Overcurrent Protection: Reference Design & Study

ECE 480
Design Team 5
Kenji Aono
Stephen England
Ryan Laderach
Joshua Myers
Facilitator: Dr. Wen Li
Sponsor Representative: Mr. Pete Semig

Overview of Project

- What is over-current protection?
  - Traditional methods
  - Advantages

Introduction

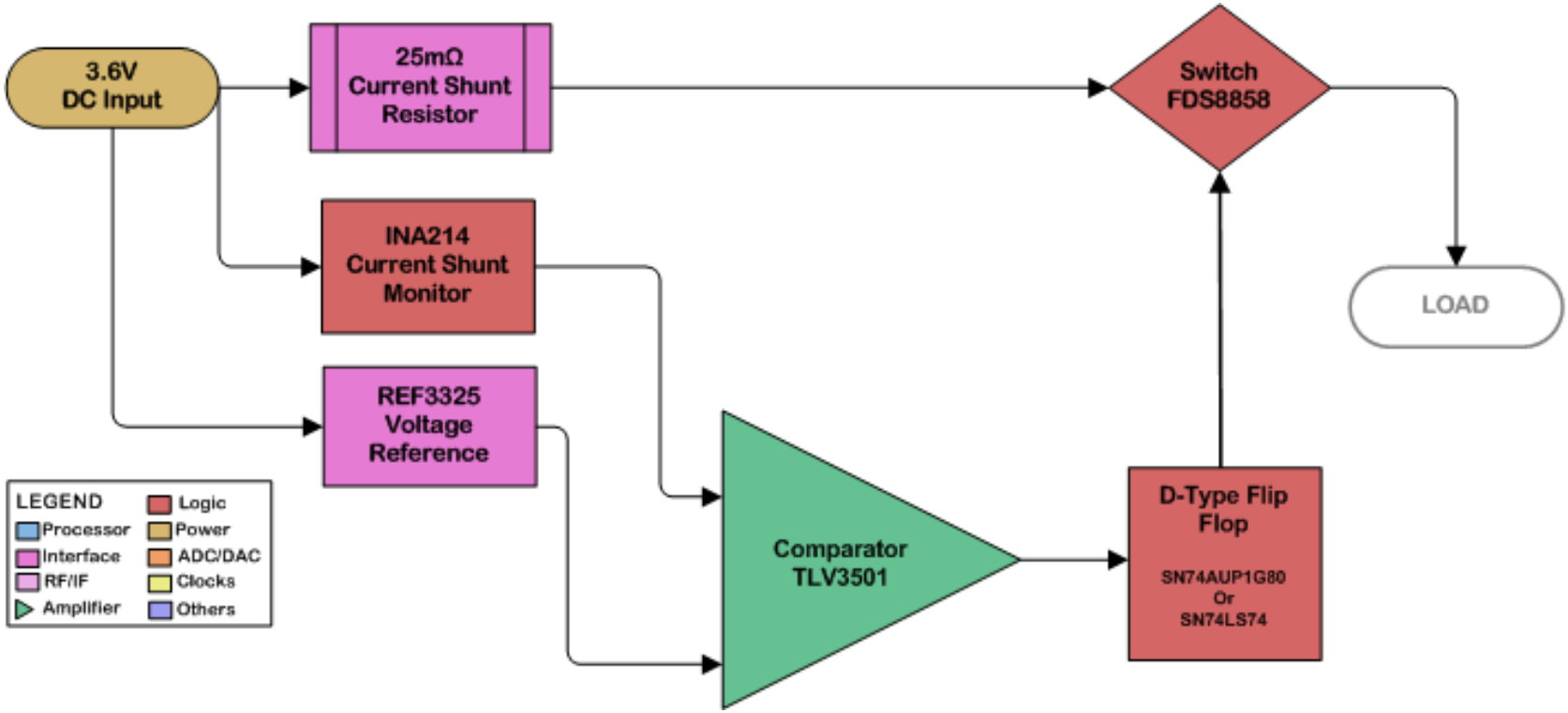
- Design two separate overcurrent protection systems
  - Application 1: Tablet PC emergency system shutdown
  - Application 2: Cell phone power monitoring system
- Use current sensing components from Texas Instruments
- Complete PCB design study cases
  - Demonstrate how undesired PCB traces adversely affect current sensing accuracy

