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。

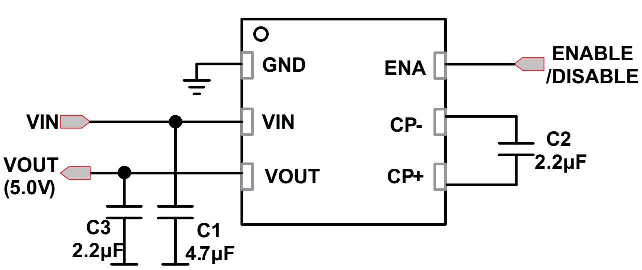
TPS60151 在自然通风环境下的额定运行温度范围为 –40°C 至 85°C。该器件采用小尺寸 2mm × 2mm 6 引脚 SON 封装 (QFN)。

器件信息(1)

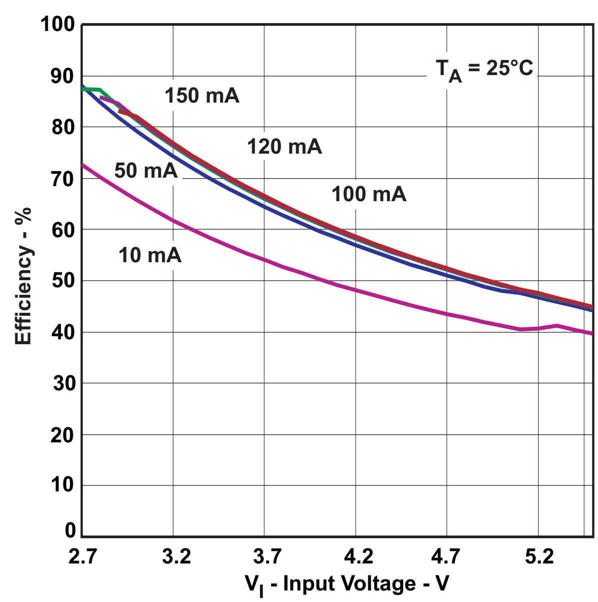
器件型号	封装	封装尺寸（标称值）
TPS60151	WSON (6)	2.00mm × 2.00mm

(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



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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。

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

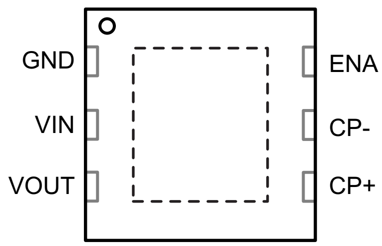
5 Device Comparison Table

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)

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	UNIT
		DRV (WSON)	
		6 PINS	
$R_{\theta JA}$	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
ψ_{JT}	Junction-to-top characterization parameter	1.2	°C/W
ψ_{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.

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.

7.6 Typical Characteristics

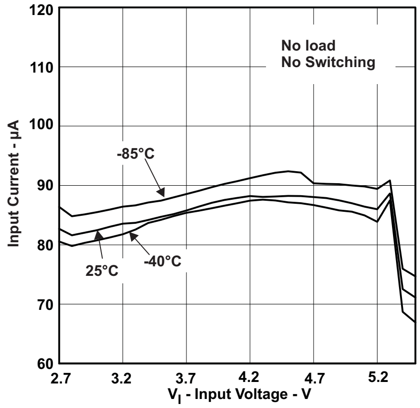


Figure 1. Quiescent Current vs Input Voltage

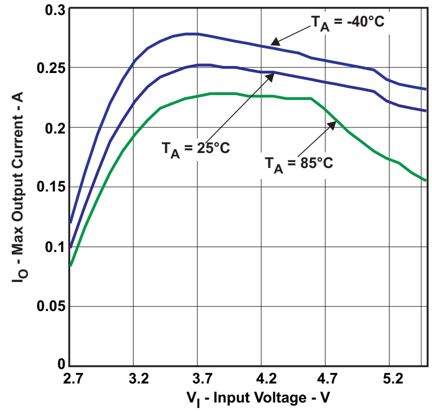


Figure 2. Maximum Output Current vs Input Voltage at Temperature

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.

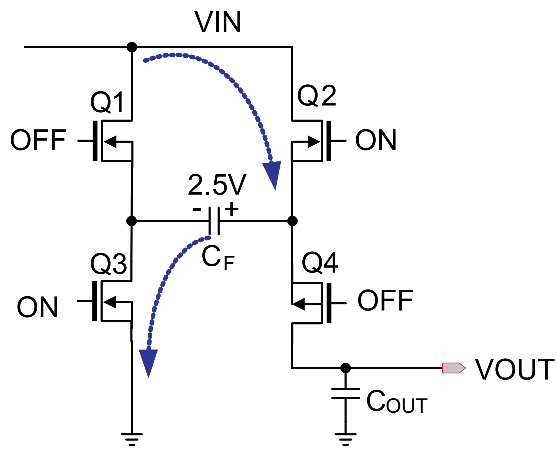


Figure 3. Charging Mode

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.

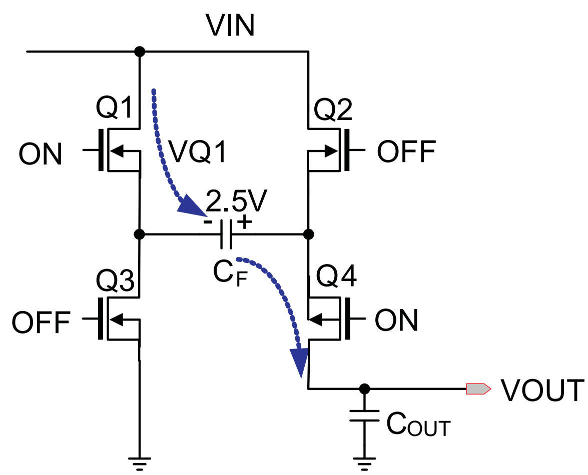


Figure 4. Discharging Mode

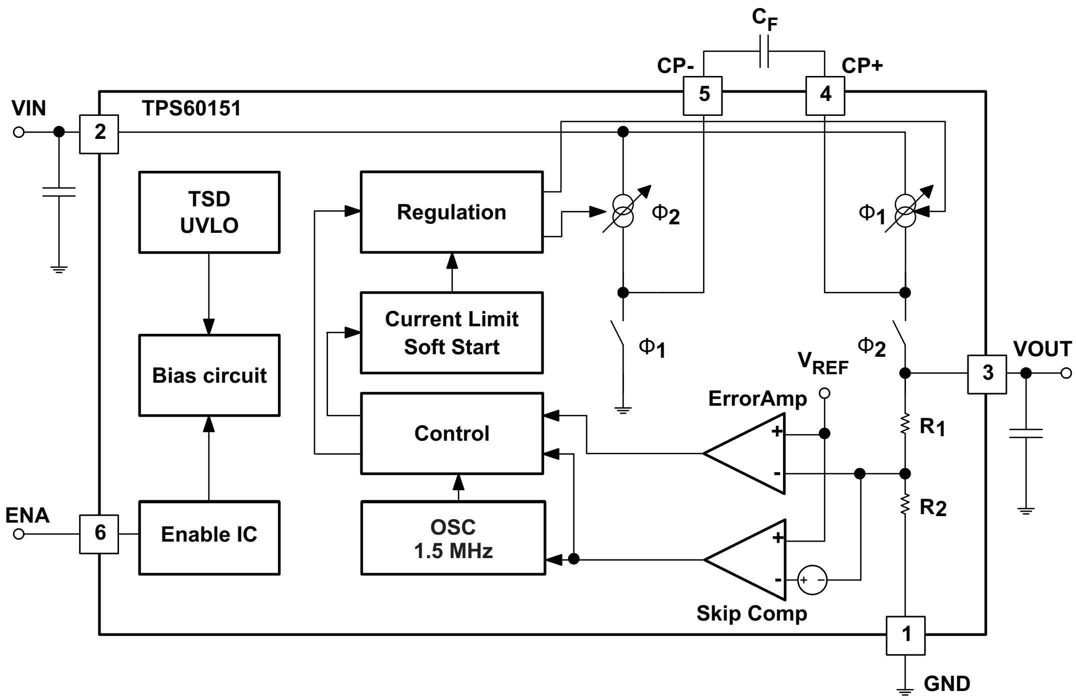
During the second half cycle, Q1 and Q4 transistors are turned on. Capacitor C_F will then be discharged to output.

