

TOWER POWER

Tower Light Show Power Supply

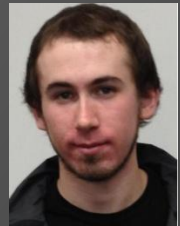


Team Members:

Jesse Walson



Jake Wagner



Dave Miller



Team Advisor:
Touraj Assefi



Sponsor:
Robert Rinker

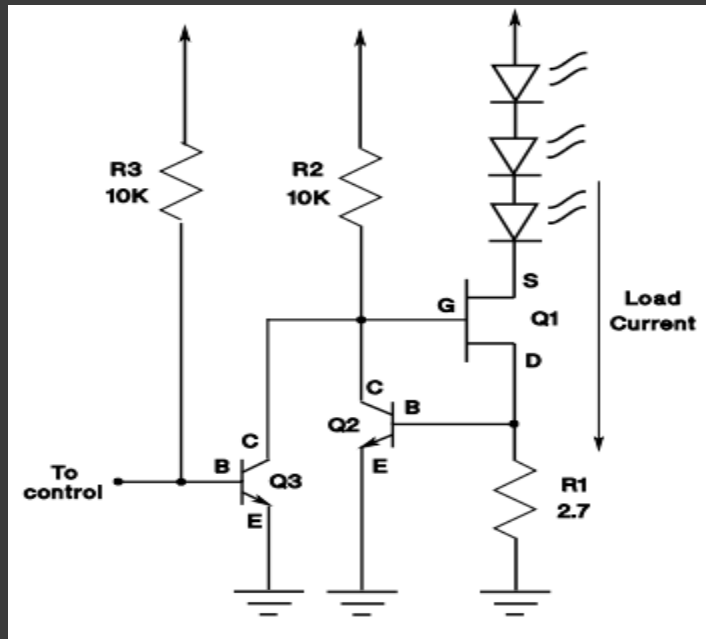
Problem Statement

- ⦿ Since 2010 the University of Idaho ACM has used the Theophilus Tower as a giant pixel display to put on LED light shows.
- ⦿ These shows are accomplished by placing strings of LEDs in the tower windows and controlling them using a laptop, and power them through the Ethernet ports.
- ⦿ The current power supplies bring in roughly 16 volts DC.
- ⦿ The diode strings only require approximately 7.5 V to 10.5 V.
- ⦿ Transistors and LED's are over-voltaged causing power losses and heat dissipation. This means that large heat sinks are required to mitigate the issue.

Specifications

- ⦿ 3 power supplies. One for each color LED (Red Green and Blue).
- ⦿ Input voltage for each supply should vary depending on the LED color.
 - Red LEDs drop approximately 2.5 V per diode (7.5 V per string).
 - Blue and green LEDs drop approximately 3.5 V per diode (10.5 V per string).
- ⦿ 270-300 mA of current should be supplied to each of the 40 parallel diode strings.
 - This means a total constant current of 12 A for each different color is needed.

