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

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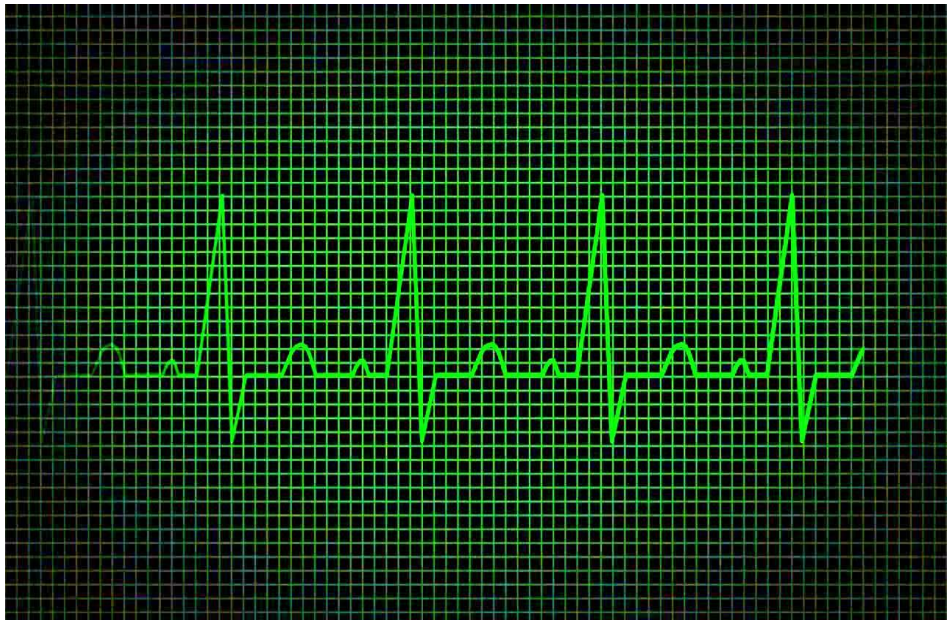
PURPOSE

