Primary Buck DC/DC Converter Series

Single 440 kHz Buck DC/DC Converter For Automotive BD9P2x6EFV-C Series Evaluation Board

BD9P2x6EFV-TSB-001 (3.5 V to 40 V Input, 2.0 A)

Introduction

This user's guide will provide the necessary steps to operate the Evaluation Board of ROHM's BD9P2x6EFV-C series Buck DC/DC converter which includes BD9P206EFV-C, BD9P236EFV-C, and BD9P256EFV-C. This includes the external parts, operating procedures and application data.

BD9P206EFV-TSB-001 VOUT=5.0V setting

BD9P236EFV-TSB-001 VOUT=3.3V fixed

BD9P256EFV-TSB-001 VOUT=5.0V fixed

Description

This Evaluation Board was developed for ROHM's single 440 kHz buck DC/DC converter BD9P2x6EFV-C series. BD9P2x6EFV-C series is a current mode synchronous buck DC/DC converter with integrated POWER MOSFETs. The BD9P2x6EFV-C series accepts a power supply input range of 3.5 V to 40 V and generates a maximum output current of 2 A. BD9P206EFV-C generates an output voltage range of 0.8 V to 8.5 V using external resistors. BD9P236EFV-C generates a fixed output voltage of 3.3 V, and BD9P256EFV-C generates a fixed output voltage of 5.0 V.

Application

Automotive Powered Supplies

Consumer Powered Supplies

Recommended Operating Conditions

Table 1. Recommended Operating Conditions

Parameter	Min	Typ	Max	Units	Conditions
Input Voltage	3.5	-	40	V	Initial startup is 4.0 V or more
Output Voltage for BD9P206EFV-C (Note1)	0.8	-	8.5	V	
Output Voltage for BD9P236EFV-C	-	3.3	-	V	
Output Voltage for BD9P256EFV-C	-	5.0	-	V	
Output Current Range	-	-	2.0	A	OCP_SEL = H : 1.5 A (Max) OCP_SEL = L : 2.0 A (Max)
Switching Frequency	-	440	-	kHz	
Maximum Efficiency(BD9P236EFV-C)	-	92.9	-	%	VIN = 12 V, Io = 0.53 A, Ta = 25 °C
Maximum Efficiency(BD9P256EFV-C)	-	94.7	-	%	VIN = 12 V, Io = 0.7 A, Ta = 25 °C

(Note1) Although the minimum output voltage is configurable up to 0.8 V, it may be limited by the SW min ON pulse width. For the same reason, although the maximum output voltage is configurable up to 8.5 V, it may be limited by the SW minimum OFF pulse width.

