TUSB8040EVM User's Guide

User's Guide

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Introduction

The TI TUSB8040 REV B EVM 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, 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 TUSB8040.

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.

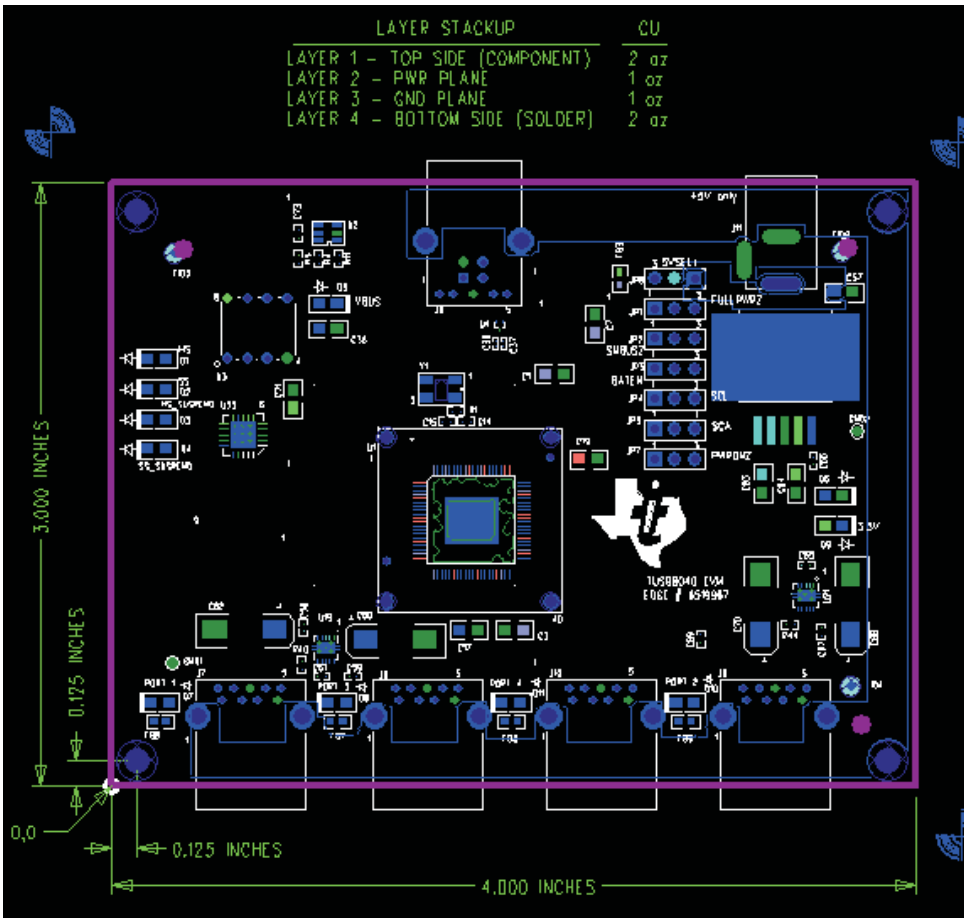

Figure 1. TUSB8040 REV B EVM Top Layer Layout

NOTE: Please note the EVM dimensions of 3 in x 4 in accommodates various lab test components, actual production implementations can be much smaller. Also, the TUSB8040 REV B EVM is laid out to accept either a TUSB8040 unit or a socket, this socket functionality would not need to be duplicated on a production implementation.

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Hardware Overview

The TUSB8040 REV B EVM board hardware can be divided into five functional areas:

1 TUSB8040

The TUSB8040 on the TUSB8040 REV B EVM (U1 on the schematic) operates as a functional interconnect between an upstream connection to a USB host or hub and up to four directly connected downstream devices or hubs. More devices and hubs can be supported if arranged in tiers. The TUSB8040 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 TUSB8040 REV B EVM limits the downstream connections to that speed (SS, HS, FS) or lower.

