EVM User's Guide: TUSB2E221QFNEVM

TUSB2E221QFN Evaluation Model

Description

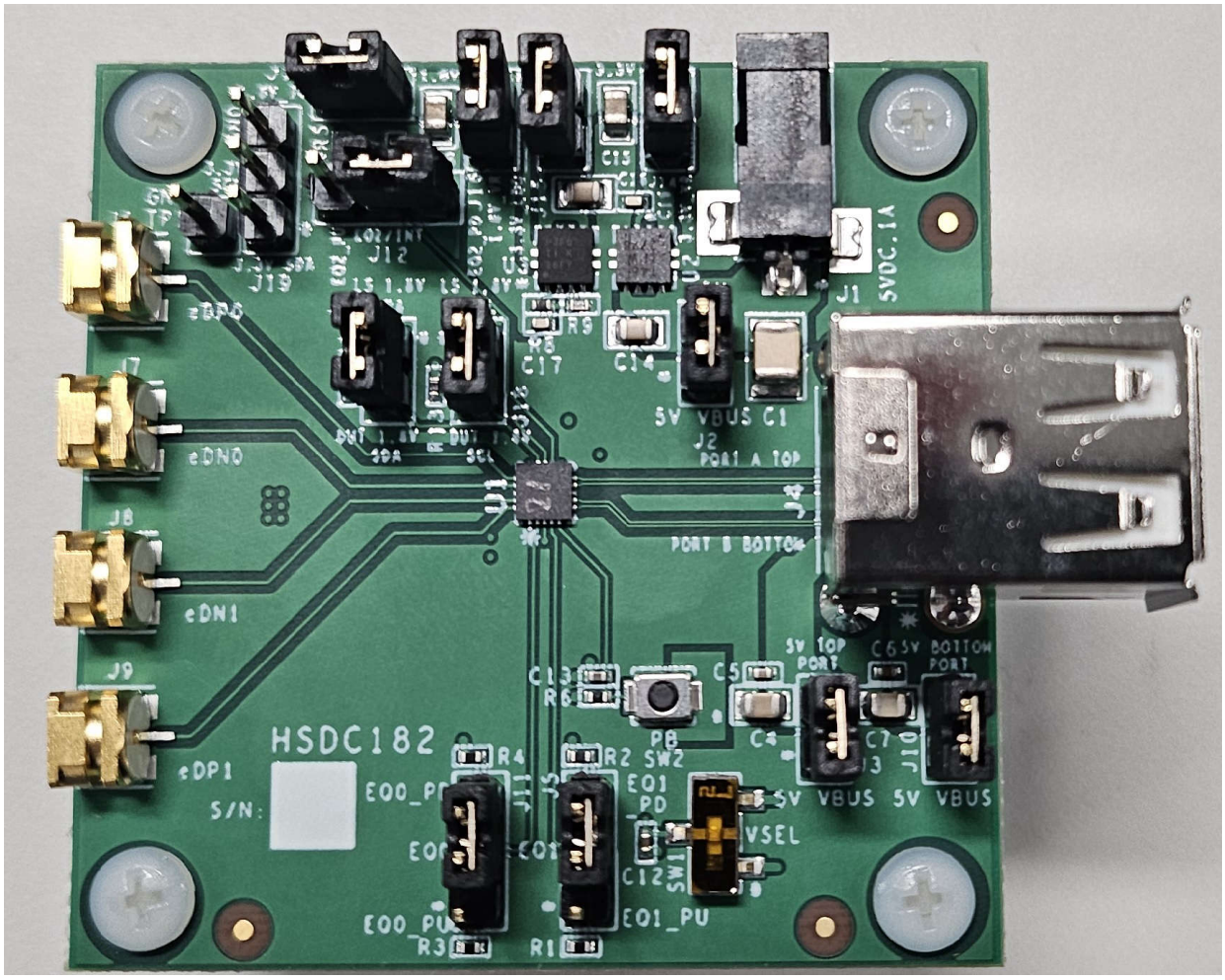
The TUSB2E221QFNEVM is designed to facilitate evaluation and validate the performance of the TUSB2E221 2-port eUSB repeater. The TUSB2E221QFNEVM incorporates a stacked Type-A USB 2.0 connector to connect to USB compliant hosts (with the use of a Type-A to B adapter), hubs, or devices. The EVM also has two sets of SMP connectors to interface with another eUSB2 PHY or test equipment.

