SPICE Modeling Report

6 V to 42 V, 0.5 A 1ch Simple Buck Converter Integrated FET BD9G102G-LB

General Description

In this report, the characteristics that can be confirmed by the simulation using the SPICE model of the regulator IC BD9G102G-LB will be described.

Simulation Environment

- Circuit Simulator : PSpice / Cadence Design System, Inc.
- Version Information : 17.2-2016
- OS Information : Windows 10 64-bit Edition

File Information

- Library File Name : BD9G102G.lib
- Symbol File Name : BD9G102G.olb
- Subcircuit and Symbol

Table 1 Correspondence Table

Product Name	Subcircuit	Symbol
BD9G102G	BD9G102G (Model for Transient Analysis)	BD9G102G
	BD9G102G_AVE (Note1) (Model for AC Analysis)	BD9G102G_AVE (Note2)

(Note 1) BD9G102G_AVE is the spice macro model for Frequency Characteristic (AC simulation). Refer to Page 9 to 12 for simulation detail.
(Note 2) Pin information for BD9G102G_AVE is same like Table 2.

Caution

- 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).
- The simulation result and characteristics described in this report may differ depending on the board design. It is recommended to perform the measurement on the actual board to verify the result.
- The values from the simulation results are not guaranteed. Use these results as a guide for your design.
- Actual measurement was done using a specific sample, thus the measured data is just as a reference.

BD9G102G-LB Spice Model

■ Pin Information

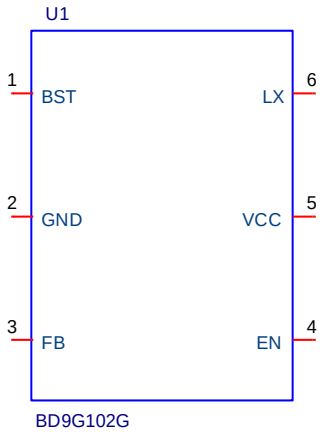

Figure 1 Symbol of BD9G102G

Table 2 Subcircuit Pin Table

Pin No.	Pin Name	Pin No.	Pin Name
1.	BST	4.	EN
2.	GND	5.	VCC
3.	FB	6.	LX

■ Model Parameter

Table 3 Model Parameter Table

Parameter	Default Value	Description
BD9G102G_AVE		
l	15u	Set the inductor value connected to SW pin.
v_vo	3.3	On Duty parameter for the Numerator.
v_vin	12	On Duty parameter for the Denominator. On Duty is given as { v_vo / v_vin }.

Verifiable Characteristics

Electrical Characteristics (vs. Datasheet)

Table 4 Electrical Characteristics Comparison

(Unless otherwise specified Ta = 25 °C, Vcc = 18 V, V_{OUT} = 5 V, V_{EN} = 3 V)

Parameter	Modeled *(Note1)*	Design Value		Unit	Error	Condition
		Datasheet	SPICE			
Circuit Current						
Shutdown supply current	Yes	0	0	μA	0 %	V_{EN} = 0 V
Operating non-switching supply current	Yes	0.5	0.5	mA	0 %	FB = 1.2 V (Non-switching)
Under voltage lockout						
Detect threshold voltage	Yes	5.3	5.3	V	0 %	VCC falling
Hysteresis width	Yes	200	200	mV	0 %	
Oscillator						
Oscillating frequency	Yes	1.00	1.00	MHz	0 %	
Error amplifier						
FB Pin Reference Voltage	Yes	0.750	0.750	V	0 %	Ta = 25° C
FB Pin Bias Current	Yes	0	0	μA	0 %	V_{FB} = 0 V
High-side MOSFET						
On resistance	Yes	800	800	mΩ	0 %	
Minimum On Time	Yes	80	80	ns	0 %	
Over current detect threshold	Yes	1.2	1.2	A	0 %	
EN control						
EN inner Reg threshold	-	-	0.5	V	-	Shutdown
	-	-	0.6	V	-	Non switching mode
EN pin output active threshold	Yes	1.8	1.8	V	0 %	Output active
EN pin current	Yes	-10.0	-10.0	μA	0 %	V_{EN} = 3 V

(Note 1) Yes: Model available (supported), No: Model not available" (not supported).

Characteristic in SPICE (vs. Measured Waveform)
1. Output Ripple Voltage (V_{CC} = 12 V, V_{OUT} = 3.3 V)

Simulation Setting
Type: Transient
Run Time: 10 ms
(Maximum Step Size: 10 ns)

