RTKA489110DE0000BU

The RAA489110 is a configurable buck-boost Narrow Output Voltage DC (NVDC) and Hybrid Power Buck-Boost (HPBB/Bypass) combo charger that uses the advanced Renesas 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 RAA489110 takes input power from a wide range (4V 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 RAA489110 supports On-the-Go (OTG) functionality from 2-cell and 4-cell battery applications. When OTG function is enabled, the RAA489110 operates in Reverse Buck mode to provide 5V at the USB port.

Serial communication through SMBus/I^{2}C allows programming of many critical parameters to deliver a customized solution. These programming parameters include, but are not limited to, adapter current limit, charger current limit, system voltage setting, and trickle charging current limit.

The RTKA489110DE0000BU evaluation board demonstrates the performance of the RAA489110. From the PROG pin to GND, a resistor can be used to program the default value numbers of the battery in series, the switching frequency, and the adapter current limit charging function. The default value numbers can also be set by SMBus.

Specifications

- V_{IN} = 3.9V to 30V (no dead zone)
- V_{OUT} = 3.9V to 18.304V
- MAX I_{charge} up to 6A

Features

- Buck-boost NVDC or hybrid power (turbo boost) charger for 2-, 3-, or 4-cell Li-ion batteries using all N-MOSFET transistors
- Bypass mode supported to connect system to adapter
- Autonomous charging option (automatic end of charging)
- Adapter current and battery current monitor (AMON/BMON)
- PROCHOT# open-drain output, IMVP compliant
- Allows trickle charging of depleted battery
- System power monitor PSYS output, IMVP8/9 compliant
- Internal 8-bit ADC for monitoring key parameters
- USB-C PD Fast Role Swap support and PPS support
- Independent compensation pins for forward and reverse operation (OTG) modes
- Supports supplemental power (Intel VMIN active protection)
- Ideal diode control in Turbo mode
- Two-level adapter current limit available
- Battery Ship mode: IC ultra-low power state
- Supports programmable temperature profile compliance using an NTC
- SMBus and auto-increment I^{2}C compatible

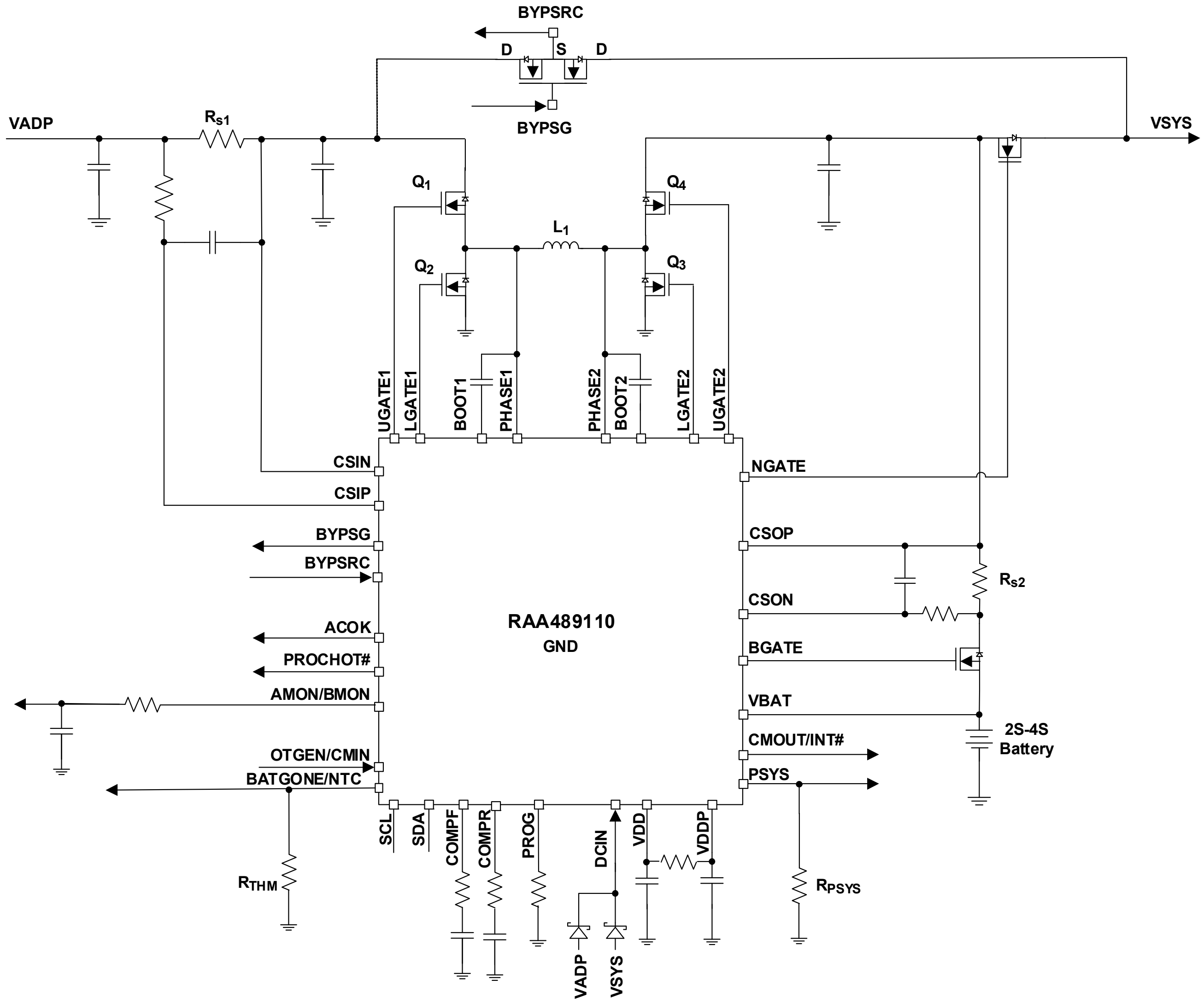


Figure 1. NVDC Plus HPBB Simplified Application Diagram

Recommended Equipment

- 0V to 40V power supply with at least 6A source current capability
- Electronic load capable of sinking current up to 12A
- 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 but cannot sink current) in parallel with an e-load Constant Current (CC) mode to emulate the battery. For example, when charging, set the charging current command lower than the CC mode e-load. If the e-load CC mode current is set at 3A, the charge current command is 2A and the e-load takes 2A from the charger and another 1A from the power supply in parallel with it. When discharging, the power supply acts just 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.

Contents

1. Functional Description

The RTKA489110DE0000BU evaluation board provides all circuits required to evaluate the features of the RAA489110. A majority of the features of the RAA489110 are available on the RTKA489110DE0000BU, such as adjustable output voltage, On-the-Go (OTG) mode, Trickle Charging mode for a depleted battery, and system power monitor at Buck, Boost, and Buck-Boost modes. The charger can be controlled through firmware to operate in Hybrid Power Buck-Boost or Bypass mode. Refer to the *RAA489110* datasheet for detailed information about the operation modes.

1.1 Setup and Configuration

The RAA489110 Control Software communicates with the RAA489110 controller using the USB to on-board SMBus Graphical User Interface (GUI). The GUI facilitates access to the RAA489110 SMBus registers.

This section describes how to install, start, and use the GUI.

1.1.1 Required Hardware

- RTKA489110DE0000BU evaluation board
- USB 2.0 A/B cable

1.1.2 Required Software

The software Installation Wizard package includes all three required components:

- RAA489110 SMBus Control Tool
- National Instruments Runtime VISA Engine
- USB interface module driver

1.1.3 Installing the GUI

Both the RAA489110 Control Software and the National Instruments Runtime Engine are installed automatically from the installation wizard.

Note: Close all other applications before this installation. Reboot the computer when the installation is complete.

1. Extract the zip file to the local drive and not the network drive. Network security prohibits copying an .inf file to a network.
2. Run autorun.exe. The menu in Figure 2 appears.

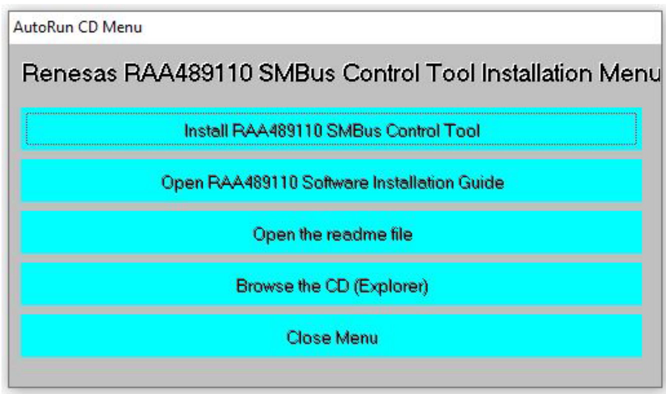


Figure 2. SMBus Control Tool Installation Wizard

3. Click **Install RAA489110 SMBus Control Tool**.
   a. The window shown in Figure 3 appears. Click **Next**.

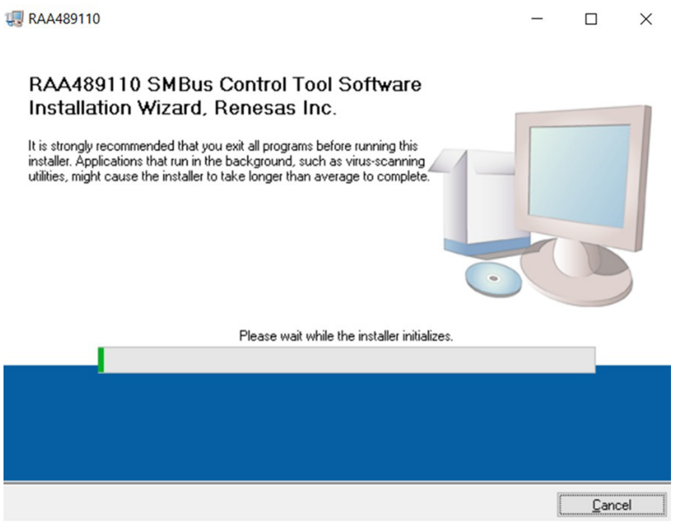


Figure 3. RAA489110 Control Software Installer

4. To complete the software installation, follow the instructions to accept both End User License Agreements.
5. Click **Close Menu** from the installation wizard.

