SwissSEM
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User guide EN / CN version below - 用户指南 EN / CN 版本如下

SwissSEM Plecs Models – How To

Roger Stark

Introduction

PLECS

PLECS is a software for modeling and simulating electrical systems, e.g., power electronics systems. Power electronics systems are based on active (e.g. power semiconductors), passive elements (resistors, inductors, capacitors), and control building blocks.

The thermal domain can be incorporated by the thermal description of the power semiconductor elements and resistive heating. The thermal modeling of the power semiconductor elements is described by their equivalent thermal networks, while the power losses are described as conduction, turn-on, and turn-off losses.

This document proposes the use of the SwissSEM semiconductor thermal models. The switching cell of a module can either be composed of discrete elements IGBTs/MOSFETs/Diodes including the thermal network from junction to case (Rth,jc), or combined with a package description to model the thermal network from case to ambient.

The user is free to select his own desired modeling method.

The thermal models are composed in **.xml files** _package, _IGBT, _diode.

Please refer to plexim.com/ for more details about PLECS

Discrete Elements of a Switching Cell

Thermal description

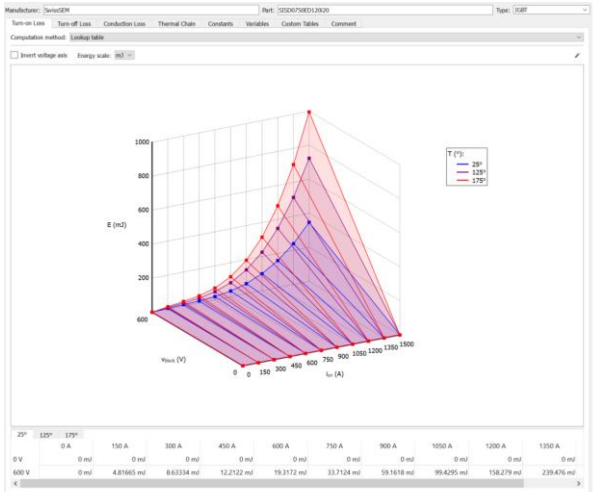
IGBT

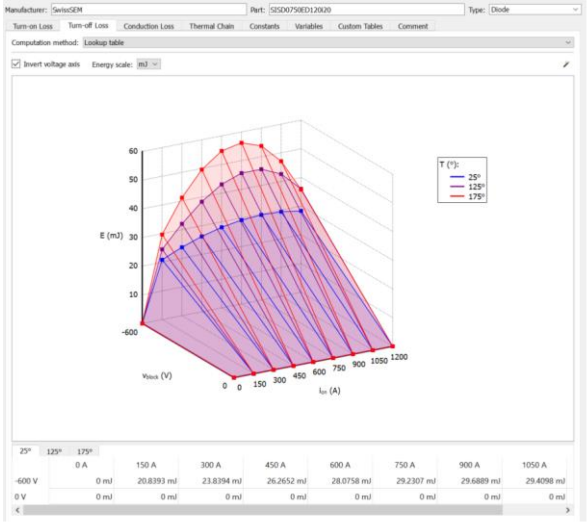
- Conduction Loss
- Turn-off loss
- Turn-on loss
- Rth,jc (Foster or equivalent Cauer network)

Diode

- Conduction Loss
- Turn-off loss
- Rth,jc (Foster or equivalent Cauer network)

The thermal models of a switching element can be used independently (without thermal package model).





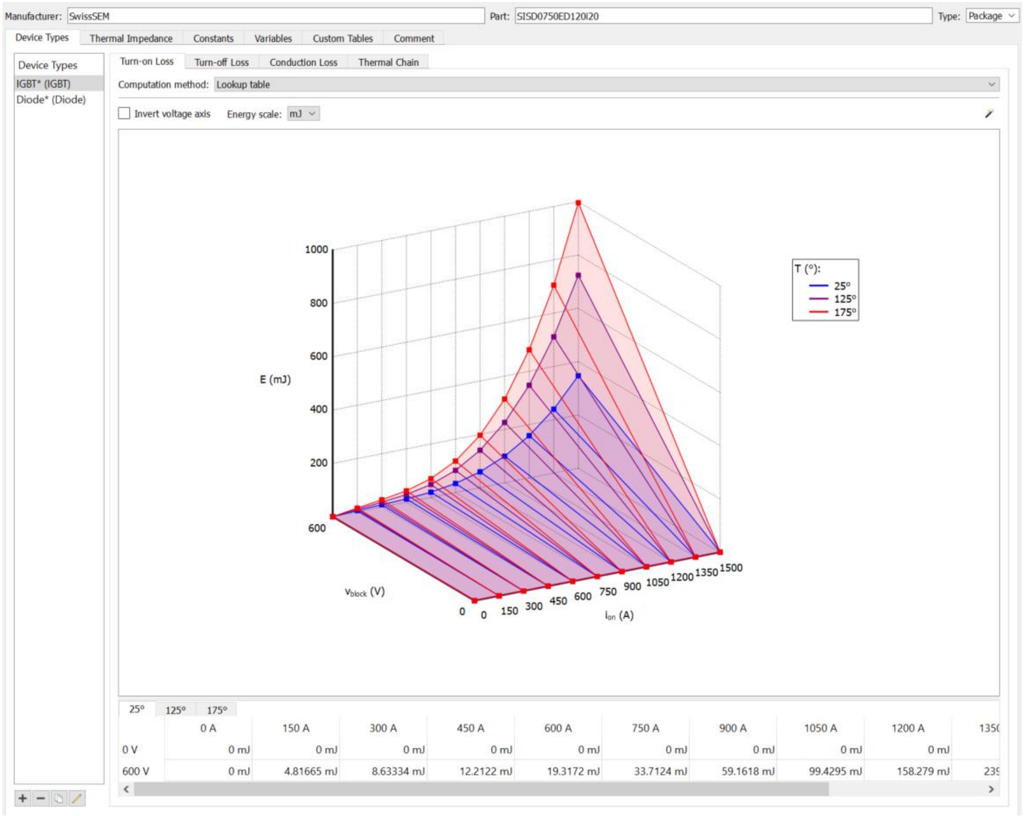
Package Model

Thermal description

The thermal description of a module (package) such as of a phase leg the thermal package model is combined with the discrete models of the switching elements (IGBTs/MOSFETs/Diodes).

The thermal package description contains the conduction and switching losses but does not contain a thermal network. This thermal network is described in the package subcircuit, which contains the discrete switching elements and the terminal lead resistance Rcc'+ee' per topological switch.

The thermal package description must be used together with the thermal models of the switching elements!

