ROHM Solution Simulator

LED Driver BD18337EFV-M, BD18347EFV-M Thermal Simulation

This document introduces and describes the use of a simulation environment that allows simultaneous electrical simulation of the BD18337EFV-M and BD18347EFV-M LED drivers and the temperature simulation of devices including energy sharing resistors*1. By changing the parameters of the components, it is possible to simulate a wide range of conditions. This document uses the circuit diagram for the BD18337EFV-M, but the procedure is the same for the BD18347EFV-M with different output LED stages.

1 Simulation circuit

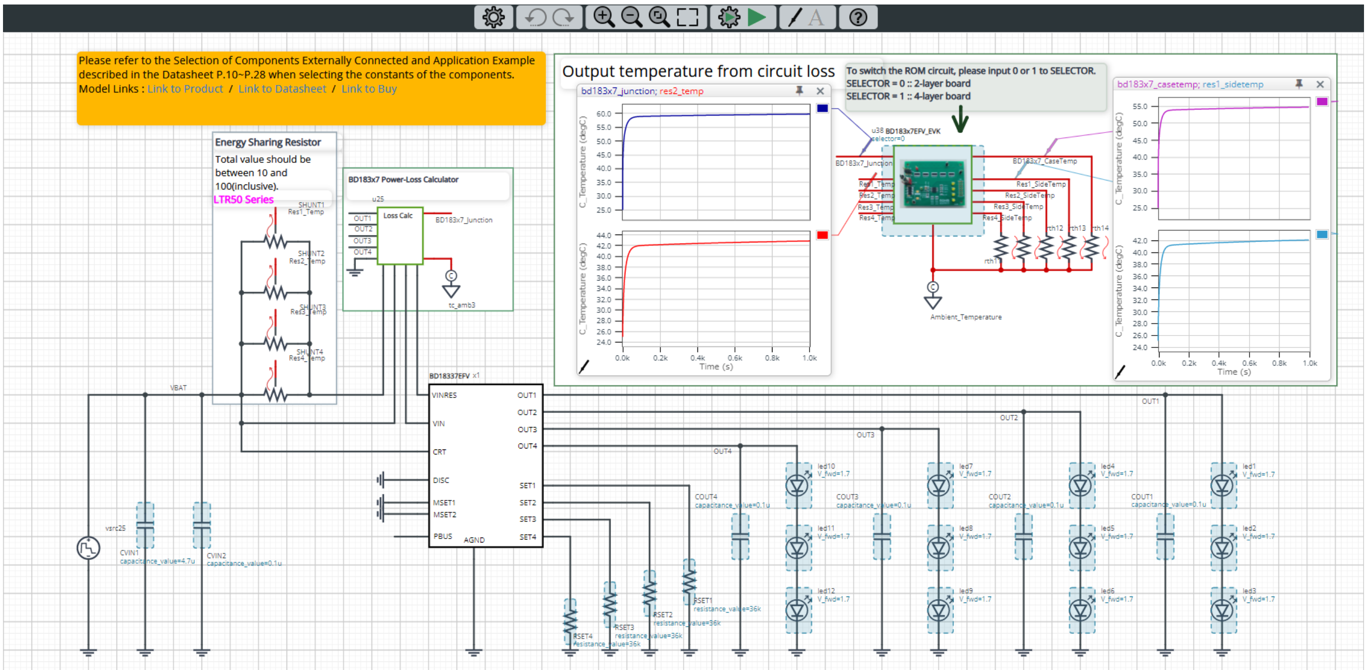

Figure 1. Simulation circuit (BD18337EFV-M)

In Figure 1, the black lines show the electrical simulation circuit and the red lines show the thermal simulation circuit.

This circuit is used to apply a constant current to the LED when the power is turned on.

The thermal simulation circuit inputs the device losses calculated in the electrical simulation and the energy sharing resistor losses to the thermal simulation model (ROM*2), and calculates the temperature of the device and the energy sharing resistor.

