TPS709 具有使能功能的 150mA、30V、1μA I_Q 稳压器

1 特性

- 超低 I_Q：1μA
- 反向电流保护
- 低 $I_{SHUTDOWN}$：150nA
- 输入电压范围：2.7V 至 30V
- 支持 200mA 峰值输出
- 在温度范围内精度为 2%
- 可提供固定输出电压：
  1.2V 至 6.5V
- 热关断及过流保护功能
- 封装：SOT-23-5、WSON-6

2 应用范围

- Zigbee™网络
- 家庭自动化
- 计量
- 电子秤
- 便携式功率工具
- 遥控器件
- 无线听筒，智能电话，掌上电脑 (PDA)，无线局域网 (WLAN)，和其它个人电脑 (PC) 扩展卡
- 大型家电

3 说明

TPS709 系列线性稳压器是针对功耗敏感型应用而设计的超低静态电流 器件。一个精密带隙和误差放大器在温度范围内的精度为 2%。这些器件的静态电流仅为 1μA，因此对于由电池供电、要求闲置状态功耗非常小的常开系统而言，这是非常理想的解决方案。为了增加安全性，这些器件还具有热关断、电流限制和反向电流保护功能。

关断模式通过将 EN 引脚拉为低电平进行使能。该模式的关断电流低至 150nA（典型值）。

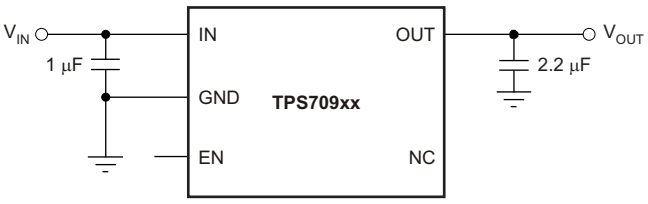
TPS709 系列采用 WSON-6 和 SOT-23-5 封装。

器件信息(1)

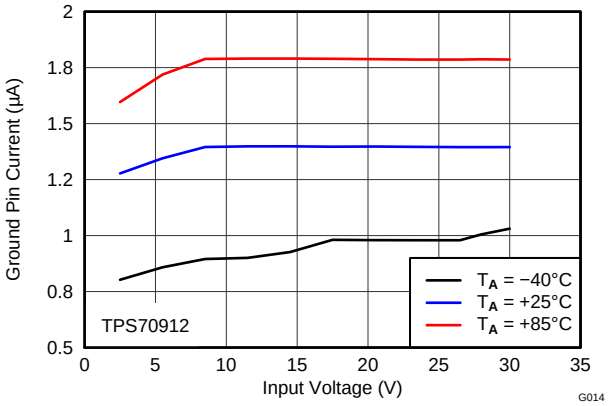
器件型号	封装	封装尺寸（标称值）
TPS709	SOT-23 (5)	2.90mm x 1.60mm
	WSON (6)	2.00mm x 2.00mm

(1) 要了解所有可用封装，请参见数据表末尾的封装选项附录。

典型应用电路



接地电流与 V_{IN} 和温度间的关系



目录

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 F (December 2014) to Revision G **Page**

- Added DBV package for TPS709A to *Pin Configurations and Functions* section ... 4
- Added DBV package for TPS709B to *Pin Configurations and Functions* section ... 4
- Added TPS709A and TPS709B to Pin Functions table ... 4
- Moved operating junction temperature from *Electrical Characteristics* to *Recommended Operating Conditions* ... 5

Changes from Revision E (November 2013) to Revision F **Page**

- 已更改标题格式以符合最新数据表标准 ... 1
- 已添加 *ESD 额定值表*，*特性 描述* 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
- 已从文档中删除 SOT-223-4 封装 ... 1
- 已删除*低压降* 特性 要点） ... 1
- 已更改封装特性要点：已删除 SOT-223-4 和脚注 ... 1
- 已删除*说明*部分最后一段中的 SOT-223-4 ... 1
- 删除了第 1 页的引脚分配图 ... 1
- Deleted DCY package and footnote from Pin Configurations section ... 4
- Changed Pin Functions table: changed title and deleted DCY package ... 4
- Changed EN pin description in Pin Functions table ... 4
- Deleted the word 'range' from the last 2 rows of the Absolute Maximum Ratings table ... 5
- Deleted DCY column from Thermal Information table ... 5
- Added description text to the enabled mode discussion in the *Device Functional Modes* section ... 14

Changes from Revision D (October 2013) to Revision E **Page**

- 已将 DRV (SON-6) 封装状态从“产品预览”改为“量产数据” ... 1
- 已删除 脚注 1 中的 SON-6 封装 （*特性*部分） ... 1
- 已删除 引脚分配图注释中的 DRV 封装 ... 1
- Deleted DRV from pinout note in the *Pin Configurations* section ... 4

Changes from Revision C (June 2013) to Revision D **Page**

- 已将器件状态从“量产数据”改为“混合状态” ... 1
- 已更改 最后一个 特性 要点：已添加脚注并已更改器件顺序 ... 1
- 已添加 在引脚分配图中添加了注释 ... 1
- Added product preview footnote to pin configurations ... 4

Changes from Revision B (November 2012) to Revision C **Page**

- 已添加 DCY (SOT-223) 和 DRV (SON) 封装至数据表 ... 1
- 已将 I_Q 特性要点的值从 1.35μA 改为 1μA ... 1
- 已将*说明*部分第一段中的静态电流值从 1.35μA 改为 1μA ... 1
- 已将*说明*部分第二段中的“泄漏”改为“关断”。 ... 1
- 添加了典型应用电路 ... 1
- Added DCY and DRV packages to *Pin Configuration* section ... 4
- Added DCY and DRV packages to Pin Descriptions table ... 4
- Added DRV and DCY packages to Thermal Information table ... 5
- Changed ground pin current typical values for I_{OUT} = 0-mA test conditions ... 6

Changes from Revision A (October 2012) to Revision B **Page**

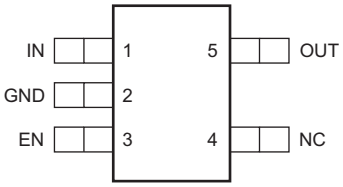
- Added *Pin Configuration* section ... 4
- Changed *Line regulation* and *Load regulation* parameters in *Electrical Characteristics* table ... 6
- Changed I_{GND} parameter test conditions in *Electrical Characteristics* table ... 6
- Changed $I_{SHUTDOWN}$ parameter test conditions in *Electrical Characteristics* table ... 6
- Changed footnote 4 in *Electrical Characteristics* table ... 6
- Changed second paragraph of *Dropout Voltage* section ... 13

Changes from Original (March 2012) to Revision A **Page**

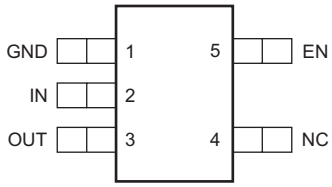
- 已将器件状态从“产品预览”改为“量产数据” ... 1

5 Pin Configuration and Functions

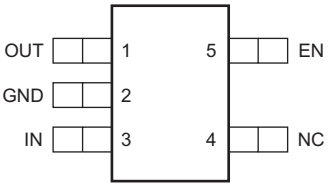
TPS709: DBV Package
5-Pin SOT-23
Top View



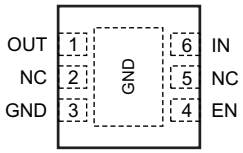
TPS709B: DBV Package
5-Pin SOT-23
Top View



TPS709A: DBV Package
5-Pin SOT-23
Top View



DRV Package
6-Pin WSON
Top View



Pin Functions

PIN					I/O	DESCRIPTION
	DRV	DBV				
NAME	TPS709	TPS709	TPS709A	TPS709B		
EN	4	3	5	5	I	Enable pin. Drive this pin high to enable the device. Drive this pin low to put the device into low current shutdown. This pin can be left floating to enable the device. The maximum voltage must remain below 6.5 V.
GND	3	2	2	1	—	Ground
IN	6	1	3	2	I	Unregulated input to the device
NC	2, 5	4	4	4	—	No internal connection
OUT	1	5	1	3	O	Regulated output voltage. Connect a small 2.2-µF or greater ceramic capacitor from this pin to ground to assure stability.
Thermal pad		—	—	—	—	The thermal pad is electrically connected to the GND node. Connect this pad to the GND plane for improved thermal performance.

6 Specifications

6.1 Absolute Maximum Ratings

specified at T_J = –40°C to 125°C (unless otherwise noted); all voltages are with respect to GND(1)

		MIN	MAX	UNIT
Voltage	V_{IN}	–0.3	32	V
	V_{EN}	–0.3	7	
	V_{OUT}	–0.3	7	
Maximum output current	I_{OUT}	Internally limited		
Output short-circuit duration		Indefinite		
Continuous total power dissipation	P_{DISS}	See *Thermal Information*		
Operating junction temperature, T_J		–55	150	°C
Storage temperature, T_{stg}		–55	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.

6.2 ESD Ratings

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

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

6.3 Recommended Operating Conditions

over operating junction temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
V_{IN}	Input voltage	2.7		30	V
V_{OUT}	Output voltage	1.2		6.5	V
V_{EN}	Enable voltage	0		6.5	V
T_J	Operating junction temperature	–40		125	°C

6.4 Thermal Information

THERMAL METRIC(1)		TPS709		UNIT
		DBV	DRV	
		5 PINS	6 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	212.1	73.1	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	78.5	97.0	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	39.5	42.6	°C/W
ψ_{JT}	Junction-to-top characterization parameter	2.86	2.9	°C/W
ψ_{JB}	Junction-to-board characterization parameter	38.7	42.9	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	12.8	°C/W

