

## Dual Voltage Detector with Adjustable Hysteresis

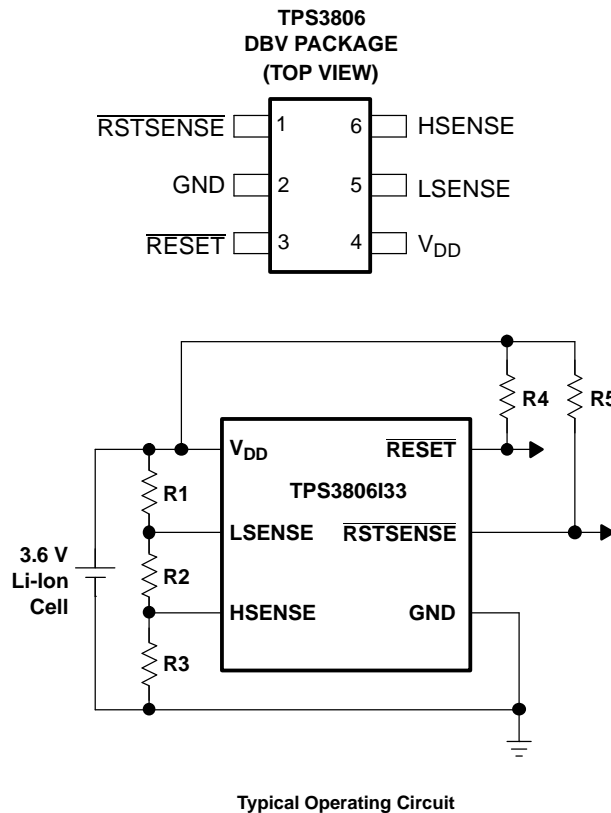
### FEATURES

- Dual Voltage Detector With Adjustable Hysteresis 3.3-V/Adjustable and 2-V/Adjustable
- Assured Reset at  $V_{DD} = 0.8\text{ V}$
- Supply Current:  $3\ \mu\text{A}$  Typical at  $V_{DD} = 3.3\text{ V}$
- Independent Open-Drain Reset Outputs
- Temperature Range:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- 6-Pin SOT-23 Package

### DESCRIPTION

The TPS3806 integrates two independent voltage detectors for battery voltage monitoring. During power-on,  $\overline{\text{RESET}}$  and  $\overline{\text{RSTSENSE}}$  are asserted when supply voltage  $V_{DD}$  or the voltage at LSENSE input become higher than 0.8 V. Thereafter, the supervisory circuit monitors  $V_{DD}$  and LSENSE, keeping  $\overline{\text{RESET}}$  and  $\overline{\text{RSTSENSE}}$  active as long as  $V_{DD}$  and LSENSE remain below the threshold voltage,  $V_{IT}$ . As soon as  $V_{DD}$  or LSENSE rise above the threshold voltage  $V_{IT}$ ,  $\overline{\text{RESET}}$  or  $\overline{\text{RSTSENSE}}$  is deasserted, respectively. The TPS3806 device has a fixed-sense threshold voltage  $V_{IT}$  set by an internal voltage divider at  $V_{DD}$  and an adjustable second-LSENSE input. In addition, an upper voltage threshold can be set at HSENSE to allow a wide adjustable hysteresis window.

The devices are available in a 6-pin SOT-23 package. The TPS3806 device is characterized for operation over a temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .



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.



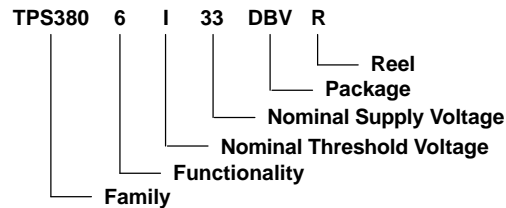
This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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.

