Switching Regulator Series

Buck Converter with Integrated FET BD9E105FP4-Z EVK

BD9E105FP4-EVK-001 (Input 12V to 24V → Output 5V, 1A)

Introduction

This user's guide provides the necessary steps to operate the EVK of ROHM's BD9E105FP4-Z 1-channel Buck DC/DC converter. This includes the external parts, operating procedures, and application data.

Description

This EVK has been developed for ROHM's synchronous buck DC/DC converter customers evaluating BD9E105FP4-Z that outputs 5V from 12V to 24V input voltage range. The output range is from VIN x 0.1 (more than 0.7V) to VIN x 0.8 and it can be designed as 0.596V x (R2+R3) / R3 by external resistors. The operating frequency is fixed at 500kHz. The current mode control DC/DC converter provides high-speed transient response performance. Additional protection functions include a built-in soft start function to prevent inrush current at startup, OVP (Over Voltage Protection), UVLO (Under Voltage Lock Out), TSD (Thermal Shutdown Detection), SCP (Short Circuit Protection), and OCP (Over Current Protection).
Light load mode operation provides better efficiency in light-load conditions.

Application

Home Appliance
Secondary Power Supply and Adapter Equipment
Communication Equipment

Operating Limits

Table 1. Operating Limits

Parameter	Min	Typ	Max	Units	Conditions
Input Voltage	12	-	24	V	
Output Voltage		5		V	
Output Current Range			1	A	
Operating Frequency		500		kHz	
Maximum Efficiency		97		%	VIN=12V, VOUT=5V
UVLO Detect Voltage		3.9		V	VCC sweep down
UVLO Hysteresis Width		350		mV	

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EVK

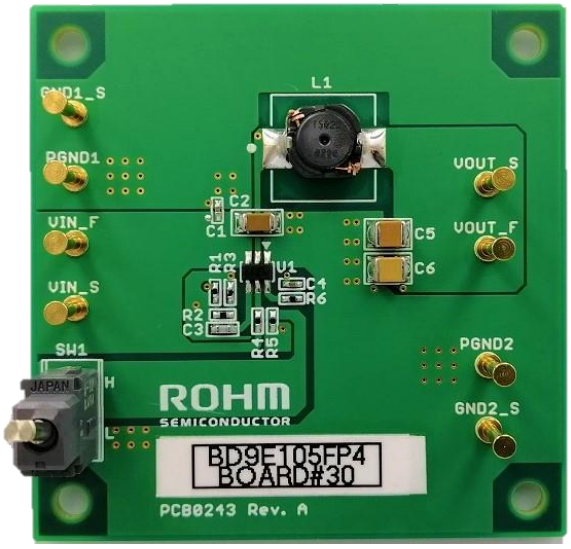

Figure 1. BD9E105FP4-EVK-001(Top View)

