TPS65987DJ Evaluation Module

This document is the user guide for the TPS65987DJ Evaluation Module (TPS65987DJEVM). The TPS65987DJEVM allows for evaluation of the TPS65987DDJ IC as part of a stand-alone testing kit for development and testing of USB Type-C™ and Power Delivery (PD) end products. Out of the box, the TPS65987DJEVM is configured to emulate a single port laptop computer. The TP65987EVM also contains a TPD6S300A device for protection.

Contents

List of Figures

List of Tables

Trademarks

USB Type-C is a trademark of USB Implementers Forum.
All other trademarks are the property of their respective owners.

1   Introduction

Texas Instrument's (TI's) TPS65987DJ evaluation module helps designers evaluate the operation and performance of the TPS65987DDJ device.

The TPS65987DDJ device is a USB Type-C and Power Delivery (PD) controller providing cable plug and orientation detection at the USB Type-C connector. Upon cable detection, the TPS65987DJ communicates on the CC wire using the USB PD protocol. When cable detection and USB PD negotiation are complete, the TPS65987DJ device enables the appropriate power path and configures Alternate Mode settings for external multiplexers. The TPS65987DDJ device has two internal power paths that can be source or sink with current rating up to 5 A. The EVM is customizable through the TPS65987DJ Application Customization Tool. Additionally, the EVM is equipped with an TIVA chip for flashing a new project through SPI or I2C for debugging and development. The scope of this document will cover the EVM hardware. For information on how to configure the EVM, refer to the TPS6598x Application Customization Tool userguide

Figure 1 shows the TPS65987DJEVM board and Figure 2 shows a block level diagram.
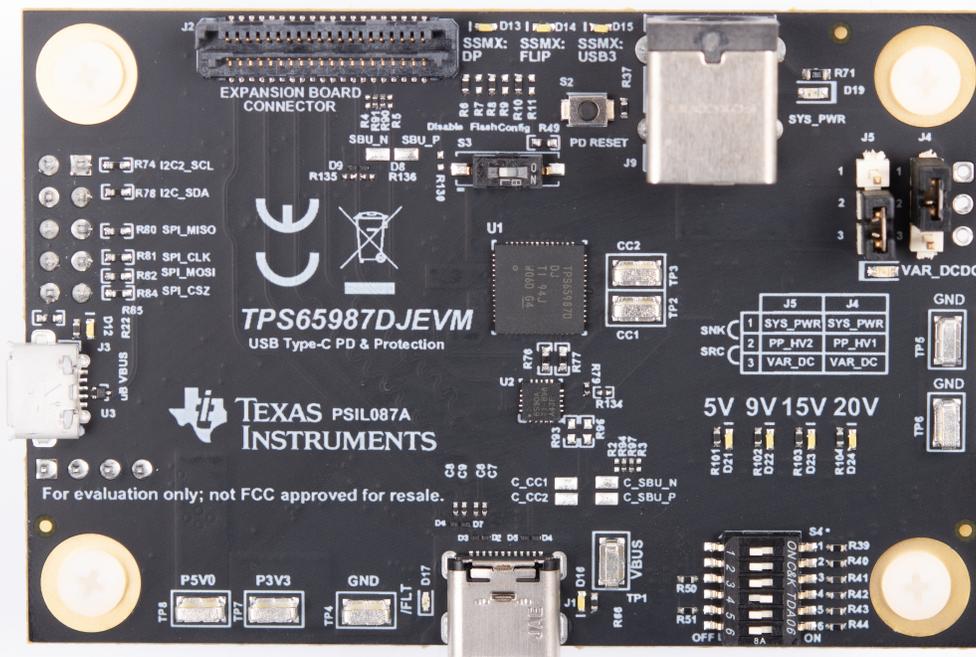
Figure 1. TPS65987DJEVM Board
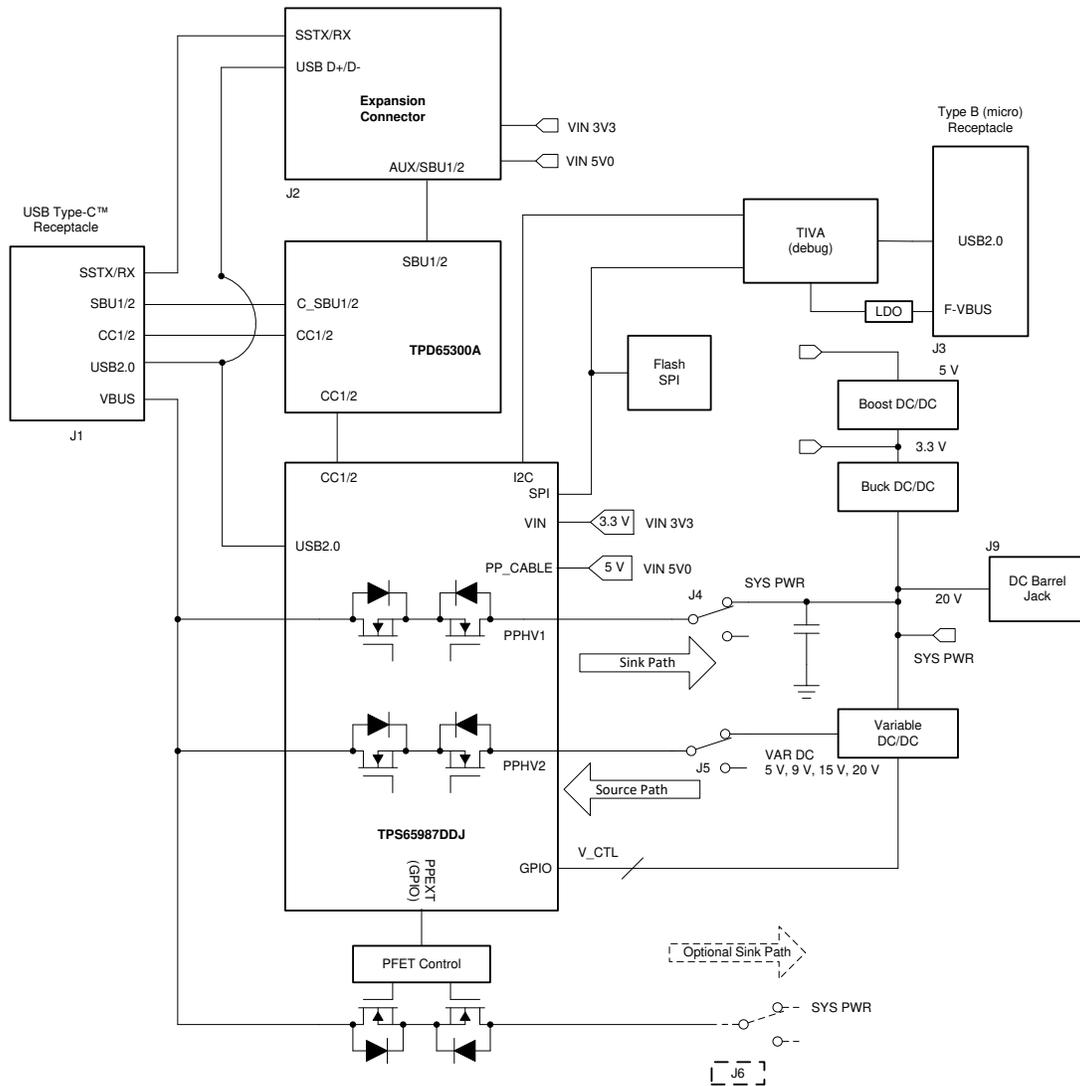
Figure 2. TPS65987DJEVM Block Level Diagram

1.1 Items Required for Operation

The following is required to operate the EVM:

- TPS65987DJEVM
- 20-V barrel jack adapter or dc power supply
- Active or e-marked USB Type-C cables
- USB Type-A to USB Micro-B cable (for configuration customization, debugging and updating FW flash)
- *TPS65987DDJ USB Type-C and USB PD Controller with Integrated Power Switches* data sheet
- *TPS6598x configuration tool*
- *TPS6598x Application Customization Tool* user's guide
- *How to evaluate and configure TI's USB Type-C PD Controllers* training videos

2 Setup

This section describes the header and jumper connections on the EVM and getting started using the TPS65987DJEVM.

2.1 Jumper Configuration

Out of the box, the TPS65987DJEVM is configured to use TPS65987DJ's PPHV1 as sink path (J4) and PPHV2 as source path (J5), which matches the configuration of firmware already programmed in the device. If you have changed FW and want to put the FW back to the way it was shipped, Recovery FW can be reprogrammed using the Application customization tool. The recovery firmware is a full flash image that comes with the Application Customization tool and will configure the EVM to match the described jumper configuration. In order to upload the recovery firmware, open the Application customization tool. Once a project has been selected, open the Device menu and select Re-Flash EVM Firmware (Recovery).

Remember, the jumper configuration in the hardware must match the source and sink paths in the software, *Application Customization Tool (GUI)*. See Figure 3 and Table 1 for the jumper configuration.

