

## Switching Regulator Series

# Step-Down DC/DC Converter

## BD9C501EFJ Evaluation Board

BD9C501EFJ-EVK-001

### Description

This evaluation board has been developed for ROHM's synchronous buck DC/DC converter customers evaluating BD9C501EFJ. While accepting a power supply of 4.72-18V, an output of 3.3V can be produced. The IC has internal 50mΩ high-side P-channel MOSFET and 35mΩ low-side N-channel MOSFET and a synchronization frequency is of 500kHz. A Soft Start circuit prevents in-rush current during startup. An EN pin allows for simple ON/OFF control of the IC to reduce standby current consumption. Include OCP (Over Current Protection) and SCP (Short Circuit Protection).

### Evaluation Board Operating Limits and Absolute Maximum Ratings (Ta=25°C)

| Parameter                | Symbol           | Limit          |     |     | Unit | Conditions |
|--------------------------|------------------|----------------|-----|-----|------|------------|
|                          |                  | MIN            | TYP | MAX |      |            |
| Supply Voltage           | V <sub>CC</sub>  | (NOTE1)<br>4.5 | -   | 18  | V    |            |
| Output Voltage / Current | V <sub>OUT</sub> | -              | 3.3 | -   | V    |            |
|                          | I <sub>OUT</sub> | -              | -   | 5   | A    |            |

(NOTE1) When the output voltage is 3.3V, it is 4.72V by limiting ratio of the maximum duty.

### Evaluation Board

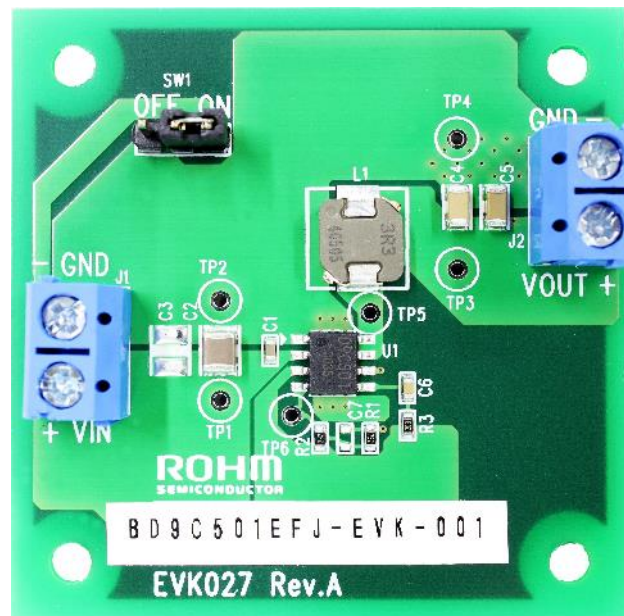


Figure 1. BD9C501EFJ-EVK-001 Evaluation Board

## Operation Procedures

### 1. Necessary equipments

- (1) DC power-supply of 4.7V to 18V/5A
- (2) Maximum 5A load
- (3) DC voltmeter

### 2. Connecting the equipments

- (1) DC power-supply presets to 12V and then the power output turns off.
- (2) The max. load should be set at 5A and over it will be disabled.
- (3) Check Jumper pin of SW1 is short, between intermediate-terminal and OFF-side terminal.
- (4) Connect positive-terminal of power-supply to VIN+terminal and negative-terminal to GND-terminal with a pair of wires.
- (5) Connect load's positive-terminal to VOUT+terminal and negative-terminal to GND-terminal with a pair of wires.
- (6) Connect positive-terminal of DC voltmeter 1 to TP1 and negative-terminal to TP2 for input-voltage measurement.
- (7) Connect positive-terminal of DC voltmeter 2 to TP3 and negative-terminal to TP4 for output-voltage measurement.
- (8) DC power-supply output is turned ON.
- (9) IC is enable (EN) by shorting Jumper-pin of SW1 between intermediate-terminal and ON-side terminal.
- (10) Check DC voltmeter 2 displays 3.3V.
- (11) The load is enabled.
- (12) Check at DC voltmeter 1 whether the voltage-drop (loss) is not caused by the wire's resistance.

