User's Guide

TPS25859-Q1 Evaluation Module

ABSTRACT

This user's guide describes the TPS25859-Q1 evaluation module (TPS25859Q1EVM-161). 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 TPS25859Q1EVM-161 is an evaluation module (EVM) for TI's TPS25859-Q1 USB Type-C® and BC1.2 dual type-C ports which is capable of providing up to 6.6-A output current, 3 A for each port with cable compensation. The EVM operates over a range from 5.5 V to 26 V and withstands 40-V transient voltage. The value of cable compensation, current limit, output voltage, and switching frequency can be adjusted by resistors on the EVM. Each port can be enabled or disabled by PA_EN and PB_EN. Each port can also assert fault as in fault condition.

1.1 Features

The following features are available on this EVM:

- 5.5-V to 26-V input range, 3-A continuous output current buck converter for each port
- 200-mA capability for OUT pin, 200-mA capability for VCONN power meeting for USB3.1 power requirement
- Forced PWM operation with spread-spectrum dithering at 200 kHz–800kHz
- Fully AEC-Q100 qualified
- Programmable output short current limit: ±15% accuracy overtemperature
- Smart thermal management
- User-programmable VBUS current limit and internal VCONN current limiting

1.2 Applications

The EVM is used in the following applications:

- Automotive: USB media hubs, USB charging ports, aftermarket Dual USB chargers

2 Schematic

Figure 2-1 illustrates the TPS25859Q1EVM-161 schematic.

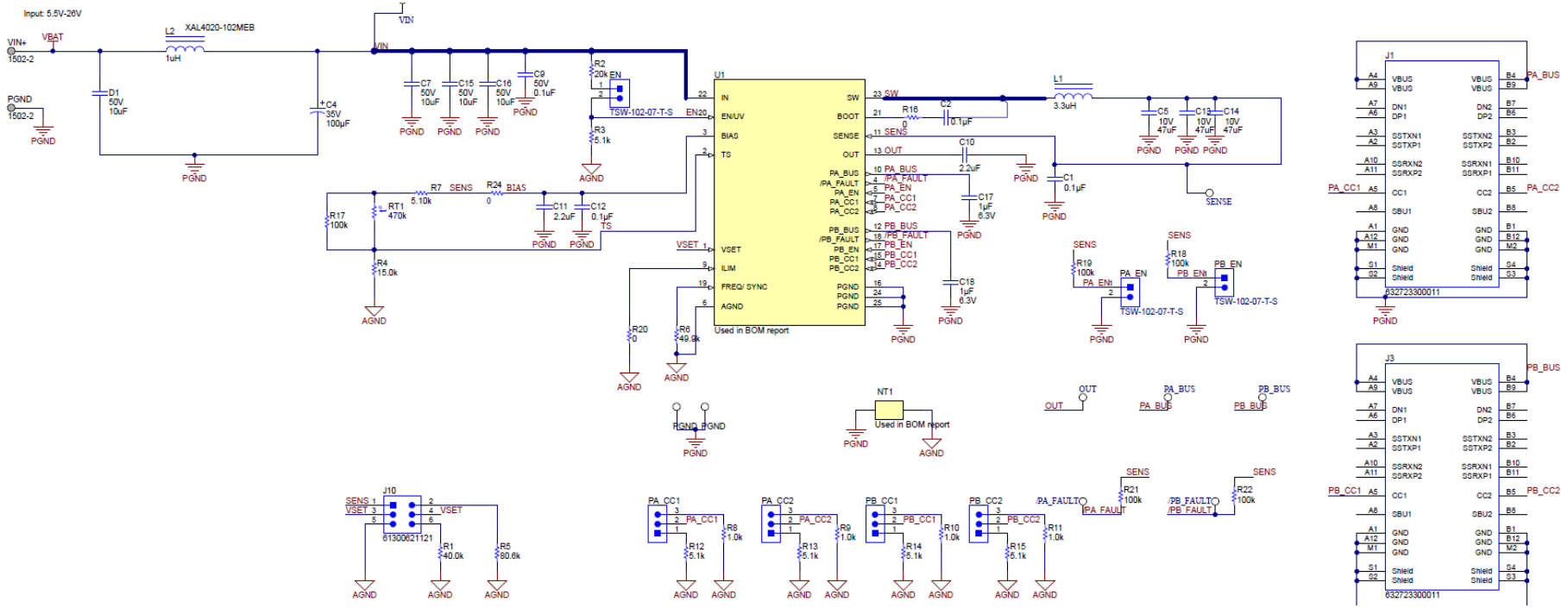

Figure 2-1. TPS25859Q1EVM-161 Schematic

3 General Configuration and Description

This section describes the connectors, jumpers, and test points on the EVM and how to properly connect, set up, and use the TPS25859Q1EVM-161.

