

**ACT8865EVK1-305 User's Guide**

**Description**

This document describes the characteristic and operation of the Active Semi ACT8865EVK1-305 evaluation kit (EVK). It provides setup and operation instructions, schematic, layout, BOM, and test data. This EVK demonstrates the ACT8865QI305 ActivePMU power management IC. Other ACT8865QIxxx 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 Active Semi's USB-TO-I2C interface dongle and use the GUI software. The EVK provides full access to the 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 world system. The EVK features three step-down DC/DC converters and four low-noise, low-dropout linear regulators. The three DC/DC converters utilize a high-efficiency, fixed-frequency (2MHz), current-mode PWM control architecture that requires a minimum number of external components. Two DC/DCs are capable of supplying up to 1150mA of output current, while the third supports up to 1300mA. All four low-dropout linear regulators are high-performance, low-noise, regulators that supply up to 320mA. Note that the ACT8865AEVK1-305 is specifically configured for the ACT8865QI305.



Figure 1 – EVK Picture

## Quick Start

### Required Equipment

ACT8865EVK1-305

USB-TO-I2C Dongle

Power supply – 5V @ 3A for full power operation

Oscilloscope – >100MHz, 4 channels

Loads – Electronic or resistive. 2A minimum current capability.

Digital Multimeters (DMM)

Windows compatible computer with spare USB port.

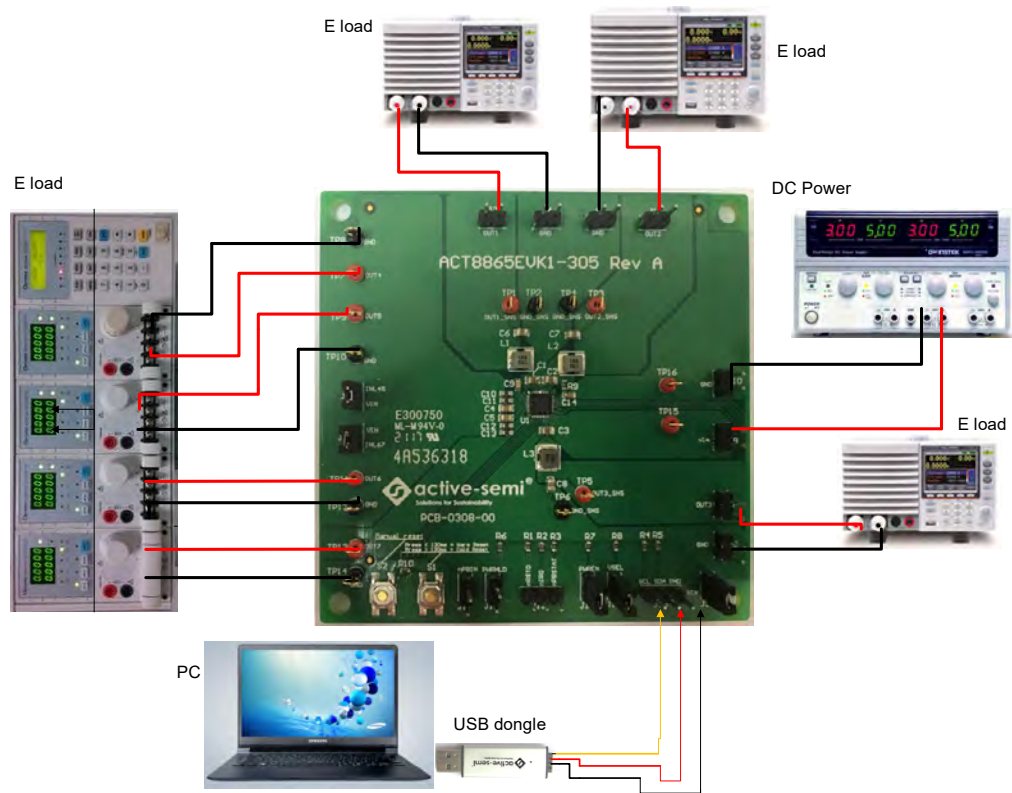


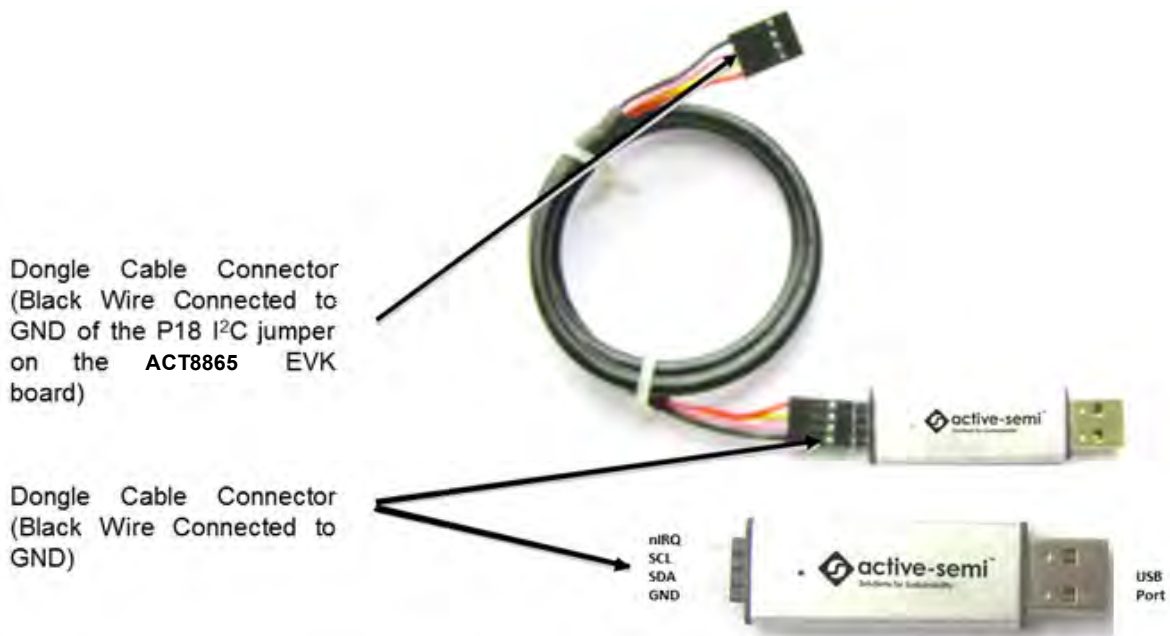
Figure 2 – EVK Setup

## Hardware Setup

1. Connect a lab supply between Vin (J9) and GND (J10) to power all the regulators and LDOs.
2. Install shorting jumper on J1 to power REG4 and REG5.
3. Install shorting jumper on J2 to power REG6 and REG7.
4. Connect an appropriate load to each power supply output.
5. Note that the typical setup is to apply the same 5V input voltage to all inputs.

