Wearable ID Device

ECE 445 Group 59
Mengchen Shi
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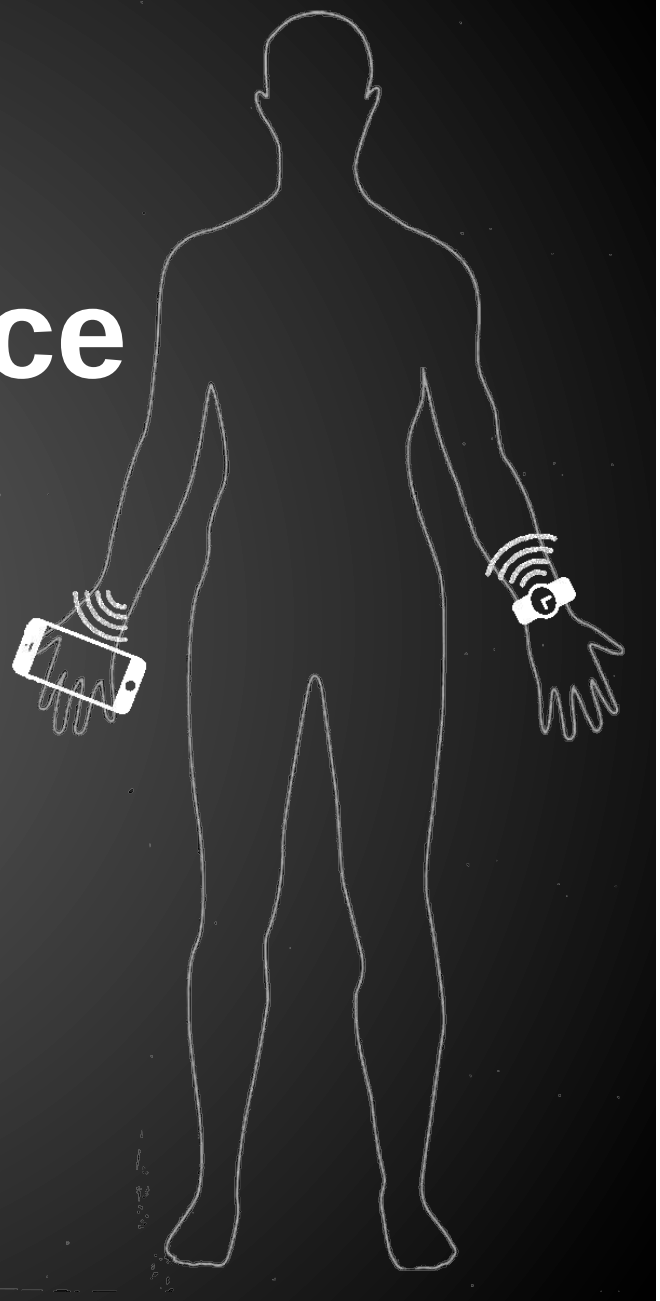
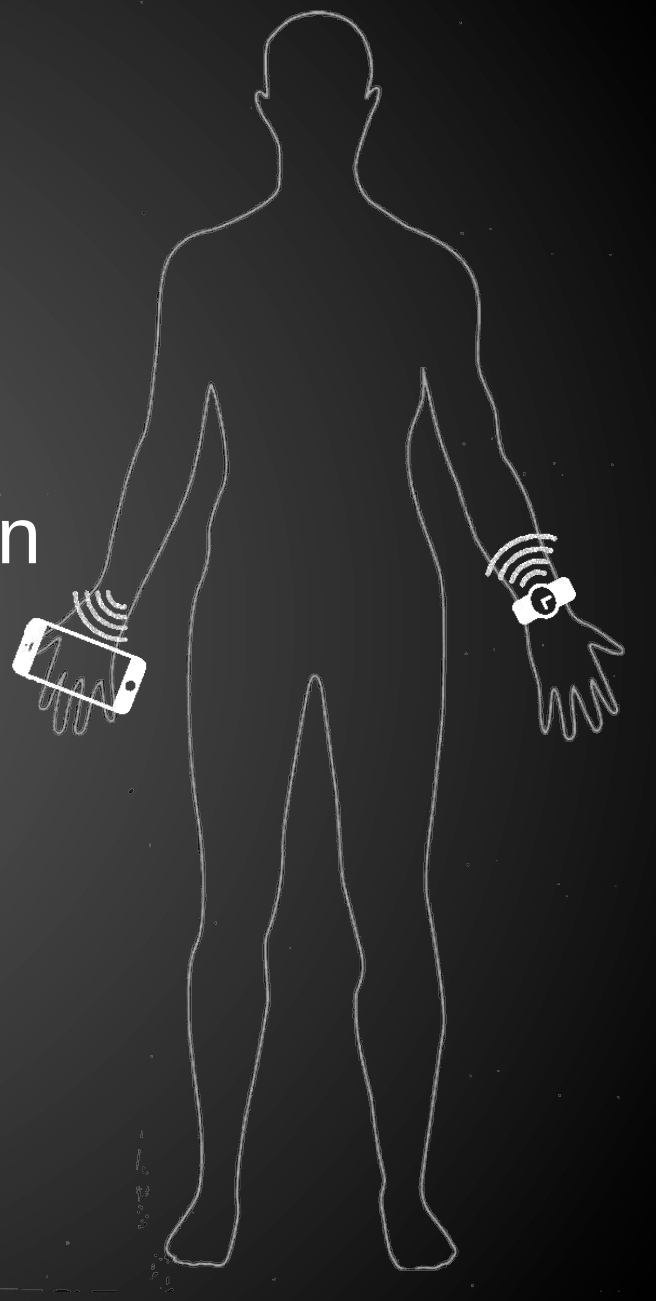


Introduction

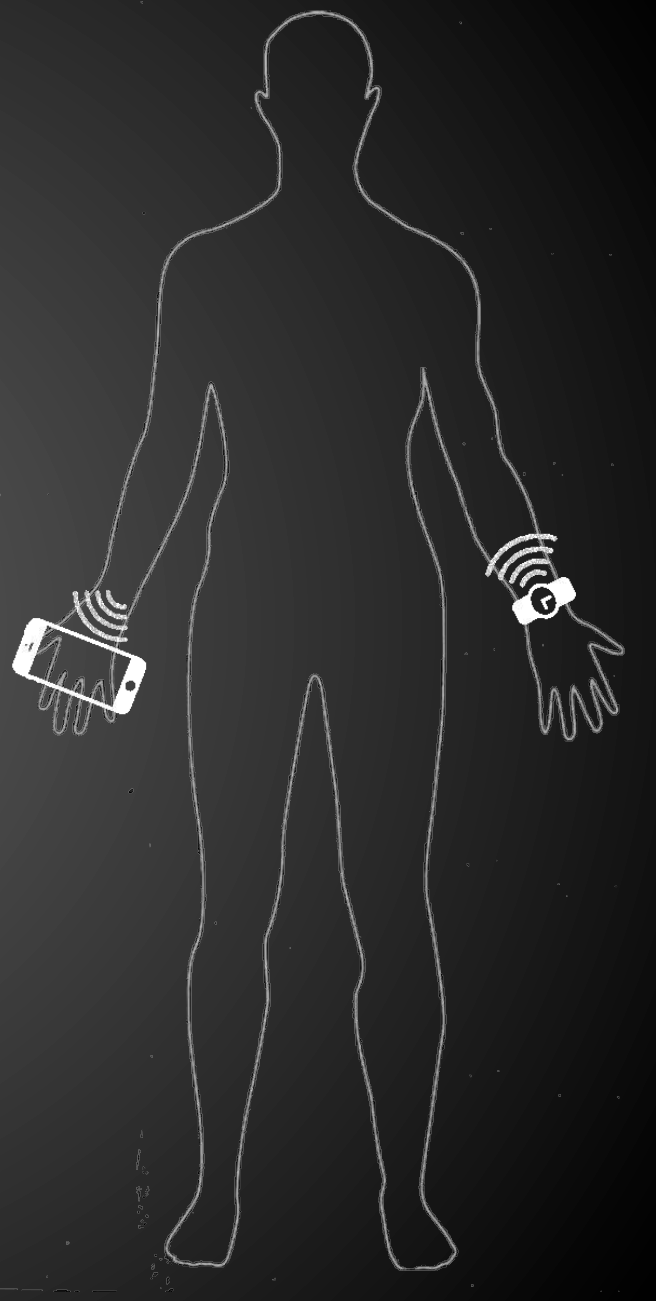
- Mobile Device Lacks Security
- Tedious Password
- Photo Hack Facial Recognition
- Reproducible Fingerprint
- New Security Mechanism

