

## 150-mA, 30-V, 1- $\mu$ A $I_Q$ Voltage Regulators with Enable

### FEATURES

- Qualified for Automotive Applications
- AEC-Q100 Qualified With the Following Results:
  - Device Temperature Grade 1:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  Ambient Operating Temperature
  - Device HBM ESD Classification Level 2
  - Device CDM ESD Classification Level C4B
- Ultra-low  $I_Q$ : 1  $\mu\text{A}$
- Reverse Current Protection
- Low  $I_{\text{SHUTDOWN}}$ : 150 nA
- Input Voltage Range: 2.7 V to 30 V
- Supports 200-mA Peak Output
- Low Dropout: 245 mV at 50 mA
- 2% Accuracy Over Temperature
- Available in Fixed-Output Voltages: 1.2 V to 6.5 V
- Thermal Shutdown and Overcurrent Protection
- Packages: SOT-23-5

### APPLICATIONS

- Automotive

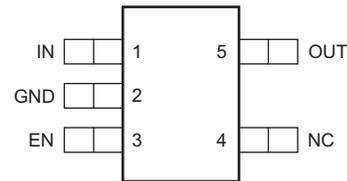
### DESCRIPTION

The TPS709xx-Q1 series of linear regulators are ultralow, quiescent current devices designed for power-sensitive applications. A precision band-gap and error amplifier provides 2% accuracy over temperature. Quiescent current of only 1  $\mu\text{A}$  makes these devices ideal solutions for battery-powered, always-on systems that require very little idle-state power dissipation. These devices have thermal-shutdown, current-limit, and reverse-current protections for added safety.

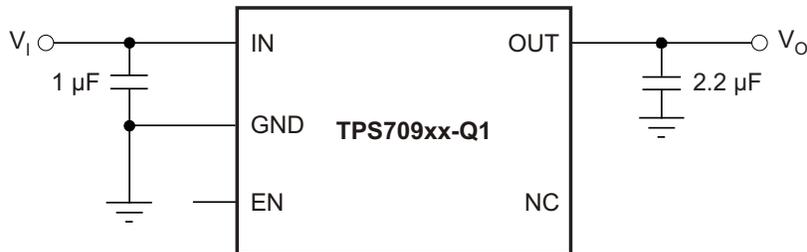
These regulators can be put into shutdown mode by pulling the EN pin low. The shutdown current in this mode goes down to 150 nA, typical.

For The TPS709xx series in other voltage options or SON-6 or SOT-223-4 packages, please contact TI sales.

**DBV PACKAGE  
SOT-23-5  
(TOP VIEW)**



### TYPICAL APPLICATION CIRCUIT



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Specified at  $T_A = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , unless otherwise noted. All voltages are with respect to GND.

		VALUE		UNIT
		MIN	MAX	
Voltage	$V_I$	-0.3	32	V
	$V_{EN}$	-0.3	7	
	$V_O$	-0.3	7	
Maximum output current	$I_O$	Internally limited		
Output short-circuit duration		Indefinite		
Continuous total power dissipation	$P_D$	See the <a href="#">Thermal Information</a> table		
Temperature	Junction, $T_J$	-55	150	$^{\circ}\text{C}$
	Storage, $T_{stg}$	-55	150	
	Ambient, $T_A$	-40	125	
Electrostatic discharge (ESD) ratings	Human body model (HBM), Classification 2		2	kV
	Charged device model (CDM), Classification C4B		750	V

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## THERMAL INFORMATION

THERMAL METRIC <sup>(1)</sup>		TPS709xx-Q1	UNITS
		DBV (SOT-23)	
		5 PINS	
$\theta_{JA}$	Junction-to-ambient thermal resistance	210.9	$^{\circ}\text{C}/\text{W}$
$\theta_{Jc\text{top}}$	Junction-to-case (top) thermal resistance	127.4	
$\theta_{JB}$	Junction-to-board thermal resistance	39.4	
$\Psi_{JT}$	Junction-to-top characterization parameter	16.8	
$\Psi_{JB}$	Junction-to-board characterization parameter	38.4	
$\theta_{Jc\text{bot}}$	Junction-to-case (bottom) thermal resistance	N/A	

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

## ELECTRICAL CHARACTERISTICS

At  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ ,  $V_I = V_O(\text{typ}) + 1\text{ V}$  or  $2.7\text{ V}$  (whichever is greater),  $I_O = 1\text{ mA}$ ,  $V_{EN} = 2\text{ V}$ , and  $C_I = C_O = 2.2\text{-}\mu\text{F}$  ceramic, unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_I$	Input voltage range		2.7		30	V
$V_O$	Output voltage range		1.2		6.5	V
$V_{O(\text{DC})}$	DC output accuracy	$V_O < 3.3\text{ V}$	-2		2	%
		$V_O \geq 3.3\text{ V}$	-1		1	%
$\Delta V_O$	Line regulation	$(V_O(\text{typ}) + 1\text{ V}, 2.7\text{ V}) \leq V_I \leq 30\text{ V}$		3	10	mV
	Load regulation	$V_I = V_O(\text{typ}) + 1.5\text{ V}$ or $3\text{ V}$ (whichever is greater), $100\text{ }\mu\text{A} \leq I_O \leq 150\text{ mA}$		20	50	mV
$V_{\text{DO}}$	Dropout voltage <sup>(1)(2)</sup>	TPS70933-Q1, $I_O = 50\text{ mA}$		295	650	mV
		TPS70933-Q1, $I_O = 150\text{ mA}$		975	1540	mV
		TPS70950-Q1, $I_O = 50\text{ mA}$		245	500	mV
		TPS70950-Q1, $I_O = 150\text{ mA}$		690	1200	mV
$I_L$	Output current-limit <sup>(3)</sup>	$V_O = 0.9 \times V_O(\text{typ})$	200	320	500	mA
$I_{\text{GND}}$	Ground pin current	$I_O = 0\text{ mA}$ , $V_O \leq 3.3\text{ V}$		1.3	2.55	$\mu\text{A}$
		$I_O = 0\text{ mA}$ , $V_O > 3.3\text{ V}$		1.4	2.7	$\mu\text{A}$
		$I_O = 100\text{ }\mu\text{A}$ , $V_{\text{IN}} = 30\text{ V}$		6.7	10	$\mu\text{A}$
		$I_O = 150\text{ mA}$		350		$\mu\text{A}$
$I_{\text{O(sd)}}$	Shutdown current	$V_{\text{EN}} \leq 0.4\text{ V}$ , $V_I = 2.7\text{ V}$		150		nA
PSRR	Power-supply rejection ratio	$f = 10\text{ Hz}$		80		dB
		$f = 100\text{ Hz}$		62		dB
		$f = 1\text{ kHz}$		52		dB
$V_n$	Output noise voltage	BW = 10 Hz to 100 kHz, $I_O = 10\text{ mA}$ , $V_I = 2.7\text{ V}$ , $V_O = 1.2\text{ V}$		190		$\mu\text{V}_{\text{RMS}}$
$t_{\text{STR}}$	Start-up time <sup>(4)</sup>	$V_O(\text{typ}) \leq 3.3\text{ V}$		200	600	$\mu\text{s}$
		$V_O(\text{typ}) > 3.3\text{ V}$		500	1500	$\mu\text{s}$
$V_{\text{EN(H)}}$	Enable pin high (enabled)		0.9			V
	Enable pin high (disabled)		0		0.4	V
$I_{\text{EN}}$	Enable pin current	$\text{EN} = 1\text{ V}$ , $V_I = 5.5\text{ V}$		300		nA
$I_{\text{R}}$	Reverse current (flowing out of IN pin)	$V_O = 3\text{ V}$ , $V_I = V_{\text{EN}} = 0\text{ V}$		10		nA
	Reverse current (flowing into OUT pin)	$V_O = 3\text{ V}$ , $V_I = V_{\text{EN}} = 0\text{ V}$		100		nA
$T_{\text{SD}}$	Thermal shutdown temperature	Shutdown, temperature increasing		158		$^\circ\text{C}$
		Reset, temperature decreasing		140		$^\circ\text{C}$
$T_A$	Ambient operating temperature		-40		125	$^\circ\text{C}$

(1)  $V_{\text{DO}}$  is measured with  $V_I = 0.98 \times V_O(\text{typ})$ .

