TPS25820 and TPS25821 Evaluation Module

User's Guide

Literature Number: SLVUAZ3A
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TPS25820 and TPS25821 Evaluation Module

This user's guide is for the TPS25820 and TPS25821 Evaluation Modules (hereafter referred to as TPS25820/21EVM) and explains how to get up and running with the TPS25820/21EVM. The EVM allows the user to test specific features of the TPS25820 device by lighting-up signals LEDs and measuring test points voltages to demonstrate what happens when different types of USB Type-C™ devices are attached to the USB Type-C port on the EVM. Note that this EVM does not support BC1.2 charging. A TPS2514A can be added to DP and DM lines of the USB Type-C connector for BC1.2 charging support. The TPS25820/21EVM is built with a TPS25820. The TPS25820 has the same functionality of the TPS25821 with the only difference being VCONN. The TPS25821 does not supply VCONN when an electronically marked cable is connected unlike the TPS25820.

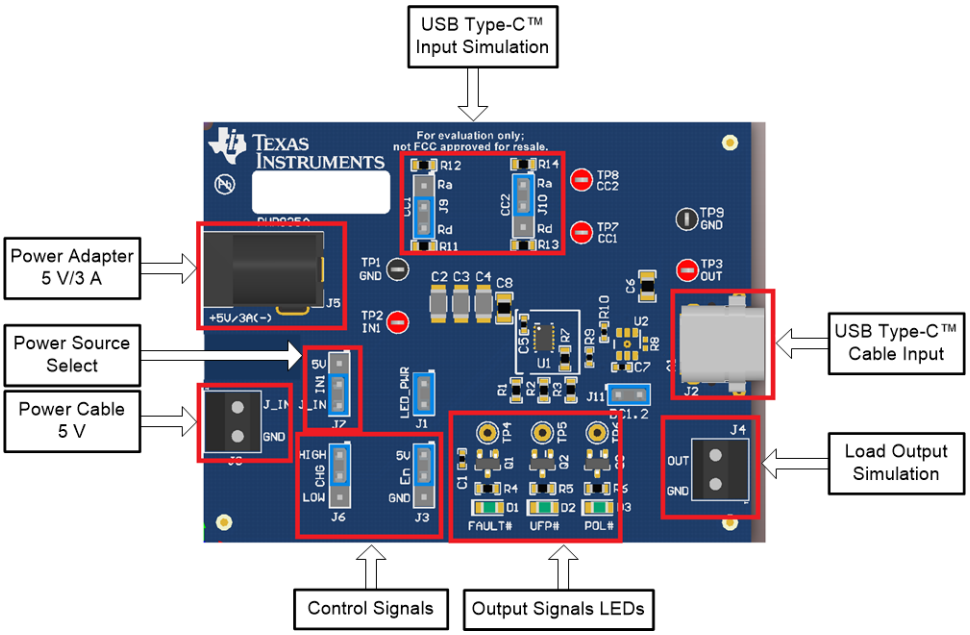

Figure 1. TPS25820/21EVM

1 Introduction

The TPS25820 device is a simple to use USB Type-C controller with an integrated 1.5-A rated USB VBUS power switch. The TPS25820 device meets the source requirements as defined in the USB Type-C specification and implements the source state machine for the detection of USB Type-C device attach/detach, connection orientation, and attached device type. For more information about the TPS25820 and TPS25821 devices, see the *TPS25820, TPS25821 USB Type-CTM 1.5-A Source Controller and Power Switch* data sheet.

