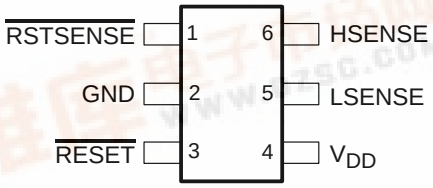
# DUAL VOLTAGE DETECTOR WITH ADJUSTABLE HYSTERESIS

SLVS393 – JULY 2001

- **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**
- **Six-Pin SOT-23 Package**

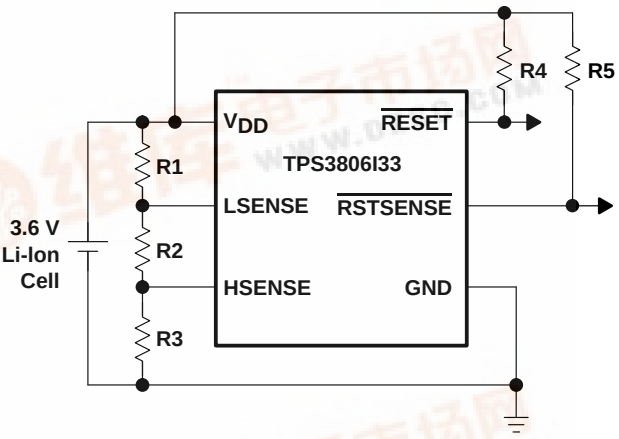
**TPS3806**
**DBV PACKAGE**
**(TOP VIEW)**




## 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.

## typical operating circuit



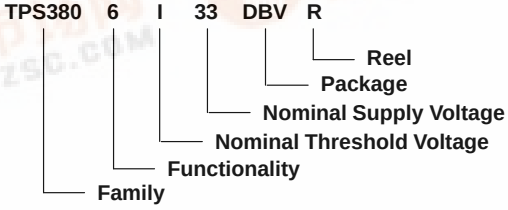

The devices are available in a 6-pin SOT-23 package. The TPS3806 device is characterized for operation over a temperature range of –40°C to 85°C.

**PACKAGE INFORMATION**

| $T_A$ | DEVICE NAME | | THRESHOLD VOLTAGE | | MARKING |
|---|---|---|---|---|---|
| | | | $V_{DD}$ | SENSE | |
| –40°C to 85°C | TPS3806J20DBVR† | TPS3806J20DBVT‡ | 1.8 V | 1.207 V | PGQI |
| | TPS3806I33DBVR† | TPS3806I33DBVT‡ | 3 V | 1.207 V | PGPI |

† The DBVR passive indicates tape and reel containing 3000 parts.
‡ The DBVT passive indicates tape and reel containing 250 parts.

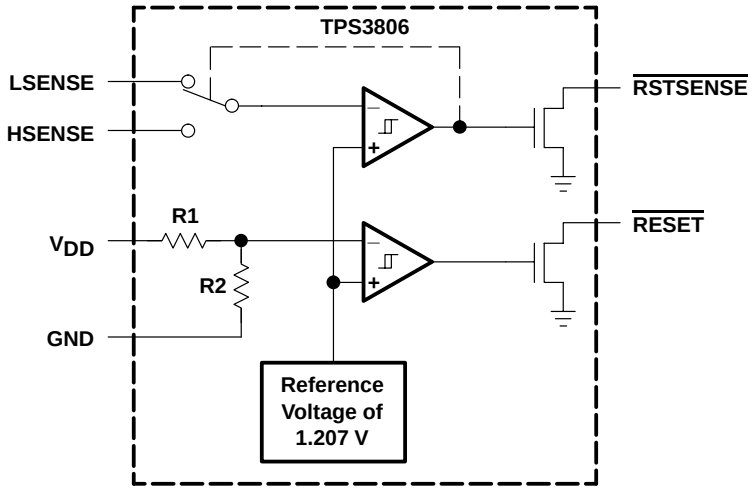
## ordering information



**Function/Truth Tables**

| 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 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 pullup resistor.

