Variable Hardware Inductance Simulator

Nathan Shepard

Final Presentation

EE 464C

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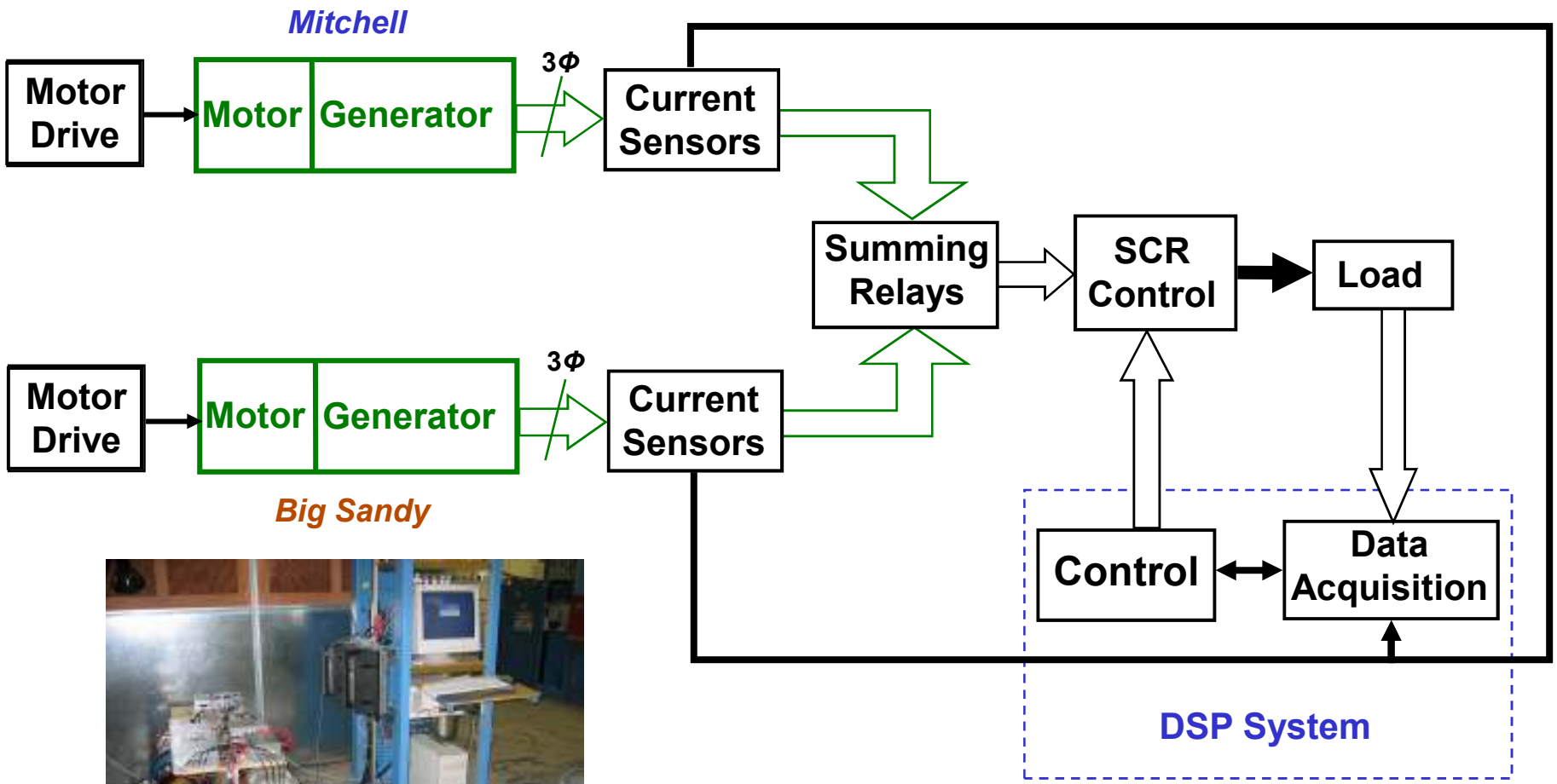
(4 min presentation)

Overview

- Pulsed alternator application
- Design requirements
- Competing designs
- Progress to date
- Conclusion
- Questions

