EVM User's Guide: TPS923612EVM

TPS923612 LED Driver Evaluation Module

Description

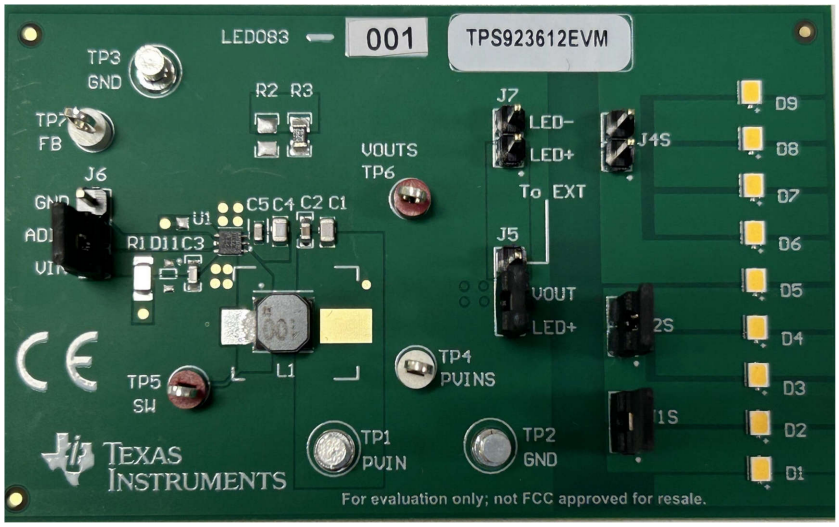
The Texas Instruments TPS923612EVM evaluation module (EVM) helps designers evaluate the operation and performance of the synchronous boost LED (light emitting diode) driver TPS923612. The TPS923612EVM operates from 2.5V to 5.5V input, 3.6V nominal, and provides default 90mA constant current to driver onboard LED string or the external LED load through the jumper.

Features

- Input voltage range: 2.5V to 5.5V
- Constant output current: 90mA
- Output voltage range: 5V to 30V
- Dimming range: 0.1% to 100%
- Switching frequency: 1.1MHz
- Force PWM mode for low output ripple

Applications

- LCD back lighting
  - Smartphone
  - Thermostat
  - HMI panel
  - GPS personal navigation device
  - Dashboard camera
- General illumination
  - IP network camera
  - Video doorbell
  - Vacuum robot



TPS923612EVM (Top View)

1 Evaluation Module Overview

1.1 Introduction

The TPS923612 is a synchronous boost LED driver operates at 400kHz or 1.1MHz switching frequency to support use of relatively small inductors for an optimized design size. The ultra-low 0.13µA current in shutdown mode can further prolong battery life. The TPS923612 can drive single or parallel LED strings for LCD backlighting and general illumination.

This user's guide contains information for the TPS923612 and support documentation for the TPS923612EVM evaluation module. This user's guide includes the performance specifications, schematic and the bill of materials of the TPS923612EVM.

1.2 Kit Contents

- One TPS923612EVM Board
- EVM disclaimer Read Me

1.3 Specification

A summary of the TPS923612EVM performance specifications is provided in Table 1-1. Specifications are given for typical input voltage 3.6V and constant output current 90mA. The ambient temperature is 25°C for all measurement, unless otherwise noted.

For applications with a different input voltage range or different output voltage and current, see the TPS923612 data sheet.

Table 1-1. Performance Specifications Summary

Specifications	Test Conditions	MIN	TYP	MAX	Unit
Input voltage range		2.5	3.6	5.5	V
Output current set point	R_{SET} = 2.2Ω, V_{IN} = 3.6V, 100% duty PWM input		90		mA
Output current dimming range		0.1		100	%
Operating frequency	V_{IN} = 3.6V, I_{OUT} = 90mA, 6 WLEDs in series		1100		kHz
Efficiency	V_{IN} = 3.6V, I_{OUT} = 90mA		86		%

1.4 Device Information

Rated input voltage and output current ranges for the evaluation module are given in Table 1-2.

Table 1-2. Input Voltage and Output Current Summary

EVM	Input Voltage (V_{IN}) Range	Output Current (I_{OUT}) Range	Maximum Output Voltage
TPS923612EVM	2.5V to 5.5V	0A to 90mA	30V

2 Hardware

2.1 Input and Output Connections

The TPS923612EVM is provided with input and output connectors and test points as shown in Table 2-1. Figure 2-1 shows connectors and jumpers placement on the TPS923612EVM board.

