

## RTKA489108DE0000BU

The [RAA489108](#) is a buck-boost Narrow Output Voltage DC (NVDC) charger that uses the Renesas advanced R3™ Technology to provide high light-load efficiency, fast transient response, and seamless DCM/CCM transitions for a variety of mobile and industrial applications.

In Charge mode, the RAA489108 takes input power from a wide range (3.9V to 30V) of DC power sources (such as conventional AC/DC charger adapters, USB PD ports, travel adapters) and safely charges battery packs with up to four cells in a series configuration.

The RAA489108 provides serial communication with SMBus/I<sup>2</sup>C that allows programming of critical parameters to deliver a customized solution. The programmable parameters include (but are not limited to) the following: adapter current limit, charger current limit, system voltage setting, and trickle charging current limit.

The RTKA489108DE0000BU evaluation board evaluates the performance of the RAA489108. The default value numbers of the battery in series, switching frequency, autonomous charging mode, and the adapter current limit charging function can be programmed by the resistor from the PROG pin to GND. The values can also be set by SMBus.

## Features

- Buck-boost NVDC charger for 2-, 3-, 4-cell Li-ion batteries
- Autonomous charging option (automatic completion of charging)
- Pass-through mode in forward direction
- System power monitor PSYS output, IMVP-8 compliant
- PROCHOT# open-drain output, IMVP-8 compliant
- Allows trickle charging of depleted battery
- Adapter current and battery current monitor (AMON/BMON)
- PROCHOT# open-drain output, IMVP compliant
- Ideal diode control in Turbo mode
- Two-level adapter current limit available
- Battery Ship mode option
- SMBus and auto-increment I<sup>2</sup>C compatible

## Specifications

- $V_{IN}$  = 3.9V to 30V (no dead zone)
- $V_{OUT}$  = 2.4V to 18.304V
- MAX  $I_{charge}$  up to 6A
- $f_{SW}$  = 1MHz maximum

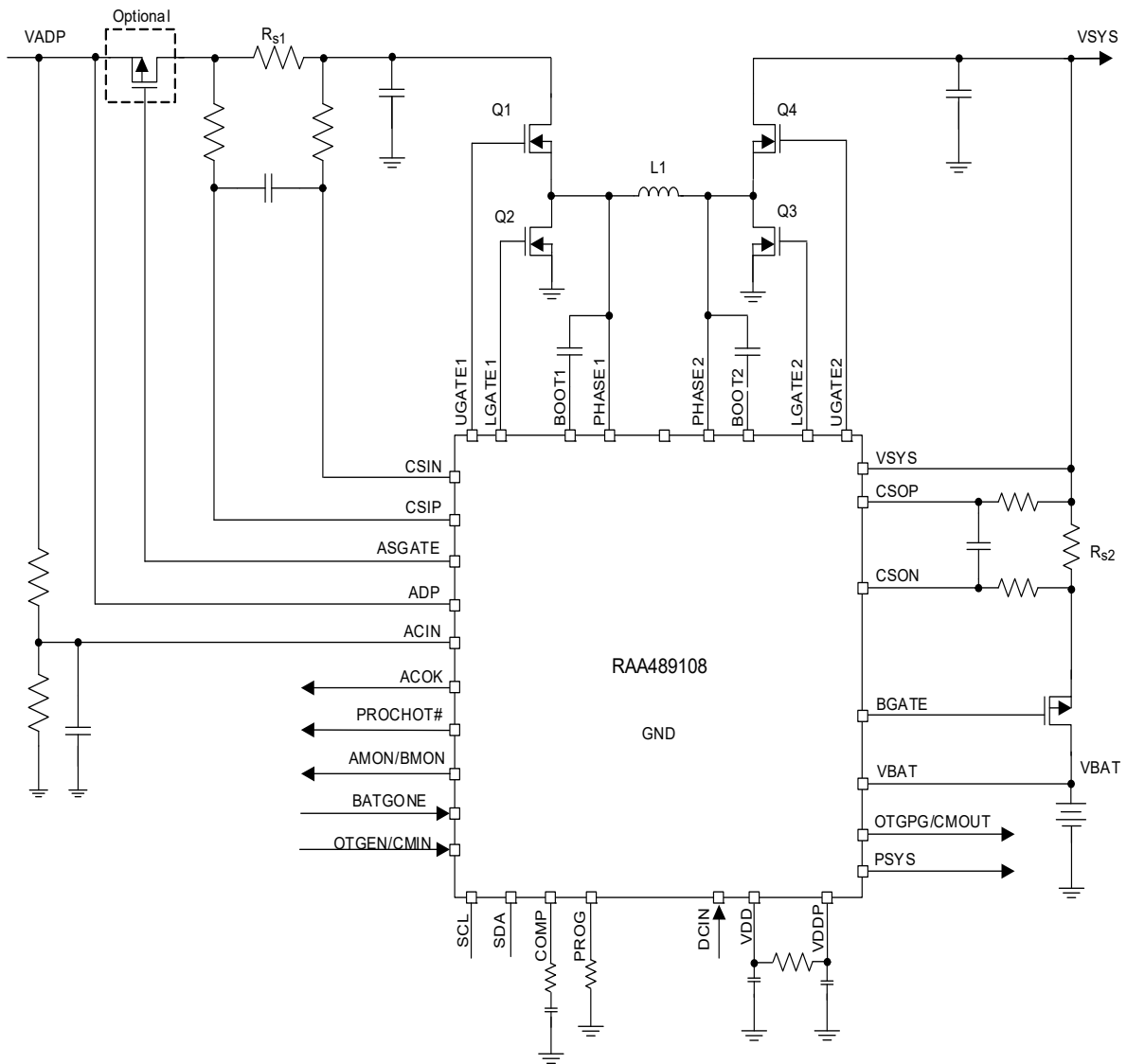


Figure 1. RTKA489108DE0000BU Block Diagram

## Contents

<b>1. Functional Description</b>	<b>4</b>
1.1 Recommended Equipment	4
1.2 Quick Start Guide	4
1.2.1 System Voltage Regulation	4
1.2.2 Input Current Limit Regulation	4
1.2.3 Charging Mode	6
1.2.4 Trickle Charging Mode	6
<b>2. Board Design</b>	<b>7</b>
2.1 Layout Guidelines	8
2.2 Schematic Diagrams	11
2.3 Bill of Materials	12
2.4 Board Layout	15
<b>3. Typical Performance Graphs</b>	<b>17</b>
<b>4. Ordering Information</b>	<b>20</b>
<b>5. Revision History</b>	<b>20</b>

# 1. Functional Description

The RTKA489108DE0000BU provides all circuits required to evaluate the features of the RAA489108. A majority of the features of the RAA489108, such as the adjustable output voltage, Trickle Charging mode for depleted battery, and the system power monitor at Buck, Boost, and Buck-Boost modes are available on this evaluation board.

## 1.1 Recommended Equipment

- 0V to 35V power supply with at least 6A source current capability
- Electronic load capable of sinking current up to 6A
- Battery emulator capable of sinking and sourcing current up to 6A
- Digital Multimeters (DMMs)
- 100MHz quad-trace oscilloscope

*Note:* You can use a power supply (that can source current but cannot sink current) in parallel with an e-load Constant Current (CC) mode to emulate the battery. For example, to charge, set the charging current command lower than the CC mode e-load. If the e-load CC mode current is set to 3A, the charge current command is 2A, and the e-load draws 2A from the charger and draws another 1A from the power supply in parallel with it. To discharge, the power supply acts like the battery to discharge current. You can also use the e-load Constant Voltage (CV) mode to emulate the battery to take the charging current from the charger and set the e-load CV voltage below the MaxSysV register setting; however, this e-load CV mode cannot source current like a battery.

## 1.2 Quick Start Guide

The number of battery cell and adapter current limit default values can be configured with a standard 1% 0603 resistor (R23) from the PROG pin to GND. The PROG Pin Programming Options table in the *RAA489108 Datasheet* shows the programming options. After the default number of cells in series is set, the default values for MaxSystemVoltage and MinSystemVoltage are set accordingly. These values can also be changed through the SMBus control registers in the Renesas GUI, shown in [Figure 2](#).

