TPS3809xxx-Q1 3-Pin Supply Voltage Supervisors

1 Features

- Qualified for Automotive Applications
- AEC-Q100 Qualified With the Following Results:
  - Device Temperature Grade 1: –40°C to +125°C Ambient Operating Temperature Range
  - Device HBM ESD Classification Level 2
  - Device CDM ESD Classification Level C5
- 3-Pin SOT-23 Package
- Supply Current of 9 µA (Typical)
- Precision-Supply Voltage Monitor 2.5 V, 3 V, 3.3 V, 5 V
- Power-On Reset Generator With Fixed Delay Time of 200 ms
- Pin-For-Pin Compatible With MAX 809

2 Applications

- Automotive Applications With DSPs, Microcontrollers, or Microprocessors
- Automotive Camera Systems
- Automotive Radar
- USB Hubs and Charging

3 Description

The TPS3809 family of supervisory circuits provides circuit initialization and timing supervision, primarily for DSPs and processor-based systems.

During power-on, $\overline{\text{RESET}}$ is asserted when the supply voltage VDD becomes higher than 1.1 V. Thereafter, the supervisory circuit monitors V_{DD} and keeps $\overline{\text{RESET}}$ active as long as V_{DD} remains below the threshold voltage V_{IT}. An internal timer delays the return of the output to the inactive state (high) to ensure proper system reset. The delay time, $t_{d(typ)}$ = 200 ms, starts after V_{DD} has risen above the threshold voltage V_{IT}. When the supply voltage drops below the threshold voltage V_{IT}, the output becomes active (low) again. No external components are required. All the devices of this family have a fixed sense-threshold voltage V_{IT} set by an internal voltage divider.

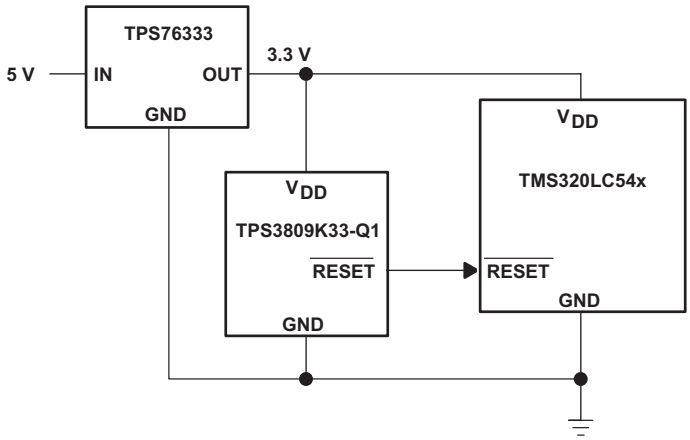
The product spectrum is designed for supply voltages of 2.5 V, 3 V, 3.3 V, and 5 V. The circuits are available in a 3-pin SOT-23. The TPS3809xxx-Q1 devices are characterized for operation over a temperature range of −40°C to 125°C, and are qualified in accordance with AEC-Q100 stress test qualification for integrated circuits. For more information about TI's voltage supervisor portfolio, please visit the Supervisor and Reset IC Overview web page.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPS3809xxx-Q1	SOT-23 (3)	2.90 mm × 1.60 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

Typical Application



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4 Revision History

Changes from Revision A (December 2002) to Revision B **Page**

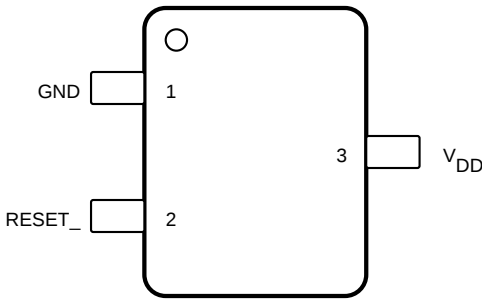
- Added AEC-Q100 Qualified information in bullets ... 1
- Changed *Applications* list items ... 1
- Added *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1
- Changed device part numbers by adding -Q1 to them throughout document ... 5

5 Voltage Options

T_A	DEVICE NAME	THRESHOLD VOLTAGE	MARKING
−40°C to 125°C	TPS3809J25QDBVRQ1	2.25 V	PCZQ
	TPS3809L30QDBVRQ1	2.64 V	PDAQ
	TPS3809K33QDBVRQ1	2.93 V	PDBQ
	TPS3809I50QDBVRQ1	4.55 V	PDCQ

6 Pin Configuration and Functions

DBV Package
3-Pin SOT-23
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
GND	1	—	Ground
$\overline{\text{RESET}}$	2	O	Reset output
V_{DD}	3	I	Supply voltage and supervising input

7 Specifications

7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

	MIN	MAX	UNIT
Supply voltage, V_{DD}(2)		7	V
All other pins(2)	–0.3	7	V
Maximum low output current, I_{OL}		5	mA
Maximum high output current, I_{OH}		–5	mA
Input clamp current, I_{IK} (V_I<0 or V_I>V_{DD})	–20	20	mA
Output clamp current, I_{OK} (V_O<0 or V_O>V_{DD})	–20	20	mA
Continuous total power dissipation			
Operating free-air temperature range, T_A	–40	125	°C
Storage temperature, T_{stg}	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to GND. For reliable operation the device should not be operated at 7 V for more than t = 1000 h continuously.

