

## 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 90 $\mu$ A 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  $\times$  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 90 $\mu$ A。

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。

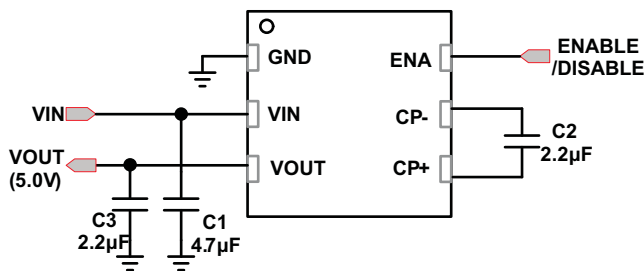
TPS60151 在自然通风环境下的额定运行温度范围为  $-40^{\circ}\text{C}$  至  $85^{\circ}\text{C}$ 。该器件采用小尺寸 2mm  $\times$  2mm 6 引脚 SON 封装 (QFN)。

#### 器件信息<sup>(1)</sup>

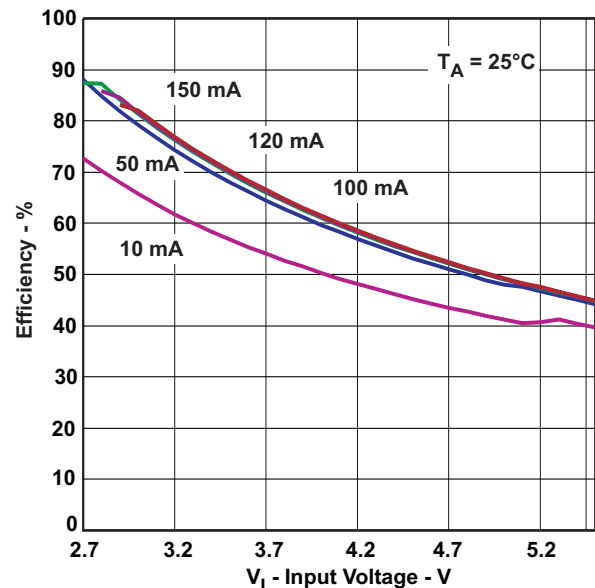
| 器件型号     | 封装       | 封装尺寸（标称值）              |
|----------|----------|------------------------|
| TPS60151 | WSON (6) | 2.00mm $\times$ 2.00mm |

(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



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## 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。

| <b>Changes from Revision A (October 2015) to Revision B</b>                               | <b>Page</b> |
|-------------------------------------------------------------------------------------------|-------------|
| • Added row for $V_{OUT}$ spec -- $3.1\text{ V} \leq V_{IN} < 5.5\text{ V}$ .....         | <b>5</b>    |
| • Added row for $V_{OUT(skip)}$ V spec -- $3.1\text{ V} \leq V_{IN} < 5.5\text{ V}$ ..... | <b>5</b>    |

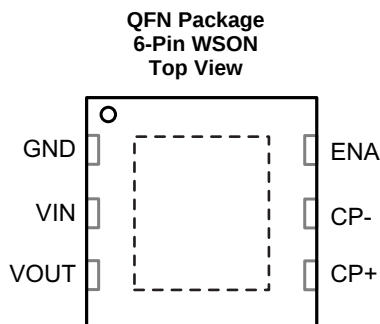
| <b>Changes from Original (August 2009) to Revision A</b>                                           | <b>Page</b> |
|----------------------------------------------------------------------------------------------------|-------------|
| • 已添加 引脚配置和功能 部分、ESD 额定值 表、特性 说明 部分、器件功能模式、应用和实施 部分、电源建议 部分、布局 部分、器件和文档支持 部分以及机械、封装和可订购信息 部分 ..... | <b>1</b>    |

## 5 Device Comparison Table

| PART NUMBER <sup>(1)</sup> | 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



**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) |

## 7 Specifications

### 7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

|                  |                                        | MIN  | MAX | UNIT |
|------------------|----------------------------------------|------|-----|------|
| V <sub>IN</sub>  | Input voltage (all pins)               | −0.3 | 7   | V    |
| T <sub>A</sub>   | Operating temperature                  | −40  | 85  | °C   |
| T <sub>J</sub>   | Maximum operating junction temperature |      | 150 | °C   |
| T <sub>stg</sub> | 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 <sub>(ESD)</sub> | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)(2)</sup>           | ±2000 |
|                    |                         | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(3)</sup> | ±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 <sub>IN</sub>  | Input voltage                  | 2.7 |     | 5.5 | V    |
| T <sub>A</sub>   | Operating ambient temperature  | −40 |     | 85  | °C   |
| T <sub>J</sub>   | Operating junction temperature | −40 |     | 125 | °C   |
| C <sub>IN</sub>  | Input capacitor                | 2.2 |     |     | μF   |
| C <sub>OUT</sub> | Output capacitor               | 2.2 |     |     | μF   |
| C <sub>F</sub>   | Flying capacitor               | 1.0 |     |     | μF   |

### 7.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                              | TPS60151  | UNIT |
|-------------------------------|----------------------------------------------|-----------|------|
|                               |                                              | DRV (WSN) |      |
|                               |                                              | 6 PINS    |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 69.1      | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 79.8      | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 38.6      | °C/W |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 1.2       | °C/W |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 38.4      | °C/W |
| R <sub>θJC(bot)</sub>         | 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](#).

## 7.5 Electrical Characteristics

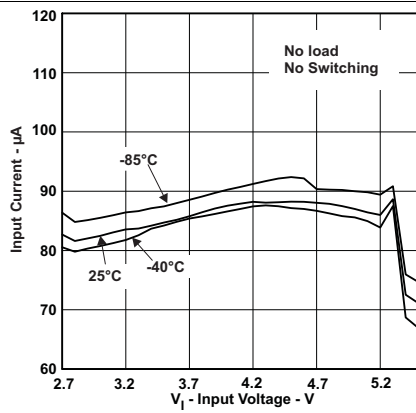
$V_{IN} = 3.6\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , typical values are at  $T_A = 25^\circ\text{C}$ ,  $C_1 = C_3 = 2.2\text{ }\mu\text{F}$ ,  $C_2 = 1\text{ }\mu\text{F}$  (unless otherwise noted)

