



Elite Power Simulator

Powered by **plecs**

User Guide

Outline of User Guide

1

Introduction to the Elite Power Simulator:
What is it and What are the benefits

2

Simulator Access

3

Step by Step Tool Flow

Outline of User Guide

1

Introduction to the Elite Power Simulator:
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Step by Step Tool Flow

onsemi's online Elite Power Simulator Powered by

- PLECS is a system level simulator that facilitates the modeling and simulation of complete systems with optimized device models for maximum speed and accuracy. PLECS is not a SPICE-based circuit simulator, where the focus is on low-level behavior of circuit components .
- Power transistors are treated as simple switches that can be easily configured to demonstrate losses associated with conduction and switching transitions.
- The PLECS models, referred to as “thermal models”, are composed of lookup tables for conduction and switching losses, along with a thermal chain in the form of a Cauer or Foster equivalent network.
- During simulation, PLECS interpolates and/or extrapolates using the loss tables to get the bias point conduction and switching losses for the circuit operation.

www.onsemi.com/elite-power-simulator

Elite Power Simulator Features

Broad Range of Circuit Topologies

Covering DC-DC, AC-DC, and DC-AC applications, including 32 circuit topologies in industrial (DC fast charging, UPS, ESS, solar inverters), automotive (OBC, traction), and non-traction spaces

Corner Simulation Capability

onsemi's PLECS models go beyond nominal data from datasheets to include industry first corner simulation based on physical correlations in the manufacturing environment.

Custom PLECS Model Upload

Interface with onsemi's **industry first Self-Service PLECS Model Generator** (SSPMG) to simulate with models tailored to your application.

Soft Switching Models

onsemi provides **industry first PLECS models valid for soft switching** applications such as DC-DC LLC and CLLC Resonant, Dual Active Bridge, and Phase Shifted Full Bridge.

Loss & Thermal Data Plotting

Explore device conduction loss, switching energy loss, and thermal impedance in a multifunctional 3D data visualization utility.

Flexible Design & Fast Simulation Results

Flexible to capture adjustments to various attributes such as, **gate drive impedance, cooling designs, and load profiling.**

www.onsemi.com/elite-power-simulator

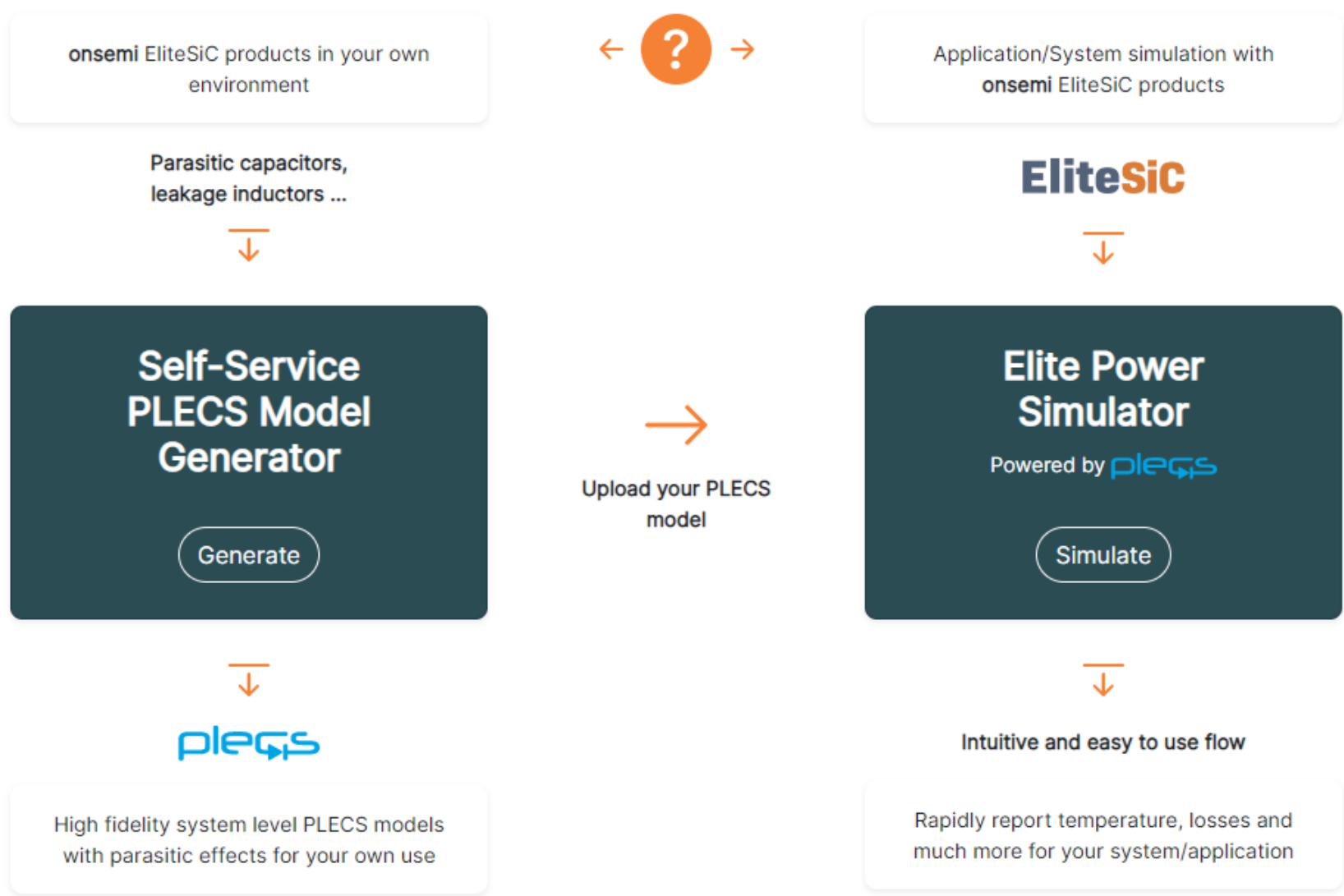
onsemi's State-of-the-Art PLECS Models

- Typical industry PLECS models are composed of measurement-based loss tables that are consistent with datasheets provided by the manufacturer.

