

## TPS763 低功耗 150mA 低压降线性稳压器

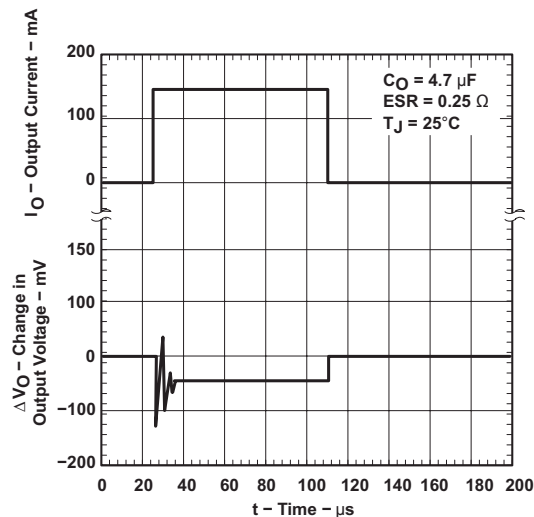
### 1 特性

- 150mA 低压降稳压器
- 输出电压：5V、3.8V、3.3V、3V、2.8V、2.7V、2.5V、1.8V、1.6V 以及可变电电压
- 150mA 时压降电压典型值为 300mV
- 过热保护
- 过流限制
- 关断模式下静态电流小于 2 $\mu$ A
- -40 $^{\circ}$ C 至 125 $^{\circ}$ C 的工作结温范围
- 5 引脚 SOT-23 (DBV) 封装

### 2 应用

- 电表
- 光伏逆变器
- HVAC 系统
- 伺服驱动器和运动控制
- 传感器变送器

TPS76350 负载瞬态响应



### 3 说明

TPS763xx 系列低压降 (LDO) 稳压器具有低压降电压、低功耗运行以及小型化封装等优点。与传统 LDO 稳压器相比，这些稳压器具有低压降电压和低静态电流。TPS763xx 系列器件采用 5 引脚、小外形集成电路 SOT-23 封装，非常适合成本敏感型设计和需要优先考虑布板空间的应用。

通过结合全新的电路设计和工艺创新，使用 PMOS 通道元件来替代普通的 PNP 通道晶体管。因为 PMOS 通道元件可用作低阻值电阻器，其压降电压较低（通常在 150mA 负载电流 (TPS76333) 下为 300mV），并且与负载电流成正比。因为 PMOS 通道元件是电压驱动型器件，其静态电流较低（最大值为 140 $\mu$ A），并且在整个输出负载电流范围 (0mA 至 150mA) 内可保持稳定。

该器件旨在用于笔记本电脑和手机等便携式系统，其低压降电压特性和低功耗运行可显著提高系统电池使用寿命。

TPS763xx 还支持使用逻辑睡眠模式关闭稳压器，从而可将  $T_J = 25^{\circ}\text{C}$  时的静态电流最大值降至 1 $\mu$ A。

TPS763xx 具有 1.6V、1.8V、2.5V、2.7V、2.8V、3V、3.3V、3.8V 和 5V 固定电压版本和可变电电压版本（可在 1.5V 至 6.5V 范围内编程）。

#### 器件信息<sup>(1)</sup>

器件型号	封装	封装尺寸 (标称值)
TPS763xx	SOT-23 (5)	2.90mm × 1.60mm

(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。

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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 I (December 2016) to Revision J

Page

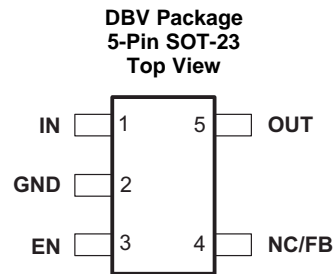
- Changed minimum specification from 4.75 V to 4.85 V in  $V_O$  parameter for TPS76350,  $I_O = 1$  mA to 150 mA row in *Electrical Characteristics* table ..... **5**

### Changes from Revision H (January 2004) to Revision I

Page

- 已添加 添加了 *ESD* 额定值表、特性说明部分、器件功能模式、应用和实施部分、电源相关建议部分、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**
- 已删除 传统应用和非陶瓷电容器已从应用中删除 ..... **1**
- 已添加 添加了电表、光伏逆变器、HVAC 系统、伺服器、运动控制以及传感器变送器，目标位置：应用 ..... **1**
- Deleted *Dissipation Ratings* table ..... **3**
- Added *Thermal Information* table ..... **4**

## 5 Pin Configuration and Functions



### Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
1	IN	I	Input supply voltage
2	GND	—	Ground
3	EN	I	Enable input
4	NC/FB	—/I	No connection (fixed-voltage option only) or feedback voltage (TPS76301 only)
5	OUT	O	Regulated output voltage

## 6 Specifications

## 7 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
Input voltage	−0.3	10	V
Voltage at EN	−0.3	$V_I + 0.3$	V
Voltage on OUT, FB		7	V
Peak output current	Internally limited		
Operating junction temperature, $T_J$	−40	150	°C
Storage temperature, $T_{stg}$	−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.

## 8 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±250	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.  
 (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

## 9 Recommended Operating Conditions

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

		MIN	MAX	UNIT
$V_I$	Input voltage <sup>(1)</sup>	2.7	10	V
$I_O$	Continuous output current	0	150	mA
$T_J$	Operating junction temperature	−40	125	°C

- (1) To calculate the minimum input voltage for your maximum output current, use the following equation:  $V_{I(min)} = V_{O(max)} + V_{DO(max\ load)}$

## 10 Thermal Information

THERMAL METRIC <sup>(1)</sup>		TPS763xx	UNIT
		DBV (SOT-23)	
		5 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	205.3	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	125.1	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	34.6	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	15.2	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter	33.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	°C/W

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

## 11 Electrical Characteristics

over recommended operating free-air temperature range,  $V_I = V_{O(typ)} + 1\text{ V}$ ,  $I_O = 1\text{ mA}$ ,  $EN = IN$ , and  $C_O = 4.7\text{ }\mu\text{F}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT	
$V_O$	Output voltage	TPS76301	$3.25\text{ V} > V_I \geq 2.7\text{ V}$ , $2.5\text{ V} \geq V_O \geq 1.5\text{ V}$ , $I_O = 1\text{ mA to } 75\text{ mA}$ , $T_J = 25^\circ\text{C}$	$0.98 \times V_O$	$V_O$	$1.02 \times V_O$	V
			$3.25\text{ V} > V_I \geq 2.7\text{ V}$ , $2.5\text{ V} \geq V_O \geq 1.5\text{ V}$ , $I_O = 1\text{ mA to } 75\text{ mA}$	$0.97 \times V_O$	$V_O$	$1.03 \times V_O$	
			$V_I \geq 3.25\text{ V}$ , $5\text{ V} \geq V_O \geq 1.5\text{ V}$ , $I_O = 1\text{ mA to } 100\text{ mA}$ , $T_J = 25^\circ\text{C}$	$0.98 \times V_O$	$V_O$	$1.02 \times V_O$	
			$V_I \geq 3.25\text{ V}$ , $5\text{ V} \geq V_O \geq 1.5\text{ V}$ , $I_O = 1\text{ mA to } 100\text{ mA}$	$0.97 \times V_O$	$V_O$	$1.03 \times V_O$	
			$V_I \geq 3.25\text{ V}$ , $5\text{ V} \geq V_O \geq 1.5\text{ V}$ , $I_O = 1\text{ mA to } 150\text{ mA}$ , $T_J = 25^\circ\text{C}$	$0.975 \times V_O$	$V_O$	$1.025 \times V_O$	
			$V_I \geq 3.25\text{ V}$ , $5\text{ V} \geq V_O \geq 1.5\text{ V}$ , $I_O = 1\text{ mA to } 150\text{ mA}$	$0.9625 \times V_O$	$V_O$	$1.0375 \times V_O$	
		TPS76316	$V_I = 2.7\text{ V}$ , $1\text{ mA} < I_O < 75\text{ mA}$ , $T_J = 25^\circ\text{C}$	1.568	1.6	1.632	
			$V_I = 2.7\text{ V}$ , $1\text{ mA} < I_O < 75\text{ mA}$	1.552	1.6	1.648	
			$V_I = 3.25\text{ V}$ , $1\text{ mA} < I_O < 100\text{ mA}$ , $T_J = 25^\circ\text{C}$	1.568	1.6	1.632	
			$V_I = 3.25\text{ V}$ , $1\text{ mA} < I_O < 100\text{ mA}$	1.552	1.6	1.648	
			$V_I = 3.25\text{ V}$ , $1\text{ mA} < I_O < 150\text{ mA}$ , $T_J = 25^\circ\text{C}$	1.56	1.6	1.64	
			$V_I = 3.25\text{ V}$ , $1\text{ mA} < I_O < 150\text{ mA}$	1.536	1.6	1.664	
		TPS76318	$V_I = 2.7\text{ V}$ , $1\text{ mA} < I_O < 75\text{ mA}$ , $T_J = 25^\circ\text{C}$	1.764	1.8	1.836	
			$V_I = 2.7\text{ V}$ , $1\text{ mA} < I_O < 75\text{ mA}$	1.746	1.8	1.854	
			$V_I = 3.25\text{ V}$ , $1\text{ mA} < I_O < 100\text{ mA}$ , $T_J = 25^\circ\text{C}$	1.764	1.8	1.836	
			$V_I = 3.25\text{ V}$ , $1\text{ mA} < I_O < 100\text{ mA}$	1.746	1.8	1.854	
			$V_I = 3.25\text{ V}$ , $1\text{ mA} < I_O < 150\text{ mA}$ , $T_J = 25^\circ\text{C}$	1.755	1.8	1.845	
			$V_I = 3.25\text{ V}$ , $1\text{ mA} < I_O < 150\text{ mA}$	1.733	1.8	1.867	

