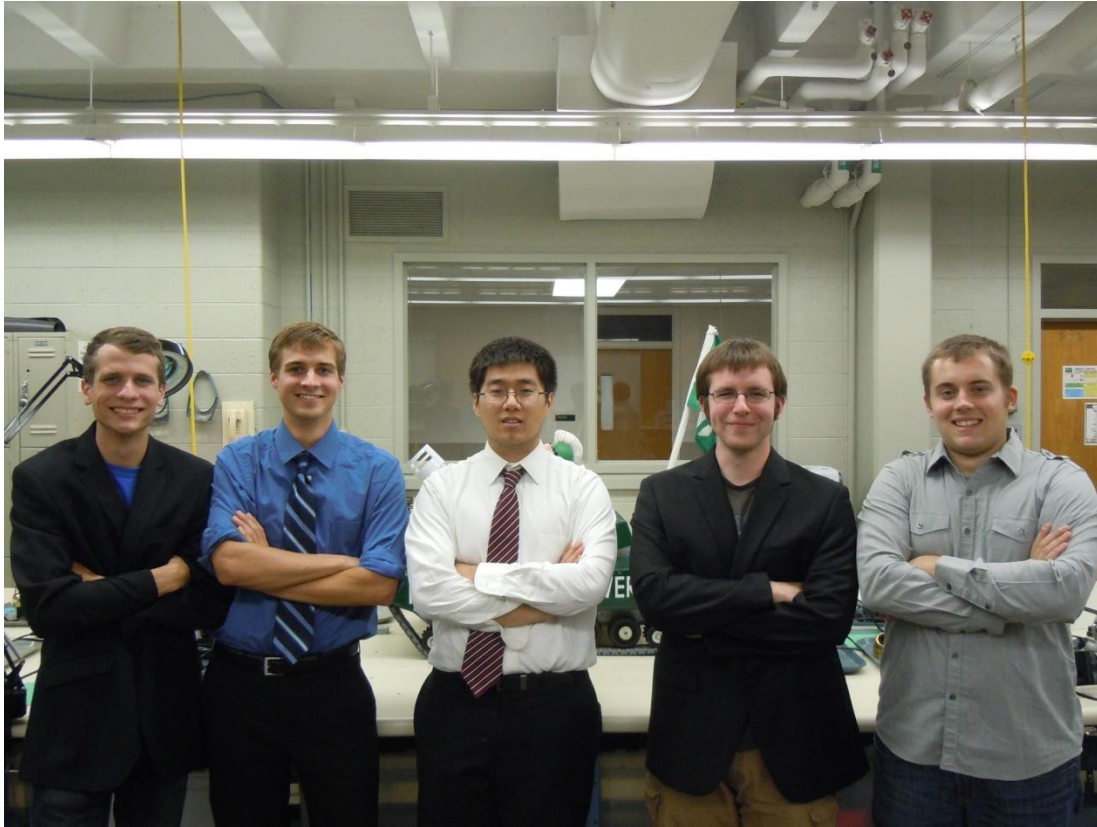


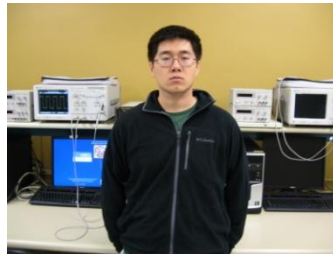
# User Settable G-switch



Seal Team Seven

# Team Members

- Sean Vanharen (manager)
- Tom Larter (document prep)
- Frank Doherty (webmaster)
- DJ Eaton (presentation prep)
- Xiao Xu (lab coordinator)
- Facilitator
  - Dr. Dean Aslam
- Sponsor
  - Greg Hoshal at Instrumented Sensor Technology, Inc.



