SPICE Modeling Report

For Automotive 300 mA CMOS LDO Regulators BUxxJA3DG-C Series

General Description

In this report, the characteristics that can be confirmed by the simulation using the SPICE model of the regulator IC BUxxJA3DG-C series 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 : BUxxJA3Dx.lib
- Symbol File Name : BUxxJA3Dx.olb
- Subcircuit and Symbol

Table 1 Correspondence Table

Product Name	Subcircuit	Symbol
BU12JA3DG-C	BU12JA3DG	BU12JA3DG
BU15JA3DG-C	BU15JA3DG	BU15JA3DG
BU18JA3DG-C	BU18JA3DG	BU18JA3DG
BU25JA3DG-C	BU25JA3DG	BU25JA3DG
BU30JA3DG-C	BU30JA3DG	BU30JA3DG
BU33JA3DG-C	BU33JA3DG	BU33JA3DG

(Note 1) Symbol with _CAD at the end of the name conform to IEC60617, and were designed so that signals flow from left to right.

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.

BUxxJA3DG-C Spice Model

■ Pin Information

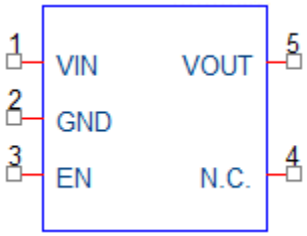


Figure 1 Symbol of BUxxJA3DG

Table 2 Subcircuit Pin Table

Pin No.	Pin Name
1.	VIN
2.	GND
3.	EN
4.	N.C.
5.	VOUT

Verifiable Characteristics

Electrical Characteristics (vs. Datasheet)

Table 3 Electrical Characteristics Comparison for BU18JA3DG

(Unless otherwise specified Tj = 25°C, V_{IN} = 3.0 V, I_{OUT} = 0 mA, V_{EN} = 1.5 V)

Parameter	Modeled *(Note1)*	Design Value		Unit	Error	Condition
		Datasheet	SPICE			
Shutdown Current	Yes	-	0	µA	0%	V_{IN} = 3.0 V, V_{EN} = 0 V
Current Consumption	Yes	37.0	35.97	µA	-2.8%	I_{OUT} ≤ 500 µA
Output Voltage (BU18JA3DG)	Yes	1.800	1.813	V	0.7%	I_{OUT} = 1 mA to 300 mA $V_{OUT} \leq$ 2.5 V V_{IN} = 3.0 V to 5.5 V
Line Regulation	Yes	4	1.3	mV	-68%	I_{OUT} = 10 mA $V_{OUT} \leq$ 2.5 V V_{IN} = 3.0 V to 5.5 V
Load Regulation	Yes	-	1.8	mV	-	I_{OUT} = 1 mA to 300 mA
Dropout Voltage (BU18JA3DG)	Yes	-	0.164	V	-	I_{OUT} = 300 mA V_{OUT} = 1.8 V
Over Current Protection	Yes	450	426	mA	-5.3%	Applied V_{OUT} × 0.95 for the VOUT Pin
Ripple Rejection	Yes	60	64.7	dB	7.8%	V_{RR} = 1 Vp-p, f_{RR} = 1 kHz I_{OUT} = 300 mA, V_{IN} = 5 V
Output Noise	No	30	-	µVrms	-	BW = 10 Hz to 100 kHz V_{OUT} = 1.2 V
Discharge Resistor	Yes	40	40	Ω	0%	V_{IN} = 4.0 V, V_{EN} = 0 V V_{OUT} = 4.0 V
Enable HIGH Voltage	Yes	-	0.87	V	-	
Enable LOW Voltage	Yes	-	0.75	V	-	
Enable Bias Current	Yes	-	0.7	µA	-	V_{IN} = 4.0 V, V_{EN} = 3 V
Thermal Shutdown Temperature	No	175	-	°C	-	
Thermal Shutdown Hysteresis	No	15	-	°C	-	

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

Characteristic in SPICE (vs. Measured Waveform)

1. Shutdown Current (V_{IN} = 3.0 V, V_{EN} = 0 V)

Simulation Setting
Type: DC
Voltage Source: V1
(0V to 6V, 0.01V step)