**Electrical Characteristics (continued)**

over recommended operating free-air temperature range,  $V_I = V_{O(\text{typ})} + 1 \text{ V}$ ,  $I_O = 1 \text{ mA}$ ,  $EN = IN$ , and  $C_O = 4.7 \text{ }\mu\text{F}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT	
$V_O$	Output voltage (continued)	TPS76325	$I_O = 1 \text{ mA to } 100 \text{ mA}$ , $T_J = 25^\circ\text{C}$	2.45	2.5	2.55	V
			$I_O = 1 \text{ mA to } 100 \text{ mA}$	2.425	2.5	2.575	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$ , $T_J = 25^\circ\text{C}$	2.438	2.5	2.562	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$	2.407	2.5	2.593	
		TPS76327	$I_O = 1 \text{ mA to } 100 \text{ mA}$ , $T_J = 25^\circ\text{C}$	2.646	2.7	2.754	
			$I_O = 1 \text{ mA to } 100 \text{ mA}$	2.619	2.7	2.781	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$ , $T_J = 25^\circ\text{C}$	2.632	2.7	2.767	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$	2.599	2.7	2.801	
		TPS76328	$I_O = 1 \text{ mA to } 100 \text{ mA}$ , $T_J = 25^\circ\text{C}$	2.744	2.8	2.856	
			$I_O = 1 \text{ mA to } 100 \text{ mA}$	2.716	2.8	2.884	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$ , $T_J = 25^\circ\text{C}$	2.73	2.8	2.87	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$	2.695	2.8	2.905	
		TPS76330	$I_O = 1 \text{ mA to } 100 \text{ mA}$ , $T_J = 25^\circ\text{C}$	2.94	3	3.06	
			$I_O = 1 \text{ mA to } 100 \text{ mA}$	2.91	3	3.09	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$ , $T_J = 25^\circ\text{C}$	2.925	3	3.075	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$	2.888	3	3.112	
		TPS76333	$I_O = 1 \text{ mA to } 100 \text{ mA}$ , $T_J = 25^\circ\text{C}$	3.234	3.3	3.366	
			$I_O = 1 \text{ mA to } 100 \text{ mA}$	3.201	3.3	3.399	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$ , $T_J = 25^\circ\text{C}$	3.218	3.3	3.382	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$	3.177	3.3	3.423	
		TPS76338	$I_O = 1 \text{ mA to } 100 \text{ mA}$ , $T_J = 25^\circ\text{C}$	3.724	3.8	3.876	
			$I_O = 1 \text{ mA to } 100 \text{ mA}$	3.705	3.8	3.895	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$ , $T_J = 25^\circ\text{C}$	3.686	3.8	3.914	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$	3.667	3.8	3.933	
		TPS76350	$I_O = 1 \text{ mA to } 100 \text{ mA}$ , $T_J = 25^\circ\text{C}$	4.875	5	5.125	
			$I_O = 1 \text{ mA to } 100 \text{ mA}$	4.825	5	5.175	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$ , $T_J = 25^\circ\text{C}$	4.85	5	5.15	
			$I_O = 1 \text{ mA to } 150 \text{ mA}$	4.8	5	5.2	
$I_{(Q)}$	Quiescent current (GND pin current)	$I_O = 1 \text{ mA to } 150 \text{ mA}$ , $T_J = 25^\circ\text{C}^{(1)}$		85	100	$\mu\text{A}$	
		$I_O = 1 \text{ mA to } 150 \text{ mA}^{(2)}$			140		
	Standby current	$EN < 0.5 \text{ V}$ , $T_J = 25^\circ\text{C}$		0.5	1	$\mu\text{A}$	
		$EN < 0.5 \text{ V}$			2		
$V_n$	Output noise voltage	$BW = 300 \text{ Hz to } 50 \text{ kHz}$ , $T_J = 25^\circ\text{C}$ , $C_O = 10 \text{ }\mu\text{F}^{(2)}$		140		$\mu\text{V}$	
PSRR	Ripple rejection	$f = 1 \text{ kHz}$ , $C_O = 10 \text{ }\mu\text{F}$ , $T_J = 25^\circ\text{C}^{(2)}$		60		dB	
	Current limit	$T_J = 25^\circ\text{C}^{(3)}$	0.5	0.8	1.5	A	
	Output voltage line regulation ( $\Delta V_O/V_O$ ) <sup>(3)</sup>	$V_O + 1 \text{ V} < V_I \leq 10 \text{ V}$ , $V_I \geq 3.5 \text{ V}$ , $T_J = 25^\circ\text{C}$		0.04%	0.07%	V	
		$V_O + 1 \text{ V} < V_I \leq 10 \text{ V}$ , $V_I \geq 3.5 \text{ V}$			0.1%		
$V_{IH}$	EN high level input <sup>(2)</sup>			1.4	2	V	
$V_{IL}$	EN low level input <sup>(2)</sup>		0.5	1.2		V	

(1) Minimum  $I_N$  operating voltage is 2.7 V or  $V_{O(\text{typ})} + 1 \text{ V}$ , whichever is greater.

(2) Test conditions includes output voltage  $V_O = 0 \text{ V}$  (for variable device FB is shorted to  $V_O$ ), and pulse duration = 10 ms.

$$\text{Line Reg. (mV)} = (\% / \text{V}) \times \frac{V_O (V_{I\text{max}} - 3.5 \text{ V})}{100} \times 1000$$

(3) If  $V_O < 2.5 \text{ V}$  and  $V_{I\text{max}} = 10 \text{ V}$ ,  $V_{I\text{min}} = 3.5 \text{ V}$ :

$$\text{Line Reg. (mV)} = (\% / \text{V}) \times \frac{V_O (V_{I\text{max}} - (V_O + 1))}{100} \times 1000$$

If  $V_O > 2.5 \text{ V}$  and  $V_{I\text{max}} = 10 \text{ V}$ ,  $V_{I\text{min}} = V_O + 1 \text{ V}$ :

