EVM User's Guide: TUSB1046EVM

TUSB1046 USB Type-C™ Enabler

Description

The TUSB1046 USB Type-C™ Alternate Mode re-driving switch supports data rates up to 10Gbps for a downstream facing port (host). This user's guide describes how to use the EVM and includes schematics that can be used as a reference design for the alternate mode implementations of the host system with the TUSB1046 device.

Get Started

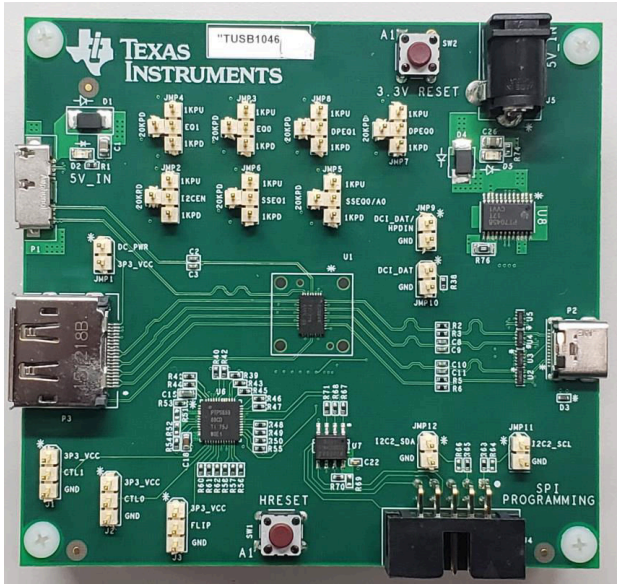
1. Order the EVM
2. Configure the board headers to fit your application
3. Use the EVM and associated design files to evaluate the TUSB1046
4. For issues, reach out to us directly on the TI E2E forum

Features

- USB Type-C™ crosspoint switch supporting
  - USB 3.1 SSP + 2 DisplayPort™ lanes
  - 4 DisplayPort™ lanes
- USB 3.1 Gen 1/Gen 2 up to 10Gbps
- DisplayPort™ 1.4 up to 8.1Gbps (HBR3)
- VESA® DisplayPort™ Alt mode DFP redriving crosspoint switch supporting C, D, E and F configurations
- Ultra-low-power architecture
- Linear redriver with up to 14dB equalization
- Transparent to DisplayPort™ link training
- Automatic LFPS de-emphasis control to meet USB 3.1 certification requirements
- Configuration through GPIO or I^2C
- Hot-plug capable

Applications

- Tablets
- Notebooks
- Desktops
- Smartphones
- Docking stations
- Automotive infotainment



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1 Evaluation Module Overview

1.1 Introduction

The TUSB1046 device is a USB Type-C/VESA DisplayPort, alternate mode, redriving MUX, which supports data rates up to 10Gbps for a downstream facing port (device). This EVM user's guide describes how to bring up the EVM, and includes schematics that can be used as a reference design for alternate mode implementations of the system with the TUSB1046 device.

1.2 Kit Contents

The TUSB1046EVM includes:

- The TUSB1046 device
- (1) USB Micro-B receptacle that connects to a USB host
- (1) DisplayPort receptacle that connects to a DisplayPort-capable host
- (1) Standard 5V barrel jack receptacle
- Headers for configuring various TUSB1046 features

1.3 Specification

Figure 1-1 shows the power and data path of the TUSB1046EVM.

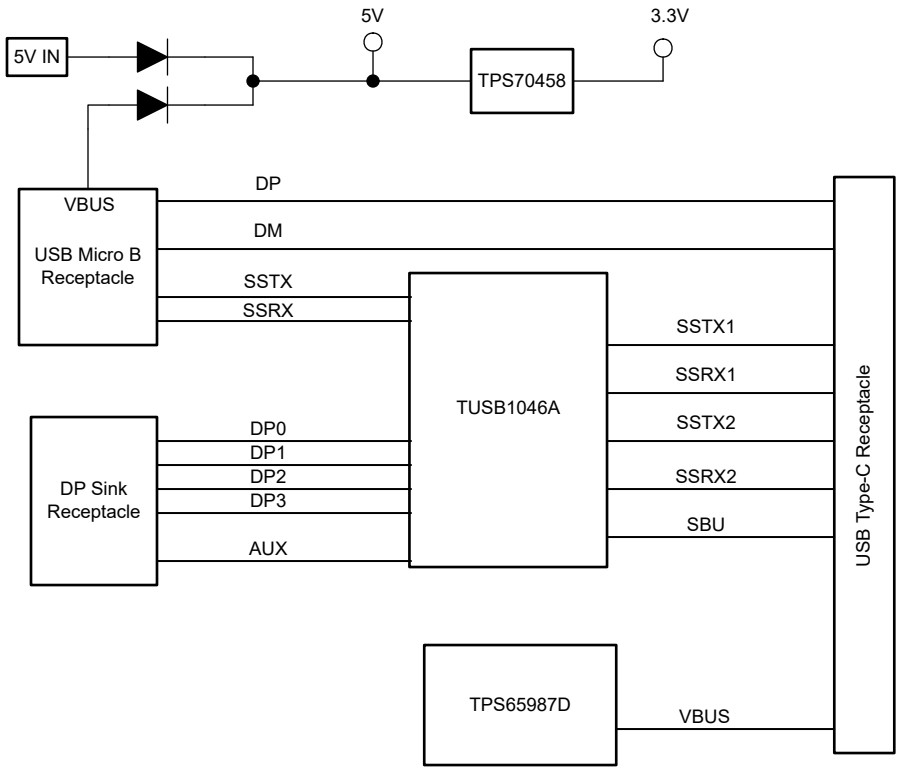


Figure 1-1. Block Diagram

1.4 Device Information

The TUSB1046 is a VESA USB Type-C Alt Mode redriving MUX that can support USB 3.2 Gen 2 x 1 data rates up to 10Gbps and DisplayPort 1.4 up to 8.1Gbps for downstream facing port (source). The device is used for DFP_D pin assignments C, D, and E from the VESA DisplayPort Alt Mode on USB Type-C standard.

