

How to Tune Switch Conductance (Gs)

Prerequisites

[How to Add the Power Electronics Add-On to the System Definition](#)

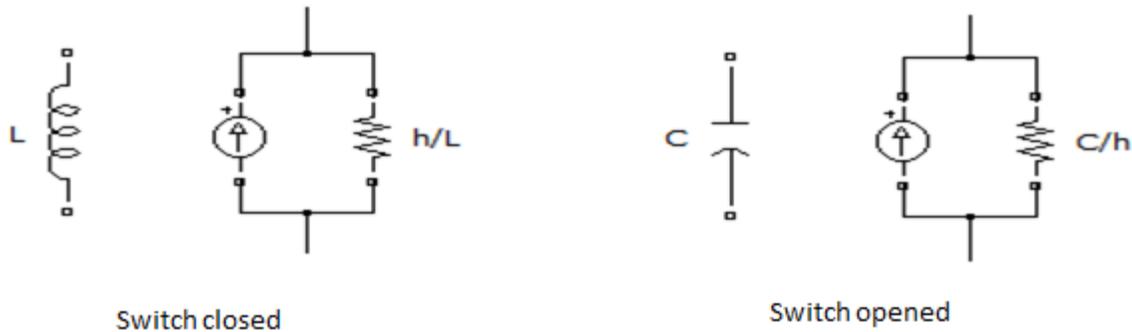
[How to Create a Circuit Model](#)

[How to Add a Circuit Model to the System Definition](#)

eHS Solver Theory

The **eHS Solver** uses **Modified Nodal Analysis** to generate a conductance matrix that, when solved, returns the voltage at each node of the circuit and the current in each branch. The conductance matrix of the circuit is generated independently from the state of the switches, and therefore does not need to be recomputed when a switch is opened or closed during the simulation. This is achieved through the implementation of the Pejovic method, which represents each **Switch** component as an impedance—a conducting switch is represented as an inductor and an open switch is represented as a capacitor.

The inductors and capacitors are further simplified using Backwards Euler discretization, and their equivalent circuits become a current source with a shunt resistance.



Understanding Gs

For the conductance matrix to remain constant throughout switching events, the following equations, which define the **Switch Conductance (Gs)**, must remain true.

$$(1) \quad G_s = h/L = C/h$$

where h is the simulation time step of the circuit. When building the nodal matrix, **Gs** is defined for each switch, typically within a range of 0.001 to 10. It determines the value of the inductance and the capacitor representing the switch in conducting and non-conducting states.

$$(2) \quad L = h/G_s$$

$$(3) \quad C = h \cdot G_s$$

For example, for a time step of 100 ns and a G_s of 1, the switch will be represented by the following inductance and capacitance:

$$(4) \quad L = h/G_s = 100nH$$

$$C = h \cdot G_s = 100nF$$

Selecting Gs

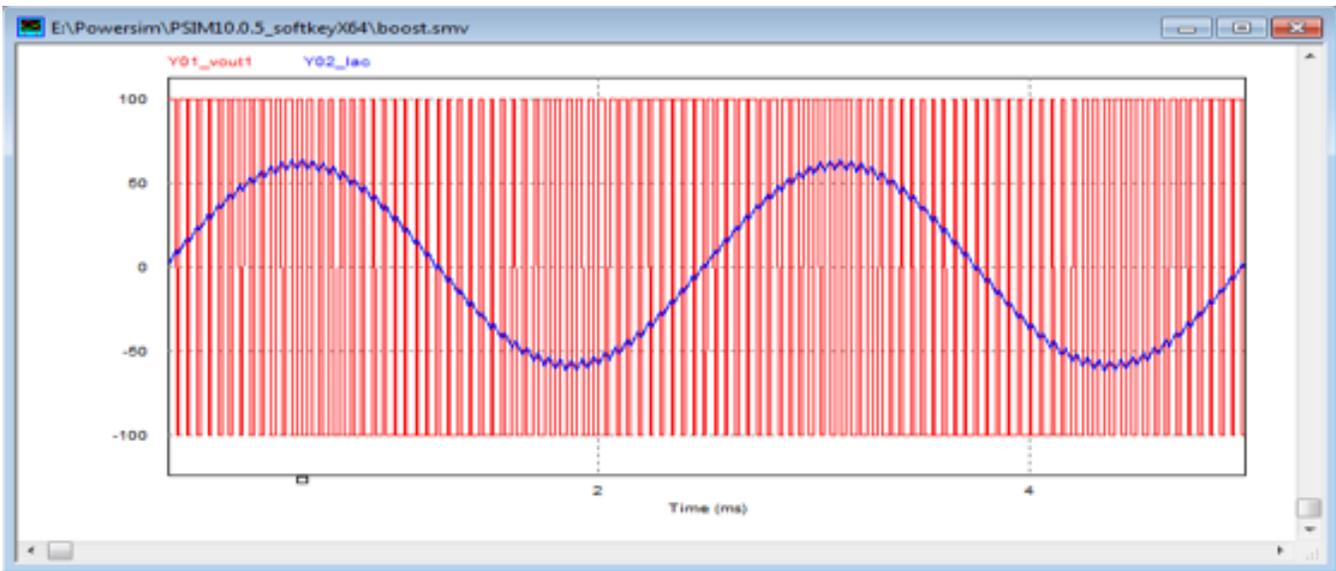
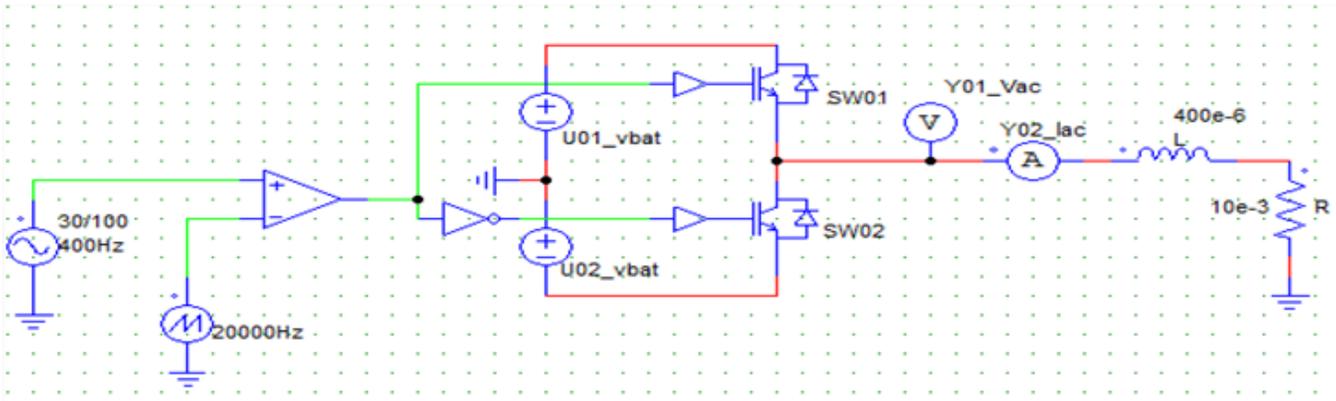
The G_s value for each switch is dependent on the following factors:

- Topology of the circuit
- Circuit parameters including Base Power, Source Current(s), Source Voltage(s), Duty Cycle, Load Current(s), Load Voltage(s)

Typically, a good approximation for G_s is:

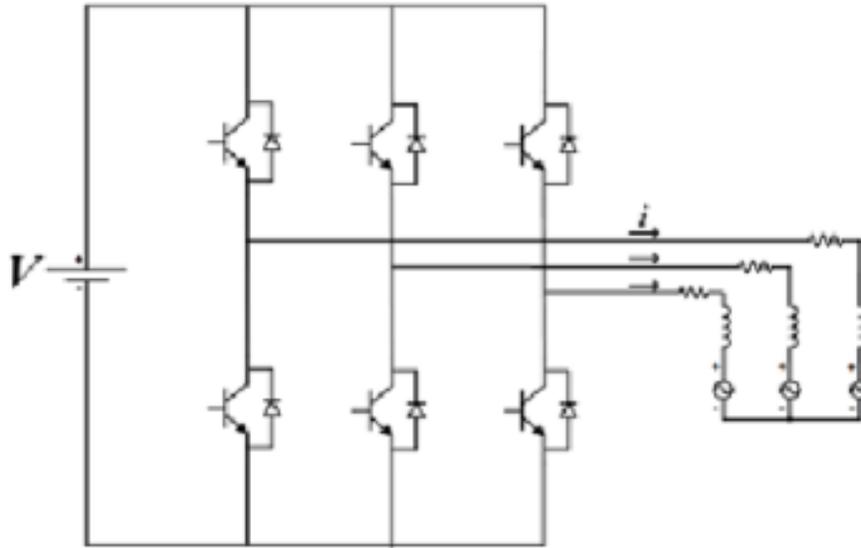
$$(5) \quad G_s = I_{max} / V_{max}$$

where I_{max} is the maximum current flowing outside the converter and V_{max} is the maximum voltage at the arm middle point. For example, in the Two Level Arm circuit below, I_{max} is 64A (signal Y02_lac) and V_{max} is 100V (signal Y01_Vac), therefore the optimal value for G_s is 0.64.



Sample G_s Values

See the table below for a sample list of recommended G_s values for a **Two-level NPC Inverter with RL Load and Back EMF** (single phase or three-phase).



DC Source Voltage (V)	Load Current RMS (A)	Gs
100	20	0.2
240	80	0.3333
500	280	0.56



When using the two-level and three-level bridge blocks in the circuit model, eHS will use the first switch's conductance to characterize all switches in the bridge.

For additional assistance tuning the Gs values, please contact [OPAL-RT Technical Support](#).