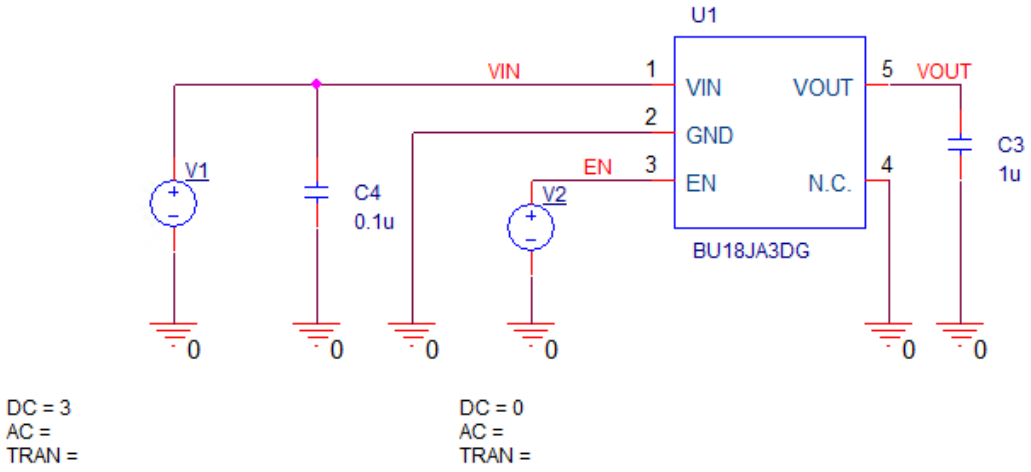


Figure 2.
Simulation Schematic 1

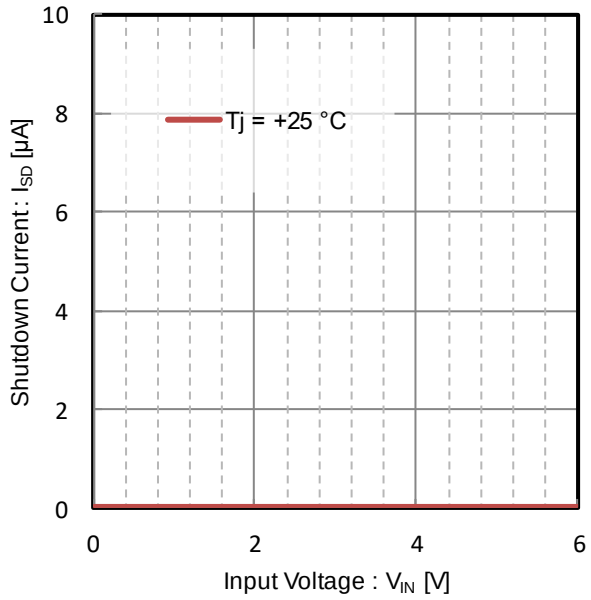


Figure 3.
Shutdown Current (VIN = 3.0 V, VEN = 0 V)
(Measured Waveform)

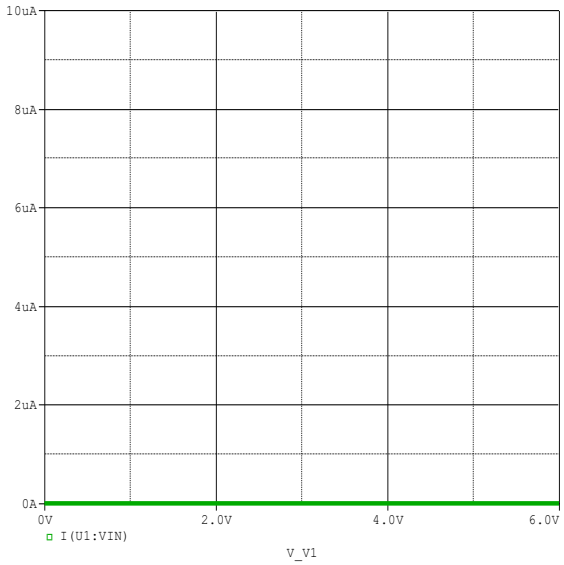


Figure 4.
Shutdown Current (VIN = 3.0 V, VEN = 0 V)
(SPICE Simulation)

Table 4 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Shutdown Current	0	0	µA	-	V_{IN} = 3.0 V, V_{EN} = 0 V, I_{OUT} = 0 A

(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. Current Consumption (V_{IN} = 3.0 V, V_{EN} = 1.5 V)

Simulation Setting
Type: DC
Voltage Source: V1
(0V to 6V, 0.01V step)