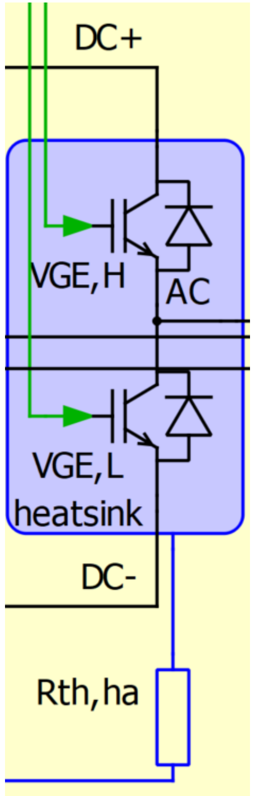


	0 A	150 A	300 A	450 A	600 A	750 A	900 A	1050 A	1200 A	135(
0 V	0 mJ	0 mJ	0 mJ	0 mJ	0 mJ	0 mJ	0 mJ	0 mJ	0 mJ	
600 V	0 mJ	4.81665 mJ	8.63334 mJ	12.2122 mJ	19.3172 mJ	33.7124 mJ	59.1618 mJ	99.4295 mJ	158.279 mJ	23(

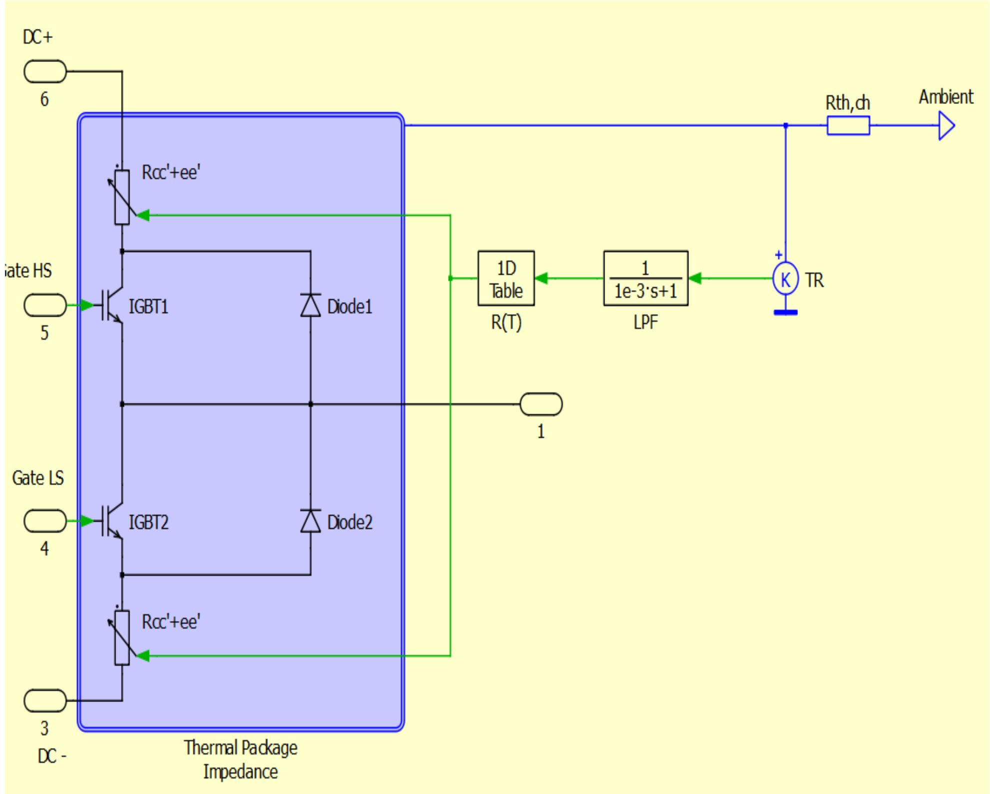
Schematic Models

Proposed modeling of package and subcircuit

Package (single phase leg)

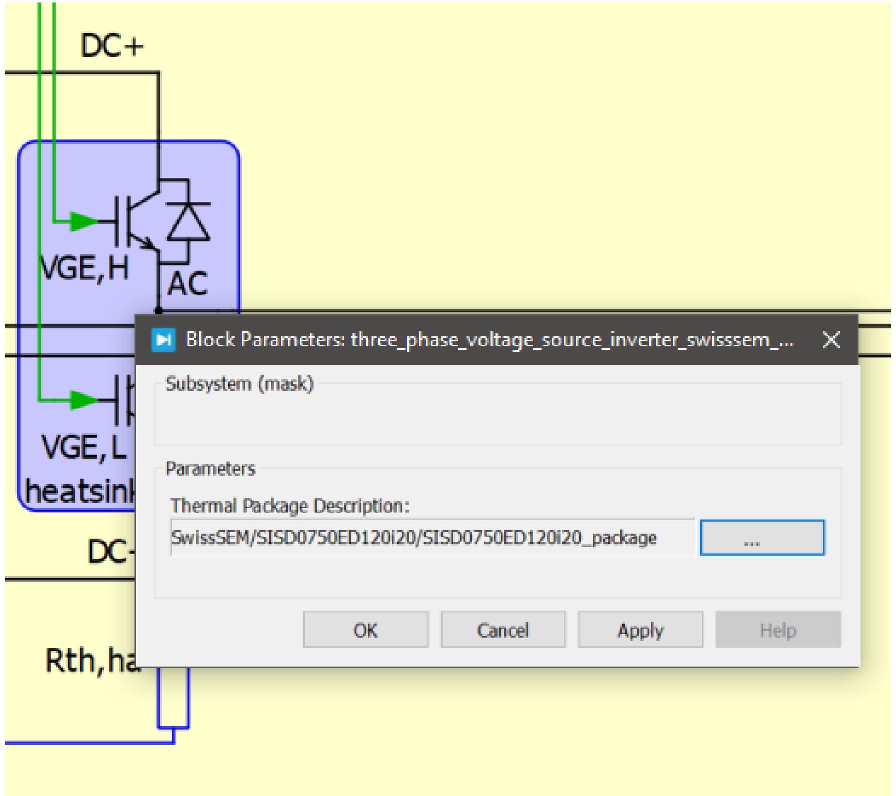


Subcircuit (discrete IGBTS, Diodes, and Rcc'+ee')

