

## SPICE Modeling Report

# 300 mA Variable / Fixed Output LDO Regulators BDxxGA3 Series

## General Description

In this report, the characteristics that can be confirmed by the simulation using the SPICE model of the regulator IC BDxxGA3 Series will be described.

## Simulation Environment

- Circuit Simulator : PSpice / Cadence Design System, Inc.
- Version Information : 17.4-2019
- OS Information : Windows 10 64-bit Edition

## File Information

- Library File Name : BDxxGA3.lib
- Symbol File Name : BDxxGA3.olb
- Subcircuit and Symbol

**Table 1 Correspondence Table**

Product Name	Subcircuit	Symbol
BDxxGA3MEFJ-LB BDxxGA3MEFJ-M / BDxxGA3VEFJ-M BDxxGA3WEFJ / BDxxGA3WNUX	BD00GA3 (Variable type)	BD00GA3 (Variable type)
	BD15GA3 (1.5 V Fixed Output Voltage)	BD15GA3 (1.5 V Fixed Output Voltage)
	BD18GA3 (1.8 V Fixed Output Voltage)	BD18GA3 (1.8 V Fixed Output Voltage)
	BD25GA3 (2.5 V Fixed Output Voltage)	BD25GA3 (2.5 V Fixed Output Voltage)
	BD30GA3 (3.0 V Fixed Output Voltage)	BD30GA3 (3.0 V Fixed Output Voltage)
	BD33GA3 (3.3 V Fixed Output Voltage)	BD33GA3 (3.3 V Fixed Output Voltage)
	BD50GA3 (5.0 V Fixed Output Voltage)	BD50GA3 (5.0 V Fixed Output Voltage)
	BD60GA3 (6.0 V Fixed Output Voltage)	BD60GA3 (6.0 V Fixed Output Voltage)
	BD70GA3 (7.0 V Fixed Output Voltage)	BD70GA3 (7.0 V Fixed Output Voltage)
	BD80GA3 (8.0 V Fixed Output Voltage)	BD80GA3 (8.0 V Fixed Output Voltage)
	BD90GA3 (9.0 V Fixed Output Voltage)	BD90GA3 (9.0 V Fixed Output Voltage)
	BDJ0GA3 (10.0 V Fixed Output Voltage)	BDJ0GA3 (10.0 V Fixed Output Voltage)
	BDJ2GA3 (12.0 V Fixed Output Voltage)	BDJ2GA3 (12.0 V Fixed Output Voltage)

## Caution

- These model characteristics are specifically at  $T_a = 25\text{ }^{\circ}\text{C}$ . 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.

Symbol image and Pin definition

Spice Model Symbol image

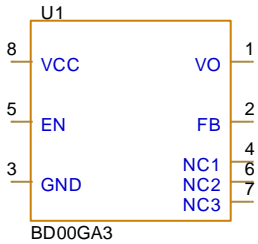


Figure 1 Symbol of BD00GA3 (Variable type)

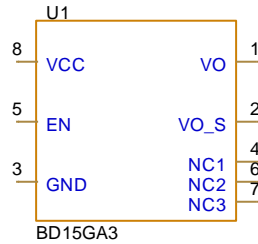


Figure 2 Symbol of BD15GA3 (Fixed type)

Table 2 Subcircuit Pin Table			
Pin No.	Pin Name	Pin No.	Pin Name
1.	VO	5.	EN
2.	FB / VO_S	6.	NC2
3.	GND	7.	NC3
4.	NC1	8.	VCC

Verifiable Characteristics

■

Electrical Characteristics (vs. Datasheet) .....3

■

Characteristic in SPICE (vs. Measured Waveform).....4

➤

BD00GA3

✓

VCC-VO.....4

✓

OCP.....5

✓

IO-ICC .....6

✓

Minimum Dropout Voltage.....7

✓

PSRR.....8

✓

Load Transient Response (IO = 0 A to 0.3 A).....9

✓

Load Transient Response (IO = 0.3 A to 0 A).....10

## Electrical Characteristics (vs. Datasheet)

Table 3 Electrical Characteristics Comparison

(Unless otherwise specified,  $V_{EN} = 3\text{ V}$ ,  $V_{CC} = 6\text{ V}$ ,  $R_1 = 43\text{ k}\Omega$ ,  $R_2 = 8.2\text{ k}\Omega$ ,  $T_a = 25\text{ }^\circ\text{C}$ )