1.1.4 Installing the USB Driver

This process explains how to install the SMBus to USB interface driver. The driver supports Microsoft Vista, Windows 7, Windows 8, and Windows 8.1 operating systems.

Note: If you installed the driver or certificate previously, skip this section.

1. Open the installation wizard package.
2. Navigate to USB-SMBus Driver. Right-click the SMBus-USB-Win10.inf file and select **Install**.

Note: Install the driver from the local drive. The driver installation fails due to network security if you install from the network drive.

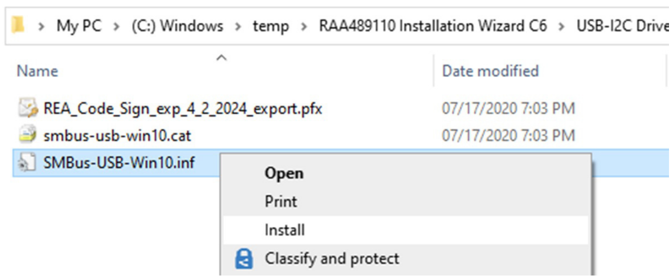


Figure 4. RAA489110 Driver Location

3. The message in Figure 5 appears when the driver is successfully installed.

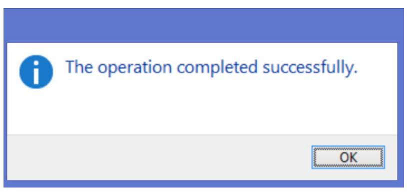


Figure 5. RAA489110 Successful Driver Installation

4. If the installation fails the Digital Signature required in Windows 10 or security settings, complete the following steps to bypass it.

Note: Print or note the following steps. The system restarts and these instructions are required to complete the process.

   a. Open the Command Prompt from the Start menu.
   b. Enter the command “shutdown /r /o /f /t 00” in the Command Prompt.
   c. Click **OK**.
   d. The system restarts to the Choose an option screen.
   e. Select **Troubleshoot** from the Choose an option screen.
   f. Select **Advanced options** from the Troubleshoot screen.
   g. Select **Windows Startup Settings** from the Advanced options screen.
   h. Click **Restart**.
   i. The system restarts to the Advanced Boot Options screen.
   j. Select **Disable Driver Signature Enforcement**.
   k. Restart and install the drivers.

1.2 Using the GUI

The RAA489110 SMBus Control Tool Software must be installed to use the evaluation system. Do not connect the RTKA489110DE0000BU evaluation board to the USB port until installation is complete.

Connect the RTKA489110DE0000BU to a power supply before using the SMBus GUI.

1.2.1 Setting the USB Connection

Connect the USB cable from the USB of the computer port to the connector J10 of the RTKA489110DE0000BU.

1.2.2 Starting the GUI

To start the GUI, navigate to the Start menu, then select **All Programs** → **Renesas** → **RAA489110 SMBus Control Tool**.

Figure 6 shows the GUI.

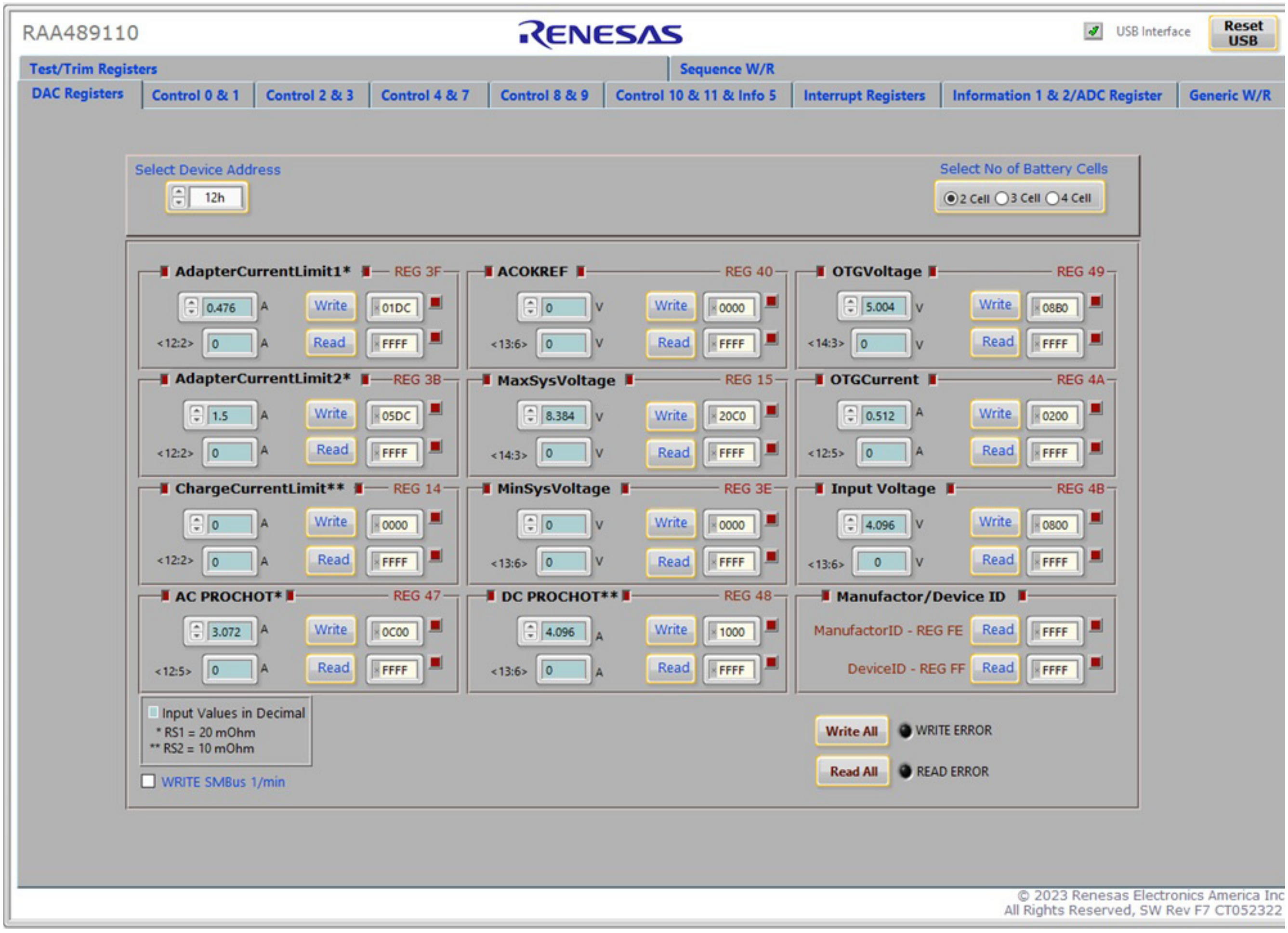


Figure 6. RAA489110 Graphical User Interface

1.2.3 Troubleshooting the GUI

Check the status of the USB interface at the top of the GUI. If the USB communication is OK, the USB Interface status shows a green check mark, as seen in Figure 6.

If the USB Interface status shows a red X, the computer cannot establish the connection. Complete the following steps to troubleshoot:

- Make sure the driver files for the USB interface are installed correctly. The driver files are in the USB-I2C Driver folder.
- Check the USB cable connections from the RTKA489110DE0000BU to the USB port of the computer.
- Try different sequences: plug in the RTKA489110DE0000BU first or start the GUI first.

If the problem continues, the USB driver may not be properly installed; therefore, the RTKA489110DE0000BU is not recognized. See Installing the USB Driver for driver installation instructions.

1.3 Quick Start Guide

The number of battery cell and adapter current limit default values can be configured with a standard 1% 0603 resistor (R13) from the PROG pin to GND. The *Prog Pin Programming Options* table in the *RAA489110* 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, which are implemented with the Renesas GUI shown in Figure 8.

The three LEDs indicate the ACOK, PROCHOT, and CMOUT/INT# status, respectively. For more details about the functions of these three pins, refer to the *RAA489110* datasheet.

Complete the following steps to evaluate the RAA489110 key functions, including system voltage regulation, input current limit regulation, Charging mode, trickle Charging mode, and OTG mode. Figure 7 shows the top view of the RTKA489110DE0000BU and highlights the key testing points and connection terminals. For more information about the RAA489110, including other operation modes, refer to the *RAA489110* datasheet.

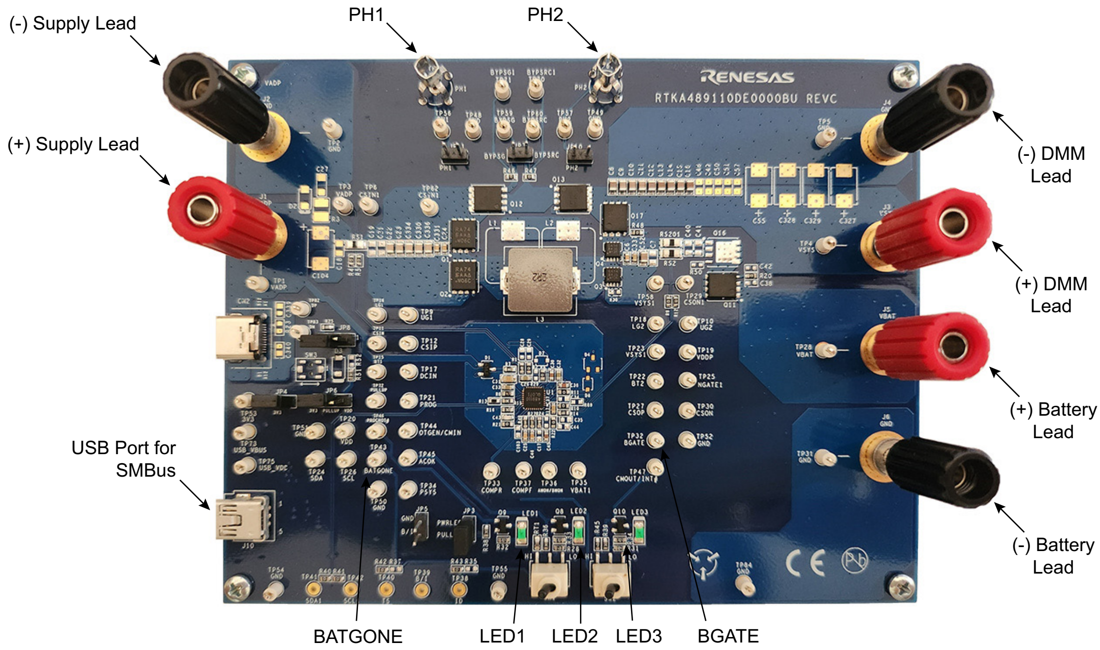


Figure 7. RTKA489110DE0000BU Evaluation Board (Top)

1.3.1 Regulating System Voltage

1. Set the power supply to 5V. Do not insert 28V adapter voltage directly to avoid inrush currents and damaging the EVB/IC. With the output disabled, 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 (+) TP4 and (-) TP5. VSYS should read 8.38V. The current meter on the supply should read <100mA. Slowly increase VADP from 5V to the target voltage (up to 30V). Monitor PH1 and PH2 to observe seamless switching from Boost mode to Buck-Boost mode and finally into Buck mode.

