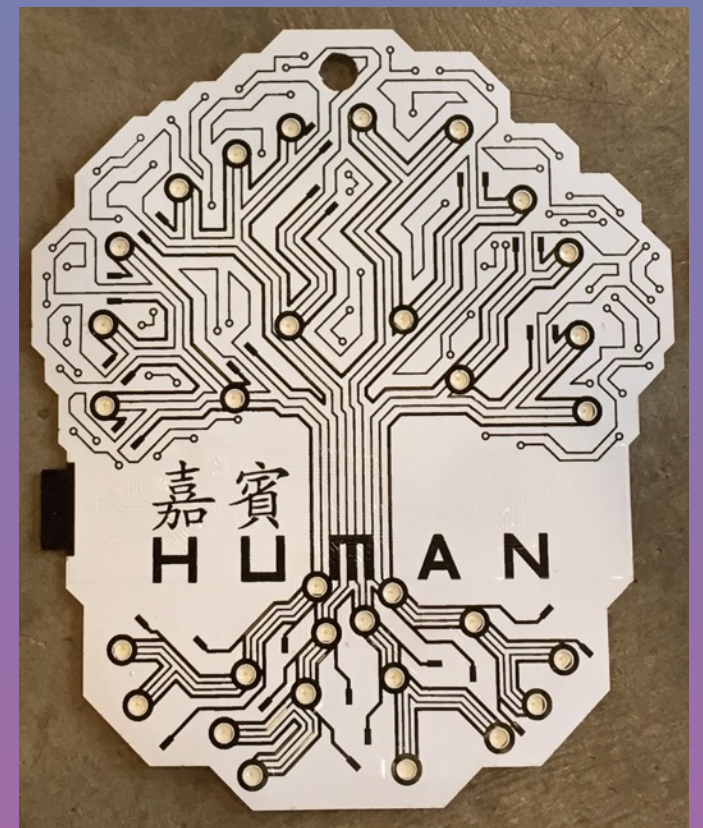
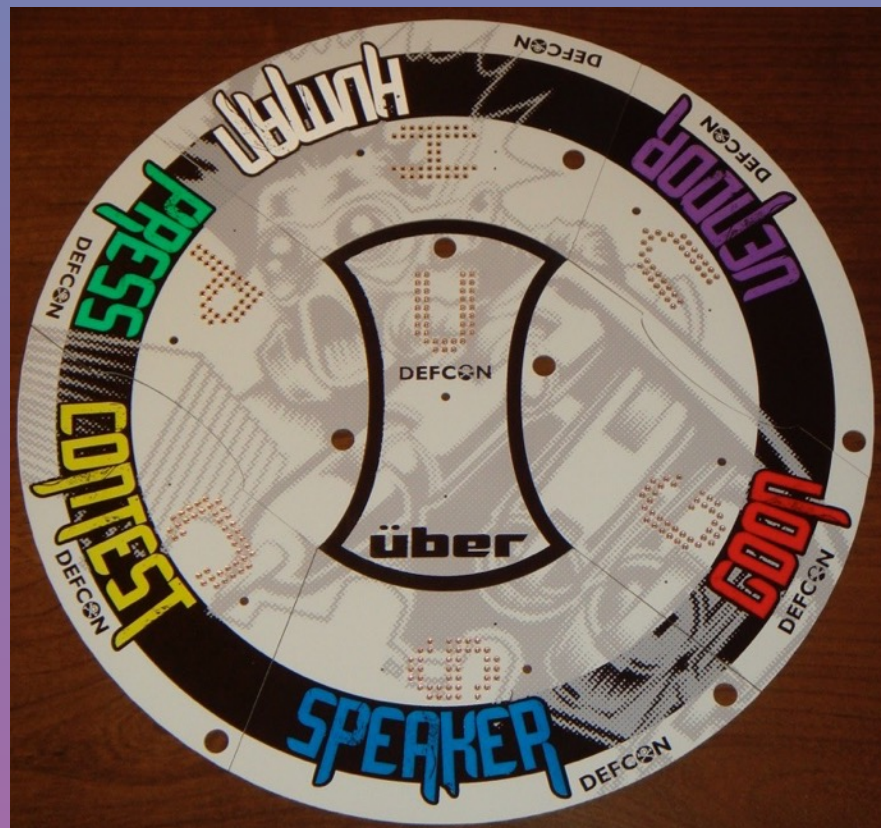


BEHIND THE SCENES OF THE DEFCON 27 BADGE



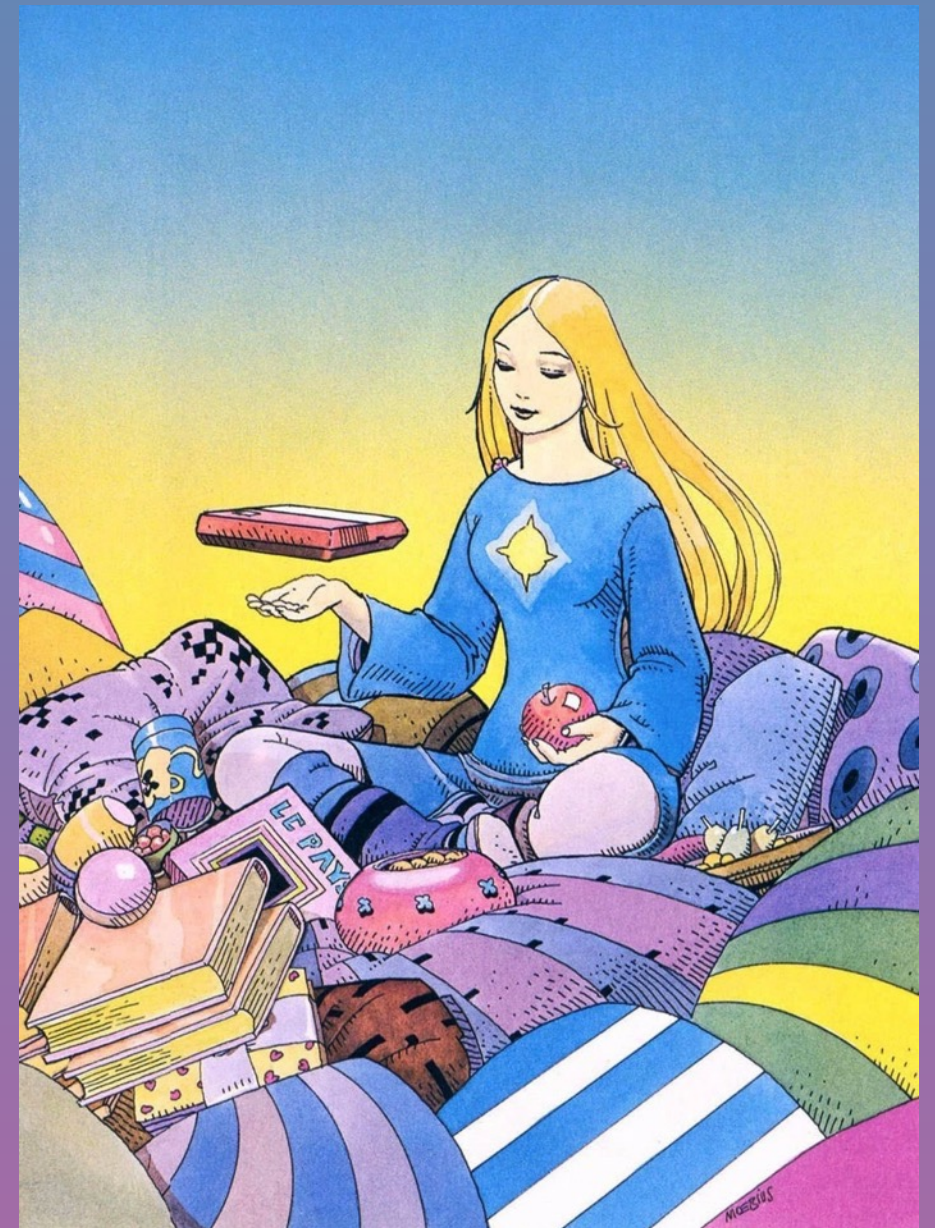
JOE GRAND AKA KINGPIN

BADGE HISTORY



GOALS

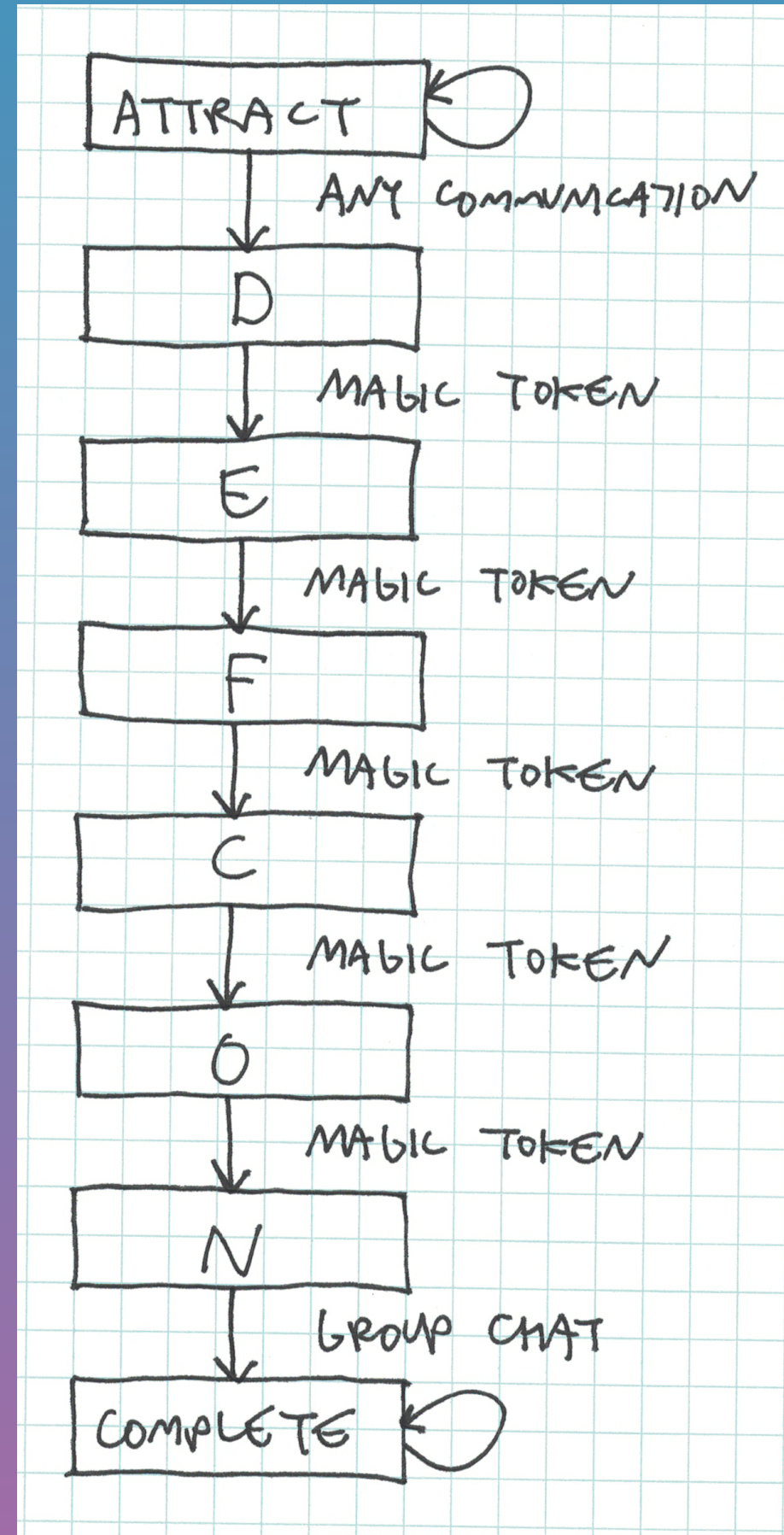
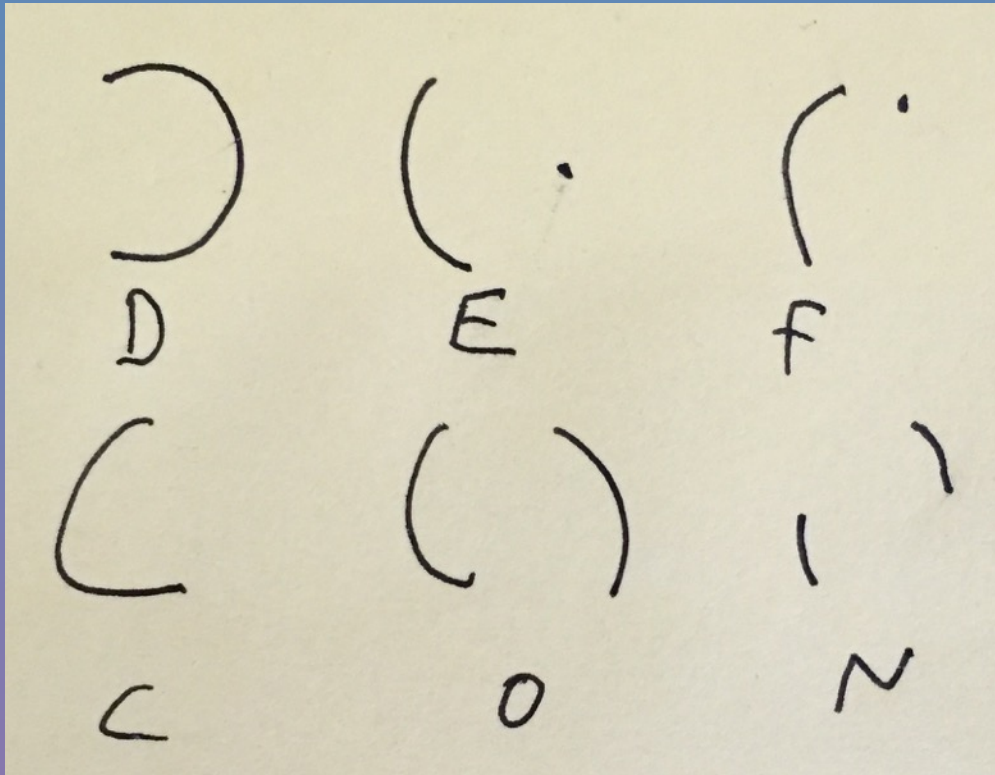
- CREATE A GAME TO ENCOMPASS THE DEFCON EXPERIENCE
- USE TECHNOLOGY TO BRING COMMUNITY TOGETHER
- ACCESSIBLE TO ALL DEFCON ATTENDEES



GAMEPLAY / BADGE QUEST

- STATES DENOTED BY LED PATTERNS
- ADVANCE TO THE NEXT STATE BY COMPLETING TASKS
 - SOME REQUIRE DISCOVERY OF MAGIC TOKENS
 - ALL REQUIRE INTERACTION WITH OTHER PEOPLE
- WHEN ALL TASKS ARE COMPLETE, CELEBRATE

