Switching Regulator Series

Buck Converter with Integrated FET BD9G401EFJ-M EVK

BD9G401EFJ-EVK-001 (12V → 5V, 3.5A)

Introduction

This user's guide will provide the steps necessary to operate the BD9G401EFJ-EVK-001 and evaluate ROHM's BD9G401EFJ-M 1channel Buck DC/DC converter. Component selection, operating procedures and application data are included.

Description

This EVK has been developed for ROHM's non-synchronous buck DC/DC converter customers evaluating BD9G401EFJ-M. While the BD9G401EFJ-M accepts a power supply input range of 4.5V to 42V, and generates output voltages from 1V to VCC(Note 1), this EVK is setup for the input voltage range of 10V to 42V and a fixed output of 5V can be produced. The IC has internal 140mΩ N-channel MOSFET and the operating frequency is fixed 300kHz. A fixed Soft Start circuit prevents inrush current during startup along with UVLO (under voltage lock out) and TSD (thermal shutdown detection), OCP (over current protection) protection circuits. The under voltage lock out and hysteresis can be set by external resistor using EN pin. EN pin allows for simple ON/OFF control of the IC to reduce standby current consumption. In addition, it has a synchronization function with an external clock that provides noise management.

(Note 1) Restricted by Maximum duty cycle. (About the restriction of input/output voltage by maximum duty cycle, refer to p.10 of the datasheet Rev.002)

Application

General consumer devices with 12V/24V lines

Automotive applications (Audio system, Navigation system, etc)

Industrial distributed-power applications

Entertainment equipment

Operating Limits

Parameter	Min	Typ	Max	Units	Conditions
Input Voltage	10	12	42	V	
Output Voltage		5.0		V	
Output Current Range			3.5	A	
Operating Frequency		300		kHz	
Maximum Efficiency		93		%	I_O = 1A
UVLO Detect Voltage		5.8		V	VCC sweep down
UVLO Release Voltage		6.9		V	VCC sweep up

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EVK

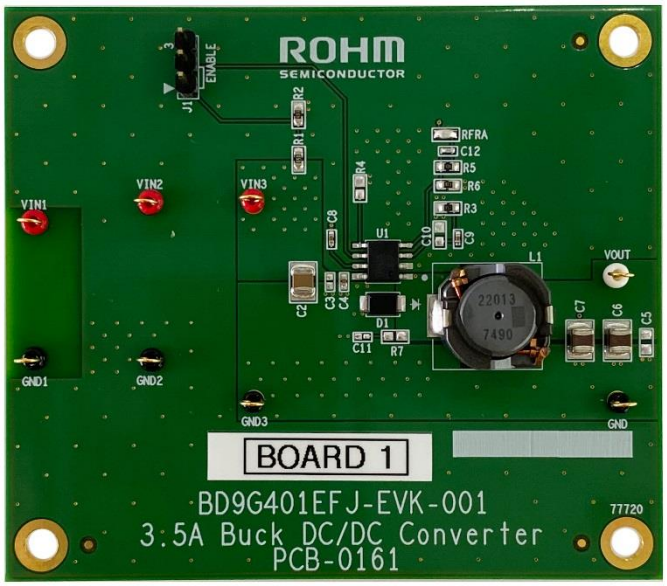

Figure 1. BD9G401EFJ-EVK-001(Top View)