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002(1)	±2000	V
		Charged-device model (CDM), per AEC Q100-011	±750	

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{DD}	Supply voltage	2		6	V
T_A	Operating free-air temperature	–40		125	°C

7.4 Thermal Information

THERMAL METRIC(1)		TPS3809xxx-Q1 DBV (SOT-23) 3 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	232.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	187.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	104.1	°C/W
ψ_{JT}	Junction-to-top characterization parameter	40.5	°C/W
ψ_{JB}	Junction-to-board characterization parameter	104.4	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

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

7.5 Electrical Characteristics

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

PARAMETER			TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{OH}	High-level output voltage		V_{DD} = 2.5 V to 6 V, I_{OH} = −500 µA		V_{DD} – 0.2			V
			V_{DD} = 3.3 V, I_{OH} = −2 µA		V_{DD} – 0.4			
			V_{DD} = 6 V, I_{OH} = −4 mA	T_A = −40°C to +25°C	V_{DD} – 0.4			
				T_A = 125°C	V_{DD} – 0.5			
V_{OL}	Low-level output voltage		V_{DD} = 2 V to 6 V, I_{OL} = 500 µA				0.2	V
			V_{DD} = 3.3 V, I_{OL} = 2 mA				0.4	
			V_{DD} = 6 V, I_{OL} = 4 mA				0.4	
	Power-up reset voltage(1)		V_{DD} ≥ 1.1 V, I_{OL} = 50 µA				0.2	V
V_{IT-}	Negative-going input threshold voltage(2)	TPS3809J25-Q1	T_A = −40°C to +125°C		2.20	2.25	2.30	V
		TPS3809L30-Q1			2.58	2.64	2.7	
		TPS3809K33-Q1			2.87	2.93	2.99	
		TPS3809I50-Q1	T_A = −40°C to +85°C		4.45	4.55	4.65	
			T_A = −40°C to +125°C		4.4	4.55	4.65	
V_{hys}	Hysteresis	TPS3809J25-Q1				30		mV
		TPS3809L30-Q1				35		
		TPS3809K33-Q1				40		
		TPS3809I50-Q1				60		
I_{DD}	Supply current		V_{DD} = 2 V, Output unconnected			9	15	µA
			V_{DD} = 6 V, Output unconnected			20	30	
C_i	Input capacitance		V_I = 0 V to V_{DD}			5		pF

(1) The lowest supply voltage at which $\overline{\text{RESET}}$ becomes active. t_r, V_{DD} ≥ 15 µs/V.
(2) To ensure best stability of the threshold voltage, a bypass capacitor (0.1 µF, ceramic) should be placed near the supply terminals.

7.6 Timing Requirements

R_L = 1 MΩ, C_L = 50 pF, T_A = 25°C

			MIN	NOM	MAX	UNIT
t_w	Pulse width at V_{DD}	V_{DD} = V_{IT-} + 0.2 V, VDD = V_{IT-} − 0.2 V	3			µs

7.7 Switching Characteristics

R_L = 1 MΩ, C_L = 50 pF, T_A = 25°C

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_d	Delay time		V_{DD} ≥ V_{IT-} + 0.2 V, See timing diagram, Figure 1	120	200	280	ms
t_{PHL}	Propagation (delay) time, high-to-low-level output	V_{DD} to $\overline{\text{RESET}}$ delay	V_{IL} = V_{IT-} − 0.2 V, V_{IH} = V_{IT-} +0.2 V		1		µs

