



Vincotech

User Guide
VINcoSIM

Vincotech Simulation Environment



EMPOWERING YOUR IDEAS



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Abstract

VINcoSIM is a web-based integrated simulation environment to simulate junction temperatures and loss for Vincotech power modules. The software is designed to choose operation conditions as voltages, currents and switching frequencies to give a good fitting to the operation of the power module in real applications. All power loss and temperature calculations are based on real measurements taken of each module.

1. Limitations of Simulation

The current simulation provides only steady-state simulation results. Therefore, no dynamics like thermal capacity of the heatsink nor mission profiles are taken into consideration.

No user management is set up which means that storing and loading simulations is not possible.

2. User Interface

The VINcoSIM user interface is divided in 4 different sections:

- **The product selection** which gives information about the selected power module itself
- **The heatsink and environment setup** where heatsink temperatures and characteristics can be set
- **The simulation setup** where operation conditions can be set
- **The simulation results** which are separated in a short summary and in detailed information

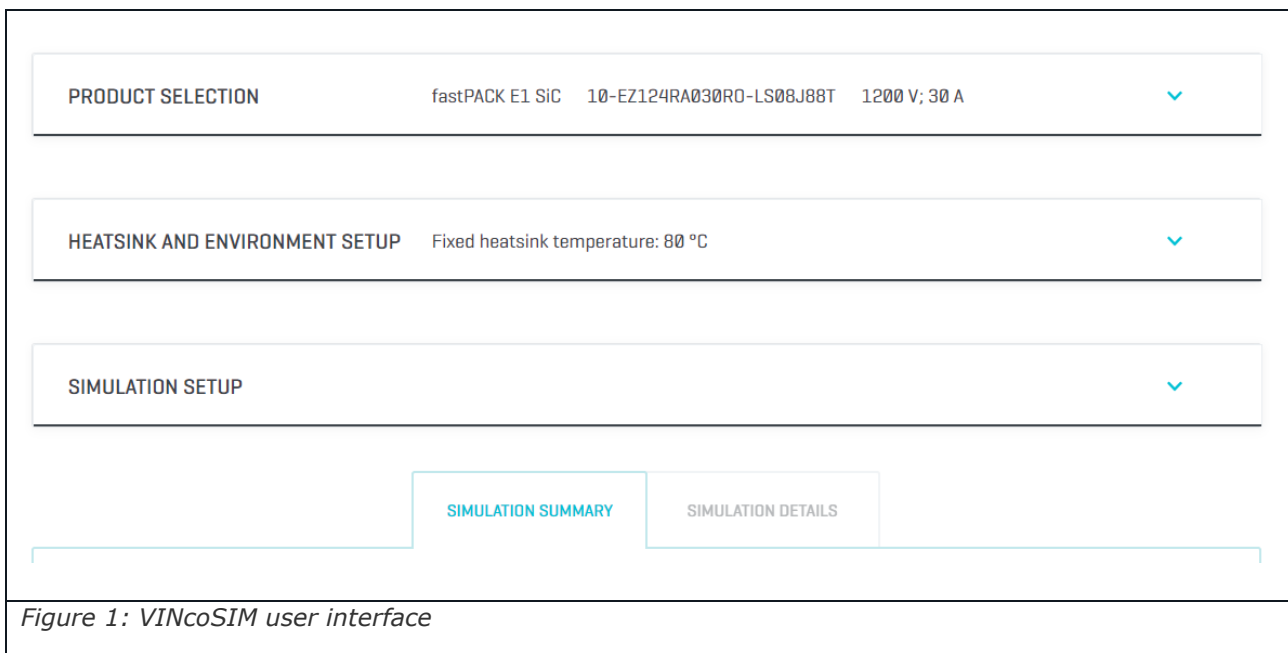


Figure 1: VINcoSIM user interface



The first three sections can be collapsed in case space is an issue or to focus on the most important information. Everything what is clickable and hold further information is marked in Vincotech blue.

2.1 Product Selection

In this section the same content for the selected module is provided similarly to the product detail page in the website. This content is just for information purpose and is not needed for the simulation per se.

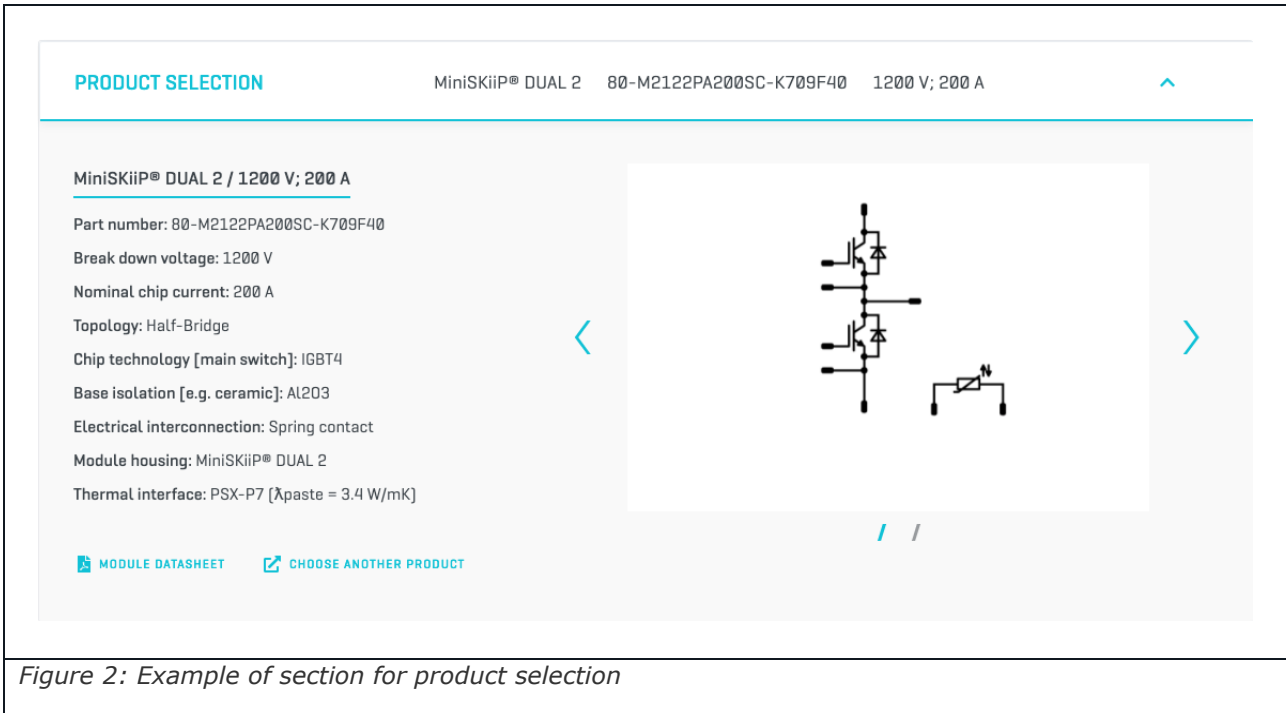


Figure 2: Example of section for product selection

A click on “Module datasheet” opens the detailed product webpage of the related product, and a click on “Choose another product” turns back to the standard website where other products can be selected for simulations.

2.2 Heatsink and Environment Setup

This section holds parameters for the heatsink temperature and/or the environment of the power module, which is needed to accurately simulate loss and junction temperatures.

The heatsink temperature is set to 80 °C as default, but can be changed from -40 °C to 150 °C with one decimal point.

