

EVM User's Guide: TPS923612EVM

## TPS923612 LED ドライバ評価基板



## 説明

テキサスインスツルメンツの TPS923612EVM 評価基板 (EVM) は、同期整流昇圧 LED (発光ダイオード) ドライバ TPS923612 の動作と性能の評価に役立ちます。

TPS923612EVM は 2.5V ~ 5.5V の入力電圧 (公称 3.6V) で動作し、ジャンパを使用してオンボード LED ストリングまたは外部の LED 負荷にデフォルトの 90mA 定電流を供給します。

## 特長

- 入力電圧範囲:2.5V～5.5V
- 定出力電流:90mA
- 出力電圧範囲:5V～30V
- 調光範囲:0.1%～100%

- スイッチング周波数: 1.1MHz
- PWM モードを強制して低出力リップルを実現

## アプリケーション

- LCD バックライト
  - スマートフォン
  - サーモスタッフ
  - HMI パネル
  - GPS パーソナル ナビゲーション デバイス
  - ダッシュボード カメラ
- 一般照明
  - IP ネットワーク カメラ
  - ビデオドアベル
  - ロボット掃除機



## TPS923612EVM (上面図)

## 1 評価基板の概要

### 1.1 概要

TPS923612 は、400kHz または 1.1MHz のスイッチング周波数で動作する同期整流昇圧 LED ドライバです。比較的小型のインダクタを使用でき、設計サイズの最適化が可能です。シャットダウン モード電流も  $0.13\mu\text{A}$  ときわめて低いことから、バッテリ駆動時間のさらなる延長が可能です。TPS923612 は、LCD バックライトおよび一般照明向けに、単一または並列の LED ストリングを駆動できます。

このユーザー ガイドには、TPS923612 に関する情報と、TPS923612EVM 評価基板のサポート資料が含まれてされています。TPS923612EVM の性能仕様、回路図、部品表が記載されています。

### 1.2 キットの内容

- 1 枚の TPS923612EVM ボード
- EVM の免責事項と手順書 (はじめにお読みください)

### 1.3 仕様

TPS923612EVM の性能仕様の概要を表 1-1 に示します。仕様は入力電圧 3.6V (標準値) と定出力電流 90mA に対するものです。特に記述のない限り、すべての測定で周囲温度は  $25^\circ\text{C}$  です。

異なる入力電圧範囲や、異なる出力電圧と出力電流を使用するアプリケーションの場合は、[TPS923612 データシート](#)をご覧ください。

**表 1-1. 性能仕様の概要**

仕様	テスト条件	最小値	標準値	最大値	単位
入力電圧範囲		2.5	3.6	5.5	V
出力電流設定ポイント	$R_{\text{SET}} = 2.2\Omega$ 、 $V_{\text{IN}} = 3.6\text{V}$ 、100% デューティ PWM 入力		90		mA
出力電流調光範囲		0.1		100	%
動作周波数	$V_{\text{IN}} = 3.6\text{V}$ 、 $I_{\text{OUT}} = 90\text{mA}$ 、6 つの WLED		1100		kHz
効率	$V_{\text{IN}} = 3.6\text{V}$ 、 $I_{\text{OUT}} = 90\text{mA}$		86		%

### 1.4 製品情報

評価基板の定格入力電圧および出力電流範囲を表 1-2 に示します。

**表 1-2. 入力電圧と出力電流の概要**

EVM	入力電圧 ( $V_{\text{IN}}$ ) 範囲	出力電流 ( $I_{\text{OUT}}$ ) 範囲	最大出力電圧
TPS923612EVM	2.5V ~ 5.5V	0A ~ 90mA	30V

## 2 ハードウェア

### 2.1 入力接続と出力接続

TPS923612EVM には、表 2-1 に示すように、入力コネクタと出力コネクタ、およびテスト ポイントが実装されています。図 2-1 に、TPS923612EVM ボードのコネクタとジャンパの配置を示します。

