



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

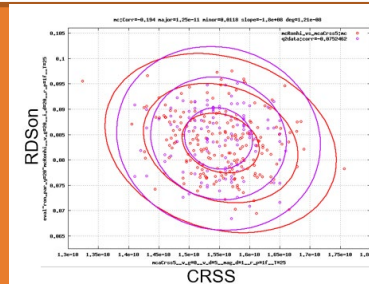
Covering DC-DC, AC-DC, and DC-AC applications, including 32 circuit topologies in industrial (DC fast charging, UPS, ESS, solar inverters), automotive (OBC, traction), and non-traction spaces

Soft Switching Simulation

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.

Corner Simulation Capability

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



Custom PLECS Model

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

Loss Plotting

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

Flexible Design & Fast Simulations

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

www.onsemi.com/elite-power-simulator

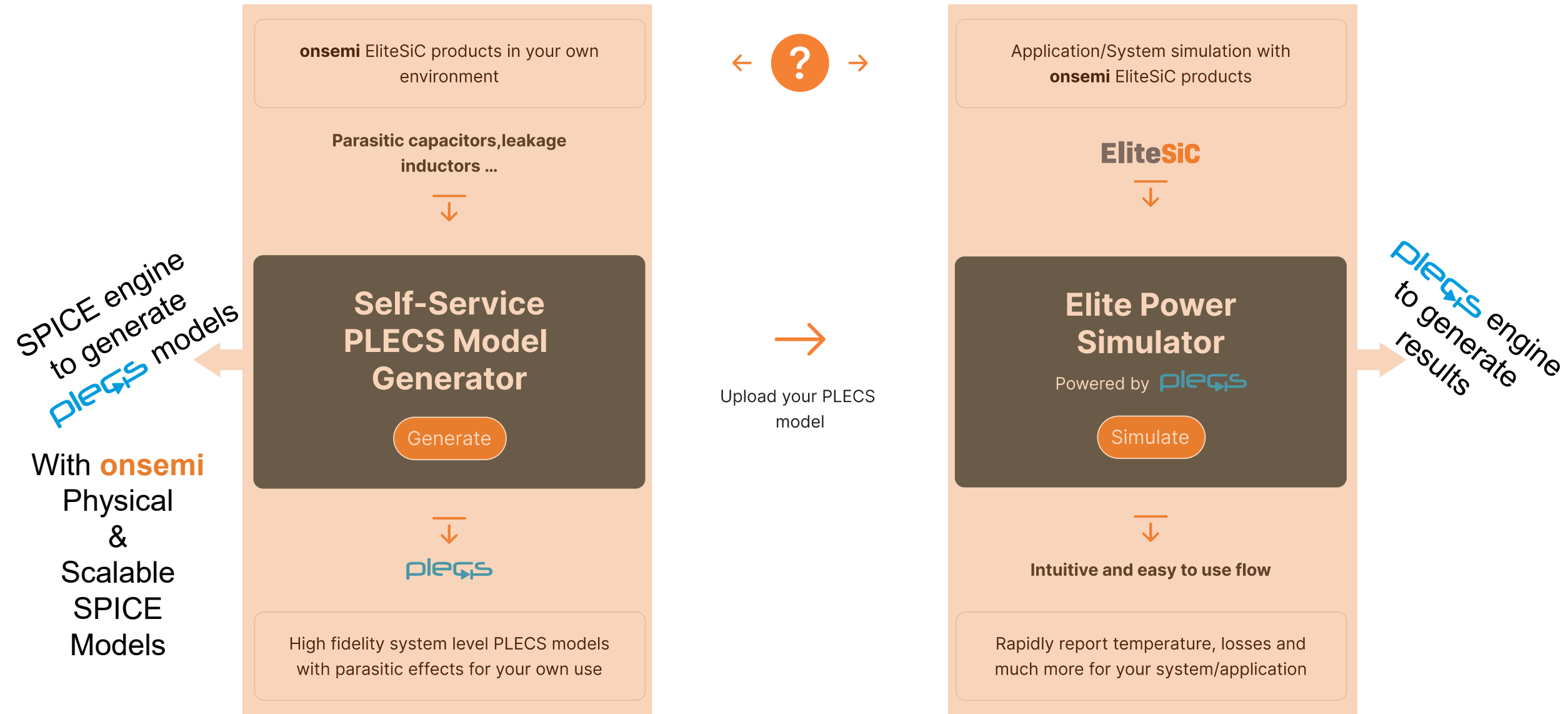
onsemi's State-of-the-Art PLECS Models

- 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

Mixing **onsemi** SPICE expertise and **plecs** power



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.
- Corner models currently only available for EliteSiC products. FS7 IGBT corner models are coming soon.
- 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

