*User's Guide*

# *TPS2583xA-Q1 Evaluation Module*


**ABSTRACT**

This user's guide describes the TPS2583xA-Q1 evaluation module (TPS2583XAQ1EVM-147). This document contains the EVM schematics, EVM configuration, bill of materials (BOM), board layout drawing and assembly drawing.


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## Trademarks

# 1 Introduction

The TPS2583XAQ1EVM-147 is an evaluation module (EVM) for TI's TPS2583xA-Q1 USB Type-C® and BC1.2 5-V, 3.5-A output and 36-V input synchronous buck with cable compensation. The EVM operates over a range from 6 V to 36 V and provides USB Type-C connectors to evaluate BC1.2, USB Type-C charging and USB2.0 data communication functions. The value of cable compensation, current limit and switching frequency can be adjusted by resistors on the EVM.

## 1.1 Features

The following features are available on this EVM:

- 6-V to 36-V input range, 3.5-A continuous output current buck converter
- Forced PWM operation with *Spread-Spectrum Dithering*
- Fully AEC-Q100 qualified
- ± 8% *Current Sense Accuracy* ($I_{OUT}$ > 1.5 A) for *Precision Cable Droop Compensation*
- USB battery charging specification Rev. 1.2 and USB Type-C Rev. 1.3 compliant
- CC1, CC2, D+ and D– Short-to-VBAT, and VBUS protection
- User-programmable VBUS current limit and internal VCONN current limiting
- High bandwidth DP, DM USB switches

## 1.2 Applications

The EVM is used in the following applications:

- Automotive: Infotainment, USB hubs, aftermarket USB chargers

# 2 Schematic

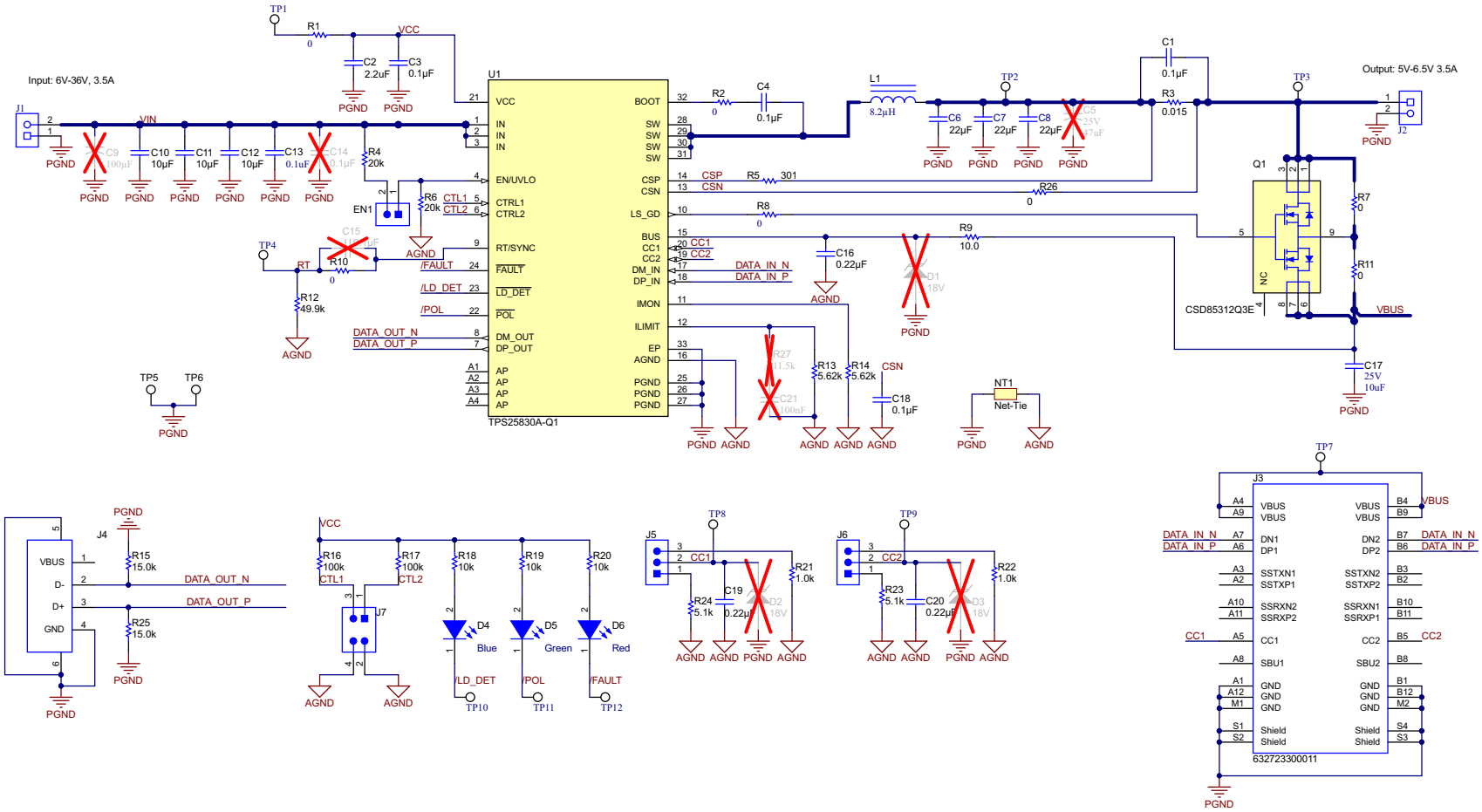


**Figure 2-1. TPS2583XAQ1EVM-147 Schematic**

# 3 General Configuration and Description

This section describes the connectors, jumpers, LED and test points on the EVM and how to properly connect, set up and use the TPS2583XAQ1EVM-147.

## 3.1 Physical Access

Table 3-1 lists the TPS2583XAQ1EVM-147 connector functionality, Table 3-2 describes the jumper configuration, Table 3-3 shows LED labels and description and Table 3-4 describes the test point availability.

**Table 3-1. Connectors**

| Connector | Component Type | Description |
|---|---|---|
| J1 | Terminal block | Power input connector for TPS2583xA-Q1. Connect to a 6-V to 36-V power supply. |
| J4 | USB Type-A connector, plug | Upstream facing USB 2.0 Type A connector. Connect to the USB 2.0 host for data pass through to J4 or J8. The power pin of this connector is float. |
| J3 | USB Type-C connector, receptacle | Downstream facing USB Type-C connector. Connect to the USB Type-C slave for data pass through from J4 and BC1.2 or USB Type-C identification. USB output power is provided to the slave from the buck converter of the TPS2583xA-Q1 device. |

**Table 3-2. Jumpers**

| Jumper | Label | Description |
|---|---|---|
| J5 | CC1 | 3 × 1 header. Install shunt to connect Ra or Rd on CC1. Remove shunt to float CC1. |
| J6 | CC2 | 3 × 1 header. Install shunt to connect Ra or Rd on CC2. Remove shunt to float CC2. |
| J7 | CTRL1 | Install shunt to select CTRL1 as LOW. Remove shunt to select CTRL1 as HIGH. |
| | CTRL2 | Install shunt to select CTRL2 as LOW. Remove shunt to select CTRL2 as HIGH. |

**Table 3-3. LED**

| LED | Label | Description |
|---|---|---|
| D4 | LD_DET | LD_DET signal LED. Turn on when LD_DET asserts. |
| D5 | POL | POL signal LED. Turn on when POL asserts. |
| D6 | FAULT | FAULT signal LED. Turn on when FAULT asserts. |

**Table 3-4. Test Points**

| Test Point | Label | Description |
|---|---|---|
| TP1 | VCONN | VCC pin test point via R1 or external Vconn input |
| TP2 | CSP | Test point of voltage between inductor and sense resistor |
| TP3 | CSN/OUT | CSN pin test point and DC-DC output test point |
| TP4 | RT | RT pin test point or external clock input |
| TP5, TP6 | GND | Power ground test point |
| TP7 | VBUS | USB Type-A and USB Type-C connector, VBUS test point |
| TP8 | CC1 | CC1 pin test point |
| TP9 | CC2 | CC2 pin test point |
| TP10 | LD_DET | LD_DET pin test point |
| TP11 | POL | POL pin test point |
| TP12 | FAULT | FAULT pin test point |
| EN1 | EN | EN pin test point or external EN input |

## 3.2 Adjusting the Switching Frequency

If other frequencies are desired, within the frequency range of 400 kHz to 2.2 MHz, the $R_t$ resistor (R12) value can be changed. Consult the data sheet for proper selection of the $R_t$ resistor (R12). Change the inductor (L1) and the total output capacitance for proper control loop operation.

The RT/SYNC pin can also be used to synchronize the internal oscillator to an external clock. The TPS2583XAQ1EVM-147 allows users to synchronize the internal oscillator to both Lo-Z clock source and Hi-Z clock source by configuring R10, R12, and C15. Refer to the data sheet for detailed information.

### 3.3 Adjusting the Current Limit Value

If other current limit values are desired, the $R_I$ resistor (R13) value can be changed. Consult the data sheet for proper selection of the $R_I$ resistor (R13).

### 3.4 Adjusting the Cable Compensation Value

If other cable compensation values are desired, the $R_m$ resistor (R14) value can be changed. Consult the data sheet for proper selection of the $R_m$ resistor (R14).

