Smart Harness

Group #15 Members

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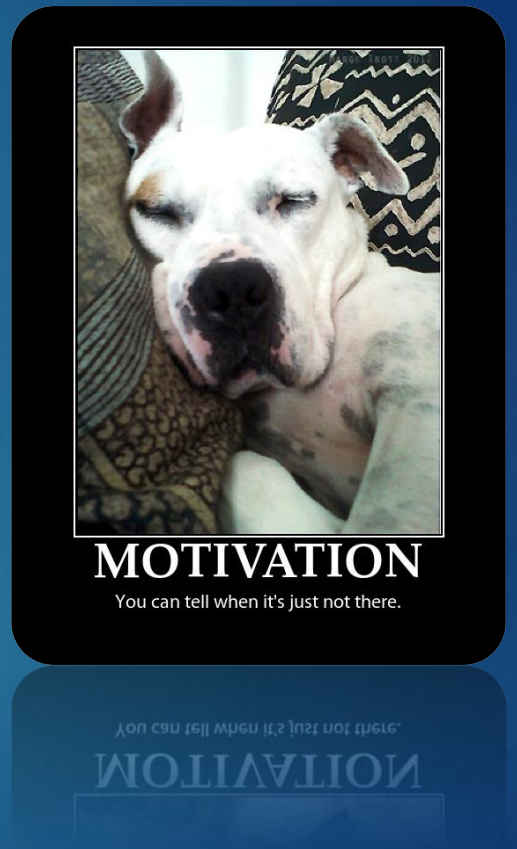
Project Description

- Harness that is designed for dogs
- The harness will be mounted with an electronic device
- Device will measure health information from the dog
- Harness will be connected with a mobile device using a bluetooth connection
- The mobile application will store information about the dog's health as well as show real time vital information

Project Motivation

- To enable owners to have real-time health information about their dog
- To tackle the lack of available smart technologies for dogs
- To enable owners to store pet information and access it easily
- Because dogs are awesome!!



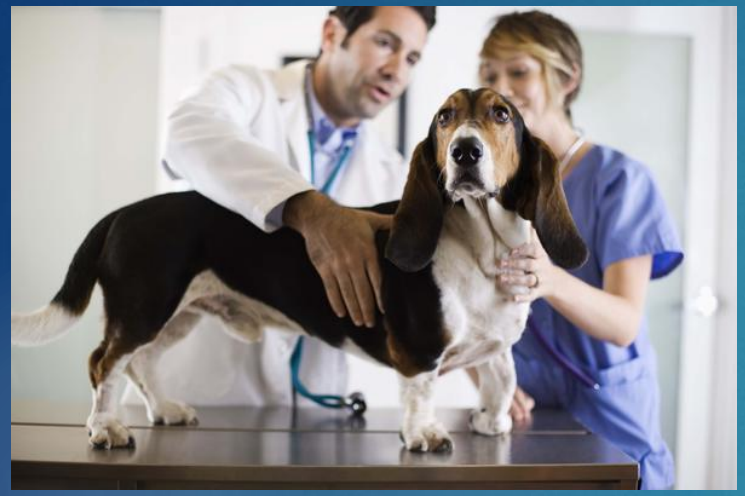
Project Goals

- Measure Heart Rate
- Measure Temperature
- Include Pedometer
- Store Information on a mobile application
- Comfortable and lightweight
- Include Global Positioning System
- User Friendly

Why a harness and not a collar?

- Comfort - it does not choke or injure the dog's throat
- Surface Area - more space to place the PCB and any peripherals
- Durability - harness fabric will help protect some components
- Safety – wiring will be easier to protect from damage and also deter the dog from damaging any of the components
- Aesthetics - circuit/sensor placement and wiring will be easier to conceal for a more attractive look

Veterinarian Consultation



- Ideal location for external sensors
- Canine temperature can vary wildly
- Typical fever for a dog begins at 103.5 °F
- Normal resting heart rate range for dogs:
  - Puppies - 160 to 220 bpm
  - Large Adult - 60 to 100 bpm
  - Small Adult - 100 to 140+ bpm
- Could be used in veterinarian offices
- Healthy dogs should be walked a minimum of 30 min. a day

Project Specifications

- Low Cost (Budget): < $400
- Small PCB: < 3" x 3"
- Low Voltage: < 10 V
- Info Quick Response displayed: < 20s
- Lightweight: < 5 lbs
- GPS Accuracy: < 10 ft
- GSM Response Time: < 15 sec

Elite "Spanker" Harness

Girth Size	M	L
(inch)	25.5" — 31.5"	27.5" — 37.5"
(cm)	65—80cm	70—95cm

- Ample surface area for device mounting
- Durable and attractive
- Fabric allows for sensors to be concealed and protected
- Cost $23.68

Circuit Enclosures

Main PCB Enclosure

- Tough and Durable ABS Plastic
- Low Cost - $14.95 at Radioshack
- Small in size - Dimensions are 4.5" x 3.25" x 1.5"
- Very light weight
- Comes with battery slot

GPS + GSM Enclosure

- Tough and Durable ABS Plastic
- Low Cost - $9.55 on eBay
- Small in size - Dimensions are 5" x 2.5" x 1"
- Very light weight

Overall Design Flowchart

Puppers

Temperature Sensor

Heart Rate Sensor

Step Counter (Accelerometer)

Wireless Communication Module (Bluetooth)

Microcontroller Unit Module

PCB

Power Supply (Battery)

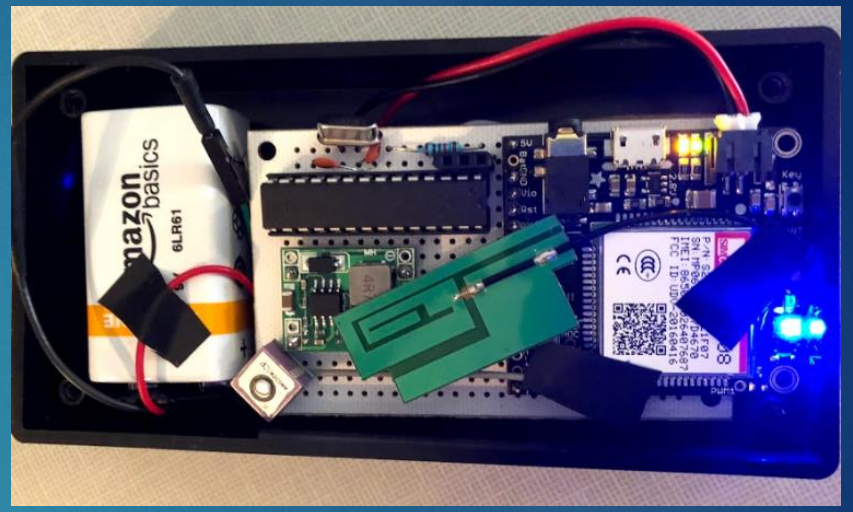
Mobile Device

GPS + GSM Module

User

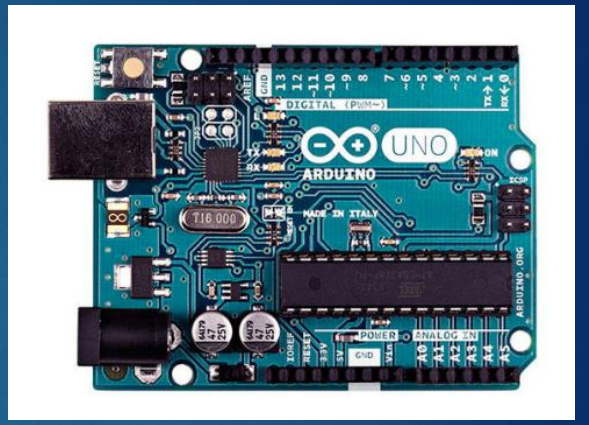
Hardware Components

- Microcontroller – Atmel ATMega328P-PU
- Accelerometer – Adafruit 3-Axis (MMA8451)
- Bluetooth - SH-HC-08 (CC2541)
- Heart Rate Sensor – SEN 11574 (APDS 9008)
- Temperature Sensor – DS18B20
- Main Battery - 9V Alkaline
- Buck Converter - MP1584EN
- Cellular GSM + GPS - Fona 808
- GSM Battery - Li-Polymer 3.7v



