

## EVM User's Guide: TPS923612EVM

# TPS923612 LED 驱动器评估模块



### 说明

德州仪器 (TI) TPS923612EVM 评估模块 (EVM) 可帮助设计人员评估同步升压 LED ( 发光二极管 ) 驱动器 TPS923612 的运行情况和性能。TPS923612EVM 的输入电压范围为 2.5V 至 5.5V ( 额定电压 3.6V ) , 可通过跳线配置为板载 LED 灯串或外部 LED 负载提供默认的 90mA 恒定电流。

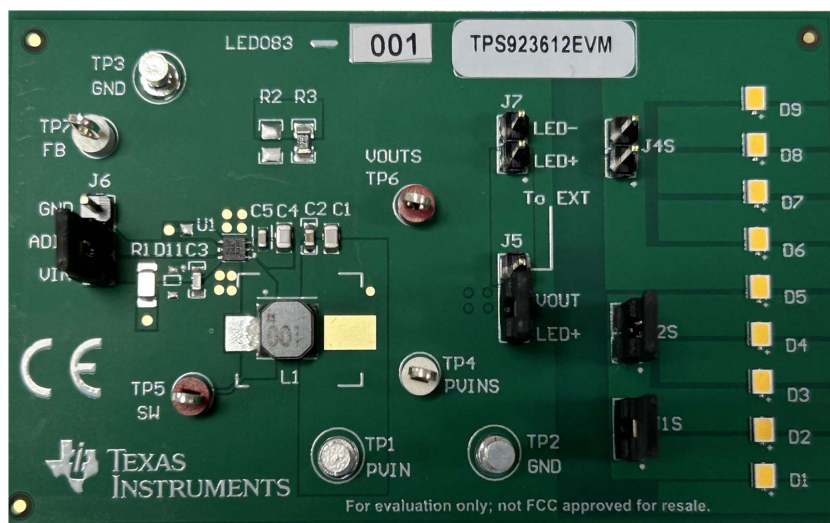
### 特性

- 输入电压范围 : 2.5V 至 5.5V
- 恒定输出电流 : 90mA
- 输出电压范围 : 5V 至 30V
- 调光范围 : 0.1% 至 100%

- 开关频率 : 1.1MHz
- 强制 PWM 模式 , 可实现低输出纹波

### 应用

- LCD 背光
  - 智能手机
  - 恒温器
  - HMI 面板
  - GPS 个人导航设备
  - 仪表板摄像头
- 常规照明
  - IP 网络摄像头
  - 可视门铃
  - 扫地机器人



TPS923612EVM ( 顶视图 )

## 1 评估模块概述

### 1.1 简介

TPS923612 是一款同步升压 LED 驱动器，以 400kHz 或 1.1MHz 的开关频率运行，支持使用较小的电感器来优化设计尺寸。它在关断模式下具有 0.13  $\mu$ A 的超低电流，可进一步延长电池使用寿命。TPS923612 可驱动单路或多路并联 LED 灯串，适用于 LCD 背光及通用照明。

本用户指南包含 TPS923612 的相关信息以及 TPS923612EVM 评估模块的支持文档。本用户指南还包含 TPS923612EVM 的性能规格、原理图和物料清单。

### 1.2 套件内容

- 一个 TPS923612EVM 电路板
- EVM 免责声明自述文件

### 1.3 规格

表 1-1 对 TPS923612EVM 性能规格进行了汇总。规格参数的各项数值，均是在典型输入电压 3.6V、恒定输出电流 90mA 的测试条件下得出。除非另有说明，所有测量的环境温度均为 25°C。

对于具有不同输入电压范围或不同输出电压和电流的应用，请参阅 [TPS923612 数据表](#)。

**表 1-1. 性能规格摘要**

规格	测试条件	最小值	典型值	最大值	单位
输入电压范围		2.5	3.6	5.5	V
输出电流设定点	$R_{SET} = 2.2\Omega$ , $V_{IN} = 3.6V$ , 100% 占空比 PWM 输入		90		mA
输出电流调光范围		0.1		100	%
工作频率	$V_{IN} = 3.6V$ , $I_{OUT} = 90mA$ , 6 个 WLED 串联		1100		kHz
效率	$V_{IN} = 3.6V$ , $I_{OUT} = 90mA$		86		%

### 1.4 器件信息

表 1-2 列出了评估模块的额定输入电压和输出电流范围。

**表 1-2. 输入电压和输出电流汇总**

EVM	输入电压 ( $V_{IN}$ ) 范围	输出电流 ( $I_{OUT}$ ) 范围	最大输出电压
TPS923612EVM	2.5V 至 5.5V	0A 至 90mA	30V

