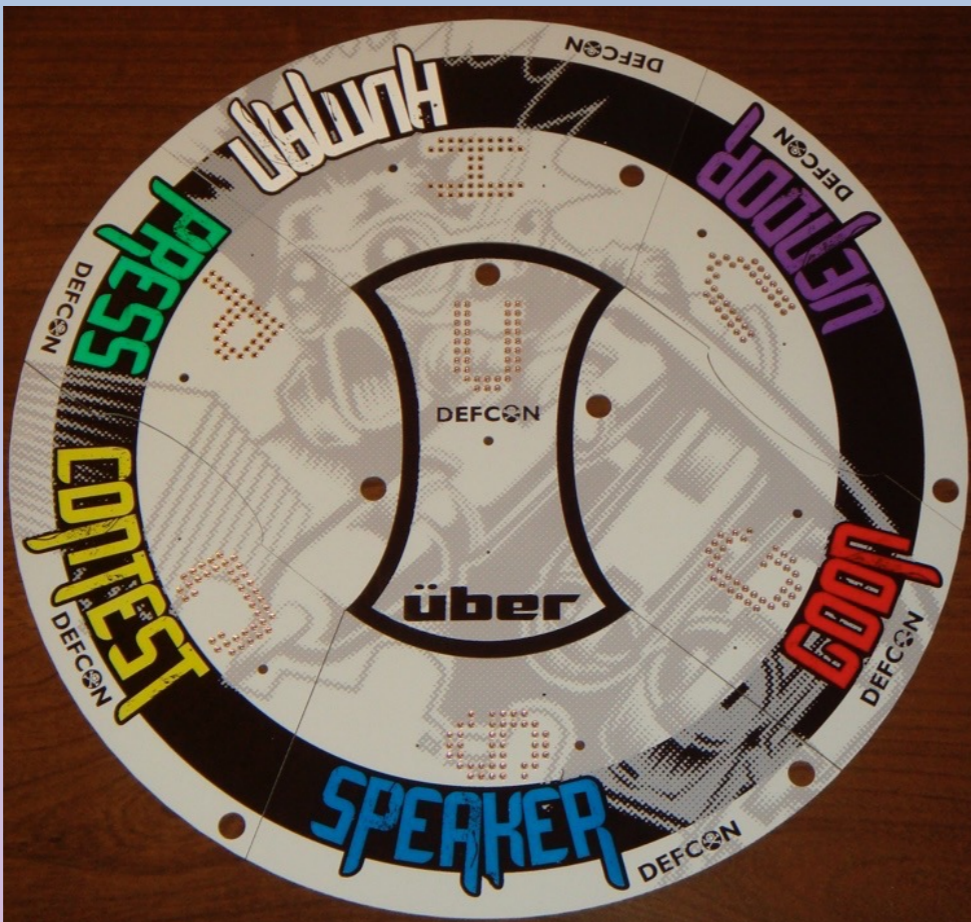


CREATING THE DEFCON CHINA 1.0 BADGE



JOE GRAND AKA KINGPIN

INTRODUCTION / BADGE HISTORY



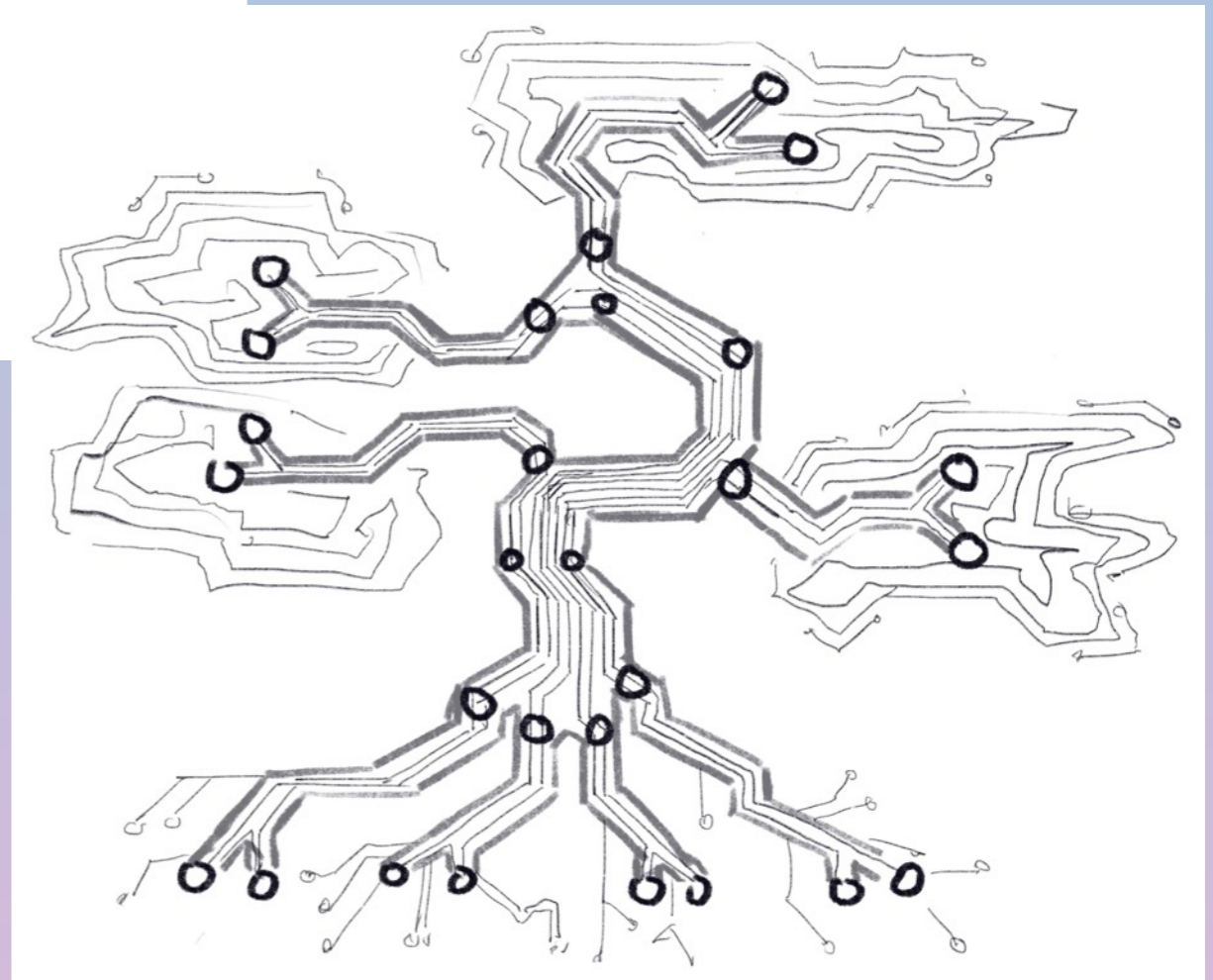
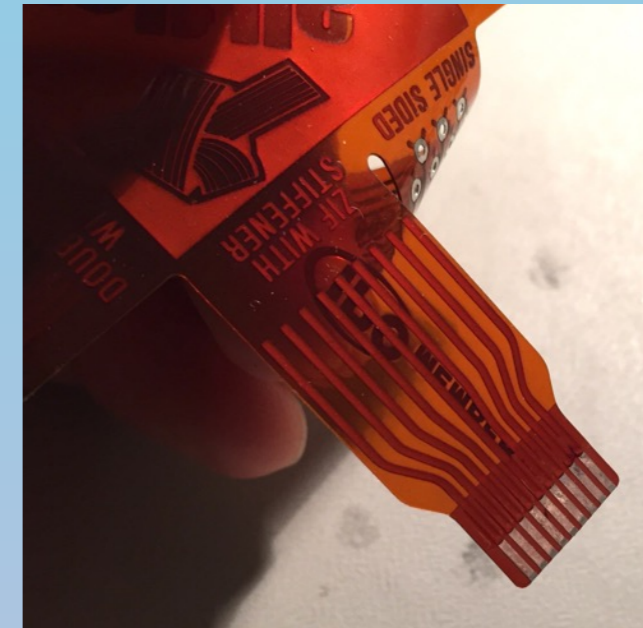
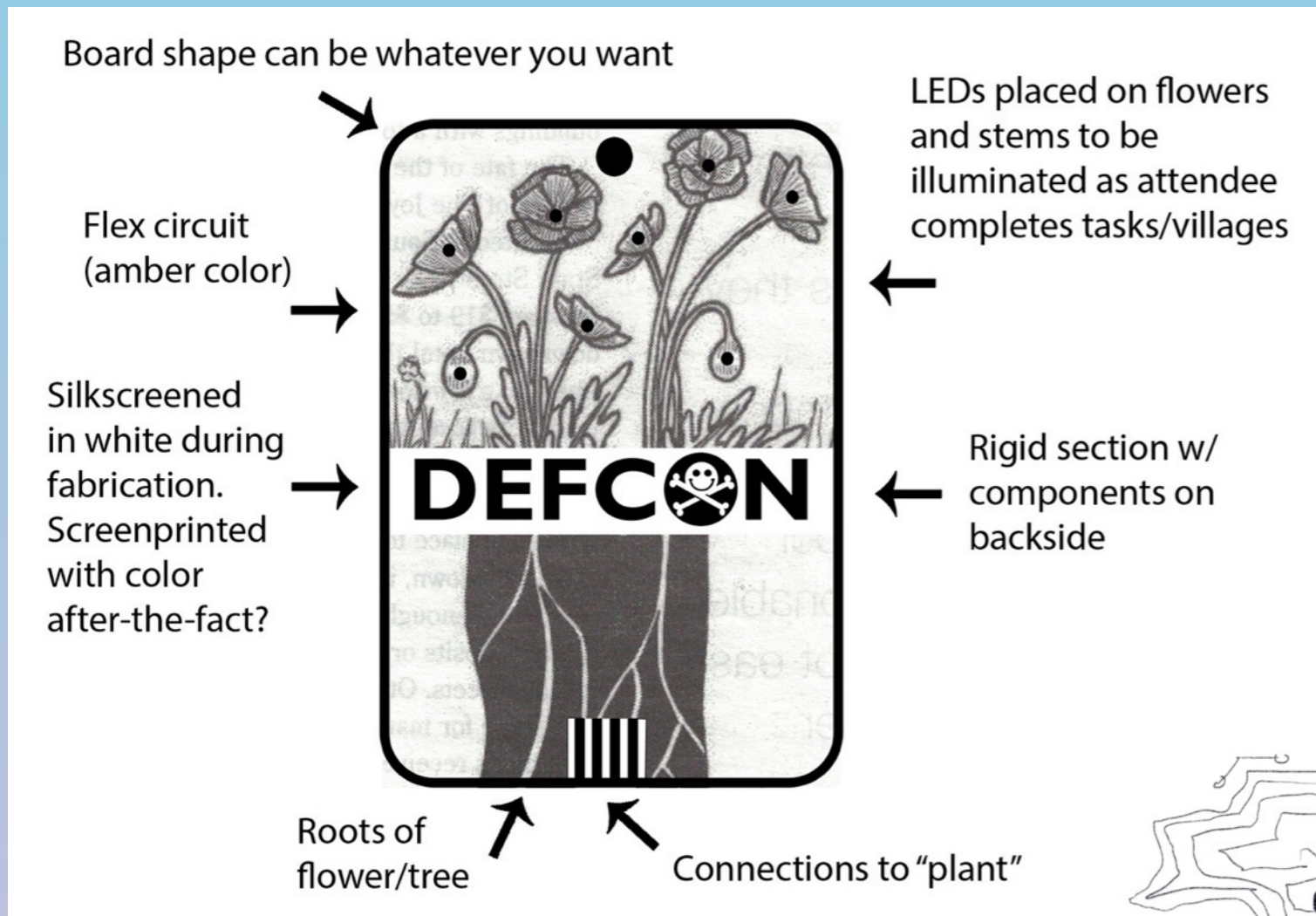
GOALS

- BRING COMMUNITY TOGETHER THROUGH INTERACTIVITY
- CREATE GAME TO ENCOMPASS THE DEFCON EXPERIENCE
- SIMPLE DESIGN THAT COULD BE EXPANDED DURING/AFTER DEFCON
- INTERACTIVE, COMMAND-BASED MENU FOR ADDITIONAL EXPLORATION