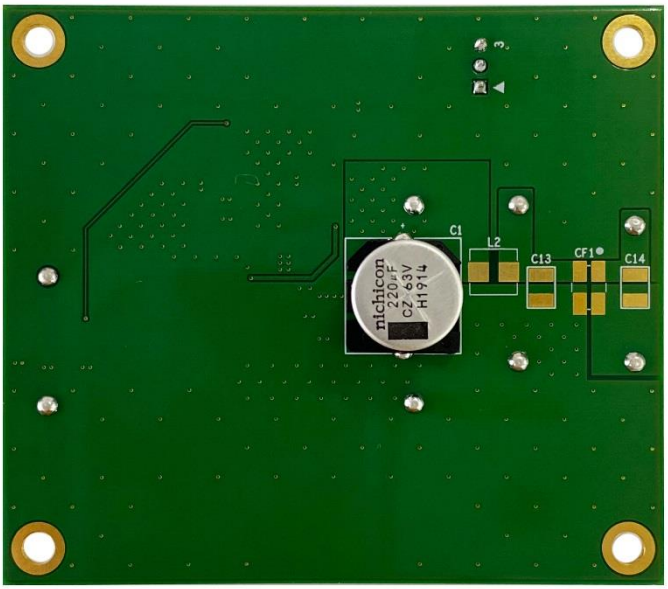

Figure 2. BD9G401EFJ-EVK-001(Bottom View)

EVK Schematic

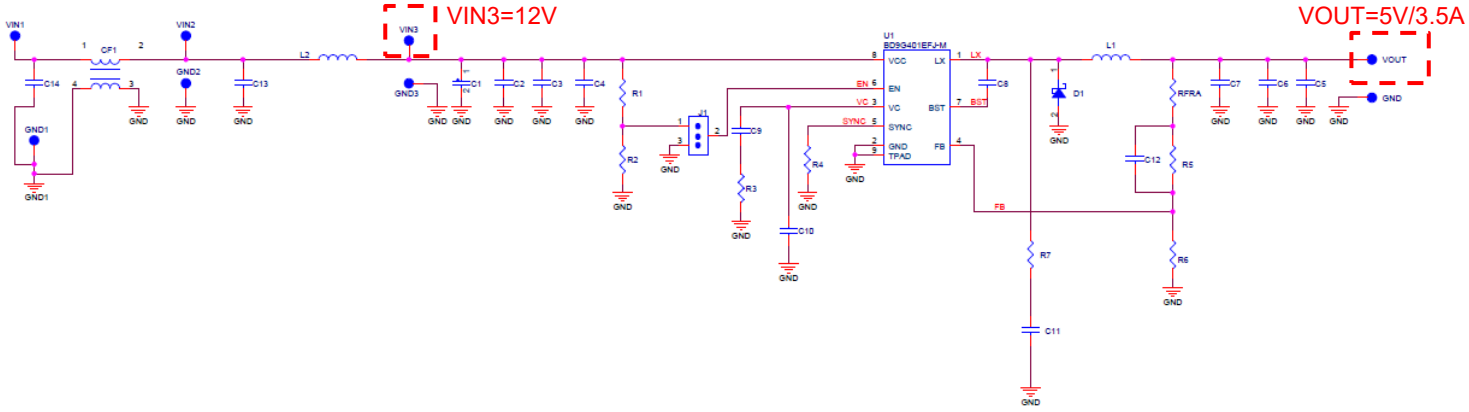

Figure 3. BD9G401EFJ-EVK-001 Schematic

The input/output pins are in the broken line (VIN3 pin and VOUT pin) in Figure 3.

Operating Procedure

Below is the procedure to operate the EVK.

1. Turn off the power supply and connect power supply's GND pin to the GND3 pin of the EVK.
2. Connect the power supply's VCC pin to the VIN3 pin of the EVK.
3. Check if the shunt jumper of J1 is at position ON (Pin 2 connect to Pin 1, the EN pin of IC U1 is pulled high)
4. Check if the electronic load is turned off and connect the electronic load to the VOUT pin and the GND pin of the EVK.
5. Connect the voltmeter to the VOUT pin and the GND pin of the EVK.
6. Turn on the power supply and check if the measured value of the voltmeter is 5V.
7. Turn on the electronic load.

Notes:

The board does not support hot plugging protection. Do not perform hot plugging on this board.

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BOM

Below is a table with the bill of materials.