Features

- Plug and play design
- The evaluation module (EVM) is powered by USB or Wall Power
- All device pin configuration options can be evaluated on the EVM
- I^2C interface accessible

Applications

- Communications equipment
- Enterprise systems
- Notebooks and desktops
- Industrial
- Tablets
- Portable electronics



1 Evaluation Module Overview

1.1 Introduction

This user's guide covers the features, operating conditions, and configuration of the TUSB2E221QFN evaluation module (EVM). The TUSB2E221 supports low speed (LS), full speed (FS), and high speed (HS) operation and supports host, peripheral, and dual-role applications.

This user's guide contains information and support documentation for the TUSB2E221QFN evaluation module (EVM). Included are the schematics, PCB layouts, and bill of materials of the TUSB2E221QFNEVM. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the TUSB2E221QFNEVM.

1.2 Kit Contents

This EVM kit contains the following items:

- TUSB2E221QFNEVM board

The user must provide one or two USB cables, a Type-A to Type-B adapter if they want to connect the EVM to a USB Host through the USB connector, one or two sets of SMP cables, and a 5V power source for the EVM.

1.3 Specification

The TUSB2E221 device is designed to comply with the Embedded USB2 (eUSB2) Physical Layer Supplement to the USB Revision 2.0 Specification published by the USB-IF. This specification defines three primary states for a eUSB repeater: default, host, and peripheral states. After powering on the EVM, the TUSB2E221 is in the default state and awaiting configuration as a host or peripheral repeater. Configuration occurs over the eUSB interface by either the eUSB Host or eUSB device. For more information about configuration, refer to the Embedded USB2 (eUSB2) Physical Layer Supplement to the USB Revision 2.0 Specification.

The following diagrams describe the system setup using the TUSB2E221QFNEVM with an eUSB host or an eUSB peripheral.

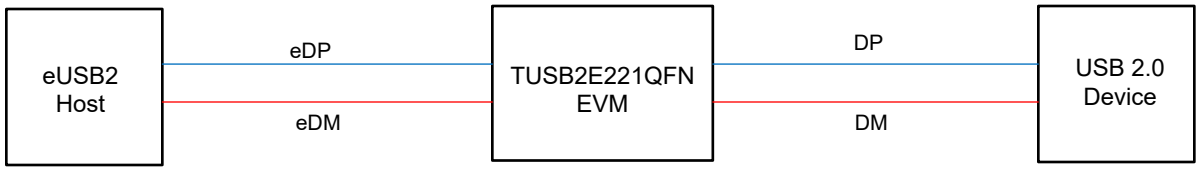


Figure 1-1. TUSB2E221QFNEVM Host Repeater Diagram

In the default state, the TUSB2E221 does not forward eUSB or USB packets. When an eUSB2 host is connected to the eUSB ports of the TUSB2E221QFNEVM, the repeater must be configured as a host repeater by the eUSB host. A 5V power source must be provided to the EVM to power to the device.

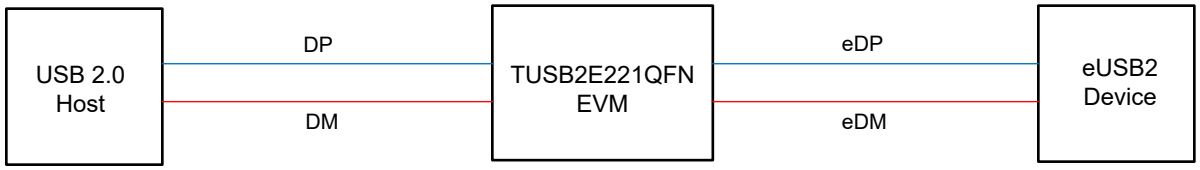


Figure 1-2. TUSB2E221QFNEVM Self-Powered Peripheral Repeater Diagram

When the eUSB ports are connected to an eUSB device, as shown Figure 1-2, the TUSB2E221 must be configured as a peripheral repeater. In a self-powered configuration, an external 5V source is provided.

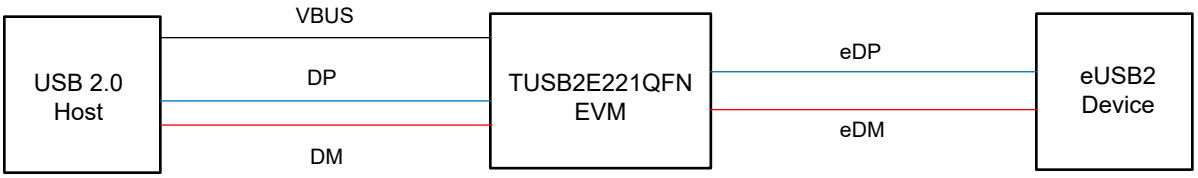


Figure 1-3. TUSB2E221QFNEVM Bus-Powered Peripheral Repeater Diagram

A 5V power source can also be provided by the USB bus. When VBUS is used to power the EVM, VBUS is referred to a *bus-powered* application. An eUSB device is still attached to the eUSB port of the TUSB2E221QFNEVM, so the EVM must be configured as a peripheral repeater.

