ROHM Solution Simulator

DC/DC Converter BD9G500EFJ-LA Thermal Simulation

This document contains electrical simulations of the DC/DC converter BD9G500EFJ-LA and introduces and describes the use of a simulation environment that allows simultaneous thermal simulation of devices including Schottky Barrier Diodes (SBD: RB088BM100TL). By changing the parameters of the components, it is possible to simulate a wide range of conditions.
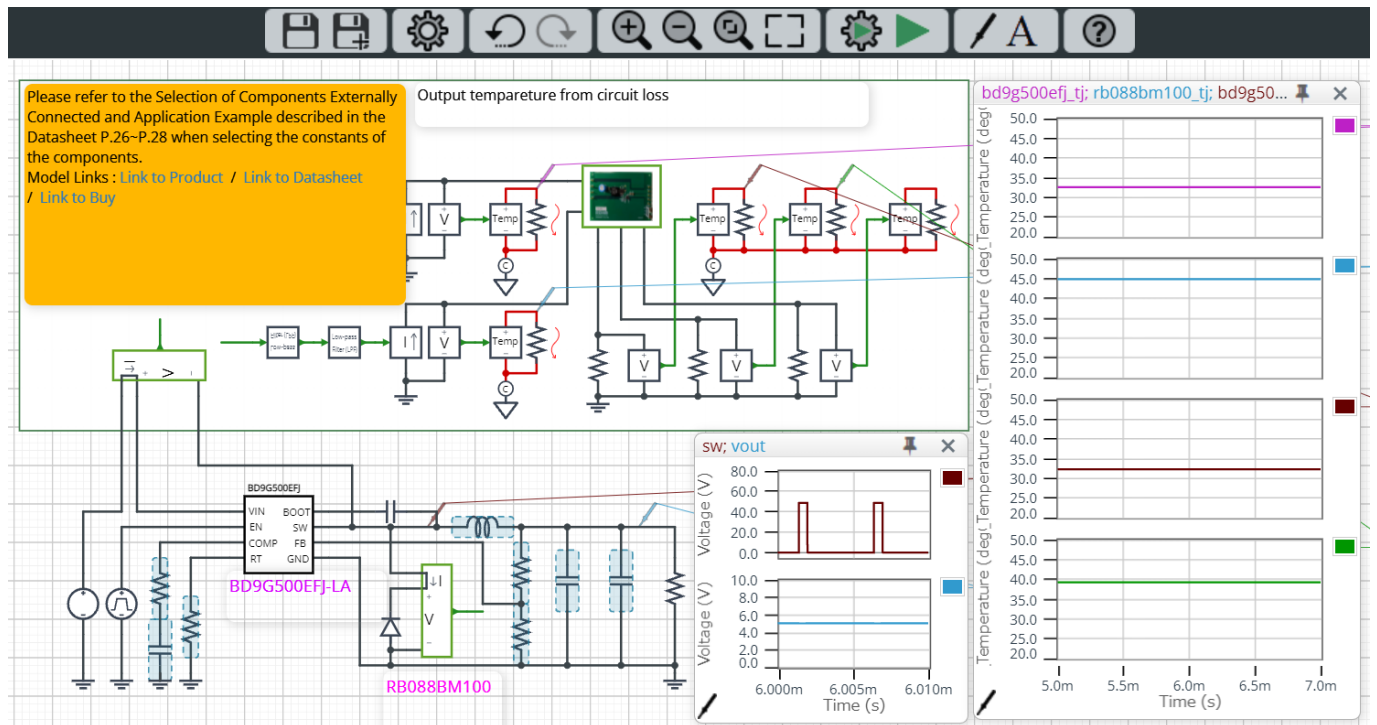
1　Simulation circuit

Figure 1. Simulation circuit (BD9G500EFJ-LA)

In Figure 1, the area within the green line shows the thermal simulation circuit and the rest of the figure shows the electrical simulation circuit.

This circuit is an application circuit based on a 1-channel buck DC/DC converter with a current output of up to 5 A using the BD9G500EFJ-LA.