GAMEPLAY / BADGE QUEST



HARDWARE

ANTENNA

PIEZO

LED DRIVER

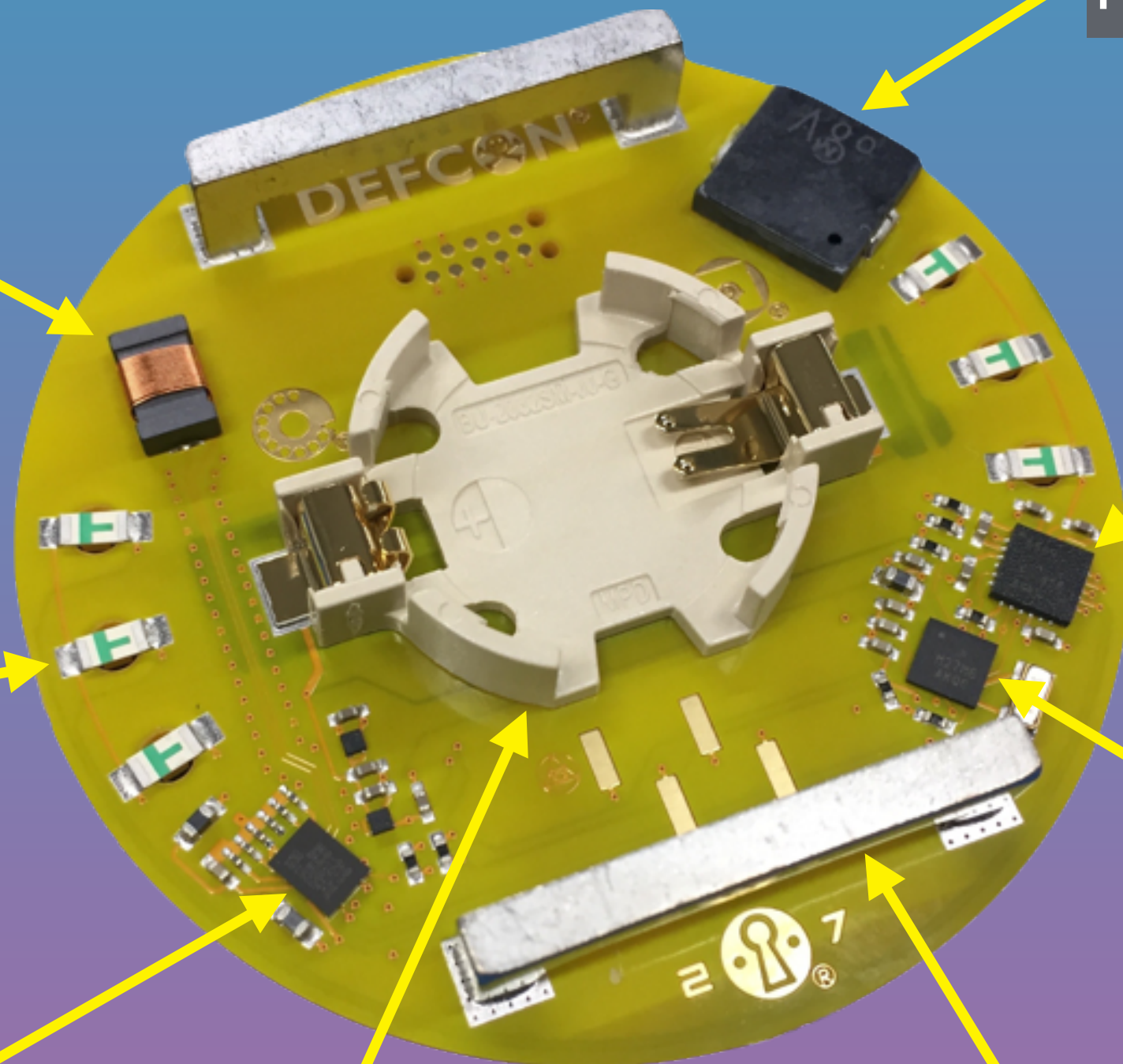
LED

MCU

NFMI

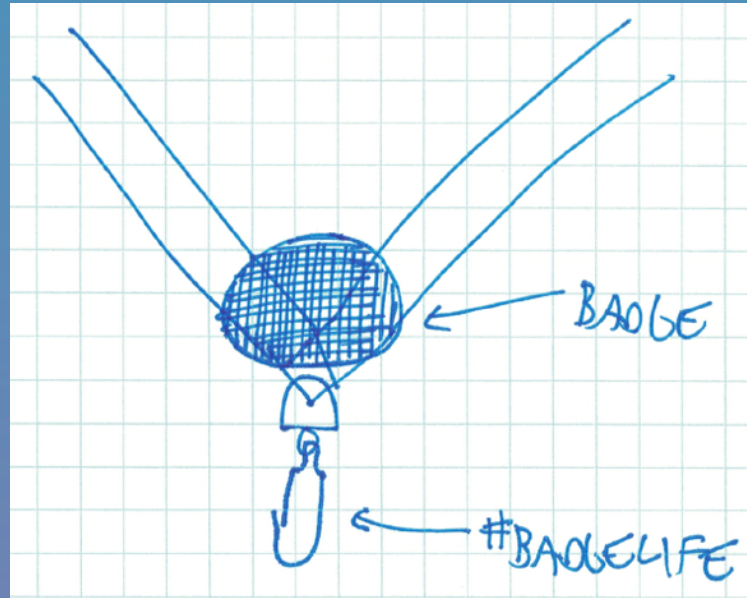
POWER

LANYARD STRAP

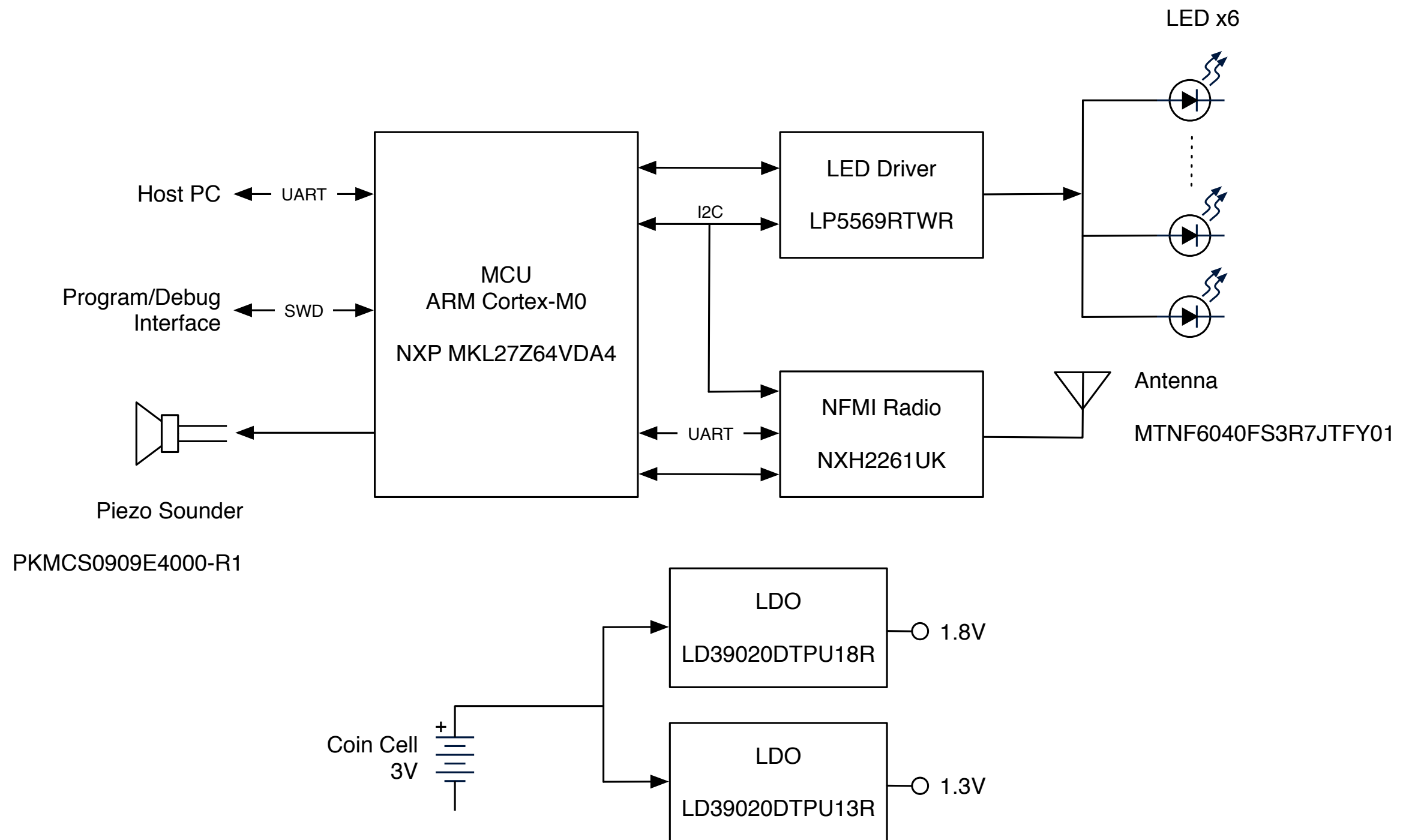


MOUNTING OPTIONS

- LANYARD
- LANYARD CLIP
- WATCH STRAP
- HEADBAND
- BROOCH / AMULET
- ???

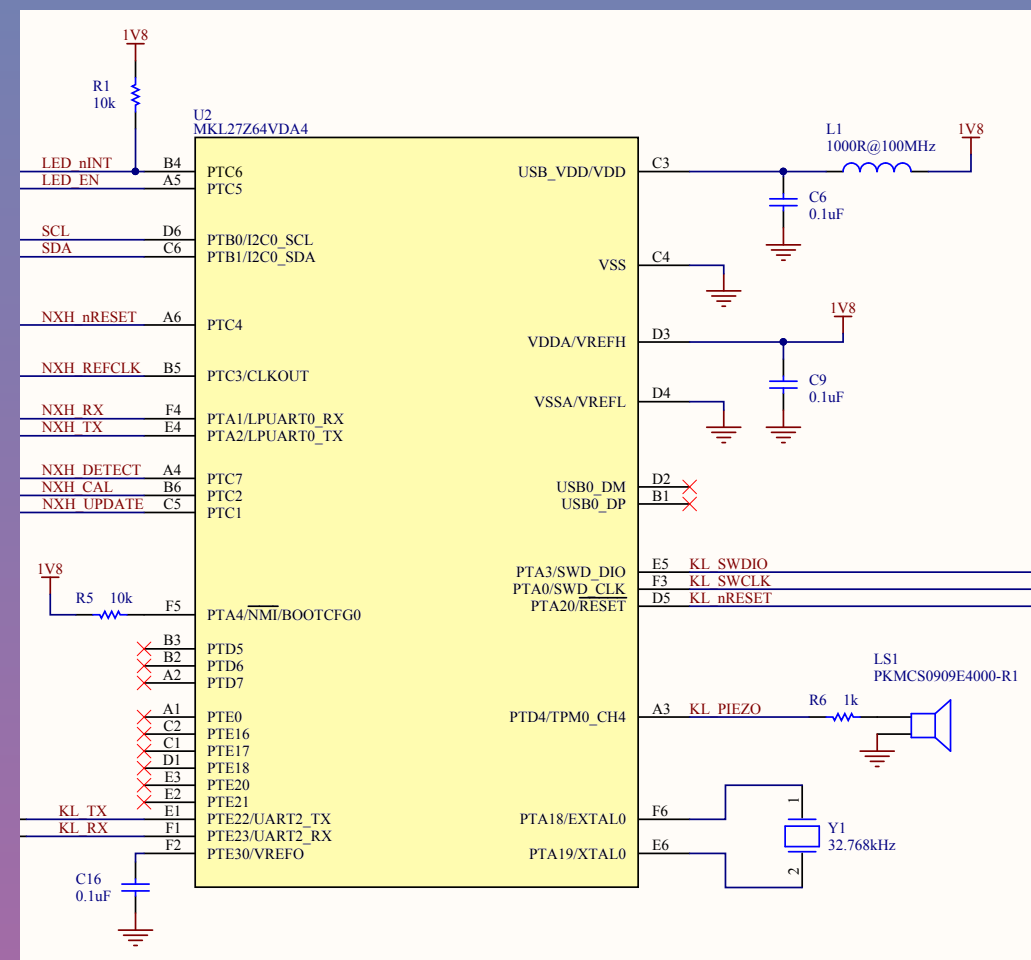
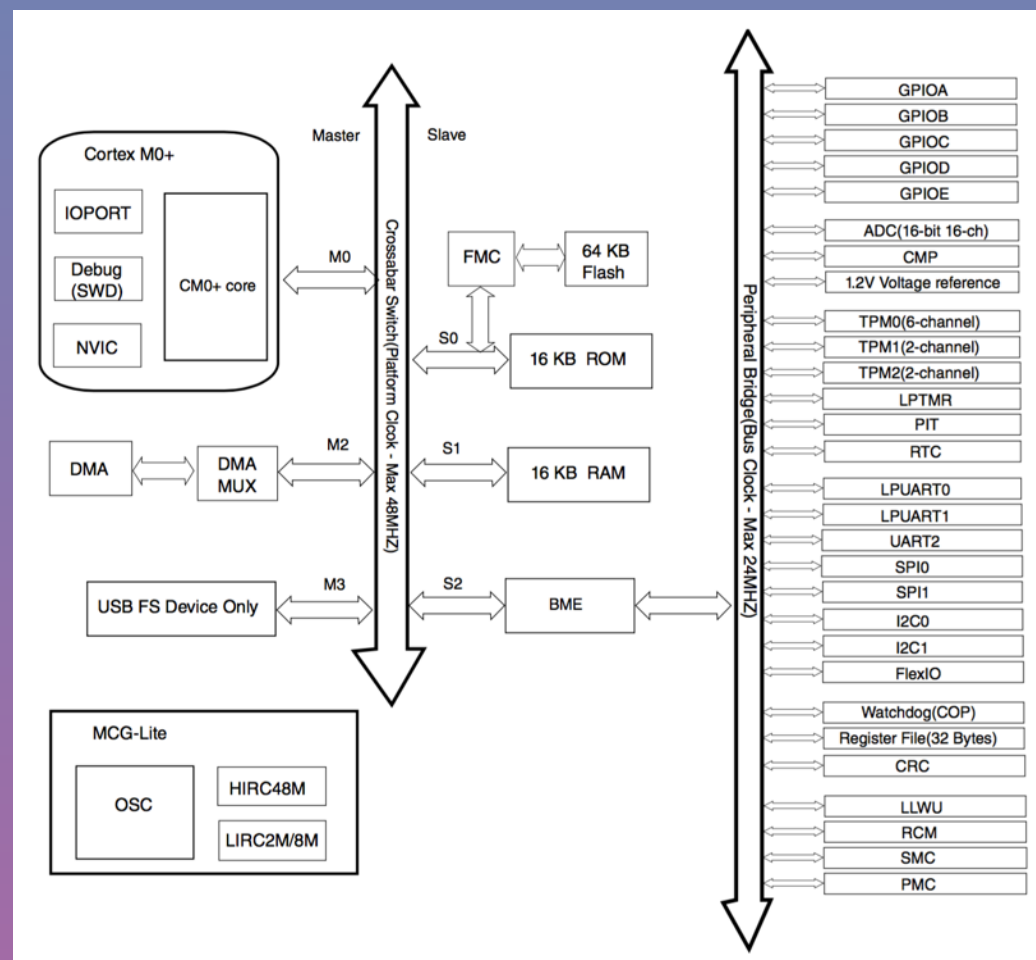


