ACT85411EVK1-101 User's Guide

Contents

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1 Description

This document describes the characteristics and operation of the Qorvo ACT85411EVK1-101 evaluation kit (EVK). It provides setup and operation instructions, schematic, layout, BOM, and test data. This EVK demonstrates the ACT85411QX101 Active PMU power management IC. Other ACT85411QXxxx options can be evaluated on this EVK by replacing the IC and any other necessary components.

2 Features

The EVK can be used as a standalone board if desired. However, to access the internal registers and to take full advantage of the IC's capability, the user must connect the EVK kit to a PC with Qorvo's USB-TO-I2C interface dongle and use the GUI software. The EVK provides full access to each converter's input and output voltage, as well as all the digital control signals. This gives the user the flexibility to configure the EVK to match their real system.

Note that the ACT85411EVK1-101 is specifically configured for the ACT85411QX101.

Figure 1 – EVK Picture

3 EVK Contents

The ACT85411EVK1-101 evaluation kit comes with the following items:

- EVK assembly
- USB-TO-I2C dongle
    a. Dongle

b. Custom 4-pin connector that connects the USB-TO-I2C dongle to the EVK assembly

4 Required Equipment

- ACT85411EVK1-101
- USB-TO-I2C Dongle
- Power supply – 12V @ 5A for full power operation
- Oscilloscope – >100MHz, >4 channels
- Loads – Electronic or resistive. 5A minimum current capability.
- Digital Multi-meters (DMM)
- Windows compatible computer with spare USB port.

5 Hardware Setup

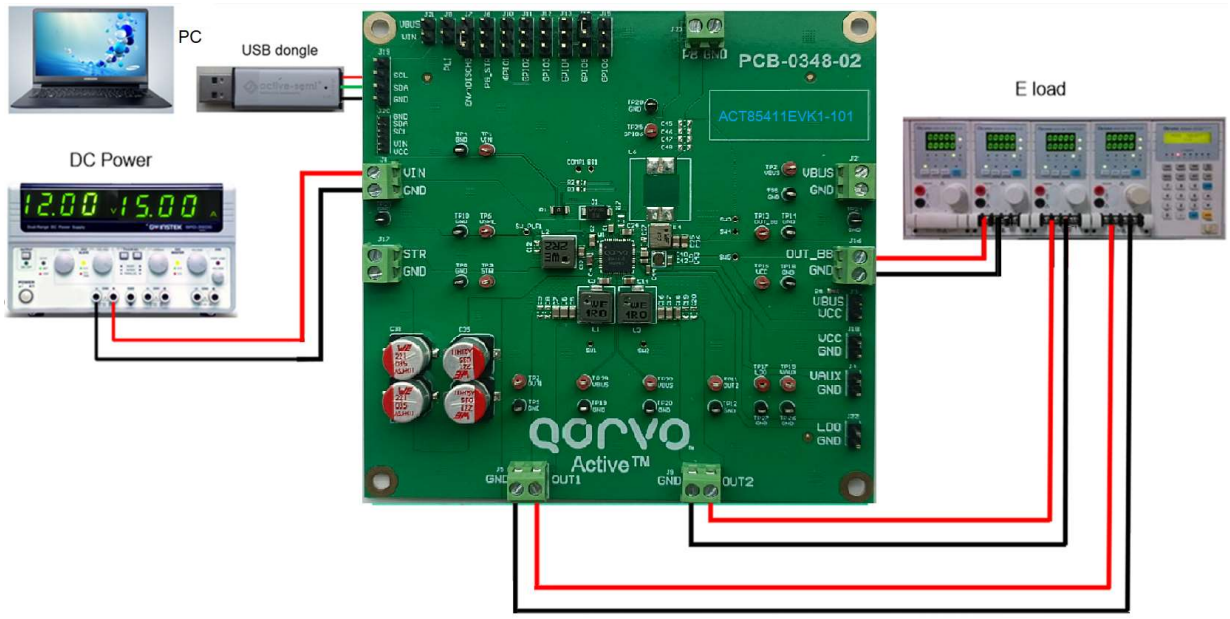

Figure 1 – EVK Setup

6 Quick Start

6.1 Hardware Setup

- Connect a shorting jumper between J7-1 and J7-2 to drive EN/DISCHG pin to high level.
- Connect a shorting jumper between J14-2 and J14-3 to drive GPIO5 pin to low level.
- Connect a lab supply between J1-1 and J1-2 to power VIN.
- Connect appropriate loads to each output of regulator.
- Turn on the lab supply.

- All regulators (except PLP Boost) turn on automatically when voltage is applied to VIN.

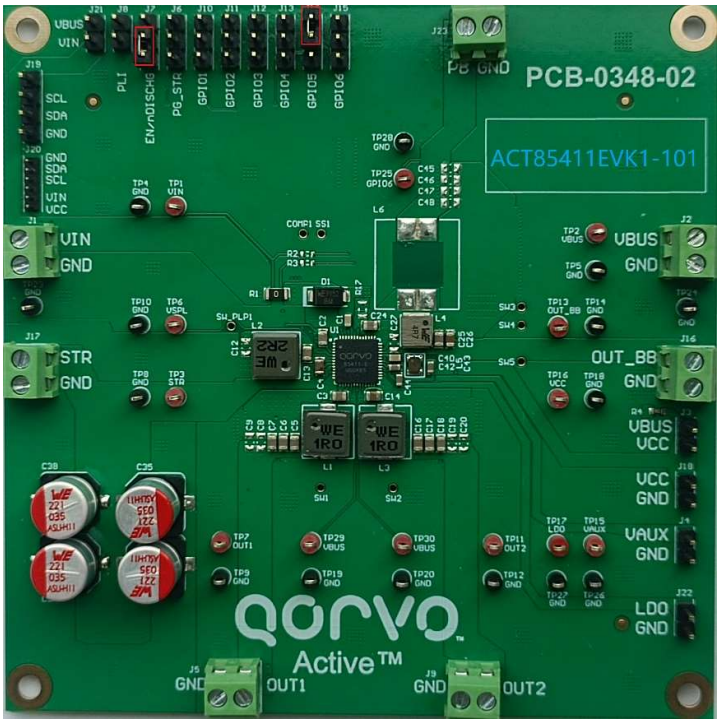

Figure 3 – Shorting jumper settings

6.2 GUI Setup (optional)

- Refer to the end of this document for detailed instructions to install the ACT85411 GUI.
- Connect the USB-TO-I2C dongle to the computer via a USB cable.
- Connect the USB-TO-I2C dongle to the EVK J19 connector. Refer to Figure 4 to ensure the correct polarity of the connection.

Figure 4 USB-TO-I2C Dongle Connection

7 EVK Design Parameters

The ACT85411EVK1-101 is designed for a 12V input voltage. The maximum operating voltage is determined by VIN_OV setting. The minimum operating voltages are determined by VIN_UV setting. Maximum currents are

determined by the IC's CMI settings, which can be changed via I2C after startup. Maximum rated current of boost is dependent on input and output voltages of boost.

Table 1. EVK Design Parameters

Parameter	Description	Min	Typ	Max	Unit
VIN	Operation Input range of Power Supply	9.6	12	14.4	V
V_{STR}	The storage capacitor voltage		31		V
V_{PLP_BUCK}	Supplement mode voltage of PLP_Buck		6		V
V_{Buck1}	Buck1 output voltage		3.3		V
V_{Buck2}	Buck2 output voltage		2.8		V
V_{BB}	Buck-Boost output voltage		12		V
V_{LDO}	LDO output voltage		3.3		V
V_{VCC}	VCC output voltage		5		V
I_{B1}	Buck 1 load current		5.0	9.0	A
I_{B2}	Buck 2 load current		3.0	6.0	A
I_{BB}	Buck-Boost load current		0.2	1.0	A
I_{LDO}	LDO load current		0.1	0.3	A
I_{VCC}	VCC load current		0.1	0.1	A

8 EVK Operation

8.1 Turn On

Apply the 12V input voltage. All regulators (except PLP Boost) automatically turn on with the programmed startup sequence.

8.2 PLP Boost Enabling

PLP Boost (STR) is turned off by default CMI setting. After applying VIN, use USB-TO-I2C dongle to change bit EN_BFET to 1 to turn on PLP Boost (STR). Backup energy will be stored in the storage capacitors.

8.3 GPIO5 Enabling Supplement Mode

Driving GPIO5 to high level enables supplement mode and PLP Buck works to supply regulators. The STR output is discharged. PLI goes low when the IC enters supplement mode.

8.4 Storage Cap Health Monitor (Storage Capacitance Measurement)

The ACT85411 has an updated internal health monitor (storage capacitance measurement) for the storage capacitors. Then ACT85411 uses a 10mA current sink to discharge the storage cap. Based on the discharge time, ACT85411 can calculate the capacitance on the STR output pin and store this value in the CAP_VALUE [12:0] register.