  Simple, Natural, Secure

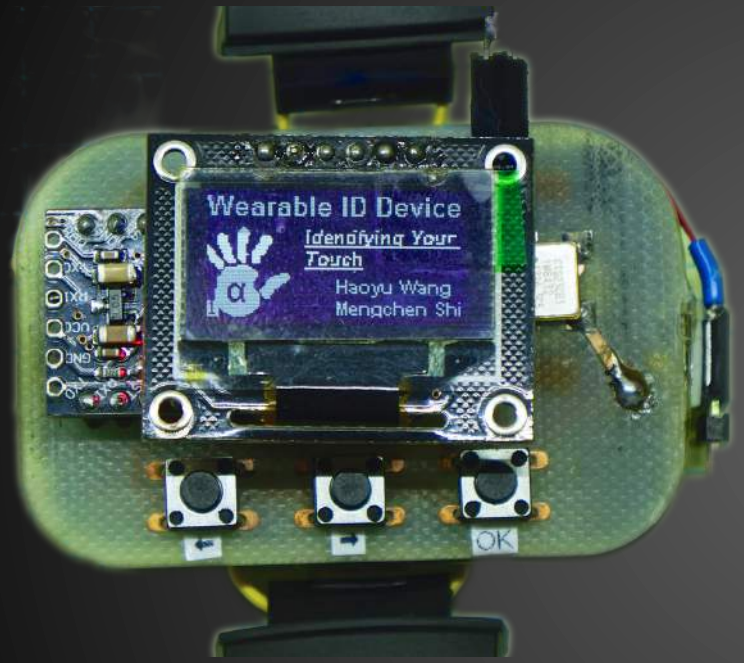


Objective

- Wearable Transmitter
- Transmit Data in Body via RF
- Receiver on Mobile Device
- Identify Instantly on Contact



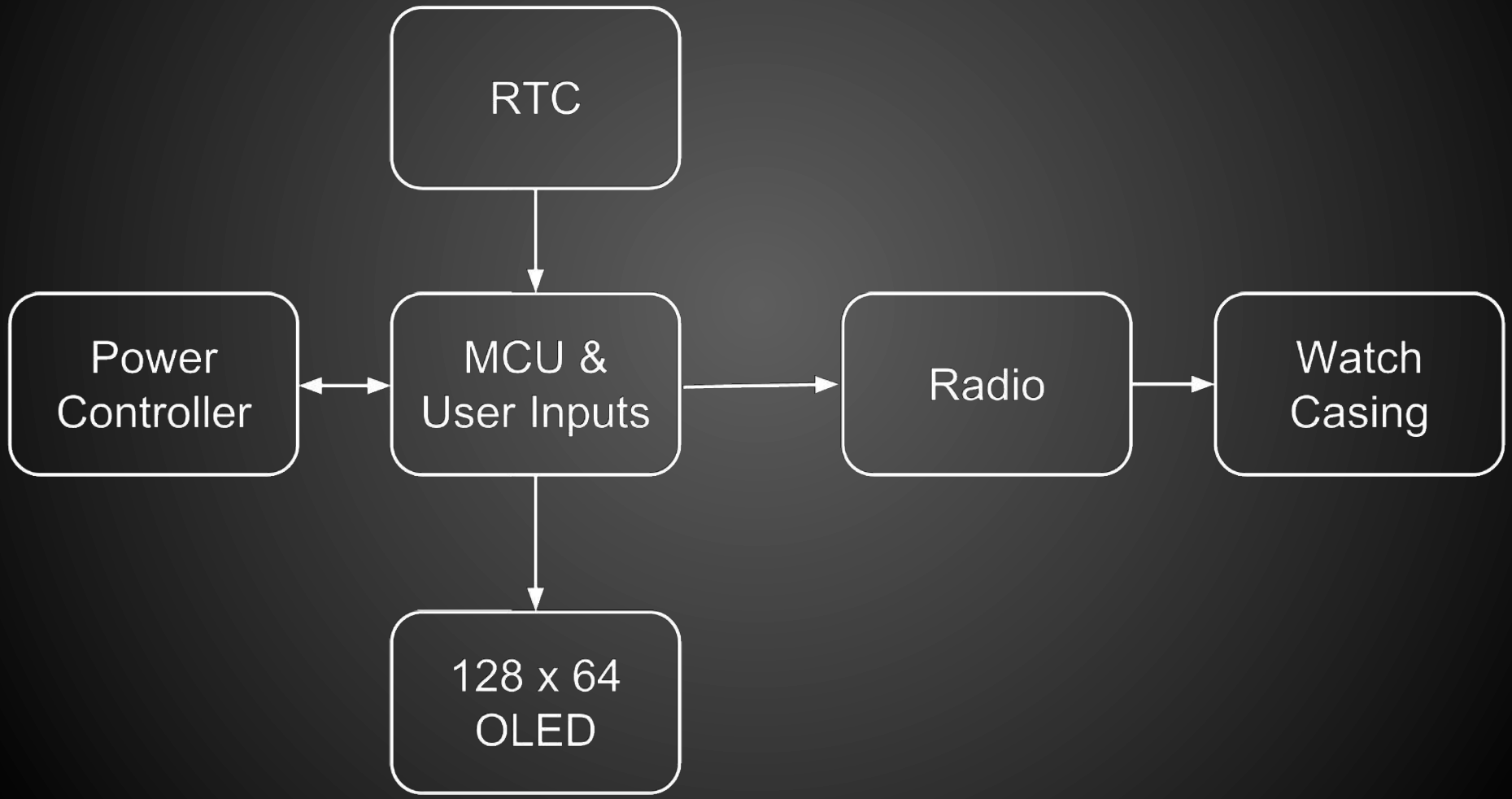
Original Design



The Watch

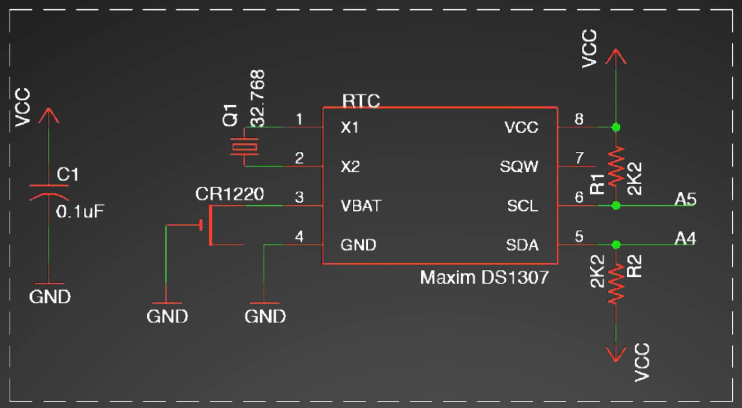
Receiver

The Watch

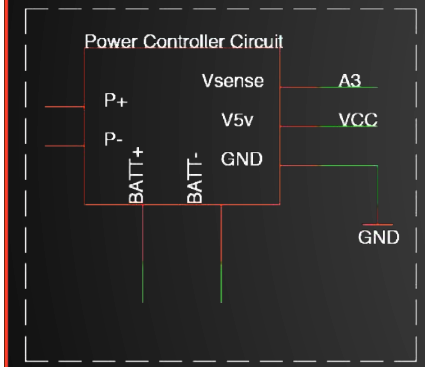

RTC
Power Controller
MCU & User Inputs
Radio
Watch Casing
128 x 64 OLED

The Watch - Components

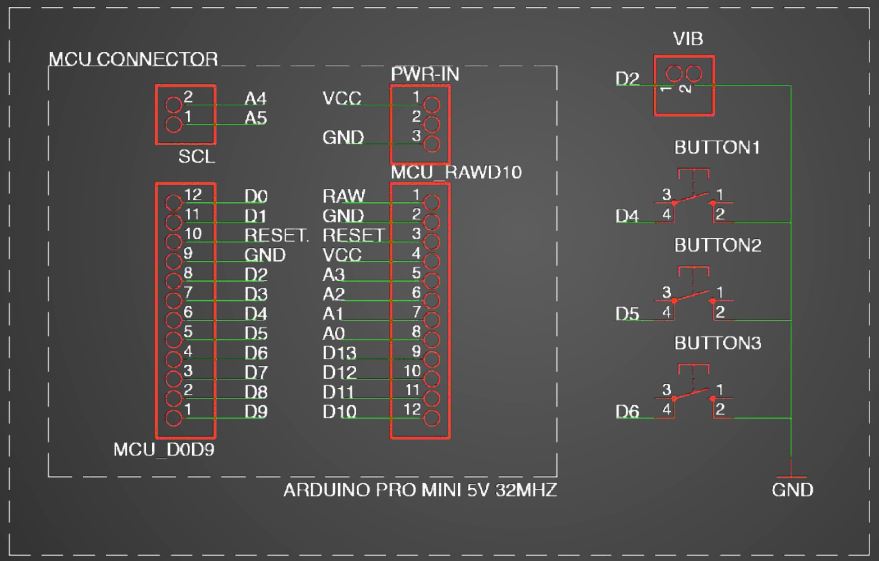
- Real Time Clock (Maxim DS1307)
- MCU & User Interface (Arduino Pro Mini)
- OLED Display (Solomon Tech SSD1307)
- Radio Module (CB3-3C-1M8432 crystal oscillator)
- Power Controller (HP-0014B PRO)



