



## TPS22860 超低泄漏电流负载开关

### 1 特性

- 集成单通道负载开关
- 偏置电压范围 ( $V_{BIAS}$ ): 1.65V 至 5.5V
- 输入电压范围: 0V 至  $V_{BIAS}$
- 导通电阻 ( $R_{ON}$ )
  - $V_{IN} = 5V$  ( $V_{BIAS} = 5V$ ) 时,  $R_{ON} = 0.73\Omega$
  - $V_{IN} = 3.3V$  ( $V_{BIAS} = 5V$ ) 时,  $R_{ON} = 0.68\Omega$
  - $V_{IN} = 1.8V$  ( $V_{BIAS} = 5V$ ) 时,  $R_{ON} = 0.63\Omega$
- 200mA 最大持续开关电流
- 超低泄漏电流
  - $V_{IN}$  泄漏电流 = 2nA
  - $V_{BIAS}$  泄漏电流 (5.5V 时) = 10nA
- 6 引脚小外形尺寸晶体管 (SOT)-23 封装或 SC70 封装
- 静电放电 (ESD) 性能经测试符合 JESD 22 规范
  - 2kV 人体放电模式 (HBM) 和 1kV 组件充电模式 (CDM)

### 2 应用

- 可穿戴产品
- 物联网
- 无线传感器网络

### 3 说明

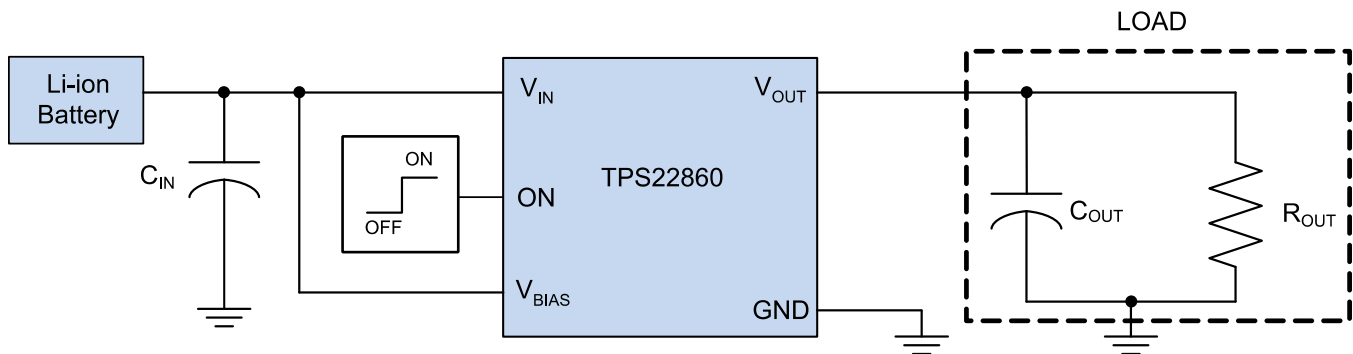
TPS22860 是一款小型、超低泄漏电流、单通道负载开关。该器件需要一个  $V_{BIAS}$  电压, 工作输入电压范围为 0V 至  $V_{BIAS}$ 。它可支持最大 200mA 的持续电流。此开关可由一个打开/关闭输入 (ON) 控制, 此输入可与低压控制信号直接对接。TPS22860 采用两种节省空间的 6 引脚 SOT-23 和 SC70 小型封装。器件在自然通风环境下的额定运行温度范围为  $-40^{\circ}\text{C}$  至  $85^{\circ}\text{C}$ 。