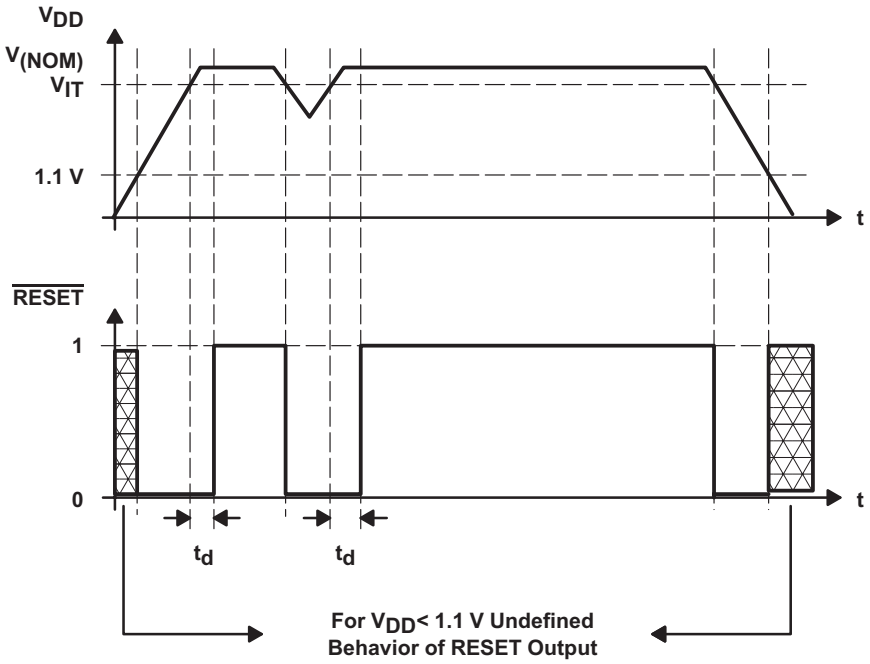


Figure 1. Timing Diagram

7.8 Typical Characteristics

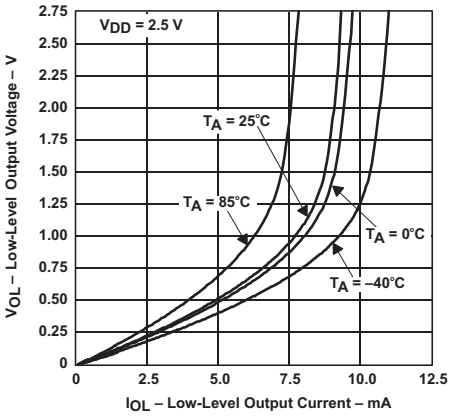


Figure 2. Low-Level Output Voltage vs Low-Level Output Current

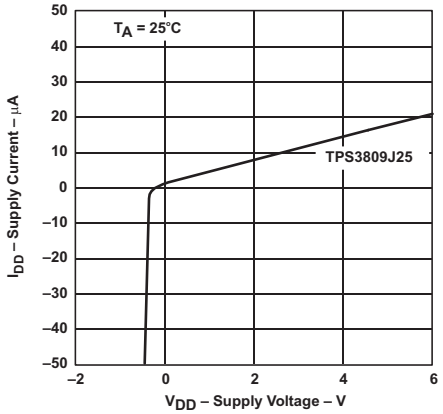
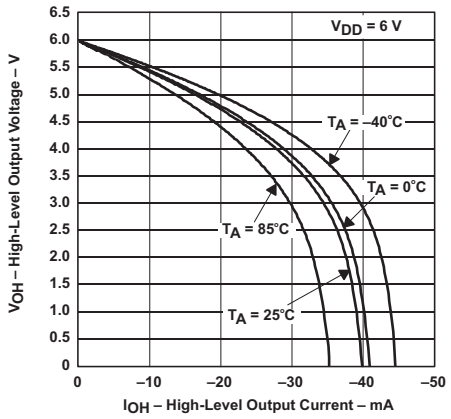
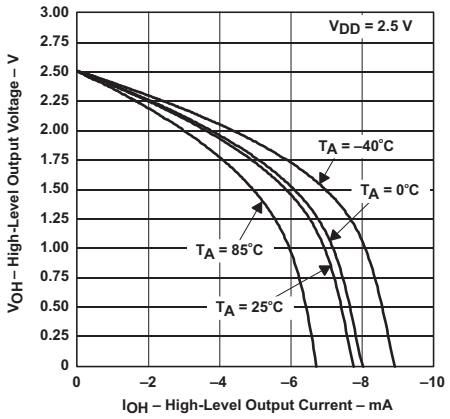