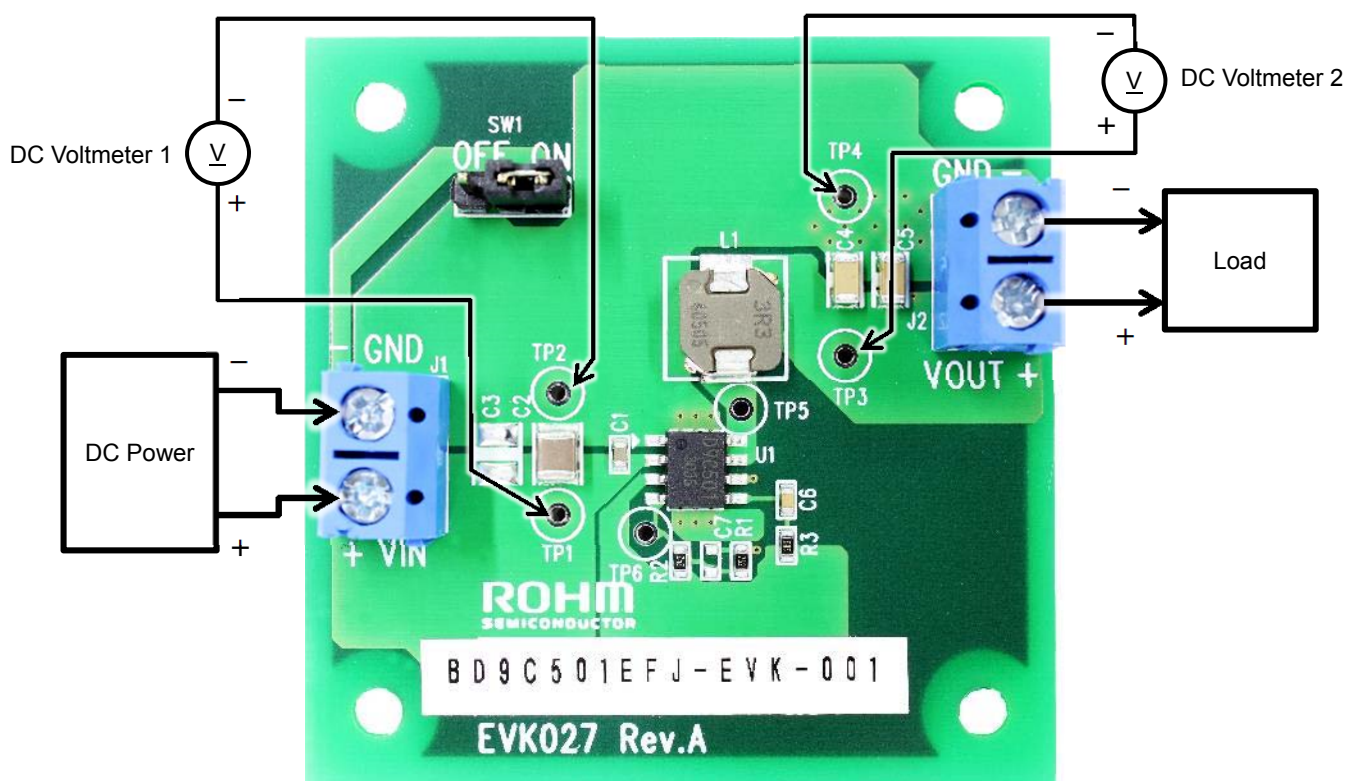


Figure 2. Connection Diagram

### Enable-Pin

To minimize current consumption during standby-mode and normal operation, Enable-mode can be switched by controlling EN pin (6pin) of the IC. Standby-mode is enabled by shorting Jumper-pin of SW1 between intermediate-terminal and OFF-side terminal and normal-mode operation by shorting between intermediate-terminal and ON-side terminal.

It also can be switched between standby-mode and normal-mode operation by removing Jumper-pin and controlling the voltage between EN and GND-terminal. Standby-mode is enabled when the voltage of EN is under 0.8V, and normal-mode operation when it is over 2.0V.

## Circuit Diagram

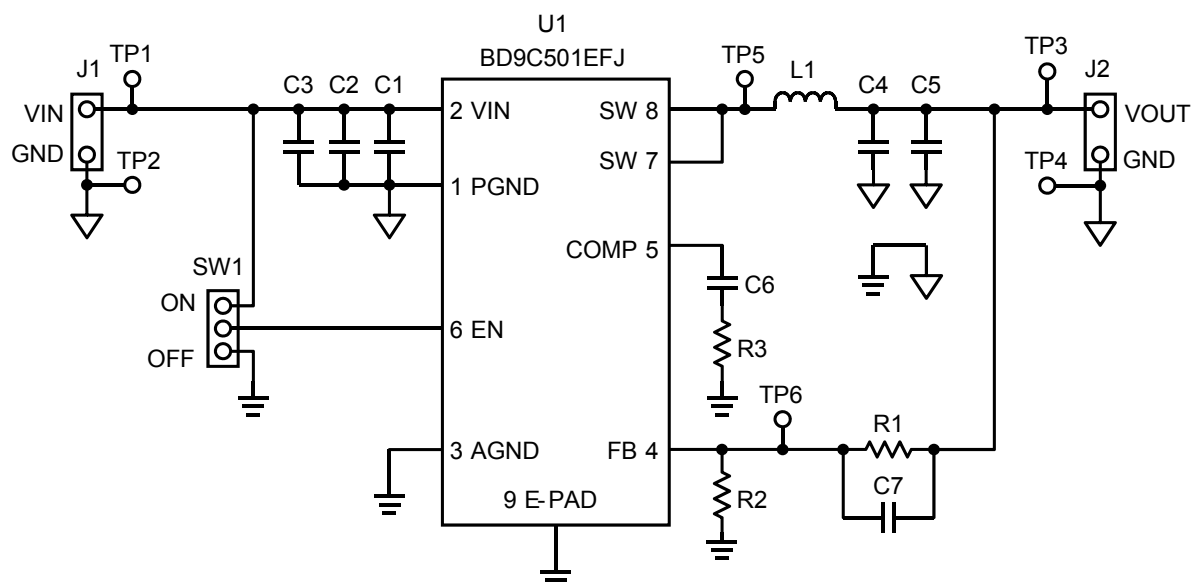
 $V_{IN} = 4.72V \sim 18V$ ,  $V_{OUT} = 3.3V$ 


