ROHM Solution Simulator

3.5V to 60V Input 1ch Boost DC/DC Controller

BD9615MUV-LB / Frequency Response

This circuit simulates the frequency response of BD9615MUV-LB. You can observe the loop gain and measure phase margin. You can customize the simulation conditions by changing the parameters of components highlighted in blue. You can simulate the circuit in the published application note: Measurement Method for Phase Margin with FRA. [JP] [EN] [CN]

General Cautions

Caution 1: The values from the simulation results are not guaranteed. Use these results as a guide for your design.
Caution 2: These model characteristics are specifically at Ta = 25 °C. Thus, the simulation result with temperature variances may significantly differ from the result with the one done at actual application board (actual measurement).
Caution 3: Please refer to the datasheet for details of the technical information.
Caution 4: The characteristics may change depending on the actual board design and ROHM strongly recommend to double check those characteristics with actual board where the chips will be mounted on.

1 Simulation Schematic

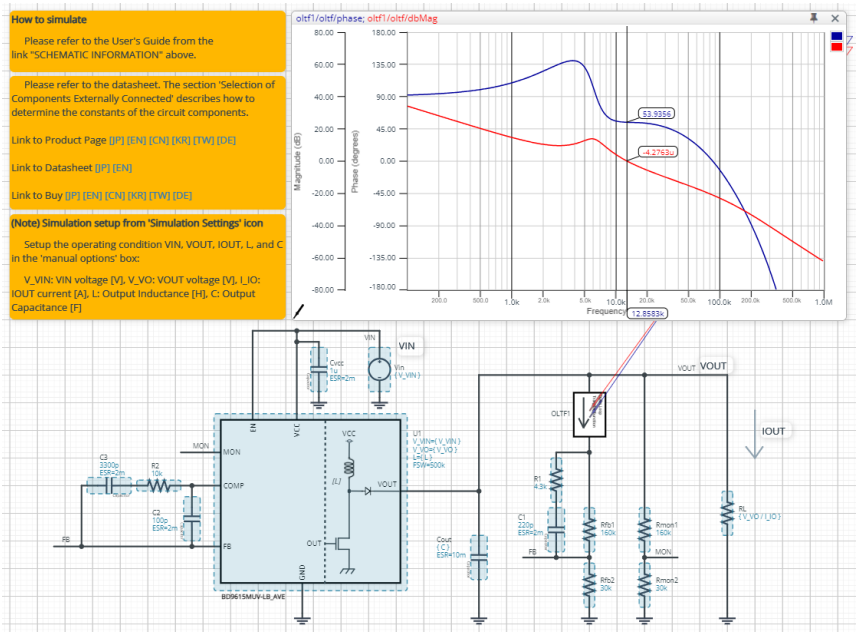


Figure 1. Simulation Circuit

2 How to simulate

The simulation settings, such as frequency range or convergence options, are configurable from the 'Simulation Settings' shown in Figure 2, and Table 1 shows the default setup of the simulation.

In case of simulation convergence issue, you can change advanced options to solve.

The parameters V_VIN, V_VO, I_IO, L, and C are defined in the 'Manual Options'.

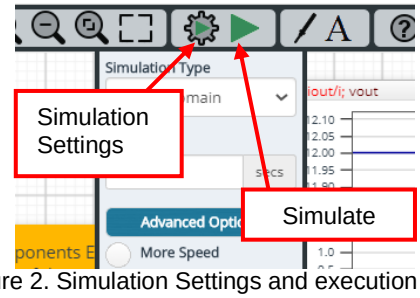


Figure 2. Simulation Settings and execution

Table 1. Simulation settings default setup

Parameters	Default	Note
Simulation Type	Frequency-Domain	(Do not change Simulation Type)
Start Frequency	100 Hz	Simulate the frequency response for the frequency range from 100 Hz to 1 MHz.
End Frequency	1Meg Hz	
Advanced options	Balanced Convergence Assist	
Manual Options	".param V_VIN=3.5 V_VO=5.1 I_IO=1 L=6.8u C=47u"	*See "Simulation Condition" for details*

3 Simulation Conditions

3.1 How to define V_{IN}, V_{OUT}, I_{OUT}, L, and C

These parameters are used to setup the simulation conditions and BD9615MUV-LB_AVE model parameters, therefore these are defined in the Manual Options as the common variables.

Table 2 shows the default values of V_{IN}, V_{OUT}, I_{OUT}, L, and C. Those values are defined and can be set in the 'Manual Options' text box from Simulation Settings as shown in Figure 3.

