# Nome's Child Safety Seat

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Sponsored By:
The Boeing Company
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# Contributors and Sponsors

| Name / Company | Field of Study / Description |
|---|---|
| The Boeing Company | Approved Funding |
| Mark Calabrese | Customer and Technical Advisor |
| 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.

# The Solution

1: Car Insert


2: Car Wedge

3: Mobile Device

4: Vehicle Interface

# Objectives and Goals

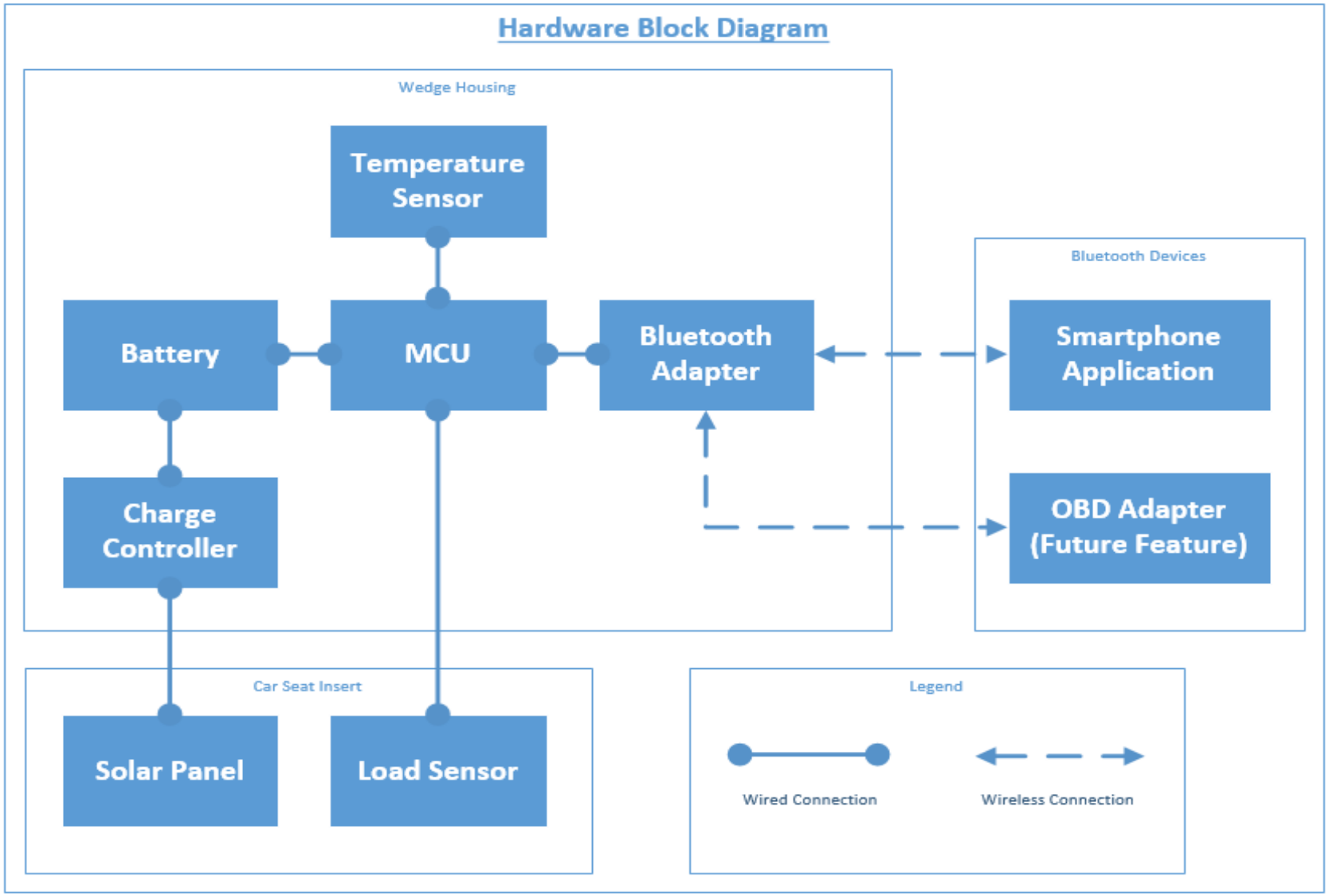
- Create a secure and reliable safety system to prevent the loss of children's lives.
- A mobile insert device that can be quickly and easily installed in multiple vehicles and child car seats.
- A three stage alarm system that will alert the owner via their mobile device.
- If no intervention is detected 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<br>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 |

