



# **1ch Buck switching regulator BD9611MUV EVK**

**BD9611MUV-EVK-001 (24V → 12V, 10A)**

**User's Guide**

## <High Voltage Safety Precautions>

◇ Read all safety precautions before use

Please note that this document covers only the **BD9611MUV** evaluation board (**BD9611MUV-EVK-001**) and its functions. For additional information, please refer to the datasheet.

**To ensure safe operation, please carefully read all precautions before handling the evaluation board**



Depending on the configuration of the board and voltages used,

**Potentially lethal voltages may be generated.**

Therefore, please make sure to read and observe all safety precautions described in the red box below.

### Before Use

- [1] Verify that the parts/components are not damaged or missing (i.e. due to the drops).
- [2] Check that there are no conductive foreign objects on the board.
- [3] Be careful when performing soldering on the module and/or evaluation board to ensure that solder splash does not occur.
- [4] Check that there is no condensation or water droplets on the circuit board.

### During Use

- [5] Be careful to not allow conductive objects to come into contact with the board.
- [6] **Brief accidental contact or even bringing your hand close to the board may result in discharge and lead to severe injury or death.**

**Therefore, DO NOT touch the board with your bare hands or bring them too close to the board.**

In addition, as mentioned above please exercise extreme caution when using conductive tools such as tweezers and screwdrivers.

- [7] If used under conditions beyond its rated voltage, it may cause defects such as short-circuit or, depending on the circumstances, explosion or other permanent damages.
- [8] Be sure to wear insulated gloves when handling is required during operation.

### After Use

- [9] The ROHM Evaluation Board contains the circuits which store the high voltage. Since it stores the charges even after the connected power circuits are cut, please discharge the electricity after using it, and please deal with it after confirming such electric discharge.
- [10] Protect against electric shocks by wearing insulated gloves when handling.

This evaluation board is intended for use only in research and development facilities and should be handled **only by qualified personnel familiar with all safety and operating procedures.**

We recommend carrying out operation in a safe environment that includes the use of high voltage signage at all entrances, safety interlocks, and protective glasses.

## ROHM Switching Regulator Solutions

# 1ch Buck switching regulator BD9611MUV EVK

**BD9611MUV-EVK-001 (24V → 12V, 10A)**

## Introduction

This user's guide will provide the steps necessary to operate the BD9611MUV-EVK-001 and evaluate ROHM's BD9611MUV synchronous buck-boost DC/DC controller. Component selection, operating procedures and application data are included.

## Description

Using a synchronous rectified step-down DC/DC converter IC BD9611MUV, BD9611MUV-EVK-001 evaluation board outputs 12.0 V with a 15V to 36V input voltage and provides 10A output current. Output current is possible with current settings by selecting high rated current FET and coil. It is possible to adjust the loop characteristics by phase compensation components and can set the output voltage by changing the IC external parts.

## Application

General Portable Equipment such as:

- Amusement machines
- Industrial Equipment
- Office Automation Equipment
- LED lighting
- General equipment that require 24V or 48V supply

## Evaluation Board Operating Limits and Absolute Maximum Ratings

(This is not typical and the characteristics)

Unless otherwise specified : VIN = 24V, VOUT = 12.0V, Iout=6A

Table 1. Operating Limits

Parameter	Min	Typ	Max	Units	Conditions
Supply Voltage	15		36	V	
Output Voltage		12.0		V	RU1=120kΩ, RU2=20kΩ, RD1=10kΩ, RD2=short
Output Voltage range	1		VIN×0.8	V	
Output Current	0		10	A	
Closed Loop Band Width		12.02		kHz	
Phase margin		82.34		degrees	I <sub>o</sub> = 8A
Soft Start Time		8		ms	
Operating frequency		250		kHz	
Maximum Efficiency		95.1		%	I <sub>o</sub> = 4A

EVK overview

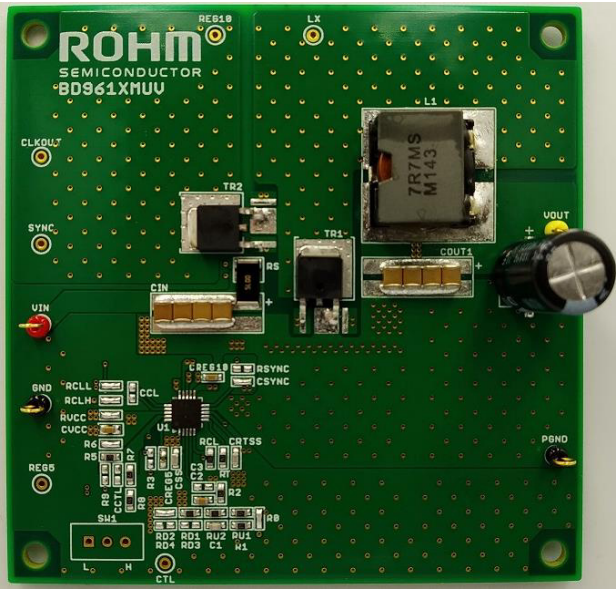


Figure 1. BD9611MUV-EVK-001(Top View)

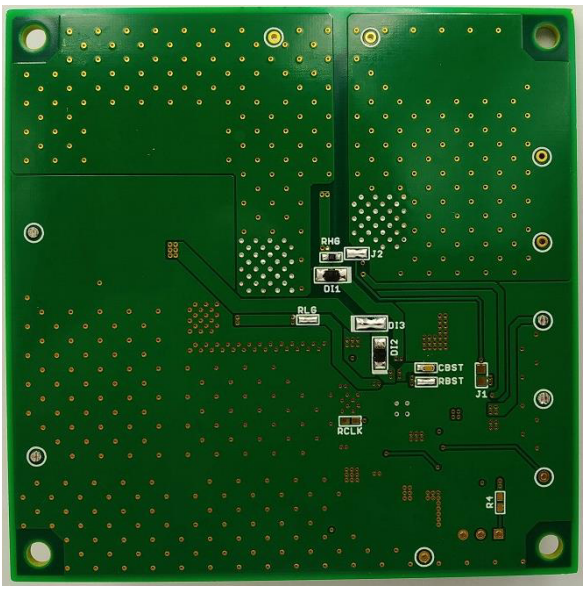


Figure 2. BD9611MUV-EVK-001(Bottom View)