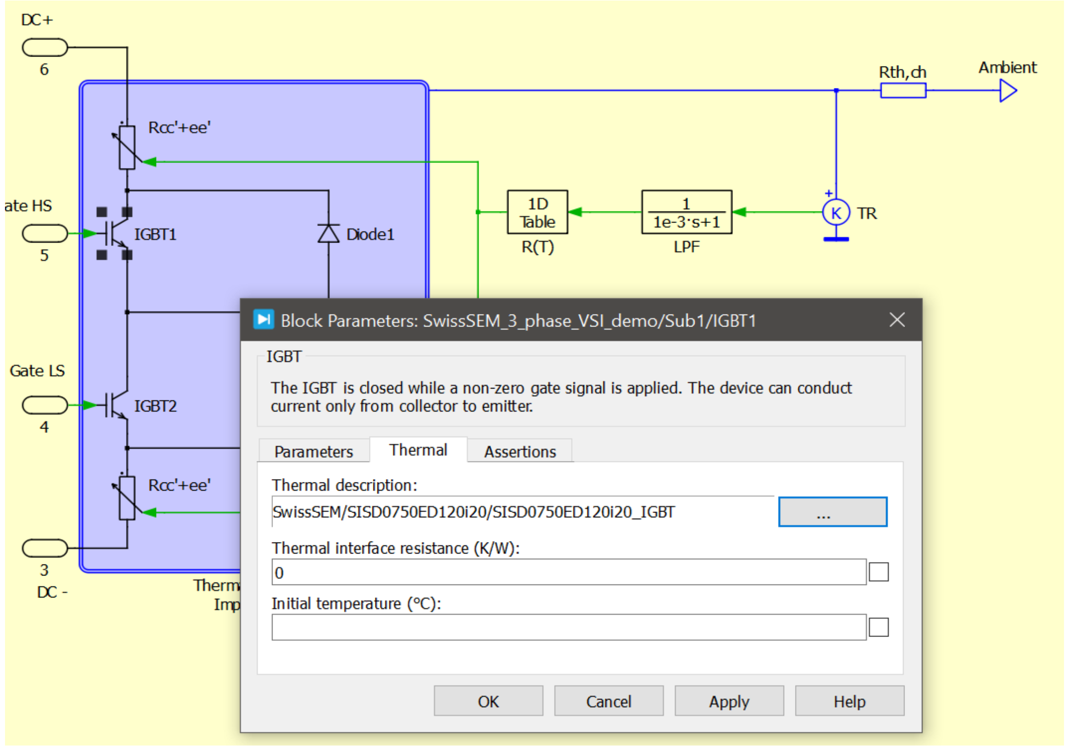


Selection of Thermal Models

Package (single phase leg)



Subcircuit (discrete IGBTS, Diodes, and Rcc'+ee')



PLECS 3-phase Voltage Source Inverter Demo Model

VSI explained

The three-phase VSI inverts DC input voltage Vdc into three phase AC voltage and current.

DC source represents e.g. battery system, solar array, or rectifier current.

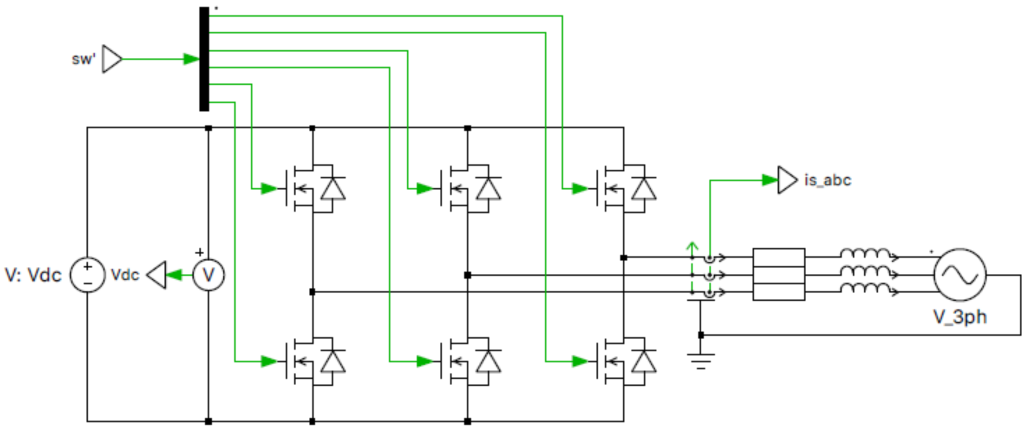
The inverter is connected to the low-voltage (230Vrms) 50Hz grid (V-3ph).

Grid-connecting reactance = 5%-10% of base impedance rating.

The reference signal is the desired average at the VSI output terminals.

The phase shift between grid voltage and VSI output terminal voltage determines the output current.

Vinv = Vgrid + Z *Irated



Three-phase voltage source inverter (VSI).

PLECS 3-phase Voltage Source Inverter Demo Model

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VDC = 600V

I0 = 400A

Power = 3*I0*VDC/(2*sqrt(2))

Vgrid,rms = 210

fGrid = 50Hz

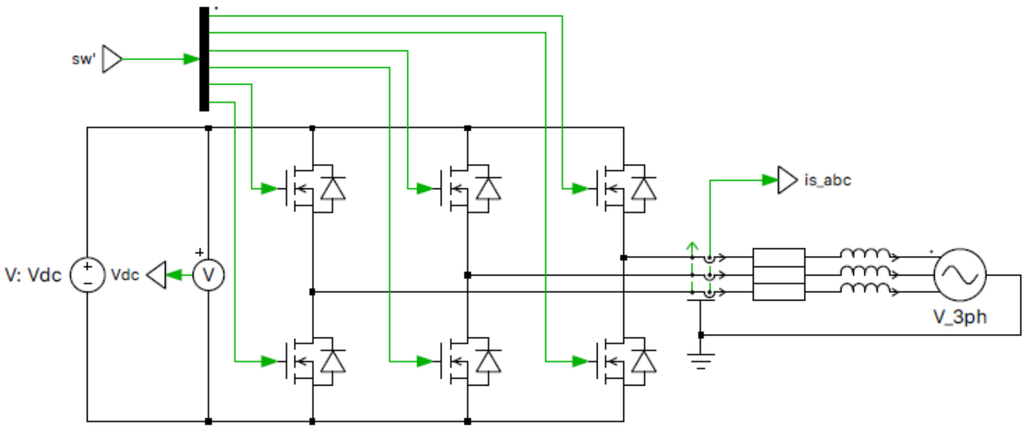
fSwitching = 5kHz

Power factor = 1

Heatsink = 20k/kW

Tambient = 50°C

Simulation time (Plecs) = 100s



Three-phase voltage source inverter (VSI).

