Switching Regulator Series

# Step-Down DC/DC Converter BD9E100FJ-LB Evaluation Board

## BD9E100FJ-EVK-001

BD9E100FJ-EVK-001 Evaluation board delivers an output 5.0 volts from an input 7.2 to 33 volts using BD9E100FJ-LB, a synchronous rectification step-down DC/DC converter integrated circuit, with output current rating of maximum 1A. The output voltage can be set by changing the external parts of circuit and the loop-response characteristics also can be adjusted by the phase compensation circuit.

## Performance specification

These are representative values, and it is not a guaranteed against the characteristics.

$V_{IN}$ = 24V, $V_{OUT}$ = 5.0V, Unless otherwise specified.

| Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|
| Input Voltage Range | 7.0 (NOTE1) | | 36 (NOTE2) | V | |
| Output Voltage | | 5.0 | | V | R1=12kΩ, R2=3kΩ |
| Output Voltage Setting Range | $V_{IN}$×0.15 (NOTE3) | | $V_{IN}$×0.7 | V | |
| Output Current Range | 0 | | 1 | A | |
| Loop Band Width | | 44.7 | | kHz | |
| Phase Margin | | 68.9 | | degrees | |
| Input Ripple Voltage | | 60 | | mVpp | $I_O$ = 1A |
| Output Ripple Voltage | | 40 | | mVpp | $I_O$ = 1A |
| Output Rising Time | | 3 | | ms | |
| Operating Frequency | | 1.0 | | MHz | |
| Maximum Efficiency | | 83.5 | | % | $I_O$ = 0.6A |

(NOTE1) When the output voltage is 5.0V, it is 7.2V by limiting ratio of the maximum duty.

(NOTE2) When the output voltage is 5.0V, it is 33V by limiting ratio of the minimum duty.

(NOTE3) However, ($V_{IN}$×0.15) ≥ 1.0V



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## Operation Procedures

1. Necessary equipments
   (1) DC power-supply of 7.2V to 33V/1A
   (2) Maximum 1A load
   (3) DC voltmeter
2. Connecting the equipments
   (1) DC power-supply presets to 24V and then the power output turns off.
   (2) The maximum load should be set at 1A 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 5.0V.
   (11) The load is enabled.
   (12) Check at DC voltmeter 1 whether the voltage-drop (loss) is not caused by the wire's resistance.

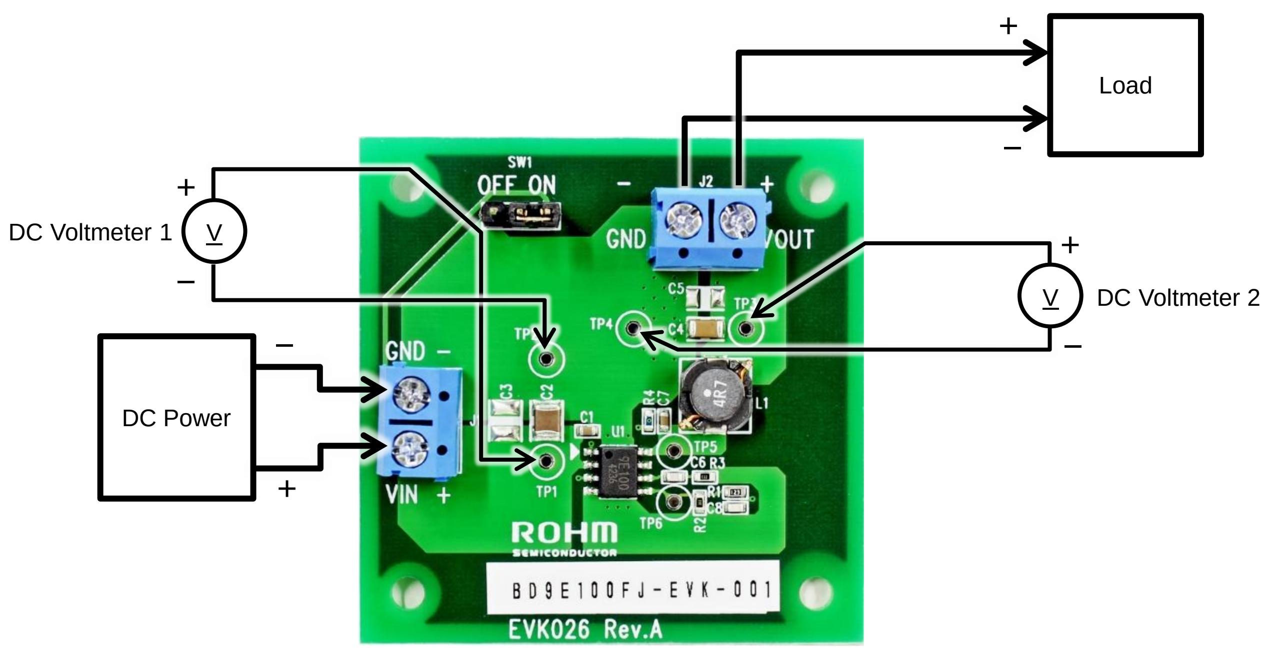


Figure 1. Connection Diagram

## Enable-Pin

To minimize current consumption during standby-mode and normal operation, Enable-mode can be switched by controlling EN pin (3pin) 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 2.5V.

