# 用于过压和欠压监控且具有内部基准的 TPS3700 高压 (18V) 窗口电压检测器

## 1 特性

- 宽电源电压范围：1.8V 至 18V
- 可调节阈值：低至 400mV
- 高阈值精度：
  - 工作温度范围内精度为 1.0%
  - 0.25%（典型值）
- 低静态电流：5.5μA（典型值）
- 用于过压和欠压检测的漏极开路输出
- 内部迟滞：5.5mV（典型值）
- 温度范围：–40°C 至 125°C
- 封装：
  - SOT-6
  - 1.5mm × 1.5mm WSON-6

## 2 应用

- 工业控制系统
- 汽车系统
- 嵌入式计算模块
- DSP、微控制器或微处理器 应用
- 笔记本电脑和台式机
- 便携式电池供电类产品
- FPGA 和 ASIC 参考设计

## 3 说明

TPS3700 宽电源窗口电压检测器在 1.8V 至 18V 的电压范围内运行。此器件具有两个带有一个内部 400mV 基准的高精度比较器和两个用于过压和欠压检测的额定值为 18V 的开漏输出。TPS3700 可以作为一个窗口电压检测器使用，也可以作为两个单独的电压监控器使用。通过外部电阻器可以设定监控电压。

当 INA+ 上的电压下降至低于 ($V_{ITP}$ - $V_{HYS}$)时，OUTA 被驱动至低电平，当电压返回到相应阈值 ($V_{ITP}$) 之上时，OUTA 变为高电平。当 INB- 上的电压上升至高于 $V_{ITP}$时，OUTB 被驱动至低电平，当电压下降至低于各自的阈值 ($V_{ITP}$ - $V_{HYS}$) 时，OUTB 变为高电平。TPS3700 中的两个比较器包括用于滤波的内置滞后来抑制短时毛刺脉冲，从而确保无故障触发的稳定输出运行。

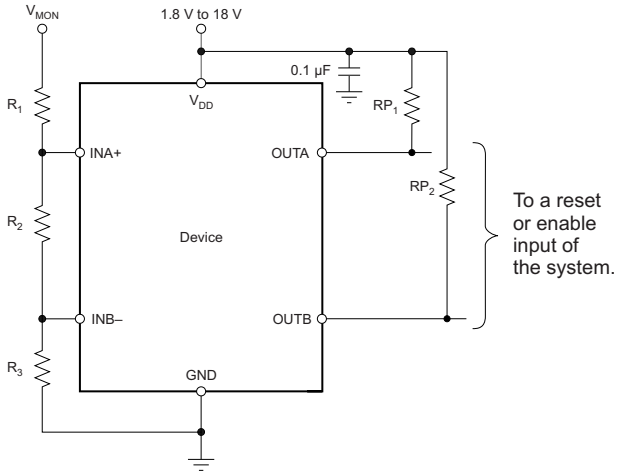
TPS3700 可提供 SOT-6 封装和 1.5mm × 1.5mm WSON-6 封装，额定工作结温范围为 –40°C 至 125°C。

器件信息(1)

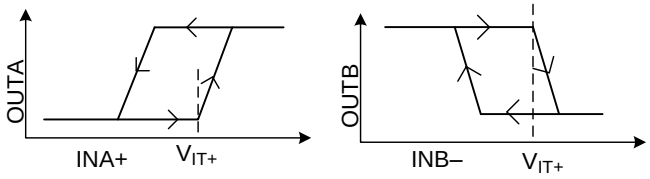
| 器件型号 | 封装 | 封装尺寸（标称值） |
|---|---|---|
| TPS3700 | SOT (6) | 2.90mm × 1.60mm |
| | WSON (6) | 1.50mm × 1.50mm |

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

简化原理图




输出与输入阈值和迟滞




本文档旨在为方便起见，提供有关 TI 产品中文版本的信息，以确认产品的概要。 有关适用的官方英文版本的最新信息，请访问 www.ti.com，其内容始终优先。 TI 不保证翻译的准确性和有效性。 在实际设计之前，请务必参考最新版本的英文版本。

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# 4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

**Changes from Revision F (January 2018) to Revision G** **Page**

- 已更改 将整个数据表中的比较器更改为电压检测器 ... 1

**Changes from Revision E (February 2017) to Revision F** **Page**

- 已更改 将整个数据表中的比较器更改为监控器 ... 1

**Changes from Revision D (January 2015) to Revision E** **Page**

- Added maximum specification to *Start-up delay* parameter ... 6
- Changed *at least 150 µs* to *450 µs (max)* in footnote 2 of *Electrical Characteristics* table ... 6

**Changes from Revision C (May 2013) to Revision D** **Page**

- 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 ... 5
- Changed HBM maximum specification from 2 kV to 2.5 kV in *ESD Ratings* ... 5
- Changed *Functional Block Diagram*; added hysteresis symbol ... 10

**Changes from Revision B (April 2012) to Revision C** **Page**

- 已更改 *封装* 特性 子要点中的 SFDR 值 ... 1
- 已添加 SON-6 封装选项添加到了 说明 部分 ... 1
- 已添加 DSE 引脚分配图到标题页 ... 1
- Added DSE pin out graphic ... 4
- Added DSE package to Thermal Information table ... 5

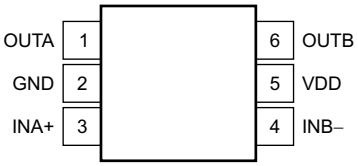
**Changes from Revision A (February 2012) to Revision B** **Page**

- 移至生产数据 ... 1

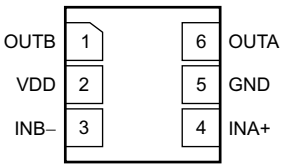
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# 5 Pin Configuration and Functions

**DDC Package**
**SOT-6**
**Top View**




**DSE Package**
**WSON-6**
**Top View**




**Pin Functions**

| PIN | | | I/O | DESCRIPTION |
|---|---|---|---|---|
| NAME | DDC | DSE | | |
| GND | 2 | 5 | — | Ground |
| INA+ | 3 | 4 | I | This pin is connected to the voltage to be monitored with the use of an external resistor divider. When the voltage at this terminal drops below the threshold voltage ($V_{ITP}$ – $V_{HYS}$), OUTA is driven low. |
| INB– | 4 | 3 | I | This pin is connected to the voltage to be monitored with the use of an external resistor divider. When the voltage at this terminal exceeds the threshold voltage ($V_{ITP}$), OUTB is driven low. |
| OUTA | 1 | 6 | O | INA+ comparator open-drain output. OUTA is driven low when the voltage at this comparator is below ($V_{ITP}$ – $V_{HYS}$). The output goes high when the sense voltage returns above the respective threshold ($V_{ITP}$). |
| OUTB | 6 | 1 | O | INB– comparator open-drain output. OUTB is driven low when the voltage at this comparator exceeds $V_{ITP}$. The output goes high when the sense voltage returns below the respective threshold ($V_{ITP}$ – $V_{HYS}$). |
| VDD | 5 | 2 | I | Supply voltage input. Connect a 1.8-V to 18-V supply to VDD to power the device. Good analog design practice is to place a 0.1-µF ceramic capacitor close to this pin. |


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# 6 Specifications

## 6.1 Absolute Maximum Ratings

over operating temperature range (unless otherwise noted)(1)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Voltage(2) | $V_{DD}$ | –0.3 | 20 | V |
| | OUTA, OUTB | –0.3 | 20 | V |
| | INA+, INB– | –0.3 | 7 | V |
| Current | Output terminal current | | 40 | mA |
| Operating junction temperature, $T_J$ | | –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 voltages are with respect to network ground terminal.

## 6.2 ESD Ratings

| | | VALUE | UNIT |
|---|---|---|---|
| $V_{(ESD)}$ Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1) | ±2500 | V |
| | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins(2) | ±1000 | |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

## 6.3 Recommended Operating Conditions

over operating temperature range (unless otherwise noted)

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Supply voltage | | 1.8 | | 18 | V |
| $V_I$ | Input voltage | INA+, INB– | 0 | | 6.5 | V |
| $V_O$ | Output voltage | OUTA, OUTB | 0 | | 18 | V |

## 6.4 Thermal Information

| THERMAL METRIC(1) | | TPS3700 | | UNIT |
|---|---|---|---|---|
| | | DDC (SOT) | DSE (WSON) | |
| | | 6 PINS | 6 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 204.6 | 194.9 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 50.5 | 128.9 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 54.3 | 153.8 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 0.8 | 11.9 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 52.8 | 157.4 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | N/A | N/A | °C/W |

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

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## 6.5 Electrical Characteristics

