Diagnosis of Power Electronic Systems (DOPES)

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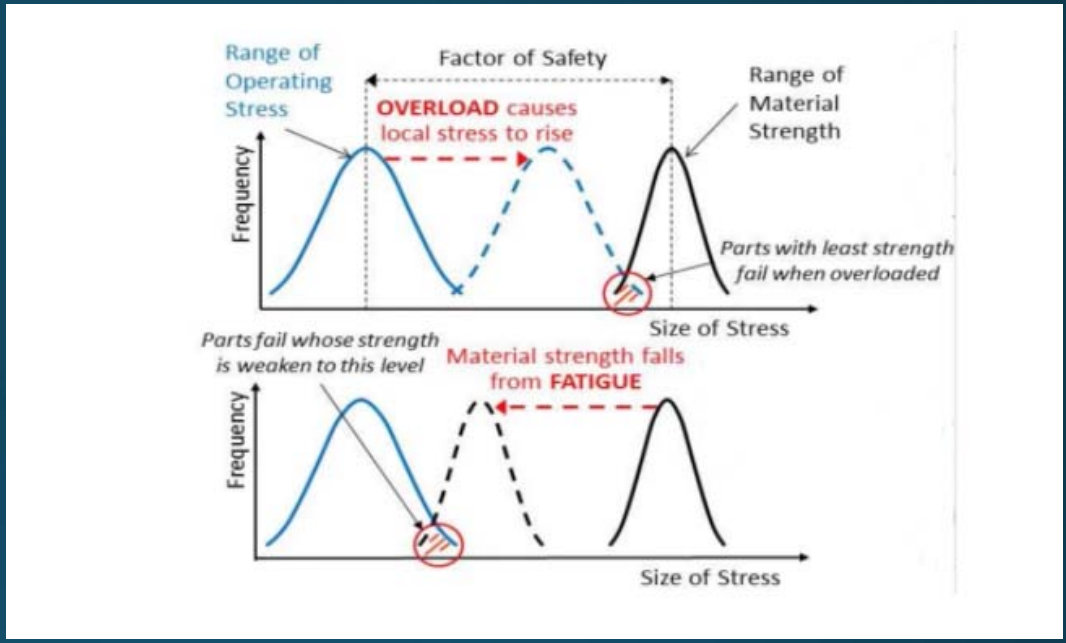
Background

- Electronic overload and fatigue have been known to degrade component health.
- This jeopardizes overall system operation and consumer safety.
- A Diagnostic method and tool are needed in order to define and correct the occurrences of failure.