Microcontroller – Atmel ATMega328P-PU

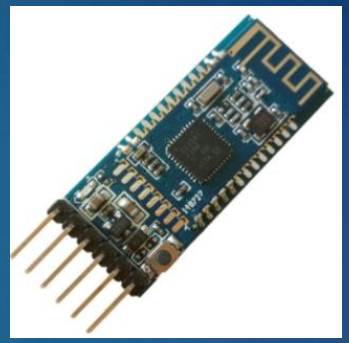
	Arduino Uno	MSP430 Launchpad	Adafruit Trinket	PICAXE 08M2
Chip	ATmega328P	MSP430G2553	Atmel ATiny85	PICAXE 08M2
Cost	$24.95	$9.99	$6.95	$2.95
Removable Chip	Yes	Yes	No	N/A
Testing Board Included	Yes	Yes	Yes	No
Onboard Clock	Yes	Yes	Yes	Yes
Clock Speed	16 MHz	16 MHz	8MHz - 16 MHz	32 MHz
Memory	32 KB	16 KB	8 KB	2 KB
Voltage	1.8V - 5.5V	1.8V - 3.6V	3V or 5V	4.5V - 5V
Number of Pins	28	24	5	6



- Voltage – 2.5 V, 3.3 V, 5 V
- Memory – 32 KB Flash
- Arduino compatible
- UART communication capable
- Cost – Development board $24.95
- Acquisition – Arduino website/Arrow electronics

Bluetooth Module – SH-HC-08

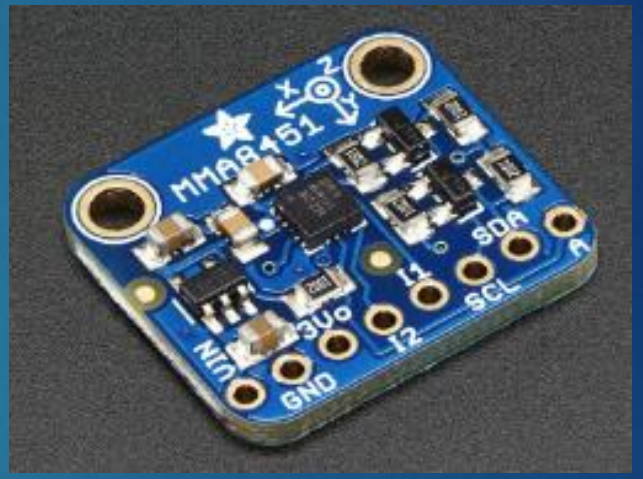
	nRF8001	BGM 113	nRF51822	SH-HC-08
Voltage input	3V – 5V	1.85V – 3.8V	1.8V – 3.6V	3.3V - 5V
Current TX+RX	100mA	16.9mA	17.7mA	9mA
Temp. operation	unknown	-40°C to +85°C	-25°C to +75°C	40°C to +85°C
Dimension	29mm x 28mm	15.73mm x 9.15mm	21mm x 18.5mm	26.7mm x 13mm x 2mm
Distance	10m	10m	10m	10m
Flash memory	Unknown	256kB	128kB	Unknown



- UART wireless communication module
- Bluetooth Version 4.0
- Range – 10 meters
- Voltage – 3.3 V to 5.5 V
- Low current draw, only 9 mA
- Arduino compatible
- Cost – $ 7.99
- Acquisition – Amazon

Accelerometer – Adafruit 3-Axis MMA8451

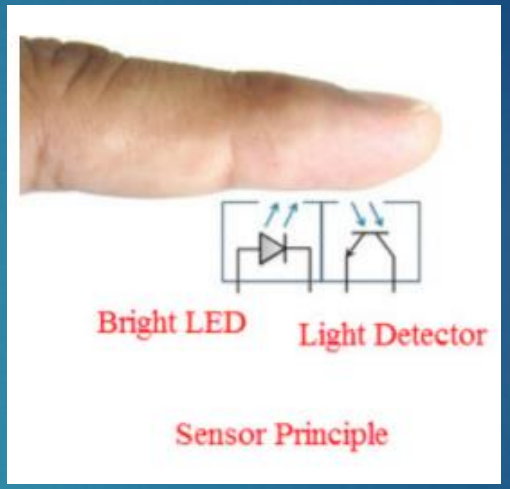
	Adafruit MMA8451	GY-27	FLORA LSM303	ADXL345-BB
Size	3mm x 3mm (small)	3.2 cm x 1.5 cm (large)	14 mm diameter (small)	25mm x 25mm (moderate)
Cost	$7.95	$5.82	$14.95	$5.01
Precision	14-bit (High)	Unknown (datasheet unavailable)	16-bit (Very High)	13-bit (Moderate)
Supply Voltage	1.95 V - 3.6V	3 V - 5 V	2.16 V - 3.6 V	2.0 V - 3.6 V



- Detects motion, tilt, and basic orientation
- Voltage – 3.6V
- Current Consumption - 6 µA to 165 µA
- Arduino compatible
- Cost – $ 7.95
- Acquisition – Adafruit website
- I2C Communication

Heart Rate Sensor - SEN 11574

	MAX 30102	SI 1143	SEN 11574
Voltage input	1.8V – 5.0V	1.8V – 3.6V	3V-5V
Current input	0.7 µA	9 µA	4mA
Dimension	5.6mm x 3.3mm	32mm x 22mm	16mm x 3mm
Cable	No	No	yes
Temp. operation	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Price	$10	$20	$5

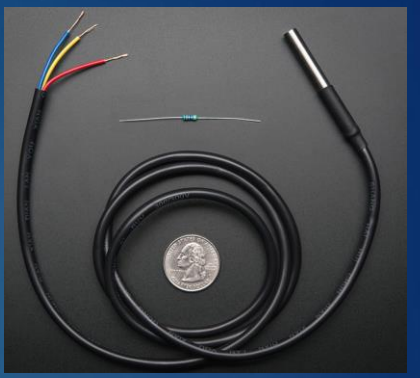


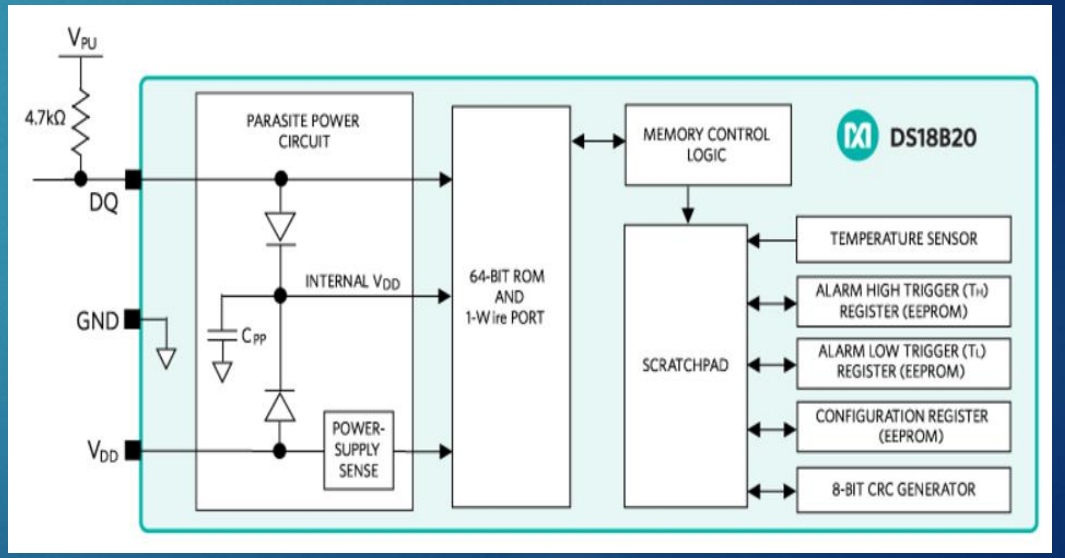
- Heart Rate Sensor - SEN 11574
- Arduino Compatible
- Long cable
- Cost $5
- Acquisition - Amazon
- Current Consumption - 4mA
- Emits and detects light to obtain pulse