There are four major problems with this approach:

1. The switching energy loss data is dependent on the parasitics of the measurements set ups and circuits.
 2. The conduction and switching energy loss data is limited and thus is often not dense enough to ensure accurate interpolation and minimal extrapolation by PLECS.
 3. The loss data is based on nominal semiconductor process conditions only.
 4. The switching energy loss data comes from datasheet double pulse generated loss data. This means the PLECS models are only valid for hard switching topology simulation. The models are highly inaccurate if used in soft switching topology simulation.
- onsemi's Self-Service PLECS Model Generator (SSPMG) provides solutions to all four problems.
 - Ultimate power is delivered to the user to build PLECS models tailored for the user's application. Unleash the power here: www.onsemi.com/self-plecs-generator

Deploying PLECS Models in Elite Power Simulator



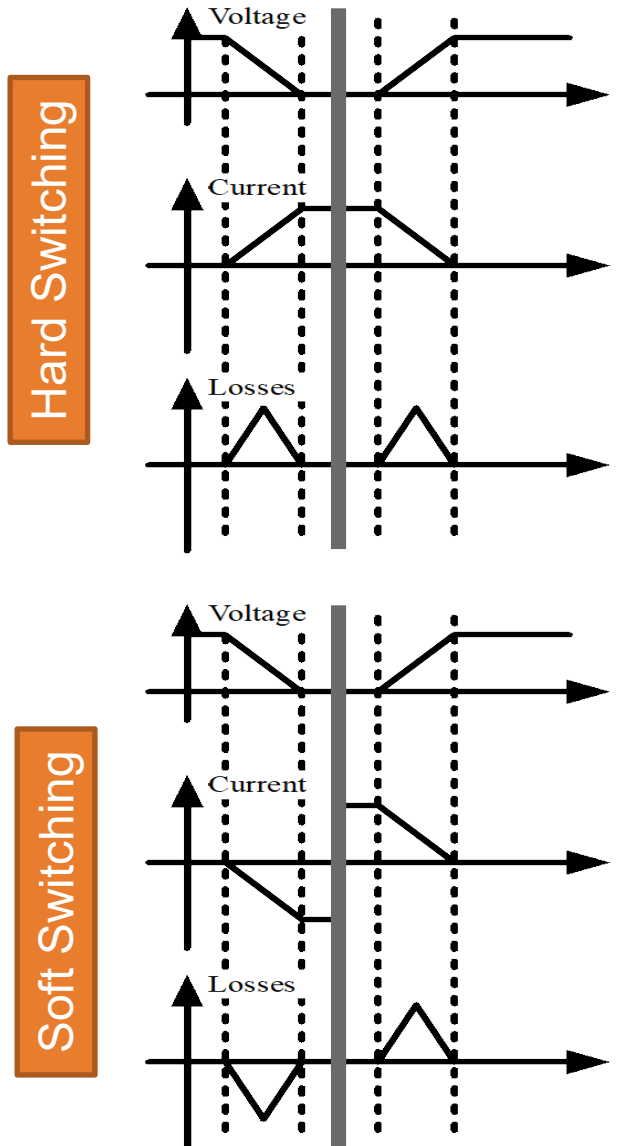
Corner PLECS Models

- Conventional PLECS models based on measurements are only valid for the typical or nominal process case in manufacturing. onsemi has developed accurate corner PLECS models based on real manufacturing distribution.
- Physics dictates that worst case conduction and switching losses do not happen simultaneously for example.
- Depending on the application, the influence of conduction and switching energy losses on the overall system performance will vary. The onsemi corner PLECS models provide the user the flexibility to investigate the entire correlated space.
- Accurate corner and statistical modeling covered in detail in
 - SiC MOSFET Corner and Statistical SPICE Model Generation – Proceeding of International Symposium on Power Semiconductor Devices and ICs (ISPSD), pp. 154-147, September 2020

Process Condition	R_{DSon} , V_{th} , BV	Capacitance, Device RG	Conduction Loss	Switching Energy Loss
Nominal	Nominal	Nominal	Nominal	Nominal
Best Case Conduction Loss, Worst Case Switching Loss	Low	High	Low	High
Worst Case Conduction Loss, Best Case Switching Loss	High	Low	High	Low

Hard vs. Soft Switching Energy Losses

- For **Hard Switching**, the conventional Double Pulse Test is the good method to calculate losses for models.
- For **Soft Switching**, it depends on the topology and the operating mode (Transition or Switching)
 - The Double Pulse Test is **NOT** representative of Soft Switching. Using double pulse switching energy losses in the simulation of a Soft Switching Topology is highly inaccurate.
 - A Soft Switching energy loss schematic is implemented in SSPMG to deliver Soft Switching **PLECS** models accurate for topologies such as
 - DC-DC LLC and CLLC Resonant, Dual Active Bridge, Phase Shifted Full Bridge, others



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Access Elite Power Simulator with MYON Account

MyON is required to use the Elite Power Simulator

MYON
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First Time User

Upcoming Tradeshow

PRT+ Interactive Charts

Technology Webinars

New SiC Technology

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Access Through Direct Link or Product Page

In addition to direct access to the Elite Power Simulator
www.onsemi.com/elite-power-simulator

Access is available on each EliteSiC Product Page.

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EN

Products / Discrete & Power Modules / Silicon Carbide (SiC) / Silicon Carbide (SiC) MOSFETs

Silicon Carbide (SiC) MOSFETs | NTB015N065SC1

Show Side Navigation

Silicon Carbide MOSFET, N-Channel, 650V, 15.3 mΩ, D2PAK-7L

Availability & Samples

Email Sales

Favorite

Datasheet

CAD Model

EliteSiC Start Simulator

Overview

Technical Documentation

Overview

Silicon Carbide (SiC) MOSFET uses a completely new technology that provide superior switching performance and higher reliability compared to Silicon. In addition, the low ON resistance and compact chip size ensure low capacitance and gate charge. Consequently, system benefits include highest efficiency, faster operation frequency, increased power density, reduced EMI, and reduced system size.

