ACT85610EVK1-101 User's Guide

Description

This document describes the characteristics and operation of the Qorvo ACT85610EVK1-101 evaluation kit (EVK). It provides setup and operation instructions, schematic, layout, BOM, and test data. This EVK demonstrates the ACT85610QX101 Active PMU power management IC. Other ACT85610QXxxx options can be evaluated on this EVK by replacing the IC and any other necessary components.

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 ACT85610EVK1-101 is specifically configured for the ACT85610QX101.

Figure 1– EVK Picture

EVK Contents

The ACT85610EVK1-101 evaluation kit comes with the following items:

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

Required Equipment

ACT85610EVK-101

USB-TO-I2C Dongle

Power supply – 12V @ 6A for full power operation

Oscilloscope – >100MHz, >4 channels

Loads – Electronic or resistive. 6.0A minimum current capability.

Digital Multi-meters (DMM)

Windows compatible computer with spare USB port.

Hardware Setup

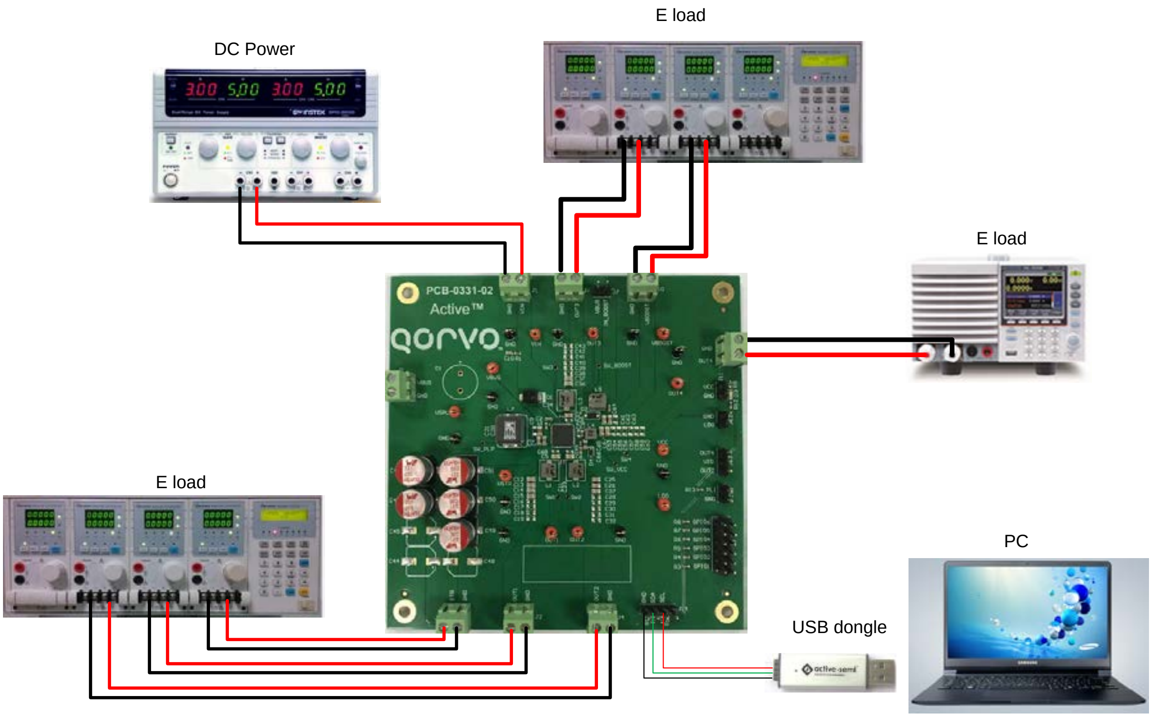


Figure 2 – EVK Setup

Quick Start

Hardware Setup

1. Decide which voltage will power VIO. Qorvo recommends powering VIO from the OUT4. Install a shorting jumper between J13-2 and J13-3 to power VIO from the OUT4 output voltage. Or connect a shorting jumper between J13-1 and J13-2 to power VIO from the OUT2 output voltage.
2. Connect a lab supply between J1-1 and J1-2 to power VIN.
3. Connect a shorting jumper to J7 to power the Boost input voltages from VBUS.
4. Connect a shorting jumper between J9-3 (GPIO5) and J9-4 (GND). This connection is required for ACT85610QX-101.
5. Note that the typical setup is to apply the same 12V input voltage to all inputs. Using different input voltage sources requires careful consideration of startup sequencing.
6. Connect an appropriate load to each power supply output.
7. Turn on the lab supplies.
8. The outputs turn on automatically when voltage is applied to VIN.

GUI Setup (optional)

1. Refer to the end of this document for detailed instructions to install the ACT85610 GUI.
2. Connect the USB-TO-I2C dongle to the computer via a USB cable.
3. Connect the USB-TO-I2C dongle to the EVK J14 connector. Refer to Figure 4 to ensure the correct polarity of the connection. As a guide, use the "Qorvo" logo or ("Active-Semi") logo on the top of the dongle so the black wire is connected to the Dongle GND pin.

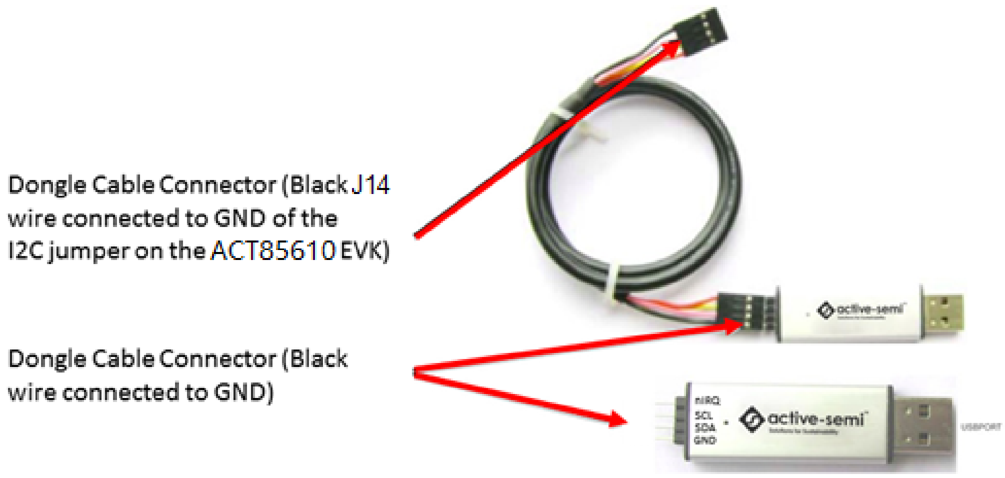


Figure 3 – USB-TO-I2C Dongle Connection

EVK Design Parameters

The ACT85610EVK1-101 is designed for a 12V input voltage. The maximum operating voltage is determined by the IC's maximum input voltage rating. The minimum operating voltages are determined by the VIN_UV. 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	6	12	13.1	V
Vstr	The storage capacitor voltage		28		V
V_{PLP_Buck}	Supplement mode voltage of PLP_Buck		4.3		V
V_{LDO}	LDO output voltage		2.5		V
I_{B1_max}	Maximum Buck 1 load current		4.0	6.0	A
I_{B2_max}	Maximum Buck 2 load current		4.0	6.0	A
I_{B3_max}	Maximum Buck 3 load current		4.0	6.0	A
I_{B4_max}	Maximum Buck 4 load current		2.0	3.0	A
I_{Boost_max}	Maximum Boost load current			1	A
I_{VCC_max}	Maximum VCC load current			0.1	A

EVK Operation

Turn On

Apply the 12V input voltage. All outputs automatically turn on with the programmed startup sequence.