Evaluation Board

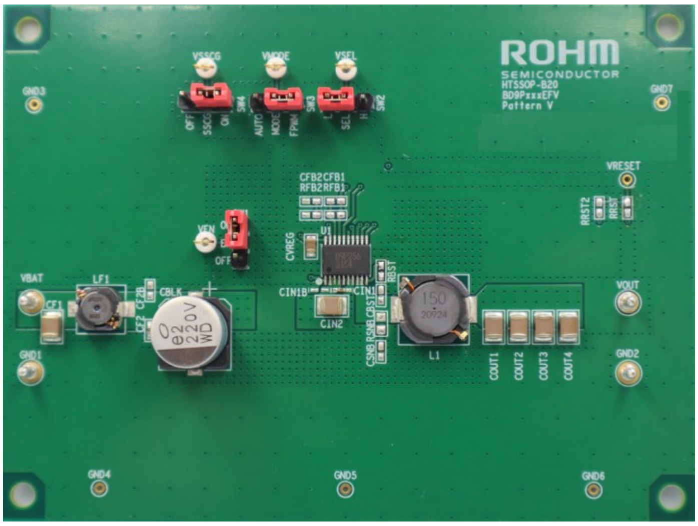

Figure 1. Evaluation Board Top View

Evaluation Board Schematic

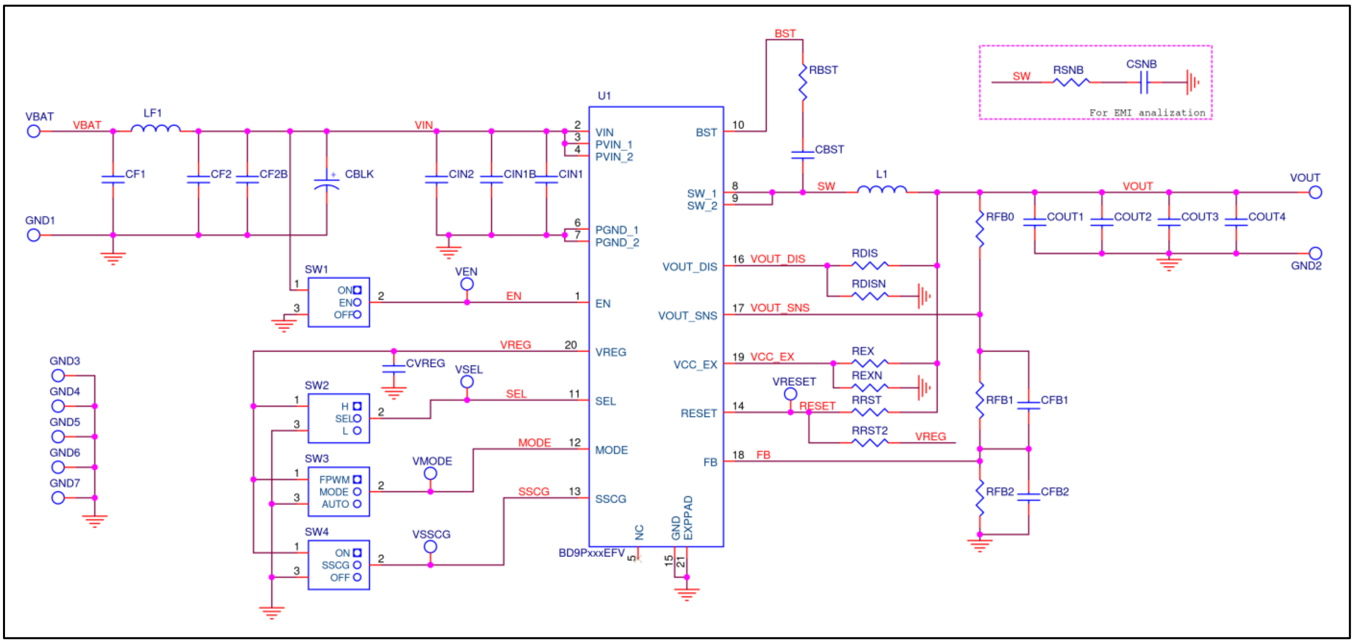

Figure 2. BD9P2x6EFV-C Circuit Diagram

Operating Procedure

1. Turn off EN and connect the GND terminal of the power supply to the GND terminal of Evaluation Board.
2. Connect VCC pin of power supply to the VBAT pin of the Evaluation Board.
3. Connect the load to the Evaluation Board’s VOUT and GND terminals. When using an electronic load, connect with the load turned off.
4. Connect a voltmeter to the Evaluation Board's VOUT and GND terminals.
5. Turn on the Power supply of VBAT. Turn ON the switch of EN terminal.
6. Make sure that the voltmeter is set to measure voltage.
7. Turn on the electronic load.

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

(Note) If EN = High (EN short to VIN) before Power ON, the turn ON and turn OFF is controlled by VBAT only.

Operation Mode Settings

Below is a table of BD9P2x6EFV-C operation modes selectable using OCP_SEL, MODE and SSCG terminals.

Table 2. Mode Settings

Terminal	Setting	Operation Mode	Function
OCP_SEL	HIGH	OCP threshold selection	OCP threshold is set to 2.250 A (Typ.) Output Current maximum is 1.5 A.
	LOW		OCP threshold is set to 3.0 A (Typ.) Output Current maximum is 2.0 A.
MODE	HIGH	FPWM	Forced PWM mode
	LOW or OPEN	AUTO	Automatically switched between PWM and LLM mode.
	Apply a clock to this pin	SYNC	Activate synchronization mode
SSCG	ON (HIGH)	Select Spread Spectrum function	Enable Spread Spectrum
	OFF (LOW)		Disable Spread Spectrum

(Note) If setting is High, the terminal is shorted to VREG, and if setting is Low, the terminal is shorted to GND.