### programming the threshold voltage levels

The low-voltage threshold at LSENSE is calculated as follows:

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

where $V_{ref}$ = 1.207 V

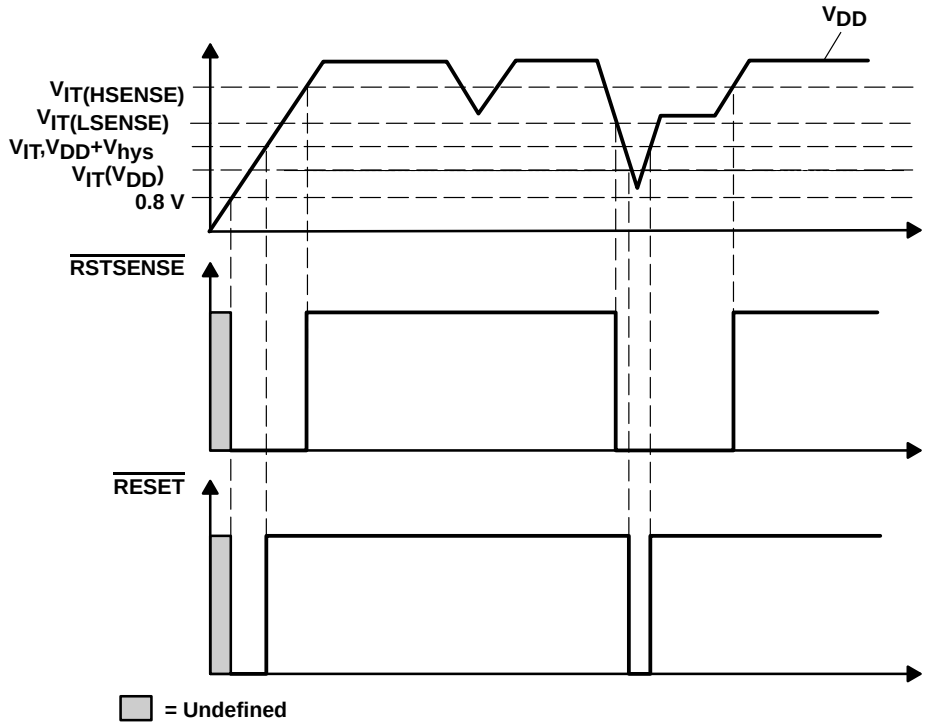
The high-voltage threshold at HSENSE is calculated as follows:

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

where $V_{ref}$ = 1.207 V

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

### timing requirements




## Terminal Functions

| TERMINAL NAME | TERMINAL NO. | I/O | DESCRIPTION |
|---|---|---|---|
| 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 |

### absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

Supply voltage, $V_{DD}$ (see Note1) . . . . . 7 V
All other pins (see Note 1) . . . . . –0.3 V 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°C to 85°C
Storage temperature range, $T_{stg}$ . . . . . –65°C to 150°C
Soldering temperature . . . . . 260°C

† 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.

NOTE 1: 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 POWER RATING | 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 | | | | |
| | | | $V_{DD}$ = 3.3 V, $I_{OL}$ = 2 mA | | | 0.3 | V |
| | | | $V_{DD}$ = 6 V, $I_{OL}$ = 3 mA | | | | |
| | Power-up reset voltage (see Note 2) | | $V_{DD} \geq$ 0.8 V, $I_{OL}$ = 50 µA | | | 0.2 | V |
| $V_{IT}$ | Negative-going input threshold voltage (see Note 3) | LSENSE | $T_A$ =25°C | 1.198 | 1.207 | 1.216 | V |
| | | TPS3806J20 | | 1.787 | 1.8 | 1.813 | |
| | | TPS3806I33 | | 2.978 | 3 | 3.022 | |
| | | 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 | 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 |