Figure 3. BD9C501EFJ-EVK-001 Circuit Diagram

## Bill of Materials

| Count | Reference Designator | Type              | Value         | Description                             | Manufacturer Part Number | Manufacturer                  | Configuration (mm) |
|-------|----------------------|-------------------|---------------|-----------------------------------------|--------------------------|-------------------------------|--------------------|
| 1     | C1                   | Ceramic Capacitor | 0.1 $\mu$ F   | 50V, B, $\pm$ 20%                       | GRM188B31H104MA92        | MURATA                        | 1608               |
| 1     | C2                   | Ceramic Capacitor | 10 $\mu$ F    | 35V, B, $\pm$ 10%                       | GRM32EB3YA106KA12        | MURATA                        | 3225               |
| 0     | C3                   | Ceramic Capacitor | -             | Not installed                           | -                        | -                             | 3225               |
| 2     | C4, C5               | Ceramic Capacitor | 22 $\mu$ F    | 10V, B, $\pm$ 10%                       | GRM31CB31A226KE19        | MURATA                        | 3216               |
| 1     | C6                   | Ceramic Capacitor | 1500pF        | 25V, B, $\pm$ 10%                       | GRM188B11E152KA01        | MURATA                        | 1608               |
| 0     | C7                   | Ceramic Capacitor | -             | Not installed                           | -                        | -                             | 3216               |
| 1     | L1                   | Inductor          | 3.3 $\mu$ H   | $\pm$ 20%, DCR=29.7m $\Omega$ max, 7.3A | SPM6530T-3R3             | TDK                           | 7165               |
| 1     | R1                   | Resistor          | 7.5k $\Omega$ | 1/10W, 50V, 1%                          | MCR03ERP7501             | ROHM                          | 1608               |
| 1     | R2                   | Resistor          | 2.4k $\Omega$ | 1/10W, 50V, 1%                          | MCR03ERP2401             | ROHM                          | 1608               |
| 1     | R3                   | Resistor          | 20k $\Omega$  | 1/10W, 50V, 1%                          | MCR03ERP2002             | ROHM                          | 1608               |
| 1     | SW1                  | Pin header        | -             | 2.54mm $\times$ 3 contacts              | PH-1x03SG                | USECONN                       | -                  |
| 1     | U1                   | IC                | -             | Buck DC/DC Converter                    | BD9C501EFJ               | ROHM                          | HTSOP-J8           |
| 2     | J1, J2               | Terminal Block    | -             | 2 contacts, 15A, 14 to 22AWG            | TB111-2-2-U-1-1          | Alphaplus Connectors & Cables | -                  |
| 1     | -                    | Jumper            | -             | Jumper pin for SW1                      | MJ254-6BK                | USECONN                       | -                  |

