2 days**	**Sun 11/19/23**	**Tue 11/21/23**		
25	Verify inputs	2 days	Sun 11/19/23	Tue 11/21/23	7	Ben,Dmitrii,Evan,John Michael
26	Verify outputs	2 days	Sun 11/19/23	Tue 11/21/23	7	Ben,Dmitrii,Evan,John Michael
27	Verify capacitor	2 days	Sun 11/19/23	Tue 11/21/23	7	Ben,Dmitrii,Evan,John Michael
28	**Round 2**	**2 days**	**Thu 11/23/23**	**Sat 11/25/23**		
29	Verify inputs	2 days	Thu 11/23/23	Sat 11/25/23	8	Ben,Dmitrii,Evan,John Michael
30	Verify outputs	2 days	Thu 11/23/23	Sat 11/25/23	8	Ben,Dmitrii,Evan,John Michael
31	Verify capacitor	2 days	Thu 11/23/23	Sat 11/25/23	8	Ben,Dmitrii,Evan,John Michael

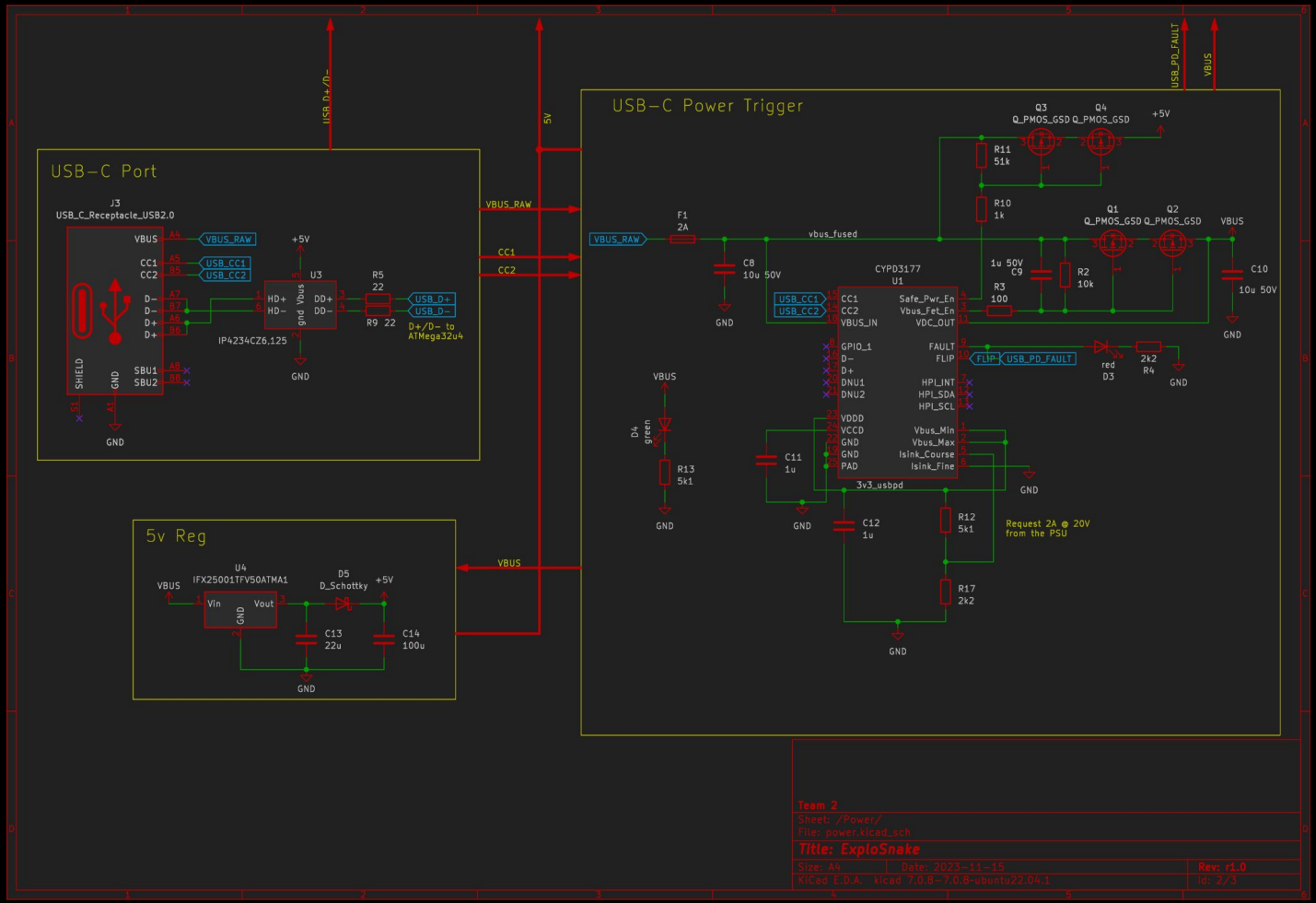
Schematics - Implementation

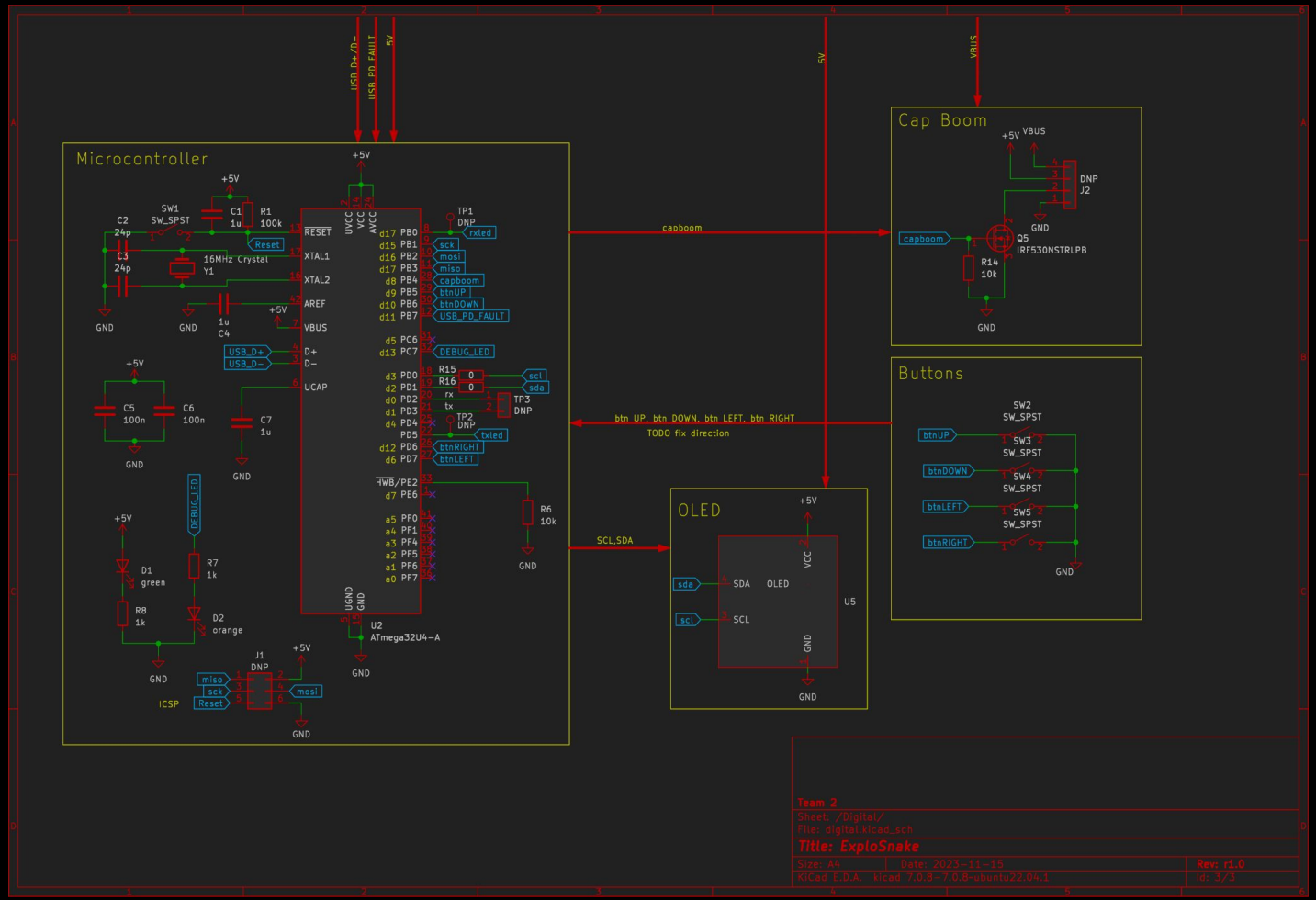
External:

- Arduino Pro Micro
- USB-C Power Chip

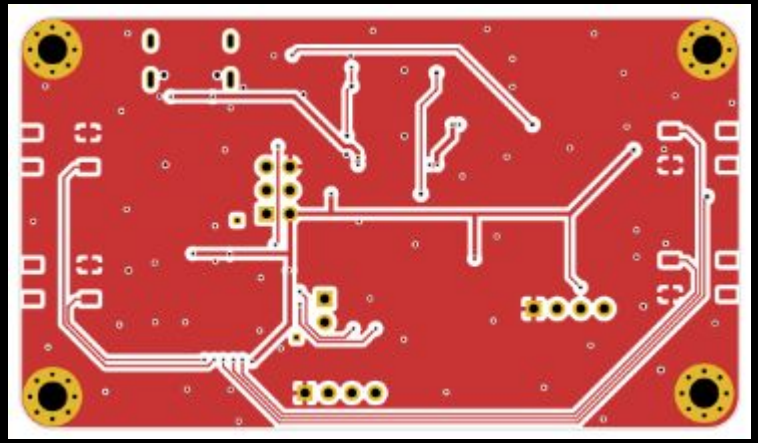
Internal

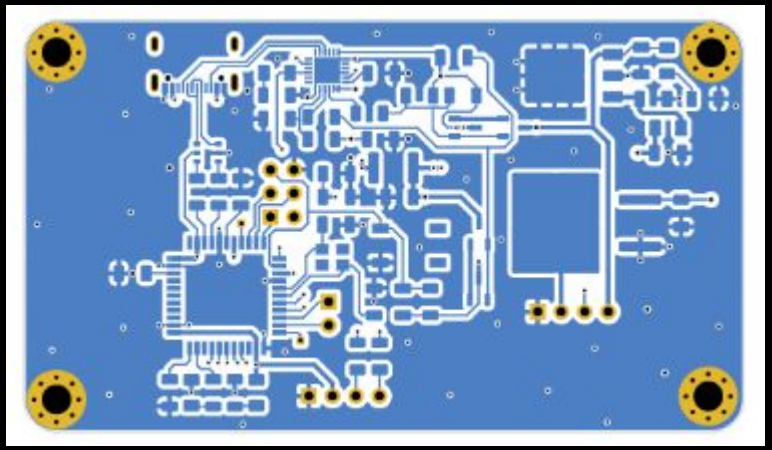
- Buttons
- Capacitor explosion


USB_D+/D-
5V
USB_PD_FAULT
VBUS
USB-C Port
J3
USB_C_Receptacle_USB2.0
VBUS
CC1
CC2
D-
D-
D+
D+
SHIELD
GND
SBU1
SBU2
VBUS_RAW
USB_CC1
USB_CC2
+5V
U3
IP4234CZ6,125
HD+
HD-
Vbus
gnd
DD+
DD-
R5
22
R9 22
USB_D+
USB_D-
D+/D- to ATMega32u4
GND
VBUS_RAW
CC1
CC2
USB-C Power Trigger
Q3
Q_PMOS_GSD
Q4
Q_PMOS_GSD
+5V
R11
51k
R10
1k
Q1
Q_PMOS_GSD
Q2
Q_PMOS_GSD
VBUS
F1
2A
VBUS_RAW
vbus_fused
C8
10u 50V
GND
CYPD3177
U1
CC1
CC2
VBUS_IN
GPIO_1
D-
D+
DNU1
DNU2
VDDD
VCCD
GND
GND
PAD
Safe_Pwr_En
Vbus_Fet_En
VDC_OUT
FAULT
FLIP
HPI_INT
HPI_SDA
HPI_SCL
Vbus_Min
Vbus_Max
Isink_Course
Isink_Fine
3v3_usbpd
1u 50V
C9
R3
100
R2
10k
C10
10u 50V
GND
USB_CC1
USB_CC2
FLIP
USB_PD_FAULT
red
D3
2k2
R4
GND
VBUS
D4
green
R13
5k1
GND
C11
1u
GND
C12
1u
R12
5k1
Request 2A @ 20V from the PSU
R17
2k2
GND
5v Reg
U4
IFX25001TFV50ATMA1
VBUS
Vin
GND
Vout
D5
D_Schottky
+5V
C13
22u
C14
100u
GND
VBUS
Team 2
Sheet: /Power/
File: power.kicad_sch
Title: ExploSnake
Size: A4
Date: 2023-11-15
Rev: r1.0
KiCad E.D.A. kicad 7.0.8-7.0.8-ubuntu22.04.1
Id: 2/3

