TPS2543EVM User's Guide

This user's guide describes the evaluation module (EVM) for the TPS2543. TPS2543 is a USB charging port power switch and controller for charging host ports and dedicated charging ports.

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1 Description

The TPS2543EVM allows reference circuit evaluation of the TI TPS2543 USB charging port power switch and controller.

1.1 Features

- USB Charging Port Power Switch and Controller
- Meets Battery Charging Specification BC1.2 for DCP and CDP
- Meets Chinese Telecommunications Industry 2.0 Standard YD/T 1591-2009
- Compatible With USB 2.0 and 3.0 Power Switch Requirements
- Adjustable Current Limit, 230 mA–2800 mA Typical
- Fast Overcurrent Response – 1.5 µs Typical
- 73-mΩ High-Side MOSFET
- 2.6-GHz Bandwidth USB 2.0 Data Switch
- EVM supports USB 3.0 data passthrough
- TPS2544EVM-064 and TPS2546EVM-064 are also available for order

1.2 Applications

- USB Ports/Hubs
- Notebook PCs

1.3 Glossary of Terms

- Charging downstream port (CDP)
  - A downstream port that complies with the USB 2.0 definition of a host or a hub, and additionally defines a handshake on DP/DM to identify a BC 1.1 compliant host to a BC 1.1 compliant portable device
  - BC 1.1 allows a high-speed portable device to draw 900 mA and low-speed or full-speed device to draw 1500 mA
  - BC 1.2 intention is to allow all devices to draw 1500 mA
  - BC 1.2 corrects BC 1.1 to ensure USB host provides 5 V at >1500 mA
- Standard downstream port (SDP)
  - USB 2.0 defined port currently adopted by most USB ports
  - Portable device is allowed to draw 100 mA initially and request additional current over USB communications in 100-mA steps up to a maximum of 500 mA
  - USB host required to provide at least 500 mA at 5 V
  - Portable device must draw less than 2.5 mA when in USB Suspend due to the absence of USB communication
- Dedicated charging port (DCP) as defined in BC 1.1
  - BC 1.1 defines a dedicated charging port as a downstream port on a device that outputs power through a USB connector, but is not capable of enumerating a downstream device.
  - Wall adapter must source between 500 mA and 1500 mA.
  - Portable device may attempt to draw 1800 mA in order to force the wall adapter into constant-current mode.
  - BC 1.2 intention is to allow DCP to current limit above 1800 mA
- YD/T 1591-2006, updated 2009
  - PROC Telecommunications Standard
  - Defines wall-adapter requirements
  - Rated current between 500 mA–1500 mA with defined I-V curve

