



T.A.A.G

Tamper Automated Alert Gadget

Final Presentation

Group 7

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Leaphar Castro	EE

Funding

Dr. Yuan, Co-Director of MIST
research center at UCF.

Motivation

With the ever expanding use of IoT sensor systems, the vulnerability of these systems must be evaluated. This project serves as a platform to demonstrate how IoT security can be implemented.

Concept

What is T.A.A.G?

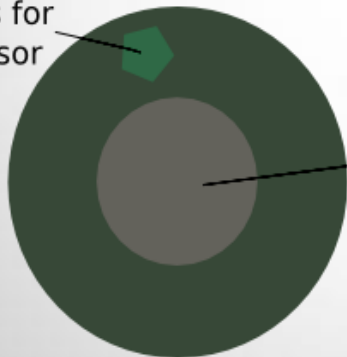
- Senses motion and light
- Wi-Fi messages to mobile app
- Place on door, gun case, etc.

User Interface



Detector

Plexiglass for Light Sensor



"Join System" Button

Detectors





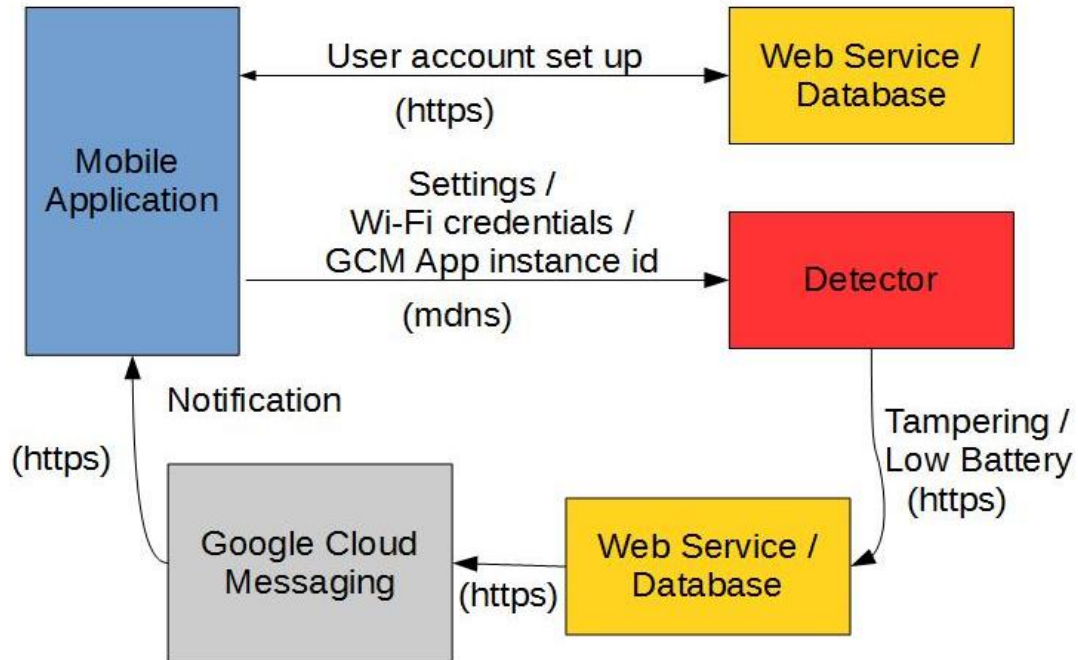
Goals & Objectives

- Secure transmission of data between device and user
- Lightweight & compact
- Easy to use and set up
- Adjustable light and motion thresholds
- Long lasting battery life
- Allows for multiple detectors

Requirement Specifications

Parameter of interest	Specification
Battery life	50 days or more with normal operation
Charging time	1 hour or less
Weight	50 grams or less
Dimensions	55 mm X 45 mm or less
Mobile application	Android mobile app
Notification	Given network connectivity detector sends notification to user when sensor thresholds are crossed -Provides low battery notification before battery is fully depleted
Security	Use of Https
Range of light sensing threshold	0 lux – 10,000 lux
Acceleration detection	Be able to detect a magnitude of 0.2g or greater in all directions

System Overview



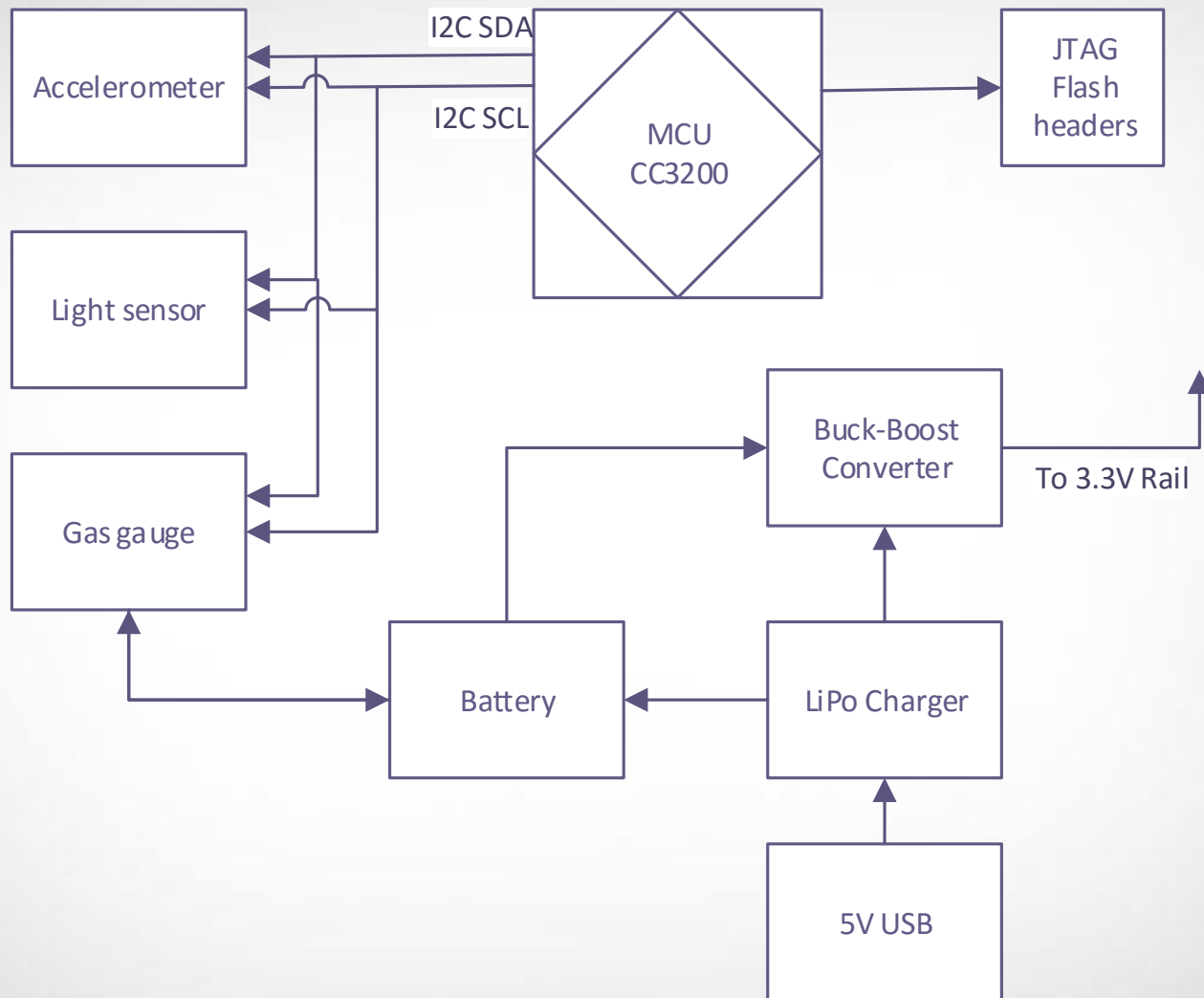
3 major components:

Mobile application, web service, and detector

Work Distribution

- Aiman Salih:
 - Administrative tasks
 - Overall system
 - PCB design
- Daniel Gibney:
 - Overall system
 - Software system
- Leapfar Castro:
 - Power system
 - Hardware system

Detector Hardware System

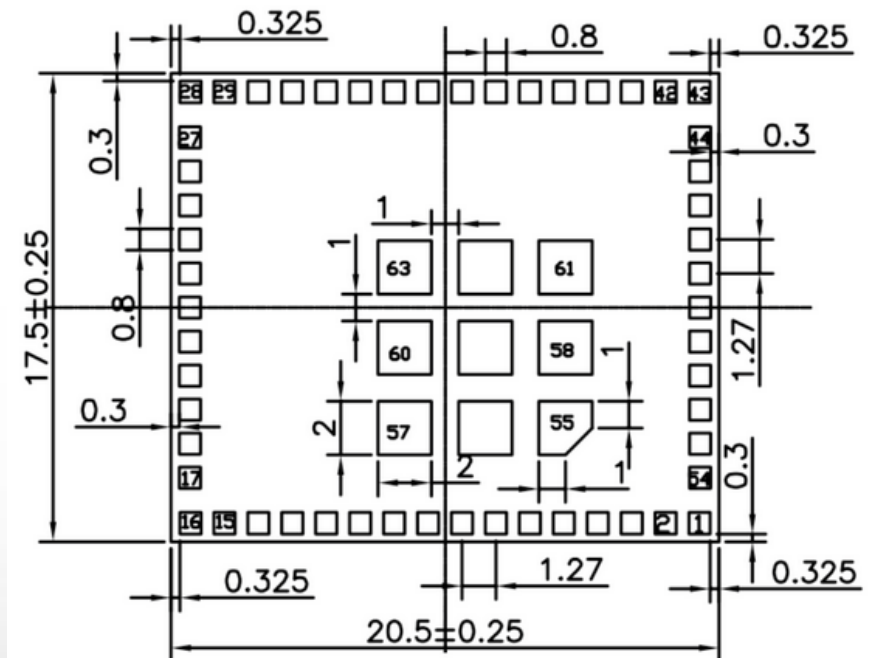


Microcontroller

T.I. SimpleLink Wi-Fi CC3200 Internet-on-a-chip Wireless MCU module:

- Most compact solution
- Crypto engine

Manufacturer	Texas Instruments
Part model	CC3200mod
Price	\$24.99
Purchased from	Mouser
Pins	65 pins
Vin	3.3V
Dimensions	17.5 mm X 20.5 mm

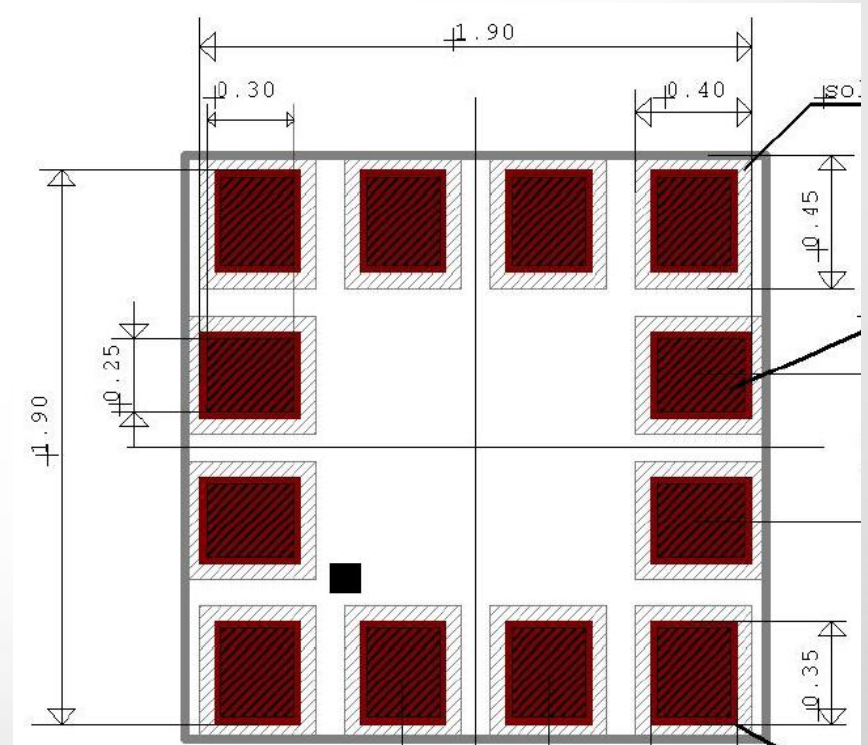


Accelerometer

- Has a dedicated interrupt pin
- Uses the 3.3V rail
- Very compact dimensions

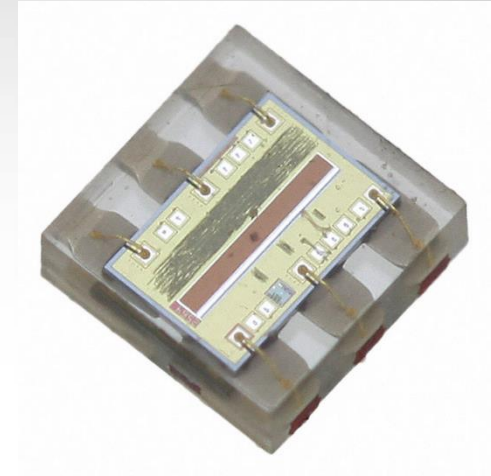


Manufacturer	Bosch
Part model	BMA222
Price	\$1.99
Purchased from	Mouser
Pins	12-pin LGA
Vin	3V Nom.
Dimensions	1.9 mm X 1.9 mm

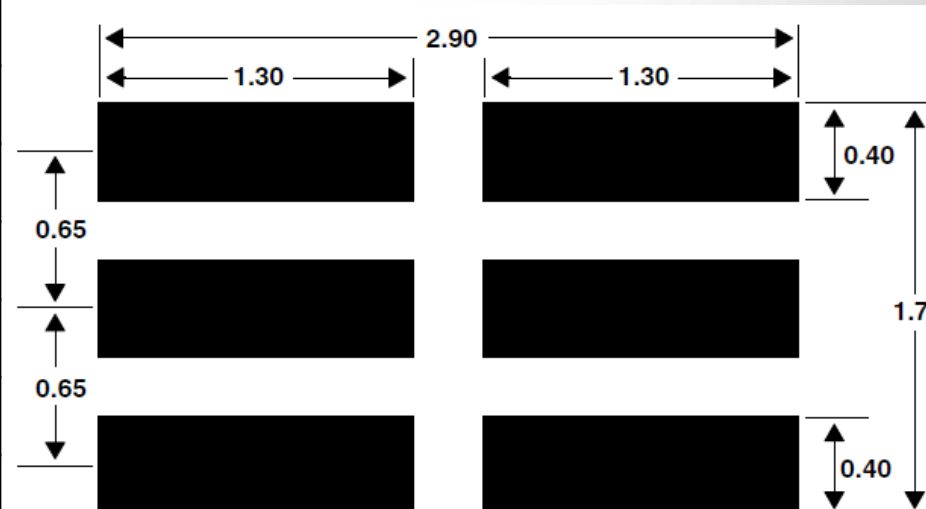


Light Sensor

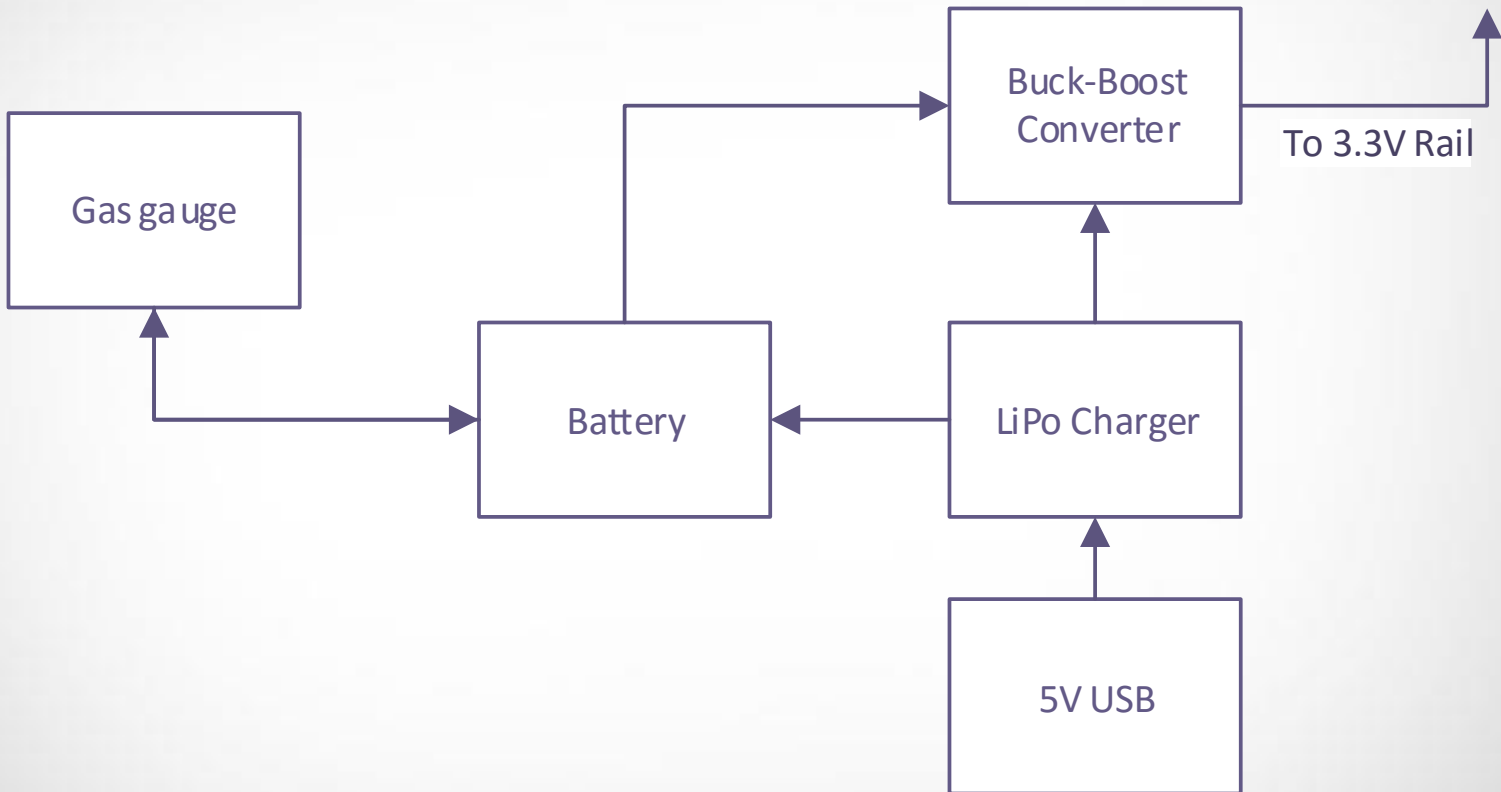
- Light responsivity down to 0.25 lux
- Offers I2C technology
- Operates on 3.3V rail



Manufacturer	TAOS
Part model	TSL561
Price	\$1.84
Purchased from	Mouser
Pins	6 pins
Vin	3 V Nom.
Dimensions	2.9 mm X 1.7 mm

