

# EVM User's Guide: TPS26750EVM

## TPS26750 Evaluation Module



### Description

The TPS26750EVM is designed to test USB-PD for sink-only, source-only, or DRP applications, in both USB-PD SPR and EPR ranges. The TPS26750EVM can operate as a sink only with no power provided, or as a source, sink, or DRP with a power supply of 15V. The TPS26750EVM supports sourcing and sinking up to 48V at 5A, in accordance with the USB-PD specification, as well as supporting battery charging applications in conjunction with the BQ25756EVM.

### Get Started

1. Order the [TPS26750EVM](#)
2. Start development with the [Application Customization Tool](#)
3. Refer to the [data sheet](#), [Technical Reference Manual](#), or E2E™ for questions and support

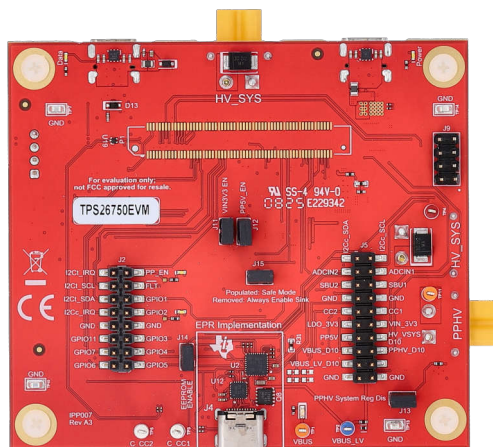
### Features

- PD controller is certified by the USB-IF for PD3.2
- Up to 240W (28V/5A) source and sink applications
  - 15W (5V/3A) Source and 240W (48V/5A) sink as standalone EVM
  - 240W (48V/5A) Source and 240W (48V/5A) sink with BQ25756EVM
- Easy-to-use GUI with pre-configured firmware to configure:

- Programmable Power Supply (PPS) for 5V-21V range
- Liquid detection and corrosion mitigation
- BC1.2 charging schemes (requires populating resistors on board)
- Integrated I2C control for BQ25756 battery charger
- Interfacing connector for BQ25756EVM
- Multiple test points and headers for quick and easy debug
  - Exposed VBUS and CCx test points to monitor PD traffic
  - VBUS, VBUS\_LV, PPHV, and VSYS test points available
  - GPIO, I2C, and power supplies available on 100mil header
  - 100 mil header pins scaled to 5V to support 5V or 10V digitizers for easier debug

### Applications

- [Battery pack for cordless power tools, power banks, retail automation and payment](#)
- [e-Bikes, wireless speakers, cordless vacuum cleaners](#)
- [Personal and portable electronics, industrial applications](#)
- [Medical applications, personal care and fitness](#)



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# 1 Evaluation Module Overview

## 1.1 Introduction

The TPS26750 is a highly integrated stand-alone USB Type-C® and Power Delivery (PD) controller optimized for applications supporting USB-C PD Power including the Extended Power Range (EPR). The TPS26750 also integrates control for the BQ25756 battery charger for added ease of use and reduced time to market. The intuitive web based GUI asks the user a few simple questions on the application needs using clear block diagrams and simple multiple-choice questions. The GUI creates the configuration image for the user's application, reducing much of the complexity associated with competitive USB-PD designs.

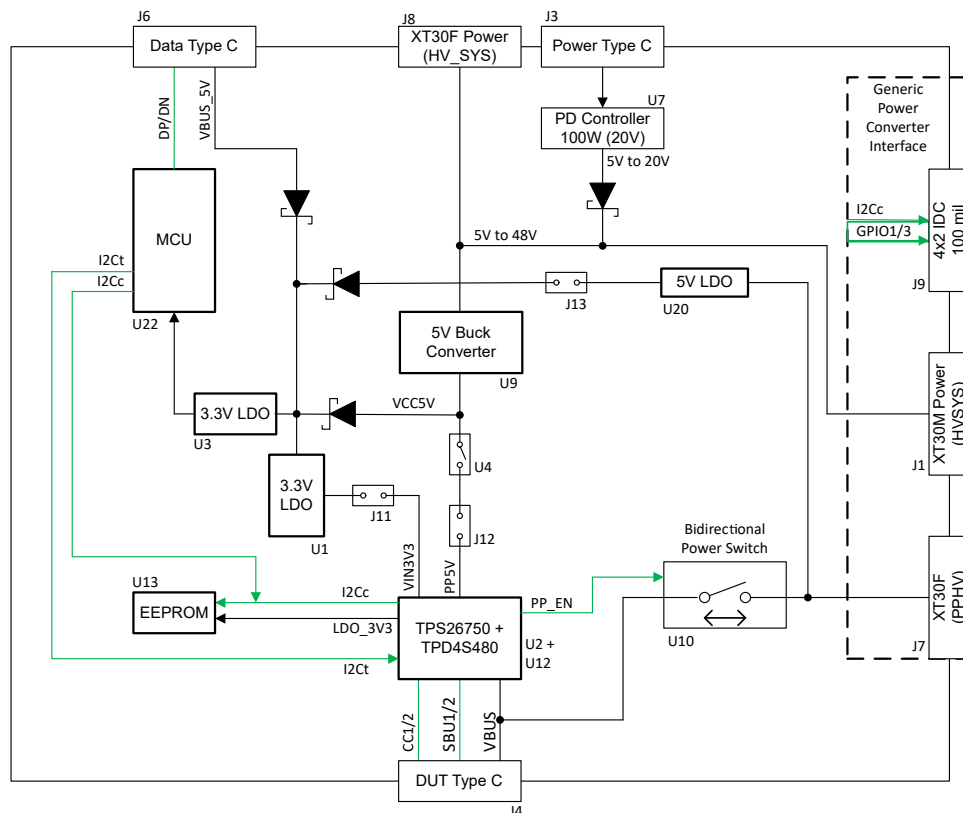
This document is the user's guide for the TPS26750 Evaluation Module (TPS26750EVM) Revision A3. This user's guide provides the schematic, bill of materials, and board layout of the EVM. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the TPS26750EVM.

## 1.2 Kit Contents

- TPS26750 EVM
- 4x2 IDC Ribbon Cable
- TPS26750EVM to BQ25756EVM Connector (Interposer) Board
- EVM Disclaimer Read Me

## 1.3 Specification

The functional block diagram of the TPS26750EVM is shown in [Figure 1-1](#). The TPS26750EVM can be used as a standalone evaluation module to test sourcing 5V and sinking from 5V to 48V. Alternatively, the EVM can be used in conjunction with the BQ25756EVM to source and sink from 5V to 48V. The TPS26750EVM can test both USB-PD SPR (Standard Power Range) and USB-PD EPR power ranges, and can be configured using the Application Customization tool as a source only device, a sink only device, or a Dual Role Power (DRP) device.



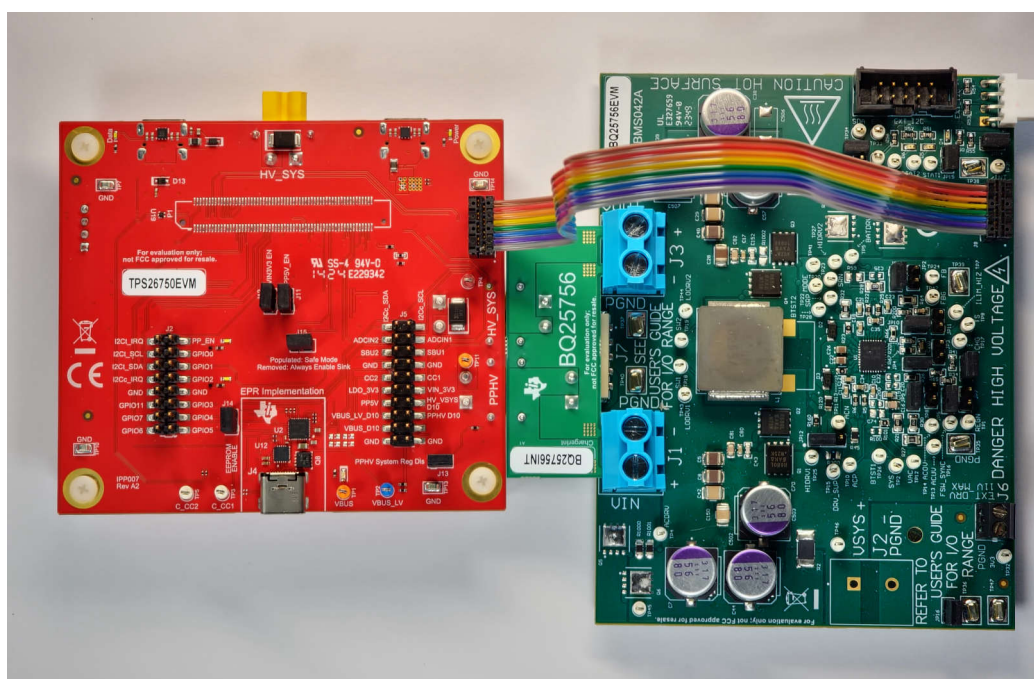
### Note

Jumpers J11, J12, and J13 control the ENABLE signal of their respective LDO or switch, and are not connected to the output of their respective LDO or switch. The jumpers are shown in the block diagram at the outputs of their respective LDO or switch to simplify and clarify the overall behavior of the device when the jumper is removed.

**Figure 1-1. TPS26750EVM Block Diagram**

The TPS26750EVM can be used in conjunction with the BQ25756 with minimal setup to test battery charging by utilizing, as shown in [Figure 1-2](#):

- TPS26750 and BQ25756 I2C capability
- The ability of the Application Customization GUI to configure the TPS26750 to work with the BQ25756 by selecting only a few parameters from a questionnaire
- The provided 4x2 IDC cable
- The BQ25756 connector board



**Figure 1-2. TPS26750EVM and BQ25756EVM Hardware Setup**

### Note

This figure depicts a previous version of the TPS26750 EVM (RevA2), but the information remains accurate and applicable to the current version.

## 1.4 Device Information

The TPS26750 is a single-port, USB Type-C PD controller with an integrated 5V source power path and the ability to control an EPR capable external power path for power-only applications. The TPS26750 PD controller is an excellent choice for single port power applications operating in the USB-PD EPR for Dual Role Power (DRP) applications up to 240W (48V/5A).

The TPS26750 PD controller is configurable through the Web-based GUI for application specific requirements, architectures, power roles, and data roles. The GUI tool provides additional optional firmware configuration to integrate control for the BQ25756 Battery Charger IC. For more information on BQ25756 configuration, refer to [Section 4.1](#).

**Table 1-1. Devices on TPS26750EVM**

Designator	Device Name	Description
U2	TPS26750RSMR	USB Type-C and USB PD controller with integrated source power switch
U1, U3	TLV75733PDRVR	1A Low-Quiescent-Current Low-Dropout (LDO) Regulator
U4	TPS259814ARPWR	2.7 - 16V, 10A, 7mΩ eFuse with transient overcurrent blanking timer
U6	LM2765M6X/NOPB	Switched capacitor voltage converter
U7	TPS25750DRJK	USB Type-C and USB PD controller with integrated power switches optimized for power applications
U8	TVS2200DRVR	22V precision surge protection clamp
U9	LM76005RNPR	0.5V to 60V 5A synchronous step-down voltage regulator
U10	LTC7004IMSE#TRPBF	Fast high side N-channel MOSFET gate driver
U12	TPD4S480RUKR	USB Type-C 48V EPR port protector: short-to-VBUS Overvoltage and IEC ESD protection
U13	CAT24C512WI-GT3	I2C supported EEPROM Serial 512-Kb
U14	TUSB2036VFR	2 / 3-Port Hub for USB with Optional Serial EEPROM Interface
U15	TPD2EUSB30DRTR	ESD design for super-speed (6Gbps) USB 3.0 interface
U17	TVS0500DRVR	5V precision surge protection clamp
U18, U19	TPD2EUSB30DRTR	Dual 0.7pF, 5.5V ±8kV ESD protection diode with 5A surge rating for USB 3.0
U20	TPS7A1650DRBR	100mA, 60V, ultra-low-IQ, low-dropout (LDO) voltage regulator with power good and enable
U22	TM4C123GH6PMTR	32-bit Arm Cortex-M4F based MCU with 80 -MHz, 256 -KB Flash, 32 -KB RAM, 2 CAN, RTC, USB, 64-pin

**Table 1-2. Connector and Interface Descriptions**

Designator	Connector or Interface	Purpose
J6	Data Type C	Interface to GUI for configuration and USB to I2C
J3	Power Type C	Provide a 20V/5A board power interface from a Type-C power source
J8	XT30F (Power)	5V to 48V Power Input for EVM and boards attached to generic power converter. XT30 to banana jack cables are readily available to attach battery models or power sources
J1, J7, and J9	Generic Power Converter	Collection of three connectors that allow connection to external EVMs with minimal parasitics
J4	DUT Type C	USB-C connector to test configuration and functionality of the TPS26750 and TPD4S480
TP[Number]	Probe Points	Support connection of lab equipment to EVM

## 2 Hardware

### 2.1 Power Requirements

For standalone PD evaluation, the main power supply for the TPS26750EVM is through either the Type-C sink-only *Power* port (J3), which accepts up to 100W Type-C PD source (5V to 20V) or the XT30 connector on the top of the board (J8). The EVM can be powered on from an external bench supply connected to HV\_SYS (J1), with the bench supply providing power in the 5V-48V range. Connector J1 supports up to 48V at 10A.

Additionally, the TPS26750EVM can be powered directly through the DUT (Device Under Test) Type-C connector (J4) to simulate powering the TPS26750 in a dead battery scenario. When the TPS26750EVM is powered only through port J4, the EVM acts as a sink only.

For battery charging applications, the BQ25756EVM can be used to power on the TPS26750EVM. The TPS26750EVM comes with an interfacing board (TPS26750EVM to BQ25756EVM connector board) to connect to the J1 and J7 connector on the TPS26750EVM. If the BQ25756EVM is connected, then the VAC net of the BQ25756EVM is connected to the high-voltage bidirectional power path (PPHV) of the TPS26750EVM. For more information on setting up and programming TPS26750 for battery charger application, refer to [Section 4.1](#).

### 2.2 Setup

Out of the box, the TPS26750EVM is configured for 15W (5V/3A) sourcing and 240W (48V/5A) sinking, utilized through the DUT Type C connector (J4). If a different configuration is required, then utilize the Application Customization Tool to create and/or load a different configuration. For detailed instructions on how to use the Application Customization Tool (also used interchangeably with the term *GUI* throughout this document), refer to [Section 3](#).

## 2.2.1 Flashing Firmware Configuration to the TPS26750EVM

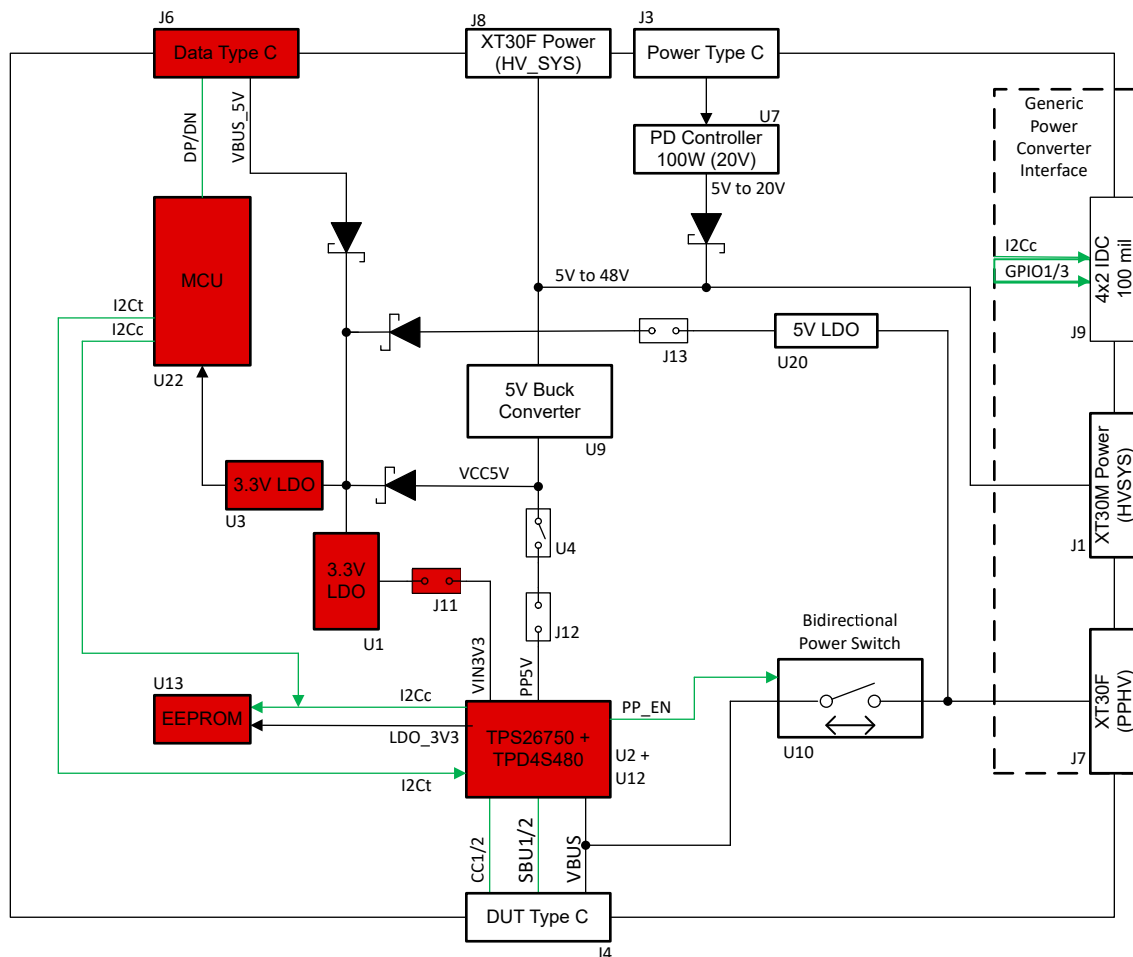


Figure 2-1. EVM Flashing Block Diagram

### Note

The red highlighting shows *active* or powered portions of the EVM for the specific setup in [Figure 2-1](#) and subsequent block diagrams.

Required hardware setup:

1. Ensure jumper J11 is connected.
2. Connect USB-C end of USB-C to USB-C cable or USB-A to USB-C cable to Data Type C port (J6).
3. Connect other end of cable to computer.

When flashing a new configuration to the TPS26750EVM, the binary configuration file is written to U13, the EEPROM. More details are provided in [Section 3.4.6.3](#).



The diagram illustrates a power management system for a DUT Type C. Key components and their interconnections include:

- MCU (U22):** Connected to Data Type C (J6) via DP/DN and VBUS\_5V. It interfaces with EEPROM (U13) via I2Ct and I2Cc. It also connects to a 3.3V LDO (U3) and a 5V Buck Converter (U9).
- Power Sources:** XT30F Power (HV\_SYS) (J8) and Power Type C (J3) provide input power. The XT30F Power is connected to a 5V Buck Converter (U9) and a 5V LDO (U20).
- Regulation and Conversion:** A PD Controller 100W (20V) (U7) converts 5V to 20V. A 5V LDO (U20) provides a regulated 5V output. A 3.3V LDO (U3) provides a regulated 3.3V output. A 5V Buck Converter (U9) converts 5V to 48V.
- Control and Monitoring:** A TPS26750 + TPD4S480 (U2 + U12) manages the power switch. It receives VBUS\_5V, SBU1/2, and CC1/2 signals. It outputs PP5V and PP\_EN signals. It also interfaces with the MCU (U22) via I2Ct and I2Cc.
- Power Switching:** A Bidirectional Power Switch (U10) is controlled by PP\_EN and PP5V. It connects the DUT Type C (J4) to the power sources.
- Connectors and Interfaces:** Data Type C (J6), XT30F Power (HV\_SYS) (J8), Power Type C (J3), and DUT Type C (J4) are external connectors. A Generic Power Converter Interface (J9) is shown with a 4x2 IDC 100 mil connector. A 4x2 IDC 100 mil connector (J1) is also shown.

1. 5V sourcing (DFP)
2. 5 - 48V sinking, both SPR and EPR capable (UFP)
3. 5V sourcing, 5V to 48V sinking (DRP)

The example setup in [Figure 2-3](#) shows a *140W 3 Port PD3.1 Supported Wall Adapter*, whose USB-C2 port is capable of providing 100W (20V at 5A) of power, connected to a *USB-C to USB-C 100W capable cable*, which is in turn connected to the Power Type C port (J3) of the TPS26750EVM. This example setup is capable of



sourcing 5V of power to the DUT Type C port (J4) and sinking from 5V to 48V of power (both SPR and EPR capable) to the DUT Type C port (J4).

