# Wireless Patient Monitoring System

Final Project Presentation
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Chris Nord, ECET-491
Justin Lange, ECET-491
Logan Isch, CPET-491

Advisor: Professor Paul I-Hai Lin
Department of Computer and Electrical Engineering Technology & Information Systems and Technology
College of Engineering, Technology, and Computer Science
Indiana University – Purdue University Fort Wayne, Indiana

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# Introduction

- The goals we wish to share with you this morning are as follows:
  - Share our motives for selecting our project
  - The steps we took to accomplish the tasks of the project
- Due to time constraints please hold questions until the presentation has concluded

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## Problem Statement and Solution

- Patient confinement
- Proper monitoring for quick alert and response time at home or in care services
- Create a multifunctional wireless monitoring system



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## Outline

- System Analysis
  - Hardware
  - Software
- System Design
  - Hardware
  - Software
- System Integration and Testing
  - Hardware
  - Software
- Conclusion
  - Lessons learned
- Acknowledgements
- Questions
- Project Demonstration

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# System Analysis

- What do we need to solve the problem?
  - Hardware
  - Software
    - Embedded software
    - Desktop software
      - Data acquisition
      - Database
      - User interface

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# System Analysis - Hardware

- Creating a wireless monitoring system with sensors including:
  - Heart rate monitoring
  - Vibration and shock sensors
  - Panic button that is LED illuminated
- Create an enclosure that is secure, comfortable, and lightweight for user to wear

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# System Analysis - Software

- Embedded software
  - Sample sensors
  - Process data
  - Transmit data sentence over wireless network

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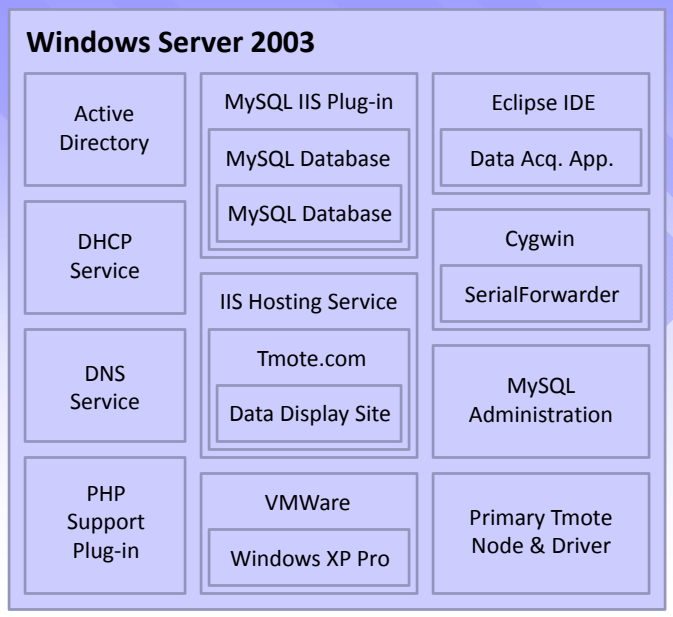
# System Analysis - Software

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# System Analysis - Software

Database Server

- Windows Server 2003
  - Active Directory Domain Controller
  - DNS and DHCP Services
  - Internet Information Services (IIS)
- MySQL Database
  - Database and GUI Administration Client
  - PHP: Hypertext Processor Extensions for IIS

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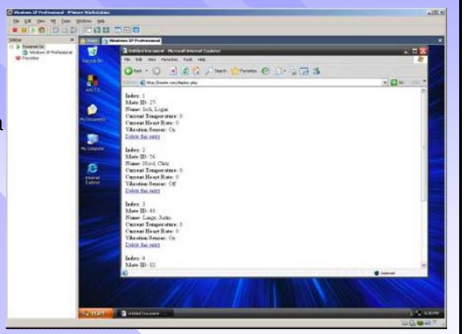
# System Analysis - Software



Database Server (cont.)