## Circuit Diagram

$V_{IN}$ = 7.2V to 33V, $V_{OUT}$ = 5.0V

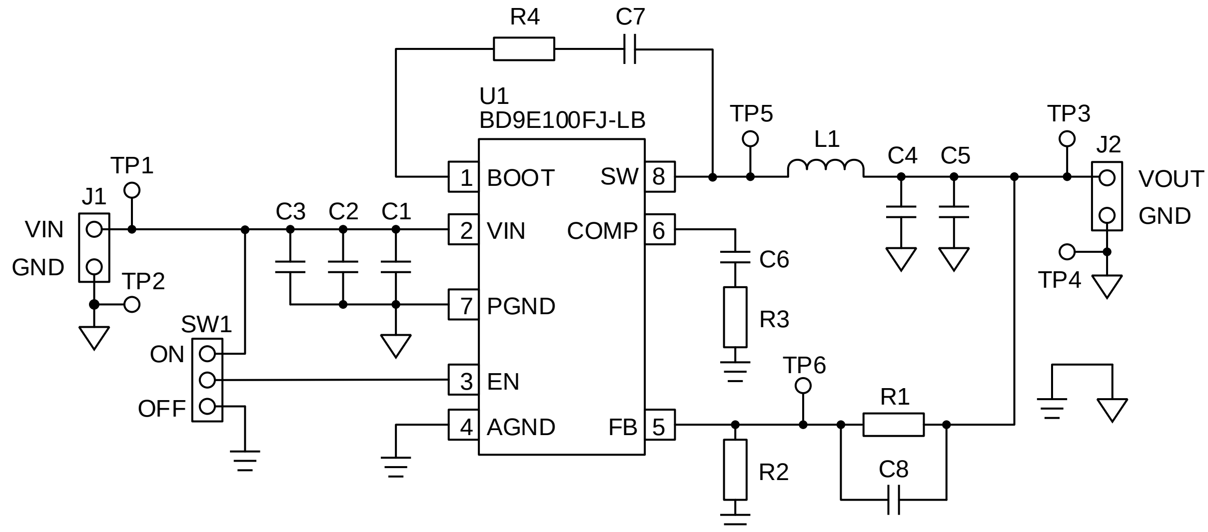


Figure 2. BD9E100FJ-EVK-001 Circuit Diagram

## Bill of Materials

| Count | Reference Designator | Type | Value | Description | Manufacturer Part Number | Manufacturer | Configuration (mm) |
|---|---|---|---|---|---|---|---|
| 2 | C1, C7 | Ceramic Capacitor | 0.1µF | 50V, B, ±20% | GRM188B31H104MA92 | MURATA | 1608 |
| 1 | C2 | Ceramic Capacitor | 10µF | 50V, B, ±10% | GRM32EB31H106KA12 | MURATA | 3225 |
| 0 | C3 | Ceramic Capacitor | - | Not installed | - | - | 3225 |
| 1 | C4 | Ceramic Capacitor | 10µF | 16V, B, ±10% | GRM31CB31C106KA88 | MURATA | 3216 |
| 0 | C5 | Ceramic Capacitor | - | Not installed | - | - | 3216 |
| 1 | C6 | Ceramic Capacitor | 1000pF | 50V, B, ±10% | GRM188B11H102KA01 | MURATA | 1608 |
| 1 | C8 | Ceramic Capacitor | 100pF | 50V, CH, ±5% | GRM1882C1H101JA01 | MURATA | 1608 |
| 1 | L1 | Inductor | 4.7µH | ±30%, DCR=26mΩmax, 4.1A | CLF7045T-4R7N | TDK | 7269 |
| 1 | R1 | Resistor | 12kΩ | 1/10W, 50V, 1% | MCR03EZPFX1202 | ROHM | 1608 |
| 1 | R2 | Resistor | 3kΩ | 1/10W, 50V, 1% | MCR03EZPFX3001 | ROHM | 1608 |
| 1 | R3 | Resistor | 22kΩ | 1/10W, 50V, 1% | MCR03EZPFX2202 | ROHM | 1608 |
| 1 | R4 | Resistor | 0Ω | Jumper | MCR03EZPJ000 | ROHM | 1608 |
| 1 | SW1 | Pin header | - | 2.54mm × 3 contacts | PH-1x03SG | USECONN | - |
| | | | | | 61300311121 | Wurth Electronics Inc. | - |
| 1 | U1 | IC | - | Buck DC/DC Converter | BD9E100FJ-LB | ROHM | SOP-J8 |
| 2 | J1, J2 | Terminal Block | - | 2 contacts, 15A, 14 to 22AWG | TB111-2-2-U-1-1 | Alphaplus Connectors & Cables | - |
| | | | | | OSTTC022162 | On Shore Technology Inc | - |
| 1 | - | Jumper | - | Jumper pin for SW1 | MJ254-6BK | USECONN | - |
| | | | | | 969102-0000-DA | 3M | - |