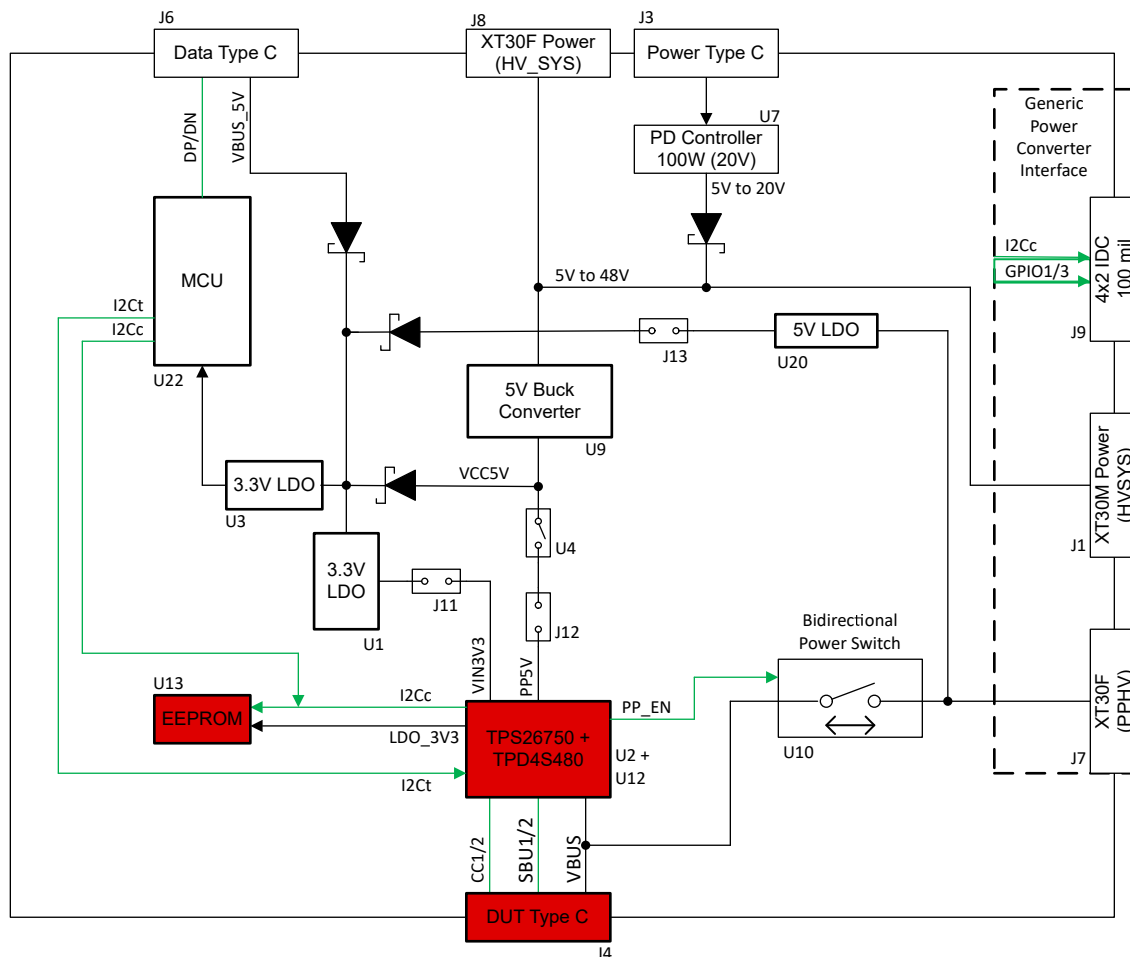


**Figure 2-3. Stand Alone Testing Example Hardware Setup**

### Note

This figure depicts a previous version of the TPS26750 EVM (RevA2), but the information remains accurate and applicable to the current version.

### 2.2.3 Dead Battery Safe Mode

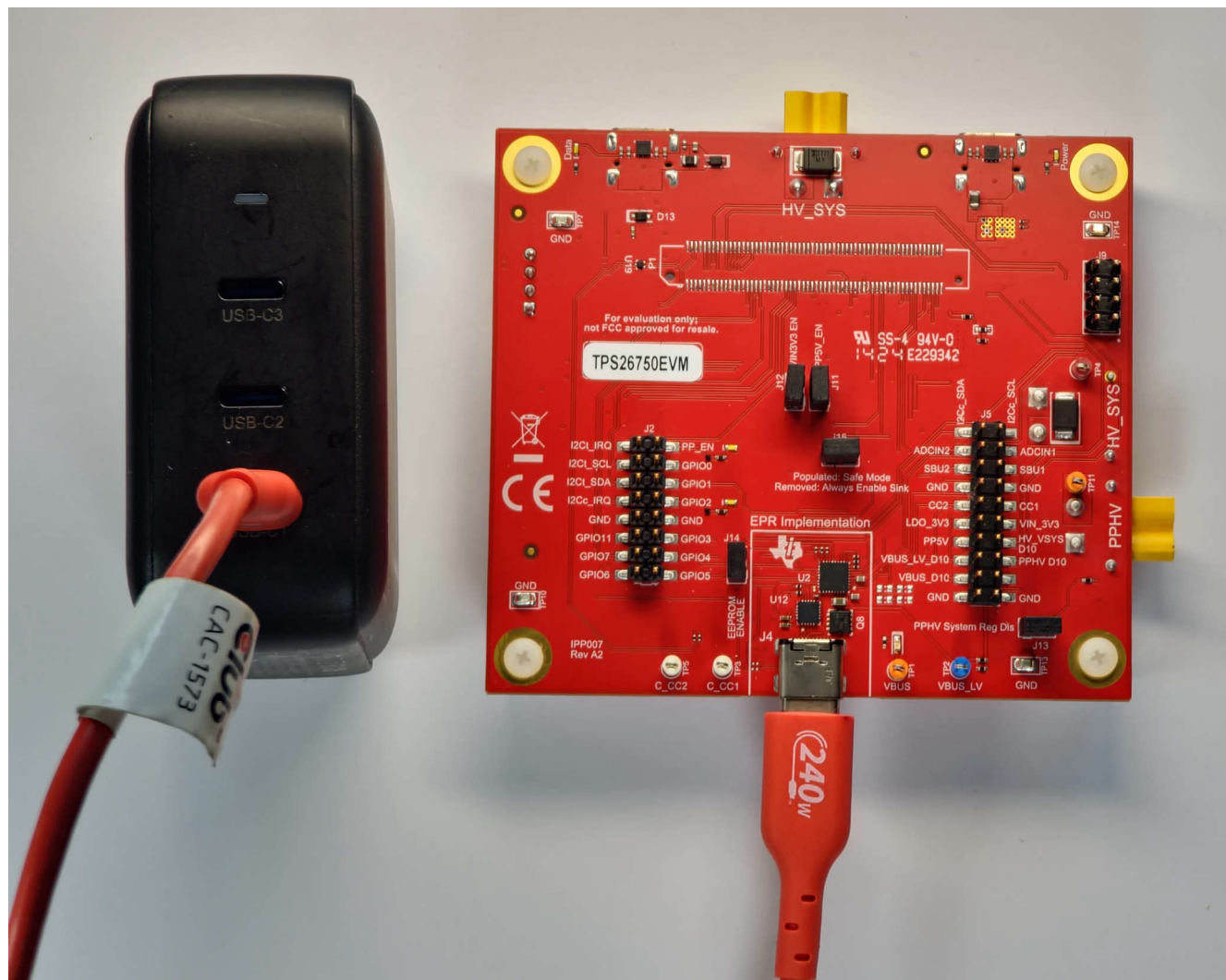


**Figure 2-4. Dead Battery Safe Mode**

The portions of the EVM highlighted in red, are powered upon TPS26750 boot up when testing the device in Dead Battery Safe Mode, as shown in [Figure 2-4](#). This mode occurs when the VIN\_3V3 pin of the TPS26750 is unpowered and a USB-PD capable source is connected to the DUT Type C (J4) connector, when jumper J15 is populated. During Dead Battery Safe Mode, the Bidirectional Power Switch (U10) remains open during the period of time that the TPS26750 boots and loads the configuration. In this mode, the TPS26750 can only operate as a sink and can sink between 5V and 48V (both SPR and EPR capable). After the configuration is loaded and the device is finished booting, the Bidirectional Power Switch closes (or remains open) based upon the configuration loaded and the capabilities of the attached source.

To successfully test the USB-PD Extended Power Range (EPR) with the TPS26750EVM and successfully negotiate an EPR contract (a USB-PD contract with a voltage greater than 20V), a [USB-IF compliant 240W](#) rated USB-C to USB-C cable must be used.

The example setup in [Figure 2-5](#) shows a *140W 3 Port PD3.1 Supported Wall Adapter*, whose USB-C1 port is capable of providing 140W (28V at 5A) of power, connected to a *USB-C to USB-C 240W capable cable*, which is in turn connected to the Power Type C port (J3) of the TPS26750EVM. This example setup is capable of sinking 28V of power (as the wall adapter can provide at maximum 28V; the TPS26750EVM is not limited to 28V) to the DUT Type C port (J4), which is in the USB-PD Extended Power Range.

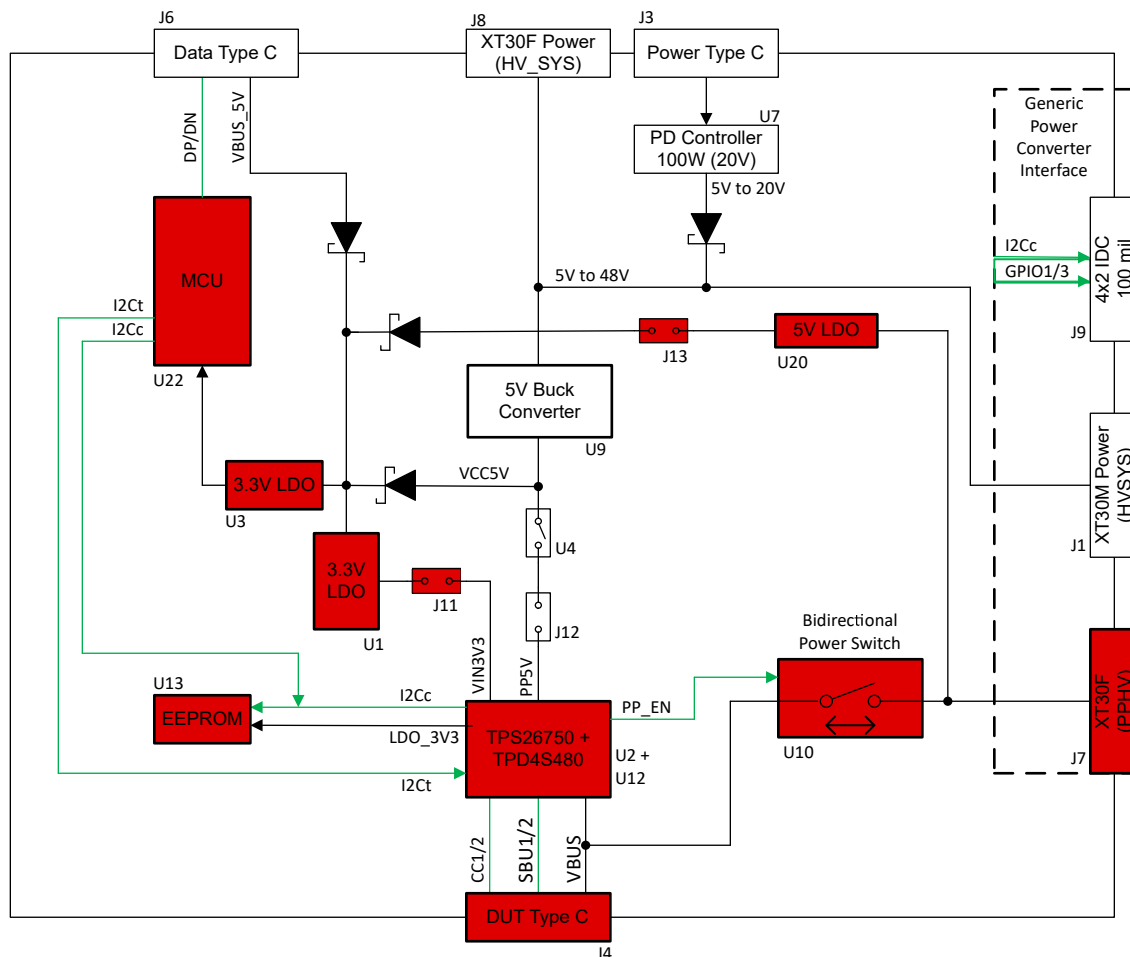


**Figure 2-5. Dead Battery Safe Mode Example Hardware Setup**

### Note

This figure depicts a previous version of the TPS26750 EVM (RevA2), but the information remains accurate and applicable to the current version.

### 2.2.4 Dead Battery Always Enable Sink



**Figure 2-6. Dead Battery Always Enable Sink Block Diagram**

The portions of the EVM highlighted in red are powered up on TPS26750 boot up when testing the device in Dead Battery Always Enable Sink Mode, and are shown in Figure 2-6. This mode occurs when the VIN\_3V3 pin of the TPS26750 is unpowered (before a USB-C connection is made) and a USB-PD capable source is connected to the DUT Type C (J4) connector, when Jumper J15 is not populated. During Dead Battery Always Enable Sink Mode, the Bidirectional Power Switch (U20) is closed during the period of time that the TPS26750 boots and loads the configuration. In this mode, the TPS26750 can only operate as a sink and can sink between 5V and 48V (both SPR and EPR capable). After the configuration is loaded and the device is finished booting, the Bidirectional Power Switch remains closed (or open) based upon the configuration loaded and the capabilities of the attached source.

The example setup is identical to the setup in Figure 2-5, except that J15 is not populated. This example setup is capable of sinking 28W of power to the DUT Type C port (J4), which is in the USB-PD Extended Power Range.

## 2.2.5 TPS26750 and BQ25756

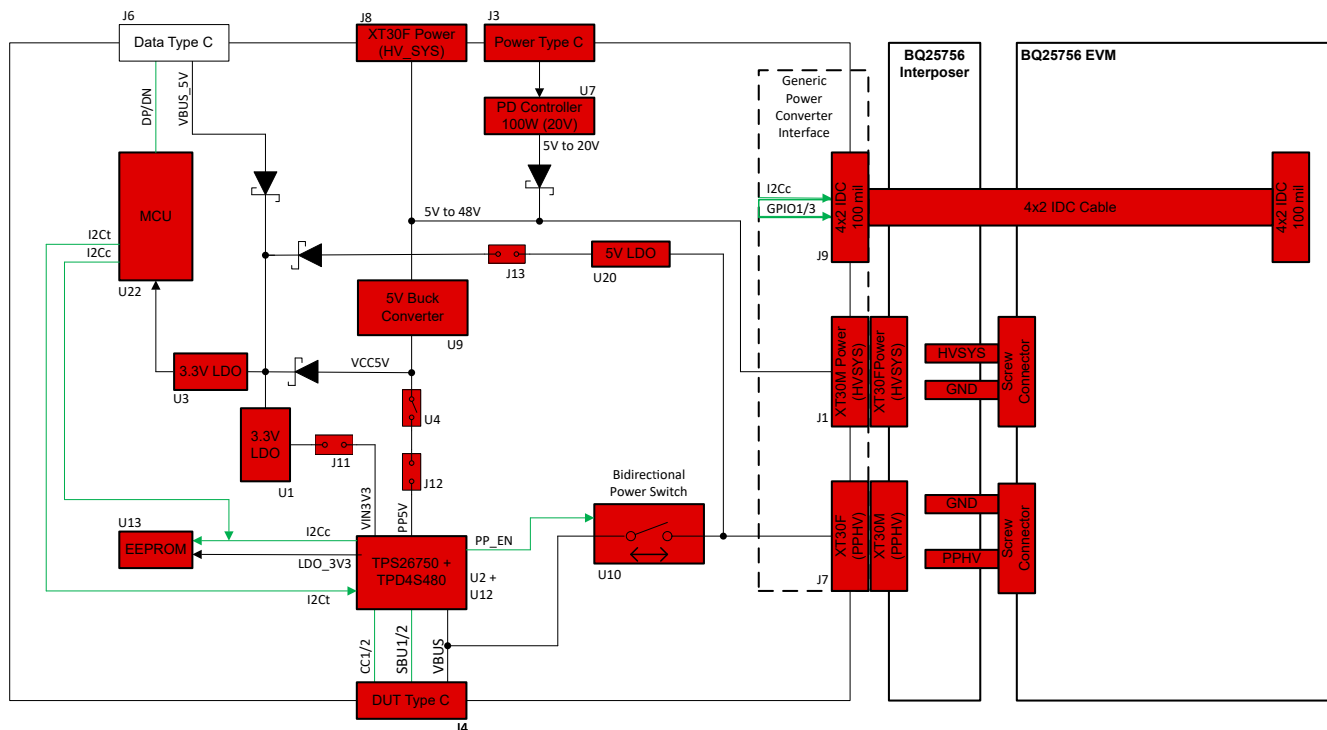


Figure 2-7. TPS26750 and BQ25756 Block Diagram

If users want to support 5V sourcing, then the power supply needs to provide at least 18W of power, due to the following board requirements:

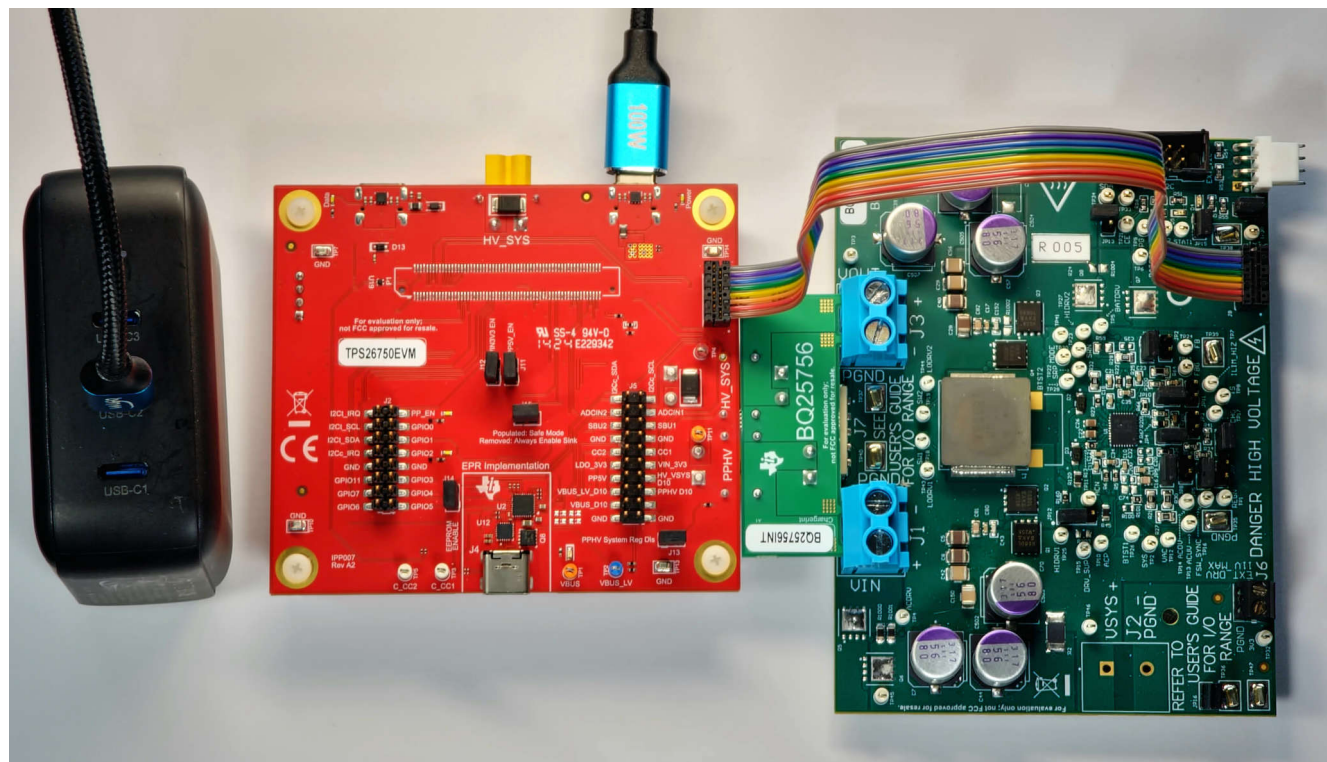
1. 5V 3A for PP5V Power Path
2. 120mA for VCONN
3. 100mA for Board MCU (U22)

If users want to support EPR sourcing (from 5V to 48V), then the power supply needs to provide at least 15V to the HV\_SYS net (using either J3, J8. A battery can be connected to J8 for testing as well). However, the exact amount of power users need to provide depends on the expected load drawn by the sink and the highest voltage EPR contract users want to source.

The example setup in [Figure 2-8](#) shows a *140W 3 Port PD3.1 Supported Wall Adapter*, whose USB-C2 port is capable of providing 100W (20V at 5A) of power, connected to a *USB-C to USB-C 100W capable cable*, which is in turn connected to the Power Type C port (J3) of the TPS26750EVM. This example setup is capable of sourcing 48V of power to the DUT Type C port (J4), which is in the USB-PD Extended Power Range.

To source and sink power in the EPR range using the TPS26750EVM, users want connect a simulated battery to the HV\_SYS header (J8) instead of powering the board through J3.





**Figure 2-8. TPS26750EVM and BQ25756EVM Example Hardware Setup**

### Note

This figure depicts a previous version of the TPS26750 EVM (RevA2), but the information remains accurate and applicable to the current version.

## 2.3 Header Information

The J2 and J5 headers are setup for ease of use with 5V and 10V level logic analyzers. The most pertinent signals and power rails for testing the TPS26750 are pulled out to these headers. If utilizing the Liquid Detection feature, note that pins SBU1 and SBU2 on Header J5 are not the SBU signals directly at the DUT Type-C connector (J4), but are instead the SBU signals from the Liquid Detection circuit to the SBUX pins of the TPD4S480, as shown in [Figure 5-2](#).

**Table 2-1. J2 Header**

Pin	Name
1	GPIO5
2	GPIO6
3	GPIO4
4	GPIO7
5	GPIO3
6	GPIO11
7	GND
8	GND
9	EPR_EN (GPIO2)
10	I2Cc_IRQ
11	GPIO1
12	I2Ct_SDA
13	FLT (GPIO0)

**Table 2-1. J2 Header (continued)**

Pin	Name
14	I2Ct_SCL
15	PP_EN (Buffered POWER_PATH_EN output)
16	I2Ct_IRQ

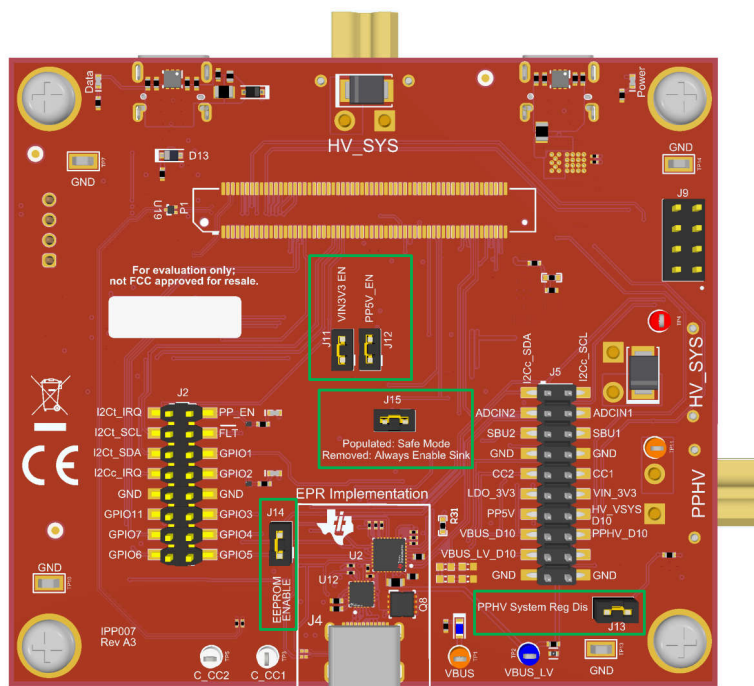
**Table 2-2. J5 Header**

Pin	Description
1	I2Cc_SDA
2	I2Cc_SCL
3	ADCIN2
4	ADCIN1
5	SBU2
6	SBU1
7	GND
8	GND
9	CC2
10	CC1
11	LDO_3V3
12	VIN_3V3
13	PP5V
14	HV_SYS_D10 (HV_SYS divided by 10)
15	VBUS_D10 (VBUS divided by 10)
16	PPHV__D10 (PPHV divided by 10)
17	VBUS_LV_D10 (VBUS_LV divide by 10)
18	No Connect
19	GND
20	GND

**Note**

The label \_D10 indicates the signal is divided by 10. For example, when VBUS is at 48V, VBUS\_D10 measures approximately 4.8V.