Old Constant Current Circuit

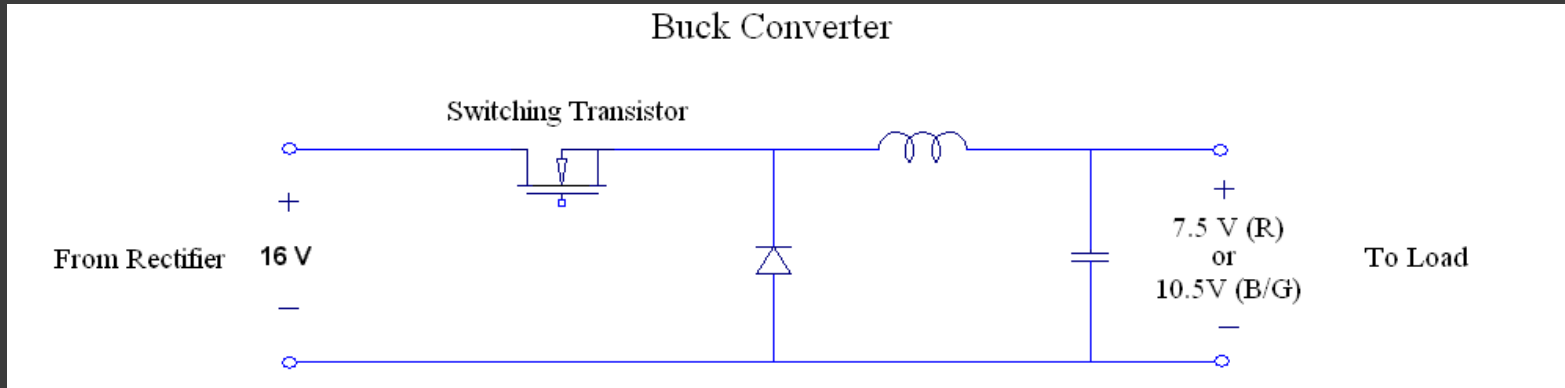


- Transistors Q1 and Q2 hold the R1 voltage constant, creating a constant current through the LED string.
- 3 Resistors and 3 Transistors used per LED string in this implementation
- Voltage inputs taken directly from input supply without being stepped down.

Project Goals

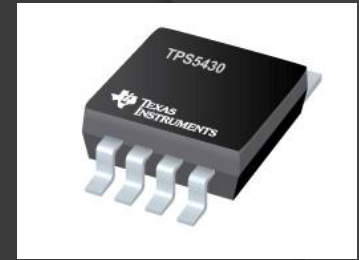
- ⦿ Dynamic voltage to automatically adjust to LED load.
- ⦿ Constant current in each channel
- ⦿ Reduced power losses and heat.

Buck Converter



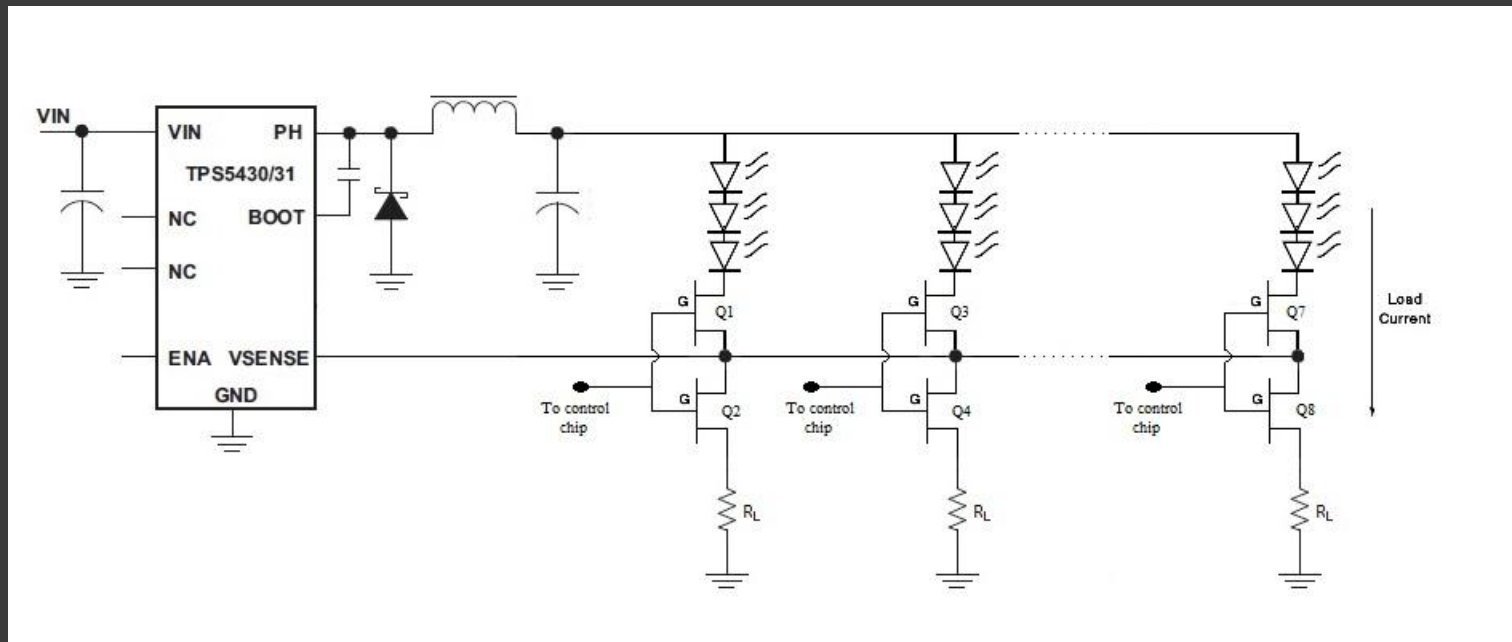
- ⦿ Using a buck converter will efficiently step down the load voltage to desired levels
- ⦿ When switch is closed current is delivered to the output load.
- ⦿ When switch is open current in the inductor will not change instantaneously. Instead it will gradually decrease, causing the voltage at the load to decrease.