3.1 Physical Access

Table 3-1 lists the TPS25859Q1EVM-161 connector functionality, Table 3-2 describes the jumper configuration, and Table 3-3 describes the test point availability.

Table 3-1. Connectors

Connector	Component Type	Description
J1, J3	USB Type-C connector, receptacle	Downstream facing USB Type-C connector. Connect to the USB Type-C peripheral for data pass through from PA/B_CC1/2 and BC1.2 or USB Type-C identification. USB output power is provided to the peripheral from the buck converter of the TPS25859-Q1 device.
VIN+, PGND	Terminal block	Power input connector for TPS25859-Q1. Connect to a 5.5-V to 26-V power supply.

Table 3-2. Jumper

Jumper	Label	Description
PA_CC1	PA_CC1	3 × 1 header. Install shunt to connect Ra or Rd on CC1 of port-A. Remove shunt to float CC1.
PA_CC2	PA_CC2	3 × 1 header. Install shunt to connect Ra or Rd on CC2 of port-A. Remove shunt to float CC2.
PB_CC1	PB_CC1	3 × 1 header. Install shunt to connect Ra or Rd on CC1 of port-B. Remove shunt to float CC1.
PB_CC2	PB_CC2	3 × 1 header. Install shunt to connect Ra or Rd on CC2 of port-B. Remove shunt to float CC2.
J10	Buck output voltage selection	3 × 2 header. Install shunt to pin 1 and pin 3 for 5.1 V, to pin 3 and pin 5 for 5.17 V, to pin 2 and pin 4 for 5.4 V, to pin 4 and pin 6 for 5.3 V.

Table 3-3. Test Points

Test Point	Label	Description
VIN	VIN	VIN pin test point
EN	EN	EN pin test point
OUT	OUT	OUT pin test point
SENSE	SENSE	SENSE pin test point
PA_BUS	PA_BUS	BUS pin of Port A test point
PB_BUS	PB_BUS	BUS pin of Port B test point
PGND	PGND	Power ground pin test point

3.2 Adjusting the Switching Frequency

If other frequencies are desired, within the frequency range of 200 kHz to 800kHz, the RFREQ (R6) resistor value can be changed. Consult the *TPS25859-Q1 data sheet* for proper selection of the RFREQ resistor. Change the inductor (L1) and the total output capacitance for proper control-loop operation. The FREQ/SYNC pin can also be used to synchronize the internal oscillator to an external clock. The TPS25859EVMQ1-161 allows users to synchronize the internal oscillator to both Lo-Z clock source and Hi-Z clock source. See the data sheet for detailed information.

3.3 Adjusting the Current Limit Value

If other current limit values are desired, the RILIM resistor value can be changed. Modifying the value of R20 can change current limit threshold. Consult the data sheet for proper selection of RILIM.

3.4 Adjusting the Cable Compensation Value

The TPS25859-Q1 must short the VSET pin to ground to enable the cable compensation. With that setting, the buck regulator increases its output voltage linearly as the load current increases, and the voltage compensation at currents of the USB ports greater than 2.4 A is 90 mV.

3.5 Thermal Management

The TS input pin allows for user programmable thermal protection. See Electrical Characteristics for TS pin thresholds. The TS input pin threshold is ratio metric with VSENSE. The external resistor divider setting, VTS (R4, R7, and R17), must be connected to the TPS2585x-Q1 SENSE pin to achieve accurate results. See the data sheet for detailed information.

3.6 Test Setup

Figure 3-1 shows a typical test setup for charging the USB Type-C device. Connect VIN+ to the power supply. Connect the USB Type-C device to the J1 and J3 connector. Connect jumper EN. Connect PA_EN, PB_EN.