Parameter	Modeled (Note 1)	Design Value		Unit	Error	Condition
		Datasheet	SPICE			
Circuit current at shutdown mode	Yes	0	0	$\mu\text{A}$	0%	$V_{EN} = 0\text{ V}$ , OFF mode
Bias Current	Yes	600	600	$\mu\text{A}$	0%	
Line Regulation	No	25	-	mV	-	$V_{CC} = (V_o + 0.9\text{ V})$ to $14.0\text{ V}$
Load Regulation	No	25	-	mV	-	$I_o = 0\text{ A}$ to $0.3\text{ A}$
Minimum Dropout Voltage	Yes	0.45	0.45	V	0%	$V_{CC} = 5\text{ V}$ , $I_o = 0.3\text{ A}$
Output reference voltage (Variable type)	Yes	0.8	0.8	V	0%	$I_o = 0\text{ mA}$
Output voltage (Fixed type)	Yes	$V_o$	$V_o$	V	0%	$I_o = 0\text{ mA}$
EN Low voltage	Yes	-	1.69	V	-	
EN High voltage	Yes	-	1.70	V	-	
EN Bias current	Yes	3	3	$\mu\text{A}$	0%	

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

Characteristic in SPICE (vs. Measured Waveform)

1. V<sub>CC</sub>-V<sub>O</sub>

Simulation Setting  
Type: DC  
Sweep Range: V<sub>CC</sub> = 0 V to 14.0 V  
(Increment: 1 mV)

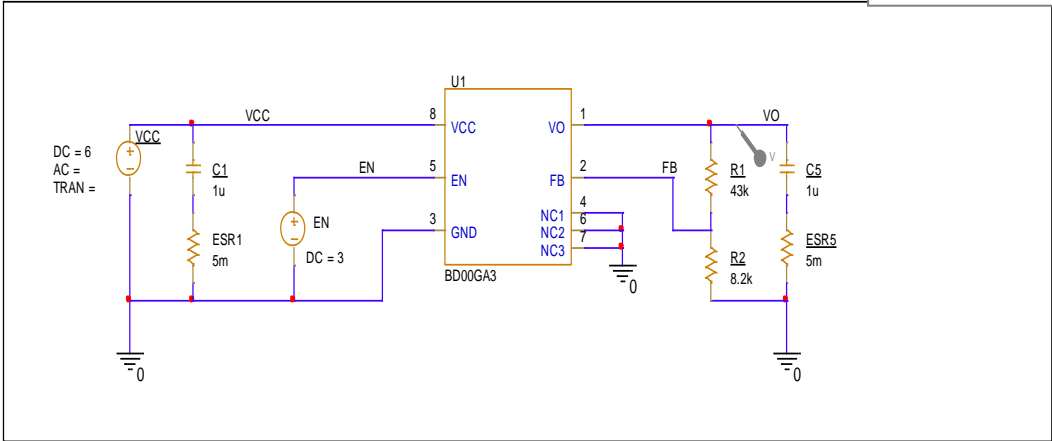


Figure 3.  
Simulation Schematic 1

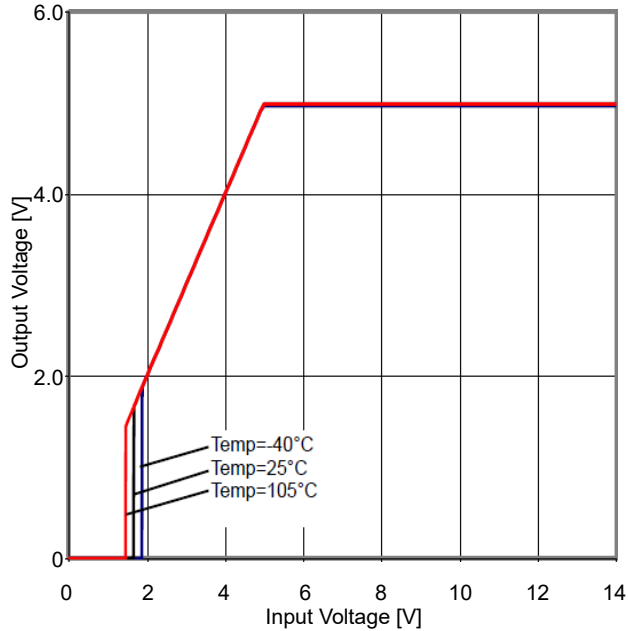


Figure 4.  
V<sub>CC</sub>-V<sub>O</sub>  
(Measured Waveform)

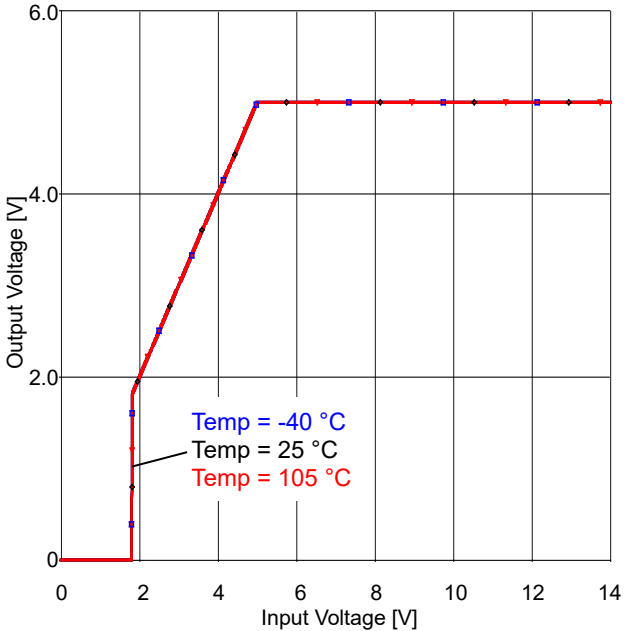


Figure 5.  
V<sub>CC</sub>-V<sub>O</sub>  
(SPICE Simulation)

