

TPS3840EVM Voltage Supervisor User Guide

This user's guide describes the TPS3840EVM evaluation module (EVM). This guide contains the EVM schematic, bill of materials (BOM), assembly drawing, and top and bottom board layouts.

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Trademarks

All trademarks are the property of their respective owners.

1 Introduction

The TPS3840EVM is an evaluation module (EVM) for the TPS3840 voltage supervisor. The TPS3840EVM can be used with any TPS3840 device variant but please note that if using the push-pull variants (TPS3840PLXX or TPS3840PHXX), the shunt on J2 must be removed as push-pull devices do not use a pull-up resistor so R1 must be disconnected. Please also note if using TPS3840EVM with the active-high variant (TPS3840PHXX), the active-low **RESET** label on the EVM board and throughout this User Guide becomes active-high **RESET**. The TPS3840 has a supply voltage range of 1.5 V to 10 V, and offers input connections for all device input and output pins. Test points are provided to give the user access to an extra ground connection if needed for oscilloscope or multimeter measurements.

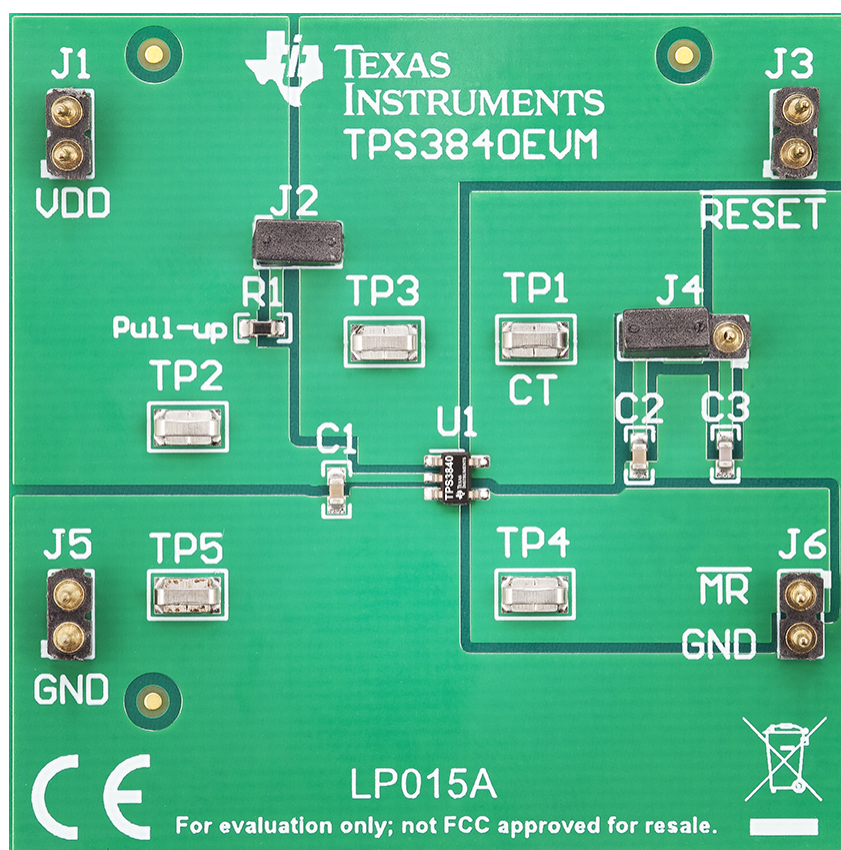


Figure 1. TPS3840EVM Board Top



Figure 2. TPS3840EVM Board Bottom

1.1 Related Documentation

TPS3840 Nano Power, High Input Voltage Supervisor with $\overline{MR}$ and programmable delay data sheet, [SBVS085](#)

1.2 TPS3808G01-Q1 Applications

- Grid Infrastructure (Circuit Breakers, Smart Meters, monitor and protection equipment)
- Factory Automation (Field Transmitters, PLC)
- Fire Safety Systems
- Electronic Point of Sale
- Portable, Battery-Powered Systems

2 Schematic, Bill of Materials, and Layout

This section provides a detailed description of the TPS3840EVM schematic, bill of materials (BOM), and layout.

