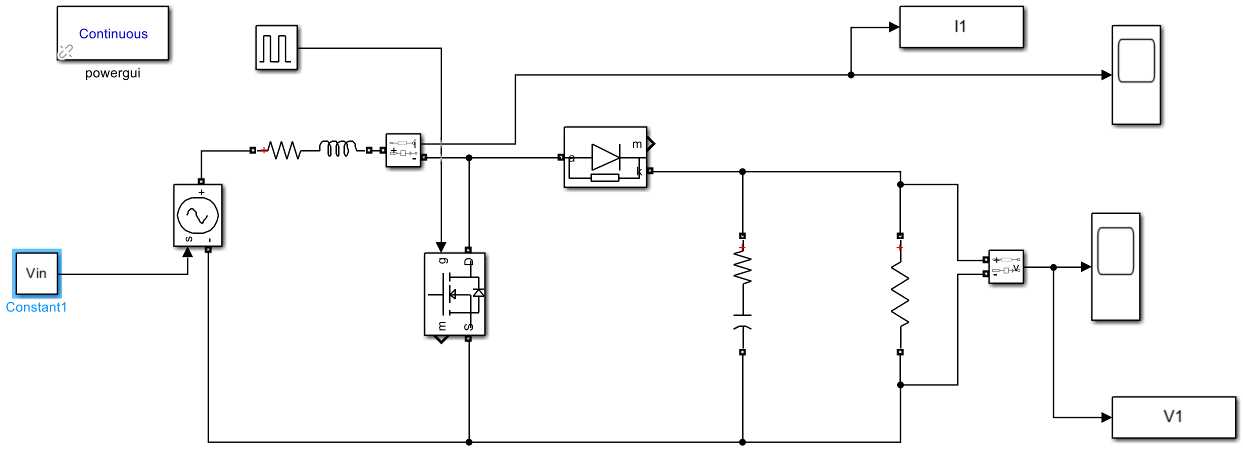
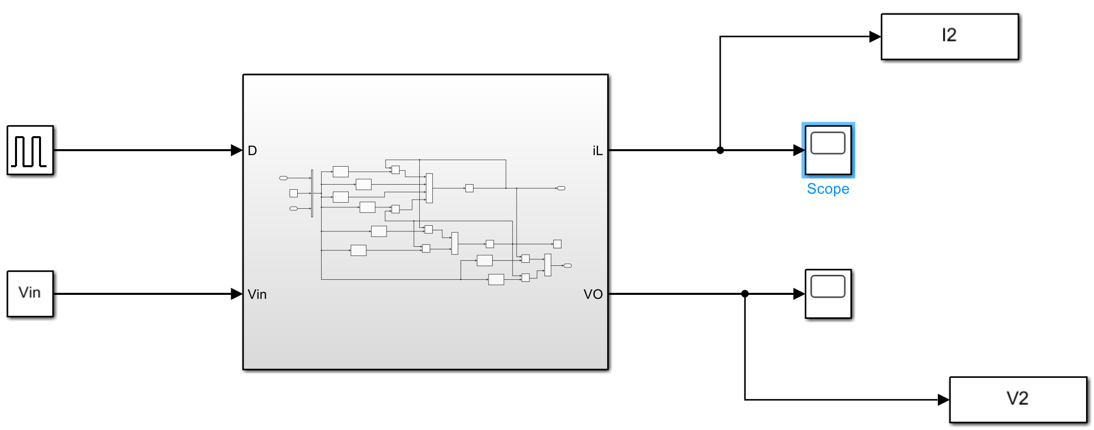
The circuit for DC/DC Boost Converter using **Simscape Electrical Block Libraries** is show in figure below.



To design non-linear or linear controller the above physical circuit should be mathematically described. To do so different approaches can be followed and applying one of them the following state space model can be developed.

$$\begin{cases} \dfrac{di_L}{dt} = -\dfrac{1}{L}\left(r_L + Dr_{DS} + (1-D)R_F + (1-D)\dfrac{r_C R_L}{R_L + r_C}\right) i_L - \dfrac{1}{L}\dfrac{R_L}{R_L + r_C}(1-D)v_C - \dfrac{1}{L}(1-D)V_F + \dfrac{1}{L}V_{in} \\ \dfrac{dv_C}{dt} = \dfrac{R_L}{C(R_L + r_C)}(1-D)i_L - \dfrac{1}{C(R_L + r_C)}v_C \end{cases}$$

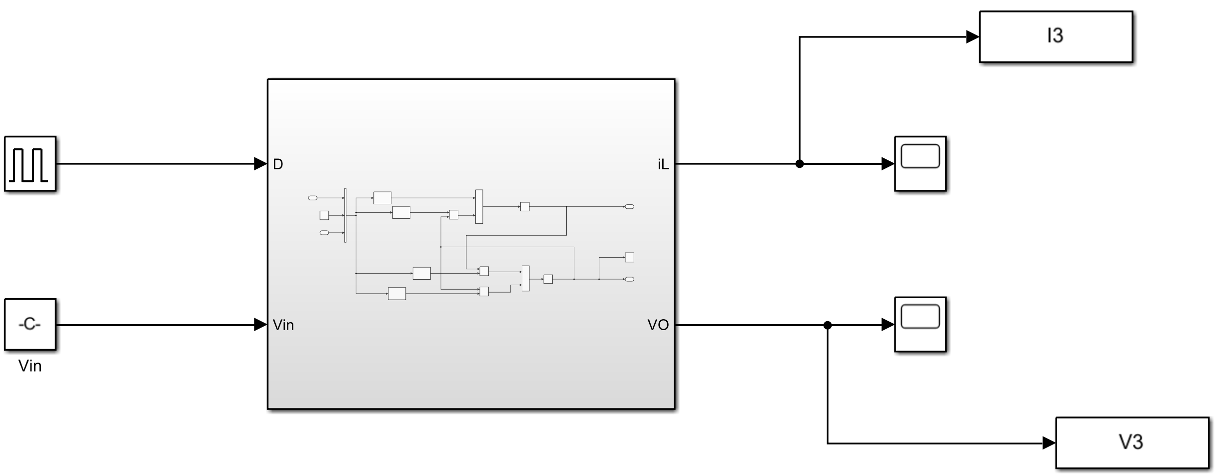
$$V_O = \frac{r_C R_L}{R_L + r_C}(1-D)i_L + \frac{R_L}{R_L + r_C}v_C$$