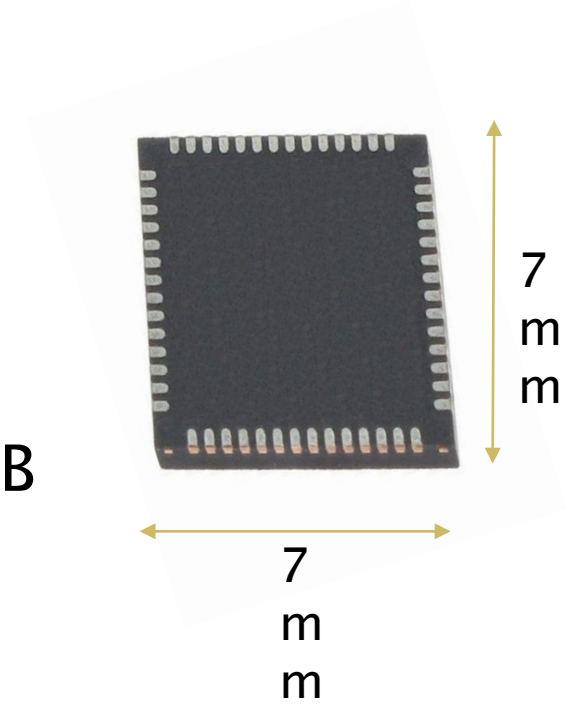
# Hardware

# Hardware Block Diagram



# Microcontroller

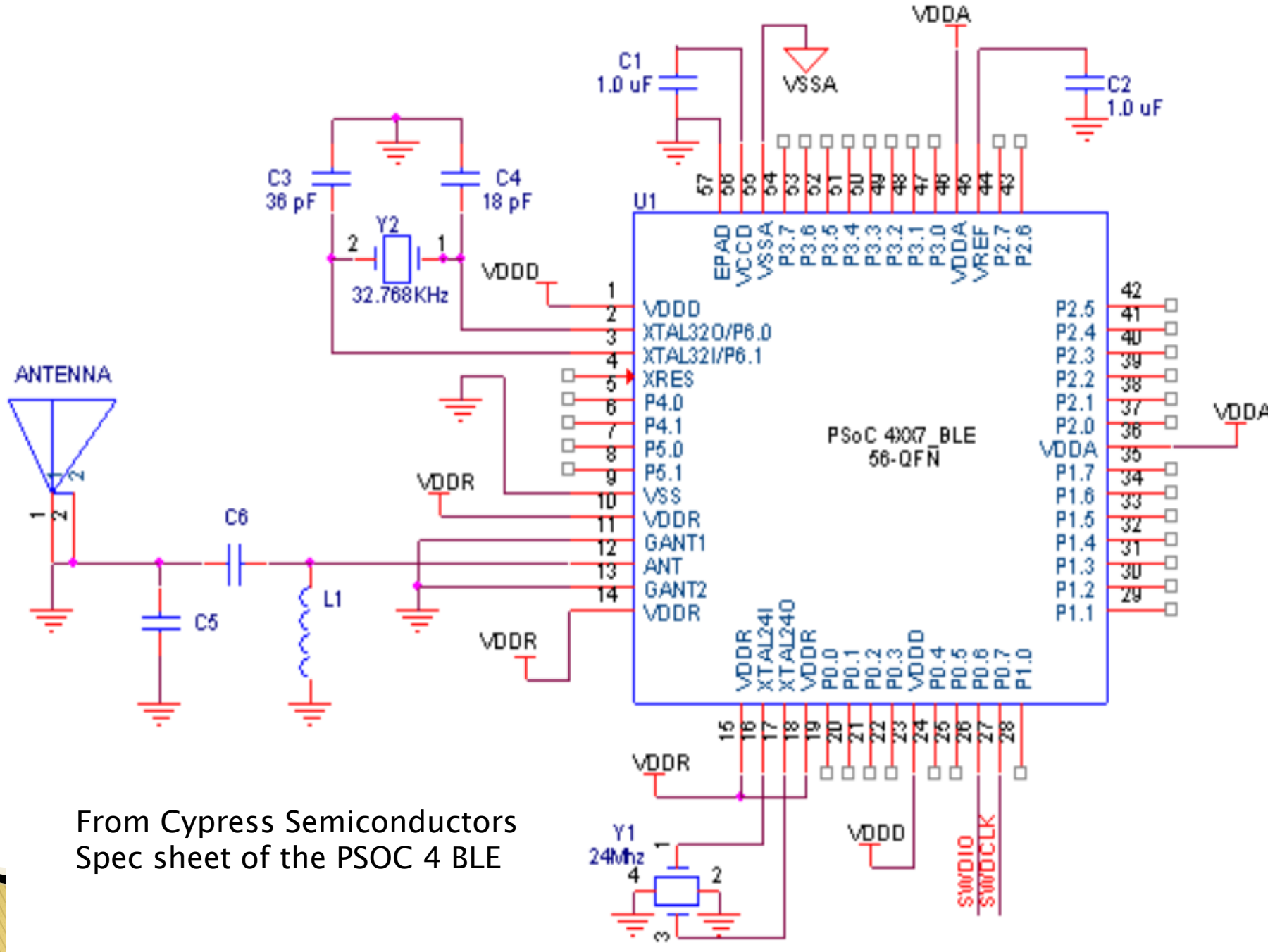
- The Microcontroller we decided to implement in our project is the PSOC 4 BLE.
- We chose this because of the low power applications.
- Has a full development board that we can use to test while building and designing the PCB and subsystems.



# Microcontroller Continued

- Features
  - ARM Cortex M0
    - 48 MHz
  - 128KB Flash Memory
  - 18.7 mA
    - Can go as low as 150 nA
  - 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

# Bluetooth

- We will be using Bluetooth to connect our system with the OBD link 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