### 3.5 Test Setup

Figure 3-1 shows a typical test setup for charging the USB Type-C device. Connect J1 to the 13.5-V power supply. Connect USB Type-C device to J3 connector. Shunts do not need to be installed on J5 or J6.

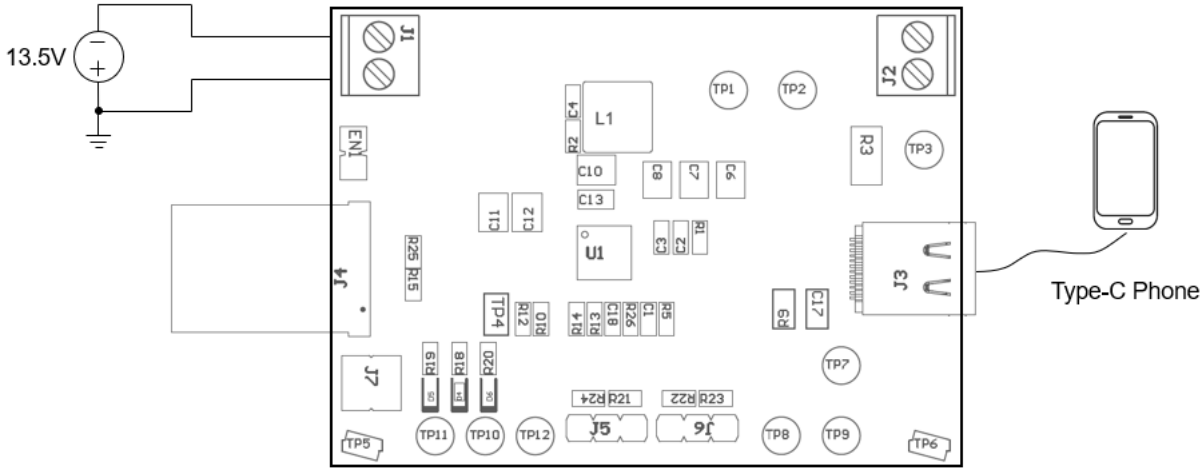


**Figure 3-1. EVM Setup for Charging USB Type-C® Device**

# 4 Board Layout

Figure 4-1 and Figure 4-2 show the top and bottom assembly. Figure 4-3 and Figure 4-4 show the top side and bottom side 3D view. Figure 4-5 to Figure 4-8 show the layout of the EVM.

