Design Team 5

Over-current Protection Reference Design and Study

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Introduction

- What is over-current protection?
  - Traditional methods
  - Advantages
- Application 1:
  - Tablet PC over-current protection
- Application 2:
  - Cell phone current display

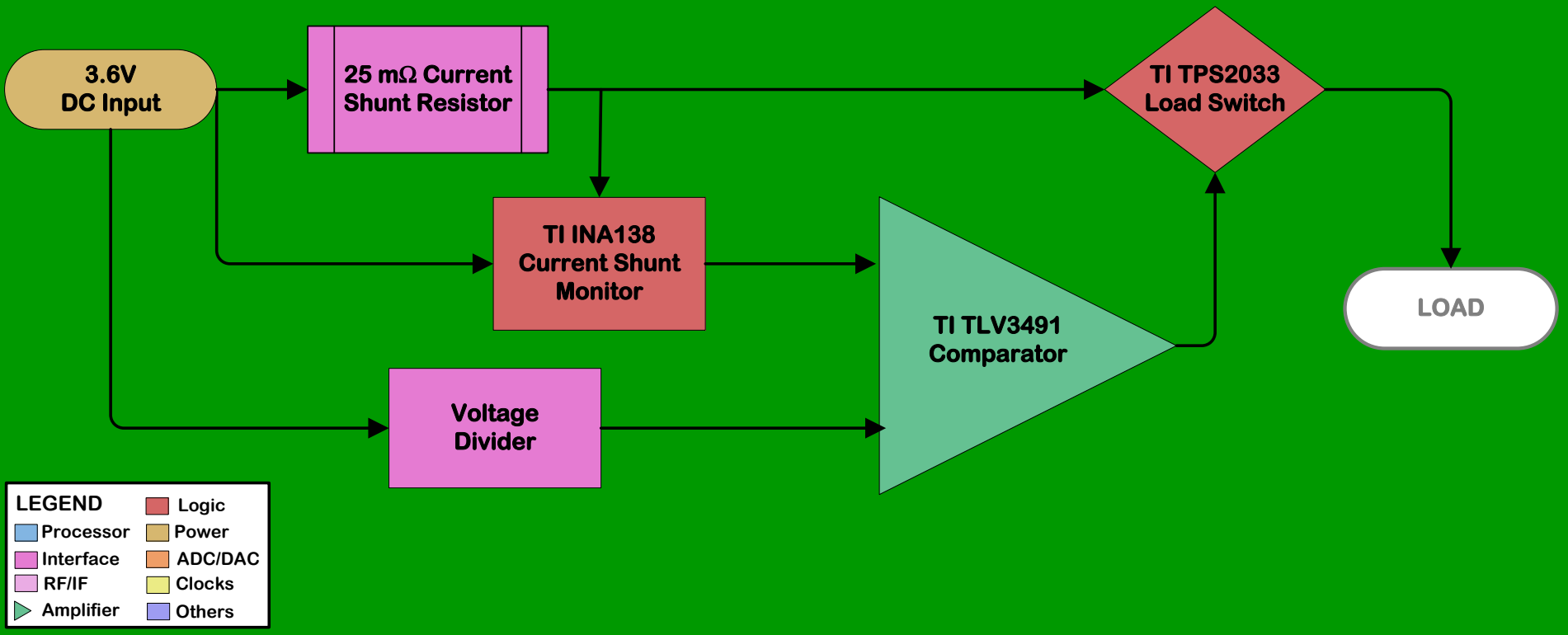
Current Sensing

- Types of current sensing
  - MOSFET
  - Hall-Effect
  - Current transformer
  - Current shunt monitor

Tablet PC over-current protection

- Purpose: Design a tablet-PC OCP system that switches off power to the load.
  - Trip at 1A of Current
  - Battery Specifications: Li-Ion 3.6V, 6.75A-hr
  - Priorities:
    - Small Size
    - Low Power
    - Fast Speed of Shutoff
    - Low Cost