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

6.5 Electrical Characteristics

At ambient temperature (T_A) = –40°C to +85°C, V_{IN} = $V_{OUT(typ)}$ + 1 V or 2.7 V (whichever is greater), I_{OUT} = 1 mA, V_{EN} = 2 V, and C_{IN} = C_{OUT} = 2.2-µF ceramic, unless otherwise noted. Typical values are at T_A = 25°C.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IN}	Input voltage range		2.7		30	V
V_{OUT}	Output voltage range		1.2		6.5	V
V_{OUT}	DC output accuracy	V_{OUT} < 3.3 V	–2%		2%	
		V_{OUT} ≥ 3.3 V	–1%		1%	
ΔV_{OUT}	Line regulation	($V_{OUT(nom)}$ + 1 V, 2.7 V) ≤ V_{IN} ≤ 30 V		3	10	mV
	Load regulation	V_{IN} = $V_{OUT(typ)}$ + 1.5 V or 3 V (whichever is greater), 100 µA ≤ I_{OUT} ≤ 150 mA		20	50	
V_{DO}	Dropout voltage(1)(2)	TPS70933, I_{OUT} = 50 mA		295	650	mV
		TPS70933, I_{OUT} = 150 mA		960	1400	
		TPS70950, I_{OUT} = 50 mA		245	500	
		TPS70950, I_{OUT} = 150 mA		690	1200	
		TPS70965, I_{OUT} = 50 mA		180	500	
		TPS70965, I_{OUT} = 150 mA		460	1000	
$I_{(CL)}$	Output current limit(3)	V_{OUT} = 0.9 × $V_{OUT(nom)}$	200	320	500	mA
I_{GND}	Ground pin current	I_{OUT} = 0 mA, V_{OUT} ≤ 3.3 V		1.3	2.05	µA
		I_{OUT} = 0 mA, V_{OUT} > 3.3 V		1.4	2.25	
		I_{OUT} = 150 mA		350		
$I_{SHUTDOWN}$	Shutdown current	V_{EN} ≤ 0.4 V, V_{IN} = 2.7 V		150		nA
PSRR	Power-supply rejection ratio	f = 10 Hz		80		dB
		f = 100 Hz		62		
		f = 1 kHz		52		
V_n	Output noise voltage	BW = 10 Hz to 100 kHz, I_{OUT} = 10 mA, V_{IN} = 2.7 V, V_{OUT} = 1.2 V		190		μV_{RMS}
t_{STR}	Start-up time(4)	$V_{OUT(nom)}$ ≤ 3.3 V		200	600	µs
		$V_{OUT(nom)}$ > 3.3 V		500	1500	
$V_{EN(HI)}$	Enable pin high (enabled)		0.9			V
	Enable pin high (disabled)		0		0.4	
I_{EN}	EN pin current	EN = 1.0 V, V_{IN} = 5.5 V		300		nA
$I_{(REV)}$	Reverse current (flowing out of IN pin)	V_{OUT} = 3 V, V_{IN} = V_{EN} = 0 V		10		nA
	Reverse current (flowing into OUT pin)	V_{OUT} = 3 V, V_{IN} = V_{EN} = 0 V		100		
t_{SD}	Thermal shutdown temperature	Shutdown, temperature increasing		158		°C
		Reset, temperature decreasing		140		

(1) V_{DO} is measured with V_{IN} = 0.98 × $V_{OUT(nom)}$.
(2) Dropout is only valid when V_{OUT} ≥ 2.8 V because of the minimum input voltage limits.
(3) Measured with V_{IN} = V_{OUT} + 3 V for V_{OUT} ≤ 2.5 V. Measured with V_{IN} = V_{OUT} + 2.5 V for V_{OUT} > 2.5 V.
(4) Startup time = time from EN assertion to 0.95 × $V_{OUT(nom)}$ and load = 47 Ω.

6.6 Typical Characteristics

Over operating temperature range (T_J = –40°C to 125°C), I_{OUT} = 10 mA, V_{EN} = 2 V, C_{OUT} = 2.2 µF, and V_{IN} = $V_{OUT(typ)}$ + 1 V or 2.7 V (whichever is greater), unless otherwise noted. Typical values are at T_J = 25°C.

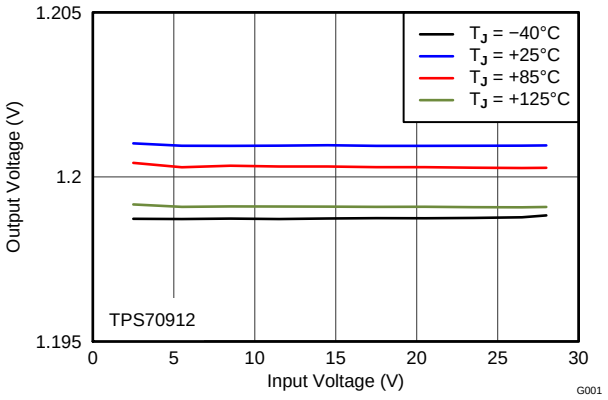


Figure 1. 1.2-V Line Regulation vs V_{IN} and Temperature

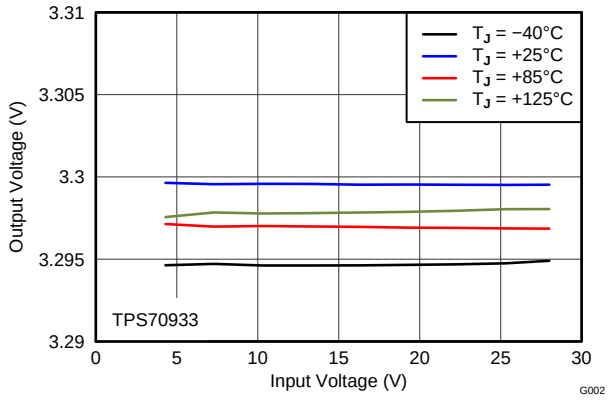


Figure 2. 3.3-V Line Regulation vs V_{IN} and Temperature

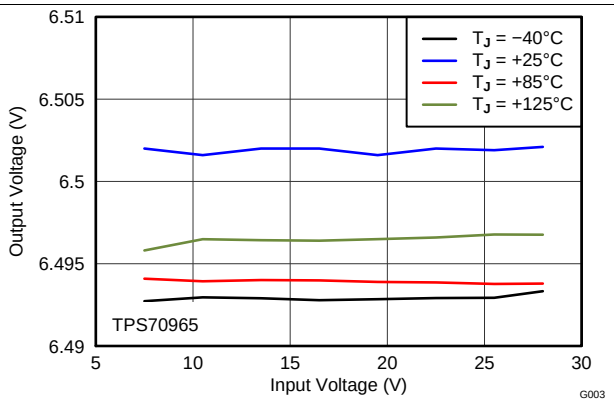


Figure 3. 6.5-V Line Regulation vs V_{IN} and Temperature

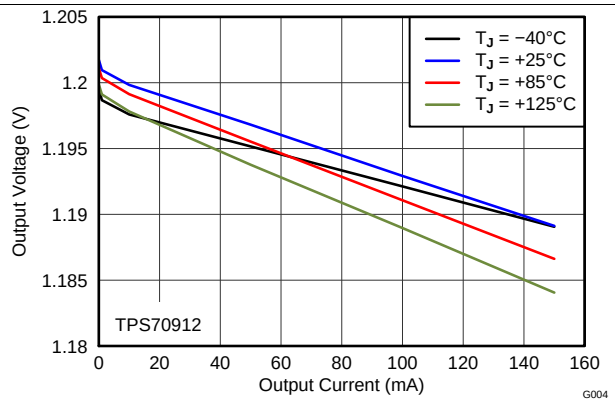


Figure 4. 1.2-V Load Regulation vs I_{OUT} and Temperature

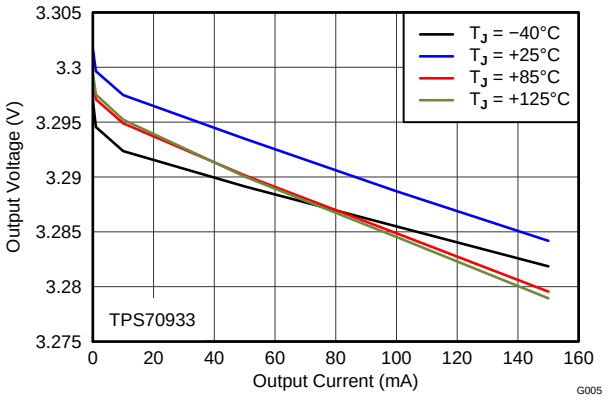


Figure 5. 3.3-V Load Regulation vs I_{OUT} and Temperature

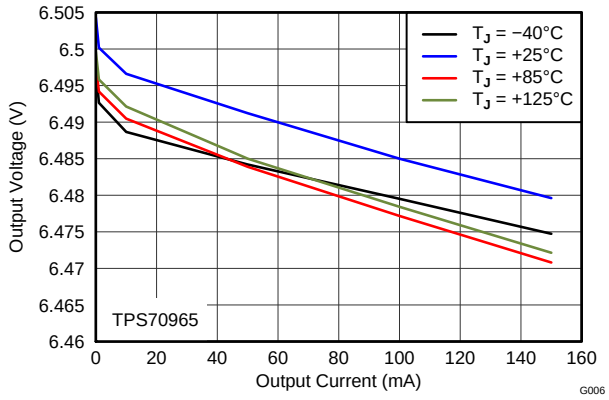


Figure 6. 6.5-V Load Regulation vs I_{OUT} and Temperature

Typical Characteristics (continued)

Over operating temperature range (T_J = –40°C to 125°C), I_{OUT} = 10 mA, V_{EN} = 2 V, C_{OUT} = 2.2 µF, and V_{IN} = $V_{OUT(typ)}$ + 1 V or 2.7 V (whichever is greater), unless otherwise noted. Typical values are at T_J = 25°C.