Table 1. Bill of Materials

Quantity	Reference Designator	Part Number	Manufacturer	Value	Description [Unit: inch(mm)]
IC					
1	U1	BD9G401EFJ-M	Rohm	-	Buck DC/DC
Capacitor					
1	C1	UCZ1J221MNQ1MS	Nichicon	220µF	Capacitor, 63V, ±20%, 5454(13.6 x 13.6)
1	C2	GCM32EC71H106KA03	Murata	10µF	Capacitor, 50V, X7S, ±10%, 1210(3225)
1	C3	-	-	-	Open
1	C4	GCM155R71H104KE02	Murata	0.1µF	Capacitor, 50V, X7R, ±10%, 0402(1005)
1	C5	-	-	-	
1	C6	GCM32EC71A476KE02	Murata	47µF	Capacitor, 10V, X7S, ±10%, 1210(3225)
1	C7	GCM32EC71A476KE02	Murata	47µF	Capacitor, 10V, X7S, ±10%, 1210(3225)
1	C8	GCM155R71H104KE02	Murata	0.1µF	Capacitor, 50V, X7R, ±10%, 0402(1005)
1	C9	GCM155R71H102KA37	Murata	1000pF	Capacitor, 50V, X7R, ±10%, 0402(1005)
1	C10	-	-	-	Open
1	C11	-	-	-	Open
1	C12	GCM1555C1H180JA16	Murata	18pF	Capacitor, 50V, X7R, ±5%, 0402(1005)
1	C13	-	-	-	Open
1	C14	-	-	-	Open
Resistor					
1	R1	MCR03EZPD1103	Rohm	110kΩ	Resistor, 50V, 0.1W, ±0.5%, 0603(1608)
1	R2	MCR03EZPD4302	Rohm	43kΩ	Resistor, 50V, 0.1W, ±0.5%, 0603(1608)
1	R3	MCR03EZPFX1502	Rohm	15kΩ	Resistor, 50V, 0.1W, ±1%, 0603(1608)
1	R4	-	-	-	Open
1	R5	MCR03EZPD4303	Rohm	430kΩ	Resistor, 50V, 0.1W, ±0.5%, 0603(1608)
1	R6	MCR03EZPD8202	Rohm	82kΩ	Resistor, 50V, 0.1W, ±0.5%, 0603(1608)
1	R7	-	-	-	Open
1	RFRA	-	-	-	Short
Diode					
1	D1	RBR5LAM60ATF	Rohm	-	Diode, 60V, 5A, 1910(4725)
Inductor					
1	L1	CLF12577NIT-220M-D	TDK	22µH	Inductor, 4.3A max, ±20%, 4949(12.8 x 12.5)
1	L2	-	-	-	-
Common Mode Filter					
1	CF1	-	-	-	-

These components listed above are prepared for automotive use. When used for non-automotive applications, please refer to "Selection of Ceramic capacitors" in p.7 and replace the parts to the ones correspond product grade.

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Board Layout

EVK PCB information

Number of Layers	Material	Board Size	Copper Thickness
4	FR-4 High TG	80mm x 70mm x 1.6mmt	2oz (70µm)