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

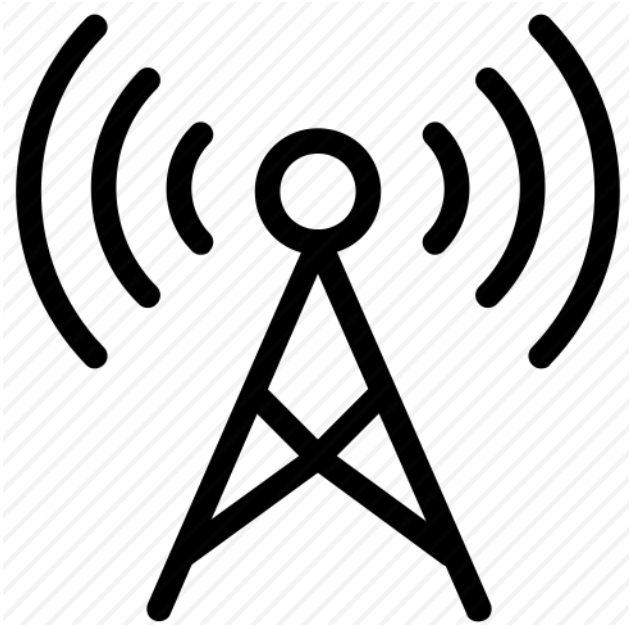
Off-Task Behavior
vs.
Meltdown

GOALS

Prevention



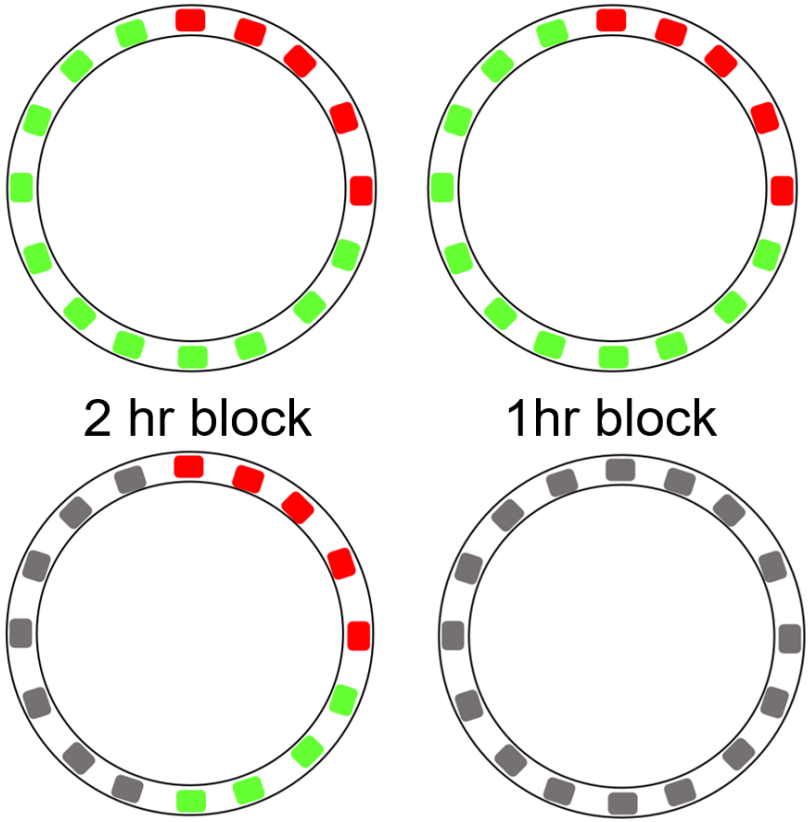
Mitigation



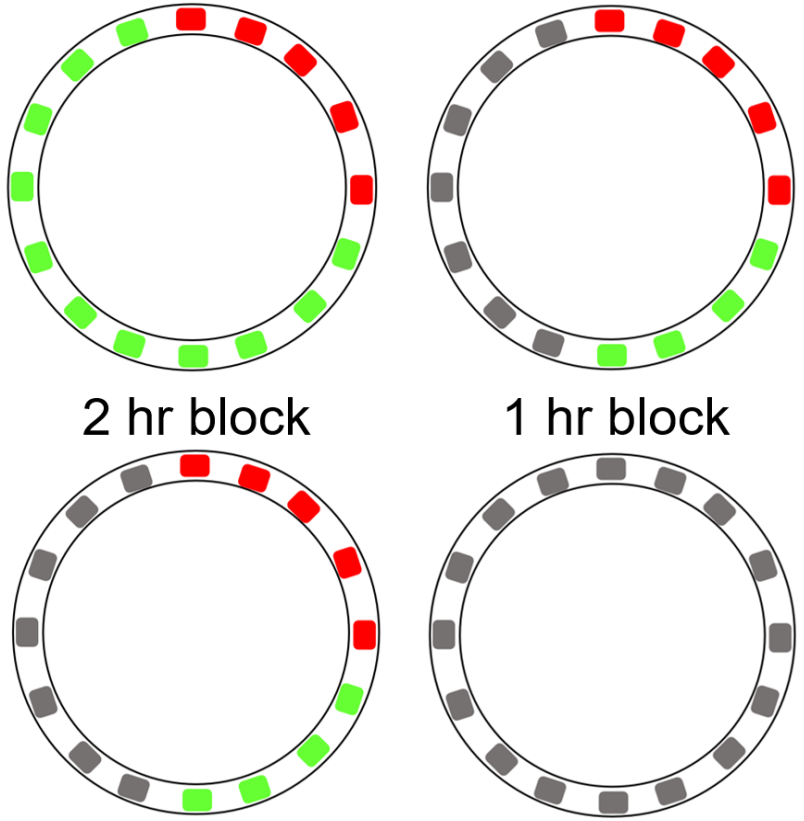
Anticipation

PREVENTION METHOD

Period-based

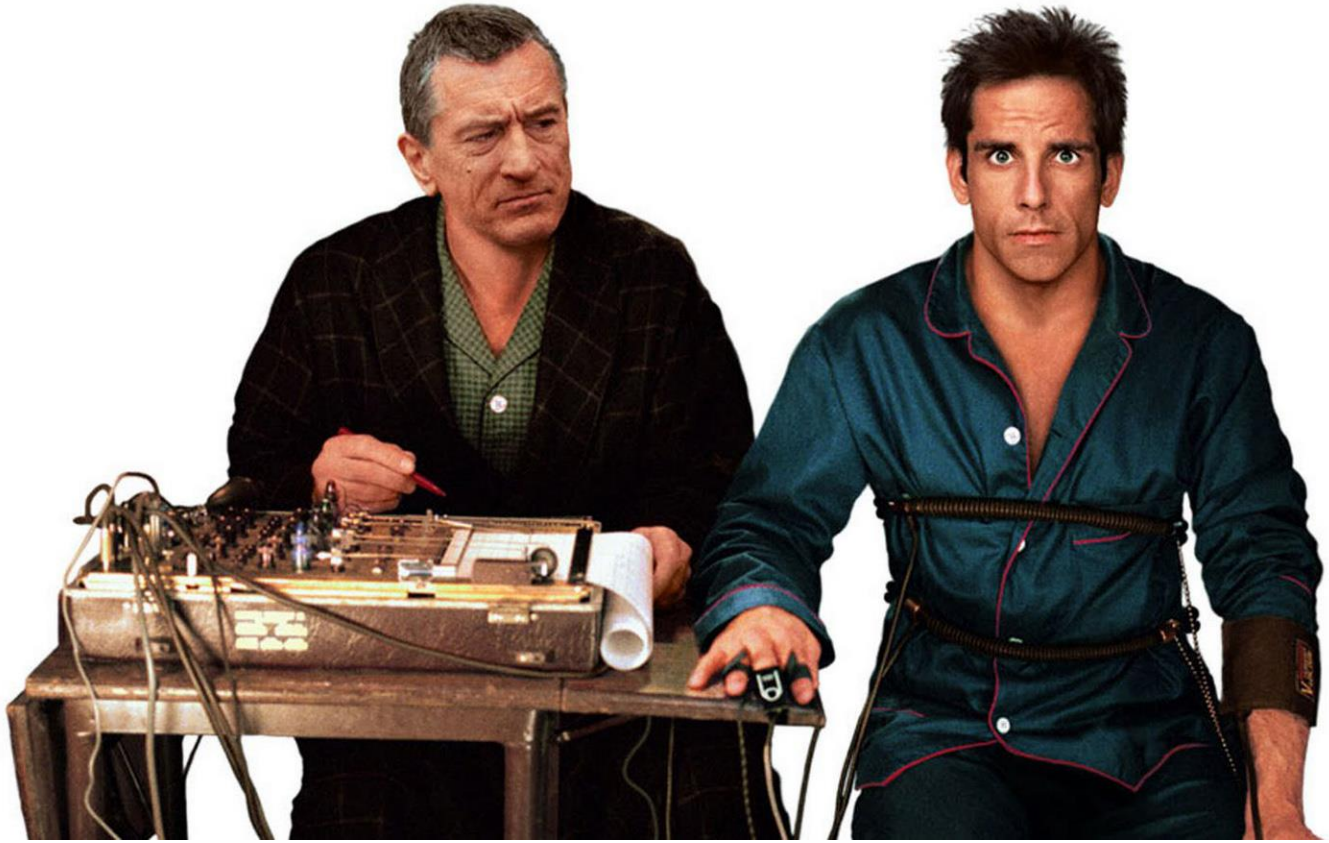


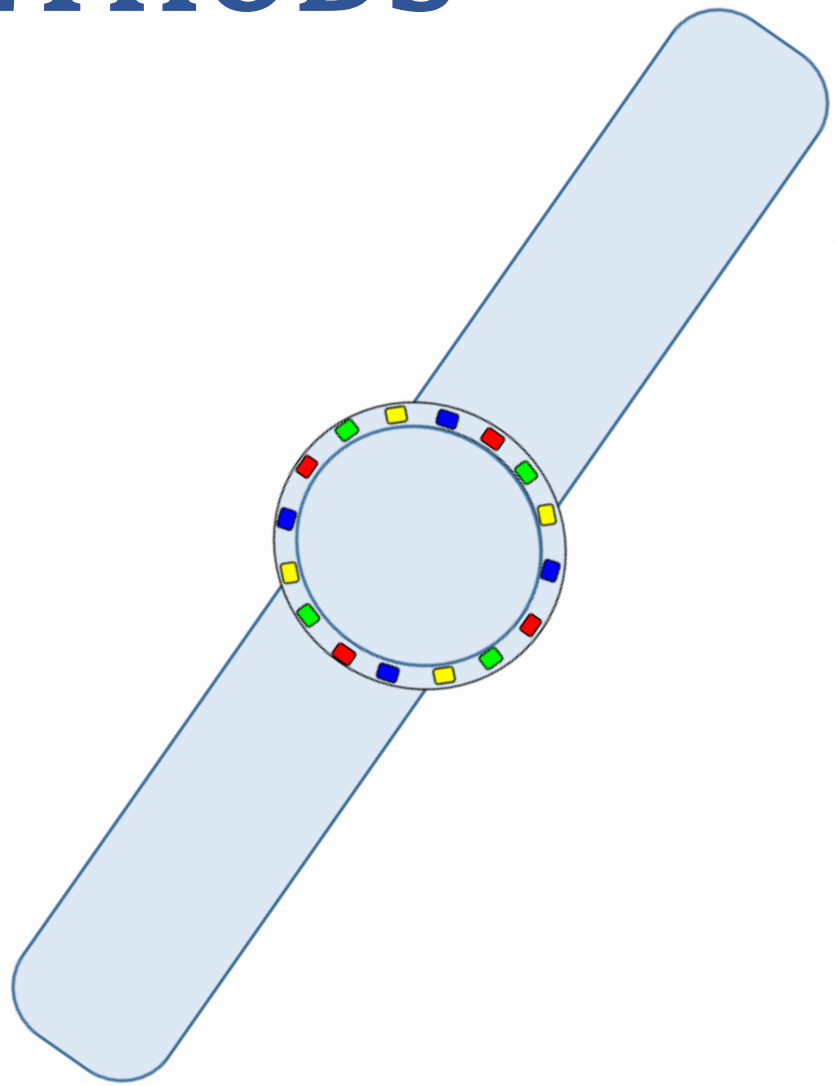
Time-based



ANTICIPATION METHODS

Wearable Sensors



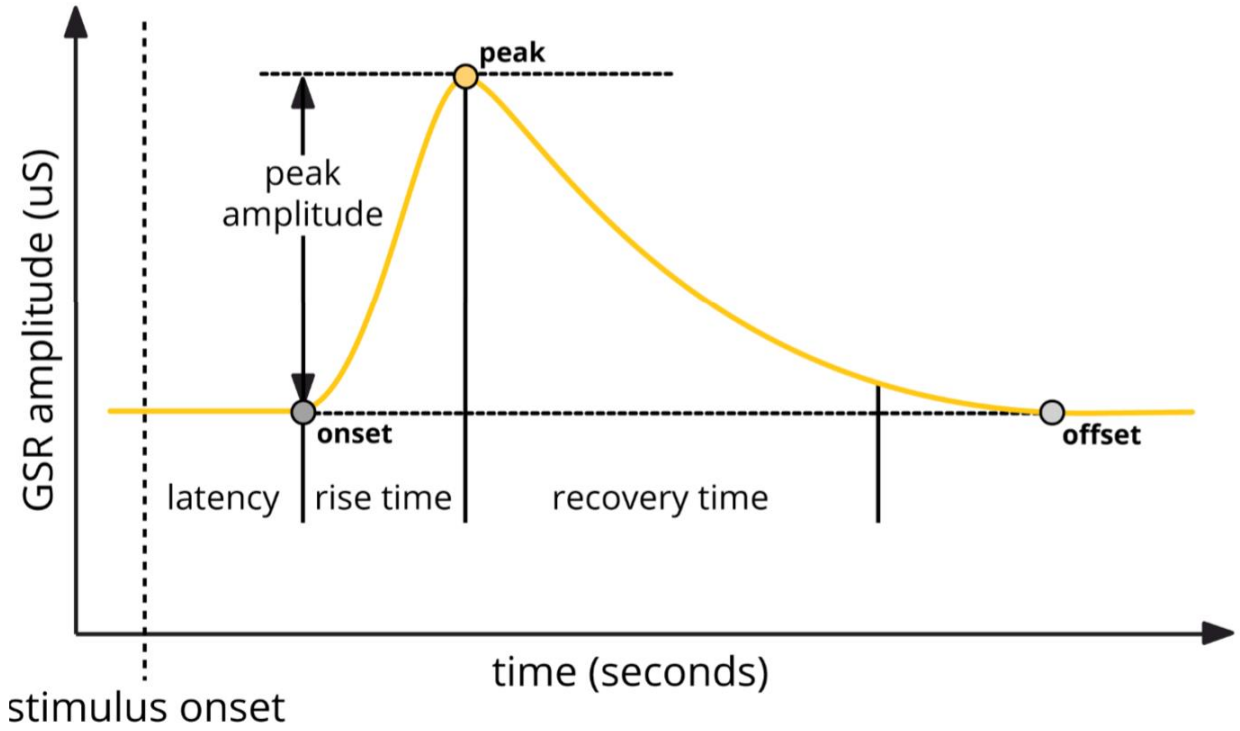


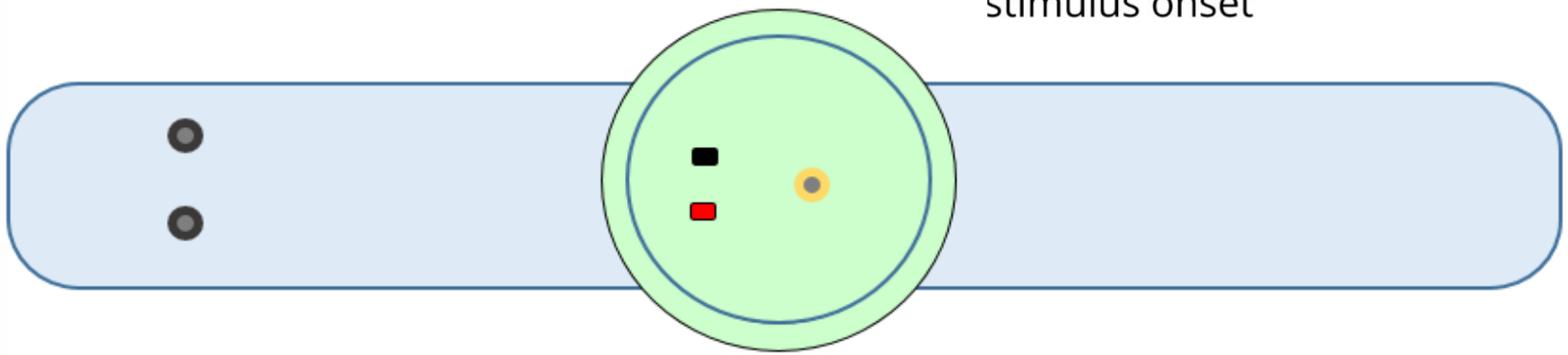
ANTICIPATION METHODS

Electrodermal Activity

Galvanic Skin Response

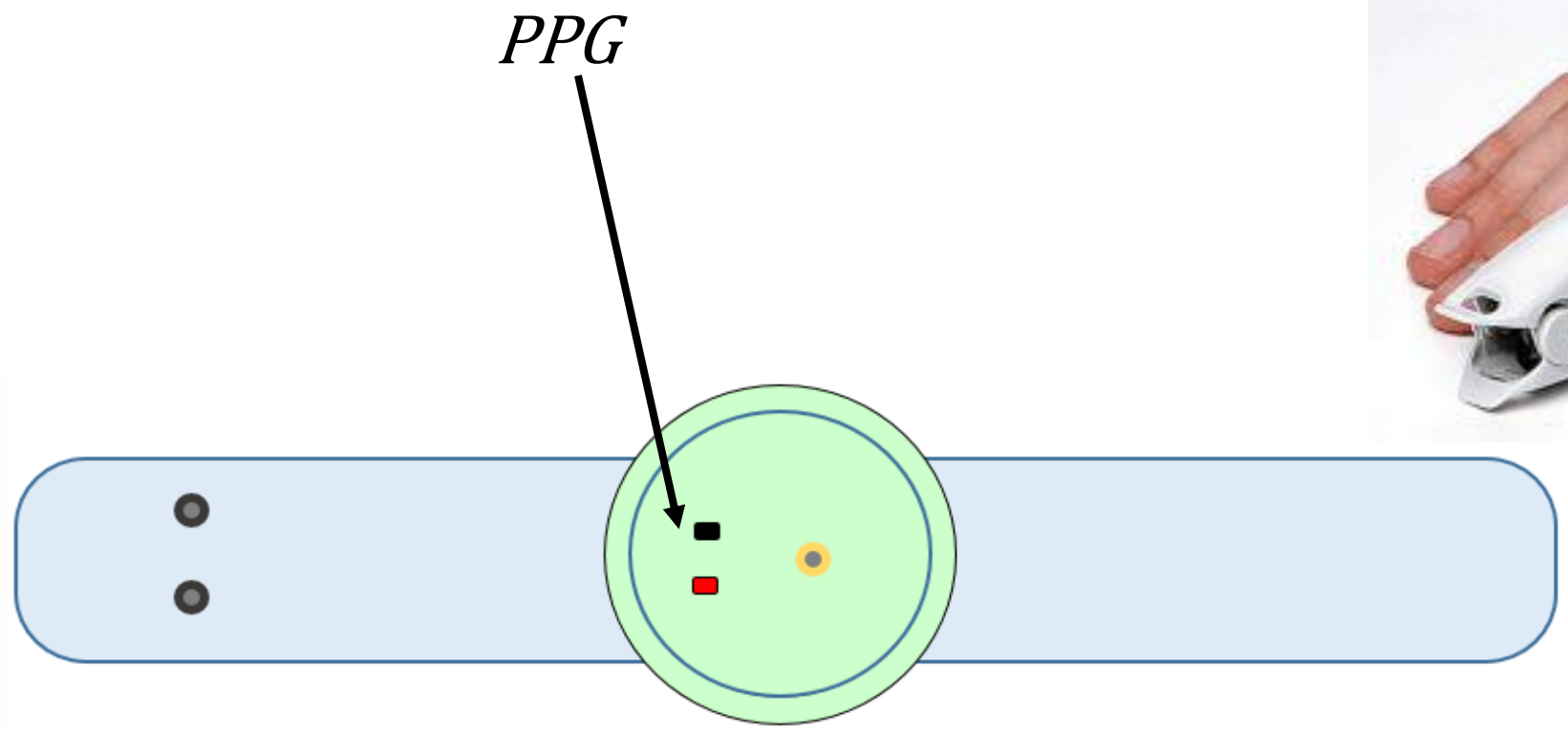
EDA





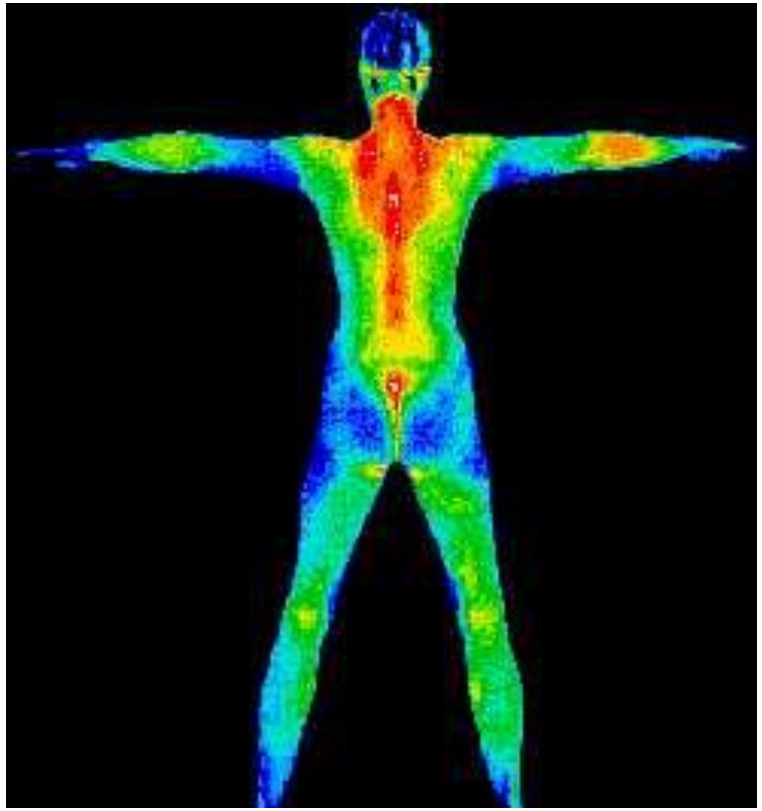
ANTICIPATION METHODS

Heart Rate by photoplethysmography

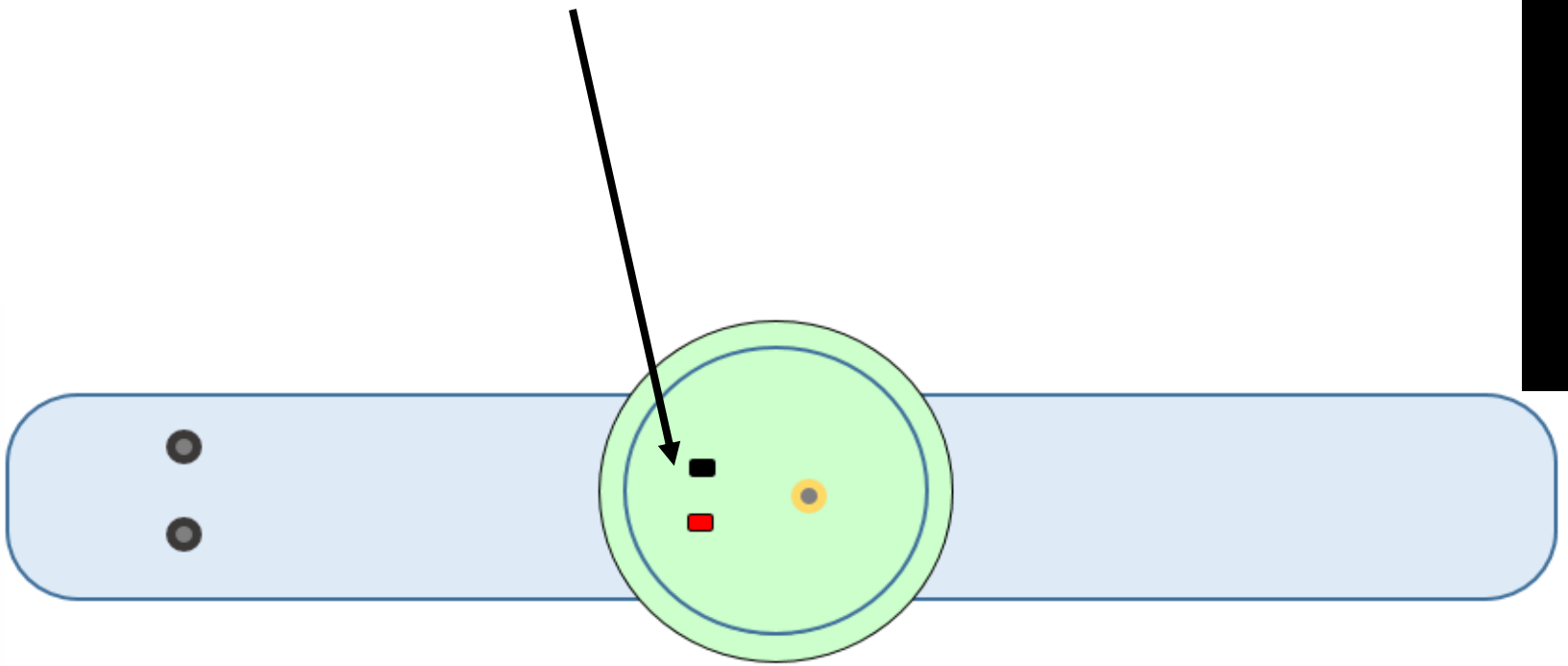


ANTICIPATION METHODS

Skin Temperature by infrared



Thermopile



MITIGATION METHODS