Over the operating temperature range of $T_J$ = –40°C to 125°C, and 1.8 V < $V_{DD}$ < 18 V, unless otherwise noted. Typical values are at $T_J$ = 25°C and $V_{DD}$ = 5 V.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Supply voltage range | | 1.8 | | 18 | V |
| $V_{(POR)}$ | Power-on reset voltage(1) | $V_{OL}$max = 0.2 V, $I_{(OUTA/B)}$ = 15 µA | | | 0.8 | V |
| $V_{IT+}$ | Positive-going input threshold voltage | $V_{DD}$ = 1.8 V | 396 | 400 | 404 | mV |
| | | $V_{DD}$ = 18 V | 396 | 400 | 404 | |
| $V_{IT–}$ | Negative-going input threshold voltage | $V_{DD}$ = 1.8 V | 387 | 394.5 | 400 | mV |
| | | $V_{DD}$ = 18 V | 387 | 394.5 | 400 | |
| $V_{hys}$ | Hysteresis voltage (hys = $V_{IT+}$ – $V_{IT–}$) | | | 5.5 | 12 | |
| $I_{(INA+)}$ | Input current (at the INA+ terminal) | $V_{DD}$ = 1.8 V and 18 V, $V_I$ = 6.5 V | –25 | 1 | 25 | nA |
| $I_{(INB–)}$ | Input current (at the INB– terminal) | $V_{DD}$ = 1.8 V and 18 V, $V_I$ = 0.1 V | –15 | 1 | 15 | nA |
| $V_{OL}$ | Low-level output voltage | $V_{DD}$ = 1.3 V, $I_O$ = 0.4 mA | | | 250 | mV |
| | | $V_{DD}$ = 1.8 V, $I_O$ = 3 mA | | | 250 | |
| | | $V_{DD}$ = 5 V, $I_O$ = 5 mA | | | 250 | |
| $I_{lkg(OD)}$ | Open-drain output leakage-current | $V_{DD}$ = 1.8 V and 18 V, $V_O$ = $V_{DD}$ | | | 300 | nA |
| | | $V_{DD}$ = 1.8 V, $V_O$ = 18 V | | | 300 | |
| $I_{DD}$ | Supply current | $V_{DD}$ = 1.8 V, no load | | 5.5 | 11 | µA |
| | | $V_{DD}$ = 5 V | | 6 | 13 | |
| | | $V_{DD}$ = 12 V | | 6 | 13 | |
| | | $V_{DD}$ = 18 V | | 7 | 13 | |
| | Start-up delay(2) | | | 150 | 450 | µs |
| UVLO | Undervoltage lockout(3) | $V_{DD}$ falling | 1.3 | | 1.7 | V |

(1) The lowest supply voltage ($V_{DD}$) at which output is active; $t_{r(VDD)}$ > 15 µs/V. Below $V_{(POR)}$, the output cannot be determined.
(2) During power on, $V_{DD}$ must exceed 1.8 V for 450 µs (max) before the output is in a correct state.
(3) When $V_{DD}$ falls below UVLO, OUTA is driven low and OUTB goes to high impedance. The outputs cannot be determined below $V_{(POR)}$.


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## 6.6 Timing Requirements

over operating temperature range (unless otherwise noted)

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{PHL}$ | High-to-low propagation delay(1) | $V_{DD}$ = 5 V, 10-mV input overdrive, $R_P$ = 10 kΩ, $V_{OH}$ = 0.9 × $V_{DD}$, $V_{OL}$ = 400 mV, see Figure 1 | | 18 | | µs |
| $t_{PLH}$ | Low-to-high propagation delay(1) | $V_{DD}$ = 5 V, 10-mV input overdrive, $R_P$ = 10 kΩ, $V_{OH}$ = 0.9 × $V_{DD}$, $V_{OL}$ = 400 mV, see Figure 1 | | 29 | | µs |

(1) High-to-low and low-to-high refers to the transition at the input terminals (INA+ and INB–).

## 6.7 Switching Characteristics

Over operating temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_r$ | Output rise time | $V_{DD}$ = 5 V, 10-mV input overdrive, $R_P$ = 10 kΩ, $V_O$ = (0.1 to 0.9) × $V_{DD}$ | | 2.2 | | µs |
| $t_f$ | Output fall time | $V_{DD}$ = 5 V, 10-mV input overdrive, $R_P$ = 10 kΩ, $V_O$ = (0.1 to 0.9) × $V_{DD}$ | | 0.22 | | µs |

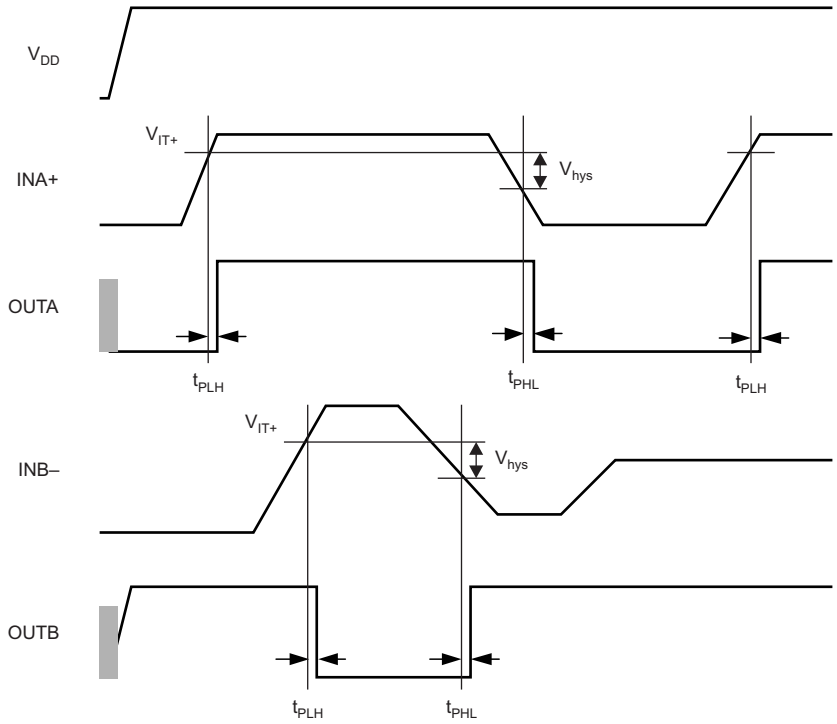



**Figure 1. Timing Diagram**

## 6.8 Typical Characteristics

at $T_J$ = 25°C and $V_{DD}$ = 5 V (unless otherwise noted)

