RTKRB86848DE0000BU

48V Bidirectional Buck-Boost Voltage Regulator Evaluation Board

Description

The RTKRB86848DE0000BU evaluation board assesses the performance of the RRB86848. The default value of the output voltage, output current limit, and adapter current limit function can be programmed by the resistor from the PROG pin to GND. The values can also be set by SMBus commands.

The RRB86848 is a bidirectional, buck-boost voltage regulator supporting 55V input and 55V output. The RRB86848 provides buck-boost voltage regulation and protection features for power tools, portable vacuums, lawn mowers, and additional system bus regulation for notebooks. This regulator supports any USB-C interface platform including USB PD EPR. The advanced Renesas R3™ technology provides highly efficient light-load operation and fast transient response.

The RRB86848 takes input power from a wide range of DC power sources (such as conventional AC/DC adapters (ADP), USB PD ports, travel ADP) and safely converts it to a regulated voltage.

The RRB86848 also operates in the reverse direction, converting a wide-range DC power source connected at its output side to a regulated voltage at its input (ADP side). The bidirectional buck-boost regulation feature provides flexibility in developing applications with the RRB86848.

The RRB86848 provides programming resistor options including the output voltage, output current limit, and adapter current limit. Additionally, it provides serial communication that enables programming of many critical parameters to deliver a customized solution.

Features

- Bidirectional buck, boost, and buck-boost operation
- Input voltage range: 3.9V to 55V (no dead zone)
- Output voltage: 2.4V to 55V
- Pass-through mode in forward direction
- Adapter current and output current monitor (AMON/BMON)
- Forward and reverse sleep modes
- Battery charging support
- SMBus and auto-increment I^2C compatible
- 4×4 32 Ld TQFN package compatible with the ISL9238, RAA489108, and RAA489118 family of parts

Specifications

- V_{IN} = 3.9V to 55V (no dead zone)
- V_{OUT} = 2.4V to 55V
- MAX output current limit up to 6A (R_{S2} = 10mΩ), 12A (R_{S2} = 5mΩ by default)
- f_{SW} = 732kHz (default) and 377kHz (recommended)

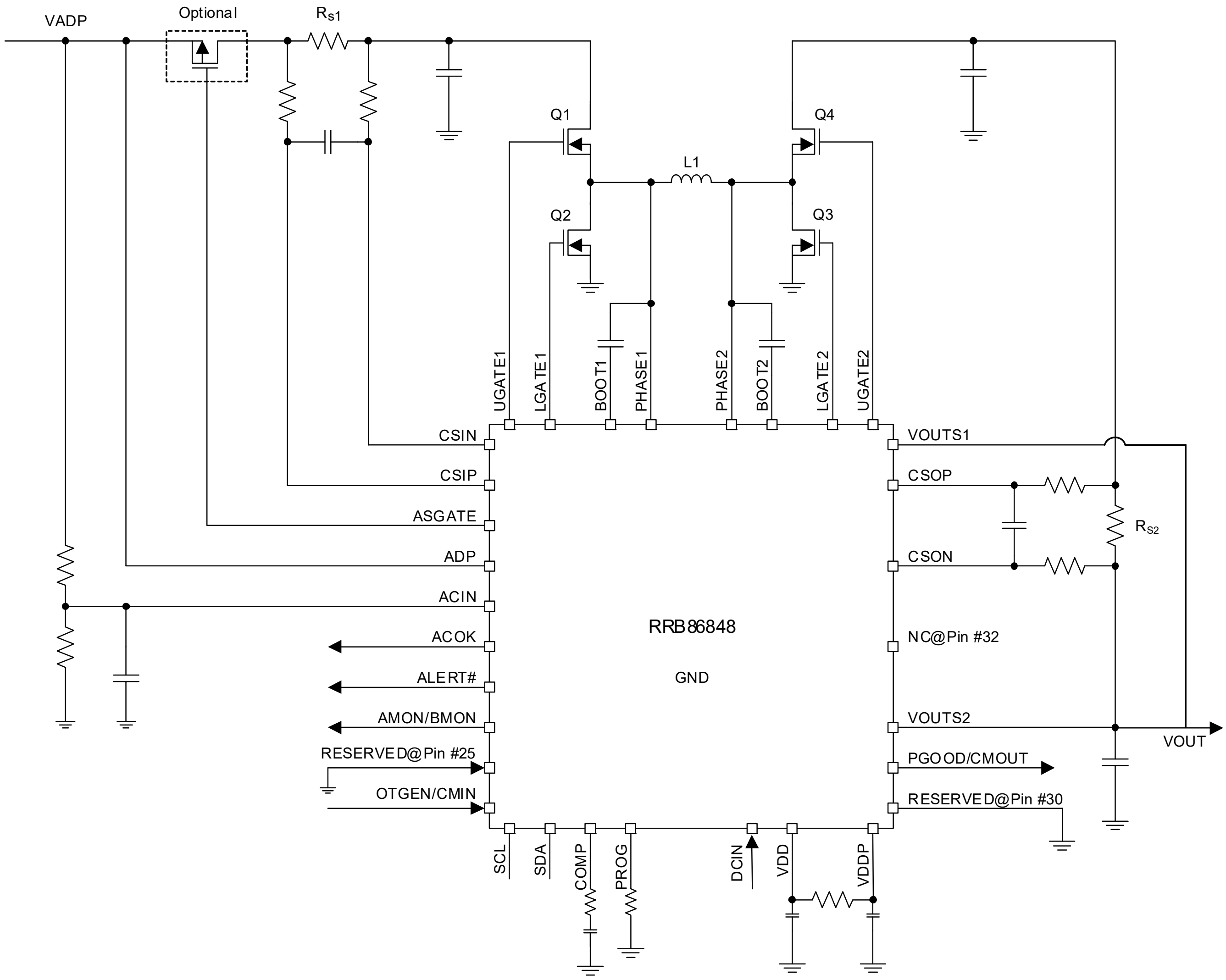


Figure 1. Typical Application Circuit

Contents

1. Functional Description

The RTKRB86848DE0000BU provides all the circuits required to evaluate the features of the RRB86848. A majority of the features of the RRB86848, such as the adjustable output voltage in forward mode and reverse mode, PGOOD indicator in forward and reverse mode, and bidirectional Buck, Boost, and Buck-Boost mode operation are available on the evaluation board.

Caution: The RTKRB86848DE0000BU is a high-voltage evaluation board without isolation circuitry. When it becomes a live circuit, there is a risk of electric shock and should only be handled with caution by qualified professionals.

1.1 Recommended Equipment

- 0V to 60V power supply with at least 6A source current capability
- Electronic load capable of sinking current up to 6A
- Digital Multimeters (DMMs)
- 100MHz quad-trace oscilloscope

1.2 Quick Start Guide

The output voltage and adapter current limit default values can be configured through SW3 to select a proper PROG R. The PROG Pin Programming Options table in the *RRB86848 Datasheet* shows the programming options. After the Program pin is read, the default values of the output voltage and the adapter current limit values are set accordingly. These values can also be changed through the SMBus control registers in the Renesas GUI, shown in Figure 2.