1.4 Device Information

The TUSB2E221QFNEVM is designed to support the TUSB2E221 eUSB repeater in either eUSB host or peripheral applications. Various headers are located on the EVM with prepopulated headers to support configuring the TUSB2E221.

Two LDOs are also present on the TUSB2E221QFNEVM to generate the 3.3V and 1.8V supplies to the TUSB2E221. The TPS73633 steps down the 5V supply to 3.3V to provide power to the TUSB2E221 as well as the TPS73601. The TPS73601 uses the 3.3V supply and steps down the voltage further to 1.8V again for the TUSB2E221 supply and the I/O input voltage used for configuration.

2 Hardware

2.1 Getting Started

Evaluation of the TUSB2E221QFNEVM requires a 5V power source, a USB connection, and an eUSB2 connection. This section assumes that the TUSB2E221QFNEVM jumpers are in placed in the default state as described in Table 2-1.

Table 2-1. TUSB2E221QFNEVM Default Jumper Configuration

Designator	Default Position	Description
J3	1-2	VBUS to J4 USB Port A connector
J2	1-2	5V Rail and DC Jack to VBUS
J19	N/A	I^2C interface
J10	1-2	VBUS to J4 USB Port B connector
J5	2-3	EQ1 low
J11	2-3	EQ0 low
J13	1-2	1.8V supply rail to 1.8V IO rail
J16	1-2	1.8V LDO output to 1.8V supply rail
J15	1-2	3.3V supply rail to 1.8V LDO
J12	Not installed	EQ2 floating
J17	1-2	I^2C SDA pullup resistor
J18	1-2	I^2C SCL pullup resistor
SW1	2-3	Set in 2-3 position

The following test procedure describes how to integrate the EVM into a eUSB system and begin evaluation. Before getting started, make sure that power is not supplied to the system and proper ESD protective measures are in place.

1. **Connect to eUSB Port 0**- The TUSB2E221QFNEVM has two eUSB ports to connect to an eUSB host or device via SMP cable. The eUSB host or device is responsible for configuring TUSB2E221 through the eUSB interface as described in Section 1.3.
2. **Connect to USB Port A** - The two USB ports on the EVM connect to a USB host or device. If the TUSB2E221 was configured as a device repeater in step 1, then attach a USB host to USB Port A. If configured as a host, then attach a USB device.
3. **Provide 5V power to the EVM** - There are multiple ways to provide 5V to the EVM. For more information on the various power modes refer to section Section 2.2.1.
4. **Power on the system, or issue a reset** - After power-on, the eUSB host or device automatically configures the repeater and establish a connection through the eUSB and USB interfaces. The TUSB2E221QFNEVM also incorporates an external reset push button in addition to a regular power reset circuit.

2.2 EVM Configuration

There are many ways to configure the TUSB2E221QFNEVM to fit various applications. The power supply cam be external or provided by VBUS. The GPIO pins and I^2C interface of the TUSB2E221 allow for configuration of signal conditioning settings. I^2C mode is enabled by default on the EVM through the jumpers installed on J11 and J5. To access the I^2C interface, attach a 3.3V I^2C controller to the SDA, SCL pins of J19 along with GND. The 7-bit I^2C target address is 0x4F.

Note

A 1.8V I^2C controller can be attached to pin 2 of headers J17 (SDA) and J18 (SCL).