BLOCK DIAGRAM



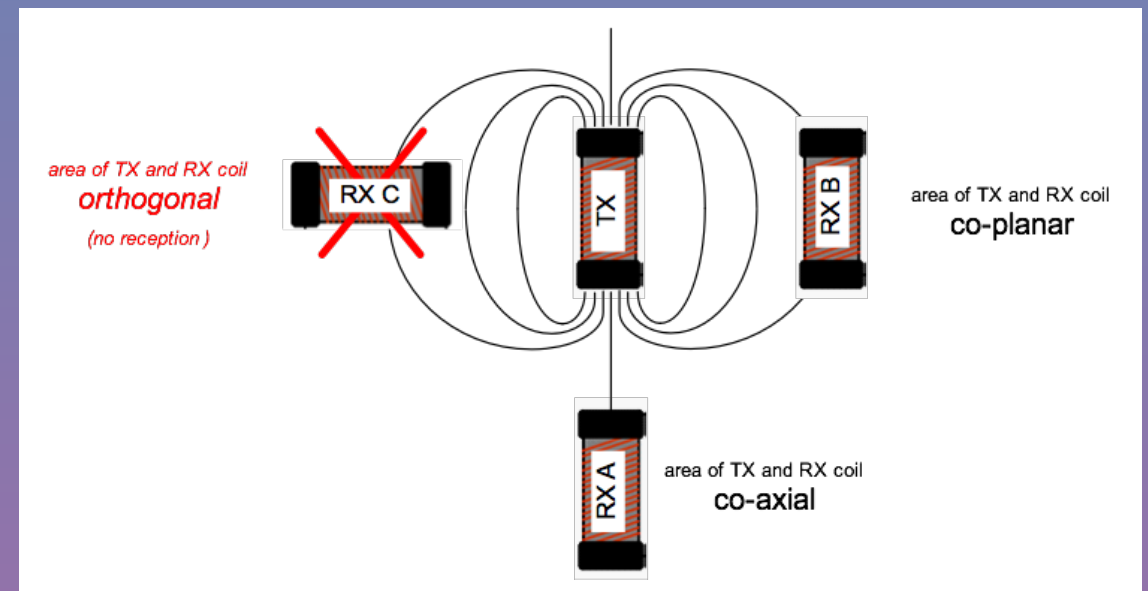
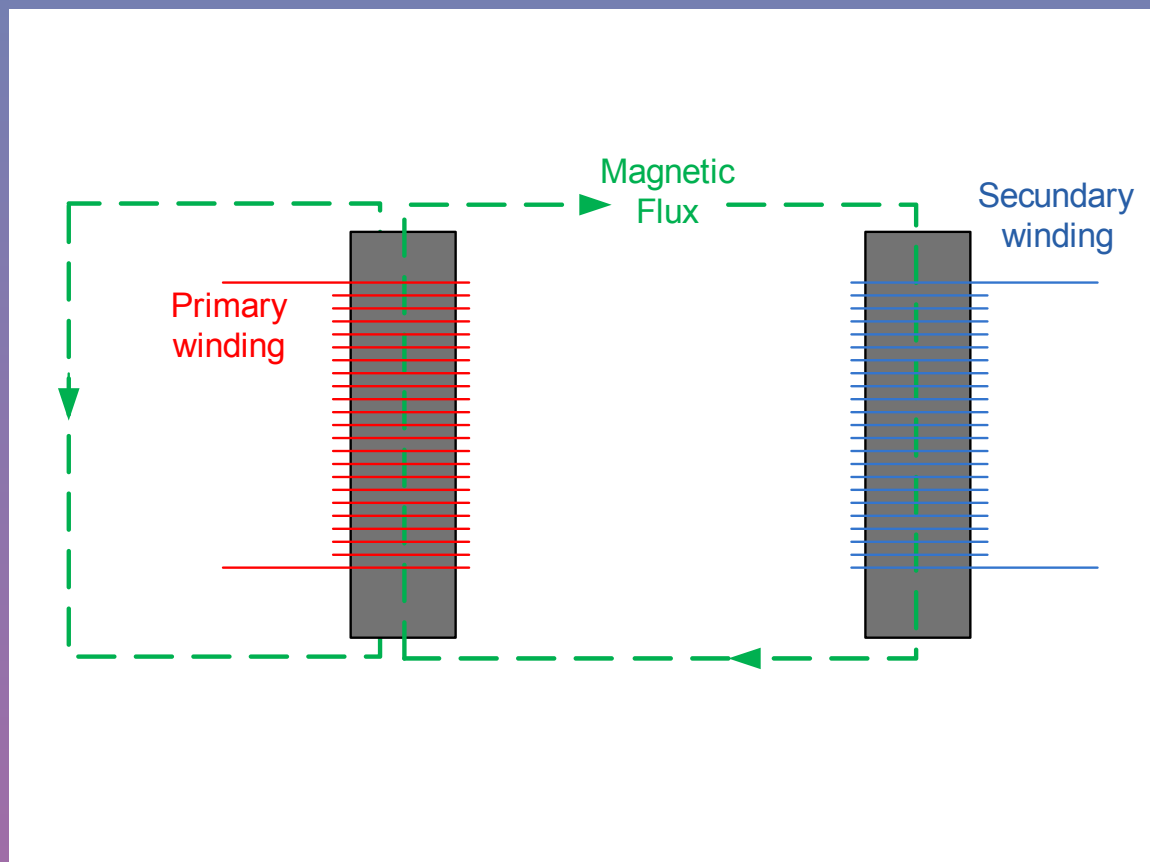
MCU

- NXP KL27
- ARM-CORTEX M0+
- 64KB FLASH, 16KB SRAM
- DC27: GPIO, I2C, LPTMR, TPM, UART (2)



NFMI

- NEAR FIELD MAGNETIC INDUCTION
- LOW POWER, NON-PROPAGATING FIELD BETWEEN DEVICES
- DESIGNED FOR SHORT RANGE DATA AND / OR AUDIO TRANSFER (< 1M)
- HEARING AIDS, WIRELESS EAR BUDS, BODY AREA NETWORK / TACTICAL



