

# TPS92612 保護機能搭載、40V、150mA シングル・チャンネル、リニア LED ドライバおよび定電流源

## 1 特長

- シングル・チャンネルの高精度電流源
  - $-40^{\circ}\text{C} \sim +125^{\circ}\text{C}$  で  $\pm 4.6\%$  の電流精度
  - 外付けセンス抵抗により電流を調整可能
  - 最大電流: 150 mA
- 広い入力電圧範囲: 4.5V~40V
- 入力 PWM デューティ・サイクルによる輝度制御
- 低いドロップアウト電圧 (電流センスでの電圧降下を含む)
  - 最大ドロップアウト: 150mV (10mA 時)
  - 最大ドロップアウト: 400mV (70mA 時)
  - 最大ドロップアウト: 700mV (150mA 時)
- 低い静止電流: 200 $\mu\text{A}$  (標準値)
- 保護機能
  - LED 短絡保護と自動回復
  - サーマル・シャットダウン
- 外付け抵抗との熱共有をサポート
- 動作時の接合部温度範囲:  $-40^{\circ}\text{C} \sim +150^{\circ}\text{C}$

## 2 アプリケーション

- LED ドライバ、定電流源、または電流リミッタとして
  - 洗濯機 / 乾燥機
  - 冷蔵庫と冷凍庫
  - ガス検知器
  - ファクトリ・オートメーション/制御
  - ビルディング・オートメーション
  - 医療用

## 3 概要

LED が光源として広く使われているなか、シンプルな LED ドライバの人気が高まっています。ディスクリート・ソリューションに比べて、低コストのモノリシック・ソリューションではシステム・レベルの部品数を減らし、電流の精度や信頼性を大幅に高めることができます。

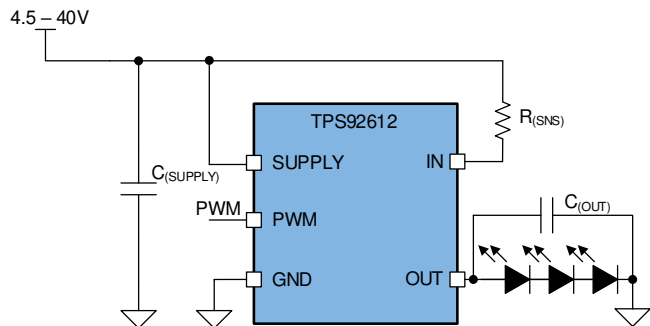
TPS92612 は広い電源電圧範囲で動作する、シングル・チャンネルのハイサイド・リニア LED ドライバです。シンプルかつ洗練されたソリューションで、1 つの LED スtring に定電流を供給できます。長いケーブルを使用したオフボードの LED 接続に対応しています。TPS92612 はその他のアプリケーションで、一般的な定電流源や電流リミッタとして使用することもできます。

### 製品情報<sup>(1)</sup>

| 型番       | パッケージ      | 本体サイズ(公称)   |
|----------|------------|-------------|
| TPS92612 | SOT-23 (5) | 2.9mm×1.6mm |

(1) 提供されているすべてのパッケージについては、巻末の注文情報を参照してください。

### 代表的なアプリケーションの図



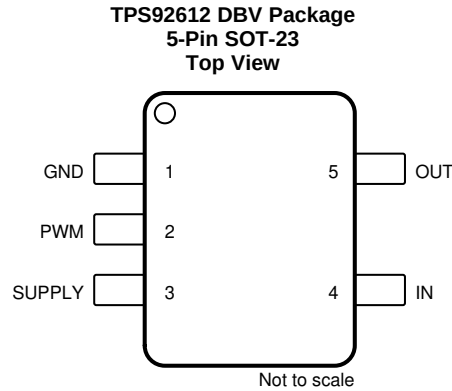
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## 4 改訂履歴

| 日付         | リビジョン | 注  |
|------------|-------|----|
| 2020 年 4 月 | *     | 初版 |

## 5 Pin Configuration and Functions



### Pin Functions

| PIN    |                 | I/O | DESCRIPTION             |
|--------|-----------------|-----|-------------------------|
| NAME   | NO.<br>TPS92612 |     |                         |
| GND    | 1               | —   | Ground                  |
| IN     | 4               | I   | Current input           |
| OUT    | 5               | O   | Constant-current output |
| PWM    | 2               | I   | PWM input               |
| SUPPLY | 3               | I   | Device supply voltage   |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating ambient temperature range (unless otherwise noted)<sup>(1)</sup>

|                                       |                           | MIN  | MAX | UNIT |
|---------------------------------------|---------------------------|------|-----|------|
| High-voltage input                    | IN, PWM, SUPPLY           | –0.3 | 45  | V    |
| High-voltage output                   | OUT                       | –0.3 | 45  | V    |
| IN to OUT                             | $V_{(IN)} - V_{(OUT)}$    | –0.3 | 45  | V    |
| SUPPLY to IN                          | $V_{(SUPPLY)} - V_{(IN)}$ | –0.3 | 1   | V    |
| Operating junction temperature, $T_J$ |                           | –40  | 150 | °C   |
| Storage temperature, $T_{stg}$        |                           | –40  | 150 | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### 6.2 ESD Ratings

|             |                         |                                                                                | VALUE | UNIT |
|-------------|-------------------------|--------------------------------------------------------------------------------|-------|------|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | ±2000 | V    |
|             |                         | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | ±500  |      |
|             |                         | Corner pins (3, 4, and 5)                                                      | ±750  |      |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

## 6.3 Recommended Operating Conditions

over operating ambient temperature range (unless otherwise noted)

|                                               |                       | MIN | NOM | MAX | UNIT |
|-----------------------------------------------|-----------------------|-----|-----|-----|------|
| SUPPLY                                        | Device supply voltage | 4.5 |     | 40  | V    |
| IN                                            | Sense voltage         | 4.4 |     | 40  | V    |
| PWM                                           | PWM inputs            | 0   |     | 40  | V    |
| OUT                                           | Driver output         | 0   |     | 40  | V    |
| Operating ambient temperature, T <sub>A</sub> |                       | –40 |     | 125 | °C   |

## 6.4 Thermal Information

| THERMAL METRIC        |                                              | TPS92612    | UNIT |
|-----------------------|----------------------------------------------|-------------|------|
|                       |                                              | DBV (SOT23) |      |
|                       |                                              | 5 PINS      |      |
| R <sub>θJA</sub>      | Junction-to-ambient thermal resistance       | 200.7       | °C/W |
| R <sub>θJC(top)</sub> | Junction-to-case (top) thermal resistance    | 104.4       | °C/W |
| R <sub>θJB</sub>      | Junction-to-board thermal resistance         | 45.6        | °C/W |
| ψ <sub>JT</sub>       | Junction-to-top characterization parameter   | 17.5        | °C/W |
| ψ <sub>JB</sub>       | Junction-to-board characterization parameter | 45.2        | °C/W |