The output voltage can be calculated as follows:

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

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

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.

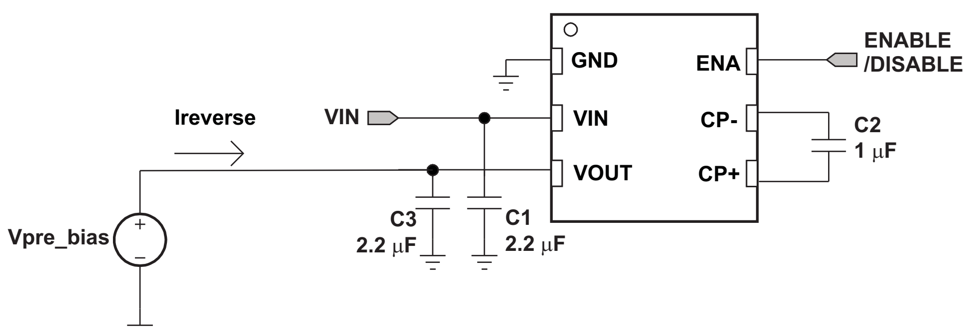


Figure 5. Output Reverse Current Test Setup

Feature Description (continued)

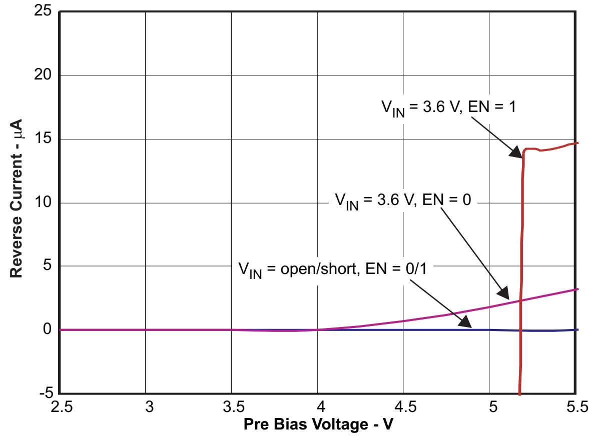


Figure 6. Reverse Current Test Results (Typical)

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

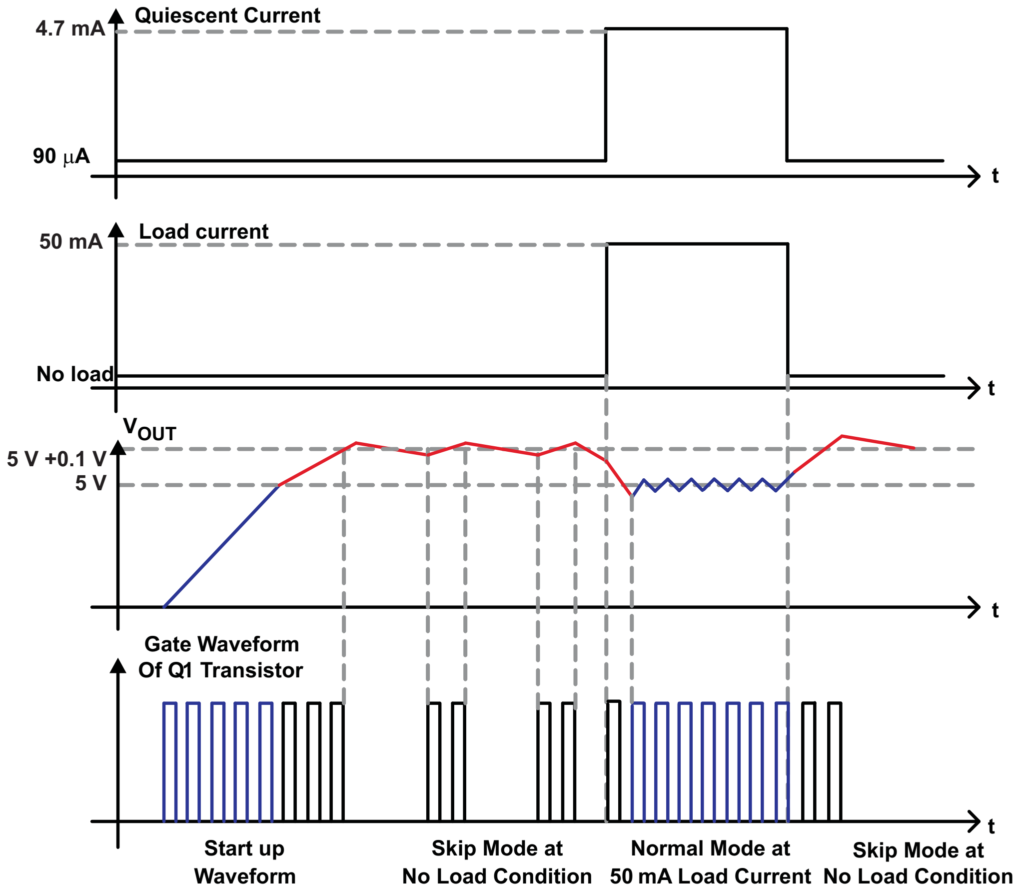


Figure 7. Normal Mode and Skip Mode Operation

The TPS60151 has skip mode operation as shown in Figure 7. The TPS60151 enters skip mode if the output voltage reaches 5 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).

