USB 3.0 Outlet Conversion

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Introduction

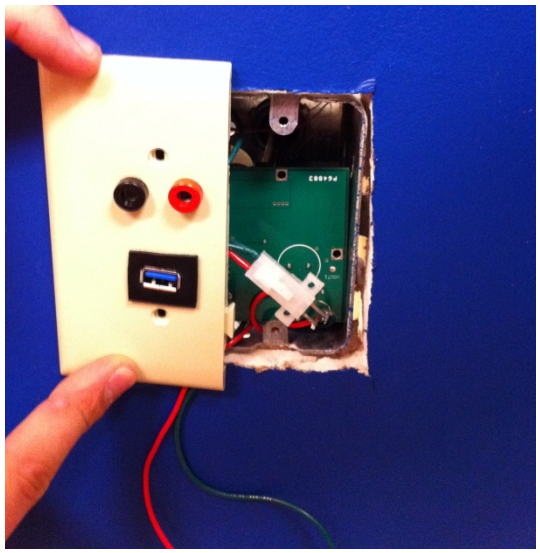
- Addresses the growth of external DC converters for consumer products.

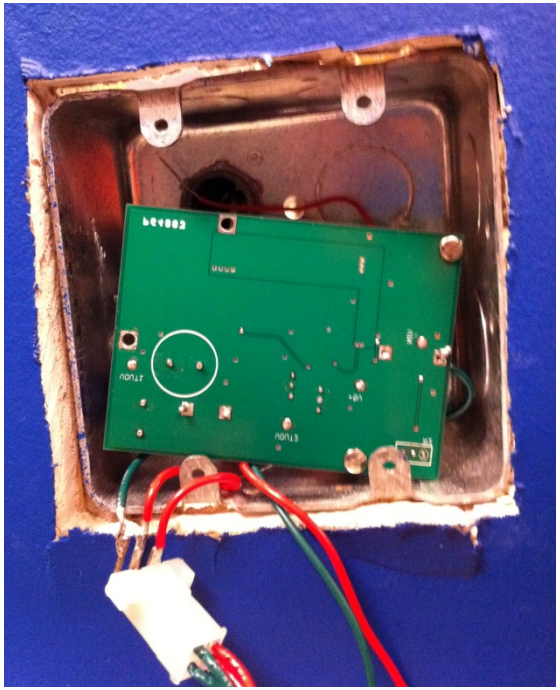
- Objective:
  - Modify an AC wall outlet
  - Include two DC power ports:

- Eliminates the need for DC converters outside the wall outlet or in appliances.

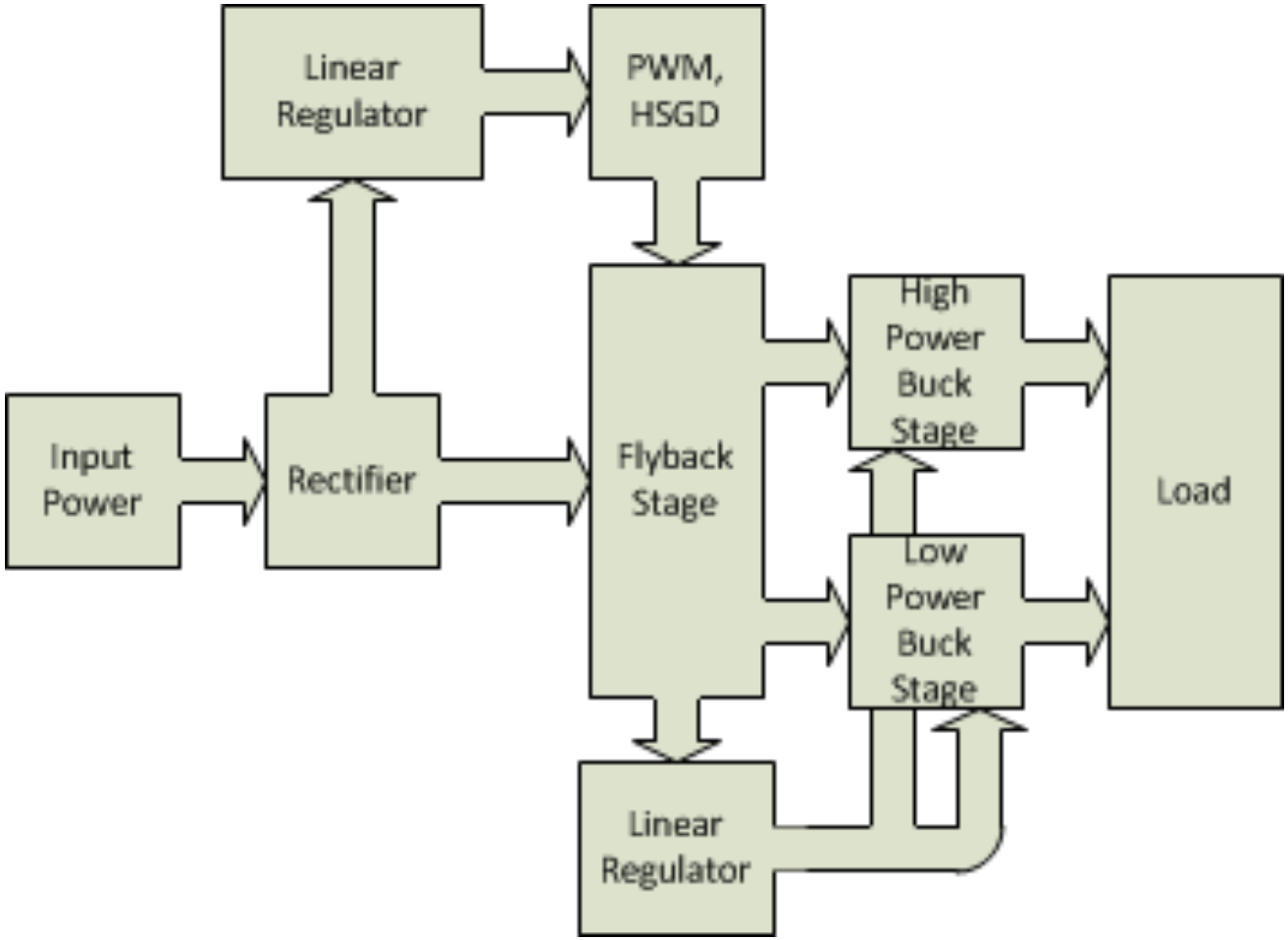
Product Features

- Two DC outputs with different power levels options
- Eliminated need of additional power converter
- High efficiency
- In-wall installation
- Simple installation process