- **NXP MIGLO**

- NXH2261 = NFMI + ARM

- UART TO / FROM KL27

- GPIO FOR STATUS / INTERRUPT

- 10.58MHZ CARRIER, 596KBPS

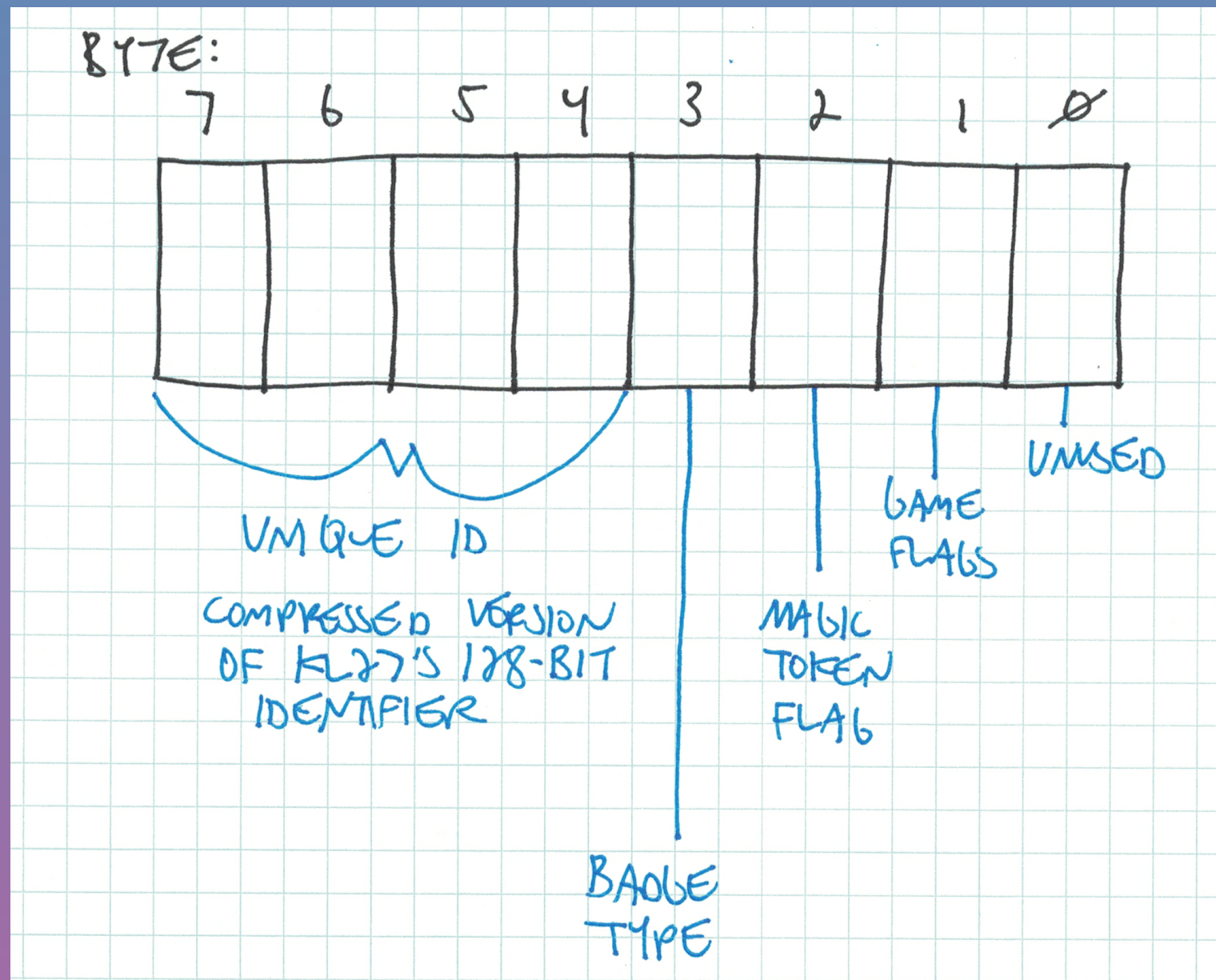
- CUSTOM MULTI-BADGE DATA TRANSFER CODE BY NXP FOR DC27

- LPBROADCAST_NXH_DC27.EEP.H



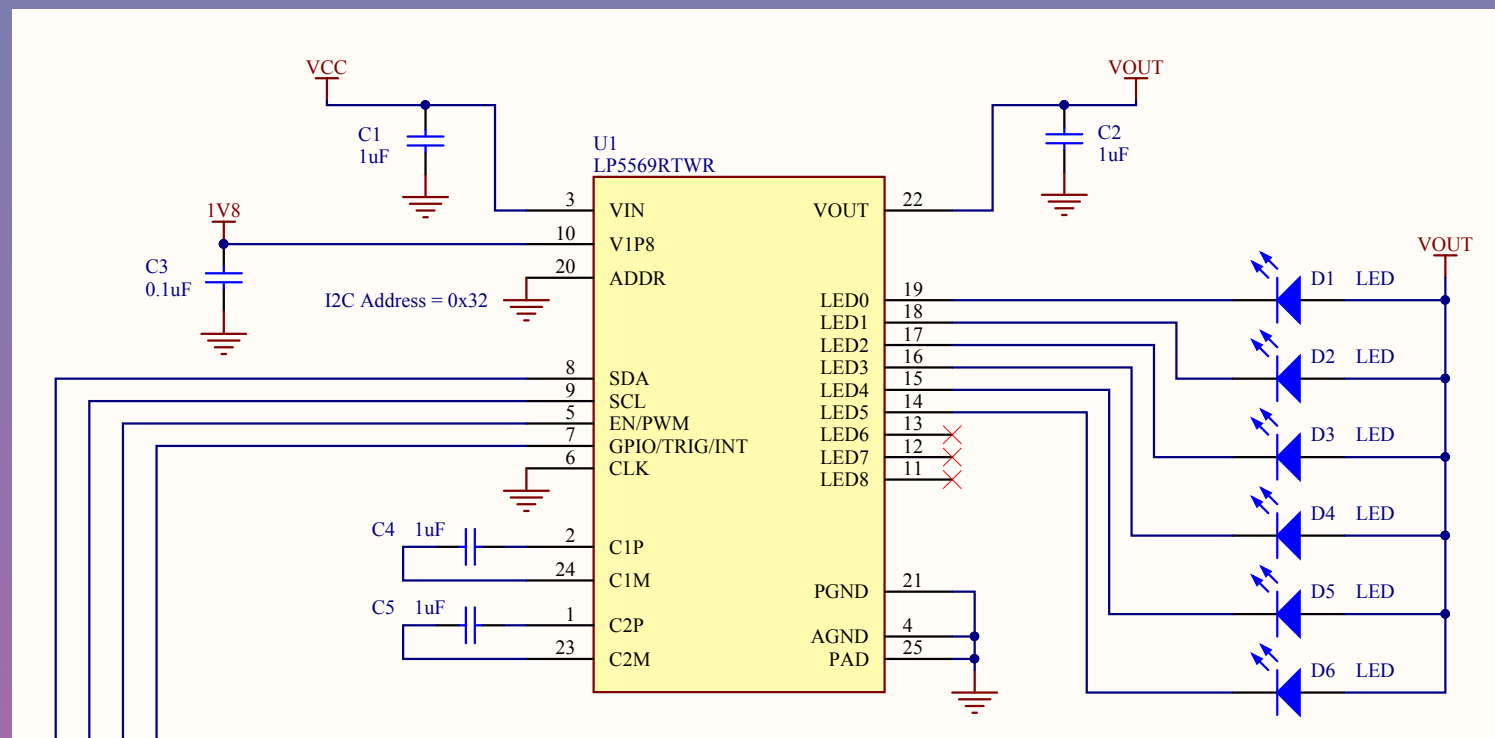
NFMI

- DATA PACKET AKA "PACKET OF INFAMY"
- BROADCAST TO ANY DEVICE WITHIN RANGE

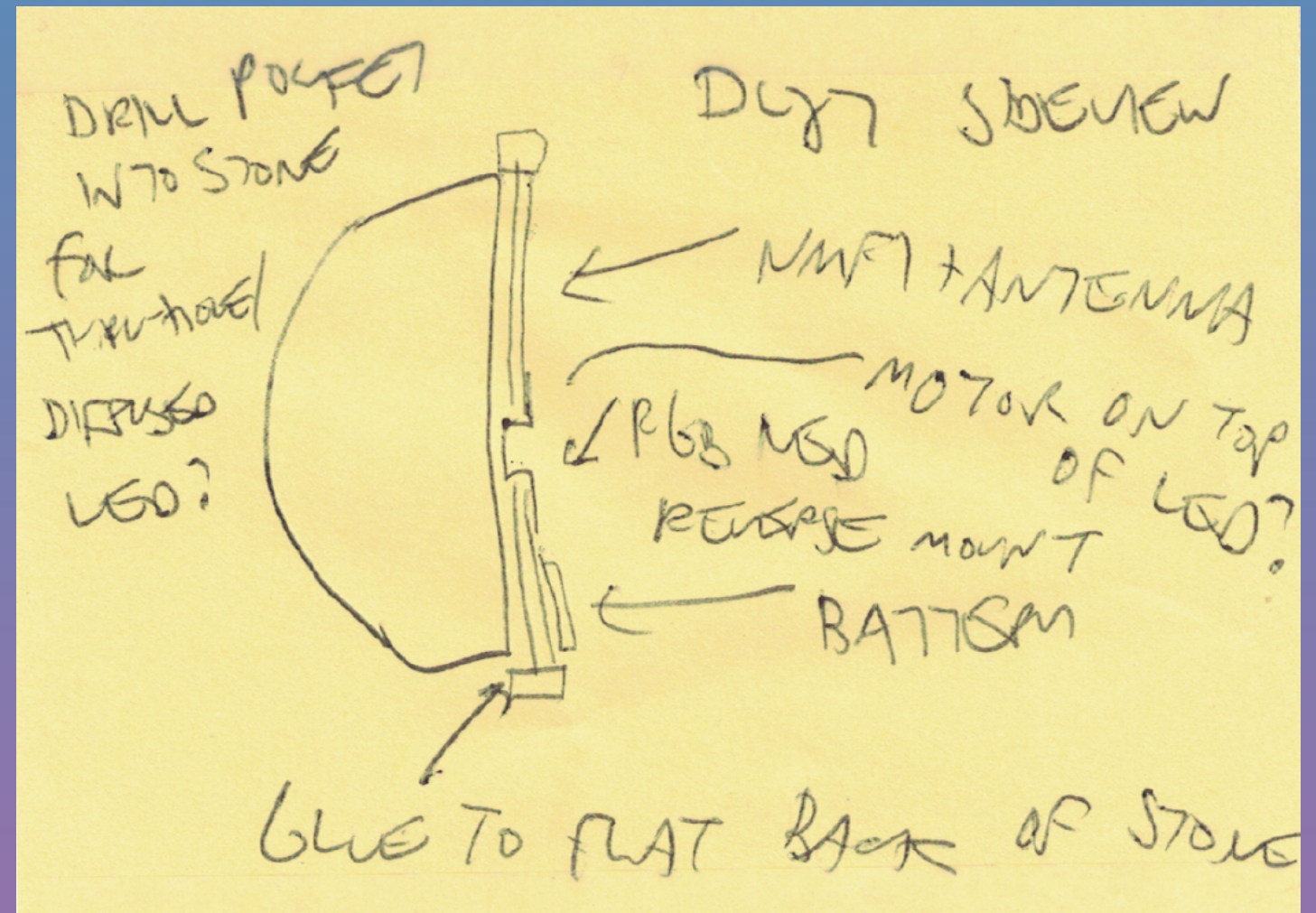


LED DRIVER

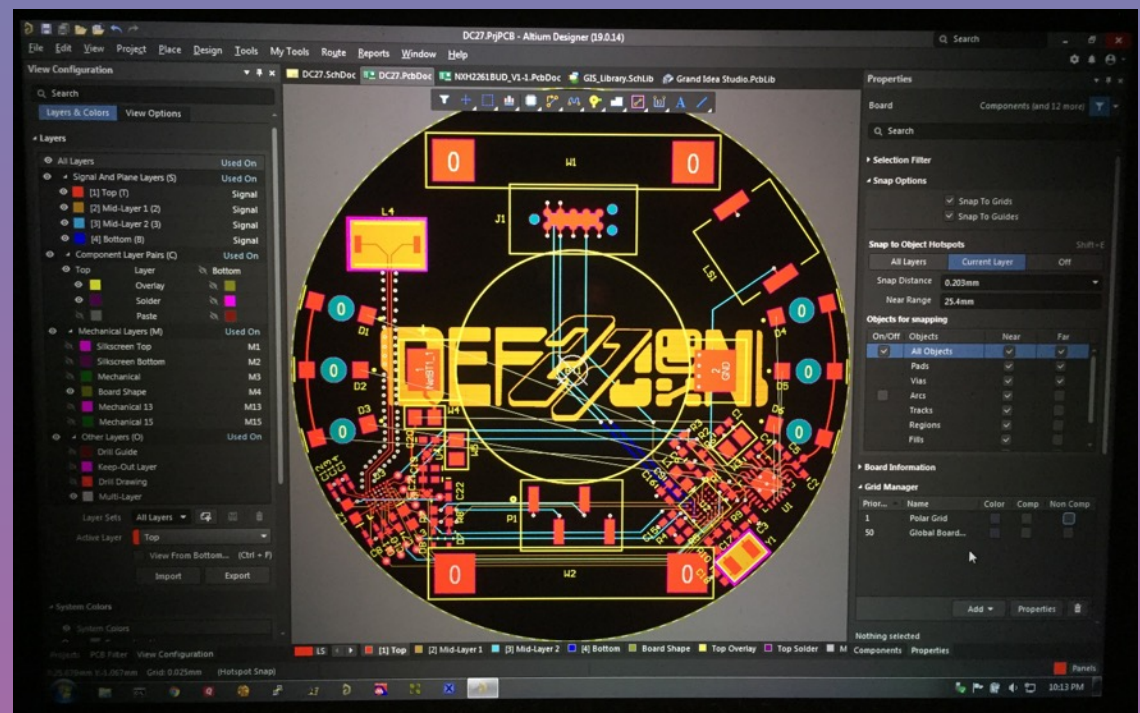
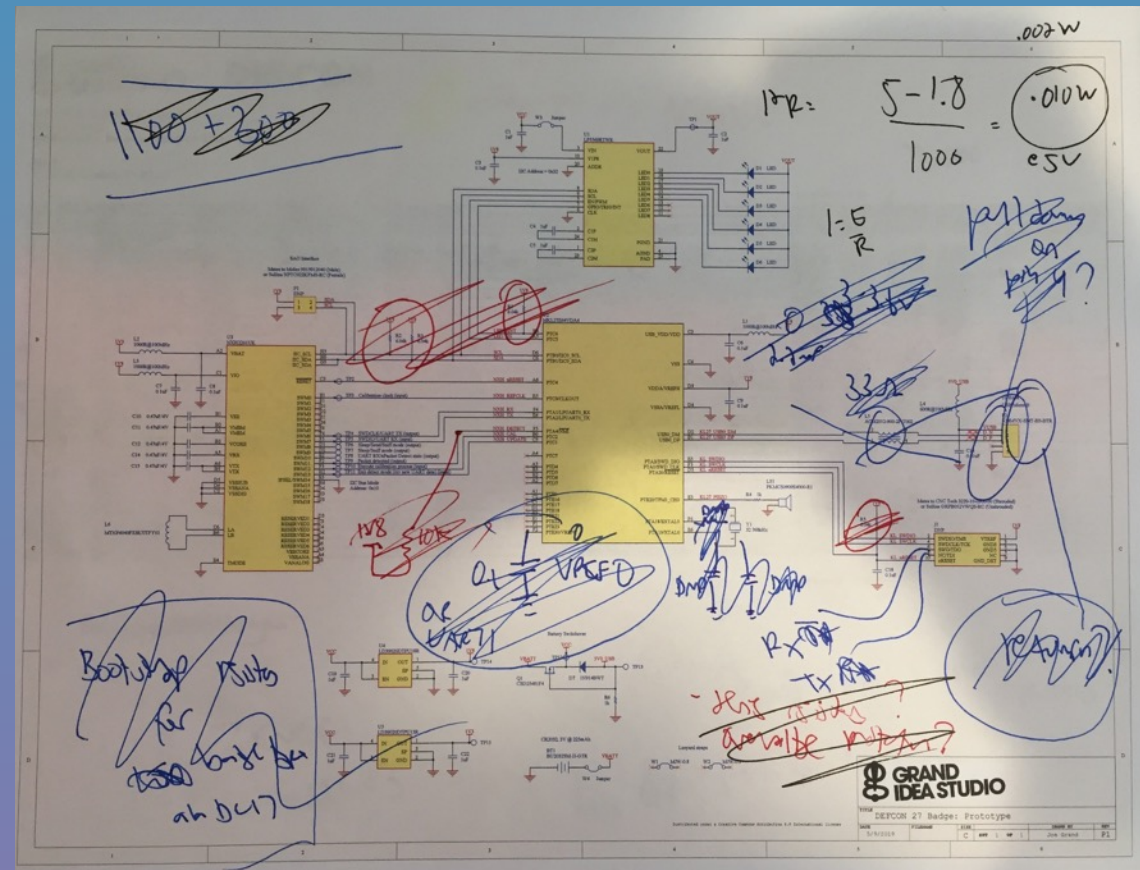
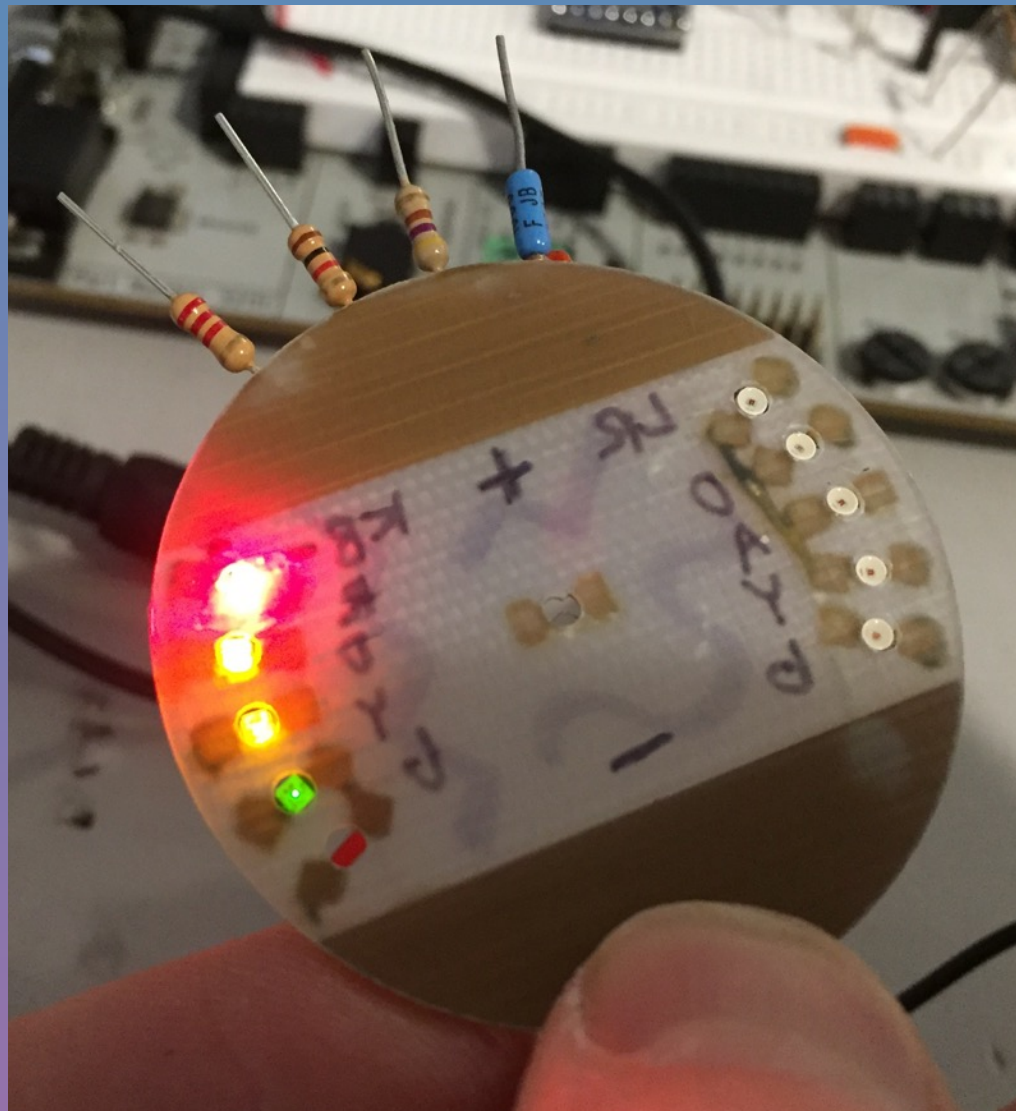
- TEXAS INSTRUMENTS LP5569
- 1.5X CHARGE PUMP = HIGH VF LEDS @ LOW VIN
- AUTOMATIC POWER SAVE MODE (10UA)
- EACH LED INDIVIDUALLY ADDRESSABLE, DIMMABLE (12-BIT PWM @ 20KHZ)
- CURRENT OUTPUT VARIES PER COLOR, SET ON POWER-UP (8-BIT, 100UA STEP)



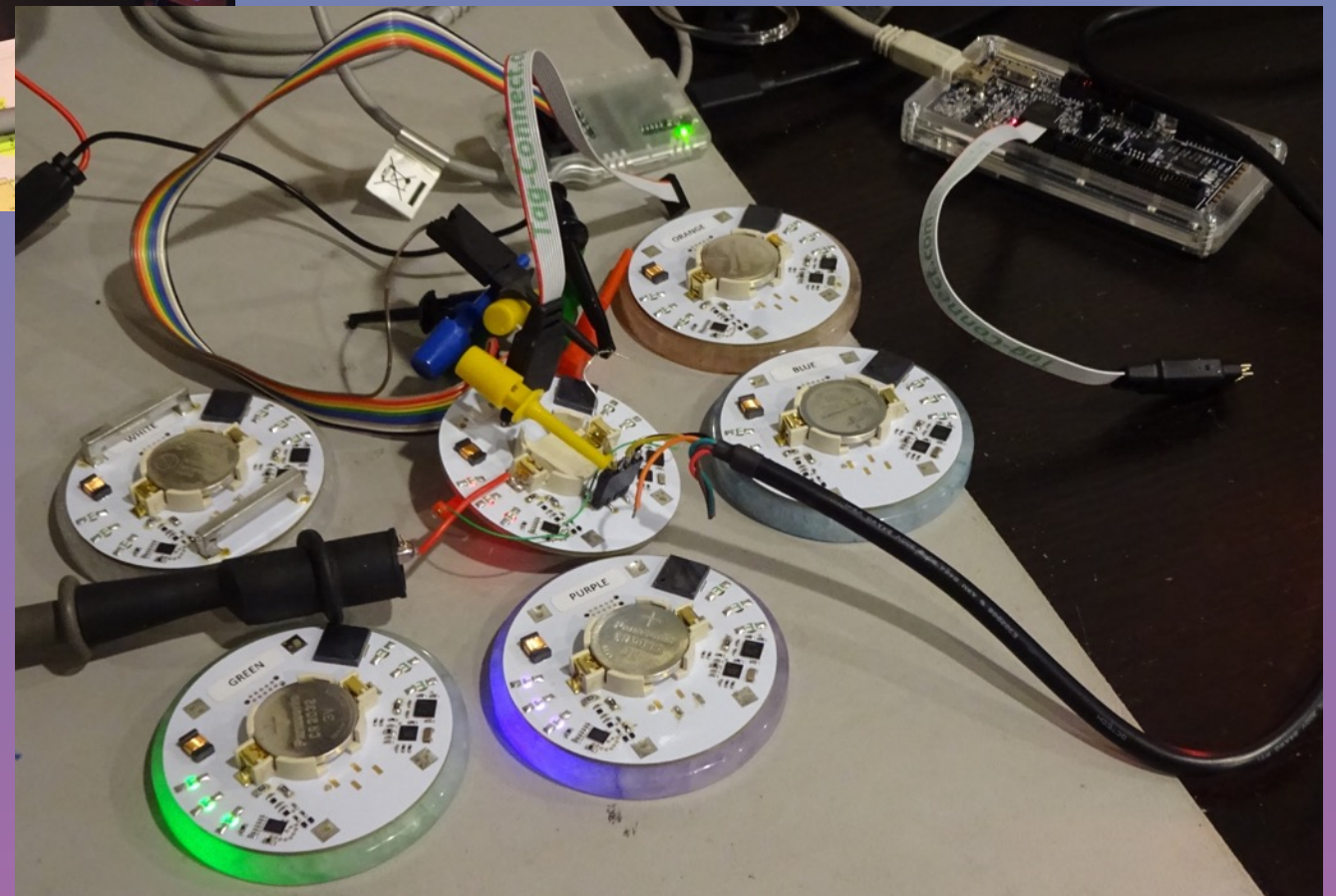
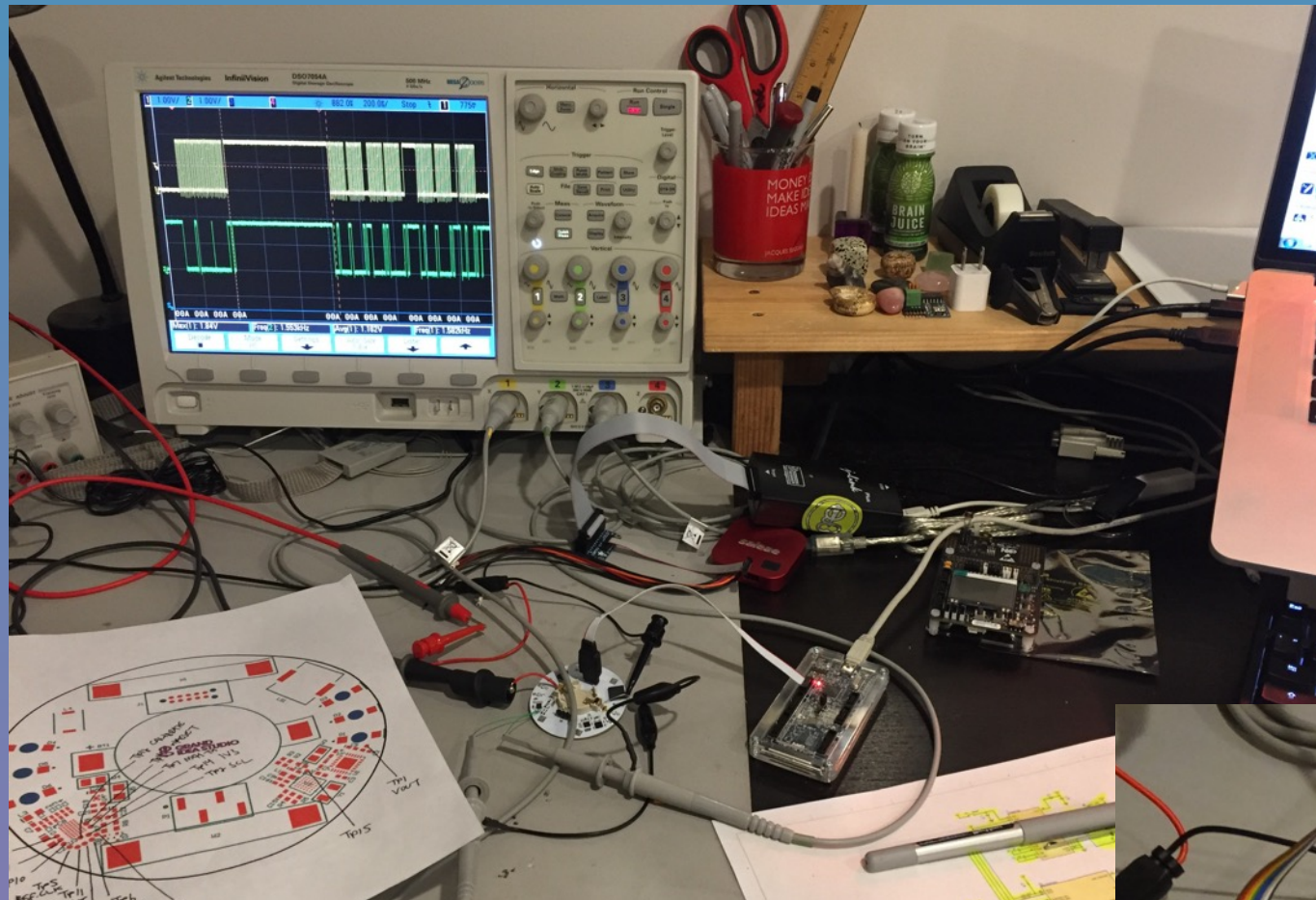
EARLY CONCEPTS



