# TPS60151 5V 与 140mA 电荷泵

## 1 特性

- 输入电压范围：2.7V 至 5.5V
- 5V 固定输出电压
- 最大输出电流：140mA
- 1.5MHz 开关频率
- 在无负载情况下具有典型值 90µA 的静态电流（跳跃模式）
- 输出反向电流保护
- X2 电荷泵
- 硬件启用和禁用功能
- 内置软启动
- 内置欠压锁定保护
- 热保护和过流保护
- 2mm × 2mm 6 引脚 SON 封装，高度为 0.8mm

## 2 应用

- USB On the Go (OTG)
- HDMI
- 便携式通信器件
- PCMCIA 卡
- 手机、智能电话
- 手持式仪表

## 3 说明

TPS60151 是一款开关电容电压转换器，能够从非稳定输入电压中产出稳定、低噪声、低波纹的 5V 输出电压。在 $V_{IN}$ 大于 5V 时仍然可以维持 5V 稳压。

5V 输出可以提供最低 140mA 的电流。

TPS60151 具有内置电流限制和输出反向电流保护，是 HDMI、USB OTG 和其他电池供电应用的 理想选择。

在典型情况下，当负载电流低于 8mA 时，TPS60151 会在跳跃模式下运行。在跳跃运行模式下，静态电流降到 90µA。

只有 3 个外部电容器需要生成输出电压，由此节省了 PCB 空间。

在上电和电源瞬态期间，浪涌电流受到软启动功能的限制。

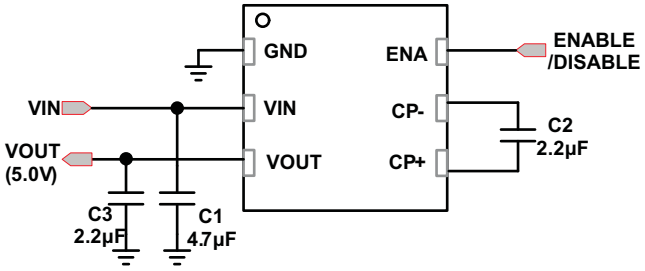
TPS60151 在自然通风环境下的额定运行温度范围为 –40°C 至 85°C。该器件采用小尺寸 2mm × 2mm 6 引脚 SON 封装 (QFN)。

器件信息(1)

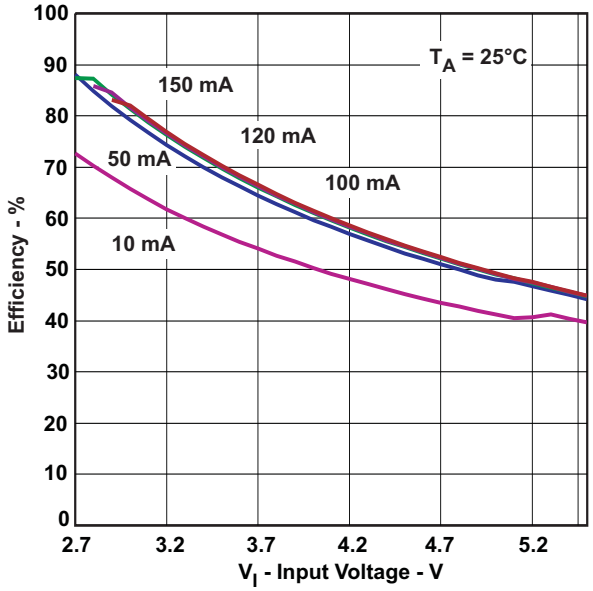
| 器件型号 | 封装 | 封装尺寸（标称值） |
|---|---|---|
| TPS60151 | WSON (6) | 2.00mm × 2.00mm |

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

典型应用原理图




效率与输入电压间的关系




本文档旨在为方便起见，提供有关 TI 产品中文版本的信息，以确认产品的概要。 有关适用的官方英文版本的最新信息，请访问 www.ti.com，其内容始终优先。 TI 不保证翻译的准确性和有效性。 在实际设计之前，请务必参考最新版本的英文版本。

# 目录

**1** 特性 ... 1
**2** 应用 ... 1
**3** 说明 ... 1
**4** 修订历史记录 ... 2
**5** **Device Comparison Table** ... 3
**6** **Pin Configuration and Functions** ... 3
**7** **Specifications** ... 4
7.1 Absolute Maximum Ratings ... 4
7.2 ESD Ratings ... 4
7.3 Recommended Operating Conditions ... 4
7.4 Thermal Information ... 4
7.5 Electrical Characteristics ... 5
7.6 Typical Characteristics ... 6
**8** **Detailed Description** ... 7
8.1 Overview ... 7
8.2 Functional Block Diagram ... 8
8.3 Feature Description ... 8
8.4 Device Functional Modes ... 9
**9** **Application and Implementation** ... 12
9.1 Application Information ... 12
9.2 Typical Application ... 12
9.3 System Example ... 16
**10** **Power Supply Recommendations** ... 17
**11** **Layout** ... 17
11.1 Layout Guidelines ... 17
11.2 Layout Example ... 17
**12** 器件和文档支持 ... 18
12.1 接收文档更新通知 ... 18
12.2 社区资源 ... 18
12.3 商标 ... 18
12.4 静电放电警告 ... 18
12.5 术语表 ... 18
**13** 机械、封装和可订购信息 ... 18

## 4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

**Changes from Revision A (October 2015) to Revision B** **Page**

- Added row for $V_{OUT}$ spec -- 3.1 V ≤ $V_{IN}$ < 5.5V ... 5
- Added row for $V_{OUT(skip)}$ V spec -- 3.1 V ≤ $V_{IN}$ < 5.5V ... 5

**Changes from Original (August 2009) to Revision A** **Page**

- 已添加 *引脚配置和功能* 部分、*ESD 额定值* 表、*特性* *说明* 部分、*器件功能模式*、*应用和实施* 部分、*电源建议* 部分、*布局* 部分、*器件和文档支持* 部分以及*机械、封装和可订购信息* 部分 ... 1


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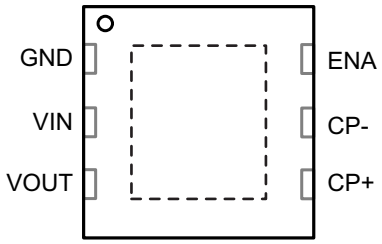
## 5 Device Comparison Table

| PART NUMBER (1) | OUTPUT VOLTAGE | PACKAGE DESIGNATOR | ORDERING | PACKAGE MARKING |
|---|---|---|---|---|
| TPS60151 | 5 V | DRV | TPS60151DRV | OCN |

(1) The DRV (2 mm × 2 mm 6-pin SON) package is available in tape on reel. Add R suffix to order quantities of 3000 parts per reel and T suffix to order quantities with 250 parts per reel.

## 6 Pin Configuration and Functions

**QFN Package**
**6-Pin WSON**
**Top View**




**Pin Functions**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NAME | NO. | | |
| GND | 1 | – | Ground |
| VIN | 2 | IN | Supply voltage input |
| VOUT | 3 | OUT | Output, connect to the output capacitor |
| CP+ | 4 | – | Connect to the flying capacitor |
| CP– | 5 | – | Connect to the flying capacitor |
| ENA | 6 | IN | Hardware enable/disable pin (High = Enable) |

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# 7 Specifications

## 7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{IN}$ | Input voltage (all pins) | –0.3 | 7 | V |
| $T_A$ | Operating temperature | –40 | 85 | °C |
| $T_J$ | Maximum operating junction temperature | | 150 | °C |
| $T_{stg}$ | Storage temperature | –55 | 150 | °C |

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

## 7.2 ESD Ratings

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

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) The Human body model (HBM) is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin. The testing is done according JEDECs EIA/JESD22-A114.
(3) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

## 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{IN}$ | Input voltage | 2.7 | | 5.5 | V |
| $T_A$ | Operating ambient temperature | –40 | | 85 | °C |
| $T_J$ | Operating junction temperature | –40 | | 125 | °C |
| $C_{IN}$ | Input capacitor | 2.2 | | | µF |
| $C_{OUT}$ | Output capacitor | 2.2 | | | µF |
| $C_F$ | Flying capacitor | 1.0 | | | µF |

## 7.4 Thermal Information

| THERMAL METRIC (1) | | TPS60151 DRV (WSON) 6 PINS | UNIT |
|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 69.1 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 79.8 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 38.6 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 1.2 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 38.4 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | 9.2 | °C/W |

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.


