

# TUSB8020BPHP REVA Evaluation Module

## User's Guide



Literature Number: SLLU196  
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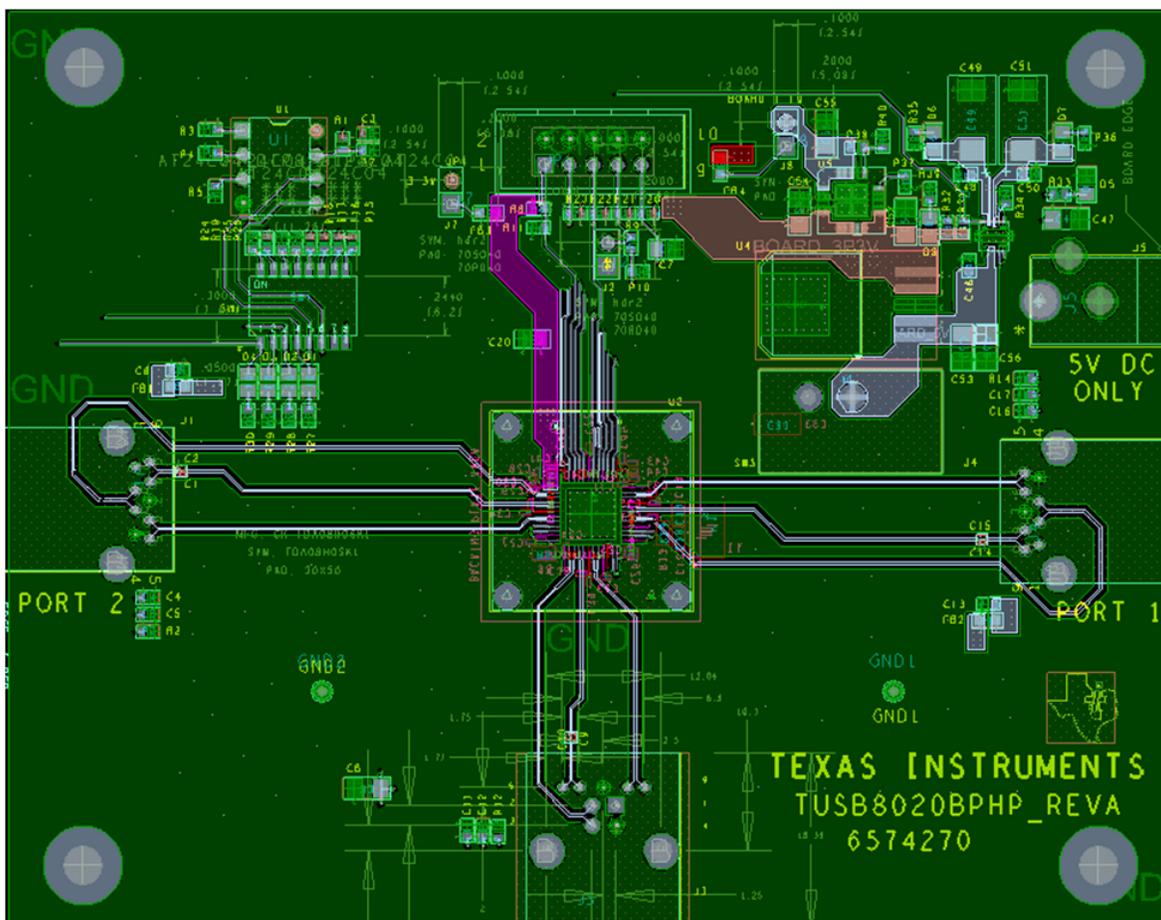
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<b>1</b>	<b>Introduction.....</b>	<b>3</b>
<b>2</b>	<b>Hardware Overview .....</b>	<b>4</b>
<b>1</b>	<b>TUSB8020BPHP .....</b>	<b>4</b>
<b>2</b>	<b>USB Port Connectors .....</b>	<b>4</b>
	2.1 USB Port Connector - Power .....	4
	2.2 USB Port Connector – Noise Filtering.....	4
<b>3</b>	<b>Optional Serial EEPROM .....</b>	<b>5</b>
<b>4</b>	<b>Power .....</b>	<b>5</b>
<b>5</b>	<b>Hub Configuration.....</b>	<b>5</b>
<b>6</b>	<b>Optional Circuitry.....</b>	<b>5</b>
<b>3</b>	<b>Hardware Set Up .....</b>	<b>6</b>
<b>1</b>	<b>Configuration Switches.....</b>	<b>6</b>
<b>2</b>	<b>EVM Installation .....</b>	<b>7</b>
<b>3</b>	<b>Troubleshooting .....</b>	<b>7</b>
	<b>Appendix A TUSB8020BPHPEVM Bill of Materials.....</b>	<b>8</b>
	<b>Appendix B Schematics .....</b>	<b>9</b>

