Dual Voltage Detector with Adjustable Hysteresis

FEATURES

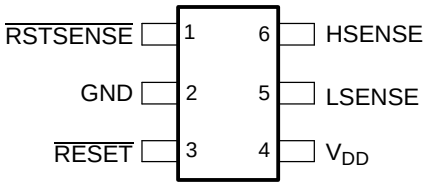
- **Dual Voltage Detector With Adjustable Hysteresis 3.3-V/Adjustable and 2-V/Adjustable**
- **Assured Reset at V_{DD} = 0.8 V**
- **Supply Current: 3 µA Typical at V_{DD} = 3.3 V**
- **Independent Open-Drain Reset Outputs**
- **Temperature Range: -40°C to +85°C**
- **6-Pin SOT-23 Package**

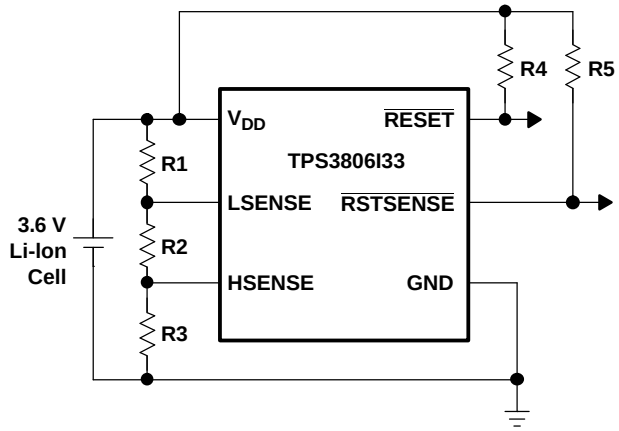
DESCRIPTION

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°C to +85°C.

TPS3806
DBV PACKAGE
(TOP VIEW)





Typical Operating Circuit

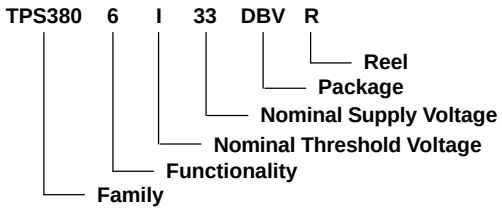
This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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(1)

T_A	DEVICE NAME		THRESHOLD VOLTAGE		MARKING
			V_{DD}	SENSE	
-40°C to +85°C	TPS3806J20DBVR(2)	TPS3806J20DBVT(3)	1.8 V	1.207 V	PGQI
	TPS3806I33DBVR(2)	TPS3806I33DBVT(3)	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.
(2) The DBV**R** passive indicates tape and reel containing 3000 parts.
(3) The DBV**T** passive indicates tape and reel containing 250 parts.



ABSOLUTE MAXIMUM RATINGS

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

	TPS3806J20, TPS3806I33	UNIT
Supply voltage, V_{DD}(2)	7	V
All other pins(2)	-0.3 to 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 $V_I > V_{DD}$)	±10	mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{DD}$)	±10	mA
Continuous total power dissipation	See Dissipation Rating Table	
Operating free-air temperature range, T_A	-40 to +85	°C
Storage temperature range, T_{stg}	-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_A < 25°C	DERATING FACTOR ABOVE T_A = 25°C	T_A = 70°C POWER RATING	T_A = 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 V, I_{OL} = 1 mA			0.3	V
			V_{DD} = 3.3 V, I_{OL} = 2 mA				
			V_{DD} = 6 V, I_{OL} = 3 mA				
	Power-up reset voltage(1)		$V_{DD} \geq$ 0.8 V, I_{OL} = 50 µA			0.2	V
V_{IT}	Negative-going input threshold voltage(2)	LSENSE	T_A = +25°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°C to +70°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°C to +85°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 V < V_{IT} < 2.5 V		60		mV
			2.5 V < V_{IT} < 3.5 V		90		
I_I	Input current	LSENSE, HSENSE		-25		25	nA
I_{OH}	High-level output current		V_{DD} = V_{IT} + 0.2 V, V_{OH} = V_{DD}			300	nA
I_{DD}	Supply current		V_{DD} = 3.3 V, Output unconnected		3	5	µA
			V_{DD} = 6 V, Output unconnected		4	6	
C_i	Input capacitance		V_I = 0 V to V_{DD}		1		pF