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## 7.5 Electrical Characteristics

$V_{IN}$ = 3.6 V, $T_A$ = –40°C to +85°C, typical values are at $T_A$ = 25°C, C1 = C3 = 2.2 μF, C2 = 1 μF (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **POWER STAGE** | | | | | | |
| $V_{IN}$ | Input voltage range | | 2.7 | | 5.5 | V |
| $V_{UVLO}$ | Undervoltage lockout threshold | | | 1.9 | 2.1 | V |
| $I_Q$ | Operating quiescent current | $I_{OUT}$ = 140 mA, Enable = $V_{IN}$ | | 4.7 | | mA |
| $I_{Qskip}$ | Skip mode operating quiescent current | $I_{OUT}$ = 0 mA, Enable = $V_{IN}$ (no switching) | | 80 | | μA |
| | | $I_{OUT}$ = 0 mA, Enable = $V_{IN}$ (minimum switching) | | 90 | | μA |
| $I_{SD}$ | Shutdown current | 2.7 V ≤ $V_{IN}$ ≤ 5.5 V, Enable = 0 V | | 4 | 10 | μA |
| $V_{OUT}$ | Output voltage(1) | $I_{OUT}$ ≤ 50 mA, 2.7 V ≤ $V_{IN}$ < 5.5V | 4.8 | 5 | 5.2 | V |
| | | $I_{OUT}$ ≤ 50 mA, 3.1 V ≤ $V_{IN}$ < 5.5V | 4.8 | 5 | 5.15 | V |
| $V_{OUT(skip)}$ V | Skip mode output voltage | $I_{OUT}$ = 0 mA, 2.7 V ≤ $V_{IN}$ ≤ 5.5 V | | $V_{OUT}$ + 0.1 | | V |
| | | $I_{OUT}$ = 0 mA, 3.1 V ≤ $V_{IN}$ ≤ 5.5 V | | $V_{OUT}$ + 0.1 | 5.25 | V |
| $F_{SW}$ | Switching frequency | | | 1.5 | | MHz |
| $t_{SS}$ | Soft-start time | From the rising edge of enable to 90% output | | 150 | | μs |
| **OUTPUT CURRENT** | | | | | | |
| $I_{OUT_nom}$ | Maximum output current | $V_{OUT}$ remains between 4.8 V and 5.2 V, 3.1 V ≤ $V_{IN}$ ≤ 5.5 V | 120 | | | mA |
| | | 3.3 V < $V_{IN}$ < 5.5 V | 140 | | | |
| $I_{OUT_max}$ | Current limit | $V_{OUT}$ = 4.5 V | | | 500 | mA |
| $I_{OUT_short}$ | Short circuit current(2) | $V_{OUT}$ = 0 V | | 80 | | mA |
| **RIPPLE VOLTAGE** | | | | | | |
| $V_R$ | Output ripple voltage | $I_{OUT}$ = 140 mA | | 30 | | mV |
| **ENABLE CONTROL** | | | | | | |
| $V_{HI}$ | Logic high input voltage | 2.7 V ≤ $V_{IN}$ ≤ 5.5 V | 1.3 | | $V_{IN}$ | V |
| $V_{LI}$ | Logic low input voltage | | –0.2 | | 0.4 | V |
| $I_{HI}$ | Logic high input current | | | | 1 | μA |
| $I_{LI}$ | Logic low input current | | | | 1 | μA |
| **THERMAL SHUTDOWN** | | | | | | |
| $T_{SD}$ | Shutdown temperature | | | 160 | | °C |
| $T_{RC}$ | Shutdown recovery | | | 140 | | °C |

(1) When in skip mode, output voltage can exceed $V_{OUT}$ spec because $V_{OUT(skip)}$= $V_{OUT}$ +0.1.
(2) TPS60151 has internal protection circuit to protect IC when $V_{OUT}$ shorted to GND.

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## 7.6 Typical Characteristics

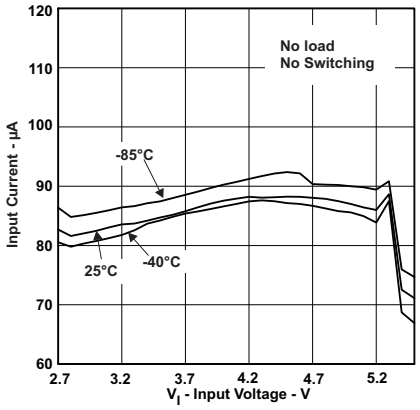



**Figure 1. Quiescent Current vs Input Voltage**

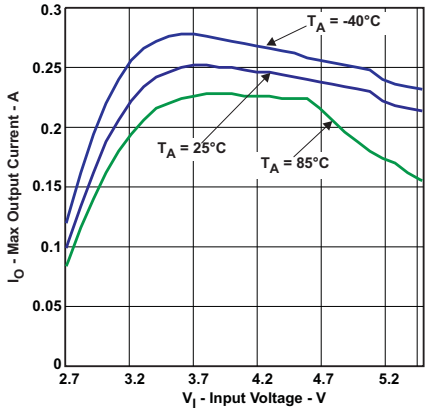



**Figure 2. Maximum Output Current vs Input Voltage at Temperature**


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# 8 Detailed Description

## 8.1 Overview

The TPS60151, regulated charge pump, provides a regulated output voltage for various input voltages. The TPS60151 regulates the voltage across the flying capacitor to 2.5 V and controls the voltage drop of Q1 and Q2 while a conversion clock with 50% duty cycle drives the FETs.

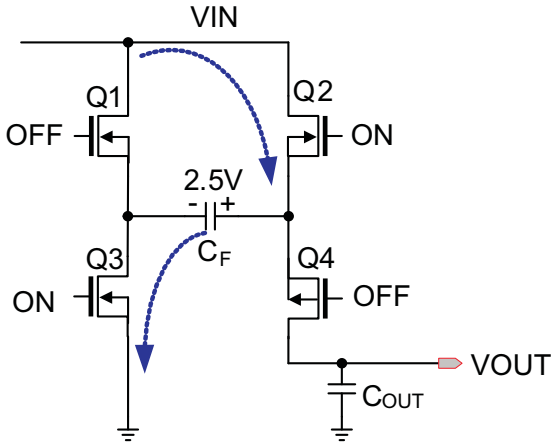



**Figure 3. Charging Mode**

During the first half cycle, Q2 and Q3 transistors are turned on and flying capacitor, $C_F$, will be charged to 2.5 V ideally.

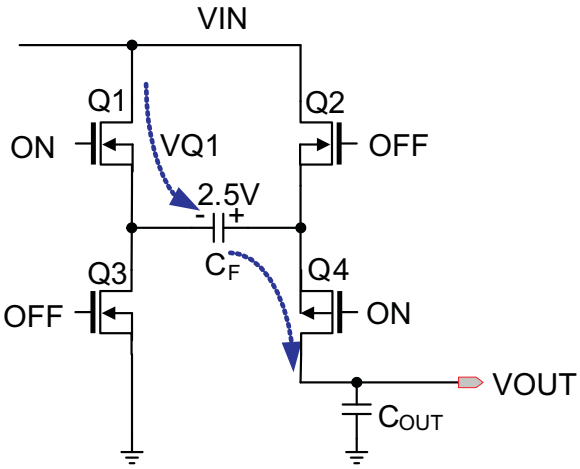



**Figure 4. Discharging Mode**

During the second half cycle, Q1 and Q4 transistors are turned on. Capacitor $C_F$ will then be discharged to output.

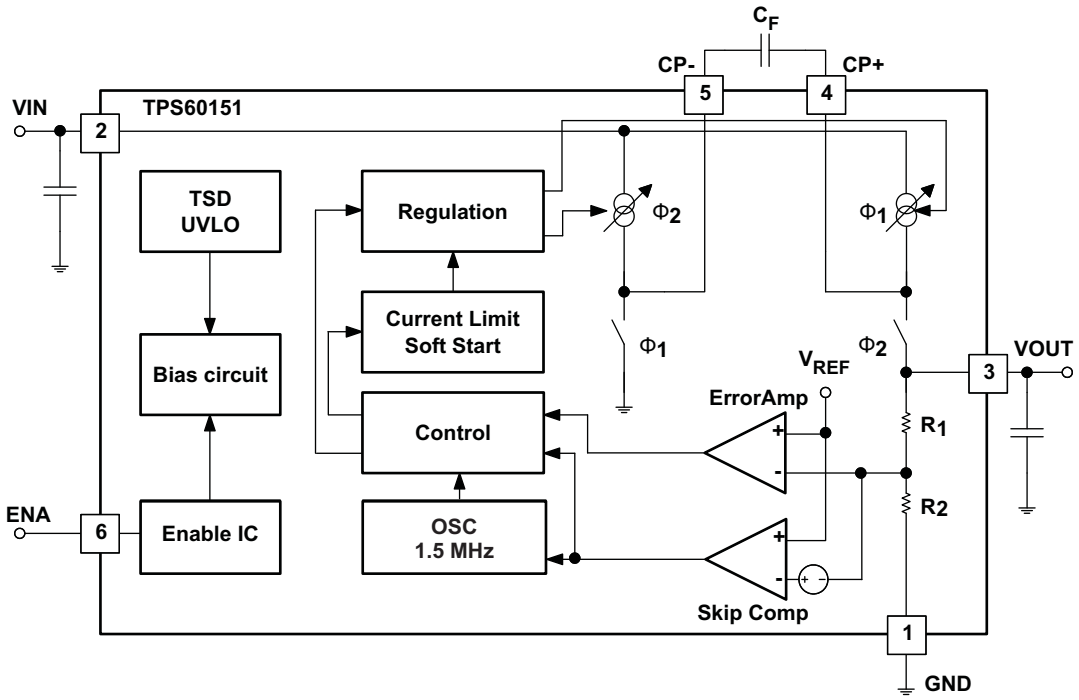
The output voltage can be calculated as follows:

$$Vout = V_{IN} – VQ1 + V(C_F) - VQ4 = VIN – VQ1 + 2.5\ V - VQ4 = 5\ V.\ (Ideal) \quad (1)$$

The output voltage is regulated by output feedback and an internally compensated voltage control loop.

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## 8.2 Functional Block Diagram




## 8.3 Feature Description

### 8.3.1 Enable

An enable pin on the regulator is used to place the device into an energy-saving shutdown mode. In this mode, the output is disconnected from the input and the input quiescent current is reduced to 10 μA maximum.

### 8.3.2 Output Reverse Current Protection

Applications like HDMI or USB OTG generally do not tolerate output reverse current that can drain power from connected devices. Special considerations were put in place to prevent that from happening. Figure 5 is a testing circuit; and, Figure 6 shows reverse current protection test results under various conditions.