1.3.2 Regulating Input Current Limit

1. Keep VADP 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.
2. Turn on the battery emulator; there is no charge and discharge current for the battery, which is consistent with BGATE FET being off.
3. 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 0.476A input current limit. For the input current limit details, refer to the *RAA489110* datasheet. 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.

1.3.3 Configuring the RTKA489110DE0000BU for Charging Mode

1. Set the power supply to a constant value between 3.9V and 30V. Next, complete steps one and two in Regulating System Voltage. Make sure the input current does not exceed 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. LED1, LED2, and LED3 turn on.
4. Turn on the power supply. LED3 turns off. Next, turn on the battery emulator and open the Renesas RAA489110 GUI (Figure 8).

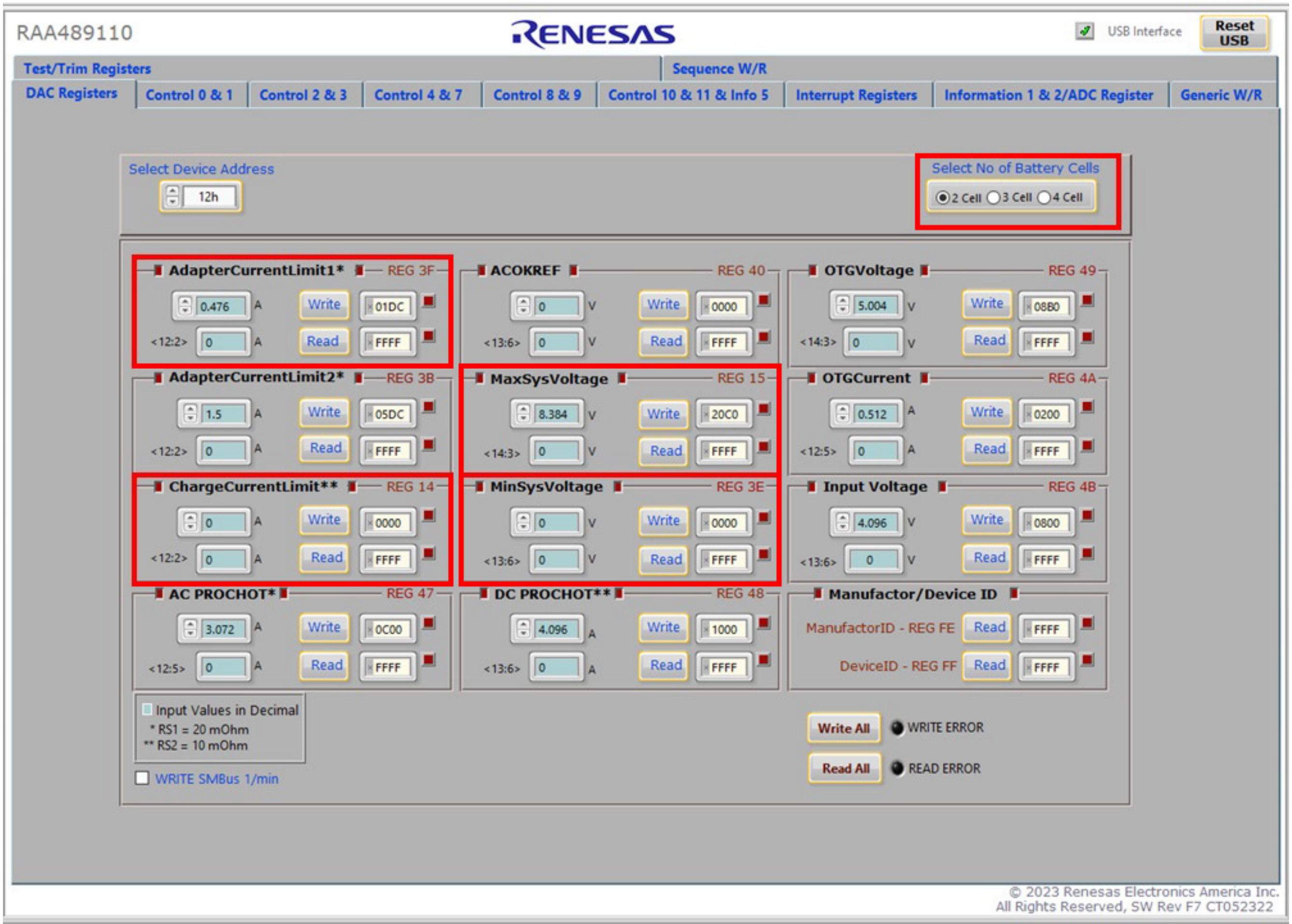


Figure 8. RAA489110 GUI

Note: A green check mark in the **USB Interface** status indicates the GUI is ready to communicate with the RTKA489110DE0000BU. If the **USB Interface** shows a red X, the GUI is not ready to communicate with the RTKA489110DE0000BU. Click the **Reset USB** button until a green check mark appears in the **USB Interface**. If the green check mark does not appear, check the USB connection. See Troubleshooting the GUI for troubleshooting information.

5. Select **2 Cell** in the **No of Battery Cell** section and click the **Write All** button. All controller register values are set to the default values correspondingly. 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. Set the minimum system voltage (**MinSysVoltage**) to a non zero value. Change the charge current limit (**ChargeCurrentLimit**) from 0A to 2A and click **Write**. The battery is now in 2A current charge operation. The charge current value can be monitored in the GUI by clicking **Read** in the **ChargeCurrentLimit** column. Monitor the BGATE signal status to confirm the battery is in Charging mode.

6. To turn on charging (trickle and fast/normal), set the **MinSysVoltage** register and the **ChargeCurrentLimit** register to non-zero values.
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 VADP input.

1.3.4 Configuring the RTKA489110DE0000BU for Trickle Charging Mode

1. Complete steps one through five in Configuring the RTKA489110DE0000BU for Charging Mode without any changes. Set the **MinSysVoltage** register and the **ChargeCurrentLimit** register to non-zero values.
2. Decrease the battery emulator voltage and monitor the battery charging current. If the battery emulator voltage is less than 5.2V (lower than **MinSysVoltage**), 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 *RAA489110* datasheet).

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

1.3.5 Configuring the RTKA489110DE0000BU for OTG Mode

1. Set the battery emulator voltage at a constant value between 5.8V and 15V. Connect battery leads J5 and J6 with the output disabled.
2. Connect an electric load on supply leads J1 and J2 with the output disabled.
3. Connect the USB cable at the USB port for SMBus. Only LED1 is on. Turn on the battery emulator and electrical load without adding any load.
4. Open the RAA489110 GUI. **OTGVoltage** is the voltage value for the load side, as shown in Figure 9, and **OTGCurrent** is the OTG output current limit at the load side. You can set these values as needed within the output limit range. Refer to the *RAA489110* datasheet for the limit ranges.

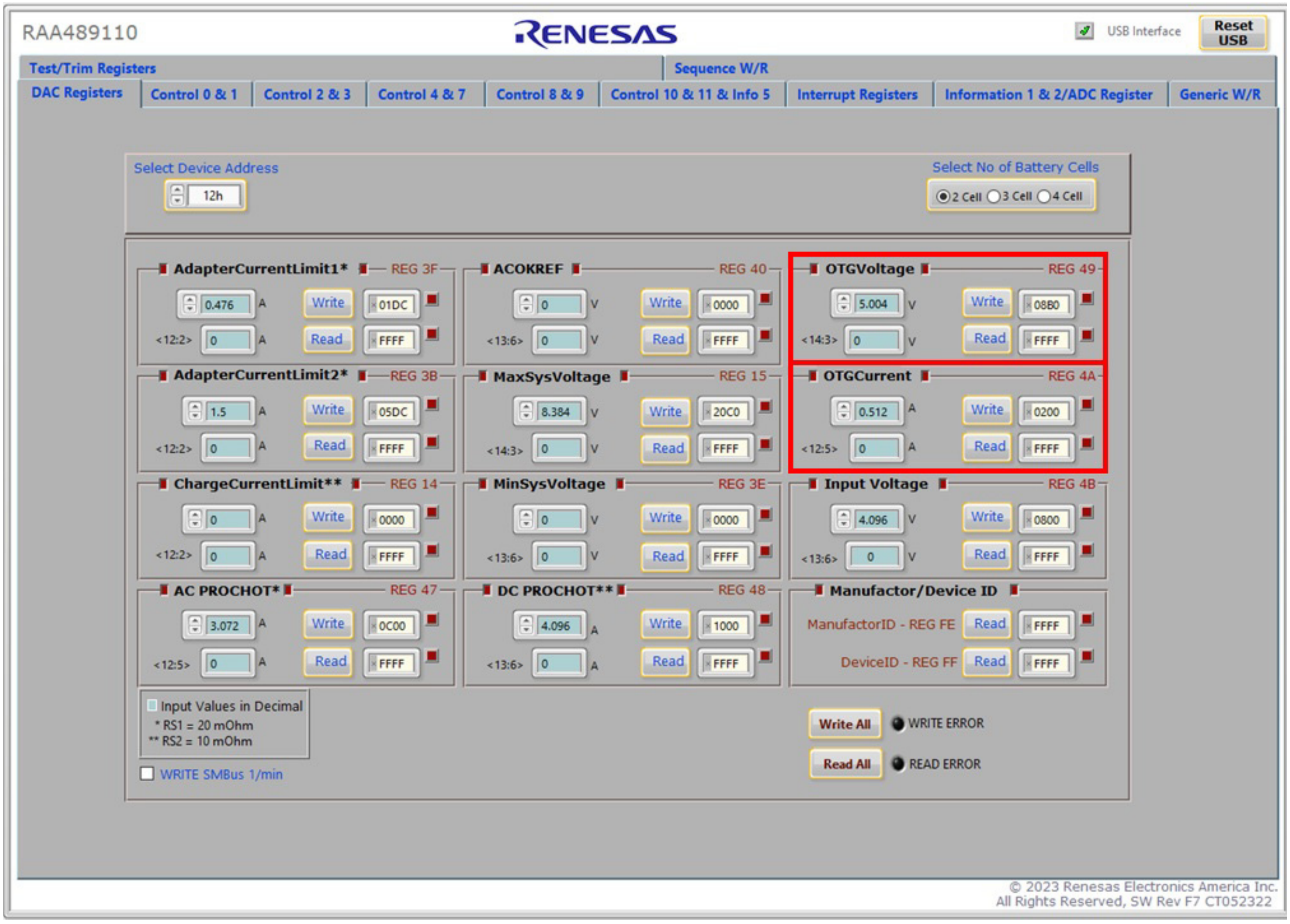


Figure 9. OTGVoltage and OTGCurrent Settings in GUI

5. Select the **Control0 & 1 Registers** tab.
6. In the **Control1 Register** column, select **1: Enable** in **OTG Function** to enable OTG, then click **Write**. See Figure 10.