The input voltage VIN, output inductance, the load resistance of RL, and the output capacitance of Cout are automatically set according to those parameters. Note that feedback resistors are not automatically set by V_VO. Set Rfb1 and Rfb2 manually.

Table 2. Simulation Conditions

Parameters	Variable Name	Default Value	Units	Descriptions
V_{IN}	V_VIN	3.5	V	Input Voltage
V_{OUT}	V_VO	5.1	V	Output Voltage
I_{OUT}	I_IO	1	A	Output Current
L	L	6.8u	H	Output Inductance
C	C	47u	F	Output Capacitance

(Note 1) Set it to the guaranteed operating range of the DC/DC Controller.

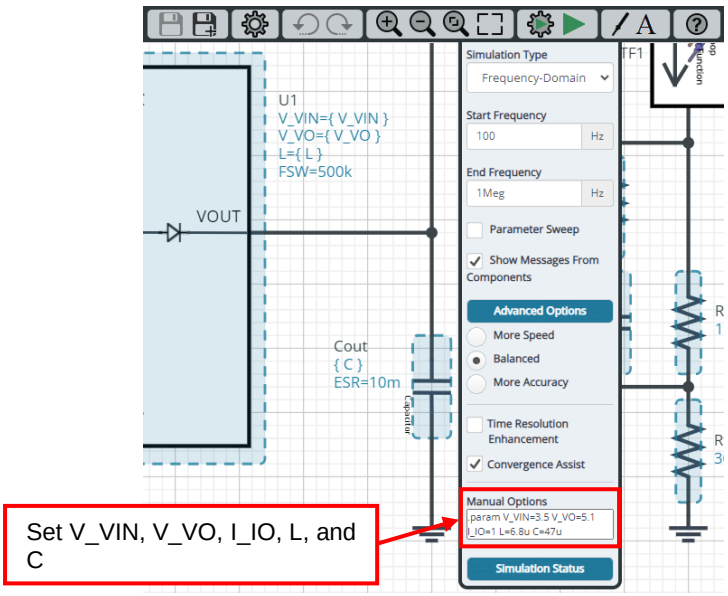


Figure 3. Definition of V_{IN}, V_{OUT}, I_{OUT}, L, and C

3.2 Resistive Load RL and Output Capacitance Cout

RL is the resistive load and its resistance is determined from V_{OUT} and I_{OUT}. Cout is the output capacitor and its capacitance is determined from C. The resistance and capacitance values are defined by the equations below.

Table 3. Resistive load and Output Capacitance

Instance Name	Default Value	Unit
RL	{ V_VO / I_IO }	Ω
Cout	{ C }	F

4 BD9615MUV-LB_AVE model

The simulation model in this circuit is designed for frequency response, and the functions not related to frequency response are not implemented.

Table 4. BD9615MUV-LB_AVE model pins used for frequency response

Pin Name	Description
VCC	Power input pin
EN	ON/OFF control pin
MON	Output voltage monitor input pin
COMP	ERROR AMP output pin
FB	ERROR AMP input pin
VOUT	Output voltage pin
GND	Ground pin

4.1 BD9615MUV-LB_AVE Model Parameters

BD9615MUV-LB_AVE model has its parameters shown in Table 5. All the parameters are pre-defined and fixed in the simulation.

Table 5. Parameter List

Parameters	Default Values	Description
V_VIN	V_VIN	VIN voltage
V_VO	V_VO	VOUT voltage
L	L	Output Inductance
FSW	500k	Switching frequency