## GUI Setup (optional)

1. Refer to the end of this document for detailed instructions to install the ACT8865 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 J13 connector. Refer to Figure 3 to ensure the correct polarity of the connection. As a guide, use the “Active-Semi” logo on the top of the dongle so the black wire is connected toward the lower left corner of the Dongle.



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

## Turn On the Evaluation board

Before applying the input voltage, please make sure the jumper (J11) is installed.

When the power source and load are connected to the evaluation board, it can be powered for operation. Perform the following steps to turn on the board.

1. Ensure that the power source voltage is >4.2V and <5.5V.
2. Ensure that nPBIN is not always low and monitor the output voltage from OUT1 to OUT7.
3. Turn on the load, check that it is drawing the proper load current, and verify that the output voltage maintains its regulation.

## Recommended Operating Conditions

The ACT8865EVK1-305 is designed for a 5V input voltage. The maximum operating voltage is determined by the IC's maximum input voltage rating. The minimum operating voltages are determined by the buck converters' minimum input voltage and by the LDOs' dropout voltages. Maximum currents are determined by the IC's CMI settings, which can be changed via I2C after startup.

**Table 1. Recommended Operating Conditions**

| Parameter             | Description                     | Min | Typ  | Max | Unit |
|-----------------------|---------------------------------|-----|------|-----|------|
| V <sub>in</sub>       | All buck and LDO input voltages | 2.7 | 5    | 5.5 | V    |
| I <sub>out1_max</sub> | Maximum Buck REG1 load current  |     | 1.15 |     | A    |
| I <sub>out2_max</sub> | Maximum Buck REG2 load current  |     | 1.15 |     | A    |
| I <sub>out3_max</sub> | Maximum Buck REG3 load current  |     | 1.3  |     | A    |
| I <sub>out4_max</sub> | Maximum LDO REG4 load current   |     | 0.32 |     | A    |
| I <sub>out5_max</sub> | Maximum LDO REG5 load current   |     | 0.32 |     | A    |
| I <sub>out6_max</sub> | Maximum LDO REG6 load current   |     | OFF  |     | A    |
| I <sub>out7_max</sub> | Maximum LDO REG7 load current   |     | OFF  |     | A    |

## EVK Operation

### Measuring Output Voltage Ripple

To observe the output voltage ripple, place the oscilloscope probe across the output capacitor with the probe ground lead connected to the negative (-) capacitor terminal and the probe tip placed at the positive (+) capacitor terminal. Set the oscilloscope to ac, 5mV/division, 1us/division time base, and 20MHz bandwidth.

A standard oscilloscope probe has a long wire ground clip. For high frequency measurements, this ground clip picks up high frequency noise and injects it into the measured output ripple. Figure 4 shows an easy way to measure the output ripple properly. It requires removing the oscilloscope probe sheath and wrapping an unshielded wire around the oscilloscope probe as short as possible, the true ripple can be measured.



**Figure 4—Measuring output voltage ripple**

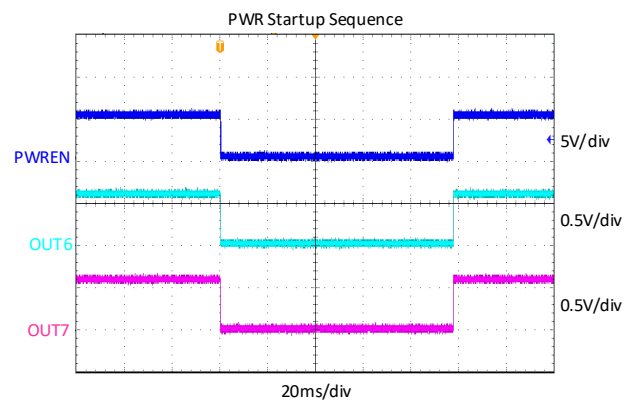
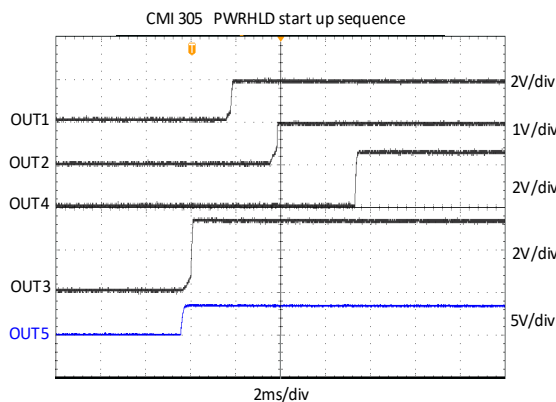
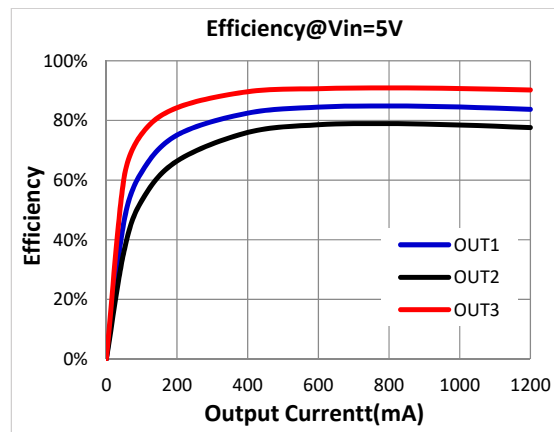
## Test Load Transient Response

