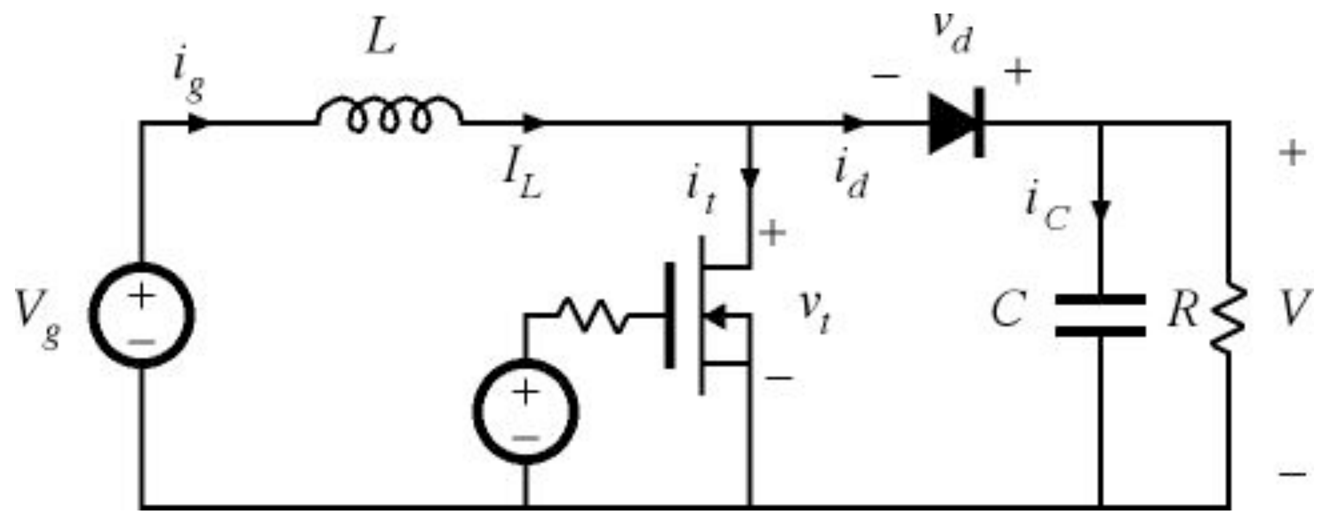
Boost Converter Example

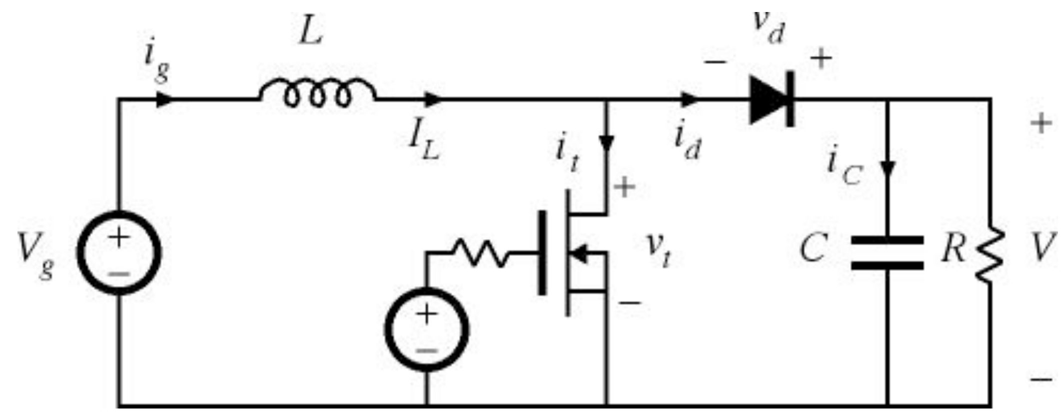


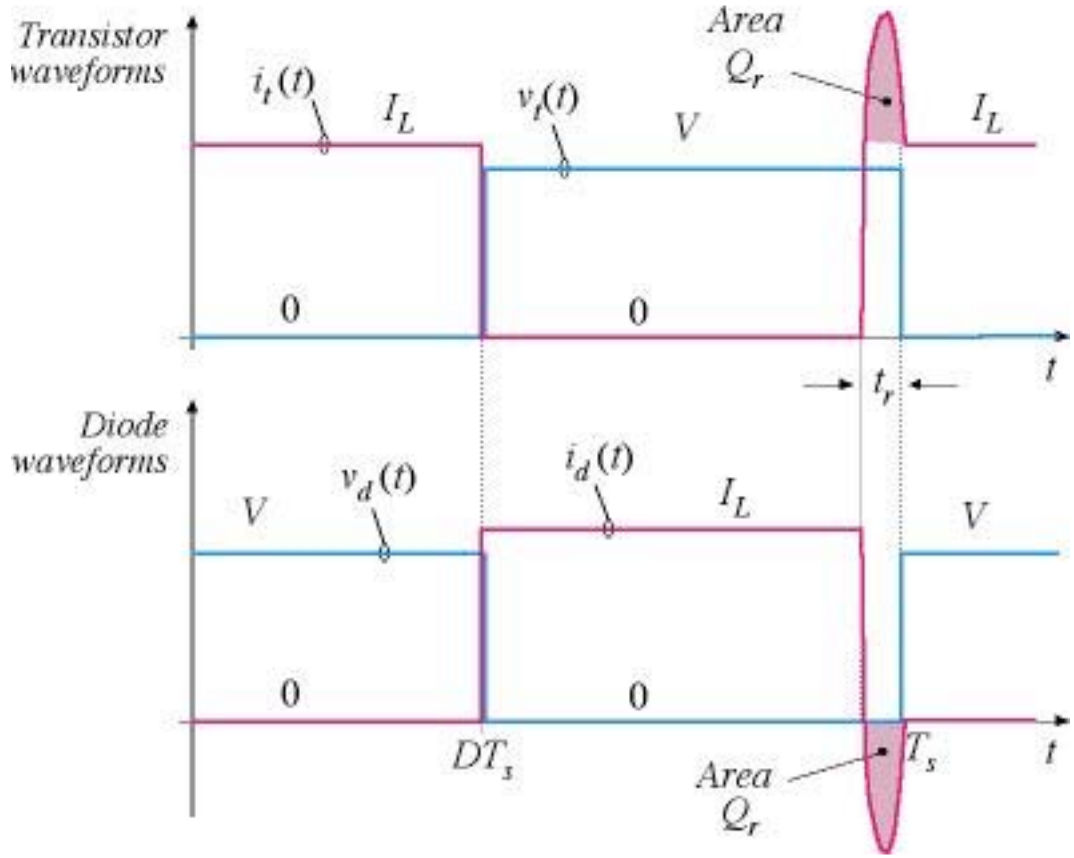
Model same effects as in previous buck converter example:

- Ideal MOSFET, *p–n* diode with reverse recovery
- Neglect semiconductor device capacitances, MOSFET switching times, etc.
- Neglect conduction losses
- Neglect ripple in inductor current and capacitor voltage

