User's Guide
SLUUBI0–August 2016

TPS254900Q1EVM-817

This user's guide describes the evaluation module (EVM) for the TPS254900-Q1 (TPS254900Q1EVM-817). The TPS254900-Q1 is a USB charging port controller with an integrated power switch and USB 2.0 high-speed data line (DP/DM) switches.

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1 Introduction

The TPS254900Q1EVM-817 allows reference circuit evaluation of the TI *TPS254900-Q1 Automotive USB Charging Port Controller* with integrated power switch, cable compensation, and short-to-battery protection. The TPS254900Q1EVM-817 provides the electrical signatures on DP_IN and DM_IN to support all current charging schemes. The TPS254900-Q1 incorporates USB cable voltage drop compensation by linearly sensing the port current and automatically adjusting the output voltage of the LMR14030SDDAR to keep the cable end device voltage within the normal operating range. The TPS254900-Q1 incorporates up to 18-V short-to-battery protection for VBUS, DP_IN, and DM_IN.

1.1 Features

General TPS254900Q1EVM features include:

- TPS254900-Q1 built-in IEC 61000-4-2 ESD protection on DP_IN and DM_IN pins
- Linear USB cable voltage droop compensation
- TPS254900-Q1 is fully AEC Q100-qualified
- Built in short-to-battery protection and notification on VBUS, DP_IN and DM_IN
- LMR14030SDDAR high-performance 2.2-MHz automotive-qualified DC/DC converter

1.2 EVM Applications

The TPS254900Q1EVM works with the following applications:

- Automotive infotainment system
- Automotive USB charging box

2 Description

The TPS254900Q1EVM-817 enables full evaluation of the TPS254900-Q1 device. Refer to the schematic shown in Figure 1. An automotive voltage range input is applied at the J1 connector. The input voltage is regulated by the LMR14030SDDAR buck regulator (U1) and associated circuitry. This provides a nominal 5-V, 3-A output at the 5VDC node for the TPS254900-Q1 (U2).

The TPS254900-Q1 internal power switch connects the 5VDC node furnished by the LMR14030SDDAR regulator to VBUS at the downstream facing USB connector, J5. When the internal power switch is ON, the D6 LED (green) will illuminate. USB 2.0 data can be passed through the TPS254900Q1EVM-817 from J5 to J4 when the TPS254900-Q1 is configured for either SDP or CDP mode using the J6 header. The TPS254900-Q1 status and fault conditions are detected using the D3 (blue) and D2 (red) LEDs, respectively.

The TPS254900-Q1 provides system-level ESD protection in accordance with IEC 61000-4-2 up to ±8-kV contact and ±15-kV air discharge at the DP_IN and DM_IN signals going to J5. These pins, as well as the VBUS pin, will also provide detection of shorts to battery by triggering the FAULT logic and illuminating D2.

The TPS254900-Q1 provides USB cable voltage droop compensation at the load through the use of the CS pin. Sinking current into the CS pin mirrors the current through the TPS254900-Q1 power switch at a rate of 82 µA / A. The CS pin current is summed with the LMR14030SDDAR regulator feedback current through R1 causing the voltage at the 5VDC node to change with USB downstream load current. The 5VDC node increases linearly as load current increases. This compensation will keep the load end voltage close to 5 V_{DC}. The default compensation resistor values (R1 and R4) target a USB cable resistance of 200 mΩ. Refer to the TPS254900-Q1 datasheet (SLUSCO9) for more information.

The TPS254900-Q1 provides a current detection function through use of the IMON pin. Sourcing current from the IMON pin mirrors the current through the TPS254900-Q1 power switch at a rate of 104 µA / A. The system can detect the load current in realtime by monitoring the IMON voltage. R18 (2.55 kΩ) creates a scale factor of 0.265 V / A at TP11.

3 Schematics

Figure 1 illustrates the TPS254900Q1EVM-817 schematic.