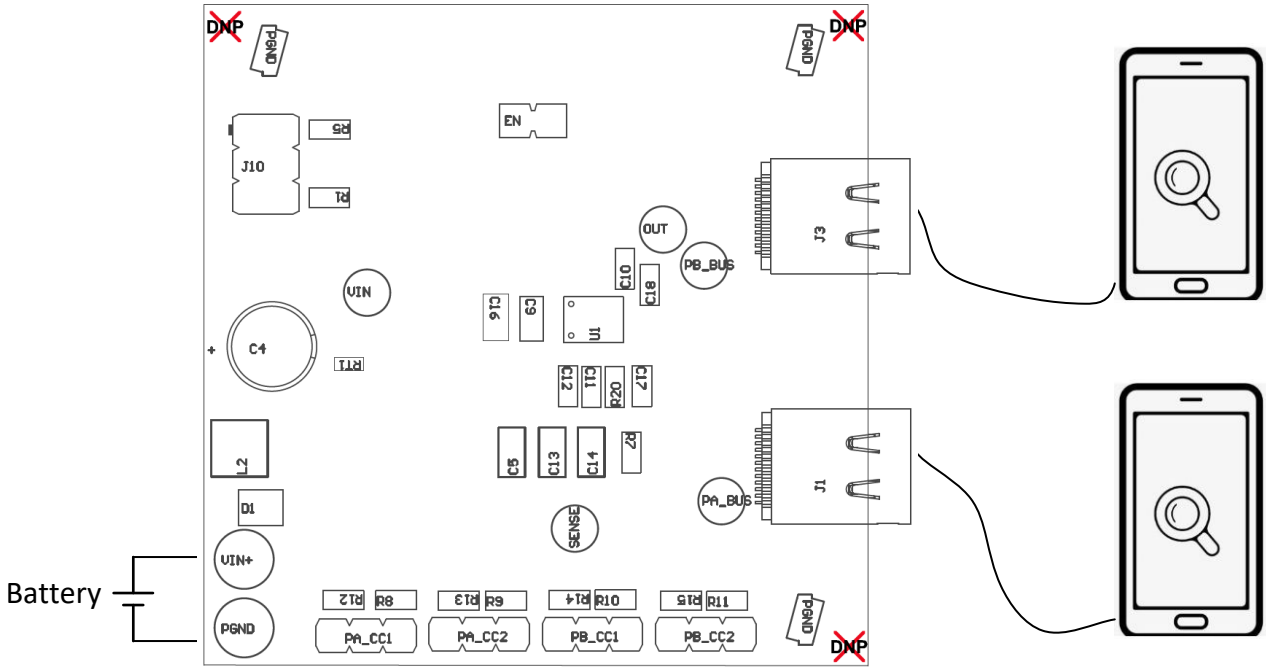

Figure 3-1. EVM Setup for Charging USB Type-C® Device

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 through Figure 4-8 show the layout images of the EVM.