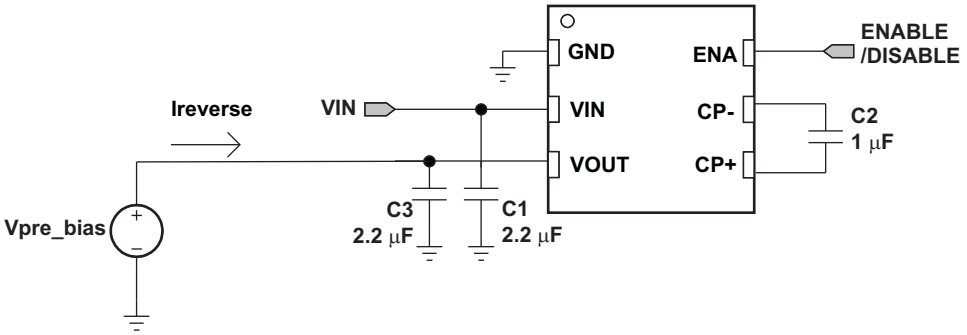



**Figure 5. Output Reverse Current Test Setup**


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## Feature Description (continued)

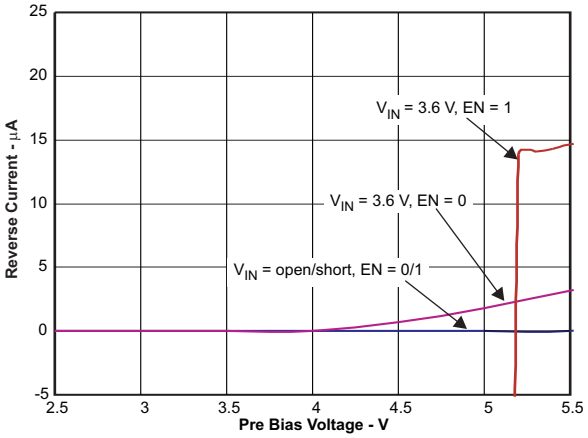



**Figure 6. Reverse Current Test Results (Typical)**

### 8.3.3 Undervoltage Lockout

When the input voltage drops, the undervoltage lockout prevents misoperation by switching off the device. The converter starts operation again when the input voltage exceeds the threshold, provided the enable pin is high.

### 8.3.4 Thermal Shutdown Protection

The regulator has thermal shutdown circuitry that protects it from damage caused by overload conditions. The thermal protection circuitry disables the output when the junction temperature reached approximately 160°C, allowing the device to cool. When the junction temperature cools to approximately 140°C, the output circuitry is automatically re-enabled. Continuously running the regulator into thermal shutdown can degrade reliability. The regulator also provides current limit to protect itself and the load.

## 8.4 Device Functional Modes

### 8.4.1 Soft Start

An internal soft start limits the inrush current when the device is being enabled.

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## Device Functional Modes (continued)

### 8.4.2 Normal Mode and Skip Mode Operation

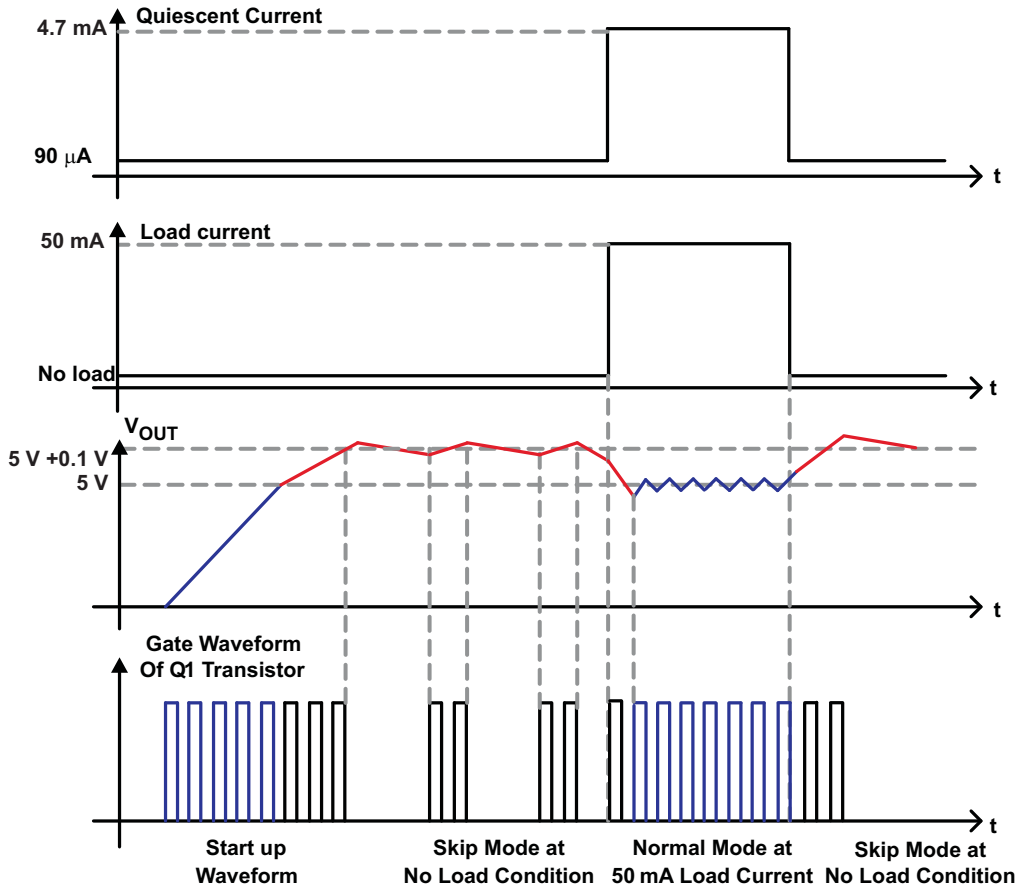



**Figure 7. Normal Mode and Skip Mode Operation**

The TPS60151 has skip mode operation as shown in Figure 7. The TPS60151 enters skip mode if the output voltage reaches 5 V + 0.1 V and the load current is below 8 mA (typical). In skip mode, the TPS60151 disables the oscillator and decreases the pre-bias current of the output stage to reduce the power consumption. Once the output voltage dips below threshold voltage, 5 V + 0.1 V, the TPS60151 begins switching to increase output voltage until the output reaches 5 V + 0.1 V. When the output voltage dips below 5 V, the TPS60151 returns to normal pulse width modulation (PWM) mode; thereby re-enabling the oscillator and increasing the pre-bias current of the output stage to supply output current.

The skip threshold voltage and current depend on input voltage and output current conditions.

### 8.4.3 Over-current Protection and Short-Circuit Protection

The TPS60151 has internal short circuit protection to protect the IC when the output is over loaded or shorted to ground. Figure 8 illustrates the protection circuit. $I_P$ is directly related to $I_{OUT}$ and the maximum $I_P$ is clamped by IR3*k*n. The TPS60151 ensures a current limit of 500 mA or less which is mandated by the HDMI electrical specification. To further avoid damage when output is shorted to ground, the short circuit protection circuitry senses the output voltage and adjusts $V_{bias}$ down to clamp the maximum output current to a lower value –80 mA (typical).


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## Device Functional Modes (continued)

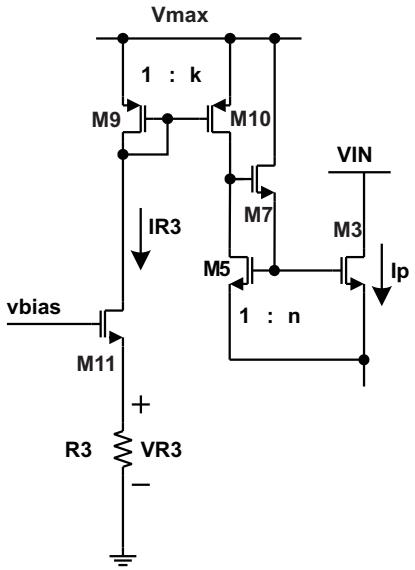



**Figure 8. Current Limit**

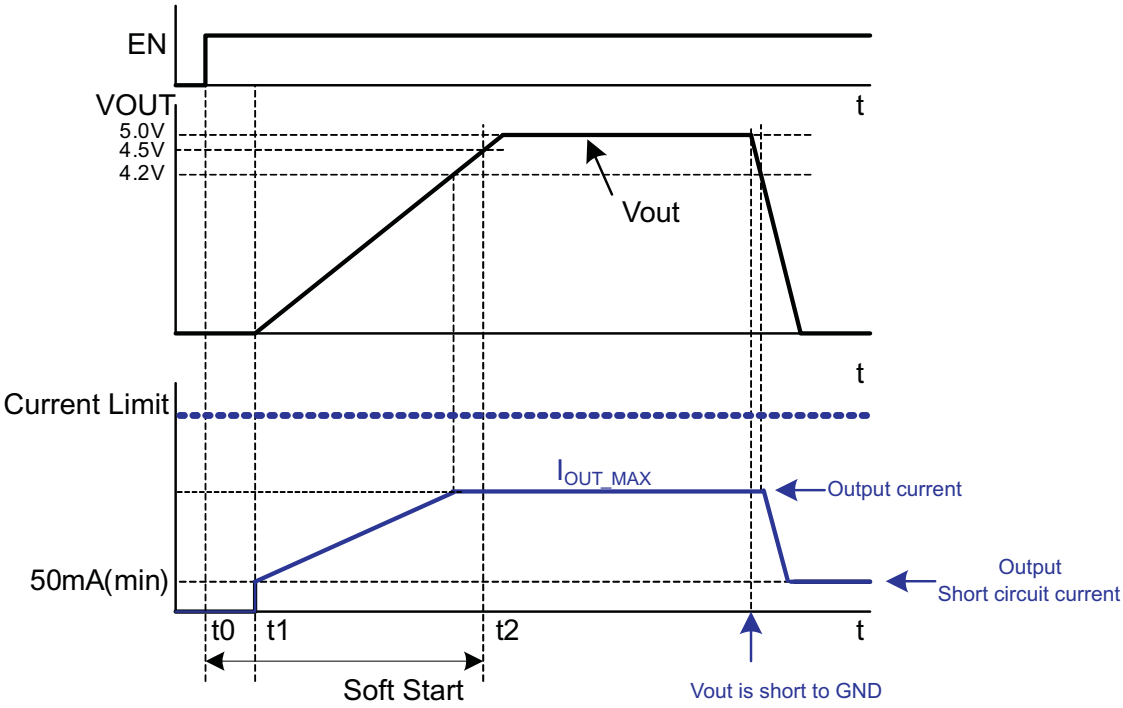



**Figure 9. Maximum Output Current Capability and Short Circuit Protection**

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# 9 Application and Implementation

**NOTE**

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.