Temperature Sensor - DS18B20

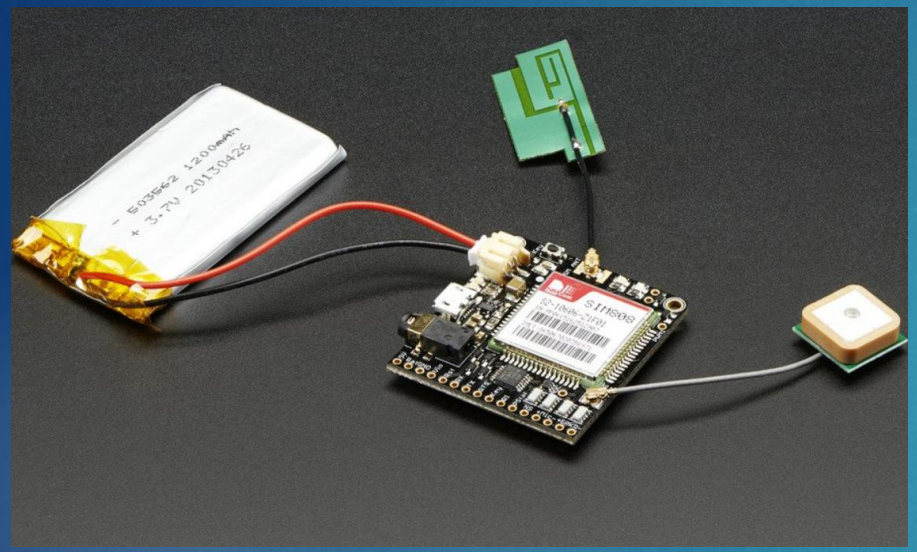
	DS18B20	MCP9700	MCP9808
Price	$ 9.95	$ 4.95	$ 4.95
Usable temperature	-55°C to 125°C	-40°C to 125°C	-40°C to 125°C
Accuracy	±5°C	±2°C	±0.25°C
Cable	Yes	No	No
Voltage	3.3 – 5.5 V	2.3 – 5.5 V	2.7 – 5.5 V
Current	9 µA	6 µA	200 µA
Water Proof	yes	No	No
Size	Long cable	20mm x 0.8mm	21mm x 13mm

- Digital Thermometer
- Current Consumption - 9uA
- Water resistant
- Long Cable
- Acquisition - Amazon
- Cost $9.95
- Arduino Compatible



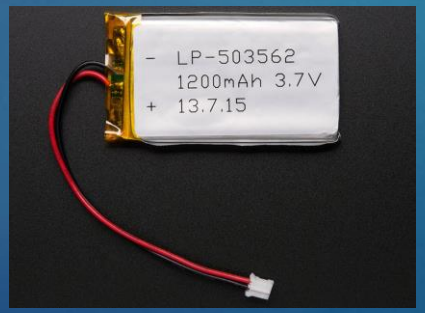


GPS + Cellular Module

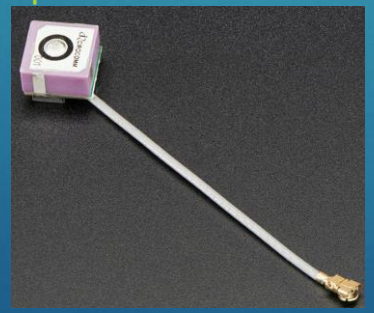


- Add on function to project
- Adafruit FONA 808 mini GSM + GPS
- -165dBm Tracking Sensitivity
- Current Consumption - 20mA
- Requires uFL passive GPS Antenna
- Requires GSM/Cellular Antenna
- Connects onto any GSM network w/ 2G SIM
- Cost $75.85
- Passive GPS location detection

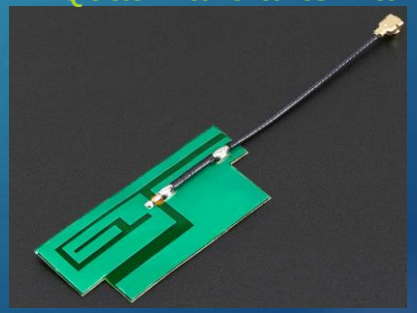
Li-Polymer Battery 3.7v



uFL passive GPS antenna



GSM/Cellular
Quad-Band antenna



Power System

- Supply Power with 9V Alkaline (550mAh)
  - ATmega328p-pu
  - DS18B20 (Temperature sensor)
  - SEN 11574 (Heartbeat sensor)
  - SH-HC-08 (Bluetooth)
  - MMA8451 (Accelerometer)
- Amp consumption table.

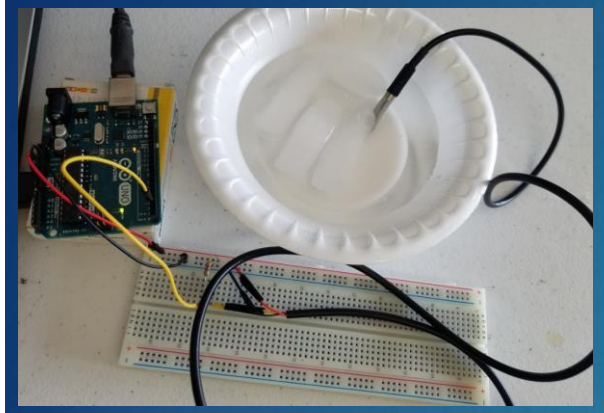
Current Consumption (Active mode)	
ATMega328p (16 MHz)	17.52 mA
Temperature Sensor (DS18B20)	1.5 mA
Heartbeat Sensor (SEN11574)	4 mA
Bluetooth (SH-HC-08)	8.5 mA
Accelerometer (MMA8451)	0.16 mA
Total	31.68 mA

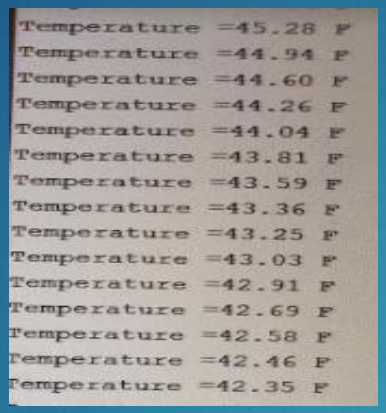
- Formula for Current drain.

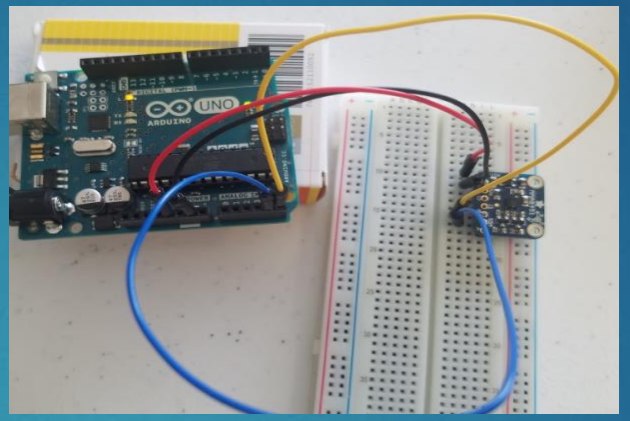
$$hour = \frac{total\ capacity\ (mAh)}{Acutal\ current\ consumption(mA)}$$