## Layout

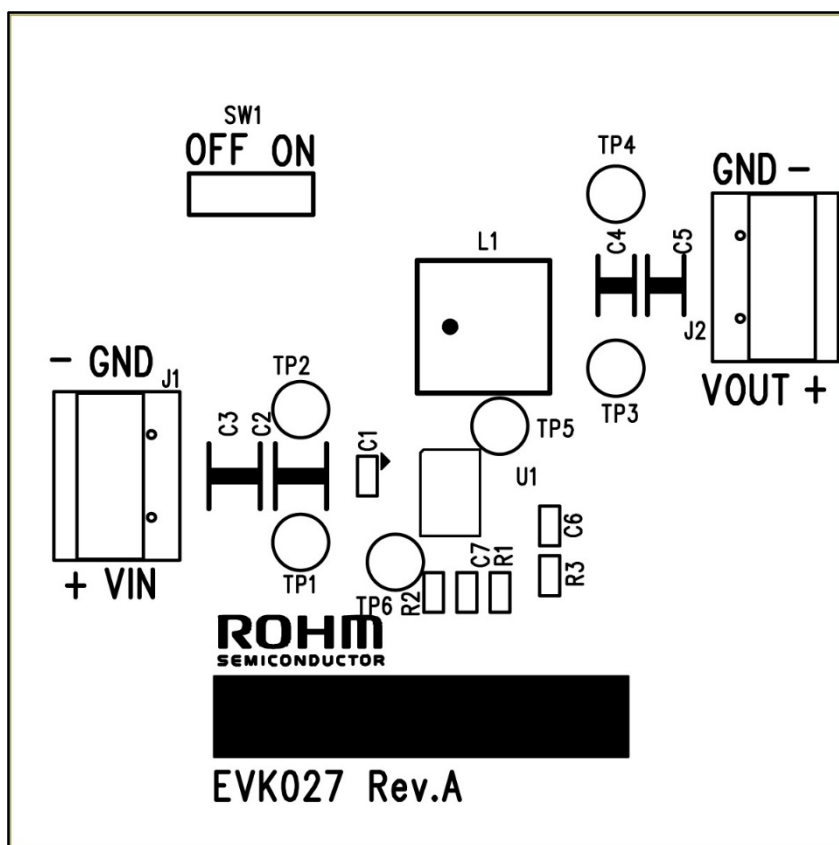


Figure 4. Top Silk Screen (Top view)

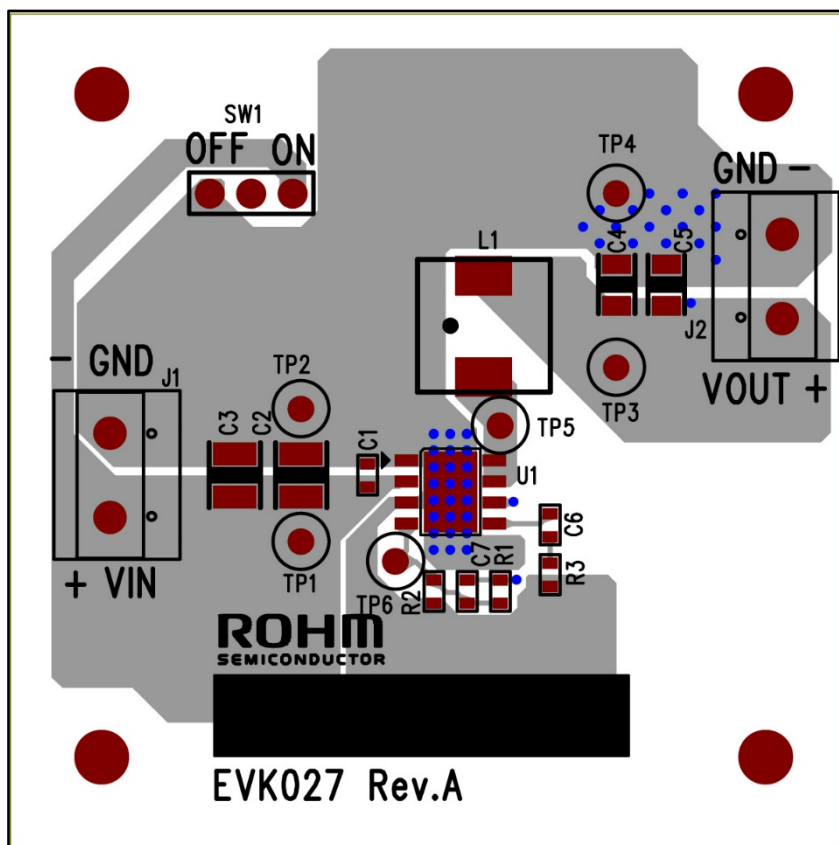


Figure 5. Top Silk Screen and Layout (Top view)