PLECS 3-phase Voltage Source Inverter Demo Model

SwissSEM Technologies AG

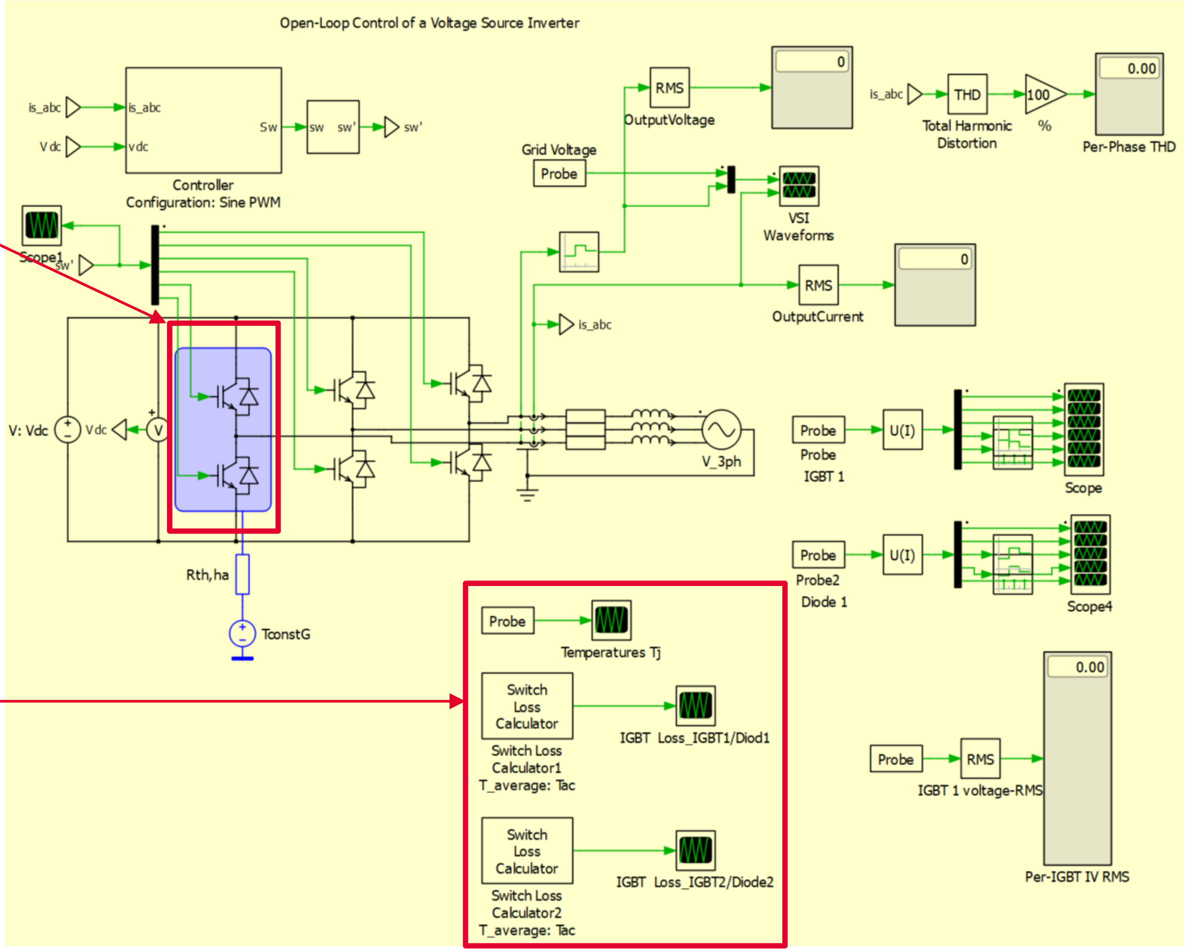
The thermal evaluation Only 1 phase leg

The thermal description is added only to 1 phase leg to reduce the simulation time.

The initial junction temperature Tj of the IGBTs/Diodes can be adjusted to reduce the transient settling time of the simulation.

A simplified model is used for the other two phase legs, whose thermal network is not bypassed, i.e., the IGBT/Diodes are referenced to the package thermal model (empty).

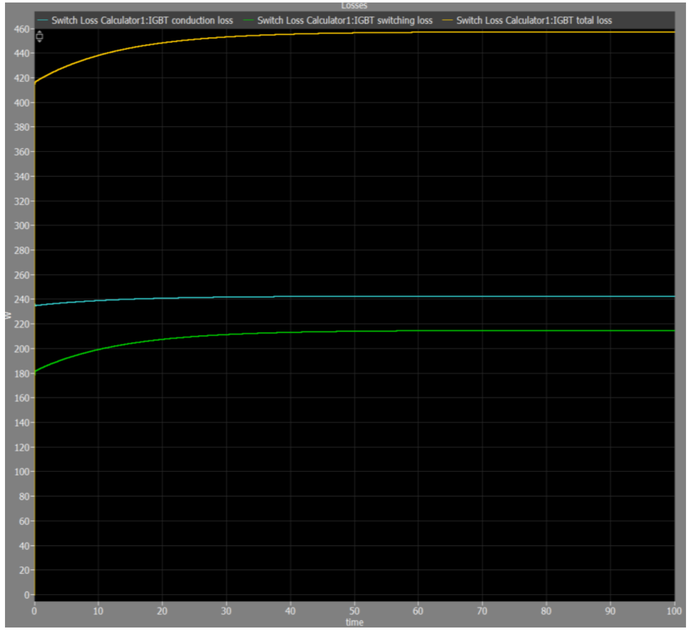
The junction temperature Tj and the losses of the first phase leg are computed.



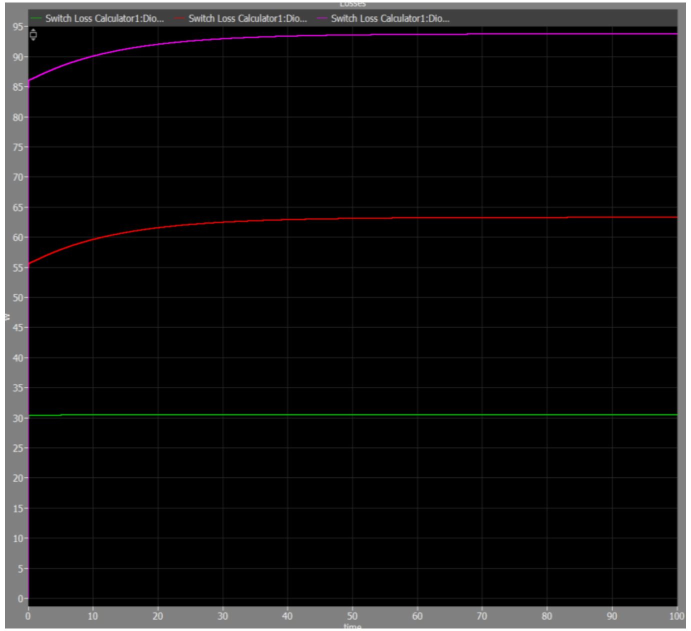
PLECS 3-phase Voltage Source Inverter Demo Model

SISD0750ED120i20_package and IGBT/Diode thermal descriptions

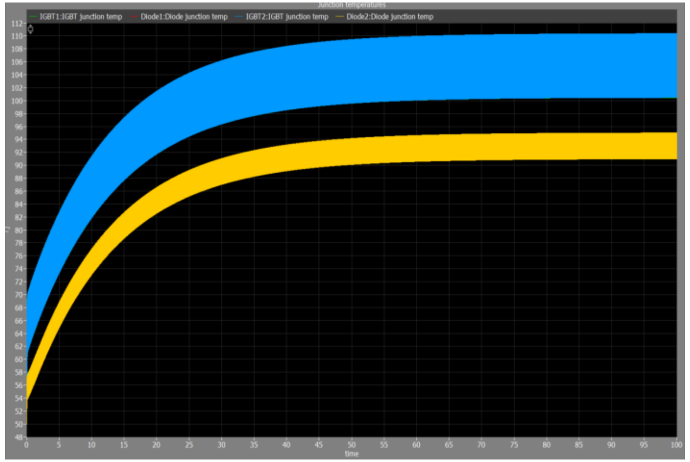
IGBT losses



Diode losses



Tj IGBT and Diode



Conclusion

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Using the SwissSEM thermal models allows the calculation of the IGBT/Diode and overall conduction, switching losses and the assessment of the junction or module case temperatures.

