Nome's Child Safety Seat

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Sponsored By:
The Boeing Company
Evenflo Company
Mark Calabrese
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Kimberly Renk

Contributors and Sponsors

Name / Company	Field of Study / Description
The Boeing Company	Approved Funding
Evenflo Company	Donated Child Car Seats
Mark Calabrese	Sponsor and Customer
Matt Civitello	Physical Therapist
Amy Hesse	Day Care Specialist
Kimberly Renk	Psychological Specialist

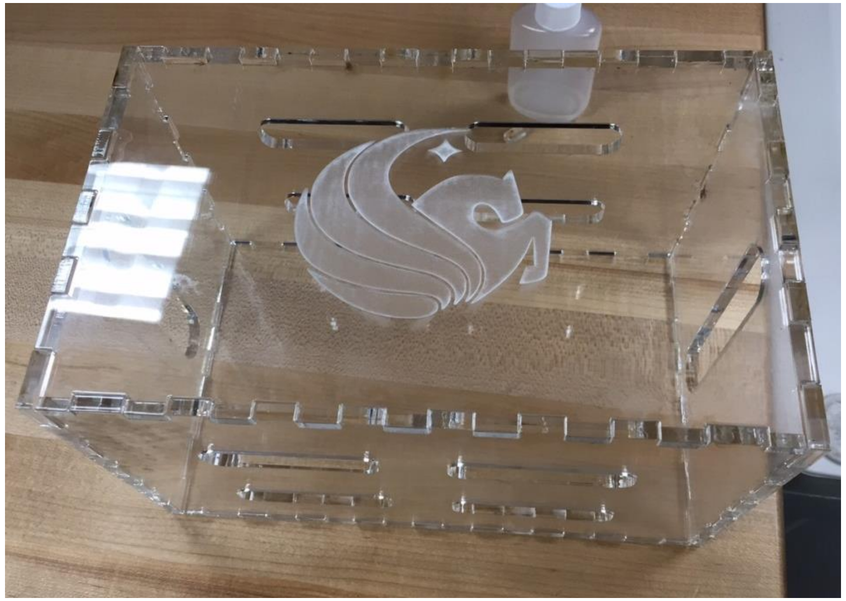
The Problem

- Since 1998 over 700 children have died as a result of being left in their car seats by either someone who will be ‘right back’ or someone who was sleep deprived, stressed out, or in a hurry. That’s about 40 per year.
- A vehicle’s temperature can increase on average by 6.8 degrees (F) per 10 minutes on a hot day.
- The vehicle quickly becomes a deadly environment for anyone locked inside.

- –*NHTSA Child Seat Research.* (n.d.). Retrieved July 20, 2015, from http://www.nhtsa.gov/Research/Child+Seat+Research

The Solution

1: Car Insert



2: Mobile Device

3: Vehicle Interface

Objectives and Goals

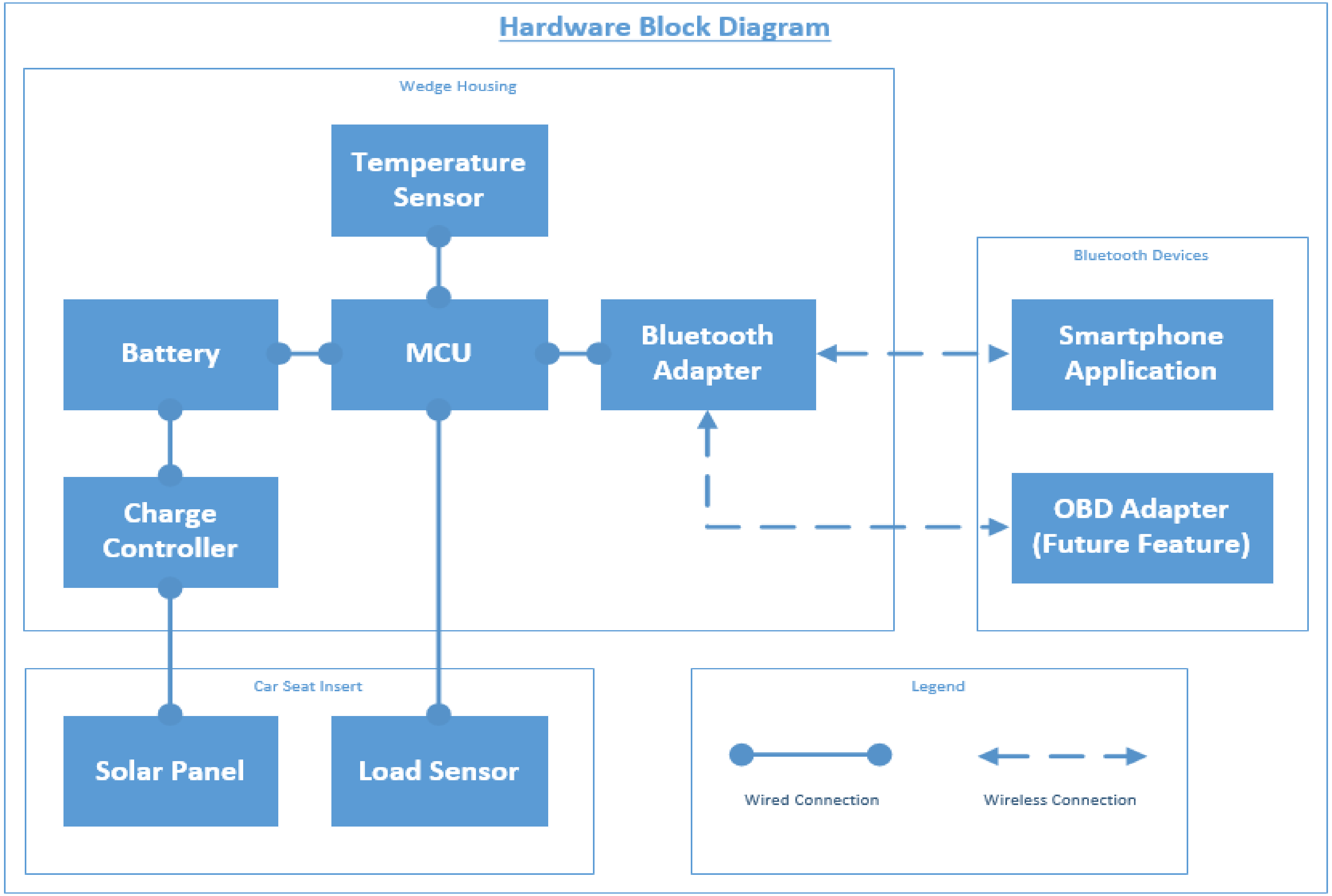
- Create a secure and reliable safety system to prevent the loss of children's lives.
- A mobile insert device that can be quickly and easily installed in multiple vehicles and child car seats.
- A three element alarm system that will alert the owner via their mobile device.
- If no intervention is detected the device will assume control of the vehicle and take actions to change the temperature to a safe range.