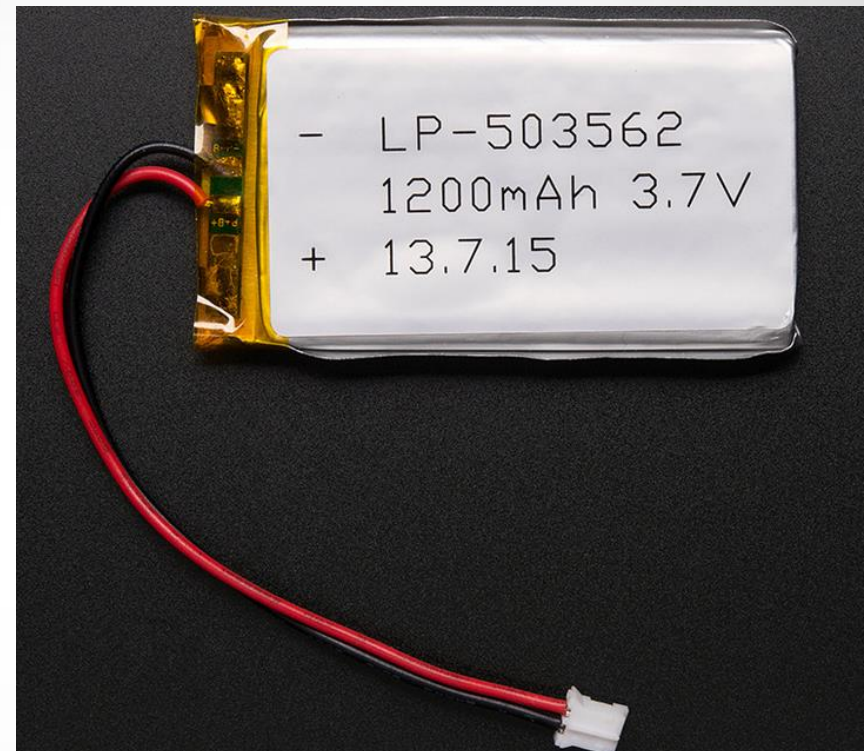


Power Flow



Battery

Manufacturer	Hunan Sounddon New Energy Co.
Part Model:	503562
Price:	\$9.95
Purchased From:	Adafruit
Type:	Polymer Lithium-Ion
Connector:	2-pin JST- PH connector
Nominal Voltage:	3.75 V
Nominal Capacity:	1200 mAh / 4.5 Wh
Weight:	23 g
Dimensions:	34mm x 62mm x 5mm



Polymer Lithium-ion Battery

- Low maintenance battery
- Self-discharge rate compared to other available technologies fairly low in most cases less than half
- Little to no harm to the environment when disposed
- No special requirements for prolong battery life
- Energy Density when compared to other technologies is typical twice as good
- Protection circuit built in
- Specialty Cells
- Dimensions
- Lightweight
- Safe to use
- Easy to implement into design and system
- Load characteristics
- Rechargeable
- Potential for even higher densities

LiPo Charger-MCP73871

Manufacturer	Microchip Technology
Part Model:	Battery Management
Price:	\$1.94
Purchased From:	Mouser
Product Type:	Charge Management
Connector:	20-pin
Output Voltage:	4.2 V
Output Current:	50mA to 1000mA
Dimensions:	4mm x 4mm



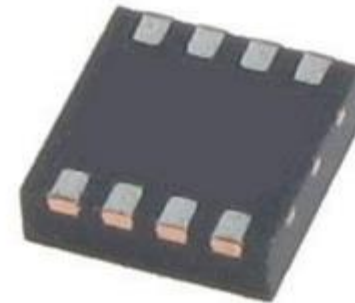


LiPo Charger

- Simultaneously Power the system and charge the battery
- Integrated reverse discharge protection
- Versatile
- Automatic recharge
- Automatic end-of-charge control
- Power on status indicator
- Autonomous power source selection
- Low external component
- Small size
- Safety features
- Low battery Status indicator

Gas Gauge - MAX17048

Manufacturer	Maxim Integrated
Product Model:	Battery Management
Price:	\$2.39
Purchased From:	Mouser
Product Type:	Fuel Gauges
Connector:	9-pin
Output Voltage:	0.4 V
Operating Voltage:	2.5 V to 4.5 V
Operating Current:	23 μ A
Dimensions:	2 mm x 2 mm

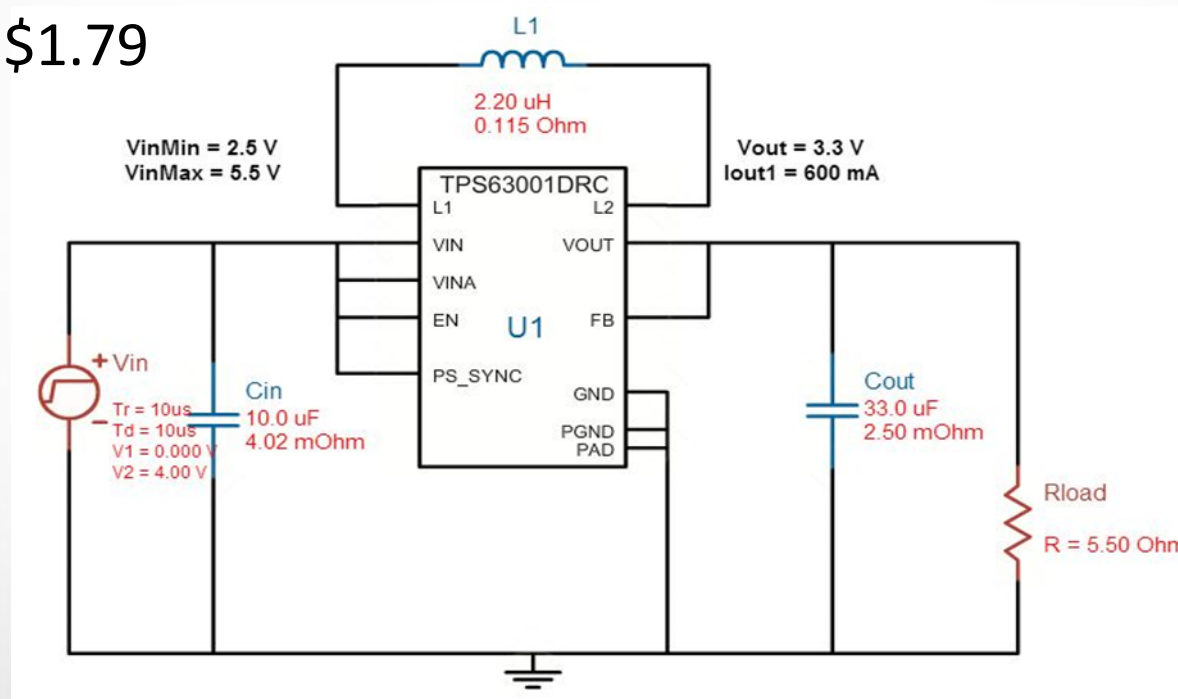


Gas Gauge

- Algorithm based sensing
- No current sense resistors
- No learned battery cycles necessary
- Temperature compensation
- Autonomous detecting
- Accurate
- Voltage measurement improvement on battery insertion
- I2C communication
- Small size
- Programmable
- Reports on battery information

Voltage Regulation

- Buck-boost topology (Webench).
- $V_{out} = 3.3V$
- Efficiency = 85%
- Cost = \$1.79



Development

T.I. CC320MOD LaunchPad

- Contains JTAG & Flash circuitry
- Useful hardware and software files

Manufacturer	Texas Instruments
Model	CC3200MODLAUNCHXL
Price	\$34.99
Purchased at	Mouser