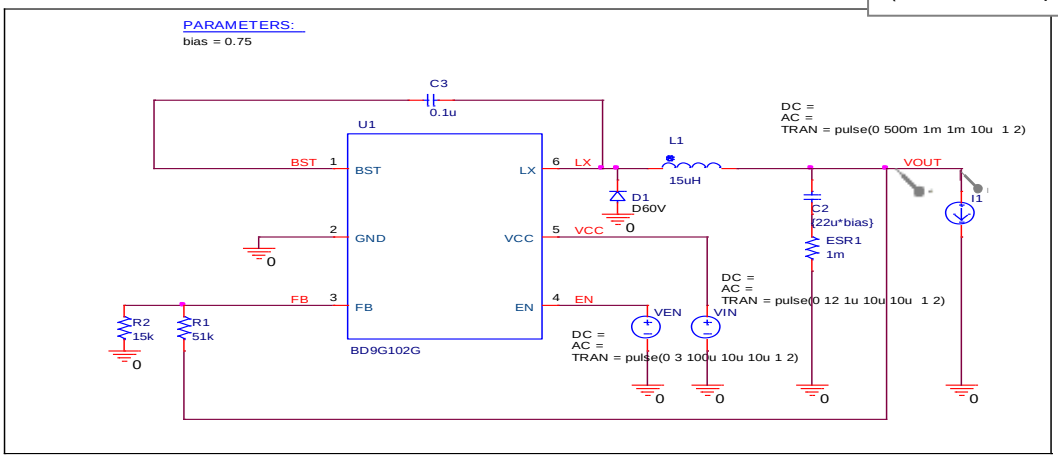

Figure 2.
Simulation Schematic 1

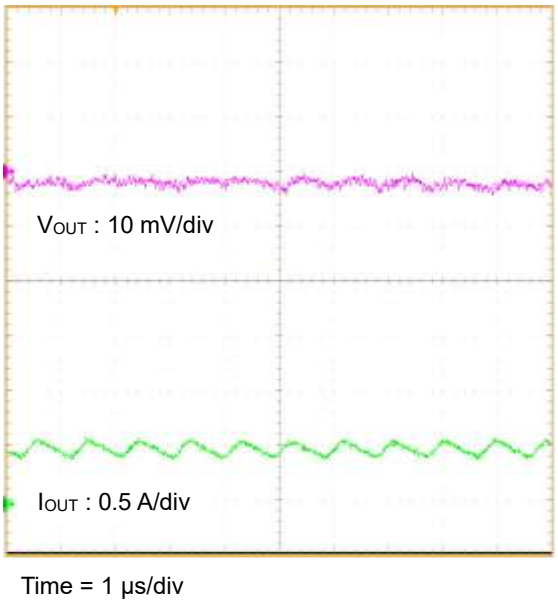

Figure 3.
Output Ripple Voltage (VCC = 12 V, VOUT = 3.3 V)
(Measured Waveform)

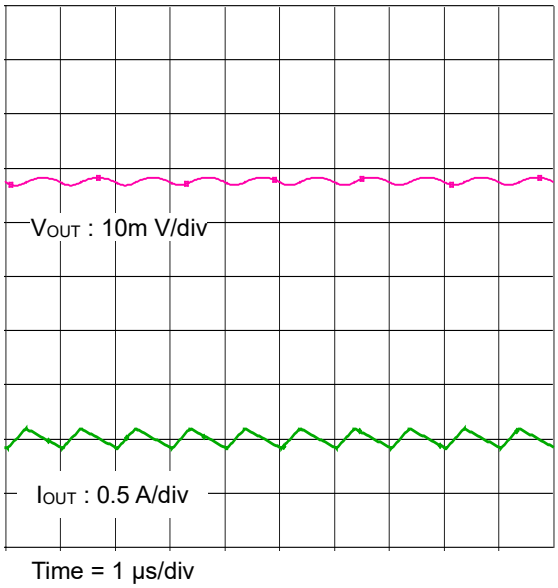

Figure 4.
Output Ripple Voltage (VCC = 12 V, VOUT = 3.3 V)
(SPICE Simulation)

Table 5 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Output Ripple Voltage	1.8	1.9	mV	5.6 %	V_{CC} = 12 V, V_{OUT} = 3.3 V, I_{OUT} = 500 mA
Output Ripple Current	160	187.3	mA	17.1 %	

(Note 1) The above data is based on a specific sample and it is not a guaranteed value.
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

2. Output Ripple Voltage (V_{CC} = 18 V, V_{OUT} = 5 V)

Simulation Setting
Type: Transient
Run Time: 10 ms
(Maximum Step Size: 10 ns)

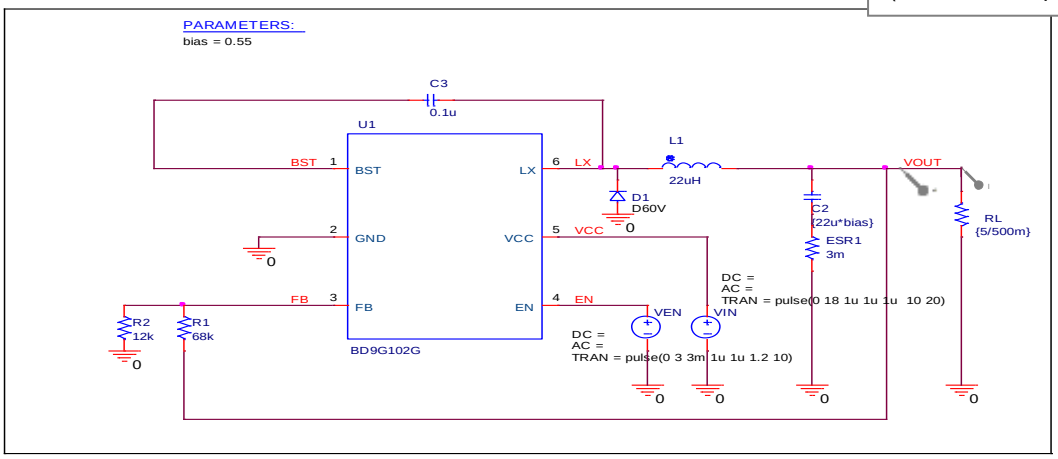

Figure 5.
Simulation Schematic 2

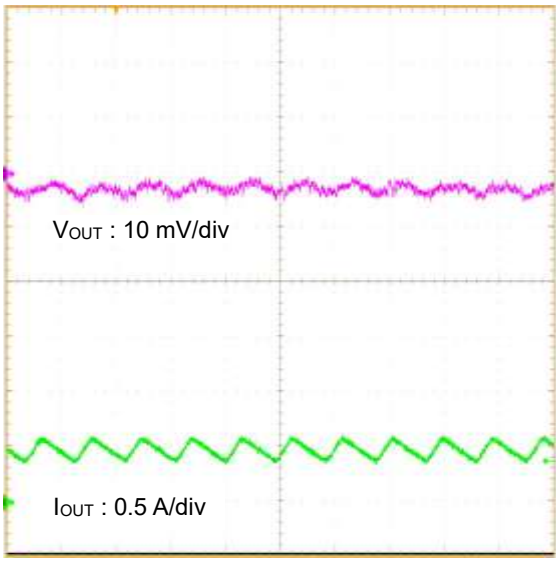

Figure 6.
Output Ripple Voltage (VCC = 18 V, VOUT = 5 V)
(Measured Waveform)