Health Checking

The ACT85610 has an internal health monitor for the storage capacitors. It applies a constant 10mA for a selected period or 50mA current for 200us and monitors the storage capacitor voltage drop. If the voltage drops below a predetermined level (HMON_THR), the PG_STR pin indicates a fault.

Hard RESET

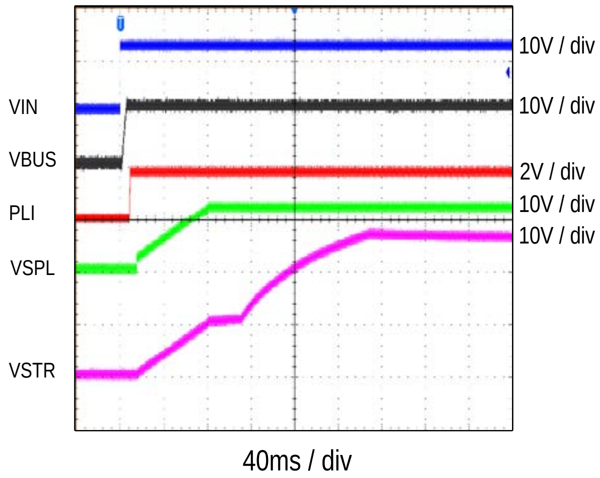
GPIO5 is used for the Hard RESET function. It is defined as an active high input. After system start up, drive GPIO5 from low to high to shut down all outputs and put the IC back in the POR state. If the 12V input voltage is still applied, pulling GPIO5 from high to low restarts the system.

Discharge Function

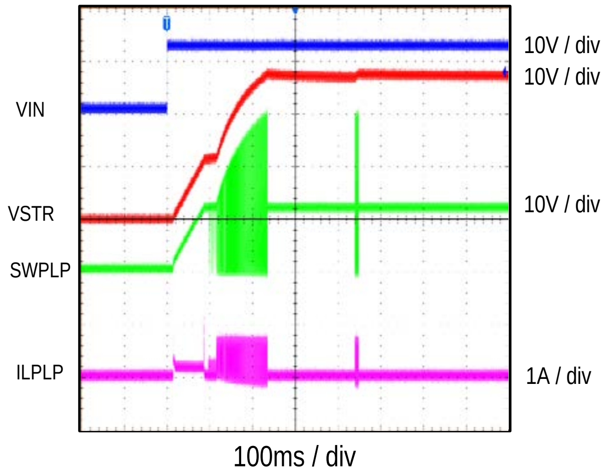
Discharge function is used to discharge VBUS and STR. It is disabled by default. To enable the Discharge functions, set bit 2 of register 0xEBh to “1” through the GUI. Pull GPIO3 high to activate this function.

Test Results

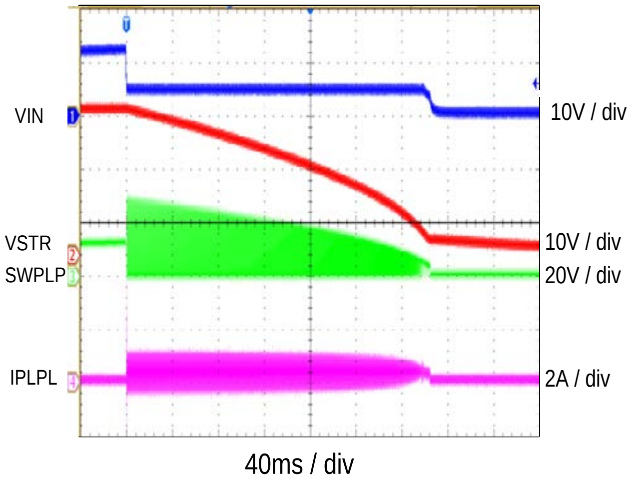
CMI 101
Startup with Hot Plug



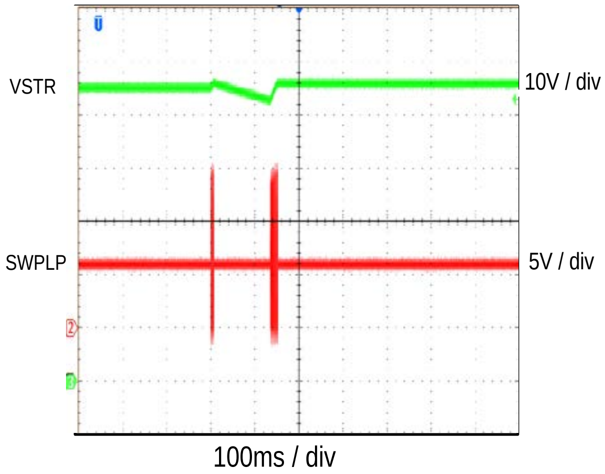
CMI 101
STR Charge at Start-up



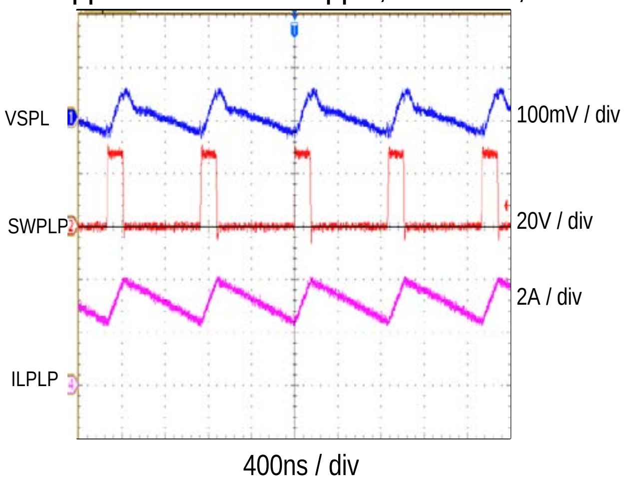
CMI 101
STR Charge at Start-up



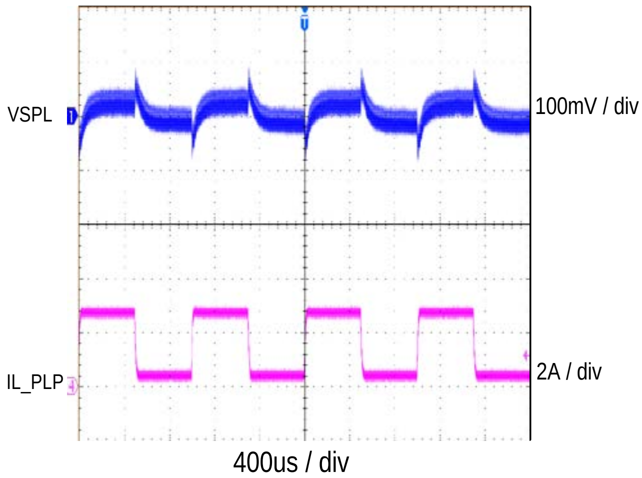
CMI 101
PLP Health Check,STR Cap=1100uF



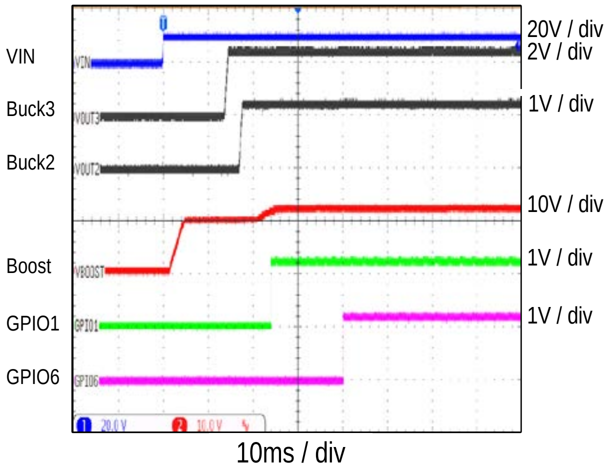
CMI 101
Supplement SW and Ripple,VSTR=28V,Io=3A