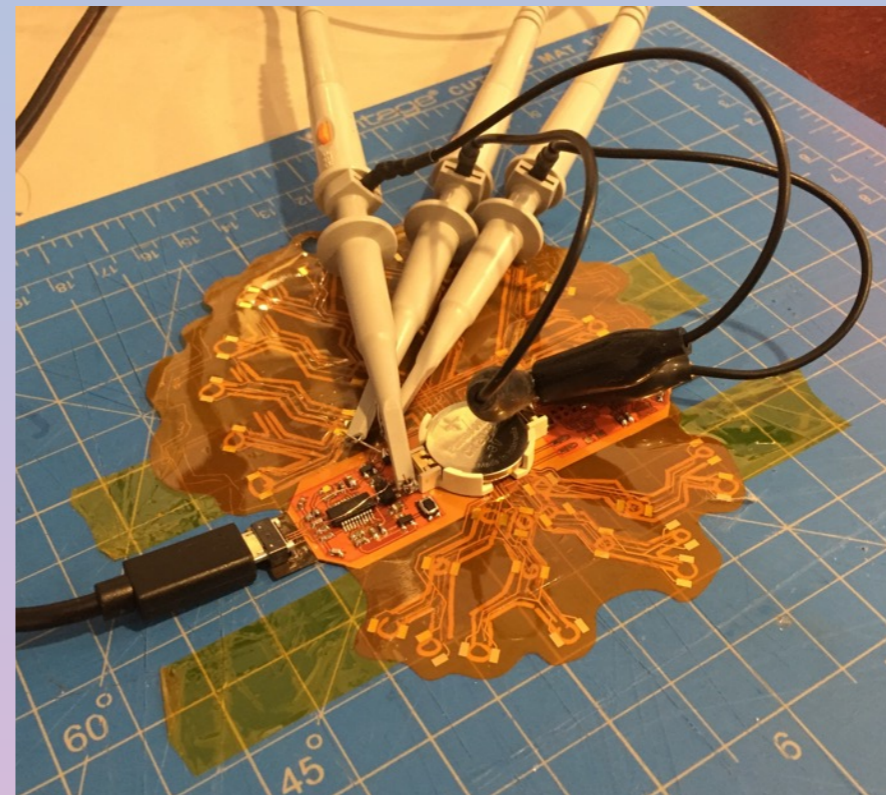
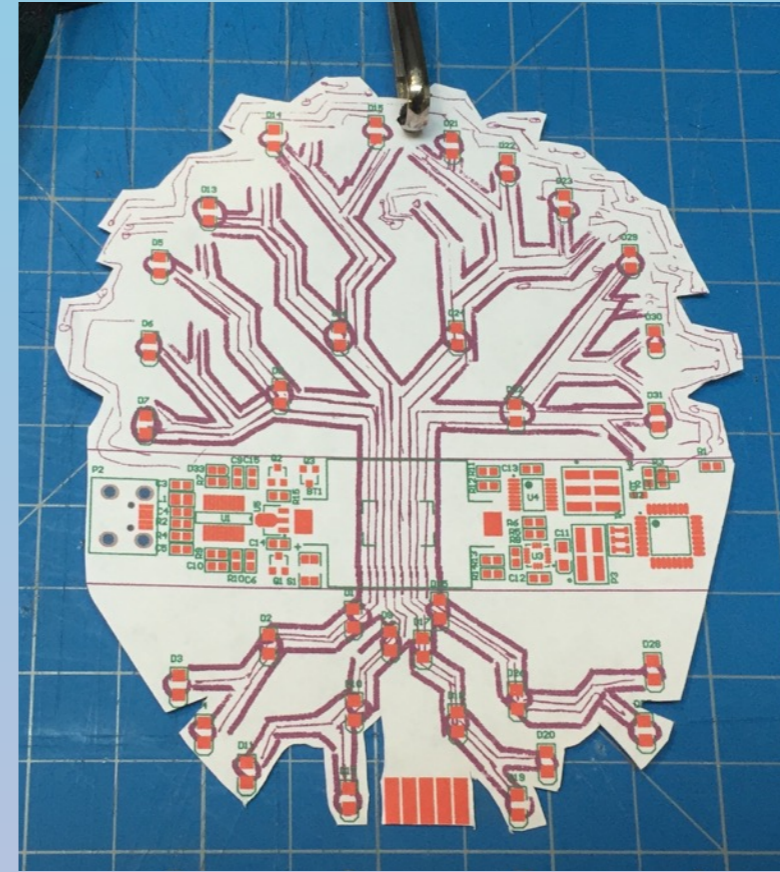
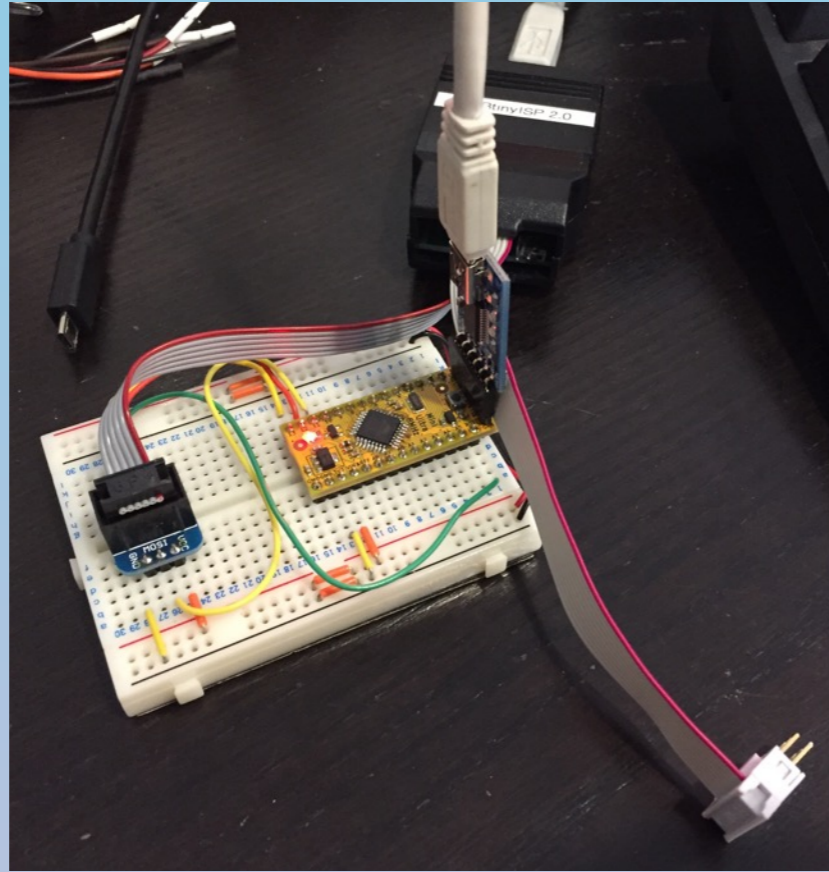
GAMEPLAY

- COMPLETE TASKS, GET REWARDED
- 4 ROOTS AND 4 BRANCHES, EACH WITH 4 LEDS
- WHEN TASK IS COMPLETE, BADGE INSERTED INTO PROGRAMMER TO UNLOCK LED
- WHEN EACH ROOT IS COMPLETE, MAGIC HAPPENS
- WHEN ALL ROOTS ARE COMPLETE, MORE MAGIC HAPPENS

