Switched Regulation

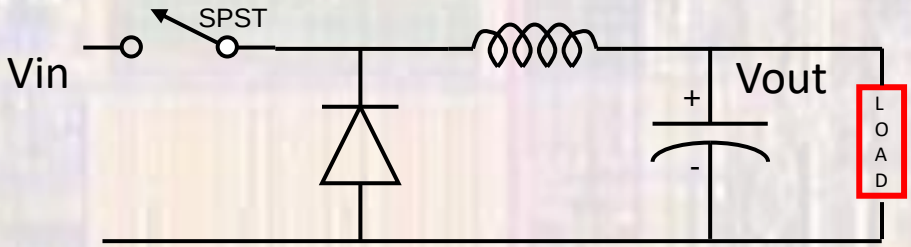
Last updated 1/18/24

Switched Regulation

- Switched Regulation
  - Create a DC voltage from an DC signal
    - Input could be from a sloppy linear regulator
  - Uses linear and non-linear components along with switching elements
  - 3 primary types
    - Buck – high voltage to lower voltage with higher current
    - Boost – low voltage to higher voltage with less current
    - Buck-Boost – convert both directions

Switched Regulation

- Buck Converter
  - High voltage to lower voltage with higher current
    - Can be very power efficient 95%+



Vout = Vin * Duty Cycle

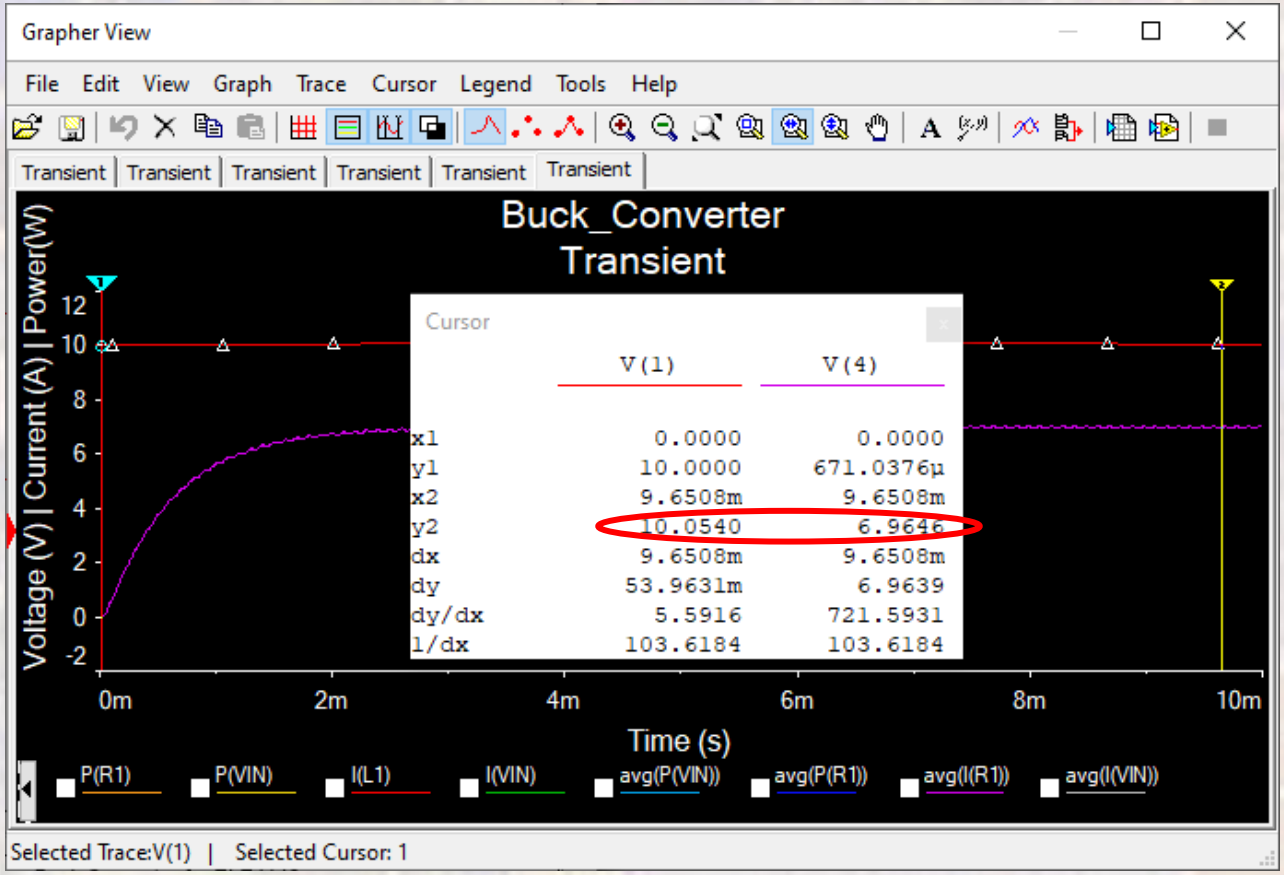
Choose L or ΔI_L

$$\Delta I_L = \frac{V_{in} \times (1 - D) \times T_{on}}{L} \qquad L = \frac{(V_{in} - V_{out}) \times D \times (1 - D) \times T_{on}}{\Delta I_L}$$

$$C = \frac{\Delta I_L}{F_s \times V_{out} \times V_{out}\, ripple}$$

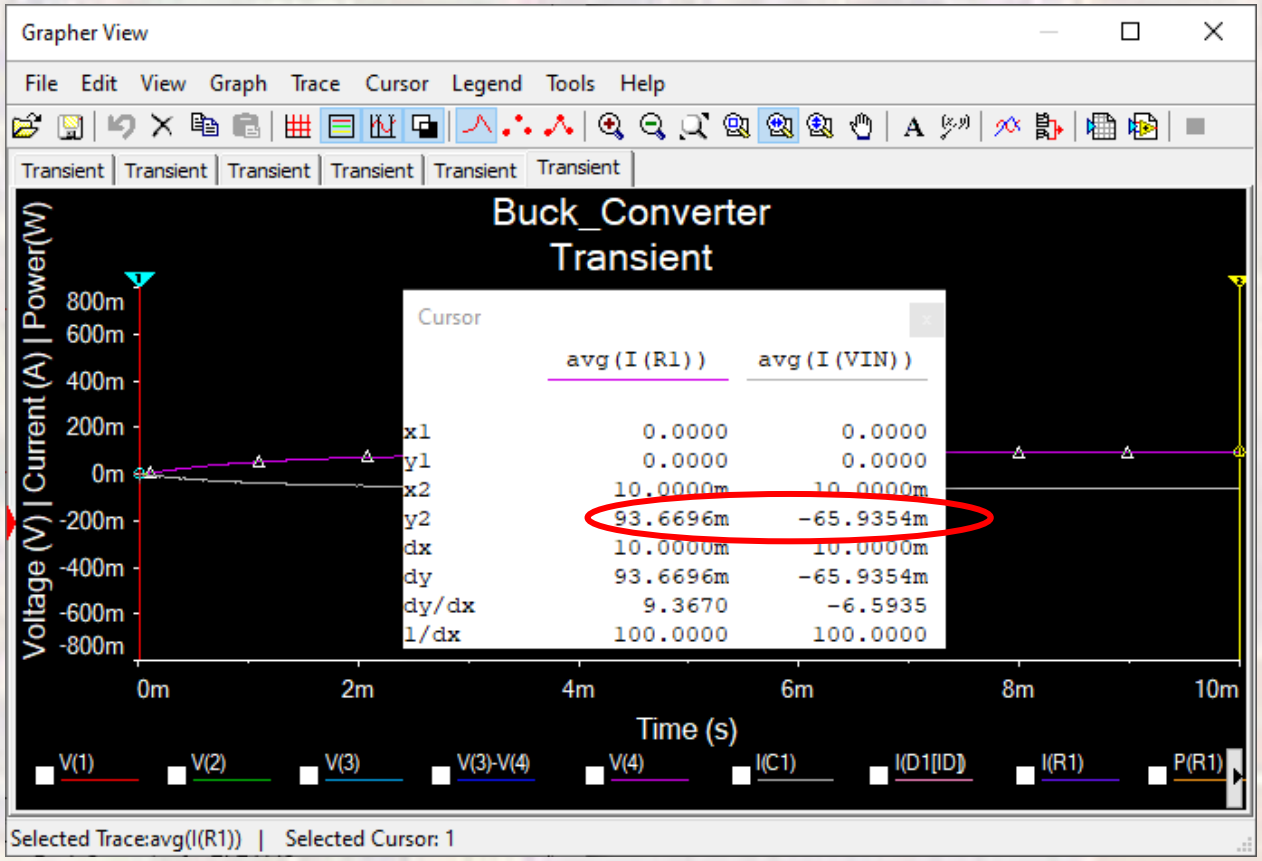
Switched Regulation

- Buck Converter
  - Fs = 10KHz, D = 0.7, L = 44mH, C = 681nF, RL = 70Ω
    - Vin = 10V, Vout = 7V