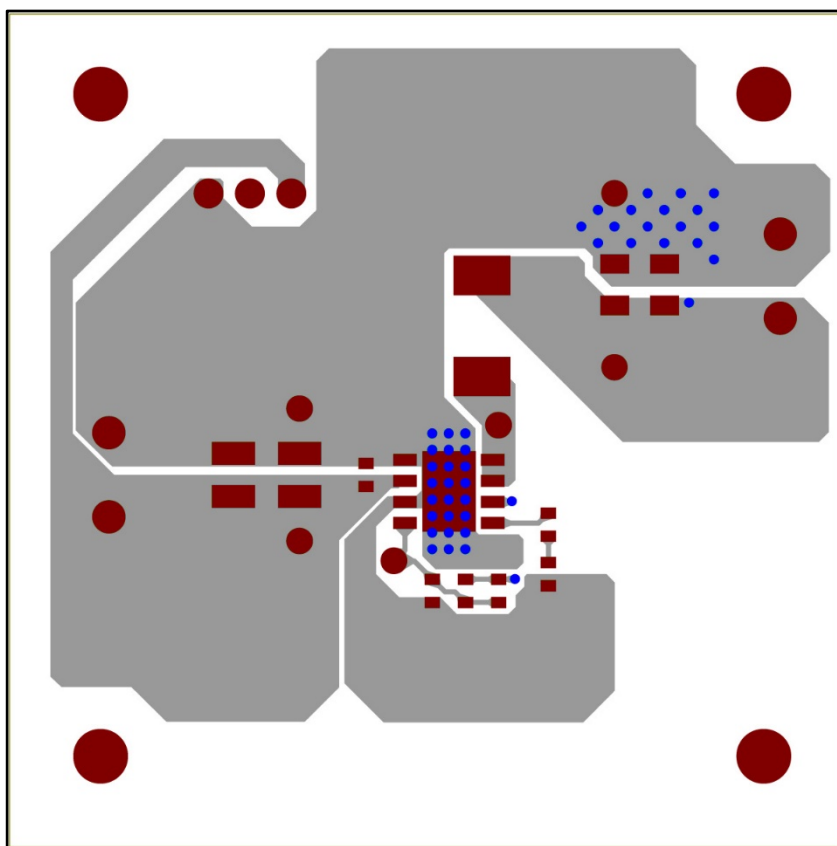


Figure 6. Top Side Layout (Top view)

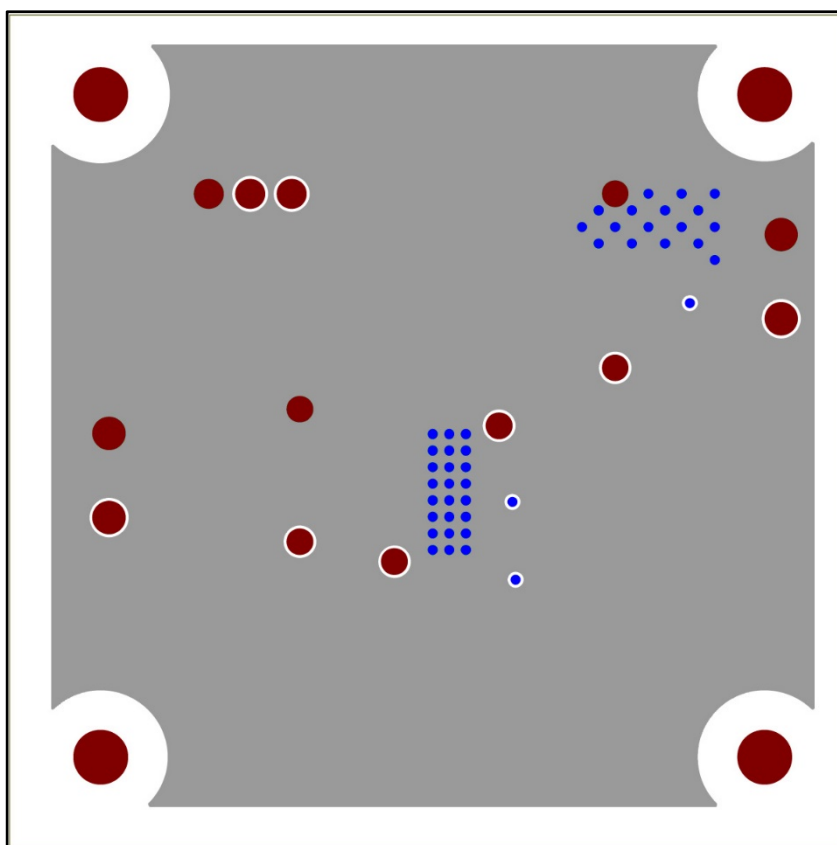


Figure 7. L2 Layout (Top view)

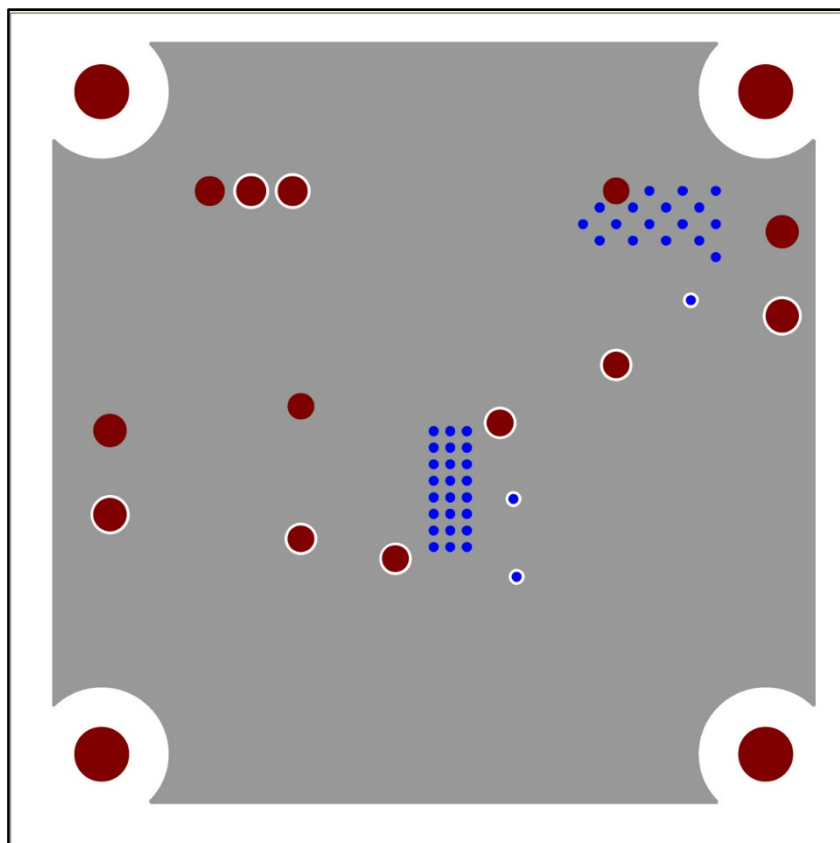


Figure 8. L3 Layout (Top view)