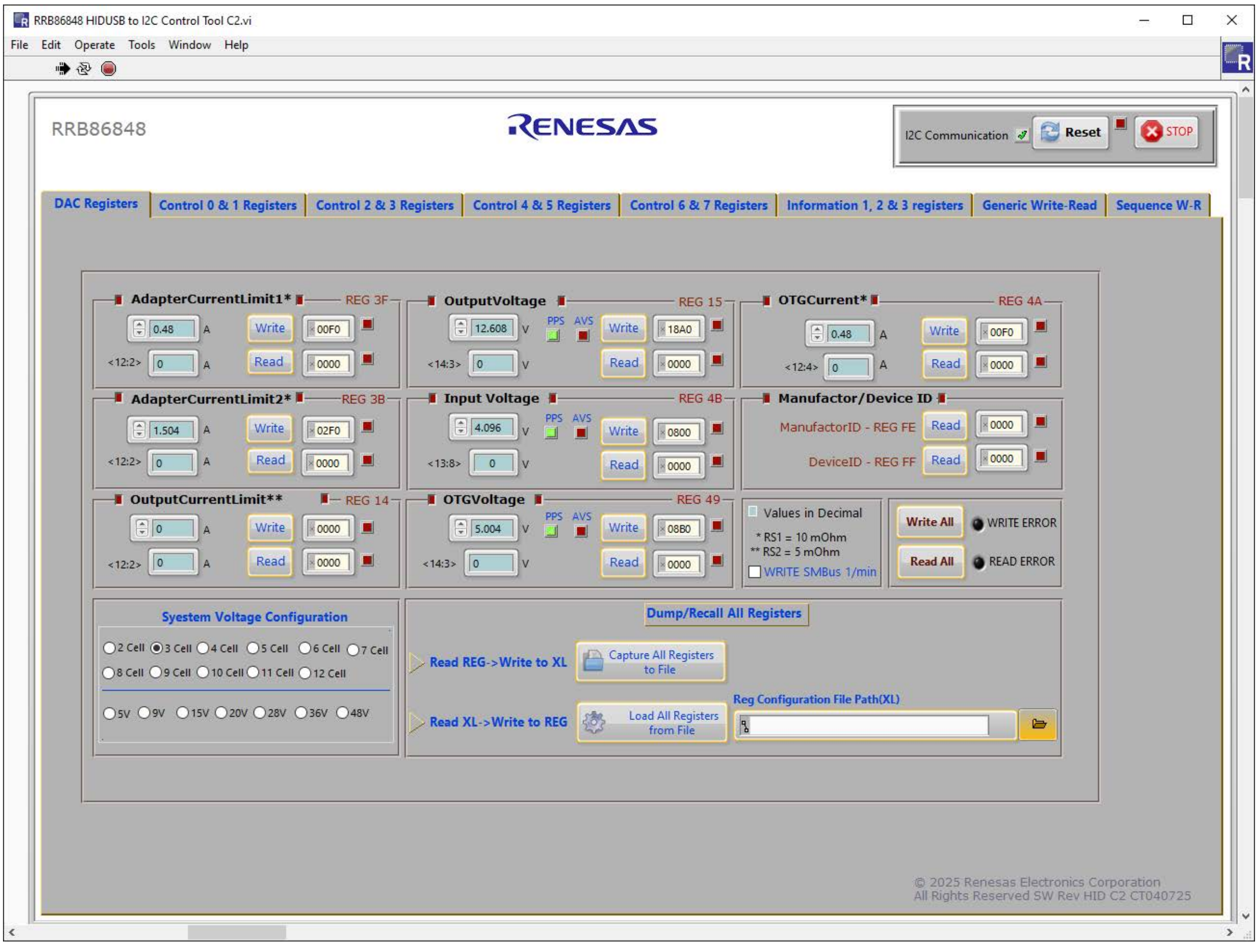


Figure 2. GUI Snapshot

The three LEDs indicate the ACOK, ALERT, and PGOOD/CMOUT status, respectively. For more details about the functions of these three pins, refer to the *RRB86848 Datasheet*. Figure 3 shows the top view of the evaluation board and highlights the key testing points and connection terminals. For more information about the RRB86848, including other modes of operation, refer to the *RRB86848 Datasheet*.

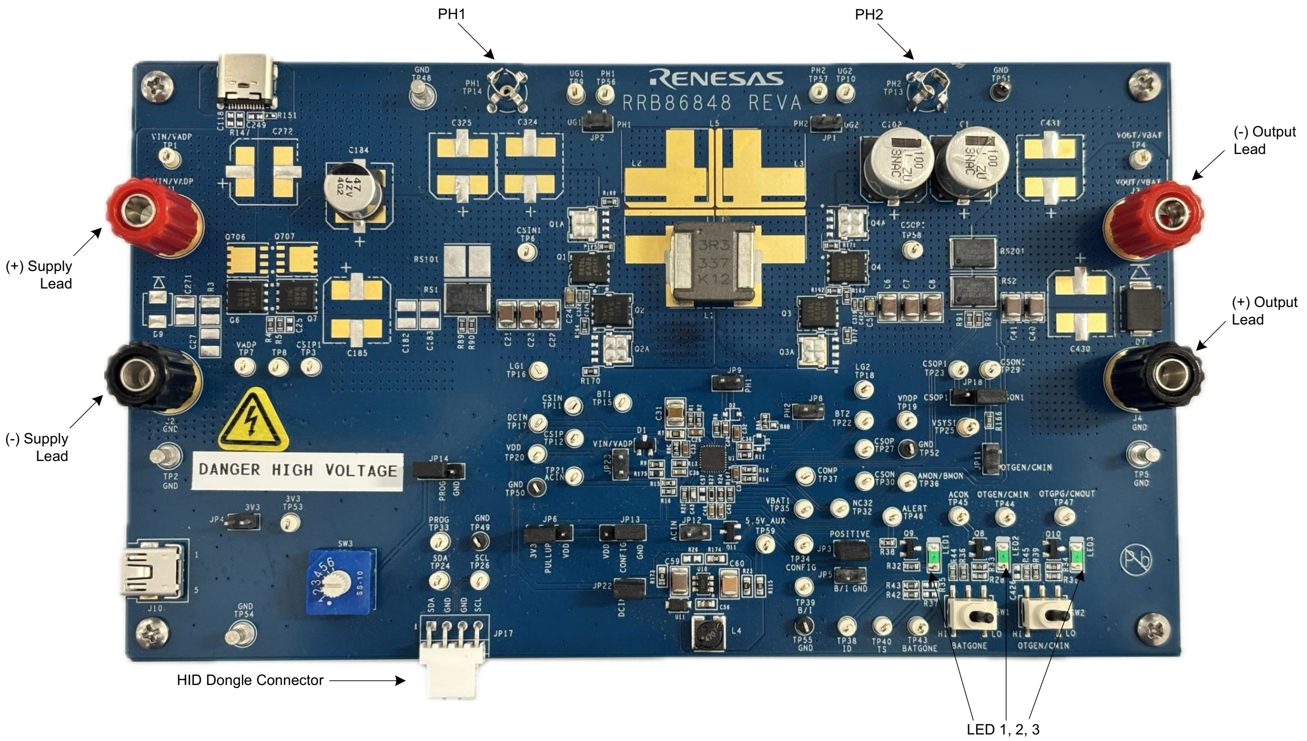


Figure 3. Evaluation Board Connection Guideline[1]

1. ***Warning***: Hot-plugging at 28V and higher voltages (USB EPR voltages) is not recommended, because this event can potentially damage the EVB components and IC.

1.2.1 Output Voltage Regulation

1. Set the power supply to 5V. Disable the output and connect the (+) end to J1 and the (-) end to J2.
2. Set SW3 to the position-4 for 28V output voltage regulation setting. Verify all the jumper connections are correct. SW1 and SW2 should switch to the LO position.
3. Turn on the power supply and measure the output voltage (VOUT) using the DMM across VOUT (TP4) and GND (TP5). VOUT should read 28V. The current meter on the supply should read <100mA. Slowly increase VIN from 5V to 48V. Monitor PH1 and PH2 to observe seamless switching from Boost mode to Buck-Boost mode and finally to Buck mode.

1.2.2 Input Current Limit Regulation

1. Complete all the steps in Output Voltage Regulation including the increase of VIN to 48V.
2. Add an electrical load on VOUT and GND terminals J3 and J4. Turn on the load and increase the electrical load slowly; the input current increases correspondingly and VOUT remains stable at 28V. VOUT starts dropping as the input current reaches the 0.48A input current limit. At that time, RRB86848 enters the input current limit loop, which can be confirmed by reading Information1[14:13]. Refer to the *RRB86848 Datasheet* for more information about the input current limit.

1.2.3 Output Current Limit Regulation

1. Complete all the steps in Output Voltage Regulation.
2. Connect the HID dongle cable with proper wiring connections for the **I2C communication**.
3. Turn on the power supply. Open the RRB86848 GUI (shown in Figure 2).
   Note: A green check mark in the **I2C Communication** section of the GUI indicates the GUI is ready to communicate with the evaluation board. A red X in the **I2C Communication** section indicates the GUI is not ready to communicate with the evaluation board. Click the **Reset** button until a green check mark shows in the **I2C Communication**. If a green check mark does not appear, verify the HID dongle connection.
4. Click the **Read All** button and check the **AdapterCurrentLimit1**, **OutputCurrentLimit**, and **OutputVoltage** values. With the SW3 to position-4 configuration, the values should be **AdapterCurrentLimit1** = 0.48A, **OutputCurrentLimit** = 0.48A, and **OutputVoltage** = 28V.
5. In the GUI, set the AdapterCurrentLimit1 DAC value to 5A, click the **Write** button, and check the read value through the **Read** button. The adapter current limit is now 5A.
6. Turn on the load and increase the electrical load slowly. Ensure that the input power supply has enough power to support the increasing load. With the increasing load current, VOUT should remain stable at 28V before entering the output current limit loop. VOUT drops when the output current reaches the 0.48A output current limit and enters the output current limit loop.
7. If the RS1 and RS2 values are different from the RS1 = 10mΩ and RS2 = 5mΩ option, scale the SMBus commands accordingly to obtain the correct current. Smaller current sense resistor values reduce power loss and larger current sense resistor values give better accuracy.

1.2.4 OTG Mode (Reverse Mode)

1. Set the Power supply voltage at a constant value between 5.8V and 48V (slow voltage ramp is recommended for voltages >20V). Connect the power supply leads to J3 and J4 with the output disabled.
2. Connect an electric load on supply leads J1 and J2 with the output disabled.
3. Connect the HID dongle cable with proper wiring connections for the I^2C communication.
4. Turn on the power supply and electrical load without adding any load.
5. Open the RRB86848 GUI. OTGVoltage at register 0x49 is the voltage value for the load side, and OTGCurrent at register 0x4A is the OTG output current limit at the load side. Set these values as required within the output limit range. Refer to the *RRB86848 Datasheet* for the limit ranges.
6. Select the Control 0 & 1 Registers tab. In the Control1 Register column, select **1: Enable** in OTG Function (Bit[11]) to enable OTG. Next, click **Write**. The load voltage is regulated at an OTGVoltage value, which is set in Step 5.
7. Increase the electrical load slowly and monitor the load voltage. If the load current is less than the OTGCurrent limit value, the load voltage is regulated at the setting value.

