Dual Voltage Detector With Adjustable Hysteresis

Check for Samples: TPS3806I33-Q1

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 H2**
  - **Device CDM ESD Classification Level C4B**
- **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**
- **6-Pin SOT-23 Package**

APPLICATIONS

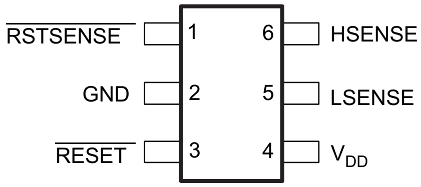
- **Voltage Supervisor**
- **Voltage Detector**
- **Battery Monitor**

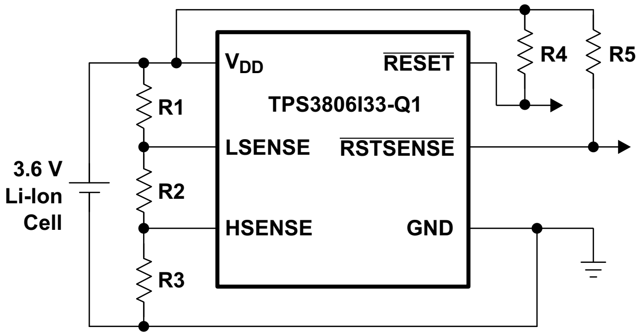
DESCRIPTION

The TPS3806I33-Q1 integrates two independent voltage detectors for battery voltage monitoring. During power on, the device asserts $\overline{\text{RESET}}$ and $\overline{\text{RSTSENSE}}$ when supply voltage V_{DD} or the voltage at the LSENSE input becomes 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 rises above the threshold voltage V_{IT}, the device deasserts $\overline{\text{RESET}}$ or $\overline{\text{RSTSENSE}}$, respectively. The TPS3806I33-Q1 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, one can set an upper voltage threshold at HSENSE to allow a wide adjustable hysteresis window.

The devices are available in a 6-pin SOT-23 package. Characterization of the TPS3806I33-Q1 device is for operation over a temperature range of –40°C to 125°C.

TPS3806I33-Q1
DBV PACKAGE
(TOP VIEW)





Typical Operating Circuit

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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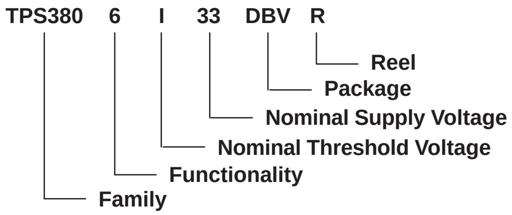
This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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.

Table 1. ORDERING INFORMATION(1)

T_A	PACKAGE	QUANTITY	PART NUMBER	TOP-SIDE SYMBOL	STATUS
–40°C to 125°C	DBV (SOT-23)	Reel of 3000	TPS3806I33QDBVRQ1	PZHQ	Active

(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 the TI Web site at www.ti.com.



ABSOLUTE MAXIMUM RATINGS

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

		TPS3806I33-Q1	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
Operating free-air temperature range, T_A		–40 to 125	°C
Storage temperature range, T_{stg}		–65 to 150	°C
Electrostatic discharge rating, ESD	Human-body model (HBM) AEC-Q100 Classification Level H2	2	kV
	Charged-device model (CDM) AEC-Q100 Classification Level 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.

(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.

THERMAL INFORMATION

THERMAL METRIC(1)		TPS3806I33-Q1 DBV 6 PINS	UNIT
θ_{JA}	Junction-to-ambient thermal resistance(2)	188.9	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance(3)	130.9	°C/W
θ_{JB}	Junction-to-board thermal resistance(4)	34.2	°C/W
ψ_{JT}	Junction-to-top characterization parameter(5)	25.4	°C/W
ψ_{JB}	Junction-to-board characterization parameter(6)	33.8	°C/W
θ_{JCbot}	Junction-to-case (bottom) thermal resistance(7)	N/A	°C/W

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

(2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.

(3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

(4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.

(5) The junction-to-top characterization parameter, ψ_{JT}, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA}, using a procedure described in JESD51-2a (sections 6 and 7).

