# ACT88760EVK-102.E2 User's Guide

## Description

This document describes the characteristics and operation of the Qorvo ACT88760EVK-102.E2 evaluation kit (EVK). It provides setup and operation instructions, schematic, layout, BOM, and test data. This EVK demonstrates the ACT88760-102.E2T Active PMU power management IC. Other ACT88760-xxx 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 ACT88760EVK-102.E2 is specifically configured for the ACT88760-102.E2T.

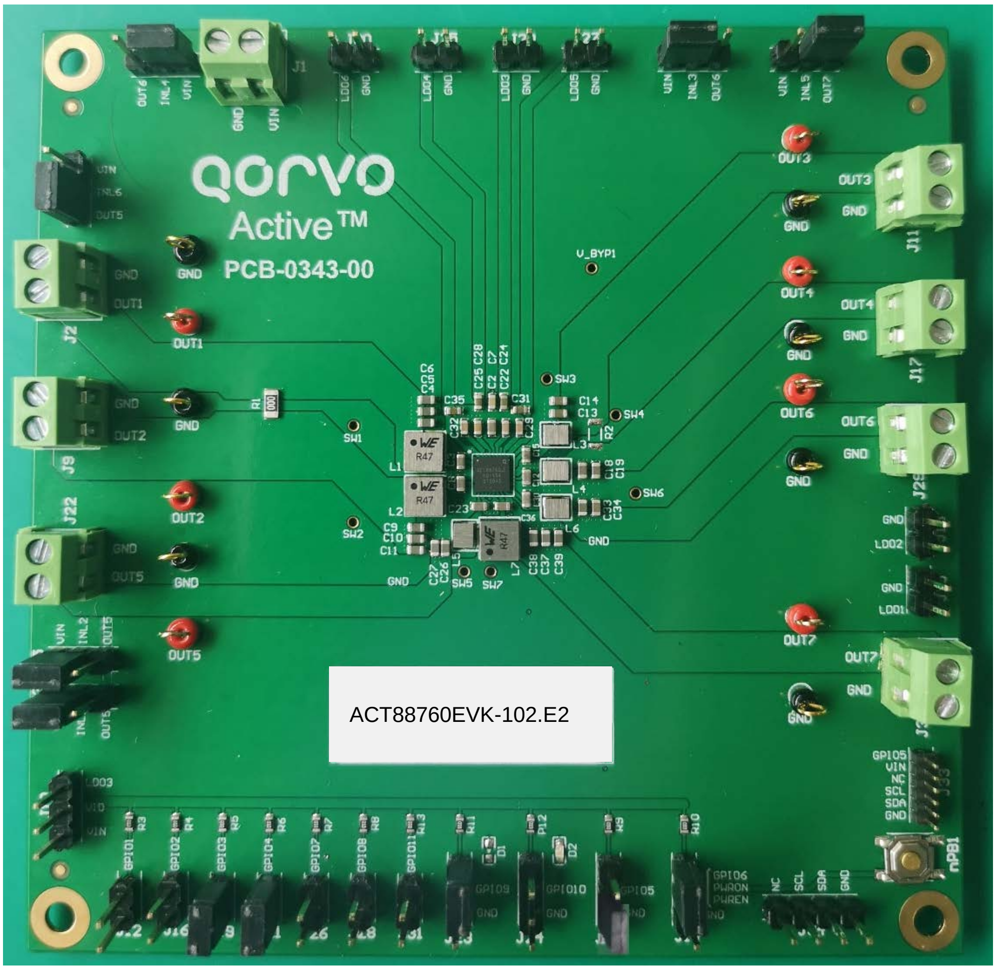



**Figure 1– EVK Picture**

## EVK Contents

The ACT88760EVK-102.E2 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

ACT88760EVK-102.E2

USB-TO-I2C Dongle

Power supply – 5V @ 8A for full power operation

Oscilloscope – >100MHz, >4 channels

Loads – Electronic or resistive. 8.0A minimum current capability.

Digital Multi-meters (DMM)

Windows compatible computer with spare USB port.

## Hardware Setup

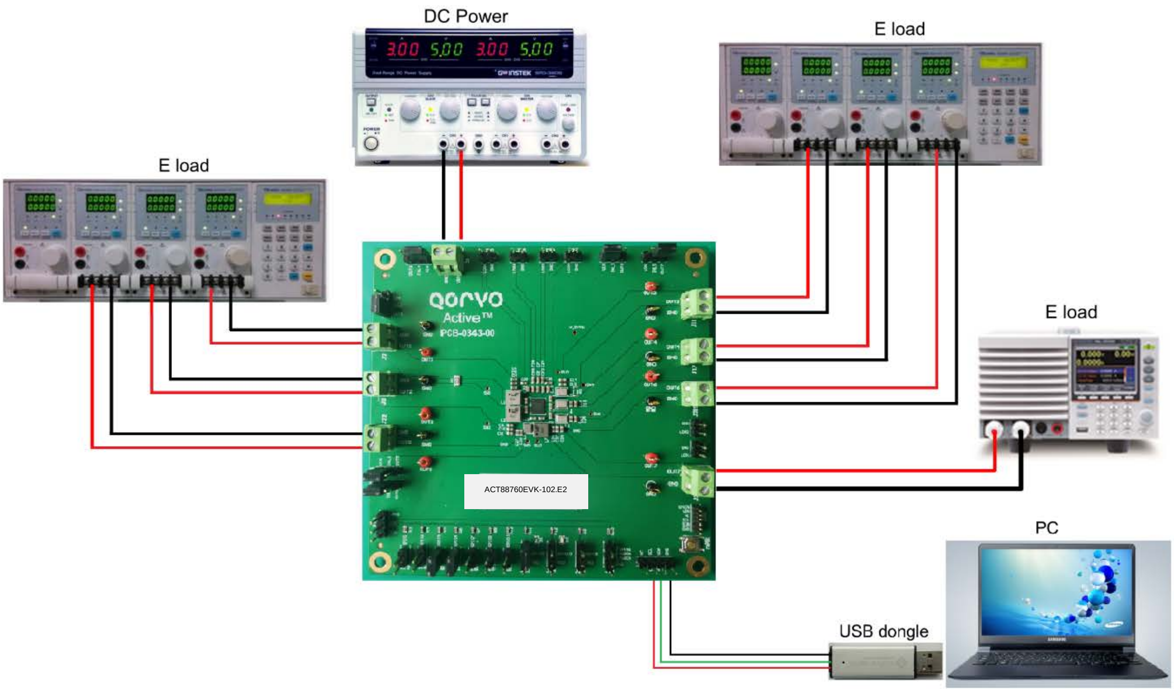



**Figure 2 – EVK Setup**

# Quick Start

### Hardware Setup

1. The EVK is configured to support the dual-phase Buck1 and Buck2 configuration, so R1 is installed on the PCB. R2 is removed because Buck3 and Buck4 operate as separate power supplies. R1 and R2 can be changed as needed depending on the specific CMI being evaluated.
2. Decide which voltage will power VIO. If the shorting jumper is not installed on J10, the ACT88760-102 powers VIO from an internal 1.8V rail. It is ok to choose a different VIO voltage by connecting a shorting jumper between J10-1(VIN) and J10-2(VIO), or between J10-2(VIO) and J10-3(LDO3), either before or after applying input power to the EVK. Note that applying a different input voltage to VIO may affect the EVK startup waveforms.
3. Connect a lab supply between J1-1(VIN) and J1-2(GND) to power VIN.
4. Connect a shorting jumper between J3-1 (VIN) and J3-2 (INL1) to use VIN to power LDO1.
5. Connect a shorting jumper between J5-1 (VIN) and J5-2 (INL2) to use VIN to power LDO2.
6. Connect a shorting jumper between J7-1 (VIN) and J7-2 (INL3) to use VIN to power LDO3.
7. Connect a shorting jumper between J4-1 (VIN) and J4-2 (INL4) to use VIN to power LDO4.
8. Connect a shorting jumper between J6-2 (INL5) and J6-3 (OUT7) to use OUT7 to power LDO5.
9. Connect a shorting jumper between J8-2 (INL6) and J8-3 (OUT5) to use OUT5 to power LDO6.
10. Connect a shorting jumper between J19-1(GPIO3) and J19-2(GND), connect a shorting jumper between J21-1(GPIO4) and J21-2(GND) to set Buck1/2/7 output VSET0.
11. Connect a shorting jumper between J23-1(VIO with a pull up resistor) and J23-2(GPIO9) to pull up GPIO9 to VIO. Note that D1 is not installed on the EVK.
12. Connect a shorting jumper between J13-2(GPIO5) and J13-3(GND) to set GPIO5 low. GPIO5 is the input control pin for Buck3/4/5 DVS.
13. Connect a shorting jumper between J14-1(VIO with a pull up resistor) and J14-2(GPIO6) to set GPIO6 high. GPIO6 is the PWREN pin to control system ON/OFF, enter/exit DPSLP for ACT88760-102.
14. Connect an appropriate load to each power supply output.
15. Apply a 5V input voltage to J1 and the outputs turn on automatically.