2. Board Design

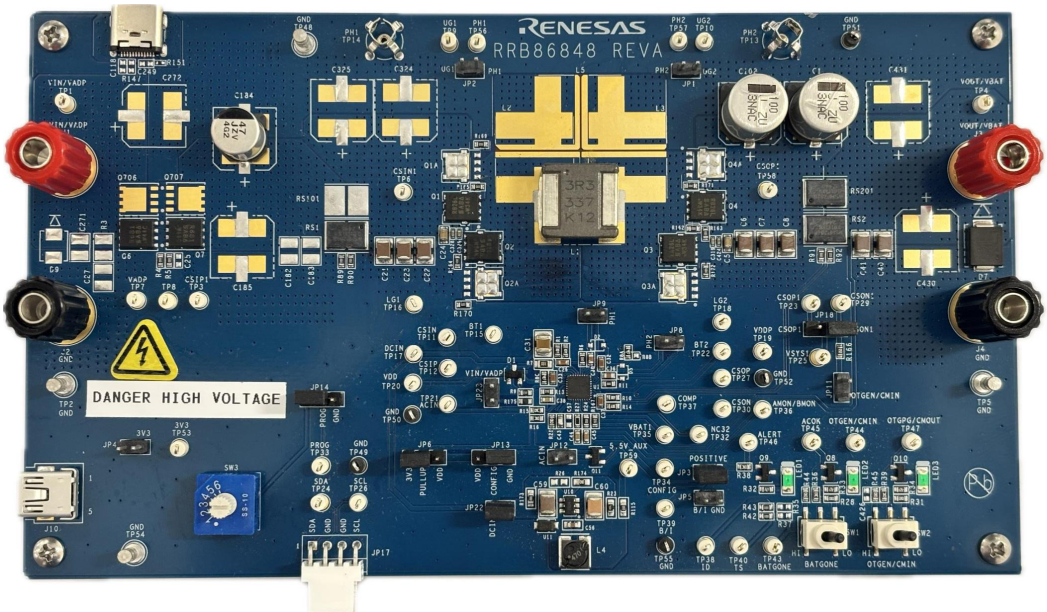


Figure 4. RTKRB86848DE0000BU Evaluation Board (Top)

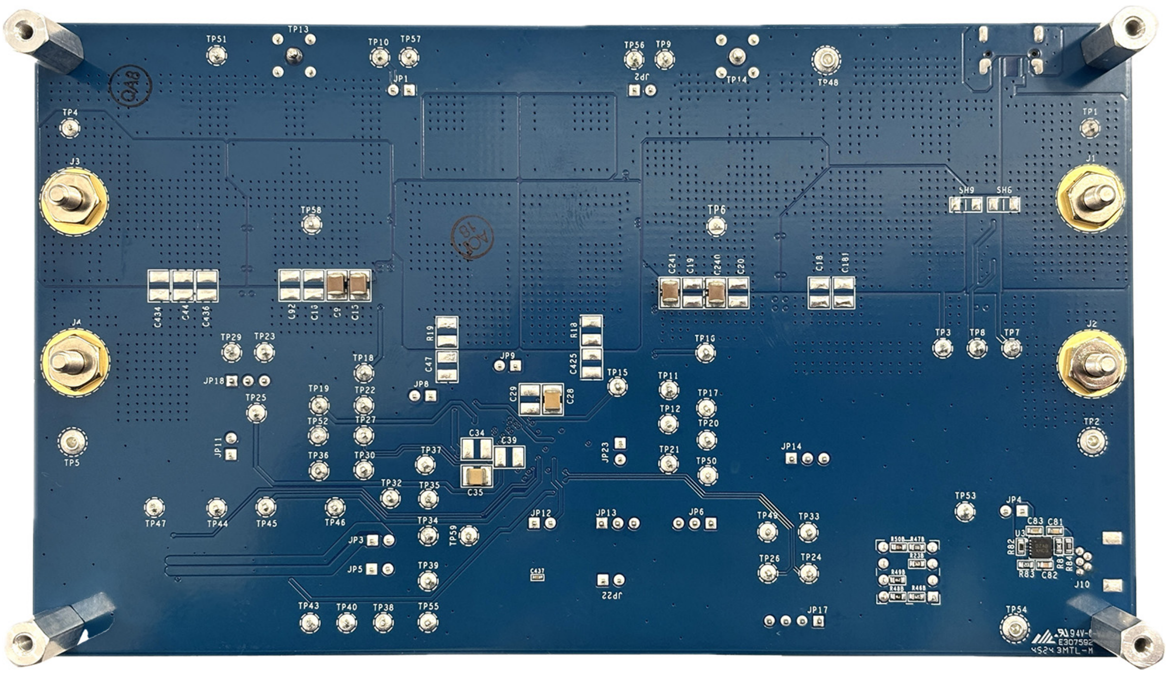
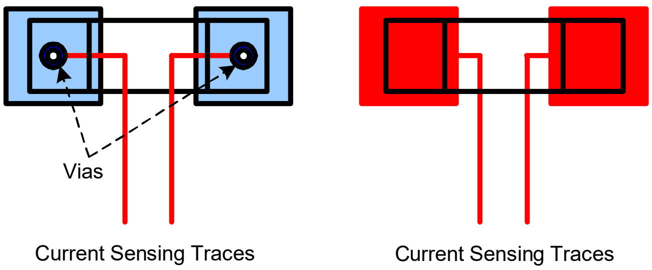


Figure 5. RTKRB86848DE0000BU Evaluation Board (Bottom)

2.1 Layout Guidelines

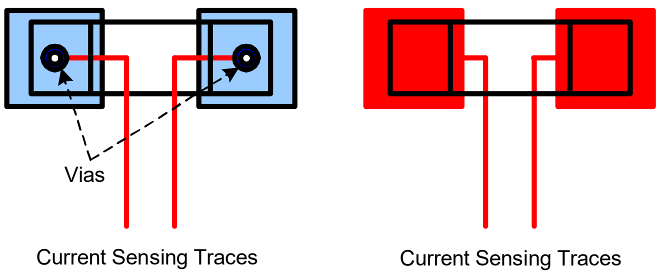
<table>
<tr><th>Pin Number</th><th>Pin Name</th><th>Layout Guidelines</th></tr>
<tr><td>Bottom Pad 33</td><td>GND</td><td>Connect this ground pad to the ground plane through a low impedance path. Use at least five vias to connect to the PCB ground planes to ensure sufficient thermal dissipation directly under the IC.</td></tr>
<tr><td>1</td><td>CSON</td><td rowspan="2">Run two dedicated traces with sufficient width in parallel (close to each other to minimize the loop area) from the two terminals of the battery current sensing resistor to the IC. Place the differential mode and common-mode RC filter components in the general proximity of the controller.

Route the current sensing traces through vias to connect the center of the pads; or route the traces into the pads from the inside of the current sensing resistor. The following drawings show the two preferred ways of routing current sensing traces.
</td></tr>
<tr><td>2</td><td>CSOP</td></tr>
<tr><td>3</td><td>VOUTS1</td><td>This signal pin provides feedback for the output bus voltage. Place the optional RC filter in the general proximity to the controller. Run a dedicated trace from the output bus to the pin and do not route near the switching traces. Do not share the same trace with the signal routing to the DCIN pin OR diodes and the CSOP trace.</td></tr>
<tr><td>4</td><td>BOOT2</td><td>Switching pin. Place the bootstrap capacitor in the general proximity of the controller. Use sufficiently wide traces. Avoid any sensitive analog signal traces from crossing over or getting close. Allocate a footprint for an external Schottky diode from VDDP to BOOT2.</td></tr>
<tr><td>5</td><td>UGATE2</td><td rowspan="2">Run these two traces in parallel fashion with sufficient width. Avoid any sensitive analog signal traces from crossing over or getting close. Route the PHASE2 trace to the high-side MOSFET source pin instead of general copper.

Place the IC close to the gate terminals of the switching MOSFETs and keep the gate drive signal traces short for a clean MOSFET drive. The IC can be placed on the opposite side of the switching MOSFETs.

Place the output capacitors as close as possible to the switching high-side MOSFET drain and the low-side MOSFET source and use the shortest PCB trace connection. Place these capacitors on the same PCB layer with the MOSFETs instead of on different layers and using vias to make the connection.

Place the inductor terminal to the switching high-side MOSFET source and low-side MOSFET drain terminal as close as possible. Minimize this phase node area to lower the electrical and magnetic field radiation but make this phase node area large enough to carry the current. Place the inductor and the switching MOSFETs on the same layer of the PCB.</td></tr>
<tr><td>6</td><td>PHASE2</td></tr>
<tr><td>7</td><td>LGATE2</td><td>Switching pin. Use sufficient width. Avoid any sensitive analog signal traces from crossing over or getting close.</td></tr>
<tr><td>8</td><td>VDDP</td><td>Place the decoupling capacitor in the general proximity of the controller. Run the trace connecting to the VDD pin with sufficient width.</td></tr>
<tr><td>9</td><td>LGATE1</td><td>Switching pin. Use sufficient width. Avoid any sensitive analog signal traces from crossing over or getting close.</td></tr>
</table>