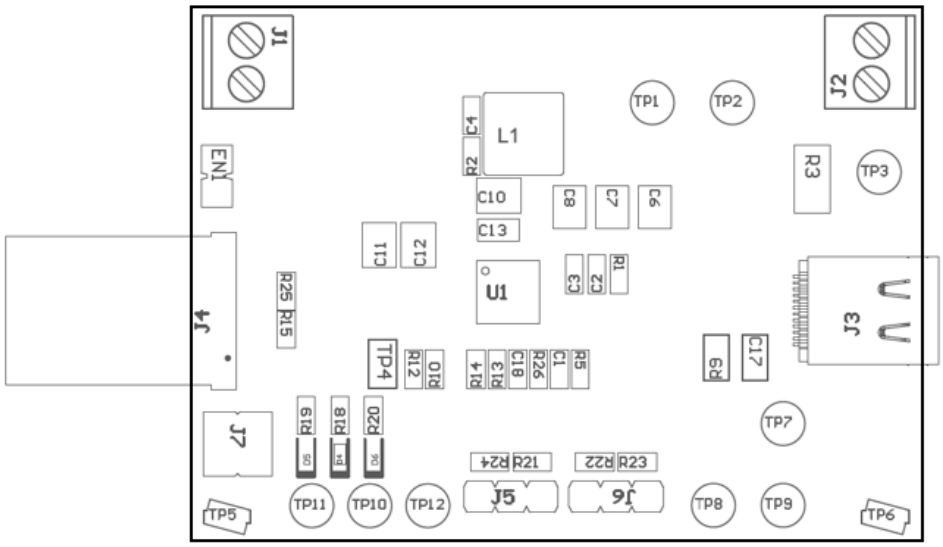


**Figure 4-1. Top Side Assembly**

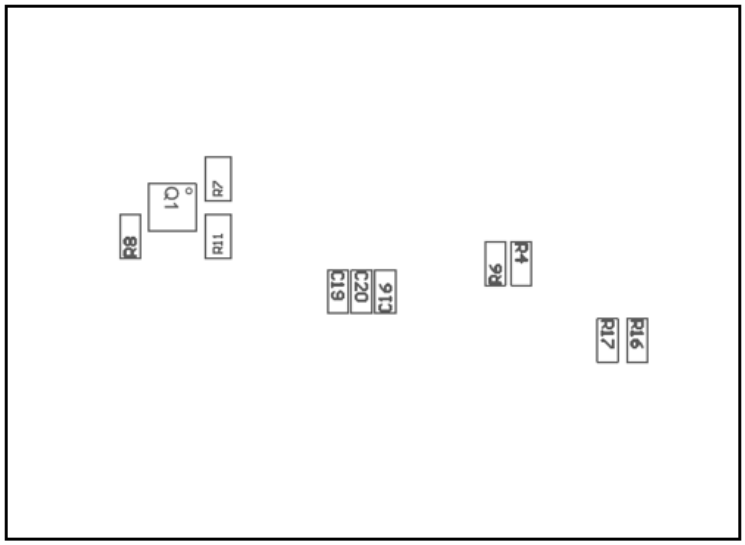


**Figure 4-2. Bottom Side Assembly**