2 Schematic

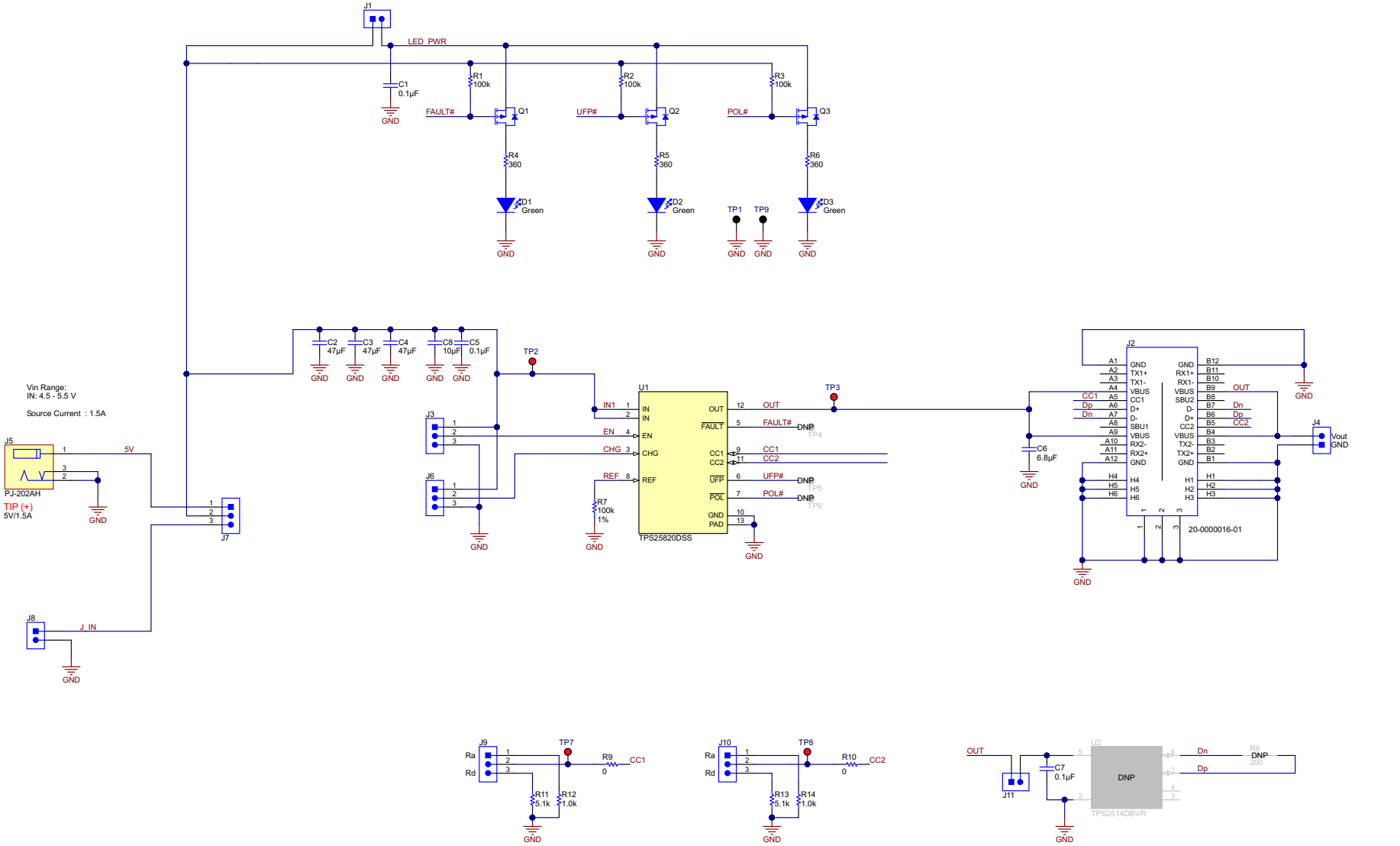

Figure 2. TPS25820 EVM Schematic

3 Test Points

Table 1 lists the test points and the description of each test point.

Table 1. Test Points

Test Point	Label	Description
TP1	GND	Ground connecting for input and output signals
TP2	IN1	Input Voltage
TP3	OUT	Output Voltage
TP4	FAULT#	Active low fault signal
TP5	UFP#	Active low Sink (SNK) detect signal
TP6	POL#	Active low polarity signal
TP7	CC1	CC1 Voltage
TP8	CC2	CC2 Voltage

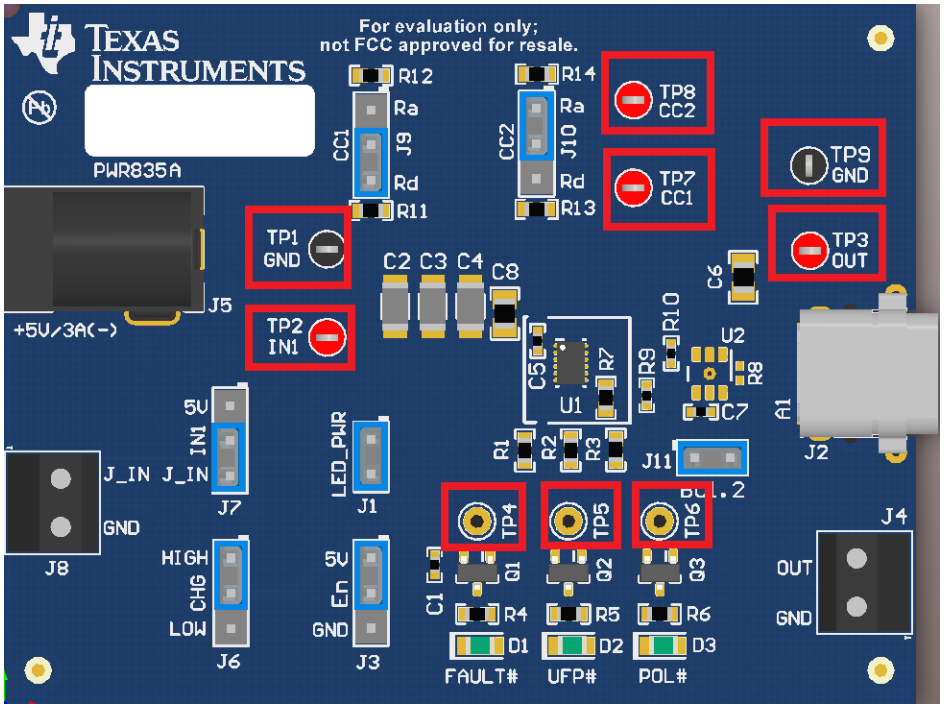

Figure 3. Test Points

4 Powering Up the EVM

The TPS25820/21EVM has two input-power Sources: a 5-V/3-A barrel jack adapter or a power supply through J8 connector. These two power Sources provide power to the TPS25820 device IN pin by setting jumper J7 either to barrel jack or to J1_IN as shown in Figure 4.