PROTOTYPING / DEVELOPMENT



PROTOTYPING / DEVELOPMENT



HUNTING FOR TREASURE

- ADVENTURES AT THE TUCSON GEM SHOW
- 48 SHOWS OVER TWO WEEKS, ~50K PEOPLE
- 36 HOURS TO FIND SUPPLIER
- RETAIL VENDORS / HOTEL ROOMS -> WHOLESALE ->
MINE OWNER-> FACTORY



HUNTING FOR TREASURE



GEMSTONE FABRICATION

- HAND CUT QUARTZ CRYSTAL
- RAW MATERIAL FROM BRAZIL
- NATURALLY FRACTURED, STRENGTH VARIES
- DYED COLORS FOR NON-HUMAN BADGES
- CRAFTED BY YEE ON GEMS & JEWELLERY



GEMSTONE FABRICATION



GEMSTONE FABRICATION



GEMSTONE FABRICATION

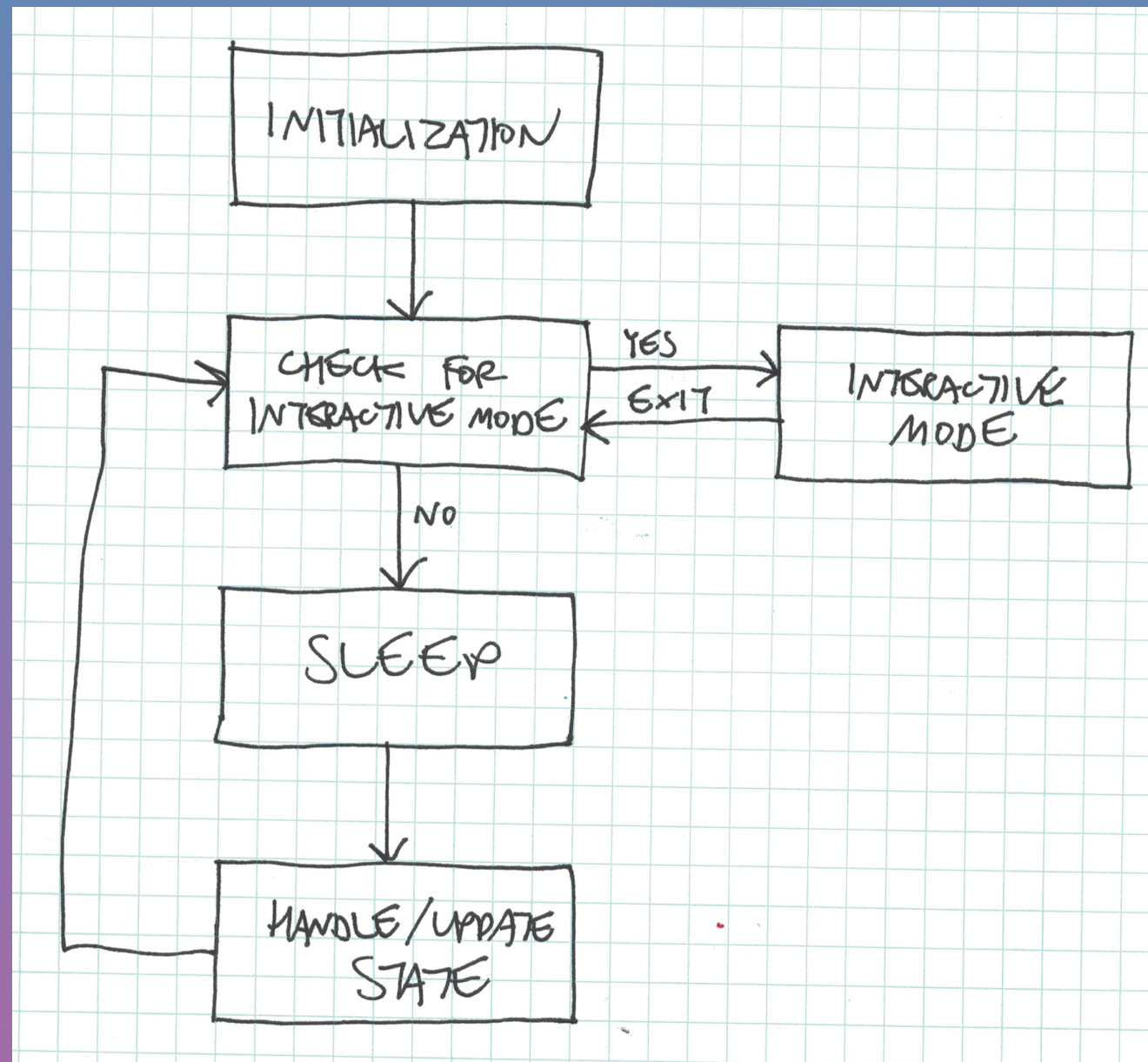


GEMSTONE FABRICATION



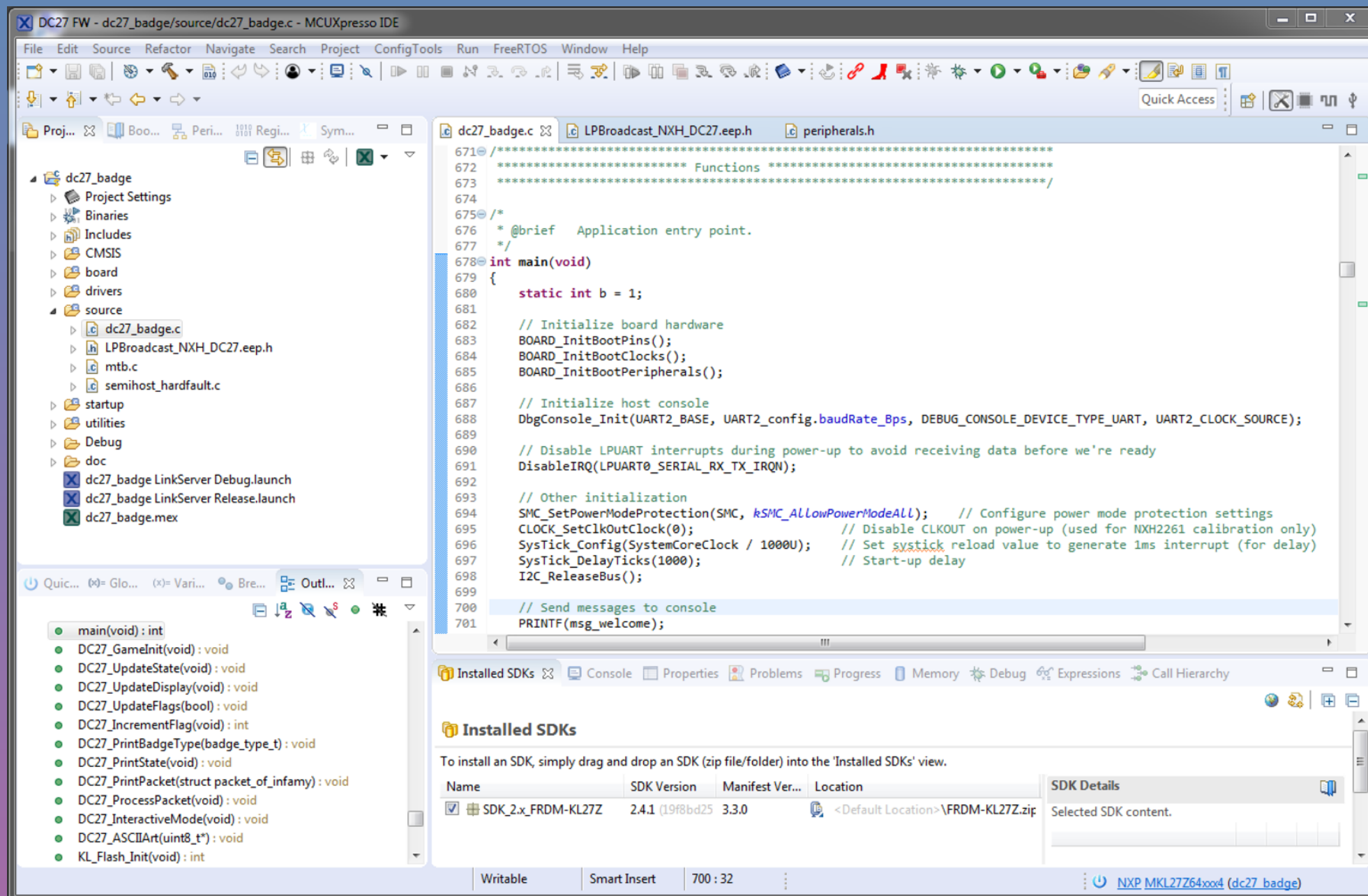
FIRMWARE

- 85% OF FLASH (56KB), 33% OF RAM (5.3KB)
- ~3K PHYSICAL SOURCE LINES OF CODE IN DC27_BADGE.C (MAIN)



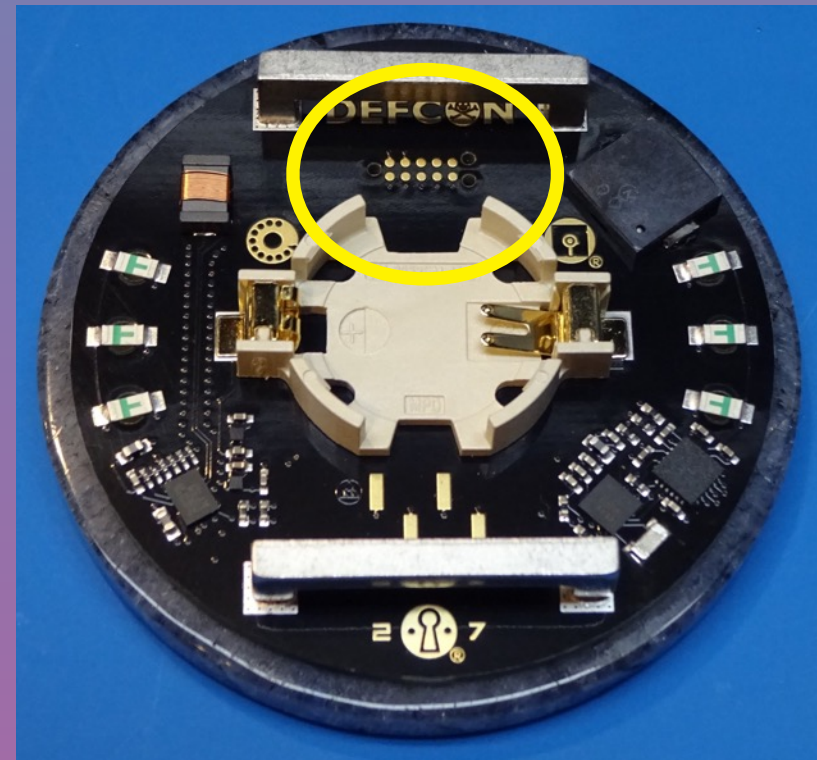
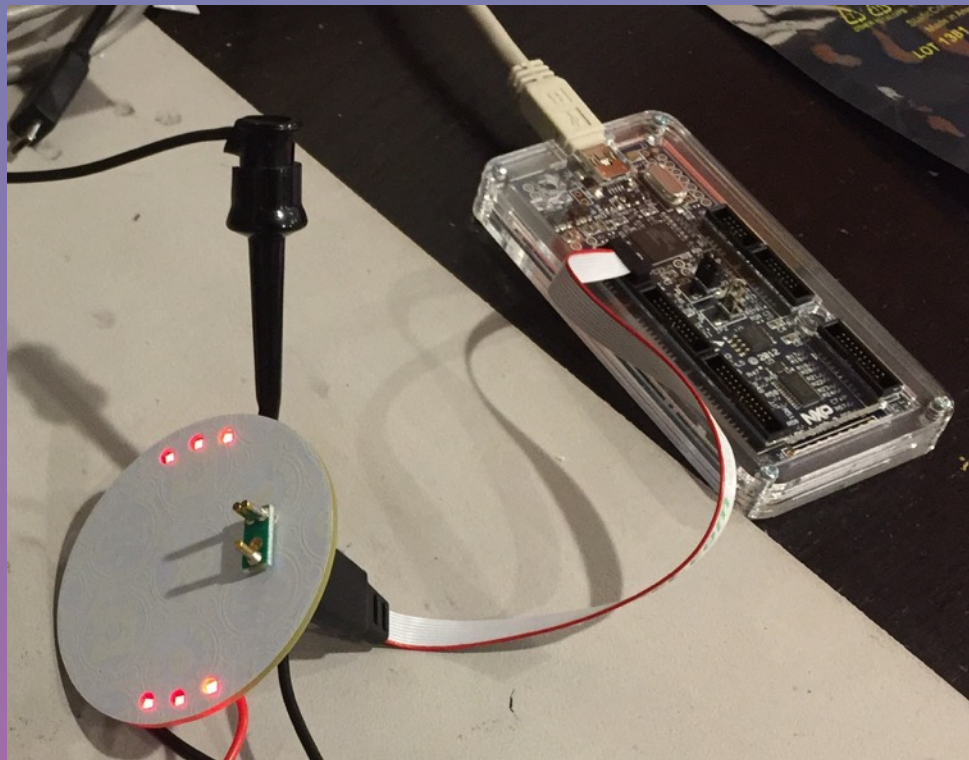
DEVELOPMENT ENVIRONMENT (SW)

- NXP MCUXPRESSO IDE 10.2.1
- FRDM-KL27Z SDK 2.4.1



DEVELOPMENT ENVIRONMENT (HW)

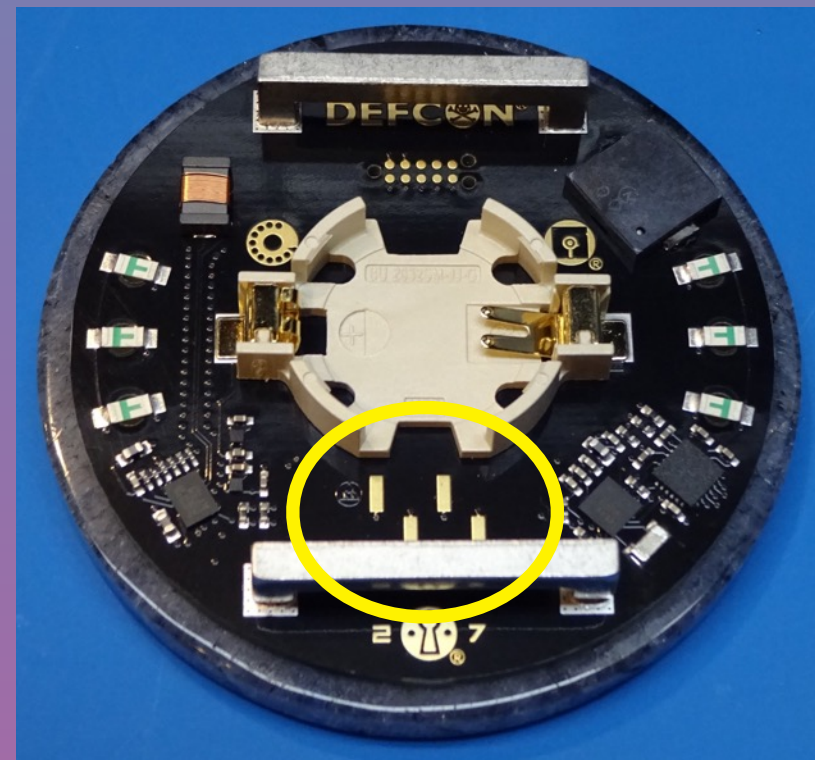
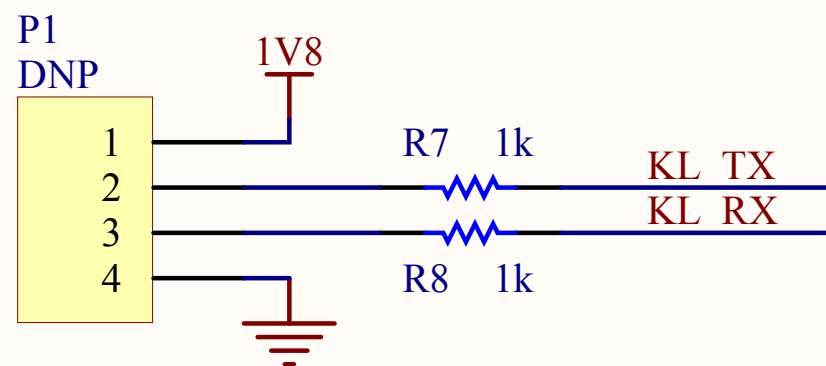
- SWD (ARM SERIAL WIRE DEBUG)
- NXP LPC-LINK2
- TAG-CONNECT TC2050-IDC-NL-050-ALL (NORMAL ORIENTATION)
 - TRIM ALIGNMENT PINS IF USING W/ MOUNTED GEMSTONE
- VTREF PROVIDES 1.8V I/O LEVEL TO DEBUG PROBE