## 6.5 Electrical Characteristics

V<sub>(SUPPLY)</sub> = 5 V to 40 V, T<sub>J</sub> = –40°C to +150°C unless otherwise noted

| PARAMETER                    |                                                                     | TEST CONDITIONS                                                         | MIN   | TYP   | MAX   | UNIT |
|------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------------|-------|-------|-------|------|
| BIAS                         |                                                                     |                                                                         |       |       |       |      |
| V <sub>(POR_rising)</sub>    | Supply voltage POR rising threshold                                 |                                                                         | 3.2   | 4     |       | V    |
| V <sub>(POR_falling)</sub>   | Supply voltage POR falling threshold                                |                                                                         | 2.2   | 3     |       | V    |
| I <sub>(Quiescent)</sub>     | Device standby current                                              | PWM = HIGH                                                              | 0.1   | 0.2   | 0.25  | mA   |
| LOGIC INPUTS (PWM)           |                                                                     |                                                                         |       |       |       |      |
| V <sub>IL(PWM)</sub>         | Input logic-low voltage, PWM                                        |                                                                         | 1.045 | 1.1   | 1.155 | V    |
| V <sub>IH(PWM)</sub>         | Input logic-high voltage, PWM                                       |                                                                         | 1.16  | 1.2   | 1.24  | V    |
| CONSTANT-CURRENT DRIVER      |                                                                     |                                                                         |       |       |       |      |
| I <sub>(OUT)</sub>           | Device output-current range                                         | 100% duty cycle                                                         | 4     |       | 150   | mA   |
| V <sub>(CS_REG)</sub>        | Sense-resistor regulation voltage                                   | T <sub>A</sub> = 25°C, V <sub>(SUPPLY)</sub> = 4.5 V to 18 V            | 94    | 98    | 102   | mV   |
|                              |                                                                     | T <sub>A</sub> = −40°C to +125°C, V <sub>(SUPPLY)</sub> = 4.5 V to 18 V | 93.5  | 98    | 102.5 |      |
| R <sub>(CS_REG)</sub>        | Sense-resistor value                                                |                                                                         | 0.66  |       | 24.5  | Ω    |
| V <sub>(DROPOUT)</sub>       | Voltage dropout from SUPPLY to OUT                                  | V <sub>(CS_REG)</sub> voltage included, current setting of 10 mA        |       | 120   | 150   | mV   |
|                              |                                                                     | V <sub>(CS_REG)</sub> voltage included, current setting of 70 mA        |       | 250   | 400   |      |
|                              |                                                                     | V <sub>(CS_REG)</sub> voltage included, current setting of 150 mA       |       | 430   | 700   |      |
| DIAGNOSTICS                  |                                                                     |                                                                         |       |       |       |      |
| V <sub>(SG_th_rising)</sub>  | Channel output V <sub>(OUT)</sub> short-to-ground rising threshold  |                                                                         | 1.14  | 1.2   | 1.26  | V    |
| V <sub>(SG_th_falling)</sub> | Channel output V <sub>(OUT)</sub> short-to-ground falling threshold |                                                                         | 0.82  | 0.865 | 0.91  | V    |
| I <sub>(Retry)</sub>         | Channel output V <sub>(OUT)</sub> short-to-ground retry current     |                                                                         | 0.64  | 1.08  | 1.528 | mA   |
| THERMAL PROTECTION           |                                                                     |                                                                         |       |       |       |      |
| T <sub>(TSD)</sub>           | Thermal shutdown junction temperature threshold                     |                                                                         | 157   | 172   | 187   | °C   |
| T <sub>(TSD_HYS)</sub>       | Thermal shutdown junction temperature hysteresis                    |                                                                         |       | 15    |       | °C   |

## 6.6 Timing Requirements

|                                 |                                                                                                                                   | MIN | NOM | MAX | UNIT |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| t <sub>(PWM_delay_rising)</sub> | PWM rising edge delay, 50% PWM voltage to 10% of output current closed loop, t <sub>2</sub> - t <sub>1</sub> as shown in Figure 1 | 10  | 17  | 25  | μs   |

## Timing Requirements (continued)

|                             |                                                                                                              | MIN | NOM | MAX | UNIT    |
|-----------------------------|--------------------------------------------------------------------------------------------------------------|-----|-----|-----|---------|
| $t_{(PWM\_delay\_falling)}$ | PWM falling edge delay, 50% PWM voltage to 90% of output current open loop, $t_5 - t_4$ as shown in Figure 1 | 15  | 21  | 30  | $\mu s$ |
| $t_{(DEVICE\_STARTUP)}$     | SUPPLY rising edge to 10% output current at 50-mA set current, $t_8 - t_7$ as shown in Figure 1              |     | 100 | 150 | $\mu s$ |
| $t_{(SG\_deg)}$             | Output short-to-ground detection deglitch time                                                               | 80  | 125 | 175 | $\mu s$ |
| $t_{(TSD\_deg)}$            | Thermal over temperature deglitch timer                                                                      |     | 50  |     | $\mu s$ |
| $t_{(Recover\_deg)}$        | Fault recovery deglitch timer                                                                                | 8.5 | 16  | 25  | $\mu s$ |