- 550mAh/31.68 mA = 17h

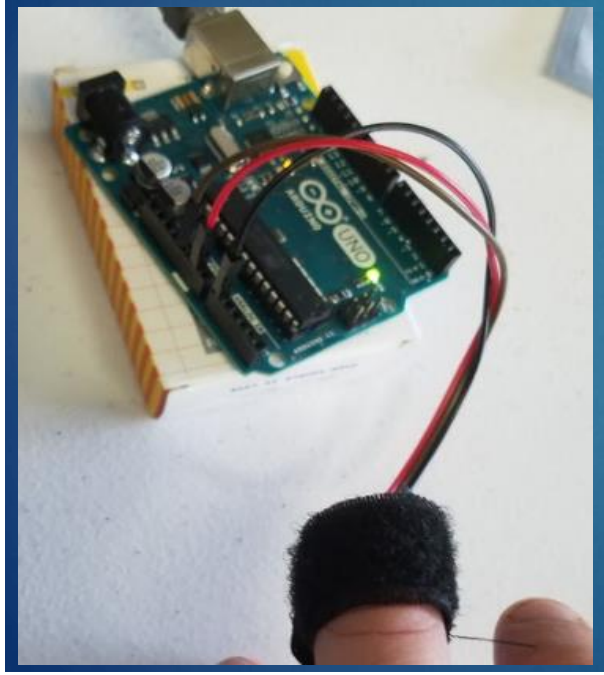
Prototype & Testing

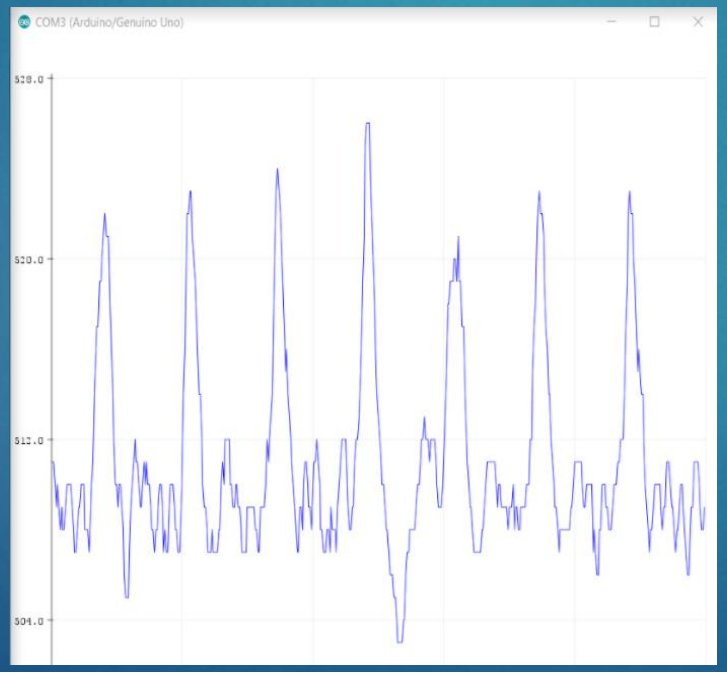


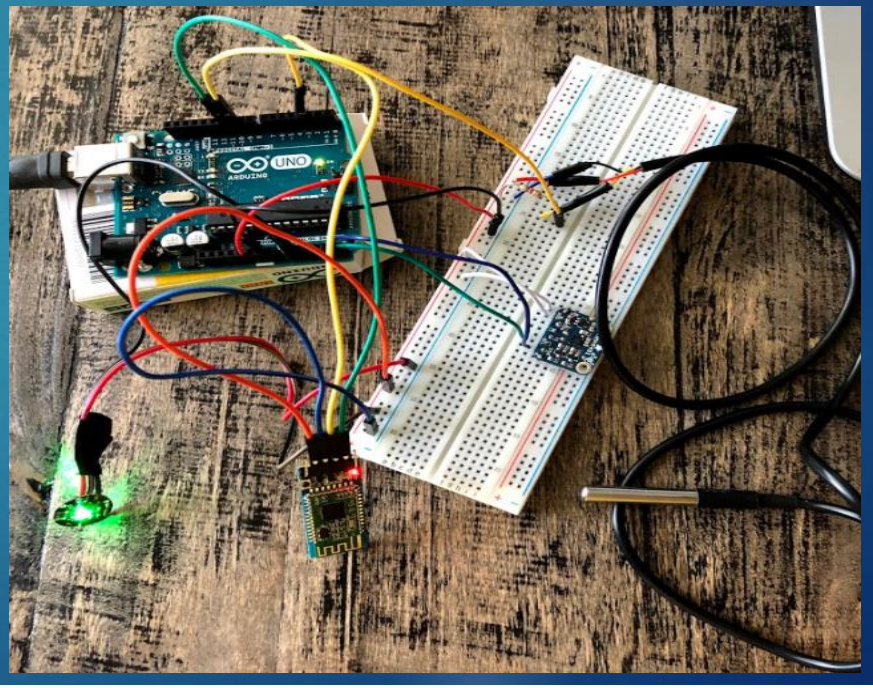




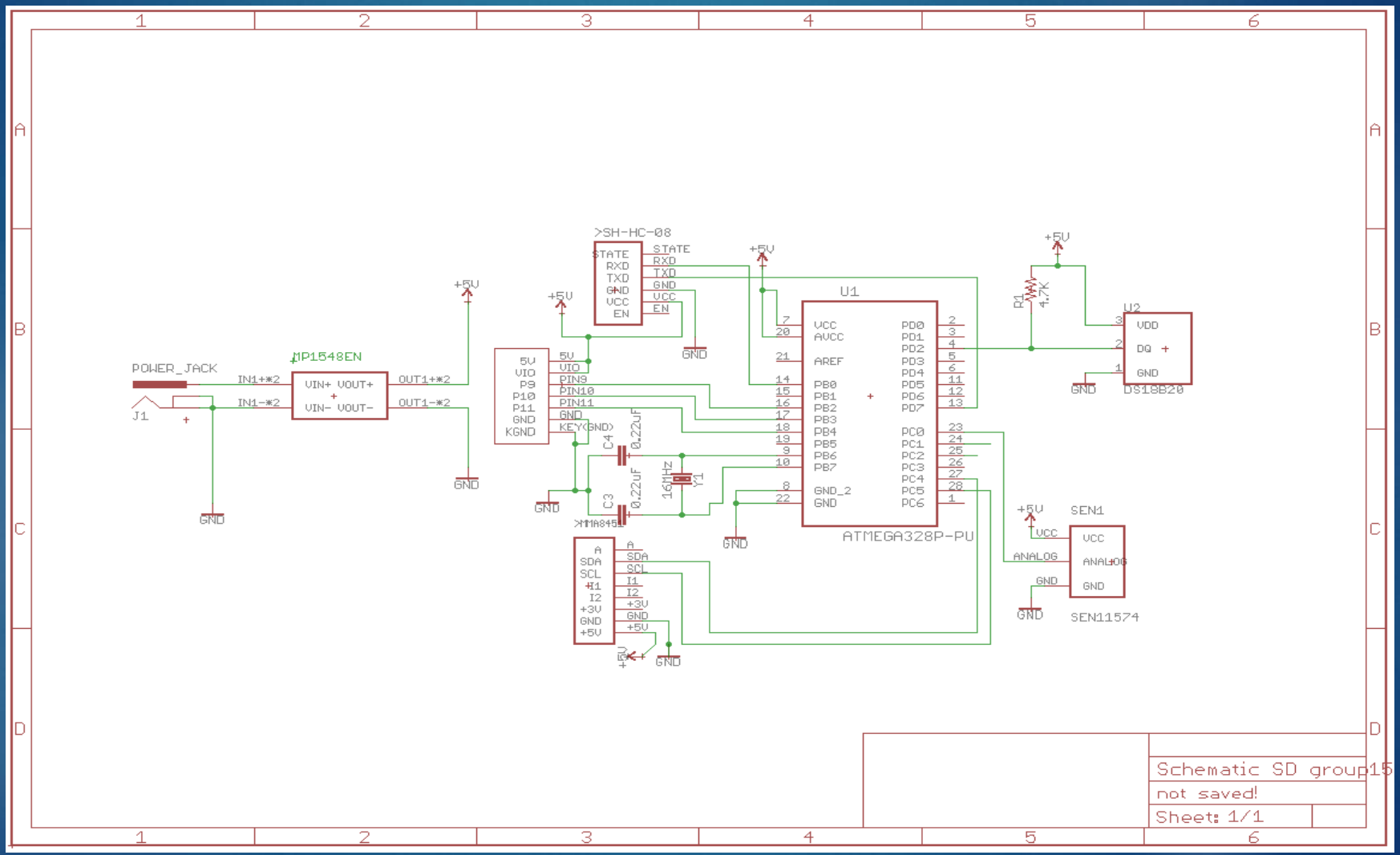
```
SD2-UCF-GROUP15-TESTING!
MMA8451 is found
Range = 2G
X:      40      Y:      -212    Z:      4152
X:      0.12    Y:      -0.53   Z:      9.85    m/s^2
Portrait Up Front

X:      58      Y:      -212    Z:      4124
X:      0.11    Y:      -0.51   Z:      9.84    m/s^2
Portrait Up Front

X:      44      Y:      -218    Z:      4112
X:      0.11    Y:      -0.53   Z:      9.78    m/s^2
Portrait Up Front
```