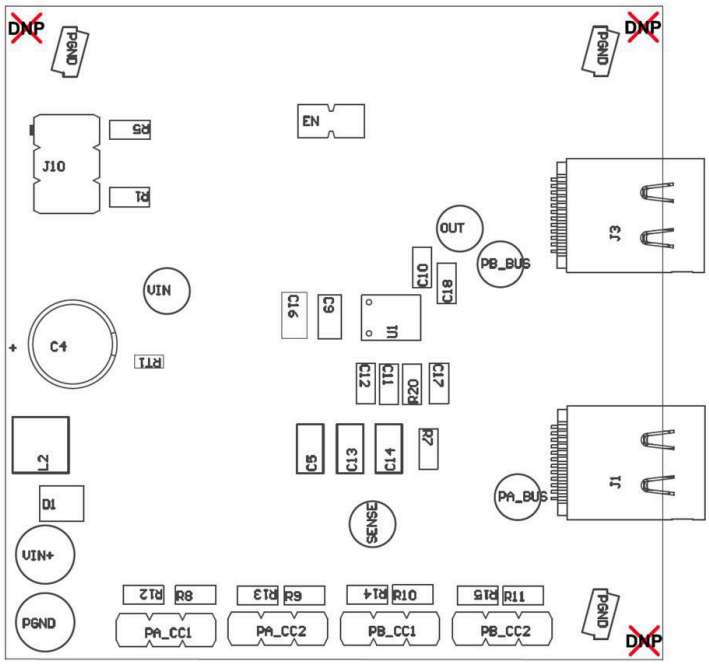

Figure 4-1. Top Side Assembly

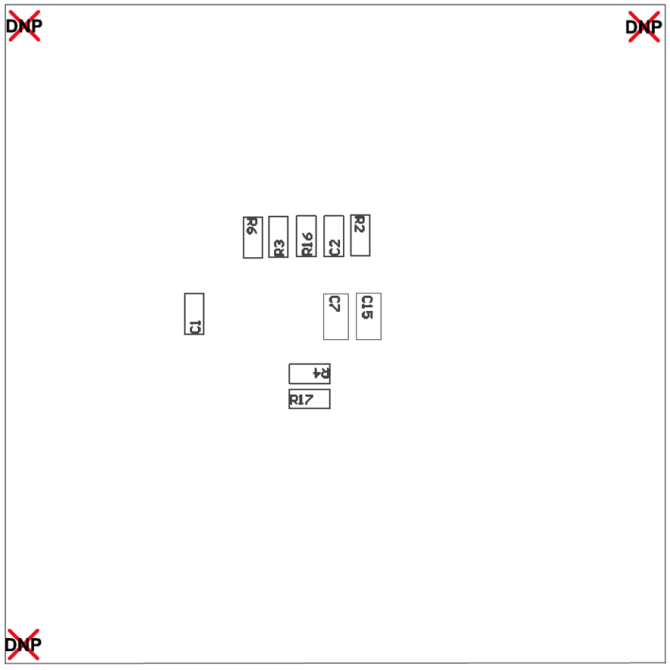

Figure 4-2. Bottom Side Assembly

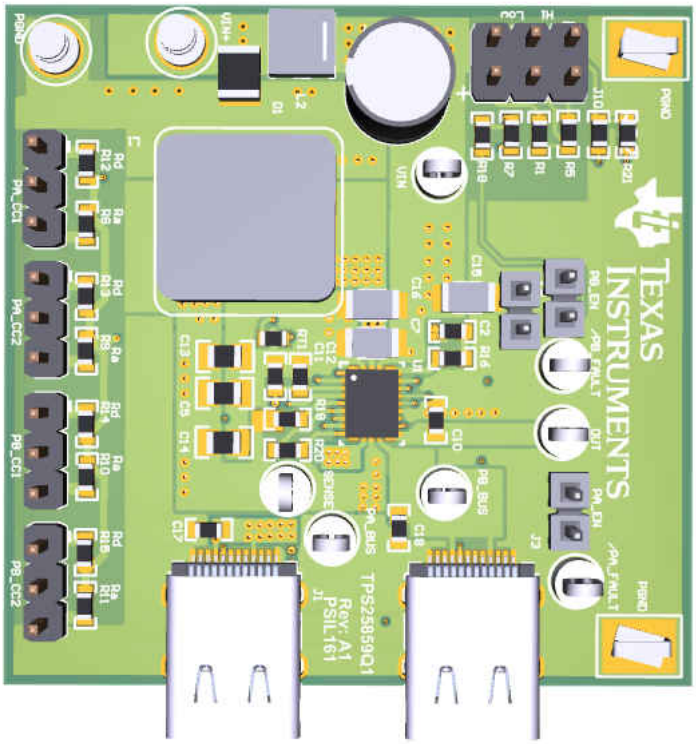

Figure 4-3. Top Side 3D View