Figure 3. Supply Current vs Supply Voltage



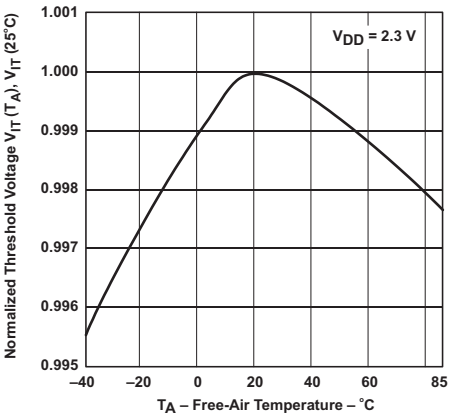
V_{DD} = 6 V

Figure 4. High-Level Output Voltage vs High-Level Output Current



V_{DD} = 2.5 V

Figure 5. High-Level Output Voltage vs High-Level Output Current



V_{DD} = 2.3 V

Figure 6. Normalized Input Threshold Voltage vs Free-Air Temperature at V_{DD}

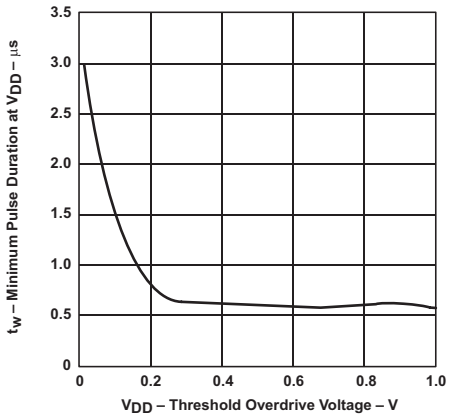


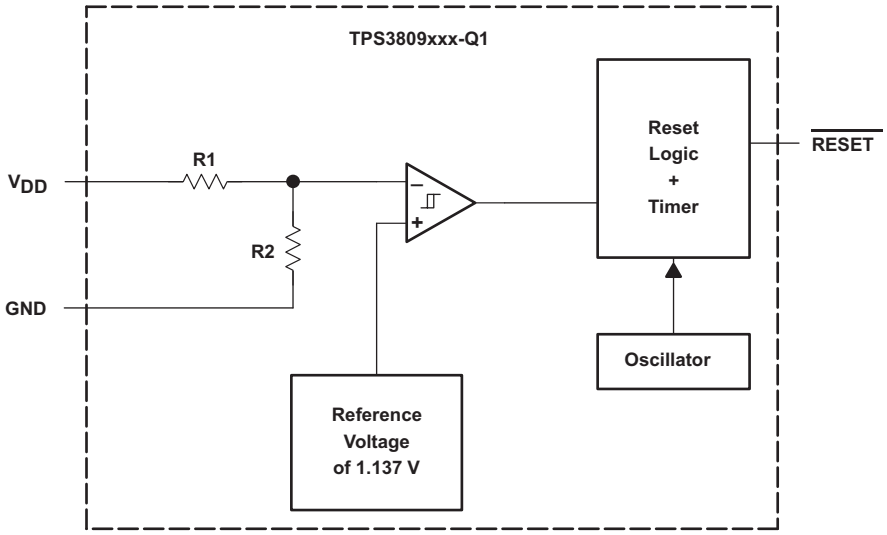
Figure 7. Minimum Pulse Duration at V_{DD} vs V_{DD} Threshold Overdrive Voltage

8 Detailed Description

8.1 Overview

The TPS3809xxx-Q1 device is a low-current supervisory circuit for monitoring system voltages above 2 V. The device asserts an active-low RESET signal when VDD drops below a preset threshold. The RESET output remains low until VDD returns above its threshold. The device design is also to be relatively immune to short negative transients on the VDD pin.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 V_{DD} Monitoring

The V_{DD} pin provides a terminal at which a system voltage can be monitored. If the voltage on this pin drops below V_{IT}, RESET is asserted low. The comparator has a built-in hysteresis to ensure smooth RESET assertions and deassertions. Refer to *Voltage Options* to determine the V_{DD} voltage threshold for each device.

8.4 Device Functional Modes

TPS3809xxx-Q1 monitors one supply using the V_{DD} pin. When V_{DD} is above the V_{IT} threshold for the device, RESET will be high. When V_{DD} is below the V_{IT} threshold for the device, RESET will be low.

9 Application and Implementation

NOTE

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

9.1 Application Information

The TPS3809xxx-Q1 voltage supervisor device design asserts an active-low RESET signal when V_{DD} drops below a voltage threshold V_{IT}. The $\overline{\text{RESET}}$ signal remains low until the voltage returns above its threshold. The typical application is with a processor or microcontroller, which needs to be reset when the supply rail drops below a specified tolerance.