2 Schematic

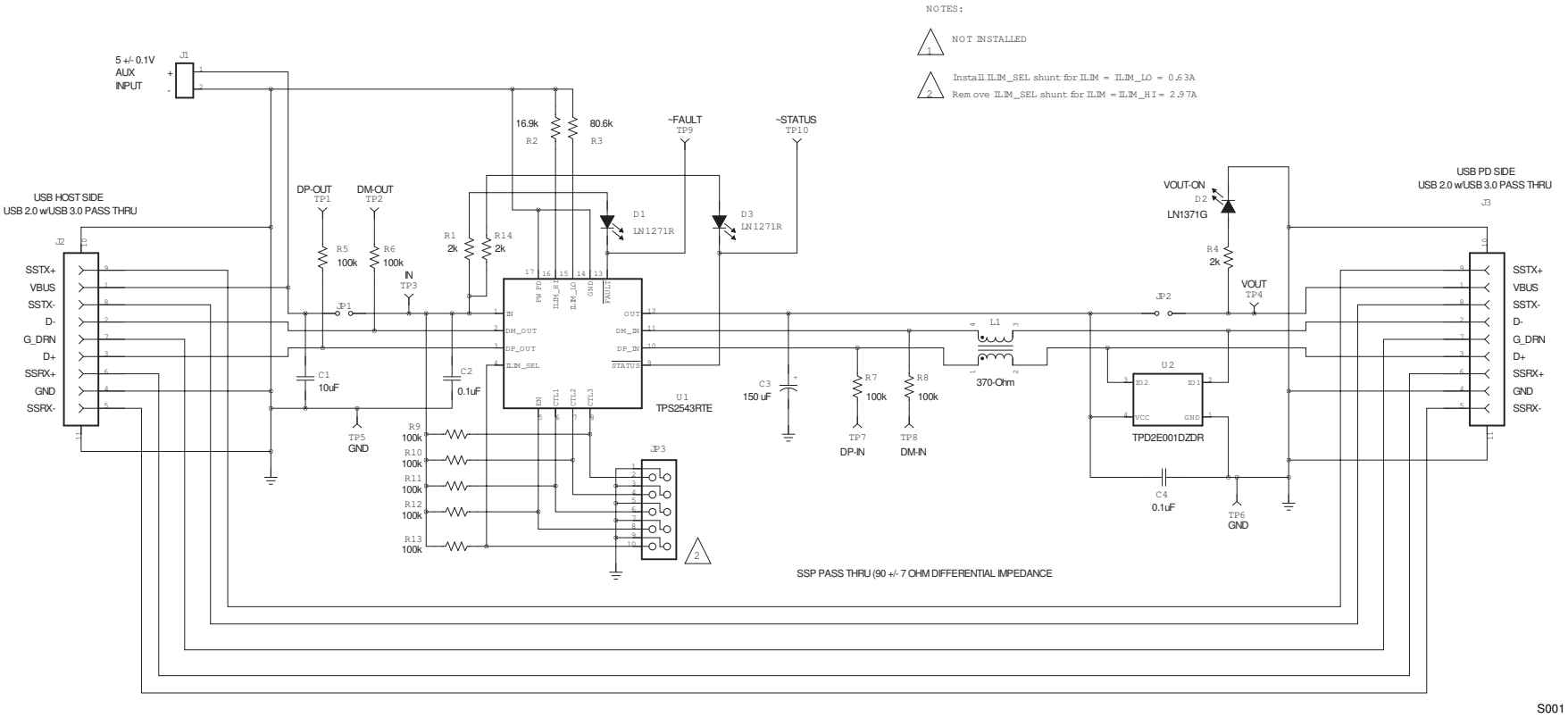

Figure 1. TPS2543EVM Schematic

3 General Configuration and Description

3.1 Physical Access

Table 1 lists the TPS2543EVM connector functionality, Table 2 describes the test point availability and Table 3 describes the jumper functionality.

Table 1. Connector Functionality

Connector	Label	Description
J1	AUX	Auxiliary high-current input connector
J2	USB INPUT	USB input port
J3	POWER+DATA	Charging port
D1 (RED)	FAULT	Fault LED
D2 (GREEN)	VOUT-ON	USB output powered
D3 (RED)	STATUS	STATUS pin LED

Table 2. Test Points

Test Point	Color	Label	Description
TP1	WHT	DP-OUT	Data+ out
TP2	WHT	DM-OUT	Data– out
TP3	RED	IN	Power bus input
TP4	RED	VOUT	Power bus output
TP5	SM	GND	Power bus GND
TP6	SM	GND	Power bus GND
TP7	ORG	DP-IN	Data+ in
TP8	ORG	DM-IN	Data– in
TP9	WHT	FAULT	Fault pin
TP10	WHT	STATUS	Status pin

Table 3. Jumpers

Jumper	Label	Description
JP1	VIN	Power bus input. Install shunt to allow charger source to power TPS2543 and downstream circuitry.
JP2	VOUT	Power bus output. Install shunt to allow charger source to power downstream devices.
JP3	CTL3	CTL3. See MODE truth table.
	CTL2	CTL2. See MODE truth table.
	CTL1	CTL1. See MODE truth table.
	EN	TPS2543 enable select. Install shunt to disable TPS2543.
	ILIM	ILIM select. Install shunt to select ILIM_LO (0.6 A typical ILIM). Remove shunt to select ILIM_HI (2.8A typical ILIM).

