

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.

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Trademarks

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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.

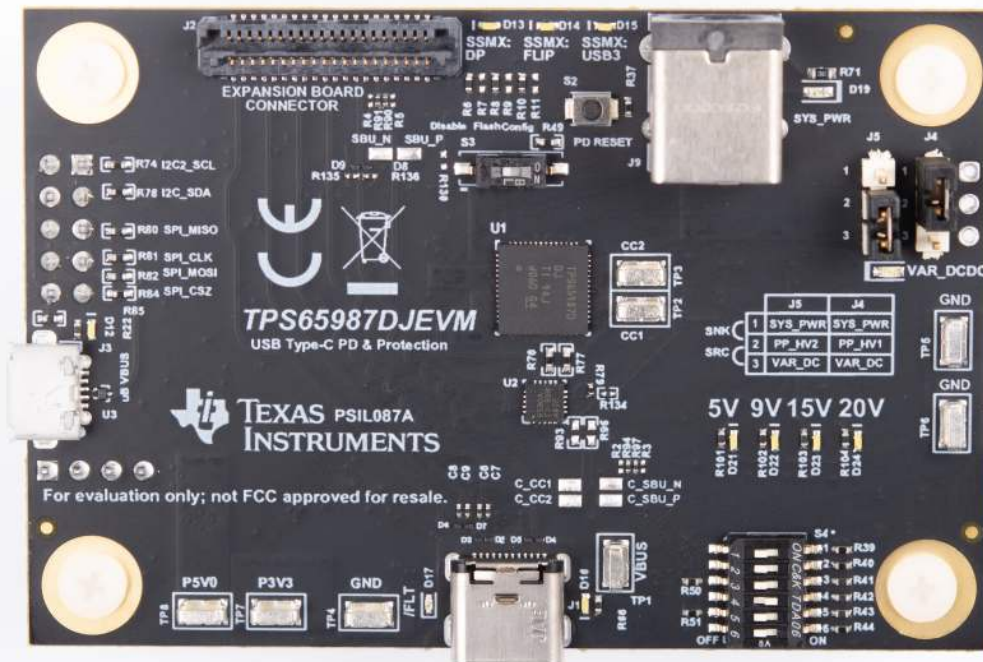


Figure 1. TPS65987DJEVM Board

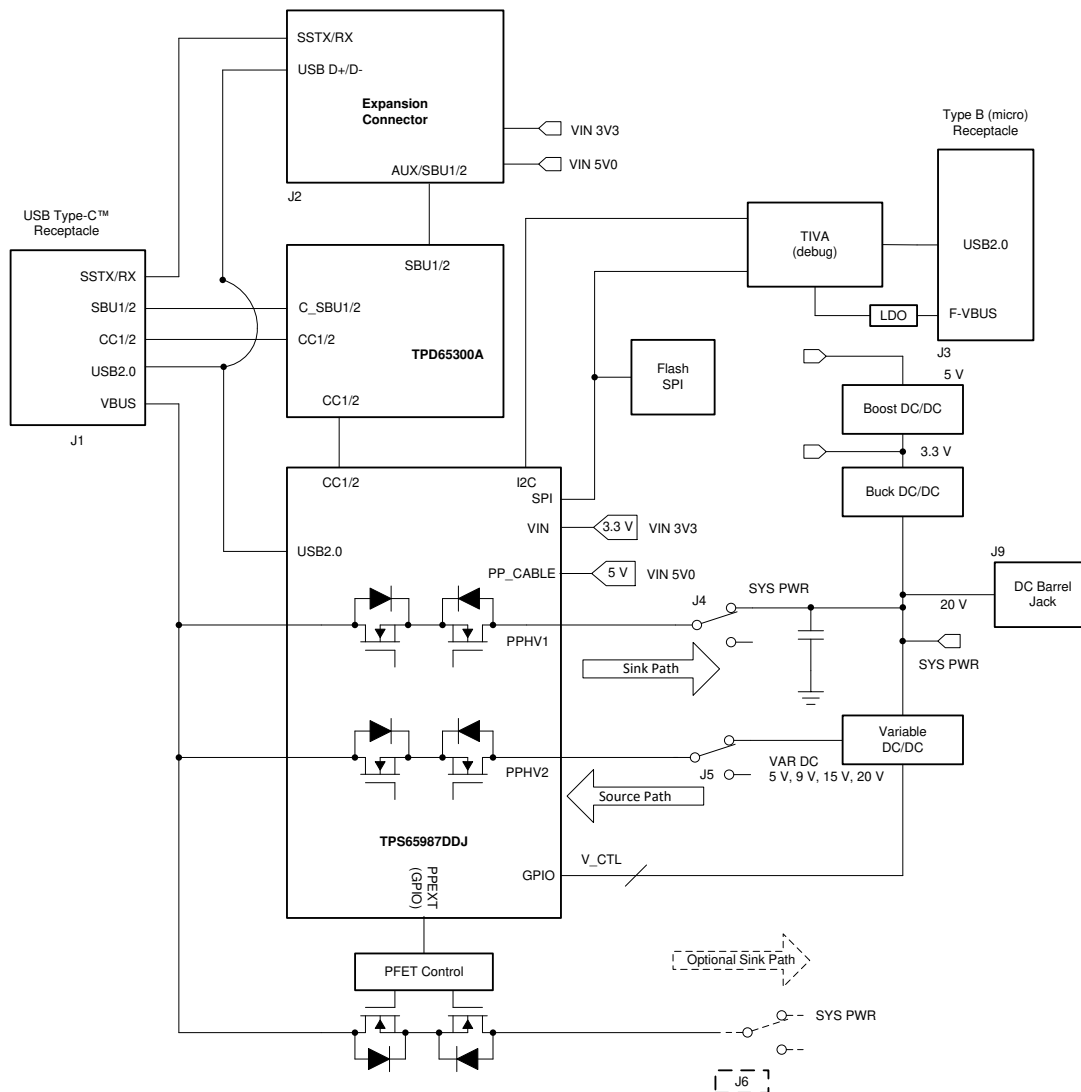


Figure 2. TPS65987DJ EVM Block Level Diagram

1.1 Items Required for Operation

The following is required to operate the EVM:

- TPS65987DJ EVM
- 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.