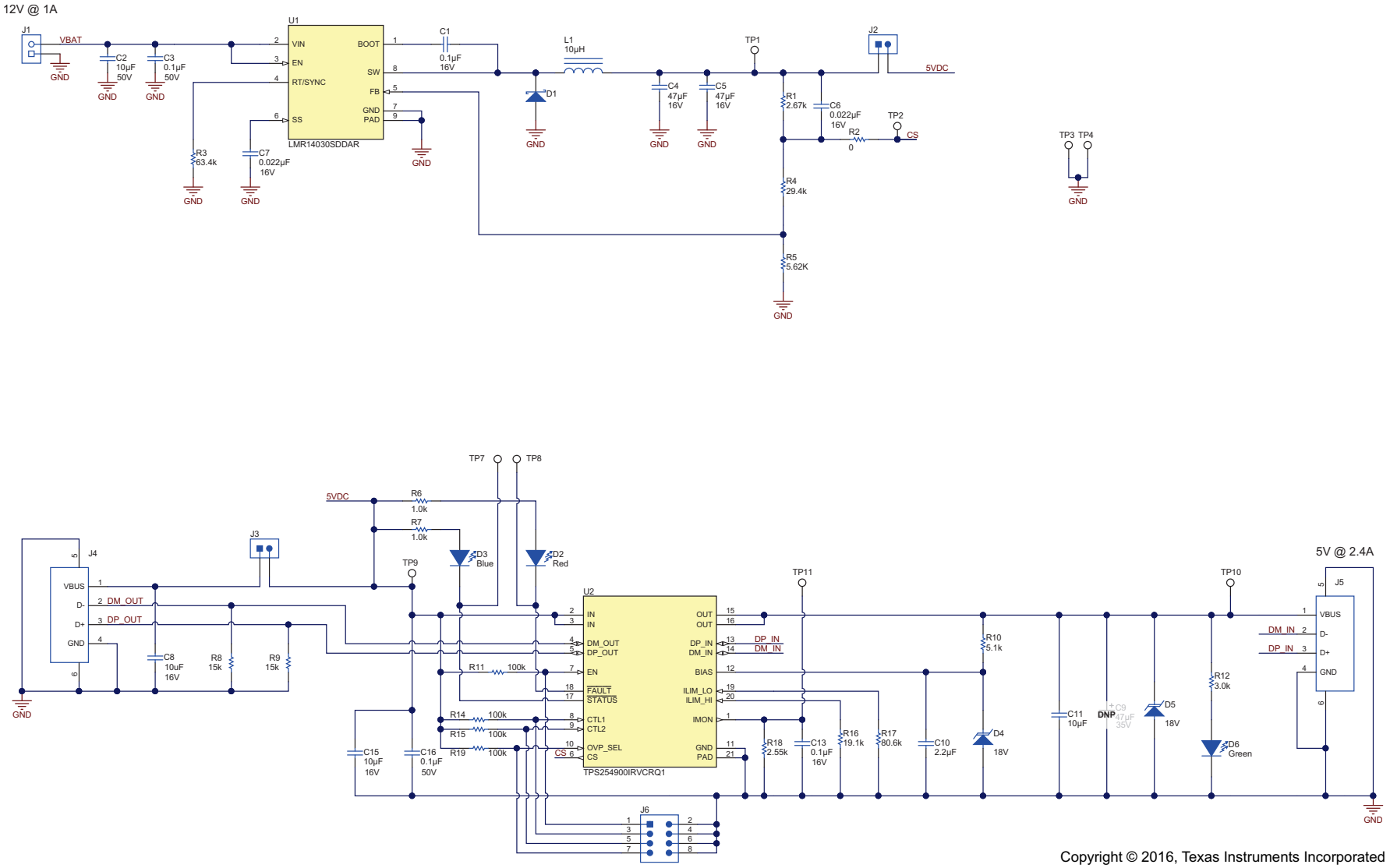

Figure 1. TPS254900Q1EVM-817 Schematic

4 General Configurations

4.1 Physical Access

Table 1 lists the TPS254900Q1EVM-817 connector functionality, Table 2 describes the test point availability and Table 3 describes the jumper functionality.

Table 1. Connector Functionality

Connector	Label	Description
J5	J5	Downstream facing USB 2.0 connector. Connect to the USB 2.0 slave for data passthrough from J4. USB output power is also provided to the slave.
J4	J4	Upstream facing USB 2.0 connector. Connect to the USB 2.0 host for data passthrough to J5. USB input power can also be provided by the host when the J3 shunt is installed.
J1	J1	Automotive input voltage range connector. Connect to a 7- to 18-V, 1.5-A voltage source according to the polarity marked on the EVM.
D2 (RED)	D2	TPS254900-Q1 FAULT output is triggered
D3 (BLUE)	D3	TPS254900-Q1 STATUS output is triggered
D6 (GREEN)	D6	TPS254900-Q1 output powered