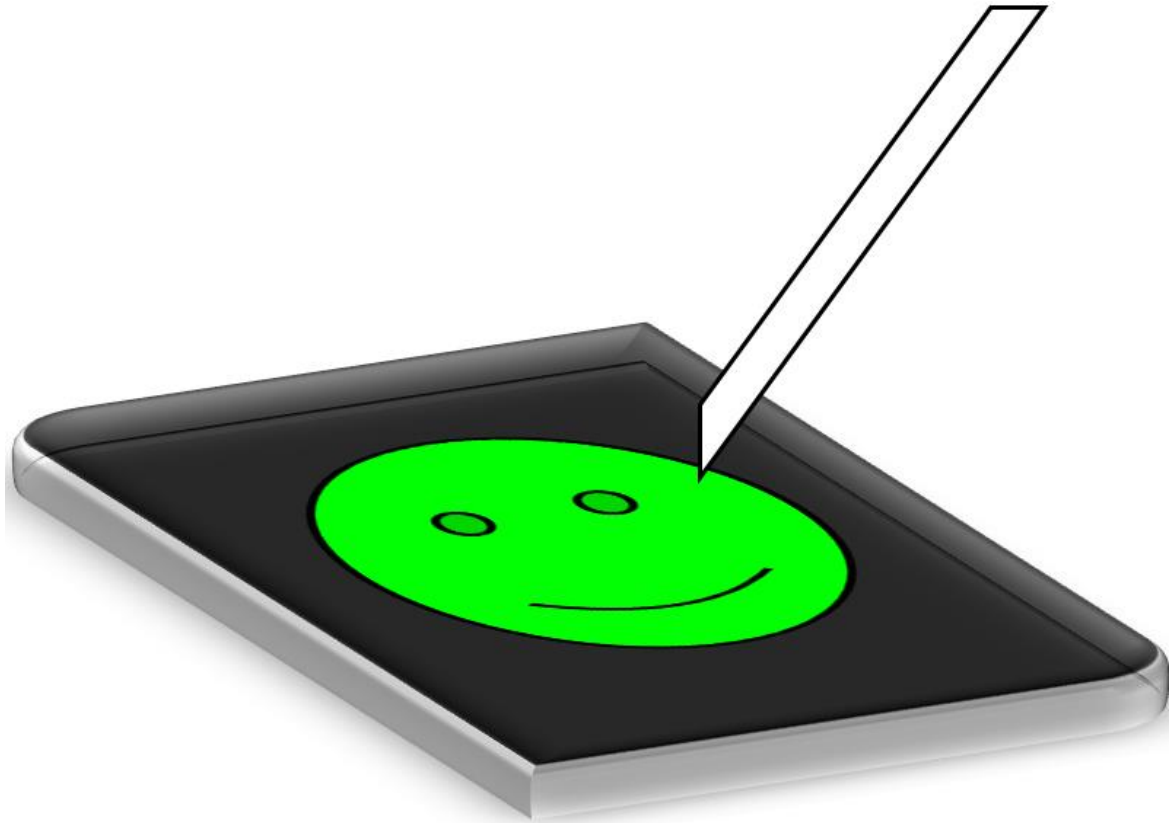
Distraction & De-escalation and/or Intervention & Consolation

MITIGATION METHODS

Distraction & De-escalation

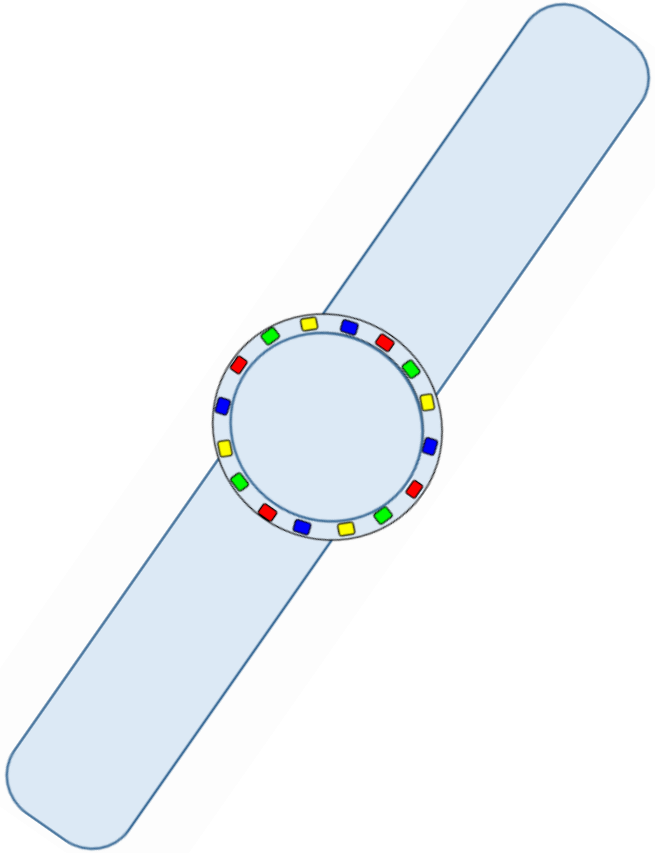
Advantages

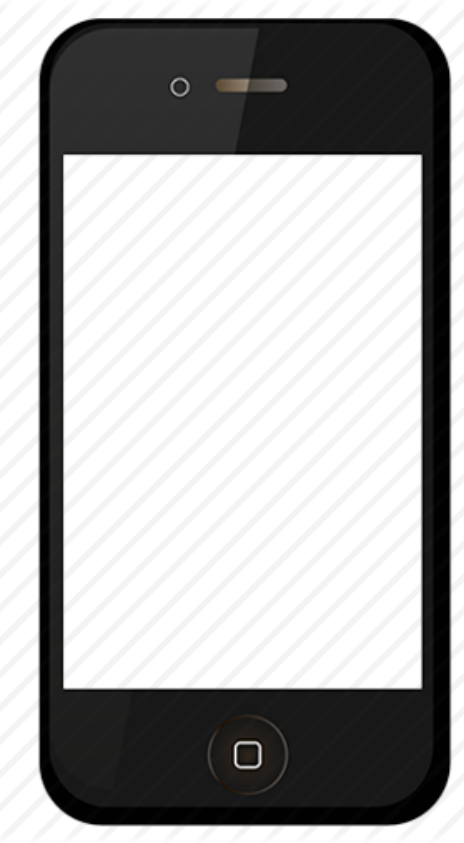
Disadvantages



MITIGATION METHODS

Intervention & Consolation





REQUIREMENTS

Portable (small, light-weight)

Durable/Water resistant

Easy to use

Wireless

Low power consumption

Accurate sensors

Low cost

SPECIFICATIONS

Wearable sensors 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 < $500

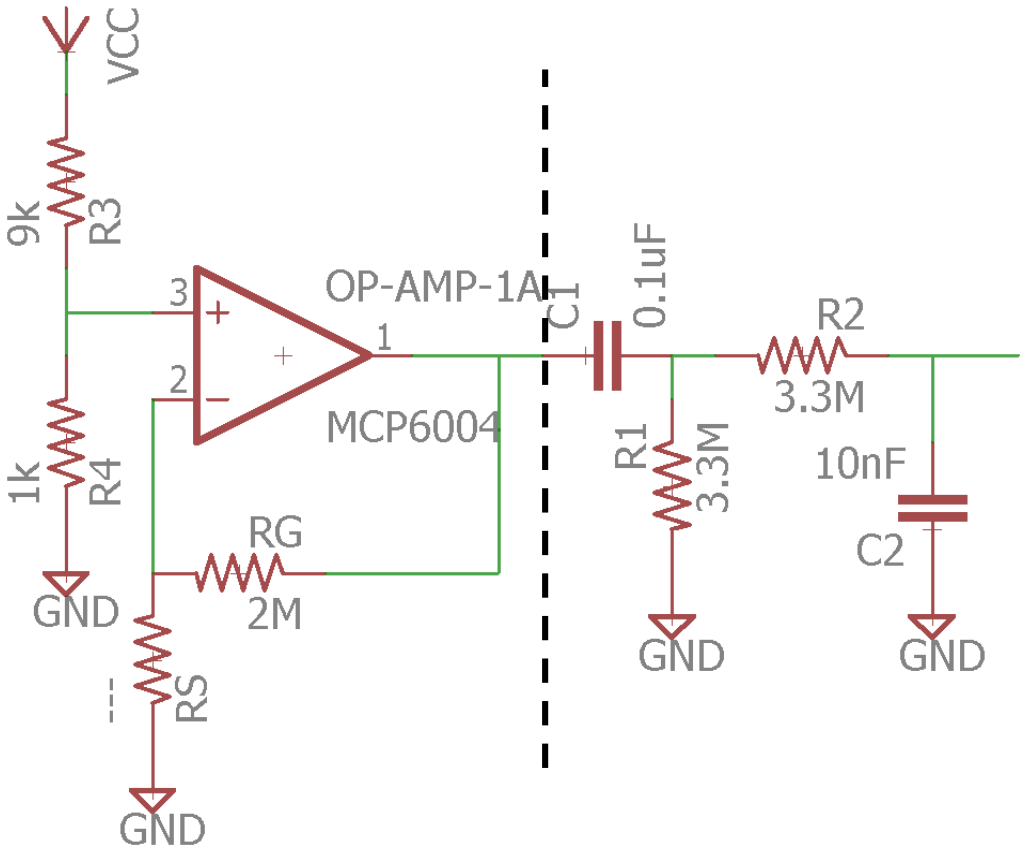
DESIGN PHILOSOPHY

YES	NO
Qualitative	Quantitative
Simple Microelectronics	Complex Circuits
Small, low power	Precise
Atmega & Arduino	Skilled programming

SENSORS DESIGN

EDA

Software filter?

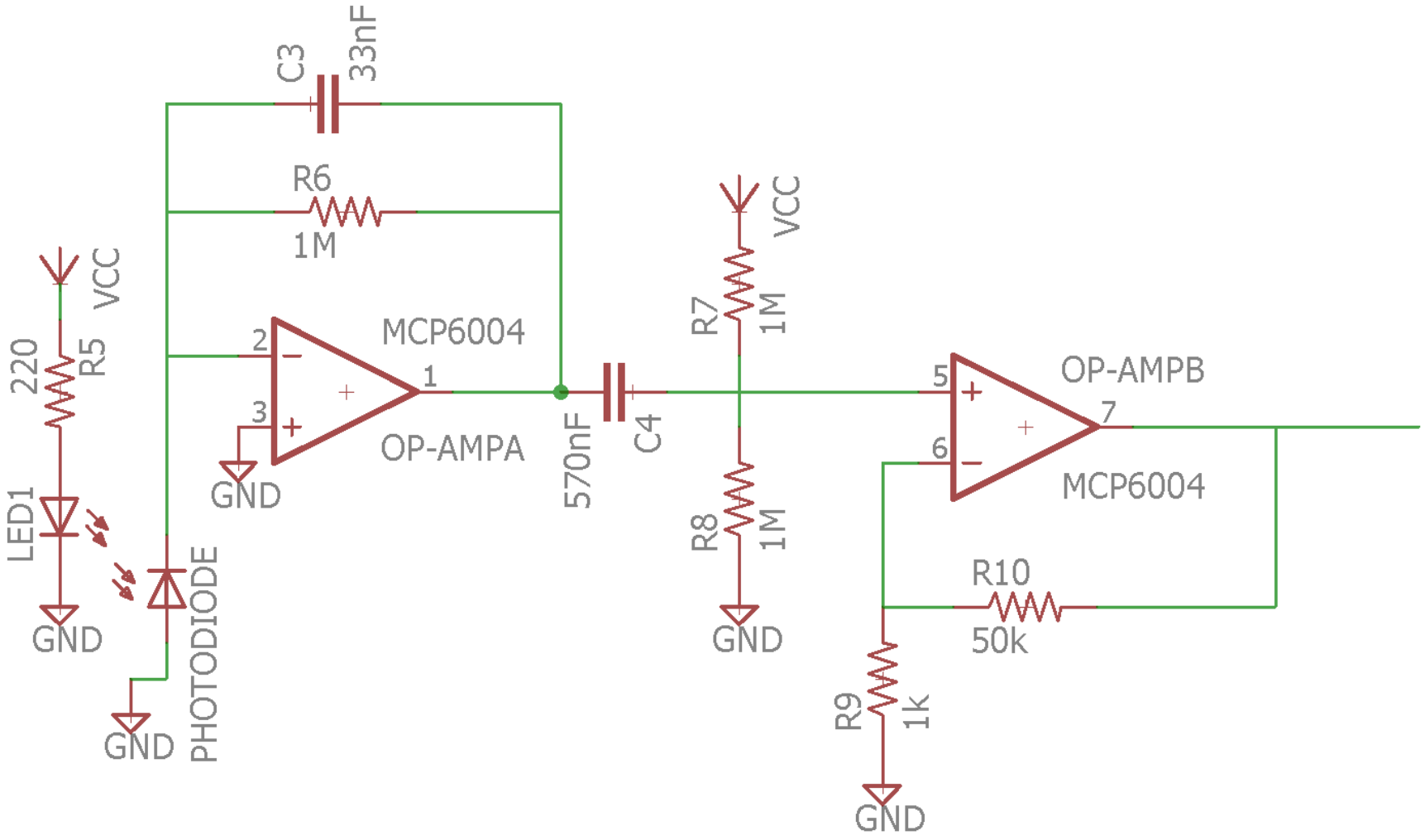


Hardware filter?