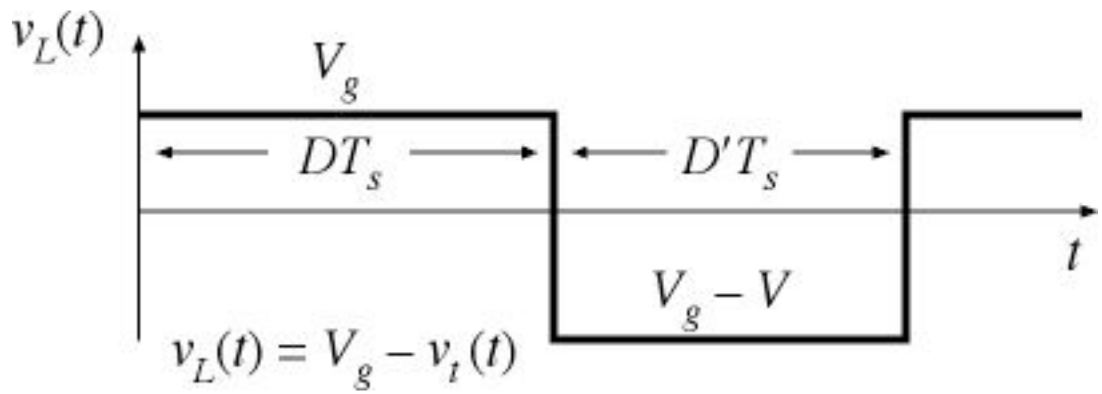
Boost converter

Transistor and diode waveforms have same shapes as in buck example, but depend on different quantities





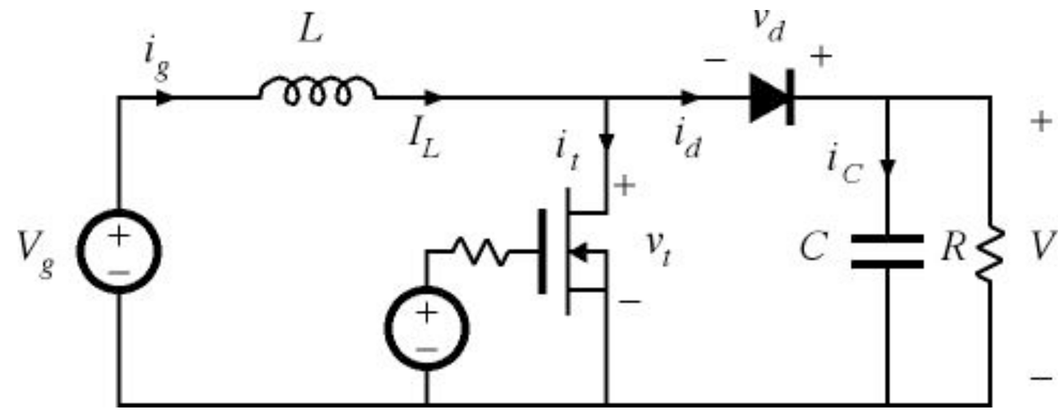
Inductor volt-second balance and average input current