EVK Schematic

VIN = 15.0V to 36V, VOUT = 12.0V

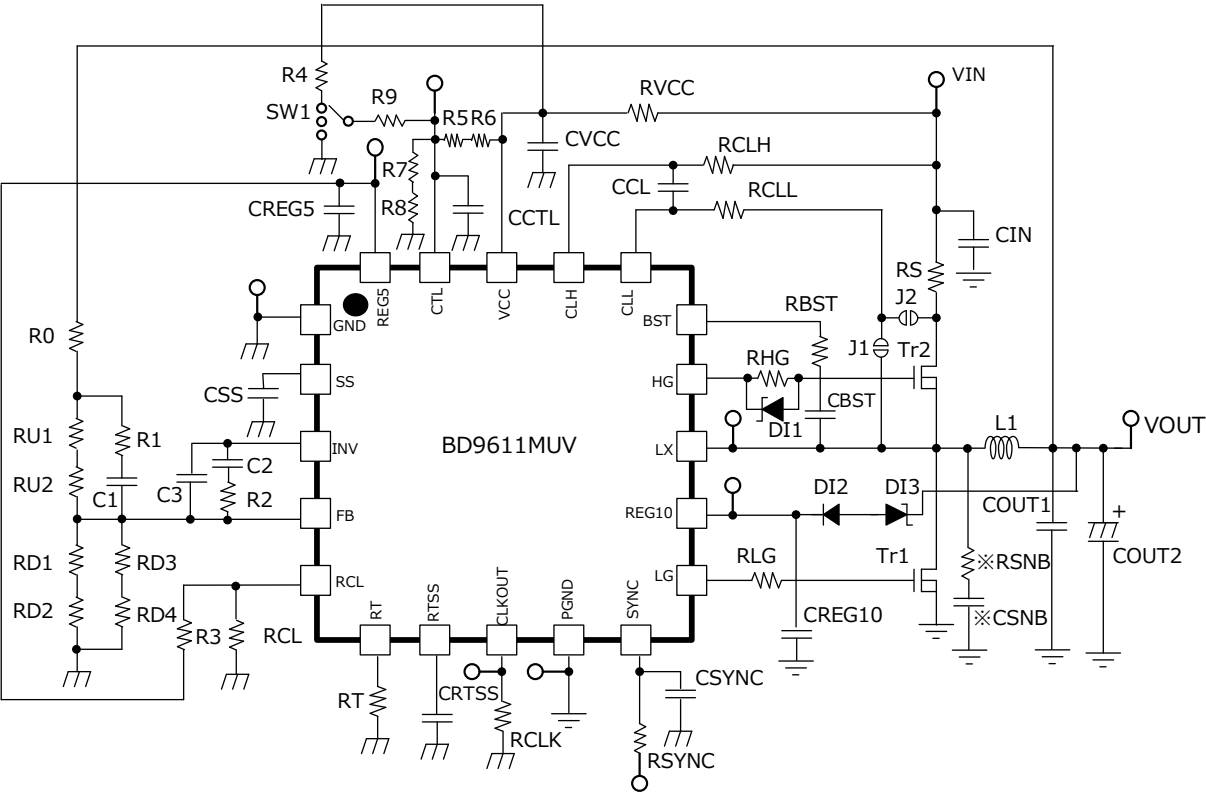


Figure 3. BD9611MUV-EVK-001 Application circuit

## Operating Procedure

1. Connect power supply's GND terminal to GND on the evaluation board.
2. Connect power supply's VIN terminal to VIN test point on the evaluation board. This will provide the power supply voltage to the IC. The EN pin of this evaluation board is set to input the resistive divided voltage of the VIN pin.
3. The output voltage can be measured at the test point VOUT. Now turn on the load. Connect an electronic load or resistive load to the VOUT pin and apply the load. The load can be increased up to 10A MAX.

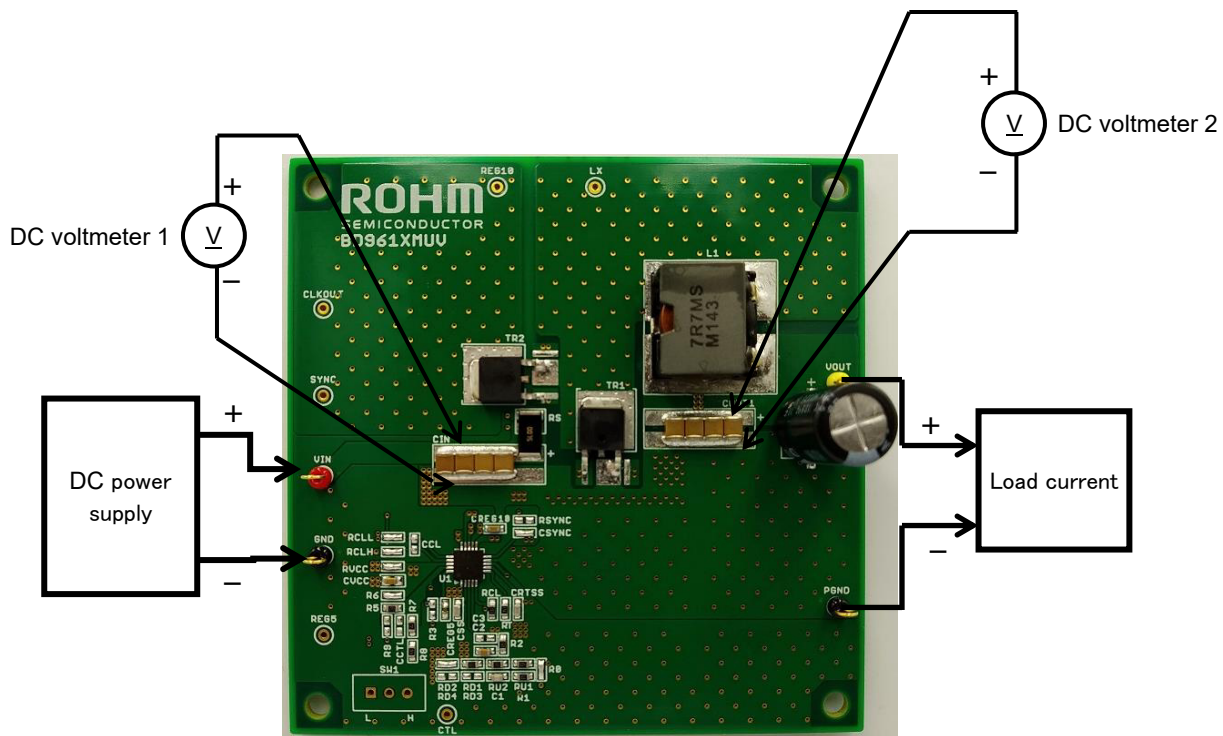


Figure 4. Evaluation board setup

## Enable

The board can switch between normal operation and standby mode to minimize power consumption by controlling the CTL of the IC (19 pin). By default, it is controlled using voltage divider resistor network of R5, R6, R7, and R8 which is referenced from VIN.