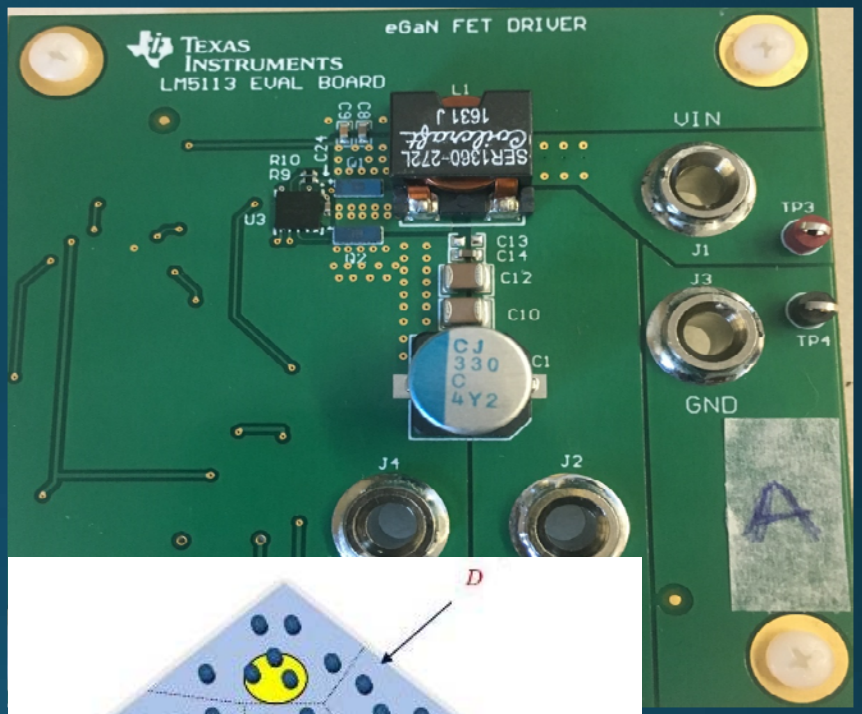


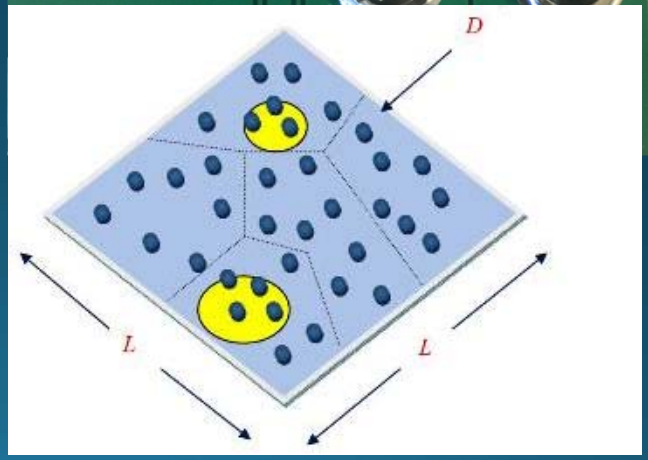
Problem Definition and Objectives

- Developing a real-time embedded sensory network coupled with a recovery system, to characterize electronic failure in order to diagnose and "heal" power electronics in their operation as they cope with electronic stress.
- Intended Users: Power Electronic manufacturers
- Focus: Development of sensory network and failure model

Approach Overview

- Texas Instruments LM5113
- GaN Transistor
- Simultaneous readings of temperature and magnetic field through IR and GMW Magnetic sensors.





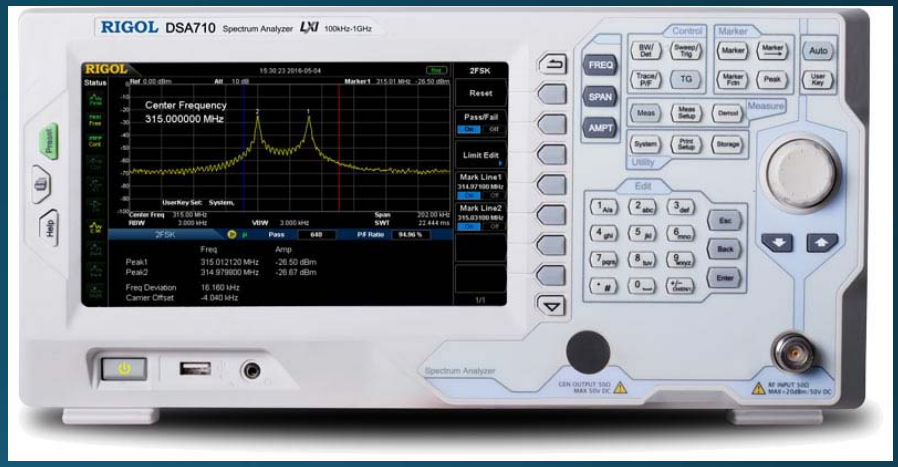
Design Requirements

- Economics
- Pinging data within 1% accuracy
- Operating conditions (65-300°C)
- Sampling Rate (1-100 reading /ms)
- FCC Part 15 Compliance
- IEC 61000-4-2 Compliance

