

SPICE Modeling Report

2.7V to 5.5V Input, 5.0A Integrated MOSFET Single Synchronous Buck DC/DC Converter

BD9B500MUV

General Description

In this report, the characteristics that can be confirmed by the simulation using the SPICE model of the regulator IC BD9B500MUV 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 : BD9B500MUV_PSpice.lib
- Symbol File Name : BD9B500MUV.olb
- Subcircuit and Symbol

Table 1 Correspondence Table

Product Name	Subcircuit	Symbol
BD9B500MUV	BD9B500MUV	BD9B500MUV

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.

BD9B500MUV Spice Model

■ Pin Information

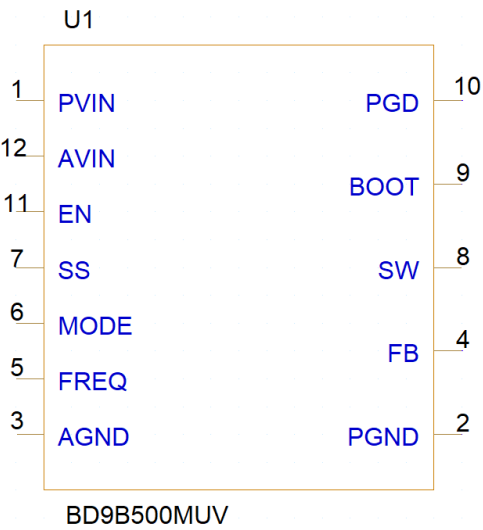


Figure 1 Symbol of BD9B500MUV

(Note) PIN configuration is different from the actual device.

Table 2 Subcircuit Pin Table

Pin No.	Pin Name	Pin No.	Pin Name
1.	PVIN	7.	SS
2.	PGND	8.	SW
3.	AGND	9.	BOOT
4.	FB	10.	PGD
5.	FREQ	11.	EN
6.	MODE	12.	AVIN

Verifiable Characteristics

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 - BD9B500MUV
 - ✓ Switching Waveform (VIN = 5 V, VOUT = 1.2 V, FREQ = L, IOU = 5 A)5
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 - ✓ Load Transient Response IOU = 0.1 A to 5 A.....8

Electrical Characteristics (vs. Datasheet)

Table 3 Electrical Characteristics Comparison

(Unless otherwise specified, Ta = 25 °C, V_{AVIN} = V_{PVIN} = 5 V, V_{EN} = 5V, V_{MODE} = GND)

Parameter	Modeled (Note1)	Design Value		Unit	Error	Condition
		Datasheet	SPICE			
AVIN pin						
Standby Supply Current	Yes	0	0	μA	0 %	EN = GND
Operating Supply Current	Yes	45	45	μA	0 %	FREQ = AVIN, IOUT = 0 mA Non switching
UVLO Detection Threshold	Yes	2.45	2.45	V	0 %	VIN falling
UVLO Release Threshold	Yes	2.55	2.55	V	0 %	VIN rising
UVLO Hysteresis	Yes	100	100	mV	0 %	
Enable						
EN Input High Level Voltage	Yes	> 2.0	> 2.0	V	-	
EN Input Low Level Voltage	Yes	< 0.8	< 0.8	V	-	
EN Input Current	Yes	5	5	μA	0 %	EN = 5 V
Reference Voltage, Error Amplifier						
FB Terminal Voltage	Yes	0.8	0.8	V	0 %	
FB Input Bias Current	Yes	< 1	< 1	μA	-	FB = 0.8 V
Internal Soft Start Time	Yes	1.0	1.0	ms	0 %	With internal constant
Soft Start Terminal Current	Yes	1.0	1.0	μA	0 %	
Control						
FREQ Input High Level Voltage	Yes	VAVIN-0.3 <	VAVIN-0.3 <	V	-	
FREQ Input Low Level Voltage	Yes	< 0.3	< 0.3	V	-	
MODE Input High Level Voltage	Yes	VAVIN-0.3 <	VAVIN-0.3 <	V	-	
MODE Input Low Level Voltage	Yes	< 0.3	< 0.3	V	-	
On time1	Yes	120	120	ns	0 %	VOUT = 1.2 V, FREQ = GND
On time2	Yes	240	240	ns	0 %	VOUT = 1.2 V, FREQ = AVIN
Power Good						
Power Good Rising Threshold	Yes	80	80	%	0 %	FB rising, VPGDH = FB / VFB x 100
Power Good Falling Threshold	Yes	70	70	%	0 %	FB falling, VPGDL = FB / VFB x 100
Output Leakage Current	Yes	0	0	μA	0 %	PGD = 5 V
Power Good On Resistance	Yes	100	100	Ω	0 %	
Power Good Low Level Voltage	Yes	0.1	0.1	V	0 %	IPGD = 1 mA
SW						
High Side FET On Resistance	Yes	30	30	mΩ	0 %	BOOT - SW = 5 V
Low Side FET On Resistance	Yes	30	30	mΩ	0 %	
High Side Output Leakage Current	Yes	0	0	μA	0 %	No switching
Low Side Output Leakage Current	Yes	0	0	μA	0 %	No switching