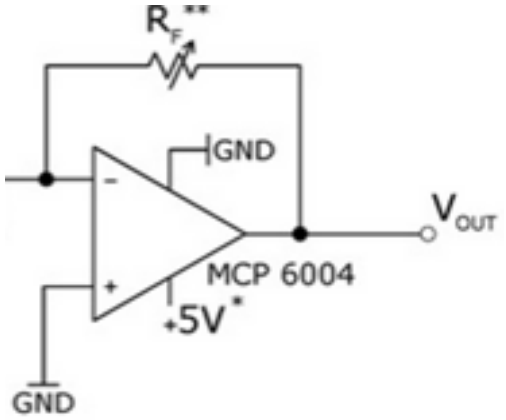
# Load Sensor

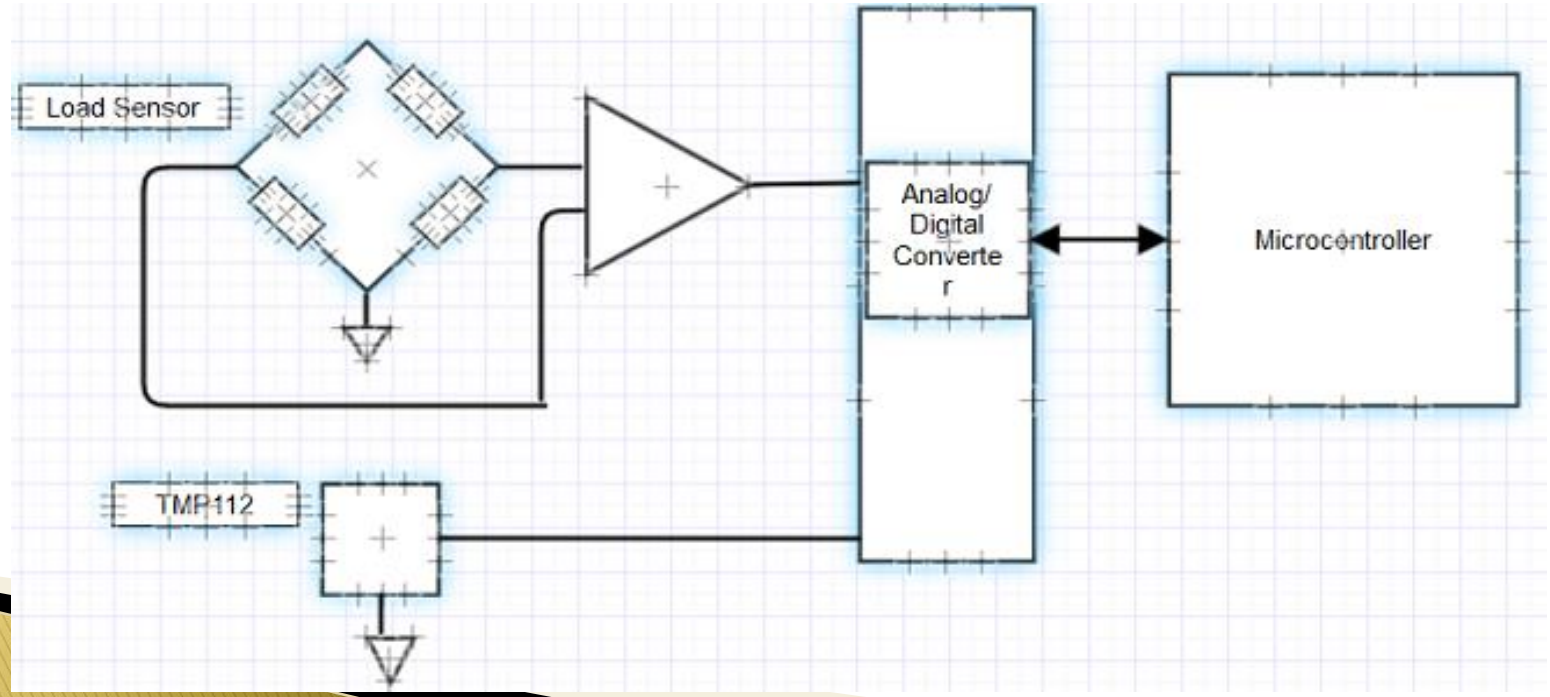
- Flexiforce pressure sensor
- ranges from 0-25lbs
  - 5 microseconds response time
- ±3% linearity error for the volt per force from a 0 to 50% load
- Force reading of sensor changes .36% per degree of temperature
- 1 inch diameter head