Followings are the layout of BD9G401EFJ-EVK-001

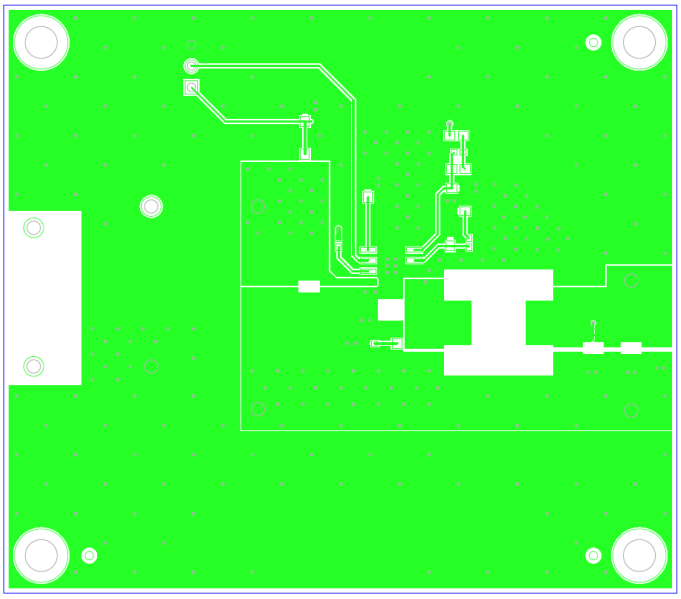

Figure 4. Top Layer Layout

(Top View)

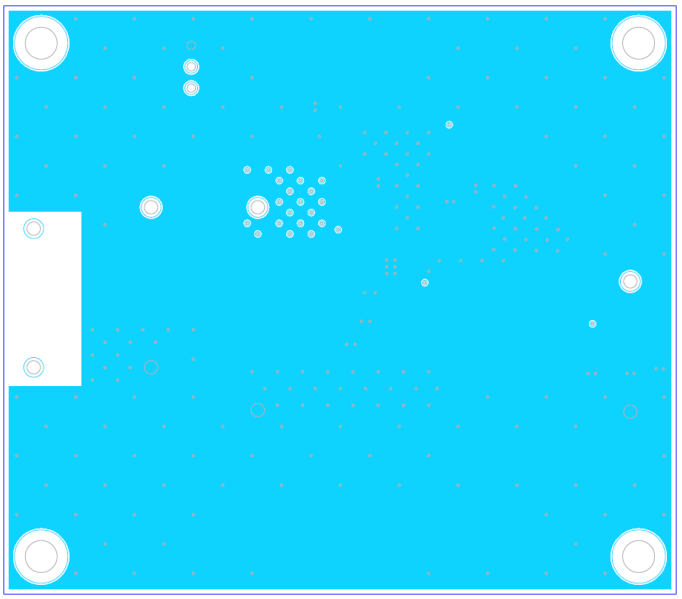

Figure 5. Middle1 Layer Layout

(Top View)

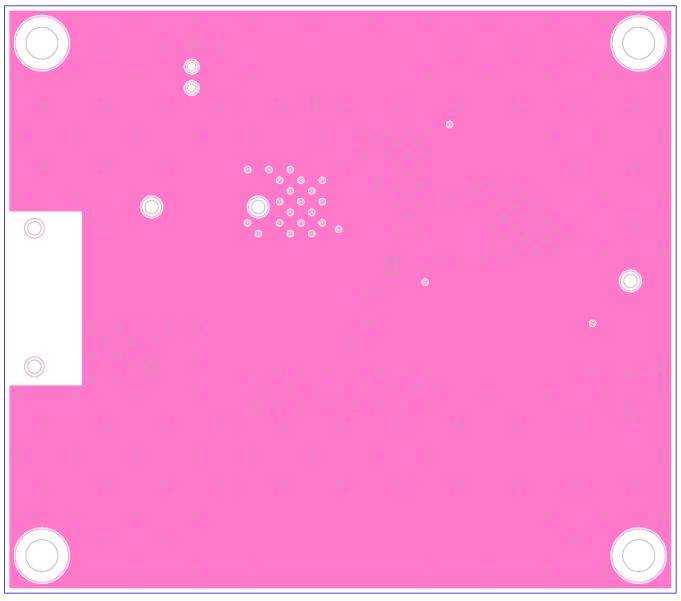

Figure 6. Middle2 Layer Layout

(Top View)