Table 4 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Output Voltage	5.0	5.0	V	0.0 %	V <sub>EN</sub> = 3 V, V <sub>CC</sub> = 0 V to 14.0 V, I <sub>O</sub> = 0 mA, C <sub>O</sub> = 1 μF, Temp = 25 °C
UVLO ON/OFF Threshold	1.7	1.8	V	5.9 %	

(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.

2. OCP

Simulation Setting  
Type: Transient  
Run Time: 100 s

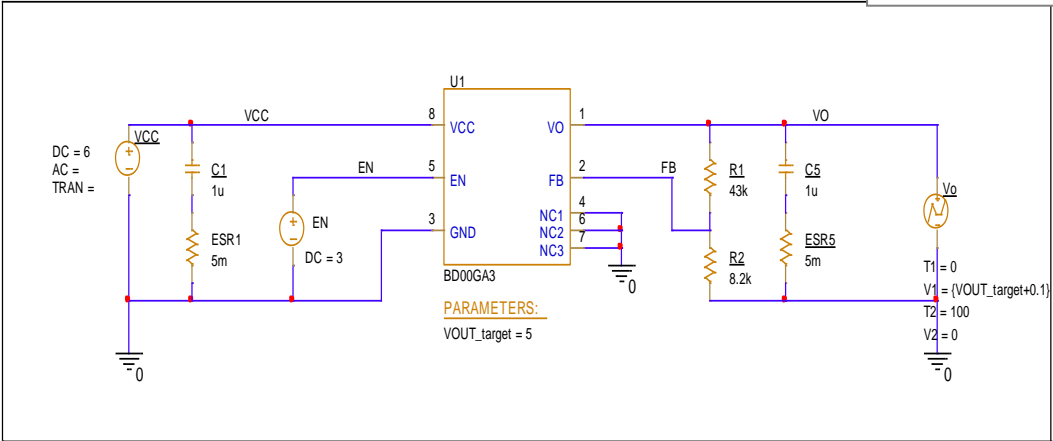


Figure 6.  
Simulation Schematic 2

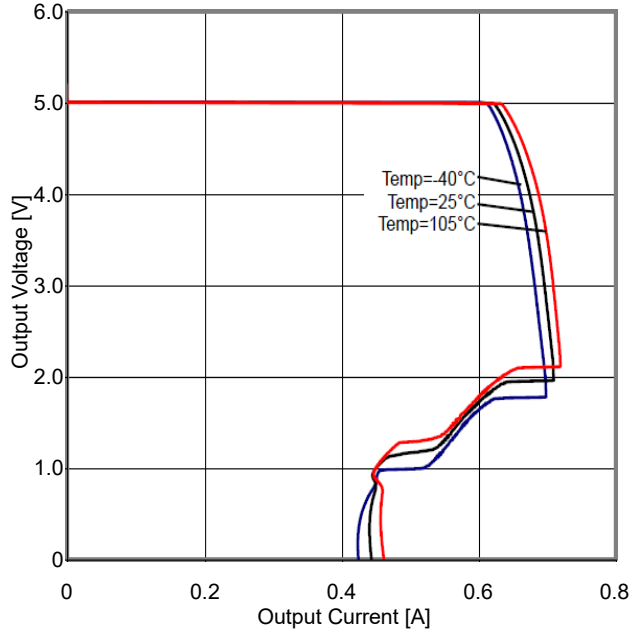


Figure 7.  
OCP  
(Measured Waveform)

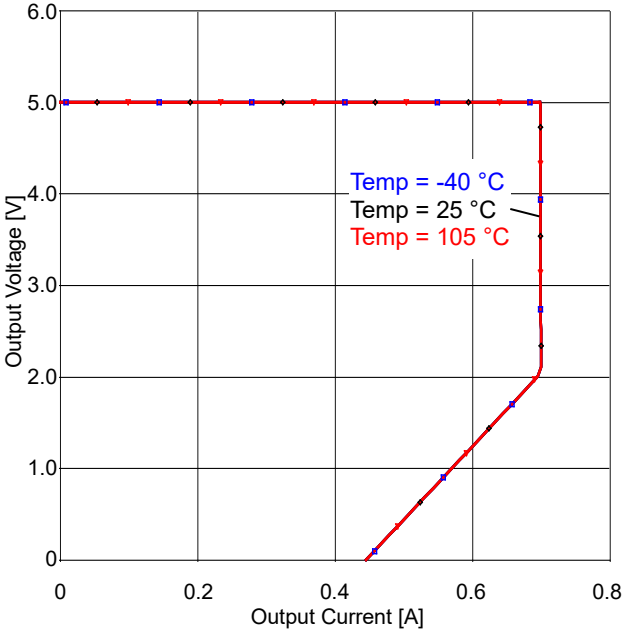


Figure 8.  
OCP  
(SPICE Simulation)