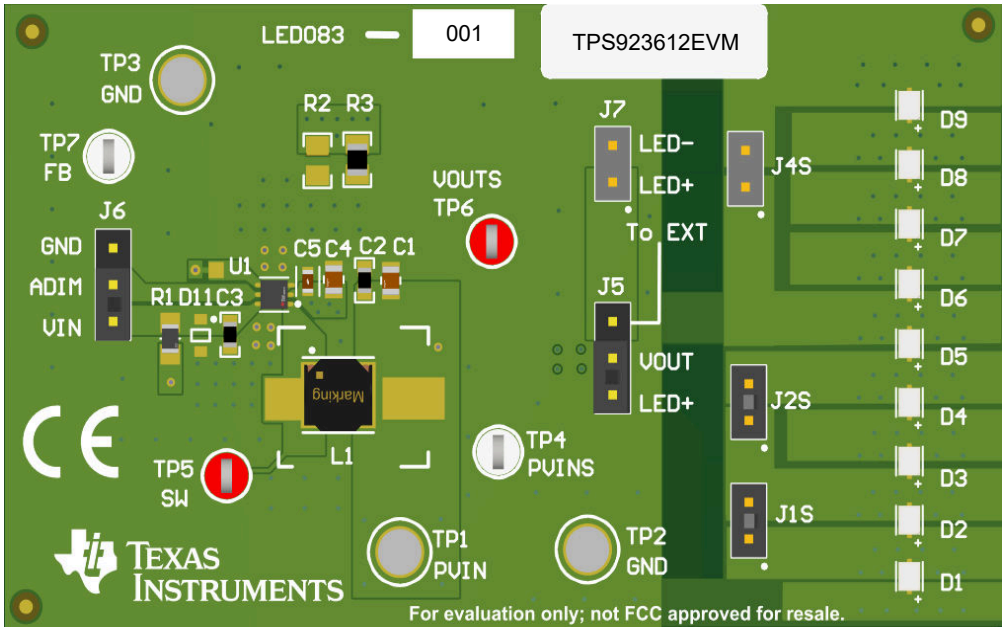


Figure 2-1. TPS923612EVM Connectors and Jumpers Placement

Table 2-1. Connector and Test Points

Reference Designator	Function
J1S	Jumper choice to short 1 WLED of D2
J2S	Jumper choice to short 2 WLEDs of D3 and D4
J4S	Jumper choice to short 4 WLEDs of D6, D7, D8 and D9
J5	• Short pin1 and pin2 to drive onboard LED string • Short pin2 and pin3 to drive external LED load
J6	• Short pin and pin2 to enable the converter and 100% output current. • Short pin2 and pin3 to shutdown the converter. • Open J6, apply external PWM signal on J6 pin2 (ADIM) for dimming control.
J7	Connect to external LED load, the total VF must be within 5V to 30V range.
TP1	PVIN positive power point
TP2, TP3	GND power point
TP4	PVIN positive sense point
TP5	SW node test point
TP6	VOUT positive sense point
TP7	FB pin voltage sense point

3 Implementation Results

3.1 Test Setup

This section describes how to properly connect, set up, and use the TPS923612EVM.

3.1.1 Start-Up Procedure

1. The converter TPS923612 is enabled when the ADIM pin is pull up to VIN pin (short J6 pin1 and pin2 on EVM)
2. J6 pin2 is the terminal for external enable and PWM dimming signal, PWM frequency range is 10KHz to 200KHz.
3. A power supply capable of supplying 3A must be connected to PVIN (TP1) and GND (TP2), wires must be twisted and kept as short as possible to minimize voltage drop, inductance, and EMI transmission.
4. Test point TP4 provides a place to monitor the PVIN input voltages. Test point TP6 is used to monitor the output voltage.
5. J5 is used to select onboard or external LED load.
6. Open or short J1S, J2S and J4S can change the White LED numbers from 1 to 9, make sure the VOUT drop on LED load is 5V or higher for proper operating.