SW1 is not mounted on the EVK, but when using SW1, opening R5, R6, R7, and R8 and shorting R9, enables the use of SW1. Switching it to the GND will enter Standby Mode while switching it to VIN will enter to Normal operation.

In addition, by removing R9 and controlling the voltage between the CTL and GND pins, standby mode and normal operation can be switched. When the voltage on the CTL pin is less than 2.6V, standby mode is used, and when the voltage is 2.6V or higher, normal operation is performed. Since the hysteresis voltage is set by an internal low current and an external resistor, when the CTL pin is directly controlled by voltage, the hysteresis voltage is determined by the impedance of the power supply supplying the voltage to the CTL pin and the internal constant current.

## Evaluation Board BOM (VOUT =12.0V)

Table 2. Part list (12V output voltage setting)

Count	Parts No.	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration inch(mm)
1	U1	IC	-	Buck DC/DC Controller	BD9611MUV-E2	ROHM	1515(4040)
1	R1	Resistor	1kΩ	0.1W, 1%	MCR03EZPFX1001	ROHM	0603(1608)
1	R2	Resistor	15kΩ	0.1W, 1%	MCR03EZPFX1502	ROHM	0603(1608)
1	R5	Resistor	27kΩ	0.1W, 1%	MCR03EZPFX2702	ROHM	0603(1608)
1	R7	Resistor	5.1kΩ	0.1W, 1%	MCR03EZPFX5101	ROHM	0603(1608)
1	R8	Resistor	430Ω	0.1W, 1%	MCR03EZPFX4300	ROHM	0603(1608)
1	RU1	Resistor	120kΩ	0.1W, 1%	MCR03EZPFX1203	ROHM	0603(1608)
2	RU2, RCL	Resistor	20kΩ	0.1W, 1%	MCR03EZPFX2002	ROHM	0603(1608)
1	RD1	Resistor	10kΩ	0.1W, 1%	MCR03EZPFX1002	ROHM	0603(1608)
1	RT	Resistor	75kΩ	0.1W, 1%	MCR03EZPFX7502	ROHM	0603(1608)
1	RHG	Resistor	10Ω	0.1W, 1%	MCR03EZPFX10R0	ROHM	0603(1608)
2	DI1, DI2	Diode	20V/ 1A	VF(max)=0.42V @IF=1A	RB161VAM-20TR	ROHM	0705(2014)
1	RS	Resistor	5mΩ	2W, 1%	PMR100PZPXFU5L00	ROHM	6432(2512)
1	C1	Ceramic Capacitor	180pF	100V, 5%, NP0	GRM1555C2A181JE01	MURATA	0402(1005)
1	C2	Ceramic Capacitor	2200pF	50V, 5%, CH	GRM1882C1H222JA01	MURATA	0603(1608)
2	CSS, CRTSS	Ceramic Capacitor	0.01μF	50V, 5%, CH	GRM1882C1H103JA01D	MURATA	0603(1608)
1	CREG10	Ceramic Capacitor	1μF	50V, 10%, X5R	GRM155R61H105KE05	MURATA	0402(1005)
1	CBST	Ceramic Capacitor	0.47μF	25V, 10%, X7R	GRM188R71E474KA12D	MURATA	0603(1608)
4	CIN	Ceramic Capacitor	10μF	100V, 22%, X7S	GRM32EC72A106KE05K	MURATA	1210(3225)
1	COUT1	Aluminum Electrolytic Capacitor	220μF	50V, 20%	UVR1H221MPD1TD	Nichicon	0504(1210)
4	COUT2	Ceramic Capacitor	10μF	50V, 10%, B	GRM32EB31H106MA12	MURATA	1210(3225)
1	CVCC	Ceramic Capacitor	1μF	100V, 22%, X7S	GRM21BC72A105KE01	MURATA	0805(2012)
1	CREG5	Ceramic Capacitor	0.1μF	25V, 10%, X7R	GRM155R71E104KE14D	MURATA	0402(1005)
2	Tr1, Tr2	FET	60V/ 22A	Nch, VGS=3V, RDS(on)=18mΩ 30nC,DPAK-3	RD3L220SNTL1	ROHM	2426(6266)
1	L1	Inductor	7.7μH	10A	CDEP147NP-7R7MC-95	Sumida	0.59 x 0.59 (14.9 x 14.9)
11	R0, R6, RD2, RLG, RBST, RCLH, RCLL, RVCC, CSYNC, J2, DI3	-	-	Short	-	-	-
10	R3, R4, R9, RD3, RD4, C3 RCLK, RSYNC, CCL, J1	-	-	Open	-	-	-

### LX pin overshoot voltage countermeasure: Snubber Circuit

Overshoot voltage of LX pin is caused by the parasitic capacitance of the high-side and low-side FET and parasitic inductance of the board layout pattern. The power supply voltage range and load range used, and also the output short circuit must ensure that LX pin voltage does not exceed the recommended operating range.

If the overshoot voltage of the LX pin is large, set a snubber circuit in where the resistor RSNB and the capacitor CSNB are connected in series between the LX pin and PGND, as described in Figure 5 and prevent overshoot.

※RSNB and CSNB are not in the evaluation board pattern. It is recommended to place the pattern to allow countermeasures when an overshoot occurs.