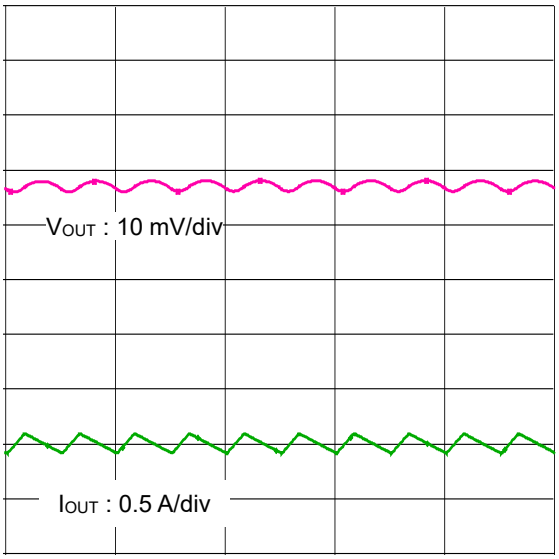

Figure 7.
Output Ripple Voltage (VCC = 18 V, VOUT = 5 V)
(SPICE Simulation)

Table 6 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Output Ripple Voltage	2.3	2.7	mV	17.4 %	V_{CC} = 18 V, V_{OUT} = 5 V, I_{OUT} = 500 mA
Output Ripple Current	163	183.8	mA	12.8 %	

(Note 1) The above data is based on a specific sample and it is not a guaranteed value.
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

3. Load Response (V_{CC} = 12 V, V_{OUT} = 3.3 V)

Simulation Setting
Type: Transient
Run Time:15 ms
(Maximum Step Size: 10 ns)

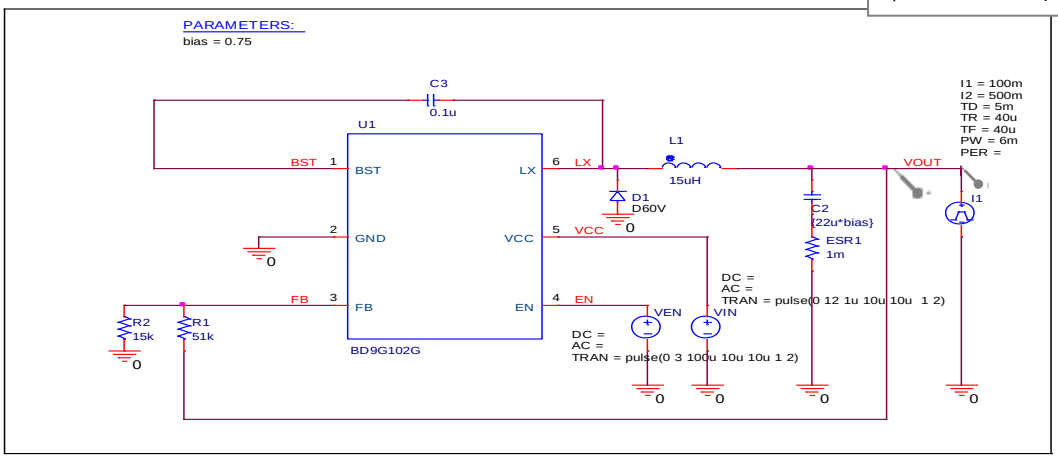

Figure 8.
Simulation Schematic 3

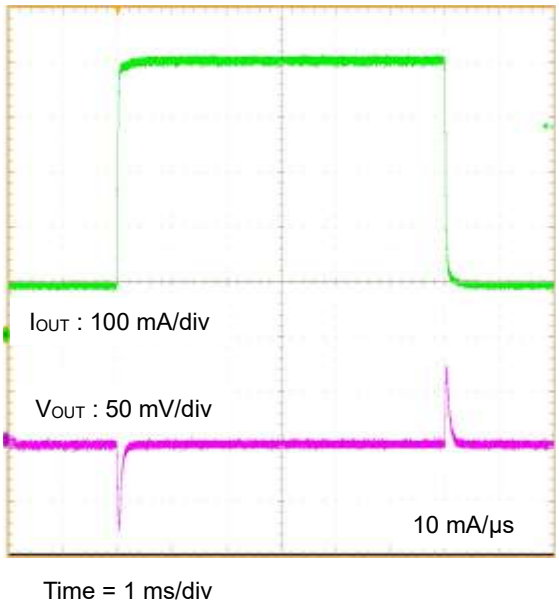

Figure 9.
Load Response (VCC = 12 V, VOUT = 3.3 V)
(Measured Waveform)