Hardware Schematic



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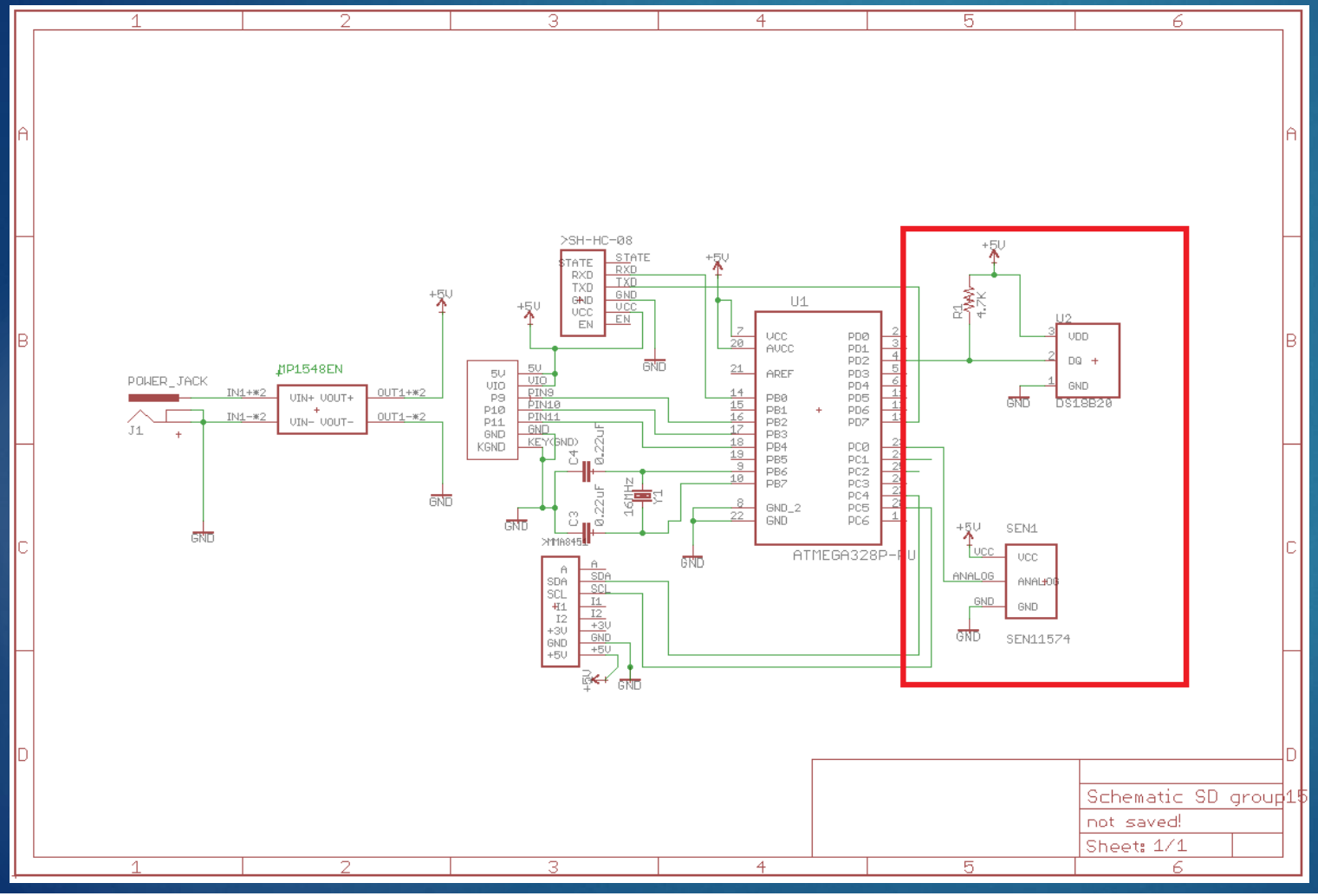

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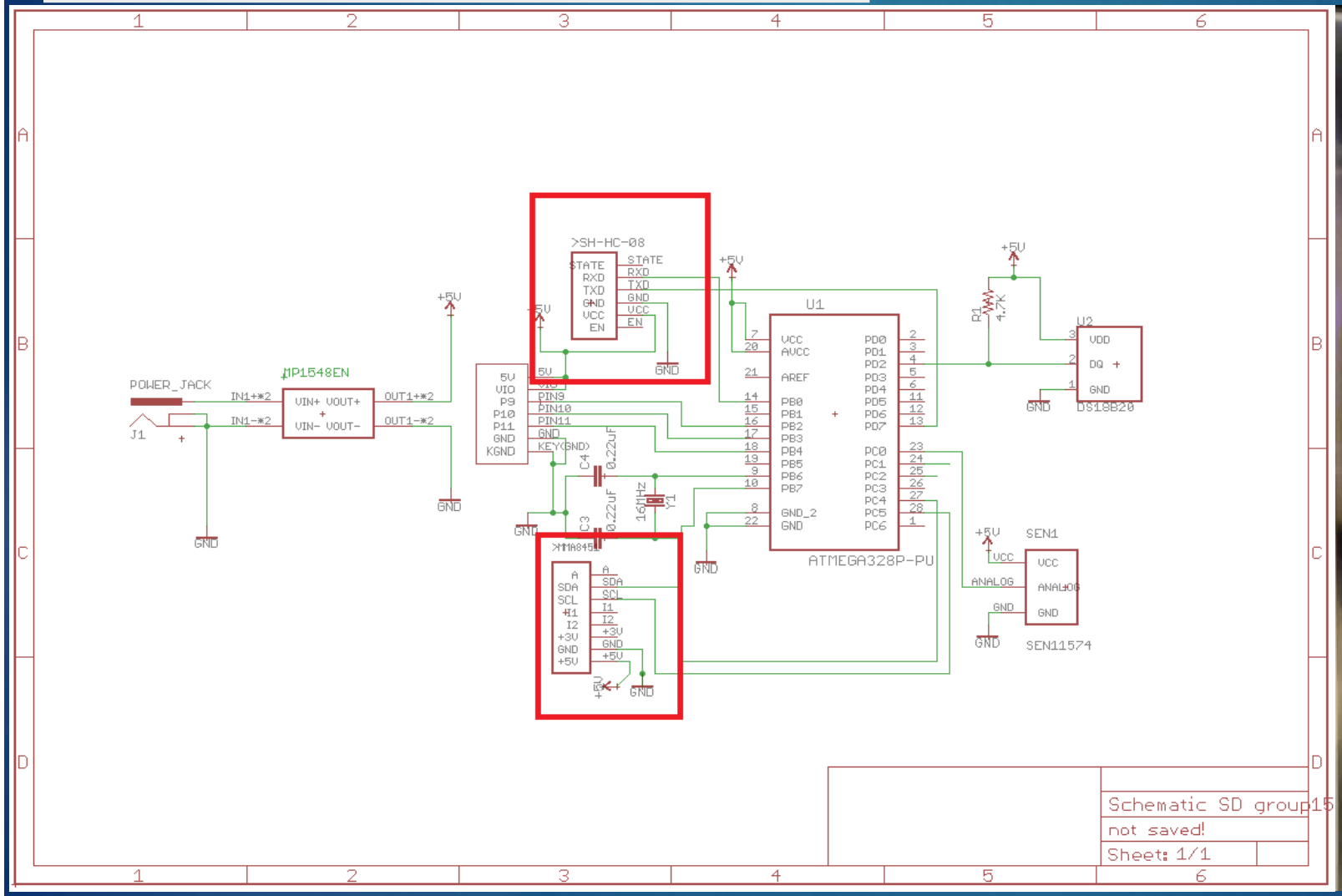


Power System

- MP1584EN DC-DC 9V-5V
  - 3A max current supply
  - Operate 1.5 MHz
  - input voltage 4.5V - 28V
  - output voltage 0.8-20V