9.2 Typical Application

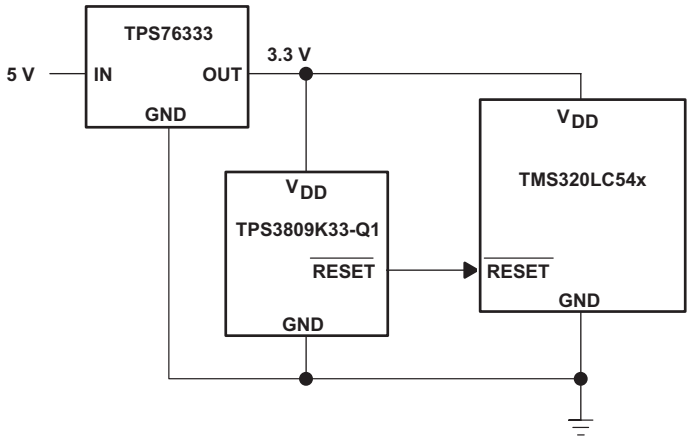


Figure 8. Typical Application Schematic

9.2.1 Design Requirements

Each device has a fixed=voltage monitoring threshold, and the device should be chosen based on the voltage being monitored. Refer to *Voltage Options* to determine the VDD voltage threshold for each device. In this example, a 3.3V supply rail to a microcontroller will be monitored.

9.2.2 Detailed Design Procedure

Because a 3.3-V supply rail needs to be monitored, TPS3809K33-Q1 should be used. This device has a 2.93-V threshold for reset. Connect the 3.3-V supply to the V_{DD} pin and the reset output of the supervisor to the reset pin of the microcontroller.

Typical Application (continued)

9.2.3 Application Curves

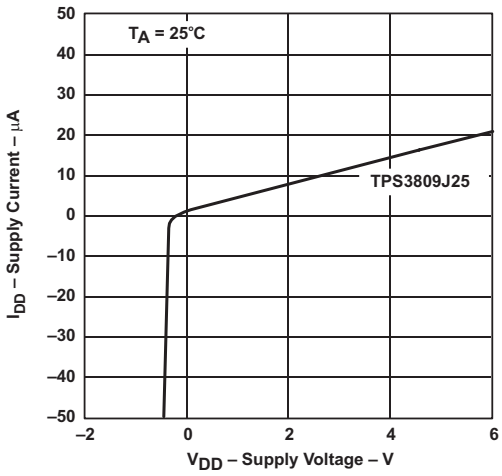
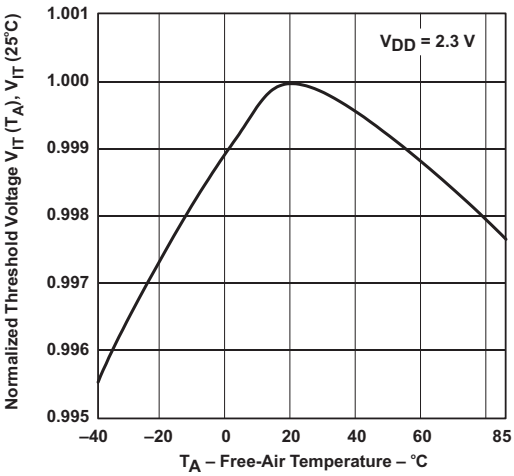


Figure 9. Supply Current vs Supply Voltage



V_{DD} = 2.3 V

Figure 10. Normalized Input Threshold Voltage vs Free-Air Temperature at V_{DD}

10 Power Supply Recommendations

The TPS3809xxx-Q1 device design operates from an input supply from 2 V to 6 V. TI recommends placing a 0.1-µF capacitor near the V_{DD} pin.

11 Layout

11.1 Layout Guidelines

TI recommends placing the 0.1-µF decoupling capacitor close to the V_{DD} pin. The V_{DD} and GND traces should be able to carry 30 µA without a significant drop in voltage.

11.2 Layout Example

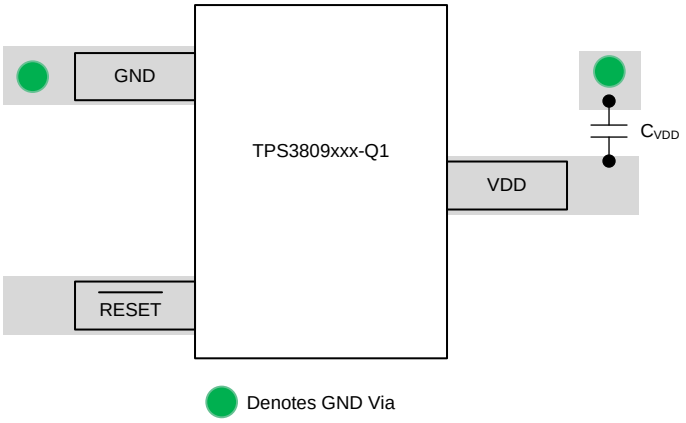


Figure 11. Layout Example

12 Device and Documentation Support

12.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
TPS3809J25-Q1	Click here	Click here	Click here	Click here	Click here
TPS3809L30-Q1	Click here	Click here	Click here	Click here	Click here
TPS3809K33-Q1	Click here	Click here	Click here	Click here	Click here
TPS3809I50-Q1	Click here	Click here	Click here	Click here	Click here

12.2 Community Resources

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.