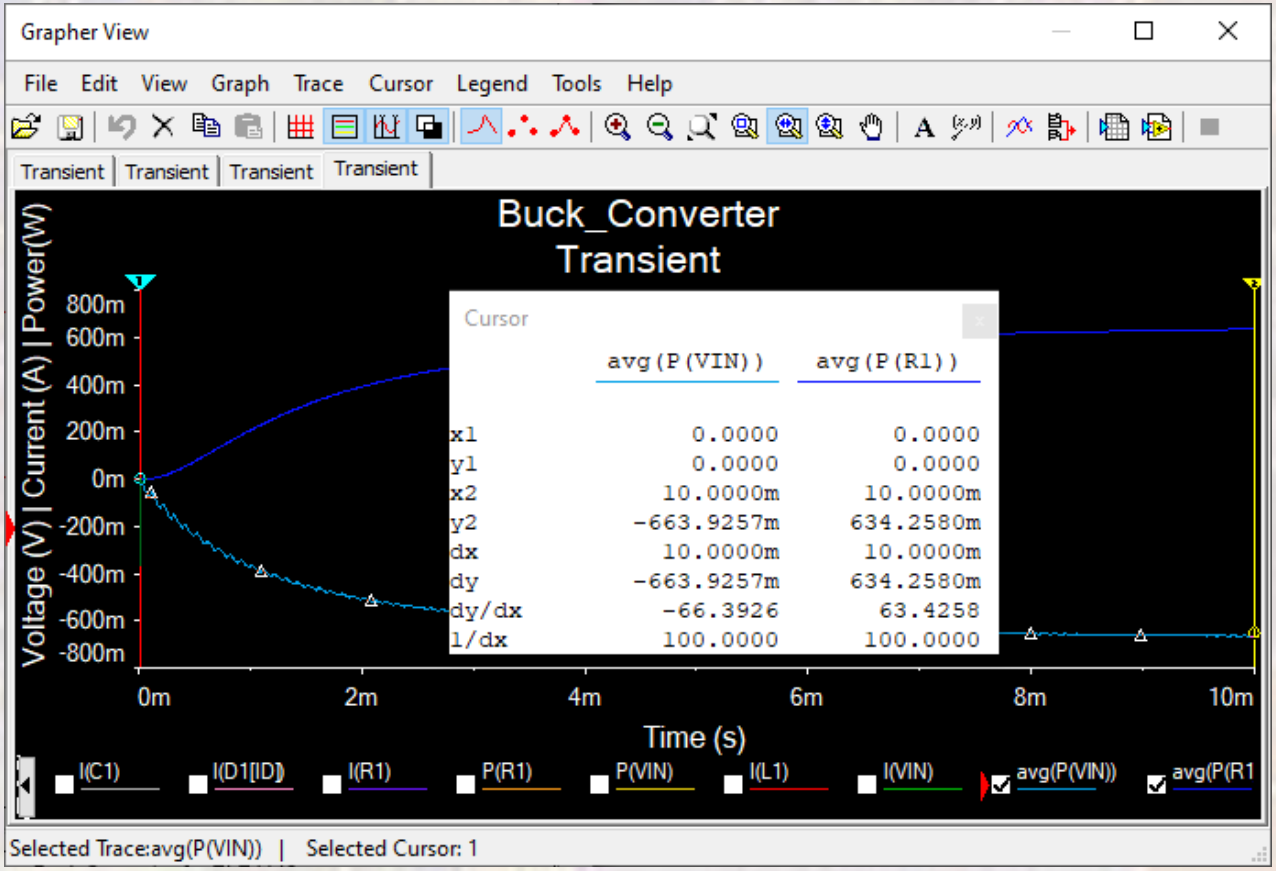
Switched Regulation

- Buck Converter
  - Fs = 10KHz, D = 0.7, L = 44mH, C = 681nF, RL = 70Ω
    - I in = 66mA, I out = 93.6mA



