User's Guide

TPS25850-Q1 Evaluation Module

ABSTRACT

This user's guide describes the TPS25850-Q1 evaluation module (TPS25850Q1EVM-088). This document contains the EVM schematics, EVM configuration, bill of materials (BOM), board layout drawing, and assembly drawing.

Table of Contents

List of Figures

List of Tables

Trademarks

1 Introduction

The TPS25850Q1EVM-088 is an evaluation module (EVM) for TI's TPS25850-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.

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 –2.4 MHz
- Fully AEC-Q100 qualified
- Programmable output short current limit: ±15% accuracy overtemperature
- Smart thermal management
- USB battery charging specification Rev. 1.2 DCP mode, divider3 mode, Samsung 1.2 V mode, and USB Type-C Rev. 1.3 compliant
- 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 TPS25850Q1EVM-088 schematic.

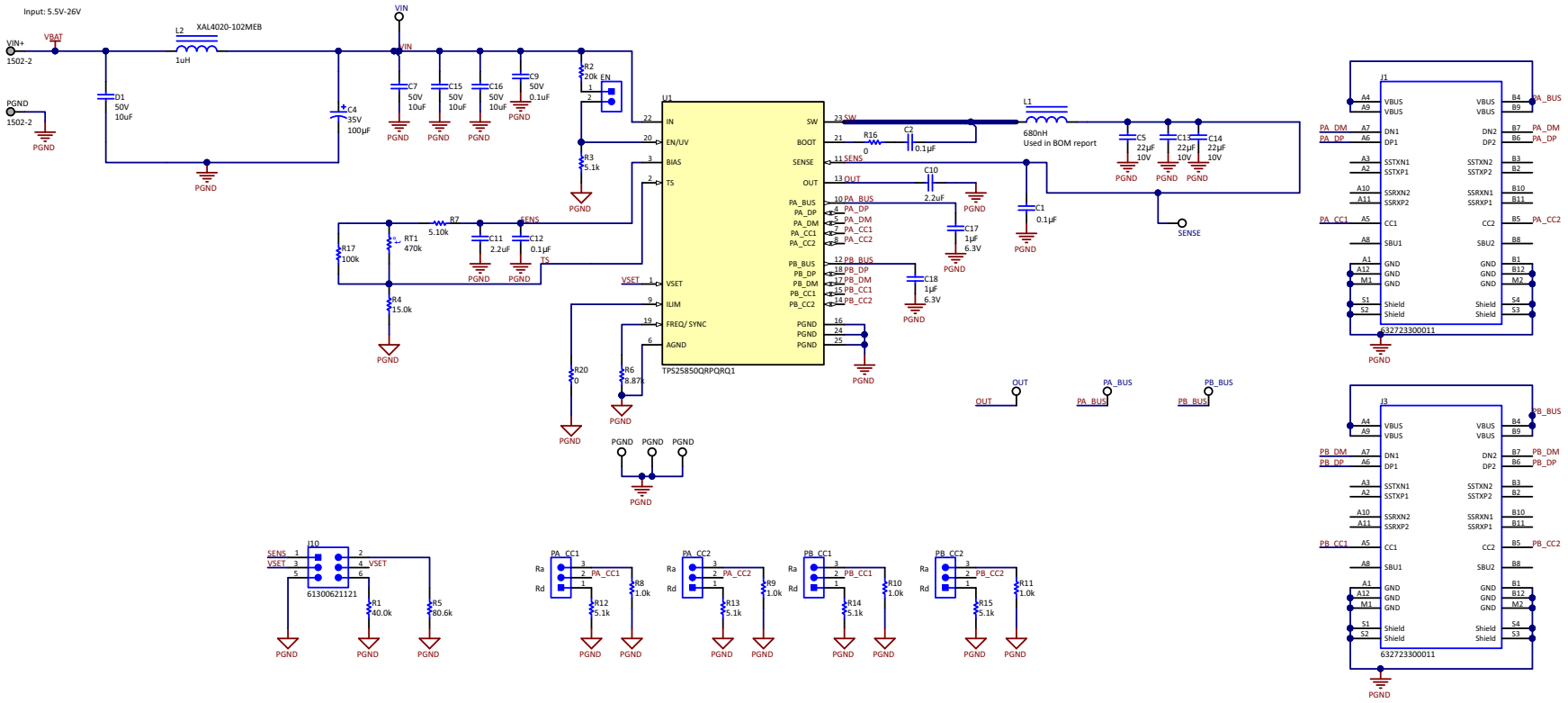

Figure 2-1. TPS25850Q1EVM-088 Schematic

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 TPS25850Q1EVM-088.