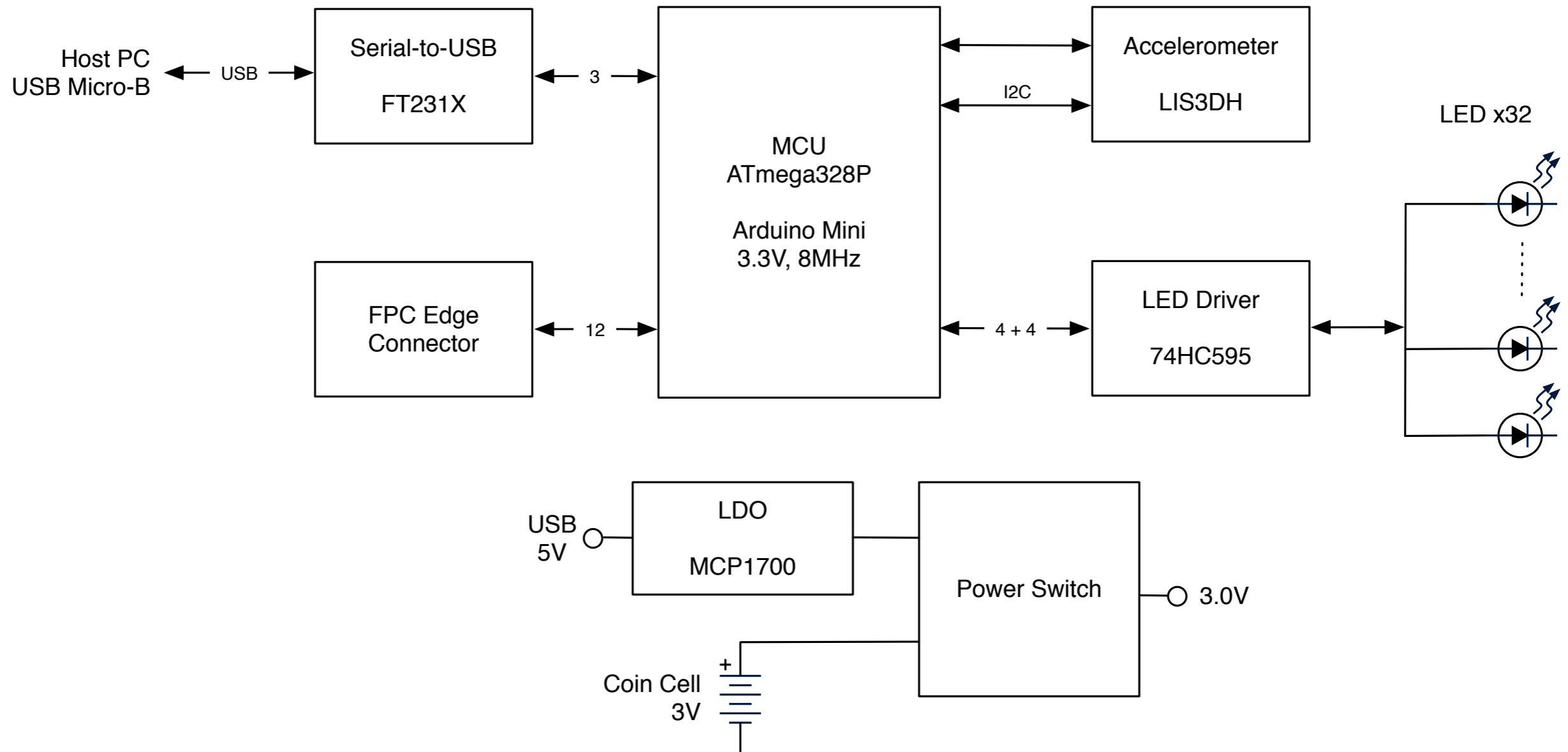
EARLY CONCEPTS



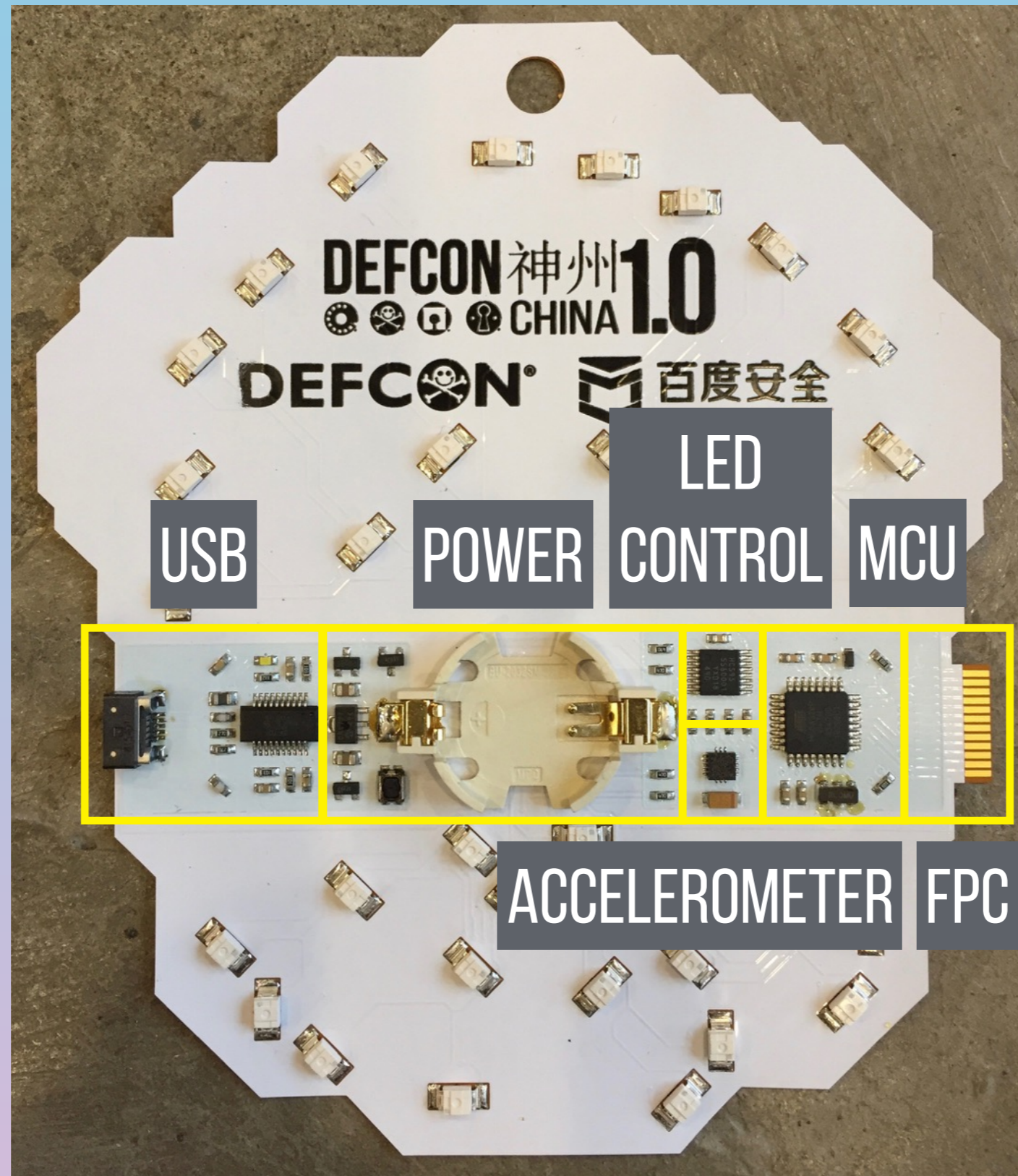
PROTOTYPING



BLOCK DIAGRAM

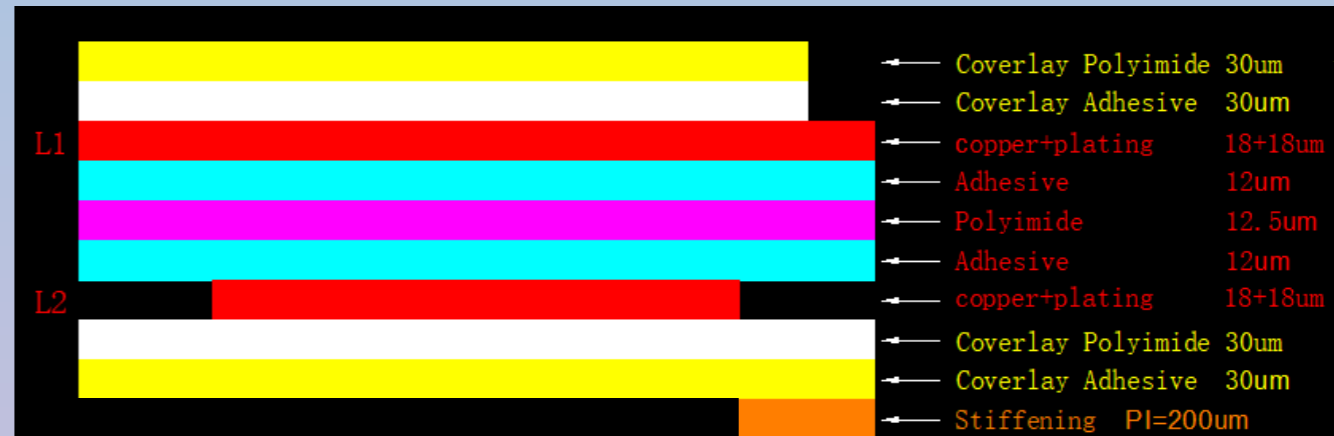
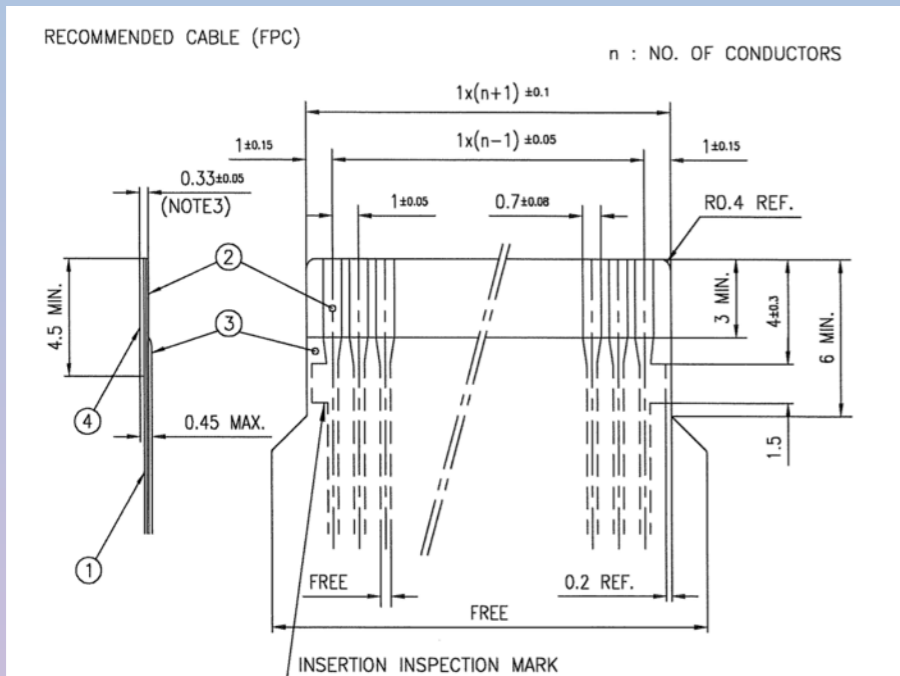


HARDWARE



FLEXIBLE PRINTED CIRCUIT (FPC)

- FIRST FOR CONFERENCE BADGE
- NEW MATERIAL (FOR US) OPENS UP NEW RISKS/CHALLENGES
- SPECIFIC STACK-UP TO MEET EDGE CONNECTOR REQUIREMENTS
- MAJOR SUPPORT BY ELECTRONIC INTERCONNECT, ADAPT ELECTRONICS



White Stackup

Finished FPC:0.23+/-0.03MM

Finished stiffener:0.33+/-0.05MM

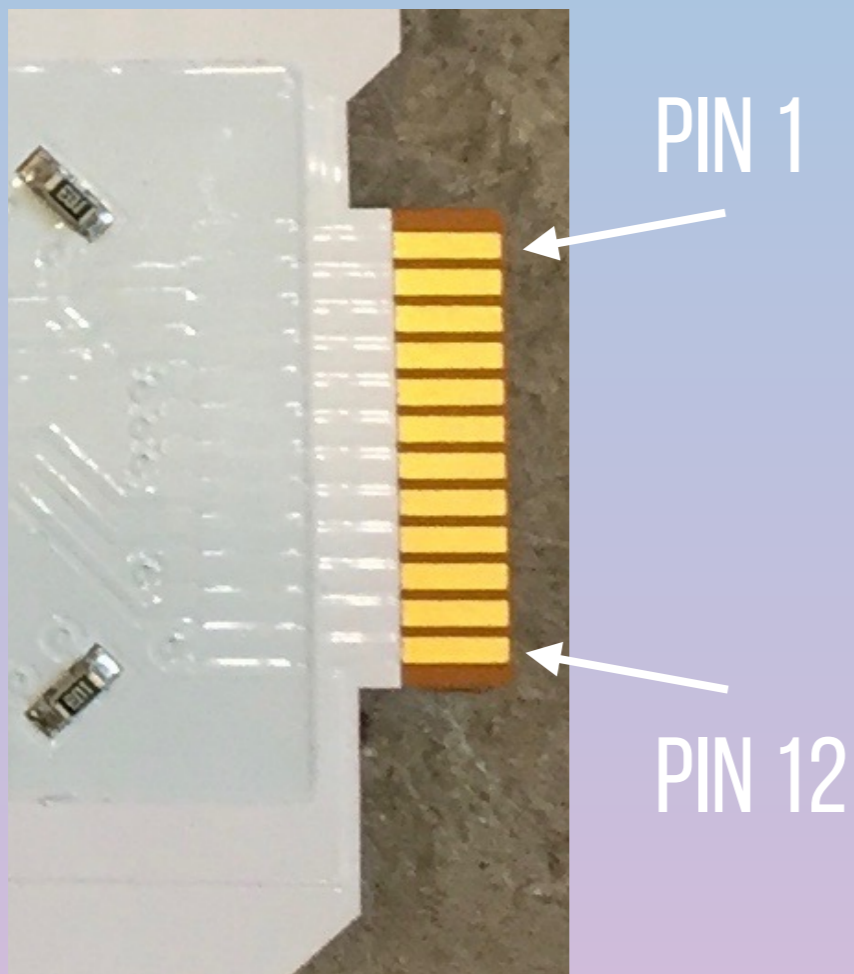
Base copper:18um

Finished copper:35um+/-5UM

Finished hole copper:18-25um

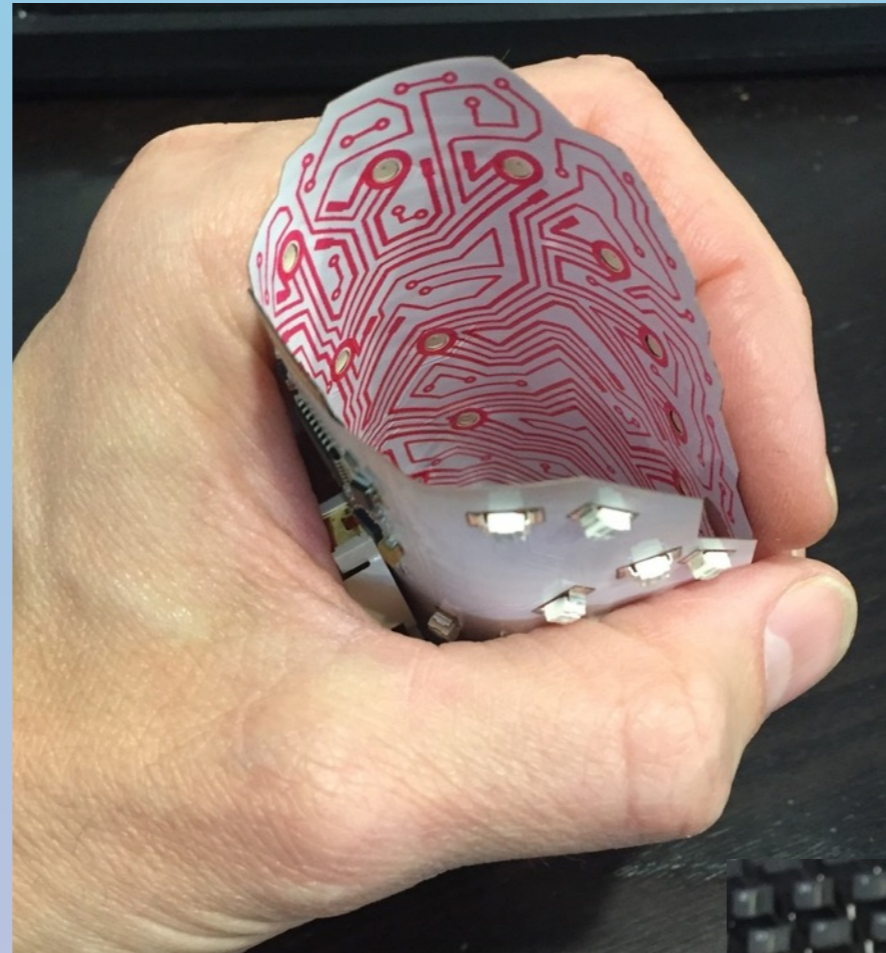
FLEXIBLE PRINTED CIRCUIT (FPC)

- EDGE CONNECTOR AS INTERFACE TO THE OUTSIDE WORLD
 - UART, I2C, AVR ICSP
- USED WITH PROGRAMMING SHIELD TO SET/READ STATE OF BADGE LEDS



1. GND	7. SCL
2. SCK	8. SIN
3. MISO	9. SOUT
4. MOSI	10. /SENSE
5. /RST	11. GPIO
6. SDA	12. VCC

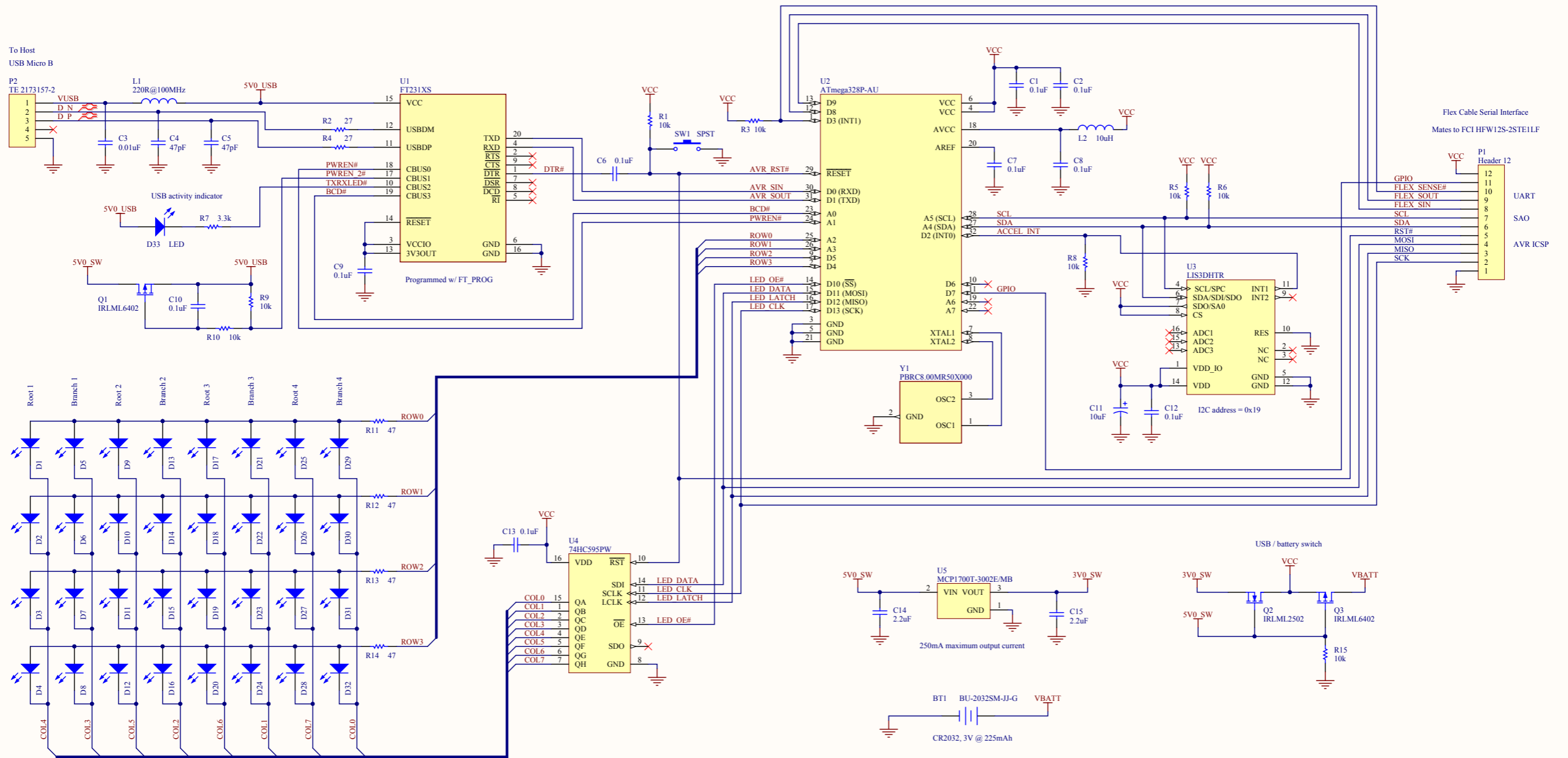
FLEXIBLE PRINTED CIRCUIT (FPC)



IT BENDS!