The thermal simulation circuit feeds the device losses and SBD losses calculated in the electrical simulation into the thermal simulation model, and calculates the IC and SBD temperatures.

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2   Simulation method

Simulation settings such as simulation time and convergence options can be set from "Simulation Settings" shown in Figure 2, and the initial simulation settings are shown in Table 1.

If you are having problems with the convergence of the simulation, you can change the advanced options to fix the problem. The simulation temperature and various parameters of the electrical circuit are defined in "Manual Options".
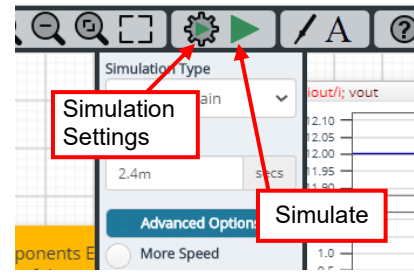

Figure 2. Simulation Settings and execution

Table 1. Initial values for Simulation Settings

Parameters	Initial values	Remarks
Simulation Type	Time-Domain	Do not change the simulation type
End time	7 msecs	
Advanced Options	More Speed	
Manual Options	.PARAM …	See Table 2 for details

3   Simulation conditions

3.1   Definition of parameters

The parameters for the components shown in blue in Figure 3 are defined in the manual options as they need to be set in the simulation conditions. Table 2 shows the initial values for each parameter. These values are written in a text box in the "Manual Options" section of the simulation settings, as shown in Figure 4.
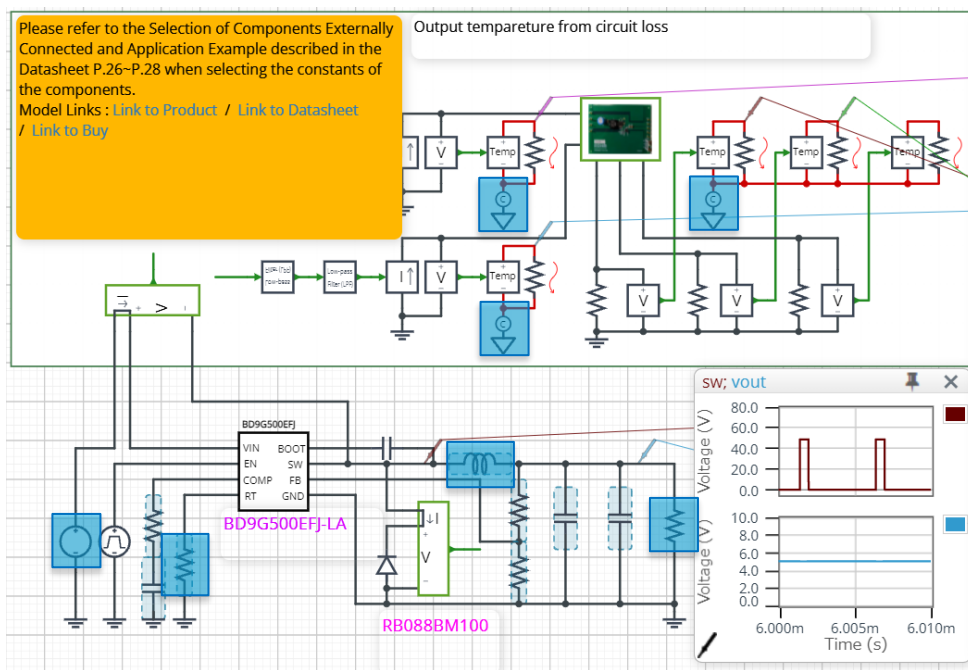