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

Characteristic in SPICE (vs. Measured Waveform)

1. Switching Waveform (VIN = 5 V, VOUT = 1.2 V, FREQ = L, IOUT = 5 A)

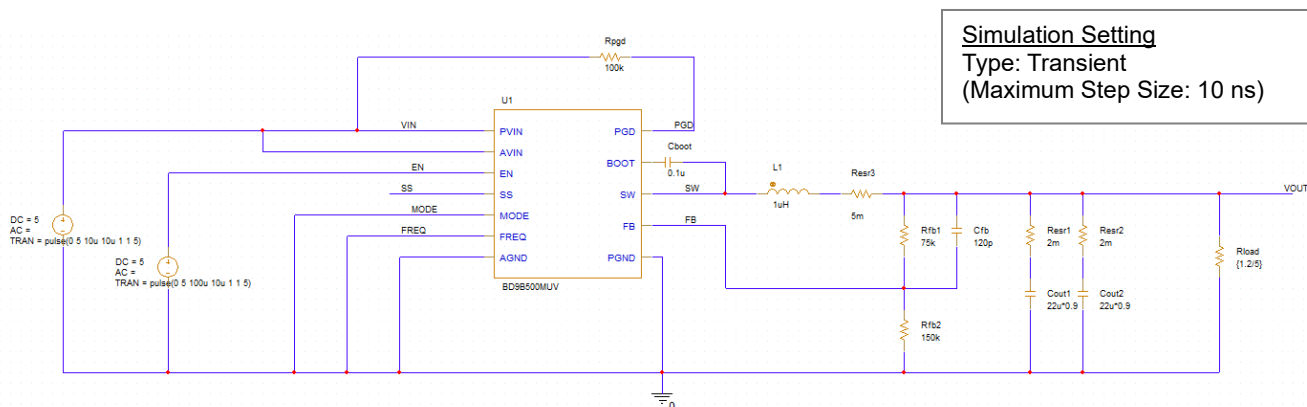


Figure 2.
Simulation Schematic 1

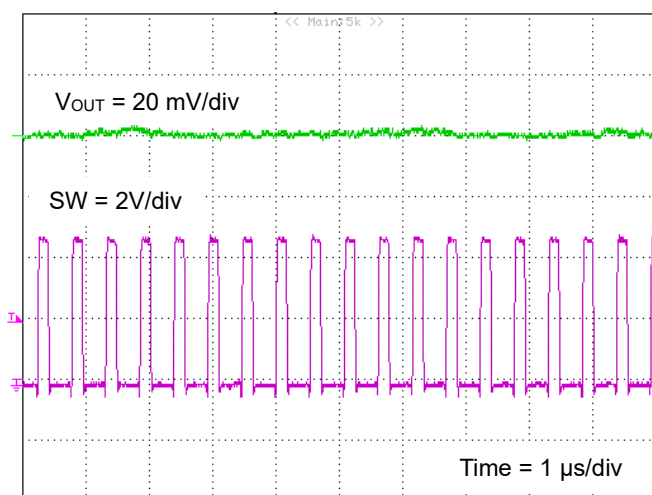


Figure 3.
Switching Waveform
(VIN = 5 V, VOUT = 1.2 V, FREQ = L, IOUT = 5 A)
(Measured Waveform)