## Layout

PCB size: 50mm×50mm×1.6mm

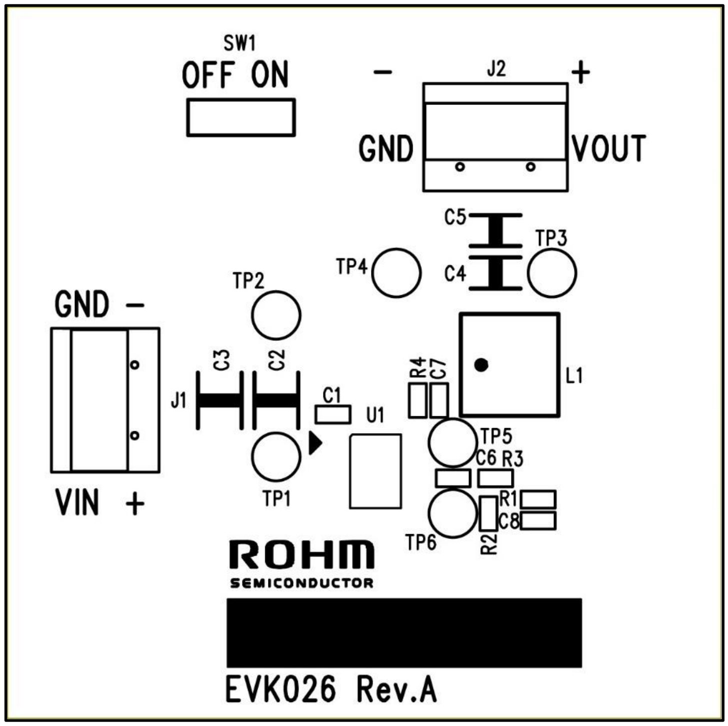


Figure 3. Top Silk Screen (Top view)

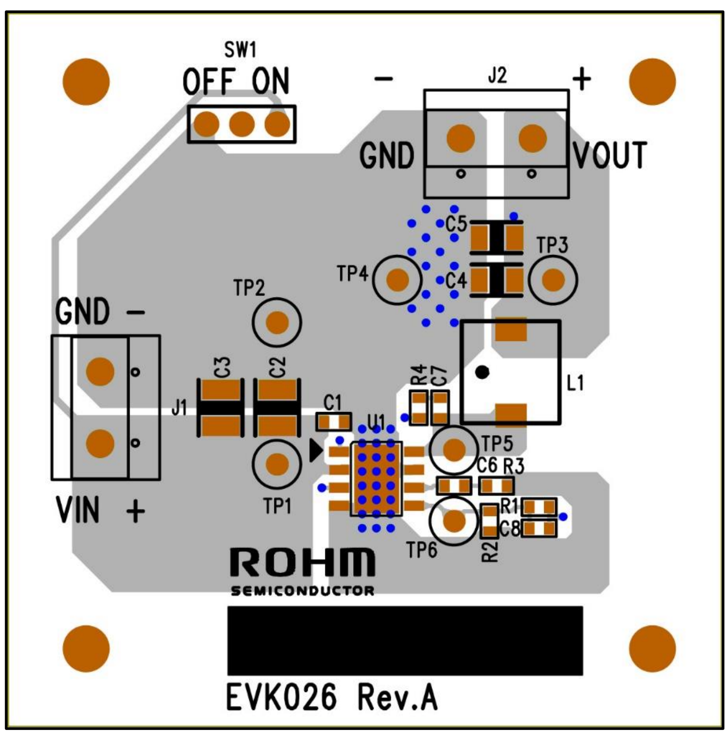


Figure 4. Top Silk Screen and Layout (Top view)

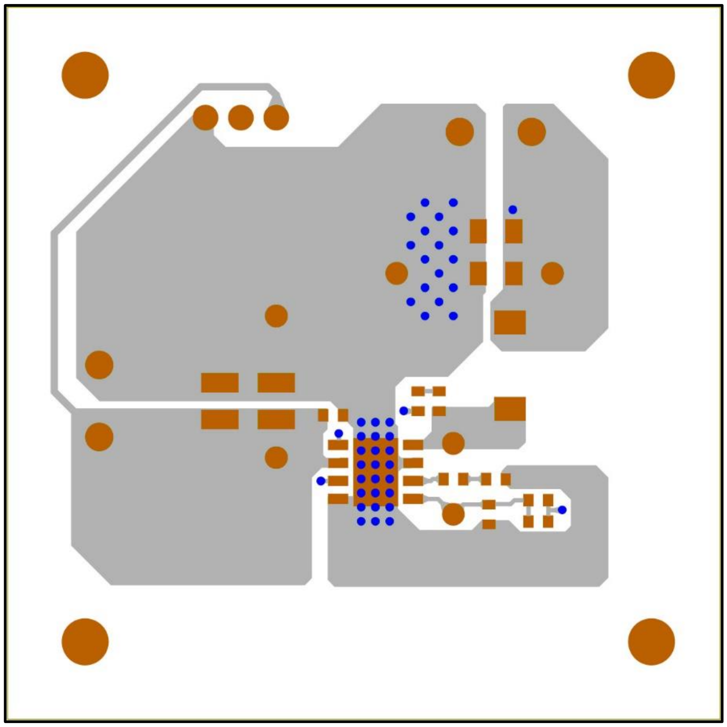

Figure 5. Top Side Layout (Top view)

