

## ***Two-Channel, Power-Distribution Switch EVM***

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This user's guide describes the TPS20xxEVM-293 and TPS20xxEVM-296 evaluation modules (EVM). This guide contains the EVM schematics, bill of materials, assembly drawings, and top and bottom board layouts.

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## 1 Introduction

The TPS20xxEVM-293 and TPS20xxEVM-296 are evaluation modules (EVM) for the Texas Instruments family of two-channel, current-limited, power-distribution switches. These EVMs operate over a 2.7-V to 5.5-V range and provide a continuous output current of up to 1.5 A (see [Table 1](#) and [Table 2](#)). Test points provide convenient access to all critical node voltages.

The silkscreen outline on the PCB top-side encloses components found in a typical USB application.

The TPS20xxEVM-293 accepts an S0-8 packaged power-distribution switch whereas the TPS20xxEVM-296 accepts MSOP-8 packaged switch with a thermal pad. These switches have an enable input, an overcurrent status output, and overtemperature shutdown; the switch pinouts are identical.

[Table 1](#) and [Table 2](#) summarize the available EVM options.

## 2 Schematics and Bill of Materials

### 2.1 EVM Options

**Table 1. TPS20xxEVM-293 Options**

EVM	Device	Continuous Output Current (A)	ENABLE
TPS2042BEVM-293	TPS2042BD	0.5	Active Low
TPS2046BEVM-293	TPS2046BD	0.25	Active Low
TPS2052BEVM-293	TPS2052BD	0.5	Active High
TPS2056AEVM-293	TPS2056AD	0.25	Active High
TPS2062EVM-293	TPS2062D	1	Active Low
TPS2062-1EVM-293	TPS2062D-1	1	Active Low
TPS2066EVM-293	TPS2066D	1	Active High
TPS2066CEVM-293	TPS2066CD	1	Active High

**Table 2. TPS20xxEVM-296 Options**

EVM	Device	Continuous Output Current (A)	ENABLE
TPS2042BEVM-296	TPS2042BDGN	0.5	Active Low
TPS2052BEVM-296	TPS2052BDGN	0.5	Active High
TPS2060EVM-296	TPS2060DGN	1.5	Active Low
TPS2062EVM-296	TPS2062DGN	1	Active Low
TPS2064EVM-296	TPS2064DGN	1.5	Active High
TPS2066EVM-296	TPS2066DGN	1	Active High
TPS2066-1EVM-296	TPS2066DGN-1	1	Active High