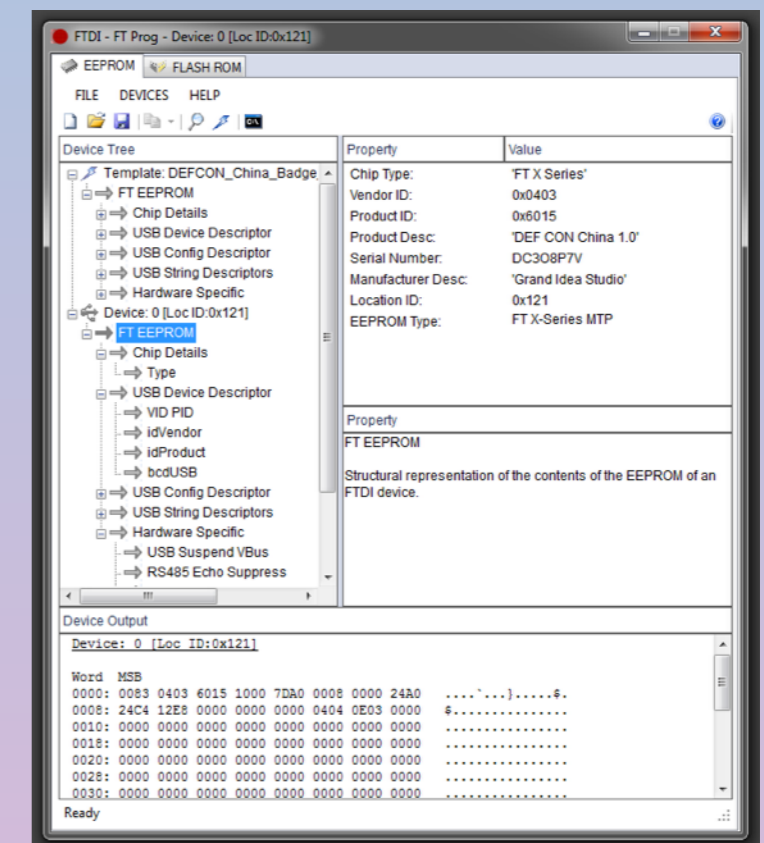
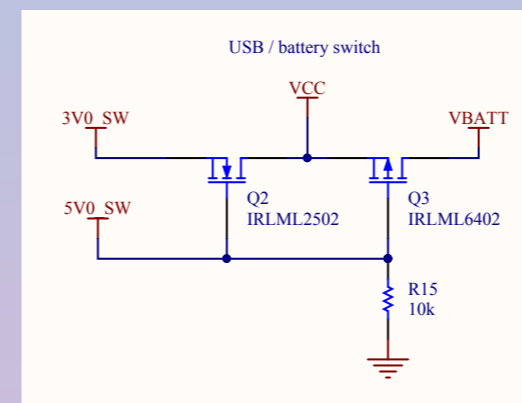
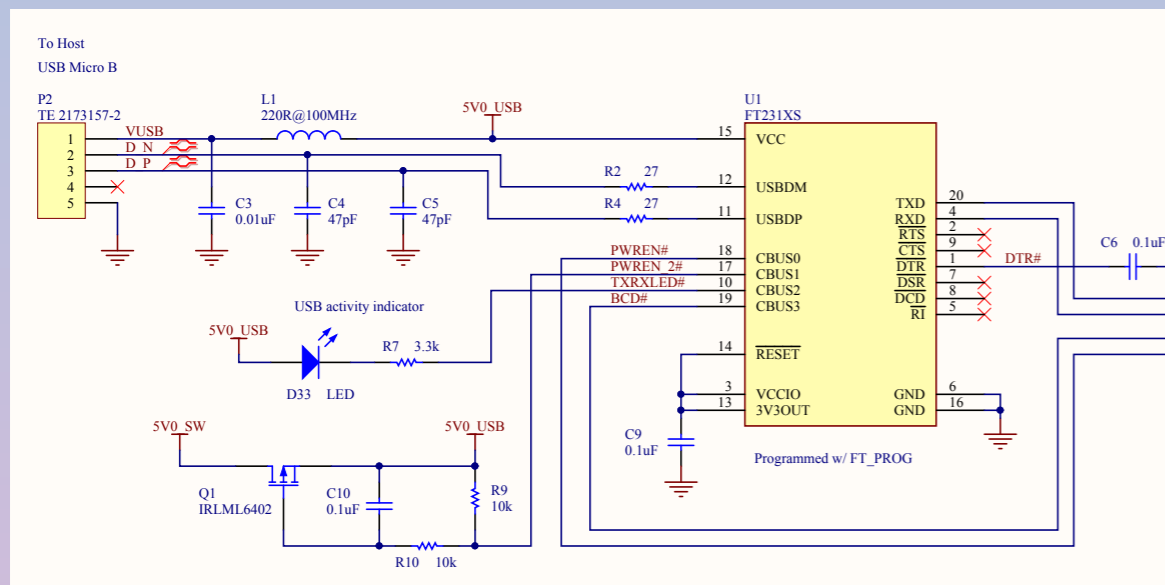


SCHEMATIC



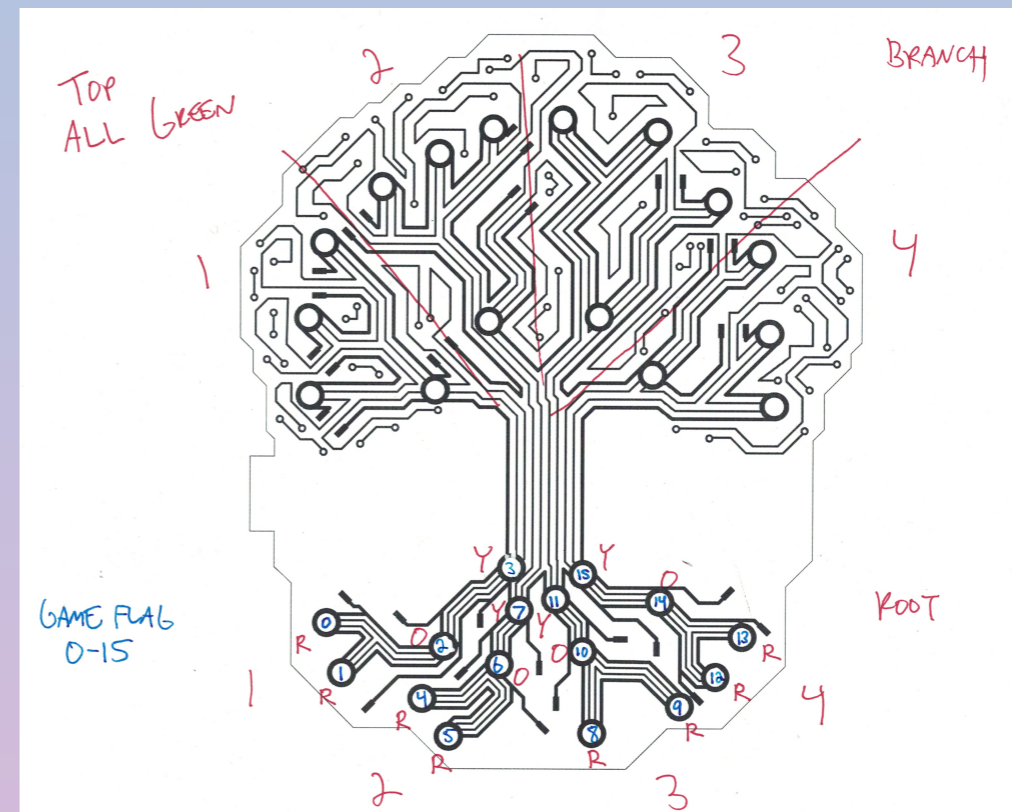
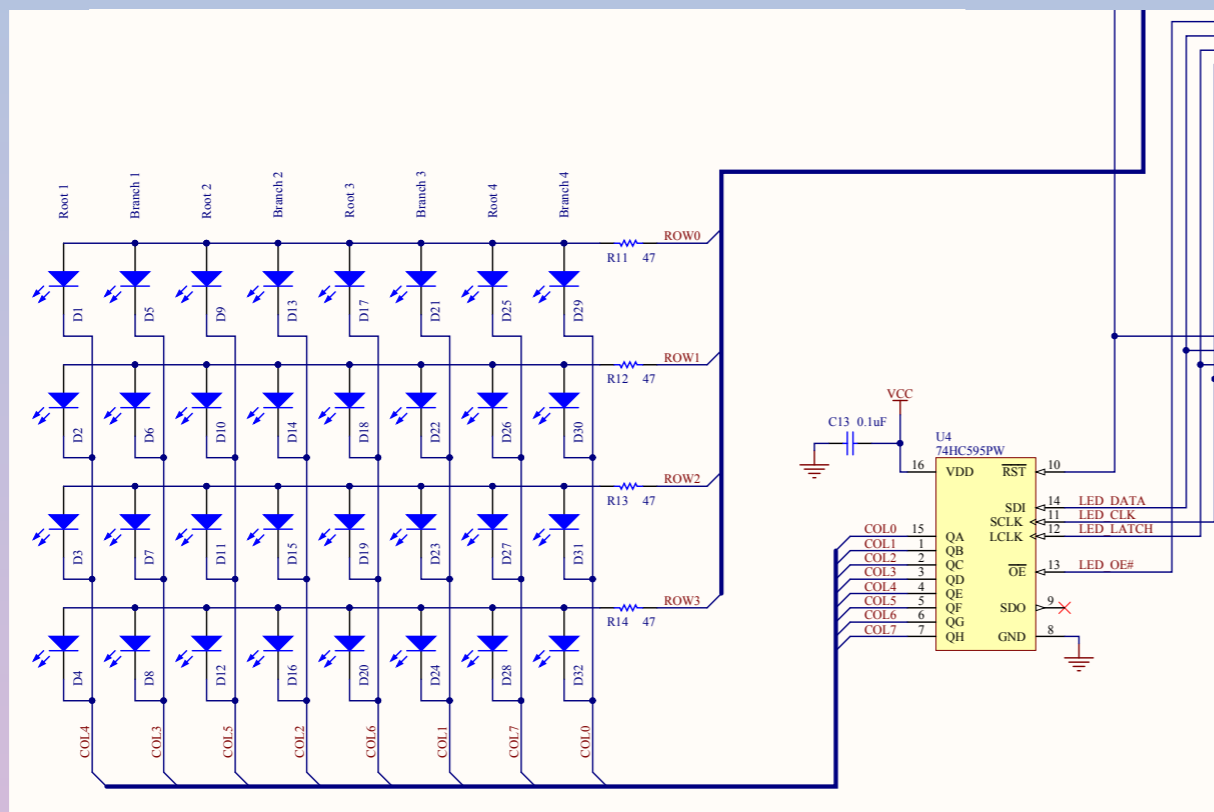
USB INTERFACE

- ALLOWS FOR ARDUINO PROGRAMMING AND INTERACTIVE MODE
- FT231X USB-TO-SERIAL UART
 - ENTIRE USB PROTOCOL HANDLED ON-CHIP
 - HOST WILL RECOGNIZE AS VIRTUAL SERIAL DEVICE/COM PORT
- MOSFETS FOR SOFT-START AND POWER SWITCHOVER



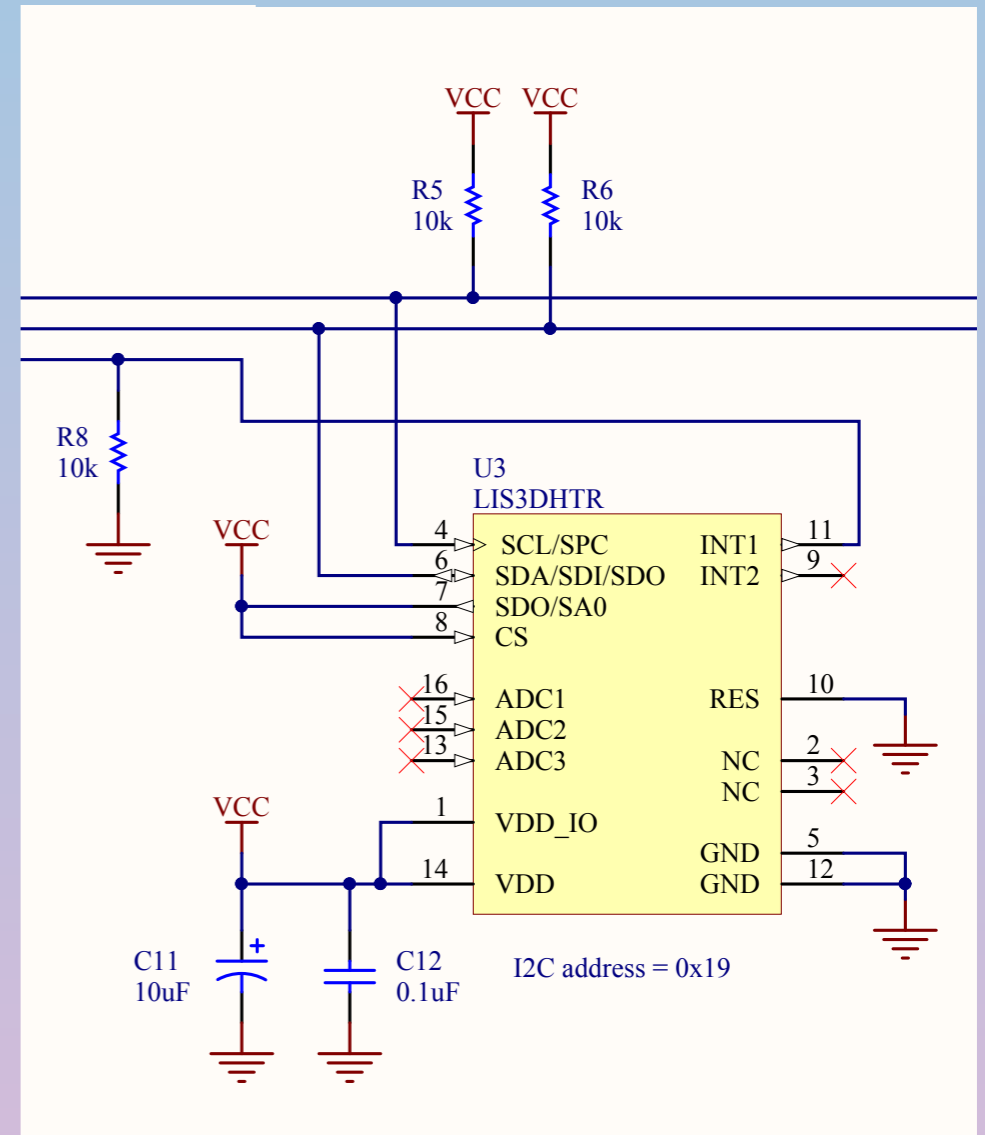
LED MATRIX

- MULTIPLEXING VIA LED MATRIX LIBRARY
- ROW CONTROLLED BY DISCRETE I/O
- COLUMN CONTROLLED THROUGH 74HC595 SHIFT REGISTER
- REFRESH @ 175HZ TO REDUCE FLICKER
- EACH LED INDIVIDUALLY ADDRESSABLE, DIMMABLE (16 LEVELS)



ACCELEROMETER

- ST MICROELECTRONICS LIS3DH
- 3-AXIS DIGITAL OUTPUT (I2C/SPI)
- +/- 2, 4, 8, 16G RANGE
- INTERRUPT ON MOTION OR FREE FALL
- USED TO PRESERVE BATTERY LIFE
 - SLEEP MODE @ 10 SECONDS OF INACTIVITY
- RAW VALUES AVAILABLE THROUGH INTERACTIVE MODE