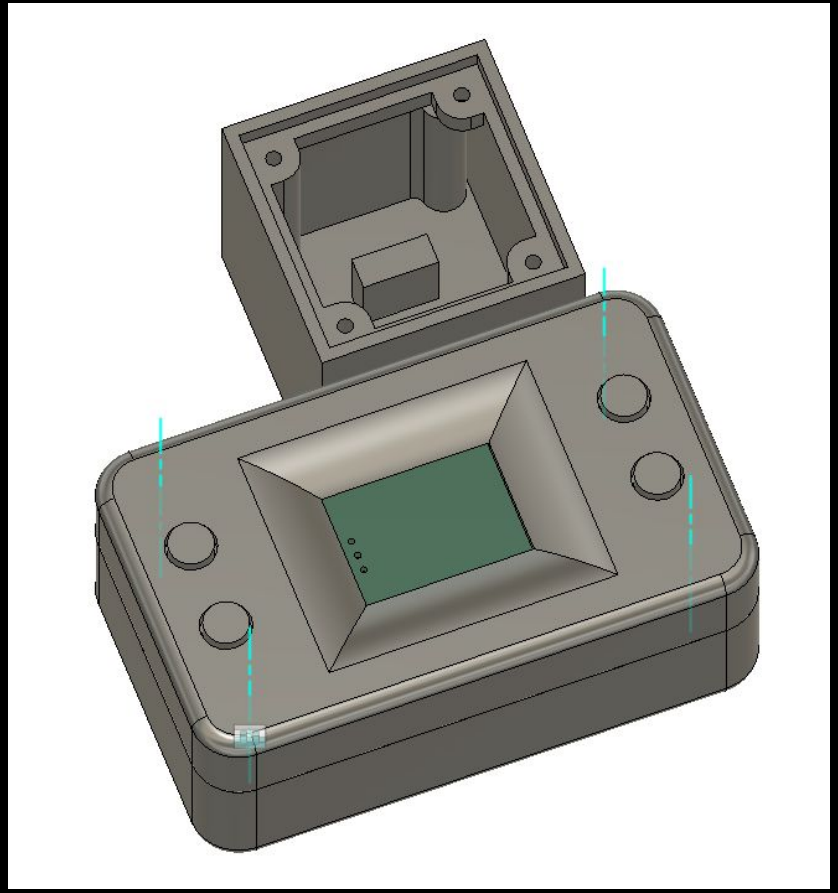

USB_D+/D-
USB_PD_FAULT
5V
VBUS
Microcontroller
Cap Boom
Buttons
OLED
capboom
btn_UP, btn_DOWN, btn_LEFT, btn_RIGHT
TODO fix direction
SCL,SDA
RESET
XTAL1
XTAL2
AREF
VBUS
D+
D-
UCAP
UVCC
VCC
AVCC
UGND
GND
HWB/PE2
16MHz Crystal
ATmega32U4-A
ICSP
DEBUG_LED
btnUP
btnDOWN
btnLEFT
btnRIGHT
SW_SPST
IRF530NSTRLPB
SDA
SCL
Team 2
Sheet: /Digital/
File: digital.kicad_sch
Title: ExploSnake
Size: A4
Date: 2023-11-15
Rev: r1.0
KiCad E.D.A. kicad 7.0.8-7.0.8-ubuntu22.04.1
Id: 3/3

Board Layout - Implementation





Case



Code Overview - Implementation

```
55  // Interrupt function (Use? Or come up with work
56  void interruptpressed()
57      {
58        delay(50);
59        Serial.println("INT PRESSED");
60        Serial.println(digitalRead(UPPIN));
61        Serial.println(digitalRead(DWNPIN));
62        Serial.println(digitalRead(LFTPIN));
63        Serial.println(digitalRead(RHTPIN));
64        updatedirection();
65      }
```

```
68  void updatedirection()
69      {
70        Serial.println("Updating direction");
71
72        butup = !digitalRead(UPPIN);
73        butdown = !digitalRead(DWNPIN);
74        butleft = !digitalRead(LFTPIN);
75        butright = !digitalRead(RHTPIN);
```

```
134 void updateGame()
135     {
136         display.clearDisplay();
137
138           display.drawPixel(scranPosX,scranPosY, WHITE);
139           scranAte = scranFood();
140
141
```

- “Interrupt” based input
- Set Directions for the game
- Update Game includes:
  - Food (“Scran”) Generation
  - Food Counts -> Scores
  - Collision Handles

Tools - Implementation

- **Tools used** (e.g. simulation/modeling tool, PCB layout, IDE, cross-compilers)
  - **KiCAD**
  - **Arduino IDE**
  - **Fusion 360**

Bill of Materials - Implementation

Bill Of Materials for Team 2 ExploSnake
Last modified: 11/09/23
PCB version: 0.0.1
BOM revision: 1.0.0