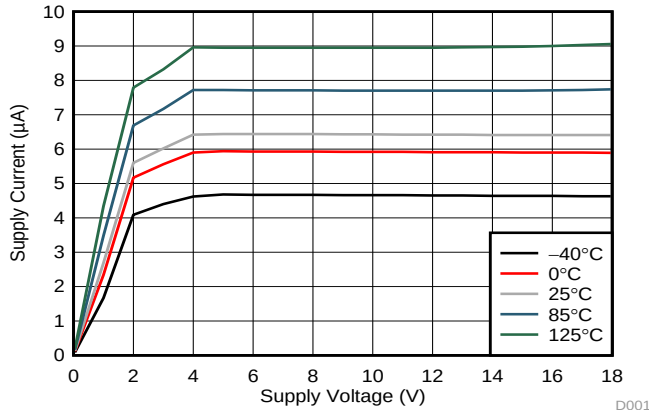



**Figure 2. Supply Current ($I_{DD}$) vs Supply Voltage ($V_{DD}$)**

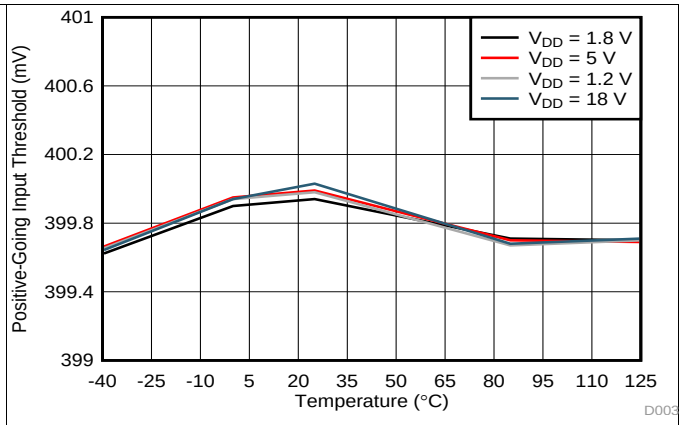



**Figure 3. Rising Input Threshold Voltage ($V_{IT+}$) vs Temperature**

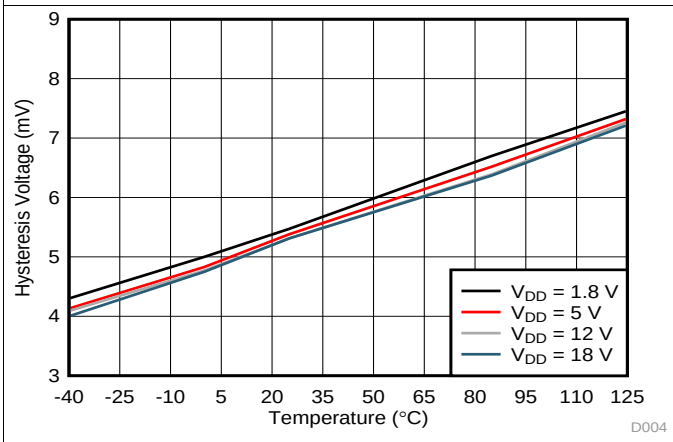



**Figure 4. Hysteresis ($V_{hys}$) vs Temperature**

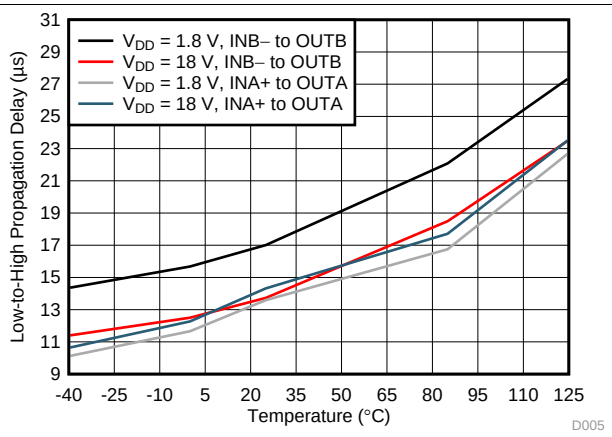



**Figure 5. Propagation Delay vs Temperature (High-to-Low Transition at the Inputs)**

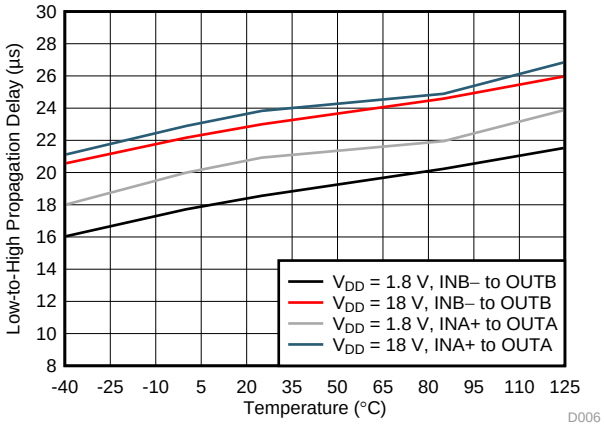
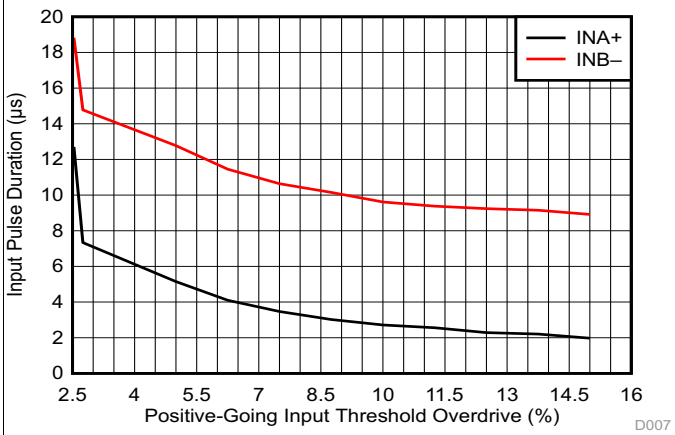



**Figure 6. Propagation Delay vs Temperature (Low-to-High Transition at the Inputs)**




INA+ = negative spike below $V_{IT–}$

INB– = positive spike above $V_{IT+}$

**Figure 7. Minimum Pulse Duration vs Threshold Overdrive Voltage**


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## Typical Characteristics (continued)

at $T_J$ = 25°C and $V_{DD}$ = 5 V (unless otherwise noted)

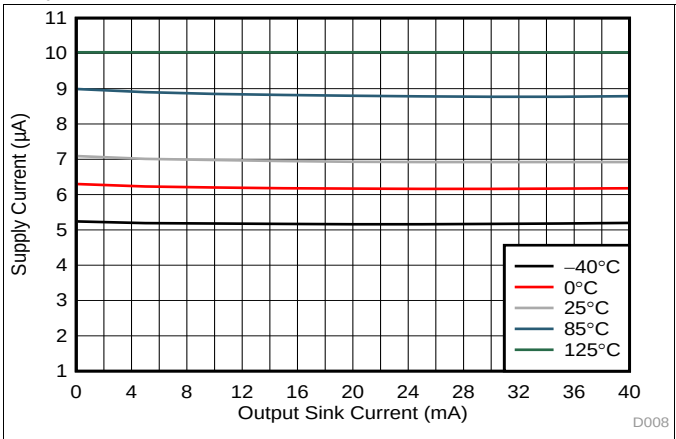



**Figure 8. Supply Current ($I_{DD}$) vs Output Sink Current**

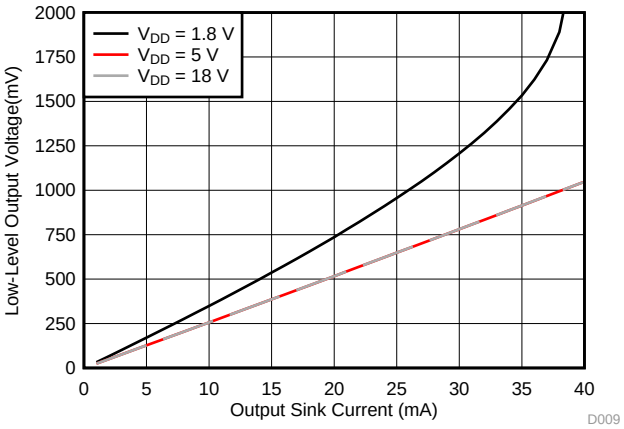



**Figure 9. Output Voltage Low ($V_{OL}$) vs Output Sink Current (–40°C)**

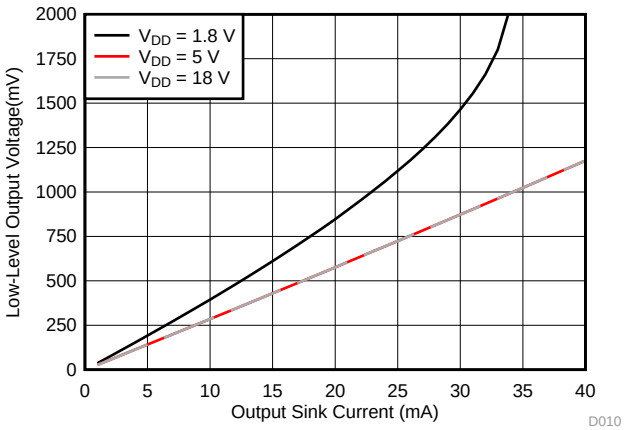



**Figure 10. Output Voltage Low ($V_{OL}$) vs Output Sink Current (0°C)**

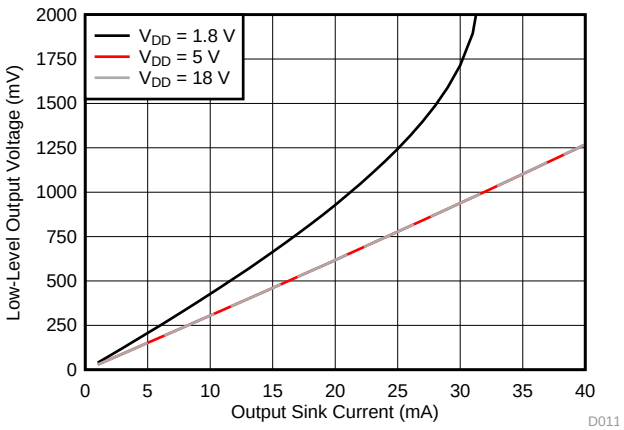



**Figure 11. Output Voltage Low ($V_{OL}$) vs Output Sink Current (25°C)**

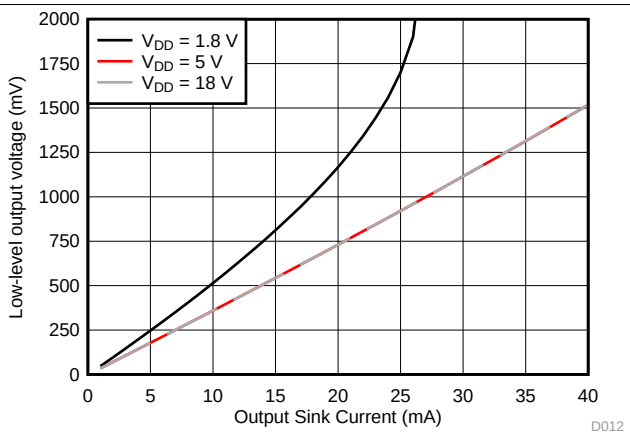



**Figure 12. Output Voltage Low ($V_{OL}$) vs Output Sink Current (85°C)**

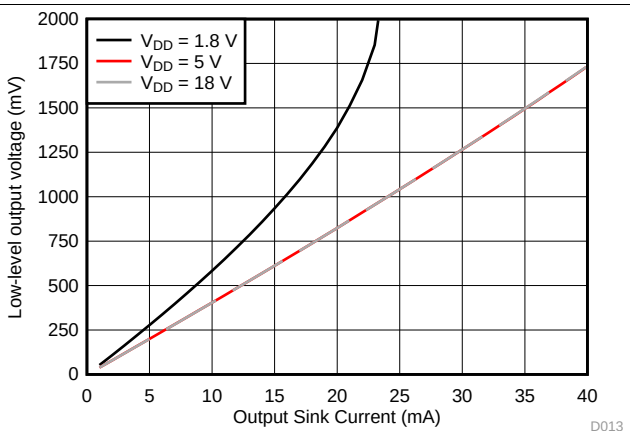



**Figure 13. Output Voltage Low ($V_{OL}$) vs Output Sink Current (125°C)**

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# 7 Detailed Description

## 7.1 Overview

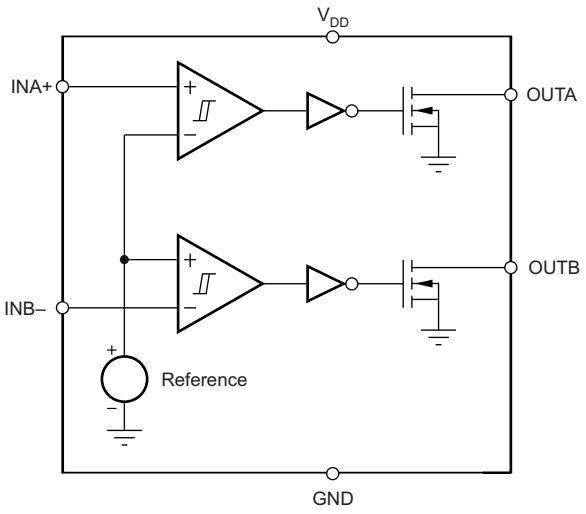
The TPS3700 device combines two voltage detectors for overvoltage and undervoltage detection. The TPS3700 device is a wide-supply voltage range (1.8 V to 18 V) device with a high-accuracy rising input threshold of 400 mV (1% over temperature) and built-in hysteresis. The outputs are also rated to 18 V and can sink up to 40 mA.