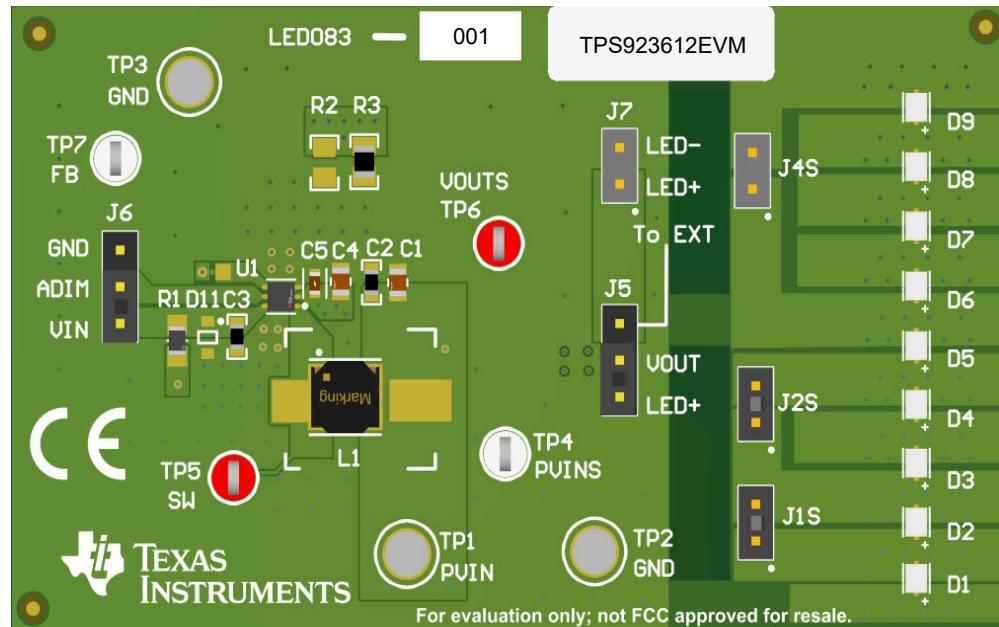


図 2-1. TPS923612EVM のコネクタとジャンパの配置

表 2-1. コネクタとテスト ポイント

参照記号	機能
J1S	D2 の 1 つの WLED を短絡するためのジャンパの選択
J2S	D3 と D4 の 2 つの WLED を短絡するためのジャンパの選択
J4S	D6、D7、D8、D9 の 4 つの WLED を短絡するためのジャンパの選択
J5	<ul style="list-style-type: none"> <li>ピン 1 とピン 2 を短絡して、オンボード LED ストリングを駆動</li> <li>ピン 2 とピン 3 を短絡して外部の LED 負荷を駆動</li> </ul>
J6	<ul style="list-style-type: none"> <li>ピン 1 とピン 2 を短絡してコンバータをイネーブルにし、100% の出力電流を供給します。</li> <li>ピン 2 とピン 3 を短絡してコンバータをシャットダウンします。</li> <li>J6 を開放し、調光制御用に J6 ピン 2 (ADIM) に外部 PWM 信号を印加します。</li> </ul>
J7	外部の LED 負荷に接続する場合、合計 VF は 5V ~ 30V の範囲内である必要があります。
TP1	PVIN 正の電力点
TP2, TP3	GND 電力点
TP4	PVIN 正のセンス ポイント
TP5	SW ノードのテスト ポイント
TP6	VOUT 正のセンス ポイント
TP7	FB ピンの電圧センス ポイント

## 3 実装結果

### 3.1 テスト設定

このセクションでは、TPS923612EVM の適切な接続、セットアップ、および使用方法について説明します。

#### 3.1.1 スタートアップ手順

1. コンバータ TPS923612 は、ADIM ピンが VIN ピンにプルアップされているときにイネーブルになります (EVM で J6 ピン 1 とピン 2 を短絡)
2. J6 ピン 2 は外部イネーブルおよび PWM 調光信号用端子であり、PWM 周波数範囲は 10KHz ~ 200KHz です。
3. 3A 対応の電源は、PVIN (TP1) および GND (TP2) に接続して、電圧降下、インダクタンス、EMI 伝送を最小限に抑えるため、ワイヤをツイストし、できる限り短くする必要があります。
4. テスト ポイント TP4 により、PVIN 入力電圧を監視できます。テスト ポイント TP6 は、出力電圧の監視に使用します。
5. J5 は、オンボードまたは外部の LED 負荷の選択に使用します。
6. J1S, J2S, J4S の開放または短絡により、白色 LED 数が 1 から 9 まで変わることの可能性があるため、適切に動作させるために、LED 負荷時の VOUT 降下が 5V 以上であることを確認してください。

### 3.2 出力電流設定

FB 電圧は 200mV の基準電圧に制御されます。LED 電流は、LED ストリングに直列に配置した電流センス抵抗を用いて外部で設定されます。R<sub>SET</sub> (EVM の R3) の値は以下の式で計算されます。