Pin Number	Pin Name	Layout Guidelines
10	PHASE1	Run these two traces in parallel fashion with sufficient width. Avoid any sensitive analog signal traces from crossing over or getting close. Route the PHASE1 trace to the high-side MOSFET source pin instead of general copper. Place the IC close to the gate terminals of the switching MOSFETs and keep the gate drive signal traces short for a clean MOSFET drive. The IC can be placed on the opposite side of the switching MOSFETs. Place the input capacitors as close as possible to the switching high-side MOSFET drain and the low-side MOSFET source and use the shortest PCB trace connection. Place these capacitors on the same PCB layer with the MOSFETs instead of on different layers and using vias to make the connection. Place the inductor terminal to the switching high-side MOSFET source and low-side MOSFET drain terminal as close as possible. Minimize this phase node area to lower the electrical and magnetic field radiation but make this phase node area big enough to carry the current. Place the inductor and the switching MOSFETs on the same layer of the PCB.
11	UGATE1	
12	BOOT1	Switching pin. Place the bootstrap capacitor in the general proximity of the controller. Use sufficiently wide traces. Avoid any sensitive analog signal traces from crossing over or getting close. Allocate a footprint for an external Schottky diode from VDDP to BOOT1.
13	ASGATE	Run this trace with sufficient width in parallel fashion with the ADP pin trace.
14	CSIN	Run two dedicated traces with sufficient width in parallel (close to each other to minimize the loop area) from the two terminals of the adapter current sensing resistor to the IC. Place the Differential mode and common-mode RC filter components in the general proximity of the controller. Route the current sensing traces through vias to connect the center of the pads or route the traces into the pads from the inside of the current sensing resistor. The following drawings show the two preferred ways of routing current sensing traces. 
15	CSIP	
16	ADP	Run this trace with sufficient width in parallel fashion with the ASGATE pin trace.
17	DCIN	Place the OR diodes and the RC filter in the general proximity of the controller. Run the VADP trace and VOUT trace to the OR diodes with sufficient width.
18	VDD	Place the RC filter connecting with the VDDP pin in the general proximity of the controller. Run the trace connecting to the VDDP pin with sufficient width.
19	ACIN	Place the voltage divider resistors and the optional decoupling capacitor in the general proximity of the controller.
20	OTGEN/CMIN	No special consideration.
21	SDA	Digital pins. Avoid running these traces near noisy traces. Run the SDA and SCL traces in parallel.
22	SCL	
23	ALERT#	Digital pin, open-drain output. No special consideration.
24	ACOK	
25	RESERVED	Connect to GND.
26	PGOOD/ CMOUT	Digital pin, open-drain output. No special consideration.
27	PROG	Signal pin. Place the PROG programming resistor in the general proximity of the controller.
28	COMP	Place the compensation components in the general proximity of the controller. Avoid any switching signal from crossing over or getting close.
29	AMON/BMON	No special consideration. Place the optional RC filter in the general proximity of the controller.
30	RESERVED	This pin should not float. Connect to either VDD or GND.

Pin Number	Pin Name	Layout Guidelines
31	VOUTS2	Place the optional R-C filter in the general proximity of the controller. Run a dedicated trace from the output voltage node VOUT to the IC.
32	Unused	-

2.2 Schematic Diagrams

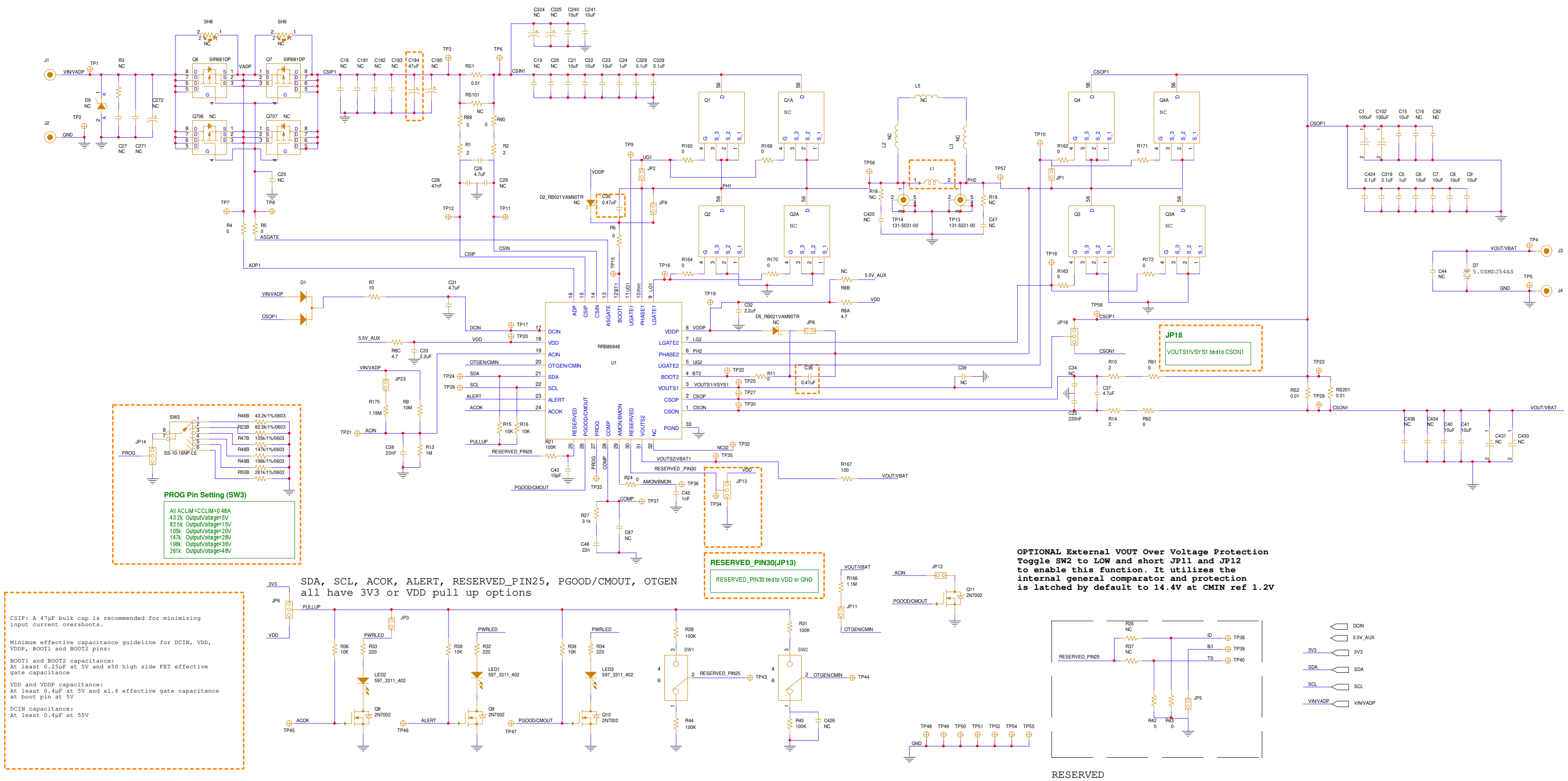


Figure 6. Schematic (1 of 2)

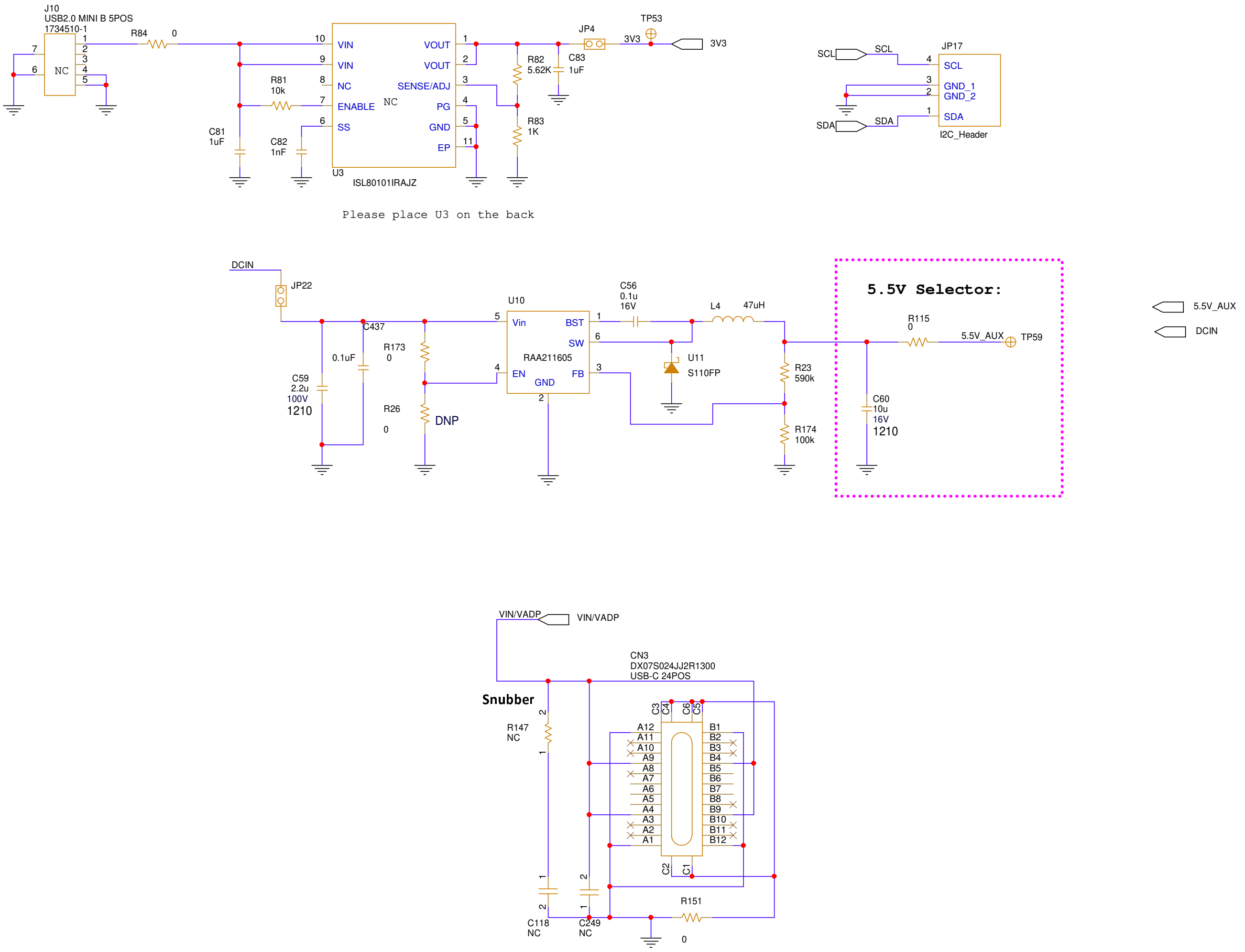


Figure 7. Schematic (2 of 2)

