Power Supply Design

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Current Solution

- LM2596S Adjustable Buck Converter
  - Input 3-40V Output 1.5-35V (3A)
- Problems
  - Not super efficient for our use case
  - It’s big
  - It’s annoying to use (plus I’m always worried about the pot accidentally spinning and not maintaining voltage)

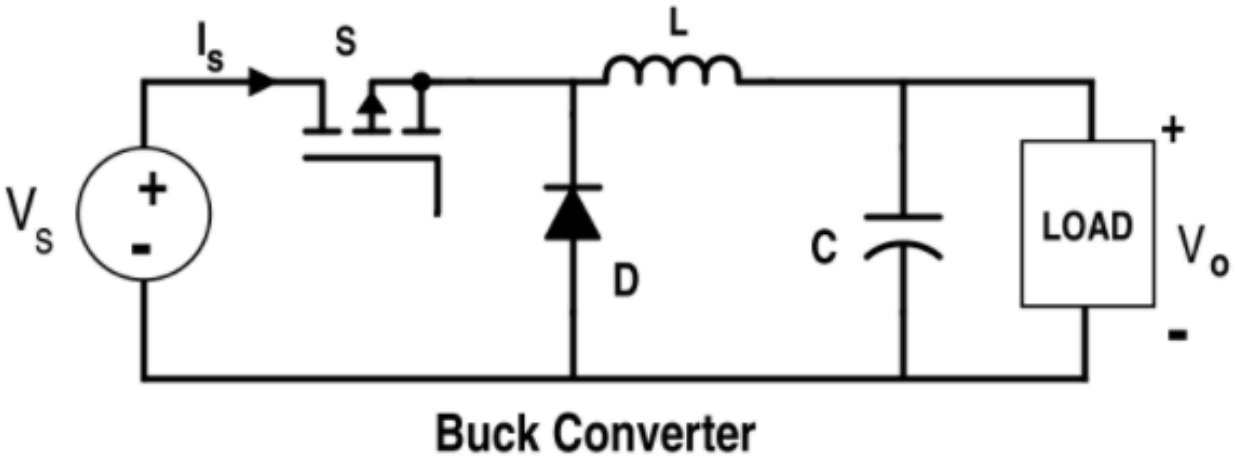
Goals

- More efficient (At 3.3V and 5V)
- Smaller
- Similar in price (Cost about $1.40-1.70/unit for 6 on Amazon)
- Similar capabilities

How do Buck Converters Work?

- The transistor is fed a PWM signal, the duty cycle effectively allows the average voltage to the load side
- The inductor/capacitor pair create a low-pass filter to smooth the output to a constant voltage (cutoff frequency $f_0 << f_s$)
- With PWM duty cycle D,

