TUSB1146 USB Type-C™ Enabler EVM

The TUSB1146 USB Type-C™ Alternate Mode re-driving switch supports data rates up to 10 Gbps 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 TUSB1146 device.

Contents

List of Figures

List of Tables

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1 TUSB1146EVM-SRC

Figure 1 illustrated the EVM board.

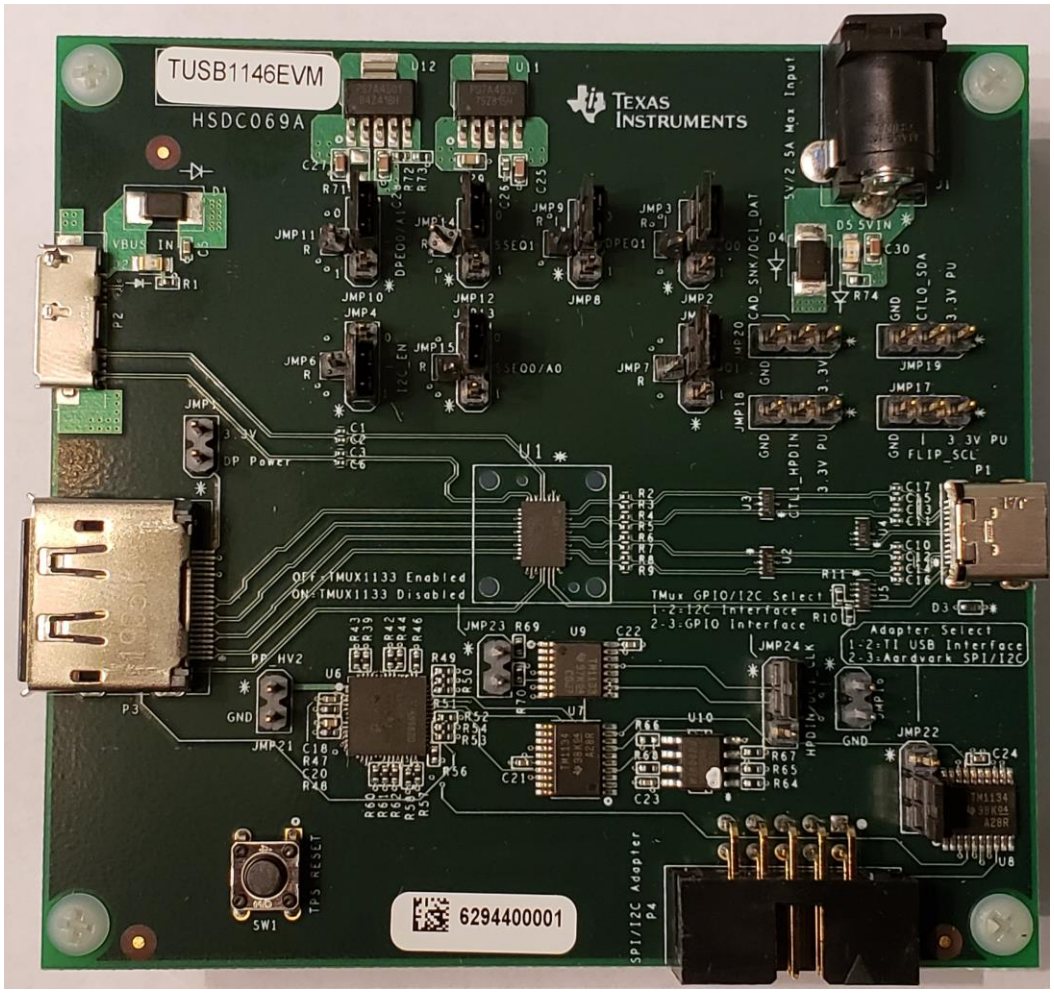

Figure 1. TUSB1146EVM

The TUSB1146EVM can be used with a legacy DP Source or USB Host system to evaluate the USB Type-C implementation. Figure 2 is a typical test setup