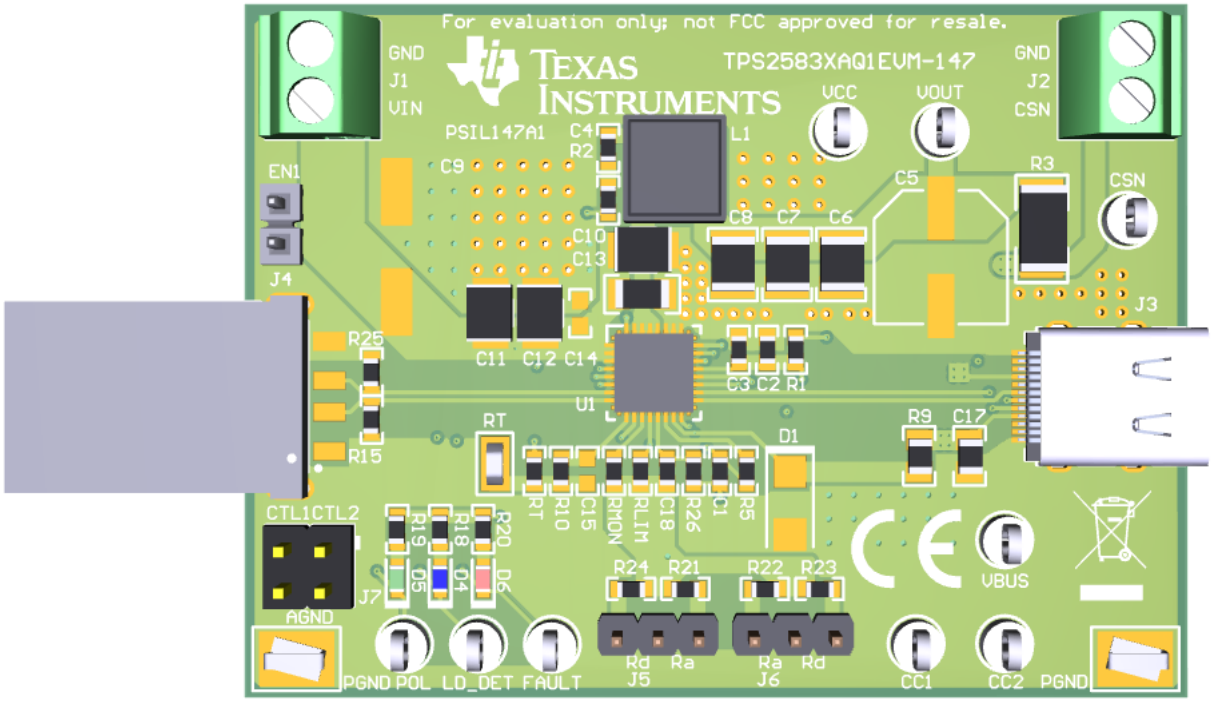


**Figure 4-3. Top Side 3D View**

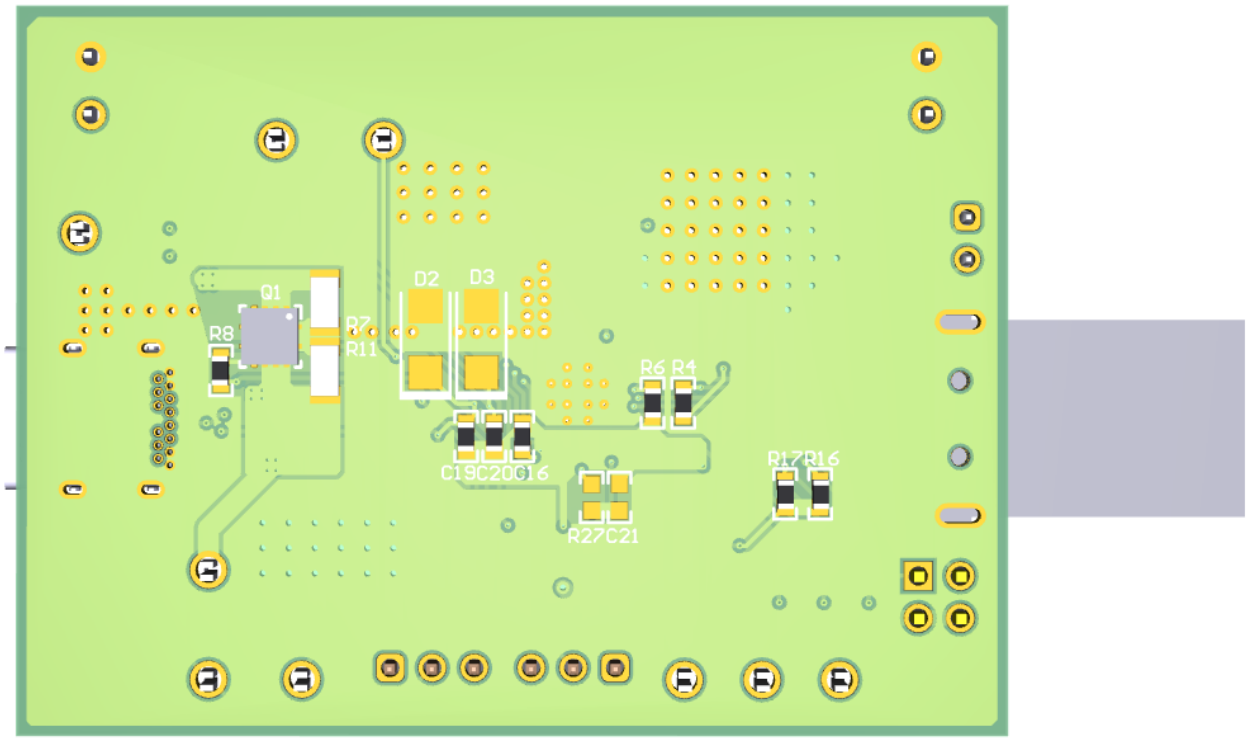


**Figure 4-4. Bottom Side 3D View**

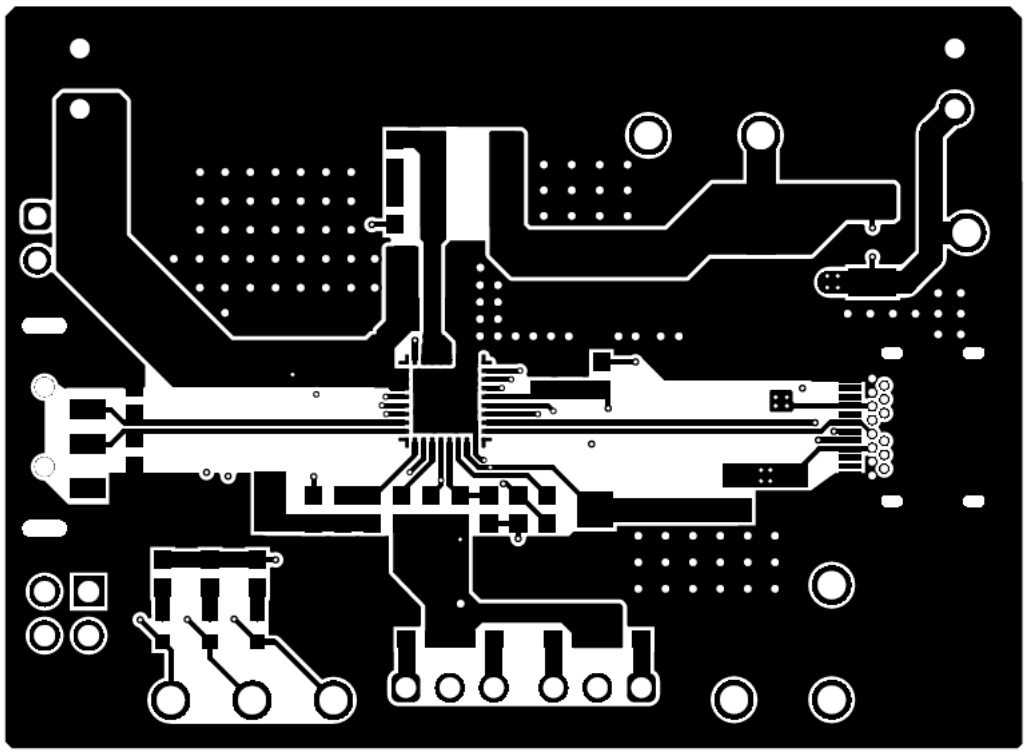