EVK Schematic

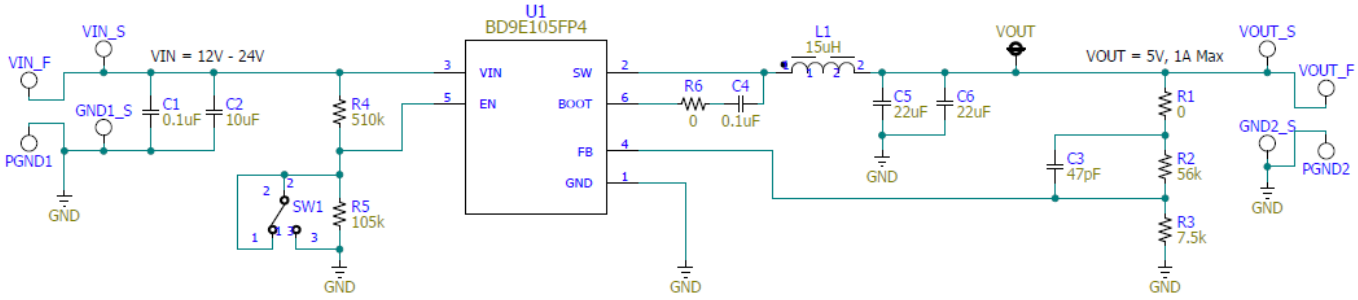

Figure 2. BD9E105FP4-EVK-001 Circuit Diagram

Operating Procedure

1. Turn off the DC power supply and connect the GND terminal of the power supply to PGND1 terminal of the EVK.
2. Connect the positive terminal of the DC power supply to VIN_F pin of the EVK.
3. Connect the load to VOUT_F and PGND2 terminals of EVK. When using an electronic load, connect with the load turned off.
4. Connect a voltmeter; the VOUT terminal to the EVK's VOUT_S pin and the GND terminal to the EVK's GND2_S pin.
5. Set the toggle switch of SW1 to H (pin 1 and pin 2 are shorted).
6. Turn on the DC power supply. Make sure the voltmeter shows 5V.
7. Turn on the electronic load.

(Caution) This EVK does not support hot plug. Do not perform hot plug test.

Operation State Settings

Below is the summary table of BD9E105FP4-Z condition by the status of SW1.

Table 2. SW1 Settings

SW_EN state	BD9E105FP4-Z Condition
H (short 1, 2 pins)	Enable
L (short 2, 3 pins)	Shutdown

Parts list

Table 3. Parts list

Count	Parts No.	Type	Value	Description	Manufacturer Part Number	Manufacturer	Size[Unit: mm(inch)]
IC							
1	U1	DCDC	-	Buck Converter	BD9E105FP4-Z	ROHM	2.8 x 2.92 (0.110x0.114)
Inductor							
1	L1	Inductor	15μH	±20%, 2.3A DCR=55mΩ±20%,	CLF7045NIT-150M-D	TDK	7045(2818)
Capacitor							
2	C1, C4	MLCC	0.1μF	50V, X5R, ±10%	GRM155R61H104KE14	MURATA	1005(0402)
1	C2	MLCC	10μF	50V, X7T, ±10%	GRM31CD71H106KE11	MURATA	3216(1206)
1	C3	MLCC	47pF	250V, C0G, ±5%	GRM1885C2E470JW07	MURATA	1608(0603)
2	C5, C6	MLCC	22μF	25V, X7R, ±20%	GRM32ER71E226ME15	MURATA	3225(1210)
Resistor							
1	R1, R6	Resistor	0Ω	1/16W, 50V, ±5%	MCR01MZPJ000	ROHM	1005(0402)
1	R2	Resistor	56kΩ	1/16W, 50V, ±1%	MCR01MZPF5602	ROHM	1005(0402)
1	R3	Resistor	7.5kΩ	1/16W, 50V, ±1%	MCR01MZPF7501	ROHM	1005(0402)
1	R4	Resistor	510kΩ	1/16W, 50V, ±1%	MCR01MZPF5103	ROHM	1005(0402)
1	R5	Resistor	105kΩ	1/16W, 50V, ±1%	MCR01MZPF1053	ROHM	1005(0402)
Connector							
1	SW1	Toggle Switch	-	Pin pitch 2.54mm SPDT	A-12HP	NKK SWITCHES	-
Contact pin							
8	VIN_F, VIN_S, VOUT_F, VOUT_S, PGND1, PGND2, GND1_S, GND2_S	Test Pin	-	Turret Terminal L=7.5mm	ST-2-2	MAC8	-

The product and manufacturer names listed in the parts list are current at the time this application note was prepared, and some parts may not be available. Please select the equivalent product based on the characteristics listed in the table. Select a ceramic capacitor with the same actual capacitance in consideration of the DC bias characteristics.

Board Layout

EVK PCB information

Number of Layers	Material	Board Size	Copper Thickness
4	FR-4 HiTg	54mm x 54mm x 1.6mmt	2/1/1/2oz (1oz≒35μm)

The layout of BD9E105FP4-EVK-001 is shown below.