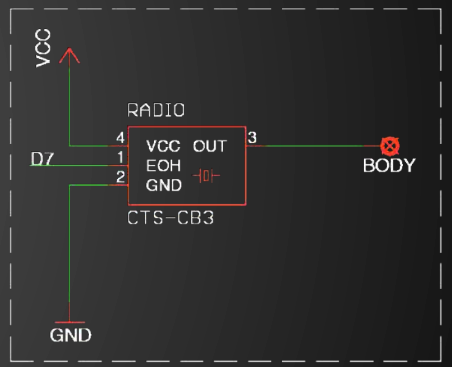
RTC Module



Power Module

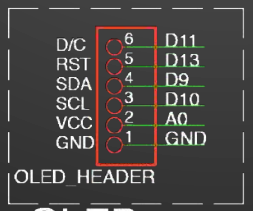


MCU Module



Radio Module

The Watch Schematics



OLED Connector

TITLE: The Watch

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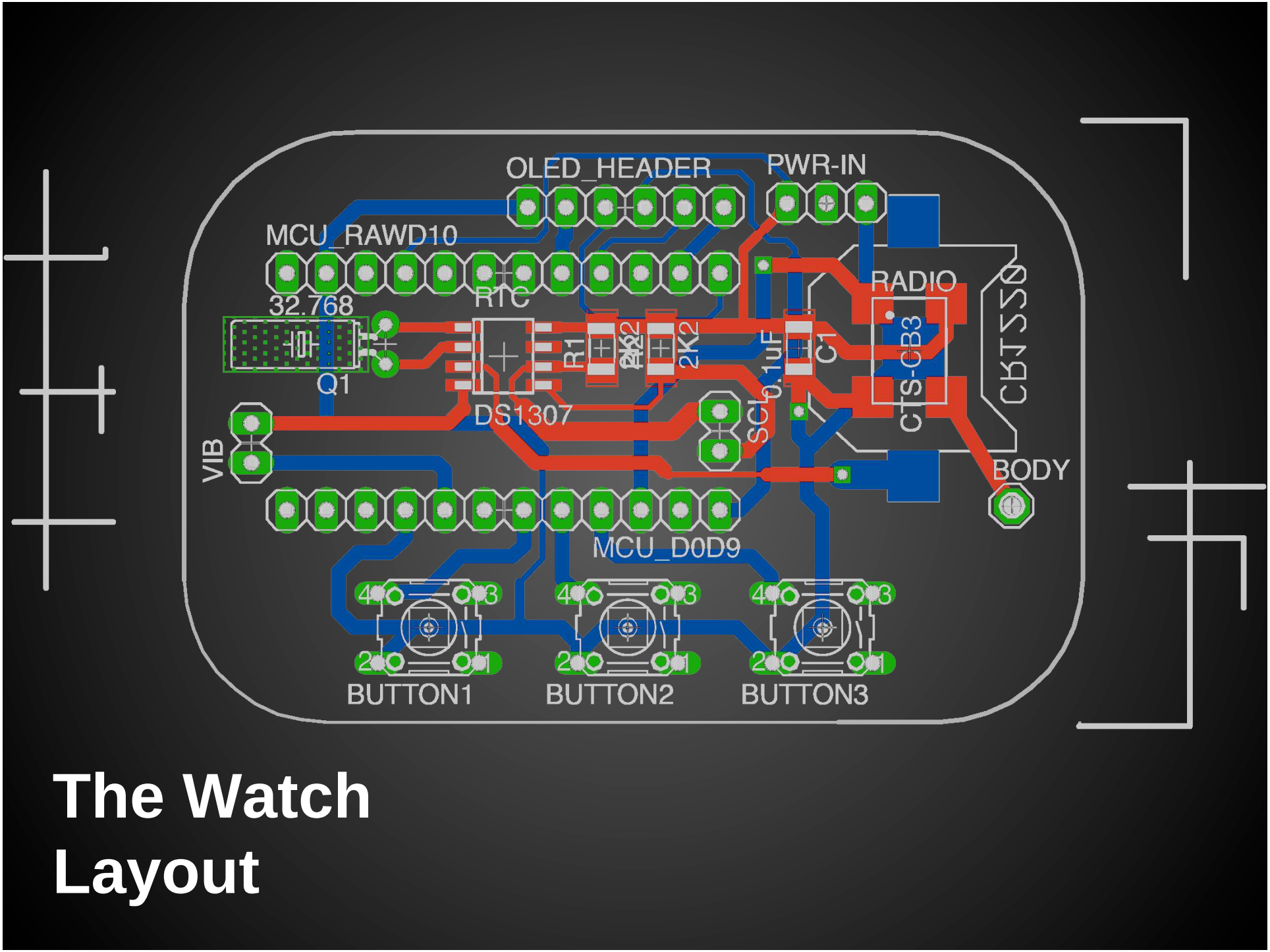
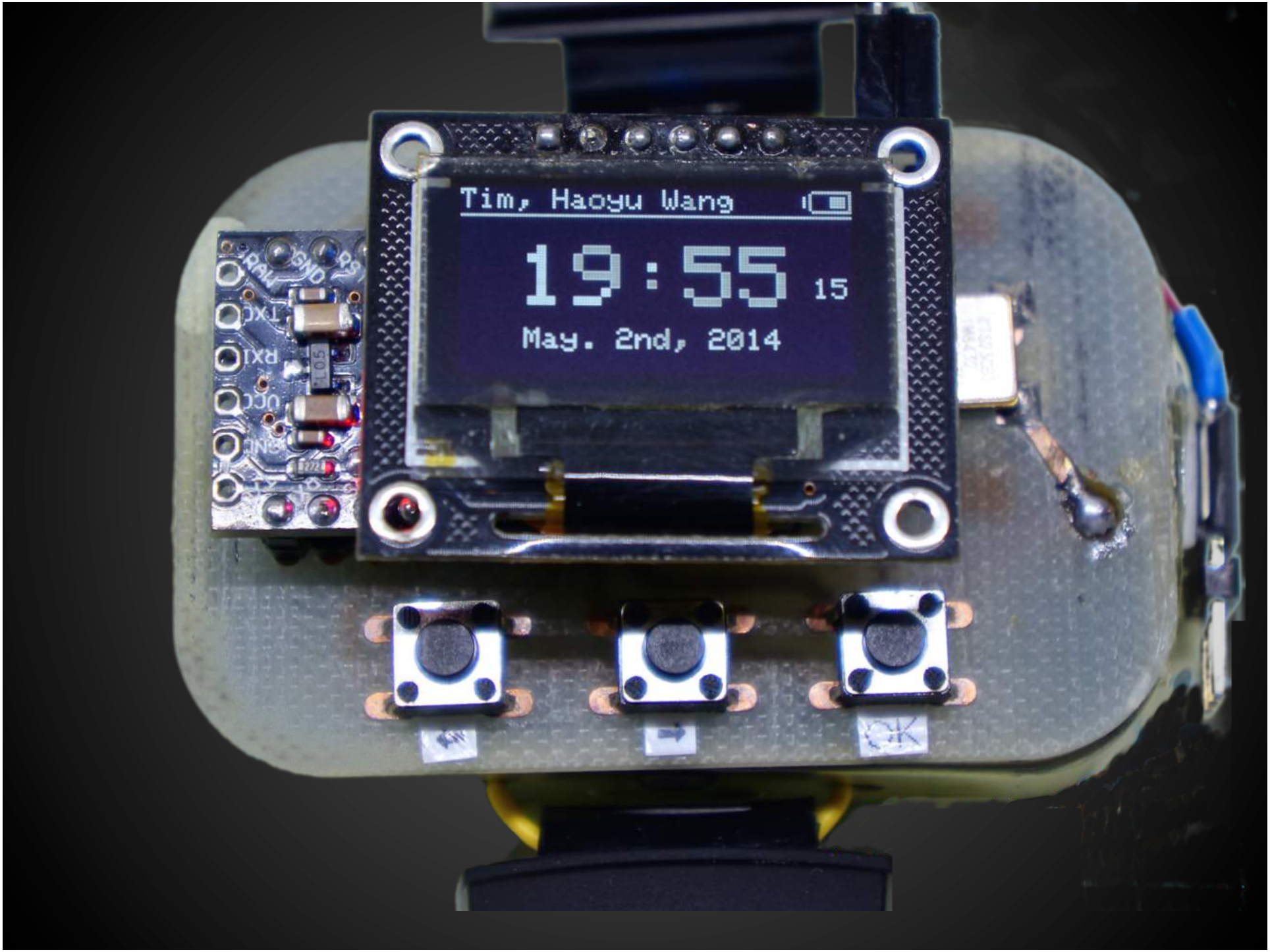
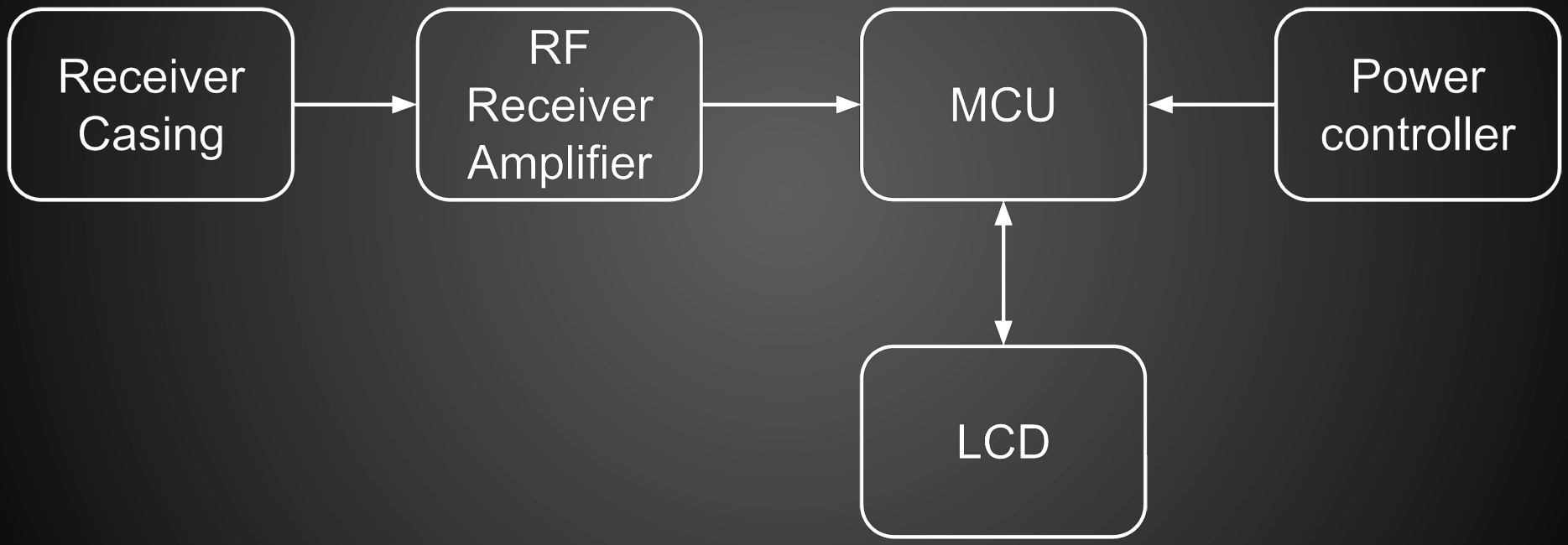