## GUI Setup (optional)

1. Install the ACT88760 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 J34 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.

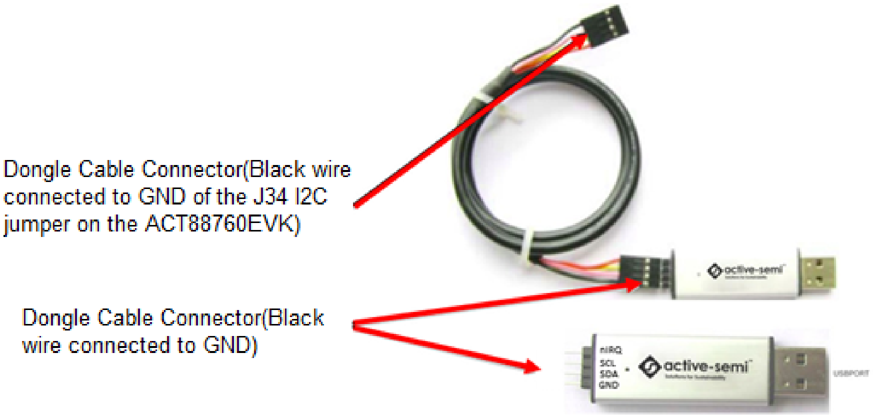



**Figure 3 – USB-TO-I2C Dongle Connection**

## EVK Design Parameters

The ACT88760EVK-102.E2 is designed for a 5V input voltage. Table1 shows the Regulators’ output voltage and the current supply capability.

**Table 1. EVK Design Parameters**

| Parameter | Description | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| VIN | Operation Input range of Power Supply | 3 | 5 | 5.8 | V |
| OUT1 | Buck1 output voltage, (Buck 12, 2-phase) | | 0.8 | | V |
| OUT2 | Buck2 output voltage, (Buck 12, 2-phase) | | 0.8 | | V |
| OUT3 | Buck3 output voltage | | 1 | | V |
| OUT4 | Buck4 output voltage | | 1.8 | | |
| OUT5 | Buck5 output voltage | | 2.7 | | |
| OUT6 | Buck6 output voltage | | 3.3 | | |
| OUT7 | Buck7 output voltage | | 0.8 | | |
| LDO1 | LDO1 output voltage | | 1.8 | | |
| LDO2 | LDO2 output voltage | | 1.2 | | |
| LDO3 | LDO3 output voltage | | 3.3 | | |
| LDO4 | LDO4 output voltage | | 3.3 | | |
| LDO5 | LDO5 output voltage, Load Switch from Buck7=0.8V | | LSW | | |
| LDO6 | LDO6 output voltage, Load Switch from Buck5=2.7V | | LSW | | |
| Io_OUT1 | Buck1 load current | | 4 | 4 | A |

| | | | | | |
|---|---|---|---|---|---|
| Io_OUT2 | Buck2 load current | | 4 | 4 | A |
| Io_OUT3 | Buck3 load current | | 3 | 3 | A |
| Io_OUT4 | Buck4 load current | | 3 | 3 | A |
| Io_OUT5 | Buck5 load current | | 2 | 2 | A |
| Io_OUT6 | Buck6 load current | | 2 | 2 | A |
| Io_OUT7 | Buck7 load current | | 4 | 4 | A |
| Io_LDO1 | LDO1 load current | | 0.8 | 0.8 | A |
| Io_LDO2 | LDO2 load current | | 0.8 | 0.8 | A |
| Io_LDO3 | LDO3 load current | | 0.2 | 0.4 | A |
| Io_LDO4 | LDO4 load current | | 0.2 | 0.4 | A |
| Io_LDO5 | LDO5 load current | | 0.2 | 0.4 | A |
| Io_LDO6 | LDO6 load current | | 0.2 | 0.4 | A |

# EVK Operation

## Turn ON

Apply the 5V input voltage.

## 2-Phase Parallel Mode

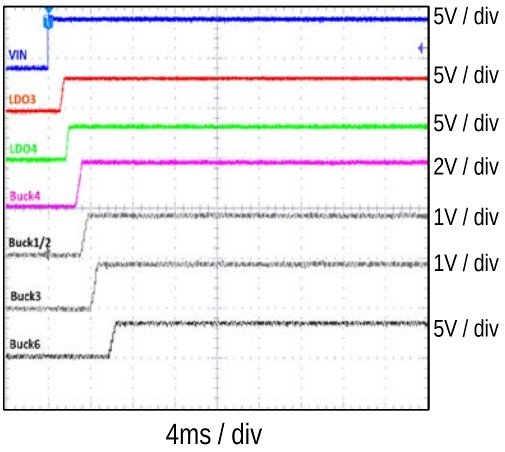
Buck1 and Buck2 work in 2-phase parallel mode in ACT88760-102.E2. In parallel mode operation they are combined into a single higher current 2-phase regulator to support up to 8A (10A peak) output currents. Buck3 and Buck4 also can be operated as a single 2-phase regulator to support output currents up to 6A (8A peak). Note that the  ACT88760-102.E2 configures Buck3 and Buck4 as separate, single phase outputs.

## PWREN

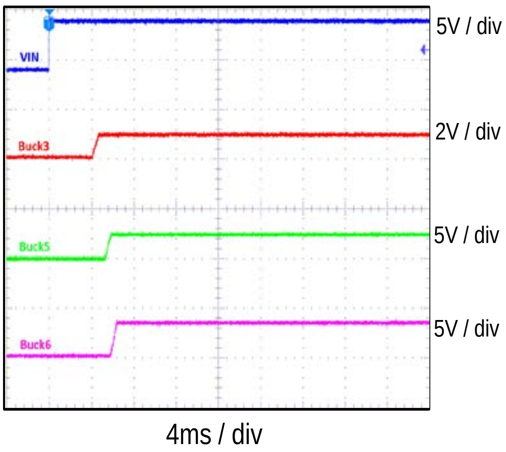
GPIO6 is used for the PWREN function. It is defined as an active high input. Connect GPIO6 to VIO using the shorting jumper on J24, apply VIN=5V, then all outputs automatically turn on with the programmed startup sequence. PWREN is then used to enter or exit DPSLP mode. Drive GPIO6 from high to low to enter DPSLP mode, and drive GPIO6 from low to high to exit DPSLP mode.