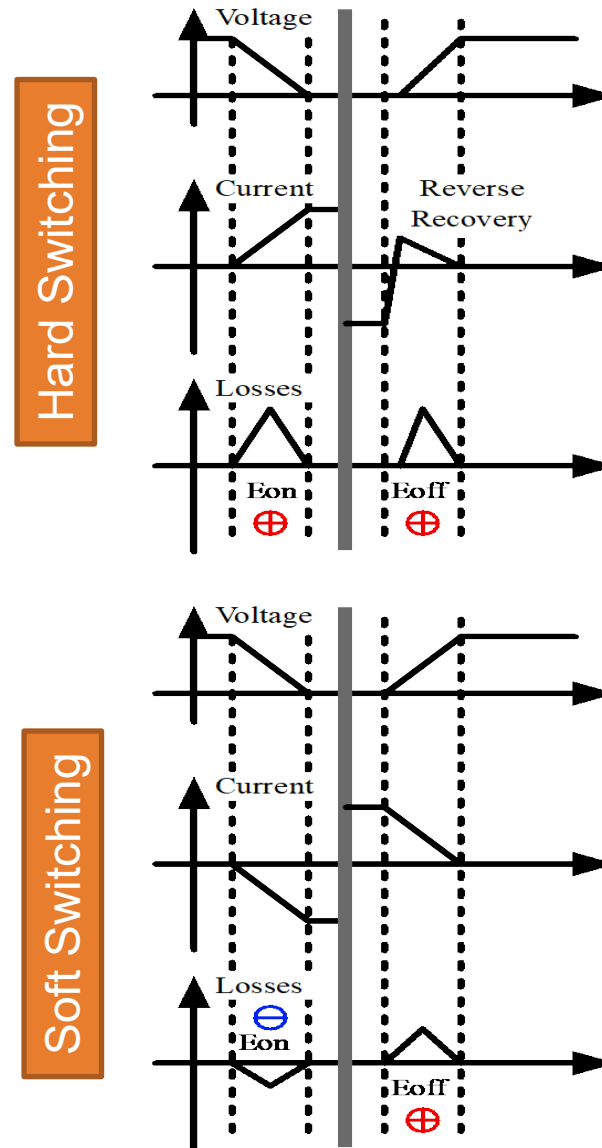
Process Condition	R_{DSon} , V_{th} , BV	Capacitance, Device RG	Conduction Loss	Switching Energy Loss
Nominal	Nominal	Nominal	Nominal	Nominal
Best Case Conduction Loss, Worst Case Switching Loss	Low	High	Low	High
Worst Case Conduction Loss, Best Case Switching Loss	High	Low	High	Low

Soft Switching Energy Losses

Soft Switching Simulation*

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

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.



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Access Elite Power Simulator with MYON Account

MyON is required to use the Elite Power Simulator

MYON Login

The screenshot shows the onsemi website header with navigation menus for Products, Solutions, Design, Support, Company, and Careers. A search bar is present with the text "Search the Site & Cross Reference". In the top right corner, there is a user profile icon, a shopping cart icon, and the language setting "EN".

The main content area is split into two panels. The left panel, titled "Supercharge your onsemi experience by creating an onsemi account", lists several benefits: "Order product samples & evaluation boards", "Save custom parametric search filters", "Join the conversation on Community Forums", and "Utilize Strata Developer Studio & other developer tools". It also includes "Save/Email Interactive Block Diagram worksheets", "Watch Exclusive Webinars", and "View browsing history & favorites using My History". A "Product Recommendation" section titled "Interact" is partially visible on the left.

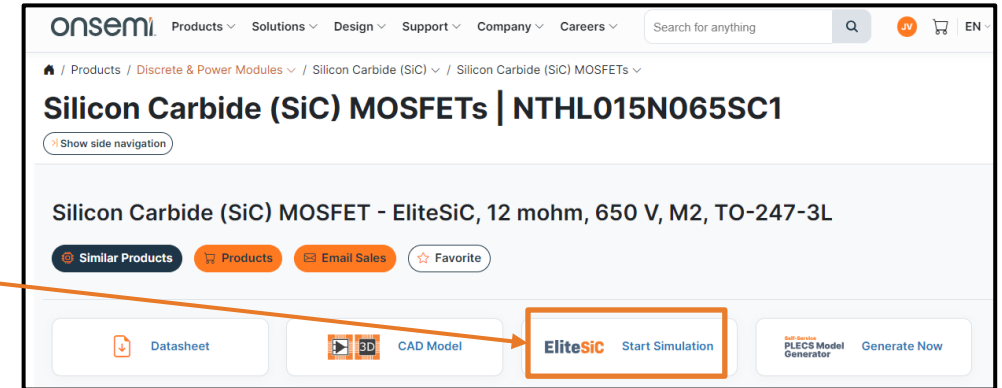
The right panel is a "Login" form. It features a "Returning User" section with "Email" and "Password" input fields, a "Forgot Password?" link, and a "Login" button. Below this is a "First Time User" section with a "Register Now" link. An orange box highlights the user profile icon in the header, with an arrow pointing to the "Returning User" label and another arrow pointing to the "Register Now" link.

At the bottom of the page, there is a navigation bar with links for "Upcoming Tradeshow", "PRT+ Interactive Charts", "Technology Webinars", and "New SiC Technology".

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 and FS7 IGBT
Product Page.



Learn more about EliteSiC and FS7 IGBTs at
[EliteSiC](#)
[Field Stop 7 \(FS7\) IGBTs](#)

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

Go to landing page
www.onsemi.com/elite-power-simulator
and select Simulate Now

Simulate Now

The screenshot shows the onsemi website's navigation bar with links for Products, Solutions, Design, Support, Company, and Careers. A search bar and user profile (JV) are also visible. The breadcrumb trail indicates the path: Design / Tools & Software / Elite Power Simulator Tool. The main heading is "Elite Power Simulator Tool". Below this, there are links for User Guide, App Note, PLECS Models (XML), SSPMG, and Support. A progress bar shows seven steps: 1 Application, Device Selection, Device Configuration, Circuit Parameters, Cooling, Simulation, and 7 Summary. At the bottom, there are radio buttons for Automotive and Industrial. Callouts highlight the SSPMG link, the User Guide and App Note, and the PLECS Models (XML) link.

onsemi Products Solutions Design Support Company Careers Search for anything JV EN

Design / Tools & Software / Elite Power Simulator Tool

Elite Power Simulator Tool

User Guide App Note PLECS Models (XML) SSPMG Support

1 Application Device Selection Device Configuration Circuit Parameters Cooling Simulation 7 Summary

Automotive Industrial

Link to Self-Service PLECS Model Generator (SSPMG)

User Guide and Detailed Application Note

Download complete onsemi PLECS Models (Thermal Descriptions) for Elite SiC and FS7 IGBTs

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

Active Front End (3 phase, 2 level)

Topologies grouped by converter class

Basic circuit schematic displayed

Next Step

Step 2: Select Device

Application — 2 Device Selection — 3 Device Configuration — 4 Circuit Parameters — 5 Cooling

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

Inputs used to filter valid devices

Circuit image toggles based on SiC MOSFET or IGBT choice

Use SiC MOSFETs, SiC modules, or Si IGBTs?