BILL-OF-MATERIALS

Item	Quantity	Reference	Manufacturer	Manuf. Part #	Distributor	Distrib. Part #	Description
1	1	BT1	MPD	BU2032SM-JJ-GTR	N/A	N/A	Battery Holder, CR2032, SMD
1b	1	N/A	Panasonic	CR2032	Digi-Key	P189-ND	Battery, Coin Cell, Lithium, 3V, 225mAh
2	9	C1, C2, C6, C7, C8, C9, C10, C12, C13	Kemet	C0603C104K4RACTU	Digi-Key	399-1096-2-ND	Capacitor, 0.1uF, 16V, Ceramic, 10%, X7R, 0603
3	1	C3	Samsung	CL10B103KB8NCNC	Digi-Key	1276-1921-2-ND	Capacitor, 0.01uF, 50V, Ceramic, 10%, X7R, 0603
4	2	C4, C5	AVX	06035A470JAT2A	Digi-Key	478-1171-2-ND	Capacitor, 47pF, 50V, Ceramic, 5%, C0G/NP0, 0603
5	1	C11	Kemet	T491A106M016AT	Digi-Key	399-3687-2-ND	Capacitor, 10uF, 16V, Tantalum, 20%, Size A
6	2	C14, C15	Taiyo Yuden	TMK212B7225KG-TR	Digi-Key	587-2991-2-ND	Capacitor, 2.2uF, 25V, Ceramic, 10%, X7R, 0805
7	4	D1, D9, D17, D25	Kingbright	AA3528SYCKT09	N/A	N/A	LED, Yellow, 250mcd, 2.0Vf, 590nm, Reverse Mount, PLCC-2
8	4	D2, D10, D18, D26	Kingbright	AA3528SECKT09	N/A	N/A	LED, Orange, 350mcd, 2.1Vf, 605nm, Reverse Mount, PLCC-2
9	8	D3, D4, D11, D12, D19, D20, D27, D28	Kingbright	AA3528SURCKT09	N/A	N/A	LED, Red, 350mcd, 1.95Vf, 630nm, Reverse Mount, PLCC-2
10	16	D5, D6, D7, D8, D13, D14, D15, D16, D21, D22, D23, D24, D29, D30, D31, D32	Kingbright	AA3528CGCKT09	N/A	N/A	LED, Green, 100mcd, 2.1Vf, 570nm, Reverse Mount, PLCC-2
11	1	D33	Kingbright	APT1608LQWF/D	N/A	N/A	LED, White, 35mcd, 2.65Vf, 0603
12	1	L1	TDK	MPZ2012S221AT000	Digi-Key	445-1568-2-ND	Inductor, Ferrite Bead, 220R @ 100MHz, 3A, 0805
13	1	L2	Taiyo Yuden	LBMF1608T100K	Digi-Key	587-1714-2-ND	Inductor, Wirewound, 10uH, 10%, 360mR, 80mA, 0603
14	1	P2	TE Connectivity	2173157-2	Verical	N/A	Connector, Micro-USB Type B, R/A, 5 position, SMD
15	2	Q1, Q3	Infineon	IRLML6402TRPBF	Digi-Key	IRLML6402PBFTR-ND	Transistor, MOSFET, P-Channel, 20V, 65mR @ 3.7A, SOT23
16	1	Q2	Infineon	IRLML2502TRPBF	Digi-Key	IRLML2502TRPBFTR-ND	Transistor, MOSFET, N-Channel, 20V, 45mR @ 4.2A, SOT23
17	8	R1, R3, R5, R6, R8, R9, R10, R15	Panasonic	ERJ-3GEYJ103V	Digi-Key	P10KGTR-ND	Resistor, 10k, 5%, 1/10W, 0603
18	2	R2, R4	Panasonic	ERJ-3GEYJ270V	Digi-Key	P27GTR-ND	Resistor, 27 ohm, 5%, 1/10W, 0603
19	1	R7	Panasonic	ERJ-3GEYJ332V	Digi-Key	P3.3KGTR-ND	Resistor, 3.3k, 5%, 1/10W, 0603
20	4	R11, R12, R13, R14	Panasonic	ERJ-3GEYJ470V	Digi-Key	P47GTR-ND	Resistor, 47 ohm, 5%, 1/10W, 0603
21	1	SW1	Panasonic	EVP-AA202K	Digi-Key	P13348SDKR-ND	Switch, SPST, Tactile Momentary, 160gf, 3.5 x 2.9mm, J-Lead
22	1	U1	FTDI	FT231XS-R	Digi-Key	768-1129-2-ND	IC, USB-to-UART Bridge, SSOP20
23	1	U2	Microchip	ATMEGA328P-AU	N/A	N/A	IC, Microcontroller, 32KB Flash, TQFP32
23b	1	N/A	Microchip	N/A	N/A	N/A	IC, Microcontroller, Programming
24	1	U3	STMicroelectronics	LIS3DHTR	Digi-Key	497-10613-6-ND	IC, Accelerometer, 3-Axis, 2-16g, LGA16
25	1	U4	Nexperia	74HC595PW,118	Digi-Key	1727-3068-2-ND	IC, Shift Register, 8-bit, TSSOP16
26	1	U5	Microchip	MCP1700T-3002E/MB	Digi-Key	MCP1700T-3002E/MBCT-ND	Voltage Regulator, LDO, 3.0V, 250mA, SOT89-3
27	1	Y1	Kyocera	PBRC8.00MR50X000	Mouser	581-PBRC8.00MR50X	Resonator, 8MHz, 0.5%, Internal 15pF Capacitor, SMD
28	1	PCB	Electronic Interconnect	DCN1.0	N/A	N/A	PCB Fabrication, Assembly, Test

FIRMWARE

- ARDUINO
 - OPEN SOURCE PLATFORM BASED ON EASY-TO-USE HW/SW/FW
 - WORLDWIDE COMMUNITY OF USERS/CONTRIBUTORS
- 90% OF FLASH (27.6KB), 43% OF RAM (887 BYTES)
- LOOP
 - SET POWER STATE (BATTERY, USB, USB CHARGER)
 - CHECK FOR/PROCESS INTERACTIVE MODE
 - CHECK FOR/PROCESS FPC COMMUNICATION
 - UPDATE LEDS
 - SLEEP UNTIL ACCELEROMETER INTERRUPT

LIBRARIES

- THIRD-PARTY LIBRARIES TO ADD FUNCTIONALITY TO ARDUINO
 - ESSENTIAL FOR RAPID DEVELOPMENT
 - SOME CODE MODIFICATIONS REQUIRED DURING BADGE INTEGRATION
- LOW POWER
 - <https://github.com/rocketscream/Low-Power>
- ADAFRUIT_LIS3DH (ACCELEROMETER)
 - https://github.com/adafruit/Adafruit_LIS3DH
- ADAFRUIT_SENSOR (SENSOR ABSTRACTION LAYER)
 - https://github.com/adafruit/Adafruit_Sensor

LIBRARIES

- LED MATRIX (INDIVIDUALLY ADDRESSABLE, DIMMABLE, SHIFT REGISTER)
 - <https://github.com/marcmerlin/LED-Matrix>
- ADAFRUIT-GFX-LIBRARY (CORE GRAPHICS PRIMITIVES)
 - <https://github.com/adafruit/Adafruit-GFX-Library>
- DIO2 (FAST DIGITAL I/O)
 - www.codeproject.com/Articles/732646/Fast-digital-I-O-for-Arduino
- TIMERONE (ENHANCED TIMER, PERIODIC INTERRUPTS)
 - <https://github.com/PaulStoffregen/TimerOne>

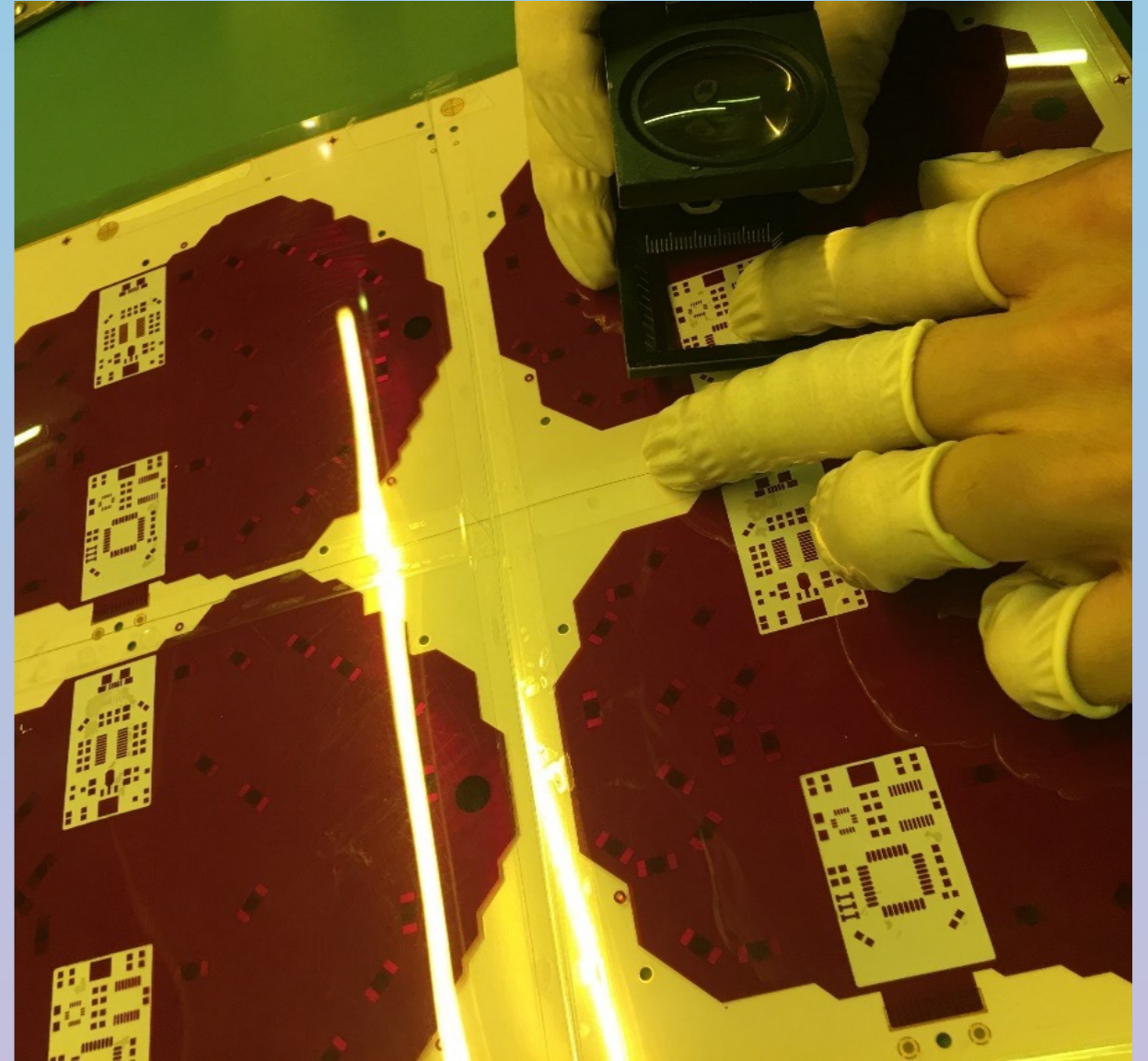
CODE MODIFICATIONS

- LED MATRIX
 - ADD #DEFINE SWAPO TO .CPP TO PREVENT COMPILING ERROR
 - REMOVE #DEFINES FOR DIO2 PINMODE AND DIGITALWRITE
 - CONFLICTED WITH THE REST OF BADGE CODE