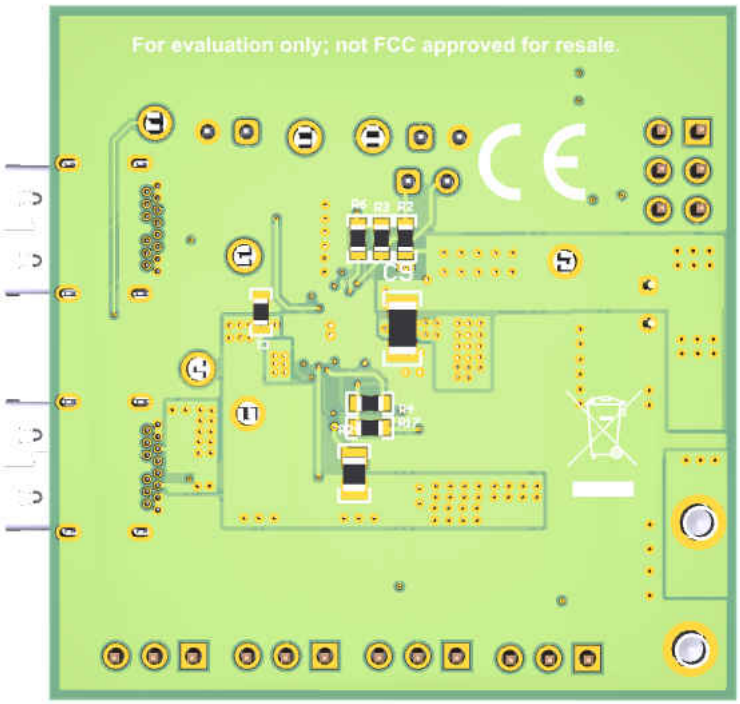

Figure 4-4. Bottom Side 3D View

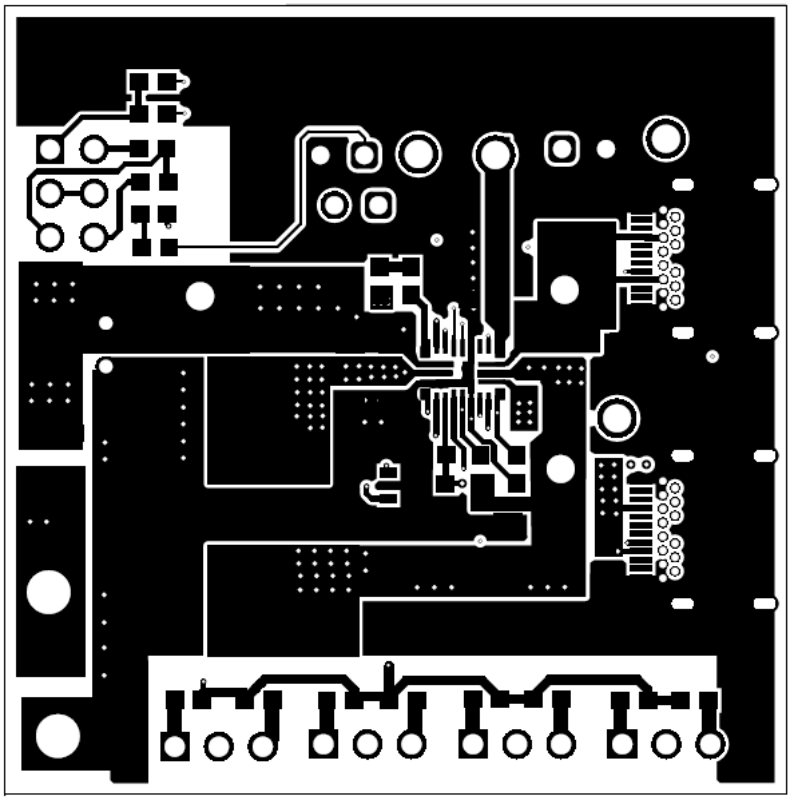

Figure 4-5. Top Layer Layout

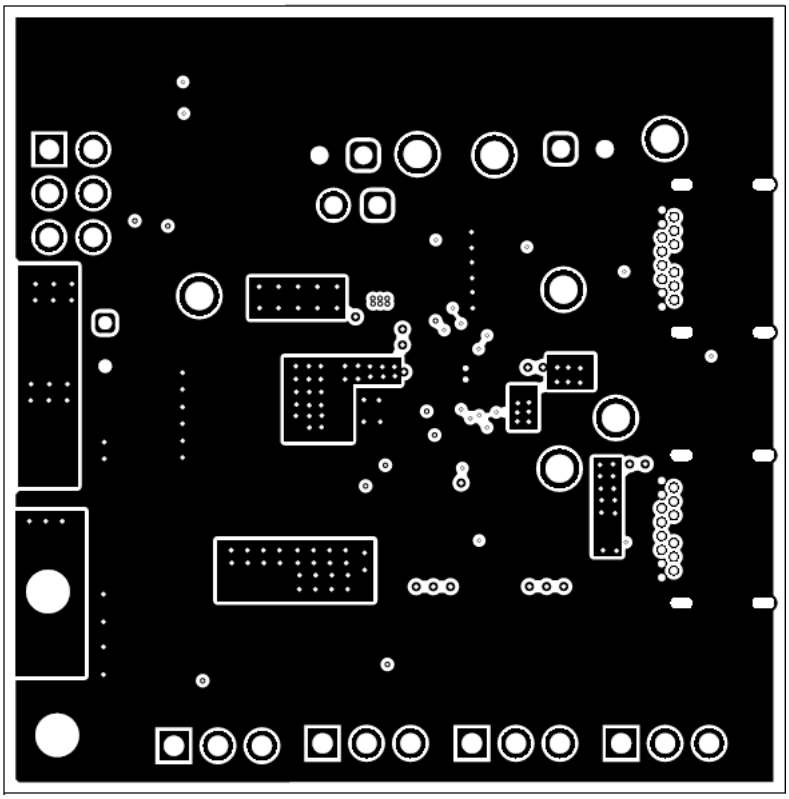

Figure 4-6. Mid-1 Layer Layout