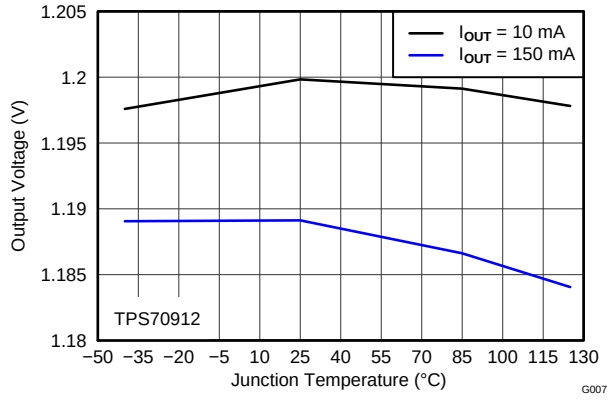


Figure 7. V_{OUT} vs Temperature

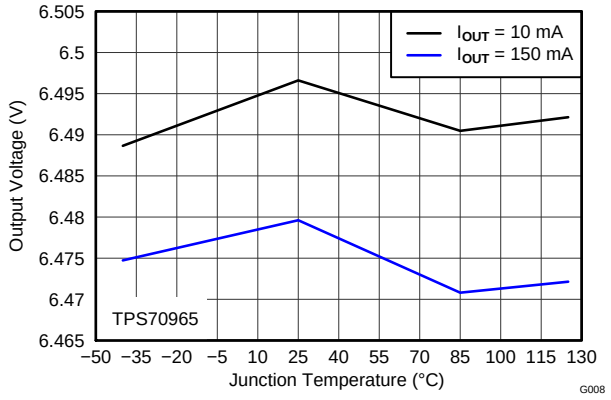


Figure 8. V_{OUT} vs Temperature

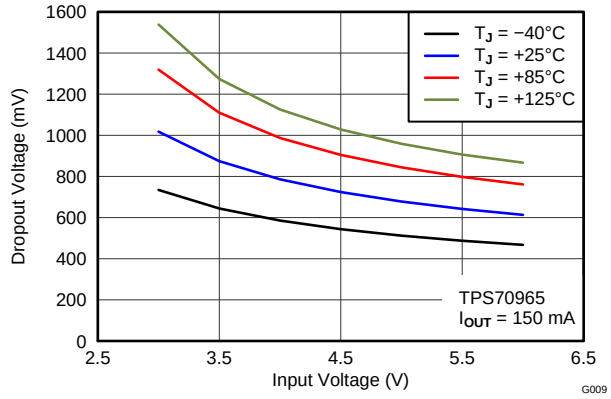


Figure 9. Dropout Voltage vs V_{IN} and Temperature

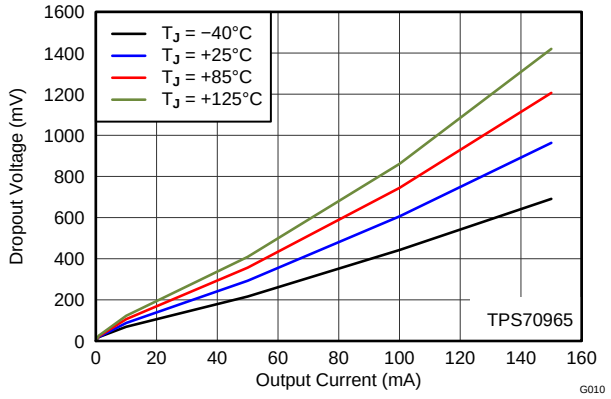


Figure 10. Dropout Voltage vs I_{OUT} and Temperature

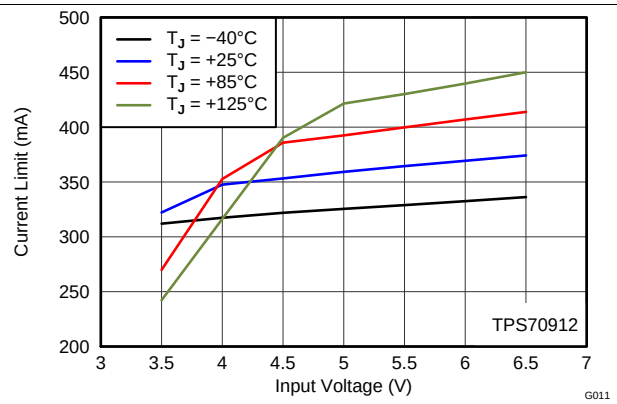


Figure 11. 1.2-V Current Limit vs V_{IN} and Temperature

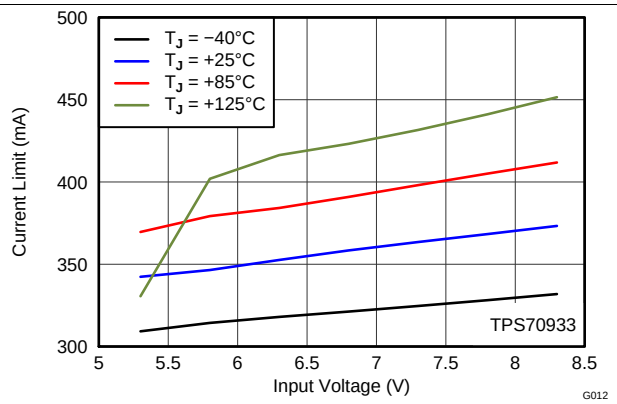


Figure 12. 3.3-V Current Limit vs V_{IN} and Temperature

Typical Characteristics (continued)

Over operating temperature range (T_J = –40°C to 125°C), I_{OUT} = 10 mA, V_{EN} = 2 V, C_{OUT} = 2.2 µF, and V_{IN} = $V_{OUT(typ)}$ + 1 V or 2.7 V (whichever is greater), unless otherwise noted. Typical values are at T_J = 25°C.

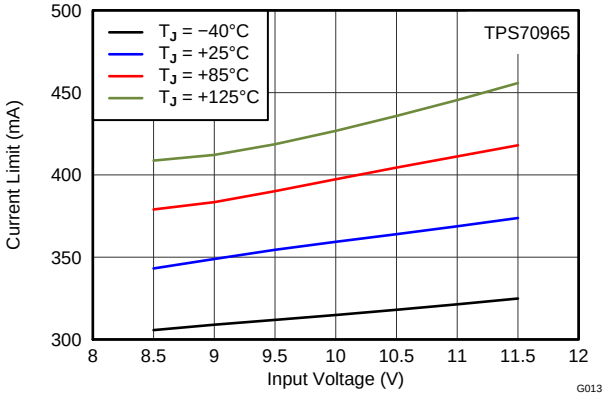


Figure 13. 6.5-V Current Limit vs V_{IN} and Temperature

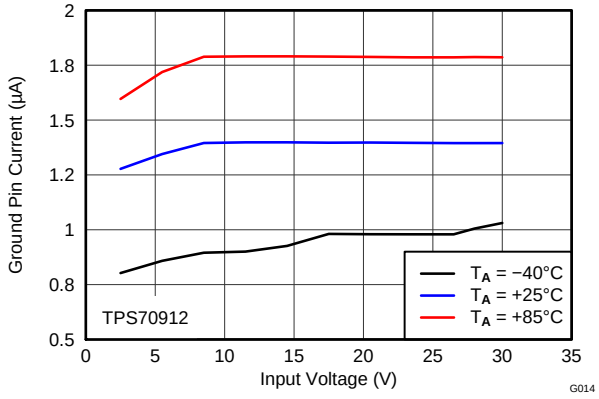


Figure 14. GND Current vs V_{IN} and Temperature

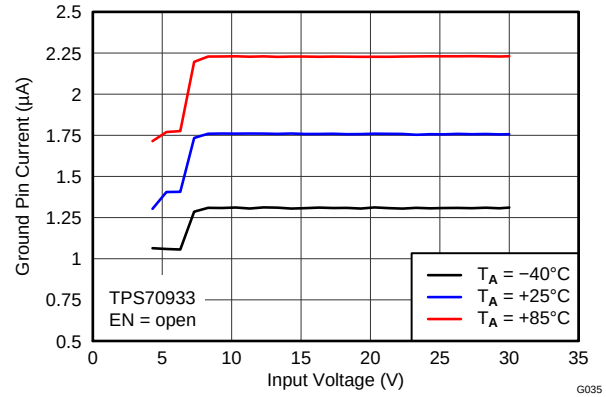


Figure 15. GND Current vs V_{IN} and Temperature

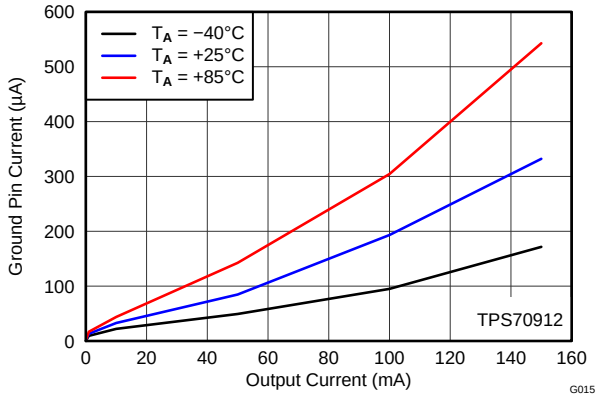


Figure 16. GND Current vs I_{OUT} and Temperature

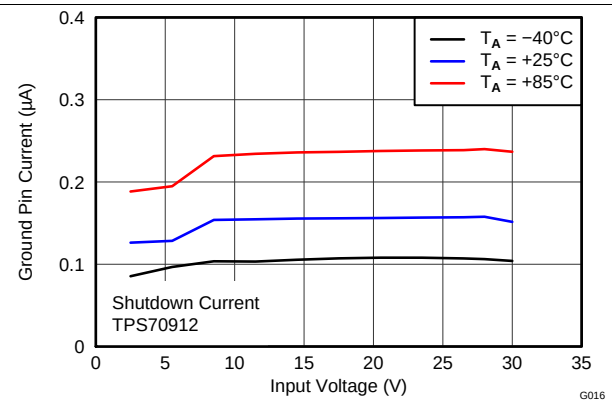


Figure 17. Shutdown Current vs V_{IN} and Temperature

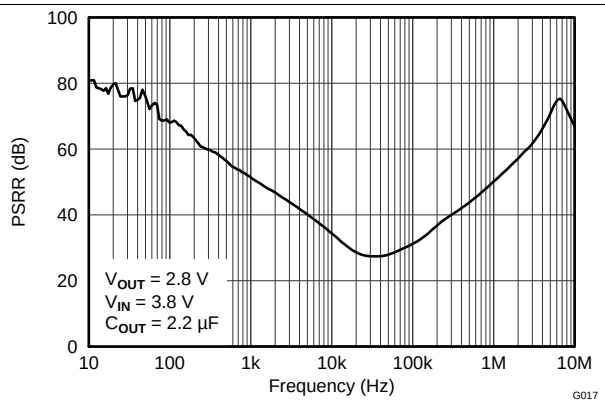


Figure 18. Power-Supply Rejection Ratio vs Frequency

Typical Characteristics (continued)

Over operating temperature range (T_J = –40°C to 125°C), I_{OUT} = 10 mA, V_{EN} = 2 V, C_{OUT} = 2.2 µF, and V_{IN} = $V_{OUT(typ)}$ + 1 V or 2.7 V (whichever is greater), unless otherwise noted. Typical values are at T_J = 25°C.

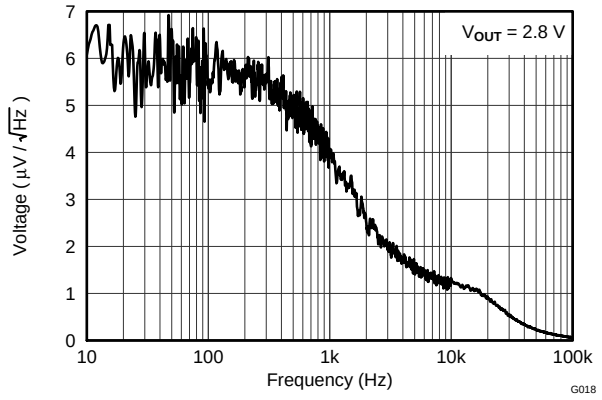


Figure 19. Noise

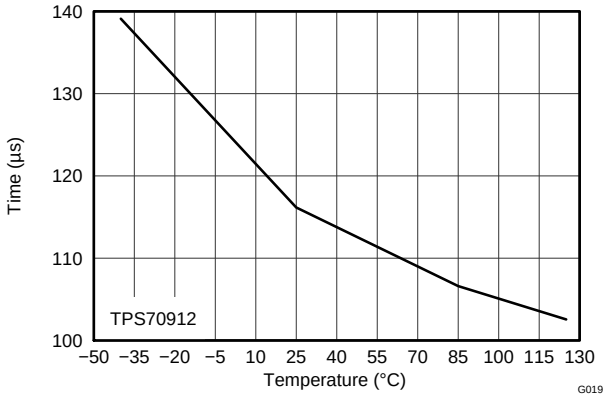


Figure 20. Start-Up Time vs Temperature

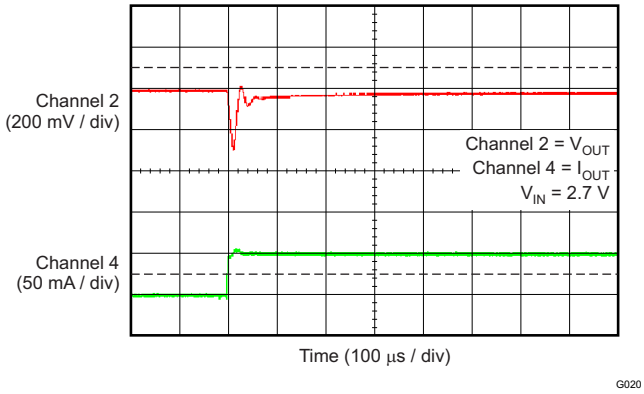


Figure 21. TPS70912 Load Transient (0 mA to 50 mA)