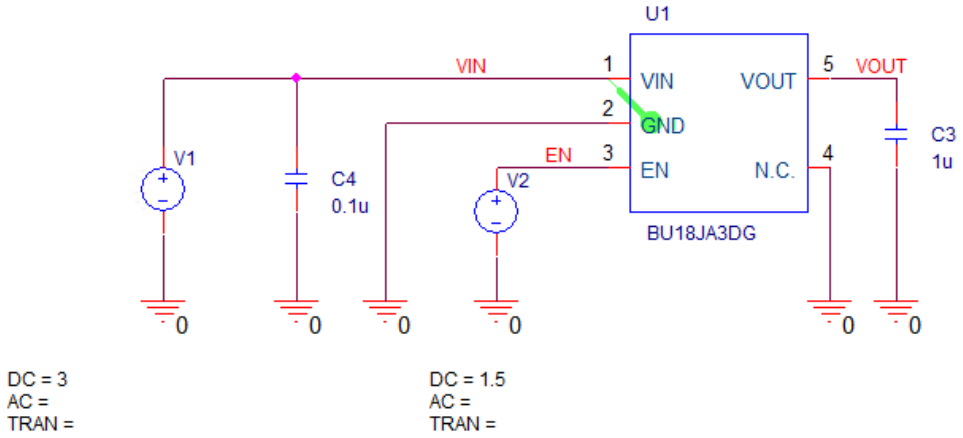
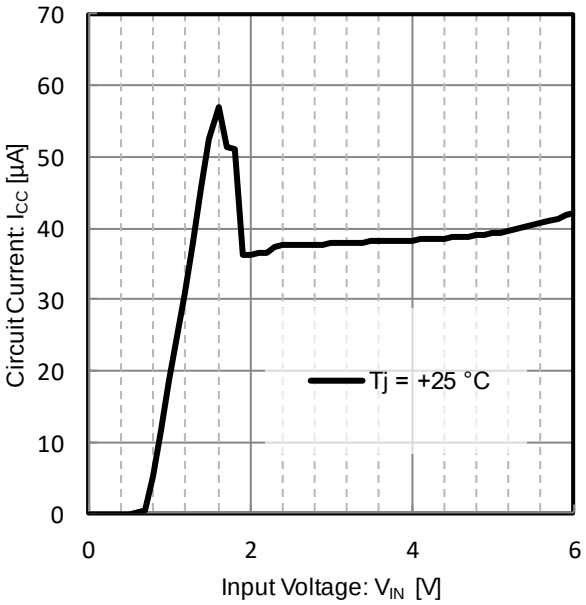


Figure 5.
Simulation Schematic 2



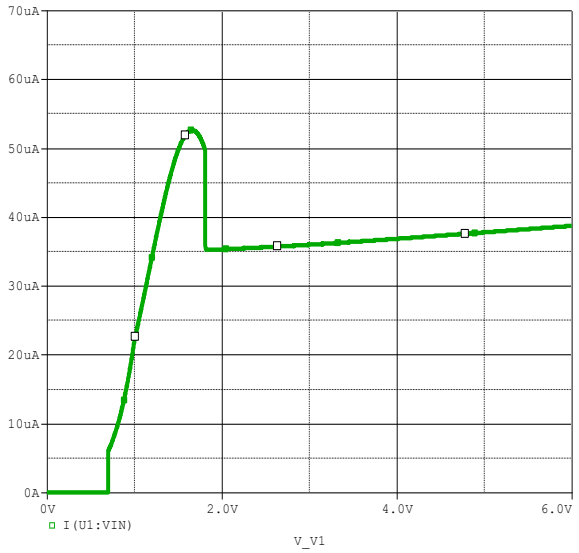


Figure 6.
Current Consumption (VIN = 3.0 V, VEN = 1.5 V)
(Measured Waveform)

Figure 7.
Current Consumption (VIN = 3.0 V, VEN = 1.5 V)
(SPICE Simulation)

Table 5 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Current Consumption	37.40	35.97	µA	-3.8%	V_{IN} = 3.0 V, V_{EN} = 1.5 V, I_{OUT} = 0 A

(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. Output Voltage (V_{IN} = 3.0 V, V_{EN} = 1.5 V, I_{OUT} = 1 mA)

Simulation Setting
Type: DC
Voltage Source: V1
(0V to 6V, 0.01V step)

