

# TPS3899 Nano-Power 高精度電圧スーパーバイザ、プッシュ・ボタン・モニタ、プログラム可能なセンスおよびリセット遅延付き

## 1 特長

- 機能安全対応
  - 機能安全システムの設計に役立つ資料を利用可能
- 高精度の電圧およびプッシュ ボタン モニタ
- VDD 範囲: 0.85V~6V (DL および PL 出力)
- VDD 範囲: 1V~6V (PH 出力)
- プログラム可能なセンスおよびリセット遅延
- わずかな静止電流: 125nA (標準値)
- 高いスレッシュホールド精度:  $\pm 0.5\%$  (標準値)
- 高精度ヒステリシス: 5% (標準値)
- 調整可能なスレッシュホールド電圧: 0.505V (標準値)
- 固定スレッシュホールド電圧: 0.8V~5.4V
  - 固定スレッシュホールド レベルは 100mV 刻みで利用可能
- 複数の出力トポロジ
  - DL: オープンドレイン アクティブ LOW
  - PL: プッシュプル アクティブ LOW
  - PH: プッシュプル アクティブ HIGH
- 温度範囲:  $-40^{\circ}\text{C} \sim +125^{\circ}\text{C}$
- パッケージ: 1.5mm × 1.5mm WSON

## 2 アプリケーション

- 電気メーター
- ビル・オートメーション
- ボディ・コントロール・モジュール (BCM)
- データ・センターおよびエンタープライズ・コンピューティング
- ノートブック / デスクトップ PC、サーバー
- スマートフォン、ハンドヘルド製品
- 携帯用、バッテリー駆動機器
- ソリッドステート・ドライブ
- STB / DVR

## 3 概要

TPS3899 は、 $\pm 0.5\%$  のスレッシュホールド精度とプログラム可能なセンスおよびリセット時間遅延を持つ nano power 高精度電圧スーパーバイザで、6 ピンの省スペース 1.5mm × 1.5mm WSON パッケージに搭載されています。TPS3899 は、豊富な機能を持つ電圧スーパーバイザで、クラス最小のソリューション サイズを実現します。ヒステリシスに加えてプログラム可能な遅延が内蔵されているので、電圧レールやプッシュ ボタン信号を監視するときに誤リセット信号が発生することを防止できます。

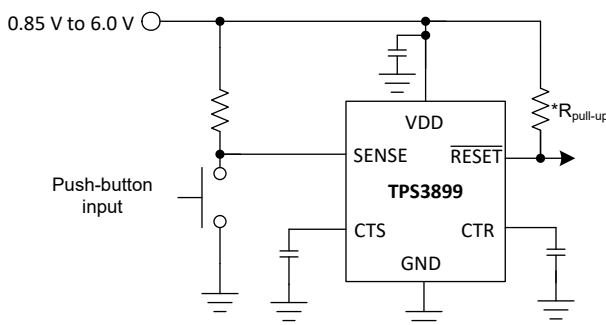
VDD ピンと SENSE ピンが別になっているので、高信頼性システムで求められる冗長性を実現できます。SENSE は VDD から分離されており、VDD 以外のレール電圧も監視できます。SENSE ピンは高インピーダンス入力なので外付け抵抗を使うこともできます。CTS と CTR は、リセット信号の立ち上がり / 立ち下がりエッジで遅延を調整するのに使います。CTS は、監視対象の電圧レールの電圧グリッチを無視するデバウンス機能として機能し、また、システムを強制的にリセットするための「手動リセット」としても動作します。

TPS3899 は、高精度とクラス最高の機能をコンパクトなフォーム ファクタで実現するため、ファクトリ / ビル オートメーション、モーター駆動、コンシューマ製品などの広範な産業用 / バッテリー駆動アプリケーションに最適なソリューションです。このデバイスは、 $-40^{\circ}\text{C} \sim +125^{\circ}\text{C}$  ( $T_A$ ) の温度範囲にわたって完全に動作が規定されています。

### 製品情報

| 部品番号    | パッケージ (1)    | 本体サイズ (公称)    |
|---------|--------------|---------------|
| TPS3899 | WSON (6) DSE | 1.5mm × 1.5mm |

1. 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照



\*R<sub>pull-up</sub> is required for open-drain variants only

### 代表的なアプリケーション回路

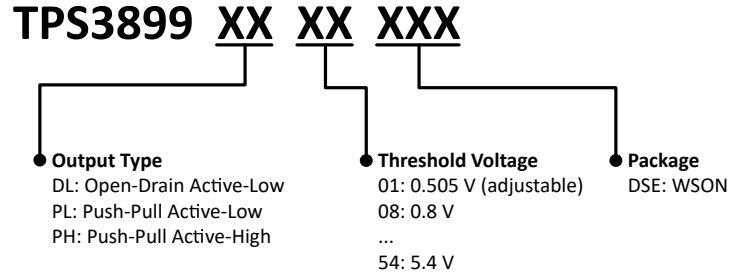


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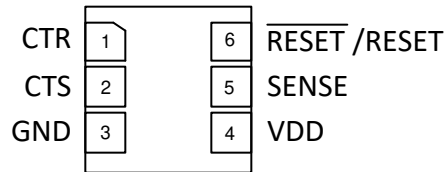
## 4 Device Comparison

4-1 shows the device naming nomenclature of the TPS3899. For all possible output types and threshold voltages options, see [Device Naming Convention](#) for a more detailed explanation. Contact TI sales representatives or on TI's [E2E forum](#) for detail and availability of other options; minimum order quantities apply.