Table 5 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
OCP detect current	0.70	0.70	A	0.0 %	V <sub>EN</sub> = 3 V, V <sub>CC</sub> = 6 V, V <sub>O</sub> = 5.1 V to 0 V, C <sub>O</sub> = 1 μF, Temp = 25 °C
Current at Shorted Circuit	0.45	0.44	A	-2.2 %	

(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. Io-Icc

Simulation Setting

Type: DC

Sweep Range: Io = 0 A to 0.3 A

(Increment: 1 mA)

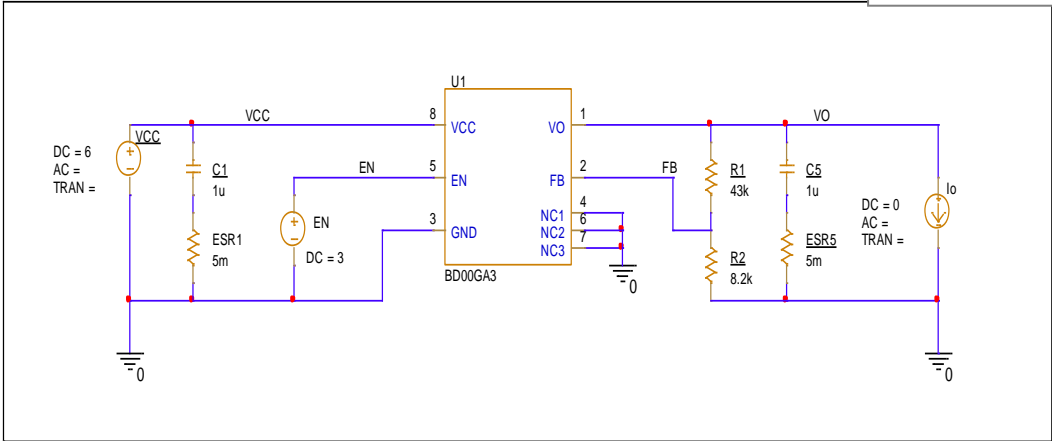


Figure 9.  
Simulation Schematic 3

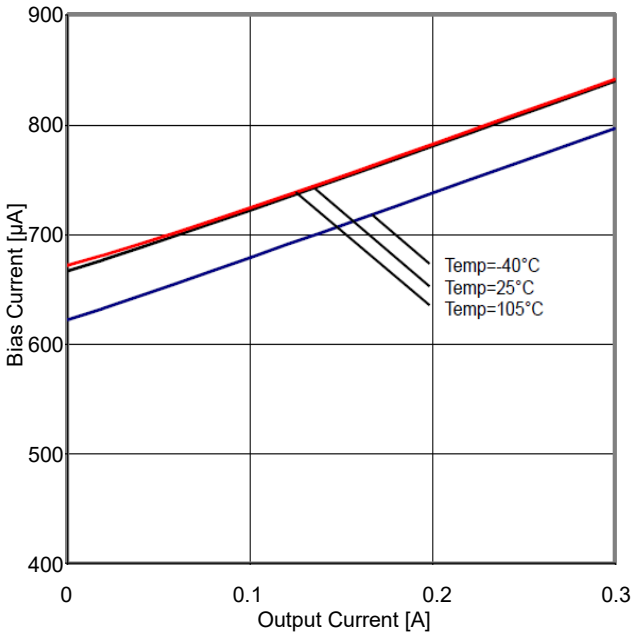


Figure 10.  
IO-ICC  
(Measured Waveform)

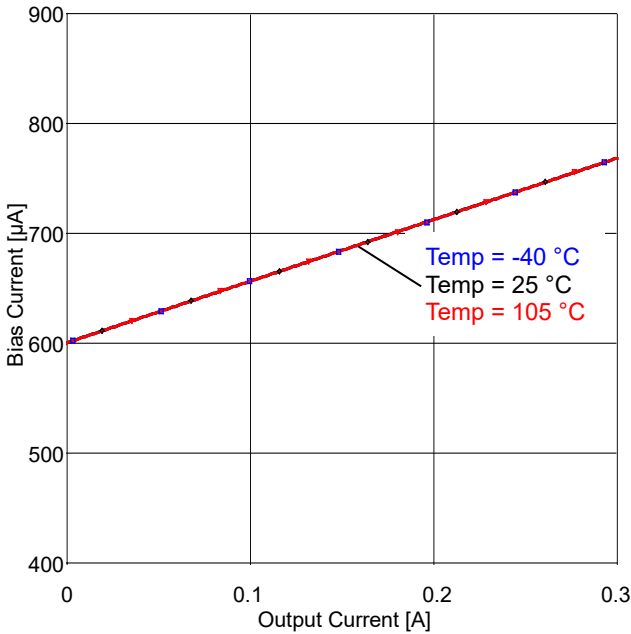


Figure 11.  
IO-ICC  
(SPICE Simulation)