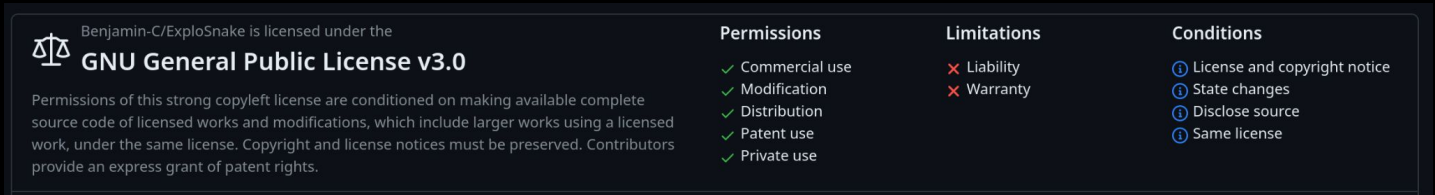
es-board-bom

Qty	Ref	P/NP	Manufacturer	MPN
5	C1, C4, C7, C11, C12	p	Samsung Electro-Mechanics	CL31B105KBHNFNE
2	C2, C3	p	KYOCERA AVX	12061A240JAT2A
2	C5, C6	p	Samsung Electro-Mechanics	CL31B104KBCNNNC
2	C8, C10	p	Samsung Electro-Mechanics	CAP CER 10UF 50V X5R 1206
1	C9	p	Samsung Electro-Mechanics	CL31B105KBHNFNE
1	C13	p	Samsung Electro-Mechanics	CL31A226MOCLNNC
1	C14	p	Murata Electronics	GRM31CR61A107MEA8L
1	C15	dnp		
2	D1, D4	p	Lite-On Inc.	LTST-C150GKT
1	D2	p	Lite-On Inc.	LTST-C150KFKT
1	D3	p	Lite-On Inc.	LTST-C150EKT
1	D5	p	KYOCERA AVX	SD1206T040S1R0
1	F1	p	Littelfuse Inc.	1812L110/33MR
1	J1	dnp		
1	J3	p	GCT	USB4105-GF-A
4	Q1, Q2, Q3, Q4	p	Diodes Incorporated	DMP3099L-7
1	Q5	p	Infineon Technologies	IRF530NSTRLPBF
1	R1	p	Stackpole Electronics Inc	RMCF1206JG100K
3	R2, R6, R14	p	Stackpole Electronics Inc	RMCF1206JG10K0
1	R3	p	Stackpole Electronics Inc	RMCF1206JT100R
2	R4, R17	p	Stackpole Electronics Inc	RMCF1206JT2K20
2	R5, R9	p	Stackpole Electronics Inc	RMCF1206JT22R0
3	R7, R8, R10	p	Stackpole Electronics Inc	RMCF1206JT1K00
1	R11	p	Stackpole Electronics Inc	RMCF1206JT51K0
2	R12, R13	p	Stackpole Electronics Inc	RMCF1206JT5K10
5	SW1, SW2, SW3, SW4, SW5	p	C&K	PTS526 SM15 SMTR2 LFS
1	U1	p	Infineon Technologies	CYPD3177-24LQXQT
1	U2	p	Microchip Technology	IC MCU 8BIT 32KB FLASH 44TQFP
1	U3	p	Nexperia USA Inc.	IP4234CZ6,125
1	U4	p	Infineon Technologies	IFX25001TFV50ATMA1
1	U5	p	Adafruit Industries LLC	93
1	Y1	p	Raltron Electronics	RH100-16.000-16-3030-EXT-TR

			1 piece		10 piece	
Desc	Dist	DPN	$ea	$tot	$ea	
Totals			39.9			35.86
CAP CER 1UF 50V X7R 1206	DigiKey	1276-3091-1-ND	0.14	0.7	0.09	0.46
CAP CER 24PF 100V NP0 1206	DigiKey	478-12061A240JAT2ACT-ND	0.28	0.56	0.19	0.39
CAP CER 0.1UF 50V X7R 1206	DigiKey	1276-1017-1-ND	0.11	0.22	0.07	0.15
CAP CER 10UF 50V X5R 1206	DigiKey	1276-6736-1-ND	0.27	0.54	0.18	0.36
CAP CER 1UF 50V X7R 1206	DigiKey	1276-3091-1-ND	0.14	0.14	0.09	0.09
CAP CER 22UF 16V X5R 1206	DigiKey	1276-2728-1-ND	0.23	0.23	0.15	0.15
CAP CER 100UF 10V X5R 1206	DigiKey	490-GRM31CR61A107MEA8LCT-ND	0.42	0.42	0.28	0.28
			0	0	0	0
LED GREEN CLEAR 1206 SMD	DigiKey	160-1169-1-ND	0.3	0.6	0.16	0.32
LED ORANGE CLEAR 1206 SMD	DigiKey	160-1403-1-ND	0.3	0.3	0.17	0.17
LED RED CLEAR 1206 SMD	DigiKey	160-1168-1-ND	0.31	0.31	0.17	0.17
DIODE SCHOTTKY 40V 1A 1206	DigiKey	478-7809-1-ND	0.4	0.4	0.31	0.31
PTC RESET FUSE 33V 1.1A 1812	DigiKey	F3486CT-ND	0.58	0.58	0.54	0.54
			0	0	0	0
CONN RCP USB2.0 TYP C 24P SMD RA	DigiKey	2073-USB4105-GF-ACT-ND	0.81	0.81	0.69	0.69
MOSFET P-CH 30V 3.8A SOT23	DigiKey	DMP3099L-7DICT-ND	0.34	1.36	0.24	0.96
MOSFET N-CH 100V 17A D2PAK	DigiKey	IRF530NSTRLPBFCT-ND	1.26	1.26	1.03	1.03
RES 100K OHM 5% 1/4W 1206	DigiKey	RMCF1206JG100K	0.1	0.1	0.02	0.02
RES 10K OHM 5% 1/4W 1206	DigiKey	738-RMCF1206JG10K0CT-ND	0.1	0.3	0.02	0.06
RES 100 OHM 5% 1/4W 1206	DigiKey	RMCF1206JT100RCT-ND	0.1	0.1	0.02	0.02
RES 2.2K OHM 5% 1/4W 1206	DigiKey	RMCF1206JT2K20CT-ND	0.1	0.2	0.02	0.04
RES 22 OHM 5% 1/4W 1206	DigiKey	RMCF1206JT22R0CT-ND	0.1	0.2	0.02	0.04
RES 1K OHM 5% 1/4W 1206	DigiKey	RMCF1206JT1K00CT-ND	0.1	0.3	0.02	0.06
RES 51K OHM 5% 1/4W 1206	DigiKey	RMCF1206JT51K0CT-ND	0.1	0.1	0.02	0.02
RES 5.1K OHM 5% 1/4W 1206	DigiKey	RMCF1206JT5K10CT-ND	0.1	0.2	0.02	0.04
TACT 5.2 X 5.2, 1.5 MM H, 160GF,	DigiKey	CKN12220-1-ND	0.14	0.7	0.14	0.68
IC USB TYPE-C PORT CONTROL 24QFN	DigiKey	448-CYPD3177-24LQXQTCT-ND	2.2	2.2	1.98	1.98
IC MCU 8BIT 32KB FLASH 44TQFP	DigiKey	ATMEGA32U4-AURCT-ND	5.39	5.39	5.39	5.39
TVS DIODE 5.5VWM 6TSOP	DigiKey	1727-4717-1-ND	0.47	0.47	0.38	0.38
IC REG LINEAR 5V 400MA TO252-3	DigiKey	IFX25001TFV50ATMA1CT-ND	1.05	1.05	0.94	0.94
MONOCHROME 1.3 128X64	DigiKey	1528-1512-ND	20	20	19.95	19.95
CRYSTAL 16.0000MHZ 16PF SMD	DigiKey	2151-RH100-16.000-16-3030-EXT-TRCT-ND	0.21	0.21	0.17	0.17

