Programmable Laser-Isolated Fuse System

76V Load Monitoring & Cyber-Physical Protection

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Case Study: The "Dumb" Fuse Problem

The Problem (Coz):

- Traditional fuses are binary; they offer no data before failure.
- Industrial 76V rails generate significant EMF noise.
- Direct electrical connections risk destroying I/O pins on microcontrollers.

Solution Goal: Create a "Smart Breaker" that uses **Light** to bridge high and low voltage fields.

System Architecture: Galvanic Isolation

- **Stage 1 (Sensing):** LT6016 detects current on the 76V high-side.
- **Stage 2 (Conversion):** Low-level analog output drives a Laser Diode.
- **Stage 3 (Isolation):** Photons travel across an air-gap to an LDR sensor.
- **Stage 4 (IoT):** ESP32 reads LDR intensity $\rightarrow$ Uploads spike data to App via WiFi.

The USP
Zero physical connection between 76V and the user interface = 100% Safety.

Implementation: Sensing Core Logic

Current Progress:

- Validated High-Side Sensing using **LT6016**.
- Shunt Resistor: 0.1Ω
- Ratio: 1V per 1A.
- Handles 76V input with 5V logic supply.

Sensing Schematic

Simulation Results: Linearity Analysis

- The triangle wave proves perfect 1V/A scaling.
- Ensures predictable laser brightness for accurate IoT data.

Simulation Results: High-Voltage Stability

- Monitoring the 76V Rail (Input) vs. 5V Rail (Op-Amp Supply).
- Proves the circuit remains stable under high DC stress.

Benefits & Future Vision

- **Noise Immunity:** Not affected by industrial magnetic fields (EMF).
- **Programmable:** Thresholds are software-defined via the IoT App.
- **Future Scope:** Using algorithms to analyze load "fingerprints" for predictive motor maintenance.

Next Steps

Project 1 Documentation complete on GitHub.

Thank You!