Main Specifications

Component	Parameter	Specification
Microcontroller	Power Usage	Maximum of 0.1 A
Bluetooth	Range	Minimum of 3 m Maximum of 10 m
Load Sensor	Sensitivity	Up to 25 lbs
Temperature Sensor	Coverage	0°C– 40°C
Battery	Nominal Voltage	Minimum of 3 V
Solar panel	Power Output	Minimum of 3 V

Hardware

Hardware Block Diagram

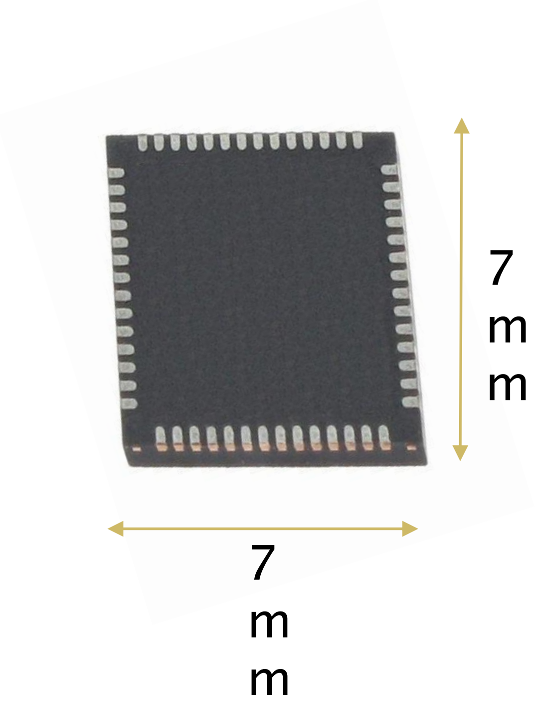


Microcontrollers

	Msp430	Tiva C	AtMega	PSOC4 BLE	NRF51822
Processor	16-bit RISC	Cortex M4	atMega2560	Cortex M0	Cortex M0
Speed	25Mhz	120Mhz	16Mhz	48 Mhz	16 Mhz
Memory	4KB	256KB	256KB	128KB	256KB
Power	2.2 V	0-4V	5V	5V	3.6
Comm Protocol	UART	UART/USB	SPI/Uart/I2C	SPI/I2C/UART/Bluetooth	SPI/I2C/UART/Bluetooth
Low Power State	Yes	Yes	Yes	Yes	Yes

Microcontroller

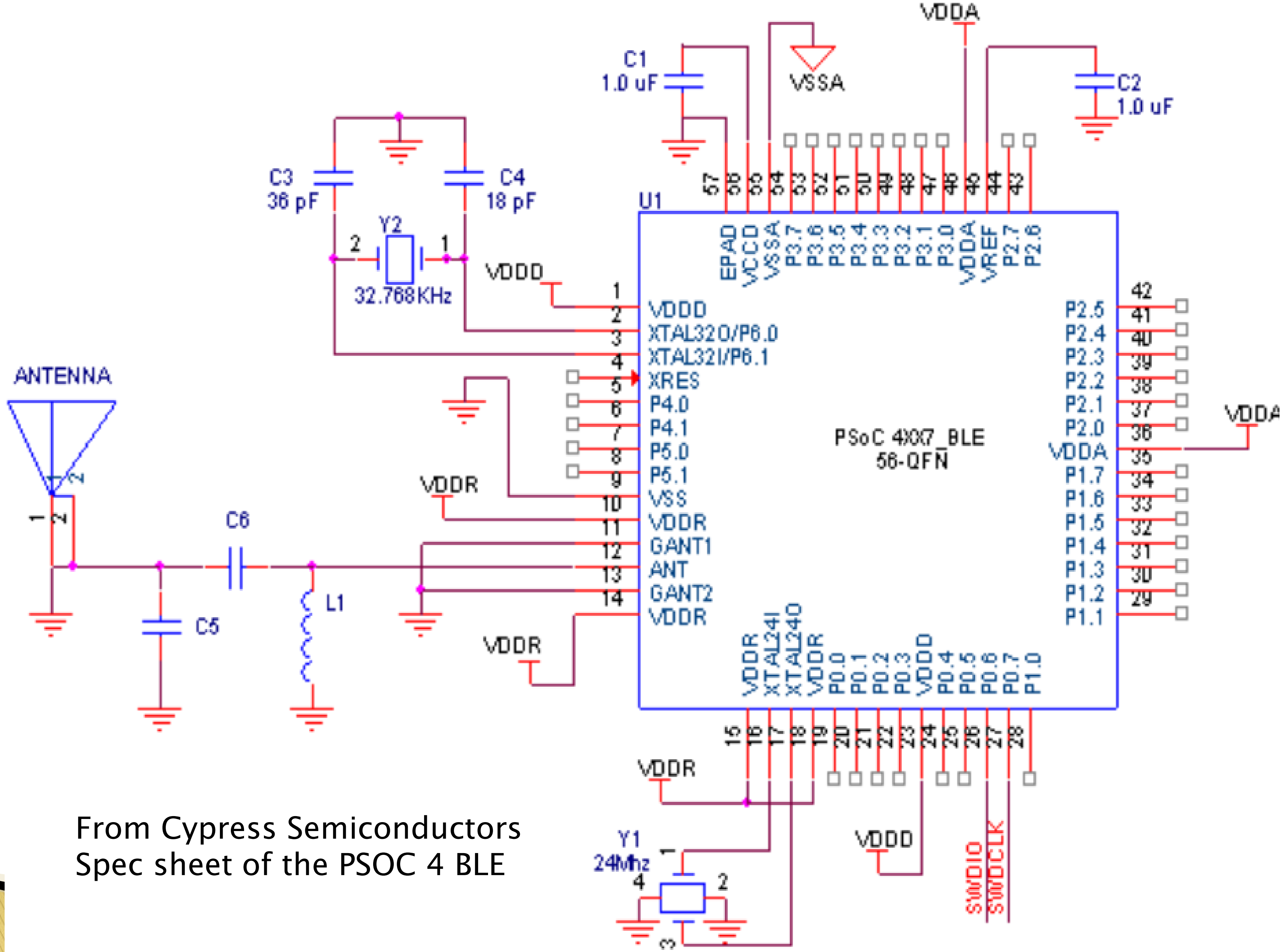
- The Microcontroller we decided to implement in our project is the PSOC 4 BLE (CY8C4247LQI-BL483).
- We chose this because of the low power applications.
- Has a full development board that we can use to test while building and designing the PCB and subsystems.
- Price : $6.53