TPS65987D
Power Paths

J5   J4

SYS_PWR   1   SYS_PWR
sink   sink
PP_HV2   2   PP_HV1
source   source
VAR_DCDC 3   VAR_DCDC

Jumper J6 is not used

J6

SYS_PWR   1   Do not populate
sink
PP_HV2   2
source
VAR_DCDC 3
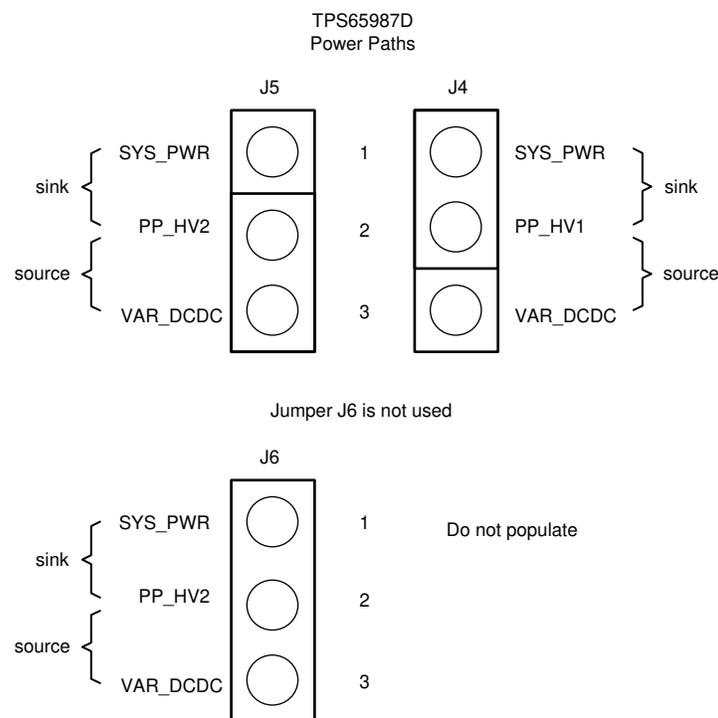
Figure 3. Power Path Jumper Configuration for Source or Sink

Table 1. Jumper Configuration

Jumper	Description
J4	TPS65987DDJ power path: Jump pins 1-2 to sink on PP_HV1 (default)
J5	TPS65987DDJ power path: Jump pins 2-3 to source on PP_HV2 (default)

2.2   Connector Functionality

Table 2 lists the TPS65987DJEVM connector and functionality.

Table 2. Connector Functionality

Designator	Description
J1	USB Type-C connector: TI recommends using an active or e-marked USB Type-C cable
J2	Expansion board connector: Option to connect to external module.
J3	Micro-B connector: Connect to a PC to flash a project on the PD controller. You must download the *TPS6598x configuration tool* (GUI) to flash a project properly.
J9	Barrel jack connector: Use a 19-V to 20-V DC supply. A standard Dell or HP notebook adapter (or similar) will provide the required power.

2.3   Test Points

Table 3 lists the TPS65987DJEVM test points.

Table 3. Test Points

Test Point	Label	Description
TP1	VBUS	V_{BUS} voltage on the USB Type-C connector. Sourcing and sinking is always in reference to V_{BUS} (Source to V_{BUS} or sink from V_{BUS}).
TP2	CC1	System side CC1. This could be VCONN or CC depending on polarity flip of the USB Type-C cable.
TP3	CC2	System side CC2. This could be VCONN or CC depending on polarity flip of the USB Type-C cable.
TP4, TP5, TP6	GND	Ground reference for entire board
TP7	P3V3	Output of 3.3-V DC/DC convertor to power up all ICs on the EVM
TP8	P5V0	Output of 5-V DC/DC convertor used for PP_CABLE (VCONN)

2.4   LEDs

Table 4 lists the TPS65987DJEVM LEDs.

Table 4. LEDs

Designator	Label	Description
D12	μB VBUS	White LED that shows when the μB port is connected (FTDI for GUI).
D13	SSMX: DP	White LED that shows when the TPS65987DDJ device has enabled this signal for the super-speed MUX (depending on version of EVM the silkscreen may appear to show this signal swapped with SSMX: USB3)
D14	SSMX: FLIP	White LED that shows when the TPS65987DDJ device has enabled the flipped cable orientation signal for the super-speed MUX
D15	SSMX: USB3	White LED that shows when the TPS65987DDJ device has enabled this signal for the super-speed MUX
D16	VBUS	White LED that shows when V_{BUS} has a voltage of 5 V, 9 V, 15 V, or 20 V
D19	SYS_PWR	Blue LED that shows when the barrel jack is connected
D20	VAR_DCDC	Green LED that shows when there is a voltage on the variable DC/DC controller (U9). When the EVM acts as a source, D20 lights up.
D21	PDO_0	White LED that shows when there is a 5-V PD contract (only shown when sourcing)
D22	PDO_1	White LED that shows when there is a 9-V PD contract (only shown when sourcing)
D23	PDO_2	White LED that shows when there is a 15-V PD contract (only shown when sourcing)
D24	PDO_3	White LED that shows when there is a 20-V PD contract (only shown when sourcing)
D17	/FLT	Red LED that shows when there is an fault occurred TPD6S300A device

2.5 Switches

Table 5 and Table 6 lists the TPS65987DJEVM switches. For S1, make sure to leave all six switches in the ON position (to the right) for flashing a project and debugging. For S4 Switch: EVM out of the box should have S4->4 (BP_WaitFor3V3_Internal) as on(right). This ensures that PD controller enables internal paths in dead battery mode. This switch can be turned off(left) if EVM is used as source only. Note, S4[1, 2, 3] only one switch should be in "ON" position at a time, same way for S4[4, 5, 6].

Table 5. S4 Switch Bank

Switch (S4)	Description
1, 2, 3 OFF	I2C address selection: 000b
1 ON Only	I2C address selection: 001b
2 ON Only	I2C address selection: 010b
3 ON Only	I2C address selection: 011b
4, 5, 6 OFF	Dead battery mode: BP_NoResponse
4 ON Only	Dead battery mode: BP_WaitFor3V3_Internal
5 ON Only	Dead battery mode: BP_WaitFor3V3_External
6 ON Only	Dead battery mode: BP_NoWait

Table 6. Push Buttons

Designator	Label	Description
S2	PD Reset	This switch is a push-button that pulls the HRESET pin (44) of the TPS65987DJD device high when pressed. Releasing the push-button pulsl HRESET low again, and the TPS65987DJD device goes through a soft reset, which consists of reloading firmware from RAM. If a valid configuration is present in RAM, the TPS65987DJD device will not reload configuration from the external flash.
S3	Disable Flash Config	This push button switch will hold the SPI Miso line to GND. Use this button when booting the device. If this button is pressed when the device is booting, the TPS65987DJD device does not load its configuration from the SPI Flash and instead boots into a default ROM configuration.

3 Using the TPS65987DJEVM

This section discusses how to power the EVM, configure the firmware, and how to debug.

3.1 Powering the TPS65987DJEVM

The main power supply for the EVM is the barrel jack (J9), which accepts 19 V to 20 V via a barrel jack adapter. The EVM can also be powered with an external power supply on SYS_PWR (for example: pin 1 of J4 or J5). The input voltage can range from 5 V to 20 V, but in order to power the EVM through an external power supply, the firmware must be appropriately configured. Use the configuration tool to change and input the power capabilities for PP_HV in the firmware. The EVM can also be powered as a sink through a USB Type-C cable from a source adaptor, EVM, or device.

3.2 Firmware Configurations

Out of the box, the TPS65987DJEVM is configured to emulate a single port laptop computer. This configuration can be used to source or sink power known as (DRP), and this configuration sets DFP_D (Downward Facing Port). If different configurations are required to test your system, use the *TPS6598x configuration tool (GUI)* to create a configuration or load a different configuration template.

3.3 Debugging the EVM

The following checks can help resolve issues when connecting the EVM to another EVM or USB Type-C device and no status LEDs are on:

Make sure that a firmware image is loaded on the TPS65987DJEVM, using the *TPS6598x configuration tool* (GUI).