2.1 TPS3840EVM Schematic

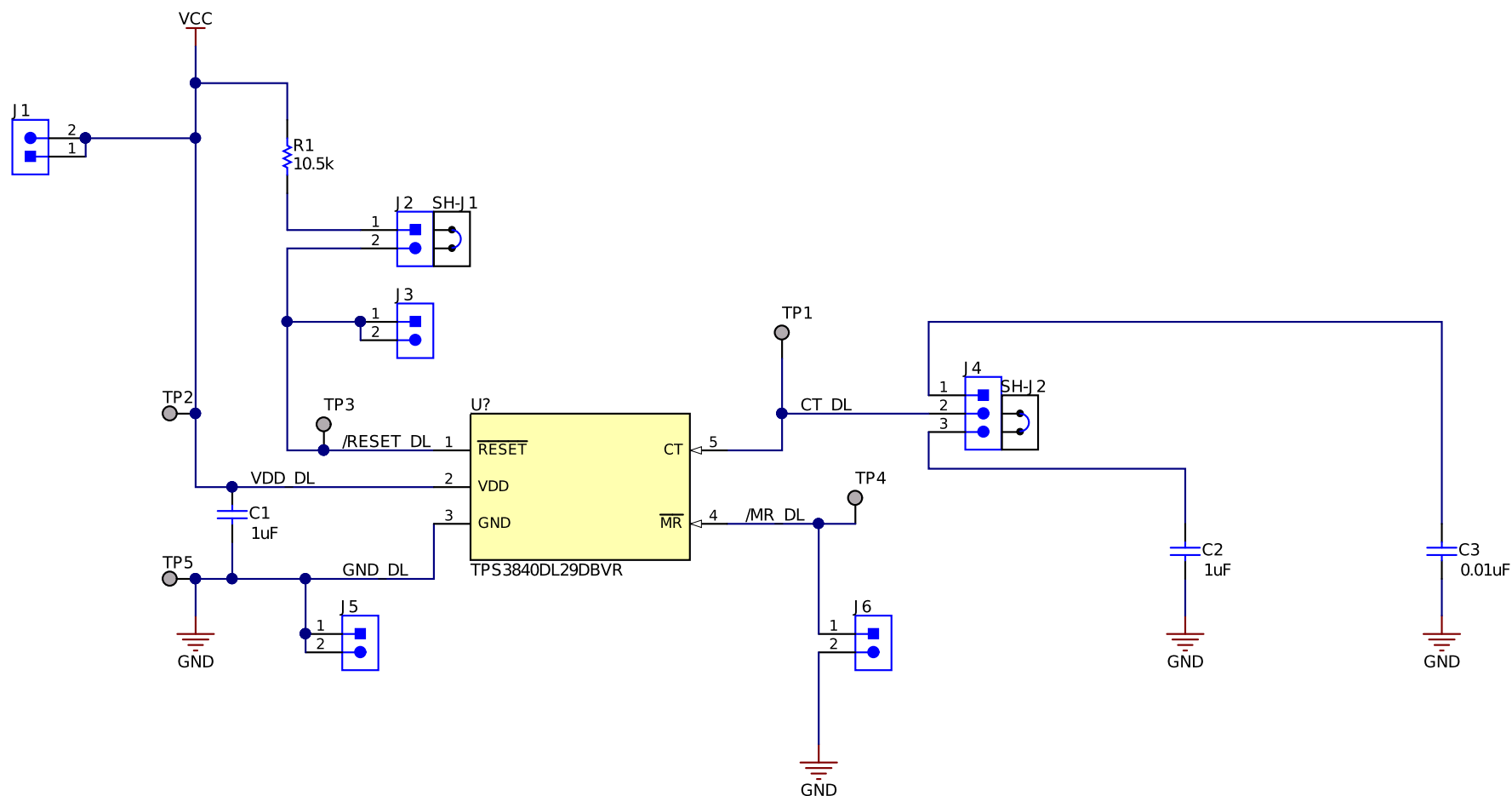


Figure 3. TPS3840EVM Schematic

2.2 TPS3840EVM Bill of Materials

Table 1. BOM

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
!PCB	1		Printed Circuit Board		LP015	Any
C1	1	1 μ F	CAP, CERM, 1 μ F, 16 V, $\pm$ 10%, X5R, 0603	0603	GRM185R61C105KE44D	MuRata
C2	1	1 μ F	CAP, CERM, 1 μ F, 16 V, $\pm$ 10%, X7R, 0603	0603	GRM188R71C105KA12D	MuRata
C3	1	0.01 μ F	CAP, CERM, 0.01 μ F, 10 V, $\pm$ 10%, X7R, 0603	0603	GRM188R71C103KA01D	MuRata
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
J1, J2, J3, J5, J6	5		Header, 100mil, 2x1, TH	Header, 2x1, 100mil, TH	800-10-002-10-001000	Mill-Max
J4	1		Header, 100mil, 3x1, TH	Header, 3x1, 100mil, TH	800-10-003-10-001000	Mill-Max
R1	1	10.5k	RES, 10.5 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710K5L	Yageo
SH-J1, SH-J2	2		Shunt, 100mil, Tin plated, Black	Shunt Connector Black Open Top, 2x1	SNT-100-BK-T-H	Samtec
TP1, TP2, TP3, TP4, TP5	5		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone
U1	1		Nano Power, Wide VIN Voltage Detector with Programmable Delay, DBV0005A (SOT-23-5)	DBV0005A	TPS3840DL29DBVR	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A

2.3 Layout and Component Placement

Figure 4 and Figure 5 show the top and bottom assemblies of the printed circuit board (PCB) to show the component placement on the EVM.

Figure 6 and Figure 7 show the top and bottom layouts, Figure 8 and Figure 9 show the top and bottom layers, and Figure 10 shows the top solder mask of the EVM.