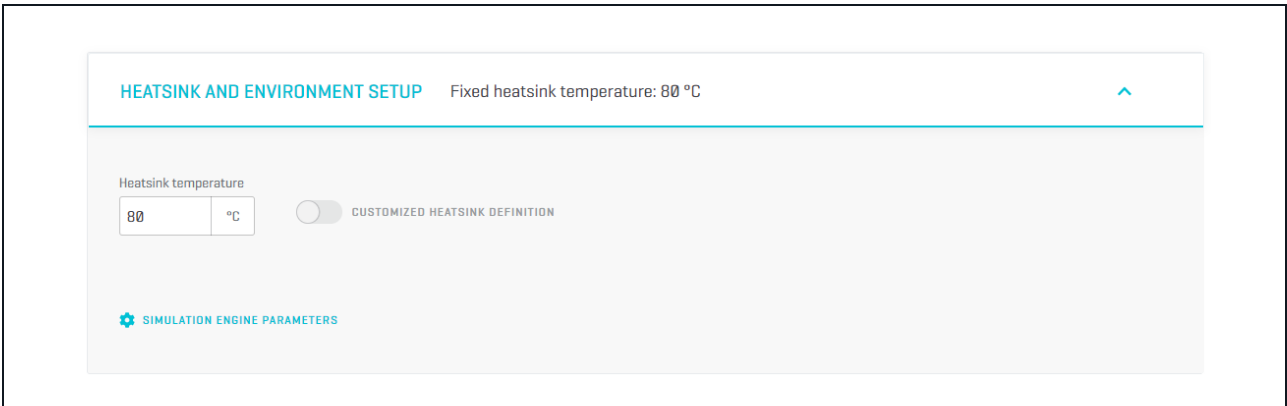


Figure 3: Heatsink setup

A click on “Customized heatsink definition” provides another option to provide information for the thermal simulation. In this case an ambient temperature has to be set and the characteristics of the heatsink has to be known.

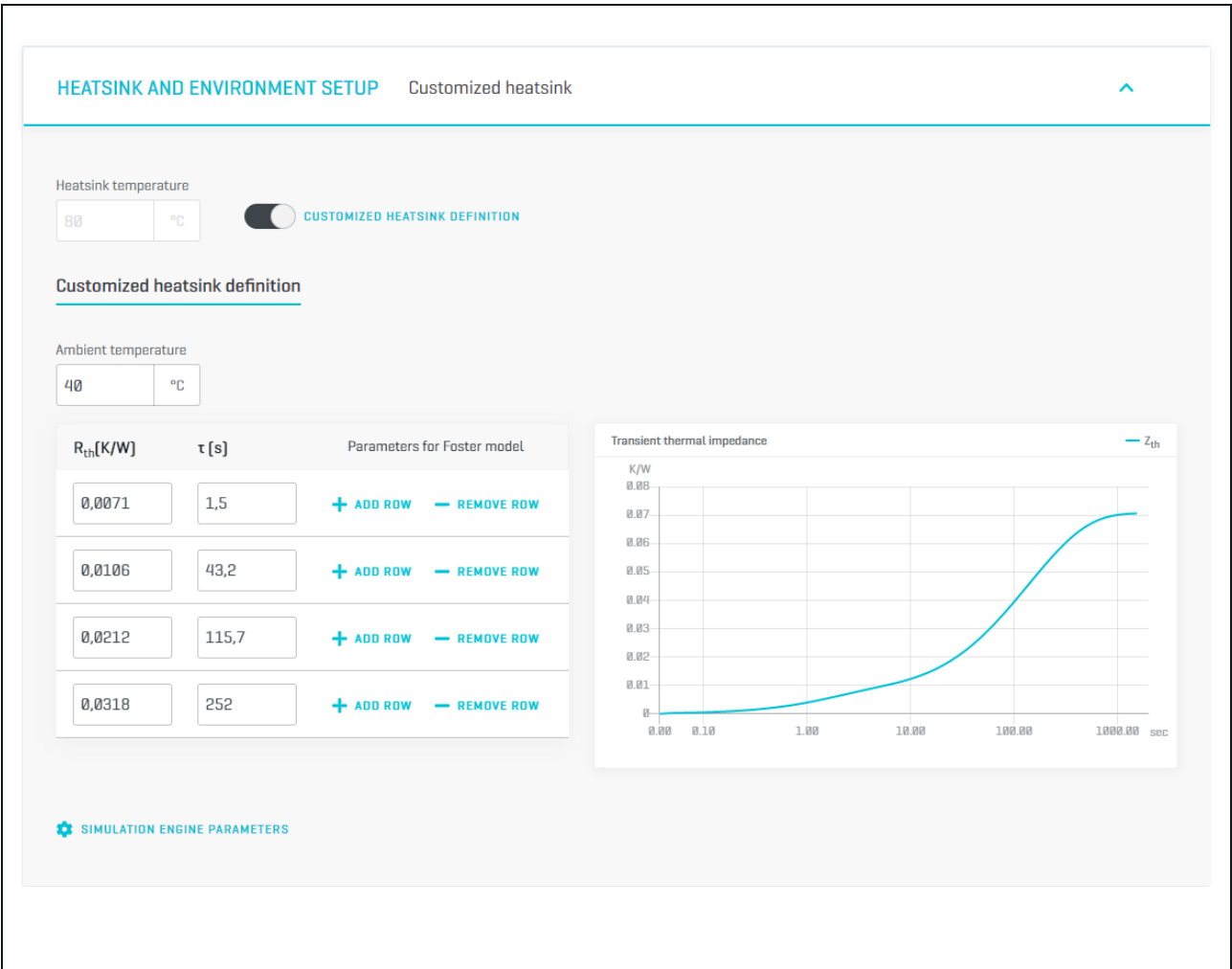
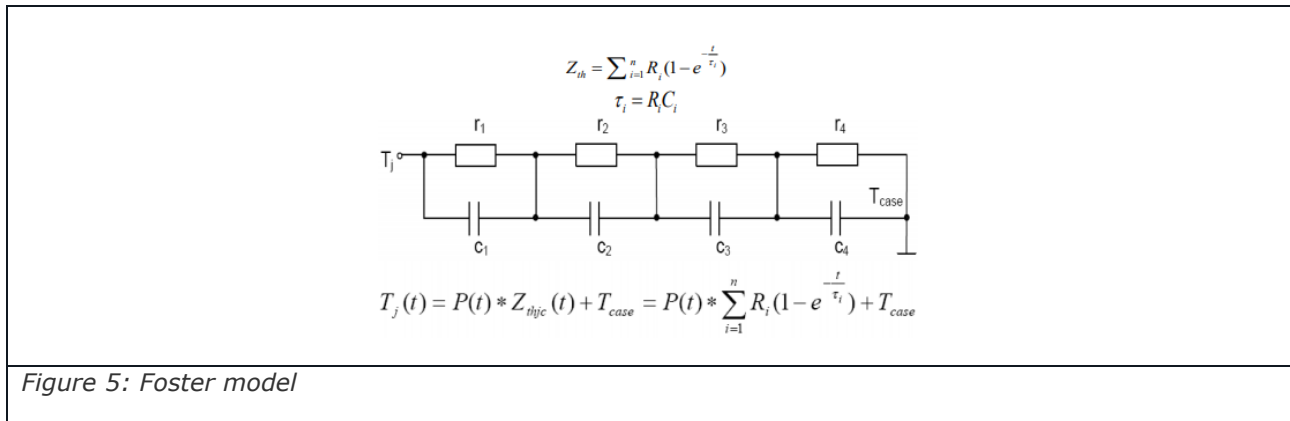


Figure 4: Environmental setup and characteristics for the heatsink

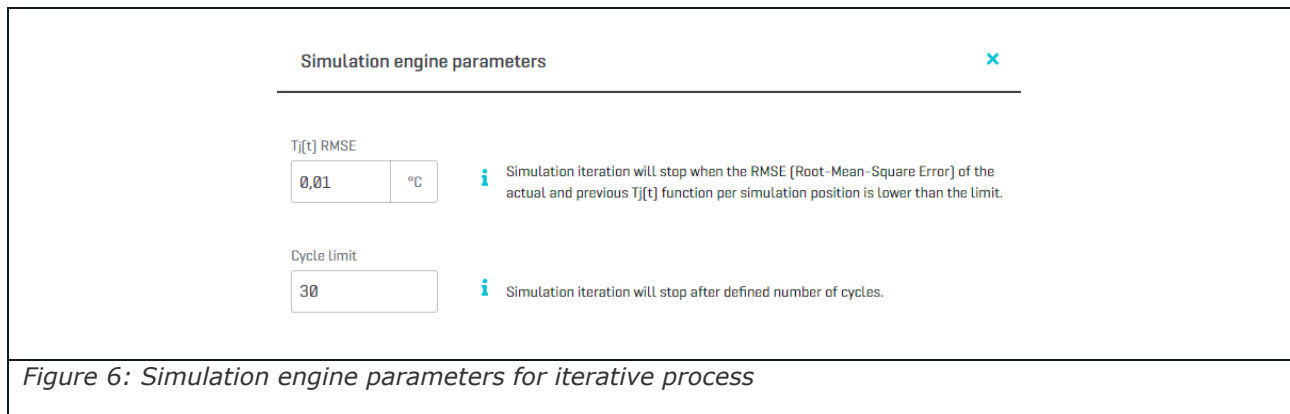


On the left hand side R and Tau pairs are used in a foster model to build up a transient thermal impedance curve, which is shown on the right hand side. Valid R values are between 0.00001 K/W and 1000 K/W with five decimal points, and Tau values are between 0.1 s and 1000 s with one decimal point.