Jumper	Name	Behavior	
J11	VIN_3V3 EN	Populated	The 3.3V LDO (U1) is enabled, providing 3.3V to the VIN_3V3 pin of the TPS26750
		Removed	The 3.3V LDO (U1) is disabled, providing 0V to the VIN_3V3 pin of the TPS26750
J12	PP5V_EN	Populated	Switch U4 is enabled, connecting the 5V buck converter (U9) to the PP5V pin of the TPS26750
		Removed	Switch U4 is disabled, disconnecting the 5V buck converter (U9) from the PP5V pin of the TPS26750
J13	PPHV System Reg Dis	Populated	5V LDO (U20) is enabled
		Removed	5V LDO (U20) is disabled
J14	EEPROM ENABLE	Populated	EEPROM is connected to TPS26750 and System MCU (U22)
		Removed	EEPROM is disconnected from TPS26750 and System MCU (U22)
J15	Dead battery configuration	Populated	Safe mode enabled
		Removed	Always enable sink enabled

Instance Name	Type	Function
S2	Momentary push button	Used to put the System MCU into programming mode. Not intended for User functionality and can result in MCU not functioning if used

### CAUTION

Use of S2 can result in the MCU not functioning, thus preventing the loading of configurations to the TPS26750EVM. Do not use.

## 2.6 Interfaces

### Type-C Data Connection

J6 is a USB Type-C port that is configured as a 5V/3A legacy sink that provides a full speed USB connection to the EVM. J6 is used to interface with the GUI for part configuration and debug. For instructions on how to use the GUI, see [Section 3.3](#).

### Generic Power Converter Interface

This set of three connectors is intended to allow various power converter boards to interface with the TPS26750EVM.

The three connectors are listed below

1. J7 XT30 connector: Power Path (PPHV) connector (power pin and ground)
2. J1: XT30 system power (HV\_SYS) (power pin and ground)
3. J9: 4x2 100 mil 90 degree IDC connector

The connectors are placed at a 600mil pitch between pin 1 of each connector. The generic power converter interface is on the right side of the board, as shown in [Figure 1-1](#). The connectors for J9 are placed from bottom to top as follows (see schematic [Figure 5-9, DC2DC Interface](#), for pinout):

**Table 2-5. IDC Connector Pinout**

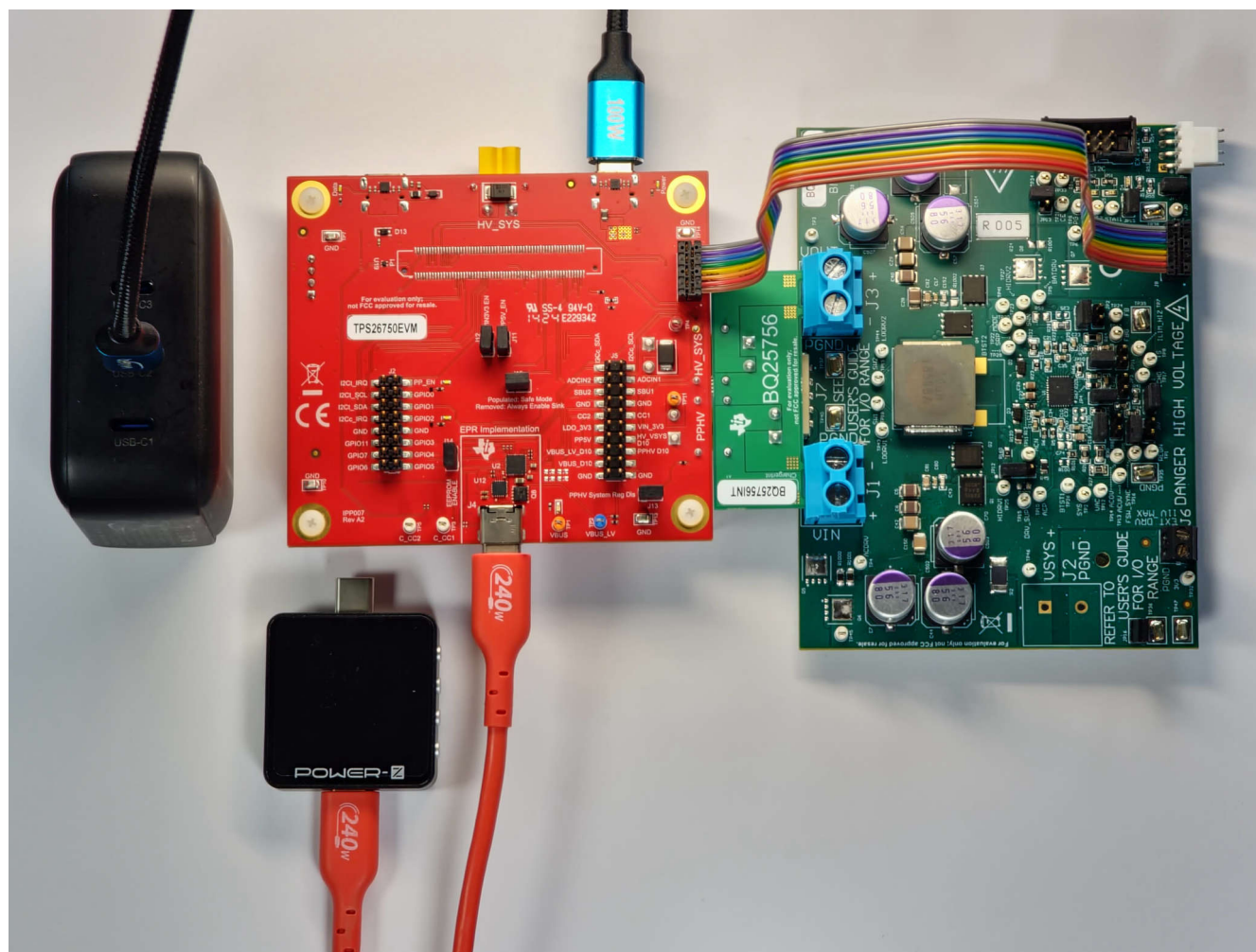
Pin Number	Signal
1 (denoted by a white dot to the lower right of the pin)	PP5V
2	GND
3	GND
4	I2Cc_SCL
5	GPIO1
6	I2Cc_SDA
7	GPIO3
8	LDO_3V3

## 2.7 Debug Information

One of the most valuable tools users can utilize when debugging USB-PD capable systems for a faster time-to-market is a USB-PD protocol analyzer. The USB-PD specification details how information is sent on the Configuration Channel (CC) lines between port partners, and the above mentioned analyzers can decode this traffic into an easily navigable log of events. These tools also show the voltage on the CC pins of the DUT for reviewing the Type-C implicit contract behavior. Utilizing this tool in conjunction with a 5V or 10V logic analyzer to view the signals available on headers J2 and J5, is a good place to start with debugging the TPS26750EVM.

When deciding which USB-PD analyzer to use, make sure that the analyzer is designed for use with EPR capable devices. The only one on the market below 200 USD, at the time of this initial publication, is the Power-Z KM003C. To log USB-PD traffic between port partners with the Power-Z KM003C, use the device in passthrough mode in conjunction with a computer. For information on how to use the Power-Z KM003C in passthrough mode, refer to the documentation manufacturer.

This device can also step through USB-PD contracts (Power Data Objects or PDOs) when acting as a power sink to relation to the port partner, the TPS26750 DUT (source), to test the TPS26750EVM's ability to source each PDO. This device is shown with a setup that allows users to test the configured USB-PD contracts (PDOs) of the TPS26750EVM with integrated control of the BQ25756EVM; see [Figure 2-10](#).



**Figure 2-10. Testing Setup Utilizing the Power-Z to Test Source PDOs of TPS26750EVM**

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**Note**

This figure depicts a previous version of the TPS26750 EVM (RevA2), but the information remains accurate and applicable to the current version.

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**Targeted Debugging**

If users are not seeing expected behavior after configuring the TPS26750 using the Application Customization Tool, then one of the first places to start is to monitor the I2Cc lines when the TPS26750EVM is first powered up to see if the EEPROM is successfully writing the configuration of the device to the TPS26750. There must be I2C traffic (from the EEPROM to the TPS26750) that matches the contents of the binary that is exported from the *Export Full Flash Binary* tool in the GUI.

To successfully test the USB-PD Extended Power Range (EPR) with the TPS26750EVM, successfully negotiate an EPR contract (a USB-PD contract with a voltage greater than 20V), a [USB-IF compliant](#) 240W rated USB-C to USB-C cable must be used. If users are able to negotiate SPR contracts, but not EPR contracts, make sure the USB-C to USB-C cable is 240W rated.

If VBUS is falling (hitting UVLO) after a USB-PD EPR contract is negotiated while sourcing and utilizing the BQ25756EVM, then check to see if the power source connected to the HV\_SYS net (either through J8 or J3) is capable of supplying sufficient current for the contract negotiated. For details on using the BQ25756EVM in conjunction with the TPS26750EVM, see [Section 4.1](#).

## 2.8 Test Points and LEDS

### LED Information

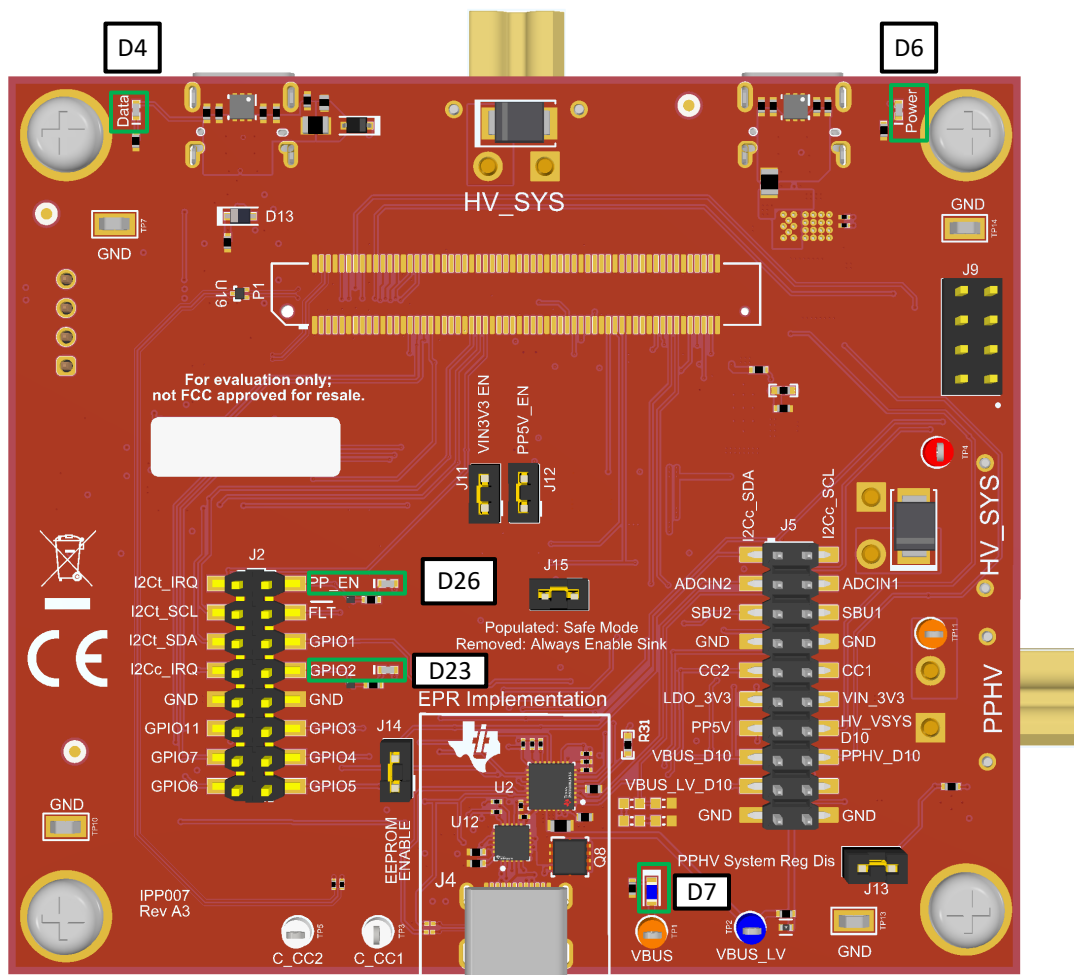


Figure 2-11. Location of LEDs

**Table 2-6. LEDS**

Designator	Net Label	Description
D4	RP_VBUS	Blue LED that turns on when USB Type-C is connected to Data Type C Port (J6).
D6	TC_VBUS_C	Blue LED that turns on when USB Type-C is connected to Power Type C Port (J3).
D26	NetD26_2	Blue LED that shows when POWER_PATH_EN is driven high to enable the Bidirectional power path (PPHV).
D23	NetD23_2	Blue LED that shows when GPIO2 (EPR_EN) is driven high to show that the TPS26750 is in EPR Mode.
D7	NetD7_2	Blue LED that lights when VBUS is driven at or above 5V.

**Table 2-7. Test Points**

Name	Test Point	Description
VBUS	TP1	VBUS (5V to 48V)
VBUS_LV	TP2	VBUS_LV. Either VBUS in SPR Mode or (VBUS x 42.18750%) in EPR Mode
PPHV	TP11	High voltage power path
HV_VSYS	TP4	High voltage system power
C_CC1	TP3	Connector side (J4) CC1
C_CC2	TP5	Connector side (J4) CC2
GND	TP7, TP10, TP13, TP13	Ground

## 3 Software

### 3.1 Software Description

The required software is available at the [TI Gallery](#) and can be run in a browser or installed to the computer and run natively. Browser requirements:

1. Google Chrome®, Firefox®, or Safari®.
2. Install TI Cloud Agent as a browser extension and on the PC.
  - a. When the application is first launched, instructions appears for installing TI Cloud Agent.

PC requirements:

1. Install GUI Composer Runtime.
  - a. To install GUI Composer Runtime, click on the downwards-facing arrow inside one of the applications listed in the Gallery, and look towards the bottom set of links that appear. After selecting the native operating system, open the installer and follow the prompts to install the program.

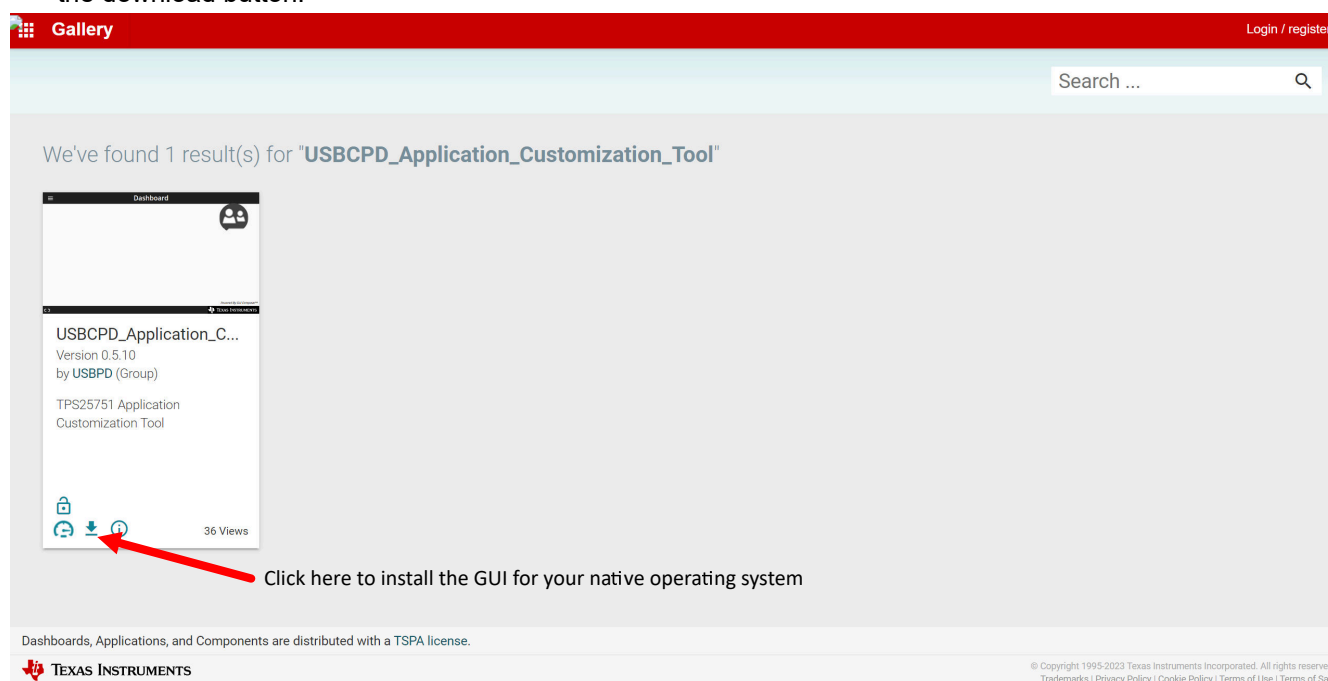
### 3.2 Software Installation

#### 3.2.1 Web Browser

1. Navigate to [Developer Gallery](#).
2. Type *USBCPD\_Application\_Customization\_Tool* into the Search Bar in the Gallery.
3. Once found, click on the title of the card that says *USBCPD\_Application\_Customization\_Tool*.
4. A new tab opens and automatically launches the application. If TI Cloud Agent is not already installed, then instructions appear for installing the required software.

#### 3.2.2 Native Application

1. Navigate to [Developer Gallery](#).
2. Search for the USBCPD Application Customization Tool in the Gallery.
3. Once found, click on the downwards-facing arrow on the bottom left side of the card, and look towards the top set of links that appear. Select the native operating system and open the installer. See figure below for the download button.



**Figure 3-1. Application Customization Tool Download**



- Once the installer is open, follow the directions to install the application.

### 3.3 Software Development

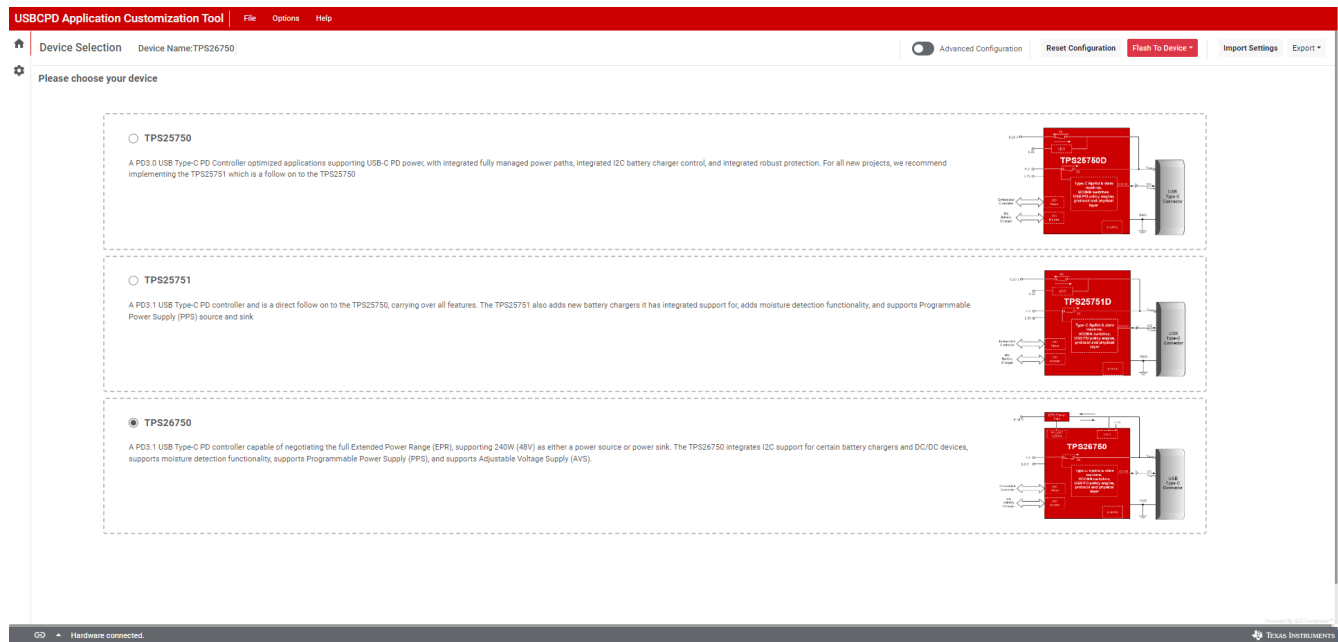
The Application Customization Tool provides users with the following capabilities:

- Generate new configuration settings.
- Load configuration settings to a device.
- Save configuration settings in JSON format.
- Export configuration settings in Binary and C format.
- Export VIF settings in XML format.

### 3.4 Using the Application Customization Tool

#### 3.4.1 Default View

After launching the Application Customization Tool, a page appears with device selections for TPS25750, TPS25751, and TPS26750. Select TPS26750 to start configuring.