## 2 硬件

### 2.1 输入和输出连接

如表 2-1 中所示，TPS923612EVM 附带输入和输出连接器以及测试点。图 2-1 展示了 TPS923612EVM 电路板上的连接器和跳线布置。

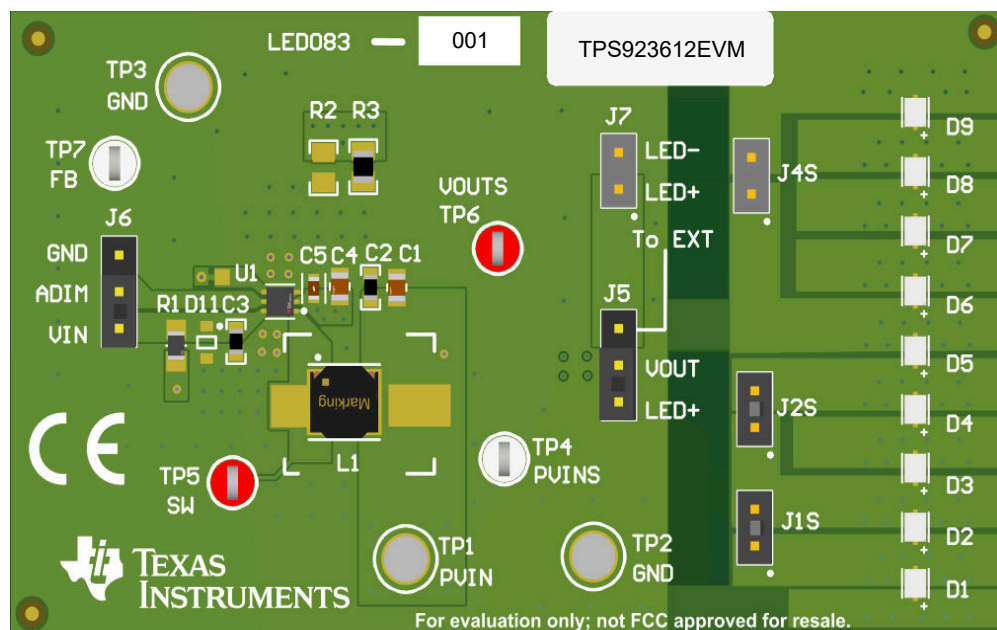


图 2-1. TPS923612EVM 连接器和跳线布置

表 2-1. 连接器和测试点

参考指示符	功能
J1S	用于短接 D2 的 1 个 WLED 的跳线选择
J2S	用于短接 D3 和 D4 的 2 个 WLED 的跳线选择
J4S	用于短接 D6、D7、D8 和 D9 的 4 个 WLED 的跳线选择
J5	<ul style="list-style-type: none"> <li>短接引脚 1 与引脚 2，以驱动板载 LED 灯串</li> <li>短接引脚 2 和引脚 3，以驱动外部 LED 负载</li> </ul>
J6	<ul style="list-style-type: none"> <li>短接引脚 1 和引脚 2，使转换器使能并输出 100% 额定电流。</li> <li>短接引脚 2 和引脚 3，以关闭转换器。</li> <li>断开 J6，在 J6 引脚 2 (ADIM) 上应用外部 PWM 信号以进行调光控制。</li> </ul>
J7	连接到外部 LED 负载时，总 VF 必须在 5V 至 30V 范围内。
TP1	PVIN 正功率点
TP2, TP3	GND 功率点
TP4	PVIN 正检测点
TP5	SW 节点测试点
TP6	VOUT 正检测点
TP7	FB 引脚电压检测点

## 3 实现结果

### 3.1 测试设置

本节介绍了如何正确连接、设置和使用 TPS923612EVM。

#### 3.1.1 启动步骤

1. 当 ADIM 引脚上拉至 VIN 引脚 ( EVM 上 J6 的引脚 1 与引脚 2 ) 时, 转换器 TPS923612 被使能
2. J6 的引脚 2 为外部使能与 PWM 调光信号端子, PWM 频率范围为 10KHz 至 200KHz。
3. 必须将能够提供 3A 电流的电源连接至 PVIN (TP1) 和 GND (TP2), 导线需绞合且尽可能短, 以最大限度降低压降、电感及电磁干扰 ( EMI ) 传导。
4. 测试点 TP4 用于监测 PVIN 输入电压。测试点 TP6 用于监测输出电压。
5. J5 用于选择板载或外部 LED 负载。
6. 开路或短接 J1S、J2S 和 J4S 可将白色 LED 数量从 1 更改为 9, 确保 LED 负载上的 VOUT 压降为 5V 或更高, 以实现正常运行。