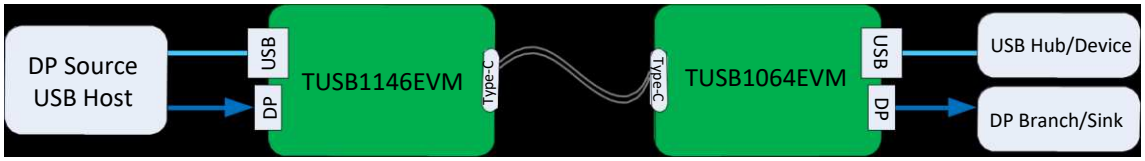

Figure 2. Test Board Setup

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 TUSB1146 EVM uses the Texas Instruments TPS65987D controller for power delivery and CC pin control.

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2 TUSB1146EVM Configuration

This section provides the configuration options available in the TUSB1146EVM.

2.1 TUSB1146 EVM Default EQ Configuration

The headers in Table 1 are provided for TUSB1146 EQ configuration, by default the TUSB1146 EQ settings are configured via I2C controlled by the TPS65987D. Alternatively, the TUSB1146 can be configured using the TI SigCon Architect GUI using the TI USB2ANY or Aardvark I2C adapter connected to connector P4.

Table 1. TUSB1146 Configuration Pins

Reference Designator	JMP Control	Configuration
JMP4	I2C_EN	Install on pins 1-2
JMP13	SSEQ0/A0	Install on pins 2-3
JMP10	DPEQ0/A1	Install on pins 2-3
JMP22	I2C Adapter Select	Install on pins 2-3
JMP24	Mux I2C/GPIO Select	Install on pins 1-2
JMP5	EQ1	Install on pins 2-3
JMP2	EQ0	Install on pins 2-3
JMP12	SSEQ1	Install on pins 2-3
JMP8	DPEQ1	Install on pins 2-3

2.2 TUSB1146 EQ Control

Each of the TUSB1146 receiver lanes has individual controls for receiver equalization. Table 2, Table 3, and Table 4 detail the gain values for each available combination for downstream, upstream, and all DisplayPort configurations.

Table 2. Configuration Pin-Level Definitions

Level	Settings
0	Option 1: Tie 1 kΩ 5% to GND Option 2: Tie directly to GND
R	Tie 20 kΩ, 5% to GND
F	Float (leave pin open)
1	Option 1: Tie 1 kΩ 5% to VCC Option 2: Tie directly to VCC

Table 3. USB 3.1 EQ Settings

	USB3.1 Downstream Facing Ports			USB3.1 Upstream Facing Port		
EQ Setting #	EQ1 Pin Level	EQ0 Pin Level	EQ Gain @ 5 GHz (dB)	SSEQ1 Pin Level	SSEQ0 Pin Level	EQ Gain @ 5 GHz (dB)
0	0	0	-1	0	0	-0.5
1	0	R	1.3	0	R	1.7
2	0	F	3	0	F	3.4
3	0	1	4.5	0	1	5
4	R	0	5.5	R	0	6
5	R	R	6	R	R	7
6	R	F	7.5	R	F	8
7	R	1	8.3	R	1	8.7
8	F	0	9	F	0	9.4
9	F	R	9.5	F	R	10

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Table 3. USB 3.1 EQ Settings (continued)

	USB3.1 Downstream Facing Ports			USB3.1 Upstream Facing Port		
EQ Setting #	EQ1 Pin Level	EQ0 Pin Level	EQ Gain @ 5 GHz (dB)	SSEQ1 Pin Level	SSEQ0 Pin Level	EQ Gain @ 5 GHz (dB)
10	F	F	10	F	F	10.6
11	F	1	10.5	F	1	11
12	1	0	11	1	0	11.5
13	1	R	11.3	1	R	11.9
14	1	F	11.6	1	F	12.1
15	1	1	12	1	1	12.5

Table 4. DisplayPort EQ Settings

	All DisplayPort Lanes		
EQ Setting #	DPEQ1 Pin Level	DPEQ0 Pin Level	EQ Gain @ 5 GHz (dB)
0	0	0	-0.4
1	0	R	1.3
2	0	F	2.8
3	0	1	4.1
4	R	0	6.1
5	R	R	6.2
6	R	F	7.1
7	R	1	7.9
8	F	0	8.6
9	F	R	9.2
10	F	F	9.8
11	F	1	10.3
12	1	0	10.7
13	1	R	11.2
14	1	F	11.5
15	1	1	12

2.3 Power

The EVM is designed to operate off of the VBUS from a USB host connected via USB Micro B, P2. No external power is to be applied via J5 unless standalone operation is desired.