## 9.1 Application Information

Most of today's battery-powered portable electronics allow and/or require data transfer with a PC. One of the fastest data transfer protocols is via USB OTG. As Figure 10 shows, the USB OTG circuitry in the portable device requires a 5-V power rail and up to 140mA of current. The HDMI specification calls for a 5-V power rail that can source 55mA or more current. The TPS60151 may be used to provide a 5-V power rail in a battery powered system.

Alternatively, low-cost portable electronics with small LCD displays require a low-cost solution for providing the WLED backlight. As shown in Figure 26, the TPS60151 can also be used to drive several WLEDs in parallel, with the help of ballast resistors.

## 9.2 Typical Application

Figure 10 shows USB OTG circuitry.

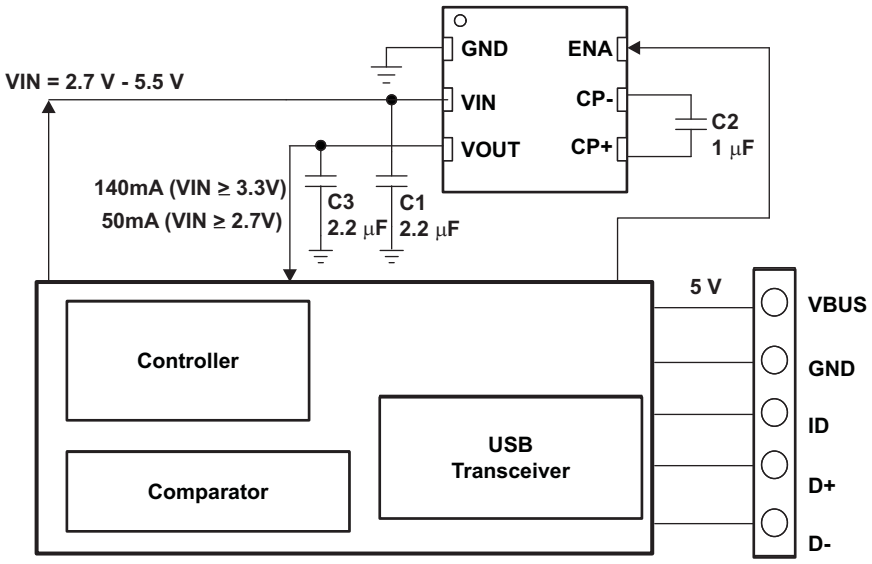



**Figure 10. Application Circuit for OTG System**

### 9.2.1 Design Requirements

The design guideline provides a component selection to operate the device within the recommended operating conditions.

### 9.2.2 Detailed Design Procedure

#### *9.2.2.1 Capacitor Selection*

For minimum output voltage ripple, the output capacitor ($C_{OUT}$) should be a surface-mount ceramic capacitor. Tantalum capacitors generally have a higher effective series resistance (ESR) and may contribute to higher output voltage ripple. Leaded capacitors also increase ripple due to the higher inductance of the package itself. To achieve the best operation with low input voltage and high load current, the input and flying capacitors ($C_{IN}$ and $C_{FLY}$, respectively) should also be surface-mount ceramic types.


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## Typical Application (continued)

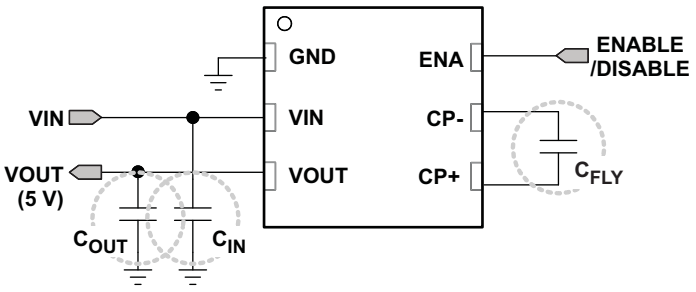



**Figure 11. Capacitors**

Generally, $C_{FLY}$ can be calculated by the following simple equation,

$$Q_{charging} = c \times v = C_{FLY} \times \Delta V_{CFLY},$$

$$Q_{discharging} = i_{discharge} \times t = 2 \times I_{LOAD(MAX)} \times \left(\frac{T}{2}\right), \text{ half duty.} \quad (2)$$

$$\therefore 2 \times I_{LOAD(MAX)} \times \left(\frac{T}{2}\right) = C_{FLY} \times \Delta V_{CFLY}$$

Both equation should be same,

$$\therefore C_{FLY} \geq \frac{2 \times I_{LOAD(MAX)} \times \left(\frac{T}{2}\right)}{\Delta V_{CFLY}} = \frac{I_{LOAD(MAX)}}{\Delta V_{CFLY} \times f} \quad (3)$$

If $I_{LOAD}$ = 140 mA, f = 1.5 MHz, and $\Delta V_{CFLY}$ = 100 mV, the minimum value of the flying capacitor should be 1 μF.

Output capacitance, $C_{OUT}$, is also strongly related to output ripple voltage and loop stability,

$$V_{OUT(RIPPLE)} = \frac{I_{LOAD(MAX)}}{(2 \times f \times C_{OUT})} + 2I_{LOAD(MAX)} \times ESR_{COUT} \quad (4)$$

The minimum output capacitance for all output levels is 2.2 μF due to control stability. Larger ceramic capacitors or low ESR capacitors can be used to lower the output ripple voltage.

**Table 1. Suggested Capacitors (Input / Output / Flying Capacitor)**

| VALUE | DIELECTRIC MATERIAL | PACKAGE SIZE | RATED VOLTAGE |
|---|---|---|---|
| 4.7 μF | X5R or X7R | 0603 | 10 V |
| 2.2 μF | X5R or X7R | 0603 | 10 V |

The efficiency of the charge pump regulator varies with the output voltage, the applied input voltage and the load current.

The approximate efficiency in normal operating mode is given by:

$$\text{Efficiency}(\%) = \frac{PD(out)}{PD(in)} \times 100 = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times I_{IN}} \times 100, \; I_{IN} = 2 \times I_{OUT} + I_Q \quad (5)$$

$$\text{Efficiency}(\%) = \frac{V_{OUT}}{2 \times V_{IN}} \times 100 \; (I_{IN} = 2 \times I_{OUT}) \quad \text{Quiescent current was neglected.} \quad (6)$$

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### 9.2.3 Application Curves

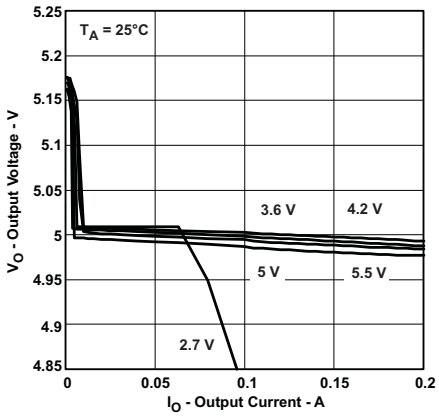



**Figure 12. Output Voltage vs Output Current**

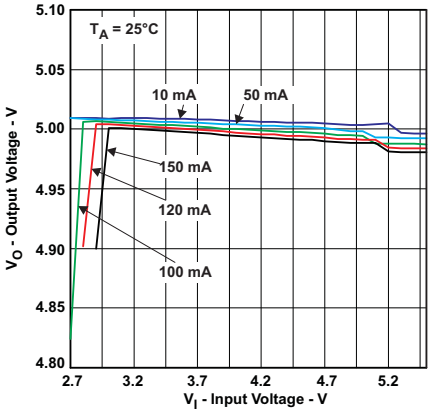



**Figure 13. Output Voltage vs Input Voltage**

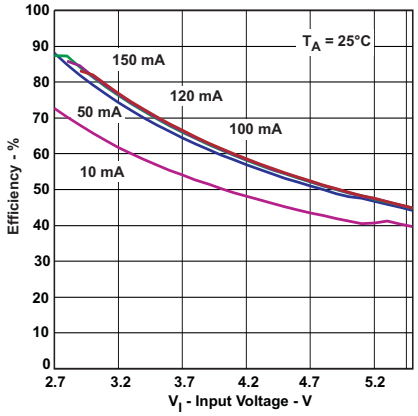
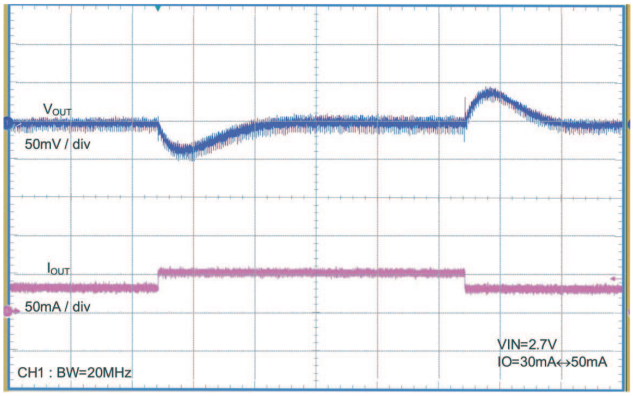
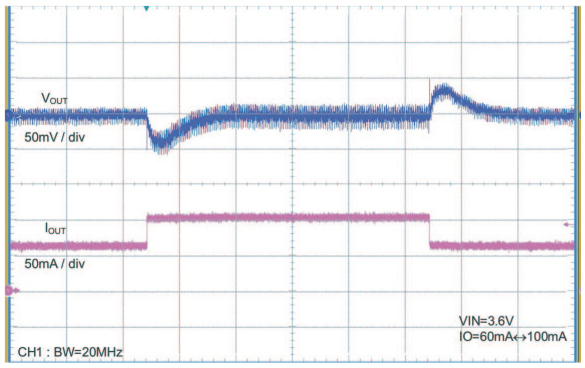