Design Specifications

- Application 1
  - Assume 3.6 V, 6.75 A-hr Li-Ion battery
  - Shutdown at 1 A
  - Priorities
    1. Small size
    2. Low cost
    3. Low power consumption
    4. Fast speed of shutoff

Final Design & Results

- Application 1 Design

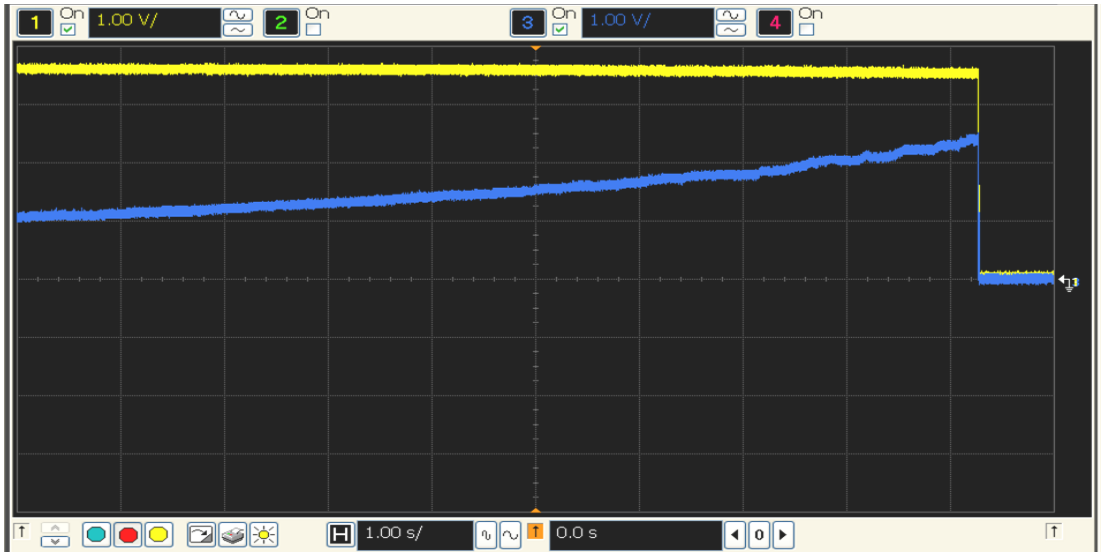


Final Design & Results

Application 1 Results

Switches off at 2.5 V

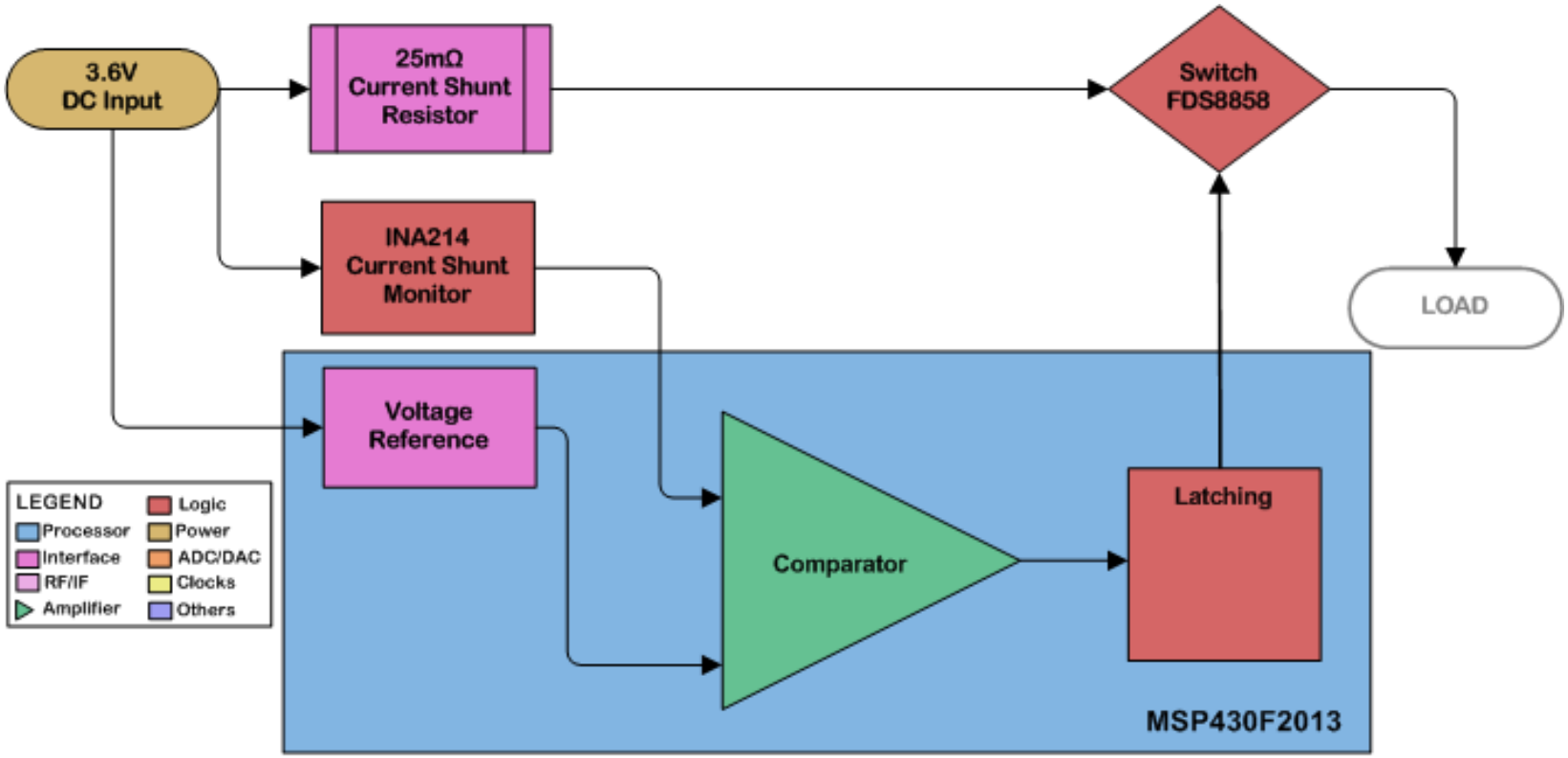
Speed: 750 µs (SN74LS74)