The TUSB8040 requires a 24-MHz low ESR crystal, Y1 with a 1-MΩ feedback resistor. The crystal should be fundamental mode with a load capacitance of 12 pF – 24 pF and a frequency stability rating of ±100 PPM or better. To ensure a proper startup oscillation condition, a maximum crystal equivalent series resistance (ESR) of 50 Ω is recommended.

The TUSB8040 can also use an oscillator or other clock source. When using an external clock source such as an oscillator, the reference clock should have ±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 TUSB8040 REV B EVM is equipped with 5 standard nine-pin USB 3.0 port connectors. One of these five connectors, J6, is a Type B connector designed to interface with an upstream USB host or hub. The remaining connectors, J7-J10, 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 TUSB8040 will automatically connect to any upstream USB 3.0 host or hub at both SuperSpeed and High-speed. Using a legacy USB cable between the TUSB8040 REV B EVM and a USB 3.0 host or hub will force it to High-speed operation. The same is true if a legacy USB cable is used between the TUSB8040 REV B EVM and a downstream SuperSpeed capable device in that operation will be limited to USB High-speed.

2.1 USB Port Connector - Power

VBUS is received from the upstream host or hub on J6. The TUSB8040 is configured as a self-powered hub, so there should not be any significant current draw by the EVM. The TUSB8040 does monitor the VBUS input after filtering through a resistor divider network of a 90.9-kΩ 1% resistor, R2, and a 10-kΩ 1% resistor, R3. VBUS cannot be directly connected to the TUSB8040 device.

NOTE: The VBUS LED implemented on the EVM will cause a USB 2.0 compliance issue because it draws greater than 2-mA of current while the USB connection is suspended. It is included for lab evaluation purposes only.

A bulk capacitor of at least 1 µF is required on the upstream port VBUS input to comply with the USB specification. The TUSB8040 REV B EVM uses a 10-µF capacitor, C36.

VBUS, sourced by the 5-V wall power input, J11, is provided to the downstream port connectors so that bus powered devices may be attached. The USB 3.0 specification limits the current consumption of a USB 3.0 device to 900 mA at 5 V. The current limiting parameter of the TPS2560 devices, U19 and U21, is configured to 1.5 A to avoid any spurious over-current events due to bus-powered HDD spin-up power fluctuations (see SLVS930). A production implementation could place stricter limits on this power consumption. An over-current event on any of the downstream port connectors will be reported to the TUSB8040 via the OVERCUR0Z input.

2.2 USB Port Connector – Noise Filtering

Each downstream VBUS output has a 150-µF bulk capacitor (C60, C62, C68, C70) as recommended by the TPS2560 data manual to prevent in-rush current events on the downstream devices. This is more bulk capacitance than a typical USB application and in most applications 47-µF capacitors could be used. In addition, there are ferrite beads and small capacitors on the VBUS lines to reduce noise and address ESD/EMI concerns.

The TUSB8040 REV B EVM also implements optional isolation using two small noise filtering capacitors and a 1-MΩ resistor between the earth ground of each connector and the digital ground of the EVM. Please note that the 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 and are not optional.

3 Hub Configuration

The TUSB8040 REV B EVM can be configured by setting several inputs to the TUSB8040 that are sampled at power-on reset or using an optional serial EEPROM. See Section 1 for a full description of these inputs and how to configure them. A production implementation would either rely on the default internal pull-up or pull-down resistor for each configuration input or over-ride it with an external pull-up or pull-down resistor. The three place jumpers used on the TUSB8040 REV B EVM: JP1-JP5 are for lab evaluation only.

4 Optional Serial EEPROM

Each TUSB8040 REV B EVM is equipped with an onboard EEPROM socket footprint. A small I^2C EEPROM can be installed with register values as defined in the TUSB8040 data manual (SLLSE42). In its default setting, the EVM does not have an EEPROM installed and instead uses the configuration inputs to determine the setting of the TUSB8040.

The EEPROM interface defaults to programmable (not write-protected) so that the EEPROM contents may be modified to test optional EVM settings. If an EEPROM data change is required, the values may be changed using the register access methods outlined in the TUSB8040 Datasheet. In addition, a Microsoft Windows® based EEPROM utility is available upon request.