**Figure 14. Efficiency vs Input Voltage**



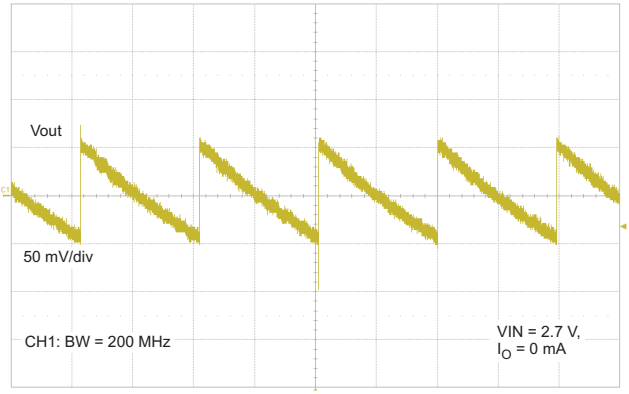

**20 µs/div**

**Figure 15. Load Transient Response**
**$V_{IN}$ = 2.7 V, Io = 30 mA to 50 mA**




**20 µs/div**

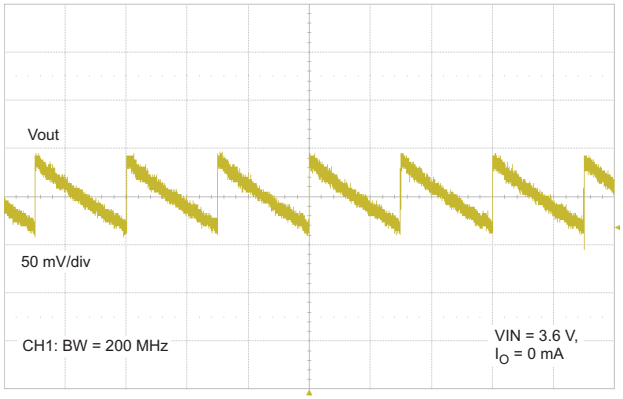
**Figure 16. Load Transient Response**
**$V_{IN}$ = 3.6 V, Io = 60 mA to 100 mA**