SN74LS74	.97in X .75in	7.58mA	27.288mW
SN74AUP1G80	1.01in X .529in	3.83mA	13.788mW

Final Design & Results

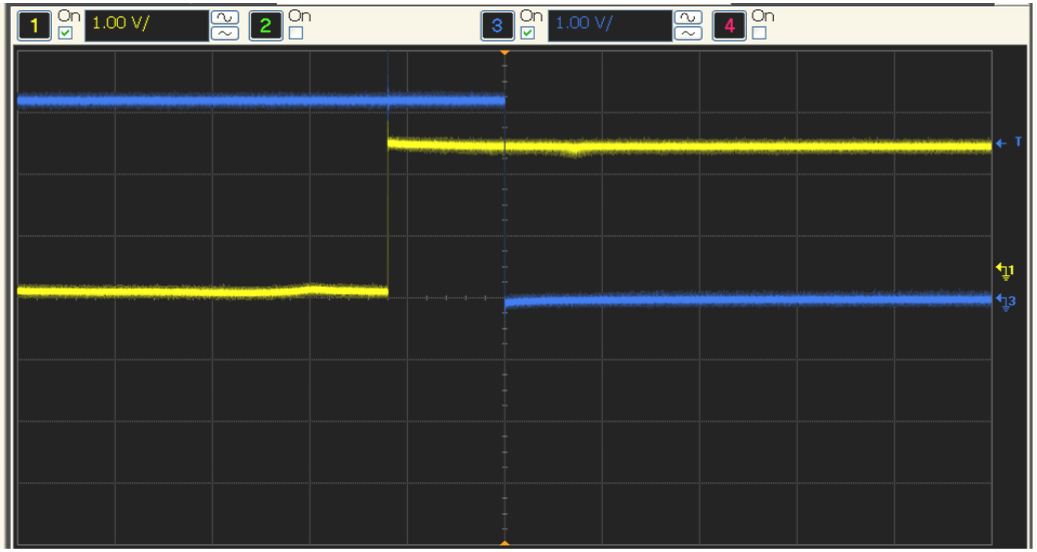
- Application 1 Alternative Design



Final Design & Results

Alternative Application 1 Results

Speed: 125 µs



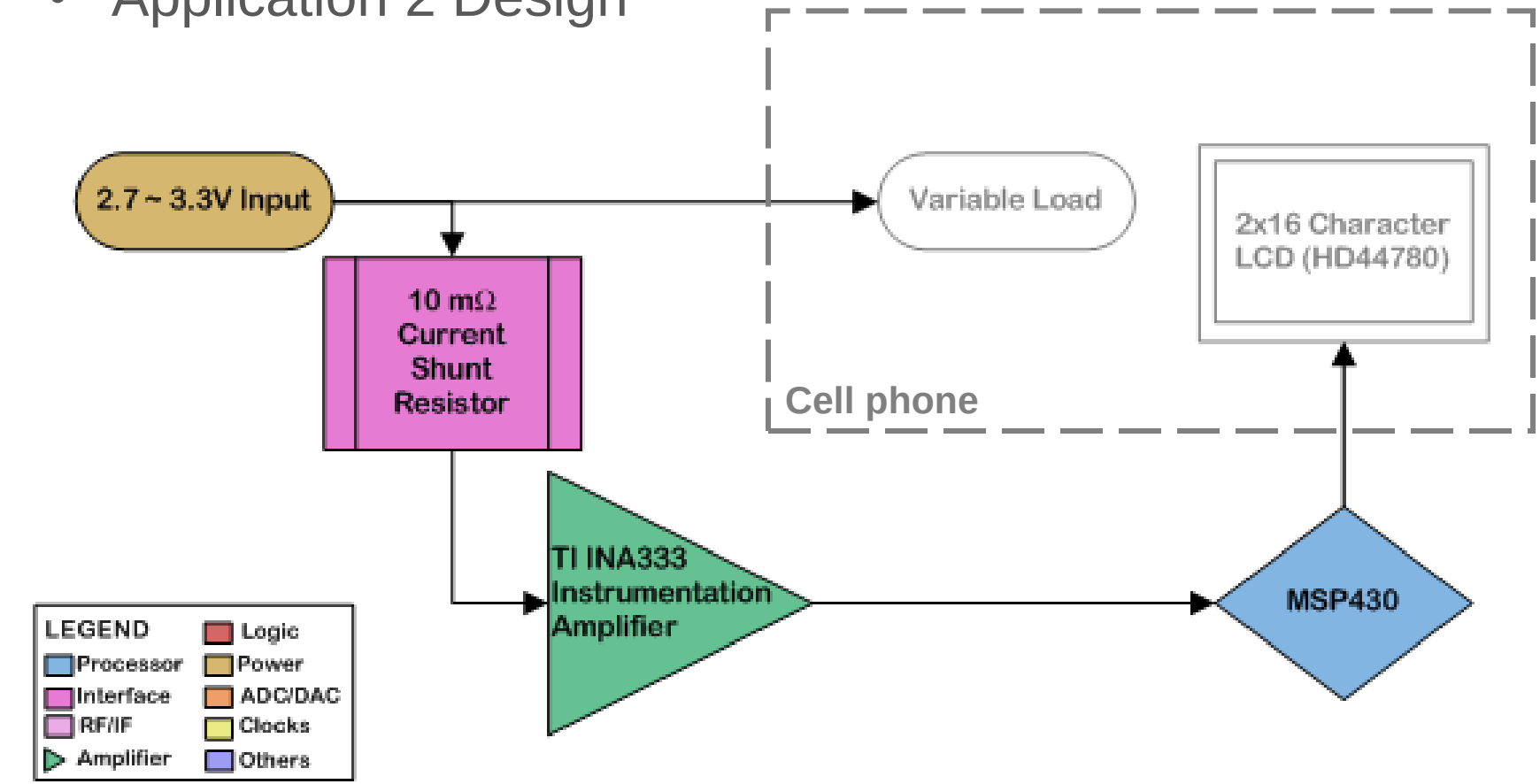
MSP430 Mode	Current Draw	Power Consumption
Sleep	4.8µA	17.28µW
Active	80.2µA	288.72µW

Design Specifications

- Application 2
  - Well regulated 3V supply voltage
  - Variable load: 2.7V-3.3V
  - Accurate between 7mA-192.5mA
  - Priorities
    1. Minimal system impact
    2. Small size
    3. High accuracy