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

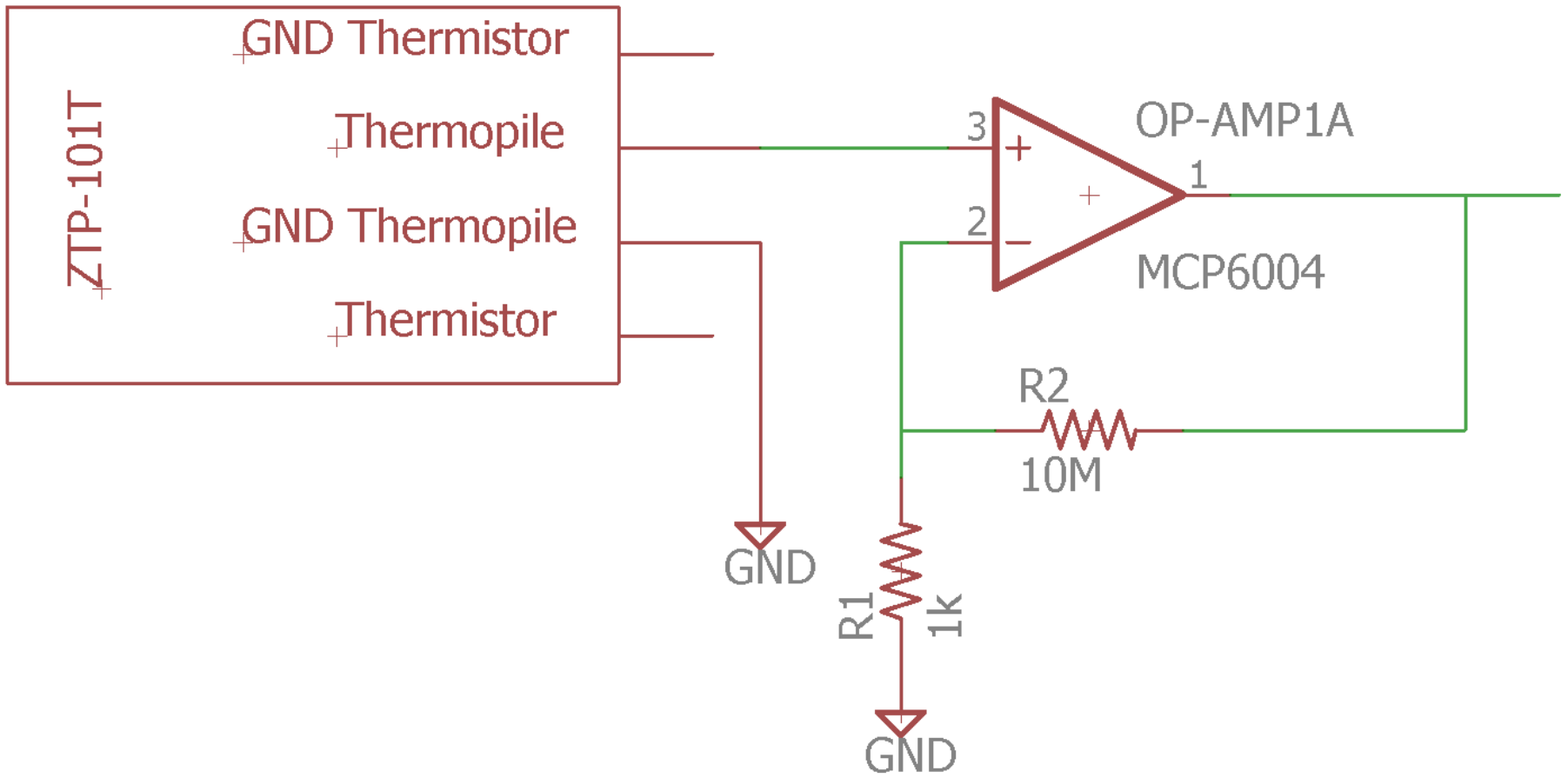
SENSORS DESIGN

Heart rate

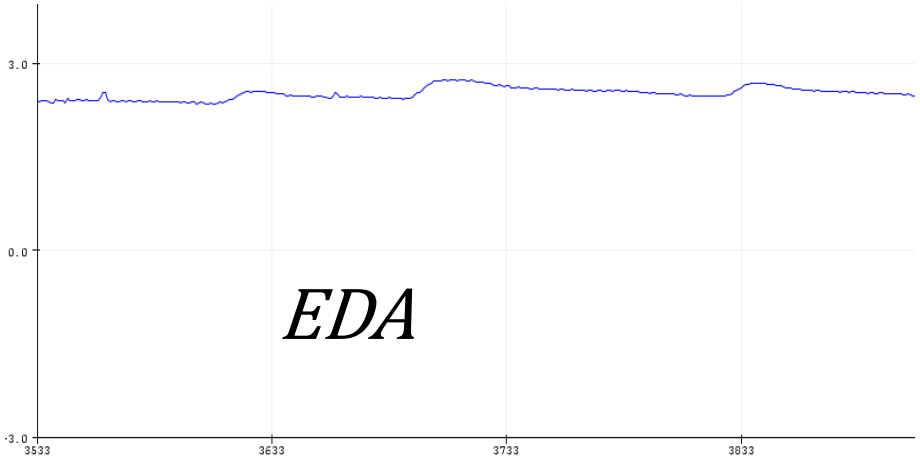


SENSORS DESIGN

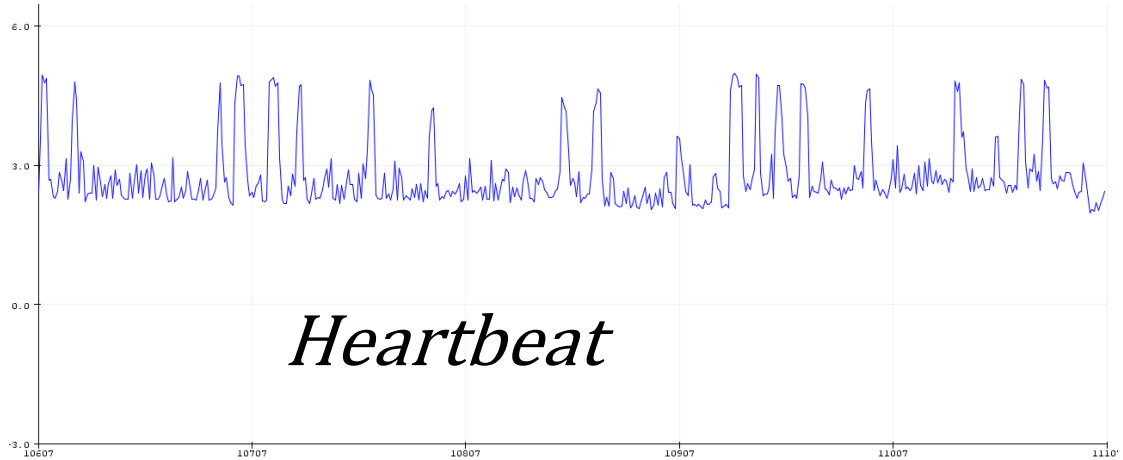
Skin temp



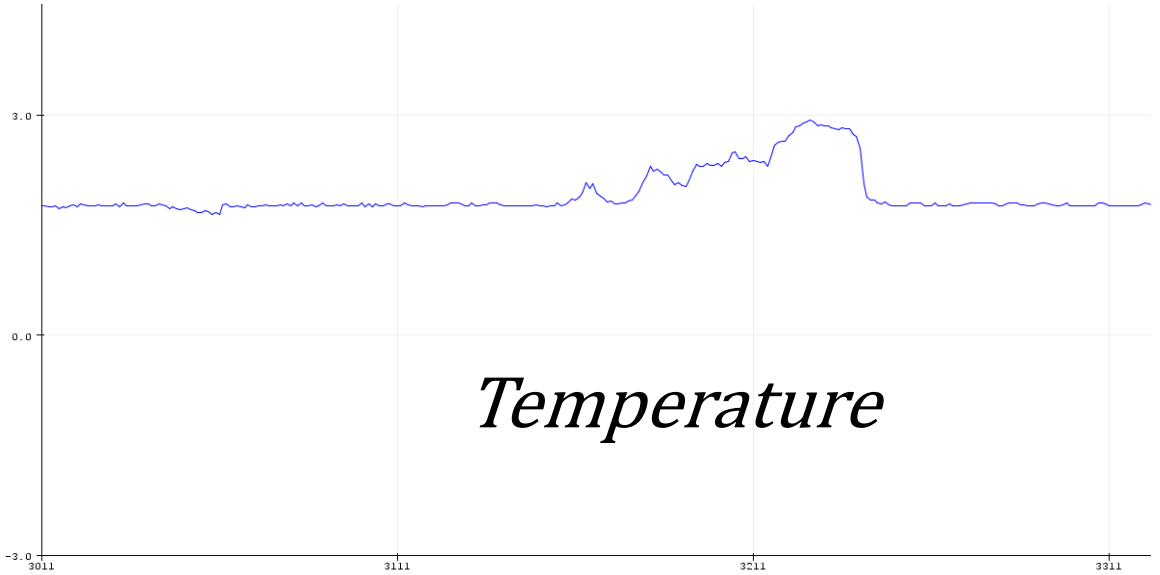
SENSORS SUCCESSES



EDA



Heartbeat



Temperature

SENSORS DIFFICULTIES

Test conditions

Heartbeat ≠ Heartrate

Software
a.k.a.
Programming
a.k.a.
Coding

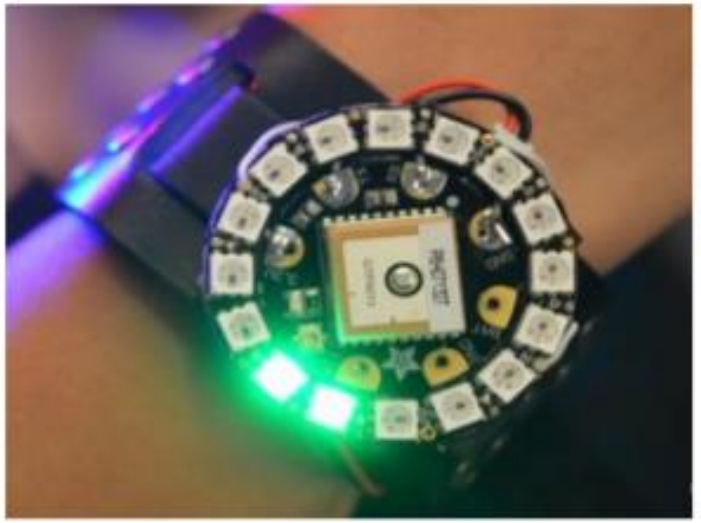
CHOOSING A TIMER

Has to be small enough to fit on a wrist strap.

Has to be programmable.

Has to be visible but not distractive.

Needs to be colorful.



CHOOSING THE NEOPIXEL RING

It weighs 3.3g.

The Thickness is 0.3”.

The inner diameter is 1”.

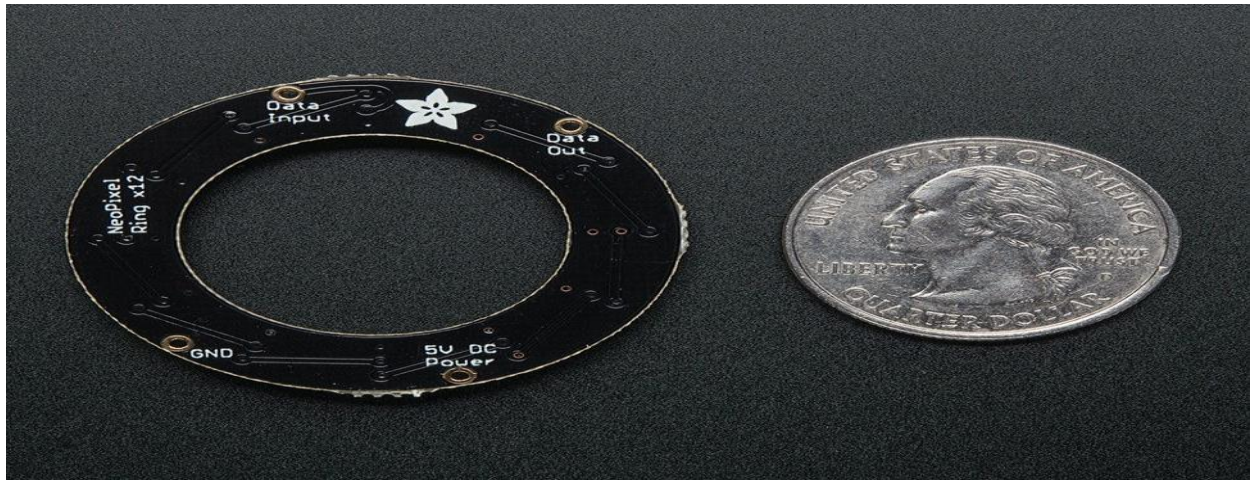
The outer diameter is 1.5”.

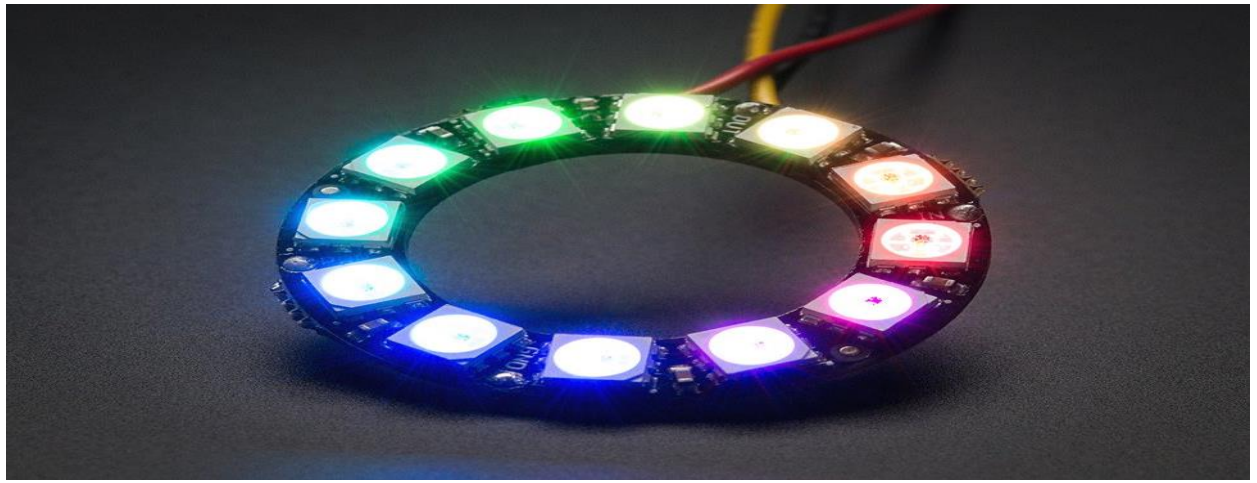
It has 12 RGB LED’s.

Is Programmable.