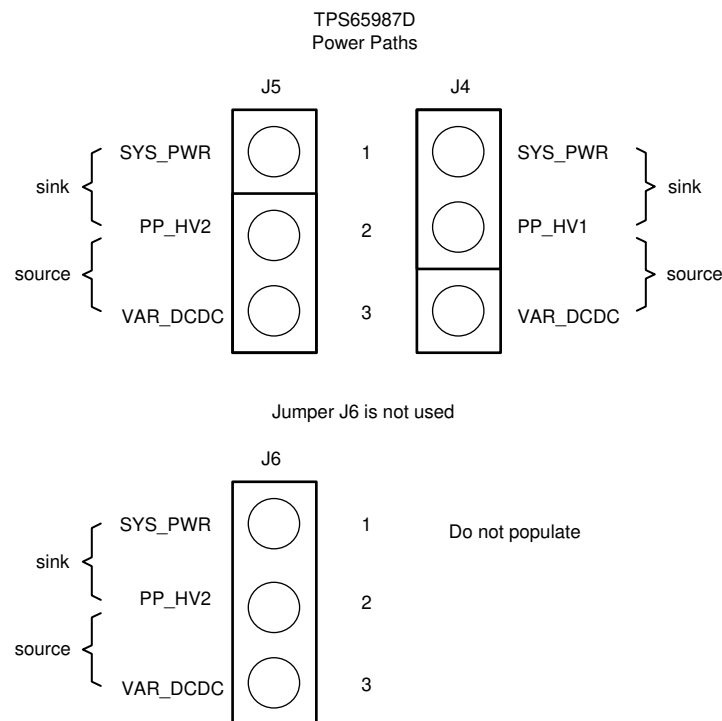


Figure 3. Power Path Jumper Configuration for Source or Sink

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 | μ B VBUS | White LED that shows when the μ B 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.