Applications

End Products

Features

Product Overview

Material Composition

Product Change Notification

Availability & Samples

Products: 1

Share

Export

Columns

Sort by Product

Product	Status	CAD Models	Compliance	Package Type	Case Outline	MSL Type	MSL Temp (°C)	Container Type	Container Qty.	Channel Polarity	Config
NTB015N065SC1	Active			D2PAK7 (TO-263-7L HV)		1	245	REEL	800	N-Channel	Single

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Language

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Learn more about EliteSiC at
www.onsemi.com/silicon-carbide



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Step by Step Tool Flow

Step 1: Select Application and Topology

1 Application

2 Device Selection

3 Device Configuration

4 Circuit Parameters

5 Cooling

6 Simulation

7 Summary

Target application

Start by selecting target application

Automotive

Industrial

Application choice filters the available topologies

Automotive converter topologies

AC/DC

Active Front End (1 phase, 2 level)

Active Front End (3 phase, 2 level)

Active Front End (3 phase, 2 level) (Traction)

Asymmetrical Bridgeless PFC Converter

Boost PFC Converter (diode bridge) (1/2 phases)

Classic Bridgeless PFC Converter

Totempole Bridgeless PFC Converter (1/2/3 phases)

Vienna Rectifier (3 phase, 1 switch per leg)

Vienna Rectifier (3 phase, 2 switches per leg)

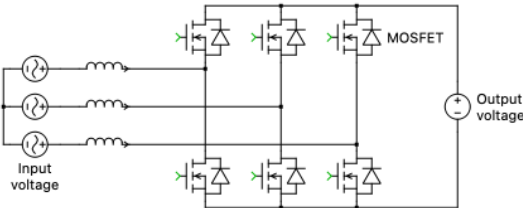
DC/DC

DC/AC

Topologies grouped by converter class

Active Front End (3 phase, 2 level)

Basic circuit schematic displayed



Next Step

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Step 2: Select Device

Application

2 Device Selection

3 Device Configuration

4 Circuit Parameters

5 Cooling

6 Simulation

7 Summary

Voltage and power rating

Input voltage V_{in}

Value *

300

Vrms, I-I

Output voltage V_{out}

Value *

600

Vdc

Rated power P_{out}

Value *

4000

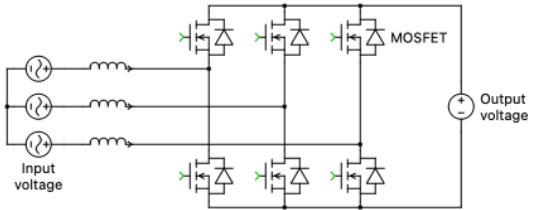
W

Use SiC MOSFETs or modules?

Select option *

SiC MOSFETs (discretes)

Inputs used to filter valid devices



Select MOSFET

Please select device from the list to continue. Devices in gray do not match the criteria and are not selectable.

Product name

Family

V_{MAX}

$R_{DS(on)}$

$I_{D(max)}$

Package

Data Sheet

NVBG015N065SC1

M2

650

12

145

D2PAK7

[PDF](#)

NVBG025N065SC1

M2

650

19

106

D2PAK7

[PDF](#)

NVBG045N065SC1

M2

650

31

62

D2PAK7

[PDF](#)

NVBG060N065SC1

M2

650

44

46

D2PAK7

[PDF](#)

NVBG075N065SC1

M2

650

56

37

D2PAK7

[PDF](#)

NVBG095N065SC1

M2

650

70

30

D2PAK7

[PDF](#)

NVH4L015N065SC1

M2

650

12

142

TO-247-4

[PDF](#)

Select device to move onto next step

Direct datasheet download

Step 3: Configure Device

Application

Device Selection

3 Device Configuration

4 Circuit Parameters

5 Cooling

6 Simulation

7 Summary

MOSFET configuration

Device name: NVBG015N065SC1

Datasheet

Product page

Number of parallel devices

Value *

1

Set parallel devices

Turn-on gate resistance $R_{g-on,ext}$

Value *

2.2

Set circuit RG

Turn-off gate resistance $R_{g-off,ext}$

Value *

2.2

Set device process corner condition

Loss model type

☒ Nominal loss data

☐ Best case conduction loss/worst case switching loss

☐ Worst case conduction loss/best case switching loss

☐ Upload PLECS custom loss model from onsemi's SSPMG tool

View loss and thermal data

Upload custom PLECS model from onsemi's Self-Service PLECS Model Generator (SSPMG)