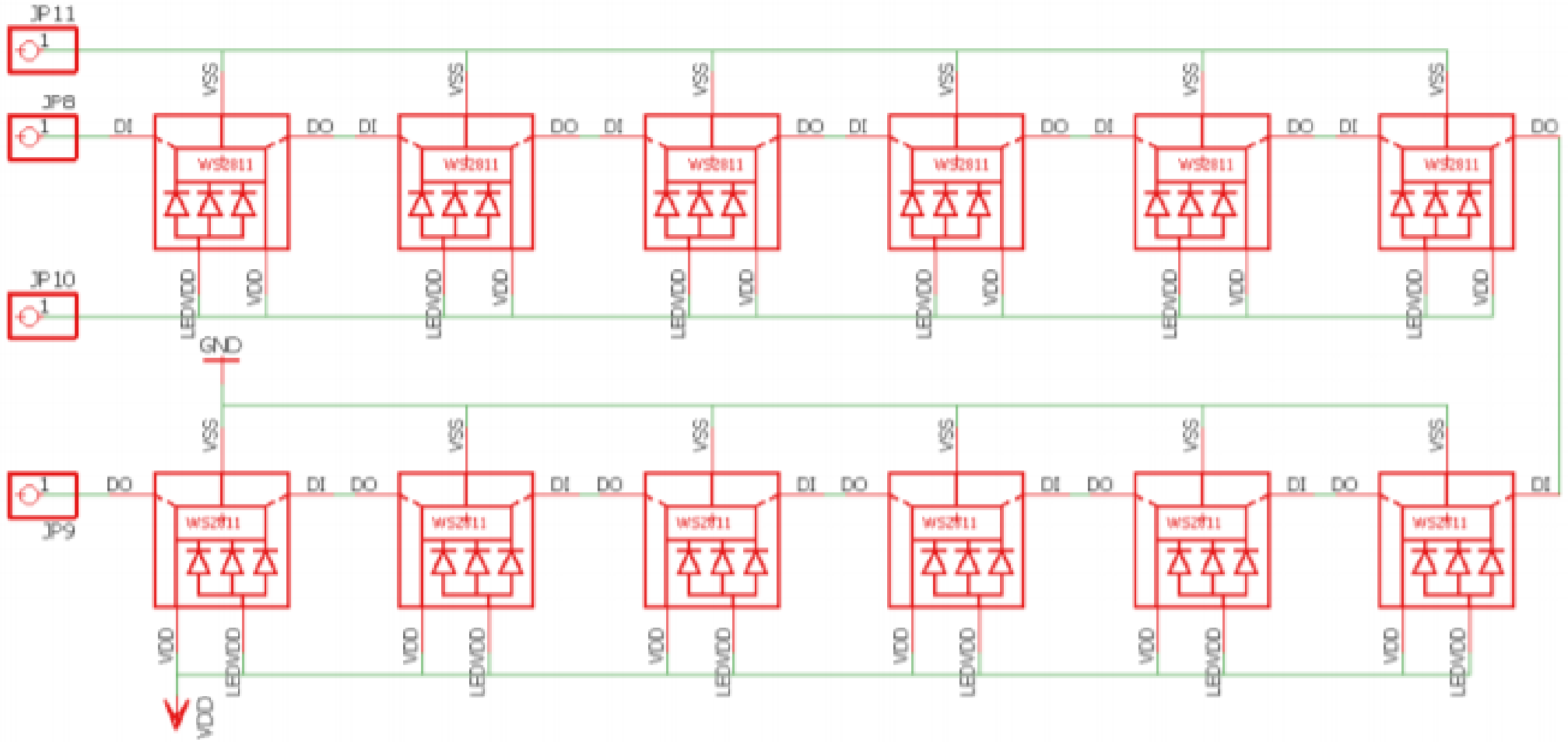
It runs on 5V Power.

Many Colors.



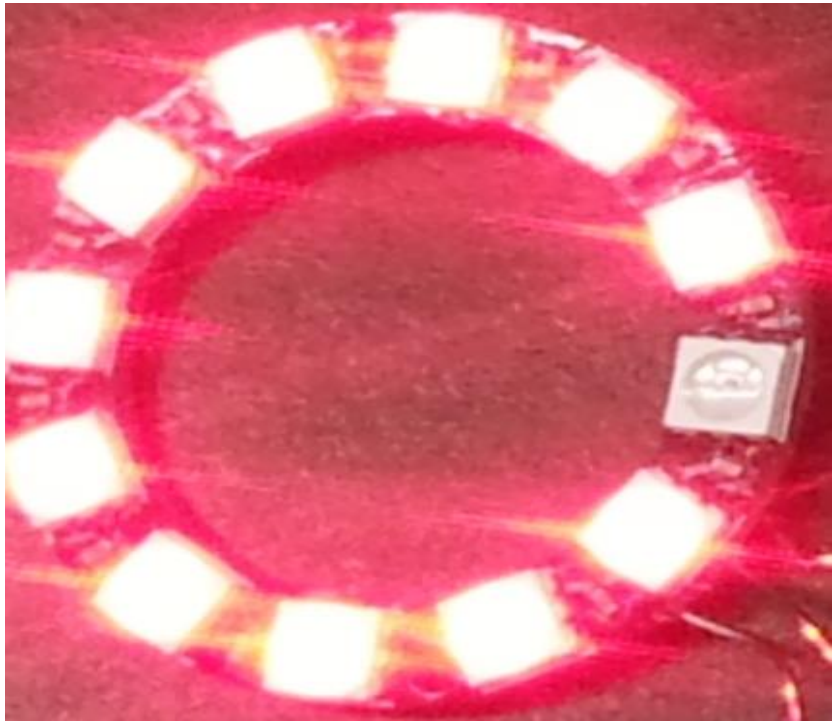


NEOPIXEL RING DESIGN



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

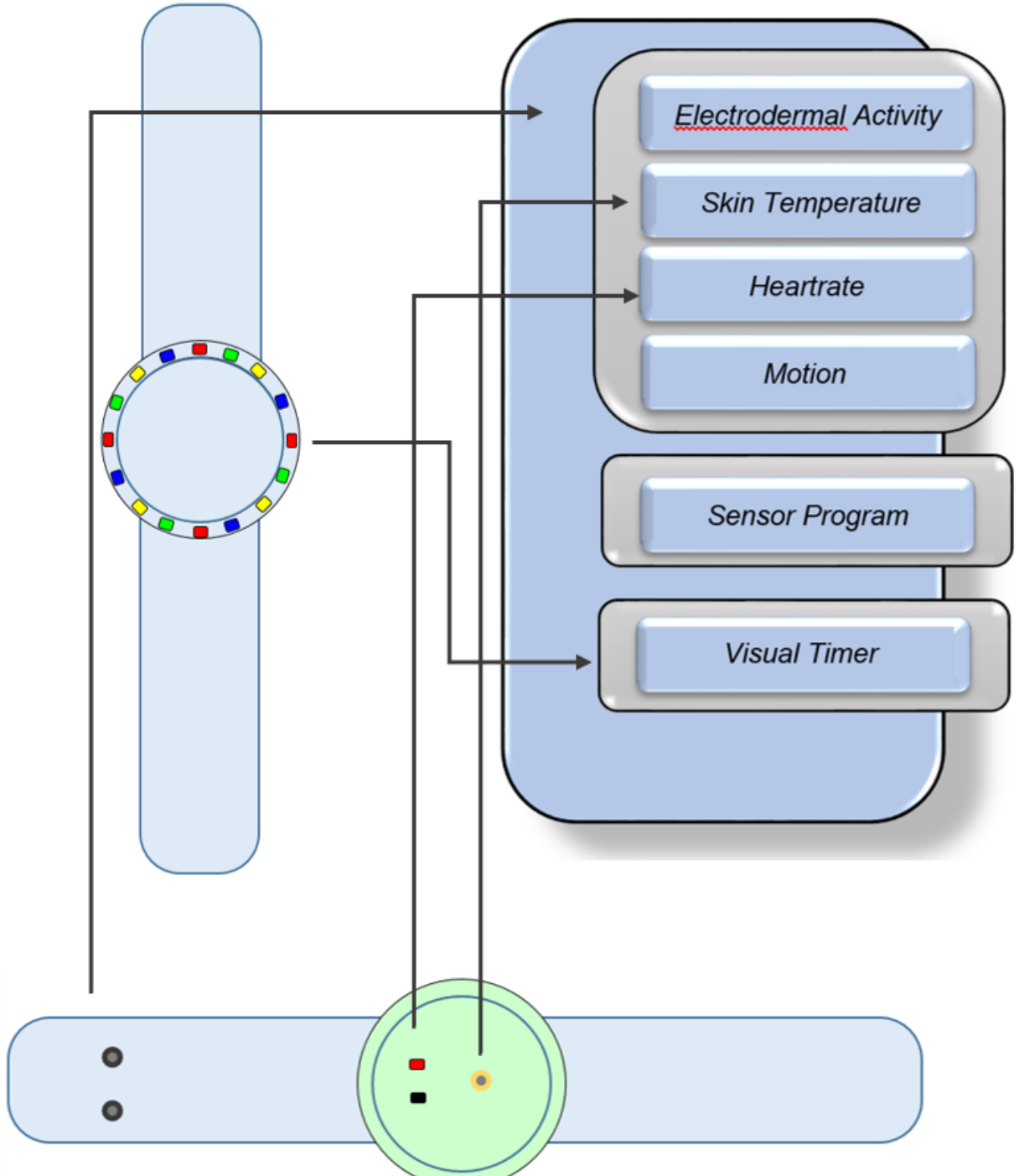
Finding the rights size ring.

Programming each color to come on.

Getting the colors to stabilize.

Synching it with the Bluetooth module.

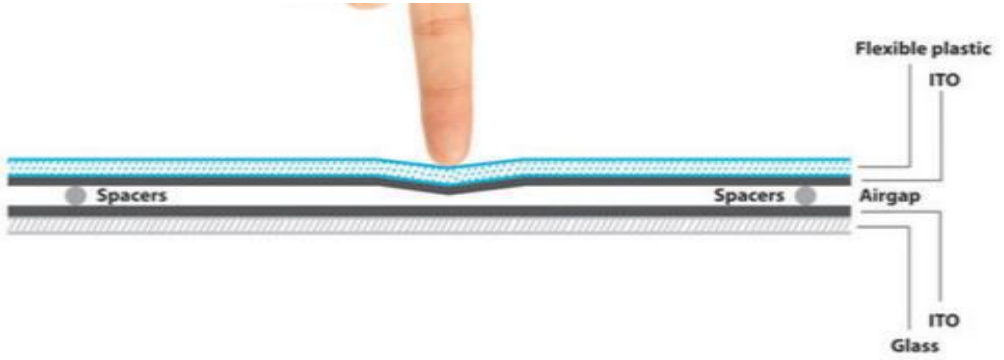
Sensor/Timer Subsection



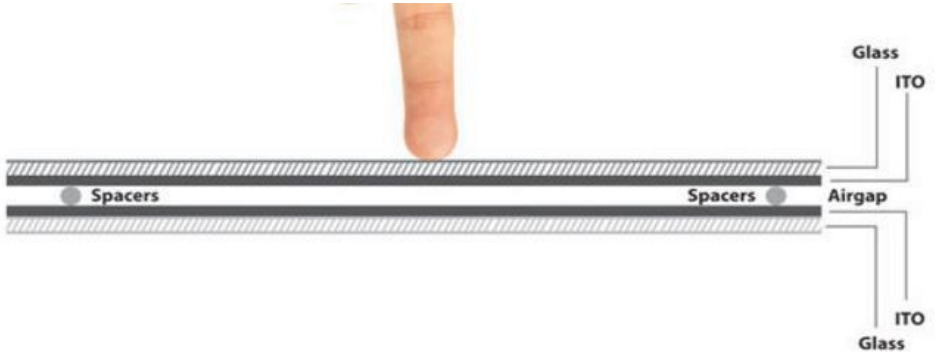
TOUCHSCREEN CHOICES

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.