2 Hardware

2.1 Power Requirements

The EVM is designed to operate off of the VBUS from a USB host connected through USB Micro B, P1. No external power is to be applied through the J5 unless standalone operation is desired.

If testing the DisplayPort only, or if bypassing VBUS power, the EVM must be powered through the J5 (5V, 1A input).

2.2 TUSB1046EVM-SRC Test Board Setup

The TUSB1046EVM-SRC can be used with a legacy DP Source or USB Host system to evaluate the USB Type-C implementation. Figure 2-1 is a typical test setup.

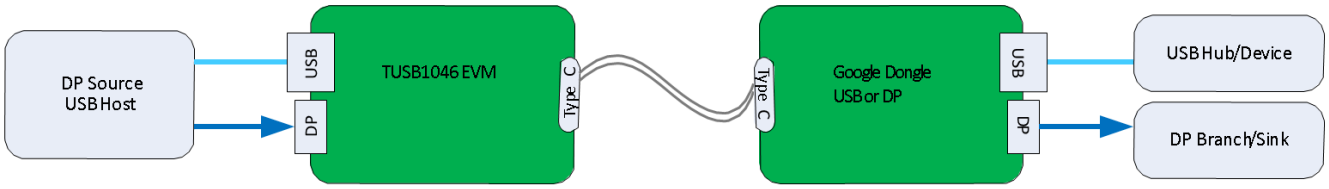


Figure 2-1. Test Board Setup

The EVM comes with a Micro B USB receptacle to connect to USB host systems and a DisplayPort receptacle to connect to DisplayPort-capable source. The TUSB1046 EVM uses the Texas Instruments TPS65987D (http://www.ti.com/product/TPS65987D) controller for power delivery and CC pin control.

2.3 TUSB1046 EVM Default EQ Configuration

The headers in Table 2-1 are provided for TUSB1046 EQ configuration by default, configuration settings may need to be optimized depending on the amount of loss of each channel in the system.

Table 2-1. TUSB1046 Configuration Pins

Reference Designator	JMP Control	Configuration
JMP2	I2C_EN	SHUNT on pin 2-3 (0 - 1k to GND)
JMP3	Downstream EQ0	SHUNT on pin 1-2 (1 - 1k to VCC)
JMP4	Downstream EQ1	SHUNT on pin 2-4 (R – 20k to GND)
JMP5	Upstream SSEQ0	SHUNT on pin 1-2 (1 – 1k to VCC)
JMP6	Upstream SSEQ1	SHUNT on pin 2-4 (R – 20k to GND)
JMP7	DP EQ0	SHUNT on pin 2-3 (0 – 1k to GND)
JMP8	DP EQ1	SHUNT on pin 2-4 (R – 20k to GND)

2.3.1 TUSB1046 EQ Control

Each of the TUSB1046 receiver lanes has individual controls for receiver equalization as shown in Table 2-2, Table 2-3, and Table 2-4. There are sixteen EQ settings with 0 being the lowest and Fh being the highest. Refer to the TUSB1046 datasheet for specific EQ value.

Table 2-2. Configuration Pin-Level Definitions

Level	Settings
0	Option 1: Tie 1kΩ 5% to GND Option 2: Tie directly to GND
R	Tie 20kΩ, 5% to GND

Table 2-2. Configuration Pin-Level Definitions (continued)

Level	Settings
F	Float (leave pin open)
1	Option 1: Tie 1kΩ 5% to VCC Option 2: Tie directly to VCC

Table 2-3. USB 3.1 EQ Settings

USB3.1 Downstream Facing Ports				USB3.1 Upstream Facing Port		
EQ1 Pin Level	EQ0 Pin Level	EQ Gain at 5GHz (dB)		SSEQ1 Pin Level	SSEQ0 Pin Level	EQ Gain at 5GHz (dB)
0	0	Lowest EQ setting		0	0	Lowest EQ setting
0	R			0	R	
0	F			0	F	
0	1			0	1	
R	0			R	0	
R	R			R	R	
R	F			R	F	
R	1			R	1	
F	0			F	0	
F	R			F	R	
F	F			F	F	
F	1			F	1	
1	0			1	0	
1	R			1	R	
1	F			1	F	
1	1	Highest EQ setting		1	1	Highest EQ setting

Table 2-4. DisplayPort EQ Settings

All DisplayPort Lanes		
DPEQ1 Pin Level	DPEQ0 Pin Level	EQ Gain at 4.05GHz (dB)
0	0	Lowest EQ setting
0	R	
0	F	
0	1	
R	0	
R	R	
R	F	
R	1	
F	0	
F	R	
F	F	
F	1	
1	0	
1	R	
1	F	
1	1	Highest EQ setting

3 Software

3.1 Firmware Description

The TUSB1046EVM uses the TPS65987 power delivery (PD) controller to manage the USB Type-C VBUS, handle the configuration channel negotiation, and to set the FLIP, CTL0, and CTL1 pins on the TUSB1046. The TPS65987 can be configured by loading firmware through the SPI programming header located on the side of the EVM. This evaluation module comes with pre-loaded firmware. However if a certain behavior is desired, custom firmware can be loaded to the PD controller as well. For details on creating a custom firmware file, see the TPS6598X-CONFIG on TI.com.

4 Hardware Design Files

4.1 TUSB1046EVM Schematics

Figure 4-1 displays the block diagram of the EVM.