Pin Configuration

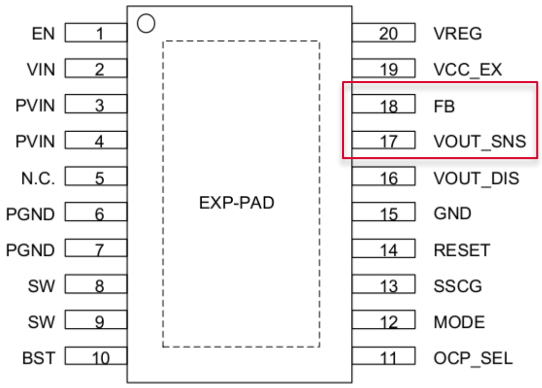

Figure 3. Pin Configuration (BD9P206EFV-C)

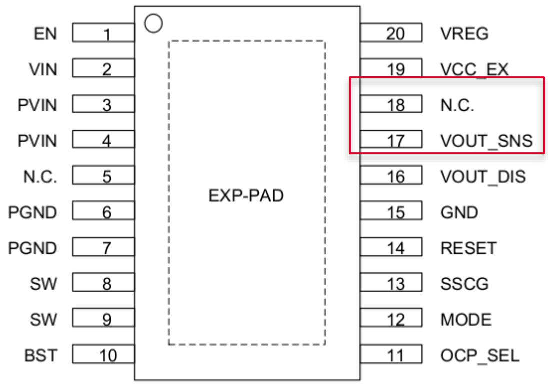

Figure 4. Pin Configuration (BD9P236EFV-C, BD9P256EFV-C)

Pin Description of difference with BD9P206EFV-C and BD9P236EFV-C/BD9P256EFV-C

Table 3. Pin Description

Pin No.	Pin Name	function
17 (BD9P206EFV-C)	VOUT_SNS	Pin to define the clamp voltage of GmAmp2 output and phase compensation. Connect this pin to the output voltage.
17 (BD9P236EFV-C, BD9P256EFV-C)		Inverting input node of the GmAmp1. This pin is used for OVP, SCP and RESET detection. And, this pin is used for defining the clamp voltage of GmAmp2 output and phase compensation. Connect this pin to the output voltage.
18 (BD9P206EFV-C)	FB	Inverting input node of the GmAmp1. This pin is used for OVP, SCP and RESET detection. Connect output voltage divider to this pin to set the output voltage.
18 (BD9P236EFV-C, BD9P256EFV-C)	N.C.	This pin is not connected to the chip. Use this as open. If this pin is used other than open and adjacent pins are expected to be shorted, please confirm if there is any problem with the actual application.

Parts List (BD9P236EFV-C, BD9P256EFV-C)

Table 4. BD9P236EFV-C (3.3 V, 2.0 A) / BD9P256EFV-C (5.0V, 2.0 A) Parts list

	Part No	Value	PKG(inch)	PKG(mm)	Manufacturer	Part Name(Series)
π type filter	CF1	4.7 µF	1210	3225	Murata	GCM32ER71H475K
	LF1	2.2 µH	2524h18	6360h45	TDK	CLF6045NIT-2R2N-D
	CF2	0.1 µF	0402	1005	Murata	GCM155R71H104K
	CF2B	Open	-	-	-	-
	CBLK	220 µF	0404h04	1010h10	Nichicon	UWD1V221MCL1GS
Basic	CIN1	0.1 µF	0402	1005	Murata	GCM155R71H104K
	CIN1B	Open	-	-	-	-
	CIN2	4.7 µF	1210	3225	Murata	GCM32ER71H475K
	CVREG	1 µF	0805	2012	Murata	GCM21BR71C105K
	CBST	0.1 µF	0402	1005	Murata	GCM155R71H104K
	RBST	0 Ω	0201	0603	ROHM	MCR006 Series
Application	L1	15 µH	-	L10*W9.7*H3.8	TDK	CLF10040T-150M-D
	COUT1 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT2 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT3 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT4 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	RFB0	0 Ω	0201	0603	ROHM	MCR006 Series
	RFB1	Open	-	-	-	-
	RFB2	Open	-	-	-	-
	CFB1 (Note 4)	Open	-	-	-	-
	CFB2 (Note 4)	Open	-	-	-	-
	RDIS	0 Ω	0201	0603	ROHM	MCR006 Series
	RDISN	Open	-	-	-	-
	REX (Note 2)	0 Ω	0201	0603	ROHM	MCR006 Series
	REXN (Note 2)	Open	-	-	-	-
	RRST (Note 3)	10 kΩ	0201	0603	ROHM	MCR006 Series
	RRST2 (Note 3)	Open	-	-	-	-
	RSNB	Open	-	-	-	-
	CSNB	Open	-	-	-	-