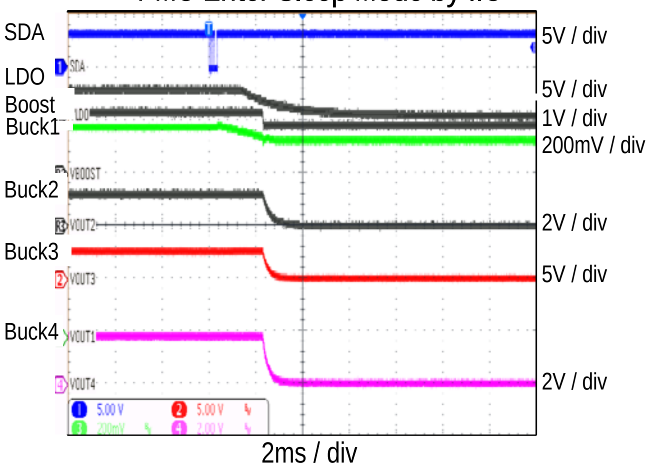
CMI 101
Supplement Load Transient,VSTR=28V,0.3A-2.7A



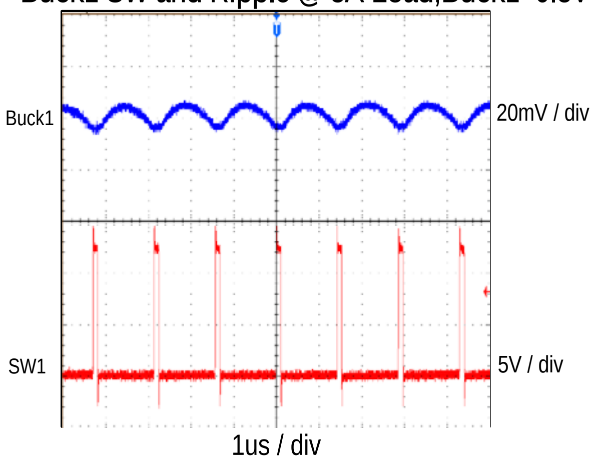
CMI 101
PMU Start Sequence



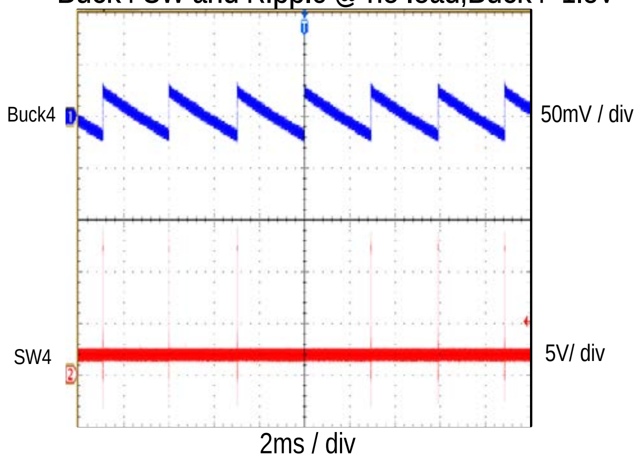
CMI 101
PMU Enter Sleep Mode by IIC



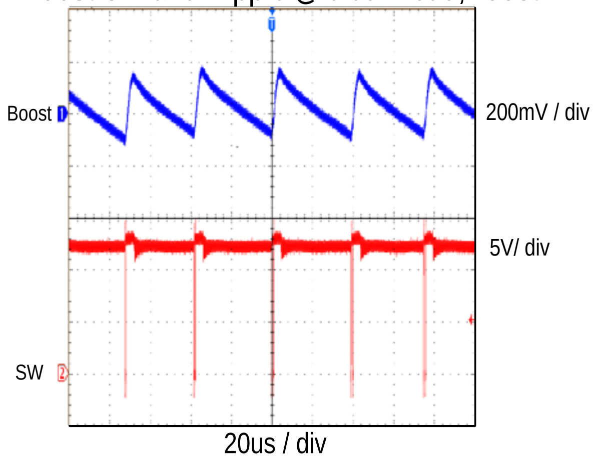
CMI 101
Buck1 SW and Ripple @ 3A Load,Buck1=0.8V



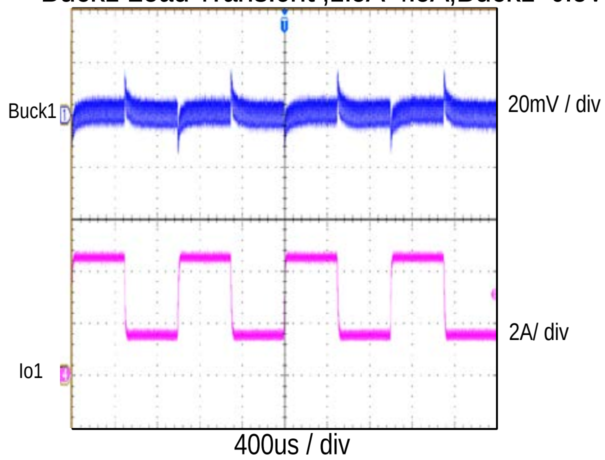
CMI 101
Buck4 SW and Ripple @ no load,Buck4=1.8V



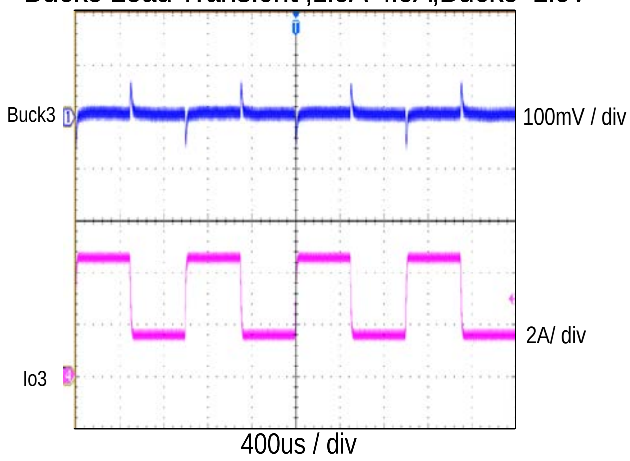
CMI 101
Boost SW and Ripple @ 0.05A load,Boost=12V



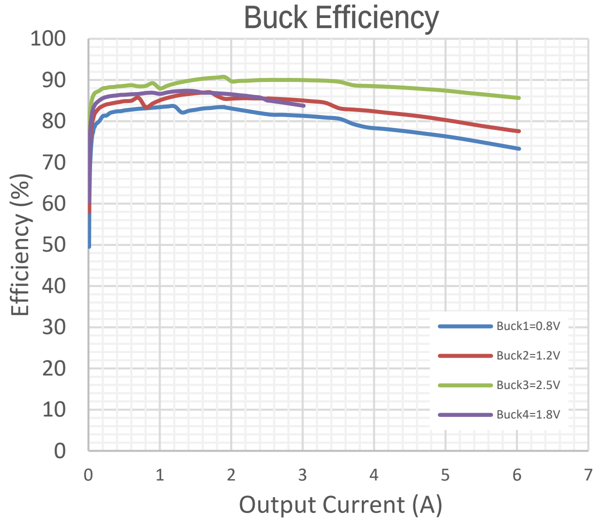
CMI 101
Buck1 Load Transient ,1.5A-4.5A,Buck1=0.8V