Select option *
SiC MOSFETs (discretes)
SiC modules (half bridge/six pack)
Si IGBTs

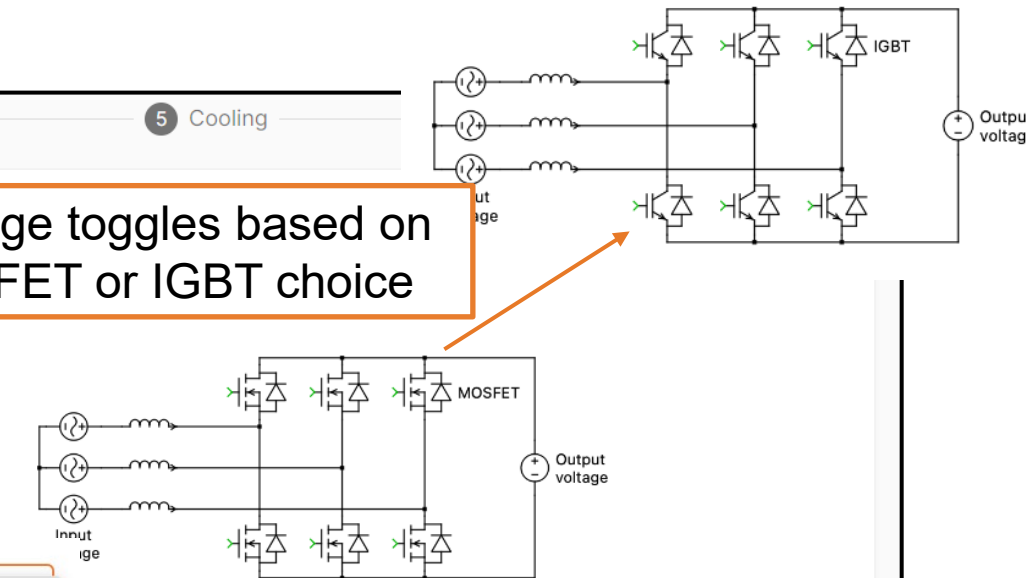
Choose IGBTs, SiC MOSFETs, or SiC modules

Select MOSFET

Please select device from the list to continue. Show all

Product name	Family	V_{MAX}	$R_{DS(on)}$	$I_{D(max)}$	Package	Data Sheet
<input type="radio"/> NVBG015N065SC1	M2	650	12	145	D2PAK7	PDF
<input type="radio"/> NVBG025N065SC1	M2	650	19	106	D2PAK7	PDF
<input type="radio"/> NVBG045N065SC1	M2	650	31	62	D2PAK7	PDF
<input type="radio"/> NVBG060N065SC1	M2	650	4			PDF
<input type="radio"/> NVBG075N065SC1	M2	650	5			PDF