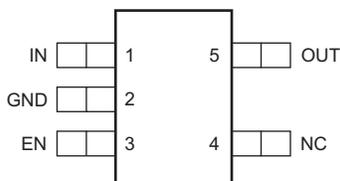
(2) Dropout is only valid when  $V_O \geq 2.8\text{ V}$  because of the minimum input voltage limits.

(3) Measured with  $V_I = V_O + 3\text{ V}$  for  $V_O \leq 2.5\text{ V}$ . Measured with  $V_I = V_O + 2.5\text{ V}$  for  $V_O > 2.5\text{ V}$ .

(4) Startup time = time from EN assertion to  $0.95 \times V_O(\text{typ})$  and load =  $47\text{ }\Omega$ .

## DEVICE INFORMATION

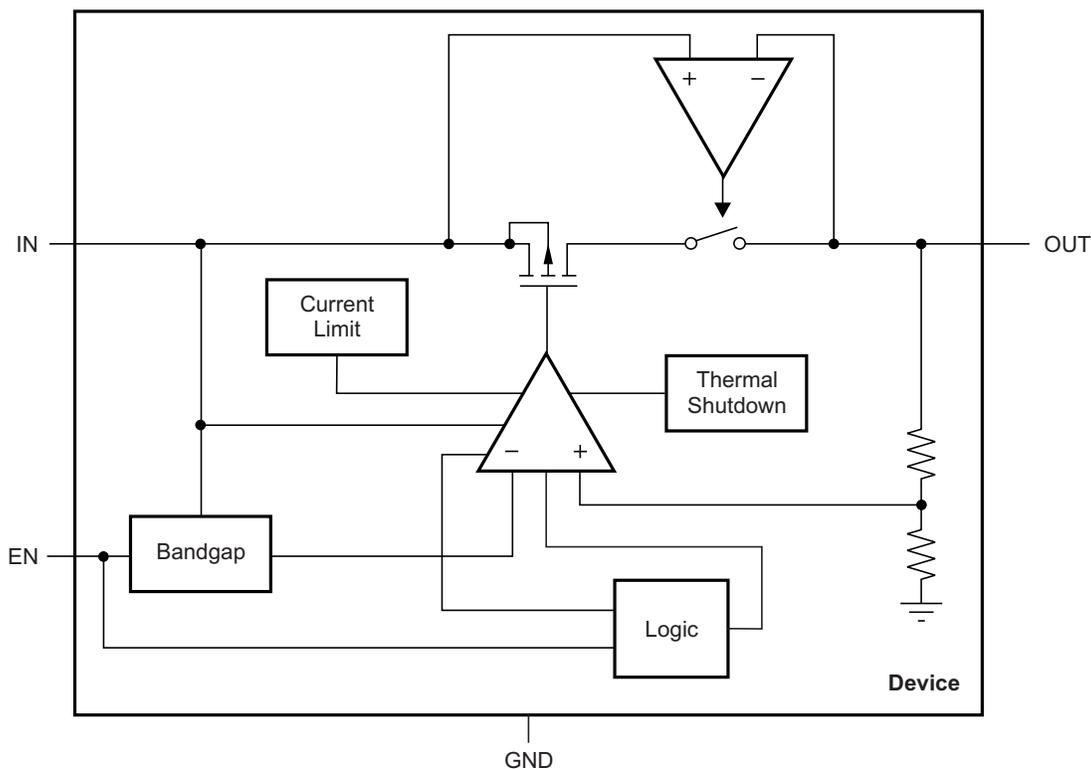
DBV PACKAGE  
 SOT-23-5  
 (TOP VIEW)



## PIN DESCRIPTIONS

PIN NAME	PIN NO.	DESCRIPTION
	DBV	
EN	3	Enable pin. Driving this pin high enables the device. Driving this pin low puts the device into low current shutdown. This pin has an internal pullup resistor and can be left floating to enable the device.
GND	2	Ground
IN	1	Unregulated input to the device
NC	4	No internal connection
OUT	5	Regulated output voltage. A small 2.2- $\mu$ F or greater ceramic capacitor should be connected from this pin to ground to assure stability.

## FUNCTIONAL BLOCK DIAGRAM



TYPICAL CHARACTERISTICS

Over operating temperature range ( $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ ),  $I_O = 10\text{ mA}$ ,  $V_{EN} = 2\text{ V}$ ,  $C_O = 2.2\text{ }\mu\text{F}$ , and  $V_I = V_O(\text{typ}) + 1\text{ V}$  or  $2.7\text{ V}$  (whichever is greater), unless otherwise noted. Typical values are at  $T_J = +25^\circ\text{C}$ .