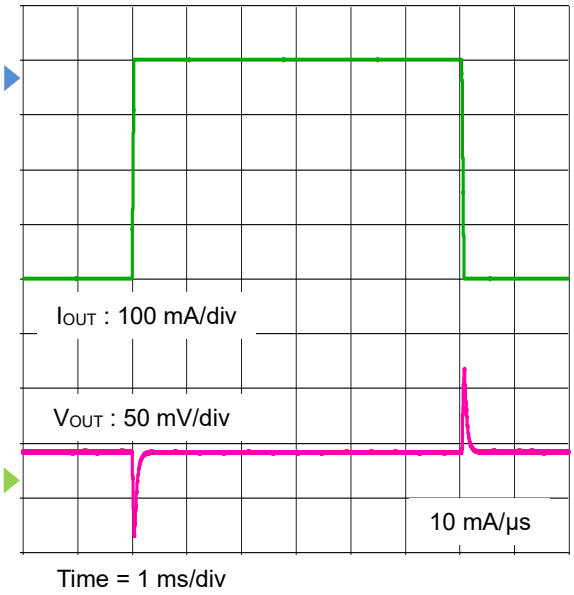

Figure 10.
Load Response (VCC = 12 V, VOUT = 3.3 V)
(SPICE Simulation)

Table 7 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Undershoot	67	73.9	mV	10.3 %	V_{CC} = 12 V, V_{OUT} = 3.3 V, I_{OUT} = 100 mA to 500 mA
Overshoot	80	81.4	mV	1.8 %	

(Note 1) The above data is based on a specific sample and it is not a guaranteed value.
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

4. Load Response (V_{CC} = 18 V, V_{OUT} = 5 V)

Simulation Setting
Type: Transient
Run Time:15 ms
(Maximum Step Size: 10 ns)

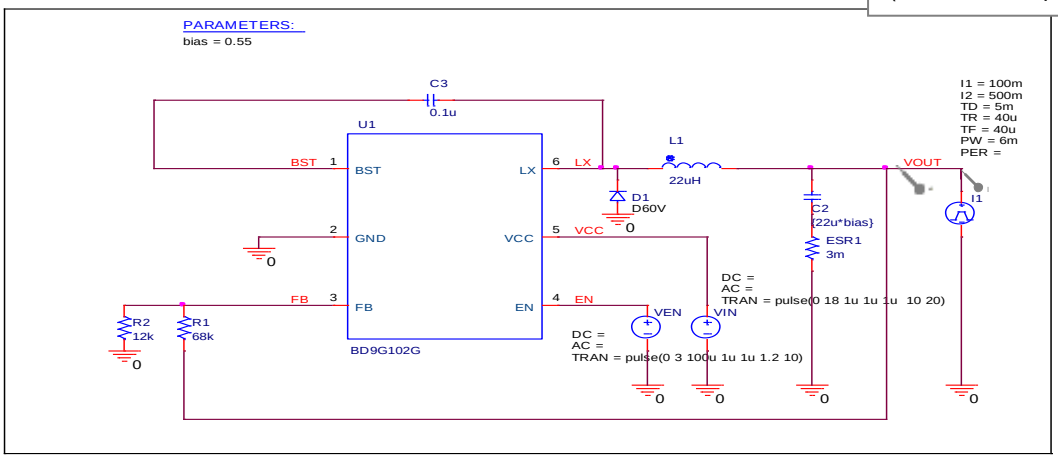

Figure 11.
Simulation Schematic 4

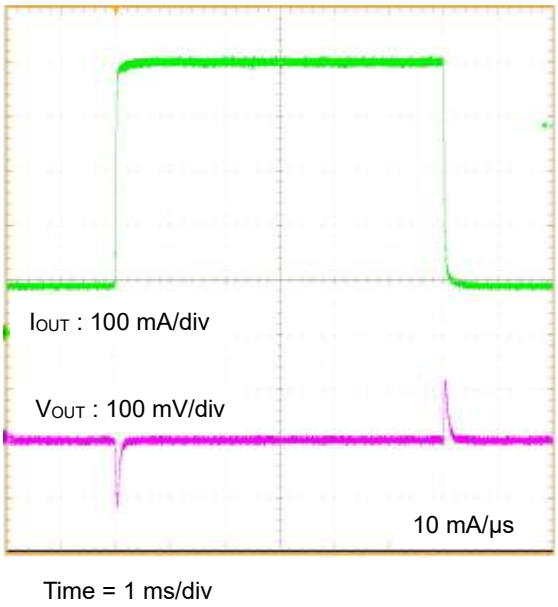

Figure 12.
Load Response (VCC = 18 V, VOUT = 5 V)
(Measured Waveform)

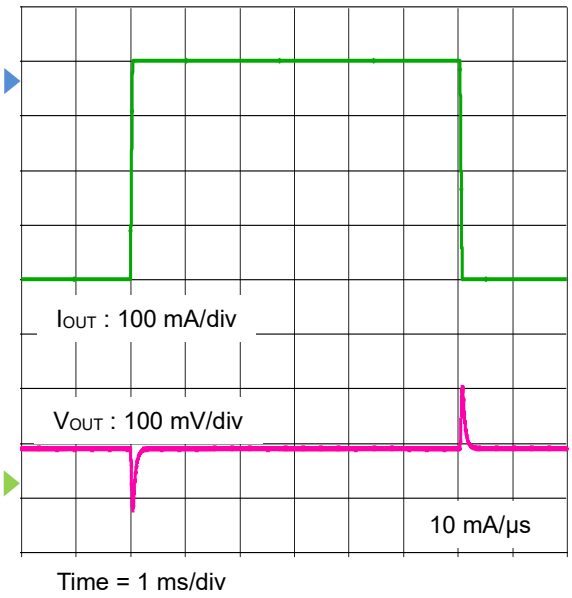

Figure 13.
Load Response (VCC = 18 V, VOUT = 5 V)
(SPICE Simulation)