The Watch Layout

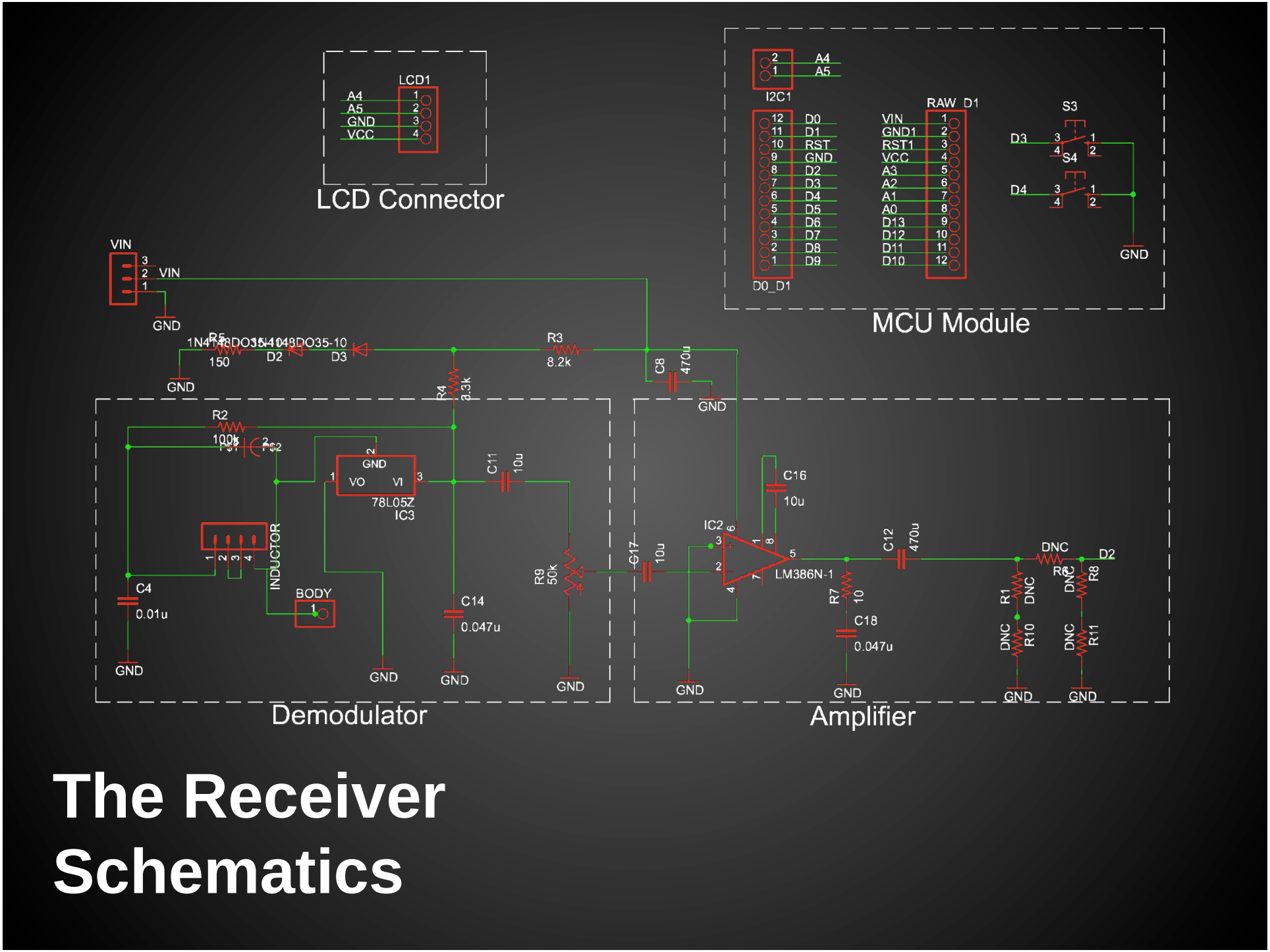

Tim, Haoyu Wang
19:55 15
May. 2nd, 2014
RAW
GND
TXD
RXD
VCC
OK

The Receiver

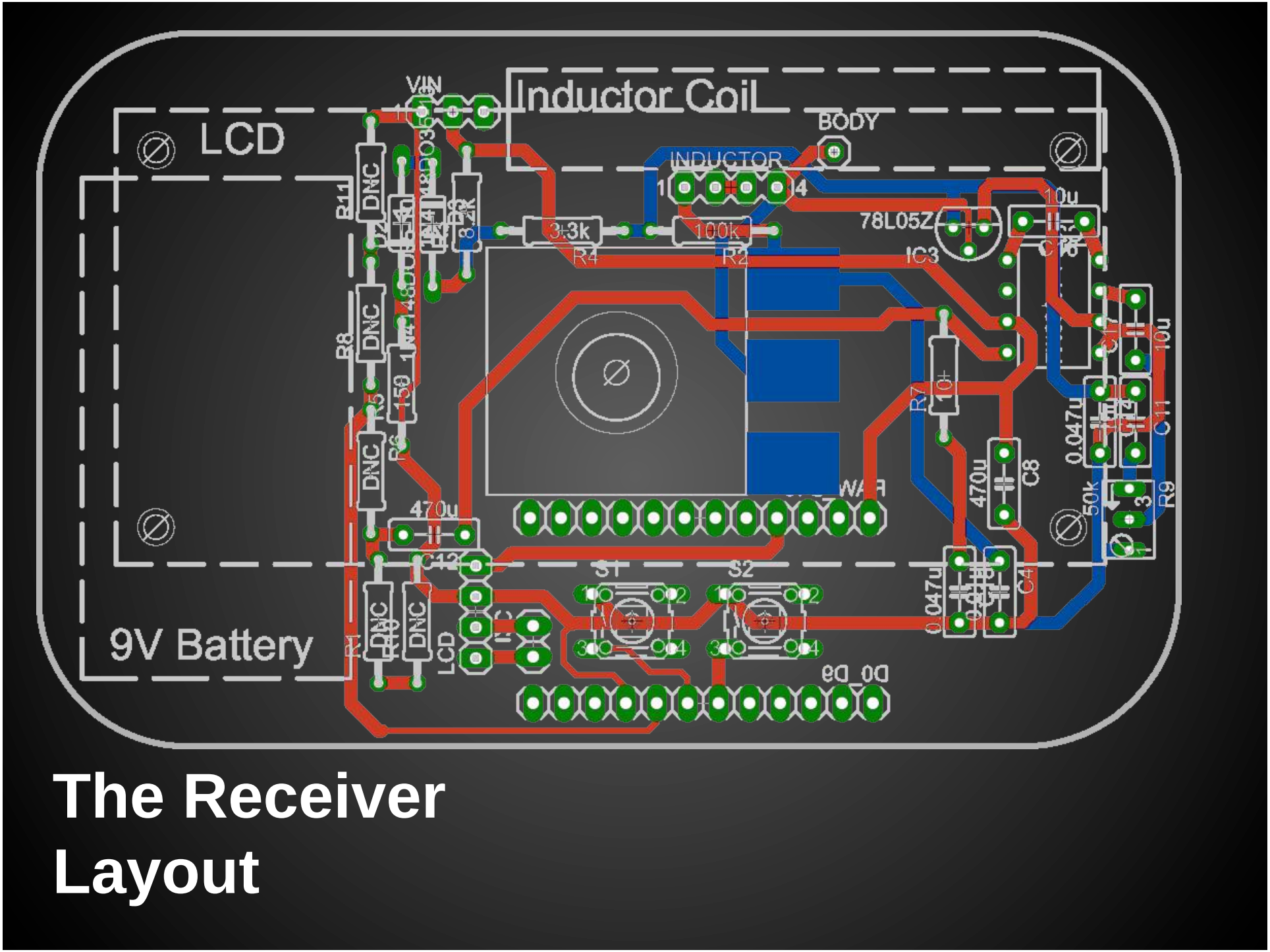


The Receiver

- MCU and interface (Arduino Pro Mini)
- LCD (Generic 1602A Character LCD)
- RF Receiver & Amplifier
- Power Controller