The three LEDs indicate the ACOK, PROCHOT, and CMOUT status, respectively. For more details about the functions of these three pins, refer to the *RAA489108 Datasheet*. Complete the following steps to evaluate the RAA489108 key functions, including system voltage regulation, input current limit regulation, Charging mode, and trickle Charging mode. [Figure 3](#) shows the top view of the evaluation board and highlights the key testing points and connection terminals. For more information about the RAA489108, including other modes of operation, refer to the *RAA489108 Datasheet*.

### 1.2.1 System Voltage Regulation

1. Set the power supply to 5V. Disable the output and connect the (+) end to J1 and the (-) end to J2.
2. Ensure jumpers JP3, JP4, and JP6 are shorted. SW1 and SW2 should switch to the low position.
3. Turn on the power supply and measure VSYS using the DMM across (+) and (-) TP5. VSYS should read either 8.38V for 2 cell, or 12.576V for 3 cell. The current meter on the supply should read <100mA. Slowly increase VIN from 5V to 30V. Monitor PH1 and PH2 to observe seamless switching from Boost mode to Buck-Boost mode, and finally into Buck mode.

### 1.2.2 Input Current Limit Regulation

1. Keep VIN as a constant value between 3.9V and 30V. Set the battery emulator voltage to 7.8V and connect the battery emulator output to battery leads J5 and J6. Turn on the battery emulator; there is no charge and discharge current for the battery, which is consistent with the BGATE signal of a high voltage level.
2. Add an electrical load on VSYS and GND terminals J3 and J4. Turn on the load and increase the electrical load slowly; the input current increases correspondingly and VSYS keeps stable at 8.38V. The output voltage (VSYS) starts dropping as the input current reaches the 1.5A input current limit. Refer to the *RAA489108*

Datasheet for more information about the input current limit. If the VSYS voltage is 150mV lower than the battery voltage, the BGATE FET turns on at a low voltage level so that the battery supplies the current to the load.

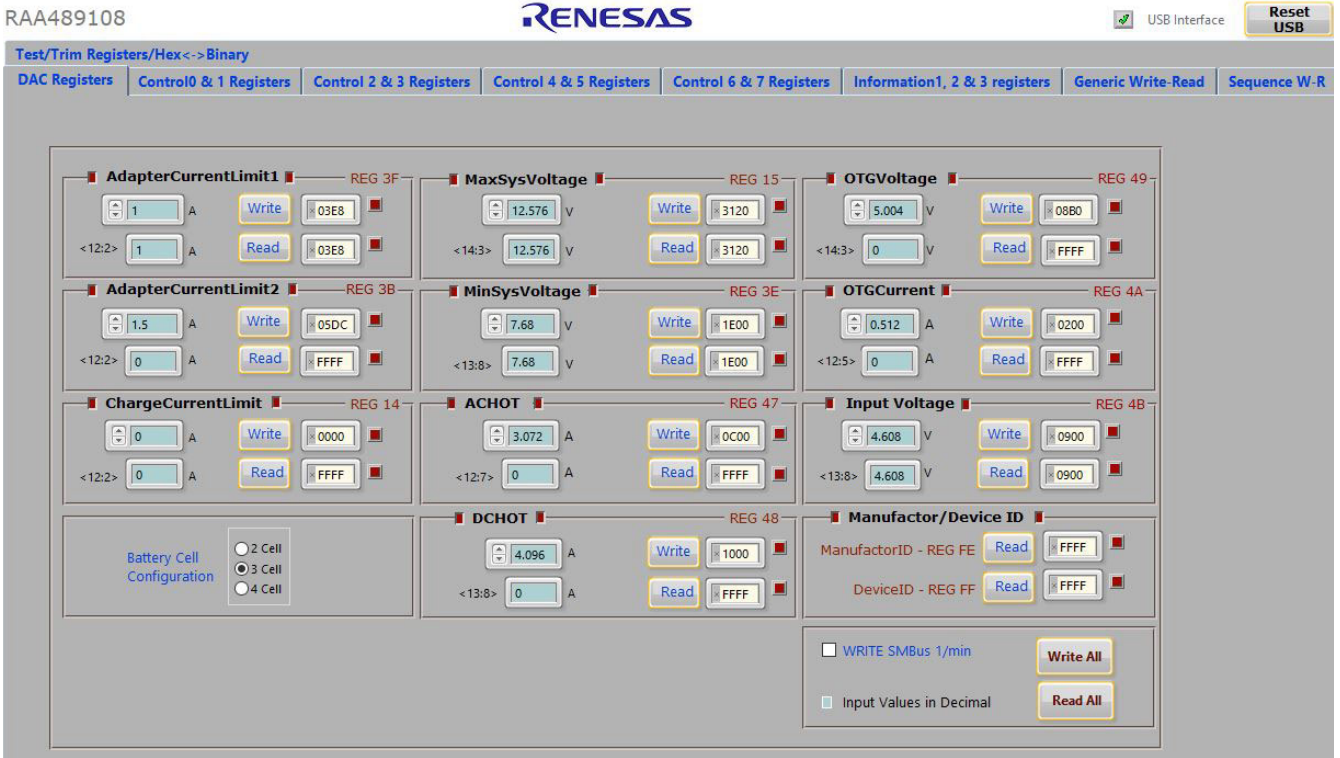


Figure 2. GUI Snapshot

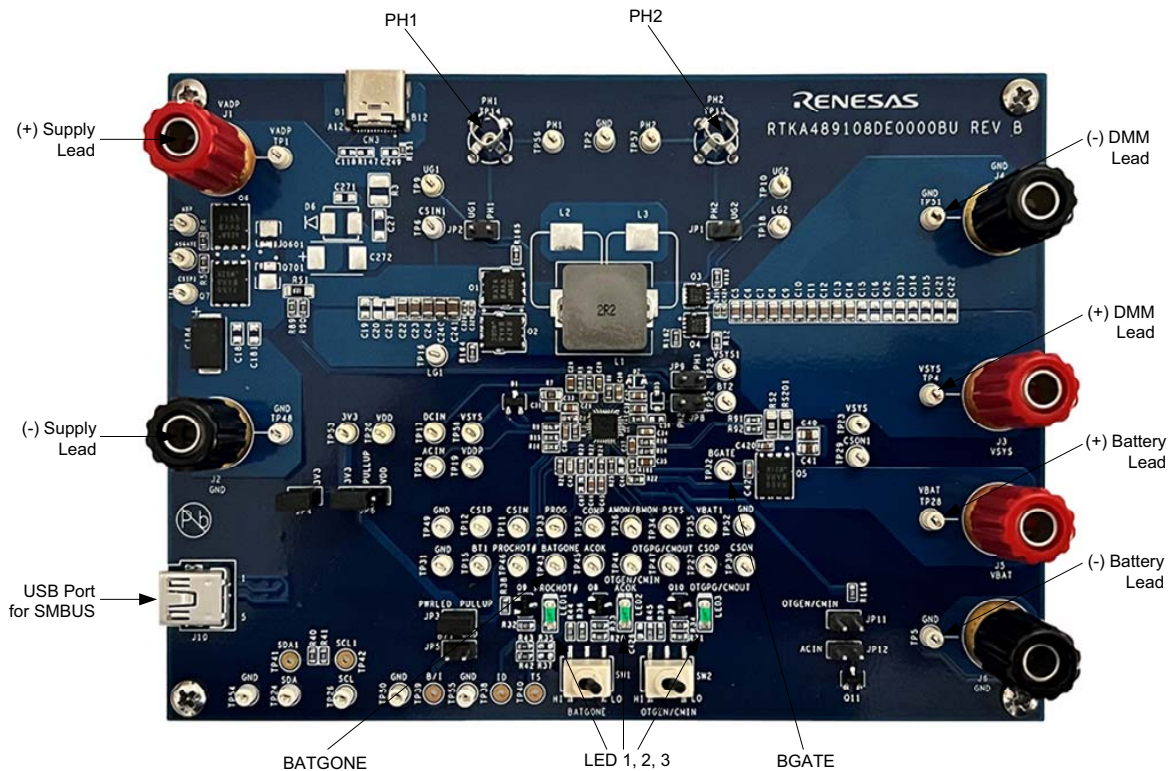


Figure 3. Evaluation Board Connection Guideline

### 1.2.3 Charging Mode

1. Set the power supply to a constant value between 3.9V and 23.4V, then complete steps 1 and 2 in [System Voltage Regulation](#). Make sure the input current does not reach the limit.
2. Set the battery emulator voltage to 7.8V and connect the battery emulator output to battery leads J5 and J6.
3. Connect the USB cable at the USB port for the SMBus. LED 1, LED 2, and LED 3 all turn on.
4. Turn on the power supply; LED 3 turns off. Turn on the battery emulator and open the RAA489108 GUI (shown in [Figure 2](#)).