Device Functional Modes (continued)

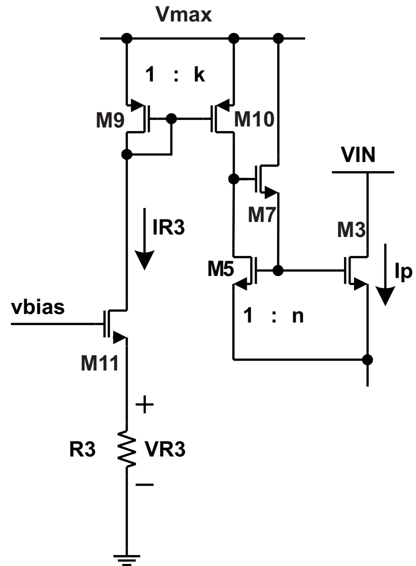


Figure 8. Current Limit

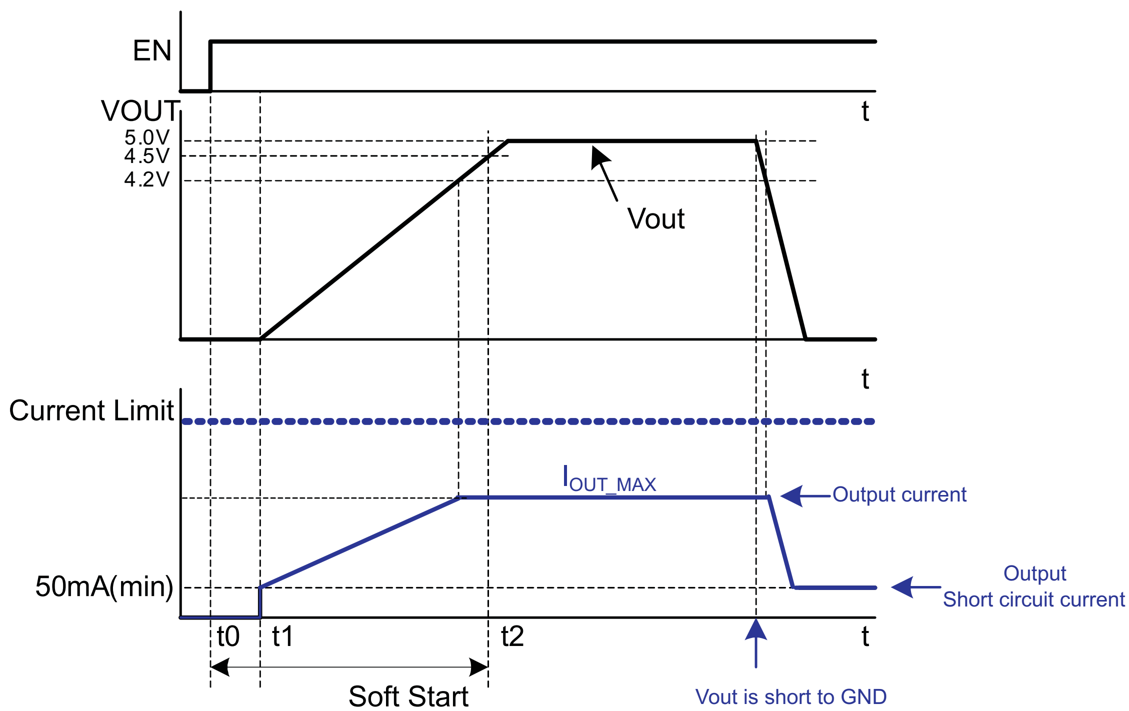


Figure 9. Maximum Output Current Capability and Short Circuit Protection

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.

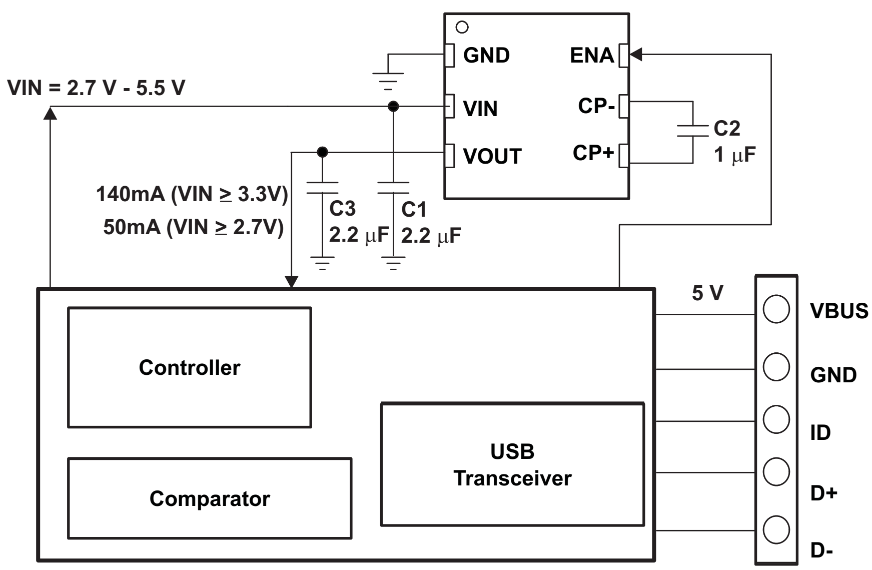


Figure 10. Application Circuit for OTG System

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)

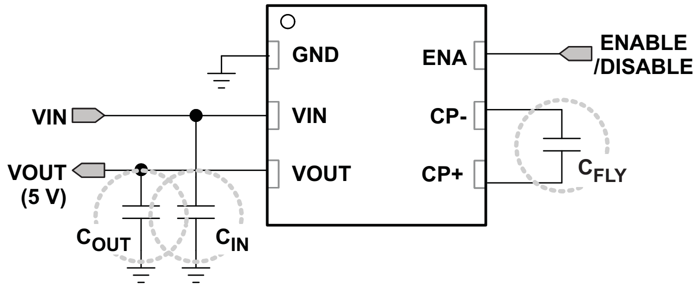


Figure 11. Capacitors

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

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

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

Both equation should be same,

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

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

If I_{LOAD} = 140 mA, f = 1.5 MHz, and ΔV_{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:

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

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

9.2.3 Application Curves

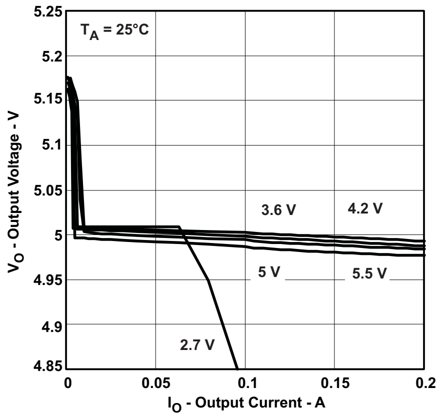


Figure 12. Output Voltage vs Output Current

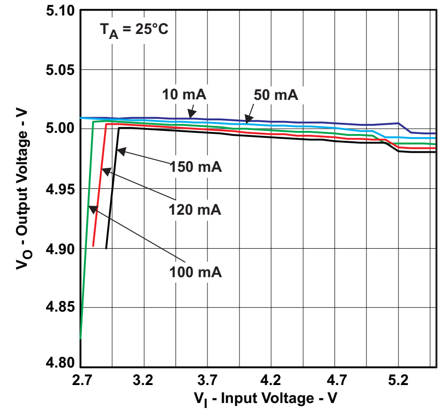


Figure 13. Output Voltage vs Input Voltage

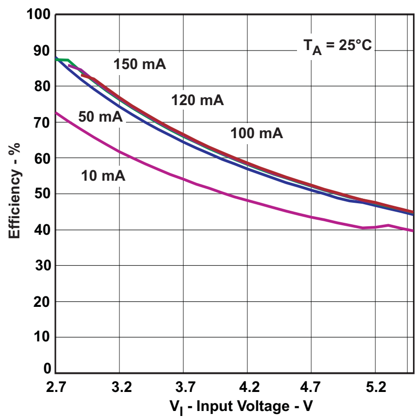
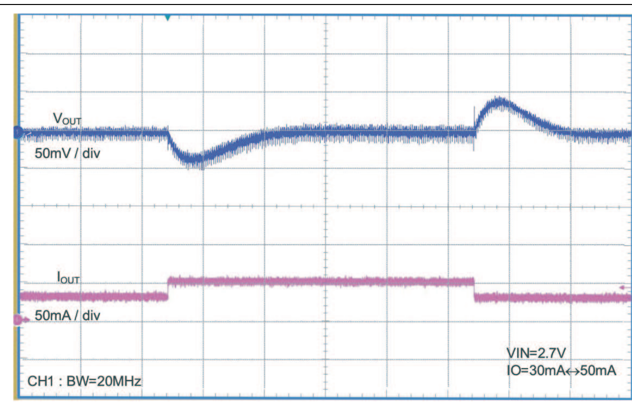
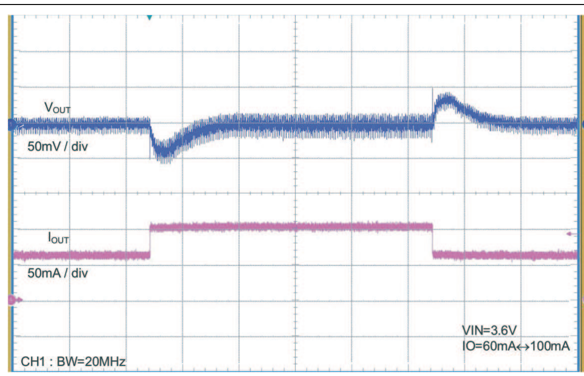