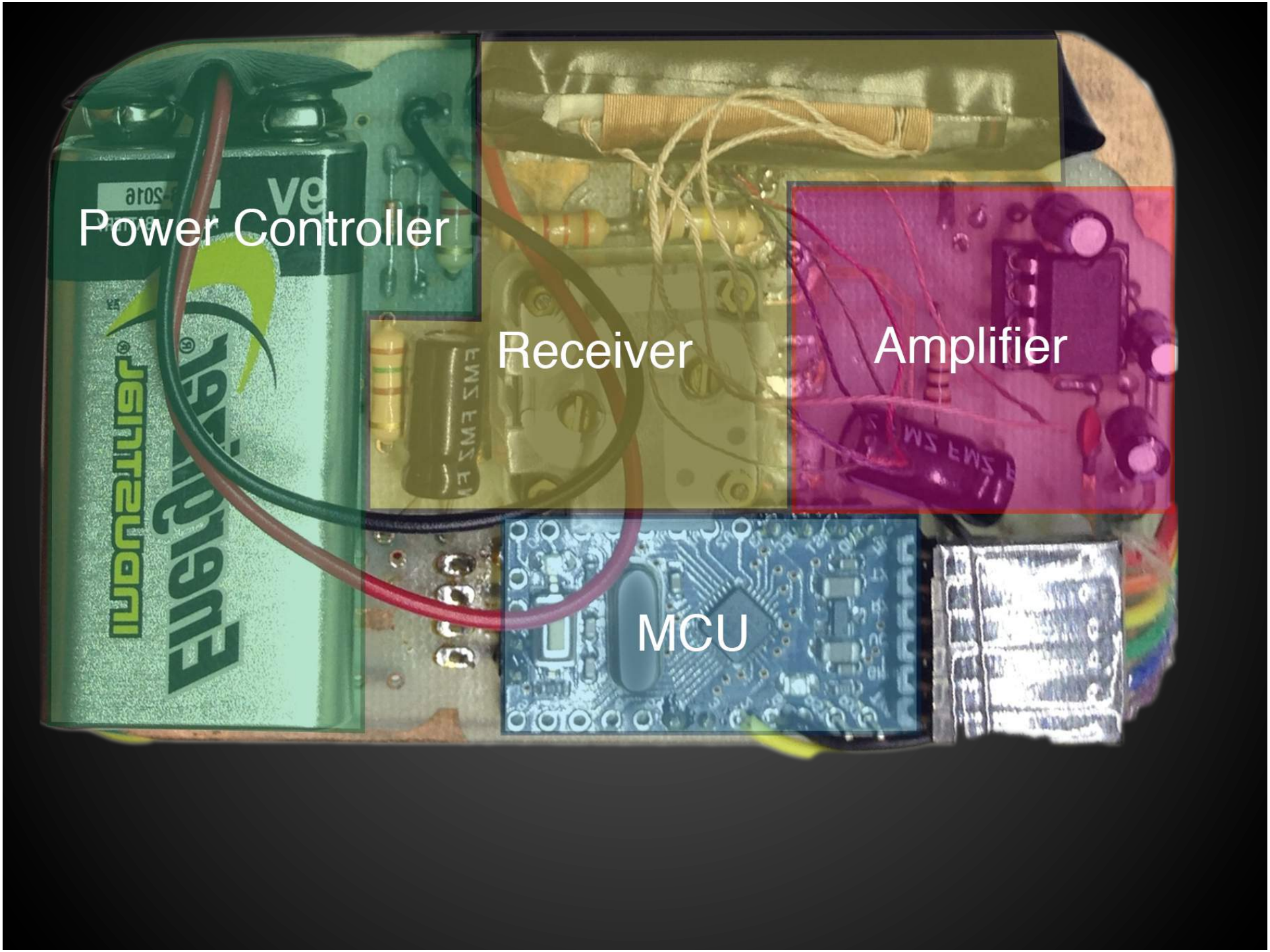


The Receiver Schematics

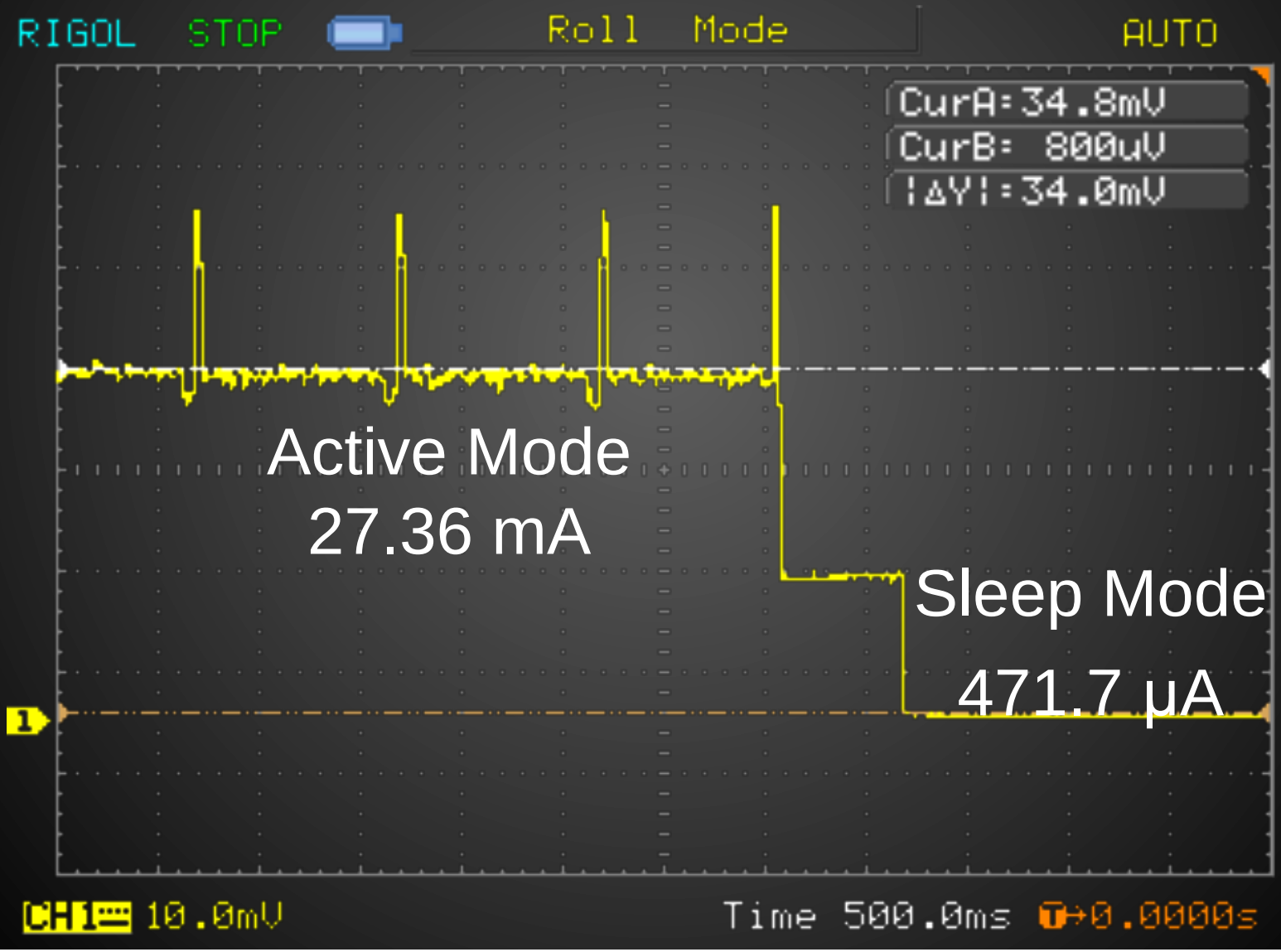


The Receiver Layout

9v
Energizer


Power Controller
Receiver
Amplifier
MCU

Power Consumption - The Watch



Power Consumption - The Watch

By Ohm's Law

$$I_{active} = \frac{34.8\ mV}{1.272\ \Omega} = 27.36\ mA$$

$$I_{sleep} = \frac{\sim 600\ \mu V}{1.272\ \Omega} = 471.7\ \mu A$$

In an experiment, We found that

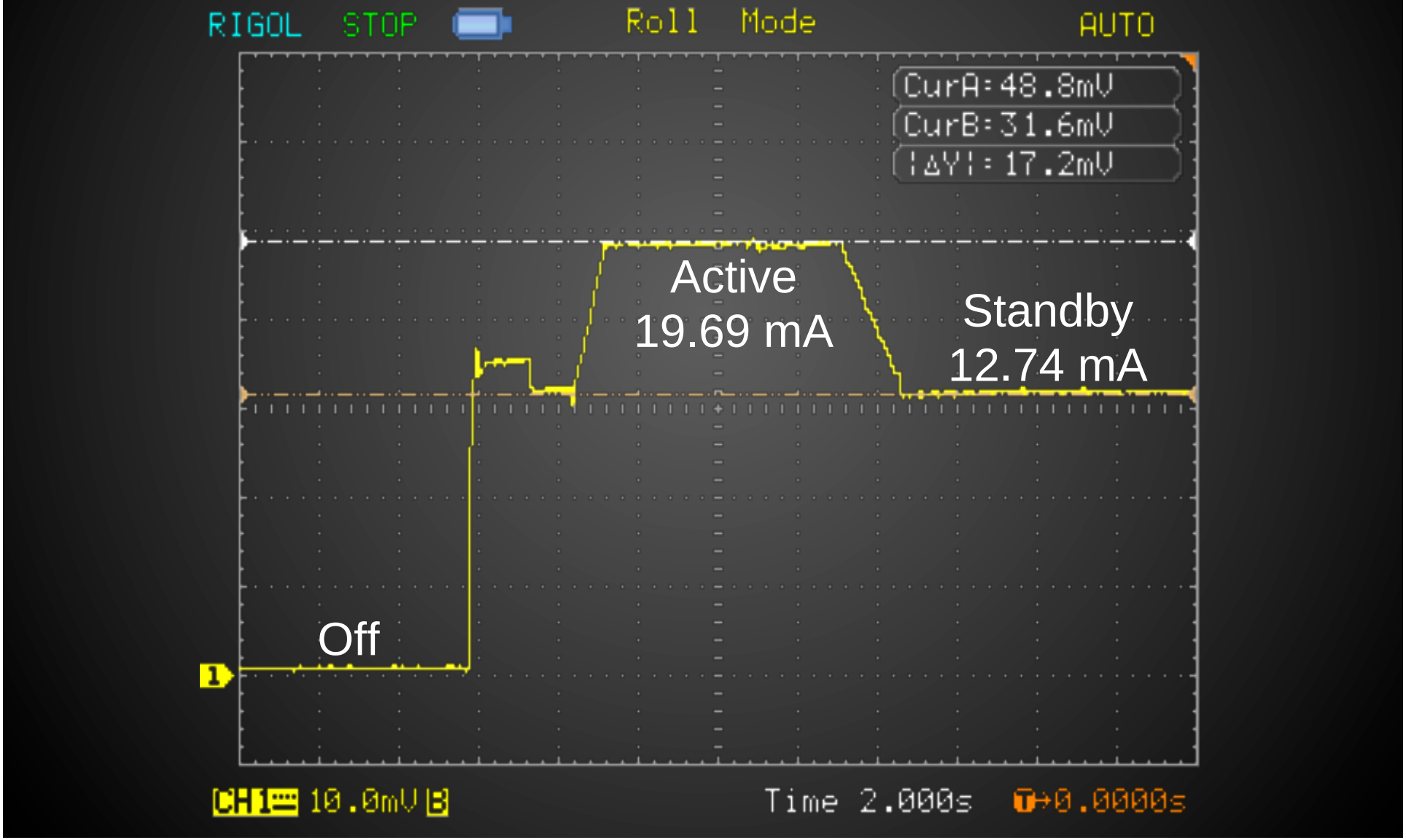
$$\boldsymbol{Active\ \% = \frac{2.2 \times 1\ min}{60\ min/hour} = 3.67\%\ of\ active\ time}$$

Assuming 5% time is on, this gives a battery life of