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

Select semiconductor

MOSFET **View loss and thermal data**

Diode

Link to product page

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

Previous Step Next Step

View Device Loss Data

Select MOSFET, IGBT, or Body Diode

Toggle on/off temperatures in 3D plot

Select semiconductor
Turn-on loss
Turn-off loss
Conduction loss
Thermal chain

MOSFET

Diode

Temperature
Click to toggle

25 °C

75 °C

125 °C

175 °C

Toggle table data with temperature

25 °C 75 °C 125 °C 175 °C

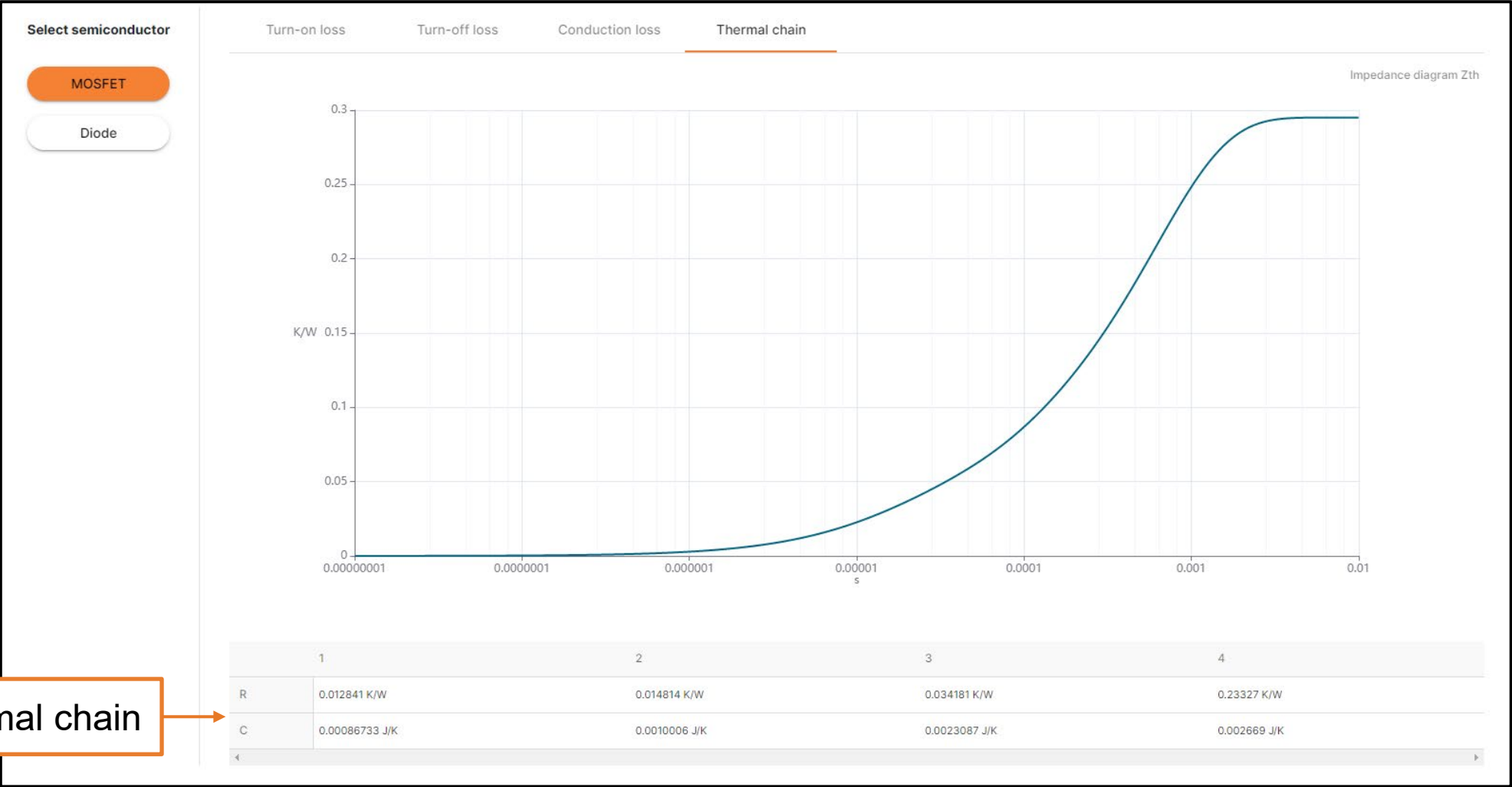
Selected temperature plot is highlighted

[J]	-1 A	0 A	1 A	9 A	17 A	25 A	33 A	41 A	49 A	57 A	65 A	73 A	81 A	89 A	97 A	105 A	113 A
-1 V	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0 V	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
300 V	0.0000	0.0000	0.000026689	0.000027558	0.000029493	0.000034086	0.000036367	0.000040567	0.000049200	0.000060209	0.000073136	0.000088014	0.00010502	0.00012252	0.00014345	0.00016481	0.00018639
400 V	0.0000	0.0000	0.000041049	0.000041945	0.000044487	0.000048131	0.000053271	0.000057382	0.000064618	0.000075513	0.000089415	0.00010605	0.00012464	0.00014549	0.00016797	0.00019314	0.00021880
500 V	0.0000	0.0000	0.000057611	0.000058410	0.000061098	0.000064109	0.000070784	0.000077459	0.000084134	0.000095186	0.00010962	0.00012810	0.00015032	0.00017278	0.00020004	0.00023209	0.00026606

Interactive 3D plot

View 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 Set Circuit parameters, varies by topology

Power factor pf	Grid frequency F_{ac}
Value *	Value *
1	50 Hz

Inductance L	Switching frequency F_{sw}
Value *	Value *
1 mH	50 kHz

Deadtime t_{dead}

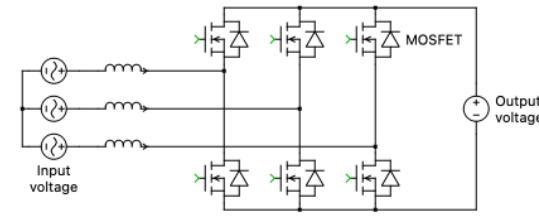
Value *

200 ns

Modulation scheme?

Select option *

Sine PWM



Input voltage

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

Heat sink model

Fixed temperature Custom thermal impedance

Fixed temperature T_h

Value *
75 °C

Previous Step Next Step

Set Thermal interface resistance

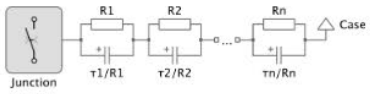
Configure Heat sink as ideal with fixed temperature or input custom thermal impedance