| 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



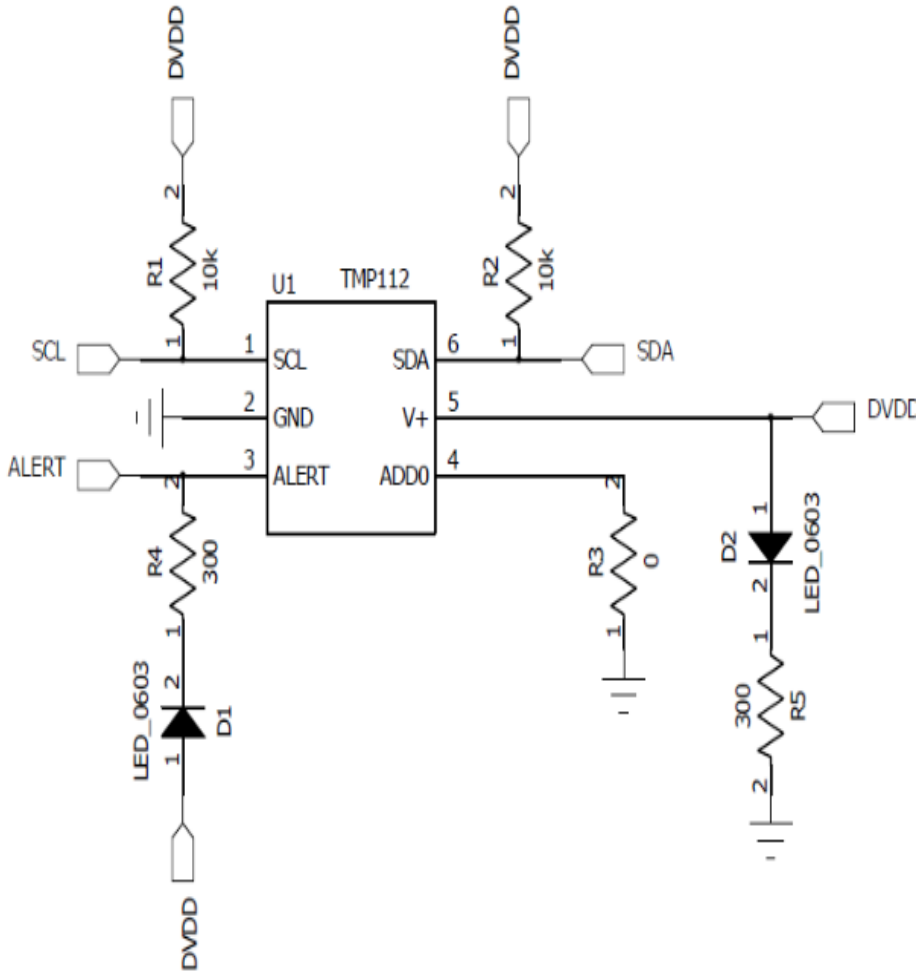



# Temperature Sensor

| 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

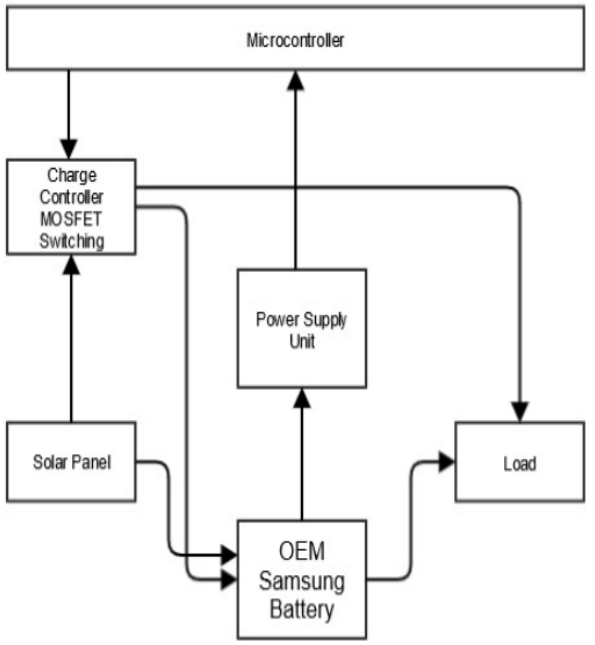
- Texas Instruments TMP112
- Operates between 40 to 125°C
- uses a SMBus
  - Two-wire and IC compatibility
- Accuracy from ±.5°C to ±.17°C
- The TMP112 has a chance of increased temperature error at low and high temperatures causing the output voltage vs Temperature to saturate due to the low resolution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