**Electrical Characteristics (continued)**

over recommended operating free-air temperature range,  $V_I = V_{O(typ)} + 1\text{ V}$ ,  $I_O = 1\text{ mA}$ ,  $EN = IN$ , and  $C_O = 4.7\text{ }\mu\text{F}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$I_i$	EN input current	EN = 0 V			-0.01	-0.5	$\mu\text{A}$
		EN = IN			-0.01	-0.5	
$V_{DO}$	Dropout voltage	TPS76325	$I_O = 0\text{ mA}$ , $T_J = 25^\circ\text{C}$		0.2		mV
			$I_O = 1\text{ mA}$ , $T_J = 25^\circ\text{C}$		3		
			$I_O = 50\text{ mA}$ , $T_J = 25^\circ\text{C}$		120	150	
			$I_O = 50\text{ mA}$			200	
			$I_O = 75\text{ mA}$ , $T_J = 25^\circ\text{C}$		180	225	
			$I_O = 75\text{ mA}$			300	
			$I_O = 100\text{ mA}$ , $T_J = 25^\circ\text{C}$		240	300	
			$I_O = 100\text{ mA}$			400	
			$I_O = 150\text{ mA}$ , $T_J = 25^\circ\text{C}$		360	450	
			$I_O = 150\text{ mA}$			600	
		TPS76333	$I_O = 0\text{ mA}$ , $T_J = 25^\circ\text{C}$		0.2		
			$I_O = 1\text{ mA}$ , $T_J = 25^\circ\text{C}$		3		
			$I_O = 50\text{ mA}$ , $T_J = 25^\circ\text{C}$		100	125	
			$I_O = 50\text{ mA}$			166	
			$I_O = 75\text{ mA}$ , $T_J = 25^\circ\text{C}$		150	188	
			$I_O = 75\text{ mA}$			250	
			$I_O = 100\text{ mA}$ , $T_J = 25^\circ\text{C}$		200	250	
			$I_O = 100\text{ mA}$			333	
			$I_O = 150\text{ mA}$ , $T_J = 25^\circ\text{C}$		300	375	
			$I_O = 150\text{ mA}$			500	
		TPS76350	$I_O = 0\text{ mA}$ , $T_J = 25^\circ\text{C}$		0.2		
			$I_O = 1\text{ mA}$ , $T_J = 25^\circ\text{C}$		2		
			$I_O = 50\text{ mA}$ , $T_J = 25^\circ\text{C}$		60	75	
			$I_O = 50\text{ mA}$			100	
			$I_O = 75\text{ mA}$ , $T_J = 25^\circ\text{C}$		90	113	
			$I_O = 75\text{ mA}$			150	
			$I_O = 100\text{ mA}$ , $T_J = 25^\circ\text{C}$		120	150	
			$I_O = 100\text{ mA}$			200	
			$I_O = 150\text{ mA}$ , $T_J = 25^\circ\text{C}$		180	225	
			$I_O = 150\text{ mA}$			300	