**Figure 4-5. Top Layer Layout**

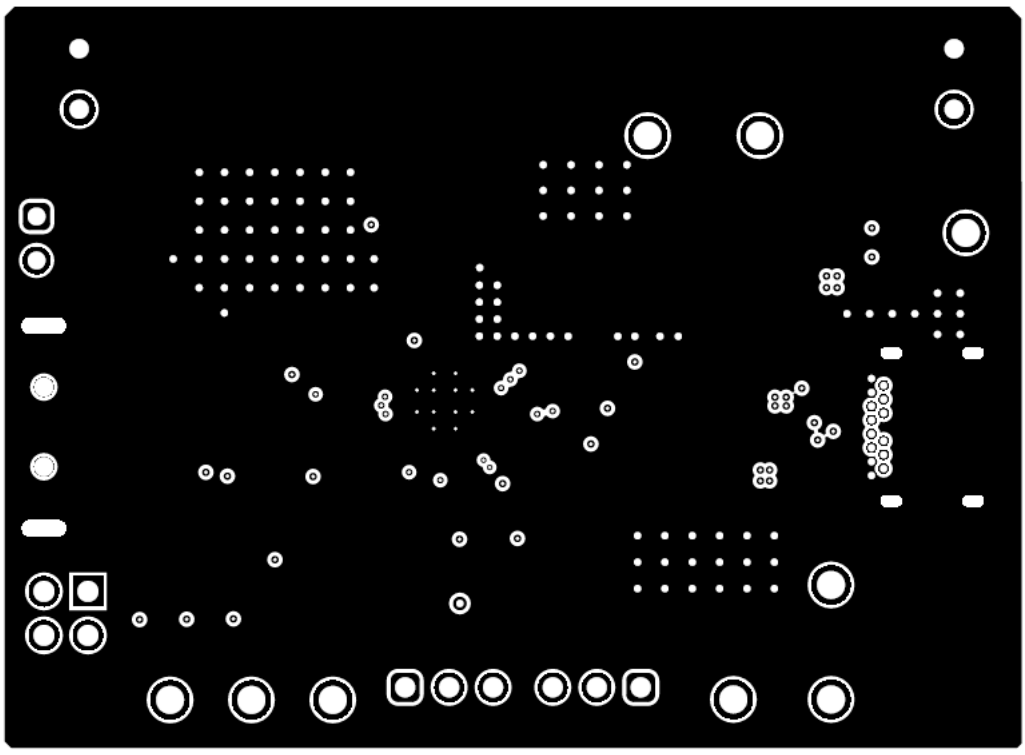

**Figure 4-6. Middle Layer 1 Layout**

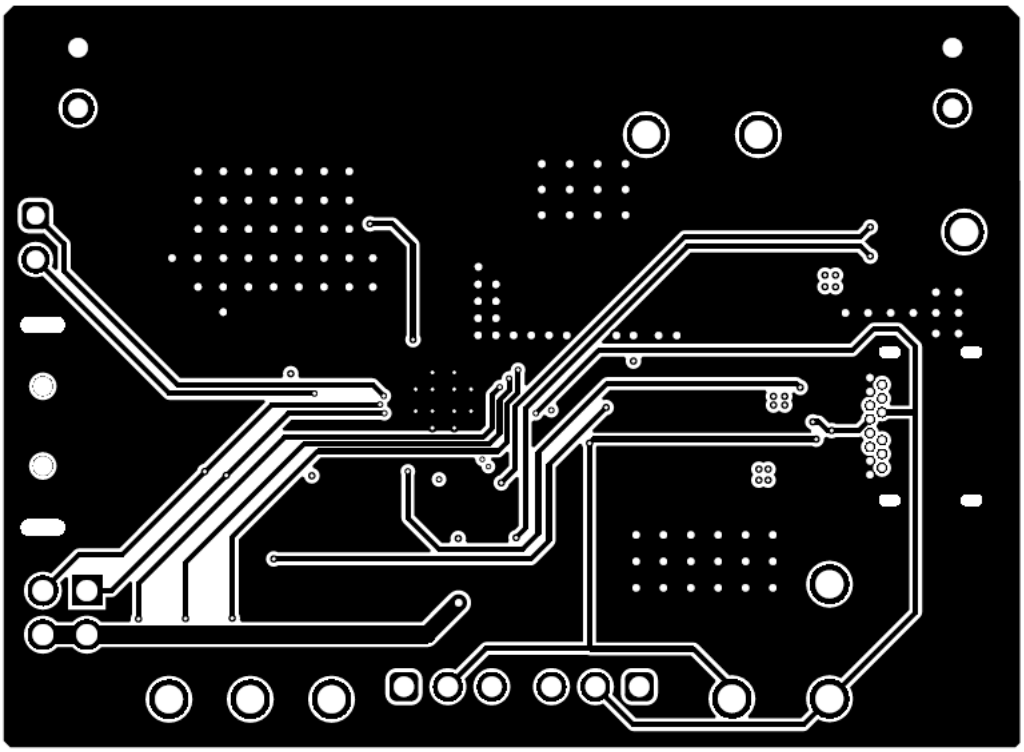