8.5 Test Results

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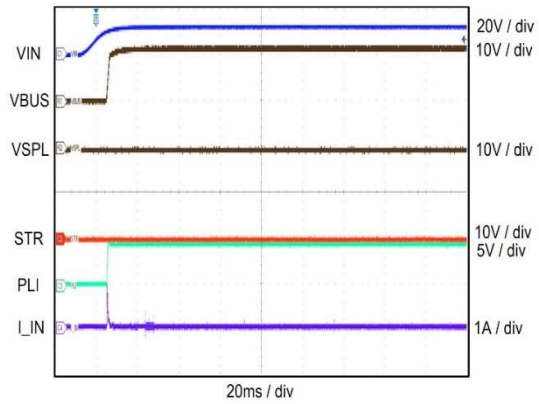
Startup with hot plug-PLP (EN_BFET=0)



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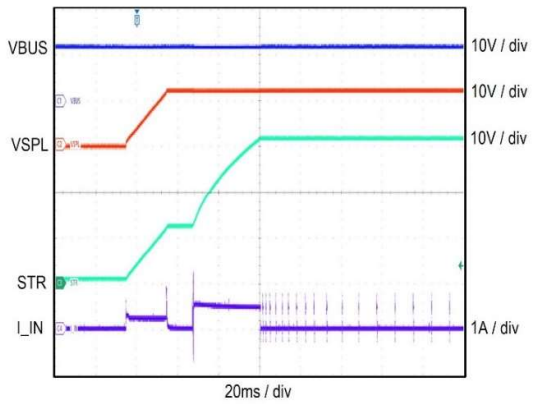
PLP soft start (EN_BFET=1)



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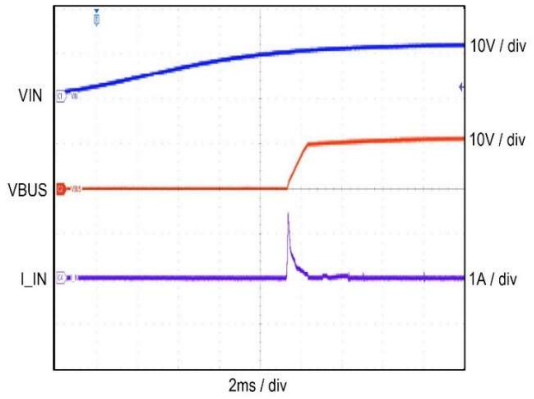
eFuse soft start



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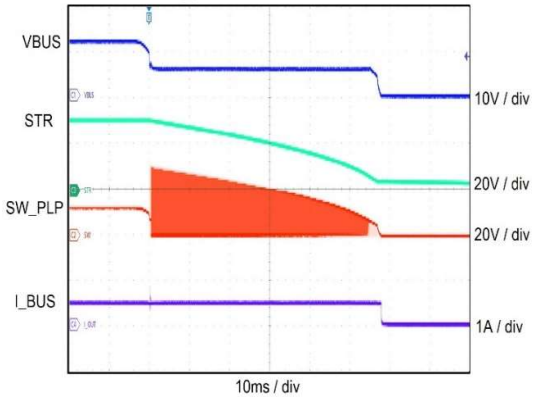
Supplement mode at 0.5A



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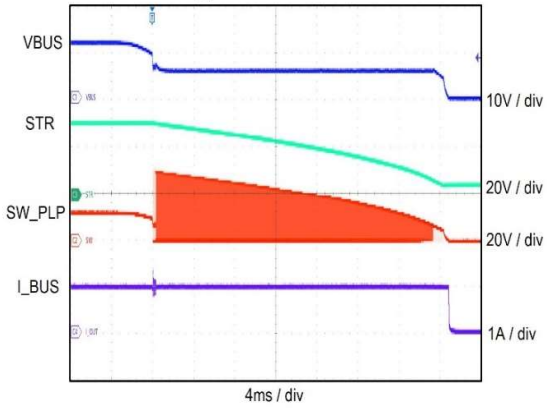
Supplement mode at 1A



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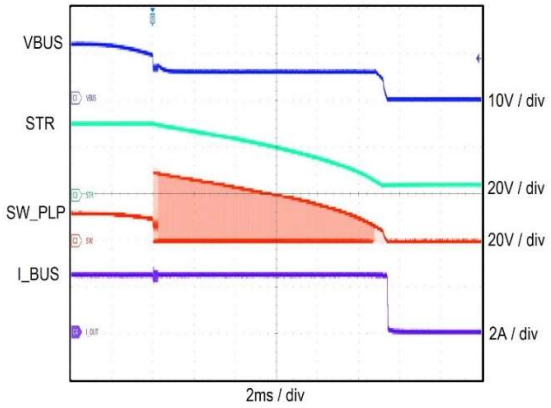
Supplement mode at 2.5A



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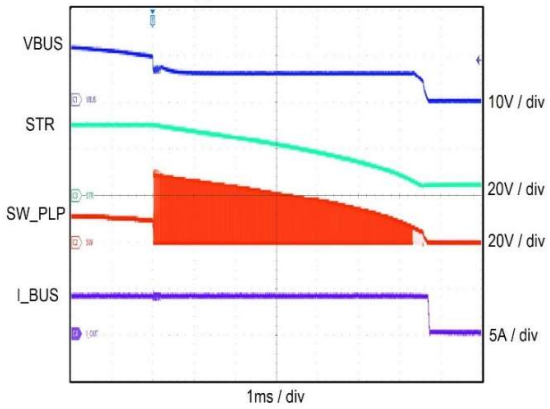
Supplement mode at 4A



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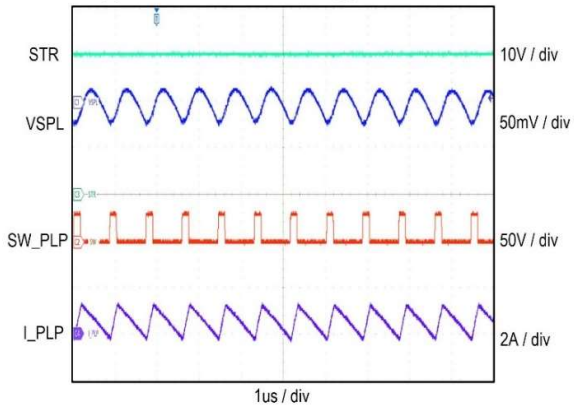
Supplement mode SW and ripple at 31V/0.5A



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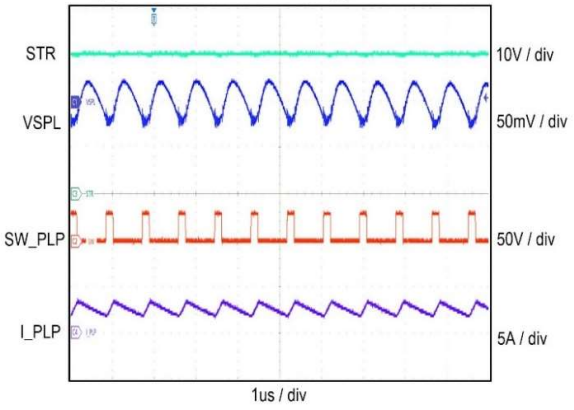
Supplement mode SW and ripple at 31V/2.5A



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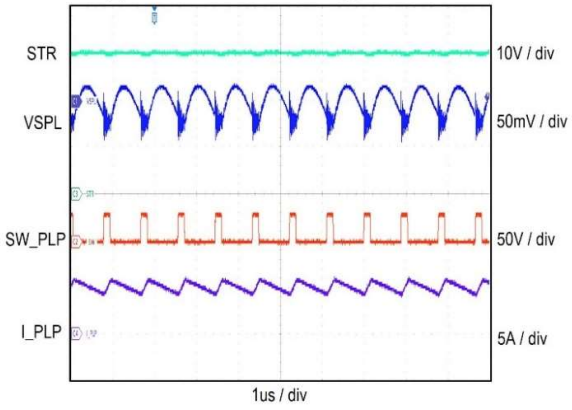
Supplement mode SW and ripple at 31V/5A



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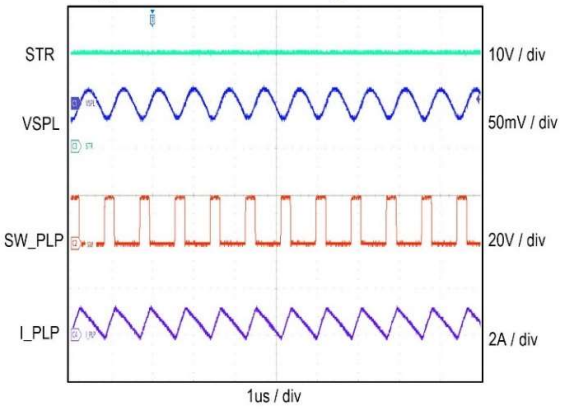