Custom Heat Sink Thermal Impedance Utility

Heat sink thermal impedance

Thermal chain Foster Cauer

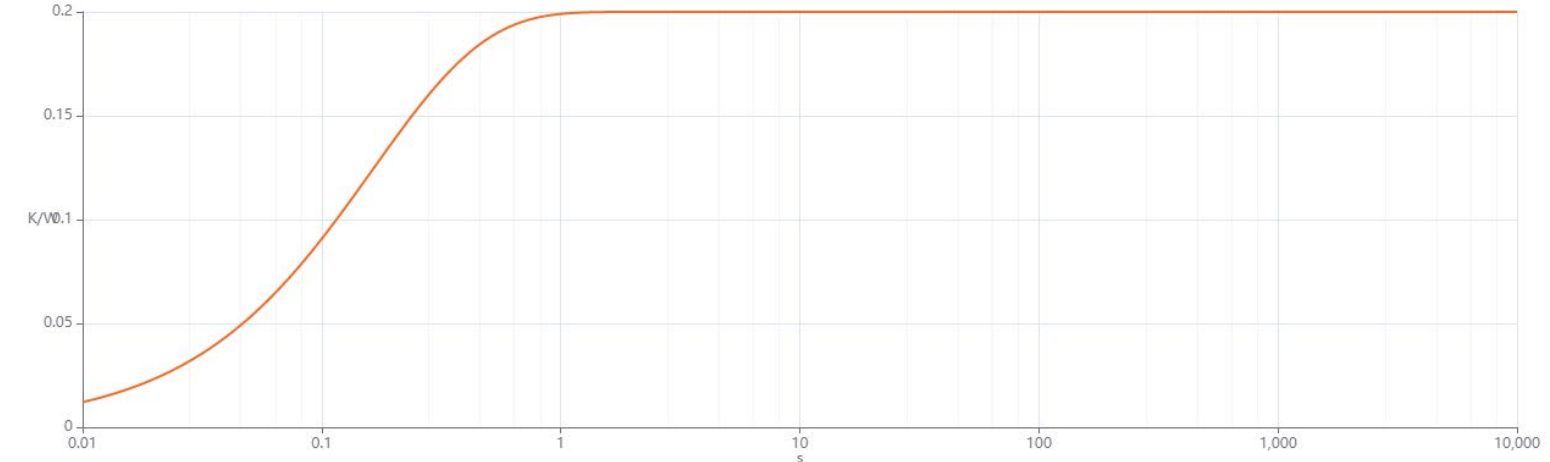
Choose Foster or Cauer format with automatic conversion feature



Thermal resistance $R_{th,ha}$	Time constant τ_{th}
0.05	K/W 0.1
0.15	K/W 0.2

Impedance diagram Z_{th}

Up to 5 rungs possible

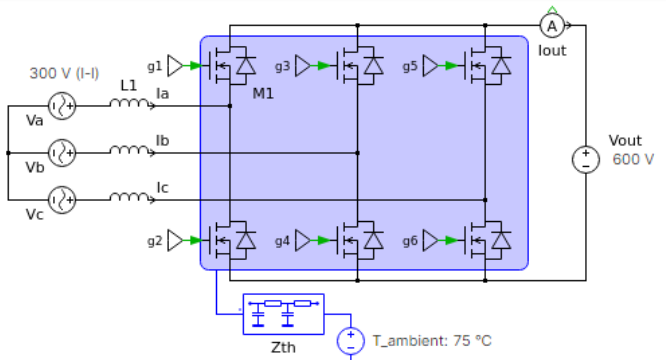


Toggle log/linear Y axis

Step 6a: Run Simulation

Application — Device Selection — Device Configuration — **Circuit Parameters**

Detailed temperature, loss, and efficiency reported



The circuit diagram shows a three-phase inverter with MOSFETs (M1) and a load (L1). The input is 300 V (I-I) and the output is 600 V (Vout). The MOSFETs are labeled g1 through g6. The load is labeled L1. The output current is labeled Iout. The MOSFET model is NVBG015N065SC1. The ambient temperature is 75 °C. The thermal impedance is Zth.

Simulation Control

Simulate **Hold Result**

Launch Simulation

Simulation completed

System Overview

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

Temperatures

MOSFET	NVBG015N065SC1
Module	
IGBT	
Number of Parallel	1
Switch Max Tj	85.2 °C
Heatsink Max Temp.	82.2 °C
Ambient Temp.	75.0 °C

Losses Overview

Losses Overview	Value
Switching Losses	32.98 W
Conduction Losses	3.20 W
Combined Losses	36.18 W
Efficiency	99.10 %

