Equivalent Circuit Model

\[ V = \left( \frac{1}{D} \right) \left( V_g - D'V_B \right) \left( \frac{D^2 R}{D^2 R + R_c + D'R_m + D'R_D} \right) \]

\[ D = 0.756 \]

\[ A = \left( \frac{V}{V_g} \right) \left( 1 - \frac{D'V_B}{V_g} \right) \left( \frac{1}{1 + \frac{R_c + D'R_m + D'R_D}{D^2 R}} \right) \]

\[ \eta = 97.6\% \]

Ideal \text{ Buck-Boost}

\[ V_g = -\frac{D}{D'} \]

\[ V = -\frac{D}{D'} \]

Switch

\[ I_{on} = I_L = -\frac{V}{R_D} = -V_g \frac{D}{D'} \]

\[ V_{off} = V_g - V + V_g - \left( -\frac{A}{D} V_g \right) = V_g \left( 1 + \frac{D}{D'} \right) \]

\[ I_L = -\frac{V}{R_D} \]

I: A on B off

II: A off B on

What voltages must it block when off
What currents must it conduct when on

\[ I_{on} = I_L = \frac{V_g D}{D'} \]

Transistor

\[ V_{off} = V_g - V \] same thing \rightarrow \text{ diode}
LTSpice Simulation

\[ L \quad C_{out} \quad f_s \quad \eta \ (Sim) \]

- 22uH
- 22uF
- 200k
- 93.9%

LTSpice Simulation

LTSpice Simulation
Switching Transition

Power Diodes
Reverse Biased Diode

Large, lightly-doped $n^-$ region used to obtain voltage blocking capability.

Poisson's Equation:
$$\frac{\partial^2 \psi}{\partial x^2} = \frac{\rho}{\varepsilon}$$
$$\varepsilon = \frac{\partial V}{\partial x} = \int_0^x \frac{\rho}{\varepsilon} dx$$

Forward Biased Diode

Minority Carrier Device: (Diode, BJT, IGBT, ...)

+ conductivity modulation $\rightarrow$ minority carriers injected

- stored minority charge that must be removed to turn the device off.