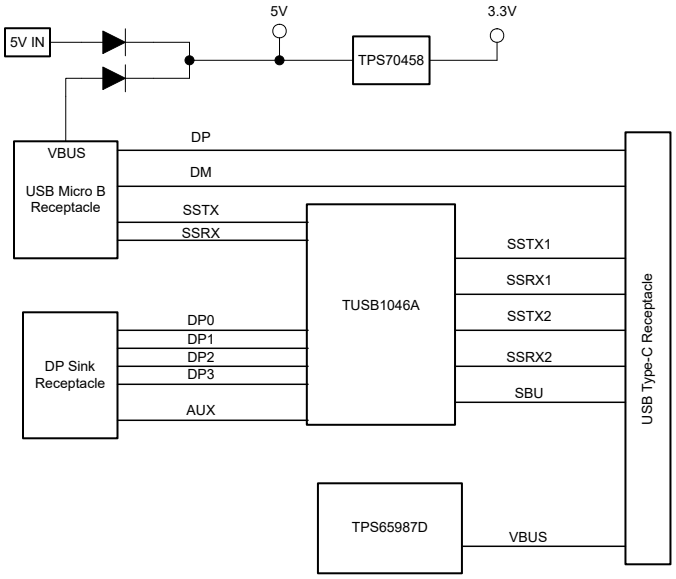


Figure 4-1. TUSB1046EVM Block Diagram

Figure 4-2 through Figure 4-5 show the EVM schematics.

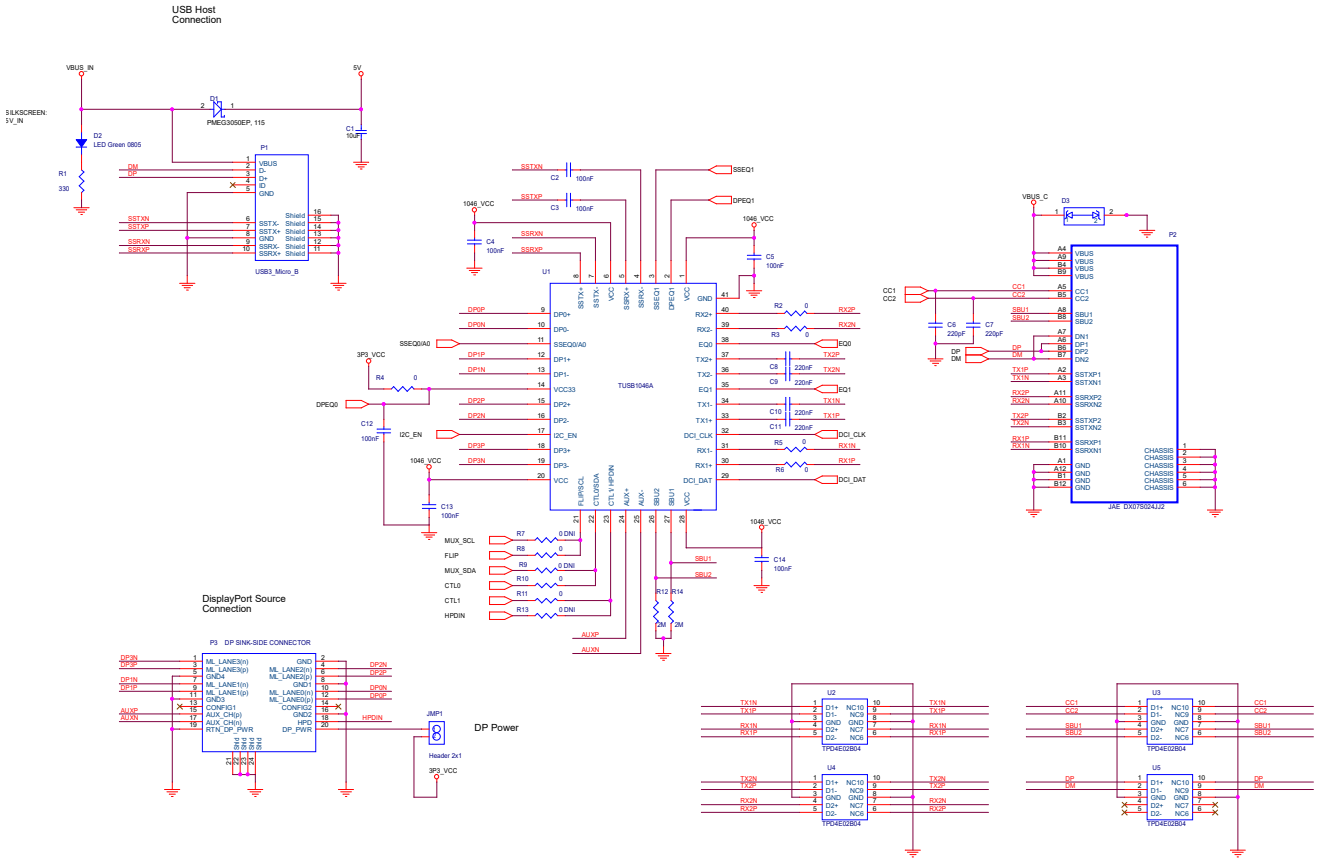
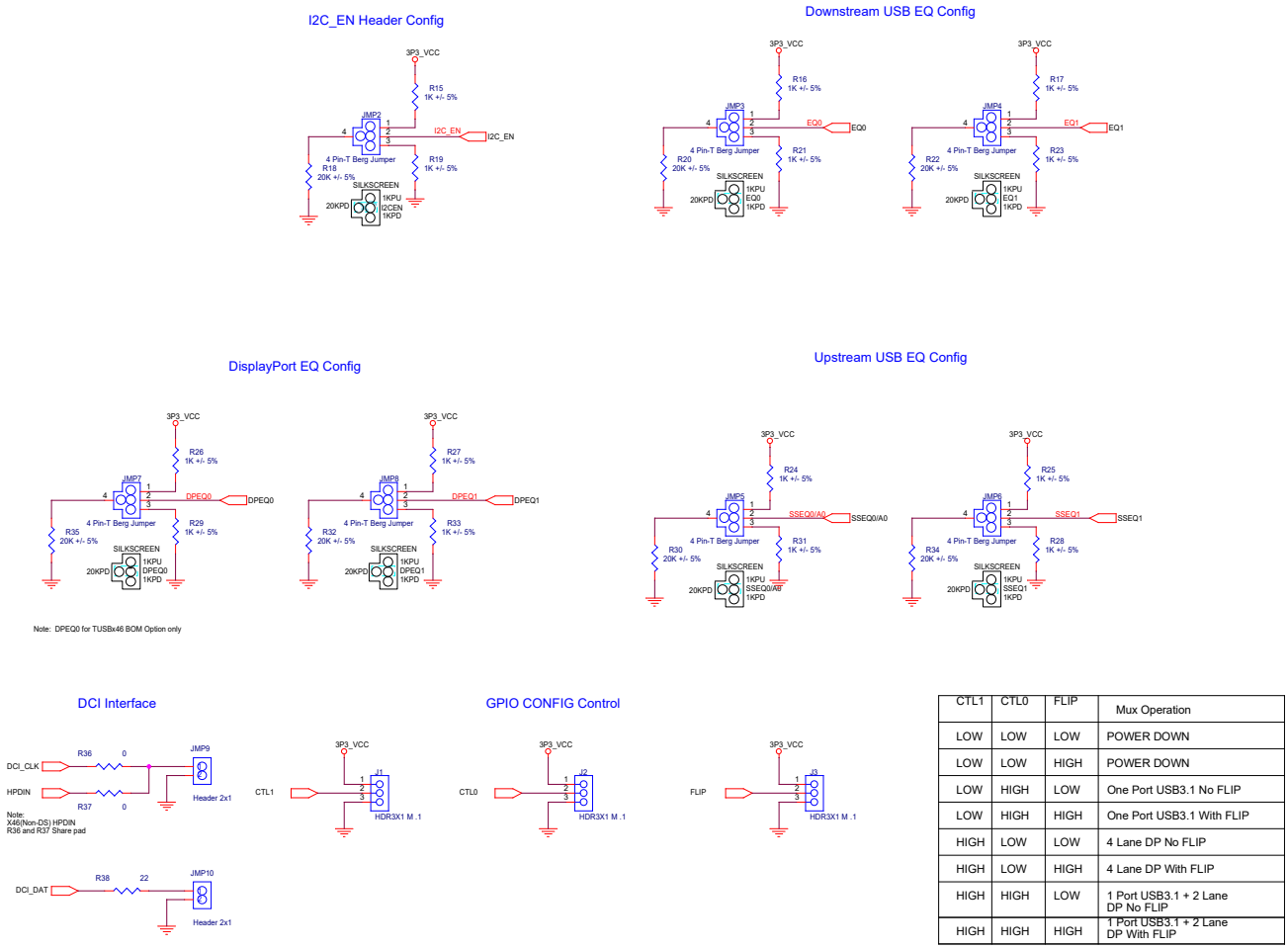