# Agenda

- Background
- Problem
  - General
  - Requirements
- Solution Statement
- Circuit Structure
- DIP switch design
- Product Choices
- Code Flow Chart
- Relay Choices
- Risk Analysis
  - Durability
  - Pros & Cons
- Budget
- Summary
- References
- Questions

# Background

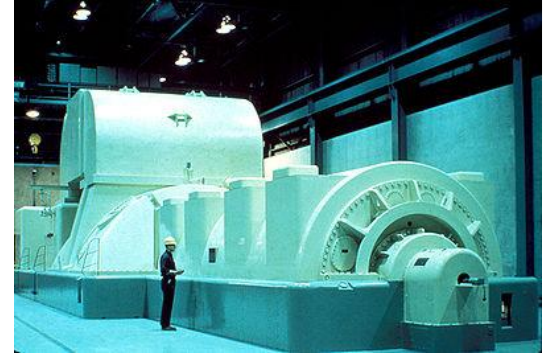
- Instrumented Sensors and Technology



- Shock, Vibration, Temperature and Humidity Sensor Recorders.
- Motion Master, Self contained sensor/Recorder measures and records 6-Axis Roll, Pitch & Yaw.
- Shock-Timer for shipment monitoring.
- Worked with NASA, Mythbusters, and the US Armed Forces

# General Problem

- Heavy Machinery (Industry)
  - Out of control/destructive oscillation
  - Earthquake/destructive weather
- Shipping
  - Cargo monitoring
  - Damage from shock and vibration
- Vehicles
  - Collisions
  - Abrupt braking/swerving



# Requirements

- Operate from DC to 100Hz
- Mode setting selected via DIP switch
- RMS and peak detection modes
- Must work with 125V/10A relay
- Battery powered (6 months) or wall powered
- No larger than 12 cubic inches
- Screw terminal strip for relay connections