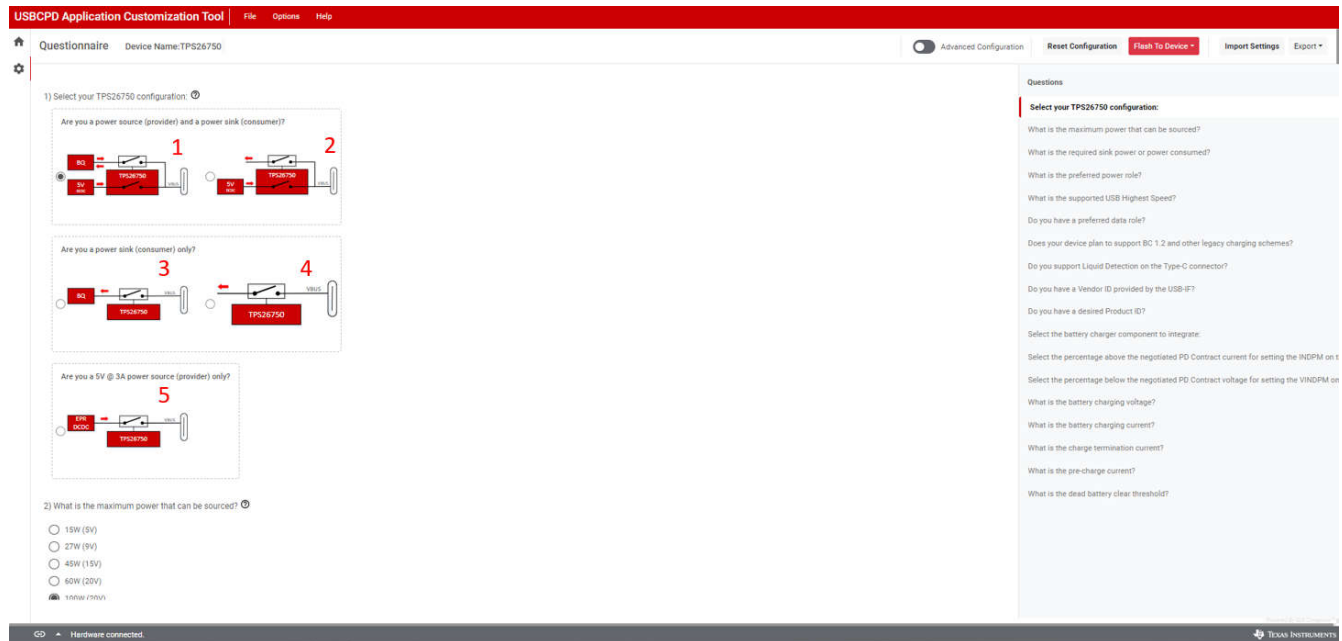


#### 3.4.2 Selecting a Configuration

The first question of the GUI asks to select a configuration the TPS26750 is used for. The 5 configurations are separated into three main categories based on power role:

1. Power Source (provider) and Power Sink (consumer), also referred to as Dual Role Power (DRP)
2. Power Sink (consumer) only
3. Power Source (provider) only

Based on the configuration selected, certain questions are disabled. See the image and table below for a breakdown of each configuration.



**Figure 3-2. Application Customization Tool Configuration**

**Table 3-1. TPS26750 Configuration**

Configuration Index	Power Role	BQ Support
1	Source and Sink (DRP)	Yes
2	Source and Sink (DRP)	No
3	Sink Only	Yes
4	Sink Only	No
5	Source Only	No

### 3.4.3 Filling Out the Questionnaire

After making a selection for Question 1, answer the remaining questions to enable flashing a TPS26750EVM or to generate and save a full configuration. Based on the selection for Question 1, some of the remaining questions can be unavailable for selection.

#### Questionnaire Explanation

Question 1: [Section 3.4.2](#)

Question 2: What is the maximum power in Watts that you want to source from the TPS26750EVM using the DUT Type C Port (J4)? If a sink only configuration was selected, this question is not selectable.

When selecting the maximum power that can be sourced, the Transmit Source Capabilities register (0x32) of the TPS26750 is configured by adding default Source PDOs (each PDO is also referred to as a USB-PD contract) as shown in [Figure 3-6](#).

#### Note

All registers referenced in this section can be modified manually by entering Advanced Configuration Mode. For details on how to enable Advanced Configuration Mode, refer to [Section 3.4.4](#).

Question 3: What is the maximum power in Watts that you want to sink to the TPS26750EVM using the DUT Type C Port (J4)? If a source only configuration was selected, then this question is not selectable.

When selecting the maximum power that can be sinked, the Transmit Sink Capabilities register (0x33) of the TPS26750 is configured by adding default Sink PDOs (each PDO is also referred to as a USB-PD contract).

**Table 3-2. PDOs Associated with Selected Power in Questions 2 and 3**

Power Option Selected	Default SPR PDOs
15W (5V)	5V/3A
27W (9V)	5V/3A, 9V/3A
45W (15V)	5V/3A, 9V/3A, 15V/3A
60W (20V)	5V/3A, 9V/3A, 15V/3A, 20V/3A
100W (20V)	5V/3A, 9V/3A, 15V/3A, 20V/5A

The PDOs included in Registers 0x32 and 0x33 are correlated with the selected power option in [Table 3-2](#).

If required power is greater than 100W, and an option greater than 100W is selected, then the PDOs greater than 100W are EPR PDOs, and the default generated PDOs are shown in [Table 3-3](#). The PDOs are listed in order. A single fixed PDO is listed in the format [PDO Voltage value]V/[PDO Current value]A:

**Table 3-3. EPR Power Ranges**

Power Option Selected	Default SPR PDOs	Default EPR PDOs
140W (28V)	5V/3A, 9V/3A, 15V/3A, 20V/5A	28V/5A, AVS PDO
180W (36V)	5V/3A, 9V/3A, 15V/3A, 20V/5A	28V/5A, 36V/5A, AVS PDO
240W (48V)	5V/3A, 9V/3A, 15V/3A, 20V/5A	28V/5A, 36V/5A, 48V/5A, AVS PDO

Question 4: If a DRP configuration is selected in question 1 (Configuration Index 1 or 2), then question 4 determines which power role (source or sink) is *preferred* by the TPS26750EVM. If Configuration Index 3,4, or 5 was selected, then this question is not selectable. The meaning of *preferred* in this context is the following:

- If the TPS26750EVM prefers to be a source, and after connection to a port partner, is acting as a sink, then the TPS26750 requests to the port partner to swap roles (power role swap) in an attempt to become a power source.
- If the TPS26750EVM prefers to be a sink, and after connection to a port partner, is acting as a source, then the TPS26750 requests to the port partner to swap roles (power role swap) in an attempt to become a power sink.

Question 5: What is the supported USB speed of the DUT? Based on the selection, this determines what USB speed is enumerated during PD negotiation. If USB data is not required, then select *No USB data is being used*.

Question 6: What is the preferred data role (UFP, DFP, or Dual Role Port (different from Dual Role Power, a power role)) of the DUT? When an implicit Type-C contract (this occurs before the explicit USB-PD contract) is made the Power-role and Data-role is either Source and DFP or Sink and UFP. If this combination does not meet the USB Data Role needs for the application, then selecting the preferred data role allows the TPS26750 to request a data role swap when appropriate. If there is no preference, then select *No*. This information is stored in the Port Control register (0x29).

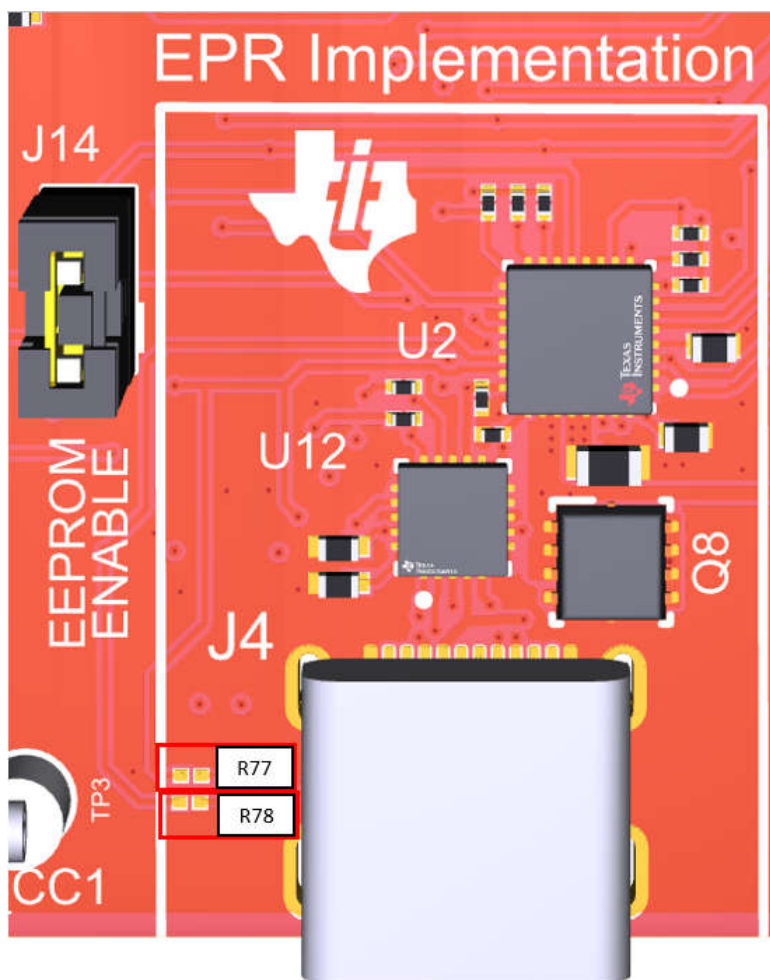
#### Note

For more details on the registers of the TPS26750, refer to the TPS26750 Technical Reference Manual.

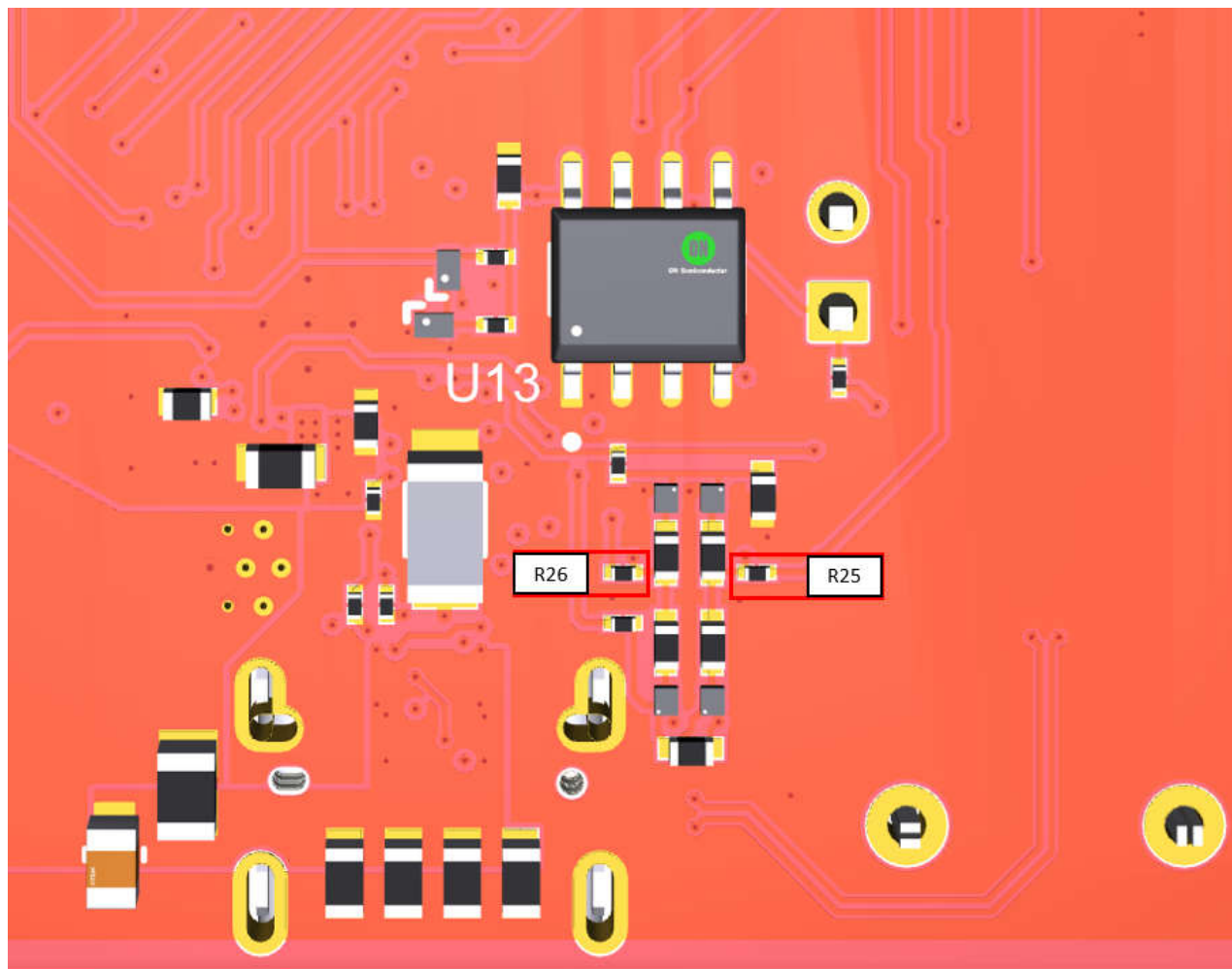
Question 7: Is USB Battery Charging 1.2 (BC1.2) and legacy charging supported in the application? Based on the selection, the TPS26750 can enumerate different BC1.2 charging schemes. Refer to the [TPS26750 USB Type-C® and USB PD Controller with Integrated Power Switches Optimized for Power Applications](#) data sheet for more details on BC1.2 implementation.

#### Note

The TPS26750EVM does not support BC1.2 out of the box. To use the TPS26750EVM in conjunction with BC1.2, populate resistors R77 and R78 with 0Ω resistors (located on the top of the board to the right of TP3 and to the left of J4, as shown in [Figure 3-3](#)), and depopulate resistors R25 and R26 (located on the bottom of the board, beneath U13, as shown in [Figure 3-4](#)).



**Figure 3-3. Resistor 77 and 78 Location**



**Figure 3-4. Resistor 25 and 26 Location**

Question 8: Enables or disables Liquid Detection support. Liquid Detection is a new feature of the TPS26750 based on the Type-C specification for Liquid Detection and Corrosion Mitigation.

**Note**

The TPS26750 is not able to support BC1.2 and Liquid Detection simultaneously, since both features utilize the same GPIO pins (GPIO4 and GPIO5).

Question 9: Allows the ability to enter a Vendor ID. The Vendor ID is given by the USB-IF, and is a 4-digit hexadecimal value. Select Yes option to enter the desired Vendor ID, otherwise select No.

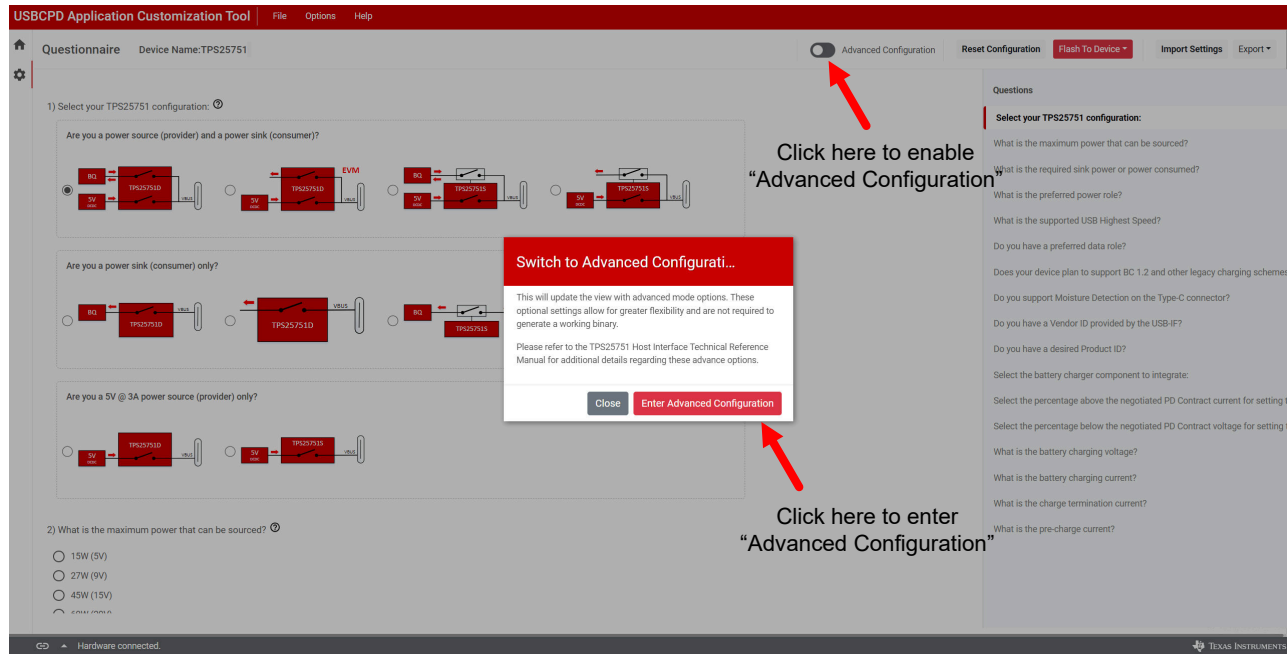
Question 10: Allows the ability to enter a Product ID, which is a 4-digit hexadecimal configuration identifier, after selecting Yes. If unused, select No.

Questions 11 through 18 corresponds to configuring the selected BQ (Battery Charger) device if applicable. These questions are only available for use if a configuration was selected in the first question that includes a BQ block. For all other configurations (TPS26750 without a BQ block), these questions are disabled. For more details on each question, refer to [Section 4.1.2](#).

The TPS26750 supports integration with the BQ25756 IC. If using the BQ25756EVM in conjunction with the TPS26750EVM, then any configuration in Question 1 with a BQ block can be used.

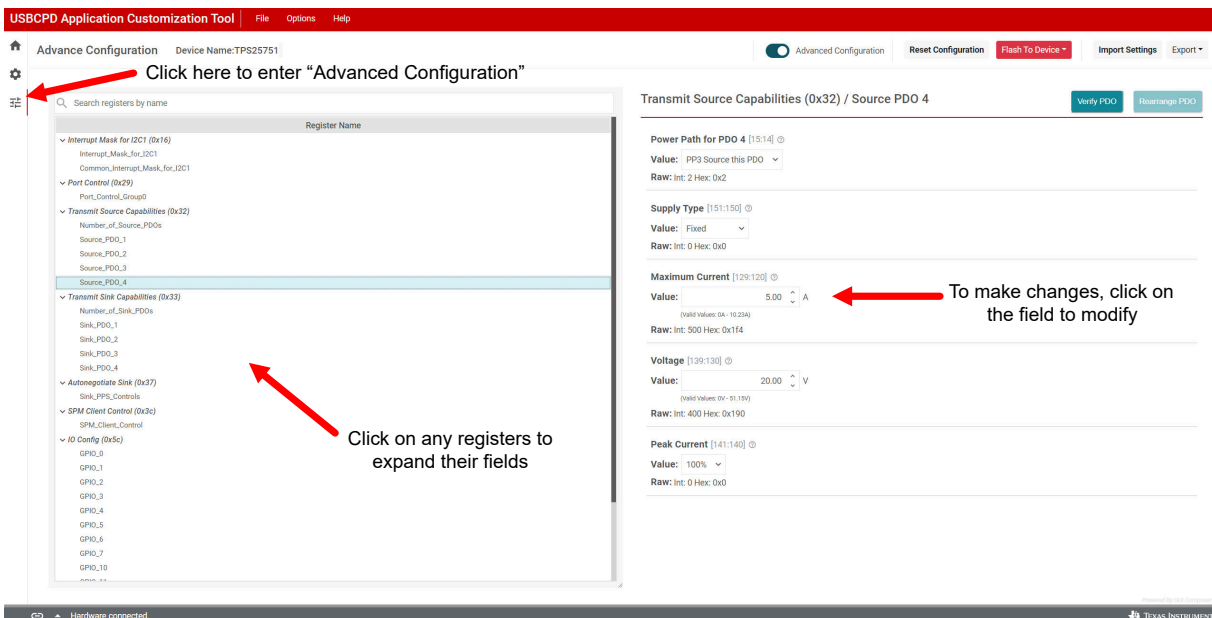
### 3.4.4 Advanced Configuration Mode

To configure additional fields and registers such as I2C Interrupt Masking, GPIO events, or making custom changes to Source/Sink PDOs, click on the *Advanced Configuration* slider at the top of the tool. After clicking on the slider, a message appears asking for confirmation before enabling *Advanced Configuration*.



**Figure 3-5. Enabling Advanced Configuration**

Once Advanced Configuration is enabled, an Advanced Icon appears on the left side underneath the gear icon to go back to the questionnaire. Within Advanced Configuration, users have the ability to configure specific registers on the TPS26750. For details on register fields and the description, refer to the TPS26750 Technical Reference Manual. See the example below of configuring the Source\_PDO\_4 under Transmit Source Capabilities (0x32).



**Figure 3-6. Using Advanced Configuration**



### 3.4.5 Flashing Configuration to TPS26750

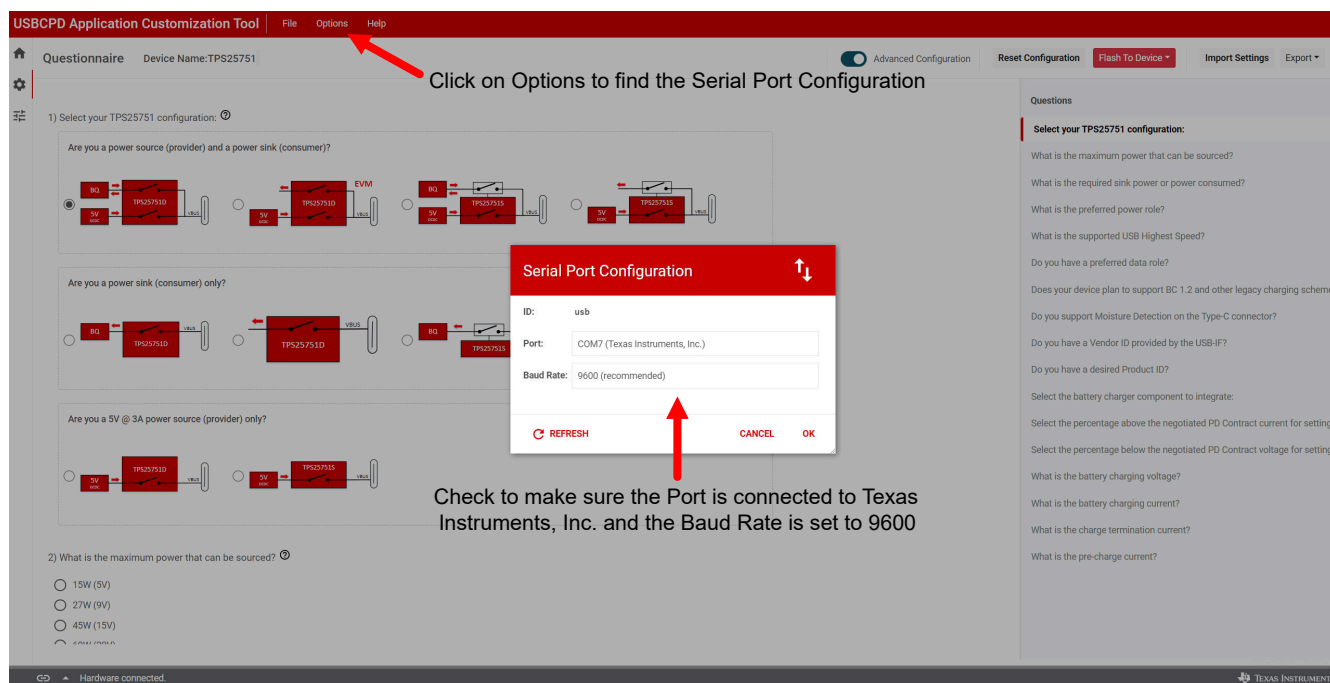
The Application Customization Tool is used to directly load a configuration onto the TPS26750. To flash a configuration, perform the following steps:

1. Open the Application Customization Tool
2. Connect the USB-C end of either a USB-A to USB-C cable or a USB-C to USB-C cable to the Data Type-C port (J6).
3. Connect the other end of the cable to a laptop or computer with the Application Customization Tool open.
4. Make sure jumper J11 is populated on the TPS26750EVM.