4-1. Device Naming Nomenclature

## Pin Configuration and Functions



**図 5-1. DSE Package,  
6 Pin,  
TPS3899 Top View**

**表 5-1. Pin Functions**

| PIN |       | I/O | DESCRIPTION   |
|-----|-------|-----|---|
| NO. | NAME  |     |   |
| 1   | CTR   | —   | Capacitor programmable reset delay: The CTR pin offers a user-adjustable delay time when returning from reset condition. Connecting this pin to a ground-referenced capacitor sets the RESET/RESET delay time to deassert.  |
| 2   | CTS   | —   | Capacitor programmable sense delay: The CTS pin offers a user-adjustable delay time when asserting reset condition. Connecting this pin to a ground-referenced capacitor sets the RESET/RESET delay time to assert.   |
| 3   | GND   | —   | Ground  |
| 4   | VDD   | I   | Supply voltage pin: Good analog design practice is to place a 0.1μF ceramic capacitor close to this pin.  |
| 5   | SENSE | I   | This pin is connected to the voltage that will be monitored for fixed variants or to a resistor divider for the adjustable variant. When the voltage on the SENSE pin transitions below the negative threshold voltage $V_{IT-}$ , RESET/RESET asserts to active logic after the sense delay set by CTS. When the voltage on the SENSE pin transitions above the positive threshold voltage $V_{IT+} + V_{HYS}$ , RESET/RESET releases to inactive logic (deasserts) after the reset delay set by CTR. For noisy applications, placing a 10nF to 100nF ceramic capacitor close to this pin may be needed for optimum performance. |
| 6   | RESET | O   | RESET active-low output that asserts to a logic low state after CTS delay when the monitored voltage on the SENSE pin is lower than the negative threshold voltage $V_{IT-}$ . RESET remains logic low (asserted) until the SENSE input rises above $V_{IT+} + V_{HYS}$ and the CTR reset delay expires.  |
| 6   | RESET | O   | RESET active-high output that asserts to a logic high state after CTS delay when the monitored voltage on the SENSE pin is lower than the negative threshold voltage $V_{IT-}$ . RESET remains logic high (asserted) until the SENSE input rises above $V_{IT+} + V_{HYS}$ and the CTR reset delay expires.   |

## 5 Specifications

### 5.1 Absolute Maximum Ratings

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

|                            |   | MIN  | MAX                                 | UNIT |
|----------------------------|---|------|-------------------------------------|------|
| Voltage                    | VDD, SENSE                                    | -0.3 | 6.5                                 | V    |
| Voltage                    | CTR, CTS                                      | -0.3 | V <sub>DD</sub> +0.3 <sup>(3)</sup> | V    |
| Voltage                    | RESET (TPS389DL)                              | -0.3 | 6.5                                 | V    |
|                            | RESET (TPS3899PL), RESET (TPS3899PH)          | -0.3 | V <sub>DD</sub> +0.3 <sup>(3)</sup> |      |
| Current                    | RESET pin and RESET pin                       |      | ±20                                 | mA   |
| Temperature <sup>(2)</sup> | Operating ambient temperature, T <sub>A</sub> | -40  | 125                                 | °C   |
| Temperature <sup>(2)</sup> | Storage, T <sub>stg</sub>                     | -65  | 150                                 |      |

- (1) Stresses beyond those listed under *Absolute Maximum Rating* 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 Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) As a result of the low dissipated power in this device, it is assumed that T<sub>J</sub> = T<sub>A</sub>.
- (3) The absolute maximum rating is (VDD + 0.3) V or 6.5 V, whichever is smaller

### 5.2 ESD Ratings

|                    |                         |  | VALUE  | UNIT |
|--------------------|-------------------------|--|--------|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | ± 2000 | V    |
|                    |                         | Charged device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | ± 750  |      |

- (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.

### 5.3 Recommended Operating Conditions

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

|                  |                                      | MIN | NOM | MAX | UNIT |
|------------------|--------------------------------------|-----|-----|-----|------|
| Voltage          | VDD, SENSE                           | 0   |     | 6   | V    |
| Voltage          | CTR, CTS                             | 0   |     | VDD | V    |
| Voltage          | RESET (TPS3899DL)                    | 0   |     | 6   | V    |
|                  | RESET (TPS3899PL), RESET (TPS3899PH) | 0   |     | VDD |      |
| Current          | RESET pin and RESET pin current      | 0   |     | ±5  | mA   |
| T <sub>A</sub>   | Operating free air temperature       | -40 |     | 125 | °C   |
| C <sub>CTR</sub> | CTR pin capacitor range              | 0   |     | 10  | µF   |
| C <sub>CTS</sub> | CTS pin capacitor range              | 0   |     | 10  | µF   |

## 5.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | TPS3899 | UNIT |
|-------------------------------|--|---------|------|
|                               |  | DSE     |      |
|                               |  | 6 PINS  |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 214.9   | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 153.7   | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 112.3   | °C/W |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 25.5    | °C/W |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 111.8   | °C/W |
| $R_{\theta JC(bot)}$          | Junction-to-case (bottom) thermal resistance | N/A     | °C/W |