- Tmote.com
  - Display page for viewing stored data
  - Setup page for adding new mote data to the database
  - Deletion option for removing mote data from the database
- VMWare Workstation
  - Running Windows XP Pro
  - Allows for testing of client website

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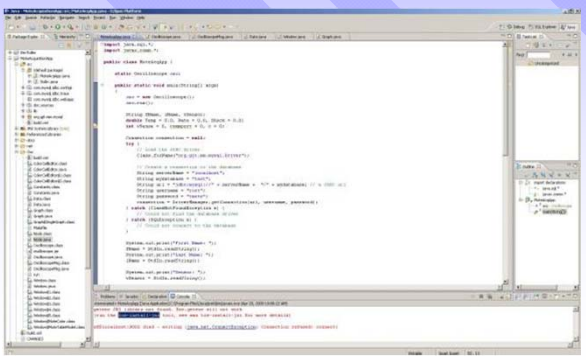
# System Analysis - Software

Database Server (cont.)

- Primary Tmote Node
  - Attached via USB interface
  - TinyOS software forwards data from Tmote to network port
  - Java application captures data and stores it to MySQL database
  - Java application also handles alerts from shock/vibration sensors



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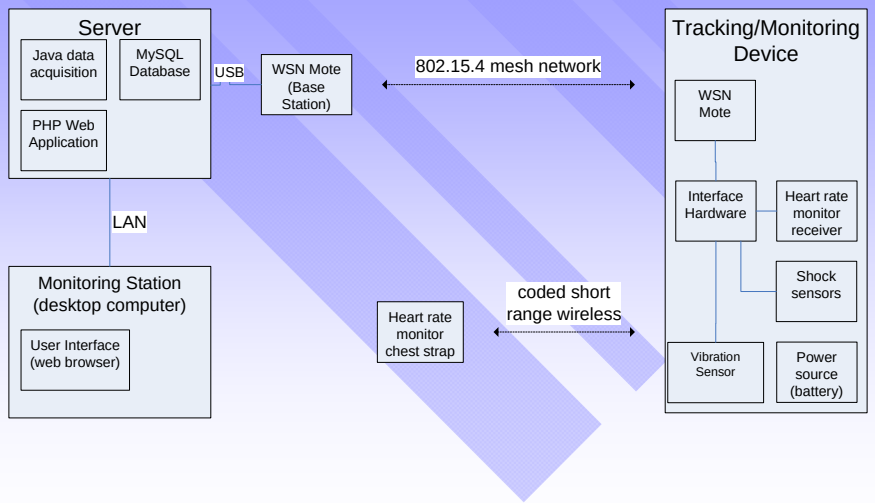
# System Design

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# System Design - Hardware

- Daughter Board Hardware
  - Heart rate Monitor
  - Shock Sensor
  - Vibration Sensor
  - Panic button with Light sensor LED (fiber optics lighting)
- Enclosure Design

From: www.computron.com

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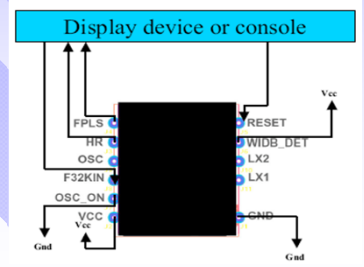
# Heart Rate Monitor

- Polar - RMCM01
- Low power consumption
- Tested before/after daughter board
- Consistent heart rate response with transceiver belt


From: Funspark.com




From: Funspark.com

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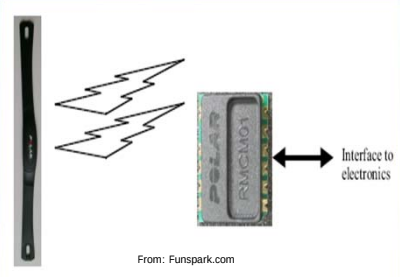
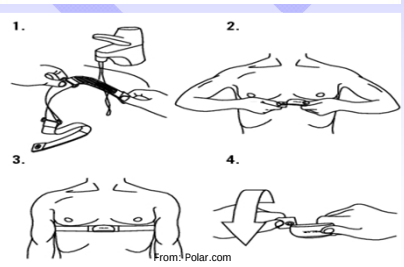
# Heart Rate Monitor

- Records stronger heart rate since attached to chest
- Heart strap transmits signal securely and consistently within a 80 cm range