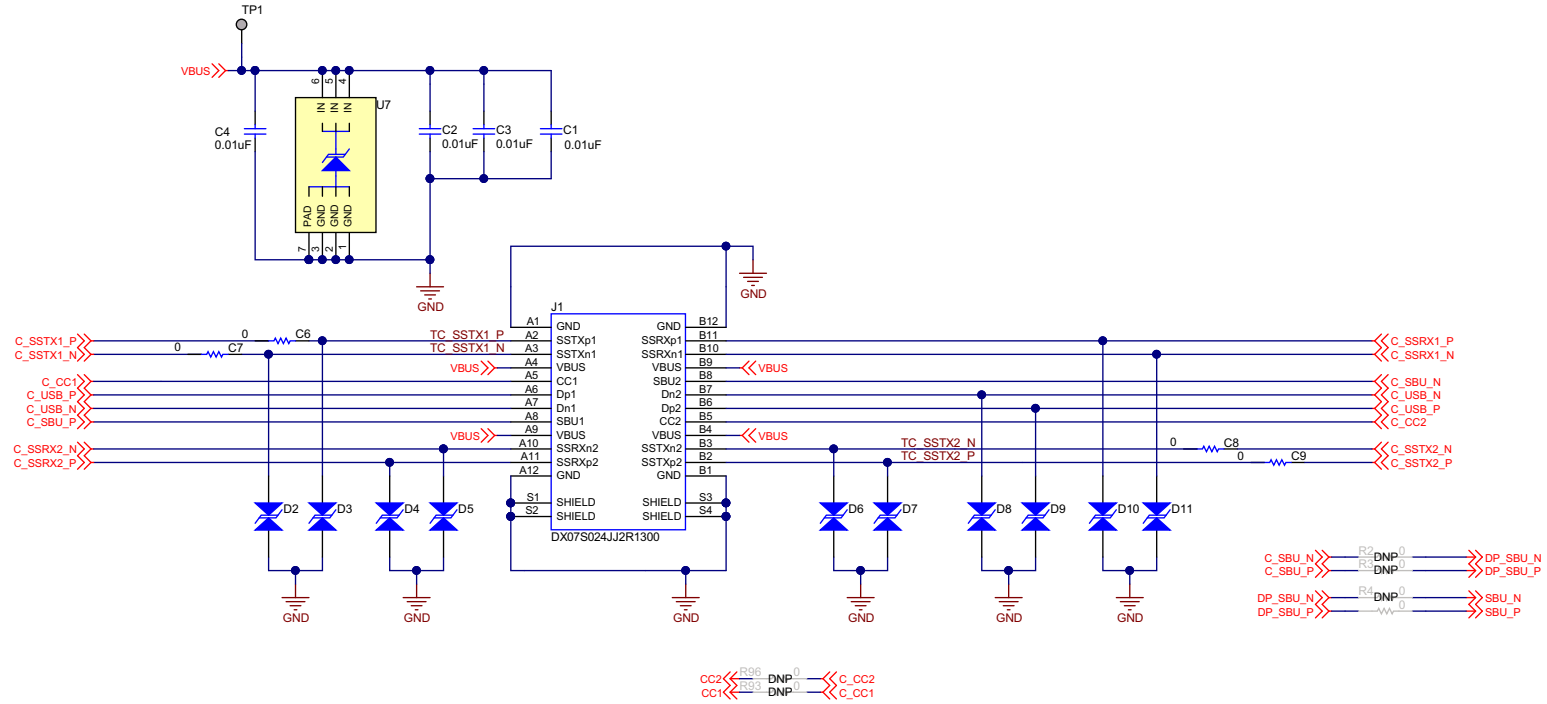


Figure 4. USB Type-C™ Connector

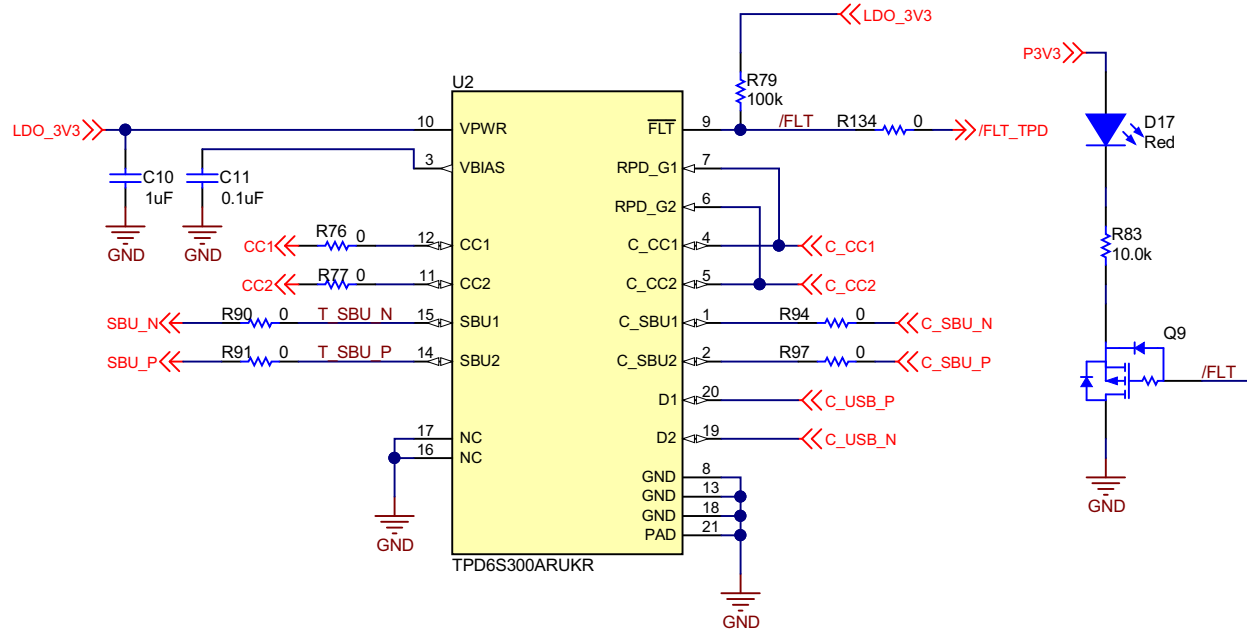


Figure 5. USB Type-C™ Protection Circuit Using TPD6S300A

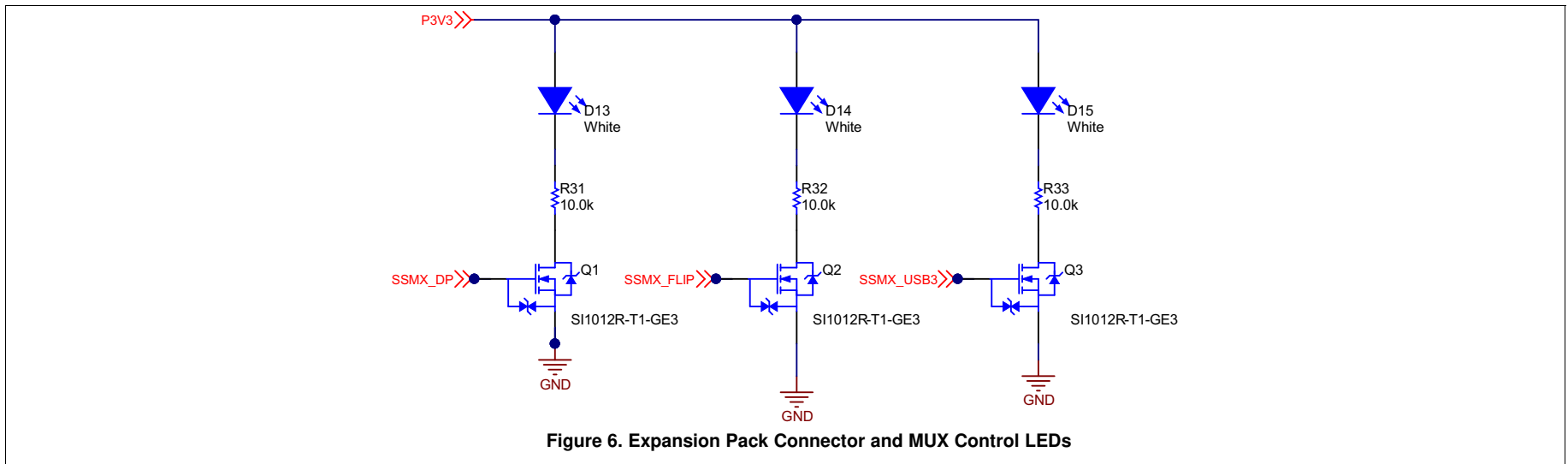