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

## 5.5 Electrical Characteristics

CTR = CTS = Open, RESET pull-up resistor ( $R_{pull-up}$ ) = 100 k $\Omega$  to  $V_{DD}$ , output reset load ( $C_{LOAD}$ ) = 10 pF and over the operating free-air temperature range  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , unless otherwise noted.  $V_{DD}$  ramp rate  $\leq 1 \text{ V}/\mu\text{s}$ . Typical values are at  $T_A = 25^{\circ}\text{C}$

| PARAMETER                                |   | TEST CONDITIONS  | MIN  | TYP             | MAX  | UNIT          |
|--|---|--|------|-----------------|------|---------------|
| <b>COMMON PARAMETERS</b>                 |   |  |      |                 |      |               |
| $V_{DD}$                                 | Input supply voltage (Open Drain Low and Push Pull Low)               |  | 0.85 |                 | 6    | V             |
| $V_{DD}$                                 | Input supply voltage (Push Pull High)                                 |  | 1    |                 | 6    | V             |
| $V_{IT-}^{(1)}$                          | Negative-going input threshold range                                  | for all output configs   | 0.8  |                 | 5.4  | V             |
| $V_{ADJ-VIT-}$                           | Negative-going input threshold for adjustable sense threshold version |  |      | 0.505           |      | V             |
| $V_{IT-}$ accuracy                       | Negative-going input threshold accuracy                               | $V_{IT-} = 0.505 \text{ V}$ (ADJ version) or $0.8 \text{ V}$ to $1.7 \text{ V}$ (Fixed threshold)        | -2.5 | $\pm 0.5$       | 2.5  | %             |
|  |   | $V_{IT-} = 1.8 \text{ V}$ to $5.4 \text{ V}$ (Fixed threshold)   | -2   | $\pm 0.5$       | 2    |               |
| $V_{HYS}$                                | Hysteresis on $V_{IT-}$   | $V_{IT-} = 0.505 \text{ V}$ and $0.8 \text{ V}$  | 3    | 5               | 8    | %             |
|  |   | $V_{IT-} = 0.9 \text{ V}$ to $5.4 \text{ V}$   | 3    | 5               | 7    |               |
| $I_{SENSE}$                              | Current into Sense pin, fixed threshold version                       | $V_{DD} = V_{SENSE} = 6 \text{ V}$   |      | 0.025           | 0.1  | $\mu\text{A}$ |
|  | Current into Sense pin, ADJ version                                   | $V_{DD} = V_{SENSE} = 6 \text{ V}$   |      | 0.025           | 0.05 | $\mu\text{A}$ |
| $I_{DD}$                                 | Supply current into VDD pin when sense pin is separate                | $V_{DD} = V_{SENSE} = 6 \text{ V}$<br>$V_{IT-} = 0.505 \text{ V}$ and $0.8 \text{ V}$ to $5.4 \text{ V}$ |      | 0.125           | 1    | $\mu\text{A}$ |
| $V_{TH\_CTS}$                            | Voltage threshold to stop CTS capacitor charge and assert RESET       |  |      | $0.73 * V_{DD}$ |      | V             |
| $V_{TH\_CTR}$                            | Voltage threshold to stop CTR capacitor charge and deassert RESET     |  |      | $0.73 * V_{DD}$ |      | V             |
| $R_{CTS}$                                | CTS pin internal pull up resistance                                   |  |      | 500             |      | k $\Omega$    |
| $R_{CTR}$                                | CTR pin internal pull up resistance                                   |  |      | 500             |      | k $\Omega$    |
| <b>TPS3899DL (Open-drain active-low)</b> |   |  |      |                 |      |               |
| $V_{POR}$                                | Power on reset voltage <sup>(2)</sup>                                 | $V_{OL(max)} = 300 \text{ mV}$<br>$I_{RESET(Sink)} = 15 \mu\text{A}$                                     |      |                 | 700  | mV            |
| $V_{OL}$                                 | Low level output voltage  | $V_{DD} = 0.85 \text{ V}$<br>$I_{RESET(Sink)} = 15 \mu\text{A}$  |      |                 | 300  | mV            |
|  |   | $V_{DD} = 3.3 \text{ V}$<br>$I_{RESET(Sink)} = 2 \text{ mA}$   |      |                 | 300  |               |
| $I_{lk(OD)}$                             | Open-Drain output leakage current                                     | $V_{DD} = V_{PULLUP} = 6 \text{ V}$ , $T_A = -40^{\circ}\text{C}$ to $85^{\circ}\text{C}$                |      | 10              | 100  | nA            |
|  |   | $V_{DD} = V_{PULLUP} = 6 \text{ V}$  |      | 10              | 350  |               |
| <b>TPS3899PL (Push-pull active-low)</b>  |   |  |      |                 |      |               |
| $V_{POR}$                                | Power on reset voltage <sup>(2)</sup>                                 | $V_{OL(max)} = 300 \text{ mV}$<br>$I_{RESET(Sink)} = 15 \mu\text{A}$                                     |      |                 | 700  | mV            |
| $V_{OL}$                                 | Low level output voltage  | $V_{DD} = 0.85 \text{ V}$<br>$I_{RESET(Sink)} = 15 \mu\text{A}$  |      |                 | 300  | mV            |
|  |   | $V_{DD} = 3.3 \text{ V}$<br>$I_{RESET(Sink)} = 2 \text{ mA}$   |      |                 | 300  |               |
| $V_{OH}$                                 | High level output voltage   | $V_{DD} = 1.8 \text{ V}$<br>$I_{RESET(Source)} = 500 \mu\text{A}$  |      | $0.8V_{DD}$     |      | V             |
|  |   | $V_{DD} = 3.3 \text{ V}$<br>$I_{RESET(Source)} = 500 \mu\text{A}$  |      | $0.8V_{DD}$     |      |               |
|  |   | $V_{DD} = 6 \text{ V}$<br>$I_{RESET(Source)} = 2 \text{ mA}$   |      | $0.8V_{DD}$     |      |               |