Current State of Art

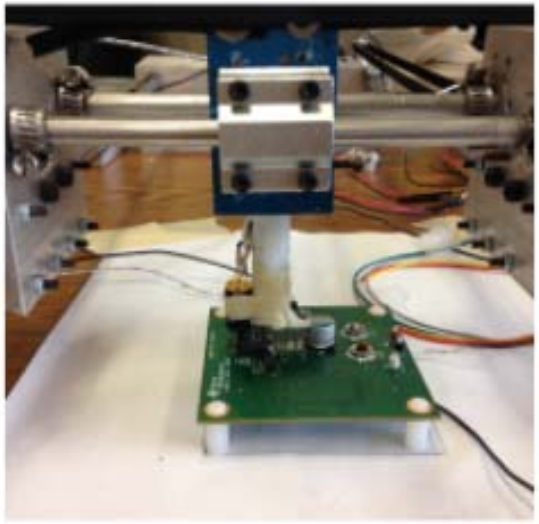
- Spectrum Analyzer
  - $4-5000.00

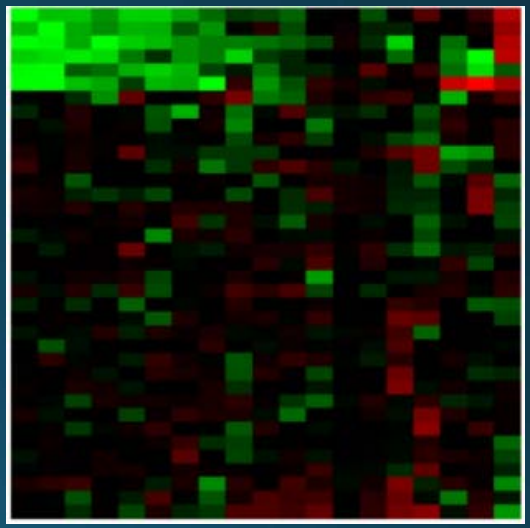
- Weaknesses:
  - Intrusive (interferes with circuit behavior)
  - Large
  - Expensive



