

Preventing, Anticipating and Mitigating Off-Task Behavior in Special Needs Students

GROUP E

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PURPOSE

Autism Spectrum Disorder
(ASD)
Emotional & Behavioral
Disorder
(EBD)

Off-Task Behavior
vs.
Meltdown

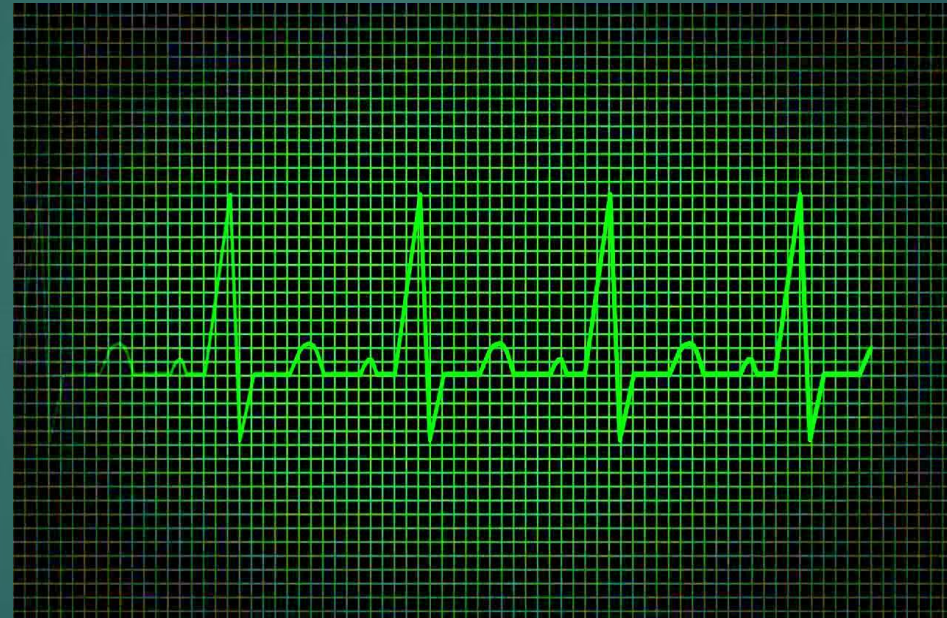


GOALS

Prevention



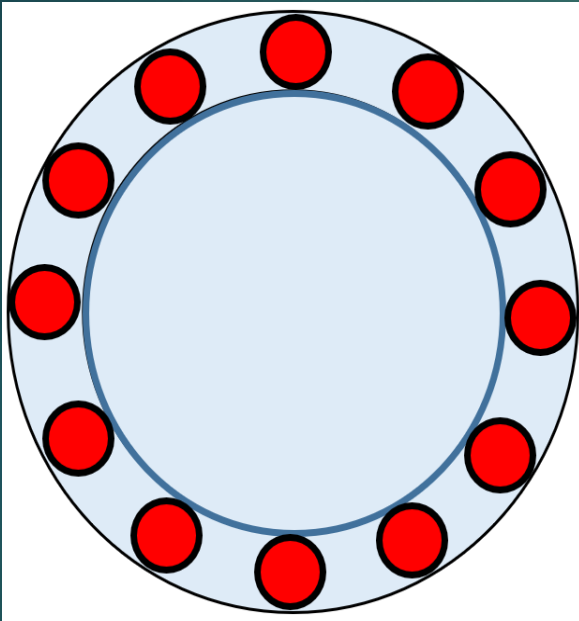
Mitigation



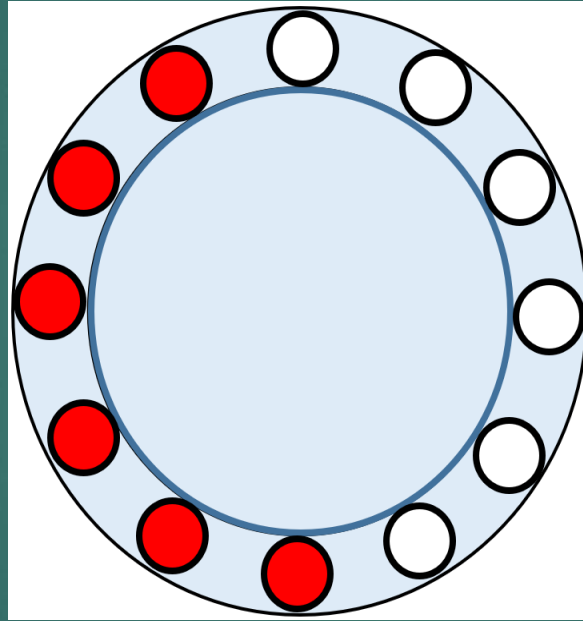
Anticipation

PREVENTION METHOD

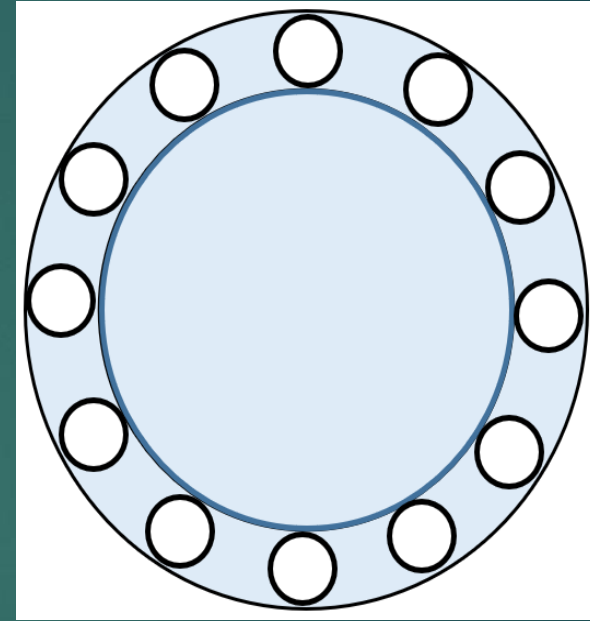
Timer Progression



5 minutes remaining



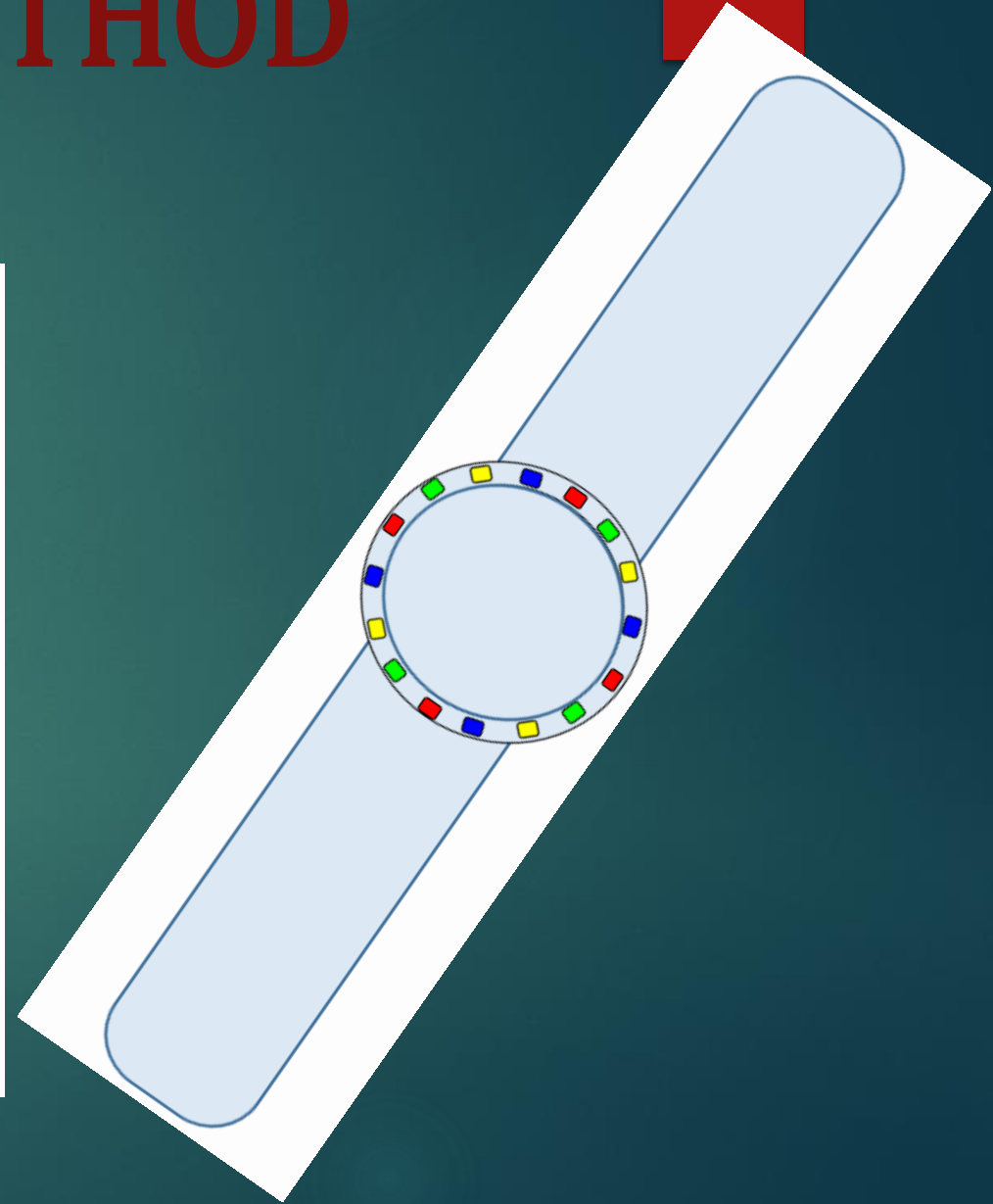
2 minutes 30 seconds
remaining



Time's up!