2.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	CN3	CONN RCP USB3.1 TYPEC 24P SMD RA	JAE Electronics	DX07S024JJ2R1300
1	C184	47µF, 63V Aluminum Hybrid CAN Cap	Panasonic Electronic Components	EEHZV1J470P
2	C1,C102	100µF, 63V Aluminum Hybrid CAN Cap	Panasonic Electronic Components	EEHZU1J101P
12	C6,C7,C8,C9,C15,C21,C22,C23,C40,C41,C240,C241	10µF ±10% 75V Ceramic Capacitor X7R 1210 (3225 Metric)	TDK Corporation	CGA6P1X7R1N106K250AC
2	C5,C24	1µF ±10% 100V Ceramic Capacitor X7S 0805 (2012 Metric)	Murata Electronics	GRM21BC72A105KE01L
2	C26,C37	CAP CER 4.7µF 16V X5R 0603	Murata Electronics	GRM188R61C475KE11D
1	C28	0.047 µF ±10% 100V Ceramic Capacitor X7R 1210 (3225 Metric)	Kemet	C1210C473K1RACAUTO
1	C35	CAP CER 0.22µF 250V X7R 1210	Murata Electronics	GCJ32DR72E224KXJ1L
2	C30, C36	AP CER 0.47µF 50V X7R 0603	TDK Corporation	C1608X7R1H474K080AC
1	C31	4.7µF ±10% 100V Ceramic Capacitor X7S 1210 (3225 Metric)	Murata Electronics	GCJ32DC72A475KE01L
2	C32,C33	CAP CER 2.2µF 50V X5R 0603	Murata Electronics	GRM188R61H225KE11D
5	C319,C328,C329,C424, C437	0.1µF ±10% 100V Ceramic Capacitor X5R 0402 (1005 Metric)	Murata Electronics	GRM155R62A104KE14D
1	C43	CAP CER 10PF 50V X7R 0603	Kyocera AVX	06035C100KAT2A
2	C45,C82	CAP CER 1000PF 50V X7R 0603	TDK Corporation	CGA3E2X7R1H102K080AA
2	C38, C46	CAP CER 0.022µF 50V X7R 0603	Murata Electronics	GCJ188R71H223KA01D
2	C81,C83	CAP CER 1µF 50V X5R 0603	Murata Electronics	GRT188R61H105KE13D
3	RS1,RS2,RS201	RES 0.01Ω 1% 10W 2818	Vishay Dale	WSHP2818R0100FEA
4	R1,R2,R10,R14	RES 2Ω 1% 1/10W 0603	Yageo	RC0603FR-072RL
22	R4,R5,R6,R11,R24,R42,R43,R84,R89,R90,R91,R92,R162,R163,R164,R165, R173,R115,R169,R170,R171,R172	RES 0Ω JUMPER 1/10W 06030	Vishay Dale	CRCW06030000Z0EAC
1	R7	RES SMD 10Ω 5% 0.4W 0805	Rohm Semiconductor	ESR10EZPJ100
2	R8A, R8C	RES 4.7Ω 1% 1/10W 0603	YAGEO	RC0603FR-074R7L
1	R9	10 MΩ ±1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thick Film	Stackpole Electronics Inc	RMCF0603FT10M0
1	R175	RES SMD 1.18MΩ 1% 1/10W 0603	Vishay Dale	CRCW06031M18FKEA
6	R21,R28,R31,R44,R45, R174	RES 100KΩ 1% 1/10W 0603	Yageo	RC0603FR-07100KL
6	R15,R16,R36,R38,R39,R81	RES 10KΩ 1% 1/10W 0603	Yageo	RC0603FR-0710KL
1	R167	RES SMD 100Ω 1% 1/10W 0603	TE Connectivity Passive Product	CRG0603F100R
1	R46B	RES 43.2KΩ 1% 1/10W 0603	Stackpole Electronics Inc	RMCF0603FT43K2
1	R23B	RES 82.5KΩ 1% 1/10W 0603	Stackpole Electronics Inc	RMCF0603FT82K5

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	R47B	RES 105KΩ 1% 1/10W 0603	Stackpole Electronics Inc	RMCF0603FT105K
1	R48B	RES 147KΩ 1% 1/10W 0603	Stackpole Electronics Inc	RMCF0603FT147K
1	R49B	RES 196KΩ 1% 1/10W 0603	Stackpole Electronics Inc	RMCF0603FT196K
1	R50B	RES 261KΩ 1% 1/10W 0603	Stackpole Electronics Inc	RMCF0603FT261K
3	R32,R33,R34	RES 220Ω 1% 1/10W 0603	YAGEO	RC0603FR-07220RL
1	R27	RES SMD 3.09KΩ 1% 1/10W 0603	Panasonic Electronic Components	ERJ-3EKF3091V
1	R82	RES SMD 5.62KΩ 1% 1/10W 0603	Panasonic Electronic Components	ERJ-3EKF5621V
1	R83	RES 1KΩ 5% 1/10W 0603	Yageo	RC0603JR-071KL
1	R166	RES 1.1MΩ 1% 1/10W 0603	Yageo	RC0603FR-071M1L
2	SW1,SW2	SWITCH TOGGLE SPDT 0.4VA 20V	C&K	GT11MSCBE
1	SW3	SWITCH ROTARY DIP SP6T 100MA 5V	Nidec Components Corporation	SS-10-16NP-LE
44	TP1,TP3,TP4,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP15,TP16,TP17,TP18,TP19,TP20,TP21,TP22,TP23,TP24,TP25,TP26,TP27,TP29,TP30,TP32,TP33,TP34,TP35,TP36,TP37,TP38,TP39,TP40,TP43,TP44,TP45,TP46,TP47,TP53,TP56,TP57,TP58,TP59	PC TEST POINT MINIATURE WHITE	Keystone Electronics	5002
5	TP49,TP50,TP51,TP52,TP55	PC TEST POINT MINIATURE BLACK	Keystone Electronics	5001
4	TP5,TP2,TP48,TP54	TERM TURRET SINGLE L = 7.65MM TIN	Keystone Electronics	1598-2
2	TP13,TP14	Test Connectors PK 25 EA 136-0962-00 and 131-4209-00	Tektronix	131-5031-00
1	D1	Diode Array 1 Pair Common Cathode 100 V 215mA Surface Mount TO-236-3, SC-59, SOT-23-3	Toshiba Semiconductor and Storage	BAV70,LM
1	D7	87.1V Clamp 57.5A Ipp Tvs Diode Surface Mount DO-214AB (SMCJ)	Littelfuse Inc.	5.0SMDJ54AS
11	JP1,JP2,JP3,JP4,JP5,JP8,JP9,JP11,JP12,JP22,JP23	CONN HEADER VERT 2POS	TE Connectivity AMP Connectors	9-146258-0-01
4	JP6,JP13,JP14,JP18	CONN HEADER VERT 3POS	Würth Elektronik	61300311121
1	JP17	CONN HEADER R/A 4POS 2.54MM	Molex	22053041
2	J1,J3	CONN BIND POST KNURLED RED	Cinch Connectivity Solutions Johnson	111-0702-001

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
2	J2,J4	CONN BIND POST KNURLED BLACK	Cinch Connectivity Solutions Johnson	111-0703-001
1	J10	CONN RCPT USB2.0 MINI B 5POS R/A	TE Connectivity AMP Connectors	1734510-1
3	LED1,LED2,LED3	LED GREEN DIFFUSED 1206 SMD	Visual Communications Company - VCC	CMD15-21VGD/TR8
4	Q1,Q2,Q3,Q4	MOSFET N-CH 80V 21.3A/86A PPAK	Vishay Siliconix	SIR826LDP-T1-GEN3
2	Q6,Q7	MOSFET P-CH 80V 17.6A/71.9A PPAK	Vishay Siliconix	SIR681DP-T1-RE3
4	Q8,Q9,Q10,Q11	MOSFET N-CH 60V 300MA TO236	Vishay Siliconix	2N7002K-T1-GE3
1	U3	IC REG LINEAR POS ADJ 1A 10DFN	Renesas Electronics Corporation	ISL80101IRAJZ
1	U1	RRB86848	Renesas Electronics Corporation	RRB86848
1	L1	3.3µH Inductor, 2.85mΩ Typ DCR, 28A Typ IDC,Size in mm 13.1×12.8×8	Delta Electronics/Cyntec	VCUD128T-3R3MS8-87
1	U10	Buck Switching Regulator IC Positive Adjustable 0.8V 1 Output 500mA SOT-23-6 Thin, TSOT-23-6	Renesas Electronics Corporation	RAA2116054GP3#JA0
1	U11	Diode 100 V 1A Surface Mount SOD-123FL	Panjit International Inc.	SS10100FL-AU_R1_000A1
1	L4	WE-SPC Series; Shielded Wire-wound SMD Inductor with Ferrite Core, 47µH	Würth Elektronik	74408943470
1	C59	Multilayer Ceramic Capacitor, 2.2µF, 100V, ±20%, X7R, 1210 [3225 Metric]	TDK Corporation	C3225X7R2A225M230AB
1	C60	Multilayer Ceramic Capacitor, 10µF, 16V, ±10%, X8R, 1210 [3225 Metric]	TDK Corporation	C3225X8R1C106K250AB
1	R23	590 kΩ ±1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thick Film	Stackpole Electronics Inc	RMCF0603FT590K
1	R13	1 MΩ ±1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thick Film	Stackpole Electronics Inc	RMCF0603FG1M00
1	C56	Ceramic Capacitor, Multilayer, Ceramic, 16V, 10% +Tol, 10% -Tol, X7R, 15% TC, 0.1µF, Surface Mount, 0603	Taiyo Yuden	EMK107B7104KA-T
1	R151	0Ω Jumper Chip Resistor 0402 (1005 Metric) Automotive AEC-Q200 Thick Film	Panasonic Electronic Components	ERJ-2GE0R00X
4	-	HEX STANDOFF #4-40 ALUMINUM 3/4"	Keystone Electronics	Standoff
4	-	MACHINE SCREW PAN PHILLIPS 4-40	B&F Fastener Supply	SCREW
7	-	CONN JUMPER SHORTING GOLD FLASH	Sullins Connector Solutions	JUMPER SHORTING