2.2.1 Power Modes

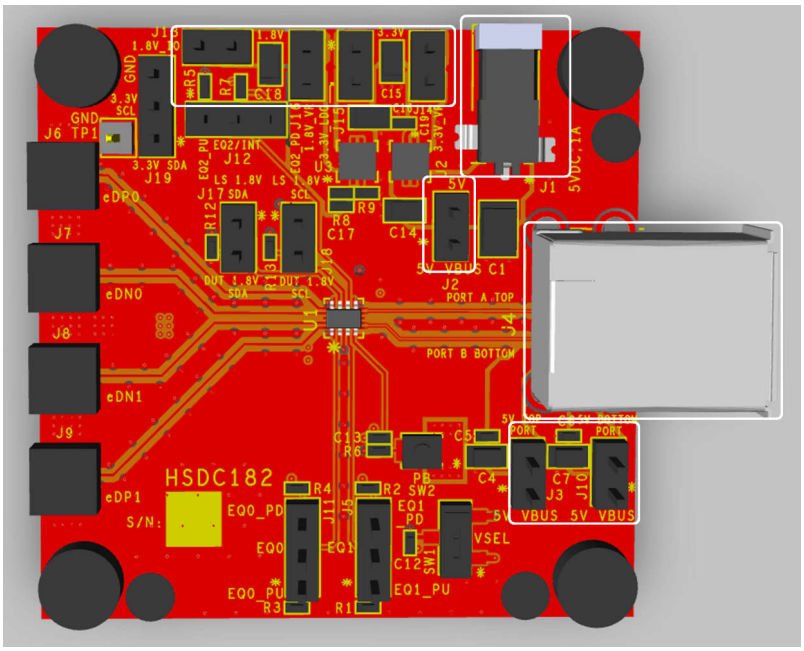


Figure 2-1. TUSB2E221QFNEVM Power Configuration Overview

The TUSB2E221 requires two supply voltages during normal operation. The 3.3V and 1.8V supply can be provided directly from an external source on pin 1 of the J14 and J16 headers. The TUSB2E221QFNEVM also includes two onboard LDOs which generate 3.3V and 1.8V from a 5V power supply. The 5V supply can be provided through the USB connectors, or provided through a 5V wall power supply.

2.2.1.1 Self-Powered Configuration

The TUSB2E221QFNEVM 5V power supply can be provided from a DC power supply provided by CUI, Digikey# 102-3584-N, or similar.

External Power Supply or Power Accessory Requirements:

- Nominal output voltage: 5 VDC
- Maximum output current: 3000mA
- Efficiency Level CoC Tier 2

Before providing power to the EVM, make sure that 5V is not already being provided to the EVM through the USB bus. Configure the EVM jumpers as shown in Table 2-2 to disable bus-power and enable wall power.

Table 2-2. EVM Wall Power Configuration

Designator	Installed	Description
J3	Yes	VBUS to J4 USB Port A connector
J2	Yes	5V Rail and DC Jack to VBUS
J10	Yes	VBUS to J4 USB Port B connector
J14	Yes	3.3V LDO to 3.3V
J15	Yes	3.3V supply rail to 1.8V input
J16	Yes	1.8V LDO output to 1.8V supply rail
J17	Yes	1.8V supply rail to 1.8V IO

After configuring the EVM, plug the DC adapter into the DC jack at J1 on the EVM. This method of providing power is useful while the TUSB2E221 is configured as either a self-powered device or a host.

2.2.1.2 Bus-Powered Configuration

When VBUS is provided through the USB connector, the TUSB2E221QFNEVM does not require an external 5V supply. Make sure that 5V is not already being provided to the EVM through other sources by configuring the EVM headers as shown in Table 2-3.

Table 2-3. EVM Bus Power Configuration

Designator	Installed	Description
J3	Yes	VBUS to J4 USB Port A connector
J2	Yes	5V Rail and DC Jack to VBUS
J10	Yes	VBUS to J4 USB Port B connector
J14	Yes	3.3V LDO to 3.3V
J15	Yes	3.3V supply rail to 1.8V input
J16	Yes	1.8V LDO output to 1.8V supply rail
J17	Yes	1.8V supply rail to 1.8V IO

After configuring the EVM, plug the USB host into the J4 USB connector using a Type-A to Type-B adapter. This method of providing power is useful while the TUSB2E221 is configured as a bus-powered device.

2.2.1.3 External Power

Alternately to providing a 5V power source to the TUSB2E221QFNEVM, a 3.3V and 1.8V power supply can be provided directly to the TUSB2E221 device.

Before providing power to the EVM, make sure that power is not already being provided through the USB bus or DC power jack. Configure the EVM jumpers as shown in Table 2-4 to disable the 3.3V and 1.8V LDOs and allow direct external power.