器件信息<sup>(1)</sup>

器件型号	封装	封装尺寸 (标称值)
TPS22860	SOT-23	2.80 x 2.90mm
	SC-70	2.10 x 2.00mm

(1) 要了解所有可用封装, 请见数据表末尾的可订购产品附录。

### 4 常见应用电路原理图



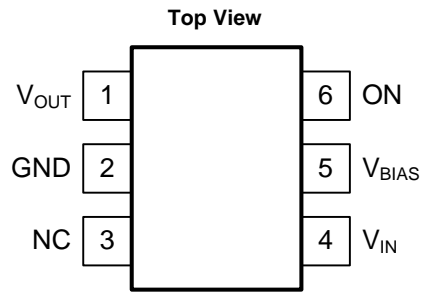
## 目录

<b>1</b>	<b>特性</b> .....	<b>1</b>	8.3	Feature Description .....	<b>7</b>
<b>2</b>	<b>应用</b> .....	<b>1</b>	8.4	Device Functional Modes .....	<b>7</b>
<b>3</b>	<b>说明</b> .....	<b>1</b>	<b>9</b>	<b>Application and Implementation</b> .....	<b>8</b>
<b>4</b>	<b>常见应用电路原理图</b> .....	<b>1</b>	9.1	Application Information .....	<b>8</b>
<b>5</b>	<b>修订历史记录</b> .....	<b>2</b>	9.2	Typical Application .....	<b>8</b>
<b>6</b>	<b>Pin Configuration and Functions</b> .....	<b>3</b>	<b>10</b>	<b>Power Supply Recommendations</b> .....	<b>9</b>
<b>7</b>	<b>Specifications</b> .....	<b>3</b>	<b>11</b>	<b>Layout</b> .....	<b>10</b>
7.1	Absolute Maximum Ratings .....	<b>3</b>	11.1	Layout Guidelines .....	<b>10</b>
7.2	ESD Ratings .....	<b>3</b>	11.2	Thermal Reliability .....	<b>10</b>
7.3	Recommended Operating Conditions .....	<b>4</b>	11.3	Improving Package Thermal Performance .....	<b>10</b>
7.4	Thermal Information .....	<b>4</b>	11.4	Layout Example .....	<b>10</b>
7.5	Electrical Characteristics .....	<b>4</b>	<b>12</b>	<b>器件和文档支持</b> .....	<b>11</b>
7.6	Switching Characteristics .....	<b>4</b>	12.1	商标 .....	<b>11</b>
7.7	Typical Characteristics .....	<b>5</b>	12.2	静电放电警告 .....	<b>11</b>
<b>8</b>	<b>Detailed Description</b> .....	<b>7</b>	12.3	术语表 .....	<b>11</b>
8.1	Overview .....	<b>7</b>	<b>13</b>	<b>机械、封装和可订购信息</b> .....	<b>11</b>
8.2	Functional Block Diagram .....	<b>7</b>			

## 5 修订历史记录

日期	修订版本	注释
2015 年 4 月	*	首次发布。

## 6 Pin Configuration and Functions



**Pin Functions**

PIN		I/O	DESCRIPTION
NAME	NO.		
V <sub>OUT</sub>	1	O	Switch output.
GND	2	—	Ground
NC	3	—	No connect
V <sub>IN</sub>	4	I	Switch input. Connect a ceramic capacitor from V <sub>IN</sub> to GND.
V <sub>BIAS</sub>	5	I	Bias voltage. Power supply to the device.
ON	6	I	Active high switch control input. Do not leave floating.

## 7 Specifications

### 7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT <sup>(2)</sup>
V <sub>BIAS</sub>	BIAS voltage range	−0.5	6.5	V
V <sub>IN</sub>	Input voltage range	−0.5	V <sub>BIAS</sub> + 0.5	V
V <sub>OUT</sub>	Output voltage range	−0.5	V <sub>BIAS</sub> + 0.5	V
V <sub>ON</sub>	Input voltage range	−0.5	6.5	V
I <sub>MAX</sub>	Maximum Continuous Switch Current		200	mA
I <sub>PLS</sub>	Maximum Pulsed Switch Current, pulse <300us, 2% duty cycle		400	mA
T <sub>A</sub>	Operating free-air temperature range <sup>(3)</sup>	−40	85	°C
T <sub>J</sub>	Maximum junction temperature		125	°C
T <sub>STG</sub>	Storage temperature	−65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to network ground terminal.
- (3) In applications where high power dissipation and/or poor package thermal resistance is present, the maximum ambient temperature may have to be derated. Maximum ambient temperature [T<sub>A(max)</sub>] is dependent on the maximum operating junction temperature [T<sub>J(max)</sub>], the maximum power dissipation of the device in the application [P<sub>D(max)</sub>], and the junction-to-ambient thermal resistance of the part/package in the application (θ<sub>JA</sub>), as given by the following equation: T<sub>A(max)</sub> = T<sub>J(max)</sub> − (MJA × P<sub>D(max)</sub>)

### 7.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	2000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	1000

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.