User guide

SwissSEM Plecs 模型 - 如何使用

Roger Stark

导言

PLECS

PLECS **是一款用于**电气系统（如电力电子系统）建模和仿真的软件。电力电子系统以主动元件（如功率半导体）、被动元件（电阻器、电感器、电容器）和控制构件为基础。功率半导体元件的热描述和电阻加热可纳入热域。

功率半导体元件的热建模由其等效热网络来描述，而功率损耗则由传导损耗、接通损耗和关断损耗来描述。本文建议使用 SwissSEM 半导体热模型。

模块的开关单元既可以由分立元件 IGBT/MOSFET/**二极管**组成，包括从结点到外壳的热网络 (Rth,jc)，**也可以与封装描述相**结合，以**模**拟从外壳到环境的热网络。用户可自由选择所需的建模方法。

The thermal models are composed in **.xml files** _package, _IGBT, _diode.

Please refer to plexim.com/ for more details about PLECS

开关单元的离散元件

热描述

IGBT

– 传导损耗

– 关断损耗

– 导通损耗

– Rth,jc（福斯特或等效考尔网络）

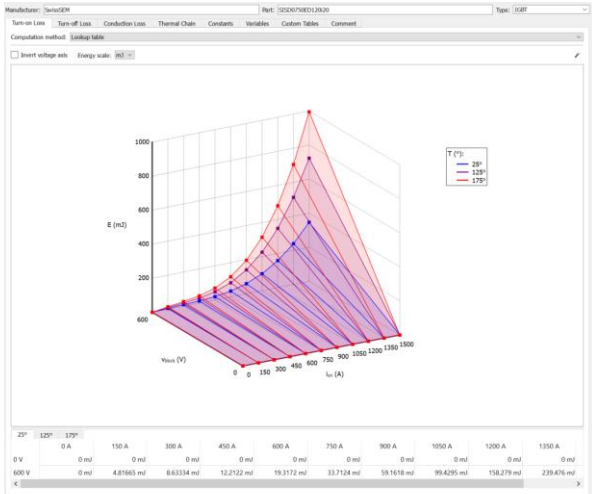
Diode

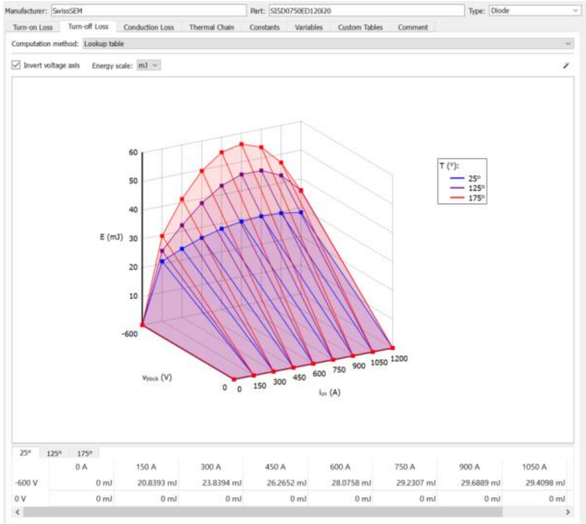
– 传导损耗

– 关断损耗

– Rth,jc（福斯特或等效考尔网络）

开关元件的热模型可独立使用（无热封装模型）





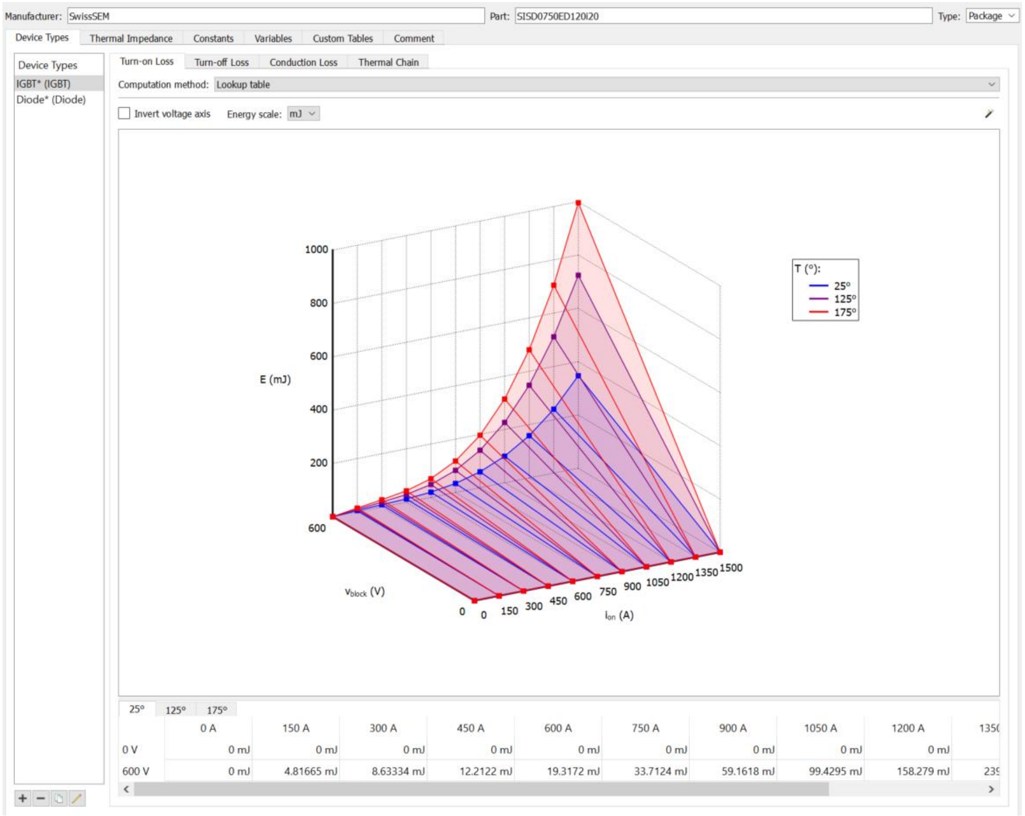
包装模式

热描述

模块（封装）的热描述，如相脚的热封装模型与开关元件**（IGBT/MOSFET/二极管）的离散模型相**结合

热封装描述包含传导和开关损耗，但不包含热网络。该热网络在封**装子**电路中描述，其中包含分立开关元件和每个拓扑开关的终端引线电阻 Rcc'+ee’