$$V_o = \frac{1}{T_s}\int_0^{T_s} v_s(t)dt = DV_s$$



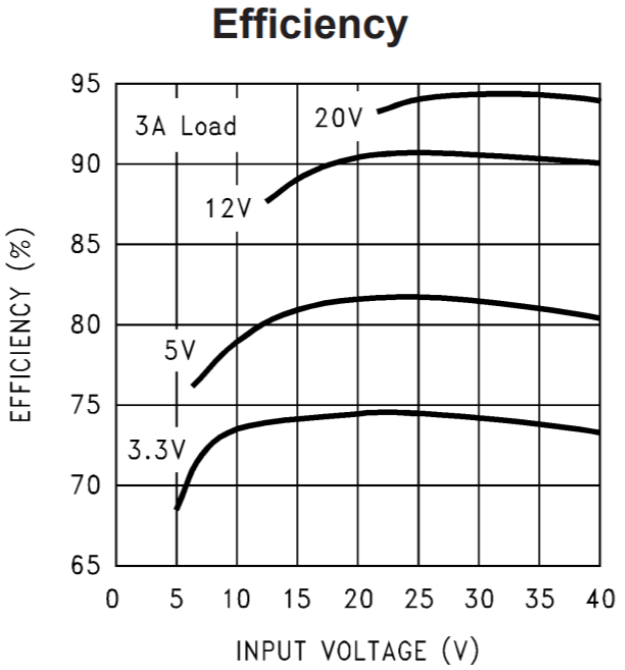
Buck Converter

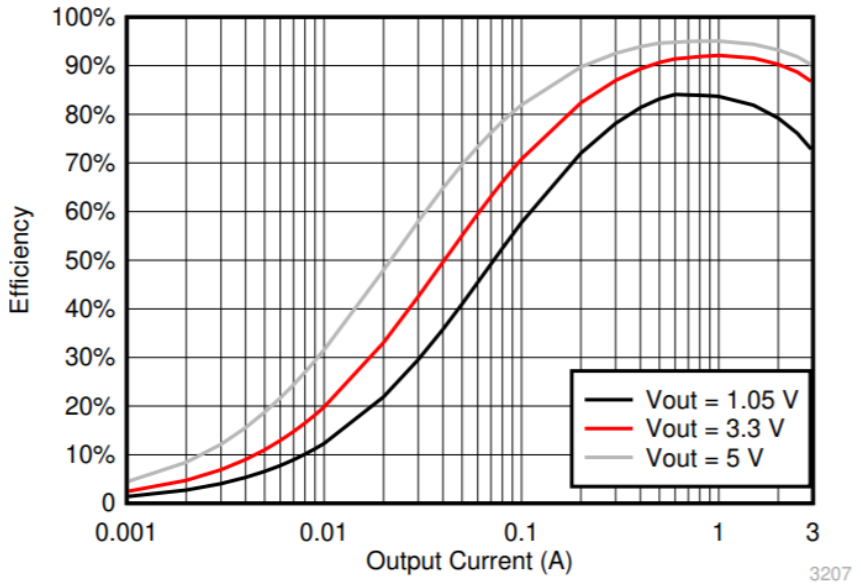
Efficiency

A linear regulator has an efficiency of

$$E = \frac{V_{out}}{V_{in}}$$

So for a linear regulator from 7.4V to 5V, it has 68% efficiency and from 7.4V to 3.3V it has 45% efficiency.





