ROHM Solution Simulator

3.5 V to 40 V Input, 6.0 A Single Buck DC/DC Converter For Automotive

BD9P608MFF-C / Frequency Response

This circuit simulates the frequency response of BD9P608MFF-C. 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

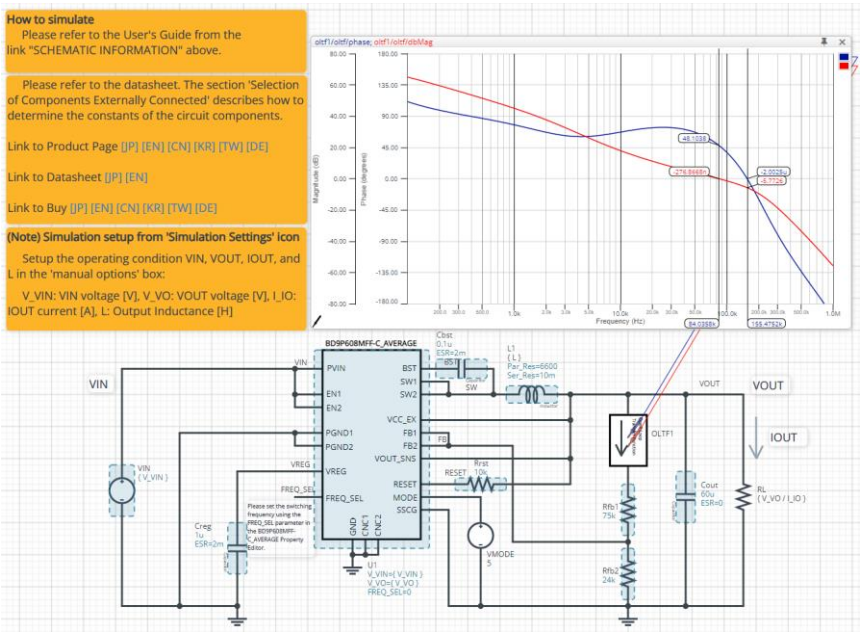


Figure 1. Simulation Circuit

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, and L are defined in the 'Manual Options'.

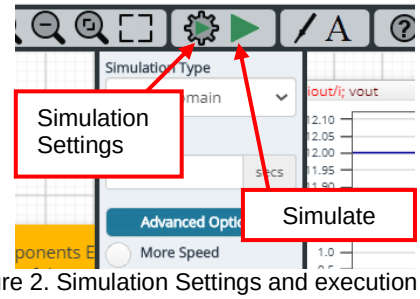


Figure 2. Simulation Settings and execution

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=12 V_VO=3.3 I_IO=3 L=2.2u"	*See "Simulation Condition" for details*

3 Simulation Conditions

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

These parameters are used to setup the simulation conditions and BD9P608MFF-C_AVERAGE model parameters, therefore these are defined in the Manual Options as the common variables.

Table 2 shows the default value of V_{IN}, V_{OUT}, I_{OUT}, and L. 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 of L1, and the load resistance of RL 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	12	V	Input Voltage
V_{OUT}	V_VO	3.3	V	Output Voltage
I_{OUT}	I_IO	3	A	Output Current
L	L	2.2u	H	Output Inductor

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

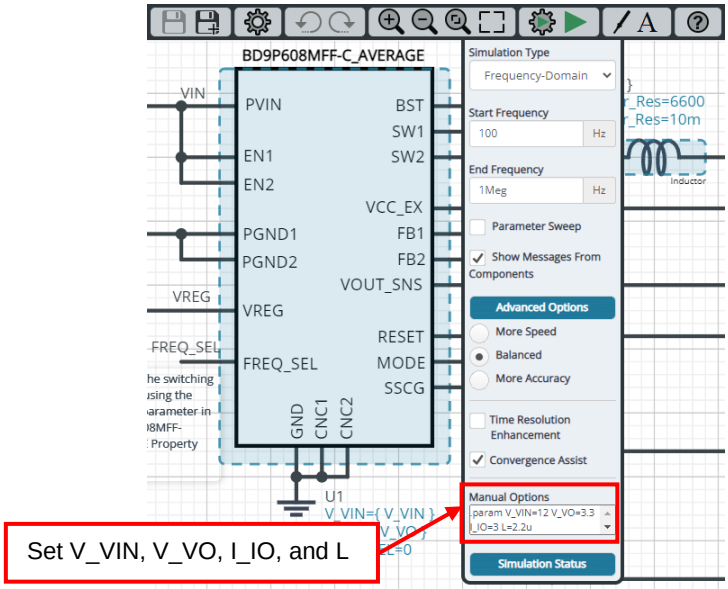


Figure 3. Definition of V_{IN}, V_{OUT}, I_{OUT}, and L

3.2 Resistive Load RL

RL is the resistive load and its resistance is determined from V_{OUT} and I_{OUT}. The resistance value is defined as the equation below.