2.4 Board Layout

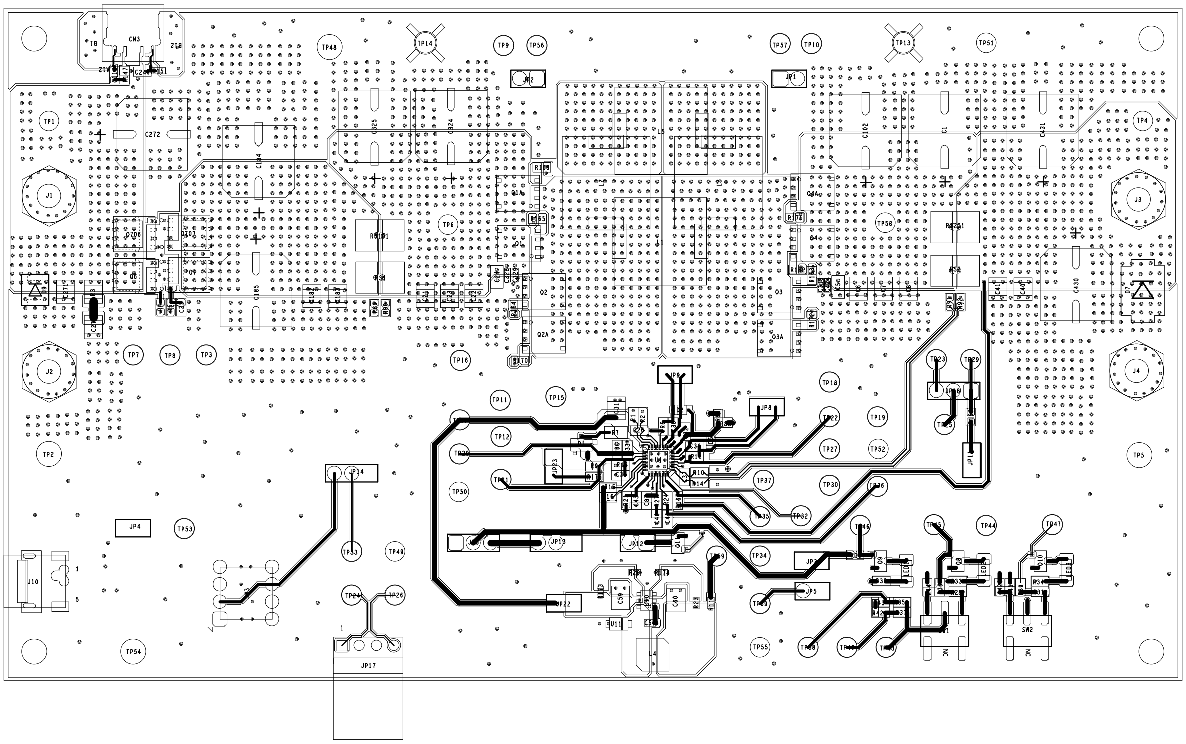


Figure 8. Top Layer

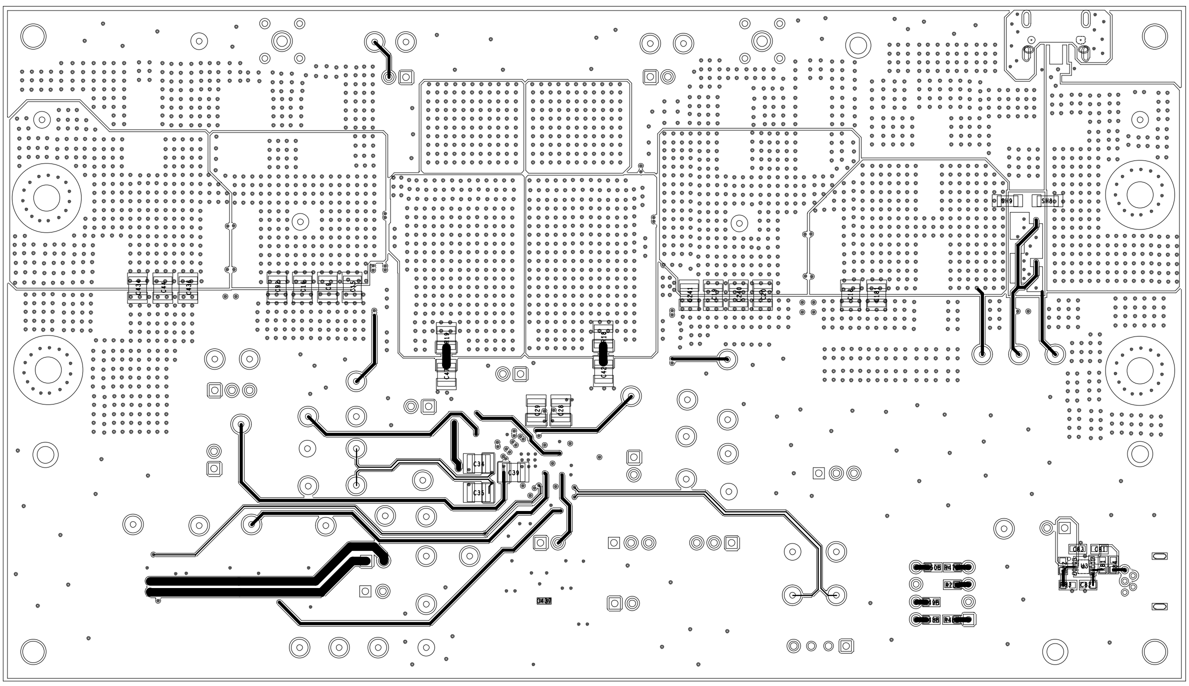


Figure 9. Bottom Layer

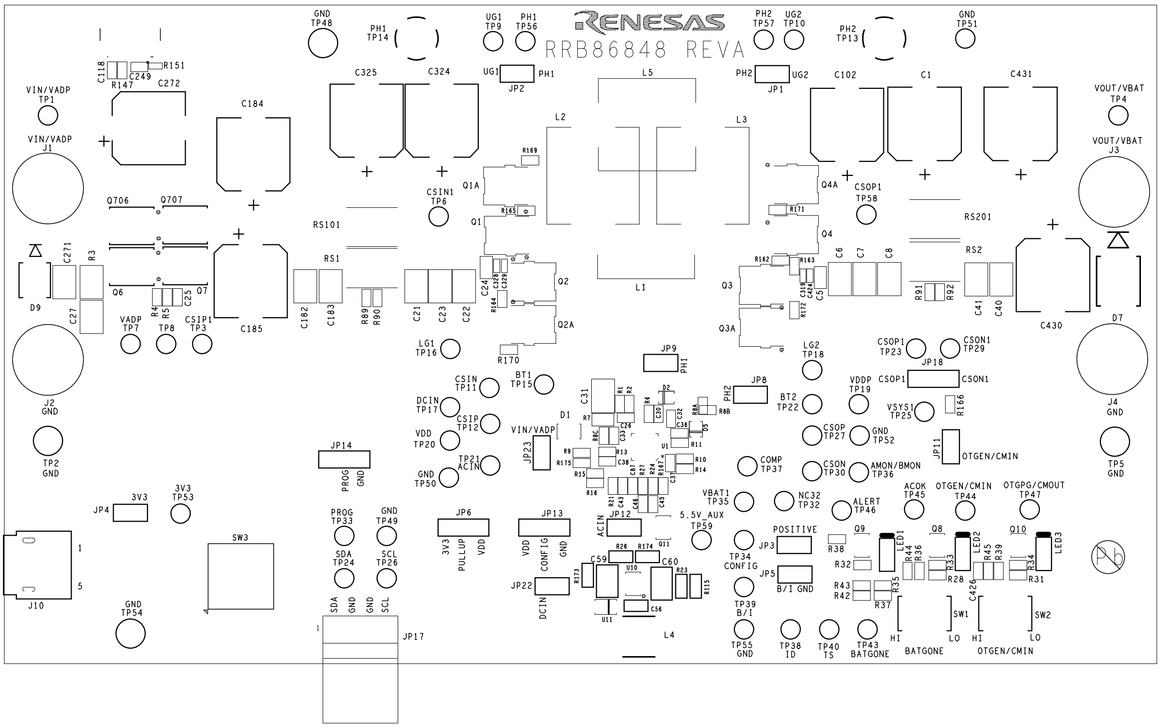


Figure 10. Top Silkscreen

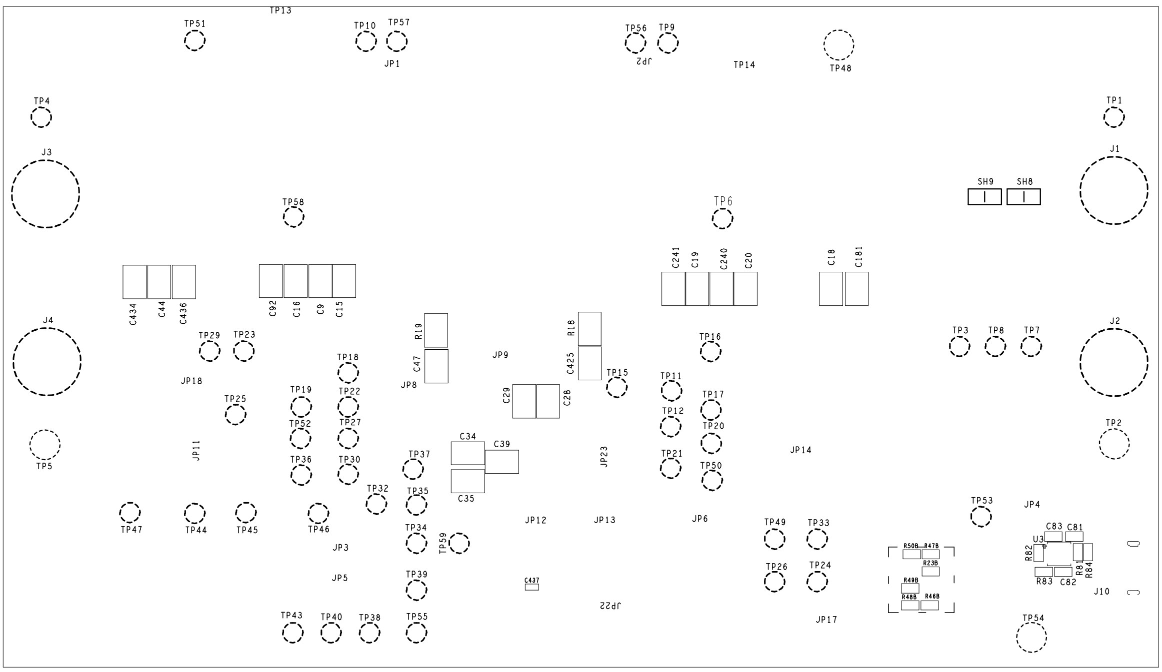
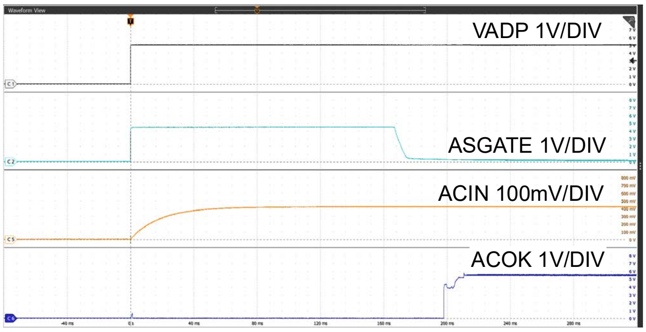


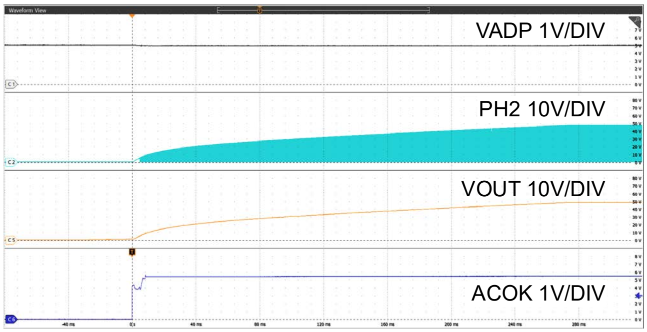
Figure 11. Bottom Silkscreen

3. Typical Performance Graphs



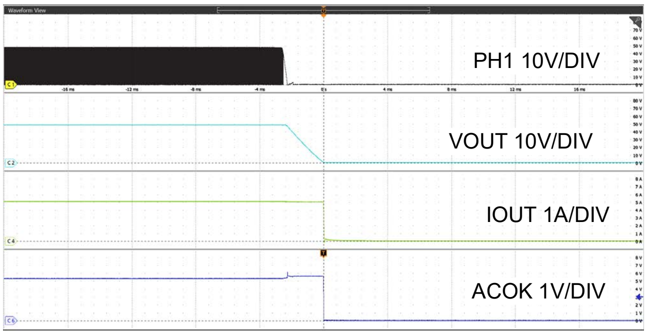
40ms/Div

Figure 12. Adapter Insertion, V_{ADP}: 0V → 5V, V_{OUT} = 48V



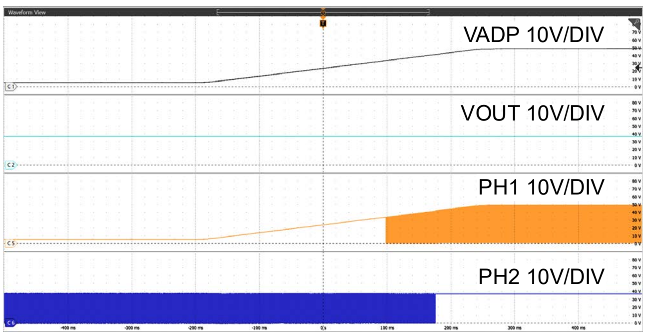
40ms/Div

Figure 13. Adapter Insertion, V_{ADP}: 0V → 5V, V_{OUT} = 48V, (Continuation of Figure 12)