### 3.2 输出电流设置

FB 电压被调节至 200mV 参考电压。LED 电流通过外接与 LED 灯串串联的检流电阻进行设置。使用以下方式计算  $R_{SET}$  ( EVM 上的 R3 ) 的值 :

$$I_{OUT} = \frac{V_{FB}}{R_{SET}} \quad (1)$$

其中

- $I_{LED}$  = LED 灯串的总输出电流
- $V_{FB}$  = FB 引脚的稳压电压
- $R_{SET}$  = 电流检测电阻器

输出电流容差取决于 FB 精度和电流传感器电阻器精度。

R2 是与 R3 并联的可选电阻器, 用于将  $R_{SET}$  微调到目标值, 也可用于平衡  $R_{SET}$  上的总功率损耗。

## 4 硬件设计文件

### 4.1 原理图

图 4-1 是 TPS923612EVM 的原理图。

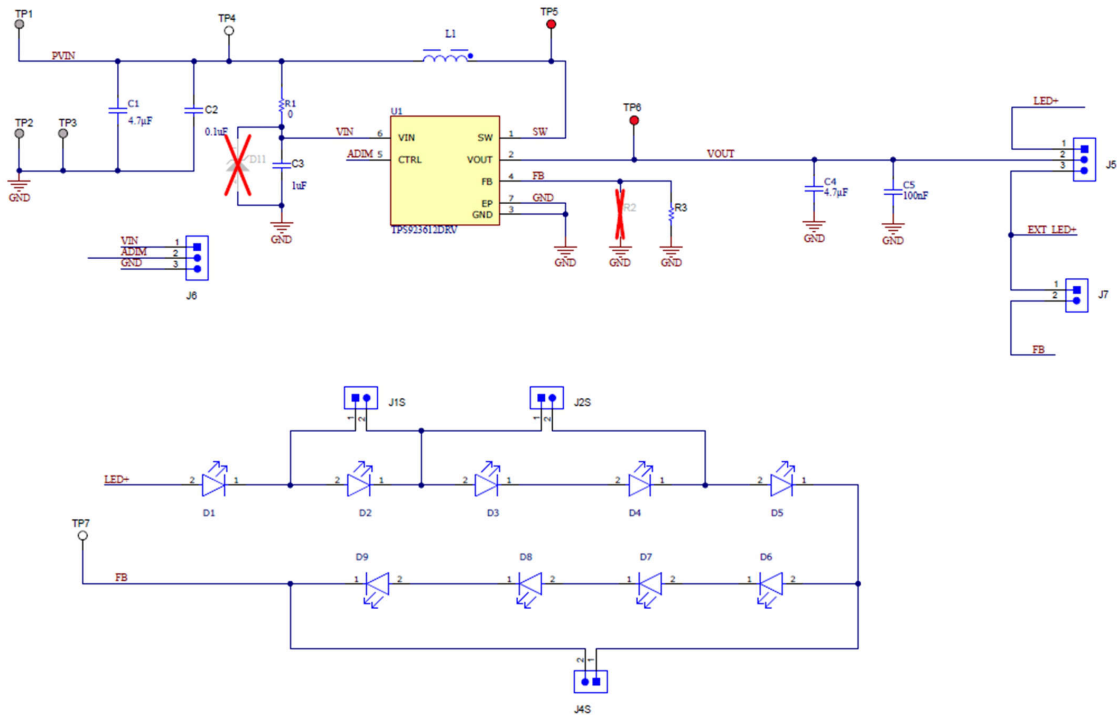


图 4-1. TPS923612EVM 原理图

### 4.2 布局

图 4-2 至图 4-4 所示为 TPS923612EVM 的电路板布局布线。顶层包含 PVIN、VOUT 和接地端的主要电源布线。顶层还有 TPS923612 引脚的接线和一大块接地区域。大多数信号布线也位于顶部。去耦电容器 C4 和 C5 尽可能靠近 IC 放置。顶层和底层都使用 2oz 厚的覆铜。