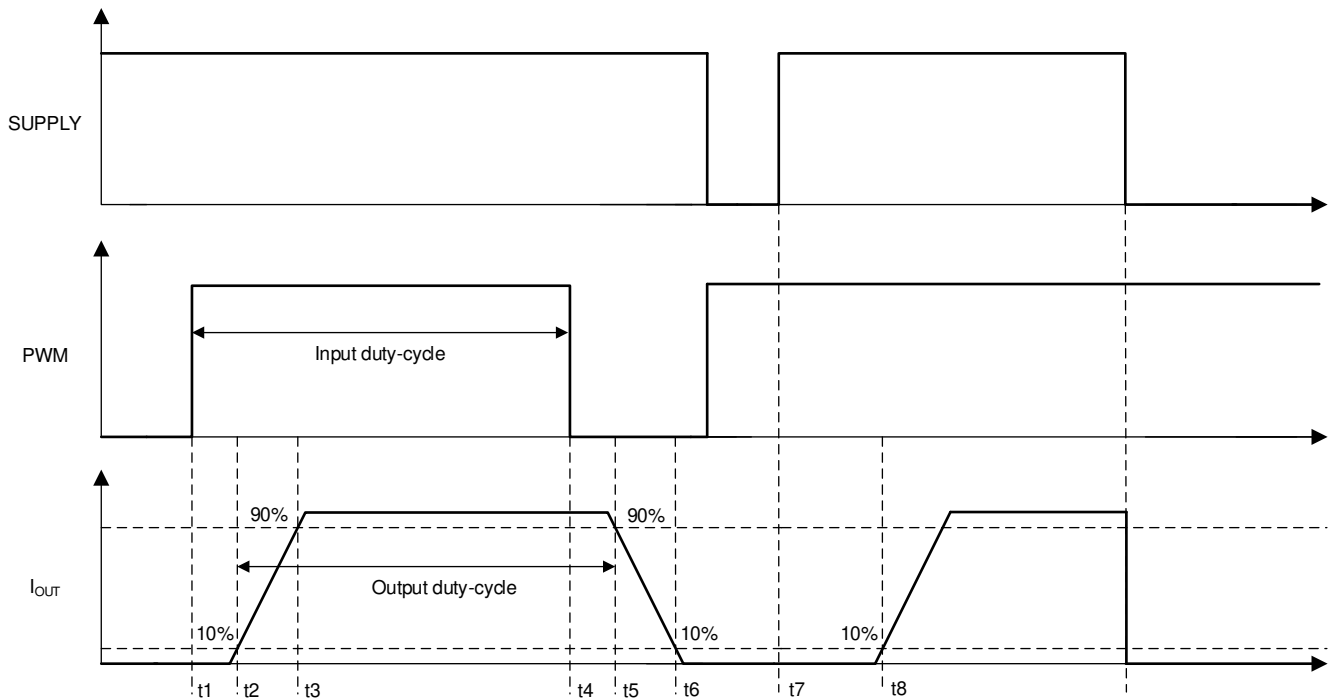


Figure 1. Output Timing Diagram

## 6.7 Typical Characteristics

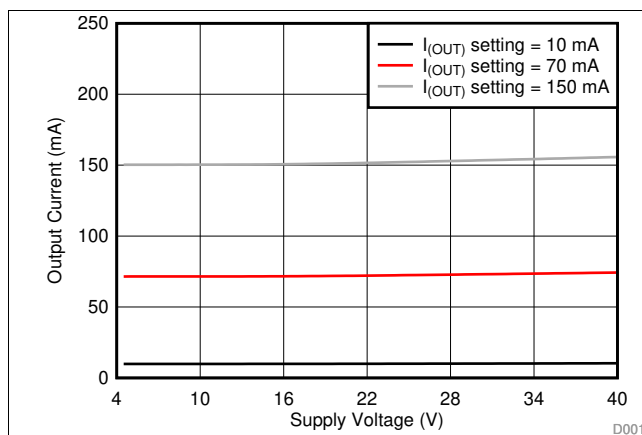


Figure 2. Output Current vs Supply Voltage

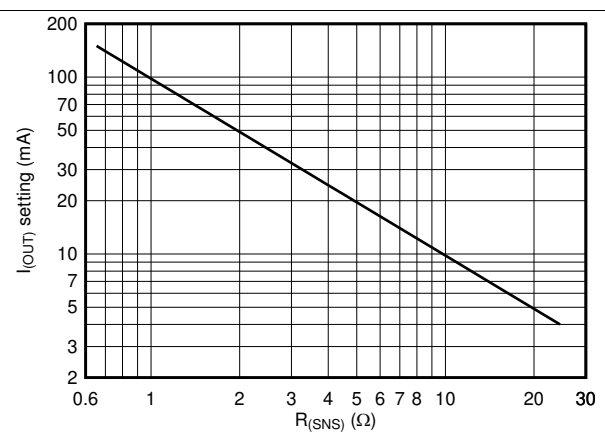


Figure 3. Output Current vs Current-Sense Resistor

## Typical Characteristics (continued)

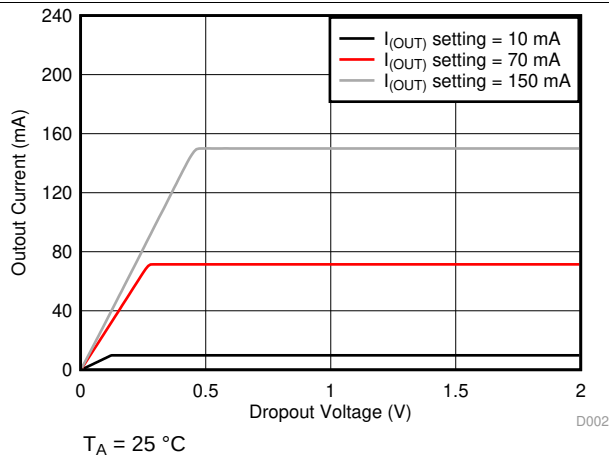


图 4. Output Current vs Dropout Voltage

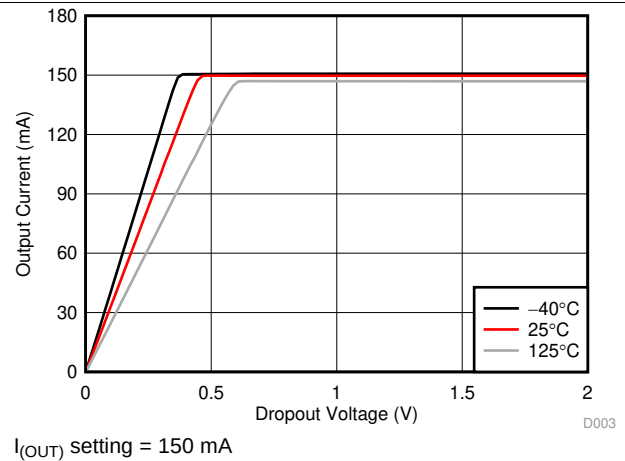


图 5. Output Current vs Dropout Voltage

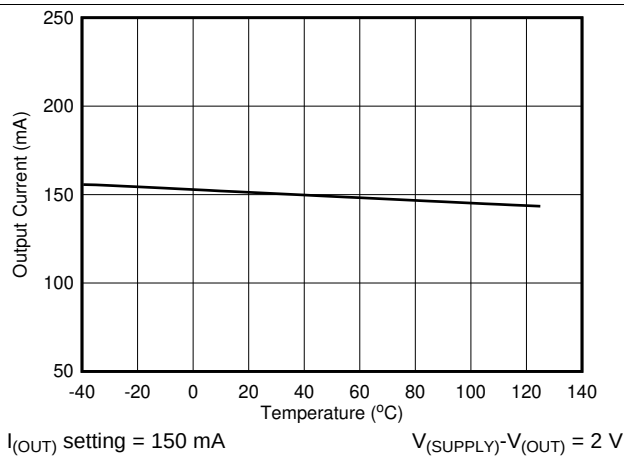


图 6. Output Current vs Temperature

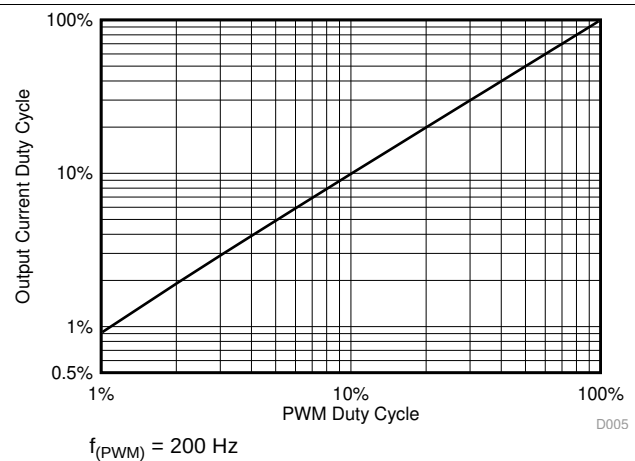


图 7. PWM Output Duty Cycle vs Input Duty Cycle

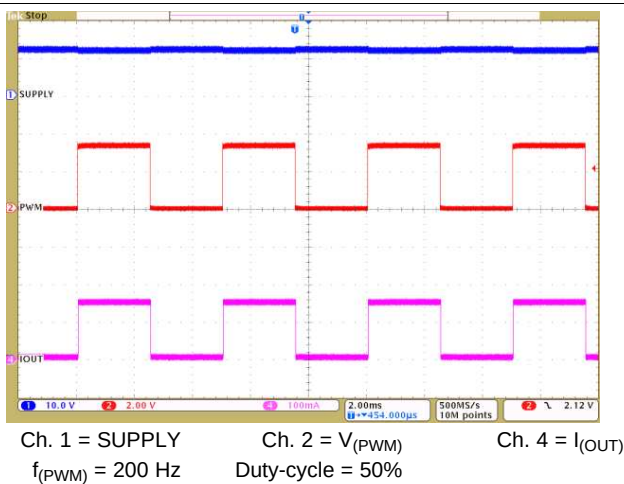


图 8. PWM Dimming at 200 Hz

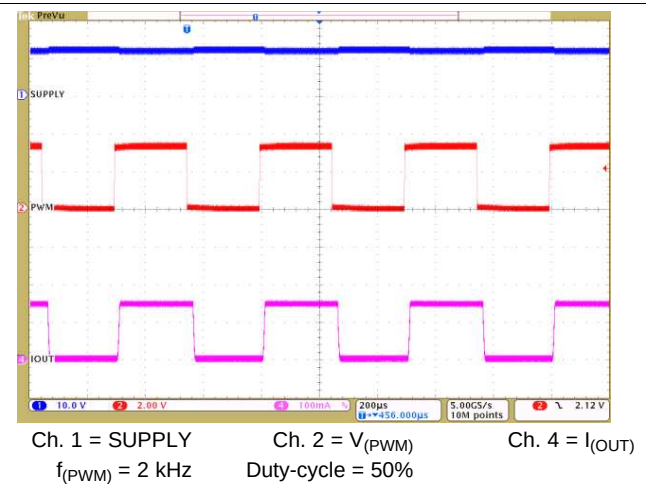
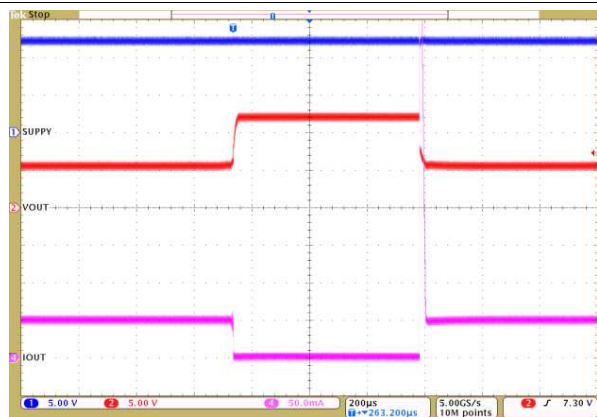


图 9. PWM Dimming at 2 kHz

## Typical Characteristics (continued)



Ch. 1 = SUPPLY      Ch. 2 =  $V_{(OUT)}$       Ch. 4 =  $I_{(OUT)}$

図 10. LED Open-Circuit and Recovery



Ch. 1 = SUPPLY      Ch. 2 =  $V_{(OUT)}$       Ch. 4 =  $I_{(OUT)}$

図 11. LED Short-Circuit Protection and Recovery

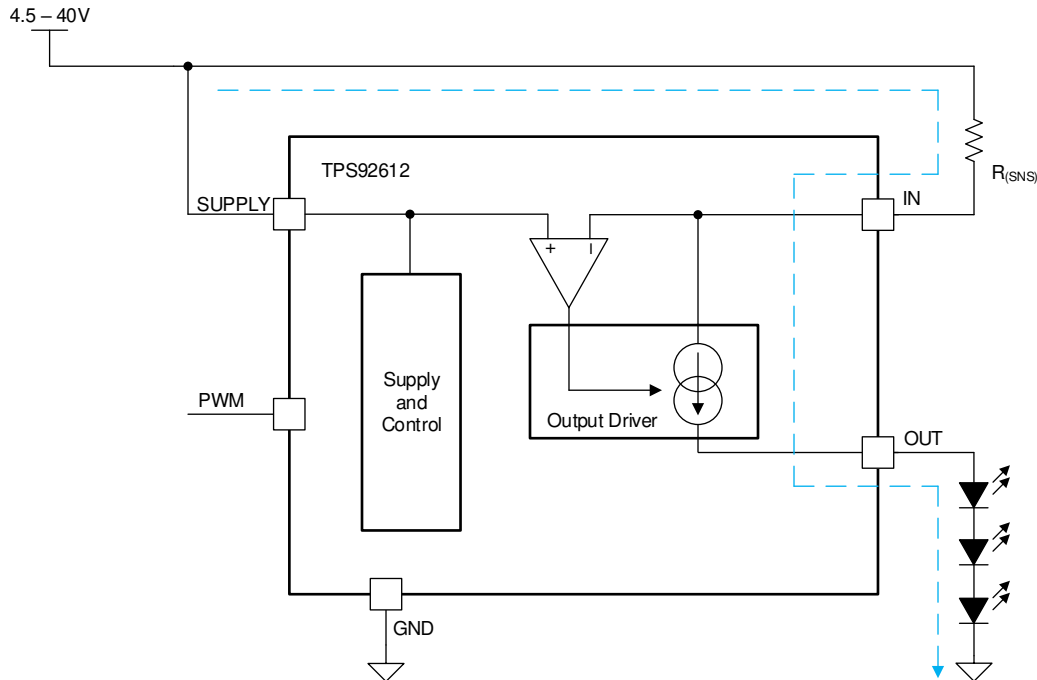
## 7 Detailed Description

### 7.1 Overview

The TPS92612 device is a single-channel linear LED driver providing a simple current source with protection.

The output current at OUT pin can be set by an external  $R_{(SNS)}$  resistor. Current flows from the supply through the  $R_{(SNS)}$  resistor into the integrated current regulation circuit and to the output through OUT pin. Brightness can be controlled by PWM pin.