3.1 Physical Access

Table 3-1 lists the TPS25850Q1EVM-088 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 slave for data pass through from PA/B_CC1/2 and BC1.2 or USB Type-C identification. USB output power is provided to the slave from the buck converter of the TPS25850-Q1 device.
VIN+, PGND	Terminal block	Power input connector for TPS25850-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 3 MHz, the RFREQ (R6) resistor value can be changed. Consult the 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 TPS25850EVMQ1-088 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. Modify 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 TPS25850-Q1 needs to short the VSET pin to ground to enable the cable compensation, with that setting, the buck regulator will increase 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.

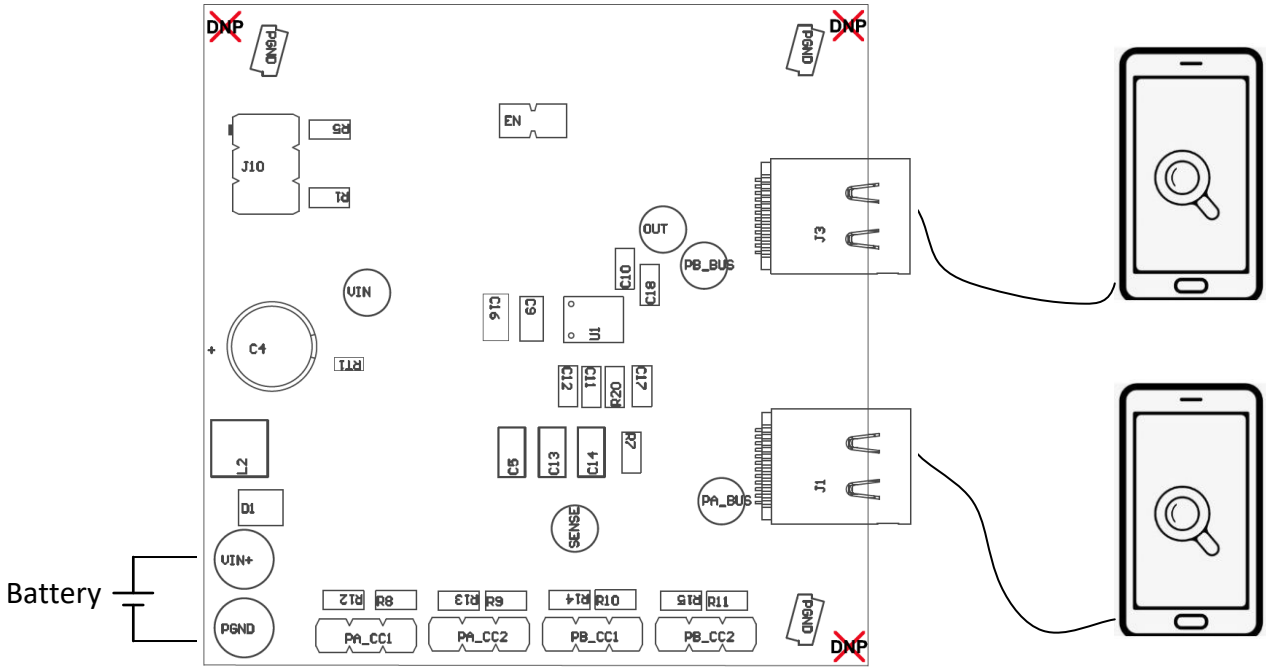

Figure 3-1. EVM Setup for Charging USB Type-C™ Device

4 Board Layout

Figure 4-1 and Figure 4-2 show the top and bottom assembly. Figure 4-4 and Figure 4-5 show the top side and bottom side 3D view. Figure 4-6 through Figure 4-9 show the layout images of the EVM.