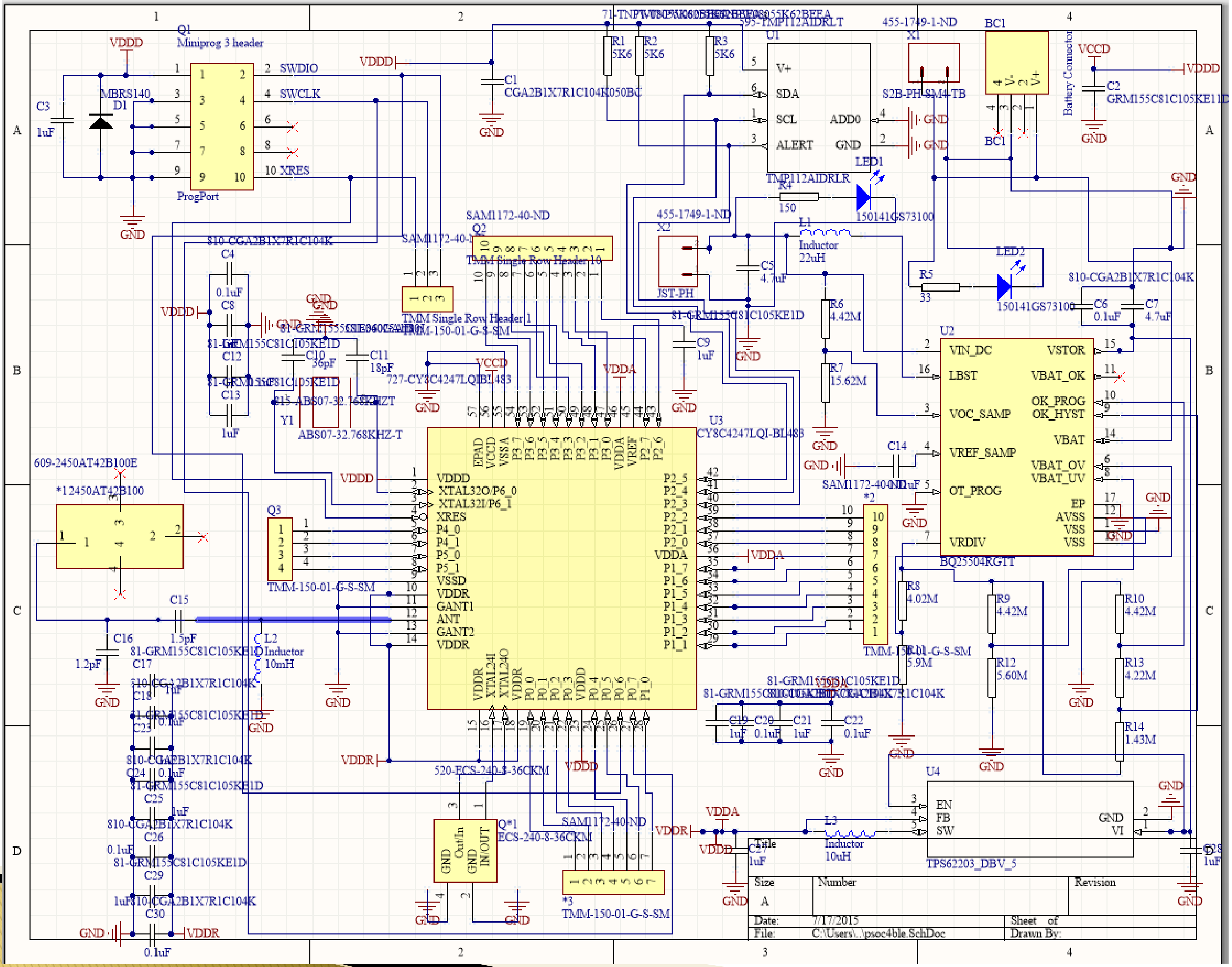
Microcontroller Continued

- Features
  - ARM Cortex M0
    - 48 MHz
  - 128KB Flash Memory
  - 18.7 mA
    - Can go as low as 150 nA in sleep mode
  - 16 KB of SRAM
  - 36 Programmable GPIOs
  - Supports I2C
  - Supports UART

Category	Specification
Dimensions	Maximum 8 x 8 x 4 inches (L x W x H)
Power Usage	Maximum of 0.1 A
Power States	Normal and Low Power
Processor Speed	Minimum of 8 MHz
RAM Memory	Minimum of 128 KB
ROM Memory	Minimum of 4 KB



From Cypress Semiconductors
Spec sheet of the PSOC 4 BLE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Miniprog 3 header
VDDD
SWDIO
SWCLK
XRES
MBRS140
D1
C3
1uF
ProgPort
GND
C1
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R1
5K6
R2
5K6
R3
5K6
U1
595-TMP112AIDRLT
V+
SDA
SCL
ALERT
ADD0
GND
TMP112AIDRLR
455-1749-1-ND
X1
S2B-PH-SM4-TB
BC1
Battery Connector
VCCD
C2
GRM155C81C105KE11D
LED1
R4
150
150141GS73100
SAM1172-40-ND
Q2
TMM Single Row Header 10
TMM Single Row Header 1
TMM-150-01-G-S-SM
X2
JST-PH
C5
4.7uF
L1
Inductor
22uH
R5
33
LED2
810-CGA2B1X7R1C104K
C6
0.1uF
C7
4.7uF
R6
4.42M
R7
15.62M
C9
1uF
U2
VIN_DC
LBST
VOC_SAMP
VREF_SAMP
OT_PROG
VRDIV
VSTOR
VBAT_OK
OK_PROG
OK_HYST
VBAT
VBAT_OV
VBAT_UV
EP
AVSS
VSS
BQ25504RGTT
C14
C4
0.1uF
C8
C10
36pF
C11
18pF
C12
C13
1uF
Y1
ABS07-32.768KHZ-T
815-ABS07-32.768KHZ-T
727-CY8C4247LQI-BL483
VCCD
VDDA
U3
CY8C4247LQI-BL483
VDDD
XTAL32O/P6_0
XTAL32I/P6_1
XRES
P4_0
P4_1
P5_0
P5_1
VSSD
VDDR
GANT1
ANT
GANT2
VDDR
EPAD
VCCD
VSSA
P3_7
P3_6
P3_5
P3_4
P3_3
P3_2
P3_1
P3_0
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VREF
P2_7
P2_6
P2_5
P2_4
P2_3
P2_2
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P2_0
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P1_4
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XTAL24O
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P0_2
P0_3
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P0_4
P0_5
P0_6
P0_7
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*1 2450AT42B100
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C16
1.2pF
C17
L2
Inductor
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C23
C24
C25
C26
C29
C30
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1uF
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Q*1
ECS-240-8-36CKM
GND
Out/In
IN/OUT
SAM1172-40-ND
*3
*2
R8
4.02M
R9
4.42M
R10
4.42M
R11
5.9M
R12
5.60M
R13
4.22M
R14
1.43M
C19
C20
C21
C22
U4
EN
FB
SW
VI
TPS62203_DBV_5
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Inductor
10uH
C27
C28
Title
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Drawn By:

Bluetooth

- We will be using Bluetooth to connect our system with the vehicle interface in order to control the vehicles air conditioner and windows.
- Bluetooth will also be used to determine when the user is too far away from the child safety seat.
  - This will allow us to notify the user that the child is left in the seat if all to proper conditions are met.
- Features
  - 2.4 GHz RF transmitter with 50 Ω antenna drive
  - Use about 16 mA while Bluetooth device is on

Why Load Sensor?