Select semiconductor

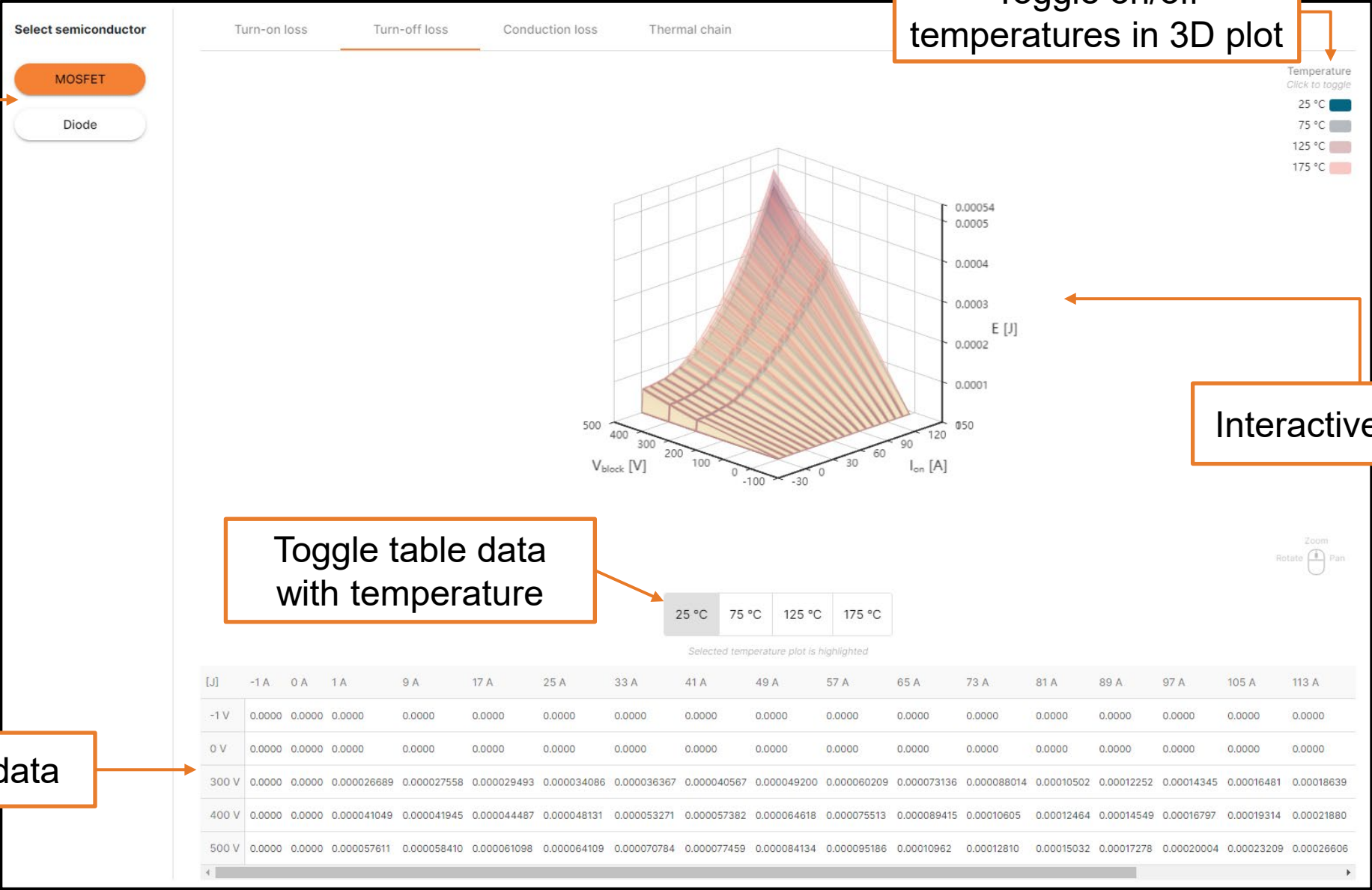
MOSFET

Diode

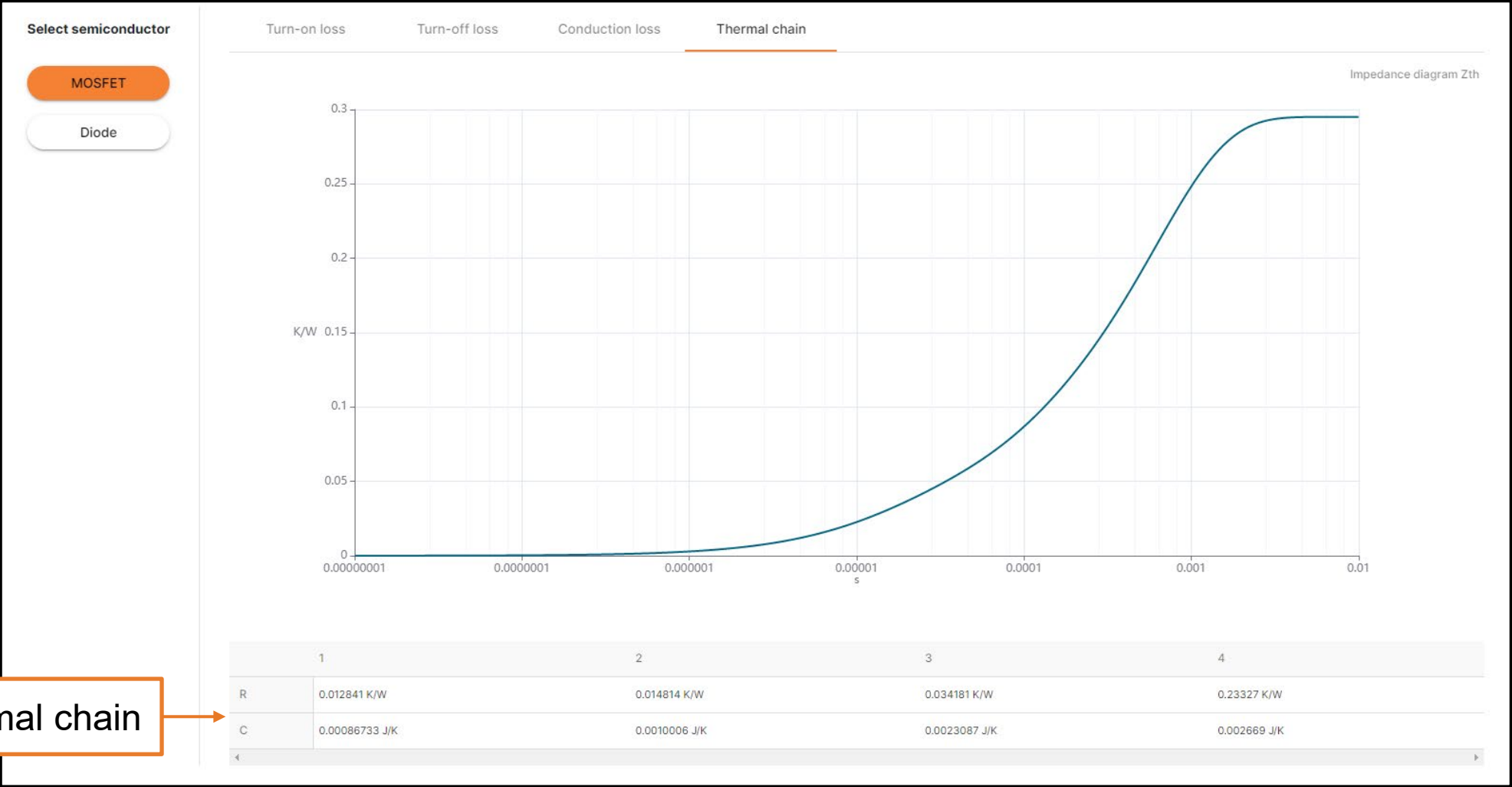
Previous Step

Next Step

View Device Loss Data



View Device Thermal Data



View thermal chain

Step 4: Configure Circuit Parameters

Application — Device Selection — Device Configuration — **4 Circuit Parameters** — 5 Cooling — 6 Simulation — 7 Summary

Circuit parameters

Power factor pf

Value *

1

Grid frequency F_{ac}

Value *

50 Hz

Inductance L

Value *

1 mH

Switching frequency F_{sw}

Value *

50 kHz

Deadtime t_{dead}

Value *

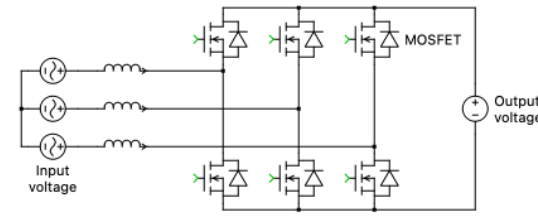
200 ns

Modulation scheme?