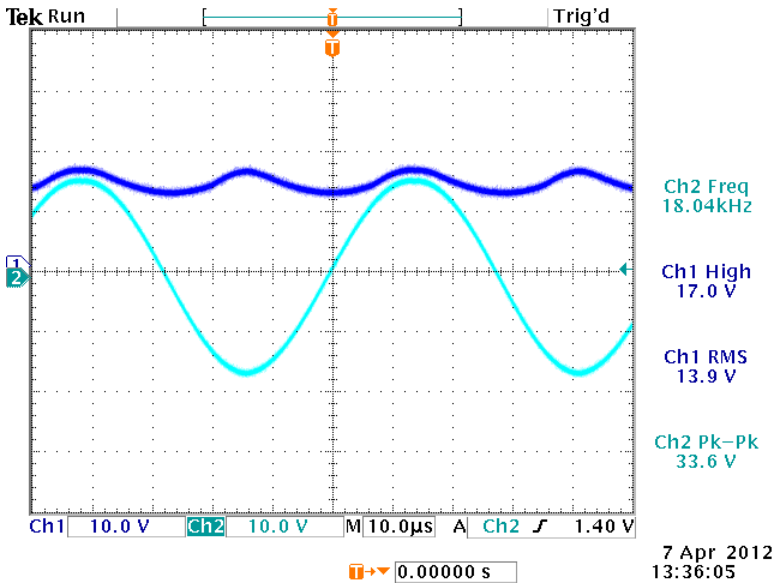


Design Overview



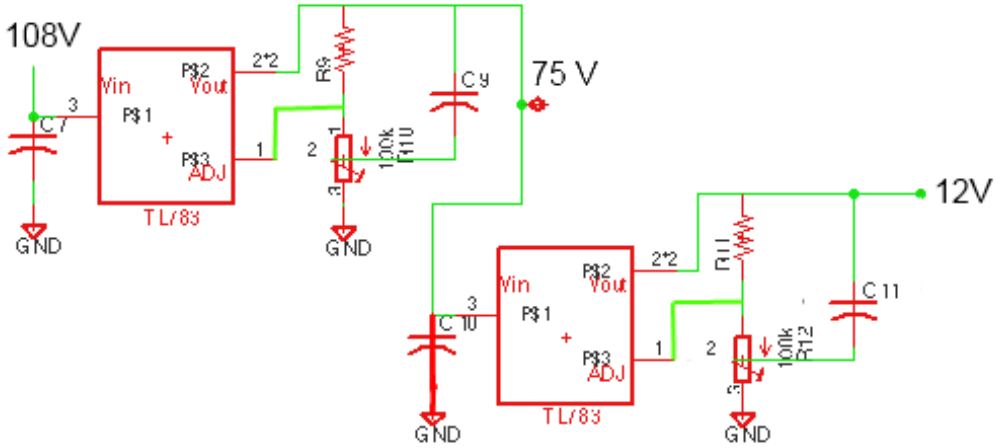
Rectifier

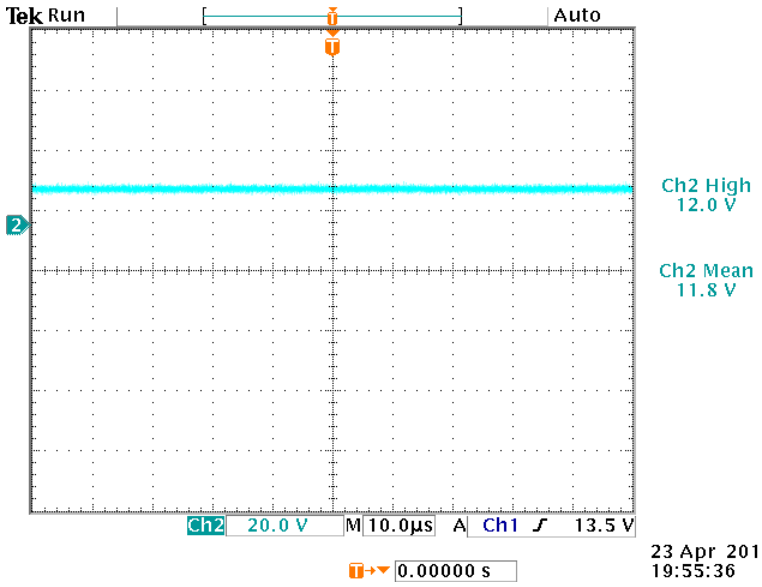
- H-bridge rectifier chip
  - convert 120Vac power from the wall to 108Vdc
- Efficiency: 97.37%
- Ripple: ±1.7V
  - With capacitor bank of 156μF
- Waveform:
  - Channel 1 Output Voltage
  - Channel 2 Input Voltage from the Function Generator



Linear Regulators

- Design:
  - Used two linear regulators
  - Step down from 108V to 75V
  - Step down from 75V to 12V
  - Avoid over stressing the components
- Waveform:
  - Input 25 V from DC power supply.
  - Pot adjusted to voltage.
  - Range from 20V-8V tested.

