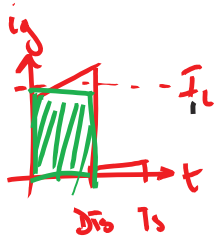
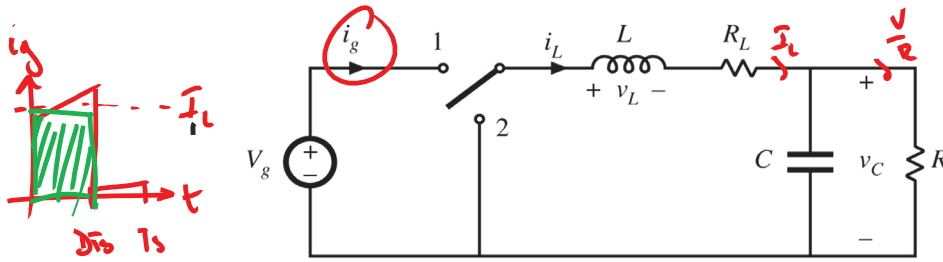


Buck Converter: Input Port Model



$$\langle v_L \rangle = DV_g - V - I_L R_L = 0$$

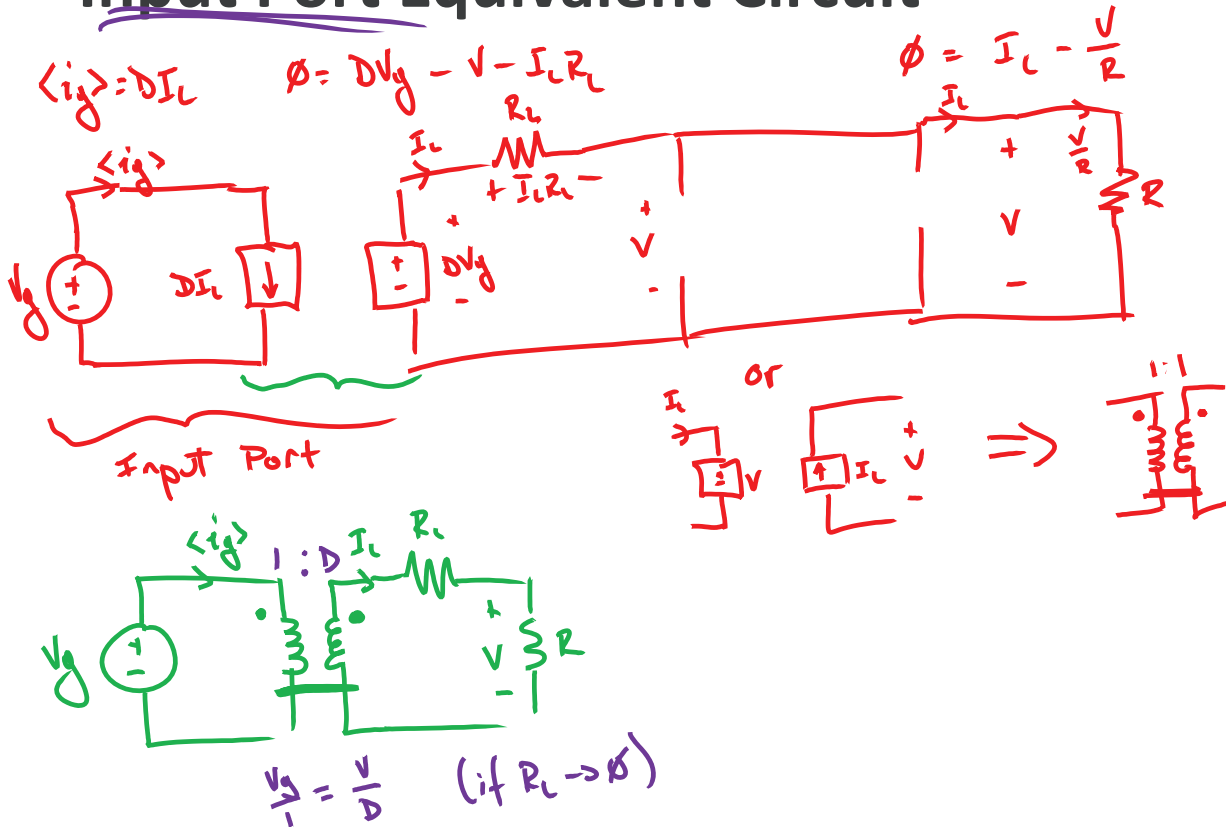
$$\langle i_C \rangle = I_L - \frac{V}{R} = 0$$

Because the input current is switched — need to add one more equation to get input port back in equiv. circuit model