VS

VS

Load

Infrared

RFID

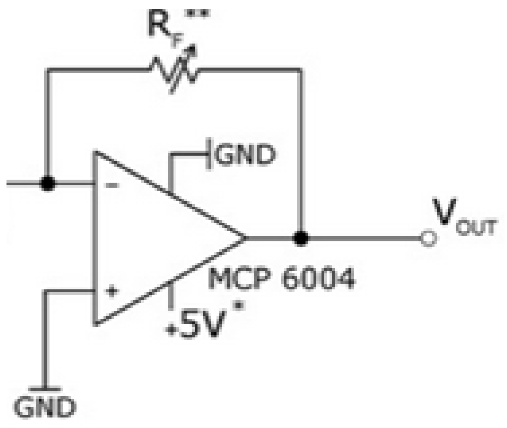
Load Sensor

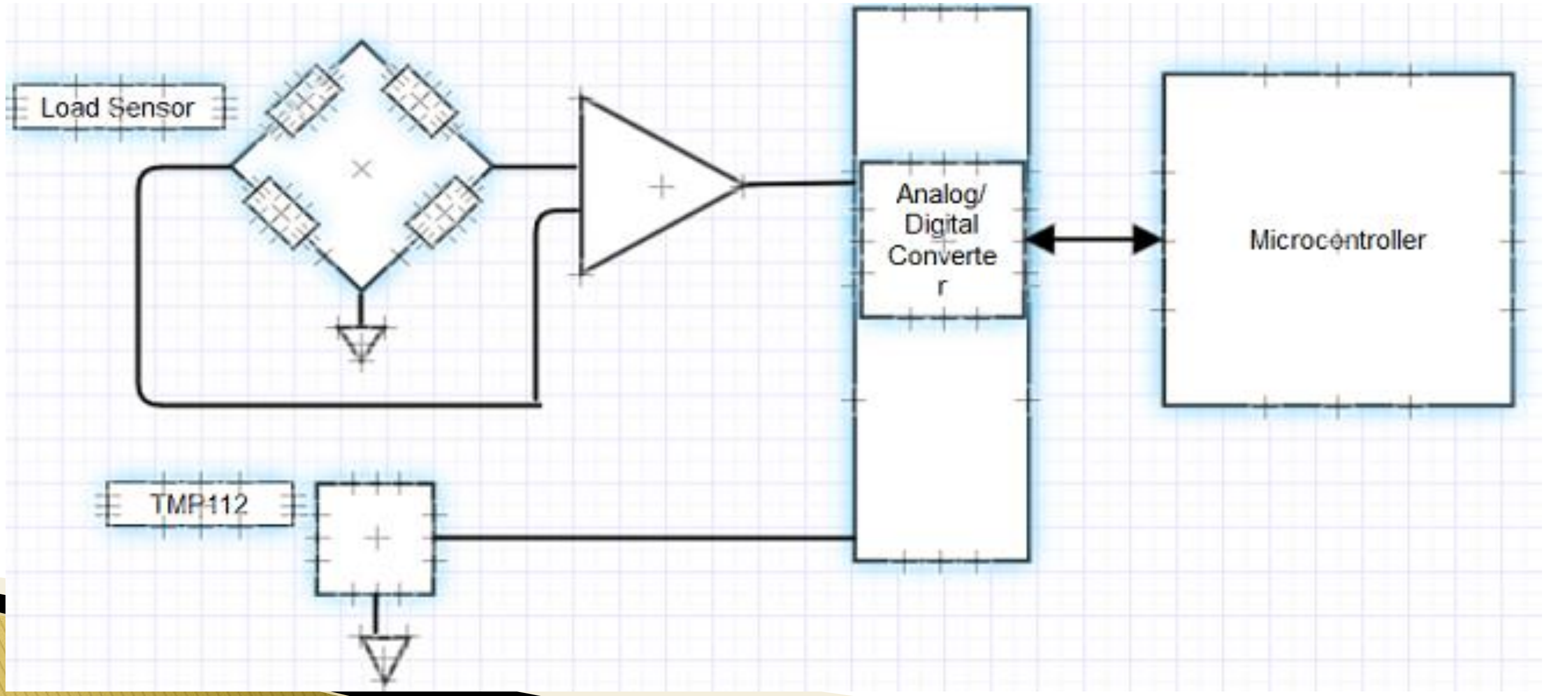
- Flexiforce pressure sensor
- ranges from 0-25lbs
  - 5 microseconds response time
- ±3% linearity error for the volt per force from a 0 to 50% load
- Force reading of sensor changes .36% per degree of temperature
- 1 inch diameter head

Condition	Details
1	Be able to sense weights from 0- 25 lbs
2	Compact and flexible Size to fit the seat lining
3	Cost effective

Load Sensor Continued

- Supply Voltages has to be constant
- Sensor Resistance R_s with on load > 5MΩ
- Max Current 2.5 mA