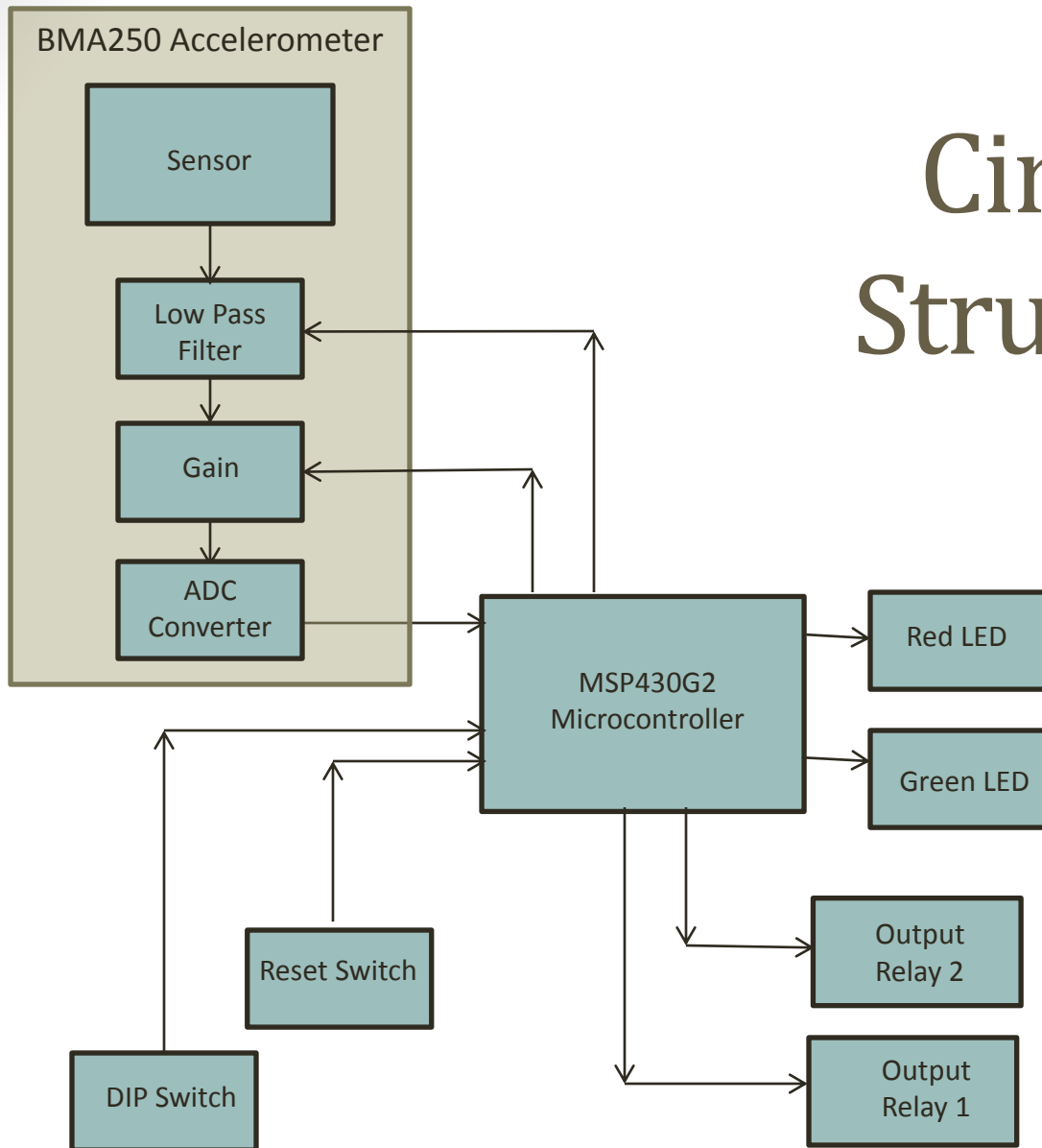
# G-level Setting Requirements

| Peak Mode | RMS Mode |
|-----------|----------|
| .25g      | .0625g   |
| .50g      | .125g    |
| 1g        | .25g     |
| 2g        | .50g     |
| 4g        | 1g       |
| 6g        | 2g       |

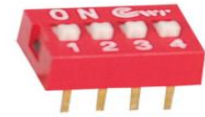
# Solution

- User-settable g-switch
  - Small, self-contained
  - Can be mounted on a machine/building/package
  - Will trip a relay necessary to cut off power/start a control procedure
  - Visually indicates a tripped or un-tripped state

# Circuit Structure



# DIP Switch Truth Table



| DIP setting | Detection mode | Trip level |
|-------------|----------------|------------|
| 0000        | Peak           | .25g       |
| 0001        | Peak           | .50g       |
| 0010        | Peak           | .75g       |
| 0011        | Peak           | 1g         |
| 0100        | Peak           | 1.5g       |
| 0101        | Peak           | 2g         |
| 0110        | Peak           | 4g         |
| 0111        | Peak           | 6g         |
| 1000        | RMS            | .0625g     |
| 1001        | RMS            | .125g      |
| 1010        | RMS            | .15g       |
| 1011        | RMS            | .25g       |
| 1100        | RMS            | .50g       |
| 1101        | RMS            | .75g       |
| 1110        | RMS            | 1g         |
| 1111        | RMS            | 2g         |

# BMA250 Bosch Triaxial Accelerometer

- Made by Bosch Sensortec
- X Y and Z triaxial acceleration sensor
- Desired Gforce measurement range
- Digital Output
- 8Hz – 1kHz Settable bandwidth with built-in filter
- 3.91 mg resolution
- Ultra Small Package – 2mm x 2mm, 0.95 mm height
- Ultra Low power – 7 $\mu$ A in Low power mode, 0.5 $\mu$ A in suspend mode
- High shock survivability