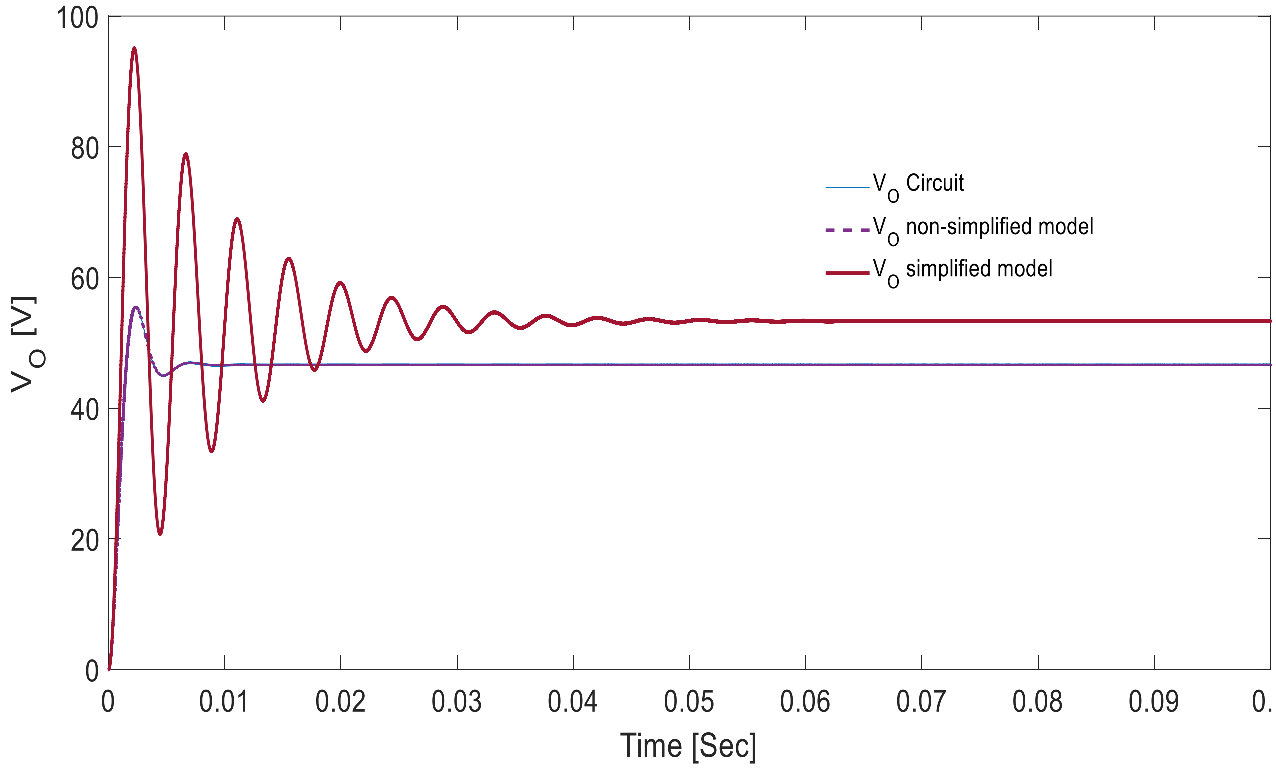


Ignoring the effects of $V_F, R_F, r_{DS}, r_L, r_C$, the above model can be simplified to:

$$\begin{cases} \dfrac{di_L}{dt} = -\dfrac{1-D}{L} v_C + \dfrac{1}{L} V_{in} \\ \dfrac{dv_C}{dt} = \dfrac{1-D}{C} i_L - \dfrac{1}{CR_L} v_C \end{cases}$$

$$V_O = v_C$$





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For step-by-step mathematical model tutorial report or for questions how to model any other types of converters, you can email me for further discussion via

yes42d@gmail.com

After linearizing the above non-linear model at the nominal conditions, the following linear models can be obtained.

1. Linear mathematical model described in the form of transfer function

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & -\frac{1 - D_{nom}}{L} \\ \frac{1 - D_{nom}}{C} & -\frac{1}{R_L C} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} \frac{V_{innom}}{(1 - D_{nom})L} & \frac{1}{L} \\ -\frac{i_{Lnom}}{C} & 0 \end{bmatrix} \begin{bmatrix} u_d \\ u_v \end{bmatrix}$$

$$y = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

2. Linear mathematical model described in the form of transfer function

$$\frac{V_O(s)}{U_d(s)} = \frac{-\left(i_{Lnom} s - \frac{(1 - D_{nom}) V_{Onom}}{L}\right)}{C^2 s^2 + \frac{Cs}{R_L} + \frac{(1 - D_{nom})^2}{L}}$$