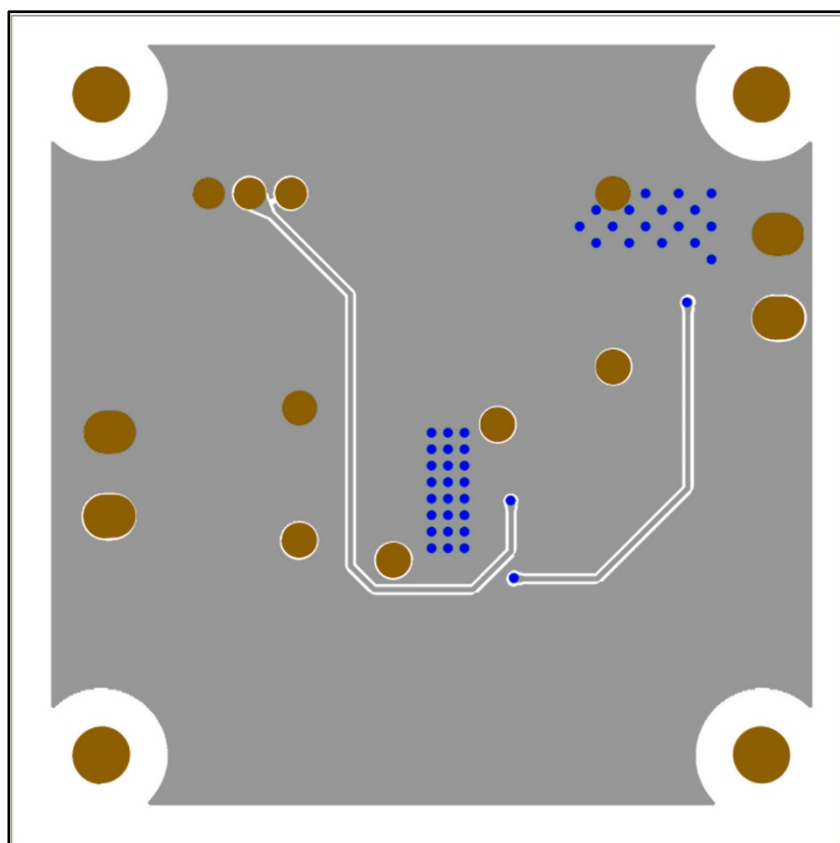


Figure 9. Bottom Side Layout (Top view)