(6) The junction-to-board characterization parameter, ψ_{JB}, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).

(7) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

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	125	°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} ≥ 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
		TPS3806I33-Q1		2.978	3	3.022	
		LSENSE	T_A = 0°C to 70°C	1.188	1.207	1.226	
		TPS3806I33-Q1		2.952	3	3.048	
		LSENSE	T_A = –40°C to 125°C	1.183	1.207	1.231	
		TPS3806I33-Q1		2.94	3	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. $t_{r,VDD}$ ≥ 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 125°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 125°C

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

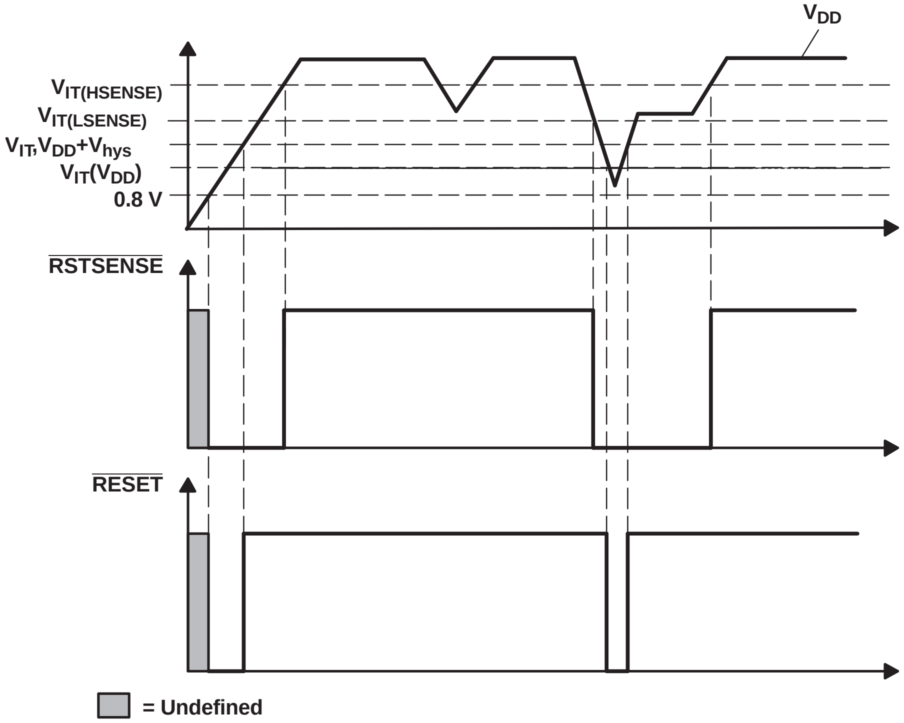

V_{DD}
$V_{IT(HSENSE)}$
$V_{IT(LSENSE)}$
$V_{IT}, V_{DD}+V_{hys}$
$V_{IT}(V_{DD})$
0.8 V
$\overline{\text{RSTSENSE}}$
$\overline{\text{RESET}}$
▨ = Undefined

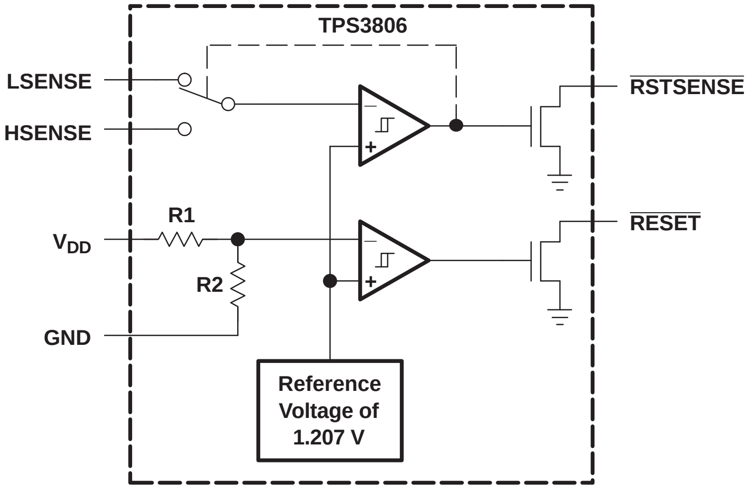
Table 2. TERMINAL FUNCTIONS

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 AND TRUTH TABLE

TPS3806I33-Q1			
$V_{DD} > V_{IT}$	$\overline{\text{RESET}}$	LSENSE > V_{IT}	$\overline{\text{RSTSENSE}}$
0	L	0	L
1	H	1	H