#### Note

For evaluating battery charging applications with the BQ25756EVM, connect the BQ25756EVM to the TPS26750EVM *after* configuration has been successfully loaded AND both Power Type-C and Data Type-C connections have been removed from ports J8 and J6, respectively. Also, make sure nothing is connected to J4. If a new configuration needs to be loaded to the TPS26750EVM, then all connections to the BQ25756EVM **must** be removed until the new configuration is loaded and ports J4, J8, and J6 are disconnected.

Open the Application Customization Tool and complete the questionnaire; for details on each question, refer to [Section 3.4.3](#). Once the questionnaire is complete and the TPS26750EVM is connected properly, click on Options → Serial Port Configuration to make sure the correct COM port is selected (*Texas Instruments, Inc* needs to be listed next to the COM port). For reference, see [Figure 3-7](#).



**Figure 3-7. Serial Port Configuration Settings**

If the TPS26750EVM is unable to connect to the Application Customization Tool, then go through the following debug recommendations:

1. Make sure the cable connecting the computer to the TPS26750EVM supports data.
2. Make sure only one tab (or instance, if using the natively run application) of the Application Customization Tool is running at any given time. Multiple tools running simultaneously can cause communication issues.

Once the questionnaires are completed and the TPS26750EVM is connected to the Application Customization Tool, click on Flash To Device → Flash to device from current configuration.



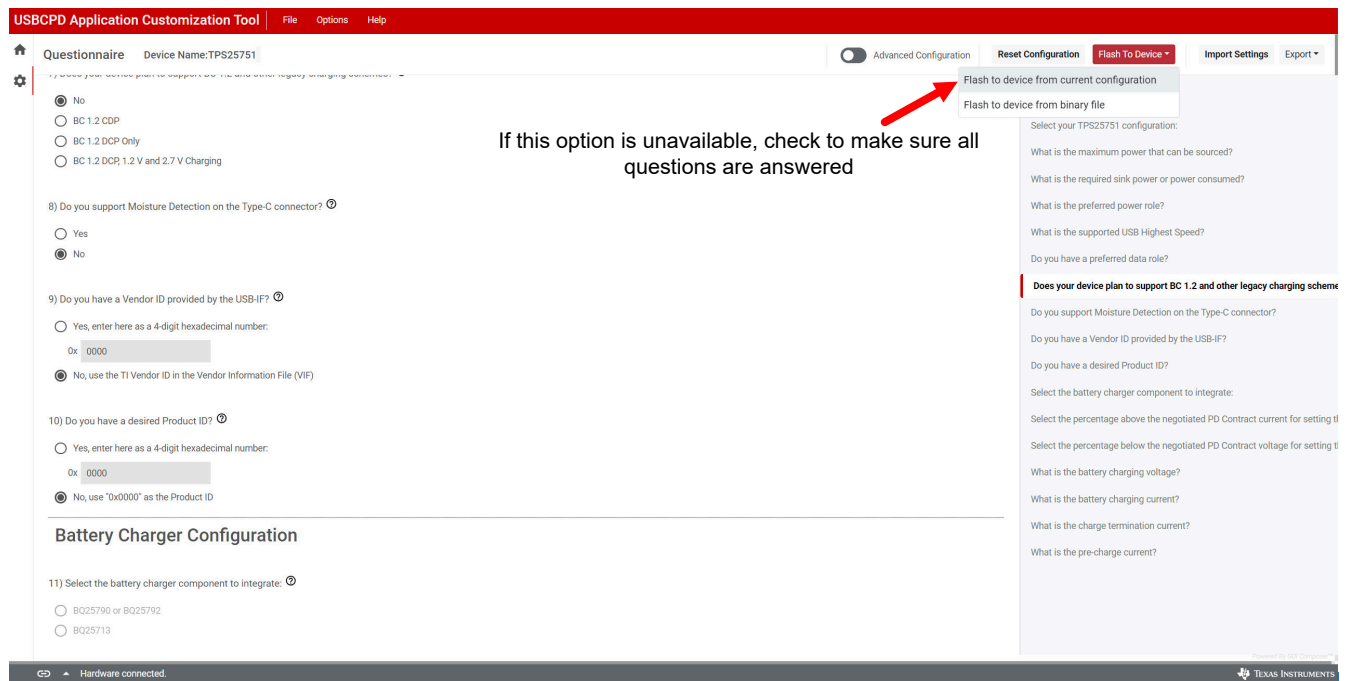


Figure 3-8. Flash to Device from Current Configuration

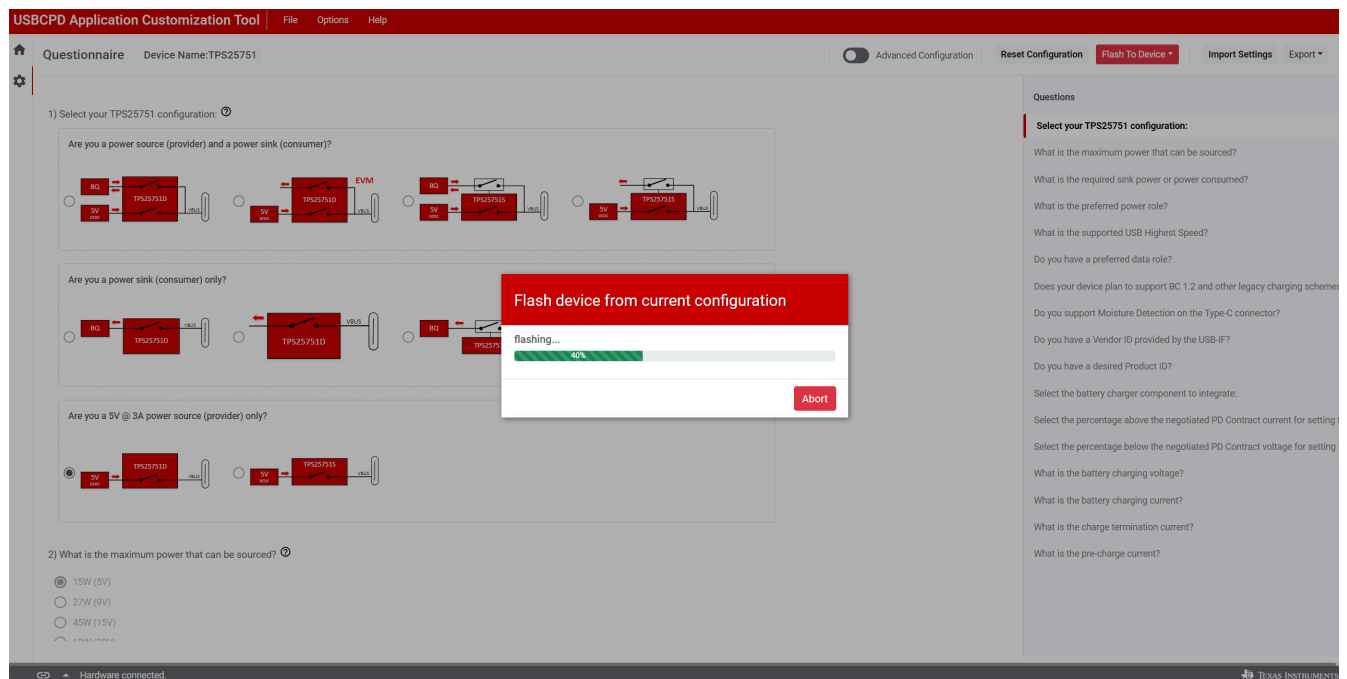
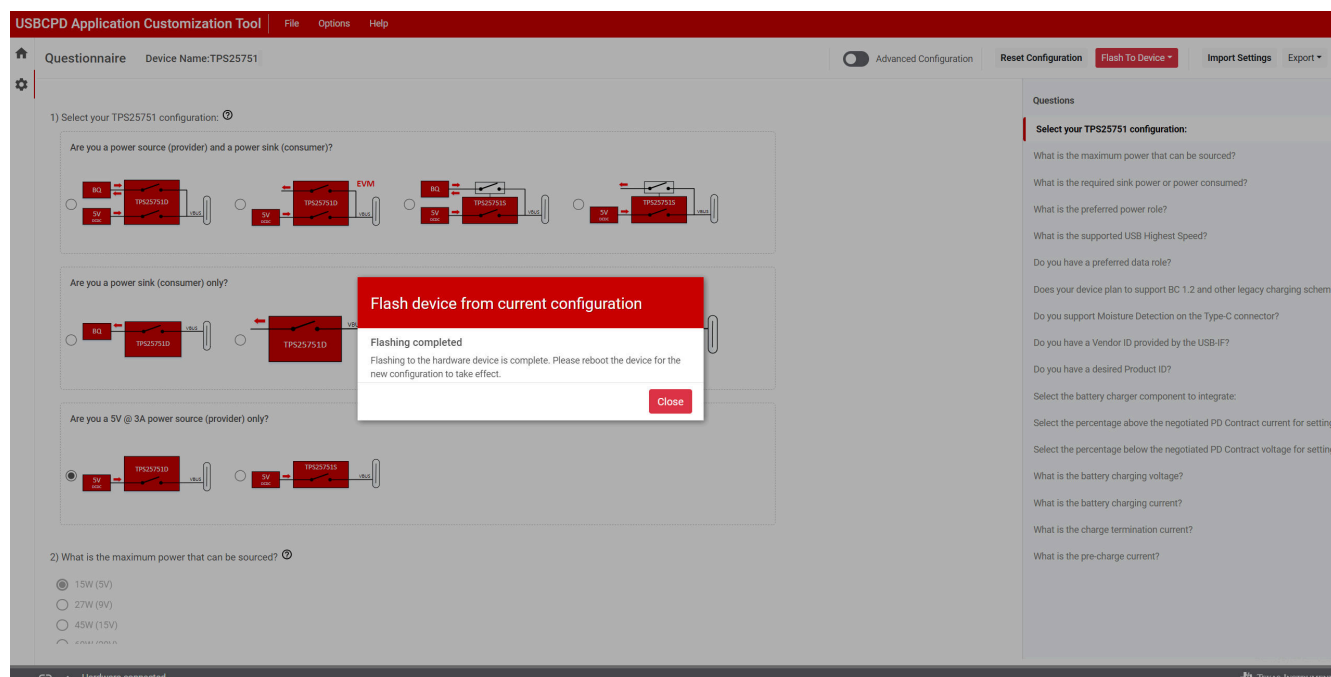


Figure 3-9. Flash to Device from Current Configuration



**Figure 3-10. Flash to Device from Current Configuration**

### Note

When the tool is flashing the configuration, DO NOT connect or disconnect any cables on the TPS26750EVM. Connecting or disconnecting any cables can cause errors when flashing.

## Flashing to Device from an Existing Binary File

If a binary file has previously been generated, then the binary can be loaded directly to the TPS26750EVM instead of filling out the questionnaire again. Make sure the TPS26750EVM is detected and connected to the Application Customization Tool using the above steps, and instead of choosing *Flash to Device from Current Configuration* under the *Flash to Device* heading, select *Flash to Device From Binary File*. Select the desired .bin file from your directory and click OK.

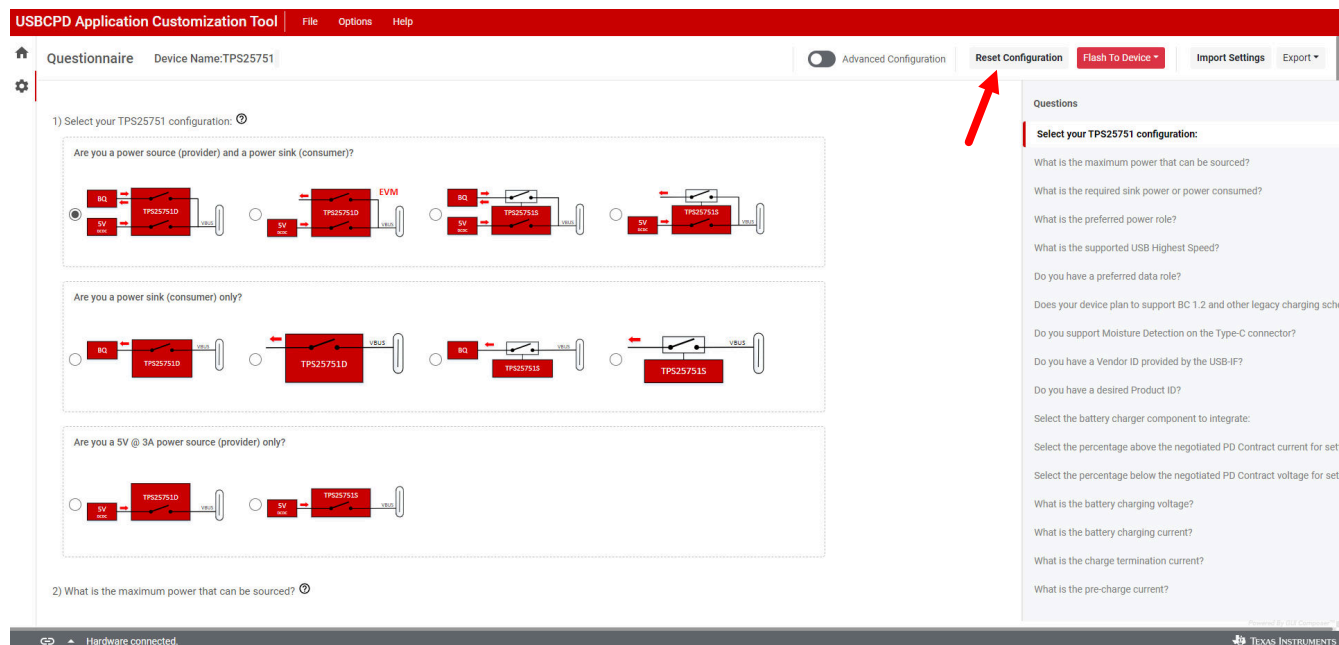
### Note

When flashing to the TPS26750EVM from an existing binary, make sure the binary is a *Full Flash Binary* and not a *Low Region Binary*. For further details, see [Section 3.4.6.3](#).

### 3.4.6 Additional Settings

#### 3.4.6.1 Generating a New Configuration

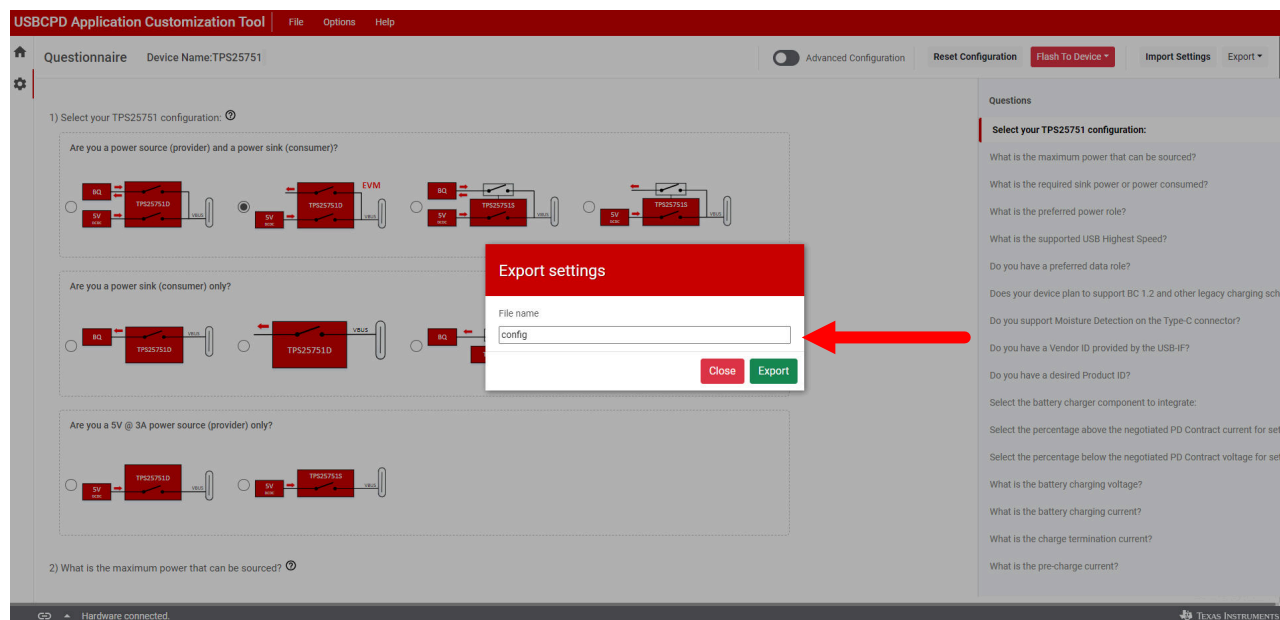
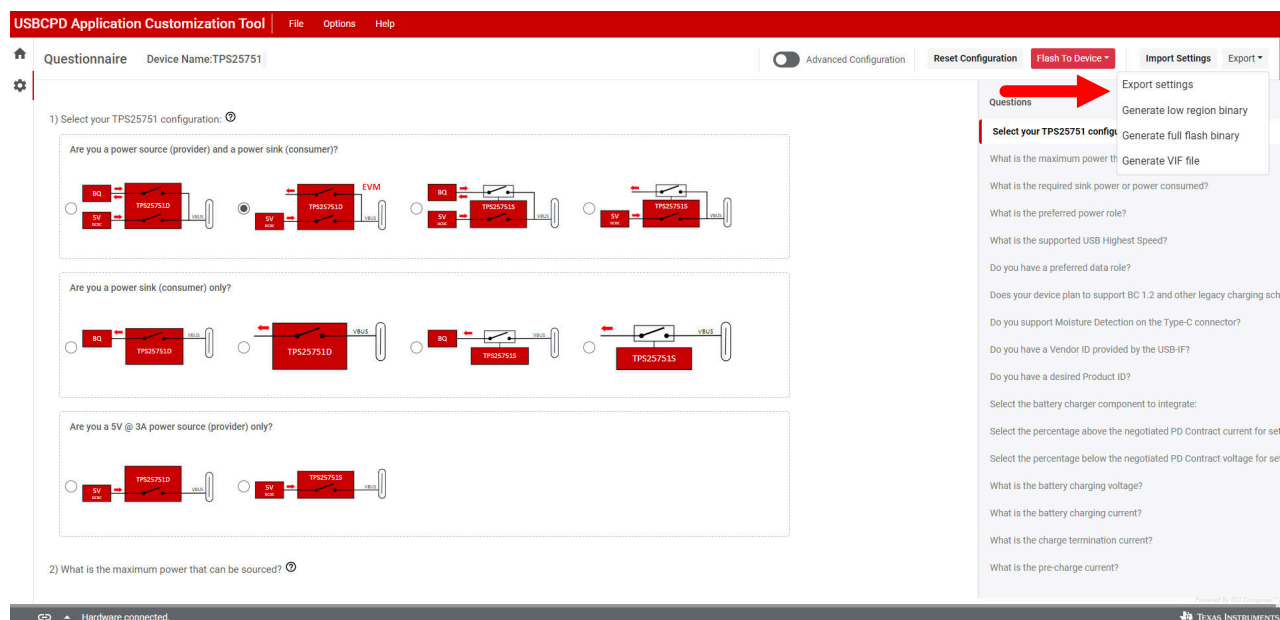
To generate a new configuration for the TPS26750EVM, click the *Reset Configuration* button on the top right side of the tool (this is next to the *Flash To Device* drop-down menu). This button erases the existing configuration and resets the form back to the default settings. TI recommends to export the existing form before resetting, so that the existing configuration is not lost. For details on how to save configurations, refer to [Section 3.4.6.2](#).