3.2 Output Current Setting

The FB voltage is regulated to a 200mV reference voltage. The LED current is set externally using a current-sense resistor in series with the LED strings. The value of the R_{SET} (R3 on EVM) is calculated using:

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

where

- I_{LED} = total output current of LED strings
- V_{FB} = regulated voltage of FB pin
- R_{SET} = current sense resistor

The output current tolerance depends on the FB accuracy and the current sensor resistor accuracy.

R2 is optional resistor paralleled with R3 to fine tune the R_{SET} to target value, or used to balance the total power loss on R_{SET}.

4 Hardware Design Files

4.1 Schematic

Figure 4-1 is the schematic for the TPS923612EVM.

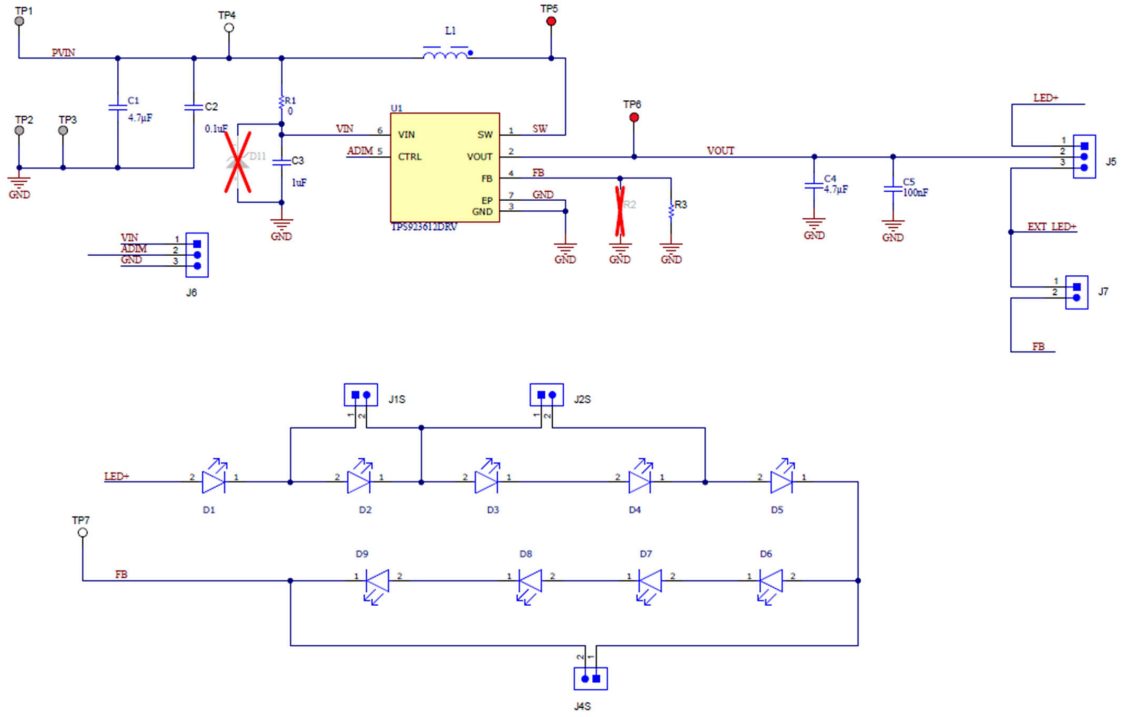


Figure 4-1. TPS923612EVM Schematic Diagram

4.2 Layout

Figure 4-2 to Figure 4-4 show the board layout for the TPS923612EVM. The top layer contains the main power traces for PVIN, VOUT, and ground. Connections for the pins of the TPS923612 and a large area filled with ground are also on the top layer. Most of the signal traces are also located on the top side. The decoupling capacitors C4, and C5 are located as close to the IC as possible. Both the top layer and bottom layer use 2oz copper thickness.