ANTICIPATION METHOD

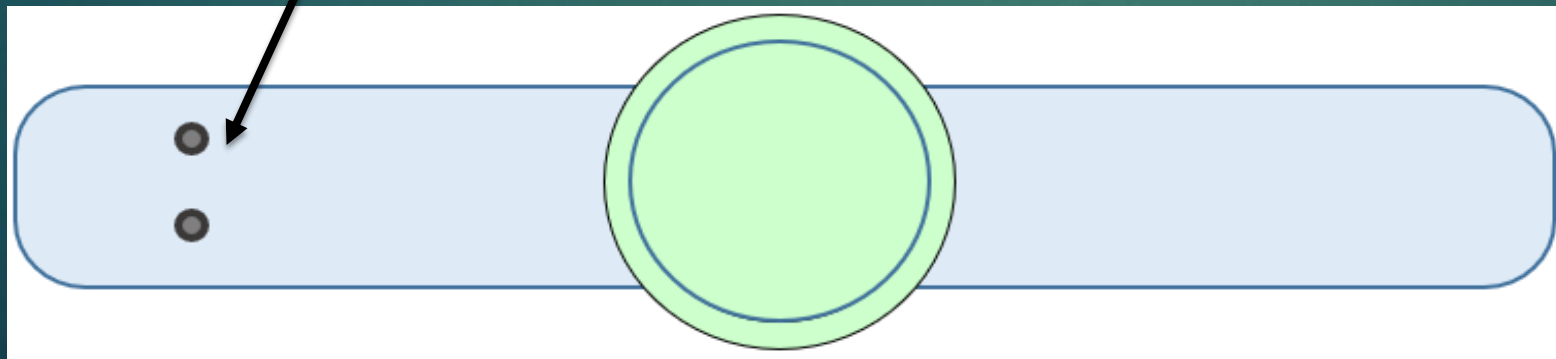
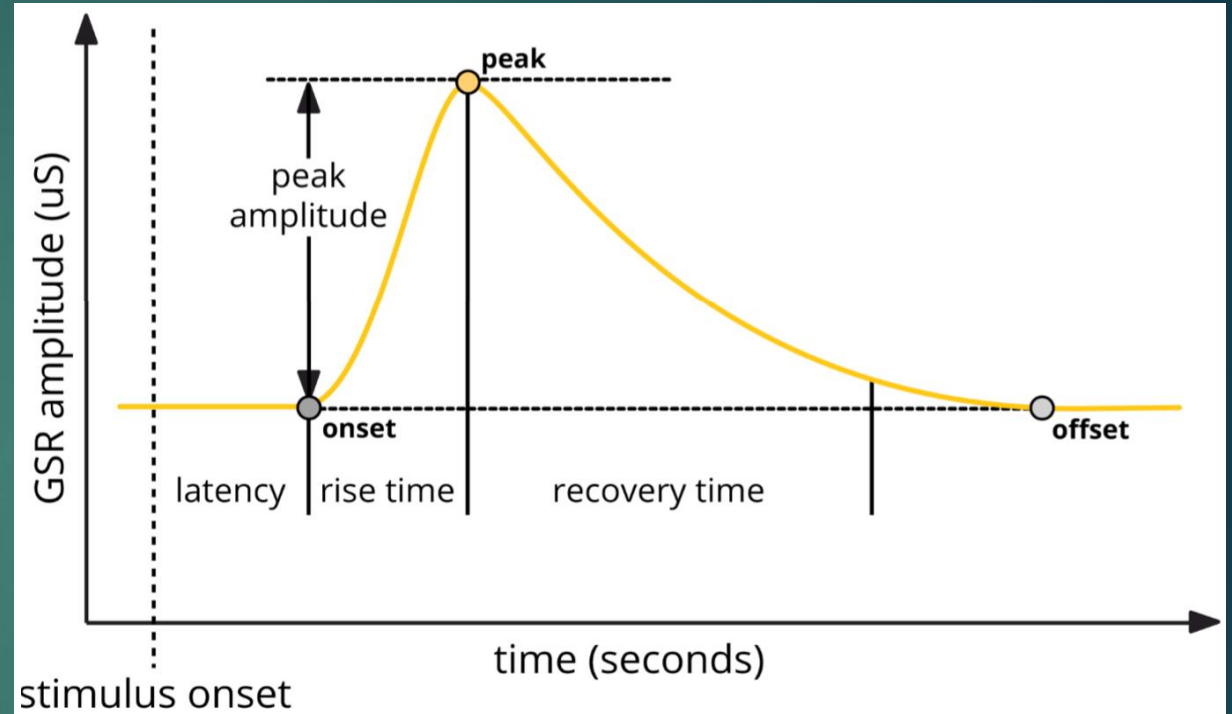
Wearable Sensor



ANTICIPATION METHOD

Electrodermal Activity
Galvanic Skin Response

EDA



MITIGATION METHODS

Distraction & De-escalation and/or Intervention & Consolation

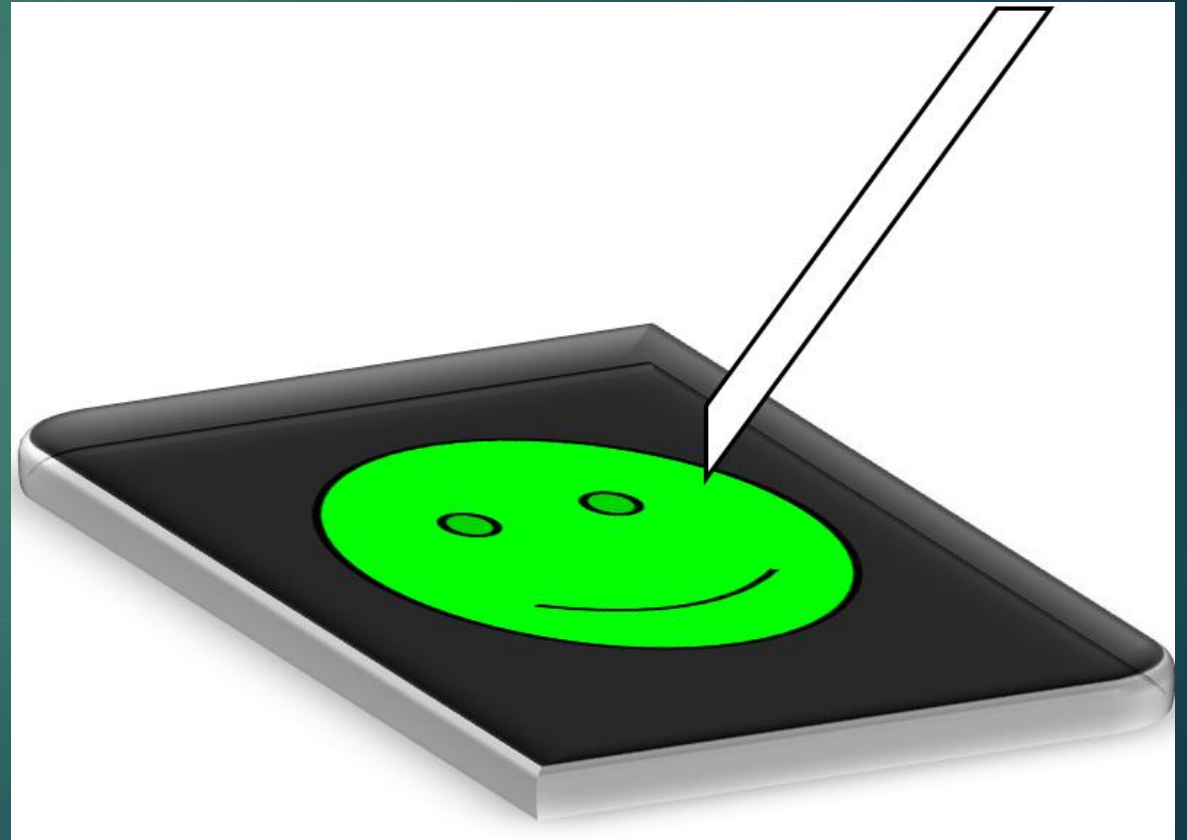


MITIGATION METHODS

Distraction & De-escalation

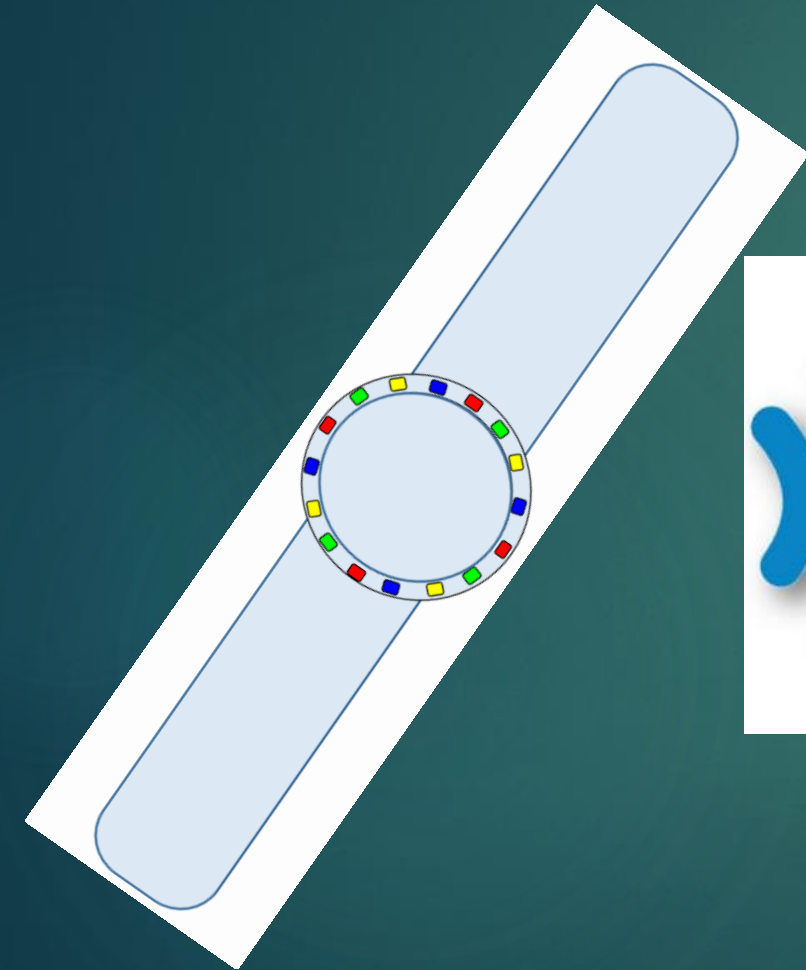
Advantages

Disadvantages

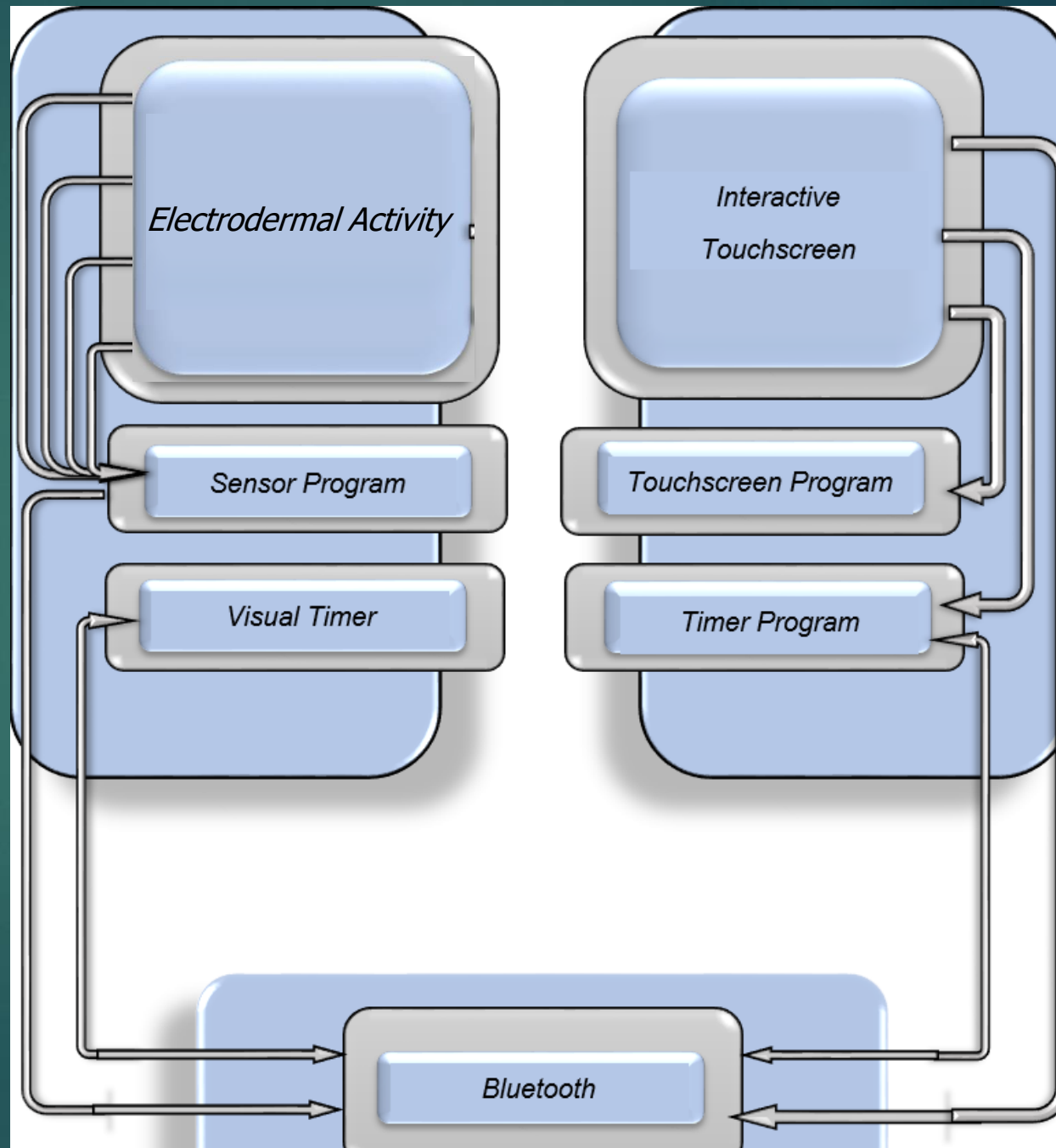


MITIGATION METHODS

Intervention & Consolation



Put it all
together...