Figure 14. Efficiency vs Input Voltage



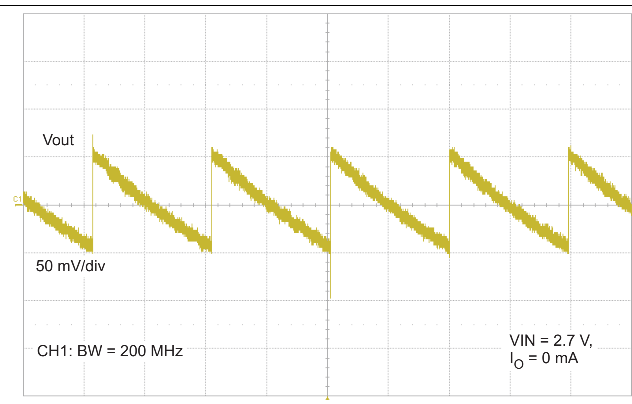
20 µs/div

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



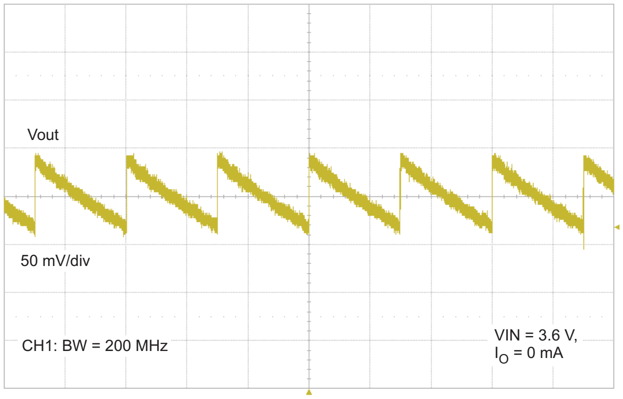
20 µs/div

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



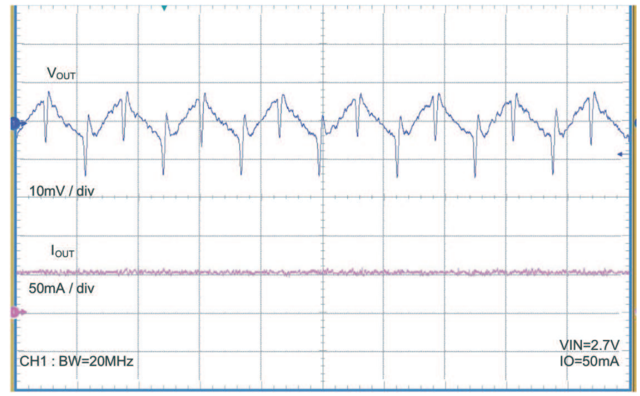
5 ms/div

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



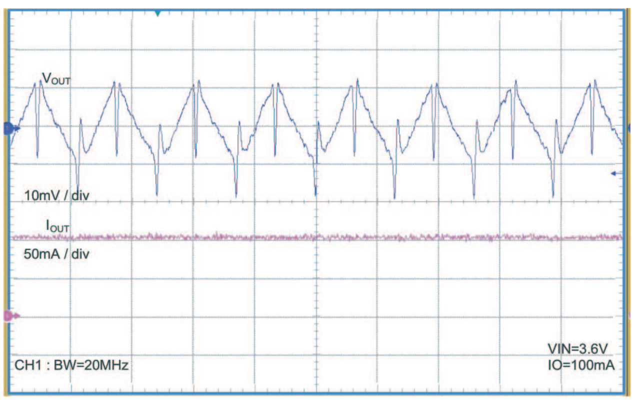
5 ms/div

Figure 18. Load Transient
V_{CC} = 3.6 V, Io = 0 mA



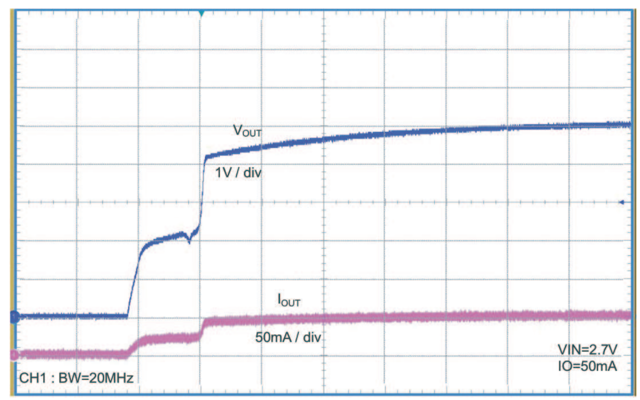
500 ns/div

Figure 19. Output Ripple Voltage (Normal Mode)
V_{IN} = 2.7 V, Io = 50 mA



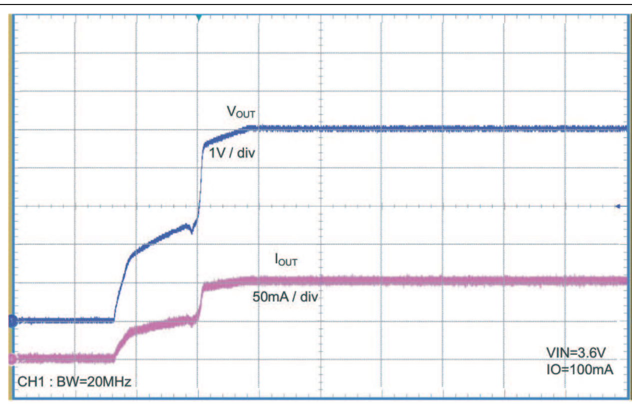
500 ns/div

Figure 20. Output Ripple (Normal Mode)
V_{IN} = 3.6 V, Io = 100 mA



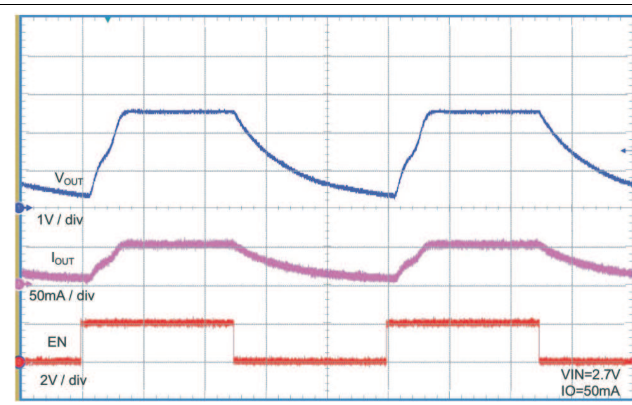
1 ms/div

Figure 21. Power On
V_{IN} = 2.7 V, Io = 50 mA



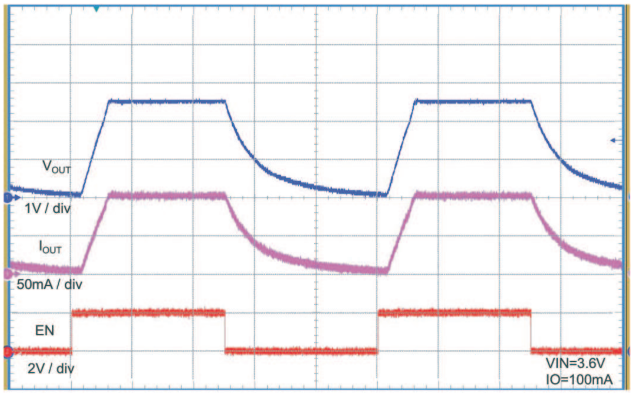
1 ms/div

Figure 22. Power On
V_{IN} = 3.6 V, Io = 100 mA



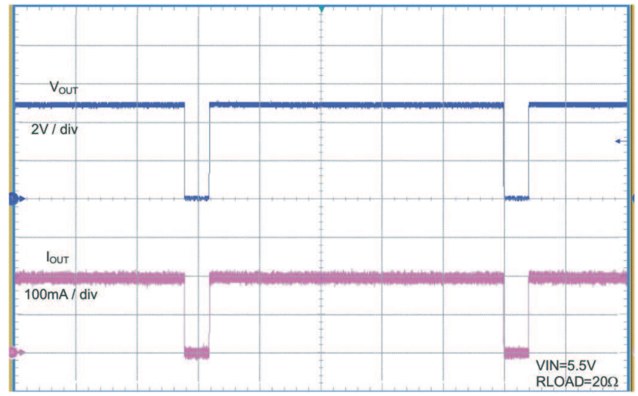
200 μs/div

Figure 23. Enable / Disable
V_{IN} = 2.7 V, Io = 50 mA



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

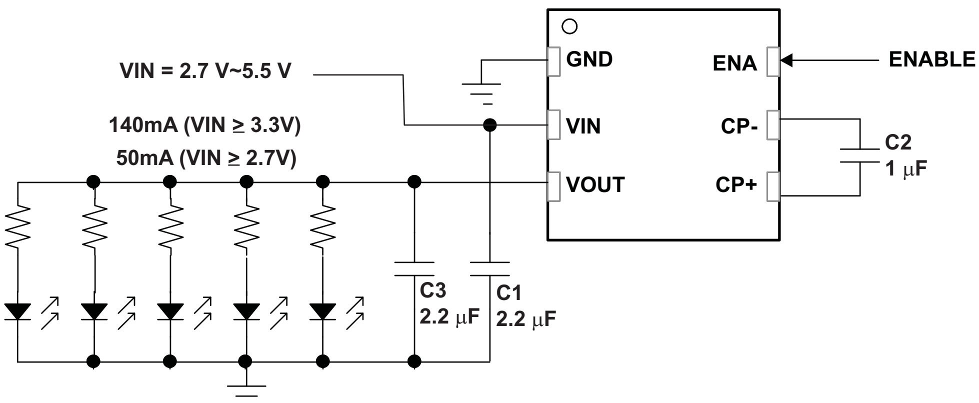


Figure 26. Application Circuit for Driving White LEDs

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

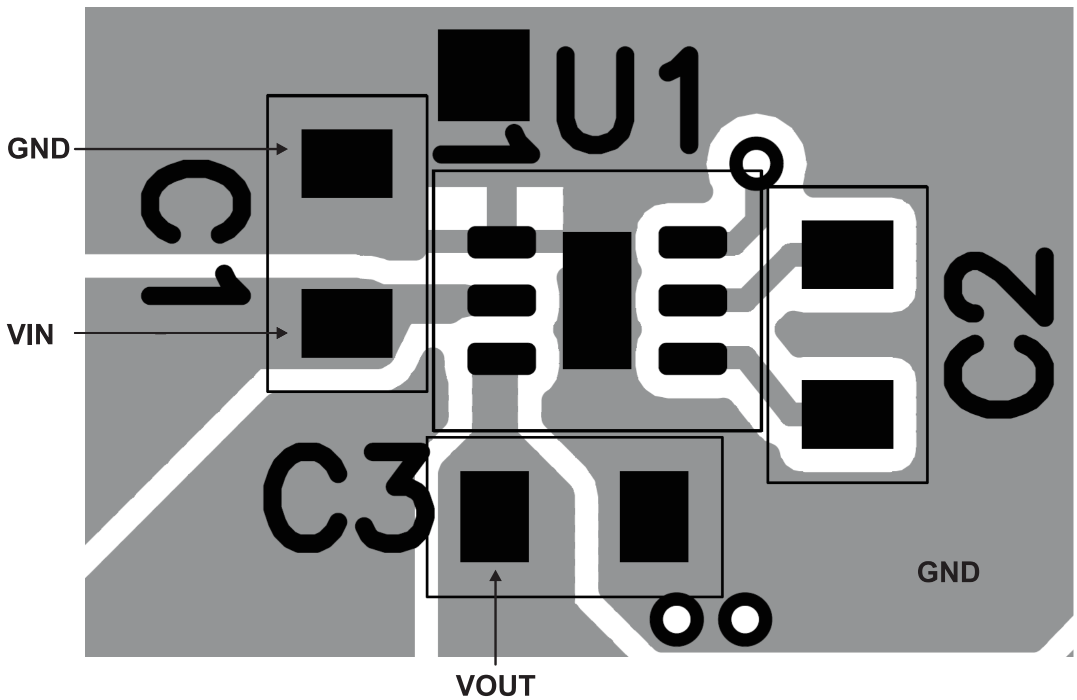


Figure 27. Recommended PCB Layout

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》。

TI E2E™ 在线社区 ***TI 的工程师对工程师 (E2E) 社区。***此社区的创建目的在于促进工程师之间的协作。在 e2e.ti.com 中，您可以咨询问题、分享知识、拓展思路并与同行工程师一道帮助解决问题。

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。

12.3 商标

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

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。

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS60151DRVR	ACTIVE	WSON	DRV	6	3000	RoHS & Green	NIPDAU | NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	OCN	Samples
TPS60151DRVT	ACTIVE	WSON	DRV	6	250	RoHS & Green	NIPDAU | NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	OCN	Samples

(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.
OBSOLETE: 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.