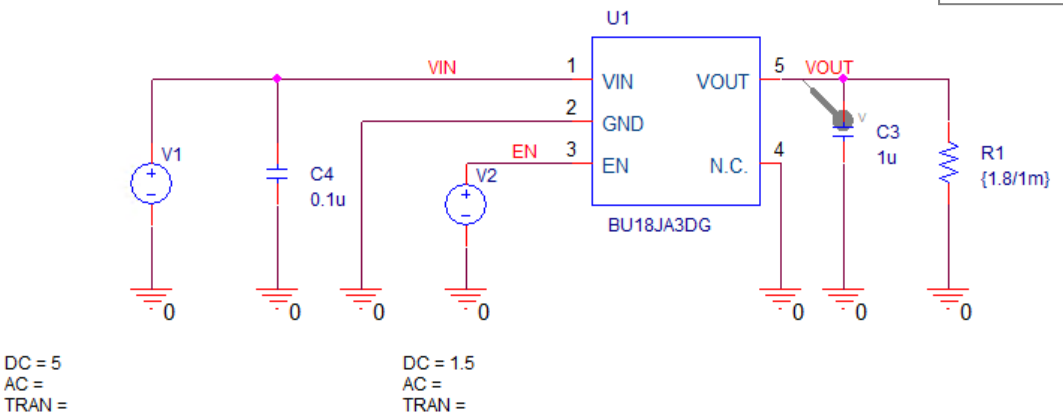


Figure 8.
Simulation Schematic 3

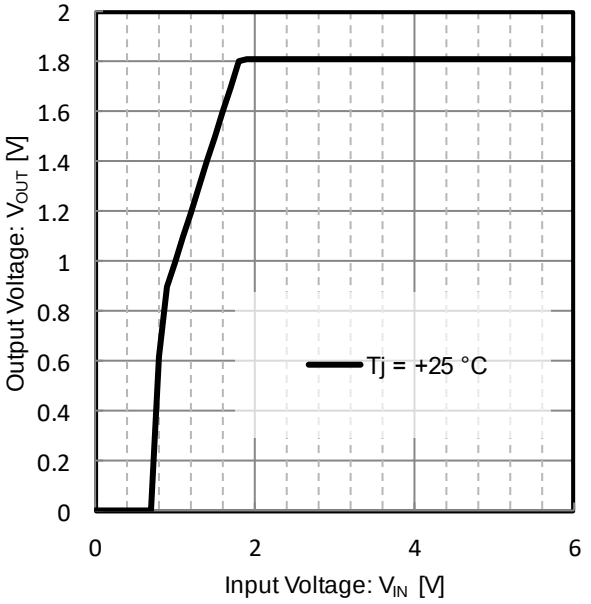


Figure 9.
Output Voltage (VIN = 3.0 V, VEN = 1.5 V, IOUT = 1 mA)
(Measured Waveform)

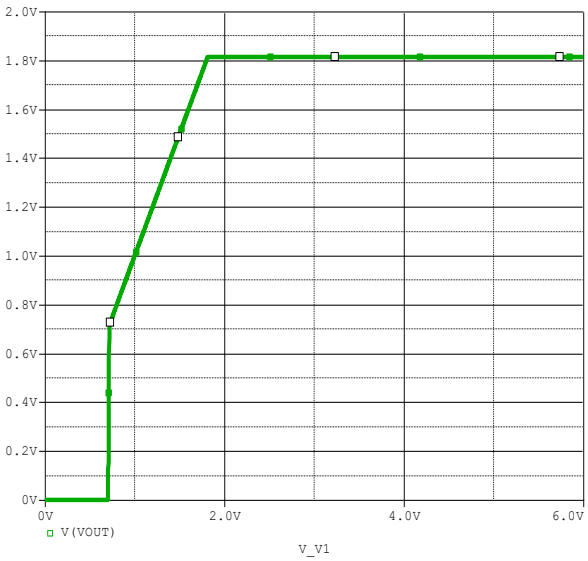


Figure 10.
Output Voltage (VIN = 3.0 V, VEN = 1.5 V, IOUT = 1 mA)
(SPICE Simulation)

Table 6 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Output Voltage	1.809	1.813	V	0.2%	V_{IN} = 3.0 V, V_{EN} = 1.5 V, I_{OUT} = 1 mA

(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. Line Regulation (V_{IN} = 3.0 V to 5.5 V)

Simulation Setting
Type: DC
Voltage Source: V1
(2.3V to 6V, 0.01V step)

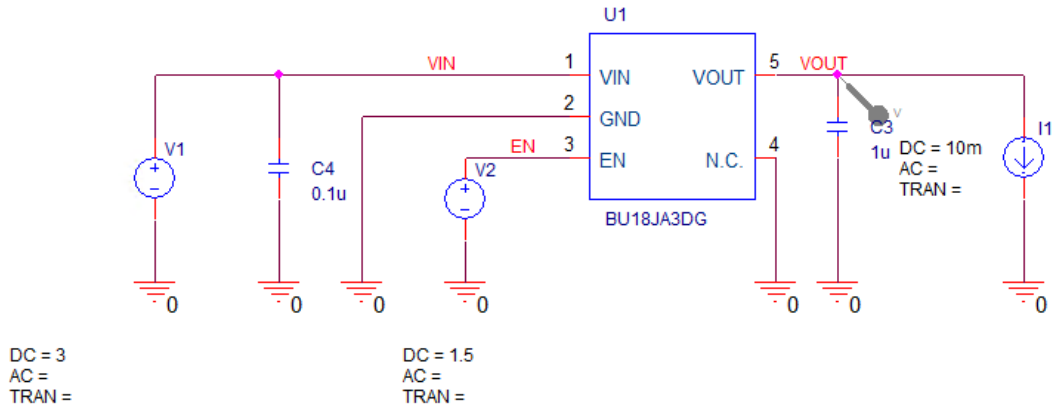


Figure 11.
Simulation Schematic 4

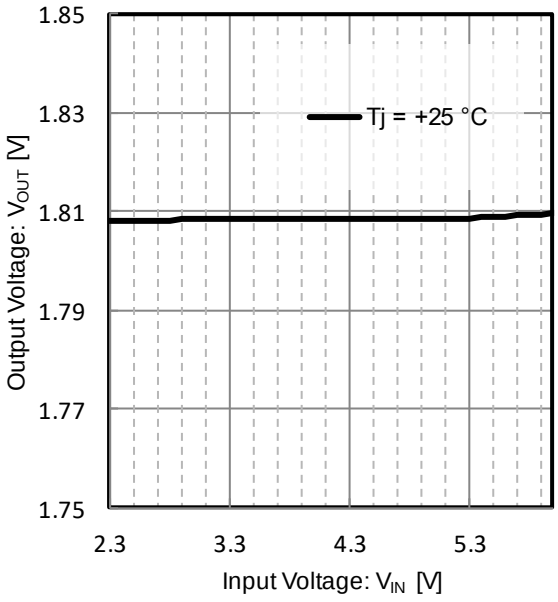


Figure 12.
Line Regulation (VIN = 3.0 V to 5.5 V)
(Measured Waveform)