*1 Energy sharing resistor: A resistor that distributes the losses generated by the IC to an external shunt resistor.

*2 ROM (Reduced Order Model): A model created by 3D-CAE using a technique to reduce the dimensionality to 1D.

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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".

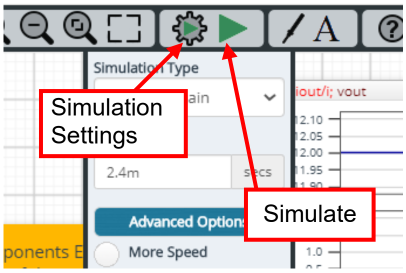

Figure 2. Simulation Settings and execution

Table 1. Initial values for Simulation Settings

Parameters	Initial values	Remarks
Simulation Type	Time-Domain	Do not change the simulation type
End time	1000 secs	
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.

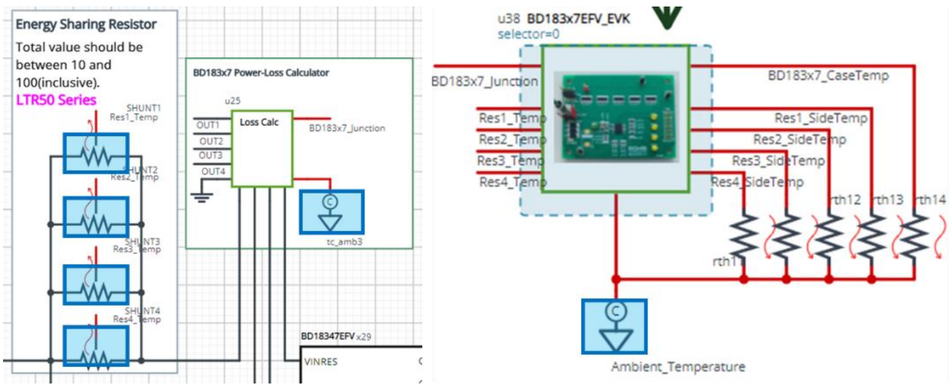

Figure 3. Definition of component parameters

Table 2. Simulation conditions

Parameters	Variable names	Initial values	Unit	Description
Resistor	RES	40	Ω	Combined resistance of energy sharing resistors connected in parallel
Number	N	4	pcs	Number of parallel resistors
Temperature	A_TEMP	25	°C	Ambient temperature

The energy sharing resistors should be set between 10Ω and 100Ω parallel combination resistors.