5 Power/Reset

The TUSB8040 REV B EVM defaults to operating from the power provided by a 5-V wall power adapter. It is recommended to use a wall power source that is capable of sourcing 4 A – 5 A because the hub is required to supply significant power on its downstream ports, 900 mA per port.

The TUSB8040 REV B EVM uses a single channel LDO voltage regulator to drop 5 V to 3.3 V. The TPS78633, U20, is a 1.5-A output linear regulator (see SLVS389). The 1.1-V core voltage required by the TUSB8040 is sourced by the 3.3-V rail to reduce unnecessary heat dissipation. The TPS74801, U22, is a 1.5-A output single channel LDO linear regulator (see SBVS074). Both regulators require few external passive components and are appropriately rated for heat dissipation.

While there are two power on reset sources on the TUSB8040 REV B EVM, only one is required. Implemented on the EVM is a supervisory circuit, TPS3808G33, U2 (see SBVS050). This device has two reset sources: the BOARD_3P3V power rail and the 1.1-V regulator power good output.

The simplest reset source would be an RC reset source such as the one created by the internal pull-up resistor of GRSTz and a 2.2-µF capacitor, in lieu of the 1-µF capacitor, C17. The TUSB8040 requires a power on reset of 3 ms, the value of the capacitor may vary based on the voltage ramp characteristics of the implementation.

6 Optional Circuitry

The TUSB8040 REV B EVM design implements a variety of LEDs, none of which are required by the USB specification. They are provided to make testing and debugging easier.

- D1 – Indicates that the upstream USB port is connected at High-speed.
- D2 – Indicates that the upstream USB port is connected at SuperSpeed.
- D3 – Indicates that the upstream USB port has entered a High-speed suspend state.
- D4 - Indicates that the upstream USB port has entered a SuperSpeed suspend state.
- D5 – Indicates when VBUS is provided to the upstream USB port.
- D6 – Indicates that 5V is being applied to the TUSB8040 REV B EVM.
- D7, D8, D10, D11 – Indicate when VBUS is applied to the downstream USB ports. The TUSB8040 REV B EVM enables or disables power to all downstream USB ports simultaneously.
- D9 – Indicates BOARD_3P3V is active.

The TUSB8040 REV B EVM incorporates ESD protection circuitry for the differential pairs of all five ports. The TPD2EUSB30 devices are not required or populated on the EVMs, but are recommended for any system where ESD events are a concern, especially if the end equipment requirements exceed the device specifications (i.e. HBM 2000 kV, CDM 500 V) (see SLVSAC2).

The TUSB8040 has a JTAG test interface which is used only for factory test. All JTAG pins can be left floating with the exception of TRSTZ, which should be pulled down using a 1-kΩ resistor.

Hardware Set Up

1 Configuration Jumpers

The TI TUSB8040 REV B EVM has several jumpers that facilitate configuration changes. Changing these jumpers without a complete understanding of the result is not recommended. In no instance should a jumper be removed or changed while the EVM is powered. Please refer to the EVM schematic included in Appendix B. The jumper definitions are as follows, with the standard setting in parenthesis:

JP1(2,3) Full Power Management Jumper— Standard setting: full power management is enabled when the jumper is placed on pins 2 and 3 at power-on reset. Pin 2 also acts as the interface for the SMBA1 signal when a SMBus host is connected to the TUSB8040. The TUSB8040 has an internal pull up on this terminal, so the TUSB8040 actually defaults to a non full power management state which is the lowest cost implementation with no active downstream port switching. Removing the jumper enables the default mode.

JP2(np) SMBUSz Jumper— Standard setting: not populated, I^2C interface mode is enabled via the internal pull-up resistor at power-on reset. If the jumper is placed on pins 2 and 3 at power-on reset, SMBUS mode is enabled.