### 11.1 Typical Characteristics

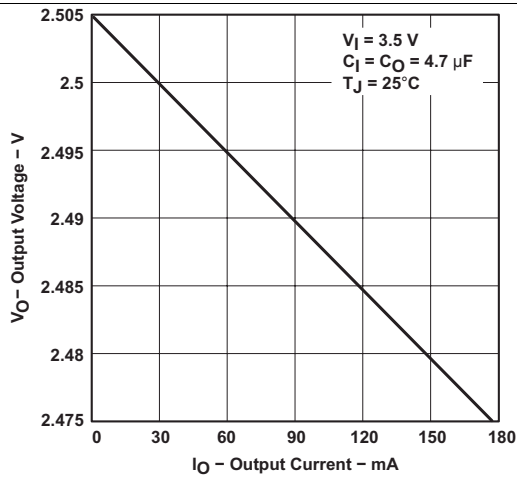


Figure 1. TPS76325 Output Voltage vs Output Current

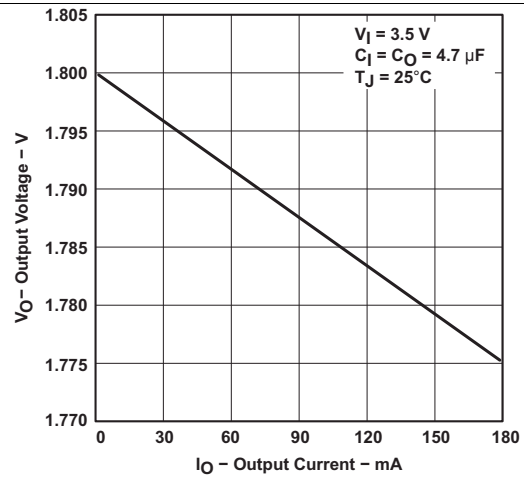


Figure 2. TPS76318 Output Voltage vs Output Current

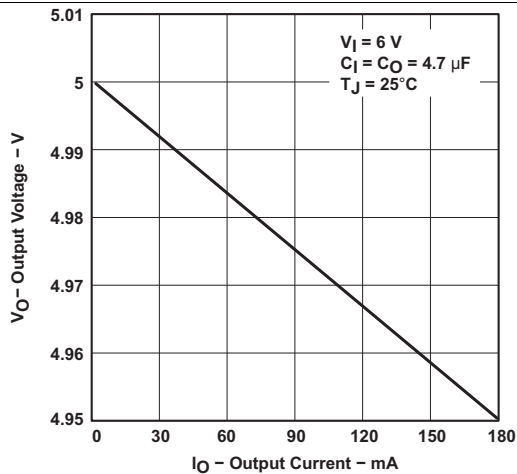


Figure 3. TPS76350 Output Voltage vs Output Current

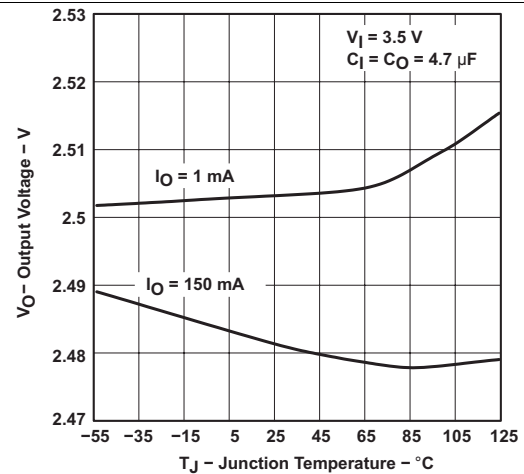


Figure 4. TPS76325 Output Voltage vs Output Current

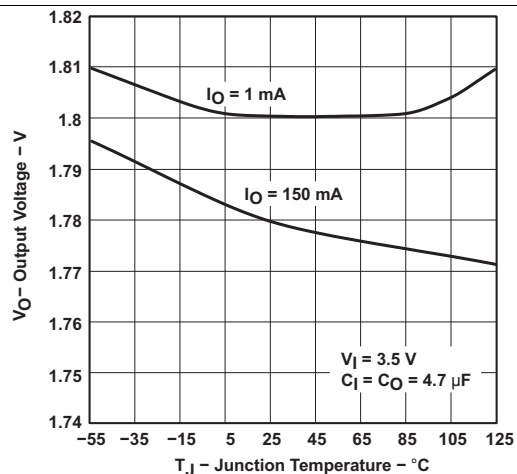


Figure 5. TPS76318 Output Voltage vs Free-Air Temperature

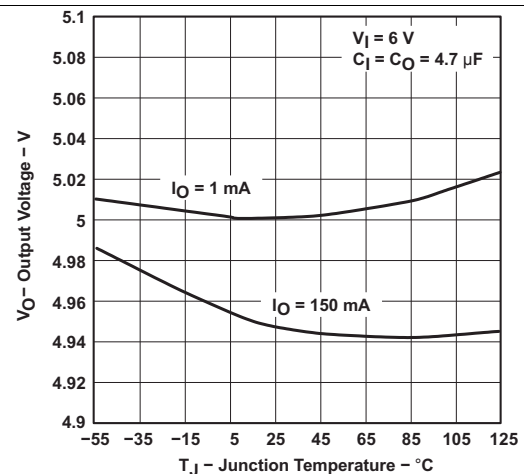
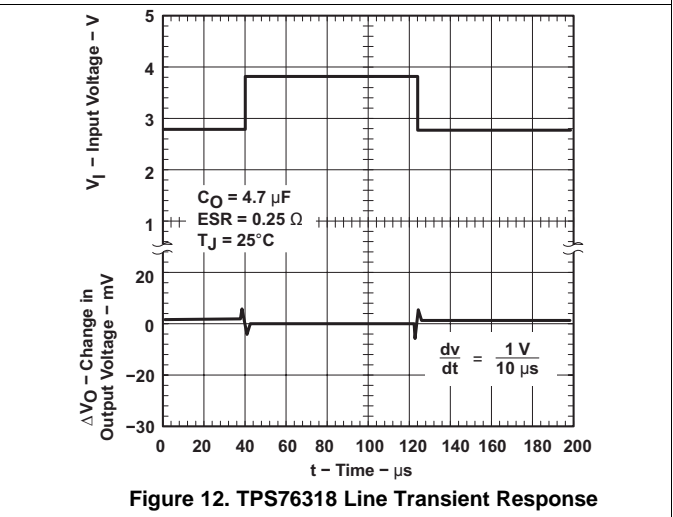
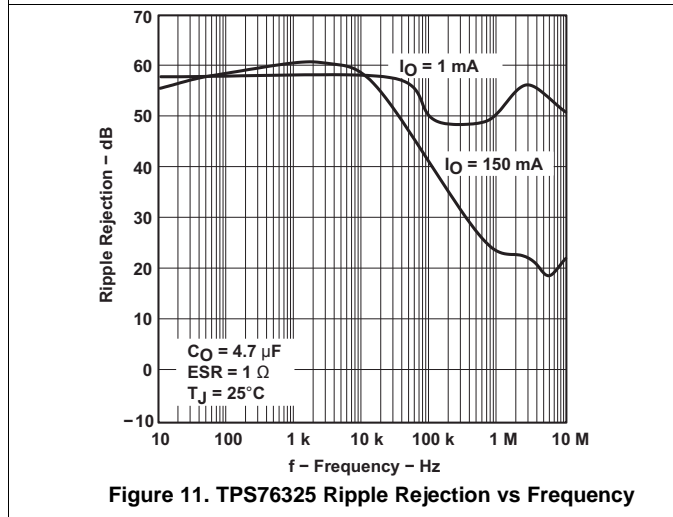
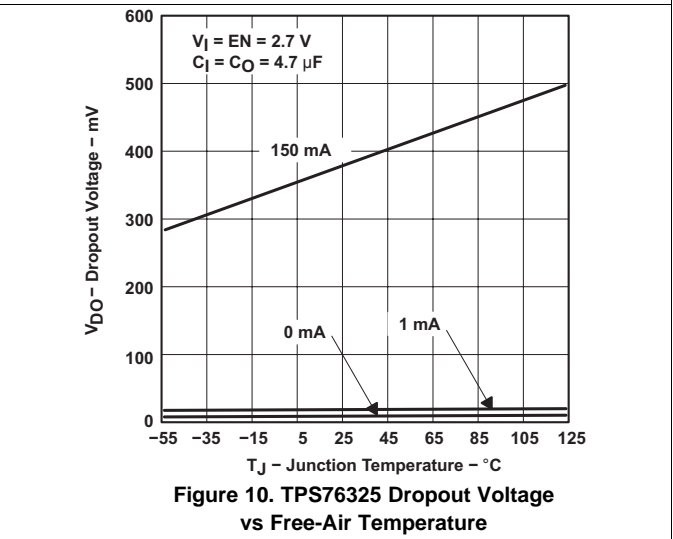
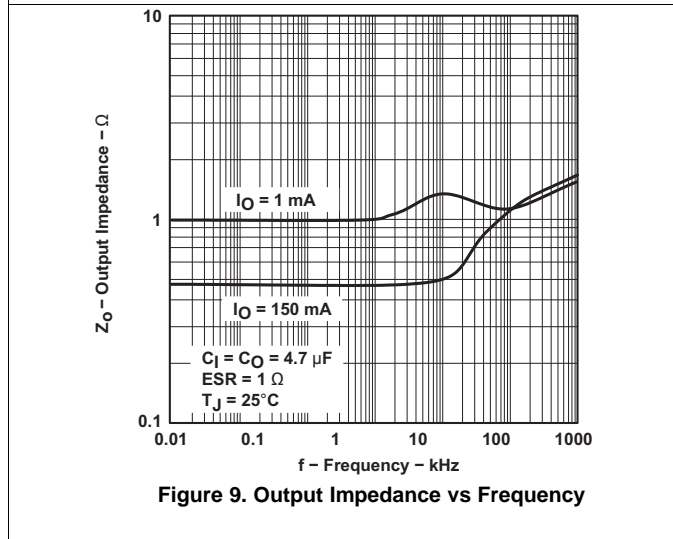
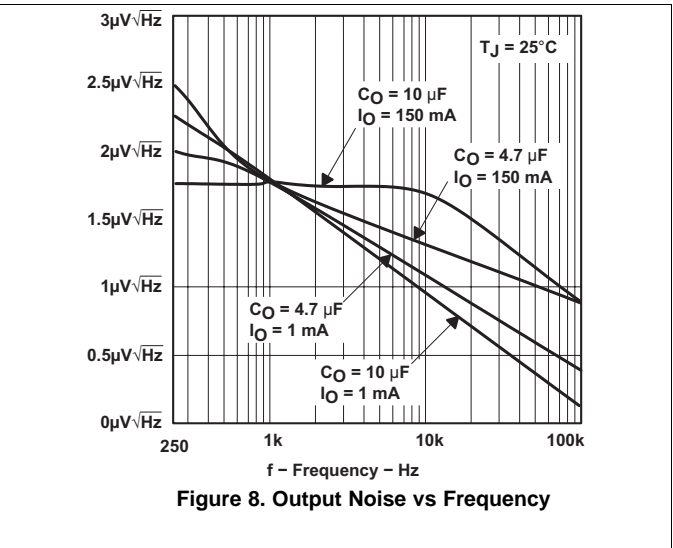
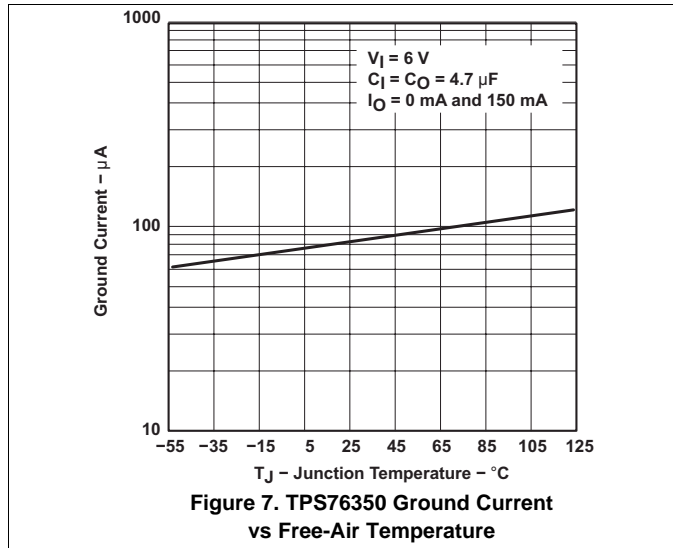


Figure 6. TPS76350 Output Voltage vs Free-Air Temperature

Typical Characteristics (continued)





Typical Characteristics (continued)