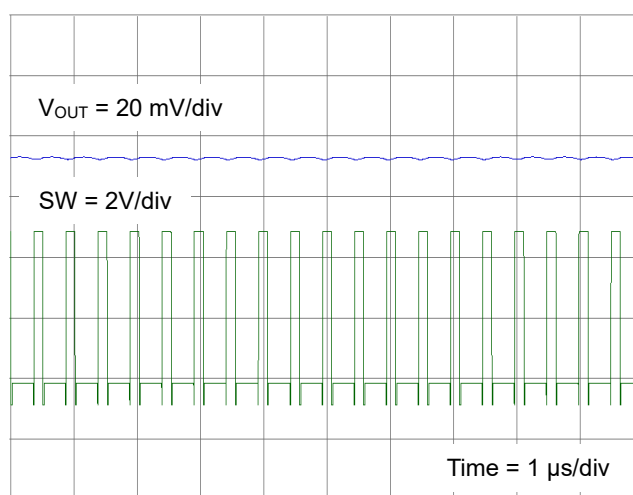


Figure 4.
Switching Waveform
(VIN = 5 V, VOUT = 1.2 V, FREQ = L, IOUT = 5 A)
(SPICE Simulation)

Table 4 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Output Ripple Voltage	1.4	0.8	mV	-42.9 %	VIN = 5 V, VOUT = 1.2 V, FREQ = L, IOUT = 5 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. Switching Waveform (VIN = 5 V, VOUT = 1.2 V, FREQ = H, IOUT = 5 A)