If testing the DisplayPort only, or if bypassing VBUS power, the EVM must be powered via J1 (5-V, 1-A input).

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3 TUSB1146EVM Schematics

Figure 3 displays the block diagram of the EVM.

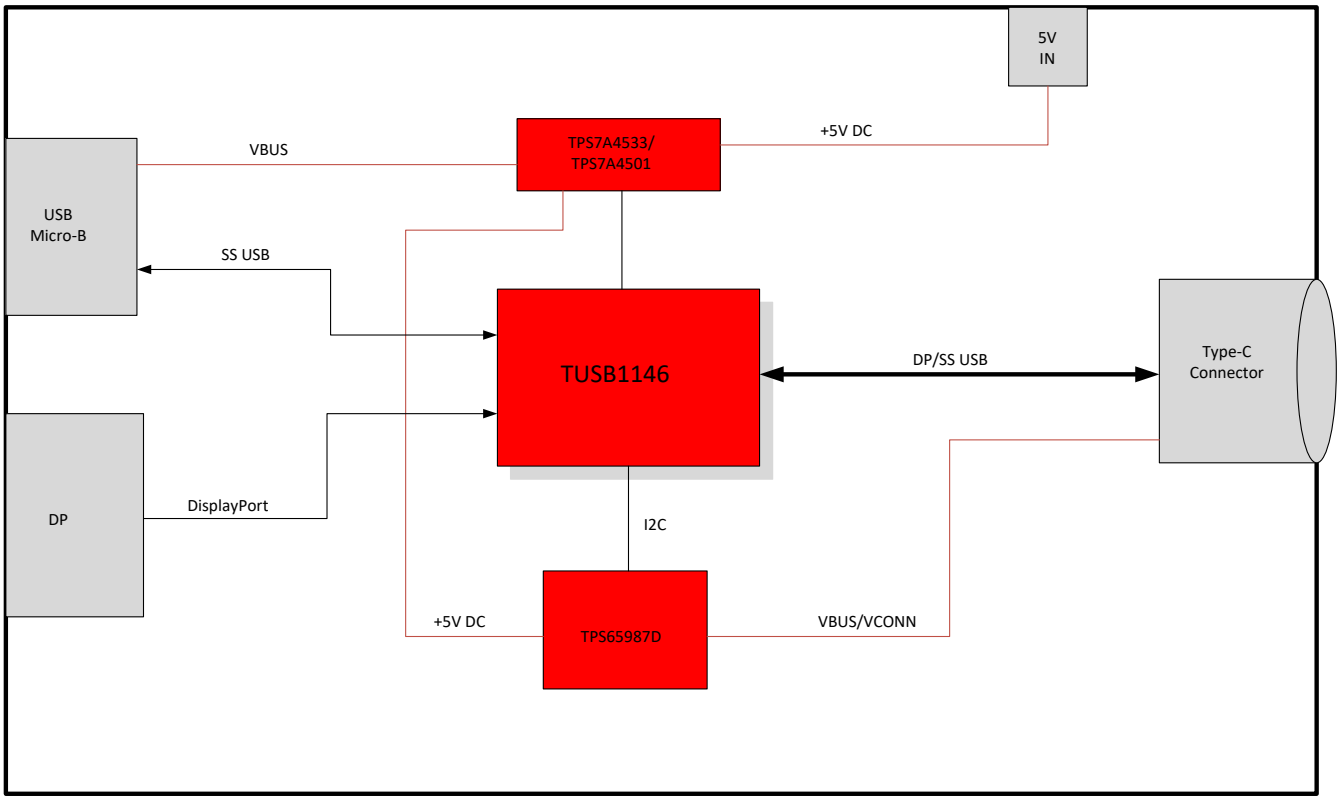

Figure 3. TUSB1146EVM Block Diagram

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Figure 4 through Figure 7 show the EVM schematics.