The number of pairs is limited to maximum five and minimum one. A new row can be added by clicking "Add row" button. In this case a new row will be created below with default values of 0.00001 for R in K/W and 0.1 s for Tau . Accordingly a click on "Remove row" deletes the selected row.

A click on "Simulation engine parameters" opens a side window where two parameters can be changed. As the simulation software does an iterative process until the junction temperature gets stable, the error in junction temperature is one parameter and the number of cycles the second.



The simulation can provide results faster, if the error limit or the cycle limit is large. Otherwise the results will be more accurate, but requires more computational resource in order to obtain the steady-state.



2.2.1 RMSE Calculation

In the simulation core a so-called RMS Error is calculated: it determines the number of performed iterations until the system reaches the steady-state. This error is calculated for each and every device in the product, and the simulation stops when all semiconductor devices reach steady-state.

$$T_j(t)RMSE = \frac{RMS(T_{i-1}(t) - T_i(t))}{RMS(T_{i-1}(t))} \quad \text{Eq. 1}$$

where $T_{i-1}(t)$ is the junction temperature time-function for the device in the previous iteration step and $T_i(t)$ is the junction temperature time-function for the device in the actual iteration step.

2.3 Simulation Setup

The simulation setup is the most important section in which all application conditions can be set and modified for the final simulation.

The setup shows the module topology in separated elements. If a module has three elements like in a CIB module - converter, inverter and brake - the elements are shown in individual setup areas. In the terminology of the simulation software we call these elements *stages*.

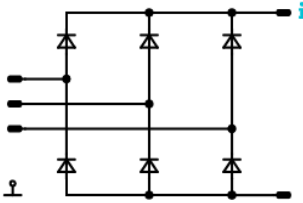
The most important is to note that the separated stages work independently from each other. Setting a higher output current does not influence the rectifier input current. This gives the advantage that some stages can be simulated with nominal condition and others over overload or worst-case conditions.



SIMULATION SETUP

To run a simulation please provide operation parameters and control parameters for all functional elements.
All fields are required.

Typical 3ph Rectifier model

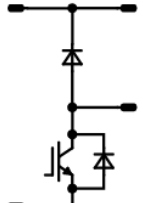


[COMPONENT CHARACTERISTICS](#)

Operation mode: RECTIFIER

Parameters		Load	
V _{ph} (RMS)	V	f _{in}	Hz
230	V	50	Hz
V _{out}	V		
300	V		

Typical Brake model



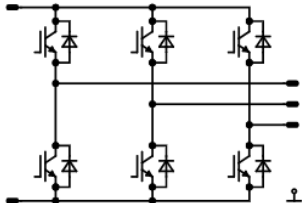
[COMPONENT CHARACTERISTICS](#)

Operation mode: **CURRENT** OFF

RESISTIVE

Parameters		Control	
V _{in}	V	V _{out}	V
800	V	400	V
I _{out}	A		
50	A		

Typical Sixpack model



[COMPONENT CHARACTERISTICS](#)

Operation mode: INVERTER

Parameters		Control	
V _{DC}	V	V _{ph} (RMS)	V
800	V	230	V
I _{ph} (RMS)	A	CosΦ	
50	A	0,8	
f _{out}	Hz		
50	Hz		

Figure 7: Separated stages for different module elements



2.3.1 Schematic

Starting from the top of the setup section, a schematic is shown for each module stage. A small info button indicates that more information is available. At this point a window opens with details about the parameters fields, e.g. where the input and output voltages are referenced to.

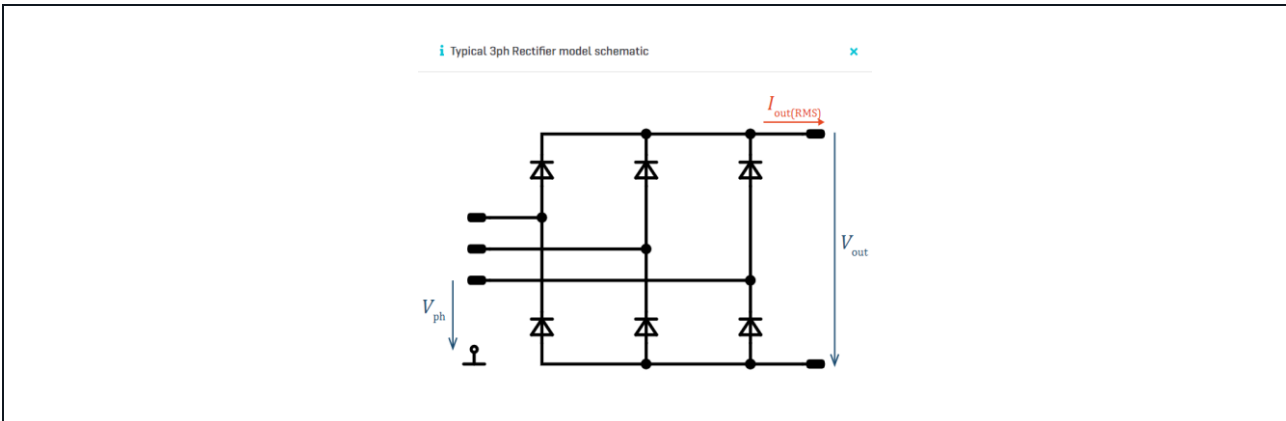


Figure 8: Example of schematic with voltage and current references

2.3.2 Component Characteristics

Component characteristics can be opened below each schematic. In this new opened side window information and performances of used components can be found. All values are 1 to 1 (similarly to the module's datasheet) and coming directly from module measurements. Electrical details are about static and dynamic behavior. Furthermore, the dynamic characteristics are separated into on, off and recovery, if available for that component. Thermal characteristics are about R_{th} in K/W and Z_{th} .

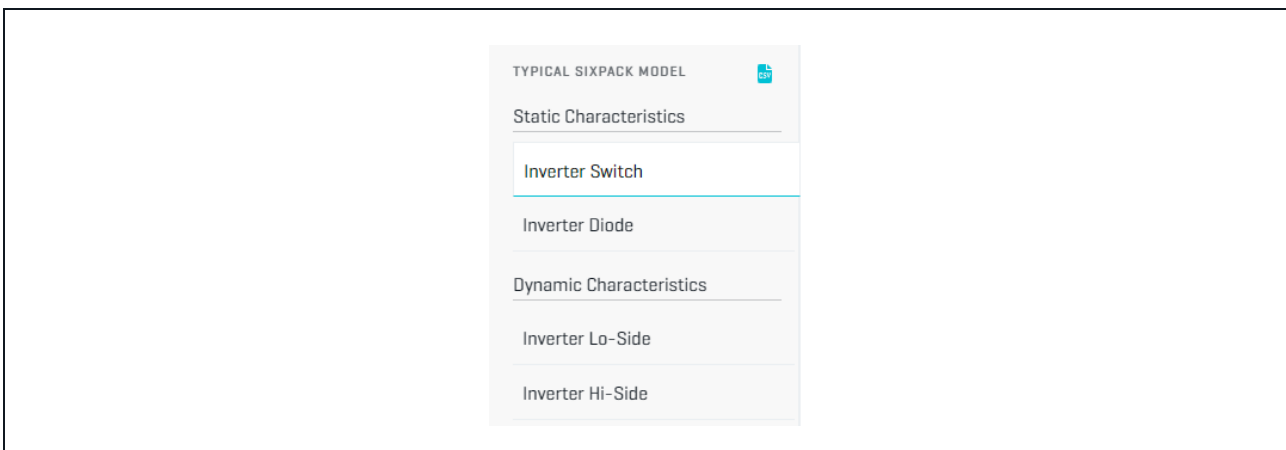


Figure 9: Component characteristics window – Top left

The component of interest can be chosen from the top left area. The static characteristics are separated for the switch and the diode. These values are not measured values, but values coming from the bare die datasheet.