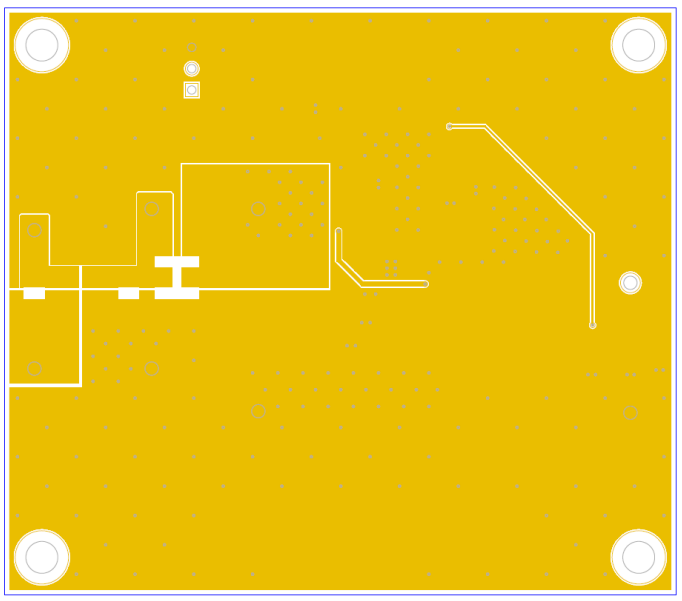

Figure 7. Bottom Layer Layout

(Top View)

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Reference Application Data

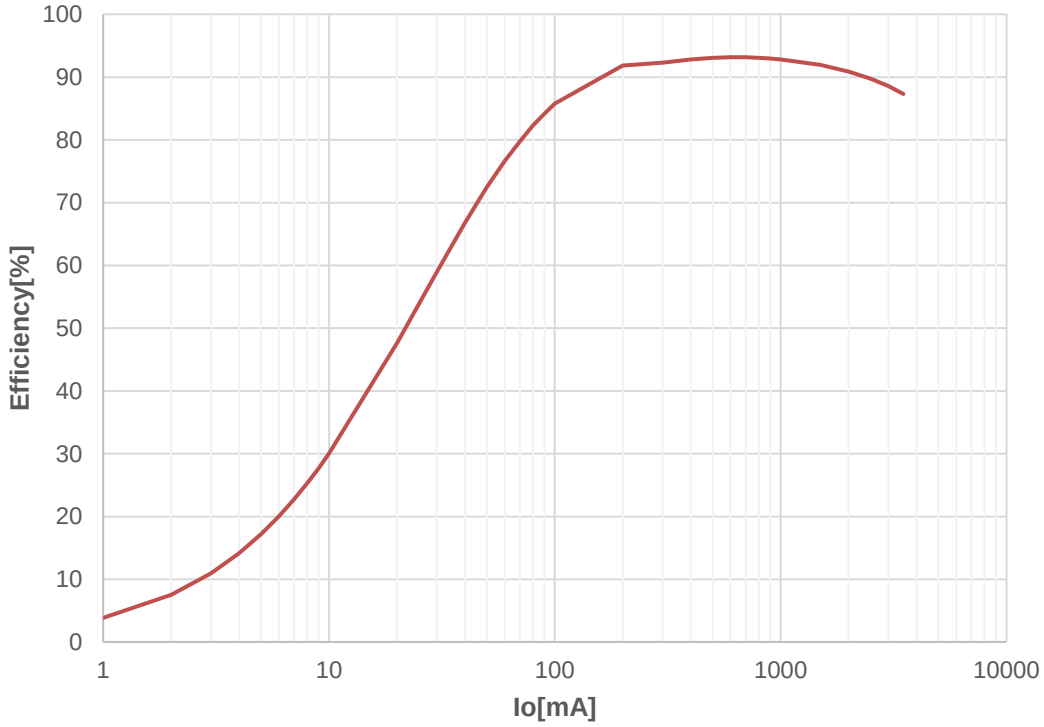

Figure 8. Efficiency vs Load Current (VIN=12V, VOUT=5V)