### ORDERING INFORMATION<sup>(1)</sup>

T <sub>A</sub>	DEVICE NAME		THRESHOLD VOLTAGE		MARKING
			V <sub>DD</sub>	SENSE	
-40°C to +85°C	TPS3806J20DBVR <sup>(2)</sup>	TPS3806J20DBVT <sup>(3)</sup>	1.8 V	1.207 V	PGQI
	TPS3806I33DBVR <sup>(2)</sup>	TPS3806I33DBVT <sup>(3)</sup>	3 V	1.207 V	PGPI

- (1) For the most current package and ordering information, see the Package Option Addendum located at the end of this data sheet or refer to our web site at [www.ti.com](http://www.ti.com).  
 (2) The DBVR passive indicates tape and reel containing 3000 parts.  
 (3) The DBVT passive indicates tape and reel containing 250 parts.



### ABSOLUTE MAXIMUM RATINGS

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

	TPS3806J20, TPS3806I33	UNIT
Supply voltage, V <sub>DD</sub> <sup>(2)</sup>	7	V
All other pins <sup>(2)</sup>	-0.3 to 7	V
Maximum low-output current, I <sub>OL</sub>	5	mA
Maximum high-output current, I <sub>OH</sub>	-5	mA
Input clamp current, I <sub>IK</sub> (V <sub>I</sub> < 0 or V <sub>I</sub> > V <sub>DD</sub> )	±10	mA
Output clamp current, I <sub>OK</sub> (V <sub>O</sub> < 0 or V <sub>O</sub> > V <sub>DD</sub> )	±10	mA
Continuous total power dissipation	See Dissipation Rating Table	
Operating free-air temperature range, T <sub>A</sub>	-40 to +85	°C
Storage temperature range, T <sub>stg</sub>	-65 to +150	°C
Soldering temperature	+260	°C

- (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.  
 (2) All voltage values are with respect to GND. For reliable operation, the device must not be continuously operated at 7 V for more than t = 1000 h.

### DISSIPATION RATING TABLE

PACKAGE	T <sub>A</sub> < 25°C	DERATING FACTOR ABOVE T <sub>A</sub> = 25°C	T <sub>A</sub> = 70°C POWER RATING	T <sub>A</sub> = 85°C POWER RATING
DBV	437 mW	3.5 mW/°C	280 mW	227 mW

## RECOMMENDED OPERATING CONDITIONS

	MIN	MAX	UNIT
Supply voltage, $V_{DD}$	1.3	6	V
Input voltage, $V_I$	0	$V_{DD} + 0.3$	V
Operating free-air temperature range, $T_A$	-40	+85	°C

## ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT	
$V_{OL}$	Low-level output voltage	$V_{DD} = 1.5\text{ V}, I_{OL} = 1\text{ mA}$					
		$V_{DD} = 3.3\text{ V}, I_{OL} = 2\text{ mA}$			0.3	V	
		$V_{DD} = 6\text{ V}, I_{OL} = 3\text{ mA}$					
Power-up reset voltage <sup>(1)</sup>		$V_{DD} \geq 0.8\text{ V}, I_{OL} = 50\text{ }\mu\text{A}$			0.2	V	
$V_{IT}$	Negative-going input threshold voltage <sup>(2)</sup>	LSENSE	$T_A = +25^\circ\text{C}$	1.198	1.207	1.216	V
		TPS3806J20		1.787	1.8	1.813	
		TPS3806I33		2.978	3.0	3.022	
	LSENSE	$T_A = 0^\circ\text{C to } +70^\circ\text{C}$	1.188	1.207	1.226	V	
			TPS3806J20	1.772	1.8		1.828
			TPS3806I33	2.952	3.0		3.048
	LSENSE	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	1.183	1.207	1.231	V	
			TPS3806J20	1.764	1.8		1.836
			TPS3806I33	2.94	3.0		3.06
$V_{hys}$	Hysteresis	$1.2\text{ V} < V_{IT} < 2.5\text{ V}$		60		mV	
		$2.5\text{ V} < V_{IT} < 3.5\text{ V}$		90			
$I_I$	Input current	LSENSE, HSENSE	-25		25	nA	
$I_{OH}$	High-level output current	$V_{DD} = V_{IT} + 0.2\text{ V}, V_{OH} = V_{DD}$			300	nA	
$I_{DD}$	Supply current	$V_{DD} = 3.3\text{ V}, \text{Output unconnected}$		3	5	$\mu\text{A}$	
		$V_{DD} = 6\text{ V}, \text{Output unconnected}$		4	6		
$C_i$	Input capacitance	$V_I = 0\text{ V to } V_{DD}$		1		pF	