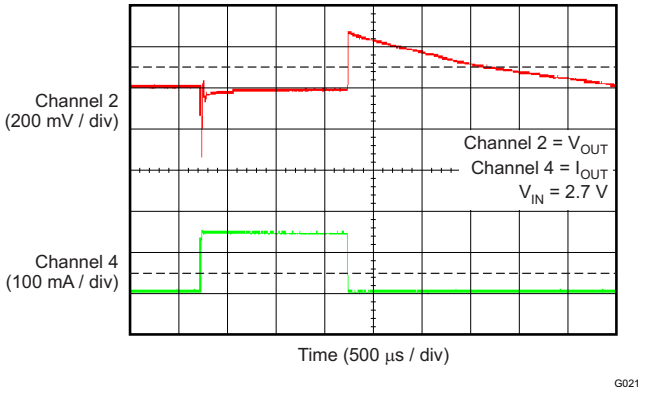


Figure 22. TPS70912 Load Transient (1 mA to 150 mA)

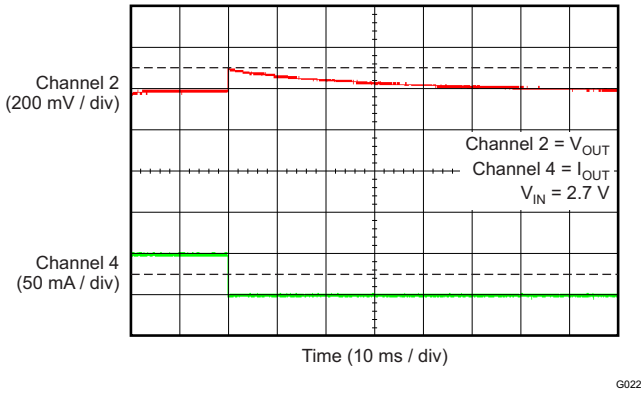


Figure 23. TPS70912 Load Transient (50 mA to 0 mA)

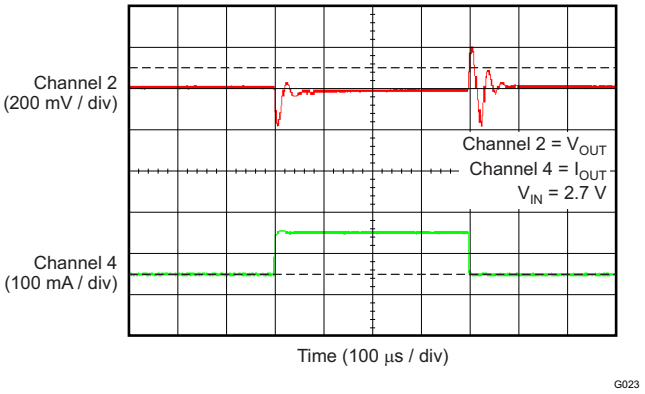


Figure 24. TPS70912 Load Transient (50 mA to 150 mA)

Typical Characteristics (continued)

Over operating temperature range (T_J = –40°C to 125°C), I_{OUT} = 10 mA, V_{EN} = 2 V, C_{OUT} = 2.2 µF, and V_{IN} = $V_{OUT(typ)}$ + 1 V or 2.7 V (whichever is greater), unless otherwise noted. Typical values are at T_J = 25°C.

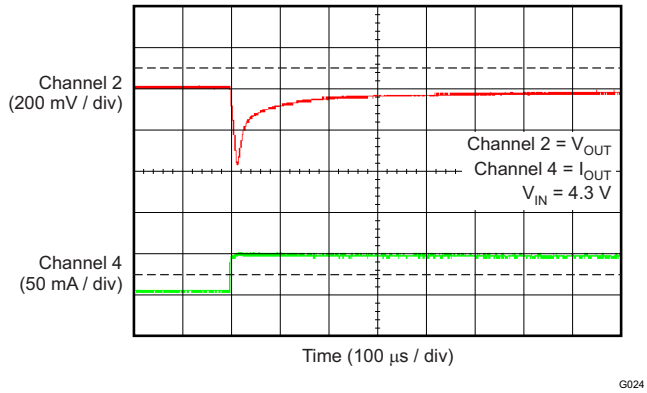


Figure 25. TPS70933 Load Transient (0 mA to 50 mA)

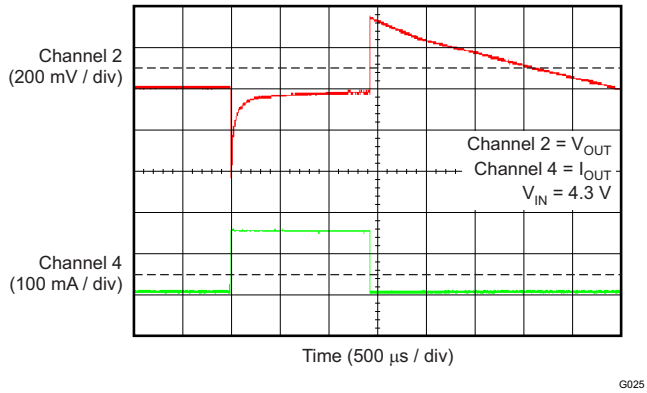


Figure 26. TPS70933 Load Transient (1 mA to 150 mA)

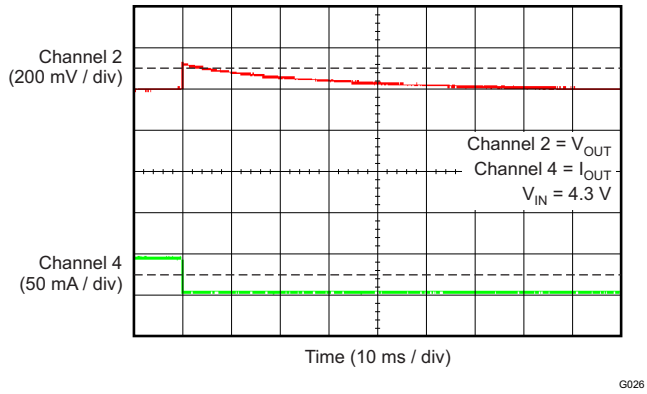


Figure 27. TPS70933 Load Transient (50 mA to 0 mA)

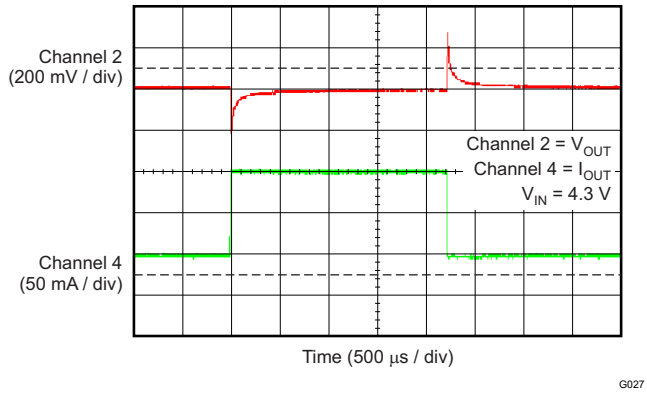


Figure 28. TPS70933 Load Transient (50 mA to 150 mA)

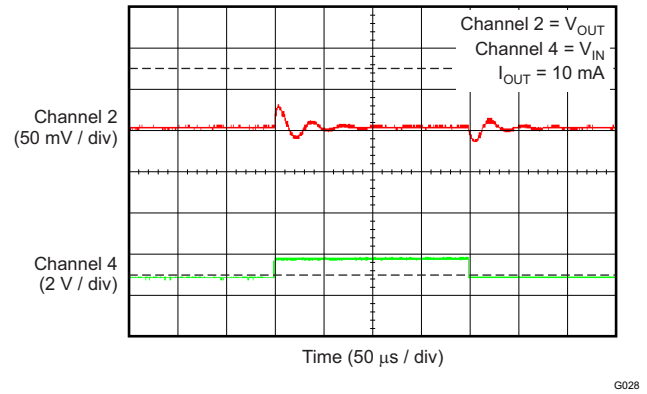


Figure 29. TPS70912 Line Transient (2.7 V to 3.7 V)

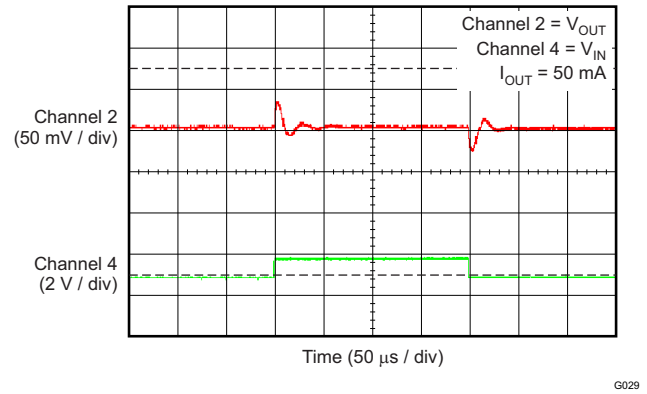


Figure 30. TPS70912 Line Transient (2.7 V to 3.7 V)

Typical Characteristics (continued)

Over operating temperature range (T_J = –40°C to 125°C), I_{OUT} = 10 mA, V_{EN} = 2 V, C_{OUT} = 2.2 µF, and V_{IN} = $V_{OUT(typ)}$ + 1 V or 2.7 V (whichever is greater), unless otherwise noted. Typical values are at T_J = 25°C.