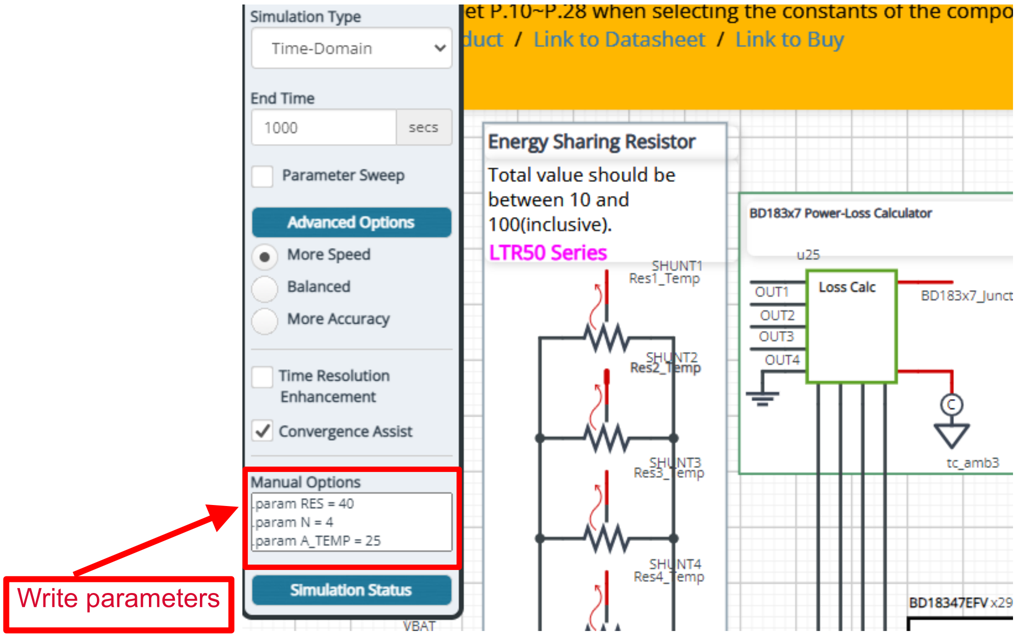

Figure 4. Definition of parameters

3.2 Output current setting

Figure 5 shows the resistors used to set the LED output current. The constant current value is determined by the resistor connected to the SETx pin and can be calculated as follows.

$$I_{Outx} = \frac{K_{SET}}{R_{SETx}} [A]$$

K_{SET} : Output current setting factor 1,800 (Typ)

R_{SETx} : Output current setting resistor (x indicates each output number)

Since the initial circuit is R_{SETx} = 36 kΩ, 50 mA will flow to each LED according to the above equation.

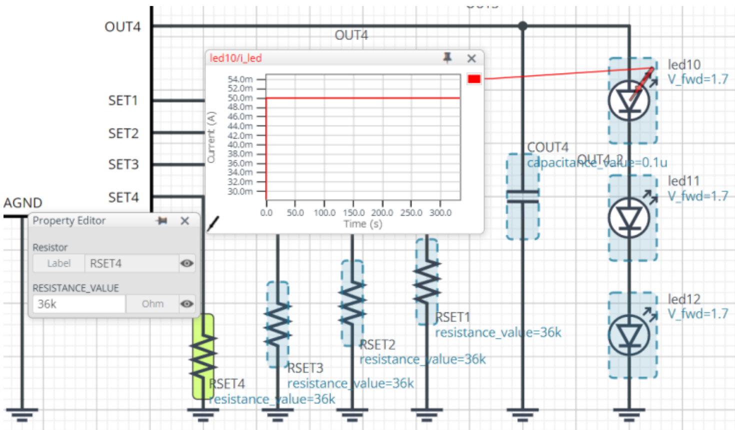

Figure 5. Output current setting resistor

3.3 Thermal circuit

The "BD183x7EFV_EVK" symbol in Figure 6 is the thermal simulation model (ROM) of the BD18337EFV-M and BD18347EFV-M. Also, Table 3 shows the terminal description for the thermal simulation model.