## 5.5 Electrical Characteristics (続き)

CTR = CTS = Open, RESET pull-up resistor ( $R_{pull-up}$ ) = 100 k $\Omega$  to  $V_{DD}$ , output reset load ( $C_{LOAD}$ ) = 10 pF and over the operating free-air temperature range  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , unless otherwise noted.  $V_{DD}$  ramp rate  $\leq 1 \text{ V}/\mu\text{s}$ . Typical values are at  $T_A = 25^{\circ}\text{C}$

| PARAMETER                                | TEST CONDITIONS                       | MIN   | TYP         | MAX | UNIT |
|--|---------------------------------------|---|-------------|-----|------|
| <b>TPS3899PH (Push-pull active-high)</b> |                                       |   |             |     |      |
| $V_{POR}$                                | Power on reset voltage <sup>(2)</sup> |   |             | 900 | mV   |
| $V_{OL}$                                 | Low level output voltage              | $V_{OH(min)} = 0.8V_{DD}$<br>$I_{RESET(SOURCE)} = 15 \mu\text{A}$ |             |     |      |
|  |                                       | $V_{DD} = 3.3 \text{ V}$<br>$I_{RESET(SINK)} = 500 \mu\text{A}$   |             | 300 | mV   |
| $V_{OH}$                                 | High level output voltage             | $V_{DD} = 6 \text{ V}$<br>$I_{RESET(SINK)} = 2 \text{ mA}$        |             | 300 | mV   |
|  |                                       | $V_{DD} = 1 \text{ V}$<br>$I_{RESET(SINK)} = 15 \mu\text{A}$      | $0.8V_{DD}$ |     | V    |
|  |                                       | $V_{DD} = 1.5 \text{ V}$<br>$I_{RESET(SINK)} = 500 \mu\text{A}$   | $0.8V_{DD}$ |     | V    |
|  |                                       | $V_{DD} = 3.3 \text{ V}$<br>$I_{RESET(SINK)} = 2 \text{ mA}$      | $0.8V_{DD}$ |     | V    |

- $V_{IT-}$  threshold voltage range from 0.8 V to 5.4 V (for DL, PL) and 1 to 5.4 V (for PH) in 100 mV steps, for released versions see Device Voltage Thresholds table.
- Minimum  $V_{DD}$  voltage level for a controlled output state. Below  $V_{POR}$ , the output cannot be determined.

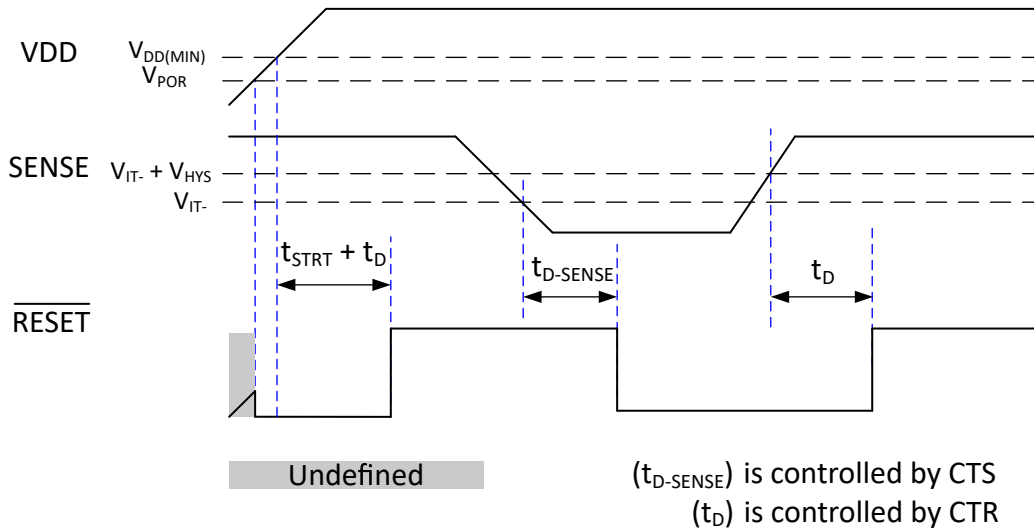
## 5.6 Timing Requirements

At  $0.85 \text{ V} \leq V_{DD} \leq 6 \text{ V}$ , CTR = CTS = Open, RESET pull-up resistor ( $R_{pull-up}$ ) = 100 k $\Omega$  to  $V_{DD}$ , output reset load ( $C_{LOAD}$ ) = 10 pF and over the operating free-air temperature range  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , unless otherwise noted.  $V_{DD}$  ramp rate  $\leq 1 \text{ V} / \mu\text{s}$ . Typical values are at  $T_A = 25^{\circ}\text{C}$

| PARAMETER      | TEST CONDITIONS   | MIN                                      | TYP | MAX | UNIT          |               |
|----------------|---|--|-----|-----|---------------|---------------|
| $t_{STRT}$     | Startup Delay <sup>(1)</sup>  |  |     | 300 | $\mu\text{s}$ |               |
| $t_{D-SENSE}$  | Detect time delay<br>$V_{DD} = (V_{IT+} + 10\%)$ to $(V_{IT-} - 10\%)$ <sup>(2)</sup> | CTS pin = Open or NC                     |     | 30  | 50            | $\mu\text{s}$ |
|                |   | CTS pin = 10 nF                          |     | 6.2 |               | ms            |
|                |   | CTS pin = 1 $\mu\text{F}$                |     | 619 |               | ms            |
| $t_D$          | Reset time delay  | CTR pin = Open or NC                     |     | 40  | 80            | $\mu\text{s}$ |
|                |   | CTR pin = 10 nF <sup>(3)</sup>           |     | 6.2 |               | ms            |
|                |   | CTR pin = 1 $\mu\text{F}$ <sup>(3)</sup> |     | 619 |               | ms            |
| $t_{GL\_VIT-}$ | Glitch immunity $V_{IT-}$   | 5% $V_{IT-}$ overdrive <sup>(4)</sup>    |     | 10  | $\mu\text{s}$ |               |