Table 2. Test Points

Test Point	Color	Label	Description
TP1	SM-L	VDC	TPS254900-Q1 power switch input from DC-DC converter.
TP2	SM-L	CS	Loop injection point.
TP3	SM-L	GND	GND Test point
TP4	SM-L	GND	GND Test point
TP7	SM-L	STATUS	TPS254900 STATUS pin test point
TP8	SM-L	FAULT	TPS254900 FAULT pin test point
TP9	SM-L	VIN	TPS254900 VIN pin test point
TP10	SM-L	OUT	TPS254900 VBUS pin test point
TP11	SM-L	IMON	TPS254900 IMON pin test point

Table 3. Jumpers

Jumper	Label	Description
J2	J2	Install to power TPS254900-Q1 with a DC/DC.
J3	J3	USB host furnished input voltage. Install to power the TPS254900-Q1 with a USB host.
J6	J6	TPS254900-Q1 mode select jumper block. Install shunt at EN (1-2) to disable the TPS254900-Q1. C1, C2, and OVP_SEL positions select the charging mode for the TPS254900-Q1. Refer to the TPS254900-Q1 datasheet (SLUSCO9) for more information.

4.2 Test Setup

Figure 2 shows a typical test setup for the TPS254900Q1EVM-817. Connect J1 to the 14-V power supply. The TPS254900-Q1 output load can be applied either between TP10 and TP4 or via the USB 2.0 cable plugged into J5.

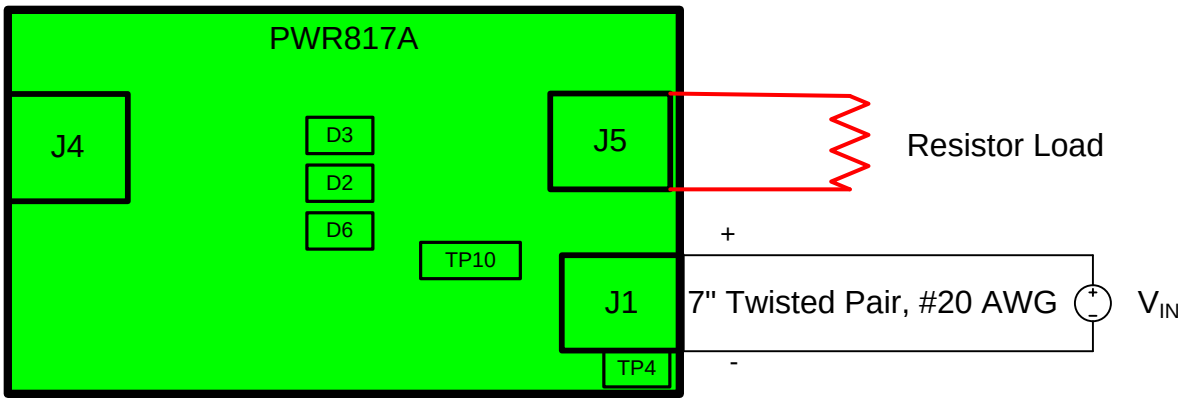

Figure 2. Typical TPS254900Q1EVM-817 Test Setup

5 EVM Assembly Drawings and Layout Guidelines

5.1 PCB Drawings

Figure 3 through Figure 8 show component placement and layout of the EVM.

