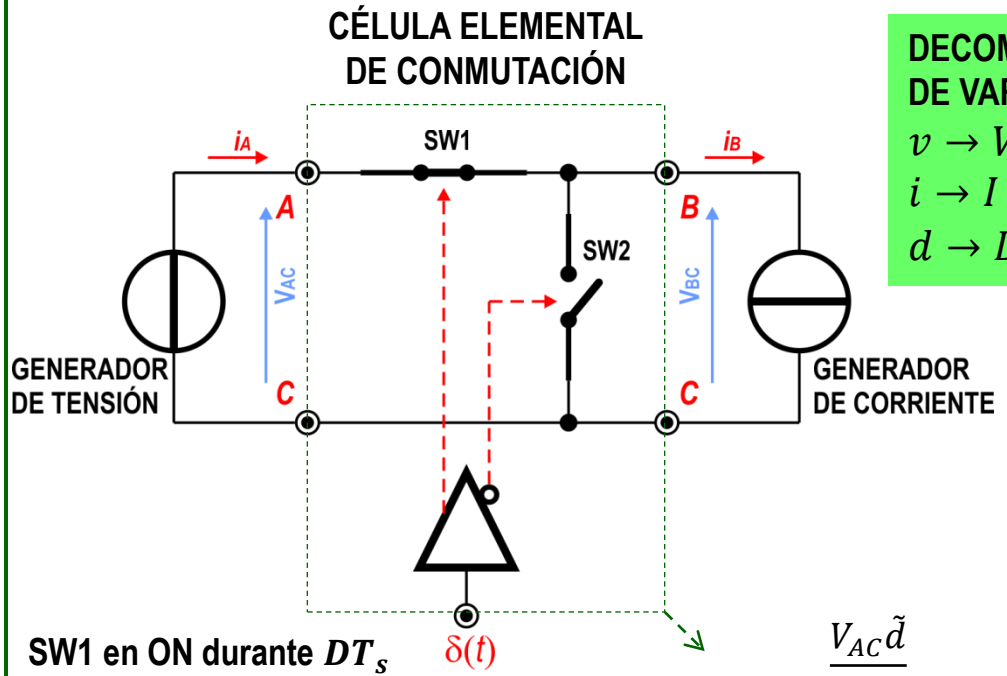
LINEALIZACIÓN DE LA CÉLULA ELEMENTAL: MÉTODO DE VORPÈRIAN



SW1 en ON durante DT_s

SW2 en ON durante $(1-D)T_s$

DECOMPOSICIÓN DE VARIABLES

$v \rightarrow V + \tilde{v}$

$i \rightarrow I + \tilde{\imath}$

$d \rightarrow D + \tilde{d}$

$$I_A+\widetilde{i_A}=(D+\tilde{d})\cdot(I_B+\widetilde{i_B})$$
$$V_{BC}+\widetilde{v_{BC}}=(D+\tilde{d})\cdot(V_{AC}+\widetilde{v_{AC}})$$

$$\widetilde{d}\cdot\widetilde{i_B}\approx 0$$
$$\widetilde{d}\cdot\widetilde{v_{AC}}\approx 0$$

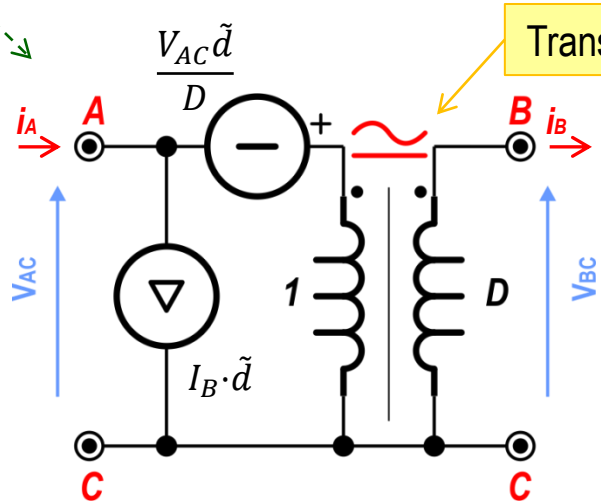
SOLUCIÓN DC (SS)

$$I_A=D\cdot I_B$$
$$V_{BC}=D\cdot V_{AC}$$

SOLUCIÓN AC (SS)

$$\widetilde{i_A}=\tilde{d}\cdot I_B+\widetilde{i_B}\cdot D$$
$$\widetilde{v_{BC}}=\tilde{d}\cdot V_{AC}+\widetilde{v_{AC}}\cdot D$$