$$P_{avg} = (27.36\ mA \times 5\ V) \times 5\% + \left(\frac{471.7\ \mu A}{1000\ \mu A/mA} \times 5\ V\right) \times 95\% = 9.081\ mW$$

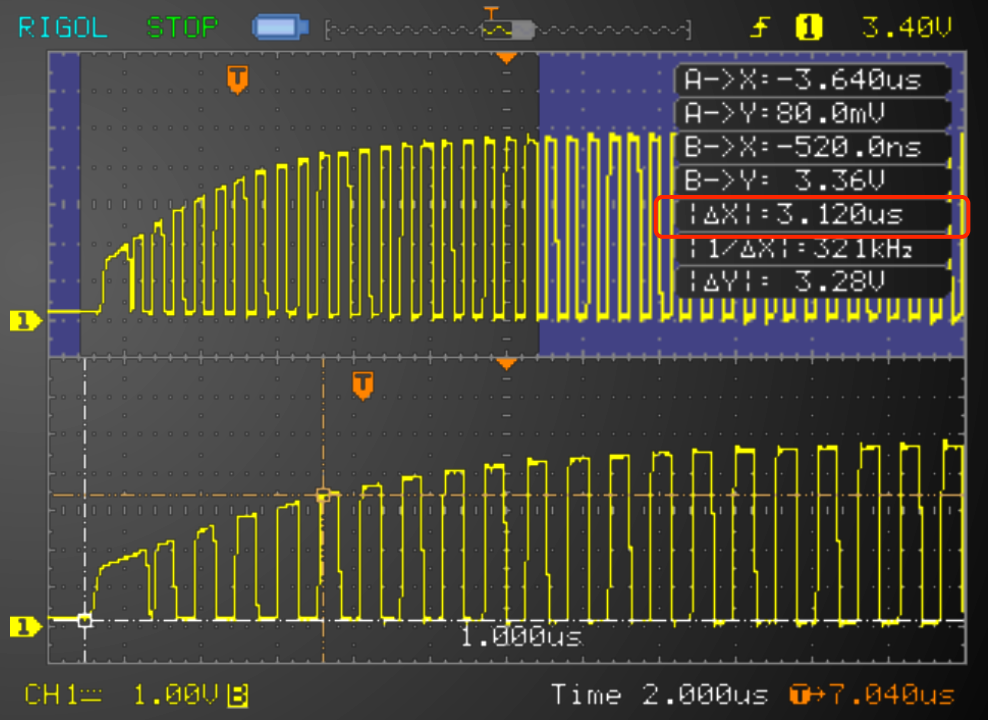
$$T_{on} = \frac{\left(\frac{578\ mAh}{1000\ mA/A} \times 3.7\ V\right) \times 93\%}{0.009081\ W} = 219.03\ h = 9.126\ day$$

Power Consumption - Receiver



Requirement and Verification

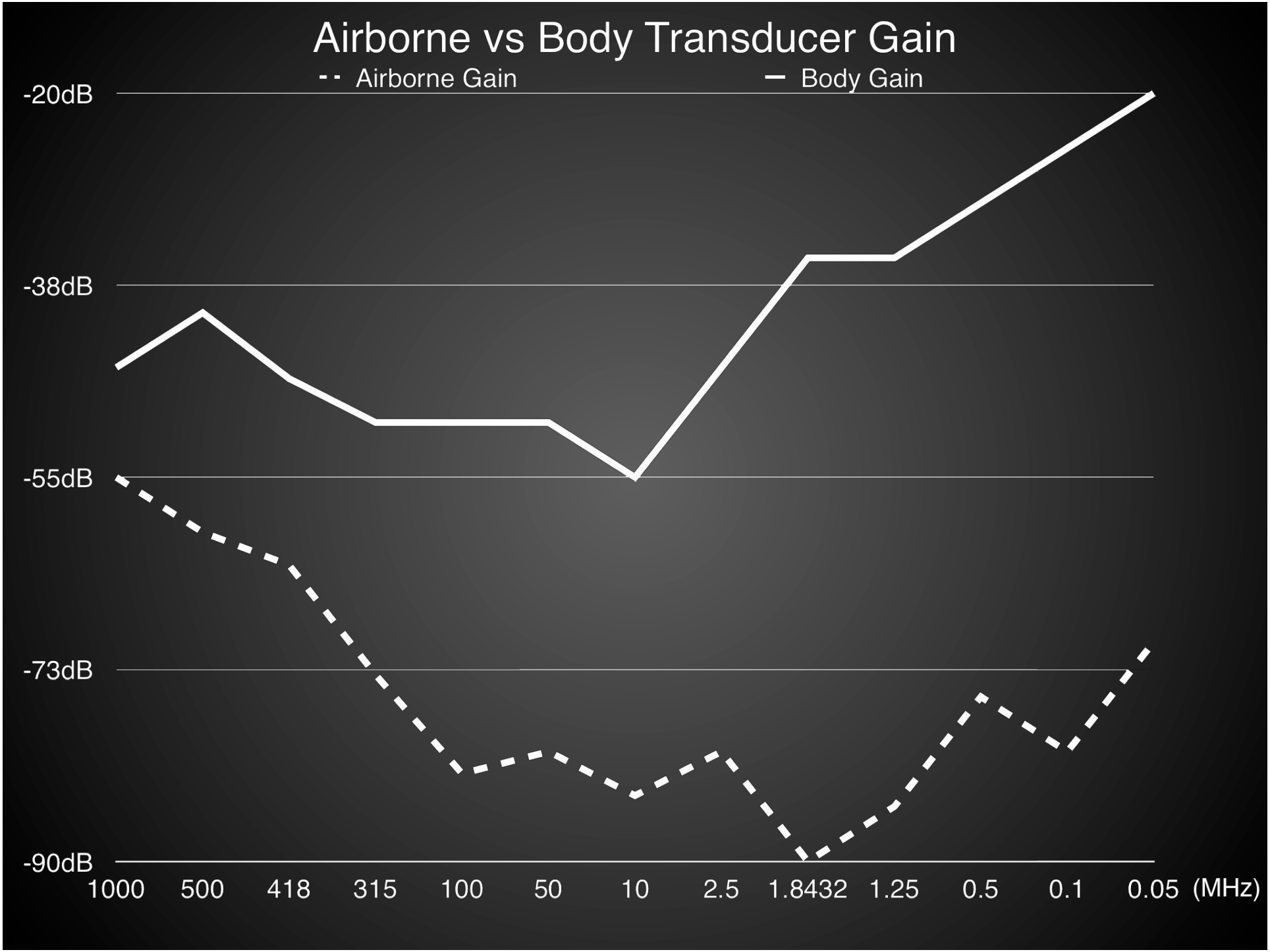
- Verification Passed for All Requirement
  - Crystal Oscillator performance exceed specification
    - Allow faster data transmission



Enable Time	T_{PLZ}	Pin 1 Logic '1'	10	ms

Theory of operation

- Human Body is Conductor
- Surface Current through Body
- Body Conduct RF Different from Air
- Difference in Gain Changes with Frequency