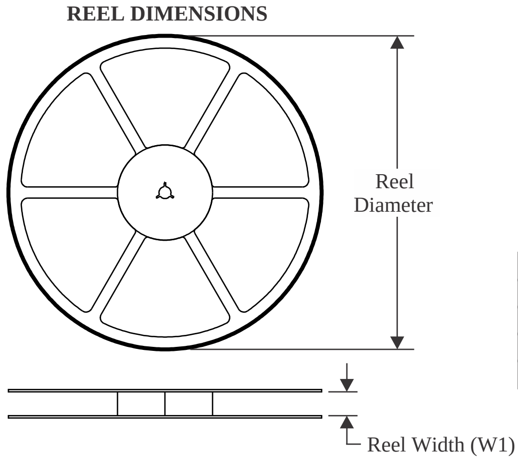
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

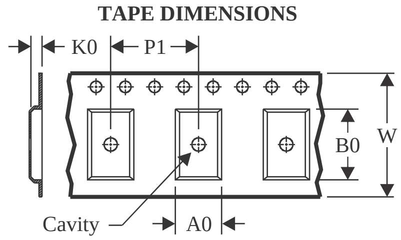
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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.

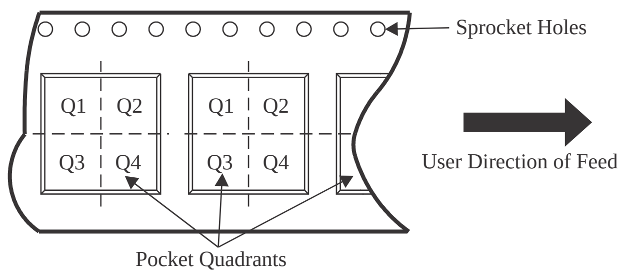
TAPE AND REEL INFORMATION





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

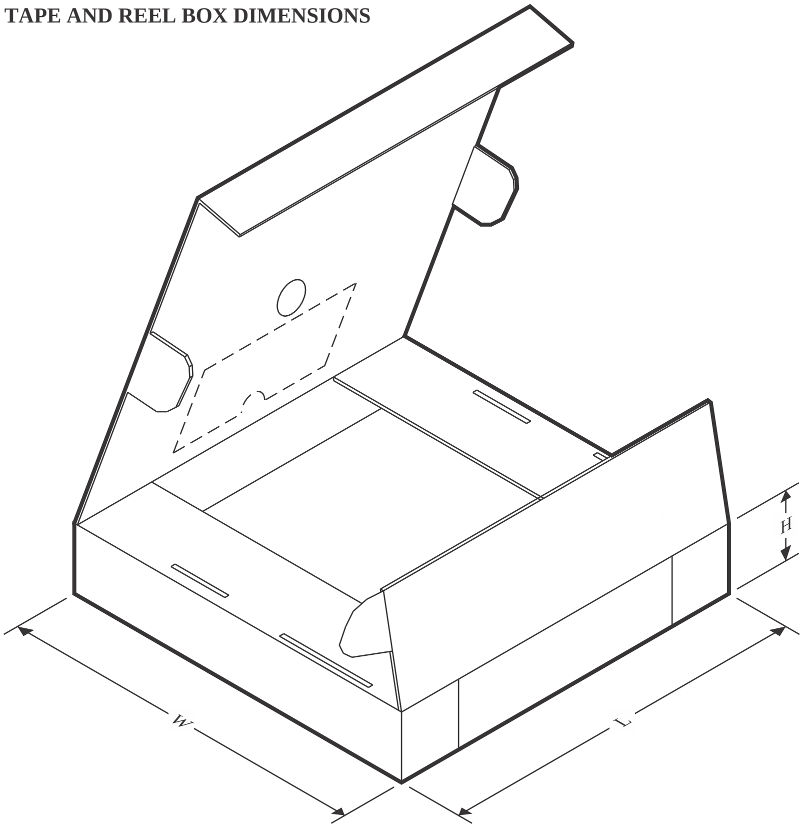
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

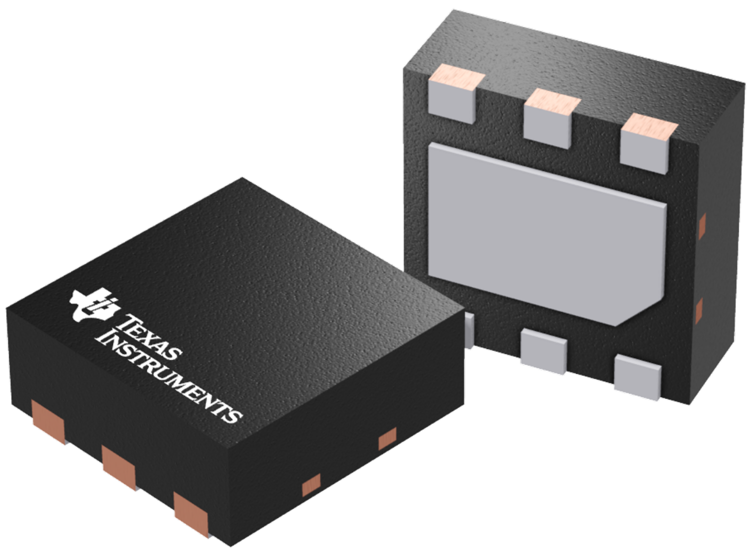
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS60151DRVR	WSON	DRV	6	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS60151DRVT	WSON	DRV	6	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2

TAPE AND REEL BOX DIMENSIONS

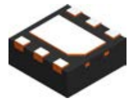


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS60151DRVR	WSON	DRV	6	3000	182.0	182.0	20.0
TPS60151DRVT	WSON	DRV	6	250	182.0	182.0	20.0



