

Circuit Design for 2000W LED Load Control

Overview: This circuit controls a 2000W LED load (36V, 56A, 100A peak) using a 40V DC input. It integrates a DC-DC buck converter, a 32-bit microcontroller, six NTC temperature sensors, and MOSFETs for load switching, ensuring reliability, efficiency, and safety for high-power applications.

Circuit Design: The system includes:

1. Power Input: A 40V DC input with reverse polarity protection (IRF9540N MOSFET), filtered by 470 μ F and 10 μ F capacitors, and guarded by a TVS diode (SMBJ36CA).
2. DC-DC Converter: A Texas Instruments LM5176 buck controller steps down 40V to 36V at 56A with >90% efficiency, using four IRF1404 MOSFETs, a 10 μ H inductor (Coilcraft SER2918), and 470 μ F output capacitors.
3. Microcontroller: The STM32F103C8T6 generates 20 kHz PWM for MOSFET control, reads NTC sensors via ADC, and monitors current with an INA219 (I2C).
4. Temperature Sensing: Six 10 k Ω NTC sensors (Vishay NTCLE100E3103JB0) monitor MOSFETs, LED, and ambient conditions via voltage dividers.
5. MOSFET Stage: Four IRF1404 MOSFETs (two parallel pairs) switch the load, driven by UCC27517A gate drivers (12V). Schottky diodes protect against back-EMF.
6. Protection: INA219 triggers shutdown above 100A; NTCs halt operation at 85°C.

Component Selection:

- STM32F103C8T6: Cost-effective (~\$5), with ADC, PWM, and I2C for control.
- LM5176: Supports high current and wide input (4V–55V) with high efficiency.
- IRF1404 MOSFETs: Low $R_{ds(on)}$ (4 m Ω) minimizes losses, handling 100A peaks.
- UCC27517A: Ensures fast MOSFET switching with 4A drive.
- NTC Sensors: Reliable, inexpensive (~\$0.50) for thermal monitoring.
- INA219, IRF9540N, SMBJ36CA: Enable precise current sensing, reverse polarity, and overvoltage protection.

Design Notes: The BOM (~\$40–50) uses standard components for cost and availability. A 4-layer PCB with 2 oz copper and heatsinks ensures thermal stability. Firmware handles PWM, sampling, and fault detection (e.g., >100A, >85°C). KiCad facilitates open-source design.

Explanation:

- Conciseness: The write-up is trimmed to half a page by focusing on essential subsystem functions and component justifications, omitting detailed PCB layout and some assumptions.
- Circuit Design: It covers the modular structure (input, converter, MCU, etc.) and safety features succinctly.
- Component Selection: Key components are justified for performance, cost, and reliability,

aligning with the 2000W requirement.

- Clarity: The design is explained for engineer review, noting tools (KiCad) and basic firmware roles.