FUNCTIONAL BLOCK DIAGRAM



Detailed Description

Operation

The TPS3806I33-Q1 monitors battery voltage and asserts $\overline{\text{RESET}}$ when a battery becomes discharged below a certain threshold voltage. A comparator monitors the battery voltage 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. One can monitor a second voltage 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 TPS3806I33-Q1 outputs are open-drain MOSFETs, most applications may require a pullup resistor.

Programming the Threshold Voltage Levels

Calculate the low-voltage threshold at LSENSE according to Equation 1:

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

where V_{ref} = 1.207 V

Calculate the high-voltage threshold at HSENSE as shown in Equation 2:

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

where V_{ref} = 1.207 V

To minimize battery current draw, TI recommends using 1 MΩ as the total resistor value $R_{(tot)}$, with $R_{(tot)}$ = R1 + R2 + R3.

TYPICAL CHARACTERISTICS

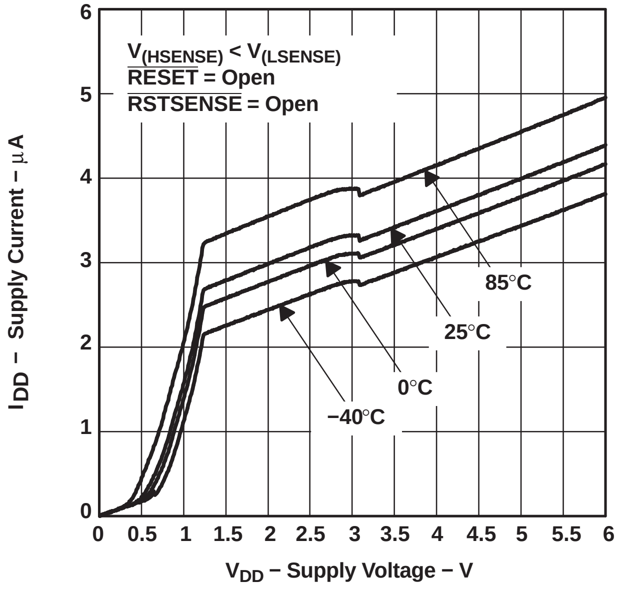

SUPPLY CURRENT versus SUPPLY VOLTAGE

Figure 1.

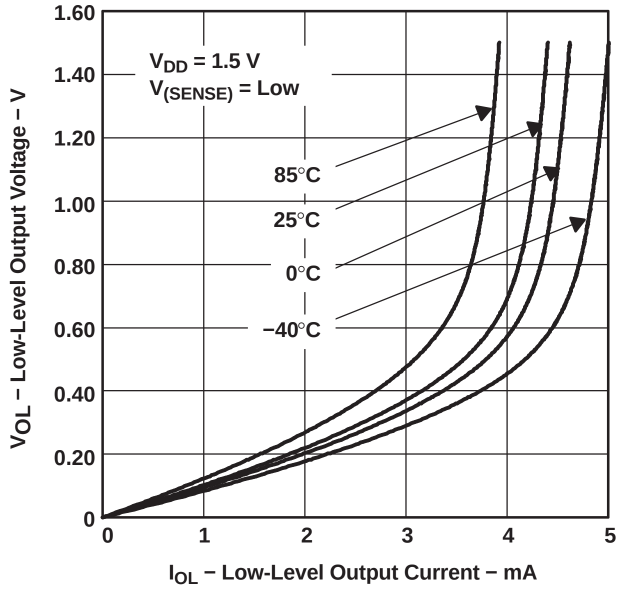

LOW-LEVEL OUTPUT VOLTAGE versus LOW-LEVEL OUTPUT CURRENT

Figure 2.