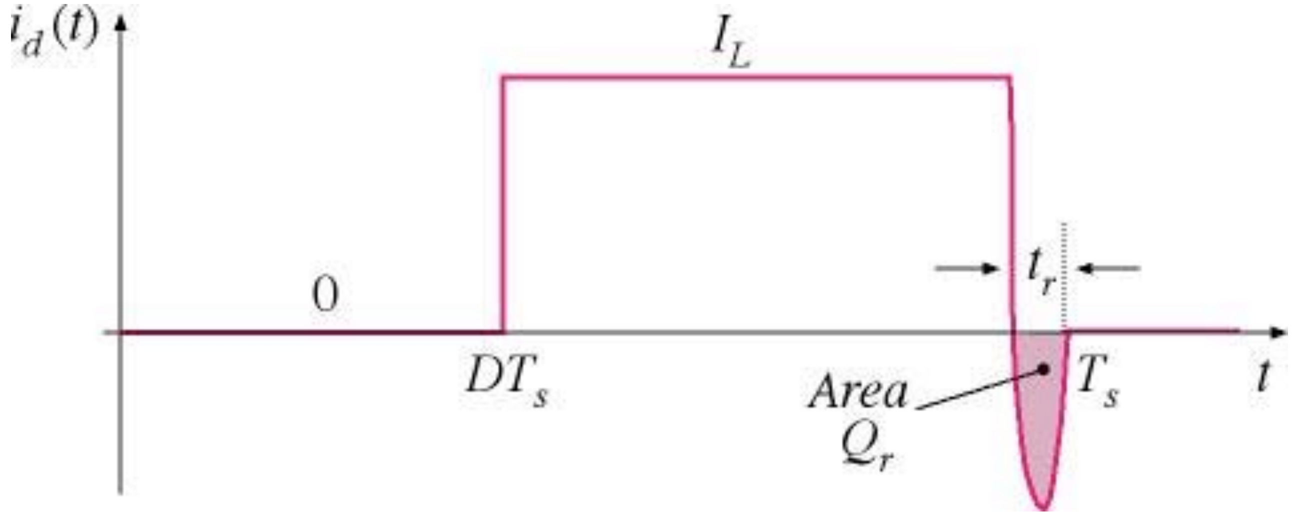


As usual: $\langle v_L \rangle = 0 = V_g - D'V$

Also as usual: $\langle i_g \rangle = I_L$

Capacitor charge balance





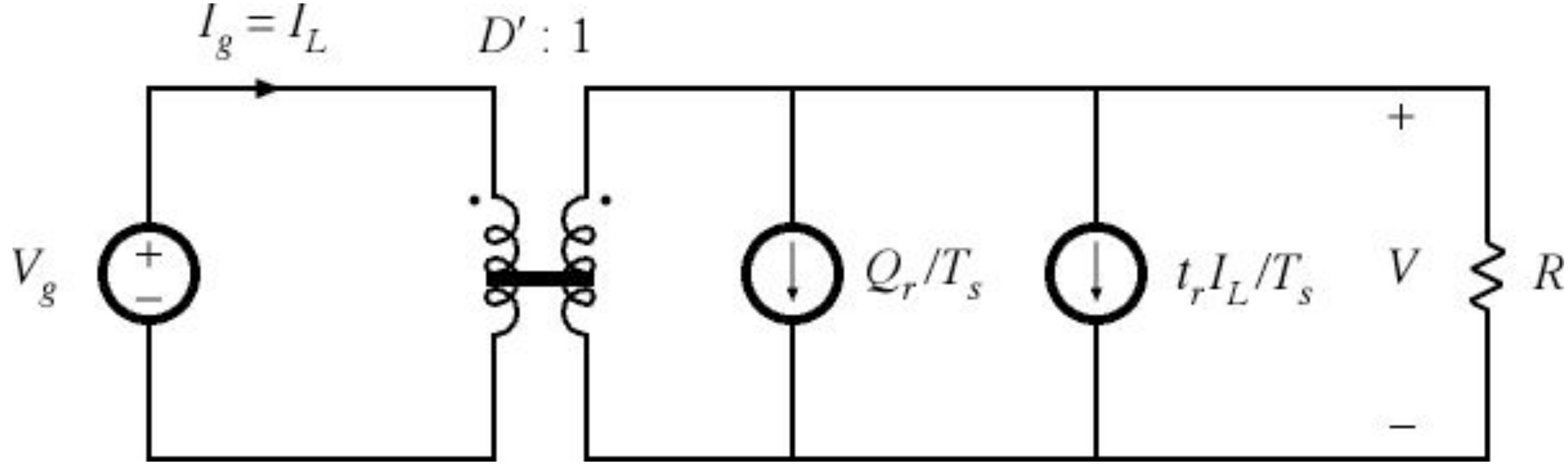
$$\langle i_C \rangle = \langle i_d \rangle - V/R = 0$$

$$= -V/R + I_L(D'T_s - t_r)/T_s - Q_r/T_s$$

Collect terms: $V/R = I_L(D'T_s - t_r)/T_s - Q_r/T_s$

Construct model

The result is:



The two independent current sources consume power

$$V\,(t_r I_L/T_s + Q_r/T_s)$$

equal to the switching loss induced by diode reverse recovery

Predicted V/V_g vs duty cycle

Switching frequency 100 kHz

Input voltage 24 V

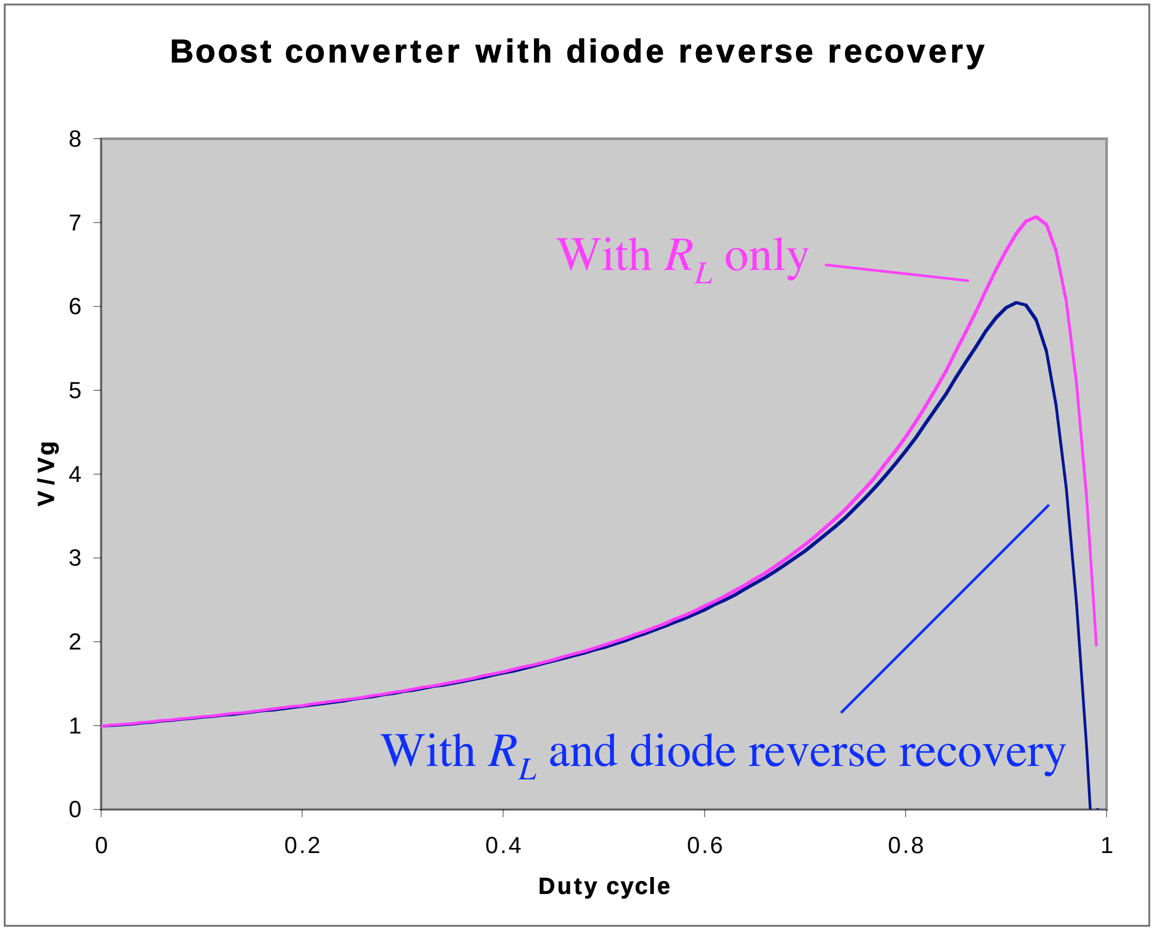
Load resistance 60 Ω

Recovered charge 5 μCoul

Reverse recovery time 100 nsec

Inductor resistance $R_L = 0.3$ Ω

(inductor resistance also inserted into averaged model here)



Summary

The averaged modeling approach can be extended to include effects of switching loss

Transistor and diode waveforms are constructed, including the switching transitions. The effects of the switching transitions on the inductor, capacitor, and input current waveforms can then be determined

Inductor volt-second balance and capacitor charge balance are applied

Converter input current is averaged

Equivalent circuit corresponding to the the averaged equations is constructed