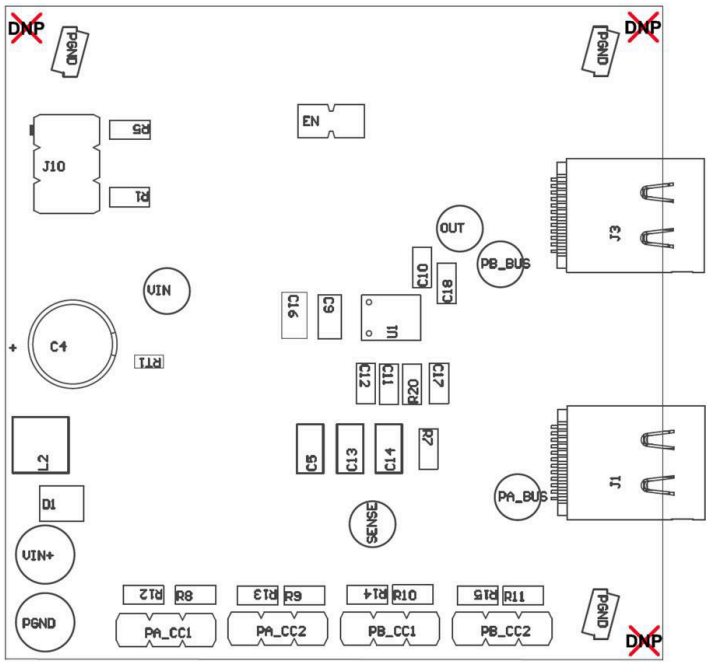

Figure 4-1. Top Side Assembly

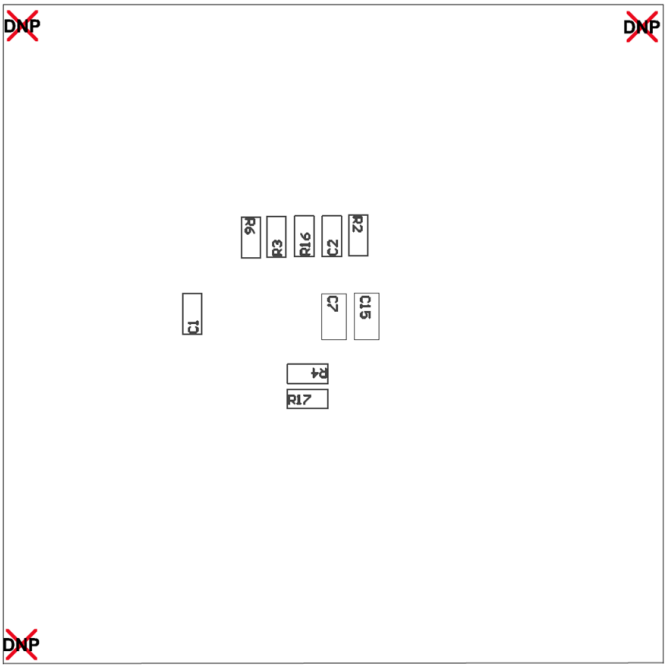

Figure 4-2. Bottom Side Assembly

Figure 4-3.