# Test Result

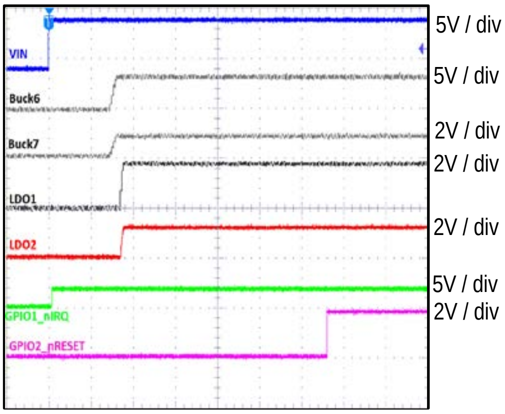
CMI 102
Startup Sequence




CMI 102
Startup Sequence

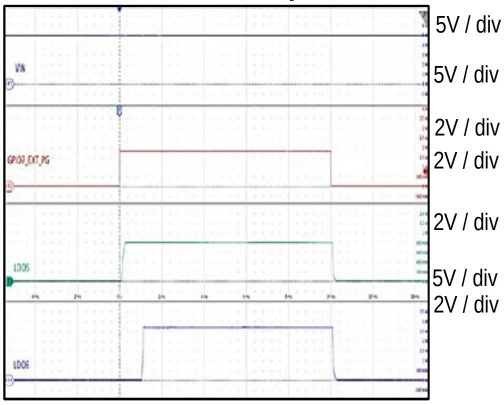


CMI 102
Startup Sequence



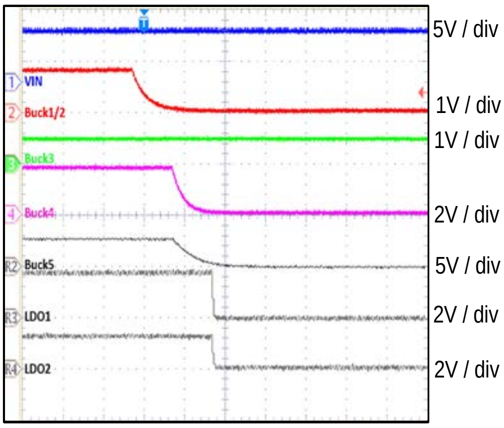

4ms / div

CMI 102
Enable LDO5/6 by GPIO7



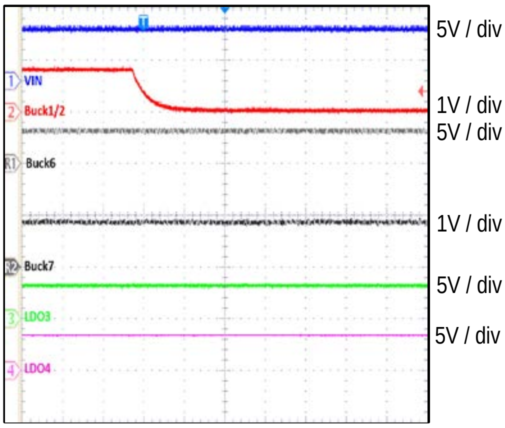

4ms / div

CMI 102
Enter SLEEP Mode by I2C



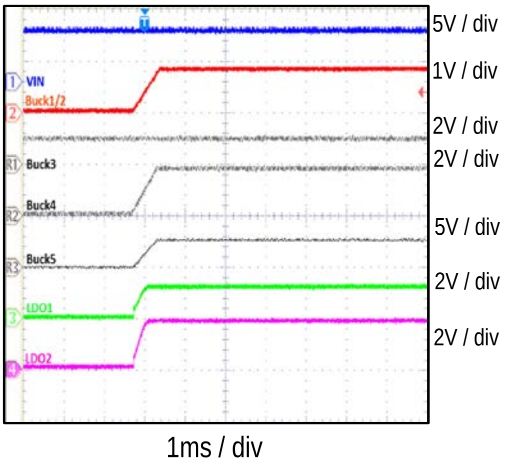

1ms / div

CMI 102
Enter SLEEP Mode by I2C

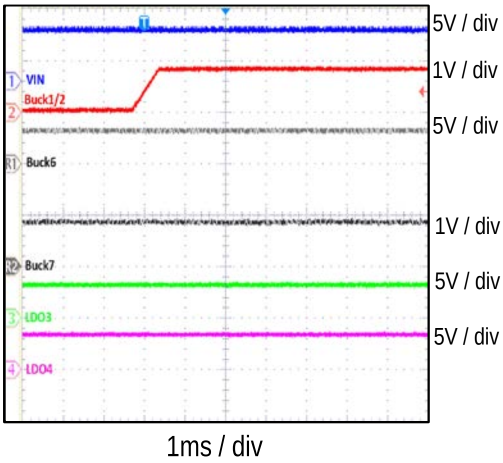



1ms / div

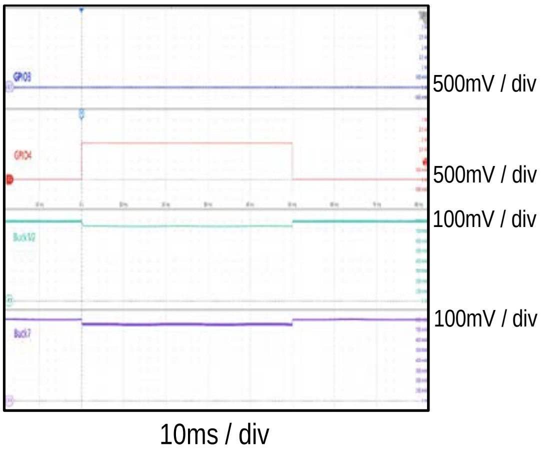
CMI 102
Exit SLEEP Mode by I2C



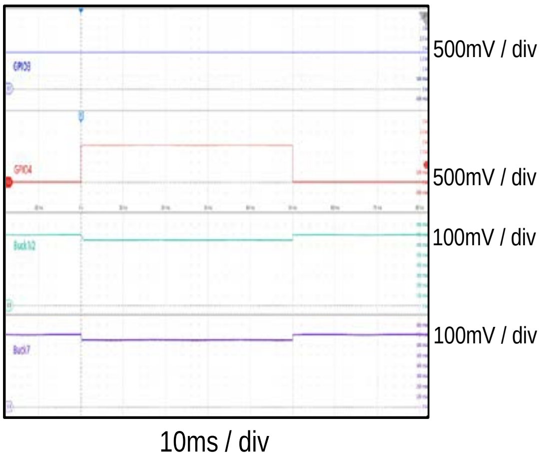

CMI 102
Exit SLEEP Mode by I2C



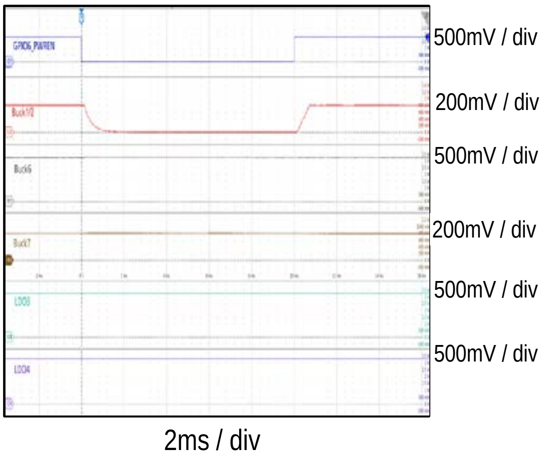

CMI 102
GPIO3/4 Control Buck1/2/7 DVS



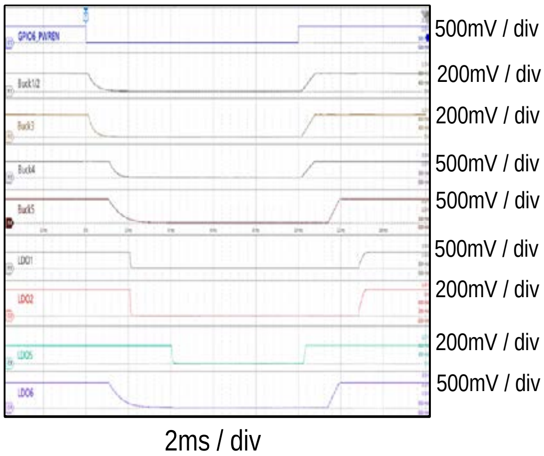

CMI 102
GPIO3/4 Control Buck1/2/7 DVS



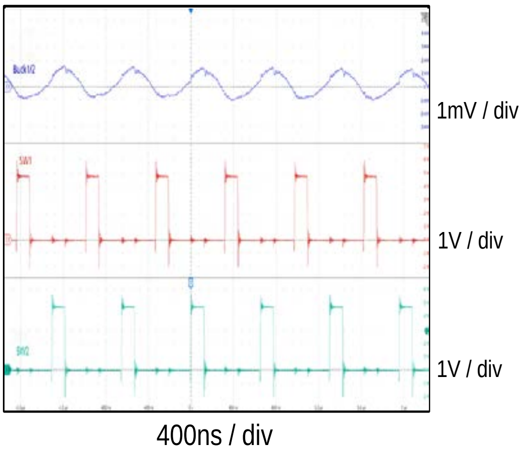
CMI 102
Enter and Exit DPSLP Mode by PWREN