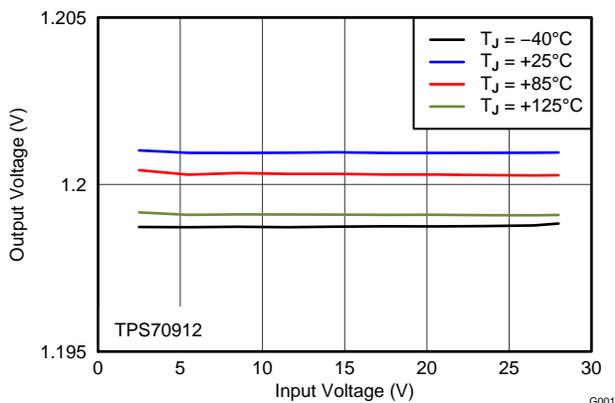


Figure 1. 1.2-V LINE REGULATION vs  $V_I$  AND TEMPERATURE

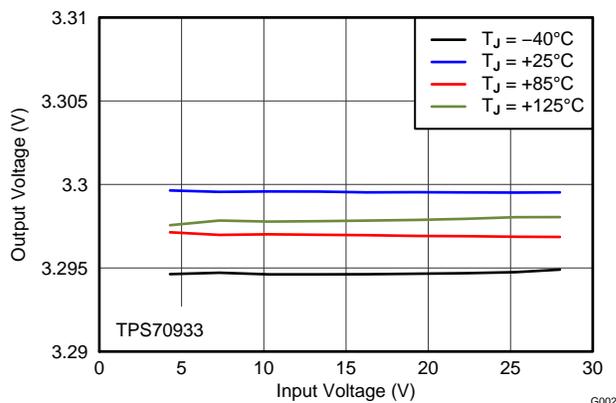


Figure 2. 3.3-V LINE REGULATION vs  $V_I$  AND TEMPERATURE

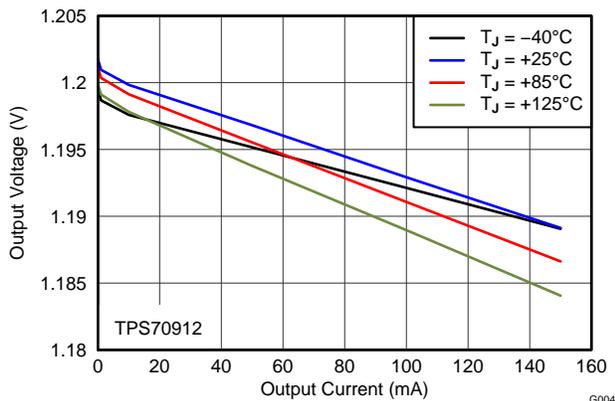


Figure 3. 1.2-V LOAD REGULATION vs  $I_O$  AND TEMPERATURE

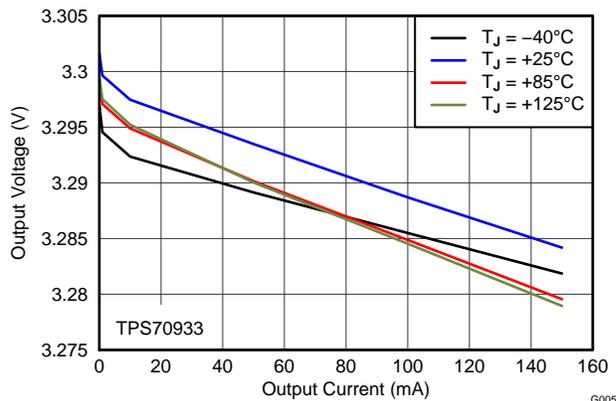


Figure 4. 3.3-V LOAD REGULATION vs  $I_O$  AND TEMPERATURE

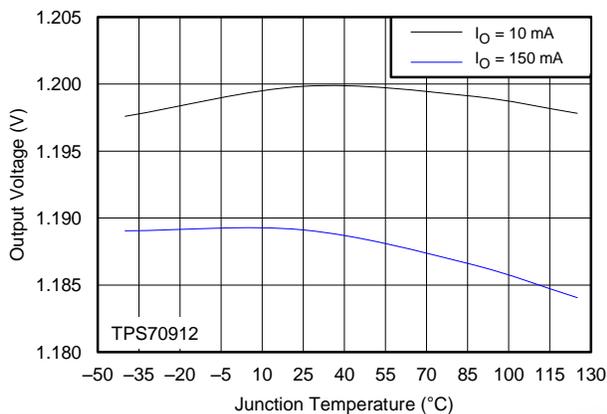


Figure 5.  $V_O$  vs TEMPERATURE

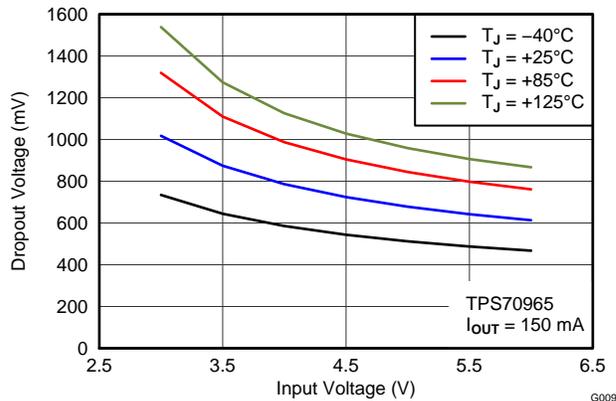
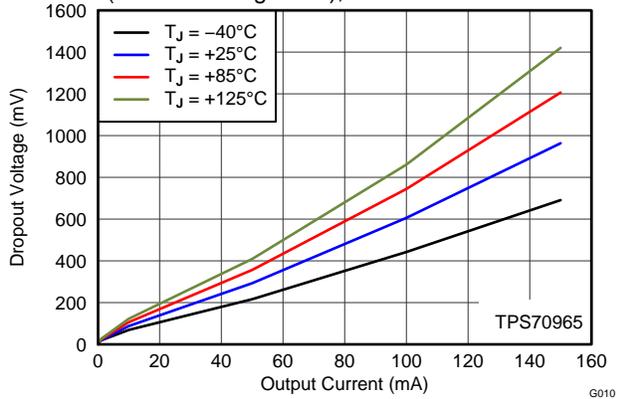


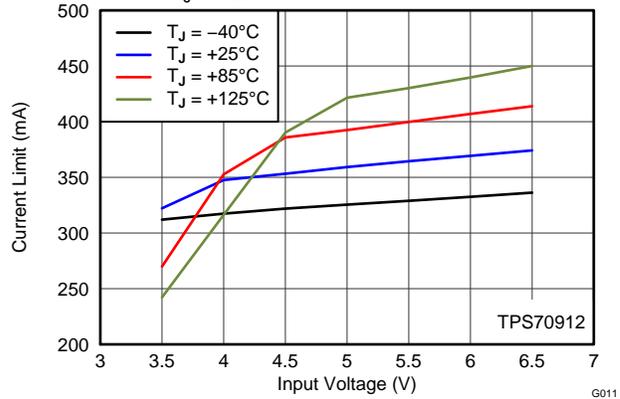
Figure 6. DROPOUT VOLTAGE vs  $V_I$  AND TEMPERATURE

**TYPICAL CHARACTERISTICS (continued)**

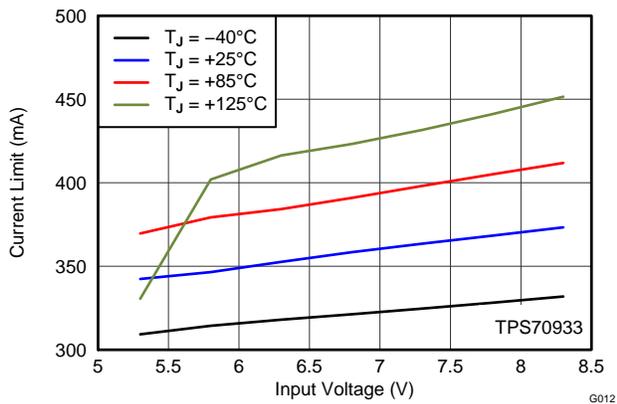
Over operating temperature range ( $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ ),  $I_O = 10\text{ mA}$ ,  $V_{EN} = 2\text{ V}$ ,  $C_O = 2.2\ \mu\text{F}$ , and  $V_I = V_O(\text{typ}) + 1\text{ V}$  or  $2.7\text{ V}$  (whichever is greater), unless otherwise noted. Typical values are at  $T_J = +25^\circ\text{C}$ .



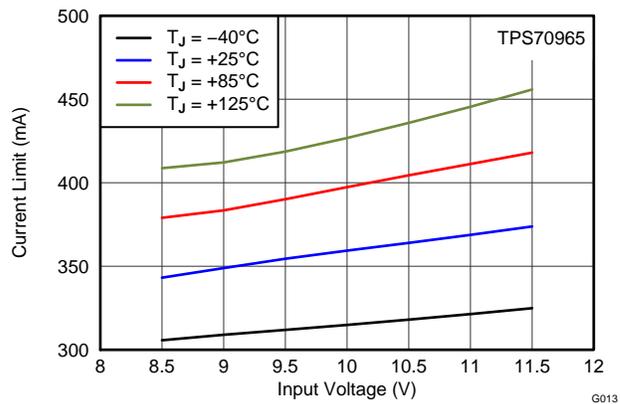
**Figure 7. DROPOUT VOLTAGE vs  $I_O$  AND TEMPERATURE**



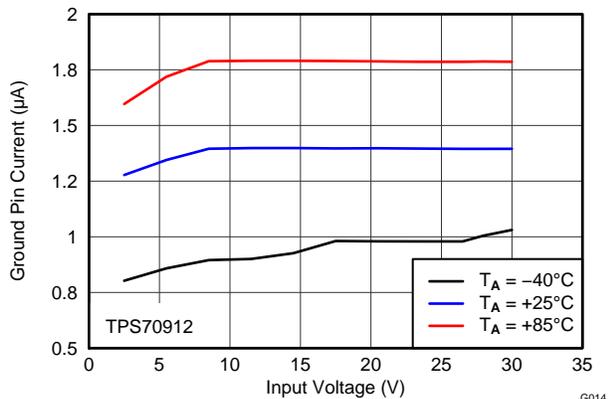
**Figure 8. 1.2-V CURRENT-LIMIT vs  $V_I$  AND TEMPERATURE**