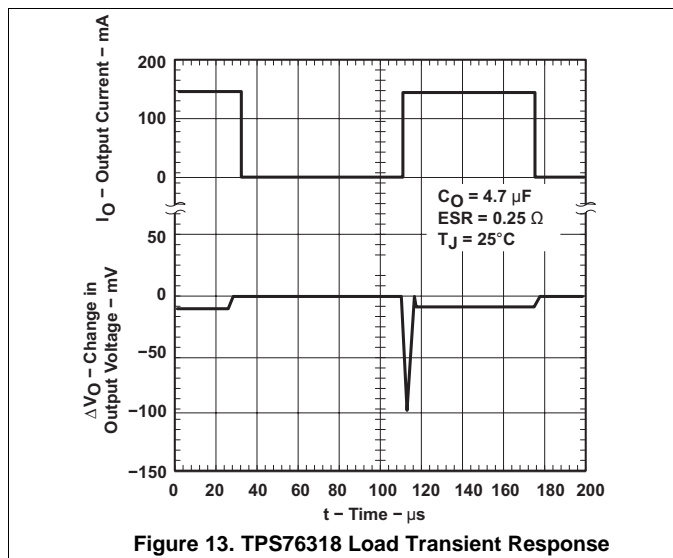


Figure 13. TPS76318 Load Transient Response

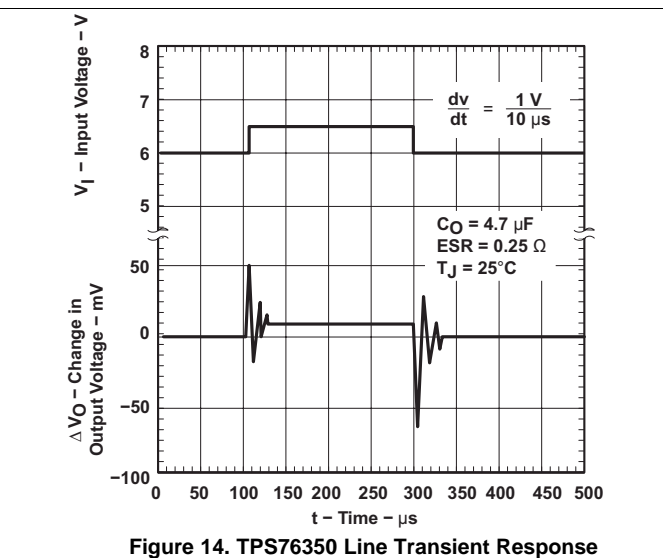


Figure 14. TPS76350 Line Transient Response

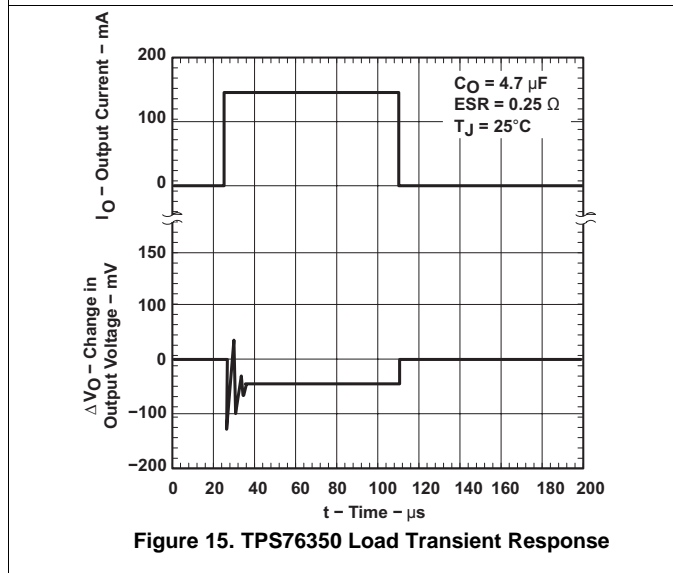


Figure 15. TPS76350 Load Transient Response

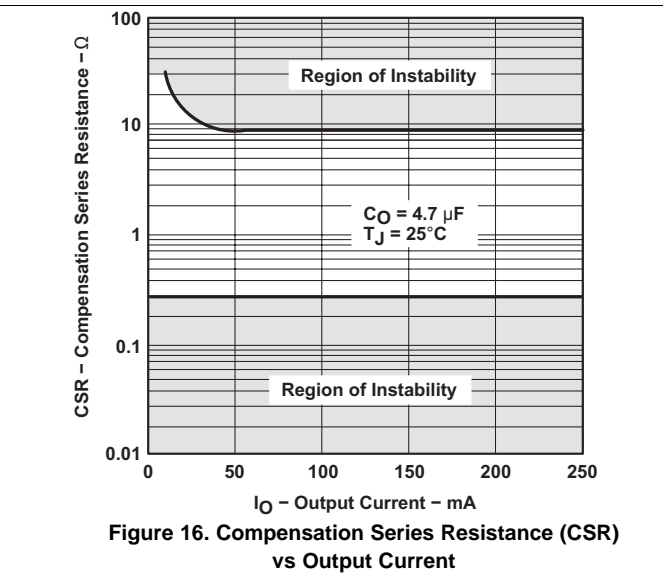


Figure 16. Compensation Series Resistance (CSR) vs Output Current

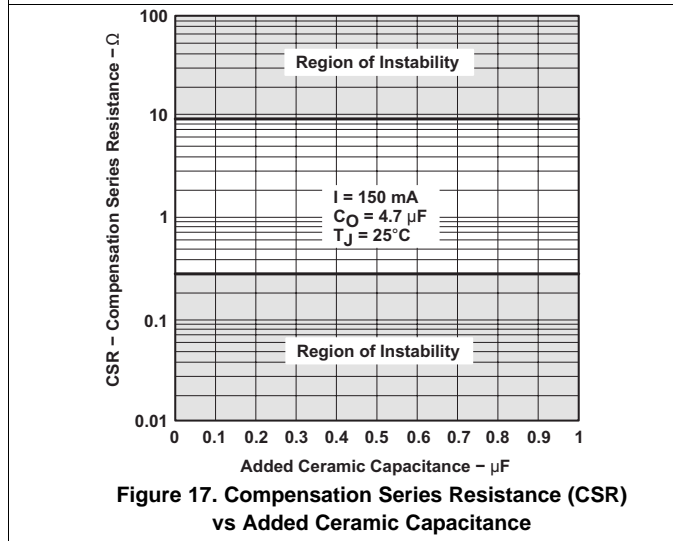


Figure 17. Compensation Series Resistance (CSR) vs Added Ceramic Capacitance

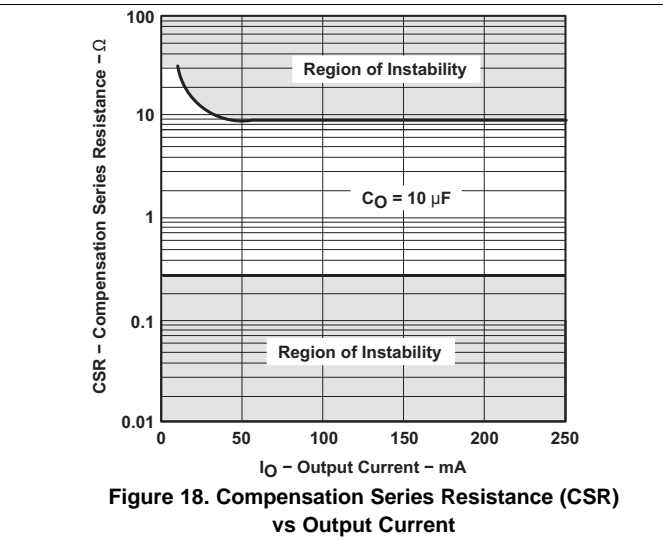
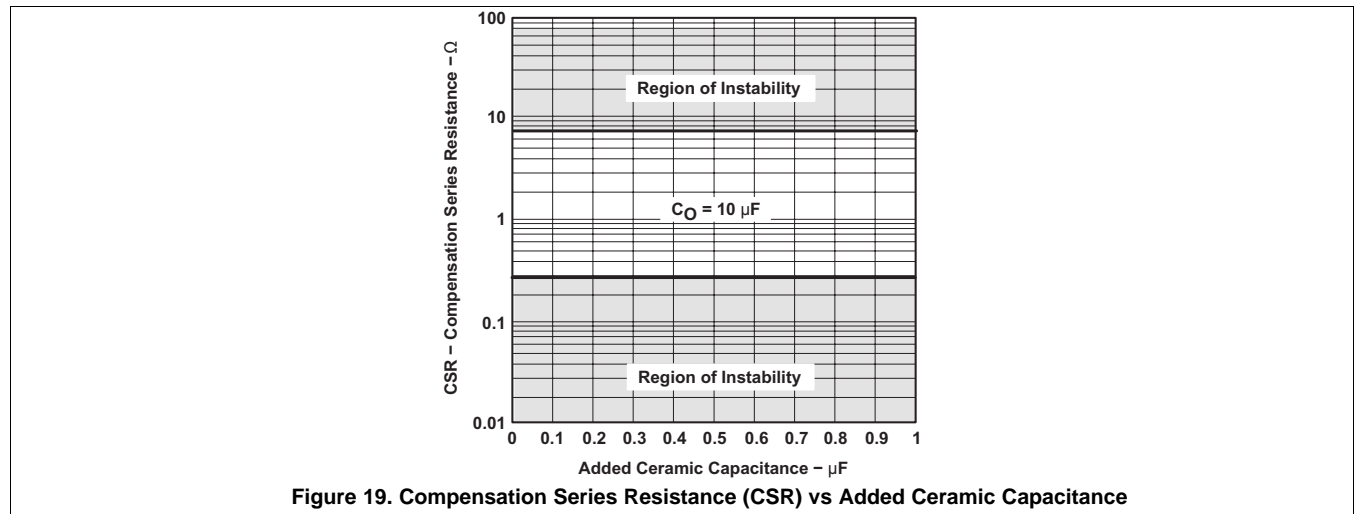