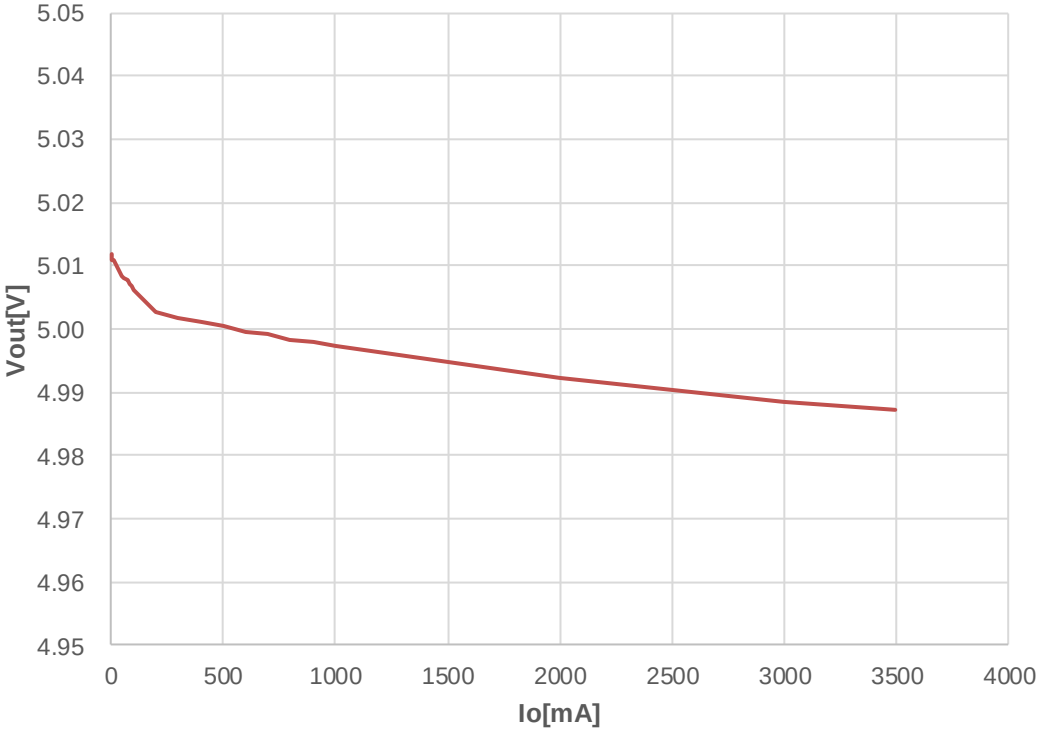

Figure 9. Load Regulation (VIN=12V, VOUT=5V)

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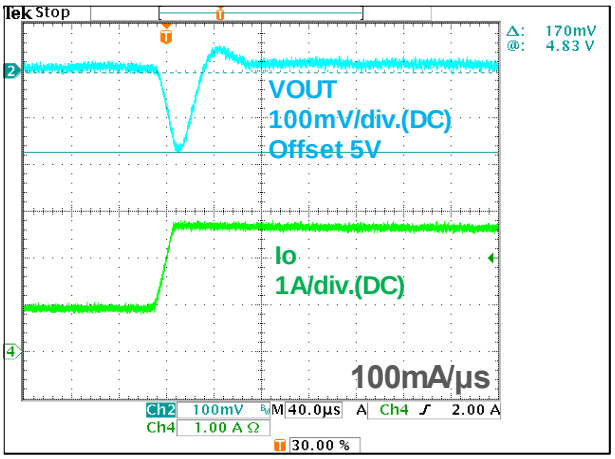

Figure 10. Transient Load Response
(VIN=12V, Io=0.875A → 2.625A)