Solution Designs

Design 1.0 - w/ scanning arm and intensity map

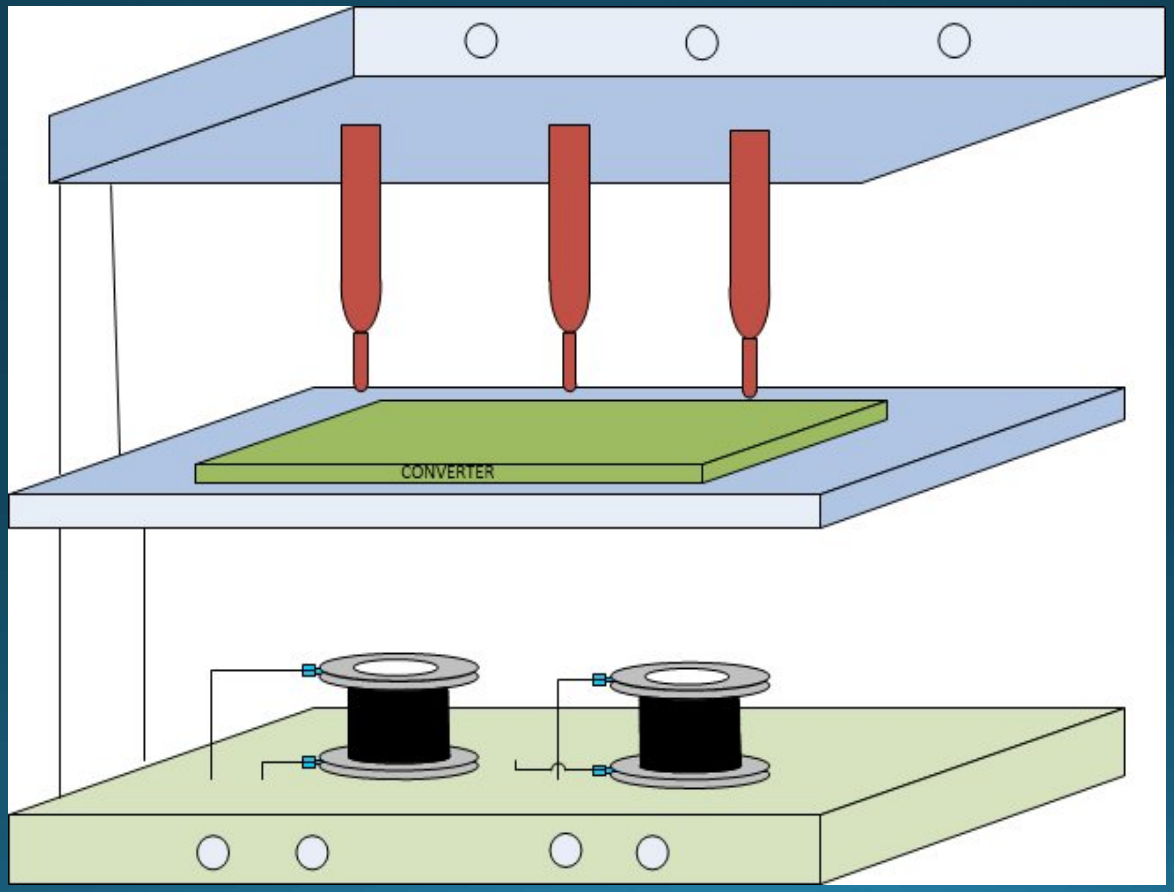




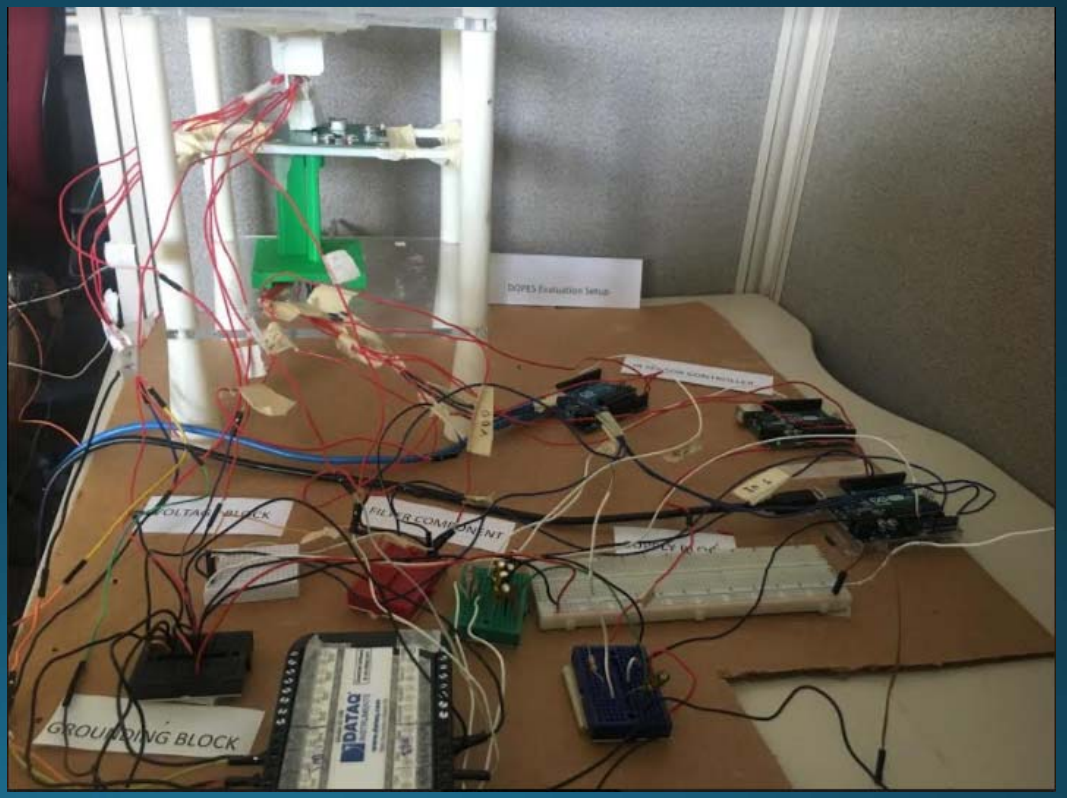
Low Points

- Inconsistencies in data
- Time

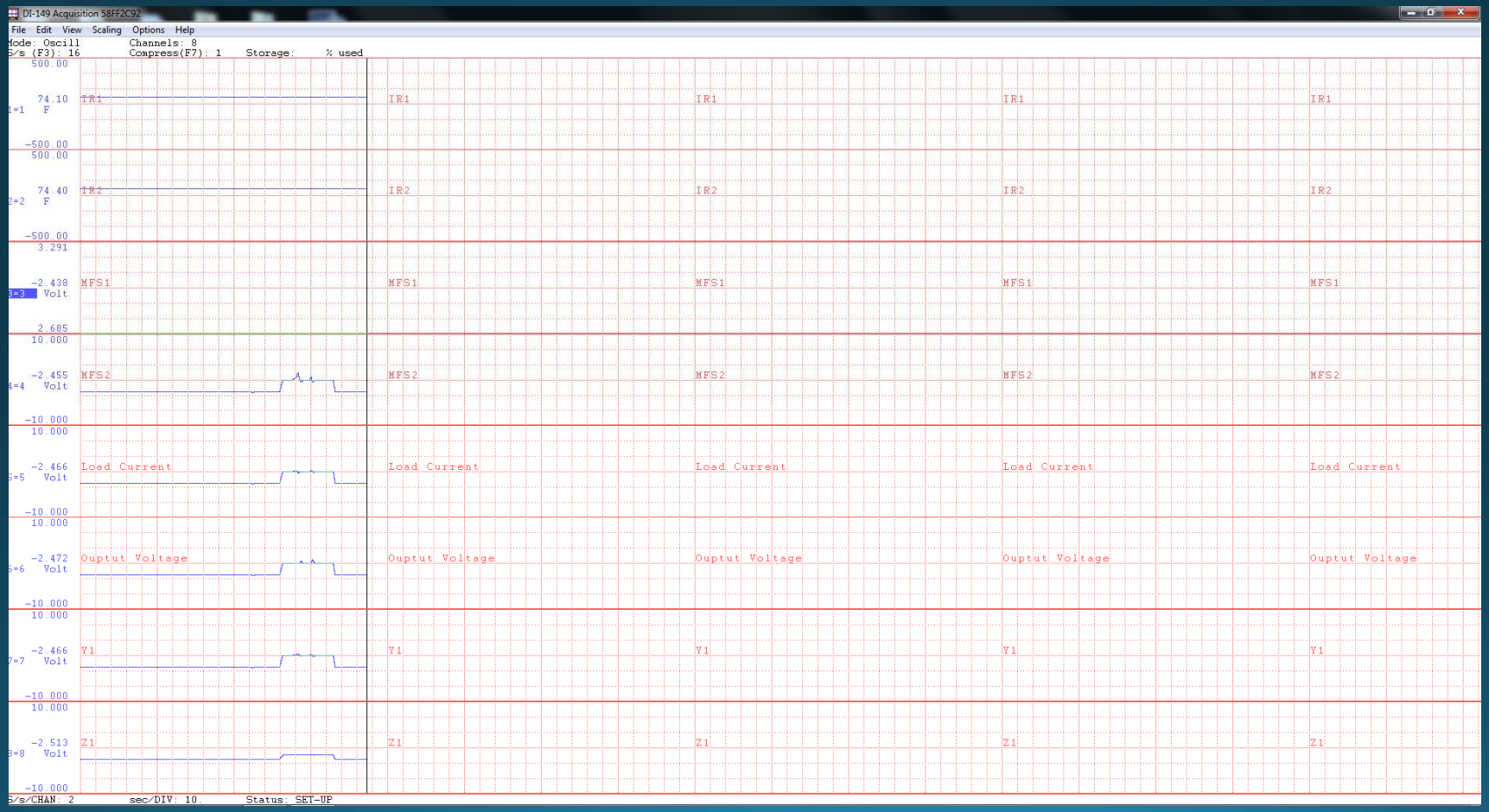