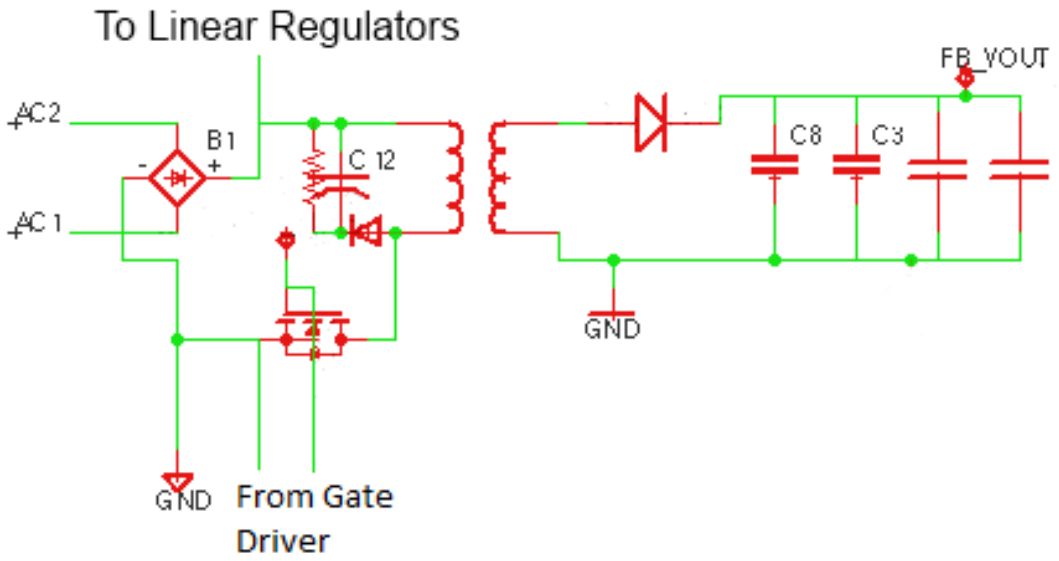




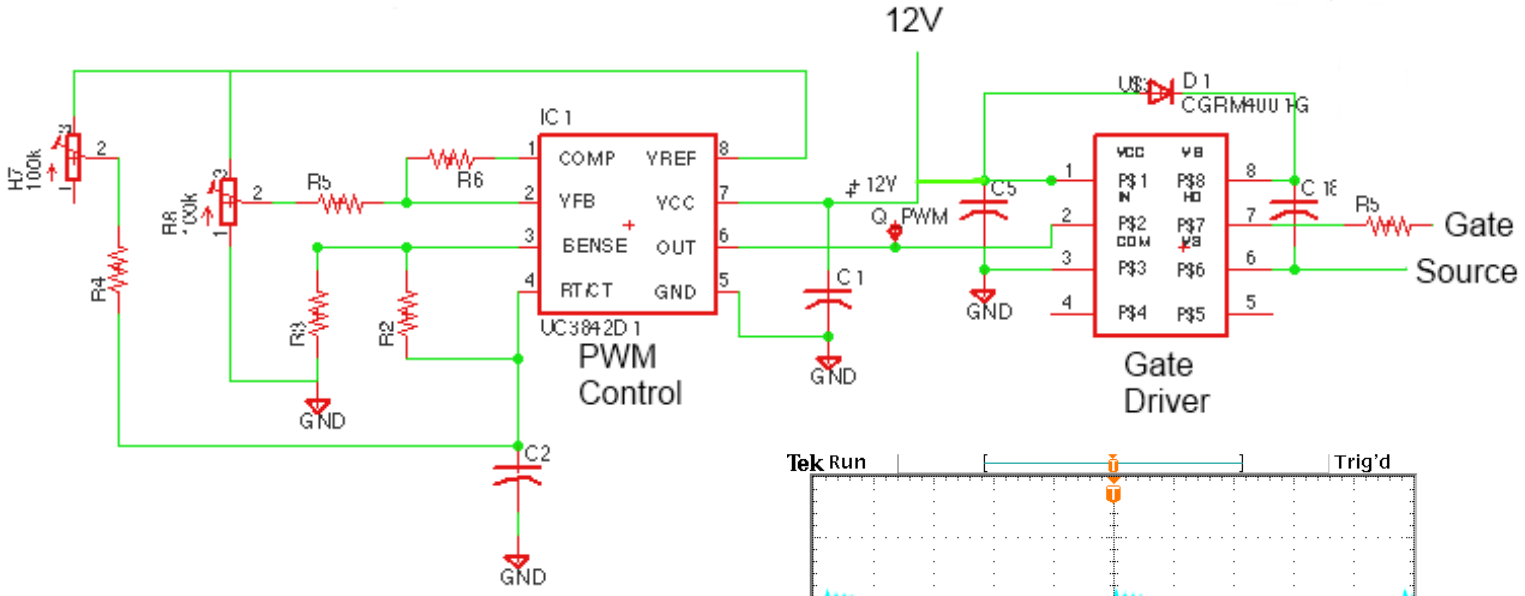
FLYBACK CONVERTER

Flyback Converter

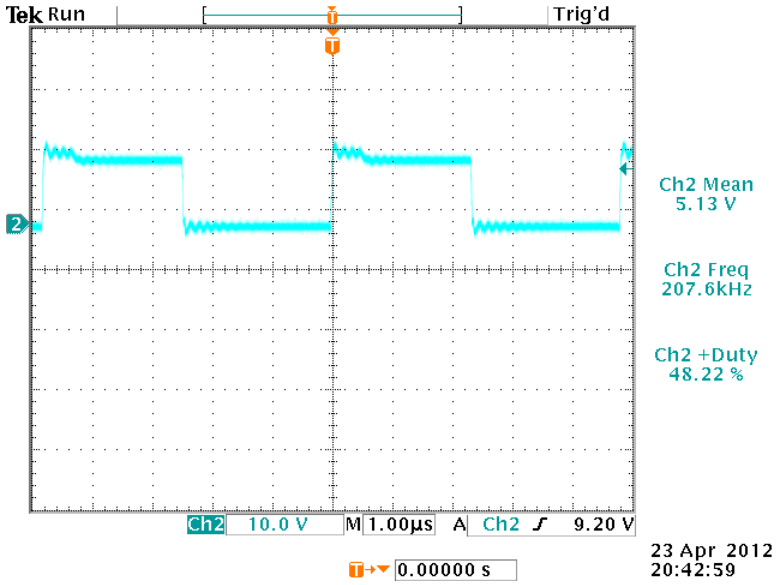
- Provides:
  - galvanic isolation between the output and input
  - an additional layer of surge protection
- Ratings:
  - Input: 108V/3 A
  - Output: 25V/8.1 A