2.2 Schematics

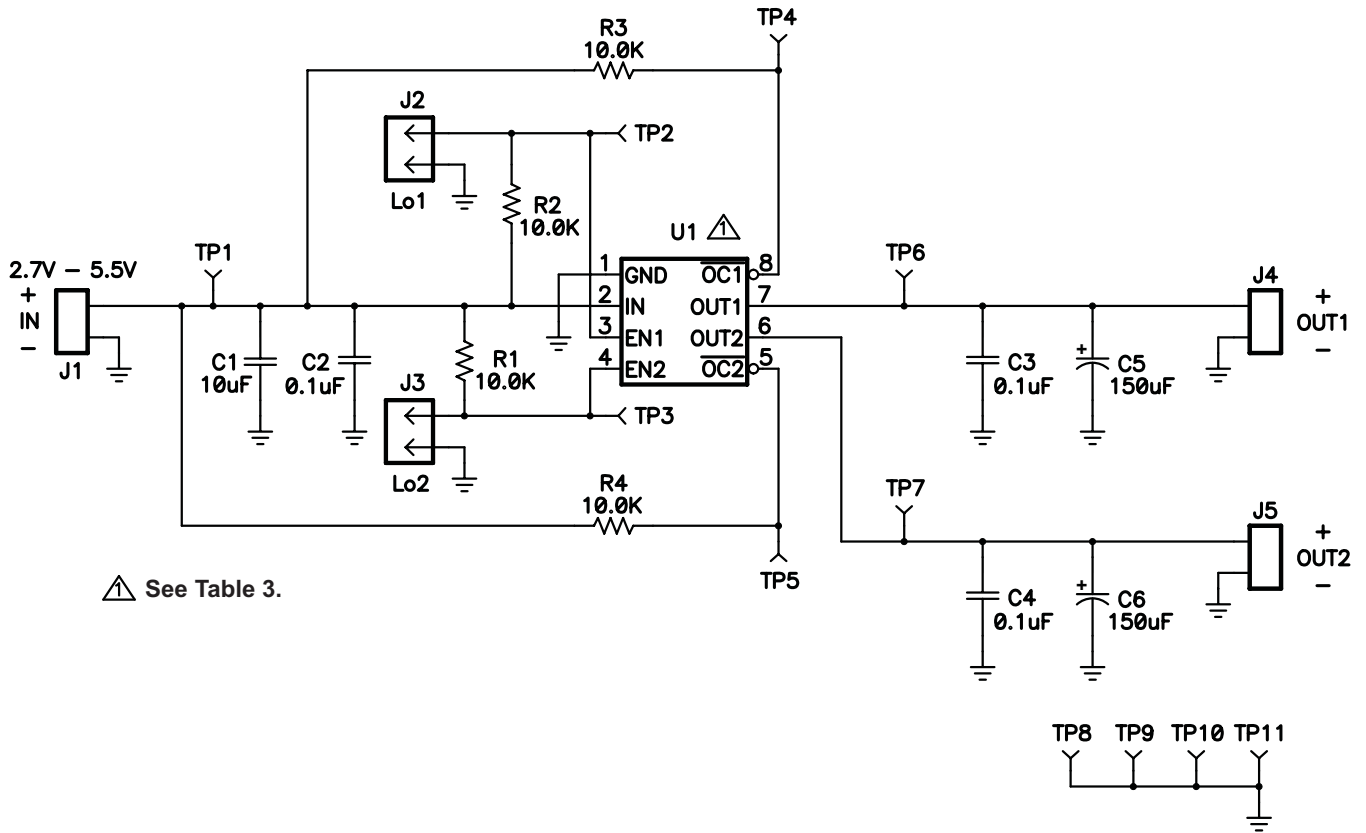


Figure 1. TPS20xxEVM-293 Schematic

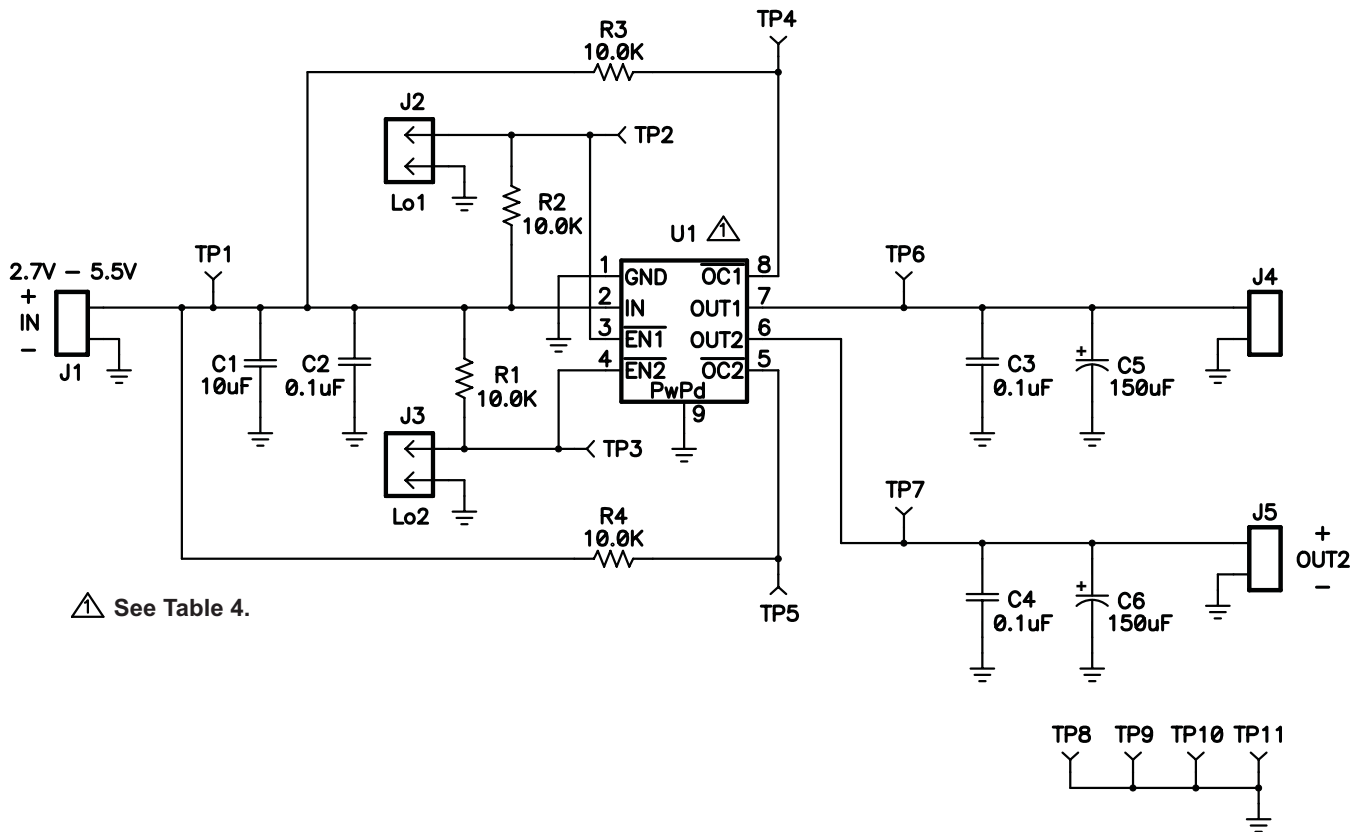


Figure 2. TPS20xxEVM-296 Schematic

### 2.3 Bill of Material

**Table 3. TPS20xxEVM-293 Bill of Materials**

QTY							RefDes	Value	Description	Size	Part Number	MFR
-001	-002	-003	-004	-005	-006	-007						
1	1	1	1	1	1	1	C1	10 $\mu$ F	Capacitor, Ceramic, 10-uF, X7R, 10V, 10%	1206	STD	STD
3	3	3	3	3	3	3	C2-C4	0.1 $\mu$ F	Capacitor, Ceramic, 16V, X7R, 10%	0805	STD	STD
2	2	2	2	2	2	2	C5, C6	150 $\mu$ F	Capacitor, Tantalum, 150 $\mu$ F, 10V, 100 m $\Omega$ , 10%	7343 (D)	B45197A2157K409	Kemet
1	0	0	0	0	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 500-mA	SO8	TPS2042BD	TI
0	1	0	0	0	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 250-mA	SO8	TPS2046BD	TI
0	0	1	0	0	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 500-mA	SO8	TPS2052BD	TI
0	0	0	1	0	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 250-mA	SO8	TPS2056AD	TI
0	0	0	0	1	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 1000-mA	SO8	TPS2062D	TI
0	0	0	0	0	1	0	U1		IC, Dual Power-distribution switch, 5.5V, 1000-mA	SO8	TPS2062D-1	TI
0	0	0	0	0	0	1	U1		IC, Dual Power-distribution switch, 5.5V, 1000-mA	SO8	TPS2066D	TI
1	1	1	1	1	1	1	--		PCB, 2.25 In x 2.225 In x 0.062 In		HPA293	Any
4	4	4	4	4	4	4	R1-R4	10.0K	Resistor, Chip, 1/10W, 1%	0805	CRCW0805-1002F	Vishay