Table 8 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Undershoot	110	110.5	mV	0.5 %	V_{CC} = 18 V, V_{OUT} = 5 V, I_{OUT} = 100 mA to 500 mA
Overshoot	130	122.1	mV	-6.1 %	

(Note 1) The above data is based on a specific sample and it is not a guaranteed value.
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

5. Frequency Characteristic (V_{CC} = 12 V, V_{OUT} = 3.3 V, I_{OUT} = 100 mA)

Simulation Setting
Type: AC
Frequency Range:
100 Hz to 1 MHz
(Points/Decade: 20)

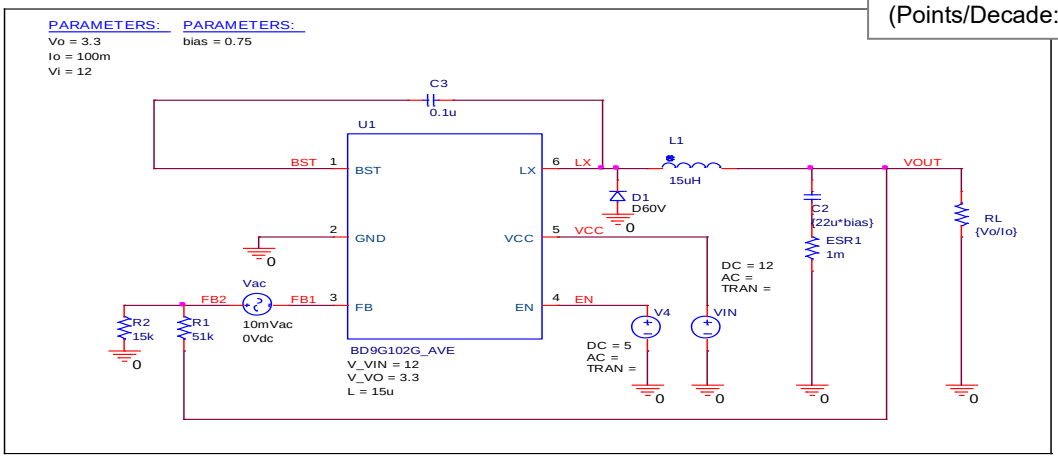

Figure 14.
Simulation Schematic 5

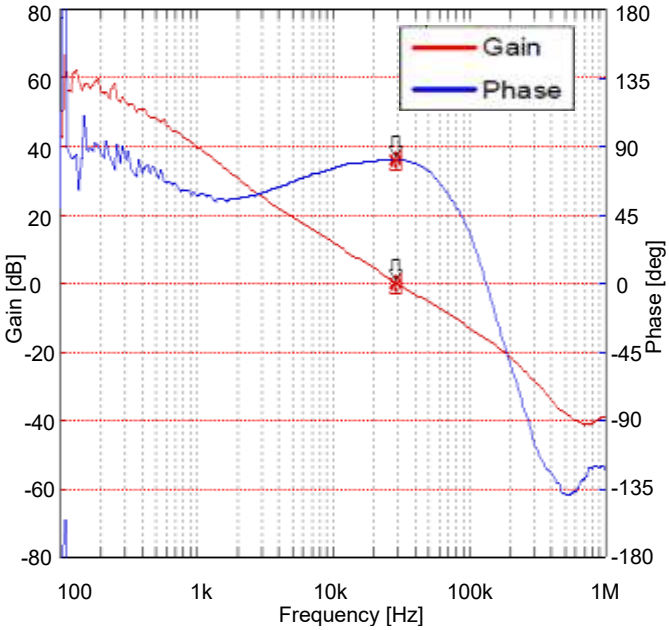

Figure 15.
Frequency Characteristic
(VCC = 12 V, VOUT = 3.3 V, IOUT = 100 mA)
(Measured Waveform)

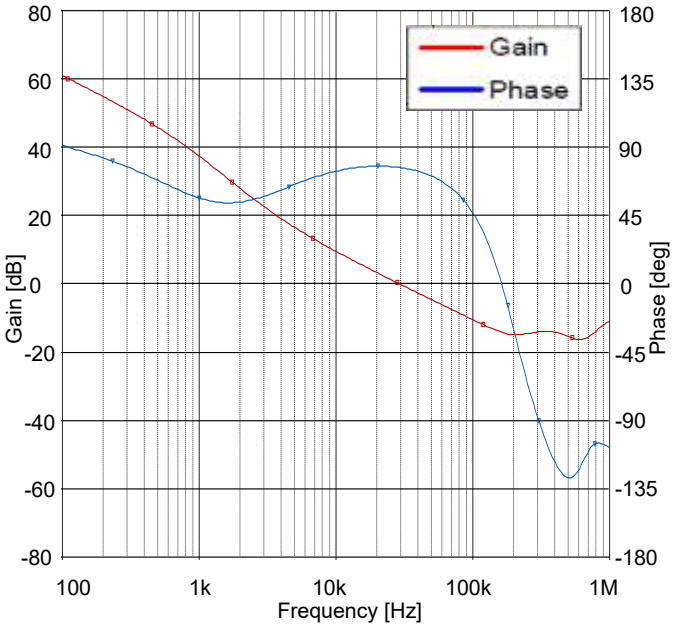

Figure 16.
Frequency Characteristic
(VCC = 12 V, VOUT = 3.3 V, IOUT = 100 mA)
(SPICE Simulation)

Table 9 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Phase Margin	81.2	76.7	degree	-5.5 %	V_{CC} = 12 V, V_{OUT} = 3.3 V, I_{OUT} = 100 mA
Crossover Frequency	28.8	29	kHz	0.7 %	

(Note 1) The above data is based on a specific sample and it is not a guaranteed value.
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