JP3(np) Battery Charging Jumper— Standard setting: not populated, battery charging is disabled via the internal pull-down resistor. If the jumper is placed on pins 1 and 2, battery charging on the downstream ports is enabled. This signal also acts at the active low power enable/disable for the downstream port power switches.

JP4(np) Serial Clock Jumper— Standard setting: not populated, the internal pull-down resistor indicates that no EEPROM is attached. A pull up resistor is connected to the serial clock terminal to indicate that an I^2C EEPROM is attached. Pin 2 also acts as the interface for the SMBCLK signal when a SMBus host is connected to the TUSB8040.

JP5(np) Serial Data Jumper— Standard setting: not populated, the internal pull-down resistor indicates that no EEPROM is attached. A pull up resistor is connected to the serial clock terminal to indicate that an I^2C EEPROM is attached. Pin 2 also acts as the interface for the SMBDAT signal when a SMBus host is connected to the TUSB8040. The SDA_SMBDAT terminal of production TUSB8040 will be sampled at the deassertion of reset to determine if the USB 3.0 SuperSpeed low power states U1 and U2 are disabled. If SDA_SMBDAT is high, U1 and U2 low power states are disabled. If SDA_SMBDAT is low, U1 and U2 low power states are enabled. If the optional EEPROM or SMBUS is implemented, the value of the u1u2Disable bit of the Device Configuration Register determines if the low power state U1 and U2 are enabled.

JP7(1,2) Power On Jumper— Standard setting: downstream power management is controlled by the PWRON0z_BATEN output of the TUSB8040. If the jumper is placed on pins 2 and 3, downstream port power is always enabled. The always enabled mode should be used when the Full Power Management setting is disabled by the removal of JP1 from pins 2 and 3.

JP8(1,2) 5-V Source Jumper— Standard setting: board 5 V is sourced from the provided 5-V, 4-A DC wall power input. The ability to source board 5 V from upstream VBUS by placing the jumper on pins 2 and 3 is a lab test option only, the TUSB8040 does not support bus power operation.

2 EVM Installation

To install the EVM, perform the following steps:

1. Attach 5-V wall power source to J11. LEDs D6 and D9 should be lit.
2. Attach a USB cable between J6 and a USB host. LEDs D5, D7, D8, D10 and D11 should be lit.
   (a) If the TUSB8040 REV B EVM is attached to a USB 3.0 host, D1 and D2 should be lit.
   (b) If the TUSB8040 REV B EVM is attached to a USB 2.0 host, D1 should be lit.

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 jumpers are in their default state and the EVM is powered on with a 5-V source with adequate current.
- If available, use a volt meter to verify that 3.3-V power appears at C63, C64 or C71. Also, verify that 1.1-V appears at C19.
- If installed, remove the serial EEPROM from the EEPROM socket. The EVM does not require an EEPROM to operate.

Appendix A TUSB8040 REV B EVM Bill of Materials

This appendix contains the TUSB8040 REV B EVM BOM (see Table 1).