Transformación DC+AC



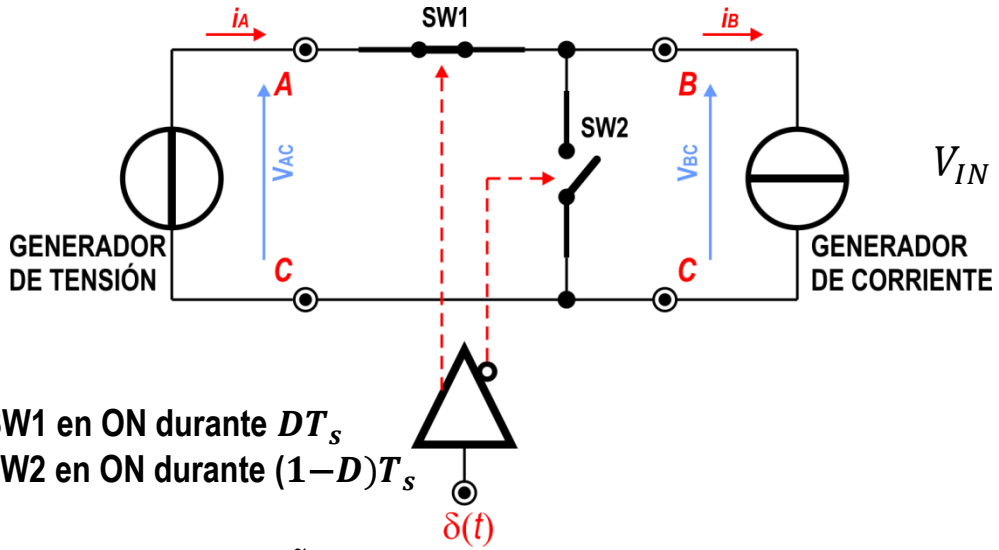
Célula PWM elemental linealizada

$$I_A=D\cdot I_B$$
$$\widetilde{i_A}=\tilde{d}\cdot I_B+\widetilde{i_B}\cdot D$$

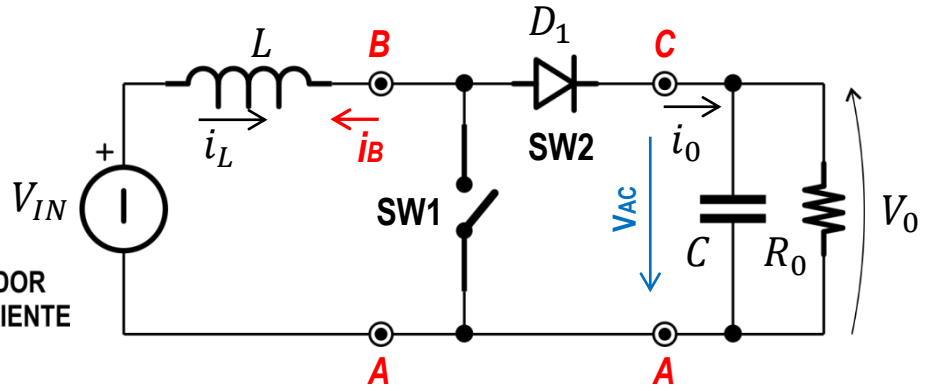
$$V_{BC}=D\cdot V_{AC}$$
$$\widetilde{v_{BC}}=\tilde{d}\cdot V_{AC}+\widetilde{v_{AC}}\cdot D$$