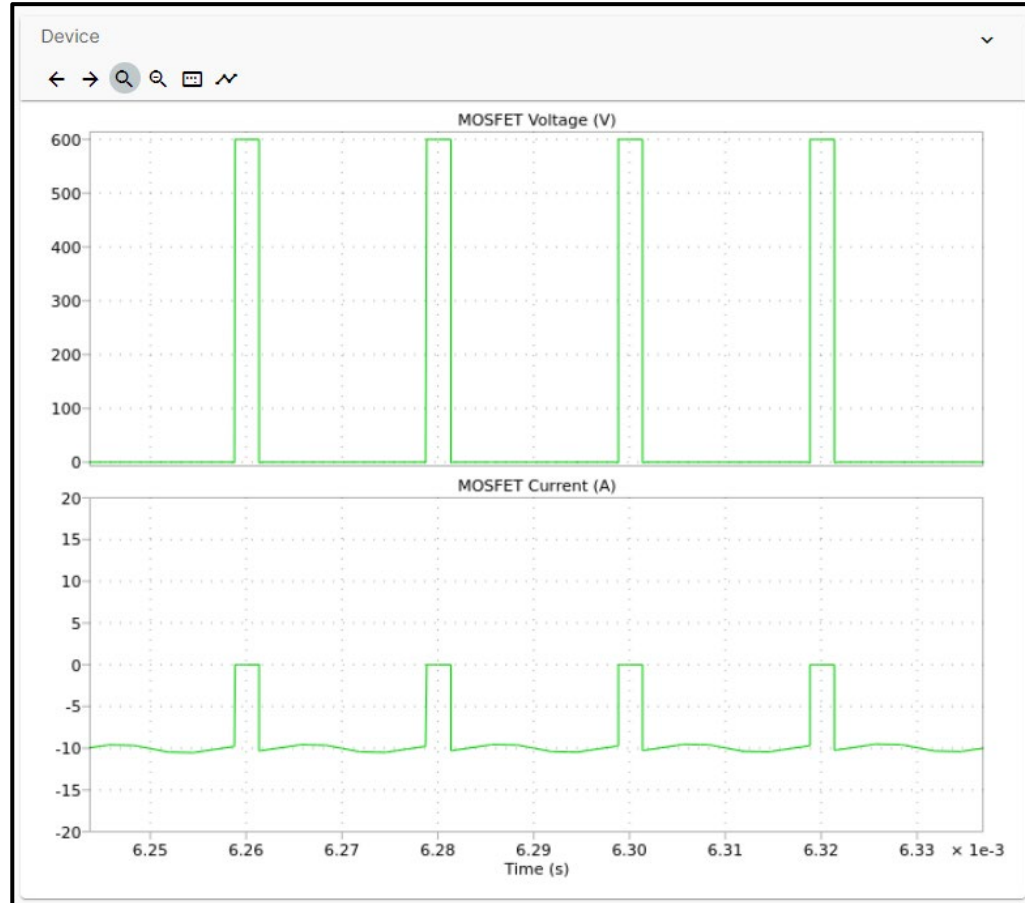
Losses Breakdown

Losses Breakdown	Value
Turn-on Losses	11.09 W
Turn-off Losses	2.71 W
Recovery Losses	19.17 W
Forward Conduction	0.32 W
Reverse Conduction	1.68 W
(Body) Diode Conduction (Deadtime)	1.21 W

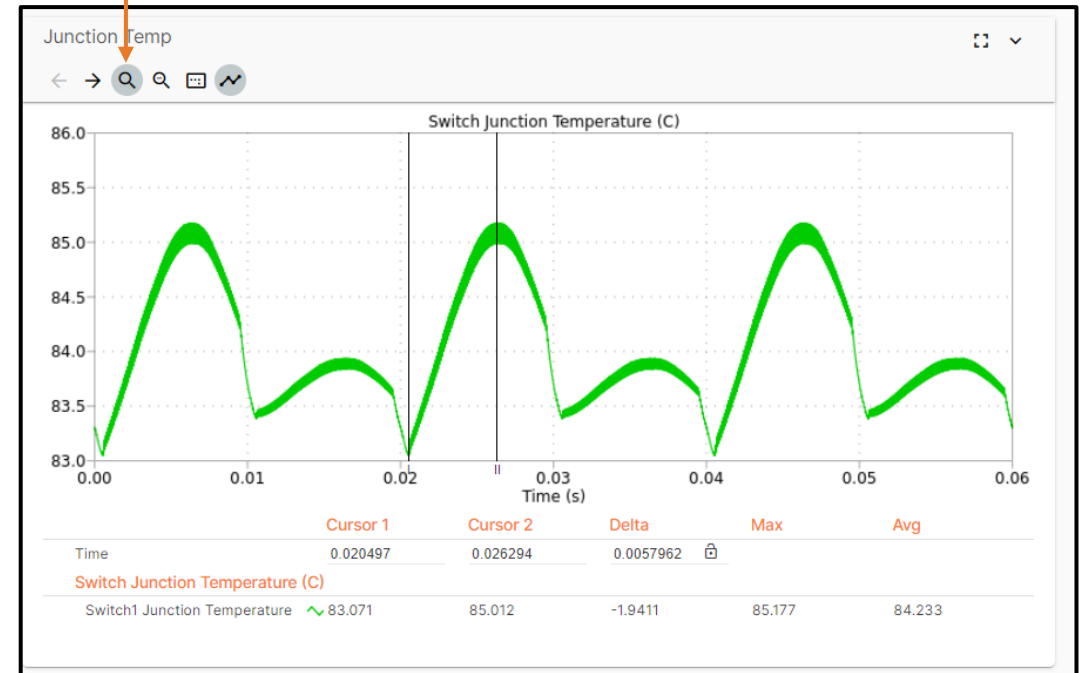
Pivot table, export csv

Step 6b: View Plots

- Application
- Device Selection
- Device Configuration
- Circuit Parameters
- Cooling
- 6 Simulation
- 7 Summary



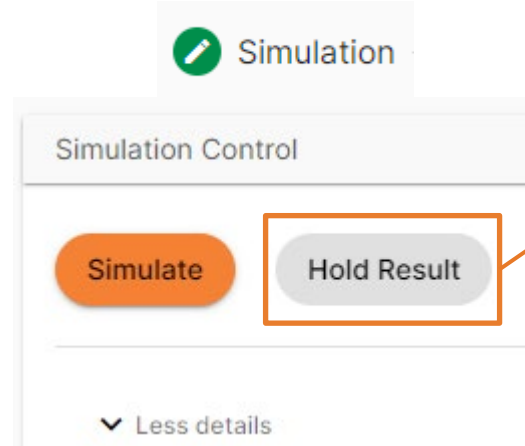
Zooming and cursor features



Step 6c: Compare Multiple Simulation Cases

Compare

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



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

2 Device Selection

MOSFET: NVBG025N065SC1

Change

Compare Results

Simulation

Simulate

Temperatures	
MOSFET	NVBG025N065SC1 NVBG015N065SC1
Module	
IGBT	
Number of Parallel	1
Switch Max Tj	83.0 °C 85.2 °C
Heatsink Max Temp.	80.5 °C 82.2 °C
Ambient Temp.	75.0 °C 75.0 °C



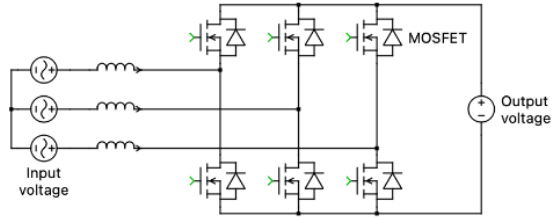
Step 7: Review Summary Table

Application Device Selection Device Configuration Circuit Parameters Cooling Simulation **7 Summary**