**Table 4. TPS20xxEVM-296 Bill of Materials**

QTY							RefDes	Value	Description	Size	Part Number	MFR
-001	-002	-003	-004	-005	-006	-007						
1	1	1	1	1	1	1	C1	10 $\mu$ F	Capacitor, Ceramic, 10- $\mu$ F, X7R, 10V, 10%	1206	STD	STD
3	3	3	3	3	3	3	C2–C4	0.1 $\mu$ F	Capacitor, Ceramic, 16V, X7R, 10%	0805	STD	STD
2	2	2	2	2	2	2	C5, C6	150 $\mu$ F	Capacitor, Tantalum, 150 $\mu$ F, 10V, 100 m $\Omega$ , 10%	7343 (D)	B45197A2157K409	Kemet
1	0	0	0	0	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 500-mA	MSOP-8	TPS2042BDGN	TI
0	1	0	0	0	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 500-mA	MSOP-8	TPS2052BDGN	TI
0	0	1	0	0	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 1500-mA	MSOP-8	TPS2060DGN	TI
0	0	0	1	0	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 1000-mA	MSOP-8	TPS2062DGN	TI
0	0	0	0	1	0	0	U1		IC, Dual Power-distribution switch, 5.5V, 1500-mA	MSOP-8	TPS2064DGN	TI
0	0	0	0	0	1	0	U1		IC, Dual Power-distribution switch, 5.5V, 1000-mA	MSOP-8	TPS2066DGN	TI
0	0	0	0	0	0	1	U1		IC, Dual Power-distribution switch, 5.5V, 1000-mA	MSOP-8	TPS2066DGN-1	TI
1	1	1	1	1	1	1	--		PCB, 2.25 In x 2.225 In x 0.062 In	2.25 in x 2.25 in	HPA296	Any
4	4	4	4	4	4	4	R1–R4	10.0K	Resistor, Chip, 1/10W, 1%	0805	CRCW0805-1002F	Vishay

### 3 Board Layout

This section contains three views of the TPS20xxEVM-293 and the TPS20xxEVM-296 evaluation boards.