Dynamic characteristics are measured characteristics under different conditions such as voltage, current, temperature, gate resistor and gate voltage. It can be that dynamics are



different for low side and high side switches in case different components, or different operation modes require to distinguish high and low sides.

All diagrams offer the possibility to hover over with the mouse and get exact values displayed.

By clicking on the top left icon, the complete characteristics package for the selected model part can be downloaded in CSV (comma-separated value) format. The downloaded package can be imported in Excel directly.

2.3.2.1 Static Characteristics

Usually three different curves, sometimes two, are shown in the static characteristics with room temperature, maximum operation temperature and 25 K less. Below the static diagram, maximum component ratings are shown.

The thermal characteristics is given with different duty cycles from single pulse with a duty cycle of 0 to 50 % duty cycle. The R_{th} in K/W for that component, as well as the pairs for the foster model, are given below the diagram.

By clicking on the top right icon, the static and thermal characteristics for the selected component can be downloaded in CSV (comma-separated value) format. The downloaded package can be imported in Excel directly.

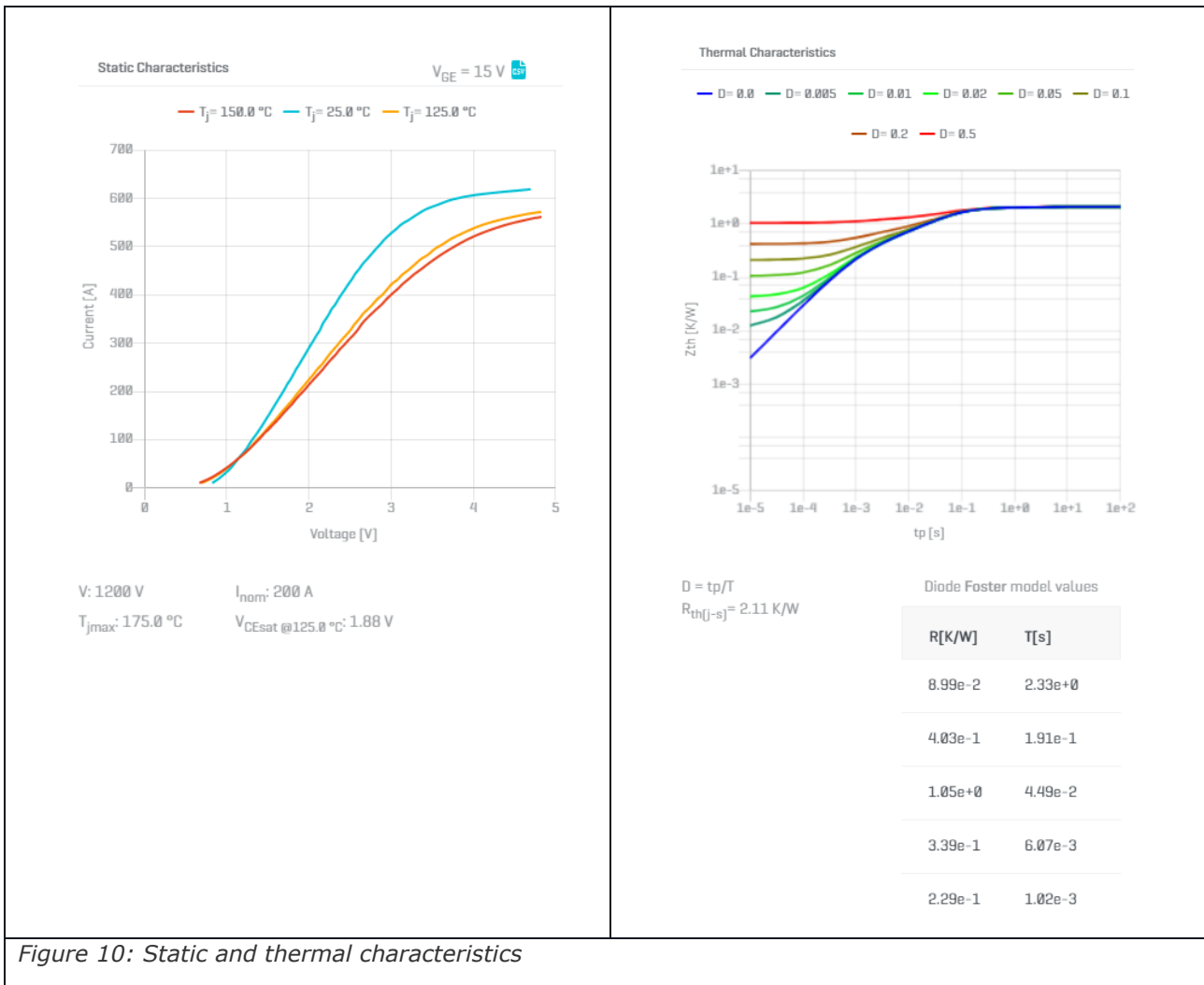


Figure 10: Static and thermal characteristics



2.3.2.2 Dynamic Characteristics

The dynamic characteristics are separated into on, off and recovery measurements, which can be selected at the very top. Here two or three different measurements on different temperatures are shown. It is always at room temperature and at maximum operation temperature. The 3D diagram can be zoomed with the mouse wheel, rotated with the left button and moved with the right button. Different options are available on the top, such as setting the diagram back to default. Below the main measurement conditions are stated.

By clicking on the top right icon, the dynamic characteristics for the selected dynamic loop can be downloaded in CSV (comma-separated value) format. The downloaded package can be imported in Excel directly.

The very bottom diagram shows a 2D diagram for better readability. Different junction temperatures can be selected with the drop down menu.

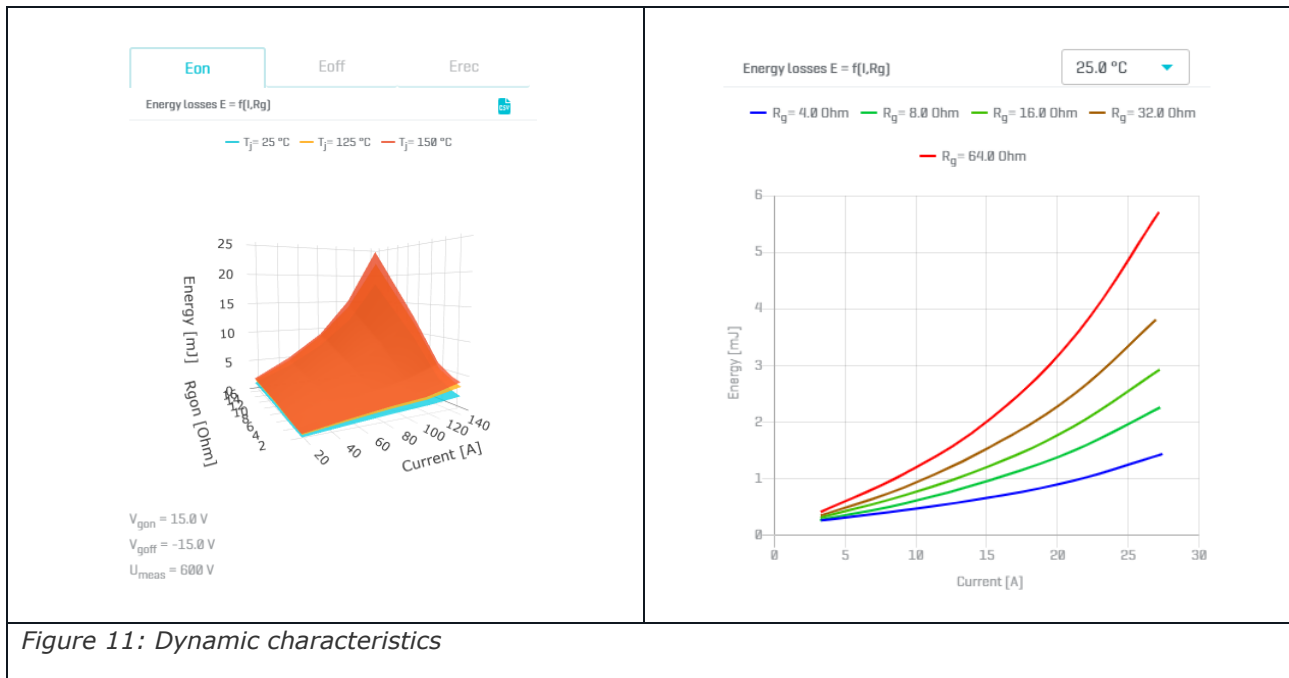


Figure 11: Dynamic characteristics

2.3.3 Operation Mode

Dependent of the functional element different operation modes are available. A standard Half-bridge, for example, can be operated as buck, boost or inverter.