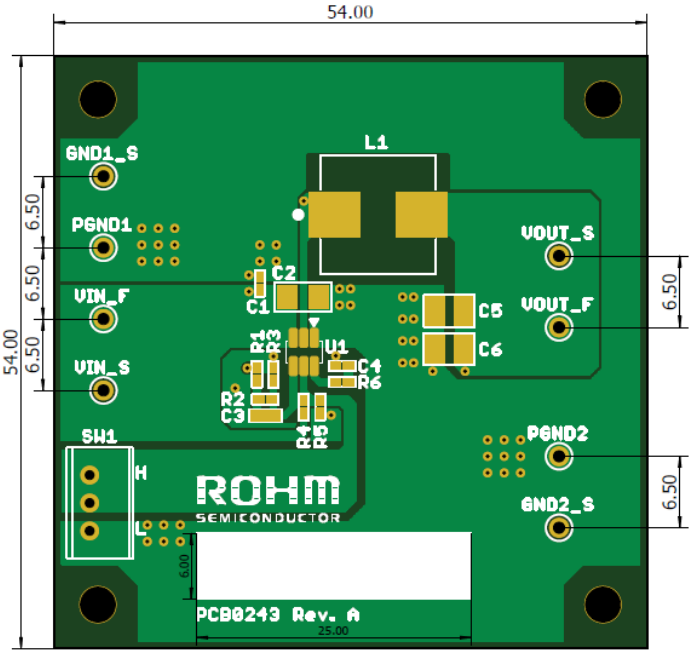

Figure 3. Top PCB Image
(Top View)

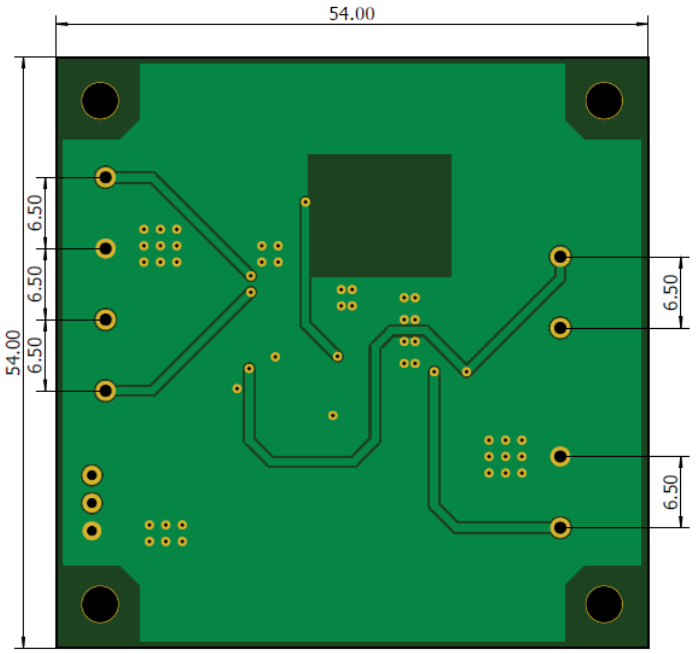

Figure 4. Bottom PCB Image
(Top View)

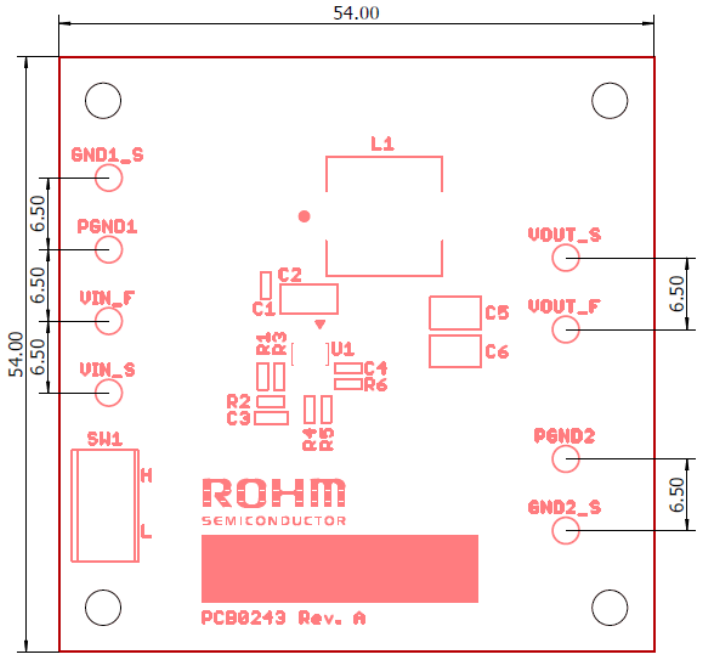

Figure 5. Top Silkscreen Layout
(Top View)