Parts List (BD9P206EFV-C)

Table 5. BD9P206EFV-C (3.3 V, 2.0 A) Parts list

	Part No	Value	PKG(inch)	PKG(mm)	Manufacturer	Part Name(Series)
π type filter	CF1	4.7 µF	1210	3225	Murata	GCM32ER71H475K
	LF1	2.2 µH	2524h18	6360h45	TDK	CLF6045NIT-2R2N-D
	CF2	0.1 µF	0402	1005	Murata	GCM155R71H104K
	CF2B	Open	-	-	-	-
	CBLK	220 µF	0404h04	1010h10	Nichicon	UWD1V221MCL1GS
Basic	CIN1	0.1 µF	0402	1005	Murata	GCM155R71H104K
	CIN1B	Open	-	-	-	-
	CIN2	4.7 µF	1210	3225	Murata	GCM32ER71H475K
	CVREG	1 µF	0805	2012	Murata	GCM21BR71C105K
	CBST	0.1 µF	0402	1005	Murata	GCM155R71H104K
	RBST	0 Ω	0201	0603	ROHM	MCR006 Series
Application	L1	15 µH	-	L10*W9.7*H3.8	TDK	CLF10040T-150M-D
	COUT1 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT2 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT3 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT4 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	RFB0	0Ω	0201	0603	ROHM	MCR006 Series
	RFB1	75 kΩ	0201	0603	ROHM	MCR006 Series
	RFB2	24 kΩ	0201	0603	ROHM	MCR006 Series
	CFB1 (Note 4)	Open	-	-	-	-
	CFB2 (Note 4)	Open	-	-	-	-
	RDIS	0 Ω	0201	0603	ROHM	MCR006 Series
	RDISN	Open	-	-	-	-
	REX (Note 2)	0 Ω	0201	0603	ROHM	MCR006 Series
	REXN (Note 2)	Open	-	-	-	-
	RRST (Note 3)	10 kΩ	0201	0603	ROHM	MCR006 Series
	RRST2 (Note 3)	Open	-	-	-	-
	RSNB	Open	-	-	-	-
	CSNB	Open	-	-	-	-

Table 6. BD9P206EFV-C (5 V, 2.0 A) Parts list

	Part No	Value	PKG(inch)	PKG(mm)	Manufacturer	Part Name(Series)
π type filter	CF1	4.7 µF	1210	3225	Murata	GCM32ER71H475K
	LF1	2.2 µH	2524h18	6360h45	TDK	CLF6045NIT-2R2N-D
	CF2	0.1 µF	0402	1005	Murata	GCM155R71H104K
	CF2B	Open	-	-	-	-
	CBLK	220 µF	0404h04	1010h10	Nichicon	UWD1V221MCL1GS
Basic	CIN1	0.1 µF	0402	1005	Murata	GCM155R71H104K
	CIN1B	Open	-	-	-	-
	CIN2	4.7 µF	1210	3225	Murata	GCM32ER71H475K
	CVREG	1 µF	0805	2012	Murata	GCM21BR71C105K
	CBST	0.1 µF	0402	1005	Murata	GCM155R71H104K
	RBST	0 Ω	0201	0603	ROHM	MCR006 Series
Application	L1	15 µH	-	L10*W9.7*H3.8	TDK	CLF10040T-150M-D
	COUT1 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT2 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT3 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	COUT4 (Note 1)	22 µF	1210	3225	Murata	GCM32ER71A226K
	RFB0	0 Ω	0201	0603	ROHM	MCR006 Series
	RFB1	68 kΩ	0201	0603	ROHM	MCR006 Series
	RFB2	13 kΩ	0201	0603	ROHM	MCR006 Series
	CFB1 (Note 4)	Open	-	-	-	-
	CFB2 (Note 4)	Open	-	-	-	-
	RDIS	0 Ω	0201	0603	ROHM	MCR006 Series
	RDISN	Open	-	-	-	-
	REX (Note 2)	0 Ω	0201	0603	ROHM	MCR006 Series
	REXN (Note 2)	Open	-	-	-	-
	RRST (Note 3)	10 kΩ	0201	0603	ROHM	MCR006 Series
	RRST2 (Note 3)	Open	-	-	-	-
	RSNB	Open	-	-	-	-
	CSNB	Open	-	-	-	-

(Note 1)