From Texas Instruments Spec Sheet

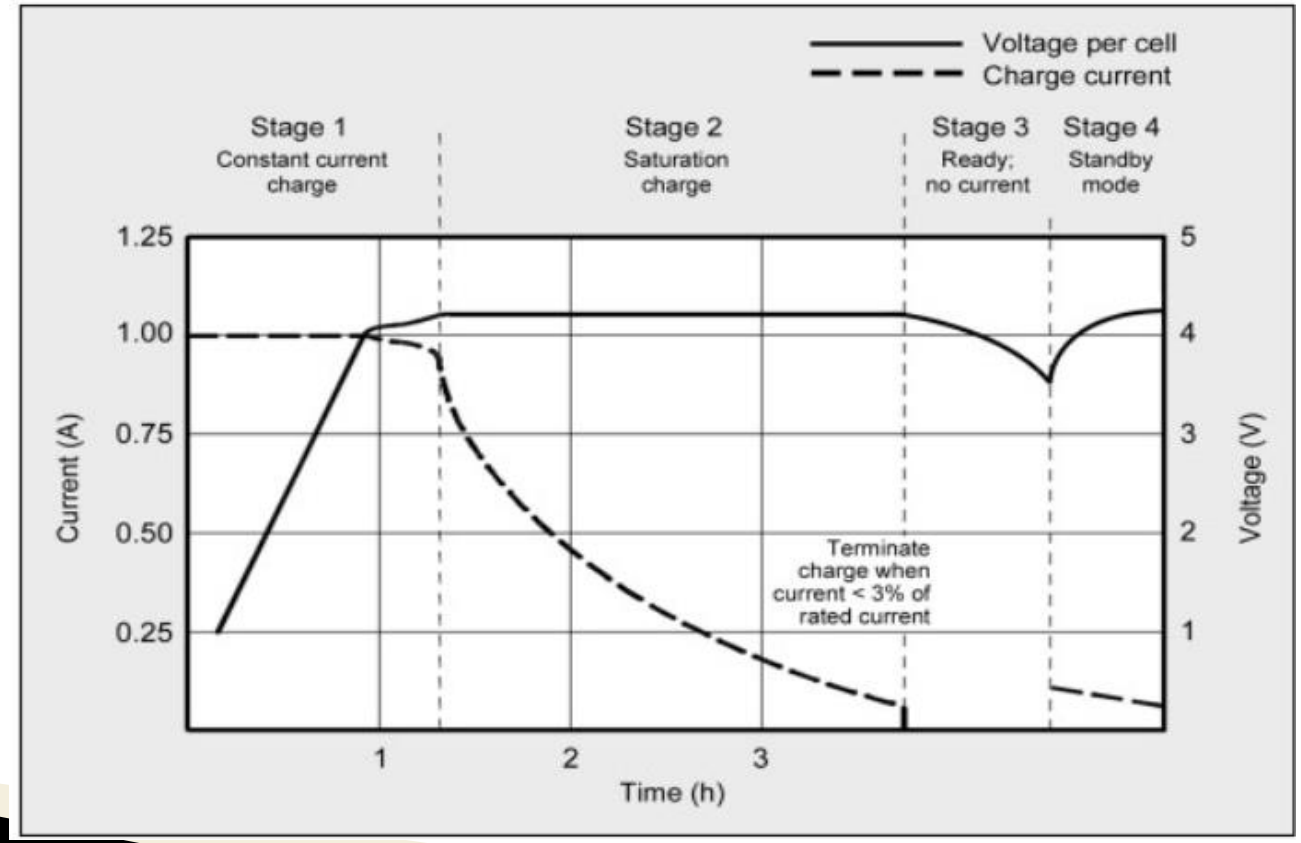
# Power System Overview

- 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



# 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



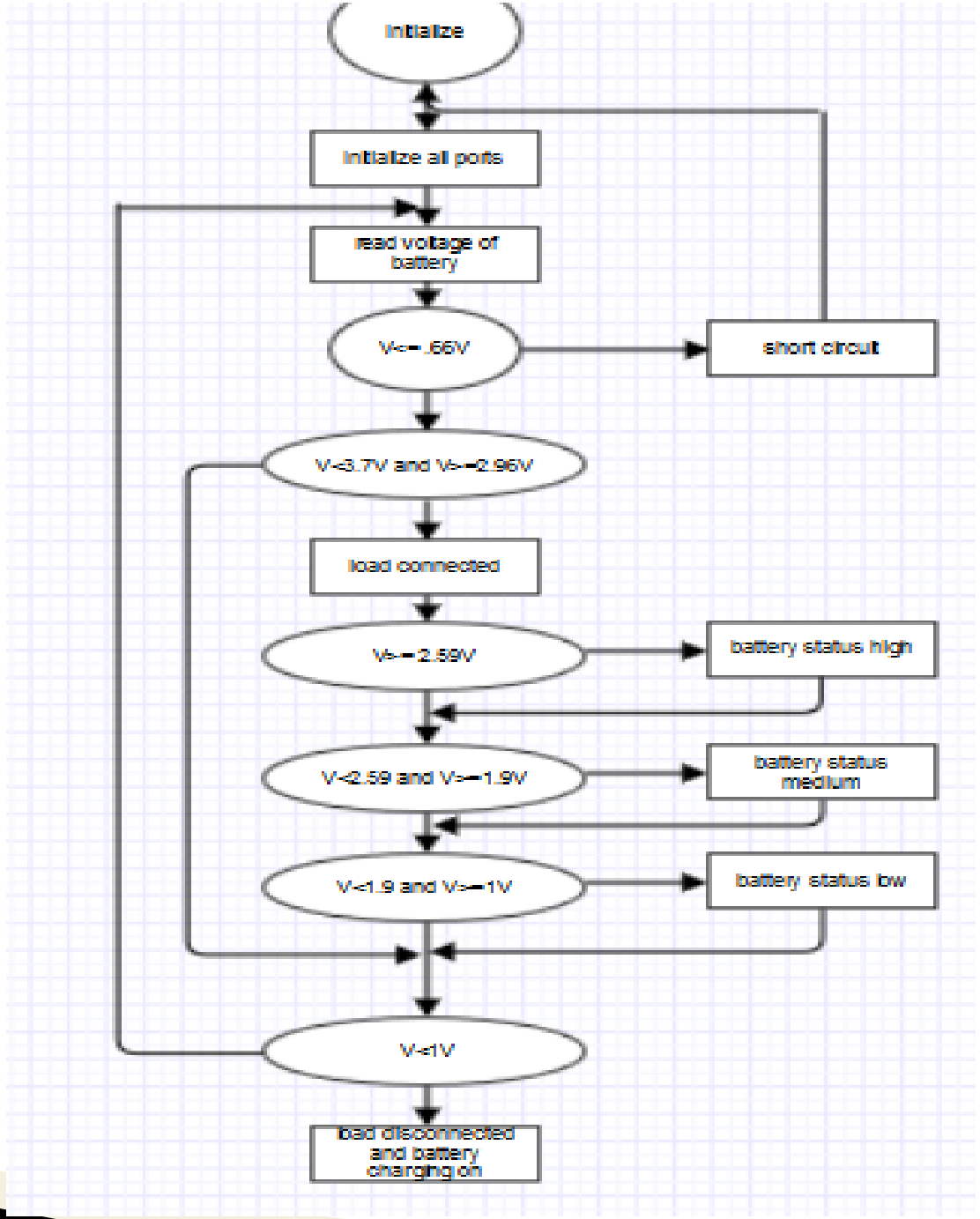
# Solar Panel Specifications

- 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

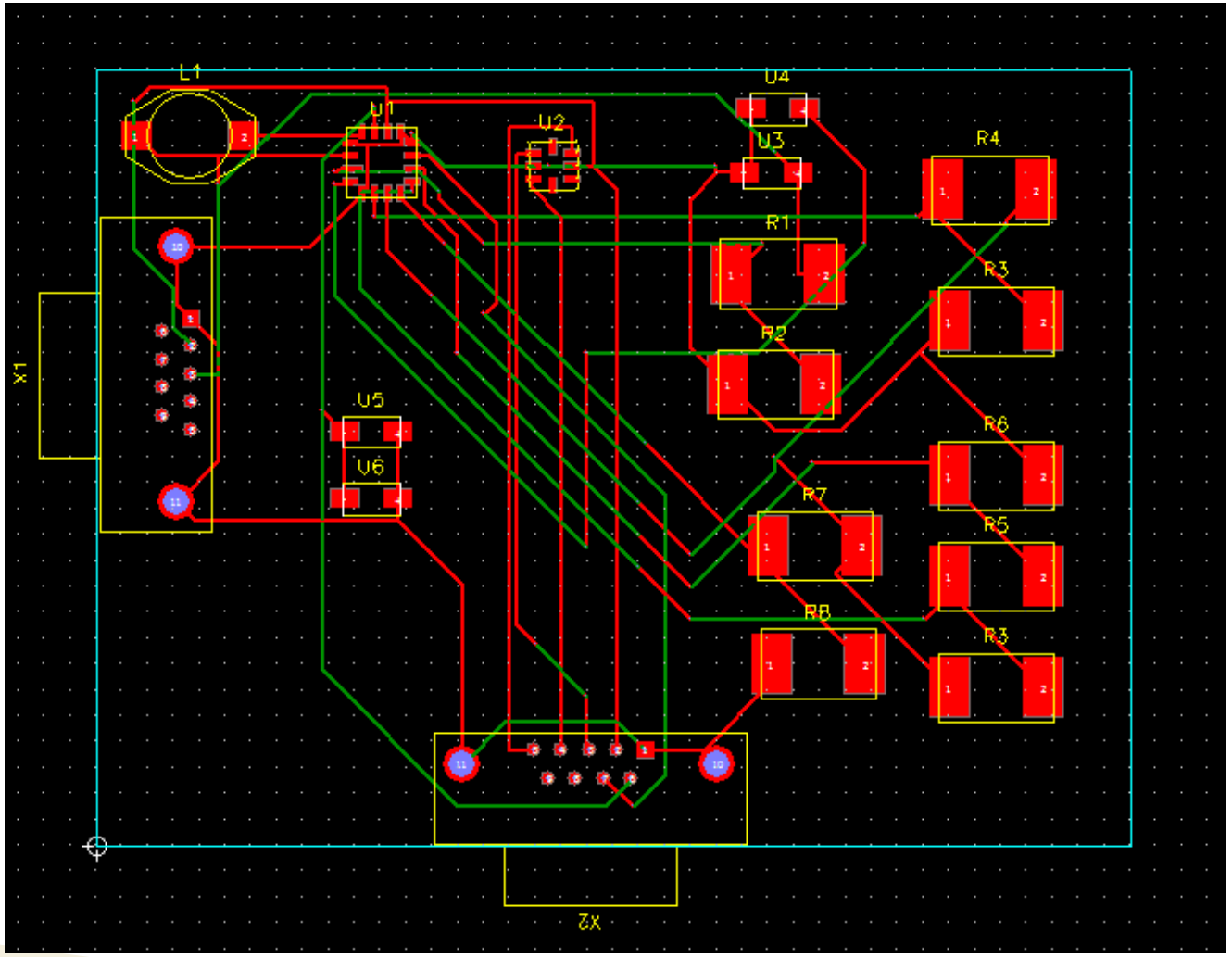
- No light Induced degradation
- Designed to charge 3.6V to 4.2V batteries
- Lightweight
- Easy to install
- Cost effective