#### 3.1 TPS20xxEVM-293 Board

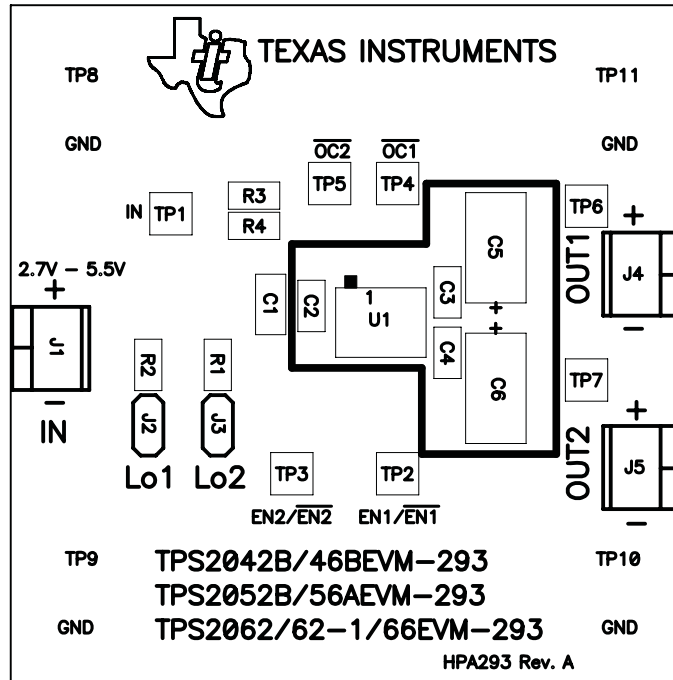


Figure 3. TPS20xxEVM-293 Component Placement

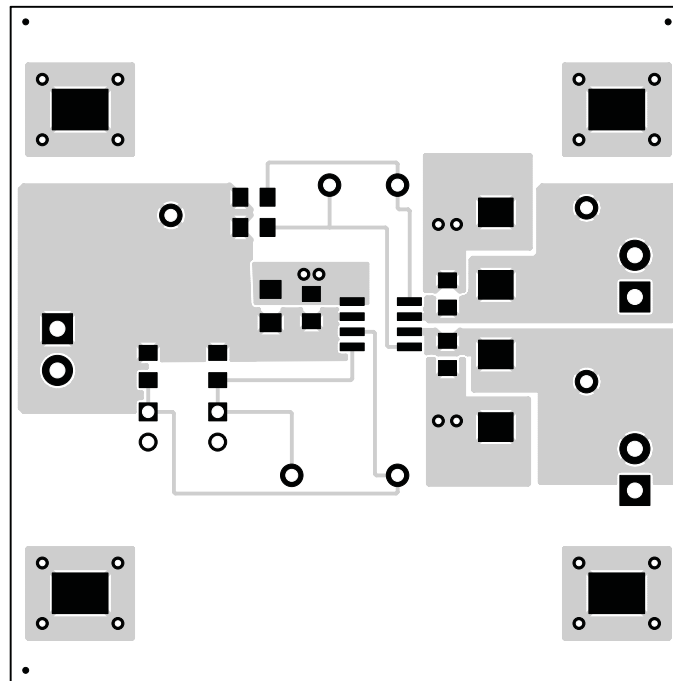


Figure 4. TPS20xxEVM-293 Top-Side Layout

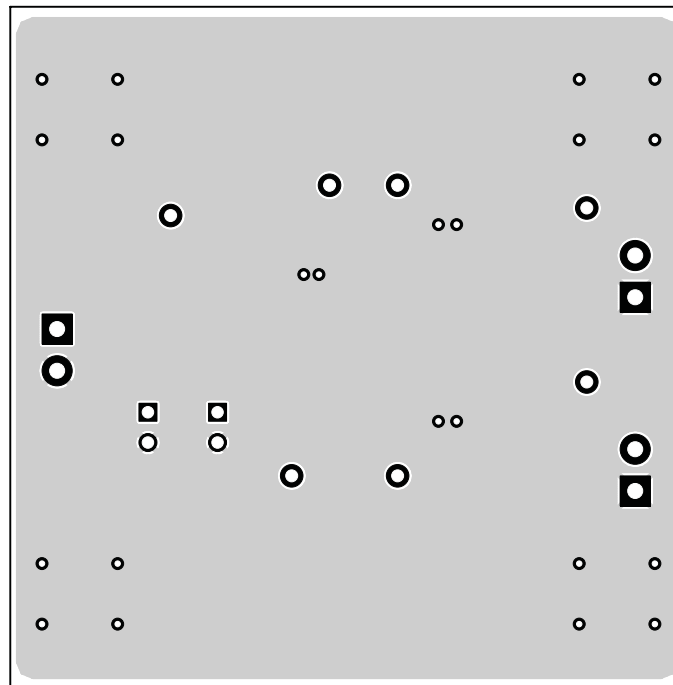


Figure 5. TPS20xxEVM-293 Bottom-Side Layout

### 3.2 TPS20xxEVM-296 Board

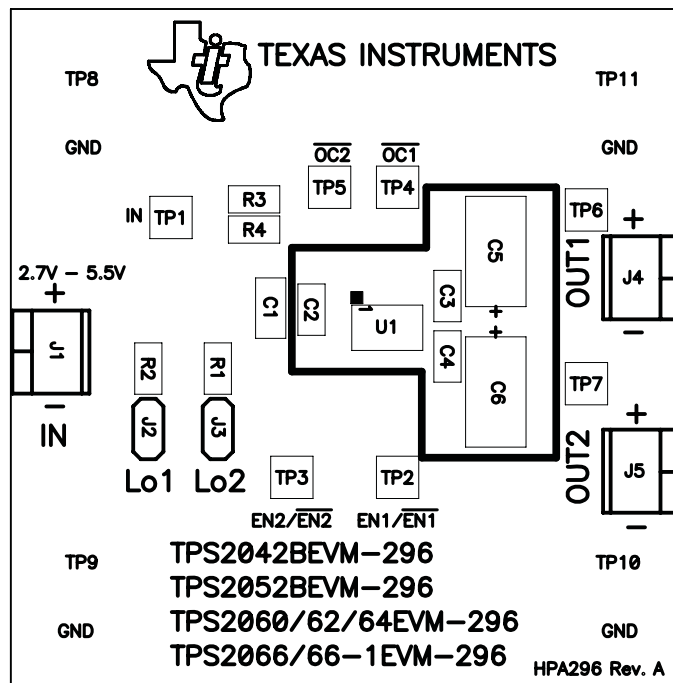