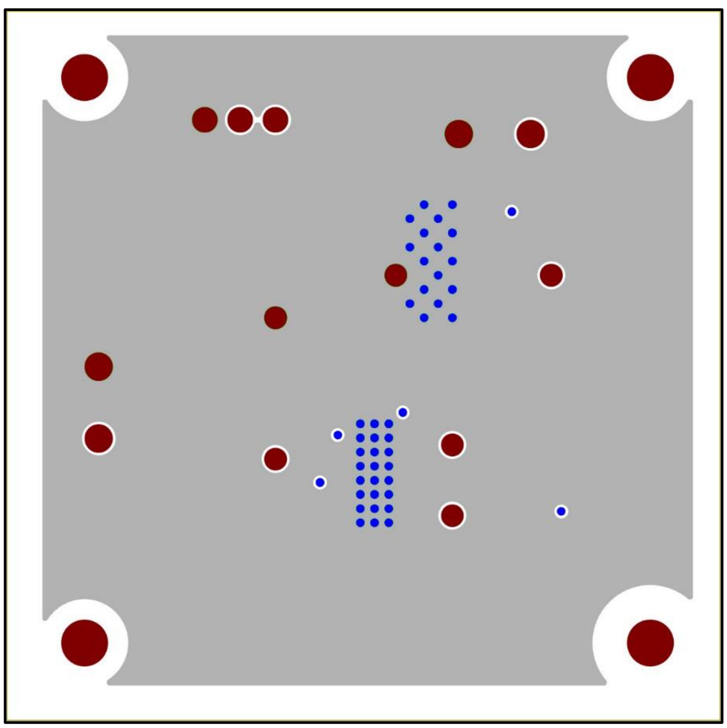

Figure 6. L2 Layout (Top view)

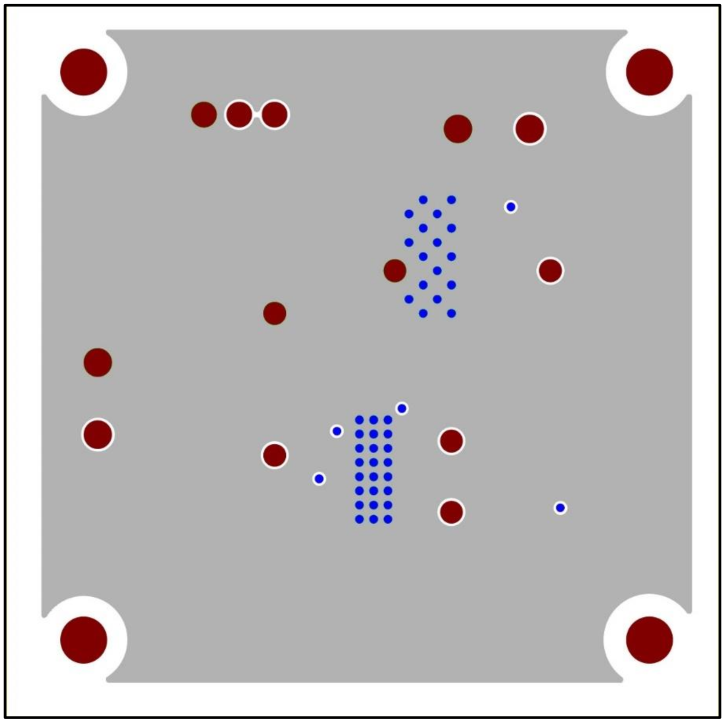

Figure 7. L3 Layout (Top view)

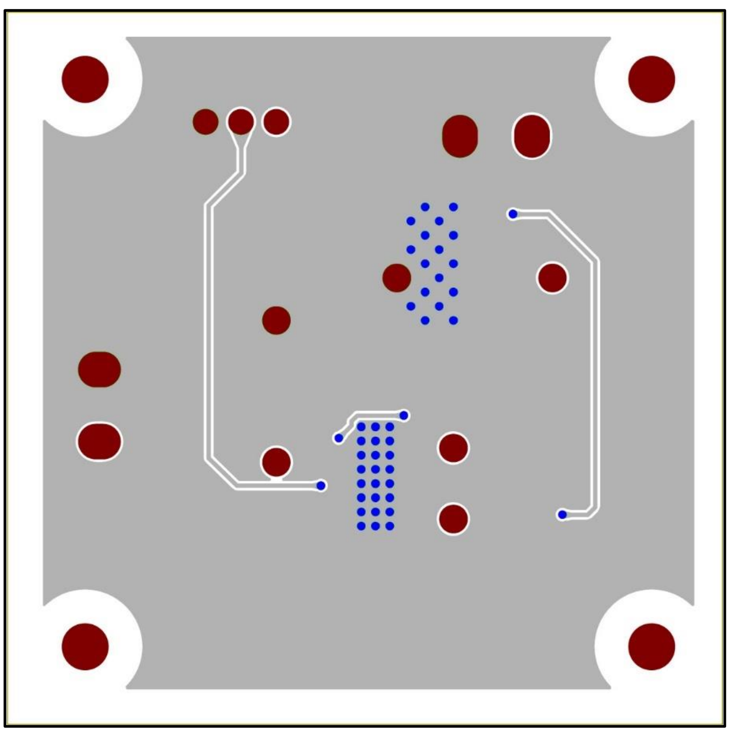

Figure 8. Bottom Side Layout (Top view)