The *i* button gives more information about the different operation modules.

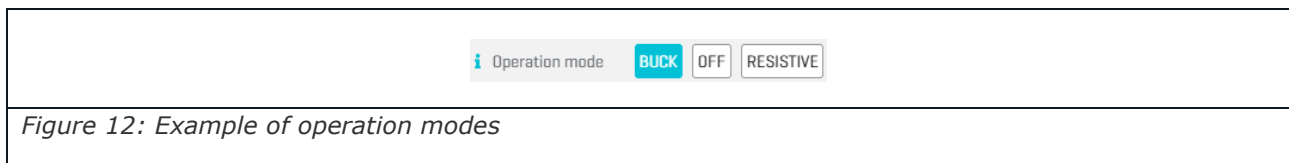


Figure 12: Example of operation modes

2.3.4 Parameters and Load/Control

The parameters area is to place application conditions like voltages and currents. These belong to the power part of the configuration.



The load or control area is about how the topology element is loaded or controlled. In case of active components this is called *Control*, and with passive components instead it is called *Load*.

As an example a usual rectifier diode has an input voltage and an input frequency as a parameter, and an output power and output voltage as a load. The output voltage is the DC-link voltage in that case. Therefore, it is important to check for the output voltage as it is not automatically the square root two value of the input voltage.

<p>Parameters</p> <p>V_{ph}(RMS) <input type="text" value="230"/> V</p> <p>f_{in} <input type="text" value="50"/> Hz</p>	<p>Load</p> <p>Load type <input type="text" value="Inf. Capac."/> <i>i</i></p> <p>P_{out} <input type="text" value="1"/> kW</p> <p>V_{out} <input type="text" value="300"/> V</p>
---	--

Figure 13: Application parameters and load conditions for a rectifier

As an example an inverter has the DC-link voltage as an input parameter as well as the motor operating conditions. The control is everything what the gate is fed: the switching frequency, gate resistor and the modulation method. As a help for the easier configuration, in the Gate drive circuit dropdown we have inserted a set to all function. With this opportunity the gate resistor settings can be set for each loop.

<p>Parameters</p> <p>V_{DC} <input type="text" value="800"/> V</p> <p>V_{ph}(RMS) <input type="text" value="230"/> V</p> <p>I_{ph}(RMS) <input type="text" value="50"/> A</p> <p>CosΦ <input type="text" value="0,8"/></p> <p>f_{out} <input type="text" value="50"/> Hz</p>	<p>Control</p> <p>f_{sw} <input type="text" value="8"/> kHz</p> <p>Modulation method <input type="text" value="SPWM"/> <i>i</i></p> <p>Gate drive circuit <input type="text" value="Inverter Hi-S..."/> <i>i</i></p> <p>R_{gon} <input type="text" value="16"/> Ohm</p> <p>R_{goff} <input type="text" value="16"/> Ohm</p>
---	--

Figure 14: Application parameters and operation conditions for an inverter



2.4.5 Validation

Simulation cannot be performed when validation issues are occurred. Each field has its own validation rule. Invalid fields are highlighted with a red border and a red exclamation mark. Detailed error message can be displayed by hovering on the exclamation mark. Validation errors are listed in a red box after clicking on the "Run Simulation" button.

1. Click on any of "Show" buttons on the right of the validation errors box to navigate to the invalid field.

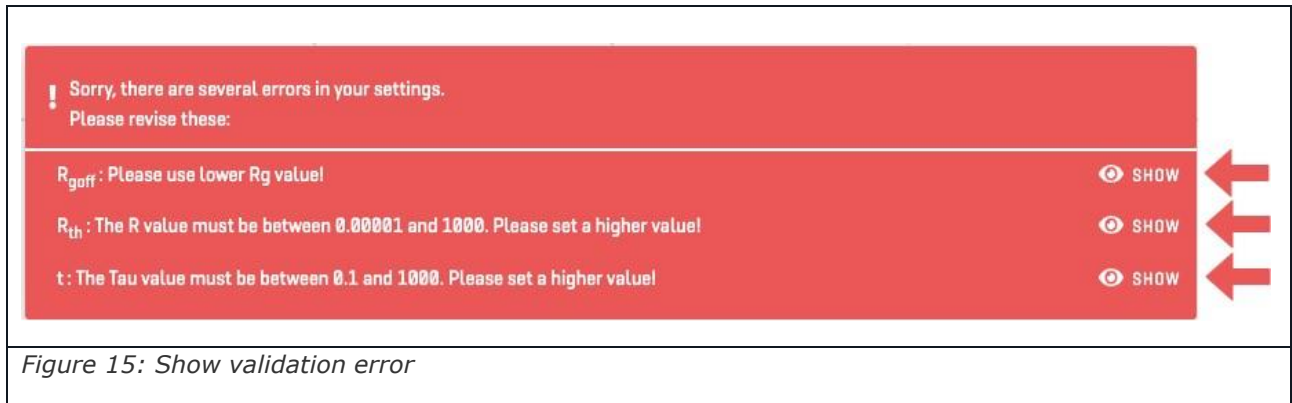


Figure 15: Show validation error

2. Investigate the invalid parameter and error message on the tooltip



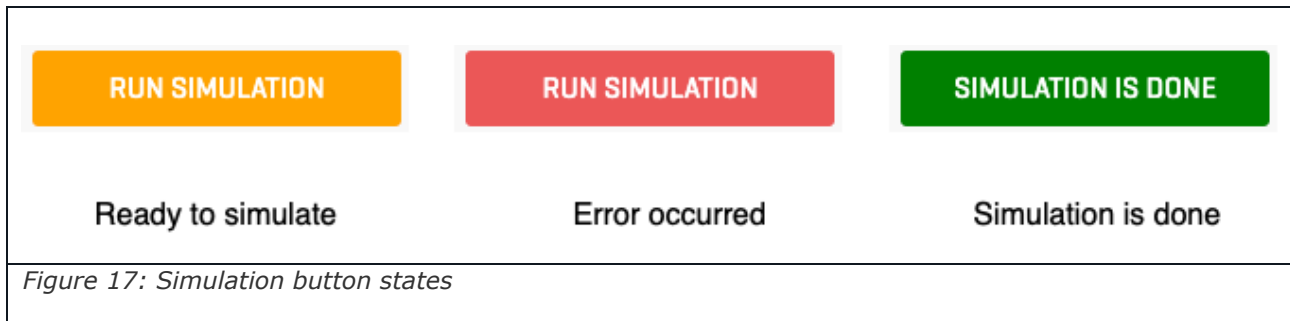
Figure 16: Invalid parameter with an error message tooltip



3. Run Simulation

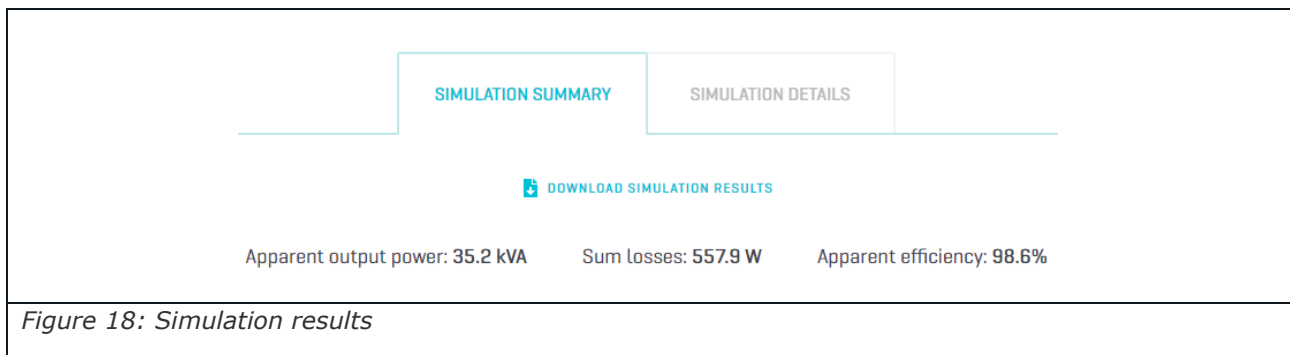
If all parameters have been changed to the application requirements, the simulation can be run.