Figure 6. Expansion Pack Connector and MUX Control LEDs

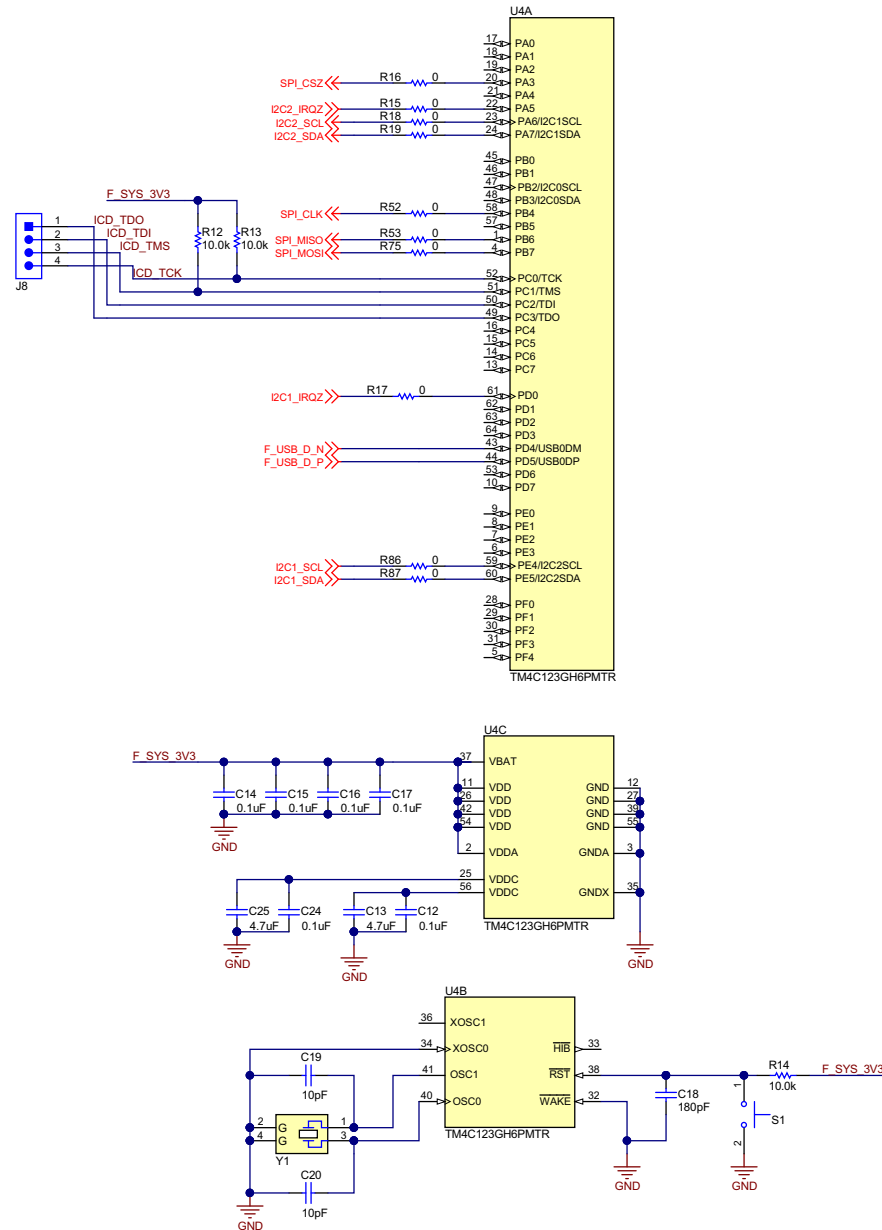


Figure 7. TIVA Device and Connector

ULINK2 Debugger

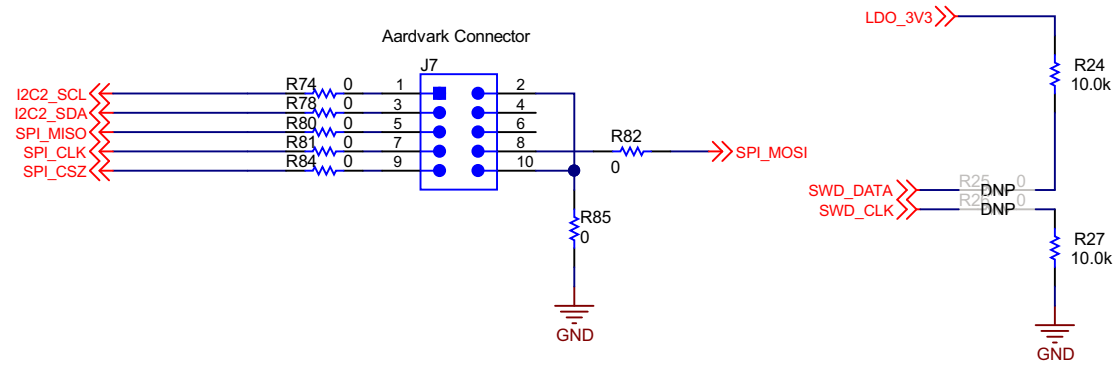