## Reference Application Data

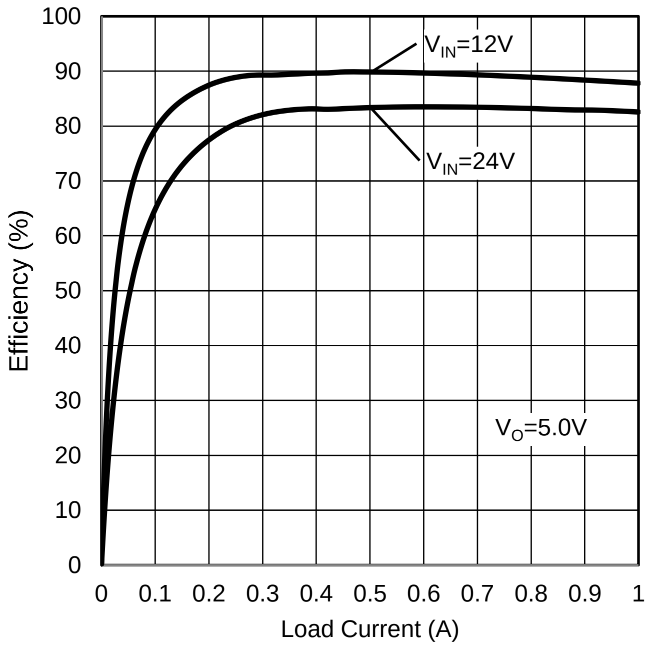


Figure 9. Efficiency vs Load Current

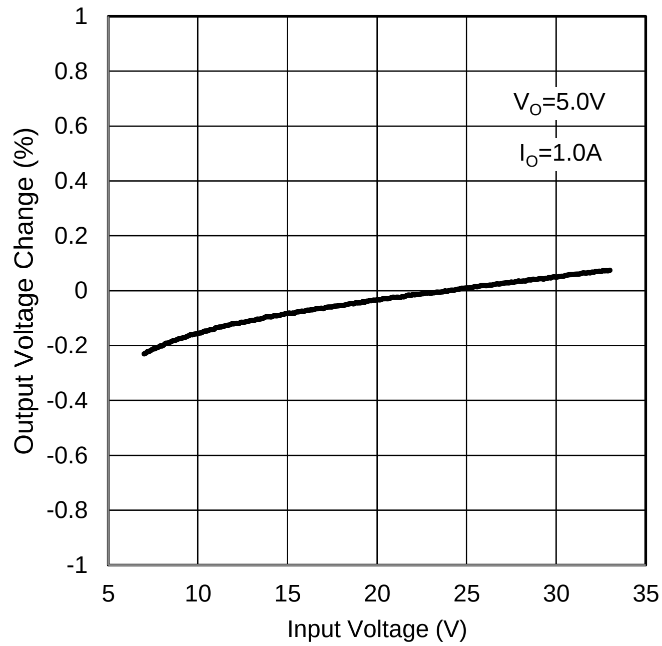


Figure 10. Line Regulation

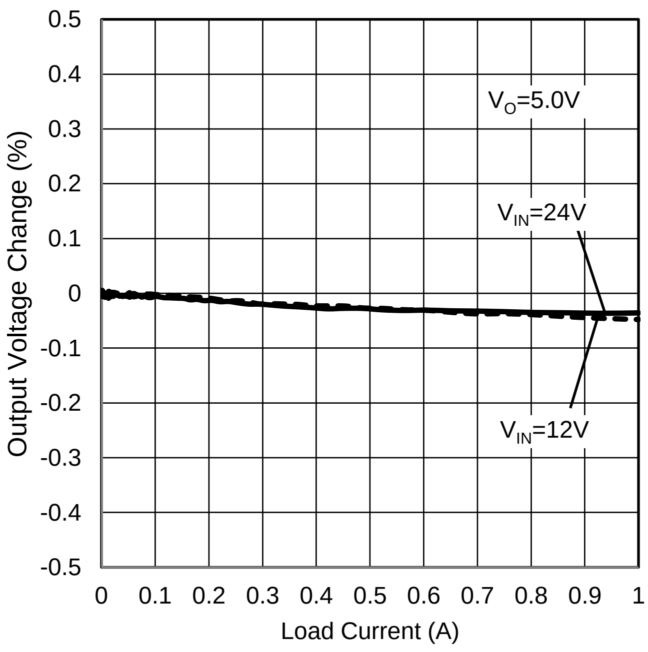


Figure 11. Load Regulation

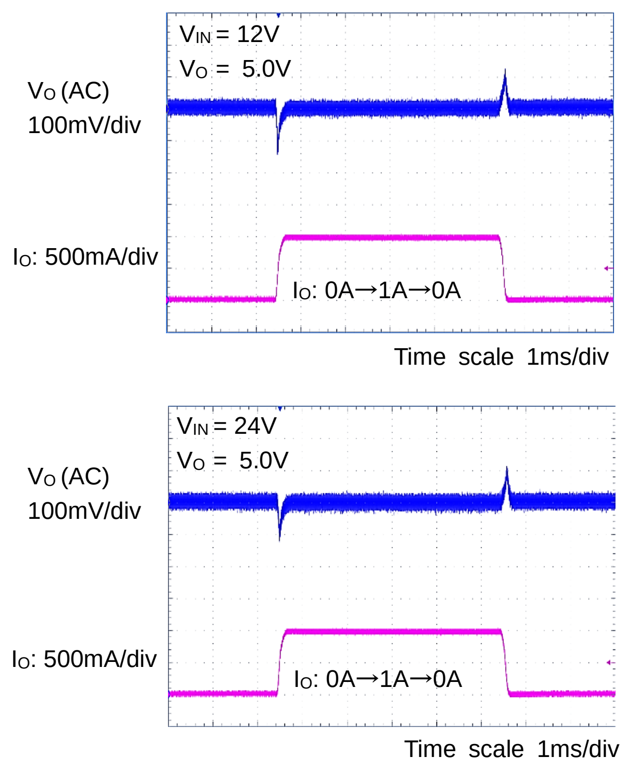


Figure 12. Load Transient Characteristics

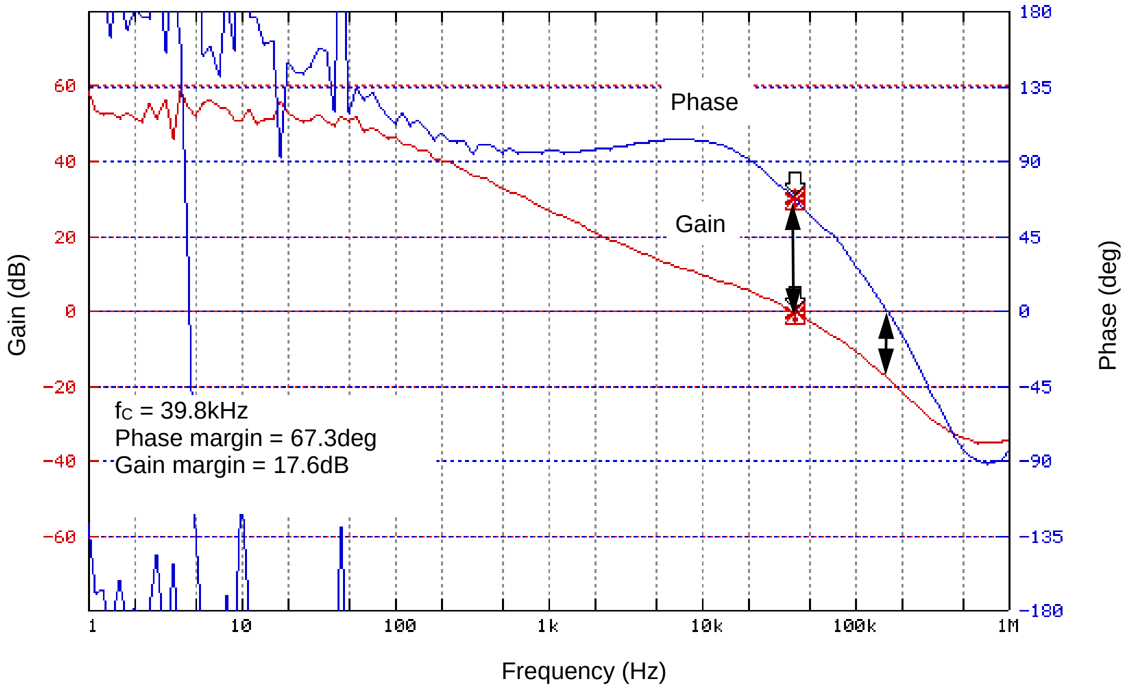


Figure 13. Loop Response $V_{IN}$ = 12V, $V_O$ = 5.0V, $I_O$ = 1A

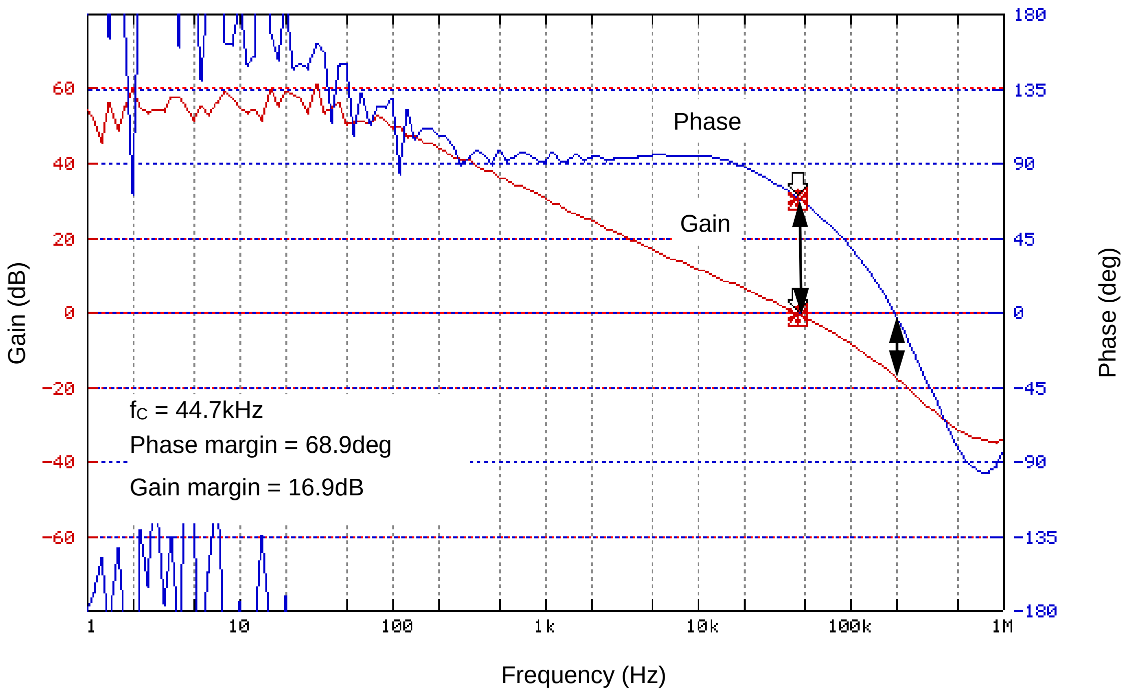