The TPS3700 device is designed to assert the output signals, as shown in Table 1. Each input terminal can be set to monitor any voltage above 0.4 V using an external resistor divider network. With the use of two input terminals of different polarities, the TPS3700 device forms a window voltage detector. Broad voltage thresholds can be supported that allow the device to be used in a wide array of applications.

**Table 1. TPS3700 Truth Table**

| CONDITION | OUTPUT | STATUS |
|---|---|---|
| INA+ > $V_{IT+}$ | OUTA high | Output A not asserted |
| INA+ < $V_{IT-}$ | OUTA low | Output A asserted |
| INB– > $V_{IT+}$ | OUTB low | Output B asserted |
| INB– < $V_{IT-}$ | OUTB high | Output B not asserted |

## 7.2 Functional Block Diagram




## 7.3 Feature Description

### 7.3.1 Inputs (INA+, INB–)

The TPS3700 device is a voltage detector that combines two comparators. Each comparator has one external input (inverting and noninverting); the other input is connected to the internal reference. The comparator rising threshold is designed and trimmed to be equal to the reference voltage (400 mV). Both comparators also have a built-in falling hysteresis that makes the device less sensitive to supply rail noise and ensures stable operation.

The INA+ and INB- inputs can swing from ground to 6.5 V, regardless of the device supply voltage used. Although not required in most cases, good analog design practice is to place a 1-nF to 10-nF bypass capacitor at the comparator input for extremely noisy applications to reduce sensitivity to transients and layout parasitics.

For comparator A, the corresponding output (OUTA) is driven to logic low when the input INA+ voltage drops below ($V_{IT+}$ – $V_{hys}$). When the voltage exceeds $V_{IT+}$, the output (OUTA) goes to a high-impedance state; see Figure 1.


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## Feature Description (continued)

For comparator B, the corresponding output (OUTB) is driven to logic low when the voltage at input INB– exceeds $V_{IT+}$. When the voltage drops below $V_{IT+} – V_{hys}$ the output (OUTB) goes to a high-impedance state; see Figure 1. Together, these comparators form a window-detection function as discussed in the *Window Voltage Detector* section.

### 7.3.2 Outputs (OUTA, OUTB)

In a typical TPS3700 application, the outputs are connected to a reset or enable input of the processor (such as a digital signal processor [DSP], central processing unit [CPU], field-programmable gate array [FPGA], or application-specific integrated circuit [ASIC]) or the outputs are connected to the enable input of a voltage regulator (such as a DC-DC or low-dropout regulator [LDO]).

The TPS3700 device provides two open-drain outputs (OUTA and OUTB). Pullup resistors must be used to hold these lines high when the output goes to high impedance (not asserted). By connecting pullup resistors to the proper voltage rails, the outputs can be connected to other devices at the correct interface-voltage levels. The TPS3700 outputs can be pulled up to 18 V, independent of the device supply voltage. By using wired-OR logic, OUTA and OUTB can merge into one logic signal that goes low if either outputs are asserted because of a fault condition.

Table 1 and the *Inputs (INA+, INB–)* section describe how the outputs are asserted or deasserted. See Figure 1 for a timing diagram that describes the relationship between threshold voltages and the respective output.

### 7.3.3 Window Voltage Detector

The inverting and noninverting configuration of the comparators forms a window-voltage detection circuit using a resistor divider network, as illustrated in Figure 14 and Figure 15. The input terminals can monitor any system voltage above 400 mV with the use of a resistor divider network. The INA+ and INB– terminals monitor for undervoltage and overvoltage conditions, respectively.

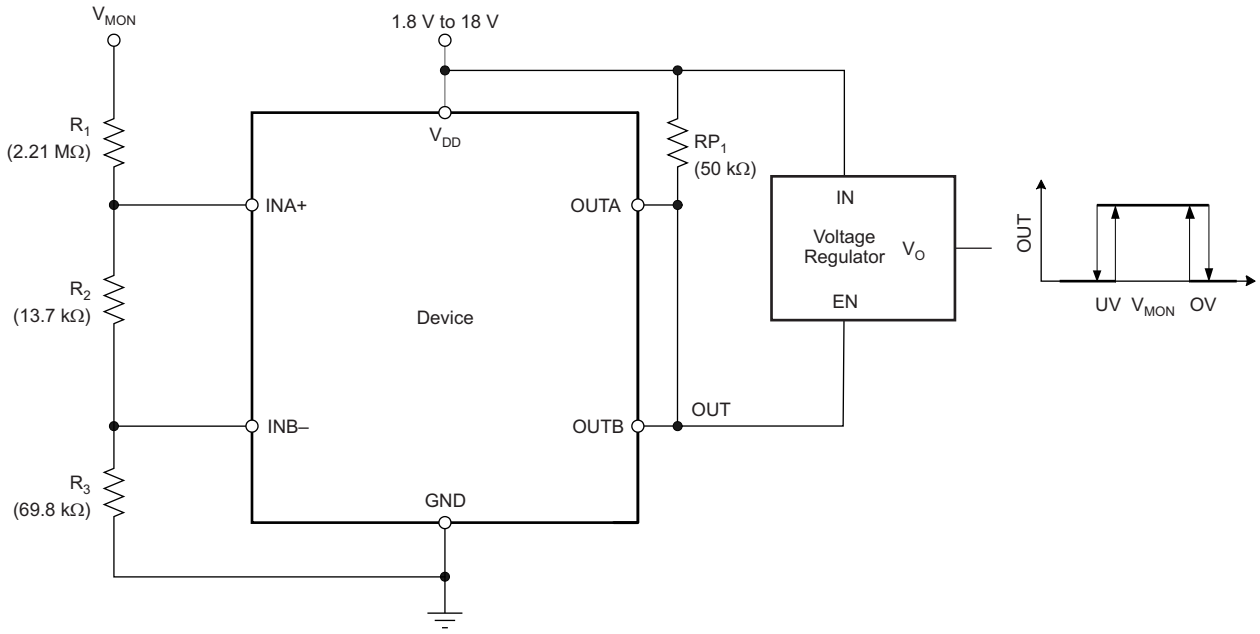



**Figure 14. Window Voltage Detector Block Diagram**

## Feature Description (continued)

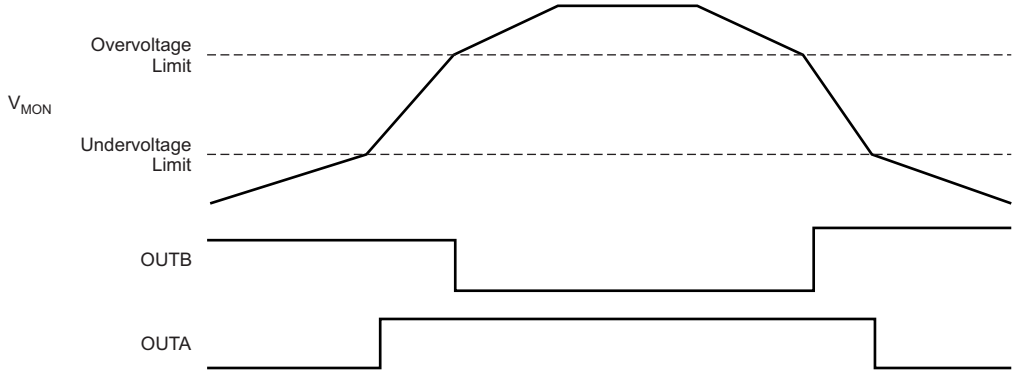



**Figure 15. Window Voltage Detector Timing Diagram**

### 7.3.4 Immunity to Input Terminal Voltage Transients

The TPS3700 device is relatively immune to short voltage transient spikes on the input terminals. Sensitivity to transients depends on both transient duration and amplitude; see the *Minimum Pulse Duration vs Threshold Overdrive Voltage* curve (Figure 7) in the *Typical Characteristics* section.

## 7.4 Device Functional Modes

### 7.4.1 Normal Operation ($V_{DD}$ > UVLO)

When the voltage on $V_{DD}$ is greater than 1.8 V for at least 150 µs, the OUTA and OUTB signals correspond to the voltage on INA+ and INB– as listed in Table 1.

### 7.4.2 Undervoltage Lockout ($V_{(POR)} < V_{DD}$ < UVLO)

When the voltage on $V_{DD}$ is less than the device UVLO voltage, and greater than the power-on reset voltage, $V_{(POR)}$, the OUTA and OUTB signals are asserted and high impedance, respectively, regardless of the voltage on INA+ and INB–.