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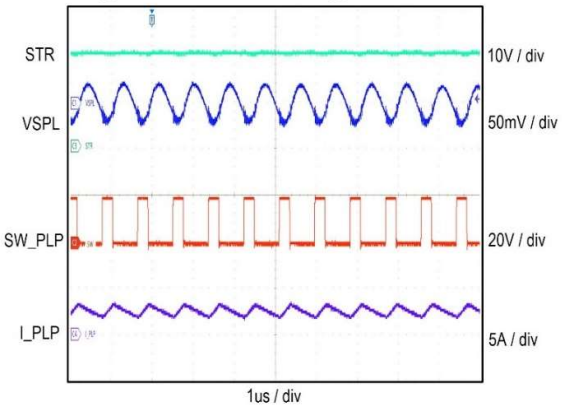

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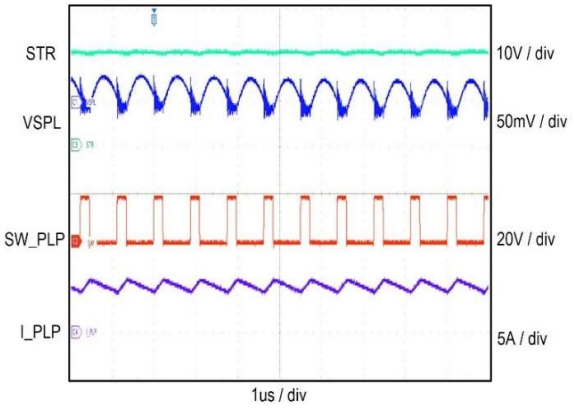

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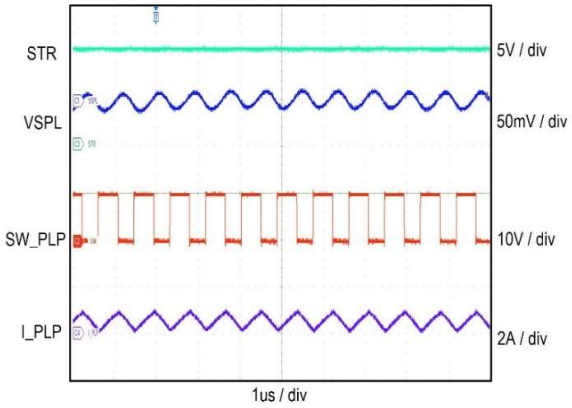

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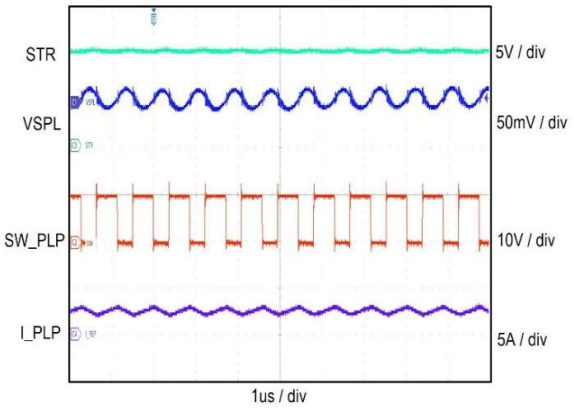

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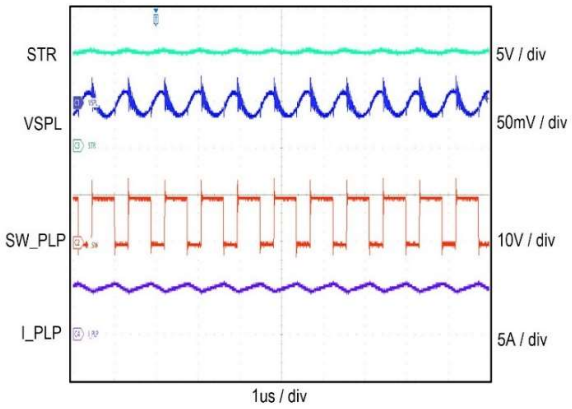

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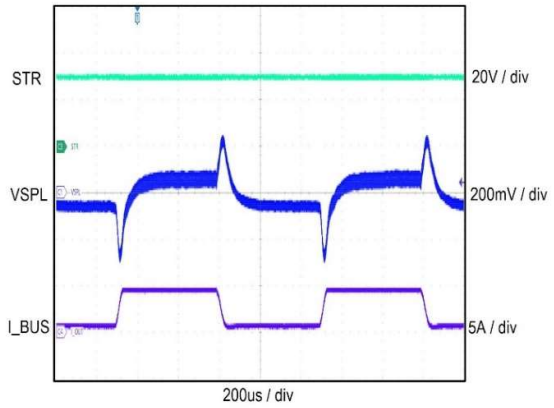
Supplement mode load transient at 31V/0.5-4.5A



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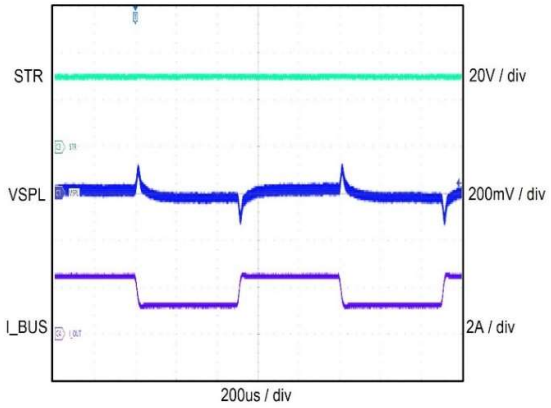

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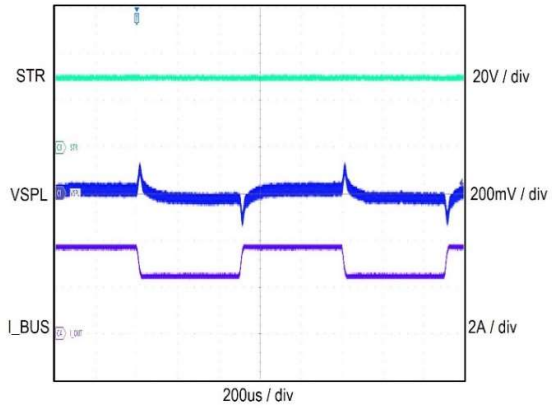

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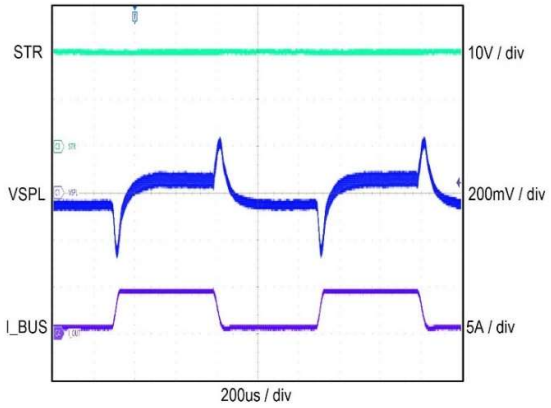

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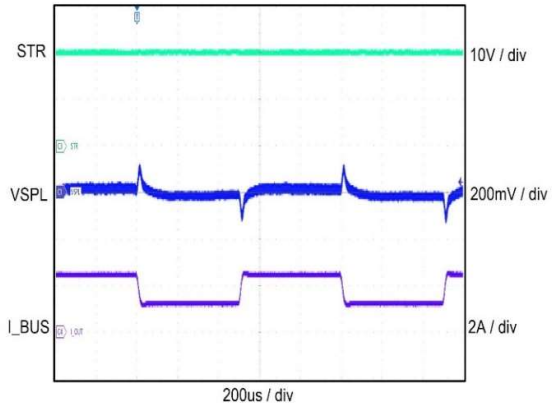

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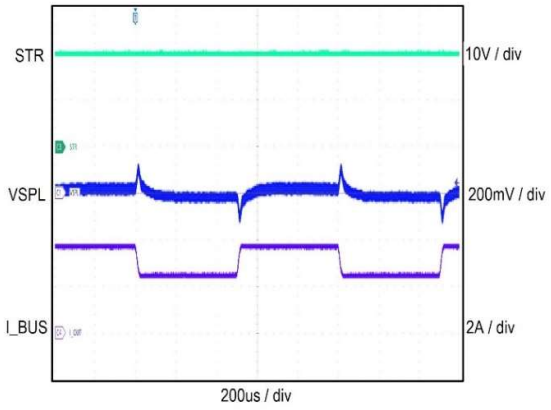