**Figure 3-11. Resetting Configuration**

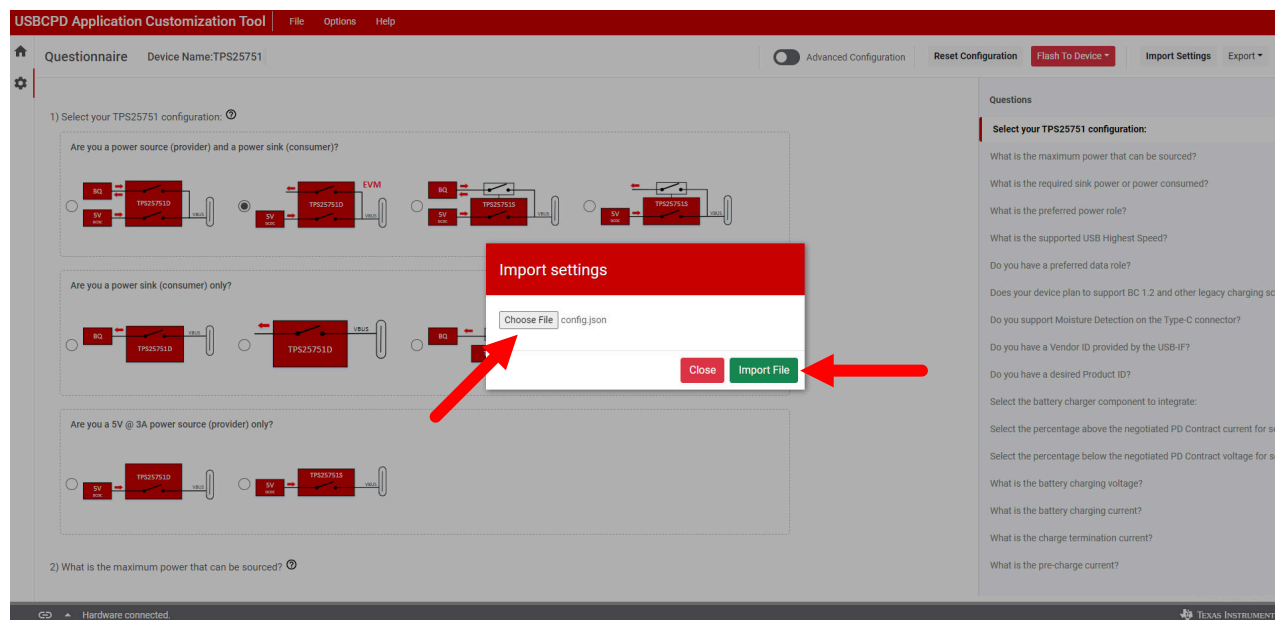
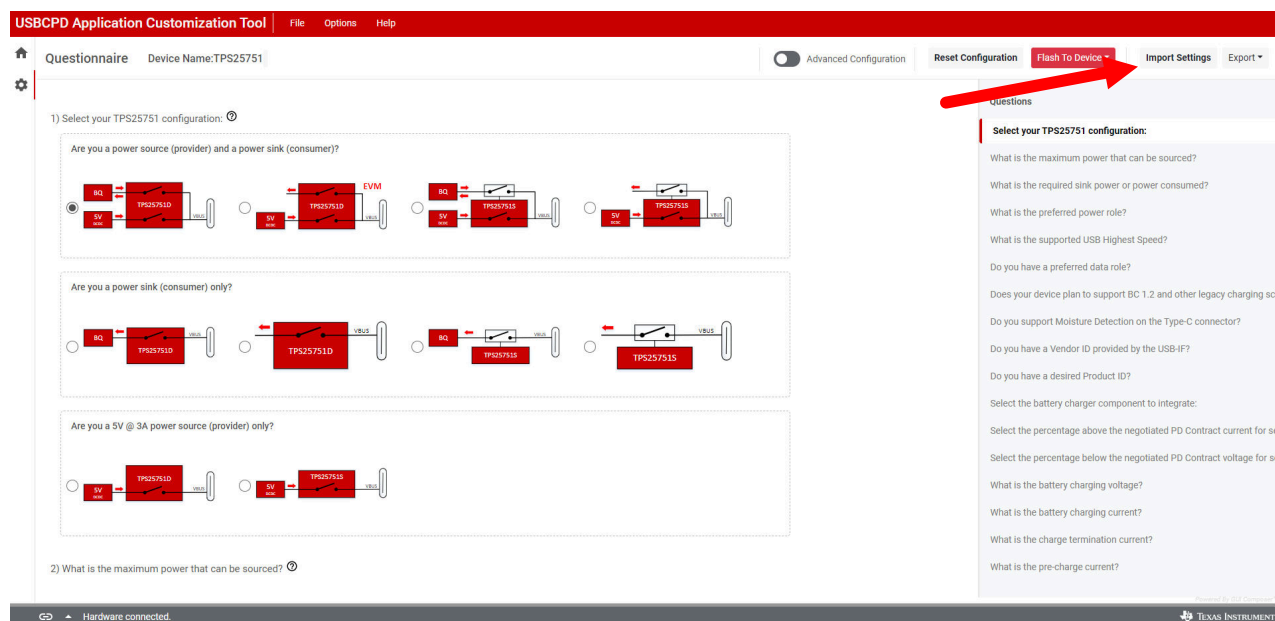
### 3.4.6.2 Exporting and Importing Settings

To save the current tool settings including the current configuration of the device as indicated by the form, click on the **Export** drop-down button on the top-right side of the tool and click on **Export settings**. A prompt will appear allowing the user to change the file name of the settings. Enter a file name and click **Export** to export a JSON file.



**Figure 3-12. Export Settings in Application Customization Tool**

To import current tool settings including the current configuration of the device as indicated by the form, click the **Import settings** button on the top-right side of the tool. Select from the directory where the JSON setting file is and click the **Import File** button. The settings are restored in the Application Customization Tool.



**Figure 3-13. Import Settings in Application Customization Tool**

**Table 3-4. Export Options**

Option under <i>Export</i> Header	Output Format	Output Extension	Description
Export settings	JSON	.json	Settings in this format can be loaded into the GUI.
Generate low region binary	binary	.bin	This format is used for booting the TPS26750 from an External Controller (EC). For more details, refer to <a href="#">TPS26750 Technical Reference Manual</a> , PBMx section.
Generate low region binary	C source file	.c	This format is used for booting the TPS26750 from an External Controller (EC). For more details, refer to <a href="#">TPS26750 Technical Reference Manual</a> , PBMx section.
Generate full flash binary	binary	.bin	This format is written to an EEPROM on the TPS26750EVM using the GUI. The TPS26750 reads from this EEPROM for configuration at boot.
Generate full flash binary	C source file	.c	This format is used to write the firmware to an EEPROM using custom code.
Generate VIF file	XML	.xml	Information on this file can be found in the pdf included in the <a href="#">USB Vendor Info File Generator</a> .

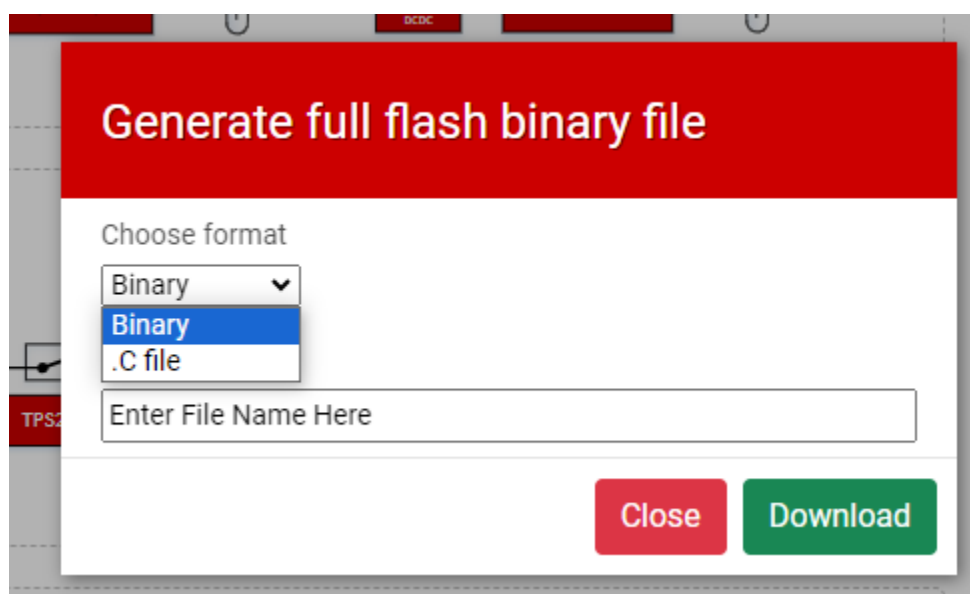
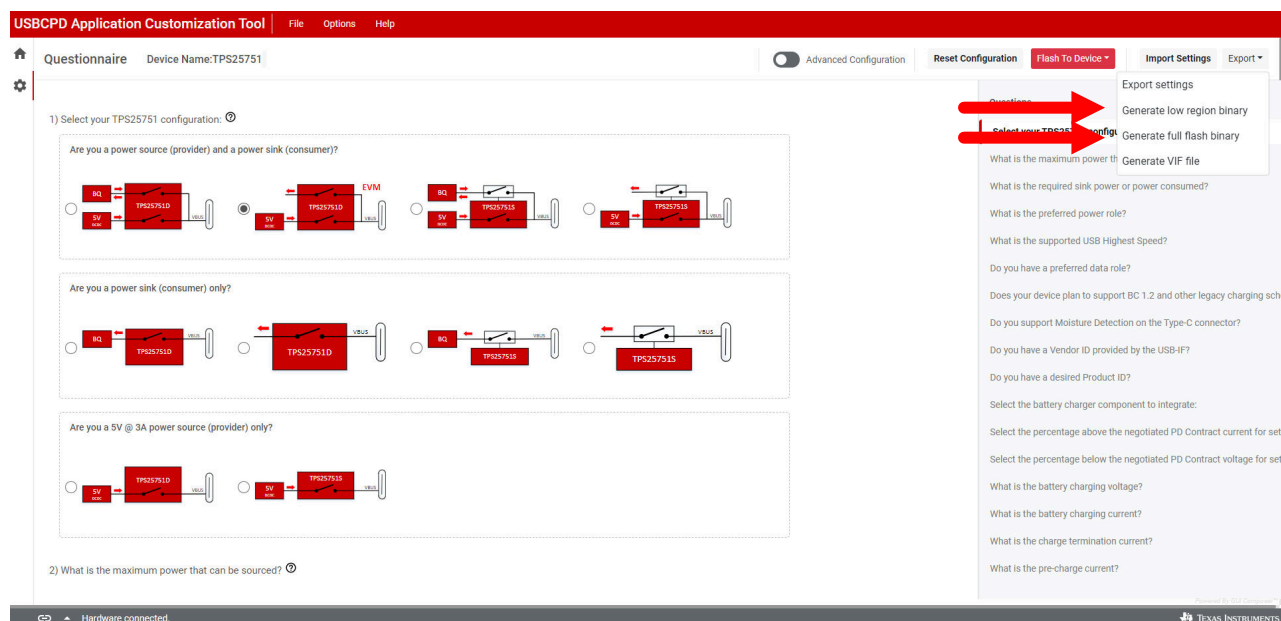
### 3.4.6.3 Generating the Binary

To generate a binary of the current tool settings including the current configuration of the device as indicated by the form, click on the *Export* drop-down button on the top-right side of the tool and click on *Generate low region binary* or *Generate full flash binary*.

#### Note

Low Region Binary includes the firmware base image and AppConfig, this is used for EC patch loading. Full Flash Binary includes the Low Region and High Region, this is used for EEPROM configuration loading. For more information, refer to the Technical Reference Manual.

Users have the option to generate a .bin or .C file. Select a file format, enter the file name and click the *Download* button to download the binary file.



**Figure 3-14. Generating Binary Configuration Using the Application Customization Tool**

#### 3.4.6.4 Generating the VIF File

To generate a VIF file of the current tool settings including the current configuration of the device as indicated by the form, click on the *Export* drop-down button on the top-right side of the tool and click on *Generate VIF file*. This automatically generates a VIF file to the default save directory on the user's computer. The VIF file is required for Compliance Testing specified by the *USB Power-Delivery Certification Process*. For more information on VIF generation refer to [VIF Generation for USB Type-C® PD Compliance](#).



## 4 Application Specific Use Cases

This section explains in more detail how to set up the following application specific use cases:

1. Battery charging application with the BQ25756

### 4.1 Use With the BQ25756EVM

To use the TPS26750EVM and BQ25756EVM, the following items are needed:

1. TPS26750EVM
2. Ribbon cable (included with TPS26750EVM)
3. BQ25756 interposer board (included with TPS26750EVM)
4. Application customization tool
5. BQ25756EVM
6. BQ25756EVM [user's guide](#) and [data sheet](#)
7. [BQStudio with EV2400](#) [optional]
8. DC power supply or battery simulator

#### 4.1.1 Hardware Setup with BQ25756EVM

To set up the hardware, follow the instructions below:

1. Connect the J1 and J7 mating connectors of the TPS26750EVM to the reciprocal connectors on the provided BQ25756 interposer board. The silk-screen **BQ25756** on the BQ25756 Interposer Board must be oriented on the same plane as the top of the TPS26750EVM. See [Figure 1-2](#)
2. Unscrew the screws on headers J1 and J3 of the BQ25756EVM enough for the BQ25756 interposer board prongs to fit into the aforementioned headers.
3. Insert the other side of the BQ25756 interposer board to headers J1 and J3 on the BQ25756EVM. Make sure the prongs are inserted all the way into the headers.

#### Note

Repeated insertion and removal of TPS26750EVM mating connectors from the BQ25756 interposer board (depending upon how the boards are grasped and pulled) can cause the prongs on the side of the interposer board connected to the BQ25756EVM to come out of the J1 and J3 headers enough to cause an insufficient electrical connection between the BQ25756EVM and the TPS26750EVM. **Please recheck interposer board connections when detaching and re-attaching BQ25756EVM from the TPS26750EVM.**

4. Tighten the screws on headers J1 and J3 of the BQ25756EVM.
5. Attach the ribbon cable to header J9 on the TPS26750EVM as shown in [Figure 1-2](#). Attach the other end of the ribbon cable to header J8 of the BQ25756EVM.
6. Connect the other end of the ribbon cable to J8 header of the BQ25756(E)EVM.
7. To power the board using a simulated battery, connect the simulated battery to header J3 in the orientation shown on the silkscreen (+ and - symbols next to J3).
8. For setting the proper jumper for battery charging application, refer to [BQ25756 Evaluation Module User's Guide](#). Incorrect jumper settings or insufficient input power can result in a faulty evaluation.

#### 4.1.2 Software Setup with the BQ25756EVM

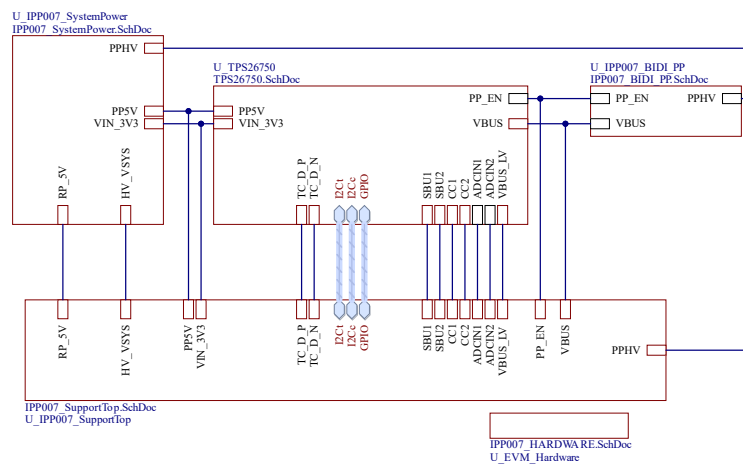
To setup the software configuration, follow the instructions below.

1. Open the [Application Customization Tool](#) and select Configuration Index 1 or 3 for Question 1 (A figure with a BQ block included).
2. Fill out the questionnaire from Q2 to Q10. For more details on each question configuration, refer to [Section 3.4.3](#). All the questions must be filled out to flash or export.
3. Questions 11 through 17 pertain to Battery Charger (BQ) settings.
4. For Question 11, select BQ25756.
5. For Question 12, select the INDPM configuration for the BQ25756.

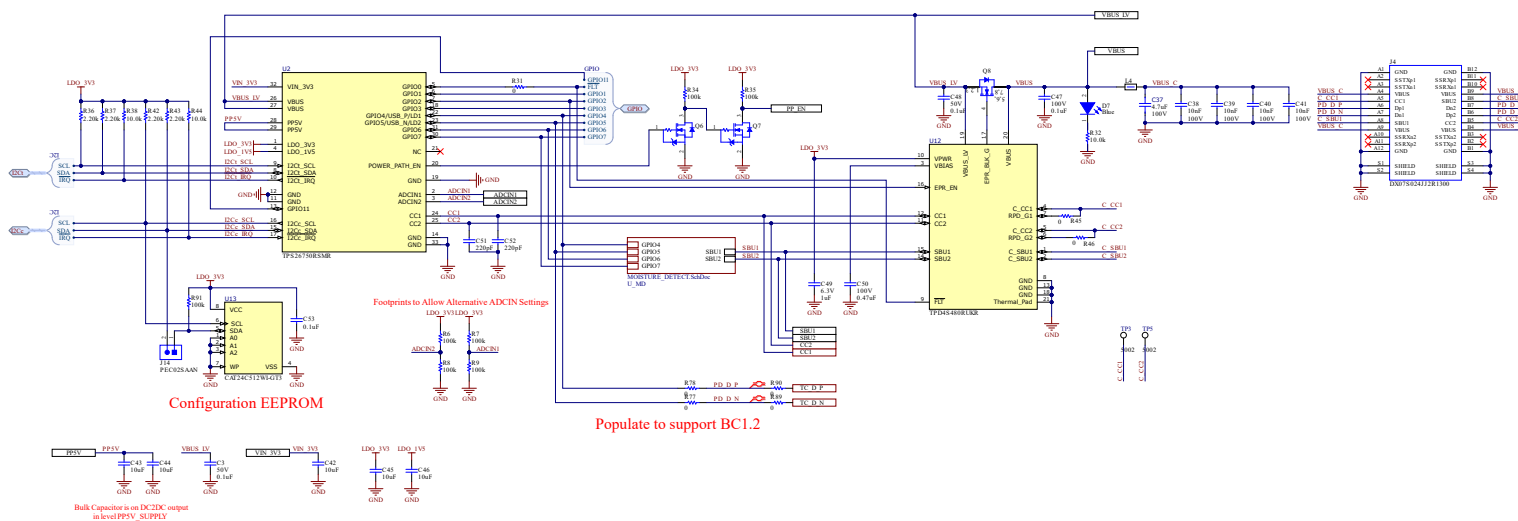
- a. For example, if the user selects 5% - *INDPM is set to 5% above the negotiated PD Contract Current* and TPS26750 negotiates a PD contract at 3A, then the INDPM is set to 3.15A.
- b. This questionnaire configures register 0x06 - IAC\_DPM of the BQ25756.
6. For Question 13, select the VINDPM configuration for the BQ25756.
  - a. For example, if the user selects 5% - *VINDPM is set to 5% below the negotiated PD Contract Voltage* and TPS26750 negotiates a PD contract at 5V, the VINDPM is set to 4.75V.
  - b. This questionnaire configures register 0x08 - VAC\_DPM of the BQ25756.
7. For question 14, enter the FB Voltage Regulation Limit in units of Voltage (1.504V through 1.566V, 2mV/bit).
  - a. This questionnaire configures register 0x00 - VFB\_REG of the BQ25756.
8. For question 15, enter the Charge Current Limit in units of Ampere (0.4A through 20A, 50mA/bit)
  - a. This questionnaire configures register 0x02 - ICHG\_REG of the BQ25756.
9. For question 16, enter the Charge Termination Current Limit in units of Ampere (0.25A through 10A, 50mA/bit).
  - a. This questionnaire configures register 0x12 - ITERM of the BQ25756.
10. For question 17, enter the Precharge Current Limit in units of Ampere (0.25A through 10A, 50mA/bit).
  - a. This questionnaire configures register 0x10 - IPRECHG of the BQ25756.
11. For flashing the configuration to the TPS26750EVM or exporting the binary, refer to [Section 3.4.6](#).

## 5 Hardware Design Files

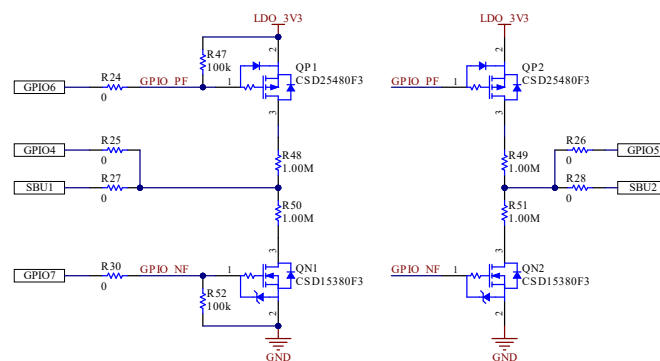
## 5.1 Schematics



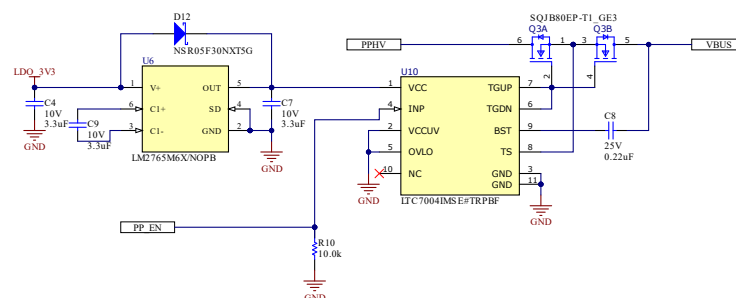
### Figure 5-1. Block Diagram (Top Level)