Figure 18. Compensation Series Resistance (CSR) vs Output Current

**Typical Characteristics (continued)**



**Figure 19. Compensation Series Resistance (CSR) vs Added Ceramic Capacitance**

## 12 Detailed Description

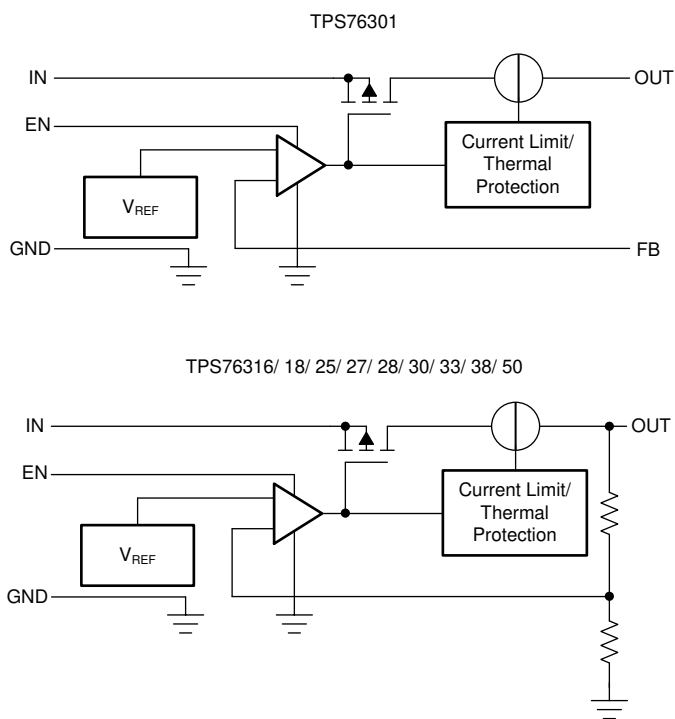
### 12.1 Overview

The TPS763xx devices use a PMOS pass element to dramatically reduce both dropout voltage and supply current over more conventional PNP pass element LDO designs. The PMOS pass element is a voltage-controlled device that, unlike a PNP transistor, does not require increased drive current as output current increases. Supply current in the TPS763xx is essentially constant from no-load to maximum load.

Current limiting and thermal protection prevent damage by excessive output current and/or power dissipation. The device switches into a constant-current mode at approximately 1 A; further load reduces the output voltage instead of increasing the output current. The thermal protection shuts the regulator off if the junction temperature rises above 165°C. Recovery is automatic when the junction temperature drops approximately 25°C below the high temperature trip point. The PMOS pass element includes a back diode that safely conducts reverse current when the input voltage level drops below the output voltage level.

A logic low on the enable input, EN, shuts off the output and reduces the supply current to less than 2 µA. EN must be tied high in applications where the shutdown feature is not used.

### 12.2 Functional Block Diagram



### 12.3 Feature Description

#### 12.3.1 Regulator Protection

The TPS763xx features internal current limiting and thermal protection. During normal operation, the TPS763xx limits output current to approximately 800 mA. When current limiting engages, the output voltage scales back linearly until the overcurrent condition ends. While current limiting is designed to prevent gross device failure, take care not to exceed the power dissipation ratings of the package. If the temperature of the device exceeds 165°C, thermal-protection circuitry shuts it down. Once the device has cooled down to below 140°C, regulator operation resumes.

## Feature Description (continued)

### 12.3.2 Enable

The enable signal ( $V_{EN}$ ) is an active-high digital control that enables the LDO when the enable voltage is past the rising threshold ( $V_{EN} \geq V_{IH(EN)}$ ) and disables the LDO when the enable voltage is below the falling threshold ( $V_{EN} \leq V_{IL(EN)}$ ). The exact enable threshold is between  $V_{IH(EN)}$  and  $V_{IL(EN)}$  because EN is a digital control. In applications that do not use the enable control, connect EN to  $V_{IN}$ .

### 12.4 Device Functional Modes

Table 1 provides a quick comparison between the regulation and disabled operation.

**Table 1. Device Functional Modes Comparison**

OPERATING MODE	PARAMETER			
	$V_{IN}$	EN	$I_{OUT}$	$T_J$
Regulation <sup>(1)</sup>	$V_{IN} > V_{OUT(nom)} + V_{DO}$	$V_{EN} > V_{IH(EN)}$	$I_{OUT} < I_{CL}$	$T_J < T_{sd}$
Disabled <sup>(2)</sup>	—	$V_{EN} < V_{IL(EN)}$	—	$T_J > T_{sd}$

(1) All table conditions must be met.

(2) The device is disabled when any condition is met.

#### 12.4.1 Regulation

The device regulates the output to the targeted output voltage when all the conditions in Table 1 are met.

#### 12.4.2 Disabled

When disabled, the pass device is turned off, the internal circuits are shutdown.

## 13 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.

### 13.1 Application Information

The TPS763xx low-dropout (LDO) regulators are part of a family of regulators which have been optimized for use in battery-operated equipment and feature extremely low dropout voltages, low quiescent current (140  $\mu$ A), and an enable input to reduce supply currents to less than 2  $\mu$ A when the regulator is turned off.

### 13.2 Typical Application

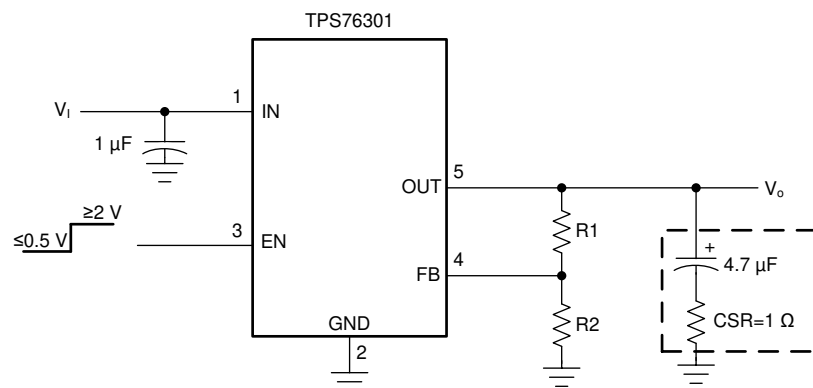


Figure 20. Typical Application Circuit

#### 13.2.1 Design Requirements

Although not required, TI recommends a 0.047- $\mu$ F or larger ceramic bypass input capacitor, connected between IN and GND and placed close to the TPS763xx, to improve transient response and noise rejection. A higher-value electrolytic input capacitor may be necessary if large, fast-rise-time load transients are anticipated and the device is placed several inches from the power source. Follow the programming guidelines from [Table 2](#).

Table 2. Output Voltage Programming Guide

OUTPUT VOLTAGE (V)	DIVIDER RESISTANCE ( $k\Omega$ ) <sup>(1)</sup>	
	R1	R2
2.5	187	169
3.3	301	169
3.6	348	169
4	402	169
5	549	169
6.45	750	169

(1) 1% values shown

### 13.2.2 Detailed Design Procedure

#### 13.2.2.1 Capacitor Selection

Like all low dropout regulators, the TPS763xx requires an output capacitor connected between OUT and GND to stabilize the internal loop control. The minimum recommended capacitance value is 4.7 μF and the ESR (equivalent series resistance) must be between 0.3 Ω and 10 Ω. Capacitor values 4.7 μF or larger are acceptable, provided the ESR is less than 10 Ω. Solid tantalum electrolytic, aluminum electrolytic, and multilayer ceramic capacitors are all suitable, provided they meet the requirements described above. Most of the commercially available 4.7 μF surface-mount solid tantalum capacitors, including devices from Sprague, Kemet, and Nichico, meet the ESR requirements stated above (see Table 3).