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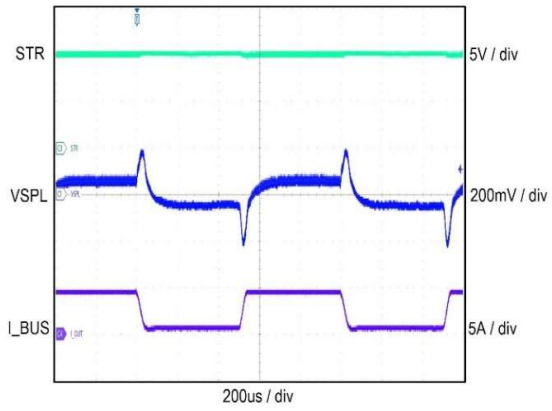

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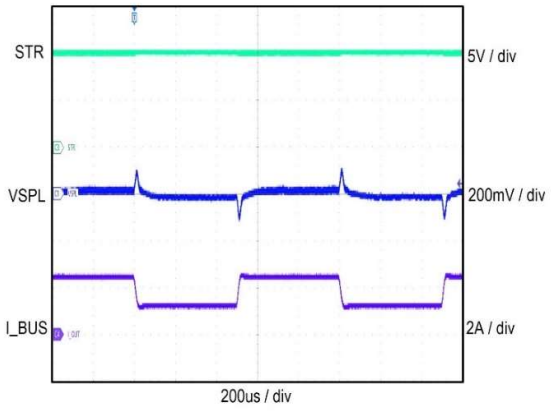

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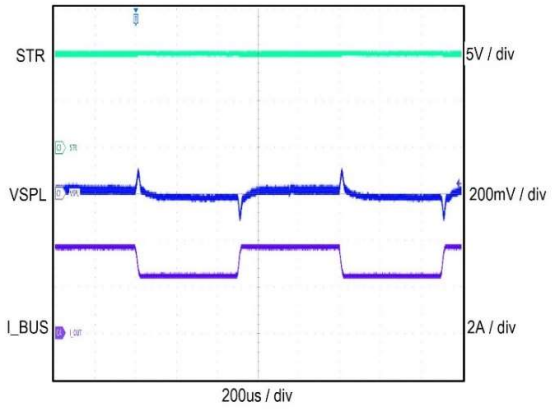

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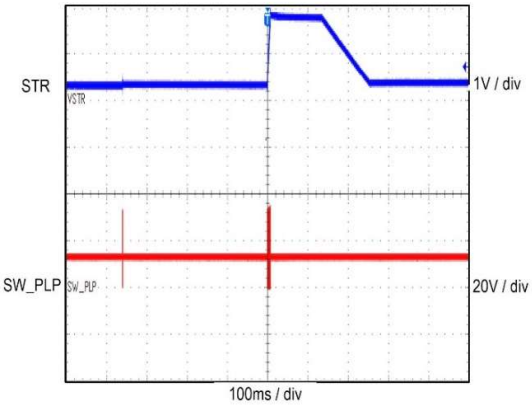

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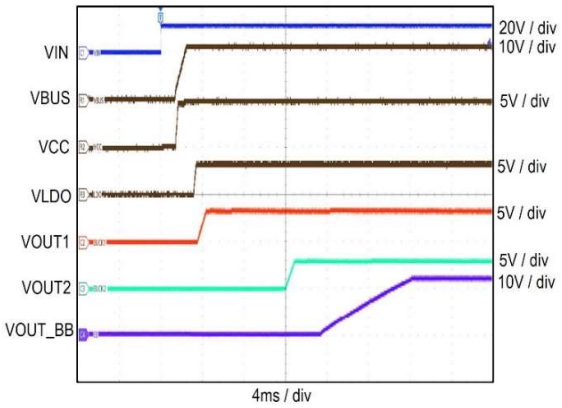
Startup sequence by VIN-PMU



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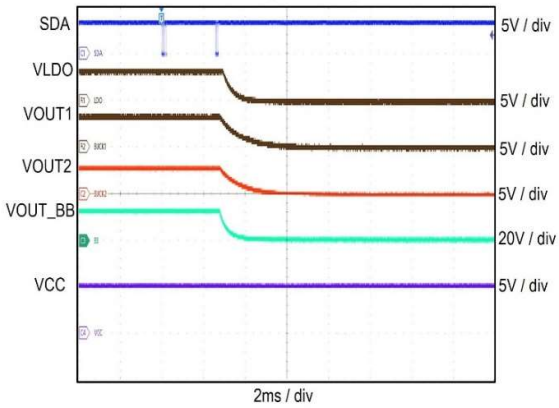
Enter Sleep Mode by I2C



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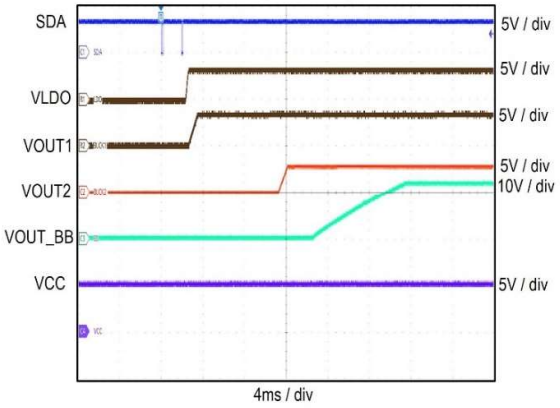
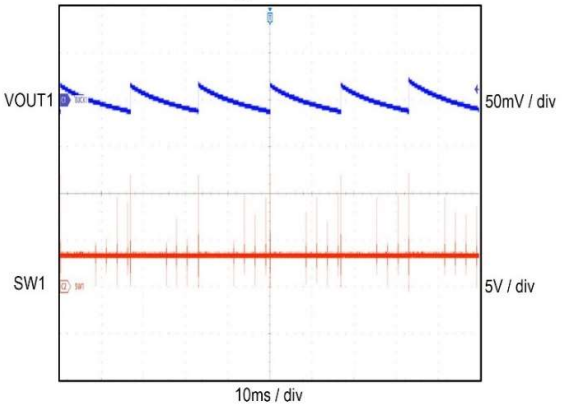
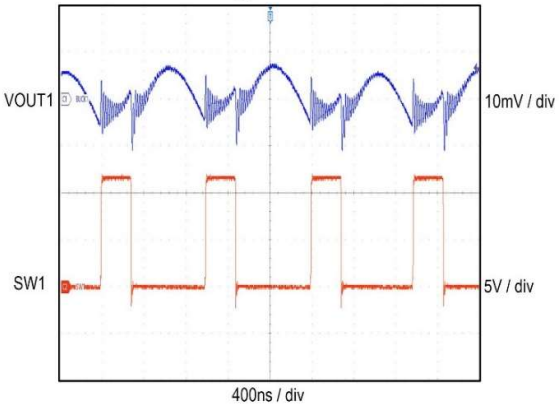
Exit Sleep Mode by I2C



CMI 101
Buck1 SW and ripple at VIN12V/No Load



CMI 101
Buck1 SW and ripple at VIN12V/5A Load



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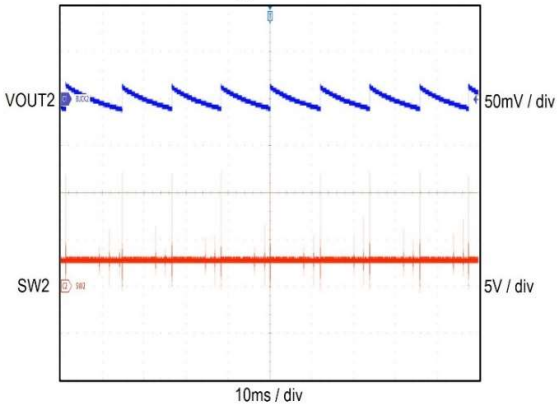
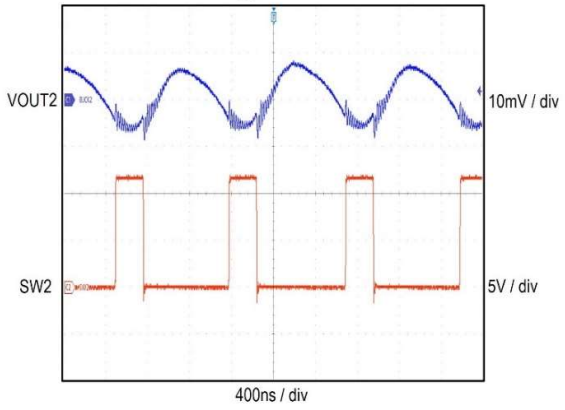
Buck2 SW and ripple at VIN12V/No Load