Table 3. Resistive load

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

4 BD9P608MFF-C_AVERAGE 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. BD9P608MFF-C_AVERAGE model pins used for frequency response

Pin Name	Description
PVIN	Power supply input.
EN1, EN2	Enable input.
FREQ_SEL	Switching frequency selector input.
SW1, SW2	Switching node.
FB1, FB2	Output voltage feedback pin.
VREG	Pin to output 5.0 V (Typ) for internal circuit.
PGND1, PGND2, GND	Ground.

Table 5. BD9P608MFF-C_AVERAGE model pins NOT used for frequency response

Pin Name	Description
BST	Input is ignored. (no switching operation in this model)
MODE	Input is ignored. (no switching operation in this model)
SSCG	Input is ignored. (no switching operation in this model)
RESET	This function is not implemented.
VCC_EX	This function is not implemented.
VOUT_SNS	This function is not implemented.
CNC1, CNC2	These pins are not connected to the chip.

4.1 BD9P608MFF-C_AVERAGE Model Parameters

BD9P608MFF-C_AVERAGE model has its parameters shown in Table 6. All the parameters are pre-defined and fixed in the simulation. V_VIN is substituted to V_VIN and V_VO is substituted to V_VO as shown in Table 6. FREQ_SEL sets the switching frequency of the chip.

Table 6. Parameter List

Parameters	Default Values	Description	
V_VIN	V_VIN	VIN voltage	
V_VO	V_VO	VOUT voltage	
FREQ_SEL	0	FREQ_SEL = 0	2.2 MHz
		FREQ_SEL = 1	440 kHz

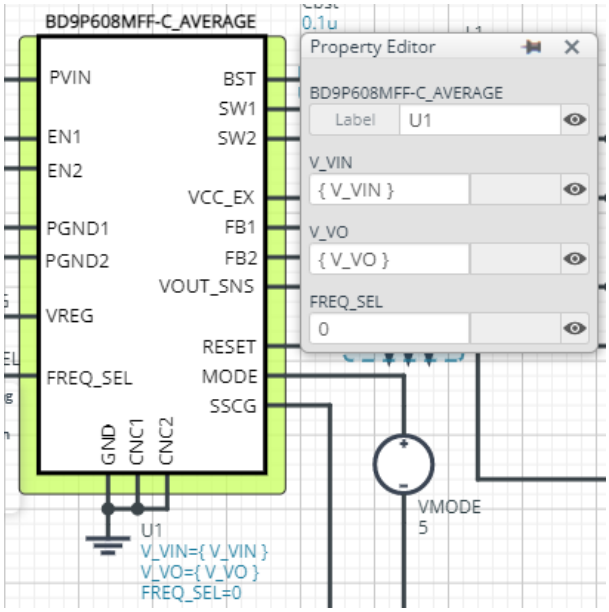


Figure 4. Property Editor of BD9P608MFF-C_AVERAGE model

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.

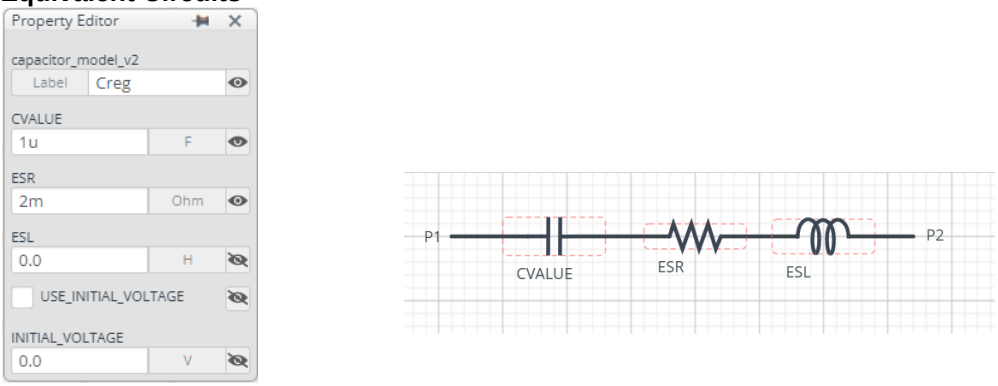
5.1 Bill of Material

Table 7 shows the list of components used in the simulation schematic. Each of the capacitor and inductor has the parameters of equivalent circuit shown below. The default value of equivalent components are set to zero except for the parallel resistance of L1 and series resistance of capacitors. You can modify the values of each component.