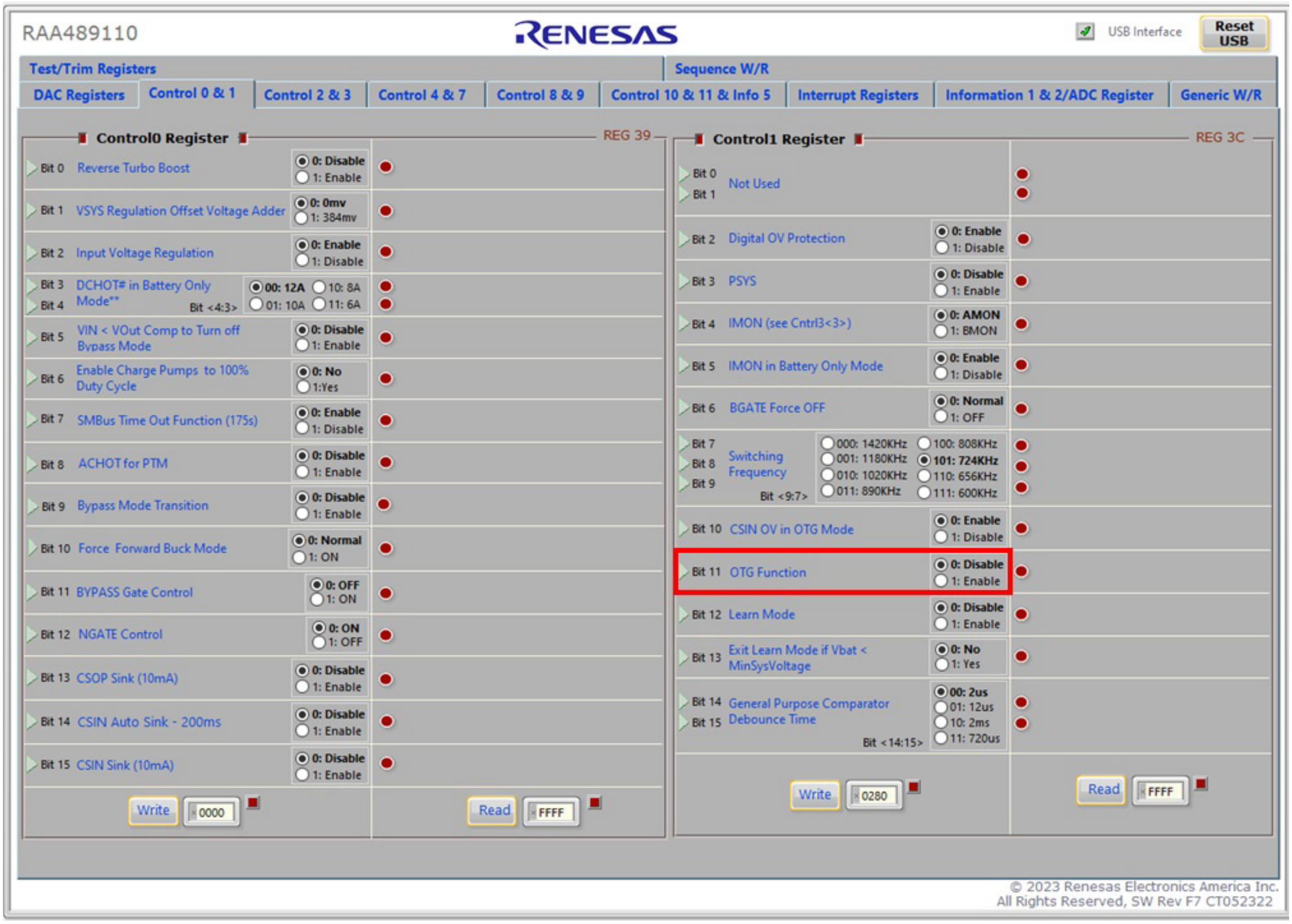


Figure 10. Enabling OTG Function

7. Switch SW_2 on the evaluation board to the HI position. The load voltage is regulated as an **OTGVoltage** value, set in step 4. LED3 is on indicating that the OTG function is enabled.
8. 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.

1.3.6 Configuring the RTKA489110DE0000BU for Bypass Mode

Refer to the *RAA489110* datasheet for information about how to transition between different NVDC and Bypass modes. The document also provides steps on how to enable charging in each mode and how to allow the battery to supplement the adapter in Bypass mode (reverse turbo boost).

1.3.7 Supplemental Mode (Intel VMIN Active Protection)

Refer to the *RAA489110* datasheet for information about how to enter Supplemental mode (Intel VMIN active protection).

2. Board Design

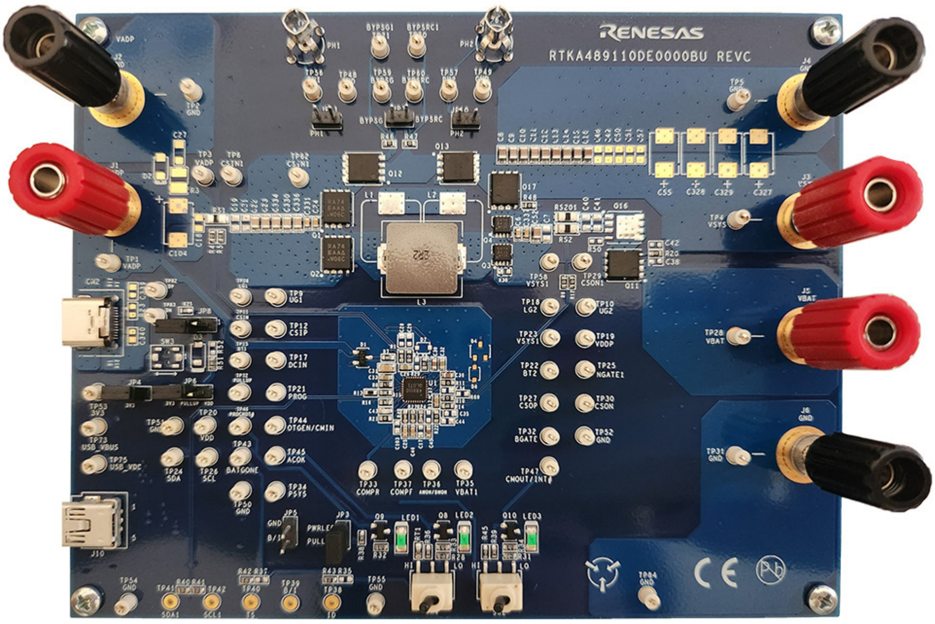


Figure 11. RTKA489110DE0000BU Evaluation Board (Top)

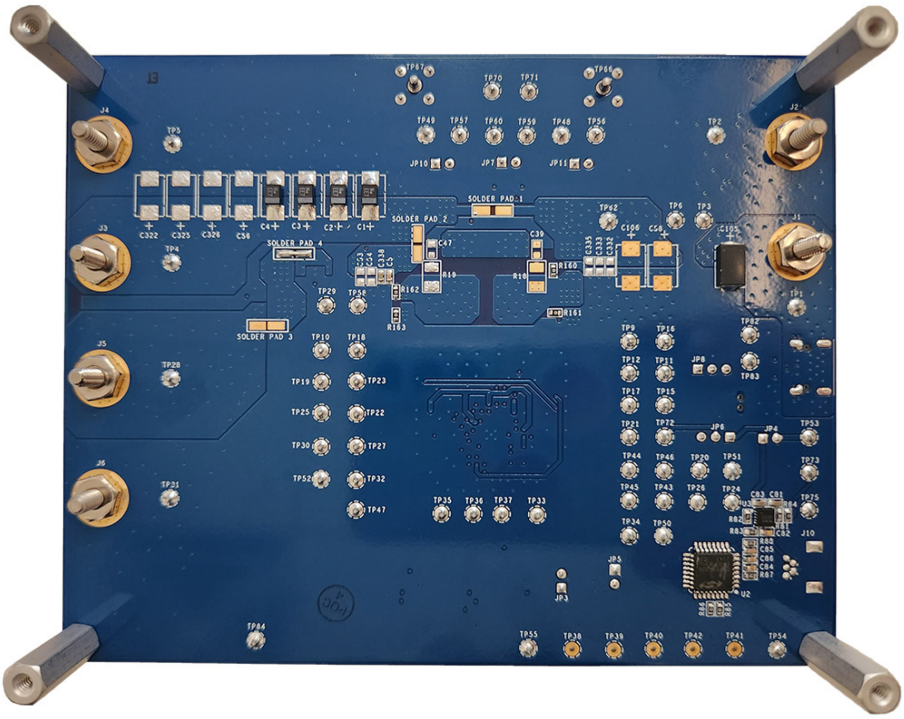
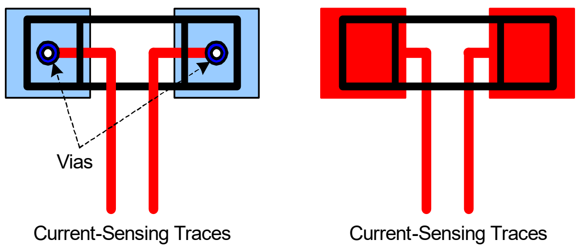
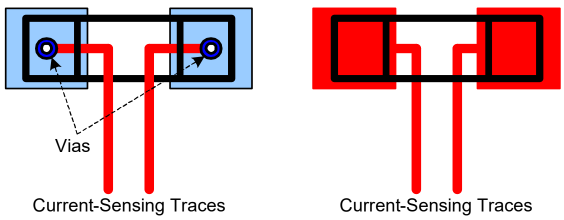