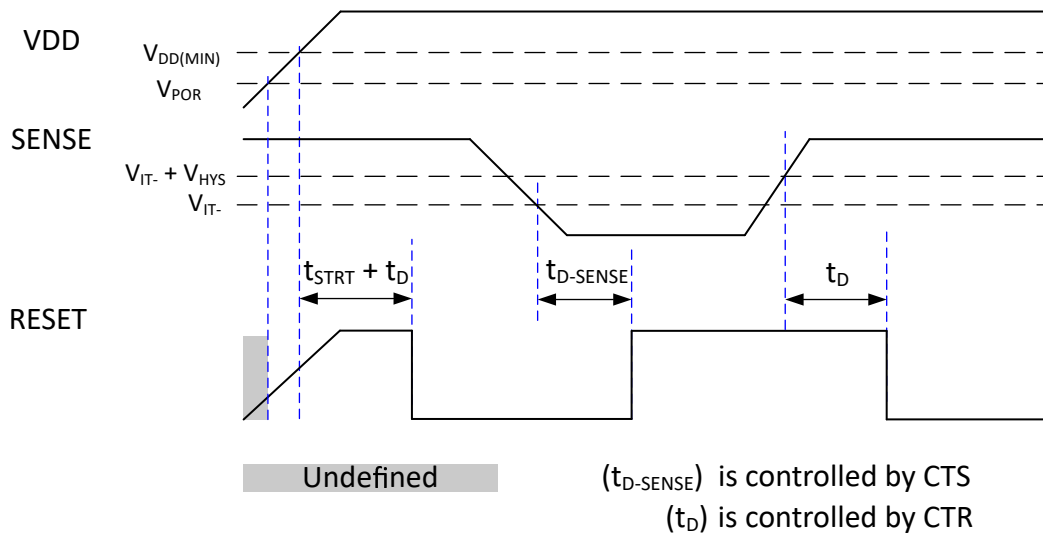
- When  $V_{DD}$  starts from less than  $V_{POR}$  and then exceeds the specified minimum  $V_{DD}$ , reset is asserted till startup delay ( $t_{STRT}$ ) +  $t_D$  delay based on capacitor on CTR pin. After this time, the device controls the RESET pin based on the SENSE pin voltage.
- $t_{D-SENSE}$  measured from threshold trip point ( $V_{IT-}$ ) to  $V_{OL}$  for active low variants and  $V_{OH}$  for active high variants.
- Ideal capacitor
- Overdrive % =  $[(V_{DD} / V_{IT-}) - 1] \times 100\%$

## 5.7 Timing Diagrams



(1)  $t_{D (no\ cap)}$  is included in  $t_{STRT}$  time delay. If  $t_D$  delay is programmed by an external capacitor connected to the CTR pin then  $t_D$  programmed time will be added to the startup time.