(1) The lowest supply voltage at which RESET becomes active.  $t_{r,VDD} \geq 15\text{ }\mu\text{s/V}$

(2) To ensure best stability of the threshold voltage, place a bypass capacitor (ceramic, 0.1  $\mu\text{F}$ ) near the supply terminals.

## SWITCHING CHARACTERISTICS

at  $R_L = 1\text{ M}\Omega, C_L = 50\text{ pF}, T_A = -40^\circ\text{C to } +85^\circ\text{C}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PHL}$	Propagation (delay) time, high-to-low-level output	$V_{DD}$ to RESET delay	$V_{IH} = 1.05 \times V_{IT},$ $V_{IL} = 0.95 \times V_{IT}$	5	100	$\mu\text{s}$
		LSENSE to $\overline{\text{RSTSENSE}}$ delay				
$t_{PLH}$	Propagation (delay) time, low-to-high-level output	$V_{DD}$ to RESET delay				
		HSENSE to $\overline{\text{RSTSENSE}}$ delay				

## TIMING REQUIREMENTS

at  $R_L = 1\text{ M}\Omega, C_L = 50\text{ pF}, T_A = -40^\circ\text{C to } +85^\circ\text{C}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_w$	Pulse width	At $V_{DD}$	$V_{IH} = 1.05 \times V_{IT}, V_{IL} = 0.95 \times V_{IT}$	5.5		$\mu\text{s}$
		At SENSE				