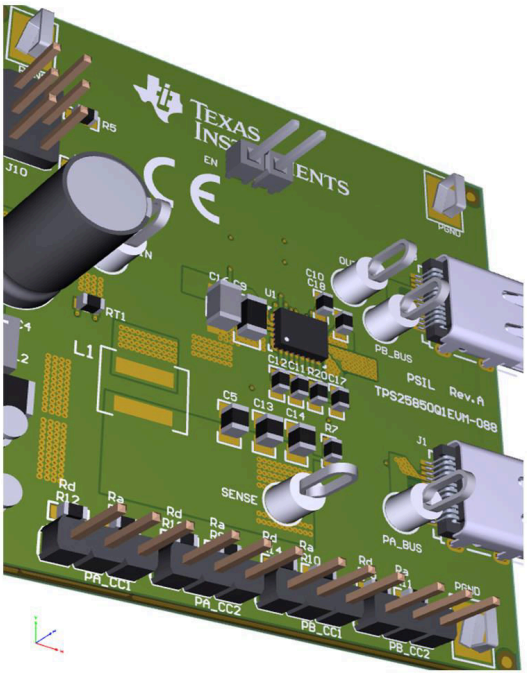

Figure 4-4. Top Side 3D View

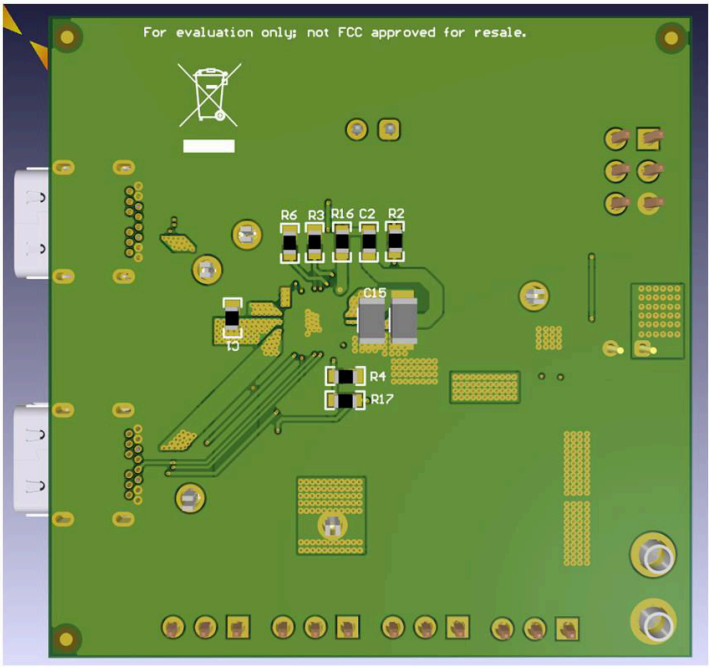

Figure 4-5. Bottom Side 3D View

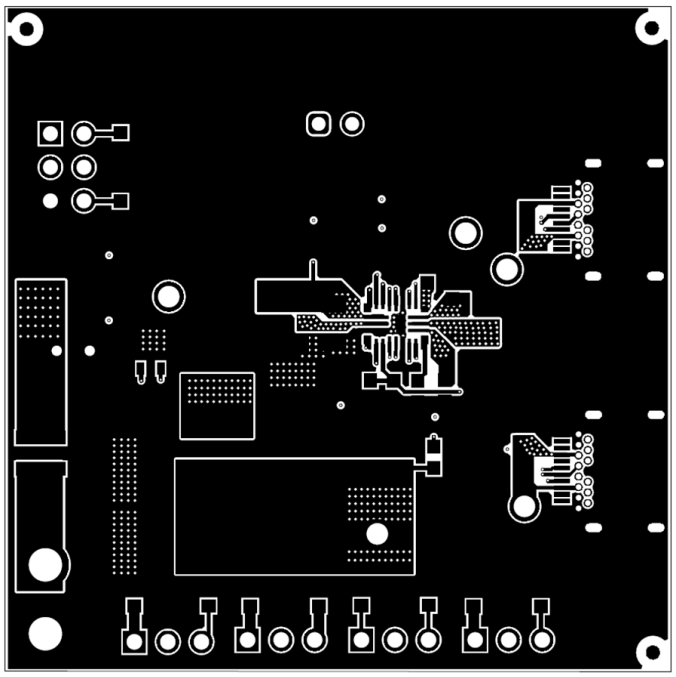

Figure 4-6. Top Layer Layout

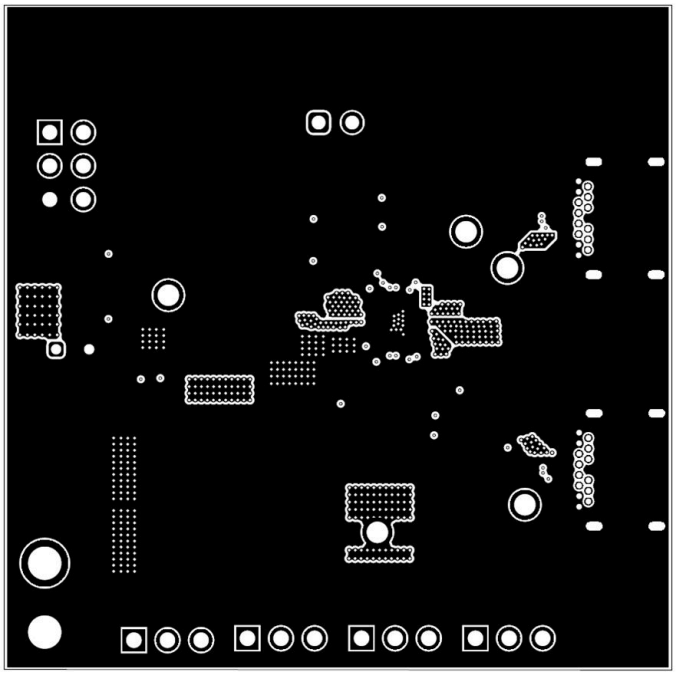

Figure 4-7. Mid-1 Layer Layout

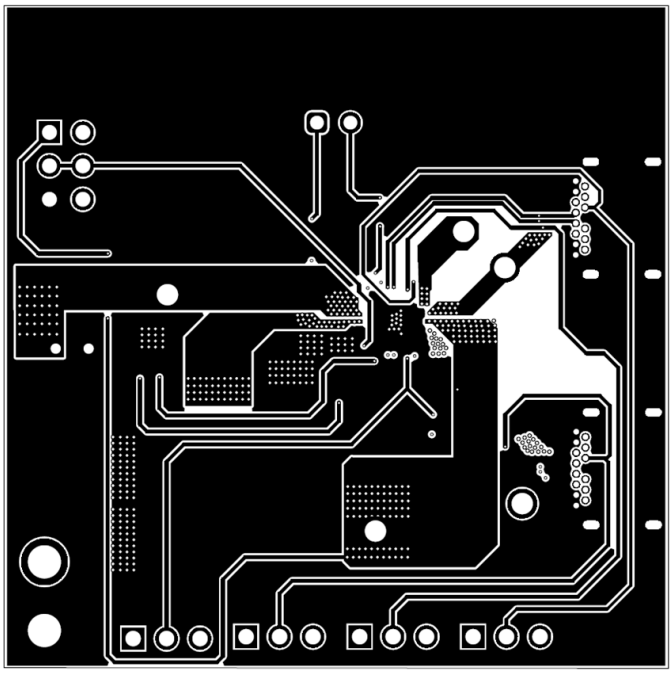

Figure 4-8. Mid-2 Layer Layout

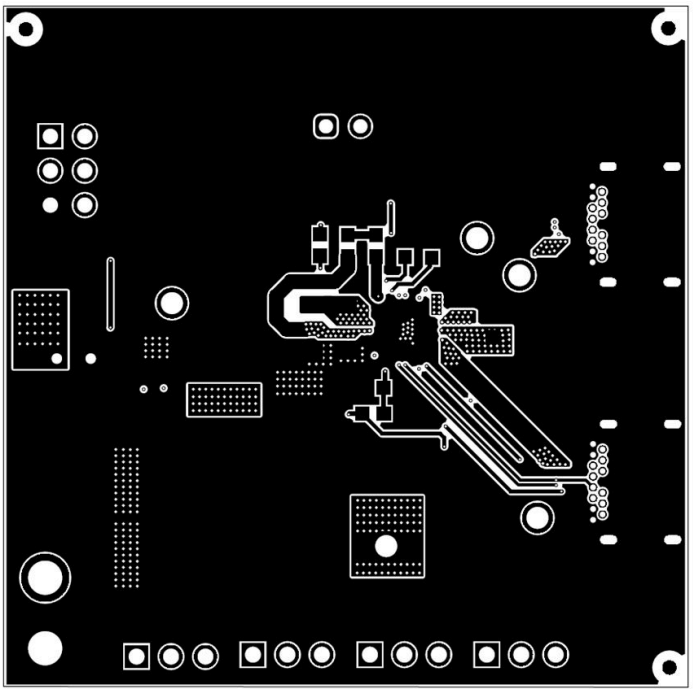

Figure 4-9. Bottom Layer Layout

5 Bill of Materials

Table 5-1 lists the EVM bill of materials

Table 5-1. TPS25850Q1EVM-088 Bill of Materials

Item #	Designator	QTY	Value	Part Number	Manufacturer	Description	Package Reference
1	C1, C2, C12	3	0.1uF	C0603C104K5RACAUTO	Kemet	CAP, CERM, 0.1 µF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603
2	C4	1	100uF	35ZLJ100M6.3X11	Rubycon	CAP, AL, 100 µF, 35 V, ±20%, TH	D6.3xL11mm
3	C5, C13, C14	3	22uF	GRM21BZ71A226ME15L	MuRata	CAP, CERM, 22 uF, 10 V, ±20%, X7R, 0805	0805
4	C7, C15, C16	3	10uF	GRT31CR61H106KE01L	MuRata	CAP, CERM, 10 uF, 50 V, ±10%, X5R, AEC-Q200 Grade 1, 1206	1206
5	C9	1	0.1uF	12065C104KAT2A	AVX	CAP, CERM, 0.1 uF, 50 V, ±10%, X7R, 1206	1206
6	C10, C11	2	2.2uF	885012106018	Wurth Elektronik	CAP, CERM, 2.2 uF, 16 V, ±20%, X5R, 0603	0603
7	C17, C18	2	1uF	CL10B105KQ8NNNC	Samsung Electro-Mechanics	CAP, CERM, 1 uF, 6.3 V, ±10%, X7R, 0603	0603