6. Frequency Characteristic (V_{CC} = 12 V, V_{OUT} = 3.3 V, I_{OUT} = 500 mA)

Simulation Setting
Type: AC
Frequency Range:
100 Hz to 1 MHz
(Points/Decade: 20)

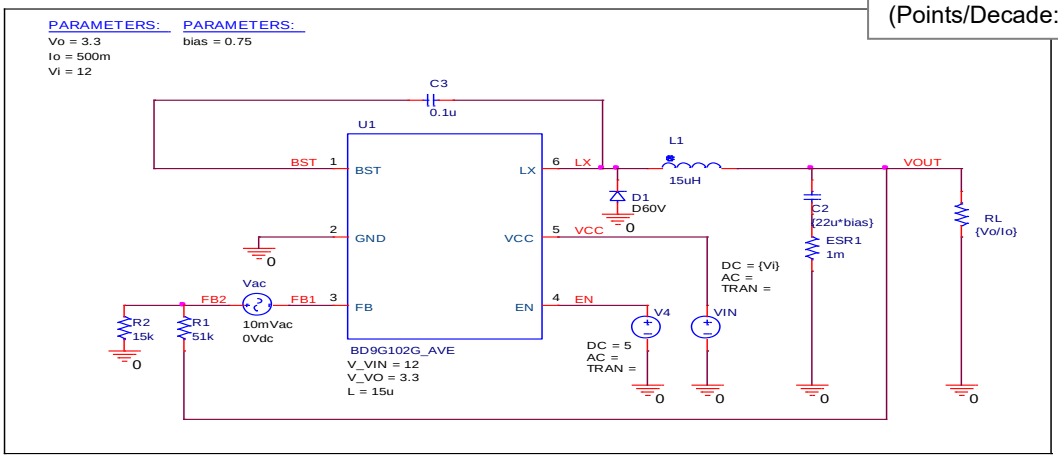

Figure 17.
Simulation Schematic 6

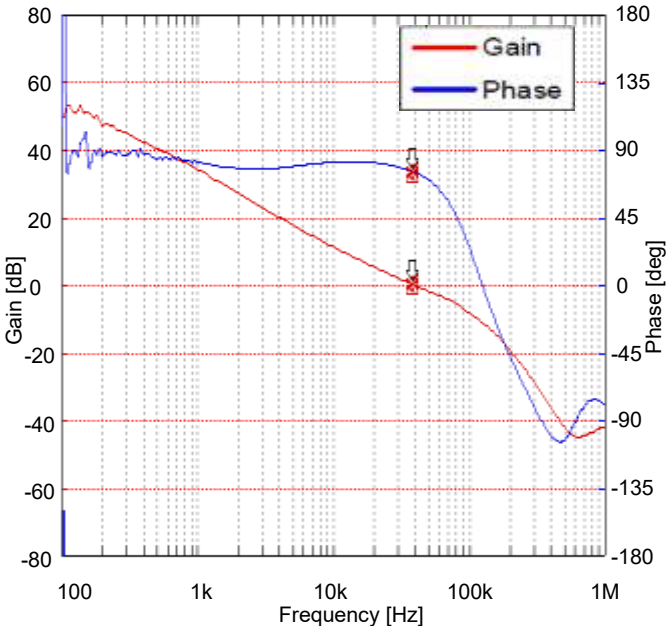

Figure 18.
Frequency Characteristic
(VCC = 12 V, VOUT = 3.3 V, IOUT = 500 mA)
(Measured Waveform)

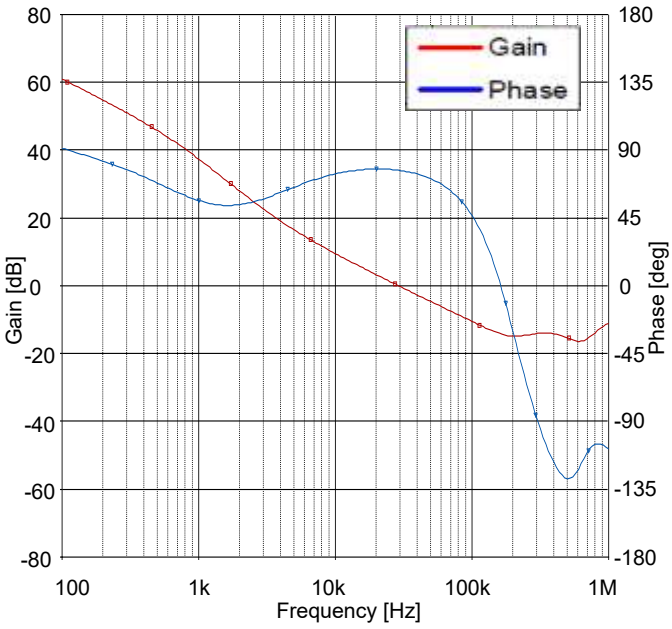

Figure 19.
Frequency Characteristic
(VCC = 12 V, VOUT = 3.3 V, IOUT = 500 mA)
(SPICE Simulation)

Table 10 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Phase Margin	81.2	79	degree	-2.7 %	V_{CC} = 12 V, V_{OUT} = 3.3 V, I_{OUT} = 500 mA
Crossover Frequency	28.8	29	kHz	0.7 %	

(Note 1) The above data is based on a specific sample and it is not a guaranteed value.
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

7. Frequency Characteristic (V_{CC} = 18 V, V_{OUT} = 5 V, I_{OUT} = 100 mA)

Simulation Setting
Type: AC
Frequency Range:
100 Hz to 1 MHz
(Points/Decade: 20)

