TPS3700EVM-114 High voltage (18V) window voltage detector evaluation module for SOT-23 package

This user’s guide describes the operational use of the TPS3700EVM-114 Evaluation Module (EVM) as a reference design for engineering demonstration and evaluation of the TPS3700 high voltage window voltage detector for over and undervoltage monitoring. Included in this user’s guide are setup instructions, a schematic diagram, PCB layout drawings, and a bill of materials for the evaluation module.

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1 Introduction
The Texas Instruments (TI) TPS3700EVM-114 Evaluation Module (EVM) helps design engineers evaluate the operation and performance of the TPS3700 IC for possible use in their own circuit application. This particular EVM configuration contains an over- and under-voltage detector circuit with a wide supply range, independent open-drain outputs, very low quiescent current, and high accuracy in a TSOT23-6 DDC package. This document describes the configuration and set up of the EVM board.

2 Setup
This section describes the jumpers and connectors on the EVM as well as how to properly connect, setup, and use the EVM.
2.1 Input/Output Connector and Jumper Descriptions

2.1.1 J1 — \( V_{DD} \)
This connector is the power supply connection.
This also may be the signal being monitored by the TPS3700.

2.1.2 J2 — GND
Return connector for the input power supply. This connector is also connected to J4, J6, and J8 in the EVM.

2.1.3 J3 — SENSE
This connector is an additional voltage signal that is monitored if \( V_{DD} \) is not monitored.

2.1.4 J4 — GND
Return connector for the SENSE voltage signal. This connector is also connected to J2, J6, and J8 in the EVM.

2.1.5 J5 — OUTA
This connector is the under-voltage open-drain output of the TPS3700 that pulls up to VPU through a 100-k\( \Omega \) resistor in the EVM. Connect a voltage meter or oscilloscope probe from J5 to GND (J6).

2.1.6 J6 — GND
Return connector for the OUTA voltage signal. This connector is also connected to J2, J4, and J8 in the EVM.

2.1.7 J7 — OUTB
This connector is the over-voltage open-drain output of the TPS3700 that pulls up to VPU through a 10-k\( \Omega \) resistor in the EVM. Connect a voltage meter or oscilloscope probe from J7 to GND (J6).

2.1.8 J8 — GND
Return connector for the OUTB voltage signal. This connector is also connected to J2, J4, and J6 in the EVM.

2.1.9 J9 — VEXT
This connector is an external voltage. OUTA and OUTB can be pulled up to this voltage.

2.1.10 J10 — MONITOR SENSE and MONITOR \( V_{DD} \) SELECT
The EVM is designed to monitor either the supply voltage \( V_{DD} \) or an additional voltage signal SENSE.
A shorting jumper allows the user to choose between monitoring \( V_{DD} \) or SENSE. Table 1 shows the connections for choosing between the two.

<table>
<thead>
<tr>
<th>Short Pins</th>
<th>Monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>SENSE</td>
</tr>
<tr>
<td>2 and 3</td>
<td>( V_{DD} )</td>
</tr>
</tbody>
</table>
2.1.11 J11 — VPU

The EVM is designed for OUTA and OUTB to pull up to $V_{DD}$ or an external voltage source VEXT. Table 2 shows the connections for choosing between the two.

Table 2. Connector J11 Selections

<table>
<thead>
<tr>
<th>Short Pins</th>
<th>Pullup Voltage VPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>$V_{DD}$</td>
</tr>
<tr>
<td>2 and 3</td>
<td>VEXT</td>
</tr>
</tbody>
</table>

2.2 Equipment Setup

• Set the first power-supply voltage between 1.8 V-18 V. Turn the power supply off. Connect the positive voltage lead from the power supply to J1 ($V_{DD}$). Connect the ground lead from the power supply to J2 (GND).

• Set the second power-supply voltage between 1.8 V-18 V. Turn the power supply off. Connect the positive voltage lead from the power supply to J3 (SENSE). Connect the ground lead from the power supply to J4 (GND).

• Set the third power-supply voltage between 1.8 V-18 V. Turn the power supply off. Connect the positive voltage lead from the power supply to J9 (VEXT). Connect the ground lead from the power supply to J4 (GND).

• Use the shorting jumper on J10 and select Monitor Sense.

• Use the shorting jumper on J11 and select VEXT.

• Turn on all power supplies.

3 Operation

This section provides information about the operation of the EVM.

3.1 General Operation

The EVM is an over- and under-voltage supervisor. The EVM monitors a selected voltage signal (SENSE or $V_{DD}$). OUTA triggers LOW when INA+ is below the 394.5-mV threshold and triggers HIGH (VPU) when INA+ goes above 400 mV. OUTB triggers LOW when INB- is above the 400-mV threshold and triggers HIGH (VPU) when INB- falls beneath 394.5 mV.