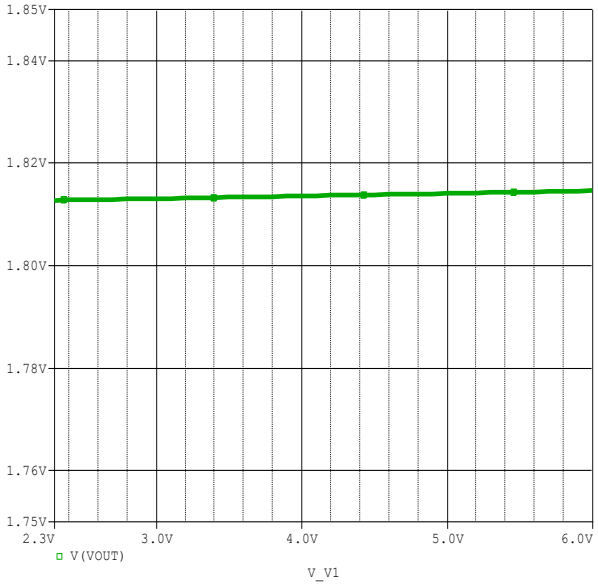


Figure 13.
Line Regulation (VIN = 3.0 V to 5.5 V)
(SPICE Simulation)

Table 7 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Line Regulation	0.9	1.3	mV	44.4 %	V_{IN} = 3.0 V to 5.5 V I_{OUT} = 10 mA

(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. Load Regulation (I_{OUT} = 1 mA to 300 mA)

Simulation Setting
Type: DC
Current Source: I1
(0A to 0.3A, 0.001A step)

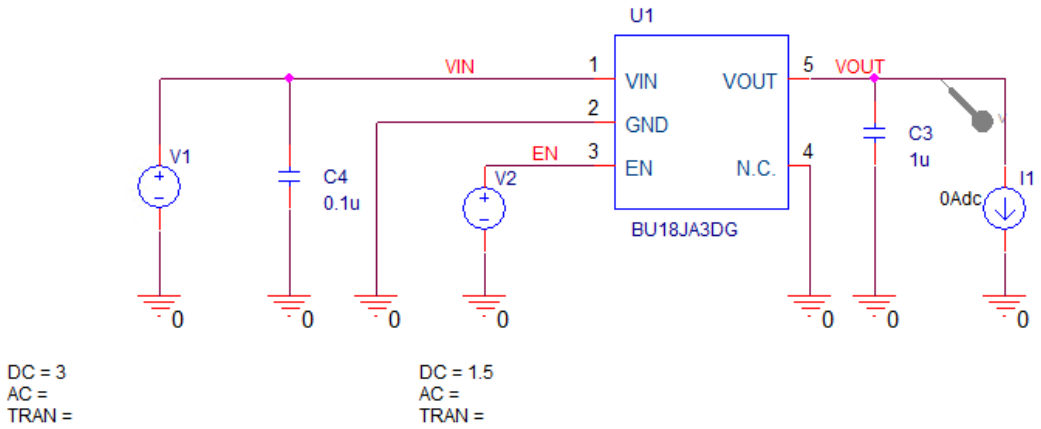


Figure 14.
Simulation Schematic 5

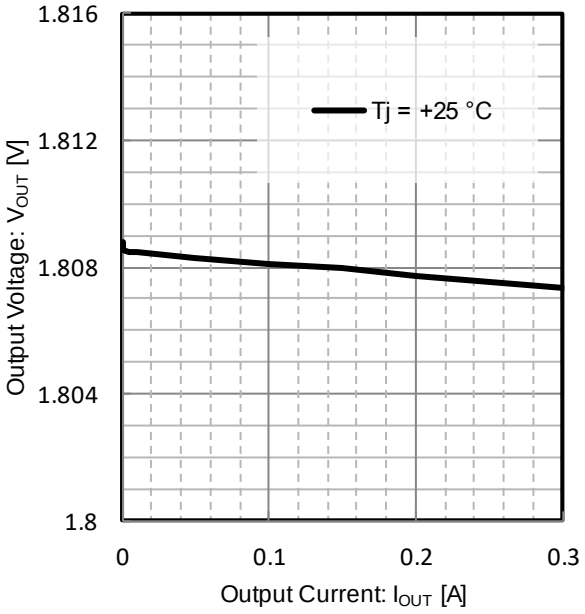


Figure 15.
Load Regulation (IOUT = 1 mA to 300 mA)
(Measured Waveform)