Simulation can be started by clicking on "Run Simulation" button. The button can have three different states based on the state of application.



- Ready to simulate (orange):
Has not run any simulation yet, or the simulation configuration has been changed since the last simulation, and all parameters are valid.
- Simulation or validation error has occurred (red):
At least one parameter is invalid, or the last simulation ran into an error. All the validation errors must be fixed, before next simulation or the configuration leads to simulation errors.
- Simulation is done (green):
Simulation configuration has not changed since the last successful simulation. The represented results are related to the configuration.

The simulation results are separated in two different depth of details. In addition, a report with the same content as the whole webpage with all parameters and detailed simulation results can be downloaded as a pdf document.



Finally, the apparent output power for the main stage (which is the inverter in case of a CIB module), the sum of loss for that power module, and the apparent efficiency are shown.



Depending on how many information pieces is requested, the simulation results can be switched from the summary to details, or vice versa. Changing parameters in the simulation setup and running simulations will not change the view of simulation results.

3.1 Simulation Core

For loss calculation the simulation software is using a temperate-feedbacked calculation and simulates the temperature dependent on the loss time-function for each semiconductor devices in the power module.

The basic is a topology model, which describes in the given topology how the semiconductor device positions are working and when in the period. In one time period the algorithm steps through the calculated excitation current and voltage waveforms point-by-point and calculates the losses and the temperature in every point. The time steps dt between points in the excitation waveforms are defined by the lowest Tau value in the module's thermal characteristics. In a special case this dt is $\frac{1}{f_{sw}*2}$.

The initial condition of the simulation is an average loss and temperature calculation using the 125 °C or 150 °C static and dynamic characteristics. This point is the initial point for all calculations, which means that the semiconductor characteristics are interpolated according to the calculated junction temperature. The calculation for the next point will be performed on that interpolated temperature. This is executed until the end of the period. At the end of the period an RMS Error is calculated, which determines the number of iterations.

3.1.1 Inter- and Extrapolation

The goal of this step is to determine, whether the dynamic characteristics with the requested parameters (I_d / A , $T / °C$, R_g / Ω) are derivable from the existing ones using interpolation and/or extrapolation operations. During the complete algorithm this operation is performed at every point, because the engine is re-calculating the characteristics on the previously resulted temperature value. Actually the general linear equation is used for extra- and interpolation:

$$y_n = y_1 + (p_n - p_1) * \frac{y_2 - y_1}{p_2 - p_1} \quad \text{Eq. 2}$$

where $y_1 = f_1(x)$, $y_2 = f_2(x)$ $y_n = f_{calc}(x)$, p_1 is the selected parameter's value from f_1 , p_2 is the selected parameter's value from f_2 . p_n is the new value of the selected parameter for which f_{calc} is calculated.



3.1.2 Temperature Feedback Equation

The main logic of the simulation is the temperature feedback, for which the simulator uses a basic differential equation and solving it with Euler formula:

$$\frac{\Delta T_m(t)}{dt} = \frac{[(P(t, T) * R_m) - \Delta T_{m_{i-1}}(t)]}{\tau_m} \quad \text{Eq. 3}$$

where $\Delta T_m(t)$ is the temperature difference of one R- Tau pair in the device's thermal characteristics at the actual iteration, $P(t, T)$ is the total loss in W, R_m is the m-th R value in the device's thermal characteristics in [K/W], τ_m is the m-th Tau value in the device's thermal characteristics in s, and $\Delta T_{m_{i-1}}(t)$ is the temperature difference for one R- Tau pair in the device's thermal characteristics at the previous iteration in [K]. This means every temperature difference for each R- Tau pair, the core will be calculated and the total summation of these functions results the $T_j(t)$ temperature function for a semiconductor device.

3.1.3 Static Loss Equation

The static loss of a semiconductor device is calculated as the followings:

$$P_{st}(t, T) = I_d(t, T) * U_d(t, T) * D_d(t) \quad \text{Eq. 4}$$

where $I_d(t, T)$ is the device current in the period in A, $U_d(t, T)$ is the device voltage generated by the current using the measured static characteristics in V, $D_d(t)$ is the duty cycle (conduction) of the device.

3.1.4 Dynamic Loss Equation

The static loss of a semiconductor device is calculated as the following. Depending on a switch- or a diode-like behavior, the equation contains E_{on} , E_{off} or E_{rec} :

$$P_{sw_switch}(t, T) = (E_{on}(I_d, T, R_g) + E_{off}(I_d, T, R_g)) * f_{sw} * \left(\frac{V_{sw} * D_{switching}}{V_{meas}} \right) \quad \text{Eq. 5}$$

$$P_{sw_diode}(t) = (E_{rec}(I_d, T, R_g)) * f_{sw} * \left(\frac{V_{sw} * D_{switching}}{V_{meas}} \right) \quad \text{Eq. 6}$$

where $E_{on}(I_d, T, R_g)$, $E_{off}(I_d, T, R_g)$ and $E_{rec}(I_d, T, R_g)$ are the measured losses from a double-pulse test with defined parameters in mJ, f_{sw} is the switching frequency in kHz, V_{sw} is the switched voltage equation based on the topology model in V, $D_{switching}$ is the switching notation in the topology model, and V_{meas} is the measured switched voltage during the double-pulse test in V.

3.1.5 Apparent Output Power Equation

The apparent output power is depending on the topology model. For every topology a certain equation is defined which is calculated in run-time. The system selects always the last stage for calculation. But generally it can be stated that the one phase/leg values are used for calculation



mainly without taking into consideration the phase shift. For multi-phase or multi-leg modules the power for one stage is multiplied by the number of legs/phases.

3.1.6 Efficiency Equation

The following equation determines the efficiency of the power module. Because the module parts (topology stages) are simulated independently, the input and output powers have to be considered regarding the energy flow.

$$\eta[\%] = \left(\frac{S_{out}}{S_{out} + P_{total}} * \right) 100 \tag{Eq. 7}$$

Where S_{out} is the output apparent power of a certain stage; P_{total} is the total loss on a certain stage. If the power module has multiple stages, the main "Apparent output power" is the S_{out} of the last stage, "Sum losses" is the sum of the stage losses and "Apparent efficiency" is calculated by Eq. 7. using S_{out} of the last stage and the sum of the stage losses as P_{total} .

In case of split topologies, where the different parts are in different products, the system will take into account the application output power and the efficiency will be calculated based on this. This means the split module's loss will be duplicated to get an application efficiency.

3.1.7 Multi-phase or Multi-leg Simulation

If the power has multiple phases or legs, the model separates in the background the phases and legs. If the semiconductor device is phase shifted, then the loss values are copied and shifted with phase shift time from the base position. The phase shift time is defined in the topology model. During heatsink simulation the multiphase solution works the same.

4. Simulation Summary

The simulation summary shows the most important results such as loss, junction temperature and efficiency for each stage.

Typical 3ph Rectifier model			Typical Brake model			Typical Sixpack model		
Component	Σ Loss	T _{j avg.}	Component	Σ Loss	T _{j avg.}	Component	Σ Loss	T _{j avg.}
Rectifier Diode	28.3 W	83.2 °C	Brake Diode	14.9 W	100.7 °C	Inverter Diode	76.9 W	92.2 °C
			Brake Switch	32.5 W	103.9 °C	Inverter Switch	430.2 W	122.9 °C
Stage loss	Efficiency		Stage loss	Efficiency		Stage loss	Efficiency	
28.3 W	99.4%		47.4 W	98.8%		507.1 W	98.7%	

Figure 19: Simulation summary

The above example in *Figure 19* shows simulation results for a CIB module.



The rectifier in this case is only based on rectifier diodes. Therefore, only total loss for the rectifier diode bridge is displayed together with an average junction temperature and efficiency of that stage.

The brake leg has two components involved. Therefore, the stage loss and efficiency is shown at the bottom, and brake diode and brake switch loss are separated above.

The same is valid for the inverter stage. Total stage loss and efficiency are shown at the bottom. Separated loss for the inverter diode and IGBT together with the corresponding average junction temperature are above.