### 7.4.3 Power-On Reset ($V_{DD} < V_{(POR)}$)

When the voltage on $V_{DD}$ is lower than the required voltage to internally pull the asserted output to GND ($V_{(POR)}$), both outputs are in a high-impedance state.


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# 8 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.

## 8.1 Application Information

The TPS3700 device is a wide-supply window voltage detector that operates over a $V_{DD}$ range of 1.8 V to 18 V. The device has two high-accuracy comparators with an internal 400-mV reference and two open-drain outputs rated to 18 V for overvoltage and undervoltage detection. The device can be used either as a window voltage detector or as two independent voltage monitors. The monitored voltages are set with the use of external resistors.

### 8.1.1 $V_{PULLUP}$ to a Voltage Other Than $V_{DD}$

The outputs are often tied to $V_{DD}$ through a resistor. However, some applications may require the outputs to be pulled up to a higher or lower voltage than $V_{DD}$ to correctly interface with the reset and enable terminals of other devices.

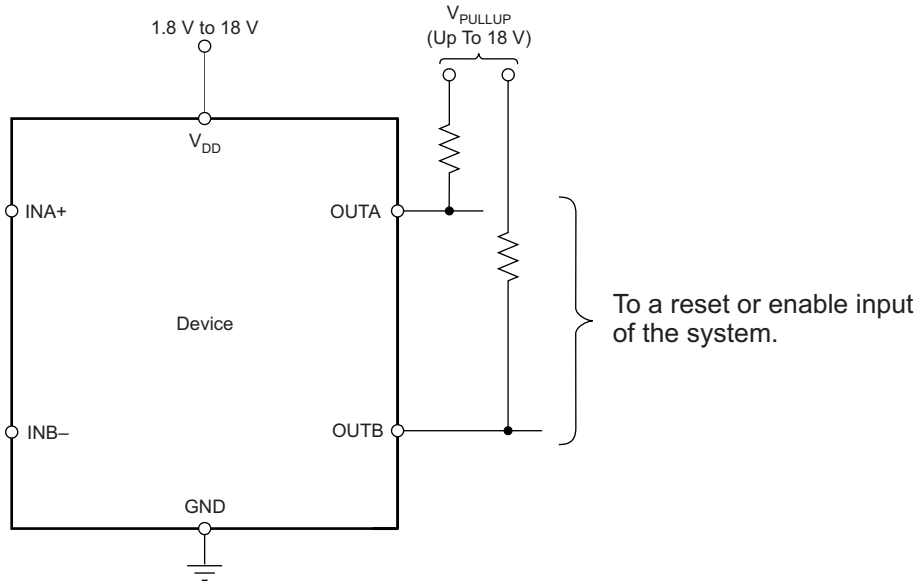



**Figure 16. Interfacing to Voltages Other Than $V_{DD}$**

## Application Information (continued)

### 8.1.2 Monitoring $V_{DD}$

Many applications monitor the same rail that is powering $V_{DD}$. In these applications the resistor divider is simply connected to the $V_{DD}$ rail.

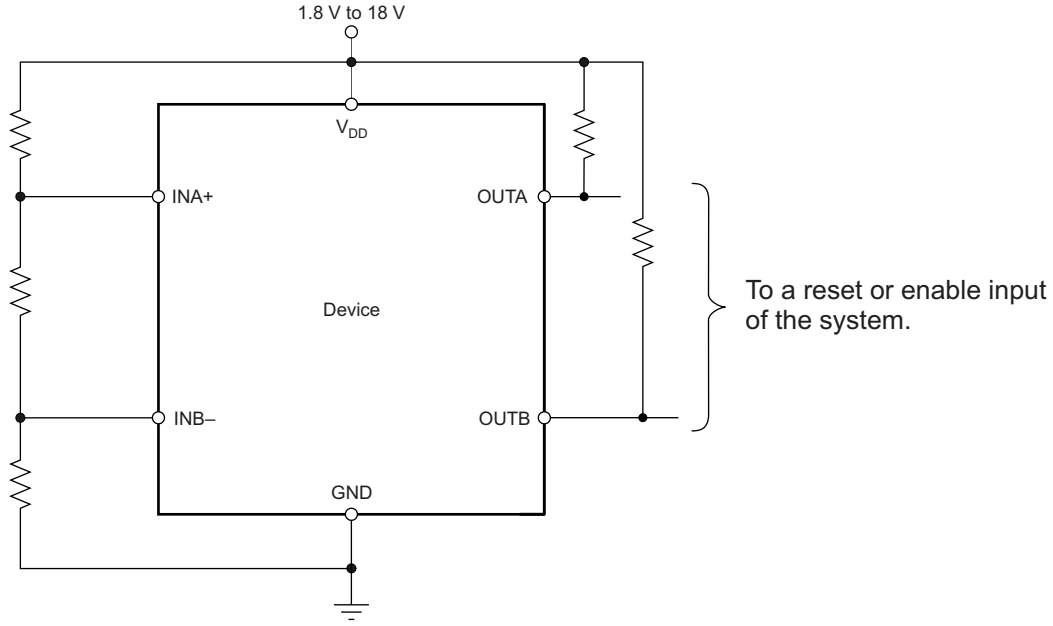
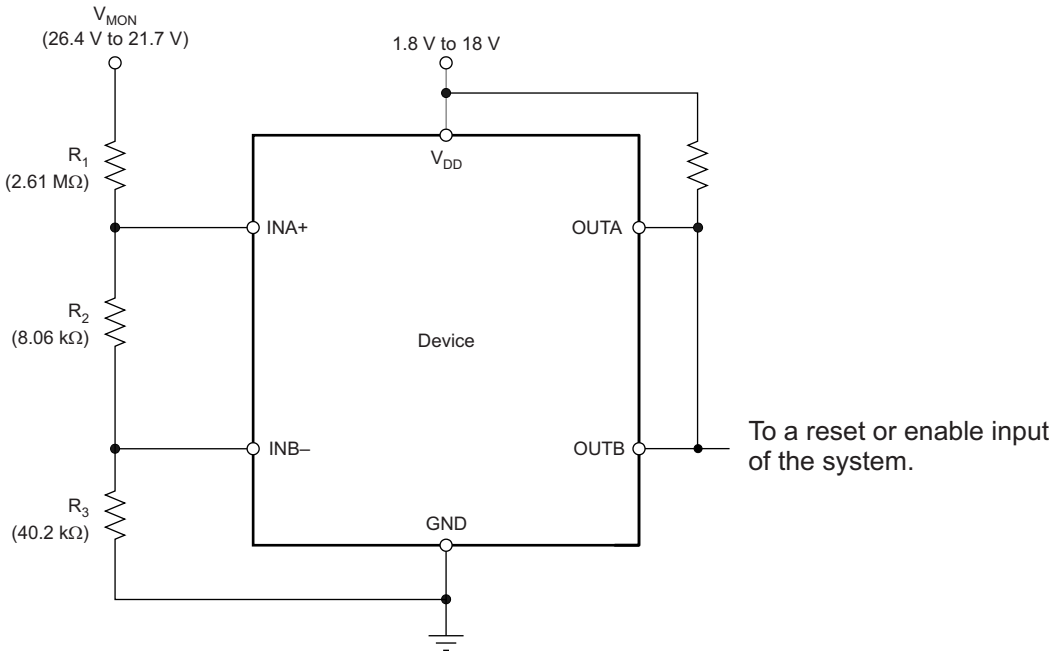



**Figure 17. Monitoring the Same Voltage as $V_{DD}$**

### 8.1.3 Monitoring a Voltage Other Than $V_{DD}$

Some applications monitor rails other than the one that is powering $V_{DD}$. In these types of applications the resistor divider used to set the desired thresholds is connected to the rail that is being monitored.




NOTE: The inputs can monitor a voltage higher than $V_{DD}$max with the use of an external resistor divider network.

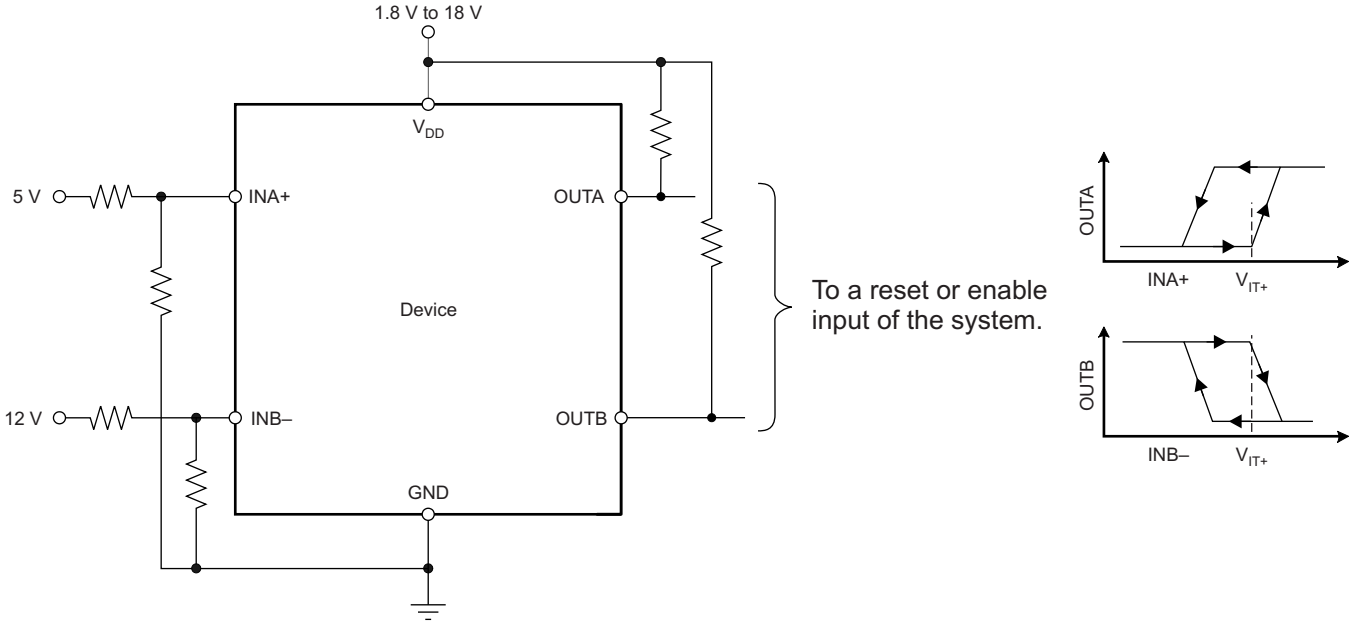
**Figure 18. Monitoring a Voltage Other Than $V_{DD}$**