- Make sure the CC lines are toggling for dual-role port functionality.
- Make sure the following system supplies:
  - P3V3 = 3.3 V
  - P5V0 = 5 V
  - Barrel jack / SYS_PWR = 20 V (when plugged in)
  - VAR_DCDC = 5 V (when barrel jack is plugged in without a USB Type-C attached cable or device)
  - V_{BUS} = 5 V, 9 V, 15 V, or 20 V (when USB Type-C port is attached to another EVM or device)

4 Schematic and Bill of Materials

4.1 Schematic

Figure 4 to Figure 19 illustrate the TPS65987DJEVM schematics.
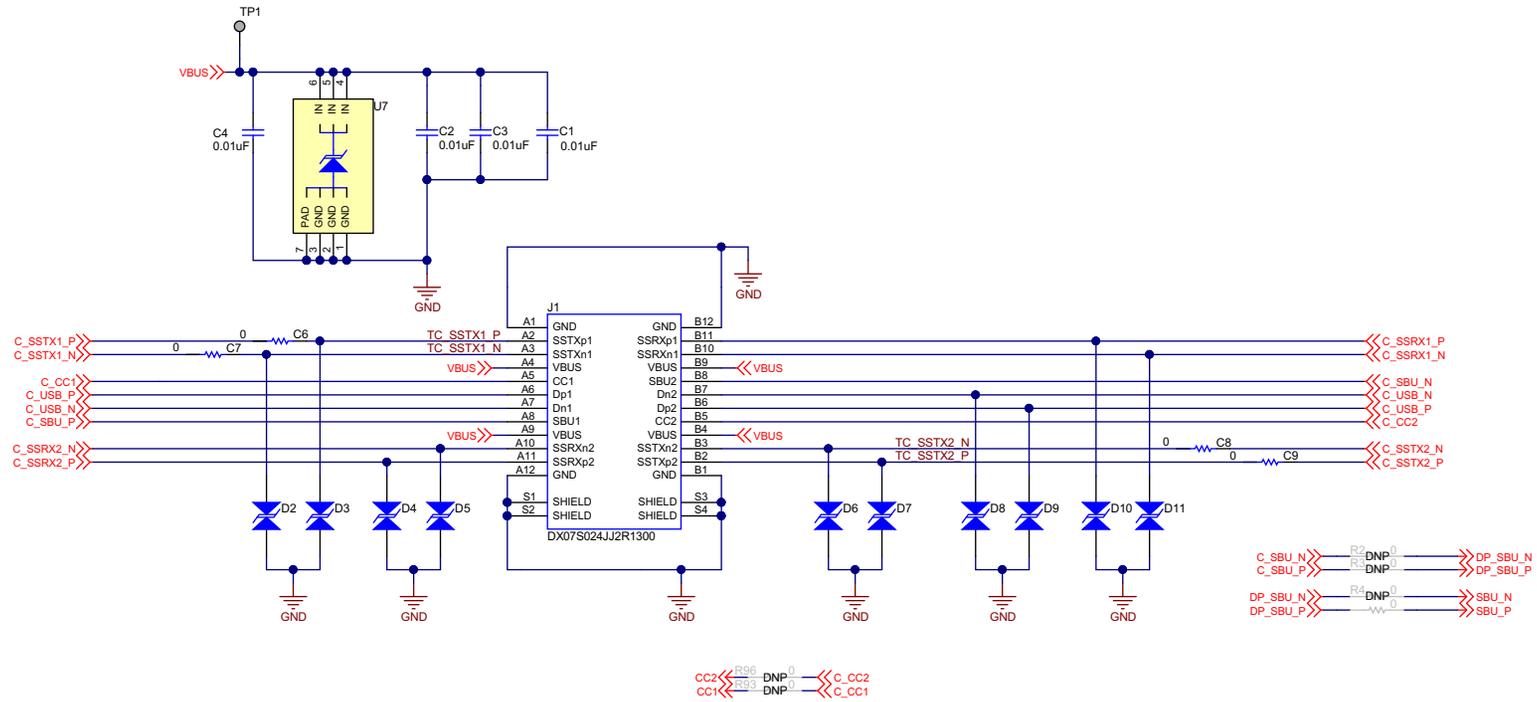
Figure 4. USB Type-C™ Connector
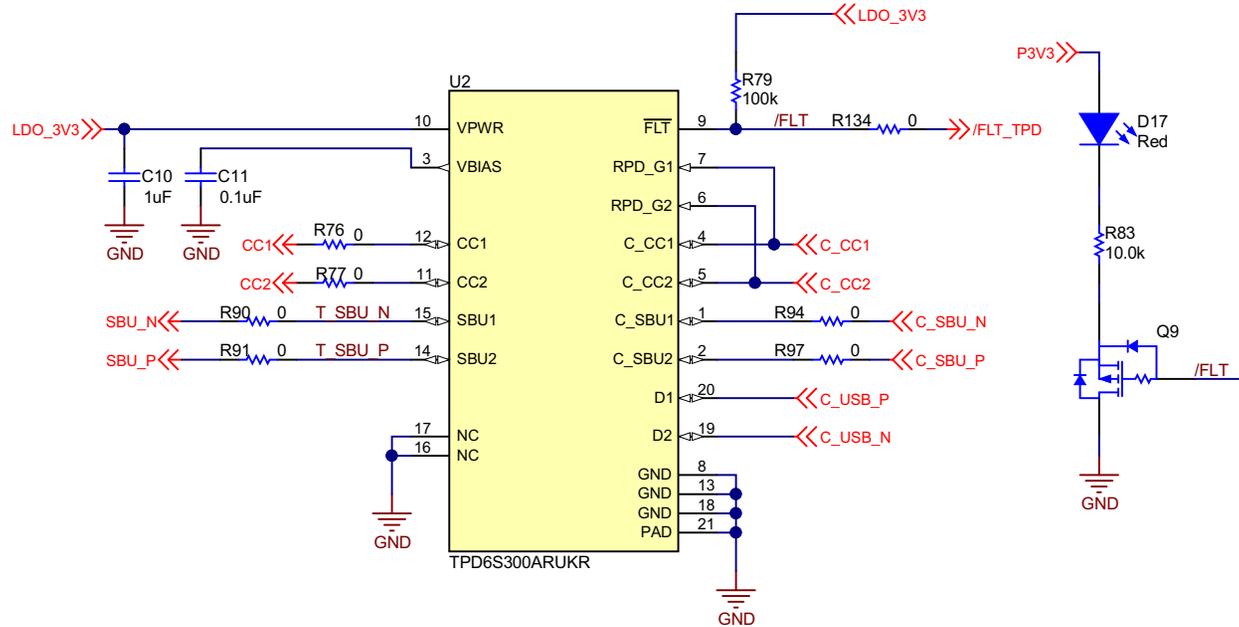
Figure 5. USB Type-C™ Protection Circuit Using TPD6S300A
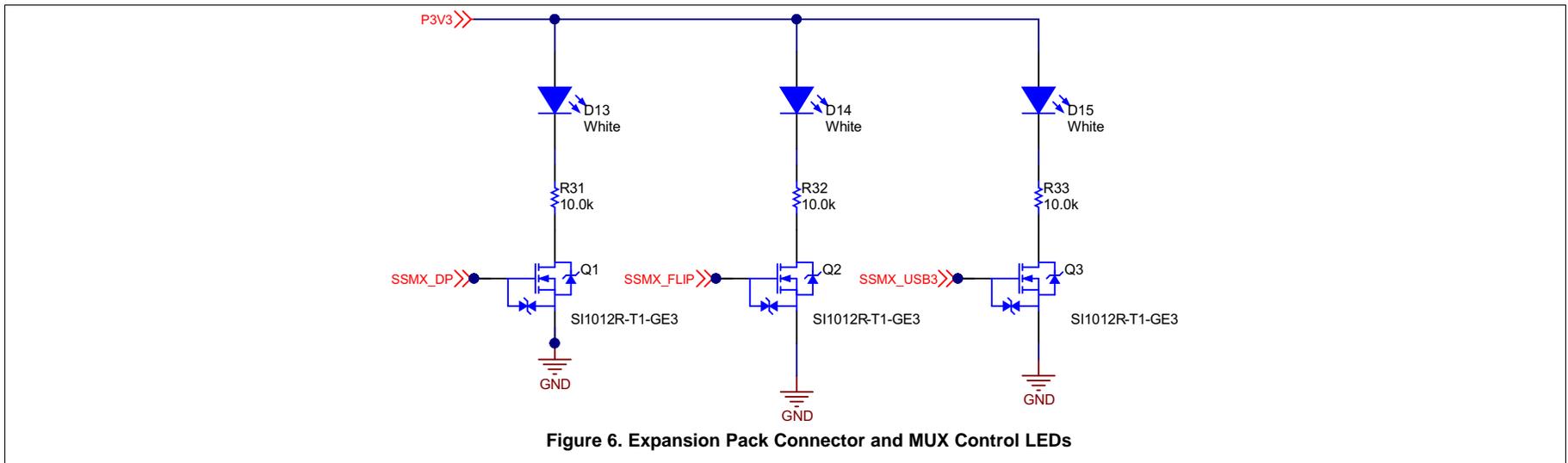
Figure 6. Expansion Pack Connector and MUX Control LEDs
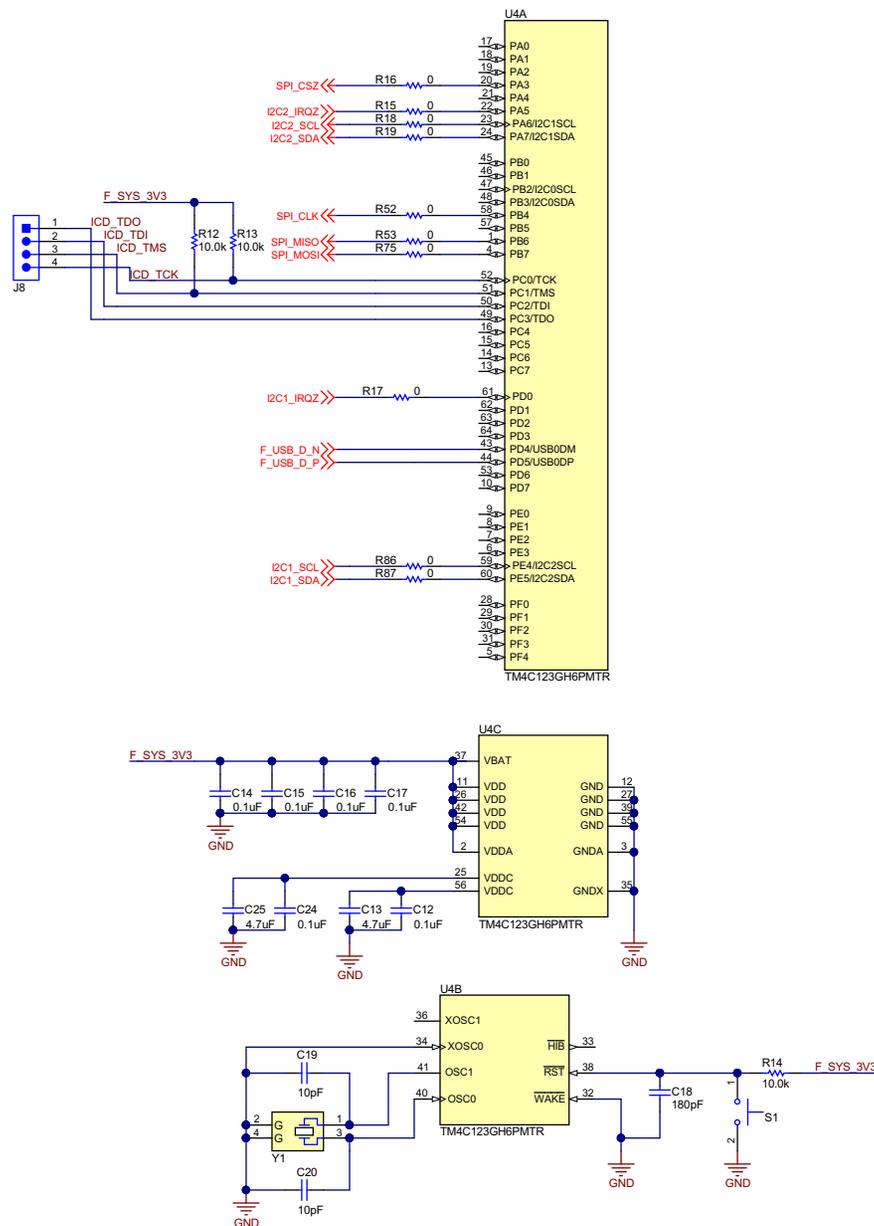
**Figure 7. TIVA Device and Connector**