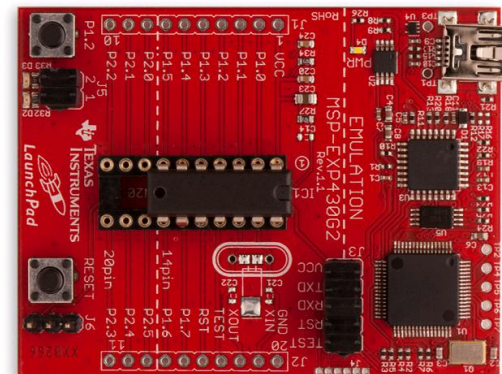
# MSP430G2 Microcontroller

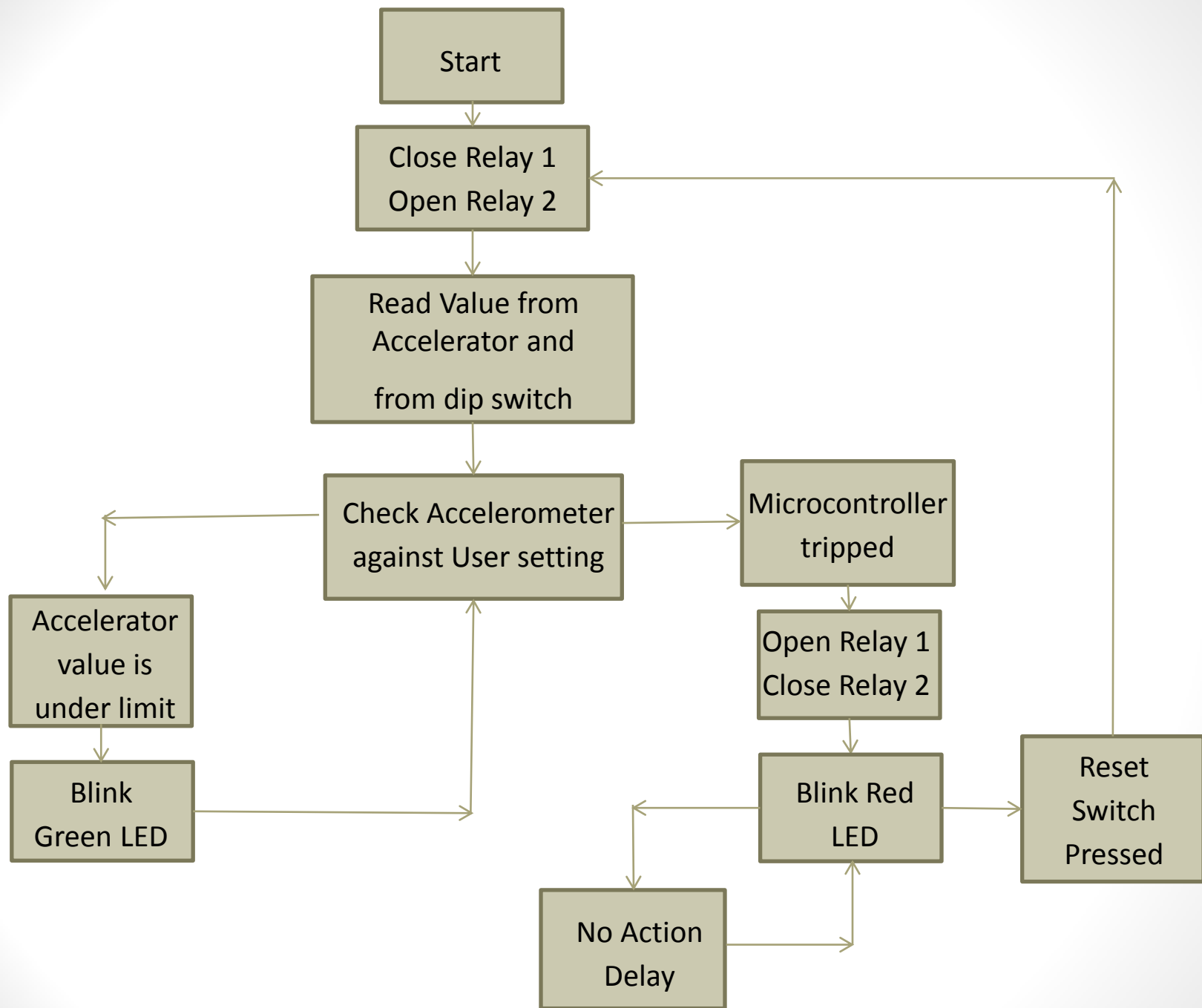
- Low cost, easy to use (Programmable in C)
- Large support base online by TI and user community
- Can do all functions desired (RMS calculation, Peak Detection)
- Up to 16MHz internal frequency with 32kHz Crystal Clock
- Ultra Low power – 0.5 $\mu$ A Standby mode, 220 $\mu$ A at 1MHz



# TI Launchpad Development Board

- Low cost
- USB Connection and DIP sockets for easy prototyping





# Issues to still overcome

## Relay choices



### Solid State Relay

Lower Minimum latching current

Faster Switching Time

Longer life span

No bouncing, cleaner operation

Less effected by environment

Can design on-board relay



### Mechanical Relay

Better Fail Safe

Cheap

More diverse/accessible

# Risk Analysis and Concerns

- Very durable, hazardous conditions
  - Heat
  - Vibrations
  - Dirt
- Low Power Consumption
  - 6 month battery life
- Portable
  - Easy to install and take apart