From: Funspark.com




From: Polar.com

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# Shock Sensor

- SQ-AS015
- Used to detect falls or collisions
- Tested with ohm meter prior to circuit fabrication
- Normally closed; chatters open when 15 G shock event occurs


From: SignalQuest.com

ELECTRICAL CHARACTERISTICS

| PARAMETER | MIN | MAX | UNITS |
|---|---|---|---|
| Supply Voltage Range | 0.5 | 12 | Vdc |
| Current Sink* | 0.00025 | 5 | mA |

From: SignalQuest.com

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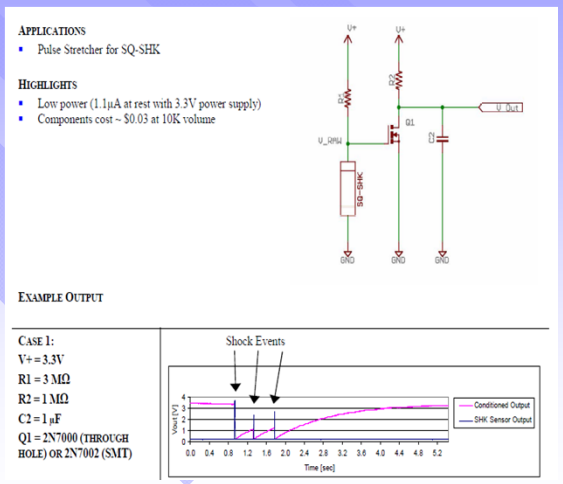
# Shock Sensor Circuit

- X and Y Axis shock sensors in series
- Sensors used as voltage divider to trigger mosfet into RC circuit to stretch signal




From: SignalQuest.com

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# Vibration Sensor

- SQ-SEN-200
- Used for recovery wake-up alert
- Tested with ohm meter prior to circuit fabrication
- Normally Closed

From: SignalQuest.com

ELECTRICAL CHARACTERISTICS

| PARAMETER | MIN | MAX | UNITS |
|---|---|---|---|
| Supply Voltage Range | 0.5 | 12 | Vdc |
| Current Sink* | 0.00025 | 5 | mA |

From: SignalQuest.com

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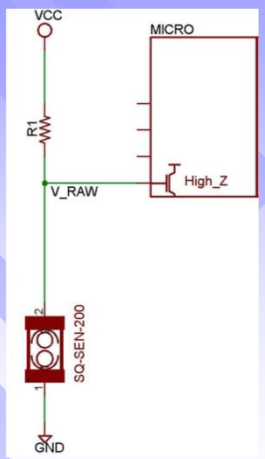
# Vibration Sensor Circuit

- Basic voltage divider into microprocessor
- Low voltage threshold needed to alert microprocessor




From: SignalQuest.com

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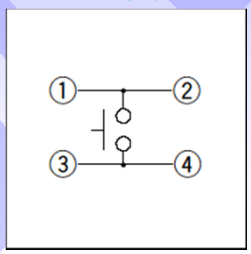
# Panic Button

- Standard tactile momentary push button
- Micro Processor will sample at 10-20 times per second

From: Digikey.com




From: alps.com

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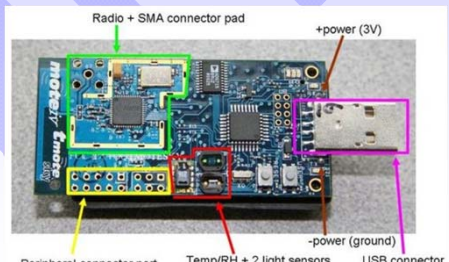
# Light Sensor and Photo Sensor

- MV6053 ultra low power LED
- LED has .275mA current draw
- Illuminates panic button to aid patient in a dark setting

From: Digikey.com




From: Sentilla.com

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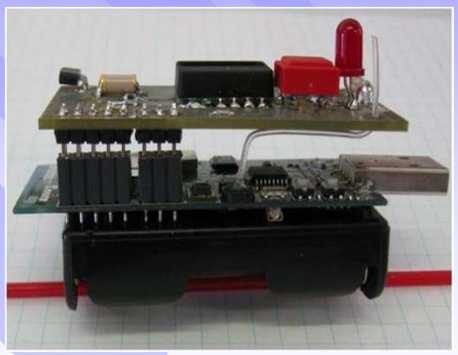
# Light Sensor with Fiber Optics