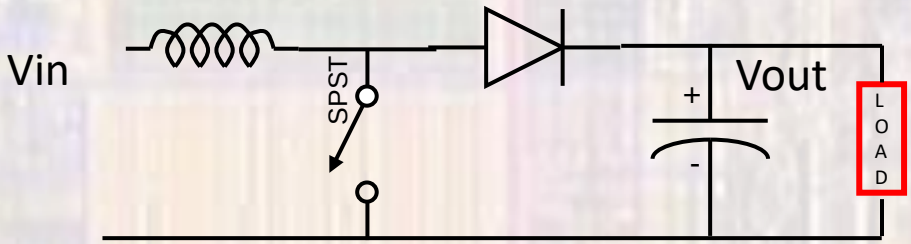
Switched Regulation

- Buck Converter
  - Fs = 10KHz, D = 0.7, L = 44mH, C = 681nF, RL = 70Ω
    - Pin = 663mW, Pout = 634mW → 95.5% efficiency



Switched Regulation

- Boost Converter
  - Low voltage to higher voltage with lower current
    - Can be very power efficient 95%+



Vout = Vin / (1 - Duty Cycle)

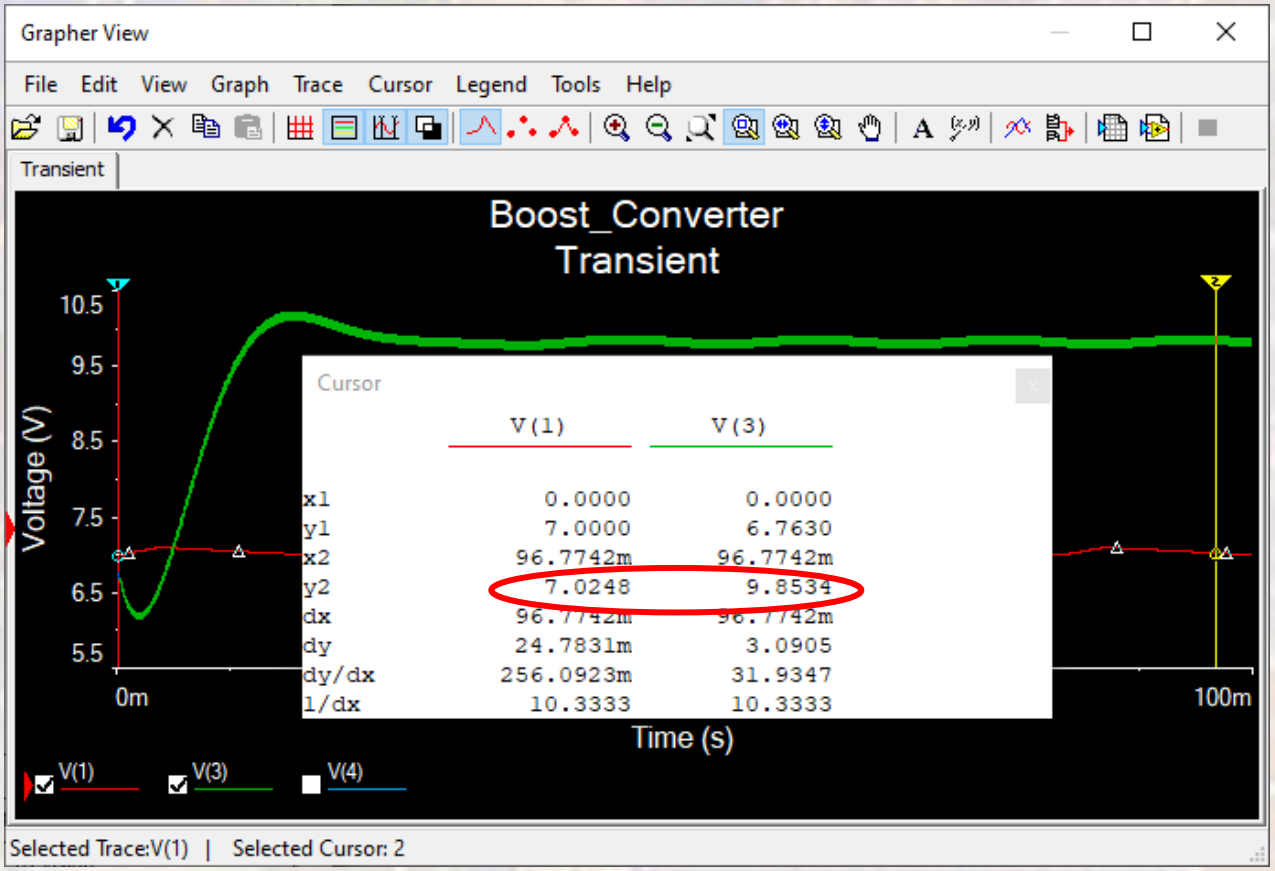
Choose L or ΔI_L

$$\Delta I_L = \frac{V_{out} \times D \times T_{on}}{L} \qquad L = \frac{V_{in} \times (1 - D) \times T_{on}}{\Delta I_L}$$