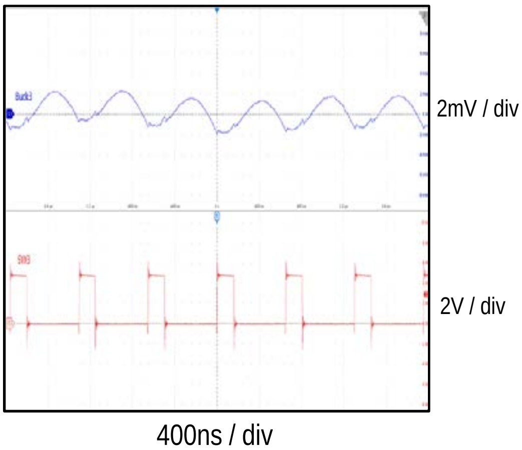

CMI 102
Enter and Exit DPSLP Mode by PWREN



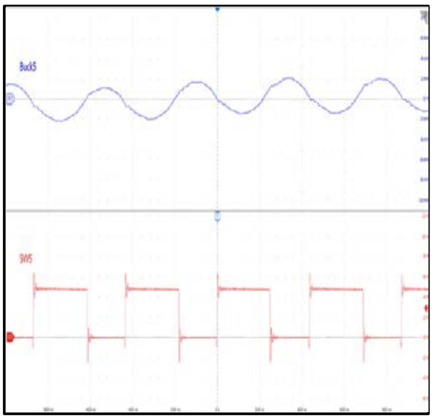

CMI 102
Buck1/2 Ripple and SW @8A Load




CMI 102
Buck3 Ripple and SW @3A Load



CMI 102
Buck5 Ripple and SW @2A Load

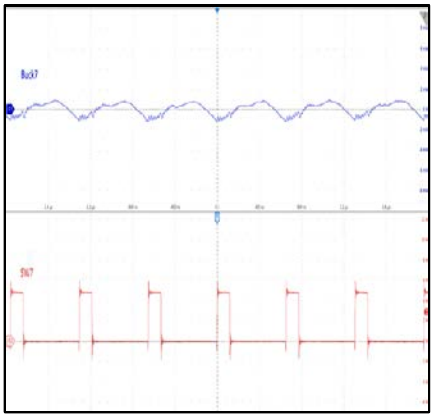


2mV / div

2V / div

200ns / div

CMI 102
Buck7 Ripple and SW @4A Load

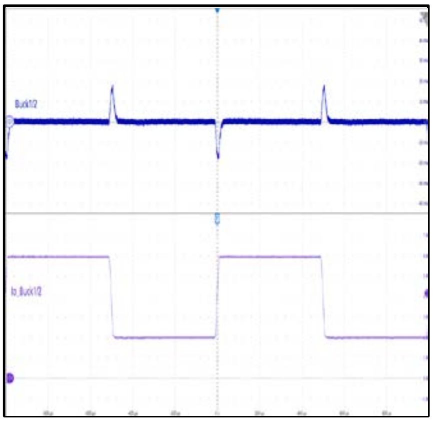


2mV / div

2V / div

400ns / div

CMI 102
Buck1/2 Load Transient,2A-6A

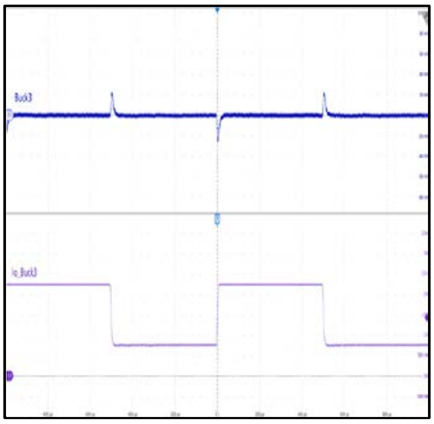


10mV / div

1A / div

200us / div

CMI 102
Buck3 Load Transient,0.75A-2.25A

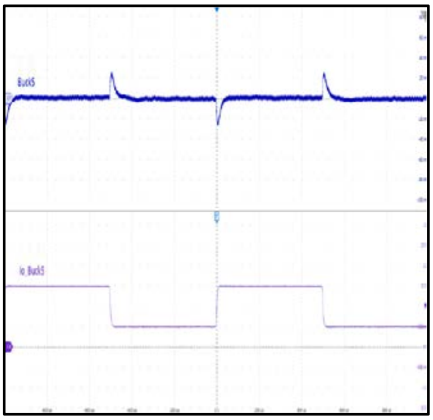


20mV / div

500mA / div

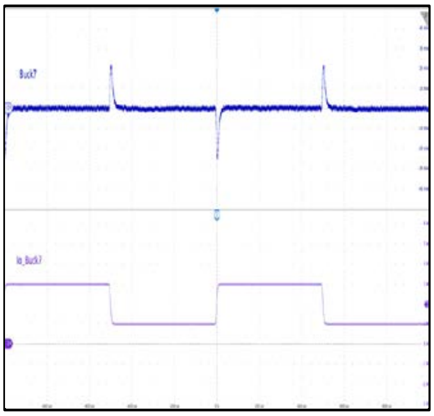
200us / div

CMI 102
Buck5 Load Transient,0.7A-1.5A



20mV / div
500mA / div
200us / div

CMI 101
Buck7 Load Transient,1A-3A



10mV / div
1A / div
200us / div

## Schematic

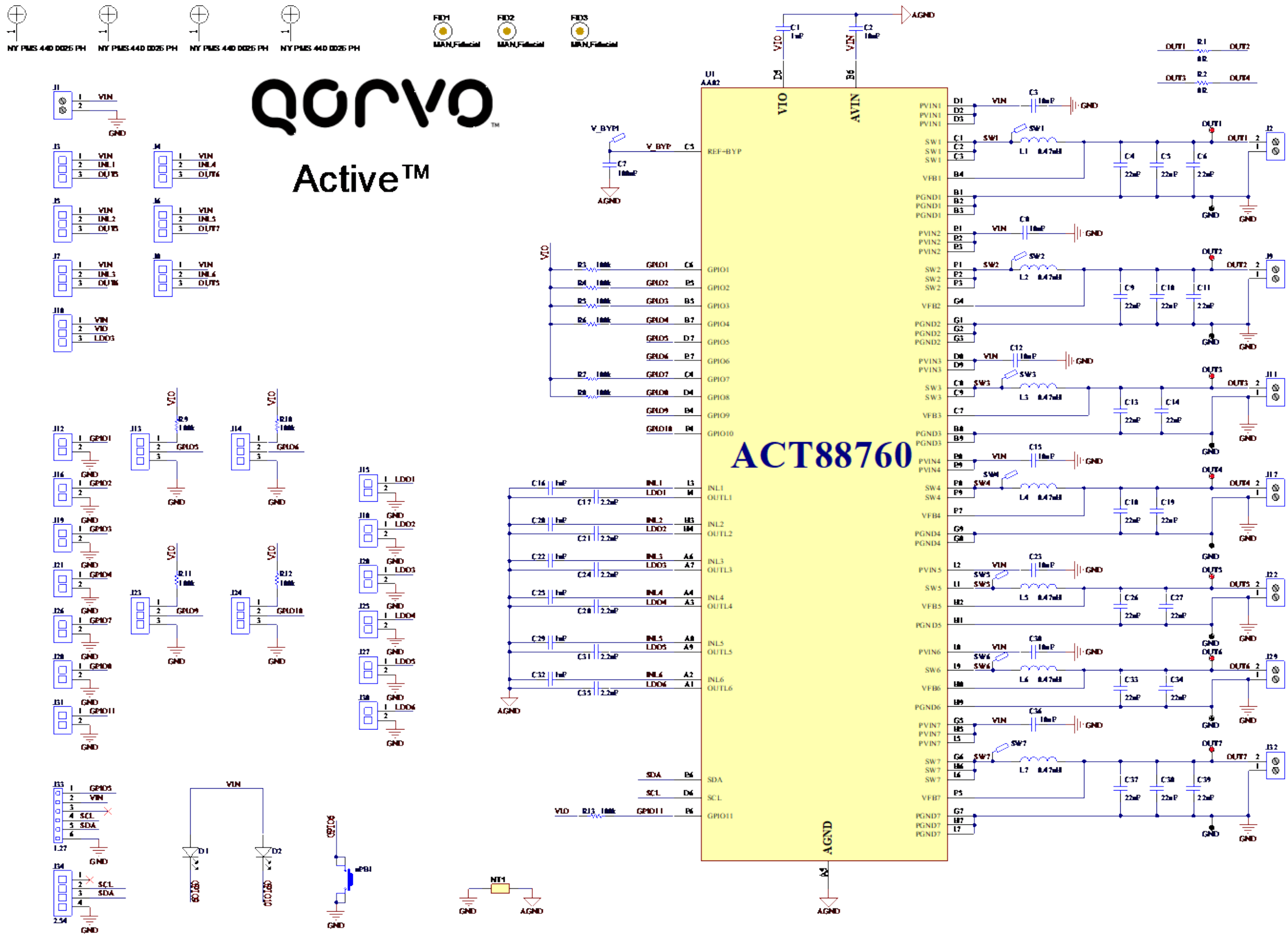



**Figure 4 – ACT88760EVK1-102 Schematic**

## Layout

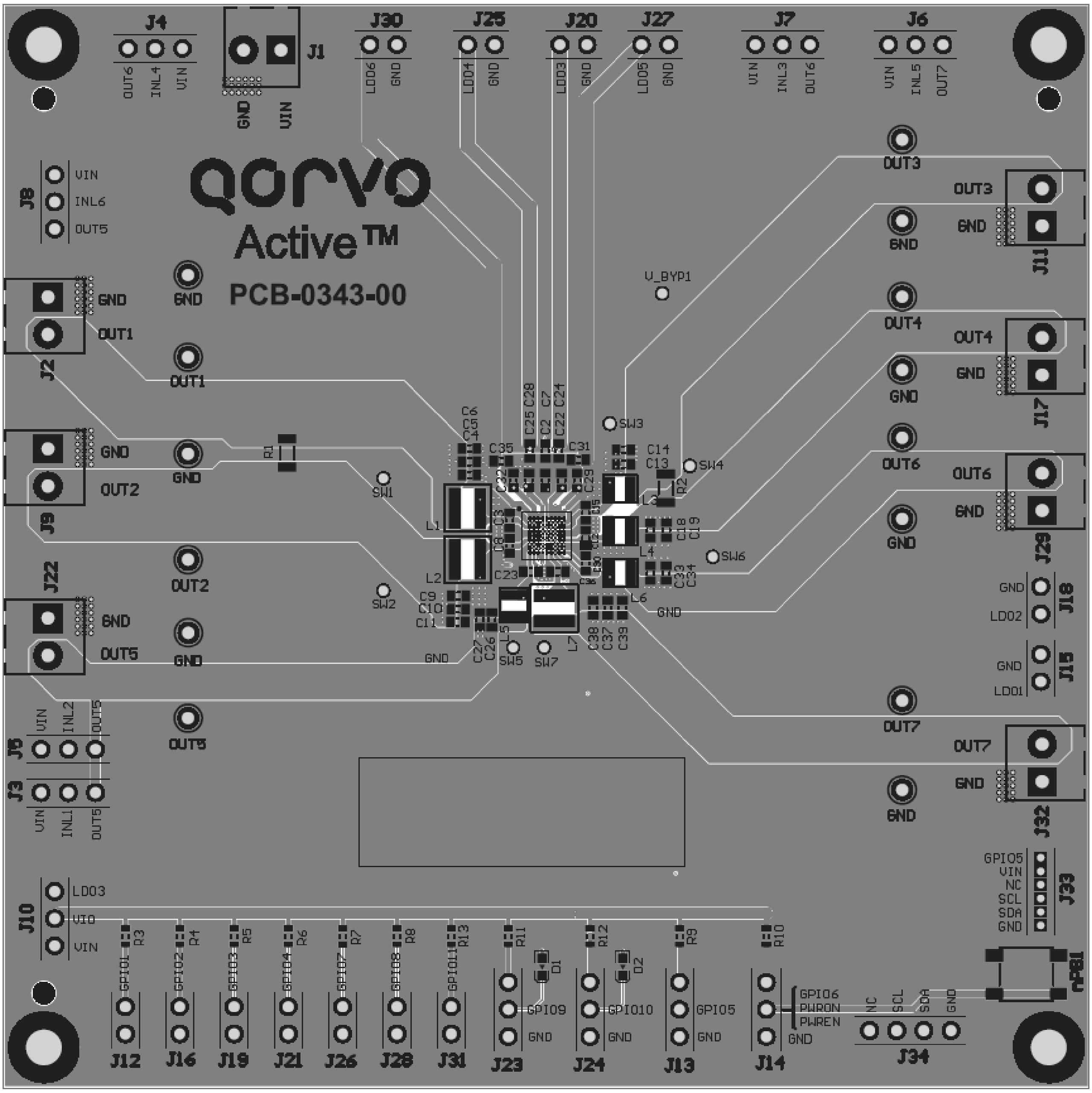



**Figure 5 – Layout Top Layer**

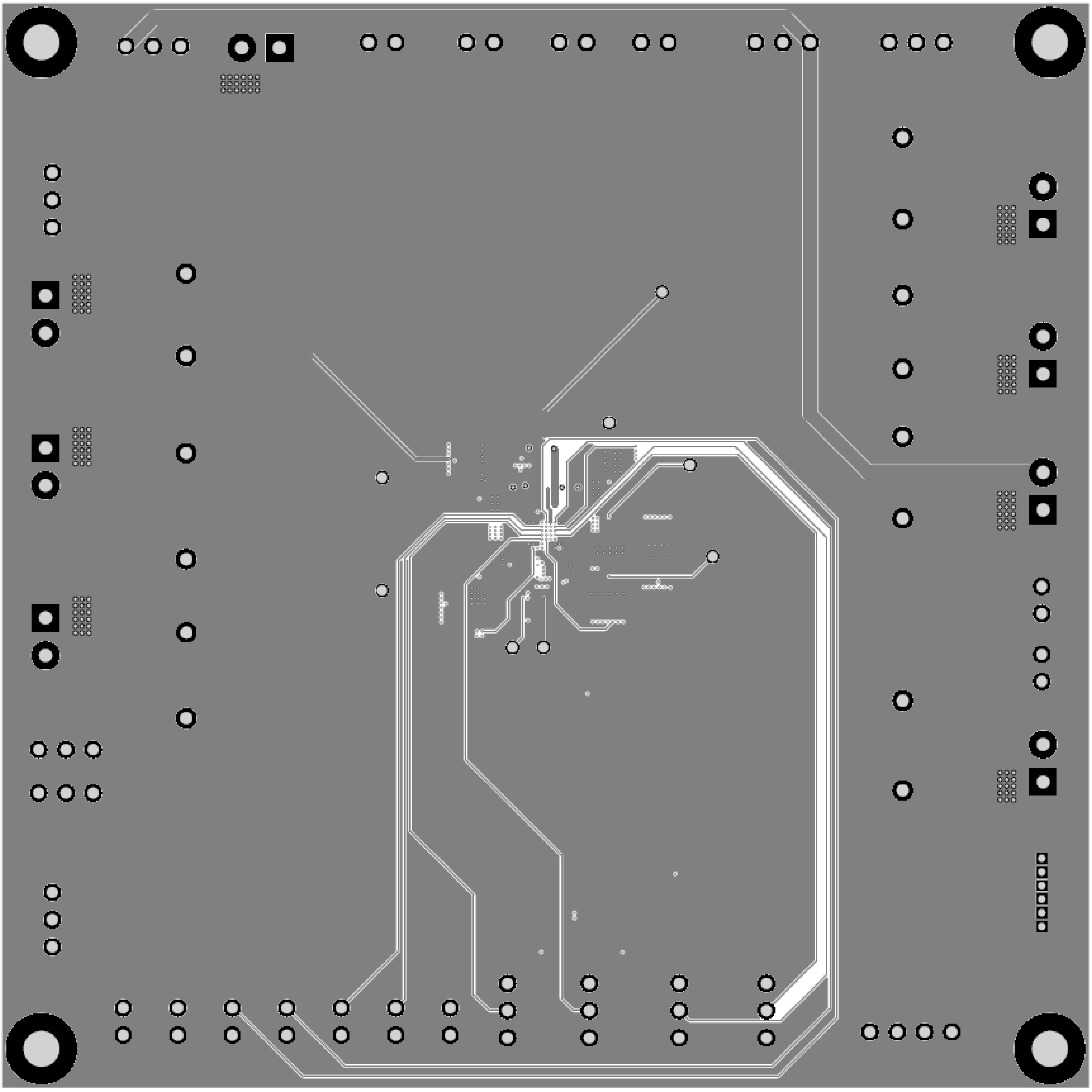


Figure 6 – Layout GND Layer

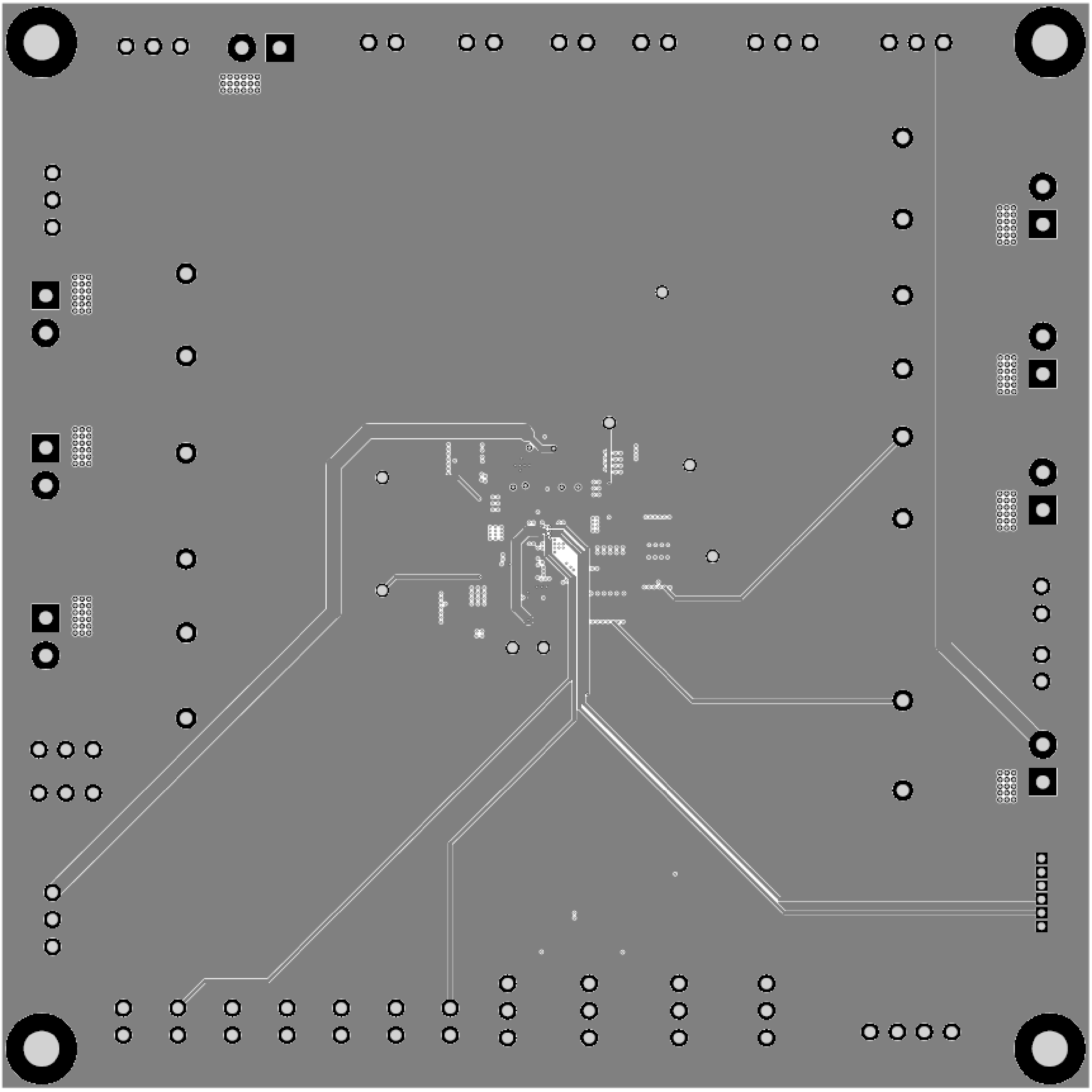


Figure 7 – Layout AGND Layer

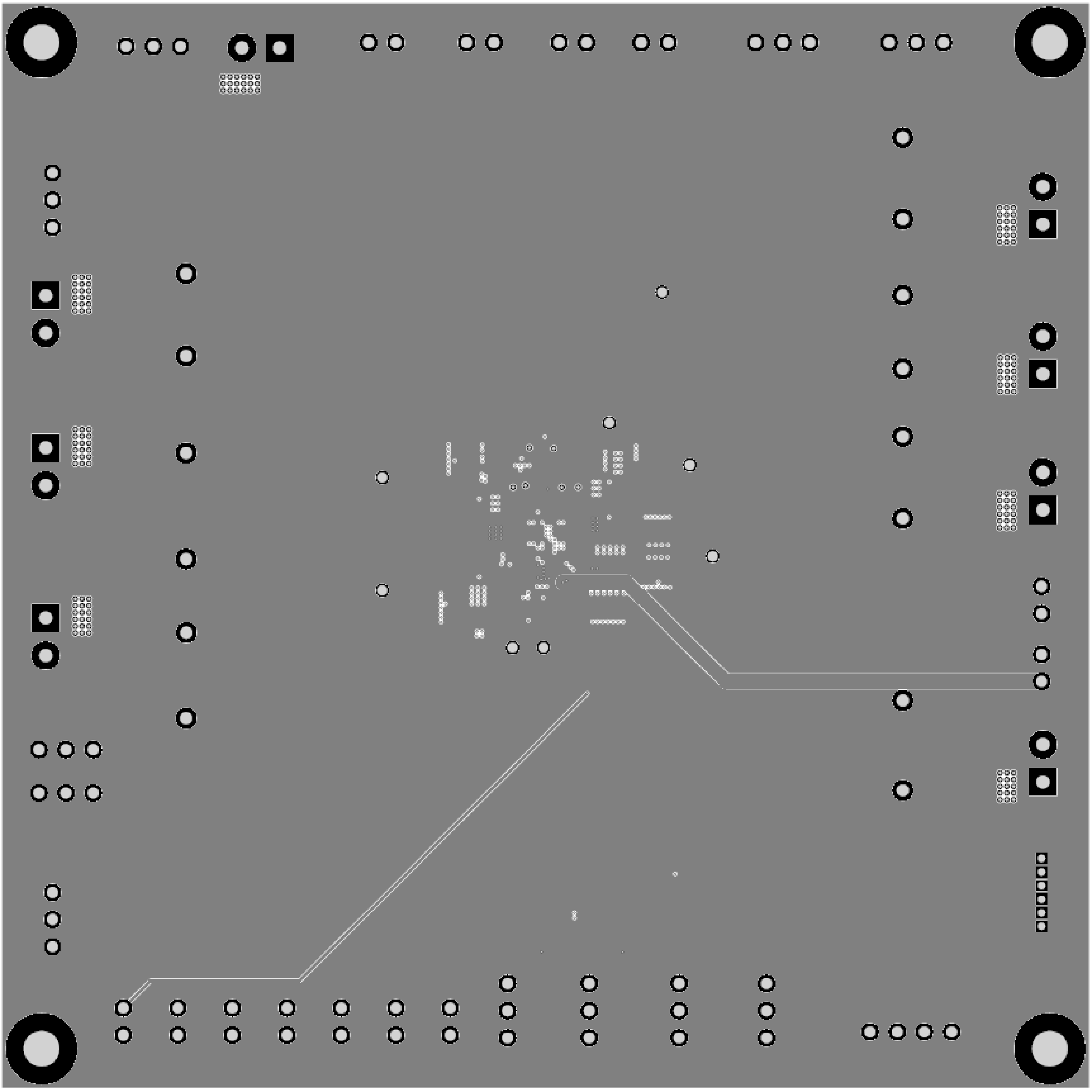


Figure 8 – Layout VIN Layer

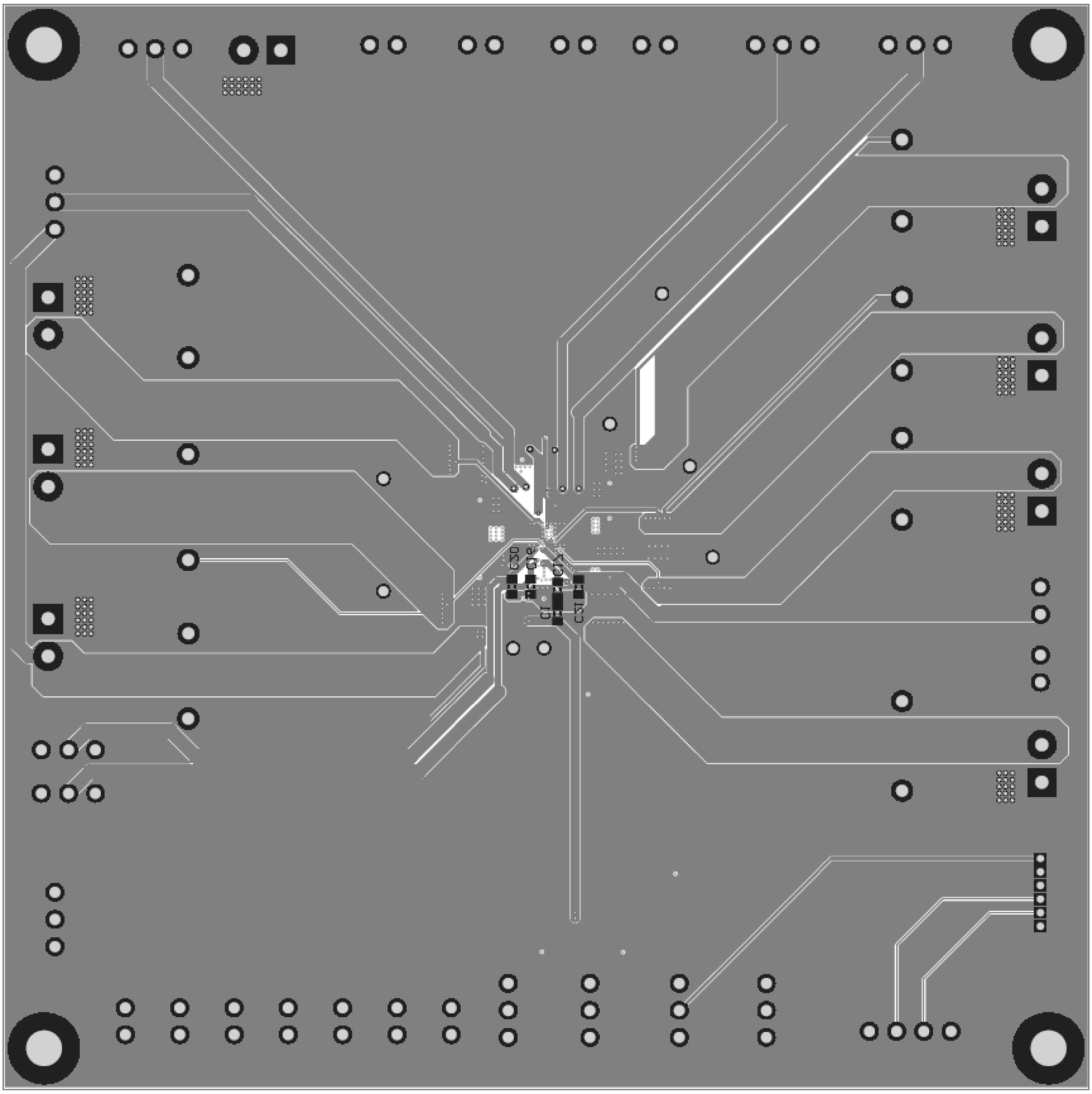


**Figure 9 – Layout Bottom Layer**

## Bill of Materials

**Table 2 – BOM**

| Item | Designator | Quantity | Description | Manufacturer | Part Number |
|---|---|---|---|---|---|