## 7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
$V_{IN}$	Input voltage range	0		$V_{BIAS}$	V
$V_{BIAS}$	Supply voltage range	1.65		5.5	V
$V_{ON}$	Control input voltage range	0		5.5	V
$V_{OUT}$	Output voltage range	0		$V_{BIAS}$	V
$V_{IH, ON}$	High-level input voltage, ON	$V_{BIAS} = 5\text{ V}$		5.5	V
$V_{IL, ON}$	Low-level input voltage, ON	$V_{BIAS} = 5\text{ V}$		0.8	V
$C_{IN}$	Input Capacitor	1			$\mu\text{F}$

## 7.4 Thermal Information

THERMAL METRIC <sup>(1)(2)</sup>		TPS22860		UNIT
		DBV	DCK	
		6 PINS	6 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	235.2	249.0	$^{\circ}\text{C/W}$
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	164.8	107.7	
$R_{\theta JB}$	Junction-to-board thermal resistance	82.5	95.8	
$\Psi_{JT}$	Junction-to-top characterization parameter	52.9	6.2	
$\Psi_{JB}$	Junction-to-board characterization parameter	82.0	93.7	

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

 (2) For thermal estimates of this device based on PCB copper area, see the [TI PCB Thermal Calculator](#).

## 7.5 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
POWER SUPPLIES AND CURRENTS							
I <sub>Q</sub> , V <sub>BIAS</sub>	V <sub>BIAS</sub> quiescent current	I <sub>OUT</sub> = 0, V <sub>IN</sub> = V <sub>ON</sub> = V <sub>BIAS</sub> = 3.3 V			10	100	nA
I <sub>SD</sub> , V <sub>BIAS</sub>	V <sub>BIAS</sub> shutdown current	V <sub>ON</sub> = 0 V			10	100	
I <sub>SD</sub> , V <sub>IN</sub>	V <sub>IN</sub> shutdown current	V <sub>ON</sub> = 0 V, V <sub>OUT</sub> = 1 V	V <sub>IN</sub> = 3.0 V		2	50	
I <sub>ON</sub>	ON pin input leakage current	V <sub>ON</sub> = 5.5 V				100	
RESISTANCE CHARACTERISTICS							
R <sub>ON</sub>	ON-state resistance	I <sub>OUT</sub> = −100 mA, V <sub>BIAS</sub> = 3.3 V	V <sub>IN</sub> = 3.3 V	T <sub>A</sub> = 25°C	0.92	1.15	Ω
				Full T <sub>A</sub>		1.31	
			V <sub>IN</sub> = 2 V	T <sub>A</sub> = 25°C	1.2	1.5	
				Full T <sub>A</sub>		1.7	
			V <sub>IN</sub> = 1.8 V	T <sub>A</sub> = 25°C	0.95	1.2	
				Full T <sub>A</sub>		1.35	

 (1) Over the operating ambient temp  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$  (full) and  $V_{BIAS} = 3.3\text{ V}$ . Typical values are for  $T_A = 25^{\circ}\text{C}$ . (unless otherwise noted)

## 7.6 Switching Characteristics

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

PARAMETER				TEST CONDITIONS		MIN	TYP	MAX	UNIT
t <sub>ON</sub>	Turn-on time	V <sub>OUT</sub> = V <sub>BIAS</sub> , R <sub>L</sub> = 50 Ω   C <sub>L</sub> = 35 pF	T <sub>A</sub> = 25°C	V <sub>BIAS</sub> = 3.3 V	2	4.5	13	ns	
			Full T <sub>A</sub>	V <sub>BIAS</sub> = 3 V to 3.6 V	1		15		
t <sub>OFF</sub>	Turn-off time	V <sub>OUT</sub> = V <sub>BIAS</sub> , R <sub>L</sub> = 50 Ω   C <sub>L</sub> = 35 pF	T <sub>A</sub> = 25°C	V <sub>BIAS</sub> = 3.3 V	3	9	15	ns	
			Full T <sub>A</sub>	V <sub>BIAS</sub> = 3 V to 3.6 V	2		20		
t <sub>ON/OFF</sub>	ON/OFF delay time					See <a href="#">Figure 9</a>			