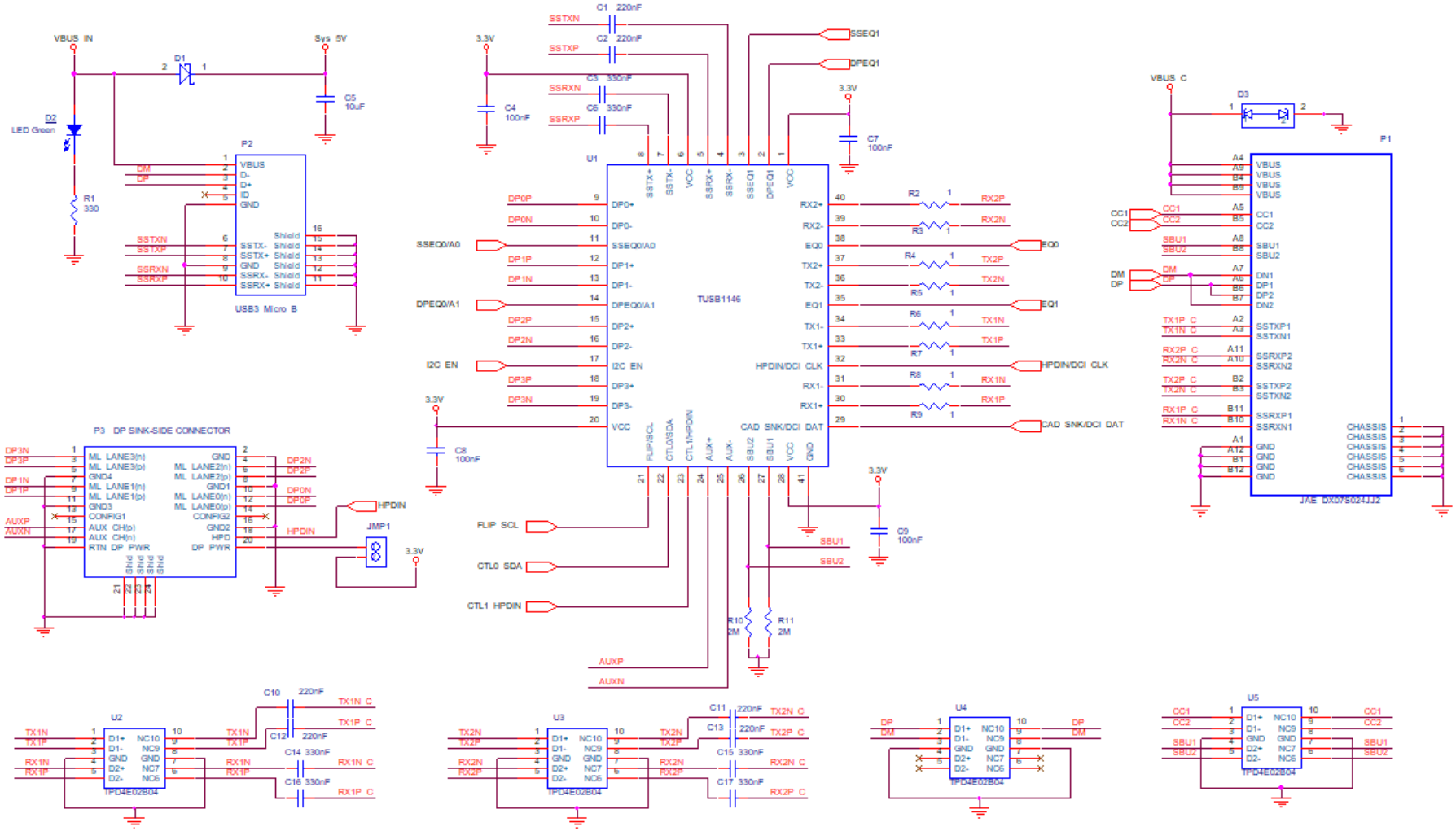

Figure 4. TUSB1146EVM Schematics (1 of 4)