TPS563207 Efficiency

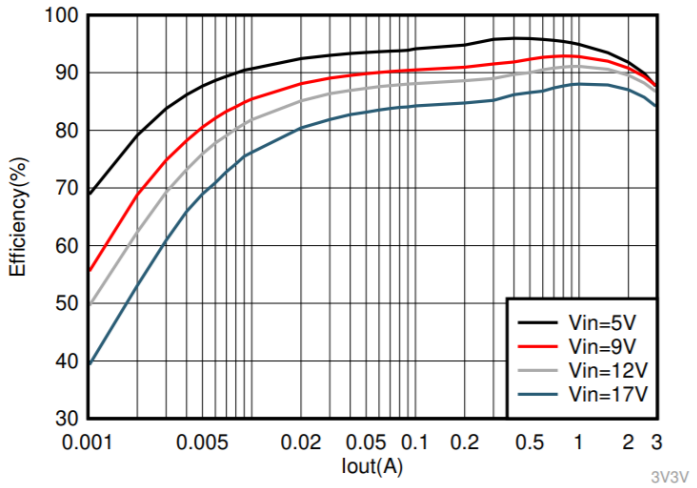


Figure 9. TPS563231 V_{OUT} = 3.3 V Efficiency

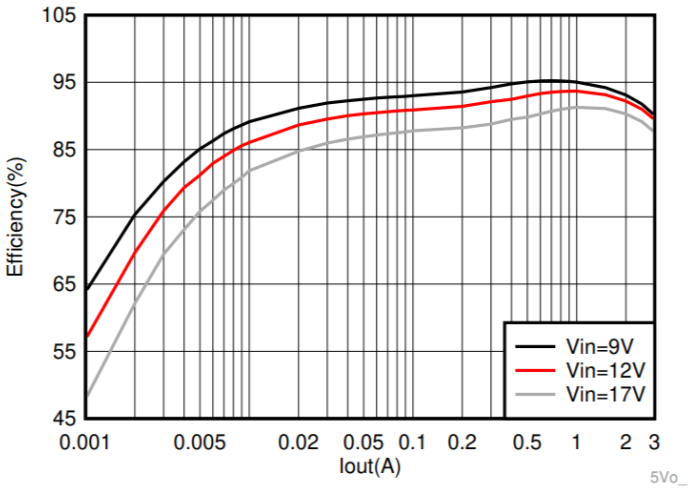
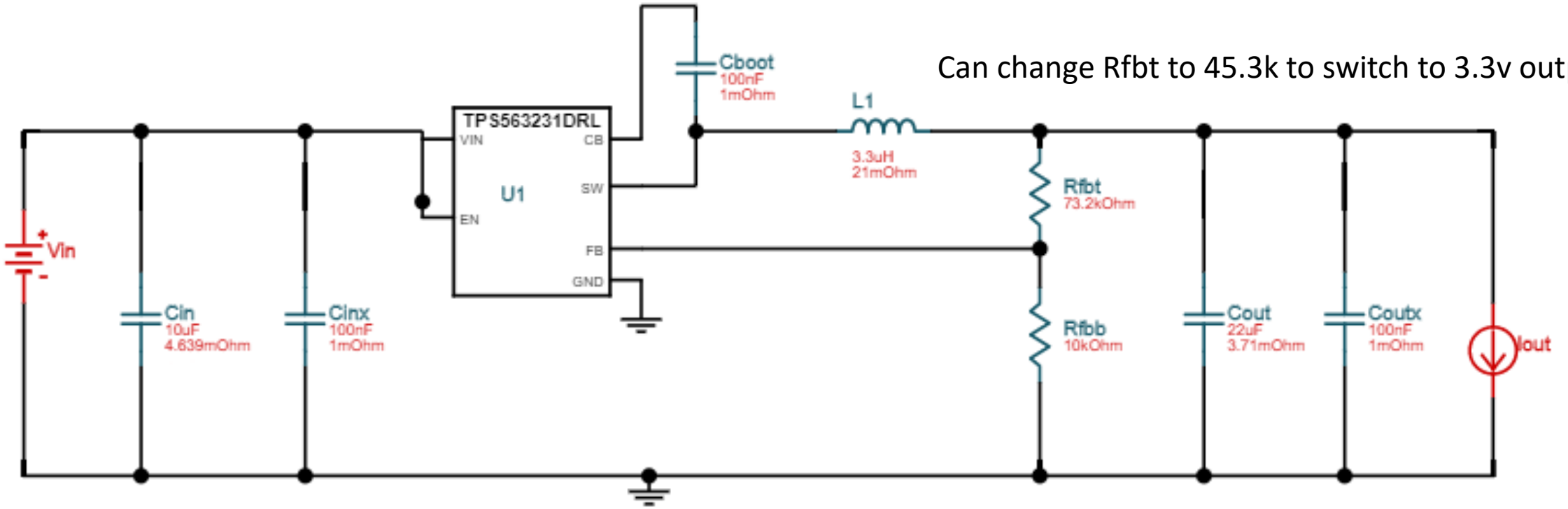


Figure 10. TPS563231 V_{OUT} = 5 V Efficiency

Schematic



Can change Rfbt to 45.3k to switch to 3.3v output

**I estimate that it will probably take up around 25% of board space compared to Amazon version

**Vin is between 4.5V and 17V

Cost

- I found that cost was mostly driven by buck converter IC and the inductor

Component	Cost ($ at qty 10)
TPS562531 (Buck converter)	0.726
3.3uH Inductor	0.595
10uF Capacitor	0.201
22uF Capacitor	0.205
0.1uF Capacitor (x3)	0.021
10k Resistor 1%	0.015
73.2k Resistor 1% (5V version)	0.015
45.3k Resistor 1% (3.3V version)	0.015
Total Cost/Unit (qty 10)	1.835
Total Cost/Unit (qty 100)	1.218