Figure 12. RTKA489110DE0000BU Evaluation Board (Bottom)

2.1 Layout Guidelines

<table>
<tr><th>Pin #</th><th>Pin Name</th><th>Layout Guidelines</th></tr>
<tr><td>Bottom Pad</td><td>GND</td><td>Connect this ground pad to the ground plane through a low impedance path. Renesas recommends using at least five vias to connect to ground planes in the PCB to ensure sufficient thermal dissipation directly under the IC.</td></tr>
<tr><td>1</td><td>CSON</td><td rowspan="2"> CSOP is the sense line for output voltage. Route using a thick, short length plane on one single layer from the drain of Q4 to the CSOP pin to minimize inductance. 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 R-C 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>NGATE</td><td>Switching pin. Run the NGATE trace to the NGATE N-type MOSFET Gate node. Use sufficient width. Avoid any sensitive analog signal trace from crossing over or getting close.</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 trace. Avoid any sensitive analog signal trace from crossing over or getting close.</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 trace from crossing over or getting close. Renesas recommends routing the PHASE2 trace to the high-side MOSFET source pin instead of general copper. Place the IC close to the switching MOSFETs 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. Place the output capacitors as close as possible to the switching high-side MOSFET drain and the low-side MOSFET source; and use shortest PCB trace connection. Place these capacitors on the same PCB layer as 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. Run the LGATE2 trace in parallel with the UGATE2 and PHASE2 traces on the same PCB layer. Use sufficient width. Avoid any sensitive analog signal trace 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. Run the LGATE1 trace in parallel with the UGATE1 and PHASE1 traces on the same PCB layer. Use sufficient width. Avoid any sensitive analog signal trace from crossing over or getting close.</td></tr>
</table>

<table>
<tr><th>Pin #</th><th>Pin Name</th><th>Layout Guidelines</th></tr>
<tr><td>10</td><td>PHASE1</td><td rowspan="2">Run these two traces in parallel fashion with sufficient width. Avoid any sensitive analog signal trace from crossing over or getting close. Renesas recommends routing the PHASE1 trace to the high-side MOSFET drain pin instead of general copper.
Place the IC close to the switching MOSFETs 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.
Place the input capacitors as close as possible to the switching high-side MOSFET drain and the low-side MOSFET source; and use shortest PCB trace connection. Place these capacitors on the same PCB layer as 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>11</td><td>UGATE1</td></tr>
<tr><td>12</td><td>BOOT1</td><td>Switching pin. Place the bootstrap capacitor in the general proximity of the controller. Use sufficiently wide trace. Avoid any sensitive analog signal trace from crossing over or getting close.</td></tr>
<tr><td>13</td><td>BYPSRC</td><td>Run this trace with sufficient width to the bypass N-type MOSFET sources/reference node.</td></tr>
<tr><td>14</td><td>CSIN</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 adapter current-sensing resistor to the IC. Place the Differential mode and common-mode R-C filter components in general proximity of the controller. Keep the CSIN node near the Q_1 drain.
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>15</td><td>CSIP</td></tr>
<tr><td>16</td><td>BYPSG</td><td>Run this trace with sufficient width to the bypass N-type MOSFET gates.</td></tr>
<tr><td>17</td><td>DCIN</td><td>Place the OR diodes and the R-C filter in the general proximity of the controller. Run the VADP trace and VSYS trace to the OR diodes with sufficient width.</td></tr>
<tr><td>18</td><td>VDD</td><td>Place the R-C filter connecting with VDDP pin in the general proximity of the controller. Run the trace connecting to the VDDP pin with sufficient width.</td></tr>
<tr><td>19</td><td>PROG</td><td>Signal pin. Place the PROG programming resistor in the general proximity of the controller.</td></tr>
<tr><td>20</td><td>OTGEN/CMIN</td><td>Digital pins. No special consideration.</td></tr>
<tr><td>21</td><td>SDA</td><td rowspan="2">Digital pins. No special consideration. Run the SDA and SCL traces in parallel.</td></tr>
<tr><td>22</td><td>SCL</td></tr>
<tr><td>23</td><td>PROCHOT#</td><td>Digital pin, open-drain output. No special consideration.</td></tr>
<tr><td>24</td><td>ACOK</td><td>Digital pin, open-drain output. No special consideration.</td></tr>
<tr><td>25</td><td>BATGONE/NTC</td><td>Digital pin (BATGONE), analog pin (NTC). Place the 10kΩ resistor series in the BATGONE signal trace and the optional decoupling capacitor in the general proximity of the controller.</td></tr>
<tr><td>26</td><td>CMOUT/INT#</td><td>Digital pin, open-drain output. No special consideration.</td></tr>
<tr><td>27</td><td>COMPR</td><td>Place the compensation components in the general proximity of the controller. Avoid any switching signal from crossing over or getting close.</td></tr>
<tr><td>28</td><td>COMPF</td><td>Place the compensation components in the general proximity of the controller. Avoid any switching signal from crossing over or getting close.</td></tr>
</table>

Pin #	Pin Name	Layout Guidelines
29	AMON/BMON	No special consideration. Place the optional R-C filter in the general proximity of the controller.
30	PSYS(REFADJ)	Signal pin, current source output. No special consideration. REFADJ is an analog signal pin for feedback of the output voltage. Place near the controller and run a dedicated trace for each resistor divider node (TOP, MIDDLE, BOTTOM). Do not inject noise or additional capacitance.
31	VBAT	Place the optional R-C 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 N-type MOSFET gate. Place the capacitor from BGATE to ground close to the MOSFET.