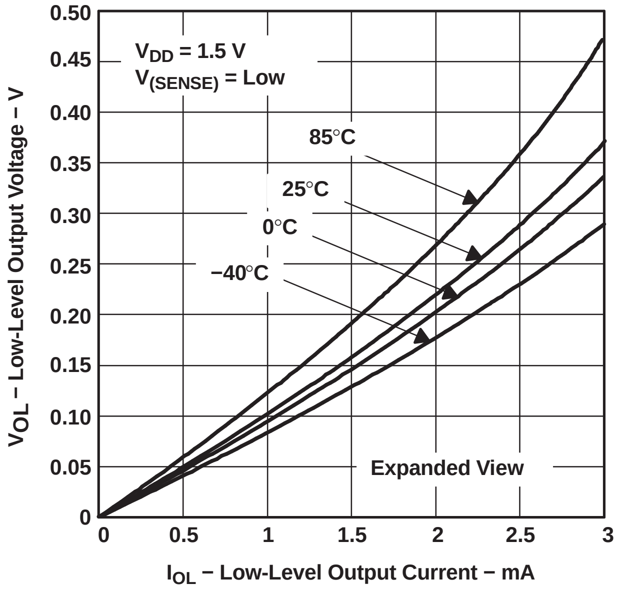

LOW-LEVEL OUTPUT VOLTAGE versus LOW-LEVEL OUTPUT CURRENT

Figure 3.

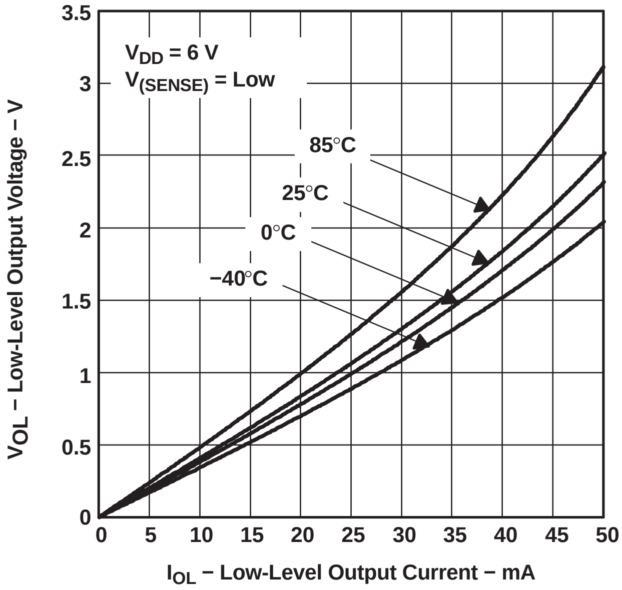

LOW-LEVEL OUTPUT VOLTAGE versus LOW-LEVEL OUTPUT CURRENT

Figure 4.

TYPICAL CHARACTERISTICS (continued)

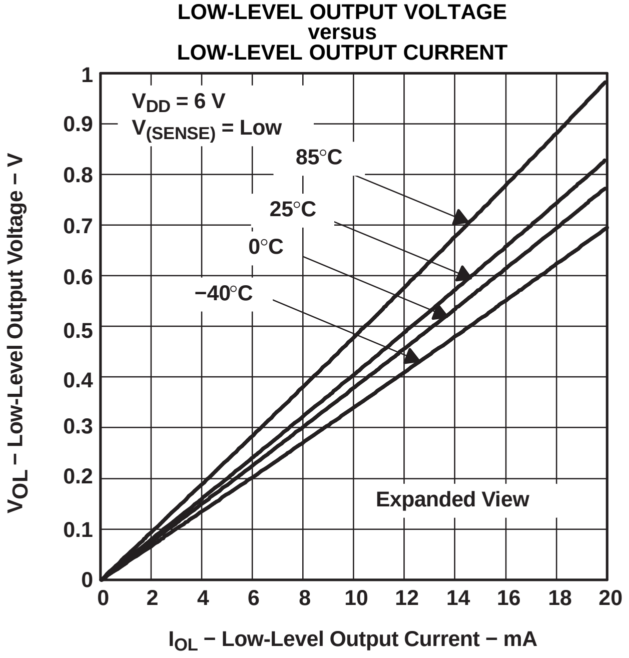


Figure 5.