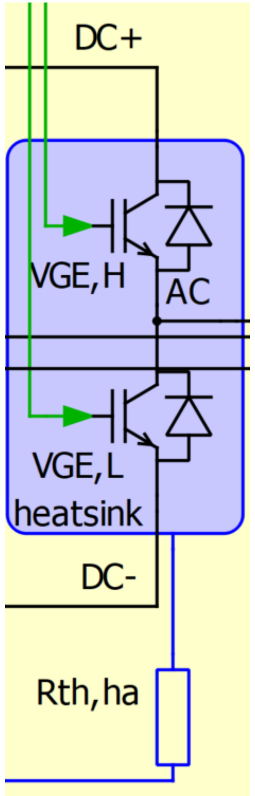
热封装说明必须与开关元件的热模型一起使用！



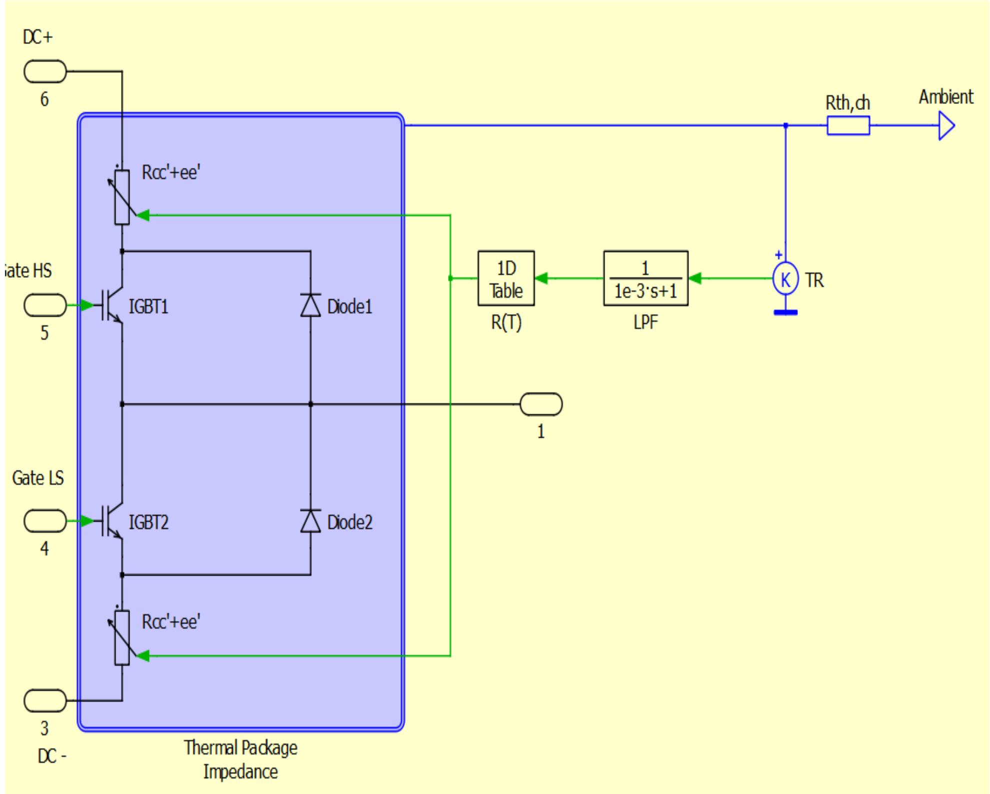
示意图模型

建议的封装和子电路建模

封装（单相脚）

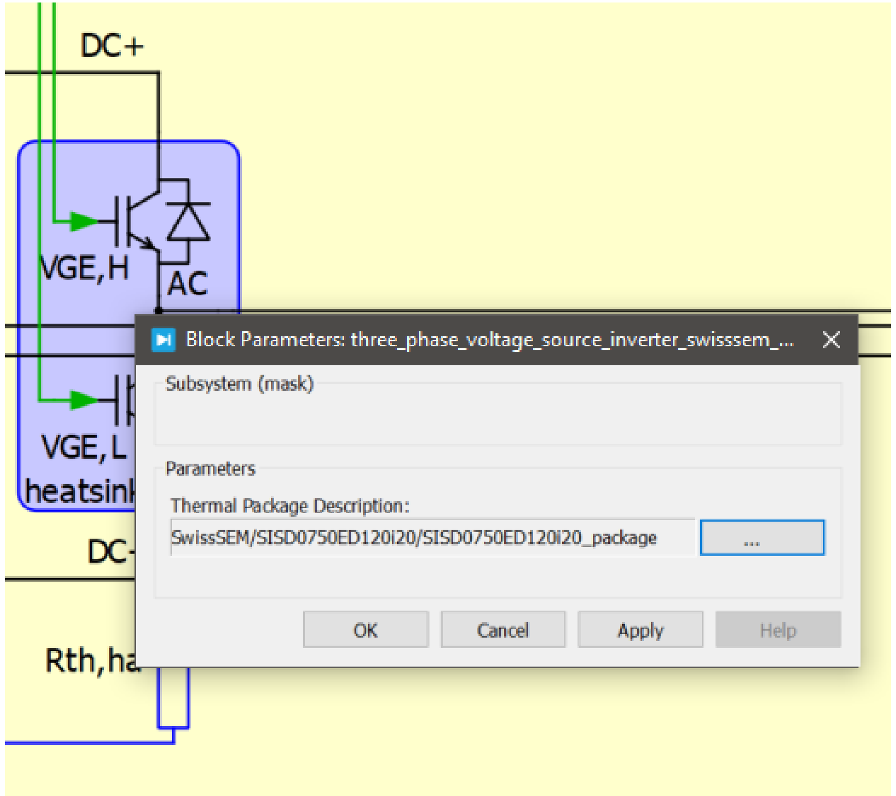


子电路（分立 IGBTS、二极管和 Rcc'+ee'）

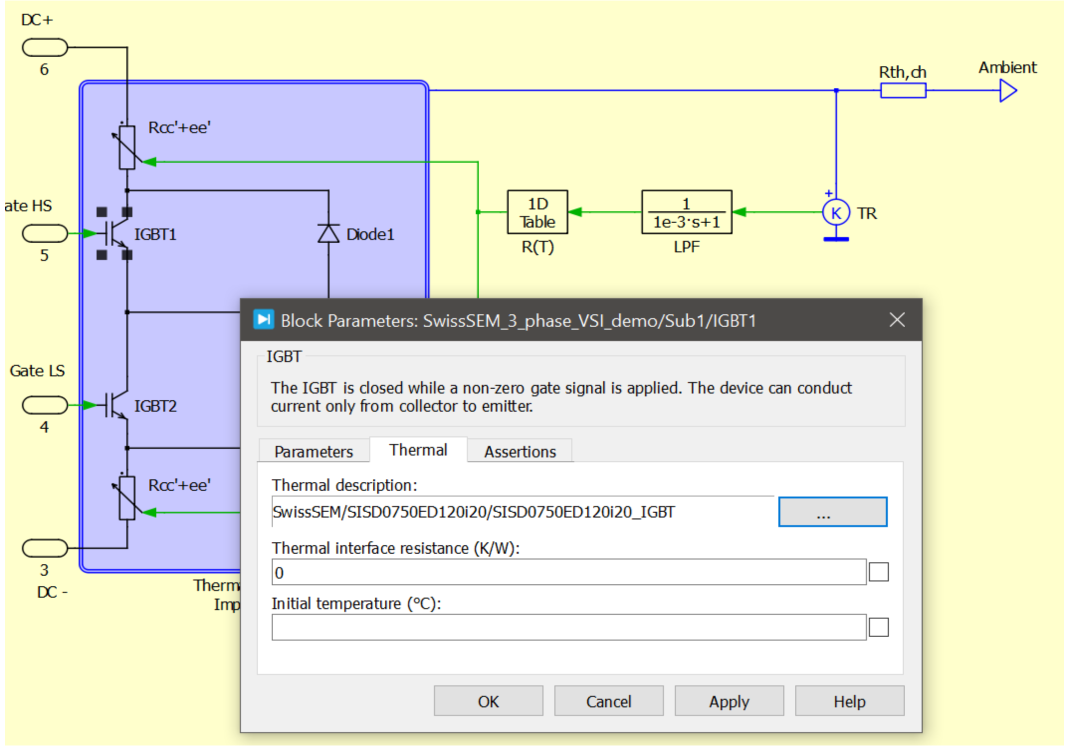


选择热模型

封装（单相脚）



子电路（分立 IGBTS、二极管和 Rcc'+ee'）



PLECS 三相电压源逆变器演示模型

VSI 解释

三相 VSI 将直流输入电压 Vdc 转换为三相交流电压和电流

直流电源代表电池系统、太阳能电池阵列或整流器电流

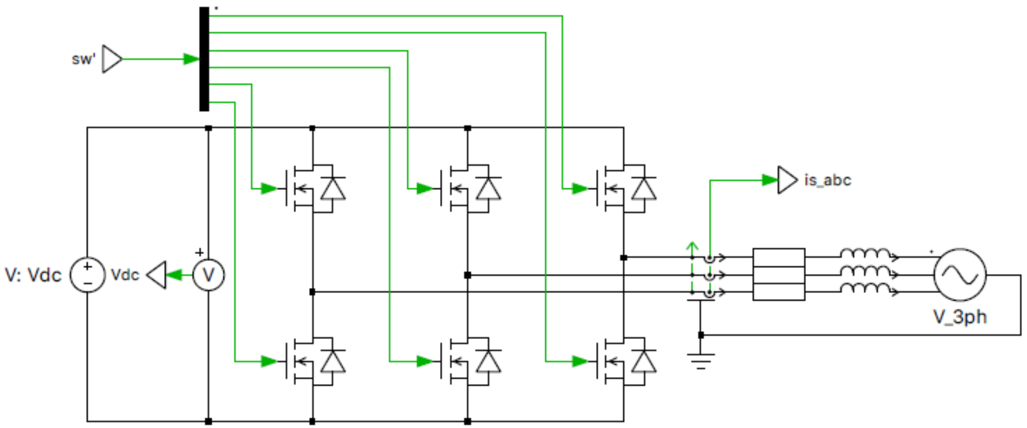