(1) The lowest supply voltage at which $\overline{\text{RESET}}$ becomes active. $t_{r,VDD} \geq$ 15 µs/V
(2) To ensure best stability of the threshold voltage, place a bypass capacitor (ceramic, 0.1 µF) near the supply terminals.

SWITCHING CHARACTERISTICS

at R_L = 1 MΩ, C_L = 50 pF, T_A = -40°C to +85°C

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

TIMING REQUIREMENTS

at R_L = 1 MΩ, C_L = 50 pF, T_A = -40°C to +85°C

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_w	Pulse width	At V_{DD}	V_{IH} = 1.05 x V_{IT}, V_{IL} = 0.95 x V_{IT}	5.5			µs
		At SENSE					

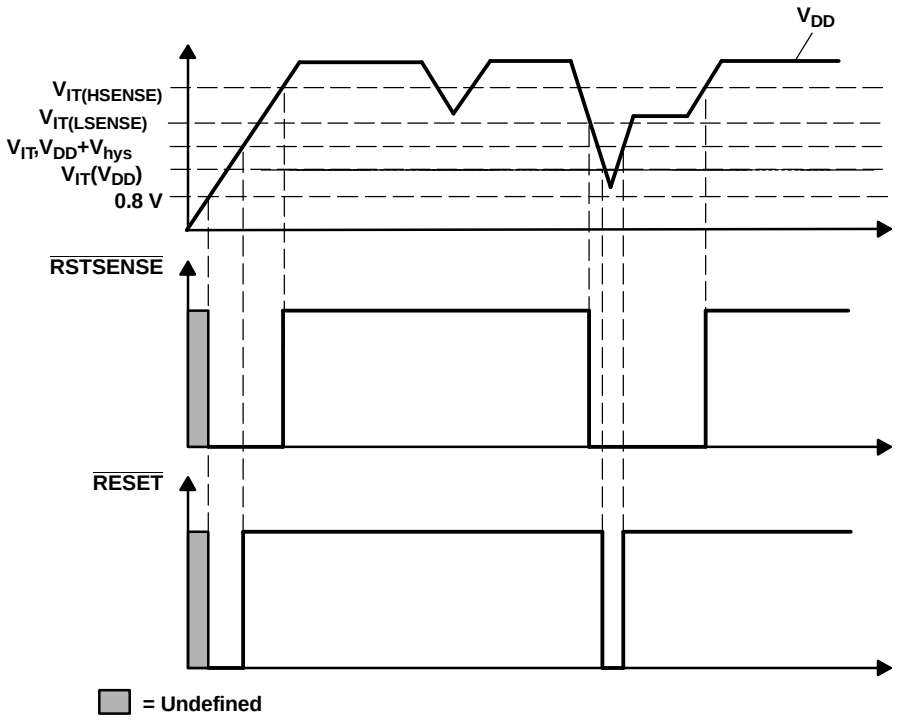


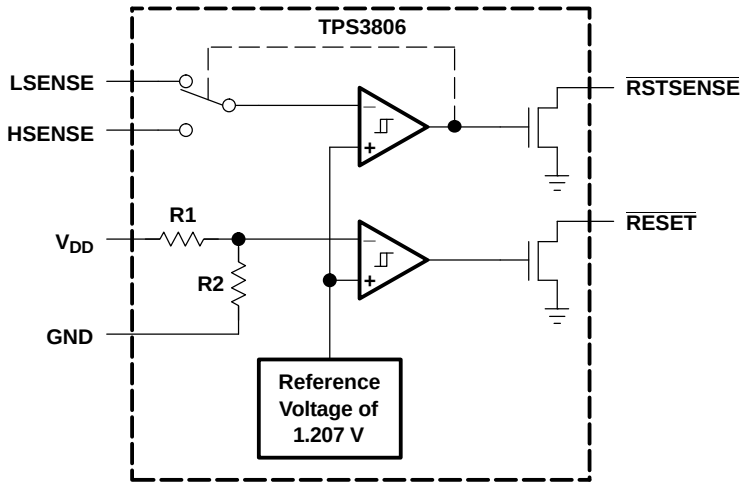
Table 1. TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
GND	2	I	Ground
HSENSE	6	I	Adjustable hysteresis input
LSENSE	5	I	Adjustable sense input
$\overline{\text{RESET}}$	3	O	Active-low open drain reset output (from V_{DD})