ULINK2 Debugger
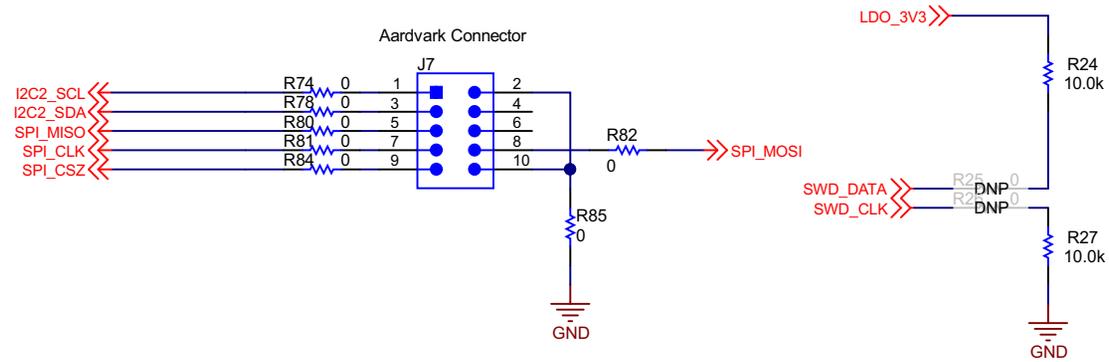
Figure 8. Aardvark Debug Connector
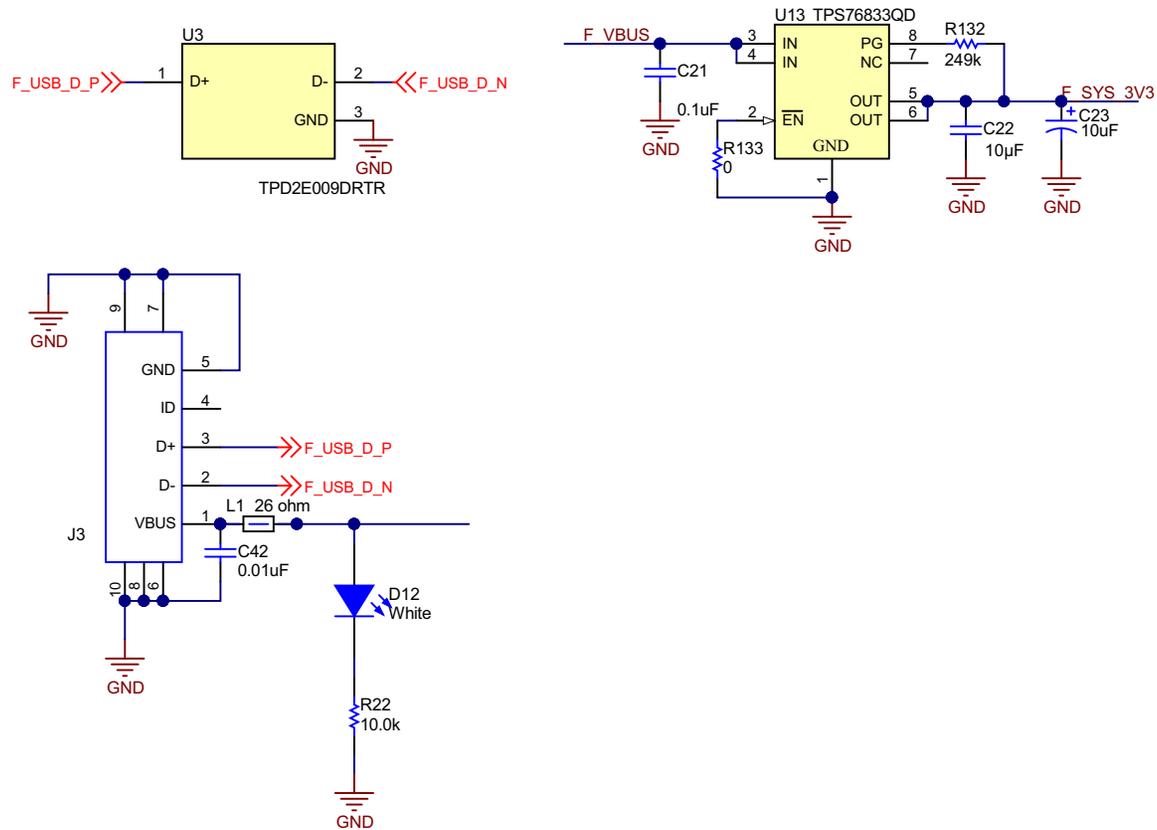
Figure 9. Mico-B Debug Connector
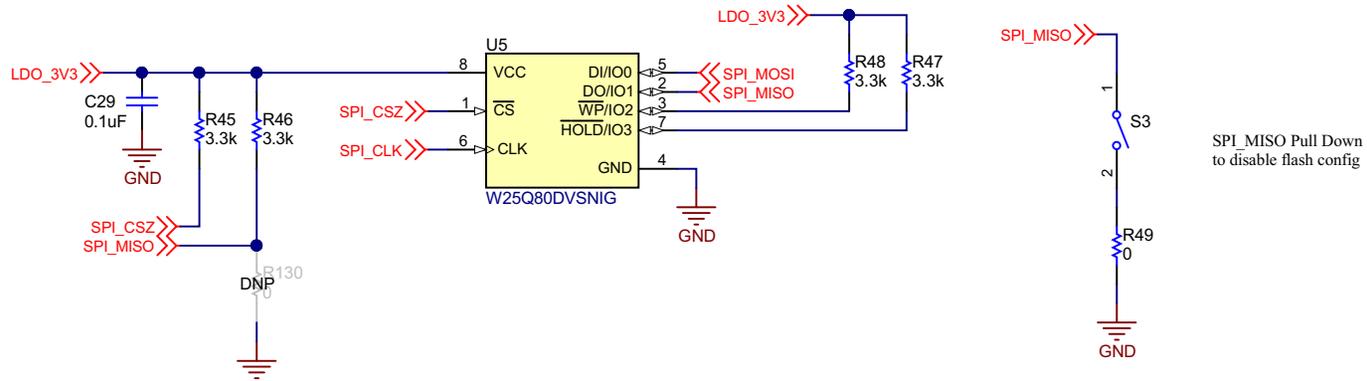
Figure 10. EEPROM Memory for PD Controller
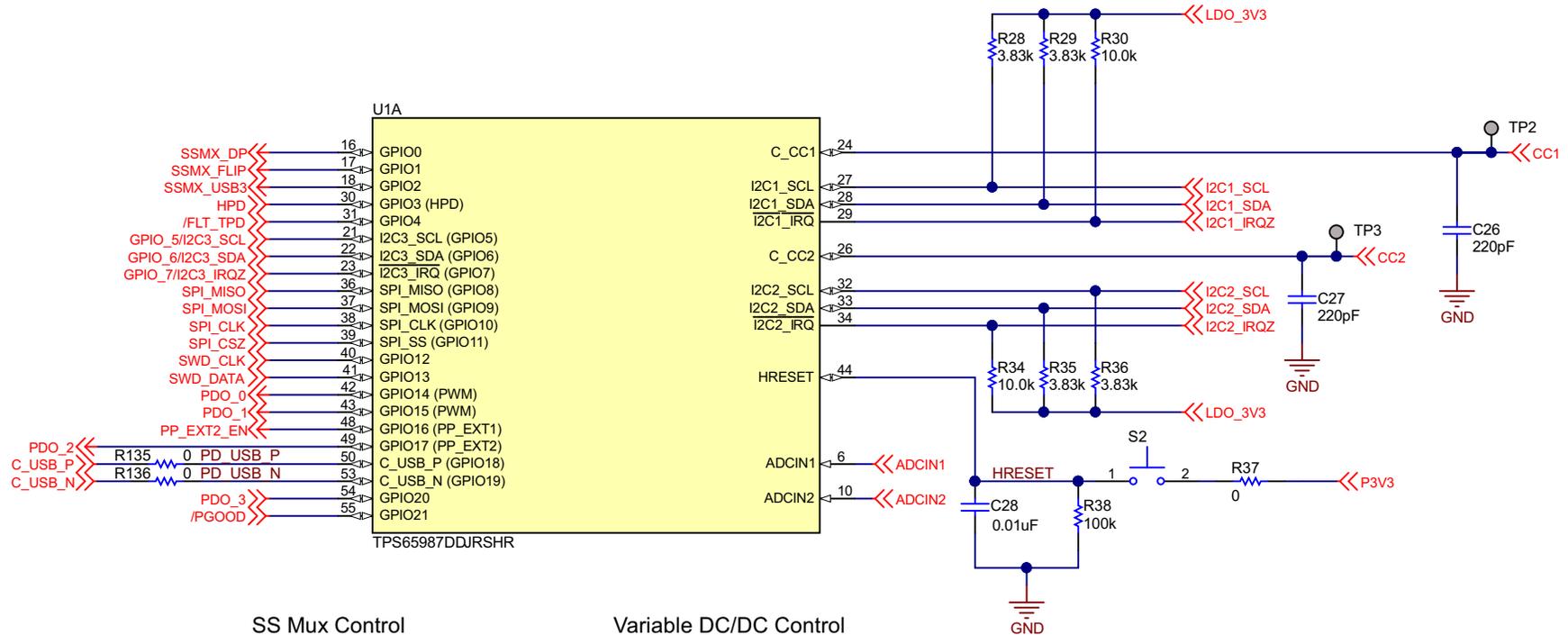
SS Mux Control