5-1. TPS3899DL01 and TPS3899PL01 Timing Diagram

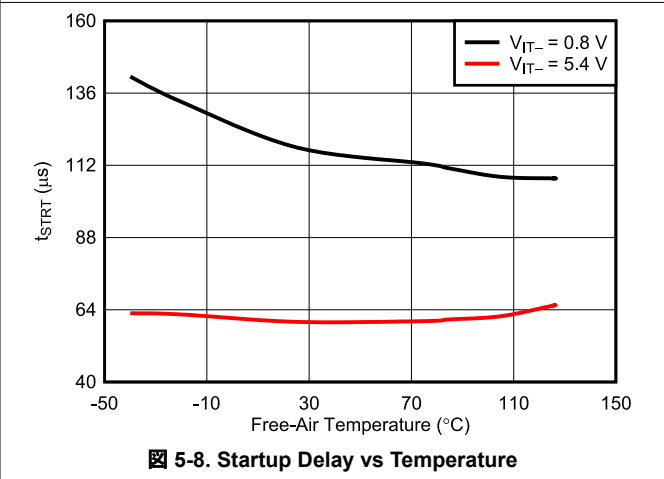
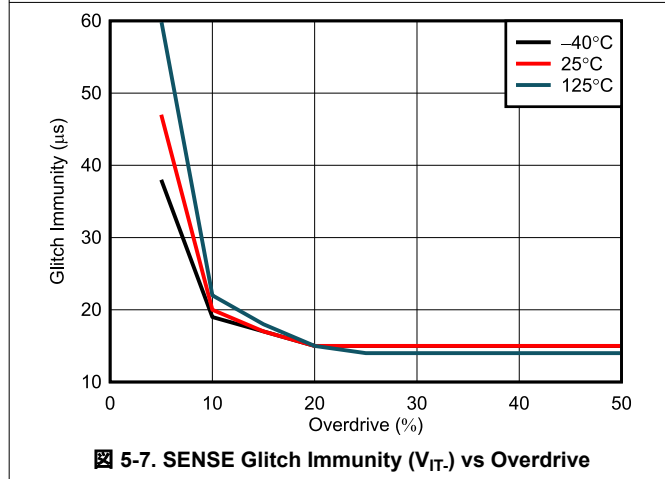
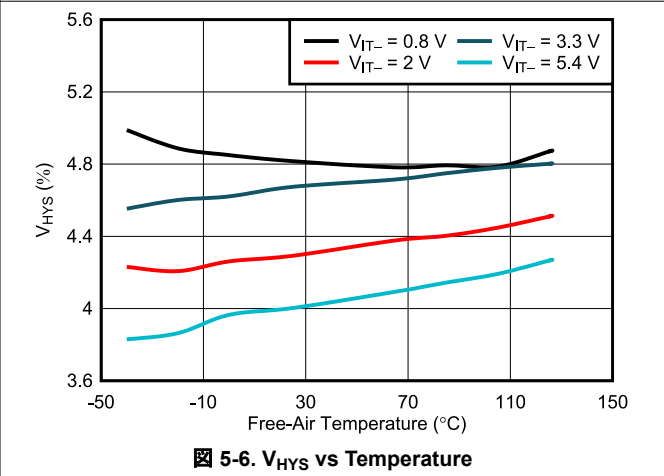
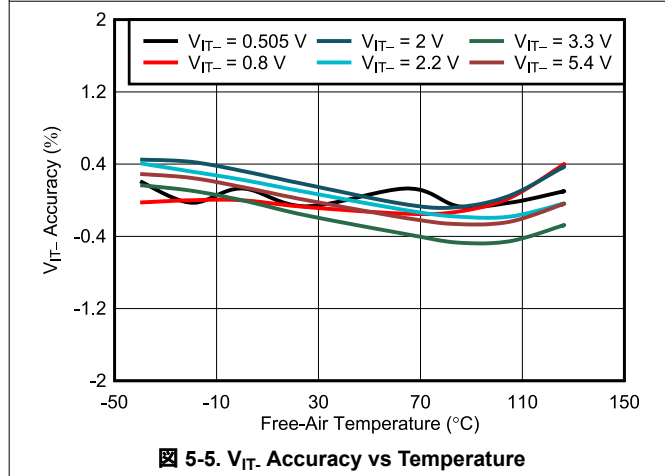
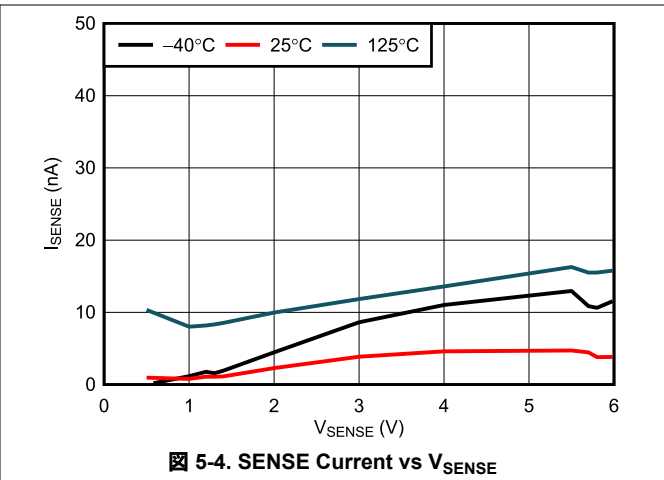
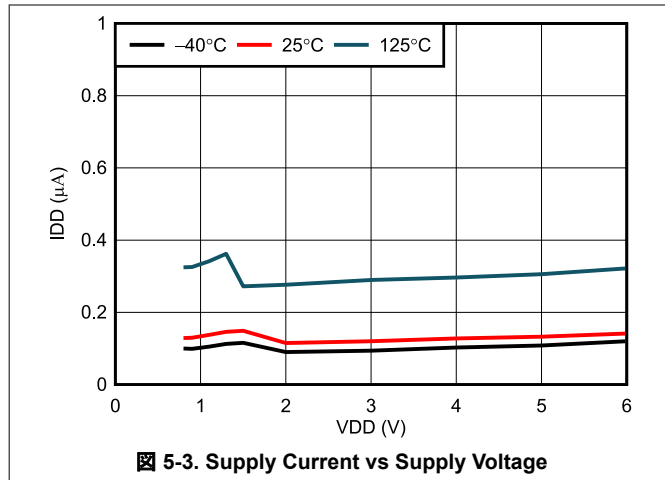


(2)  $t_{D (no\ cap)}$  is included in  $t_{STRT}$  time delay. If  $t_D$  delay is programmed by an external capacitor connected to the CTR pin then  $t_D$  programmed time will be added to the startup time.