REQUIREMENTS

- ▶ Portable (small, light-weight)
- ▶ Durable/Water resistant
 - ▶ Easy to use
 - ▶ Wireless
- ▶ Low power consumption
 - ▶ Accurate sensor
 - ▶ Low cost

SPECIFICATIONS

- ▶ Wearable sensor/timer 2" × 2" × 0.75", < 8 oz
 - ▶ Touchscreen 8" × 4" × 1", < 3 lbs
- ▶ 12-hour batter life with 50 W average consumption
 - ▶ ±20% sensor accuracy
- ▶ Minimal screen prompts: "ENTER", "NEXT", numerical input
 - ▶ Cost < \$300

DESIGN PHILOSOPHY

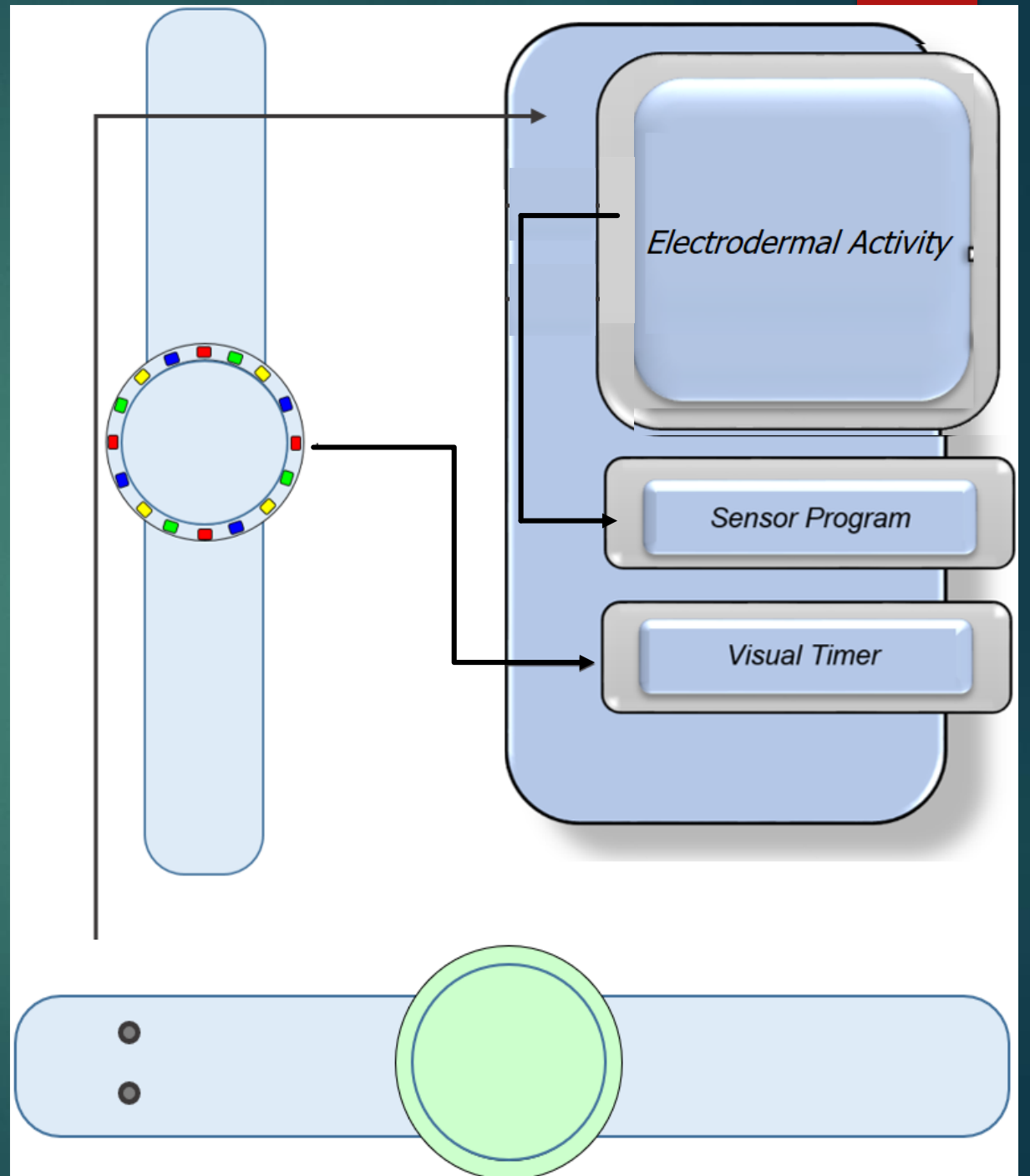
YES

- ▶ Qualitative
- ▶ Simple Microelectronics
- ▶ Small, low power
- ▶ Atmega & Arduino

NO

- Quantitative
- Complex Circuits
- Precise
- Skilled programming

Sensor/Timer Subsection



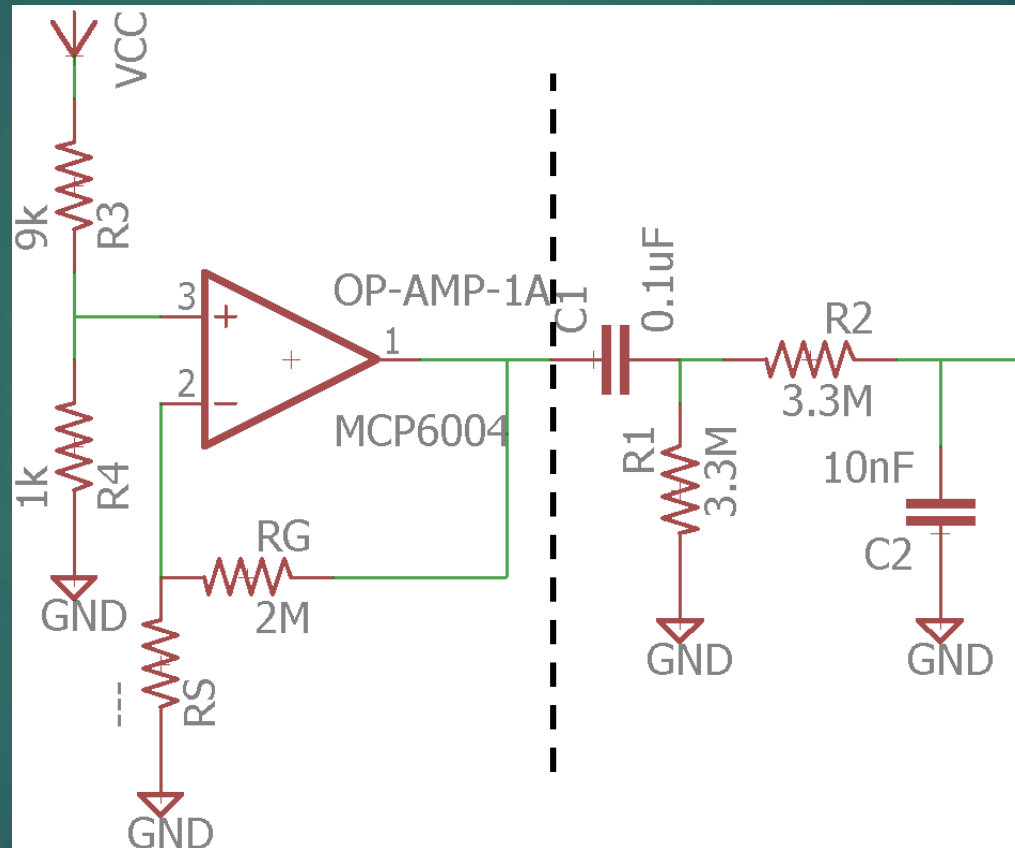
SENSOR DESIGN

EDA

Software filter

vs.

Hardware filter



$$V_{OP-AMP} = 0.5 \left(1 + \frac{R_G}{R_S} \right)$$

SENSOR DIFFICULTIES

Test conditions:

Cannot induce an autonomic response

Software

a.k.a.

Programming

a.k.a.

Coding

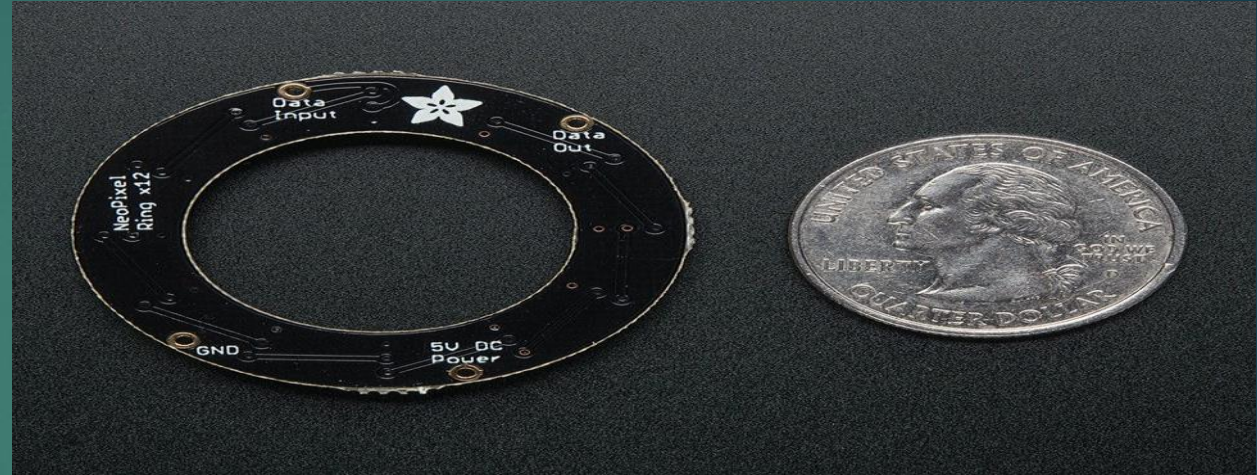
CHOOSING A TIMER

- ▶ Has to be small enough to fit on a wrist strap.
- ▶ Has to be programmable.
- ▶ Has to be visible but not distracting.
- ▶ Needs to be colorful.