Buck Converter Chip



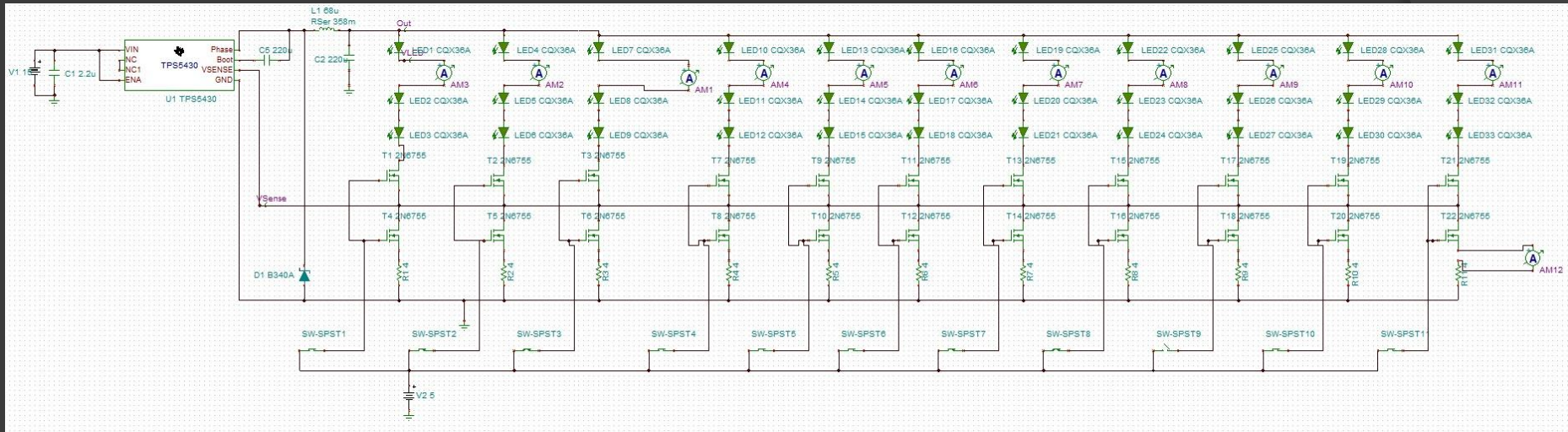
- ◎ 5.5V - 36 V Input Voltage
- ◎ Up to 3A output current
- ◎ 1.22 V - 31 V Output Voltage
- ◎ 500 kHz switching frequency
- ◎ Cost \$2.25 per unit. Potential for free samples
- ◎ 4 Chips per color if used near maximum current range.
- ◎ 95% efficiency