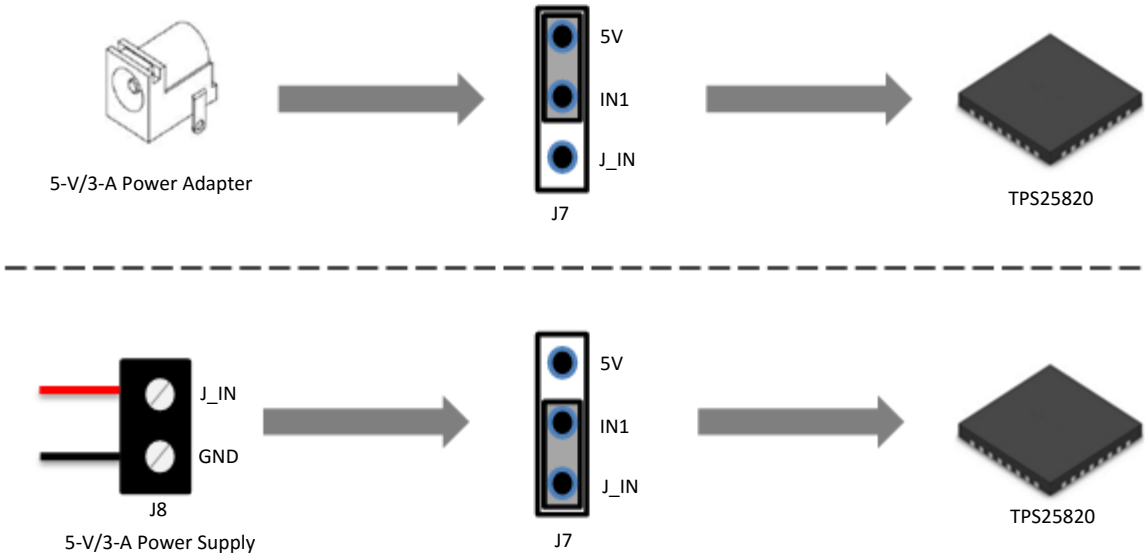

Figure 4. Choosing the Right Power Source

TI recommends a power adaptor that is a standard 2.1-mm DC power adaptor with a positive tip that can support 5-V and 3-A. An example of a power adaptor to use is the WSU050-3000 wall power supply. When using a power supply through J8 connector as a power source, make sure to stay within the specified voltage limits for each pin listed in the data sheet

4.1 Measuring TPS25820 Device Power Consumption

The TPS25820 device is powered through IN pin which is the same pin that powers OUT pin, thus the easy way to measure power consumption is to connect an ammeter to jumper J7 on the EVM. Figure 5 shows how to connect the Ammeter to IN1 pin through J7 jumper (depending on how the EVM is powered). For accurate power consumption measurements, remove jumpers J1 and J11 powering output signals LEDs and BC1.2 device respectively.

When no Sink is attached to the USB port on the EVM, the TPS25820 consumes only 1 μA. To test this, have the Ammeter connected properly to jumper J7, remove jumper J1 to disconnect output signals LEDs, jumper J11 to disconnect TPS2514A device, jumpers J9 and J10 to disconnect Rd resistors for CC lines, and make sure nothing is connected to the USB port.

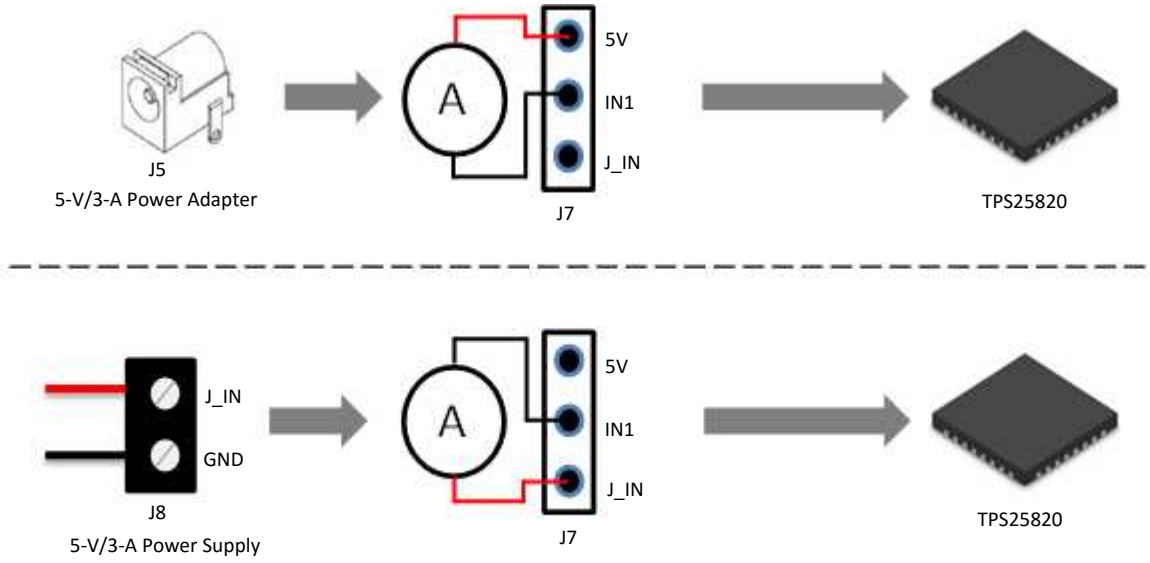

Figure 5. Connecting the Ammeter to IN1 Pin and Pre-Selected Power Source

5 Enabling and Configuring the TPS25820

5.1 Enabling and Disabling the TPS25820

The TPS25820 has an enable pin that creates a convenient way to turn on or off the device without interrupting the power Source. Jumper J3 on the TPS25820/21EVM can be used to enable or disable TPS25820 device, Figure 6 shows enable and disable positions for this jumper.

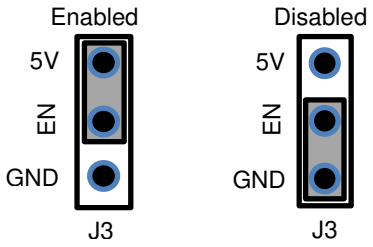

Figure 6. How to Enable and Disable TPS25820 Device on the EVM

5.2 Configuring the Broadcasted Current Limit for the TPS25820 Device

TPS25820 device can advertise (using CC lines) how much current it can supply to the attached Sink device. The two current limits that the TPS25820 device support are: STD and 1.5-A. Jumper J6 allows switching between these two current limit levels by either setting the jumper to 5-V (High) or to GND (Low) which in turn sets CHG pin on the TPS25820 device to change the current limit advertisement level. Figure 7 shows how to set Jumper J6 to advertise the desired current limit broadcast through the CC lines.