| PARAMETER               |                                       | TEST CONDITIONS                                                                         | MIN             | TYP | MAX      | UNIT             |
|-------------------------|---------------------------------------|-----------------------------------------------------------------------------------------|-----------------|-----|----------|------------------|
| <b>POWER STAGE</b>      |                                       |                                                                                         |                 |     |          |                  |
| $V_{IN}$                | Input voltage range                   |                                                                                         | 2.7             |     | 5.5      | V                |
| $V_{UVLO}$              | Undervoltage lockout threshold        |                                                                                         |                 | 1.9 | 2.1      | V                |
| $I_Q$                   | Operating quiescent current           | $I_{OUT} = 140\text{ mA}$ , Enable = $V_{IN}$                                           |                 | 4.7 |          | mA               |
| $I_{Qskip}$             | Skip mode operating quiescent current | $I_{OUT} = 0\text{ mA}$ , Enable = $V_{IN}$ (no switching)                              |                 | 80  |          | $\mu\text{A}$    |
|                         |                                       | $I_{OUT} = 0\text{ mA}$ , Enable = $V_{IN}$ (minimum switching)                         |                 | 90  |          | $\mu\text{A}$    |
| $I_{SD}$                | Shutdown current                      | $2.7\text{ V} \leq V_{IN} \leq 5.5\text{ V}$ , Enable = 0 V                             |                 | 4   | 10       | $\mu\text{A}$    |
| $V_{OUT}$               | Output voltage <sup>(1)</sup>         | $I_{OUT} \leq 50\text{ mA}$ , $2.7\text{ V} \leq V_{IN} < 5.5\text{ V}$                 | 4.8             | 5   | 5.2      | V                |
|                         |                                       | $I_{OUT} \leq 50\text{ mA}$ , $3.1\text{ V} \leq V_{IN} < 5.5\text{ V}$                 | 4.8             | 5   | 5.15     | V                |
| $V_{OUT(skip)}$         | Skip mode output voltage              | $I_{OUT} = 0\text{ mA}$ , $2.7\text{ V} \leq V_{IN} \leq 5.5\text{ V}$                  | $V_{OUT} + 0.1$ |     |          | V                |
|                         |                                       | $I_{OUT} = 0\text{ mA}$ , $3.1\text{ V} \leq V_{IN} \leq 5.5\text{ V}$                  | $V_{OUT} + 0.1$ |     | 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 |          | $\mu\text{s}$    |
| <b>OUTPUT CURRENT</b>   |                                       |                                                                                         |                 |     |          |                  |
| $I_{OUT\_nom}$          | Maximum output current                | $V_{OUT}$ remains between 4.8 V and 5.2 V, $3.1\text{ V} \leq V_{IN} \leq 5.5\text{ V}$ | 120             |     |          | mA               |
|                         |                                       | $3.3\text{ V} < V_{IN} < 5.5\text{ V}$                                                  | 140             |     |          |                  |
| $I_{OUT\_max}$          | Current limit                         | $V_{OUT} = 4.5\text{ V}$                                                                |                 |     | 500      | mA               |
| $I_{OUT\_short}$        | Short circuit current <sup>(2)</sup>  | $V_{OUT} = 0\text{ V}$                                                                  |                 | 80  |          | mA               |
| <b>RIPPLE VOLTAGE</b>   |                                       |                                                                                         |                 |     |          |                  |
| $V_R$                   | Output ripple voltage                 | $I_{OUT} = 140\text{ mA}$                                                               |                 | 30  |          | mV               |
| <b>ENABLE CONTROL</b>   |                                       |                                                                                         |                 |     |          |                  |
| $V_{HI}$                | Logic high input voltage              | $2.7\text{ V} \leq V_{IN} \leq 5.5\text{ V}$                                            | 1.3             |     | $V_{IN}$ | V                |
| $V_{LI}$                | Logic low input voltage               |                                                                                         | -0.2            |     | 0.4      | V                |
| $I_{HI}$                | Logic high input current              |                                                                                         |                 |     | 1        | $\mu\text{A}$    |
| $I_{LI}$                | Logic low input current               |                                                                                         |                 |     | 1        | $\mu\text{A}$    |
| <b>THERMAL SHUTDOWN</b> |                                       |                                                                                         |                 |     |          |                  |
| $T_{SD}$                | Shutdown temperature                  |                                                                                         |                 | 160 |          | $^\circ\text{C}$ |
| $T_{RC}$                | Shutdown recovery                     |                                                                                         |                 | 140 |          | $^\circ\text{C}$ |

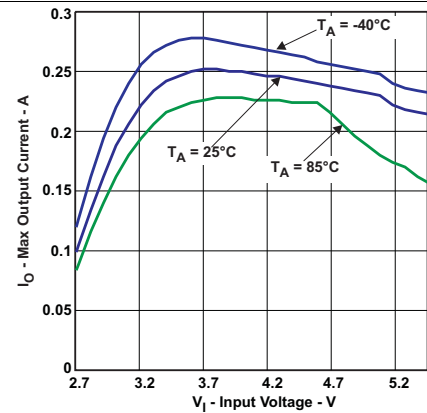
(1) When in skip mode, output voltage can exceed  $V_{OUT}$  spec because  $V_{OUT(skip)} = V_{OUT} + 0.1$ .

(2) TPS60151 has internal protection circuit to protect IC when  $V_{OUT}$  shorted to GND.

## 7.6 Typical Characteristics



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

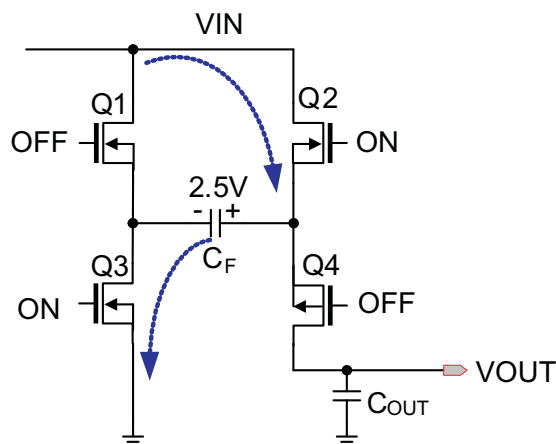


**Figure 2. Maximum Output Current vs Input Voltage at Temperature**

## 8 Detailed Description

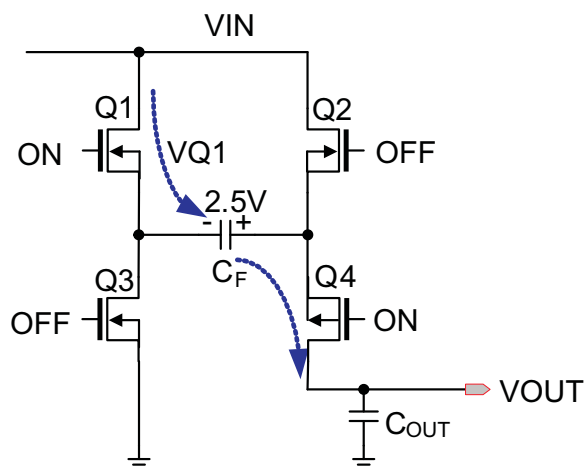
### 8.1 Overview

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:

$$V_{out} = V_{IN} - V_{Q1} + V(C_F) - V_{Q4} = V_{IN} - V_{Q1} + 2.5 \text{ V} - V_{Q4} = 5 \text{ V. (Ideal)} \quad (1)$$

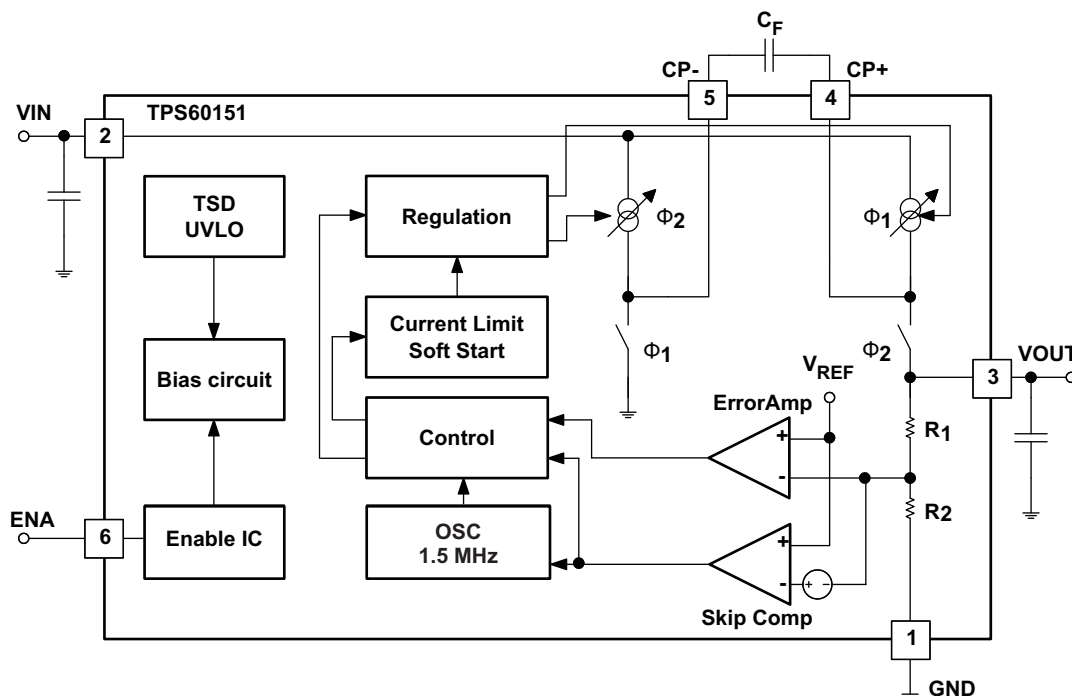
The output voltage is regulated by output feedback and an internally compensated voltage control loop.