Flyback MOSFET Control

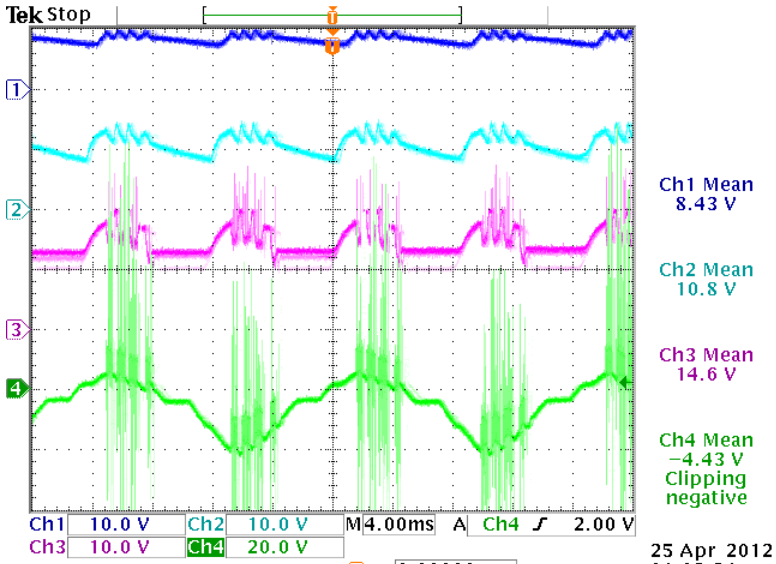


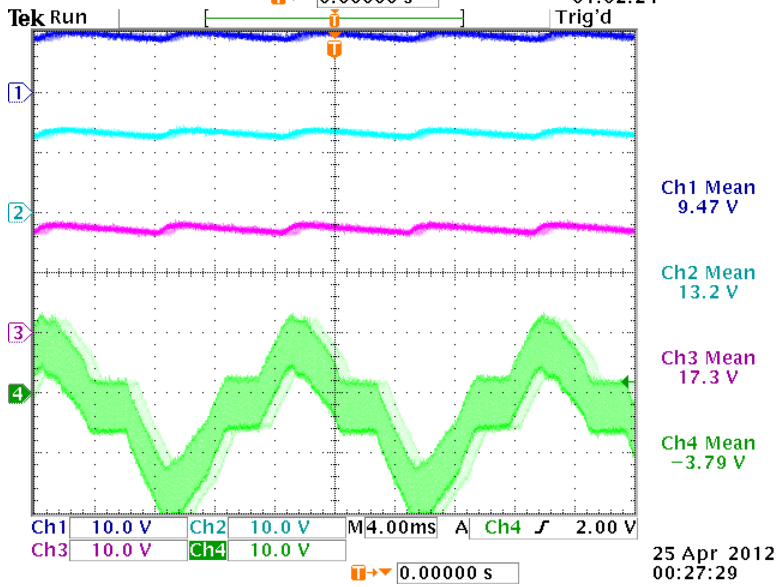
- Waveform of PWM control signal for the flyback converter



Flyback Converter Challenges

- Top Waveforms:
  - Noise on the switching signal
- Bottom Waveforms:
  - Floating ground
- Channels:
  1. second voltage regulator output
  2. first voltage regulator
  3. bridge rectifier output.
  4. switching signal (not on differential probe)