CMI 101
Buck2 SW and ripple at VIN12V/3A Load



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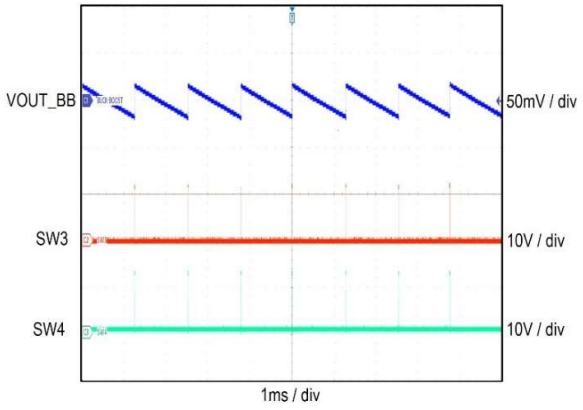
Buck-Boost SW and ripple at VIN12V/0.01A Load



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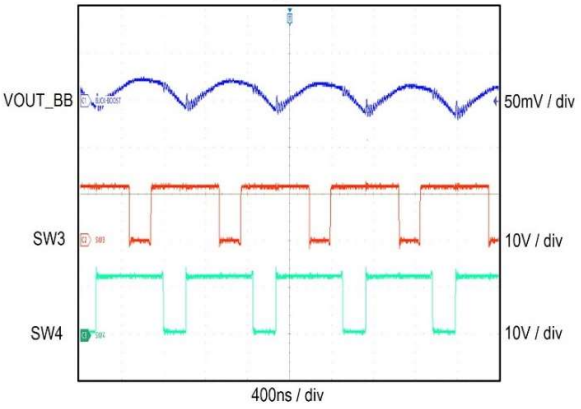
Buck-Boost SW and ripple at VIN12V/0.5A Load



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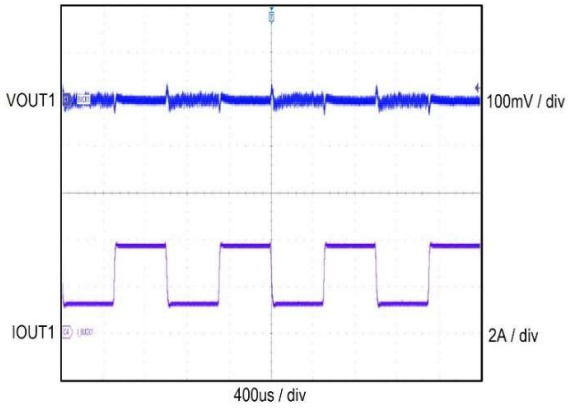
Buck1 load transient at VIN12V/1.25-3.75A



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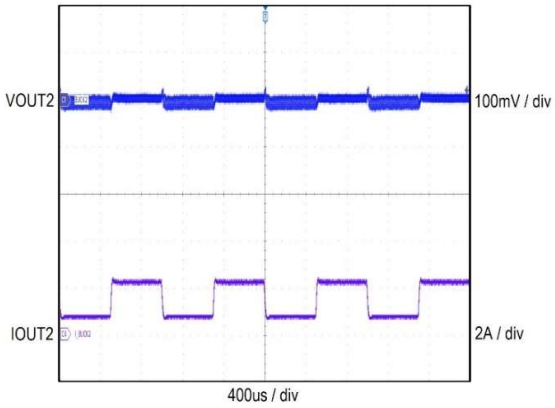
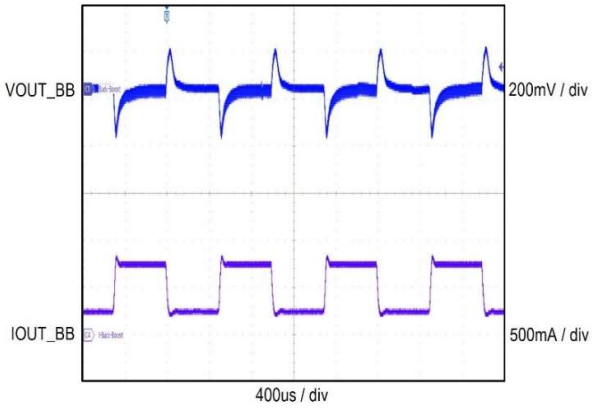
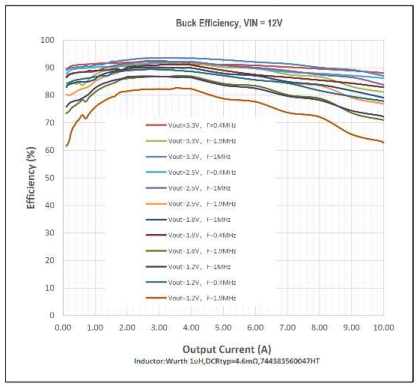


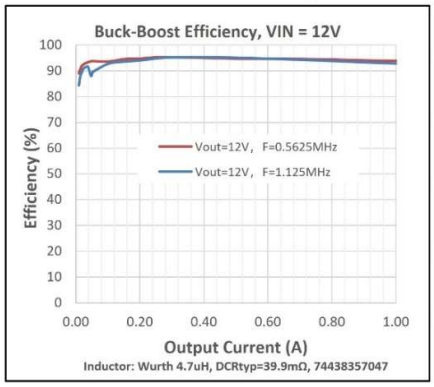
CMI 101
Buck-Boost load transient at VIN12V/0.25-0.75A



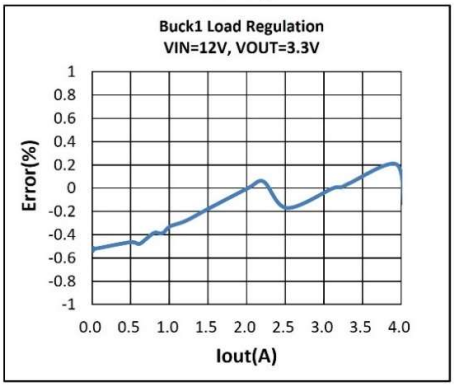
CMI 101
Buck1/2 Efficiency



CMI 101
Buck-Boost Efficiency



CMI 101
Buck1 Load Regulation



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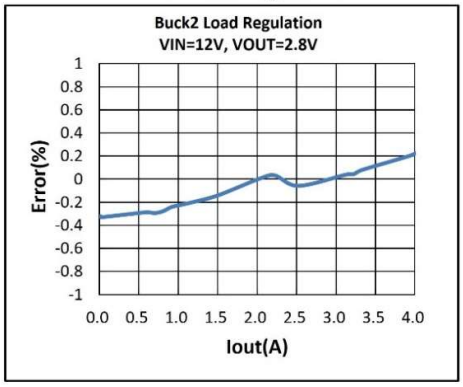
Buck2 Load Regulation



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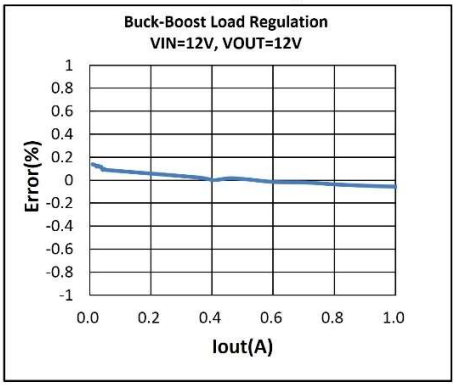
Buck-Boost Load Regulation