## TPS60151

ZHCSJ97B –SEPTEMBER 2009–REVISED JANUARY 2019

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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  $\mu$ A 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.

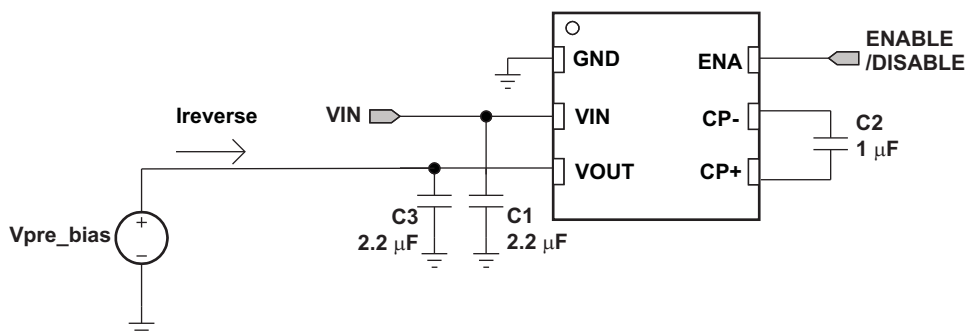
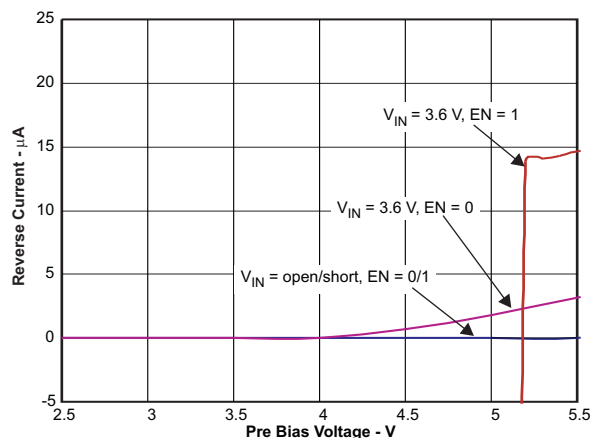


Figure 5. Output Reverse Current Test Setup

## 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.

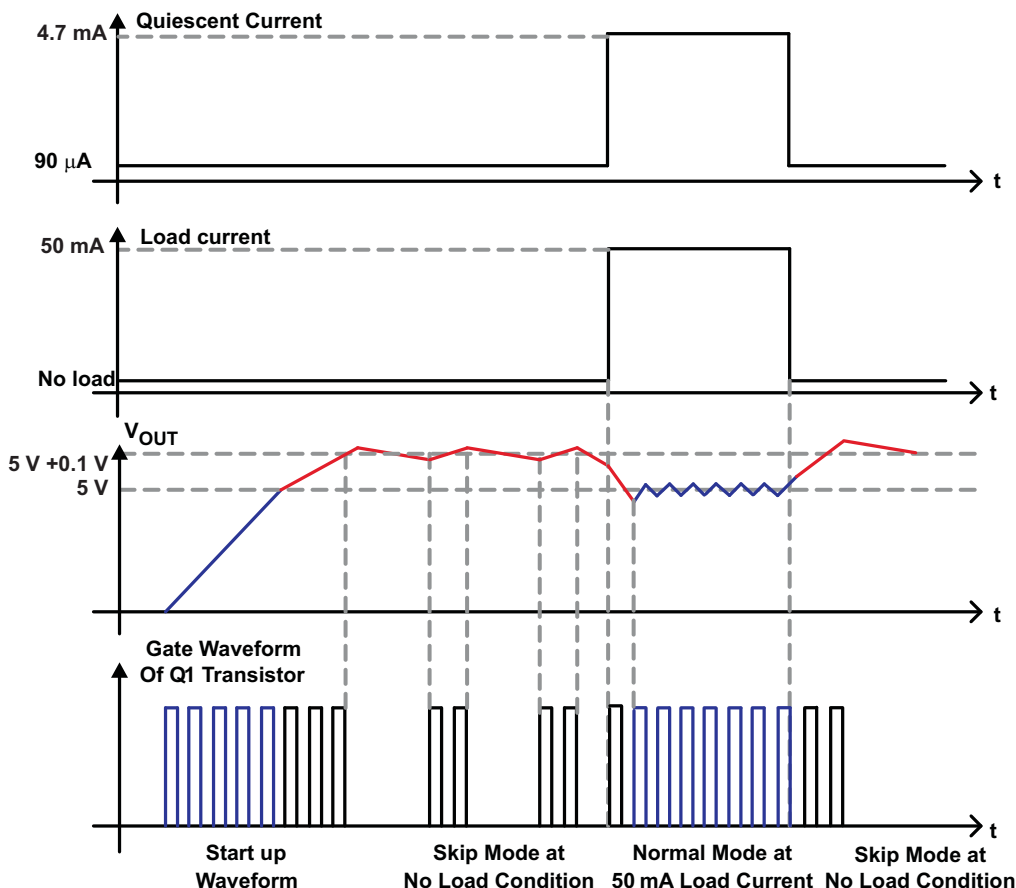
## 8.4 Device Functional Modes

### 8.4.1 Soft Start

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

## Device Functional Modes (continued)

### 8.4.2 Normal Mode and Skip Mode Operation



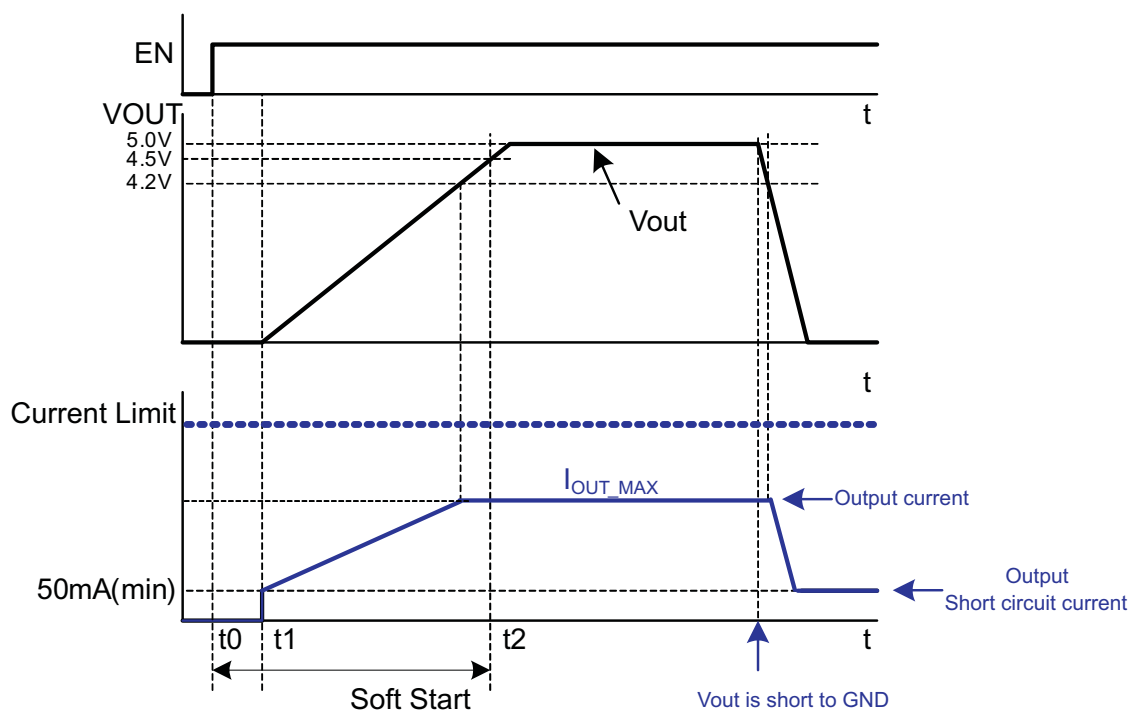
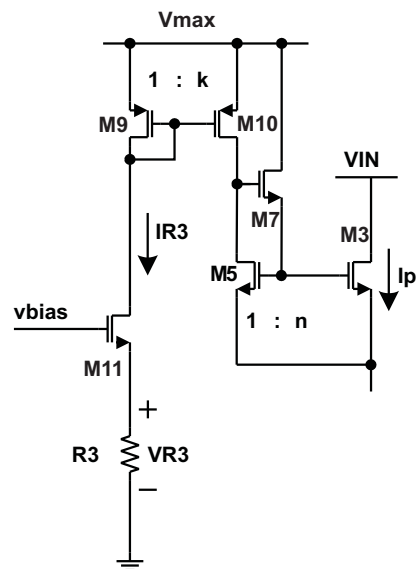
**Figure 7. Normal Mode and Skip Mode Operation**