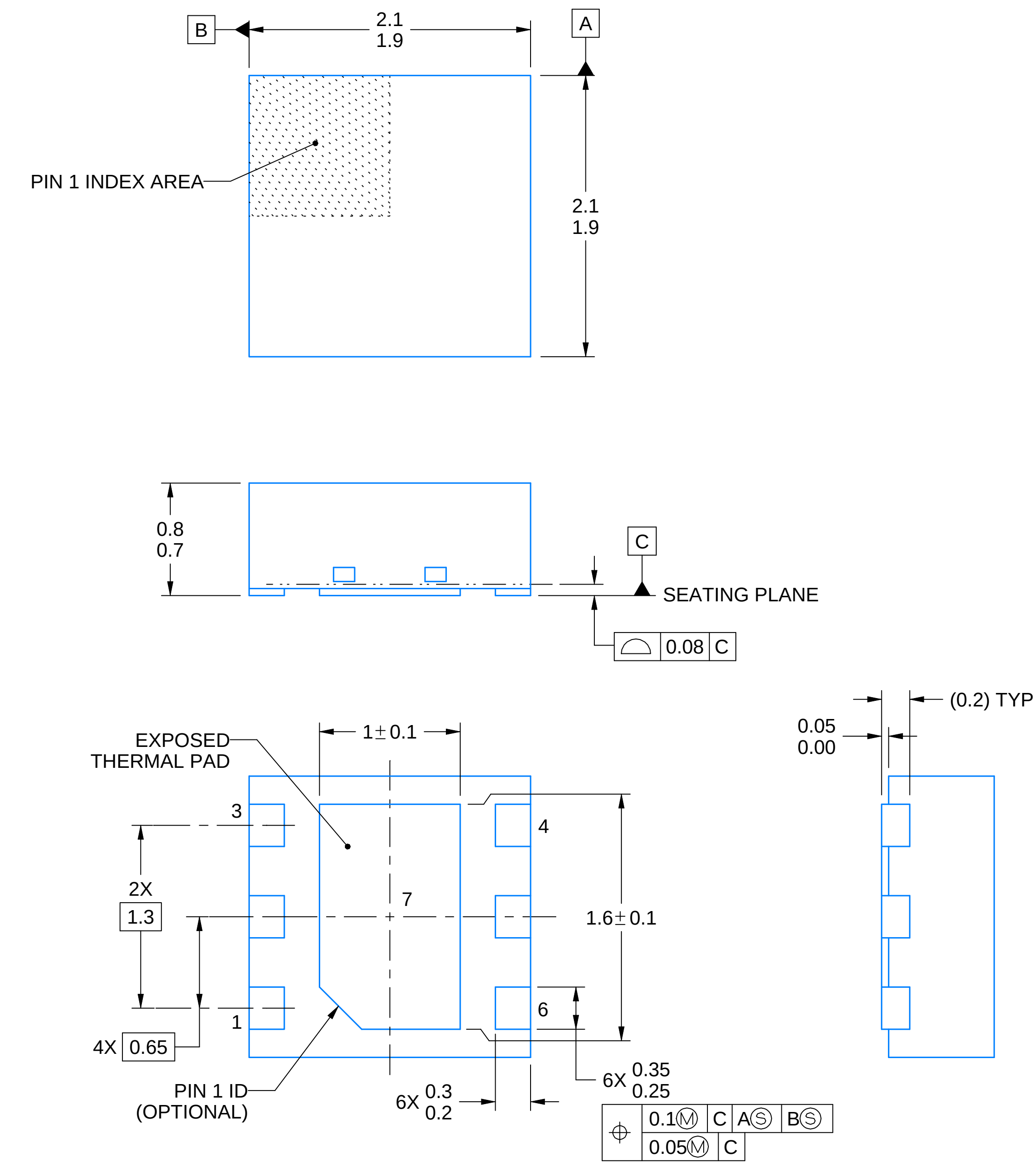
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



PACKAGE OUTLINE

WSON - 0.8 mm max height

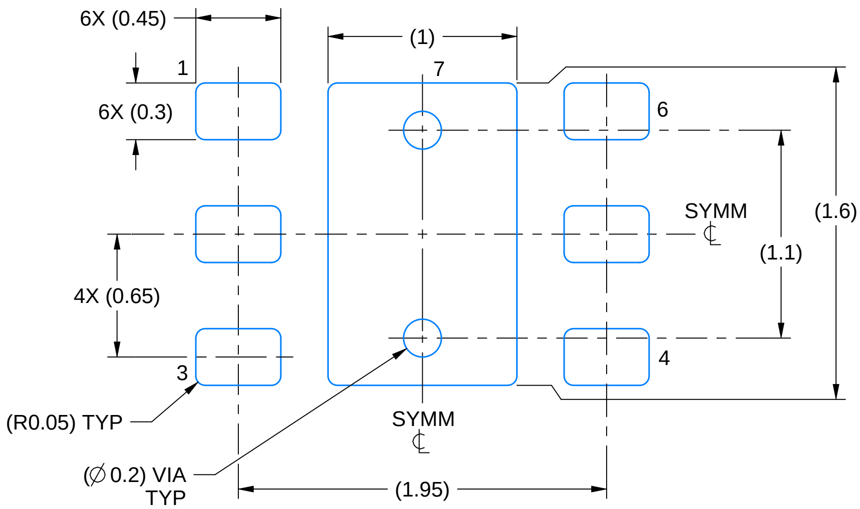
PLASTIC SMALL OUTLINE - NO LEAD



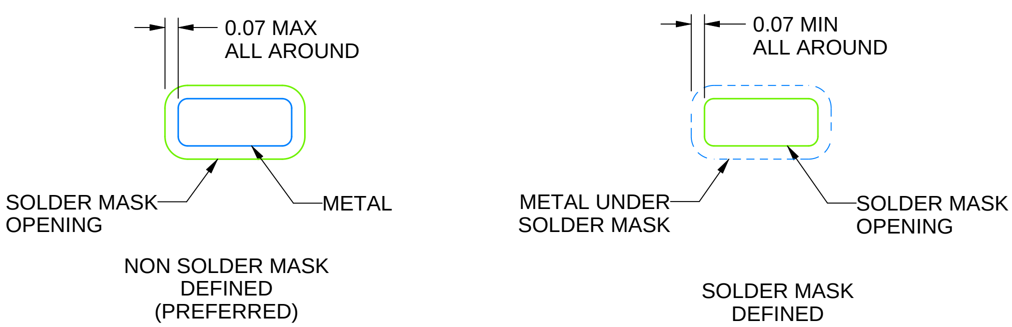
4222173/B 04/2018

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.



LAND PATTERN EXAMPLE
SCALE:25X

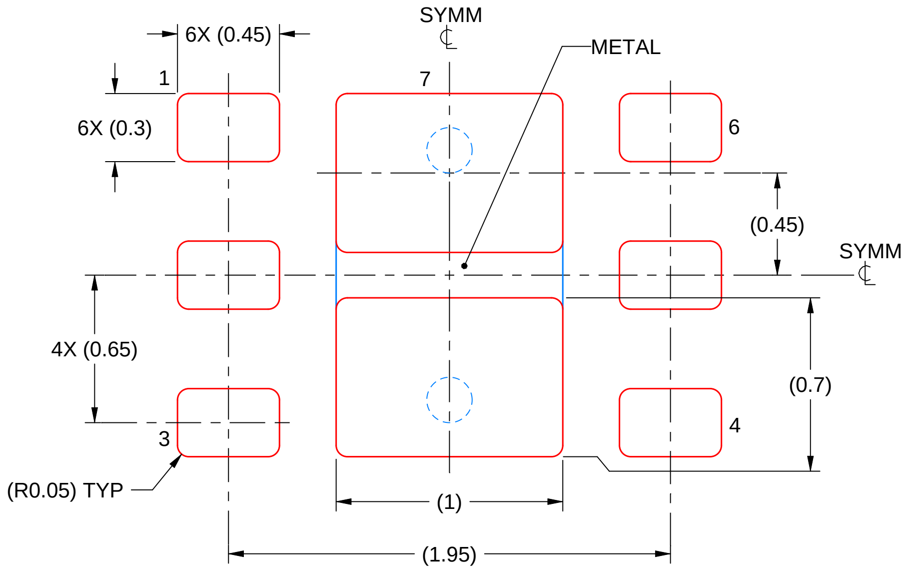


SOLDER MASK DETAILS

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/slua271).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.