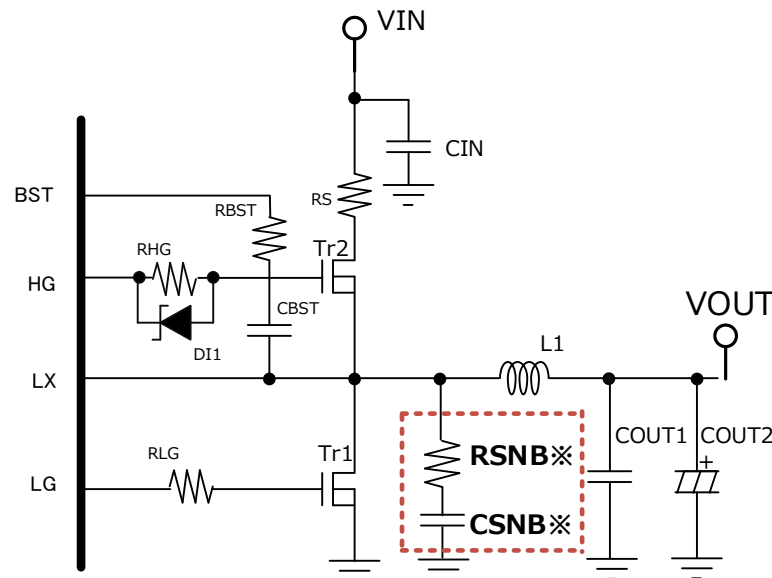


Figure 5. Snubber circuit

### DI2 and DI3 between output voltage and REG10

By connecting the diode of DI3 between the output and REG10, loss can be reduced by supplying power from the output voltage instead of REG10 inside the IC.

For the REG10 maximum rated voltage of 15V, it is necessary to consider output voltage fluctuations (IC variations, resistance tolerances, load fluctuations) and other factors.

#### <Precaution>

This document is an example of BD9611MUV application circuit and operation; it is not a guarantee to work.



Reference Application Data

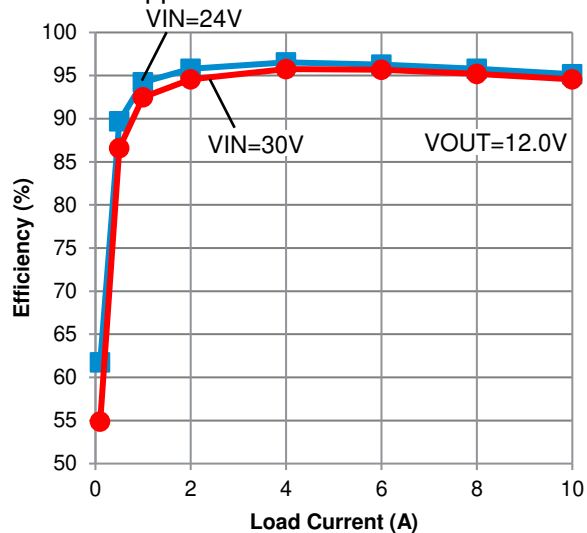


Figure 6. Efficiency – Load Current

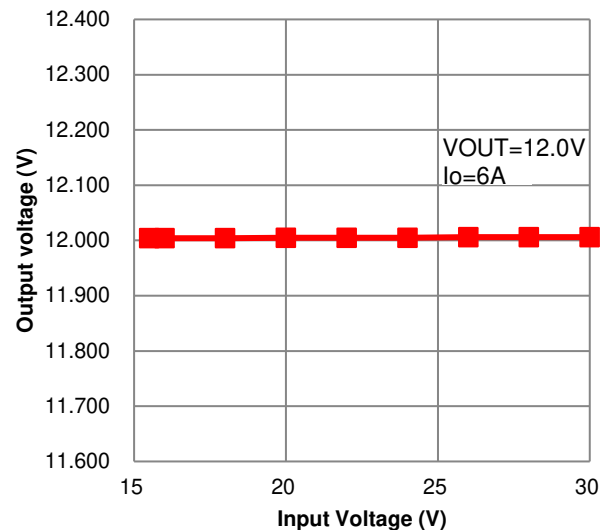


Figure 7. Line Regulation

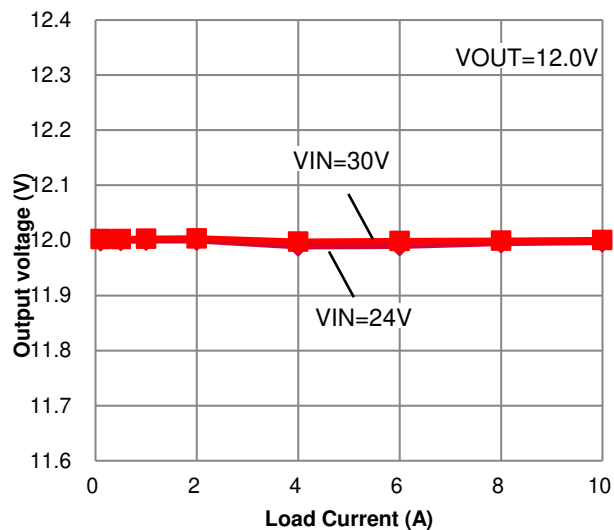


Figure 8. Load Regulation

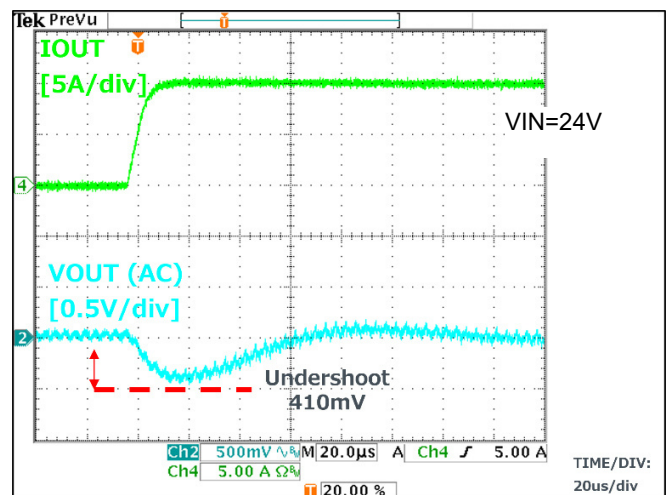


Figure 9. Load Response Characteristics (0A → 10A)

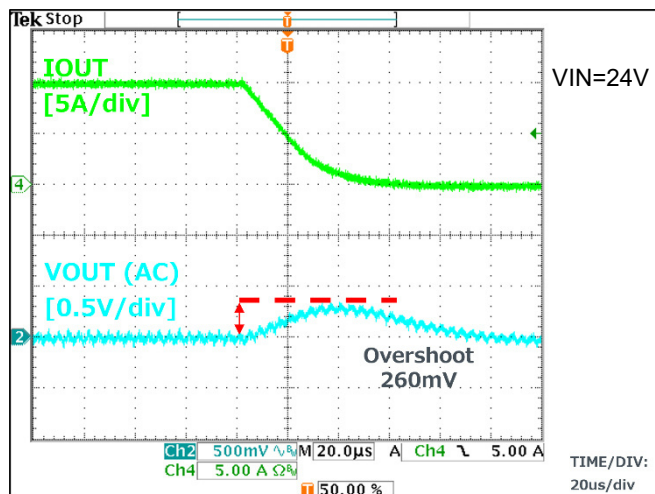


Figure 10. Load Response Characteristics (10A → 0A)