Table 2-4. EVM External Power Configuration

Designator	Installed	Description
J3	No	VBUS to J4 Port A connector
J2	No	5V Rail and DC Jack to VBUS
J10	No	VBUS to J4 USB Port B connector
J14	No	3.3V LDO to 3.3V
J15	Yes	3.3V supply rail to 1.8V input
J16	No	1.8V LDO output to 1.8V supply rail
J17	No	1.8V supply rail to 1.8V IO

After configuring the EVM, attach the 3.3V power supply to pin 1 of J14, then attach the 1.8V supply to pin 1 of J16. This method of providing power is useful when evaluating the power consumption of the TUSB2E221. Current and voltage measurements can be made on the 3.3V and 1.8V rails provided to the EVM.

2.2.2 Functional Modes

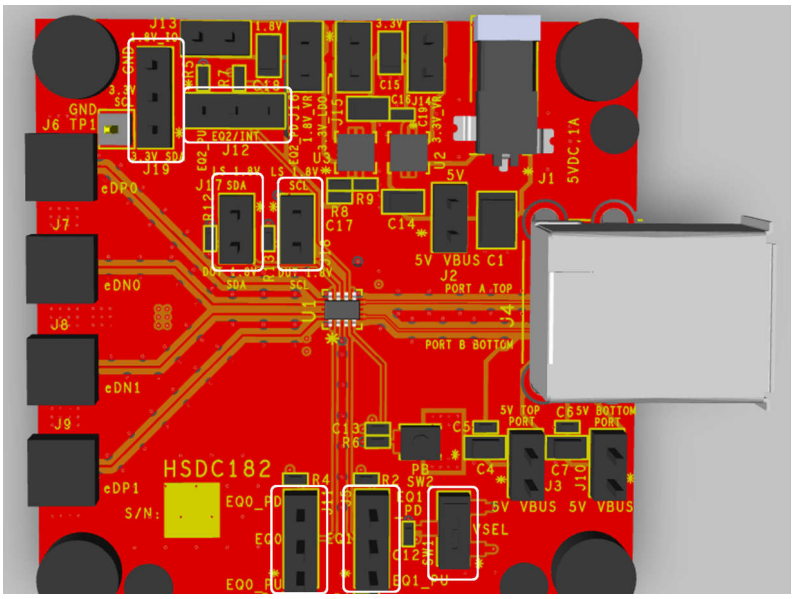


Figure 2-2. TUSB2E221QFNEVM Configuration Overview

The TUSB2E221 has three functional modes: I²C-enabled, GPIO, and UART. Figure 2-2 shows the locations of each header and switch used to configure the TUSB2E221.

2.2.2.1 I²C-Enabled Repeater Mode

In I²C-enabled repeater mode, the EVM can be configured through register settings. EQ0 and EQ1 must be set high. When set low, the repeater is configured for UART mode and does not forward eUSB or USB packages.

Table 2-5. I²C-Enabled Repeater Mode Jumper Configuration

Designator	Jumper Position	Description
J5	2-3	EQ1 set low
J11	2-3	EQ0 set low
J17	1-2	SDA pulled high through a 1KΩ resistor
J18	1-2	SLC pulled high through a 1KΩ resistor

2.2.2.2 GPIO Repeater Mode

In GPIO repeater mode, the I^{2}C interface is disabled, and signal conditioning settings can be set by modifying the EQ0, EQ1, and EQ2 pins. These pins are sampled at start-up.

Table 2-6. GPIO Repeater Mode Jumper Configuration

Designator	Jumper Position	Description
J5	N/A	Set EQ1 to desired signal conditioning settings.
J11	N/A	Set EQ0 to desired signal conditioning settings.
J17	N/A	Do not populate jumper, keep SDA floating
J18	N/A	Do not populate jumper, keep SCL floating

2.2.2.3 UART Mode

In UART mode, the TUSB2E11 acts a 3.3V to 1.2V level shifter to support in-system debug. UART mode can be set per-port as described in the TUSB2E221 data sheet. In the configuration below, both eUSB-USB ports are set to UART mode.

Table 2-7. UART Mode Jumper Configuration

Designator	Jumper Position	Description
J5	1-2	EQ1 set high
J11	1-2	EQ0 set high
J17	1-2	SDA pulled high through a 1KΩ resistor
J18	1-2	SLC pulled high through a 1KΩ resistor

2.2.3 I/O and Interrupts

After the TUSB2E221 is configured for I^{2}C mode, the EQ0, EQ1, and EQ2/INT pins can be used as programmable I/O pins. These pins can be useful in situations where system debug is necessary, or side-band signaling is needed.

The TUSB2E221 can be configured to use either 1.8V or 1.2V I/O voltages. SW1 on the EVM controls the VIOSEL pin. To modify the signaling, refer to Table 2-8. Changing this setting modifies the threshold voltage of the EQ0, EQ1, EQ2/INT, SCL and SDA pins.