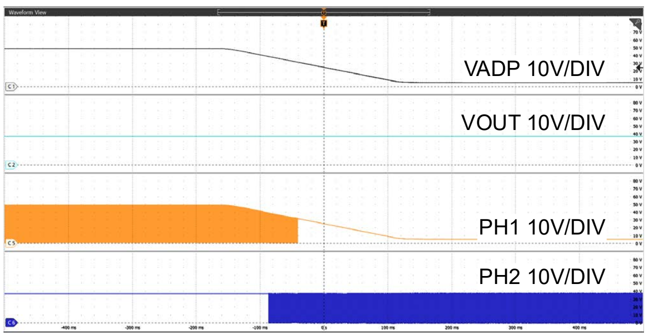
4ms/Div

Figure 14. Adapter Removal, V_{ADP}: 48V → 0V, V_{OUT} = 48V, Load = 5A



100ms/Div

Figure 15. Adapter Voltage Ramp Up, Boost → Buck-Boost → Buck Operation Mode Transitions



100ms/Div

Figure 16. Adapter Voltage Ramp Down, Buck → Buck-Boost → Boost Operation Mode Transitions

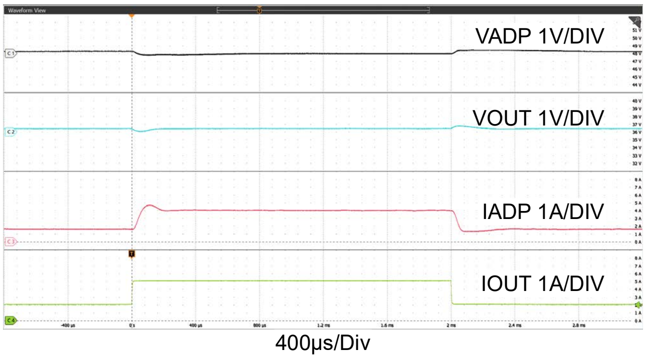


Figure 17. Buck Mode: Output Voltage Loop Load Transient, V_{ADP} = 48V, V_{OUT} = 36V, Load: 2A ↔ 5A

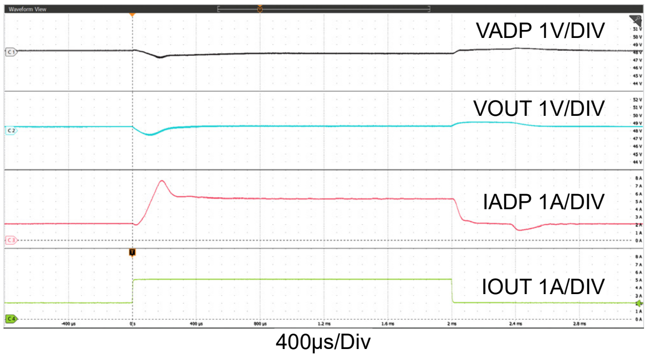


Figure 18. Buck-Boost Mode: Output Voltage Loop Load Transient, V_{ADP} = 48V, V_{OUT} = 48V, Load: 2A ↔ 5A