**Table 3. Capacitor Selection**

PART NO.	MFR	VALUE	MAX ESR	SIZE (H x L x W)
T494B475K016AS	Kemet	4.7 μF	1.5 Ω	1.9 x 3.5 x 2.8
195D106x0016x2T	Sprague	10 μF	1.5 Ω	1.3 x 7 x 2.7
695D106x003562T	Sprague	10 μF	1.3 Ω	2.5 x 7.6 x 2.5
TPSC475K035R0600	AVX	4.7 μF	0.6 Ω	2.6 x 6 x 3.2

#### 13.2.2.2 Output Voltage Programming

The output voltage of the TPS76301 adjustable regulator is programmed using an external resistor divider as shown in Figure 21. The output voltage is calculated using Equation 1.

$$V_O = 0.995 \times V_{ref} \times \left( 1 + \frac{R1}{R2} \right)$$

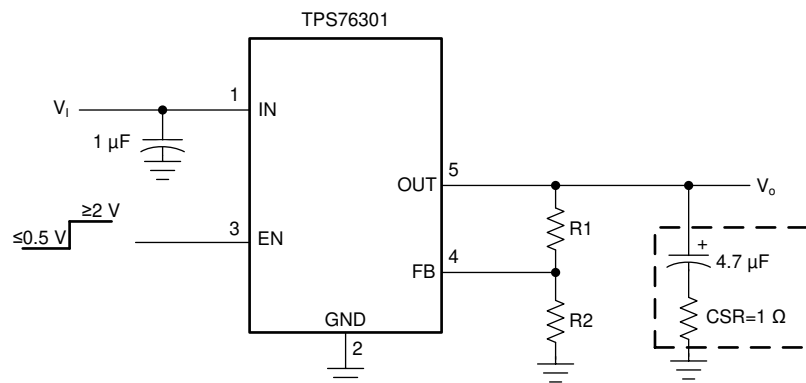
where

- Vref = 1.192 V typical (the internal reference voltage)
  - 0.995 is a constant used to center the load regulator (1%)
- (1)

Resistors R1 and R2 must be chosen for approximately 7-μA divider current. Lower value resistors can be used but offer no inherent advantage and waste more power. Higher values must be avoided as leakage currents at FB increase the output voltage error. TI recommends choosing a design procedure of R2 = 169 kΩ to set the divider current at 7 μA and then calculate R1 using Equation 2.

$$R1 = \left( \frac{V_O}{0.995 \times V_{ref}} - 1 \right) \times R2$$

(2)

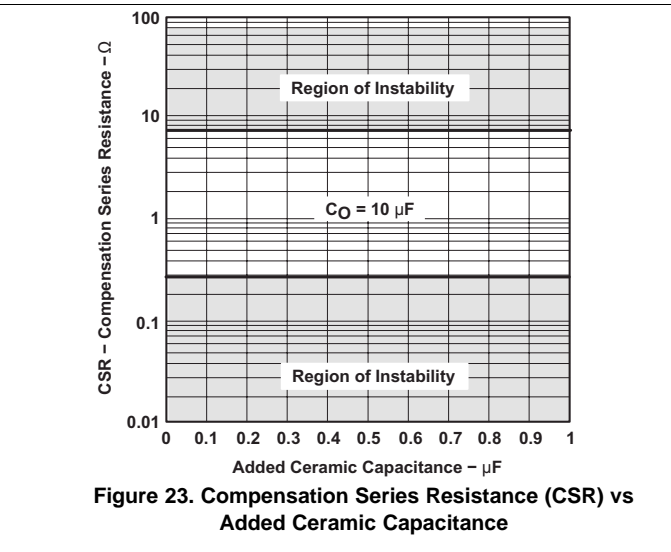
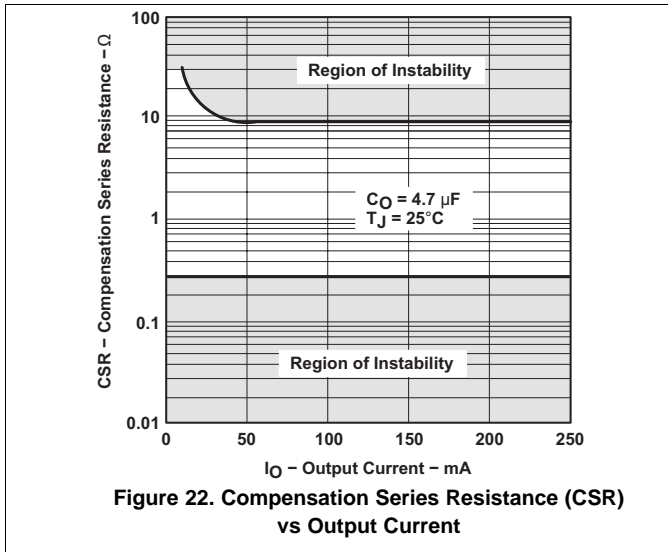


**Figure 21. TPS76301 Adjustable LDO Regulator Programming**

### 13.2.2.3 Reverse Current

The TPS763xx pass element has a built-in back diode that safely conducts reverse currents when the input voltage drops below the output voltage (for example, during power down). Current is conducted from the output to the input and is not internally limited. If extended reverse voltage is anticipated, external limiting might be appropriate.

### 13.2.3 Application Curves



## 14 Power Supply Recommendations

A 1- $\mu$ F or larger input capacitor must be used.

### 14.1 Power Dissipation and Junction Temperature

Specified regulator operation is assured to a junction temperature of 125°C; the maximum junction temperature allowable to avoid damaging the device is 150°C. This restriction limits the power dissipation the regulator can handle in any given application. To ensure the junction temperature is within acceptable limits, calculate the maximum allowable dissipation,  $P_{D(max)}$ , and the actual dissipation,  $P_D$ , which must be less than or equal to  $P_{D(max)}$ .

The maximum-power-dissipation limit is determined using [Equation 3](#).

$$P_{D(max)} = \frac{T_{Jmax} - T_A}{R_{\theta JA}}$$

where

- $T_{Jmax}$  is the maximum allowable junction temperature
- $R_{\theta JA}$  is the thermal resistance junction-to-ambient for the package, see [Thermal Information](#)
- $T_A$  is the ambient temperature

(3)

The regulator dissipation is calculating using [Equation 4](#).

$$P_D = (V_I - V_O) \times I_O$$

(4)

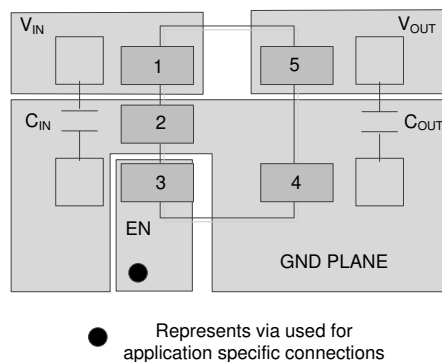
Power dissipation resulting from quiescent current is negligible.

## 15 Layout

### 15.1 Layout Guidelines

- Place input and output capacitors as close to the device as possible.
- Use copper planes for device connections to optimize thermal performance.
- Place thermal vias around the device to distribute the heat.

### 15.2 Layout Example



**Figure 24. Layout Example for DBV Package**



## 16 器件和文档支持

### 16.1 接收文档更新通知

要接收文档更新通知，请导航至 [ti.com](http://ti.com) 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。

### 16.2 社区资源

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

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### 16.3 商标

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

### 16.4 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。

### 16.5 Glossary

[SLYZ022](#) — *TI Glossary*.

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

## 17 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
TPS76301DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PAZI	<a href="#">Samples</a>
TPS76301DBVRG4	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PAZI	<a href="#">Samples</a>
TPS76301DBVT	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PAZI	<a href="#">Samples</a>
TPS76316DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBHI	<a href="#">Samples</a>
TPS76316DBVRG4	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBHI	<a href="#">Samples</a>
TPS76316DBVT	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBHI	<a href="#">Samples</a>
TPS76318DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBAI	<a href="#">Samples</a>
TPS76318DBVRG4	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBAI	<a href="#">Samples</a>
TPS76318DBVT	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBAI	<a href="#">Samples</a>
TPS76318DBVTG4	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBAI	<a href="#">Samples</a>
TPS76325DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBBI	<a href="#">Samples</a>
TPS76325DBVRG4	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBBI	<a href="#">Samples</a>
TPS76325DBVT	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBBI	<a href="#">Samples</a>
TPS76327DBVR	LIFEBUY	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBCI	
TPS76327DBVT	LIFEBUY	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBCI	
TPS76327DBVTG4	LIFEBUY	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBCI	
TPS76328DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBDI	<a href="#">Samples</a>
TPS76328DBVT	LIFEBUY	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBDI	
TPS76330DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBII	<a href="#">Samples</a>
TPS76330DBVT	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBII	<a href="#">Samples</a>
TPS76333DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBEI	<a href="#">Samples</a>

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
TPS76333DBVRG4	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBEI	<a href="#">Samples</a>
TPS76333DBVT	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBEI	<a href="#">Samples</a>
TPS76333DBVTG4	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBEI	<a href="#">Samples</a>
TPS76338DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBFI	<a href="#">Samples</a>
TPS76338DBVT	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBFI	<a href="#">Samples</a>
TPS76350DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBGI	<a href="#">Samples</a>
TPS76350DBVRG4	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBGI	<a href="#">Samples</a>
TPS76350DBVT	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBGI	<a href="#">Samples</a>
TPS76350DBVTG4	ACTIVE	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PBGI	<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 <=100ppm 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.