 (1)  $V_{IN} = V_{ON} = V_{BIAS} = 5\text{ V}, T_A = 25^{\circ}\text{C}$

## 7.7 Typical Characteristics

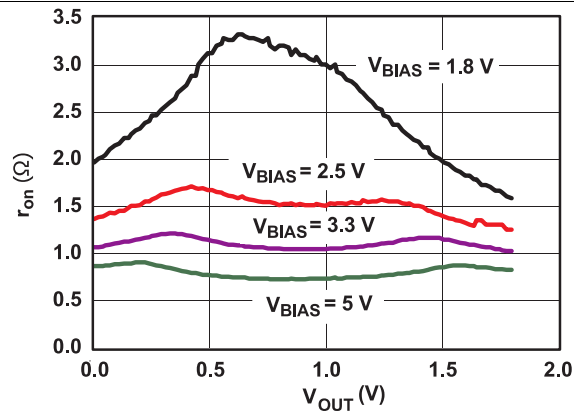


Figure 1.  $r_{on}$  vs  $V_{OUT}$

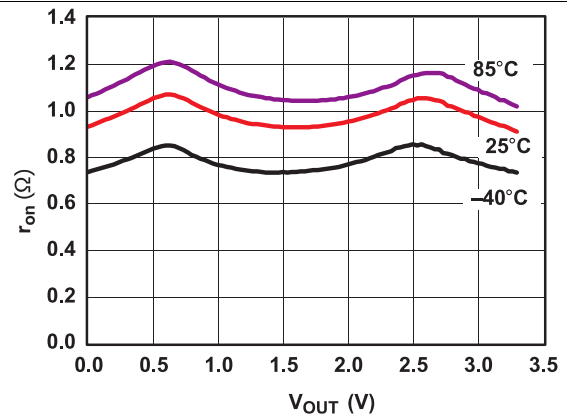


Figure 2.  $r_{on}$  vs  $V_{OUT}$  ( $V_{BIAS} = 3.3\text{ V}$ )

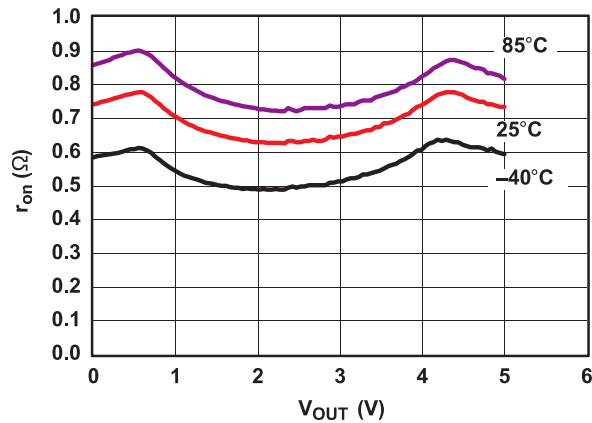


Figure 3.  $r_{on}$  vs  $V_{OUT}$  ( $V_{BIAS} = 5\text{ V}$ )

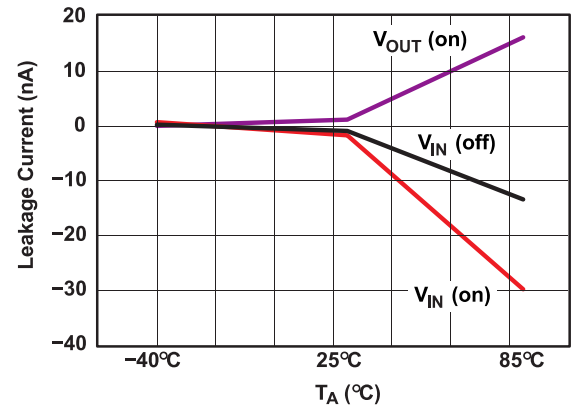


Figure 4. Leakage Current vs Temperature ( $V_{BIAS} = 5.5\text{ V}$ )

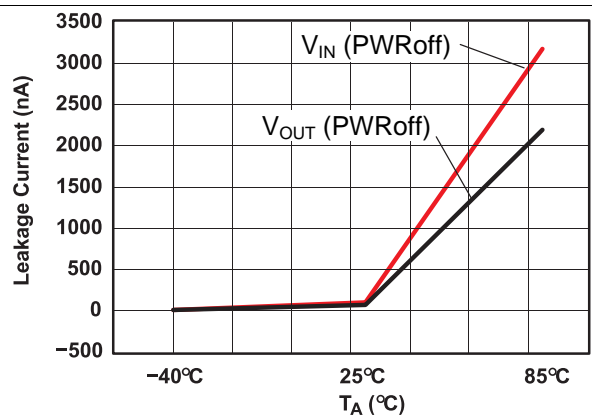


Figure 5. Leakage Current vs Temperature ( $V_{BIAS} = 5\text{ V}$ )