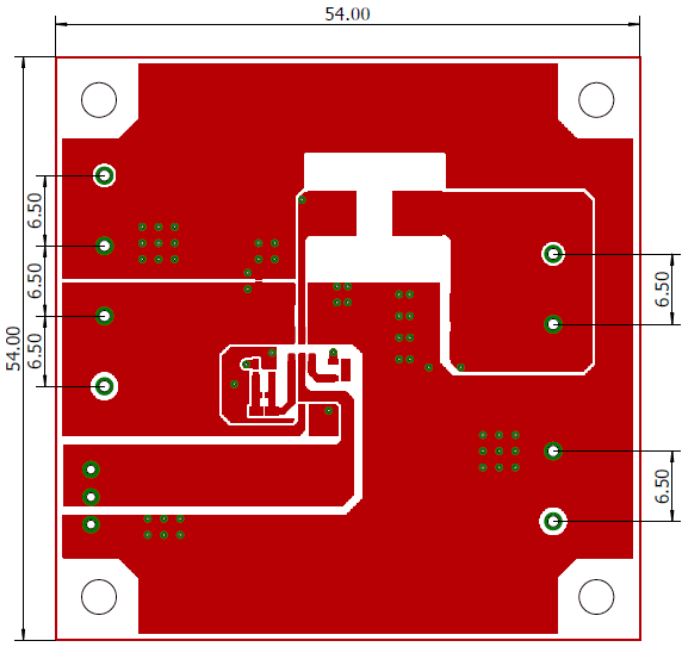

Figure 6. Top Layer
(Top View)

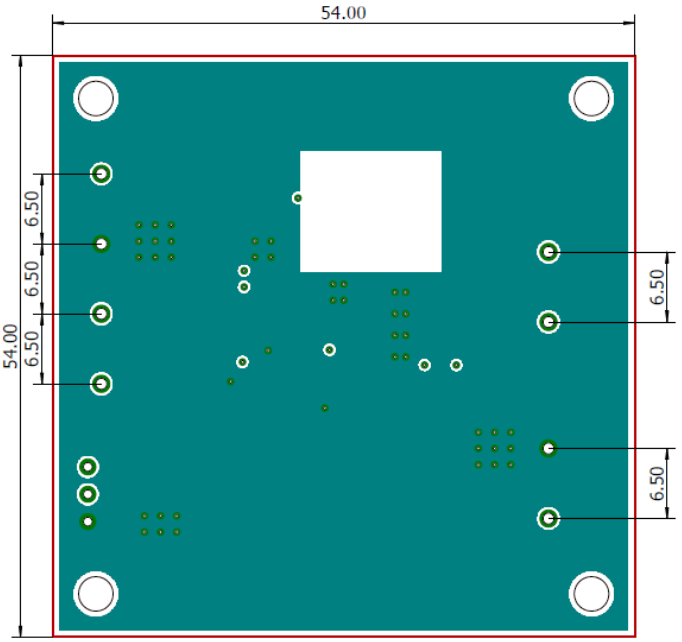

Figure 7. Middle Layer 1
(Top View)

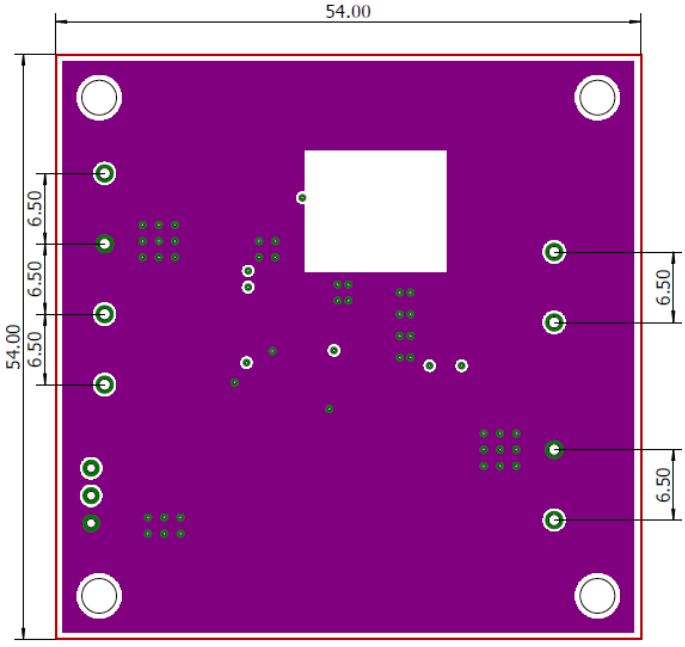

Figure 8. Middle Layer 2
(Top View)