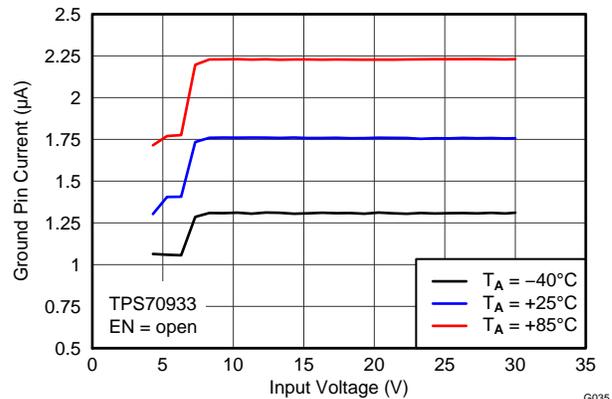
**Figure 9. 3.3-V CURRENT-LIMIT vs  $V_I$  AND TEMPERATURE**



**Figure 10. 6.5-V CURRENT-LIMIT vs  $V_I$  AND TEMPERATURE**



**Figure 11. GND CURRENT vs  $V_I$  AND TEMPERATURE**



**Figure 12. GND CURRENT vs  $V_I$  AND TEMPERATURE**

**TYPICAL CHARACTERISTICS (continued)**

Over operating temperature range ( $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ ),  $I_O = 10\text{ mA}$ ,  $V_{EN} = 2\text{ V}$ ,  $C_O = 2.2\text{ }\mu\text{F}$ , and  $V_I = V_O(\text{typ}) + 1\text{ V}$  or  $2.7\text{ V}$  (whichever is greater), unless otherwise noted. Typical values are at  $T_J = +25^\circ\text{C}$ .

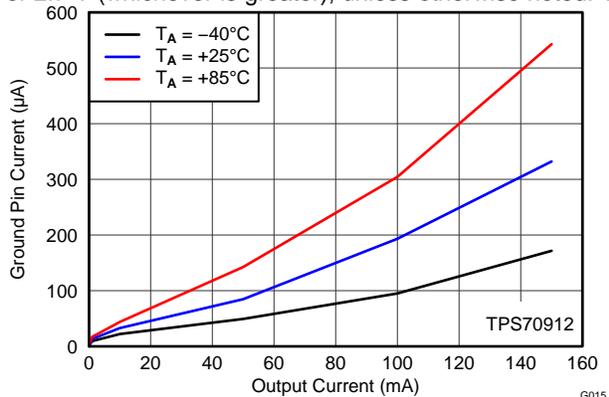


Figure 13. GND CURRENT vs  $I_O$  AND TEMPERATURE

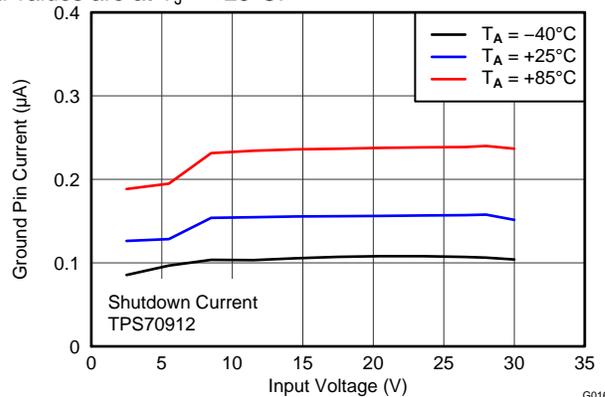


Figure 14. SHUTDOWN CURRENT vs  $V_I$  AND TEMPERATURE

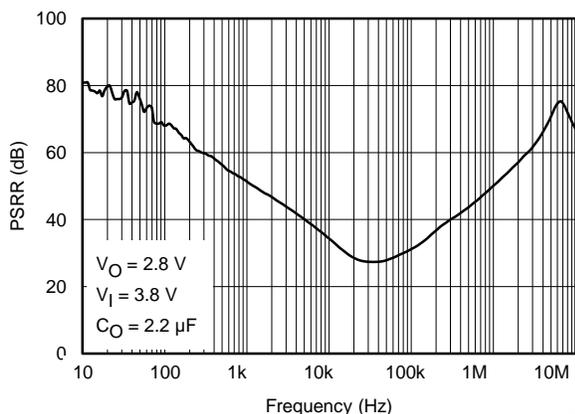


Figure 15. POWER-SUPPLY REJECTION RATIO vs FREQUENCY

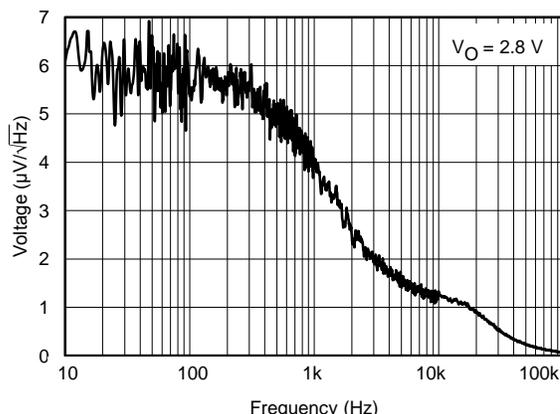


Figure 16. NOISE

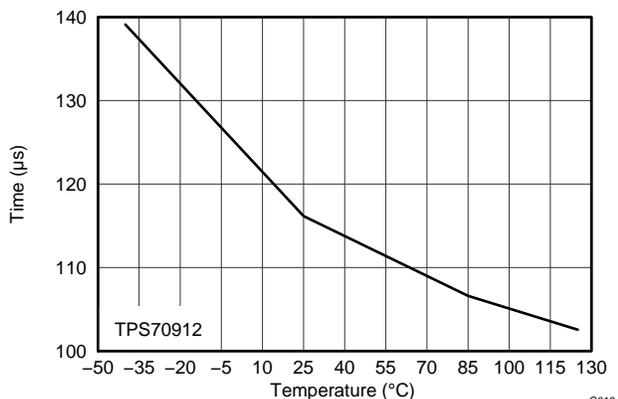


Figure 17. START-UP TIME vs TEMPERATURE

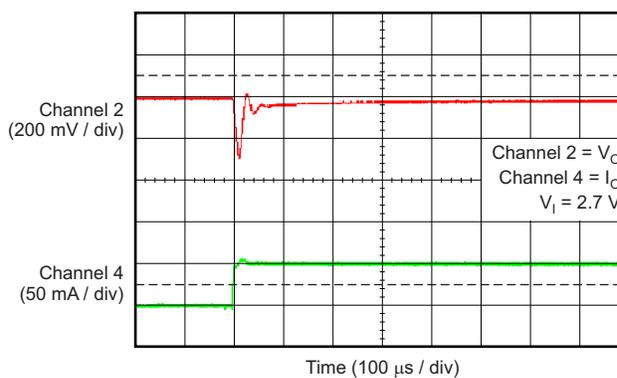
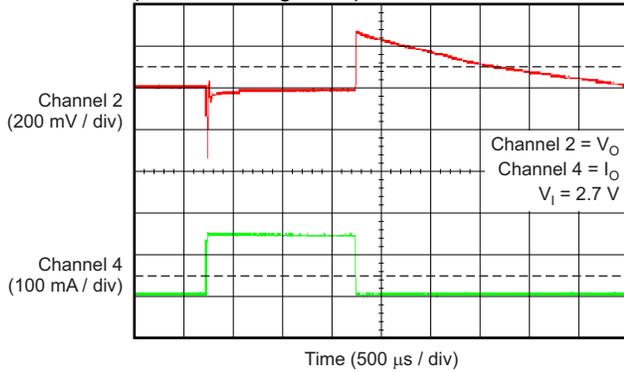


Figure 18. TPS70912 LOAD TRANSIENT (0 mA to 50 mA)