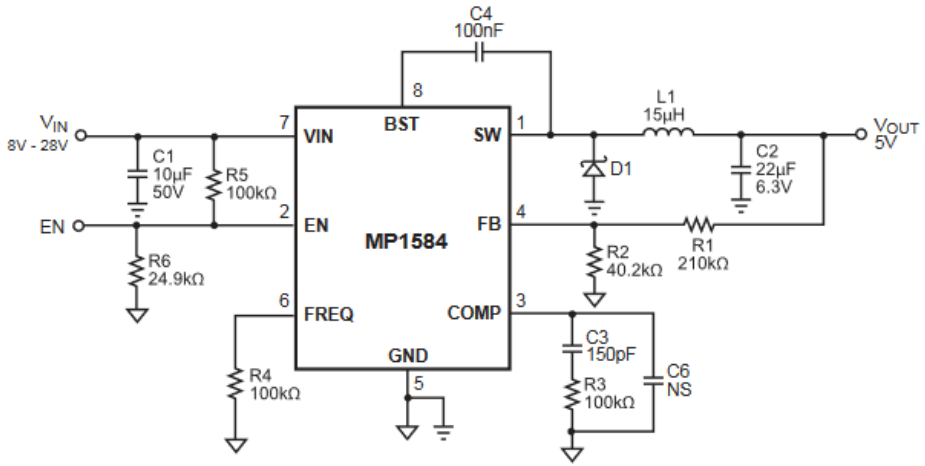
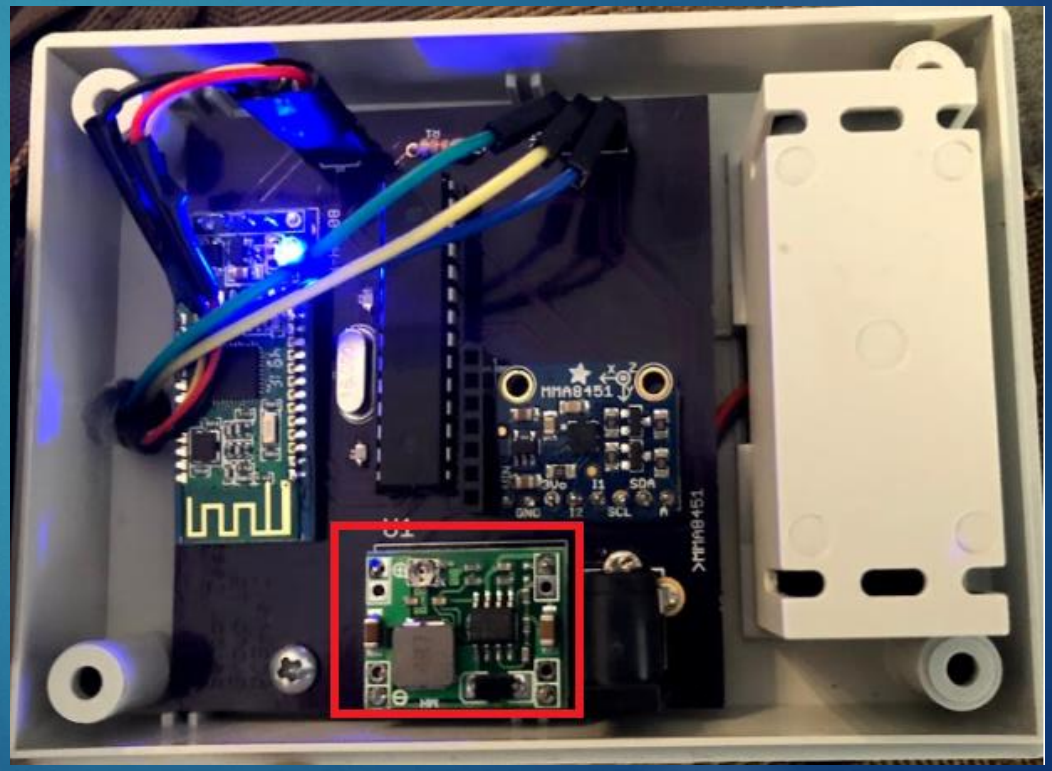
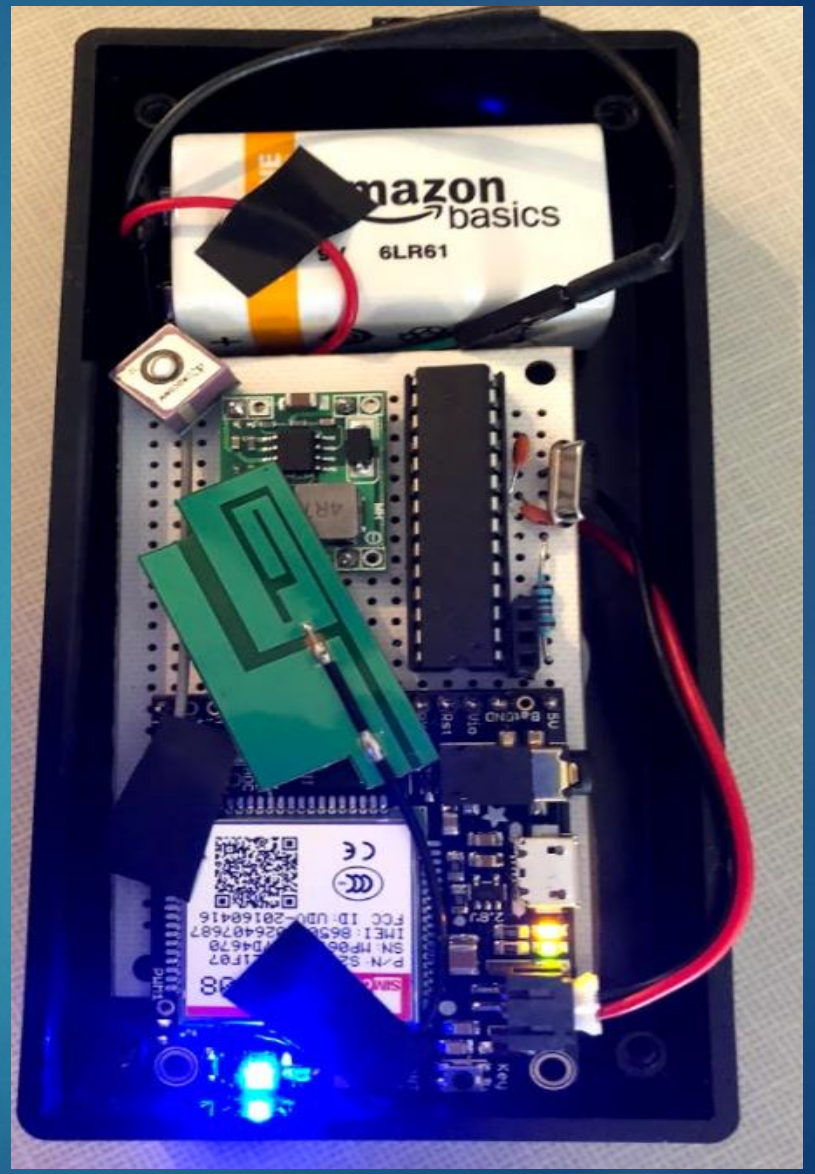


Figure 4—5V Output Typical Application Schematic



Fona 808 GPS + GSM

- Component inside.
  - Development Board
  - MP1584EN 9V-4V
  - 9v Alkaline Battery
  - Atmega328P-PU
  - FONA 808
    - SIM 800 (GSM)
    - MT3336 (GPS)
  - uFL passive GPS Antenna
  - GSM/Cellular Antenna
  - Ting Sim 2G
  - GSM Li-Polymer Battery 3.7v



Application Requirements

- User Friendly
  - easily accessible information
  - least clicks as possible
- Useful
  - pertinent information
  - accurately display vitals
- Communicate with the harness
  - wireless
  - able to transfer data
- Store Data
  - keep track of previous readings
  - display previous data to see trend

Implementation

- Platform: Android vs Apple

	AVAILABILITY	USABILITY	POPULARITY	PROJECT SIZE	COST	ACCESSIBILITY
ANDROID	✓	✓	✓	✓	✓	✓
APPLE	✓	✓	✓	✓		✓

Operating System	4Q16 Units	4Q16 Market Share (%)	4Q15 Units	4Q15 Market Share (%)
Android	352,669.9	81.7	325,394.4	80.7
iOS	77,038.9	17.9	71,525.9	17.7
Windows	1,092.2	0.3	4,395.0	1.1
BlackBerry	207.9	0.0	906.9	0.2
Other OS	530.4	0.1	887.3	0.2
Total	**431,539.3**	**100.0**	**403,109.4**	**100.0**