## Introduction

The Texas Instruments TUSB8020BPHP REVA evaluation module is a functional board design of a single device that implements both a USB 3.0 hub and a USB 2.0 hub. The EVM can support both SuperSpeed (SS) and USB 2.0 (HS, FS, and LS) operation on its USB ports. This EVM is intended for use in evaluating system compatibility, developing optional EEPROM firmware, and validating interoperability. This EVM also acts as a hardware reference design for any implementation of the TUSB8020B.

Upon request, layout files for the EVM can be provided to illustrate techniques used to route the differential pairs, use of split power planes, placement of filters and other critical components, and methods used to achieve length matching of critical signals.



**NOTE:** The EVM accommodates various lab test components, actual production implementations can be much smaller.

**Figure 1. TUSB8020B REVA Top Layer Layout**

## Hardware Overview

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The TUSB8020B EVM board hardware is divided into the following functional areas:

### 1 TUSB8020BPHP

The TUSB8020B on the TUSB8020B EVM (U2 on the schematic) operates as a functional interconnect between an upstream connection to a USB host or hub and up to two directly connected downstream devices or hubs. More devices and hubs can be supported, if arranged in tiers. The TUSB8020B is capable of supporting operation at USB SuperSpeed (SS), High-Speed (HS), Full Speed (FS) or Low Speed (LS). In general, the speed of the upstream connection of the TUSB8020B EVM limits the downstream connections to that speed (SS, HS, and FS) or lower.

The TUSB8020B requires a 24-MHz low ESR crystal, Y1 with a 1-M $\Omega$  feedback resistor. The crystal should be fundamental mode with a load capacitance of 12 pF – 24 pF and a frequency stability rating of  $\pm 100$  PPM, or better. To ensure a proper startup oscillation condition, a maximum crystal equivalent series resistance (ESR) of 50  $\Omega$  is recommended.

The TUSB8020B can also use an oscillator or other clock source. When using an external clock source such as an oscillator, the reference clock should have  $\pm 100$  PPM (or better) frequency stability and have less than 50-ps absolute peak-to-peak jitter (or less) than 25-ps peak-to-peak jitter after applying the USB 3.0 jitter transfer function.

### 2 USB Port Connectors

The TUSB8020B EVM is equipped with three standard nine pin USB 3.0 port connectors. One of these three connectors, J3, is a Type B connector designed to interface with an upstream USB host or hub. The remaining connectors, J1 and J4, are Type A connectors for connection to downstream devices or hubs. Standard size connectors were used on the EVM design, but USB micro connectors can be used if desired. It is also possible to implement a legacy USB connector on one or more of the downstream ports if SuperSpeed operation is not desired.

The USB ports can be attached via a standard USB cable to any USB 3.0 or legacy USB host, hub or device. The TUSB8020B automatically connects to any upstream USB 3.0 host or hub at both SuperSpeed and High-Speed. Using a legacy USB cable between the TUSB8020B EVM and a USB 3.0 host or hub forces it to High-Speed operation. The same is true if a legacy USB cable is used between the TUSB8020B EVM and a downstream SuperSpeed capable device: operation is limited to USB 2.0 High-Speed.

#### 2.1 USB Port Connector - Power

VBUS is received from the upstream host or hub on J3. The TUSB8020B is configured as a self-powered hub, so there is not any significant current draw by the EVM from VBUS. The TUSB8020B does monitor the VBUS input after filtering through a resistor divider network of a 90.9-k $\Omega$ , 1% resistor, R9, and a 10-k $\Omega$ , 1% resistor, R10. VBUS cannot be directly connected to the TUSB8020B device. A bulk capacitor of at least 1  $\mu$ F is required on the upstream port VBUS input to comply with the USB specification. The TUSB8020BEVM uses a 10- $\mu$ F capacitor, C8.