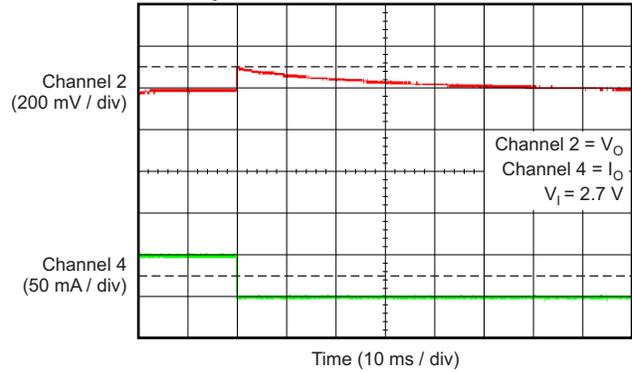
**TYPICAL CHARACTERISTICS (continued)**

Over operating temperature range ( $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ ),  $I_O = 10\text{ mA}$ ,  $V_{EN} = 2\text{ V}$ ,  $C_O = 2.2\ \mu\text{F}$ , and  $V_I = V_O(\text{typ}) + 1\text{ V}$  or  $2.7\text{ V}$  (whichever is greater), unless otherwise noted. Typical values are at  $T_J = +25^\circ\text{C}$ .



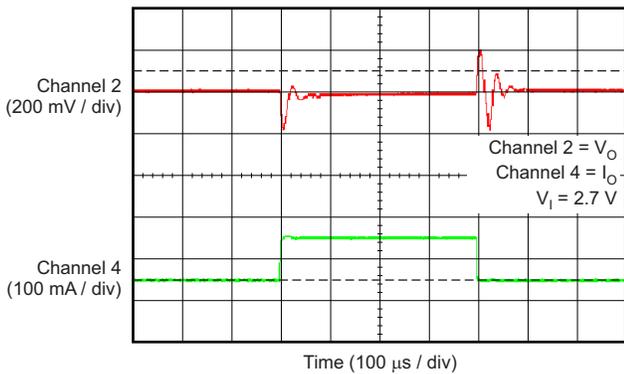
**Figure 19. TPS70912 LOAD TRANSIENT (1 mA to 150 mA)**

G021



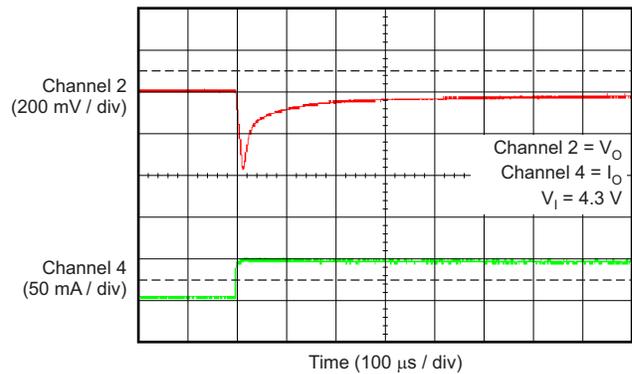
**Figure 20. TPS70912 LOAD TRANSIENT (50 mA to 0 mA)**

G022



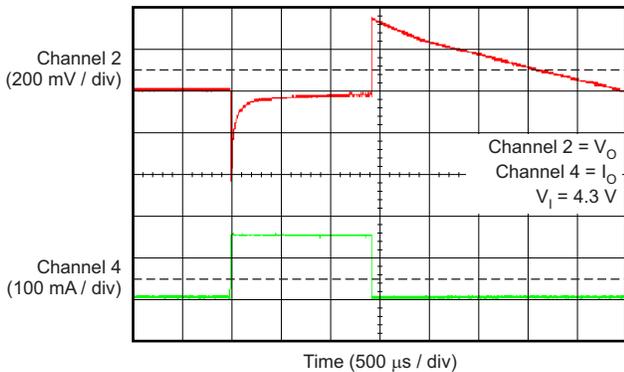
**Figure 21. TPS70912 LOAD TRANSIENT (50 mA to 150 mA)**

G023



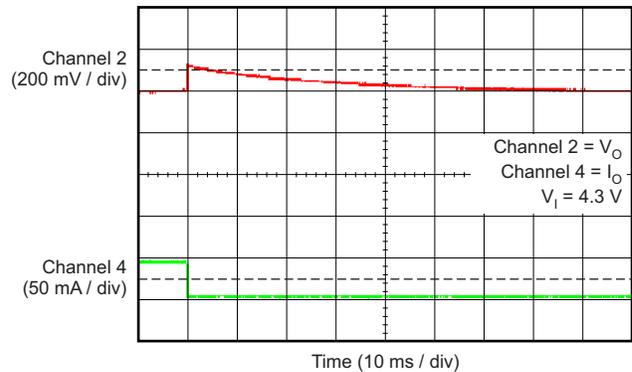
**Figure 22. TPS70933 LOAD TRANSIENT (0 mA to 50 mA)**

G024



**Figure 23. TPS70933 LOAD TRANSIENT (1 mA to 150 mA)**

G025

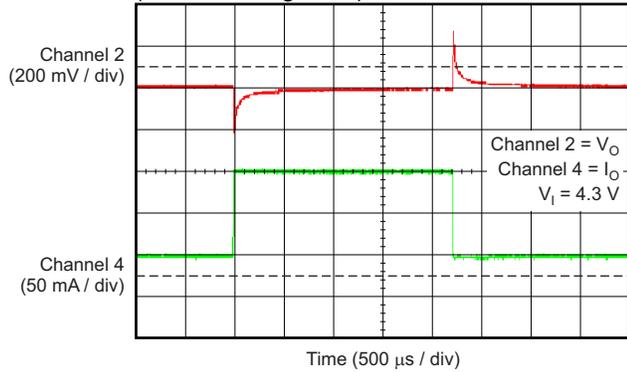


**Figure 24. TPS70933 LOAD TRANSIENT (50 mA to 0 mA)**

G026

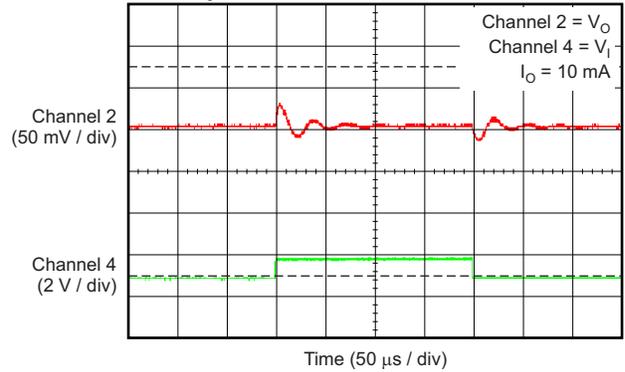
**TYPICAL CHARACTERISTICS (continued)**

Over operating temperature range ( $T_J = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ),  $I_O = 10\text{ mA}$ ,  $V_{EN} = 2\text{ V}$ ,  $C_O = 2.2\text{ }\mu\text{F}$ , and  $V_I = V_O(\text{typ}) + 1\text{ V}$  or  $2.7\text{ V}$  (whichever is greater), unless otherwise noted. Typical values are at  $T_J = +25^{\circ}\text{C}$ .