$\overline{\text{RSTSENSE}}$	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			
$V_{DD} > V_{IT}$	$\overline{\text{RESET}}$	LSENSE > V_{IT}	$\overline{\text{RSTSENSE}}$
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_{DD}. The independent $\overline{\text{RESET}}$ output pulls low when the voltage at V_{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:

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

where V_{ref} = 1.207 V

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

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

where V_{ref} = 1.207 V

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

TYPICAL CHARACTERISTICS

SUPPLY CURRENT
vs
SUPPLY VOLTAGE

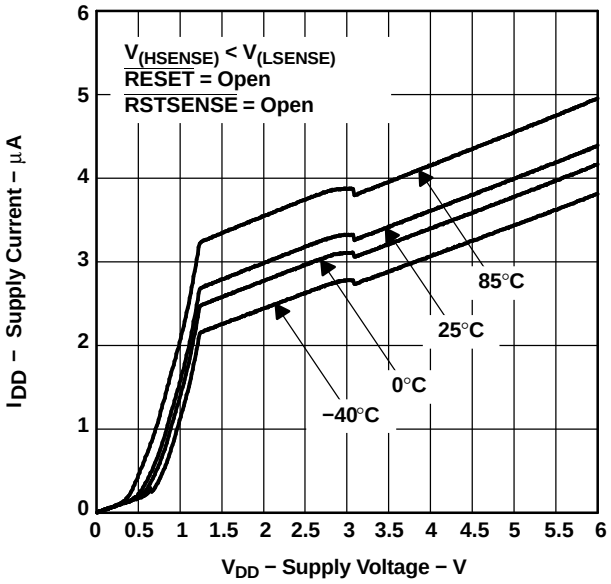


Figure 1.

LOW-LEVEL OUTPUT VOLTAGE
vs
LOW-LEVEL OUTPUT CURRENT

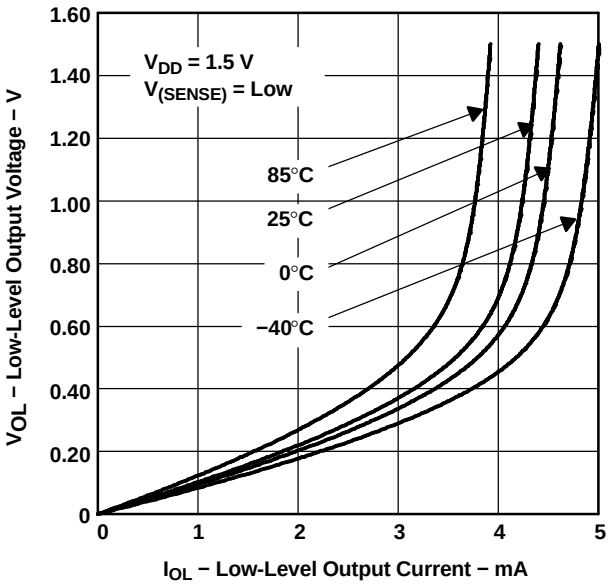


Figure 2.