IP and Prior Work

- **What IP license did you use for your project?**



- **What IP did you use in your project?** Briefly summarize what use you made of prior work or IP including but not limited to ideas, designs, schematics, board layouts, code.
  - Snake LED 16x16 Matrix Game
  - Arduino Snake Game with 32x16
  - Arduino Snake Game

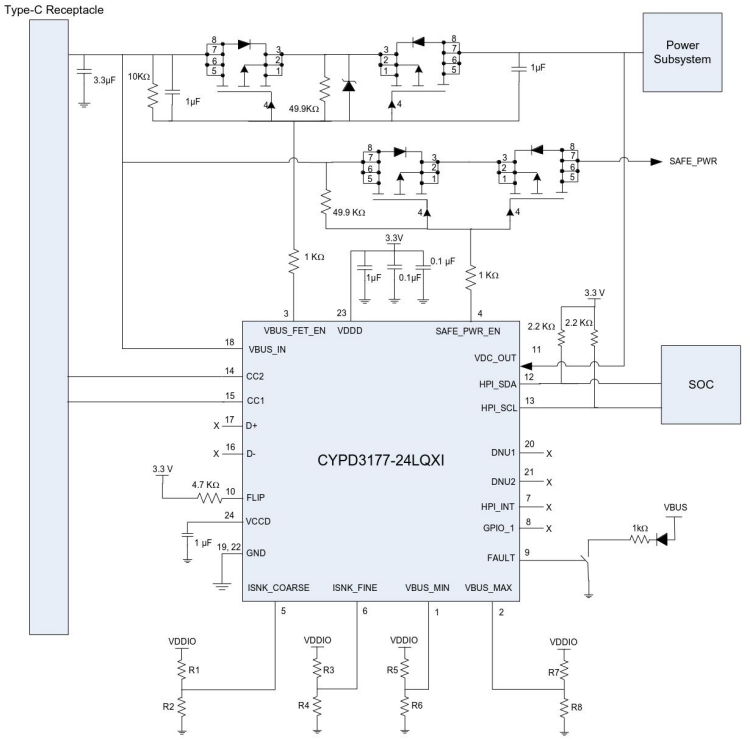
Schematic Sources

USB-C PD:

EZ-PD™ BCR Datasheet by Cypress

The 'Fault' pin is used to indicate any voltage faults. When a fault condition is enabled, the output voltage of this application will go down to 0V and the EZ-PD BCR device will attempt a protocol reset to recover from fault. For a detailed reference schematic, refer to the CY4533 EZ-PD BCR EVK schematic.

Figure 3. EZ-PD BCR based Application Diagram (for Electronic Systems Requiring 12 V to 15 V Input at 2 A)