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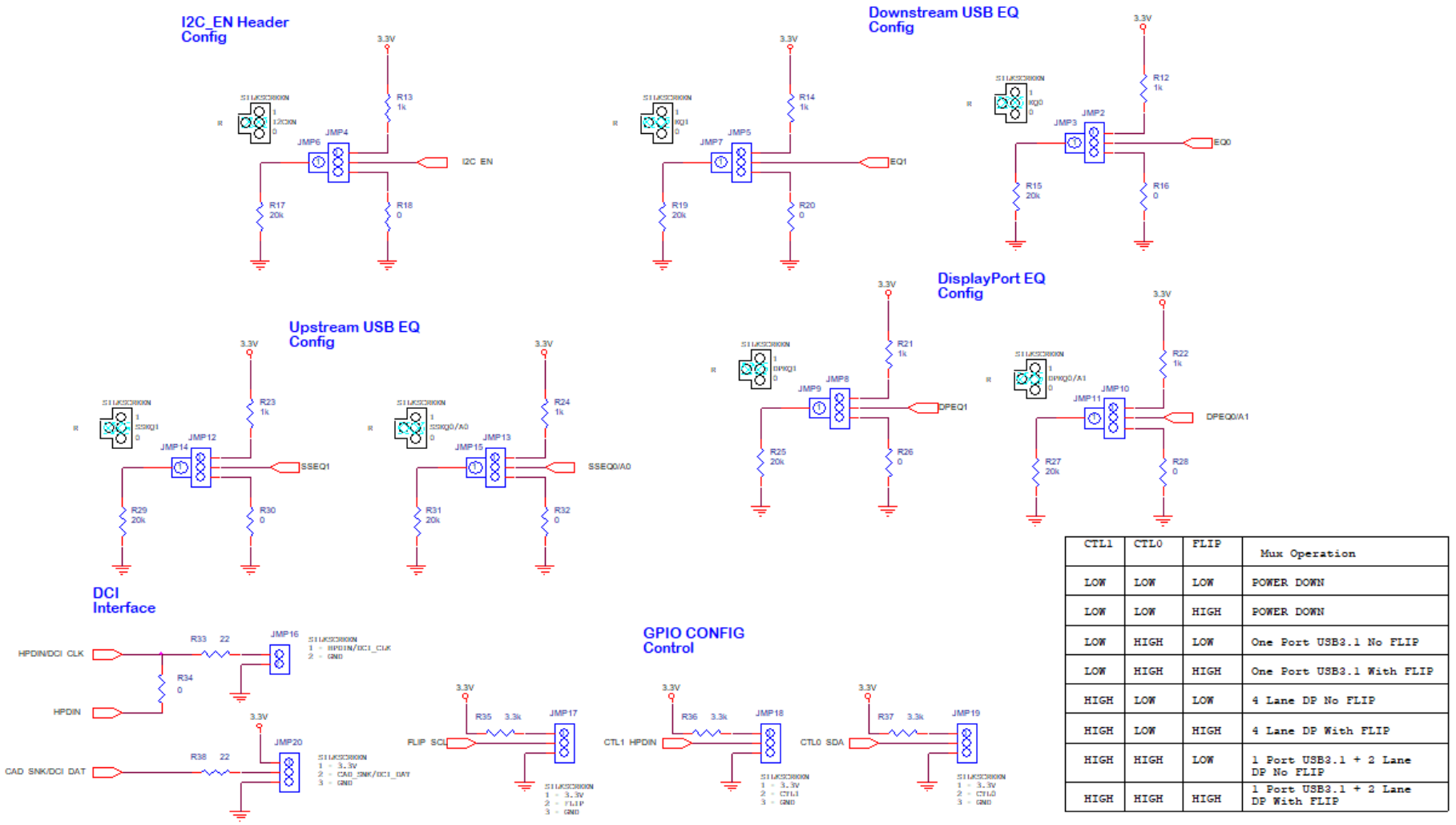