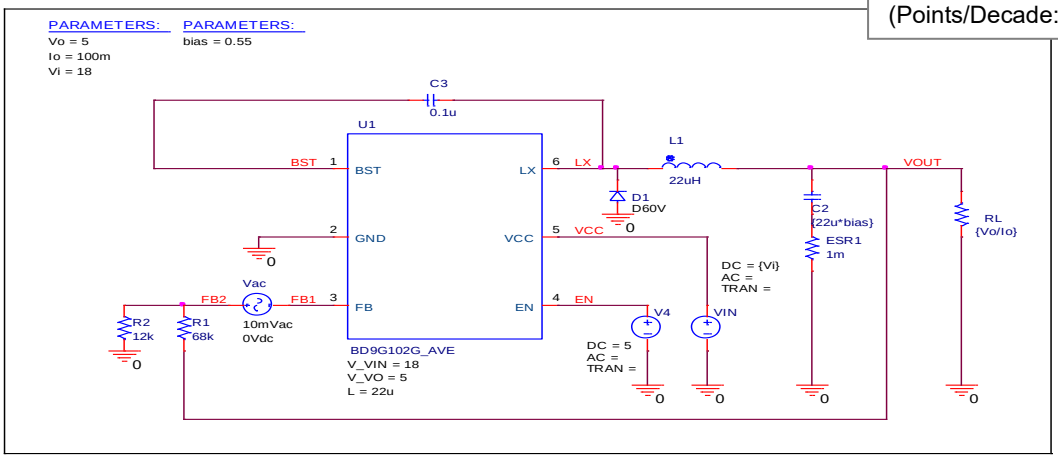

Figure 20.
Simulation Schematic 7

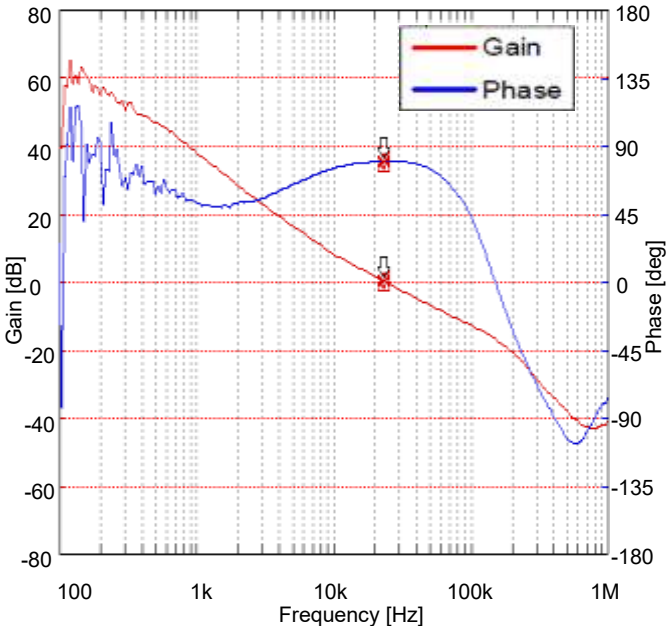

Figure 21.
Frequency Characteristic
(VCC = 18 V, VOUT = 5 V, IOUT = 100 mA)
(Measured Waveform)

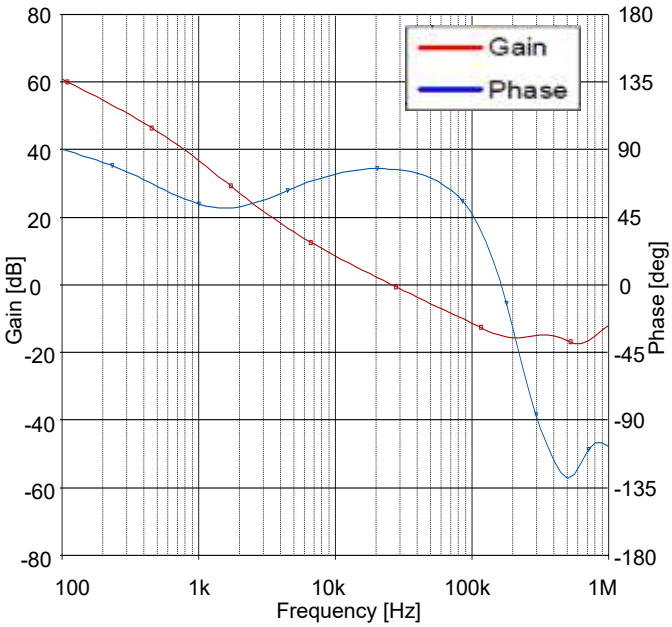

Figure 22.
Frequency Characteristic
(VCC = 18 V, VOUT = 5 V, IOUT = 100 mA)
(SPICE Simulation)

Table 11 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Phase Margin	80.1	77	degree	-3.9 %	V_{CC} = 18 V, V_{OUT} = 5 V, I_{OUT} = 100 mA
Crossover Frequency	23	26.2	kHz	13.9 %	

(Note 1) The above data is based on a specific sample and it is not a guaranteed value.
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

8. Frequency Characteristic (V_{CC} = 18 V, V_{OUT} = 5 V, I_{OUT} = 500 mA)

Simulation Setting
Type: AC
Frequency Range:
100 Hz to 1 MHz
(Points/Decade: 20)