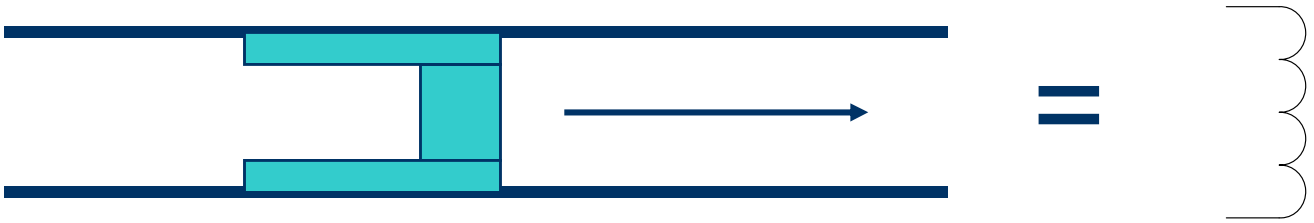
Pulsed Alternator Application

Pulsed Alternator Application



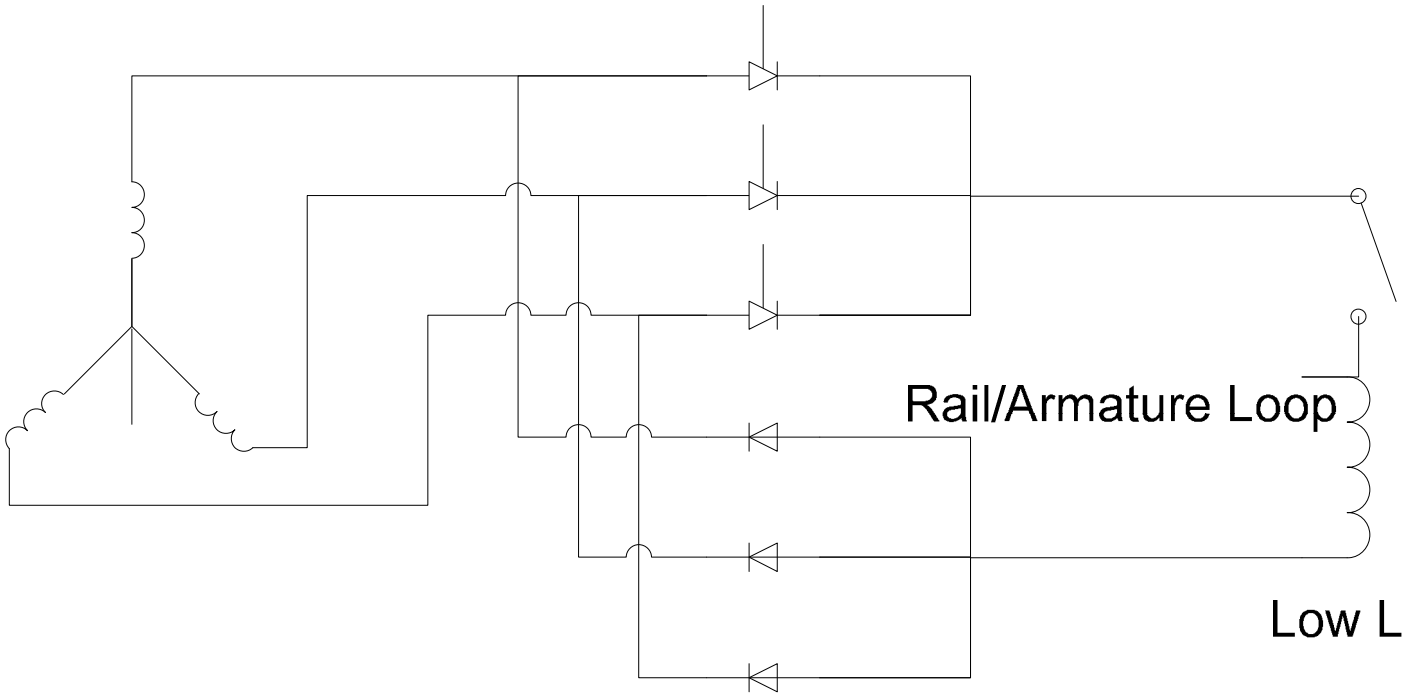
Pulsed Alternator Application

- The rail gun acts like an inductor with very small (<10mΩ) series resistance
- The high current passing through the rail/armature loop is broken when the armature escapes