### 7.2 Functional Block Diagram



### 7.3 Feature Description

#### 7.3.1 Device Bias

##### 7.3.1.1 Power-On Reset (POR)

The TPS92612 device has an internal power-on-reset (POR) function. When power is applied to the SUPPLY pin, the internal POR holds the device in the reset condition until  $V_{(SUPPLY)}$  reaches  $V_{(POR\_rising)}$ .

#### 7.3.2 Constant-Current Driver

The TPS92612 device is a high-side constant-current driver. The device controls the output current through regulating the voltage drop on an external high-side current-sense resistor,  $R_{(SNS)}$ . An integrated error amplifier drives an internal power transistor to maintain the voltage drop on the current-sense resistor  $R_{(SNS)}$  to  $V_{(CS\_REG)}$  and therefore regulates the current output to target value. When the output current is in regulation, the current value can be calculated by using 式 1.

$$I_{(OUT)} = \frac{V_{(CS\_REG)}}{R_{(SNS)}}$$

where

- $V_{(CS\_REG)} = 98 \text{ mV (typical)}$

(1)



## Feature Description (continued)

When the SUPPLY-to-OUT voltage difference is below the required dropout voltage,  $V_{(DROPOUT)}$ , at a given output current, the TPS92612 is not able to deliver enough current output as set by the value of  $R_{(SNS)}$ , and the voltage across the current-sense resistor  $R_{(SNS)}$  is less than  $V_{(CS\_REG)}$ .