Temperature Sensor Comparisons

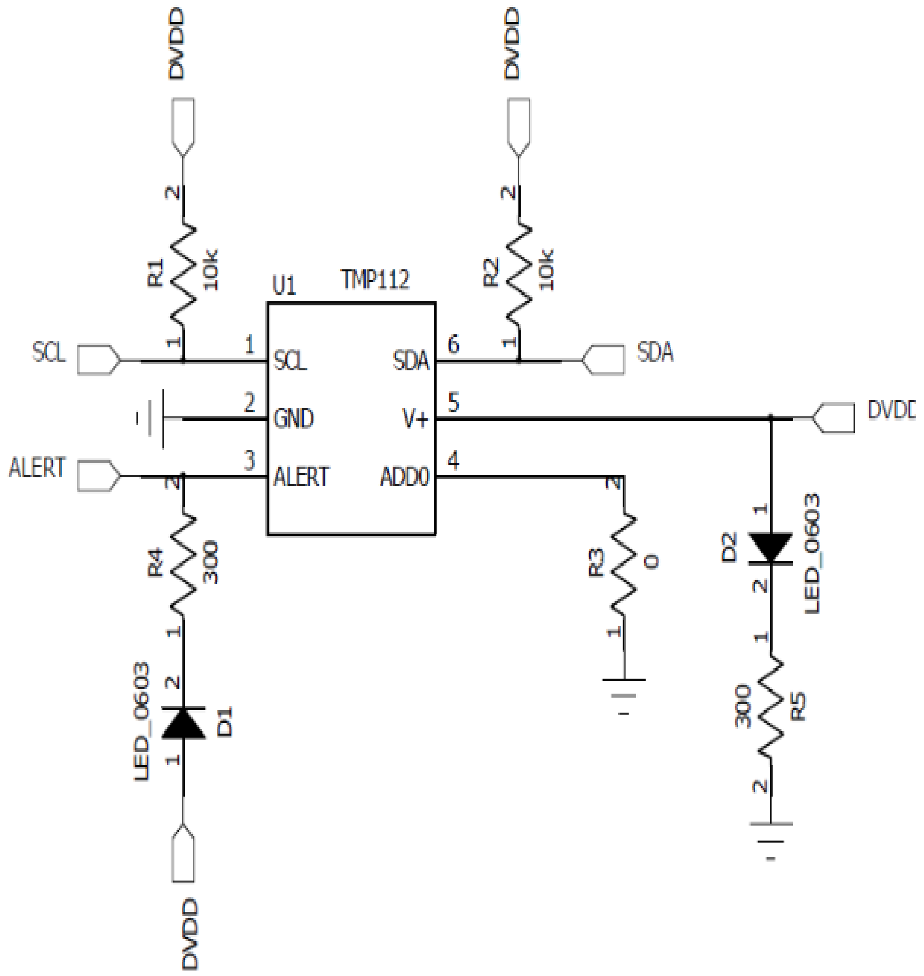
	LM 35	TMP112	MAX1617
Operating Temperature	−55°C to +150° C	−40°C to +125°C	−55°C to +125°C
Output Interface (Digital/Analog)	Analog Output	Digital Output: SMBus, Two-Wire and IC Interface Compatibility	Digital Output: SMBus, Two-Wire Serial Interface
Supply Range (VDD Range)	1V to 6V	1.4V to 3.6V	3V to 5.5V
Temperature Accuracy	± .2°C	±.5°C	±2°C

Temperature Sensor

Specification	Value
Measurement	Temperature (°C)
Accuracy	± 3°C
Total Lifespan	5 years
Max Operating Voltage	5 V
Max Operating Current	10 mA
Temperature Range	0°C– 40°C

Temperature Sensor Continued

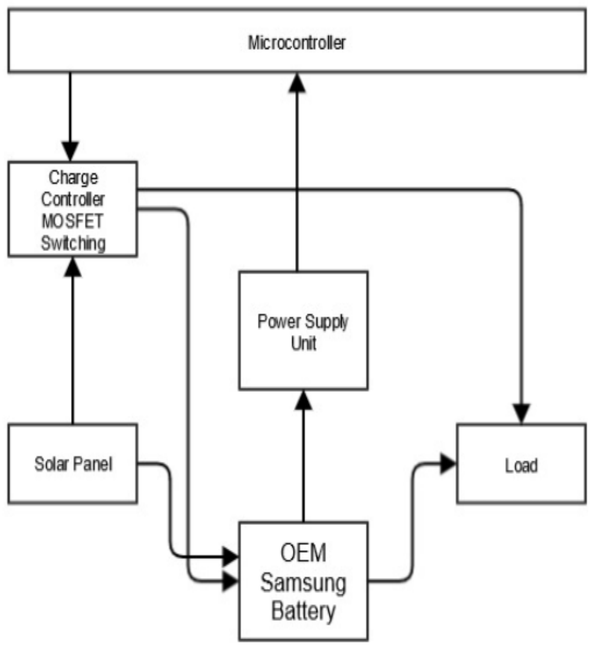
- Texas Instruments TMP112
- Operates between 40 to 125°C
- uses a SMBus
  - Two-wire and IC compatibility
- Accuracy from ±.5°C to ±.17°C
- The TMP112 has a chance of increased temperature error at low and high temperatures causing the output voltage vs Temperature to saturate due to the low resolution to detect the change in output voltage per degree Celsius



From Texas Instruments Spec Sheet

Power System Overview

- Once the system is active from load sensor the microcontroller communicates with the charge controller for state of charge of battery.
- The charge controller will check to make sure the battery is above 20% power capacity threshold and will charge the battery via the solar panel.
- The battery will power the MCU and loads of the temperature sensor and load sensor