Table 4. TPS2543 Mode Truth Table

CTL1	CTL2	CTL3	ILIM_SEL	Mode
0	0	0	X	OUT discharge, power switch OFF
0	0	1	0	Dedicated charging port, auto-detect, without power-wake function
0	0	1	1	Dedicated charging port, auto-detect, with power wake function(1)
0	1	1	0	Dedicated charging port, auto-detect, with load detection disabled
0	1	1	1	Dedicated charging port, auto-detect, with load detection enabled(2)
1	0	0	X	Dedicated charging port, BC 1.2 only, ILIM_HI or ILIM_LO is selected to set I_{OS} by ILIM_SEL.
1	0	1	X	Dedicated charging port, Divider1 mode only, ILIM_HI or ILIM_LO is selected to set I_{OS} by ILIM_SEL.
X	1	0	X	Standard downstream port, USB 2.0 mode, ILIM_HI or ILIM_LO is selected to set I_{OS} by ILIM_SEL.
1	1	0	1	Standard downstream port, USB 2.0 mode, ILIM_LO is selected to set I_{OS} , no discharge to or from 1111
1	1	1	1	Charging downstream port, BC 1.2, with load detection enabled(2)

(1) Current limit (I_{OS}) is automatically changed, I_{OS} is I_{OS_PW} while no load, I_{OS} is switched to the value set by ILIM_HI and $\overline{\text{STATUS}}$ is active-low while with load

(2) ILIM_HI is selected to set I_{OS}, ILIM_LO is selected to set load-detection current threshold (I_{LD})

3.2 Test Setup

Figure 2 shows a typical test setup for TPS2543EVM. Connect J2 to the PC either directly (insert J2 into available/accessible PC USB port) or using any Type A Male to Type A Female USB v2.0 extension cable. USB power and data are available at J3.

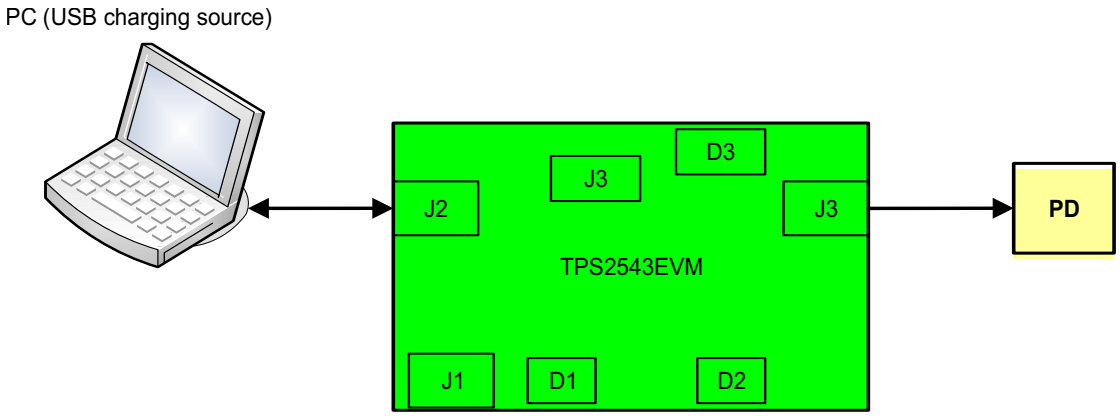

Figure 2. Typical TPS2543EVM Test Setup

4 EVM Assembly Drawings and Layout Guidelines

4.1 PCB Drawings

The following figures show component placement and layout of the EVM.