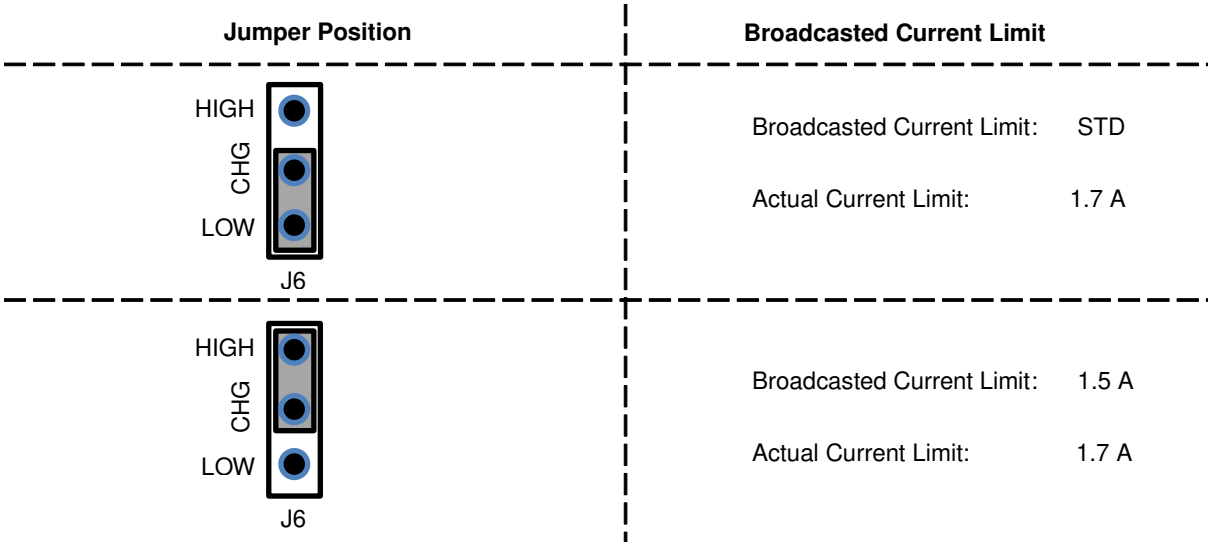

Figure 7. Jumper J6 Setting for Each Broadcasted Current Level

6 TPS25820/21EVM Features

The TPS25820/21EVM allows for all the features of the TPS25820 device to be tested without a USB Type-C Cable and external Sink device. This section lists the most common types of situations that can happen with the TPS25820/21EVM and within each section is an explanation of how to test each situation with and without external components. Remember how the test jumpers J9 and J10 (which control CC1 and CC2, respectively) connect to the TPS25820 device and the resistors. Figure 8 shows how these resistors are connected.

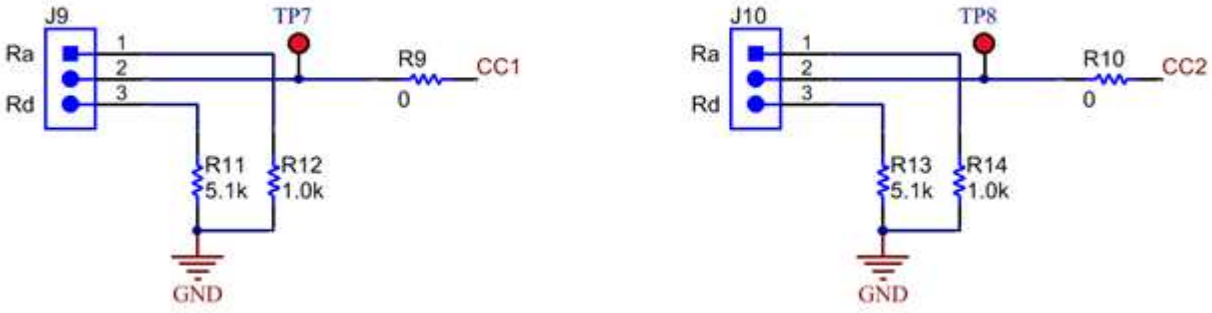

Figure 8. Schematic Showing How CC1 and CC2 are Connected to Jumpers J9 and J10

CAUTION

When connecting a physical USB Type-C Cable into the port of the EVM, make sure to disconnect jumpers (J9, J10) and disconnect any loads on J4 connector (which is connected to OUT pin) in order to avoid interference on the CC lines

6.1 No Connection on the EVM

When nothing is connected to the output of the TPS25820/21EVM, the TPS25820 will not output any power over the OUT pin. In this mode the TPS25820 device will consume only 1 μA.

In order to replicate this mode on the EVM, make sure that jumpers J1, J9, J10, and J11 are left open (not set to any position) so that power goes only to the TPS25820 device.

6.2 Connecting a Source (SRC) Device

The TPS25820 device is a Source and it continuously monitors the CC lines to detect if an SINK device is attached. The way it determines if a SINK is attached by monitoring the voltages on CC lines to see if these voltages get pulled down by an Rd resistors values. Connecting SOURCE device such as the TPS25820 to another SOURCE device will not turn on the output of the TPS25820 device since both Sources will continue to monitor their CC lines for a valid connection (Rd pull-down resistors). This can be tested on the TPS25820/21EVM by connecting a known Source device to the USB Type-C port on the EVM or by connecting two TPS25820/21EVMs via a USB Type-C cable.