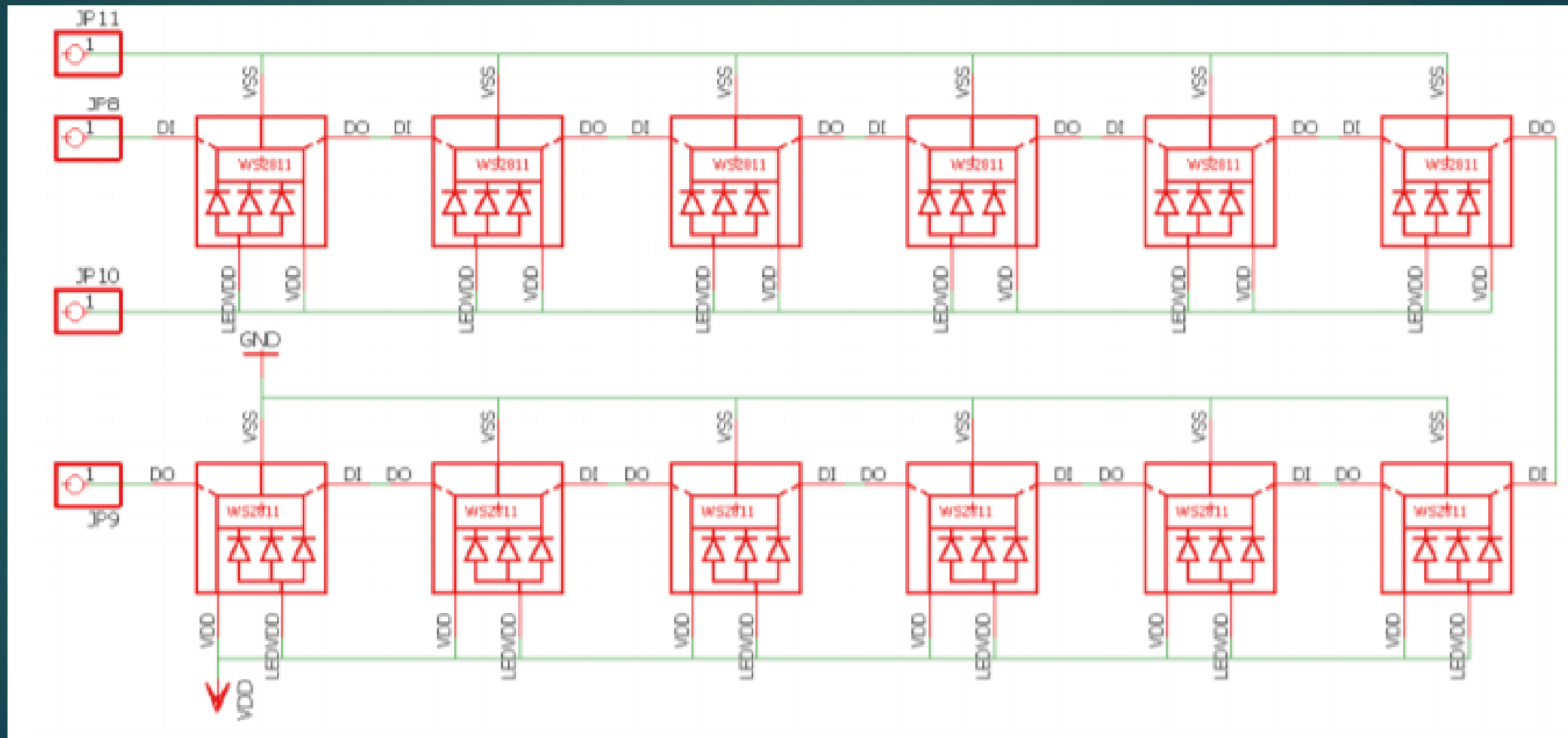


CHOOSING THE NEOPIXEL RING

- ▶ It weighs 3.3g.
- ▶ The Thickness is 0.3”.
- ▶ The inner diameter is 1”.
- ▶ The outer diameter is 1.5”.
- ▶ It has 12 RGB LED's.
- ▶ Is Programmable.
- ▶ It runs on 5V Power.
- ▶ Many Colors.



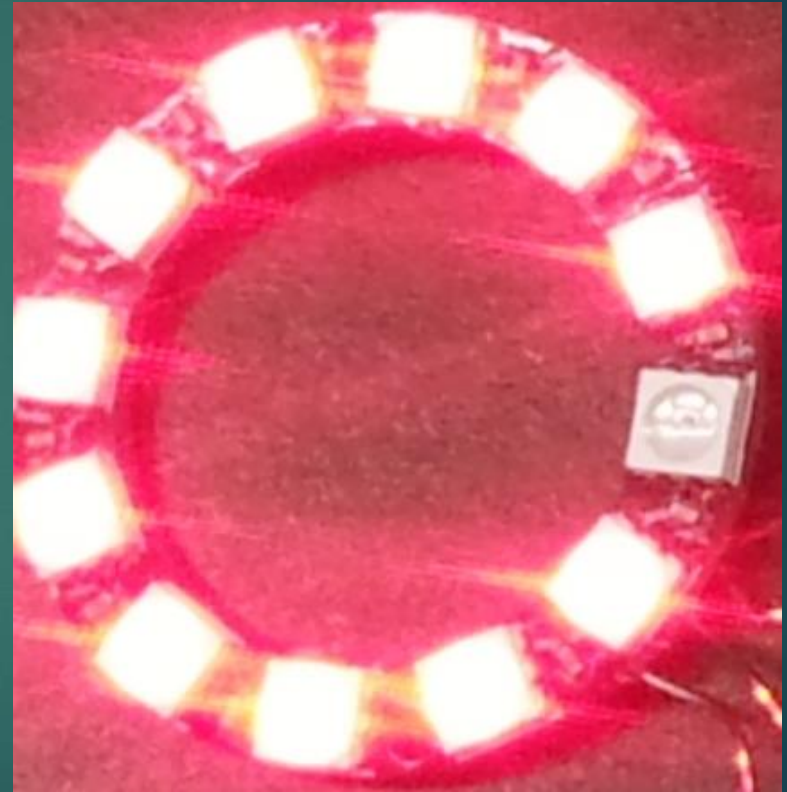
NEOPIXEL RING DESIGN



NEOPIXEL RING SUCCESS

As can be seen on the right the Neopixel ring is lit up red. All but one of the LED's are lit up indicating successful programming.

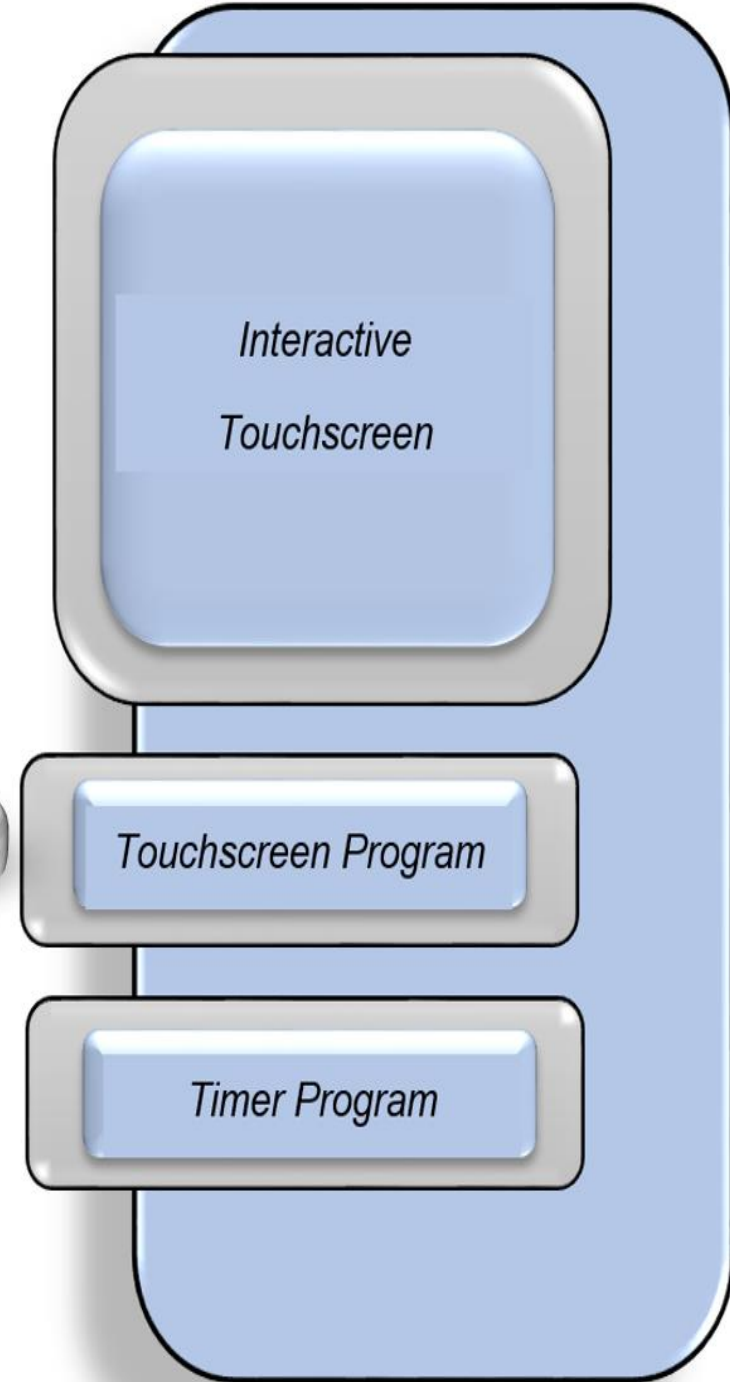
We use this ring as a timer which will extinguish after each subject. It is great because it meets all of our demands and requirements.



NEOPIXEL RING DIFFICULTIES

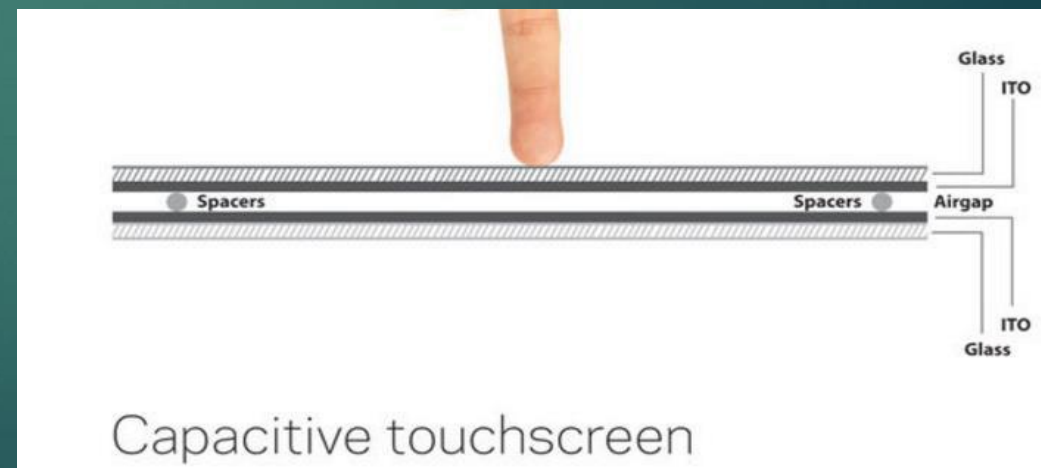
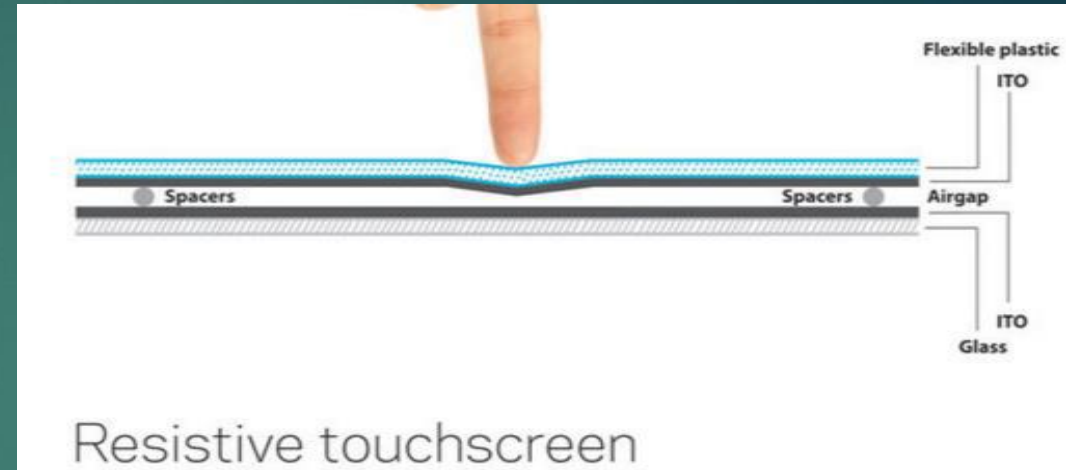
- ▶ Finding the right size ring.
- ▶ Programming each color to come on.
 - ▶ Getting the colors to stabilize.
- ▶ Syncing it with the Bluetooth module.