Table 7. List of components used in the simulation circuit

Type	Instance Name	Default Value	Units
Capacitor	Creg	1	µF
	Cbst	0.1	µF
	Cout	60	µF
Inductor	L1	2.2	µH
Resistor	Rrst	10	kΩ
	Rfb1	75	kΩ
	Rfb2	24	kΩ

5.2 Capacitor Equivalent Circuits

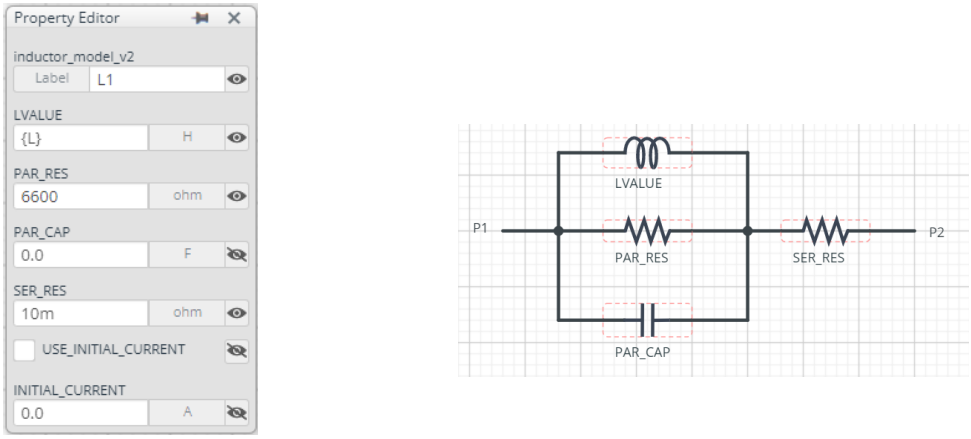


(a) Property editor (b) Equivalent circuit

Figure 5. Capacitor property editor and equivalent circuit

The default value of ESR is 2 mΩ.

5.3 Inductor Equivalent Circuits



(a) Property editor (b) Equivalent circuit

Figure 6. Inductor property editor and equivalent circuit

The default value of PAR_RES is 6.6 kΩ.

(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.

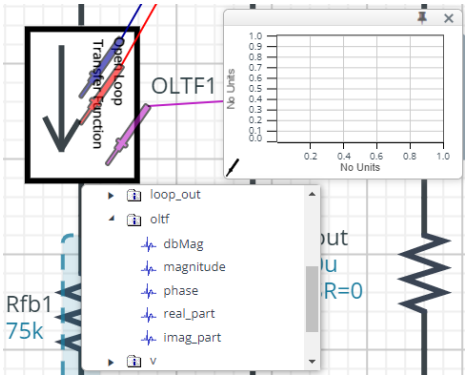


Figure 7. Probe Items of OLTF1

7 Link to the product information and tools

7.1 DC/DC Converter
BD9P608MFF-C : Integrated FET Synchronous Buck DC/DC Converter. [JP] [EN] [CN] [KR] [TW] [DE]

7.2 General Purpose Chip Resistors
MCR01MZPF : Thick Film Chip Resistors. [JP] [EN] [CN] [KR] [TW] [DE]

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

Notice

1) The information contained in this document is intended to introduce ROHM Group (hereafter referred to asROHM) products. When using ROHM products, please verify the latest specifications or datasheets before use.

2) ROHM products are designed and manufactured for use in general electronic equipment and applications (such as Audio Visual equipment, Office Automation equipment, telecommunication equipment, home appliances, amusement devices, etc.) or specified in the datasheets. Therefore, please contact the ROHM sales representative before using ROHM products in equipment or devices requiring extremely high reliability and whose failure or malfunction may cause danger or injury to human life or body or other serious damage (such as medical equipment, transportation, traffic, aircraft, spacecraft, nuclear power controllers, fuel control, automotive equipment including car accessories, etc. hereafter referred to as Specific Applications). Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses, or losses incurred by you or third parties arising from the use of ROHM Products for Specific Applications.

3) Electronic components, including semiconductors, can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against physical injury, and damage to any property, which a failure or malfunction of products may cause.

4) The information contained in this document, including application circuit examples and their constants, is intended to explain the standard operation and usage of ROHM products, and is not intended to guarantee, either explicitly or implicitly, the operation of the product in the actual equipment it will be used. As a result, you are solely responsible for it, and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses, or losses incurred by you or third parties arising from the use of such information.

5) When exporting ROHM products or technologies described in this document to other countries, you must abide by the procedures and provisions stipulated in all applicable export laws and regulations, such as the Foreign Exchange and Foreign Trade Act and the US Export Administration Regulations, and follow the necessary procedures in accordance with these provisions.

6) The technical information and data described in this document, including typical application circuits, are examples only and are not intended to guarantee to be free from infringement of third parties intellectual property or other rights. ROHM does not grant any license, express or implied, to implement, use, or exploit any intellectual property or other rights owned or controlled by ROHM or any third parties with respect to the information contained herein.

7) No part of this document may be reprinted or reproduced in any form by any means without the prior written consent of ROHM.

8) All information contained in this document is current as of the date of publication and subject to change without notice. Before purchasing or using ROHM products, please confirm the latest information with the ROHM sales representative.

9) ROHM does not warrant that the information contained herein is error-free. ROHM shall not be in any way responsible or liable for any damages, expenses, or losses incurred by you or third parties resulting from errors contained in this document.

ROHM SEMICONDUCTOR

Thank you for your accessing to ROHM product informations.
More detail product informations and catalogs are available, please contact us.

ROHM Customer Support System

https://www.rohm.com/contactus