$$C = \frac{\Delta I_L}{F_s \times V_{out} \times V_{out}\, ripple}$$

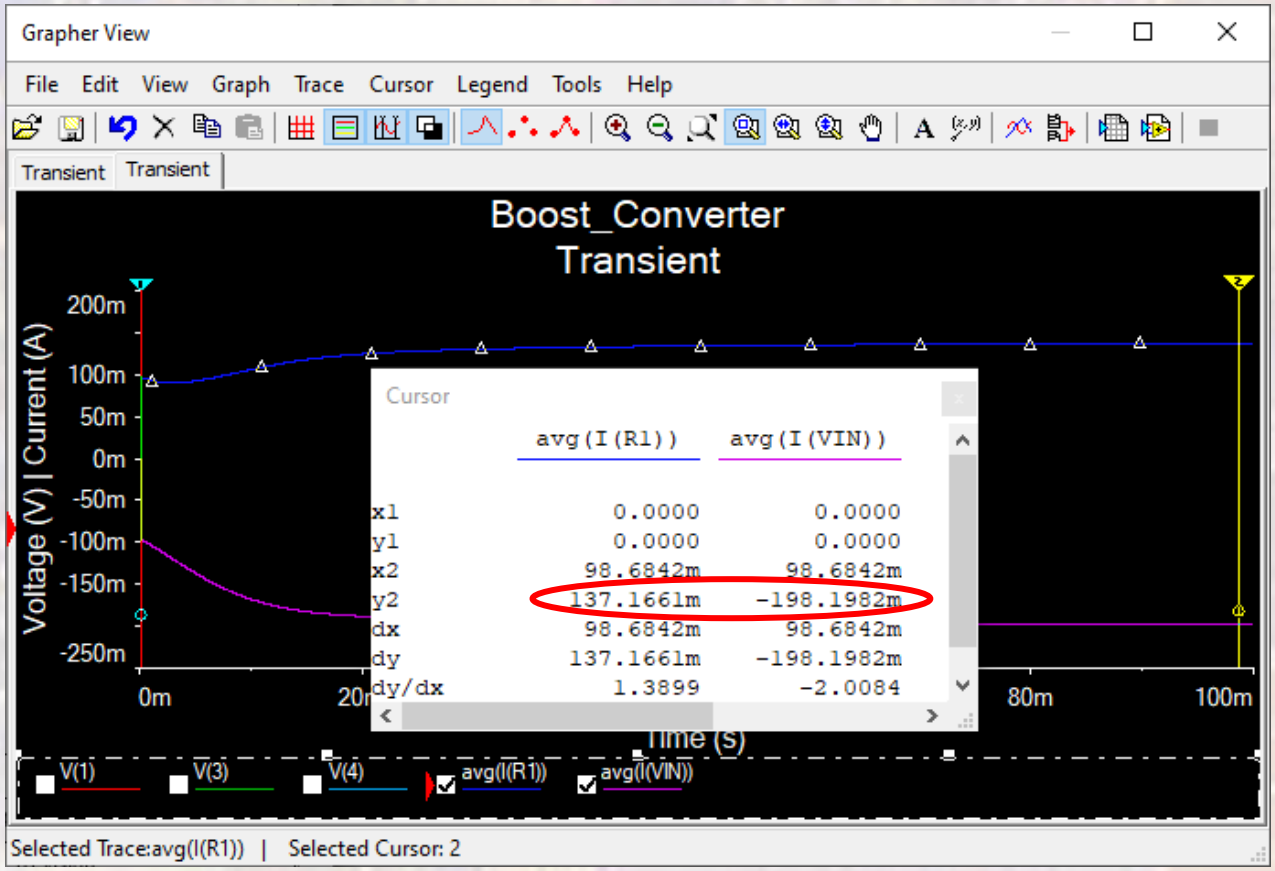
Switched Regulation

- Buck Converter
  - Fs = 10KHz, D = 0.3, L = 147mH, C = 43uF, RL = 70Ω
    - Vin = 7V, Vout = 10V



Switched Regulation

- Buck Converter
  - Fs = 10KHz, D = 0.3, L = 147mH, C = 43uF, RL = 70Ω
    - I in = 198mA, I out = 137mA



Switched Regulation

- Buck Converter
  - Fs = 10KHz, D = 0.3, L = 147mH, C = 43uF, RL = 70Ω
    - Pin = 1.4W, Pout = 1.32W → 94.3% efficiency