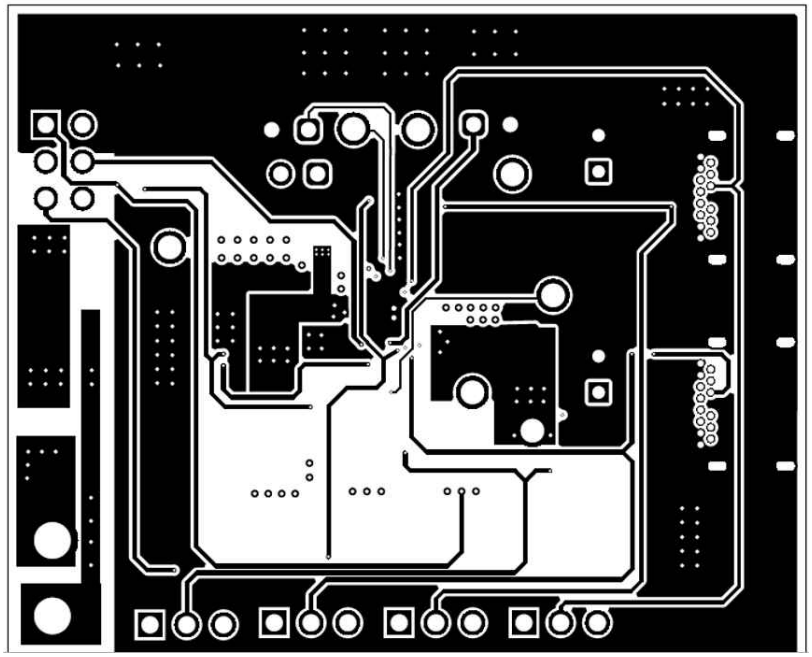

Figure 4-7. Mid-2 Layer Layout

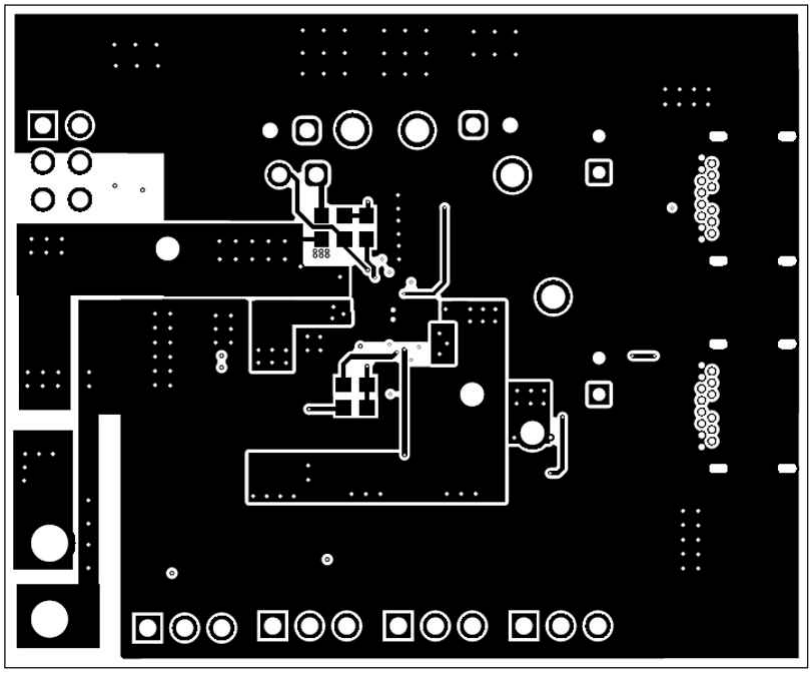

Figure 4-8. Bottom Layer Layout

5 Bill of Materials

Table 5-1 lists the EVM bill of materials.