Select option *

Sine PWM

Set Circuit parameters, varies by topology



Input voltage

MOSFET

Output voltage

Previous Step

Set modulation scheme, varies by topology

Next Step

Step 5: Configure Cooling

Application

Device Selection

Device Configuration

Circuit Parameters

5 Cooling

6 Simulation

7 Summary

Thermal parameters

Thermal interface (grease) resistance $R_{th,ch}$

Value *
0

K/W

Set Thermal interface resistance

Heat sink model

☒ Fixed temperature ☐ Custom thermal impedance

Fixed temperature T_h

Value *
75

°C

Configure Heat sink as ideal with fixed temperature or input custom thermal impedance

Previous Step

Next Step

Custom Heat Sink Thermal Impedance Utility

Heat sink thermal impedance

Thermal chain ☒ Foster ☐ Cauer

Choose Foster or Cauer format with automatic conversion feature

Thermal resistance $R_{th,ha}$

0.05 K/W

0.15 K/W

Time constant τ_{th}

0.1 s

0.2 s

Impedance diagram Z_{th}

Logy ☐

Up to 5 rungs possible

Toggle log/linear Y axis

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Step 6a: Run Simulation

Application

Device Selection

Device Configuration

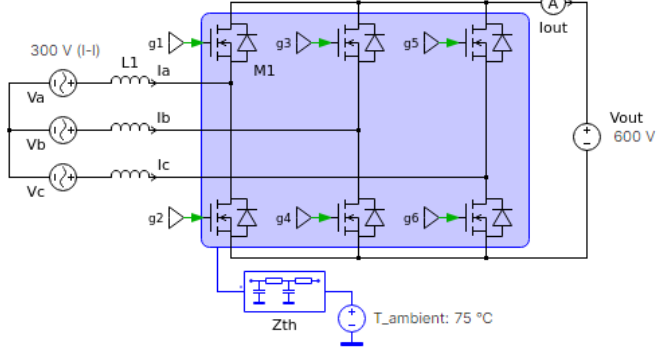
Circuit Parameters

Cooling

6 Simulation

7 Summary

Circuit



Simulation Control

Simulate

Hold Result

Less details

Simulation completed

System Overview

Input Voltage	Output Voltage	Power Rating	Power Factor	Grid Frequency	Switching Frequency
300.0 V _{l-l,rms}	600.0 V _{dc}	4.000 kW	1.0	50.0 Hz	50.0 kHz

Detailed temperature, loss, and efficiency reported

Temperatures and Total Loss

MOSFET	NVBG015N065SC1
Module	
MOSFET Max T _j	77.7 °C
Heatsink Max Temp.	75.0 °C
Ambient Temp.	75.0 °C
Combined Losses *	43.08 W
Efficiency	98.93 %

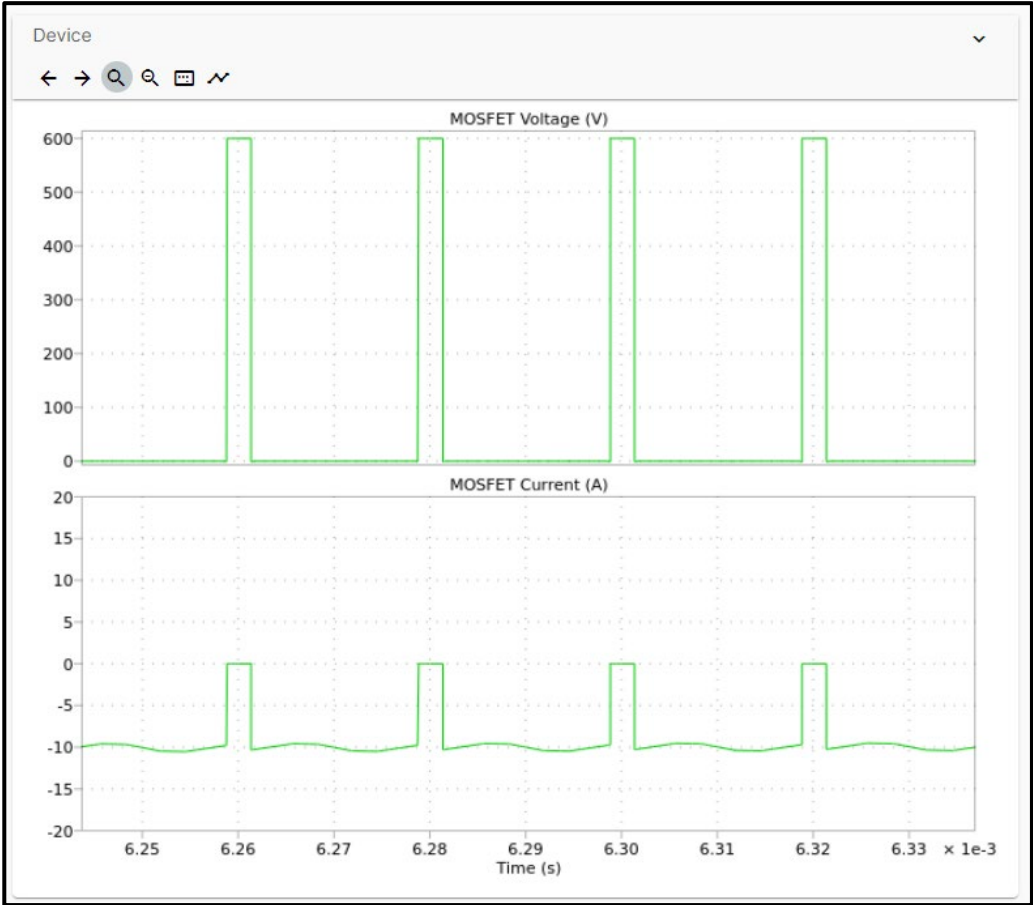
Pivot table, export csv

Losses Breakdown

Turn-on Losses E _{on}	12.55 W
Turn-off Losses E _{off}	8.76 W
Recovery Losses Err	18.59 W
Forward Conduction	0.31 W
Reverse Conduction	1.65 W
Body Diode Conduction (Deadtime)	1.22 W