Table 1. Bill of Materials

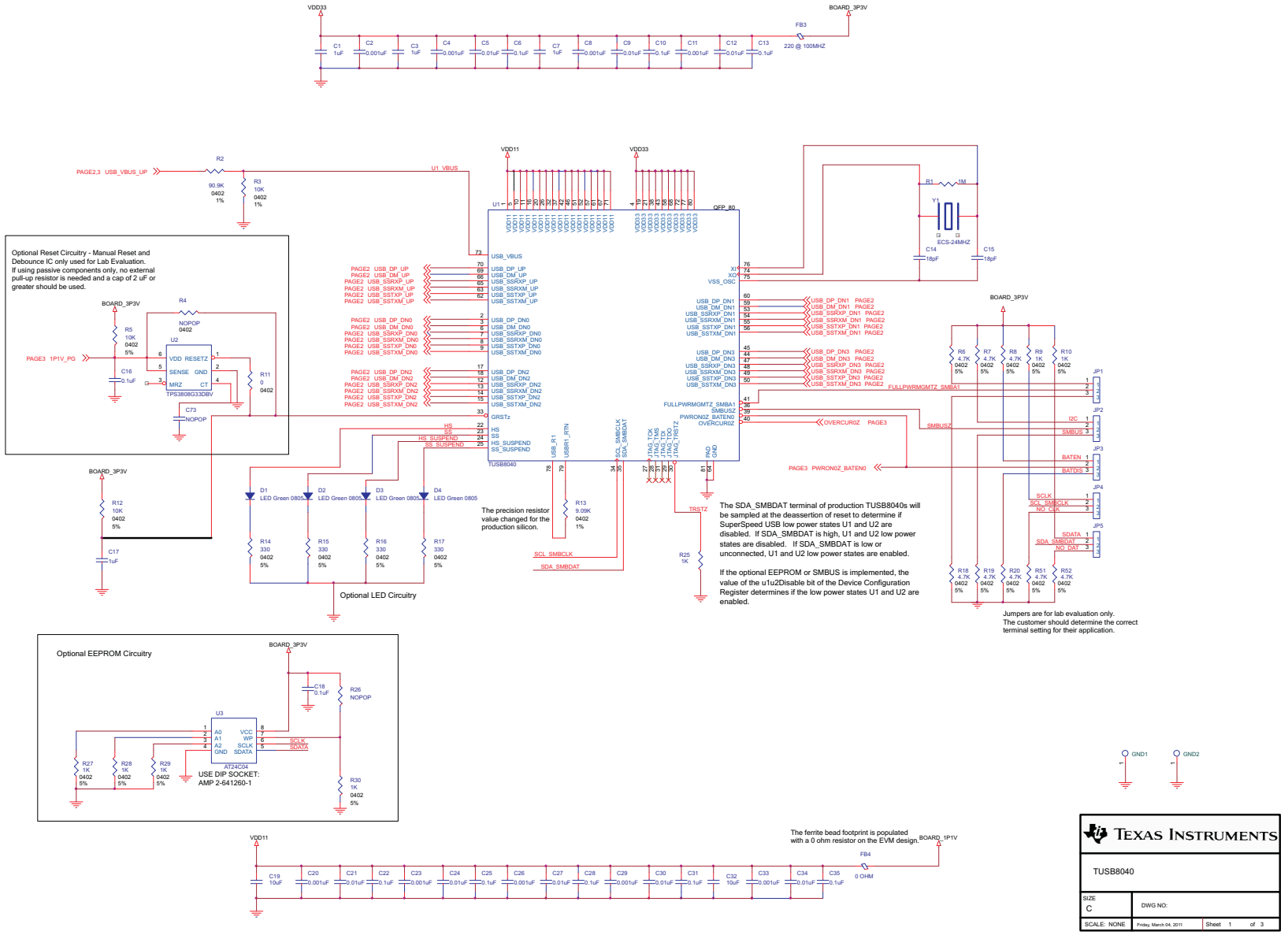
Item	Quantity	Reference	Part	MFR	Part Number	Pkg
1	4	C1,C3,C7,C17	1 µF	TDK	C2012X7R1A105K	805
2	14	C2,C4,C8,C11,C20,C23,C26,C29,C33,C40,C46, C48,C54, C56	0.001 µF	TDK	C1005X7R1H102K	402
3	9	C5,C9,C12,C21,C24,C27,C30,C34,C66	0.01 µF	AVX	0402YC103KAT2A	402
4	25	C6,C10,C13,C16,C18,C22,C25,C28,C31,C35, C39,C45,C47,C53,C55,C58,C59,C61,C65,C67, C69,C74,C75,C76,C77	0.1 µF	Yageo	CC0402KRX5R6BB104	402
5	10	C37,C38,C41,C42,C43,C44,C49,C50,C51,C52	0.1 µF	TDK	C0603X5R0J104M	201
6	2	C14,C15	18 pF	AVX	04025A180JAT2A	402
7	8	C19,C32,C36,C57,C63,C64,C71,C72	10 µF	Kemet	T491A106M006AT (Tantalum)	1206
8	4	C60,C62,C68,C70	150 µF	Kemet	B45197A2157K409 (Tantalum)	7343
9	4	R4,R26,R47,C73	NOPOP			402
10	11	D1,D2,D3,D4,D5,D6,D7,D8,D9,D10,D11	LED Green 0805	Lite On	LTST-C171GKT	805
11	5	FB3,FB6,FB7,FB8,FB9	220 at 100-MHz Ferrite Bead	Murata	BLM18PG221SN1D	603
12	7	JP1,JP2,JP3,JP4,JP5,JP7,JP8	Head 1x3 (HDR3X1 M .1)	3M	961103-6404-AR	HDR3X1 M 0.1" TH
13	1	J6	USB3_TYPEB_CONNECTOR	FoxConn	UEB1112C-2AK1-4H	9_RA_TH_B
14	4	J7,J8,J9,J10	USB3_TYPEA_CONNECTOR	FoxConn	UEA1112C-4HK1-4H	9_RA_TH_A
15	1	J11	2.1-mm x 5.5-mm DC Power Jack	CUI Inc.	PJ-202AH (PJ-002AH)	2.1-mm x 5.5-mm