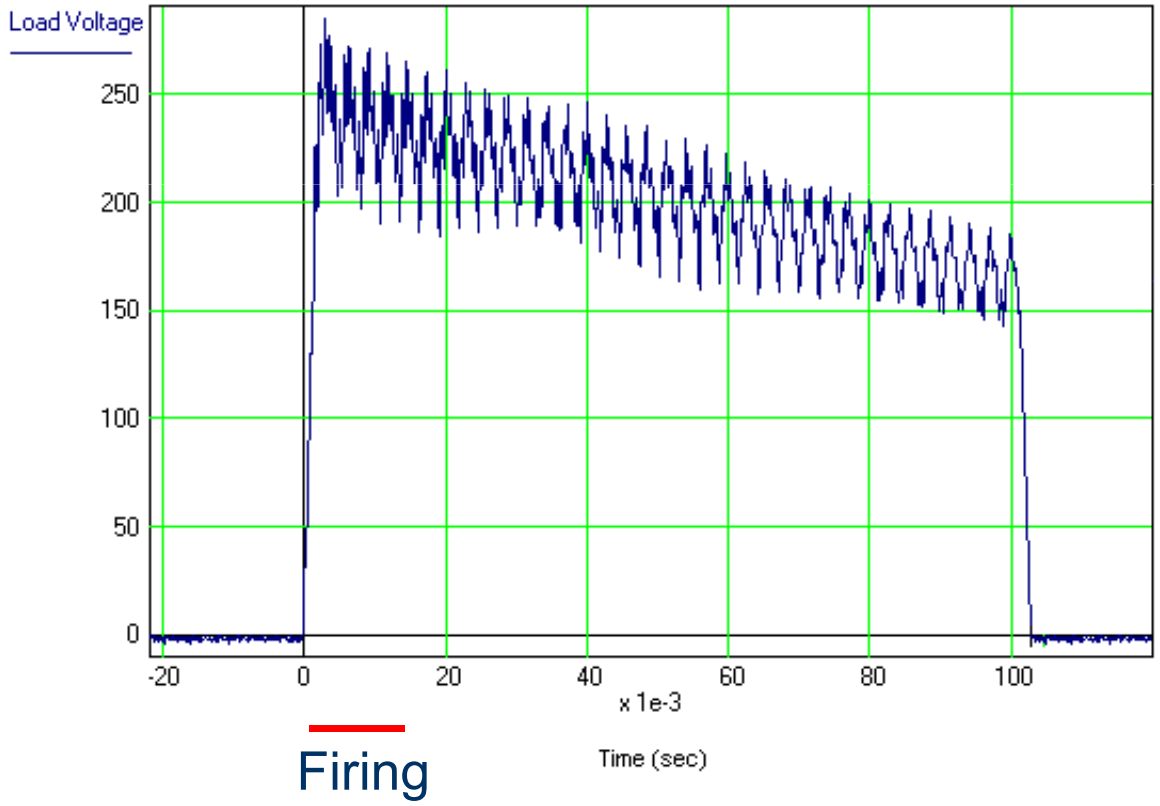
Pulsed Alternator Application

- Problem: Quick break in high-current (>1kA) inductive loop



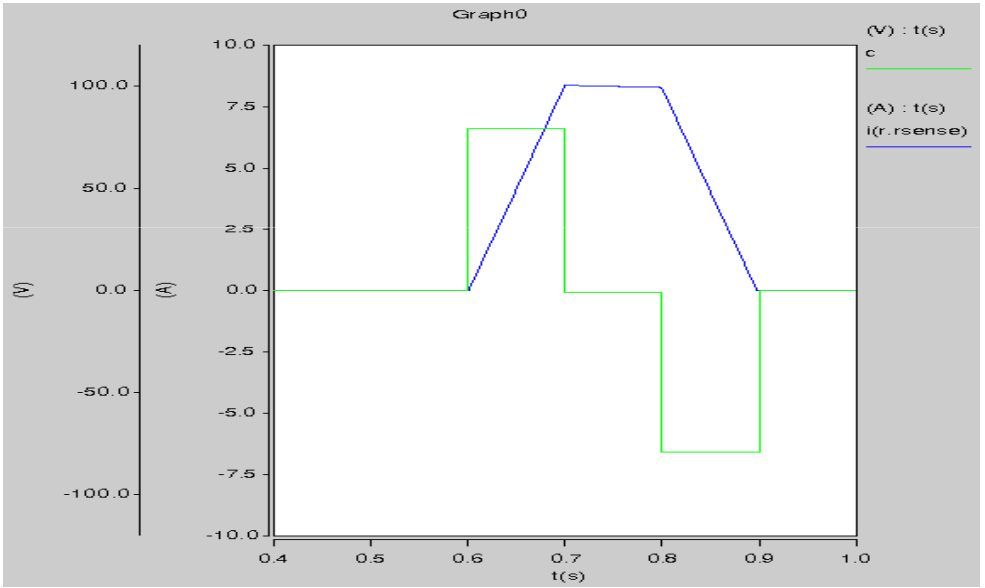
Pulsed Alternator Application

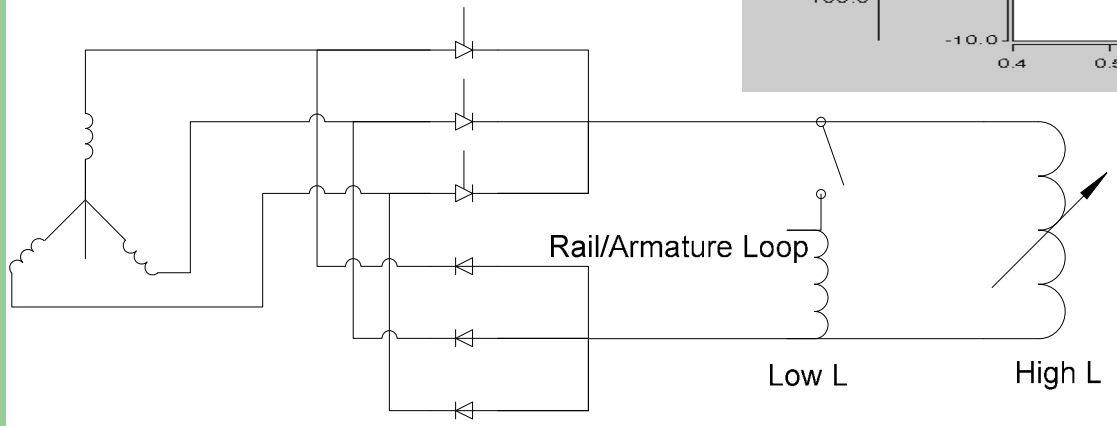
- Problem: Unused energy reduces efficiency



Pulsed Alternator Application

- Solution: Parallel current path to store energy



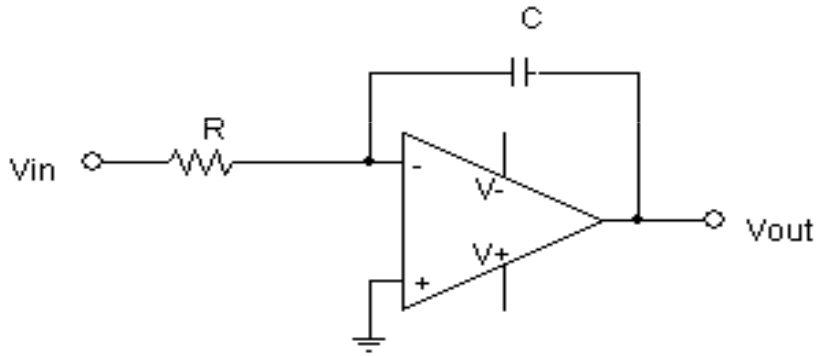


Design Requirements

- Variable inductance (100mH – 10H)
- 20A maximum DC current
- +-200V input pulse
- Compact, user-friendly operation