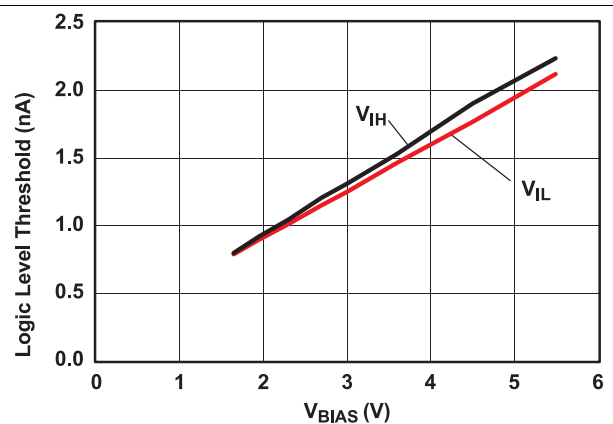
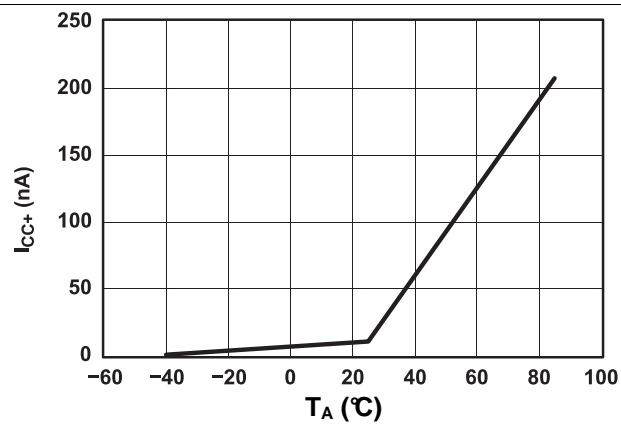


Figure 6. Logic-Level Threshold vs  $V_{BIAS}$

## Typical Characteristics (continued)



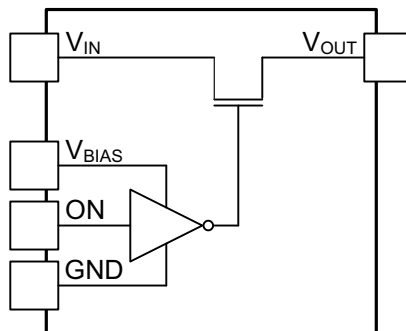
**Figure 7. Power-Supply Current vs Temperature**  
( $V_{BIAS} = 5\text{ V}$ )

## 8 Detailed Description

### 8.1 Overview

The TPS22860 is a small, ultra-low leakage current, single channel bi-directional load switch. The device requires a  $V_{BIAS}$  voltage and can operate over an input voltage range of 0 V to  $V_{BIAS}$ . It can support a maximum continuous current of 200 mA. The switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage control signals. The TPS22860 is available in two small, space-saving 6-pin SOT-23 and SC70 packages. The device is characterized for operation over the free-air temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

### 8.2 Functional Block Diagram



### 8.3 Feature Description

#### 8.3.1 ON/OFF Control

The ON input controls the load switch with positive logic.

#### 8.3.2 Pass Transistor

The TPS22860 supports up to 200-mA current flow in either direction.  $R_{ON}$  is dependent on  $V_{BIAS}$  as shown in [Figure 1](#), [Figure 2](#), and [Figure 3](#).

### 8.4 Device Functional Modes

**Table 1. Functional Table**

ON	$V_{IN}$ to $V_{OUT}$
L	Off
H	On

## 9 Application and Implementation

### NOTE

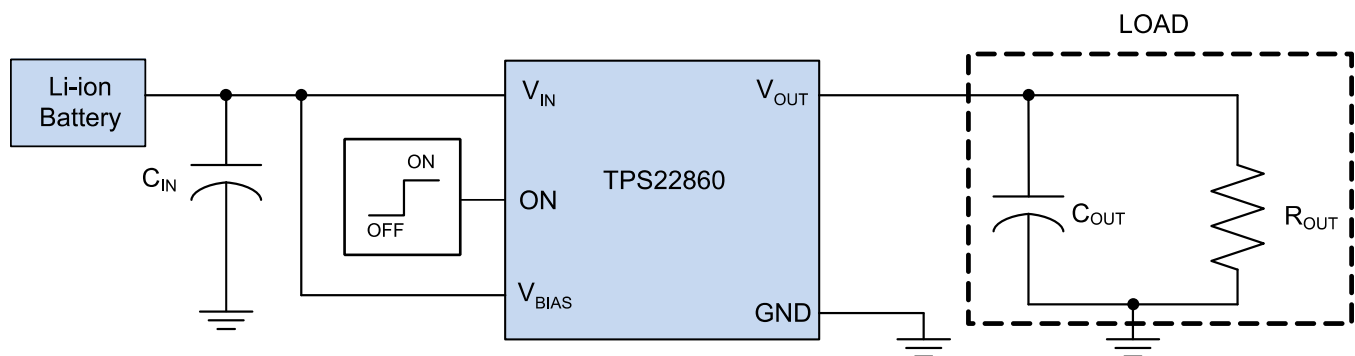
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation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

### 9.1 Application Information

This section will highlight some of the design considerations when implementing this device in a common application.