| 1 | C1, C16, C20, C22, C25, C29, C32 | 7 | Capacitor, Ceramic, 1uF, 0603 | SAMSUNG | std |
| 2 | C2, C3, C8, C12, C15, C23, C30, C36 | 8 | Capacitor, Ceramic, 10uF, 0603 | Murata | std |
| 3 | C4, C5, C6, C9, C10, C11, C13, C14, C18, C19, C26, C27, C33, C34, C37, C38, C39 | 17 | Capacitor, Ceramic, 22uF, 0603 | Murata | std |
| 4 | C7 | 1 | Capacitor, Ceramic, 100nF, 0603 | Murata | std |
| 5 | C17, C21, C24, C28, C31, C35 | 6 | Capacitor, Ceramic, 2.2uF, 0603 | Murata | std |
| 6 | D2 | 1 | Diode, Led, blue, 0603 | | |
| 7 | D1 | 0 | Diode, Led, blue, 0603 | | |
| 8 | J1, J2, J9, J11, J17, J22, J29, J32 | 8 | Connector, Screw Ter-minal, 3.50, 2P | Wurth | 691214110002S |
| 9 | J3, J4, J5, J6, J7, J8, J10, J13, J14, J23, J24 | 11 | Header, Unshrouded , 2.54, Male, 3P | Wurth | 61300311121 |
| 10 | J12, J15, J16, J18, J19, J20, J21, J25, J26, J27, J28, J30, J31 | 13 | Header, Unshrouded , 2.54, Male, 2P | Wurth | 61300211121 |
| 11 | J33 | 1 | Header, Unshrouded , 1.27, Male, 6P | Wurth | GRPB061VWVN-RC |
| 12 | J34 | 1 | Header, Unshrouded , 2.54, Male, 4P | Wurth | 61300411121 |
| 13 | L1, L2, L7 | 3 | Inductor, 0.47uH, 4020 | WURTH | 744383560047HT |
| 14 | L3, L4, L5, L6 | 4 | Inductor, 0.47uH, 2512 | WURTH | 744383240047 |
| 15 | nPB | 1 | Switch, TSW, TE-1437565-0 | std | std |
| 16 | R1 | 1 | Resistor, 0R, 1206 | Standard | Standard |
| 17 | R2 | 0 | Resistor, 0R, 1206 | Standard | Standard |
| 18 | R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13 | 11 | Resistor, 100k, 0603 | Standard | Standard |