#### 2.2 USB Port Connector – Noise Filtering

Each downstream VBUS output has a 150- $\mu$ F bulk capacitor (C49, C51) as recommended by the TPS2561 data manual ([SLVS930](#)) to prevent in-rush current events on the downstream devices. In addition, there are ferrite beads and small capacitors on the VBUS lines to reduce noise and address ESD/EMI concerns.

The TUSB8020BEVM also implements optional isolation using two small noise filtering capacitors and a 1-M $\Omega$  resistor between the earth ground of each connector and the digital ground of the EVM, this is not a requirement but should be used if ground isolation is desired.

Please note that the series capacitors implemented on the SS TX pairs are incorporated to satisfy the USB 3.0 requirement that differential links be AC coupled on the transmit pair.

### 3 Optional Serial EEPROM

Each TUSB8020BEVM is equipped with an onboard EEPROM/socket placeholder, U1. A small I2C EEPROM can be installed to set the configuration registers as defined in the TUSB8020B data sheet ([SLLSEF6](#)). In its default setting, the EVM does not have an EEPROM installed and instead uses the configuration inputs to determine any optional settings of the TUSB8020B.

The EEPROM interface defaults to programmable (not write-protected) so that any installed EEPROM's contents may be modified to test various settings. If an EEPROM data change is required, the values may be changed using the register access methods outlined in the TUSB8020B data sheet. In addition, a Microsoft® Windows® based EEPROM utility is available upon request.

### 4 Power

The TUSB8020B EVM operates from the power provided by a 5-V wall power adapter, J5, not bus power supplied by a USB host. TI recommends using a wall power adapter that is capable of sourcing 2 A to 3 A because the hub must be able to source significant power on its downstream ports (900 mA per port).

The TUSB8020B EVM uses a single-channel LDO voltage regulator to drop 5 V to 3.3 V. The TPS7A4533, U4, is a 1.5-A output linear regulator (SLVS720). The 1.1-V core voltage required by the TUSB8020B is sourced by the 3.3-V rail to reduce unnecessary heat dissipation. The TPS74801, U5, is a 1.5-A output single channel LDO linear regulator (SBVS074). Both regulators require few external passive components and are appropriately rated for heat dissipation.

### 5 Hub Configuration

The TUSB8020BEVM can be configured by setting several inputs to the TUSB8020B that are sampled at power-on reset or using an optional serial EEPROM or SMBUS host. A production implementation without EEPROM or SMBUS could either rely on the default internal pull-up or pull-down resistor for each configuration input or override it with an external pull-up or pull-down resistor. The settings can be modified using SW1 on the EVM. Descriptions of the possible configuration changes are included in the [Configuration Switches](#) section.

### 6 Optional Circuitry

The TUSB8020B EVM design implements a variety of LEDs, none of which are required by the USB specification. They are provided to make testing and debug easier.

- D1 – Indicates that the upstream USB port is connected at High-Speed.
- D2 - Indicates that the downstream USB port 2 is connected at SuperSpeed.
- D3 – Indicates that the downstream USB port 1 is connected at SuperSpeed.
- D4 – Indicates that the upstream USB port is connected at SuperSpeed.
- D5 – Indicates that 5 V is being applied to the TUSB8020B EVM.
- D6 – Indicates downstream USB port 1 power is on.
- D7 – Indicates downstream USB port 2 power is on.
- D8 – Indicates BOARD\_3P3V is active

The switches (SW1 and SW3) and headers (J2, J7, J8, JP1) present on the TUSB8020B EVM are intended for lab evaluation only and are not required for production designs.

## Hardware Set Up

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### 1 Configuration Switches

The TI TUSB8020BEVM has a set of switches to facilitate configuration changes. Changing these switch settings without a complete understanding of the result is not recommended. Configuration inputs are only read by the TUSB8020B during power on reset, changing the switch settings while the EVM is powered on has no effect. Refer to the EVM schematic in [Appendix B](#) for additional information .