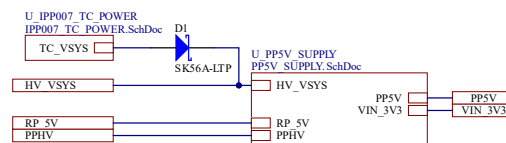
### Figure 5-2. TPS26750



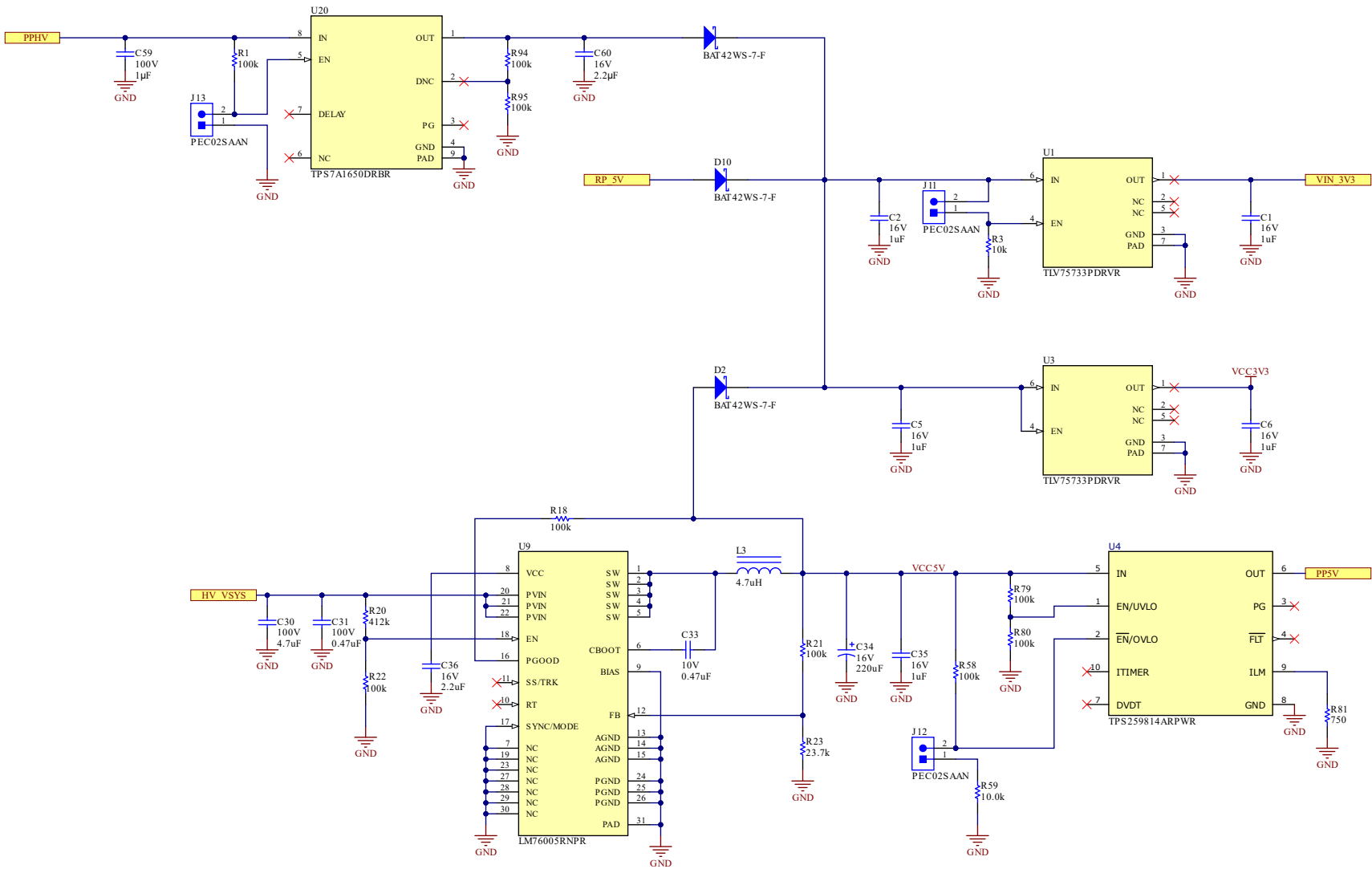
### Figure 5-3. Liquid Detection



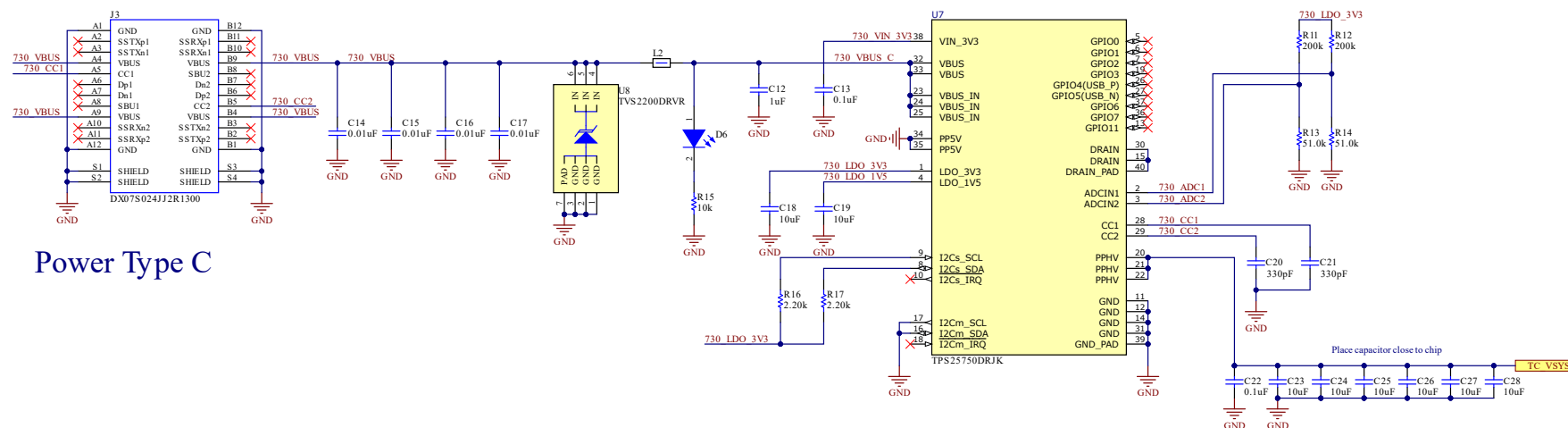
### Figure 5-4. Bidirectional Power Path



### Figure 5-5. System Power



### Figure 5-6. System Power Supplies



Power Type C

Figure 5-7. Type-C Power Input

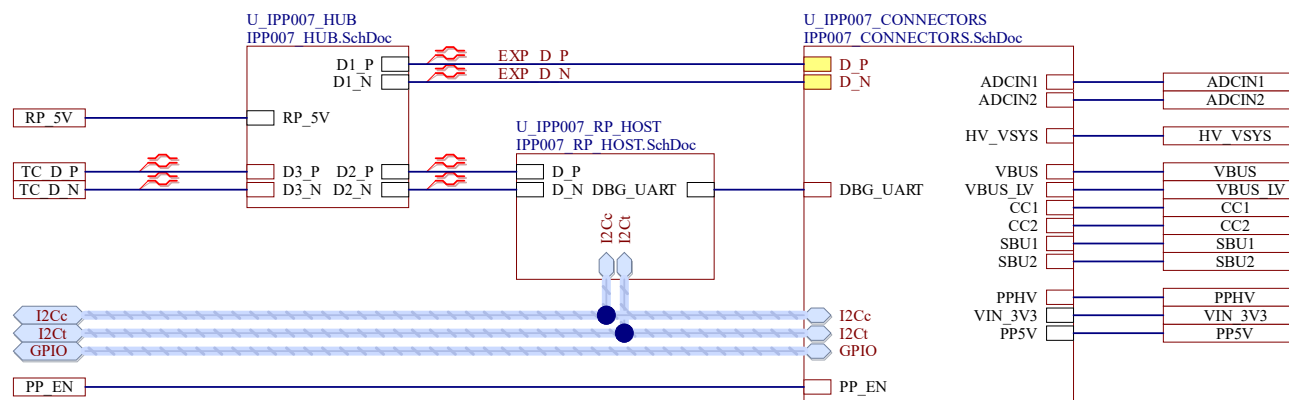
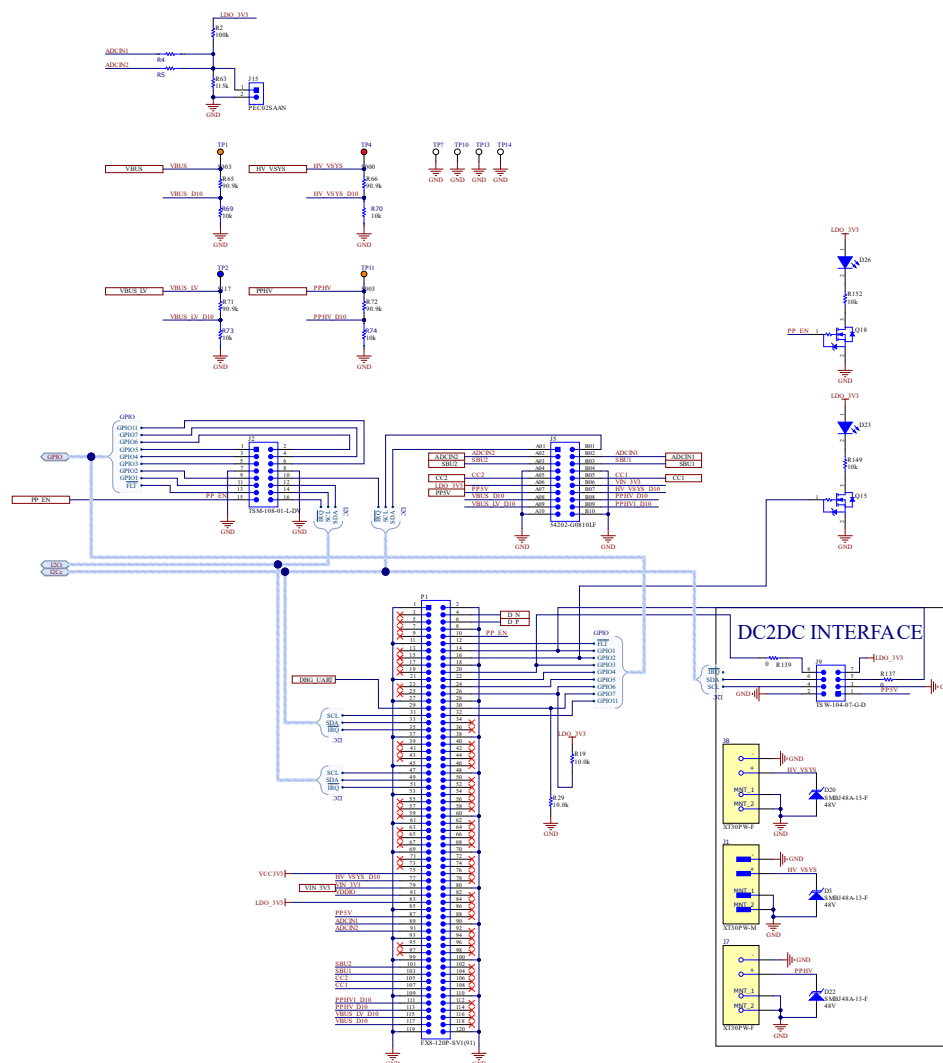


Figure 5-8. Support Circuits Top Level





**Figure 5-9. Connectors**

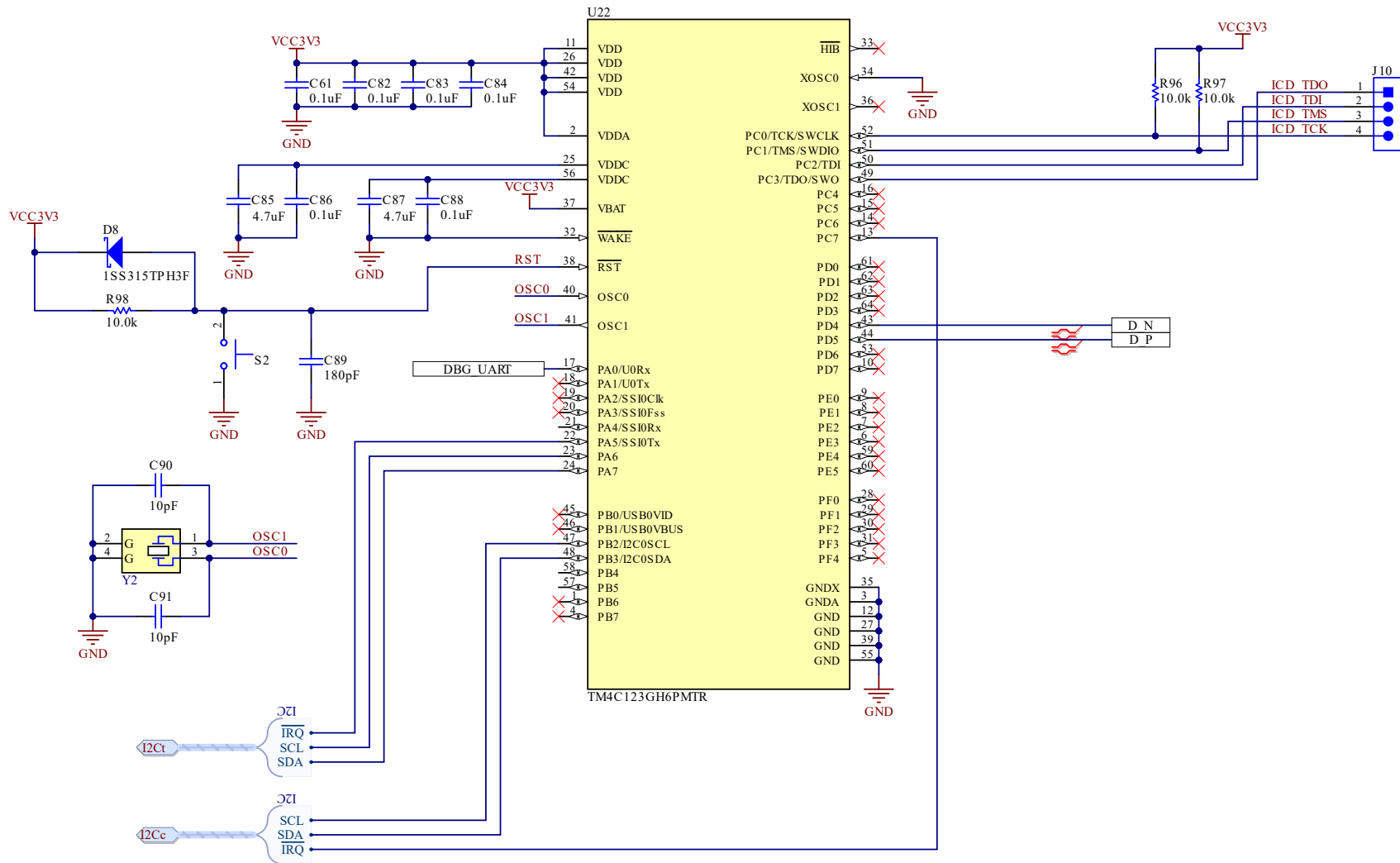


Figure 5-10. TIVA MCU

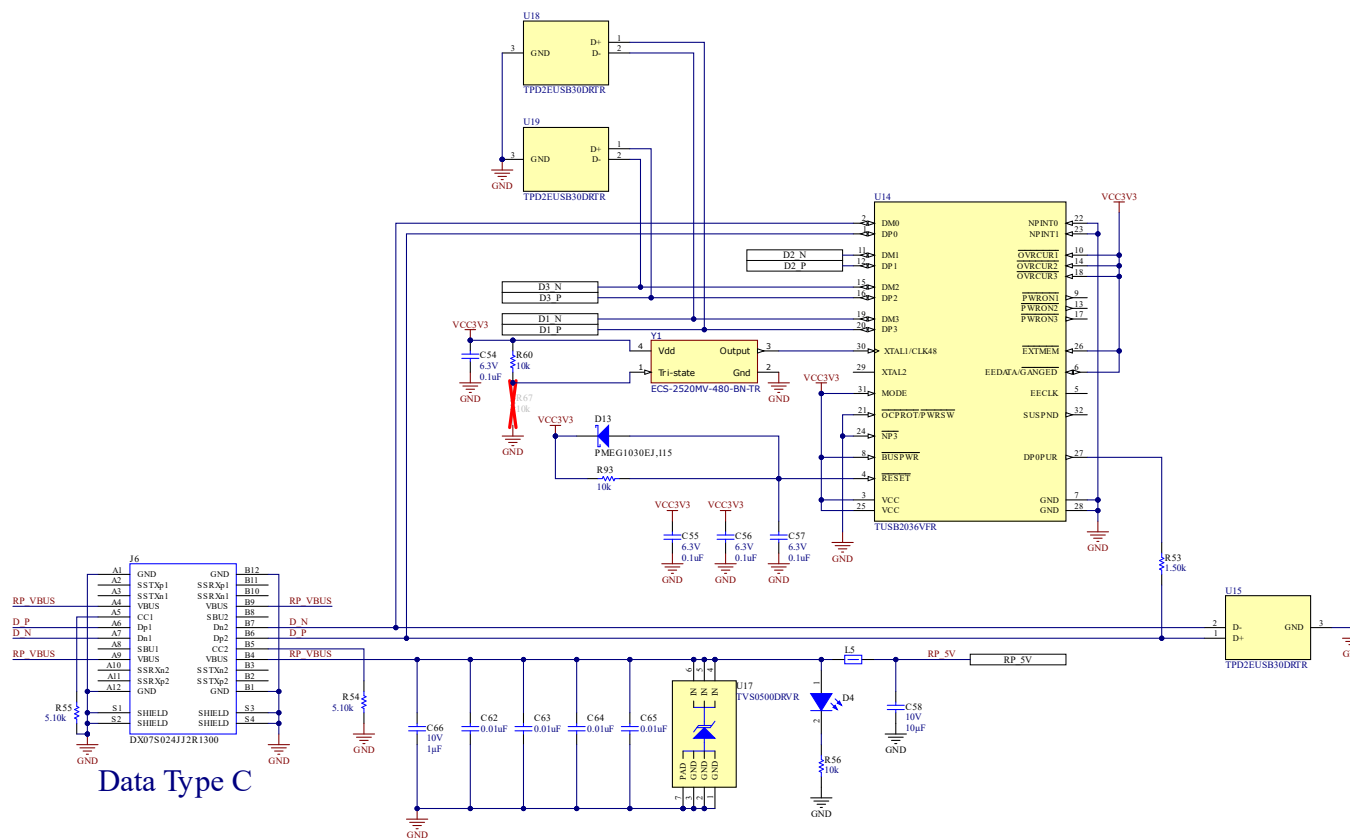
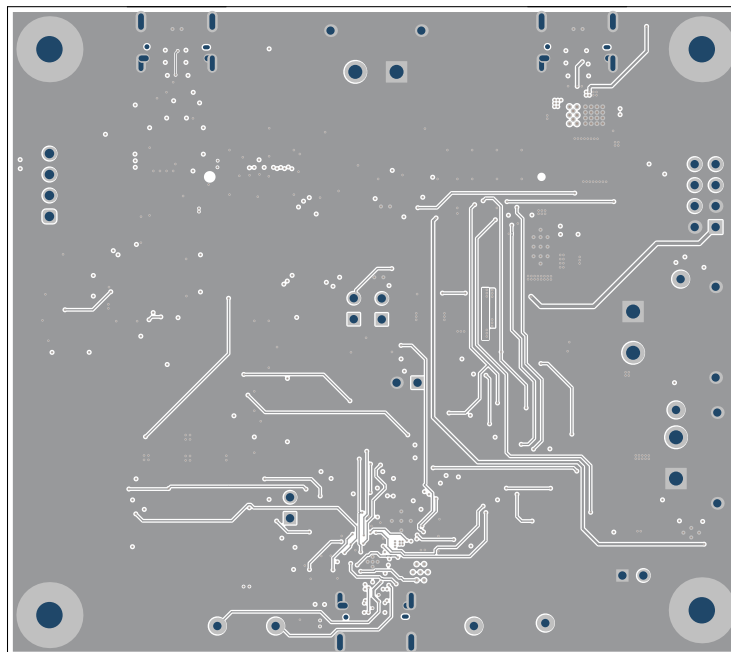
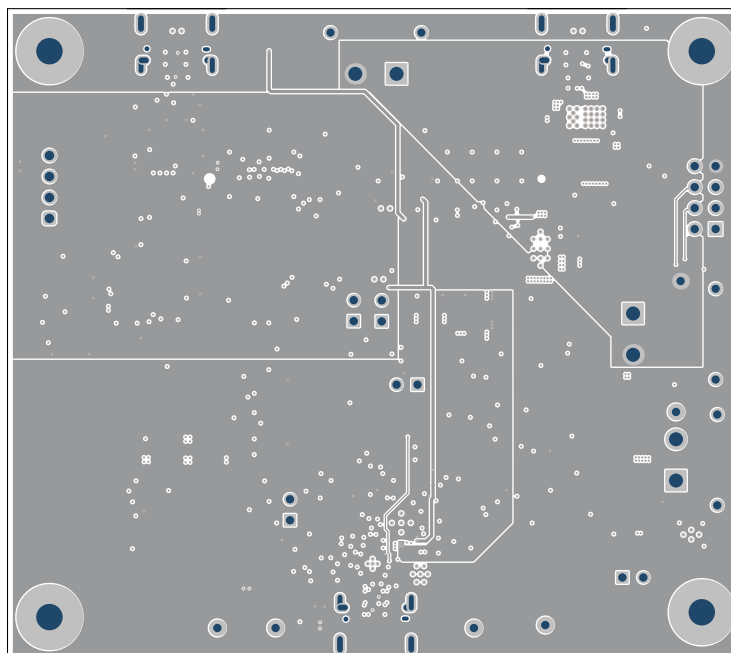


Figure 5-11. HUB

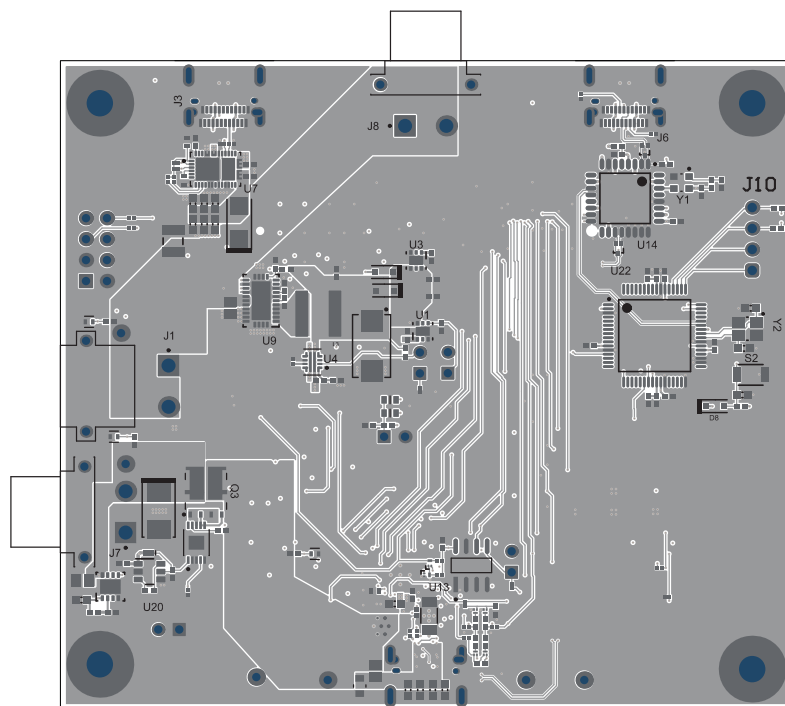
46 *TPS26750 Evaluation Module*



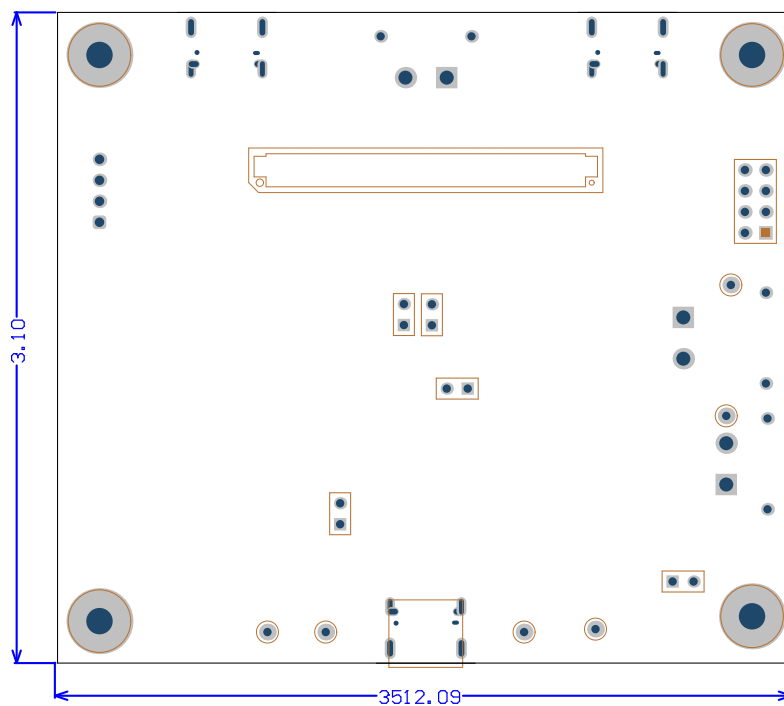
**Figure 5-14. TPS26750EVM Internal Layer 1**