Table 6 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Bias Current	660	600	μA	-9.1 %	V <sub>EN</sub> = 3 V, V <sub>CC</sub> = 6 V, I <sub>o</sub> = 0 A, C <sub>o</sub> = 1 μF, Temp = 25 °C
	840	768	μA	-8.6 %	V <sub>EN</sub> = 3 V, V <sub>CC</sub> = 6 V, I <sub>o</sub> = 0.3 A, C <sub>o</sub> = 1 μF, Temp = 25 °C

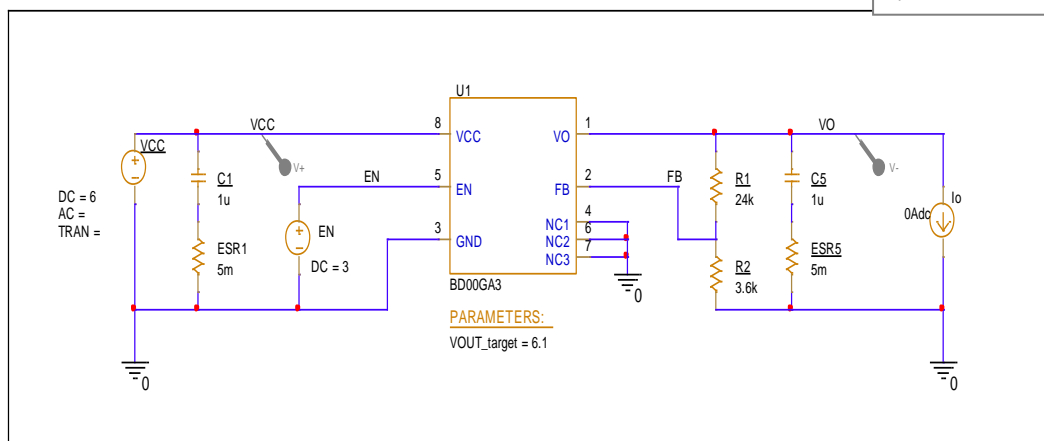
(Note 1) The above data is based on a specific sample and it is not a guaranteed value.  
(Note 2) These characteristics depend on some dynamic characteristics of external components, input signal speed, PCB pattern and mounting condition of each on-board parts.

#### 4. Minimum Dropout Voltage

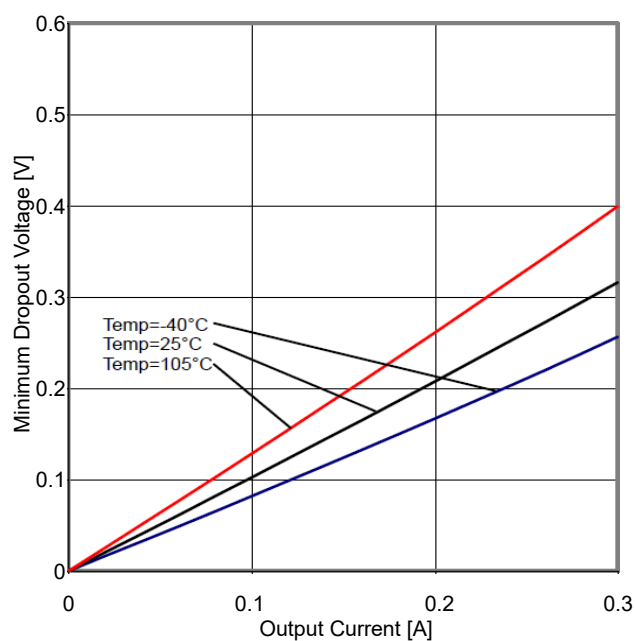
### Simulation Setting

Type: DC

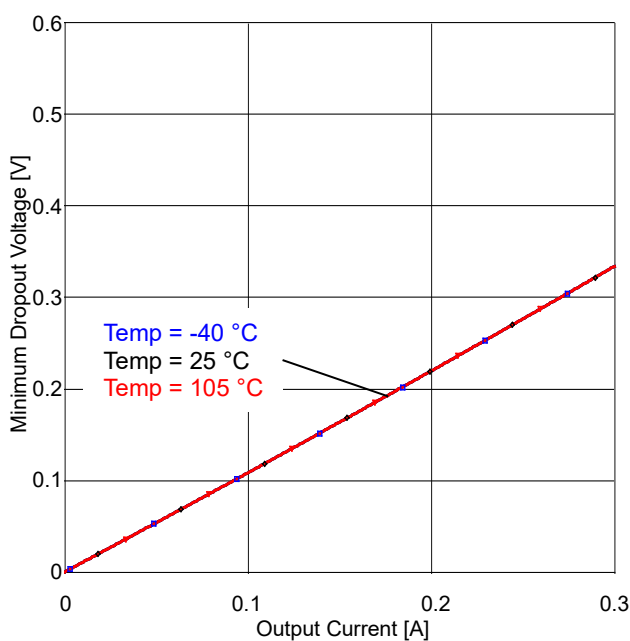
Sweep Range:  $I_0 = 0 \text{ A}$  to  $0.3 \text{ A}$   
(Increment:  $1 \text{ mA}$ )