9 Schematic and PCB layout

9.1 Schematic

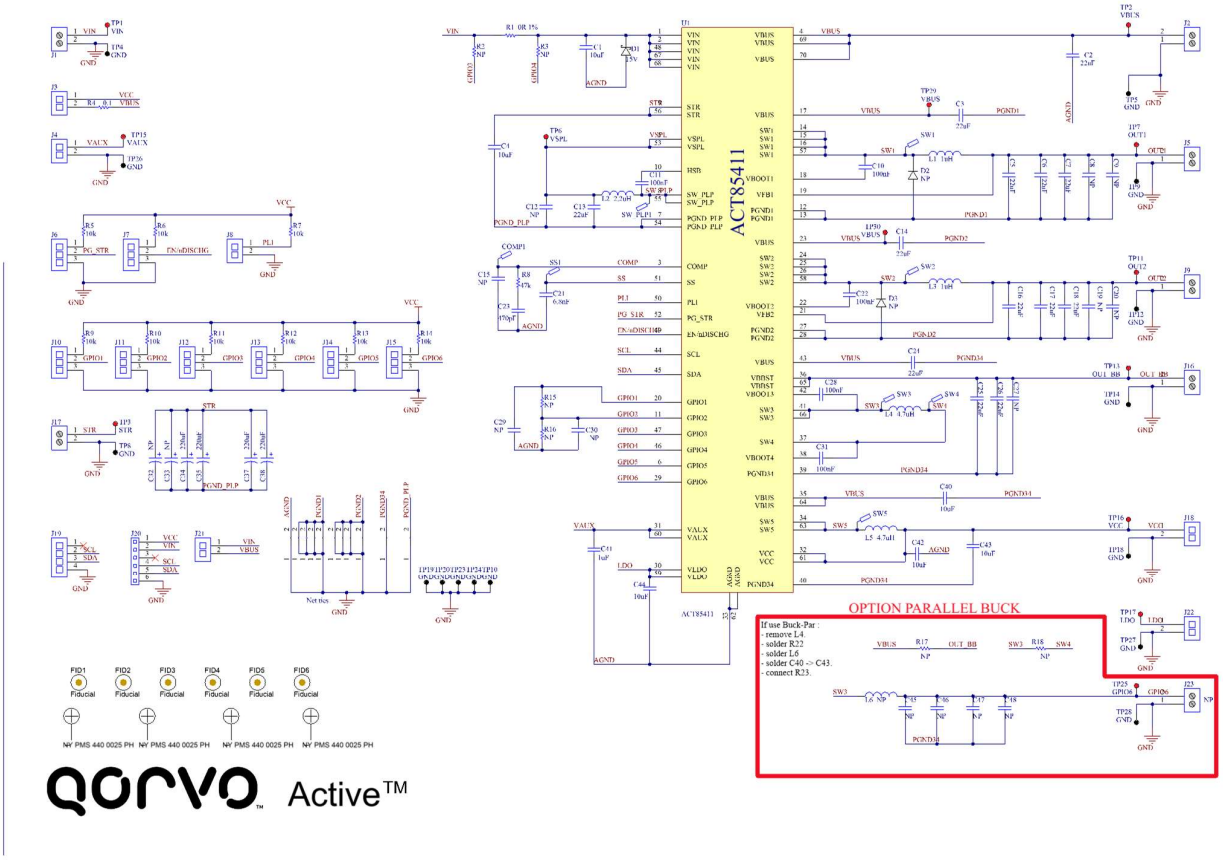


Figure 5 – ACT85411 EVK1-101 Schematic

9.2 Bill of Materials

Table2 - BOM

Item	Designator	Quantity	Description	Package	Manufacturer	Part Number
1	C1, C40	2	Capacitor, Ceramic, 10uF, 25V, 20%, X6S	0603	Standard	Standard
2	C2, C3, C13, C14, C24	5	Capacitor, Ceramic, 22uF, 25V, 20%, X6S	0805	Standard	Standard
3	C4	1	Capacitor, Ceramic, 10uF, 35V, 20%, X6S	0805	Standard	Standard
4	C5, C6, C7, C16, C17, C18, C25, C26	8	Capacitor, Ceramic, 22uF, 25V, 20%, X5R	0805	Samsung	CL21A226MAQNNNE
5	C8, C9, C19, C20, C27, C45, C46, C47, C48	0	Capacitor, Ceramic, 22uF, 25V, 20%, X5R	0805	Samsung	CL21A226MAQNNNE
6	C12	0	Capacitor, Ceramic, 22uF, 25V, 20%, X6S	0805	Standard	Standard

7	C15	0	Capacitor, Ceramic, 10pF, 25V, 20%, X5R	0603	Standard	Standard
8	C21	1	Capacitor, Ceramic, 6.8nF, 25V, 20%, X5R	0603	Standard	Standard
9	C23	1	Capacitor, Ceramic, 470pF, 25V, 20%, X5R	0603	Standard	Standard
10	C10, C11, C22, C28, C31	5	Capacitor, Ceramic, 100nF, 25V, 20%, X6S	0402	Standard	Standard
11	C32, C33	0	Capacitor, Aluminium Electrolytic, 220uF, 35V, 20%	8x10.5	Wurth	865080553014
12	C34, C35, C37, C38	4	Capacitor, Aluminium Electrolytic, 220uF, 35V, 20%	8x10.5	Wurth	865080553014
13	C41	1	Capacitor, Ceramic, 1uF, 25V, 20%, X6S	0603	Standard	Standard
14	C42, C43, C44	3	Capacitor, Ceramic, 10uF, 16V, 20%, X5R	0603	Standard	Standard
15	D1	1	Diode, TVS 15V	DO-214AC	Wurth	824500151
16	D2, D3	0	Schottky, 5A, 20V	SMC (DO-214AB)	Diodes Incorporated	B520C-13-F
17	J1, J2, J5, J9, J16, J17	6	Connector, Screw Terminal, 3.50, 2P	con,tbk,350-2p,kf350	Standard	Standard
18	J3, J4, J8, J18, J21, J22	6	Header, Unshrouded , 2.54, Male, 2P	con,hdr,254-2p	Standard	Standard
19	J6, J7, J10, J11, J12, J13, J14, J15	8	Header, Unshrouded , 2.54, Male, 3P	con,hdr,254-3p	Standard	Standard
20	J19	1	Header, Unshrouded , 2.54, Male, 4P	con,hdr,254-4p	Standard	Standard
21	J20	1	Header, Unshrouded , 1.27, Male, 6P	con,hdr,1.27-6P	Digekey	GRPB061VWVN-RC
22	J23	0	Connector, Screw Terminal, 3.50, 2P	con,tbk,350-2p,kf350	Wurth	691214110002S
23	L1, L3	2	Inductor, 1uH, 12A, 5.5mOhm	4020	Wurth	74439344010
24	L2	1	Inductor, 2.2uH, 8A, 10.5mOhm	6030	Wurth	74439344022
25	L4	1	Inductor, 4.7uH, 3.9A, 39.9mOhm	4030	Wurth	74438357047
26	L5	1	Inductor, 4.7uH, 0.8A, 370mOhm	2512	Wurth	74405020047
27	L6	0	Inductor, 4.7uH, 9.3A, 7mOhm	1210	Wurth	7447709004
28	R1	1	Resistor, 0R, 1%	1206	Standard	Standard
29	R2, R3	0	Resistor, 0R	0603	Standard	Standard
30	R4	1	Resistor, 0.1	0603	Standard	Standard
31	R15	0	Resistor, 10k, 1%	0402	Standard	Standard
32	R5, R6, R7, R9, R10, R11, R12, R13, R14	9	Resistor, 10k	0603	Standard	Standard
33	R8	1	Resistor, 47k	0603	Standard	Standard
34	R16	0	NTC, 10k @ 25°C, -40°C ~ 125°C	0402	Murata	NCU15XH103F60RC
35	R17, R18	0	Resistor, 0R	0805	Standard	Standard
36	TP1, TP2, TP3, TP6, TP7, TP11, TP13, TP15, TP16, TP17, TP29, TP30	12	TEST POINT PC MINI .040"D RED	tpt,keystone-5000	KeyStone	5000
37	TP4, TP5, TP8, TP9, TP10, TP12, TP14, TP18, TP19, TP20, TP23, TP24, TP26, TP27	14	TEST POINT PC MINI .040"D BLK	tpt,keystone-5001	KeyStone	5001

38	TP25	0	TEST POINT PC MINI .040"D RED	tpt,keystone-5000	KeyStone	5000
39	TP28	0	TEST POINT PC MINI .040"D BLK	tpt,keystone-5001	KeyStone	5001
40	U1	1	IC, ACT85411, multiple output power management IC with built-in power loss protection	QFN52,FCSLP-6x6	Qorvo	ACT85411QX101
41	Jumper	4	Shunt, 2.54 mm	/	Standard	Standard
42	PCB	1	PCB, 4-Layer FR4, 100*100*1mm	/	/	PCB-0348-02
43	Label	1	ACT85411EVK1-101, Arail, 6	/	/	/