16	6	R1,R31,R33,R34,R35,R36	1M	Rohm Semiconductor	MCR01MZPJ105	402
17	1	R2	90.9K 1%	Rohm Semiconductor	MCR01MZPF9092	402
18	3	R5,R12,R38	10K	Rohm Semiconductor	MCR01MZPJ103	402
19	1	R3	10K 1%	Rohm Semiconductor	MCR01MZPF1002	402
20	9	R6,R7,R8,R18,R19,R20,R39,R51,R52	4.7K	Rohm Semiconductor	MCR01MZPJ472	402
21	7	R9,R10,R25,R27,R28,R29,R30	1K	Rohm Semiconductor	MCR01MZPJ102	402
22	1	R11	0	Rohm Semiconductor	MCR01MZPJ000	402
23	11	R14,R15,R16,R17,R32,R37,R41,R42,R43,R45, R46	330	Rohm Semiconductor	MCR01MZPJ331	402
24	2	R40,R44	37.4K	Vishay / Dale	CRCW040237K4FKED	402
25	1	R48	1.87K	Vishay / Dale	CRCW04021K87FKED	402
26	1	R49	4.99K	Vishay / Dale	CRCW04024K99FKED	402
27	1	U1	TUSB8040 - USB 3.0 Hub	Texas Instruments	TUSB8040	80QFP
28	1	U2	TPS3808G33DBV - Voltage Supervisor	Texas Instruments	TPS3808G33DBV	6DBV
29	1	U3	AT24C04 / SOCKET - I^2C EEPROM	Atmel / Tyco	AT24C04A-10PU-1.8 / 2-641260-1	8DIP/8SOIC SOCKET
30	15	U4,U5,U6,U7,U8,U9,U10,U11,U12,U13,U14,U15, U16, U17,U18	TPD2EUSB30 - USB ESD Protection	Texas Instruments	TPD2EUSB30	3DRT
31	2	U19,U21	TPS2560DRC - USB Power Switch	Texas Instruments	TPS2560DRC	10SON
32	1	U20	TPS78633KTT - 3.3-V Voltage Regulator	Texas Instruments	TPS78633KTT	DDPAK-5