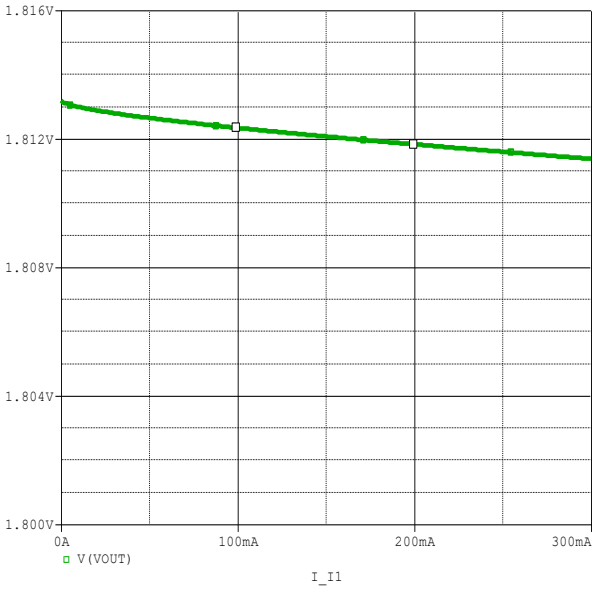


Figure 16.
Load Regulation (IOUT = 1 mA to 300 mA)
(SPICE Simulation)

Table 8 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Load Regulation	1.8	1.8	mV	0.0 %	V_{IN} = 3.0 V I_{OUT} = 1 mA to 300 mA

(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. Dropout Voltage (V_{IN} = 1.764 V)

Simulation Setting
Type: DC
Current Source: I1
(0A to 0.3A, 0.001A step)

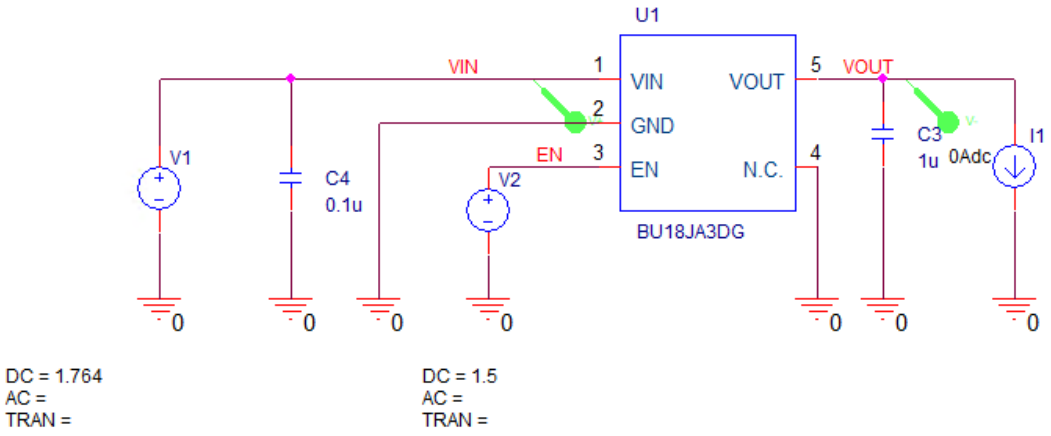


Figure 17.
Simulation Schematic 6

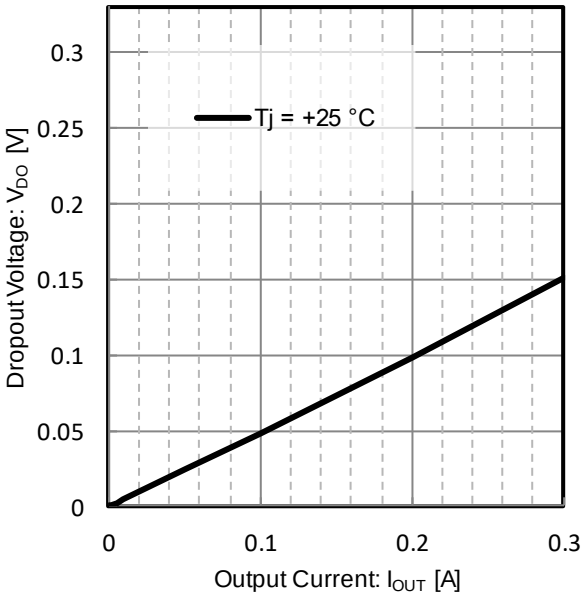


Figure 18.
Dropout Voltage (VIN = 1.764 V)
(Measured Waveform)