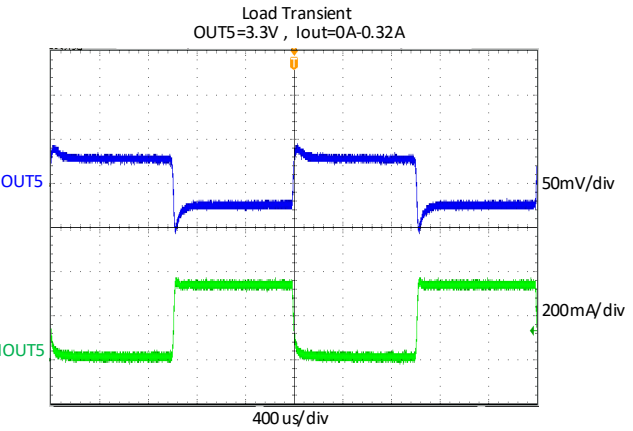
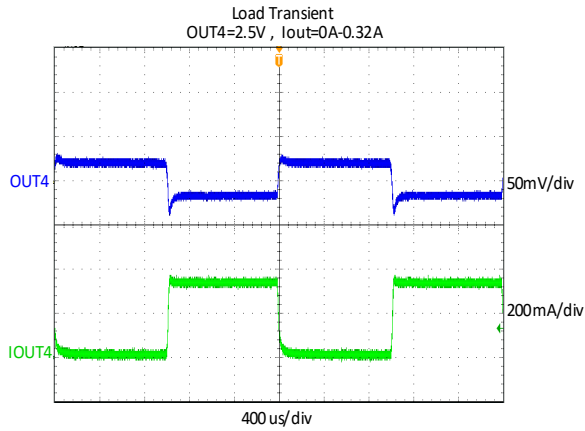
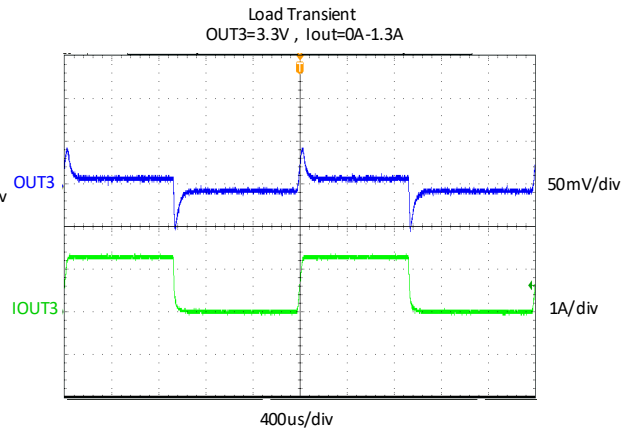
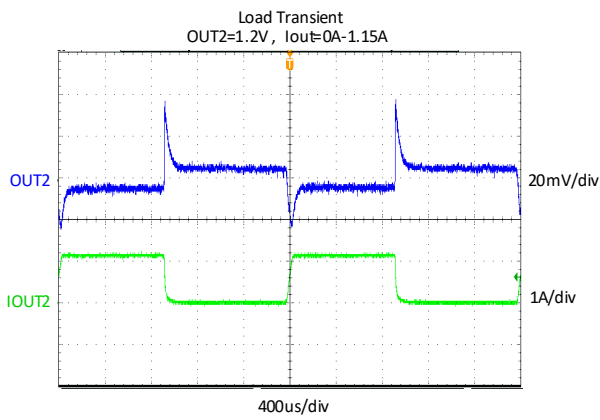
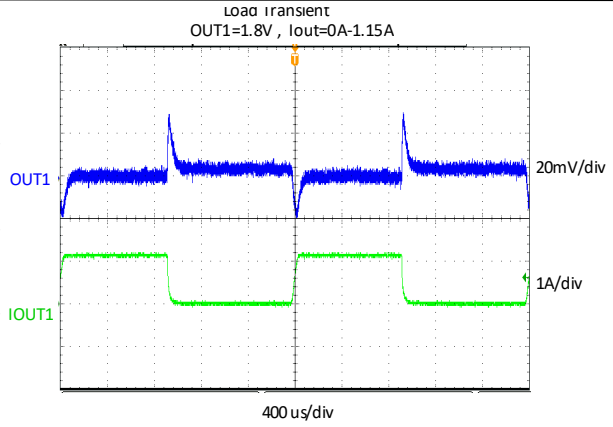
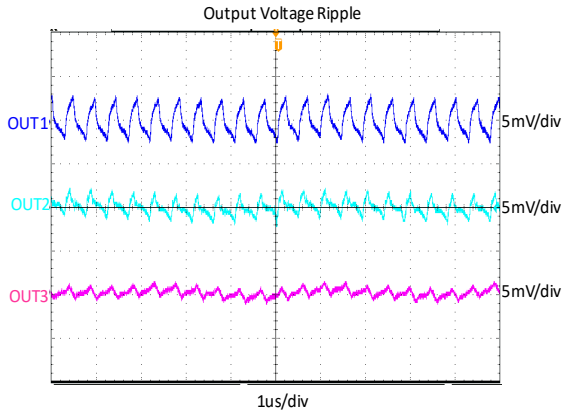
To test the load transient response, generate a load current transient at the output and observe the output voltage response using an oscilloscope. Attach the current probe to the wire between the output and the load to capture the current transient waveform. The method of testing the output voltage load transient response is the same as that of testing output voltage ripple.

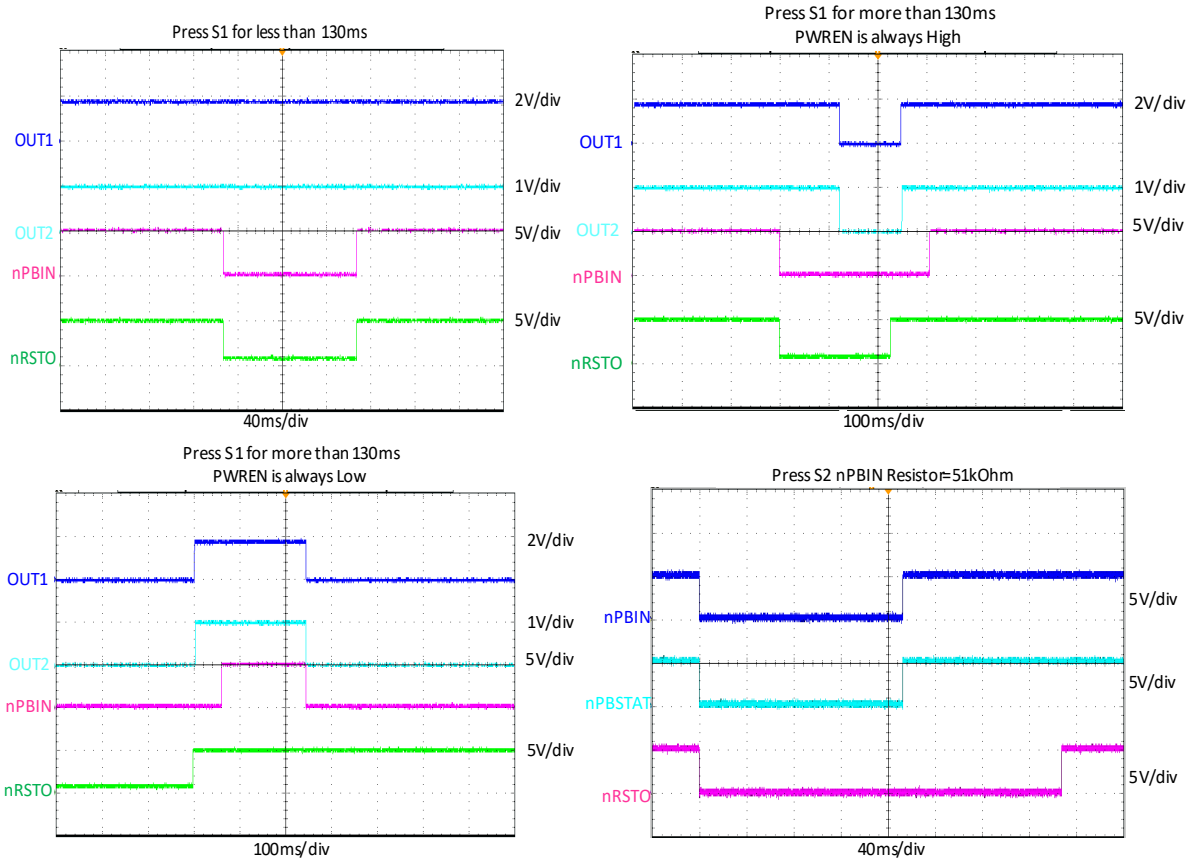
## Measuring Efficiency

The Efficiency is measured by comparing the input power with the output power. Measure the input and output voltage as close as possible to the input and output capacitor to reduce the effect of voltage drops in the PCB and connectors.