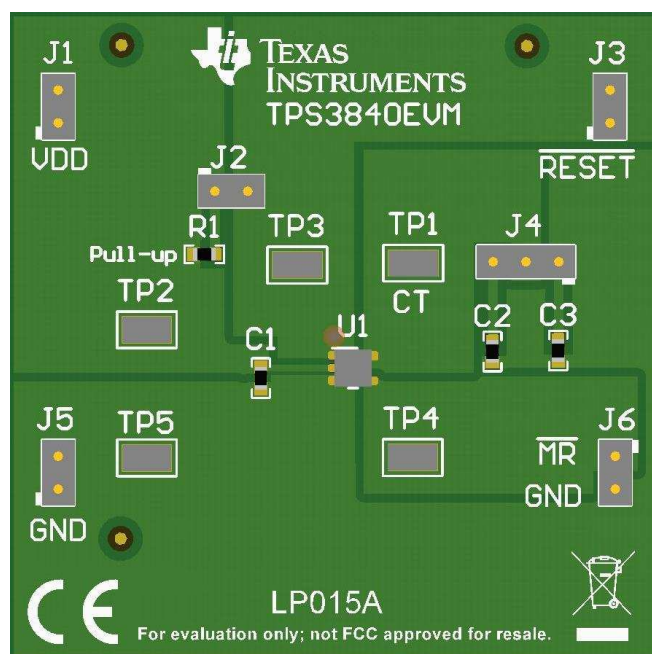


Figure 4. Component Placement—Top Assembly

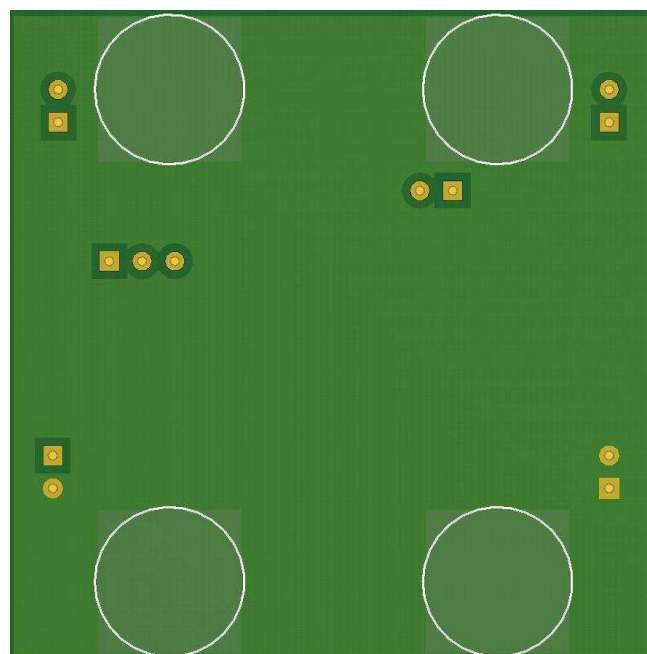


Figure 5. Component Placement—Bottom Assembly

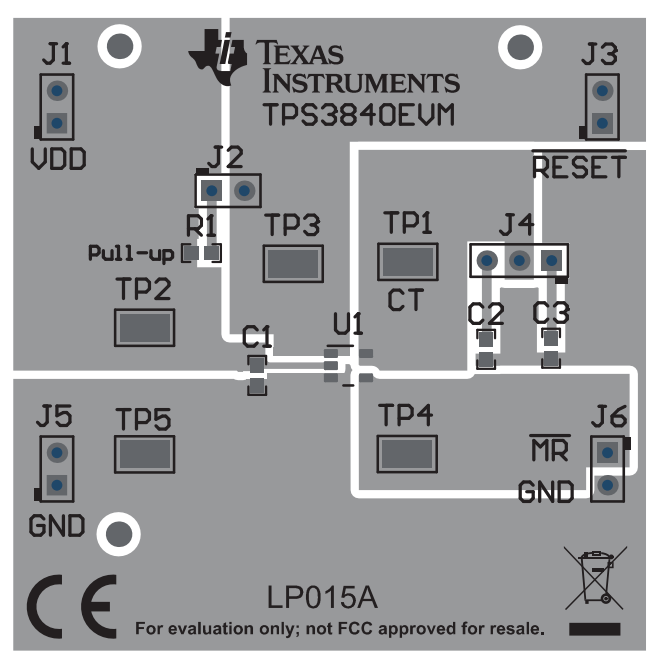


Figure 6. Layout—Top

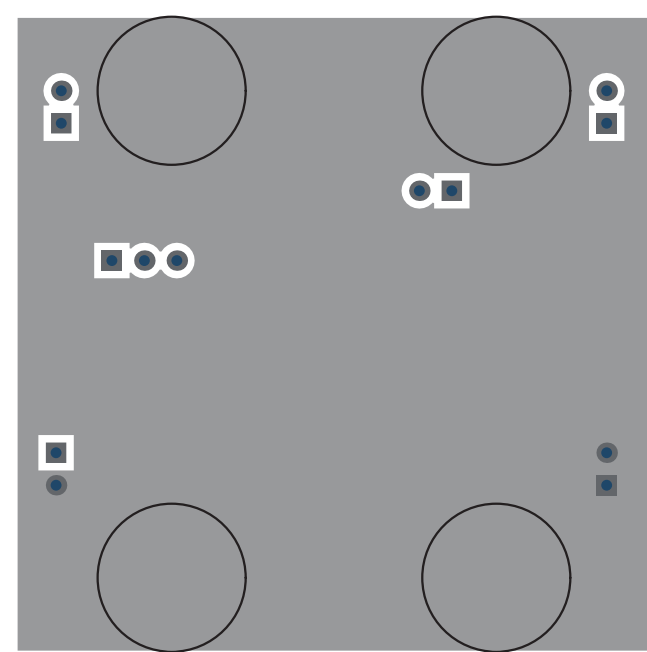


Figure 7. Layout—Bottom

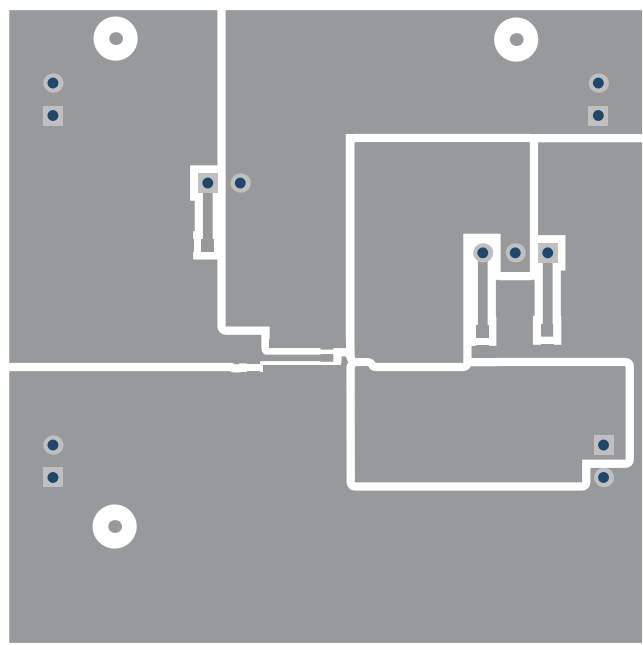


Figure 8. Top Layer

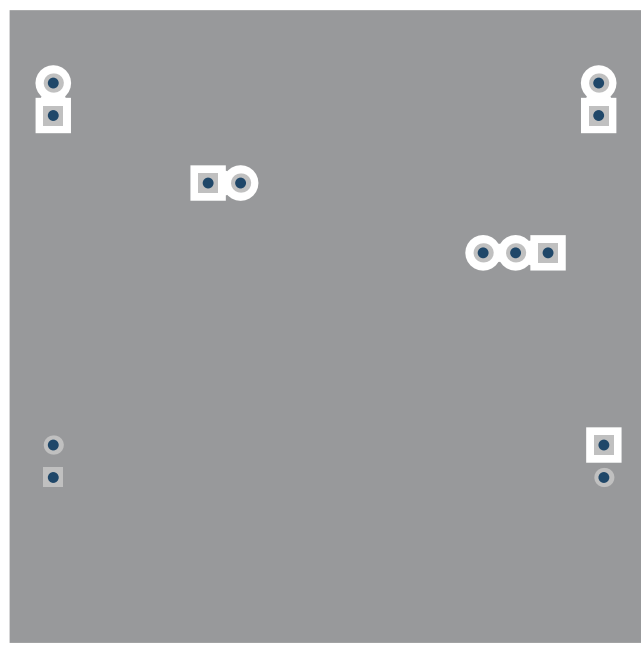


Figure 9. Bottom Layer

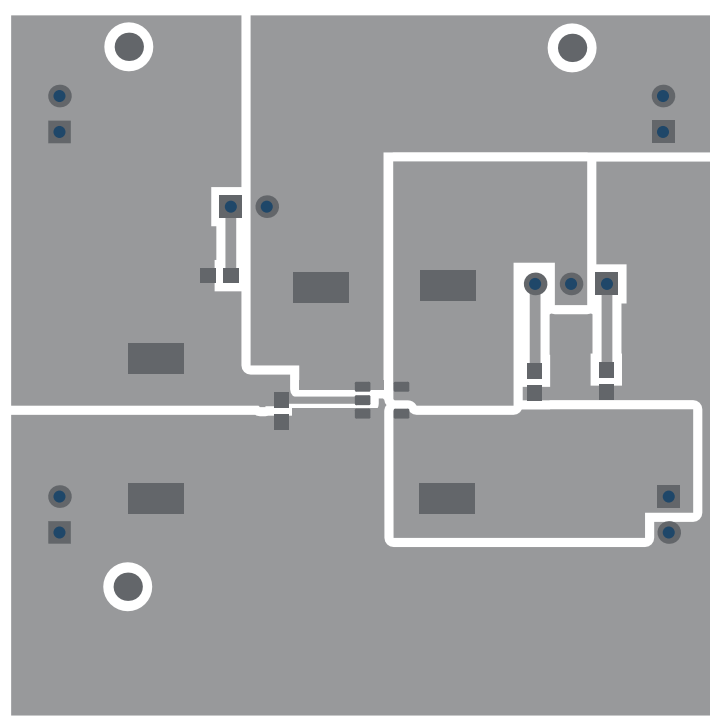


Figure 10. Top Solder Mask

3 EVM Connectors

This section describes the connectors, jumpers, and test points on the EVM as well as how to connect, set up, and properly use the EVM. Each device has an independent supply connection, but all grounds are connected on the board.

3.1 EVM Test Points

[Table 2](#) lists the test points and functional descriptions. All pins of the device are broken out to test points on the EVM.

Table 2. Test Points

Test Point Number	Test Point Silkscreen Label	Function	Description
TP1	CT	Connection to CT pin	Allows user to monitor the CT pin. This pin charges up according to the CT pin configuration. The CT capacitor sets the reset delay.
TP2	VDD	Connection to VDD pin	Allows user to monitor the VDD pin. The VDD pin connects to the input power supply.
TP3	RESET	Connection to RESET pin	Allows user to monitor the RESET output pin.
TP4	MR	Connection to MR pin	Allows user to monitor the logic level of the manual reset pin. Logic low on MR forces a reset.
TP5	GND	Connection to GND pin.	Allows user to connect to the ground plane.

3.2 EVM Jumpers

[Table 3](#) lists the jumpers on the TPS3840EVM. As ordered, the EVM will have five jumpers installed.