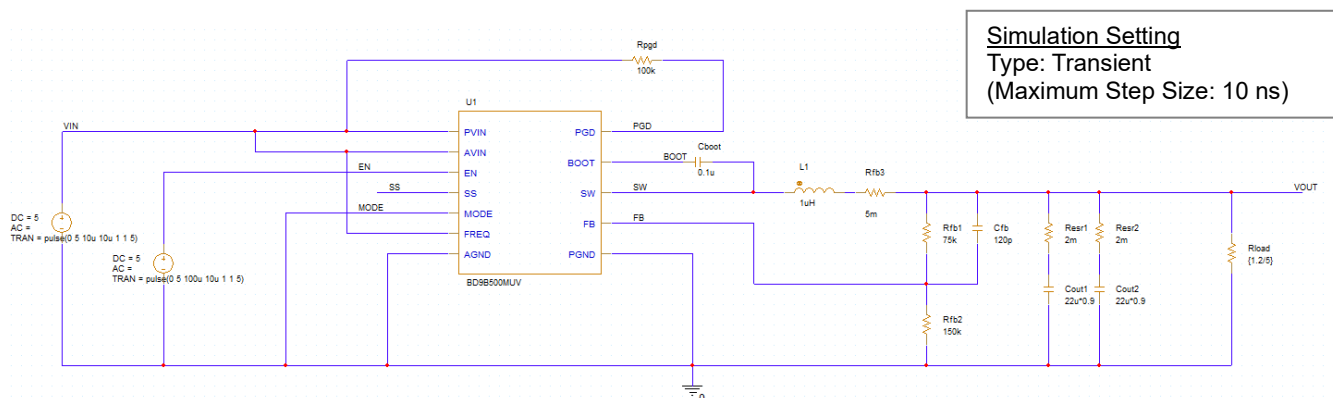


Figure 5.
Simulation Schematic 2

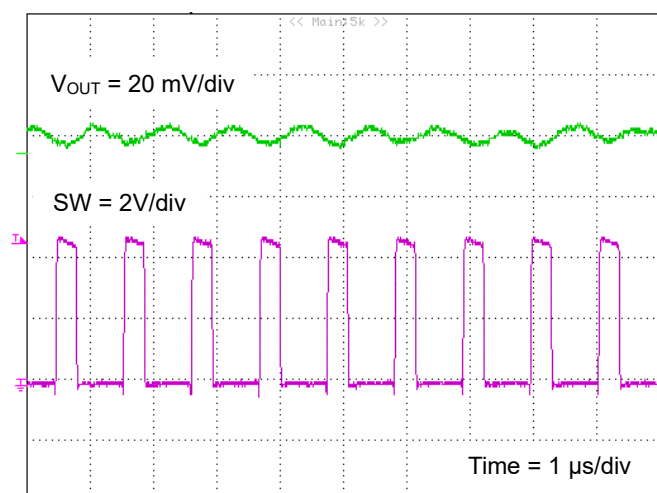


Figure 6.
Switching Waveform
(VIN=5V, VOUT=1.2V, FREQ=H, IOUT=5A)
(Measured Waveform)

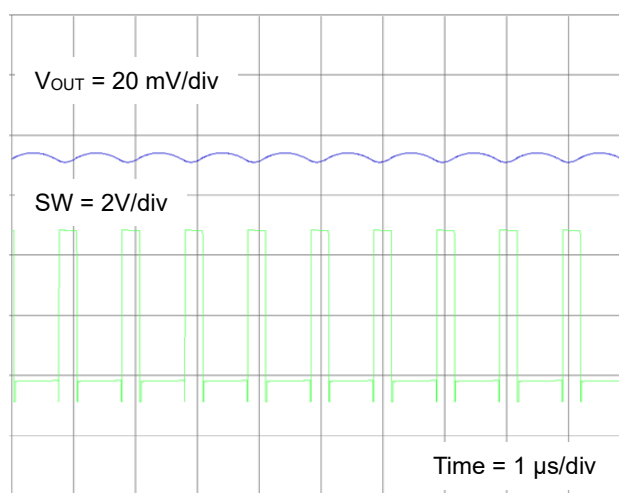


Figure 7.
Switching Waveform
(VIN=5V, VOUT=1.2V, FREQ=H, IOUT=5A)
(SPICE Simulation)

Table 5 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Output Ripple Voltage	4.6	3.5	mV	-23.9 %	VIN = 5 V, VOUT = 1.2 V, FREQ = H, IOUT = 5 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.

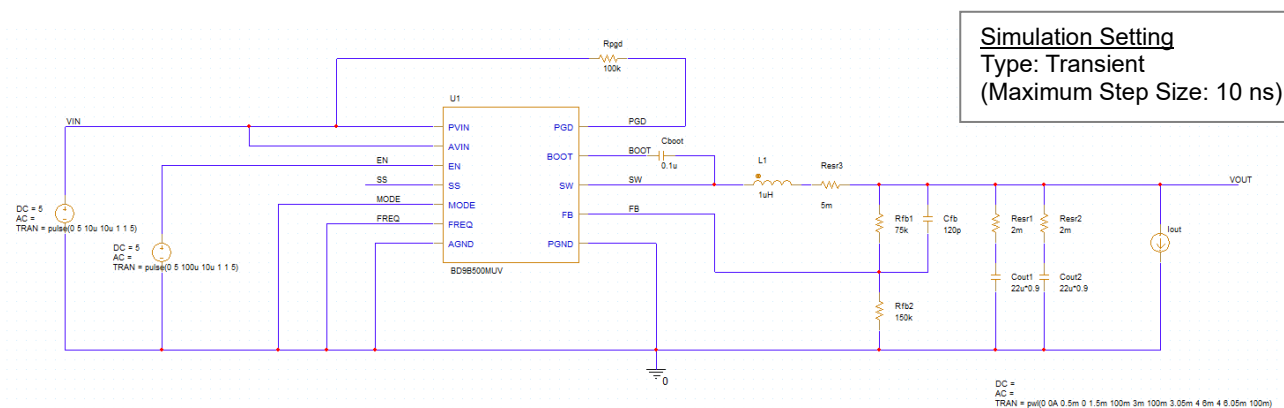
3. Load Transient Response $I_{OUT} = 0.1 \text{ A}$ to 4 A 