SSMX_DP --> GPIO_0
SSMX_FLIP --> GPIO_1
SSMX_USB3 --> GPIO_2
HPD --> GPIO3

Variable DC/DC Control

Truth Table

PDO_3	PDO_2	PDO_1	Output Voltage
0	0	0	5V
0	0	1	9V
0	1	0	15V
1	0	0	20V

Figure 11. USB PD Controller and Memory

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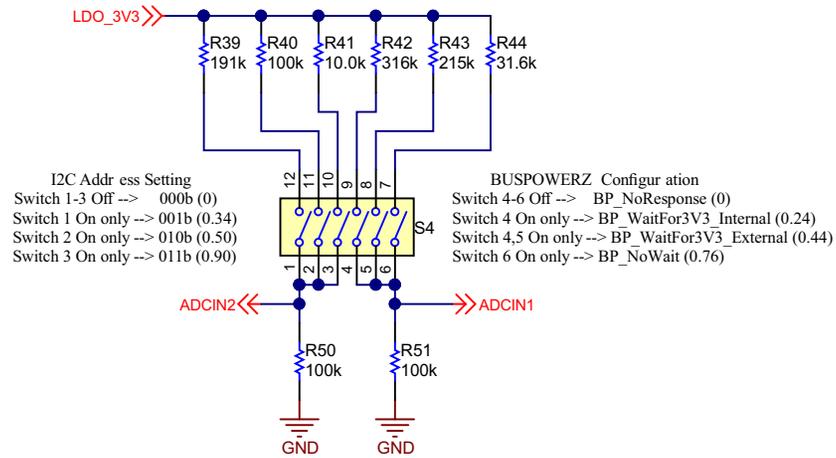
Figure 12. USB PD Controller ADCINx Resistor Divider Settings (for Boot)
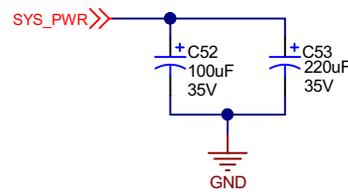
Figure 13. Barrel Jack, Variable DC/DC and SYS_PWR
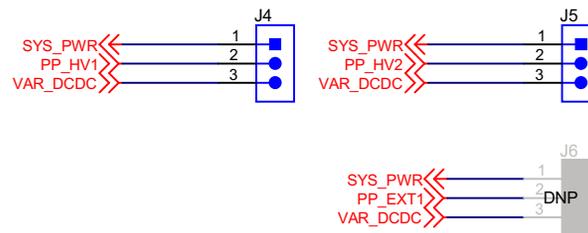
Figure 14. USB PD Power Path Jumpers
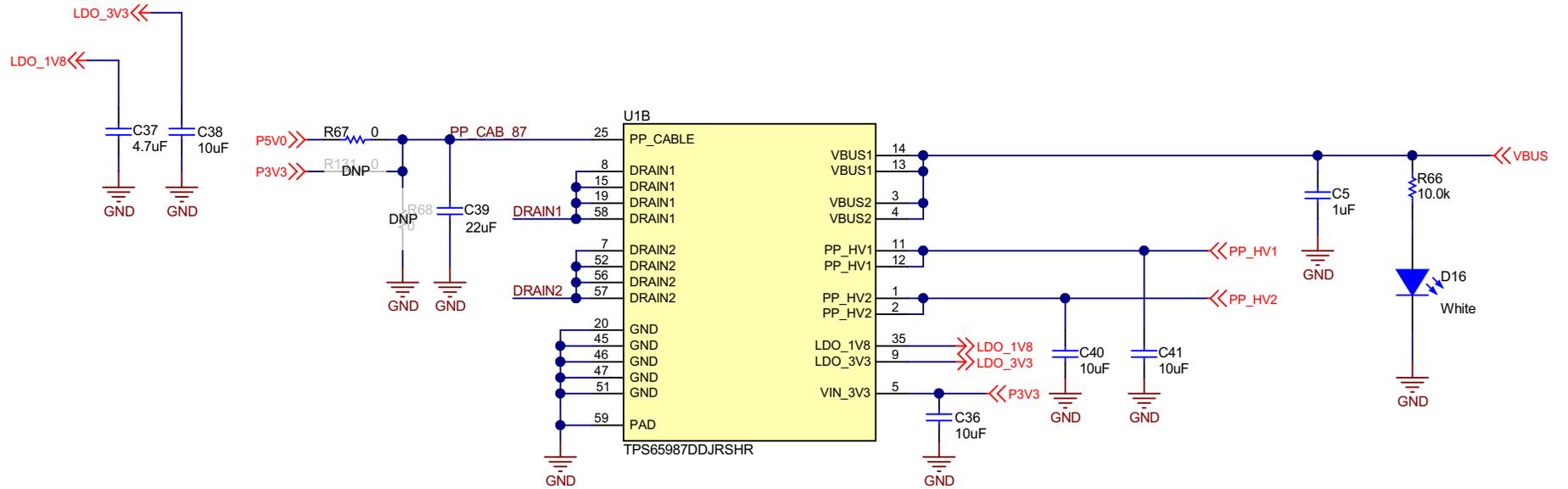
Figure 15. USB PD Power Paths
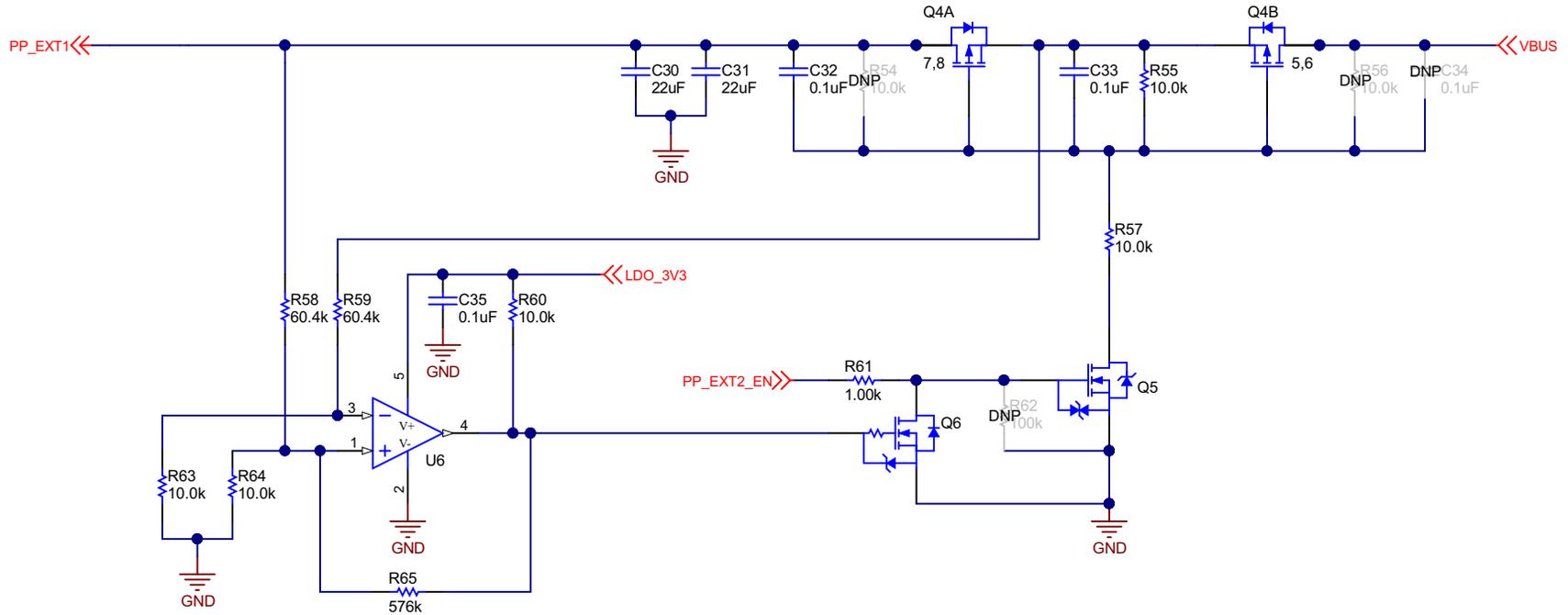
Figure 16. USB PD External (Sink) Power Path with RCP
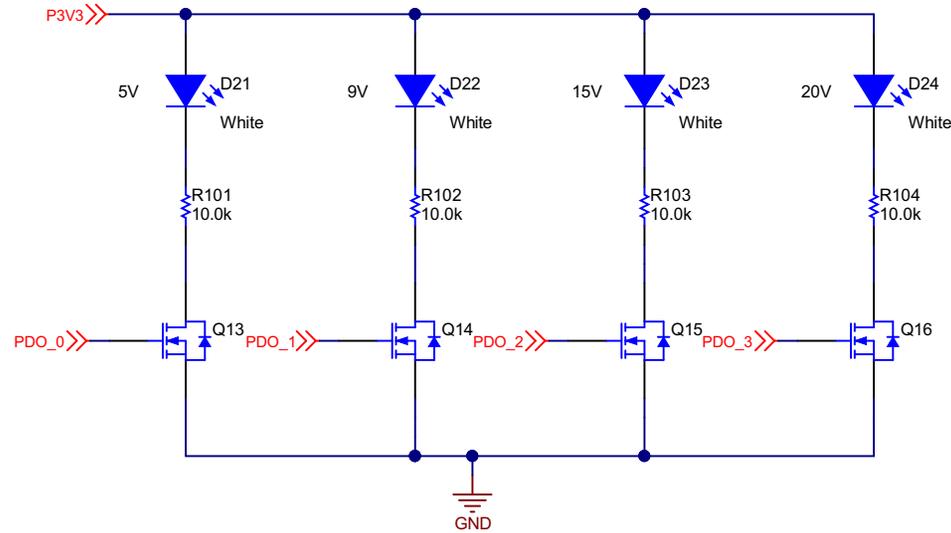
Figure 17. Variable DC/DC Control LEDs