Table 2-8. TUSB2E221EVM I/O Voltage Switch

SW1 Position	I/O Voltage
1-2 (bottom)	1.2V
2-3 (top)	1.8V

3 Hardware Design Files

3.1 Schematic

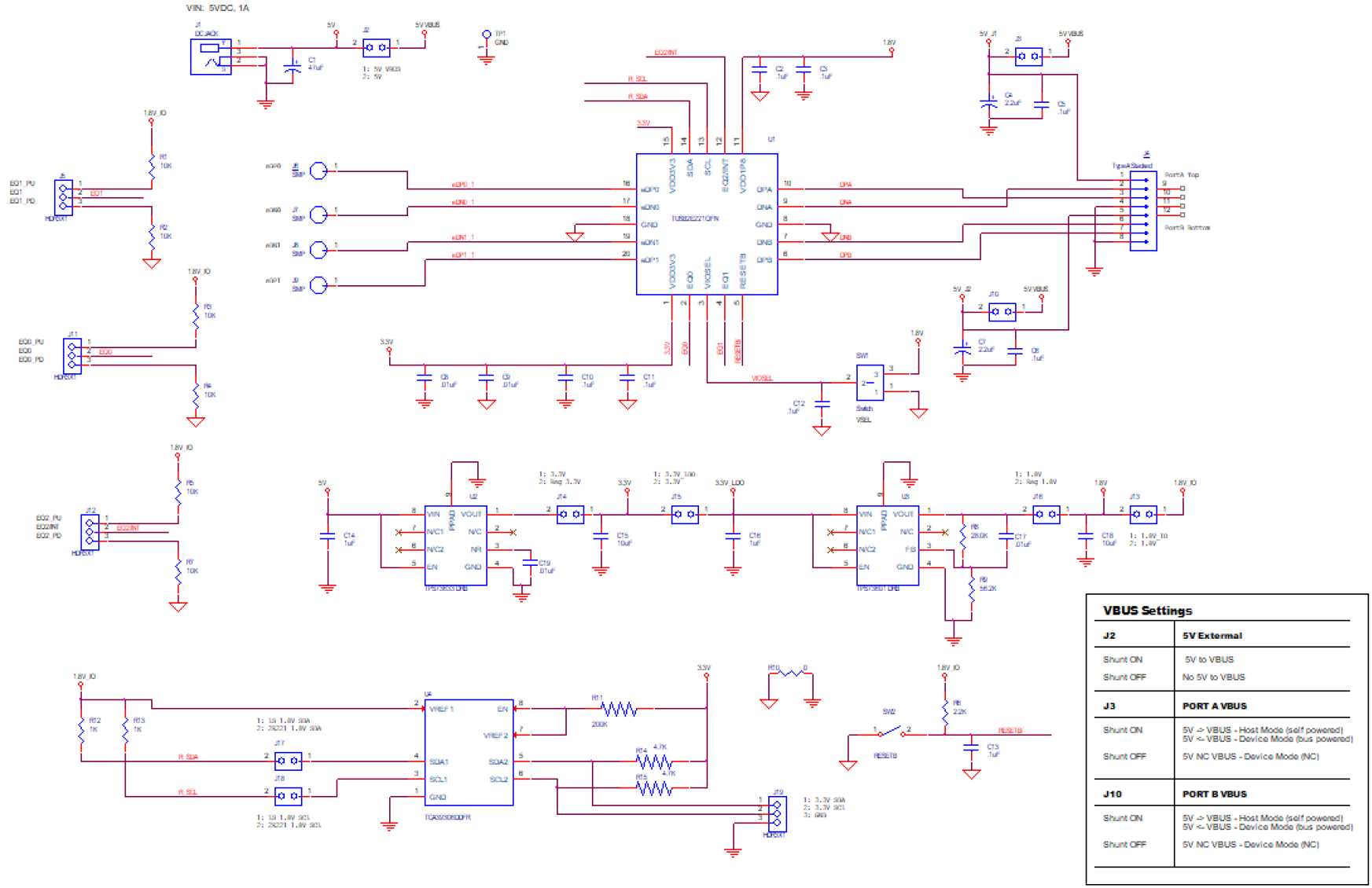


Figure 3-1. TUSB2E221QFNEVM Schematic

3.2 Board Layout

The TUSB2E221QFNEVM uses the following layout considerations:

- USB 2.0 signals impedance controlled 90Ω differential ±5%.
- eUSB2 signals impedance controlled 45Ω signal ended ±5%.
- USB 2.0 and eUSB2 signal pairs routed with matched trace lengths and minimal vias.
- All other signals to be impedance controlled 45Ω ±10% or 50Ω ±10%.