8	D1	1	10uF	GRM32ER71H106MA12	MuRata	CAP, CERM, 10 uF, 50 V, ±20%, X7R, 1210	1210
9	EN	1		TSW-102-07-T-S	Samtec	Header, 2.54 mm, 2x1, Tin, TH	Header, 2.54 mm, 2x1, TH
10	J1, J3	2		632723300011	Wurth Elektronik	Connector, Receptacle, USB Type C, R/A	Connector, Receptacle, USB Type C, R/A, THT/SMT
11	J10	1		61300621121	Wurth Elektronik	Header, 2.54mm, 3x2, Gold, TH	Header, 2.54mm, 3x2, TH
12	L1	1		XEL5050-681ME_	Coilcraft	680nH	eg: 0603, used in PnP report
13	L2	1	1uH	XAL4020-102MEB	Coilcraft	Inductor, Shielded, Composite, 1 uH, 8.75 A, 0.01 ohm, SMD	4x2.1x4mm
14	OUT, PA_BUS, PB_BUS, SENSE, VIN	5		5012	Keystone	Test Point, Multipurpose, White, TH	White Multipurpose Testpoint
15	PA_CC1, PA_CC2, PB_CC1, PB_CC2	4		61300311121	Wurth Elektronik	Header, 2.54 mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH
16	PGND	3		5016	Keystone	Test Point, Compact, SMT	Testpoint_Keystone_Compact
17	PGND, VIN+	2		1502-2	Keystone	Terminal, Turret, TH, Double	Keystone1502-2
18	R1	1	40.0k	PAT0603E4002BST1	Vishay Thin Film	RES, 40.0 k, 0.1%, 0.15 W, AEC-Q200 Grade 0, 0603	0603
19	R2	1	20k	CRCW060320K0JNEA	Vishay-Dale	RES, 20 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
20	R3, R12, R13, R14, R15	5	5.1k	CRCW06035K10JNEA	Vishay-Dale	RES, 5.1 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