Basic Design

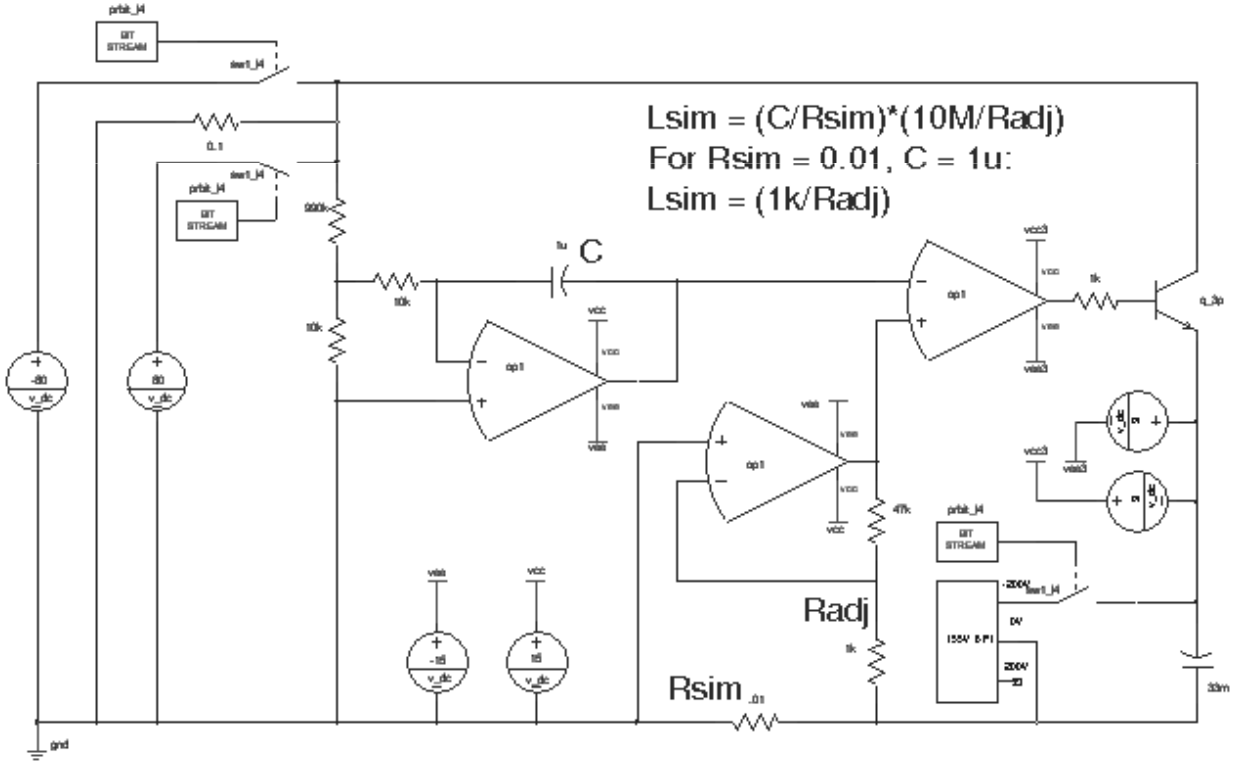
- Voltage integrator circuit defines current



- $V_{out} = -(1/RC)*\int V_{in}(t)dt$
- $I_L = (1/L)*\int V_{in}(t)dt$
- $L_{sim} = (I_{out}/V_{out})*(1/RC)$