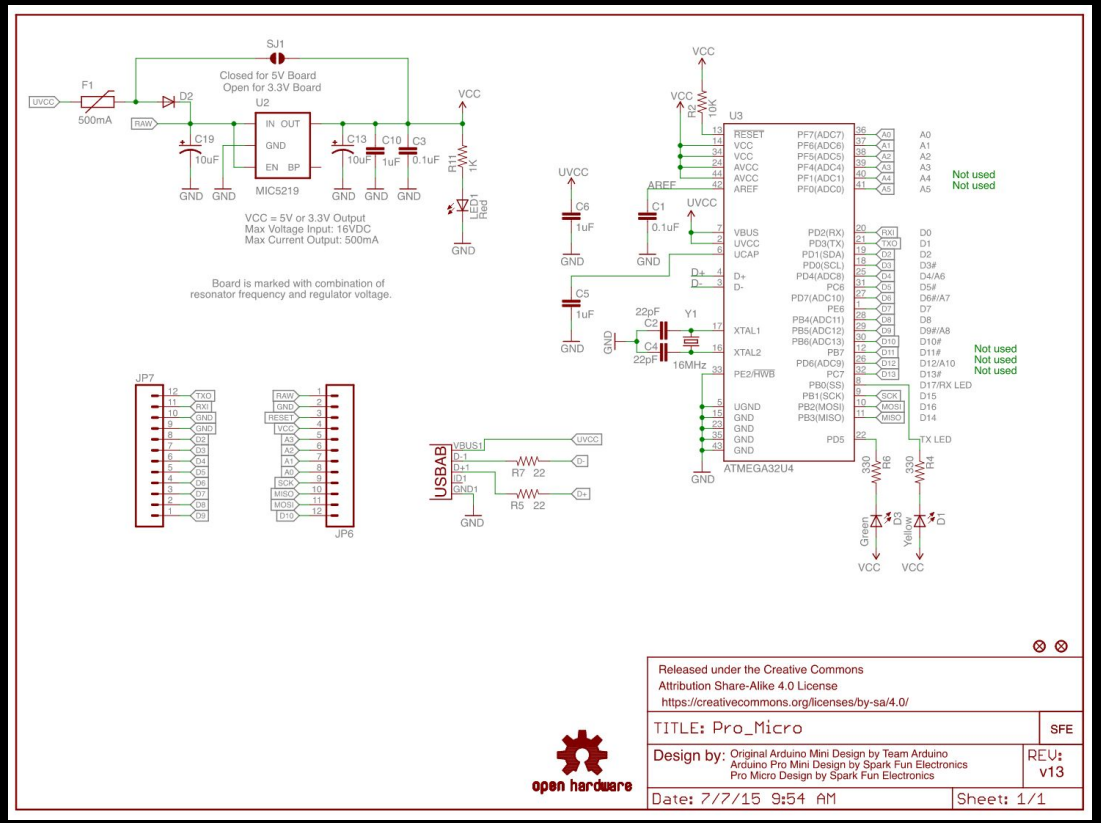
Notes
1. Refer to Table 2, Table 3, and Table 4 for values of these resistor divider networks.
2. FLIP pin is in LOW state when TypeC Plug is upside-up, and in Hi-Z state when upside-down.
3. Use a 50-kΩ resistor on the FLIP pin to set the UFP VDO data capability bit to 0.

Schematic Sources

ATMega32u4

Arduino Pro Micro Schematic

by Sparkfun



Putting it all together

Assembly

Step 1 - Assemble the PCB

1. Generate the iBOM and open it
2. Go through the list and collect all of your parts. Leave them in their cut tape or bags for now
3. Get the PCB
4. Clean the PCB
    i. File down the rabbit bites on the edges until they are flush with the edge of the board
    ii. Wash the board with soap and water, dry it. Try not to touch component locations after this (although its not a big problem if you do)
    iii. OPTIONAL: Wash the board with IPA.
5. Install U1 by reflow if possible or by hand
6. Install Y1 by reflow if possible or by hand if you do not plan to ultrasonic the board later
7. Install all R,C
8. Install D1-4 (Pin 1 is the end with less gold on it)
9. Use a DMM to confirm that VBUS_RAW, VBUS_FUSED are not shorted to ground or anything else nearby
10. Install F1
11. Install the USB_C connector
12. Test the USBC power supply
    i. Connect a USBC power supply capable of 20V
    ii. Confirm that VBUS_FUSED is 20V
    iii. Connect a USBC power supply not capable of 20V (e.g. a USB A-C cable)
    iv. Confirm that D3 is the only LED that is lit
    v. Confirm that VBUS_FUSED is 5V
    vi. Unplug the power supply
13. Install U4
14. Install Q1-4
15. Test the USBC Power supply some more
    i. Connect a USBC power supply capable of 20V
    ii. Confirm that VBUS is 20V
    iii. Confirm that D5-A net is at 5V
    iv. Confirm that D4 is the only LED lit
    v. Connect a USBC power supply not capable of 20V (e.g. a USB A-C cable)
    vi. Confirm that D3 is the only LED that is lit
    vii. Confirm that VBUS is 0V
    viii. Confirm that 5V net is at 5V
    ix. Unplug the power supply
16. Install D5. The bar is on the pin 1 side
17. Test the 5v reg
    i. Connect a USBC power supply capable of 20V
    ii. Confirm that VBUS is 20V
    iii. Confirm that 5V is roughly 4.7V
    iv. Confirm that D4 and D1 are both lit
    v. Connect a USBC port to your computer
    vi. Confirm that D3 and D1 are both lit
    vii. Confirm that VBUS is roughly 0V
    viii. Confirm that 5V net is at 5V
    ix. Unplug the power supply
18. Install U2 and U3
19. Install Y1
    i. Match the direction of the text to the silkscreen
    ii. Install by reflow if possible or by hand if you have not already installed it
20. Install Q5
21. Install all switches
22. Clean the board