# Charge Controller Operational Flow



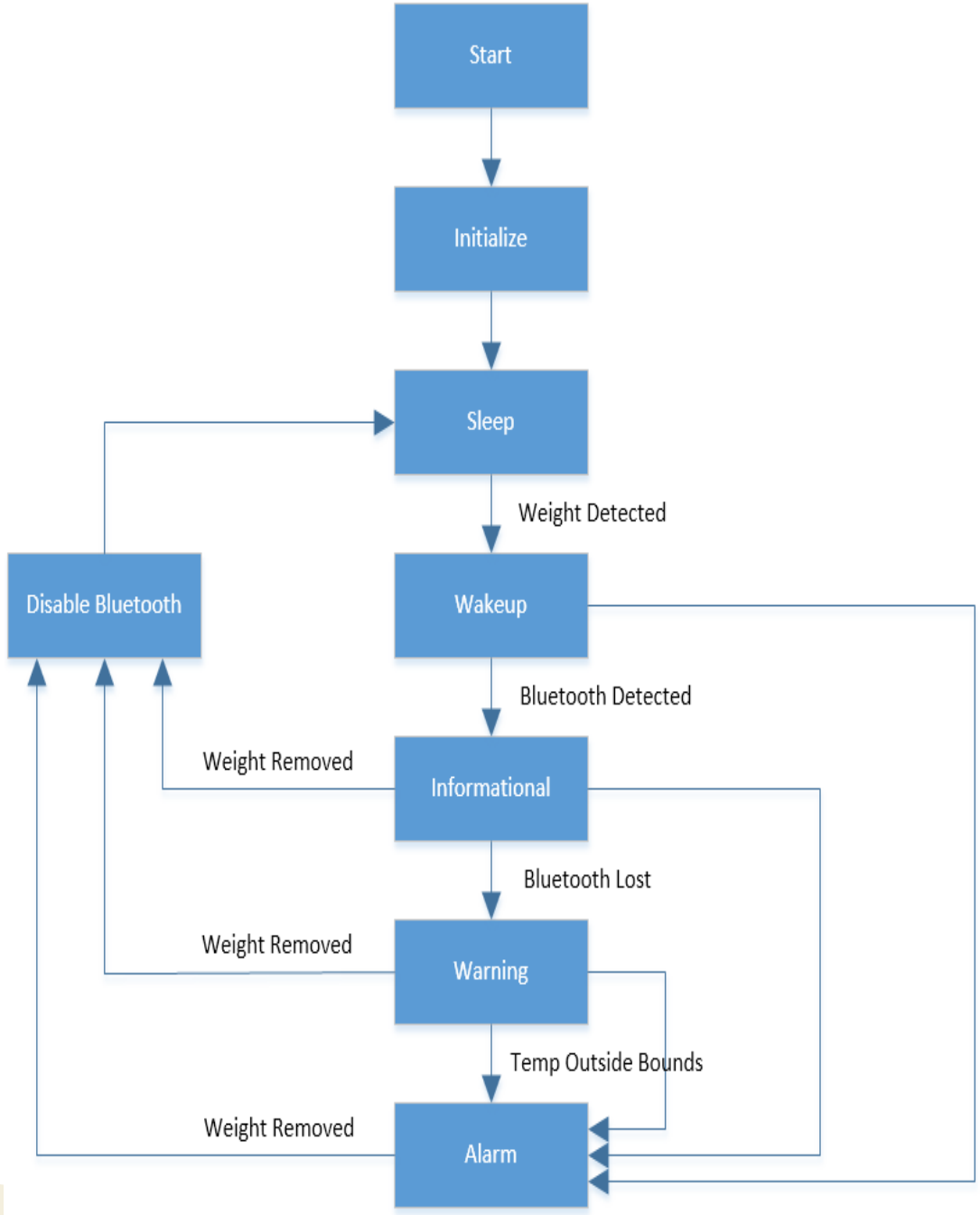
| | |
|---|---|
| Voltage <= .74V | The micro controller will determine the system is in a short circuit condition and the load is disconnected immediately to begin charging of the battery via the solar panel. |
| Voltage <1V | The micro controller turns on the battery charging and the load is disconnected 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