12.3 Trademarks

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

12.4 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.5 Glossary

SLYZ022 — *TI Glossary*.

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

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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
2T09I50QDBVRG4Q	ACTIVE	SOT-23	DBV	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PDCQ	Samples
2T09J25QDBVRG4Q	LIFEBUY	SOT-23	DBV	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PCZQ	
2U3809K33QDBVRG4Q1	LIFEBUY	SOT-23	DBV	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PDBQ	
2U3809L30QDBVRG4Q1	LIFEBUY	SOT-23	DBV	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PDAQ	
TPS3809I50QDBVRQ1	ACTIVE	SOT-23	DBV	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PDCQ	Samples
TPS3809J25QDBVRQ1	LIFEBUY	SOT-23	DBV	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PCZQ	
TPS3809K33QDBVRQ1	ACTIVE	SOT-23	DBV	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PDBQ	Samples
TPS3809L30QDBVRQ1	ACTIVE	SOT-23	DBV	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PDAQ	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) 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.

(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 TPS3809-Q1, TPS3809I50-Q1, TPS3809J25-Q1, TPS3809K33-Q1, TPS3809L30-Q1 :

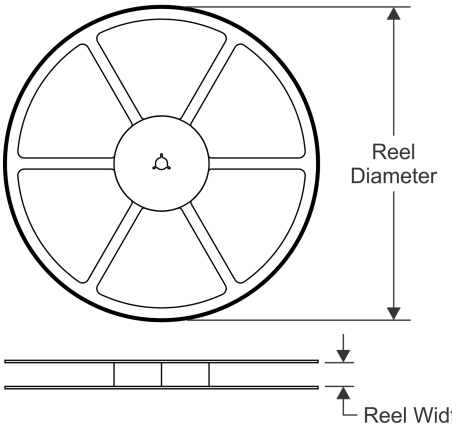
- Catalog: TPS3809I50, TPS3809J25, TPS3809K33, TPS3809L30
- Enhanced Product: TPS3809-EP, TPS3809I50-EP, TPS3809K33-EP, TPS3809L30-EP

NOTE: Qualified Version Definitions:

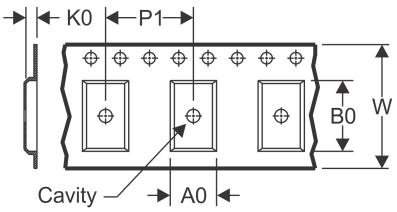
- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

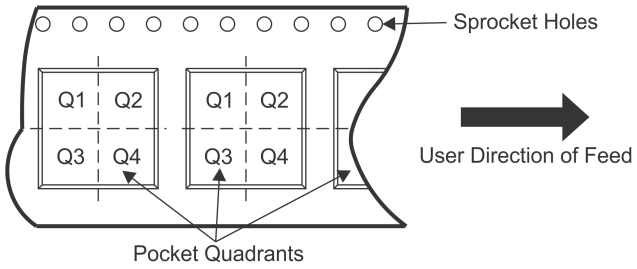


TAPE DIMENSIONS



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

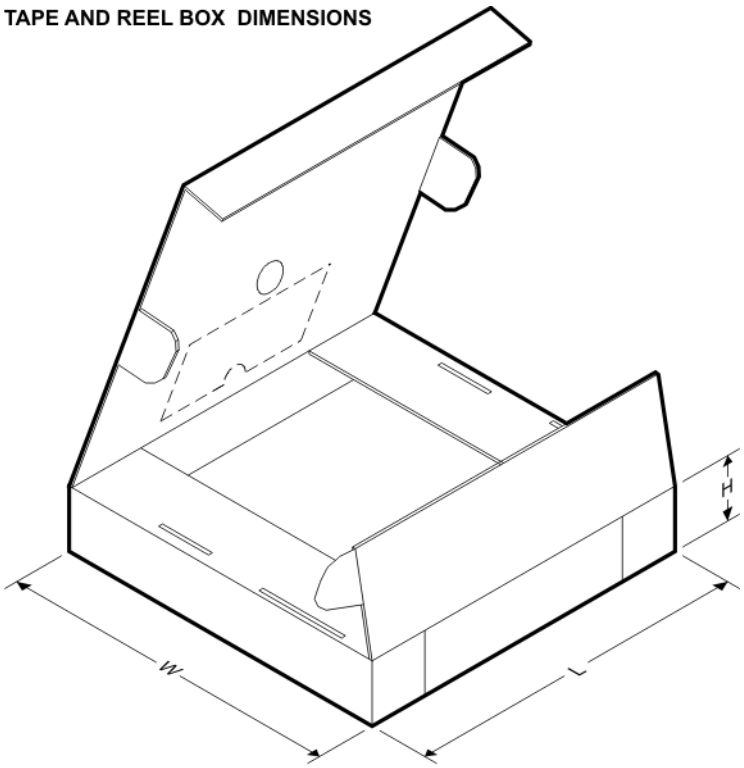
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
2T09I50QDBVRG4Q	SOT-23	DBV	3	3000	180.0	9.0	3.3	3.2	1.47	4.0	8.0	Q3
2T09J25QDBVRG4Q	SOT-23	DBV	3	3000	180.0	9.0	3.3	3.2	1.47	4.0	8.0	Q3
2U3809K33QDBVRG4Q1	SOT-23	DBV	3	3000	180.0	9.0	3.3	3.2	1.47	4.0	8.0	Q3
2U3809L30QDBVRG4Q1	SOT-23	DBV	3	3000	180.0	9.0	3.3	3.2	1.47	4.0	8.0	Q3
TPS3809I50QDBVRQ1	SOT-23	DBV	3	3000	180.0	9.0	3.3	3.2	1.47	4.0	8.0	Q3
TPS3809J25QDBVRQ1	SOT-23	DBV	3	3000	180.0	9.0	3.3	3.2	1.47	4.0	8.0	Q3
TPS3809K33QDBVRQ1	SOT-23	DBV	3	3000	180.0	9.0	3.3	3.2	1.47	4.0	8.0	Q3
TPS3809L30QDBVRQ1	SOT-23	DBV	3	3000	180.0	9.0	3.3	3.2	1.47	4.0	8.0	Q3