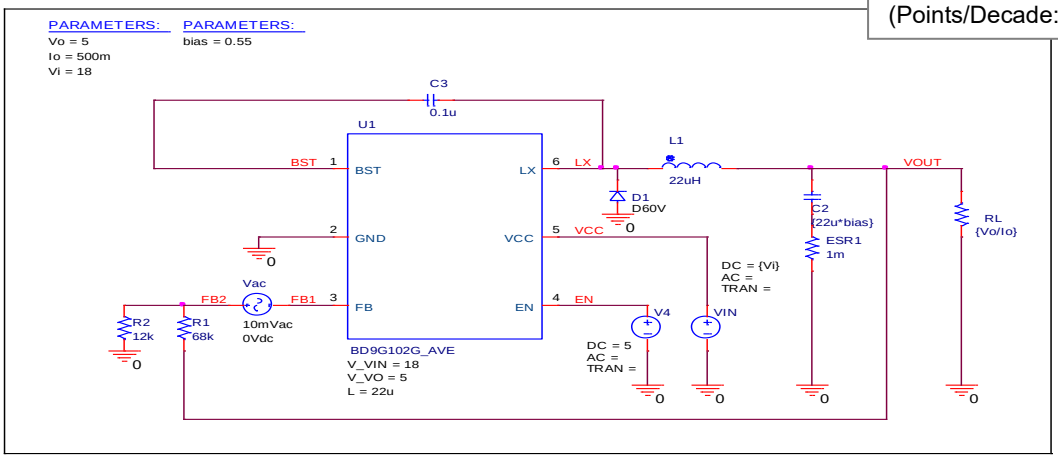

Figure 23.
Simulation Schematic 8

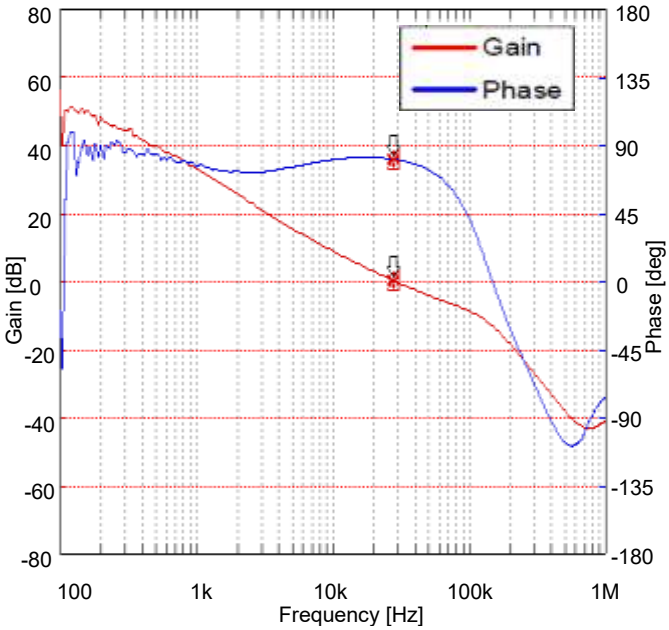

Figure 24.
Frequency Characteristic
(VCC = 18 V, VOUT = 5 V, IOUT = 500 mA)
(Measured Waveform)

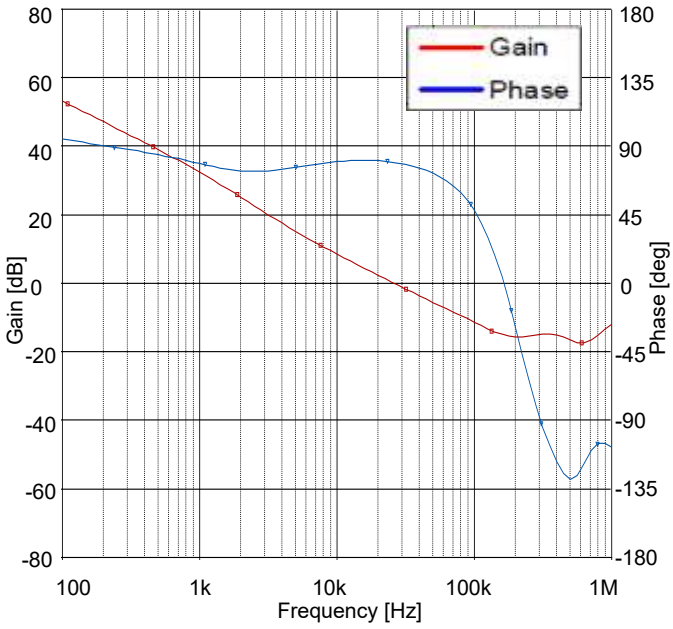

Figure 25.
Frequency Characteristic
(VCC = 18 V, VOUT = 5 V, IOUT = 500 mA)
(SPICE Simulation)

Table 12 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Phase Margin	80.9	85.1	degree	5.2 %	V_{CC} = 18 V, V_{OUT} = 5 V, I_{OUT} = 500 mA
Crossover Frequency	27.5	24	kHz	-12.7 %	

(Note 1) The above data is based on a specific sample and it is not a guaranteed value.
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

Revision History

Date	Revision	Changes
Oct.2021	001	New Release

Notes

1) The information contained herein is subject to change without notice.

2) Before you use our Products, please contact our sales representative and verify the latest specifications :

3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors.
Therefore, in order to prevent personal injury or fire arising from failure, please take safety measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures. ROHM shall have no responsibility for any damages arising out of the use of our Poducts beyond the rating specified by ROHM.

4) Examples of application circuits, circuit constants and any other information contained herein are provided only to illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

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6) The Products specified in this document are not designed to be radiation tolerant.

7) For use of our Products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a ROHM representative : transportation equipment (i.e. cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, servers, solar cells, and power transmission systems.

8) Do not use our Products in applications requiring extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters.

9) ROHM shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions and specifications contained herein.

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ROHM SEMICONDUCTOR

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