**5 ms/div**

**Figure 17. Output Ripple**
**$V_{CC}$ = 2.7 V, Io = 0 mA**

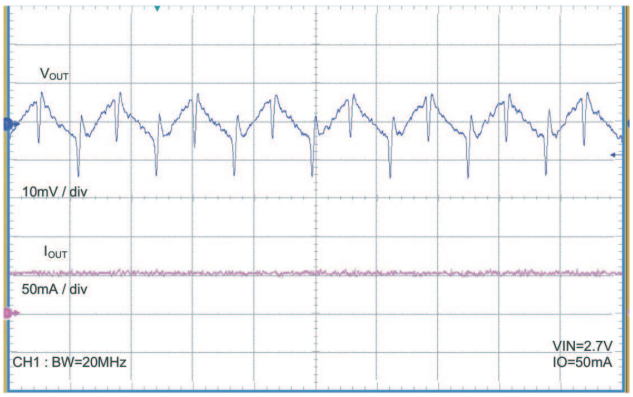

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**5 ms/div**

**Figure 18. Load Transient**

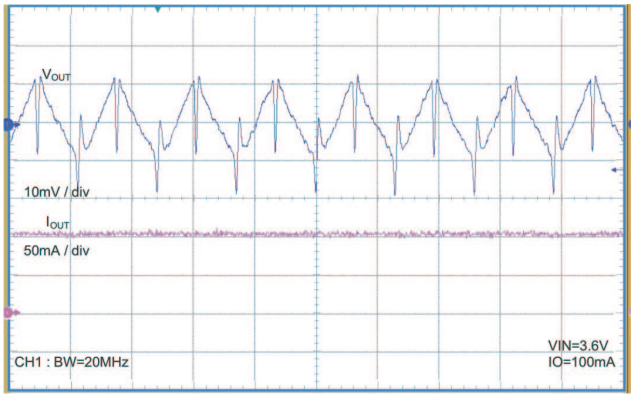
**$V_{CC}$ = 3.6 V, Io = 0 mA**




**500 ns/div**

**Figure 19. Output Ripple Voltage (Normal Mode)**

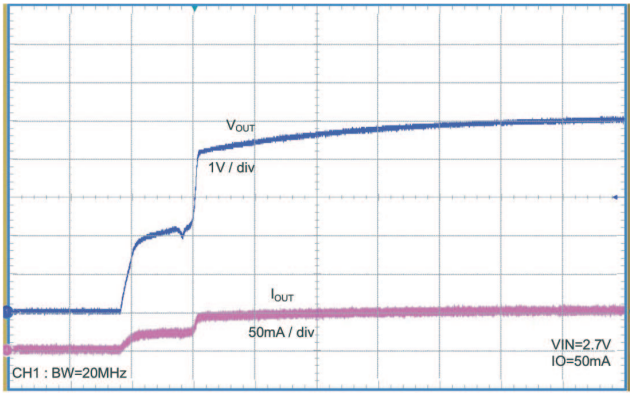
**$V_{IN}$ = 2.7 V, Io = 50 mA**




**500 ns/div**

**Figure 20. Output Ripple (Normal Mode)**

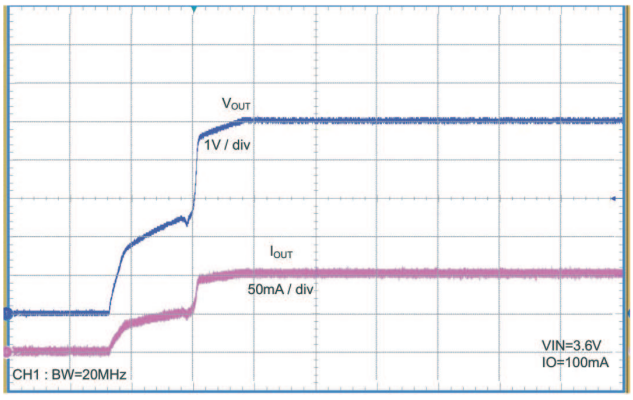
**$V_{IN}$ = 3.6 V, Io = 100 mA**




**1 ms/div**

**Figure 21. Power On**

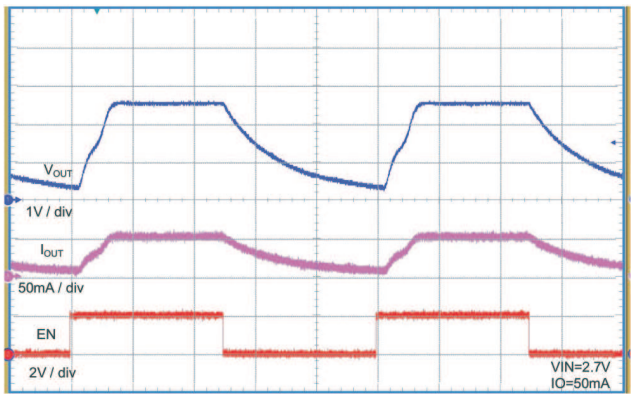
**$V_{IN}$ = 2.7 V, Io = 50 mA**




**1 ms/div**

**Figure 22. Power On**

**$V_{IN}$ = 3.6 V, Io = 100 mA**

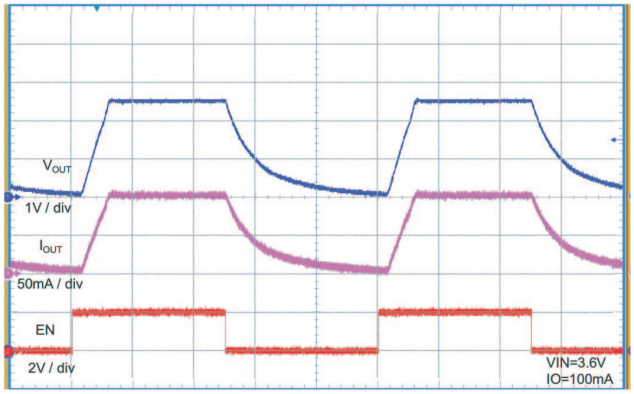



**200 µs/div**

**Figure 23. Enable / Disable**

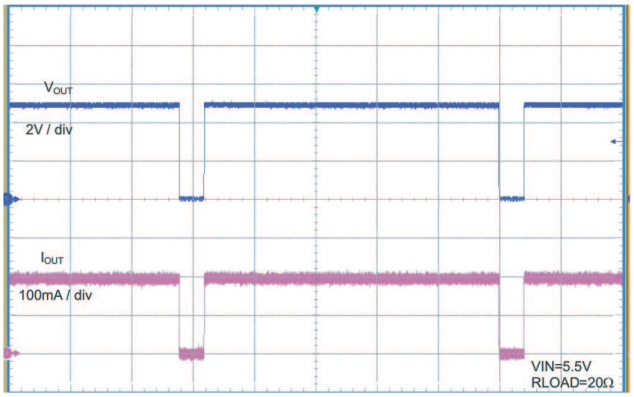
**$V_{IN}$ = 2.7 V, Io = 50 mA**

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200 μs/div

**Figure 24. Enable / Disable**
**$V_{IN}$ = 3.6 V, Io = 100 mA**




50 ms/div

**Figure 25. Thermal Shutdown Operation**
**$V_{IN}$ = 5.5 V, $R_{LOAD}$= 20 Ω**

## 9.3 System Example

### 9.3.1 Circuit for Driving White LEDs

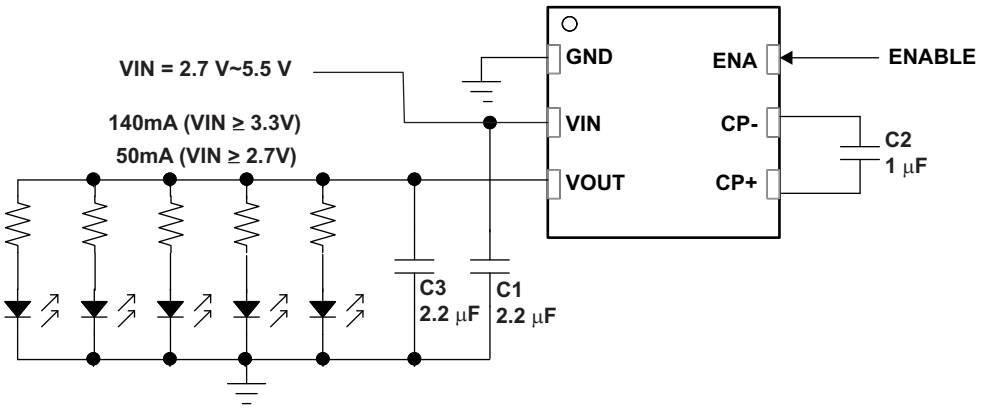



**Figure 26. Application Circuit for Driving White LEDs**


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# 10 Power Supply Recommendations

The TPS60151 has no special requirements for its input power supply. The input power supply's output current needs to be rated according to the supply voltage, output voltage and output current of the TPS60151.

# 11 Layout

## 11.1 Layout Guidelines

Large transient currents flow in the VIN, VOUT, and GND traces. To minimize both input and output ripple, keep the capacitors as close as possible to the regulator using short, direct circuit traces.

## 11.2 Layout Example

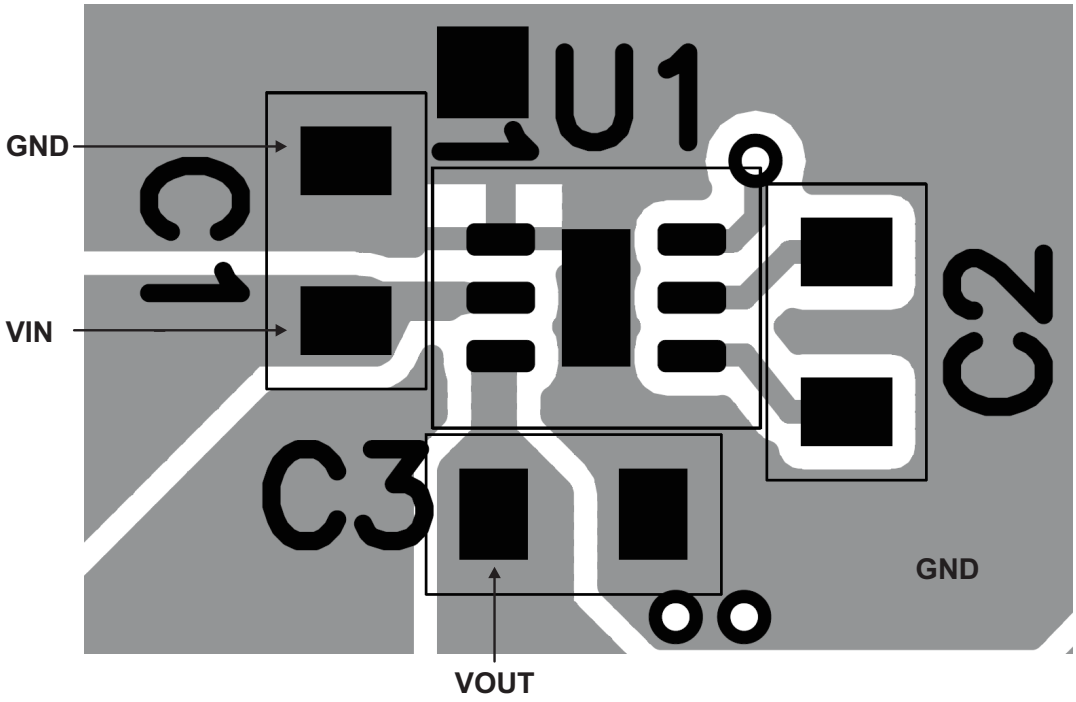



**Figure 27. Recommended PCB Layout**

# 12 器件和文档支持

## 12.1 接收文档更新通知

要接收文档更新通知，请导航至 TI.com.cn 上的器件产品文件夹。单击右上角的*通知我*进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

## 12.2 社区资源

**下列链接提供到 TI 社区资源的连接。链接的内容由各个分销商“按照原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 《使用条款》。**

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**设计支持** ***TI 参考设计支持*** **可帮助您快速查找有帮助的 E2E 论坛、设计支持工具以及技术支持的联系信息。**

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## 12.4 静电放电警告



这些装置包含有限的内置 ESD 保护。 存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

## 12.5 术语表

SLYZ022 — *TI 术语表*。

这份术语表列出并解释术语、缩写和定义。

# 13 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。


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## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| TPS60151DRVR | Active | Production | WSON (DRV) \| 6 | 3000 \| LARGE T&R | Yes | NIPDAU \| NIPDAUAG | Level-1-260C-UNLIM | -40 to 85 | OCN |
| TPS60151DRVR.A | Active | Production | WSON (DRV) \| 6 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | OCN |
| TPS60151DRVRG4 | Active | Production | WSON (DRV) \| 6 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | OCN |
| TPS60151DRVRG4.A | Active | Production | WSON (DRV) \| 6 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | OCN |
| TPS60151DRVT | Active | Production | WSON (DRV) \| 6 | 250 \| SMALL T&R | Yes | NIPDAU \| NIPDAUAG | Level-1-260C-UNLIM | -40 to 85 | OCN |
| TPS60151DRVT.A | Active | Production | WSON (DRV) \| 6 | 250 \| SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | OCN |

(1) **Status:** For more details on status, see our product life cycle.

(2) **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.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **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.

(5) **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.

(6) **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.

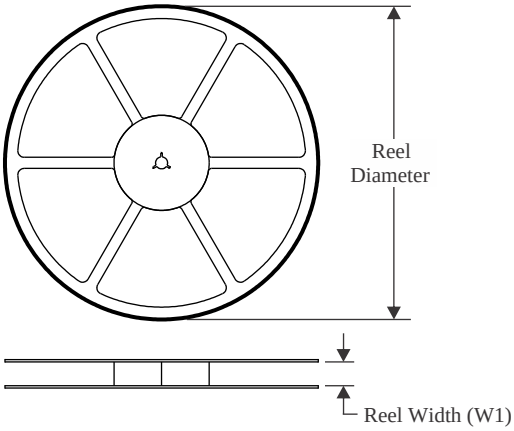
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

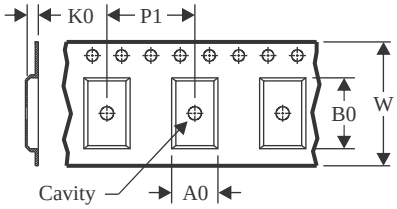
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

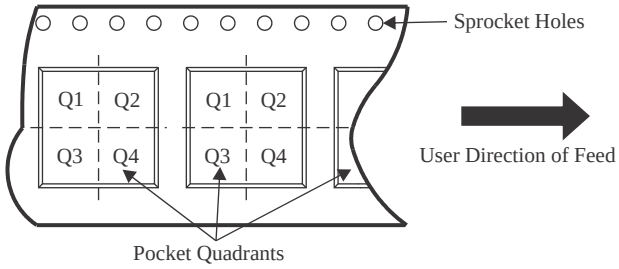



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

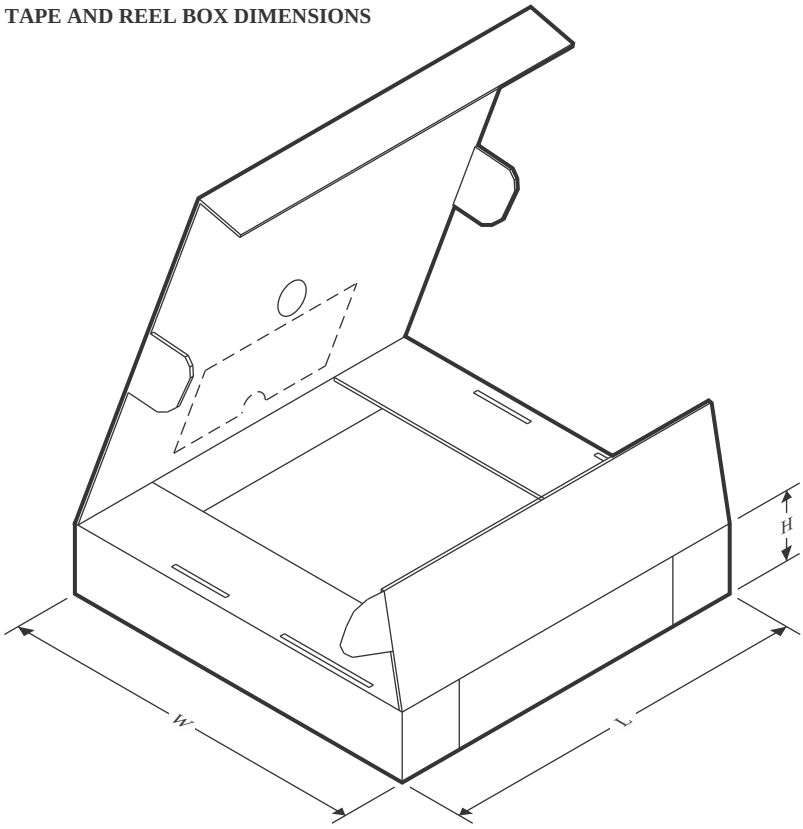
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPS60151DRVR | WSON | DRV | 6 | 3000 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| TPS60151DRVR | WSON | DRV | 6 | 3000 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| TPS60151DRVRG4 | WSON | DRV | 6 | 3000 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| TPS60151DRVT | WSON | DRV | 6 | 250 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS

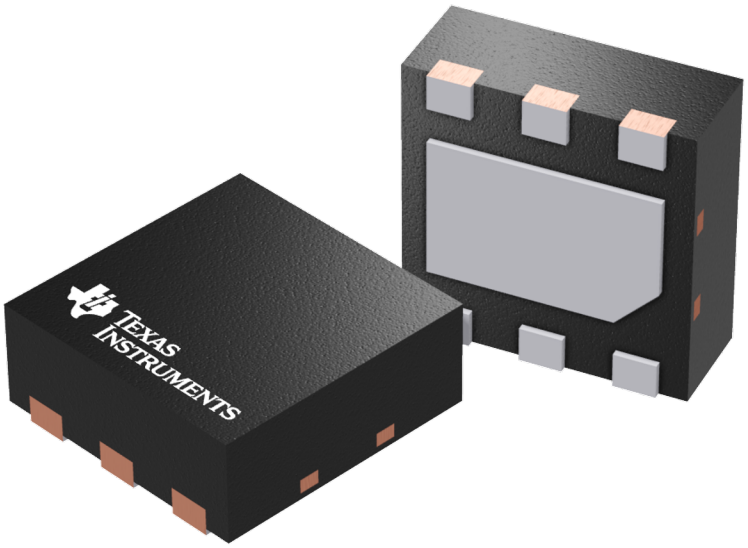



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TPS60151DRVR | WSON | DRV | 6 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS60151DRVR | WSON | DRV | 6 | 3000 | 213.0 | 191.0 | 35.0 |
| TPS60151DRVRG4 | WSON | DRV | 6 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS60151DRVT | WSON | DRV | 6 | 250 | 182.0 | 182.0 | 20.0 |

# DRV 6 WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



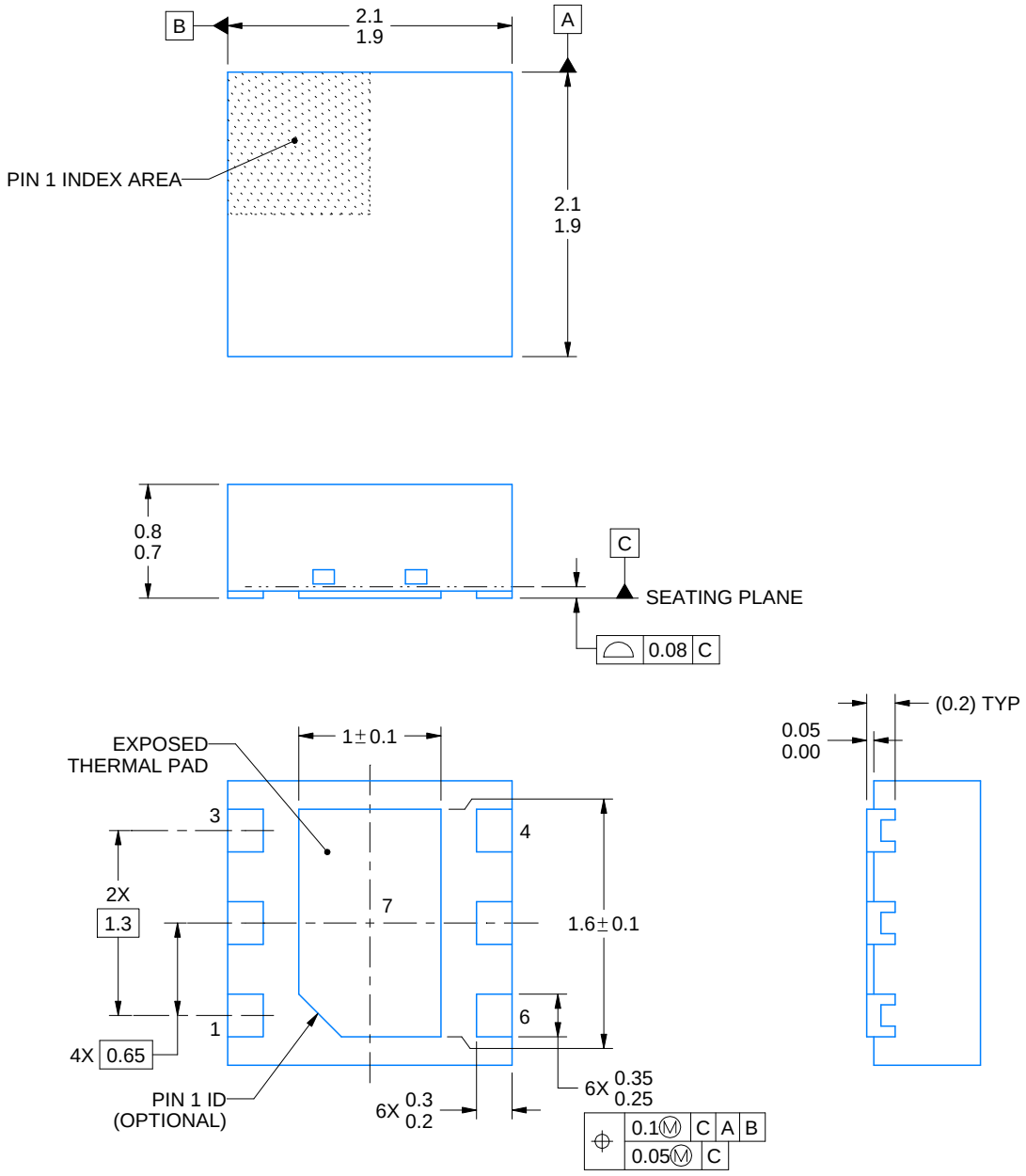

Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

# DRV0006D

# PACKAGE OUTLINE

## WSON - 0.8 mm max height

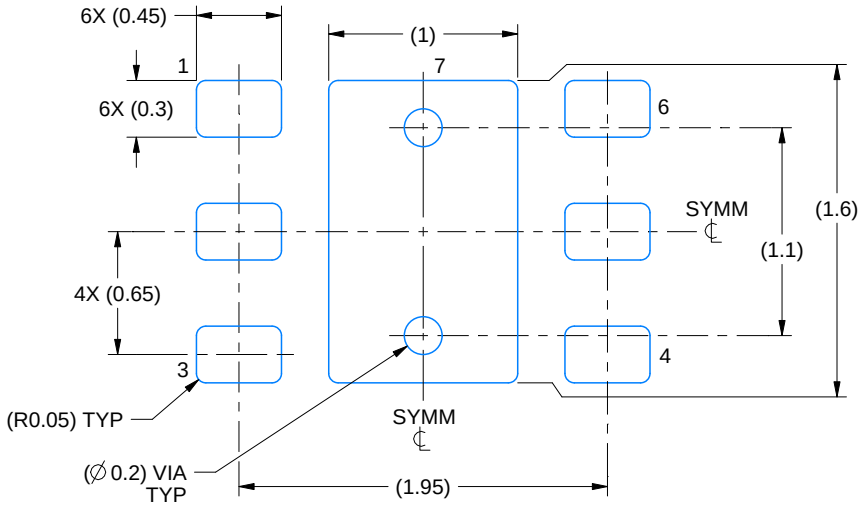
PLASTIC SMALL OUTLINE - NO LEAD



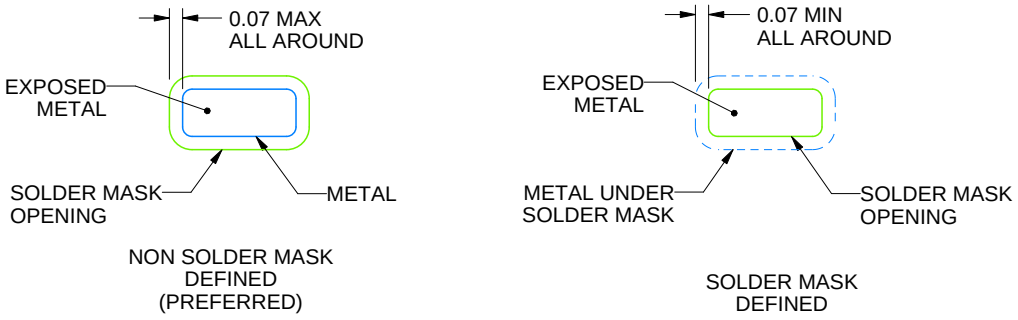

4225563/A 12/2019

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:25X

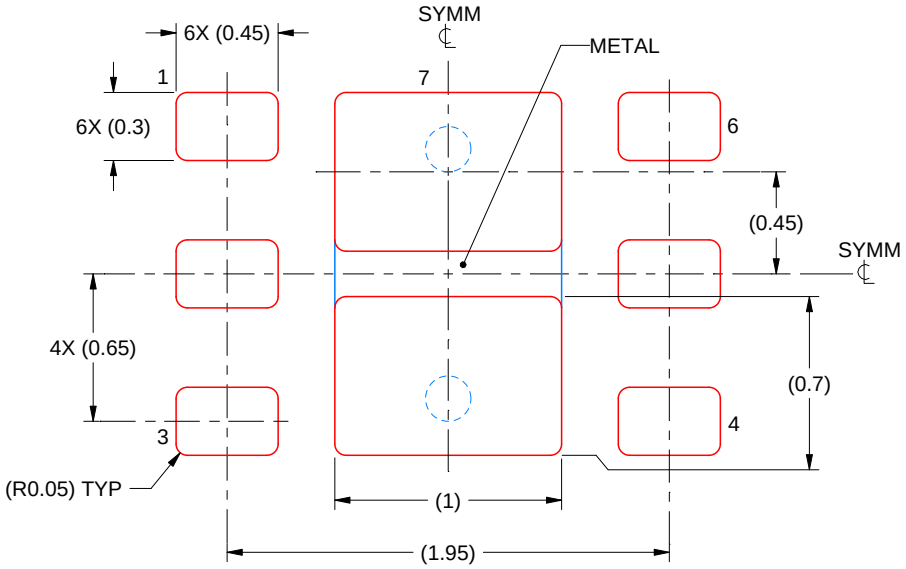



SOLDER MASK DETAILS

4225563/A 12/2019

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.