### 9.2 Typical Application

The TPS22860 IC is a high side load switch. The TPS22860 internal components are rated for 1.65-V to 5.5-V supply and support up to 200 mA of load current. The TPS22860 can be used in a variety of applications. Figure 8 below shows a general application of TPS22860 to control the load inrush current.



**Figure 8. Standard Load Switching Application**

#### 9.2.1 Design Requirements

**Table 2. Component Table**

COMPONENT	DESCRIPTION
$C_{IN}$	Input capacitance <sup>(1)</sup>
LOAD	Load resistance and capacitance will affect the output rise time

(1) Required for load inrush current (slew rate) control



## 9.2.2 Detailed Design Procedure

### 9.2.2.1 Inrush Current

To limit the voltage drop on the input supply caused by transient inrush currents when the switch turns on into a discharged load capacitor, a capacitor must be placed between  $V_{IN}$  and GND. A 1- $\mu$ F ceramic capacitor,  $C_{IN}$ , placed close to the pins, is usually sufficient. Higher values of  $C_{IN}$  can be used to further reduce the voltage drop during high-current applications. When switching heavy loads, TI recommends to have an input capacitor about 10x higher than the output capacitor to avoid excessive voltage drop. Do not float the ON pin.

### 9.2.2.2 ON/OFF Interface

The load switch is controlled by the voltage at the ON pin. To turn ON, the input voltage must be larger than  $V_{IH}$  and to turn off the voltage must be below  $V_{IL}$ .

In applications where an ON/OFF signal is not available, connect ON pin to  $V_{IN}$ . The TPS22860 will turn ON/OFF in sync with the input supply connected to  $V_{IN}$ .

#### NOTE

Connect a pull down resistor from the ON pin to GND when the ON/OFF signal is driven by a high-impedance (tri-state) driver.

## 9.2.3 Application Curves

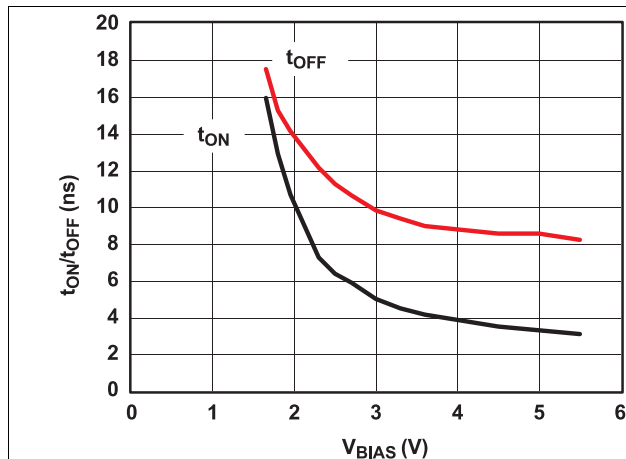


Figure 9.  $t_{ON}$  and  $t_{OFF}$  vs  $V_{BIAS}$

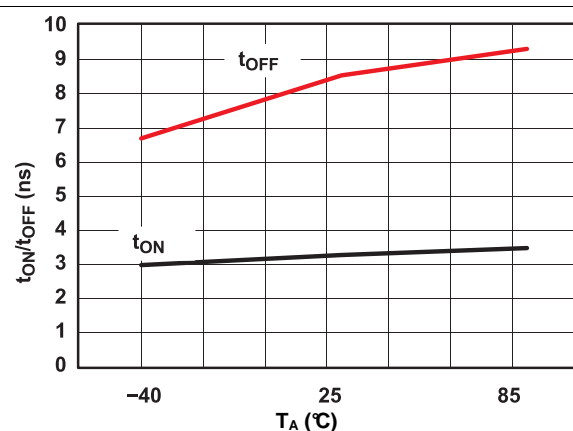


Figure 10.  $t_{ON}$  and  $t_{OFF}$  vs Temperature ( $V_{BIAS} = 5$  V)

## 10 Power Supply Recommendations

The device is designed to operate from a  $V_{IN}$  range of 1.65 V to 5.5 V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 1- $\mu$ F bypass capacitor. If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 1  $\mu$ F may be sufficient.

## 11 Layout

### 11.1 Layout Guidelines

For best operational performance of the device, use good PCB layout practices, including:

- $V_{IN}$  and  $V_{OUT}$  traces should be as short and wide as possible to accommodate for high current.
- The  $V_{IN}$  pin should be bypassed to ground with low ESR ceramic bypass capacitors. The typical recommended bypass capacitance is 1- $\mu$ F ceramic with X5R or X7R dielectric. This capacitor should be placed as close to the device pins as possible.
- The  $V_{OUT}$  pin should be bypassed to ground with low ESR ceramic bypass capacitors. The typical recommended bypass capacitance is one-tenth of the  $V_{IN}$  bypass capacitor of X5R or X7R dielectric rating. This capacitor should be placed as close to the device pins as possible.