Airborne vs Body Transducer Gain
Airborne Gain
Body Gain
-20dB
-38dB
-55dB
-73dB
-90dB
1000
500
418
315
100
50
10
2.5
1.8432
1.25
0.5
0.1
0.05
(MHz)

Our Choice - 1.8432MHz

- Where Difference in Airborne and Body Transducer Gain is Greatest
- Multiple of Pre-existing Transmission Rate
  - 1.8432MHz = 16 x 115200 Baud
  - 1.8432MHz = 192 x 9600 Baud
  - 1.8432MHz = 1538 x 1200 Baud
- Oscillator Readily Available
- Outside of AM Radio Frequency Range

Our Choice
1.8432MHz

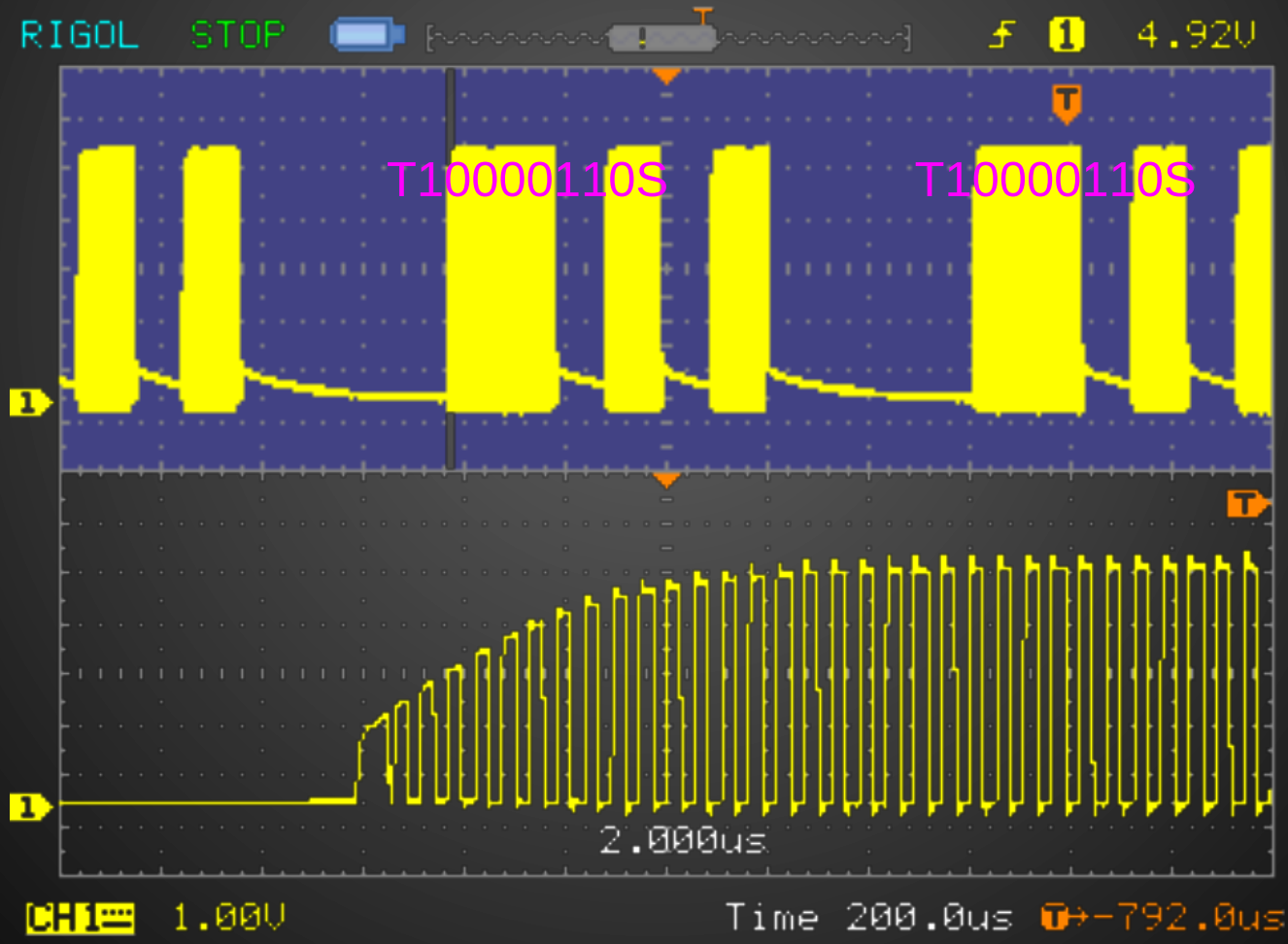
United States Table	
Federal Table	Non-Federal Table
1800-1900	1800-1900 AMATEUR
1900-2000 RADIOLOCATION US290	

Table of Frequency Allocations International Table		
Region 1 Table	Region 2 Table	Region 3 Table
1800-1810 RADIOLOCATION 5.93	1800-1850 AMATEUR	1800-2000 AMATEUR FIXED MOBILE except aeronautical mobile RADIONAVIGATION Radiolocation
1810-1850 AMATEUR 5.98 5.99 5.100 5.101		
1850-2000 FIXED MOBILE except aeronautical mobile 5.92 5.96 5.103	1850-2000 AMATEUR FIXED MOBILE except aeronautical mobile RADIOLOCATION RADIONAVIGATION 5.102	 5.97

*FCC ONLINE TABLE OF FREQUENCY ALLOCATIONS
http://transition.fcc.gov/oet/spectrum/table/fcctable.pdf

Data Transmission

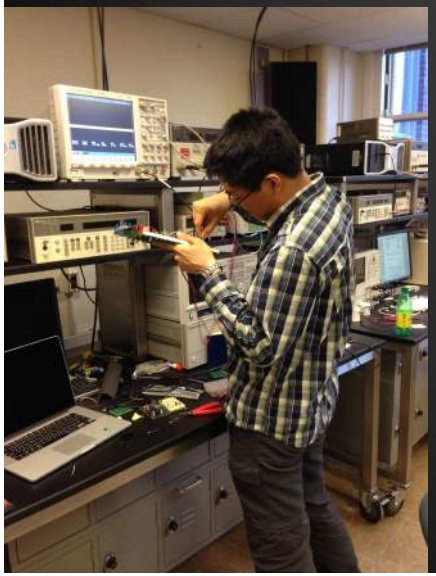
Amplitude Shift Keying (ASK)

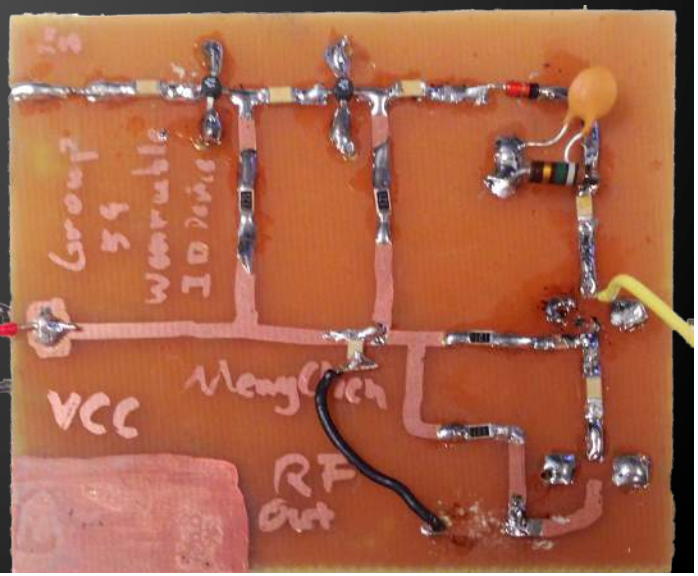


* Char ‘a’ transmitted using RS-232, 9600 Baud

Data Transmission

- Simplify Transmitter Design
- Receiver can be Modified From AM Radio
- Increase Body Transmission Stability