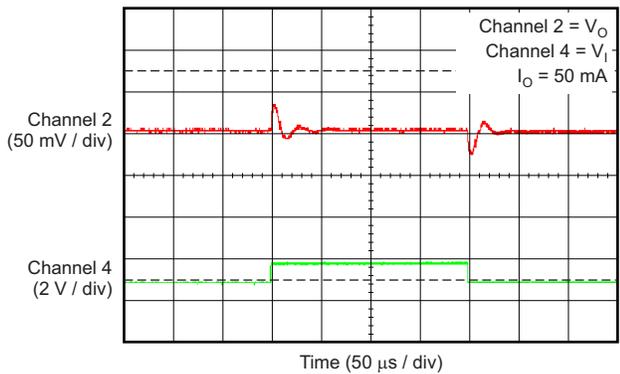
**Figure 25. TPS70933 LOAD TRANSIENT (50 mA to 150 mA)**

G027



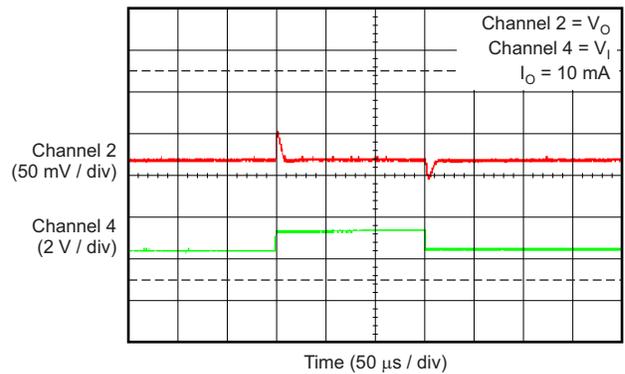
**Figure 26. TPS70912 LINE TRANSIENT (2.7 V to 3.7 V)**

G028



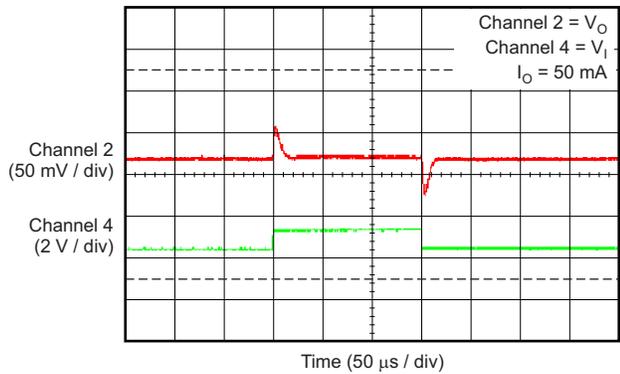
**Figure 27. TPS70912 LINE TRANSIENT (2.7 V to 3.7 V)**

G029



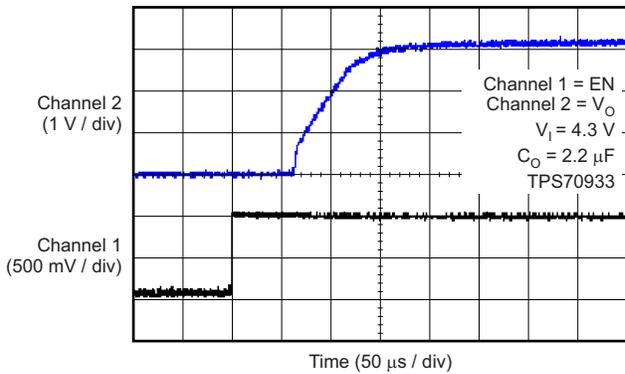
**Figure 28. TPS70933 LINE TRANSIENT (4.3 V to 5.3 V)**

G030



**Figure 29. TPS70933 LINE TRANSIENT (4.3 V to 5.3 V)**

G031



**Figure 30. POWER-UP WITH ENABLE**

G032

**TYPICAL CHARACTERISTICS (continued)**

Over operating temperature range ( $T_J = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ),  $I_O = 10\text{ mA}$ ,  $V_{EN} = 2\text{ V}$ ,  $C_O = 2.2\text{ }\mu\text{F}$ , and  $V_I = V_O(\text{typ}) + 1\text{ V}$  or  $2.7\text{ V}$  (whichever is greater), unless otherwise noted. Typical values are at  $T_J = +25^{\circ}\text{C}$ .

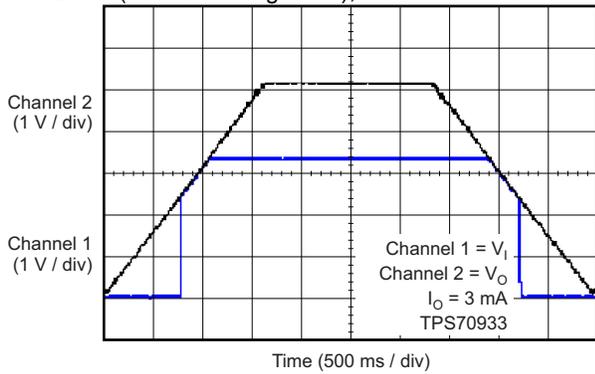


Figure 31. POWER-UP AND POWER-DOWN RESPONSE G033

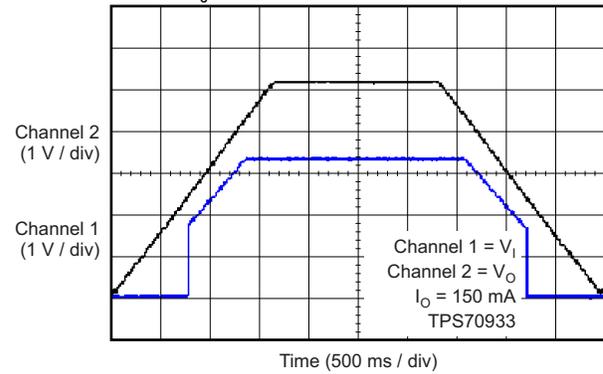


Figure 32. POWER-UP AND POWER-DOWN RESPONSE G034

## APPLICATION INFORMATION

The TPS709xx-Q1 family 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 ( $V_I - V_O$ ) headroom, makes these devices ideal for RF portable applications, current-limit, and thermal protection. The TPS709xx-Q1 devices are specified from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

### BOARD LAYOUT RECOMMENDATIONS TO IMPROVE PSRR AND NOISE PERFORMANCE

Input and output capacitors must be placed 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  $V_I$  and  $V_O$ , 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.

### INTERNAL CURRENT LIMIT

The TPS709xx-Q1 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 ( $V_O = I_L \times R_{\text{LOAD}}$ ). The PMOS pass transistor dissipates  $[(V_I - V_O) \times I_L]$  until a thermal shutdown is triggered and the device turns off. As the device cools down, it 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 Information](#) section for more details.

The TPS709xx-Q1 devices are 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 TPS709xx-Q1 devices continue to operate for output currents between 150 mA and 200 mA but some data sheet parameters may not be met.

### DROPOUT VOLTAGE

The TPS709xx-Q1 devices use a PMOS pass transistor to achieve low dropout. When ( $V_I - V_O$ ) is less than the dropout voltage ( $V_{\text{DO}}$ ), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the  $R_{\text{DS(on)}}$  of the PMOS pass element.  $V_{\text{DO}}$  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 TPS709xx-Q1 family of devices 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.

### INPUT AND OUTPUT CAPACITOR

The TPS709xx-Q1 devices are stable with output capacitors with an effective capacitance of 2  $\mu\text{F}$  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  $\mu\text{F}$ . The maximum capacitance for stability is 47  $\mu\text{F}$ . The equivalent series resistance (ESR) of the output capacitor must be between 0  $\Omega$  and 0.2  $\Omega$  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, connecting a 0.1- $\mu\text{F}$  to 2.2- $\mu\text{F}$  capacitor from IN to GND is good analog design practice. 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.

### TRANSIENT RESPONSE

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

## UNDERVOLTAGE LOCK-OUT (UVLO)

The TPS709xx-Q1 devices use an undervoltage-lockout (UVLO) circuit to keep the output shut off until the internal circuitry operates properly.

## REVERSE CURRENT PROTECTION

The TPS709xx-Q1 device have integrated reverse-current protection. Reverse current protection prevents current from flowing 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 it detects that 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.