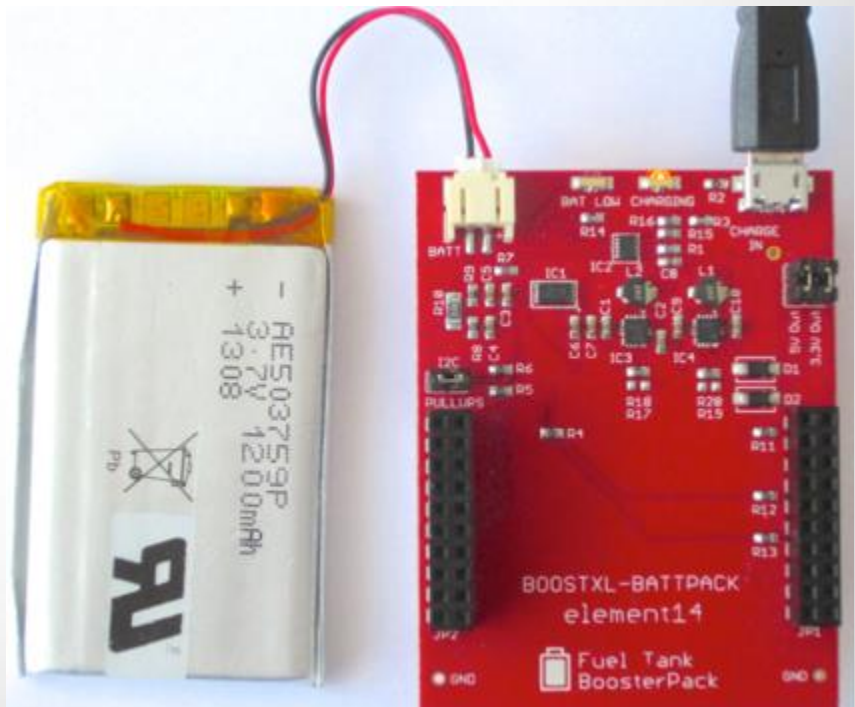


Development

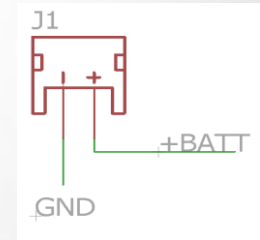
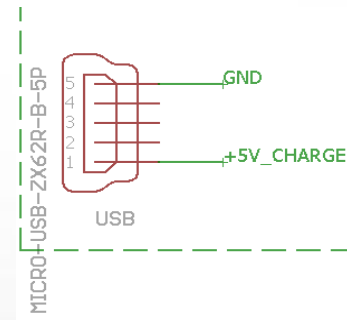
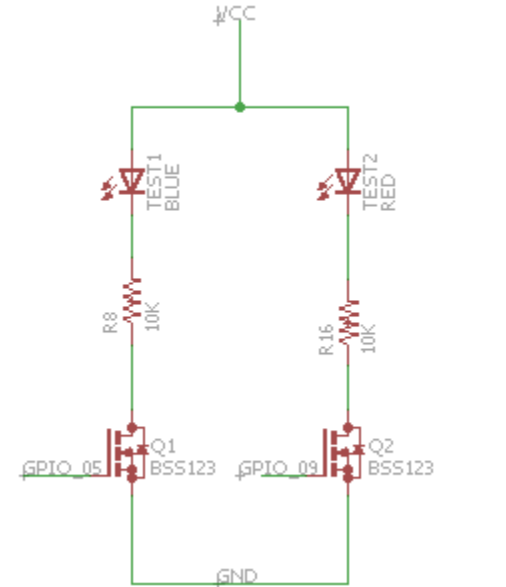
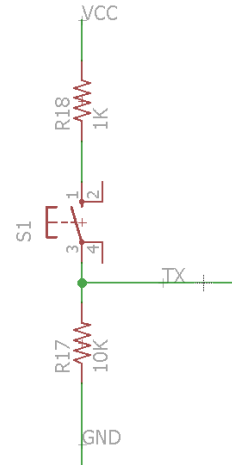
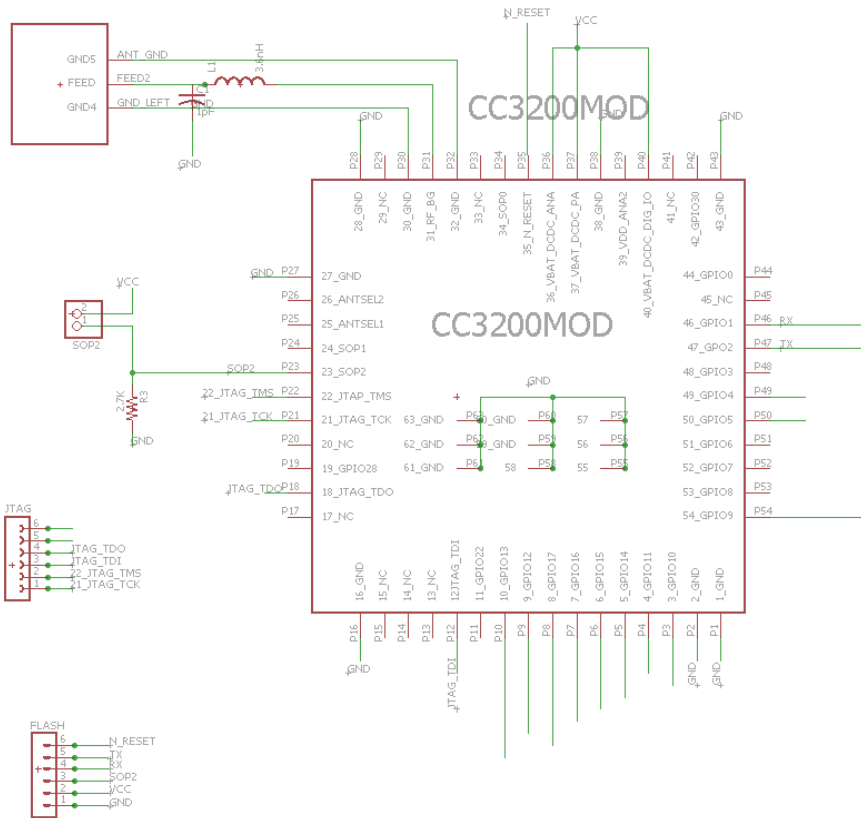
Battery Booster Pack

- Comes with LiPo battery
- Gave platform for hardware and software development

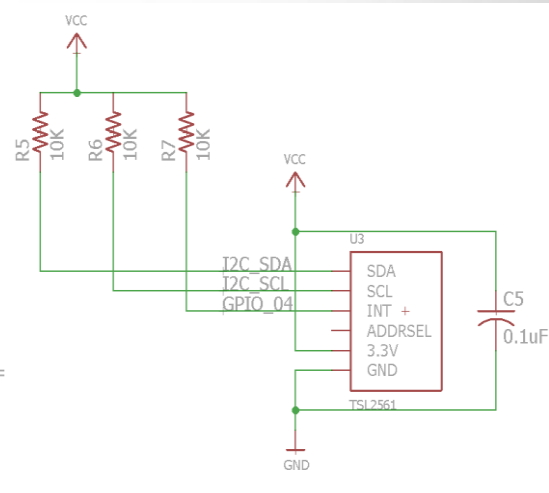
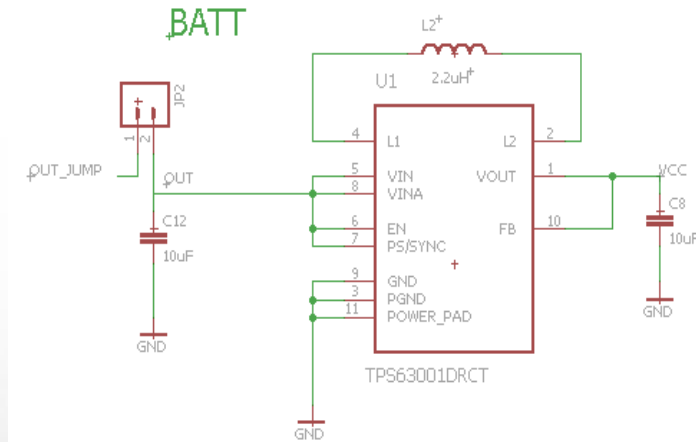
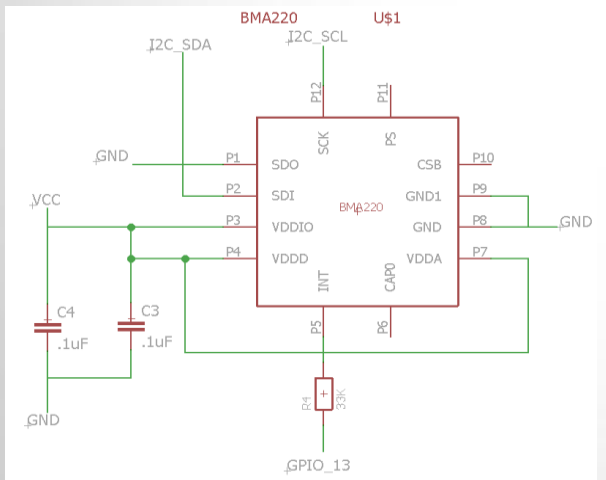
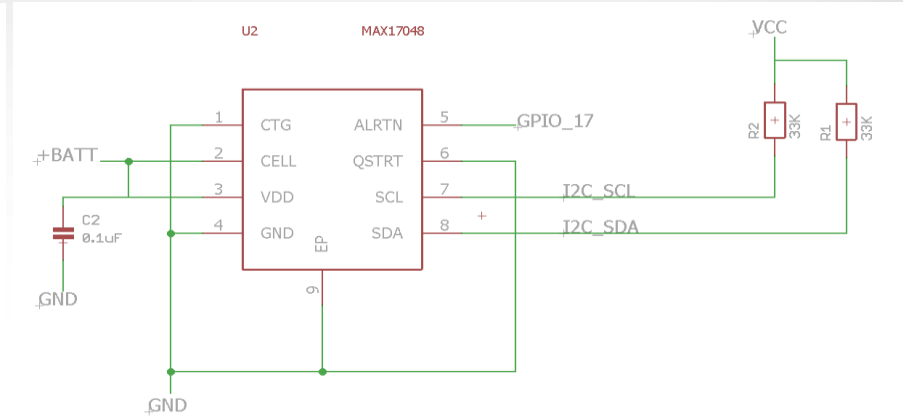
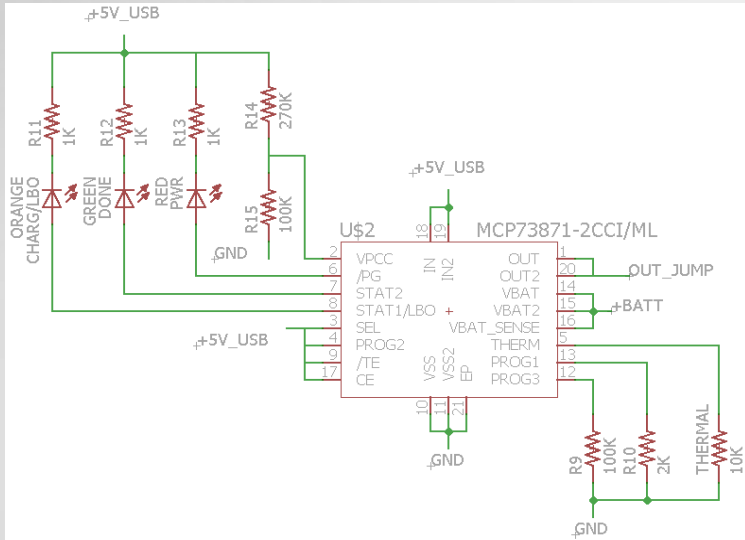
Manufacturer	Texas Instruments
Model	BOOSTXL-BATTPACK
Price	\$19.99
Purchased at	Element 14