Max Output Current	VOUT	OCP_SEL	Recommended L Value	Recommended COUT Value	Minimum COUT Value (Note1-1,2)
2.0 A	≥ 3.3 V	L	15 µH	COUT ≥ 88 µF	COUT_WORST ≥ 60 µF
	> 1.1 V < 3.3 V		15 µH	COUT $\geq \frac{290.4}{VOUT}$ µF (*)	COUT_WORST $\geq \frac{198.0}{VOUT}$ µF (*)
	≤ 1.1 V		22 µH	COUT $\geq \frac{426.0}{VOUT}$ µF (*)	COUT_WORST $\geq \frac{290.4}{VOUT}$ µF (*)
1.5 A	≥ 3.3 V	H	15 µH	COUT ≥ 88 µF	COUT_WORST ≥ 60 µF
	> 1.1 V < 3.3 V		15 µH	COUT $\geq \frac{290.4}{VOUT}$ µF (*)	COUT_WORST $\geq \frac{198.0}{VOUT}$ µF (*)
	≤ 1.1 V		22 µH	COUT $\geq \frac{426.0}{VOUT}$ µF (*)	COUT_WORST $\geq \frac{290.4}{VOUT}$ µF (*)

* VOUT is the output voltage [V]

(Note 1-1) When selecting the output capacitor, ensure that the capacitance, COUT_WORST, of the above equation is maintained at the characteristics of DC Bias, AC Voltage, temperature, and tolerance.

(Note 1-2) If the capacitance falls below this value, oscillation may happen. When using electrolytic capacitor and conductive polymer hybrid aluminum electrolytic capacitor, please place it in addition to the ceramic capacitors with the capacity described above. The changes in the frequency characteristic are greatly affected by the type and the condition (temperature, etc.) of parts that are used, the wire routing and the layout of the PCB. Please confirm stability and responsiveness in actual application.

(Note 2) VCC_EX is power supply input for internal circuit. VREG voltage is supplied from VCC_EX when voltage between 3.2V (VTEXH, Max) and 5.65 V (VEXOVPL, Min) is connected to this pin. Connecting this pin to VOUT improves efficiency. In case this function will not be used, connect this pin to GND.

Output Voltage	REX setting	REXN setting	VCC_EX State
3.2 V ≤ VOUT ≤ 5.65 V	0Ω	Open	Connected to VOUT
3.2 V > VOUT > 5.65 V	Open	0Ω	Connected to GND

(Note 3) RESET is an output reset pin with open drain. Connect a pull-up resistor, with recommended value of 5 kΩ to 100 kΩ, to the VREG pin or the power supply within the absolute maximum voltage ratings of the RESET pin.
RESET terminal should be pulled-up to VREG via RRST2 when the output setting is over 6.5 V because RESET pin’s absolute maximum rating is 7.0 V. If RESET is not pulled-up to VOUT, it can be pulled-up to VREG via RRST2 by default.

(Note 4) Please use CFB1 and CFB2 PCB patterns to improve the frequency characteristics. Set these values by following the guide in page 34 of datasheet.

(Note 5) If the recommended parts on tables 4, 5 and 6 are not available anymore due to end of production, different parts will be used on the test board because the end of production parts are deprecated.

Board Layout

Evaluation Board PCB information

Number of Layers	Material	Board Size	Copper Thickness
4	FR-4 High Tg	114.3mm x 76.2mm x 1.57mm	2oz(70μm) / 1oz (35μm) / 1oz (35μm) / 2oz(70μm)

The layout of BD9P2x6EFV-C series is shown below.