The TPS60151 has skip mode operation as shown in Figure 7. The TPS60151 enters skip mode if the output voltage reaches  $5\text{ V} + 0.1\text{ V}$  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,  $5\text{ V} + 0.1\text{ V}$ , the TPS60151 begins switching to increase output voltage until the output reaches  $5\text{ V} + 0.1\text{ V}$ . 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  $IR3 \cdot k \cdot n$ . 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).



## 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.

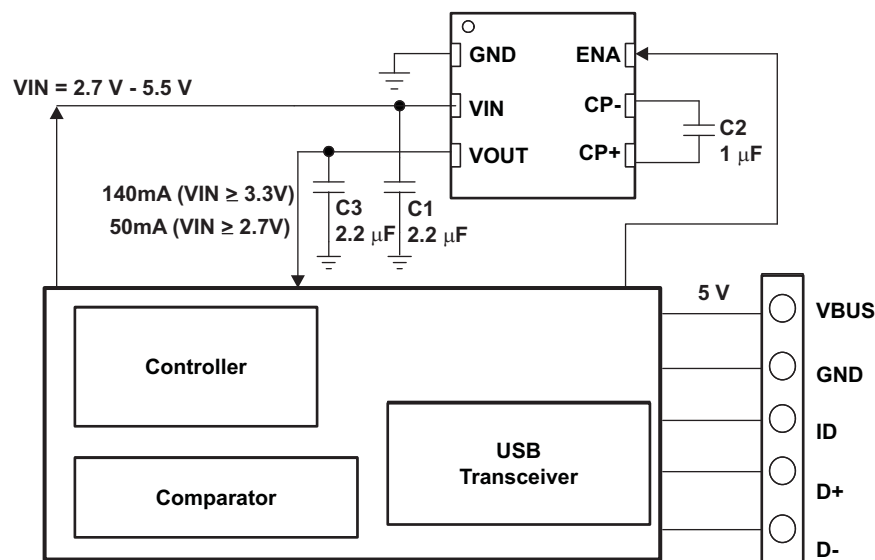
### 9.1 Application Information

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

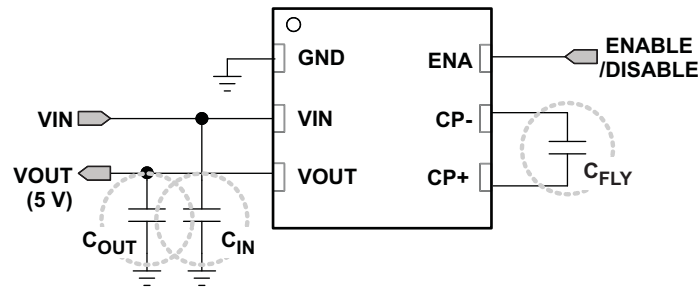
The design guideline provides a component selection to operate the device within the recommended operating conditions.

#### 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.

## Typical Application (continued)



**Figure 11. Capacitors**

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

$$Q_{\text{charging}} = C \times V = C_{FLY} \times \Delta V_{CFLY},$$

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

Both equation should be same,  $\therefore 2 \times I_{\text{LOAD(MAX)}} \times \left(\frac{T}{2}\right) = C_{FLY} \times \Delta V_{CFLY}$

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

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

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

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

The minimum output capacitance for all output levels is  $2.2 \mu\text{F}$  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 $\mu\text{F}$ | X5R or X7R          | 0603         | 10 V          |
| 2.2 $\mu\text{F}$ | X5R or X7R          | 0603         | 10 V          |

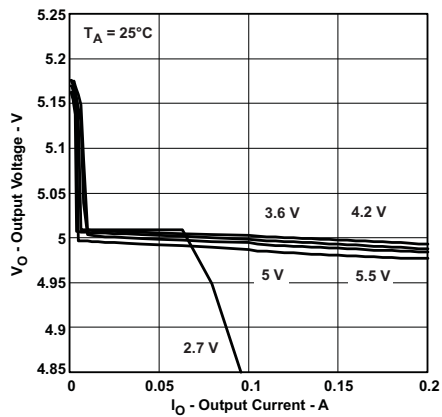
The efficiency of the charge pump regulator varies with the output voltage, the applied input voltage and the load current.

The approximate efficiency in normal operating mode is given by:

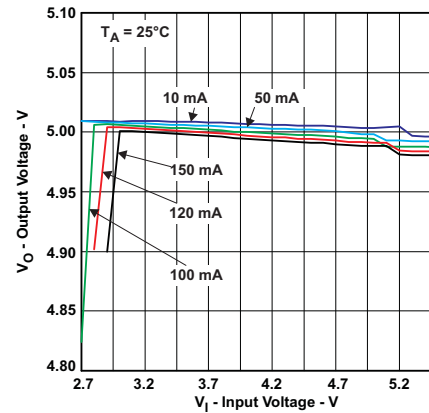
$$\text{Efficiency(\%)} = \frac{\text{PD(out)}}{\text{PD(in)}} \times 100 = \frac{V_{\text{OUT}} \times I_{\text{OUT}}}{V_{\text{IN}} \times I_{\text{IN}}} \times 100, I_{\text{IN}} = 2 \times I_{\text{OUT}} + I_{\text{Q}} \quad (5)$$

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

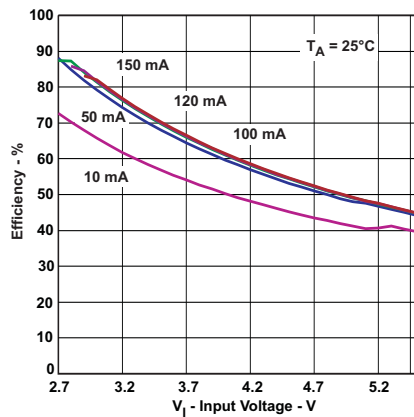
## 9.2.3 Application Curves



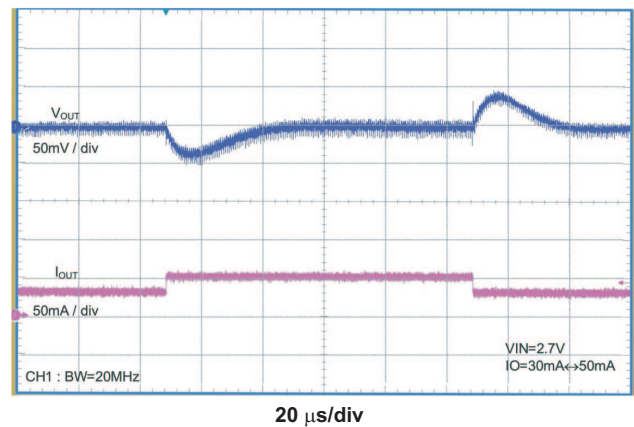
**Figure 12. Output Voltage vs Output Current**