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## Application Information (continued)

### 8.1.4 Monitoring Overvoltage and Undervoltage for Separate Rails

Some applications may want to monitor for overvoltage conditions on one rail while also monitoring for undervoltage conditions on a different rail. In these applications two independent resistor dividers must be used.




NOTE: In this case, OUTA is driven low when an undervoltage condition is detected at the 5-V rail and OUTB is driven low when an overvoltage condition is detected at the 12-V rail.

**Figure 19. Monitoring Overvoltage for One Rail and Undervoltage for a Different Rail**

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## 8.2 Typical Application

The TPS3700 device is a wide-supply window voltage detector that operates over a $V_{DD}$ range of 1.8 to 18 V. The monitored voltages are set with the use of external resistors, so the device can be used either as a window voltage detector or as two independent overvoltage and undervoltage monitors.

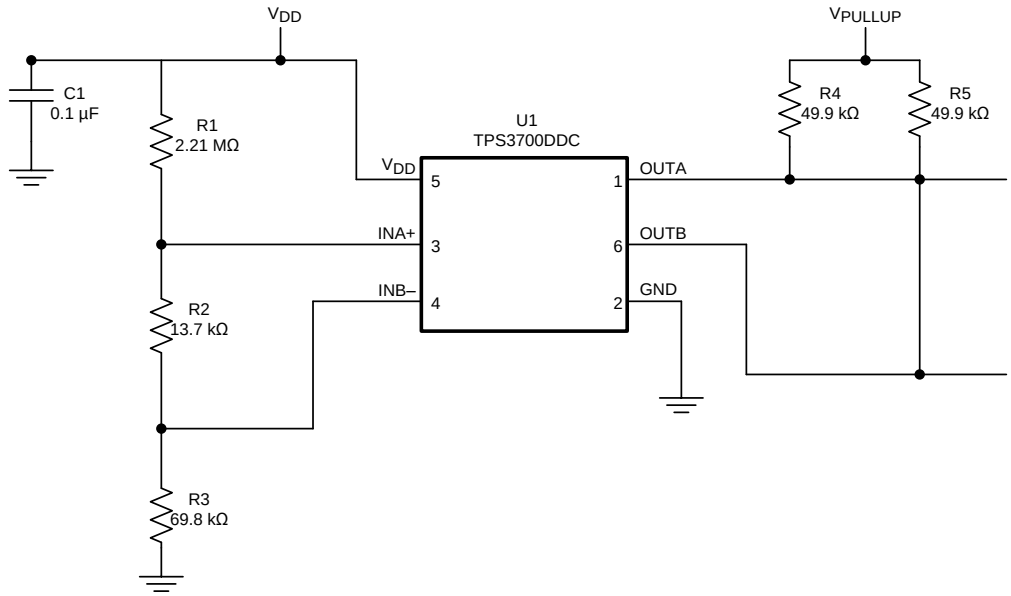



**Figure 20. Typical Application Schematic**

### 8.2.1 Design Requirements

For this design example, use the values summarized in Table 2 as the input parameters.

**Table 2. Design Parameters**

| PARAMETER | DESIGN REQUIREMENT | DESIGN RESULT |
|---|---|---|
| Monitored voltage | 12-V nominal rail with maximum rising and falling thresholds of ±10% | $V_{MON(UV)}$= 10.99 V (8.33%) ±2.94%, $V_{MON(OV)}$= 13.14 V (8.33%) ±2.94% |

### 8.2.2 Detailed Design Procedure

#### *8.2.2.1 Resistor Divider Selection*

Use Equation 1 through Equation 4 to calculate the resistor divider values and target threshold voltages.

$$R_T = R_1 + R_2 + R_3 \quad (1)$$

Select a value for $R_T$ such that the current through the divider is approximately 100 times higher than the input current at the INA+ and INB– terminals. The resistors can have high values to minimize current consumption as a result of low-input bias current without adding significant error to the resistive divider. See the application note *Optimizing Resistor Dividers at a Comparator Input* (SLVA450) for details on sizing input resistors.

Use Equation 2 to calculate the value of $R_3$.

$$R_3 = \frac{R_T}{V_{MON(OV)}} \times V_{IT+}$$

where:

$V_{MON(OV)}$ is the target voltage at which an overvoltage condition is detected (2)


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Use Equation 3 or Equation 4 to calculate the value of $R_2$.

$$R_2 = \left( \frac{R_T}{V_{MON}\,(\text{no UV})} \times V_{IT+} \right) - R_3$$

where:

$V_{MON(no\ UV)}$ is the target voltage at which an undervoltage condition is removed as $V_{MON}$ rises (3)

$$R_2 = \left( \frac{R_T}{V_{MON(UV)}} \times (V_{IT+} - V_{hys}) \right) - R_3$$

where:

$V_{MON(UV)}$ is the target voltage at which an undervoltage condition is detected (4)

The worst-case tolerance can be calculated by referring to Equation 13 in application report SLVA450, *Optimizing Resistor Dividers at a Comparator Input* (available for download at www.ti.com). An example of the rising threshold error, $V_{MON(OV)}$, is given in Equation 5.

$$\%\ ACC = \%\ TOL(V_{IT+(INB)}) + 2 \times \left( 1 - \frac{V_{IT+(INB)}}{V_{MON(OV)}} \right) \times \%\ TOL_R = 1\% + 2 \times \left( 1 - \frac{0.4}{13.2} \right) \times 1\% = 2.94\% \quad (5)$$

#### 8.2.2.2 Pullup Resistor Selection

To ensure proper voltage levels, the pullup resistor value is selected by ensuring that the pullup voltage divided by the resistor does not exceed the sink-current capability of the device. This confirmation is calculated by verifying that the pullup voltage minus the output-leakage current ($I_{lkg(OD)}$) multiplied by the resistor is greater the desired logic-high voltage. These values are specified in the *Electrical Characteristics* table.

Use Equation 6 to calculate the value of the pullup resistor.

$$\frac{(V_{HI} - V_{PU})}{I_{lkg(OD)}} \geq R_{PU} \geq \frac{V_{PU}}{I_O} \quad (6)$$

#### 8.2.2.3 Input Supply Capacitor

Although an input capacitor is not required for stability, connecting a 0.1-µF low equivalent series resistance (ESR) capacitor across the $V_{DD}$ terminal and GND terminal is good analog design practice. A higher-value capacitor may be necessary if large, fast rise-time load transients are anticipated, or if the device is not located close to the power source.

#### 8.2.2.4 Input Capacitors

Although not required in most cases, for extremely noisy applications, placing a 1-nF to 10-nF bypass capacitor from the comparator inputs (INA+, INB–) to the GND terminal is good analog design practice. This capacitor placement reduces device sensitivity to transients.

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### 8.2.3 Application Curves

At $T_J$ = 25°C

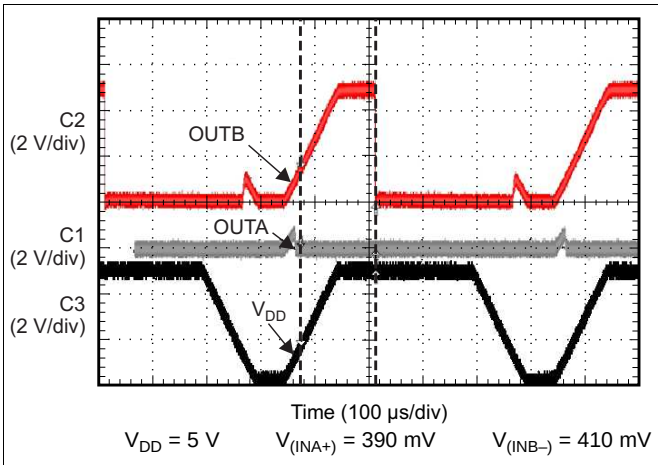



**Figure 21. Start-Up Delay (Outputs Pulled Up to $V_{DD}$)**

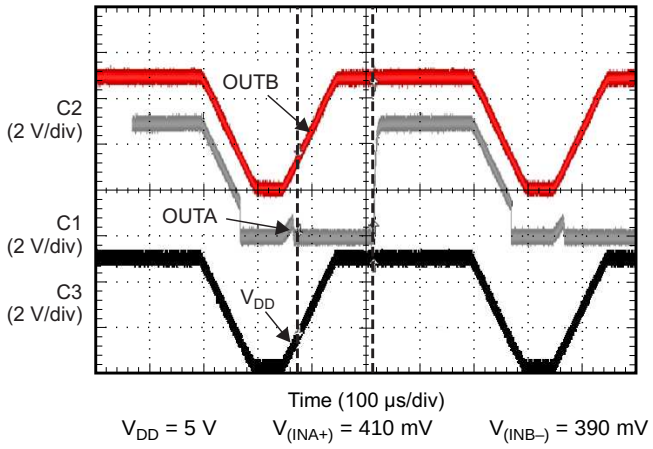



**Figure 22. Start-Up Delay (Outputs Pulled Up to $V_{DD}$)**

## 8.3 Do's and Don'ts

It is good analog design practice to have a 0.1-µF decoupling capacitor from $V_{DD}$ to GND.