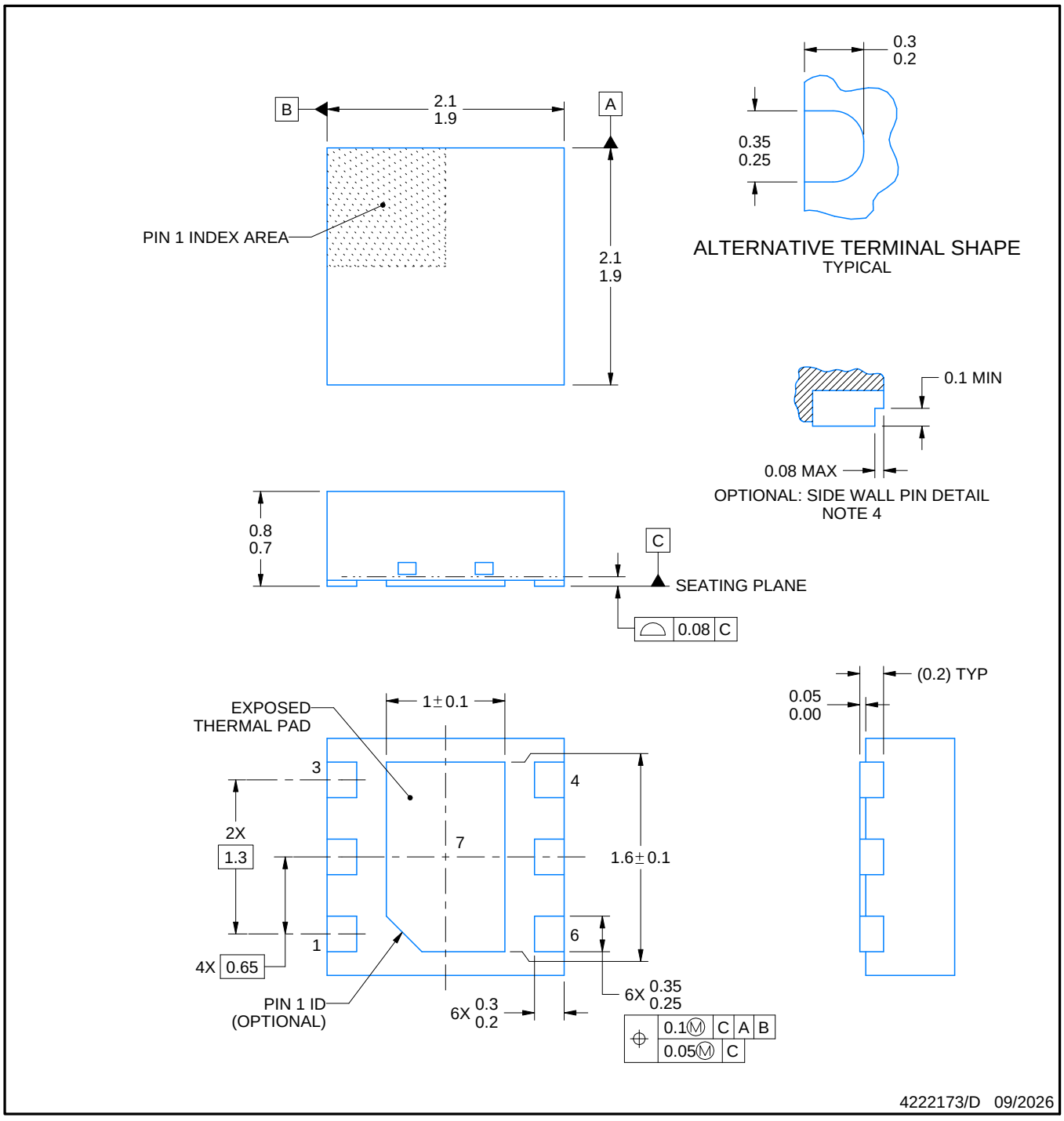

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD #7
88% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:30X

4225563/A 12/2019

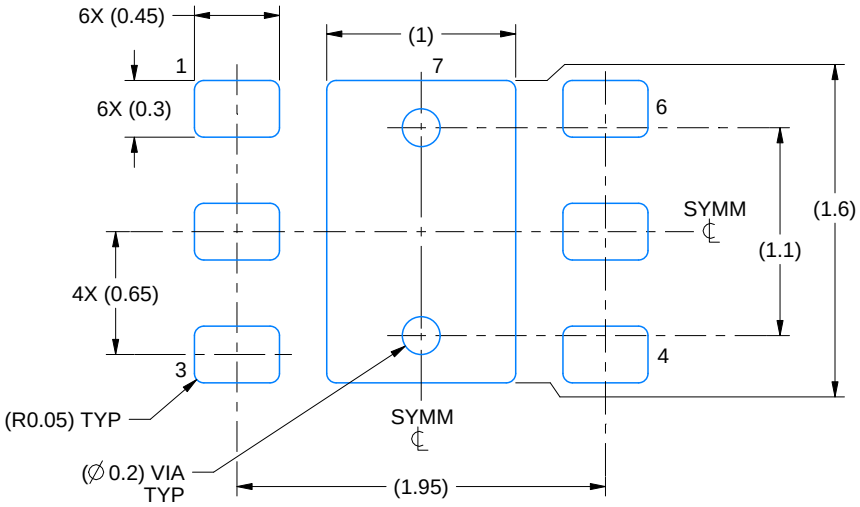
NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

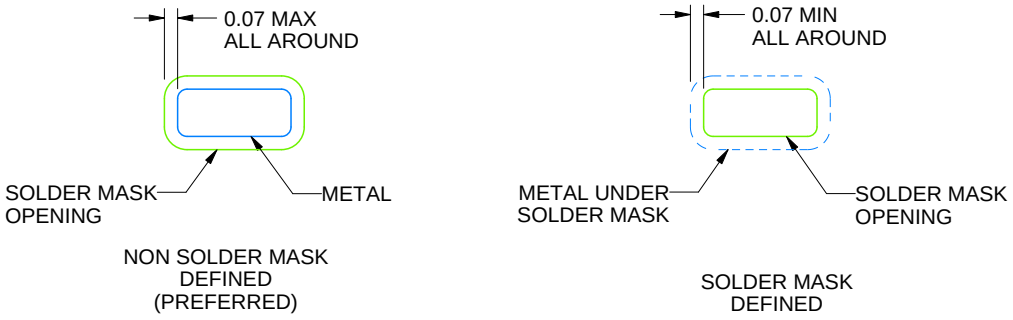



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.
4. Minimum 0.1 mm solder wetting on pin side wall. Available for wettable flank version only.




LAND PATTERN EXAMPLE
SCALE:25X

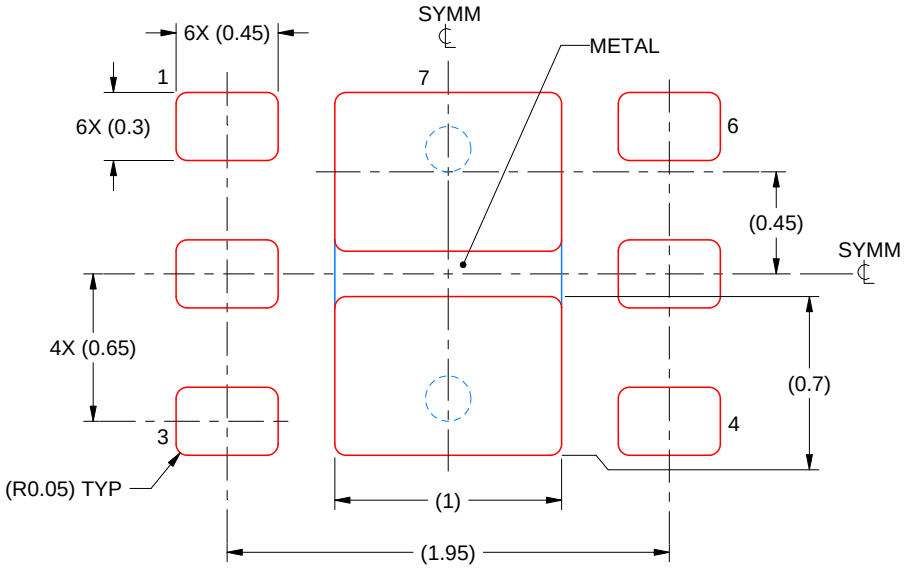



SOLDER MASK DETAILS

4222173/D 09/2026

NOTES: (continued)

5. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
6. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD #7
88% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:30X

4222173/D 09/2026

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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