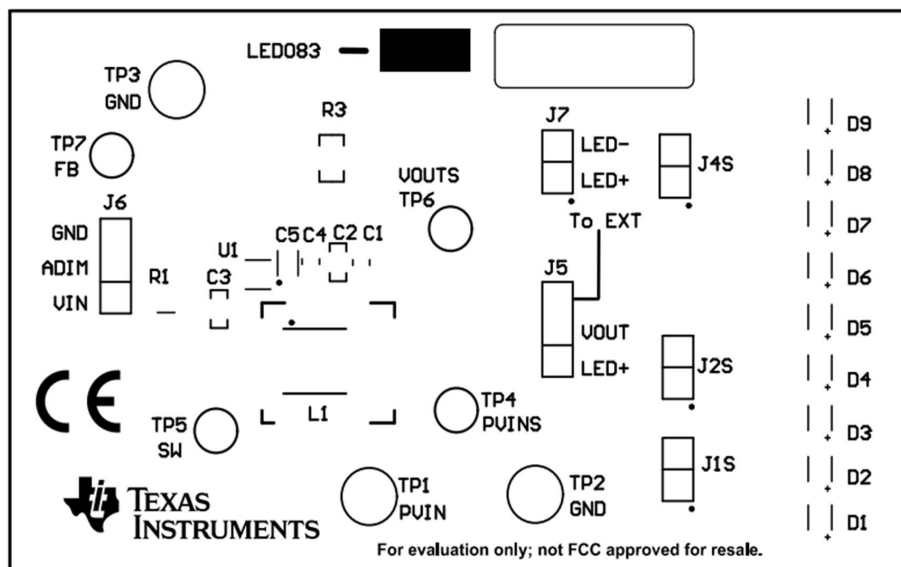


图 4-2. TPS923612EVM 顶层装配图

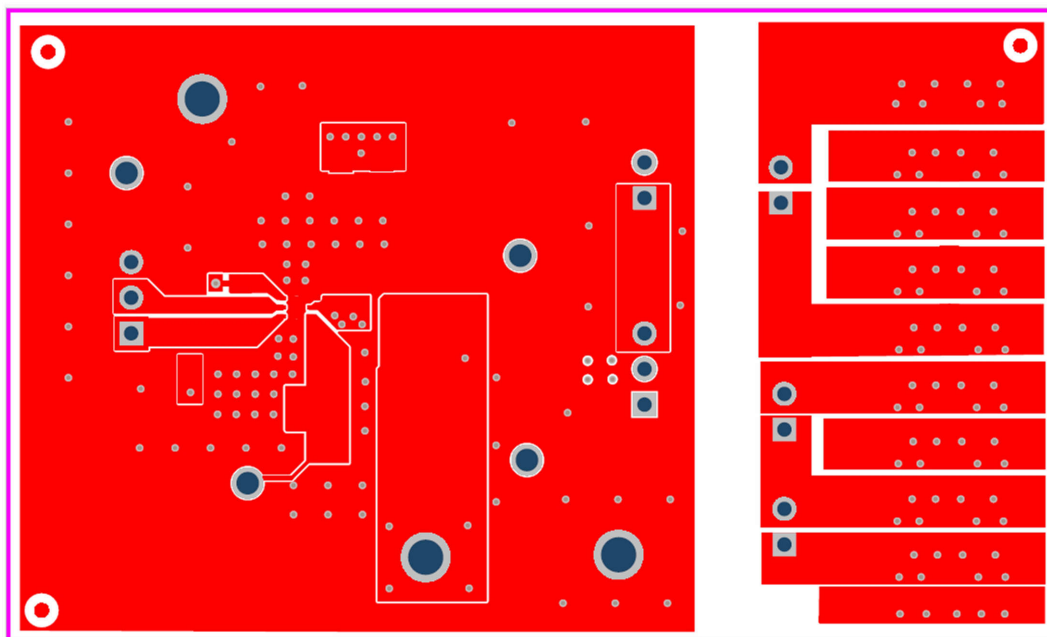


图 4-3. TPS923612EVM 顶层

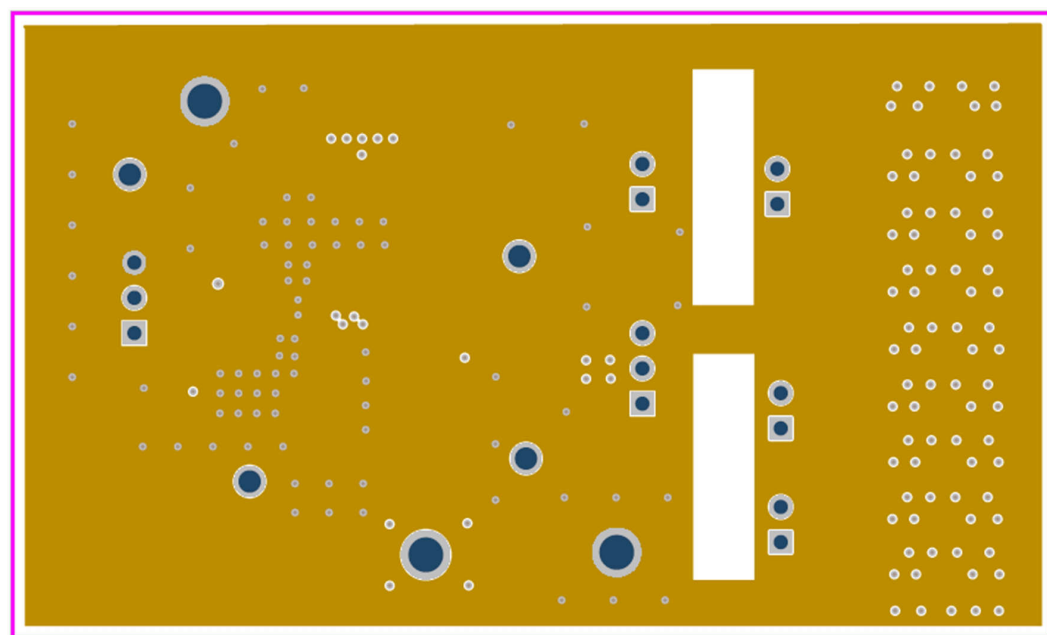


图 4-4. TPS923612EVM 中间层 1

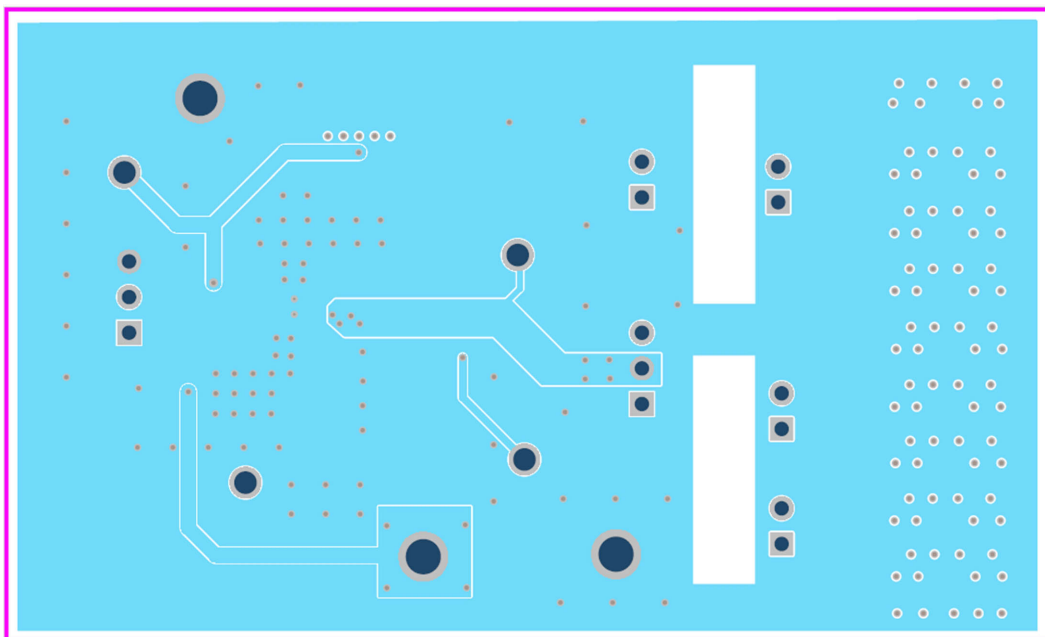


图 4-5. TPS923612EVM 中间层 2

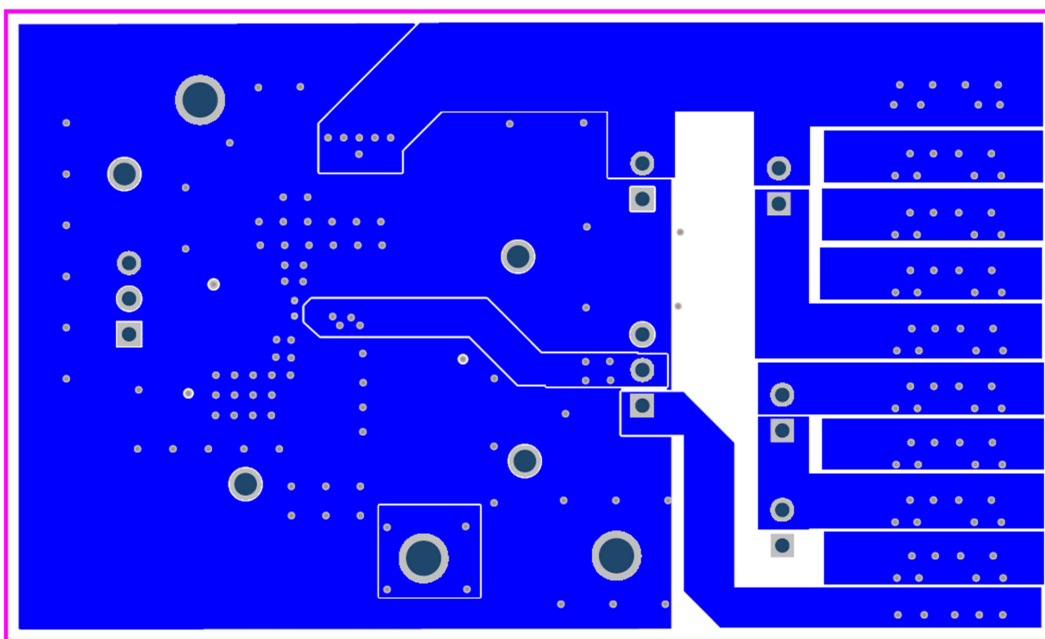


图 4-6. TPS923612EVM 底层

## 4.3 物料清单

表 4-1. 物料清单

标识符	数量	说明	器件型号	制造商
PCB1	1	印刷电路板, 4 层, 尺寸 75mm×45mm。	LED083A	不限
C1	1	电容, 陶瓷, 4.7μF, 10V, +/-10%, X7R, 0805	GRM21BR71A475KE51L	MuRata
C2	1	电容, 陶瓷, 0.1μF, 25V, +/-10%, X5R, 0603	06033D104KAT2A	AVK
C3	1	电容, 陶瓷, 1μF, 10V, +/-10%, X5R, 0603	C1608X5R1A105K080AC	TDK
C4	1	电容, 陶瓷, 4.7μF, 50V, +/- 10%, 0805	GRM21BZ71H475KE15L	MuRata
C5	1	电容, 陶瓷, 0.1μF, 50V, +/- 10%, 0603	CL10B104KB8NNWC	Samsung
D1、D2、 D3、D4、 D5、D6、 D7、D8、 D9	9	LED 照明, 白色	MP-2016-1100-40-80	Luminus Devices
L1	1	10uH, 屏蔽鼓芯, 2.1A, DCR 64mΩ	74404054100	Würth