Figure 4-2. TUSB1046EVM Schematics (1 of 4)



CTL1	CTL0	FLIP	Mux Operation
LOW	LOW	LOW	POWER DOWN
LOW	LOW	HIGH	POWER DOWN
LOW	HIGH	LOW	One Port USB3.1 No FLIP
LOW	HIGH	HIGH	One Port USB3.1 With FLIP
HIGH	LOW	LOW	4 Lane DP No FLIP
HIGH	LOW	HIGH	4 Lane DP With FLIP
HIGH	HIGH	LOW	1 Port USB3.1 + 2 Lane DP No FLIP
HIGH	HIGH	HIGH	1 Port USB3.1 + 2 Lane DP With FLIP

Figure 4-3. TUSB1046EVM Schematics (2 of 4)

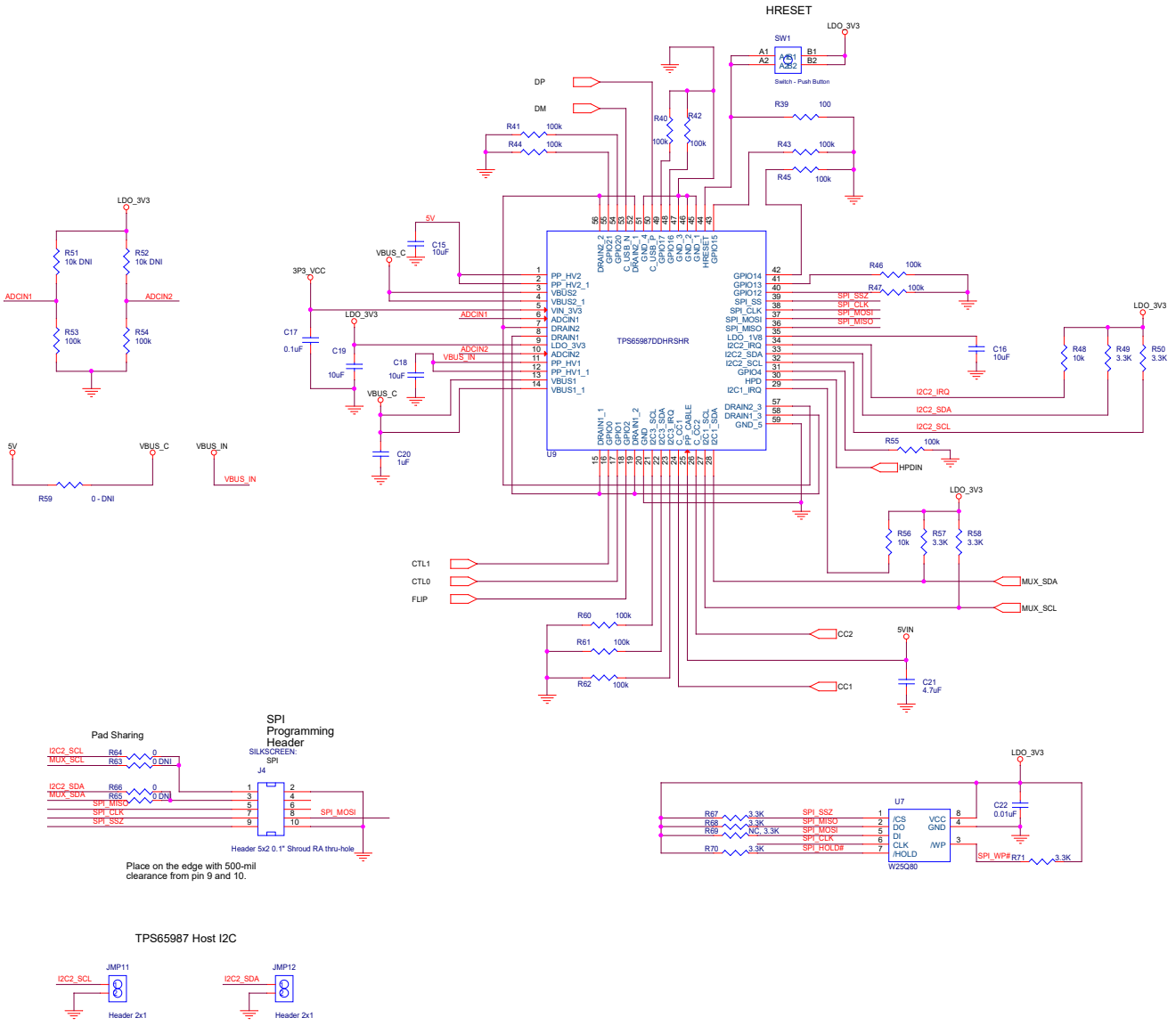
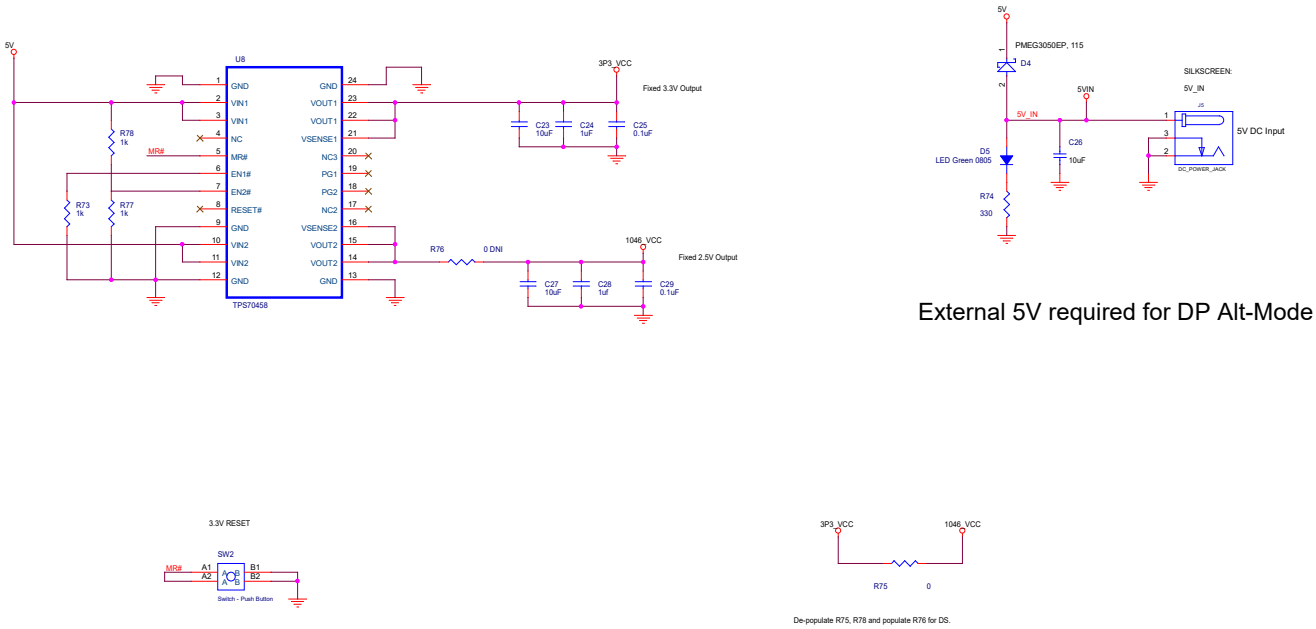


Figure 4-4. TUSB1046EVM Schematics (3 of 4)



External 5V required for DP Alt-Mode

Figure 4-5. TUSB1046EVM Schematics (4 of 4)

4.2 PCB Layouts

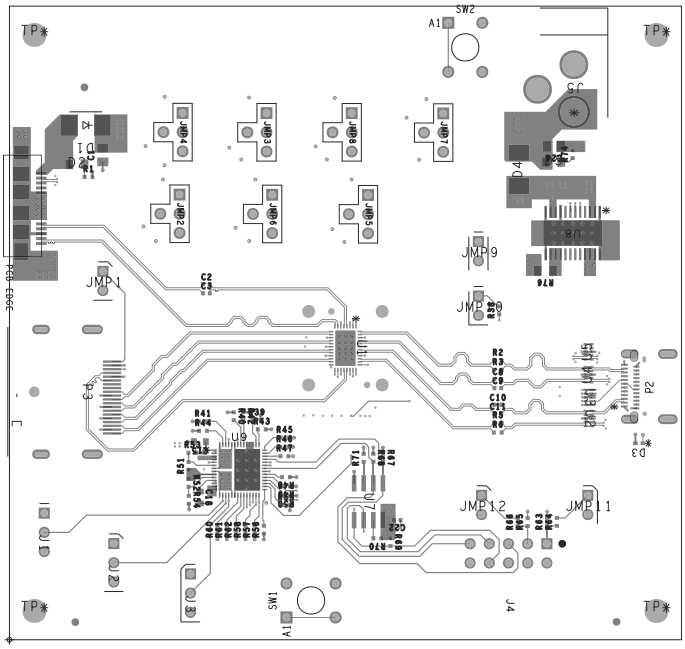


Figure 4-6. PCB Layer 1 (Top Side)