Figure 14. Loop Response $V_{IN}$ = 24V, $V_O$ = 5.0V, $I_O$ = 1A

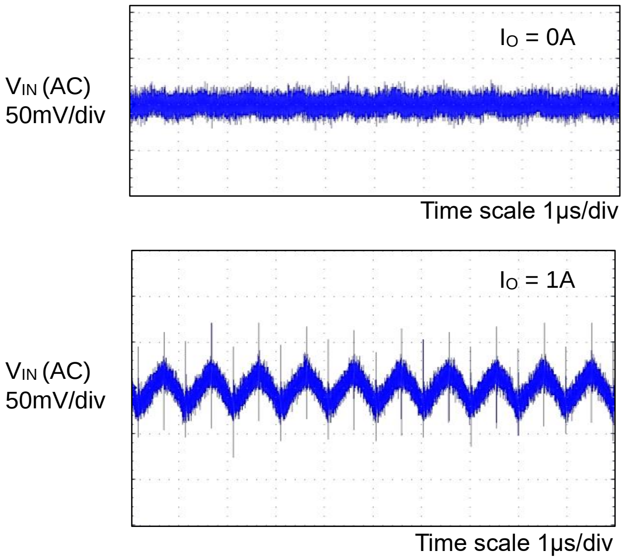


Figure 15. Input Voltage Ripple Wave
$V_{IN}$ = 12V, $V_O$ = 5.0V

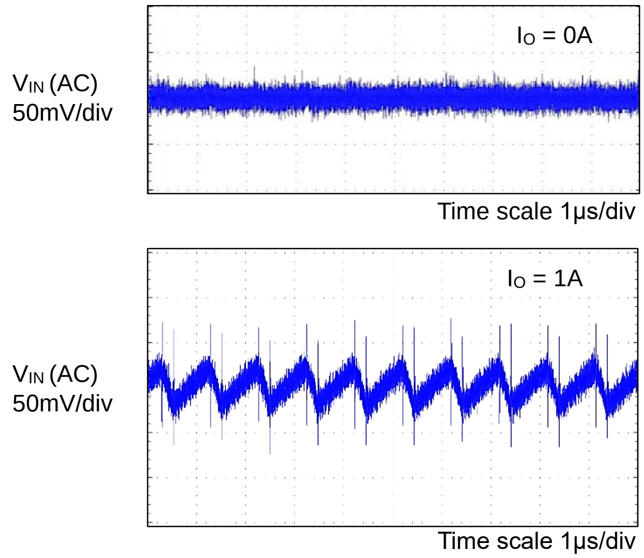


Figure 16. Input Voltage Ripple Wave
$V_{IN}$ = 24V, $V_O$ = 5.0V

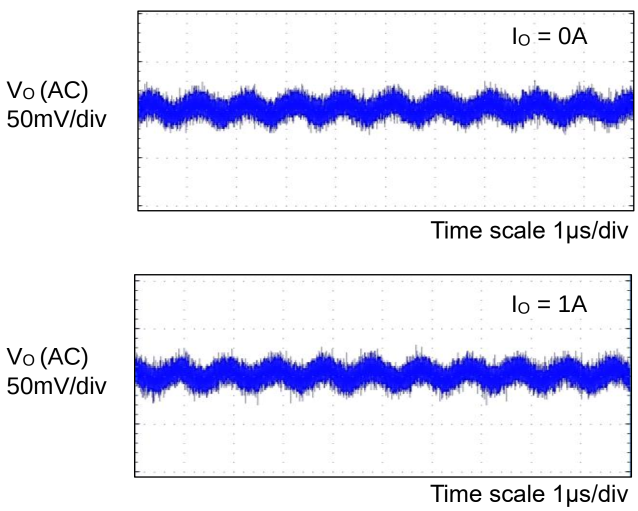


Figure 17. Output Voltage Ripple Wave
$V_{IN}$ = 12V, $V_O$ = 5.0V

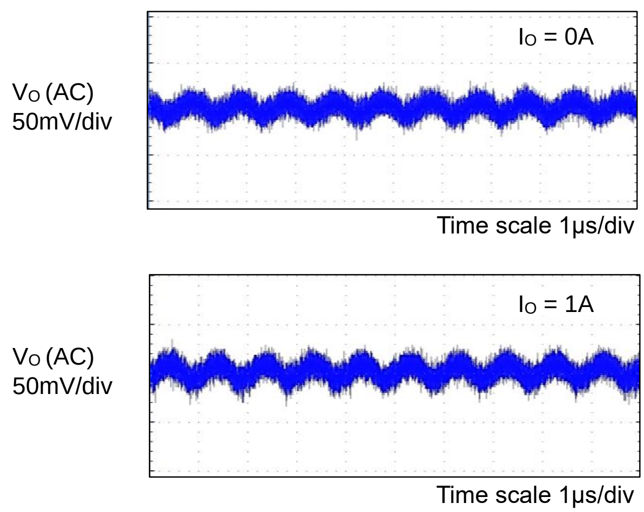


Figure 18. Output Voltage Ripple Wave
$V_{IN}$ = 24V, $V_O$ = 5.0V