A 4-layer stack-up was used for the TUSB2E221QFNEVM.

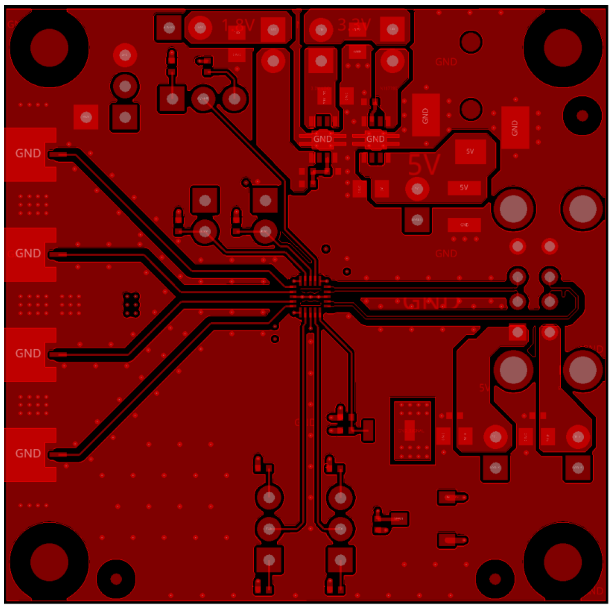


Figure 3-2. TUSB2E221QFNEVM PCB Top Layer

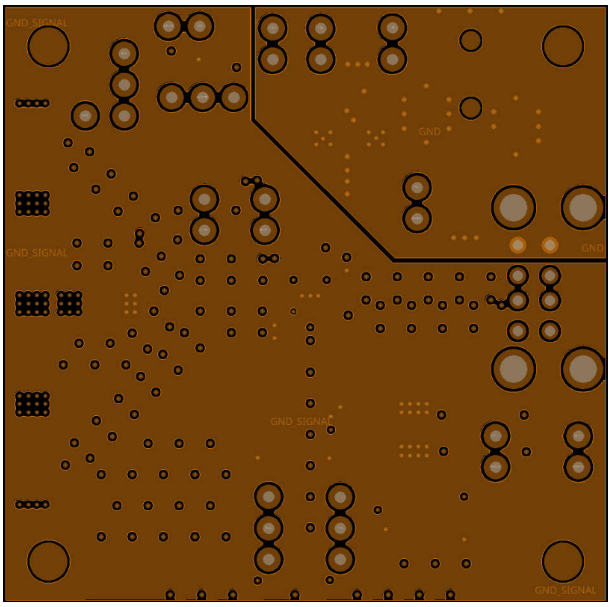


Figure 3-3. TUSB2E221QFNEVM PCB Layer 2 (Ground Plane)

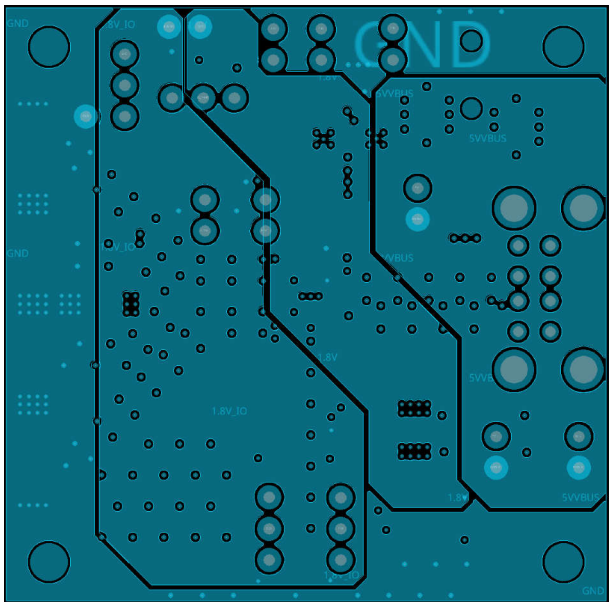


Figure 3-4. TUSB2E221QFNEVM PCB Layer 3 (Power Plane)