Launch Simulation

Step 6b: View Plots



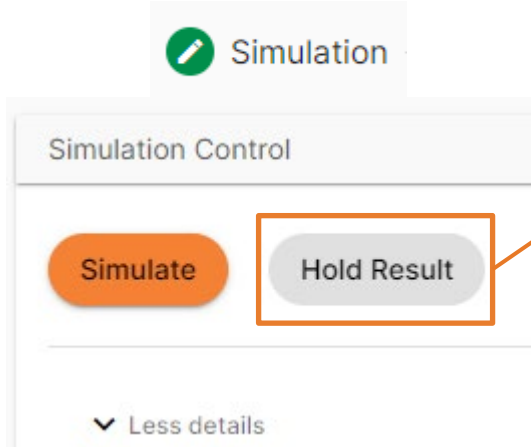
Zooming and cursor features



Step 6c: Compare Multiple Simulation Cases

Compare

- Device Selection
- Device Configuration
 - ✓ Corner process loss data
 - ✓ SSPMG Model
- Circuit Parameters
- Cooling



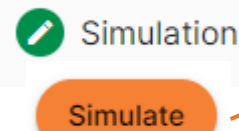
Go back to steps 2, 3, 4, or 5 to make changes

2 Device Selection

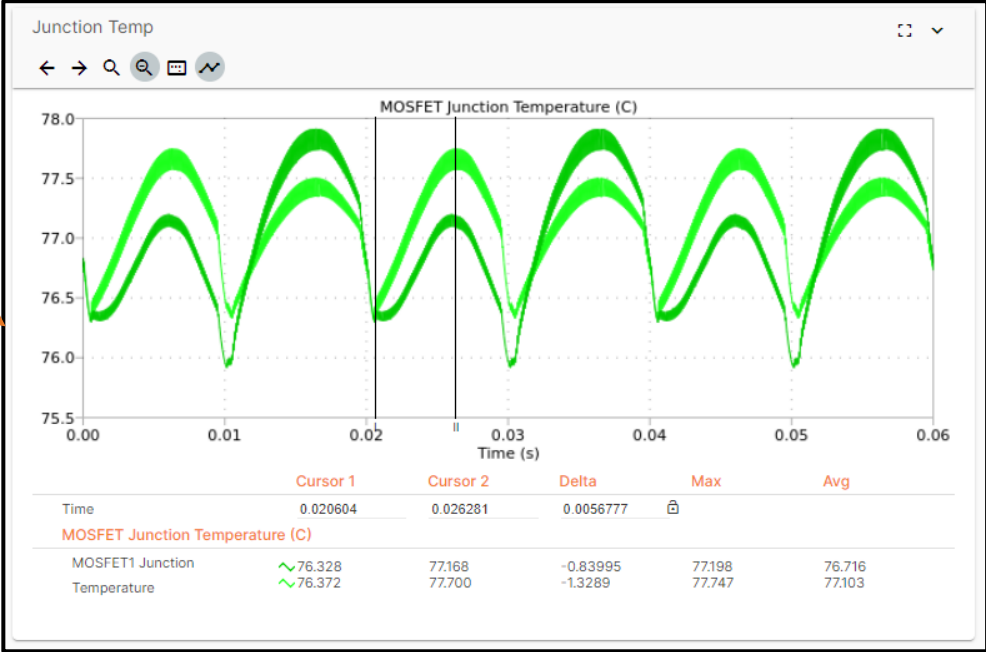
MOSFET: NVBG025N065SC1

Change

Compare Results



Temperatures and Total Loss		
	Sine PWM, NVBG015N065SC1, Nominal loss data, Trace 1	Sine PWM, NVBG025N065SC1, Nominal loss data
MOSFET	NVBG015N065SC1	NVBG025N065SC1
Module		
MOSFET Max TJ	77.7 °C	77.9 °C
Heatsink Max Temp.	75.0 °C	75.0 °C
Ambient Temp.	75.0 °C	75.0 °C
Combined Losses *	43.08 W	31.86 W
Efficiency	98.93 %	99.21 %



Step 7: Review Summary Table

Application

Device Selection

Device Configuration

Circuit Parameters

Cooling

Simulation

7 Summary

Summary for Active Front End (3 phase, 2 level) topology (automotive)

Download PLECS Models

Download Thermal Descriptions

Print

CSV Download

You can highlight rows by clicking on them

Highlight rows to be print or downloaded to CSV

Parameter	Sine PWM, NVBG025N065SC1, Nominal loss data	Sine PWM, NVBG015N065SC1, Nominal loss data, Trace 1
Variables ▾		
Selected part	NVBG025N065SC1	NVBG015N065SC1
Input voltage V_{in}	300 Vrms,I-I	300 Vrms,I-I
Output voltage V_{out}	600 Vdc	600 Vdc
Rated power P_{out}	4000 W	4000 W
Use SiC MOSFETs or modules?	SiC MOSFETs (discretes)	SiC MOSFETs (discretes)
Number of parallel devices	1	1
Turn-on gate resistance $R_{g-on,ext}$	4 Ω	2.2 Ω
Turn-off gate resistance $R_{g-off,ext}$	4 Ω	2.2 Ω
Loss model type	Nominal loss data	Nominal loss data
Power factor pf	1	1
Grid frequency F_{ac}	50 Hz	50 Hz
Inductance L	1 mH	1 mH
Switching frequency F_{sw}	50 kHz	50 kHz
Deadtime t_{dead}	200 ns	200 ns
Modulation scheme?	Sine PWM	Sine PWM

Load Profile Simulation

- Load profile simulation enables power and thermal estimations at multiple, user-defined operating points
- Simple intuitive flow

Topologies with Load Profiling

NPC inverter (1 phase, 3 level)

NPC inverter (3 phase, 3 level)

T-Type inverter (1 phase, 3 level)

T-Type inverter (3 phase, 3 level)

ANPC inverter (1 phase, 3 level)

ANPC inverter (3 phase, 3 level)

Inverter (3 phase, 2 level, grid load)

Inverter (3 phase, 2 level, motor load)

Traction Inverter (3 phase)

4 Circuit Parameters

Circuit parameters

Use variable toggle to enable mission profile

Output voltage V_{out} Value * 380	☒ $V_{rms}, I-I$	Power factor pf Value * 1	☒
Load frequency F_{ac} Value * 50 Hz		Switching frequency F_{sw} Value * 20 kHz	☐
Deadtime t_{dead} Value * 50 ns		Inductance L Value * 1 mH	
Output Current Value * 15 A			☐

Modulation scheme?