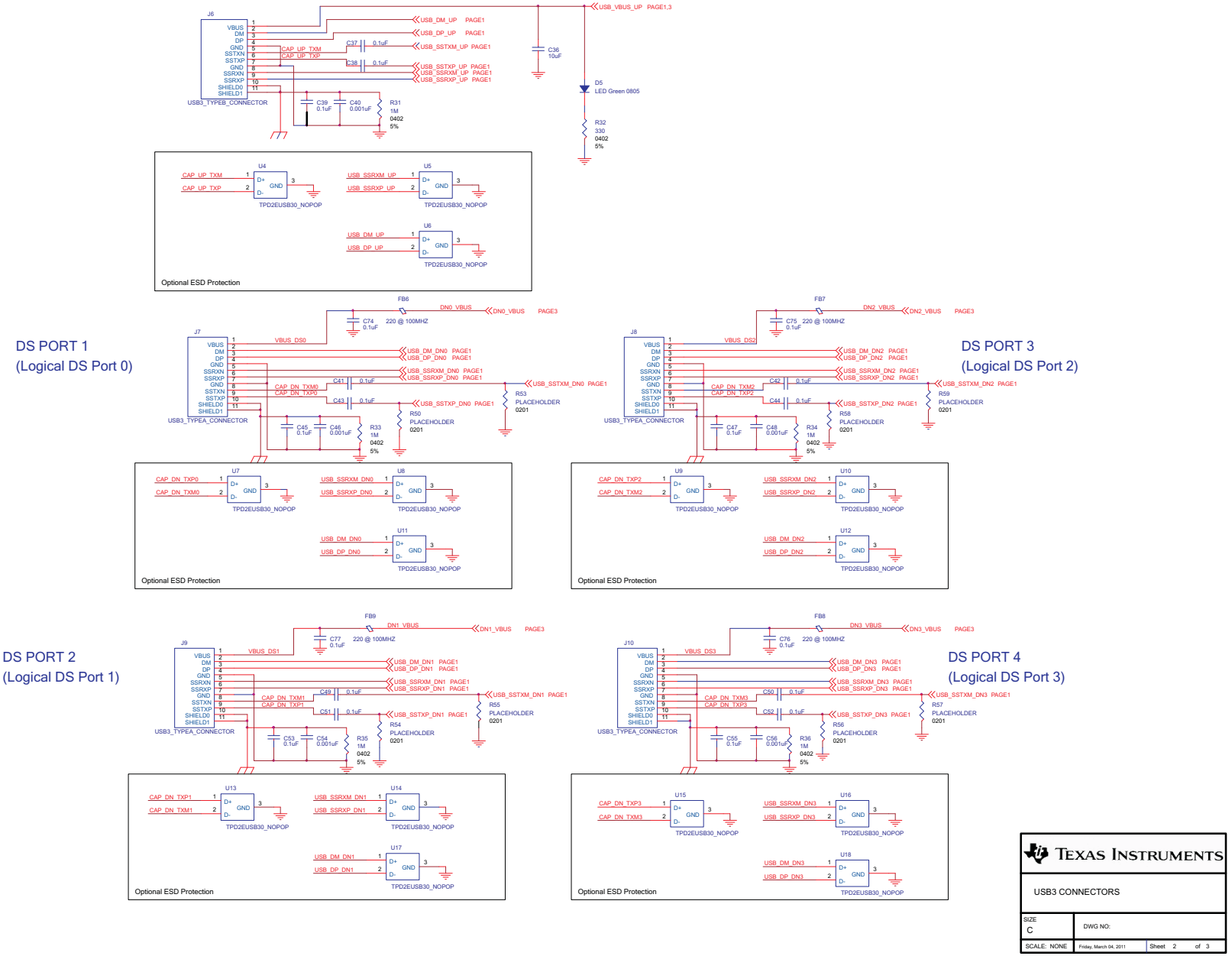
Table 1. Bill of Materials (continued)