Table 3. List of Onboard Jumpers

Jumper	Default Connection	Description
J1	Shorted	Both pins on J1 are connected together. Connect either pin on jumper J1 to the input power supply.
J2	Closed	Connect a shunt jumper to jumper J2 to use R1 as the pull-up resistor on the RESET output pin.
J3	Shorted	Both pins on J3 are connected together. Use either pin on jumper J3 to monitor the RESET output pin.
J4	Closed (pin 2, pin 3)	Jumper J4 configures the CT pin to set the reset delay. Connect a shunt jumper to pin 2 and pin 3 of jumper J4 to use C2 as the delay capacitor for the CT pin. Connect shunt jumper to pin 1 and pin 2 of jumper J4 to use C3 as the delay capacitor. Remove shunt jumper from jumper J4 to set the default fixed delay of 80 μ s (maximum).
J5	Shorted	Both pins on J5 are connected together. Use either pin on jumper J5 as the ground connection.
J6	Open	Jumper J6 configures the manual reset pin. Remove shunt jumper from J6 and leave floating for normal operation. Connect shunt jumper to J6 to force a reset. Pin 1 of jumper J6 can also be connected to a control signal to set the logic level on MR pin. If pin 1 on jumper J6 is logic low, the device remains in reset.

4 EVM Setup and Operation

This section describes the functionality and operation of the TPS3840EVM. The user should read the [TPS3840](#) datasheet for electrical characteristics of the device.

4.1 Input Power (V_{DD})

The V_{DD} supply is connected through the J1 header on board. Both pins of jumper J1 are connected together so power can be applied to either pin. Supply voltage is dependent on what the user wants to monitor, but the range is 1.6 V to 10 V. [Table 4](#) details the nominal supply and typical threshold voltage.

Table 4. Nominal Supply and Typical Threshold Voltages

Device	Nominal Supply Voltage (V)	Typical Threshold Voltage (V)
TPS3840DL29	2.9	$2.9 \pm 1\%$

4.1.1 Manual Reset ($\overline{MR}$)

The TPS3840 devices offers a manual reset pin that is utilized via jumper J6. If a shunt jumper is placed on jumper J6, the $\overline{RESET}$ pin is asserted and forced into a low state. After the shunt jumper is removed and V_{DD} is above its reset threshold, $\overline{MR}$ returns to a logic high due to the internal pull-up resistor, and $\overline{RESET}$ is deasserted to logic high after the user-defined delay expires. If jumper J6 is left floating, the device operates normally as the $\overline{MR}$ pin defaults to logic high. Pin 1 of jumper J6 can also be connected to a control signal to set the logic level on $\overline{MR}$ pin. If pin 1 on jumper J6 is logic low, the device asserts a reset. There is also a test point TP4 connected directly to the $\overline{MR}$ pin in case the user wants to monitor the $\overline{MR}$ pin. See [Figure 11](#) through [Figure 15](#).

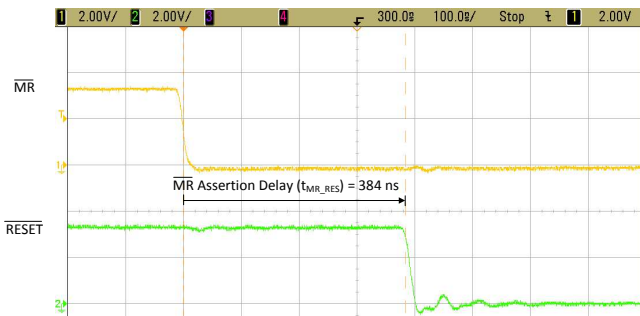


Figure 11. TPS3840EVM $\overline{RESET}$ Asserted Due to $\overline{MR}$ Pulled Low

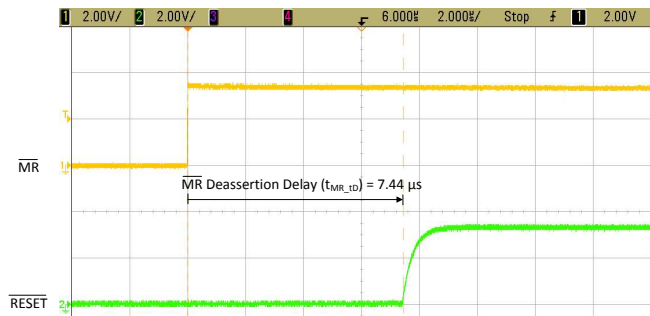


Figure 12. TPS3840EVM $\overline{RESET}$ Deasserted Due to $\overline{MR}$ Pulled High, With Delay t_D , C_T Floating

4.2 Monitoring Voltage on V_{DD}

The TPS3840 device monitors voltage via the V_{DD} pin. The EVM provides jumper J1 and test point TP2 for connecting the power supply input to the V_{DD} pin. If the voltage on this pin drops below V_{IT} , $\overline{RESET}$ is asserted low. The V_{DD} pin is connected internally to a comparator through an internal resistor divider at the positive input and the negative input is connected to an internal reference. The internal resistor divider is set to provide the input voltage threshold to cause a reset, V_{IT} , that corresponds to the chosen device variant. Please see the Device Comparison Table in the [TPS3840 Datasheet](#) for more information on the different device variants.