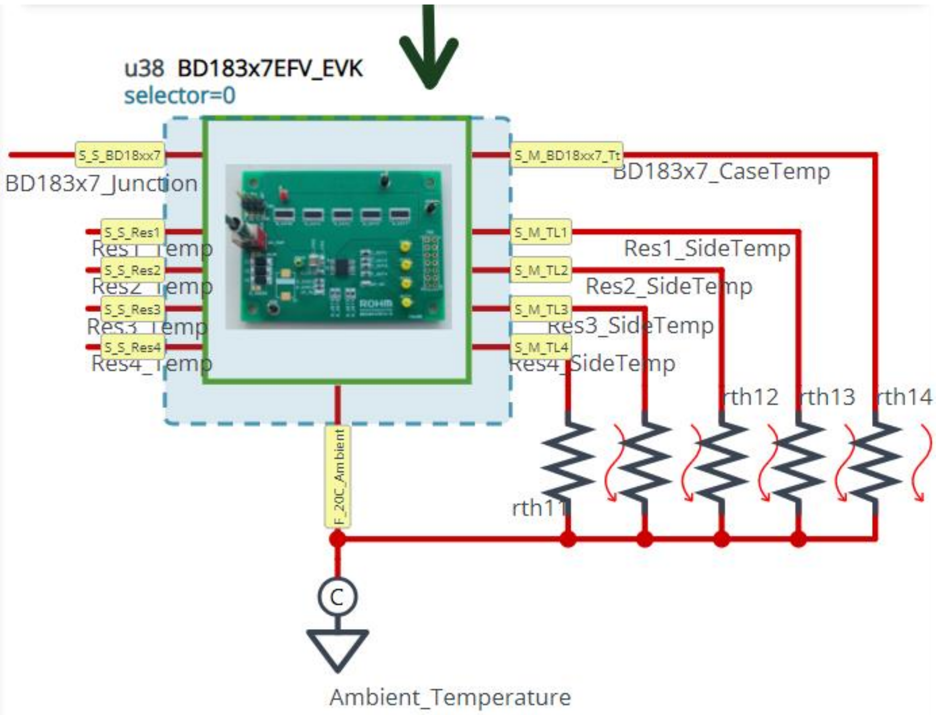

Figure 6. BD18337EFV-M, BD18347EFV-M thermal simulation model

Table 3. Terminal description of the thermal simulation model

Terminal name	Description
S_S_BD18xx7	Inputs the losses of BD183x7EFV-M and monitors T_J
S_S_Res1	Inputs the losses of shunt resistor SHUNT1 and monitors the center temperature of the resistor.
S_S_Res2	Inputs the losses of shunt resistor SHUNT2 and monitors the center temperature of the resistor.
S_S_Res3	Inputs the losses of shunt resistor SHUNT3 and monitors the center temperature of the resistor.
S_S_Res4	Inputs the losses of shunt resistor SHUNT4 and monitors the center temperature of the resistor.
F_20CAmbient	Ambient temperature
S_M_BD18xx7_Tt	Monitors the center temperature of the package surface of BD183x7EFV-M (received at high impedance)
S_M_TL1	Monitors the lead temperature of shunt resistor SHUNT1 (received at high impedance)
S_M_TL2	Monitors the lead temperature of shunt resistor SHUNT2 (received at high impedance)
S_M_TL3	Monitors the lead temperature of shunt resistor SHUNT3 (received at high impedance)
S_M_TL4	Monitors the lead temperature of shunt resistor SHUNT4 (received at high impedance)

• The S_S_xxxx pin allows monitoring of the device temperature by inputting the device losses.

• The F_xxxx pin is connected to "tc_amb" and is set to the ambient temperature.

• The S_M_xxxx pin allows monitoring of the temperature of the package surface of BD183x7EFV-M and the lead temperature of the shunt resistor.

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 7 shows how to select one. First, right-click on the BD183x7EFV_EVK component and select "Properties". In the Property Editor, set the value of "SELECTOR" to the value you selected from Table 4 to change the thermal simulation model.