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

CSV Download

Print CSV Download



You can highlight rows by clicking on them

Highlight rows to be print or downloaded to CSV

Parameter	Sine PWM, NVBG015N065SC1, Nominal loss data
Selected part	NVBG015N065SC1
Input voltage V_{in}	300 Vrms,I-I
Output voltage V_{out}	600 Vdc
Rated power P_{out}	4000 W
Use SiC MOSFETs, SiC modules, or Si IGBTs?	SiC MOSFETs (discretes)
Number of parallel devices	1
Turn-on gate resistance $R_{g-on,ext}$	2.2 Ω
Turn-off gate resistance $R_{g-off,ext}$	2.2 Ω
Loss model type	Nominal loss data
Power factor pf	1
Grid frequency F_{ac}	50 Hz
Inductance L	1 mH
Switching frequency F_{sw}	50 kHz
Deadtime t_{dead}	200 ns
Modulation scheme?	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	<input checked="" type="checkbox"/>	Power factor pf Value * 1	<input checked="" type="checkbox"/>
Load frequency F_{ac} Value * 50 Hz		Switching frequency F_{sw} Value * 20 kHz	<input type="checkbox"/>
Deadtime t_{dead} Value * 50 ns		Inductance L Value * 1 mH	
Output Current Value * 15 A			<input type="checkbox"/>

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

Set up parameter profiles

Enable stepped changes

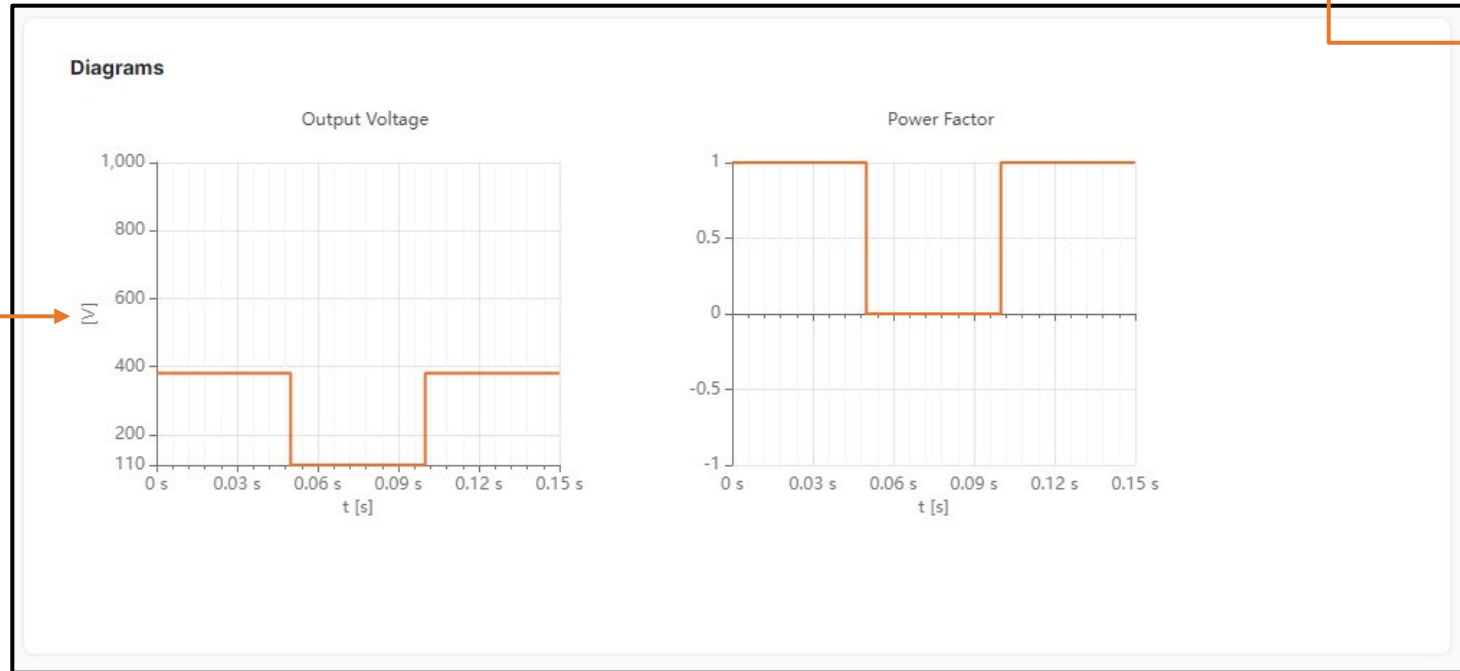
Enable stepped changes

Linear ramping when stepped changes not enabled

Add or subtract time intervals

Mission Profile

Time [s]	Output Voltage [V]	Power Factor
Value * 0	Value * 380	Value * 1
Value * 0.05	Value * 110	Value * 0
Value * 0.1	Value * 380	Value * 1
Value * 0.15	Value * 380	Value * 1