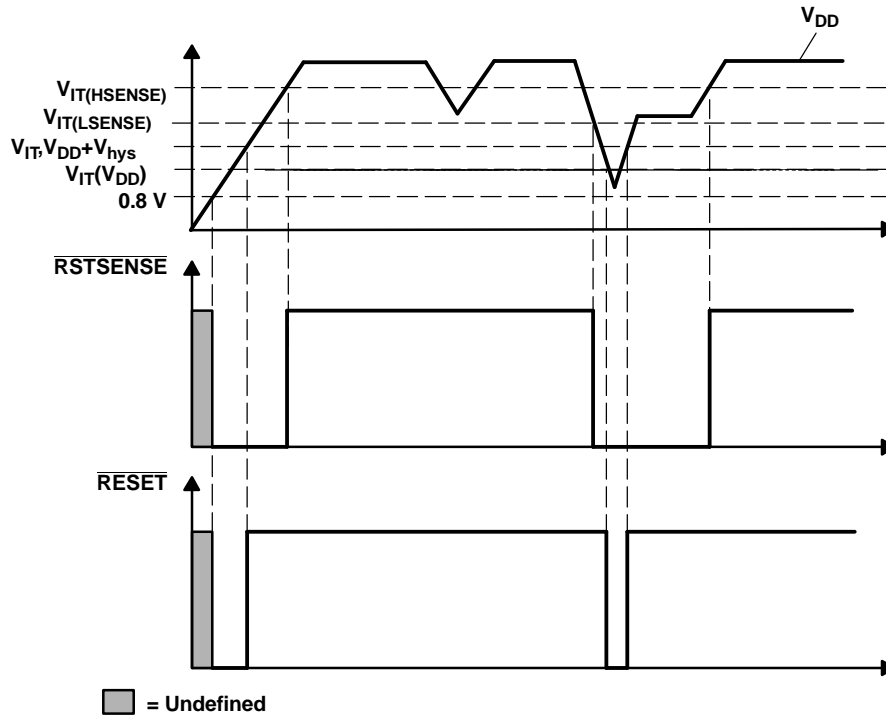


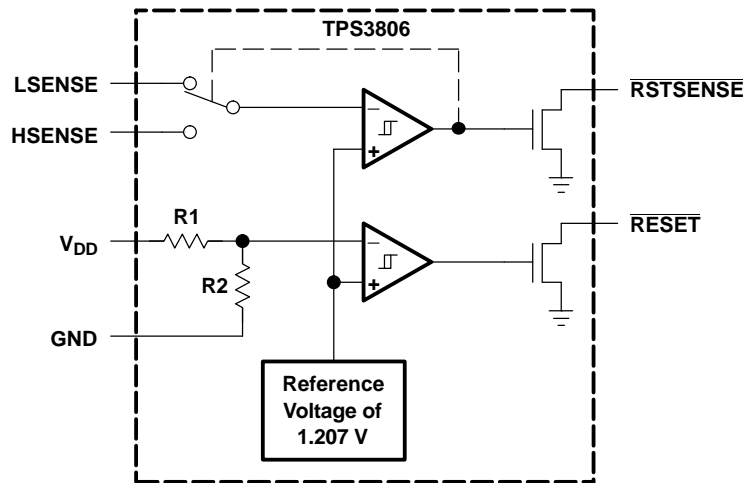
Table 1. TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
GND	2	I	Ground
HSENSE	6	I	Adjustable hysteresis input
LSENSE	5	I	Adjustable sense input
$\overline{RESET}$	3	O	Active-low open drain reset output (from $V_{DD}$ )
$\overline{RSTSENSE}$	1	O	Active-low open-drain reset output (from LSENSE)
$V_{DD}$	4	I	Input supply voltage and fixed sense input

FUNCTION/TRUTH TABLE

TPS3806			
$V_{DD} > V_{IT}$	$\overline{RESET}$	LSENSE > $V_{IT}$	$\overline{RSTSENSE}$
0	L	0	L
1	H	1	H

### FUNCTIONAL BLOCK DIAGRAM



## Detailed Description

### Operation

The TPS3806 is used for monitoring battery voltage and asserting  $\overline{\text{RESET}}$  when a battery gets discharged below a certain threshold voltage. The battery voltage is monitored by a comparator via an external resistor divider. When the voltage at the LSENSE input drops below the internal reference voltage the  $\overline{\text{RSTSENSE}}$  output pulls low. The output remains low until the battery is replaced, or recharged above a second higher trip-point, set at HSENSE. A second voltage can be monitored at  $V_{\text{DD}}$ . The independent  $\overline{\text{RESET}}$  output pulls low when the voltage at  $V_{\text{DD}}$  drops below the fixed threshold voltage. Because the TPS3806 outputs are open-drain MOSFETs, most applications may require a pull-up resistor.

### Programming the Threshold Voltage Levels

The low-voltage threshold at LSENSE is calculated according to Equation 1:

$$V_{(\text{LSENSE})} = V_{\text{ref}} \left( \frac{R1 + R2 + R3}{R2 + R3} \right) \quad (1)$$