逆变器连接至低压（230Vrms）50Hz 电网（V-3ph）

并网电抗 = **基准**额定阻抗的 5%-10%

参考信号是 VSI 输出端所需的平均值

电网电压与 VSI 输出端电压之间的相移决定了输出电流

Vinv = Vgrid + Z *Irated



Three-phase voltage source inverter (VSI).

PLECS 三相电压源逆变器演示模型

VDC = 600V

I0 = 400A

功率 = 3*I0*VDC/(2*sqrt(2)

Vgrid,rms = 210

fGrid = 50Hz

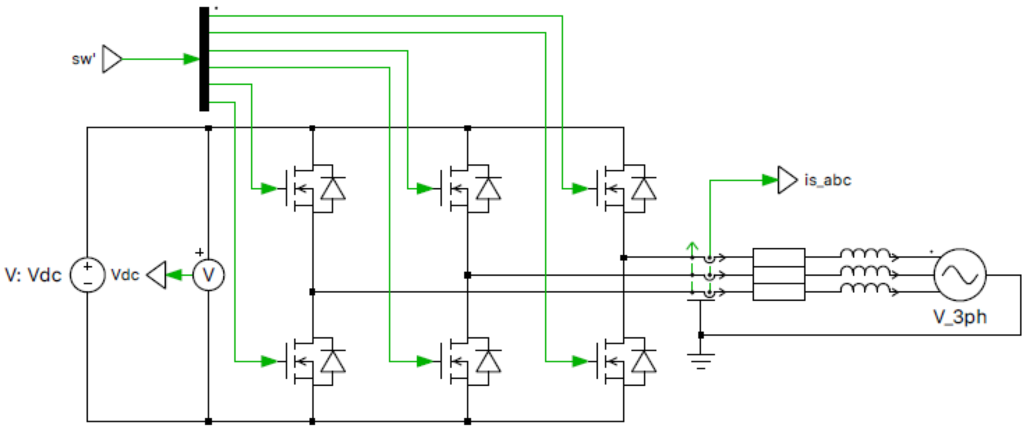
fSwitching = 5kHz

功率因数 = 1

散热器 = 20k/kW

温度 = 50°C

模拟时间 (Plecs) = 100 秒



三相电压源逆变器（VSI)