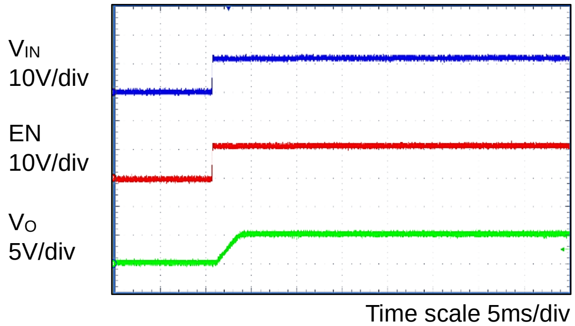


Figure 19. Start-up EN = $V_{IN}$
$V_{IN}$ = 12V, $V_O$ = 5.0V, $I_O$ = 0A

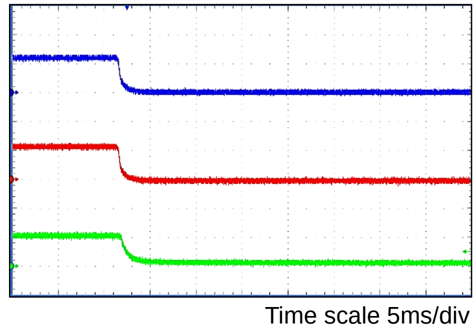


Figure 20. Power-down EN = $V_{IN}$
$V_{IN}$ = 12V, $V_O$ = 5.0V, $I_O$ = 0A

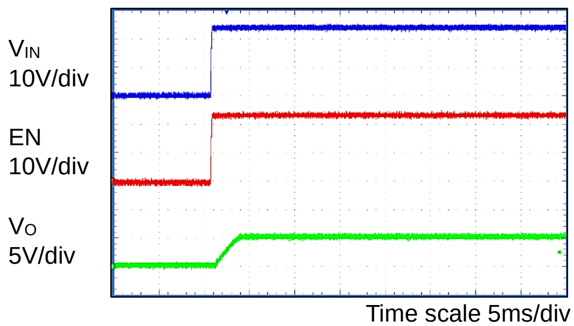


Figure 21. Start-up EN = $V_{IN}$
$V_{IN}$ = 24V, $V_O$ = 5.0V, $I_O$ = 0A

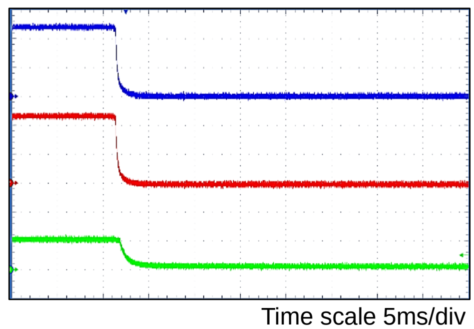


Figure 22. Power-down EN = $V_{IN}$
$V_{IN}$ = 24V, $V_O$ = 5.0V, $I_O$ = 0A