Figure 8. Aardvark Debug Connector

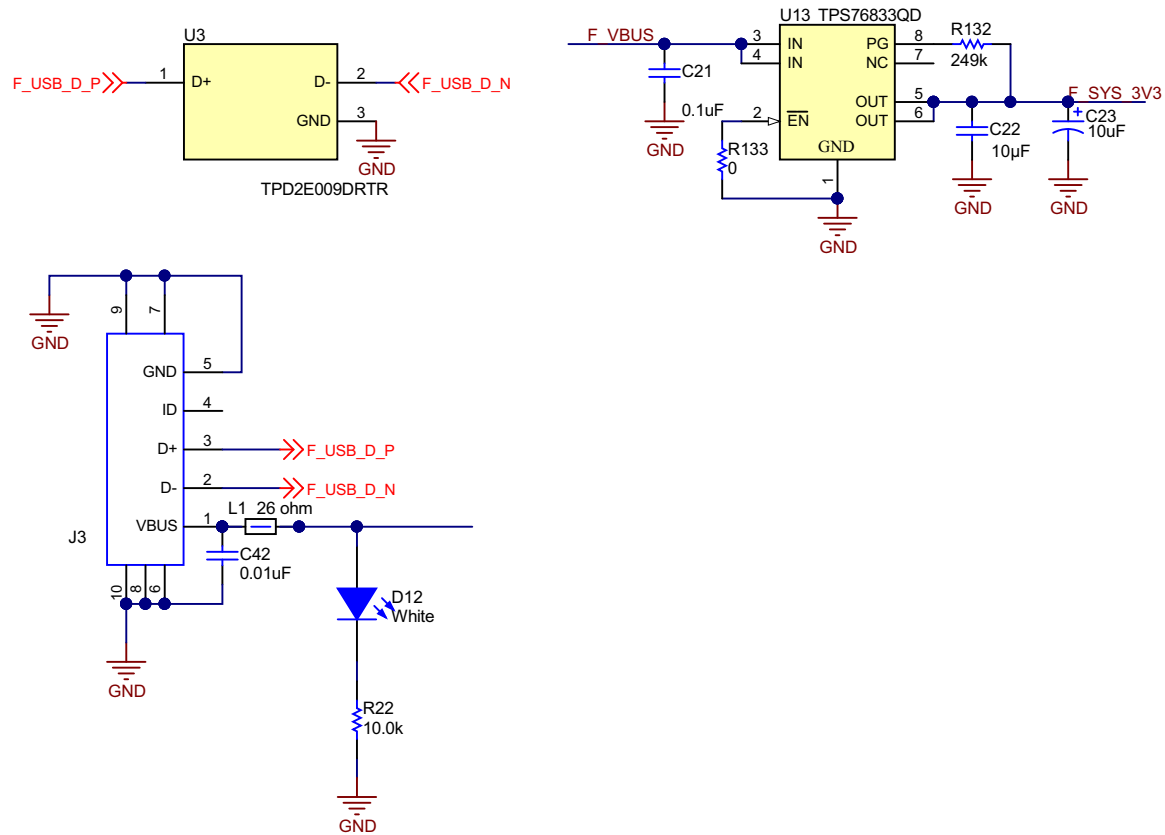


Figure 9. Mico-B Debug Connector

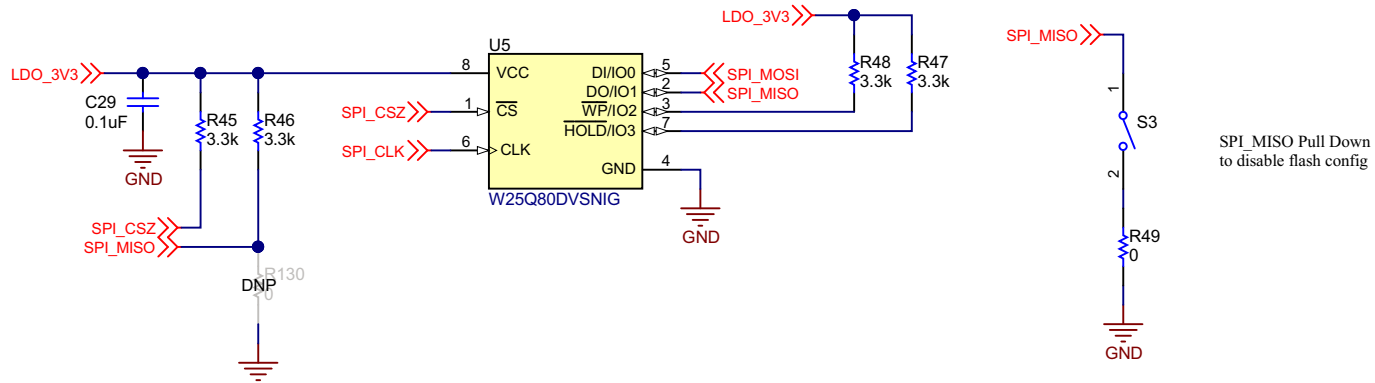
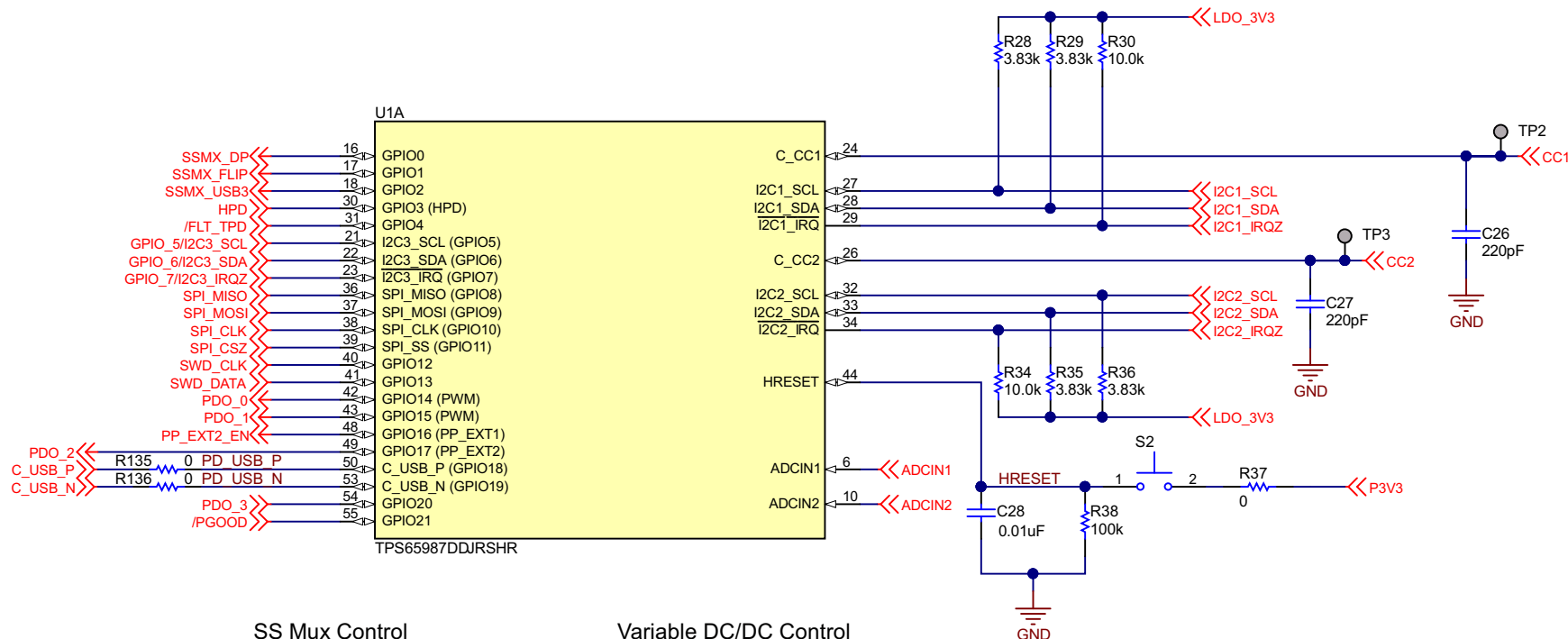