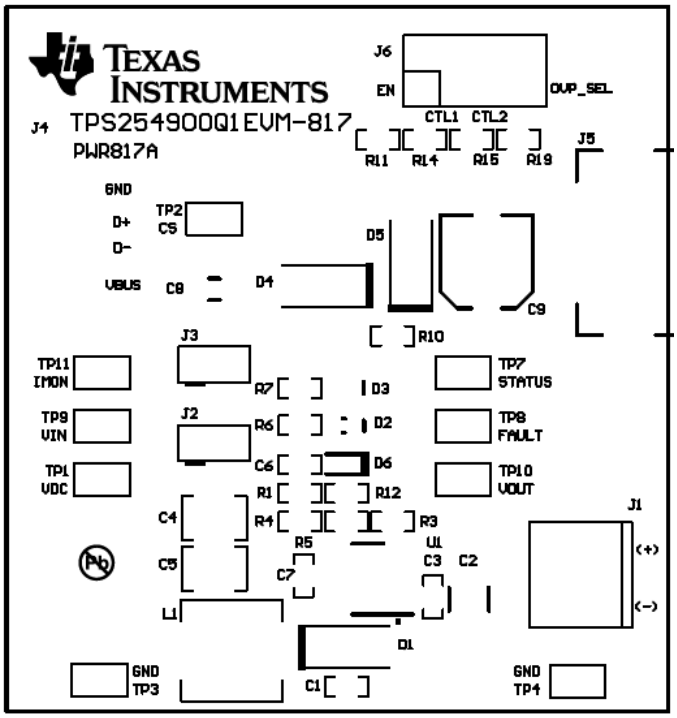

Figure 3. Top Side Placement

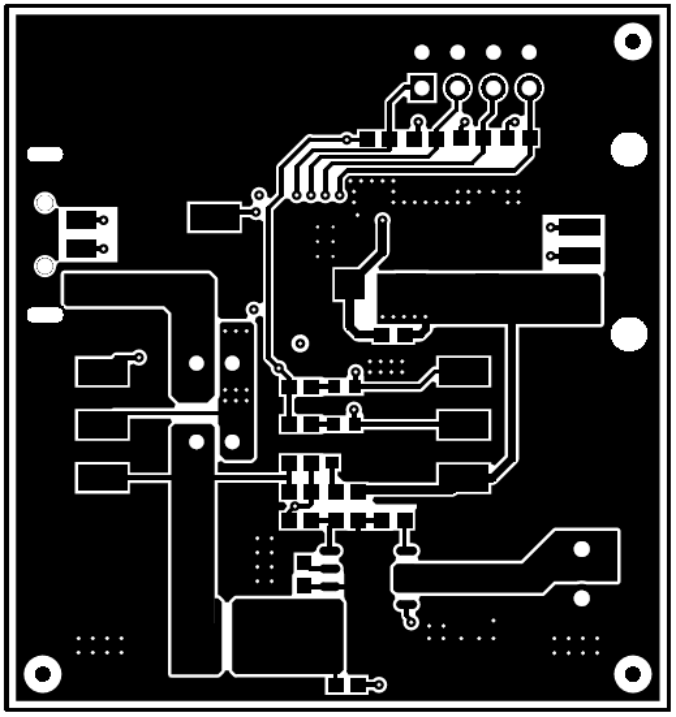

Figure 4. Top Side Routing

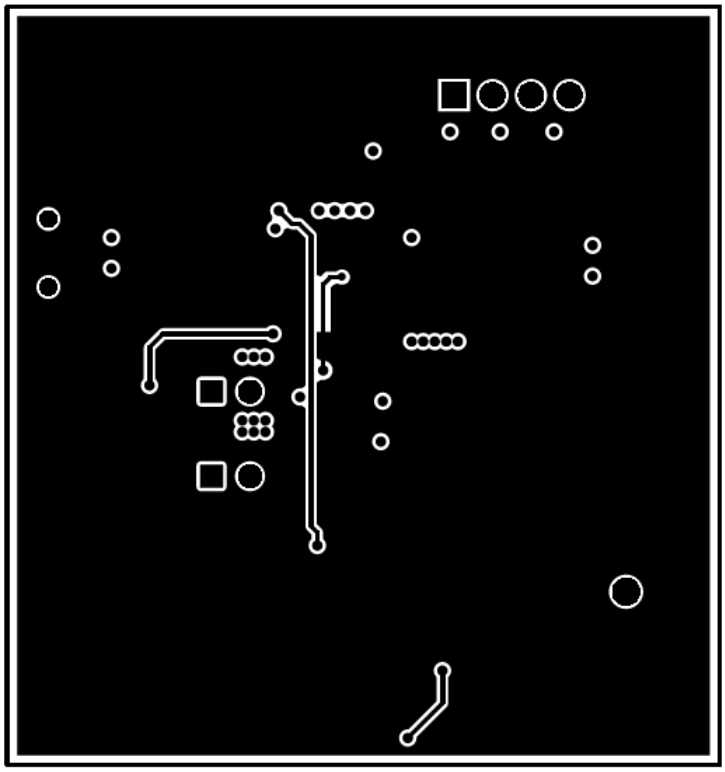

Figure 5. Layer Two Routing

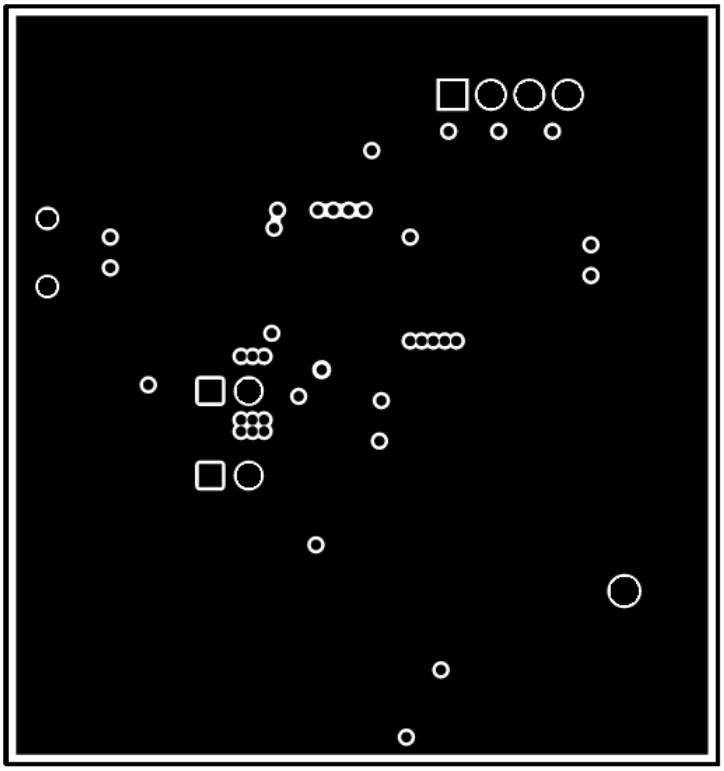

Figure 6. Layer Three Routing

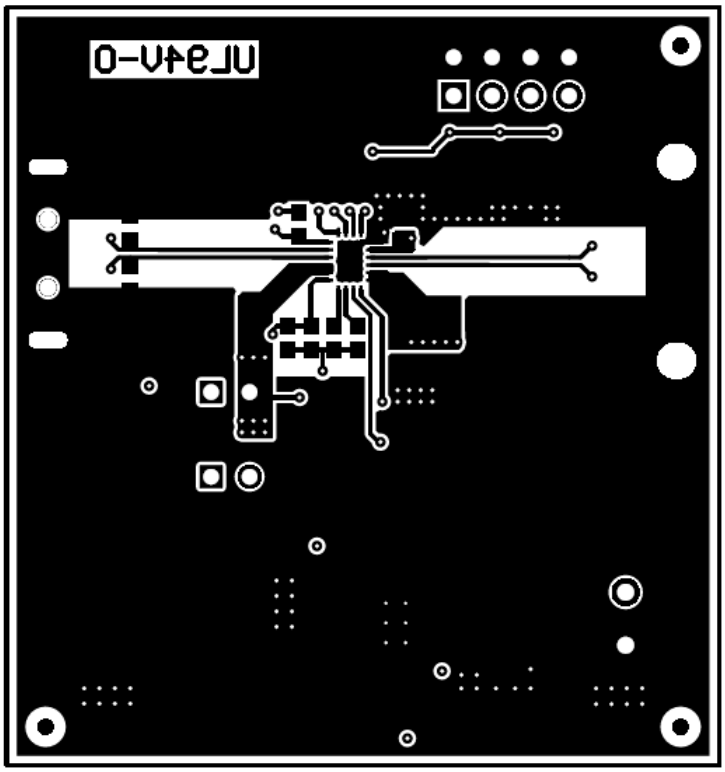

Figure 7. Bottom Side Routing

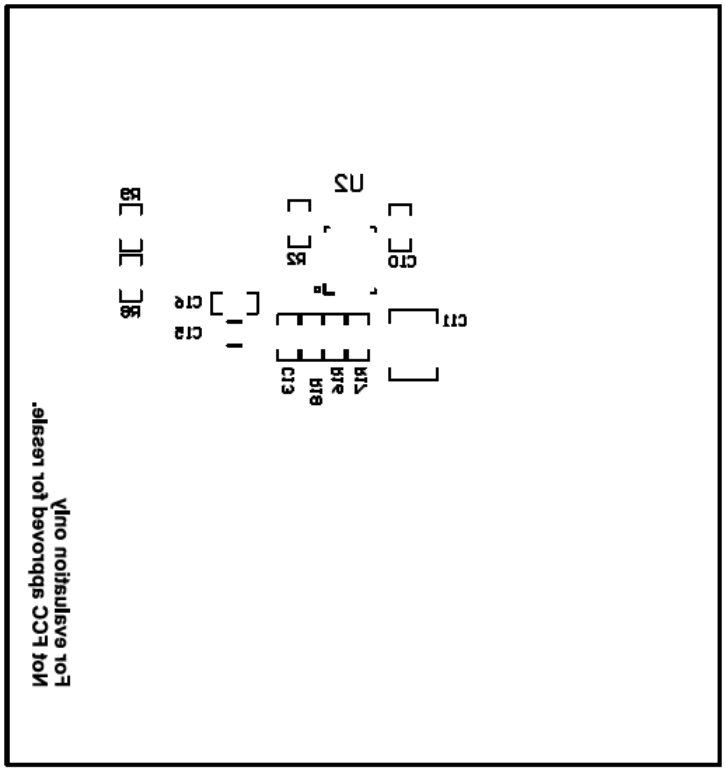

Figure 8. Bottom Side Placement

5.2 Layout Guidelines

Use the following EVM layout guidelines:

- TPS254900-Q1 placement: Place the TPS254900-Q1 near the USB output connector and OUT pin filter capacitors. 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.