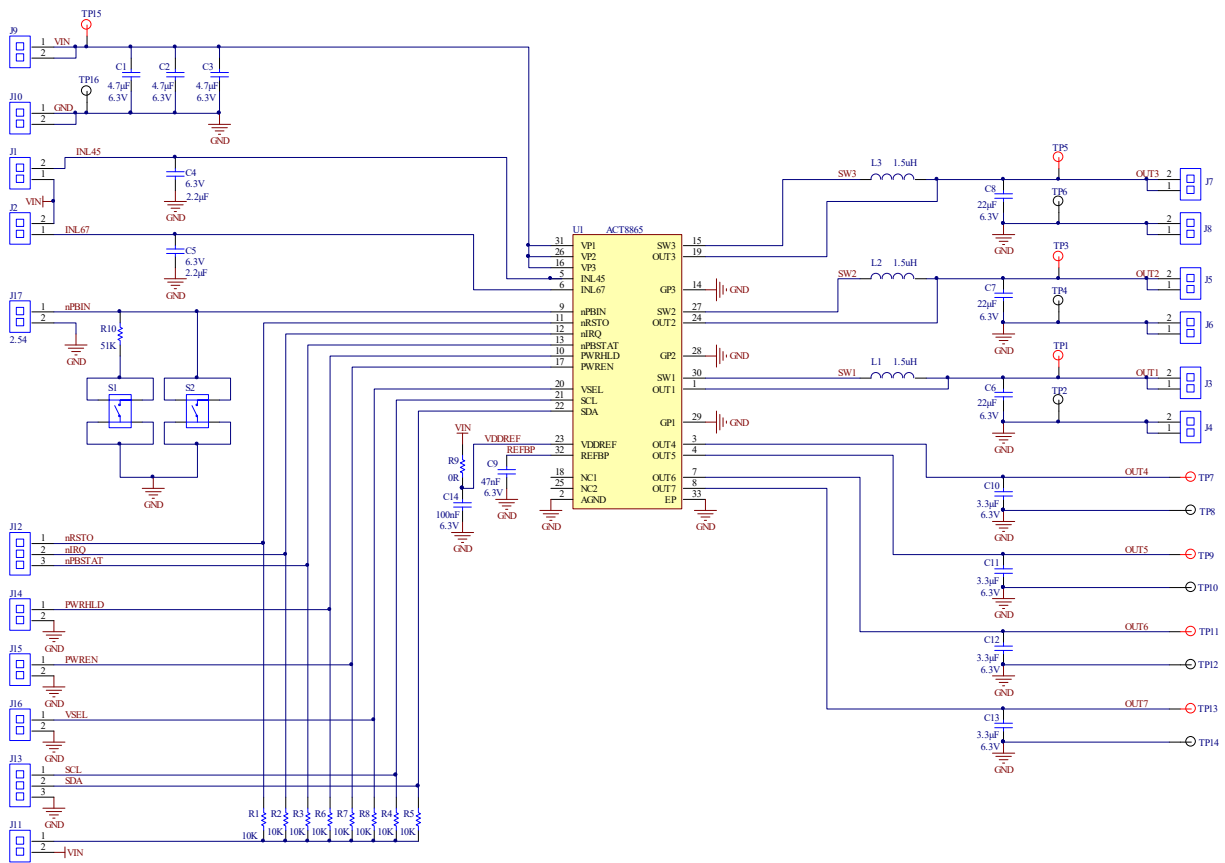
## Test Results





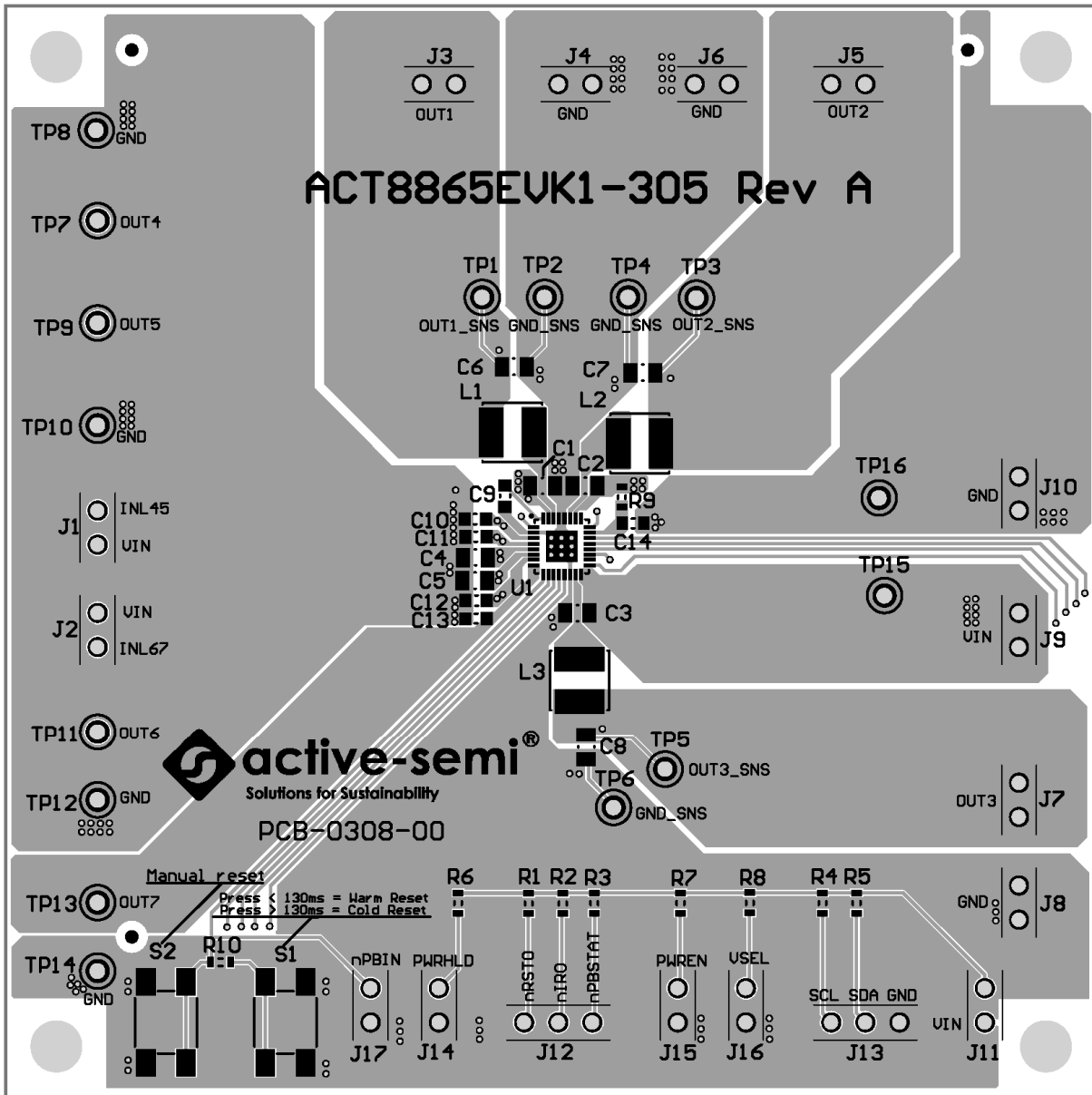


**Schematic**

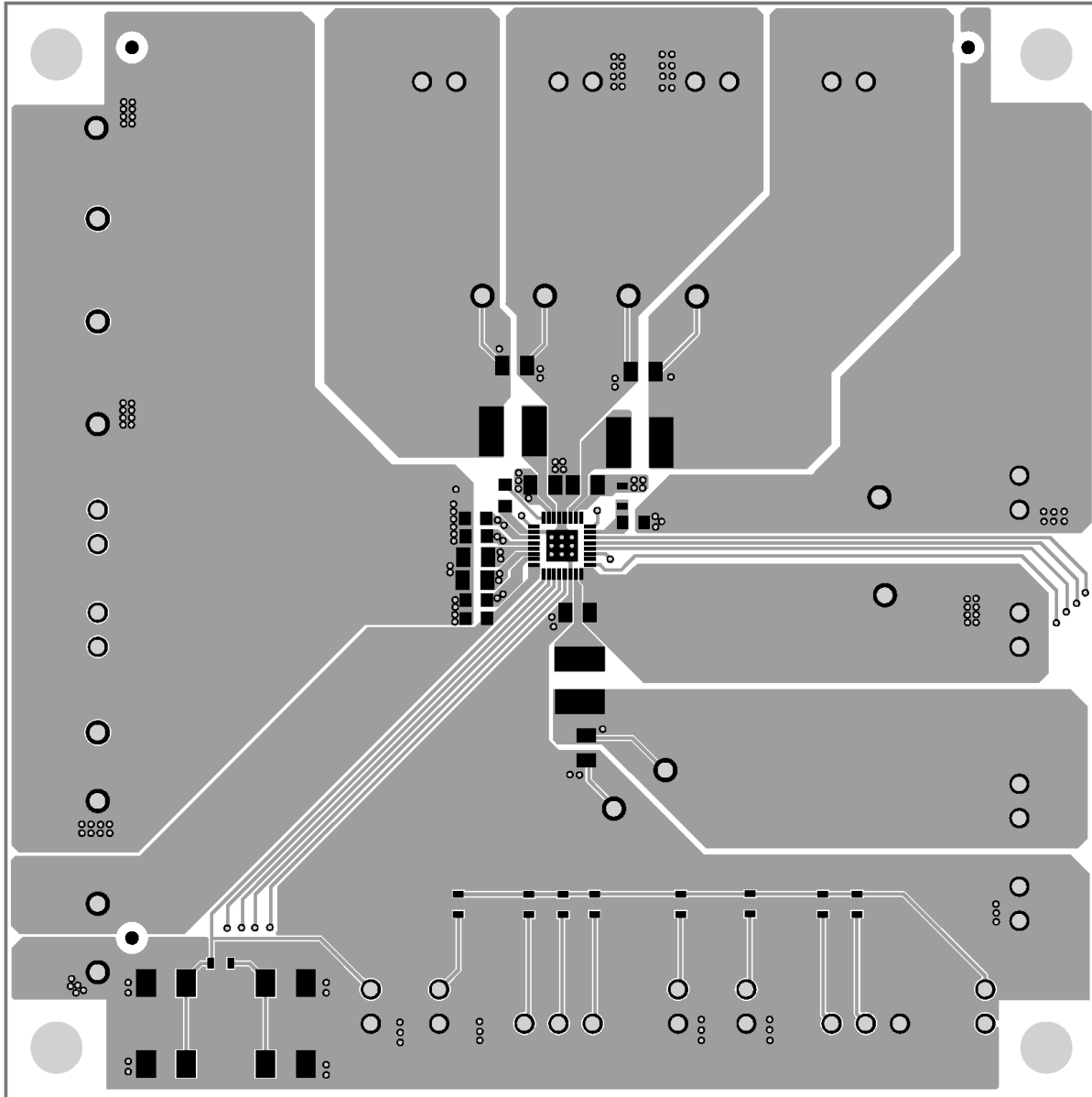




**Layout**



**Figure 5 –Layout Assembly Layer**



**Figure 6 –Layout Top Layer**

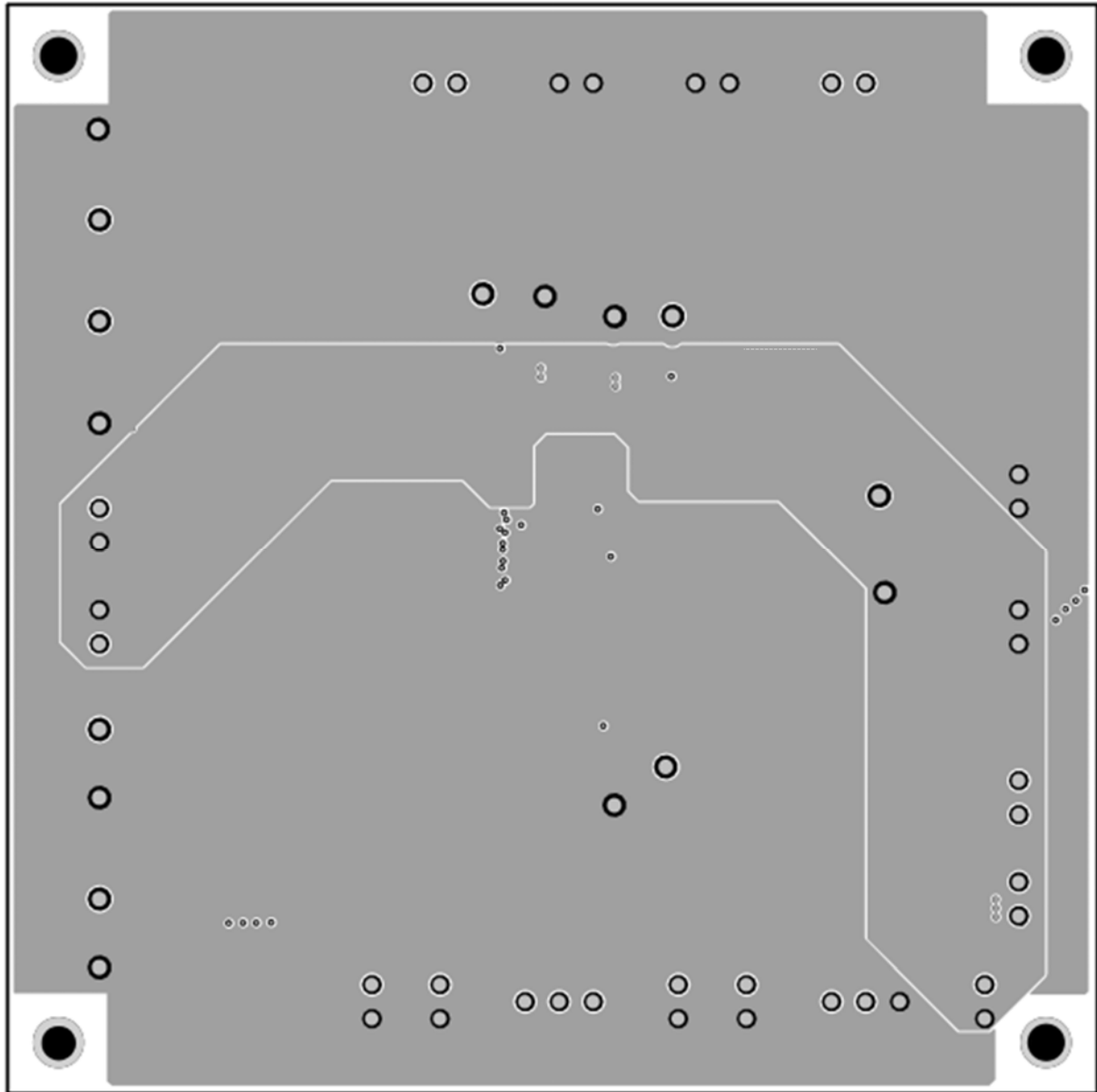


Figure 7 – Layout Layer 2

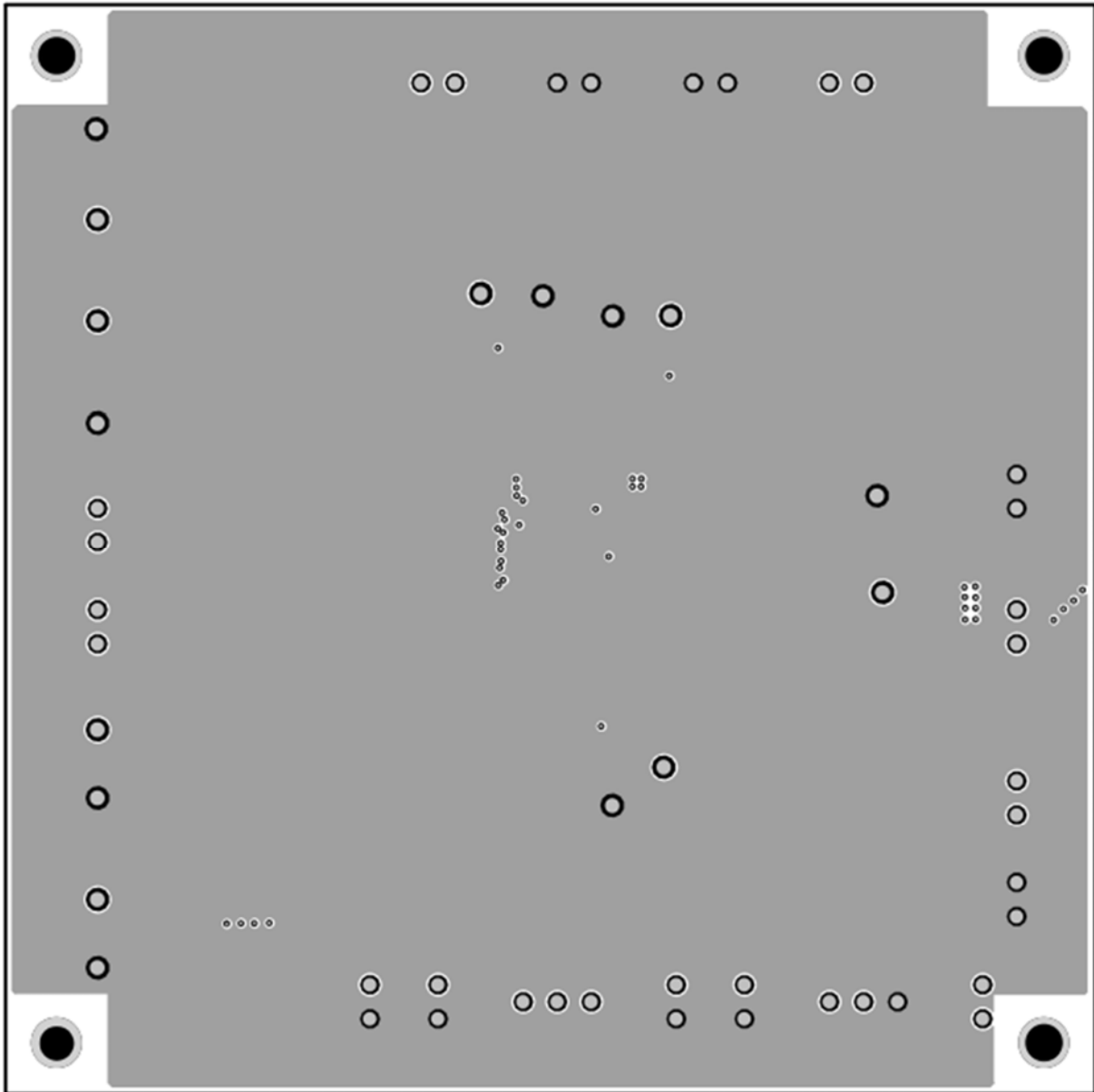


Figure 7 – Layout Layer 3

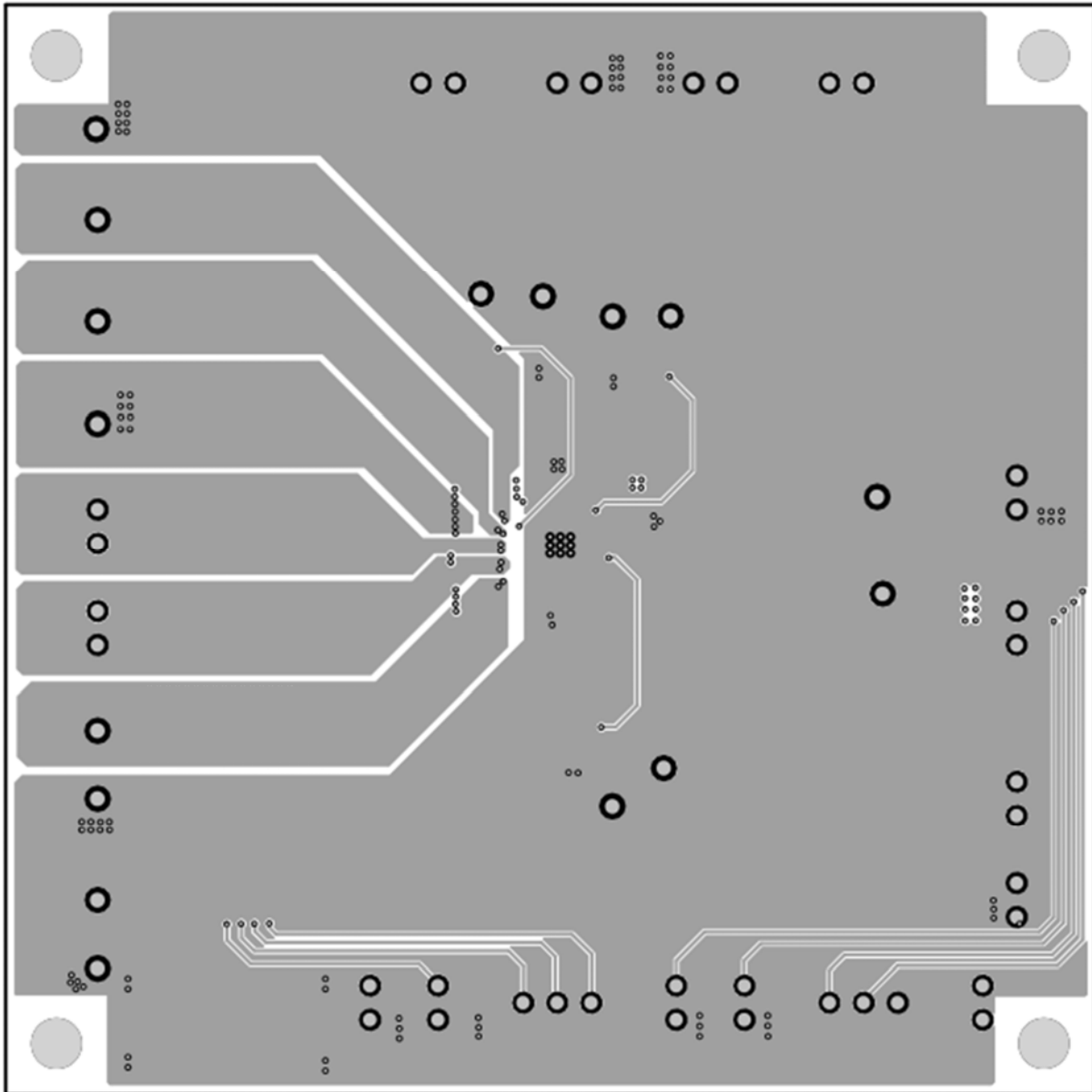


Figure 8 –Layout Bottom Layer

**Bill of Materials**
**Table 2. BOM list of EVK board**

| Item | Ref Des  | QTY | Description                          | Package         | MFR              | Part Number         |
|------|--|-----|--------------------------------------|-----------------|------------------|---------------------|