The EVM is designed to sense a 12-V rail and trigger when the rail falls below 10% or rises above 10% of 12 V. Specifically, OUTA will trigger LOW during a −10% drop (10.8 V) while OUTB will trigger LOW during a +10% rise (13.2 V). In between this window, the outputs are pulled up to VPU. Figure 1 and Figure 2 shows the OUTA and OUTB response for monitoring $V_{DD}$ and the output pulled up (VPU) to an external 5V source (VEXT=5V).
Resistors R1, R2, and R3 can be replaced with different values to change the window at which OUTA and OUTB triggers HIGH and LOW. Design information can be found in the applications section of the TPS3700 datasheet (SBVS187A).
4 Board Layout

Figure 3. Assembly Layer

Figure 4. Top Layer Routing
Figure 6. TPS3700EVM-114 Schematic
# Bill of Materials

Table 3 lists the bill of materials for the TPS300EVM-114.

## Table 3. TPS3700EVM-114 Bill of Materials

<table>
<thead>
<tr>
<th>Count</th>
<th>RefDes</th>
<th>Value</th>
<th>Description</th>
<th>Size</th>
<th>Part Number</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C1</td>
<td>0.1 µF</td>
<td>Capacitor, Ceramic, 25 V, X7R, 20%</td>
<td>0603</td>
<td>STD STD STD</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>J1-9</td>
<td>PEC02SAAN</td>
<td>Header, Male 2-pin, 100-mil spacing</td>
<td>0.100 inch x 2</td>
<td>PEC02SAAN Sullins</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>J10-11</td>
<td>PEC03SAAN</td>
<td>Header, Male 3-pin, 100-mil spacing</td>
<td>0.100 inch x 3</td>
<td>PEC03SAAN Sullins</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>R1</td>
<td>2.21 MΩ</td>
<td>Resistor, Chip, 1/16 W, 1%</td>
<td>0603</td>
<td>STD STD STD</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>R2</td>
<td>13.7 kΩ</td>
<td>Resistor, Chip, 1/16 W, 1%</td>
<td>0603</td>
<td>STD STD STD</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>R3</td>
<td>69.8 kΩ</td>
<td>Resistor, Chip, 1/16 W, 1%</td>
<td>0603</td>
<td>STD STD STD</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>R4 R5</td>
<td>100 kΩ</td>
<td>Resistor, Chip, 1/16 W, 1%</td>
<td>0603</td>
<td>STD STD STD</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>R6</td>
<td>Open</td>
<td>Resistor, Chip, 1/16 W, 1%</td>
<td>0603</td>
<td>STD STD STD</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>U1</td>
<td>TPS3700DDC</td>
<td>IC, High Voltage, Window Voltage Detector for Over and Undervoltage Monitoring</td>
<td>SOT-23</td>
<td>TPS3700DDC TI</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk (**) cannot be substituted. All other components can be substituted with equivalent MFG's components.
# Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

## Changes from Original (March 2012) to A Revision

<table>
<thead>
<tr>
<th>Change Description</th>
<th>Page</th>
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<tbody>
<tr>
<td>Changed title of document</td>
<td>1</td>
</tr>
<tr>
<td>Changed comparator to voltage detector</td>
<td>8</td>
</tr>
</tbody>
</table>
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User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:
EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.
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.

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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.

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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 bruitage 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.

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

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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 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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8. **Limitations on Damages and Liability:**

8.1 **General Limitations.** In no event shall TI be liable for any special, collateral, indirect, punitive, incidental, consequential, or exemplary damages in connection with or arising out of these terms or the use of the EVMs, regardless of whether TI has been advised of the possibility of such damages. Excluded damages include, but are not limited to, cost of removal or reinstallation, ancillary costs to the procurement of substitute goods or services, retesting, outside computer time, labor costs, loss of goodwill, loss of profits, loss of savings, loss of use, loss of data, or business interruption. No claim, suit or action shall be brought against TI more than twelve (12) months after the event that gave rise to the cause of action has occurred.

8.2 **Specific Limitations.** In no event shall TI's aggregate liability from any use of an EVM provided hereunder, including from any warranty, indemnity or other obligation arising out of or in connection with these terms, exceed the total amount paid to TI by user for the particular EVM(s) at issue during the prior twelve (12) months with respect to which losses or damages are claimed. The existence of more than one claim shall not enlarge or extend this limit.

9. **Return Policy.** Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

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