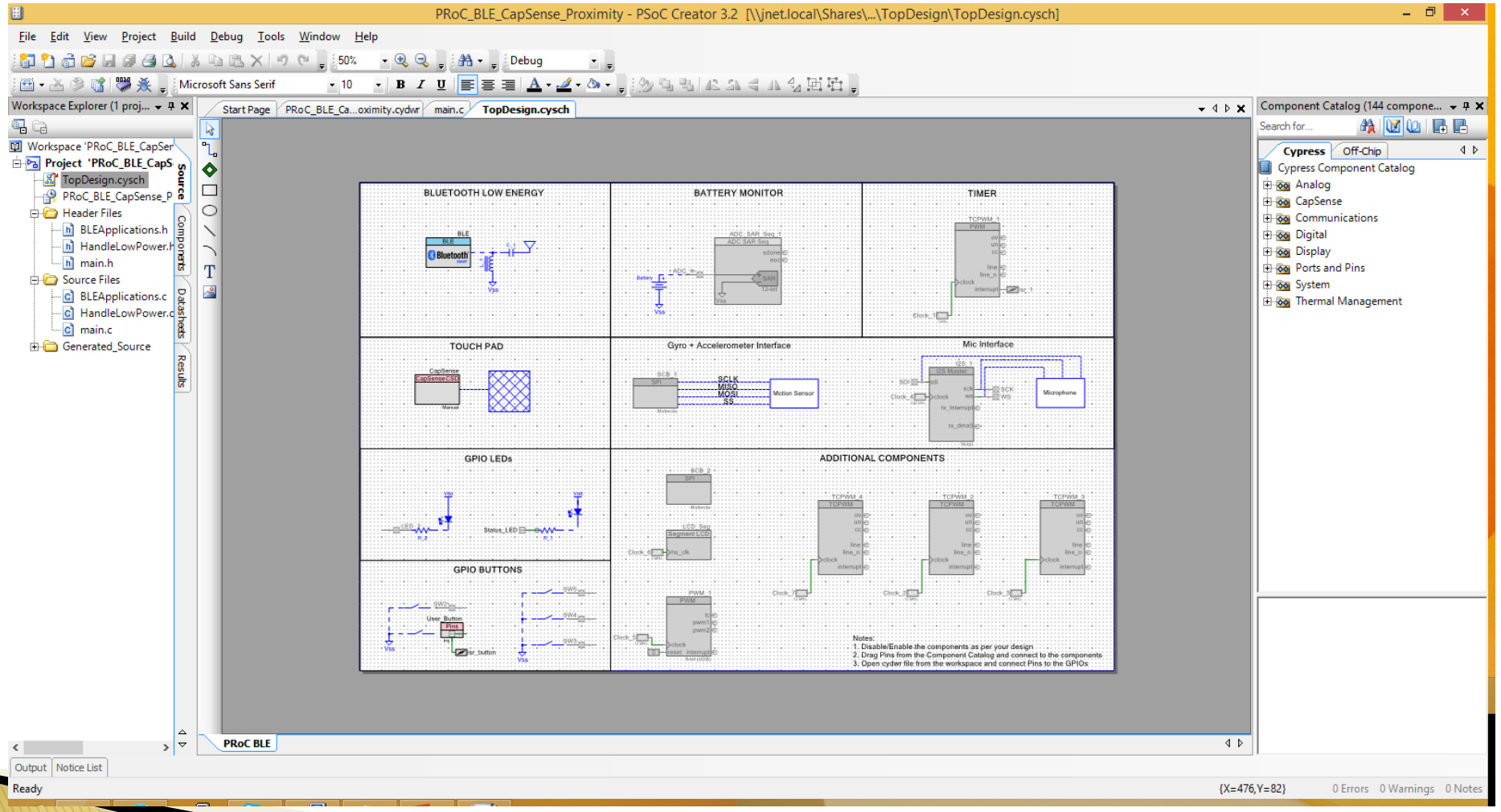


# Software

# Software States



# Software Development

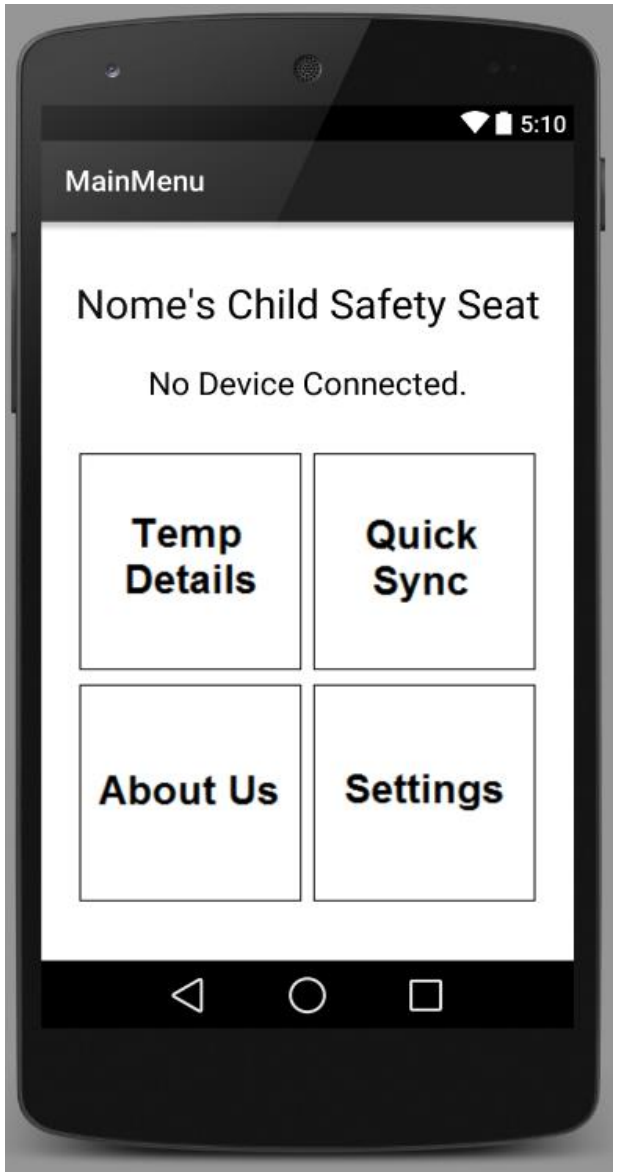


# Android Application

| 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
- Learn about safe temperatures
- Easily configured to the device
- Trigger for the alarms
- Alarms are customizable



# Administrative Content

# Work Distribution

| Name | Research and Design | Hardware Configuration | Hardware Assembly | MCU Programming | Android Application |
|---|---|---|---|---|---|
| Matt Bivona | + | + | – | | |
| Michael Covitt | + | | | – | + |
| Jason Nagin | + | | | + | – |
| Donnell Robinson | + | – | + | | |
| + Main Task | | | – Assistant | | |