Figure 6. TPS20xxEVM-296 Component Placement



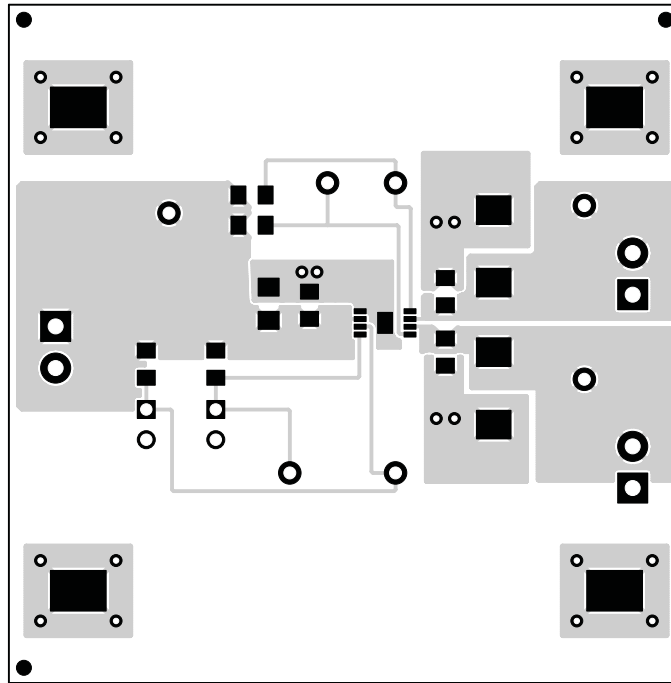


Figure 7. TPS20xxEVM-296 Top-Side Layout

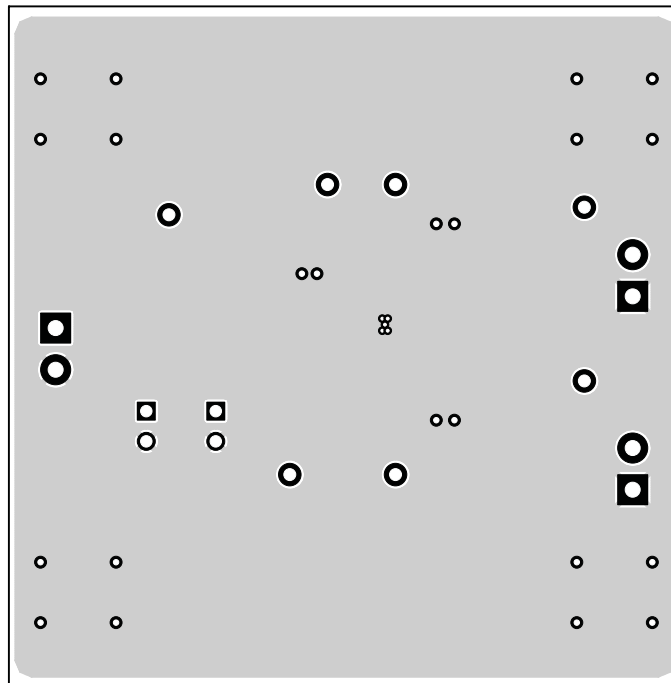


Figure 8. TPS20xxEVM-296 Bottom-Side Layout

## 4 EVM Setup

### 4.1 Recommended Test Equipment

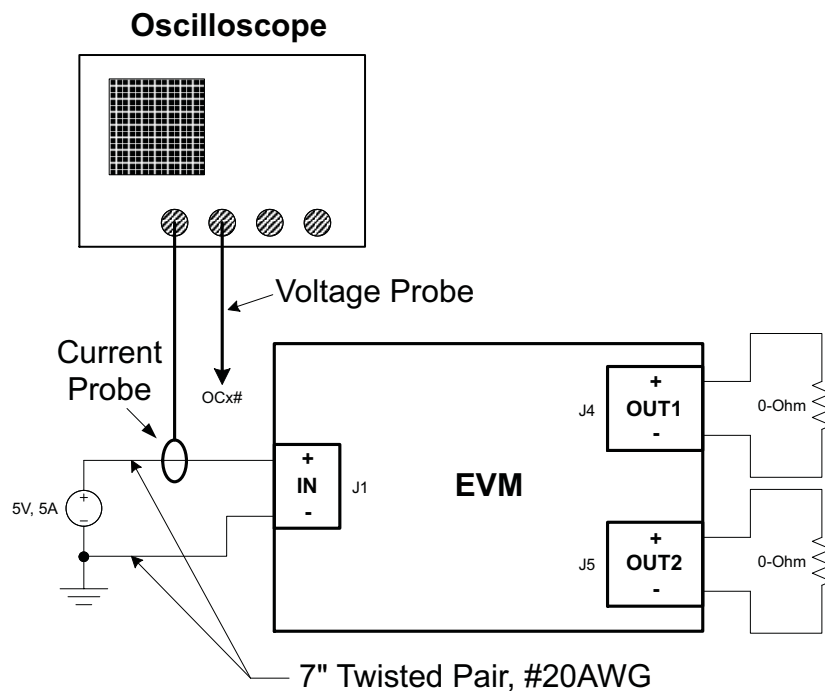
The following test equipment is recommended:

- Two-channel storage oscilloscope
- Current probe
- Voltage probe
- An adjustable power supply with a 2.7-V to 5.5-V output and a 5-A output current-limit
- Volt-ohm meter
- A passive or active load capable of handling 5-A

### 4.2 Measuring Current Limit

The user should read the applicable data sheet before using the EVM.

Figure 9 shows the EVM test set up for measuring current limit. A single switch is enabled into a short circuit for this measurement. Figure 10 shows the current waveform for the TPS2052BEVM-293.



**Figure 9. EVM Setup For Measuring Current Limit**

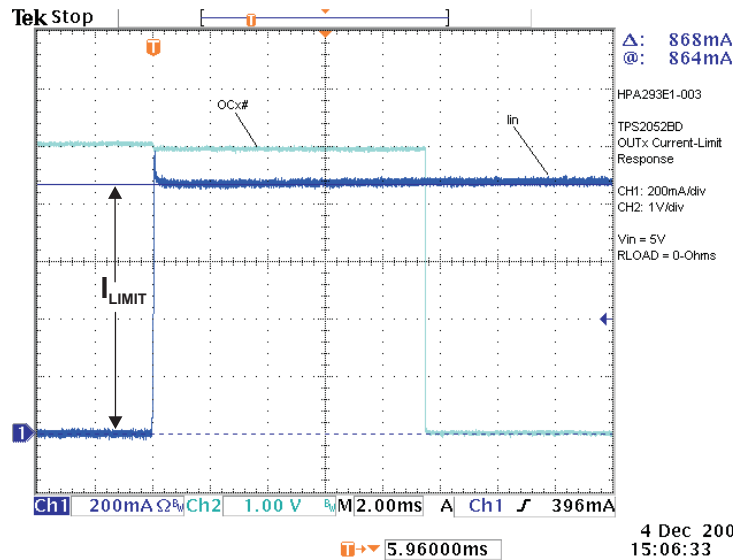


Figure 10. TPS2052BEVM-293 Short-Circuit Output Current and  $\overline{OCx}$  Status

## 5 Related Documentation from Texas Instruments

- *TPS2041B, TPS2042B, TPS2043B, TPS2044B, TPS2051B, TPS2052B, TPS2053B, TPS2054B, Current-Limited, Power-Distribution Switches* data sheet ([SLVS514](#))
- *TPS2045B, TPS2055B, TPS2046B, TPS2047B, Current-Limited, Power-Distribution Switches* data sheet ([SLVS532](#))
- *TPS2045A, TPS2046A, TPS2047A, TPS2048A, TPS2055A, TPS2056A, TPS2057A, TPS2058A, Current-Limited, Power-Distribution Switches* data sheet ([SLVS251](#))
- *TPS2061, TPS2062, TPS2063, TPS2065, TPS2066, TPS2067, Current-Limited, Power-Distribution Switches* data sheet ([SLVS490](#))
- *TPS2062-1, TPS2065-1, TPS2066-1, Current-Limited, Power-Distribution Switches* data sheet ([SLVS714](#))
- *TPS2060, TPS2064, TPS2068, TPS2069, Current-Limited, Power-Distribution Switches* data sheet ([SLVS553](#))

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Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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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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**For Feasibility Evaluation Only, in Laboratory/Development Environments.** Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

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.

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