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

## 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 | | | | | |

## 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 | | | | | |

## TYPICAL CHARACTERISTICS

**SUPPLY CURRENT vs SUPPLY VOLTAGE**

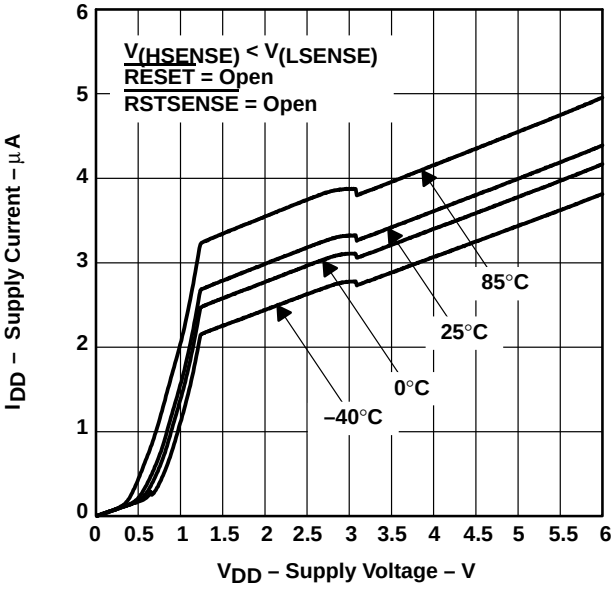



**Figure 1**

**LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT**

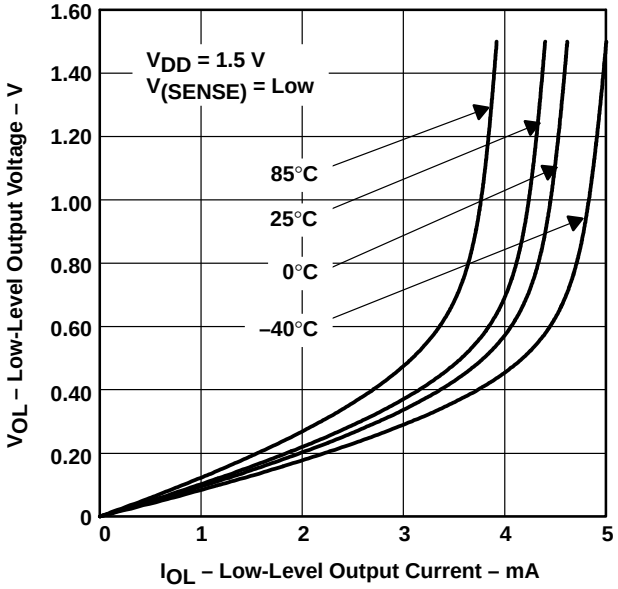



**Figure 2**

**LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT**

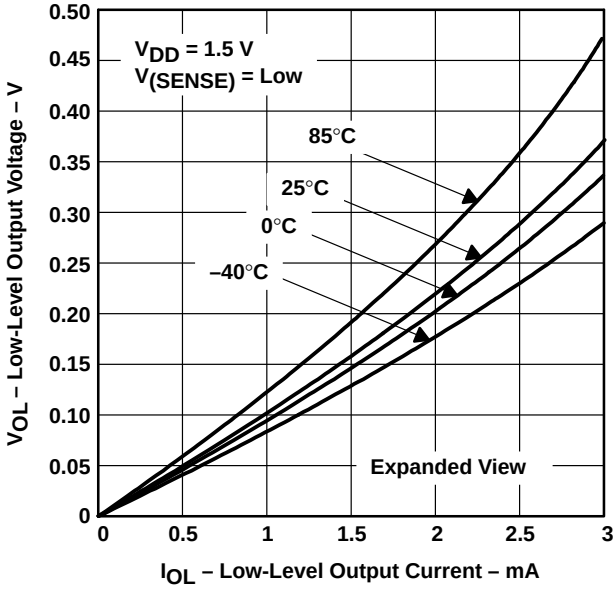



**Figure 3**

**LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT**

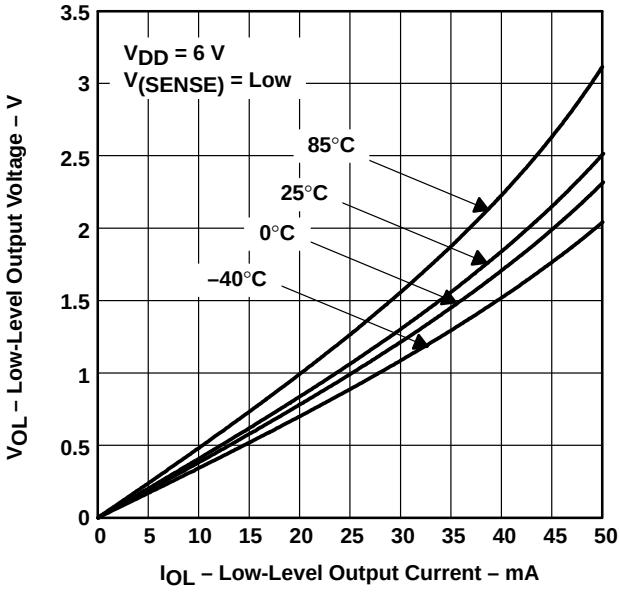