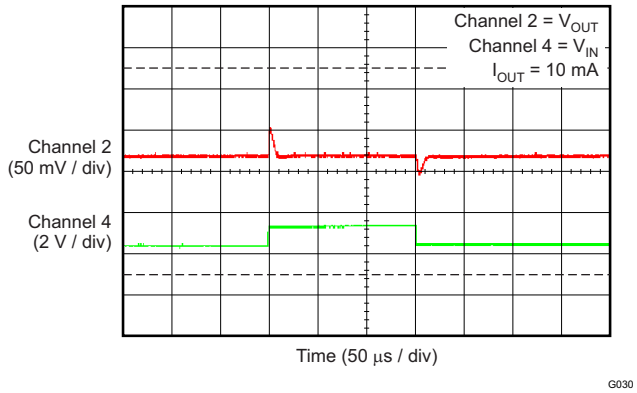


Figure 31. TPS70933 Line Transient (4.3 V to 5.3 V)

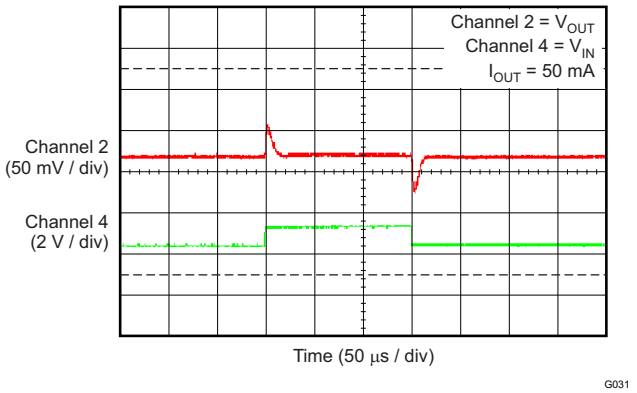


Figure 32. TPS70933 Line Transient (4.3 V to 5.3 V)

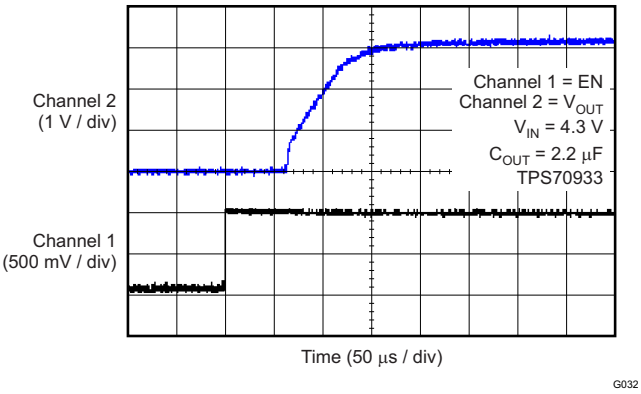


Figure 33. Power-Up with Enable

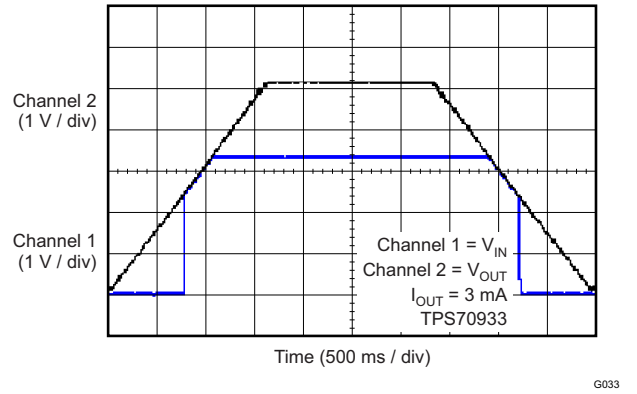


Figure 34. Power-Up and Power-Down Response

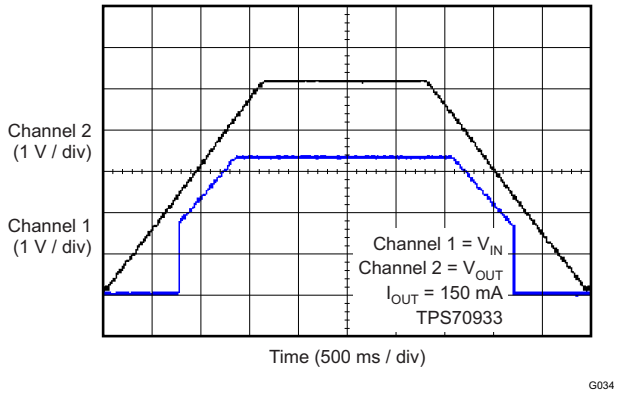


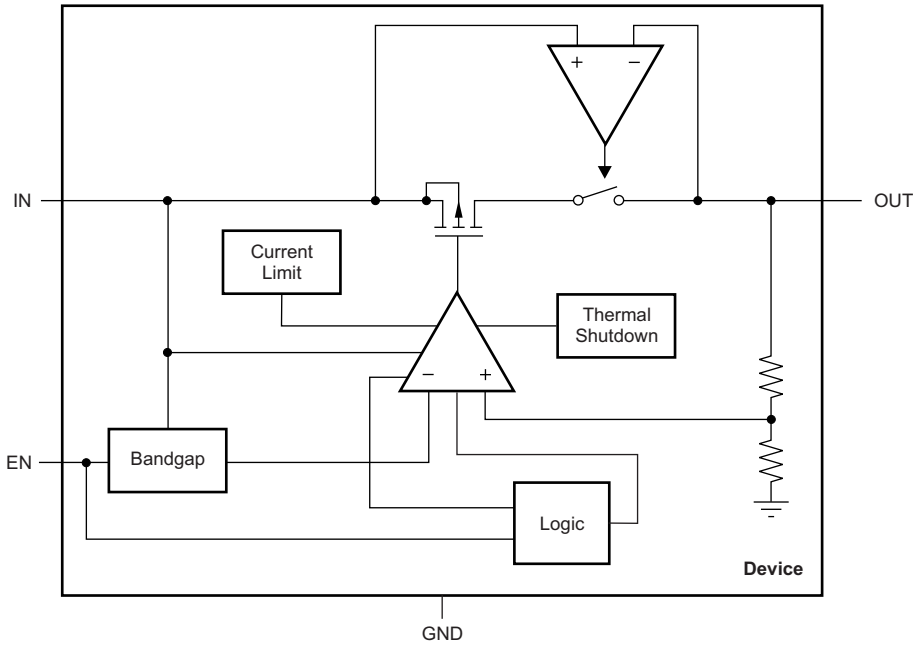
Figure 35. Power-Up and Power-Down Response

7 Detailed Description

7.1 Overview

The TPS709 series of devices are ultralow quiescent current, low-dropout (LDO) linear regulators. The TPS709 offers reverse current protection to block any discharge current from the output into the input. The TPS709 also features current limit and thermal shutdown for reliable operation.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Internal Current Limit

The TPS709 internal current limit helps protect the regulator during fault conditions. During current limit, the output sources a fixed amount of current that is largely independent of output voltage. In such a case, the output voltage is not regulated, and can be measured as (V_{OUT} = I_{LIMIT} × R_{LOAD}). The PMOS pass transistor dissipates [(V_{IN} – V_{OUT}) × I_{LIMIT}] until a thermal shutdown is triggered and the device turns off. When cool, the device is turned on by the internal thermal shutdown circuit. If the fault condition continues, the device cycles between current limit and thermal shutdown; see the *Thermal Protection* section for more details.

The TPS709 is characterized over the recommended operating output current range up to 150 mA. The internal current limit begins to limit the output current at a minimum of 200 mA of output current. The TPS709 continues to operate for output currents between 150 mA and 200 mA but some data sheet parameters may not be met.

7.3.2 Dropout Voltage

The TPS709 use a PMOS pass transistor to achieve low dropout voltage. When (V_{IN} – V_{OUT}) is less than the dropout voltage (V_{DO}), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the $R_{DS(ON)}$ of the PMOS pass element. V_{DO} approximately scales with the output current because the PMOS device functions like a resistor in dropout.

The ground pin current of many linear voltage regulators increases substantially when the device is operated in dropout. This increase in ground pin current while operating in dropout can be several orders of magnitude larger than when the device is not in dropout. The TPS709 employs a special control loop that limits the increase in ground pin current while operating in dropout. This functionality allows for the most efficient operation while in dropout conditions that can greatly increase battery run times.

Feature Description (continued)

7.3.3 Undervoltage Lockout (UVLO)

The TPS709 uses an undervoltage lockout (UVLO) circuit to keep the output shut off until the internal circuitry operates properly.

7.3.4 Reverse-Current Protection

The TPS709 has integrated reverse-current protection. Reverse-current protection prevents the flow of current from the OUT pin to the IN pin when output voltage is higher than input voltage. The reverse-current protection circuitry places the power path in high impedance when the output voltage is higher than the input voltage. This setting reduces leakage current from the output to the input to 10 nA, typical. The reverse current protection is always active regardless of the enable pin logic state or if the OUT pin voltage is greater than 1.8 V. Reverse current can flow if the output voltage is less than 1.8 V and if input voltage is less than the output voltage.

If voltage is applied to the input pin, then the maximum voltage that can be applied to the OUT pin is the lower of three times the nominal output voltage or 6.5 V. For example, if the 1.2-V output voltage version is used, then the maximum reverse bias voltage that can be applied to the OUT pin is 3.6 V. If the 5.0-V output voltage version is used, then the maximum reverse bias voltage that can be applied to the OUT pin is 6.5 V.

7.4 Device Functional Modes

The TPS709 has the following functional modes:

1. **Enabled:** When the enable pin (EN) goes above 0.9 V, the device is enabled. EN is pulled high by a 300-nA current source; therefore, EN can be left floating to enable the device. Do not connect EN to VIN. The EN pin is clamped by a 6.5-V Zener diode. Do not exceed the 7-V absolute maximum rating on the enable pin or excessive current flowing into the Zener clamp will destroy the device.
2. **Disabled:** When EN goes below 0.4 V, the device is disabled. During this time, OUT is high impedance and the current into IN ($I_{(SHUTDOWN)}$) is typically 150 nA.

8 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.

8.1 Application Information

The TPS709 is a series of devices that belong to a new family of next-generation voltage regulators. These devices consume low quiescent current and deliver excellent line and load transient performance. This performance, combined with low noise and very good PSRR with little (V_{IN} – V_{OUT}) headroom, makes these devices ideal for RF portable applications, current limit, and thermal protection. The TPS709 is specified from –40°C to +125°C.

8.1.1 Input and Output Capacitor

The TPS709 devices are stable with output capacitors with an effective capacitance of 2.0 µF or greater for output voltages below 1.5 V. For output voltages equal or greater than 1.5 V, the minimum effective capacitance for stability is 1.5 µF. The maximum capacitance for stability is 47 µF. The equivalent series resistance (ESR) of the output capacitor must be between 0 Ω and 0.2 Ω for stability.

The effective capacitance is the minimum capacitance value of a capacitor after taking into account variations resulting from tolerances, temperature, and dc bias effects. X5R- and X7R-type ceramic capacitors are recommended because these capacitors have minimal variation in value and ESR over temperature.

Although an input capacitor is not required for stability, good analog design practice is to connect a 0.1-µF to 2.2-µF capacitor from IN to GND. This capacitor counteracts reactive input sources and improves transient response, input ripple, and PSRR. An input capacitor is necessary if line transients greater than 10 V in magnitude are anticipated.

8.1.2 Transient Response

As with any regulator, increasing the output capacitor size reduces over- and undershoot magnitude, but increases transient response duration.

8.2 Typical Application

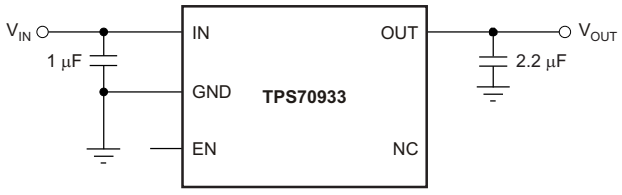


Figure 36. Wide Input, 3.3-V, Low-I_Q Rail

8.2.1 Design Requirements

Table 1 summarizes the design requirements for Figure 36.