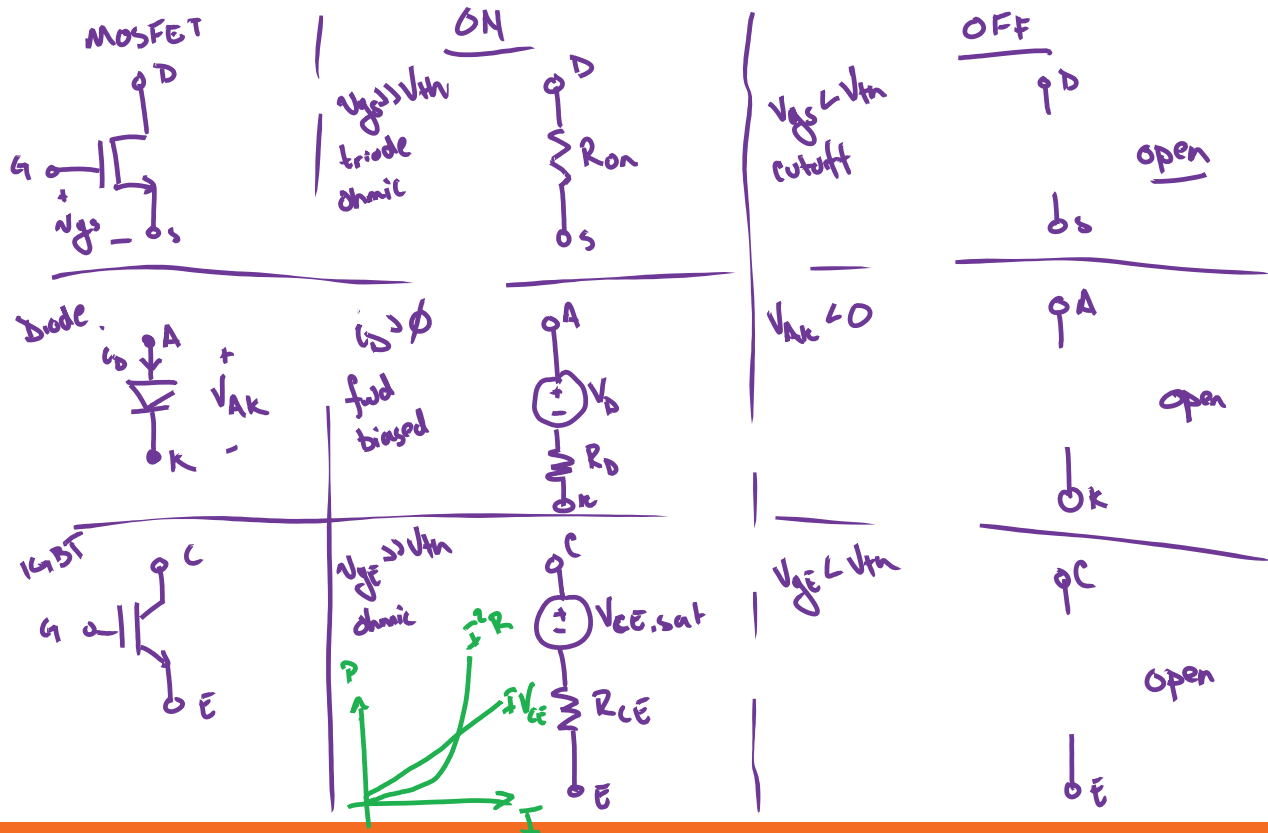
$$\langle i_g \rangle = \frac{1}{T_s} \int_0^{T_s} i_g(t) dt = \frac{1}{T_s} [D \times I_L] = DI_L$$

$$\langle i_g \rangle = DI_L$$

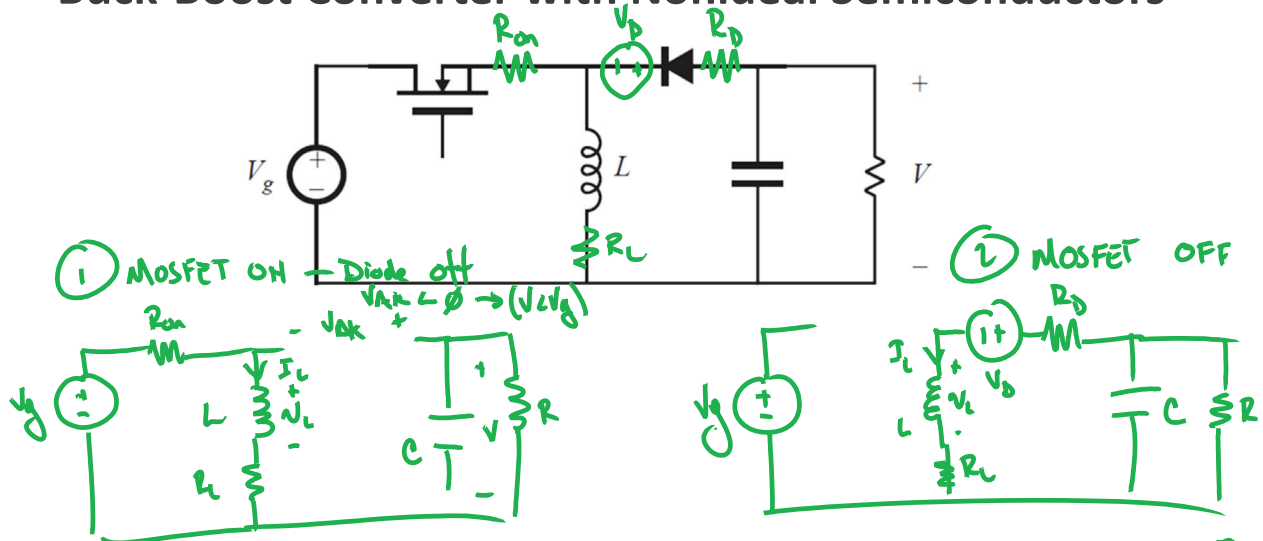
Input Port Equivalent Circuit



Semiconductor Conduction Loss Models



Buck-Boost Converter with Nonideal Semiconductors



$$\langle V_c \rangle = \phi = D [V_g - I_L R_{on} - I_L R_L] + D' [V - I_L R_D - I_L R_L - V_D]$$

$$\phi = DV_g - DI_L R_{on} + D'V - D'I_L R_D - D'V_D - I_L R_L$$

$$\langle i_c \rangle = -\frac{V}{R} - D'I_L \quad \langle i_g \rangle = DI_L$$