- Fiber optics allows photo sensor to sample light outside of enclosure
- Flexible material
- Microprocessor will activate LED is light level goes below threshold



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# Enclosure Design and Fabrication

- Constructed from .08” thick acrylic
- USB port added for product stability
- .2” padding added to bottom and sides for product protection
- ACE wristband used for comfort (Velcro)

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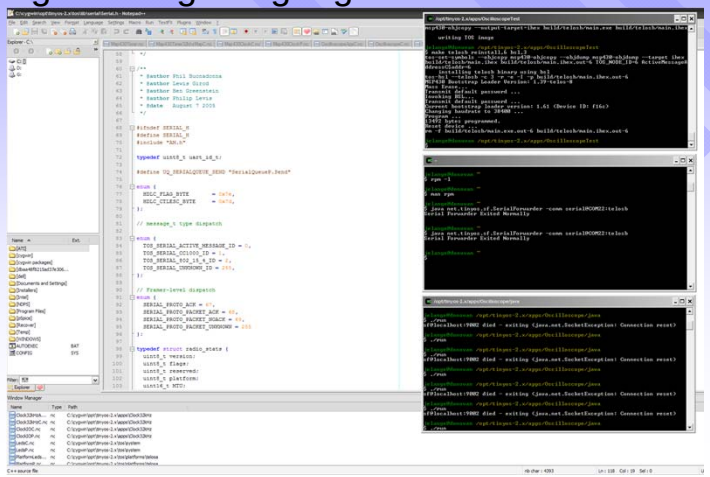
# Development System

- Software Platform: TinyOS 2.1
- Programming Language: nesC



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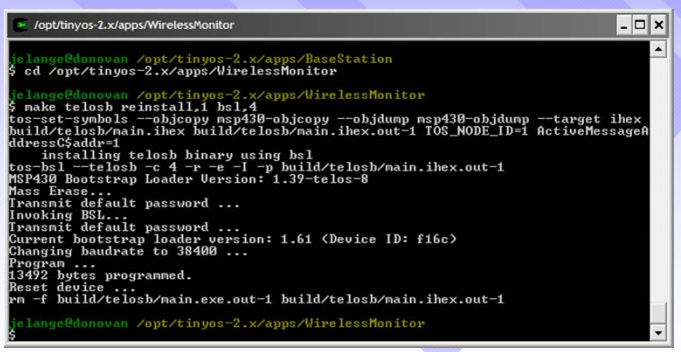
# Development System

- Command line programming tools
  - Unix emulation on Windows using Cygwin

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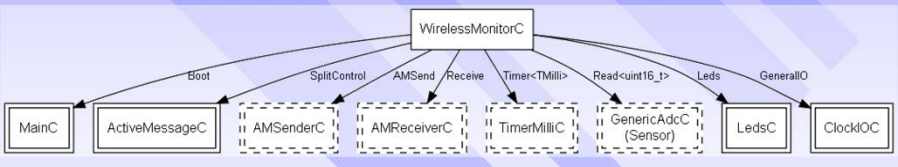
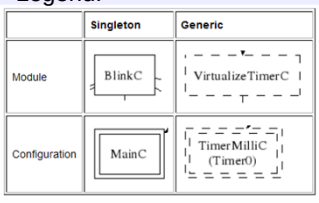
# System Design - Software

- Top level software components and connections




Legend:

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## System Design - Software

- Software components allow monitoring of these sensors/values
  - Heart rate
  - Shock
  - Vibration
  - Light
  - Temperature
  - Battery voltage
  - Call button

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## System Integration and Testing - Hardware

- All components tested before and after daughter board assembly to ensure individual and integrated functionality
- Daughter board design and fabrication
- Daughter board integration to TMote