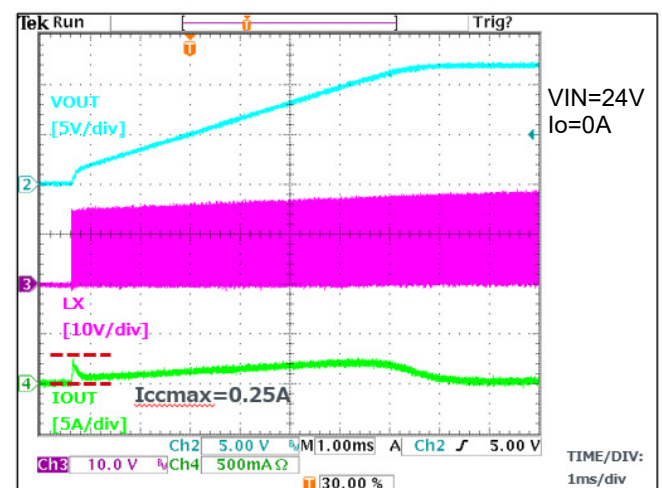


Figure 11. Start-up waveform (Soft Start)



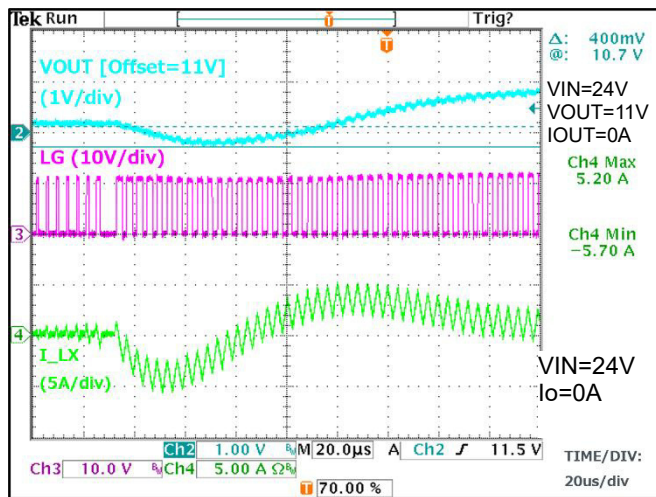


Figure 12. Start-up waveform (Pre-Bias)

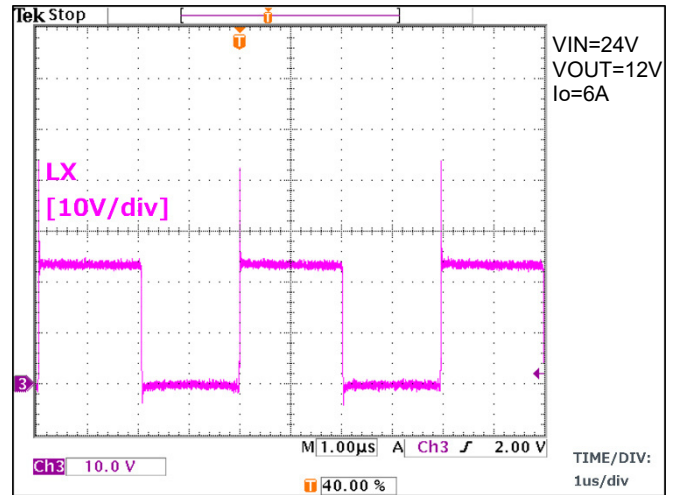


Figure 13. LX Terminal Waveform

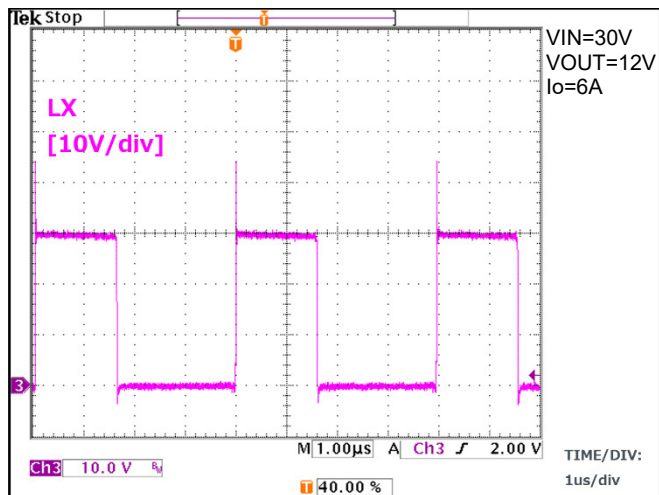


Figure 14. LX Terminal Waveform

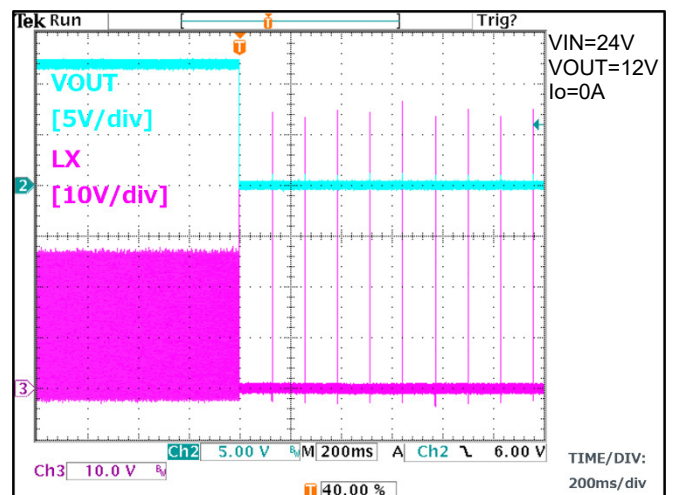


Figure 15. OCP Waveform

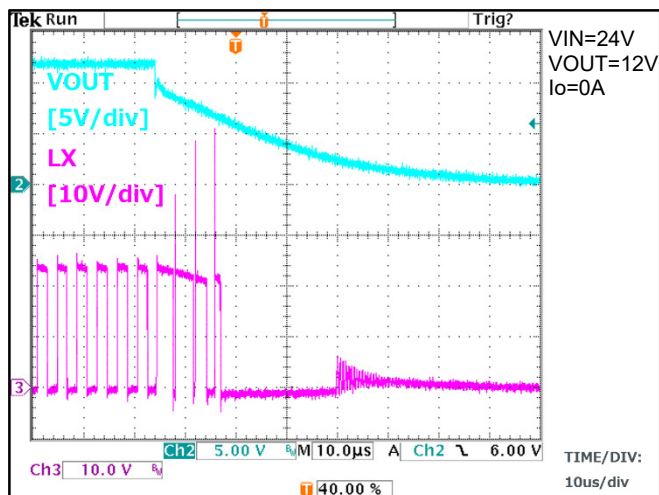


Figure 16. OCP Waveform (Zoom in)