*Note:* A green check mark in the **USB Interface** section of the GUI indicates the GUI is ready to communicate with the evaluation board. A red X in the **USB Interface** section indicates the GUI is not ready to communicate with the evaluation board. Click the **Reset USB** button until a green check mark shows in the **USB Interface**. If a green check mark does not appear, verify the USB connection.

5. Select **2 Cell** in the **Battery Cell Configuration** section. Click the **Write All** button. All controller register values are set to the corresponding default values. The system voltage is 8.4V, which is the value of **MaxSysVoltage** in the GUI. There is no charge and discharge current for the battery.
6. Change the **ChargeCurrentLimit** from 0A to 2A and click the **Write** button. The battery is now in a 2A current charge configuration. The charge current value can be monitored in the GUI by clicking the **Read** button in the **ChargeCurrentLimit** section. Monitor the BGATE signal status to confirm that the battery is in Charging mode.
7. If the RS1 and RS2 values are different from the RS1 = 20mΩ and RS2 = 10mΩ option, scale the SMBus commands accordingly to obtain the correct current. Smaller current sense resistor values reduce the power loss and larger current sense resistor values give better accuracy. For example, if using RS1 = 10mΩ and RS2 = 5mΩ, which is the populated sensing resistors on the evaluation board, multiply each value in the DAC table by 2.

*Note:* Make sure the input current does not reach the input current limit value, especially for a small VIN input.

### 1.2.4 Trickle Charging Mode

1. Complete steps one through six in [Charging Mode](#) without any changes.
2. Decrease the battery emulator voltage and monitor the battery charging current. As long as the battery emulator voltage is less than 5.2V (lower than SystemMinVoltage), the battery enters trickle Charging mode and the charge current decreases to 0.26A. The trickle charge current value can be changed through the SMBus control registers. Refer to the *RAA489108 Datasheet* for more information.

*Note:* Make sure the input current does not reach the input current limit value, especially for small VIN input.

## 2. Board Design

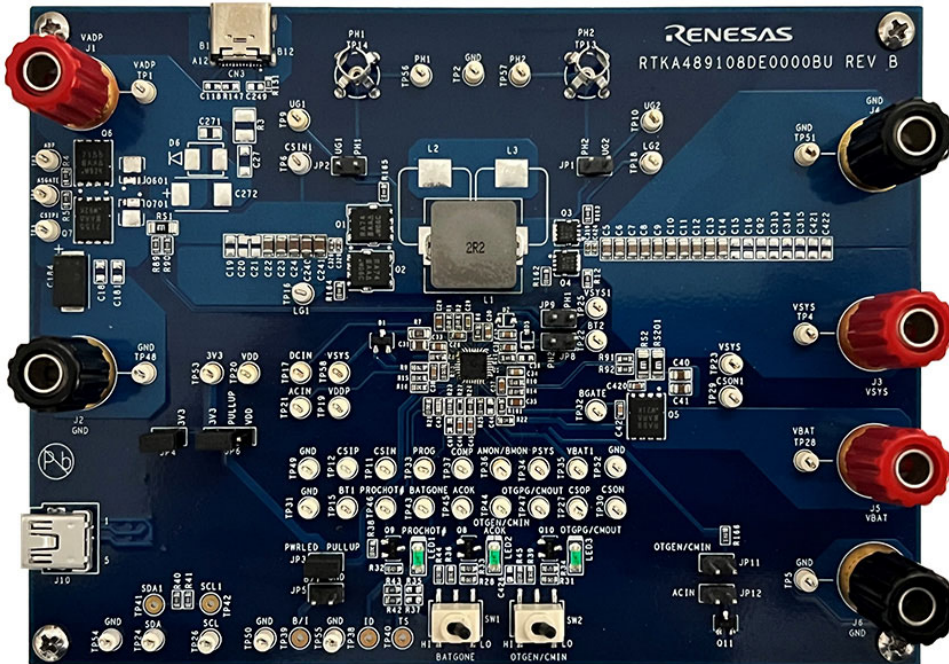


Figure 4. RTKA489108DE0000BU Evaluation Board (Top)

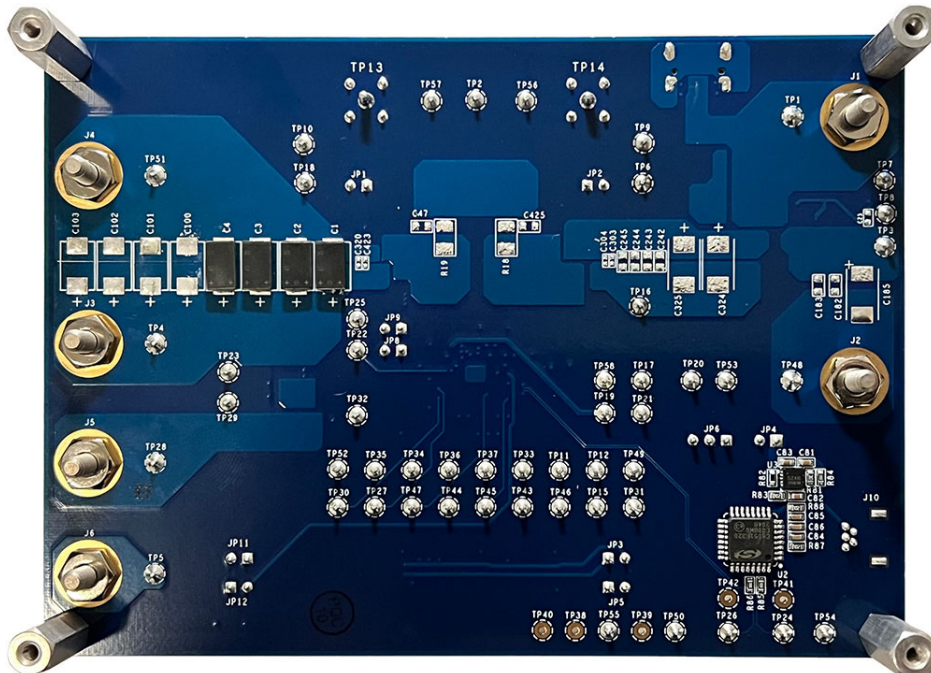
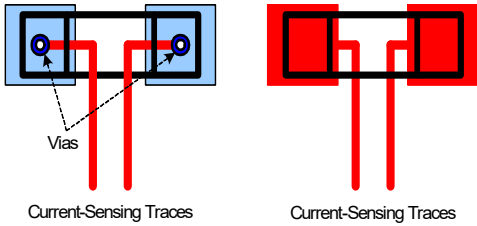
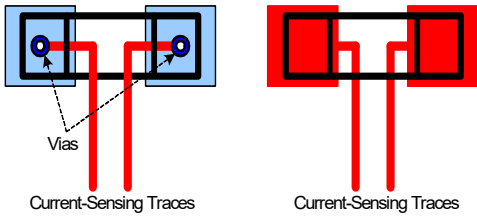


Figure 5. RTKA489108DE0000BU Evaluation Board (Bottom)

## 2.1 Layout Guidelines

Pin #	Pin Name	Layout Guidelines
Bottom Pad 33	GND	Connect the ground pad to the ground plane through a low impedance path. Use at least five vias to connect to the ground planes in the PCB to ensure sufficient thermal dissipation directly under the IC.
1	CSON	Run two dedicated traces with sufficient width parallel (close to each other to minimize the loop area) to 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.
2	CSOP	<p>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.</p> 
3	VSYS	Signal pin provides feedback for the system bus voltage. Place the optional RC filter in the general proximity of the controller. Run a dedicated trace from the system 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.
4	BOOT2	Switching pin. Place the bootstrap capacitor in the general proximity of the controller. Use sufficiently wide traces. Do not allow any sensitive analog signal traces to cross over or get close to this pin.
5	UGATE2	Run the UGATE2 and PHASE2 traces in parallel with sufficient width. Do not allow any sensitive analog signal traces to cross over or get close to this pin. Renesas recommends routing the PHASE2 trace to the high-side MOSFET source pin instead of general copper.
6	PHASE2	<p>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.</p> <p>Place the output capacitors as close as possible to the switching high-side MOSFET drain and the low-side MOSFET source. Use the shortest PCB trace connection. Place the capacitors on the same PCB layer as the MOSFETs instead of on different layers and using vias to make the connection.</p> <p>Place the inductor terminal as close as possible to the switching high-side MOSFET drain and low-side MOSFET source terminal. 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 PCB layer.</p>
7	LGATE2	Switching pin. Run the LGATE2 trace parallel to the UGATE2 and PHASE2 traces on the same PCB layer. Use sufficient width. Do not allow any sensitive analog signal traces to cross over or get close to this pin.
8	VDDP	Place the decoupling capacitor in the general proximity of the controller. Run the trace connecting to the VDD pin with sufficient width.
9	LGATE1	Switching pin. Run the LGATE1 trace parallel to the UGATE1 and PHASE1 traces on the same PCB layer. Use sufficient width. Do not allow any sensitive analog signal traces to cross over or get close to this pin.