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

ここで、

- I<sub>LED</sub> = LED ストリングの総出力電流
- V<sub>FB</sub> = FB ピンの制御電圧
- R<sub>SET</sub> = 電流検出抵抗

出力電流の許容誤差は、FB 精度および電流検出抵抗の精度に依存します。

R2 は、R3 と並列接続して R<sub>SET</sub> を目標値が得られるように微調整するオプションの抵抗です。または、R<sub>SET</sub> の総電力損失のバランスを取るために使用されます。

## 4 ハードウェア設計ファイル

### 4.1 回路図

図 4-1 は、TPS923612EVM の回路図です。

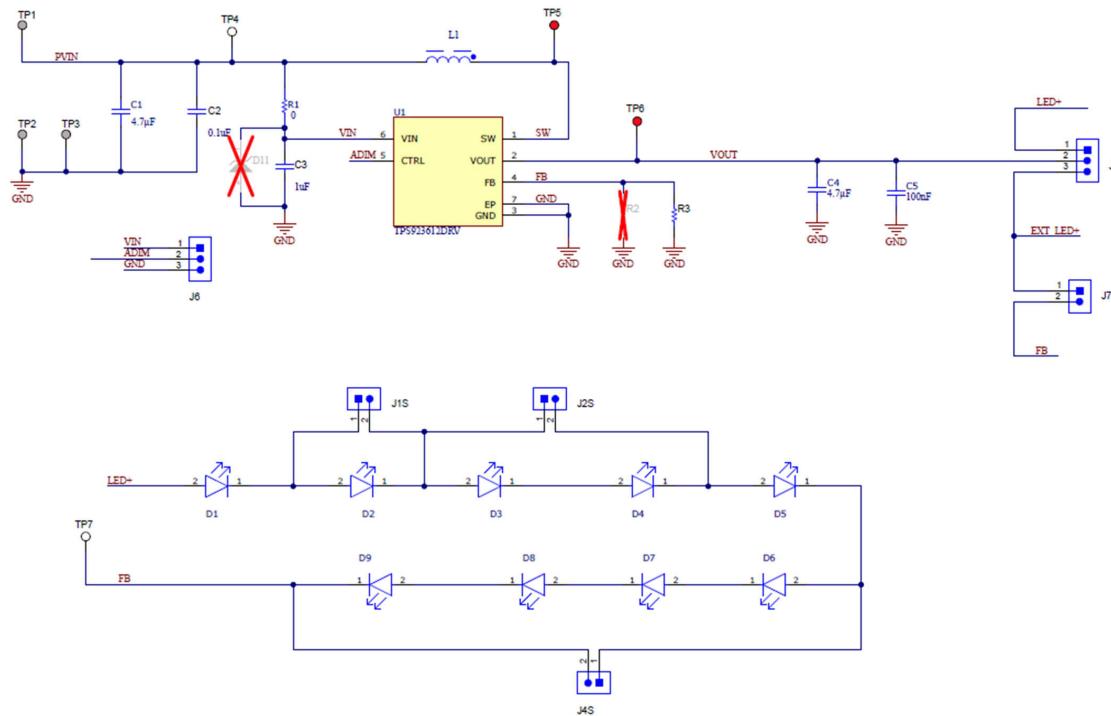


図 4-1. TPS923612EVM 回路図

### 4.2 レイアウト

図 4-2 から図 4-4 に、TPS923612EVM の基板レイアウトを示します。最上層には、PVIN、VOUT、グランドの主な電源パターンが含まれています。TPS923612 のピンへの接続と、グランドで埋められた大きな領域も最上層に配置されています。ほとんどの信号パターンも上面に配置されています。デカッピングコンデンサ C4 および C5 は、IC のできるだけ近くに配置します。最上層と最下層はどちらも 2 オンスの銅箔厚を使用しています。