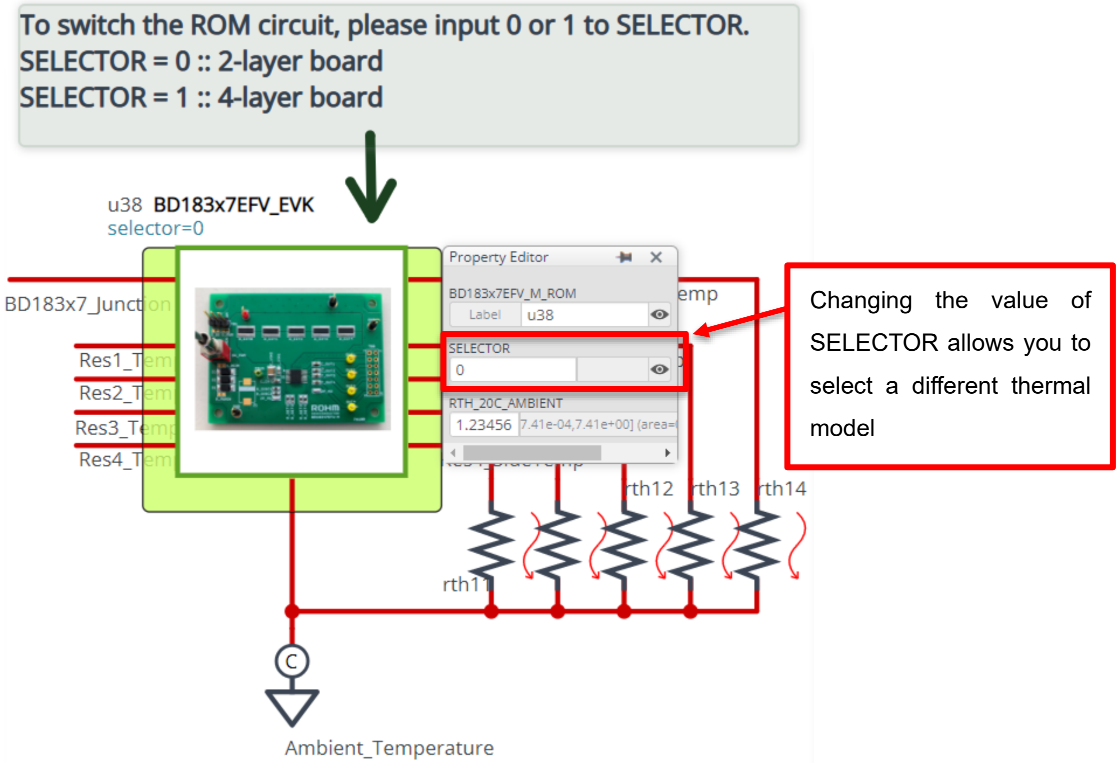

Figure 7. How to select a thermal simulation model

Table 4. List of available components

Component name	SELECTOR value	Description
U38	0	Thermal simulation model for a two-layer board
U38	1	Thermal simulation model for a four-layer board

For more information on the board, see "Reference: About the BD18337EFV-M, BD18347EFV-M thermal simulation model" on page 7.

3.5 LED forward voltage setting

Figure 8 shows how to change the forward voltage of the LED. Right mouse click on the component and select "Properties". In the "Property Editor", enter the forward voltage of the LED to be analyzed in the "V_FWD" field.