DEVELOPMENT ENVIRONMENT (HW)

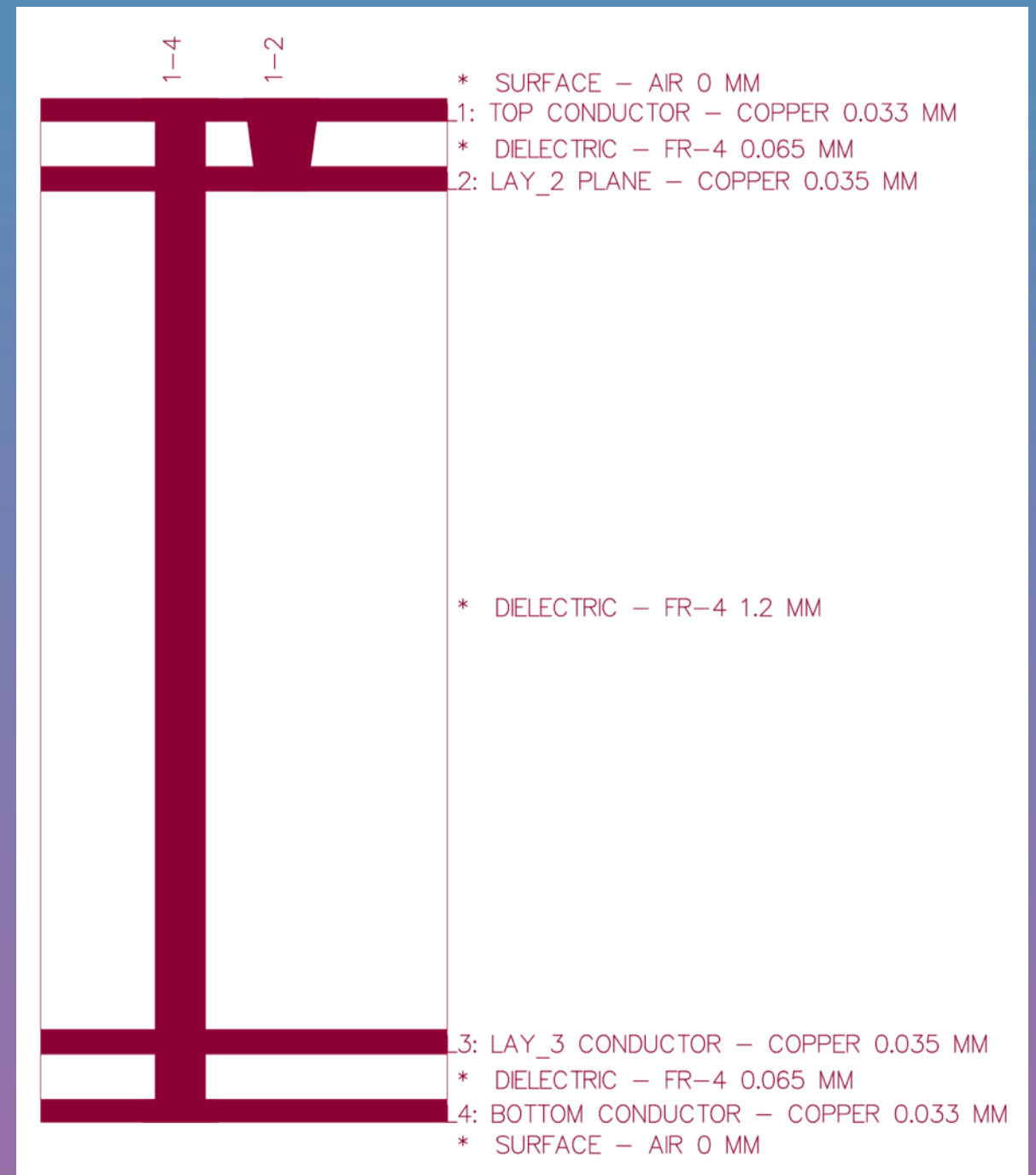
- UART
 - 1.8V @ 115200, 8N1
 - DEBUG OUTPUT / SYSTEM STATUS
 - COMMAND-BASED INTERACTIVE MODE
 - WILL ENTER AUTOMATICALLY IF RX LINE IS PULLED HIGH
 - MUST EXIT W/ CTRL-X

Mates to Harwin M20-8770442 or compatible

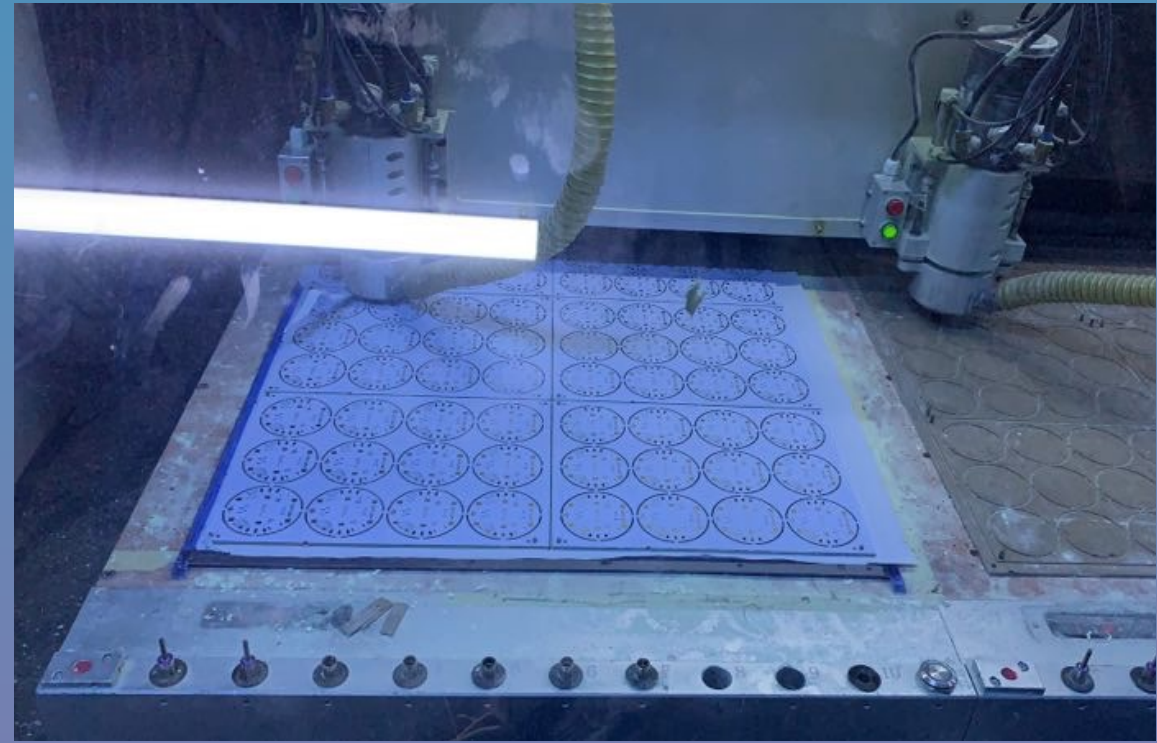


PCB SPECIFICATIONS

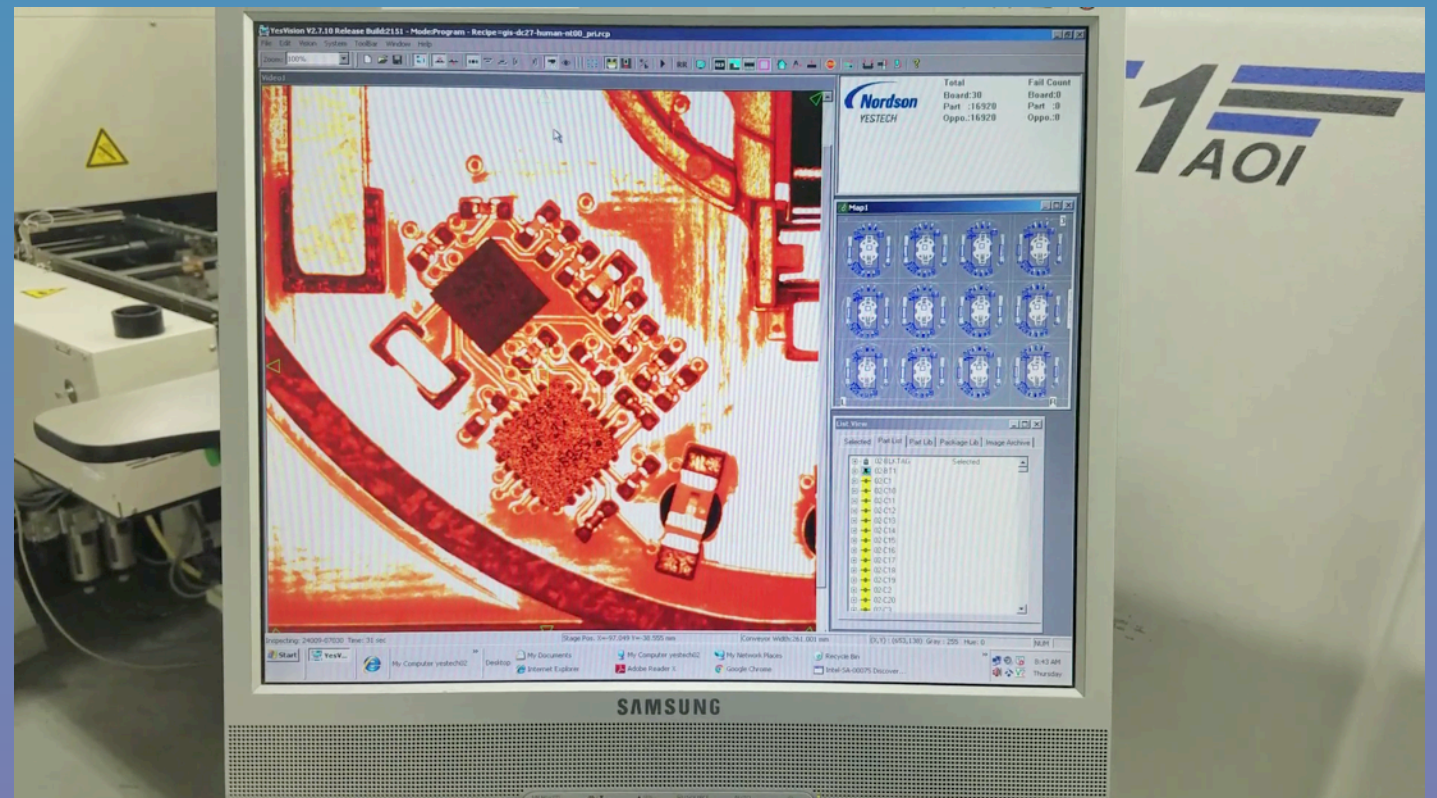
- 4 LAYER
- VIAS
 - MECHANICAL & LASER
 - EPOXY-FILLED VIA-IN-PAD
 - MINIMUM HOLE = 0.125MM (~0.005")
- TRACE / SPACE = 0.1MM (~0.004")
- FOOTPRINTS
 - XFBGA-36 (3.5 X 3.5MM)
 - WLCSP-48 (3.72 X 2.79MM)
 - DFN-4 (1 X 1MM)