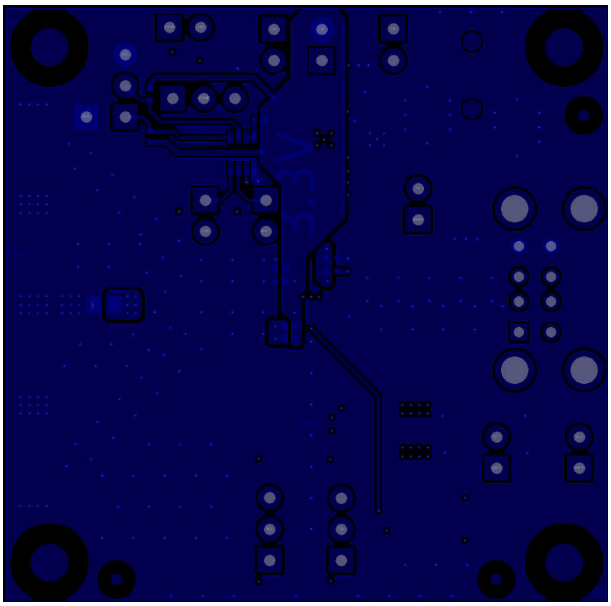


Figure 3-5. TUSB2E221QFNEVM Layer 4 (Bottom)

3.3 Bill of Materials

The default devices installed on the TUSB2E221QFNEVM are listed in this section.

Table 3-1. TUSB2E221QFNEVM Bill of Materials

Item	Quantity	Reference	Value	Manufacturer	Manufacturer Part Number
1	1	C1	47uF	TDK	C3225X5R1A476M250AC
2	8	C2,C3,C5,C6,C10,C11,C12,C13	.1uF	Yageo	CC0402KRX5R6BB104
3	2	C4,C7	2.2uF	TDK	CGA4J3X7R1C225K125AB
4	4	C8,C9,C17,C19	.01uF	Kemet	C0402C103K3RACTU
5	2	C14,C16	1uF	Kemet	C0805C105K4RACTU
6	2	C15,C18	10uF	Kemet	C0805C106K8PACTU
7	1	J1	DC JACK	CUICUI-STACK	PJ1-022-SMT-TRPJ-202B
8	9	J2,J3,J10,J13,J14,J15,J16,J17,J18	HDR2X1	Sullins	PEC02SAAN
9	1	J4	TypeA Stacked	Assmann	AU-Y1008-2
10	4	J5,J11,J12,J19	HDR3X1	Sullins	PEC03SAAN
11	4	J6,J7,J8,J9	SMP	Rosenberger	19S201-40ML5
12	1	PCB1	HSDC182	Any	HSDC124
13	6	R1,R2,R3,R4,R5,R7	10K	Yageo	RC0402JR-0710KL
14	1	R6	2.2K	Yageo	RC0402FR-072K2L
15	1	R8	28.0K	Yageo	RC0402FR-0728KL
16	1	R9	56.2K	Yageo	RT0402BRD0756K2
17	1	R10	0	Yageo	RC0805JR-070RL
18	1	R11	200K	YAGEO	RC0603FR-07200KL
19	2	R12,R13	1K	Yageo	RT0402BRE071KL
20	2	R14,R15	4.7K	YAGEO	RC0603FR-074K7L
21	4	SCRW1,SCRW2,SCRW3,SCRW4	NY PMS 440 005 PH	B&F Fastener	NY PMS 440 0050 PH
22	12	SHNT1,SHNT2,SHNT3,SHNT4,SHNT5,SHNT6,SHNT7,SHNT8,SHNT9,SHNT10,SHNT11,SHNT12	QPC02SXGN-RC	Sullins	QPC02SXGN-RC
23	4	STDOFF1,STDOFF2,STDOFF3,STDOFF4	1902E	Keystone	1902E
24	1	SW1	Switch	Nidec Copal	CJS-1201TB
25	1	SW2	RESETB	OMRON	B3U-1000P

Table 3-1. TUSB2E221QFNEVM Bill of Materials (continued)

Item	Quantity	Reference	Value	Manufacturer	Manufacturer Part Number
26	1	TP1	TEST POINT	Sullins	PEC01SAAN
27	1	U1	TUSB2E221QFN	Texas Instruments	TUSB2E221QFN
28	1	U2	TPS73633 DRB	Texas Instruments	TPS73633DRB
29	1	U3	TPS73601 DRB	Texas Instruments	TPS73601DRB
30	1	U4	TCA39306DDFR	Texas Instruments	TCA39306DDFR

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

4.2 Related Documentation

For related documentation, see the following:

- Texas Instruments, *TUSB2E221 USB 2.0-eUSB2 Dual Repeater* data sheet

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