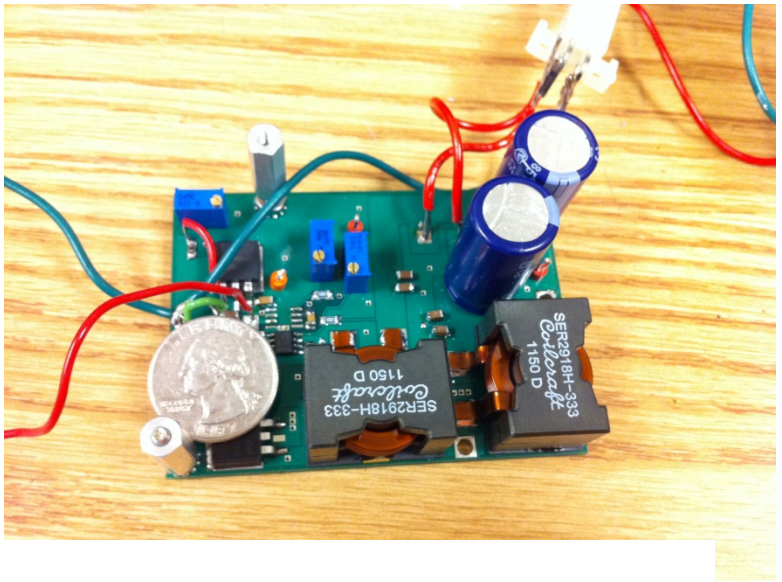


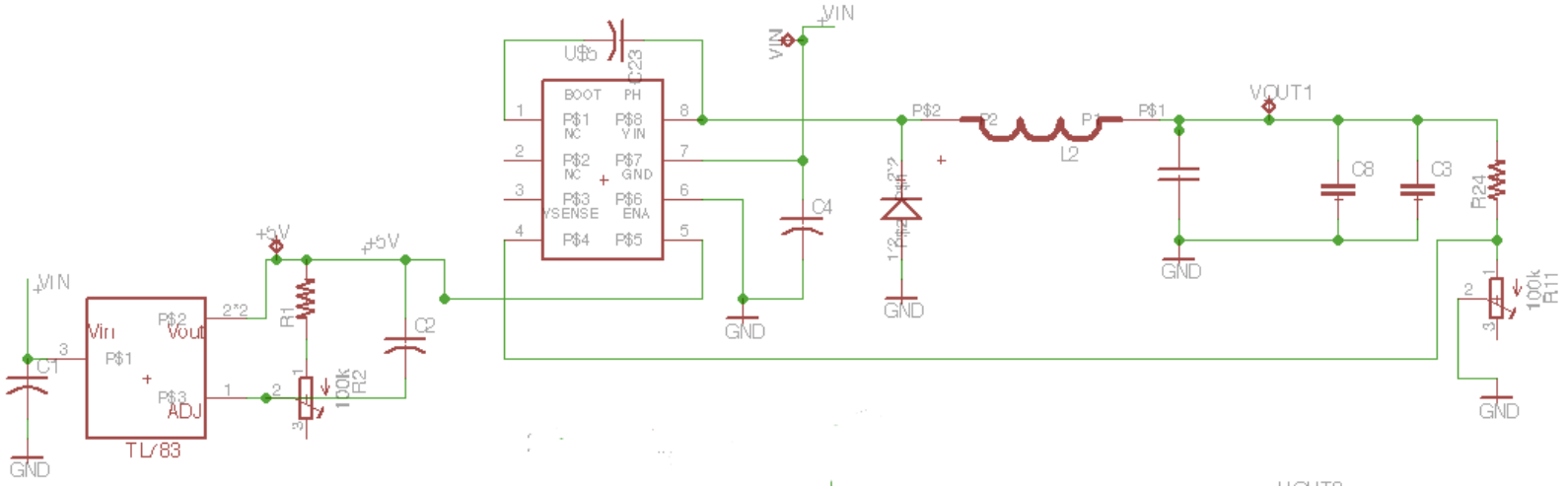


LOW BUCK CONVERTER

Low Buck Converter

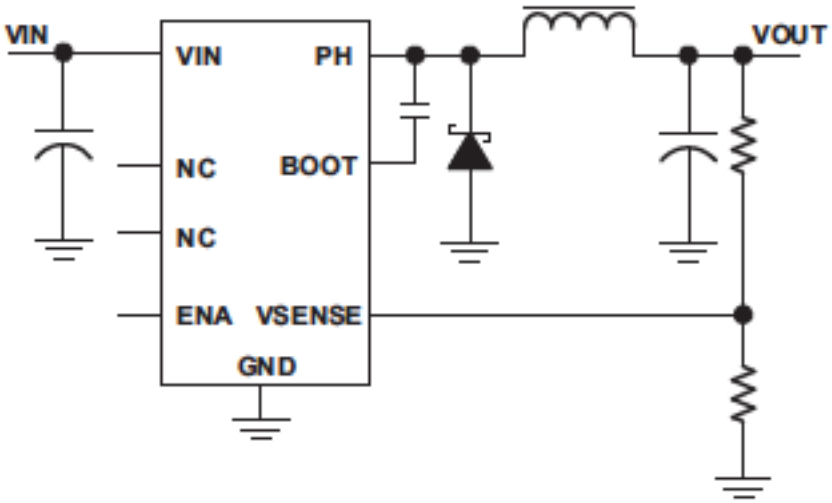
- Ratings:
  - Input: 25V/1A
  - Output: 5V/5A
  - Switching Frequency 300 kHz





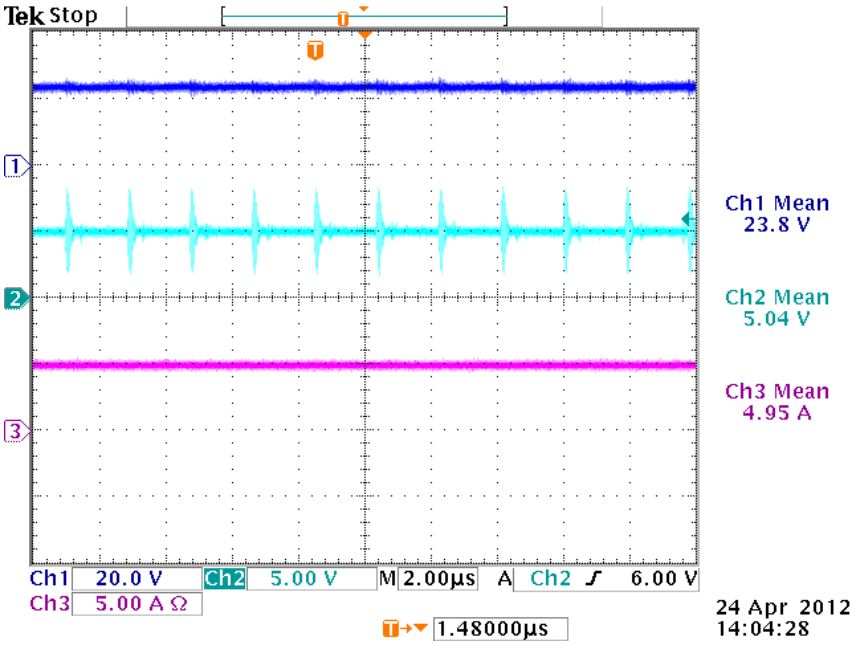
Low Buck Control

- Used IC chip: TSP5450
- Included the MOSFET and controls for linear regulations
  - Voltage output regulated itself to be 5V