Interactive Touchscreen



TOUCHSCREEN CHOICES

- ▶ Resistive touchscreens can be used either with a finger or stylus. However these displays are not as sharp as the capacitive ones.
- ▶ Capacitive touchscreens take advantage of multi-touch gestures. These displays have thin glass.
- ▶ Both offer are less than \$20 on amazon.



CHOOSING THE 2.8" TFT

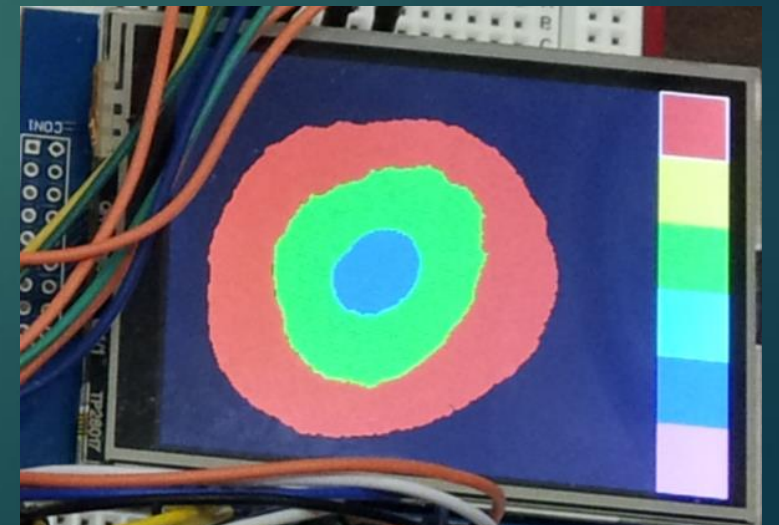
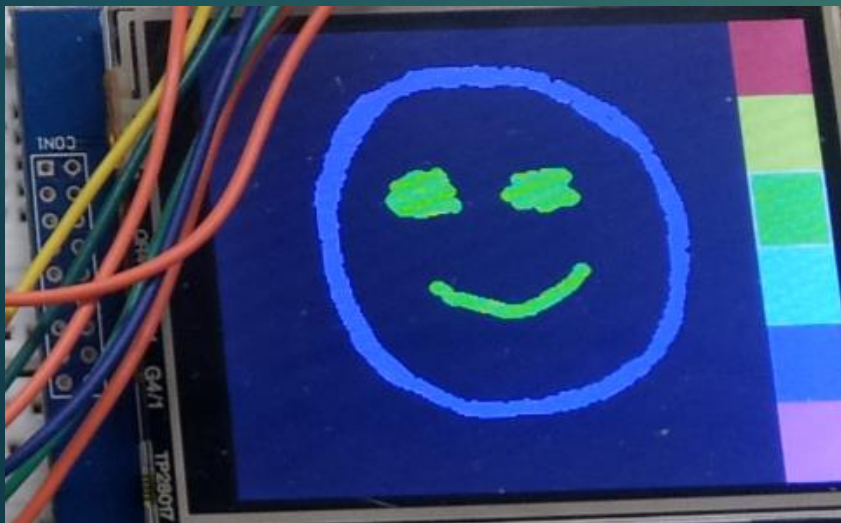
We chose the Uno 2.8" TFT from Amazon because it can be used with your finger or a stylus. Also it fit our budget needs and is small in size. Below is more details of the screen.

| Description | Size |
|-------------------------|---------------|
| Type of Display | TFT LCD Color |
| Response Time (typical) | 25 ms |
| Pixels | 320 x 240 |
| Colors | 16-bit |
| Backlight Type | 4 LED |
| Contrast Ratio | 500:1 |



TOUCHSCREEN SUCCESS

Here we can see three different images created by us. The colors on each screen are to the right that can be used for the kids to draw with. The screen is used as part of their De-escalation.



TOUCHSCREEN DIFFICULTIES



- ▶ Getting all the wires connected.
- ▶ Making sure the colors matched.
- ▶ Finding an easy to use screen.
- ▶ Getting the coordinates correct.

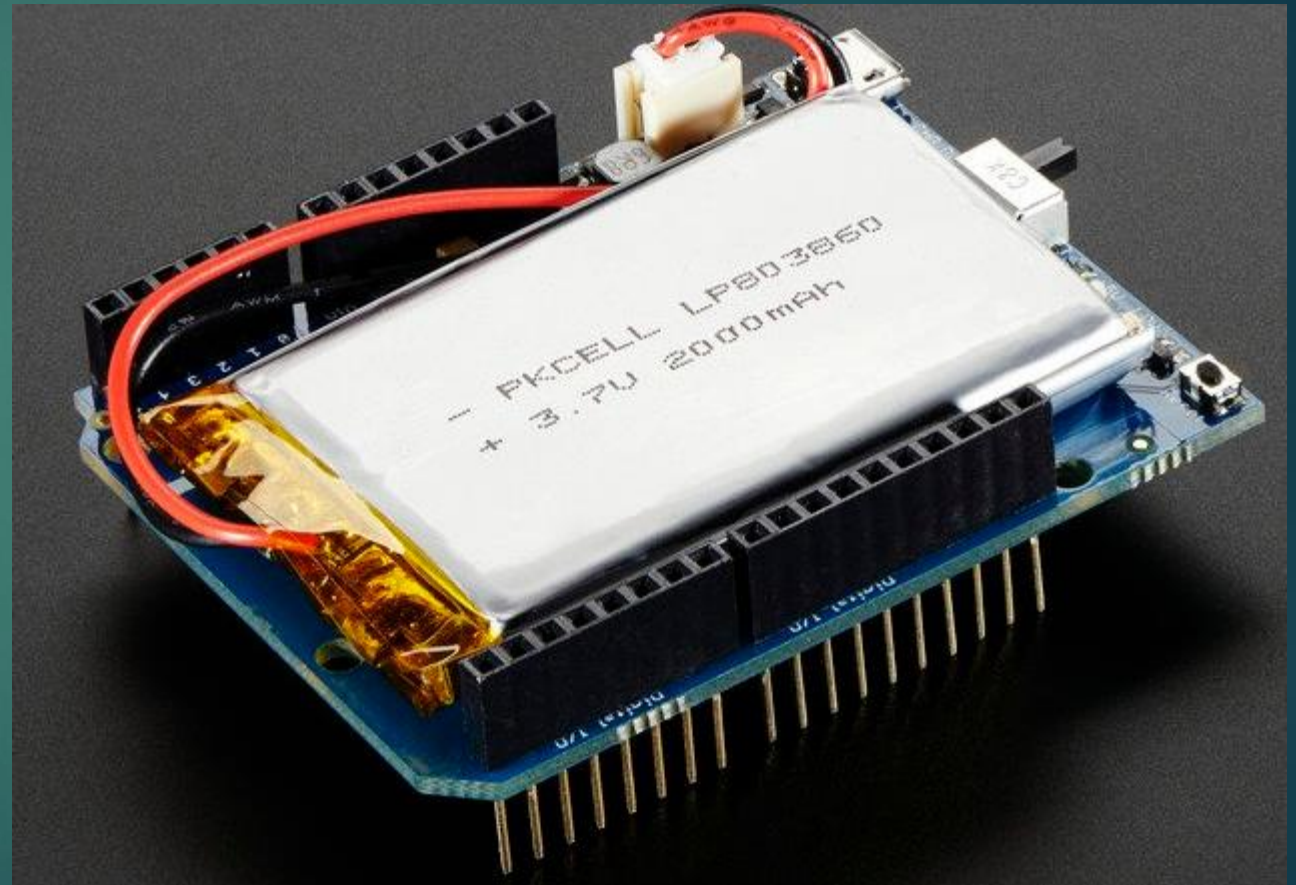
CHOOSING THE RIGHT BATTERY

- ▶ Lithium Polymer (Li-Po) can be made thinner but the cost goes up from 10 to 30% from Li-Ion batteries.
- ▶ Lithium Ion (Li-Ion) is cheaper and is common in phones but they are larger in size.
- ▶ Both are great choices for our project and we will choose the one that offers ease of use.



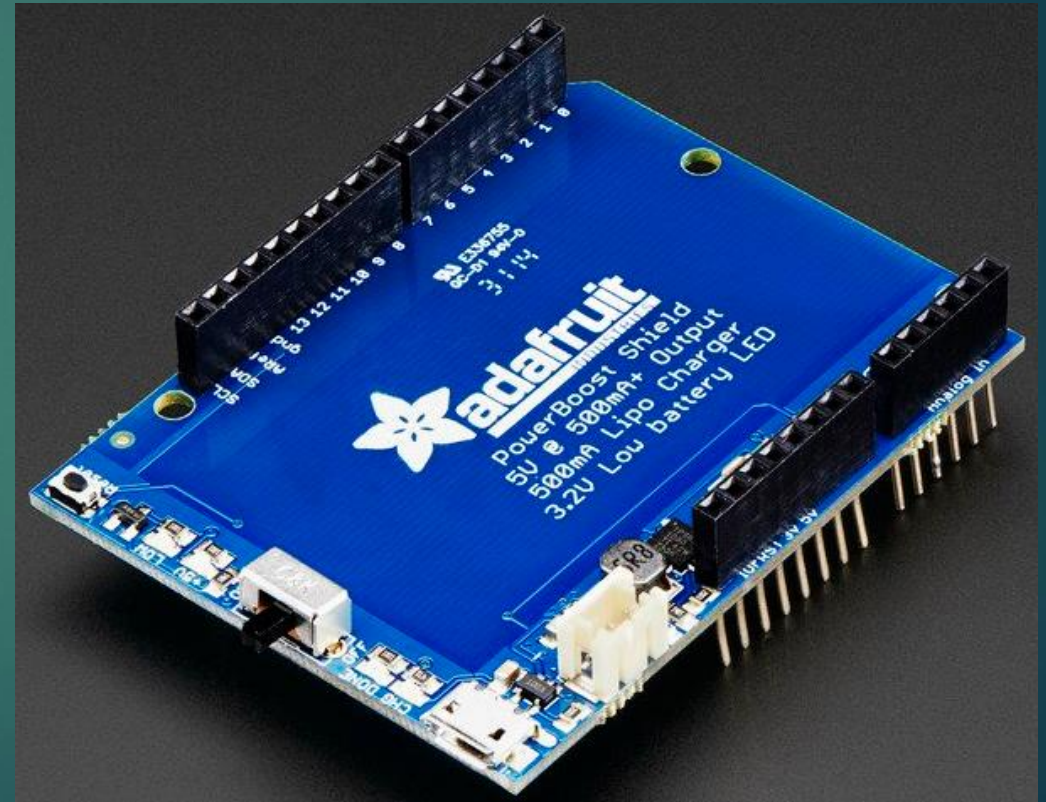
CHOOSING THE LP803860 FOR THE PORTABLE DEVICE

- ▶ It has 3.7V Li-Po Battery
- ▶ Output ranges from 4.2V when completely charged to 3.7V
- ▶ Small in size and flexible.
- ▶ The battery comes with a 2-pin JST-PH connector so it wont get stuck or snag.
- ▶ Requires a constant voltage/constant current charger at a rate of 2A or less (500mA is best).