Pin #	Pin Name	Layout Guidelines
10	PHASE1	Run the PHASE1 and UGATE1 traces in parallel with sufficient width. Do not allow any sensitive analog signal traces to cross over or get close to these pins. Renesas recommends routing the PHASE1 trace to the high-side MOSFET source pin instead of general copper.
11	UGATE1	<p>Place the IC close to the switching MOSFET's gate terminals 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.</p> <p>Place the input capacitors as close as possible to the switching high-side MOSFET drain and the low-side MOSFET source. Use the shortest PCB trace connection. Place the input capacitors on the same PCB layer as the MOSFETs instead of on different layers and using vias to make the connection.</p> <p>Place the inductor terminal to the switching high-side MOSFET drain and low-side MOSFET source terminal as close as possible. Minimize the 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.</p>
12	BOOT1	Switching pin. Place the bootstrap capacitor in the general proximity of the controller. Use a sufficiently wide trace. Do not allow any sensitive analog signal traces to cross over or get close to this pin.
13	ASGATE	Run this trace with sufficient width parallel to the ADP pin trace.
14	CSIN	Run two dedicated traces with sufficient width parallel to (close to each other to minimize the loop area) 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.
15	CSIP	<p>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.</p> 
16	ADP	Run this trace with sufficient width parallel to 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 VSYS trace to the OR diodes with sufficient width.
18	VDD	Place the RC filter connecting with the VDDP pin in general proximity of the controller. Run the trace connecting to 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	CMIN	No special consideration.
21	SDA	Digital pins. No special consideration. Run the SDA and SCL traces in parallel.
22	SCL	
23	PROCHOT#	Digital pin, open-drain output. No special consideration.
24	ACOK	
25	BATGONE	Digital pin. Place the 100kΩ resistor series in the BATGONE signal trace and the optional decoupling capacitor in the general proximity of the controller.
26	CMOUT	Digital pin, open-drain output. No special consideration.

<b>Pin #</b>	<b>Pin Name</b>	<b>Layout Guidelines</b>
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. Do not allow any switching signals to cross over or get close to this pin.
29	AMON/BMON	No special consideration. Place the optional RC filter in the general proximity of the controller.
30	PSYS	Signal pin, current source output. No special consideration.
31	VBAT	Place the optional RC filter in the general proximity of the controller. Run a dedicated trace from the battery positive connection point to the IC.
32	BGATE	Use a sufficiently wide trace from the IC to the BGATE MOSFET gate. Place the capacitor from BGATE to ground close to the MOSFET.

## 2.2 Schematic Diagrams

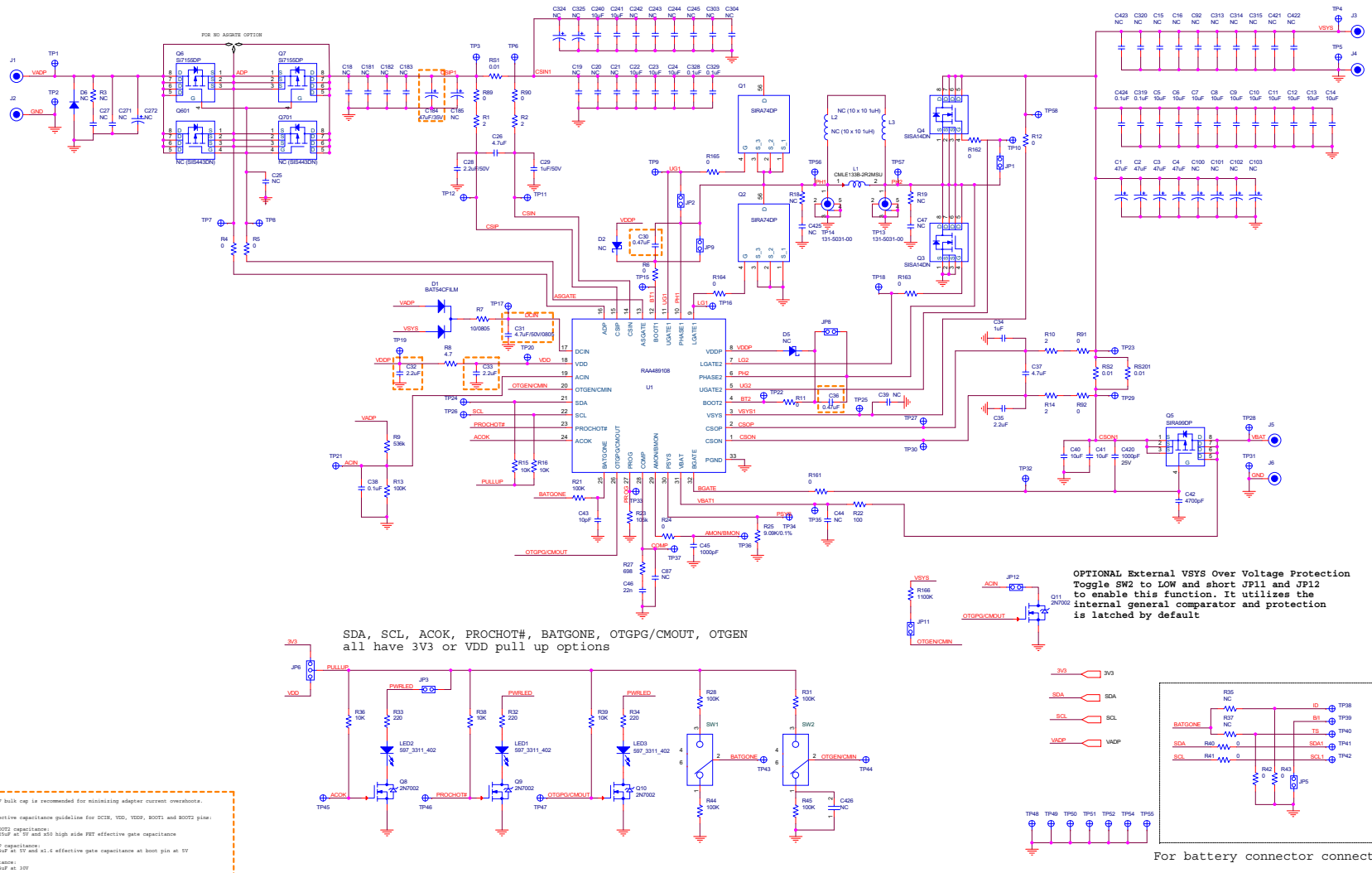


Figure 6. Schematic (1 of 2)

C21P: A 47µF bulk cap is recommended for minimizing adaptive current overshoots.  
 Minimum effective capacitance guideline for DC1B, VDD, VDDP, BOOT1 and BOOT2 pins:  
 BOOT1 and BOOT2 capacitance:  
 At least 0.5µF at 5V and high side PBT effective gate capacitance  
 VDD and VDDP capacitance:  
 At least 0.5µF at 5V and at least 1.6 effective gate capacitance at boot pin at 5V  
 DC1B capacitance:  
 At least 0.5µF at 30V