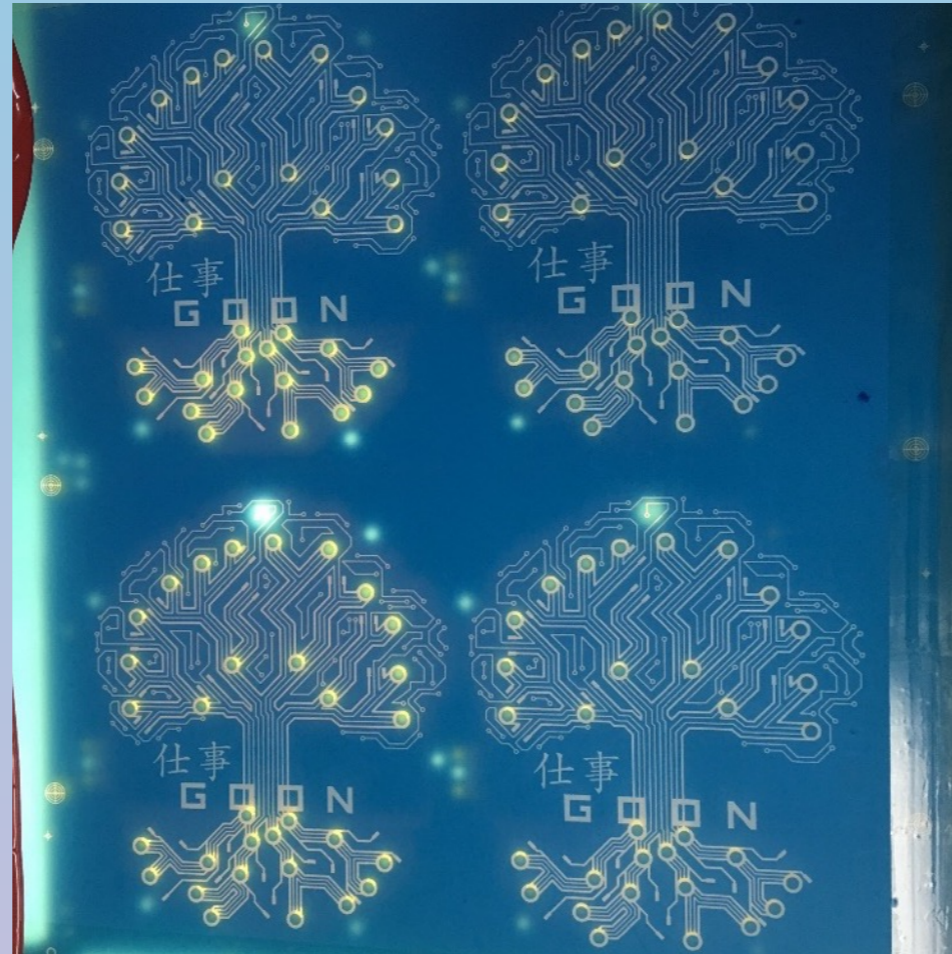
FABRICATION



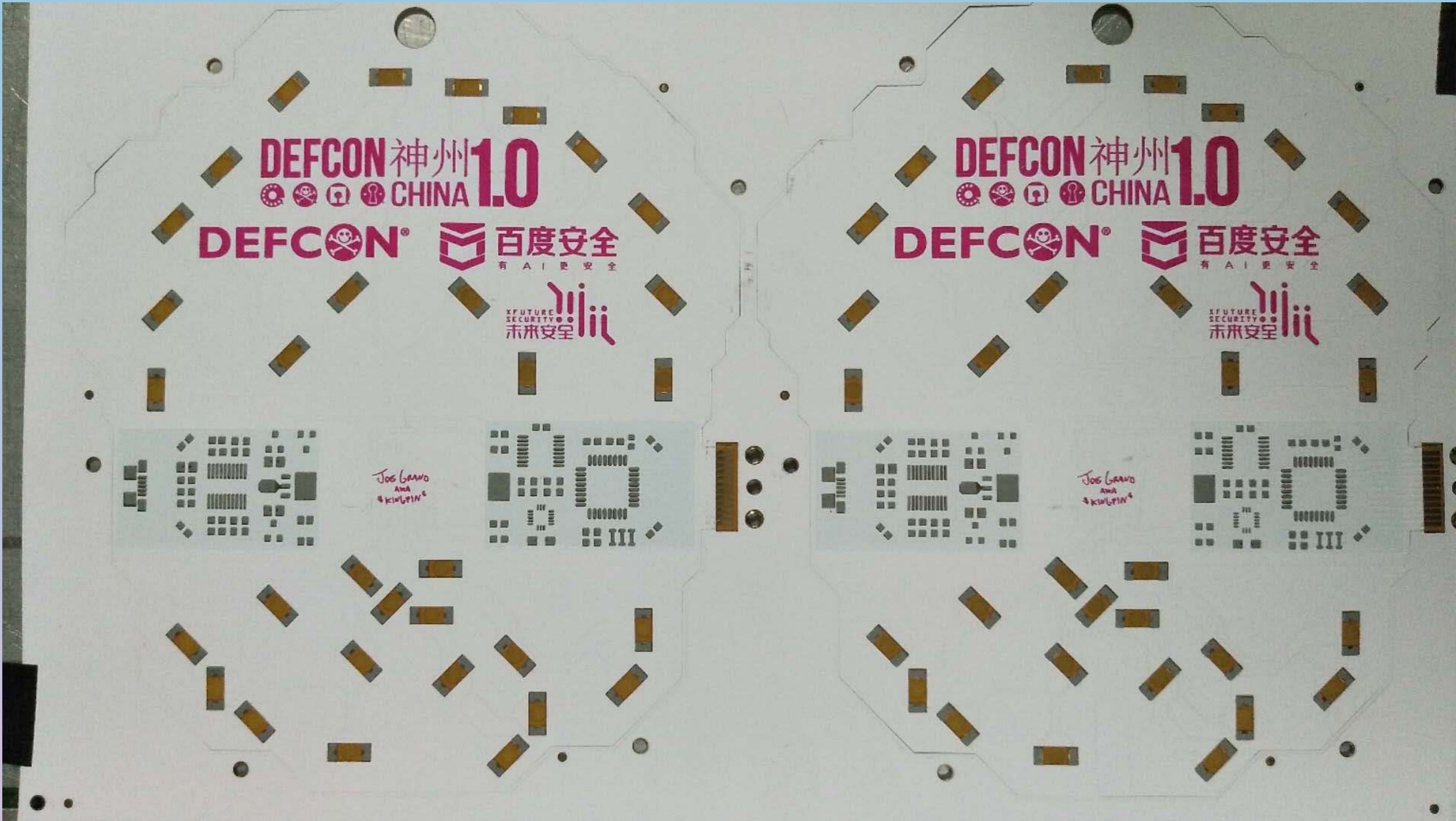
FABRICATION



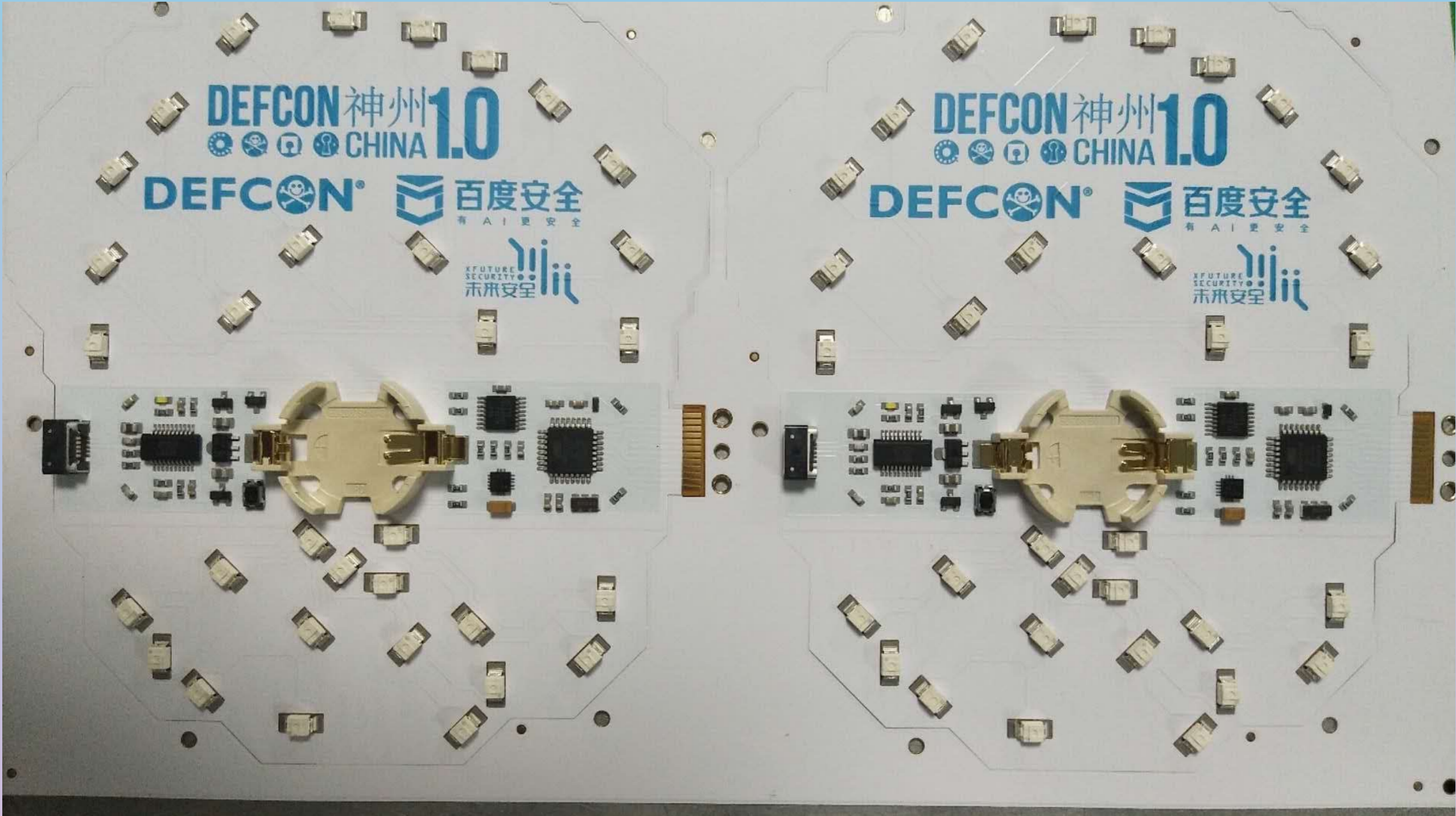
FABRICATION



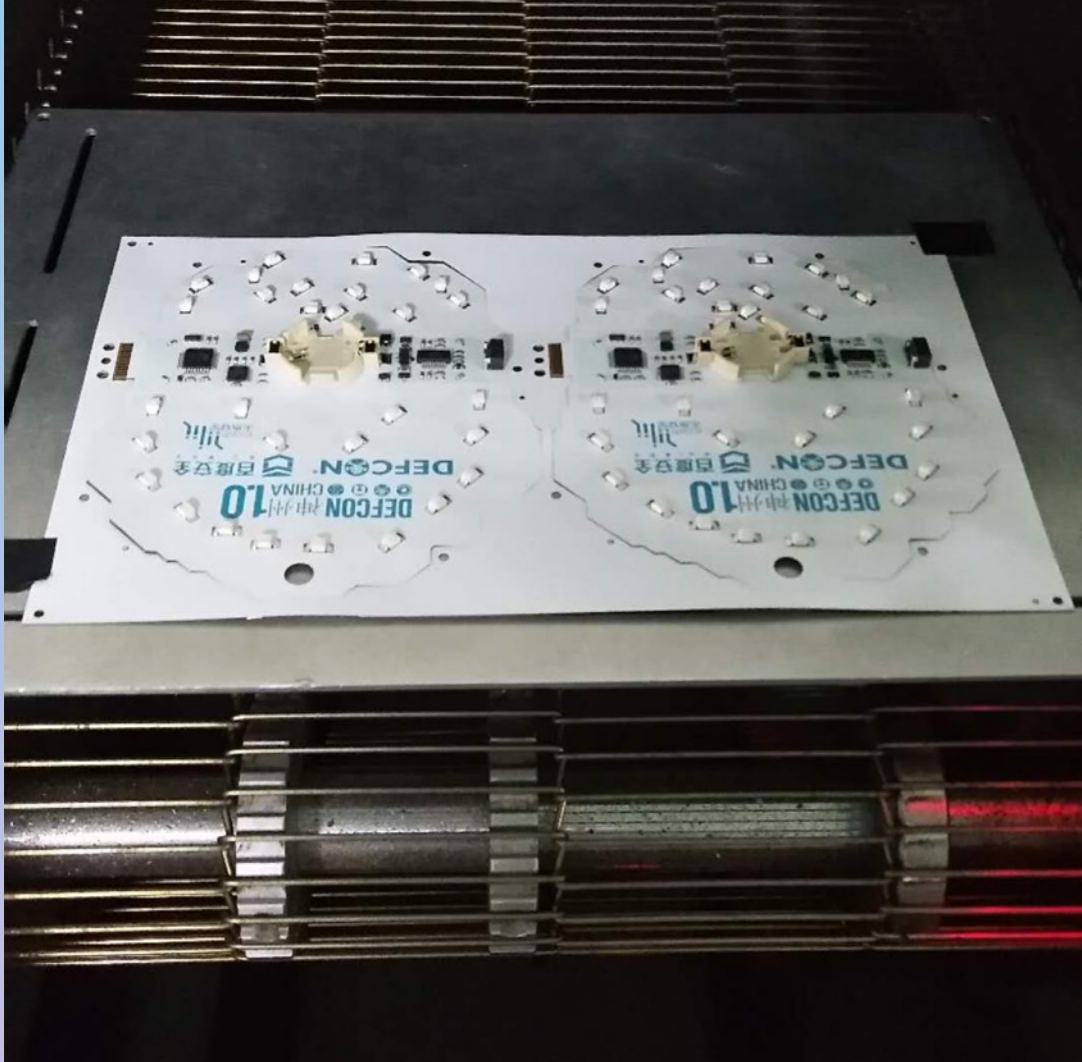
ASSEMBLY



ASSEMBLY

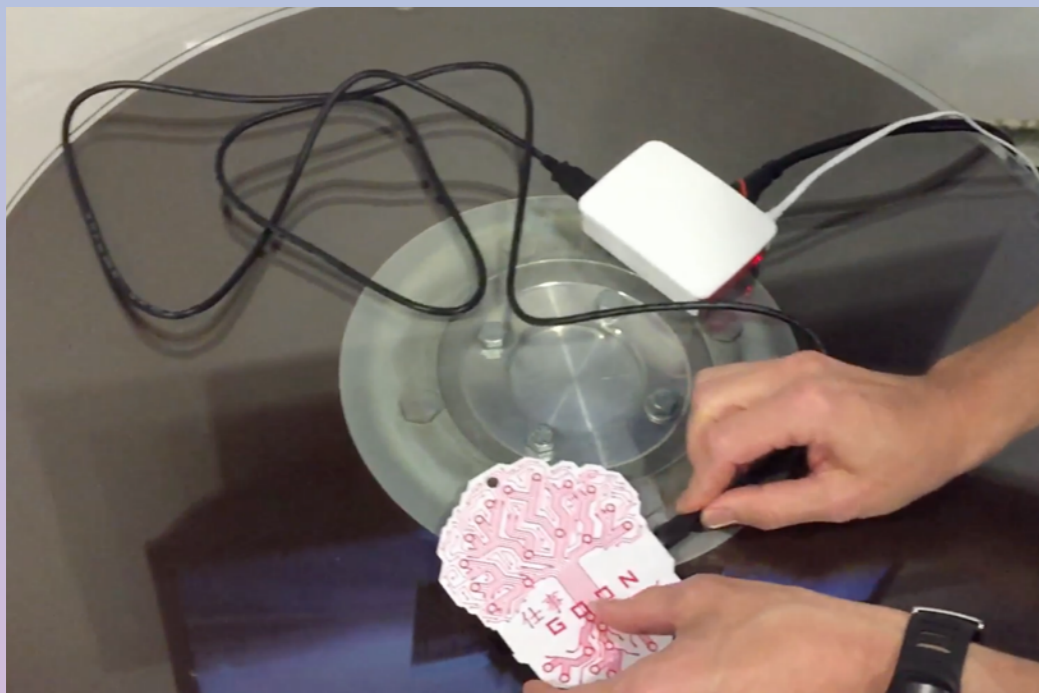


ASSEMBLY



PROGRAMMING / TESTING

- RASPBERRY PI 3 MODEL B+
 - SHELL SCRIPT TO PROGRAM FT231X AND ATMEGA328P VIA USB
- POWER ON SELF TEST
 - VISUAL INSPECTION OF LEDS
 - DETECTION OF ACCELEROMETER



```
sudo
File Edit Tabs Help
Welcome to the DEF CON China 1.0 Badge Programming Station
[*] Connect New Board to USB... █
```