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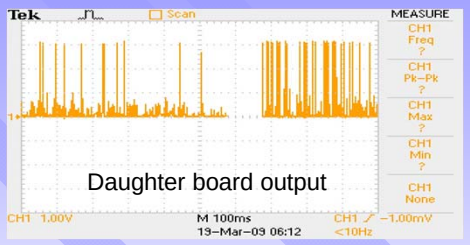
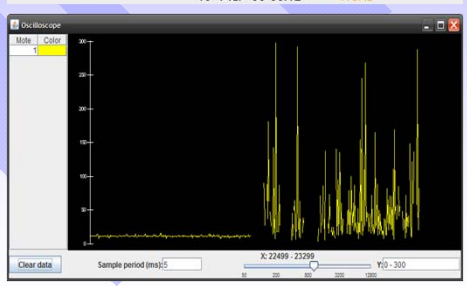
# Vibration Sensor Circuit

- Tested after daughter board construction was complete
- Sensor output behaved exactly as planned
- Disturbance enough to alert TMote




After Assembly on TMote

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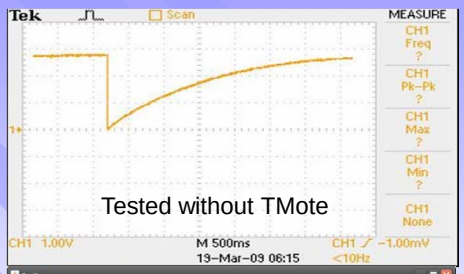
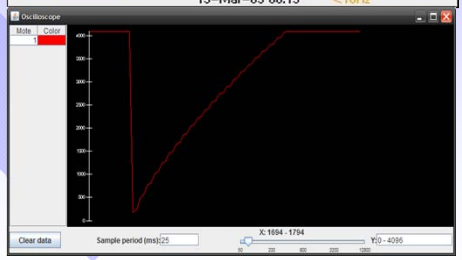
# Shock Sensor Circuit

- Tested with Pspice prior to fabrication
- TMote signal output match circuit board waveform
- Pulse stretcher allows plenty of time to trigger alarm




After Assembly on TMote

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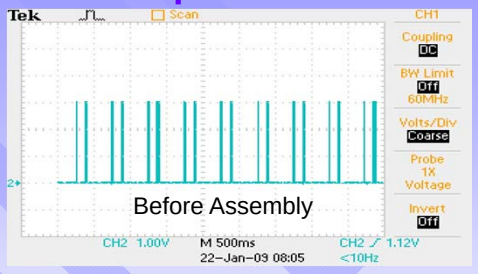
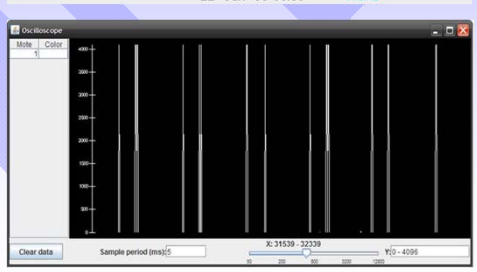
# Heart Rate Output

- Heart rate output at about 120 BPM
- Reception limits of 80 cm tested in all three axis
- Signal extremely consistent within 80 cm limit




After Assembly on TMote

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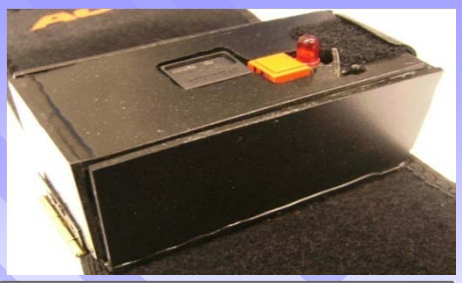
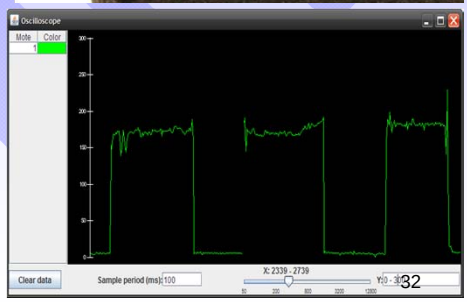
# Light Sensor/Fiber Optics Testing

- Tested in sealed enclosure with 120 Lumen flash light
- Received well defined response easily detected by microcontroller to switch LED