CTL1	CTL0	FLIP	Mux Operation
LOW	LOW	LOW	POWER DOWN
LOW	LOW	HIGH	POWER DOWN
LOW	HIGH	LOW	One Port USB3.1 No FLIP
LOW	HIGH	HIGH	One Port USB3.1 With FLIP
HIGH	LOW	LOW	4 Lane DP No FLIP
HIGH	LOW	HIGH	4 Lane DP With FLIP
HIGH	HIGH	LOW	1 Port USB3.1 + 2 Lane DP No FLIP
HIGH	HIGH	HIGH	1 Port USB3.1 + 2 Lane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

Figure 5. TUSB1146EVM Schematics (2 of 4)

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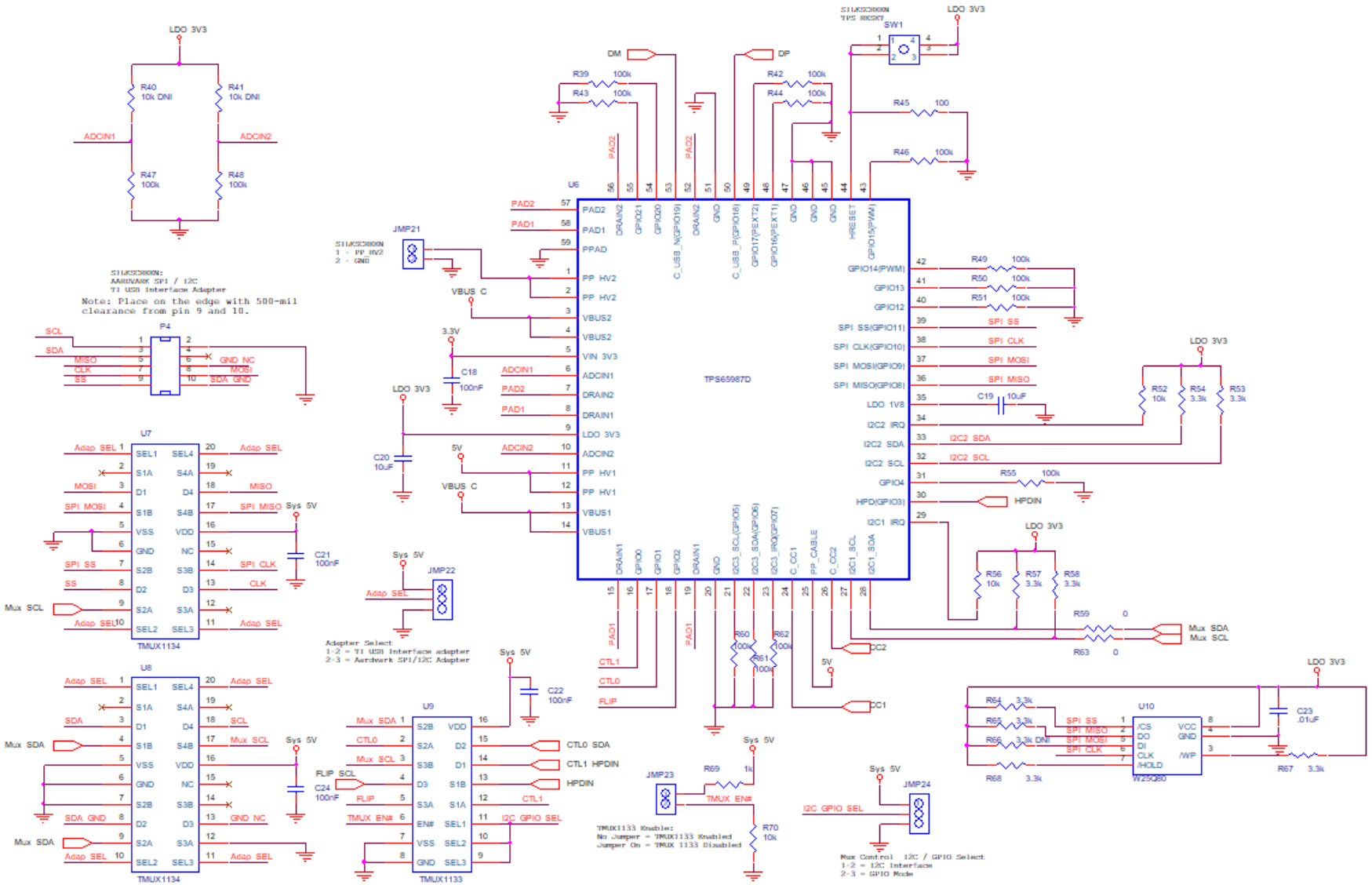