- ILIM_LO and ILIM_HI Pin Connections: Current-limit, set-point accuracy can be compromised by stray current leakage from a higher voltage source to the ILIM_LO or ILIM_HI pins. Ensure that there is adequate spacing between IN pin copper/trace and ILIM_LO pin trace to prevent contaminant buildup during the PCB assembly process.
- The capacitor on BIAS helps improve IEC ESD performance, 2.2-μF capacitor should be placed close to BIAS and the whole *current* path from BIAS to GND cross this capacitor should be as short as possible. Do not use via along the connection traces.
- A 10-μF output capacitor should be placed close to the OUT pin and TVS.

5.3 EMI Containment

The following list provides guidelines for EMI containment:

- Use compact loops for dv/dt and di/dt circuit paths (power loops and gate drives)
- Use minimal, yet thermally adequate, copper areas for heat sinking of components tied to switching nodes (minimize exposed radiating surface).
- Use copper ground planes (possible stitching) and top-layer copper floods (surround circuitry with ground floods)
- Use 4-layer PCB, if economically feasible (for better grounding)
- Minimize the amount of copper area associated with input traces (to minimize radiated pickup)
- Maintain physical separation between input-related circuitry and power circuitry (use ferrite beads as boundary line)
- Possible use of common-mode inductors

6 Bill of Materials (BOM)

Table 4 lists the BOM for this EVM.