If the monitored rail is noisy, connect decoupling capacitors from the comparator inputs to GND.

Do not use resistors for the voltage divider that cause the current through them to be less than 100 times the input current of the comparators without also accounting for the effect to the accuracy.

Do not use pullup resistors that are too small, because the larger current sunk by the output then exceeds the desired low-level output voltage ($V_{OL}$).


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# 9 Power-Supply Recommendations

These devices are designed to operate from an input voltage supply range between 1.8 V and 18 V.

# 10 Layout

## 10.1 Layout Guidelines

Placing a 0.1-µF capacitor close to the $V_{DD}$ terminal to reduce the input impedance to the device is good analog design practice. The pullup resistors can be separated if separate logic functions are needed (as shown in Figure 23) or both resistors can be tied to a single pullup resistor if a logical AND function is desired.

## 10.2 Layout Example

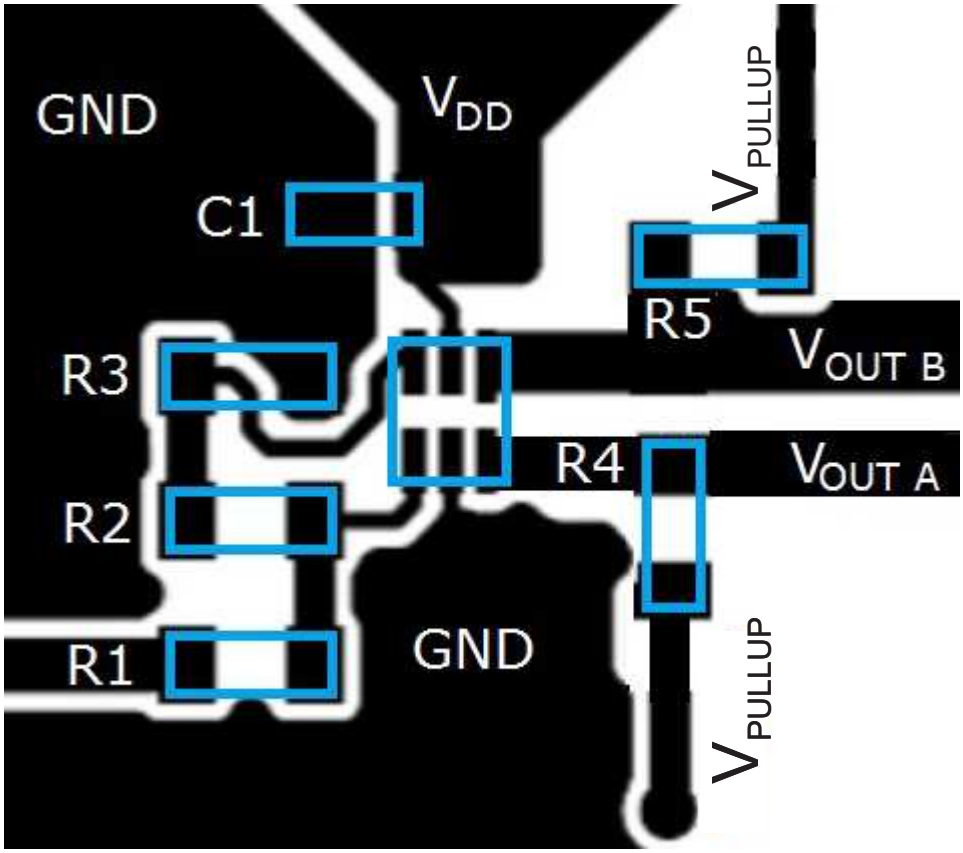



**Figure 23. TPS3700 Layout Schematic**

# 11 器件和文档支持

## 11.1 器件支持

### 11.1.1 开发支持

#### *11.1.1.1 评估模块*

有两个评估模块 (EVM) 可与 TPS3700 配套使用，帮助评估初始电路性能。TPS3700EVM-114 评估模块和 TPS3700EVM-202 评估模块（以及相关用户指南）可在德州仪器 (TI) 网站上的 TPS3700 产品文件夹中获取，也可直接从 TI 网上商店购买。

### 11.1.2 器件命名规则

表 **3.** 器件命名规则

| 产品 | 说明 |
|---|---|
| TPS3700**yyyz** | **yyy** 为封装标识符<br>**z** 为封装数量 |

## 11.2 文档支持

### 11.2.1 相关文档

请参阅如下相关文档：

- *《将 TPS3700 用作负轨过压和欠压检测器》*
- *《优化比较器输入上的电阻分压器》*
- *《TPS3700EVM-114 评估模块用户指南》*
- *《TPS3700EVM-202 评估模块用户指南》*

## 11.3 接收文档更新通知

要接收文档更新通知，请导航至 TI.com.cn 上的器件产品文件夹。单击右上角的*通知我* 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

## 11.4 社区资源

**下列链接提供到 TI 社区资源的连接。链接的内容由各个分销商“按照原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 《使用条款》。**

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**Design Support** ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

## 11.5 商标

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## 11.6 静电放电警告

ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。


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### 11.7 术语表

SLYZ022 — *TI 术语表*。

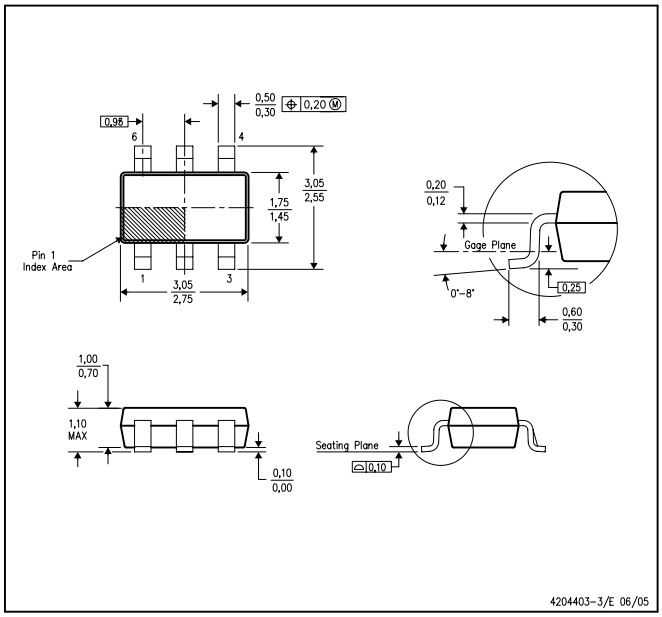
这份术语表列出并解释术语、缩写和定义。

## 12 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此产品说明书的浏览器版本，请查阅左侧的导航栏。

MECHANICAL DATA

DDC (R–PDSO–G6) PLASTIC SMALL–OUTLINE

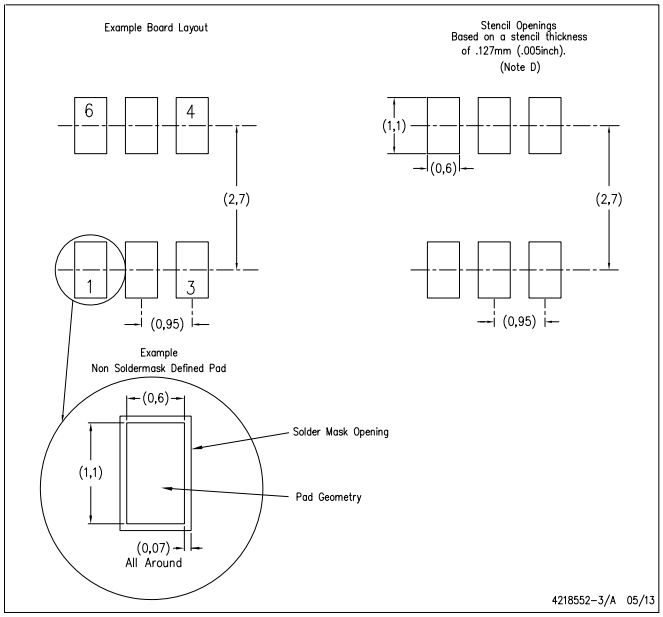



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO–193 variation AA (6 pin).