## THERMAL INFORMATION

Thermal protection disables the output when the junction temperature rises to approximately 165°C which allows the device to cool. When the junction temperature cools to approximately 145°C, the output circuitry is again enabled. Based 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 which protects 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, junction temperature must be limited 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 TPS709xx-Q1 internal-protection circuitry is designed to protect against overload conditions. This circuitry is not intended to replace proper heatsinking. Continuously running the TPS709xx-Q1 device into thermal shutdown degrades device reliability.

## POWER DISSIPATION

The ability to remove heat from the die is different for each package type, which presents 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 ( $P_D$ ) is equal to the product of the output current and the voltage drop across the output pass element, as shown in [Equation 1](#):

$$P_D = (V_I - V_O) \times I_O \quad (1)$$

## REVISION HISTORY

Changes from Original (December 2013) to Revision A	Page
• Changed to production data .....	1
• Changed HBM classification level from H2 to 2 in the <i>FEATURES</i> list .....	1
• Changed pin out diagram image from the DRV to the correct DBV package to show 5 pins and leads .....	1
• Changed HBM classification level from H2 to 2 in the <i>ABSOLUTE MAXIMUM RATINGS</i> table .....	2
• Changed the max value for the $V_{DO}$ parameter with test condition, TPS70933-Q1, $I_O = 150$ mA, from 1400 to 1540 in the <i>ELECTRICAL CHARACTERISTICS</i> table .....	3
• Changed the max value for the $I_{GND}$ parameter with test condition, $I_O = 0$ mA, $V_O \leq 3.3$ V, from 2.05 to 2.55 in the <i>ELECTRICAL CHARACTERISTICS</i> table .....	3
• Added $I_O = 100$ $\mu$ A, $V_{IN} = 30$ V test condition for $I_{GND}$ parameter. ....	3

**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
TPS70912QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		<a href="#">Samples</a>
TPS70918QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		<a href="#">Samples</a>
TPS70925QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		<a href="#">Samples</a>
TPS70928QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		<a href="#">Samples</a>
TPS70930QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		<a href="#">Samples</a>
TPS70933QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		<a href="#">Samples</a>
TPS70936QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		<a href="#">Samples</a>
TPS70950QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		<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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(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.

<sup>(5)</sup> 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/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.

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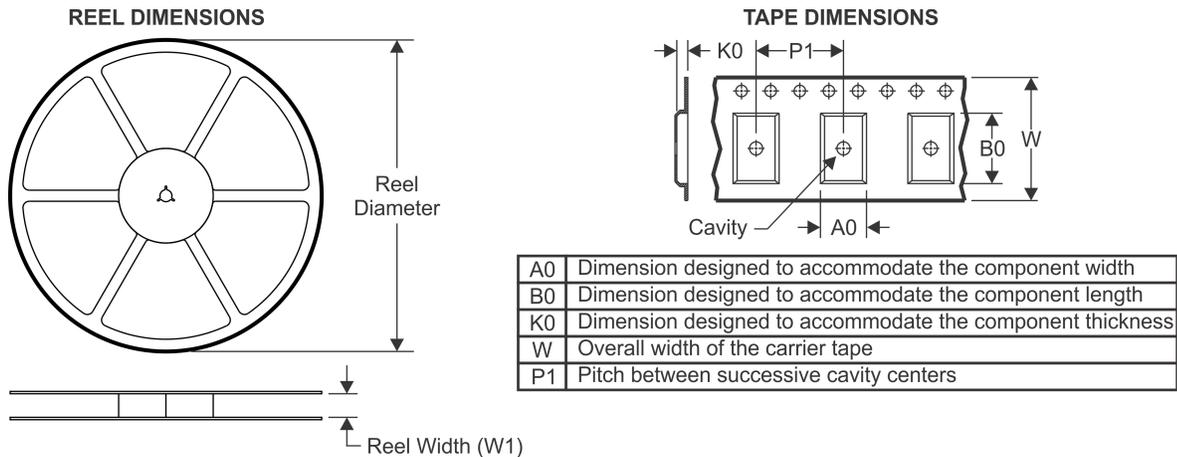
**OTHER QUALIFIED VERSIONS OF TPS70912-Q1, TPS70918-Q1, TPS70925-Q1, TPS70928-Q1, TPS70930-Q1, TPS70933-Q1, TPS70936-Q1, TPS70950-Q1 :**

● Catalog: [TPS70912](#), [TPS70918](#), [TPS70925](#), [TPS70928](#), [TPS70930](#), [TPS70933](#), [TPS70936](#), [TPS70950](#)

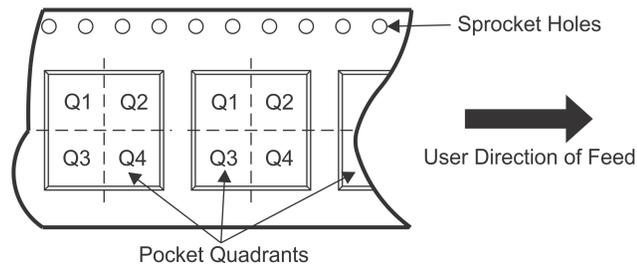
NOTE: Qualified Version Definitions:

● Catalog - TI's standard catalog product

## TAPE AND REEL INFORMATION

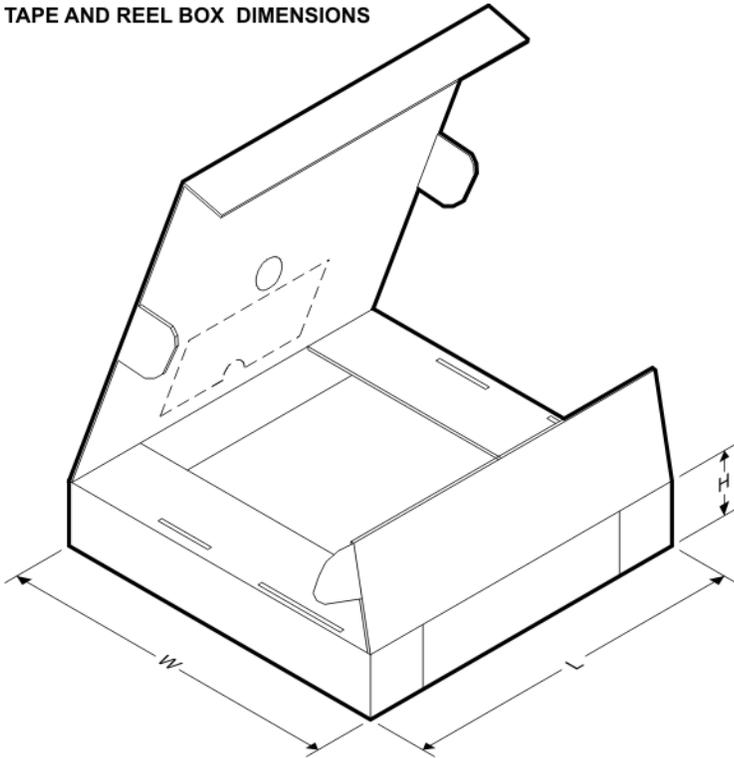


### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*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
TPS70912QDBVRQ1	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70918QDBVRQ1	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70925QDBVRQ1	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70928QDBVRQ1	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70930QDBVRQ1	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70933QDBVRQ1	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70936QDBVRQ1	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS70950QDBVRQ1	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