Block Diagram



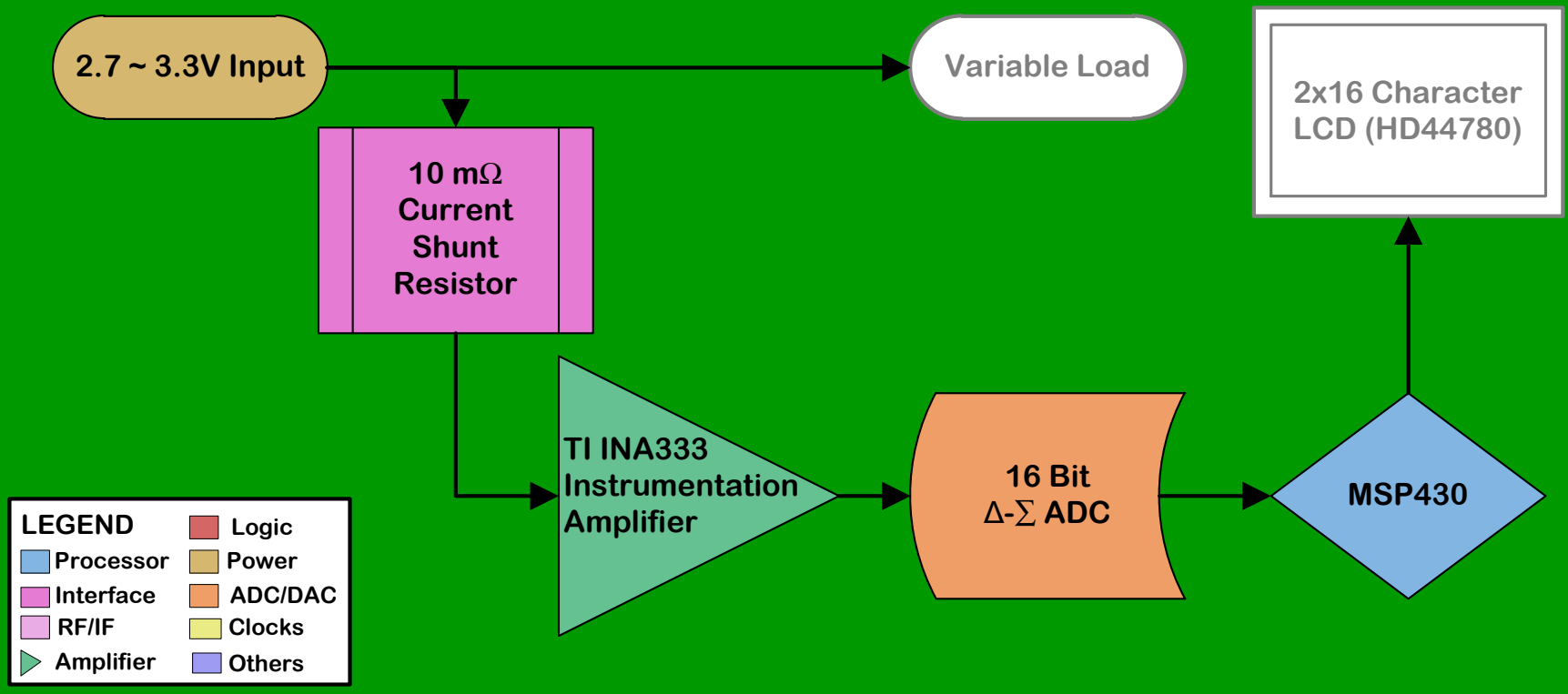
Part Justification

- TI INA138 Current Shunt Monitor
  - Variable Gain
  - Possible Issue: High Input Offset Voltage
- TI TLV3491 Comparator
  - Fast Switching Speed (6µs)
  - Low Power Consumption
- TI TPS2033 Power Switch
  - Rated at 2A
  - High Enabled

Cell Phone Current Display

- Monitors current
  - No shutdown circuitry
  - Low levels 7~120mA
- Display measurements
- Voltage source 2.7~3.3V

Block Diagram



Texas Instruments MSP430

- Ultra low power
  - 220 µA/MIPS
  - 300 nA Standby
- High bit resolution ADC
- Easy porting to OMAP
- Programmable in Assembly/C
- Very small footprint