Buck Converter Application



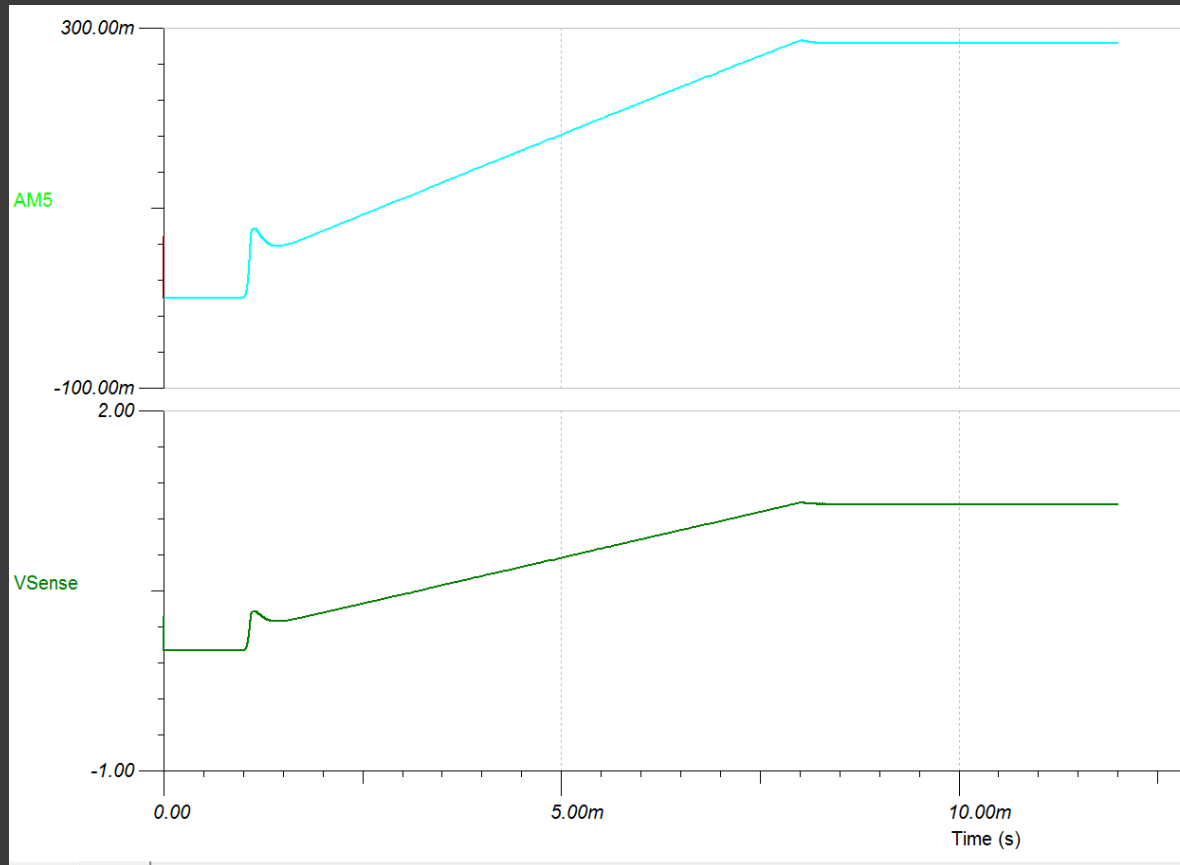
- Phase voltage will adjust to maintain 1.22 V at Vsense. Load resistor maintains constant current.
- Load Resistor needs to be chosen with respect to required current and transistor voltage.

Circuit Simulations



- Full simulation for one chip contains a maximum of 10 LED strings.
- Four chips are required per color.

Simulation Results



- ⦿ Vsense reaches 1.22V in about 7.9 milliseconds.
- ⦿ Load current reaches 270 mA at 7.5 milliseconds.

Application Concerns

- ⦿ Since the V_{sense} is connected to multiple lines, the lines are sensitive to the load, and unforeseen resistances.
- ⦿ For each individual chip, the loads should be similar, i.e. the same floor and the same color, in order to prevent unbalanced currents.
- ⦿ Suggest 8 channels per chip, three chips per two floors (three colors) to maintain similar loads. This will have a maximum of 2.4 A per chip.