Figure 10. EEPROM Memory for PD Controller



SS Mux Control

SSMX_DP --> GPIO_0
 SSMX_FLIP --> GPIO_1
 SSMX_USB3 --> GPIO_2
 HPD --> GPIO_3

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

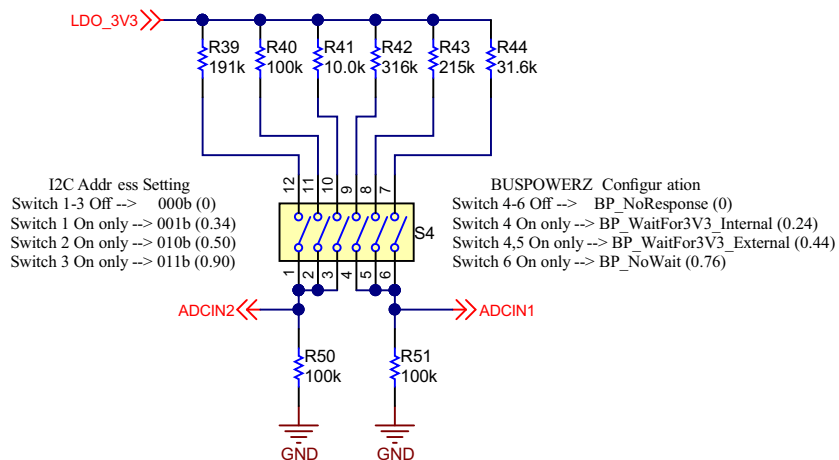


Figure 12. USB PD Controller ADCINx Resistor Divider Settings (for Boot)