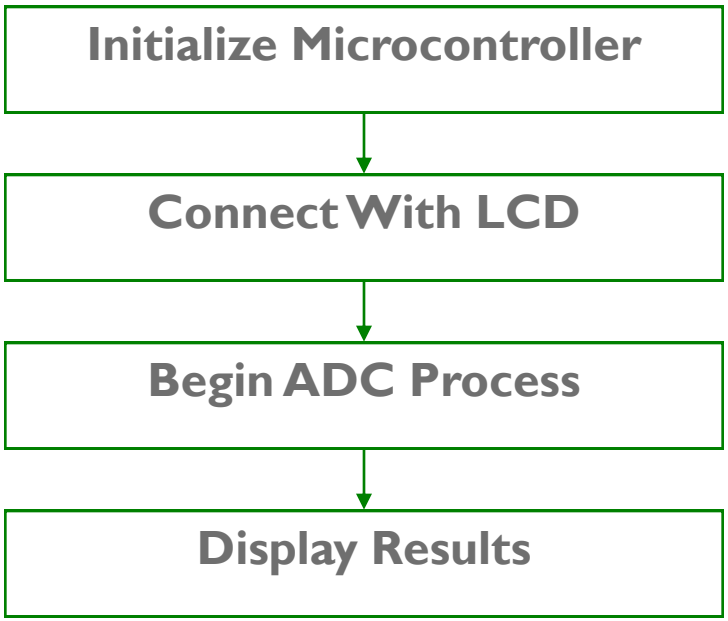
Final Design & Results

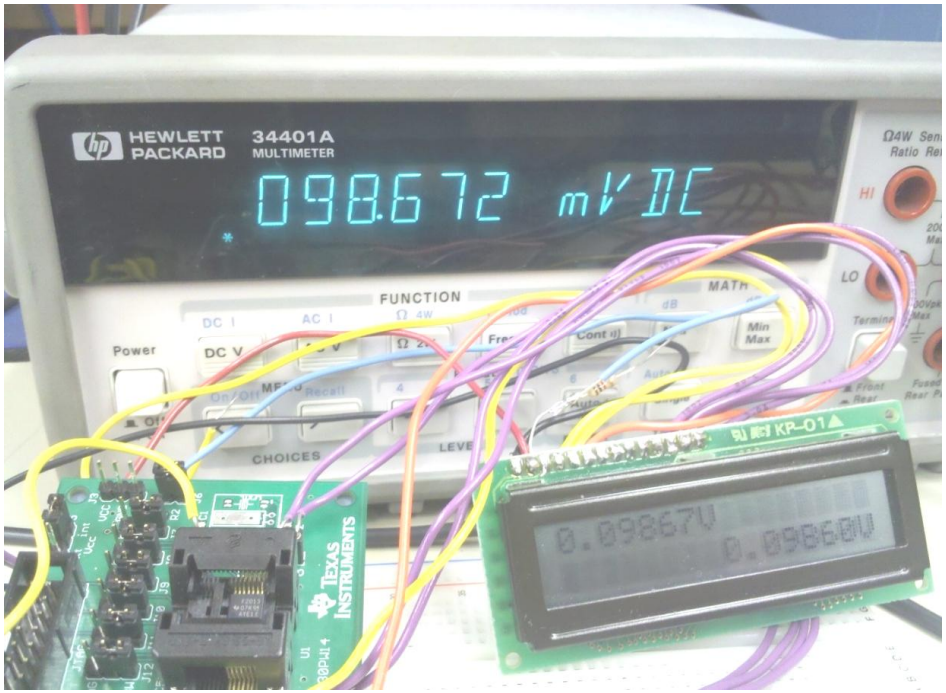
- Application 2 Design



Final Design & Results

Application 2 Software Results





Final Design & Results

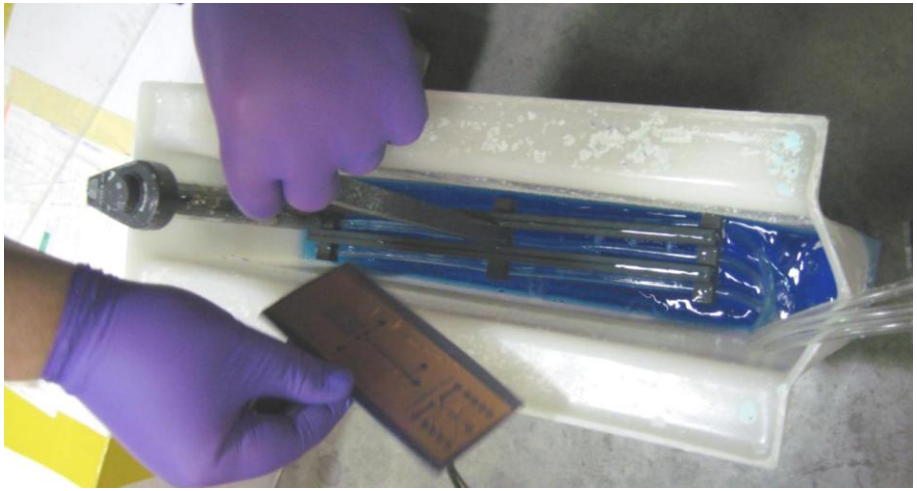
Application 2 Demonstration

Design Challenges & Recommendations

- Printed Circuit Boards (PCBs)
  - Necessary for testing all design iterations
  - Professional fabrication methods are high cost and provide slow turnaround
  - Requires a quick, cheap method
  - CNC milling provided by ECE department ineffective for our designs

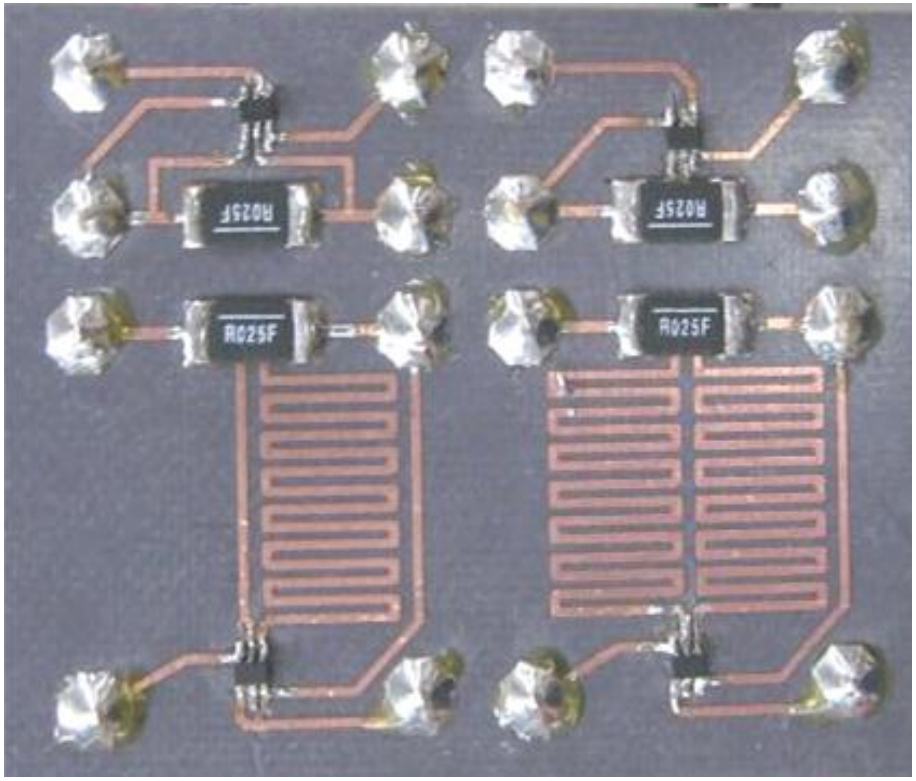
PCB Design and Fabrication

- EAGLE software used for PCB design
- A method of chemical etching was created
  - Performed on campus in the Engineering Research Complex
  - Higher resolution than CNC milling
  - Quick turnaround
  - Low cost



PCB Design Study Results

- Four cases tested
  - Ideal trace
  - Long distance traces
  - Non-symmetrical traces
  - Non-Kelvin connection traces



PCB Design Study Results

Case	Current	Expected output	Output	%Error
Ideal	118.92mA	297.3mV	323.5mV	8.81%
Long	111.42mA	278.55mV	493.89mV	77.31%
Non-symmetrical	100.24mA	250.56mV	273.77mV	9.57%
Non-Kelvin	99.513mA	248.78mV	325.24mV	30.77%

*Results with 30Ω load (100mA current draw)

Conclusions

- Application One
  - Low cost
  - Reasonably fast shutoff speed
  - Accurate
  - Minimal size with given resources
- Application Two
  - Precise
  - Small size
  - Minimal impact

Future Suggestions

- Use MSP430 for application one
- Solve soldering issues of MSP430 and other small components
- Higher budget

Questions