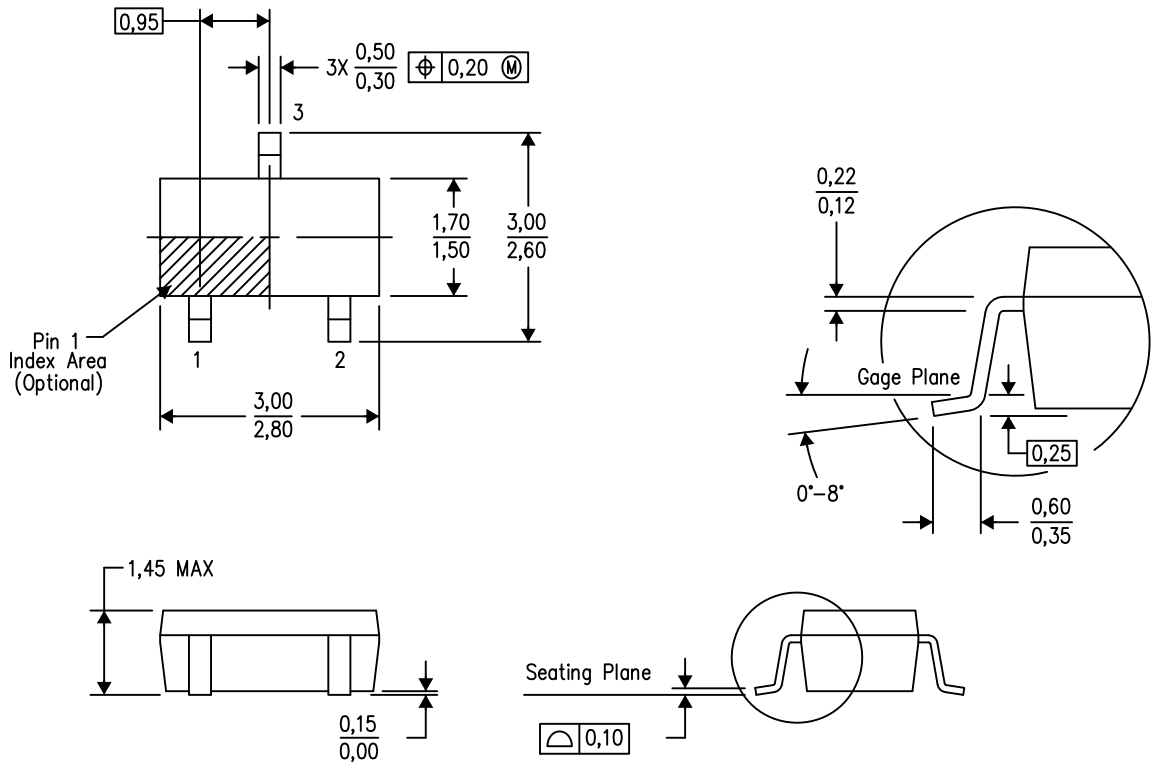
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
2T09I50QDBVRG4Q	SOT-23	DBV	3	3000	182.0	182.0	20.0
2T09J25QDBVRG4Q	SOT-23	DBV	3	3000	182.0	182.0	20.0
2U3809K33QDBVRG4Q1	SOT-23	DBV	3	3000	182.0	182.0	20.0
2U3809L30QDBVRG4Q1	SOT-23	DBV	3	3000	182.0	182.0	20.0
TPS3809I50QDBVRQ1	SOT-23	DBV	3	3000	182.0	182.0	20.0
TPS3809J25QDBVRQ1	SOT-23	DBV	3	3000	182.0	182.0	20.0
TPS3809K33QDBVRQ1	SOT-23	DBV	3	3000	182.0	182.0	20.0
TPS3809L30QDBVRQ1	SOT-23	DBV	3	3000	182.0	182.0	20.0