9.3 PCB Layout

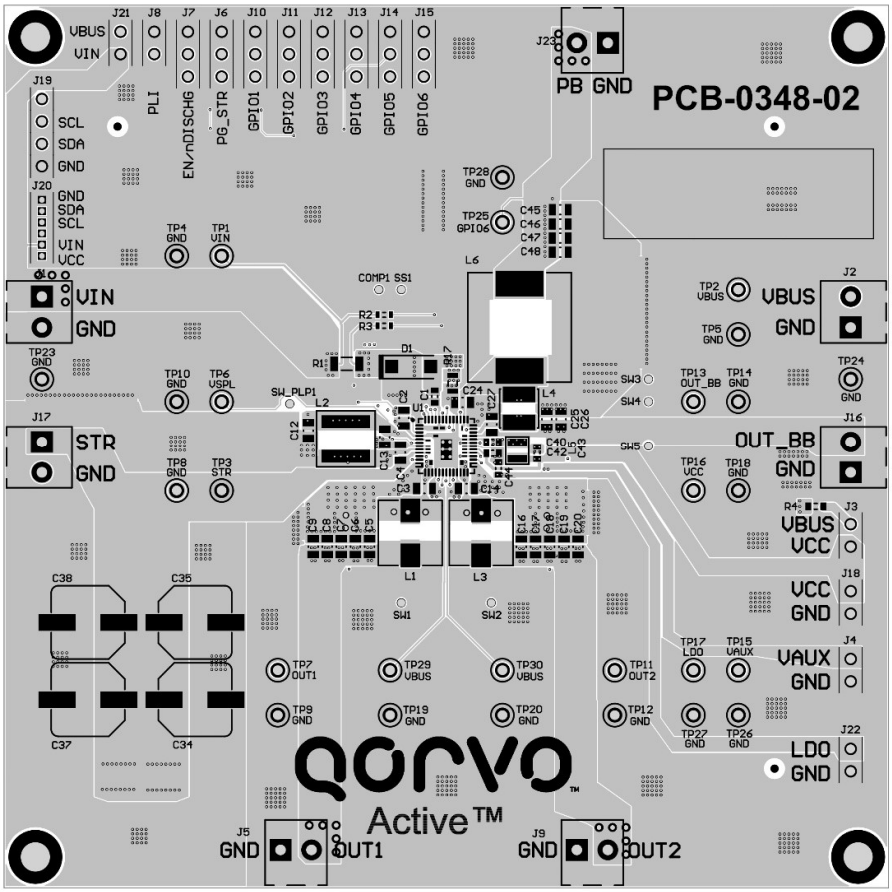


Figure 6 – Layout Top Layer

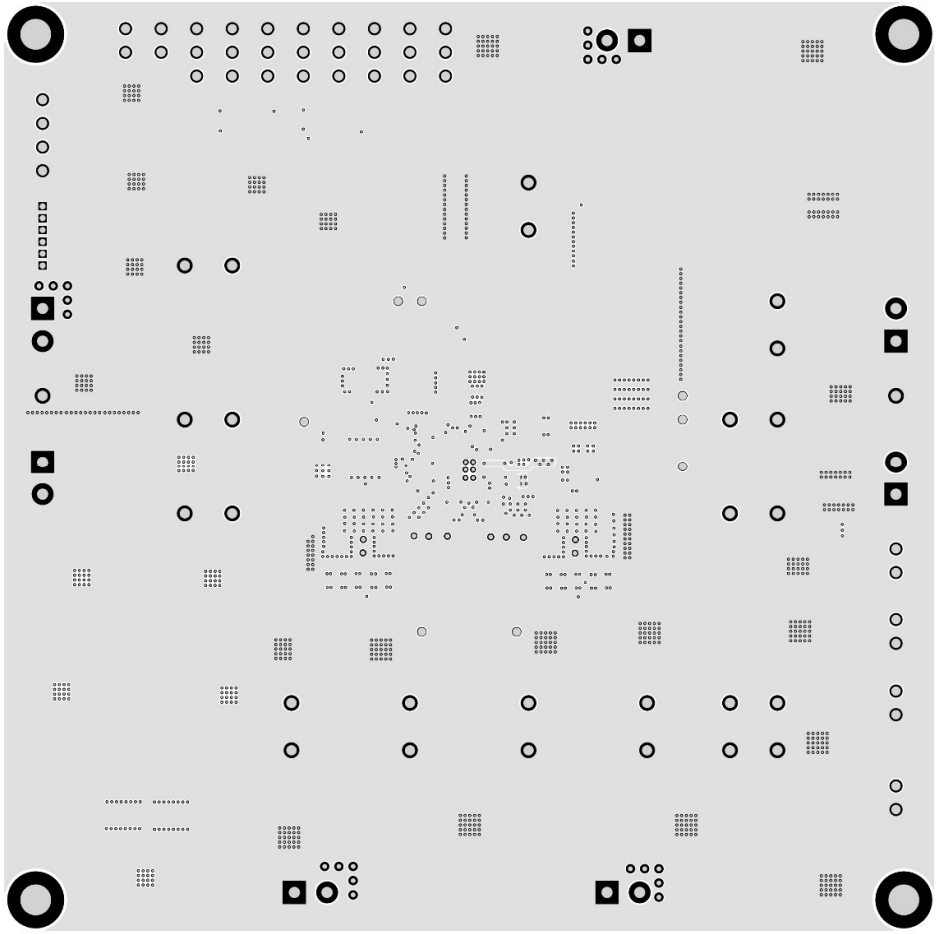


Figure 7 – Layout Layer 2

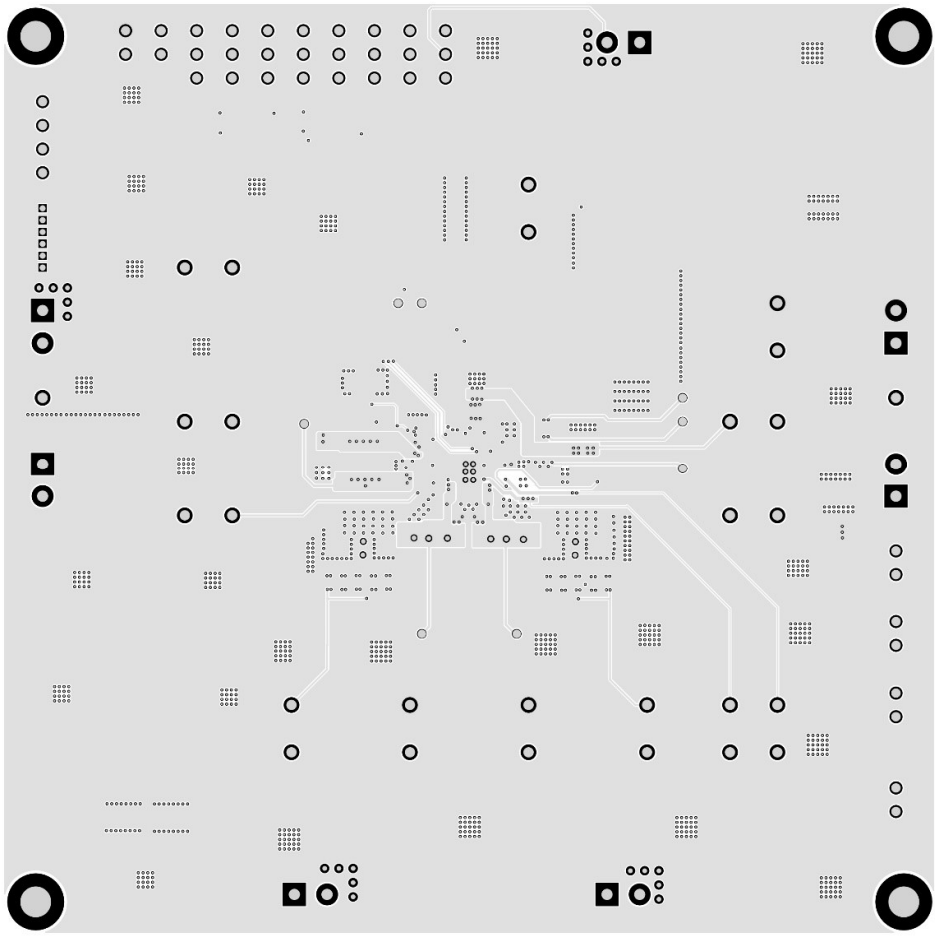


Figure 8 – Layout Layer 3

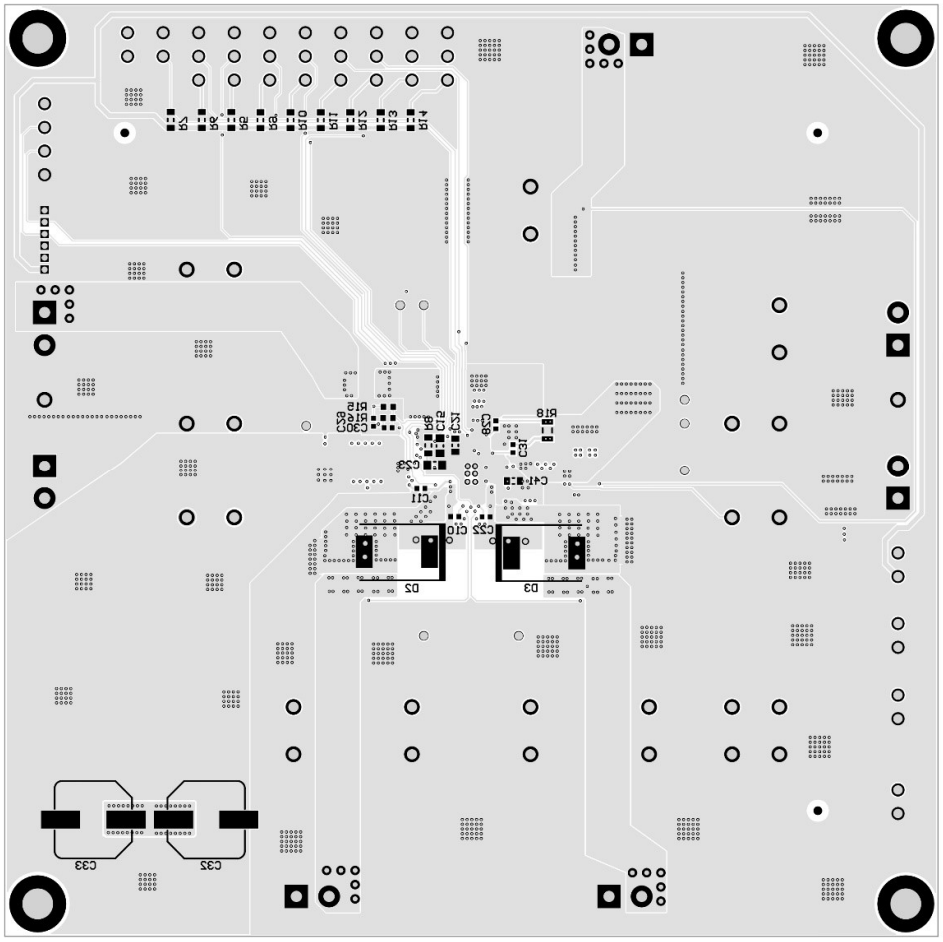


Figure 9 – Layout Bottom Layer

10 ACT85411 GUI

10.1 GUI Installation

1. You can find the ACT85411 GUI files on the Qorvo website. Save them on your computer.
2. Plug the USB-TO-I²C dongle into a free USB port.
3. Follow the instructions of “Qorvo's GUI and Dongle Driver Installation Rev2” in the folder.
4. Double click on the ACT85411 GUI Rev4.4.1.exe to start the ACT85411 GUI.