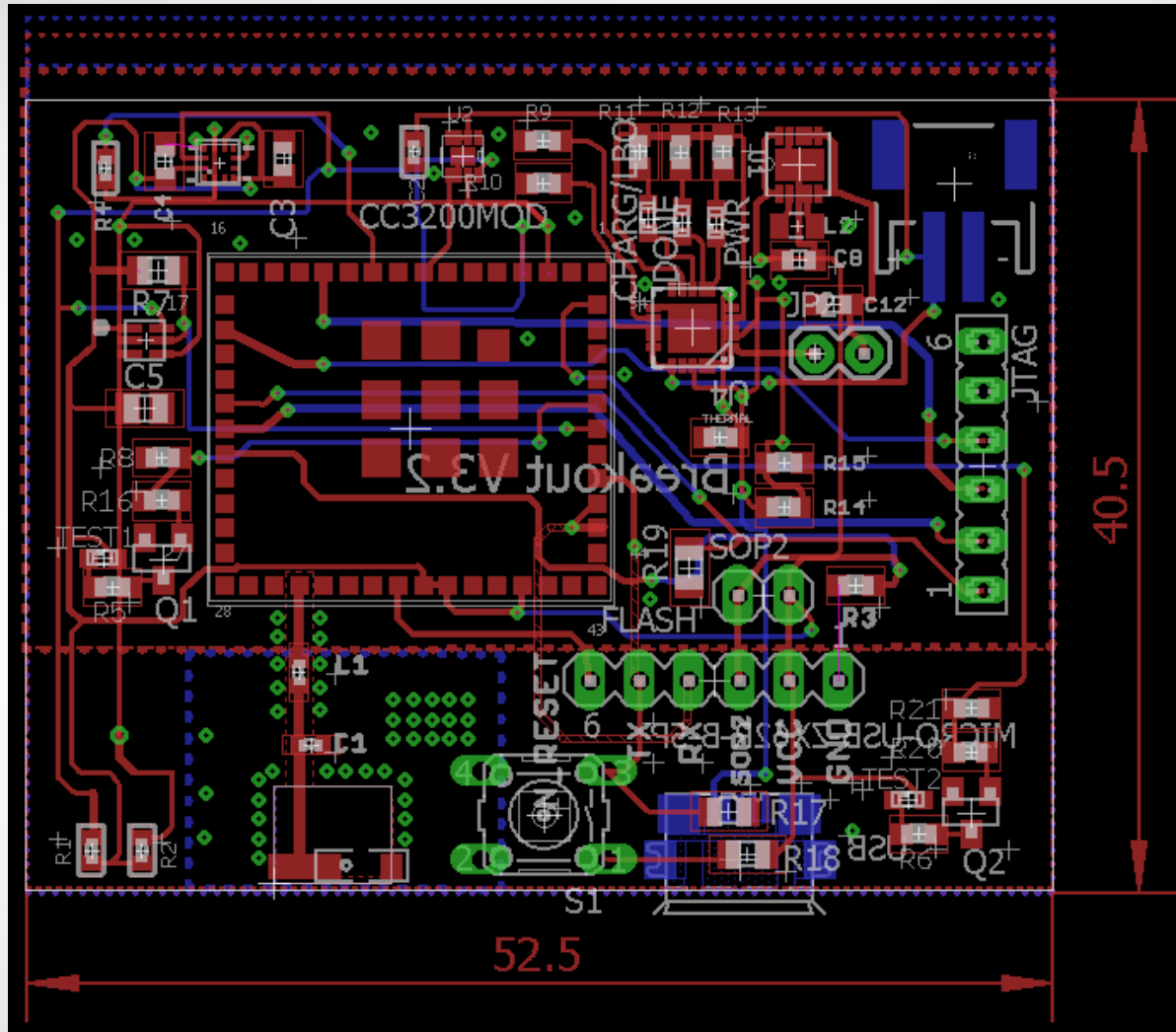
PCB Schematic



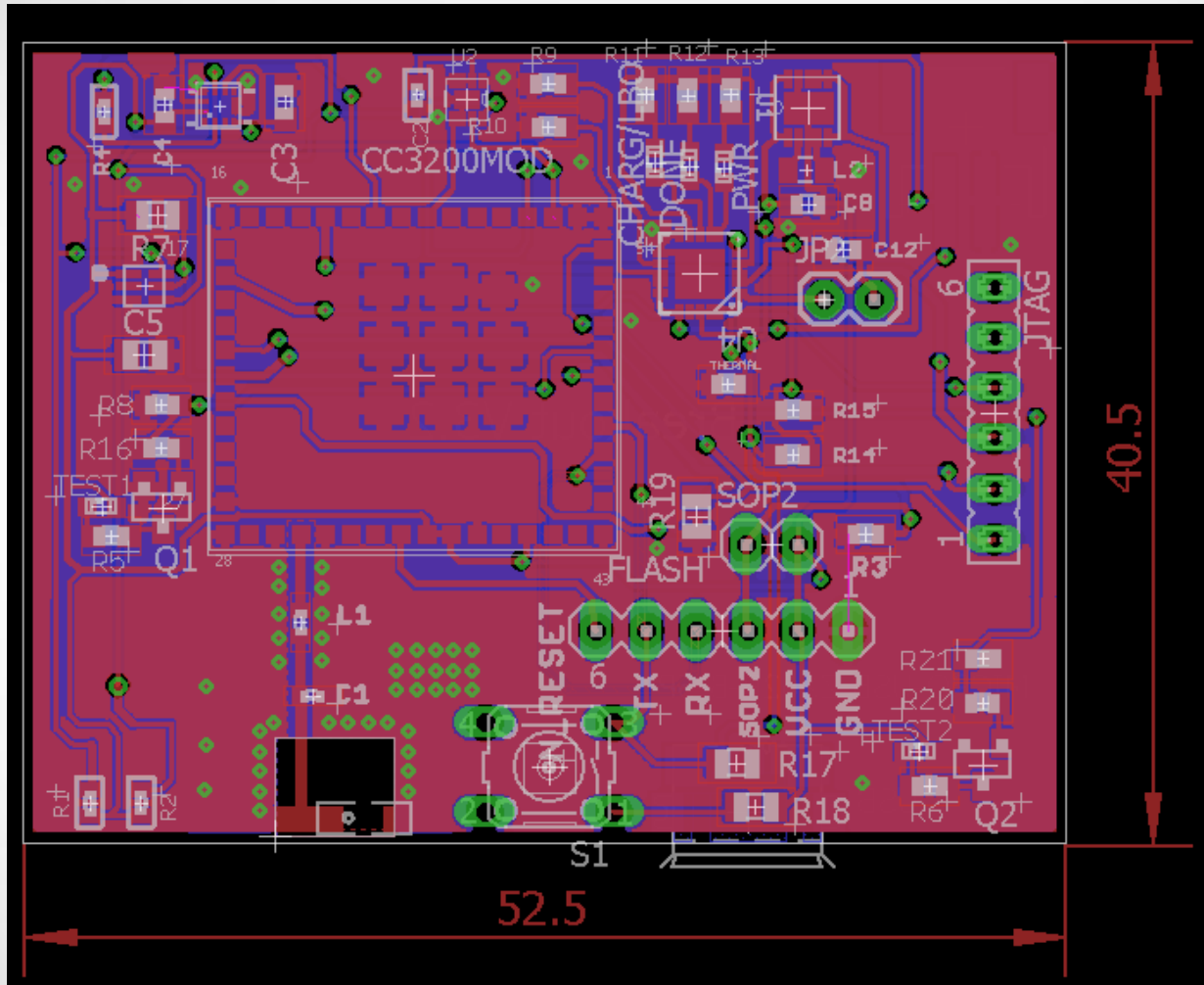
PCB Schematic



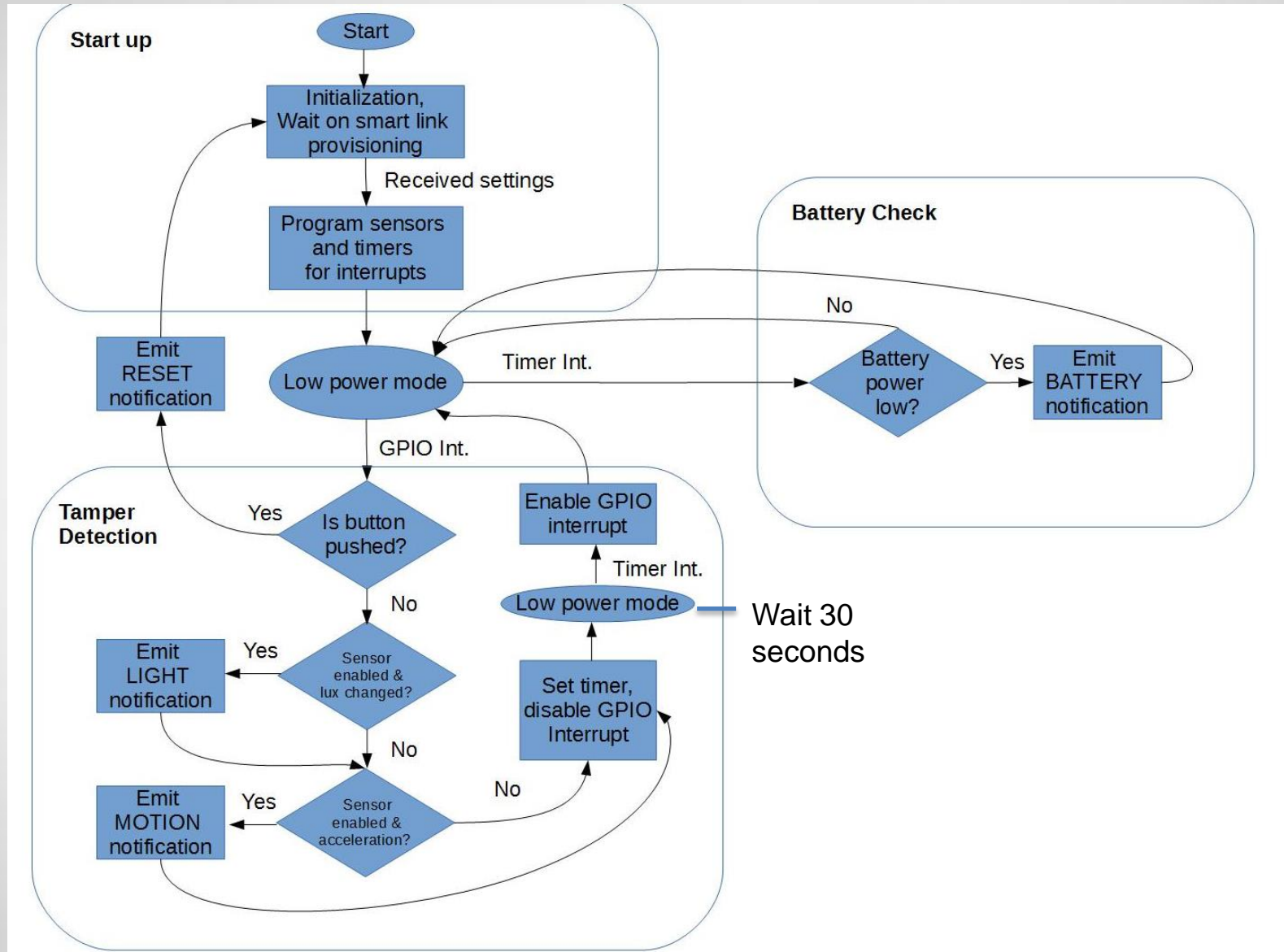
Final PCB Layout



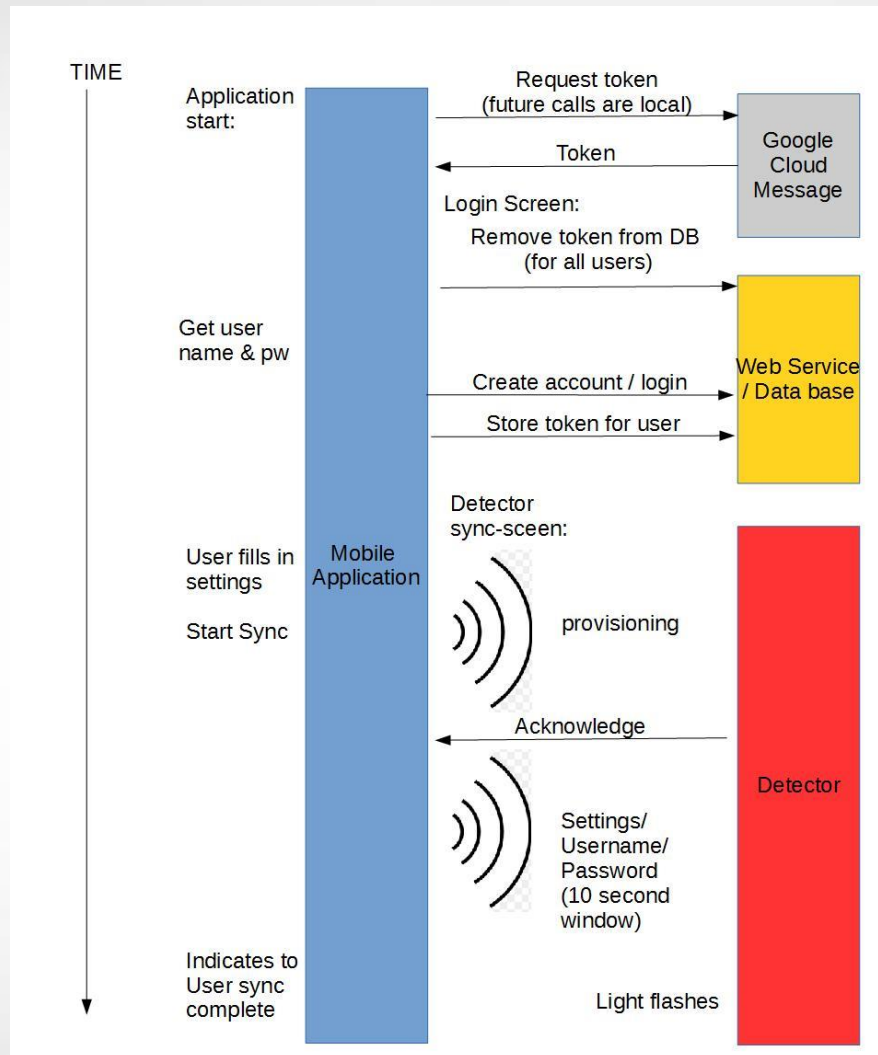
Final PCB Layout



Detector Program Flow



Start-up Overview



Google Cloud Messaging

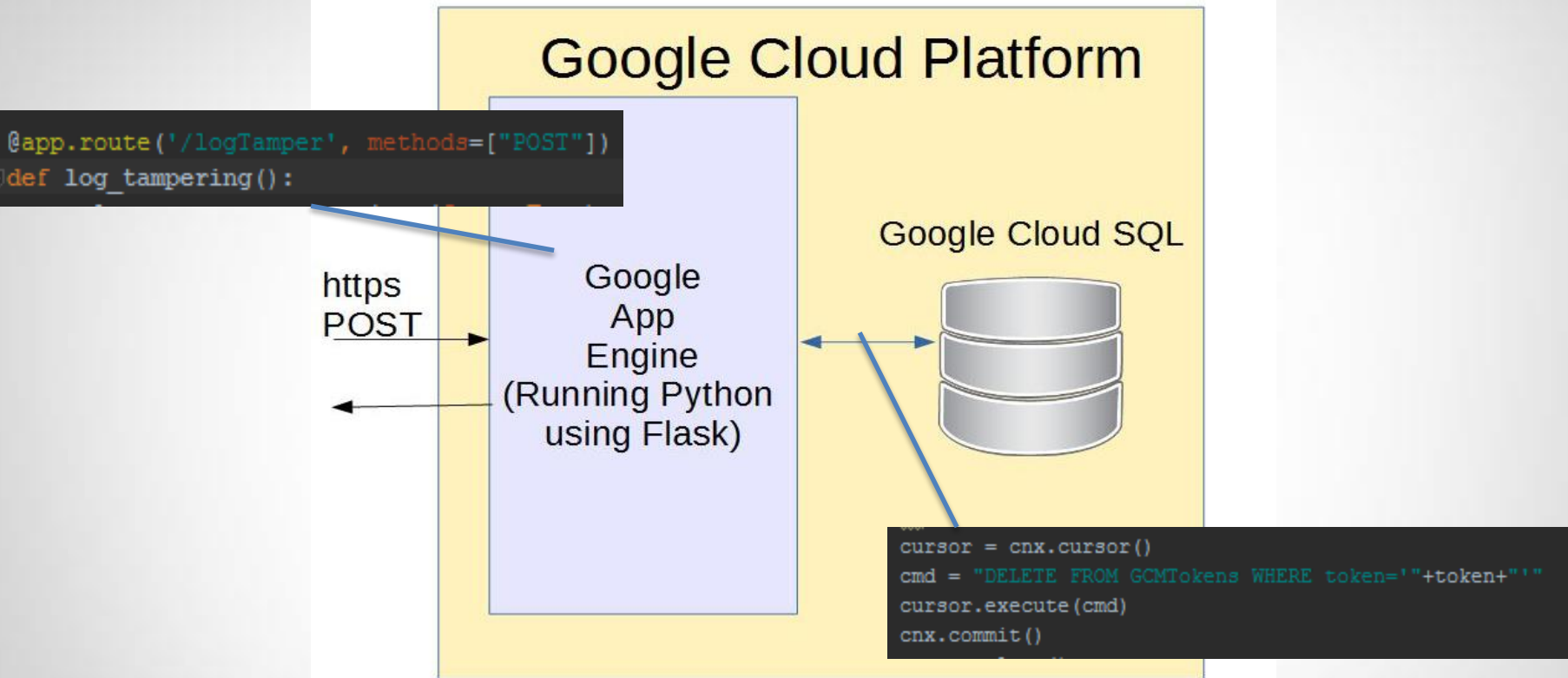
- **Application ID:**
 - App is registered with google by developer to obtain.
 - Shared amongst all instances of the application .
 - Hard coded into both mobile application and the web server.
- **Token: Tied to particular physical device.**
 - Gotten at initial application start-up, stored for reuse. Communicated to detector during sync process.
 - Stored in database for sending notifications.

Communication between System Components (except provisioning and mDNS)

- POST requests over https
- Data is exclusively formatted in JSON
- Example:

```
{  
  "name" : "a@b.com",  
  "password" : "12345",  
  "detector" : "cereal",  
  "message" : "cereal tasted"  
}
```

The Web Service - Google makes it easy



- A total of 6 URI are used. (/logIn, /createAccount, /deleteAccount, /logTamper, /displayLog, /storeGCMTToken, /deleteGCMTToken)
- Google Cloud Messaging is a separate service.

Web Service Program Design – Python using Flask

- Program design is a set of functions which get called when a particular URI is requested.
- Contents of JSON are parsed and helper functions are used to access and update the database.
- Very little, to no, iteration used

Database - User

```
mysql> describe User;
```

Field	Type	Null	Key	Default	Extra
id	int(10) unsigned	NO	PRI	NULL	auto_increment
name	varchar(100)	YES		NULL	
password	varchar(500)	YES		NULL	
ts	timestamp	NO		CURRENT_TIMESTAMP	

- Actual password is not stored in database, rather irreversible hash of password is stored.
- Row added to table from login screen on mobile application (create account).
- Row can be deleted from login on mobile application (delete account).
- Table checked for username and password hash match on login.

Database - Tampering

```
mysql> describe Tampering;
```

Field	Type	Null	Key	Default	Extra
id	int(10) unsigned	NO	PRI	NULL	auto_increment
name	varchar(100)	YES		NULL	
detector	varchar(100)	YES		NULL	
message	varchar(500)	YES		NULL	
ts	timestamp	NO		CURRENT_TIMESTAMP	

- User name must exist in the database, and password hash must agree, before tamper gets stored in the database.