21	R4	1	15.0k	RT0603DRE0715KL	Yageo America	RES, 15.0 k, 0.5%, 0.1 W, 0603	0603
22	R5	1	80.6k	RT0603DRE0780K6L	Yageo America	RES, 80.6 k, 0.5%, 0.1 W, 0603	0603
23	R6	1	8.87k	CRCW06038K87FKEA	Vishay-Dale	RES, 8.87 k, 1%, 0.1 W, 0603	0603

Table 5-1. TPS25850Q1EVM-088 Bill of Materials (continued)

Item #	Designator	QTY	Value	Part Number	Manufacturer	Description	Package Reference
24	R7	1	5.10k	RC0603FR-075K1L	Yageo America	RES, 5.10 k, 1%, 0.1 W, 0603	0603
25	R8, R9, R10, R11	4	1.0k	CRCW06031K00JNEA	Vishay-Dale	RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
26	R16, R20	2	0	RMCF0603ZT0R00	Stackpole Electronics Inc	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
27	R17	1	100k	CRCW0603100KFKEA	Vishay-Dale	RES, 100 k, 1%, 0.1 W, 0603	0603
28	RT1	1	470k	NCP18WM474E03RB	MuRata	Thermistor NTC, 470k ohm, 3%, 0603	0603
29	U1	1		TPS25850QRPQRQ1	Texas Instruments	Dual 3A USB Type-C Charging Ports Controller with Programmable Current Limit and Thermal Management, RPQ0025A (VQFN-25)	RPQ0025A
30	FID1, FID2, FID3, FID4, FID5, FID6	0		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (May 2020) to Revision A (September 2020)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document	2
• Changes made throughout to accomodate TPS25850Q1EVM-088 Rev. A	2
• Change L1 from 1uH to 680nH in BOM	10

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