### 11.2 Thermal Reliability

For higher reliability it is recommended to limit TPS22860 IC's die junction temperature to less than 105°C. The IC junction temperature is directly proportional to the on-chip power dissipation. Use the following equation to calculate maximum on-chip power dissipation to achieve the maximum die junction temperature target:

$$PD_{(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}}$$

Where:

$T_{J(MAX)}$  is the target maximum junction temperature.

$T_A$  is the operating ambient temperature.

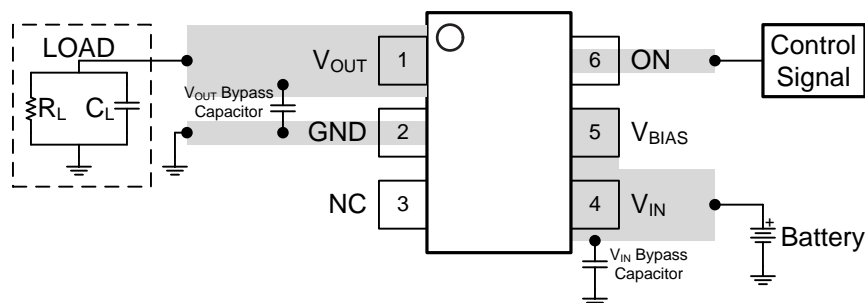
$R_{\theta JA}$  is the package junction to ambient thermal resistance.

(1)

### 11.3 Improving Package Thermal Performance

The package  $R_{\theta JA}$  value under standard conditions on a High-K board is listed in the [Thermal Information](#) table.  $R_{\theta JA}$  value depends on the PC board layout. An external heat sink and/or a cooling mechanism, like a cold air fan, can help reduce  $R_{\theta JA}$  and thus improve device thermal capabilities. Refer to TI's design support web page at [www.ti.com/thermal](http://www.ti.com/thermal) for a general guidance on improving device thermal performance.

### 11.4 Layout Example



⊥ Indicates connection to ground plane

**Figure 11. Basic PCB Layout**

## 12 器件和文档支持

### 12.1 商标

All trademarks are the property of their respective owners.

### 12.2 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。

### 12.3 术语表

[SLYZ022](#) — TI 术语表。

这份术语表列出并解释术语、首字母缩略词和定义。

## 13 机械、封装和可订购信息

以下页中包括机械、封装和可订购信息。 这些信息是针对指定器件可提供的最新数据。 这些数据会在无通知且不对本文档进行修订的情况下发生改变。 欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

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	产品		应用
数字音频	<a href="http://www.ti.com.cn/audio">www.ti.com.cn/audio</a>	通信与电信	<a href="http://www.ti.com.cn/telecom">www.ti.com.cn/telecom</a>
放大器和线性器件	<a href="http://www.ti.com.cn/amplifiers">www.ti.com.cn/amplifiers</a>	计算机及周边	<a href="http://www.ti.com.cn/computer">www.ti.com.cn/computer</a>
数据转换器	<a href="http://www.ti.com.cn/dataconverters">www.ti.com.cn/dataconverters</a>	消费电子	<a href="http://www.ti.com.cn/consumer-apps">www.ti.com.cn/consumer-apps</a>
DLP® 产品	<a href="http://www.dlp.com">www.dlp.com</a>	能源	<a href="http://www.ti.com.cn/energy">www.ti.com.cn/energy</a>
DSP - 数字信号处理器	<a href="http://www.ti.com.cn/dsp">www.ti.com.cn/dsp</a>	工业应用	<a href="http://www.ti.com.cn/industrial">www.ti.com.cn/industrial</a>
时钟和计时器	<a href="http://www.ti.com.cn/clockandtimers">www.ti.com.cn/clockandtimers</a>	医疗电子	<a href="http://www.ti.com.cn/medical">www.ti.com.cn/medical</a>
接口	<a href="http://www.ti.com.cn/interface">www.ti.com.cn/interface</a>	安防应用	<a href="http://www.ti.com.cn/security">www.ti.com.cn/security</a>
逻辑	<a href="http://www.ti.com.cn/logic">www.ti.com.cn/logic</a>	汽车电子	<a href="http://www.ti.com.cn/automotive">www.ti.com.cn/automotive</a>
电源管理	<a href="http://www.ti.com.cn/power">www.ti.com.cn/power</a>	视频和影像	<a href="http://www.ti.com.cn/video">www.ti.com.cn/video</a>
微控制器 (MCU)	<a href="http://www.ti.com.cn/microcontrollers">www.ti.com.cn/microcontrollers</a>		
RFID 系统	<a href="http://www.ti.com.cn/rfidsys">www.ti.com.cn/rfidsys</a>		
OMAP应用处理器	<a href="http://www.ti.com.cn/omap">www.ti.com.cn/omap</a>		
无线连通性	<a href="http://www.ti.com.cn/wirelessconnectivity">www.ti.com.cn/wirelessconnectivity</a>	德州仪器在线技术支持社区	<a href="http://www.deyisupport.com">www.deyisupport.com</a>