PDO_3	PDO_2	PDO_1	Output Voltage	Feedback (R1)	Feedback (R2)	Output Voltage
0	0	0	5V	60.4k	19.1k	5.14V
0	0	1	9V	60.4k	9.1k	9.3V
0	1	0	15V	60.4k	5.12k	15.6
1	0	0	20V	60.4k	3.9k	21.03
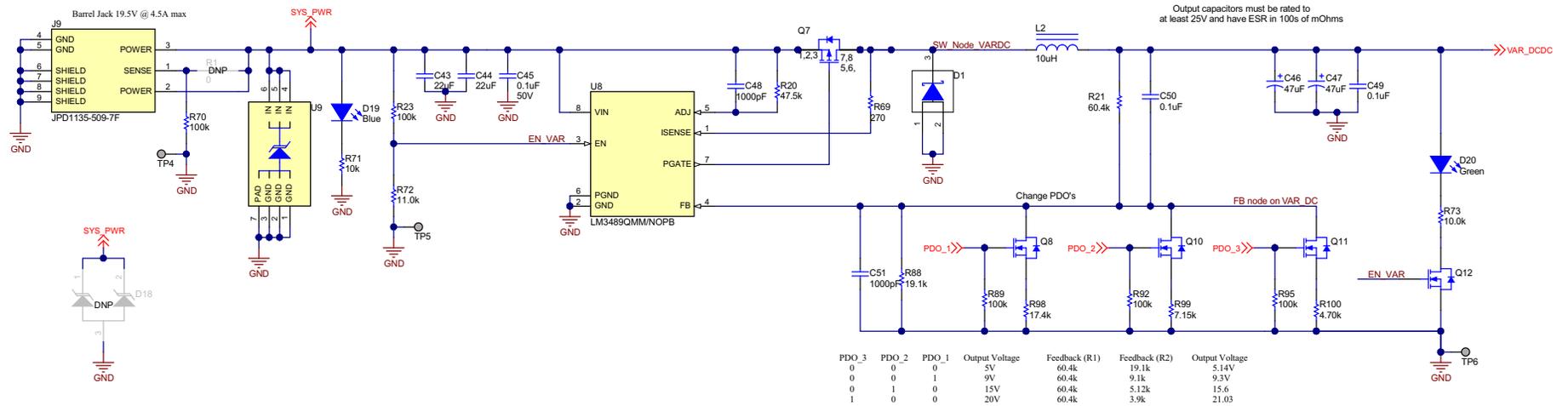
Figure 18. Variable DC/DC Controller
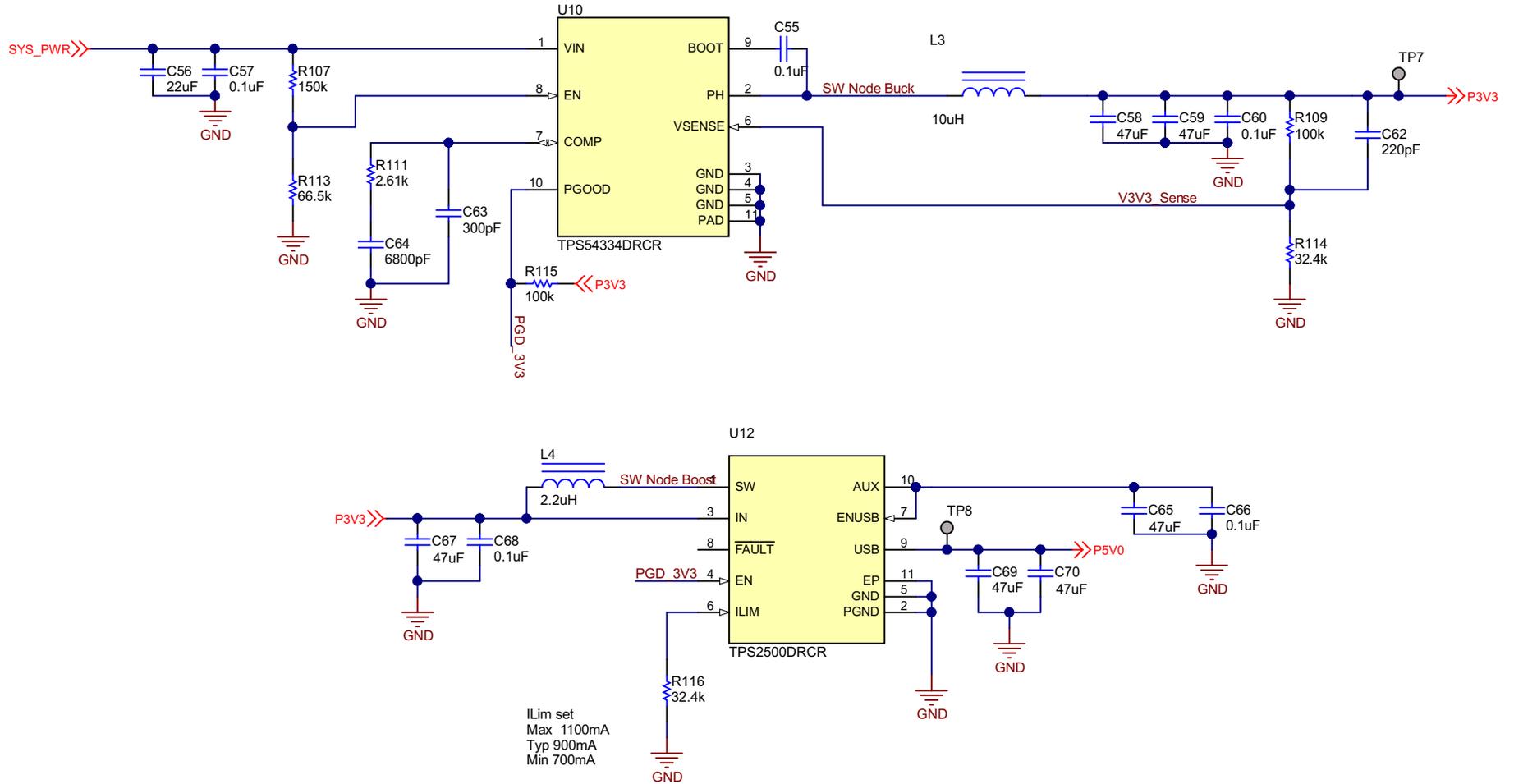
Figure 19. Buck and Boost DC/DC Convertors

4.2   Bill of Materials

Table 7 lists the TPS65987DJEVM BOM.