Resistive touchscreen



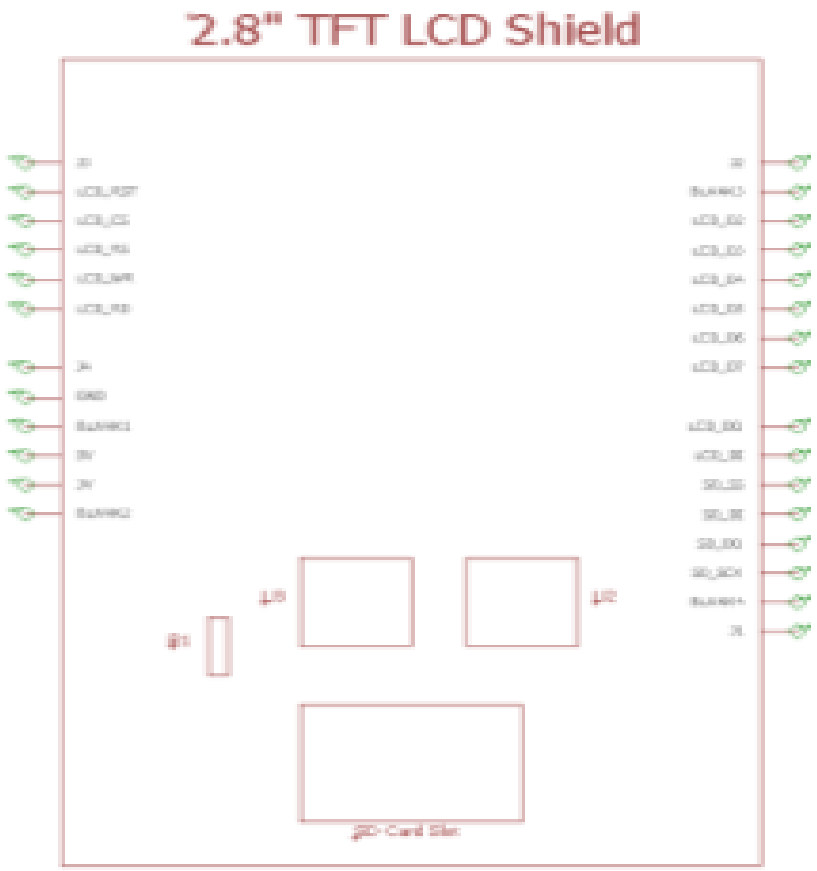
Capacitive touchscreen

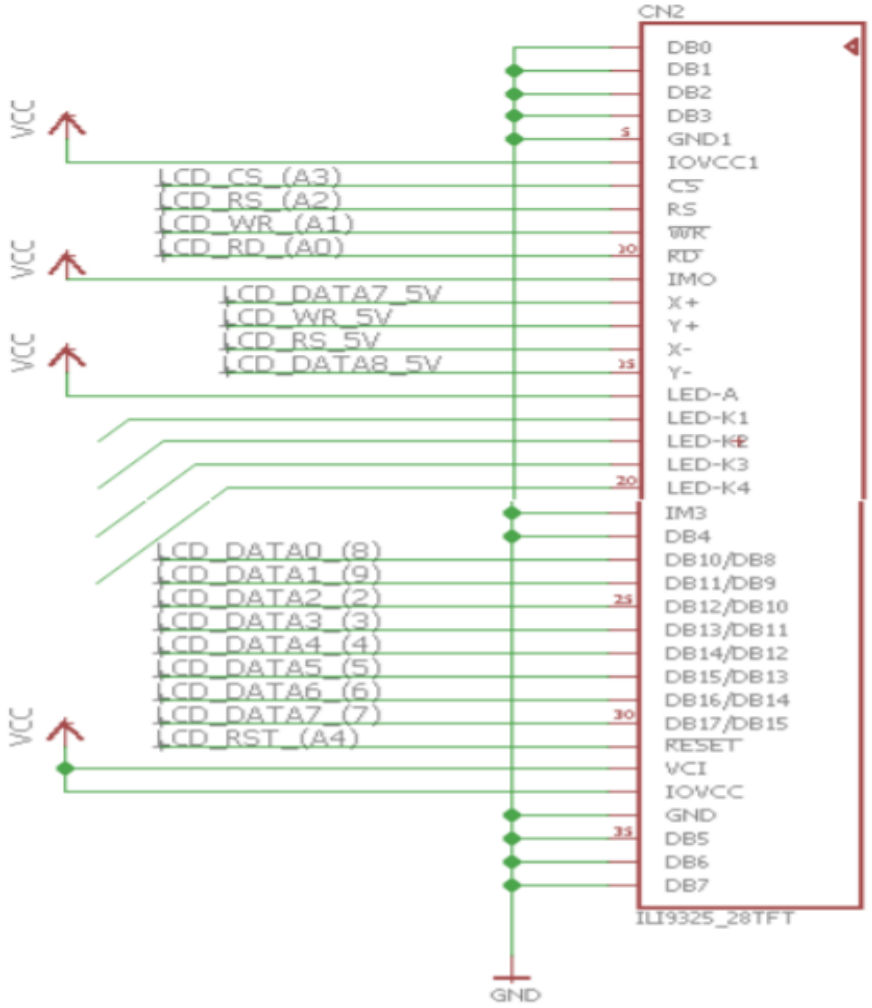
CHOOSING THE 2.8” TFT

We chose the Uno 2.8” TFT because it can be used with your finger or a stylus.

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

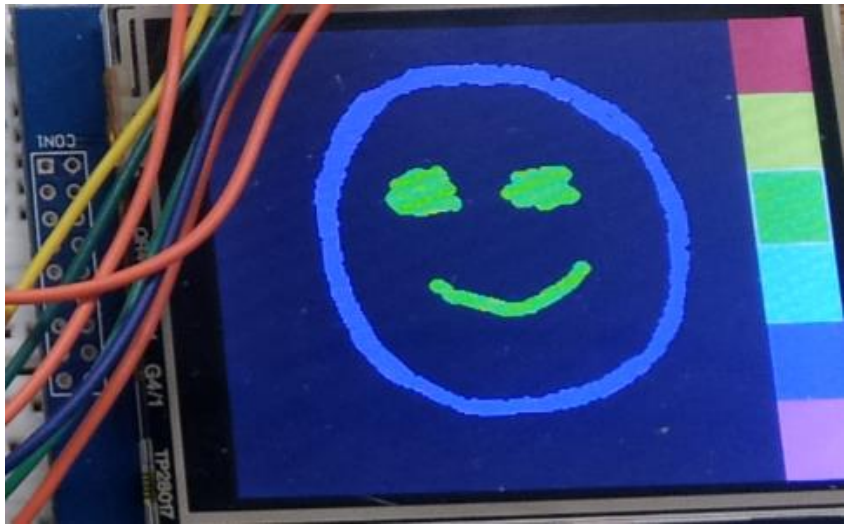
TOUCHSCREEN DESIGN

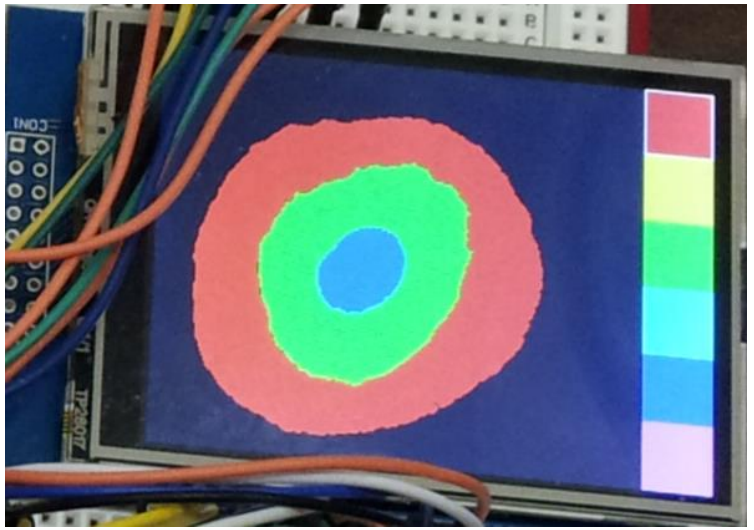




TOUCHSCREEN SUCCESS

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

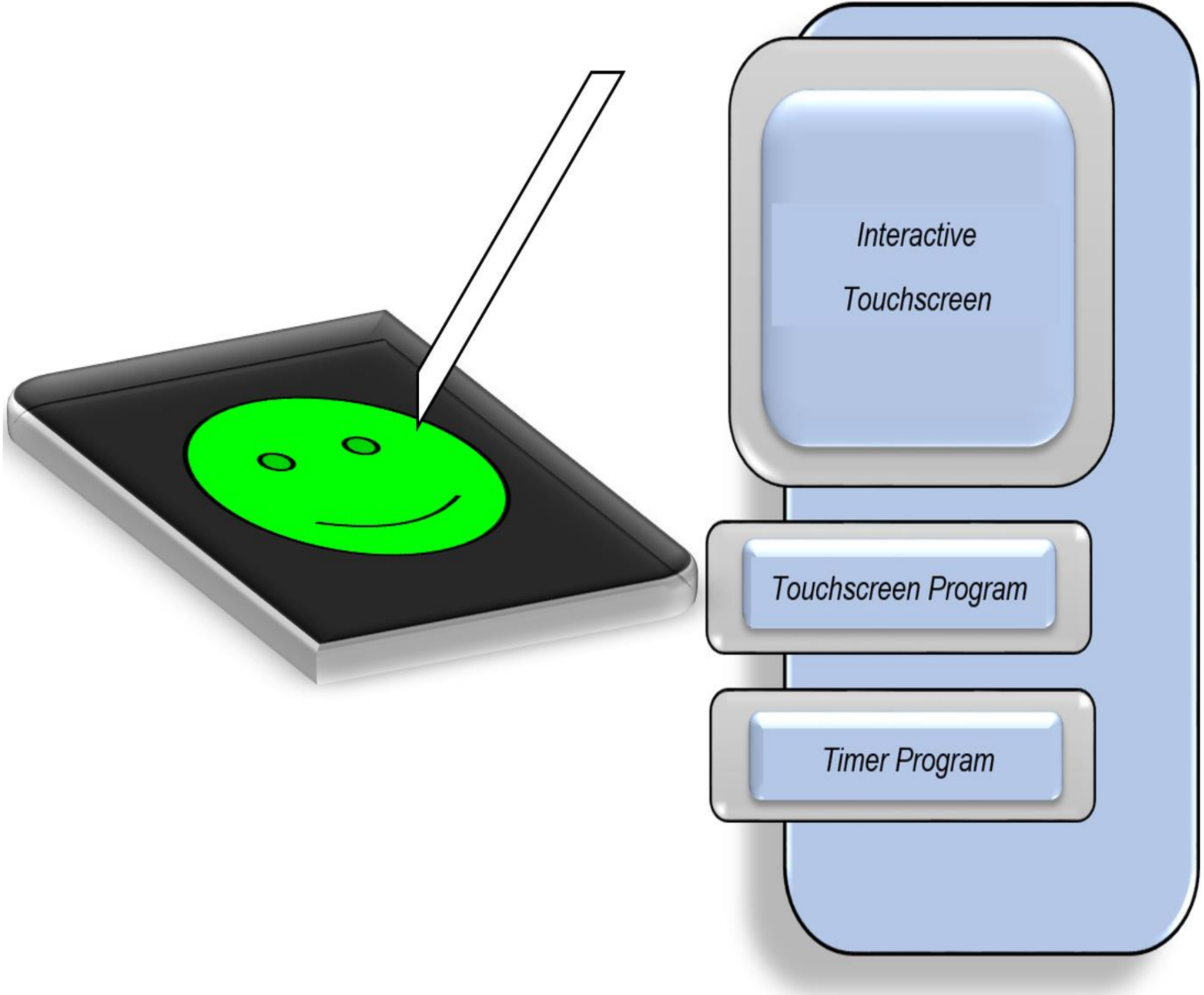
Getting all the wires connected.

Making sure the colors matched.

Finding an easy to use screen.

Getting the coordinates correct.

Interactive Touchscreen



CHOOSING THE RIGHT BATTERY

Lithium Polymer (Li-Po) can be made thinner but the cost goes up from 10 to 30 percent from Li-Ion betteries.

Lithium Ion (Li-Ion) is cheaper and is common is phones but they are larger in size.

CHOOSING THE LI-PO 785060

It has 3.7V.

Can be hooked up to a power boost charger to output 5V.

Small in size and flexible.

Will need 2 for the wrist strap and Display.

CHARGING THE BATTERIES

We chose to go with the PowerBoost 500 Charger.

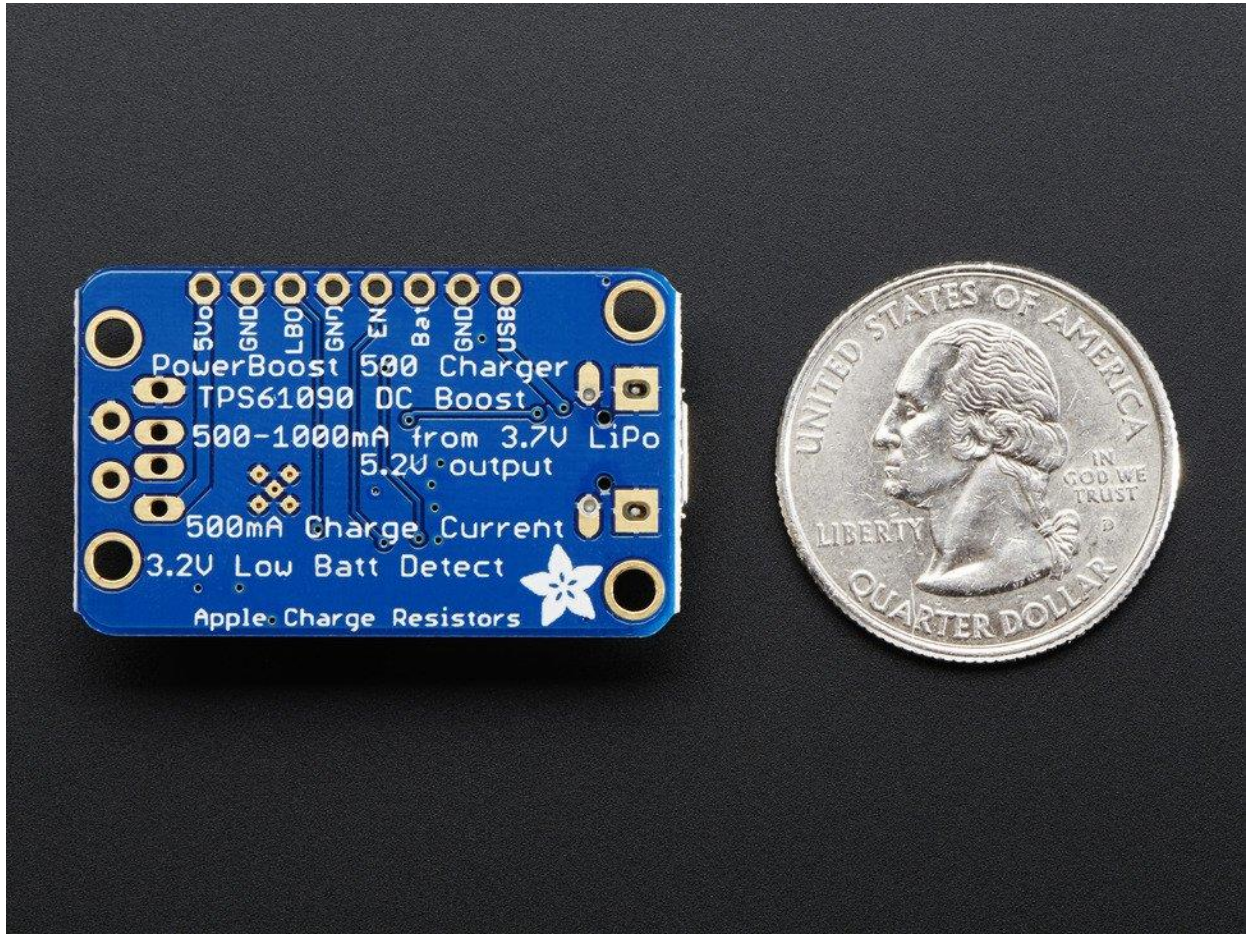
09.” x 0.08”.

Weighs 4g.

Comes with a low battery indicator.

90% operating efficiency.