Figure 3. Definition of component parameters

Table 2. Simulation conditions

Parameters	Variable names	Initial values	Unit	Description
Temperature	Ta	25	°C	Ambient temperature
Voltage	V_VIN	48	V	Input voltage Set in the range of 7 to 76 V
Voltage	V_VOUT	5	V	Output voltage Set in the range of 1 V to (0.97 × V_VIN)
Current	I_IOUT	1	A	Output current 5 A (MAX)
Inductance	L_PRM	33	µH	Smoothing inductor
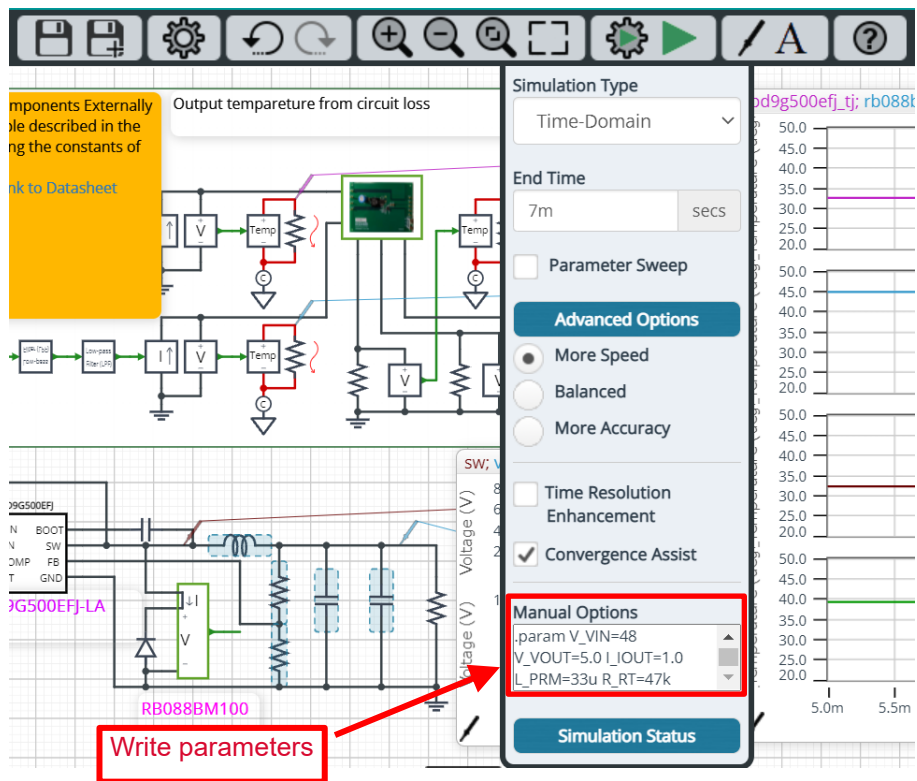
Figure 4. Definition of parameters

3.2   Setting of component constants

For the method of setting switching frequency, output LC filter constant, output voltage, etc., refer to "Selection of Components Externally" in the data sheet or the calculation sheet.

BD9G500EFJ-LA Data sheet

Calculation-Sheet For The Circuit Theoretical Formula – BD9G500EFJ-LA

3.3   Thermal circuit

The "BD9G500EFJ_LA" symbol in Figure 5 is the thermal simulation model of the BD9G500EFJ-LA. The nodes shown in red in Figure 5 can be used to check the temperature of the junction, the mold surface and the FIN surface. Detailed information for each node is shown in Table 3.
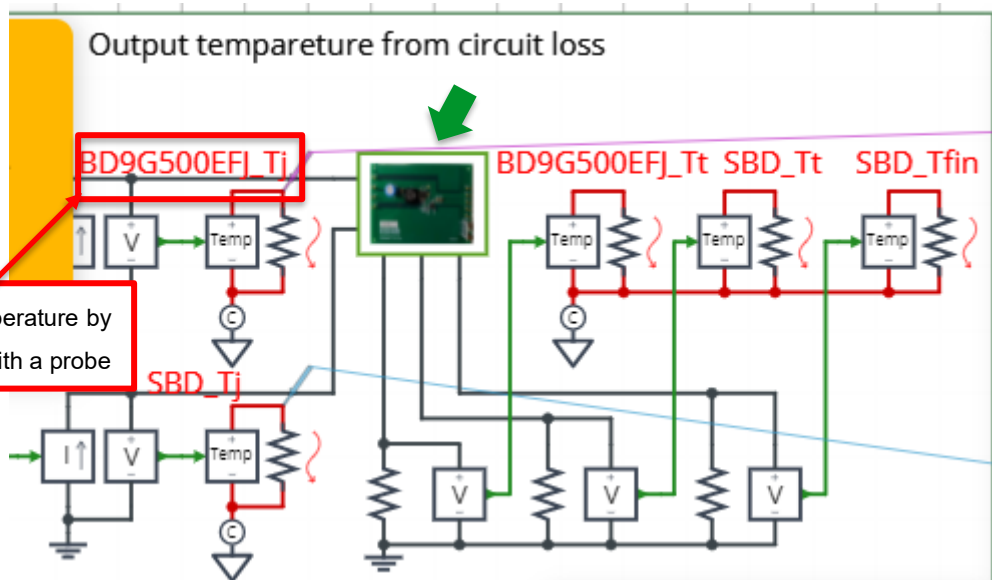