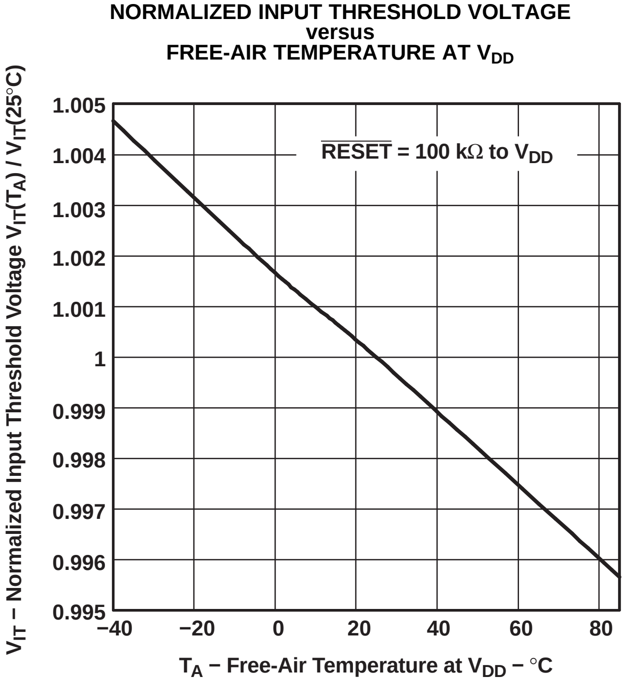


Figure 6.

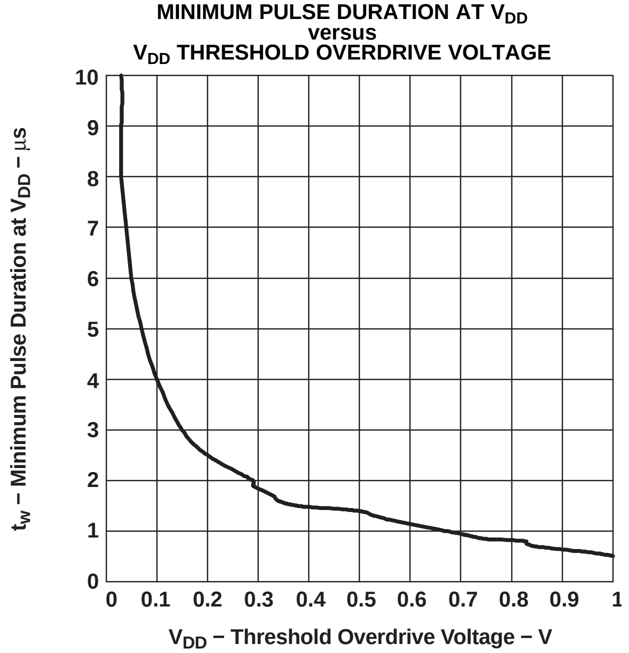


Figure 7.

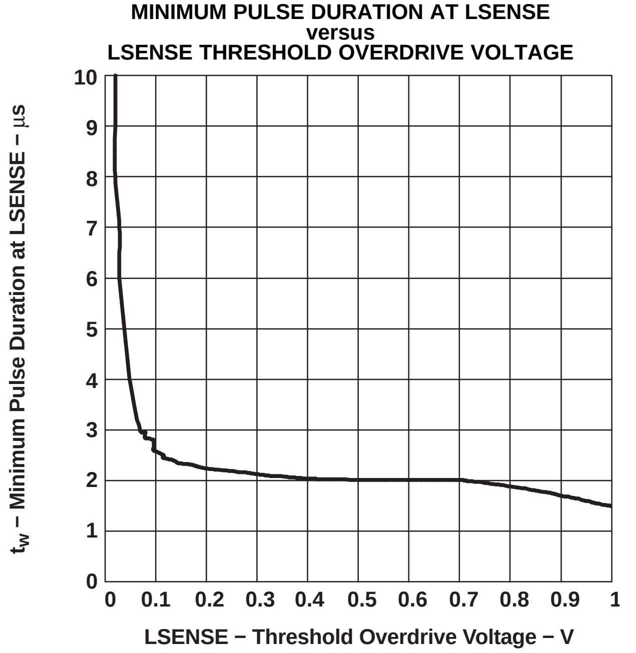


Figure 8.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
TPS3806I33QDBVRQ1	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	PZHQ	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] Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