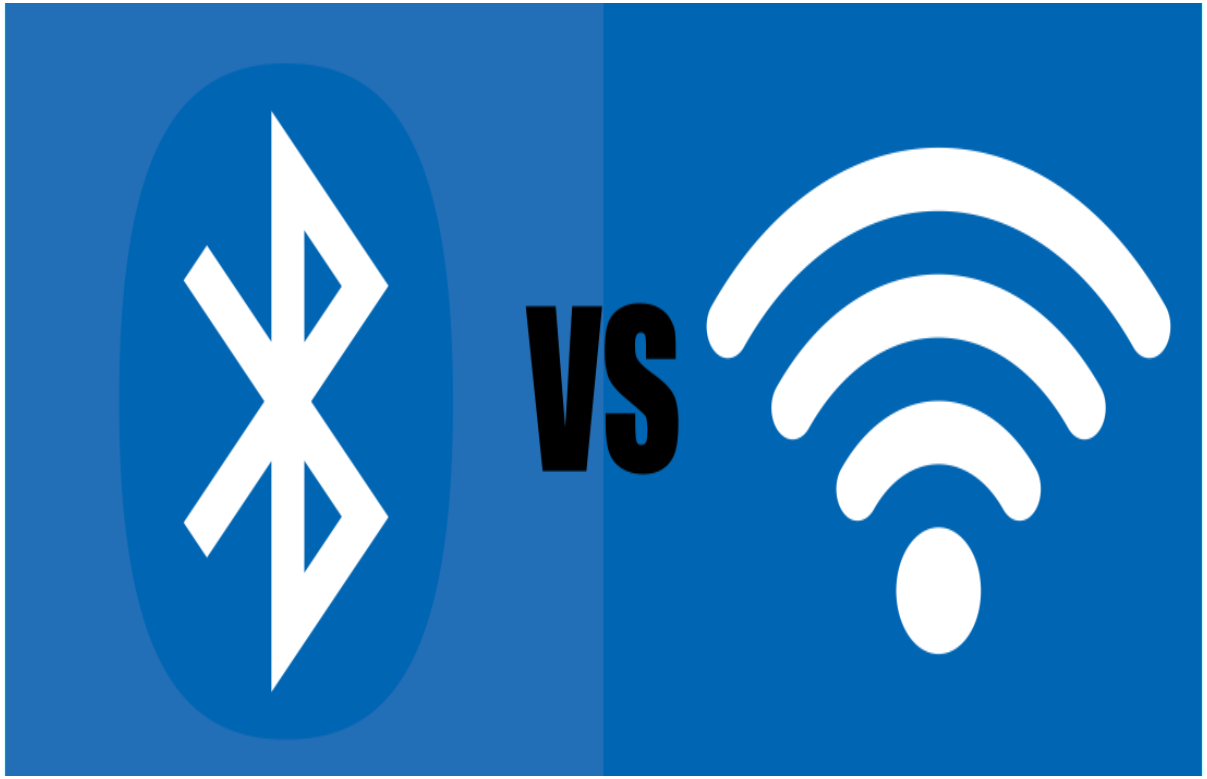
Low current at 5mA.



CHOOSING A WIRELESS CONNECTION

Bluetooth is cheaper in cost and is easier to program for.

Wi-fi has better range and has much faster data rates.



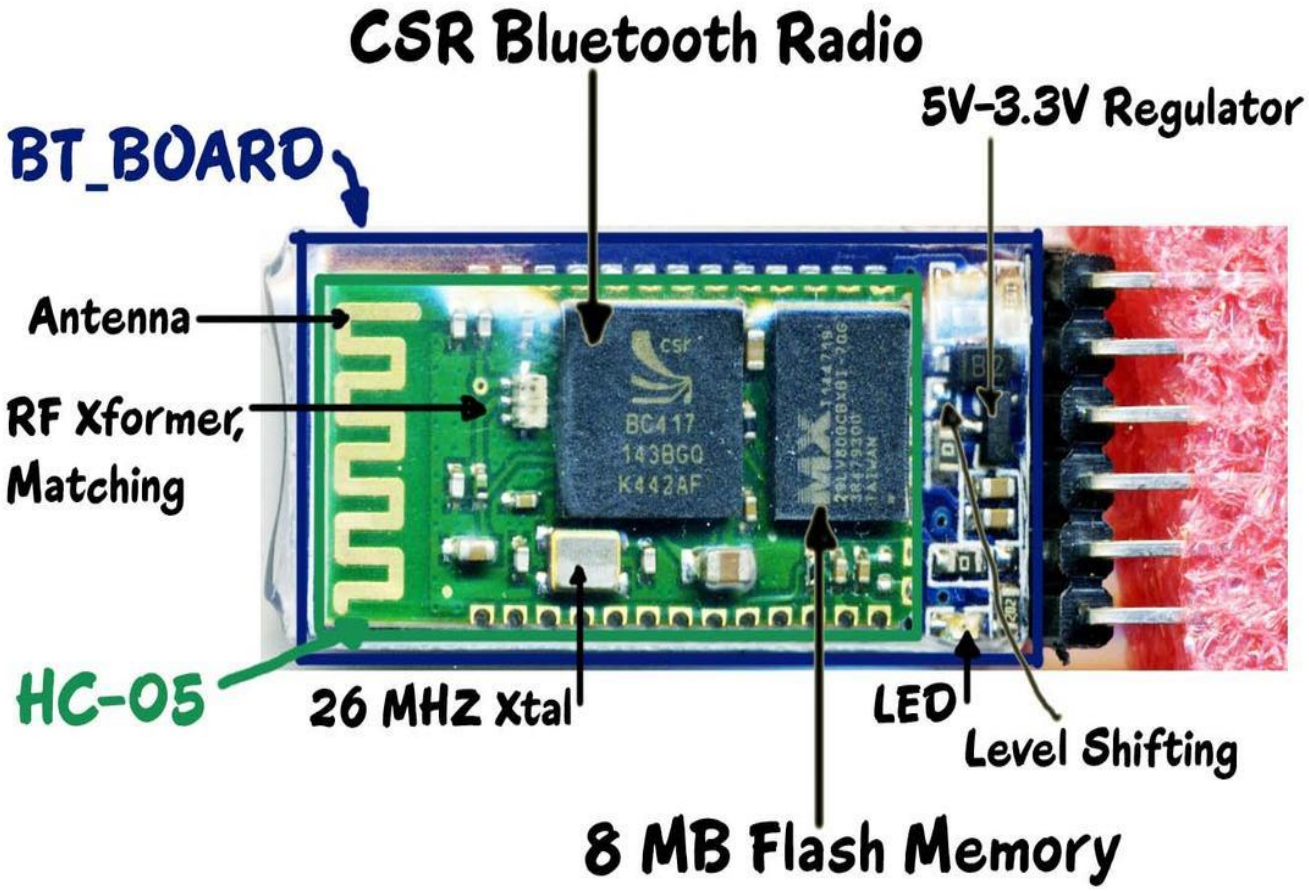
HC-05 BLUETOOTH MODULE

The HC-05 can be set as a master or a slave.

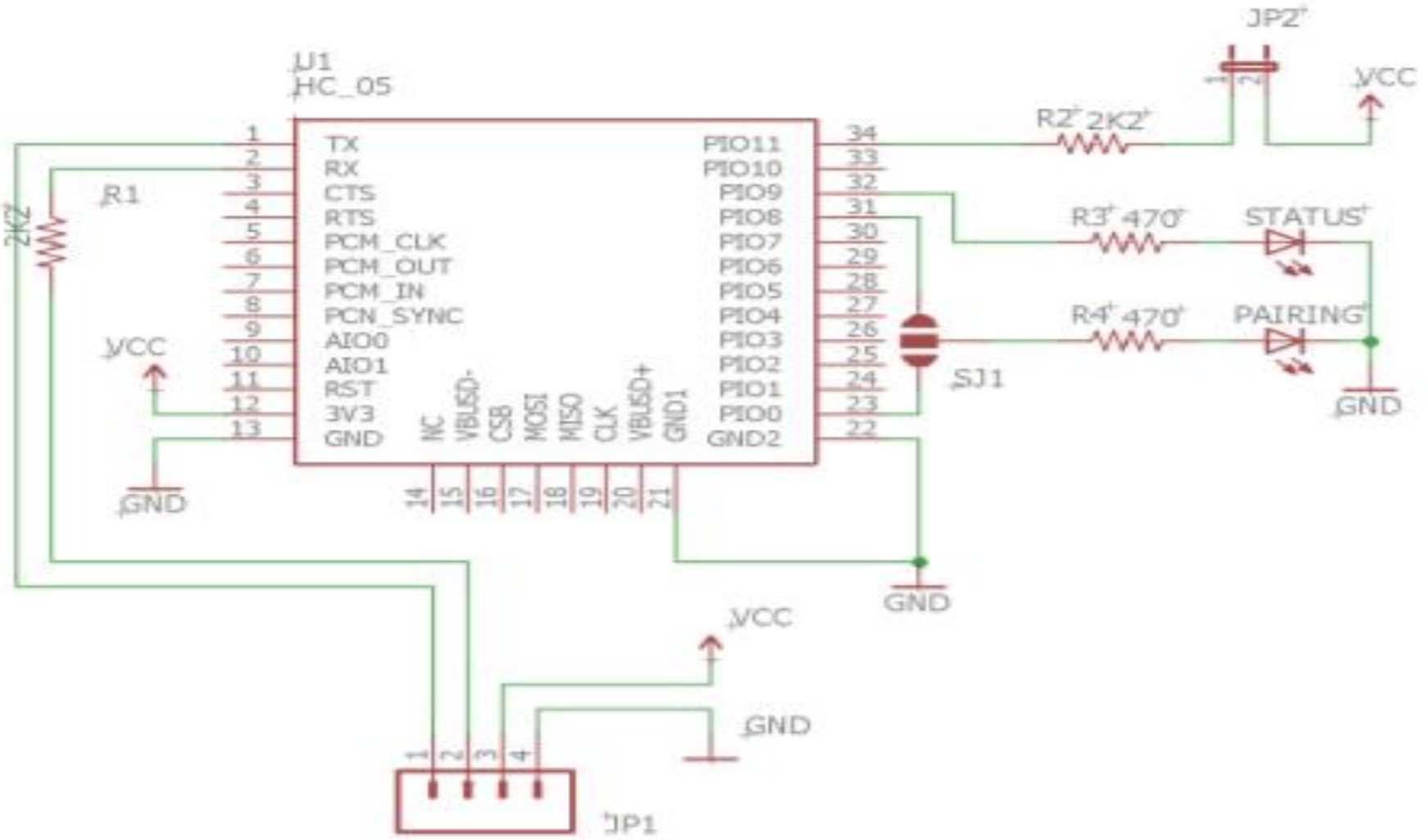
It is very small (3cm long).

It runs on 3.3V power.

It has 2.4 GHz ISM band.

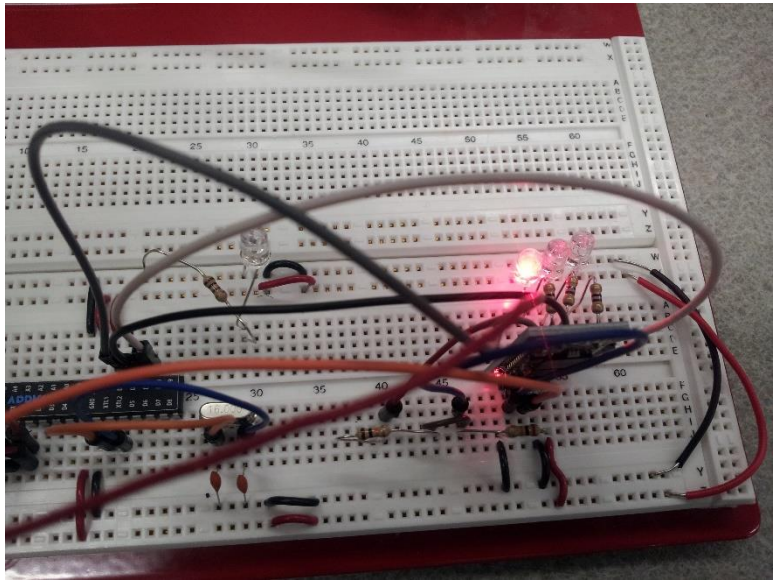


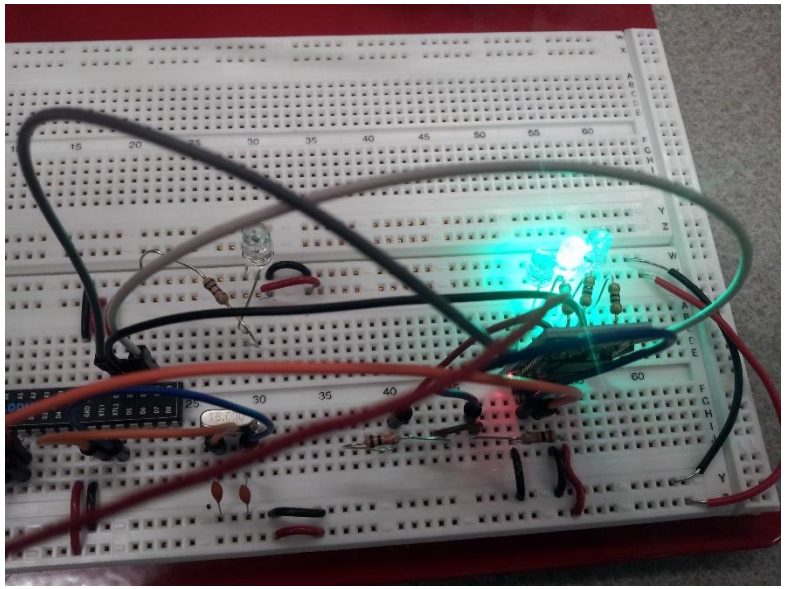
BLUETOOTH DESIGN

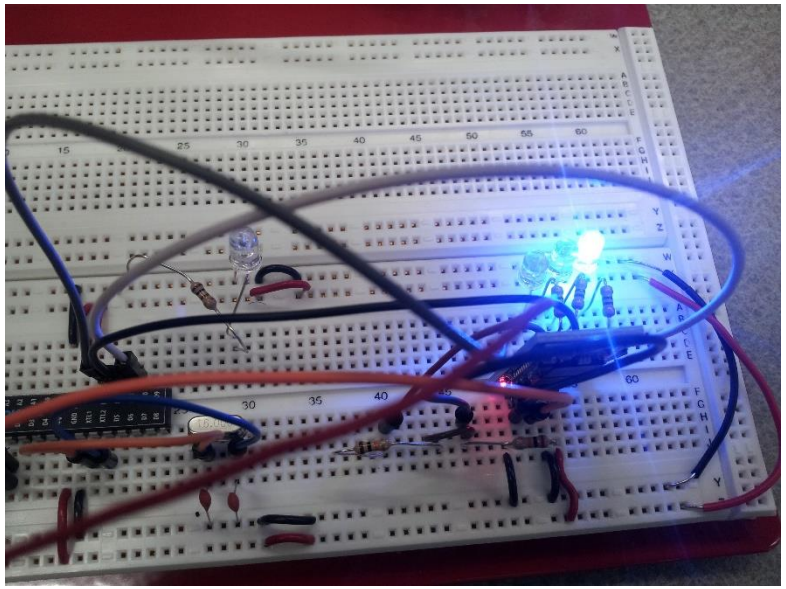


BLUETOOTH SUCCESS

Here we can see the HC-05 is connected successfully to our phone and we are able to change the LED's accordingly. The point of the LED's changing is to allow the teacher to know that a child needs to De-escalate.