**Figure 5-15. TPS26750EVM Internal Layer 2**



**Figure 5-16. TPS26750EVM Bottom Layer**



**Figure 5-17. TPS26750EVM Board Dimensions**



## 5.3 Bill of Materials (BOM)

**Table 5-1. Bill of Materials**

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
!PCB1	1		IPP007	Any	Printed Circuit Board	
C1, C2, C5, C6, C35	5	1uF	C1005X6S1C105K050BC	TDK	CAP, CERM, 1 uF, 16 V, +/- 10%, X6S, 0402	0402
C3, C48	2	0.1uF	C1005X5R1H104K050BB	TDK	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X5R, 0402	0402
C4, C7, C9	3	3.3uF	C1005X5R1A335K050BC	TDK	CAP, CERM, 3.3 uF, 10 V, +/- 10%, X5R, 0402	0402
C8	1	0.22uF	C1005X5R1E224M050B C	TDK	CAP, CERM, 0.22 uF, 25 V, +/- 20%, X5R, 0402	0402
C12	1	1uF	GRM155R6YA105KE11D	MuRata	CAP, CERM, 1 uF, 35 V, +/- 10%, X5R, 0402	0402
C13, C22	2	0.1uF	GMK105BJ104KV-F	Taiyo Yuden	CAP, CERM, 0.1 uF, 35 V, +/- 10%, X5R, 0402	0402
C14, C15, C16, C17, C62, C63, C64, C65	8	0.01uF	C0402C103J5RACTU	Kemet	CAP, CERM, 0.01 uF, 50 V, +/- 5%, X7R, 0402	0402
C18, C19, C42, C45, C46	5	10uF	CL05A106MP5NUNC	Samsung Electro-Mechanics	CAP, CERM, 10 uF, 10 V, +/- 20%, X5R, 0402	0402
C20, C21	2	330pF	CGA1A2X7R1H331K030 BA	TDK	CAP, CERM, 330 pF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0201	0201
C23, C24, C25, C26, C27, C28	6	10uF	GRM188R6YA106MA73D	Murata	CAP, CERM, 10 uF, 35 V, +/- 20%, X5R, 0603	0603
C30	1	4.7uF	C3225X7S2A475K200AE	TDK	CAP, CERM, 4.7 uF, 100 V, +/- 10%, X7S, 1210	1210
C31	1	0.47uF	C2012X7S2A474K125AB	TDK	CAP, CERM, 0.47 uF, 100 V, +/- 10%, X7S, 0805	0805
C33	1	0.47uF	GRM155R61A474KE15D	MuRata	CAP, CERM, 0.47 uF, 10 V, +/- 10%, X5R, 0402	0402
C34	1	220uF	TPSE227M016R0100	AVX	CAP, TA, 220 uF, 16 V, +/- 20%, 0.1 ohm, SMD	7343-43
C36	1	2.2uF	C1005X6S1C225K050BC	TDK	CAP, CERM, 2.2 uF, 16 V, +/- 10%, X6S, 0402	0402
C37	1	4.7µF	C2012X5R2A475K125AC	TDK	4.7 µF ±10% 100V Ceramic Capacitor X5R 0805 (2012 Metric)	0805
C38, C39, C40, C41	4	0.01uF	C0603X103K1RACTU	Kemet	CAP, CERM, 0.01 uF, 100 V, +/- 10%, X7R, 0603	0603
C43, C44	2	10uF	GRM188R61E106MA73D	MuRata	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603	0603

**Table 5-1. Bill of Materials (continued)**

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
C47	1	0.1uF	GRM155R62A104KE14D	MuRata	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X5R, 0402	0402
C49	1	1uF	GRM033R60J105MEA2D	MuRata	CAP, CERM, 1 uF, 6.3 V, +/- 20%, X5R, 0201	0201
C50	1	0.47uF	C3216X7R2A474K160AA	TDK	CAP, CERM, 0.47 uF, 100 V, +/- 10%, X7R, 1206	1206
C51, C52	2	220pF	CGA1A2X7R1H221K030 BA	TDK	CAP, CERM, 220 pF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0201	0201
C53, C61, C82, C83, C84, C86, C88	7	0.1uF	CGA2B3X7R1H104K050 BB	TDK	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402
C54, C55, C56, C57	4	0.1uF	GRM155R60J104KA01D	MuRata	CAP, CERM, 0.1 uF, 6.3 V, +/- 10%, X5R, 0402	0402
C58	1	10uF	0402ZD106MAT2A	AVX	CAP, CERM, 10 uF, 10 V, +/- 20%, X5R, 0402	0402
C59	1	1uF	C2012X7S2A105K125AE	TDK	CAP, CERM, 1 uF, 100 V, +/- 10%, X7S, 0805	0805
C60	1	2.2uF	GRM188Z71C225KE43	MuRata	CAP, CERM, 2.2 uF, 16 V, +/- 10%, X7R, 0603	0603
C66	1	1uF	CC0402MRX5R6BB105	Yageo America	CAP, CERM, 1 uF, 10 V, +/- 20%, X5R, 0402	0402
C85, C87	2	4.7uF	C1005X5R1A475M050B C	TDK	CAP, CERM, 4.7 uF, 10 V, +/- 20%, X5R, 0402	0402
C89	1	180pF	06035A181JAT2A	AVX	CAP, CERM, 180 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603
C90, C91	2	10pF	06035A100JAT2A	AVX	CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603
D1	1	60V	SK56A-LTP	Micro Commercial Components	Diode, Schottky, 60 V, 5 A, SMA	SMA
D2, D5, D10	3	30V	BAT42WS-7-F	Diodes Inc.	Diode, Schottky, 30 V, 0.2 A, SOD-323	SOD-323
D3, D20, D22	3	48V	SMBJ48A-13-F	Diodes Inc.	Diode, TVS, Uni, 48 V, 77.4 Vc, SMB	SMB
D4, D6, D23, D26	4	White	LW QH8G-Q2S2-3K5L-1	OSRAM	LED, White, SMD	0402, White
D7	1	Blue	150060BS75000	Wurth Elektronik	LED, Blue, SMD	LED_0603
D8	1	5V	1SS315TPH3F	Toshiba	Diode, Schottky, 5 V, 0.03 A, SOD-323	SOD-323

**Table 5-1. Bill of Materials (continued)**

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
D12	1	30V	NSR05F30NXT5G	ON Semiconductor	Diode, Schottky, 30 V, 0.5 A, 0402 Diode	0402 Diode
D13	1	10V	PMEG1030EJ,115	Nexperia	Diode, Schottky, 10 V, 3 A, SOD-323F	SOD-323F
FID1, FID2, FID3	3		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
H1, H2, H3, H4	4		NY PMS 440 0025 PH	B&F Fastener Supply	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw
H5, H6, H7, H8	4		1902C	Keystone	Standoff, Hex, 0.5"L #4-40 Nylon	Standoff
J1	1		XT30PW-M	Amass	Socket, DC supply, XT30, male, PIN: 2, on PCBs, THT, yellow, 15A, 500V	CONN_PLUG2
J2	1		TSM-108-01-L-DV	Samtec	Header, 2.54mm, 8x2, Gold, SMT	Header, 2.54mm, 8x2, SMT
J3, J4, J6	3		DX07S024JJ2R1300	JAE Electronics	Receptacle, USB 3.1 Type C, R/A, Gold, SMT	Receptacle, USB 3.1 Type C, R/A, SMT
J5	1		54202-G0810LF	FCI	Header, 2.54mm, 10x2, Tin, SMT	Header, 2.54mm, 10x2, SMT
J7, J8	2		XT30PW-F	Amass	Socket, DC supply, XT30, female, PIN: 2, on PCBs, THT, yellow, 15A	CONN_SOCKET_DC2
J9	1		TSW-104-07-G-D	Samtec	Header, 100mil, 4x2, Gold, TH	4x2 Header
J10	1		61300411121	Würth Elektronik	Header, 2.54 mm, 4x1, Gold, TH	Header, 2.54mm, 4x1, TH
J11, J12, J13, J14, J15	5		PEC02SAAN	Sullins Connector Solutions	Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin
L2, L4, L5	3	22 ohm	742792021	Würth Elektronik	Ferrite Bead, 22 ohm @ 100 MHz, 6 A, 0805	0805
L3	1	4.7uH	XAL6060-472MEB	Coilcraft	Inductor, Shielded, Composite, 4.7 µH, 10.5 A, 0.0144 ohm, AEC-Q200 Grade 1, SMD	IND_6.4x6.1x6.6
LBL1	1		THT-14-423-10	Brady	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch

**Table 5-1. Bill of Materials (continued)**

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
Q3	1		SQJB80EP-T1_GE3	Vishay	Mosfet Array 80V 30A (Tc) 48W Surface Mount PowerPAK® SO-8 Dual	SO-8L-DUAL
Q6, Q7	2	30V	CSD17484F4T	Texas Instruments	MOSFET, N-CH, 30 V, 3 A, YJJ0003A (PICOSTAR-3)	YJJ0003A
Q8	1	30V	CSD17581Q3A	Texas Instruments	MOSFET, N-CH, 30 V, 60 A, DNH0008A (VSONP-8)	DNH0008A
Q15, Q18, QN1, QN2	4	20V	CSD15380F3	Texas Instruments	MOSFET, N-CH, 20 V, 0.5 A, YJM0003A (PICOSTAR-3)	YJM0003A
QP1, QP2	2	-20V	CSD25480F3	Texas Instruments	MOSFET, P-CH, -20 V, -1.7 A, YJM0003A (PICOSTAR-3)	YJM0003A
R1, R18, R21, R22, R58, R79, R80	7	100k	CRCW0402100KFKED	Vishay-Dale	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402
R2	1	100k	ERJ-2RKF1003X	Panasonic	RES, 100 k, 1%, 0.1 W, 0402	0402
R3, R15, R56, R60, R93, R149, R152	7	10k	CRCW040210K0JNED	Vishay-Dale	RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402
R4, R5	2	0	ERJ-H3G0R00V	Panasonic	0 Ohms Jumper 0.125W, 1/8W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thick Film	0603
R11, R12	2	200k	CRCW0201200KFKED	Vishay-Dale	RES, 200 k, 1%, 0.05 W, 0201	0201
R13, R14	2	51.0k	RC0201FR-0751KL	Yageo America	RES, 51.0 k, 1%, 0.05 W, 0201	0201
R16, R17, R36, R37, R42, R43	6	2.20k	CRCW02012K20FKED	Vishay-Dale	RES, 2.20 k, 1%, 0.05 W, 0201	0201
R20	1	412k	CRCW0402412KFKED	Vishay-Dale	RES, 412 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402
R23	1	23.7k	ERJ-2RKF2372X	Panasonic	RES, 23.7 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402
R24, R25, R26, R27, R28, R30, R45, R46, R89, R90	10	0	CRCW02010000Z0ED	Vishay-Dale	RES, 0, 5%, 0.05 W, 0201	0201
R31	1	0	CRCW04020000Z0ED	Vishay-Dale	RES, 0, 5%, 0.063 W, 0402	0402

**Table 5-1. Bill of Materials (continued)**

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
R32, R96, R97, R98	4	10.0k	CRCW040210K0FKED	Vishay-Dale	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402
R34, R35	2	100k	RC0201FR-07100KL	Yageo America	RES, 100 k, 1%, 0.05 W, 0201	0201
R38, R44, R59	3	10.0k	CRCW020110K0FKED	Vishay-Dale	RES, 10.0 k, 1%, 0.05 W, 0201	0201
R47, R52	2	100k	RC1005F104CS	Samsung Electro-Mechanics	RES, 100 k, 1%, 0.063 W, 0402	0402
R48, R49, R50, R51	4	1.00Meg	ERJ-2RKF1004X	Panasonic	RES, 1.00 M, 1%, 0.1 W, 0402	0402
R53	1	1.50k	RMCF0402FT1K50	Stackpole Electronics Inc	RES, 1.50 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402
R54, R55	2	5.10k	RC0201FR-075K1L	Yageo America	RES, 5.10 k, 1%, 0.05 W, 0201	0201
R63	1	115k	RC0402FR-07115KL	Yageo America	RES, 115 k, 1%, 0.063 W, 0402	0402
R65, R66, R71, R72	4	90.9k	CRCW040290K9FKED	Vishay-Dale	RES, 90.9 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402
R69, R70, R73, R74	4	10k	CRCW040210K0FKEDC	Vishay	10 kOhms $\pm$ 1% 0.063W, 1/16W Chip Resistor 0402 (1005 Metric) Thick Film	0402
R81	1	750	RC0201FR-07750RL	Yageo America	RES, 750, 1%, 0.05 W, 0201	0201
R91	1	100k	RC0201FS-7D100KL	Yageo America	RES, 100 k, 1%, 0.05 W, 0201	0201
S2	1		B3U-1000P	Omron Electronic Components	SWITCH TACTILE SPST-NO 0.05A 12V	3x1.6x2.5mm
SH-J11, SH-J12, SH-J13, SH-J14, SH-J15	5	1x2	SNT-100-BK-G	Samtec	Shunt, 100mil, Gold plated, Black	Shunt
TP1, TP11	2		5003	Keystone Electronics	Test Point, Miniature, Orange, TH	Orange Miniature Testpoint
TP2	1		5117	Keystone	Test Point, Miniature, Blue, TH	Blue Miniature Testpoint
TP3, TP5	2		5002	Keystone Electronics	Test Point, Miniature, White, TH	White Miniature Testpoint
TP4	1		5000	Keystone Electronics	Test Point, Miniature, Red, TH	Red Miniature Testpoint

**Table 5-1. Bill of Materials (continued)**

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
TP7, TP10, TP13, TP14	4		5015	Keystone Electronics	Test Point, Miniature, SMT	Testpoint_Keystone_Miniature
U1, U3	2		TLV75733PDRVR	Texas Instruments	1A Low-Quiescent-Current Low-Dropout (LDO) Regulator, DRV0006A (WSO-6)	DRV0006A
U2	1		TPS26750RSMR	Texas Instruments	USB Type-C® and USB PD Controller with Integrated Power Switches Optimized for Power Applications	VQFN32
U4	1		TPS259814ARPWR	Texas Instruments	2.7- 16 V, 10 A, 7 mΩ eFuse with transient overcurrent blanking timer	QFN10
U6	1			Texas Instruments	Switched Capacitor Voltage Converter, 6-pin SOT-23, Pb-Free	DBV0006A
U7	1		TPS25750DRJK	Texas Instruments	USB Type-C and USB PD Controller with Integrated Power Switches Optimized for Power Applications	VQFN32
U8	1		TVS2200DRVR	Texas Instruments	22-V Precision Surge Protection Clamp, DRV0006A (WSO-6)	DRV0006A
U9	1		LM76005RNPR	Texas Instruments	3.5V to 60V 5A Synchronous Step-Down Voltage Regulator, RNP0030A (WQFN-30)	RNP0030A
U10	1		LTC7004IMSE#TRPBF	Analog Devices	High-Side Gate Driver IC Non-Inverting 10-MSOP-EP	MSOP10
U12	1		TPD4S480RUKR	Texas Instruments	USB Type-C® 48V EPR Port Protector: Short-to-VBUS Overvoltage and IEC ESD Protection	WQFN20
U13	1		CAT24C512WI-GT3	ON Semi	EEPROM Memory IC 512Kb (64K x 8) I²C 1MHz 900ns 8-SOIC	SOIC8

**Table 5-1. Bill of Materials (continued)**

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
U14	1		TUSB2036VFR	Texas Instruments	2 / 3-Port Hub for USB with Optional Serial EEPROM Interface, 3.3V, 0 to 70 degC, 32-Pin LQFP (VF), Green (RoHS & no Sb/Br)	VF0032A
U15, U18, U19	3		TPD2EUSB30DRTR	Texas Instruments	ESD Solution for Super-Speed (6 Gbps) USB 3.0 Interface, 2 Channels, -40 to +85 degC, 3-pin SOT (DRT), Green (Rohs & No Sb/Br)	DRT0003A
U17	1		TVS0500DRVR	Texas Instruments	5-V Precision Surge Protection Clamp, DRV0006A (WSON-6)	DRV0006A
U20	1		TPS7A1650DRBR	Texas Instruments	60V, 5uA Iq, 100mA Low-Dropout (LDO) Voltage Regulator With Enable and Power Good, DRB0008B (VSON-8)	DRB0008B
U22	1		TM4C123GH6PMTR	Texas Instruments	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
Y1	1		ECS-2520MV-480-BN-TR	ECS International	Oscillator XO 48MHz ±50ppm 15pF HCMOS 55% 1.8V/2.5V/3.3V 4-Pin Mini-CSMD T/R	SMT_OSC_2MM5_2MM0
Y2	1		NX3225GA-16.000M-STD-CRG-1	NDK	Crystal, 16 MHz, 8pF, SMD	3.2x0.75x2.5mm
P1	0		FX8-120P-SV1(91)	Hirose Electric Co. Ltd.	Header(shrouded), 0.6mm, 60x2, Gold, SMT	Header(shrouded), 0.6mm, 60x2, SMD
R6, R7, R8, R9	0	100k	RC0603FR-07100KL	Yageo	RES, 100 k, 1%, 0.1 W, 0603	0603
R10	0	10.0k	RC0201FS-7D10KL	Yageo America	RES, 10.0 k, 1%, 0.05 W, 0201	0201
R19, R29	0	10.0k	CRCW020110K0FKED	Vishay-Dale	RES, 10.0 k, 1%, 0.05 W, 0201	0201
R67	0	10k	CRCW040210K0JNED	Vishay-Dale	RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402



**Table 5-1. Bill of Materials (continued)**

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
R77, R78, R137, R139	0	0	CRCW02010000Z0ED	Vishay-Dale	RES, 0, 5%, 0.05 W, 0201	0201
R94, R95	0	100k	CRCW0402100KFKED	Vishay-Dale	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402

## 6 Additional Information

### 6.1 Trademarks

USB Type-C® is a registered trademark of USB Implementers Forum.

Google Chrome® is a registered trademark of Google LLC.

Firefox® is a registered trademark of Mozilla Foundation.

Safari® is a registered trademark of Apple Inc.

All trademarks are the property of their respective owners.

### 6.2 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits can be more susceptible to damage because very small parametric changes can cause the device not to meet the published specifications.

### 6.3 Terminology

[TI Glossary](#) lists and explains generic terms, acronyms, and definitions.

[A Primer on USB Type-C® and USB Power Delivery Applications and Requirements](#) lists and explains USB Type-C and USB Power Delivery terms, acronyms and definitions.

### 6.4 Device Support

#### 6.4.1 Third-Party Products Disclaimer

TI's publication of information regarding third-party products or services does not constitute an endorsement regarding the ability of such products or services or a warranty, representation or endorsement of such products or services, either alone or in combination with any TI product or service.

#### 6.4.2 Supplemental Content

For the device to function in accordance with the relevant specifications, the user needs to download the latest version of the firmware for the device (see section on receiving notification of documentation and firmware updates). If the latest version of the firmware is not downloaded and incorporated into the device, then the device is provided “as is” and TI makes no warranty or representation whatsoever in respect of such device, and disclaims any and all warranties and representations with respect to such device. Further, if the latest version of the firmware is not downloaded and incorporated into the device, TI is not be liable for and specifically disclaims any damages, including direct damages, however caused, whether arising under contract, tort, negligence, or other theory of liability relating to the device, even if TI is advised of the possibility of such damages.

### 6.5 Documentation Support

- [USB Power Delivery Specification](#)
- [USB-PD Specifications](#)
- [USB Type-C Cable and Connector Specifications](#)
- [USB Document Library](#)
- [USB Power Delivery - Compliance Reports](#)
- [Designing a Battery Charging System for Diversifying Applications](#), application note
- [USB Type-C PD3.1 extended power range, and the benefits of Type-C + BQ solution](#), seminar
- [Designing an application to support a wide input voltage and battery voltage](#), technical article

## 6.6 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](https://www.ti.com). Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. for change details, review the revision history included in any revised document.

## 6.7 Support Resources

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## 7 Revision History

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

<b>Changes from Revision * (September 2024) to Revision A (June 2025)</b>	<b>Page</b>
• Updated USB-IF PD specification version from 3.1 to 3.2.....	<a href="#">1</a>
• Updated EVM image to RevA3.....	<a href="#">1</a>
• Updated EVM to RevA3.....	<a href="#">3</a>
• Deleted wall adapter brand, added note for RevA2 image .....	<a href="#">8</a>
• Deleted wall adaptor brand, added note for RevA2 image.....	<a href="#">10</a>
• Deleted wall adaptor brand, added note for RevA2 image.....	<a href="#">13</a>
• Updated table name.....	<a href="#">14</a>
• Updated image to RevA3.....	<a href="#">16</a>
• Added note for RevA2 image.....	<a href="#">18</a>
• Updated image to RevA3.....	<a href="#">20</a>
• Deleted debug mode, added VIF generation.....	<a href="#">23</a>
• Updated link to newly released VIF Generation Application Note.....	<a href="#">36</a>
• Removed Liquid Detection use case.....	<a href="#">37</a>
• Updated layout image to RevA3.....	<a href="#">46</a>
• Updated BOM table for RevA3.....	<a href="#">49</a>

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