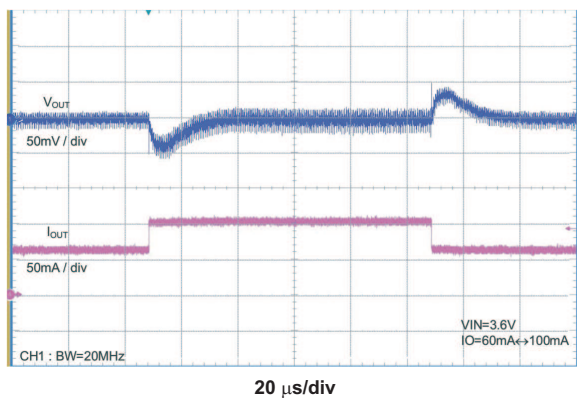
**Figure 13. Output Voltage vs Input Voltage**



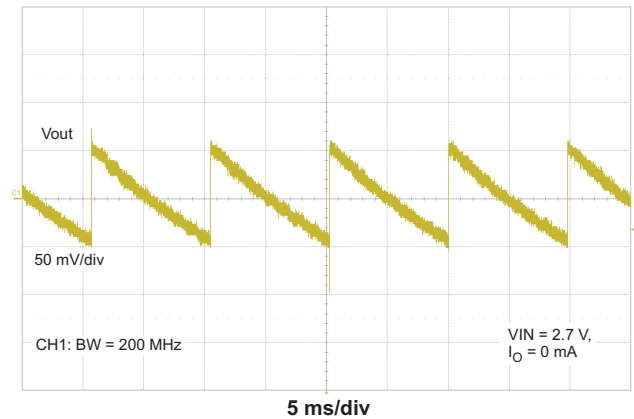
**Figure 14. Efficiency vs Input Voltage**



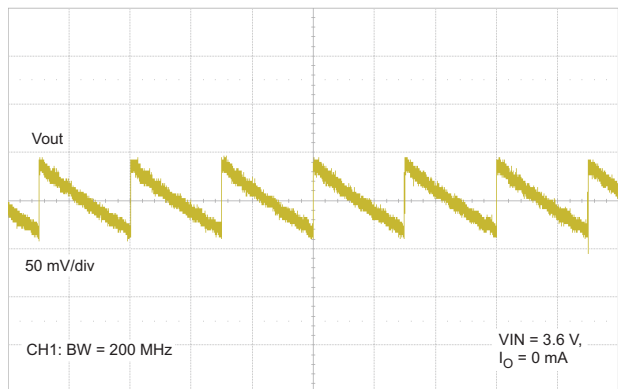
**Figure 15. Load Transient Response**  
 $V_{IN} = 2.7\text{ V}$ ,  $I_O = 30\text{ mA}$  to  $50\text{ mA}$



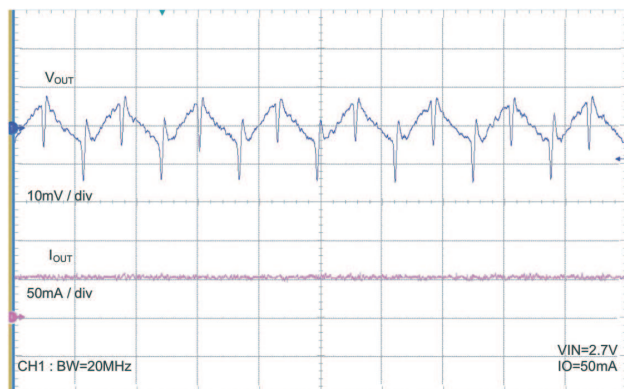
**Figure 16. Load Transient Response**  
 $V_{IN} = 3.6\text{ V}$ ,  $I_O = 60\text{ mA}$  to  $100\text{ mA}$



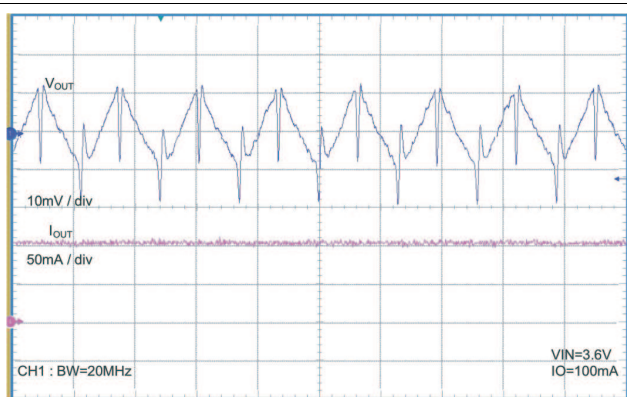
**Figure 17. Output Ripple**  
 $V_{CC} = 2.7\text{ V}$ ,  $I_O = 0\text{ mA}$



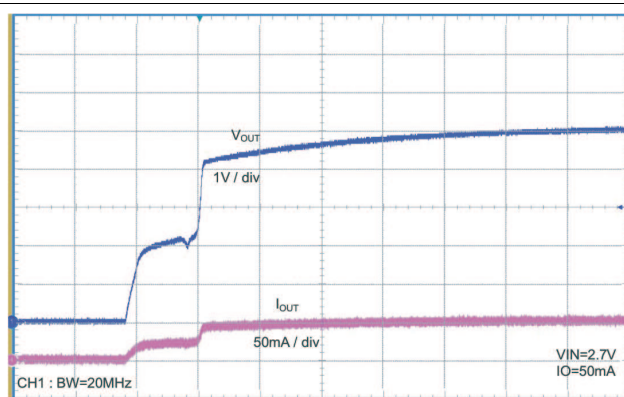
5 ms/div  
**Figure 18. Load Transient**  
 $V_{CC} = 3.6\text{ V}$ ,  $I_O = 0\text{ mA}$



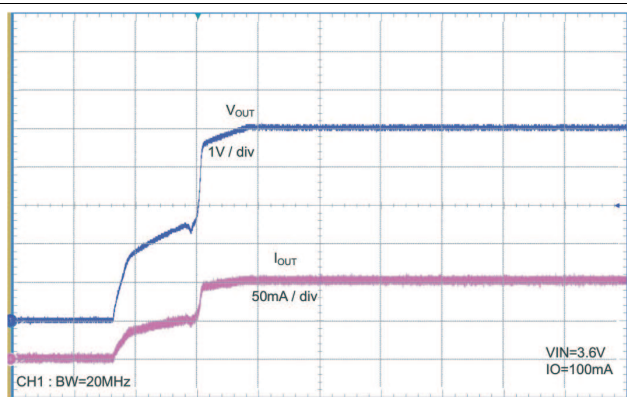
500 ns/div  
**Figure 19. Output Ripple Voltage (Normal Mode)**  
 $V_{IN} = 2.7\text{ V}$ ,  $I_O = 50\text{ mA}$



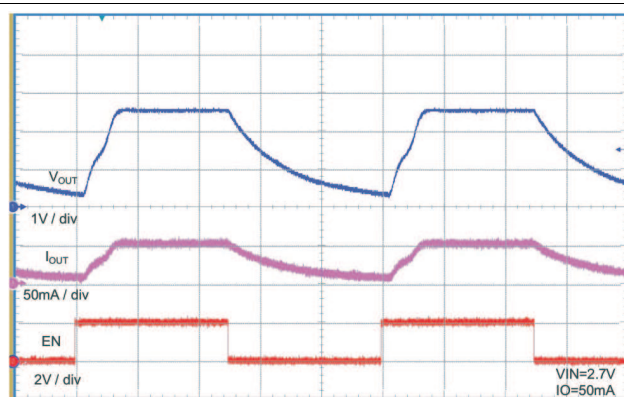
500 ns/div  
**Figure 20. Output Ripple (Normal Mode)**  
 $V_{IN} = 3.6\text{ V}$ ,  $I_O = 100\text{ mA}$