Table 1. Design Requirements for a Wide Input, 3.3-V, Low-I_Q Rail Application

PARAMETER	DESIGN SPECIFICATION
V_{IN}	5 V to 20 V
V_{OUT}	3.3 V
$I_{(IN)}$ (no load)	< 5 µA
I_{OUT} (max)	150 mA

8.2.2 Detailed Design Procedure

Select a 2.2-µF, 10-V X7R output capacitor to satisfy the minimum output capacitance requirement with a 3.3-V dc bias.

Select a 1.0-µF, 25-V X7R input capacitor to provide input noise filtering and eliminate high-frequency voltage transients.

8.2.3 Application Curves

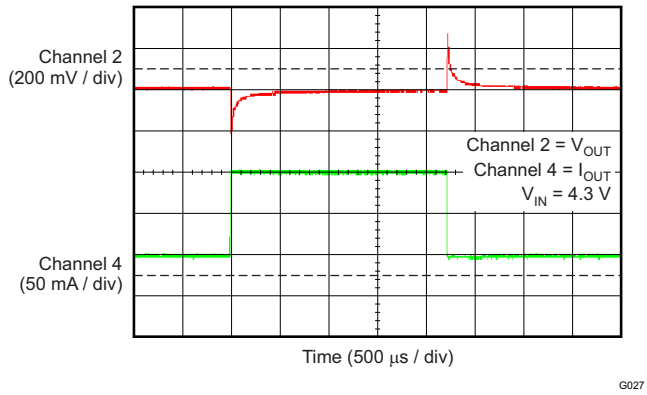


Figure 37. TPS70933 Load Transient (50 mA to 150 mA)

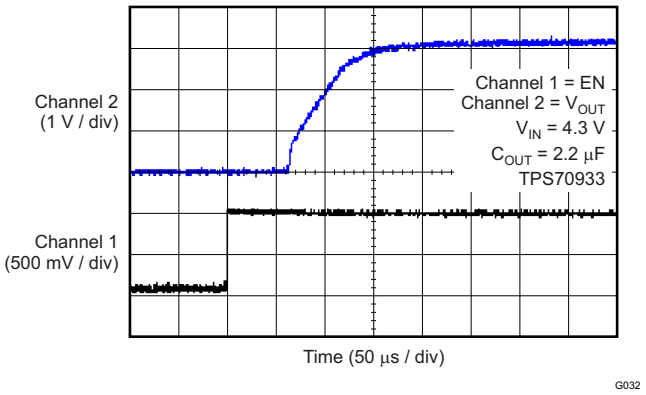


Figure 38. Power-Up with Enable

9 Power Supply Recommendations

This device is designed to operate with an input supply range of 2.7 V to 30 V. If the input supply is noisy, additional input capacitors with low ESR can help improve output noise performance.

9.1 Power Dissipation

The ability to remove heat from the die is different for each package type, presenting different considerations in the printed circuit board (PCB) layout. The PCB area around the device that is free of other components moves the heat from the device to ambient air. Performance data for JEDEC low and high-K boards are given in the *Thermal Information* table. Using heavier copper increases the effectiveness in removing heat from the device. The addition of plated through-holes to heat-dissipating layers also improves the heatsink effectiveness.

Power dissipation depends on input voltage and load conditions. Power dissipation (P_{DISS}) is equal to the product of the output current and the voltage drop across the output pass element, as shown in Equation 1:

$$P_{DISS} = (V_{IN} - V_{OUT}) \times I_{OUT} \quad (1)$$

10 Layout

10.1 Layout Guidelines

Place input and output capacitors as close to the device pins as possible. To improve ac performance (such as PSRR, output noise, and transient response), TI recommends that the board be designed with separate ground planes for V_{IN} and V_{OUT}, with the ground plane connected only at the GND pin of the device. In addition, the ground connection for the output capacitor must be connected directly to the device GND pin.

10.1.1 Thermal Protection

Thermal protection disables the output when the junction temperature rises to approximately 165°C, allowing the device to cool. When the junction temperature cools to approximately 145°C, the output circuitry is again enabled. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit can cycle on and off. This cycling limits the dissipation of the regulator, protecting it from damage as a result of overheating.

Any tendency to activate the thermal protection circuit indicates excessive power dissipation or an inadequate heatsink. For reliable operation, limit junction temperature to 125°C, maximum. To estimate the margin of safety in a complete design (including heatsink), increase the ambient temperature until the thermal protection is triggered; use worst-case loads and signal conditions. For good reliability, thermal protection must trigger at least 35°C above the maximum expected ambient condition of the particular application. This configuration produces a worst-case junction temperature of 125°C at the highest expected ambient temperature and worst-case load.

The TPS709 internal protection circuitry is designed to protect against overload conditions. This circuitry is not intended to replace proper heatsinking. Continuously running the TPS709 into thermal shutdown degrades device reliability.

10.2 Layout Example

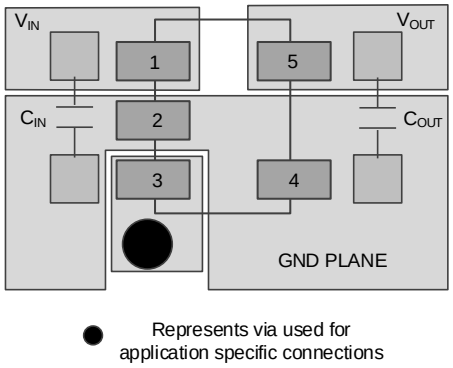


Figure 39. Layout Example for DBV Package

11 器件和文档支持

11.1 器件支持

11.1.1 开发支持

11.1.1.1 评估模块

评估模块 (EVM) 可与 TPS709xx 配套使用，帮助评估初始电路性能。TPS70933EVM-110 评估模块（和相关的用户指南）可在德州仪器 (TI) 网站上的产品文件夹中获取，也可直接从 TI 网上商店购买。

11.1.1.2 Spice 模型

分析模拟电路和系统的性能时，使用 SPICE 模型对电路性能进行计算机仿真非常有用。您可以从产品文件夹中的*仿真模型*下获取 TPS709 的 SPICE 模型。

11.1.2 器件命名规则

表 **2.** 器件命名规则(1)

产品	V_{OUT}
TPS709**xx(x)***yyyz*	**XX(X)** 是标称输出电压。对于分辨率为 100mV 的输出电压，订货编号中使用两位数字；否则，使用三位数字（例如，28 = 2.8V；125 = 1.25V）。 **YYY** 为封装标识符。 **Z** 为卷带数量（R = 3000，T = 250）。

(1) 要获得最新的封装和订货信息，请参阅本文档末尾的封装选项附录，或者登录 TI 的网站 www.ti.com.cn进行查询。

11.2 文档支持

11.2.1 相关文档

- 《TPS70933EVM-110 评估模块用户指南》，SLVU689

11.3 社区资源

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

11.6 Glossary

SLYZ022 — *TI Glossary*.

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

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

邮寄地址： 上海市浦东新区世纪大道1568 号，中建大厦32 楼邮政编码： 200122

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS70912DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SCX	Samples
TPS70912DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SCX	Samples
TPS70912DRVR	ACTIVE	WSON	DRV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SCX	Samples
TPS70912DRVT	ACTIVE	WSON	DRV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SCX	Samples
TPS709135DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SCY	Samples
TPS709135DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SCY	Samples
TPS70915DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SIM	Samples
TPS70915DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SIM	Samples
TPS70915DRVR	ACTIVE	WSON	DRV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SIM	Samples
TPS70915DRVT	ACTIVE	WSON	DRV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SIM	Samples
TPS70916DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SCZ	Samples
TPS70916DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SCZ	Samples
TPS70918DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDA	Samples
TPS70918DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDA	Samples
TPS70918DRVR	ACTIVE	WSON	DRV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDA	Samples
TPS70918DRVT	ACTIVE	WSON	DRV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDA	Samples
TPS70919DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDB	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS70919DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDB	Samples
TPS70925DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDC	Samples
TPS70925DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDC	Samples
TPS70925DRVR	ACTIVE	WSON	DRV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDC	Samples
TPS70925DRVT	ACTIVE	WSON	DRV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDC	Samples
TPS70927DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDD	Samples
TPS70927DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDD	Samples
TPS70928DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDE	Samples
TPS70928DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDE	Samples
TPS70930DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDF	Samples
TPS70930DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDF	Samples
TPS70930DRVR	ACTIVE	WSON	DRV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDF	Samples
TPS70930DRVT	ACTIVE	WSON	DRV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDF	Samples
TPS70933DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDG	Samples
TPS70933DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDG	Samples
TPS70933DRVR	ACTIVE	WSON	DRV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDG	Samples
TPS70933DRVT	ACTIVE	WSON	DRV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDG	Samples
TPS70936DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SEJ	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS70936DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SEJ	Samples
TPS70938DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SIC	Samples
TPS70938DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SIC	Samples
TPS70939DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SID	Samples
TPS70939DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SID	Samples
TPS70950DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDH	Samples
TPS70950DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDH	Samples
TPS70950DRVR	ACTIVE	WSON	DRV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDH	Samples
TPS70950DRVT	ACTIVE	WSON	DRV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SDH	Samples
TPS70960DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SIT	Samples
TPS70960DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SIT	Samples
TPS70960DRVR	PREVIEW	WSON	DRV	6	3000	TBD	Call TI	Call TI	-40 to 125		
TPS70960DRVT	PREVIEW	WSON	DRV	6	250	TBD	Call TI	Call TI	-40 to 125		
TPS709A30DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	11RF	Samples
TPS709A30DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	11RF	Samples
TPS709A33DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	11SF	Samples
TPS709A33DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	11SF	Samples
TPS709B33DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	13C7	Samples
TPS709B33DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	13C7	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS709B50DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	13D7	Samples
TPS709B50DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	13D7	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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

OTHER QUALIFIED VERSIONS OF TPS709 :

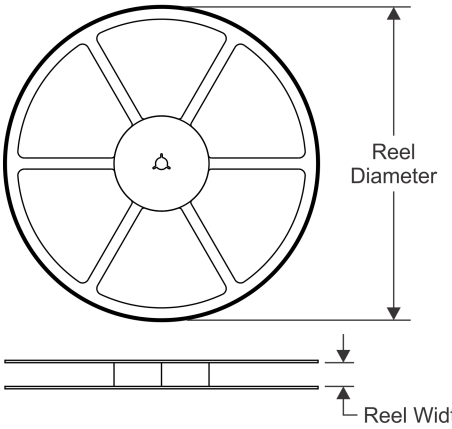
- Automotive: TPS709-Q1

NOTE: Qualified Version Definitions:

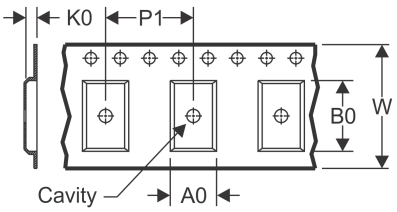
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

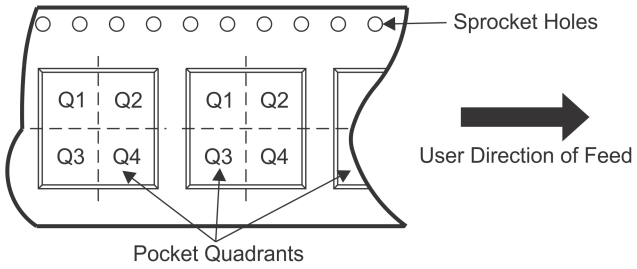


TAPE DIMENSIONS



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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