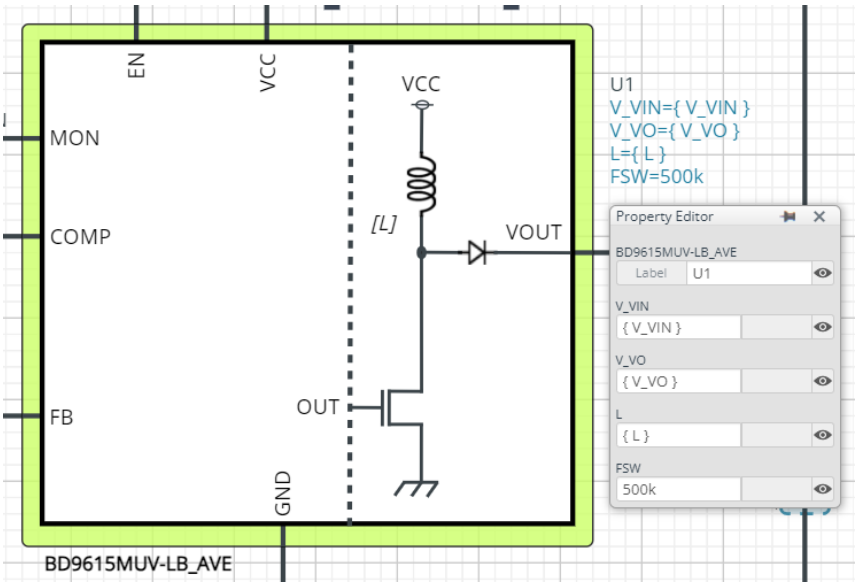


Figure 4. Property Editor of BD9615MUV-LB_AVE model

5 Peripheral Components

To set parameters of components, open 'property' by double clicking or right clicking on a component. You can input a value to a property text box if available. Please refer to the hands-on manual for more details.

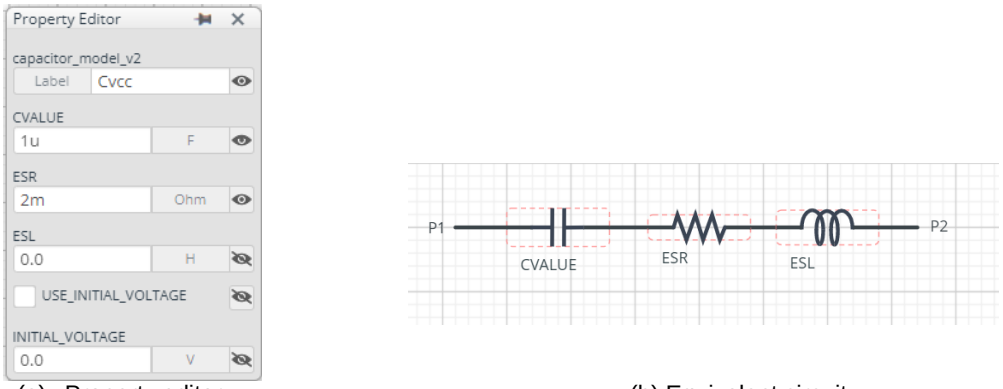
5.1 Bill of Material

Table 6 shows the list of components used in the simulation schematic. Each capacitor has the parameters of equivalent circuit shown below. The default value of equivalent components are set to zero except for the series resistance of capacitors. You can modify the values of each component.

Table 6. List of components used in the simulation circuit

Type	Instance Name	Default Value	Units
Capacitor	Cvcc	1	µF
	C1	220	pF
	C2	100	pF
	C3	3300	pF
Resistor	R1	4.3	kΩ
	R2	10	kΩ
	Rfb1	160	kΩ
	Rfb2	30	kΩ
	Rmon1	160	kΩ
	Rmon2	30	kΩ

5.2 Capacitor Equivalent Circuits



(a) Property editor (b) Equivalent circuit

Figure 5. Capacitor property editor and equivalent circuit

The default value of ESR is 2 mΩ.

(Note 2) These parameters can take any positive value or zero in simulation but it does not guarantee the operation of the IC in any condition. Refer to the datasheet to determine adequate value of parameters.

6 Open Loop Transfer Function (OLTF) Monitor

OLTF1 is the insert model to measure AC open loop transfer function and is inserted to acquire the gain and phase output. To monitor the gain and phase from OLTF1, select probe items 'dbMag' for gain and 'phase' for phase plot, respectively from 'property' of OLTF1.

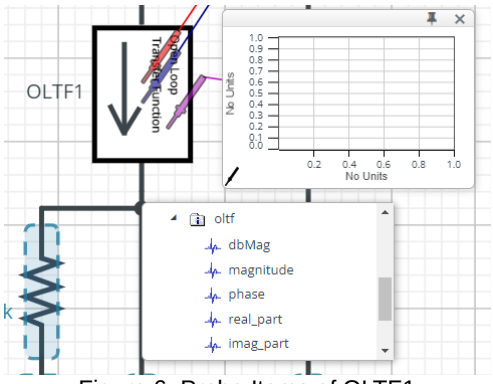


Figure 6. Probe Items of OLTF1

7 Link to the product information and tools

7.1 DC/DC Controller

BD9615MUV-LB : 3.5V to 60V Input 1ch Boost DC/DC Controller. [JP] [EN] [CN] [KR] [TW] [DE]

Technical Articles and Tools can be found in the Design Resources on the product web page.

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