# Pros and Cons

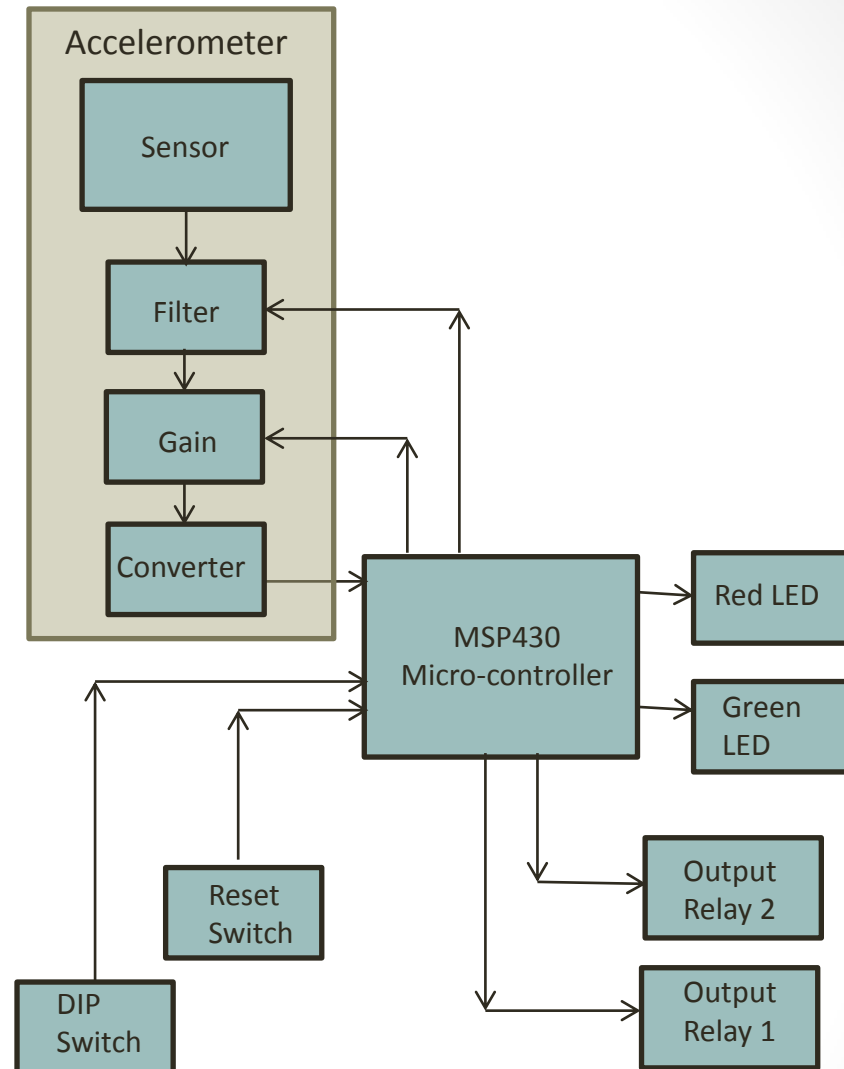
- Low Power Consumption
- Cheap
- Set and Forget
- Easy to Use
- Small design
- Limited space for additional batteries
- Durable enough

# Budget

| Part                                       | Cost                  |
|--------------------------------------------|-----------------------|
| 2 Bosch Sensortec Accelerometer            | \$7.08                |
| 3-Axis Digital Accelerometer PCB – BMA 250 | \$10.00               |
| TI Launchpad Experimenter                  | \$4.30                |
| Relay and MOSFET                           | \$40.00*              |
| DIP Switch                                 | (from lab) \$0.00     |
| PCB                                        | \$33.00*              |
| Power Supply                               | \$10.00*              |
| CURRENT TOTAL:                             | \$104.38 * Estimation |

# Conclusion

- Problem Statement
- Solution Statement
- Block Diagram
- DIP switch design
- Relay Choices
- Risk Management
- Pros v Cons
- Budget





# Technical Roles

- Software Development
  - Xiao
  - David
- Circuit and PCB Design
  - Tom
- Assembly and Testing
  - Frank
  - Sean

QUESTIONS?

# References

- <http://www.crydom.com/en/Tech/Tips/why%20use%20a%20solid%20state%20relay.pdf>
- <http://www.4pcb.com/33-each-pcbs.html>
- <http://www.ti.com/>
- <http://www.bosch.us/content/language1/html/index.htm>
- <http://www.isthq.com/>