Figure 5. BD9G500EFJ-LA thermal simulation model

Table 3. Description of the nodes in Figure 5

Node name	Description
BD9G500EFJ_Tj	Monitors the junction temperature of BD9G500EFJ-LA
SBD_Tj	Monitors the junction temperature of RB088BM100
BD9G500EFJ_Tt	Monitors the top center temperature of BD9G500EFJ-LA
SBD_Tt	Monitors the top center temperature of RB088BM100
SBD_Tfin	Monitors the FIN center temperature of RB088BM100

3.4　Selecting a thermal simulation model

There are a number of thermal simulation models to choose from and their components are shown in Table 4. Figure 6 shows how to select one. First, right-click on the BD9G500EFJ-LA component and select "Properties". In the "Property Editor", set the value of the "SpiceLib Part" to the value you selected from Table 4 to change the thermal simulation model.
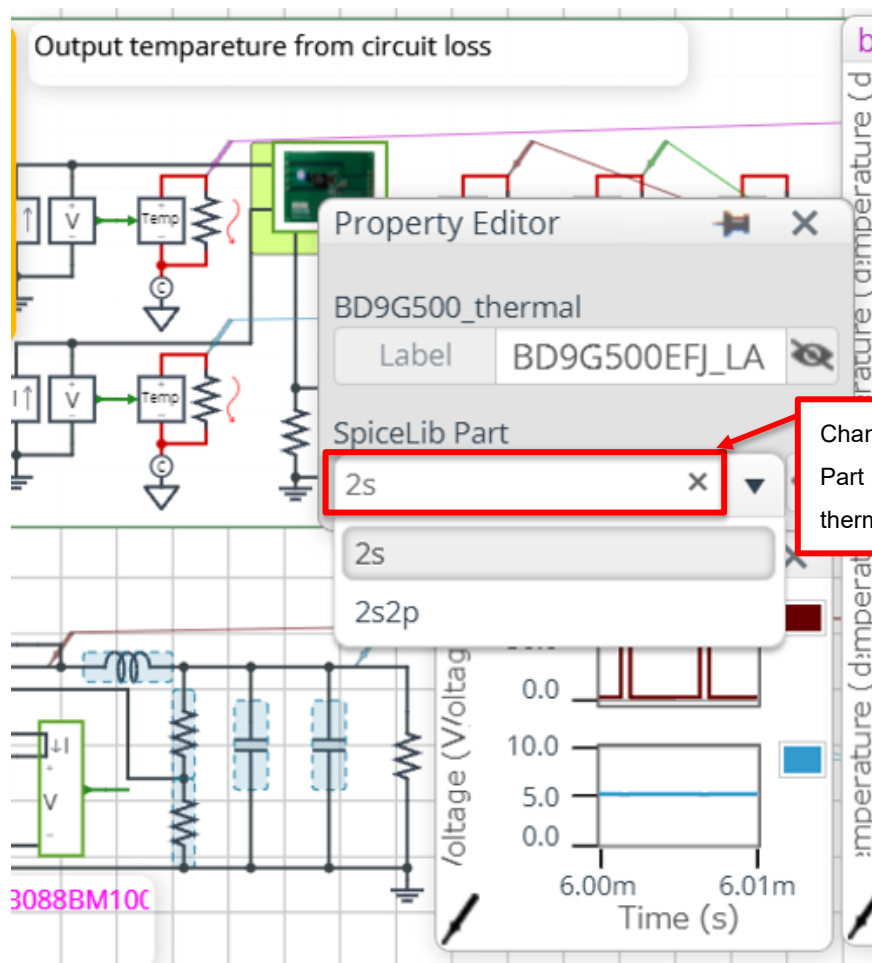
Figure 6. How to select a thermal simulation model