Database - Tokens

```
mysql> DESCRIBE GCMTokens;
```

Field	Type	Null	Key	Default	Extra
name	varchar(255)	YES		NULL	
token	varchar(500)	YES		NULL	

- User name must exist in database, and password hash agree, before the token can be stored.
- Unlimited number of tokens per user allows user to get notifications on unlimited number of devices.
- What if users are sharing a device, and one user force stops application? Will device receive notifications for both users? – This is why tokens are removed on start up.

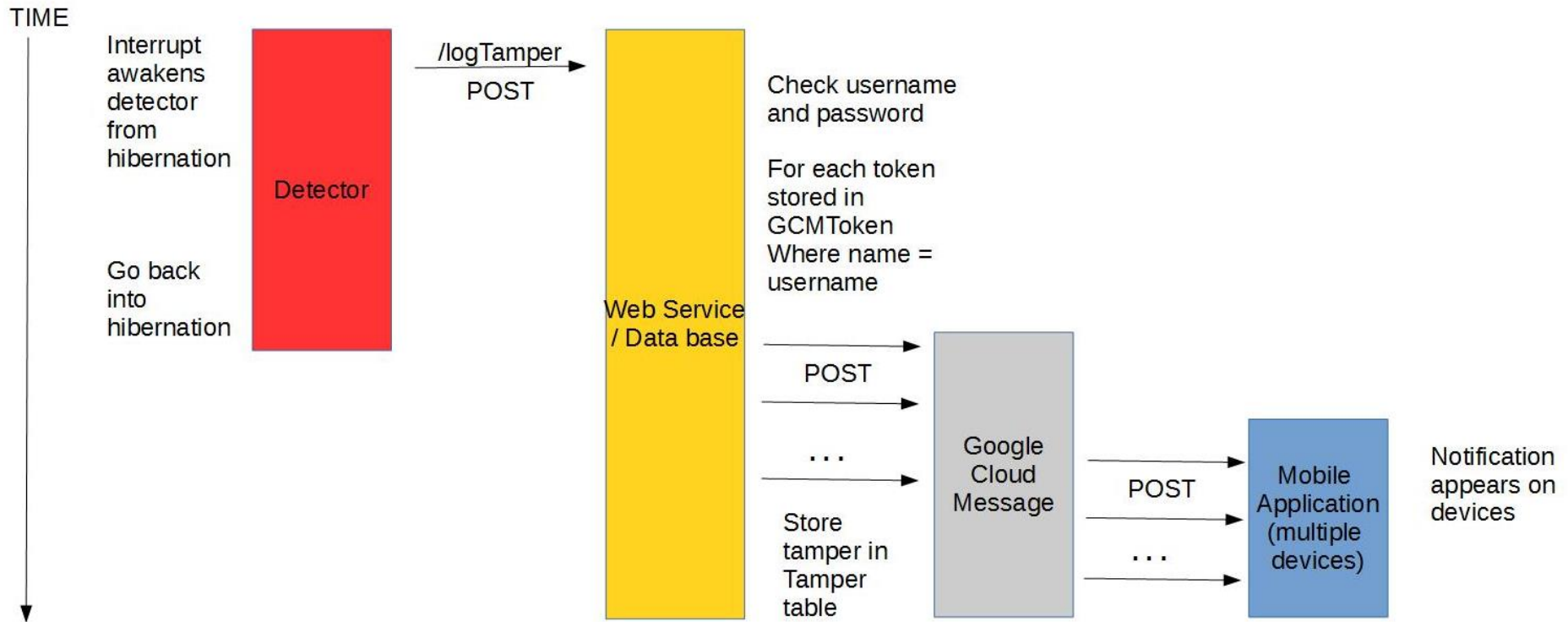
Provisioning – TI Smart-Config

- Best seen here as a black box that gets the CC3200 on the Wi-Fi network.
- It communicates Wi-Fi ssid and passkey to CC3200 using packet lengths.
- Smart-Config libraries continue the process connecting the CC3200 to Wi-Fi network.
- **ISSUE – DOES NOT SUPPORT ADDITIONAL FIELDS TO TRANSMIT SETTINGS DATA!**

mDNS and DNS-SD

- Multicast DNS resolves host names to IP addresses
- Used with DNS Service Discovery it allows one device to look for a service advertised with a particular name.
- Service advertises port, service type, and a text field.
- This text field is used here to transmit additional information from the mobile app to the detector.
- `<light-settings>_<motion-settings>_<detector-name>_<user-name>_<password>`
- Then service is deregistered

A Tampering



Manufacturing

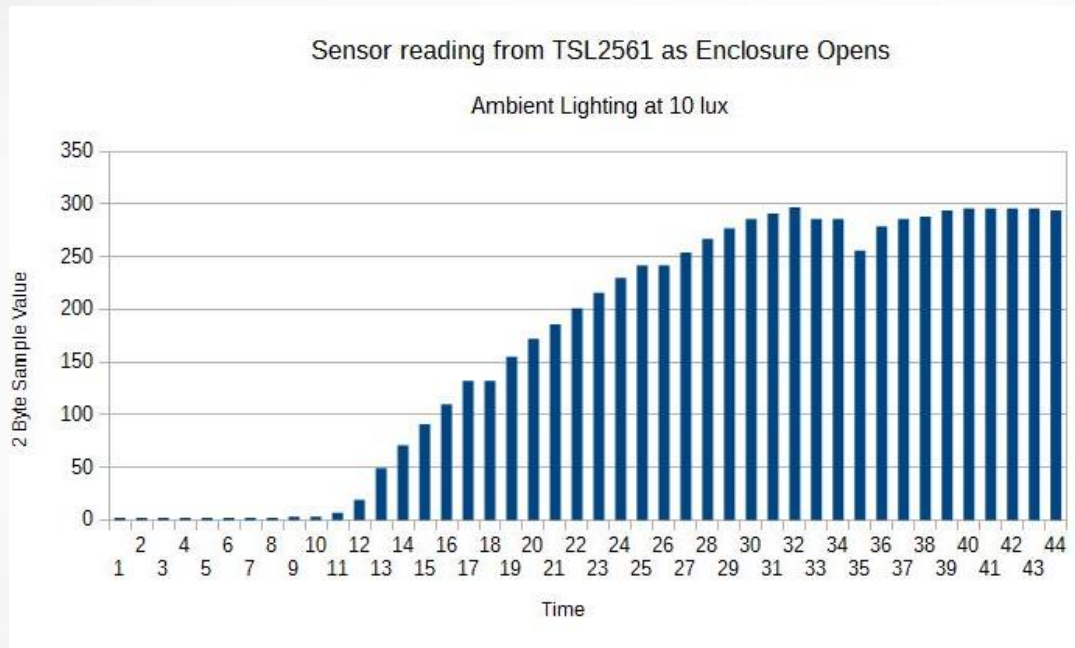
- PCB was printed with OshPark.
- Parts were assembled with Quality Manufacturing Services in Lake Mary, FL.
- Casing was designed and laser cut at the UCF TI innovation lab.

Testing

- Testing light sensitivity in different ambient settings.
- Motion testing.
- Network connectivity testing.
- Case drop testing.
- Regulator voltage.
- Tested reverse battery testing.

Light Testing

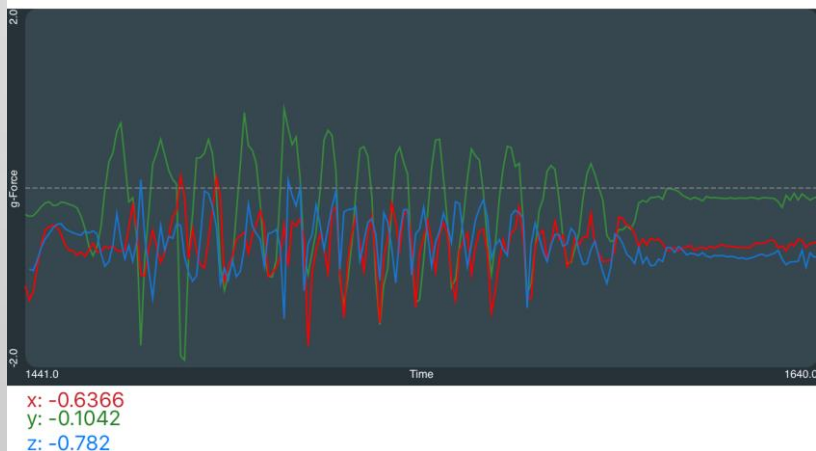
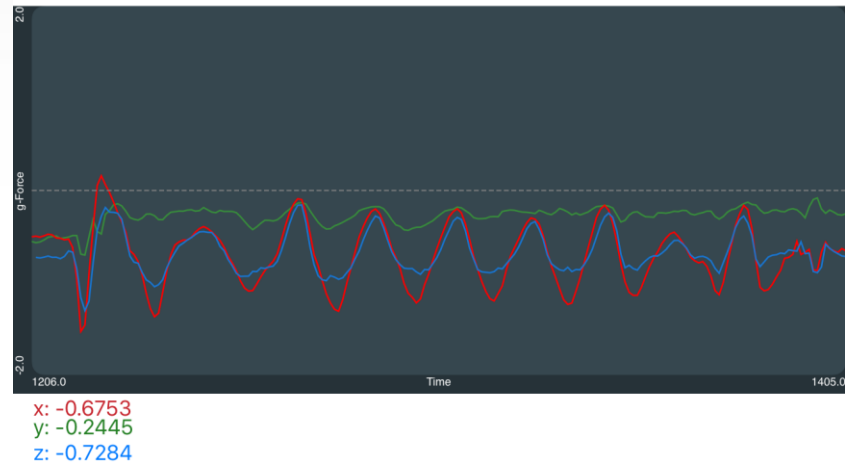
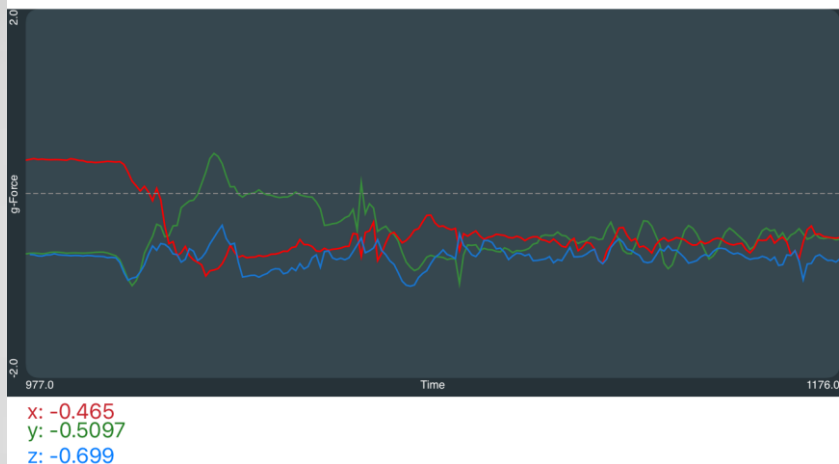
- Live sensor readings.