### 7.3.3 PWM Control

The pulse width modulation (PWM) input of the TPS92612 functions as enable for the output current. When the voltage applied on the PWM pin is higher than  $V_{IH(PWM)}$ , the output current is enabled. When the voltage applied on PWM pin is lower than  $V_{IL(PWM)}$ , the output current is disabled. Besides output current enable and disable function, the PWM input of TPS92612 also supports adjustment of the average current for LED brightness control. TI recommends a 200 Hz – 2 kHz PWM signal for brightness control, which is out of visible frequency range of human eyes.

### 7.3.4 Protection

#### 7.3.4.1 Short-to-GND Protection

The TPS92612 device has OUT short-to-GND protection. The device monitors the  $V_{(OUT)}$  voltage when the output current is enabled and compares it with the internal reference voltage to detect a short-to-GND failure. If  $V_{(OUT)}$  falls below  $V_{(SG\_th\_falling)}$  longer than the deglitch time of  $t_{(SG\_deg)}$ , the device asserts the short-to-GND fault. During the deglitching time period, if  $V_{(OUT)}$  rises above  $V_{(SG\_th\_rising)}$ , the timer is reset.

Once the device has detected a short-to-GND fault, the device turns off the output channel and retries automatically by sourcing a small current  $I_{(retry)}$  from IN to OUT to pull up the loads continuously, regardless of the state of the PWM input. Once auto retry detects output voltage rising above  $V_{(SG\_th\_rising)}$ , the device clears the short-to-GND fault and resumes normal operation.

#### 7.3.4.2 Over Temperature Protection

The TPS92612 device monitors device junction temperature. When the junction temperature reaches thermal shutdown threshold  $T_{(TSD)}$ , the output shuts down. Once the junction temperature falls below  $T_{(TSD)} - T_{(TSD\_HYS)}$ , the device recovers to normal operation.

## 7.4 Device Functional Modes

### 7.4.1 Undervoltage Lockout, $V_{(SUPPLY)} < V_{(POR\_rising)}$

When the TPS92612 device is in undervoltage lockout mode, the device disables all functions until the supply rises above the  $V_{(POR\_rising)}$  threshold.

### 7.4.2 Normal State, $V_{(SUPPLY)} \geq 4.5\text{ V}$

The device regulates output current in normal state. With enough voltage drop across SUPPLY and OUT, the device is able to drive the output in constant-current mode.

## 8 Application and Implementation

### 注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 8.1 Application Information

The TPS92612 device is a constant-current regulator which can be used as a LED driver, general constant-current source or current limiter in industrial applications.

Thermal performance is one of the design challenges for linear devices. To increase current-driving capability, the device supports heat sharing using an external parallel resistor, as shown in [Figure 15](#). This technique provides the low-cost solution of using external resistors to minimize thermal accumulation on the device itself, and still keeps high accuracy of the total current output.

### 8.2 Typical Application

#### 8.2.1 Single LED Driver

The TPS92612 offers a cost-effective and easy-to-use solution for LED driver applications. PWM input can be adopted for LED brightness adjust and LED ON/OFF control. The device also supports off-board LED connection with long cables.

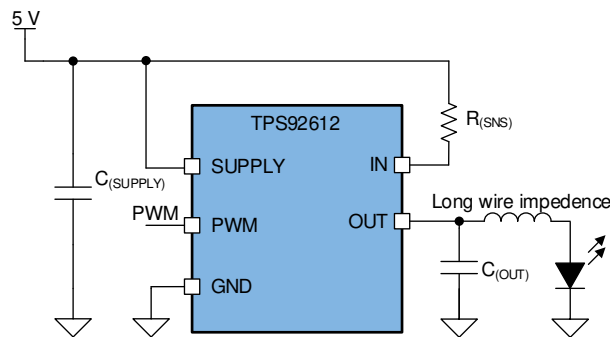


Figure 12. Typical Application Diagram

##### 8.2.1.1 Design Requirements

The input voltage is  $5\text{ V} \pm 5\%$ . LED maximum forward voltage  $V_{F\_MAX} = 2.5\text{ V}$ , minimum forward voltage  $V_{F\_MIN} = 1.9\text{ V}$ , current  $I_{(LED)} = 150\text{ mA}$ . LED is connected to device OUT pin through a 1-m long wire.

##### 8.2.1.2 Detailed Design Procedure

**STEP 1:** Determine the current setting resistor,  $R_{(SNS)}$  value by using [Equation 2](#).

$$R_{(SNS)} = \frac{V_{(CS\_REG)}}{I_{(LED)}} = 0.653\Omega$$

where

- $V_{(CS\_REG)} = 98\text{ mV}$  (typical)
- $I_{(LED)} = 150\text{ mA}$

(2)

**STEP 2:** Power consumption analysis for the worst application conditions.

## Typical Application (continued)

Normally the thermal analysis is necessary for linear LED-driver applications to ensure that the operation junction temperature of TPS92612 is well managed. The total power consumption on the TPS92612 itself is one important factor determining operation junction temperature, and it can be calculated by using 式 3. Based on the worst-case analysis for maximum power consumption on device, consider either optimizing PCB layout for better power dissipation as [Layout](#) describes or adding an extra heat-sharing resistor as described in [Single-Channel LED Driver With Heat Sharing](#).

$$P_{(DEV)} = (V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)}) \times I_{(LED)} + V_{(SUPPLY)} \times I_{(Quiescent)}$$

$$P_{(DEV\_MAX)} = (5.25 - 0.098 - 1.9) \times 0.15 + 5.25 \times 0.00025 = 0.489W$$

where

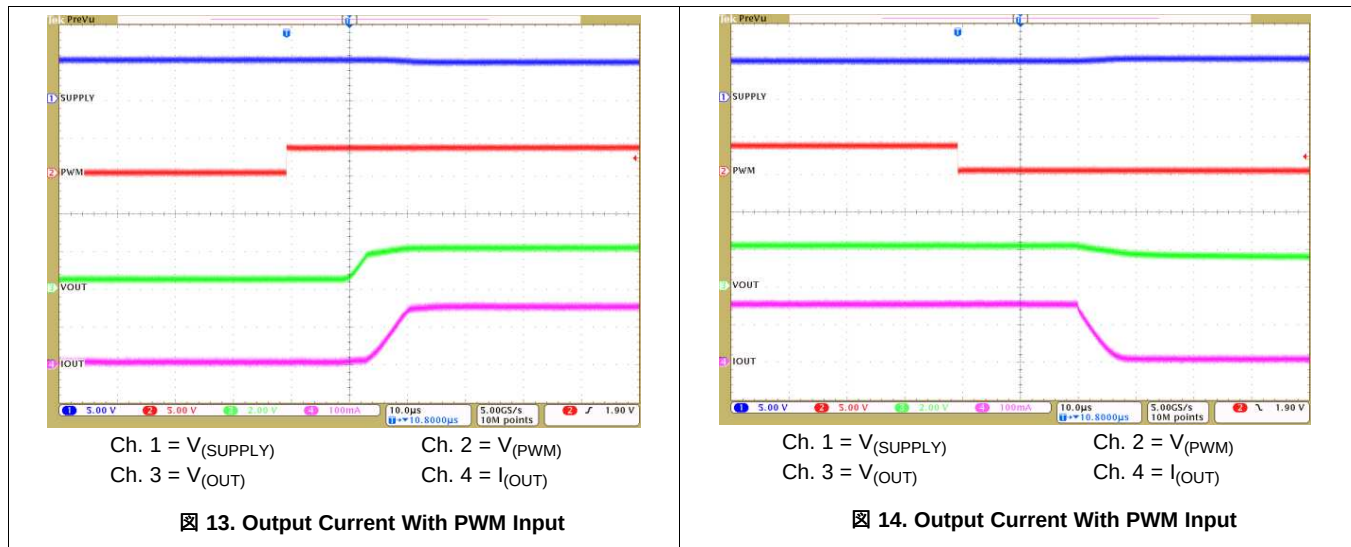
- $V_{(CS\_REG)} = 98 \text{ mV}$  (typical)
  - $I_{(Quiescent)} = 250 \text{ }\mu\text{A}$  (maximum)
- (3)

In this application, the calculated result for maximum power consumption on the TPS92612 is 0.489 W at  $V_{(SUPPLY)} = 5.25 \text{ V}$  and  $I_{(LED)} = 150 \text{ mA}$  conditions.