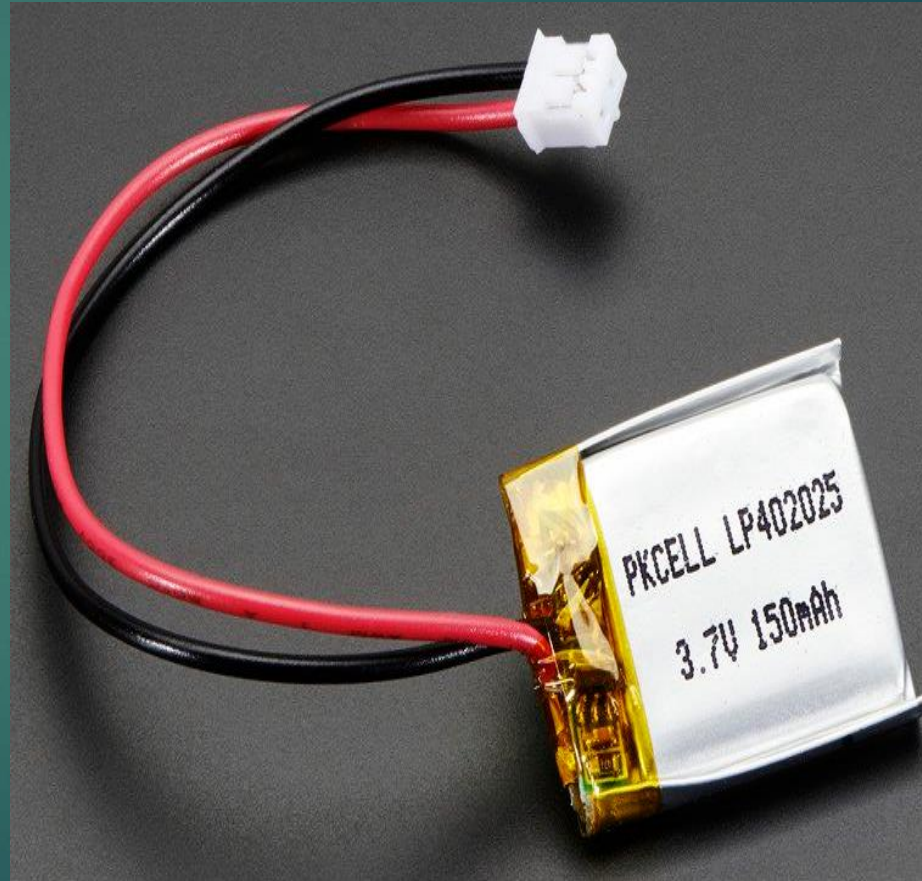
CHARGING THE LP803860 FOR THE PORTABLE DEVICE

- ▶ We chose to go with the PowerBoost 500 Charger for our portable device.
- ▶ 2.1" x 2.7" x 0.08".
- ▶ Weighs 12.5g.
- ▶ Comes with a 3.2V low battery LED indicator.
- ▶ 90% operating efficiency.
- ▶ Low current at 5mA.



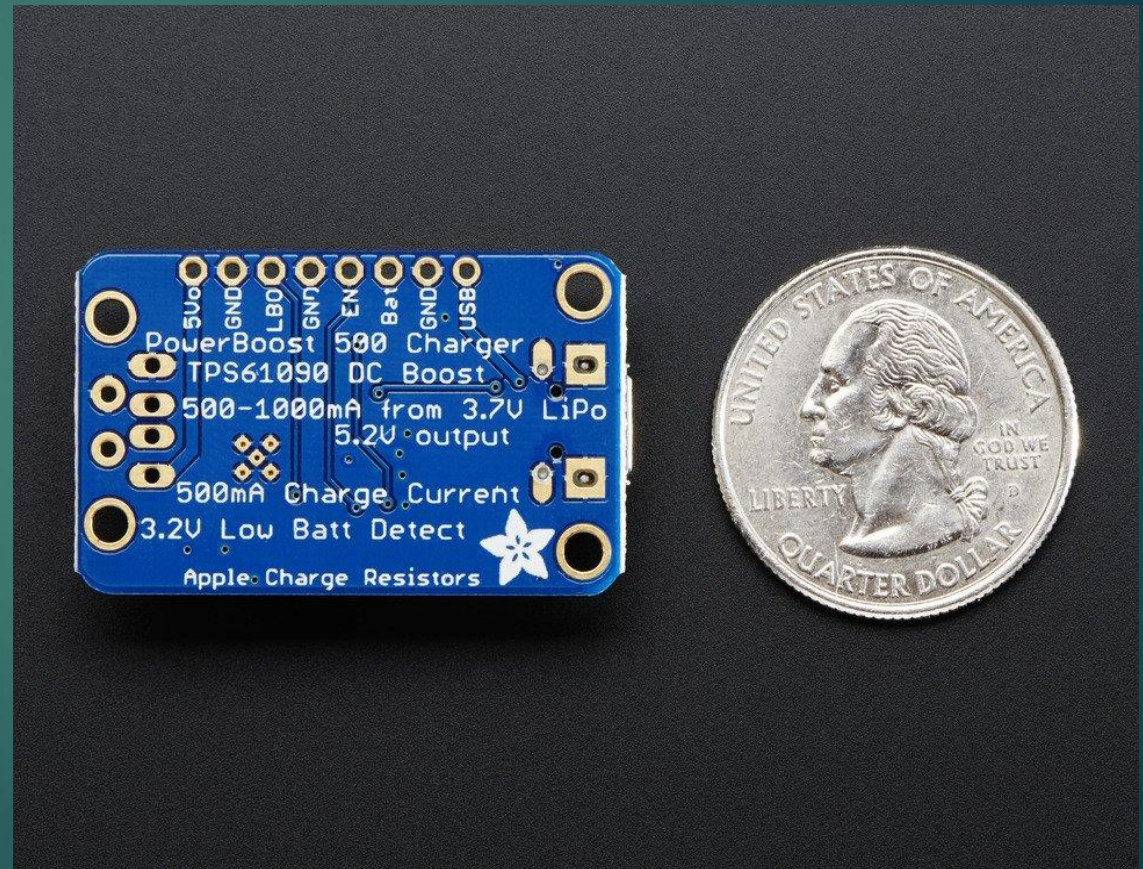
CHOOSING THE LP402025 FOR THE WEARABLE DEVICE

- ▶ This is a 3.7V 150mAh Li-Po Battery
- ▶ The output ranges from 4.2V when completely charged to 3.7V.
- ▶ Comes pre-attached with a 2-pin JST-PH connector.
- ▶ It has included protection circuitry which keeps the battery voltage from going to high (over-charging) or too low (over-use).
- ▶ Battery cuts out (completely dead) at 3.0V.



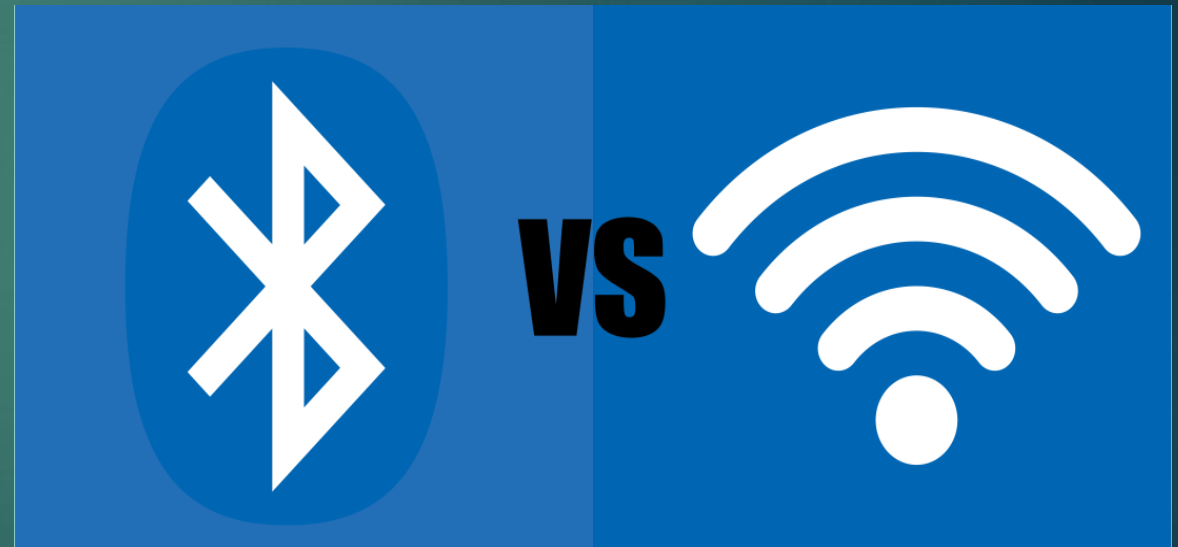
CHARGING THE LP402025 FOR THE WEARABLE DEVICE

- ▶ We chose to go with the PowerBoost 500 Charger for the wearable device.
- ▶ 09." x 0.08".
- ▶ Weighs 4g.
- ▶ Comes with a low battery indicator.
- ▶ 90% operating efficiency.
- ▶ Low current at 5mA.