CMI 101
Buck3 Load Transient ,1.5A-4.5A,Buck3=2.5V



CMI101
Buck Efficiency



Schematic

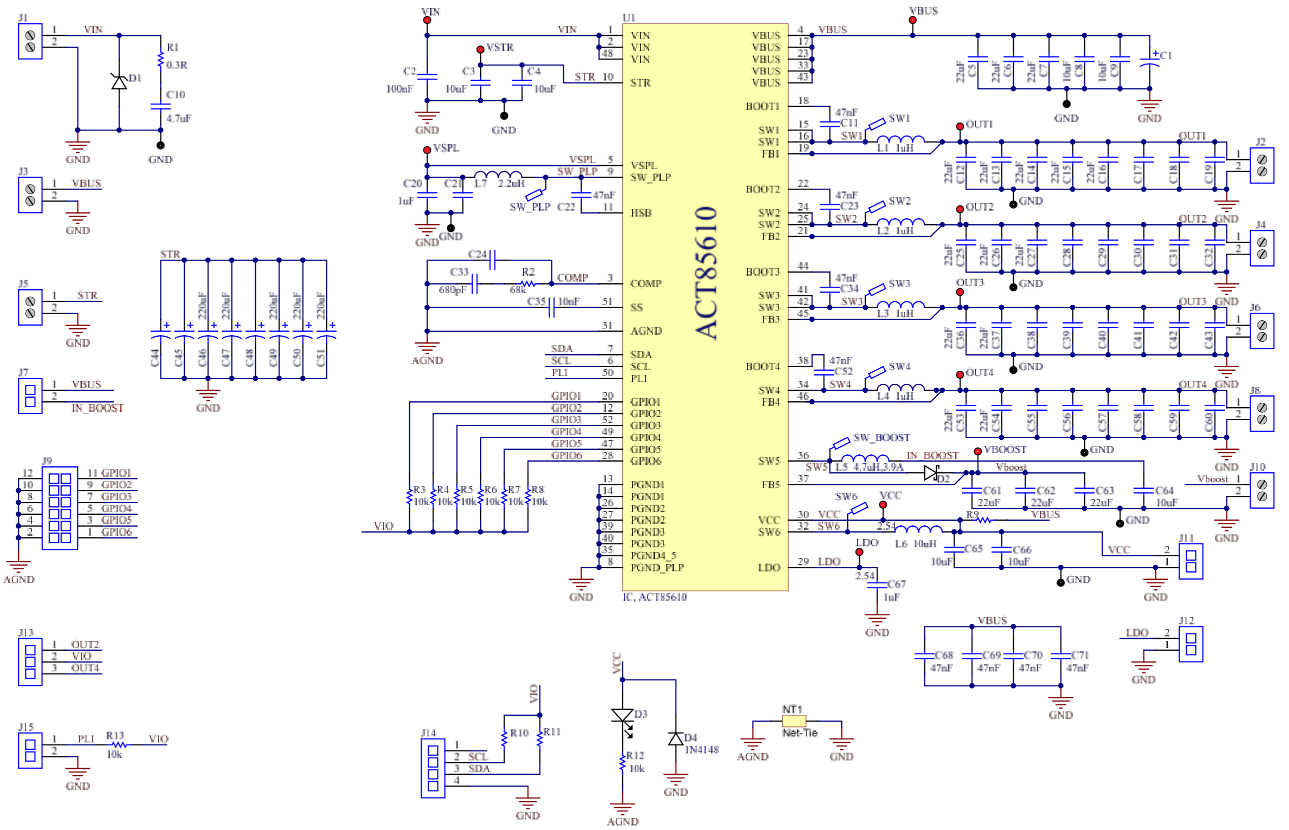


Figure 4 – ACT85610 EVK1-101 Schematic

Layout

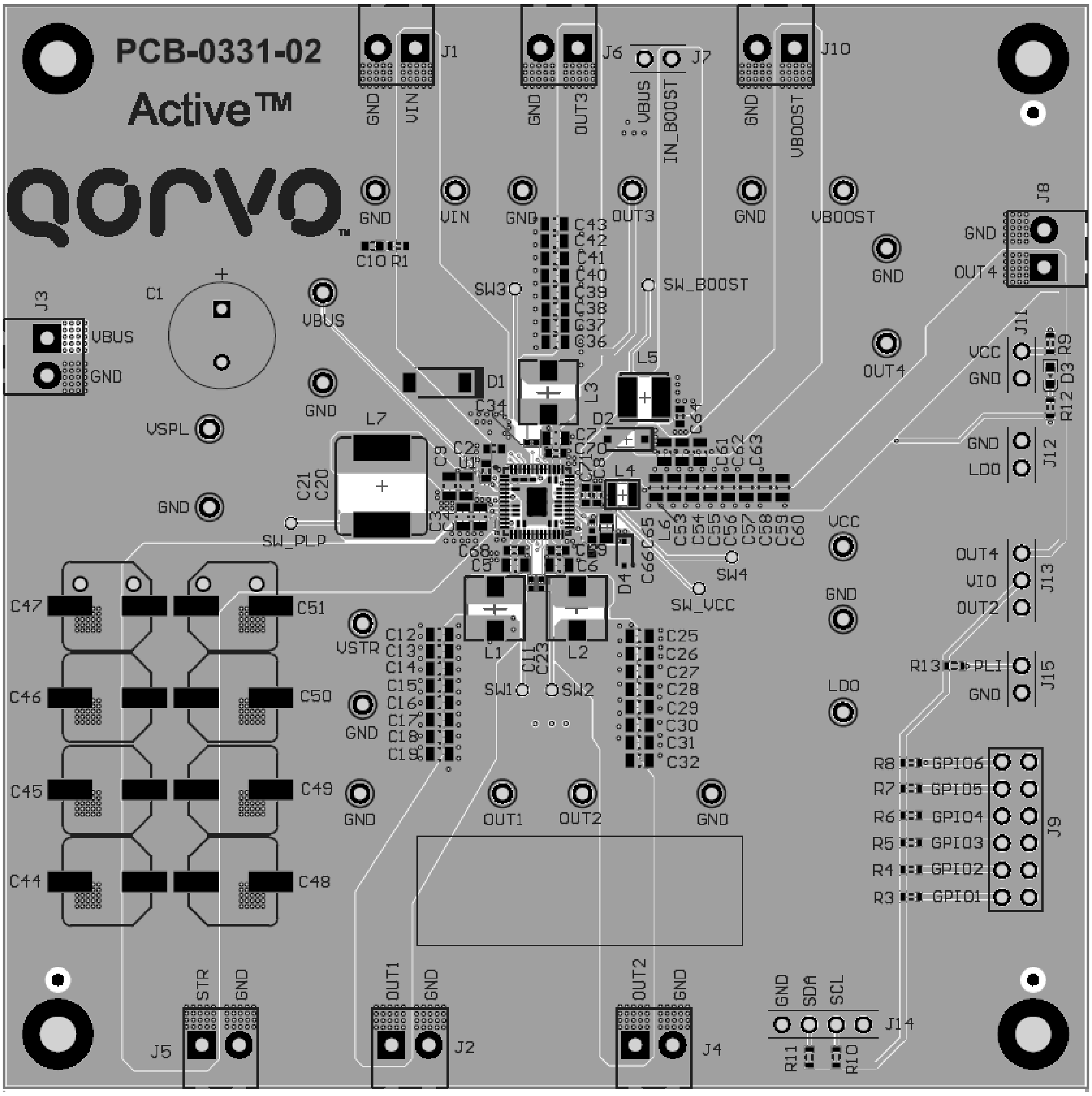


Figure 5 – Layout Top Layer

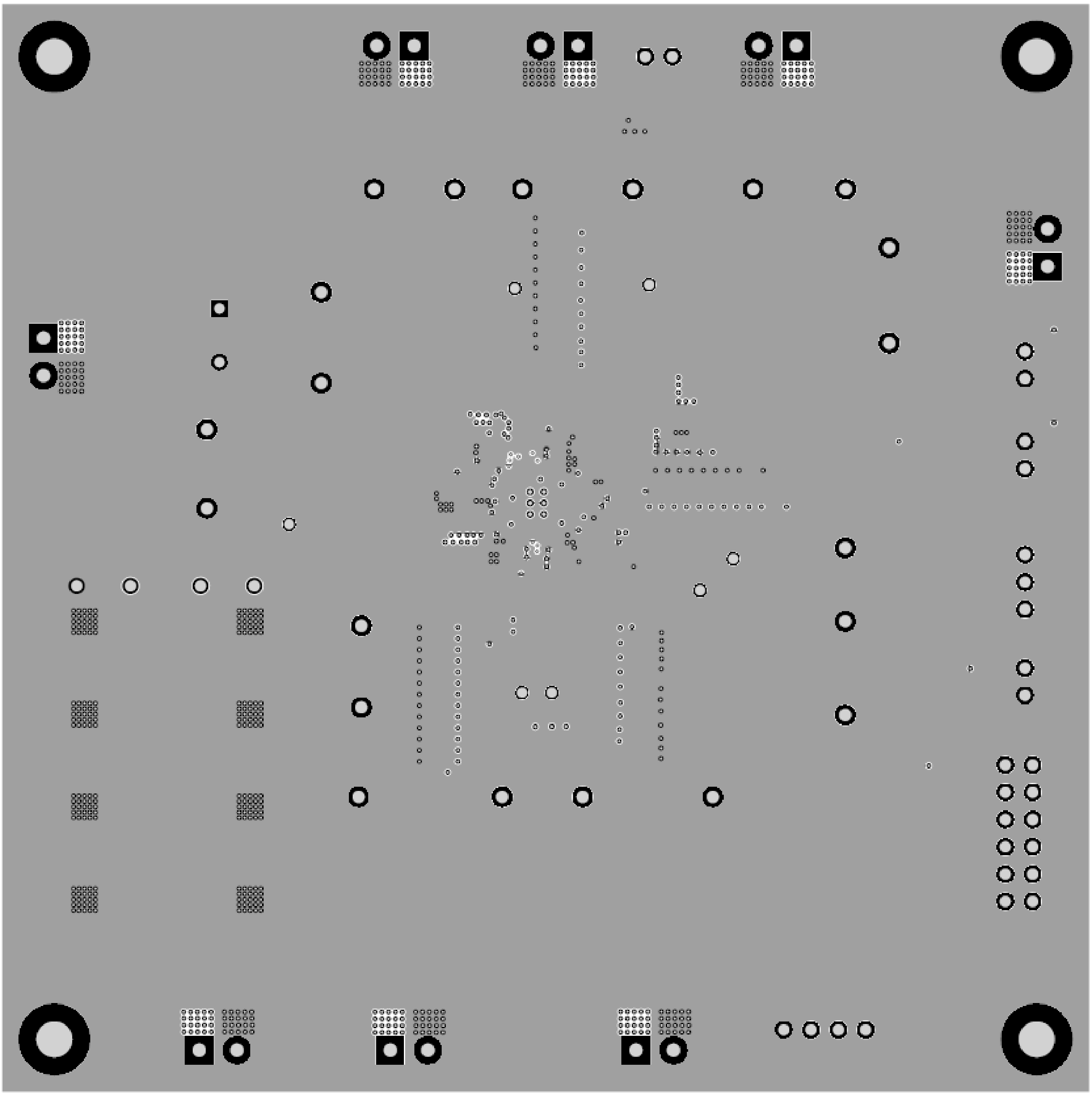


Figure 6 – Layout Layer 2

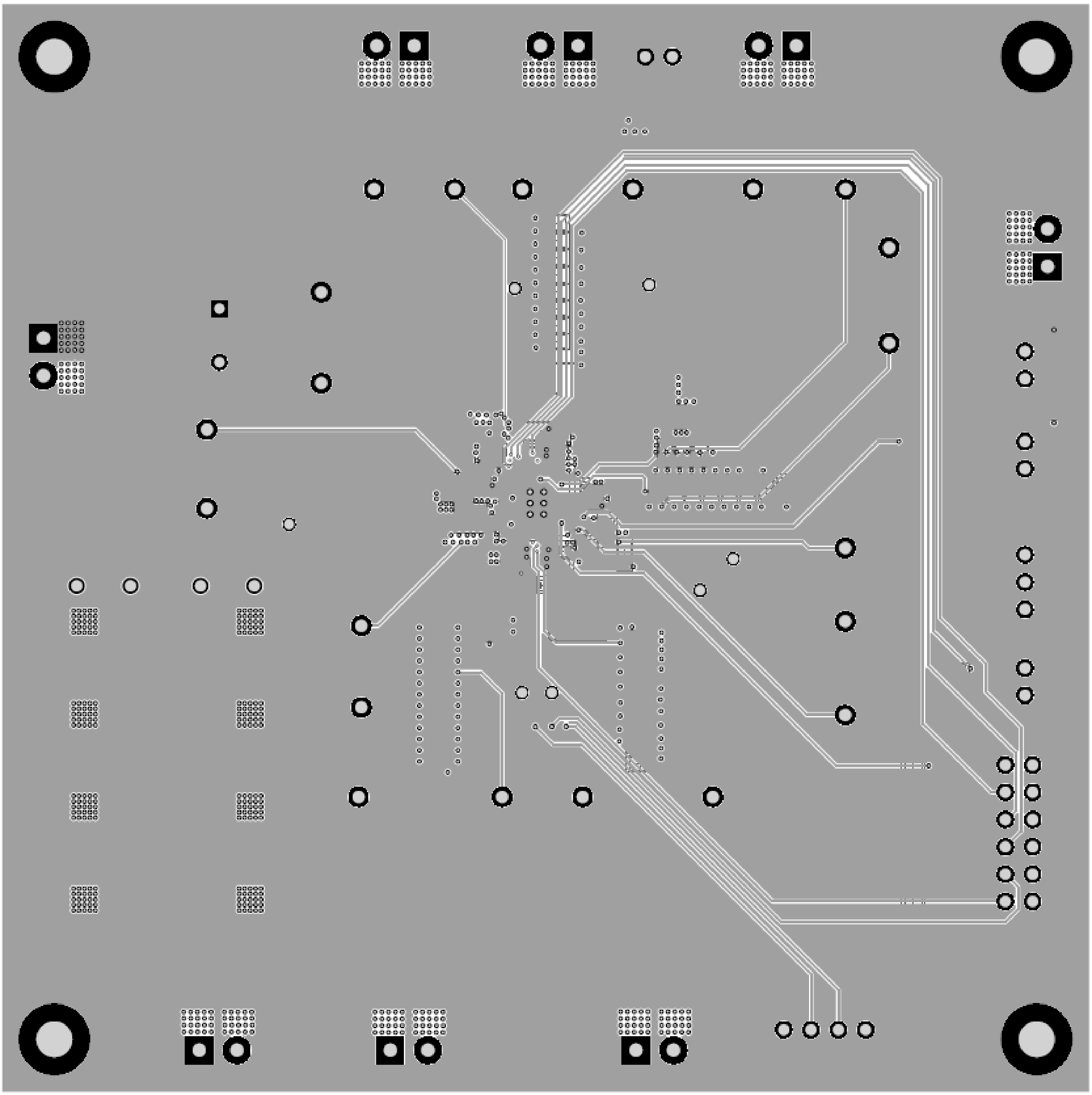


Figure 7 – Layout Layer 3

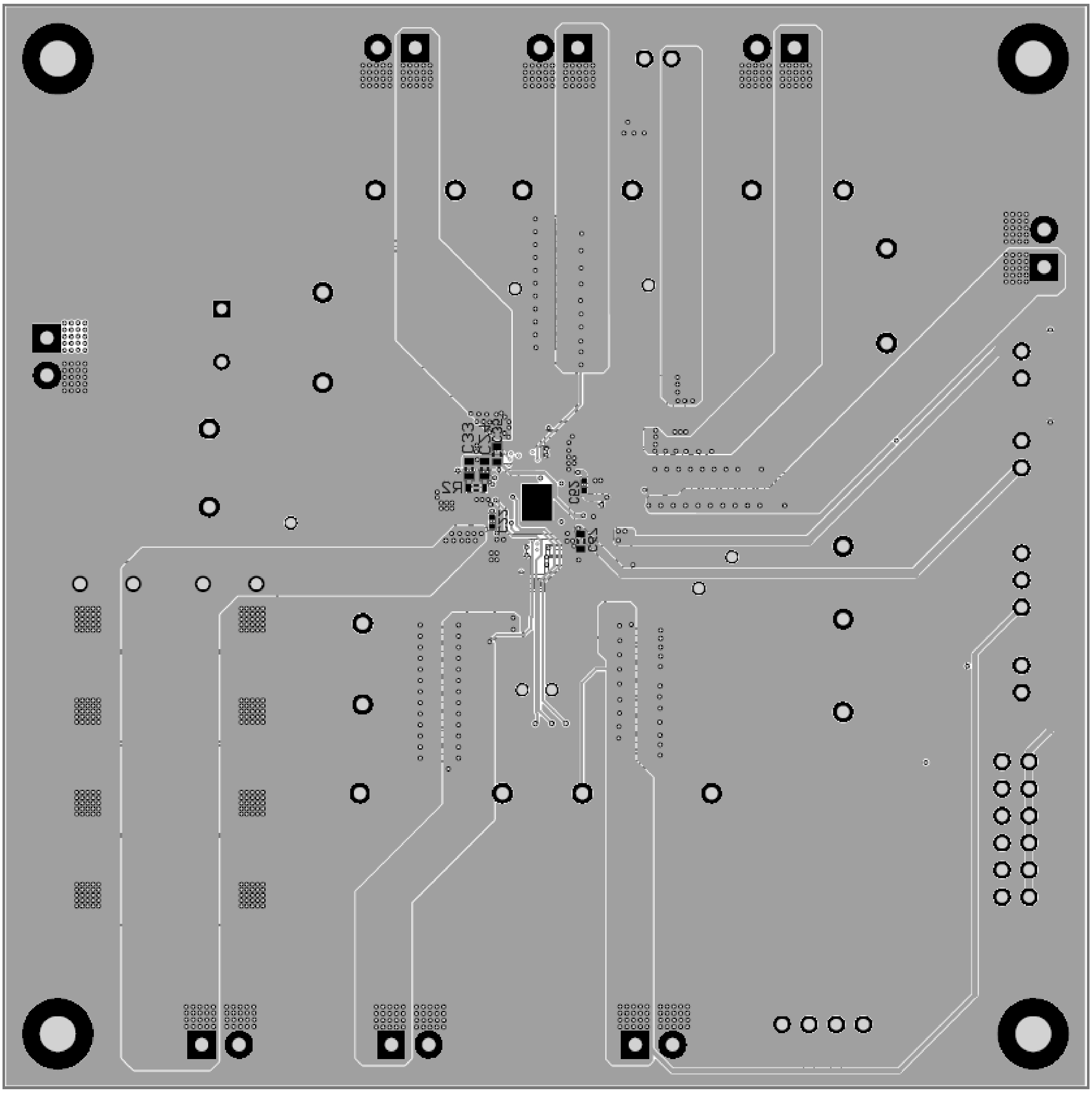


Figure 8 – Layout Bottom Layer

Bill of Materials

Table 2 – BOM

Item	Designator	Quantity	Description	Package	Manufacturer	Part Number
1	C1	0	Cap, Aluminium Electrolytic, 220uF, 35V	6.3*11mm	Wurth Elektronik	860010674014
2	C2	1	Cap, Ceramic,100nF, 35V, 20%, X5R	603	std	std
3	C3, C4, C61, C62	3	Cap, Ceramic, 10uF, 35V, 20%, X5R	805	std	std
4	C63	0	Cap, Ceramic, 10uF, 35V, 20%, X5R	805	std	std
5	C5, C6, C7, C12, C13, C14, C15, C16, C25, C26, C27, C36, C37, C53, C54	15	Cap, Ceramic, 22uF, 25V, 20%, X5R	805	std	std