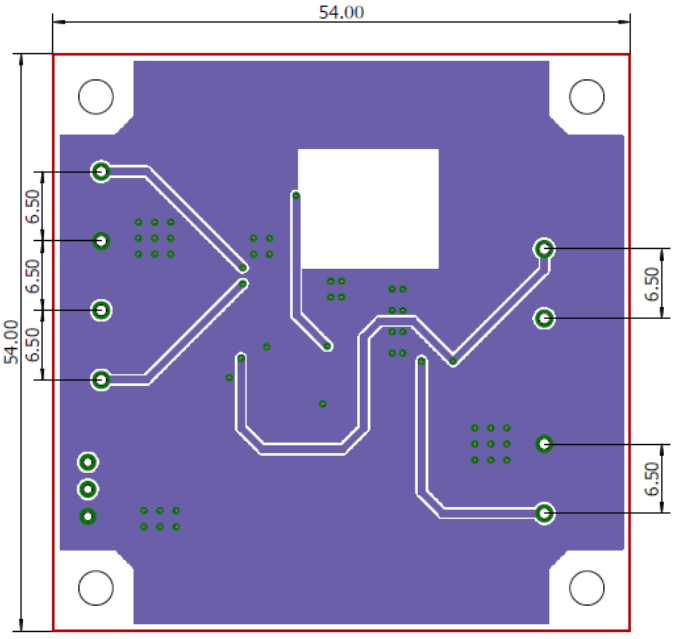

Figure 9. Bottom Layer
(Top View)

Reference Application Data

Time= 2 ms/div

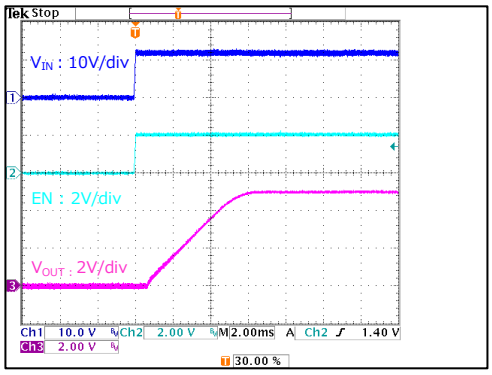

Figure 10. Startup waveform R_{LOAD}=5Ω
(V_{IN}=0V to 12V, SW1=H, V_{OUT}=5V)

Time= 2 ms/div

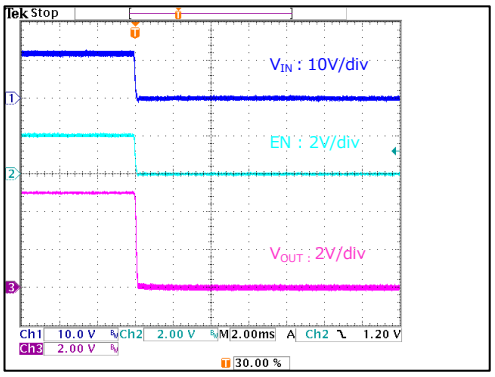

Figure 11. Shutdown waveform R_{LOAD}=5Ω
(V_{IN}=0V to 12V, SW1=H, V_{OUT}=5V)

Time= 2 ms/div

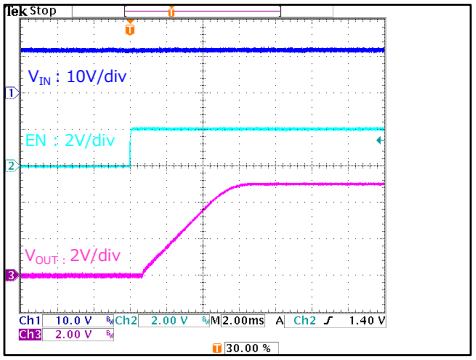

Figure 12. Startup waveform R_{LOAD}=5Ω
(V_{IN}=12V, SW1=L to H, V_{OUT}=5V)