| 1    | C1,C2,C3   | 3   | Cap, Ceramic, 4.7uF, 6.3V, 10%, X7R  | 0805            | std              | std                 |
| 2    | C4,C5  | 2   | Cap, Ceramic, 2.2uF, 6.3V, 10%, X7R  | 0805            | std              | std                 |
| 3    | C6,C7,C8   | 3   | Cap, Ceramic, 22uF, 6.3V, 10%, X7R   | 0805            | std              | std                 |
| 4    | C9   | 1   | Cap, Ceramic, 47nF, 6.3V, 10%, X7R   | 0603            | std              | std                 |
| 5    | C10,C11,C12,C13                                    | 4   | Cap, Ceramic, 3.3uF, 6.3V, 10%, X7R  | 0603            | std              | std                 |
| 6    | C14  | 1   | Cap, Ceramic, 100nF, 16V, 10%, X7R   | 0603            | std              | std                 |
| 7    | J1,J2,J3,J4,J5,J6,J7,J8,J9,J10,J11,J14,J15,J16,J17 | 15  | Header, 2 pin, 100mil                |                 | Wurth Elektronik | 61300211119         |
| 8    | J12,J13  | 2   | Header, 3 pin, 100mil                |                 | Wurth Elektronik | 61300211120         |
| 9    | L1,L2,L3   | 3   | Wurth inductor 1.5uH                 | 4mmx4mmx3.8mm   | Wurth Elektronik | 74438336015         |
| 10   | R1,R2,R3,R4,R5,R6,R7,R8                            | 8   | Res, 10kΩ, 1%                        | 0603            | std              | std                 |
| 11   | R9   | 1   | Res, 0Ω, 1%                          | 0603            | std              | std                 |
| 12   | R10  | 1   | Res, 51kΩ, 1%                        | 0603            | std              | std                 |
| 13   | S1,S2  | 2   | SMT Tact switch 4mmx4mmx1.5mm        | 4x4x1.5         | C&K              | PTS525SK15SM TR2LFS |
| 14   | TP1,TP3,TP5,TP7,TP9,TP11,TP13,TP15                 | 8   | Test Point, Red, Through Hole, 1mm   | 0.040"          | Keystone         | 5000                |
| 15   | TP2,TP4,TP6,TP8,TP10,TP12,TP14,TP16                | 8   | Test Point, Black, Through Hole, 1mm | 0.040"          | Keystone         | 5001                |
| 16   | U1   | 1   | ACT8865QI305-T                       | 4x4mm TQFN44-32 | std              | std                 |
| 17   | --   | 1   | PCB, ACT8865EVK1-305 Rev A           | n/a             | n/a              | PCB-0308-00         |
| 18   | --   | 3   | Jumper, 100mil, Black                | n/a             | Wurth Elektronik | 60900213421         |