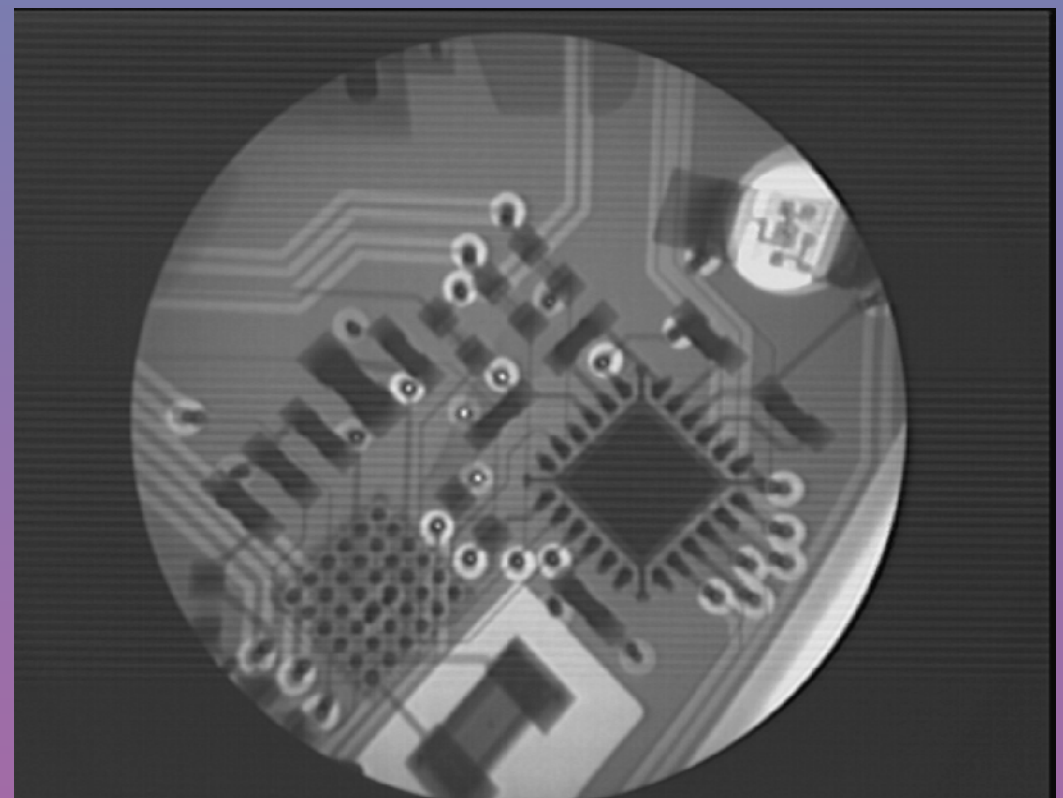
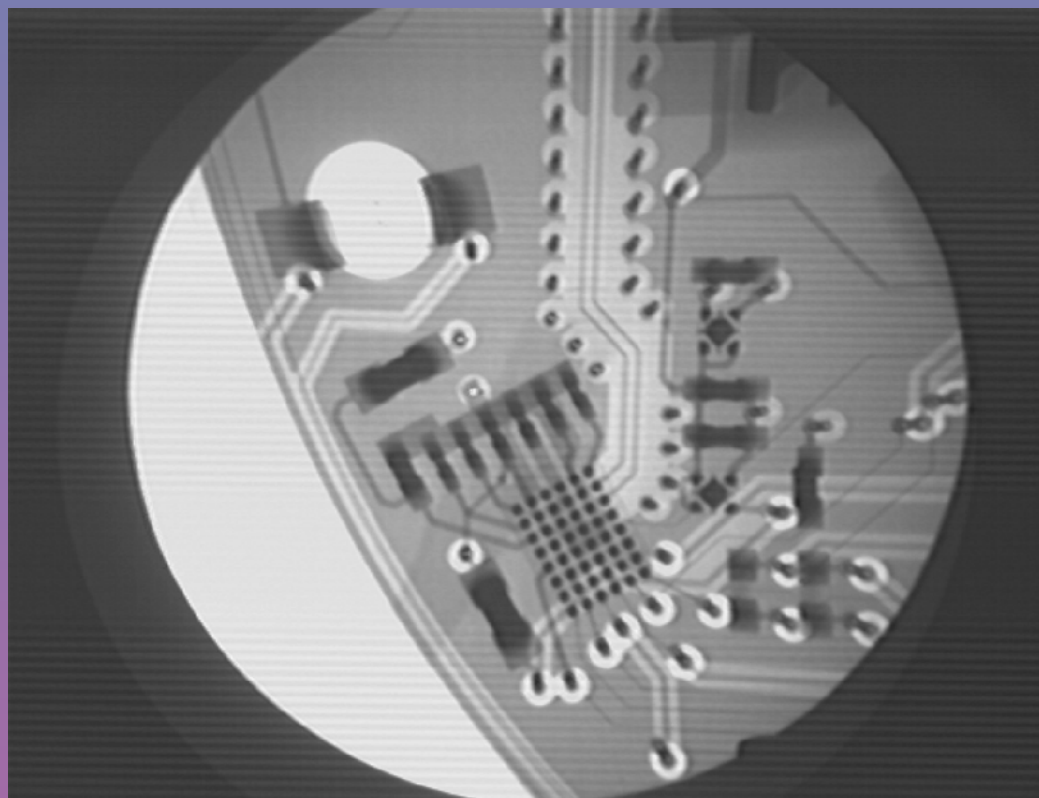
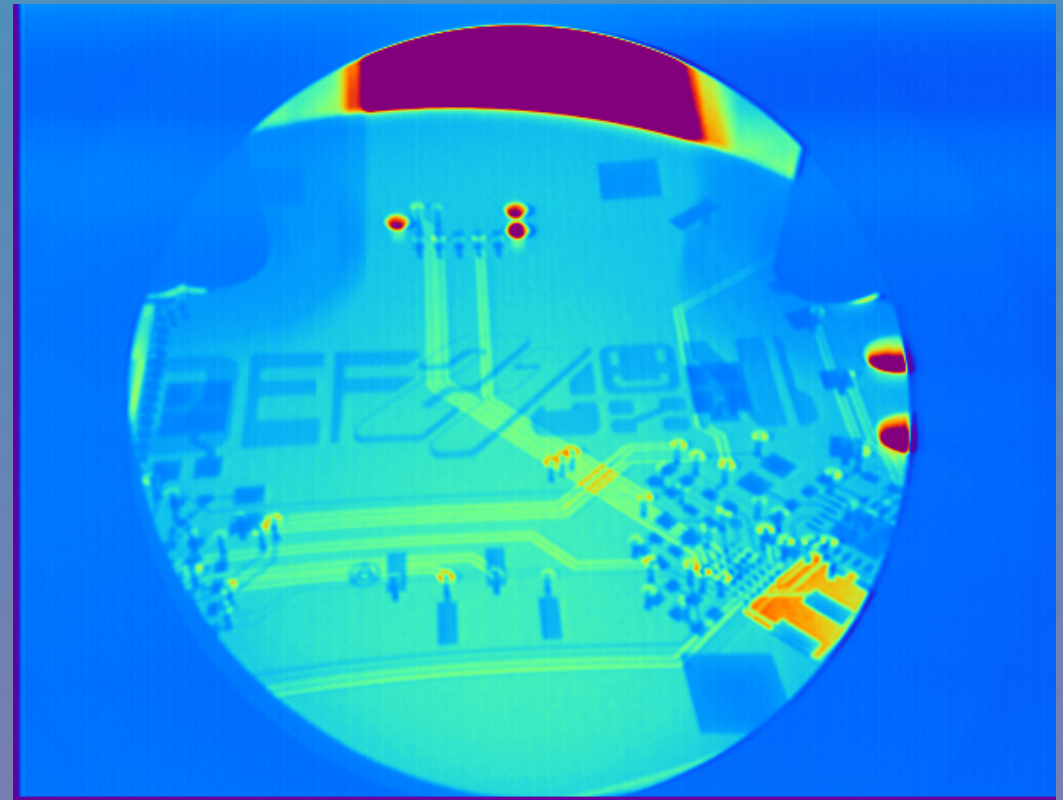
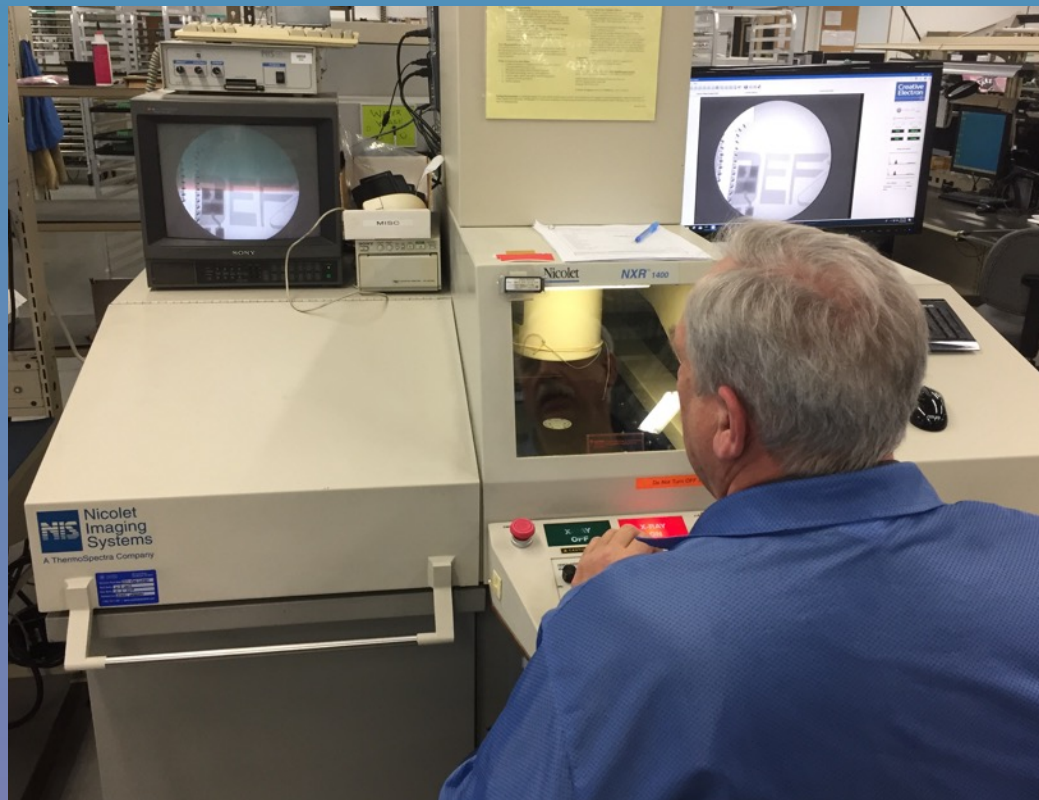
PCB FABRICATION



PCB ASSEMBLY

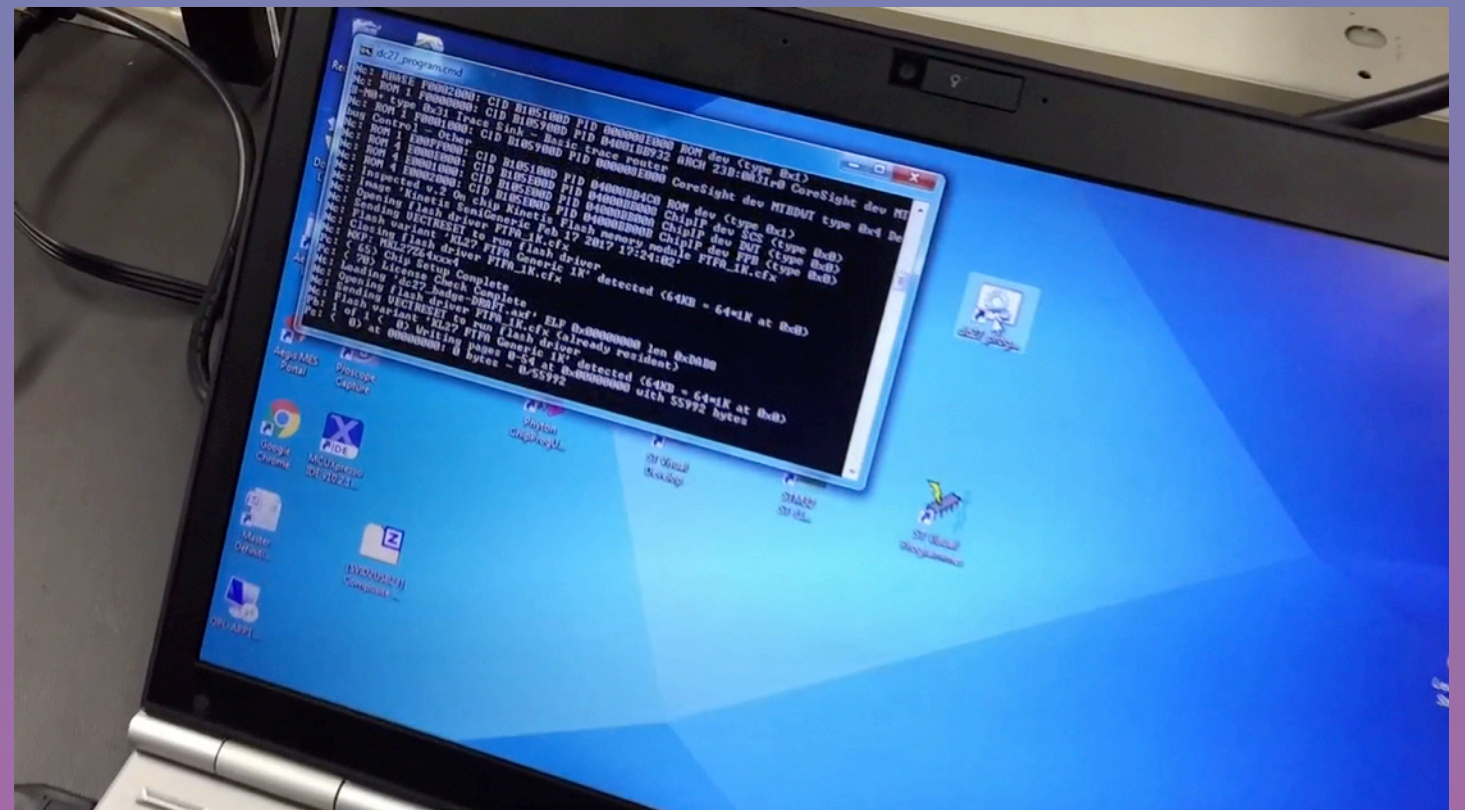
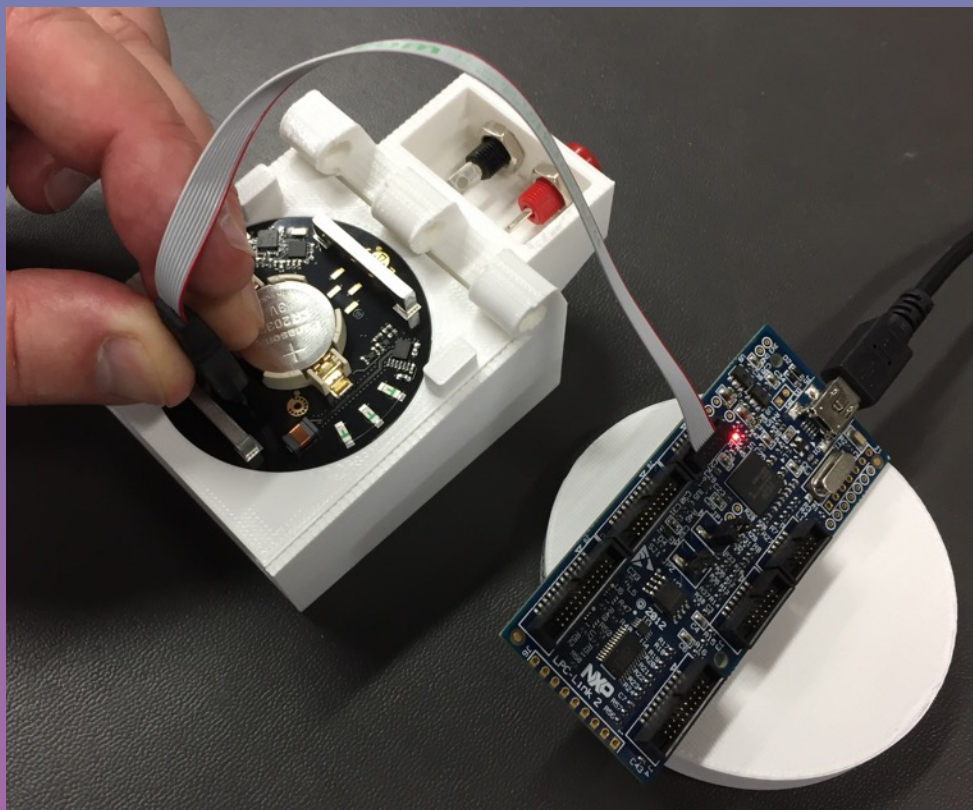


X-RAY



PROGRAMMING / TESTING

- WINDOWS W/ MCUXPRESSO + LPC-LINK2
- CMD SCRIPT TO PROGRAM KL27
- POWER ON SELF TEST
 - INSPECTION OF LEDS (VISIBLE) AND PIEZO (AUDIBLE)
 - DETECTION / CONFIGURATION OF NXH2261 + LP5569



FINAL ASSEMBLY



NUMBERS

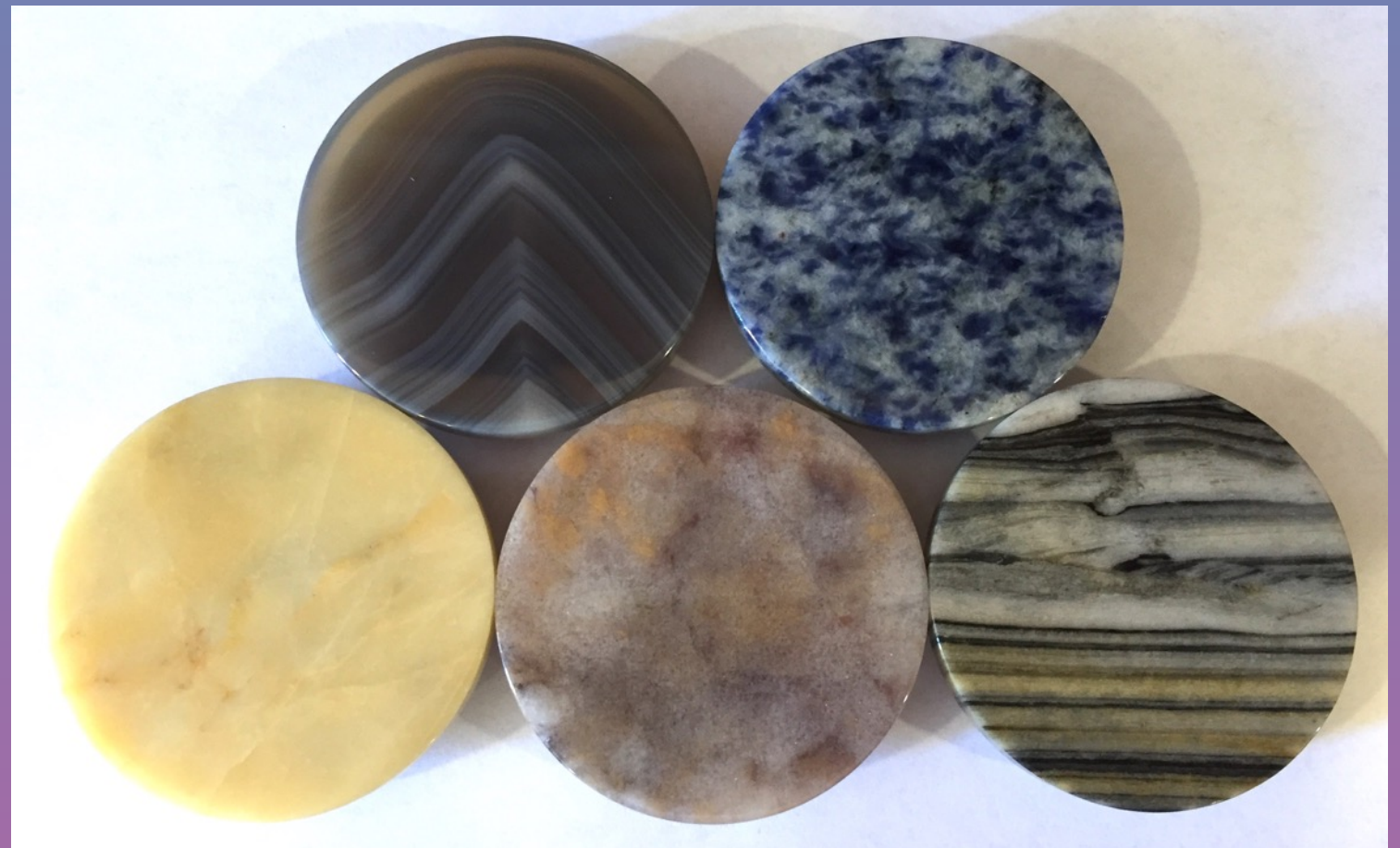
- HUMAN, WHITE: 26,500
- GOON, RED: 550
- SPEAKER, BLUE: 375
- VENDOR, PURPLE: 250
- PRESS, GREEN: 250
- VILLAGE, ORANGE: 250
- CONTEST, YELLOW: 250
- ARTIST, LIGHT BLUE: 100
- CFP REVIEW, GREY: 45
- UBER, BLACK: 20