The switch definitions are as follows, with the standard setting in parenthesis:

**SW1\_1 (on):** FULLPWRMGMTZ\_SMBA1\_SS Switch. The TUSB8020B has an internal pull up on this terminal, so the TUSB8020B defaults to a non full power management mode. If the switch is set to the ON position, the terminal is pulled low and full power management mode is enabled. This means that the TUSB8020B reports that it supports downstream port power switching in the USB descriptors it sends to the USB host. Since the TUSB8020B EVM does implement downstream port power switching, enable full power management mode.

**SW1\_2 (off):** PWRCTL\_POL\_SS\_DN1 Switch. The TUSB8020B has an internal pull down on this terminal, so port power control polarity defaults to active **high**. If the switch is set to the ON position, the terminal is pulled high and the port power control polarity changes to active low.

**SW1\_3 (off):** SMBUSz\_SS\_DN2 Switch. The TUSB8020B has an internal pull up on this terminal, so I2C interface mode is enabled by default. If the switch is set to the ON position, the terminal is pulled low and SMBUS mode is enabled.

**SW1\_4 (on):** GANGED\_SMBA2\_HS Switch. The TUSB8020B has an internal pull up on this terminal, so ganged mode is enabled by default. If the switch is set to the ON position, the terminal is pulled low and individual port power control mode is enabled. Since the TUSB8020B EVM does implement individual port power controls, this terminal should be set high.

**SW1\_5 (off):** SCL\_SMBCLK Switch. The TUSB8020B has an internal pull down on this terminal, so the serial EEPROM/SMBUS interface is disabled. If the switch is set to the ON position, a pull up resistor is connected to the serial clock terminal to indicate that an I2C EEPROM may be attached (along with a pull up resistor on SDA).

**SW1\_6 (off):** SDA\_SMBDAT Switch. The TUSB8020B has an internal pull down on this terminal, so the serial EEPROM/SMBUS interface is disabled. If the switch is set to the ON position, a pull up resistor is connected to the serial clock terminal to indicate that an I2C EEPROM may be attached (along with a pull up resistor on SCL).

**SW1\_7 (off):** PWRCTL1\_BATEN1 Switch. The TUSB8020B has an internal pull down on this terminal, so USB Battery Charging mode on Port 1 is disabled by default. If the switch is set to the ON position, the terminal is pulled high and battery charging is enabled on downstream port 1.

**SW1\_8 (off):** PWRCTL2\_BATEN2 Switch. The TUSB8020B has an internal pull down on this terminal, so USB Battery Charging mode on Port 2 is disabled by default. If the switch is set to the ON position, the terminal is pulled high and battery charging is enabled on downstream port 2.

## 2 EVM Installation

Install the EVM using the following steps:

1. Attach a 5-V, 3-A wall power source to J5. LED D5 should turn on.
2. Turn on switch SW3, LED D8 should turn on.
3. Attach a USB cable between J3 and a USB host. LEDs D6 and D7 should turn on.
  - (a) If the EVM is attached to a USB 3.0 host, D1 and D4 should turn on.
  - (b) If the EVM is attached to a USB 2.0 host, D1 should turn on.

## 3 Troubleshooting

**Case 1:** Device function(s) are “banged out” in Device Manager.

- Make sure that the latest updates are installed for the operating system.
- Make sure that the latest drivers are installed for the host controller.

**Case 2:** The EVM does not work at all.

- Verify that all switches are in their default state and the EVM is powered on with a 5-V source with adequate current to support any bus-powered devices (3 A+).
- If installed, remove the serial EEPROM from the EEPROM socket. The EVM does not require an EEPROM to operate.
- Make sure shunts are installed on J2, J7, and J8.
- In the case where a 12-V power supply has been attached to the EVM, the fault is non-recoverable.