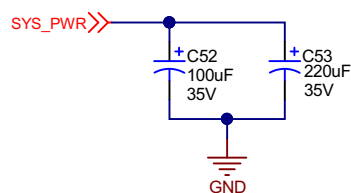


Figure 13. Barrel Jack, Variable DC/DC and SYS_PWR

SYS_PWR => Sink from VBUS
 VAR_DCDC => Source to VBUS

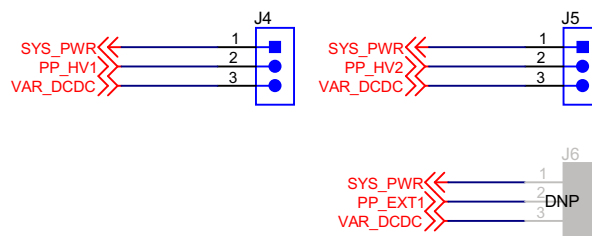


Figure 14. USB PD Power Path Jumpers

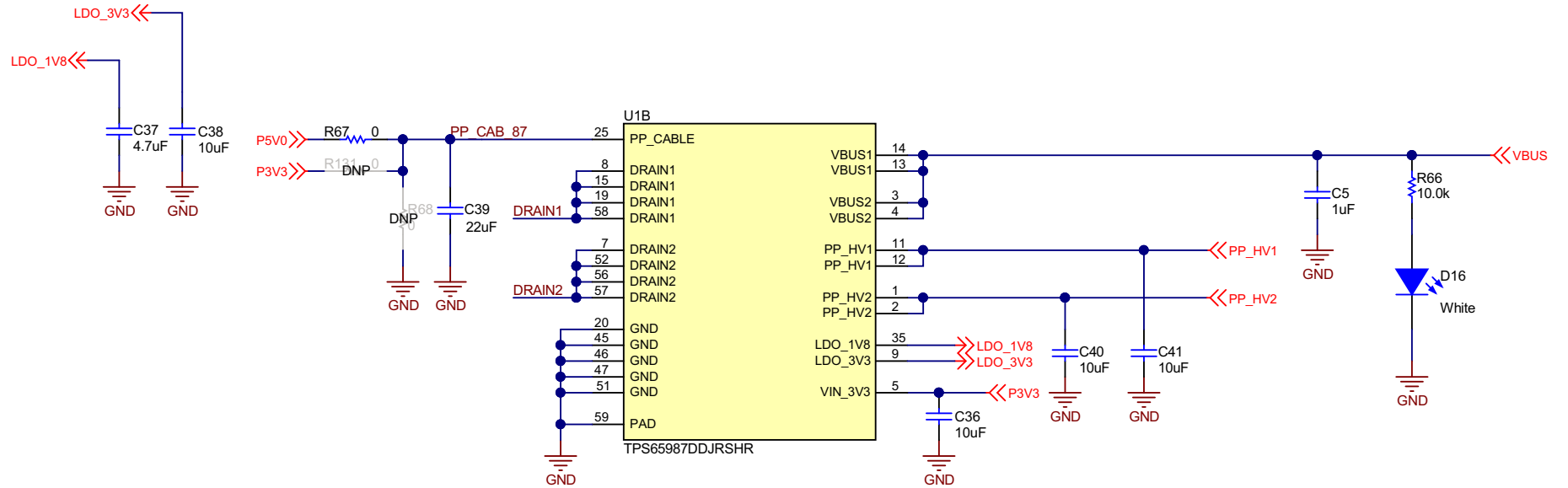


Figure 15. USB PD Power Paths

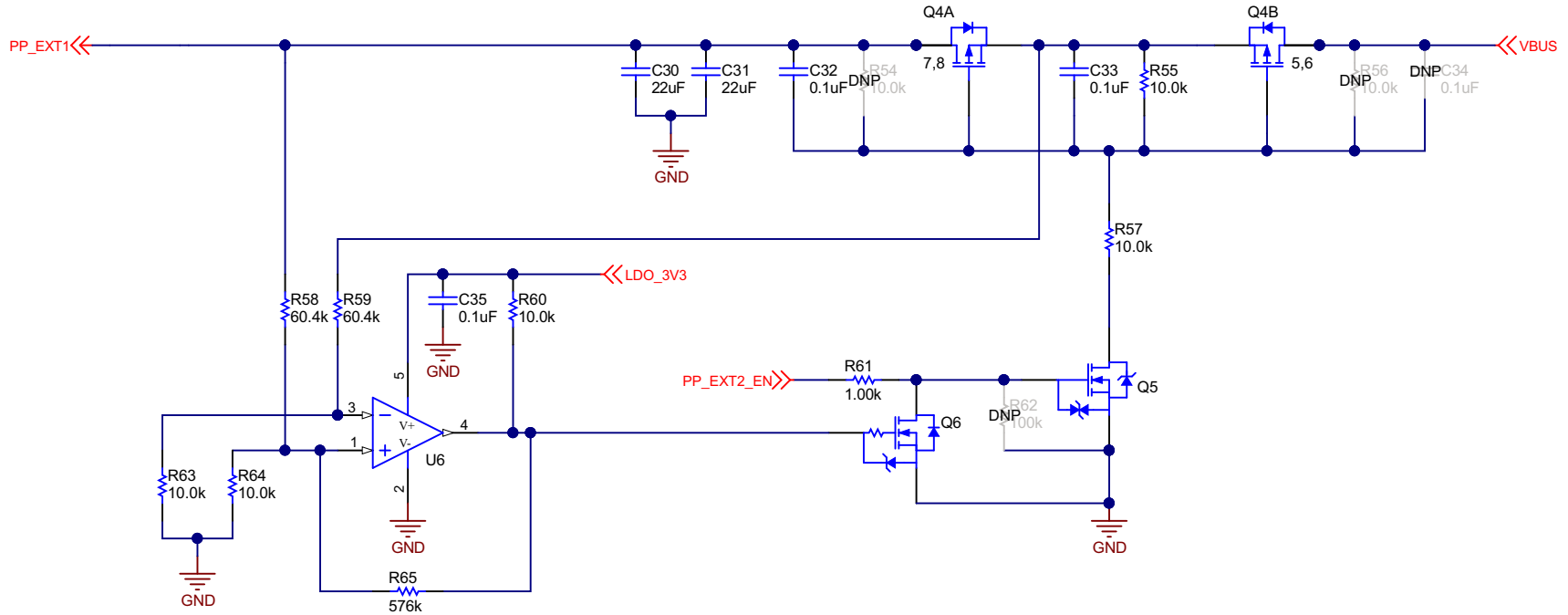


Figure 16. USB PD External (Sink) Power Path with RCP

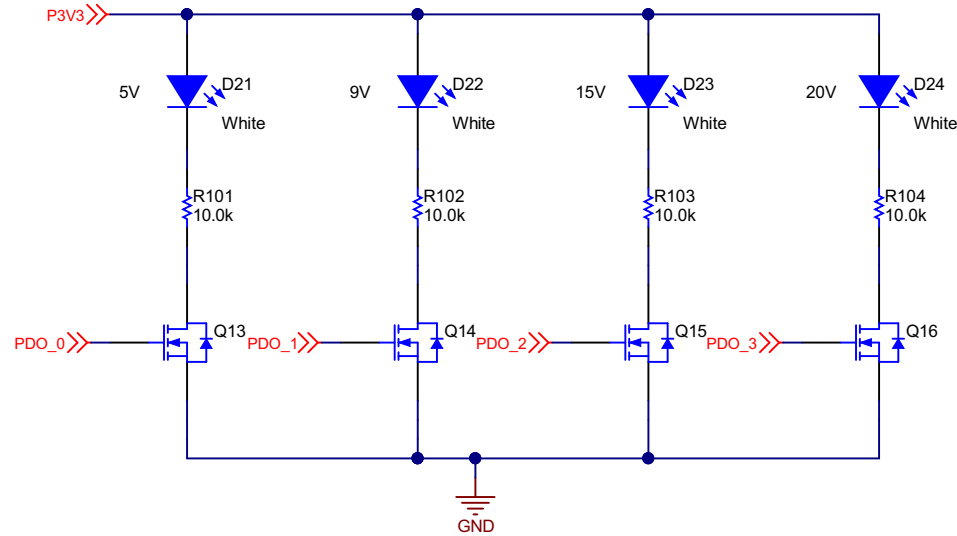


Figure 17. Variable DC/DC Control LEDs

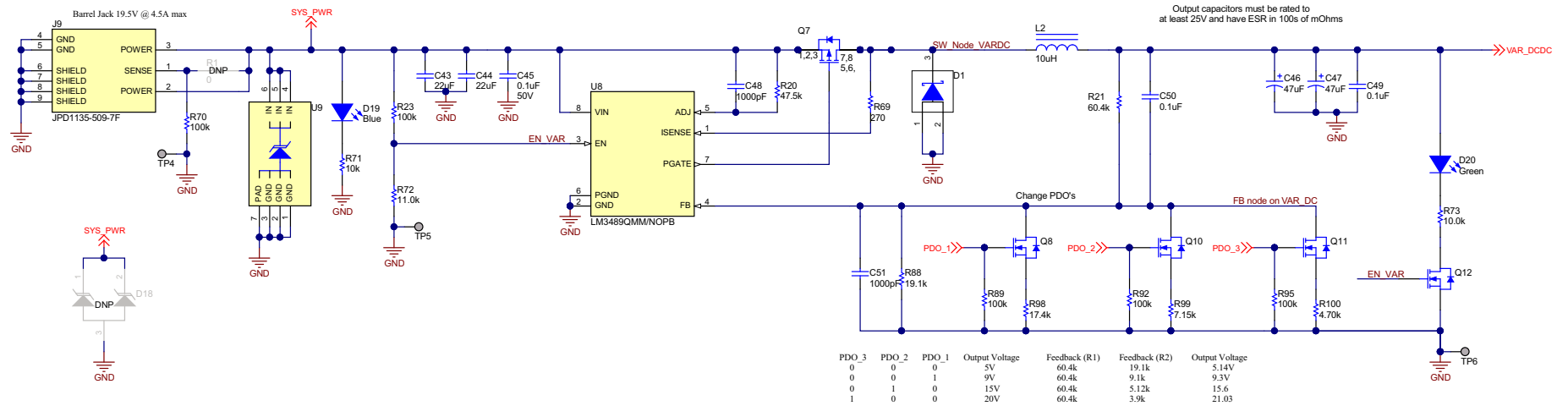


Figure 18. Variable DC/DC Controller

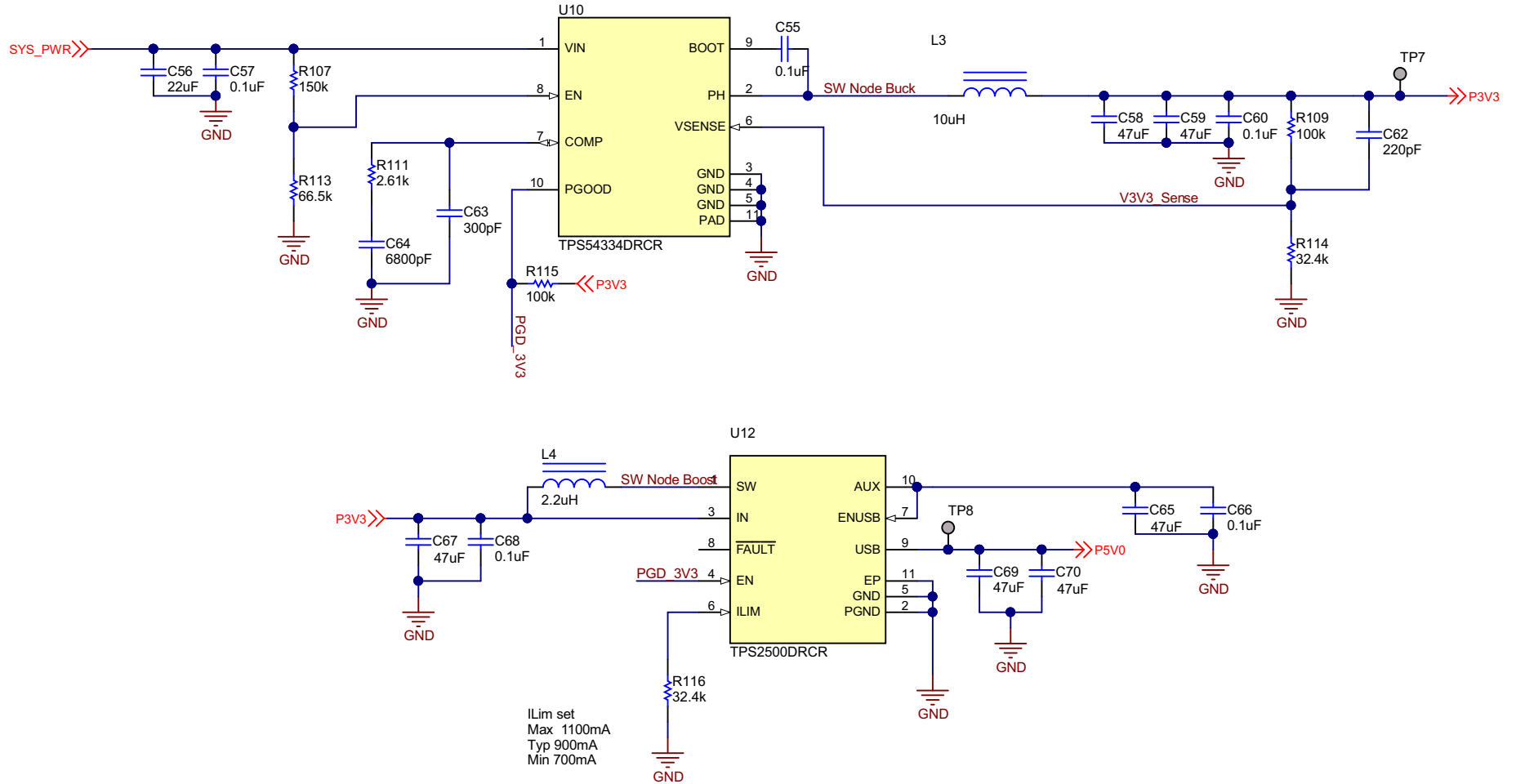


Figure 19. Buck and Boost DC/DC Converters

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 uF, 50 V, +/- 10%, C0G/NPO, 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/NPO, 0603 | 0603 | 06035A181JAT2A | AVX | | |
| C19, C20 | 2 | 10 pF | CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NPO, AEC-Q200 Grade 1, 0603 | 0603 | CGA3E2C0G1H100D080AA | TDK | | |
| C22 | 1 | 10 uF | CAP, CERM, 10 uF, 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 | Würth Elektronik | | |
| C30, C31, C43, C44, C56 | 5 | 22 uF | CAP, CERM, 22 uF, 25 V, +/- 20%, X5R, 0805 | 0805 | GRM21BR61E226ME44L | MuRata | | |
| C36, C38 | 2 | 10 uF | CAP, CERM, 10 uF, 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 uF, 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/NPO, 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/NPO, 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, GERM, 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 | Würth Elektronik | | |