Data Transmission

- Transmission Rate

  $0.5\ \text{sec} \times 20\ \text{KHz} = 10\ \text{Kbit}$

- Receiver Filter

With a ~ 1pF Variable Capacitor

$$f_{carrier} = \frac{\omega_0}{2\pi} = \frac{1}{2\pi\sqrt{LC}} = 1.8432MHz$$

$$L_{coil} \approx 74.55\mu H$$

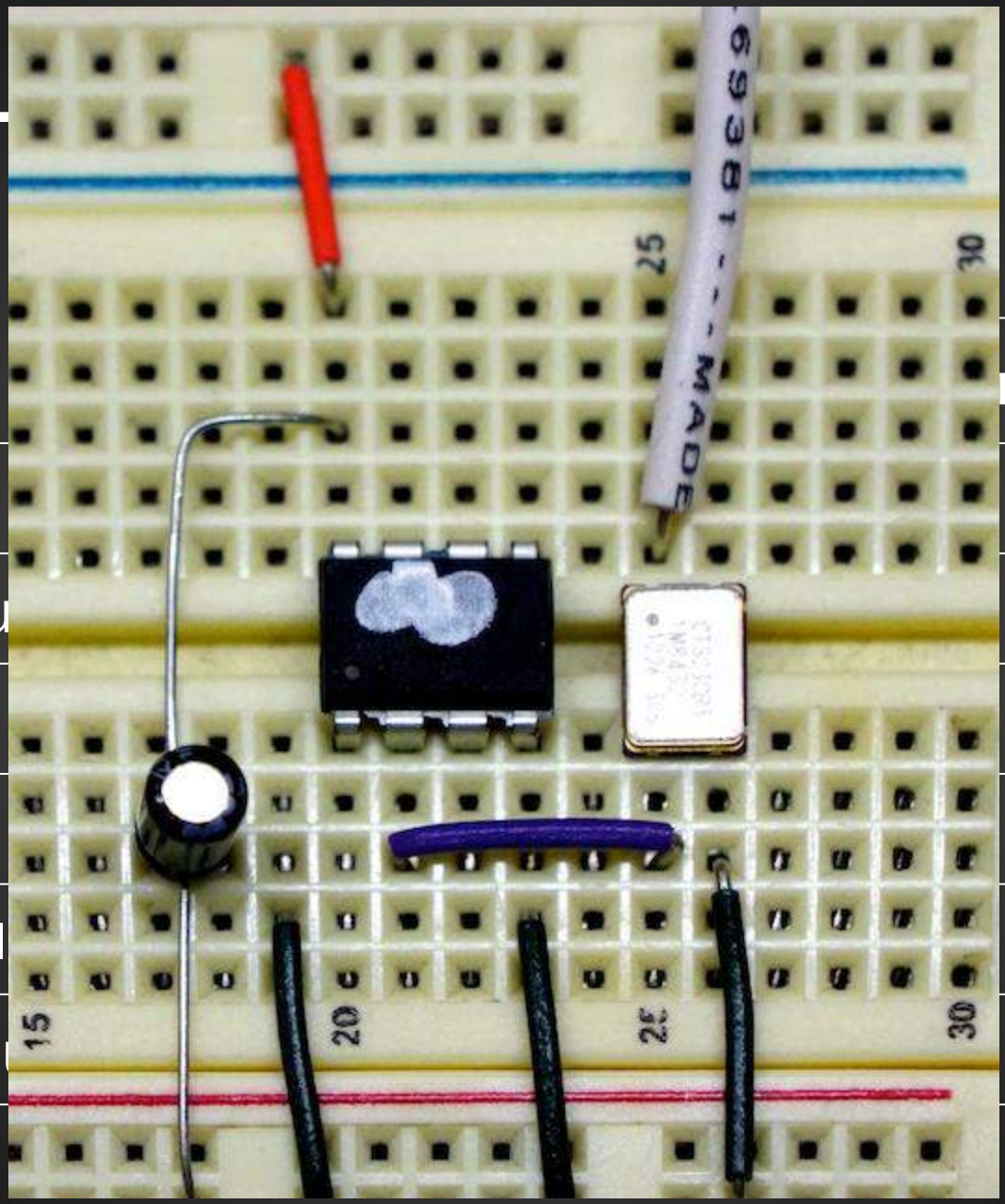
Issue & Challenges

- Proof of Theory
- Transmission Protocol
- Signal Generation and Acquisition
- Power Budget

Future Work

- Improve Receiver design
- Adaption to other application
- Dual way communication
  - Handshake Transmission
  - Expand Data Usage
  - Integration with Other Security Technology
- Patenting

Cost - T



Parts	ntegration
MCU	~
Radio Modu	$0.9086
Display	~
RTC	~
Power Control	~
Miscellaneou	$0.50
Total	**$1.4086**

Cost - Receiver

Parts	This Project	Production	Integration
MCU	$5.95	~	~
RF Demodulator	$14.67	$2.40	$2.40
Display	$6.82	~	~
Power Controller	$2.72	$1.02	~
Miscellaneous	$80.00	$0.70	$0.50
Total	**$110.16**	**$4.12**	**$2.90**

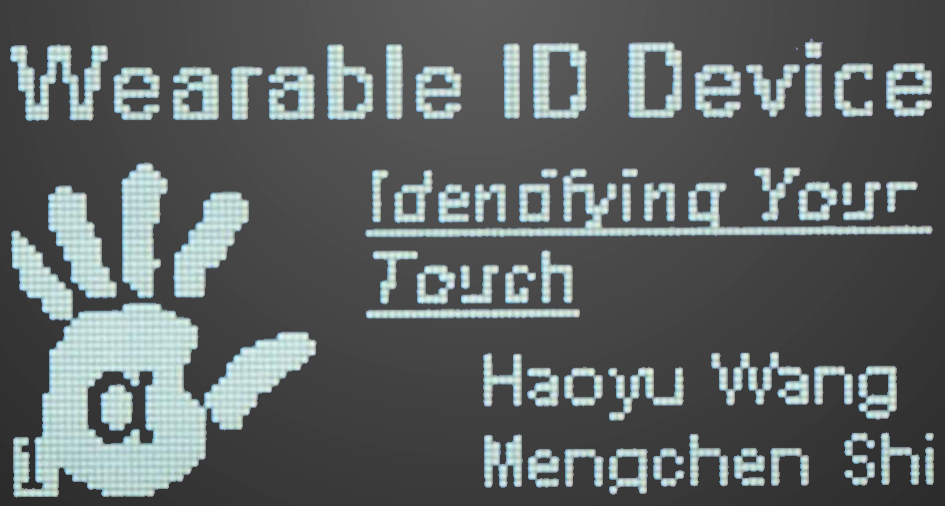
SWOT Analysis

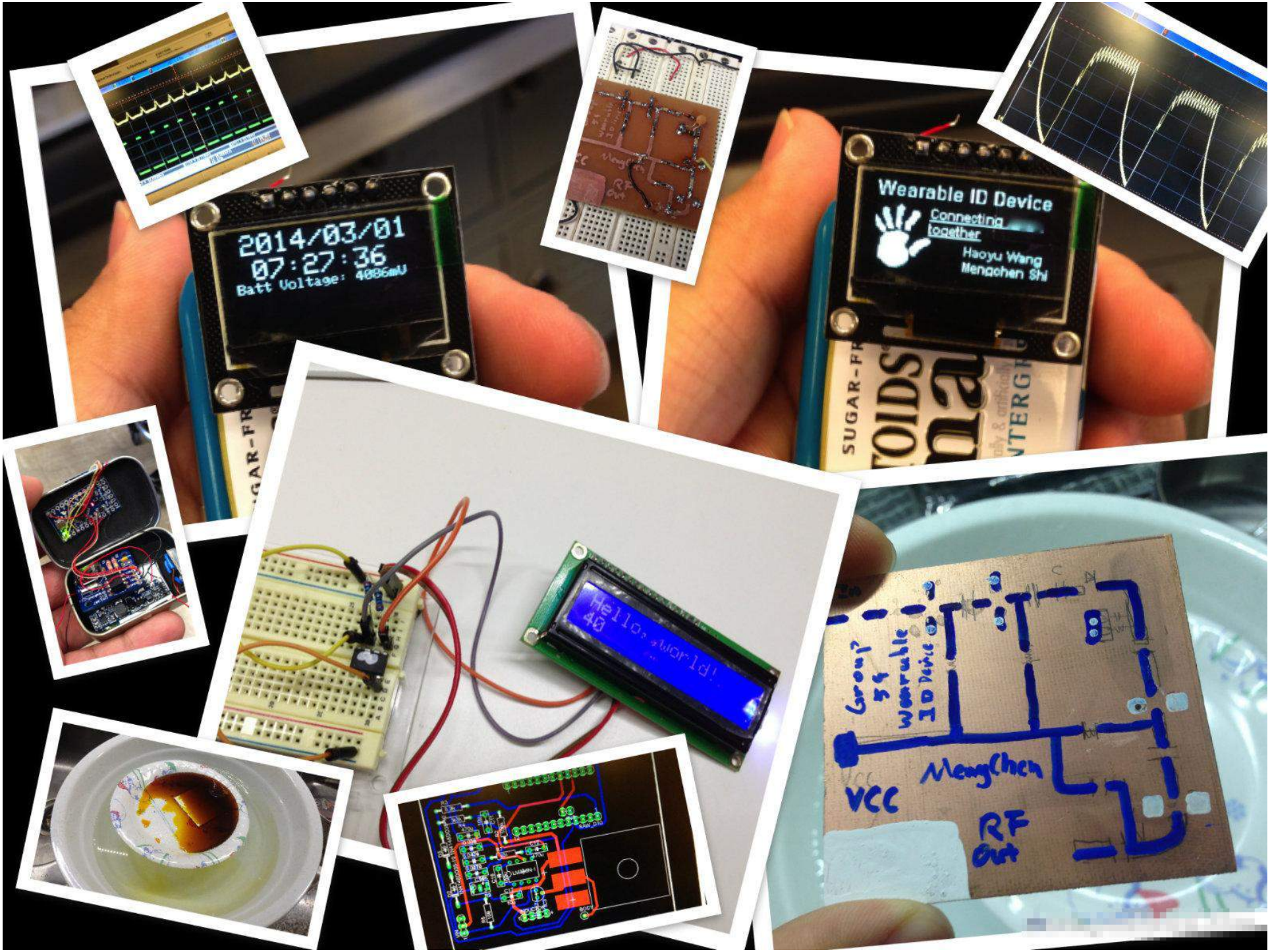
Marketing Plan

	The Watch	Receiver	Integratable Transmitter	Integratable Receiver
Cost	$11.19	$4.12	$1.41	$2.90
Selling Price per Unit	$59.99	$49.99	$12.69	$26.09
Return on Cost (Unit)	1.2	9.1	5.6	17

Conclusion

- Revolutionary Security Mechanism
- Low Cost, Low Power
- Simple, Natural, Secure




2014/03/01
07:27:36
Batt Voltage: 4086mV
Wearable ID Device
Connecting
together
Haoyu Wang
Mengchen Shi
Hello, world!
Mengchen
VCC
RF
Out