## Appendix A TUSB8020BPHEVM Bill of Materials

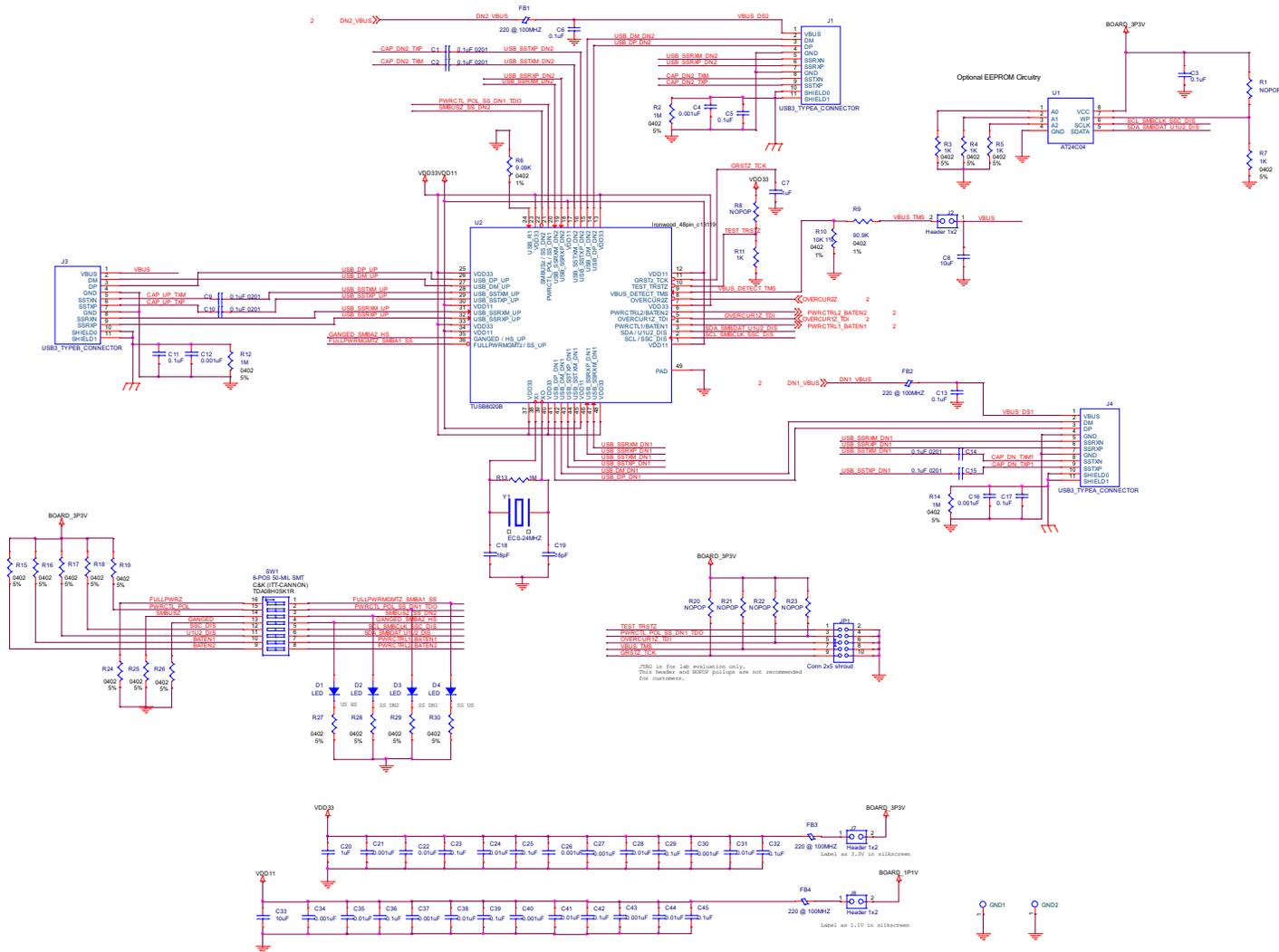
Table 1 contains the BOM for the EVM.