Implementation

- IDE: Android Studio vs Eclipse

	AVAILABILITY	USABILITY	POPULARITY	PROJECT SIZE	COST	ACCESSIBILITY
ANDROID STUDIO	✓	✓	✓	✓	✓	✓
Eclipse	✓	✓		✓		✓

Implementation

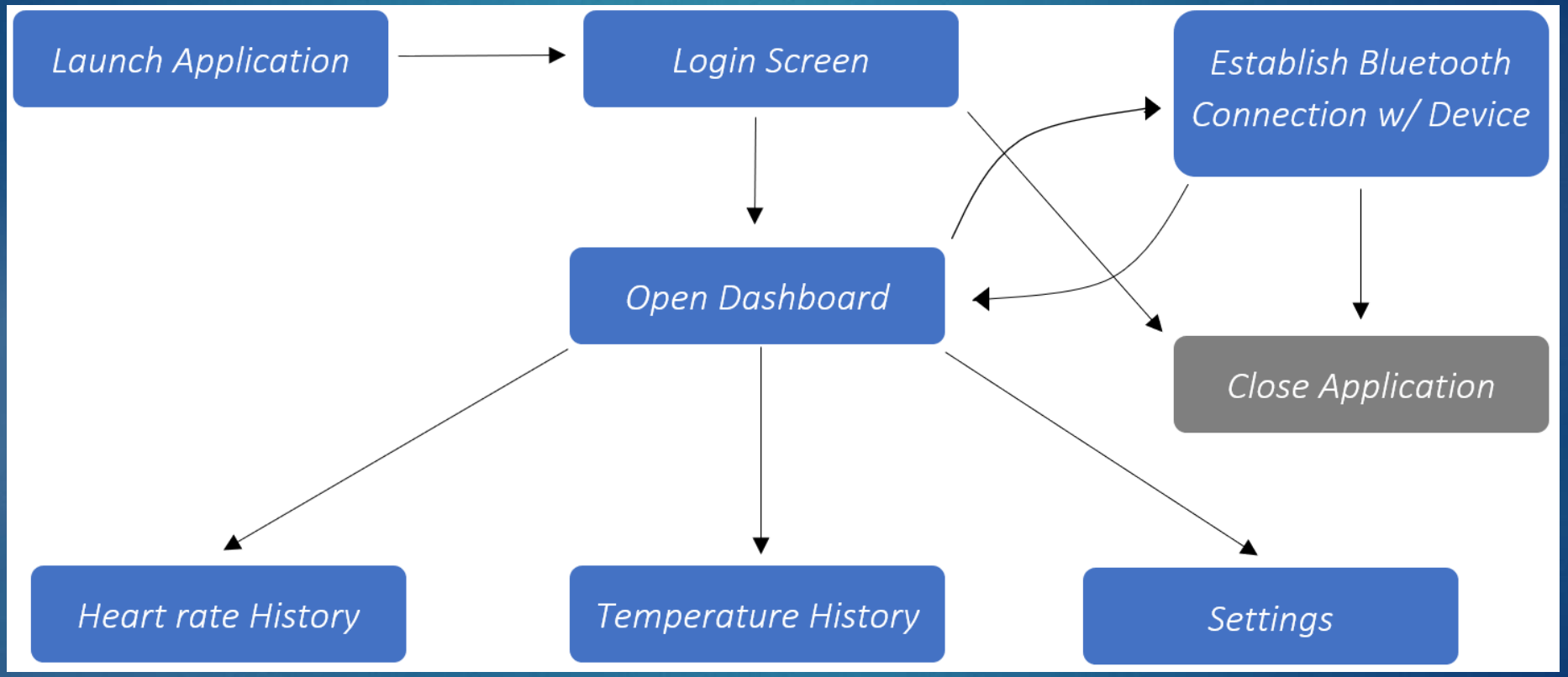
- Language: Java

	AVAILABILITY	USABILITY	POPULARITY	PROJECT SIZE	COST	ACCESSIBILITY
JAVA	✓	✓	✓	✓	✓	✓

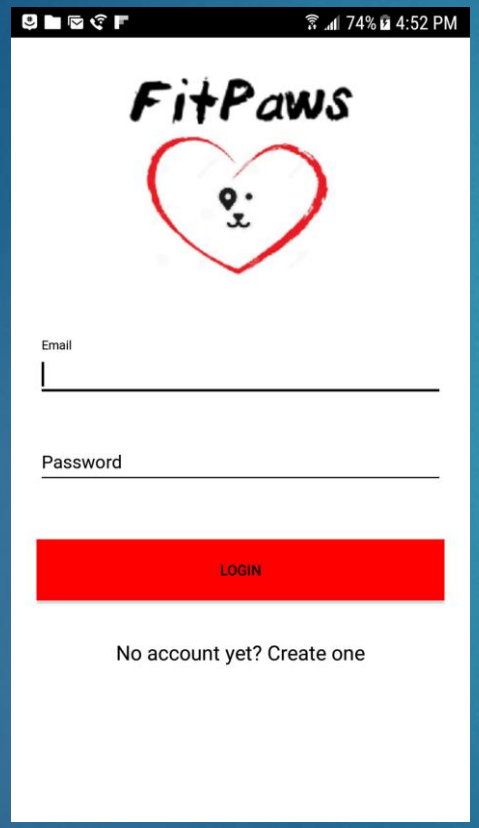
Implementation

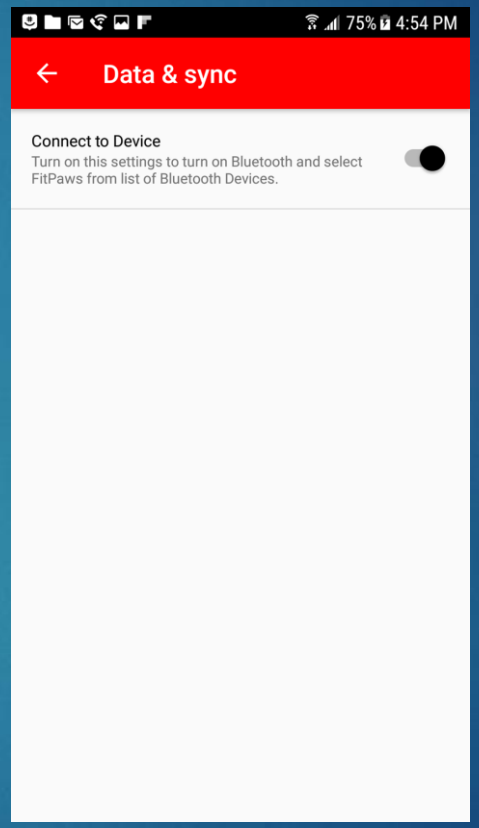
- Android sdk 25
  - Supports android 6 marshmellow
- UI Components
  - AppCompat v7:25.3.1
  - Cardview v7:25.3.1
  - Layout 1.0.2
- Database
  - Sqlite 3.9.2
- Bluetooth
  - BluetoothAdapter
  - GATT (Generic Attribute Profile)

Software Flow



UI Flow and Design





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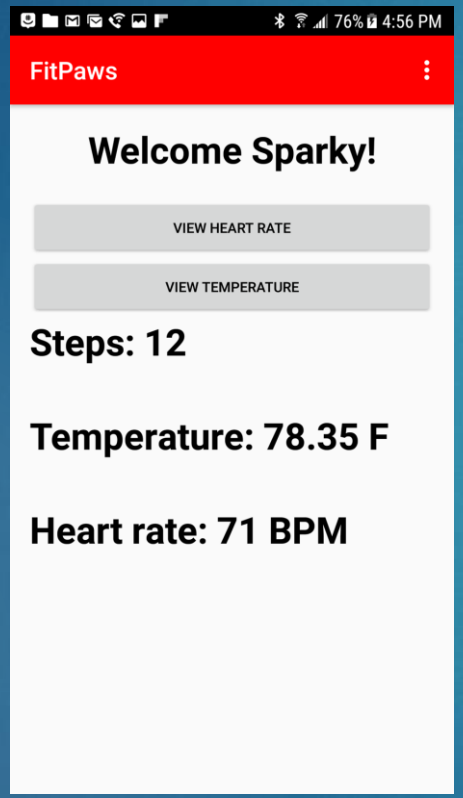