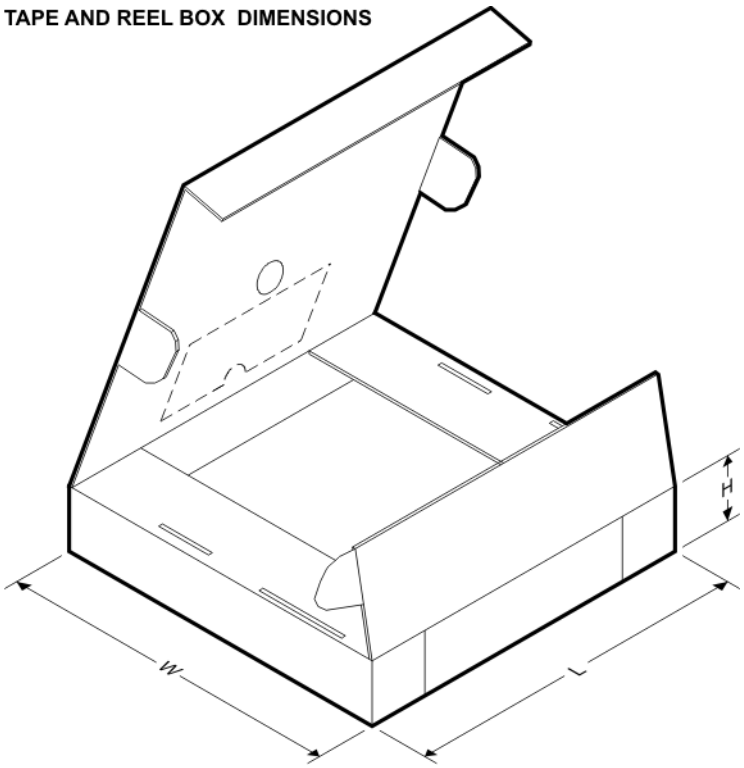


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS70912DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TPS70912DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70912DRVR	WSON	DRV	6	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70912DRVT	WSON	DRV	6	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS709135DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709135DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70915DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70915DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70915DRVR	WSON	DRV	6	3000	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
TPS70915DRVR	WSON	DRV	6	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70915DRVT	WSON	DRV	6	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70915DRVT	WSON	DRV	6	250	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
TPS70916DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70916DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70918DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70918DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70918DRVR	WSON	DRV	6	3000	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
TPS70918DRVT	WSON	DRV	6	250	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2

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
TPS70919DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70919DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70925DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70925DBVT	SOT-23	DBV	5	250	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TPS70925DRVR	WSON	DRV	6	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70925DRVT	WSON	DRV	6	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70927DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70927DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70928DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70928DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70930DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70930DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70930DRVR	WSON	DRV	6	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70930DRVT	WSON	DRV	6	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70933DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TPS70933DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70933DRVR	WSON	DRV	6	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70933DRVT	WSON	DRV	6	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
TPS70936DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TPS70936DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70938DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70938DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70939DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70939DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70950DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70950DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70950DRVR	WSON	DRV	6	3000	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
TPS70950DRVT	WSON	DRV	6	250	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
TPS70960DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70960DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709A30DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709A30DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709A33DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709A33DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709B33DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709B33DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709B50DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS709B50DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS

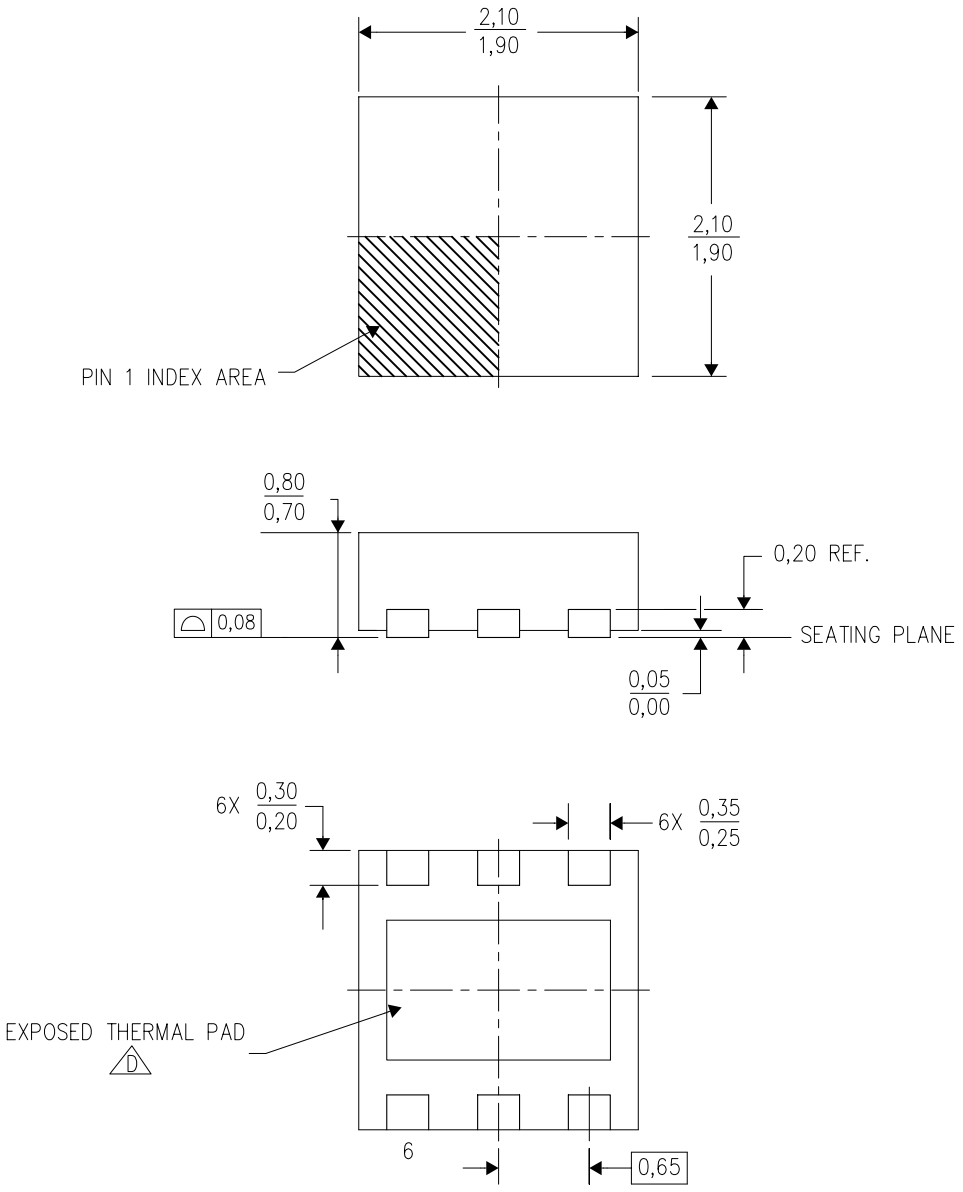


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS70912DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70912DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70912DRVR	WSON	DRV	6	3000	210.0	185.0	35.0
TPS70912DRVT	WSON	DRV	6	250	210.0	185.0	35.0
TPS709135DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS709135DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70915DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70915DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70915DRVR	WSON	DRV	6	3000	203.0	203.0	35.0
TPS70915DRVR	WSON	DRV	6	3000	210.0	185.0	35.0
TPS70915DRVT	WSON	DRV	6	250	210.0	185.0	35.0
TPS70915DRVT	WSON	DRV	6	250	203.0	203.0	35.0
TPS70916DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70916DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70918DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70918DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70918DRVR	WSON	DRV	6	3000	203.0	203.0	35.0
TPS70918DRVT	WSON	DRV	6	250	203.0	203.0	35.0
TPS70919DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70919DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS70925DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70925DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70925DRVR	WSON	DRV	6	3000	210.0	185.0	35.0
TPS70925DRVT	WSON	DRV	6	250	210.0	185.0	35.0
TPS70927DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70927DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70928DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70928DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70930DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70930DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70930DRVR	WSON	DRV	6	3000	210.0	185.0	35.0
TPS70930DRVT	WSON	DRV	6	250	210.0	185.0	35.0
TPS70933DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70933DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70933DRVR	WSON	DRV	6	3000	210.0	185.0	35.0
TPS70933DRVT	WSON	DRV	6	250	210.0	185.0	35.0
TPS70936DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70936DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70938DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70938DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70939DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70939DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70950DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70950DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS70950DRVR	WSON	DRV	6	3000	203.0	203.0	35.0
TPS70950DRVT	WSON	DRV	6	250	203.0	203.0	35.0
TPS70960DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70960DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS709A30DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS709A30DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS709A33DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS709A33DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS709B33DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS709B33DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TPS709B50DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS709B50DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0

DRV (S–PWSON–N6) PLASTIC SMALL OUTLINE NO–LEAD



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NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Small Outline No–Lead (SON) package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.

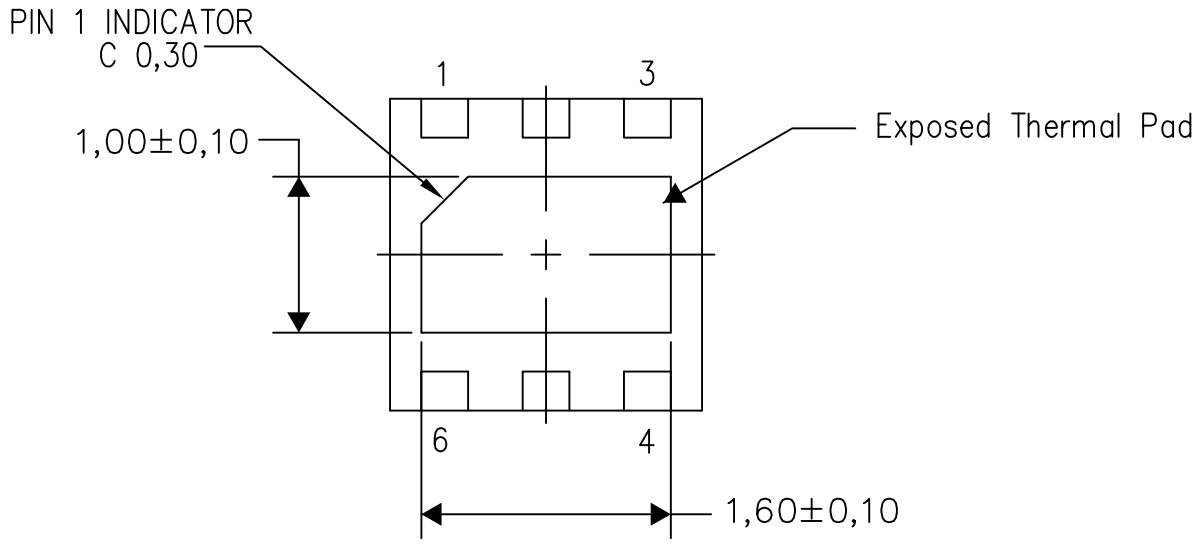
DRV (S–PWSON–N6) PLASTIC SMALL OUTLINE NO–LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No–Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