**Figure 12.**  
**Simulation Schematic 4**



**Figure 13.**  
**Minimum Dropout Voltage**  
**(Measured Waveform)**



**Figure 14.**  
**Minimum Dropout Voltage**  
**(SPICE Simulation)**

### Table 7 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Minimum Dropout Voltage	0.32	0.33	V	3.1 %	V <sub>EN</sub> = 3 V, V <sub>CC</sub> = 6 V, I <sub>O</sub> = 0.3 A, C <sub>O</sub> = 1 μF, Temp = 25 °C

(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. PSRR

Simulation Setting

Type: AC

Frequency Range:

100 Hz to 100 kHz

(Points/Decade: 20)

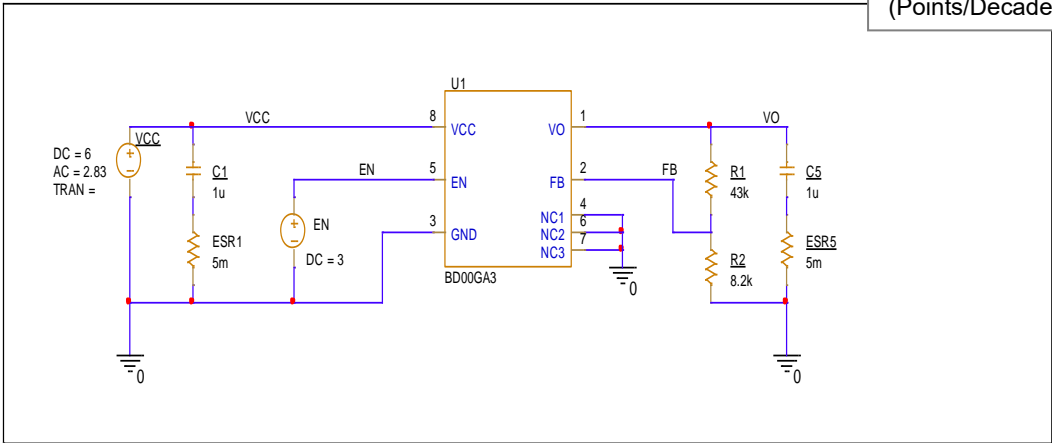


Figure 15.  
Simulation Schematic 5

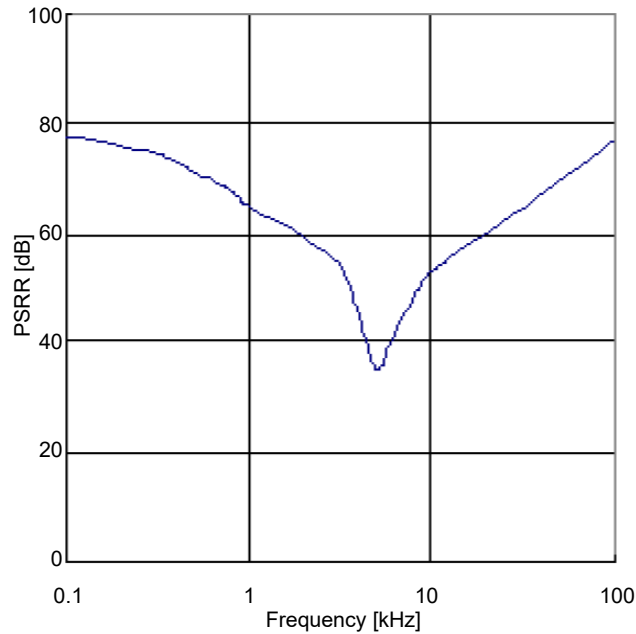


Figure 16.  
PSRR  
(Measured Waveform)

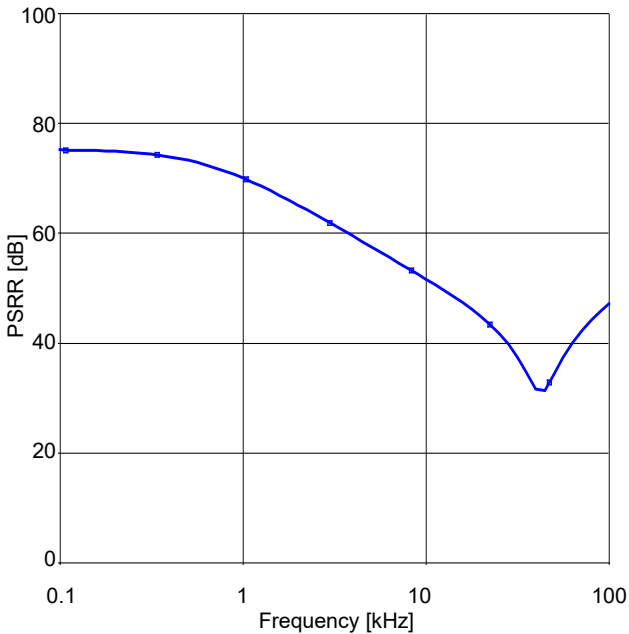


Figure 17.  
PSRR  
(SPICE Simulation)