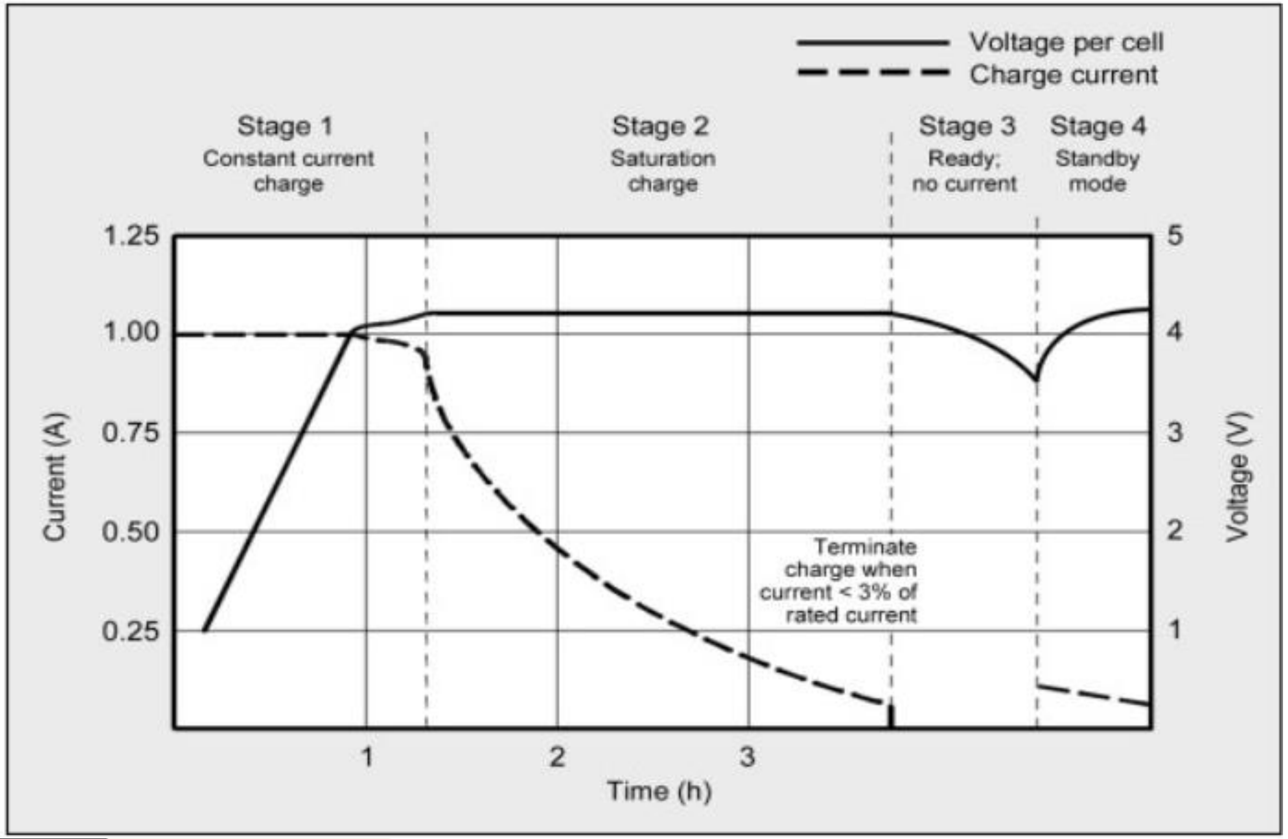


Battery Sensor Comparison

	APC RBC35	WKA12-8F2	DURA6-10F	LIP 1522
Weight	2.9 lbs	5.6 lbs	3.9 lbs	1.5 lbs
Voltage/Amp Hours	12V/3.5AH	12V/8AH	6V/10AH	3.7/1000 mAh
Time to Charge	11.45 hours	12.25 hours	12.5 hours	6 hours
Product Dimensions	2.6 x 2.28 x 5.28 inches	8.5 x 6 x 2.3 inches	8.5 x 7 x 3.3 inches	2.11 x 1.35 x .32 inches

Lithium Ion Battery

- High Power density and low self discharge
- No memory effect also known as voltage depression.
- High Charge Efficiency(80-90%)
- 3.7V
- 1750 mAh



Solar Panel Specifications

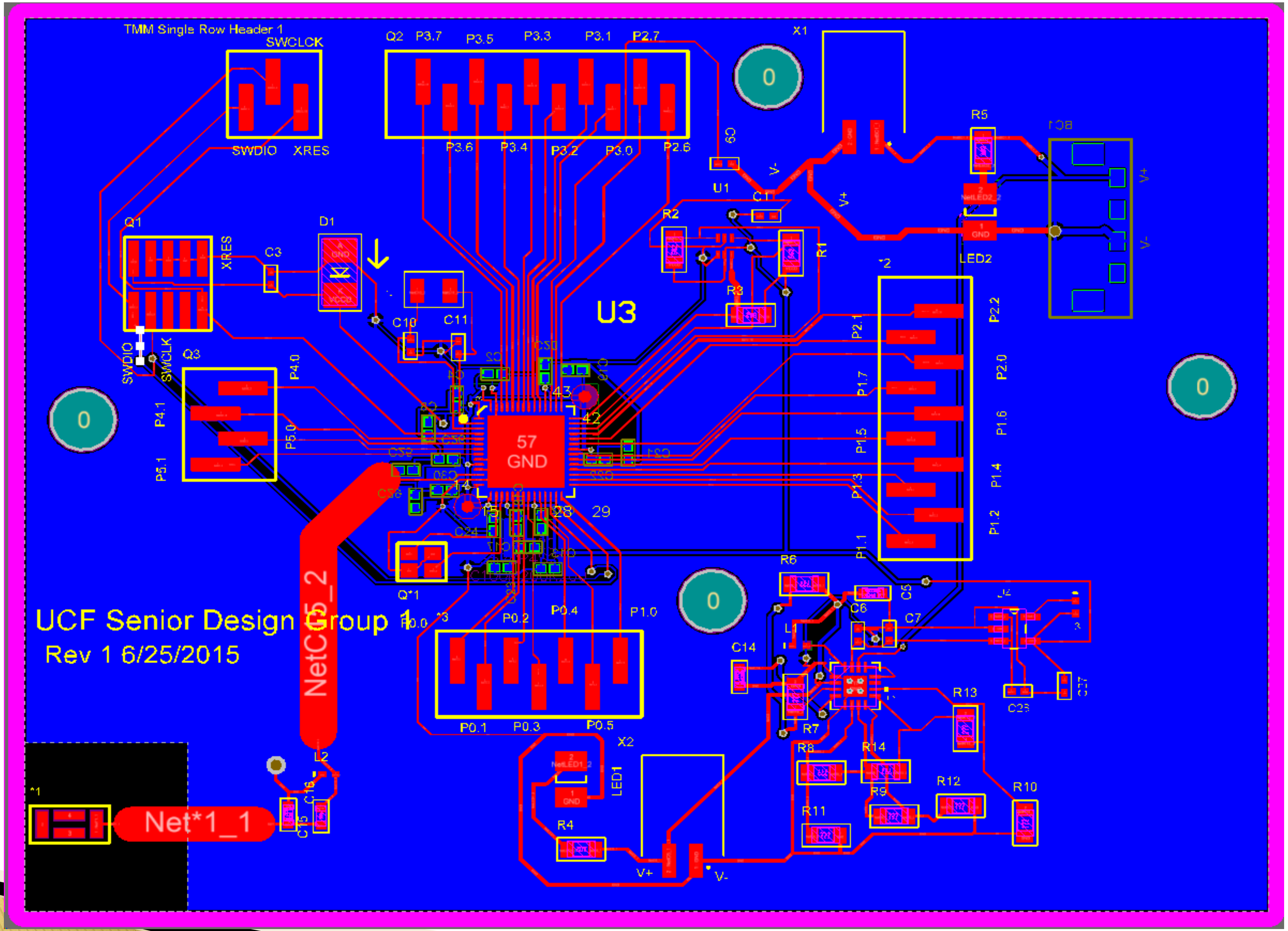
- Peak Power Voltage: 6V
- Peak Power Current: 100mA
- VOC: 7.2V
- ISC: 110mA
- Dimensions: 100 mm(3.94 in) diameter
- Weight: 1.3 lbs.
- Allows for a charge time of 6 hours on 3.7V battery.

