Boost Converter (draft 2/27/2015)

- Switching type DC-DC converter
- Output voltage is greater than input voltage

\[ + V_L - \]

1. Fill in the plots for two periods of the boost converter’s operation.

For simplicity, assume \( i_L \) goes from \( i_{max} \) to \( i_{min} \) in a linear fashion in time \( T_{off} \), with a change of \( \Delta i = i_{min} - i_{max} \) (<0). Also assume \( V_{out} \) is approximately constant. During \( T_{off} \) the instantaneous power delivered to the capacitor and load from the inductor in series with \( V_{in} \) is

\[ p(t) = i_L(t) (-V_L(t) + V_{in}) \]

The inductor voltage during \( T_{off} \) is assumed constant:

\[ V_L(t) = L \frac{\Delta i}{T_{off}}, \]

where \( V_{in} \) is boosted by \( V_L \).

The work delivered per cycle from battery and inductor (when switch is open) is:

\[ W = i_L (-V_L + V_{in}) T_{off} = i_L (-L \frac{\Delta i}{T_{off}} + V_{in}) T_{off} = i_L (-L \Delta i + V_{in} T_{off}) \]

The time average power delivered to the load (through the diode) is

\[ P_{ave} = \frac{i_L (-L \Delta i + V_{in} T_{off})}{(T_{on} + T_{off})} = \frac{L (i^2_{max} - i^2_{min})/2 + i_L V_{in} T_{off}}{(T_{on} + T_{off})} \]

Note that there is a contribution from energy stored in the inductor and the power provided by battery.

The average power in the load should equal delivered power to load so

\[ P_{ave} = \frac{(L (i^2_{max} - i^2_{min})/2 + i_L V_{in} T_{off})}{(T_{on} + T_{off})} = \frac{V_{out}^2}{R} \]

Note that the current may instead oscillate around an average current value, delivering more power to load.