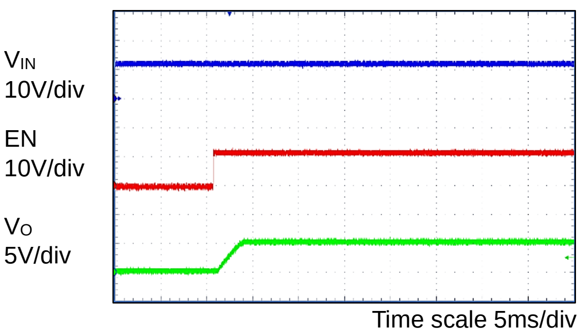


Figure 23. Start-up by EN
$V_{IN}$ = 12V, $V_O$ = 5.0V, $I_O$ = 0A

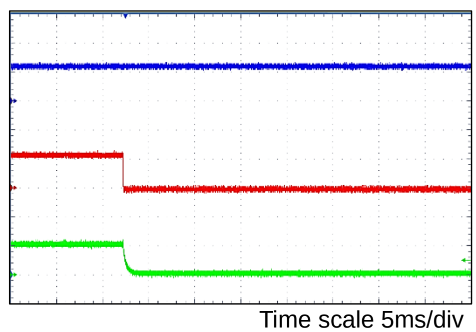


Figure 24. Power-down by EN
$V_{IN}$ = 12V, $V_O$ = 5.0V, $I_O$ = 0A

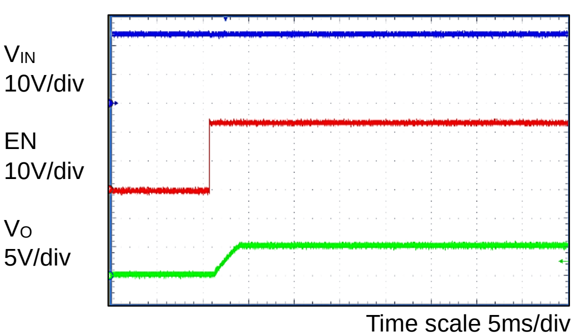


Figure 25. Start-up by EN
$V_{IN}$ = 24V, $V_O$ = 5.0V, $I_O$ = 0A

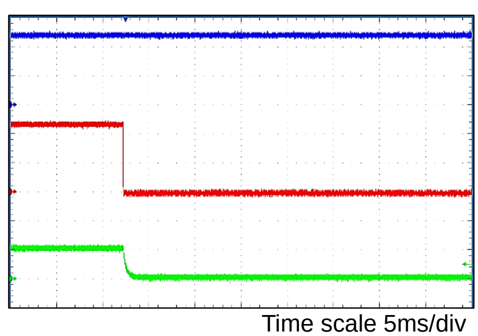


Figure 26. Power-down by EN
$V_{IN}$ = 24V, $V_O$ = 5.0V, $I_O$ = 0A

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