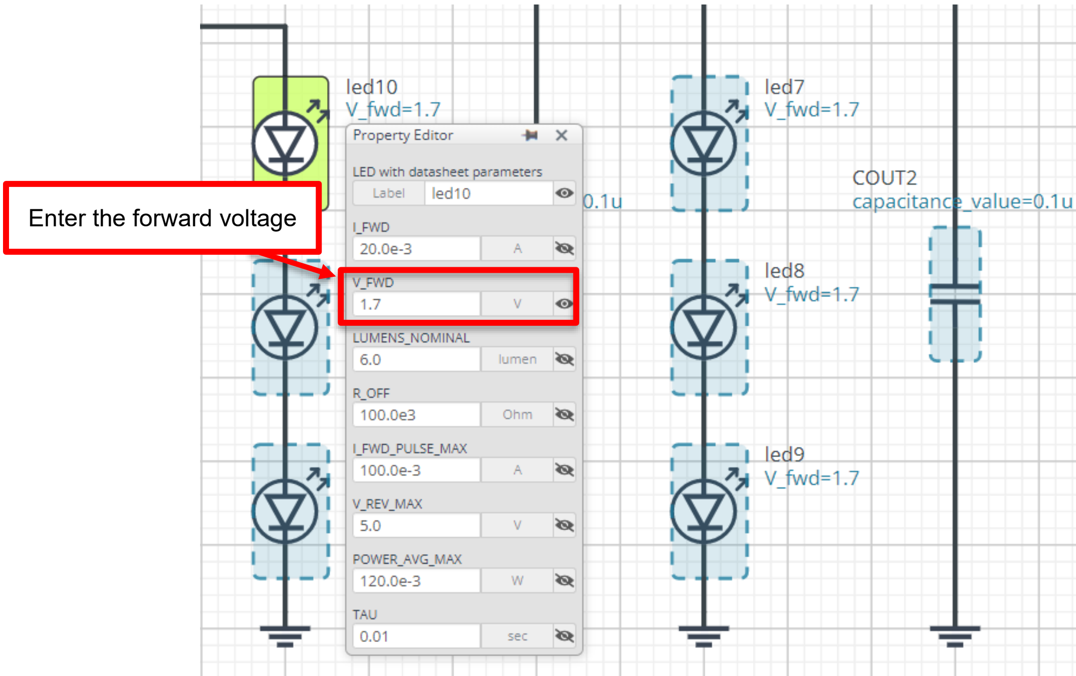

Figure 8. How to change the LED forward voltage

4 Links to related documents

4.1 Products

BD18337EFV-M (HTSSOP-B16 package, 4-channel output, 3 LED stages)

BD18347EFV-M (HTSSOP-B16 package, 4-channel output, 2 LED stages)

Wide Terminal Type High Power Thick Film Shunt Resistors (LTR) series

Reference: About the BD18337EFV-M, BD18347EFV-M thermal simulation model

An image of the 3D model used to create the thermal simulation model (ROM) is shown in Figure A. Structural information is also shown in Table A.

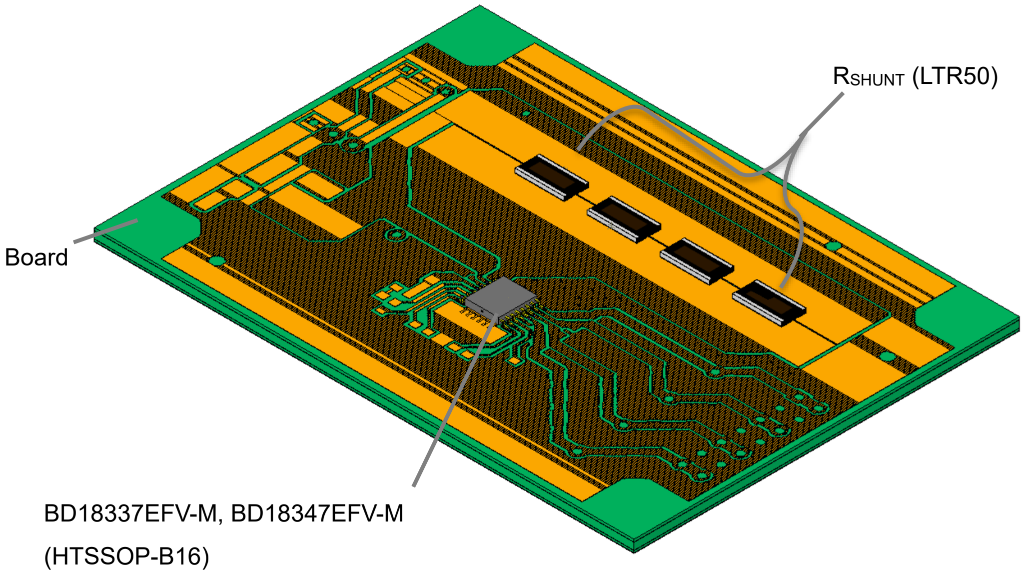

Figure A. BD18337EFV-M, BD18347EFV-M 3D images

Table A. Structural information

Structural parts	Description
Board outline dimensions	70mm × 50mm ,t=1.6mm
Board material	FR-4
2-layer board Layer structure	TOP Layer: 70 µm (2 oz) / Layout pattern copper foil Bottom layer: 70 µm (2 oz) / equivalent thermal conductivity 90% copper
4-layer board Layer structure	TOP Layer: 70 µm (2 oz) / Layout pattern copper foil 2nd & 3rd layers: 35 µm (1 oz) / equivalent thermal conductivity 85% copper Bottom layer: 70 µm (2 oz) / equivalent thermal conductivity 90% copper

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