图 0. UNDEFINED

LAND PATTERN DATA

DDC (R–PDSO–G6) PLASTIC SMALL OUTLINE

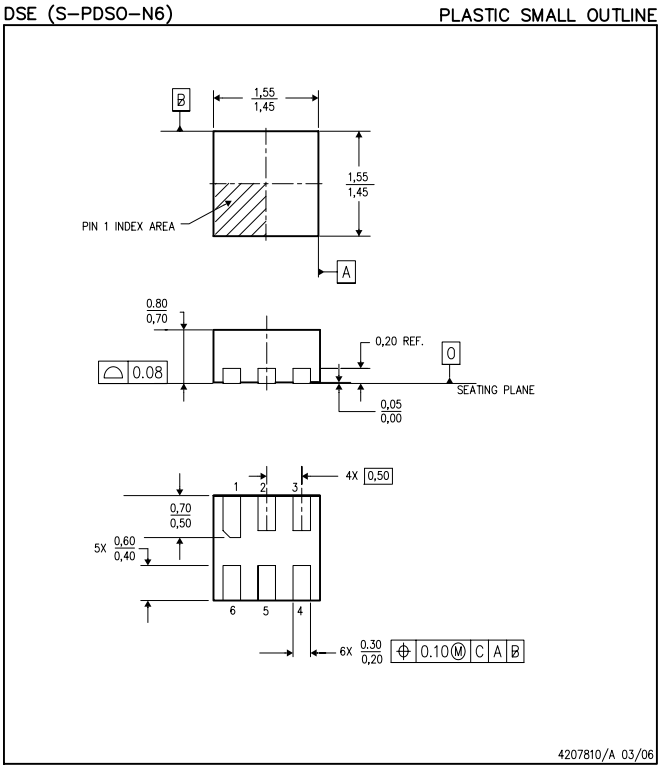



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.

图 0. UNDEFINED

MECHANICAL DATA

DSE (S–PDSO–N6) PLASTIC SMALL OUTLINE

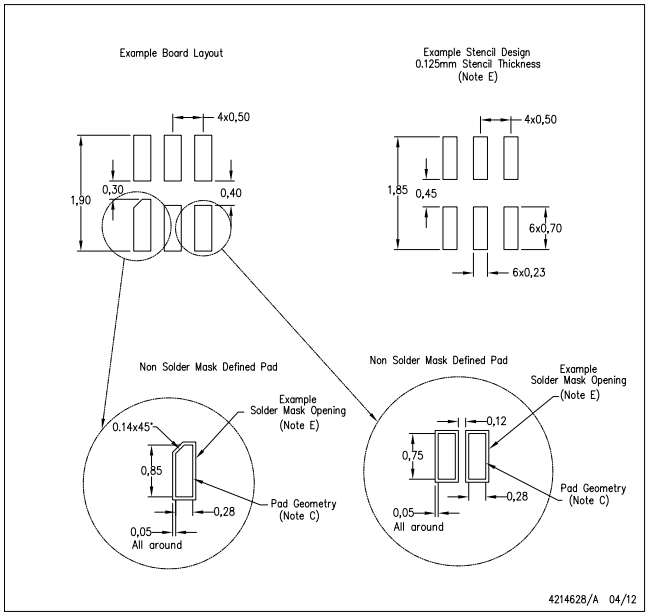



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Small Outline No–Lead (SON) package configuration.
D. This package is lead–free.

**图 0. UNDEFINED**

LAND PATTERN DATA

DSE (S–PWSON–N6) PLASTIC SMALL OUTLINE NO–LEAD




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. 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. Refer to IPC 7525 for stencil design considerations.
E. Customers should contact their board fabrication site for solder mask tolerances.

**图 0. UNDEFINED**


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## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| TPS3700DDCR | Active | Production | SOT-23-THIN (DDC) \| 6 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PXVQ |
| TPS3700DDCR2 | Active | Production | SOT-23-THIN (DDC) \| 6 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PB4Q |
| TPS3700DDCT | Active | Production | SOT-23-THIN (DDC) \| 6 | 250 \| SMALL T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PXVQ |
| TPS3700DSER | Active | Production | WSON (DSE) \| 6 | 3000 \| LARGE T&R | Yes | NIPDAU \| NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (7I, BE) |
| TPS3700DSET | Active | Production | WSON (DSE) \| 6 | 250 \| SMALL T&R | Yes | NIPDAU \| NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (7I, BE) |

**(1) Status:** For more details on status, see our product life cycle.

**(2) Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

**(3) RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

**(4) Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

**(5) MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

**(6) Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TPS3700 :**

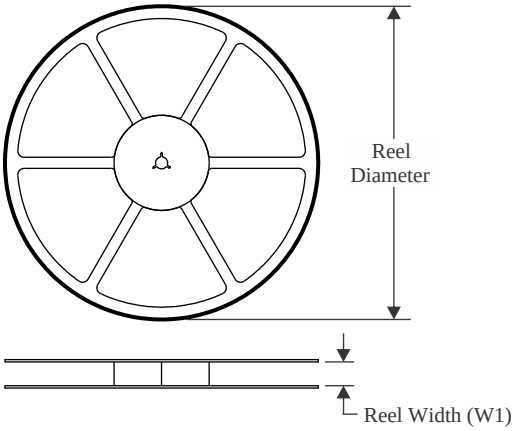
- Automotive : TPS3700-Q1

NOTE: Qualified Version Definitions:

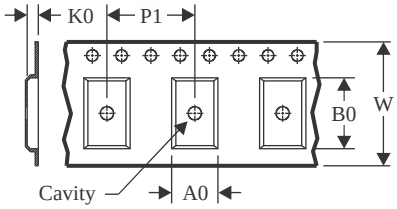
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

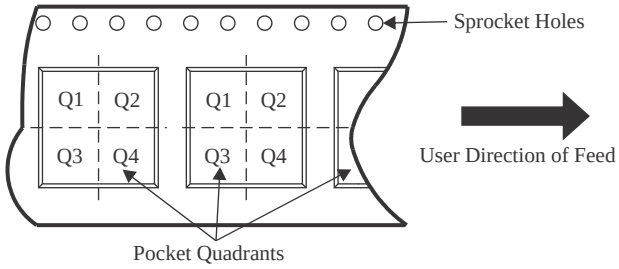



**TAPE DIMENSIONS**




| | |
|---|---|
| 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 |

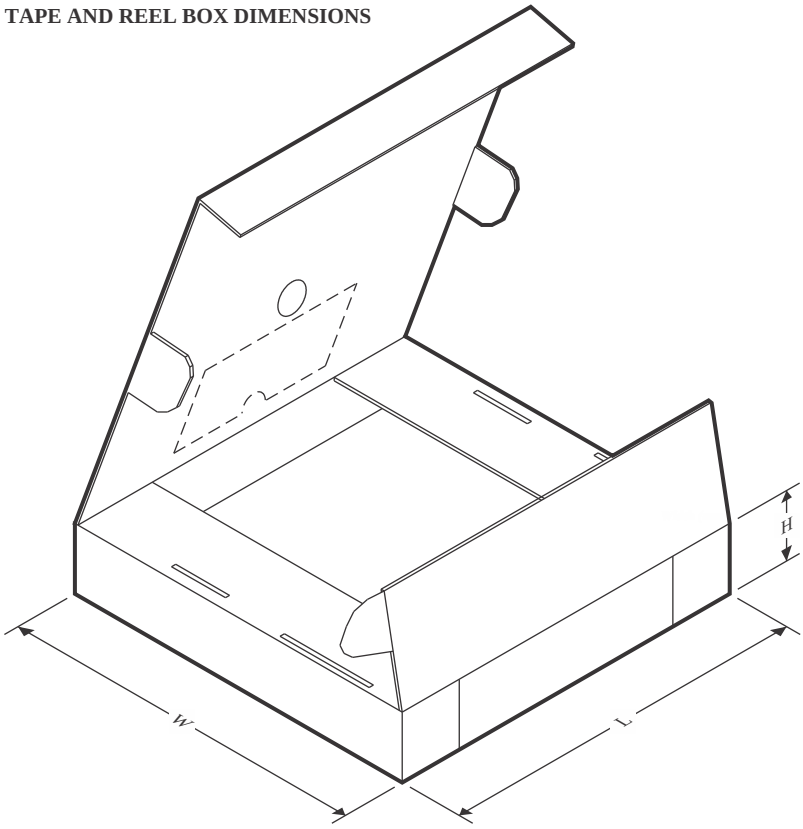
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPS3700DDCR | SOT-23-THIN | DDC | 6 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS3700DDCR2 | SOT-23-THIN | DDC | 6 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q2 |
| TPS3700DDCT | SOT-23-THIN | DDC | 6 | 250 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS3700DSER | WSON | DSE | 6 | 3000 | 178.0 | 8.4 | 1.7 | 1.7 | 0.95 | 4.0 | 8.0 | Q2 |
| TPS3700DSET | WSON | DSE | 6 | 250 | 178.0 | 8.4 | 1.7 | 1.7 | 0.95 | 4.0 | 8.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TPS3700DDCR | SOT-23-THIN | DDC | 6 | 3000 | 213.0 | 191.0 | 35.0 |
| TPS3700DDCR2 | SOT-23-THIN | DDC | 6 | 3000 | 213.0 | 191.0 | 35.0 |
| TPS3700DDCT | SOT-23-THIN | DDC | 6 | 250 | 213.0 | 191.0 | 35.0 |
| TPS3700DSER | WSON | DSE | 6 | 3000 | 205.0 | 200.0 | 33.0 |
| TPS3700DSET | WSON | DSE | 6 | 250 | 205.0 | 200.0 | 33.0 |

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