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OTHER QUALIFIED VERSIONS OF TPS3806I33-Q1 :

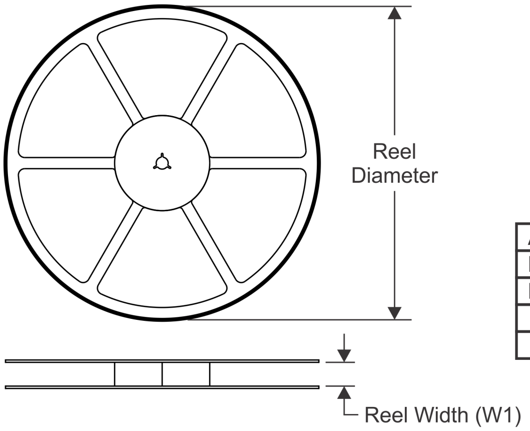
- Catalog: TPS3806I33

NOTE: Qualified Version Definitions:

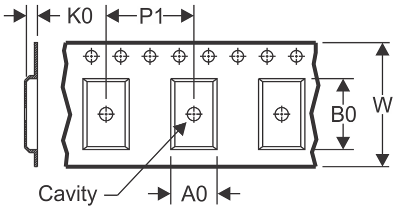
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

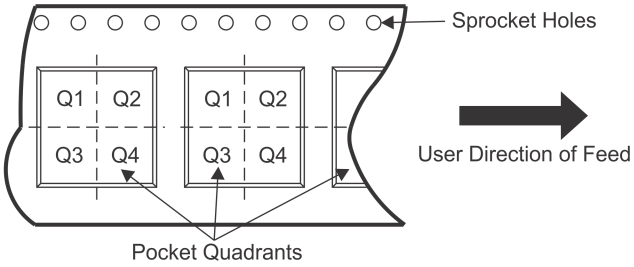

Reel
Diameter
Reel Width (W1)

TAPE DIMENSIONS


K0
P1
B0
W
Cavity
A0

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

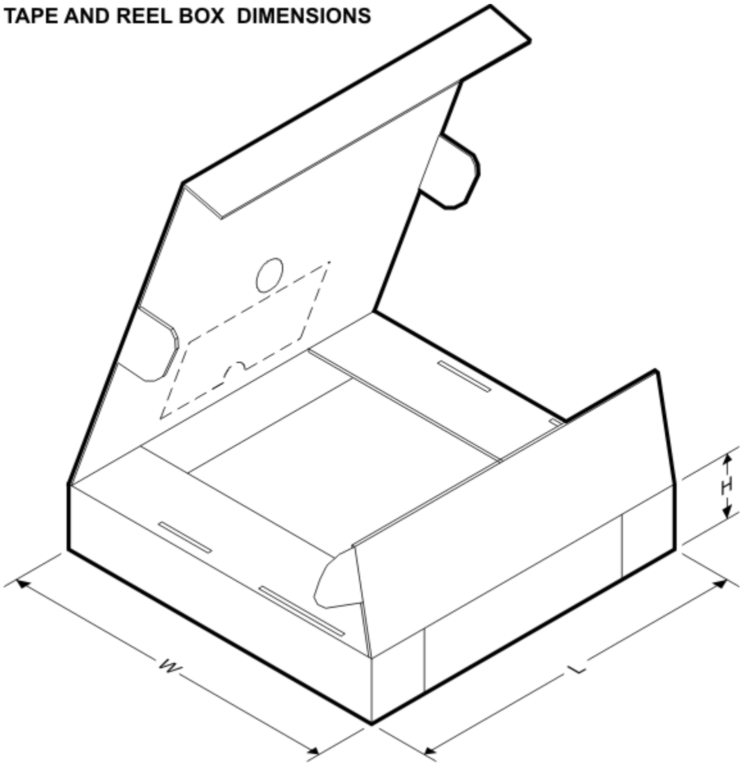
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