TI recommends to add capacitors  $C_{(SUPPLY)}$  at SUPPLY and  $C_{(OUT)}$  at OUT. TI recommends one 1- $\mu\text{F}$  capacitor plus one 100-nF decoupling ceramic capacitor close to the SUPPLY pin for  $C_{(SUPPLY)}$  and a 10-nF ceramic capacitor close to the OUT pin for  $C_{(OUT)}$ . The larger capacitor for  $C_{(SUPPLY)}$  or  $C_{(OUT)}$  is helpful for EMI and ESD immunity; however, large  $C_{(OUT)}$  takes a longer time to charge up the capacitor and may affect PWM dimming performance.

### 8.2.1.3 Application Curve

A 1- $\mu\text{H}$  inductor is connected between OUT and the LED to simulate the 1-m long cable.



### 8.2.2 Single-Channel LED Driver With Heat Sharing

Using parallel resistors, thermal performance can be improved by balancing current between the TPS92612 device and the external resistors as follows. As the current-sense resistor controls the total LED string current, the LED string current  $I_{(LED)}$  is set by  $V_{(CS\_REG)} / R_{(SNS)}$ , while the TPS92612 current  $I_{(DRIVE)}$  and parallel resistor current  $I_{(P)}$  combine to the total current.

## Typical Application (continued)

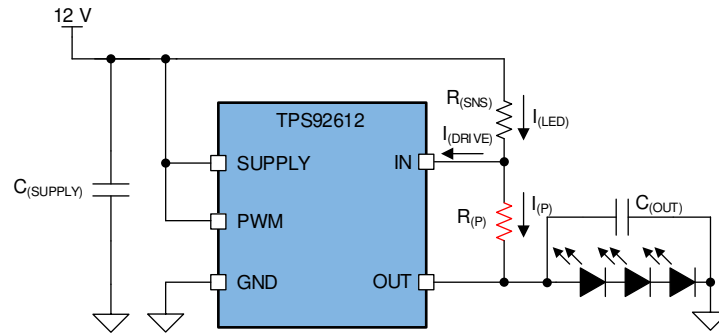


图 15. Heat Sharing With a Parallel Resistor

### 8.2.2.1 Design Requirements

The input voltage range is 12 V  $\pm$  10%, LED maximum forward voltage  $V_{F\_MAX} = 2.5$  V, minimum forward voltage  $V_{F\_MIN} = 1.9$  V, current  $I_{(LED)} = 150$  mA.

### 8.2.2.2 Detailed Design Procedure

In linear LED driver applications, the input and output voltage variation generates the most of the thermal concerns. The resistor current  $I_{(P)}$ , as indicated by Ohm's law, depends on the voltage across the external resistors. The TPS92612 controls the driver current  $I_{(DRIVE)}$  to attain the desired total current. If  $I_{(P)}$  increases, the TPS92612 device decreases  $I_{(DRIVE)}$  to compensate, and vice versa. The parallel-resistor takes highest current and generates maximum heat at maximum supply voltage and minimum LED-string forward voltage.

The parallel resistor value must be carefully calculated to ensure that 1) thermal dissipation for both the TPS92612 device and the resistor is within their thermal dissipation limits, and 2) device current at high voltage drop condition is above the minimal output-current requirement.

**STEP 1:** Determine the current setting resistor,  $R_{(SNS)}$  value by using 式 4.

$$R_{(SNS)} = \frac{V_{(CS\_REG)}}{I_{(LED)}} = 0.653\Omega$$

where

- $V_{(CS\_REG)} = 98$  mV (typical)
- $I_{(LED)} = 150$  mA

(4)

The calculated result for  $R_{(SNS)}$  is 0.653  $\Omega$ .

**STEP 2:** Calculate the parallel resistor,  $R_{(P)}$  value by using 式 5.

The parallel resistor  $R_{(P)}$  is recommended to consume 50% of the total current at maximum supply voltage and minimum LED-string forward voltage.

$$R_{(P)} = \frac{V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)}}{0.5 \times I_{(LED)}} = \frac{13.2 - 0.098 - 3 \times 1.9}{0.5 \times 0.15} \approx 100\Omega$$

where

- $V_{(CS\_REG)} = 98$  mV (typical)
- $I_{(LED)} = 150$  mA

(5)

The calculated result for  $R_{(P)}$  is about 100  $\Omega$  at  $V_{(SUPPLY)} = 13.2$  V.

**STEP 3:** Power consumption analysis for the worst application conditions.

The total device power consumption can be calculated by 式 6.

## Typical Application (continued)

$$P_{(DEV)} = (V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)}) \times \left( I_{(LED)} - \frac{V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)}}{R_{(P)}} \right) + V_{(SUPPLY)} \times I_{(Quiescent)}$$

$$P_{(DEV\_MAX)} = (13.2 - 0.098 - 3 \times 1.9) \times \left( 0.15 - \frac{13.2 - 0.098 - 3 \times 1.9}{100} \right) + 13.2 \times 0.00025 = 0.566W$$

where

- $V_{(CS\_REG)} = 98 \text{ mV}$  (typical)
- $I_{(Quiescent)} = 250 \text{ }\mu\text{A}$  (maximum)

The calculated maximum power consumption on the TPS92612 device is 0.566 W at  $V_{(SUPPLY)} = 13.2 \text{ V}$ ,  $V_{(OUT)} = 3 \times 1.9 \text{ V} = 5.7 \text{ V}$  and  $I_{(LED)} = 150 \text{ mA}$ .

The power consumption on resistor  $R_{(P)}$  can be calculated through 式 7.

$$P_{(RP)} = \frac{(V_{(SUPPLY)} - V_{(CS\_REG)} - V_{(OUT)})^2}{R_{(P)}}$$

$$P_{(RP\_MAX)} = \frac{(13.2 - 0.098 - 3 \times 1.9)^2}{100} = 0.548W$$

where

- $V_{(CS\_REG)} = 98 \text{ mV}$  (typical)

The calculated maximum power consumption on the  $100 \text{ }\Omega$ ,  $R_{(P)}$  parallel resistor is 0.548 W at  $V_{(SUPPLY)} = 13.2 \text{ V}$  and  $V_{(OUT)} = 3 \times 1.9 \text{ V} = 5.7 \text{ V}$ .