PLECS 三相电压源逆变器演示模型

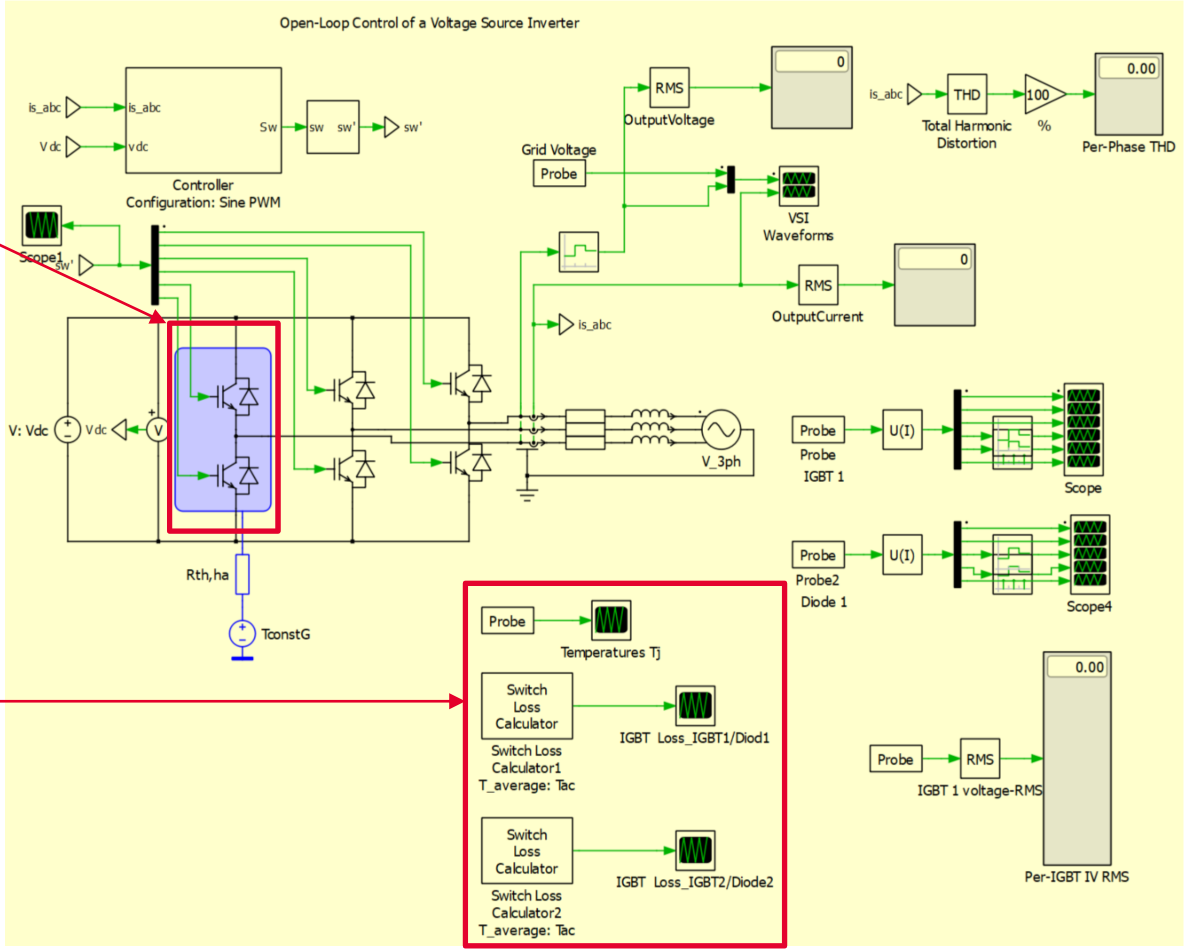
热评估 **只有一个相位**

为减少模拟时间，仅在一个相位上添加了热描述

可以调整 IGBT/二极管的初始结温 Tj， **以缩短模拟的**
瞬态稳定时间

其他两个相脚使用简化模型，其热网络未旁路，即
IGBT/二极管**参照封装**热模型（空）

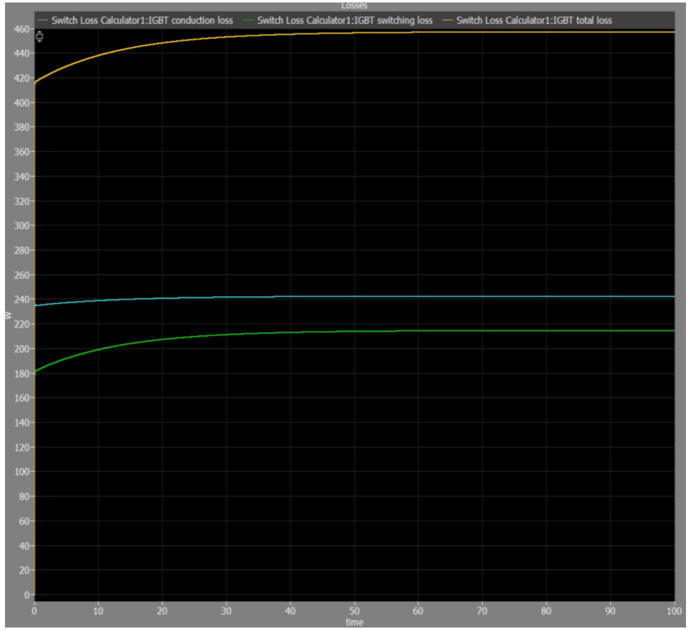
计算结温 **Tj 和第一相脚的**损耗



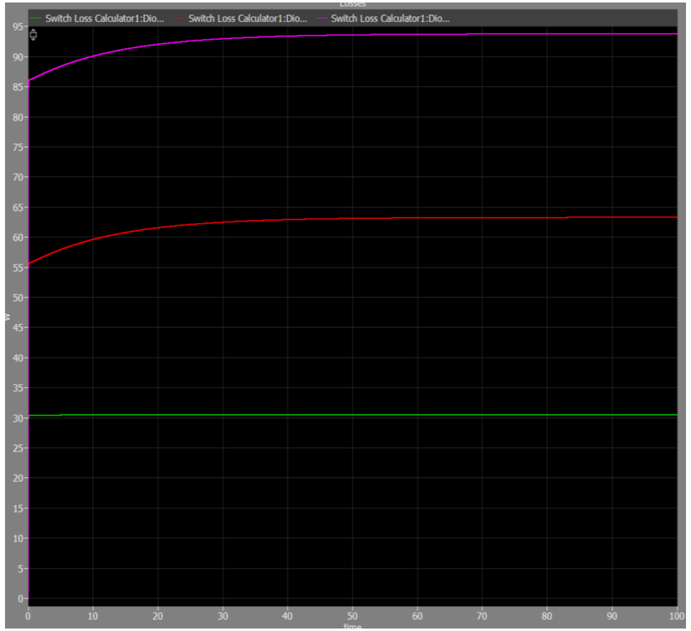
PLECS 三相电压源逆变器演示模型

SISD0750ED120i20_ 封装和 IGBT/Diode 热说明

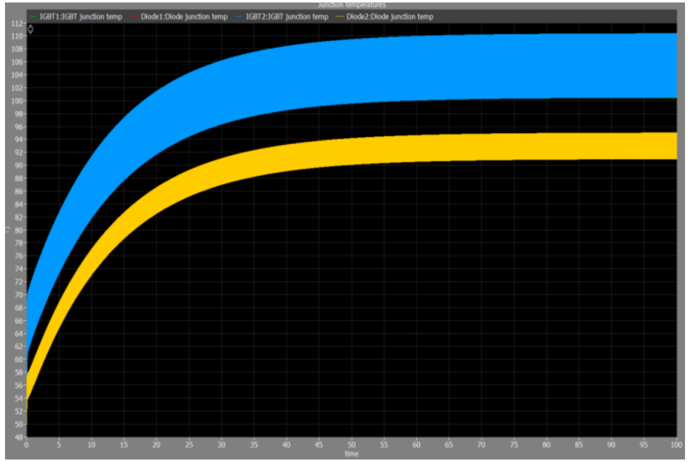
IGBT 损失



Diode 损失



Tj IGBT and Diode



结论

使用 SwissSEM 热模型可以计算 **IGBT/二极管和整体**传导、开关损耗，并评估结温或模块外壳温度

Thank you

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