Time= 2 ms/div

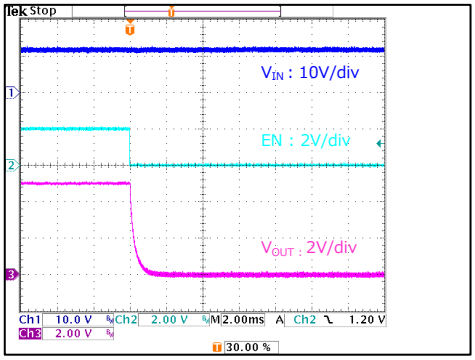

Figure 13. Shutdown waveform R_{LOAD}=5Ω
(V_{IN} =12V, SW1=H to L, V_{OUT}=5V)

Reference Application Data - continued

Time=2 ms/div

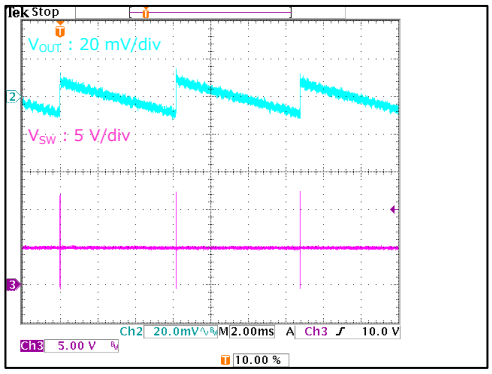

Figure 14. Ripple voltage
(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0A)

Time=1 µs/div

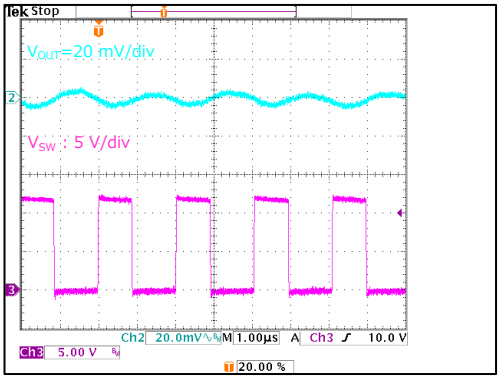

Figure 15. Ripple voltage
(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=1A)

Time=2 ms/div

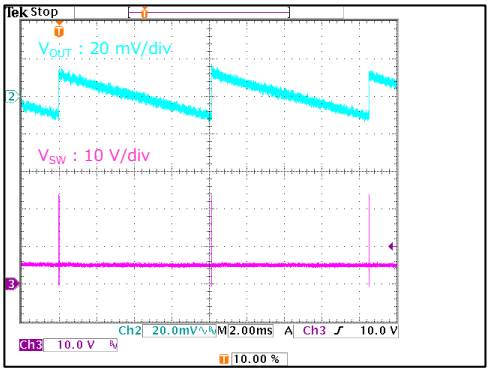

Figure 16. Ripple voltage
(V_{IN}=24V, V_{OUT}=5V, I_{OUT}=0A)

Time=1 µs/div

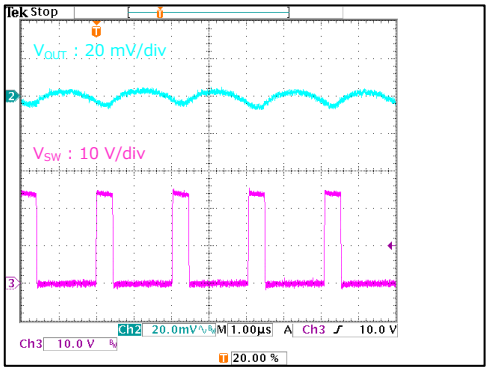

Figure 17. Ripple voltage
(V_{IN}=24V, V_{OUT}=5V, I_{OUT}=1A)

Reference Application Data – continued

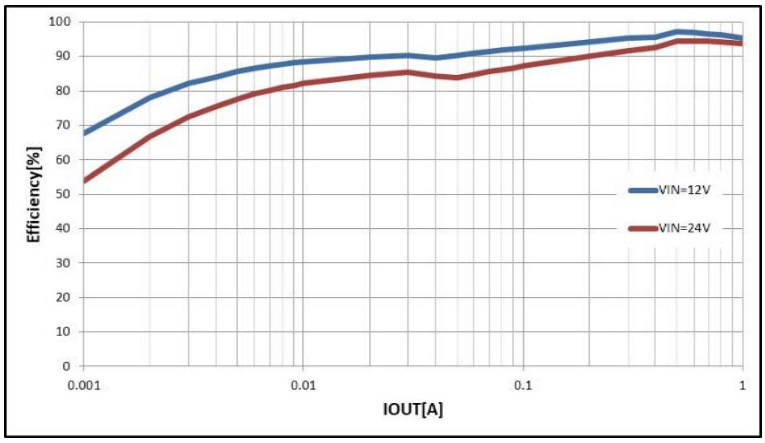

Figure 18. Efficiency vs Load current
(V_{IN}=12V / 24V, V_{OUT}=5V)