**Table 1. TUSB8020BPHEVM Bill of Materials**

Item	Quantity	Reference	Part	Manufacturer	Part Number	Pkg
1	2	C7,C20	1uF	TDK	C2012X7R1A105K	805
2	3	C4,C12,C16,	0.001uF	TDK	C1005X7R1H102K	402
3	8	C21,C26,C27,C30,C34,C37,C40,C43	0.001uF	TDK	C0603X7R1E102K	201
4	8	C22,C24,C28,C31,C35,C38,C41,C44	0.01uF	TDK	C0603X5R1A103K	201
5	9	C3,C5,C6,C11,C13,C17,C46,C48,C50	0.1uF	Yageo	CC0402KRX5R6BB104	402
6	14	C1,C2,C9,C10,C14,C15,C23,C25,C29,C32,C36,C39,C42,C45,	0.1uF	TDK	C0603X5R0J104M	201
7	2	C18,C19	18pF	AVX	04025A180JAT2A	402
8	8	C8,C33,C47,C52,C53,C54,C55, C56	10uF	Murata Electronics	GRM31CR61C106KC31L	1206
9	2	C49,C51	150uF	Kemet	B45197A2157K409 (Tantalum)	7343
10	8	R1,R8,R20,R21,R22,R23,R37	NOPOP			402
11	8	D1,D2,D3,D4,D5,D6,D7,D8	LED Green 0805	Lite On	LTST-C171GKT	805
12	4	FB1,FB2,FB3,FB4	220 @ 100MHZ Ferrite Bead	Murata	BLM18PG221SN1D	603
13	1	SW1	8-POS 50-MIL SMT	C&K Components	SD08H0SBR	
14	1	J3	USB3_TYPEB_CONNECTOR	FoxConn	UEB1112C-2AK1-4H	9_RA_TH_B
15	2	J1,J4	USB3_TYPEA_CONNECTOR	FoxConn	UEA1112C-4HK1-4H	9_RA_TH_A
16	1	J5	2.1mm x 5.5mm DC Power Jack	CUI Inc.	PJ-202AH (PJ-002AH)	2.1mm x 5.5mm
17	4	R2,R12,R13,R14	1M	Rohm Semiconductor	MCR01MZPJ105	402
18	1	R9	90.9K 1%	Rohm Semiconductor	MCR01MZPF9092	402
19	2	R31,R32	10K	Rohm Semiconductor	MCR01MZPJ103	402
20	1	R10	10K 1%	Rohm Semiconductor	MCR01MZPF1002	402
21	12	R15,R16,R17,R18,R19,R24,R25,R26, R27,R28,R29, R30	4.7K	Vishay / Dale	CRCW04024K70FKED	402
22	5	R3,R4,R5,R7,R11	1K	Rohm Semiconductor	MCR01MZPJ102	402
23	4	R33,R35,R36,R39	330	Rohm Semiconductor	MCR01MZPJ331	402
24	1	R34	25.5K	Panasonic - ECG	ERJ-2RKF2552X	402
25	1	R38	1.87K	Vishay / Dale	CRCW04021K87FKED	402
26	1	R40	4.99K	Vishay / Dale	CRCW04024K99FKED	402
27	1	U2	TUSB8020B	Texas Instruments	TUSB8020B	48QFP
28	1	U1	AT24C04 Socket	TE Connectivity	AT24C04A-10PU-1.8 / 2-641260-1	8DIP / 8SOIC SOCKET
29	1	U3	TPS2561DRC - USB Power Switch	Texas Instruments	TPS2561DRC	10SON
30	1	U4	TPS7A4533 - 3.3V Voltage Regulator	Texas Instruments	TPS7A4533KTT	DDPAK-5
31	1	U5	TPS74801RGW - 1.1V Voltage Regulator	Texas Instruments	TPS74801RGW	20VQFN
32	1	Y1	ECS-24MHZ Crystal	ECS	ECX-53B (ECS-240-20-30B-TR)	5.0mm x 3.2mm
33	1	JP1	Conn 2x5 shroud - NOPOP			
34	1	R6	9.09K 1%	Panasonic - ECG	ERJ-2RKF9091X	402
35	2	GND1,GND2	TEST POINT - NOPOP			
36	1	J2,J7,J8	Header 1x2	3M	961102-6404-AR	
37	1	SW3	L101_switch	C&K Components	L101011MS02Q	

## Appendix B Schematics

Figure 2 and Figure 3 contain the schematics for this EVM.