5-2. TPS3899PH01 Timing Diagram

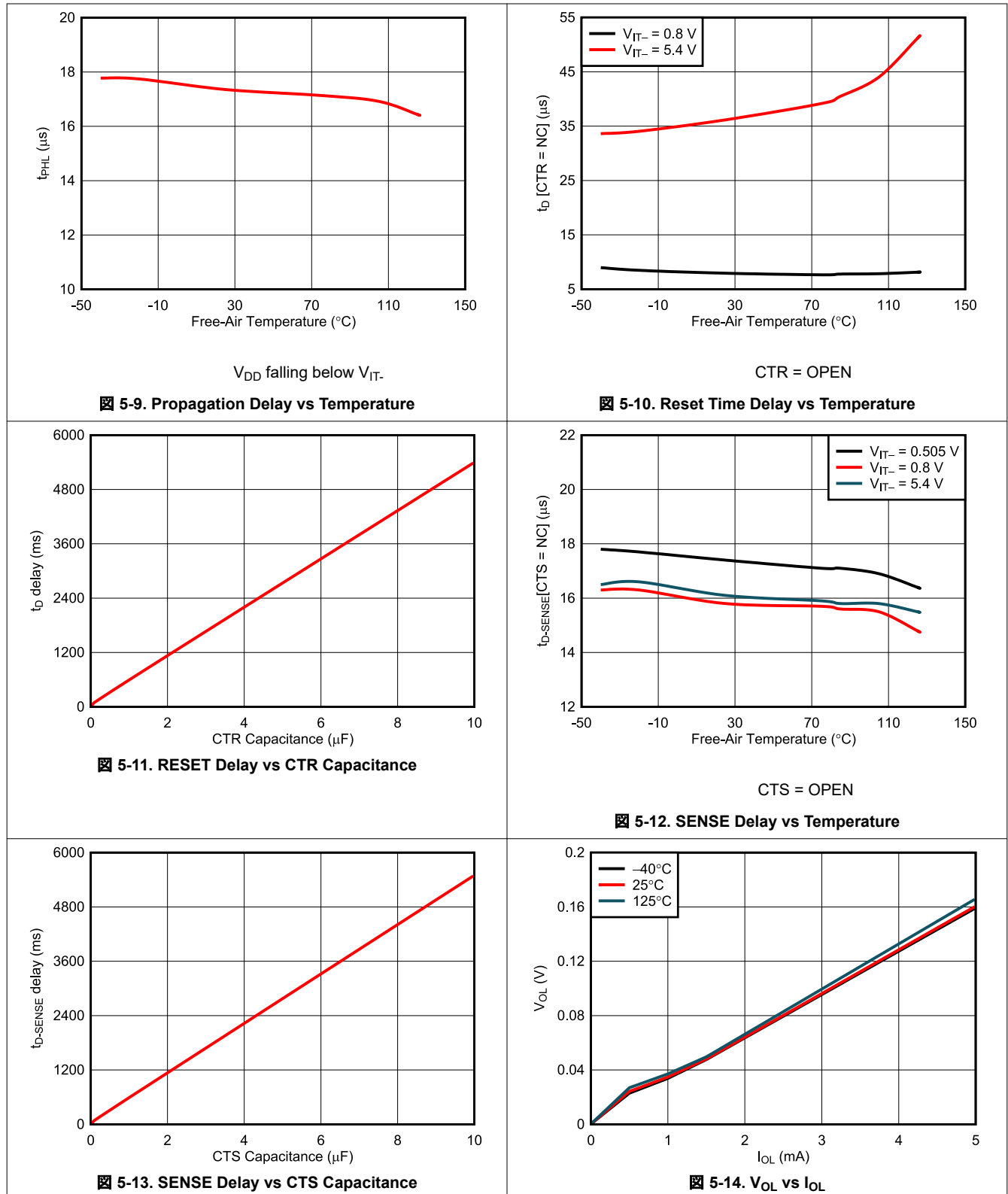
## 5.8 Typical Characteristics

Typical characteristics show the typical performance of the TPS3899 device. Test conditions are  $T_A = 25^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V}$ , and  $R_{\text{pull-up}} = 100\text{k}\Omega$ , unless otherwise noted.



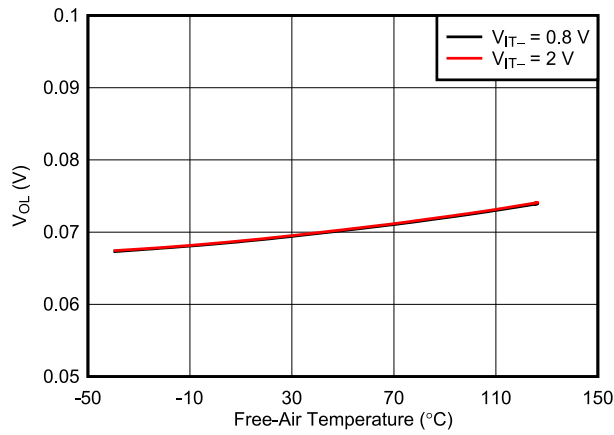
## 5.8 Typical Characteristics (continued)

Typical characteristics show the typical performance of the TPS3899 device. Test conditions are  $T_A = 25^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V}$ , and  $R_{\text{pull-up}} = 100\text{k}\Omega$ , unless otherwise noted.



### 5.8 Typical Characteristics (continued)

Typical characteristics show the typical performance of the TPS3899 device. Test conditions are  $T_A = 25^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V}$ , and  $R_{\text{pull-up}} = 100\text{k}\Omega$ , unless otherwise noted.