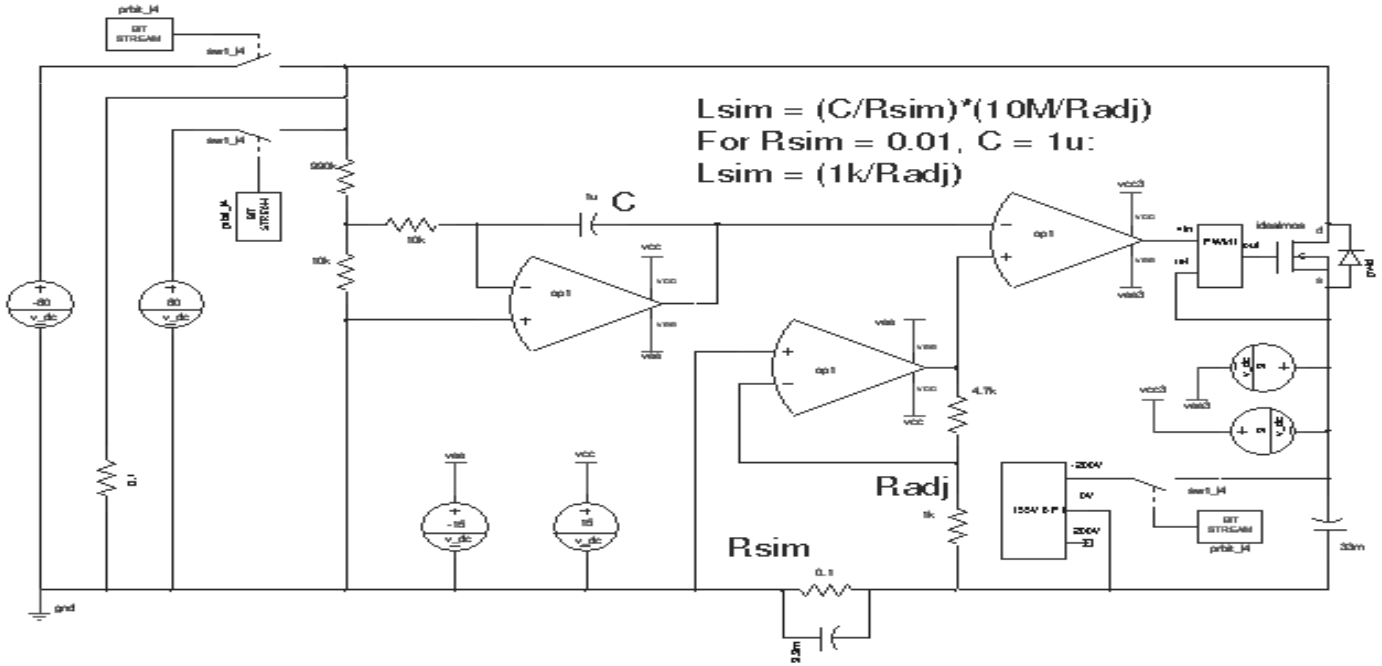
Linear Transistor Design

- Pros: Easy to simulate and build, low noise
- Cons: Operating NPN transistor in linear region = significant heating (>400W)



Switching MOSFET Design

- Pros: Low on-resistance (<10m Ω) = less heating (<4W)
- Cons: Switching creates high-frequency noise



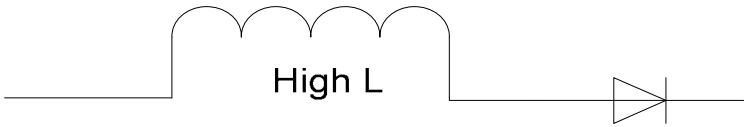
Design Overview

- Design and simulate competing circuits
- Build a small-scale version of each
- Choose the most desirable alternative
- Implement chosen design on a large scale

Progress to Date

- Designed both linear and switching circuits
- Simulated both linear and switching
- Implemented small-scale versions of each
- Chose linear version as preferable

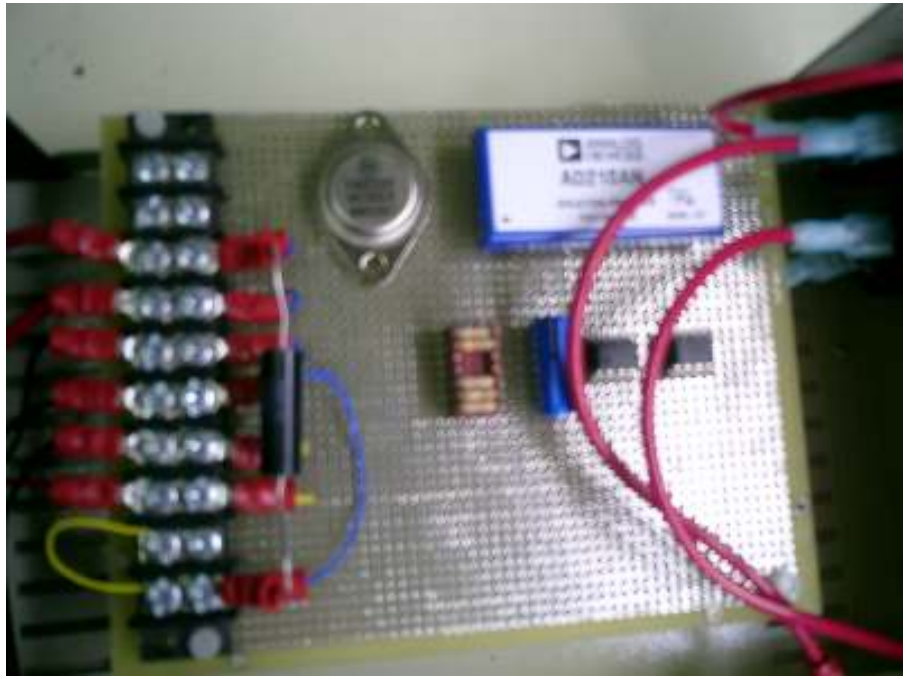
Problems Encountered



- Bi-polar supply too expensive
  - Design adjusted for polarized operation
- MOSFET design shorts inputs
  - Power resistor in series necessary
- MOSFET design generates noise
  - High-frequency ground plane implemented

Progress to date

- On schedule
- Large-scale linear circuit finished
- Next week:
  - Testing & application



Conclusion

- Project proceeding as planned
  - Progress is on schedule
- Final deliverable will meet specifications
  - Design criteria and component specifications are well understood

Questions?