<sup>(6)</sup> 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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**OTHER QUALIFIED VERSIONS OF TPS763 :**

- Automotive : [TPS763-Q1](#)

NOTE: Qualified Version Definitions:

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

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

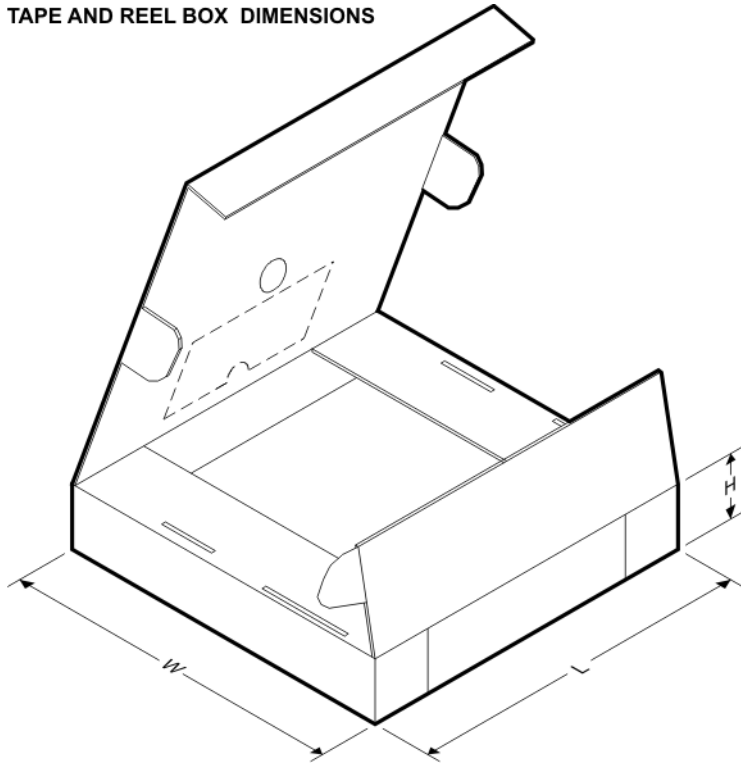


\*All dimensions are nominal

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
TPS76301DBVR	SOT-23	DBV	5	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS76301DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76301DBVT	SOT-23	DBV	5	250	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS76301DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76316DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76316DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76318DBVR	SOT-23	DBV	5	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS76318DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TPS76318DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76318DBVT	SOT-23	DBV	5	250	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS76325DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76325DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76327DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76327DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76328DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76328DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76330DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76330DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

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
TPS76333DBVR	SOT-23	DBV	5	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS76333DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76333DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76333DBVT	SOT-23	DBV	5	250	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS76338DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76338DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76350DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS76350DBVT	SOT-23	DBV	5	250	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS76301DBVR	SOT-23	DBV	5	3000	200.0	183.0	25.0
TPS76301DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76301DBVT	SOT-23	DBV	5	250	200.0	183.0	25.0
TPS76301DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS76316DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76316DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS76318DBVR	SOT-23	DBV	5	3000	200.0	183.0	25.0
TPS76318DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76318DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS76318DBVT	SOT-23	DBV	5	250	200.0	183.0	25.0
TPS76325DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76325DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS76327DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76327DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS76328DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76328DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS76330DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76330DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS76333DBVR	SOT-23	DBV	5	3000	200.0	183.0	25.0
TPS76333DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76333DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS76333DBVT	SOT-23	DBV	5	250	200.0	183.0	25.0
TPS76338DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76338DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS76350DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS76350DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0



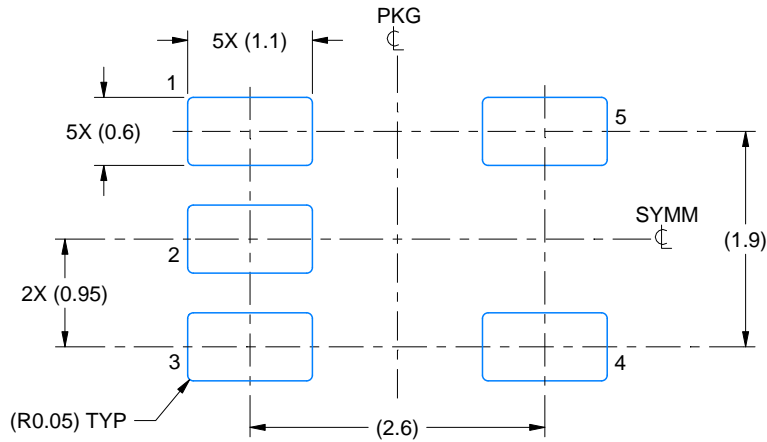


# EXAMPLE BOARD LAYOUT

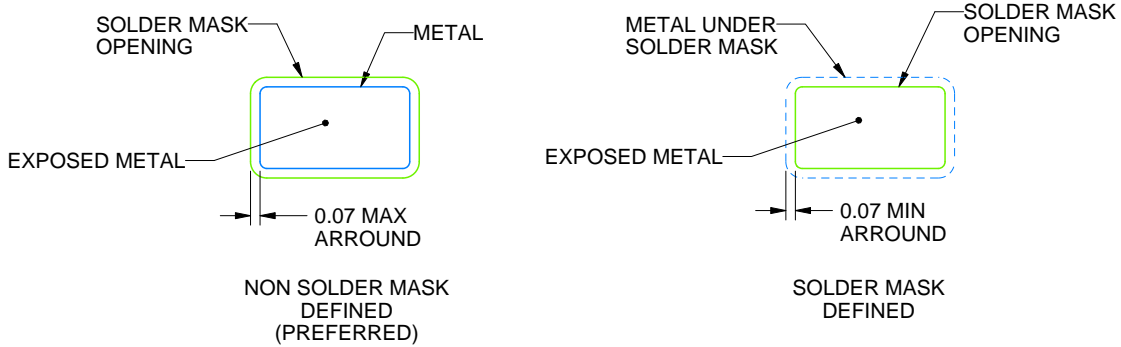
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

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NOTES: (continued)

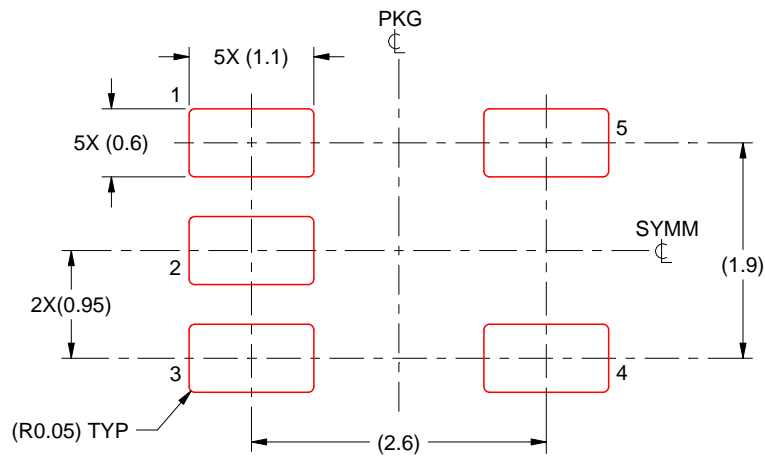
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



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

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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.

## 重要声明和免责声明

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