Table 7. TPS65987DJEVM Bill of Materials[1]

| Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		PSIL087	Any	-	-
C1, C2, C3, C4, C28	5	0.01 uF	CAP, CERM, 0.01 µF, 50 V, +/- 10%, C0G/NP0, 0402	0402	GCM155R71H103KA55D	MuRata		
C5	1	1 uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0603	0603	UMK107AB7105KA-T	Taiyo Yuden		
C6, C7, C8, C9, R133	5	0	RES, 0, 5%, .05 W, AEC-Q200 Grade 0, 0201	0201	ERJ-1GN0R00C	Panasonic		
C10	1	1 uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X5R, 0402	0402	EMK105BJ105KVHF	Taiyo Yuden		
C11, C12, C14, C15, C16, C17, C21, C24, C32, C33, C35, C45, C50, C54, C55, C57, C60, C66, C68	19	0.1 uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71H104KE02D	MuRata		
C13, C25	2	4.7 uF	CAP, CERM, 4.7 uF, 10 V, +/- 20%, X5R, 0402	0402	C1005X5R1A475M050BC	TDK		
C18	1	180 pF	CAP, CERM, 180 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	06035A181JAT2A	AVX		
C19, C20	2	10 pF	CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	0603	CGA3E2C0G1H100D080AA	TDK		
C22	1	10 uF	CAP, CERM, 10 µF, 10 V,+/- 20%, X5R, 0402	0402	0402ZD106MAT2A	AVX		
C23	1	10 uF	CAP, TA, 10 uF, 10 V, +/- 10%, 2.5 ohm, SMD	3528-21	293D106X9010B2TE3	Vishay-Sprague		
C26, C27	2	220 pF	CAP, CERM, 220 pF, 25 V, +/- 10%, X7R, 0201	0201	GRM033R71E221KA01D	MuRata		
C29	1	0.1 uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, 0402	0402	885012205037	Wurth Elektronik		
C30, C31, C43, C44, C56	5	22 uF	CAP, CERM, 22 µF, 25 V, +/- 20%, X5R, 0805	0805	GRM21BR61E226ME44L	MuRata		
C36, C38	2	10 uF	CAP, CERM, 10 µF, 10 V, +/- 20%, X5R, 0402	0402	CL05A106MP5NUNC	Samsung Electro-Mechanics		
C37	1	4.7 uF	CAP, CERM, 4.7 uF, 10 V, +/- 20%, X5R, 0402	0402	CL05A475MP5NRNC	Samsung Electro-Mechanics		
C39	1	22 uF	CAP, CERM, 22 µF, 10 V, +/- 20%, X5R, 0603	0603	C1608X5R1A226M080AC	TDK		

[1]   Unless otherwise noted in the Alternate PartNumber and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

Table 7. TPS65987DJEVM Bill of Materials[1] (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
C40, C41	2	10 uF	CAP, CERM, 10 µF, 25 V, +/- 20%, X5R, 0603	0603	GRM188R61E106MA73D	MuRata		
C42	1	0.01 uF	CAP, CERM, 0.01 µF, 50 V,+/- 5%, X7R, 0402	0402	C0402C103J5RACTU	Kemet		
C46, C47	2	47 uF	CAP, TA, 47 uF, 35 V, +/- 20%, 0.9 ohm, AEC-Q200 Grade 1, SMD	7343-43	TAJE476M035RNJ	AVX		
C48, C51	2	1000 pF	CAP, CERM, 1000 pF, 50 V,+/- 20%, X7R, 0402	0402	C1005X7R1H102M050BE	TDK		
C49	1	0.1 uF	CAP, CERM, 0.1 uF, 35 V, +/- 10%, X5R, 0402	0402	GMK105BJ104KV-F	Taiyo Yuden		
C52	1	100 uF	CAP, AL, 100 uF, 35 V, +/- 20%, 0.26 ohm, AEC-Q200 Grade 2, SMD	D6.3xL5.8mm	EEE-FT1V101AP	Panasonic		
C53	1	220 uF	CAP, AL, 220 uF, 35 V, +/- 20%, AEC-Q200 Grade 3, SMD		EEE-1VA221UP	Panasonic		
C58, C59	2	47 uF	CAP, CERM, 47 uF, 6.3 V, +/- 20%, X5R, 0805	0805	GRM219R60J476ME44D	MuRata		
C61	1	22 pF	CAP, CERM, 22 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	0402	GCM1555C1H220JA16D	MuRata		
C62	1	220 pF	CAP, CERM, 220 pF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0201	0201	CGA1A2X7R1H221K030BA	TDK		
C63	1	300 pF	CAP, CERM, 300 pF, 25 V,+/- 5%, C0G/NP0, 0402	0402	C0402C301J3GAC7867	Kemet		
C64	1	6800 pF	CAP, CERM, 6800 pF, 50 V,+/- 10%, X7R, 0402	0402	GCM155R71H682KA55D	MuRata		
C65, C67, C69, C70	4	47 uF	CAP, CERM, 47 uF, 6.3 V, +/- 20%, X5R, 0603	0603	GRM188R60J476ME15D	MuRata		
D1	1	40 V	Diode, Schottky, 40 V, 10 A, PowerDI5	PowerDI5	PDS1040L-13	Diodes Inc.		
D2, D3, D4, D5, D6, D7, D8, D9, D10, D11	10		1-Channel ESD Protection Diode for USB Type-C and Thunderbolt 3, DPL0002A (X2SON-2)	DPL0002A	TPD1E01B04DPLR	Texas Instruments	TPD1E01B04DPLT	Texas Instruments
D12, D13, D14, D15, D16, D21, D22, D23, D24,	9	White	LED, White, SMD	0402, White	LW QH8G-Q2S2-3K5L-1	OSRAM	LW QH8G-Q2OO-3K5L-1	
D17	1	Red	LED, Red, SMD	0402	APHHS1005SURCK	Kingbright		
D19	1	Blue	LED, Blue, SMD	1.6x0.8mm	LTST-C193TBKT-5A	Lite-On		
D20	1	Green	LED, Green, SMD	LED_0603	150060GS75000	Wurth Elektronik		
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply		
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone		

Table 7. TPS65987DJEVM Bill of Materials[1] (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
J1	1		Receptacle, USB 3.1 Type-C, R/A, Gold, SMT	Receptacle, USB 3.1 Type-C, R/A, SMT	DX07S024JJ2R1300	JAE Electronics		
J2	1		Socket, 0.8mm, 20x2, Gold, SMT	Socket, 0.8mm, 20x2, Gold, SMT	LSEM-120-03.0-F-DV-A-N-K-TR	Samtec		
J3	1		Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	ZX62RD-AB-5P8(30)	Hirose Electric Co. Ltd.		
J4, J5	2		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec		
J7	1		Header, 100mil, 5x2, Tin, TH	Header, 5x2, 100mil, Tin	PEC05DAAN	Sullins Connector Solutions		
J8	1		Header, 100mil, 4x1, Tin, TH	Header, 4x1, 100mil, TH	PEC04SAAN	Sullins Connector Solutions		
J9	1		Connector, DC Power Jack, R/A, 3 Pos, TH	Power connector	JPD1135-509-7F	Foxconn		
L1	1	26 ohm	Ferrite Bead, 26 ohm at 100 MHz, 6 A, 0603	0603	BLM18SG260TN1D	MuRata		
L2	1	10 uH	Inductor, Shielded, Powdered Iron, 10 µH, 7.5 A, 0.03 ohm, AEC-Q200 Grade 1, SMD	11x10mm	SRP1038A-100M	Bourns		
L3	1	10 uH	Inductor, Shielded, 10 µH, 4 A, 0.068 ohm, SMD	7.2 mm x 6.65 mm	ASPI-0630LR-100M-T15	Abracon Corporation	-	-
L4	1	2.2 uH	Inductor, Shielded, Powdered Iron, 2.2 uH, 4.7 A, 0.035 ohm, AEC-Q200 Grade 1, SMD	4.1 mm x 4.1 mm	78438356022	Wurth Elektronik		
Q1, Q2, Q3	3	20 V	MOSFET, N-CH, 20 V, 0.6 A, SOT-416	SOT-416	SI1012R-T1-GE3	Vishay-Siliconix		None
Q4	1	–30 V	MOSFET, 2-CH, P-CH, -30 V, -60 A, 610x604x515mm	610x604x515mm	SI7997DP-T1-GE3	Vishay-Siliconix		None
Q5	1	30 V	MOSFET, N-CH, 30 V, 0.35 A, AEC-Q101, SOT-323	SOT-323	NX3008NBKW,115	Nexperia		None
Q6	1	20 V	MOSFET, N-CH, 20 V, 0.5 A, YJM0003A (PICOSTAR-3)	YJM0003A	CSD15380F3	Texas Instruments		None
Q7	1	–30 V	MOSFET, P-CH, -30 V, -11 A, FET, 3x0.8x3mm	FET, 3x0.8x3mm	AONR21321	AOS	AON7403	None
Q8, Q10, Q11	3	20 V	MOSFET, N-CH, 20 V, 1.05 A, SOT-23	SOT-23	BSH105,215	Nexperia		None
Q9	1	–20 V	MOSFET, P-CH, -20 V, -0.76 A, SOT-416	SOT-416	NTA4151PT1G	ON Semiconductor		None
Q12, Q13, Q14, Q15, Q16	5	30 V	MOSFET, N-CH, 30 V, 0.18 A, SOT-323	SOT-323	NX3020NAKW,115	Nexperia		None
R6, R8, R10	3	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GE0R00X	Panasonic		
R12, R13, R14	3	10.0 k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0FKED	Vishay-Dale		