Sprocket Holes
Q1
Q2
Q3
Q4
Q1
Q2
Q3
Q4
User Direction of Feed
Pocket Quadrants

*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
TPS3806I33QDBVRQ1	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

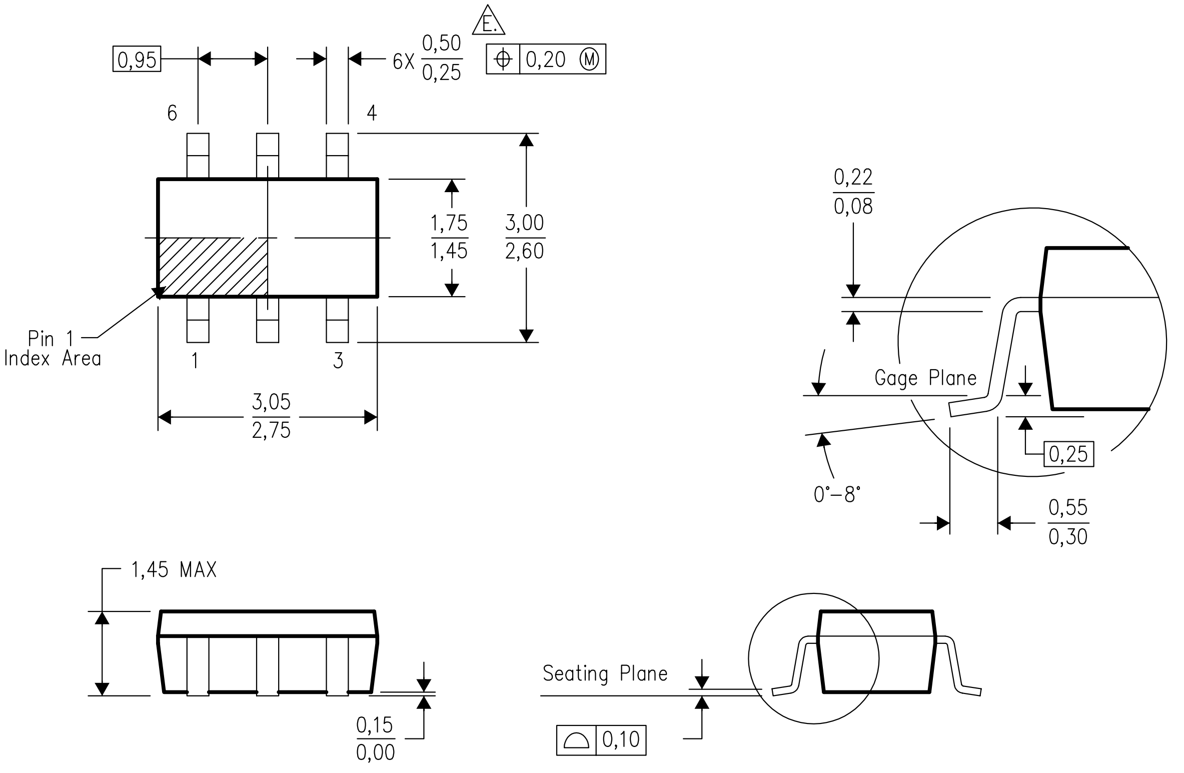
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS3806I33QDBVRQ1	SOT-23	DBV	6	3000	180.0	180.0	18.0