| H1, H2, H3, H4 | 4 | | Machine Screw, Round, #4-40 x 1/4, Nylon, Phillips 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 uH, 7.5 A, 0.03 ohm, AEC-Q200 Grade 1, SMD | 11x10mm | SRP1038A-100M | Bourns | | |
| L3 | 1 | 10 uH | Inductor, Shielded, 10 uH, 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 | Würth 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 uF, 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 | | |

Revision History

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

| Changes from Original (October 2019) to A Revision | Page |
|--|-------------|
| • Changed <i>Sink Path</i> to <i>Source Path</i> on PPHV2 and added the trademark tag to <i>USB Type-C</i> in Figure 2 | 3 |
| • Replaced reference and link to <i>10G-DP-EXPANSION-EVM</i> with the training video link. | 3 |
| • Reversed <i>PP_HV1</i> with <i>PP_HV2</i> in the description section of Table 1 | 4 |
| • In the <i>J2</i> row of Table 2 , removed reference to <i>10G-DP-EXPANSION-EVM</i> in the description section and replaced with 'Option to connect to external module'. | 5 |
| • In the <i>D13</i> , <i>D14</i> , and <i>D15</i> rows of Table 4 , removed reference to <i>10G-DP-EXPANSION-EVM</i> | 5 |
| • Deleted reference to <i>10G-DP-EXPANSION-EVM</i> from Section 3.2 | 7 |
| • Deleted <i>DP</i> from title of Figure 6 | 9 |

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