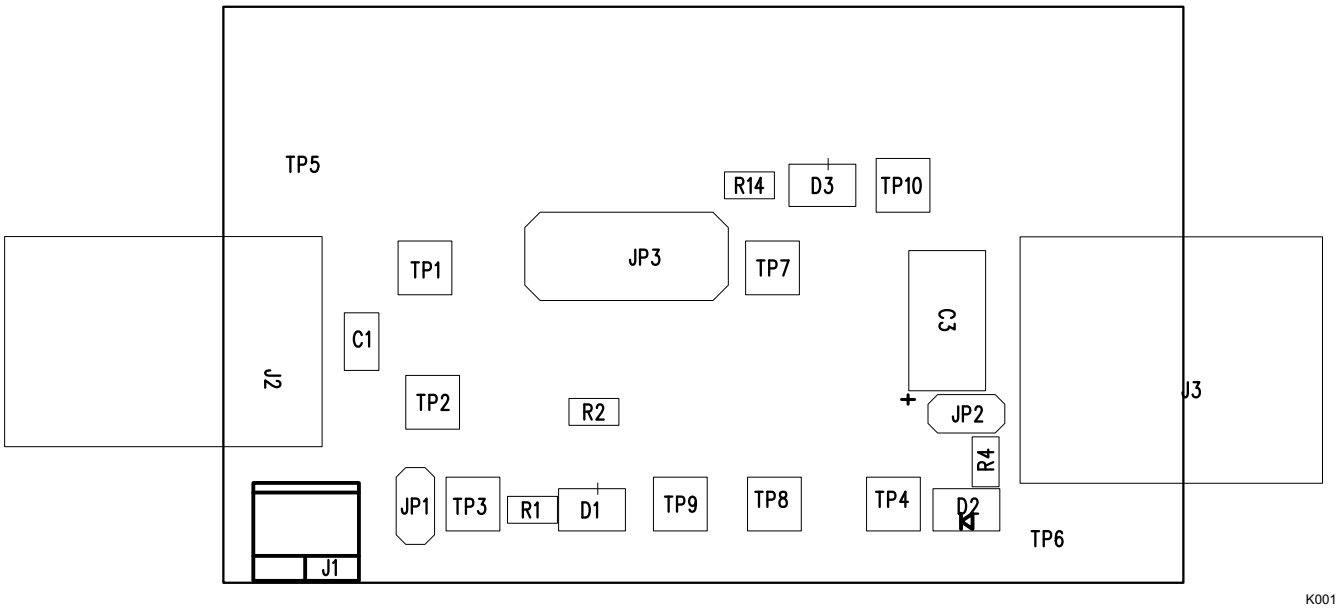

Figure 3. Top Side Placement

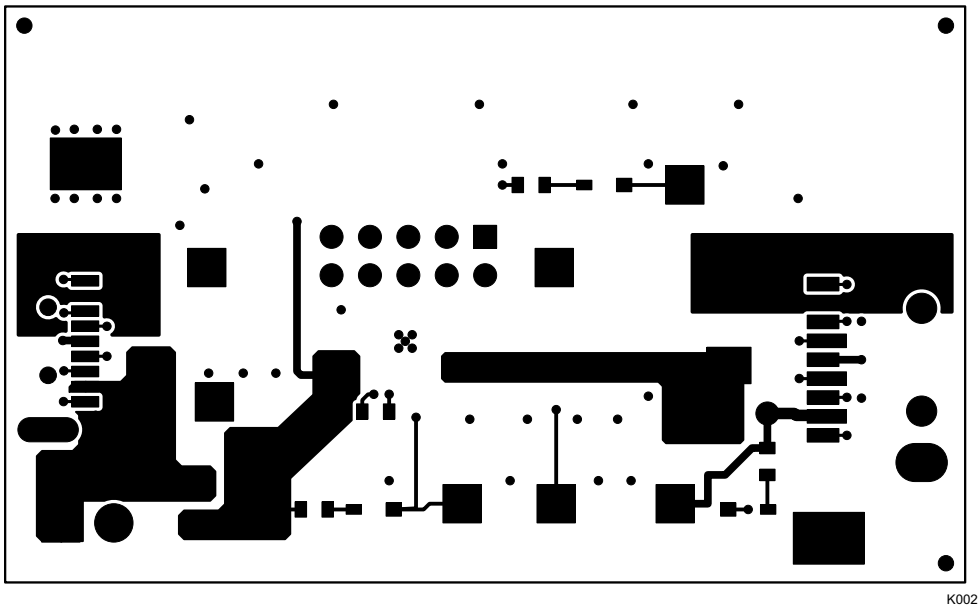

Figure 4. Top Side Routing

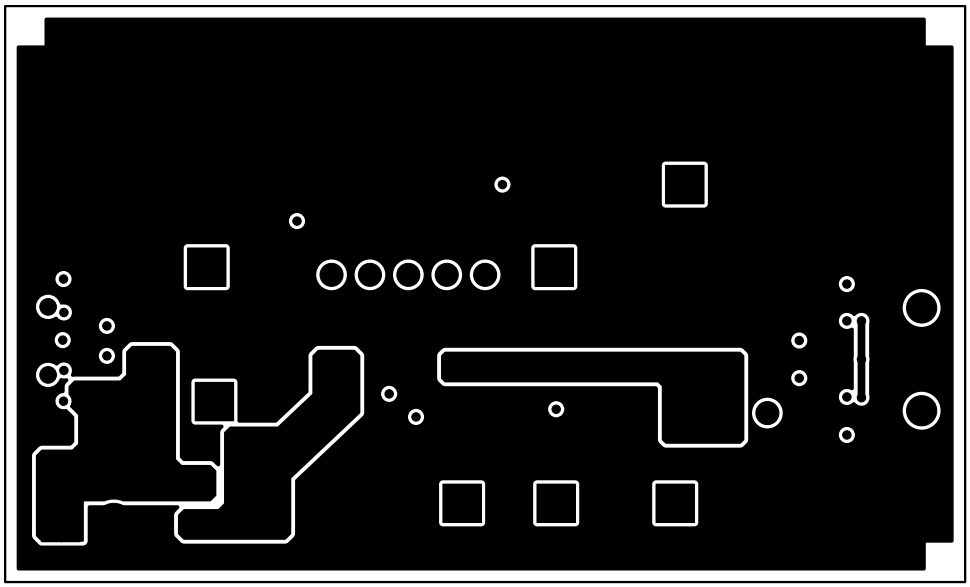

Figure 5. Layer Two Routing

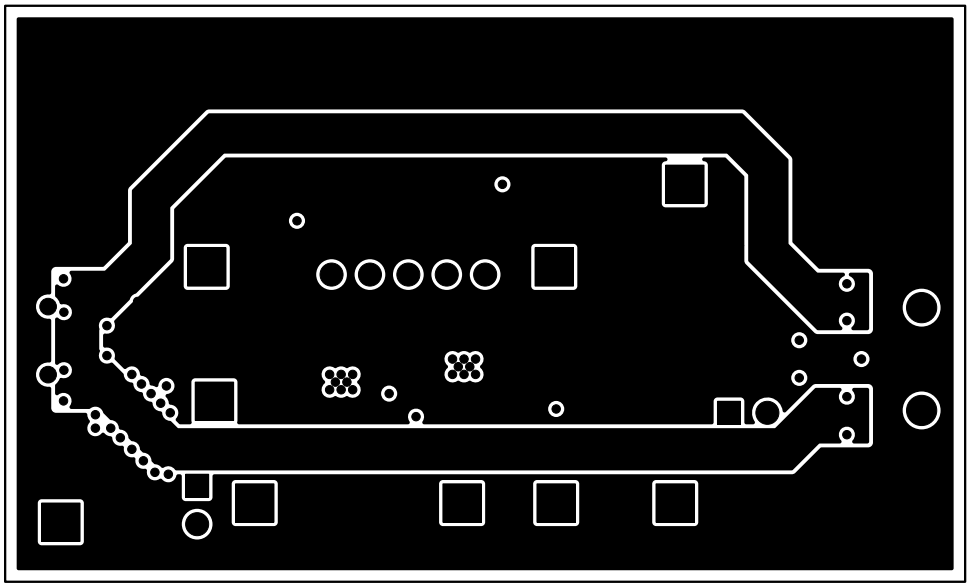

Figure 6. Layer Three Routing

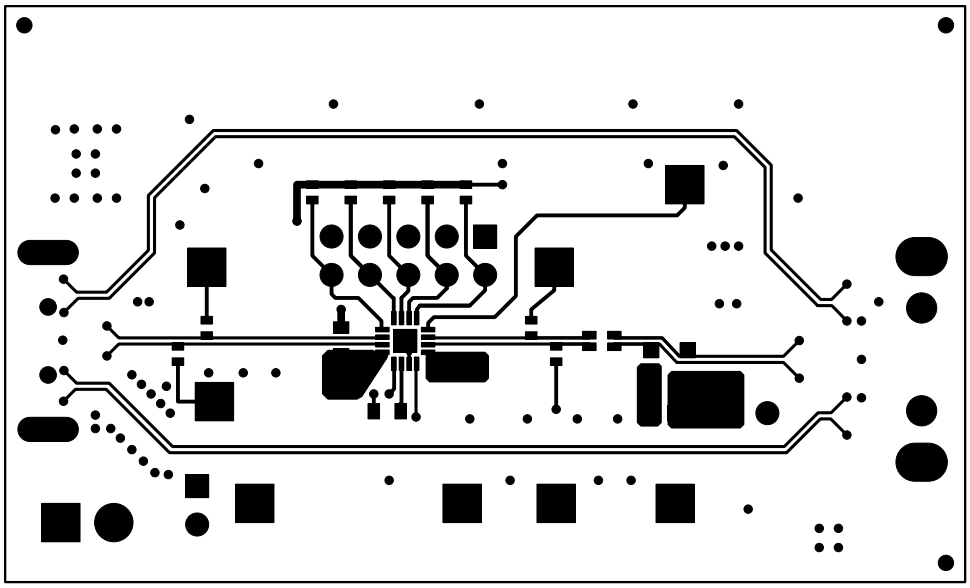

Figure 7. Figure 7. Bottom Side Routing

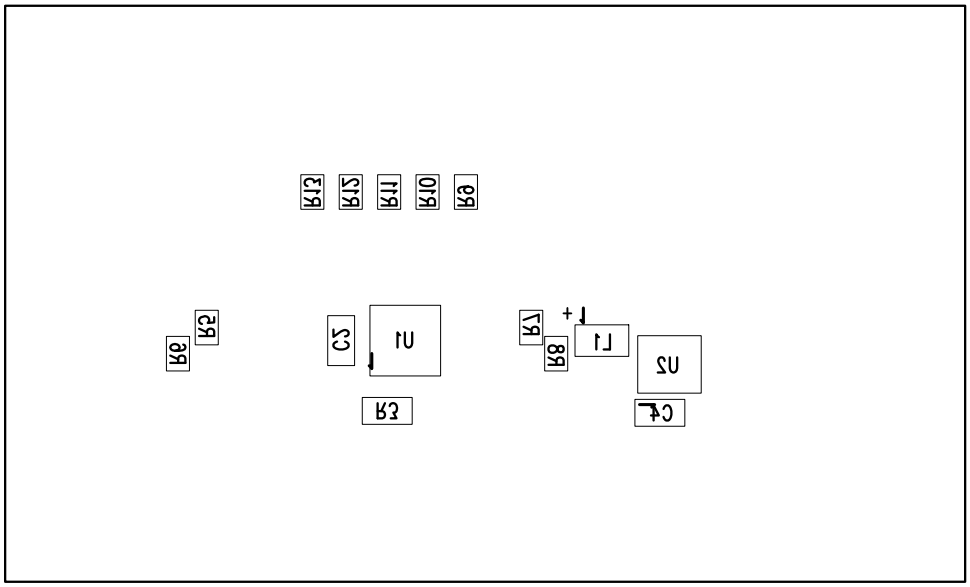

Figure 8. Bottom Side Placement

4.2 Layout Guidelines

- TPS2543 placement: Place the TPS2543 near the USB output connector and 150-µF OUT pin filter capacitor. Connect the exposed pad to the GND pin and the system ground plane using an array of vias.
- IN pin bypass capacitance: Place the 0.1-µF bypass capacitor near the IN pin and make the connection using a low-inductance trace.
- DP-OUT/DM-OUT, DP-IN/DM-IN traces: Route these traces as controlled-impedance differential pairs per the USB-2.0 specification. Minimize the use of vias in the high-speed data lines. Figure 7 provides a good signal-routing example for the high-speed data traces. In this example, the data pairs are routed as edge-coupled microstrips with nominal differential impedance of 90 Ω. The reference plane is tied to GND and is shown in Figure 6. Ensure that the reference plane is void of cuts or splits above the differential pairs to prevent impedance discontinuities.