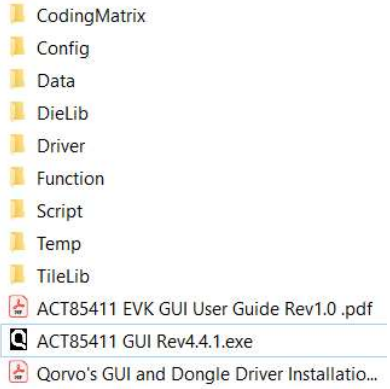


Figure 10 – GUI Folder

10.2 GUI Overview

The GUI has 2 basic function buttons allocated in top-left of the Tool Bar which are Read and Write I2C. The GUI contains 2 setting modes: Setting Mode and Register Mode. In Setting screen it displays basic user programmable configuration options are programmed using the drop-down boxes or check boxes. Register contains the button text for changing setting for every single bit.

Setting Mode: The following figure shows the GUI in Setting mode. This mode allows the user to easily change one or more IC settings.

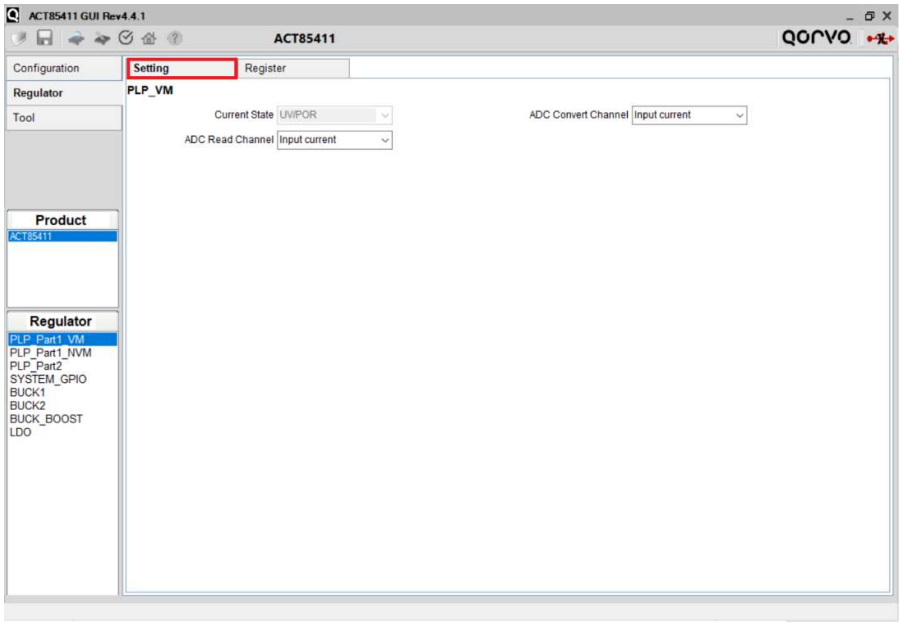


Figure 2 – GUI Setting Mode

Register Mode: Click the “Register” button in the top-left of the GUI screen to see all available user programmable options. With Register Mode, additional user programmable features can be selected using the button text. In the left side of the Advanced Mode Screen, click on the Tiles Selector to display the register to view or change. Then change a register one bit at a time by clicking on the desired bit. The value of the bit is display right next to the bit-name button.

Note that the far-right side of the screen contains a scroll down button to scroll down to additional registers since the Tile Screen can only display up to 8 bytes at once.

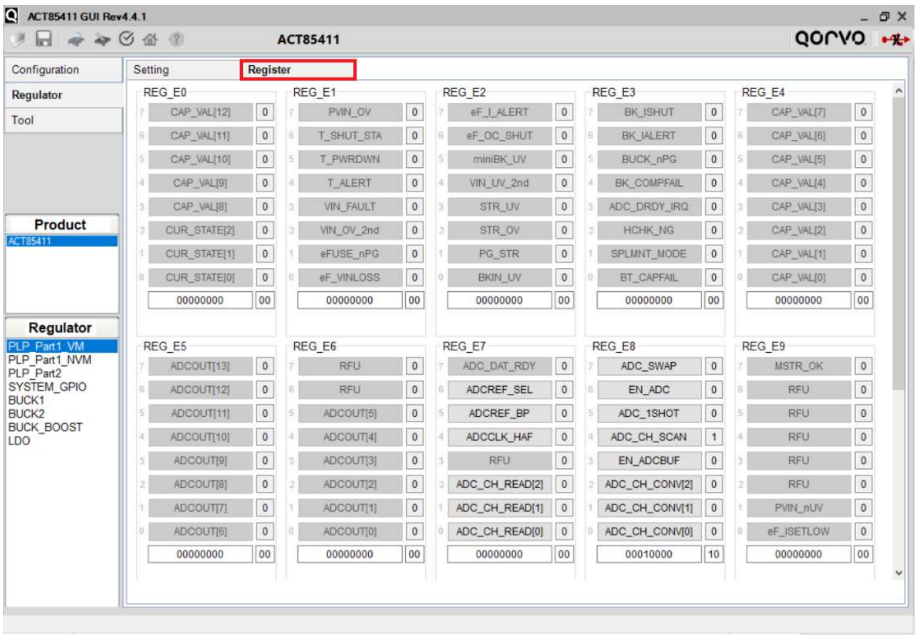


Figure 12 – GUI Register Mode

10.3 GUI Button Descriptions

Read: Clicking on this button reads the ACT85411 registers and displays them in the GUI. Note that this reads all registers. Qorvo recommends reading registers each time the ACT85411 powers-up to acquire the initial register settings. Qorvo also recommends reading registers after making changes to them. Immediately reading the registers after a write confirms the changes were properly stored. This also updates the SYSTEM STATUS box to ensure that one of the changes did not generate a fault condition.

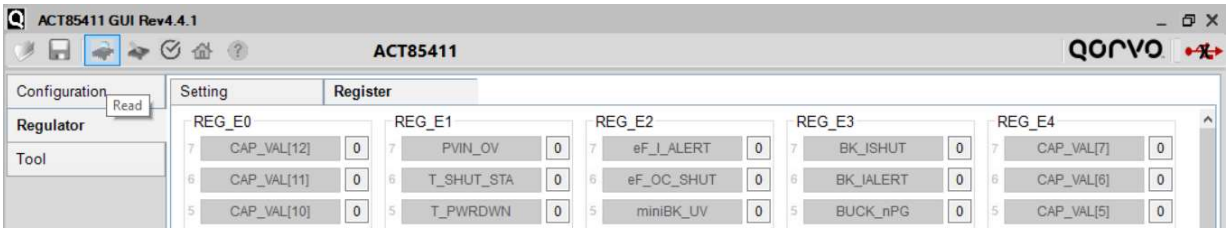


Figure 3 – Read Button

Write: Clicking on this button writes the GUI settings to the ACT85610's registers. All registers are written, regardless of whether or not they were changed.

Figure 4 – Write Button

Dongle Connection Status: The GUI also contains a dongle is connected status which indicates that Active-Semi's USB-TO-I2C dongle is connected to the USB port of the driver installed. The figure below shows the two possible indication status graphics.

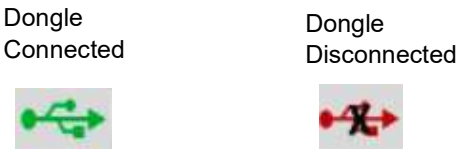


Figure 5– Dongle Connection Status

11 Revision History

No.	Revision	Date	Descritpion
1	Rev.D	Oct 24, 2023	First edition released.
2	Rev.E	Jun 03, 2024	Second edition released.