TI recommends adding capacitors  $C_{(SUPPLY)}$  at SUPPLY and  $C_{(OUT)}$  at OUT. One 1- $\mu\text{F}$  capacitor plus one 100-nF decoupling ceramic capacitor close to the SUPPLY pin is recommended for  $C_{(SUPPLY)}$ , and a 10-nF ceramic capacitor close to the OUT pin is recommended for  $C_{(OUT)}$ . The larger capacitor for  $C_{(SUPPLY)}$  or  $C_{(OUT)}$  is helpful for EMI and ESD immunity, however large  $C_{(OUT)}$  takes a longer time to charge up the capacitor and could affect PWM dimming performance.

Note that the parallel resistor path cannot be shut down by PWM or fault protection. If PWM control is required, TI recommends an application circuit as shown in 图 16. A NPN bipolar transistor with a base current-limiting resistor,  $R_1$ , can modulate the output current together with the device PWM function. The resistor value of  $R_1$  needs to be calculated based on the applied PWM voltage and  $\beta$  value of selected NPN transistor.

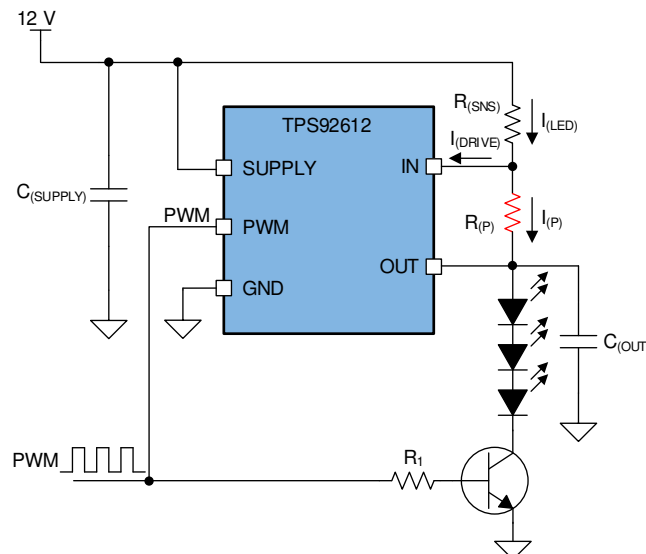


图 16. PWM Control With Heat Sharing Resistor

## Typical Application (continued)

### 8.2.2.3 Application Curve



Ch. 1 =  $V_{(SUPPLY)}$    Ch. 2 =  $V_{(OUT)}$    Ch. 3 =  $I_{(P)}$    Ch. 4 =  $I_{(LED)}$

✎ 17. Constant Output Current With Heat Sharing Resistor

## 9 Power Supply Recommendations

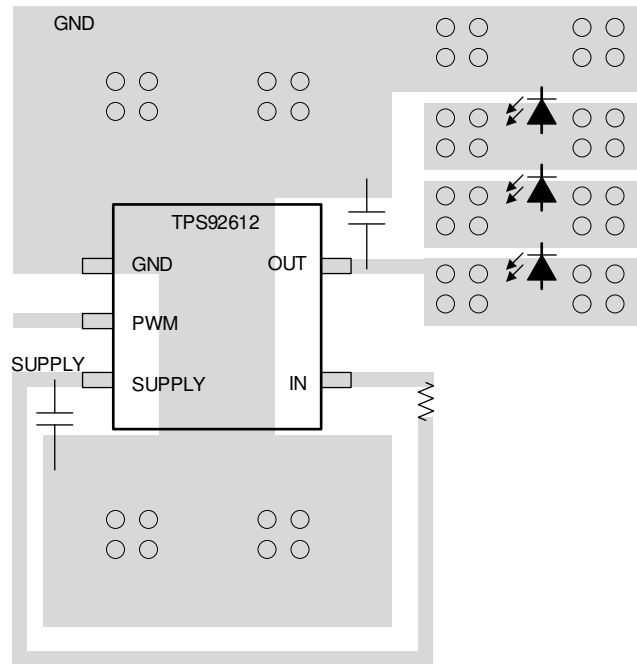
The TPS92612 is designed to operate from a power system within the range specified in the [Recommended Operating Conditions](#). The SUPPLY input must be protected from reverse voltage and overvoltage over 40 V. The impedance of the input supply rail must be low enough that the input current transient does not cause drop below LED string required forward voltage. If the input supply is connected with long wires, additional bulk capacitance may be required in addition to normal input capacitor.

## 10 Layout

### 10.1 Layout Guidelines

Thermal dissipation is the primary consideration for TPS92612 layout. TI recommends good thermal dissipation area beneath the device for better thermal performance.

### 10.2 Layout Example



✕ 18. TPS92612 Example Layout Diagram

## 11 デバイスおよびドキュメントのサポート

### 11.1 ドキュメントの更新通知を受け取る方法

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### 11.2 サポート・リソース

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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### 11.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 12 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。



## PACKAGING INFORMATION

| Orderable part number        | Status<br>(1) | Material type<br>(2) | Package   Pins   | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">TPS92612DBVR</a> | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | 22SF                |
| TPS92612DBVR.A               | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | 22SF                |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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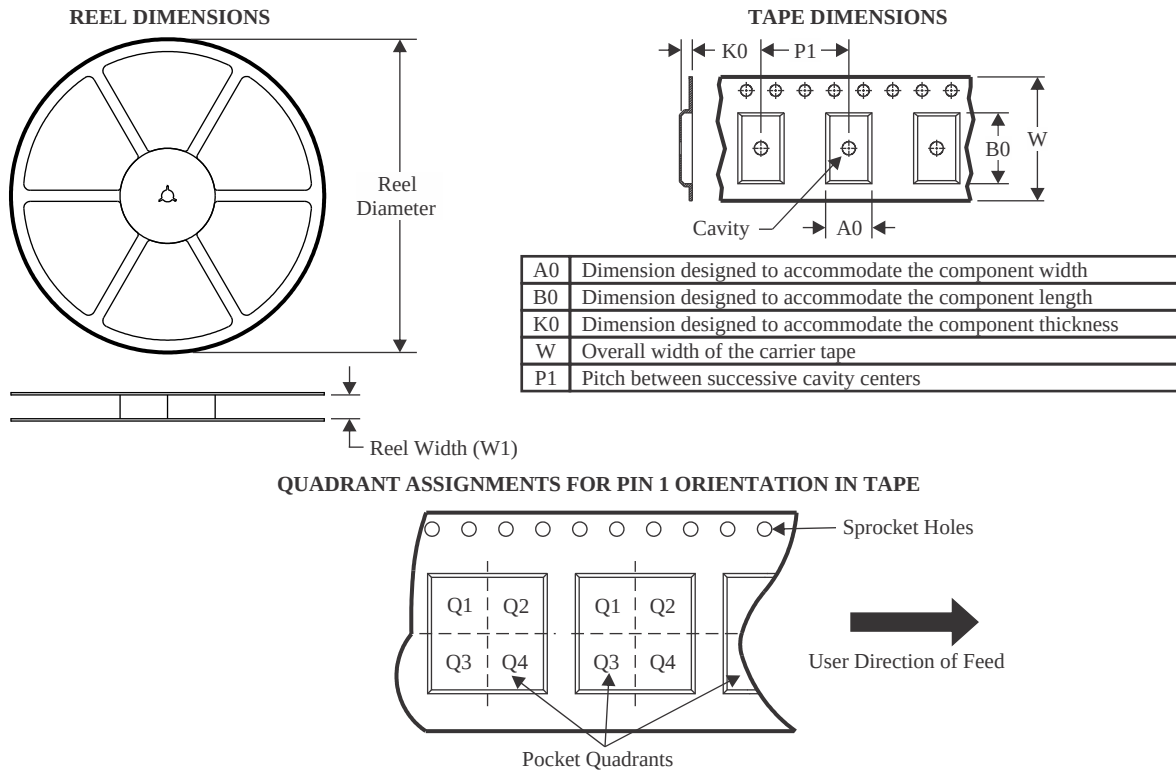
### OTHER QUALIFIED VERSIONS OF TPS92612 :