NUMBERS

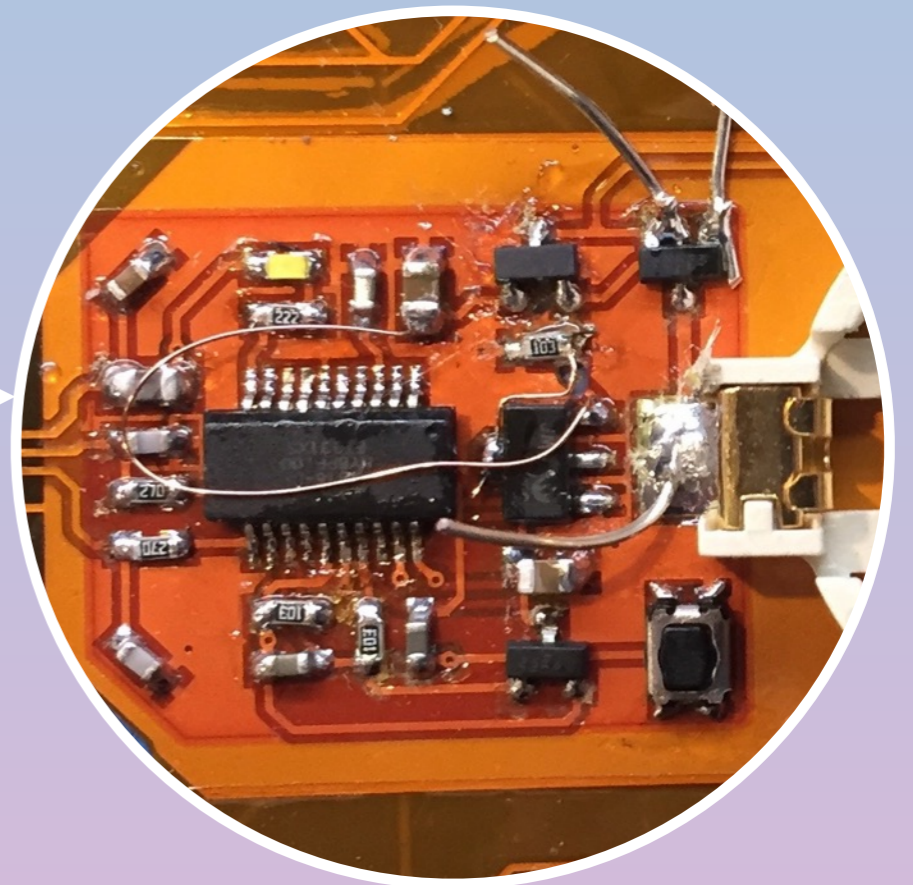
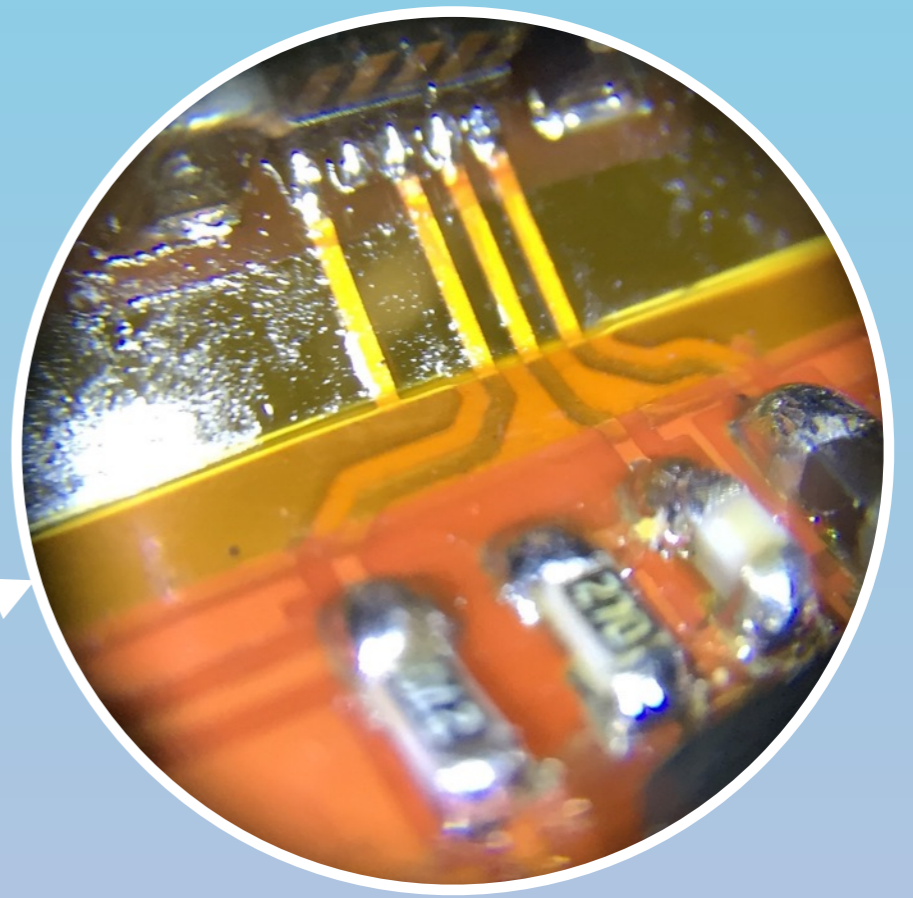
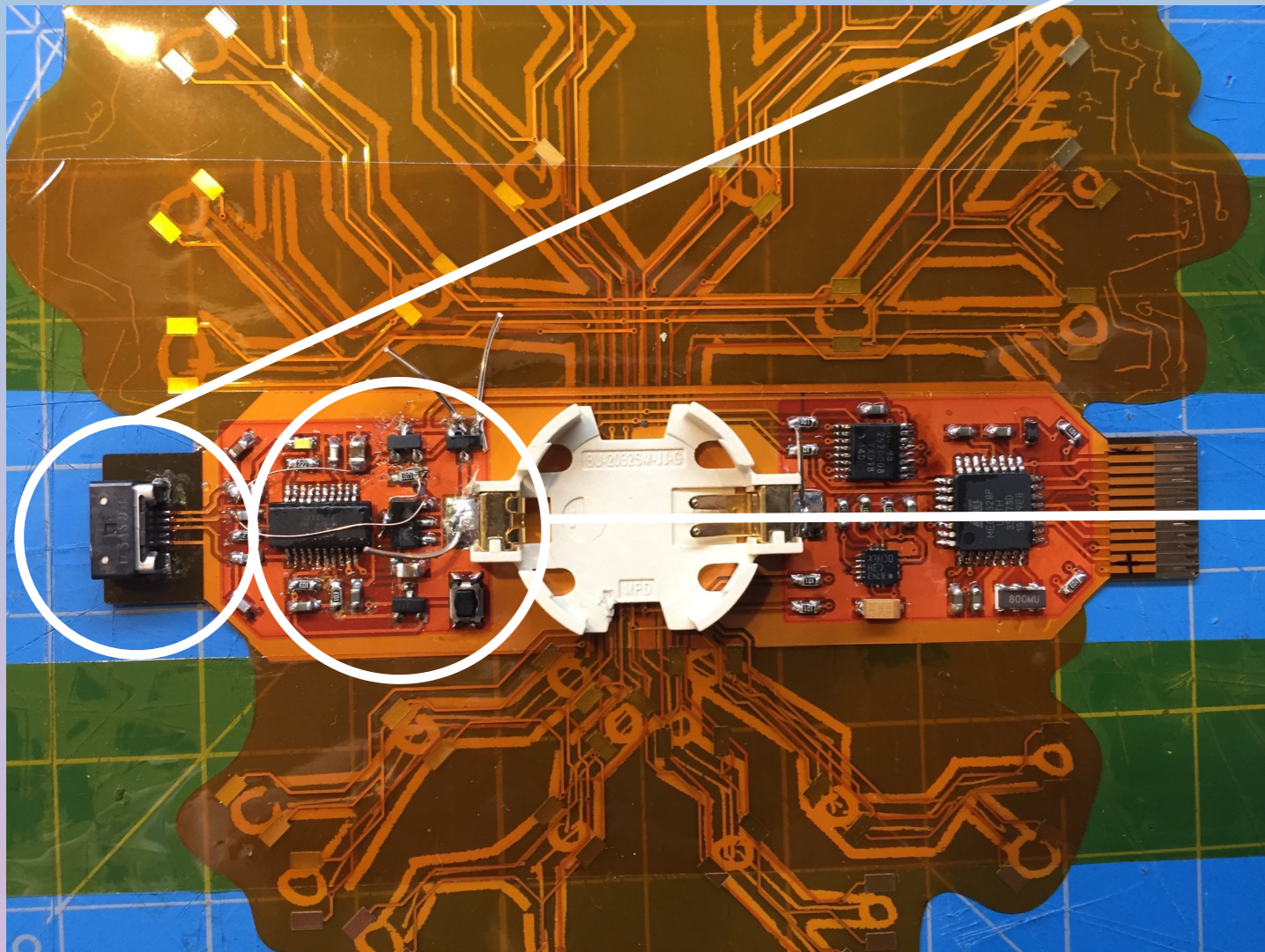
- HUMAN (ATTENDEE), BLACK SILKSCREEN: 2,784
- GOON, RED: 156
- SPEAKER, BLUE: 50
- VILLAGE, BLUE: 90
- SPONSOR, GREY: 120
- PRESS, GREEN: 100
- TOTAL: 3,300



(NOT PRODUCTION VERSIONS)