Figure 8.
Simulation Schematic 3

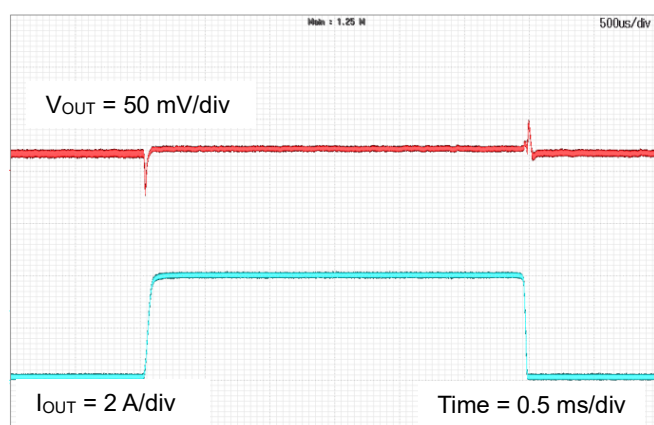


Figure 9.
Load Response $I_{OUT} = 0.1 \text{ A}$ to 4 A
(VIN = 5 V, VOUT = 1.2 V, FREQ = L, MODE = L)
(Measured Waveform)

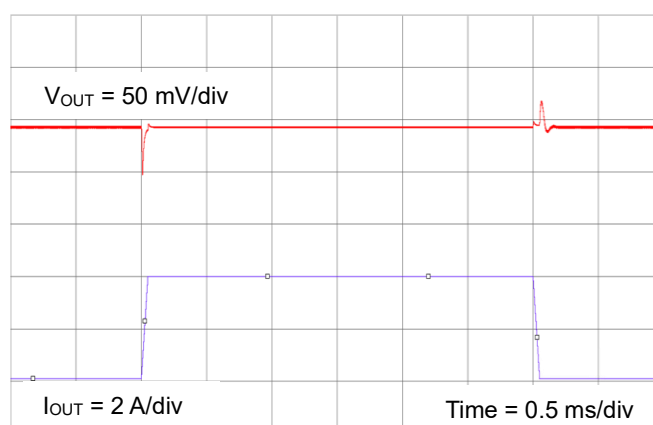


Figure 10.
Load Response $I_{OUT} = 0.1 \text{ A}$ to 4 A
(VIN = 5 V, VOUT = 1.2 V, FREQ = L, MODE = L)
(SPICE Simulation)

Table 6 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Overshoot	27.8	24.6	mV	-11.5 %	VIN = 5 V, VOUT = 1.2 V, FREQ = L, MODE = L, COUT = 44 μF , I _{OUT} = 4 A to 0.1 A
Undershoot	42.7	43.4	mV	1.6 %	VIN = 5 V, VOUT = 1.2 V, FREQ = L, MODE = L, COUT = 44 μF , I _{OUT} = 0.1 A to 4 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.