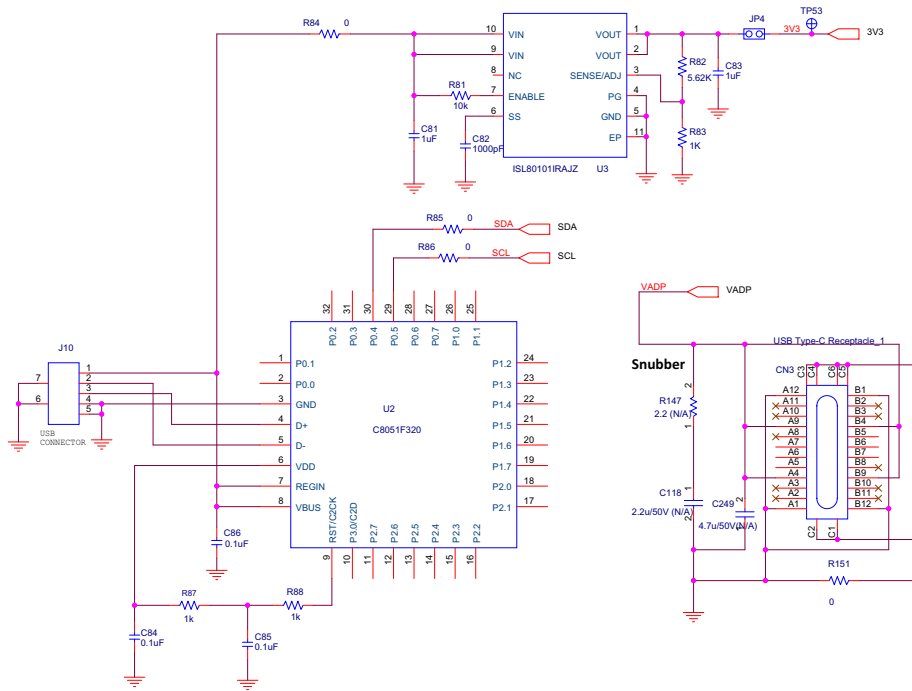


Figure 7. Schematic (2 of 2)

### 2.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	CN3	USB-C Receptacle Connector 24 Position Surface Mount, Right Angle; Through Hole, ROHS	JAE Electronics	DX07S024JJ2R1300
4	C1, C2, C3, C4	CAP, SMD, TANT, 47µF, 25V, 2917, 55mΩ /at 100kHz, ROHS	Vishay Polytech	T52E5476M025C0055
12	C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C40, C41	CAP, SMD, 0805, 10µF, 25V, 10%, X5R, ROHS	TDK Corporation	C2012X5R1E106K085AC
5	C22, C23, C24, C240, C241	CAP, SMD, 0805, 10µF, 35V, 10%, X5R, ROHS	Murata Electronics	GRM21BR6YA106KE43L
1	C31	CAP, SMD, 0805, 4.7µF, 50V, 10%, X7S, ROHS	Murata Electronics	GRM21BC71H475KE11K
2	C26, C37	CAP, SMD, 0603, 4.7µF, 16V, 10%, X5R, ROHS	Murata Electronics	GRM188R61C475KE11D
2	C28, C35	CAP, SMD, 0603, 2.2µF, 50V, 10%, X5R, ROHS	Murata Electronics	GRM188R61H225KE11D Alt: GRT188R61H225KE13D
2	C32, C33	CAP, SMD, 0603, 2.2µF, 10V, 10%, X7R, LOW ESL, ROHS	TDK Corporation	C1608X7R1A225K080AC
3	C34, C81, C83	CAP, SMD, 0603, 1µF, 25V, 10%, X5R, ROHS	Murata Electronics	GRM185R61E105KA12D
1	C29	CAP, SMD, 0603, 1µF, 50V, 10%, X5R, ROHS	Murata Electronics	GRT188R61H105KE13D

2	C30, C36	CAP, SMD, 0603, 0.47 $\mu$ F, 50V, 10%, X7R, ROHS	TDK Corporation	C1608X7R1E474K080AE
4	C38, C84, C85, C86	CAP, SMD, 0603, 0.1 $\mu$ F, 25V, 10%, X7R, ROHS	YAGEO	CC0603KRX7R8BB104
4	C319, C328, C329, C424	CAP, SMD, 0402, 0.1 $\mu$ F, 50V, 10%, X7R, ROHS	Murata Electronics	GRM155R71H104KE14J
1	C42	CAP, SMD, 0603, 4700pF, 100V, 10%, X7R, ROHS	TDK Corporation	C1608X7R2A472K080AA
1	C43	CAP, SMD, 0603, 10pF, 50V, 1%, C0G, ROHS	TDK Corporation	C1608C0G1H100D080AA
3	C45, C82, C420	CAP, SMD, 0603, 1000pF, 50V, 10%, X7R, ROHS	TDK Corporation	CGA3E2X7R1H102K080AA
1	C46	CAP-AEC-Q200, SMD, 0603, 0.022 $\mu$ F, 25V, 10%, X7R, ROHS	TDK Corporation	CGJ3E2X7R1E223K080AA
1	C184	CAP, SMD, TANT, 47 $\mu$ F, 35V, 2917, 70m $\Omega$ at 100kHz, ROHS	Vishay Polytech	T52E5476M035C0070
1	D1	DIODE-RECTIFIER, SMD, SOT23, 40V, 300mA, DUAL DIODE, ROHS	STMicroelectronics	BAT54CFILM
3	J1, J3, J5	CONN BIND POST KNURLED RED	Cinch Connectivity Solutions Johnson	111-0702-001
3	J2, J4, J6	CONN BIND POST KNURLED BLACK	Cinch Connectivity Solutions Johnson	111-0703-001
9	JP1, JP2, JP3, JP4, JP5, JP8, JP9, JP11, JP12	CONN HEADER VERT 2POS	TE Connectivity AMP Connectors	9-146258-0-01
1	JP6	CONN HEADER VERT 3POS 2.54MM	Würth Elektronik	61300311121
3	LED1, LED2, LED3	LED GREEN DIFFUSED 1206 SMD	Visual Communications Company	CMD15-21VGD/TR8
4	Q8, Q9, Q10, Q11	MOSFET N-CH 60V 190MA TO236AB	Nexperia USA Inc.	2N7002NXAKR
4	R1, R2, R10, R14	RES, SMD, 0603, 2 $\Omega$ , 1/10W, 1%, TF, ROHS	YAGEO	RC0603FR-072RL
23	R4, R5, R6, R11, R12, R24, R40, R41, R42, R43, R84, R85, R86, R89, R90, R91, R92, R151, R161, R162, R163, R164, R165	RES, SMD, 0603, 0 $\Omega$ , Jumper, 1/10W, TF, ROHS	Vishay Dale	CRCW06030000Z0EAC
1	R7	RES, SMD, 0805, 10 $\Omega$ , Jumper, 2/5W, 5%, Pulse Withstanding TF, ROHS	Rohm Semiconductor	ESR10EZPJ100
1	R8	4.7 $\Omega$ s $\pm$ 1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Moisture Resistant Thick Film	YAGEO	RC0603FR-074R7L
1	R9	RES, SMD, 0603, 536k $\Omega$ , 1/10W, 1%, TF, ROHS	YAGEO	RC0603FR-07536KL
6	R13, R21, R28, R31, R44, R45	RES, SMD, 0603, 100k $\Omega$ , 1/10W, 1%, TF, ROHS	YAGEO	RC0603FR-07100KL

6	R15, R16, R36, R38, R39, R81	RES, SMD, 0603, 10kΩ, 1/10W, 1%, TF, ROHS	YAGEO	RC0603FR-0710KL
1	R22	RES, SMD, 0603, 100Ω, 1/10W, 1%, TF, ROHS	TE Connectivity Passive Product	CRG0603F100R
1	R23	RES, SMD, 0603, 105kΩ, 1/10W, 1%, TF, ROHS	YAGEO	RC0603FR-07105KL
1	R25	RES, SMD, 0603, 9.09kΩ, 1/10W, 0.1%, TF, ROHS	YAGEO	RT0603BRD079K09L
1	R27	RES, SMD, 0603, 698Ω, 1/10W, 1%, TF, ROHS	Panasonic Electronic Components	ERJ-3EKF6980V
3	R32, R33, R34	RES, SMD, 0603, 220Ω, 1/10W, 1%, TF, ROHS	YAGEO	RC0603FR-07220RL
1	R82	RES, SMD, 0603, 5.62kΩ, 1/10W, 1%, TF, ROHS	Panasonic Electronic Components	ERJ-3EKF5621V
3	R83, R87, R88	RES, SMD, 0603, 1kΩ, 1/10W, 1%, TF, ROHS	YAGEO	RC0603JR-071KL
2	SW1, SW2	SWITCH TOGGLE SPDT 0.4VA 20V	C&K	GT11MSCBE
51	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36, TP37, TP43, TP44, TP45, TP46, TP47, TP48, TP49, TP50, TP51, TP52, TP53, TP54, TP55, TP56, TP57, TP58	PC TEST POINT MINIATURE WHITE	Keystone Electronics	5002
2	TP13, TP14	Test Connectors PK 25 EA 136-0962-00 AND 131-4209-00	Tektronix	131-5031-00
3	JP3, JP4, JP6- Pins 1-2	CONN JUMPER SHORTING GOLD FLASH	Sullins Connector Solutions	SPC02SYAN
4	Four corners	STANDOFF, 4-40×3/4in, F/F, HEX, ALUMINUM, 0.25 OD, ROHS	Keystone Electronics	2204
4	Four corners	SCREW, 4-40×1/4in, PHILLIPS, PANHEAD, STAINLESS, ROHS	B&F Fastener Supply	H703-ND
1	J10	USB Connectors MINI USB, TYPE B, R/A, T/H	TE Connectivity	1734510-1
1	R166	RES 1.1MΩ 1% 1/10W 0603	YAGEO	RC0603FR-071M1L
3	RS1, RS2, RS201	RES-CURR.SENSE, SMD, 1206, 0.01Ω, 1W, 1%, 75ppm, ROHS	Vishay Dale	WSLP1206R0100FEA