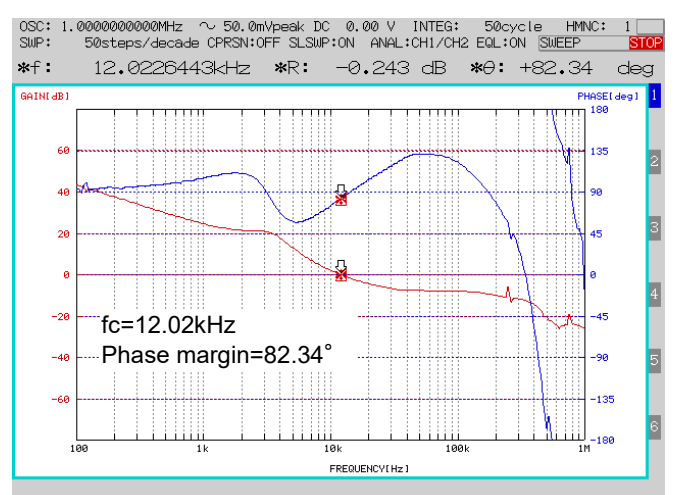


Figure 17. Frequency Response, VIN=24V, VOUT=12.0V / 8A

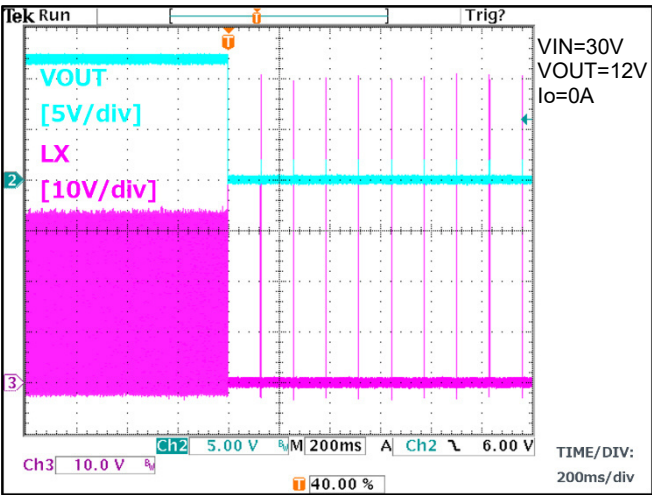


Figure 18. OCP Waveform

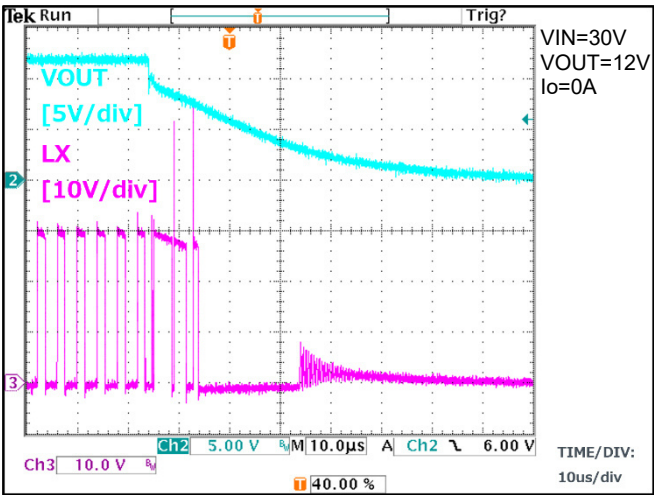


Figure 19. OCP Waveform (Zoom in)

Board Layout

EVK PCB information

Number of Layers	Material	Board Size	Copper Thickness
4	FR-4	80mm x 80mm x 1.6mm	1oz (35μm)

Followings are the layout of BD9611MUV-EVK-001

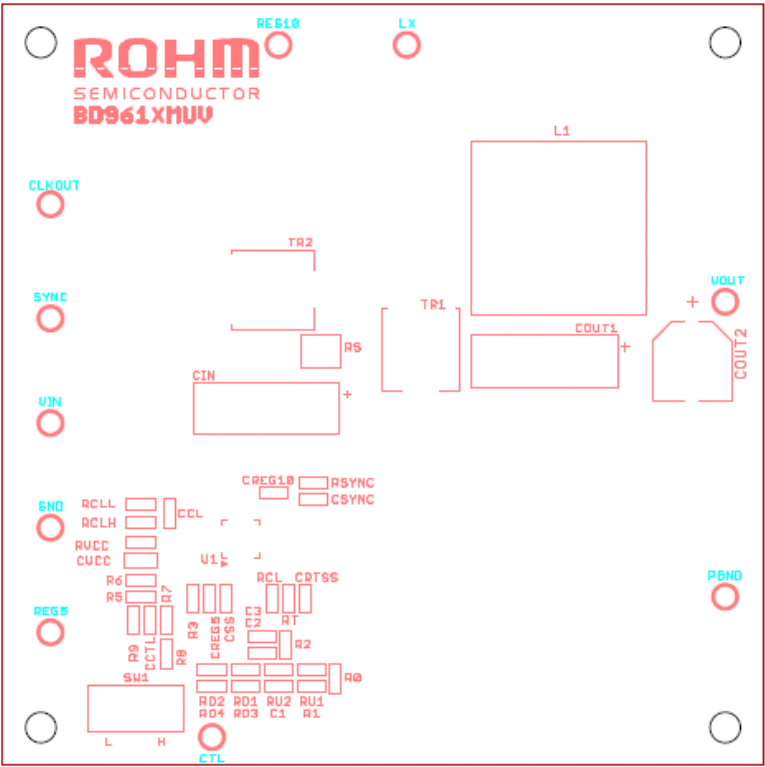


Figure 20. Top Silkscreen (Top view)