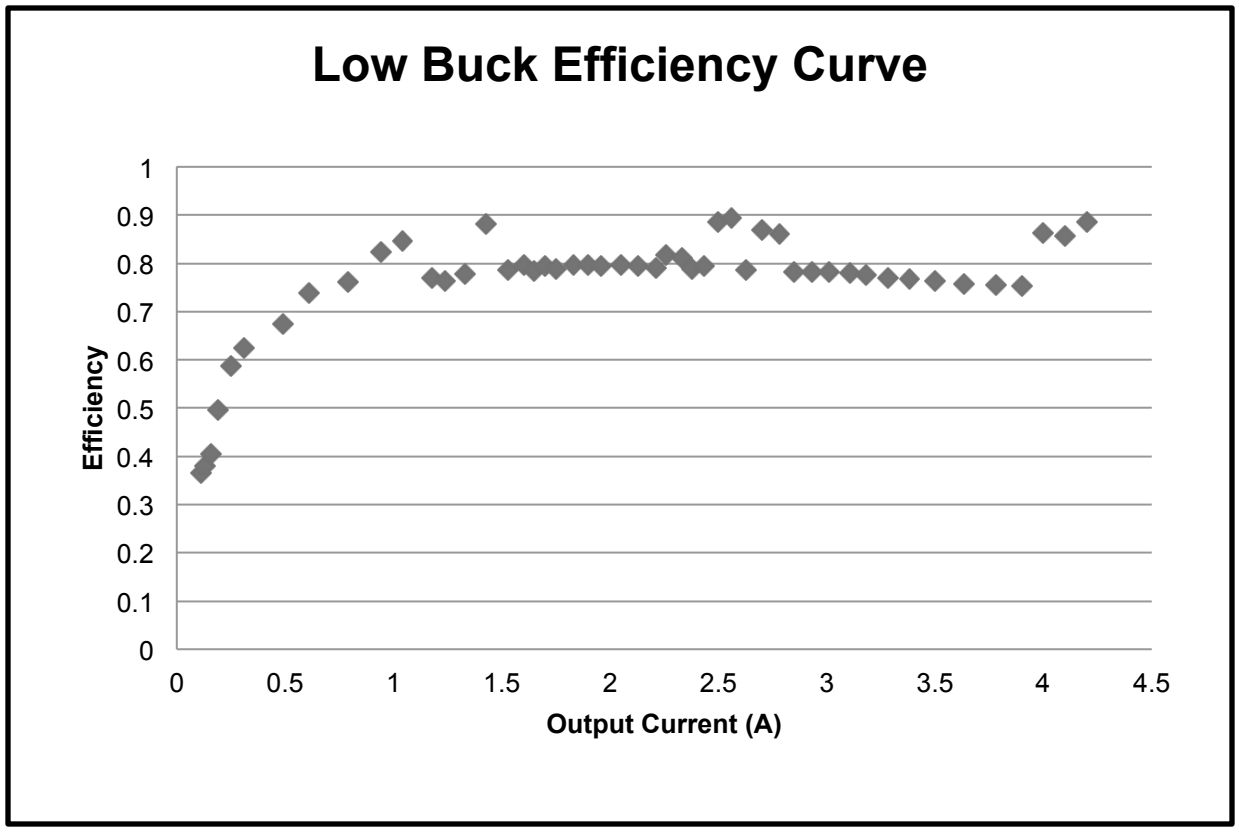
Low Buck Output

- Average Voltage: 5V
- Ripple: ± 100mV
- Waveform:
  - Low buck converter with an electronic load.
  - The electronic load with set output current of 4.75A
  - Channels:
    1. Input Voltage
    2. Output Voltage
    3. Output Current



Efficiency Curve

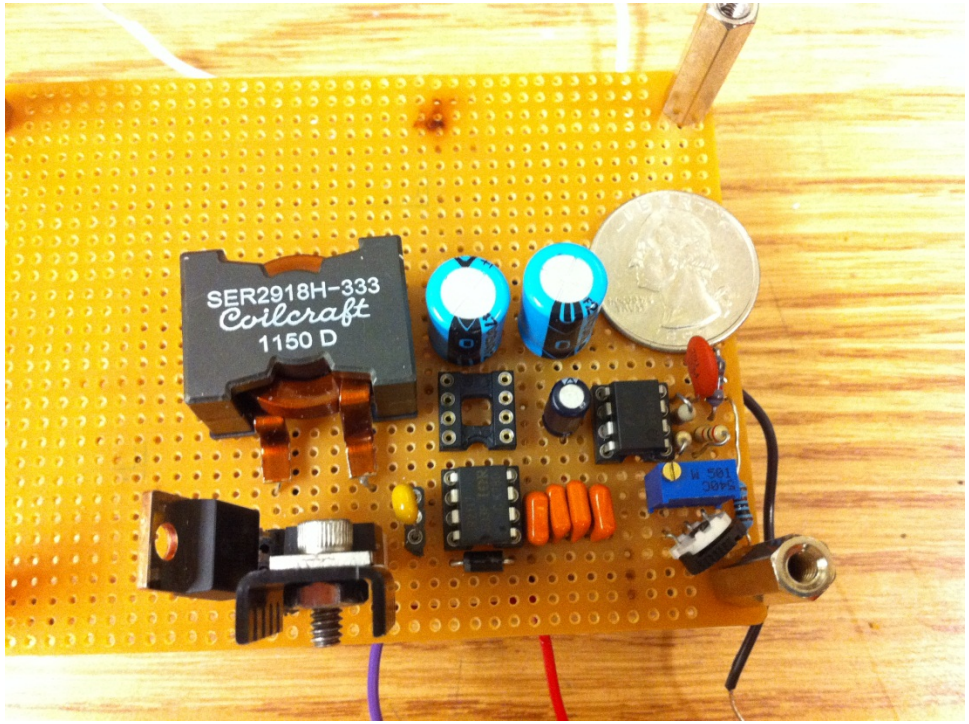
- Average Efficiency is 80.3%



HIGH BUCK CONVERTER

High Buck Converter

- Rating:
  - Input: 25V/7.2A
  - Output: 12V/15A
  - Switching Frequency 115 kHz