Table 5-1. TPS25859Q1EVM-161 Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
/PA_FAULT, /PB_FAULT, OUT, PA_BUS, PB_BUS, SENSE, VIN	7		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone
C1, C2, C12	3	0.1 uF	CAP, CERM, 0.1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	C0603C104K5RACAUTO	Kemet
C4	1	100 uF	CAP, AL, 100 µF, 35 V, +/- 20%, TH	D6.3xL11mm	35ZLJ100M6.3X11	Rubycon
C5, C13, C14	3	47 uF	CAP, CERM, 47 uF, 10 V, +/- 20%, X5R, 0805	0805	C2012X5R1A476M125AC	TDK
C7, C15, C16	3	10 uF	CAP, CERM, 10 uF, 50 V, +/- 10%, X5R, AEC-Q200 Grade 1, 1206	1206	GRT31CR61H106KE01L	MuRata
C9	1	0.1 uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 1206	1206	12065C104KAT2A	AVX
C10, C11	2	2.2 uF	CAP, CERM, 2.2 uF, 16 V, +/- 20%, X5R, 0603	0603	885012106018	Wurth Elektronik
C17, C18	2	1 uF	CAP, CERM, 1 uF, 6.3 V, +/- 10%, X7R, 0603	0603	CL10B105KQ8NNNC	Samsung Electro-Mechanics
D1	1	10 uF	CAP, CERM, 10 uF, 50 V, +/- 20%, X7R, 1210	1210	GRM32ER71H106MA12	MuRata
EN, PA_EN, PB_EN	3		Header, 2.54 mm, 2x1, Tin, TH	Header, 2.54 mm, 2x1, TH	TSW-102-07-T-S	Samtec
J1, J3	2		Connector, Receptacle, USB Type C, R/A	Connector, Receptacle, USB Type C, R/A, THT/SMT	632723300011	Wurth Elektronik
J10	1		Header, 2.54mm, 3x2, Gold, TH	Header, 2.54mm, 3x2, TH	61300621121	Wurth Elektronik
L1	1	3.3 uH	Inductor, Shielded Drum Core, Superflux, 3.3 uH, 12 A, 0.0059 ohm, SMD	WE-HC6	744325330	Wurth Elektronik

Table 5-1. TPS25859Q1EVM-161 Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
L2	1	1 uH	Inductor, Shielded, Composite, 1 uH, 8.75 A, 0.01 ohm, SMD	4x2.1x4mm	XAL4020-102MEB	Coilcraft
NT1, PGND, U1	4			eg: 0603, used in PnP report	Used in BOM report	Used in BOM report
PA_CC1, PA_CC2, PB_CC1, PB_CC2	4		Header, 2.54 mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Wurth Elektronik
PGND, VIN+	2		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
R1	1	40.0 k	RES, 40.0 k, 0.1%, 0.15 W, AEC-Q200 Grade 0, 0603	0603	PAT0603E4002BST1	Vishay Thin Film
R2	1	20 k	RES, 20 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060320K0JNEA	Vishay-Dale
R3, R12, R13, R14, R15	5	5.1 k	RES, 5.1 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06035K10JNEA	Vishay-Dale
R4	1	15.0 k	RES, 15.0 k, 0.5%, 0.1 W, 0603	0603	RT0603DRE0715KL	Yageo America
R5	1	80.6 k	RES, 80.6 k, 0.5%, 0.1 W, 0603	0603	RT0603DRE0780K6L	Yageo America
R6	1	49.9 k	RES, 49.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ-3EKF4992V	Panasonic
R7	1	5.10 k	RES, 5.10 k, 1%, 0.1 W, 0603	0603	RC0603FR-075K1L	Yageo America
R8, R9, R10, R11	4	1.0 k	RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031K00JNEA	Vishay-Dale
R16, R20	2	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc
R17	1	100 k	RES, 100 k, 1%, 0.1 W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R18, R19, R21, R22	4	100k	RES, 100 k, 0.1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERA-3AEB104V	Panasonic
R24	1	0	RES, 0, 5%, 0.125 W, 0805	0805	MCR10EZPJ000	Rohm
RT1	1	470 k	Thermistor NTC, 470k ohm, 3%, 0603	0603	NCP18WM474E03RB	MuRata

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