where  $V_{\text{ref}} = 1.207 \text{ V}$

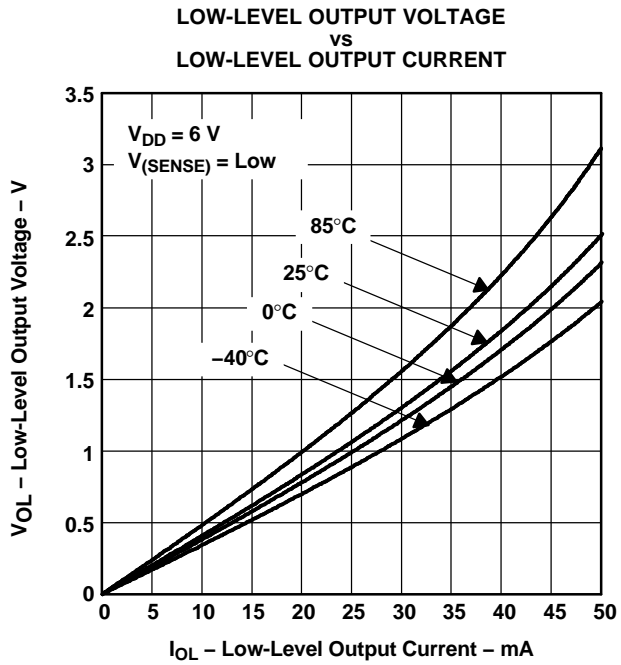
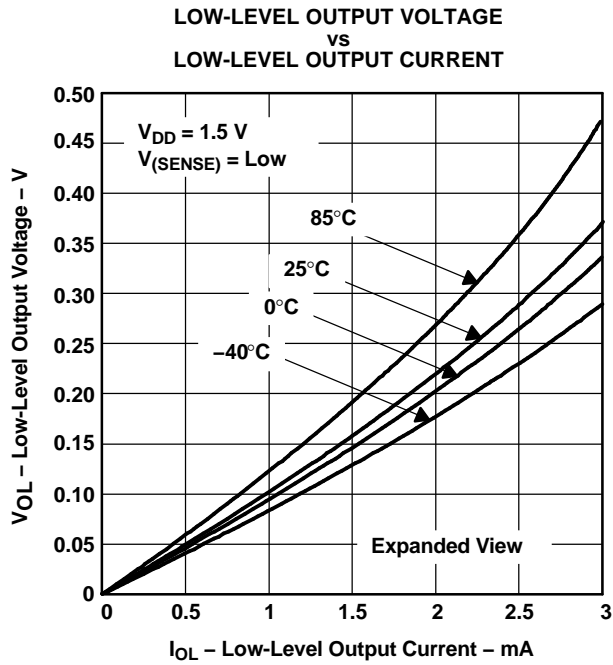
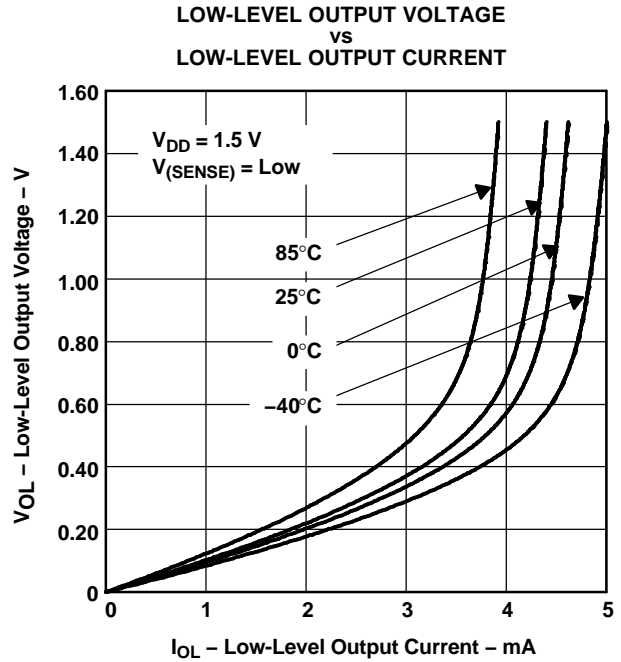
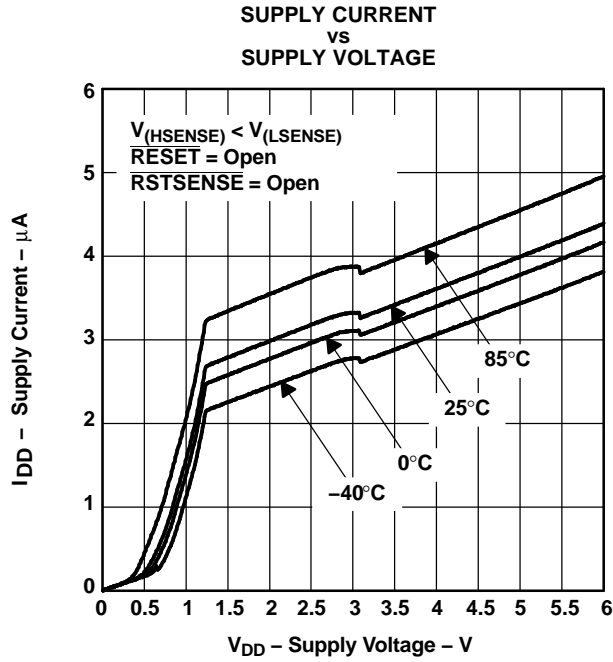
The high-voltage threshold at HSENSE is calculated as shown in Equation 2:

$$V_{(\text{HSENSE})} = V_{\text{ref}} \left( \frac{R1 + R2 + R3}{R3} \right) \quad (2)$$

where  $V_{\text{ref}} = 1.207 \text{ V}$

To minimize battery current draw it is recommended to use 1-M $\Omega$  as the total resistor value  $R_{(\text{tot})}$ , with  $R_{(\text{tot})} = R1 + R2 + R3$ .

TYPICAL CHARACTERISTICS



**TYPICAL CHARACTERISTICS (continued)**

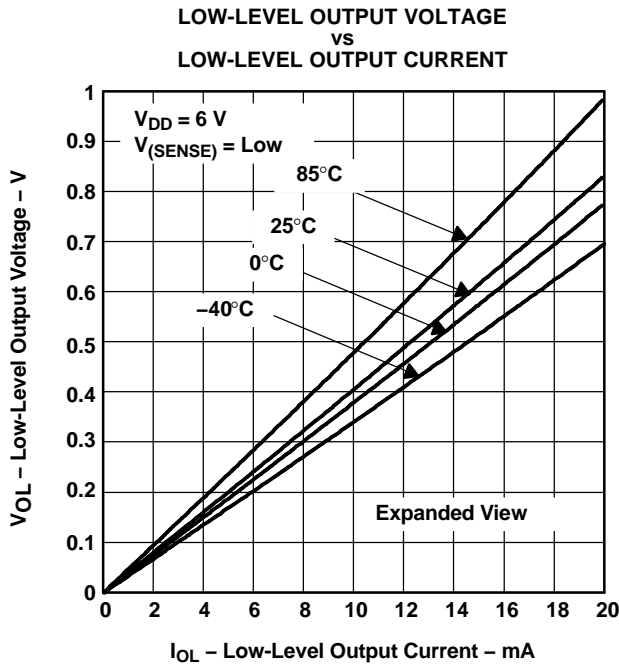


Figure 5.

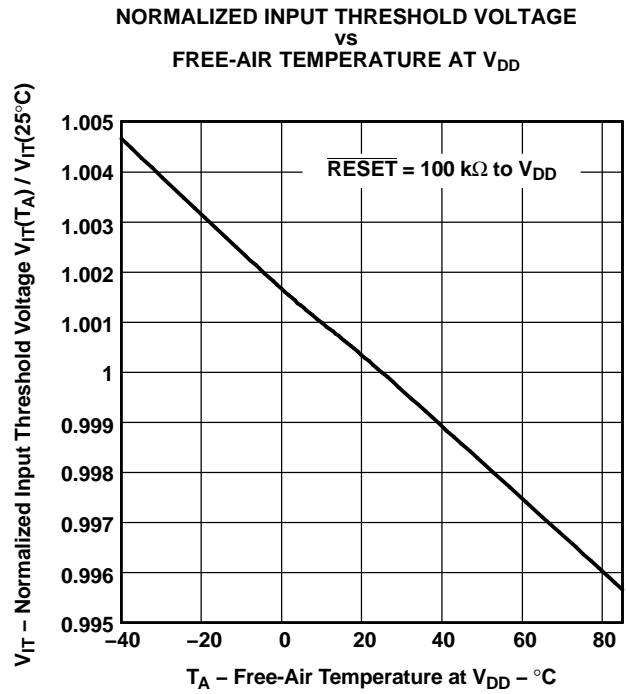


Figure 6.