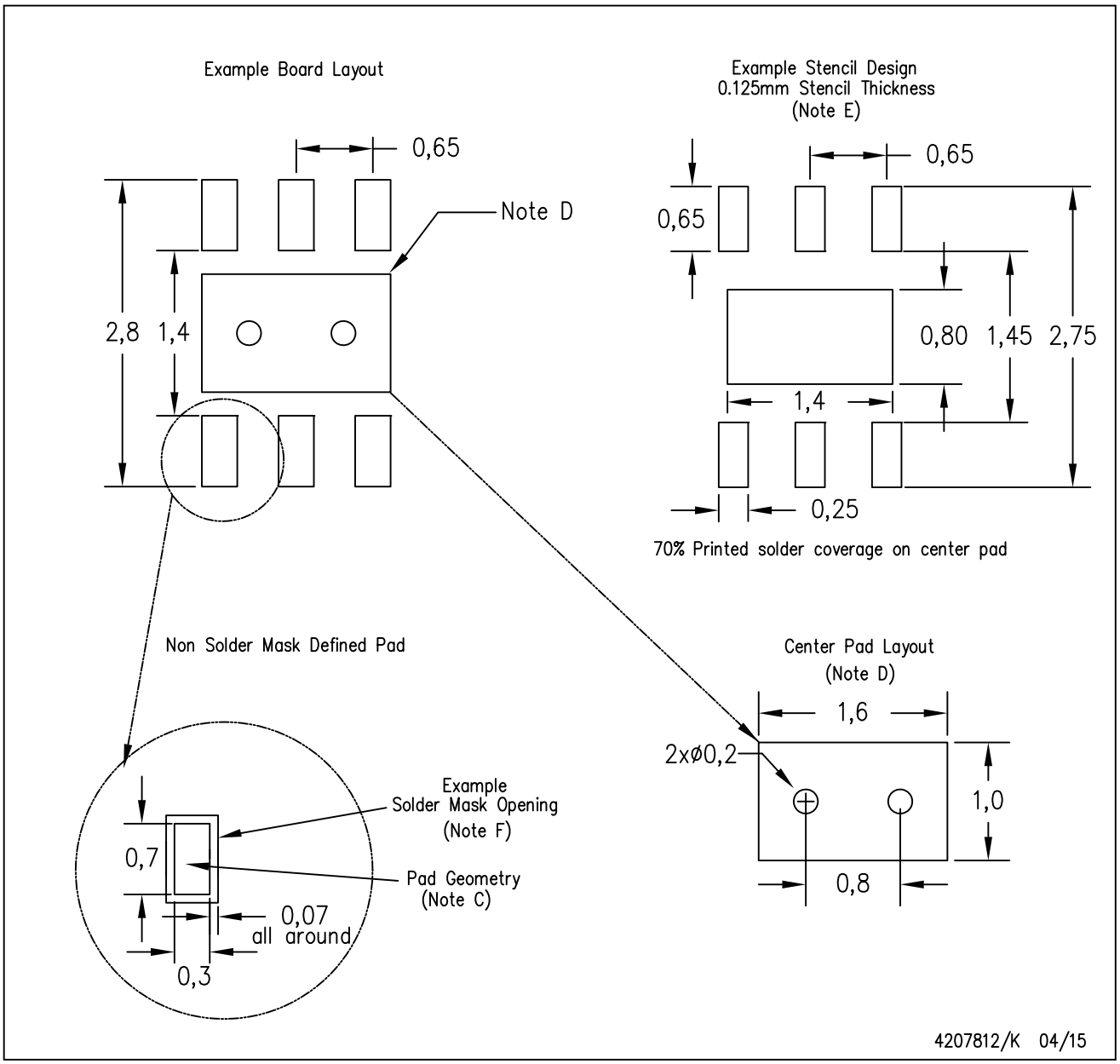
Bottom View

Exposed Thermal Pad Dimensions

4206926/Q 04/15

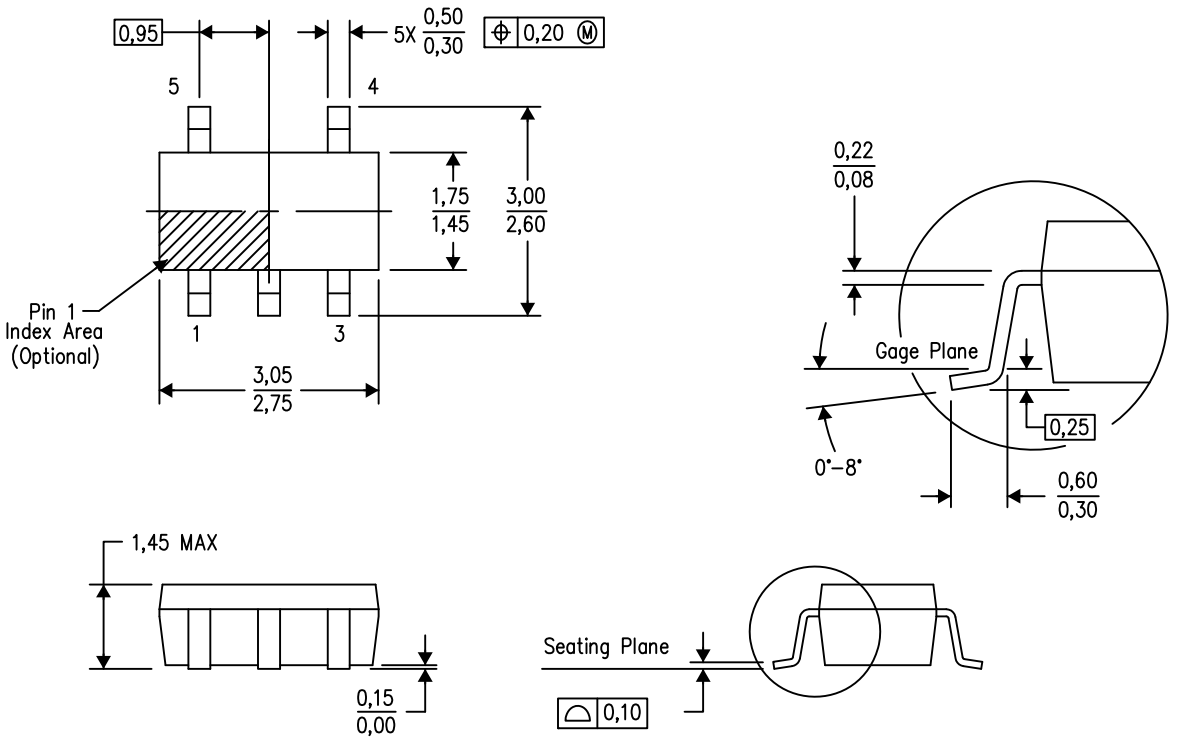
NOTE: All linear dimensions are in millimeters

DRV (S–PWSON–N6) PLASTIC SMALL OUTLINE NO–LEAD



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
F. Customers should contact their board fabrication site for solder mask tolerances.

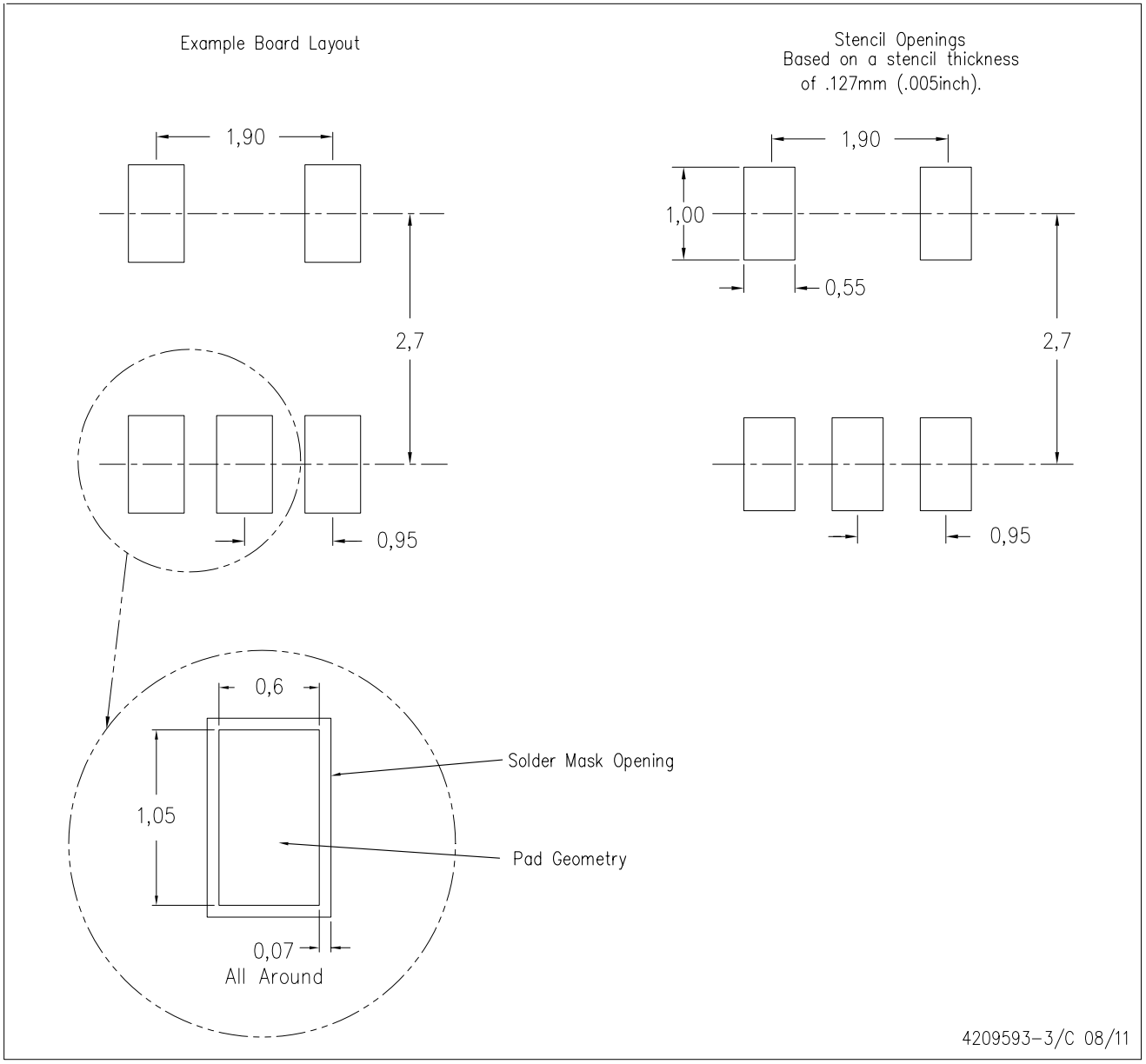
DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



4073253–4/N 12/14

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–178 Variation AA.

DBV (R–PDSO–G5) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

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