6	C8, C9, C64, C66	4	Cap, Ceramic, 10uF, 25V, 20%, X5R	603	std	std
7	C10	1	Cap, Ceramic, 4.7uF, 25V, 20%, X5R	603	std	std
8	C11, C22, C23, C34, C52	5	Cap, Ceramic,47nF, 10V, 20%, X5R	402	std	std
9	C17, C18, C19, C28, C29, C30, C31, C32, C38, C39, C40, C41, C42, C43, C55, C56, C57, C58, C59, C60	0	Cap, Ceramic, 22uF, 25V, 20%, X5R	805	std	std
10	C20	1	Cap, Ceramic, 1uF, 25V, X5R	805	std	std
11	C21	0	Cap, Ceramic, 1uF, 25V, X5R	805	std	std
12	C24	0	Cap, Ceramic,1pF, 25V, 20%, X5R	603	std	std
13	C33	1	Cap, Ceramic, 680pF, 50V	603	std	std
14	C35	1	Cap, Ceramic, 22nF, 25V, 20%, X5R	603	std	std
15	C46, C47, C49, C50, C51	5	Cap, Aluminium Electrolytic, 220uF, 35V	8*10.8mm	Wurth Elektronik	865080553014
16	C44, C45, C48	0	Cap, Aluminium Electrolytic, 220uF, 35V	8*10.8mm	Wurth Elektronik	865080553014
17	C65	1	Cap, Ceramic,10uF, 10V, 20%, X5R	402	std	std
18	C67	1	Cap, Ceramic,1uF, 25V, 20%, X5R	603	std	std