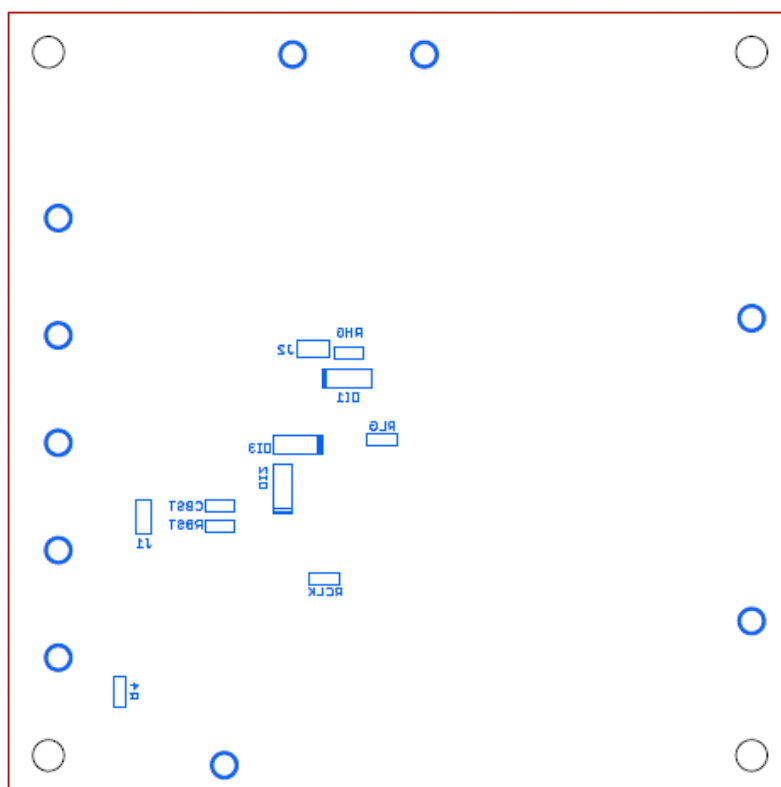


Figure 21. Bottom Silkscreen (Bottom view)

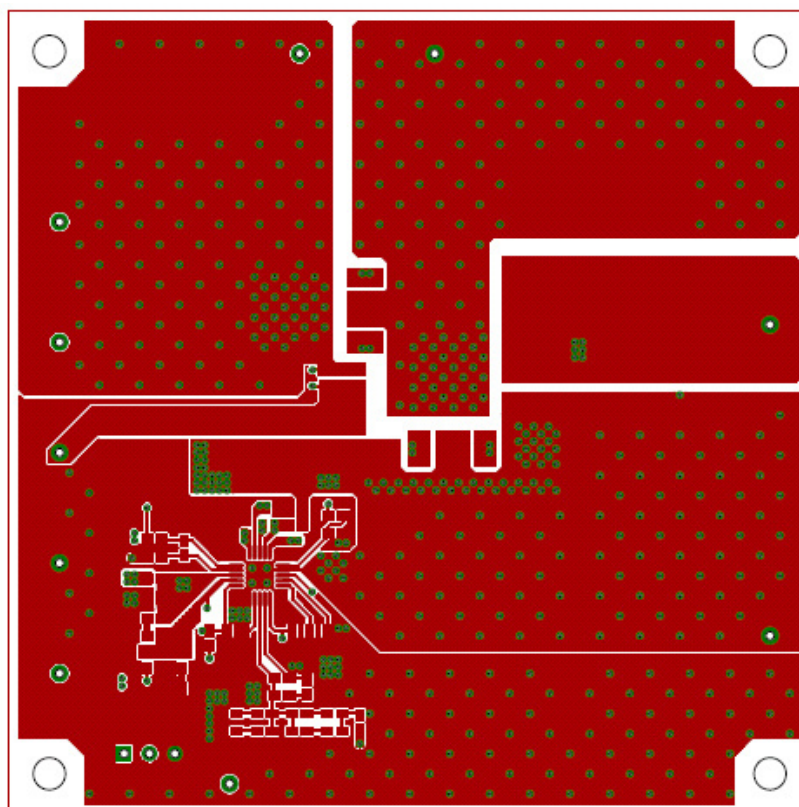


Figure 22. Top Layer (Top view)



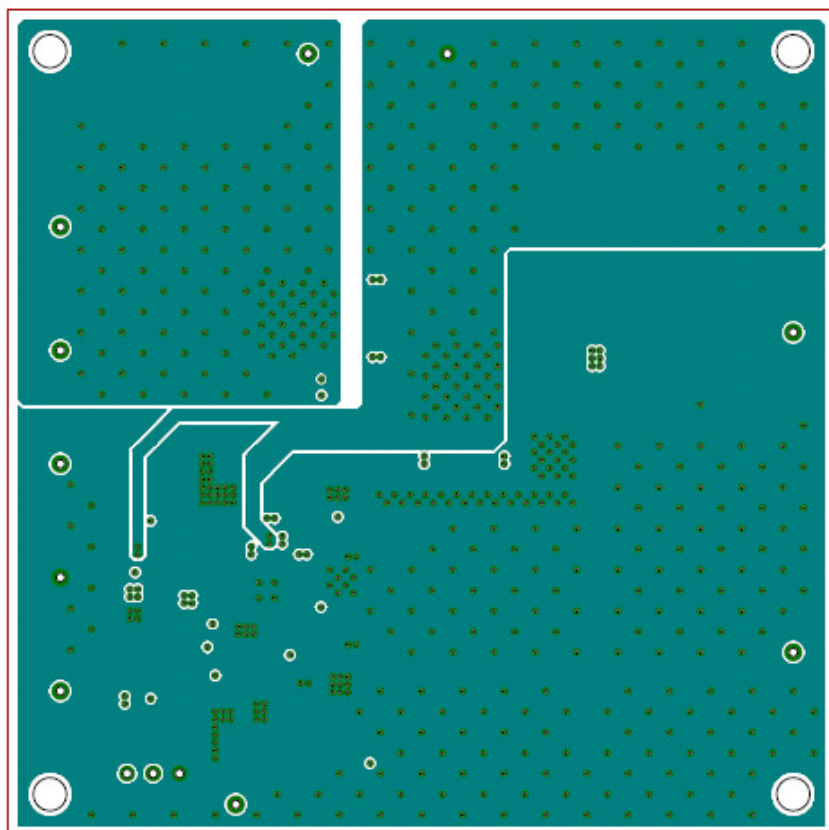


Figure 23. L2 Layer (Middle view)