- Automotive : [TPS92612-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

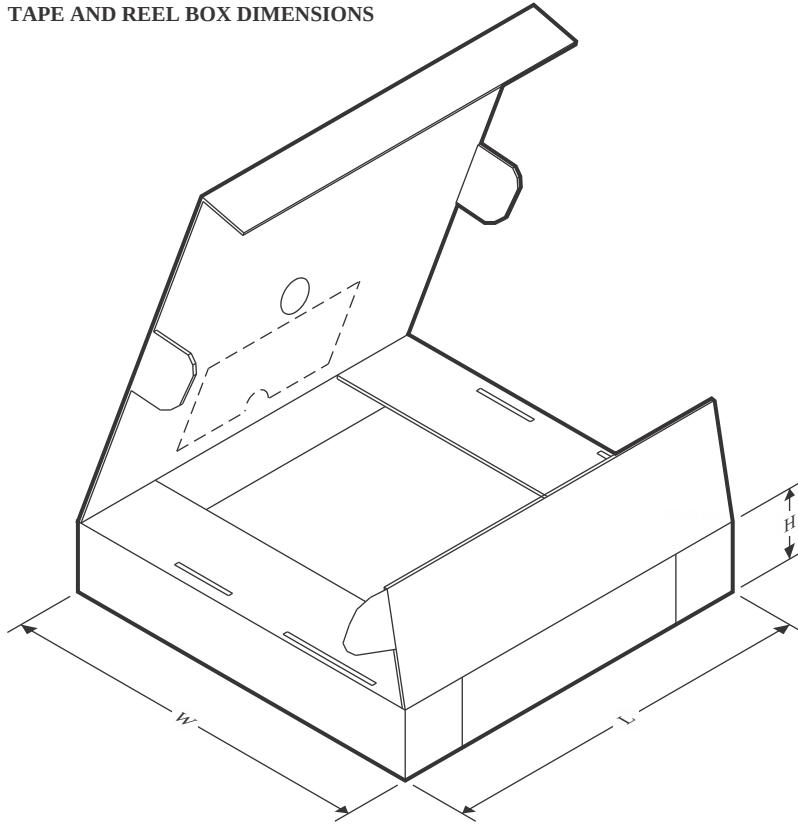
## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS92612DBVR | SOT-23       | DBV             | 5    | 3000 | 180.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TPS92612DBVR | SOT-23       | DBV             | 5    | 3000 | 180.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS92612DBVR | SOT-23       | DBV             | 5    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS92612DBVR | SOT-23       | DBV             | 5    | 3000 | 210.0       | 185.0      | 35.0        |

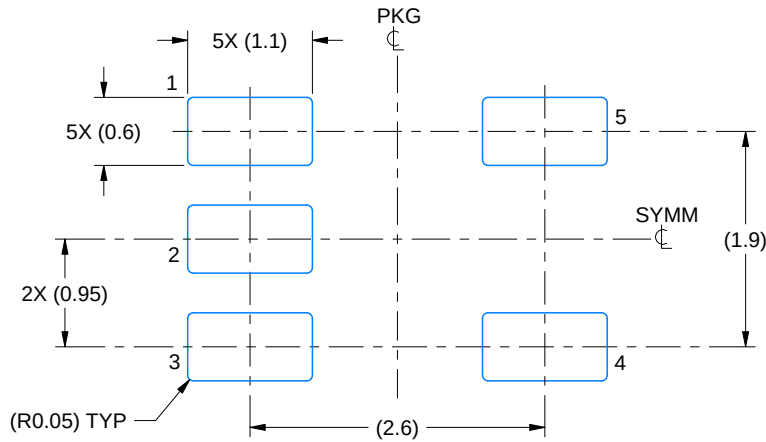


# EXAMPLE BOARD LAYOUT

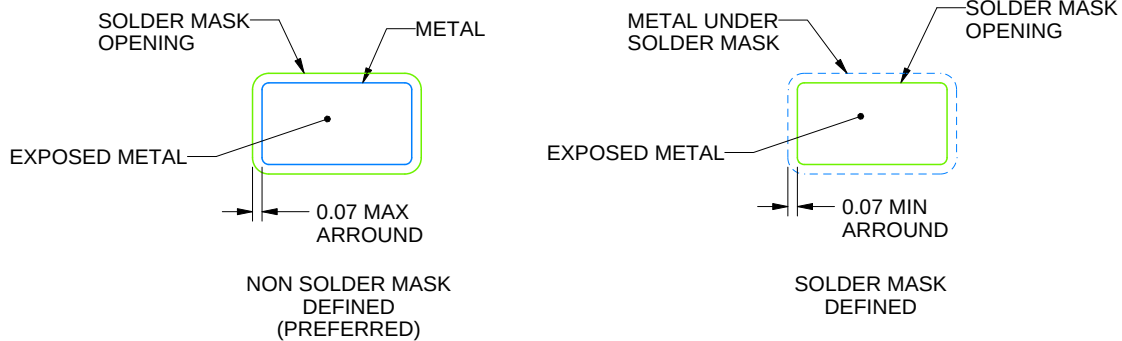
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4214839/K 08/2024

NOTES: (continued)

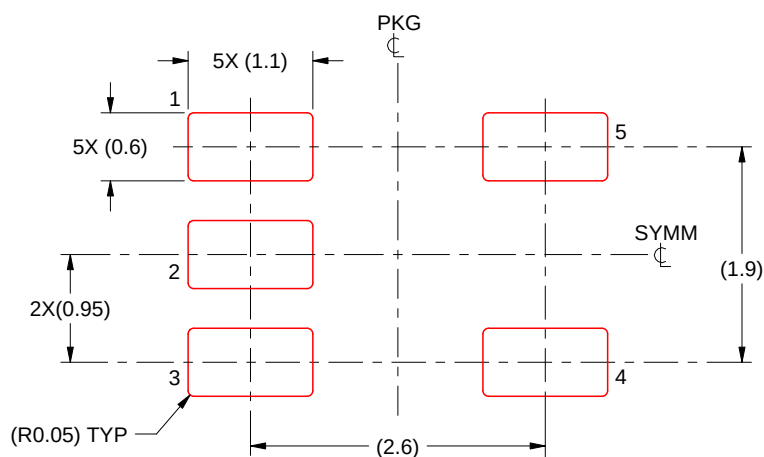
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4214839/K 08/2024

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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