Design – 1.1a stationary sensor network



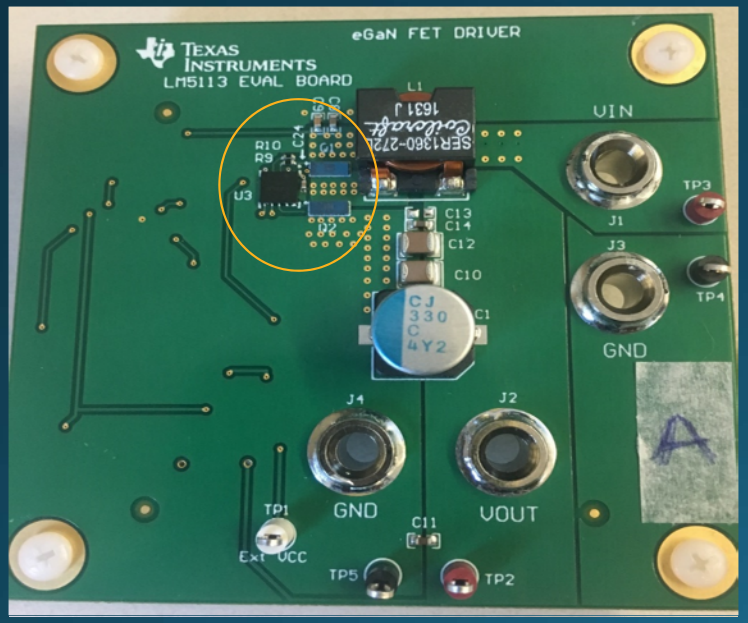
Design 1.1a Implementation

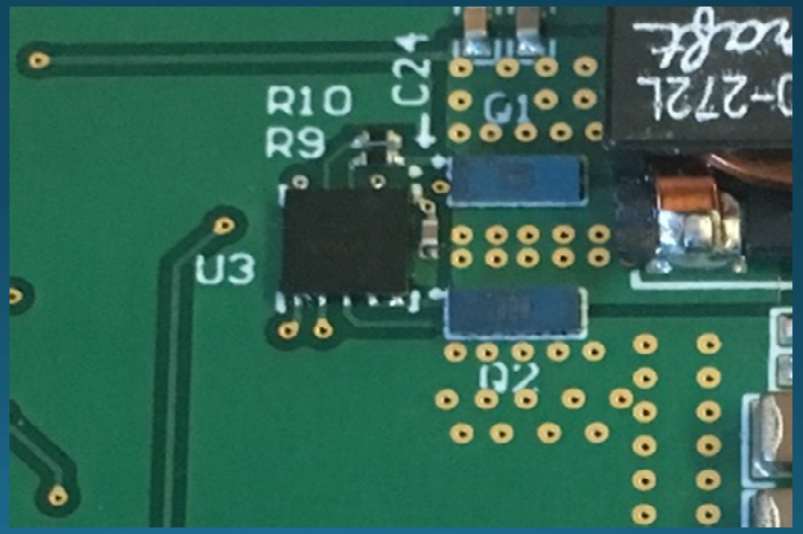


Sample Data from Design 1.1a