Upon startup, the TPS3840 requires V_{DD} to be above $V_{DD(MIN)} = 1.6$ V for a maximum of 500 μ s before the $\overline{RESET}$ output is in the correct logic state. [Figure 13](#) shows the actual startup delay may be much shorter than the maximum of 500 μ s especially in the case when V_{DD} is above $V_{DD(MIN)} = 1.6$ V but below $V_{IT} + V_{HYS}$ because this case does not require the additional $\overline{RESET}$ time delay (t_D) for $\overline{RESET}$ to transition to logic high like in the case when V_{DD} is above $V_{IT} + V_{HYS}$. The startup delay when V_{DD} is above $V_{IT} + V_{HYS}$.

must account for the $\overline{\text{RESET}}$ time delay (t_D). The TPS3840 has built-in glitch immunity so voltage transients on VDD are ignored if the pulse duration is 10 μs or less as shown in Figure 14. The glitch immunity specification depends on the amplitude of the voltage transient and the operating conditions. Please see the Glitch Immunity specification in the Timing Requirements section of the [TPS3840 Datasheet](#) for more detailed information.

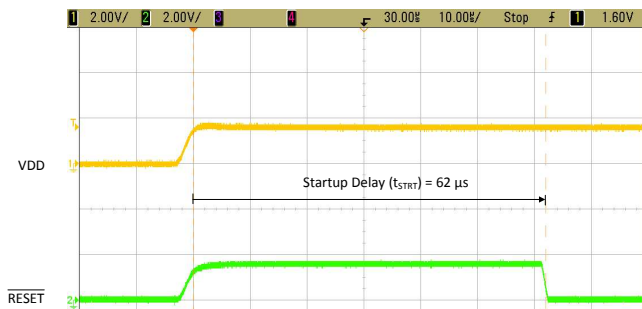


Figure 13. TPS3840EVM Startup Delay Time (t_{STRT}) with VDD = 1.6 V and C_T Floating

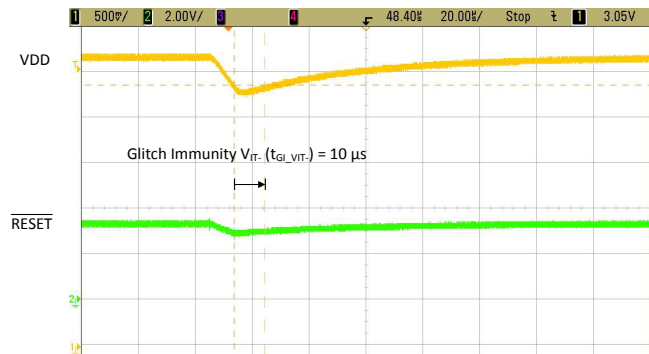


Figure 14. TPS3840EVM Glitch Immunity

4.3 Reset Output ($\overline{\text{RESET}}$)

The TPS3840EVM comes populated with TPS3840DL29 device variant which has open-drain, active-low output topology for the $\overline{\text{RESET}}$ pin. The other device variants provide different output topologies and can be used on this EVM. Note: if using a TPS3840 device variant with push-pull output topology, the pull-up resistor must be disconnected by leaving jumper J2 open. The EVM provides a jumper J3 and a test point TP3 connected directly to the $\overline{\text{RESET}}$ pin for monitoring and/or interfacing to other devices. The reset signal will be asserted low when $\overline{\text{MR}}$ is pulled low or when the voltage on the VDD pin falls below V_{IT-} . When the voltage on VDD rises higher than the hysteresis voltage above the threshold voltage, and the $\overline{\text{MR}}$ pin is pulled high or floating, the reset pins will deassert and remain deasserted until a reset condition occurs again.