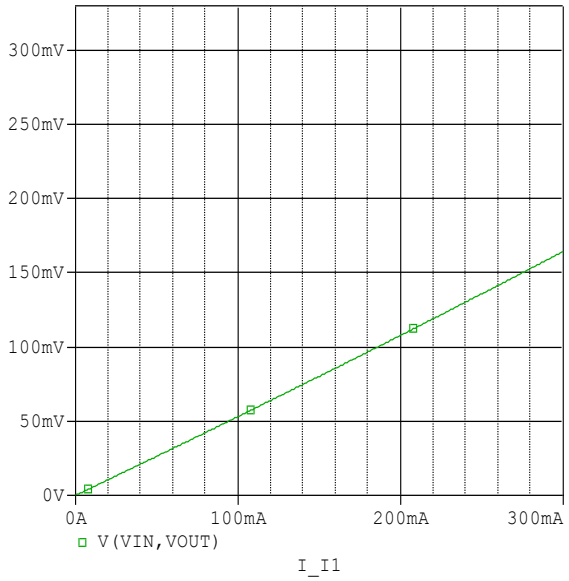


Figure 19.
Dropout Voltage (VIN = 1.764 V)
(SPICE Simulation)

Table 9 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Dropout Voltage	152	164	mV	7.9 %	V_{IN} = 1.764 V I_{OUT} = 300 mA

(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. Over Current Protection

Simulation Setting
Type: DC
Voltage Source: V3
(2.0V to 0V, -0.01V step)

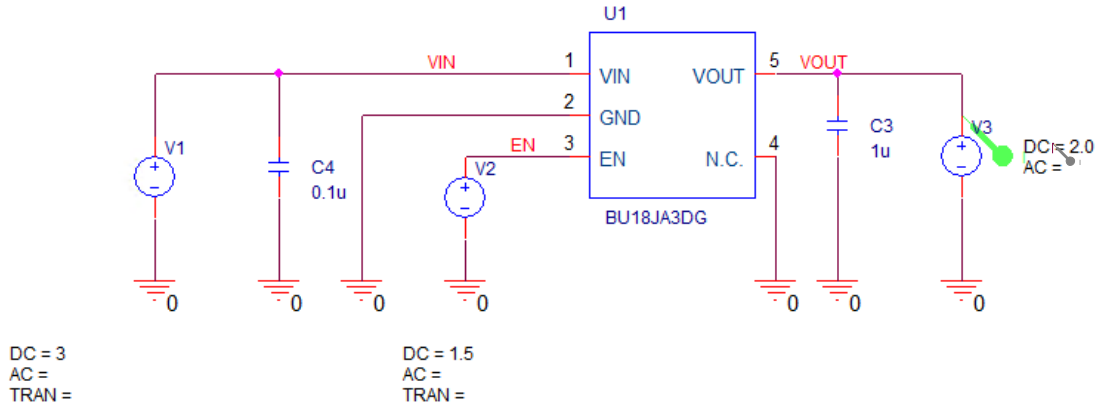


Figure 20.
Simulation Schematic 7

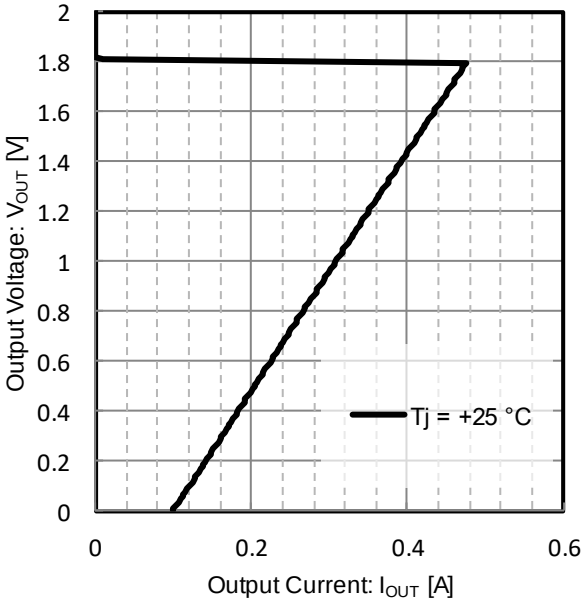


Figure 21.
Over Current Protection
(Measured Waveform)

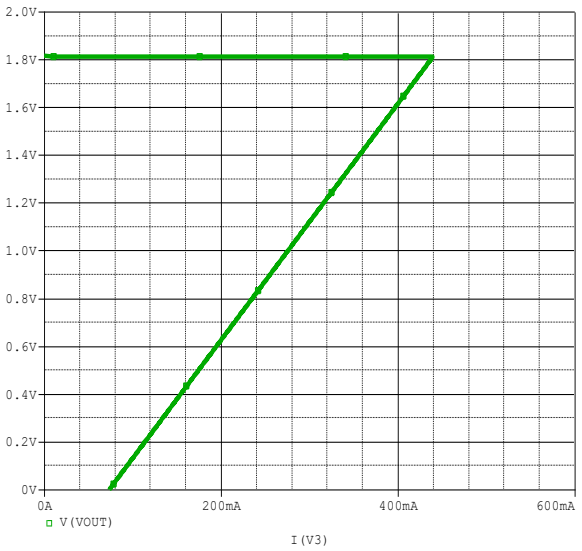


Figure 22.
Over Current Protection
(SPICE Simulation)