6.3 Connecting a Sink (SNK) Device

A Sink device can be attached to a Source device such as the TPS25820 via a standard USB Type-C cable or a full-featured USB Type-C cable. The TPS25820 device detects that a Sink is attached by sensing if any of the CC lines is pulled down by an Rd resistor value. If a Sink with a full-featured USB Type-C cable is attached, then one CC line will be pulled down by an Rd resistor value while the other CC line will be pulled down by a Ra resistor value, thus the TPS25820 device will supply VCONN on the CC line with the Ra resistor value. The TPS25820/21EVM will report the polarity of the Sink device attached to its USB port via POL# LED when a flipped USB Type-C cable is connected. To replicate those two types of Sink connections along with their cable polarity orientations on the TPS25820/21EVM, set jumpers J9 (controls CC1) and J10 (controls CC2) based on Figure 9. Figure 9 shows UFP# and POL# signals LEDs behavior based on jumper J9 and J10 settings.

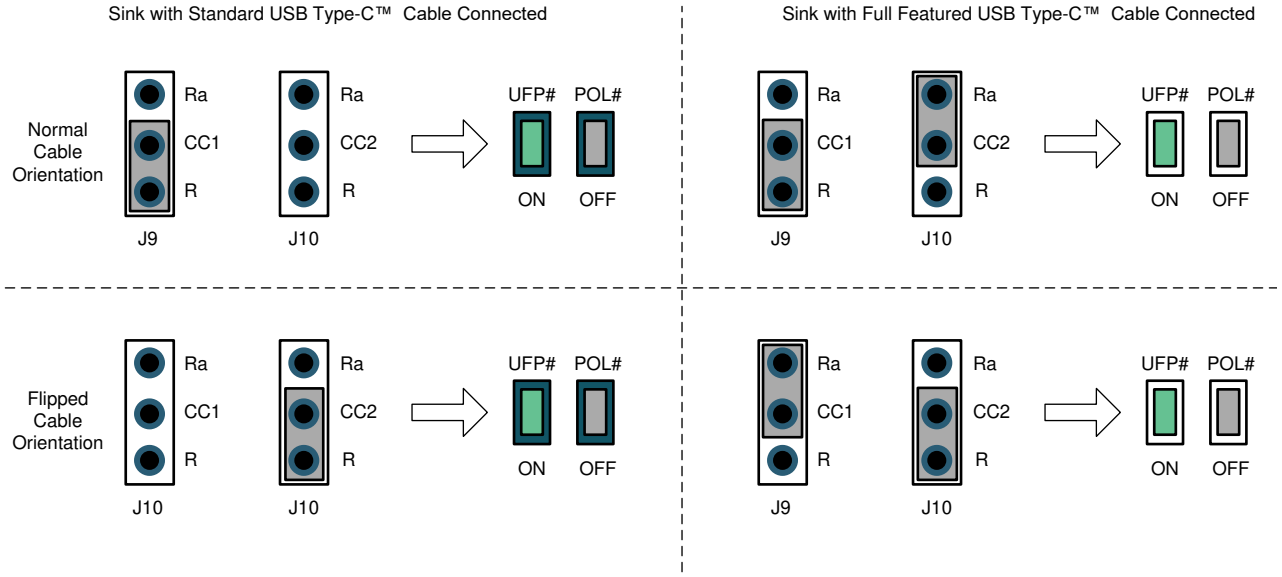

Figure 9. Simulating a Sink (SNK) Device Connected to TPS25820/21EVM

6.4 Connecting a Full-Featured USB Type-C™ Cable

The way the TPS25820 device detects a Sink device is attached is by checking if either of the CC lines is connected to Rd resistor value, connecting only a full-featured USB Type-C cable to the port on the EVM will not light-up UFP# and POL# LEDs since TPS25820 Sink attached signal will not be triggered. To replicate such connection on the TPS25820 EVM, set jumpers J9 or J10 to apply Ra resistor value to CC line as shown in Figure 10. Note that the UFP# and POL# LEDs will not light up.

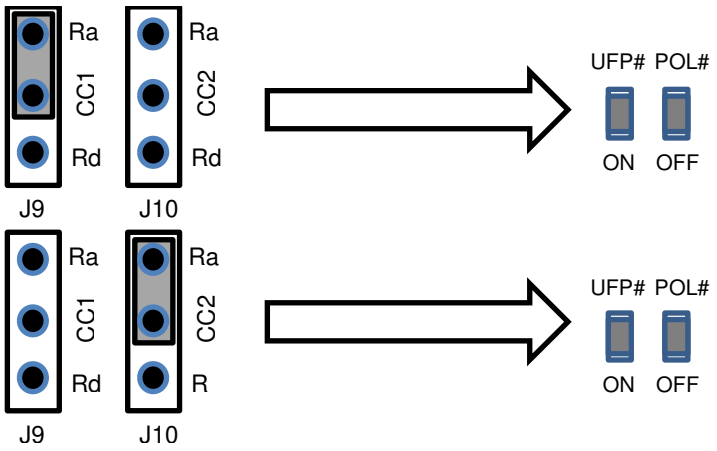

Figure 10. Connecting a Full-Featured USB Type-C™ Cable to TPS25820/21EVM

6.5 Legacy Charging Support

The TPS25820/21EVM supports legacy USB charging scheme via TPS2514A device which supports legacy battery charging schemes such as BC1.2. For more information about the TPS2514A device, refer to the TPS2514A data sheet. Note that in order to connect legacy USB device to the TPS25820/21EVM, a USB Type-C cable adaptor will be needed. Jumper J11 is used to enable or disable the TPS2514A device. Figure 11 shows the schematic connection for the TPS2514A device. Note that the TPS2514A is not populated on the TPS25820/21EVM and would need to be in order to support USB charging schemes.