Table 8 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Ripple Rejection	75	75	dB	0.0 %	f = 120 Hz, ein = 1 Vrms, Io = 0 mA, Co = 1 μF, Temp = 25 °C

(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. Load Transient Response ( $I_o = 0\text{ A}$  to  $0.3\text{ A}$ )

Simulation Setting  
Type: Transient  
Run Time: 22 ms  
(Maximum Step Size: 20 ns)

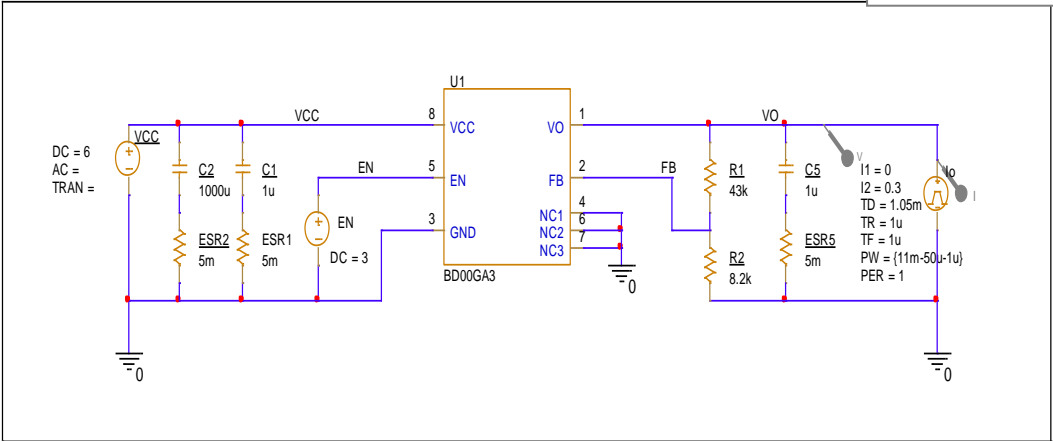


Figure 18.  
Simulation Schematic 6

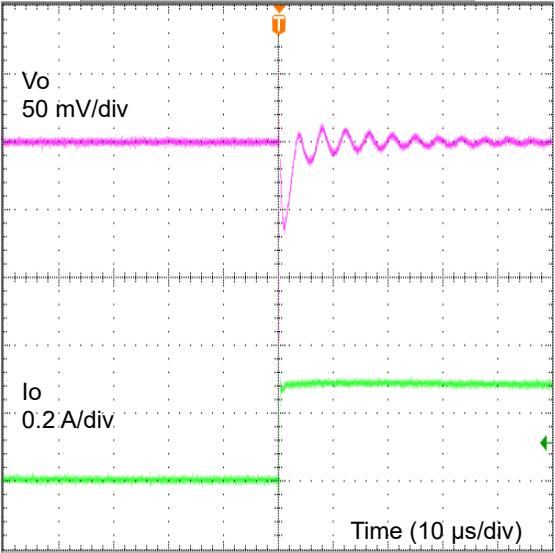


Figure 19.  
Load Transient Response ( $I_o = 0\text{ A}$  to  $0.3\text{ A}$ )  
(Measured Waveform)

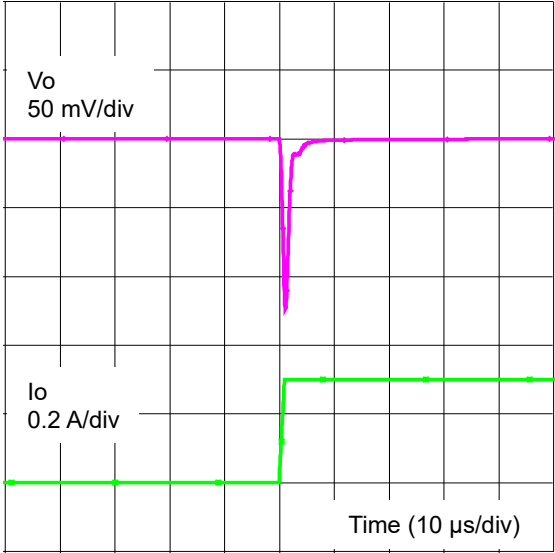


Figure 20.  
Load Transient Response ( $I_o = 0\text{ A}$  to  $0.3\text{ A}$ )  
(SPICE Simulation)