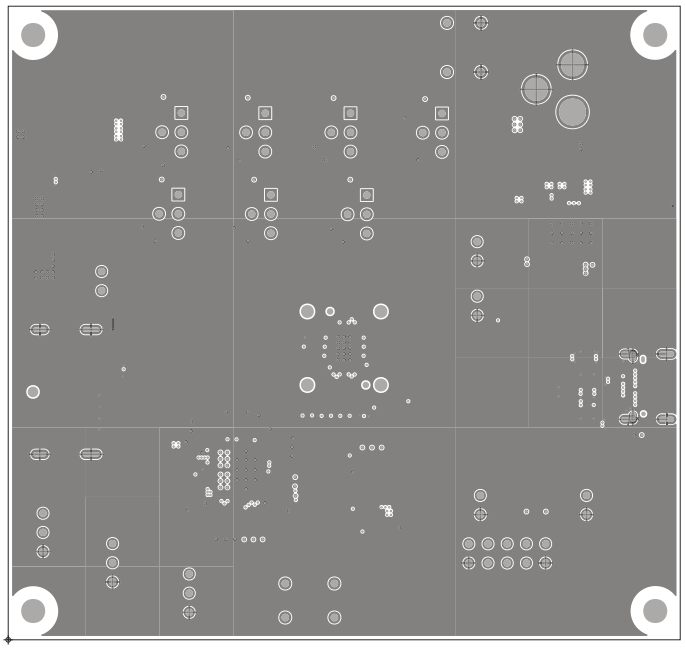


Figure 4-7. PCB Layer 2 (GND Plane)

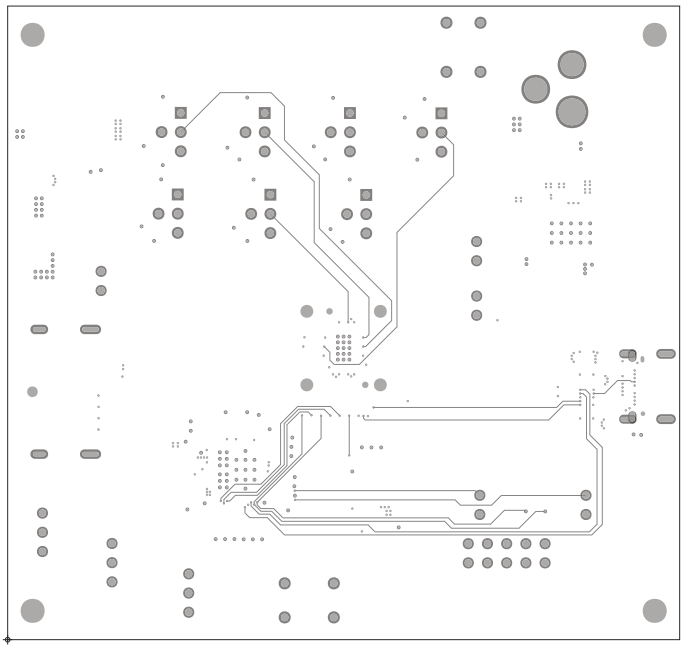


Figure 4-8. PCB Layer 3 (Signal)

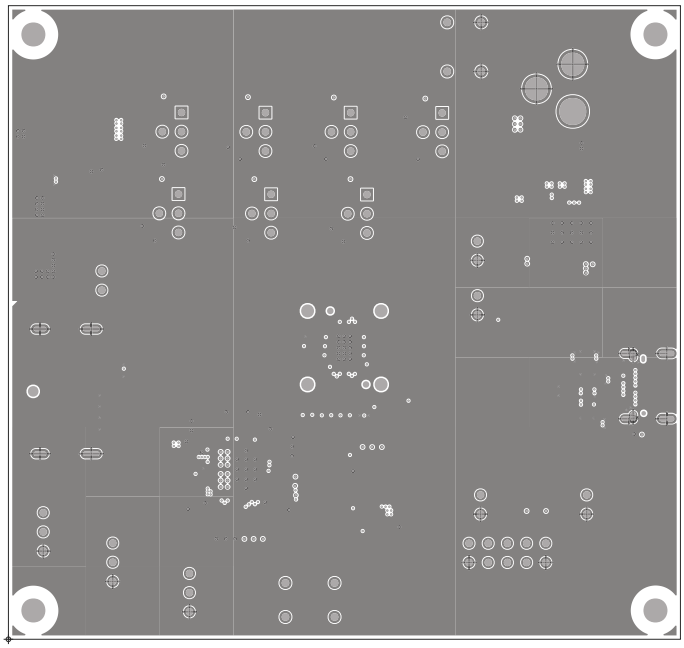


Figure 4-9. PCB Layer 4 (Ground)

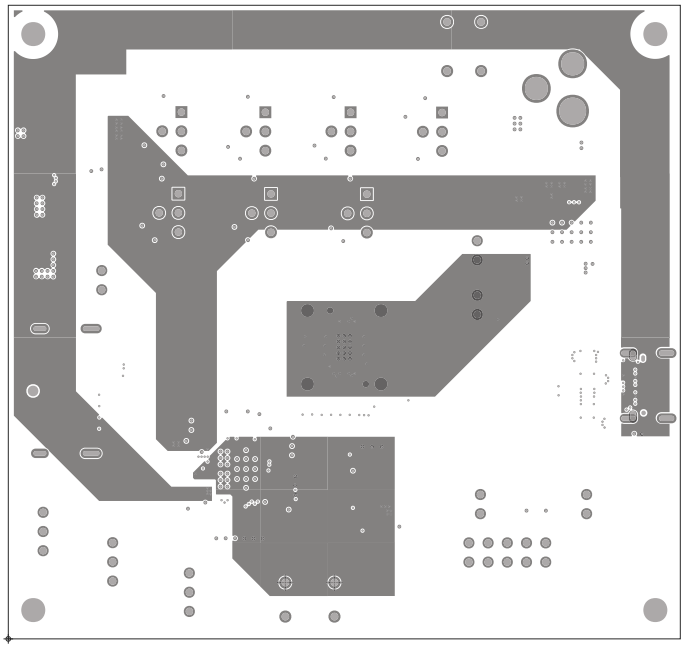


Figure 4-10. PCB Layer 5 (Power)