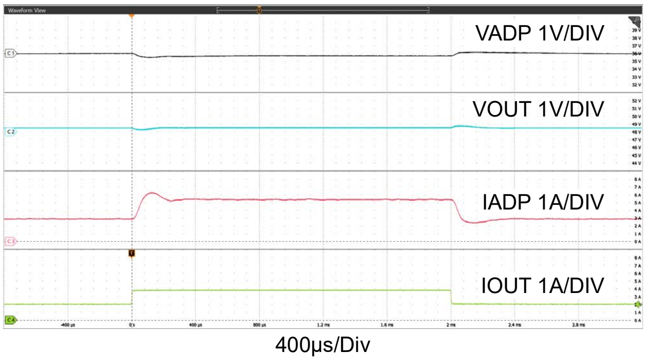


Figure 19. Boost Mode: Output Voltage Loop Load Transient, V_{ADP} = 36V, V_{OUT} = 48V, Load: 2A ↔ 3.75A

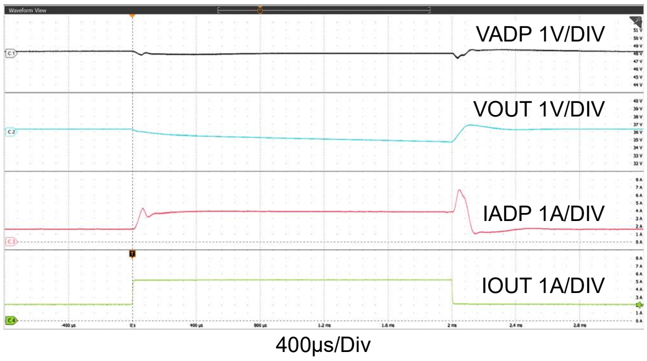


Figure 20. Buck Mode: Output Voltage Loop ↔ Output Current Loop, V_{ADP} = 48V, V_{OUT} = 36V, OutputCurrentLimit = 5A, Load: 2A ↔ 5.1A

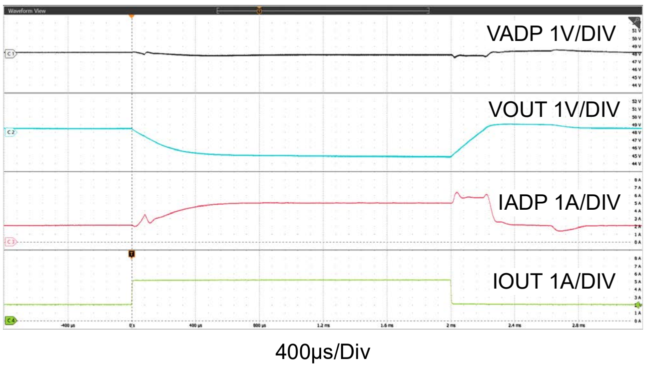


Figure 21. Buck-Boost Mode: Output Voltage Loop ↔ Output Current Loop, V_{ADP} = 48V, V_{OUT} = 48V, OutputCurrentLimit = 5A, Load: 2A ↔ 5.1A

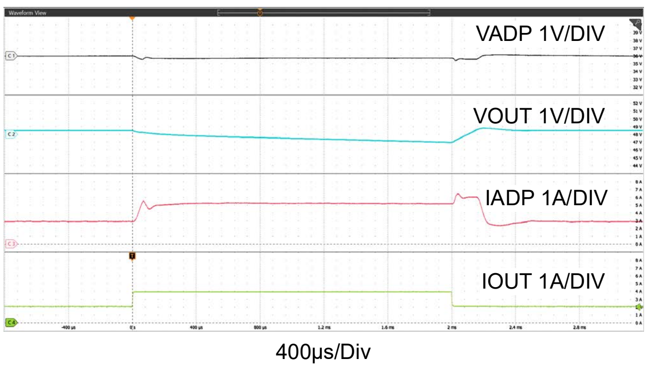


Figure 22. Boost Mode: Output Voltage Loop ↔ Output Current Loop, V_{ADP} = 36V, V_{OUT} = 48V, OutputCurrentLimit = 5A, Load: 2A ↔ 3.85A

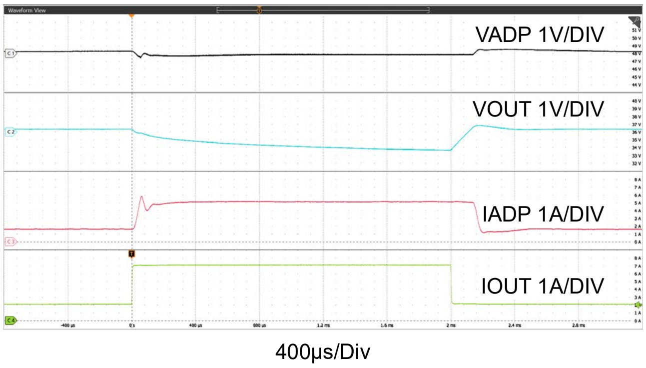


Figure 23. Buck Mode: Output Voltage Loop ↔ Input Current Loop, V_{ADP} = 48V, V_{OUT} = 36V, AdapterCurrentLimit = 5A, Load: 2A ↔ 7A

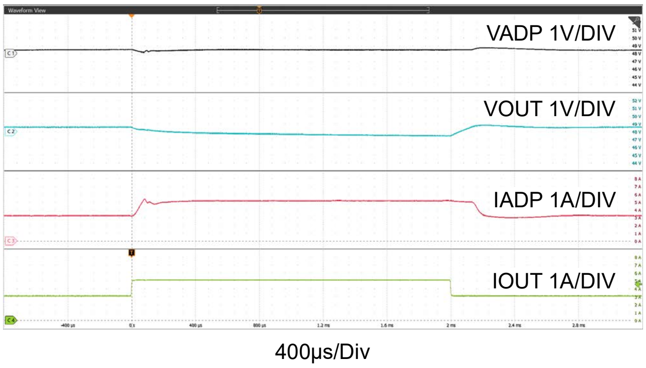


Figure 24. Buck-Boost Mode: Output Voltage Loop ↔ Input Current Loop, V_{ADP} = 48V, V_{OUT} = 48V, AdapterCurrentLimit = 5A, Load: 3A ↔ 5A

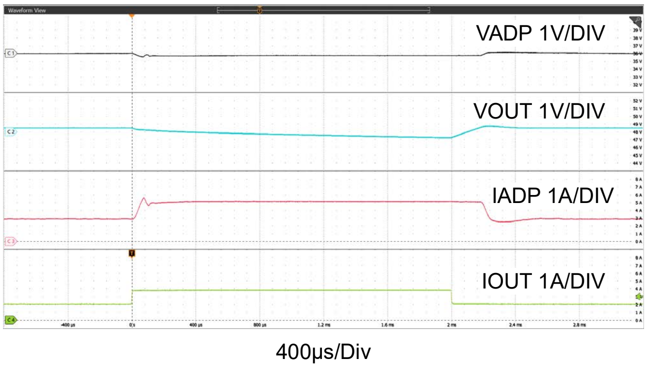


Figure 25. Boost Mode: Output Voltage Loop ↔ Input Current Loop, V_{ADP} = 36V, V_{OUT} = 48V, AdapterCurrentLimit = 5A, Load: 2A ↔ 3.75A

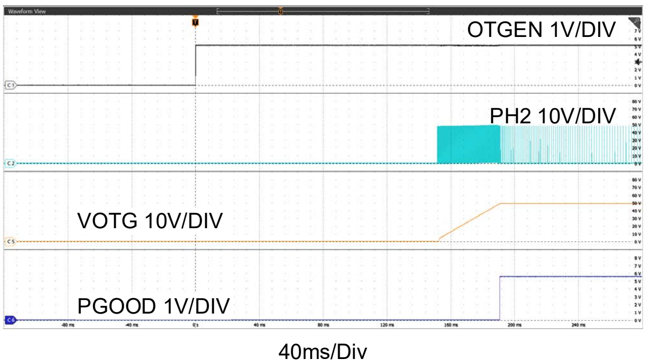


Figure 26. OTG Mode Enable, OTG_Debounce = 150ms, V_{OUT} = 48V, V_{OTG} = 48V

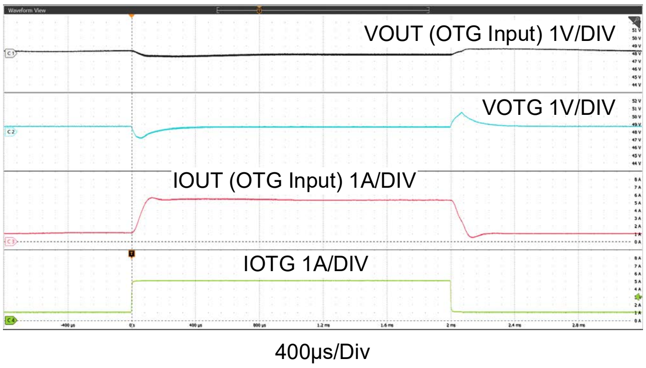


Figure 27. OTG Mode Transients, V_{OUT} = 48V, V_{OTG} = 48V, OTG Load: 1A ↔ 5A

Note: The performance waveforms were captured using the default switching frequency of 723kHz.

4. Ordering Information

Part Number	Description
RTKRB86848DE0000BU	RRB86848 evaluation board

5. Revision History

Revision	Date	Description
1.01	Jun 3, 2025	Updated the Description. Updated the input and output voltage range to 55V. Updated the Functional Description. Updated Figures 2, 3, 4, 6, and 7. Updated Layout Guidelines for BOOT1 and BOOT2.
1.00	Feb 11, 2025	Initial release.

IMPORTANT NOTICE AND DISCLAIMER

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.