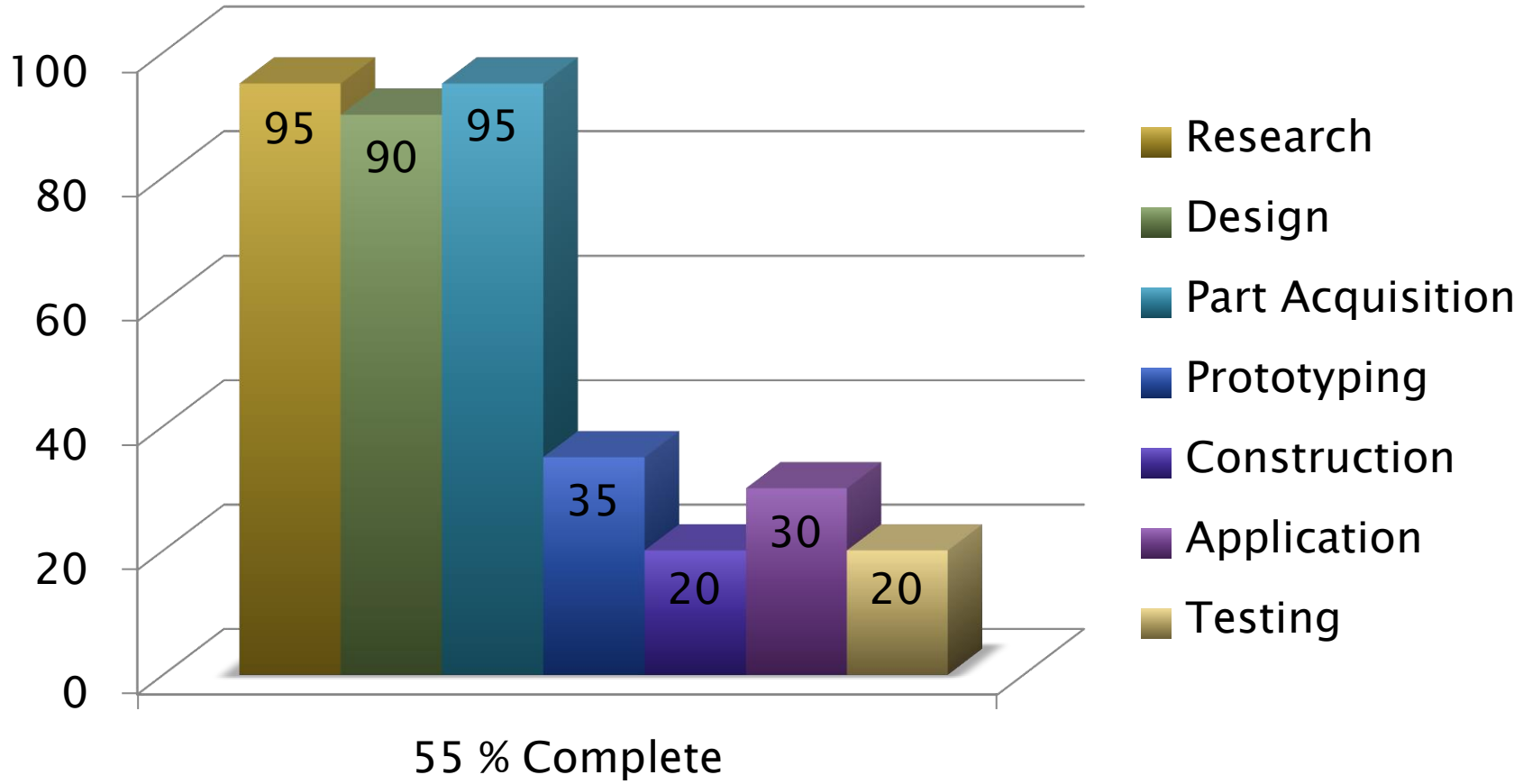
# Budget and Financing

| Part | Location | Component Name | Price | Quantity | Totals |
|---|---|---|---|---|---|
| MCU | Mouser | Cypress Semiconductor CY8C4247LQI-BL483 | 6.53 | 3 | 19.59 |
| Solar Panel | Sun Dance | 6.0V 100MA Round Solar Cell | 7.95 | 2 | 15.9 |
| OBD Link | Amazon | ScanTool 426101 OBDLink MX Bluetooth | 100.91 | 1 | 100.91 |
| Battery | Amazon | Samsung Galaxy Nexus GT-I9250 Standard 1750mAh Lithium Battery, EB-L1F2HVU | 11.76 | 1 | 11.76 |
| Board / BLE | Digi-Key | Cypress Semiconductor Corp CY8CKIT-042-BLE | 45.94 | 2 | 91.88 |
| Button | Digi-Key | C&K Components D6R90 F2 LFS | 1.09 | 1 | 1.09 |
| LEDs | Digi-Key | Lite-On Inc LTST-C191KGKT | 0.3 | 3 | 0.9 |
| Power Management | Digi-Key | Texas Instruments BQ25504RGTT | 6.17 | 1 | 6.17 |
| Temp Sensor | Digi-Key | Texas Instruments TMP112AIDRLR | 3.12 | 1 | 3.12 |
| Load Sensor | SparkFun | Flexiforce Pressure Sensor - 25lbs. | 21.95 | 1 | 21.95 |
| | | | | Grand Total: | 273.27 |

# Estimated Single Unit Cost

| Part | Component Name | Price | Quantity | Totals |
|---|---|---|---|---|
| MCU | Cypress Semiconductor CY8C4247LQI-BL483 | 6.53 | 1 | 6.53 |
| Solar Panel | 6.0V 100MA Round Solar Cell | 7.95 | 2 | 15.9 |
| OBD Link | ScanTool 426101 OBDLink MX Bluetooth | 100.91 | 1 | 100.91 |
| Battery | Samsung Galaxy Nexus GT-I9250 Standard 1750mAh Lithium Battery, EB-L1F2HVU | 11.76 | 1 | 11.76 |
| Button | C&K Components D6R90 F2 LFS | 1.09 | 1 | 1.09 |
| LEDs | Lite-On Inc LTST-C191KGKT | 0.3 | 3 | 0.9 |
| Power Management | Texas Instruments BQ25504RGTT | 6.17 | 1 | 6.17 |
| Temp Sensor | Texas Instruments TMP112AIDRLR | 3.12 | 1 | 3.12 |
| Load Sensor | Flexiforce Pressure Sensor - 25lbs. | 21.95 | 1 | 21.95 |
| PCB | Estimated Bulk Manufacturing Price | 10 | 1 | 10 |
| Wedge / Insert Materials | Estimated Bulk Manufacturing Price | 30 | 1 | 30 |
| | | | Grand Total: | 208.33 |

# Progress


100
80
60
40
20
0
95
90
95
35
20
30
20
Research
Design
Part Acquisition
Prototyping
Construction
Application
Testing
55 % Complete

# Issues

1. No legitimate way to test cold temperature triggers
2. Ford and GM vehicle's Control Area Network unencrypted.
   - No Ford / GM vehicle ownership

# Questions?