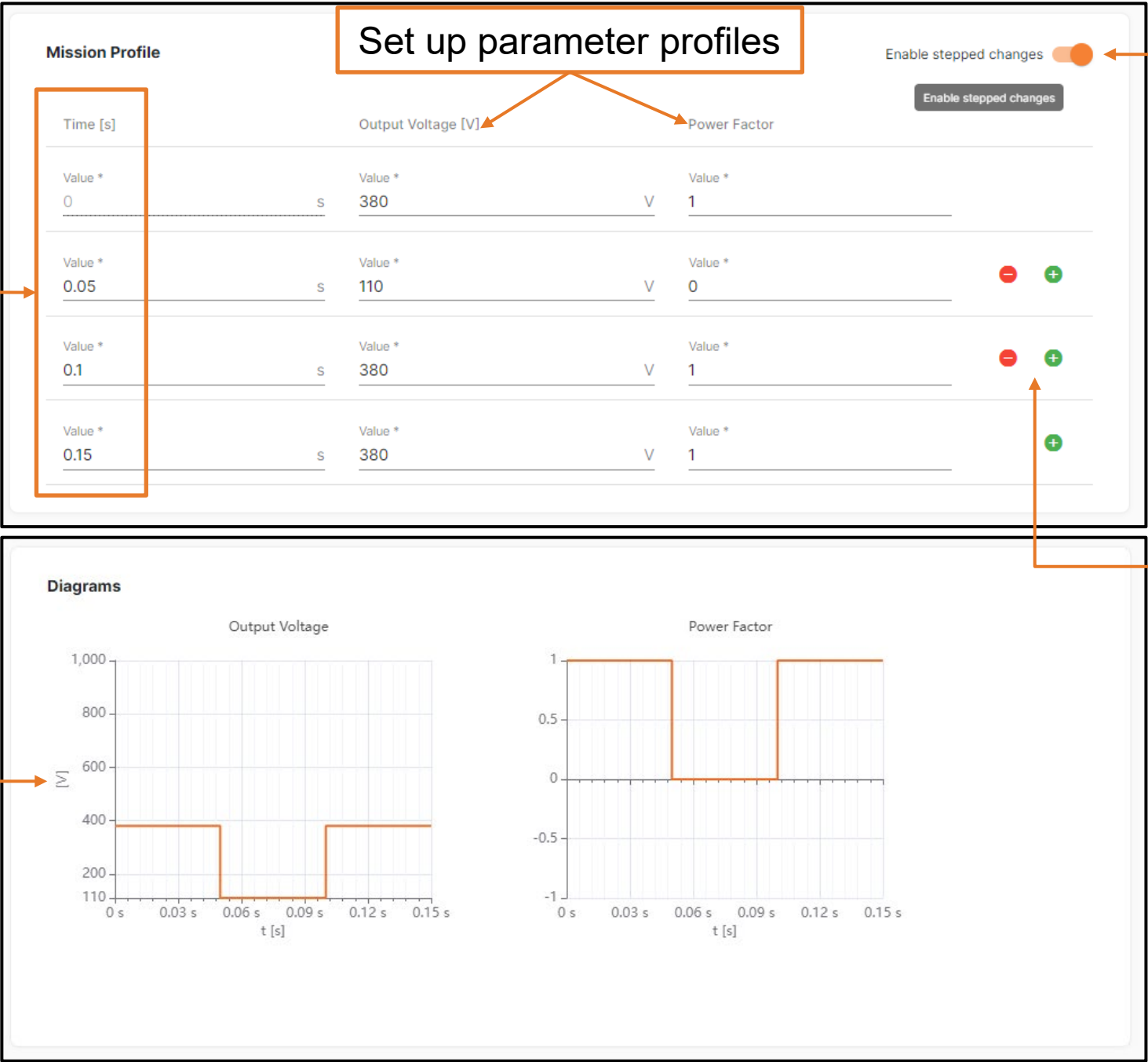
Select option *
Sine PWM

Load Profile Setup

Set up time intervals

Real time plotting of load profile parameters for inspection before launching simulation

4 Circuit Parameters

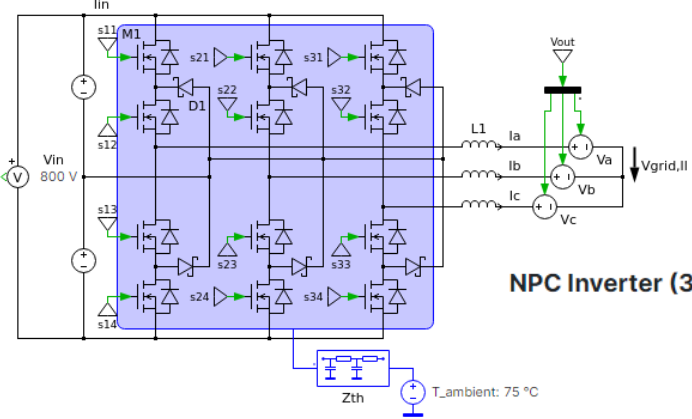


Load Profile Simulation

6 Simulation

Mission Profile simulation button is enabled (orange) when any circuit parameter is enabled with a load profile

Circuit/MissionProfile



NPC Inverter (3 phase, 3 level)