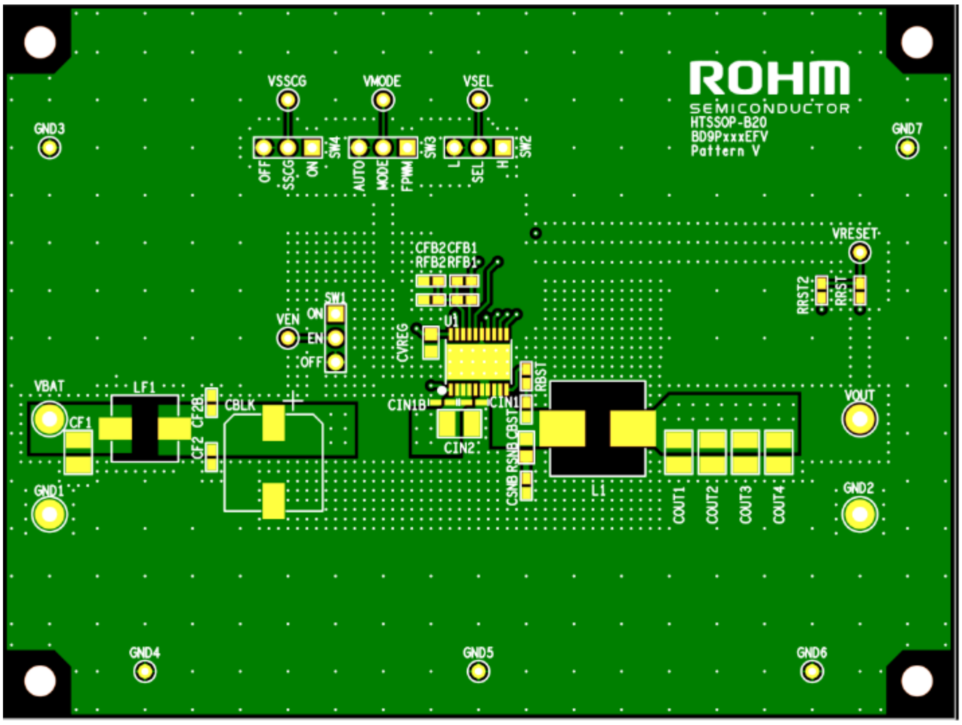

Figure 5. Top Layer Layout

(Top View)

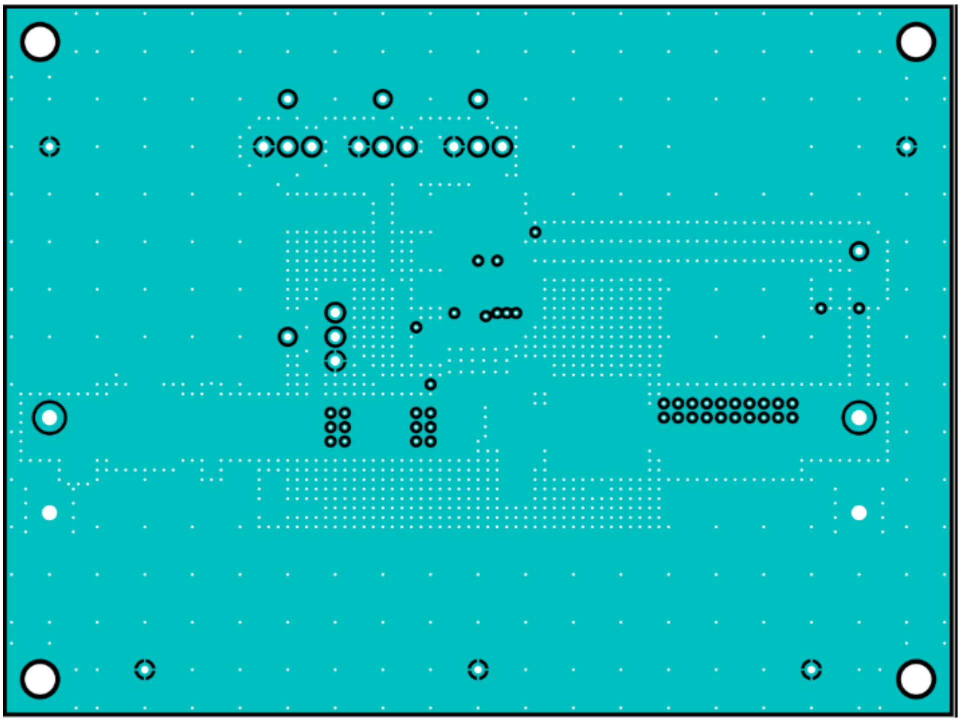

Figure 6. Middle1 Layer Layout

(Top View)