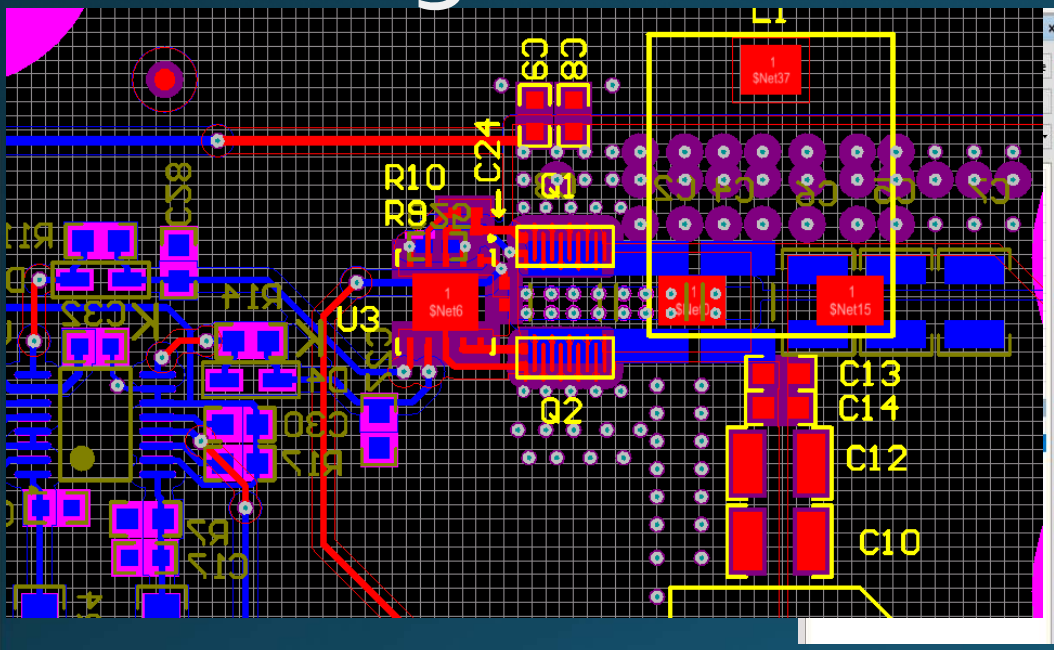


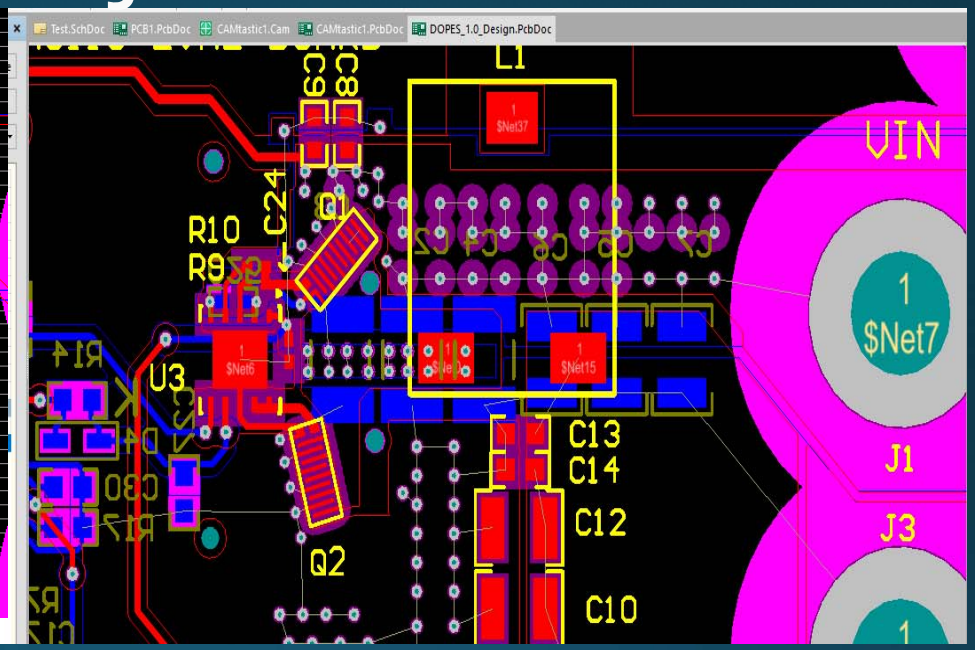
Design 1.1b - PCB Modification





Design 1.1b PCB Adjustment





- Capacity for sensor self mount
- Modified transistor placement

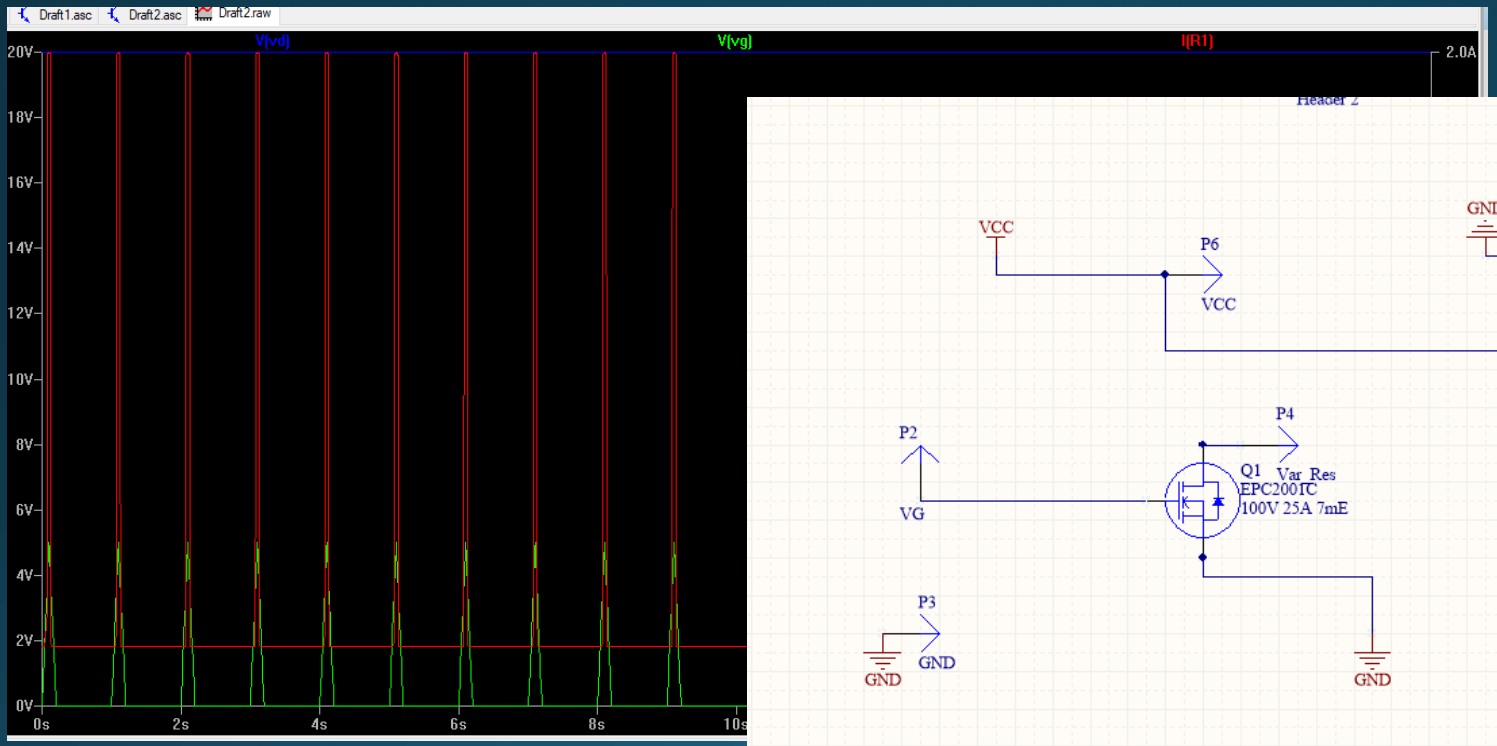