LINEALIZACIÓN DE LA CÉLULA ELEMENTAL: MÉTODO DE VORPÈRIAN

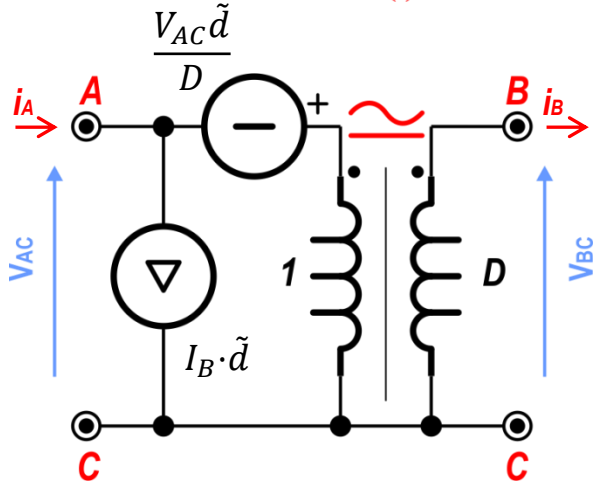
Caso de aplicación: Convertidor boost



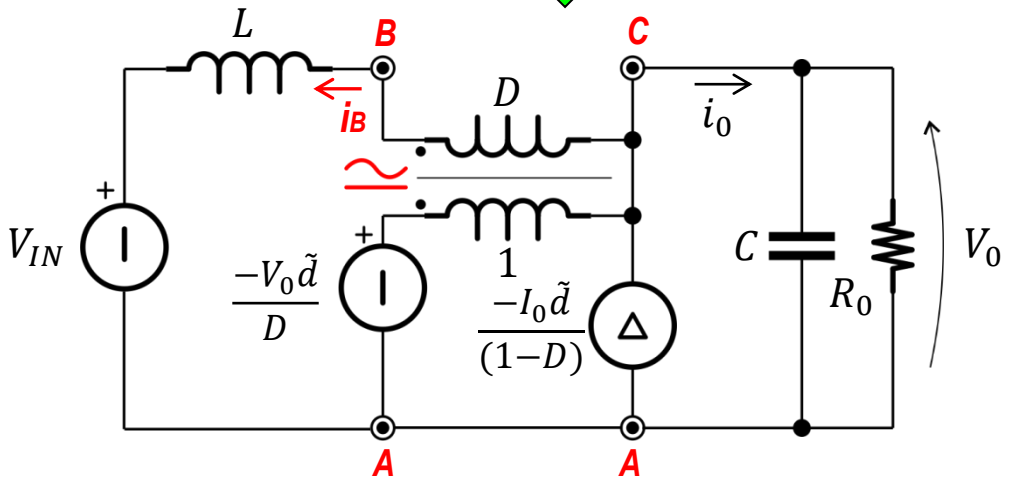
SW1 en ON durante DT_s
SW2 en ON durante $(1-D)T_s$



$$-I_B = I_L = I_0/(1-D)$$
$$V_{AC} = -V_0$$



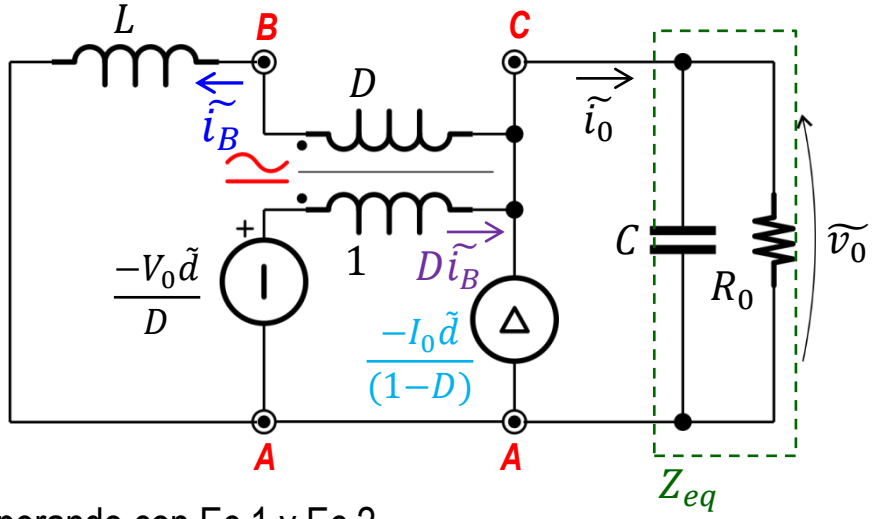
Célula PWM elemental linealizada



LINEALIZACIÓN DE LA CÉLULA ELEMENTAL: MÉTODO DE VORPÈRIAN

Cálculo función transferencia $G_{\tilde{d}}$ (modelo de pequeña señal)

$\widetilde{v_{IN}} = 0$



$$Z_{eq} = \frac{R_0}{1 + sCR_0}$$

$$\widetilde{i_0} = \frac{\widetilde{v_0}}{Z_{eq}} = -\frac{I_0\tilde{d}}{(1-D)} - \widetilde{i_B} + D\widetilde{i_B}$$

$$\widetilde{i_0} = \frac{\widetilde{v_0}}{Z_{eq}} = -\frac{I_0\tilde{d}}{(1-D)} - (1-D)\widetilde{i_B} \qquad \text{Ec. 1}$$

$$SL\widetilde{i_B} = \widetilde{v_L} = \widetilde{v_0} - \left[\widetilde{v_0} + V_0\tilde{d}/D\right]D \qquad \text{Ec. 2}$$