| 19 | TP1, TP3, TP5, TP7, TP9, TP11, TP13 | 7 | TEST POINT PC MINI .040"D RED | KeyStone | 5000 |
| 20 | TP2, TP4, TP6, TP8, TP10, TP12, TP14 | 7 | TEST POINT PC MINI .040"D BLK | KeyStone | 5001 |
| 21 | U1 | 1 | IC, ACT88760 | Qorvo | ACT88760-102.E2T |

## GUI Installation

1. You can find the ACT88760 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 Rev1.1" in the "Driver" folder.
4. Double click on the ACT88760 GUI Rev1.2.exe to start the ACT88760 GUI.

| Name | Date modified | Type | Size |
|---|---|---|---|
| Archive | 9/4/2020 5:07 PM | File folder | |
| CodingMatrix | 9/4/2020 5:07 PM | File folder | |
| Config | 9/4/2020 5:07 PM | File folder | |
| Data | 9/4/2020 9:06 AM | File folder | |
| DieLib | 9/4/2020 5:07 PM | File folder | |
| Driver | 9/4/2020 5:07 PM | File folder | |
| Function | 9/4/2020 9:06 AM | File folder | |
| Note | 9/4/2020 9:06 AM | File folder | |
| Script | 9/4/2020 5:07 PM | File folder | |
| Temp | 9/4/2020 5:07 PM | File folder | |
| TileLib | 9/4/2020 5:07 PM | File folder | |
| ACT88760 ActiveCiPS GUI User's Guide-Rev0.2 20200821.pdf | 9/4/2020 5:07 PM | Adobe Acrobat D... | 322 KB |
| ACT88760 EVK GUI User's Guide-Rev0.2 20200727.pdf | 9/4/2020 5:07 PM | Adobe Acrobat D... | 626 KB |
| ACT88760 GUI Rev1.2.exe | 9/4/2020 5:07 PM | Application | 21,484 KB |
| Qorvo's GUI and Dongle Driver Installation Rev1.1.pdf | 9/4/2020 5:07 PM | Adobe Acrobat D... | 1,268 KB |