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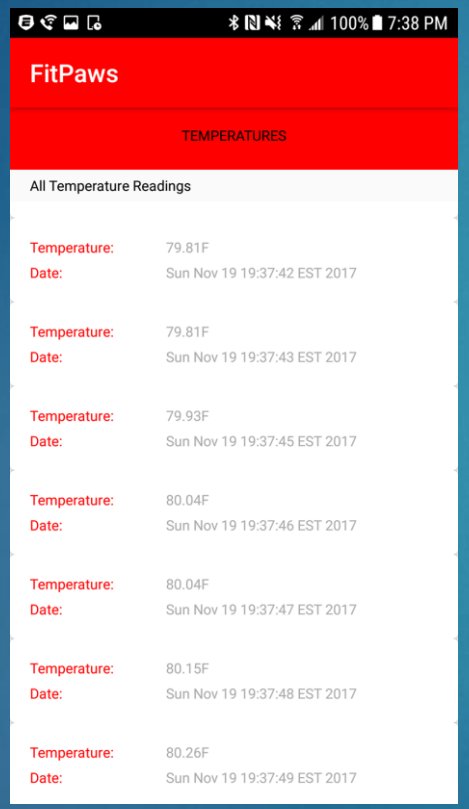
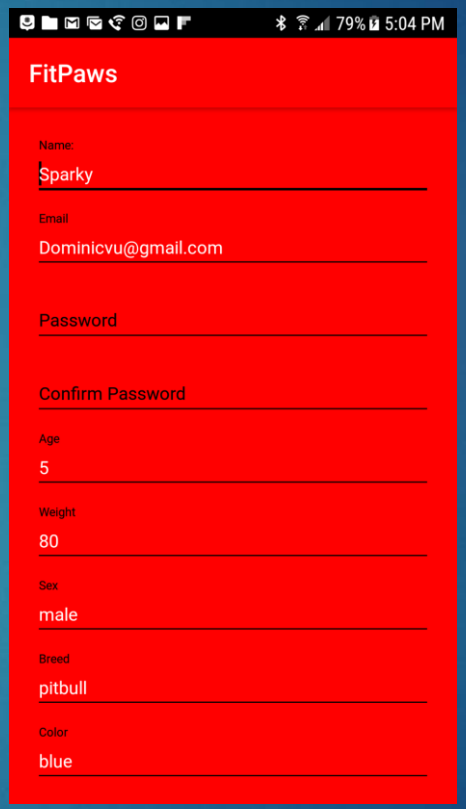




Team Member Design Breakdown

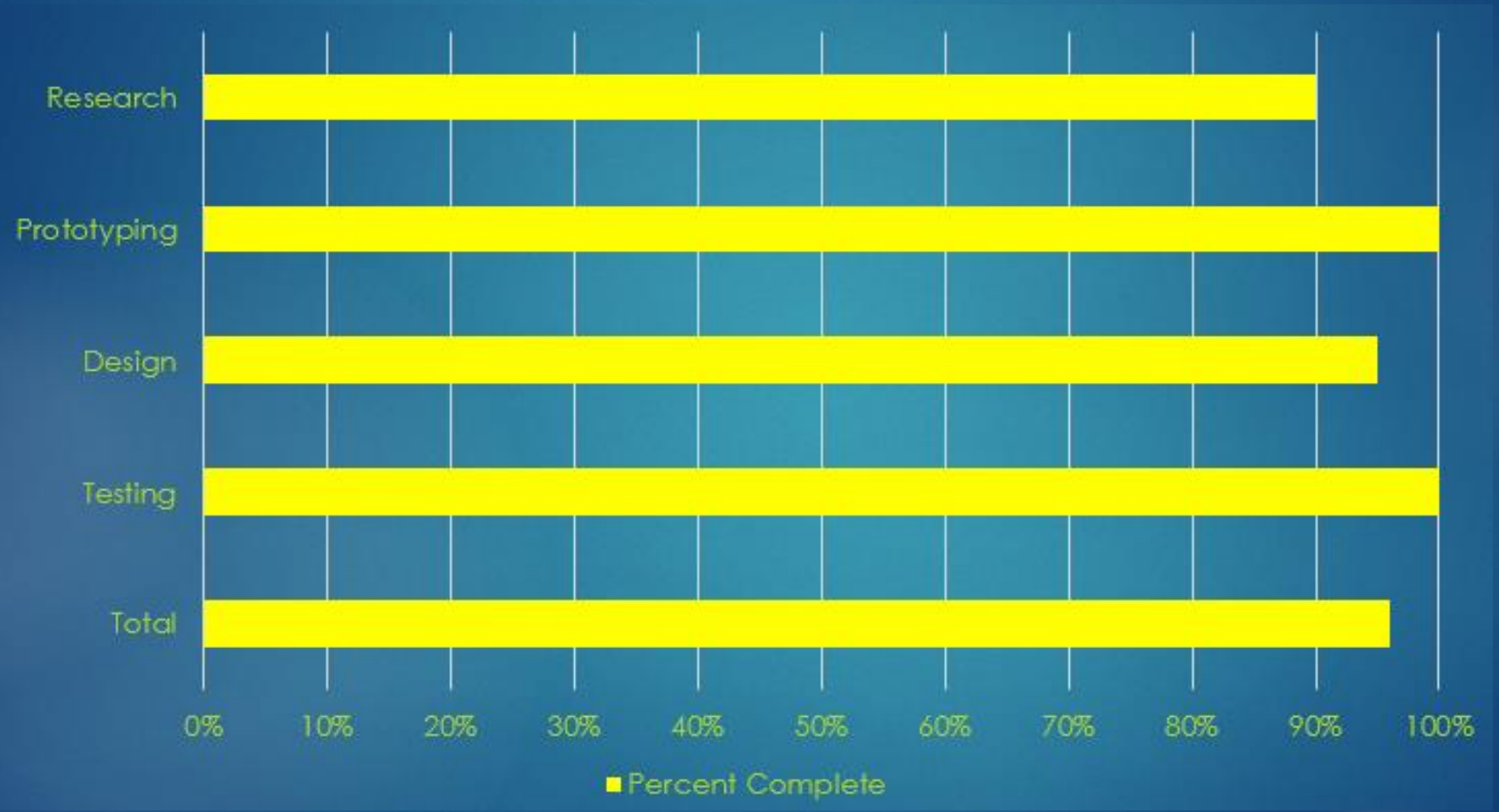
	Design PCB, PCB etching, Soldering	Assembly Coding	Installation PCB to Harness	Software Application	Testing
Dominic Vu			Primary	Primary	Primary
Matthew Horton	Secondary	Primary	Primary		Primary
Hai Nguyen	Primary	Secondary	Secondary	Secondary	Primary

Development Budget

PARTS	WEBSITE	QUANTITY	PRICE			COST PER UNIT
Temperature sensor DS18B20	https://www.amazon.com/ELENKER-Water	5	$11.99	$11.99		$1.92
Bluetooth	https://www.amazon.com/Core51822-Bluet	3	$7.95	$23.85		$6.36
Heartbeat	https://www.walmart.com/ip/Heart-Rate-	3	$5.80	$17.40		$4.64
MCU Arduino Uno	https://www.amazon.com/Arduino-Uno-F	1	$25.00	$25.00		$0.00
Accelerometer	https://www.amazon.com/gp/product/B00SI	3	$8.96	$26.88		$7.17
ATMega328P	https://www.arrow.com/en/products/atmega	2	$2.13	$4.26		$1.71
9V Alkaline Battery	https://www.amazon.com	6	$1.40	$8.40		$1.12
Harness	https://www.amazon.com/dp/B071NSHTG7	1	$23.68	$23.68		$18.95
PCB Circuit Enclosure	Radioshack	1	$12.45	$12.45		$9.96
16MHZ	https://www.amazon.com	10	$0.51	$5.10		$0.41
Diodes	https://www.amazon.com	3	$0.54	$1.62		$0.43
GSM Battery	https://www.amazon.com	2	$20.00	$40.00		$16.00
Buck Converter MP1584EN	https://www.amazon.com	6	$1.62	$9.72		$1.30
GPS + GSM module	https://www.adafruit.com/added	1	$75.80	$75.80		$60.64
GPS Circuit Enclosure	https://www.ebay.com/itm/USA-made-BLA	1	$9.95	$9.95		$7.64
PCB	https://oshpark.com/	3	$11.33	$33.99		$9.06
DevBoard GPS + GSM	Radioshack	1	$2.99	$2.99		$2.39
Testing Subject	Target	1	$29.99	$29.99		$0.00
				0		
				0		
				TOTAL		TOTAL
				$363.07		$149.70

- Each member of the group will contribute ⅓ of the total cost.

Project Progress



Project Issues

- Heart Rate Sensor measurements/stability
  - Inability to test on a dog via UCF
- GPS Implementation
  - Needed 2nd MCU for GPS module
- BLE connectivity with Android Device
- Time constraints on software specifications

Questions?

DEMONSTRATION VIDEO