DBV (R–PDSO–G3) PLASTIC SMALL–OUTLINE PACKAGE



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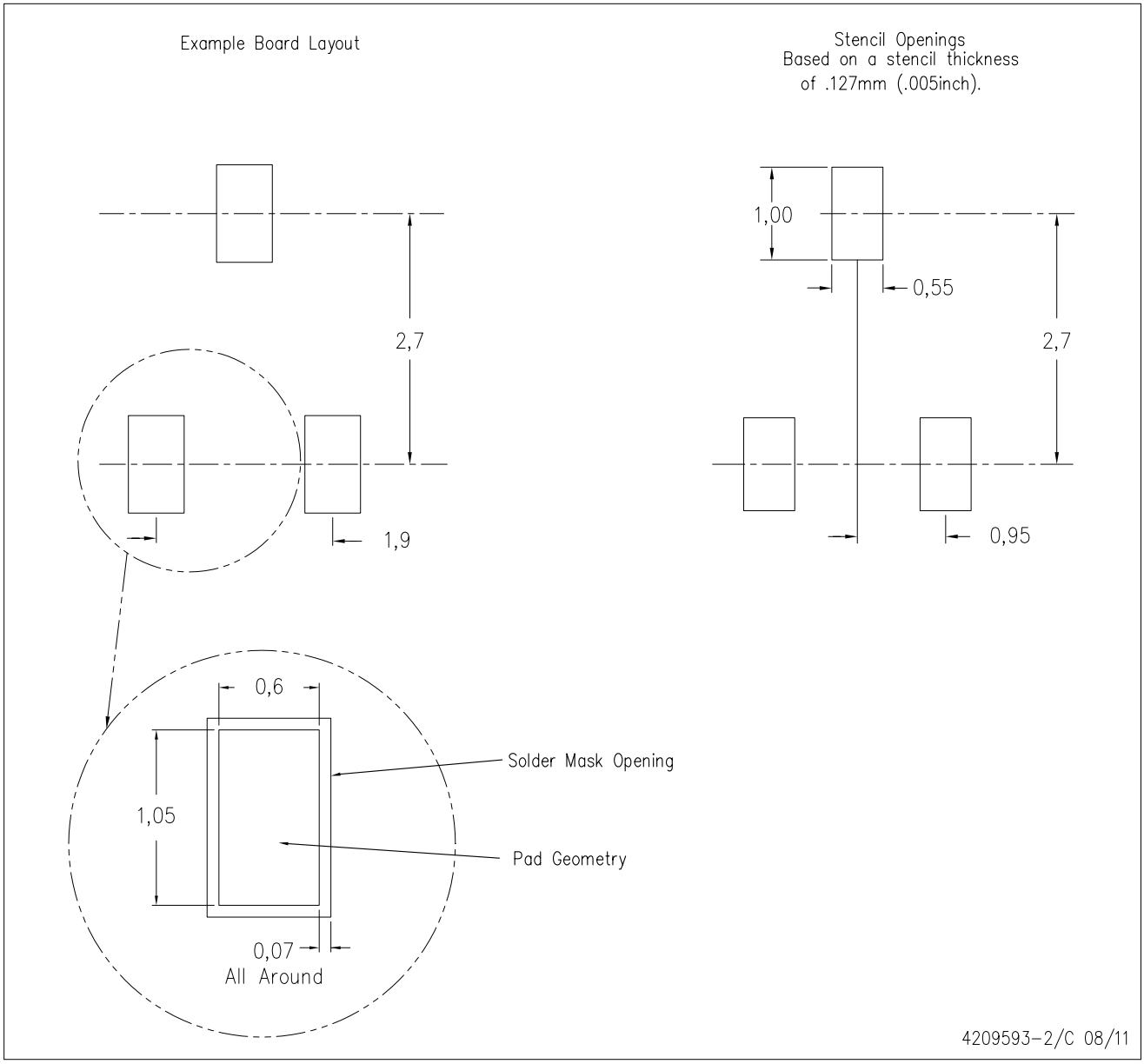
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.

DBV (R–PDSO–G3) 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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