**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: Configuration Mode and Regulator Mode. In Configuration Mode screen it displays each regulator's basic information on a single page, all the information is user configurable via the drop-down boxes. Regulator Mode allows the user to view and change the IC's advanced internal registers of each regulator.

### Configuration Mode

Click the "Configuration" button in the left of the GUI screen to see the basic user programmable options. This display mode allows user to change some basic settings of each regulator (voltages, current…). User can use either the mouse scroll or the right-side scroll bar to navigate to other regulators. Using drop-boxes, left-click the small arrow next to the value, then a selection pop-up displays all possible options to choose from. Scroll up/down to find the target value and left-click to select it. After the required parameters are changed, click the "Write" button to transfer the changes from the GUI to the IC.

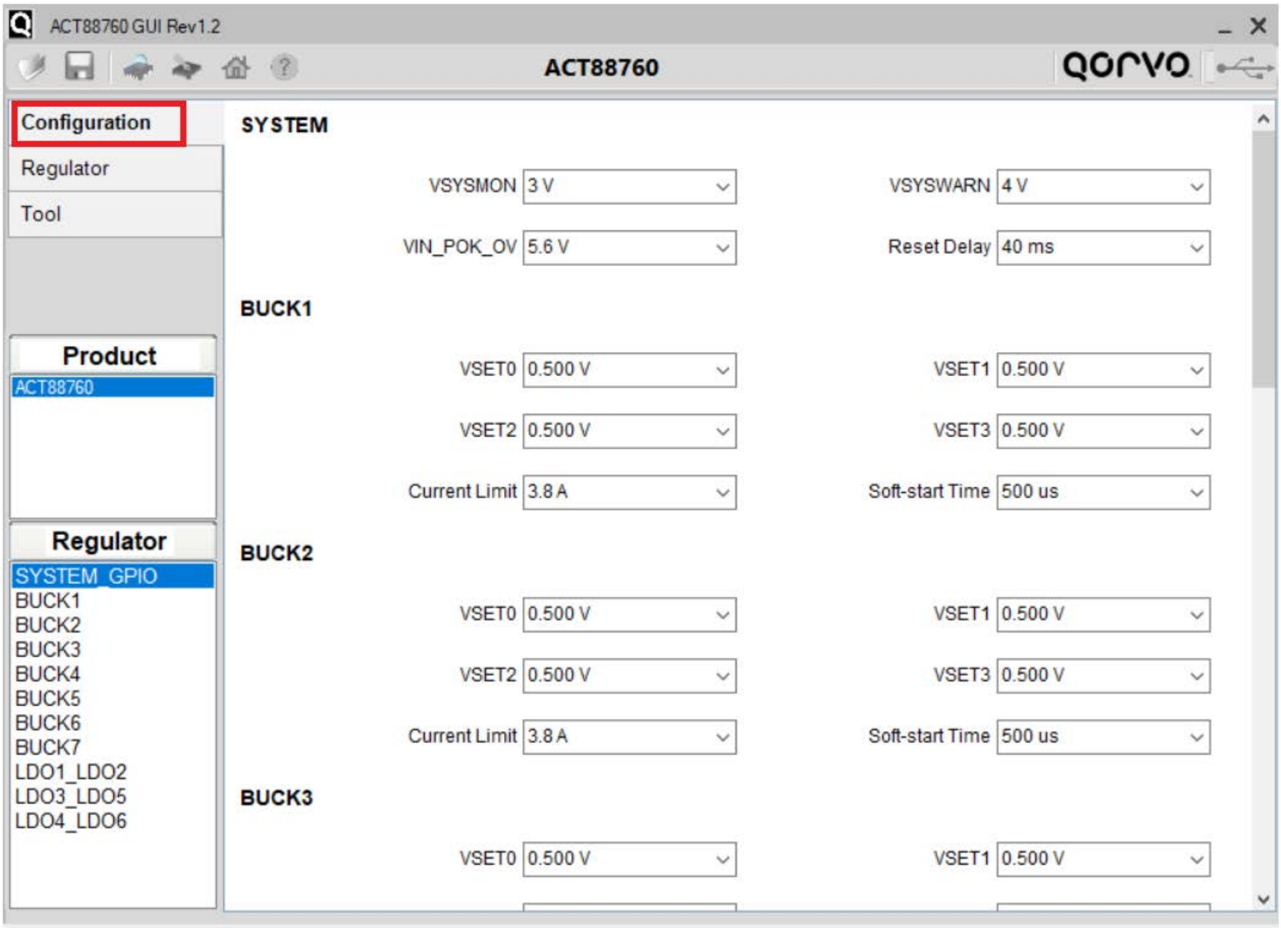



**Figure 10 – GUI Configuration Mode**

**Regulator Mode**

Click the "Regulator" button in the left of the GUI screen to see all available user programmable options. In the left side of the screen, click on the Tiles Selector to choose which regulator or LDO's to show. There are two tabs for each tile, "Setting "and "Register".

The "Settings" tab is easy to read and has drop down menus that show the available choices. The "Registers" tab shows the actual register values required to achieve a desired setting.