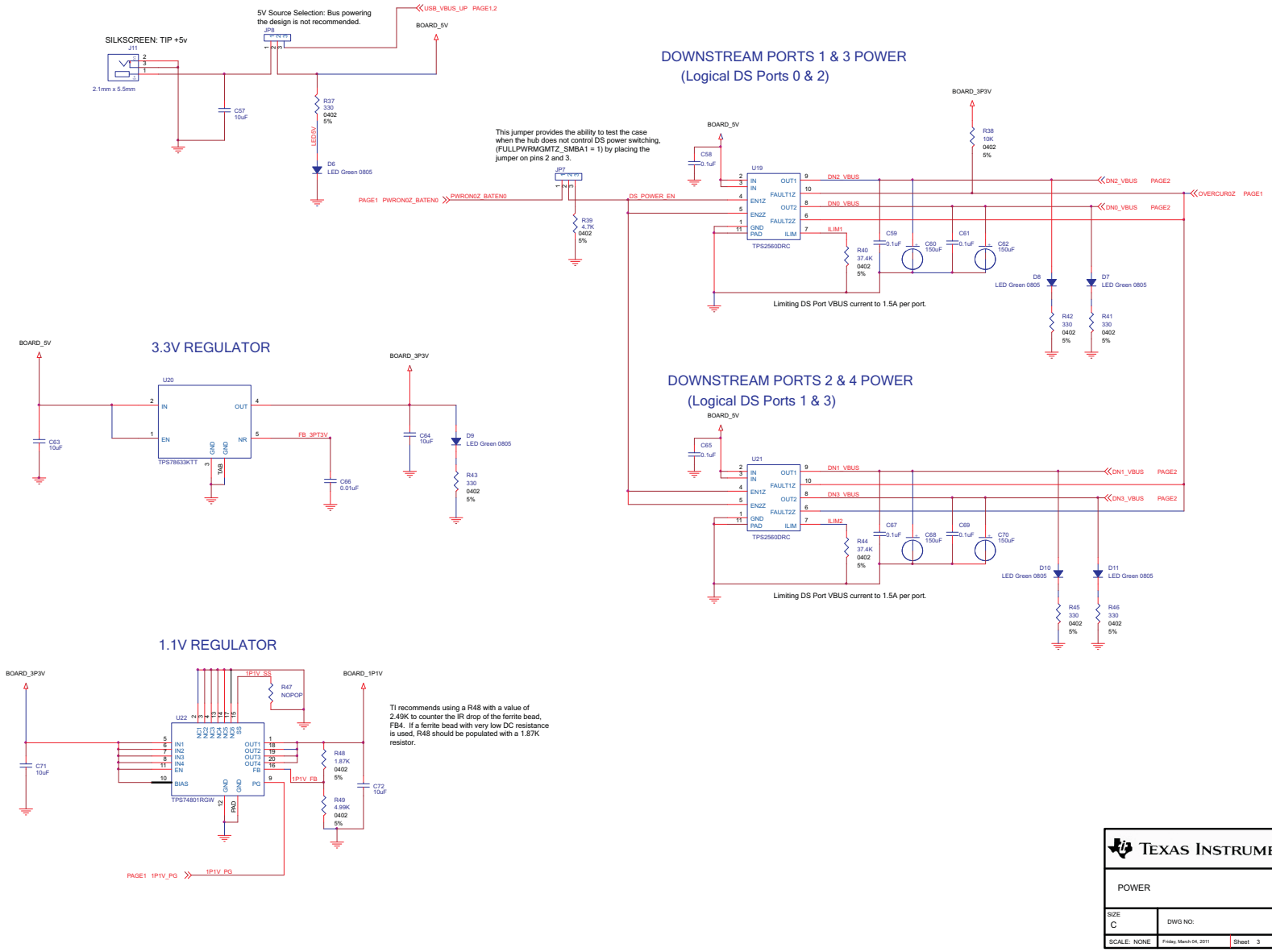
Item	Quantity	Reference	Part	MFR	Part Number	Pkg
33	1	U22	TPS74801RGW - 1.1-V Voltage Regulator	Texas Instruments	TPS74801RGW	20VQFN
34	1	Y1	ECS-24-MHz Crystal	ECS	ECX-53B (ECS-240-20-30B-TR)	5-mm x 3.2-mm
35	8	R50,R53,R54,R55,R56,R57,R58,R59	PLACEHOLDER			201
36	1	R13	9.09K1%	Vishay / Dale	CRCW04029K09FKED	402
37	1	FB4	0 Ω	Rohm Semiconductor	MCR03EZPJ000	603

Appendix B TUSB8040 REV B EVM Schematics

This appendix contains the TUSB8040 REV B EVM schematics.







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