5. Simulation Details

All simulation results, which were shown within the simulation summary, are also available in simulation details. Furthermore, some information of high value are displayed as well.

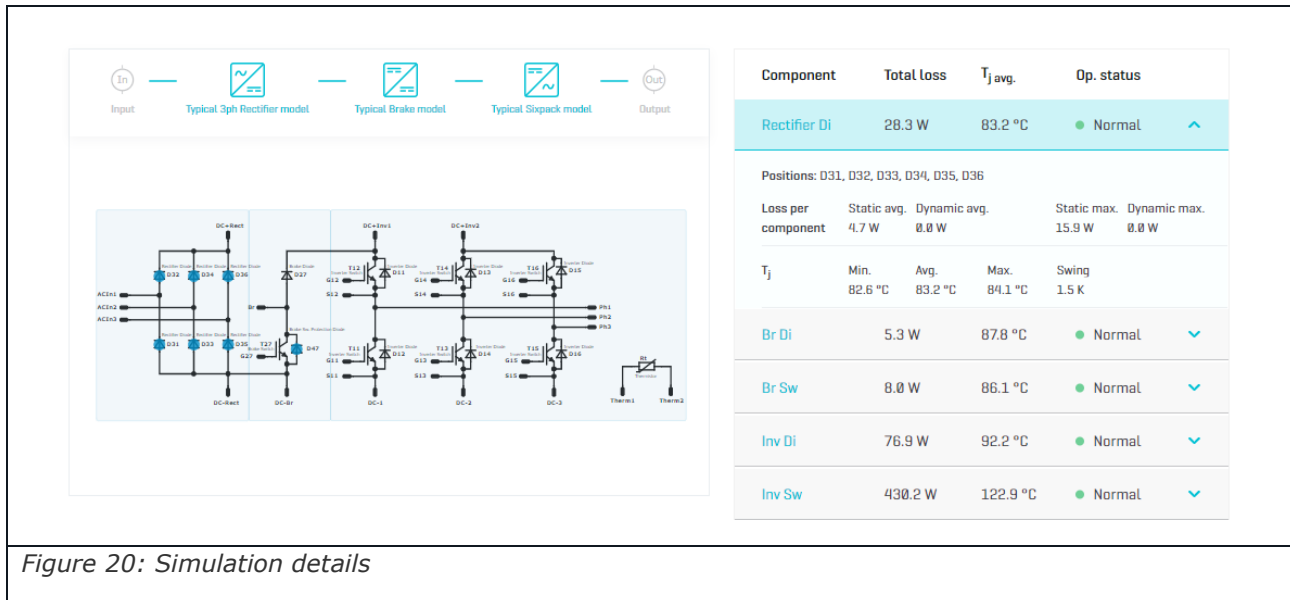


Figure 20: Simulation details

The left area shows the power chain and the power module topology with component designators. The blue marked boxes can be enabled and disabled in case not all stages are of interest. In this case the grey background in the schematic stages appears and or disappears in order to indicate active and inactive stages. The right hand area will also change accordingly, and rows will be hide or shown.

Some components in the schematic have a blue dot by default. These are the components that are not considered for the simulation nor for any results.

A click on the considered components indicates the click with a blue dot. The background color of the header on the table on right will change into blue and enrolls the simulation details for components used in that sub topology. With clicks a toggle can be managed for collapsing or enrolling other simulation details.

The table on the right hand side holds total subtopology loss and the highest junction temperate in the header. A click on "Component" changes the background color in the header to blue and sets a blue dot in the left schematic to indicate all components that are used in this

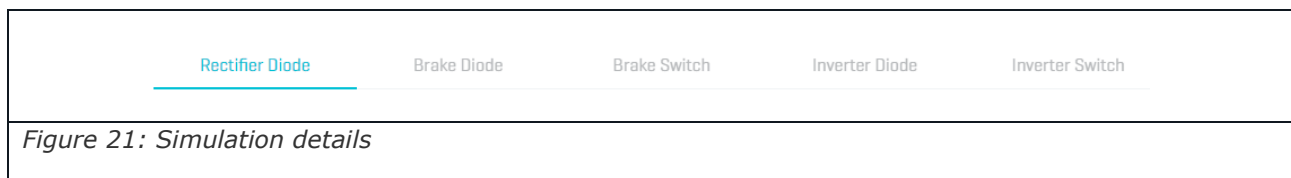


particular subtopology. An additional click removes the header color as well as the dot indication from the schematic.

Clicking the blue arrow on the very right side enrolls the subtopology and shows additional simulation results belonging to components. These are separated into loss per component and junction related temperatures. The component loss itself is divided into static and dynamic loss for average and maximum. Temperatures are given for minimum, average and maximum, and additionally for the temperature swing.

6. Switching / Loss Diagrams

These diagrams work independently from the previously mentioned power chain blocks. Therefore, enabling or disabling blocks does not affect the number stages and diagrams.



Each subtopology has its own set of diagrams. All diagrams support the hover function with which precise values are displayed above the mouse pointer.

6.1 Component Performance Curves

The first four diagrams represent the component performance.

Here the top left diagrams show total, static and dynamic loss as a function of time. The junction temperature as a function of time is shown in the top right diagram. Additionally to that, the maximum junction temperature is indicated with a red dot.

The next diagrams show the device voltage and current as a function of time. Here the device on voltage is displayed in relation to the current that flows through that device.

The device current duty cycle shows the ratio of output voltage to input voltage for that component relative to the time.



Inverter Diode

Inverter Switch

Component performance

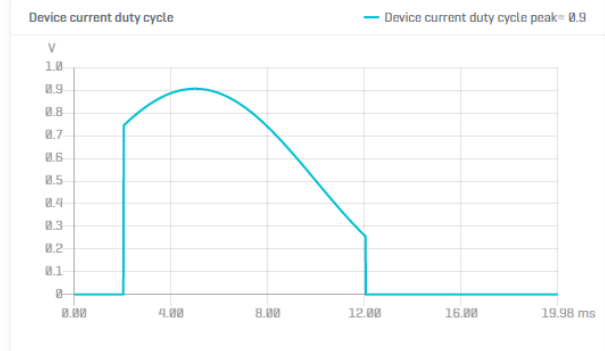
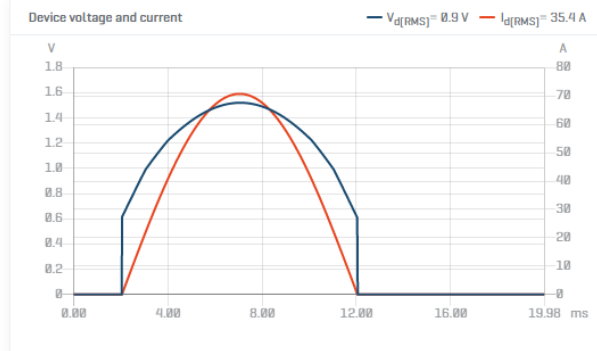
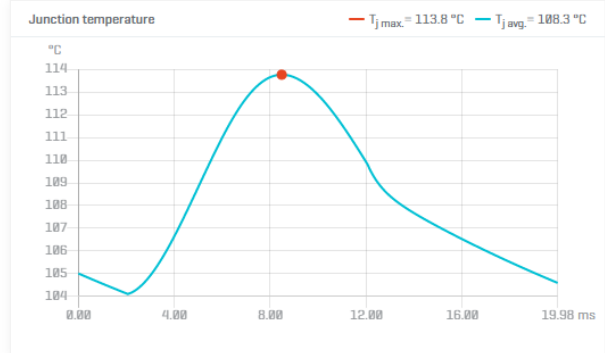
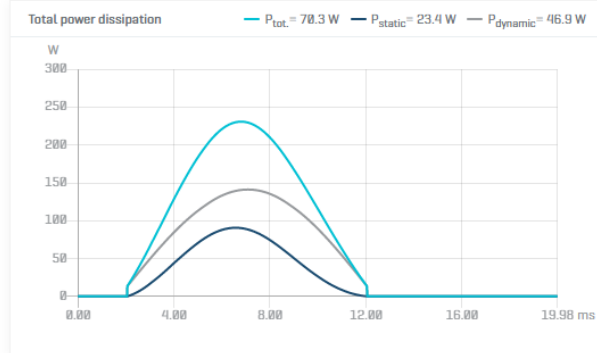
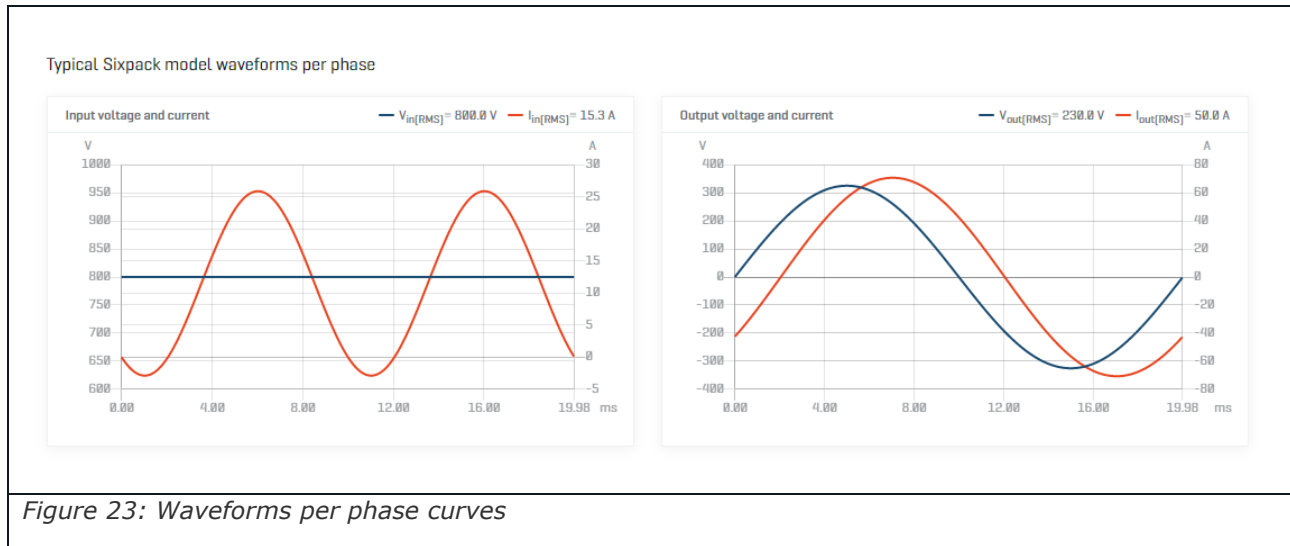