**Figure 4**

## TYPICAL CHARACTERISTICS

**LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT**

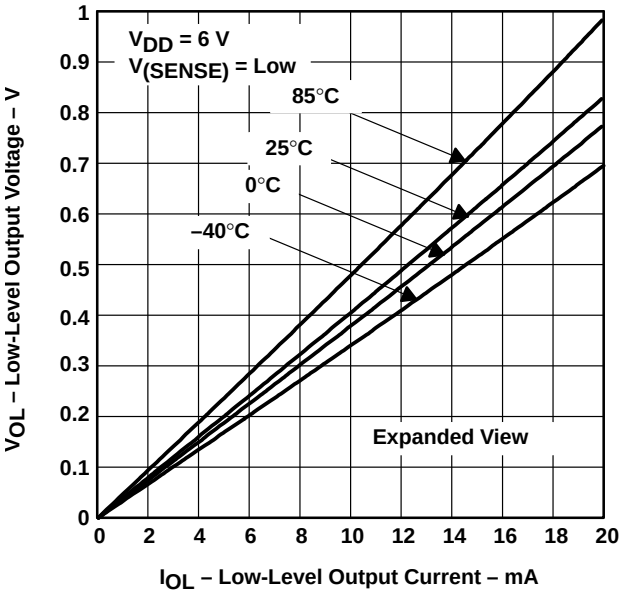



Figure 5

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

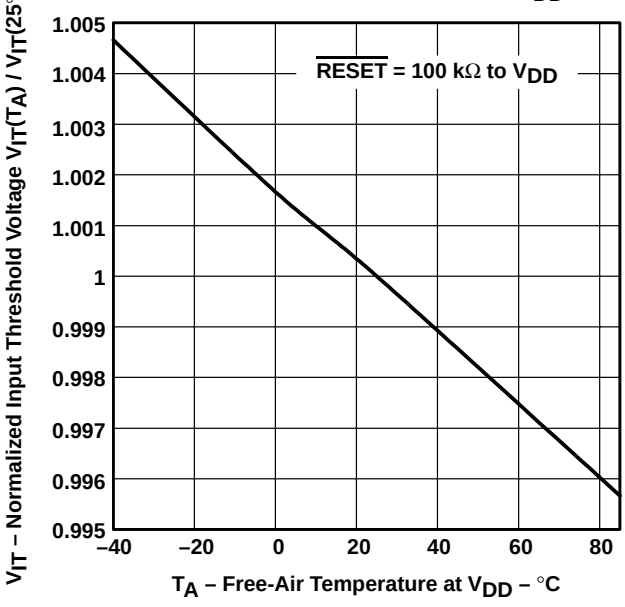



Figure 6

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

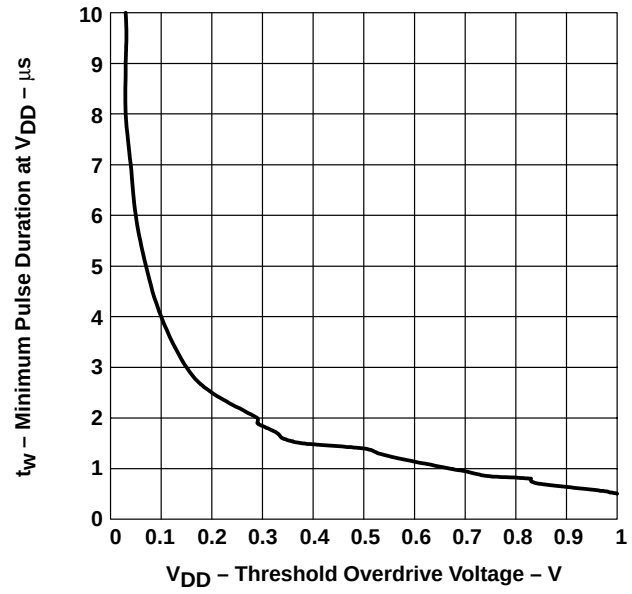



Figure 7

**MINIMUM PULSE DURATION AT LSENSE vs LSENSE THRESHOLD OVERDRIVE VOLTAGE**

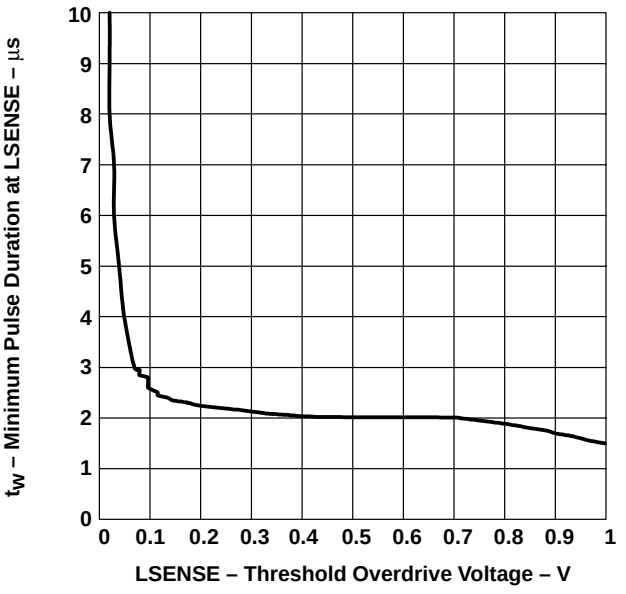
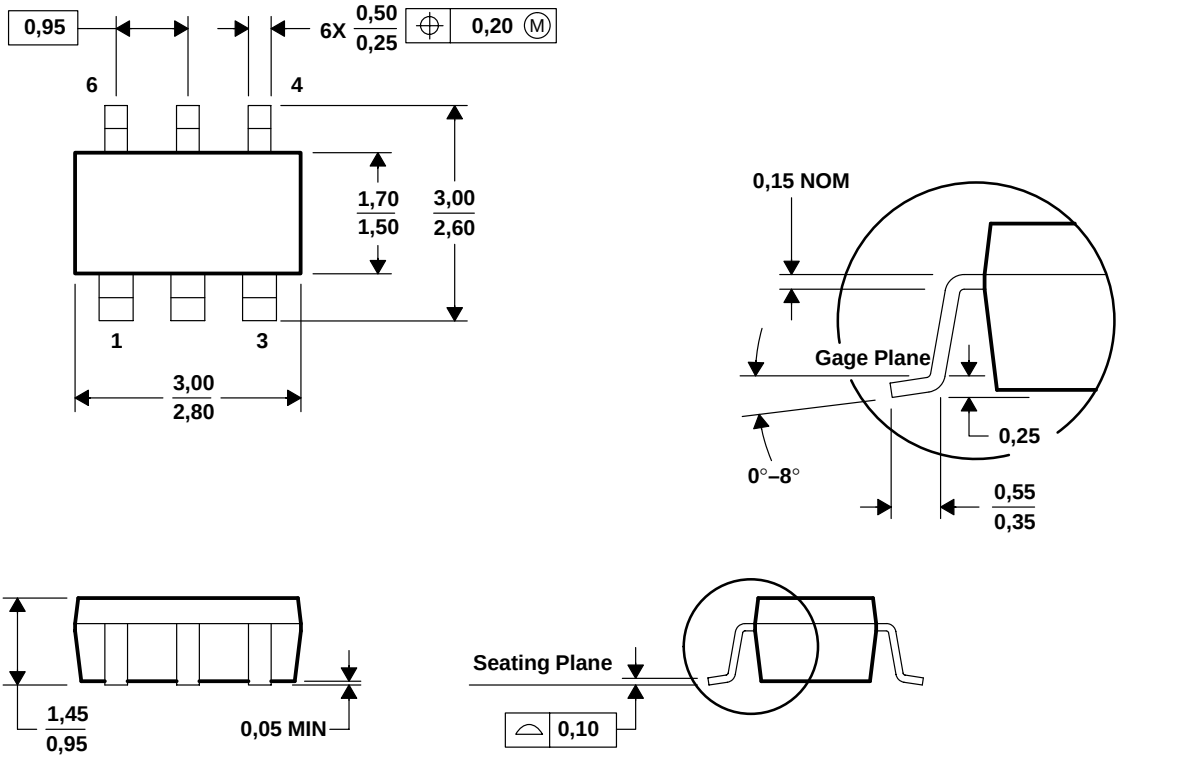



Figure 8

## MECHANICAL DATA

**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. Body dimensions do not include mold flash or protrusion.
D. Leads 1, 2, 3 are wider than leads 4, 5, 6 for package orientation.

## IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, license, warranty or endorsement thereof.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations and notices. Representation or reproduction of this information with alteration voids all warranties provided for an associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Resale of TI's products or services with *statements different from or beyond the parameters* stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Also see: Standard Terms and Conditions of Sale for Semiconductor Products. www.ti.com/sc/docs/stdterms.htm

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265