Operando con Ec.1 y Ec.2

$$\widetilde{i_0} = \frac{\widetilde{v_0}(1 + sCR_0)}{R_0} = -\frac{V_0\tilde{d}}{R_0(1-D)} - \frac{\widetilde{v_0}(1-D)^2}{SL} + \frac{V_0\tilde{d}(1-D)}{SL}$$

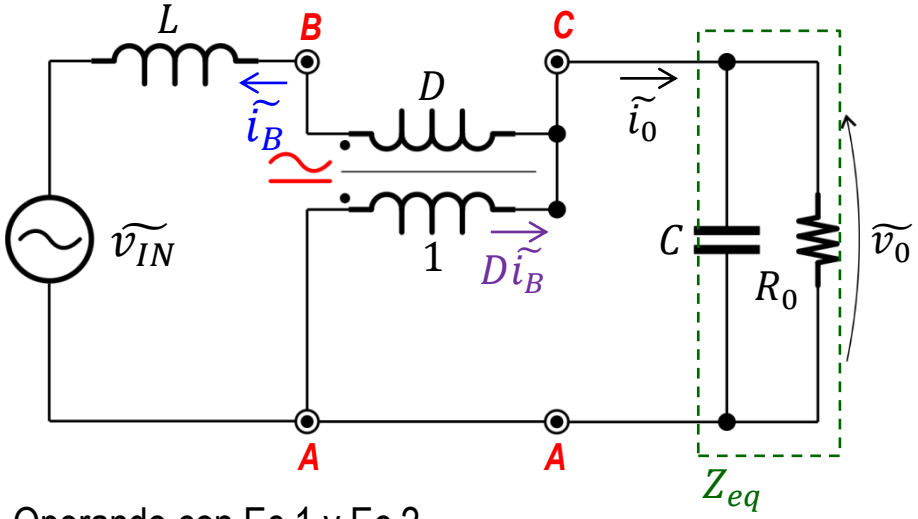
$$\left[\frac{(1 + sCR_0)}{R_0} + \frac{(1-D)^2}{SL}\right]\widetilde{v_0} = \left[\frac{(1-D)}{SL} - \frac{1}{R_0(1-D)}\right]V_0\tilde{d}$$

$$\frac{\widetilde{v_0}}{\tilde{d}} = \frac{V_0}{(1-D)} \frac{\left[1 - \frac{SL}{R_0(1-D)^2}\right]}{\left[\frac{S^2LC}{(1-D)^2} + \frac{SL}{R_0(1-D)^2} + 1\right]}$$

LINEALIZACIÓN DE LA CÉLULA ELEMENTAL: MÉTODO DE VORPÈRIAN

Cálculo función transferencia $G_{\widetilde{vi}}$ (modelo de pequeña señal)

$\tilde{d} = 0$



$$Z_{eq} = \frac{R_0}{1 + sCR_0}$$

$$\widetilde{i_0} = \frac{\widetilde{v_0}}{Z_{eq}} = -\widetilde{i_B} + D\widetilde{i_B}$$

$$\widetilde{i_0} = \frac{\widetilde{v_0}}{Z_{eq}} = -(1-D)\widetilde{i_B} \qquad \text{Ec. 1}$$

$$SL\widetilde{i_B} = \widetilde{v_L} = [\widetilde{v_0} - \widetilde{v_0}D] - \widetilde{v_{IN}} \qquad \text{Ec. 2}$$

Operando con Ec.1 y Ec.2

$$\widetilde{i_0} = \frac{\widetilde{v_0}(1 + sCR_0)}{R_0} = \frac{(1-D)\widetilde{v_{IN}}}{SL} - \frac{\widetilde{v_0}(1-D)^2}{SL}$$

$$\left[\frac{(1 + sCR_0)}{R_0} + \frac{(1-D)^2}{SL}\right]\widetilde{v_0} = \frac{(1-D)}{SL}\widetilde{v_{IN}}$$

$$\frac{\widetilde{v_0}}{\widetilde{v_{IN}}} = \frac{1}{(1-D)} \frac{1}{\left[\frac{S^2LC}{(1-D)^2} + \frac{SL}{R_0(1-D)^2} + 1\right]}$$