Load Profile Simulation

Circuit/MissionProfile

Simulation Control

Simulate Mission Profile Hold Result

Less details

Simulation completed

System Overview

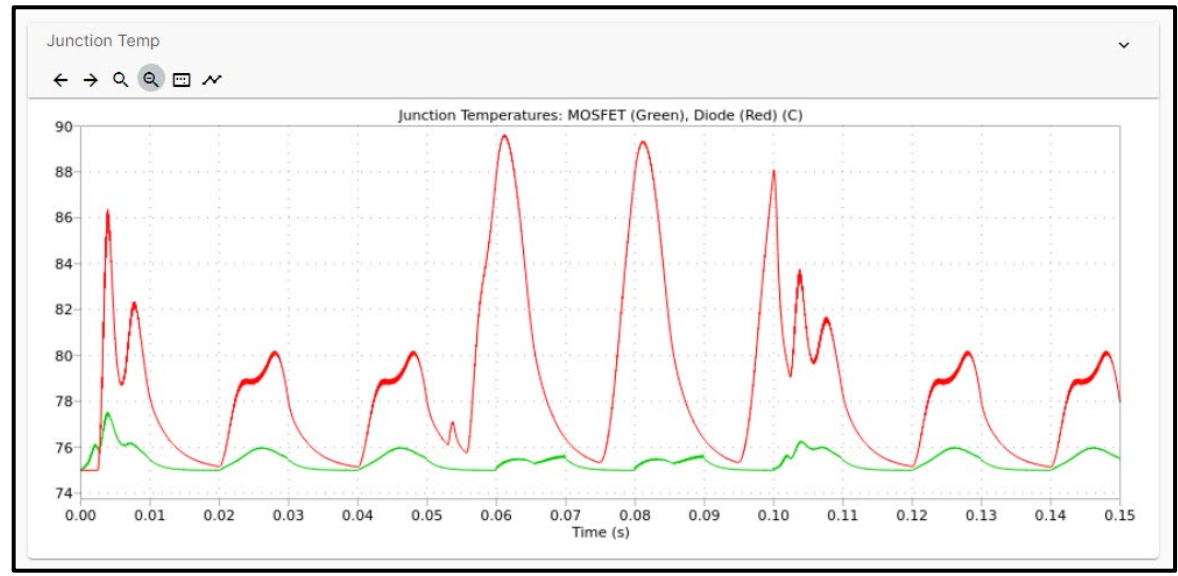
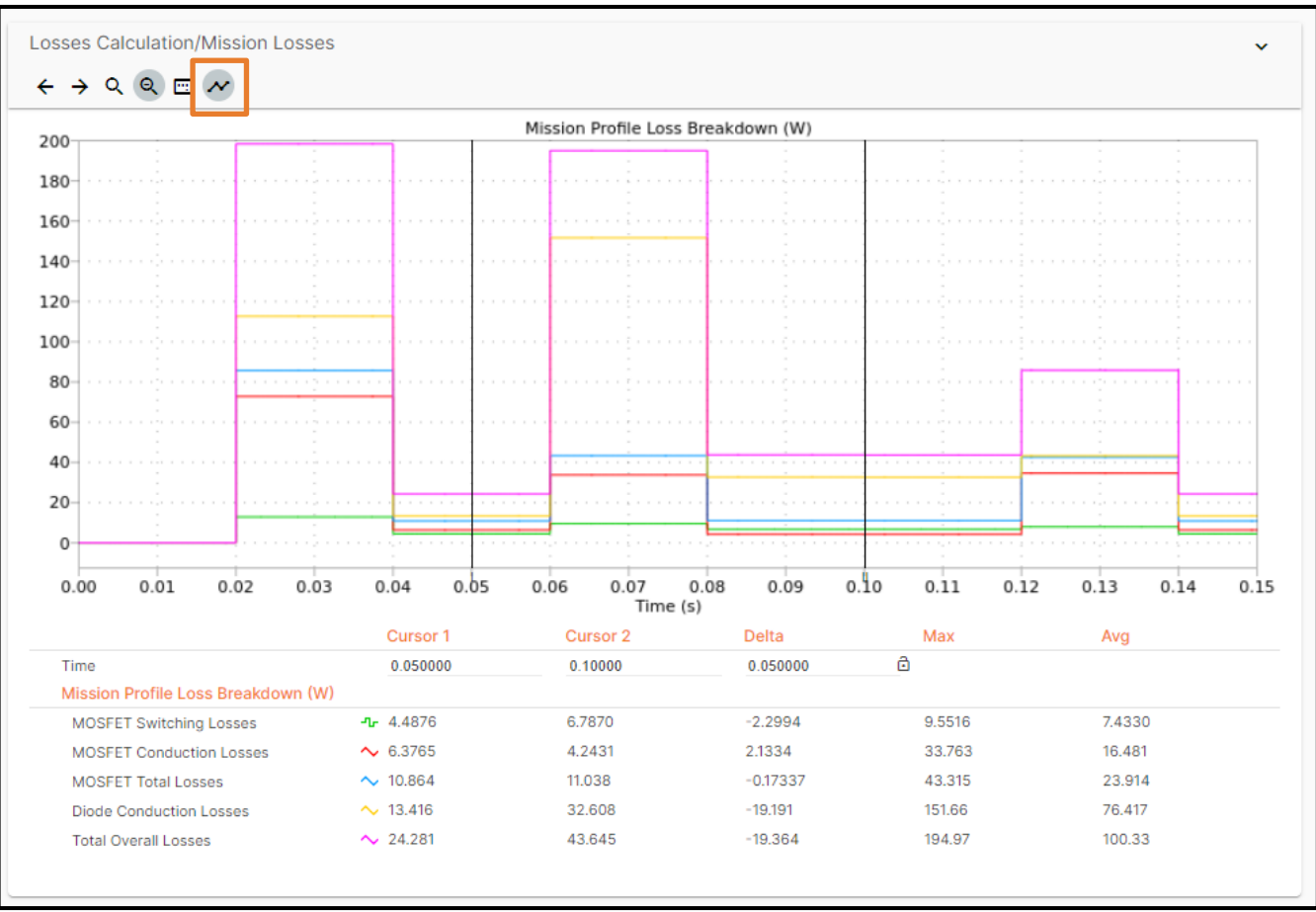
Input Voltage	Output Voltage	Power Rating	Power Factor	Load Frequency	Switching Frequency
800.0 V	380.0 V	20.00 kW	1.0	50.0 Hz	20.0 kHz

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

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

Example Load Profile Simulation Results



Junction Temperature

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

Questions?

Have questions, comments, or need support with your Elite Power Simulator needs? We're here to help! Write us an email at **elitesim@onsemi.com**.

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

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