**Figure 2. TUSB8020BPHEVM Schematic**

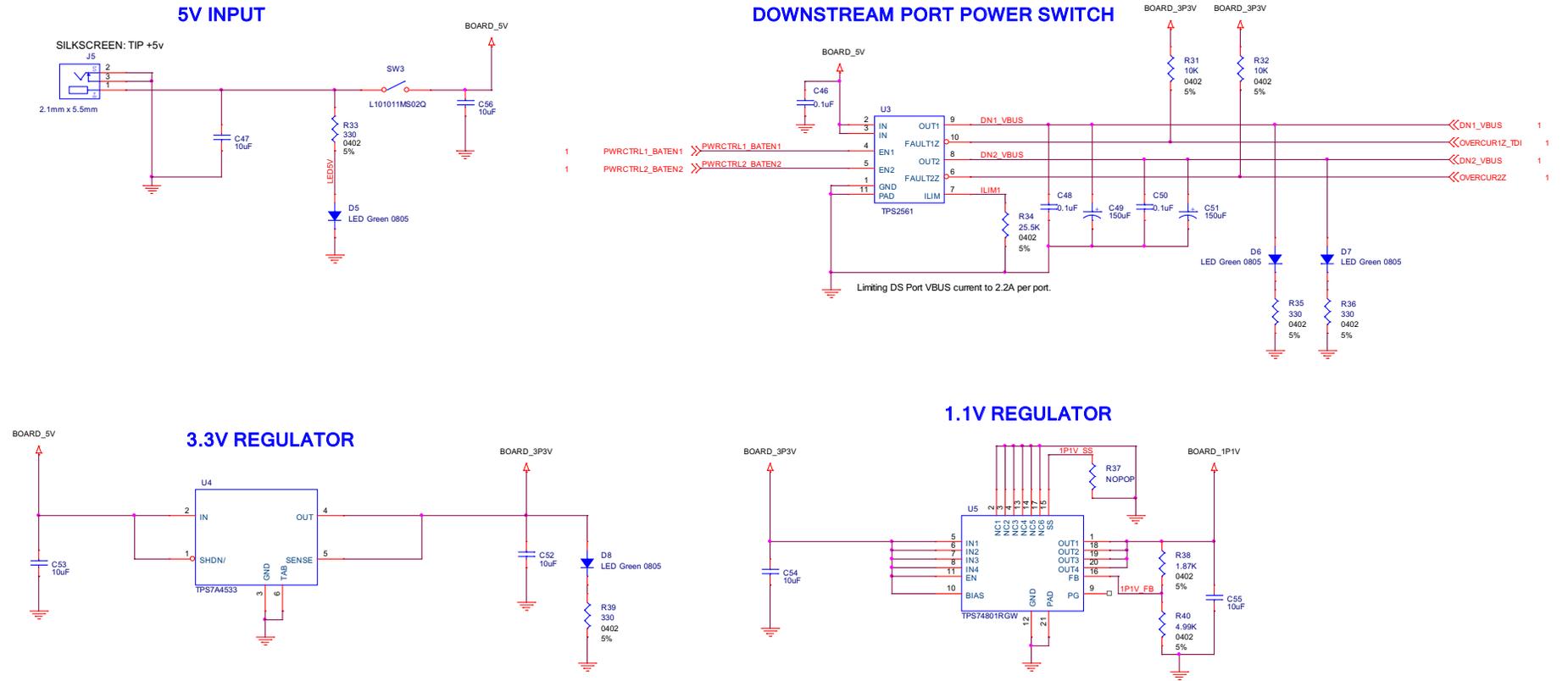


Figure 3. TUSB8020BPHEVM Power Schematic

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### General Statement for EVMs including a radio

*User Power/Frequency Use Obligations:* For EVMs including a radio, the radio included in such EVMs is intended for development and/or professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability in such EVMs and their development application(s) must comply with local laws governing radio spectrum allocation and power limits for such EVMs. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by TI unless user has obtained appropriate experimental and/or development licenses from local regulatory authorities, which is the sole responsibility of the user, including its acceptable authorization.

### U.S. Federal Communications Commission Compliance

#### For EVMs Annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

##### Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications could void the user's authority to operate the equipment.

##### FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at its own expense.

##### FCC Interference Statement for Class B EVM devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

##### Industry Canada Compliance (English)

#### For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

##### Concerning EVMs Including Radio Transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

##### Concerning EVMs Including Detachable Antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

## Canada Industry Canada Compliance (French)

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

### Concernant les EVMs avec appareils radio

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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## Important Notice for Users of EVMs Considered “Radio Frequency Products” in Japan

**EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.**

If user uses EVMs in Japan, user is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after user obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after user obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless user gives the same notice above to the transferee. Please note that if user does not follow the instructions above, user will be subject to penalties of Radio Law of Japan.

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