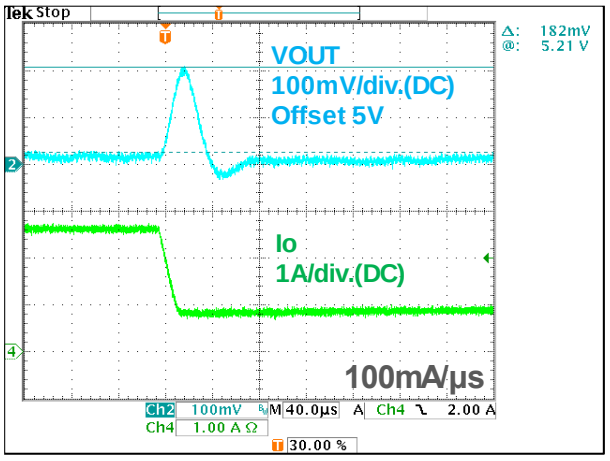

Figure 11. Transient Load Response
(VIN=12V, Io=2.625A → 0.875A)

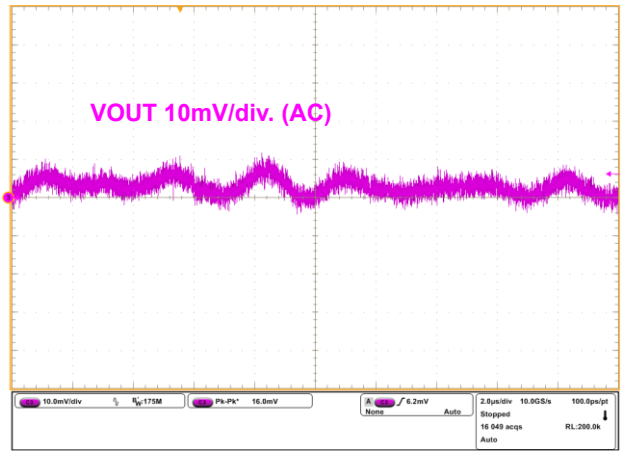

Figure 12. Output Ripple Voltage
(VIN=12V, Io=0A)

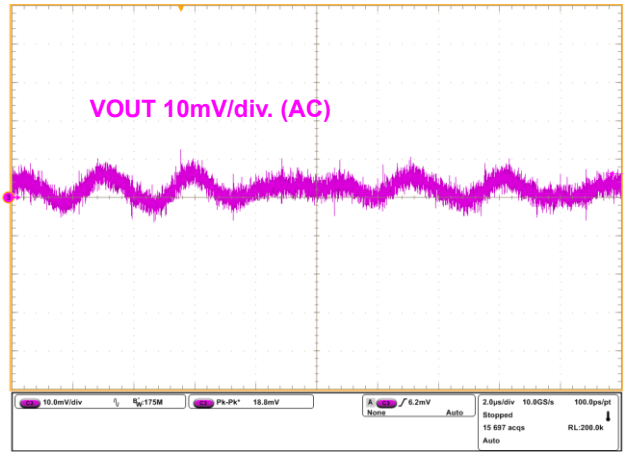

Figure 13. Output Ripple Voltage
(VIN=12V, Io=3.5A)

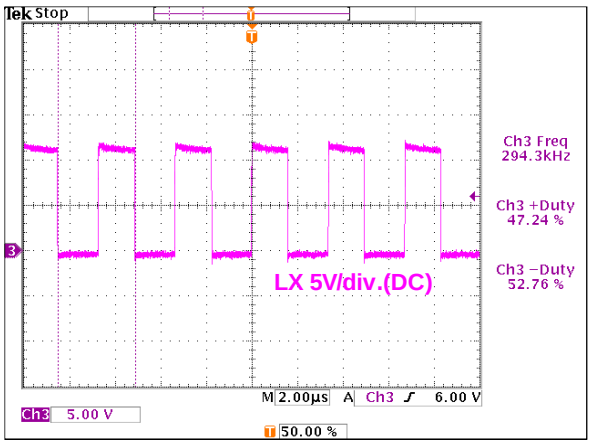

Figure 14. Switching Waveform
(VIN=12V, Io=3.5A)