Table 4. TPS254900Q1EVM-817 Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed Circuit Board		PWR817	Any	-	-
C1, C13, C16	3	0.1uF	CAP, CERM, 0.1 µF, 16 V, +/- 10%, X7R, 0603	0603	GRM188R71C104KA01D	Murata		
C2	1	10uF	CAP, CERM, 10 µF, 50 V, +/- 10%, X5R, 1210	1210	C3225X5R1H106K250AB	TDK		
C3	1	0.1uF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0603	0603	GRM188R71H104KA93D	Murata		
C4, C5	2	47uF	CAP, CERM, 47 µF, 16 V, +/- 20%, X5R, 1210	1210	GRM32ER61C476ME15L	Murata		
C6, C7	2	0.022uF	CAP, CERM, 0.022 µF, 16 V, +/- 10%, X7R, 0603	0603	C0603C223K4RACTU	Kemet		
C8, C15	2	10uF	CAP, CERM, 10 µF, 16 V, +/- 10%, X7R, 1206	1206	GRM31CR71C106KAC7L	Murata		
C10	1	2.2uF	CAP, CERM, 2.2 µF, 50 V, +/- 10%, X5R, 0603	0603	GRM188R61H225KE11D	Murata		
C11	1	10uF	CAP, CERM, 10 µF, 35 V, +/- 10%, X7R, 1210	1210	GRM32ER7YA106KA12L	Murata		
D1	1	50V	Diode, Schottky, 50 V, 3 A, SMA	SMA	B350A-13-F	Diodes Inc.		
D2	1	Red	LED, Red, SMD	SMD, 2-Leads, Body 1.3x0.8mm	LS L29K-G1J2-1-Z	OSRAM		
D3	1	Blue	LED, Blue, SMD	BLUE 0603 LED	LB Q39G-L2N2-35-1	OSRAM		
D4, D5	2	18V	Diode, TVS, Uni, 18 V, 400 W, SMA	SMA	SMAJ18A	Littelfuse		
D6	1	Green	LED, Green, SMD	0.8x1.6mm	HSMG-C190	Avago		
J1	1		Conn Term Block, 2POS, 3.5mm, TH	11x8.5x7.3mm	1751248	Phoenix Contact		
J2, J3	2		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
J4	1		Connector, Plug, USB Type A, R/A, Top Mount SMT	USB Type A right angle	48037-1000	Molex		
J5	1		Connector, Receptacle, USB TYPE A, R/A, Top Mount SMT	USB TYPE A CONNECTOR RECEPTACLE 4POS SMD	896-43-004-00-000000	Mill-Max		
J6	1		Header, 100mil, 4x2, Tin, TH	Header, 4x2, 100mil, Tin	PEC04DAAN	Sullins Connector Solutions		
L1	1	10uH	Inductor, Shielded Drum Core, Powdered Iron, 10 µH, 3 A, 0.075 ohm, SMD	Inductor, 6.6x3x6.6mm	74437346100	Wurth Elektronik eiSos		
R1	1	2.67k	RES, 2.67 k, 1%, 0.1 W, 0603	0603	CRCW06032K67FKEA	Vishay-Dale	Equivalent	Any
R2	1	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale		
R3	1	63.4k	RES, 63.4 k, 1%, 0.1 W, 0603	0603	RC0603FR-0763K4L	Yageo America		
R4	1	29.4k	RES, 29.4 k, 1%, 0.1 W, 0603	0603	CRCW060329K4FKEA	Vishay-Dale		
R5	1	5.62K	RES, 5.62 k, 1%, 0.1 W, 0603	0603	CRCW06035K62FKEA	Vishay-Dale	Equivalent	Any
R6, R7	2	1.0k	RES, 1.0 k, 5%, 0.1 W, 0603	0603	CRCW06031K00JNEA	Vishay-Dale		
R8, R9	2	15k	RES, 15 k, 5%, 0.1 W, 0603	0603	CRCW060315K0JNEA	Vishay-Dale		
R10	1	5.1k	RES, 5.1 k, 5%, 0.1 W, 0603	0603	CRCW06035K10JNEA	Vishay-Dale		
R11, R14, R15, R19	4	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	RC0603FR-07100KL	Yageo America		
R12	1	3.0k	RES, 3.0 k, 5%, 0.1 W, 0603	0603	CRCW06033K00JNEA	Vishay-Dale		
R16	1	19.1k	RES, 19.1 k, 1%, 0.1 W, 0603	0603	CRCW060319K1FKEA	Vishay-Dale		
R17	1	80.6k	RES, 80.6 k, 1%, 0.1 W, 0603	0603	CRCW060380K6FKEA	Vishay-Dale		

Table 4. TPS254900Q1EVM-817 Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R18	1	2.55k	RES, 2.55 k, 1%, 0.1 W, 0603	0603	CRCW06032K55FKEA	Vishay-Dale		
SH-J2, SH-J3	2	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP7, TP8, TP9, TP10, TP11	9	SMT	Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone		
U1	1		SIMPLE SWITCHER 40 V 3.5 A, 2.2 MHz Step-Down Converter with 40 uA IQ, DDA0008E	DDA0008E	LMR14030SDDAR	Texas Instruments	LMR14030SDDA	Texas Instruments
U2	1		Automotive USB Charging Port Controller and Power Switch with Short to BAT protection, RVC0020A	RVC0020A	TPS254900IRVCRQ1	Texas Instruments	TPS254900IRVCTQ1	Texas Instruments
C9	0	47uF	CAP, AL, 47 µF, 35 V, +/- 20%, 0.44 ohm, SMD	6.3x5.8	UUD1V470MCL1GS	Nichicon		
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
		Note:	Unless otherwise noted in the Alternate PartNumber and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.					

IMPORTANT NOTICE

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *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

      NOTE: 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

NOTE: 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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-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.

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.

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.

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

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of 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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should 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 also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure 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. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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