Table 7. TPS65987DJEVM Bill of Materials[1] (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
R15, R16, R17, R18, R19, R52, R53, R75, R86, R87, R90, R91, R94, R97, R134, R135, R136	17	0	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale		
R20	1	47.5 k	RES, 47.5 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040247K5FKED	Vishay-Dale		
R21, R58, R59	3	60.4 k	RES, 60.4 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040260K4FKED	Vishay-Dale		
R22, R30, R32, R33, R34, R41, R55, R57, R60, R63, R64, R66, R73, R101, R102, R103, R104	17	10.0 k	RES, 10.0 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1002X	Panasonic		
R23, R38, R40, R50, R51, R70, R89, R92, R95, R105, R109, R115	12	100 k	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KFKED	Vishay-Dale		
R24, R27	2	10.0 k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710KL	Yageo		
R28, R29, R35, R36	4	3.83 k	RES, 3.83 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04023K83FKED	Vishay-Dale		
R31	1	10.0 k	RES, 10.0 k, 0.5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0DHEDP	Vishay-Dale		
R37, R49, R67, R74, R76, R77, R78, R80, R81, R82, R84, R85	12	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America		
R39	1	191 k	RES, 191 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402191KFKED	Vishay-Dale		
R42	1	316 k	RES, 316 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402316KFKED	Vishay-Dale		
R43	1	215 k	RES, 215 k, 1%, 0.063 W, 0402	0402	CRCW0402215KFKED	Vishay-Dale		
R44	1	31.6 k	RES, 31.6 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040231K6FKED	Vishay-Dale		
R45, R46, R47, R48	4	3.3 k	RES, 3.3 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04023K30JNED	Vishay-Dale		

Table 7. TPS65987DJEVM Bill of Materials[1] (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
R61	1	1.00 k	RES, 1.00 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1001X	Panasonic		
R65	1	576 k	RES, 576 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402576KFKED	Vishay-Dale		
R69	1	270	RES, 270, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402270RJNED	Vishay-Dale		
R71	1	10 k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC0603JR-0710KL	Yageo		
R72	1	11.0 k	RES, 11.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040211K0FKED	Vishay-Dale		
R79	1	100 k	RES, 100 k, 5%, 0.05 W, 0201	0201	RC0201JR-7D100KL	Yageo America		
R83	1	10.0 k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0710KL	Yageo America		
R88	1	19.1 k	RES, 19.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040219K1FKED	Vishay-Dale		
R98	1	17.4 k	RES, 17.4 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040217K4FKED	Vishay-Dale		
R99	1	7.15 k	RES, 7.15 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04027K15FKED	Vishay-Dale		
R100	1	4.70 k	RES, 4.70 k, 1%, 0.0625 W, 0402	0402	RC0402FR-074K7L	Yageo America		
R106	1	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R107	1	150 k	RES, 150 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402150KFKED	Vishay-Dale		
R108	1	15.0 k	RES, 15.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040215K0FKED	Vishay-Dale		
R110	1	39 k	RES, 39 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040239K0JNED	Vishay-Dale		
R111	1	2.61 k	RES, 2.61 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K61FKED	Vishay-Dale		
R112	1	560 k	RES, 560 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402560KJNED	Vishay-Dale		
R113	1	66.5 k	RES, 66.5 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040266K5FKED	Vishay-Dale		
R114, R116	2	32.4 k	RES, 32.4 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040232K4FKED	Vishay-Dale		
R132	1	249 k	RES, 249 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603249KFKEA	Vishay-Dale		
S1, S2	2		SWITCH TACTILE SPST-NO 0.05A 12 V	3x1.6x2.5mm	B3U-1000P	Omron Electronic Components		
S3	1		Switch, Slide, SPST, Top Slide, SMT	Switch, Single Top Slide, 2.5x8x2.5mm	CHS-01TB	Copal Electronics		
S4	1		DIP Switch, SPST, 6Pos, Slide, SMT	8.75x6.2mm	TDA06H0SB1	C&K Components		
SH-J1, SH-J2	2	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M

Table 7. TPS65987DJEVM Bill of Materials[(1)] (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	8		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone		
U1	1		USB Type-C and USB PD Controller with Integrated Power Switches, RSH0056E (VQFN-56)	RSH0056E	TPS65987DJDDHRSHR	Texas Instruments		Texas Instruments
U2	1		USB Type-C Port Protector: Short-to-VBUS Overvoltage and IEC ESD Protection, RUK0020B (WQFN-20)	RUK0020B	TPD6S300ARUKR	Texas Instruments		Texas Instruments
U3	1		ESD Protection Array for High-Speed Data Interfaces, 2 Channels, -40 to +85 degC, 3-pin SOT (DRT), Green (RoHS & no Sb/Br)	DRT0003A	TPD2E009DRTR	Texas Instruments		
U4	1		Tiva C Series Microcontroller, 256 KB Flash, 32 KB SRAM, 12 Bit, 12 Channels, -40 to 105 degC, 64-Pin LQFP (PM), Green (RoHS & no Sb/Br), Tape and Reel	PM0064A	TM4C123GH6PMTR	Texas Instruments	TM4C123GH6PMI7	
U5	1		3 V, 8Mbit, Serial Flash Memory with Dual and Qual SPI, SOIC-8	SOIC-8	W25Q80DVSNIG	Winbond		
U6	1		2.2-V to 36-V, microPower Comparator, DBV0005A (SOT-23-5)	DBV0005A	TLV1701AIDBVR	Texas Instruments	TLV1701AIDBVT	Texas Instruments
U7, U9	2		22-V Precision Surge Protection Clamp, DRV0006A (WSON-6)	DRV0006A	TVS2200DRVR	Texas Instruments		Texas Instruments
U8	1		Automotive Grade 4.5-35 V, Hysteretic Non-Synchronous PFET Buck Controller with Enable Pin, DGK0008A (VSSOP-8)	DGK0008A	LM3489QMM/NOPB	Texas Instruments		Texas Instruments
U10	1		4.2-V to 28-V Input voltage, 3-A Output current Synchronous buck Converter with 570kHz fixed frequency, DRC0010J (VSON-10)	DRC0010J	TPS54334DRCR	Texas Instruments	TPS54334DRCT	Texas Instruments
U11	1		Nanopower, 1.8 V, SOT23 Push-Pull Comparator with Voltage Reference, DCK0006A (SOT-SC70-6)	DCK0006A	TLV3012AIDCKR	Texas Instruments	TLV3012AIDCKT	Texas Instruments
U12	1		Integrated USB Power Switch with Boost Converter, DRC0010J (VSON-10)	DRC0010J	TPS2500DRCR	Texas Instruments		
U13	1		Single Output Fast Transient Response LDO, 1 A, Fixed 3.3 V Output, 2.7 to 10 V Input, with Low IQ, 8-pin SOIC (D), -40 to 125 degC, Green (RoHS & no Sb/Br)	D0008A	TPS76833QD	'Texas Instruments		
Y1	1		CRYSTAL, 16 MHz, 8 pF, SMD	3.2x0.75x2.5mm	NX3225GA-16.000M-STD-CRG-1	NDK		
C34	0	0.1 uF	CAP, CERM, 0.1 μF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71H104KE02D	MuRata		
D18	0	24 V	Diode, TVS, Uni, 24 V, 70 Vc, SOT-23	SOT-23	PESD24VS2UT,215	Nexperia		

Table 7. TPS65987DJEVM Bill of Materials[1] (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
J6	0		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec		
R1, R7, R9, R11	0	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GE0R00X	Panasonic		
R2, R3, R4, R5	0	0	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale		
R25, R26, R68, R93, R96, R130, R131	0	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America		
R54, R56	0	10.0 k	RES, 10.0 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1002X	Panasonic		
R62	0	100 k	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KFKED	Vishay-Dale		

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