Figure 22: Component performance curves



6.2 Waveforms per Phase Curves

The last two diagrams show voltage and current for the selected component. The first one shows the input voltage and the input current as a function of time. The second diagram shows the same for the output of that component.



7. Error Messages and Notifications

The simulation software provides information for the user about issues. It can be split into two groups. *Warnings* are indicated with orange background. With warning the simulation can be performed, but caution must be exercised. In case of *errors* a red message appears. Error messages can appear before or during simulation depending on the source of it. However, in this case the simulation cannot provide good results.

The following error messages can appear:

- **Sorry, an error occurred. Please try again later.**
Cause: Unknown or unexpected error occurred.
Example: HTTP request failed, Not well-formed HTTP response.
- **Sorry, an error occurred during PDF report generation. Please try it later.**
Cause: PDD generator is unreachable or cannot generate a pdf report.
- **Internal server error.**
Cause: Unexpected or non-user-visible server error.
- **Bad request.**
Cause: Request body is not well-formed, or some parameters are invalid.
Example: Missing part number.



- **Cannot load characteristics data.**
Cause: Database is unreachable, or some characteristics are missing.
- **Parameter validation violation: $V_{out} > V_{in}$.**
Cause: Functional topology level validation errors occurred.
Note: $V_{out} > V_{in}$ is only an example, it could be different!
- **The junction temperature of at least one component exceeds the specified value in the datasheet!**
Cause: The system can calculate the simulation results, but some components are not able to perform continuous work with the selected parameters.
- **Product instance descriptor cannot be null!**
Cause: The selected part number cannot not found in the database.
- **Cannot calculate static loss because of load current is out of range for 1st stage. The maximum allowed peak currents are 25.0 °C - 758.9 A, 125.0 °C - 576.1 A, 150.0 °C - 577.3 A. Please adjust the load accordingly!**
Cause: Over-current during P_{St} calculation in the 1st functional topology.
Note: The 1st stage value is only an example. It could be 2nd stage or 3rd stage also!
Note: The temperature and current values (25.0 °C - 758.9 A) are only examples. These values could be different!
- **Cannot calculate static loss because of load current is out of range for 1st stage. The maximum allowed peak currents are 25.0 °C - 758.9 A, 125.0 °C - 576.1 A, 150.0 °C - 577.3 A. Please adjust the load accordingly! (Initialization time)**
Cause: Over-current during Device Voltage calculation in the 1st functional topology.
Note: The 1st stage value is only an example. It could be 2nd stage or 3rd stage also!
Note: The temperature and current values (25.0 °C - 758.9 A) are only examples. These values could be different!
- **Cannot calculate dynamic loss because of load current is out of range for 1st stage. The maximum allowed peak currents are 25.0 °C - 758.9 A, 125.0 °C - 576.1 A, 150.0 °C - 577.3 A. Please adjust the load accordingly!**
Cause: Over-current during P_{sw} (E_{on} , E_{off} , E_{rec}) calculation in the 1st functional topology.
Note: The 1st stage value is only an example. It could be 2nd stage or 3rd stage also!
Note: The temperature and current values (25.0 °C - 758.9 A) are only examples. These values could be different!
- **Cannot calculate dynamic loss because of load current is out of range for 1st stage. The maximum allowed peak currents are 25.0 °C - 758.9 A, 125.0 °C - 576.1 A, 150.0 °C - 577.3 A. Please adjust the load accordingly! (Initialization time).**
Cause: Over-current during Energy function calculation
Note: The 1st stage value is only an example. It could be 2nd stage or 3rd stage also!
Note: The temperature and current values (25.0 °C - 758.9 A) are only examples. These values could be different!



- **Simulation did not converge. Please adjust the simulation engine parameters!**
Cause: Cannot converge the simulation.
- **Could not calculate sumLoss. (values diverge to infinite).**
Cause: Sum loss cannot be calculated (sum loss is not finite value).
- **Invalid simulation request: Modulation Index (MI) of the 1st stage of the product violates the range validation rule ($0.00 \leq MI \leq 1.00$; $MI = 1.8856180831641267$).**
Cause: ModulationIndex expression evaluated value is out of range (defined in Functional Topology)
Note: $MI = 1.8856180831641267$ is only an example value, it could be different!
- **Invalid simulation request: duty cycle (D) of the 1st stage of the product violates the range validation rule ($0 \leq D(t) \leq 1$; min value: -2.1, max value: 0.3) in functional topology.**
Cause: At least one of the DutyCycle function values is out of range.
Note: The 1st stage value is only an example. It could be 2nd stage or 3rd stage also!
Note: Validation rule ($0 \leq D(t) \leq 1$) is only an example. It could be different!
Note: Min (-2.1) and max (0.3) values are an example. These values could be different!
- **Characteristics cannot be estimated, simulation cannot be executed! Please adjust the Rg settings!**
Cause: The requested dynamic characteristics cannot be calculated (e.g. new curve contains negative values).
- **Simulation error: [Static loss (Pst) | Switching loss (Psw) | Junction temperature (Tj)] result contains negative values for [REF_DES]. Please adjust the parameters!**
Cause: Pst, Psw or Tj contains negative values. It is usually caused by characteristics extrapolation.



Remarks

Supported Browsers

1.1.1 Operating system	1.1.2 Browser
Windows	Google Chrome (from version 94.0.4606.81)
	Mozilla Firefox (from version 93.0)
	Edge (from version 95.0.1020.30)
macOS	Safari (from version 14.1.2)
	Google Chrome (from version 94.0.4606.81)
	Mozilla Firefox (from version 93.0)

Document Release Notes

1.1.3 Date	1.1.4 Action	1.1.5 Content
01.10.2021	Initial release of VINcoSIM User Guide	
19.10.2021	Update of Section 4.1.6. Update of Section 8. Added Chapter 9. and 10.	Introduction of updated efficiency calculation Added two error messages Added list of supported browsers Added document release notes
04.04.2022	Added new features	Downloading characteristics extension "Set to all" Rg definition



Vincotech

Thank you for your interest of Vincotech products and VINcoSIM.
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