Solar Panel

- No light Induced degradation
- Designed to charge 3.6V to 4.2V batteries
- Lightweight
- Easy to install
- Cost effective

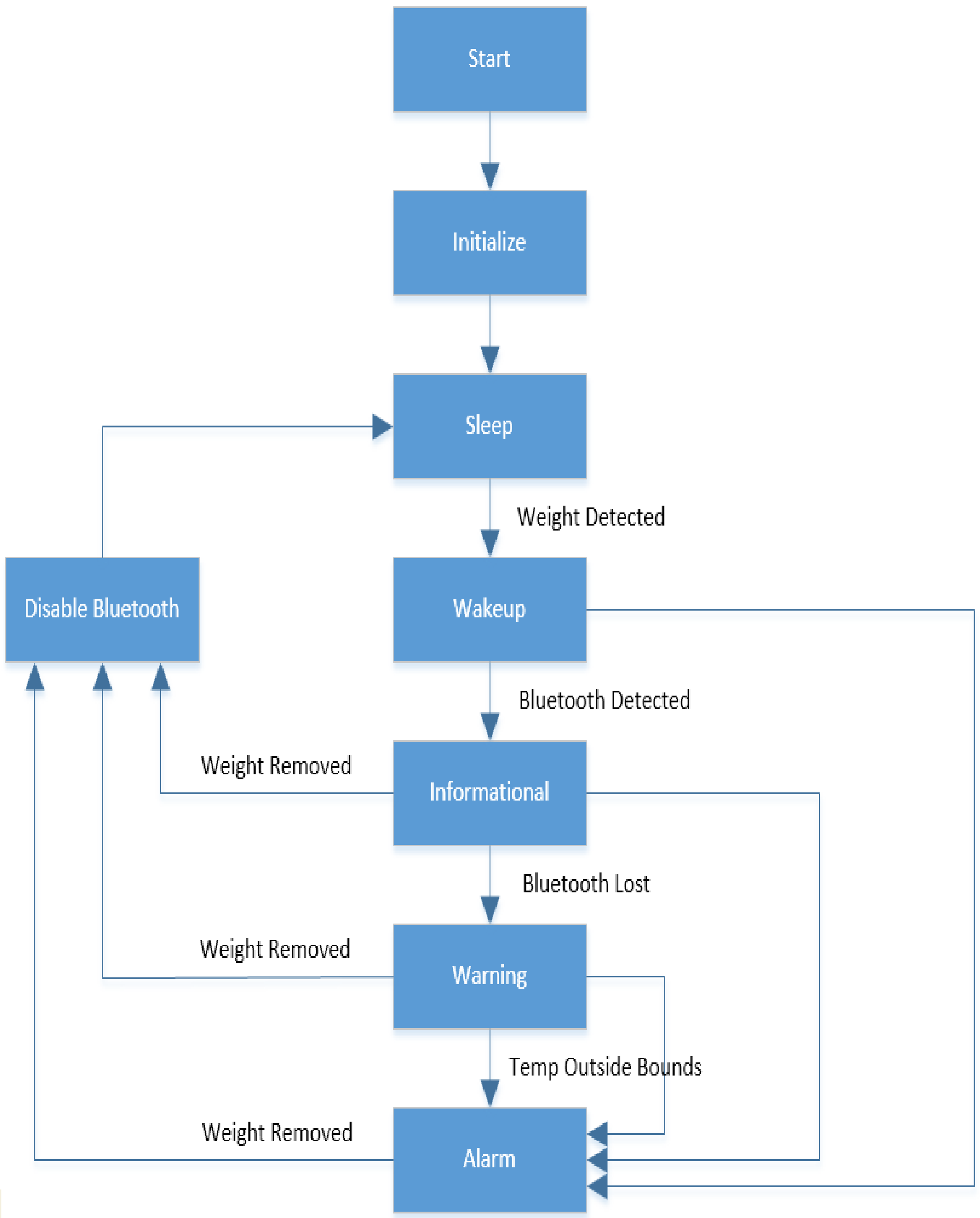
Voltage <= .74V	The micro controller will determine the system is in a short circuit condition and the load is disconnected immediately to begin charging of the battery via the solar panel.
Voltage <1V	The micro controller turns on the battery charging and the load is disconnected until a charge of 2.96 V is reached to extend the batteries life cycle
Voltage > 3.7V	The battery is now in the overcharging state and the micro controller will turn off the battery charging between the solar panel and battery via the charge controller.
Voltage >= 2.96V	The battery is above the 80% threshold of charge capacity and will charge slowly until the optimal 3.7V is reached or comes close to it.