Table 10 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Over Current Protection	457	426	mA	-6.8 %	V_{OUT} = 1.71 V

(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. Ripple Rejection

Simulation Setting
Type: AC
Frequency: 10Hz to 10MHz
(Points/Aprade:20)

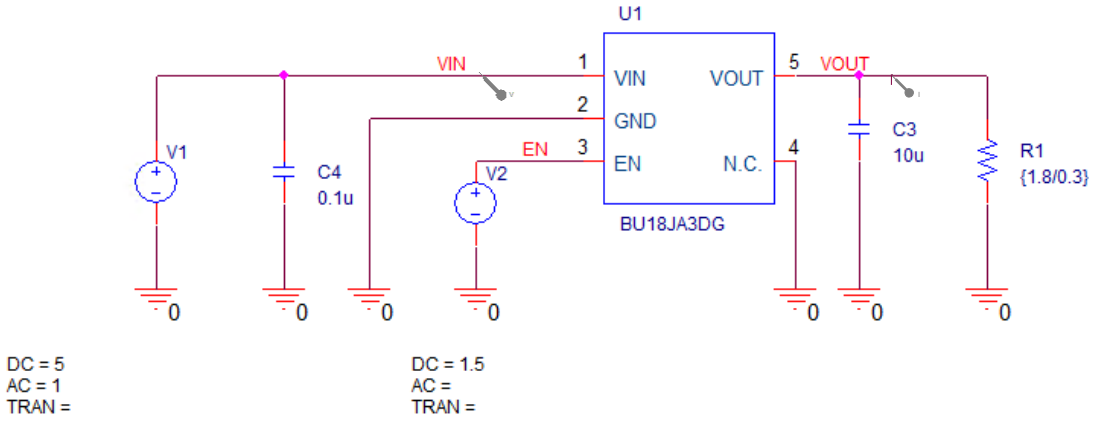


Figure 23.
Simulation Schematic 8

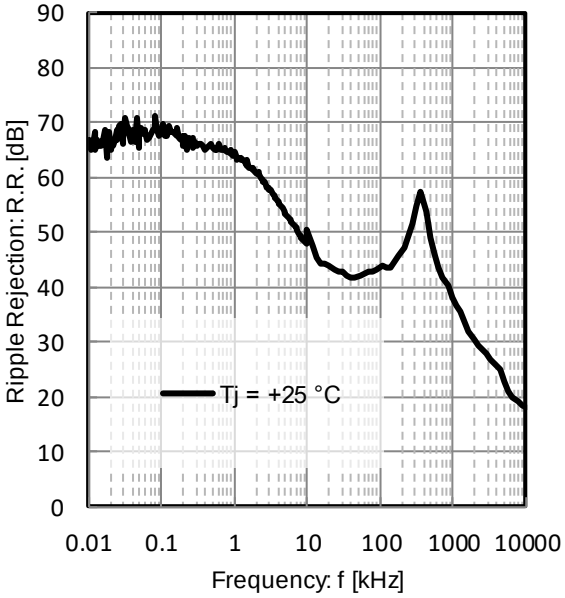


Figure 24.
Ripple Rejection
(Measured Waveform)

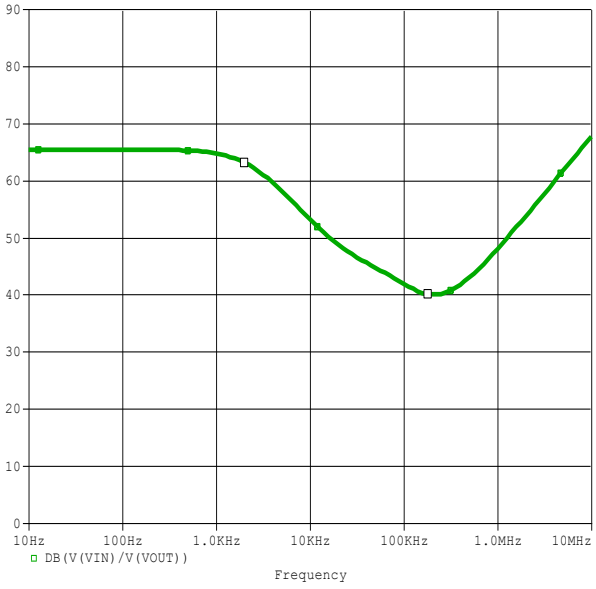


Figure 25.
Ripple Rejection
(SPICE Simulation)

Table 11 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Ripple Rejection	64.7	64.7	dB	0.0 %	V_{IN} = 5 V, I_{OUT} = 300 mA V_{RR} = 1 Vp-p, f_{RR} = 1 kHz

(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
Jul.2022	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.

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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.

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