(BEFORE GEMSTONE ATTACHMENT)

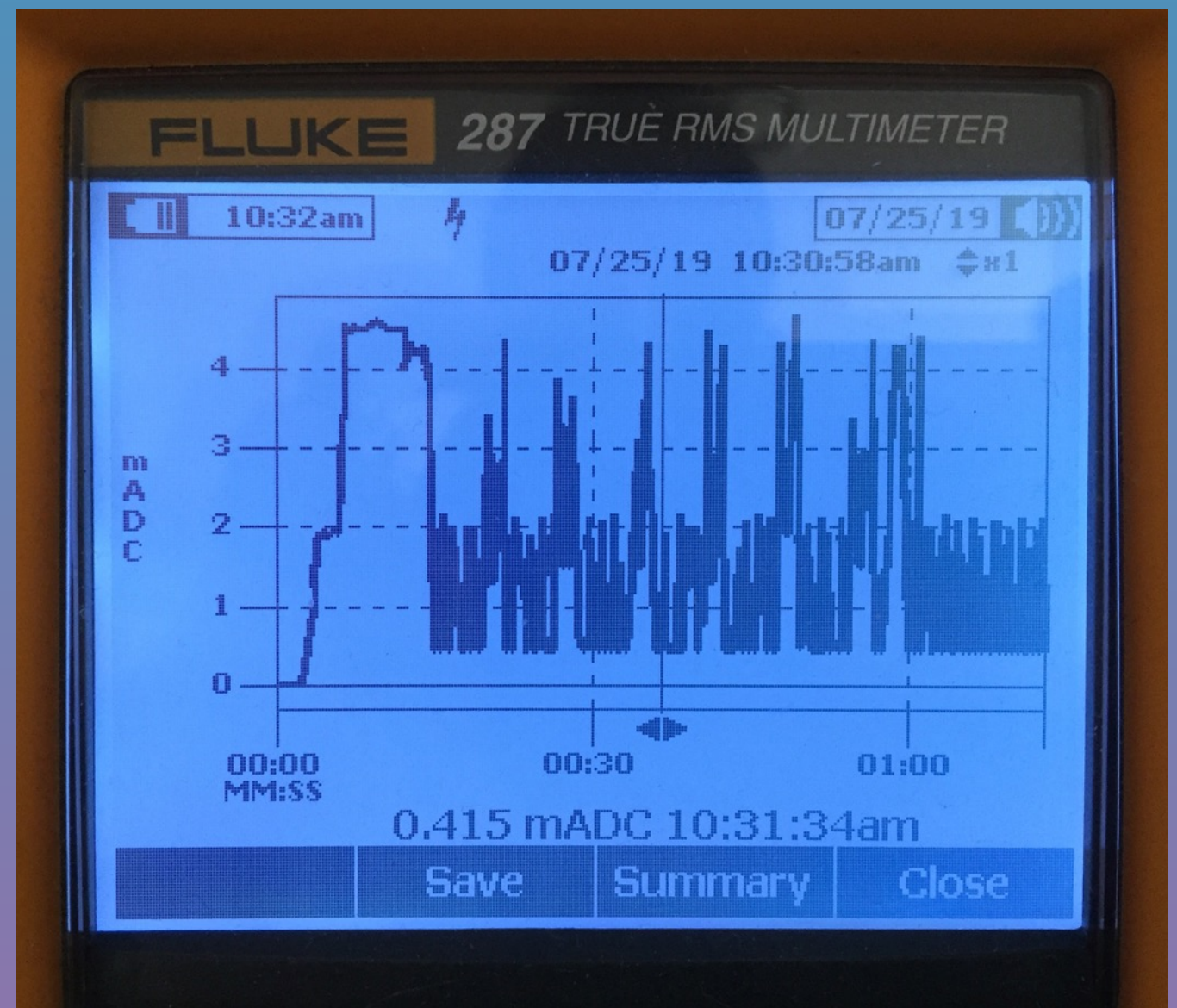
MAGIC TOKENS

- BADGES W/ SPECIAL FLAG ENABLED
 - ARTS & ENTERTAINMENT: NATURAL AGATE
 - SPEAKER: BRAZILIAN SODALITE
 - VILLAGE: HONEY JADE
 - CONTEST: PURPLE JADE
 - PARTIES: BANDED AGATE



BATTERY LIFE

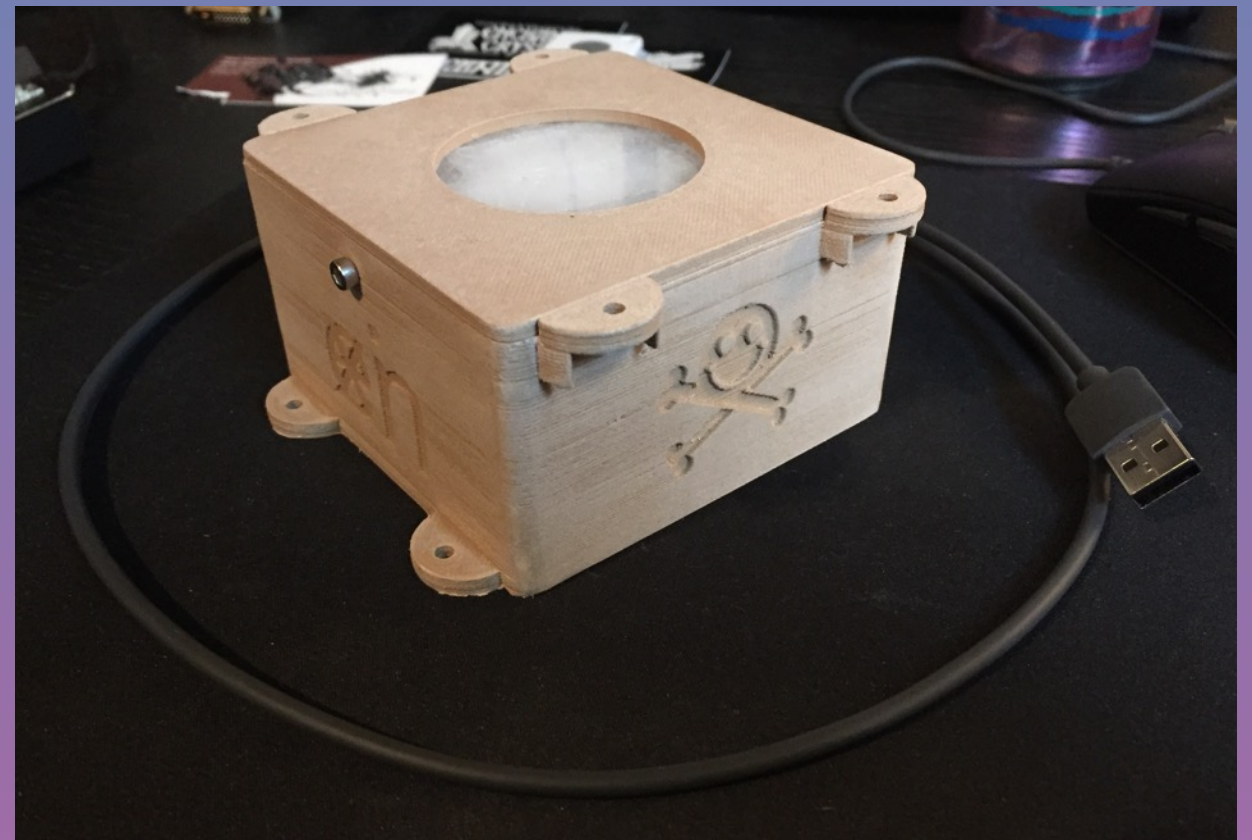
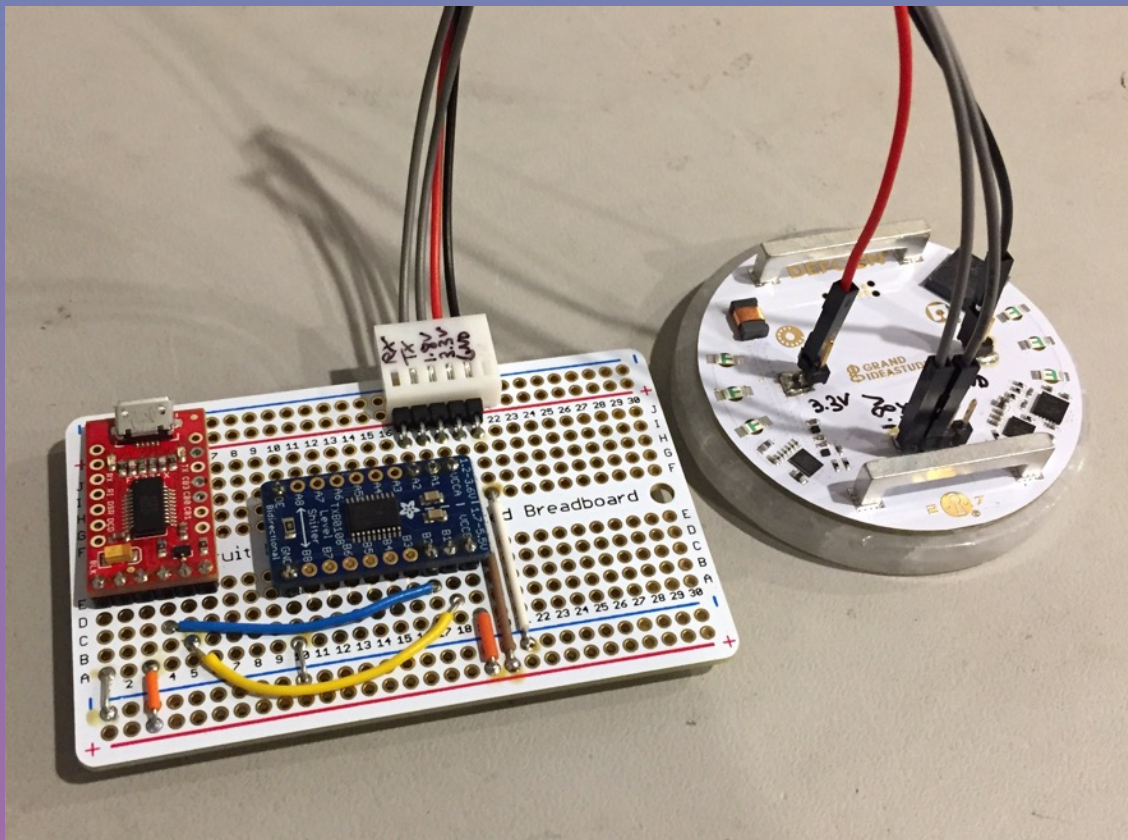
- CR2032 3V LITHIUM COIN CELL
 - 225MAH TO 2V
- POWER UP: 4.2MA
- ATTRACT MODE: 2.3 - 4.6MA
- SLEEP MODE (NFM1 ENABLED)
 - 0.41 - 2.0MA
 - 0.61MA AVERAGE



- MINIMUM DESIRED LIFE = 4 DAYS (96 HOURS) -> 2.3MAH AVERAGE

INTERACTIVE ARTWORK

- INSTALLATION BY ZEBBLER STUDIOS
- DC27 CHILLOUT LOUNGE
- VIDEO MAPPING CHANGES IN REAL-TIME BASED ON BADGE DATA
- BADGE -> LEVEL TRANSLATOR -> RASPBERRY PI -> OSC -> RESOLVME



INTERACTIVE ARTWORK



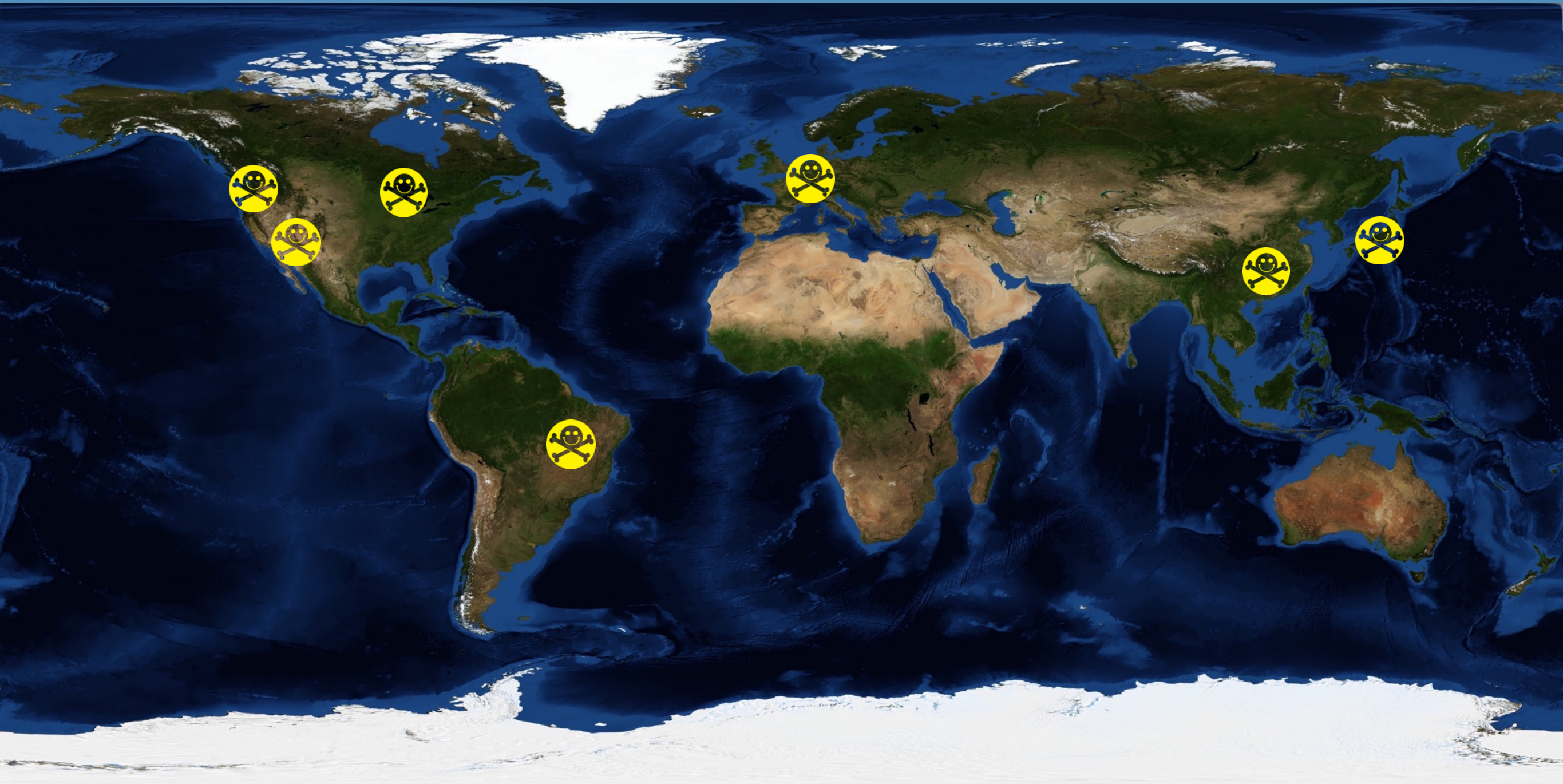
CHALLENGES / INSIGHTS

- TIME FRAME
- COMMUNICATION W/ PCB FAB
- USING UNFAMILIAR TECHNOLOGIES / NON-STANDARD MATERIALS
- BREAK PROJECT INTO SMALL BITES
- ALL PROBLEMS HAVE A ROOT CAUSE

FUTURE USE

- DATA TRANSFER
 - COVERT MESSAGE PASSING (NO RF SIGNATURE)
 - ROBOTICS (LOCATION TRACKING / SENSING)
- BLINKENLIGHTS
- GENERAL PURPOSE ARM DEV. ENVIRONMENT
- ???

A GLOBAL EFFORT



BLUE MARBLE, RETO STÖCKLI, NASA EARTH OBSERVATORY

RESOURCES

- DC27 HARDWARE HACKING VILLAGE (HHV)
 - EXTRA MATERIALS (GEMSTONES, COMPONENTS, BATTERIES)
 - REAL-LIFE ENGINEER FROM NXP
- DESIGN DOCUMENTATION, CODE, ETC.
 - `www.grandideastudio.com/portfolio/defcon-27-badge/`

ENJOY THE CON!

@JOEGRAND | WWW.GRANDIDEASTUDIO.COM