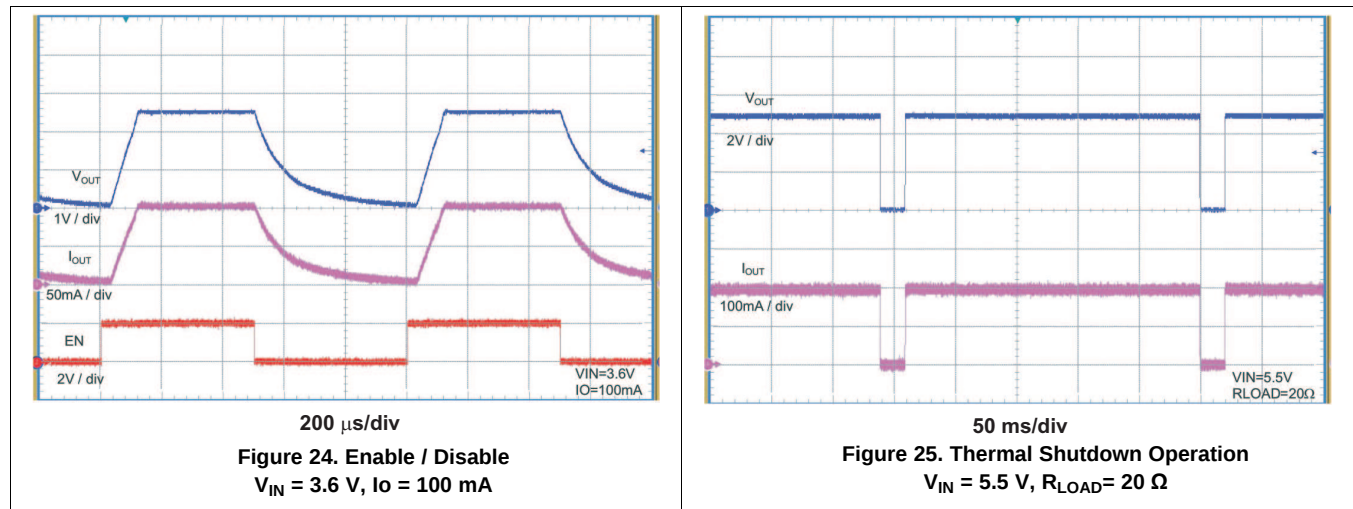
1 ms/div  
**Figure 21. Power On**  
 $V_{IN} = 2.7\text{ V}$ ,  $I_O = 50\text{ mA}$



1 ms/div  
**Figure 22. Power On**  
 $V_{IN} = 3.6\text{ V}$ ,  $I_O = 100\text{ mA}$

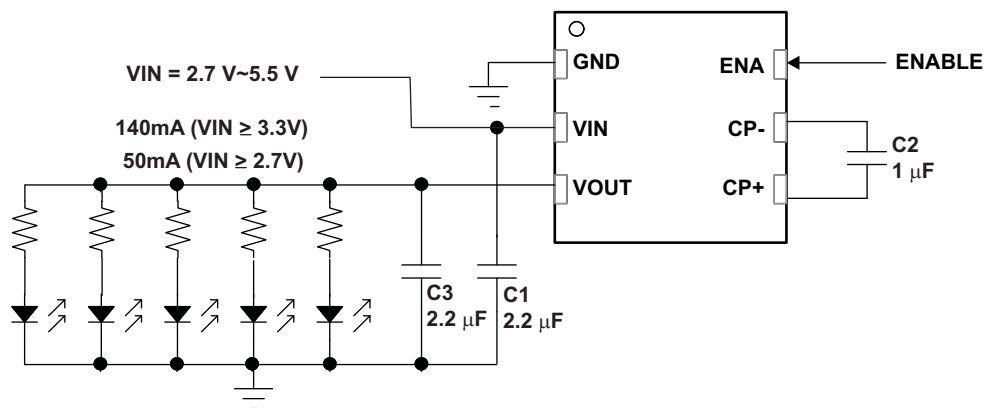


200  $\mu$ s/div  
**Figure 23. Enable / Disable**  
 $V_{IN} = 2.7\text{ V}$ ,  $I_O = 50\text{ mA}$



## 9.3 System Example

### 9.3.1 Circuit for Driving White LEDs



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

## 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

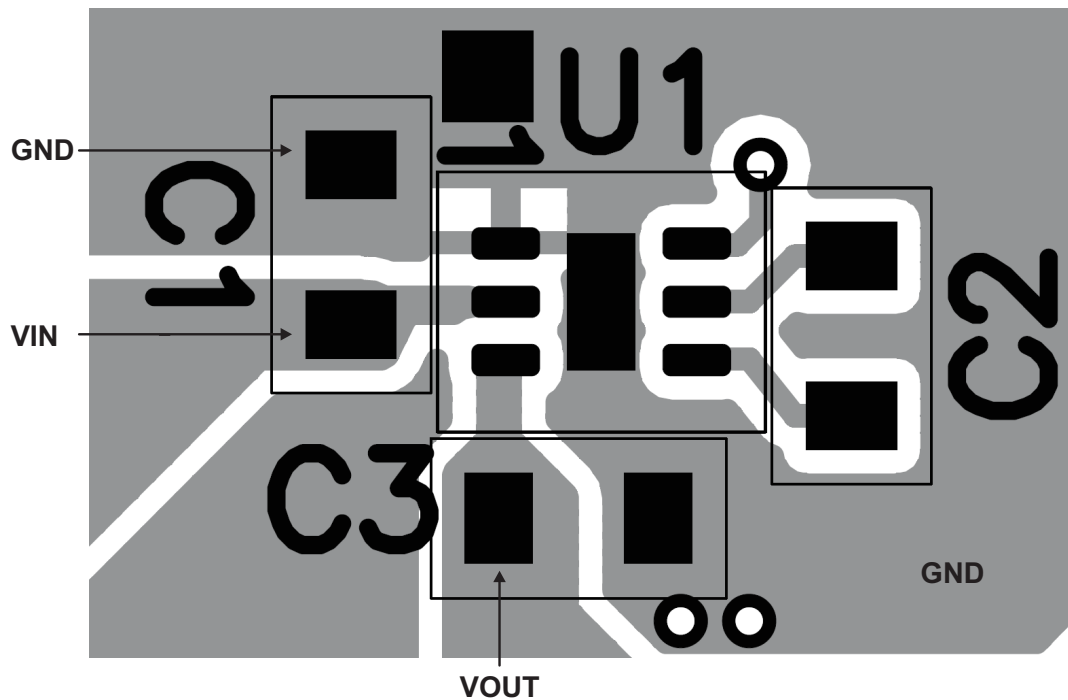


Figure 27. Recommended PCB Layout

## 12 器件和文档支持

### 12.1 接收文档更新通知

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### 12.4 静电放电警告



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### 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 Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS60151DRVR     | ACTIVE        | WSO          | DRV                | 6    | 3000           | RoHS & Green    | NIPDAU   NIPDAUAG                    | Level-1-260C-UNLIM   | -40 to 85    | OCN                     | <a href="#">Samples</a> |
| TPS60151DRV      | ACTIVE        | WSO          | DRV                | 6    | 250            | RoHS & Green    | NIPDAU   NIPDAUAG                    | Level-1-260C-UNLIM   | -40 to 85    | OCN                     | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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**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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS60151DRV | WSO          | DRV             | 6    | 3000 | 179.0              | 8.4                | 2.2     | 2.2     | 1.2     | 4.0     | 8.0    | Q2            |
| TPS60151DRV | WSO          | DRV             | 6    | 3000 | 180.0              | 8.4                | 2.3     | 2.3     | 1.15    | 4.0     | 8.0    | Q2            |
| TPS60151DRV | WSO          | DRV             | 6    | 3000 | 178.0              | 8.4                | 2.25    | 2.25    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS60151DRV | WSO          | DRV             | 6    | 250  | 180.0              | 8.4                | 2.3     | 2.3     | 1.15    | 4.0     | 8.0    | Q2            |