1	U3	IC REG LINEAR POS ADJ 1A 10DFN	Renesas Electronics America Inc.	ISL80101IRAJZ
1	L1	FIXED IND, 2.2μH, 13.45x12.6x3mm, Universal footprint	Cyntec	CMLE133B-2R2MSU
2	Q1, Q2	SIRA74DP, 40V, $r_{DS(ON)} = 4.2m\Omega$ , SO-8, 5mmx6mm	Vishay Siliconix	SIRA74DP-T1-GE3
2	Q3, Q4	TRANSISTOR-MOS, N-CHANNEL, 8P, PWRPAK, 30V, 20A, ROHS	Vishay Siliconix	SISA14DN-T1-GE3
1	Q5	TRANSISTOR-MOS, P-CHANNEL, SO-8, 30V, 47.9A, ROHS	Vishay Siliconix	SIRA99DP-T1-GE3
2	Q6, Q7	TRANSISTOR-MOS, P-CHANNEL, SO-8, 40V, 3.6mΩ, ROHS	Vishay Siliconix	SI7155DP-T1-GE3
1	U2	8051 series Microcontroller IC	Silicon Labs	C8051F320
1	U1	RAA489108	Renesas Electronics America Inc.	

## 2.4 Board Layout

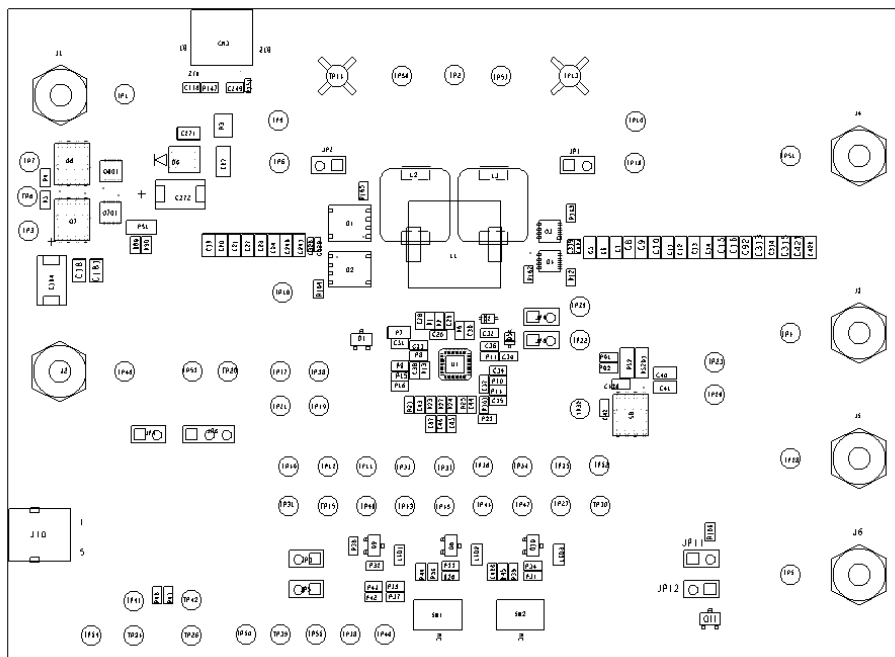


Figure 8. Top Layer

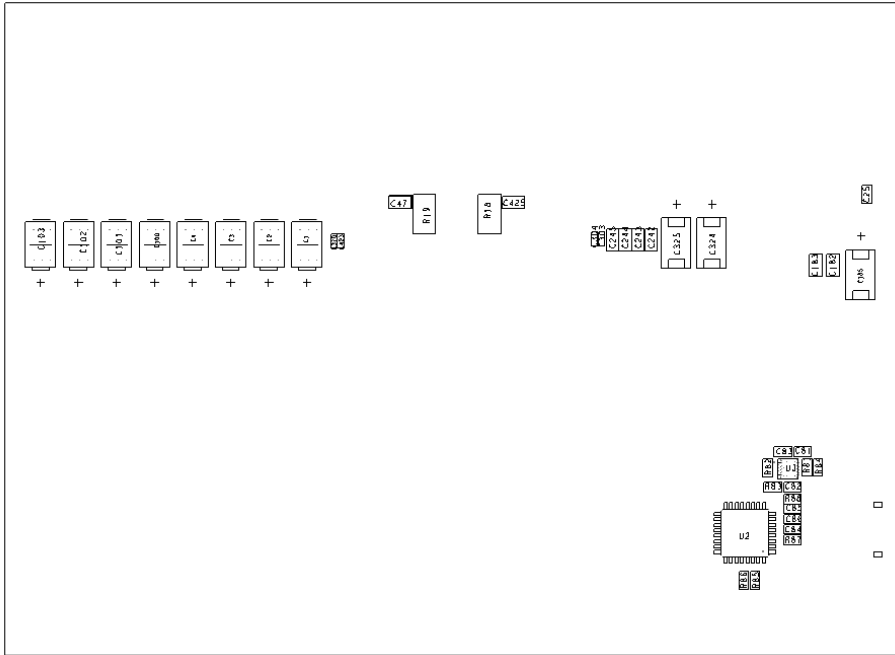


Figure 9. Bottom Layer

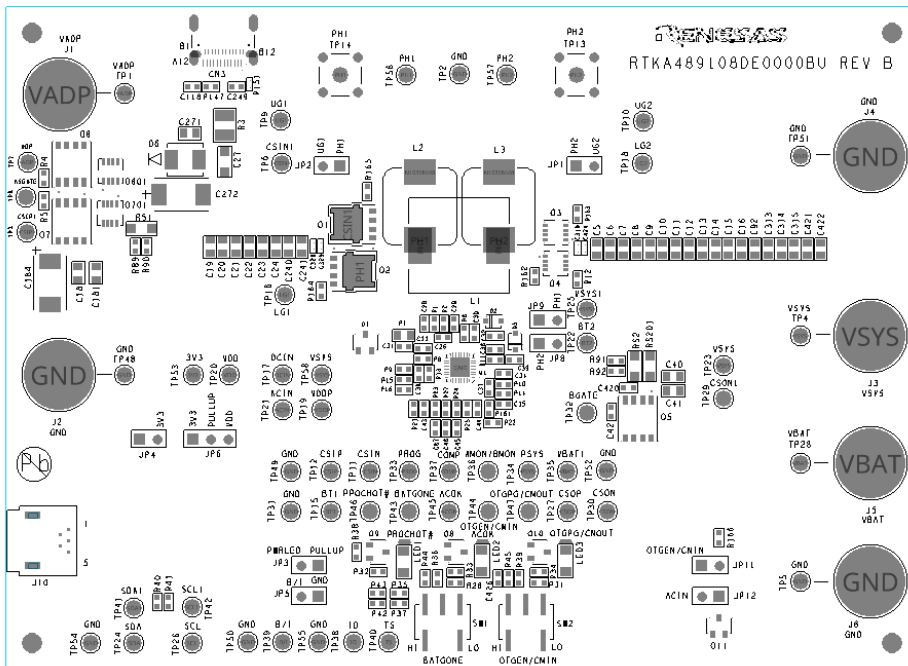