LOW-LEVEL OUTPUT VOLTAGE
vs
LOW-LEVEL OUTPUT CURRENT

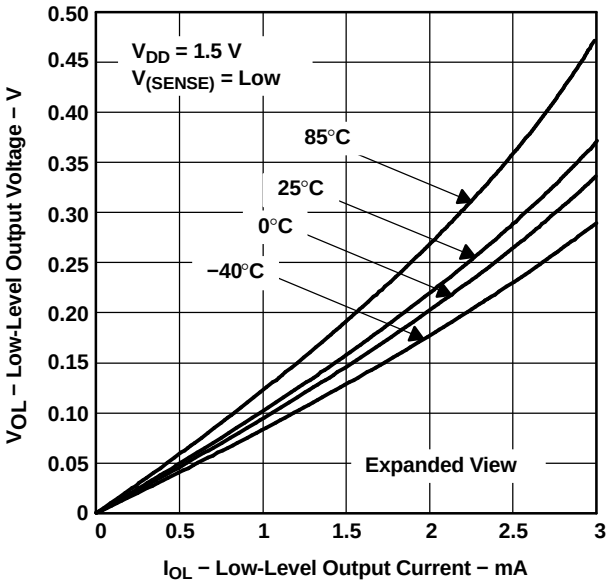


Figure 3.

LOW-LEVEL OUTPUT VOLTAGE
vs
LOW-LEVEL OUTPUT CURRENT

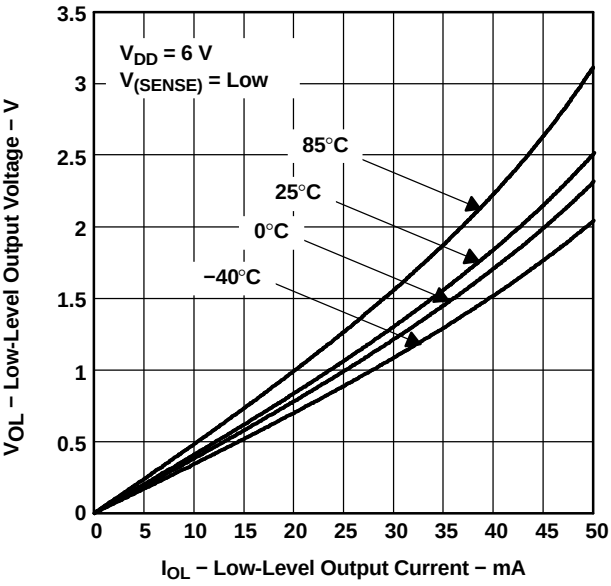


Figure 4.

TYPICAL CHARACTERISTICS (continued)

LOW-LEVEL OUTPUT VOLTAGE
vs
LOW-LEVEL OUTPUT CURRENT

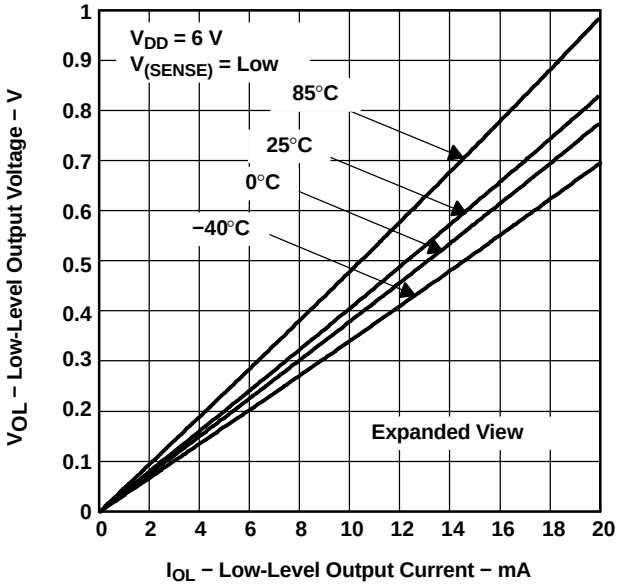


Figure 5.