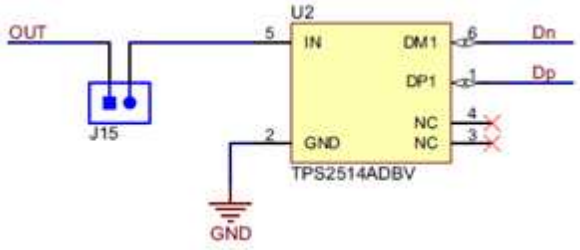

Figure 11. Schematic of TPS2514A Device Section

7 TPS25820/21EVM Output Signals LEDs Operation

7.1 FAULT Detected (FAULT# LED)

There are two conditions that can cause this fault signal to occur and lights up FAULT# LED; those conditions are:

1. The output of the TPS25820 exceeds the actual current limit.
2. The TPS25820 device exceeds the Rising threshold temperature for device shutdown or Rising threshold temperature for OUT/VCONN switches shutdown in current limit.

As soon as the current and the temperature go back to their normal ranges, the fault signal is cleared, FAULT# LED will turn off, and the device resumes normal operation. Refer to Electrical Characteristics section located in the TPS25820 data sheet, for more information on the current and temperature thresholds.

7.2 Sink (SNK) device attached Detected (UFP# LED)

UFP# LED will turn on as soon as a Sink device is attached to the USB Type-C port and is communicating properly through the CC lines. See Table 2 to determine the necessary conditions for the CC lines to activate this signal.

Table 2. TPS25820 Responses Based on Port Connection Type

TPS25820 USB Type-C™ Port	CC1	CC2	OUT	TPS25820 Responses		
				VCONN on CC1 or CC2	POL#	UFP#
Nothing Attached	OPEN	OPEN	OPEN	NO	HI-Z	HI-Z
SINK Attached	Rd	OPEN	IN1	NO	HI-Z	LOW
SINK Attached	OPEN	Rd	IN1	NO	LOW	LOW
Powered Cable/NO SINK Attached	OPEN	Ra	OPEN	NO	HI-Z	HI-Z
Powered Cable/NO SINK Attached	Ra	OPEN	OPEN	NO	HI-Z	HI-Z
Powered Cable/SINK Attached	Rd	Ra	IN1	CC2	HI-Z	LOW
Powered Cable/SINK Attached	Ra	Rd	IN1	CC1	LOW	LOW

7.3 Flipped USB Type-C™ Cable Detected (POL# LED)

Polarity signal was introduced in USB Type-C plug connection since you can insert USB Type-C cable in either orientation. The TPS25820 device detects the orientation of the USB Type-C Cable attached by lighting up POL# LED when a Sink device with Flipped USB Type-C Cable is attached. Refer to Table 2 to see what conditions for the CC lines are necessary to activate this signal.

8 TPS25820 EVM Board Layout

The following images show the silkscreen, top, bottom, and assembly layers of the TPS25820/21EVM-xxx