5 Bill of Materials

Table 5. TPS2543EVM Bill of Materials

REFDES	Count	Value	Description	Size	Part Number	Supplier
C1	1	10 µF	Capacitor, ceramic, 10-V, X5R, 10%	0805	Std	Std
C2, C4	2	0.1 µF	Capacitor, ceramic, 50-V, X7R, 10%	0603	Std	Std
C3	1	150 µF	Capacitor, tantalum, low-ESR, 10-V, ±10%	7343 (D)	TPSD157K010R0100	AVX
D1, D3	2	LN1271R	Diode, LED, red, 10-mA, 0.4-mcd	0.114 × 0.049 inch (2.9 × 1.25 mm)	LN1271RTR	Panasonic
D2	1	LN1371G	Diode, LED, green, 10-mA, 2.6-mcd	0.114 × 0.049 inch (2.9 × 1.25 mm)	LN1371GTR	Panasonic
J1	1	ED555/2DS	Terminal block, 2-pin, 6-A, 3.5-mm	0.27 × 0.25 inch (6.86 × 6.35 mm)	ED555/2DS	OST
J2	1	692 112 030 100	Connector, SMT, USB 3.0 plug with clip, type A	12 mm × 21 mm	692 112 030 100	Wurth Elektronik
J3	1	692 122 030 100	Connector, SMT, USB 3.0 horizontal, type A	12 mm × 15 mm	692 122 030 100	Wurth Elektronik
JP1, JP2	2	PEC02SAAN	Header, male 2-pin, 100-mil spacing	0.100 inch (2.54 mm) × 2	PEC02SAAN	Sullins
JP3	1	PEC05DAAN	Header, male 2 × 5-pin, 100-mil spacing	0.100 inch (2.54 mm) × 5 × 2	PEC05DAAN	Sullins
L1	1	370 Ω	Choke, common-mode	0.050 × 0.080 inch (1.27 × 2.03 mm)	0805USB-372ML or 744231371	Coilcraft or Wurth Elektronik
R1, R4, R14	3	2 kΩ	Resistor, chip, 1/16-W, 1%	0603	Std	Std
R2	1	16.9 kΩ	Resistor, chip, 1/16-W, 1%	0603	Std	Std
R3	1	80.6 kΩ	Resistor, chip, 1/16-W, 1%	0603	Std	Std
R5–R13	9	100 kΩ	Resistor, chip, 1/16-W, 1%	0402	Std	Std
TP1, TP2, TP9, TP10	4	5012	Test point, white, through-hole	0.125 × 0.125 inch (3.18 × 3.18 mm)	5012	Keystone
TP3, TP4	2	5010	Test point, red, through-hole	0.125 × 0.125 inch (3.18 × 3.18 mm)	5010	Keystone
TP5, TP6	2	5016	Test point, SM	0.185 × 0.135 inch (3.81 × 3.43 mm)	5016	Keystone
TP7, TP8	2	5013	Test point, orange, through-hole	0.125 × 0.125 inch (3.18 × 3.18 mm)	5013	Keystone
U1	1	TPS2543RTE or TPS2544RTE or TPS2545RTE or TPS2546RTE	USB charging-port power switch controller with load detect/status	QFN-16	TPS2543RTE or TPS2544RTE or TPS2545RTE or TPS2546RTE	TI
U2	1	TPD2E001DZDR	IC, low-capacitance 2-chan ±15-kV ESD-protection array	SOP	TPD2E001DZDR	TI

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As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. 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 Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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 not expressly approved by the party responsible for compliance 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 his 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.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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