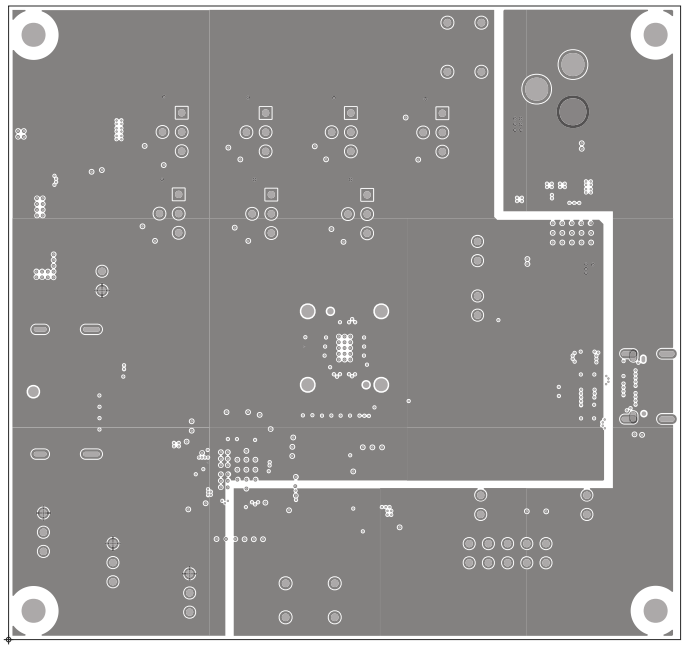


Figure 4-11. PCB Layer 6 (Signal)

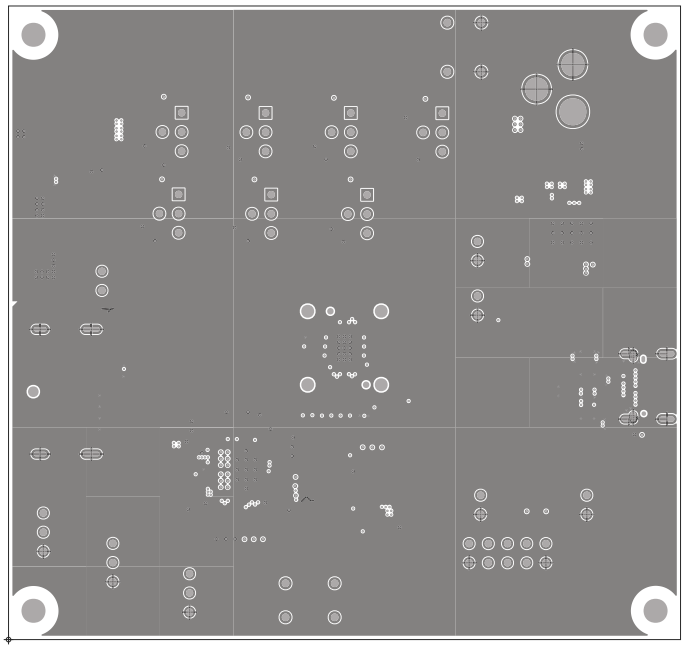


Figure 4-12. PCB Layer 7 (Ground)

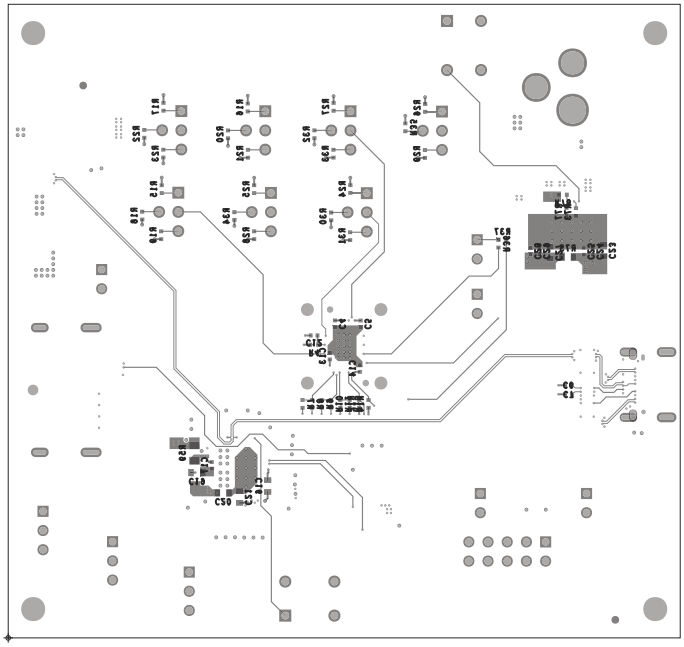


Figure 4-13. PCB Layer 8 (Bottom Side)

4.3 Bill of Materials (BOM)

Table 4-1 lists the TUSB1046EVM bill of materials (BOM).