Figure 10. Top Silkscreen



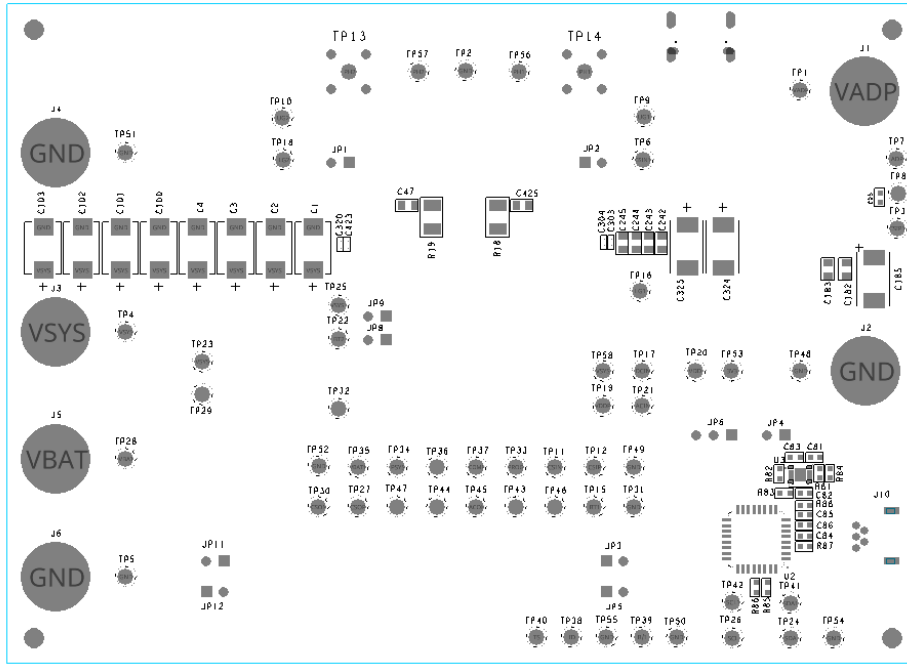


Figure 11. Bottom Silkscreen

### 3. Typical Performance Graphs

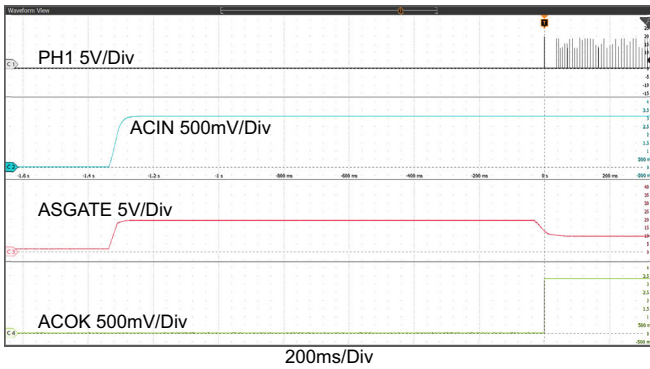


Figure 12. Adapter Insertion,  $V_{ADP} = 20V$ ,  $V_{BAT} = 11V$ , ChargeCurrent = 0A

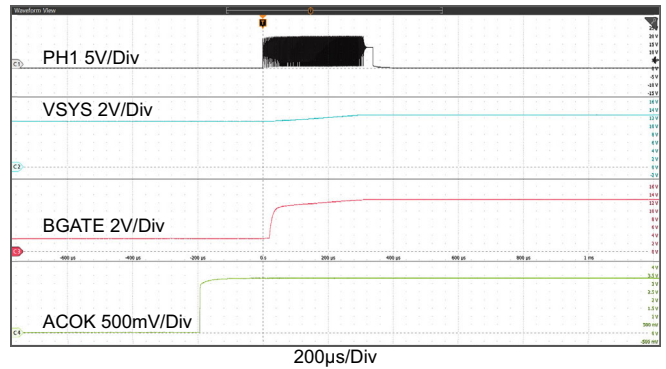


Figure 13. Adapter Insertion,  $V_{ADP} = 20V$ ,  $V_{BAT} = 11V$ , ChargeCurrent = 0A (Figure 12 Zoomed In)

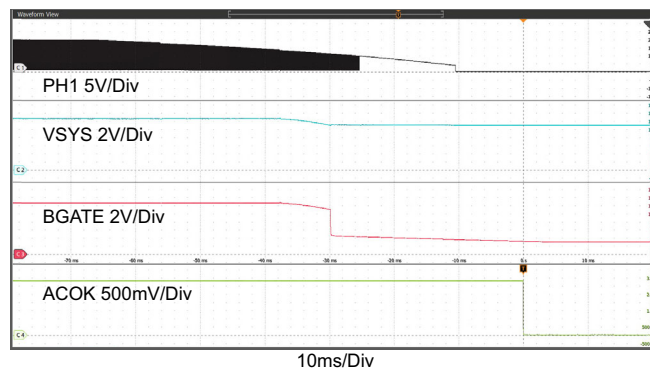
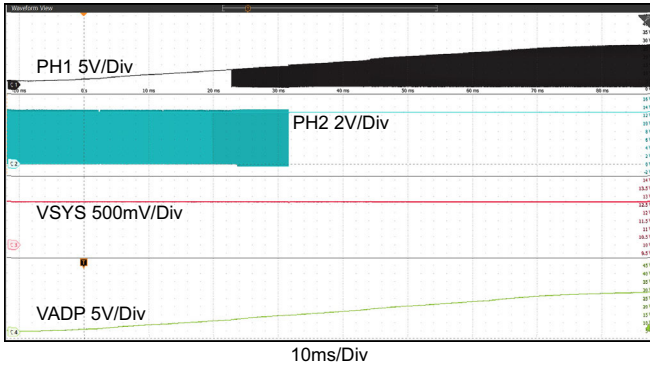
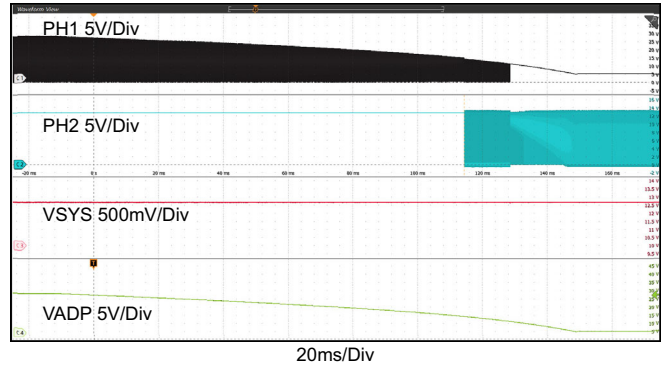


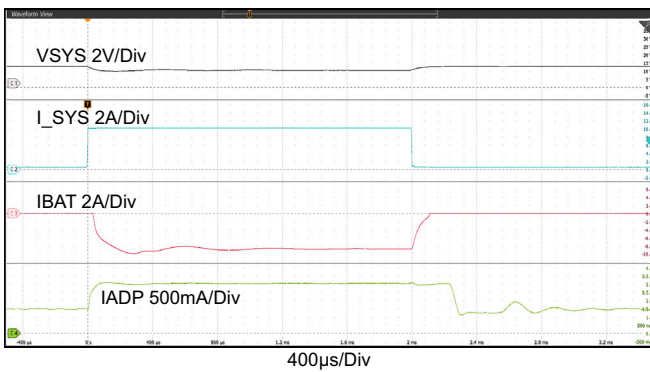
Figure 14. Adapter Removal,  $V_{ADP} = 20V$ ,  $V_{BAT} = 11V$ , ChargeCurrent = 0A



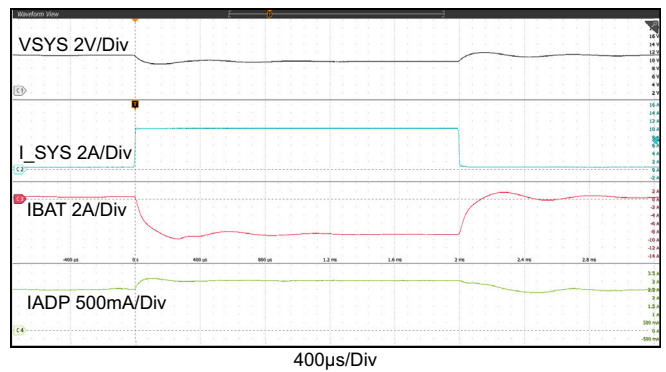
**Figure 15. Adapter Voltage Ramps Up, Boost -> Buck-Boost -> Buck Operation Mode Transition**