Simulation Control

Simulate Mission Profile Hold Result

Less details

Simulation completed

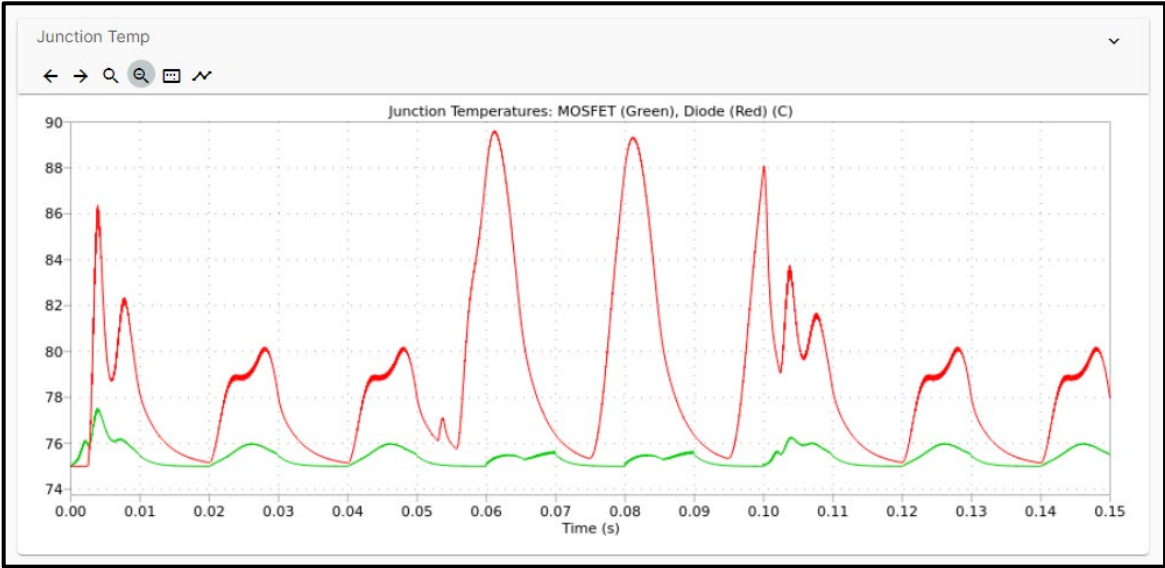
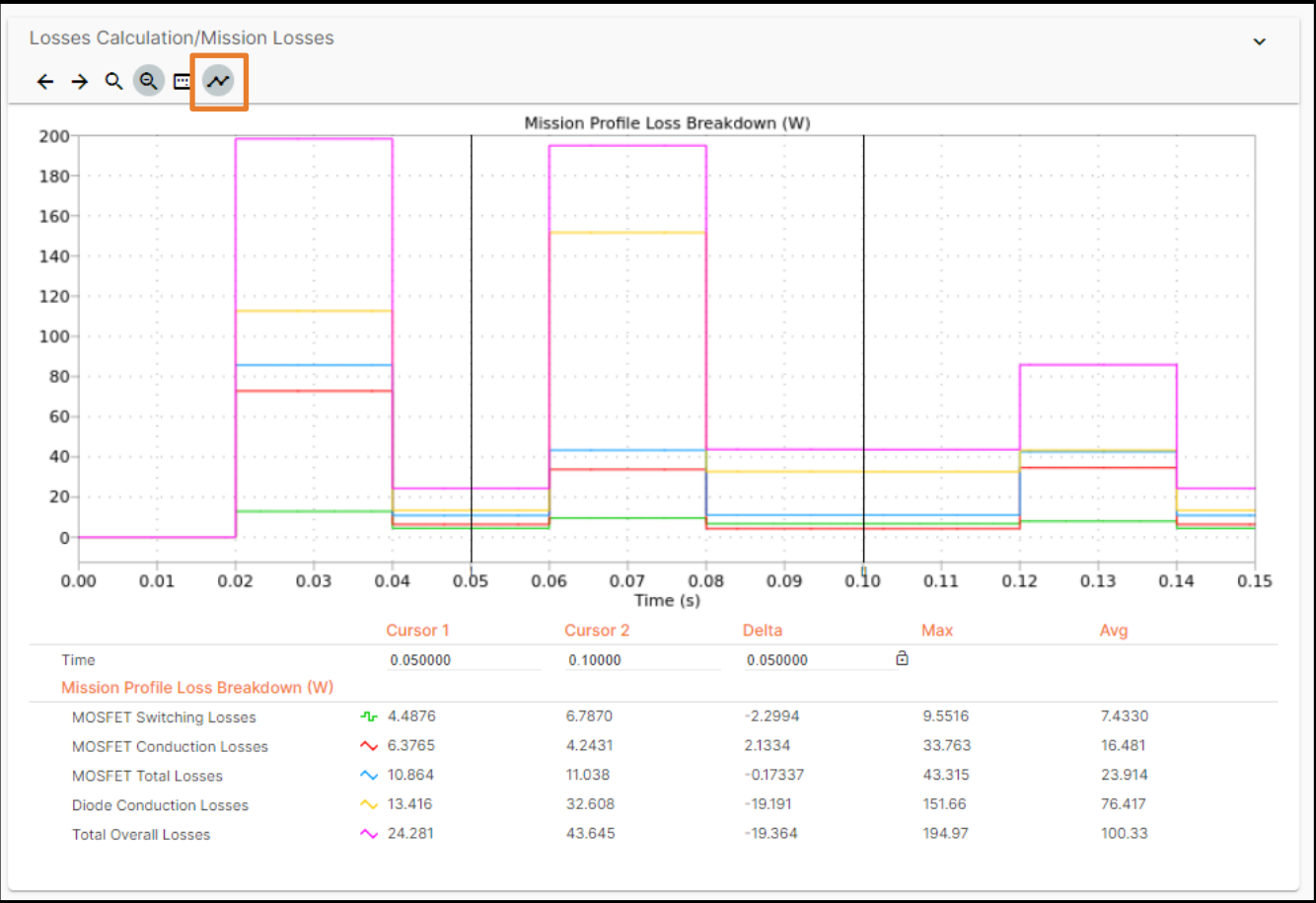
System Overview

Input Voltage	Output Voltage	Power Rating	Power Factor	Load Frequency	Switching Frequency
800.0 V	380.0 V	20.00 kW	1.0	50.0 Hz	20.0 kHz

Temperatures

SIC MOSFET	MOSFET Max TJ	SIC Diode	Diode Max TJ	Heatsink Max Temp.	Ambient Temp.
NTBG015N065SC1	77.5 °C	FFSB2065B	89.6 °C	75.0 °C	75.0 °C

Example Load Profile Simulation Results



Junction Temperature

Losses can be tracked over the load profile by enabling the cursor

Question?

Have questions, comments, or need support with your Self-Service PLECS Model Generator needs? We're here to help! Write us an email at simulator@onsemi.com.

- Self-Service PLECS Model Generator: www.onsemi.com/self-plecs-generator
- Elite Power Simulator: www.onsemi.com/elite-power-simulator



Novel Silicon Carbide (SiC) System Level Simulation

Elite Power Simulator and Self-Service PLECS Model Generator

Industry-first PLECS Models and system level simulation valid for hard and soft switching applications, corner modeling, and custom parasitic environment, making virtual prototyping possible.

Selecting the best EliteSiC products to fit your application.

Simulate Now

The advertisement features a computer monitor displaying a circuit simulation interface with various components and a list of parameters on the right. The background is a dark blue space-themed image with light streaks.



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