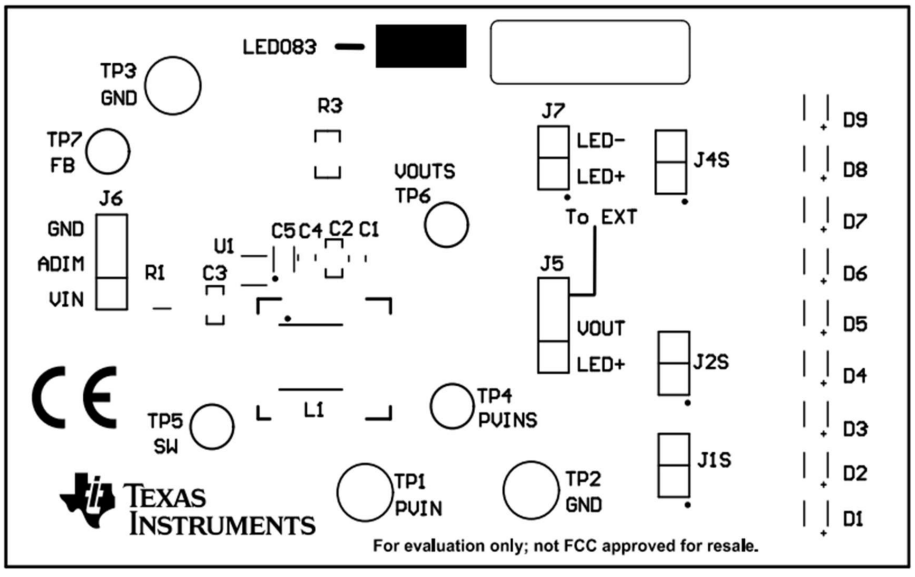


Figure 4-2. TPS923612EVM Top Assembly

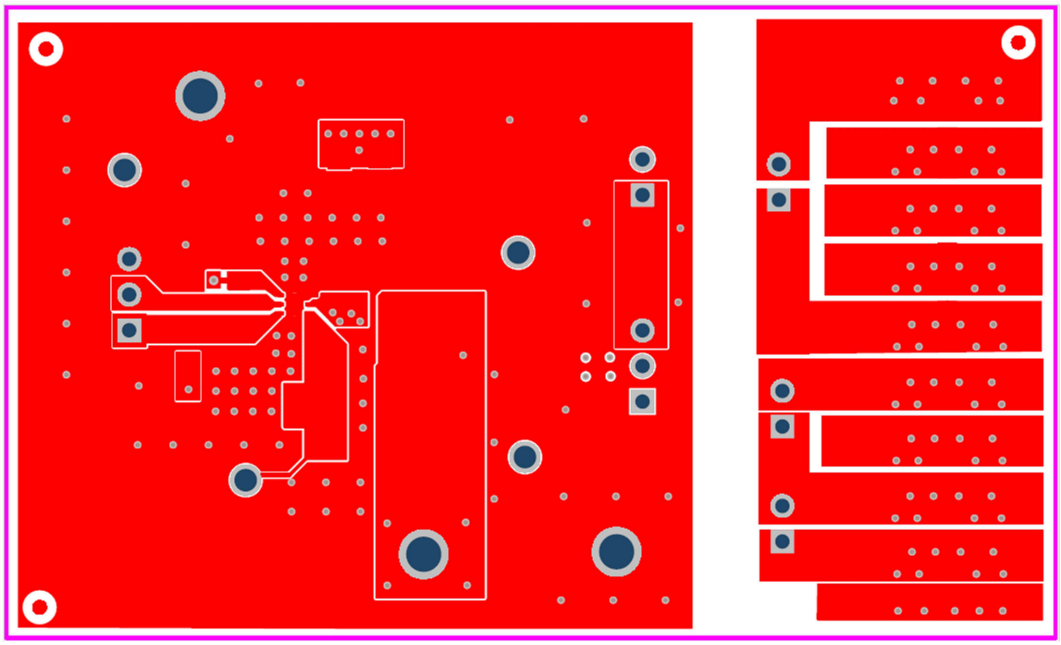


Figure 4-3. TPS923612EVM Top Layer

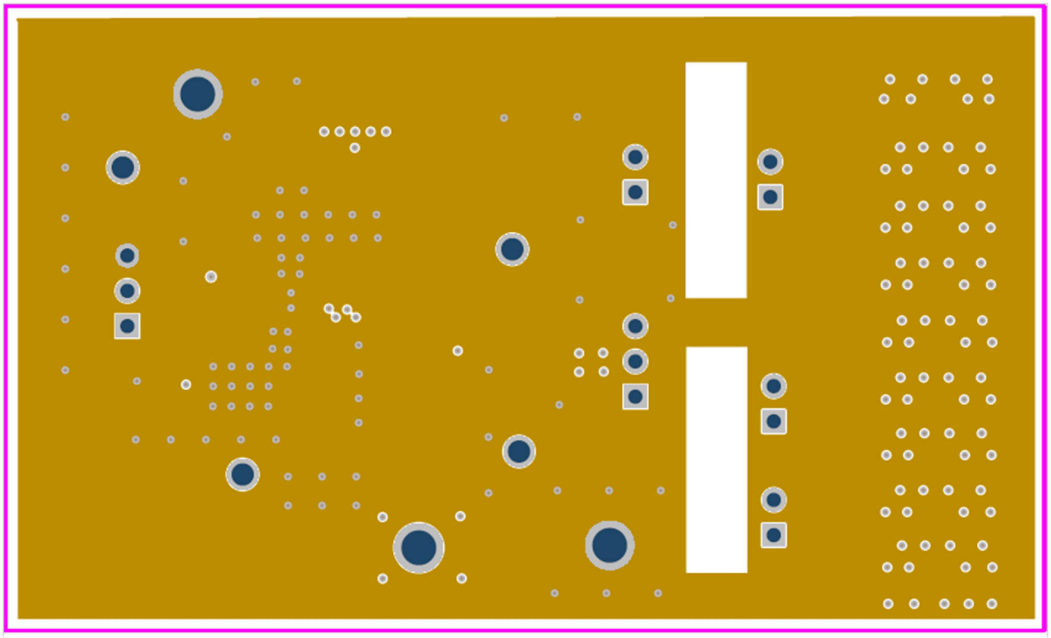


Figure 4-4. TPS923612EVM Middle Layer 1

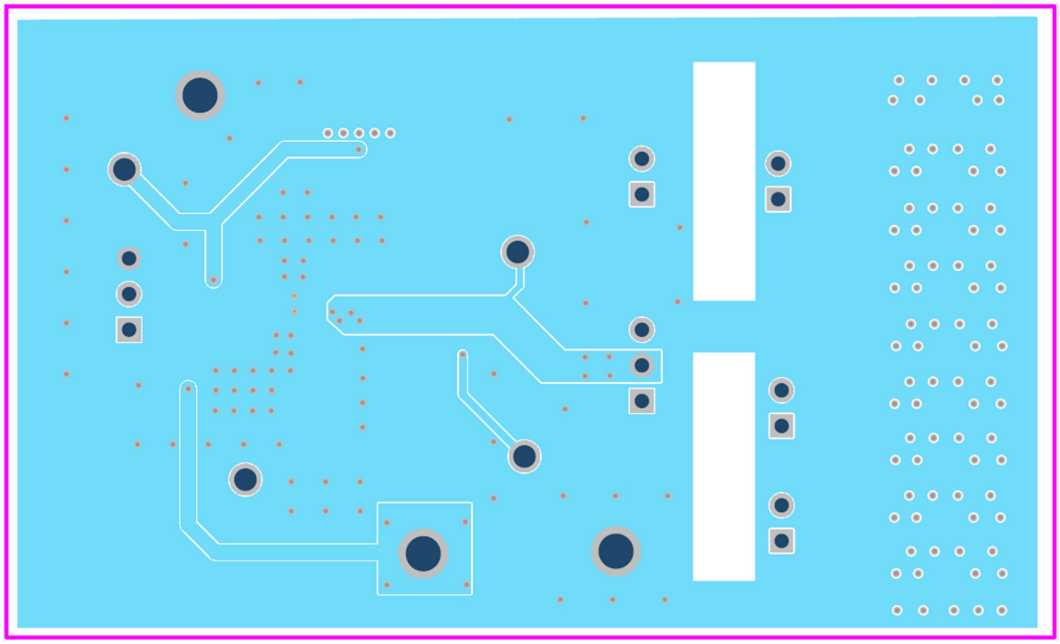


Figure 4-5. TPS923612EVM Middle Layer 2

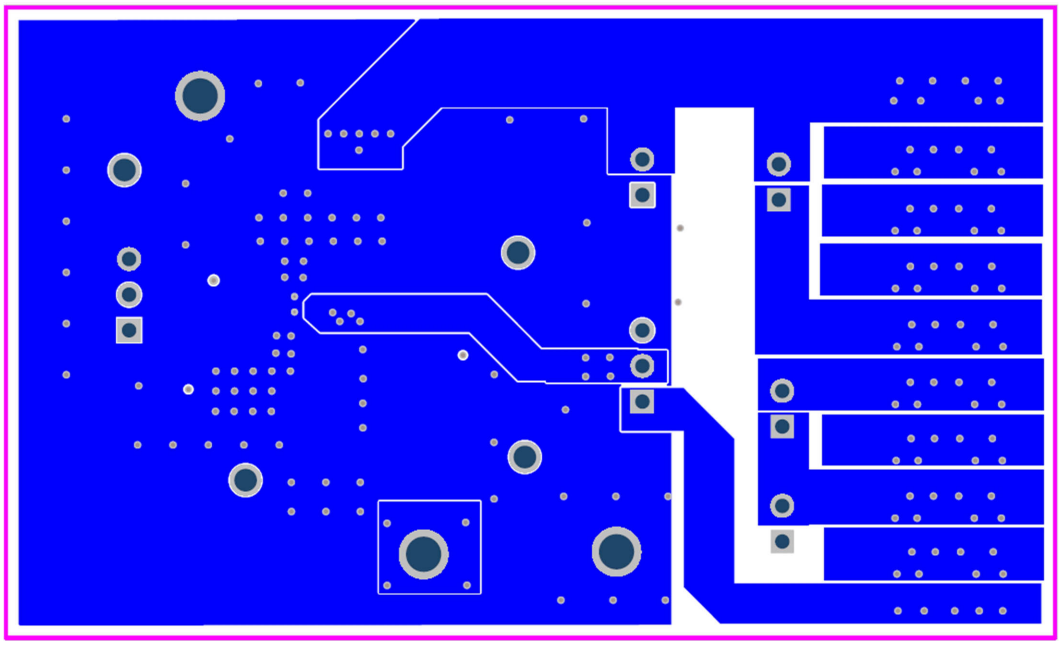


Figure 4-6. TPS923612EVM Bottom Layer

4.3 Bill of Materials

Table 4-1. Bill of Materials

Des	Qty	Description	Part Number	Manufacturer
PCB1	1	Printed Circuit Board, 4 layers, 75mm x 45mm.	LED083A	Any
C1	1	CAP, CERM, 4.7µF, 10V, +/- 10%, X7R, 0805	GRM21BR71A475KE51L	MuRata
C2	1	CAP, CERM, 0.1µF, 25V, +/- 10%, X5R, 0603	06033D104KAT2A	AVK
C3	1	CAP, CERM, 1uF, 10V, +/- 10%, X5R, 0603	C1608X5R1A105K080AC	TDK
C4	1	CAP, CERM, 4.7µF, 50V, +/- 10%, 0805	GRM21BZ71H475KE15L	MuRata