19	C68, C69, C70, C71	4	Cap, Ceramic, 47nF, 25V, 20%, X5R	603	std	std
20	D1	1	Power TVS Diode, 15V/24.6A	D0-214AA	Wurth Elektronik	824520151
21	D2	1	Diode, Schottky, 40V/3A	SOD123	Nexperia	PMEG40T30ER
22	D3	1	LED, Blue	603	std	std
23	D4	1	Diode, 1N4148, 75V/150mA	SOD323	std	std
24	J1, J2, J3, J4, J5, J6, J8, J10	8	CON, Screw Terminal, 3.50, 2P, KF350		Wurth Elektronik	691214110002
25	J7, J11, J12, J15	4	Header, Unshrouded , 2.54, Male, 2P	CON2	Wurth Elektronik	61300211121
26	J9	1	Header, Unshrouded , 2.54, Male, 6x2P	CON6x2	Wurth Elektronik	61301221121
27	J13	1	Header, Unshrouded , 2.54, Male, 3P	CON3	Wurth Elektronik	61300211121
28	J14	1	Header, Unshrouded , 2.54, Male, 4P	CON4	Wurth Elektronik	61300211121
29	L1, L2, L3	3	Inductor, 1uH	4020	Wurth Elektronik	74438356010
30	L4	1	Inductor, 1uH	3020	Wurth Elektronik	74438336010
31	L5	1	Inductor, 4.7uH, 3.9A	4030	Wurth Elektronik	74438357047