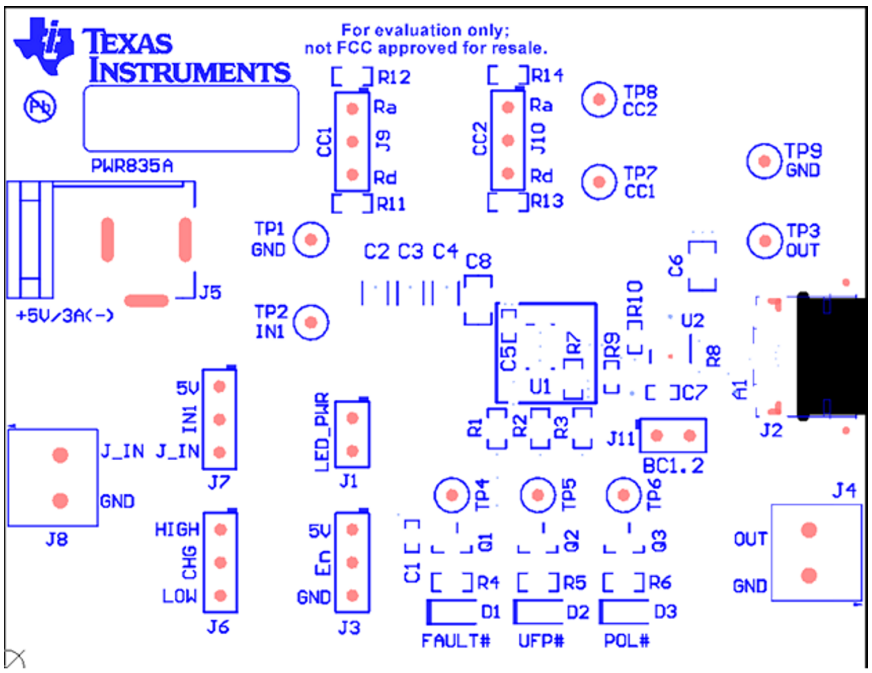

Figure 12. Top Silkscreen

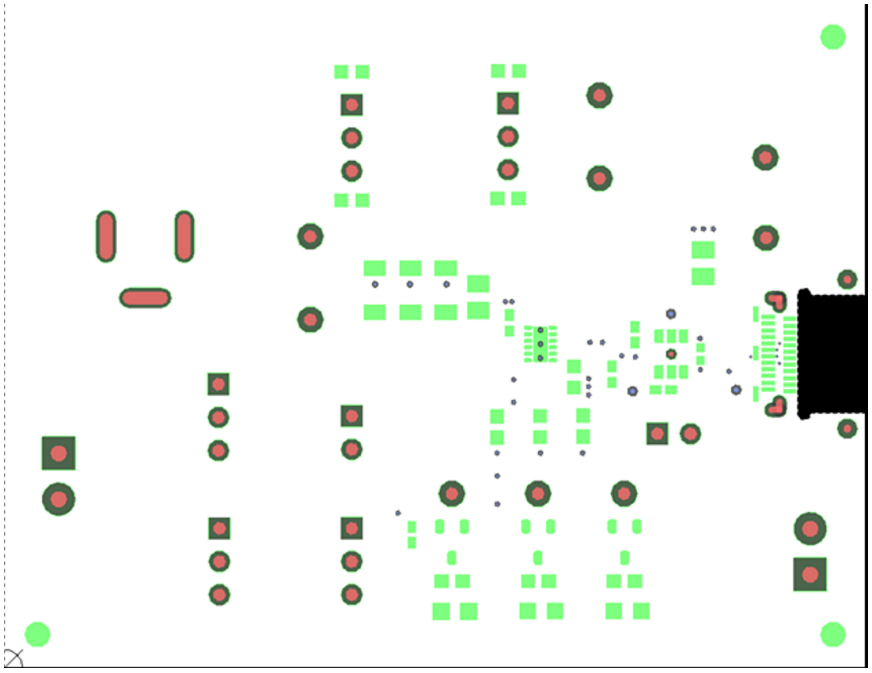

Figure 13. Top Solder Mask

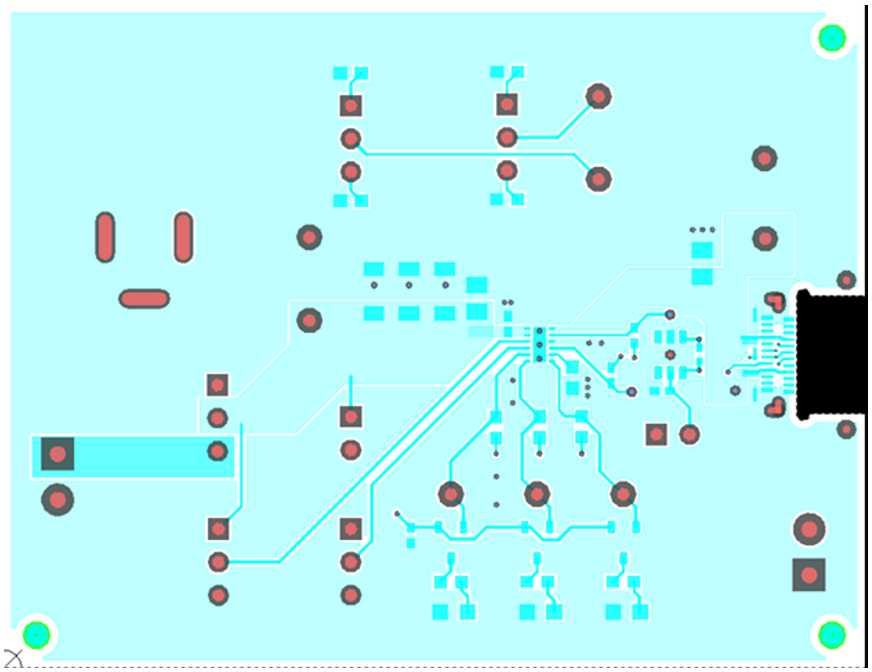

Figure 14. Top Layer

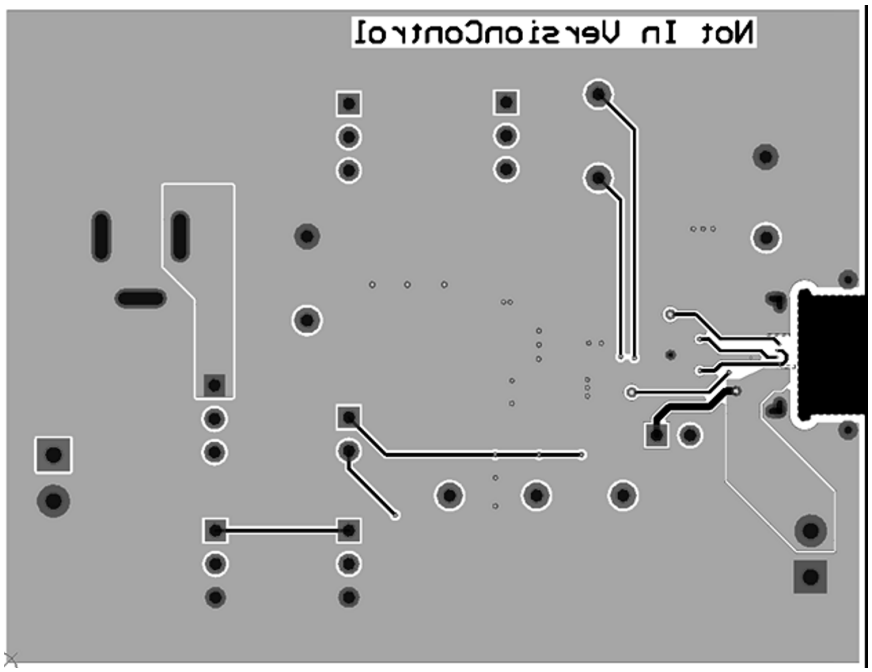

Figure 15. Bottom Layer

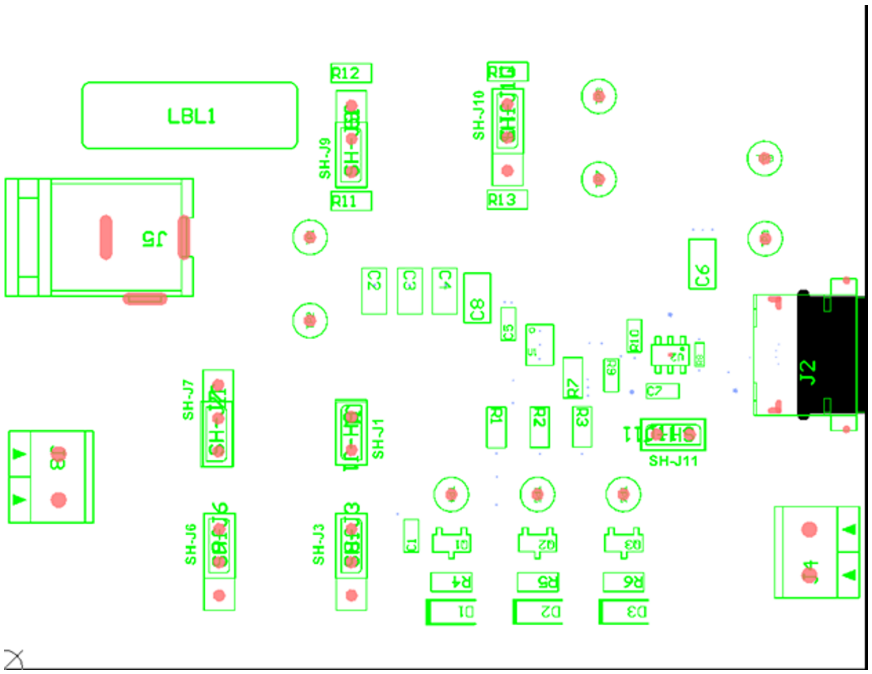

Figure 16. Top Assembly

9 Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C2, C3, C4	3	47uF	CAP, CERM, 47 µF, 10 V, +/- 10%, X5R, 1206	1206	GRM31CR61A476KE15L	Murata
C6	1	6.8uF	CAP, CERM, 6.8 µF, 25 V, +/- 10%, X5R, 0805	0805	C2012X5R1E685K125AC	TDK
C8	1	10uF	CAP, CERM, 10 µF, 16 V, +/- 20%, X5R, 0805	0805	0805YD106MAT2	AVX
D1, D2, D3	3	Green	LED, Green, SMD	LED_0805	LTST-C170KGKT	Lite-On
J1, J11	2		Header, 100mil, 2x1, Tin, TH	Header, 2x1, 100mil, TH	5-146278-2	TE Connectivity
J2	1		Connector, Receptacle, USB Type-C, R/A, SMT	Connector, Receptacle, USB Type-C, SMT	20-0000016-01	Lintes Technology
J3, J6, J7, J9, J10	5		Header, 100mil, 3x1, Tin, TH	Header, 3x1, 100mil, TH	5-146278-3	TE Connectivity
J4, J8	2		Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
J5	1		Connector, DC Jack 2.1X5.5 mm, TH	Conn, DC Jack, pin 2mm Dia.	PJ-202AH	CUI Inc.
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650" H x 0.200" W	THT-14+423-10	Brady
Q1, Q2, Q3	3	-50V	MOSFET, P-CH, -50 V, -0.13 A, SOT-23	SOT-23	BSS84-7-F	Diodes Inc.
R1, R2, R3	3	100k	RES, 100 k, 5%, 0.1 W, 0603	0603	CRCW0603100KJNEA	Vishay-Dale
R4, R5, R6	3	360	RES, 360, 5%, 0.1 W, 0603	0603	CRCW0603360RJNEA	Vishay-Dale
R7	1	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R9, R10	2	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R11, R13	2	5.1k	RES, 5.1 k, 5%, 0.1 W, 0603	0603	CRCW06035K10JNEA	Vishay-Dale