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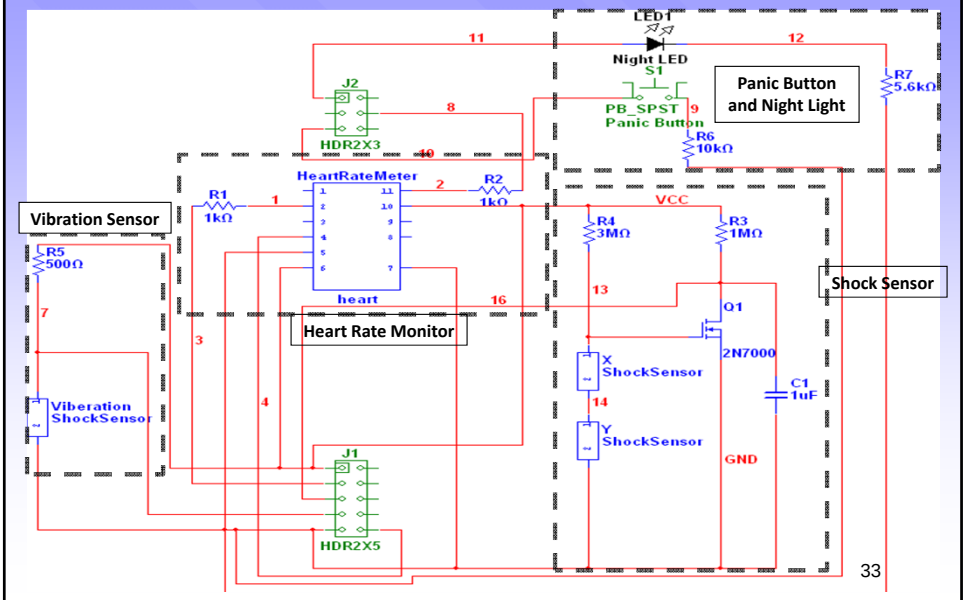
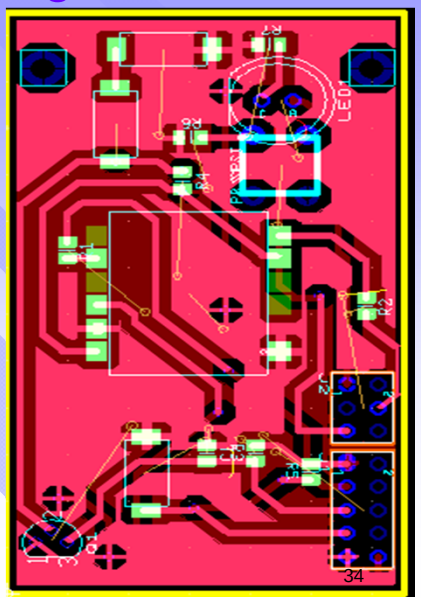
# Circuit Integration in MultiSim



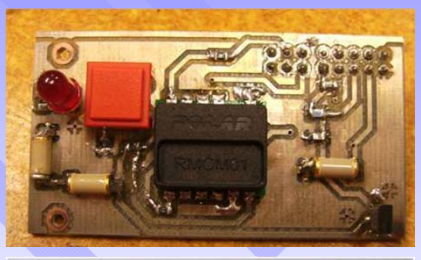

# Daughter Board Design in Ultiboard

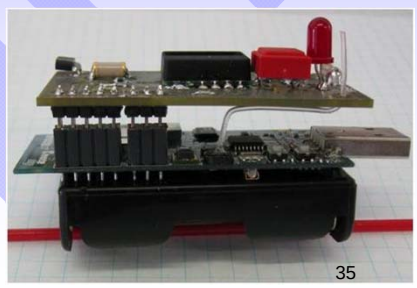
- 2 layer board
- 1.3” x 2.6” board
- 15 components
- Through hole copper covered vias
- Board built to line up perfectly on top of TMote



# Daughter Board Fabrication

- 16 pin connector applied to join boards
- Combined board dimensions:
  - Length 3.18”
  - Height 1.60”
  - Width 1.35”
- Fiber optics applied after board assembly