NORMALIZED INPUT THRESHOLD VOLTAGE
vs
FREE-AIR TEMPERATURE AT V_{DD}

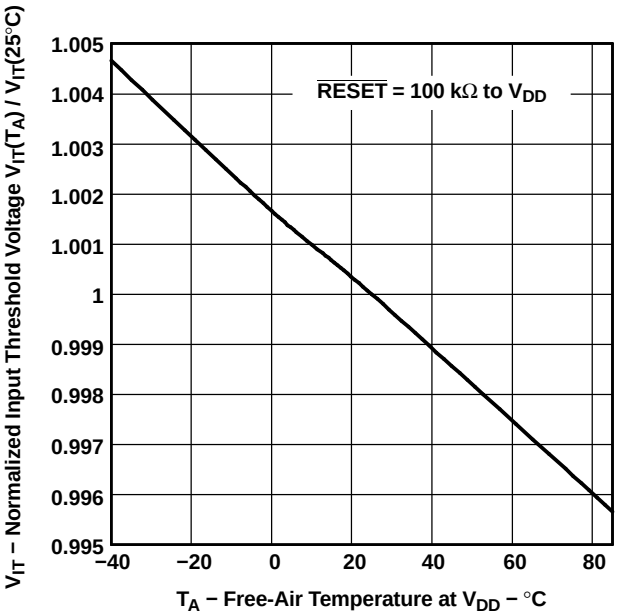


Figure 6.

MINIMUM PULSE DURATION AT V_{DD}
vs
V_{DD} THRESHOLD OVERDRIVE VOLTAGE

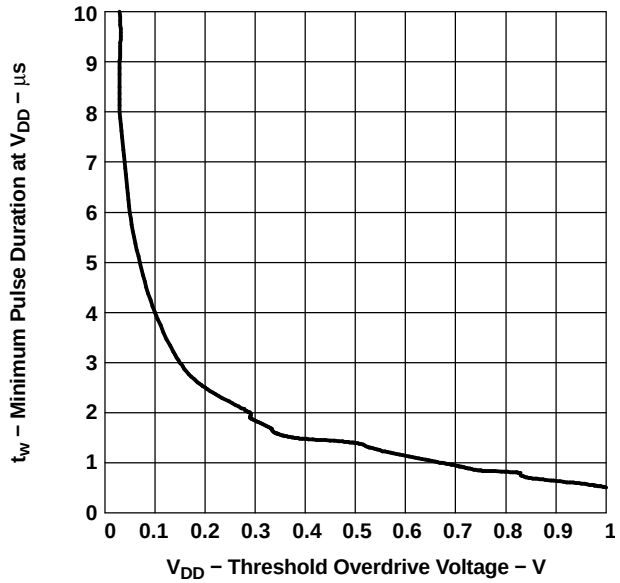


Figure 7.

MINIMUM PULSE DURATION AT LSENSE
vs
LSENSE THRESHOLD OVERDRIVE VOLTAGE

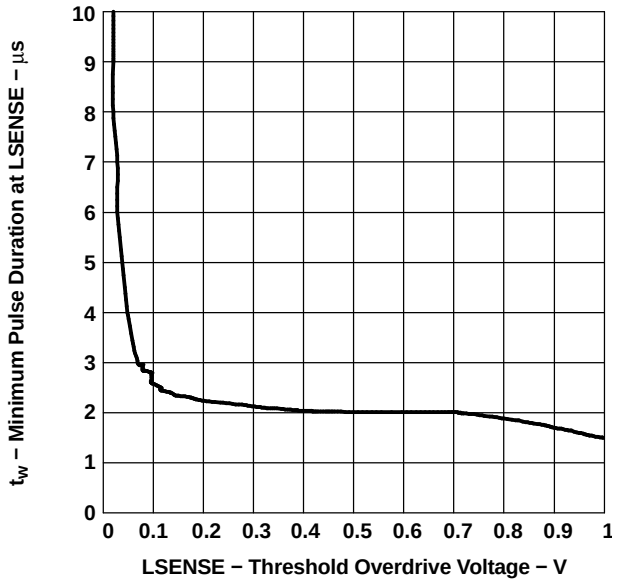


Figure 8.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TPS3806I33DBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPS3806I33DBVRG4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPS3806I33DBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPS3806I33DBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPS3806J20DBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPS3806J20DBVRG4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPS3806J20DBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPS3806J20DBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