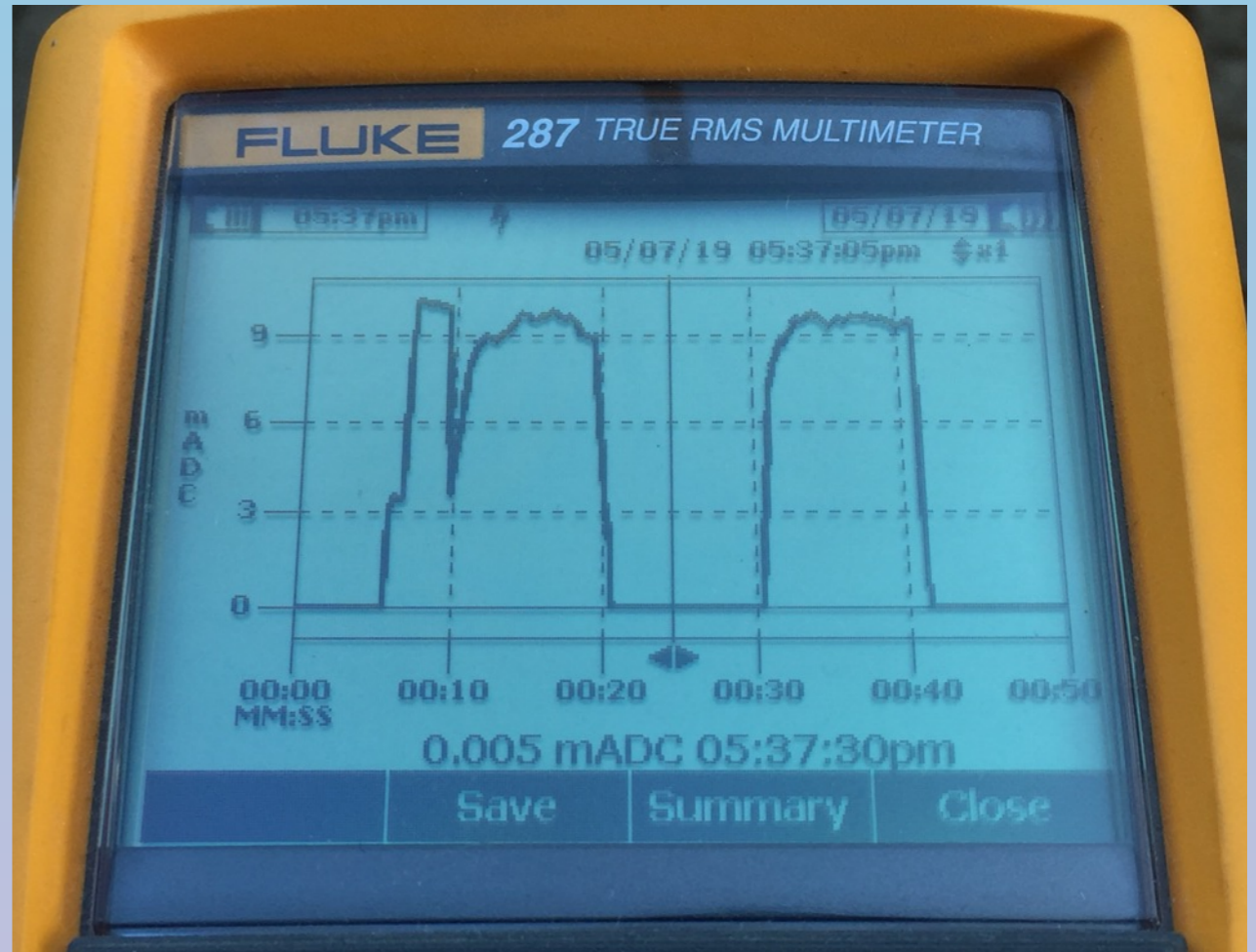
CHALLENGES

- MECHANICAL STRESS
- REWORKING FLEX PCB
- TIME FRAME



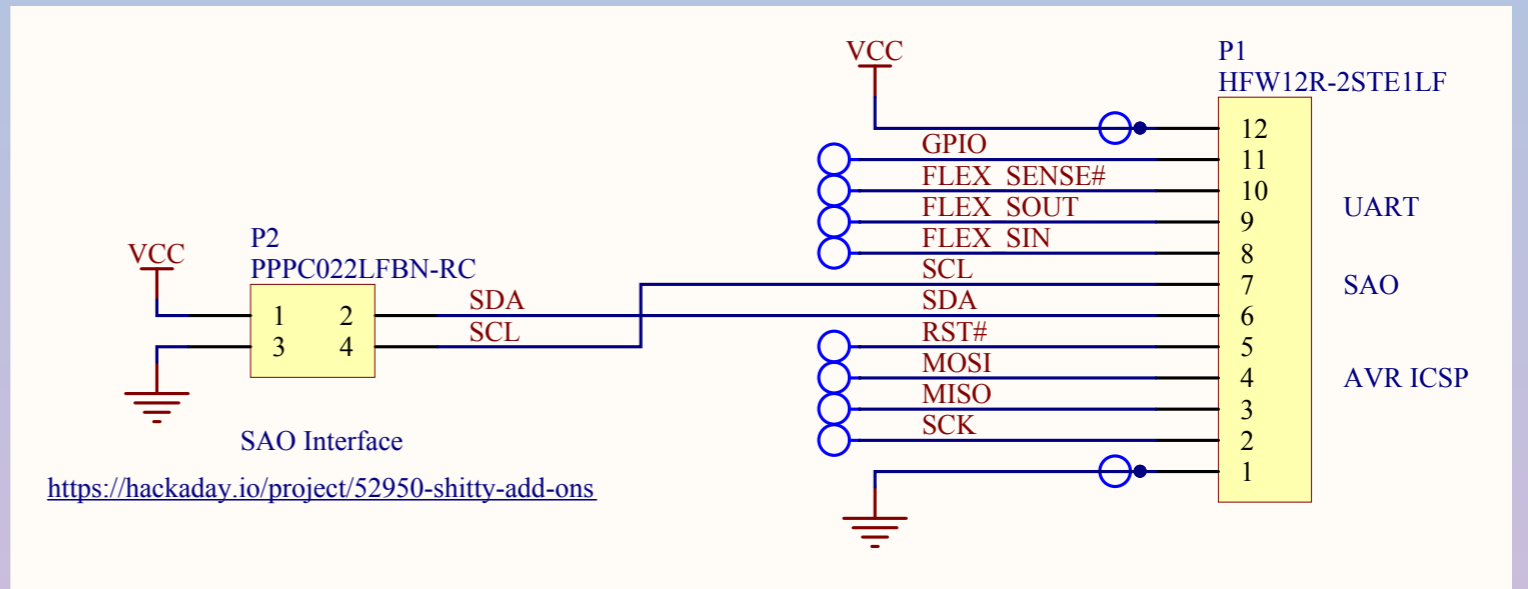
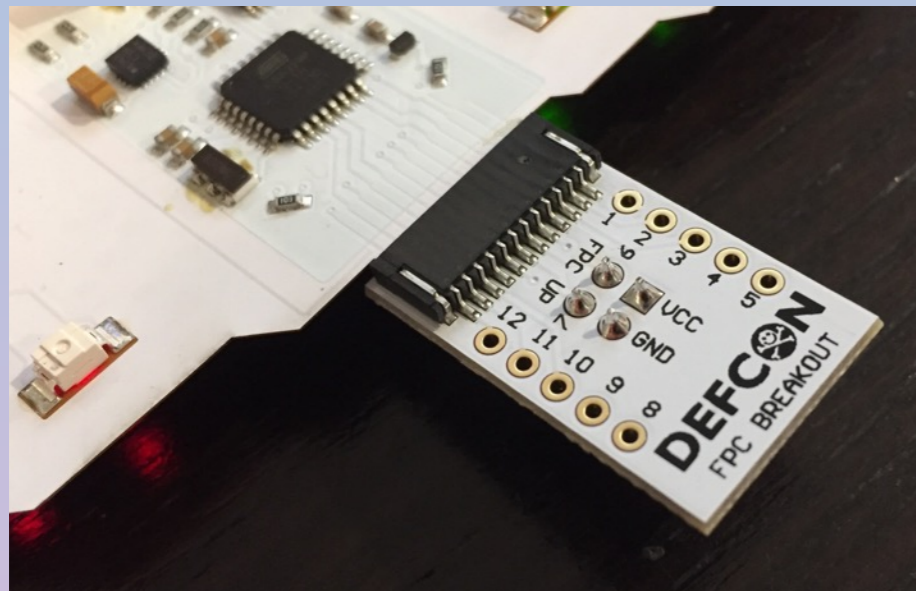
BATTERY LIFE

- CR2032 3V LITHIUM COIN CELL
 - 225MAH TO 2V
- POWER UP, IDLE: 3.3MA
- ALL LEDS ENABLED: 10MA
- SLEEP MODE: 4-6UA
- ACCELEROMETER TO DETECT MOTION
 - SLEEP MODE @ 10 SECONDS OF INACTIVITY

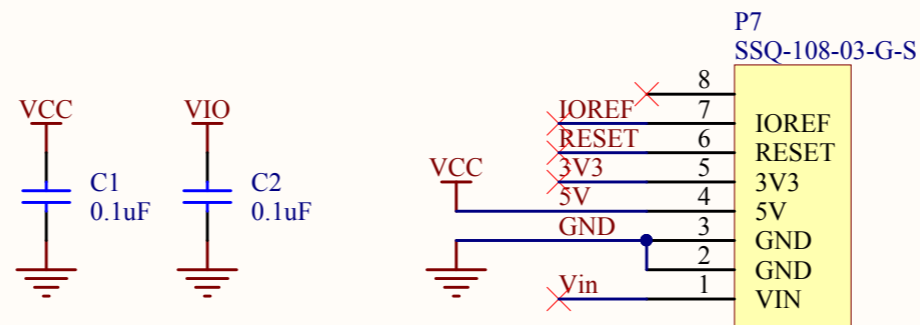
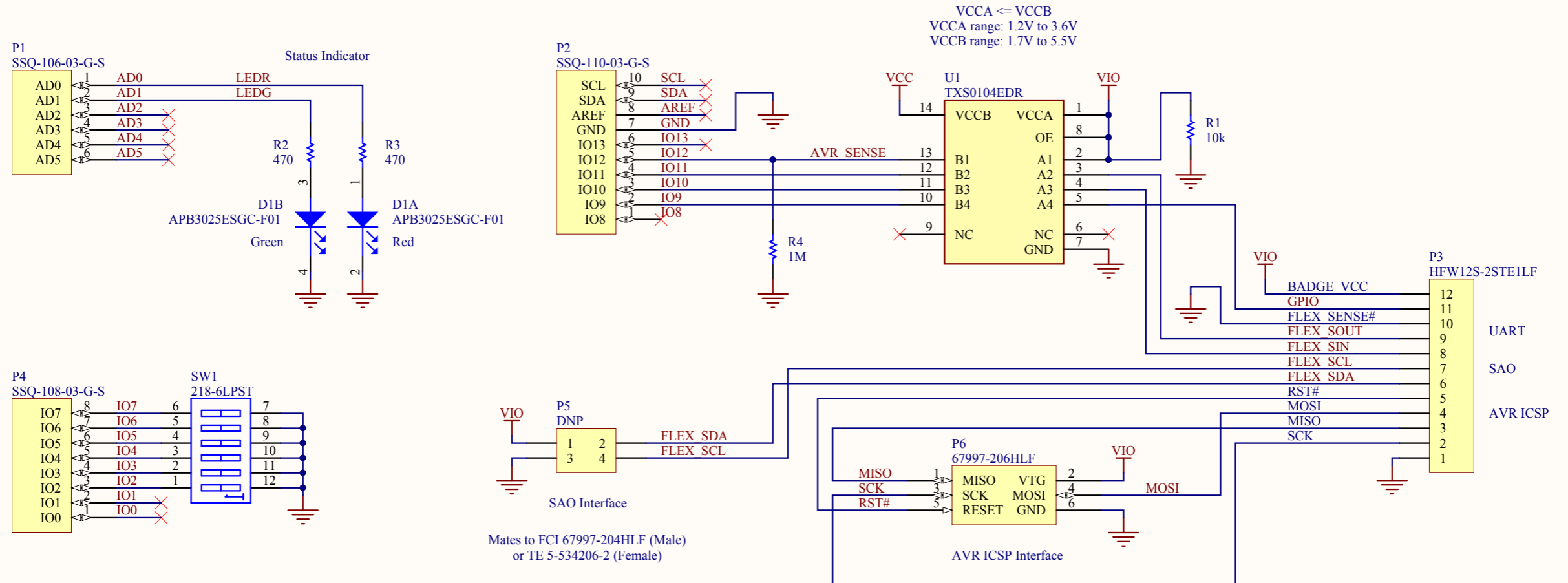


FPC BREAKOUT BOARD

- ACCESS ALL FPC SIGNALS
 - UART, I2C, AVR ICSP
- SAO ADAPTER
- http://oshpark.com/shared_projects/X4QDh3nj



PROGRAMMING SHIELD



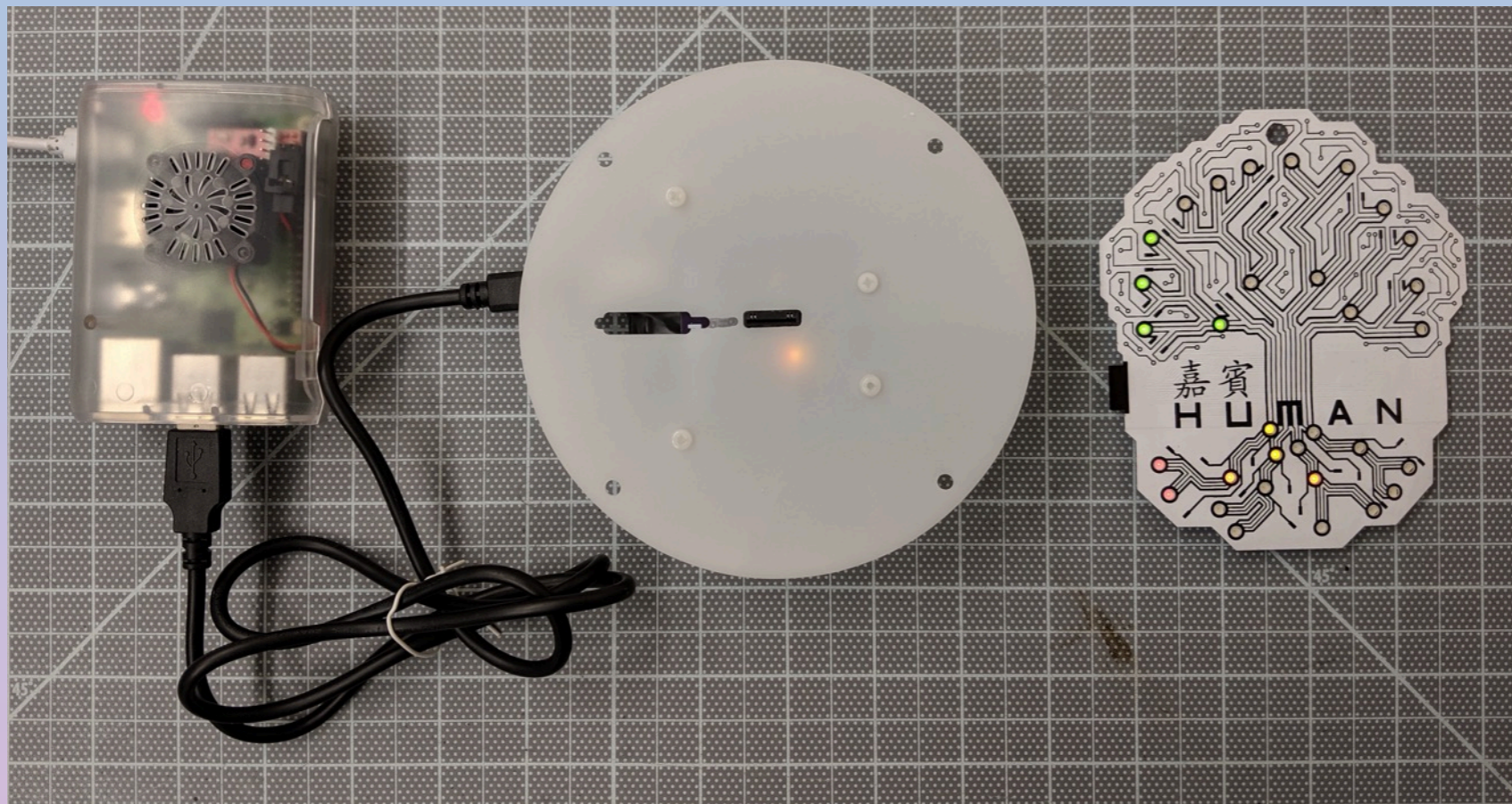
PROGRAMMING SHIELD

- DIP SWITCH SETTINGS DETERMINE FUNCTIONALITY
 - 00: OFF
 - 01: SET SELECTED LED
 - 10: CLEAR SELECTED LED
 - 11: READ BADGE STATE



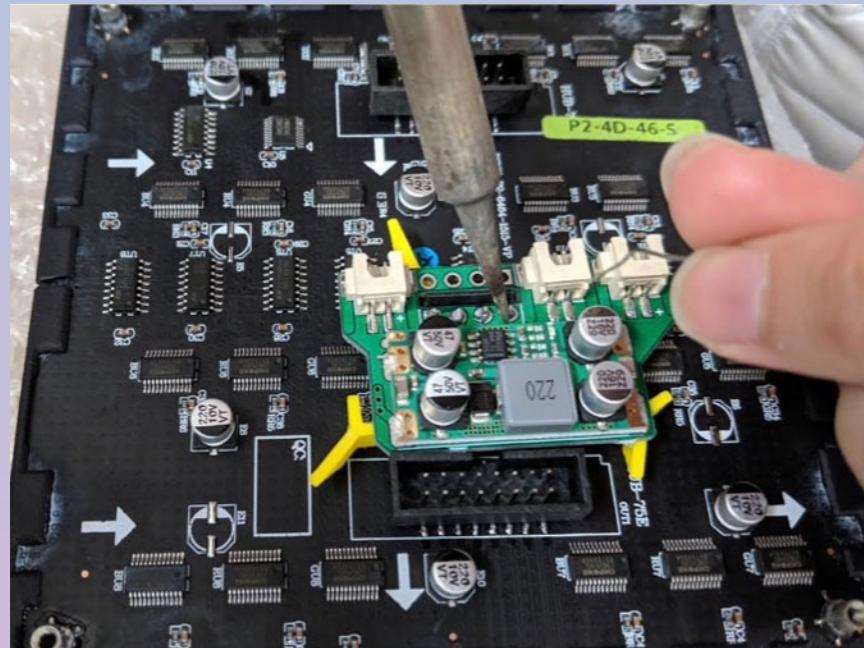
THE TREE OF PROMISE

- INSTALLATION BY DEQING SUN & PEIQI SU (NEW YORK INTERACTIVE)
- EXTENDS THE BADGE FUNCTIONALITY INTO INTERACTIVE ART
- SEMI-PHYSICAL-SEMI-DIGITAL TREE GROWS IN A 6 METER CONTAINER
- BADGE -> ARDUINO -> RASPBERRY PI (OPENFRAMEWORKS) -> PC



THE TREE OF PROMISE

- LED TREE FRUIT
 - GRAPHICS DISPLAYED ON A 3D CUBE
 - TOUCH SENSITIVE
- TREE BRANCHES
 - ALGORITHM TO GENERATE UNIQUE BRANCH FOR EACH ATTENDEE



RESOURCES

- DESIGN DOCUMENTATION, CODE, ETC.
 - www.grandideastudio.com/portfolio/defcon-china-2019-badge

ENJOY THE CONFERENCE!



@JOEGRAND | WWW.GRANDIDEASTUDIO.COM