BLUETOOTH CHALLENGES

We ran into issues with testing.

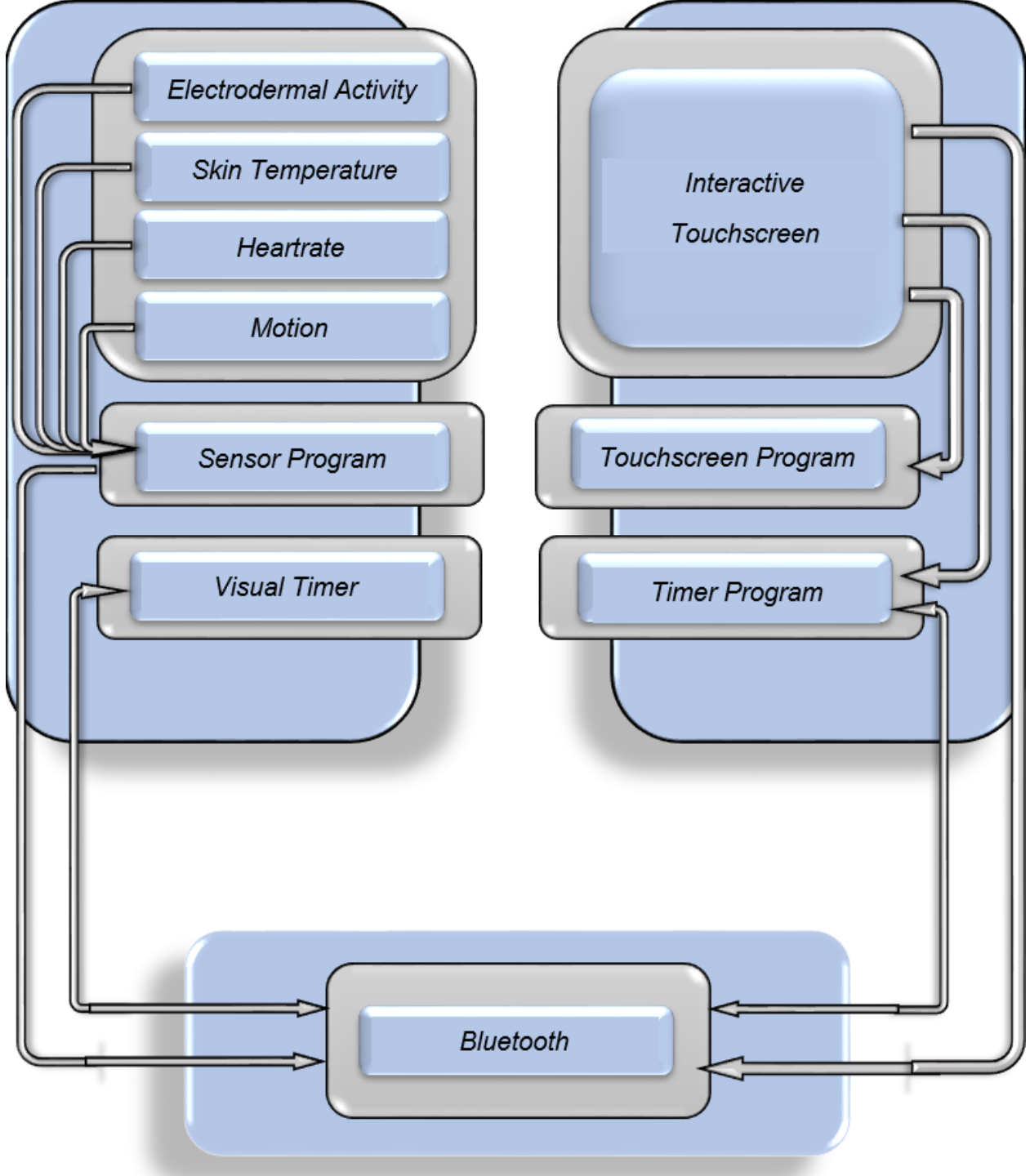
Finding a suitable app.

Programming each LED to change properly.

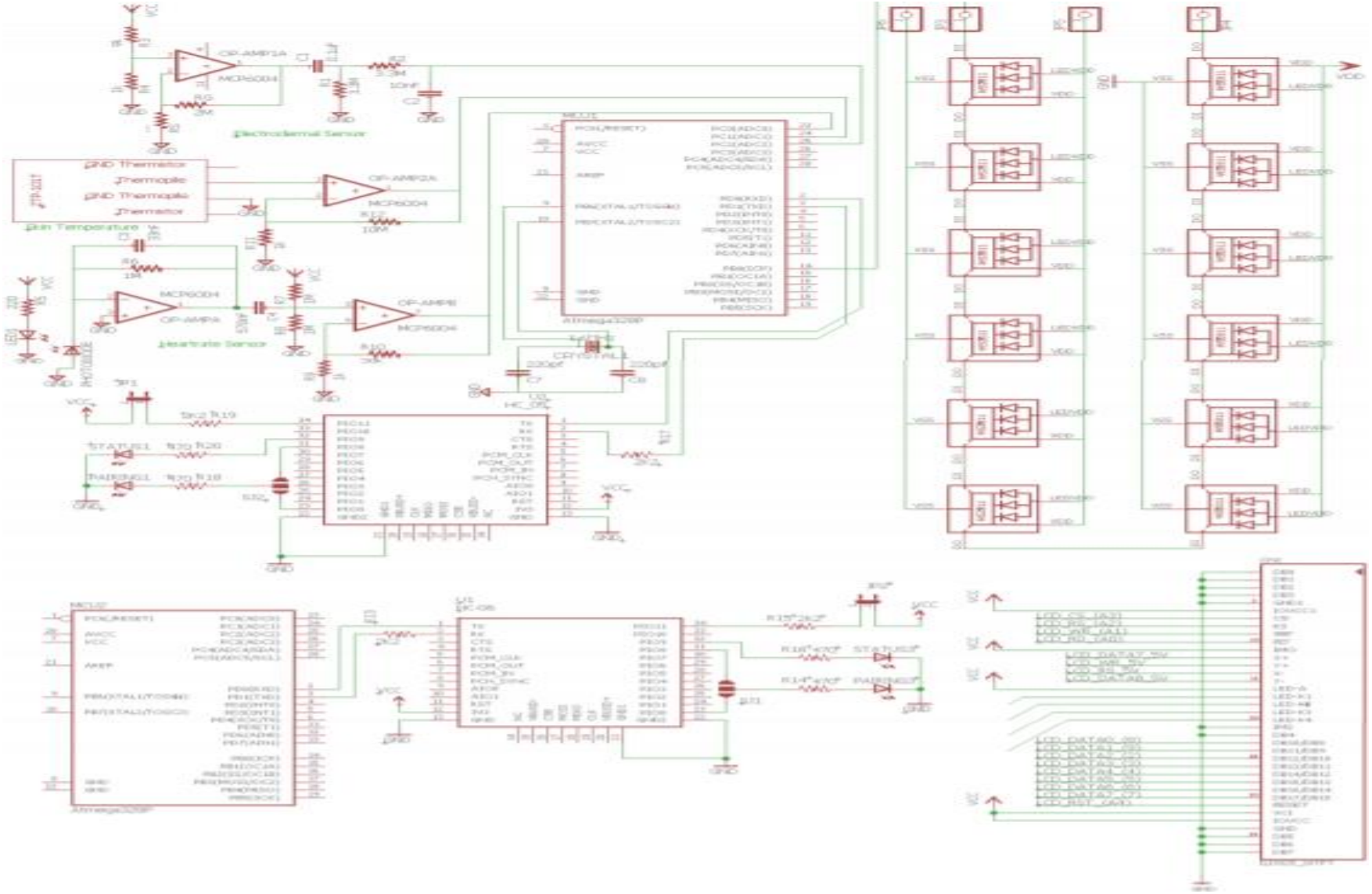
Making sure the connection stayed on.

Making the program work with our MCU.

Put it all together…



FULL PCB SCHEMATIC



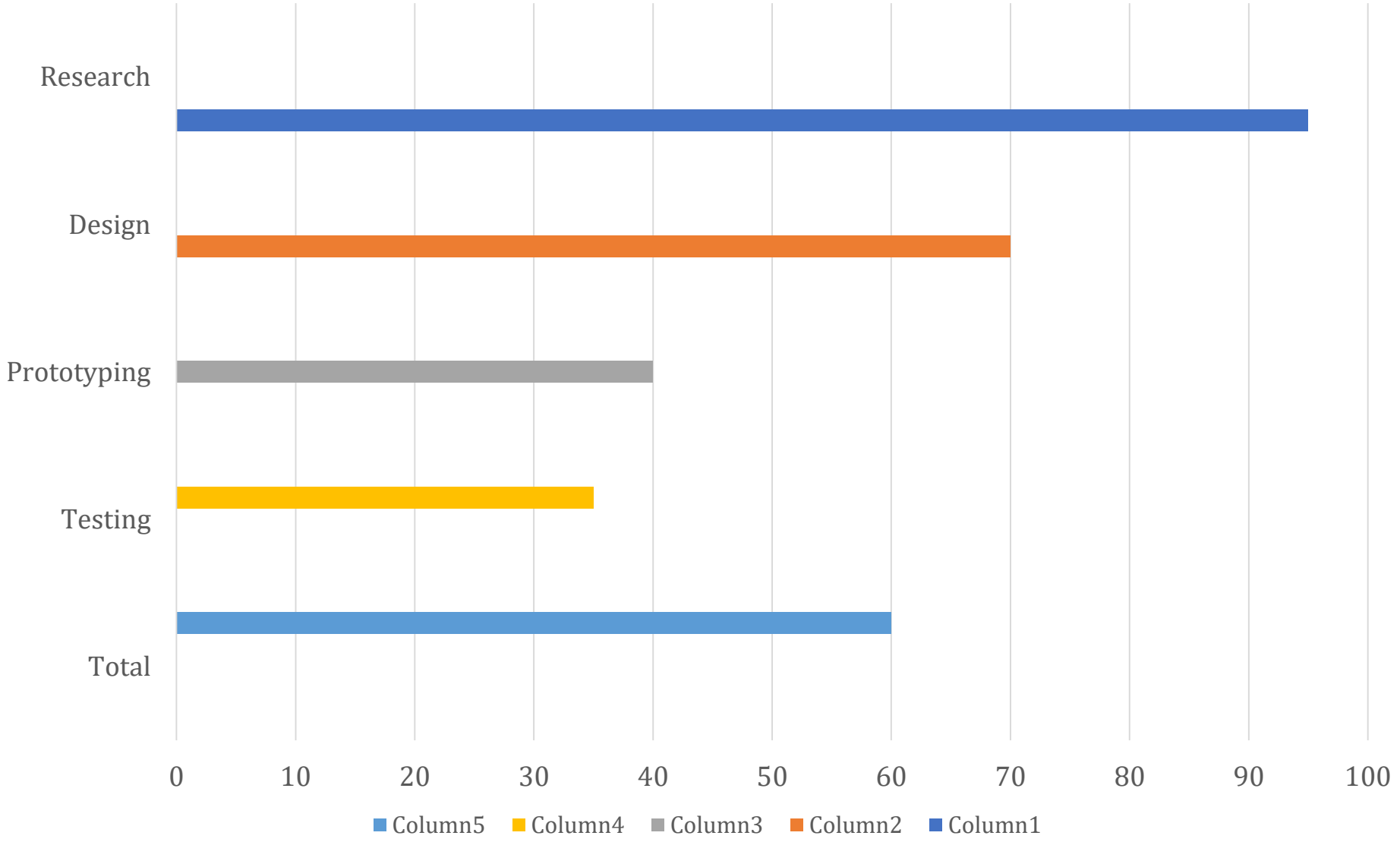
WORK DISTRIBUTION

NAME	EDA	Heart Rate	Skin Temp	MCU	Blue-tooth	Power	Touch screen	LED Timer	PCB Design
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	Thermopile (5 pk)	Amphenol Advanced Sensors	ZTP-101T	$22.00
4	LEDs/photodiodes (50 pairs)	XLX	B01MFCFLA7	$11.99
5	Accelerometer (10 pk)	Freescale	MMA8652FC	$14.76
6	Microcontroller (3 pk)	Atmel	ATmega328P	$13.45
7	Touchscreen	Amazon	LYSB00UAA2XIC	$15.99
8	Bluetooth Master (2 pk)	DSD TECH	B01G9KSAF6	$7.99
9	Bluetooth Slave (2 pk)	DSD TECH	B01FCQZ8VW	$7.99
10	Timer (3 pk)	Banggood	976036	$10.56
11	Crystal Oscillator (10 pk)	Uxcell	HC-49S	$4.57
12	Serial Adapter (2 pk)	Gifkun	FT232RL	$9.88
13	Breadboard Power Supply Module (2 pk)	Wangdd22	B10	$8.99
14	PCB (	-	-	$100*
	Battery		Pending	
* The PCB cost is estimated.			Total	$248.88

Milestone	Start	End
Senior Design 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	-
PCB Construction	04/27/2017	-
Senior Design II	08/21/2017	12/02/22017
Build Prototype	08/21/2017	-
Testing and Redesign	-	-
Finalize Prototype	-	-
Critical Design Review	09/22/2017	-
Peer Review	-	-
Conference Paper	-	-
Final Documentation	-	-
Final Presentation	-	-

CURRENT PROGRESS



QUESTIONS?/COMMENTS