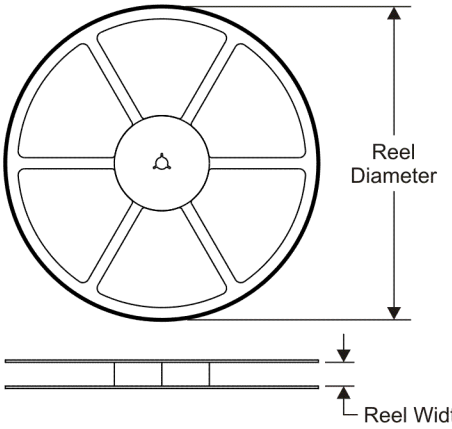
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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)

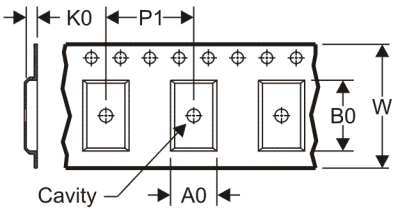
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

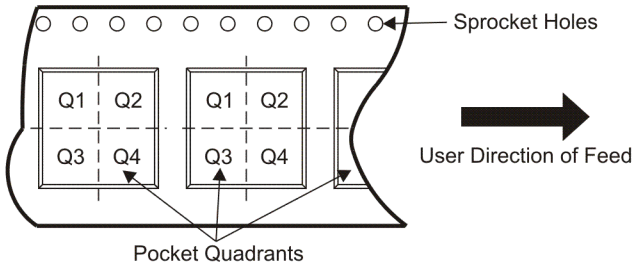


TAPE DIMENSIONS



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

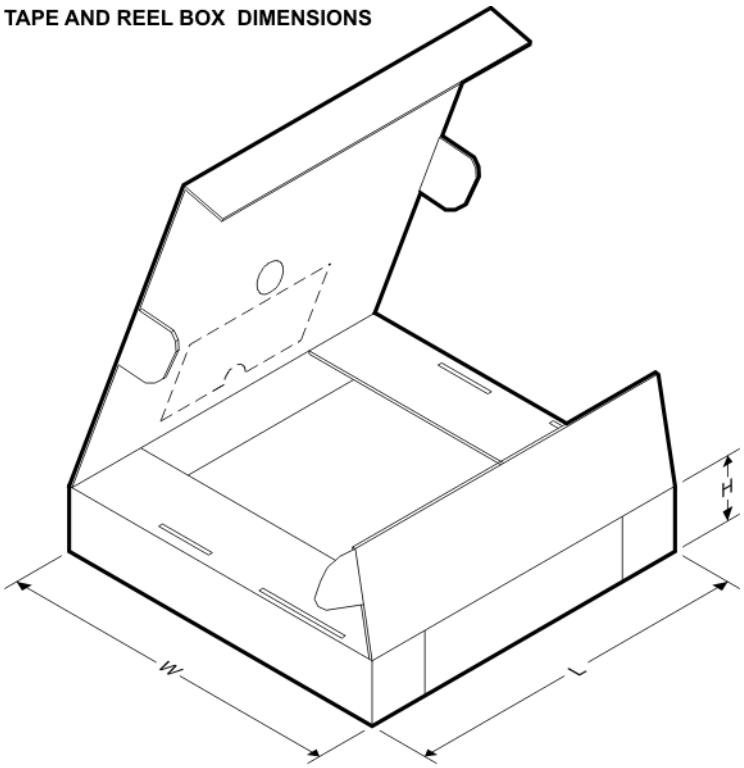
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS3806I33DBVR	SOT-23	DBV	6	3000	179.0	8.4	3.2	3.2	1.4	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	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPS3806J20DBVT	SOT-23	DBV	6	250	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