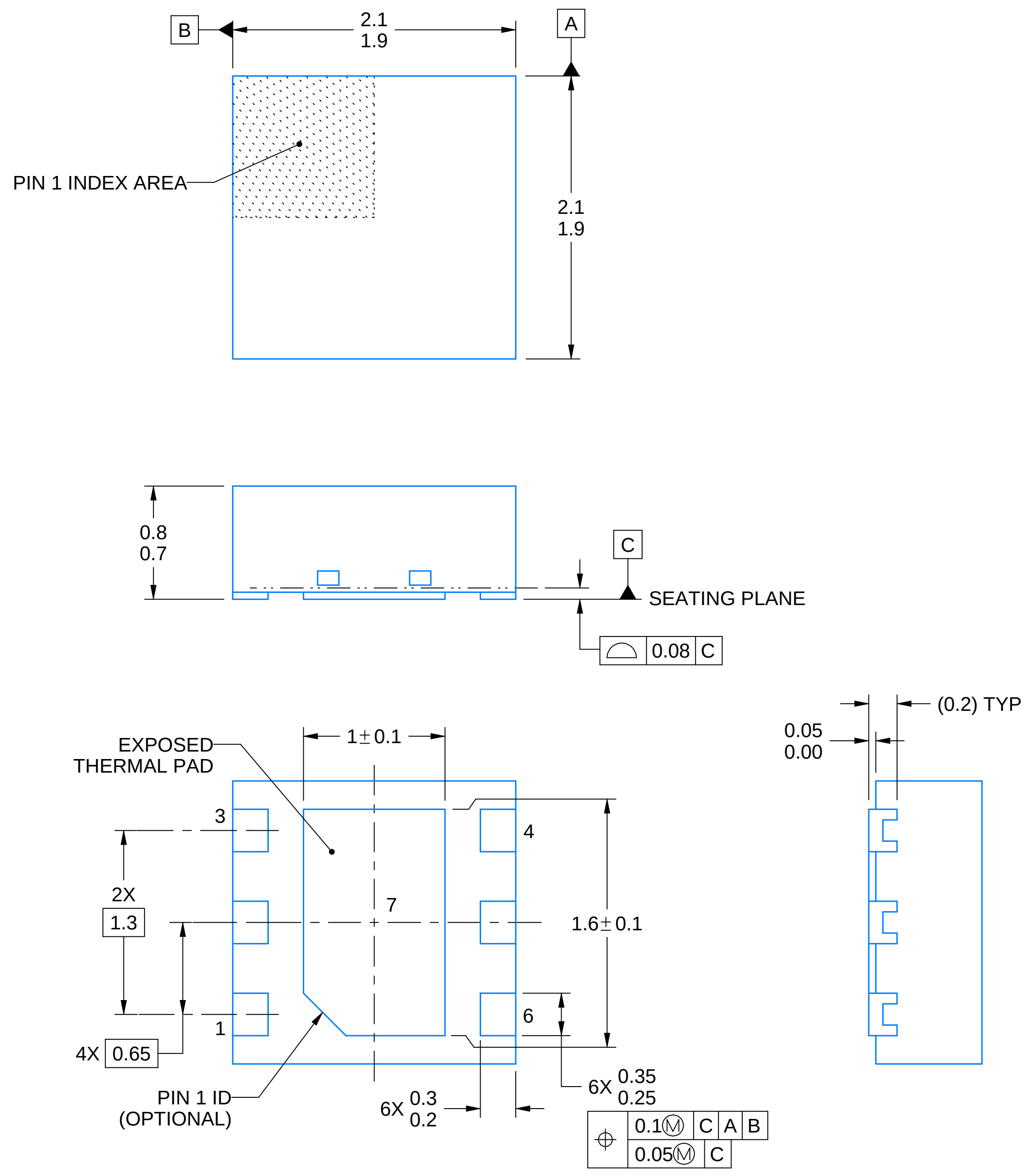
SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

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

4222173/B 04/2018

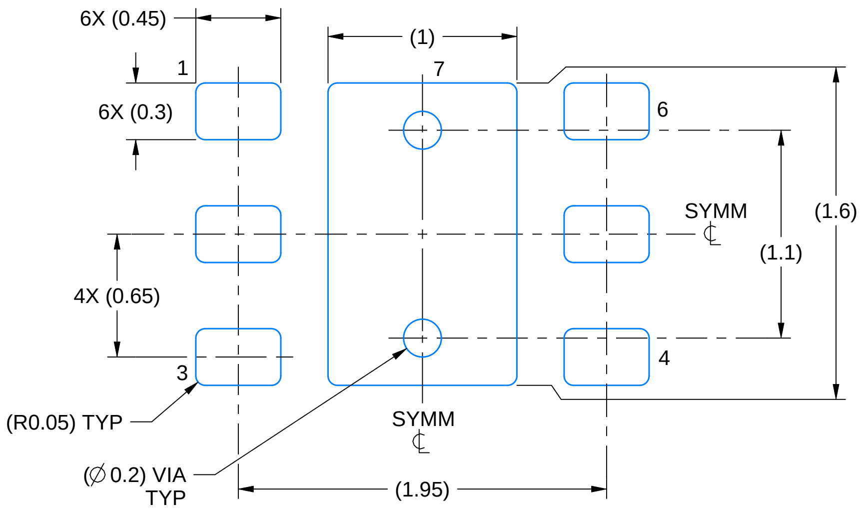
NOTES: (continued)

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

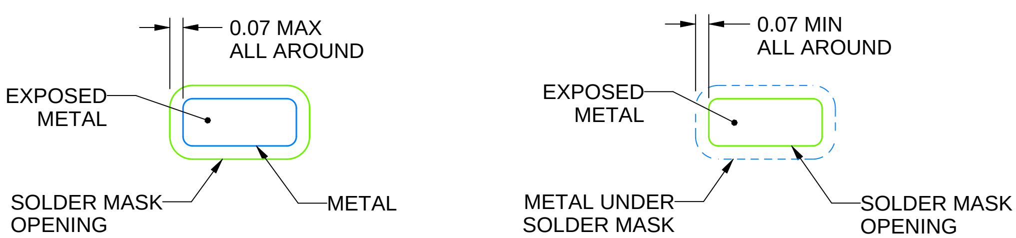


NOTES:

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



NON SOLDER MASK
DEFINED
(PREFERRED)

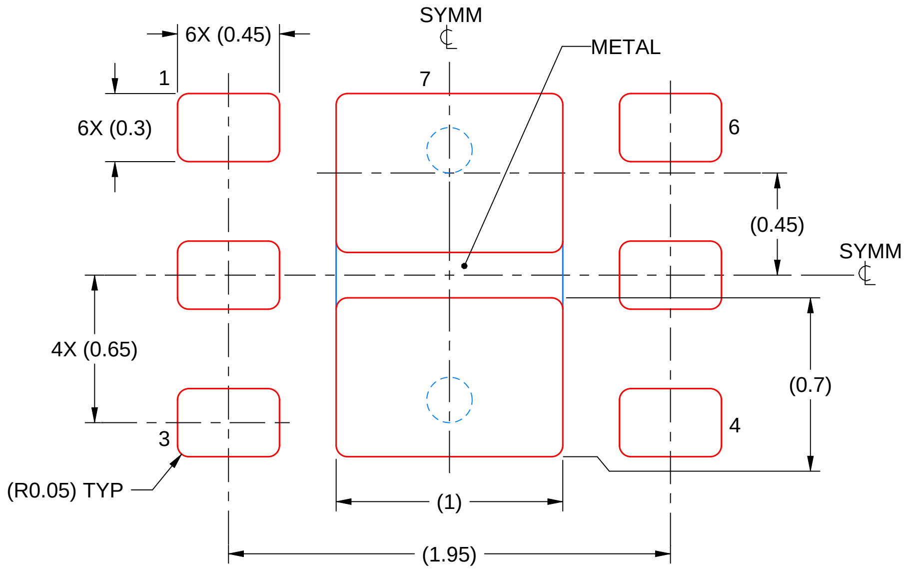
SOLDER MASK
DEFINED

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.