4.4 Reset Time Delay Programming (program t_D via C_T)

The TPS3840 device has two options for setting the $\overline{\text{RESET}}$ time delay: connect C_T pin to a capacitor to GND, or leave C_T pin floating. The reset time delay can be set to a minimum value of 80 μs by leaving the C_T pin floating, or a maximum value of approximately 6.2 seconds by connecting 10 μF delay capacitor. The reset time delay (t_D) can be programmed to any value within the range by connecting a capacitor no larger than 10 μF between C_T pin and GND. The relationship between external capacitor (C_{CT_EXT}) at C_T pin and the $\overline{\text{RESET}}$ time delay is given by Equation 1.

$$t_D = -\ln(0.29) \times R_{CT} \times C_{CT_EXT} + t_D(\text{no cap}) \quad (1)$$

Equation 1 is simplified to Equation 2 by plugging R_{CT} and $T_{D(\text{no cap})}$ given in the Electrical Characteristics Table in [TPS3840 Datasheet](#)

$$t_D = 618937 \times C_{CT_EXT} + 80\mu\text{s} \quad (2)$$

Equation 3 solves for external capacitor value (C_{CT_EXT})

$$C_{CT_EXT} = (t_D - 80\mu\text{s}) \div 618937 \quad (3)$$

The recommended maximum delay capacitor for the TPS3840 is limited to 10 μF as this ensures there is enough time for the capacitor to fully discharge when the reset condition occurs. When a voltage fault occurs, the previously charged up capacitor discharges, and if the monitored voltage returns from the fault condition before the delay capacitor discharges completely, the delay capacitor will begin charging from a voltage above zero and the reset delay will be shorter than expected. Larger delay capacitors can be used so long as the capacitor has enough time to fully discharge during the duration of the voltage fault.

The EVM provides the jumper J4 to configure the CT pin and test point TP1 to monitor the CT pin. Place a shunt jumper on pin 2 (middle pin) and pin 3 (left pin) of jumper J4 to connect CT to delay capacitor C2. This connects the CT pin to a 1- μ F capacitor to set the RESET delay (t_D) to ~619 ms as shown in Figure 15. Or place a shunt jumper on pin 1 (right pin) and pin 2 (middle pin) of jumper J4 to connect CT to delay capacitor C3. This connects the CT pin to a 0.01- μ F capacitor to set the RESET delay (t_D) to ~6.2 ms as shown in Figure 16. By removing the shunt jumper from jumper J4, the RESET time delay defaults to the minimum value of 80 μ s. Figure 17 shows the actual delay with no capacitor may be shorter than the typical value of 80 μ s. If using a different delay capacitor, the capacitor must be ≥ 100 pF to be recognized.

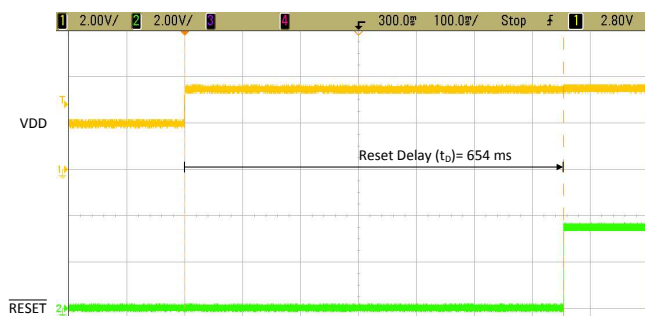


Figure 15. TPS3840EVM RESET Delay Time (t_D) with C_T Tied to GND Through 1- μ F Capacitor



Figure 16. TPS3840EVM RESET Delay Time (t_D) with C_T Tied to GND Through 0.01- μ F Capacitor

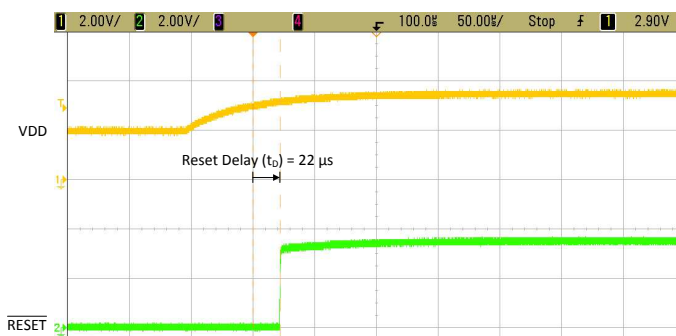


Figure 17. TPS3840EVM RESET Delay Time (t_D) with C_T Floating

Revision History

DATE	REVISION	NOTES
December 2018	*	Initial Release

STANDARD TERMS FOR EVALUATION MODULES

1. **Delivery:** TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

- 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 semiconductor 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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
- 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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:**

FCC NOTICE: 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 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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/llds/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/llds/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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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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2. 実験局の免許を取得後ご利用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page
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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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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