**TAPE AND REEL BOX DIMENSIONS**


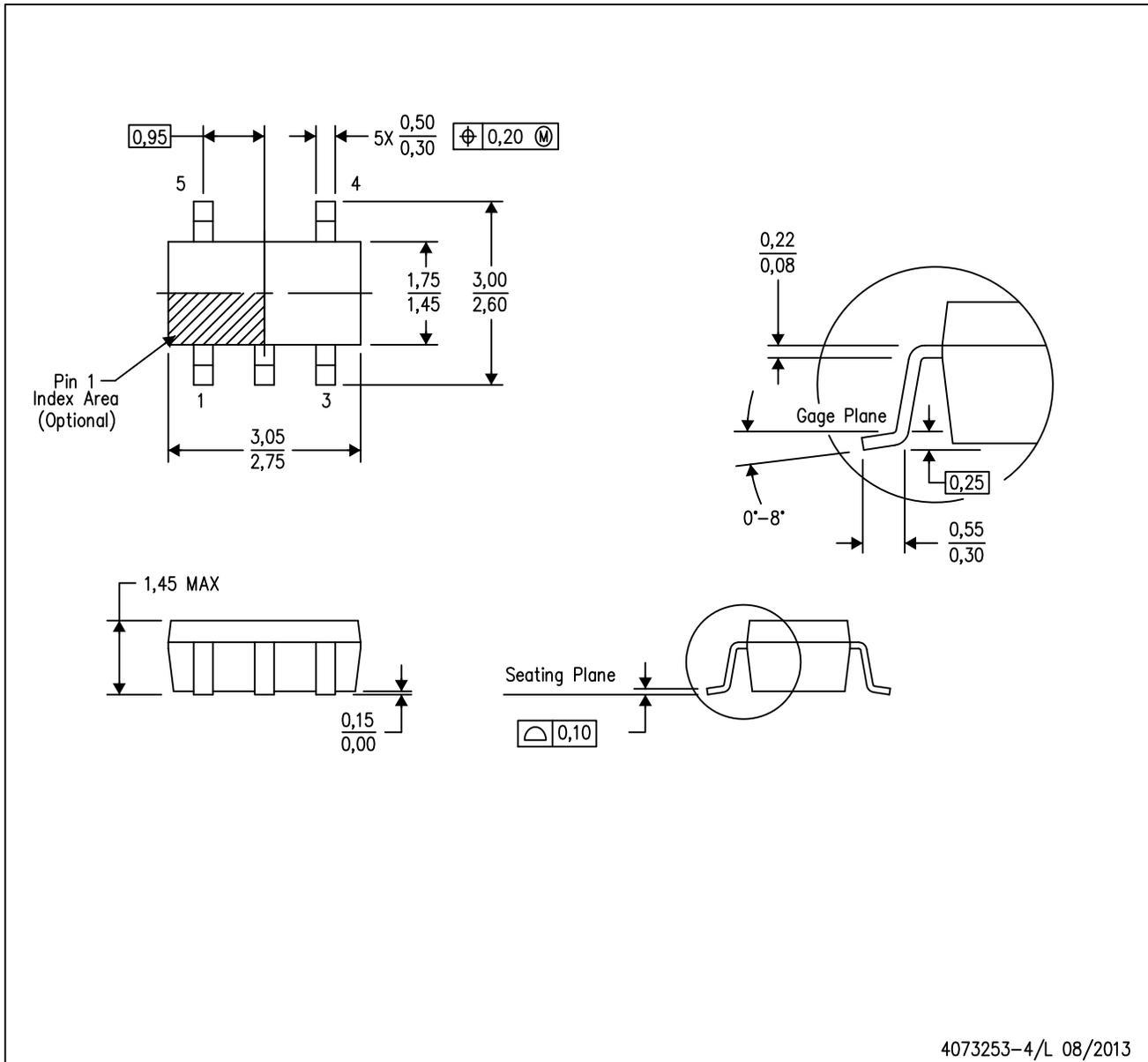
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS70912QDBVRQ1	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70918QDBVRQ1	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70925QDBVRQ1	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70928QDBVRQ1	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70930QDBVRQ1	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70933QDBVRQ1	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70936QDBVRQ1	SOT-23	DBV	5	3000	180.0	180.0	18.0
TPS70950QDBVRQ1	SOT-23	DBV	5	3000	180.0	180.0	18.0

# MECHANICAL DATA

DBV (R-PDSO-G5)

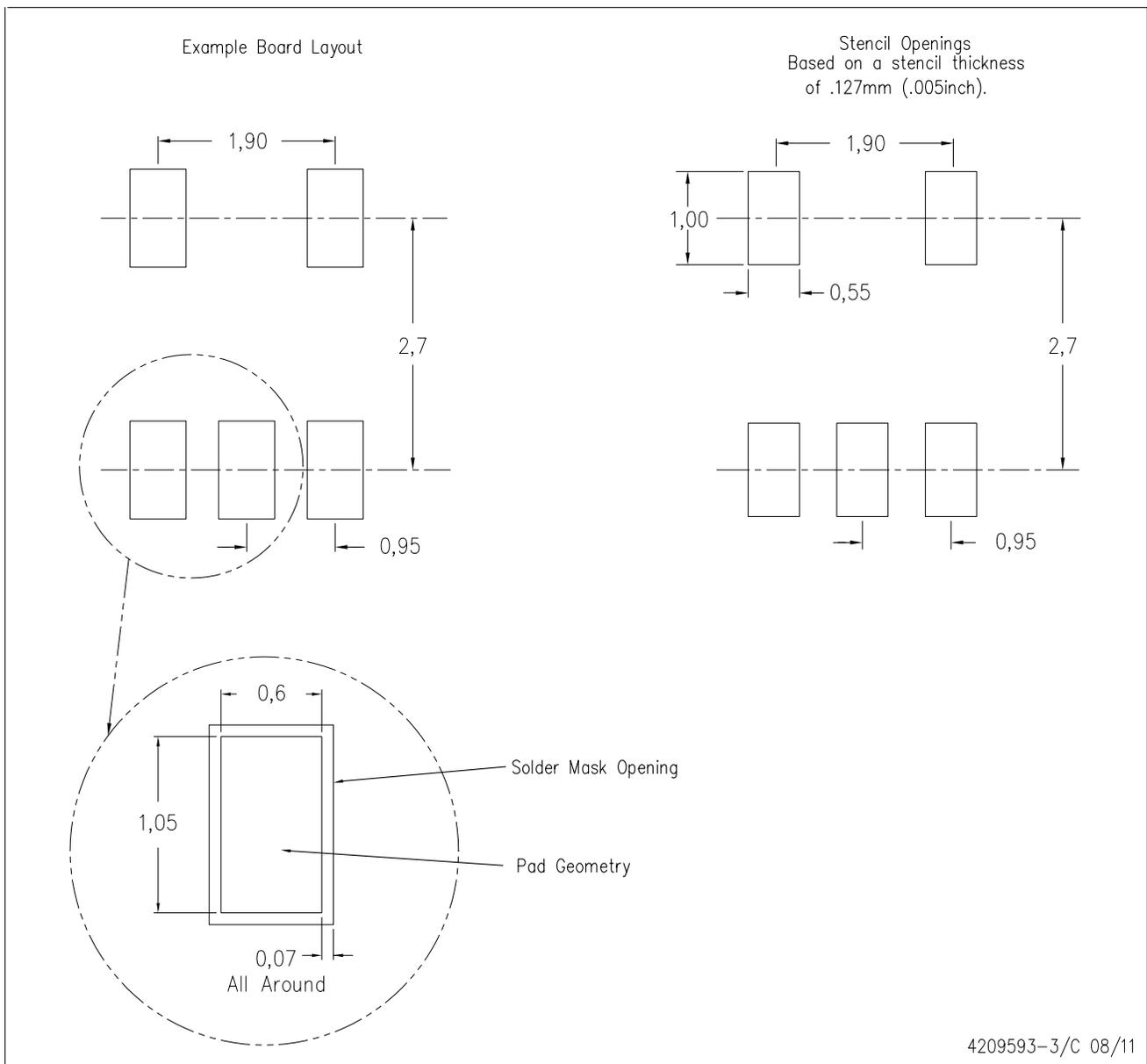
PLASTIC SMALL-OUTLINE PACKAGE



- 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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Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
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