Board Layout - continuation

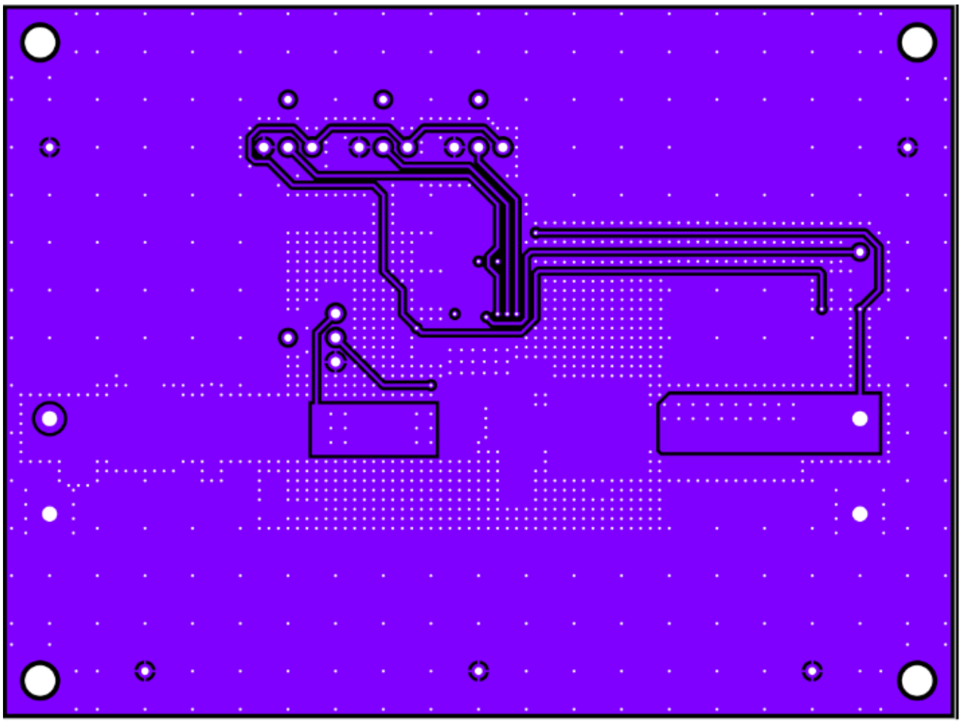

Figure 7. Middle2 Layer Layout
(Top View)

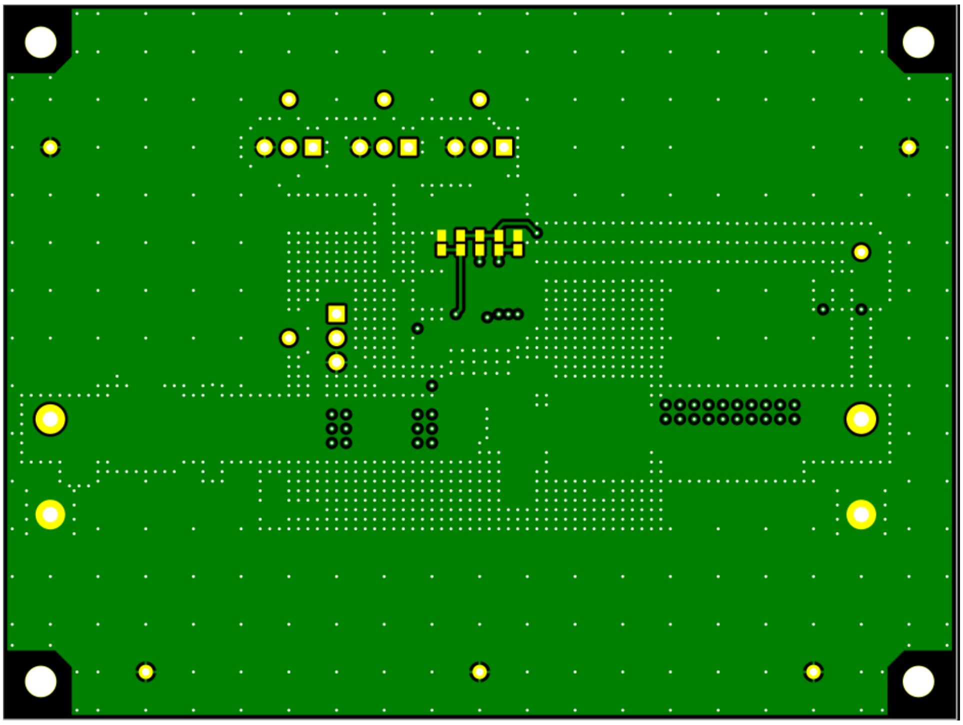

Figure 8. Bottom Layer Layout
(Top View)

Revision History

Date	Revision Number	Description
24. Sep. 2024	001	New release
25. Dec. 2024	002	Add the VOUT setting value of Test Board to Introduction

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ROHM SEMICONDUCTOR

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