PCB Design

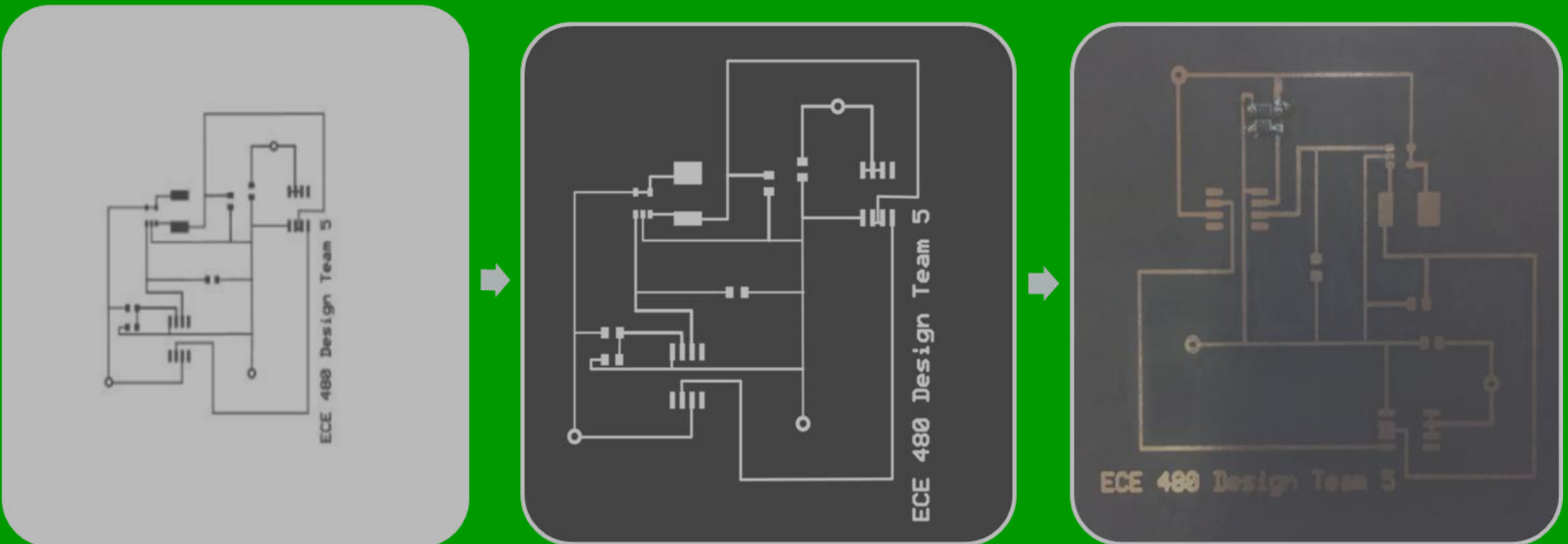
- Why are PCBs so important to this project?
  - Protoboards and other traditional testing equipment add parasitic elements from wires and metal.
    - Current sensing requires high accuracy and precision
    - Avoid added series resistance with shunt resistor (~25mΩ)
- PCBs allow us avoid these issues
  - Proper PCB design reduces interference
  - Traces provide low resistance connections

PCB Design

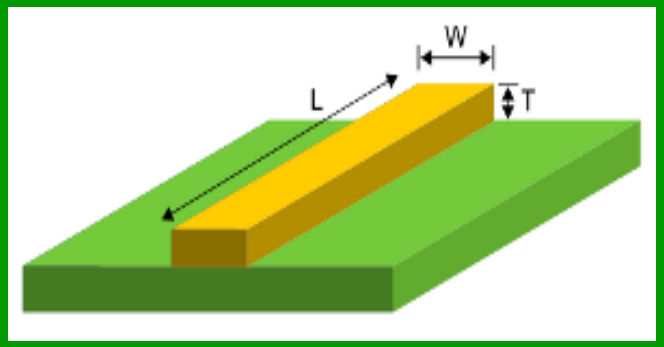
- Three Primary PCB Fabrication Methods:
  - CNC Milling
    - —Accurate
    - —Low Resolution (~300 microns)
  - Chemical Etching
    - —Higher resolution (~150 microns)
    - —Inexpensive
    - —Fast
  - Professional Fabrication
    - —Highest Resolution and Accuracy
    - —Expensive
    - —Slow

PCB Design

- Design PCB using Express PCB
- Invert colors and print mask onto transparency
- Expose mask and substrate to UV light
- Wash substrate to remove unwanted mask
- Etch remaining copper to substrate where desired



PCB Design



http://www.eeweb.com/toolbox/trace-resistance

- Future PCB studies:
  - Optimal parts placement
  - Trace size (L,W)
    - $R = \rho \frac{L}{TW}$
    - Length increases resistance, width decreases resistance
  - Corner angles
  - Layers and Vias

Questions?