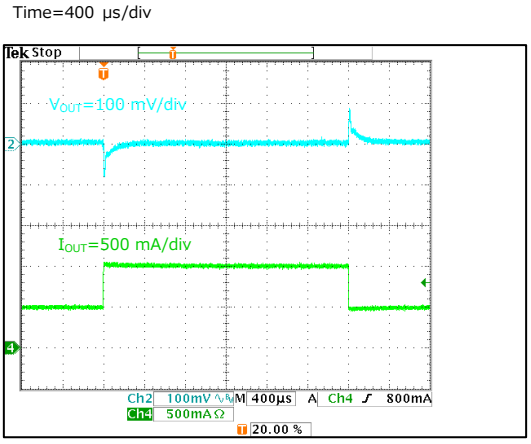

Figure 19. Load transient
(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.5A to 1A)

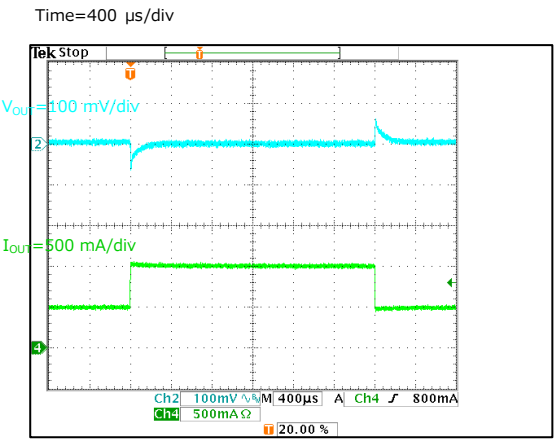

Figure 20. Load transient
(V_{IN}=24V, V_{OUT}=5V, I_{OUT}=0.5A to 1A)

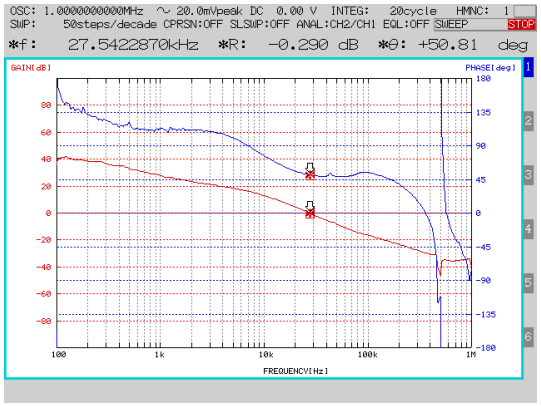

Figure 21. Frequency response
(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=1A)

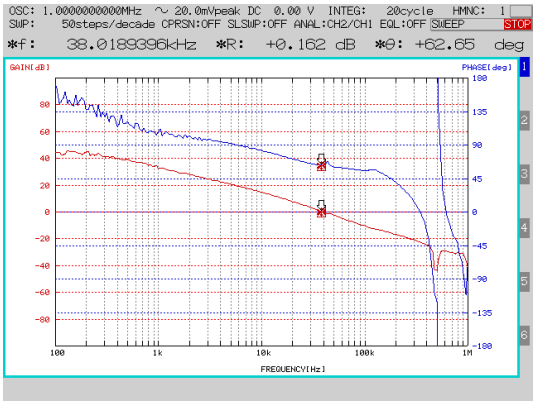

Figure 22. Frequency response
(V_{IN}=24V, V_{OUT}=5V, I_{OUT}=1A)

Revision History

Date	Revision Number	Description
27th, Aug. 2021	001	Initial release
5th, Oct. 2022	002	p.6 Figure 10 Correct output voltage condition

Notes

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