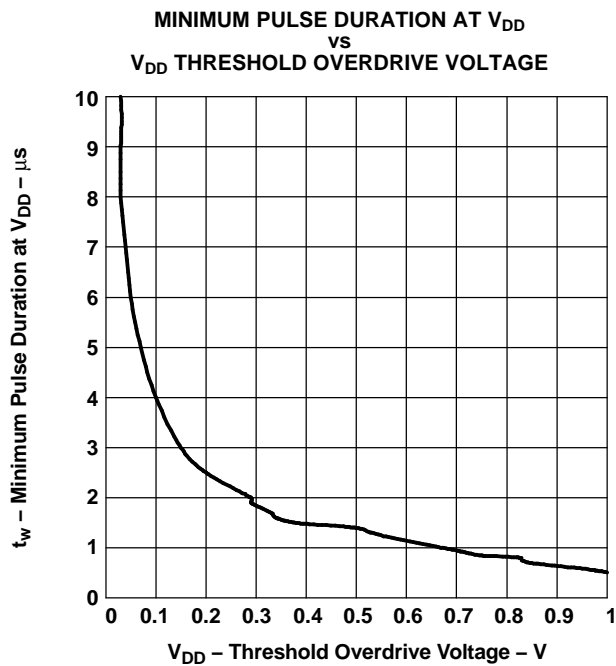


Figure 7.

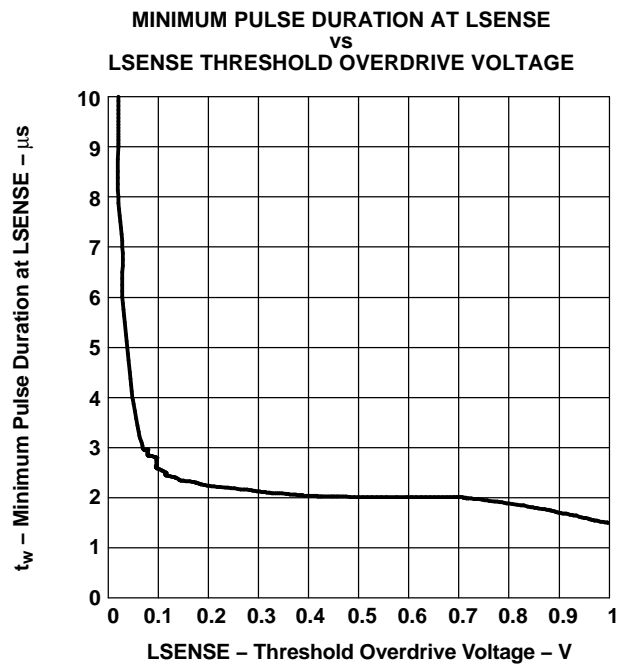


Figure 8.

**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
TPS3806I33DBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PGPI	<a href="#">Samples</a>
TPS3806I33DBVRG4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PGPI	<a href="#">Samples</a>
TPS3806I33DBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PGPI	<a href="#">Samples</a>
TPS3806I33DBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PGPI	<a href="#">Samples</a>
TPS3806J20DBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PGQI	<a href="#">Samples</a>
TPS3806J20DBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PGQI	<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.

**OBSELETE:** 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.



<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 TPS3806I33 :**

- Automotive: [TPS3806I33-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

**TAPE AND REEL INFORMATION**

\*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
TPS3806I33DBVR	SOT-23	DBV	6	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS3806I33DBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS3806I33DBVT	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS3806I33DBVT	SOT-23	DBV	6	250	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS3806J20DBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPS3806J20DBVT	SOT-23	DBV	6	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)
TPS3806I33DBVR	SOT-23	DBV	6	3000	203.0	203.0	35.0
TPS3806I33DBVR	SOT-23	DBV	6	3000	180.0	180.0	18.0
TPS3806I33DBVT	SOT-23	DBV	6	250	180.0	180.0	18.0
TPS3806I33DBVT	SOT-23	DBV	6	250	203.0	203.0	35.0
TPS3806J20DBVR	SOT-23	DBV	6	3000	180.0	180.0	18.0
TPS3806J20DBVT	SOT-23	DBV	6	250	180.0	180.0	18.0

# MECHANICAL DATA

DBV (R-PDSO-G6)