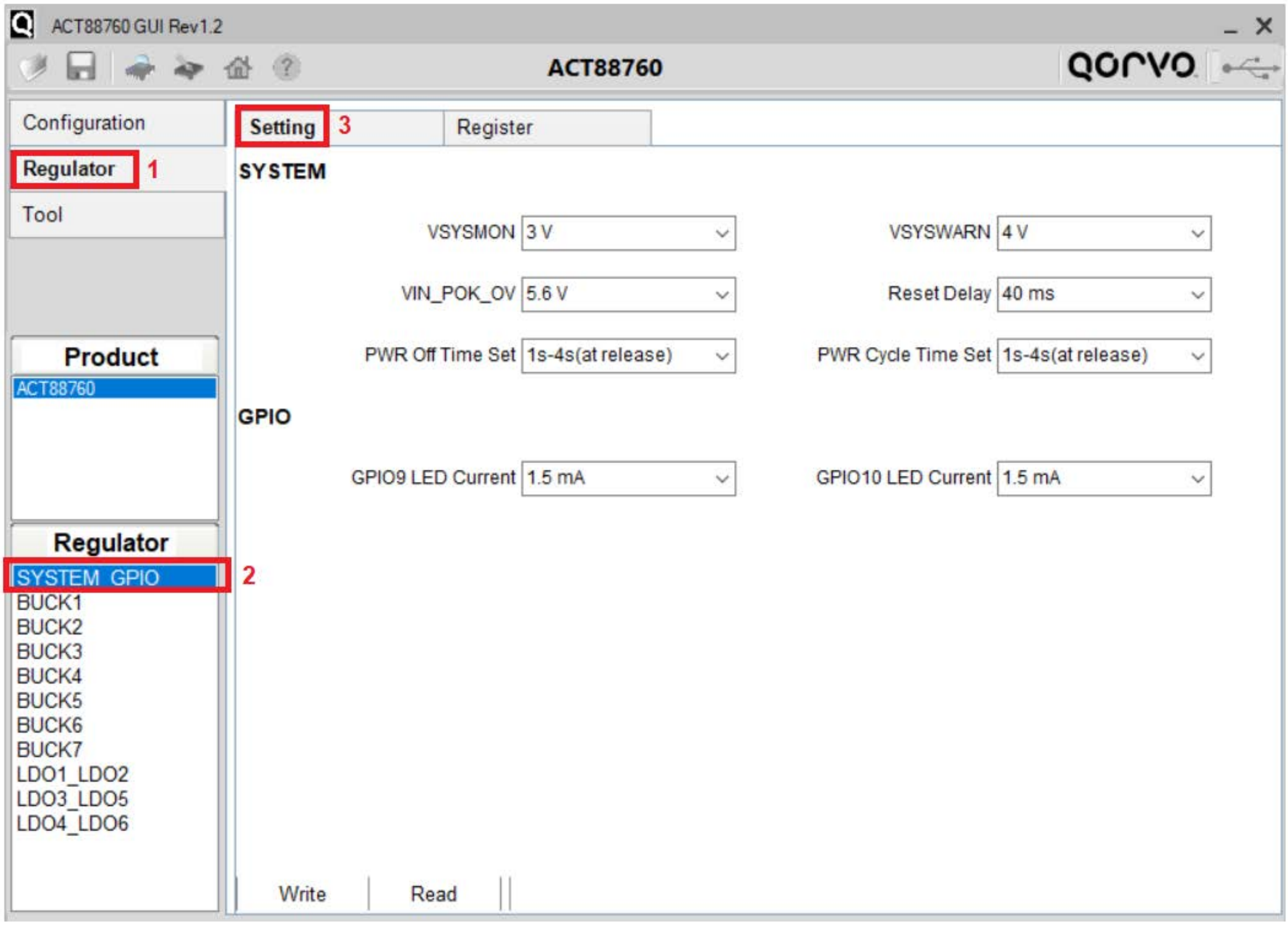



**Figure 11 – GUI Setting Tab of Regulator Mode**

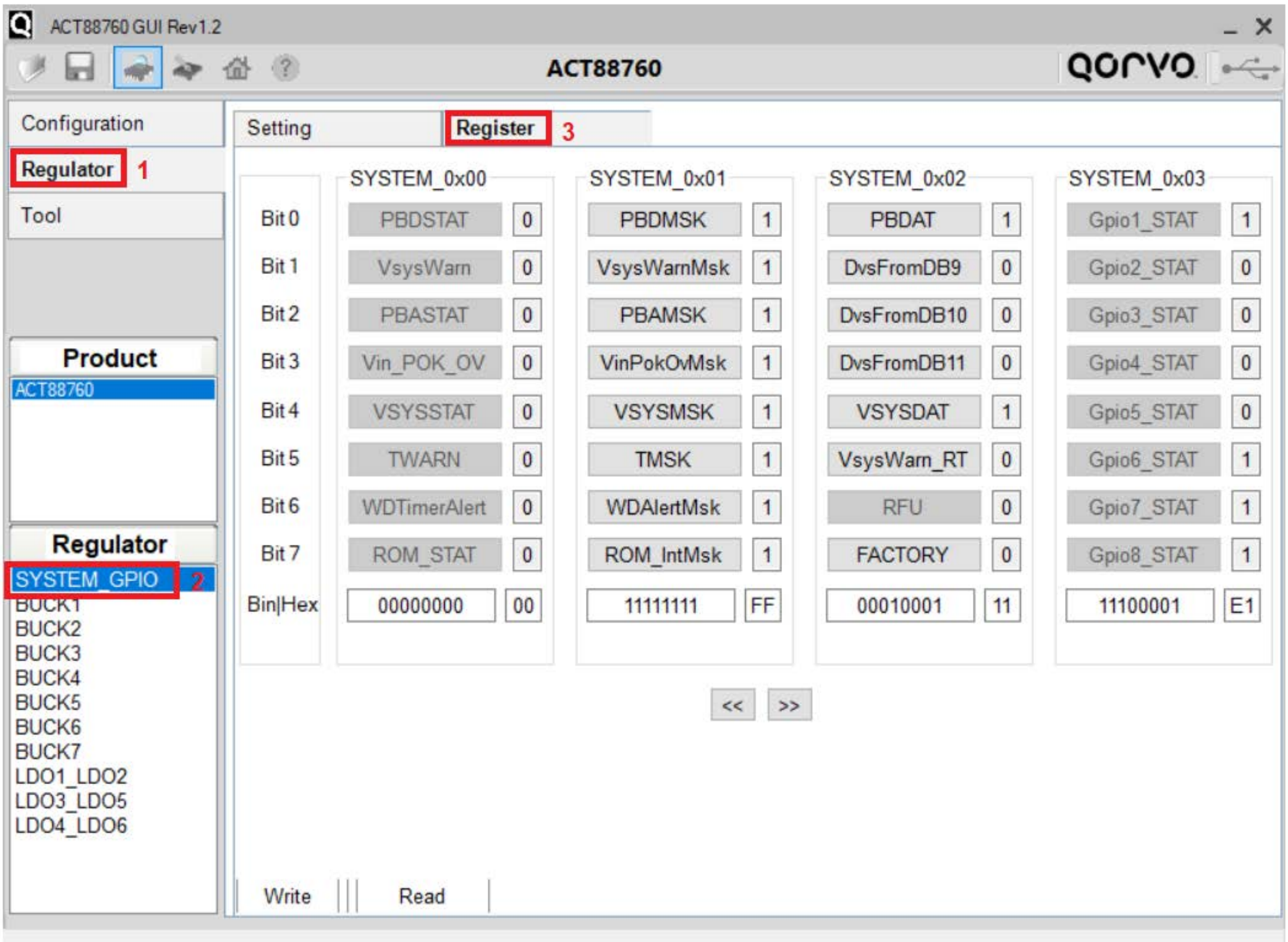



**Figure 13 – GUI Register Tab of Regulator Mode**

**Button Descriptions**

**Read:** Clicking on this button reads the ACT88760 registers and displays them in the GUI. Note that this reads all registers. Active-Semi recommends reading registers each time the ACT88760 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.

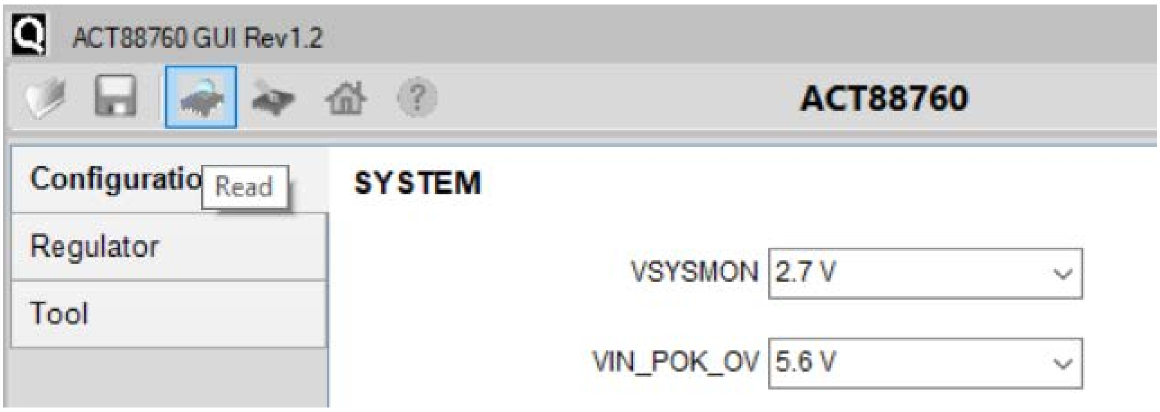



**Figure 12 – Read Button**

**Write:** Clicking on this button writes the GUI settings to the ACT88760's registers. All registers are written, regardless of whether or not they were changed.

Note: Remember that changes to the GUI settings are not transferred into the IC until the GUI's "Write" button is pressed.


**Figure 15 – Write Button**