## GUI Installation

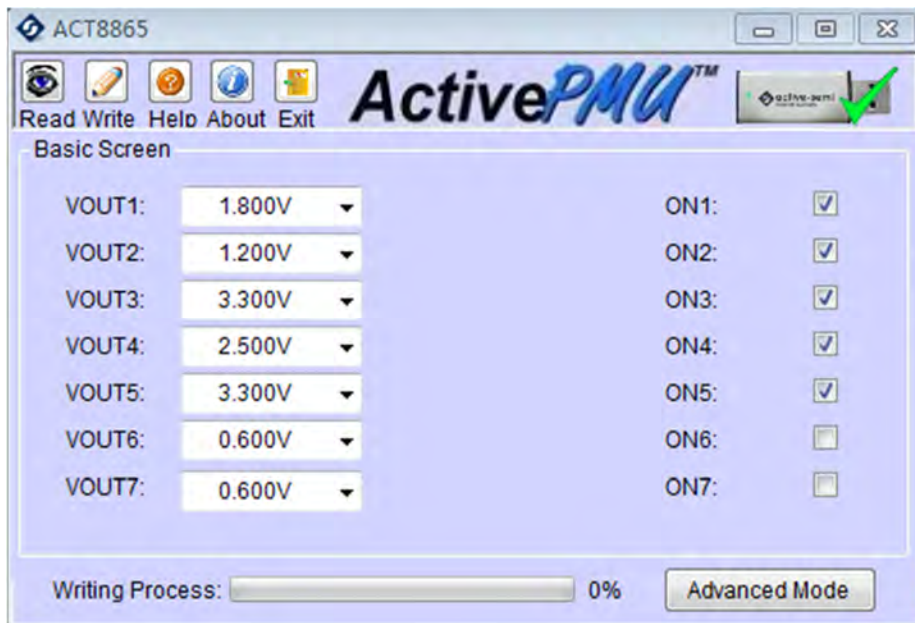
1. Contact Active Semi for the GUI files and save them on your computer.
2. Plug the USB-TO-I2C dongle into a free USB port.
3. Follow the instructions in the “How to install driver for dongle” folder.
4. Double click on the ACT8865 GUI.exe to start the ACT8865 GUI.

## 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 contain the button text for changing setting for every single bit.

### Basic Mode

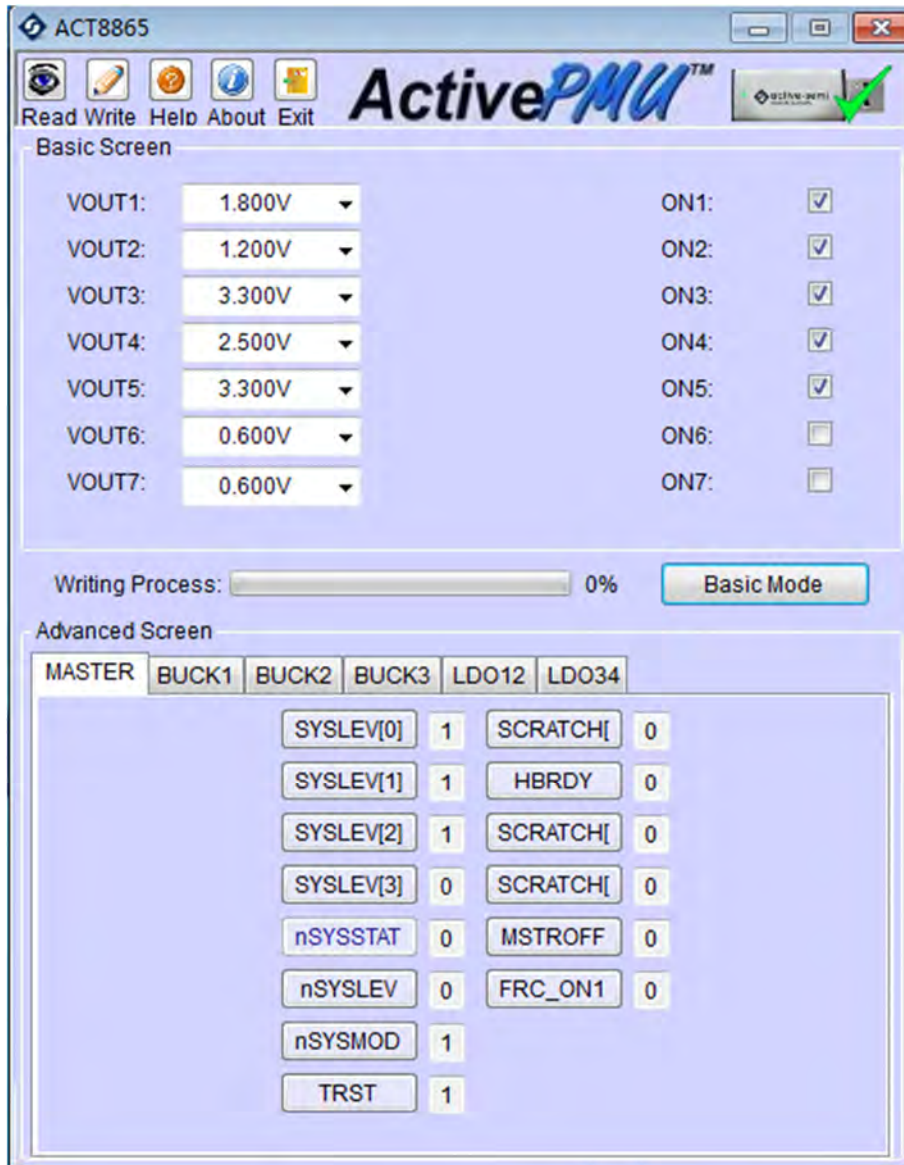
The following figure show the GUI in basic mode. This mode allows the user to easily change one or more IC settings.



**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.

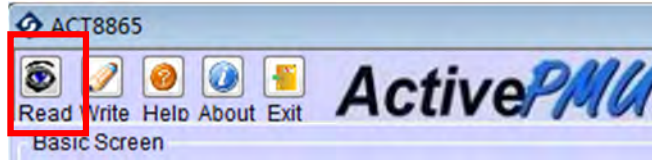
Note that the far right side of the screen contains a scroll down button to scroll down to additional registers since the Tile Screen can only display up to 8 bytes at once.





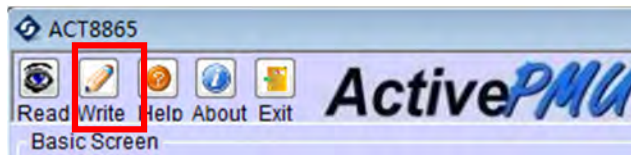
**Button Descriptions**

**Read:** Clicking on this button reads the ACT8865 registers and displays them in the GUI. Note that this reads all registers. Active-Semi recommends reading registers each time the ACT8865 powers-up to acquire the initial register settings. Active-semi also recommends reading registers after making changes to them. Immediately reading the registers after a write confirms the changes were properly stored.



Read Button

**Write:** Clicking on this button writes the GUI settings to the ACT8865's registers. All registers are written, regardless of whether or not they were changed.



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.

**Dongle connected**



**Dongle Disconnected**



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