## TAPE AND REEL BOX DIMENSIONS

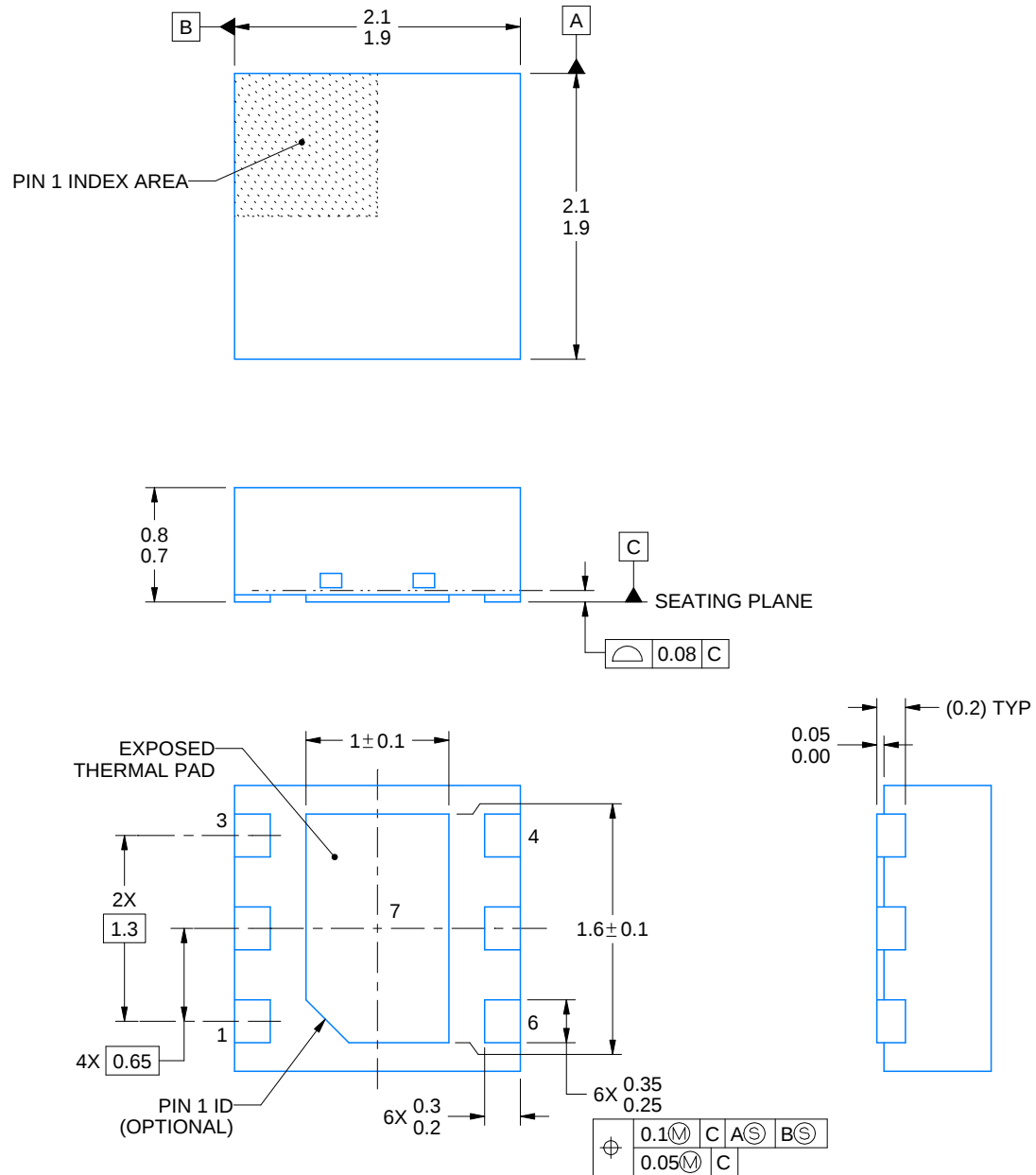
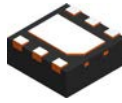


\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS60151DRVR | WSON         | DRV             | 6    | 3000 | 200.0       | 183.0      | 25.0        |
| TPS60151DRVR | WSON         | DRV             | 6    | 3000 | 182.0       | 182.0      | 20.0        |
| TPS60151DRVR | WSON         | DRV             | 6    | 3000 | 205.0       | 200.0      | 33.0        |
| TPS60151DRVT | WSON         | DRV             | 6    | 250  | 182.0       | 182.0      | 20.0        |



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



4222173/B 04/2018

## NOTES:

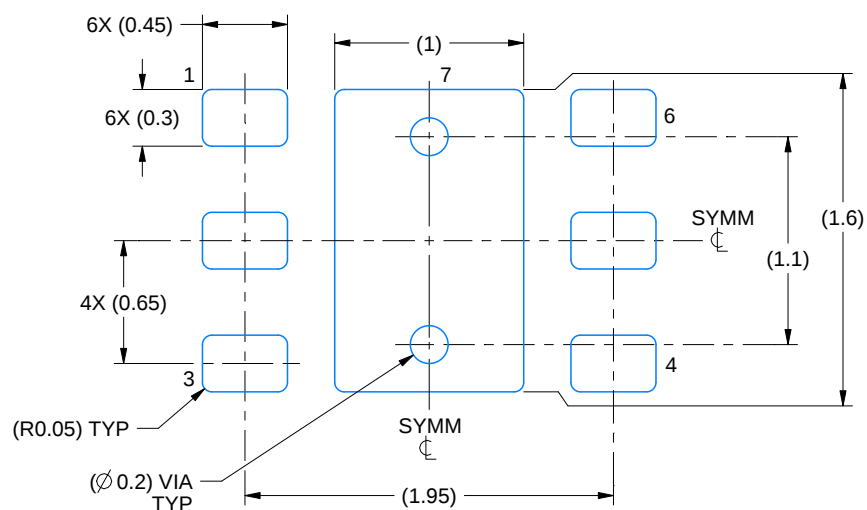
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

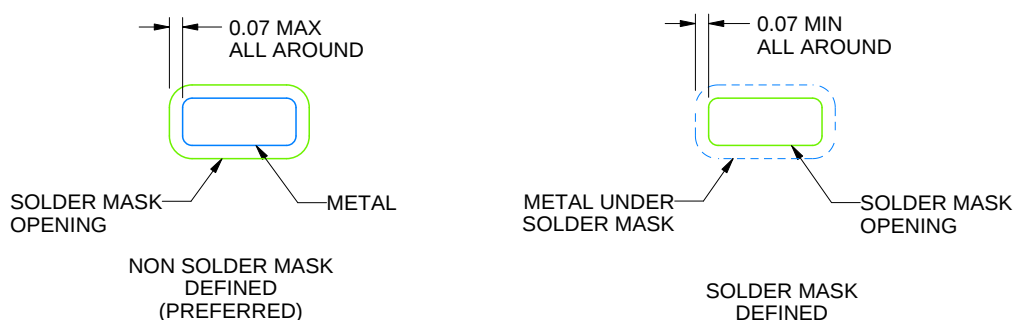
DRV0006A

WSN - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:25X



SOLDER MASK DETAILS

4222173/B 04/2018

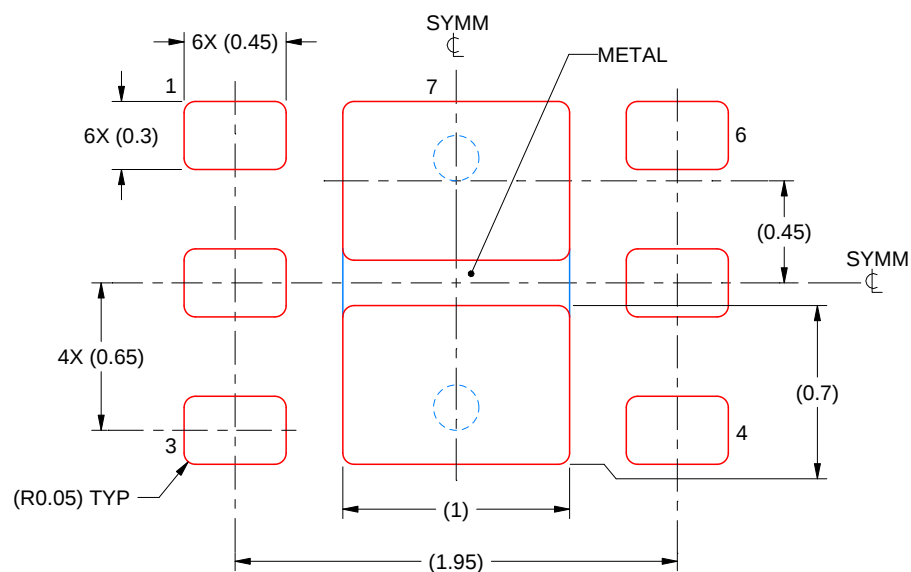
NOTES: (continued)

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/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.