2.2 Schematic Diagrams

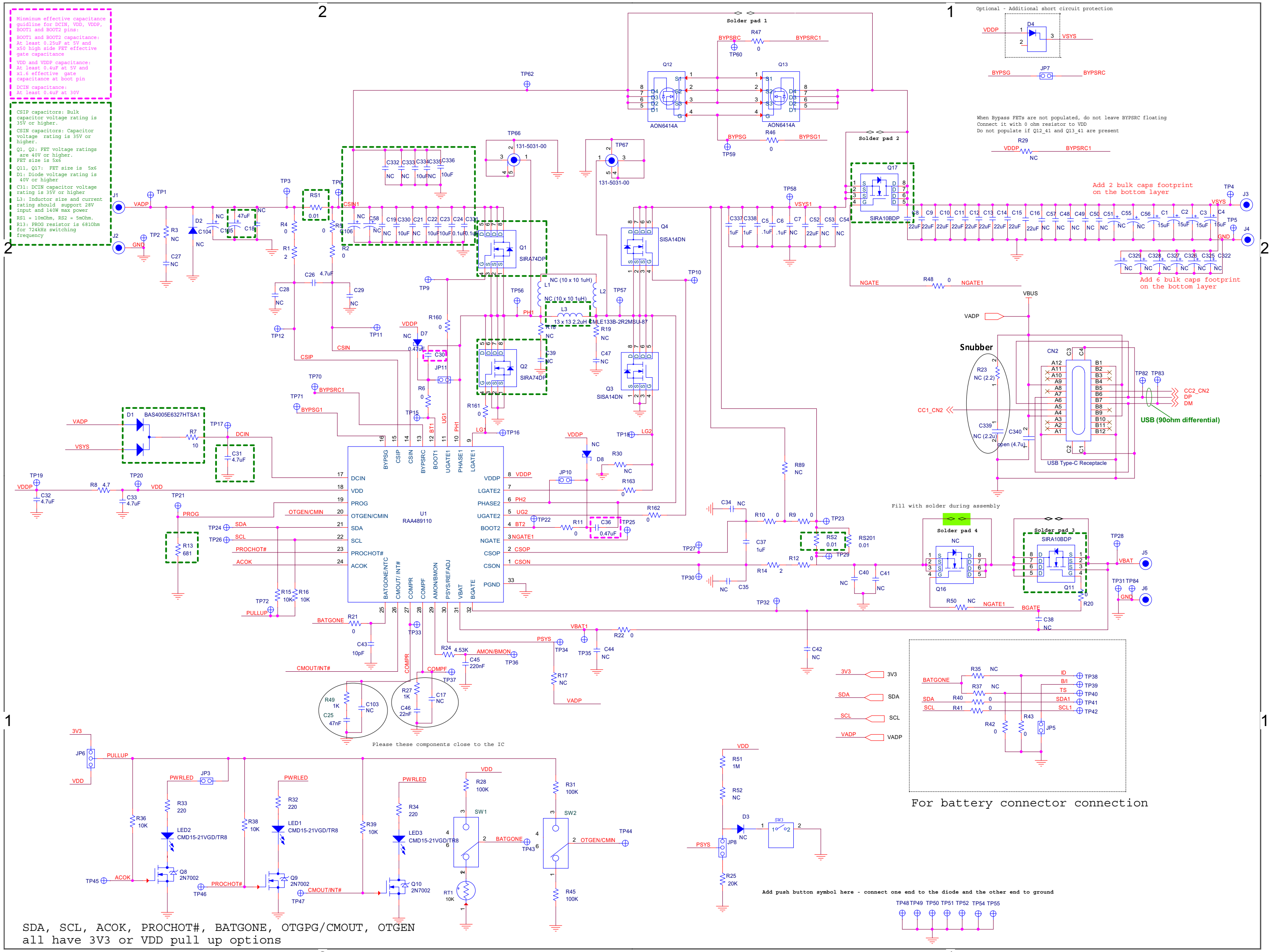


Figure 13. RTKA489110DE0000BU Schematic

2.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
4	C1, C2, C3, C4	CAP TANT POLY 15µF 25V 1411	Vishay Sprague	T55B156M025C0100
5	C37, C81, C83, C337, C338	CAP CER 1µF 25V X5R 0603	Murata Electronics	GRM188R61E105KAADD
10	C8, C9, C10, C11, C12, C13, C14, C15, C16, C52	22 µF ±20% 25V Ceramic Capacitor X5R 0805 (2012 Metric)	Murata Electronics	GRM21BR61E226ME44L
1	C31	CAP CER 4.7µF 50V X7R 0805	Murata Electronics	GRM21BZ71H475KE15L
5	C22, C23, C330, C334, C336	10µF ±10% 35V Ceramic Capacitor X5R 0805 (2012 Metric)	Murata Electronics	GRM21BR6YA106KE43L
4	C5, C6, C24, C331	CAP CER 0.1µF 50V X8R 0603	Murata Electronics	GCJ188R91H104KA01D
1	C25	CAP CER 0.047µF 25V X7R 0603	KEMET	C0603C473K3RAC7867
3	C26, C32, C33	CAP CER 4.7µF 10V X5R 0603	Murata Electronics	GRM188R61A475KAAJD
2	C30, C36	CAP CER 0.47µF 50V X7R 0603	TDK Corporation	C1608X7R1H474K080AC
1	C43	CAP CER 10PF 50V C0G/NP0 0603	KEMET	C0603C100K5GAC7867
1	C45	CAP CER 0.22µF 25V X7R 0603	KEMET	C0603C224K3RAC7867
1	C46	CAP CER 0.022µF 25V X7R 0603	KEMET	C0603C223K3RAC7867
1	C82	CAP CER 1000PF 16V X7R 0603	KYOCERA AVX	0603YC102KAT2A
3	C84, C85, C86	CAP CER 0.1µF 25V X8R 0603	Murata Electronics	GCM188R91E104KA37D
1	C105	CAP TANT POLY 47µF 35V 2917	Vishay Polytech	T52E5476M035C0070
1	D1	Diode Array Schottky 40V SOT23	Infineon Technologies	BAS4005E6327HTSA1
6	JP3, JP4, JP5, JP7, JP10, JP11	CONN Header VERT 2POS	TE Connectivity AMP Connectors	9-146258-0-01
2	JP6, JP8	CONN Header VERT 3POS 2.54MM	Würth Elektronik	61300311121
3	J1, J3, J5	CONN BIND Post Knurled Red	Keystone Electronics	7006
3	J2, J4, J6	CONN BIND Post Knurled Black	Cinch Connectivity Solutions Johnson	111-0703-001
1	J10	USB Connectors Mini USB, Type B, R/A, T/H	TE Connectivity	1734510-1
3	LED1, LED2, LED3	LED Green Diffused 1206 SMD	Visual Communications Company - VCC	CMD15-21VGD/TR8
2	Q1, Q2	MOSFET 40V N-Channel (D-S)MOSFET	Vishay Siliconix	SIRA74DP-T1-GE3
2	Q11, Q17	N-Channel 30 V 30A (Ta), 60A (Tc) 5W (Ta), 43W (Tc) Surface Mount PowerPAK® SO-8	Vishay Siliconix	SIRA10BDP-T1-GE3
2	Q3, Q4	MOSFET For New Design See: 78-SISHA14DN-T1-GE3	Vishay Siliconix	SISA14DN
3	Q8, Q9, Q10	MOSFET N-CHANNEL 60V 115MA SOT23	NTE Electronics, Inc	2N7002

2	Q12, Q13	MOSFET N-CH 30V 13A/30A 8DFN	Alpha & Omega Semiconductor Inc.	AON6414A
3	RS1, RS2, RS201	RES 0.01Ω 1% 1W 1206	Panasonic Electronic Components	ERJ-8CWFR010V
1	RT1	Thermistor NTC 10KΩ 3380K 0603	Murata Electronics	NCP18XH103F03RB
2	R1, R14	RES 2Ω 1% 1/10W 0603	Yageo	RC0603FR-072RL
25	R2, R4, R5, R6, R9, R10, R11, R12, R20, R21, R22, R40, R41, R42, R43, R46, R47, R48, R84, R85, R86, R160, R161, R162, R163	RES SMD 0Ω Jumper 1/10W 0603	Yageo	RC0603FR-070RL
1	R7	RES 10Ω 1% 1/10W 0603	Yageo	RC0603FR-0710RL
1	R8	RES 4.7Ω 1% 1/10W 0603	Yageo	RC0603FR-074R7L
1	R13	RES SMD 681Ω 1% 1/10W 0603	Panasonic Electronic Components	ERJ-3EKF6810V
6	R15, R16, R36, R38, R39, R81	RES 10KΩ 1% 1/10W 0603	Yageo	RC0603FR-0710KL
1	R24	RES 4.53KΩ 1% 1/10W 0603	Yageo	RC0603FR-074K53L
1	R25	RES 20KΩ 1% 1/10W 0603	Yageo	RC0603FR-0720KL
5	R27, R49, R83, R87, R88	RES 1KΩ 1% 1/10W 0603	Yageo	RC0603FR-071KL
3	R28, R31, R45	RES 100KΩ 5% 1/10W 0603	Yageo	RC0603JR-10100KL
3	R32, R33, R34	RES 220Ω 1% 1/10W 0603	Yageo	RC0603FR-07220RL
1	R51	RES 1MΩ 1% 1/10W 0603	Yageo	RC0603FR-071ML
1	R82	RES 5.62KΩ 1% 1/10W 0603	Yageo	RC0603FR-075K62L
2	SW1, SW2	Switch Toggle SPDT 0.4VA 20V	C&K	GT11MSCBE

60	TP1, TP2, TP3, TP4, TP5, TP6, 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, TP59, TP60, TP62, TP70, TP71, TP72, TP73, TP75, TP82, TP83, TP84	PC Test Point Miniature White	Keystone Electronics	5002
2	TP66, TP67	Test Connectors PK 25 EA 136-0962-00 and 131-4209-00	Tektronix	131-5031-00
1	U3	IC REG Linear POS ADJ 1A 10DFN	Renesas Electronics America Inc	ISL80101IRAJZ
1	CN2	CONN RCP USB3.1 Type C 24P SMD RA	JAE Electronics	DX07S024JJ2R1300
4	Four corners top PCB	Screw,4-40X1/4in, Phillips, Panhead, Stainless, ROHS	Keystone	2204
4	Four corners bottom PCB	Standoff, 4-40X3/4in, F/F, HEX, Aluminum, 0.25 OD, ROHS	Keystone	9900
4	P3-Pins 1-2, JP4-Pins 1-2, JP6-Pins 1-2, JP8-Pins 2-3	CONN Jumper Shorting Gold Flash	Sullins Connector Solutions	SPC02SYAN
1	L3	COIL-PWR Choke, 2.2µH, 20%, 19A, 5.8mΩ, SMD,13.45×12.6, ROHS	Cyntec	CMLE133B-2R2MSU-87
1	U1	IC-Notebook Battery Charger, 32P, QFN, 4×4, ROHS	Renesas Electronics America Inc	RAA489110
1	U2	IC-USB Microcontroller, 32P, LQFP, Programmed, ROHS	Silicon Labs	C8051F320
1	AFFIX TO BACK OF PCB	LABEL-DATE CODE = LINE 1:YRWK-REV#, LINE 2:BOM NAME	Renesas Electronics America Inc	LABEL-DATE CODE