- Used to determine the best threshold settings

Motion Testing

- Accelerometer sampling for determining slope thresholds

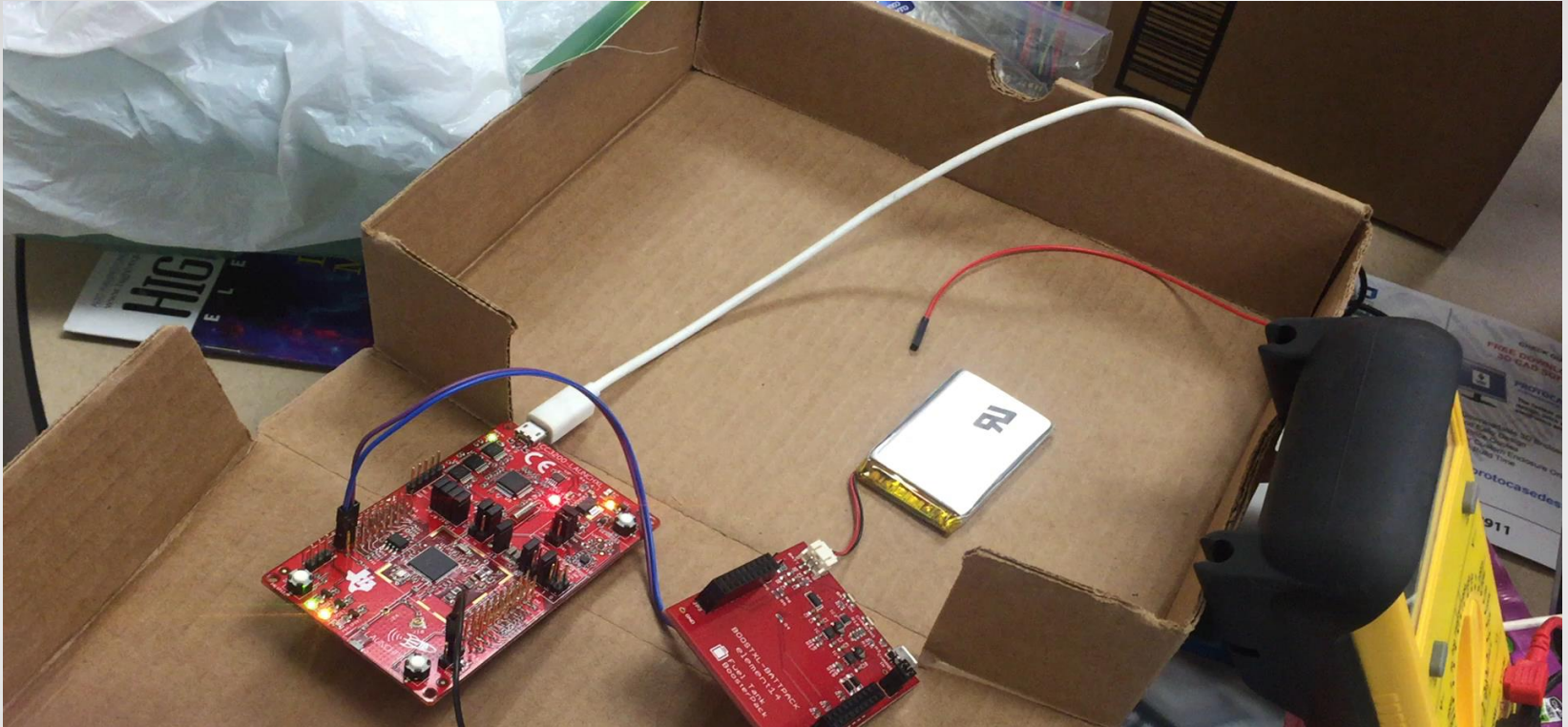


Threshold Low value acceleration = .375 g
Threshold Medium value acceleration = .5 g
Threshold High value acceleration = .725 g

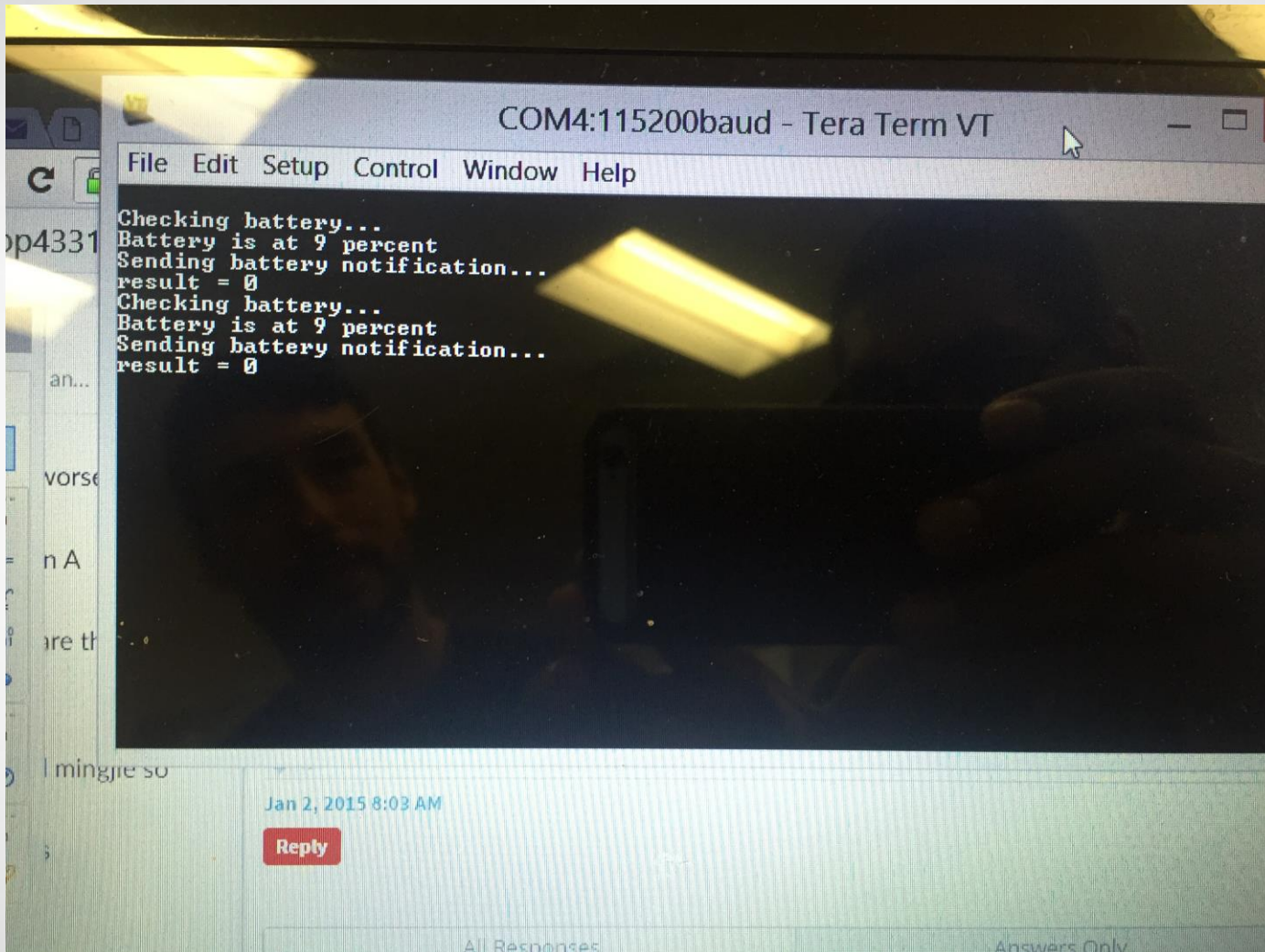
Battery Testing

- To assure maximize battery functionality, multiple test will be ran on the battery to figure the overall performance. In order to verify the battery will not fail during normal operations.
- General Performance
- Environmental Testing
- Mechanical Testing
- Safety testing
- Charge time: about 1 hr.
- No interrupts: 37 days
- Stuck at start up: 1 day
- Normal operation: 37 days

Battery Testing



Battery Testing



Budget

- Amount spent by purchase:

Supplier	Date	Price
Adafruit	9/23/2015	\$24.73
Mouser	9/23/2015	\$50.62
Banggood	9/28/2015	\$10.12
Newark	11/2/2015	\$36.61
Texas Instruments	11/8/2015	\$31.03
Texas Instruments	11/11/2015	\$41.99
UCF Print	12/8/2015	\$44.46
Newark	1/20/2016	\$44.08
Mouser	1/20/2016	\$104.64
OSH Park	1/21/2016	\$37.80
OSH Stencils	3/5/2016	\$22.63
Proto Advantage	4/6/2016	\$29.95
Lowes	4/15/2016	\$10.12
Google Cloud Service		\$10.00
Total		\$498.78
Budget		\$700
Remaining		\$201.22



Questions?