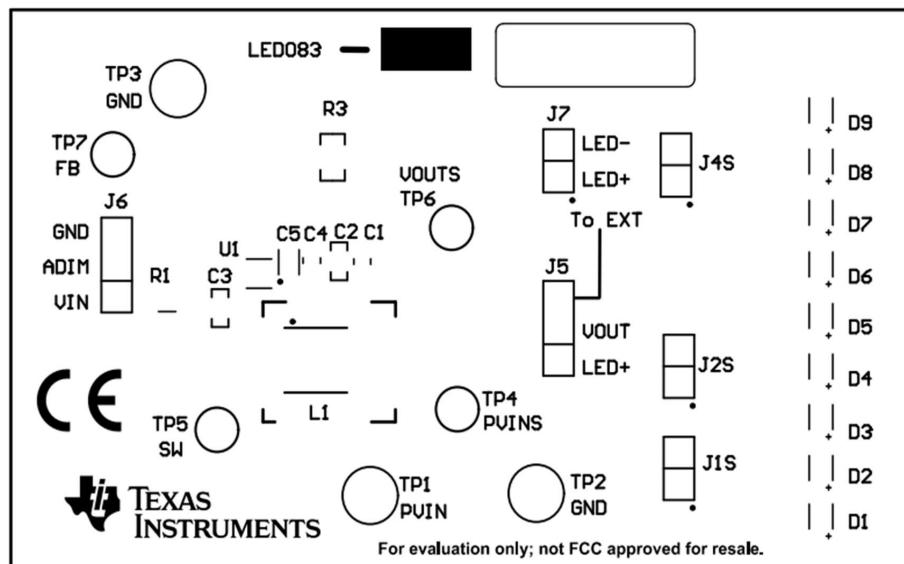


図 4-2. TPS923612EVM 上部アセンブリ

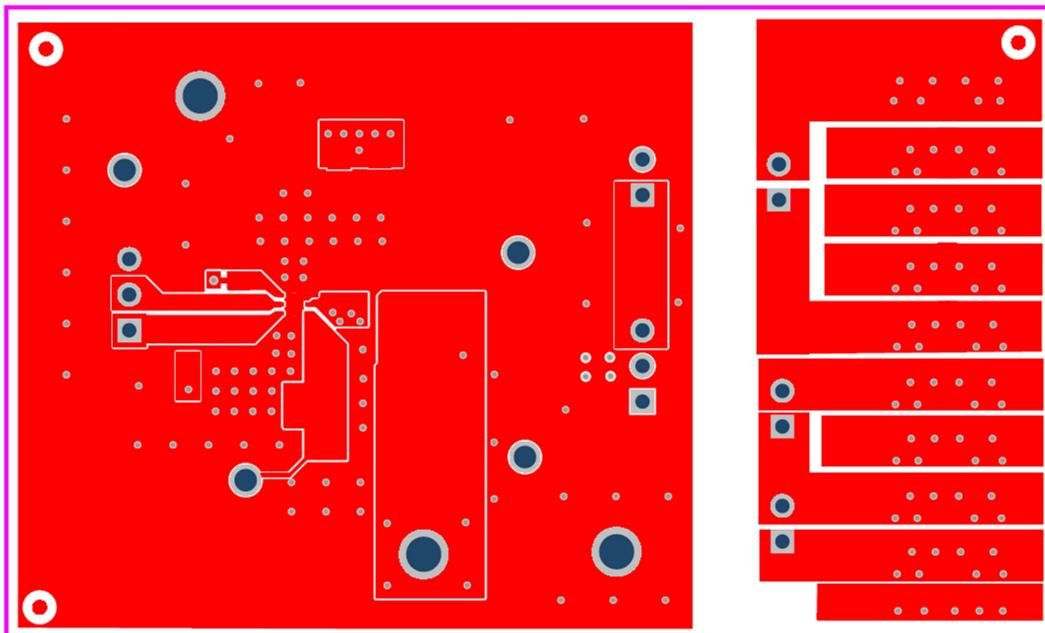


図 4-3. TPS923612EVM 最上層

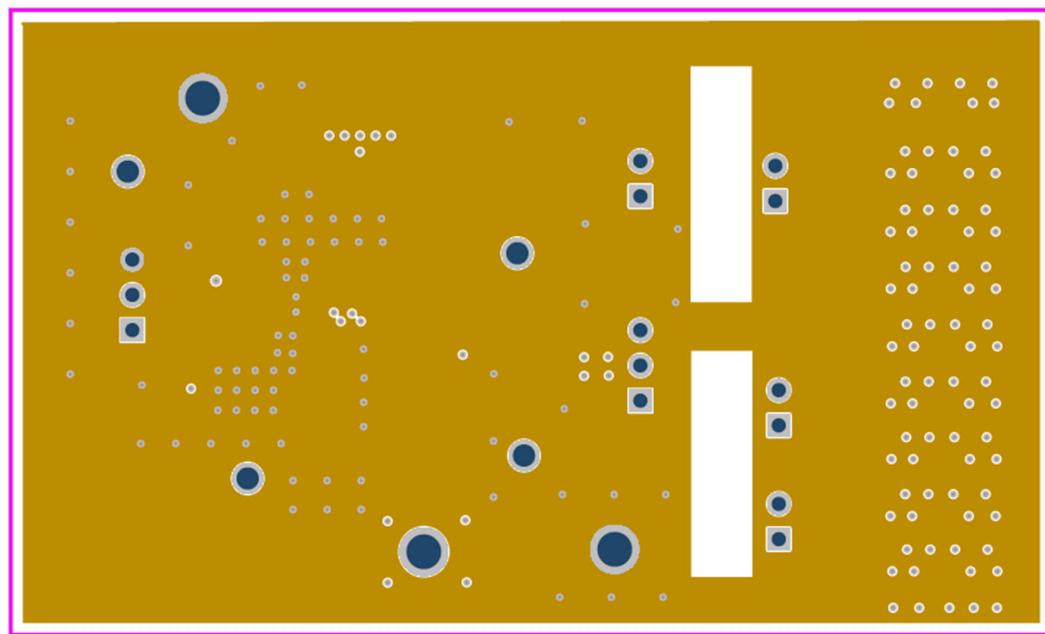


図 4-4. TPS923612EVM 中間層 1

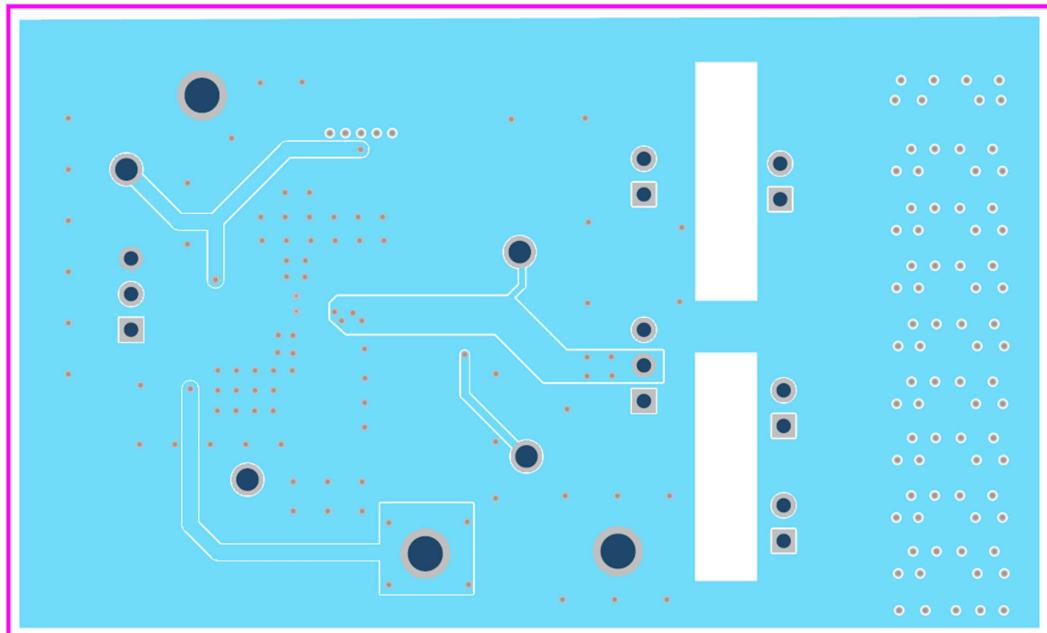


図 4-5. TPS923612EVM 中間層 2

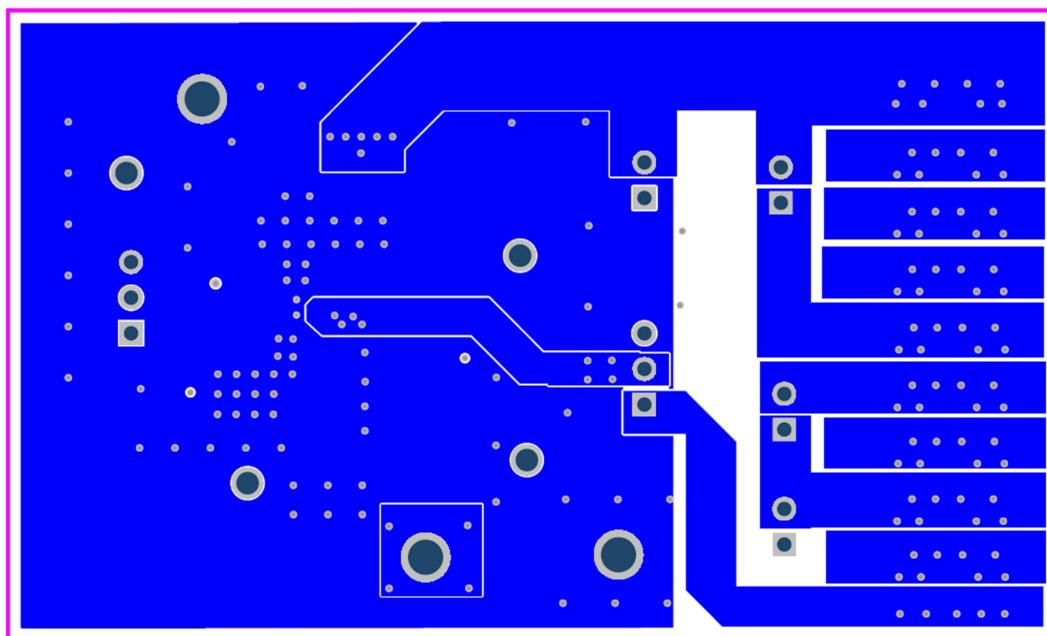


図 4-6. TPS923612EVM 最下層

## 4.3 部品表

表 4-1. 部品表

記号	数量	説明	部品番号	メーカー
PCB1	1	プリント基板、4 層、75mm x 45mm。	LED083A	任意
C1	1	コンデンサ、セラミック、4.7 $\mu$ F、10V、 $\pm 10\%$ 、X7R、0805	GRM21BR71A475KE51L	MuRata
C2	1	コンデンサ、セラミック、0.1 $\mu$ F、25V、 $\pm 10\%$ 、X5R、0603	06033D104KAT2A	AVK
C3	1	コンデンサ、セラミック、1uF、10V、 $\pm 10\%$ 、X5R、0603	C1608X5R1A105K080AC	TDK