4. Load Transient Response IOUT = 0.1 A to 5 A

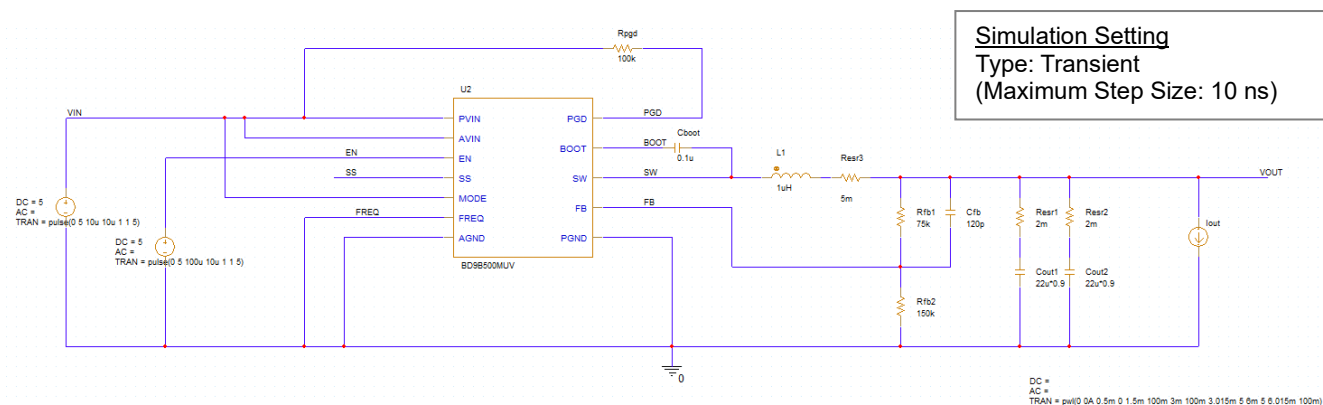
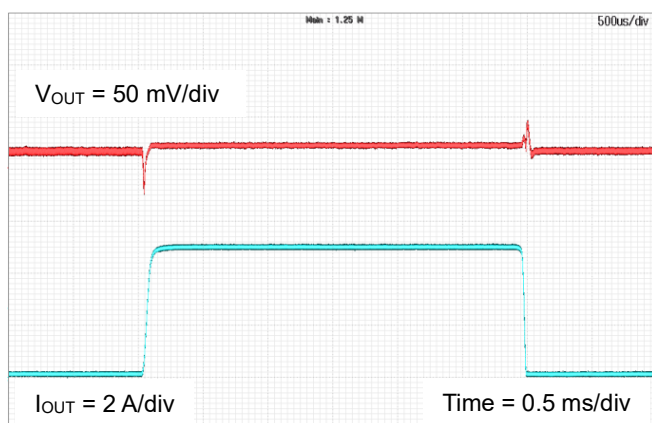
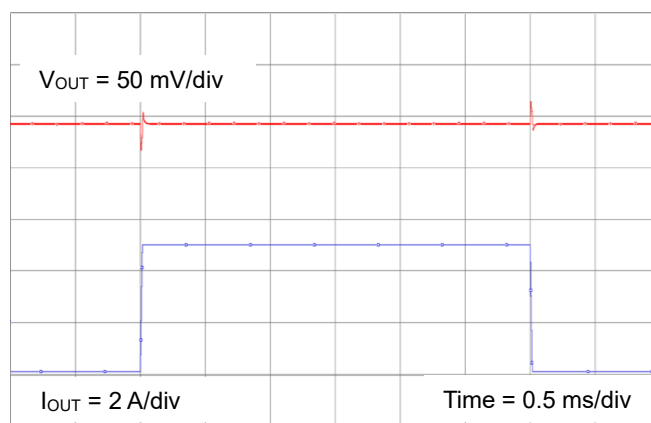
Figure 11.
Simulation Schematic 4Figure 12.
Load Response IOUT = 0.1 A to 5 A
(VIN = 5 V, VOUT = 1.2 V, FREQ = L, MODE = H)
(Measured Waveform)Figure 13.
Load Response IOUT = 0.1 A to 5 A
(VIN = 5 V, VOUT = 1.2 V, FREQ = L, MODE = H)
(SPICE Simulation)

Table 7 Characteristics Comparison

Parameter	Measured Result (Note1)(Note2)	SPICE Simulation Result	Unit	Error	Condition
Overshoot	25.3	21.8	mV	-11.5 %	VIN = 5 V, VOUT = 1.2 V, FREQ = L, MODE = H, COUT = 44 μ F, IOUT = 5 A to 0.1 A
Undershoot	40	31.2	mV	-22.0 %	VIN = 5 V, VOUT = 1.2 V, FREQ = L, MODE = H, COUT = 44 μ F, IOUT = 0.1 A to 5 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.

Revision History

Date	Revision	Changes
Sep.2023	001	New Release

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