1 Introduction

The Texas Instruments TPS61169EVM evaluation module, containing a TPS61169 integrated circuit (IC), helps designers evaluate the operation and performance of the TPS61169, which is a WLED driver providing highly integrated solutions for single-cell Li-ion battery powered backlight for small-to-medium form-factor LCD Display. The EVM contains one DC / DC converter (see Table 1).

Table 1. Device and Package Configurations

<table>
<thead>
<tr>
<th>CONVERTER</th>
<th>IC</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>TPS61169</td>
<td>SC70 5L - DCK</td>
</tr>
</tbody>
</table>

1.1 1.1 Performance Specification Summary

The TPS61169EVM is designed to operate from an input voltage source ranging from 2.7 V to 5.5 V and provides a 20-mA output current for string LEDs. There can be 4 to 10 LEDs in series according to customer application. Table 2 provides a summary of the TPS61169 performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 2. Typical Performance Specification Summary

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$ supply</td>
<td>2.7</td>
<td>5.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td></td>
<td>20</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Number of LEDs in series as the load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JP3 shorted</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JP4 shorted</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JP5 shorted</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JP6 shorted</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2 Set-Up

This section describes the jumpers and connectors on the EVM as well and how to properly connect, set up, and use the TPS61169EVM.

2.1 Input/Output Connector Description

J1, J2 – Input are the power input terminals for the converter. The terminal blocks provide a power ($V_{BAT}$) and ground (GND) connection to allow the user to attach the EVM to a cable harness.

JP1 – Output is the regulated output terminal for the converter. The terminal block provides a connection for LED load, and it allows the user to add a current meter between its two pins to measure the output current.

JP2 – CTRL is the jumper used to enable the device. Connecting pin 1 and pin 2 will toggle the CTRL high and enable the device. Connecting pin 2 and pin 3 will toggle the CTRL low and disable the device.

JP3, JP4, JP5, JP6 function has been described in Table 2.
2.2 **Hardware Requirements**

This EVM requires an external power supply capable of providing 2.7 V to 5.5 V at 0.5 A. To change the default current value (that is, implement dimming), the user can apply a PWM signal to JP2-pin 2.

2.2.1 **Normal Operation without Dimming Control**

No additional hardware is required.

2.2.2 **PWM Dimming**

A function generator capable of driving the PWM pin with 1.2 V to \( V_{\text{IN}} \) amplitude, and a 5-kHz to 100-kHz PWM signal is required for PWM-controlled dimming.

2.3 **Set-Up**

The input voltage range for the converter is 2.7 V to 5.5 V. A load should be applied to the output terminal for proper operation.

2.4 **Operation**

2.4.1 **Non-Dimming Operation (Default Configuration)**

For non-dimming operation of the TPS61169, JP1 and JP2 should be properly configured. The recommended settings using shorting blocks are shown in Table 3. The configurations for JP3 to JP5 is determined by the specific application.

<table>
<thead>
<tr>
<th>REFERENCE DESIGNATOR</th>
<th>SETTING ON BOARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>JP1</td>
<td>Short pin 1 and pin 2</td>
</tr>
<tr>
<td>JP2</td>
<td>Short pin 1 and pin 2</td>
</tr>
</tbody>
</table>

In this default configuration, the device will power up when power is applied.

2.4.2 **PWM-Dimming Operation**

Remove the jumper on JP2 of default configuration. Connect the appropriately configured function generator output between pin 2 and pin 3 (for GND connection) of JP2. The device will power up when power is applied. Duty cycle of the PWM signal is directly proportional to the regulated current.

2.5 **Test Results**

This section provides typical efficiency for the TPS61169EVM board.
Figure 1. Efficiency of 10s1p

Figure 2. Efficiency of 8s1p

Figure 3. Efficiency of 6s1p
Figure 4, Figure 5, and Figure 6 show the board layout for the TPS61169EVM. The EVM offers resistors, capacitors, and jumpers. Jumpers are provided to configure the device. The PCB provides 1-oz. copper planes on the top and bottom to dissipate heat.
Figure 5. Top Layer Routing