32	L6	1	Inductor, 10uH, 0.7A	806	Wurth Elektronik	74479777310A
33	L7	1	Inductor, 2.2uH	8070	Wurth Elektronik	7443340220
34	LDO, OUT1, OUT2, OUT3, OUT4, VBOOST, VBUS, VCC, VIN, VSPL, VSTR	11	TEST POINT PC MINI .040"D RED		std	std
35	R1	1	Res, 0.3Ω, 5%	603	std	std
36	R10, R11	0	Res, 10kΩ, 5%	603	std	std
37	R2	1	Res, 68kΩ, 5%	603	std	std
38	R3, R4, R5, R6, R7, R8, R12, R13	8	Res, 10kΩ, 5%	603	std	std
39	R9	0	Res, 0Ω, 5%	603	std	std
40	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10	10	TEST POINT PC MINI .040"D BLK		std	std
41	U1	1	IC, ACT85610QX101	QFN52, FCSLP-6x6	Active-Semi	ACT85610QX101

GUI Installation

1. You can find the ACT85610 GUI files on the Qorvo website. Save them on your computer.
2. Plug the USB-TO-I^{2}C dongle into a free USB port.
3. Follow the instructions of “Qorvo's GUI and Dongle Driver Installation Rev1.1” in the “Driver” folder.
4. Double click on the ACT85610 GUI Rev1.0.exe to start the ACT85610 GUI.

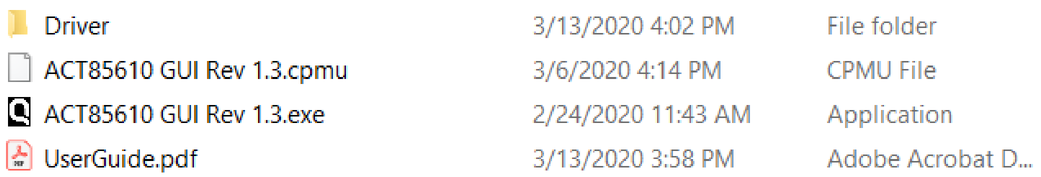


Figure 9 – GUI Folder

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: Basic Mode and Advanced Mode. In Basic Mode screen it displays basic user programmable configuration options are programmed using the drop-down boxes or check boxes. Advanced Mode contains the button text for changing setting for every single bit.

Basic Mode

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

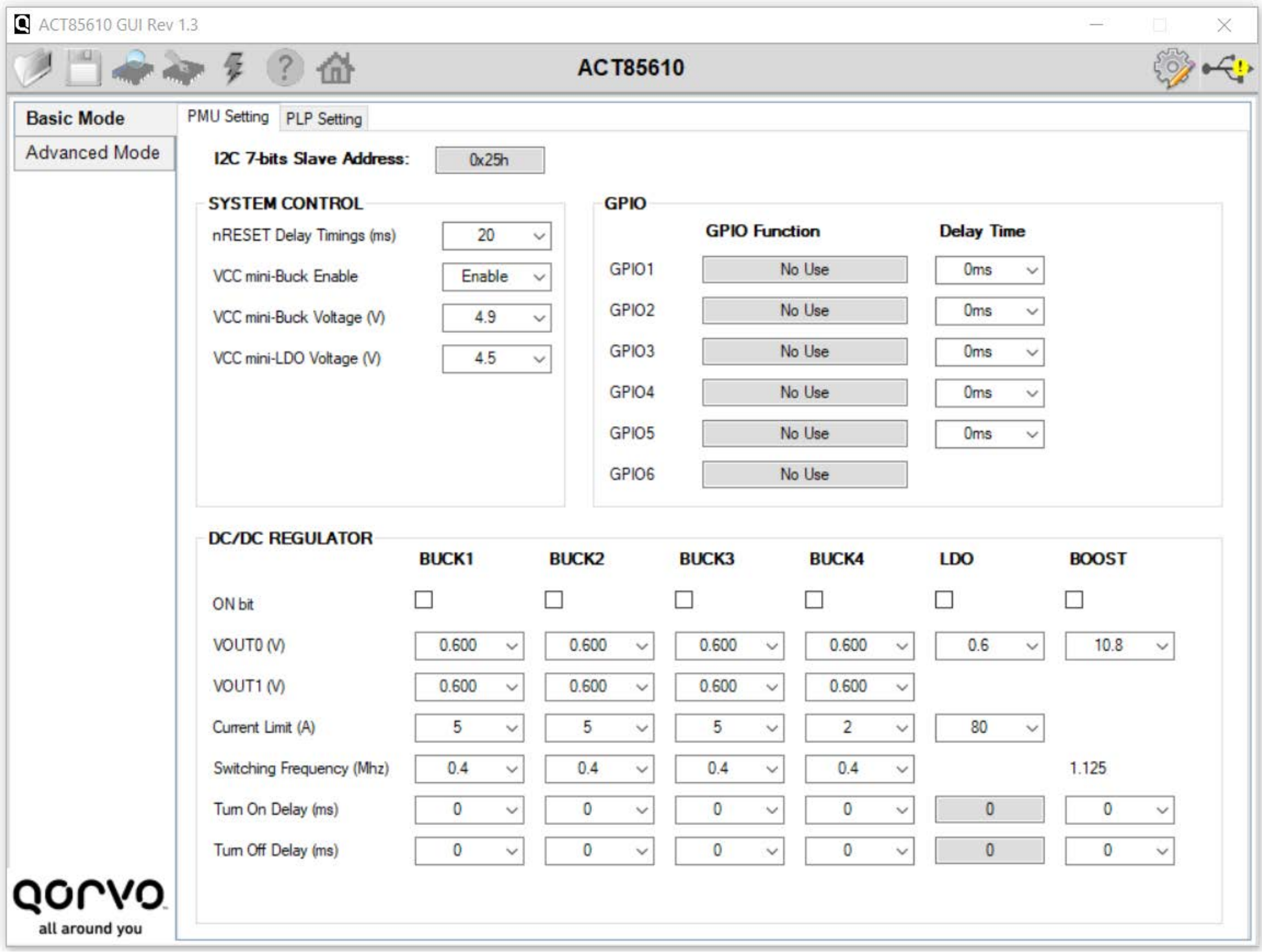


Figure 10 – GUI Basic Mode

Advanced Mode

Click the "Advanced Mode" button in the left of the GUI screen to see all available user programmable options. With Advanced 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.