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## 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
TPS22860DBVR	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ZFNR	<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.

**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.

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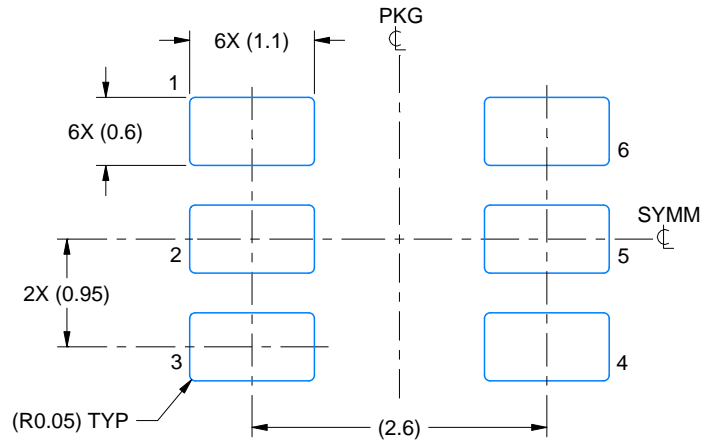


# EXAMPLE BOARD LAYOUT

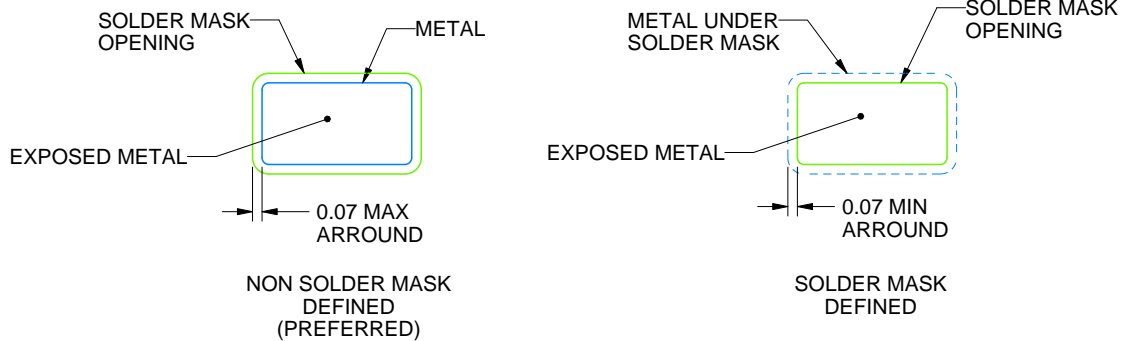
DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4214840/B 03/2018

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

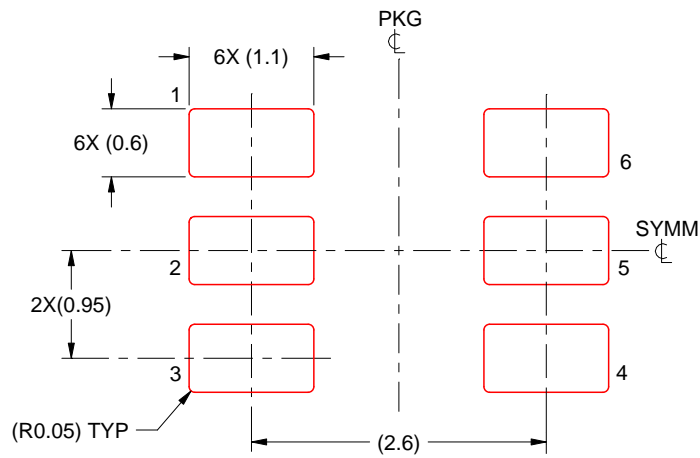
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



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

4214840/B 03/2018

NOTES: (continued)

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



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