Figure 6. TUSB1146EVM Schematics (3 of 4)

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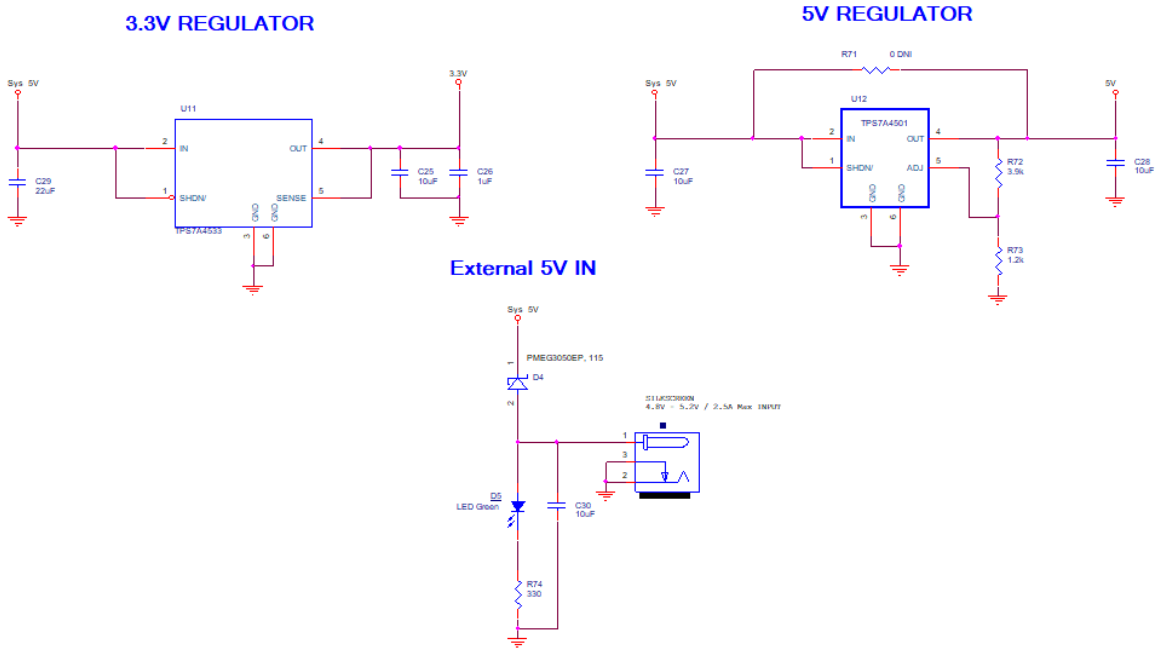

Figure 7. TUSB1146EVM Schematics (4 of 4)