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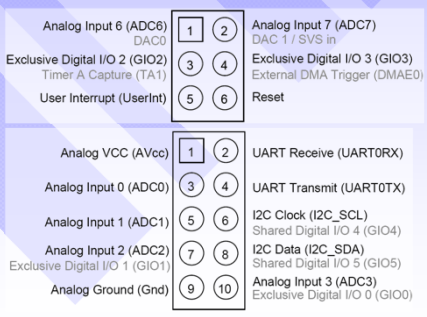
# Daughterboard Integration

- Connections between daughtercard and TMote Sky

Connections

| Input/ Sensor | Type | Function | µC pin |
|---|---|---|---|
| **Shock** | analog | sensor in | ADC1 |
| **Vibration** | analog | sensor in | ADC2 |
| **Heart Rate** | analog | sensor in | ADC0 |
| | digital | clock | ADC3 |
| | digital | reset | GIO3 |
| **Call Button** | digital | Momentary PB in (NO) | UserInt |
| **LED** | analog | DAC out | ADC6 |

Expansion Headers

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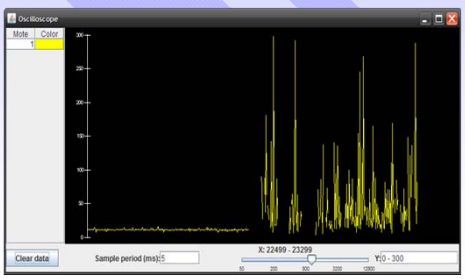
# System Integration and Testing - Software

- Embedded software developed to capture sensor data
  - Seen in examples throughout the hardware section

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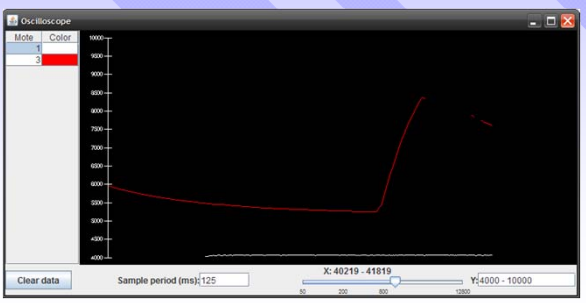
# System Integration and Testing - Software

- Temperature sensor
  - Sensirion SHT11
  - Extreme values of 111.9 F and 55.2 F

$$Temp_{^\circ F} = -39.3 + 0.018 \cdot raw\,data$$
$$\max observed\,temp = -39.3 + 0.018 \cdot 8400 = 111.9^\circ F$$
$$\min observed\,temp = -39.3 + 0.018 \cdot 5250 = 55.2^\circ F$$

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# System Integration and Testing - Software

Database Server Testing

- Tmote.com
  - Accessed via Internet Explorer on Windows XP Pro
  - Default page shows contents of website
    - Display data
    - Add new device
    - Edit existing device
  - All website functions are verified working
  - Data is continually updated by Java application
    - Refreshing display page yields new data
    - Alerts are thrown as pop-ups from the Java application
  - Displayed data is verified against stored data
    - MySQL Administration Client used to view stored data

| Name | Data | Vibration | Control |
|---|---|---|---|
| Isch, Logan | 87.366 | Off | Delete Data |
| Isch, Logan | 87.348 | Off | Delete Data |
| Isch, Logan | 87.366 | Off | Delete Data |
| Isch, Logan | 87.348 | Off | Delete Data |
| Isch, Logan | 87.366 | Off | Delete Data |
| Isch, Logan | 87.348 | Off | Delete Data |
| Isch, Logan | 87.348 | Off | Delete Data |
| Isch, Logan | 87.366 | Off | Delete Data |
| Isch, Logan | 87.348 | Off | Delete Data |
| Isch, Logan | 87.33 | Off | Delete Data |
| Isch, Logan | 87.366 | Off | Delete Data |
| Isch, Logan | 87.384 | Off | Delete Data |
| Isch, Logan | 87.348 | Off | Delete Data |
| Isch, Logan | 87.348 | Off | Delete Data |

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# Conclusion

- Lessons learned

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# Acknowledgements


- Professor Paul Lin
- Dr. Suzanne Rumsey
- Bob Tilbury
- James Nord
- Mark Lange


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# Questions?

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# Demonstration


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