Table 4. List of available components

Component name	SpiceLib Part value	Description
BD9G500EFJ-LA	2s	Thermal simulation model for a two-layer board
	2s2p	Thermal simulation model for a four-layer board

For more information on the board, see "Reference: About the BD9G500EFJ-LA thermal simulation model" on page 7.

4   Links to related documents

4.1　　Products

　　　BD9G500EFJ-LA

　　　RB088BM100

4.2　　User's Guide

　　　Single Buck Switching Regulator BD9G500EFJ-LA EVK User's Guide

Reference: About the BD9G500EFJ-LA thermal simulation model

An image of the 3D model used to create the thermal simulation model is shown in Figure A. Structural information is also shown in Table A.
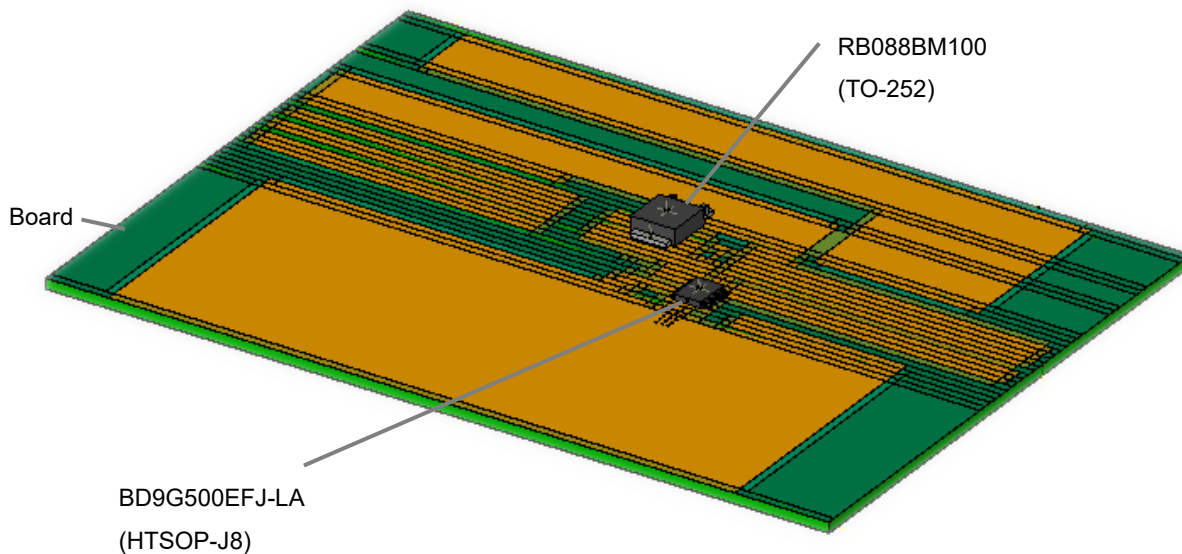
Figure A. BD9G500EFJ-LA 3D image

Table A. Structural information

Structural parts	Description
Board outline dimensions	114.3mm × 76.2mm, t=1.6mm
Board material	FR-4
Layout pattern	Refer to "Single Buck Switching Regulator BD9G500EFJ-LA EVK User's Guide"
2-layer board Layer structure	Top Layer : 70μm (2oz) Bottom Layer : 70μm (2oz)
4-layer board Layer structure	Top Layer : 70μm (2oz) Middle1 & Middle2 Layer : 35μm (1oz) Bottom Layer : 70μm (2oz)

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