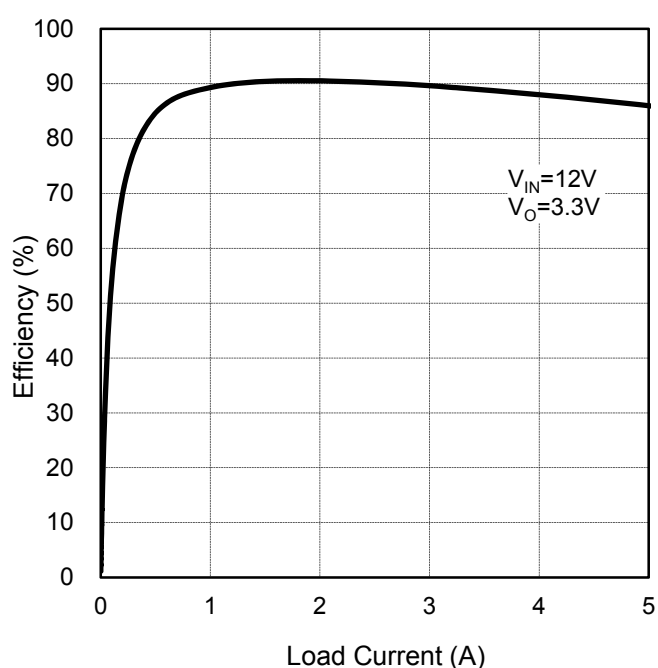


Figure 10. Efficiency vs Load Current

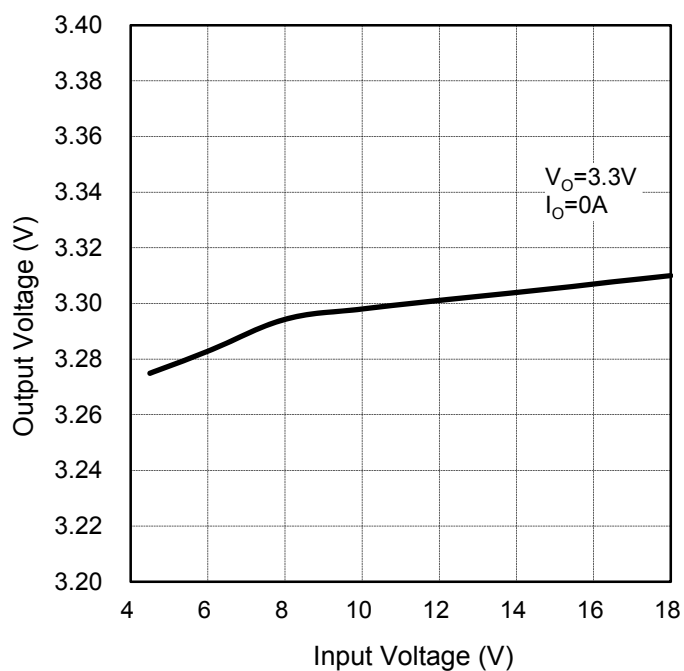


Figure 11. Efficiency vs Load Current

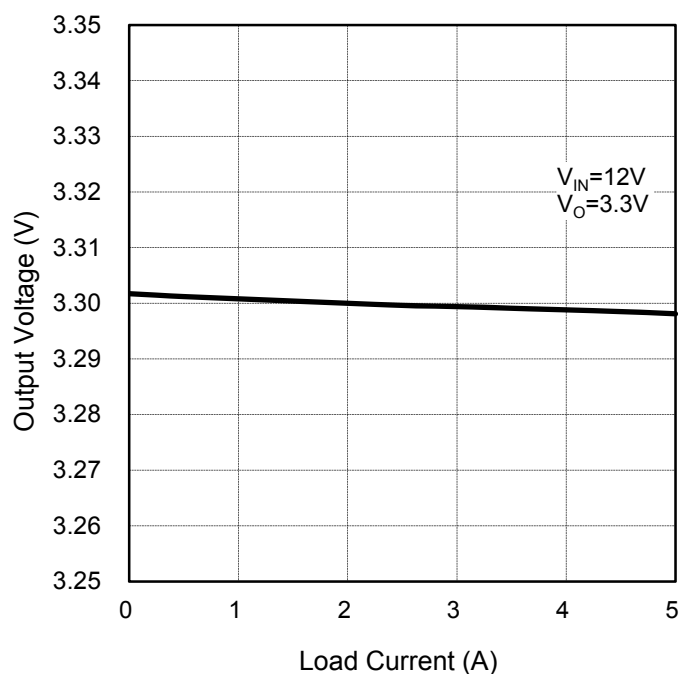


Figure 12. Load Regulation

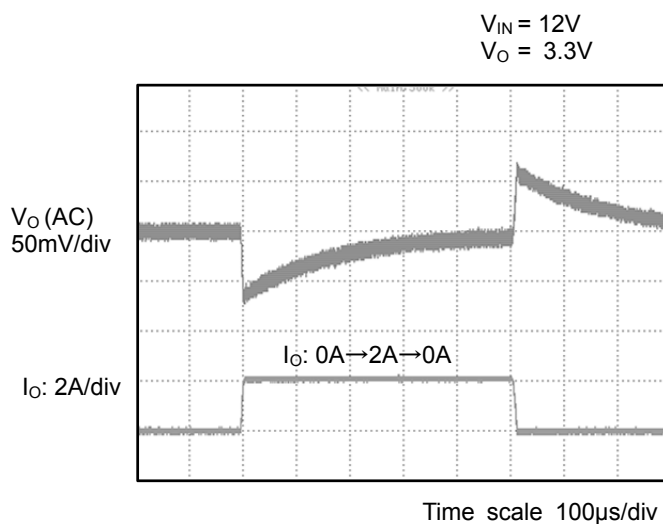


Figure 13. Load Transient Characteristics

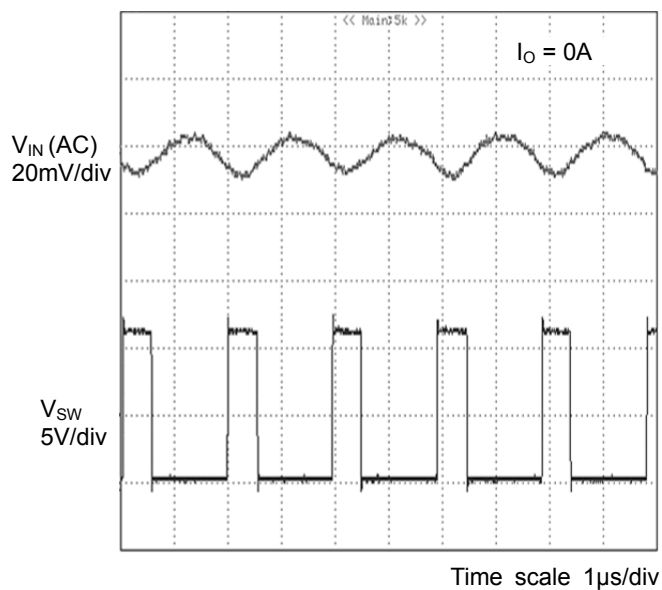


Figure 14. Output Voltage Ripple Wave  
 $V_{IN} = 12V$ ,  $V_O = 3.3V$