**Figure 4-7. Middle Layer 2 Layout**

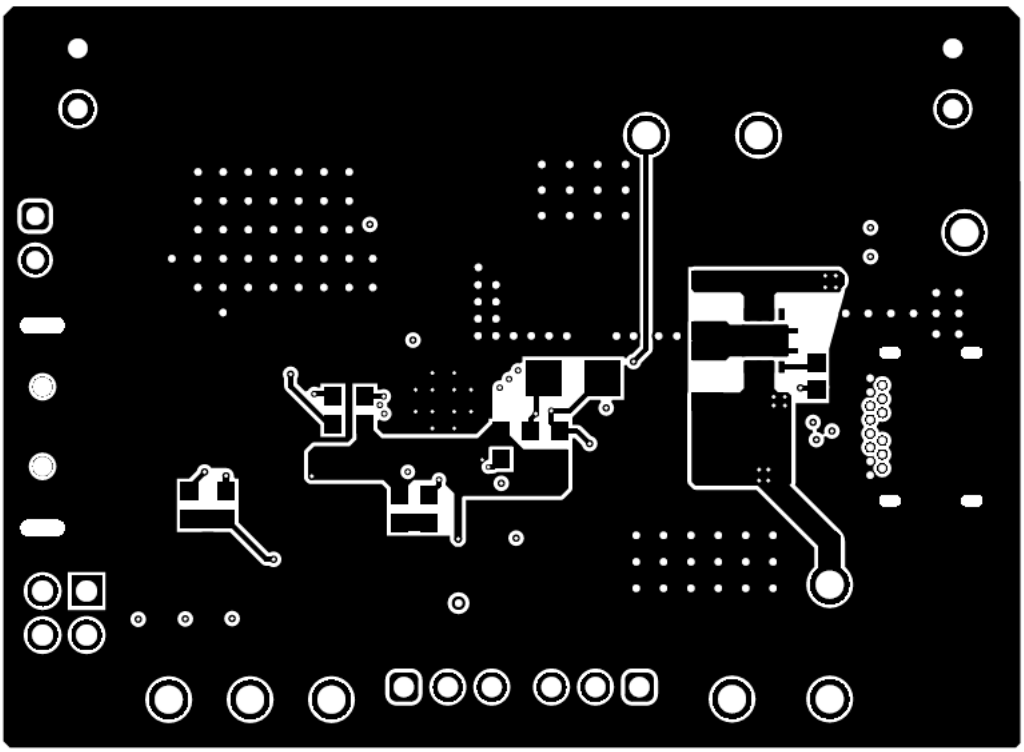

**Figure 4-8. Bottom Layer Layout**

# 5 Bill of Materials

Table 5-1 details the EVM bill of materials.