iBOM

ExploSnake
Team 2

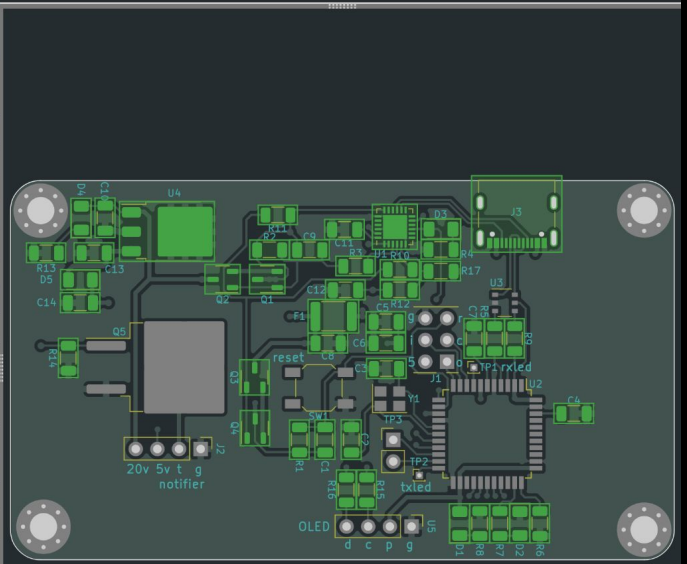
Rev: v1.0
2023-11-15

Bitwarden

F | FB | B

Ref lookup | Filter

	Sourced	Placed	References	Value	Footprint	Quantity
1	☐	☑	C1, C4, C7, C11, C12	1u	C_1206_3216Metric	5
2	☐	☑	C2, C3	24p	C_1206_3216Metric	2
3	☐	☑	C5, C6	100n	C_1206_3216Metric	2
4	☐	☑	C8, C10	10u 50V	C_1206_3216Metric	2
5	☐	☑	C9	1u 50V	C_1206_3216Metric	1
6	☐	☑	C13	22u	C_1206_3216Metric	1
7	☐	☑	C14	100u	C_1206_3216Metric	1
8	☐	☑	R2, R6, R14	10k	R_1206_3216Metric	3
9	☐	☑	R7, R8, R10	1k	R_1206_3216Metric	3
10	☐	☑	R4, R17	2k2	R_1206_3216Metric	2
11	☐	☑	R5, R9	22	R_1206_3216Metric	2
12	☐	☑	R12, R13	5k1	R_1206_3216Metric	2
13	☐	☑	R15, R16	0	R_1206_3216Metric	2
14	☐	☑	R1	100k	R_1206_3216Metric	1
15	☐	☑	R3	100	R_1206_3216Metric	1
16	☐	☑	R11	51k	R_1206_3216Metric	1
17	☐	☑	D1, D4	green	LED_1206_3216Metric	2
18	☐	☑	D2	orange	LED_1206_3216Metric	1
19	☐	☑	D3	red	LED_1206_3216Metric	1
20	☐	☑	D5	D_Schottky	D_1206_3216Metric	1
21	☐	☑	U1	CYPD3177	QFN-24-1EP_4x4mm_P0.5mm_EP2.8x2.8mm	1
22	☐	☐	U2	ATmega32U4_A	TQFP-44_10x10mm_P0.8mm	1



Testing

- What was the testing strategy and plan?
  - Unit Test:
    - Voltage Test:
      - VBus, Voltage Rail, Voltage Regulator, ATMega32u4, OLED.
    - Capacitor Explosions
  - Verification:
    - Operational Microcontroller
    - OLED Screen, 4 Input Buttons
    - Capacitor Explosion on game over
  - Validation
    - Playable? Responsive? Is it actually a Snake Game?

Results

- **The game works!!!!!**
  - **Board requests high voltage**
  - **Can program microcontroller with computer**
  - **Snake shows up on screen**
  - **Buttons control snake**
  - **Caps explode reliably**

Contributions

- What we did
  - Ben: Schematic, Boom, Ordering Items, Testing, Case Printing
  - Dmitrii: Schematic, PCB, Case Printing
  - Evan: Software, Debugging
  - John: Software, debugging, documentation

Lesson Learned

- What did we learn?
  - First time PCB design/PAR and 3D modelling
  - Using GitHub to maintain version control and project documentation
  - Proper hardware and software integration
  - Capacitors don’t like to explode

- What would you do differently?
  - Add more features to the game.
    - More games. DOOM!
    - Different types of Explosion connection.
    - Battery…
    - More ergonomic case
  - Work earlier
    - Finals took much effort

Demo