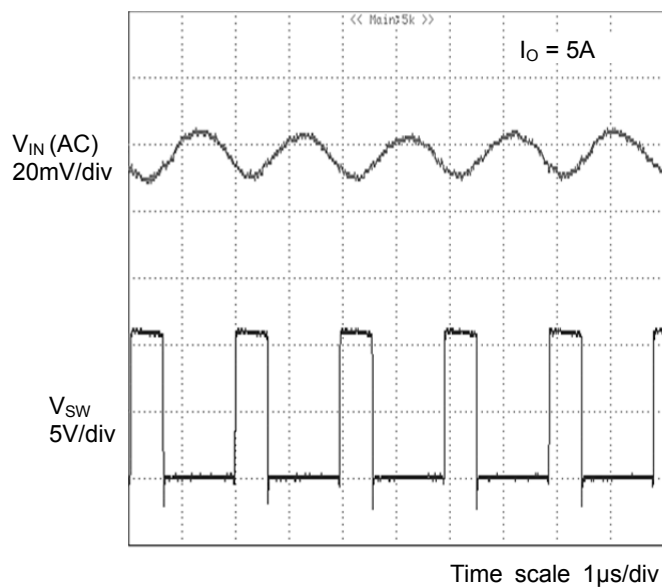


Figure 15. Output Voltage Ripple Wave  
 $V_{IN} = 12V$ ,  $V_O = 3.3V$

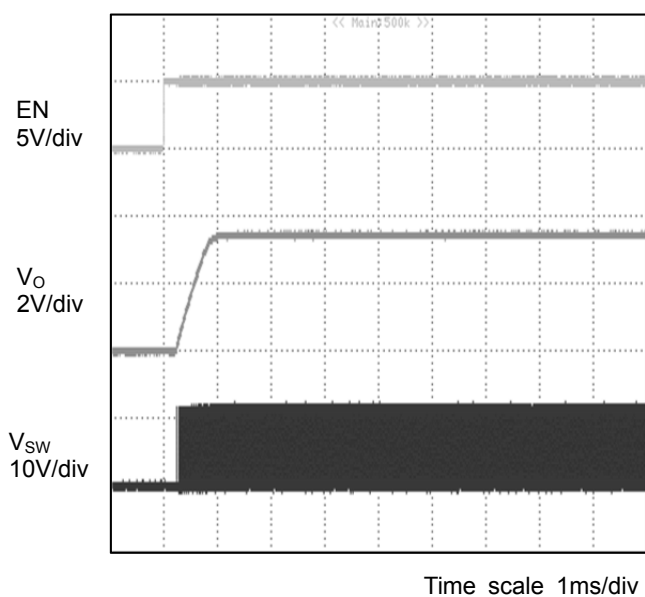


Figure 16. Start-up by EN  
 $V_{IN} = 12V$ ,  $V_O = 3.3V$ ,  $I_O = 0A$

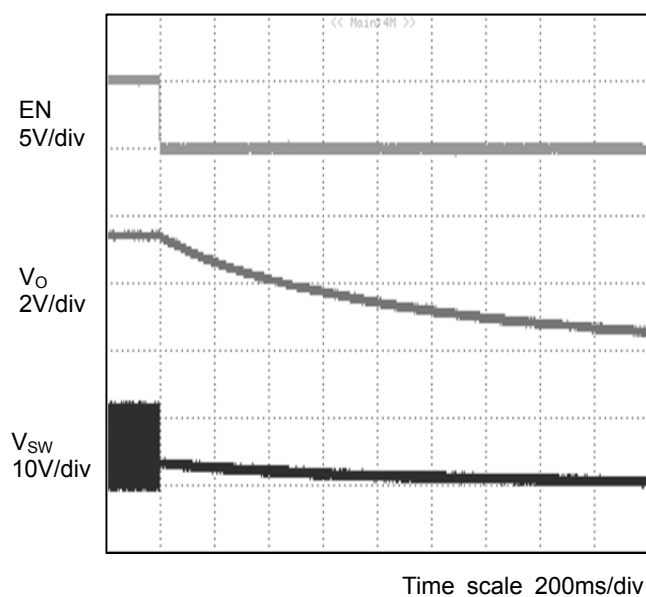


Figure 17. Power-down by EN  
 $V_{IN} = 12V$ ,  $V_O = 3.3V$ ,  $I_O = 0A$

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