**Table 5-1. Bill of Materials**

| Designator | QTY | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| C1, C3, C4, C18 | 4 | 0.1uF | CAP, CERM, 0.1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603 | 0603 | C0603C104K5RACAUTO | Kemet |
| C2 | 1 | 2.2uF | CAP, CERM, 2.2 uF, 16 V, +/- 20%, X5R, 0603 | 0603 | 885012106018 | Wurth Elektronik |
| C6, C7, C8 | 3 | 22uF | CAP, CERM, 22 µF, 25 V,+/- 10%, X7R, 1210 | 1210 | CL32B226KAJNFNE | Samsung Electro-Mechanics |
| C10, C11, C12 | 3 | 10uF | CAP, CERM, 10 µF, 50 V,+/- 20%, X7R, AEC-Q200 Grade 1, 1210 | 1210 | UMJ325KB7106MMHP | Taiyo Yuden |
| C13 | 1 | 0.1uF | CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 1206 | 1206 | 12065C104JAT2A | AVX |
| C16, C19, C20 | 3 | 0.22uF | CAP, CERM, 0.22 µF, 16 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603 | 0603 | CL10B224KO8VPNC | Samsung |
| C17 | 1 | 10uF | CAP, CERM, 10 uF, 25 V, +/- 10%, X5R, 0805 | 0805 | C2012X5R1E106K125AB | TDK |
| D4 | 1 | Blue | LED, Blue, SMD | LED_0603 | 150060BS75000 | Wurth Elektronik |
| D5 | 1 | Green | LED, Green, SMD | LED_0603 | 150060GS75000 | Wurth Elektronik |
| D6 | 1 | Red | LED, Red, SMD | LED_0603 | 150060RS75000 | Wurth Elektronik |
| EN1 | 1 | | Header, 2.54 mm, 2x1, Tin, TH | Header, 2.54 mm, 2x1, TH | TSW-102-07-T-S | Samtec |
| J1, J2 | 2 | | Conn Term Block, 2POS, 3.5mm, TH | 11x8.5x7.3mm | 1751248 | Phoenix Contact |
| J3 | 1 | | Connector, Receptacle, USB Type C, R/A | Connector, Receptacle, USB Type C, R/A, THT/SMT | 632723300011 | Wurth Elektronik |
| J4 | 1 | | Connector, Plug, USB Type A, R/A, Top Mount SMT | USB 2.0, SMT Plug, 18.65x4.5x12mm | 931 | Keystone |
| J5, J6 | 2 | | Header, 2.54 mm, 3x1, Gold, TH | Header, 2.54mm, 3x1, TH | 61300311121 | Wurth Elektronik |
| J7 | 1 | | Header, 2.54mm, 2x2, Gold, TH | Header, 2.54mm, 2x2, TH | PBC02DAAN | Sullins Connector Solutions |
| L1 | 1 | 8.2uH | Inductor, Shielded, Hyperflux, 8.2 µH, 5.3 A, 0.0253 ohm, SMD | 6.65x6.45mm | 74439346082 | Wurth Elektronik |
| Q1 | 1 | 20V | MOSFET, 2-CH, N-CH, 20 V, 12 A, DPA0008A (VSON-8) | DPA0008A | CSD85312Q3E | Texas Instruments |
| R1, R2, R8, R10, R26 | 5 | 0 | RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | RMCF0603ZT0R00 | Stackpole Electronics Inc |
| R3 | 1 | 0.015 | RES, 0.015, 1%, 0.5 W, 2010 | 2010 | WSL2010R0150FEA | Vishay-Dale |
| R4, R6 | 2 | 20k | RES, 20 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW060320K0JNEA | Vishay-Dale |
| R5 | 1 | 301 | RES, 301, 1%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW0603301RFKEA | Vishay-Dale |
| R7, R11 | 2 | 0 | RES, 0, 1%, 0.5 W, 1206 | 1206 | 5108 | Keystone |
| R9 | 1 | 10.0 | RES, 10.0, 1%, 0.125 W, AEC-Q200 Grade 0, 0805 | 0805 | CRCW080510R0FKEA | Vishay-Dale |
| R12 | 1 | 49.9k | RES, 49.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW060349K9FKEA | Vishay-Dale |
| R13, R14 | 2 | 5.62k | RES, 5.62 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW06035K62FKEA | Vishay-Dale |
| R15, R25 | 2 | 15.0k | RES, 15.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW060315K0FKEA | Vishay-Dale |
| R16, R17 | 2 | 100k | RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW0603100KFKEA | Vishay-Dale |
| R18, R19, R20 | 3 | 10k | RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW060310K0JNEA | Vishay-Dale |
| R21, R22 | 2 | 1.0k | RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW06031K00JNEA | Vishay-Dale |
| R23, R24 | 2 | 5.1k | RES, 5.1 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW06035K10JNEA | Vishay-Dale |

**Table 5-1. Bill of Materials (continued)**

| Designator | QTY | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| TP1, TP2, TP3, TP7, TP8, TP9, TP10, TP11, TP12 | 9 | | Test Point, Multipurpose, White, TH | White Multipurpose Testpoint | 5012 | Keystone |
| TP4 | 1 | | Test Point, Miniature, SMT | Testpoint_Keystone_Miniature | 5015 | Keystone |
| TP5, TP6 | 2 | | Test Point, Compact, SMT | Testpoint_Keystone_Compact | 5016 | Keystone |
| U1 | 1 | | USB Type-C and BC1.2 5V 3.5A Output, 36V Input Synchronous Buck with Cable Compensation, RHB0032R (VQFN-32) | RHB0032R | TPS25830S10QWRHB | Texas Instruments |
| C5 | 0 | 47uF | CAP, AL, 47 uF, 25 V, +/- 20%, 0.4 ohm, SMD | SMT Radial E | EEE-FC1E470P | Panasonic |
| C9 | 0 | 100uF | CAP, AL, 100 µF, 50 V, +/- 20%, SMD | D8xL10.5mm | 865060653010 | Wurth Elektronik |
| C14, C15 | 0 | 0.1uF | CAP, CERM, 0.1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603 | 0603 | C0603C104K5RACAUTO | Kemet |
| C21 | 0 | 0.1uF | CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, 0603 | 0603 | CL10B104KO8NNNC | Samsung Electro-Mechanics |
| D1, D2, D3 | 0 | 18V | Diode, TVS, Uni, 18 V, 29.2 Vc, 400 W, 13.7 A, AEC-Q101, SMA | SMA | SZ1SMA18AT3G | Littelfuse |
| R27 | 0 | 11.5k | RES, 11.5 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW060311K5FKEA | Vishay-Dale |

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