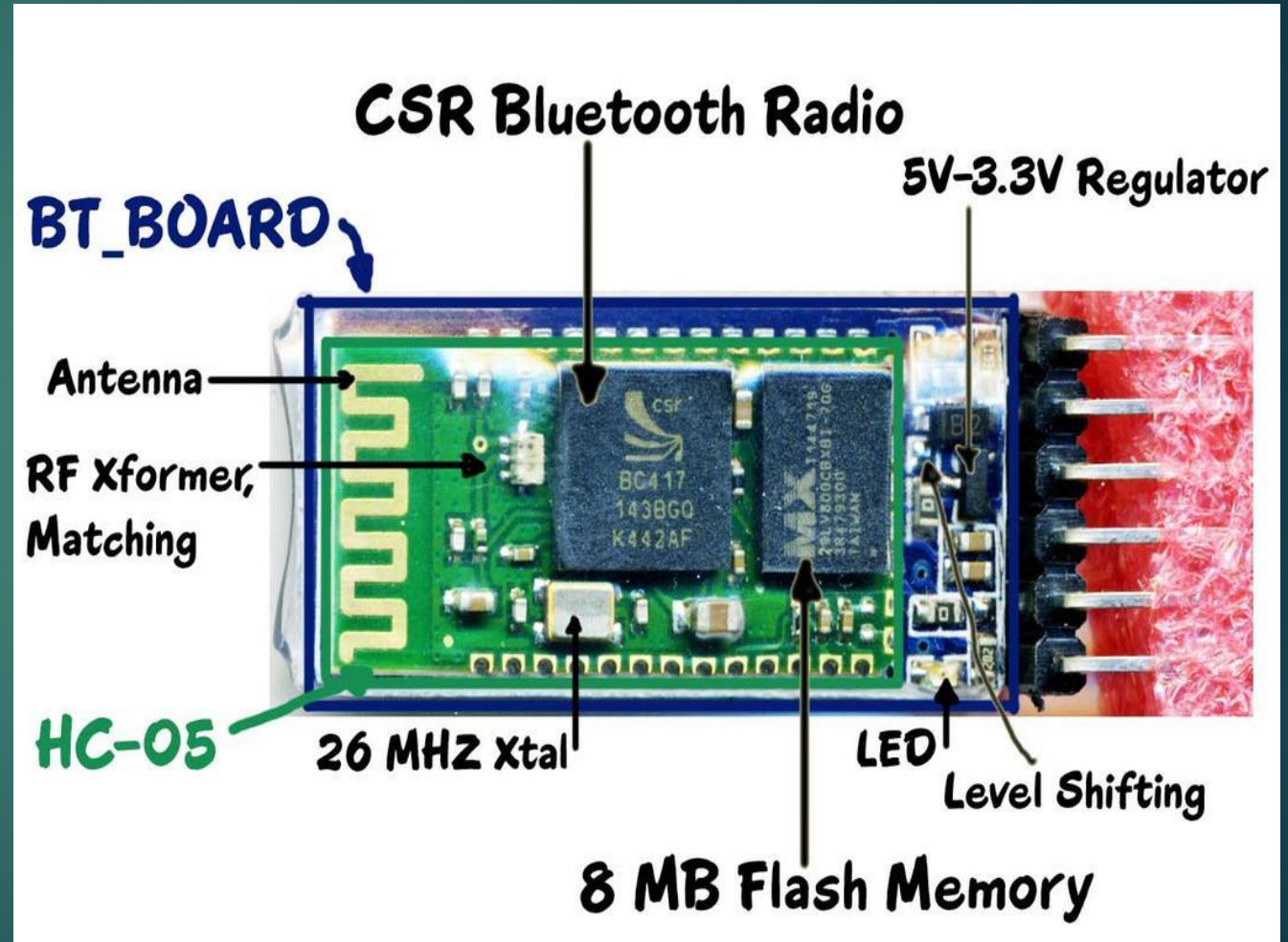
CHOOSING A WIRELESS CONNECTION: BT VS WI-FI

| Parameter | Wi-Fi | Bluetooth |
|--------------------------|-----------------|---------------|
| Data Rate | 1 to 866 Mbit/s | 1 to 3 Mbit/s |
| Distance | 10ft to 330ft | 330ft |
| Security | 128 to 256-bit | 56 to 128-bit |
| Latency | 6 ms to 35 ms | 100 ms |
| Power Consumption | 1 to 6 Watts | 1 Watt |
| Peak Current Consumption | 40ma | 30mA |
| Bandwidth | 20 to 160 MHz | 25 Mbit/s |
| Frequency | 2.4 GHz | 2.4 GHz |
| Cost | \$45 | \$20 |
| Ease of Setup | Complex | Simple |



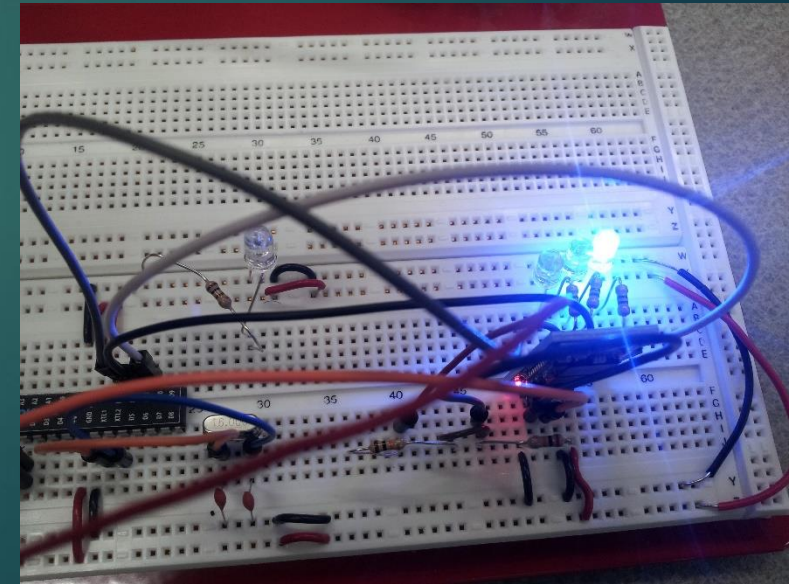
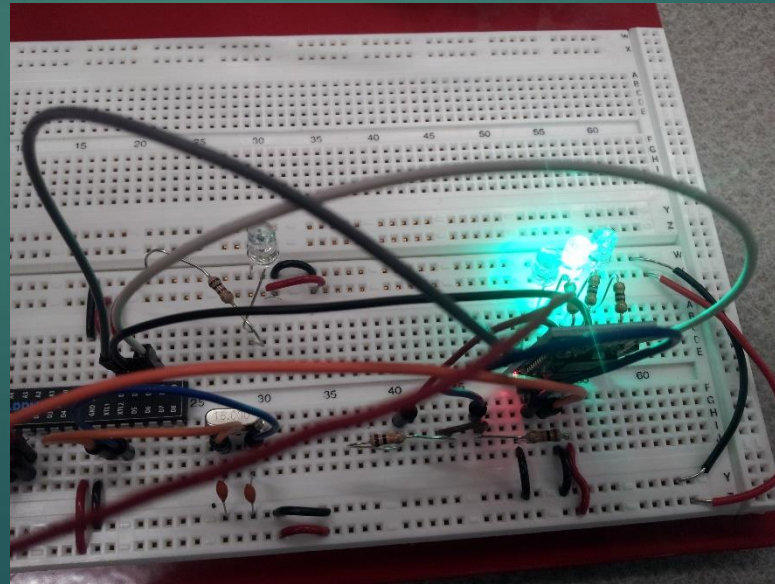
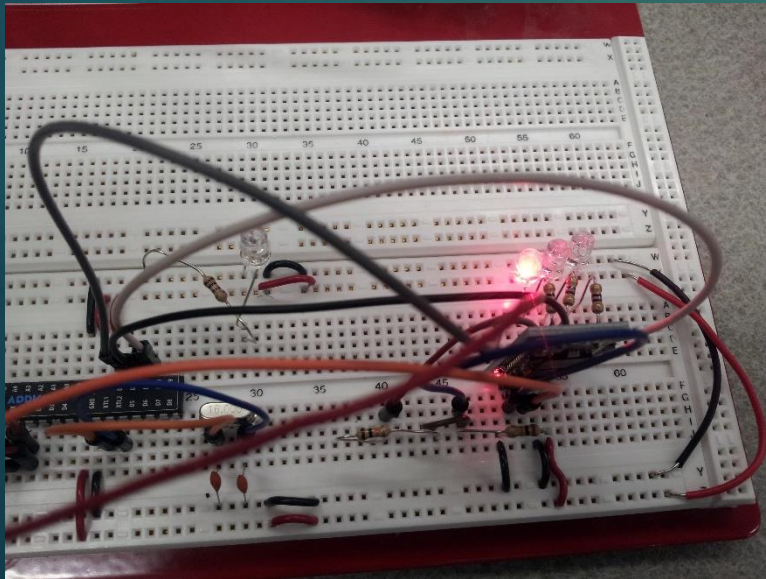
HC-05 BLUETOOTH MODULE

- ▶ The HC-05 (wearable) has 6 pins so it can be set as a master or a slave.
- ▶ The HC-06 (portable) has 4 pins as it can only be set to slave.
- ▶ It is very small (3cm long).
- ▶ It runs on 3.3V power.
- ▶ It has 2.4 GHz ISM band.



BLUETOOTH SUCCESS

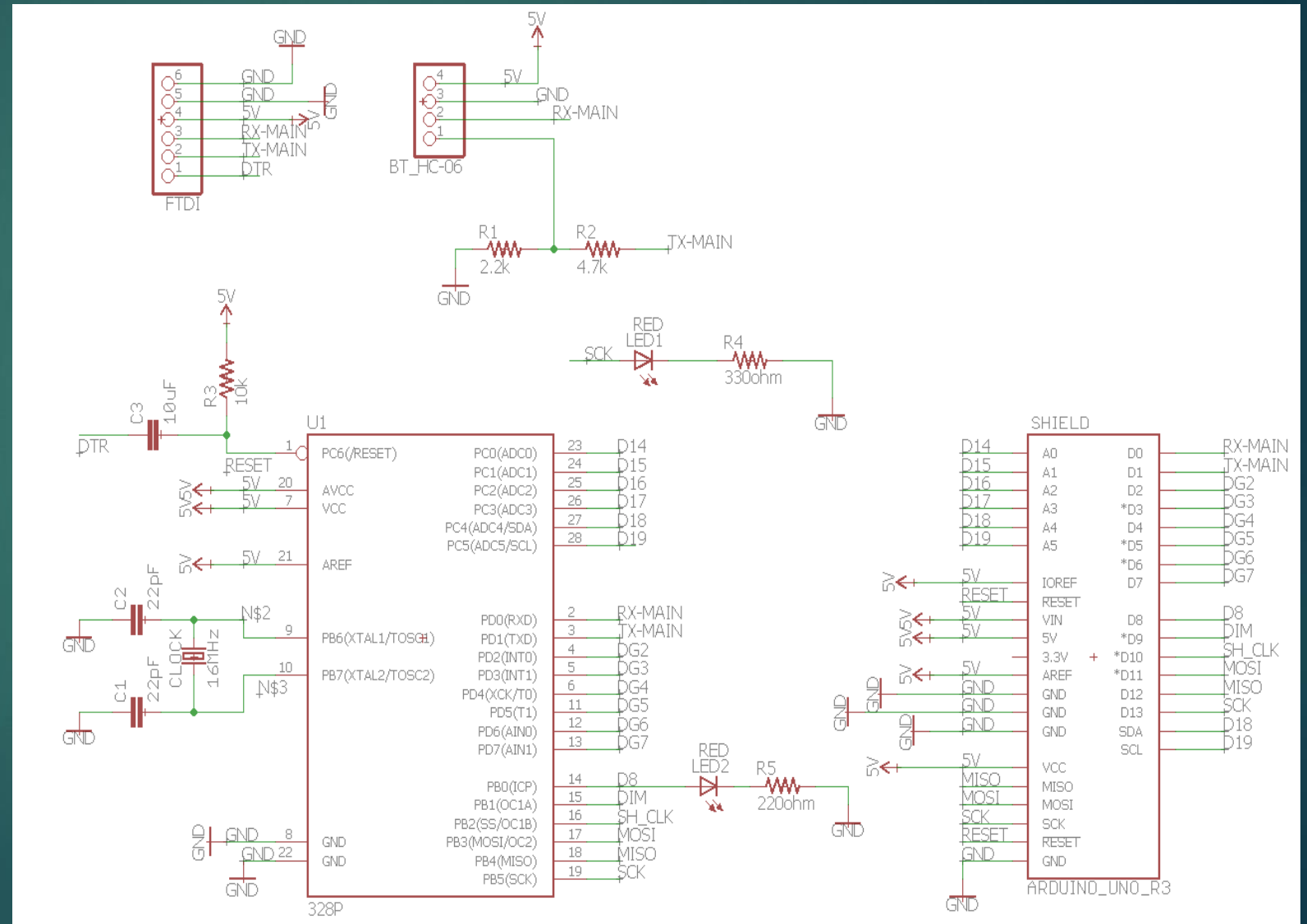
Here we can see the HC-06 (portable) is connected successfully to our phone and we are able to change/flash the LEDs accordingly. The point of flashing The LED is to allow the teacher to know that a child needs to De-escalate.