Figure 6. Bottom Layer Routing
## Bill of Materials

<table>
<thead>
<tr>
<th>DESIGNATOR</th>
<th>QTY</th>
<th>VALUE</th>
<th>DESCRIPTION</th>
<th>PACKAGE</th>
<th>PART NUMBER</th>
<th>MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>1</td>
<td>open</td>
<td>CAP, CERM, 1 µF, 10 V, ±10%, X5R, 0603</td>
<td>0603</td>
<td>C1608X5R1A105K</td>
<td>TDK</td>
</tr>
<tr>
<td>C2</td>
<td>1</td>
<td>4.7 µF</td>
<td>CAP, CERM, 4.7 µF, 16 V, ±10%, X5R, 0603</td>
<td>0603</td>
<td>GRM188R61C475KAAJ</td>
<td>MuRata</td>
</tr>
<tr>
<td>C3, C4</td>
<td>2</td>
<td>1 µF, open</td>
<td>CAP, CERM, 1 µF, 50 V, ±10%, X7R, 0805</td>
<td>0805</td>
<td>GRM21BR71H105KA12L</td>
<td>MuRata</td>
</tr>
<tr>
<td>C5</td>
<td>1</td>
<td>1 µF</td>
<td>CAP, CERM, 1 µF, 10 V, ±10%, X5R, 0402</td>
<td>0402</td>
<td>GRM155R61A105KE15D</td>
<td>MuRata</td>
</tr>
<tr>
<td>D1</td>
<td>1</td>
<td>40 V</td>
<td>Diode, Schottky, 40 V, 0.25 A, SOD-523</td>
<td>SOD-523</td>
<td>NSR0240V2T1G</td>
<td>ON Semiconductor</td>
</tr>
<tr>
<td>D2, D3, D4, D5, D6, D7, D8, D9, D10, D11</td>
<td>10</td>
<td>white</td>
<td>Machine screw, round #4-40 x 1/4, Nylon, Philips panhead</td>
<td>Screw</td>
<td>NY PMS 440 0025 PH</td>
<td>B&amp;F Fastener Supply</td>
</tr>
<tr>
<td>FID1, FID2, FID3</td>
<td>3</td>
<td></td>
<td>Fiducial mark. There is nothing to buy or mount.</td>
<td>Fiducial</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>H1, H2, H3, H4</td>
<td>4</td>
<td></td>
<td>Machine screw, round #4-40 x 1/4, Nylon, Philips panhead</td>
<td>Screw</td>
<td>NY PMS 440 0025 PH</td>
<td>B&amp;F Fastener Supply</td>
</tr>
<tr>
<td>H5, H6, H7, H8</td>
<td>4</td>
<td></td>
<td>Standoff, Hex, 0.5&quot;L #40-40 Nylon</td>
<td>Standoff</td>
<td>1902C</td>
<td>Keystone</td>
</tr>
<tr>
<td>J1, J2, JP1, JP3, JP4, JP5, JP6</td>
<td>7</td>
<td></td>
<td>Header, 100 mil, 2 x 1, tinned, TH</td>
<td>Header, 2-pin, 100 mil, Tin</td>
<td>PEC02SAAN</td>
<td>Sullins Connector Solutions</td>
</tr>
<tr>
<td>J5</td>
<td>1</td>
<td></td>
<td>Header, 100 mil, 4x1, gold-plated, 230 mil above insulator</td>
<td>4x1 header</td>
<td>TSW-104-07-G-S</td>
<td>Samtec, Inc.</td>
</tr>
<tr>
<td>JP2</td>
<td>1</td>
<td></td>
<td>Header, 100 mil, 2x1, tinned, TH</td>
<td>Header, 3-pin, 100 mil, tin</td>
<td>PEC03SAAN</td>
<td>Sullins Connector Solutions</td>
</tr>
<tr>
<td>L1</td>
<td>1</td>
<td>4.7 µH</td>
<td>Inductor, shielded drum core, ferrite, 4.7 µH, 1.8 A, 0.13 Ω, SMD</td>
<td>LPS4018</td>
<td>LPS4018-472MLB</td>
<td>Coilcraft</td>
</tr>
<tr>
<td>LBL1</td>
<td>1</td>
<td></td>
<td>Thermal transfer printable labels, 0.650&quot; W x 0.200&quot; H - 10,000 per roll</td>
<td>PCB label 0.650&quot;H x 0.200&quot;W</td>
<td>THT-14-423-10</td>
<td>Brady</td>
</tr>
<tr>
<td>R1, R3, R4</td>
<td>3</td>
<td>10, open, open</td>
<td>RES, 10 Ω, 5%, 0.063W, 0402</td>
<td>0402</td>
<td>CRCW040210RNJNED</td>
<td>Vashay-Dale</td>
</tr>
<tr>
<td>R2</td>
<td>1</td>
<td>0</td>
<td>RES, 0 Ω, 5%, 0.063W, 0402</td>
<td>0402</td>
<td>RC0402JR-070RL</td>
<td>Yageo America</td>
</tr>
<tr>
<td>R5</td>
<td>1</td>
<td>10.2</td>
<td>RES, 10.2 Ω, 1%, 0.063W, 0402</td>
<td>0402</td>
<td>CRCW040210R2FKED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>SH-JP1, SH-JP2</td>
<td>2</td>
<td>1 x 2</td>
<td>Shunt, 2 mm, gold-plated, black</td>
<td>2-mm shunt, closed top</td>
<td>2SN-BK-G</td>
<td>Samtec</td>
</tr>
<tr>
<td>U1</td>
<td>1</td>
<td>38-V High-Current Boost WLED driver with PWM control, DCK0005A</td>
<td>DCK0005A</td>
<td>TPS61159DCK</td>
<td>Texas Instruments</td>
<td></td>
</tr>
</tbody>
</table>
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3 **Regulatory Notices:**

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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/lads/ta/eng/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/lads/ta/eng/general/eStore/notice_01.page

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If User uses EVMs in 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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西新宿三菱ビル

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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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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.
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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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