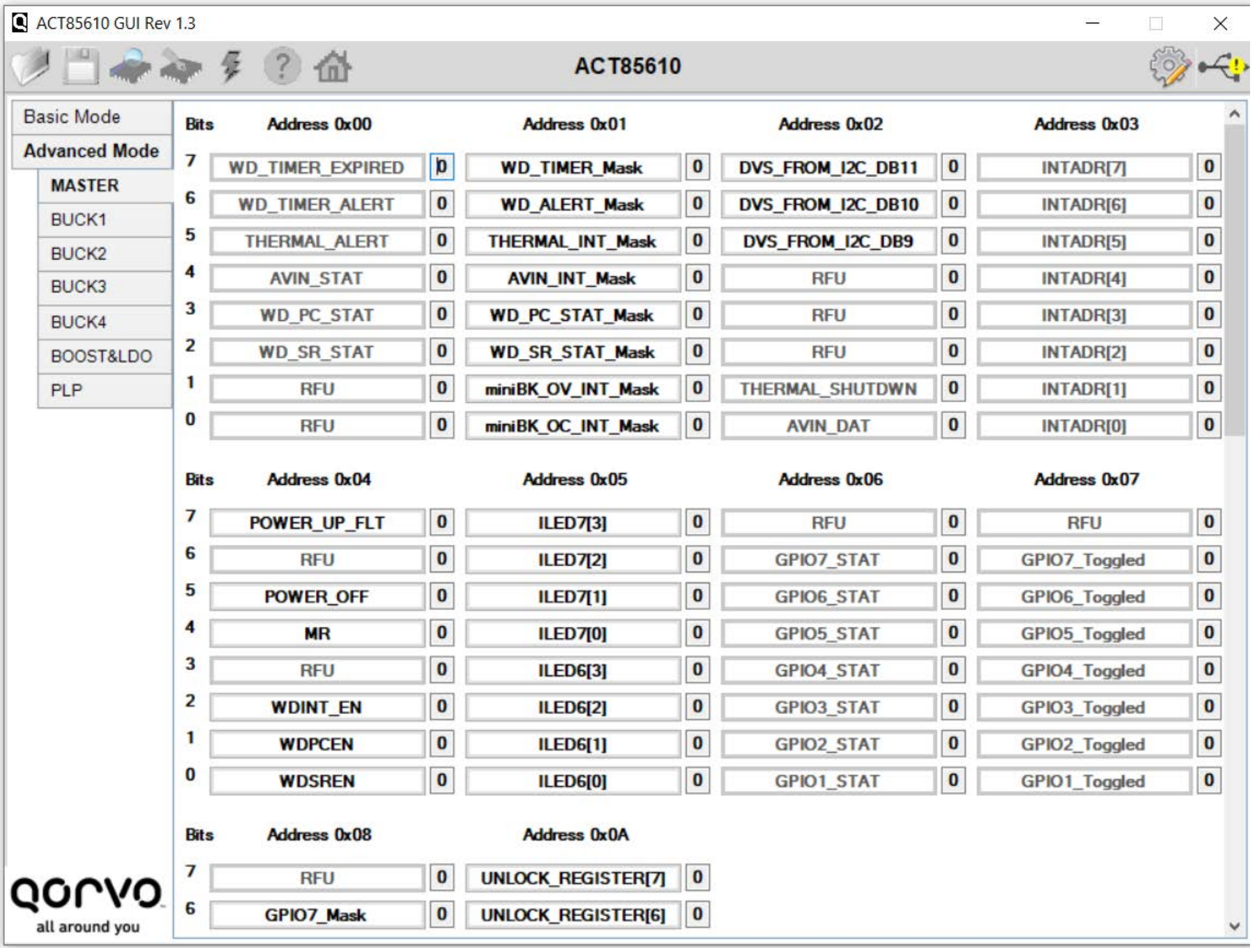


Figure 11 – GUI Advanced Mode

Button Descriptions

Read: Clicking on this button reads the ACT85610 registers and displays them in the GUI. Note that this reads all registers. Active-Semi recommends reading registers each time the ACT85610 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.

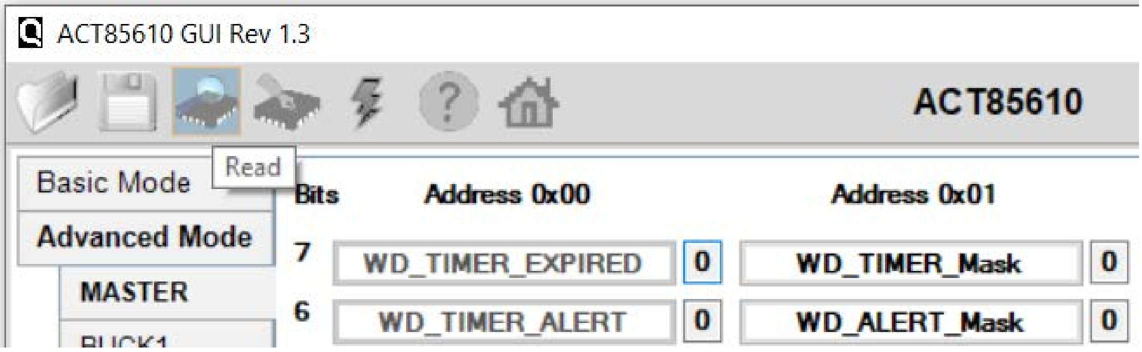


Figure 12 – Read Button

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.

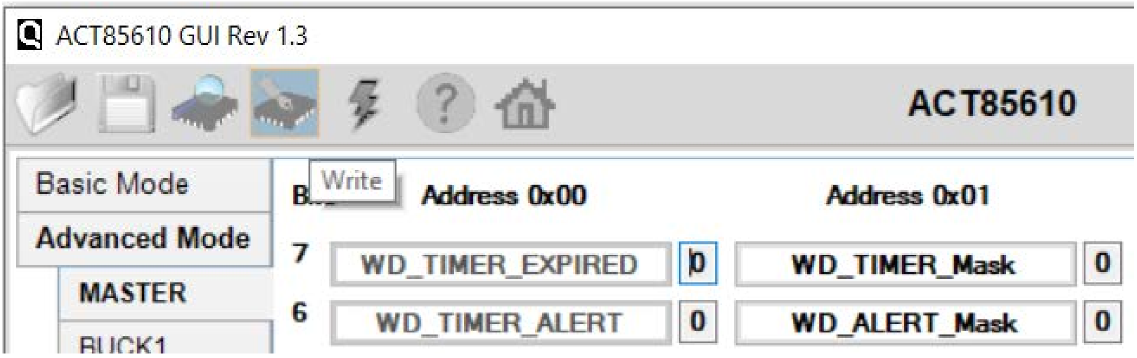


Figure 13 – Write Button

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 14– Dongle Connection Status

Storage Cap Health Monitor

GO/NO GO Test

The ACT85610 has an internal health monitor for the storage capacitors. It will apply a constant 10mA for a selected period then followed by 50mA current for 200us and monitor that the delta voltage is not exceed. If the voltage falls below a predetermined level (HMON_THR), a fault will be indicated on the PG_STR.

When the ACT85610 is in autonomous health checking mode, the boost is activated just before the health check to ensure the storage capacitor is topped off. Then when the current source is applied the boost will be locked out. The HMON_THR is monitored only while the current source is on, and if the STR voltage falls below it, then a fault is latched and the PG_STR and nIRQ are set low. When the set time has expired, then the boost will be turned back on to replace the charge removed from the storage capacitor.

Process of Health Checking & Capacitance Read

1. Make sure have good I2C connection with IC with correct I2C address. Please notice that the PLP and PMIC have two different I2C addresses.
2. Choose proper HMON_TSET[3:0] and HMON_THR[3:0] values.
3. If want single shot operation, set DIS_HEALTH_CHK = 1.
4. Set FORCE_HCHK = 1 to start the health checking and capacitance read.
5. Wait for HMON_TSET plus proper time for capacitance read.
6. Check the Go/No Go status at HCHK_NG.
7. Make sure no error on FAIL_MEASURE.
8. Read the capacitance on CAP_VALUE [12:0].