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4 Bill of Materials

Table 5. Bill of Materials

Designator	Qty	Value	Part Number	Manufacturer
C1,C2,C10,C11,C12,C13	6	220 nF	GRM033R60J224ME15D	Murata
C3,C6,C14,C15,C16,C17	6	330 nF	GRM033R60J334ME90D	Murata
C4,C7,C8,C9,C18,C21,C22,C24	8	100 nF	GRM155R71E104KE14D	Murata
C5,C19,C20	3	10 uF	GRM155R60G106ME44D	Murata
C23	1	.01 uF	GRM155R71H103KA88D	Murata
C25,C27,C28,C30	4	10 uF	GRM188R61C106MA73D	Murata
C26	1	1 uF	GRM155C81A105KA12D	Murata
C29	1	22 uF	GRM188R61A226ME15D	Murata
D1,D4	2	SCHOTTKY	PMEG3050EP,115	NXP
D2,D5	2	LED Green	LTST-C170KGKT	LITE-ON TECHNOLOGY CORPORATION
D3	1	TPD1E10B06	TPD1E10B06DPYR	Texas Instruments
JMP1,JMP16,JMP21,JMP23	4	Header 2x1	68001-402HLF	FCI
JMP2,JMP4,JMP5,JMP8,JMP10,JMP12,JMP13,JMP17, JMP18,JMP19,JMP20,JMP22,JMP24	13	Header 3x1	961103-6404-AR	3M
JMP3,JMP6,JMP7,JMP9,JMP11,JMP14,JMP15	7	HDR1x1	68001-401HLF	FCI
J1	1	DC_PWR_JACK	PJ-202AH	CUI Inc.
PCB1	1	HSDC069	HSDC069	Any
P1	1	JAE DX07S024JJ2	DX07S024JJ2R1300	Jae
P2	1	USB3_Micro_B	GSB343133HR	Amphenol
P3	1	DP SINK-SIDE CONNECTOR	472720001	Molex Inc
P4	1	Header 5x2 0.1" Shroud RA thru-hole	30310-5002HB	3M
R1,R74	2	330	ERJ-2GEJ331X	Panasonic Electronic Components
R2,R3,R4,R5,R6,R7,R8,R9	8	1	ERJ-1GNJ1R0C	Panasonic Electronic Components
R10,R11	2	2 M	ERJ-2GEJ205X	Panasonic Electronic Components
R12,R13,R14,R21,R22,R23,R24,R69	8	1 k	ERJ-2GEJ102X	Panasonic Electronic Components
R15,R17,R19,R25,R27,R29,R31	7	20 k	ERJ-2GEJ203X	Panasonic Electronic Components
R16,R18,R20,R26,R28,R30,R32,R34,R59,R63	10	0	ERJ-2GE0R00X	Panasonic Electronic Components
R33,R38	2	22	ERA-2AKD220X	Panasonic Electronic Components
R35,R36,R37,R53,R54,R57,R58,R64,R65,R67,R68	11	3.3 k	ERJ-2GEJ332X	Panasonic Electronic Components
R39,R42,R43,R44,R46,R47,R48,R49,R50,R51,R55,R60 ,R61,R62	14	100 k	ERJ-2GEJ104X	Panasonic Electronic Components
R40,R41	0	10 k DNI	ERJ-2GEJ103X	Panasonic Electronic Components
R45	1	100	ERA-2AED101X	Panasonic Electronic Components
R52,R56,R70	3	10k	ERJ-2GEJ103X	Panasonic Electronic Components

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Table 5. Bill of Materials (continued)

Designator	Qty	Value	Part Number	Manufacturer
R66	0	3.3k DNI	ERJ-2GEJ332X	Panasonic Electronic Components
R71	0	0 DNI	ERJ-6GEY0R00V	Panasonic Electronic Components
R72	1	3.9k	ERJ-2GEJ392X	Panasonic Electronic Components
R73	1	1.2k	ERJ-2GEJ122X	Panasonic Electronic Components
SW1	1	B3F-1020	B3F-1020	Omron Electronics
U1	1	TUSB1146	TUSB1146RNQ	Texas Instruments
U2,U3,U4,U5	4	TPD4E02B04	TPD4E02B04DQAR	Texas Instruments
U6	1	TPS65987D	TPS65987DDHRSHR	Texas Instruments
U7,U8	2	TMUX1134	TMUX1134PWR	Texas Instruments
U9	1	TMUX1133	TMUX1133PWR	Texas Instruments
U10	1	W25Q80	W25Q80DVSNIG	WINBOND
U11	1	TPS7A4533	TPS7A4533DCQ	Texas Instruments
U12	1	TPS7A4501	TPS7A4501DCQ	Texas Instruments

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