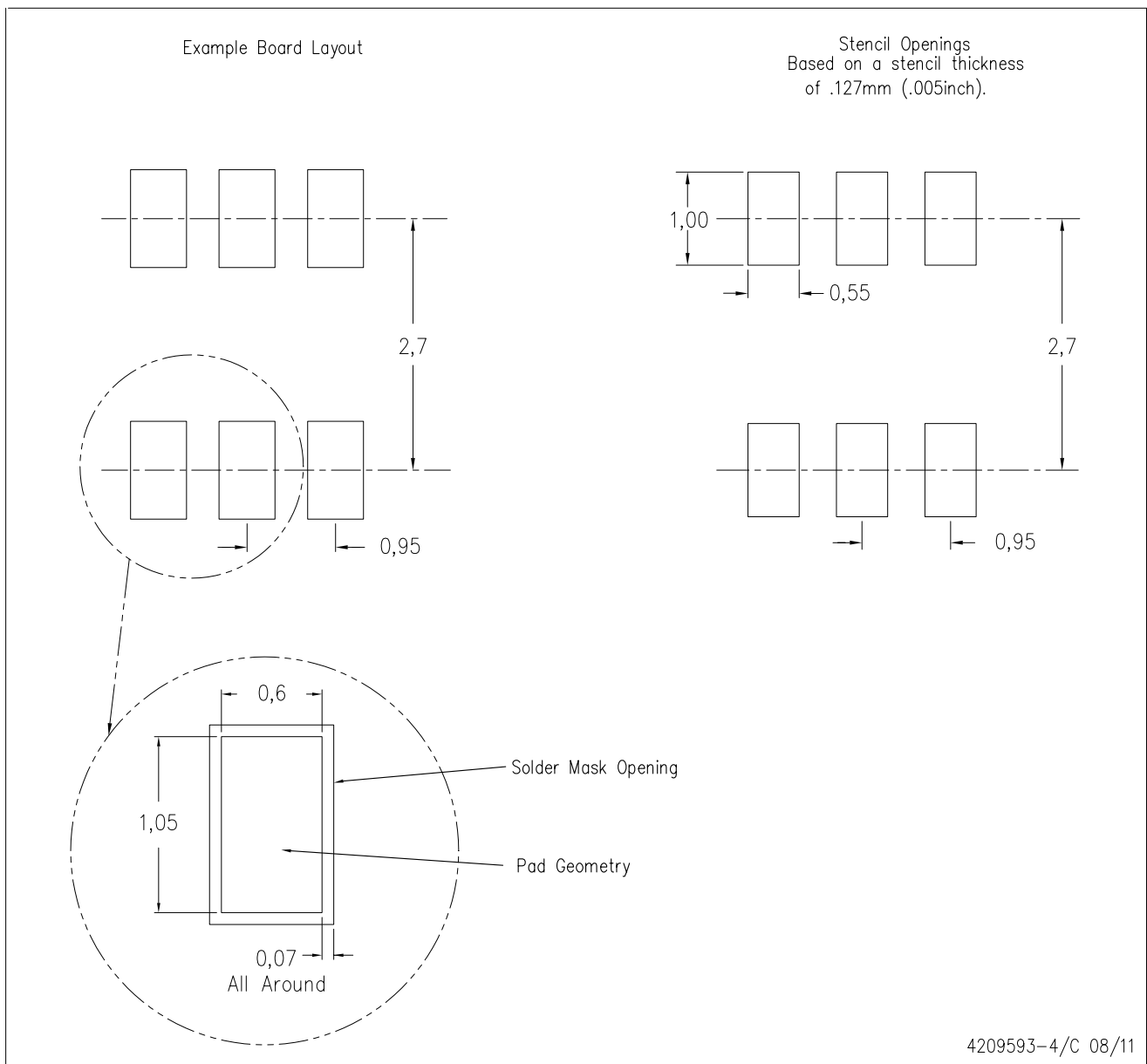
PLASTIC SMALL-OUTLINE PACKAGE



- 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. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
- Falls within JEDEC MO-178 Variation AB, except minimum lead width.

DBV (R-PDSO-G6)

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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DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

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