R12, R14	2	1.0k	RES, 1.0 k, 5%, 0.1 W, 0603	0603	CRCW06031K00JNEA	Vishay-Dale
SH-J1, SH-J3, SH-J6, SH-J7, SH-J9, SH-J10, SH-J11	7		Shunt, 2.54 mm Gold Blue	Shunt, 2.54 mm Blue	60900213621	Wurth Elektronik
TP1, TP9	2	Black	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
TP2, TP3, TP7, TP8	4	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
U1	1		USB Type-C 1.5 A DFP Controller and Power Switch, DSS0012B	DSS0012B	TPS25820DSS	Texas Instruments
U2	1		USB Dedicated Charging Port Controller, DBV0006A (SOT-23-6)	DBV0006A	TPS2514DBV	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
R8	0	200	RES, 200, 1%, 0.063 W, 0402	0402	CRCW0402200RFKED	Vishay-Dale
TP4, TP5, TP6	0	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone

10 PCB Layout Recommendations

- Keep input capacitors as close as possible to IC.
- USB protocol recommends having an input capacitance of 120 μF.
- Pullup resistors recommended being 100 kΩ.
- Keep CC lines close to the same length.
- Have the IN and OUT traces as short as possible and wide enough for 1.5-A (3-A if using two TPS25820.
- The resistor attached to the REF pin and GND pin of the device has two requirements:
  - The connection between the resistor and the GND pin should be isolated from the GND plane.
  - Place the resistor as close as possible to REF pin.

11 Trademarks

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Revision History

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

Changes from Original (September 2017) to A Revision **Page**

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