J1S、 J2S、 J4S, J7	4	接头, 100mil, 2x1, 金, TH	PBC02SAAN	Sullins Connector Solutions
J5, J6	2	接头, 100mil, 3x1, 金, TH	PBC03SAAN	Sullins Connector Solutions
SH-D1、 SH-D2、 SH-D3、 SH-D4	4	分流器, 100mil, 镀金, 黑色	881545-2	TE Connectivity
R1	1	电阻, 0Ω, 跳线电阻器, 0805	RK73Z2ATTD	KOA Speer
R3	1	电阻, 2.2Ω, 1%, 0805	RC0805FR-072R2L	Yageo America
LBL1	1	热转印打印标签, 1.250" (宽) x 0.250" (高) - 10,000/卷	THT-14-423-10	Brady
TP1、 TP2、TP3	3	引脚, 双转塔, TH	1502-2	Keystone
TP5, TP6	2	测试点, 多用途, 红色, TH	5010	Keystone
TP4, TP7	2	测试点, 通用, 白色, TH	5012	Keystone
U1	1	2.5V 至 5.5V 输入电压, 同步升压 LED 驱动器	TPS923612DRLR	德州仪器 (TI)

## 5 其他信息

### 5.1 商标

所有商标均为其各自所有者的财产。

## 6 参考资料

- 德州仪器 (TI), [TPS923610/1/2 30V 同步升压 LED 驱动器](#), 具备超低关机电流及 0.1% 调光比 PWM 控制模拟调光功能 数据表



## 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 semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms 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.

### **WARNING**

**Evaluation Kits 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 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.

### 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/sds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/sds/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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社  
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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/sds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_02.page)

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

#### 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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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
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