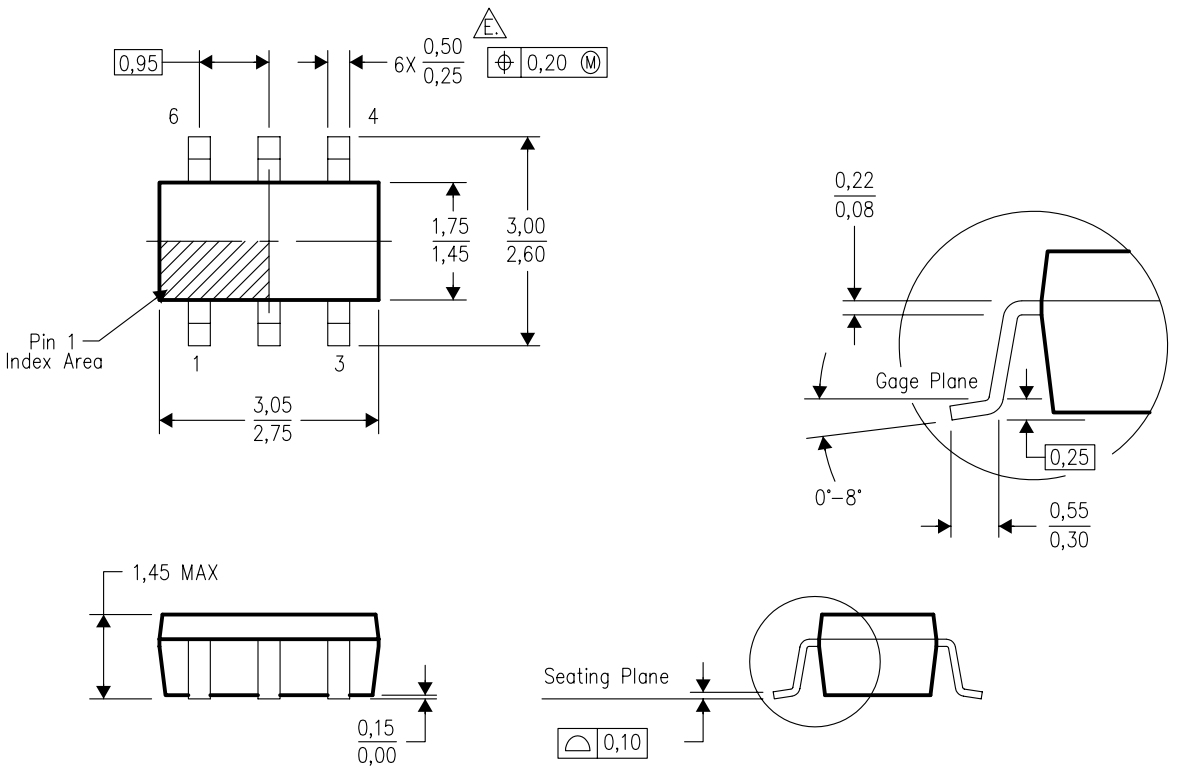
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS3806I33DBVR	SOT-23	DBV	6	3000	195.0	200.0	45.0
TPS3806I33DBVT	SOT-23	DBV	6	250	195.0	200.0	45.0
TPS3806J20DBVR	SOT-23	DBV	6	3000	195.0	200.0	45.0
TPS3806J20DBVT	SOT-23	DBV	6	250	195.0	200.0	45.0

DBV (R–PDSO–G6) 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.
D. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
E. Falls within JEDEC MO–178 Variation AB, except minimum lead width.

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