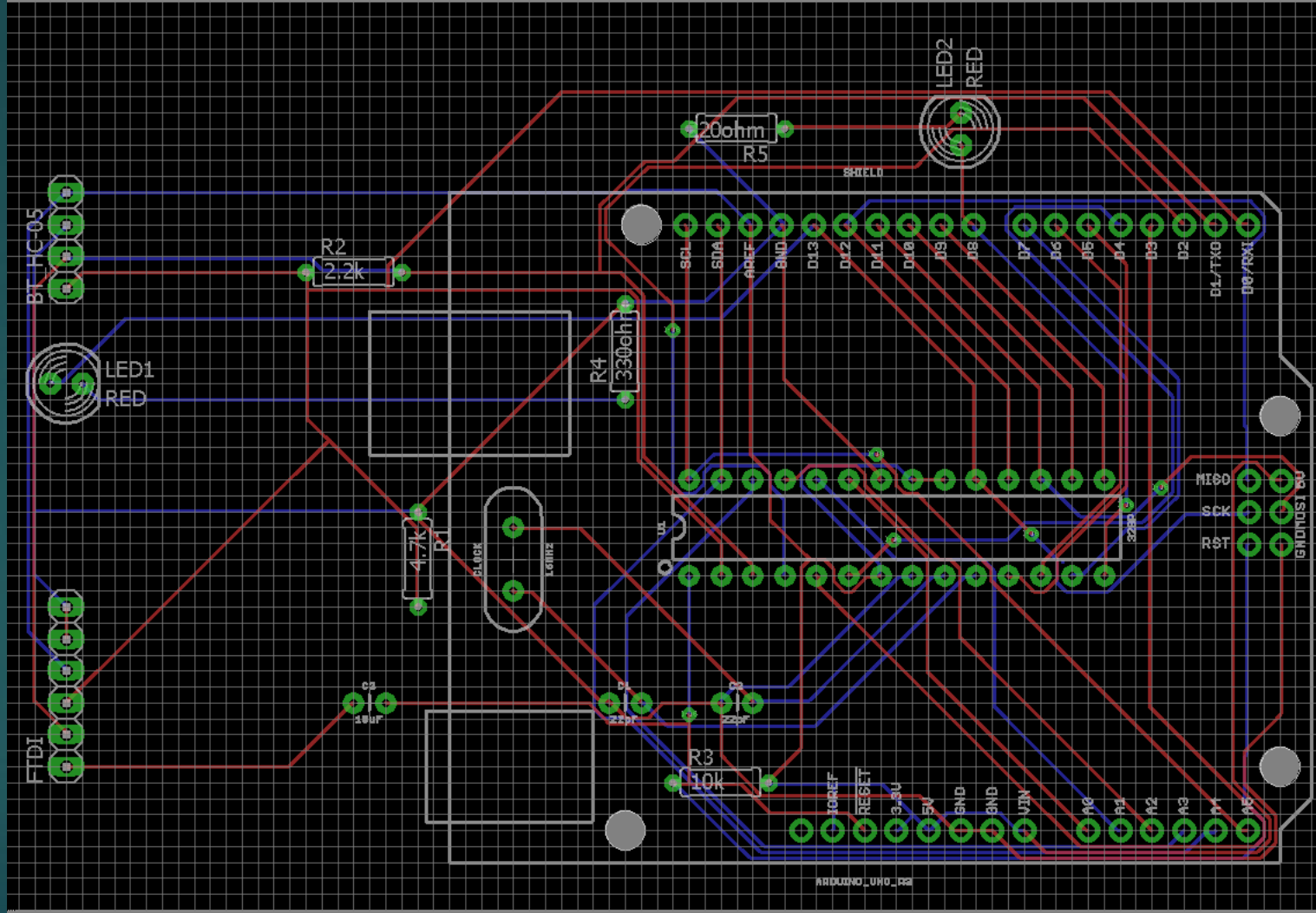
BLUETOOTH CHALLENGES

- ▶ Finding a suitable app.
- ▶ We ran into issues with testing.
- ▶ Making sure the connection stayed on.
- ▶ Making the program work with our MCU.
- ▶ Programming each LED to change properly.

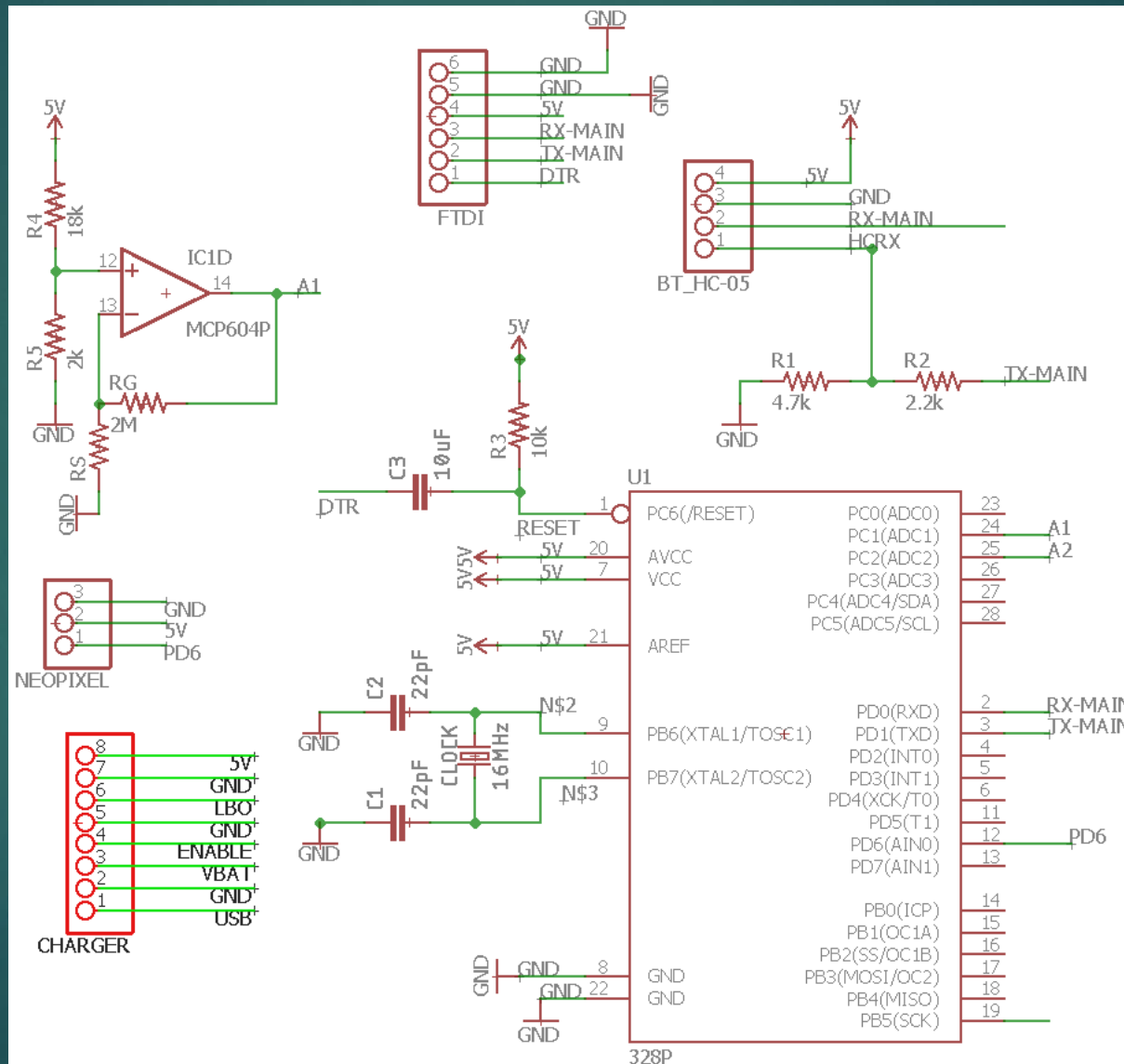
PORTABLE PCB SCHEMATIC



PORTABLE PCB



WEARABLE PCB SCHEMATIC




WORK DISTRIBUTION

| NAME | EDA | MCU | Blue-tooth | Power | Touch screen | LED Timer | PCB Design | CODE |
|------|-----|-----|------------|-------|--------------|-----------|------------|------|
| Jeff | X | X | | X | | | X | X |
| Gary | | | X | X | X | X | X | |

| | Part Name | Manufacturer/Seller | Part Number | Cost |
|-----------|---------------------------------------|----------------------|----------------------|----------|
| 1 | Electrodes (10 pk) | PLUX | EL-DRY-REUSABLE-5-10 | \$14.00 |
| 2 | MCP6004 Op-Amp (10 pk) | Microchip Technology | MCP6004-E/P | \$6.71 |
| 3 | Microcontroller (3 pk) | Atmel | ATmega328P | \$13.45 |
| 4 | Touchscreen | Amazon | LYSB00UAA2XIC | \$15.99 |
| 5 | Bluetooth Master (2 pk) | DSD TECH | B01G9KSAF6 | \$7.99 |
| 6 | Bluetooth Slave (2 pk) | DSD TECH | B01FCQZ8VW | \$7.99 |
| 7 | Timer (3 pk) | Banggood | 976036 | \$10.56 |
| 8 | Crystal Oscillator (10 pk) | Uxcell | HC-49S | \$4.57 |
| 9 | Serial Adapter (2 pk) | Gifkun | FT232RL | \$9.88 |
| 10 | Breadboard Power Supply Module (2 pk) | Wangdd22 | B10 | \$8.99 |
| 11 | PCB (2 Separate PCB's) | PCB Way | Custom PCB | \$54 |
| 12 | Battery and Charger (Port) | Adafruit | LP803860 | \$35 |
| 13 | Battery and Charger (Wear) | Adafruit | LP402025 | \$25 |
| | | | Total | \$214.13 |

| Milestone | Start | End |
|--------------------------------------|--------------|-------------|
| <i>Senior Design I</i> | 01/09/2017 | 04/27/2017 |
| Project Ideas | 01/09/2017 | 01/13/2017 |
| Divide and Conquer 1 | 01/13/2017 | 02/03/2017 |
| Divide and Conquer 2 | 02/03/2017 | 02/10/2017 |
| Research and Parts Selection | 02/10/2017 | 03/31/2017 |
| 60 Page Draft Document | 02/10/2017 | 03/31/2017 |
| Breadboard Design and Testing | 03/31/2017 | 04/27/2017 |
| 100 Page Draft Document | 03/31/2017 | 04/14/2017 |
| Final Document | 04/14/2017 | 04/27/2017 |
| Summer Break | 04/27/2017 | 08/21/2017 |
| Finalize Software | 04/27/2017 | 11/28/2017 |
| PCB Construction | 04/27/2017 | 11/01/2017 |
| <i>Senior Design II</i> | 08/21/2017 | 12/02/22017 |
| Build Prototype | 08/21/2017 | 11/10/2017 |
| Testing and Redesign | 10/02/2017 | 11/20/2017 |
| Finalize Prototype | 10/21/2017 | 11/25/2017 |
| Critical Design Review | 09/22/2017 | 10/06/2017 |
| Peer Review | 11/30/2017 | 12/06/2017 |
| Conference Paper | 11/05/2017 | 11/17/2017 |
| Final Documentation | 11/21/2017 | 12/05/2017 |
| Final Presentation | 11/29/2017 | 11/29/2017 |



QUESTIONS?/COMMENTS