C5	1	CAP, CERM, 0.1µF, 50V, +/- 10%, 0603	CL10B104KB8NNWC	Samsung
D1, D2, D3, D4, D5, D6, D7, D8, D9	9	LED Lighting, White	MP-2016-1100-40-80	Luminus Devices
L1	1	10uH, Shielded Drum Core, 2.1A, DCR 64mΩ	74404054100	Wurth
J1S, J2S, J4S, J7	4	Header, 100mil, 2x1, Gold, TH	PBC02SAAN	Sullins Connector Solutions
J5, J6	2	Header, 100mil, 3x1, Gold, TH	PBC03SAAN	Sullins Connector Solutions
SH-D1, SH-D2, SH-D3, SH-D4	4	Shunt, 100mil, Gold plated, Black	881545-2	TE Connectivity
R1	1	RES, 0Ω, jumper resistor, 0805	RK73Z2ATTD	KOA Speer
R3	1	RES, 2.2Ω, 1%, 0805	RC0805FR-072R2L	Yageo America
LBL1	1	Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll	THT-14-423-10	Brady
TP1, TP2, TP3	3	Terminal, Turret, TH, Double	1502-2	Keystone
TP5, TP6	2	Test Point, Multipurpose, Red, TH	5010	Keystone
TP4, TP7	2	Test Point, Multipurpose, White, TH	5012	Keystone
U1	1	2.5V to 5.5V Input, Synchronous Boost LED Driver	TPS923612DRLR	Texas Instruments

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

6 References

1. Texas Instruments, *TPS923610/1/2 30V Synchronous Boost LED Driver with Ultra-low Shutdown Current and 0.1%-ratio PWM Controlled Analog Dimming*, data sheet

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NOTE:

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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.

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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 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

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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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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.

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