Table 4-1. TUSB1046EVM Bill of Materials

ITEM	QTY	REFERENCE	PART	MANUFACTURER	MANUFACTURER PART NUMBER	FOOTPRINT
1	2	C1,C26	10uF	Murata	GRM219R60J106KE19D	c0805
2	7	C2,C3,C4,C5,C12,C13,C14	100nF	Murata	GRM155R61A104KA01D	c0402
3	2	C6,C7	220pF	Murata	GRM1555C1H221JA01D	c0402
4	4	C8,C9,C10,C11	220nF	Murata	GRM155R71C224KA12D	c0402
5	6	C15,C16,C18,C19,C23,C27	10uF	Murata	GRM188R61C106MA73D	c0603
6	3	C17,C25,C29	0.1uF	Murata	GRM155R61A104KA01D	c0402
7	1	C20	1uF	Murata	GRM188R61C105KA93D	c0603
8	1	C21	4.7uF	Murata	GRM188R60J475KE19D	c0603
9	1	C22	0.01uF	Murata	GRM155R71C103KA01D	c0402
10	2	C24,C28	1uf	Murata	GRM155R60J105ME19D	cc0402
11	1	D1	SCHOTTKY	NXP	PMEG3050EP,115	diode_smb
12	2	D2,D5	LED Green 0805	Lumex	LTST-C170KGKT	805
13	1	D3	TPD1E10B06	Texas Instruments	TPD1E10B06DPYR	DPY0002AA
14	1	D4	SCHOTTKY	Nexperia	PMEG3050EP,115	DO-214AA
15	5	JMP1,JMP9,JMP10,JMP11, JMP12	Header 2x1	FCI	68001-402HLF	HDR_THVT_1x2_100_M
16	7	JMP2,JMP3,JMP4,JMP5, JMP6,JMP7,JMP8	4 Pin-T Berg Jumper	AMP	68000-103HLF, 68000-101HLF	berg2x3tee
17	3	J1,J2,J3	HDR3X1 M .1	3M	961103-6404-AR	HDR_THVT_1x3_100_M
18	1	J4	Header 5x2 0.1" Shroud RA thru-hole	3M	20210-5002HB	HDR_THRT_2X5_100
19	1	J5	DC_PWR_JACK	CUI Inc.	PJ-202AH	pj-202ah
20	1	LB1	THD-47-478-10	Brady	THD-47-478-10	rectangle
21	1	PCB1	INT053	Any	INT053	n/a
22	1	P1	USB3_Micro_B	Amphenol	GSB343133HR	USB3_micro_b_receptacle
23	1	P2	JAE DX07S024JJ2	Jae	DX07S024JJ2	USB-C_SMRT_DX07S024JJ2
24	1	P3	DP SINK-SIDE CONNECTOR	Molex Inc	472720001	con_DP_SD-47272-001
25	2	R1,R74	330	Panasonic Electronic Components	ERJ-2GEJ331X	r0402
26	10	R2,R3,R4,R5,R6,R8,R10,R11,R64,R66	0	Panasonic Electronic Components	ERJ-2GE0R00X	r0402

Table 4-1. TUSB1046EVM Bill of Materials (continued)

ITEM	QTY	REFERENCE	PART	MANUFACTURER	MANUFACTURER PART NUMBER	FOOTPRINT
27	0	R7,R9,R13,R36,R37,R63,R65	0 DNI	Panasonic Electronic Components	ERJ-2GE0R00X	r0402
28	2	R12,R14	2M	Panasonic Electronic Components	ERJ-2GEJ205X	r0402
29	14	R15,R16,R17,R19,R21,R23, R24,R25,R26,R27,R28,R29, R31,R33	1K +/- 5%	Panasonic Electronic Components	ERJ-2GEJ102X	r0402
30	7	R18,R20,R22,R30,R32,R34, R35	20K +/- 5%	Panasonic Electronic Components	ERJ-2GEJ203X	r0402
31	1	R38	22	Panasonic Electronic Components	ERA-2AKD220X	r0402
32	1	R39	100	Panasonic Electronic Components	ERA-2AED101X	r0402
33	14	R40,R41,R42,R43,R44,R45, R46,R47,R53,R54,R55,R60, R61,R62	100k	Panasonic Electronic Components	ERJ-2GEJ104X	r0402
34	2	R48,R56	10k	Panasonic Electronic Components	ERJ-2GEJ103X	r0402
35	8	R49,R50,R57,R58,R67,R68, R70,R71	3.3K	Panasonic Electronic Components	ERJ-2GEJ332X	r0402
36	0	R51,R52	10k DNI	Panasonic Electronic Components	ERJ-2GEJ103X	r0402
37	1	R59	0	Panasonic Electronic Components	ERJ-6GEY0R00V	r0805
38	0	R69	3.3K DNI	Panasonic Electronic Components	ERJ-2GEJ332X	r0402
39	3	R73,R77,R78	1k	Panasonic Electronic Components	ERJ-2GEJ102X	r0402
40	1	R75	0	Panasonic Electronic Components	ERJ-3GEY0R00V	r0603
41	0	R76	0 DNI	Panasonic Electronic Components	ERJ-6GEY0R00V	r0805
42	4	SCRW1,SCRW2,SCRW3, SCRW4	Screw	B & F Fastener	NY PMS 440 005 PH	4-40 x .5 inch nylon
43	7	SHNT1,SHNT2,SHNT3, SHNT4,SHNT5,SHNT6,SHNT7	QPC02SXGN-RC	Sullins Connector Solutions	QPC02SXGN-RC	0.1
44	4	STDOFF1,STDOFF2, STDOFF3,STDOFF4	Standoff	Keystone	1902E	1 inch long nylon
45	2	SW1,SW2	Switch - Push Button	Panasonic Electronic Components	EVQ-PAD05R	SW_THVT_EVQPAX04
46	1	U1	TUSB1046A	Texas Instruments	TUSB1046A-DCIRNQ	QFN
47	4	U2,U3,U4,U5	TPD4E02B04	Texas Instruments	TPD4E02B04DQAR	DQA

Table 4-1. TUSB1046EVM Bill of Materials (continued)

ITEM	QTY	REFERENCE	PART	MANUFACTURER	MANUFACTURER PART NUMBER	FOOTPRINT
48	1	U9	TPS65987D	Texas Instruments	TPS65987D	RSH0056_7x7mm
49	1	U7	W25Q80	WINBOND	W25Q80DVSNIG	SOIC_8_197x157_50
50	1	U8	TPS70458	Texas Instruments	TPS70458PWP	PWP

5 Additional Information

5.1 Trademarks

USB Type-C™ is a trademark of USB Implementers Forum, Inc.
DisplayPort™ is a trademark of VESA.
VESA® is a registered trademark of Video Electronics Standards Association.
All trademarks are the property of their respective owners.

6 Related Documentation

For related documentation, see the following:

- Texas Instruments, *TUSB1046A-DCI USB Type-C™ DP ALT Mode 10Gbps Linear Redriver Crosspoint Switch* data sheet

7 Revision History

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

Changes from Revision * (October 2016) to Revision A (November 2024)	Page
• Changed Table 2-1	4
• Changed Table 2-3 and Table 2-4	4
• Changed the schematic images	7
• Added PCB layouts images	10
• Changed the Bill of Materials (BOM) table	15

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