2.4 Board Layout

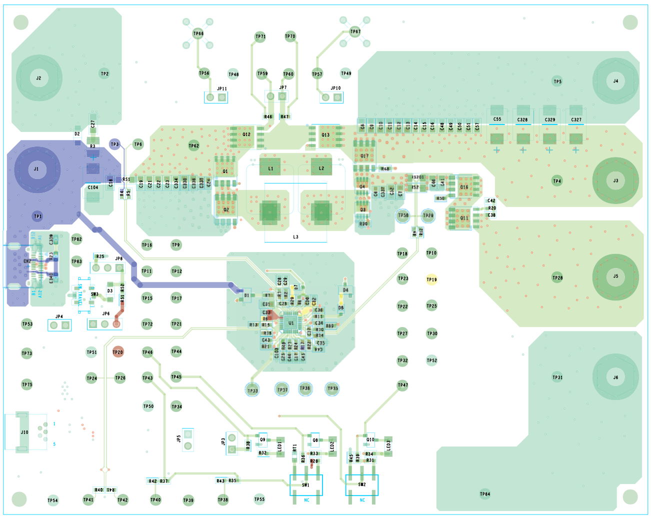


Figure 14. Silkscreen Top Layer

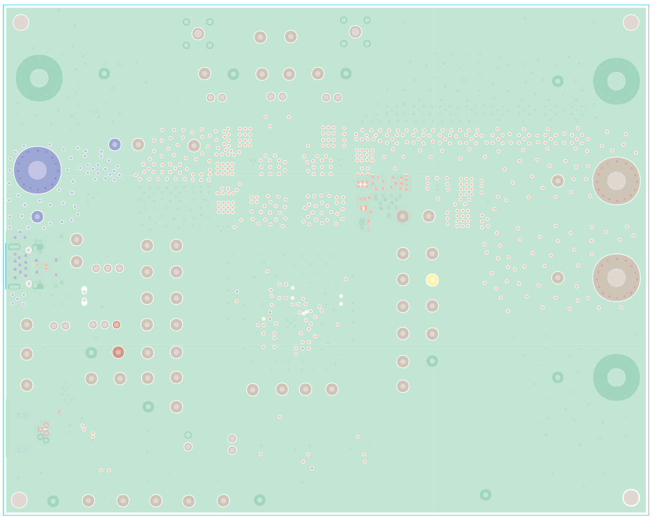


Figure 15. Inner Layer 1

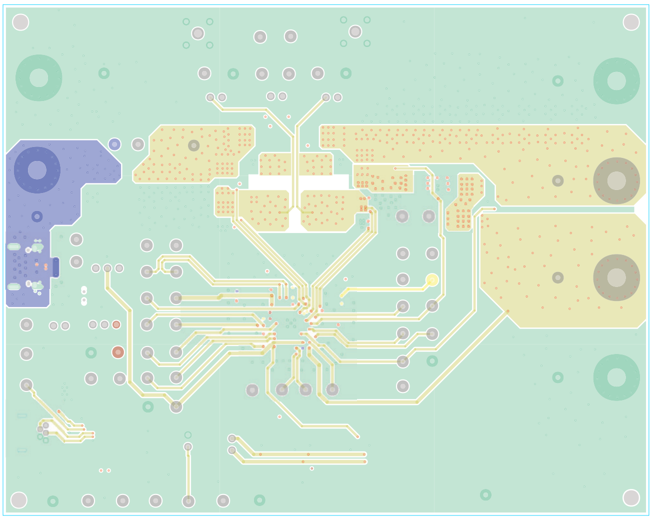


Figure 16. Inner Layer 2

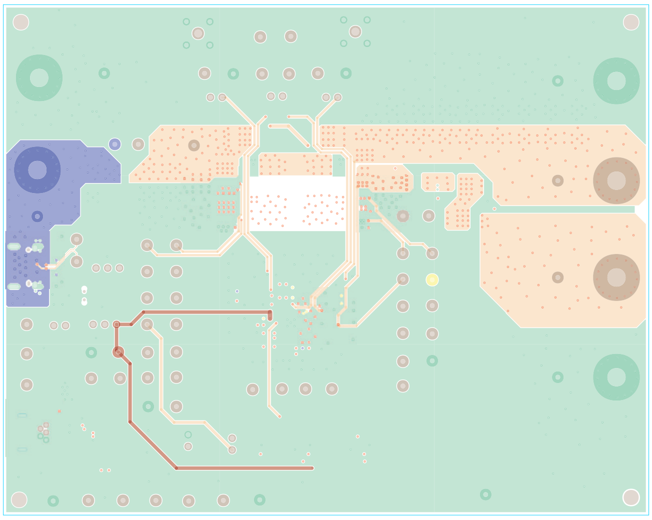


Figure 17. Inner Layer 3

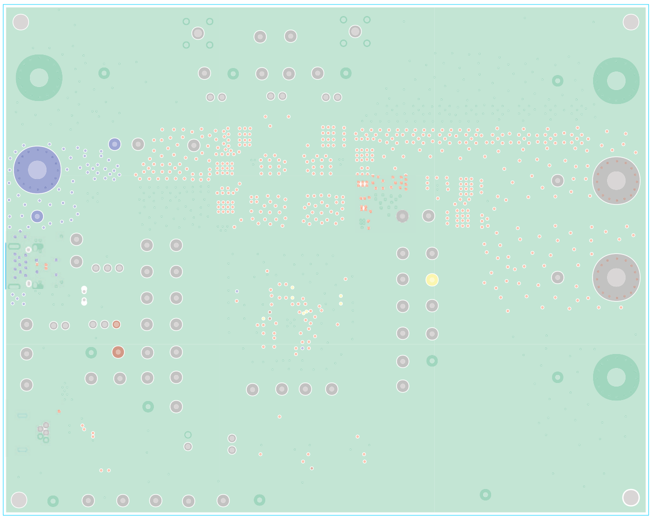


Figure 18. Inner Layer 4

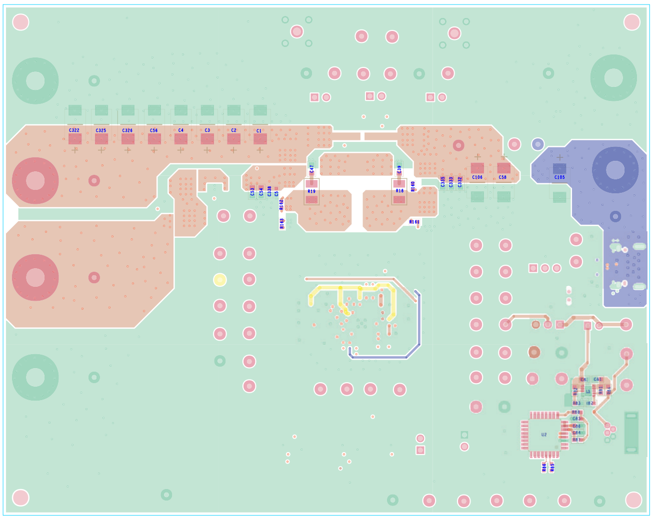


Figure 19. Bottom Layer (Mirror Image)

3. Typical Performance Graphs

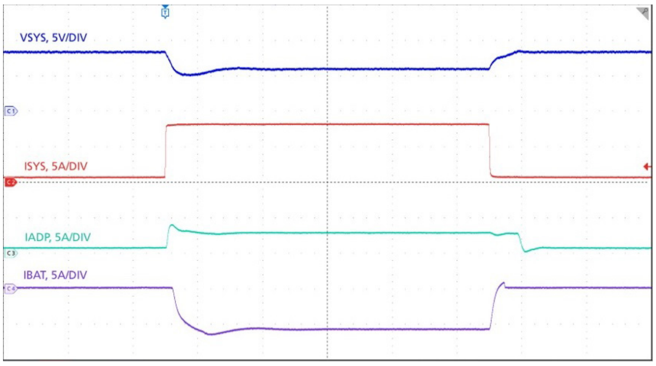


Figure 20. Boost Mode Transitions: Output Voltage Loop to/from Adapter Current Loop. VADP = 5V, VBAT = 7V, MaxSystemVoltage = 8.384V, AdapterCurrentLimit = 3A, ChargeCurrent = 0, SystemLoad: 0.5A <=> 8A

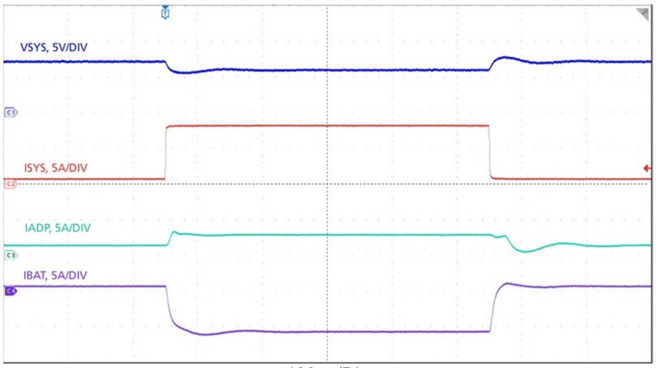


Figure 21. Boost Mode Transitions: Charge Current Loop to/from Adapter Current Loop. VADP = 5V, VBAT = 7V, MaxSystemVoltage = 8.384V, AdapterCurrentLimit = 3A, ChargeCurrent = 0.5A, SystemLoad: 0.5A <=> 8A

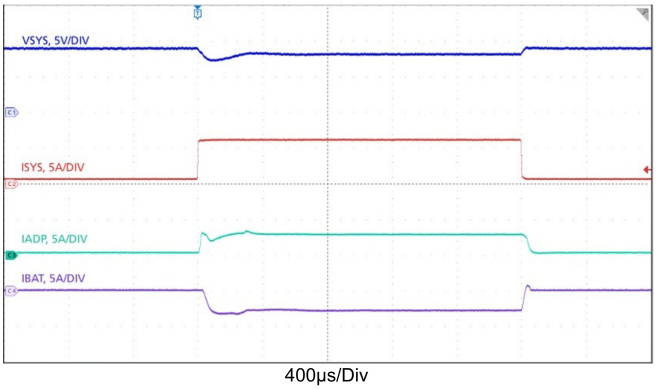


Figure 22. Buck_Boost Mode Transitions: Output Voltage Loop to/from Adapter Current Loop. VADP = 9V, VBAT = 8.4V, MaxSystemVoltage = 8.8V, AdapterCurrentLimit = 3A, ChargeCurrent = 0, SystemLoad: 0.5A <=> 6A, Buck_Boost_CCM_stretch_period = 2x

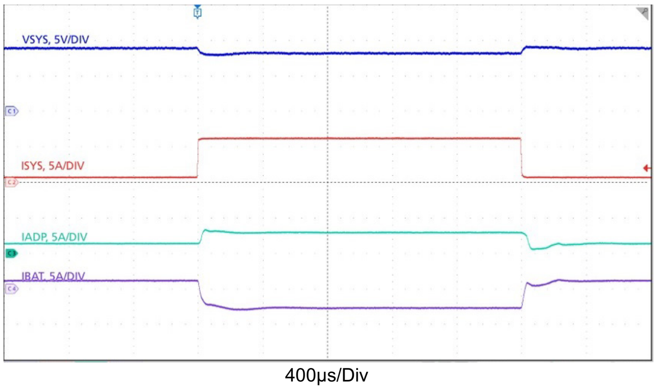


Figure 23. Buck_Boost Mode Transitions: Charge Current Loop to/from Adapter Current Loop. VADP = 9V, VBAT = 8.4V, MaxSystemVoltage = 8.8V, AdapterCurrentLimit = 3A, ChargeCurrent = 1A, SystemLoad: 0.5A <=> 6A, Buck_Boost_CCM_stretch_period = 2x

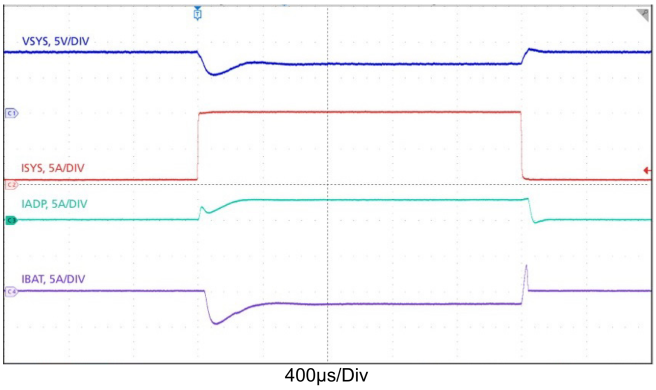


Figure 24. Buck Mode Transitions: Output Voltage Loop to/from Adapter Current Loop. VADP = 20V, VBAT = 7V, MaxSystemVoltage = 8.384V, AdapterCurrentLimit = 3A, ChargeCurrent = 0, SystemLoad: 0.5A <=> 10A