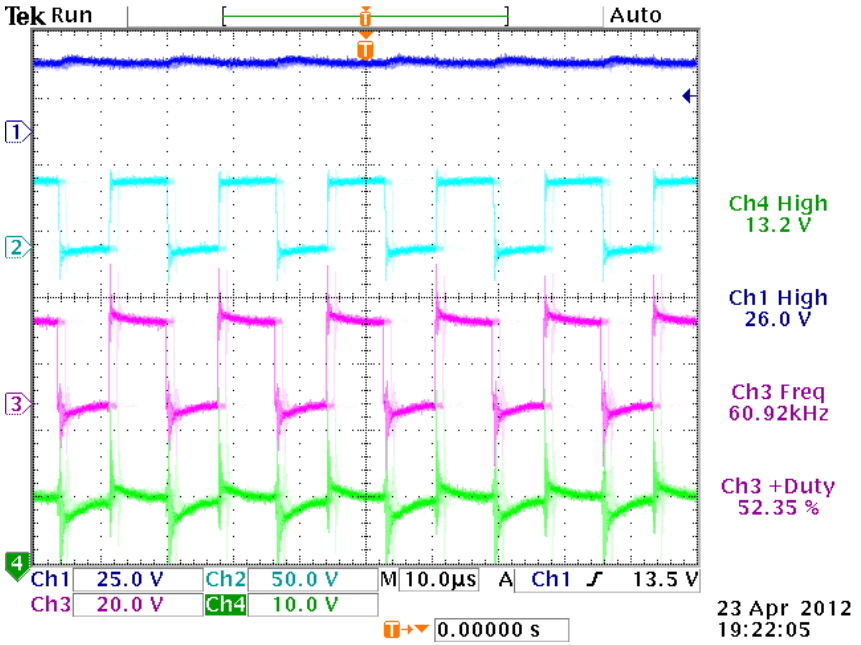


High Buck Control

- Original Idea:
  - TI Buck Controller (TPS40020)
  - Over Current Protection mode
- Alternative Approach:
  - PWM (UC3843)
  - High Side Gate Driver (IR2117)

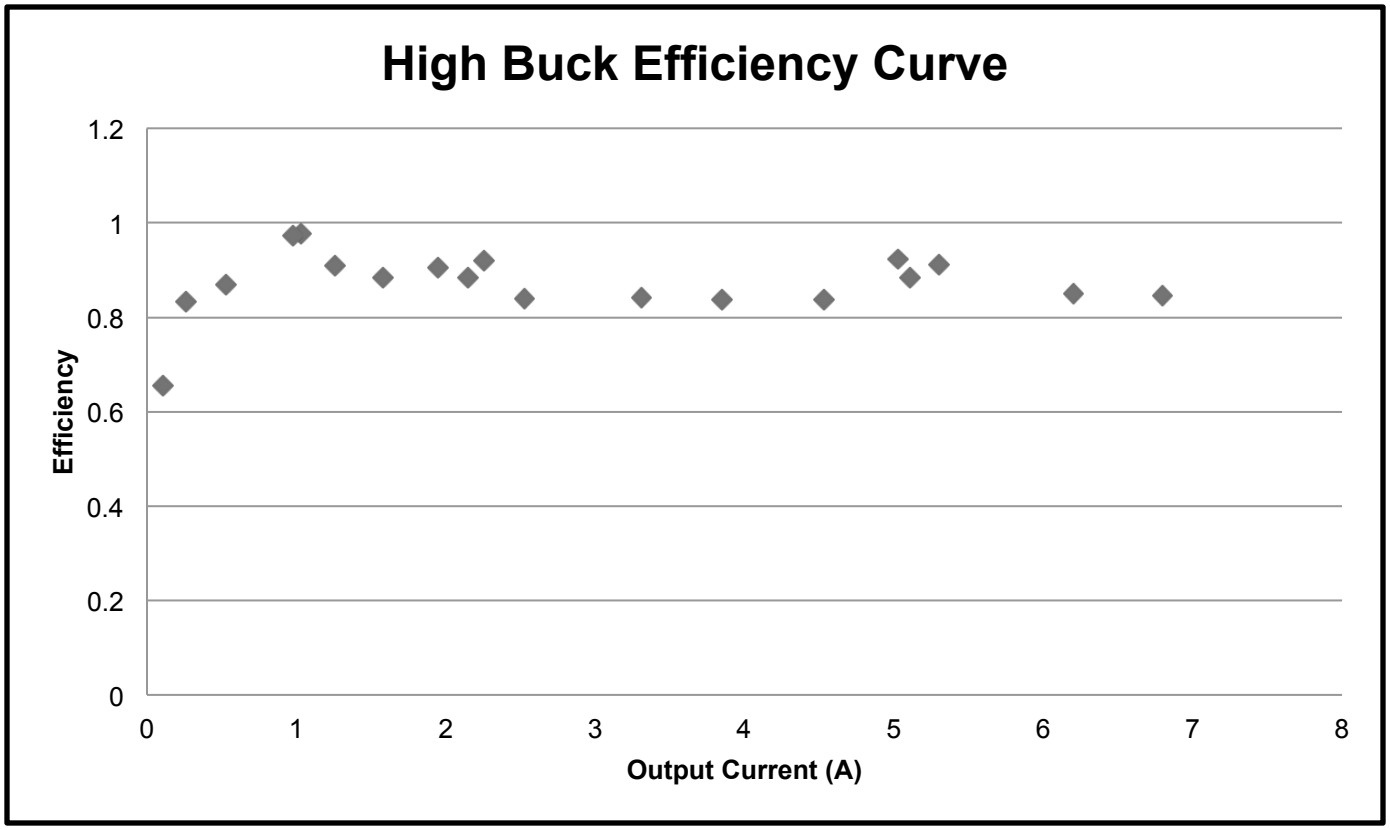
High Buck Output

- Waveform:
  - loaded with drill 25V input from DC power supply.
  - Channels:
    1. Voltage output (unadjusted)
    2. Gate signal
    3. PWM output
    4. Input Voltage load drawing 3.5A