PCB Creation

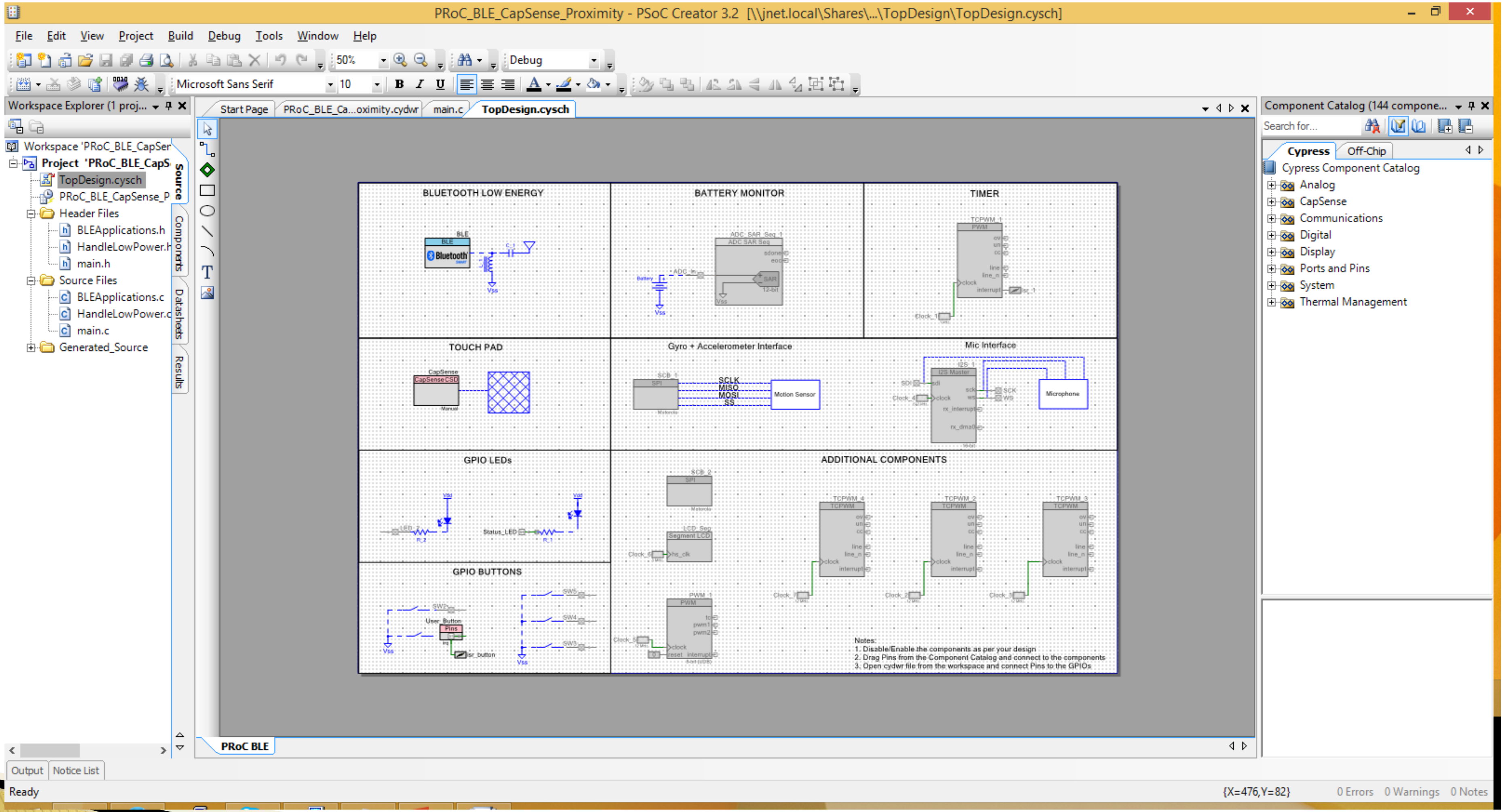


Software

Software States



Software Development

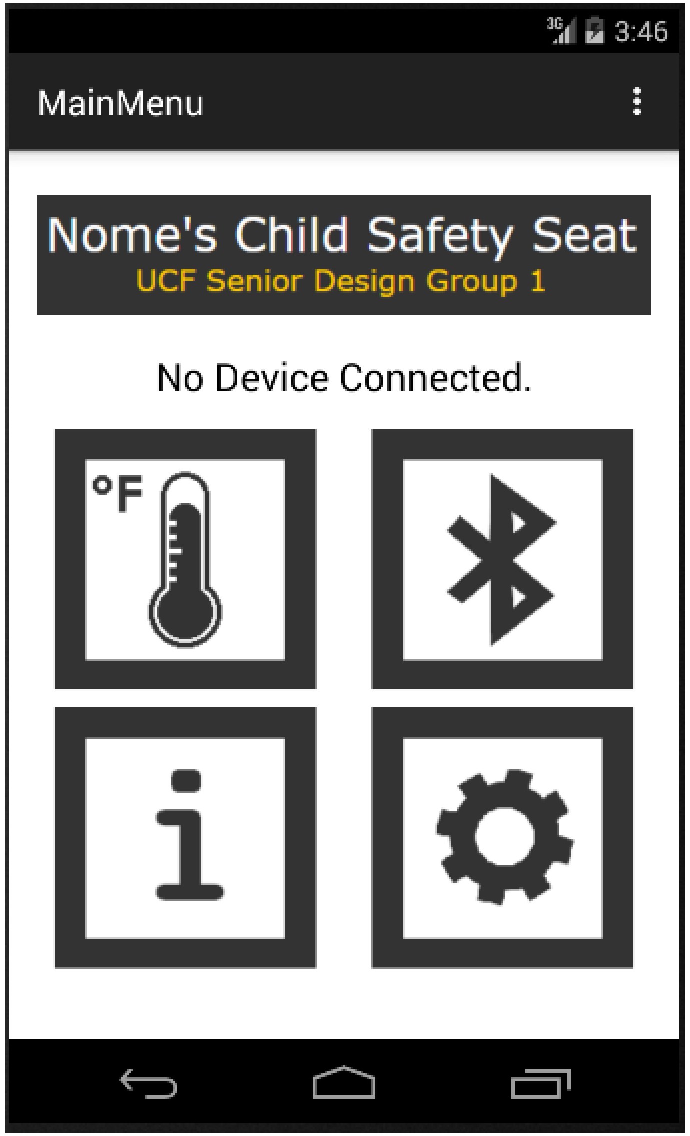


Android Application

Details	
Environment	Android Studio
Version	API 15: Android 4.0.3 (IceCreamSandwich)
Accessibility	Applies to 90.4% of devices active on the Google Play Store

Application Features

- Main interaction device
- Easily configured to the device
- Trigger for the alarms
- Learn about safe temperatures



Administrative Content

Work Distribution

Name	PCB Design	Part Comparisons	MCU Programming	Android Application	Testing
Matt Bivona	+	–			+
Michael Covitt			–	+	–
Jason Nagin			+	–	+
Donnell Robinson	–	+			–
+ Primary			– Secondary		

Budget and Financing

Description	Component Name/Number	Quantity	Unit Price (USD)	Subtotal Price (USD)
Microcontroller with BLE	CY8CKIT-042-BLE	2	48.88	97.76
Battery	GT-i9250 EB-L1F2HVU	1	14.87	14.87
Battery Charger	BQ25504	1	5.51	5.51
Temperature Sensor	TMP112	1	3.12	3.12
Load Sensor	Flexiforce 25 Pounds	1	21.95	21.95
Solar Panels	6.0V 100MA Round Solar Cell	2	7.95	15.9
LED	LTST-C191KGKT	3	0.3	0.9
Pair Button	D6R90 F2 LFS	1	1.09	1.09
OBD Link	OBDLink MX Bluetooth	1	100.91	100.91
Voltage Regulator	TPS62203	1	1.9	1.9
PCB	Printed Circuit Board	3	10.00	30.00
Board Components	Wires, Connectors, etc.	3	45.06	135.02
			Total Cost:	**428.93**

Estimated Single Unit Cost

Component	Quantity	Price	Sub Total
Bluetooth LE Adapter	1	5.99	5.99
Battery	1	14.87	14.87
Battery Charger	1	5.51	5.51
Temperature Sensor	1	3.12	3.12
Load Sensor	1	21.95	21.95
Solar Panels	2	7.95	15.9
LED	3	0.3	0.9
Pair Button	1	1.09	1.09
OBD Link	1	100.91	100.91
Voltage Regulator	1	1.9	1.9
Circuit Board	1	10	10
Board Components	1	15	15
	-	**Total Cost**	**197.14**

Issues

1. No legitimate way to test cold temperature triggers
2. No Ford and GM vehicle’s unencrypted available.
   - Team had to replicate a car
3. Wedge was found to be illegal past a certain height
   - Team decided to attach a box to the back

Questions?

Demonstration