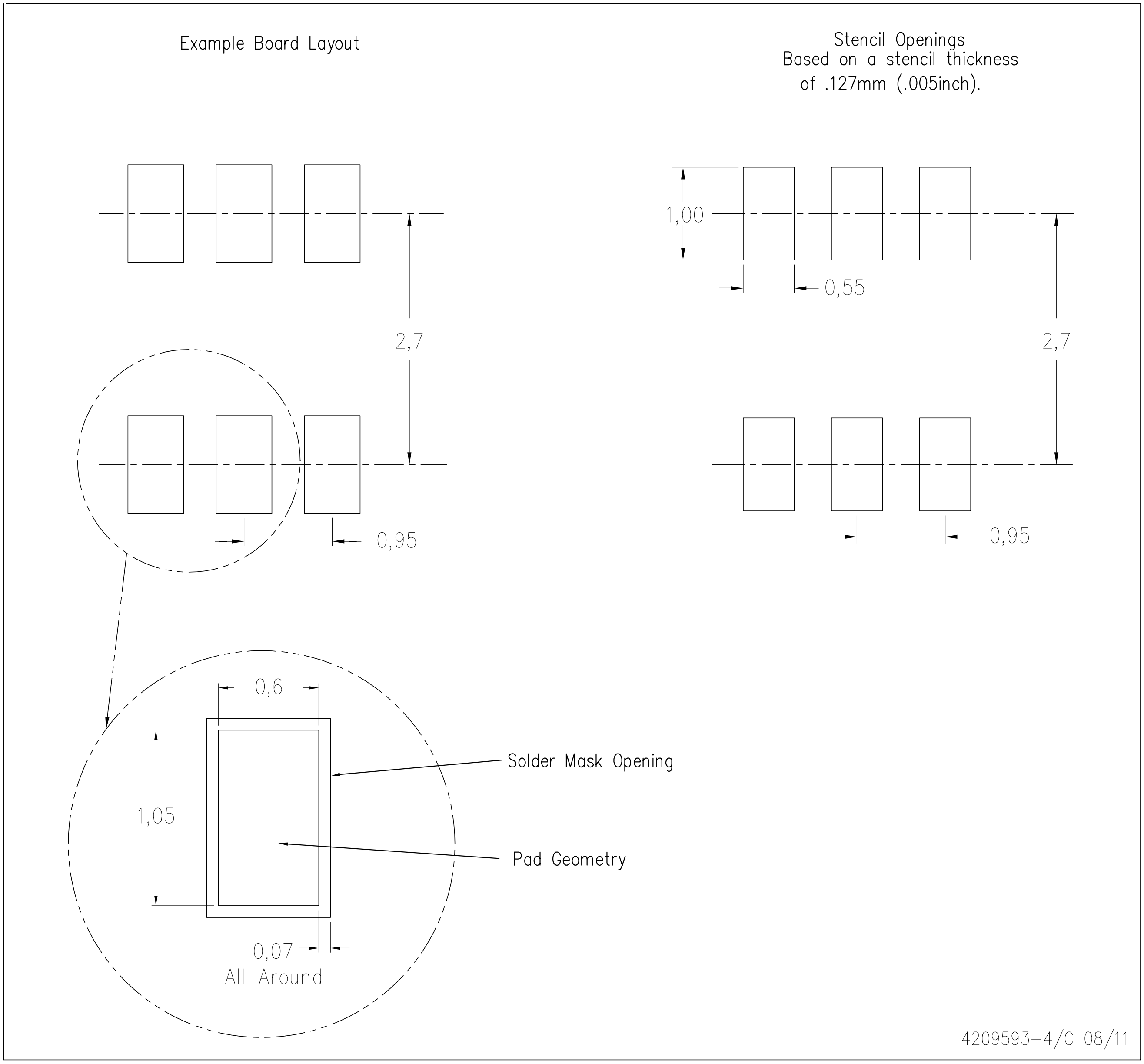
DBV (R–PDSO–G6) PLASTIC SMALL–OUTLINE PACKAGE


0,95
6X 0,50 / 0,25
E.
0,20 M
6
4
1
3
Pin 1 Index Area
1,75 / 1,45
3,00 / 2,60
3,05 / 2,75
0,22 / 0,08
Gage Plane
0,25
0°–8°
0,55 / 0,30
1,45 MAX
0,15 / 0,00
Seating Plane
0,10

4073253–5/K 03/2006

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.

DBV (R–PDSO–G6) PLASTIC SMALL OUTLINE


Example Board Layout
Stencil Openings
Based on a stencil thickness
of .127mm (.005inch).
1,00
0,55
2,7
2,7
0,95
0,95
0,6
1,05
Solder Mask Opening
Pad Geometry
0,07
All Around
4209593–4/C 08/11

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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No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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