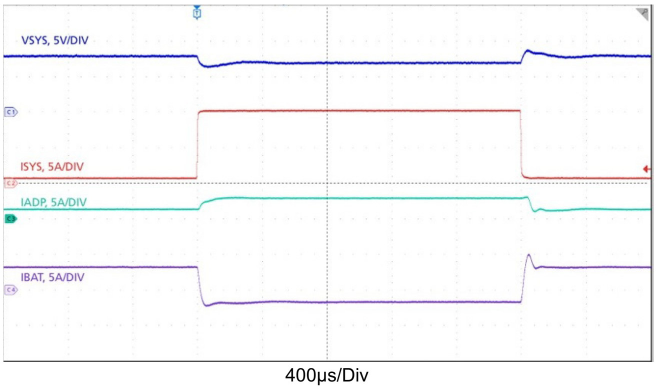


Figure 25. Buck Mode Transitions: Charge Current Loop to/from Adapter Current Loop. VADP = 20V, VBAT = 7V, MaxSystemVoltage = 8.384V, AdapterCurrentLimit = 3A, ChargeCurrent = 3A, SystemLoad: 0.5A <=> 10A

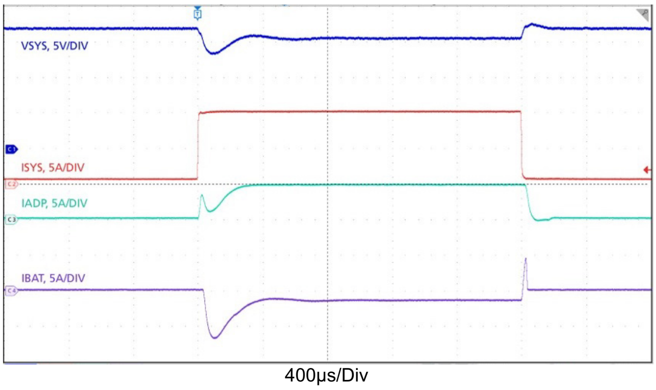


Figure 26. Buck Mode Transitions: Output Voltage Loop to/from Adapter Current Loop. VADP = 28V, VBAT = 15.5V, MaxSystemVoltage = 16.768V, AdapterCurrentLimit = 5A, ChargeCurrent = 0, SystemLoad: 0.5A <=> 10A

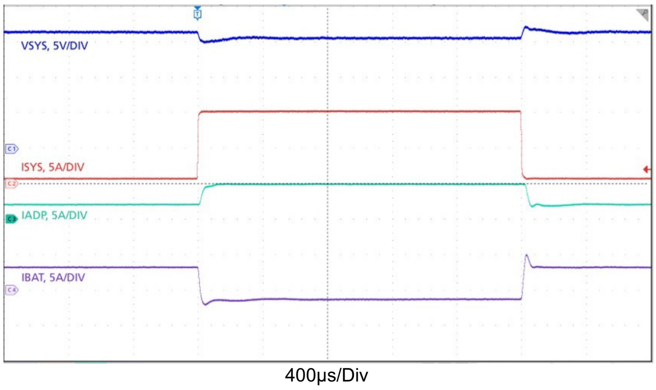


Figure 27. Buck Mode Transitions: Charge Current Loop to/from Adapter Current Loop. VADP = 28V, VBAT = 15.5V, MaxSystemVoltage = 16.768V, AdapterCurrentLimit = 5A, ChargeCurrent = 3A, SystemLoad: 0.5A <=> 10A

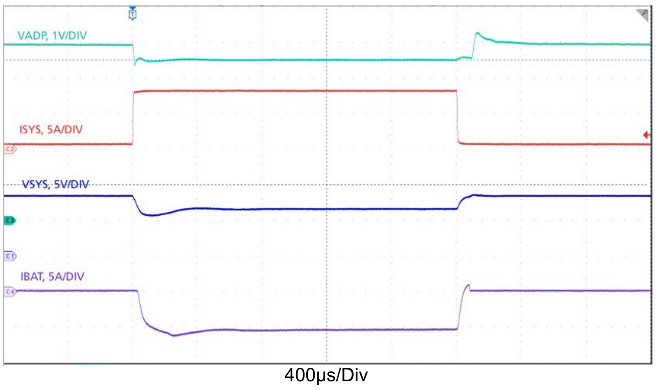


Figure 28. Boost Mode Transitions: Output Voltage Loop to/from Input Voltage Loop. VADP = 5V, VBAT = 7.5V, MaxSystemVoltage = 8.384V, AdapterCurrentLimit Disabled, ChargeCurrent = 0, SystemLoad: 0.5A <=> 8A, InputVoltageLimit = 4.48V

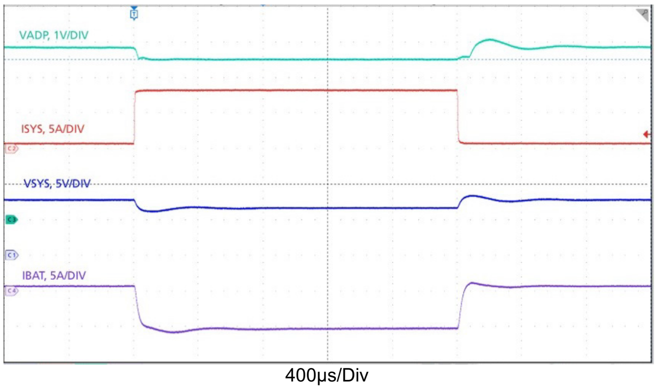
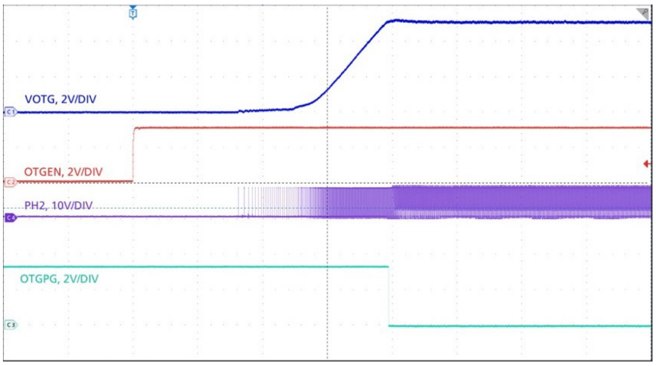
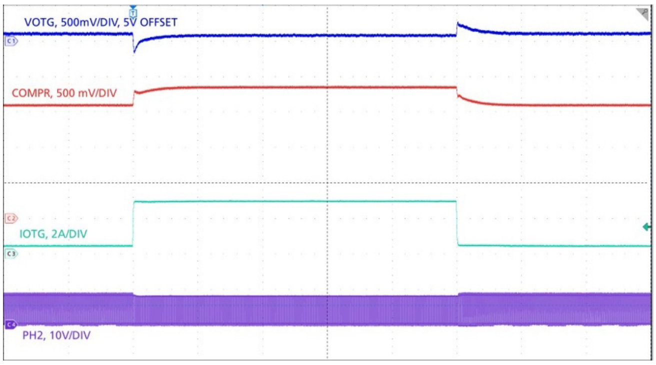


Figure 29. Boost Mode Transitions: Charge Current Loop to/from Input Voltage Loop. VADP = 5V, VBAT = 7.5V, MaxSystemVoltage = 8.384V, AdapterCurrentLimit Disabled, ChargeCurrent = 0.5A, SystemLoad: 0.5A <=> 8A, InputVoltageLimit = 4.48V



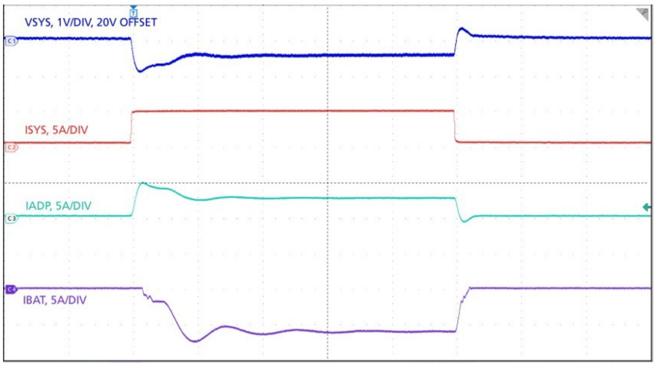
400µs/Div

Figure 30. OTG Mode Enable Using OTGEN Pin. VBAT = 8V, VOTG = 5V, General-Purpose Comparator Disabled, OTGEN Control Bit Enabled



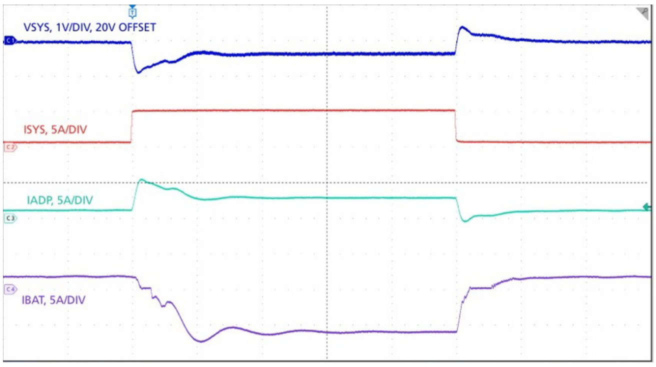
400µs/Div

Figure 31. OTG Mode Transients. VBAT = 8V, VOTG = 5V, OTG Current = 4A, SystemLoad: 0.5 <=> 3A



400µs/Div

Figure 32. Bypass (HPBB) Mode, Reverse Turbo Boost Enabled. Output Voltage Loop to/from Adapter Current Limit Loop Transitions, VADP = 20V, VBAT = 8V, MaxSystemVotlage = 8.384V, AdapterCurrentLimit = 3A, ChargeCurent = 0, SystemLoad: 0.5 <=> 5A



400µs/Div

Figure 33. Bypass (HPBB) Mode, Reverse Turbo Boost Enabled. Charge Current Loop to/from Adapter Current Limit Loop Transitions, VADP = 20V, VBAT = 8V, MaxSystemVotlage = 8.384V, AdapterCurrentLimit = 3A, ChargeCurent = 2A, SystemLoad: 0.5 <=> 5A

4. Ordering Information

Part Number	Description
RTKA489110DE0000BU	RAA489110 evaluation board

5. Revision History

Revision	Date	Description
1.01	Feb 24, 2023	Updated GUI images: Figures 6, 10, 11, and 12. Moved Using the GUI section into the Functional Description section.
1.00	Feb 16, 2023	Initial release

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www.renesas.com/contact/