Table 9 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Undershoot	70	124	mV	77.1 %	$V_{EN} = 3\text{ V}$ , $V_{CC} = 6\text{ V}$ , $V_O = 5\text{ V}$ , $I_o = 0\text{ A} \rightarrow 0.3\text{ A}$ ( $T_r = T_f = 1\text{ }\mu\text{s}$ ), $C_O = 1\text{ }\mu\text{F}$ , Temp = $25\text{ }^\circ\text{C}$

(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. Load Transient Response ( $I_O = 0.3\text{ A}$  to  $0\text{ A}$ )

Simulation Setting  
Type: Transient  
Run Time: 22 ms  
(Maximum Step Size: 20 ns)

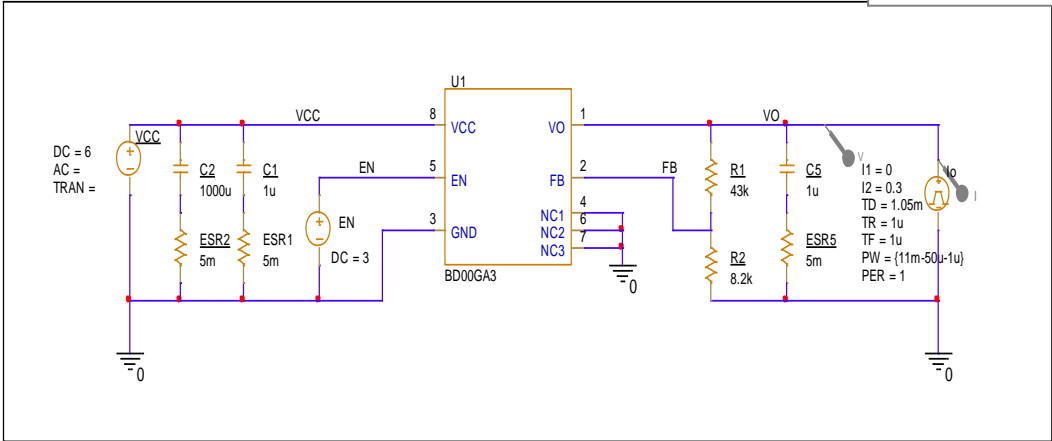


Figure 21.  
Simulation Schematic 7

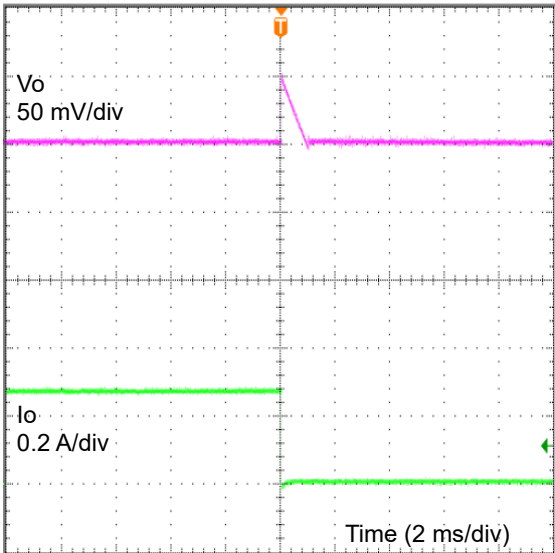


Figure 22.  
Load Transient Response ( $I_O = 0.3\text{ A}$  to  $0\text{ A}$ )  
(Measured Waveform)

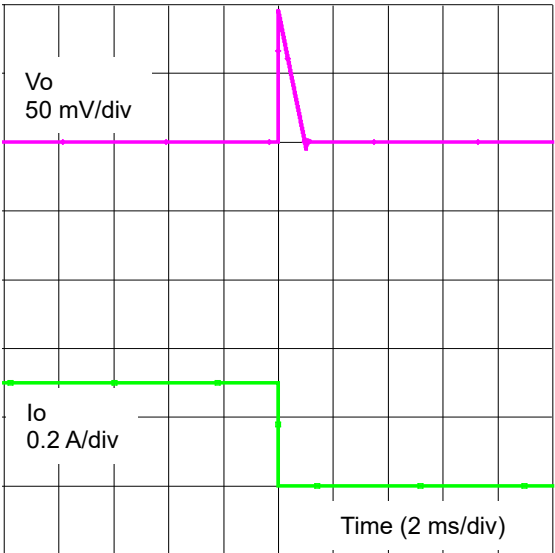


Figure 23.  
Load Transient Response ( $I_O = 0.3\text{ A}$  to  $0\text{ A}$ )  
(SPICE Simulation)

Table 10 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Overshoot	50	96	mV	92.0 %	$V_{EN} = 3\text{ V}$ , $V_{CC} = 6\text{ V}$ , $V_O = 5\text{ V}$ , $I_O = 0.3\text{ A} \rightarrow 0\text{ A}$ ( $T_r = T_f = 1\text{ }\mu\text{s}$ ), $C_O = 1\text{ }\mu\text{F}$ , Temp = $25\text{ }^\circ\text{C}$

(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
Jan.2024	001	New Release