C4	1	コンデンサ、セラミック、4.7 $\mu$ F、50V、 $\pm 10\%$ 、0805	GRM21BZ71H475KE15L	MuRata
C5	1	コンデンサ、セラミック、0.1 $\mu$ F、50V、 $\pm 10\%$ 、0603	CL10B104KB8NNWC	Samsung
D1、D2、 D3、D4、 D5、D6、 D7、D8、D9	9	LED ライティング、白	MP-2016-1100-40-80	Luminous Devices
L1	1	10uH、シールド付きドラム コア、2.1A、DCR 64m $\Omega$	74404054100	Wurth
J1S、J2S、 J4S、J7	4	ヘッダ、100mil、2x1、金、TH	PBC02SAAN	Sullins Connector Solutions
J5、J6	2	ヘッダ、100mil、3x1、金、TH	PBC03SAAN	Sullins Connector Solutions
SH-D1、 SH-D2、 SH-D3、 SH-D4	4	シャント、100mil、金メッキ、黒	881545-2	TE の接続
R1	1	RES、0 $\Omega$ 、ジャンパ抵抗、0805	RK73Z2ATT	KOA スピア
R3	1	抵抗、2.2 $\Omega$ 、1%、0.1W、0805	RC0805FR-072R2L	Yageo America
LBL1	1	熱転写プリントブル ラベル、幅 1.250 インチ x 高さ 0.250 インチ、ロールあたり 10,000	THT-14-423-10	Brady
TP1、TP2、 TP3	3	端子、タレット、TH、ダブル	1502-2	Keystone
TP5、TP6	2	テスト ポイント、多目的、赤色、TH	5010	Keystone
TP4、TP7	2	テスト ポイント、多目的、白色、TH	5012	Keystone
U1	1	2.5V ~ 5.5V 入力、同期整流昇圧 LED ドライバ	TPS923612DRLR	テキサス・インスツルメンツ

## 5 追加情報

### 5.1 商標

すべての商標は、それぞれの所有者に帰属します。

### 6 参考資料

1. テキサス インスツルメンツ、『[TPS923610/1/2 30V、同期整流昇圧 LED ドライバ、超低シャットダウン電流および 0.1% 比 PWM 制御アナログ調光機能搭載](#)』、データシート

## 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.

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

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

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