Low Points

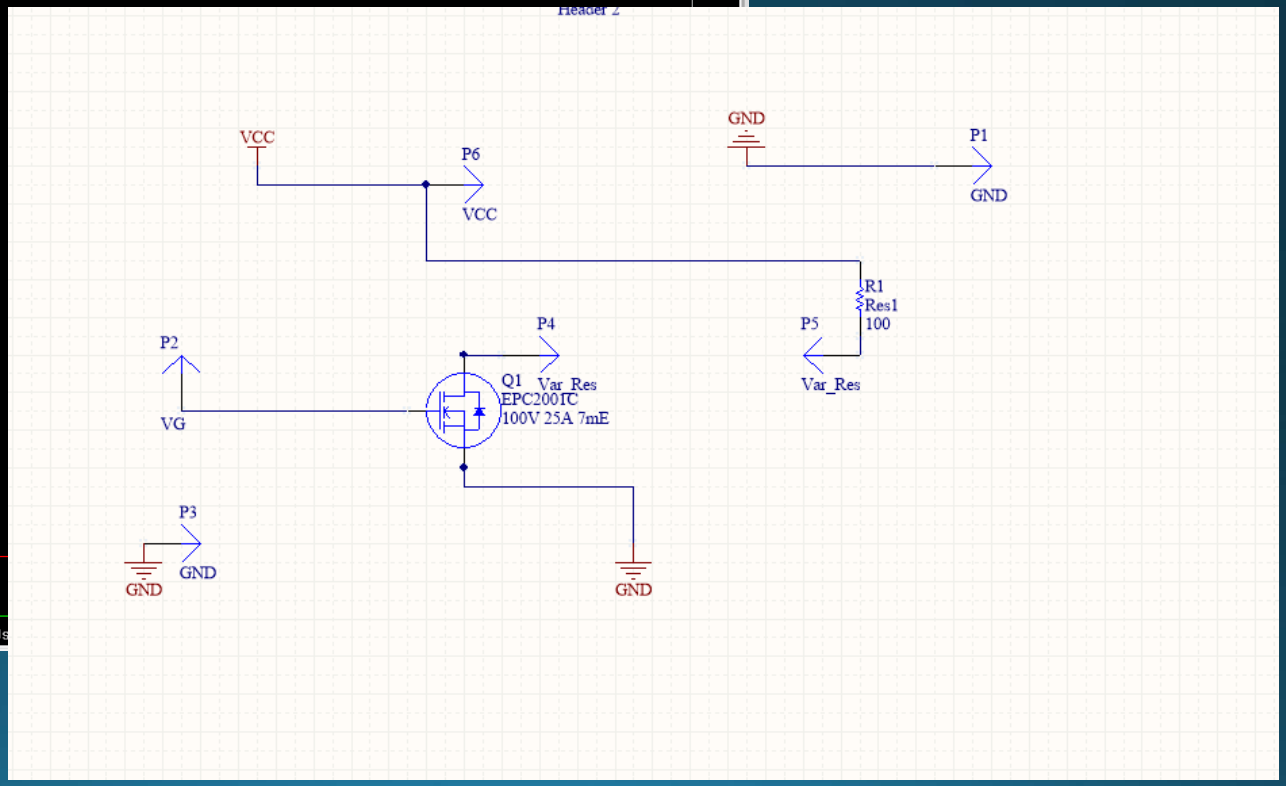
- Expensive to fabricate
- Time

Design 1.1c - Isolated Transistor

- Transistor Isolation
- Simple Set Up

Schematic and Simulation for verification





Conclusion

- The movement forward
  - Implementation of Design 1.1c
  - Further refinement of mathematical model
- Impact
  - Window into physical phenomena at GaN level
  - Commencement of diagnosis methodologies