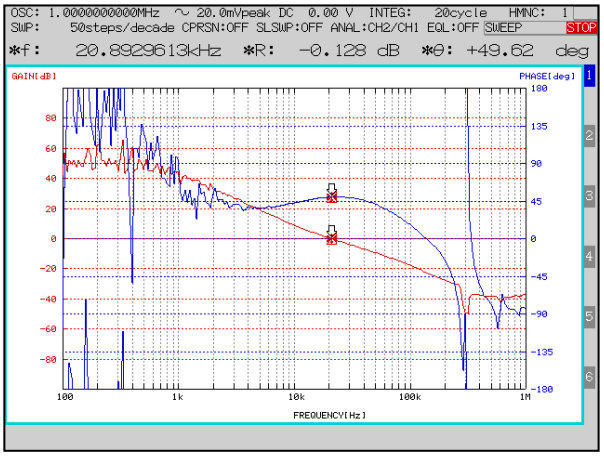

Figure 15. Frequency Characteristics
(VIN=12V, Io=3.5A)

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Products listed in the BOM

The product names listed in the bill of materials are available ones at the time of creating this user's guide. In case some parts are no longer available in the future, select the equivalent products.

Selection of Ceramic Capacitors

In selecting the ceramic capacitors, consider the DC bias characteristics and select the ones with actual capacitance are equivalent. For reference, Figure 16 shows the DC bias characteristics of GCM32EC71A476KE02(Murata) listed in the BOM C6. Actual capacitance degrades to 31.6µF from the nominal value of 47µF under the condition of 5V output(DC bias voltage is 5V.) When selecting an alternative component, select the product that has same capacitance under 5V of DC bias voltage. (The data in Figure 16 is only as reference. Please check with the capacitor manufacturer for the DC bias characteristics of ceramic capacitors.).

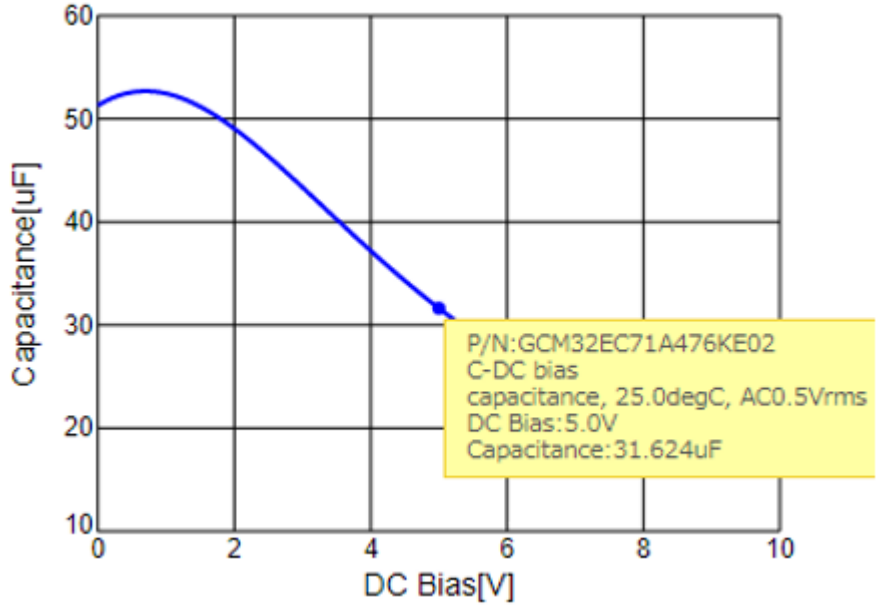

Figure 16. GCM32EC71A476KE0(Murata) DC bias characteristics

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Revision History

Date	Revision Number	Description
9. Mar. 2020	001	Initial release
4. Aug. 2021	002	p.3 Update Table 1 Part Number of C8 and add description about the parts selection via its usage
		p.5 Update Figure 8
		p.6 Update Figure 12, 13 and add Figure 15
		p.7 Add "Products listed in the BOM" and "Selection of Ceramic Capacitors"

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