Efficiency Curve

- Average Efficiency is 88.93%



Loads

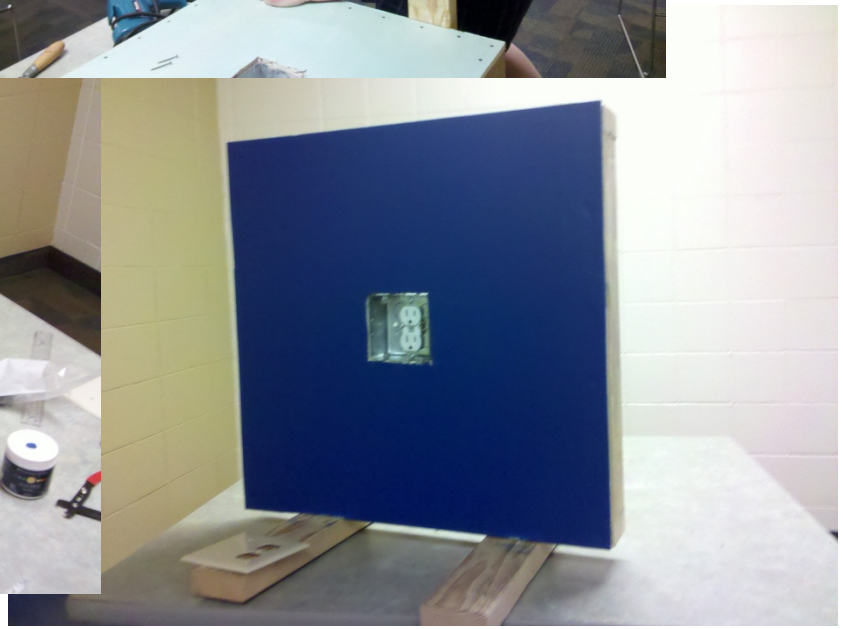

DEWALT


9:42 AM
iPhone
32GB


MOTOROLA
9:48 PM
verizon

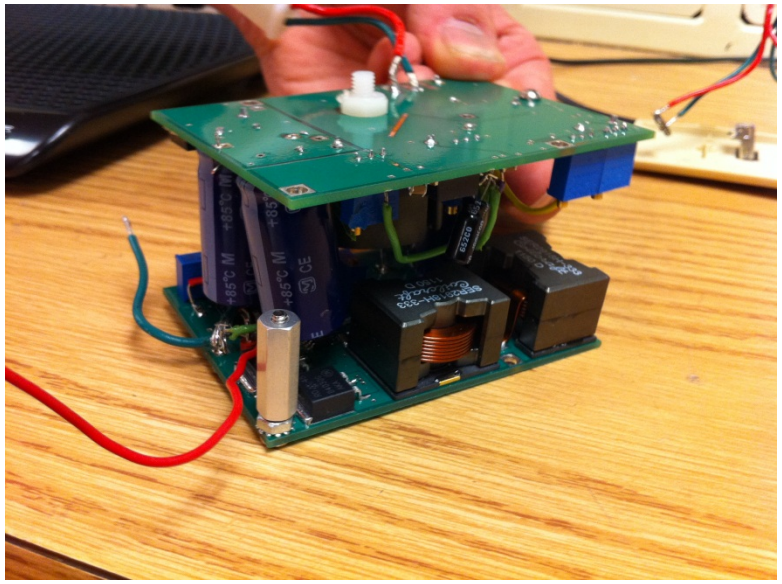

1:24
FRI
27.3

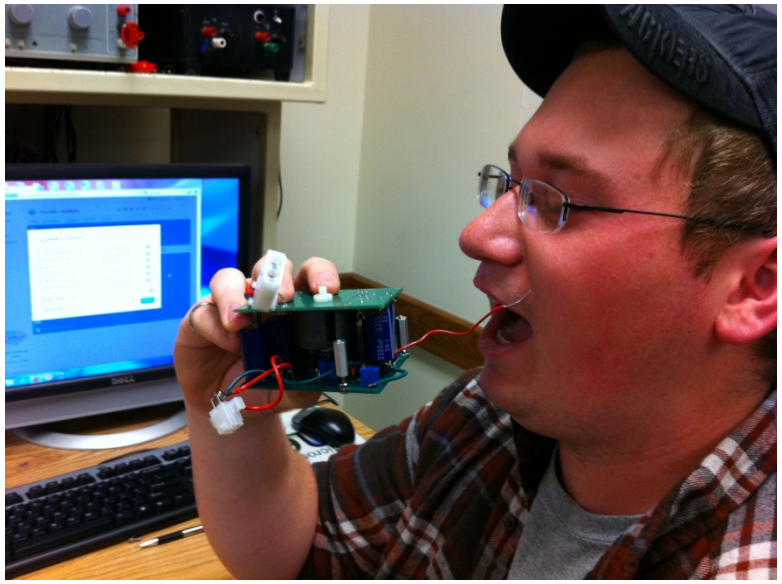
Wall Construction



Overall Results

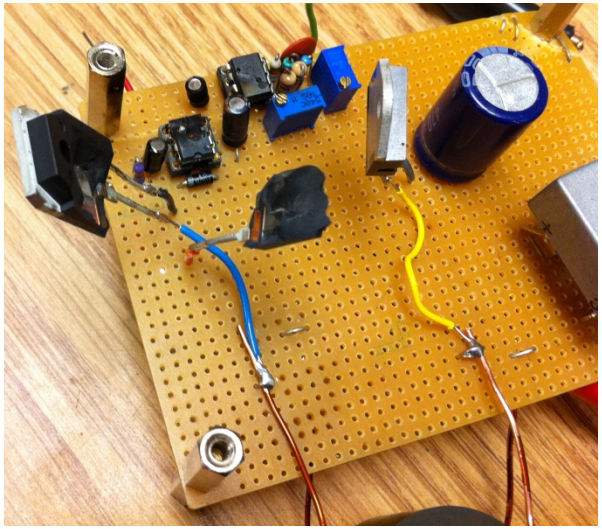
- Each PCB worked
- Problems with Flyback PCB
- 100% operational Buck Modules





Lessons Learned

- Check Circuit (signals)
- Ground
- Don’t plug in the circuit with power on during the demo
- Cindy is a good cook



Future

- Smaller Components
  - Potentiometers, higher switching frequency, inductor, PCB layout
- Lower ESR Capacitors
- PCB High Buck
- Commercialize

The Battle Continues…

Questions