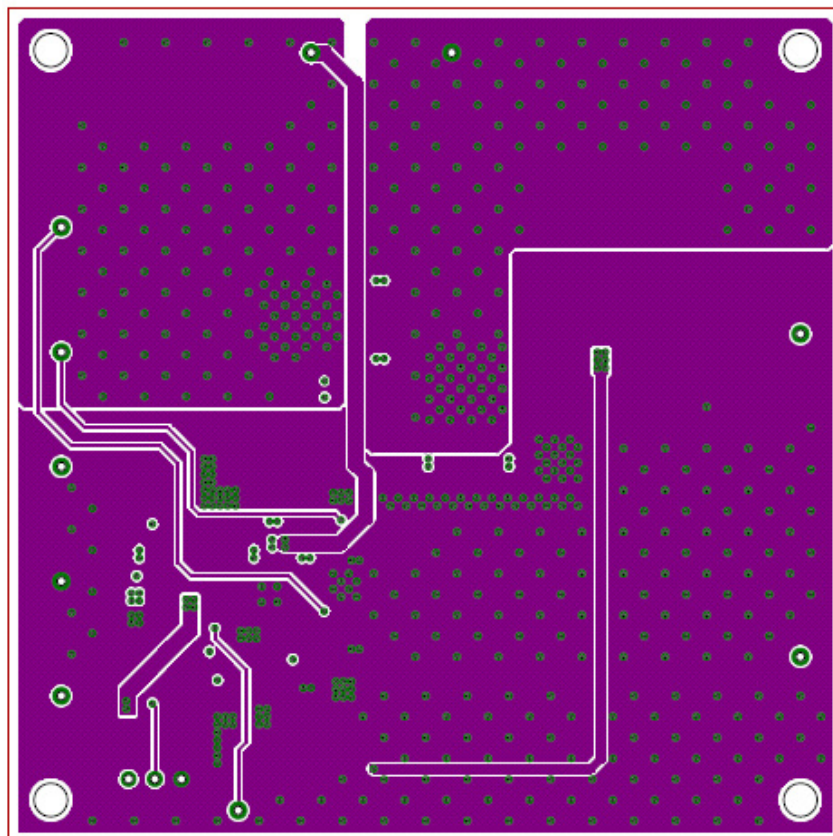


Figure 24. L3 Layer (Middle view)

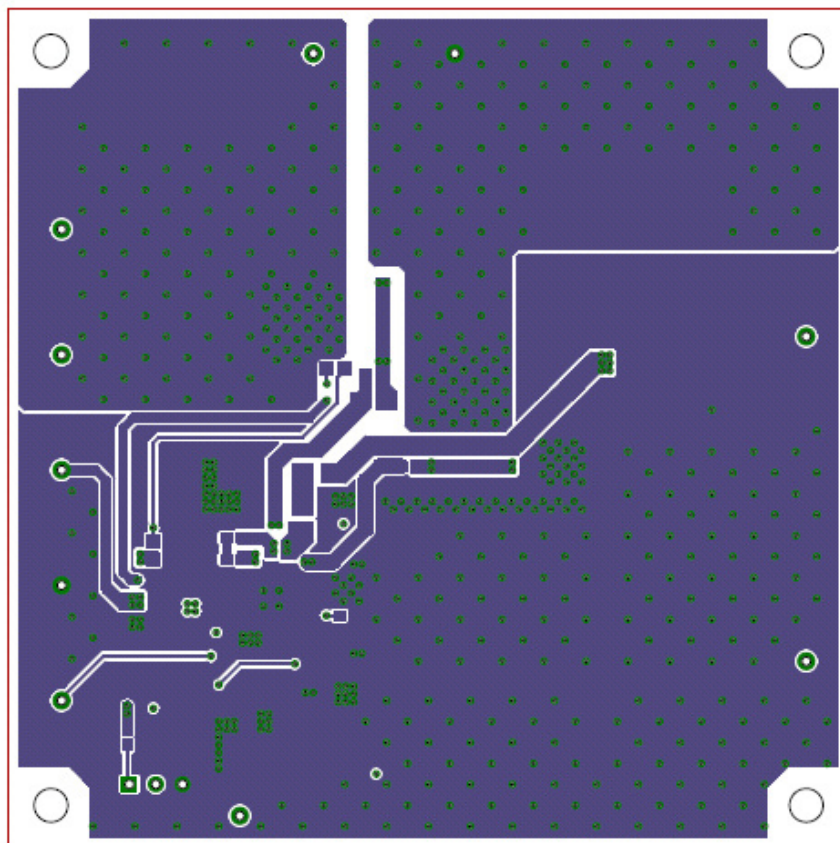


Figure 25. Bottom Layer (Bottom view)

## Products listed in the Part list

The product names listed in the part list 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.

## Revision History

Date	Revision Number	Description
9. Dec. 2014	001	Initial release
21. Aug. 2015	002	p.1 Corrected "maximum 8A" to "maximum 10A".
8. Dec. 2015	003	p.4 Update part number of resistor MCR03EZPF to MCR03EZPFX in table 2.
30. Nov. 2022	004	<p>p.1 Updated "Introduction" and "Application".</p> <p>p.1 Corrected " with a 15V to 24V input voltage " to " with a 15V to 36V input voltage".</p> <p>p.2 Updated "EVK overview".</p> <p>p.2 Changed schematic drawing. There is no change in component constants.</p> <p>p.2 Corrected "VIN 30V" to "VIN 36V".</p> <p>p.4 Update part number of Tr1 and Tr2 in table 2.</p> <p>p.4 Update part number of DI1 and DI2 from RB161VA-20 to RB161VAM-20TR.</p> <p>p.4 Update part number of all ceramic capacitors in table 2.</p> <p>p.5 Updated "DI2 and DI3 between output voltage and REG10".</p> <p>p.5 Updated Figure. 5 of snubber circuit.</p> <p>p.6 to p.8 Updated Figure.6 to Figure.19.</p> <p>p.8 Update "Board Layout".</p> <p>p.11 Update "Products listed in the Part list".</p>

## Notes

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- 2) Before you use our Products, please contact our sales representative and verify the latest specifications :
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