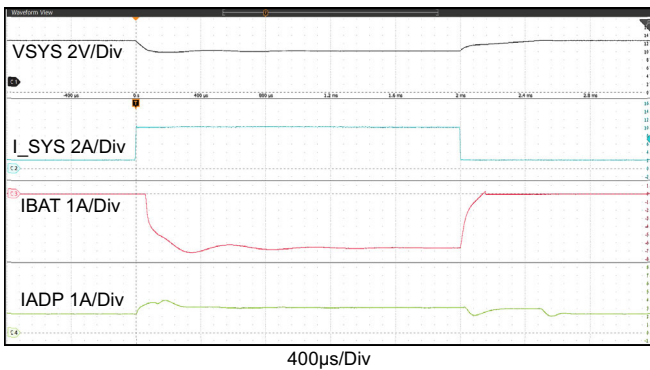
**Figure 16. Adapter Voltage Ramps Down, Buck -> Buck-Boost -> Boost Operation Mode Transition**



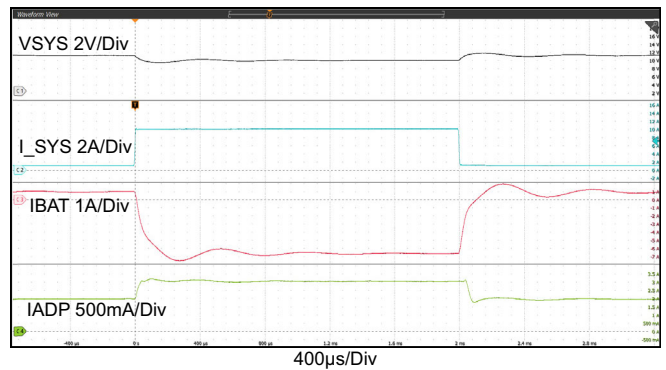
**Figure 17. Boost Mode, Output Voltage Loop to Adapter Current Loop Transition.  $V_{ADP} = 5V$ ,  $MaxSystemVoltage = 12.576V$ ,  $V_{BAT} = 11V$ , System Load 0.5A to 10A Step,  $AdapterCurrentLimit = 3A$ ,  $ChargeCurrent = 0A$**



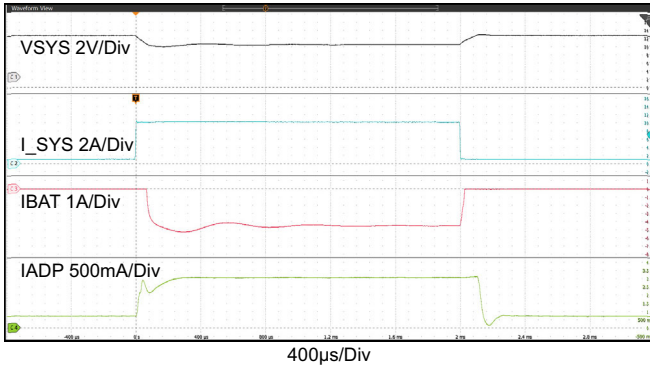
**Figure 18. Boost Mode, Charging Current Loop to Adapter Current Loop Transition.  $V_{ADP} = 5V$ ,  $MaxSystemVoltage = 12.576V$ ,  $V_{BAT} = 11V$ , System Load 0.5A to 10A Step,  $AdapterCurrentLimit = 3A$ ,  $ChargeCurrent = 0.5A$**



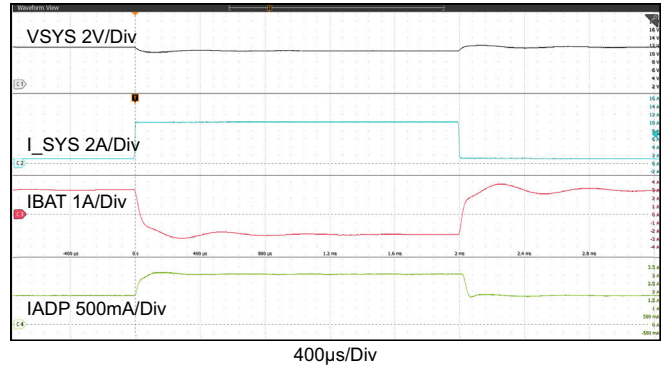
**Figure 19. Buck-Boost Mode, Output Voltage Loop to Adapter Current Loop Transition.  $V_{ADP} = 12V$ ,  $MaxSystemVoltage = 12.576V$ ,  $V_{BAT} = 11V$ , System Load 2A to 10A Step,  $AdapterCurrentLimit = 3A$ ,  $ChargeCurrent = 0A$**



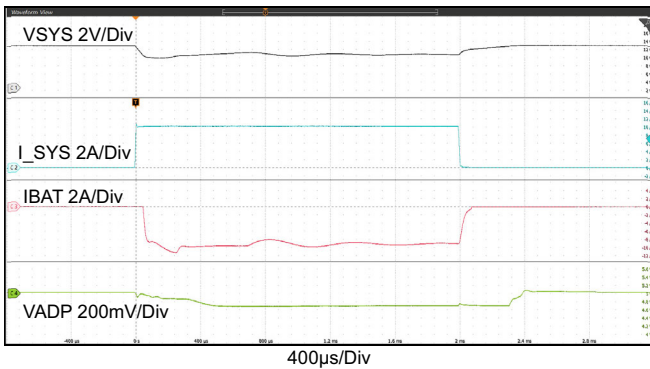
**Figure 20. Buck-Boost Mode, Charging Current Loop to Adapter Current Loop Transition.  $V_{ADP} = 12V$ ,  $MaxSystemVoltage = 12.576V$ ,  $V_{BAT} = 11V$ , System Load 1A to 10A Step,  $AdapterCurrentLimit = 3A$ ,  $ChargeCurrent = 1A$**



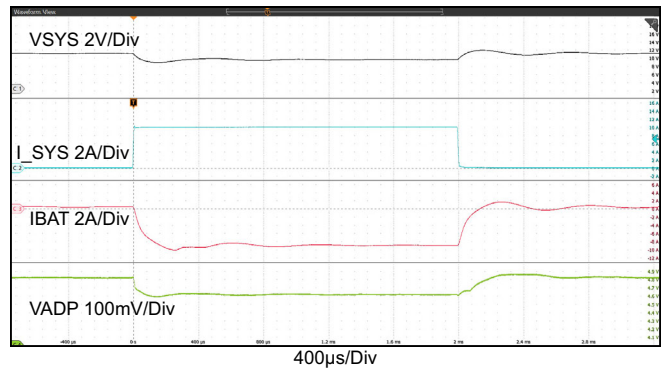
**Figure 21. Buck Mode, Output Voltage Loop to Adapter Current Loop Transition.  $V_{ADP} = 28V$ , MaxSystemVoltage = 12.576V,  $V_{BAT} = 11V$ , System Load 1A to 10A Step, AdapterCurrentLimit = 3A, ChargeCurrent = 0A**



**Figure 22. Buck Mode, Charging Current Loop to Adapter Current Loop Transition.  $V_{ADP} = 28V$ , MaxSystemVoltage = 12.576V,  $V_{BAT} = 11V$ , System Load 1A to 10A Step, AdapterCurrentLimit = 3A, ChargeCurrent = 3A**



**Figure 23. Boost Mode, Output Voltage Loop to Input Voltage Loop Transition.  $V_{ADP} = 5.004V$ , MaxSystemVoltage = 12.576V,  $V_{BAT} = 11V$ , VINDAC = 4.608V, System Load 0A to 10A Step, ChargeCurrent = 0A**



**Figure 24. Boost Mode, Charging Current Loop to Input Voltage Loop Transition.  $V_{ADP} = 5.004V$ , MaxSystemVoltage = 12.576V,  $V_{BAT} = 11V$ , VINDAC = 4.608V, System Load 0A to 10A Step, ChargeCurrent = 0.5A**

## 4. Ordering Information

Part Number	Description
RTKA489108DE0000BU	RAA489108 evaluation board

## 5. Revision History

Revision	Date	Description
1.02	Jul 10, 2023	Updated BOM Updated Figure 6.
1.01	Feb 24, 2023	Updated section 1.2.3 Charging Mode. Updated Schematic, Figure 6.
1.00	Feb 10, 2023	Initial release

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