**DRV0006A**

**WSON - 0.8 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



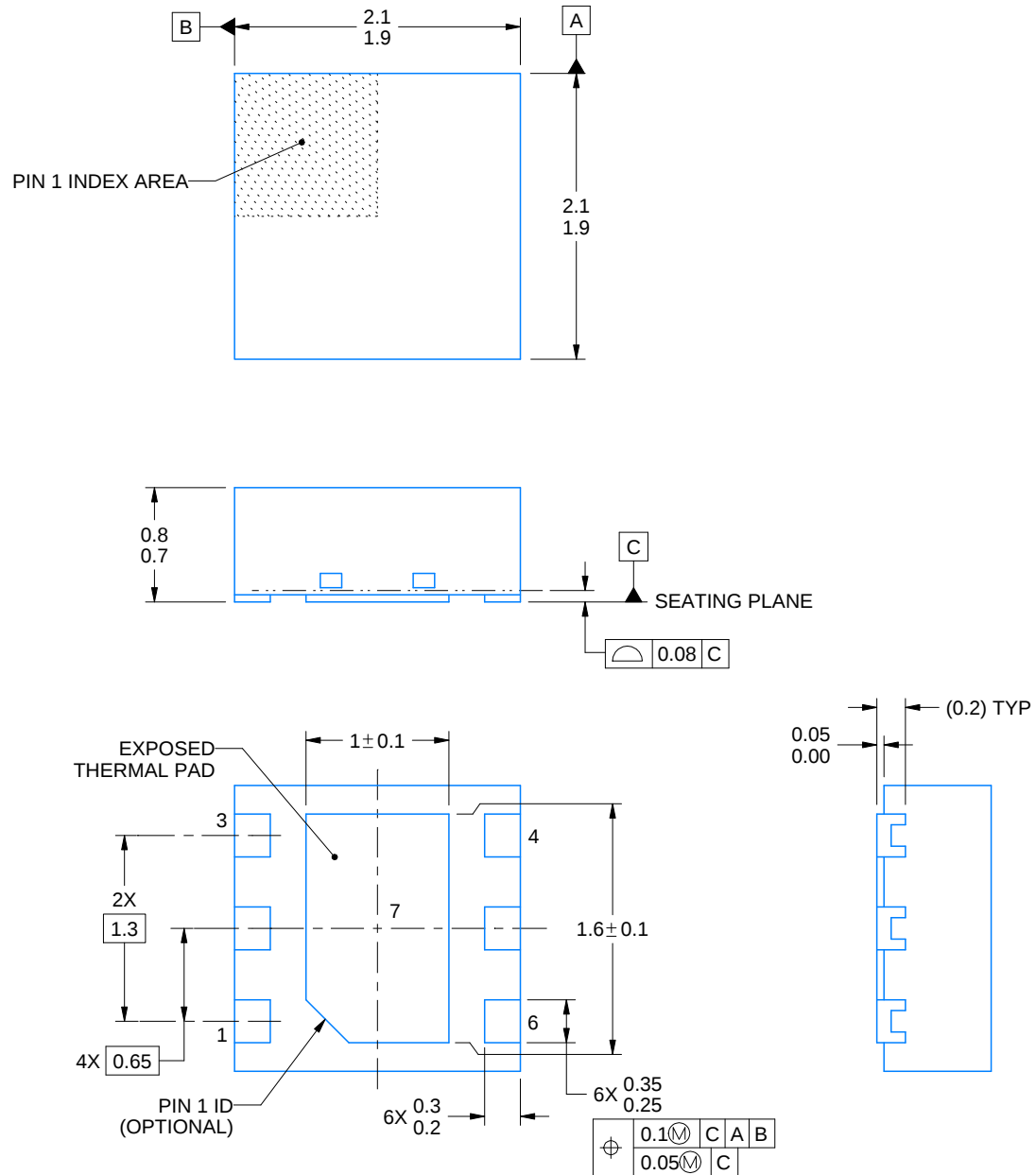
## SOLDER PASTE EXAMPLE BASED ON 0.125 mm THICK STENCIL

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

4222173/B 04/2018

NOTES: (continued)

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



4225563/A 12/2019

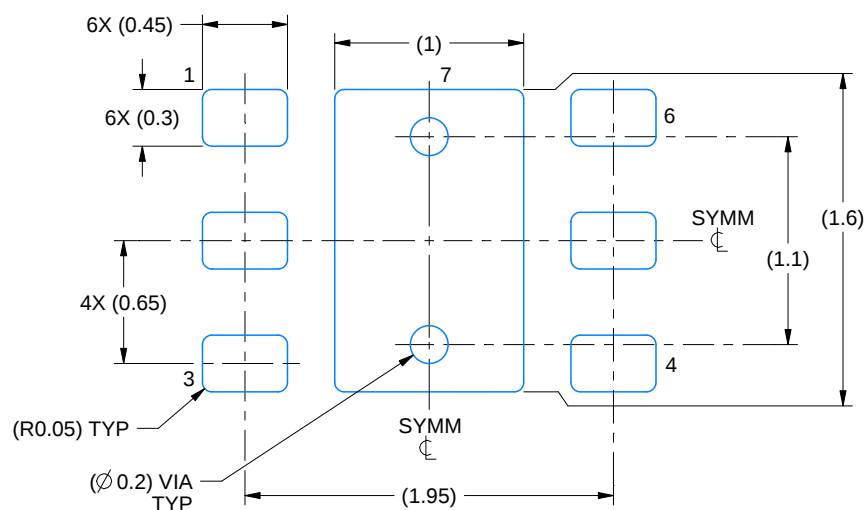
**NOTES:**

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.

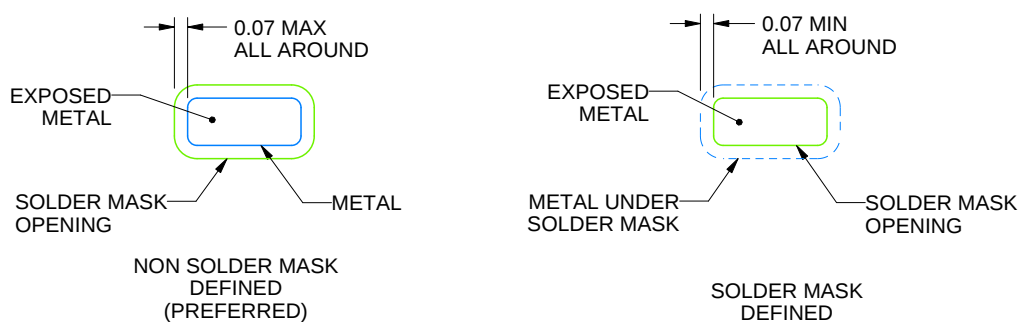
**DRV0006D**

**WSN - 0.8 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:25X



## SOLDER MASK DETAILS

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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](http://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.

# EXAMPLE STENCIL DESIGN

DRV0006D

WSO - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



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.

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