5-15.  $V_{OL}$  vs Temperature

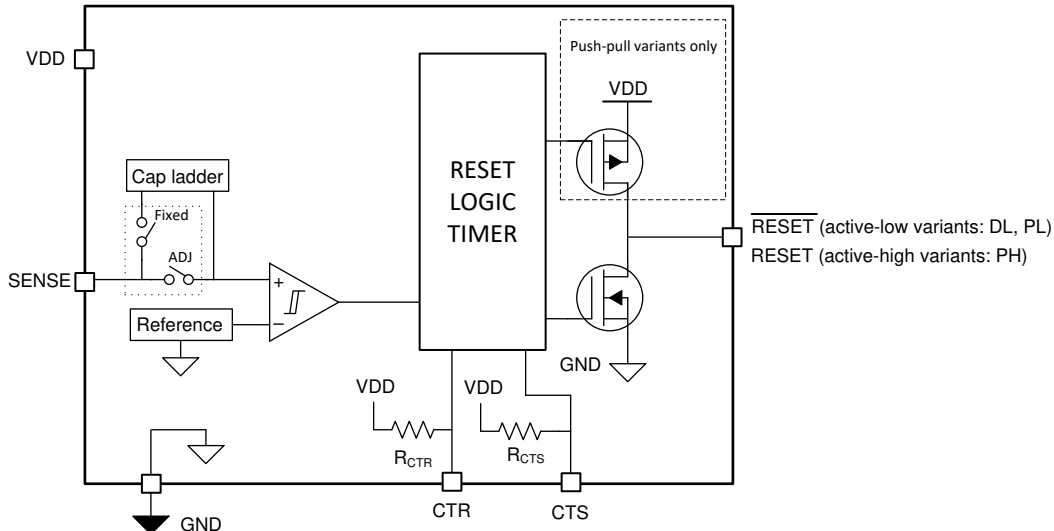
## 6 Detailed Description

### 6.1 Overview

The TPS3899 voltage supervisor with push-button monitor asserts a  $\overline{\text{RESET}}$ /RESET signal when the SENSE pin voltage drops below  $V_{IT-}$  for the duration of the sense delay set by CTS. If the SENSE pin voltage rises above  $V_{IT-} + V_{HYS}$  before the sense delay expires, the  $\overline{\text{RESET}}$ /RESET pin does not assert. When asserted, the  $\overline{\text{RESET}}$ /RESET output remains asserted until SENSE voltage returns above  $V_{IT-} + V_{HYS}$  for the duration of the reset delay set by CTR. If the SENSE pin voltage falls below  $V_{IT-}$  before the reset delay expires while  $\overline{\text{RESET}}$  is asserted,  $\overline{\text{RESET}}$ /RESET will remain asserted.

Like most voltage supervisors, the TPS3899 includes a reset delay  $t_D$  to provide time for the power and clocks to settle before letting the processor out of reset. At power up, the circuits inside the TPS3899 need additional time to start the reset delay timer after its power supply VDD has reached minimum  $V_{DD(MIN)}$  for these circuits to start operating properly. This additional time is specified with the parameter start-up delay  $t_{STRT}$ . [Figure 5-1](#) shows the timing diagram indicating this additional delay. After VDD is stable and above  $V_{DD(MIN)}$  subsequent changes of the sense voltage across the threshold voltage will trigger reset after only the reset delay. The reset time delay  $t_D$  is set by a capacitor on the CTR pin. The start-up delay has a max spec limit of 300 $\mu$ s for a ramp rate of  $V_{DD} \leq 1V/\mu$ s.

### 6.2 Functional Block Diagram



### 6.3 Feature Description

The combination of user-adjustable sense delay time via CTS and reset delay time via CTR with a broad range of threshold voltages allow these devices to be used in a wide array of applications. Fixed negative threshold voltages  $V_{IT-}$  can be factory set from 0.8V to 5.4V in steps of 100mV [1.1V to 5.4V for the -PH (push-pull active high) variants]. CTS and CTR pins allow the sense delay and reset delay to be set to typical values of 30 $\mu$ s and 40 $\mu$ s, respectively, by leaving these pins floating. External capacitors can be placed on the CTS and CTR pins to program the sense and reset delays independently.

#### 6.3.1 VDD Hysteresis

The internal comparator has built-in hysteresis to avoid erroneous output reset release. If the voltage at the VDD pin falls below  $V_{IT-}$  the output reset is asserted. When the voltage at the VDD pin goes above  $V_{IT-}$  plus hysteresis ( $V_{HYS}$ ) the output reset is deasserted after  $t_D$  delay.

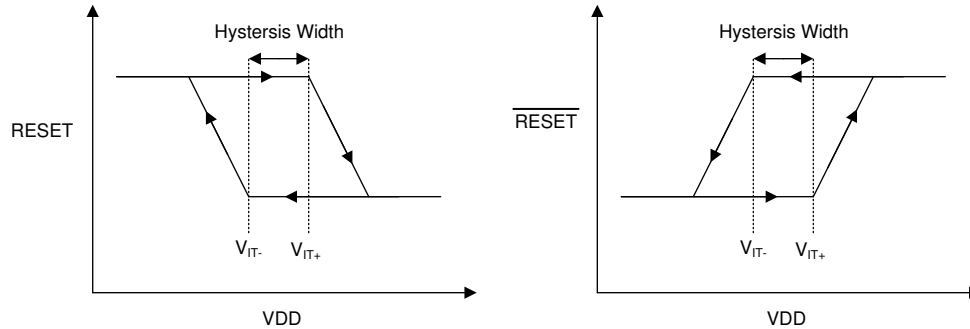


図 6-1. Hysteresis Diagram

### 6.3.2 User-Programmable Sense and Reset Time Delay

The sense delay corresponds to the configuration of CTS and the reset delay corresponds to the configuration of CTR. The sense and reset time delay can be set to a minimum value of 50 $\mu$ s and 80 $\mu$ s by leaving the CTS and CTR pins floating respectively, or a maximum value of approximately 6.5 seconds by connecting 10 $\mu$ F delay capacitor.

The relationship between external capacitor ( $C_{CT\_EXT}$ ) in Farads at CTS or CTR pins and the time delay in seconds is given by 式 1.

$$t_D = -\ln(0.27) \times R_{CT} \times C_{CT\_EXT} + t_{D(CTS \text{ or } CTR = OPEN)} \quad (1)$$

式 1 is simplified to 式 2 and 式 3 by plugging  $R_{CT}$  and  $t_{D(CTS \text{ or } CTR = OPEN)}$  given in セクション 5.5 and セクション 5.6 section:

$$t_{D-SENSE} = 654666 \times C_{CTS\_EXT} + 50\mu s \quad (2)$$

$$t_D = 654666 \times C_{CTR\_EXT} + 80\mu s \quad (3)$$

式 4 and 式 5 solves for both external capacitor values ( $C_{CTS\_EXT}$ ) and ( $C_{CTR\_EXT}$ ) in units of Farads where  $t_{D-SENSE}$  and  $t_D$  are in units of seconds

$$C_{CTS\_EXT} = (t_{D-SENSE} - 50\mu s) \div 654666 \quad (4)$$

$$C_{CTR\_EXT} = (t_D - 80\mu s) \div 654666 \quad (5)$$

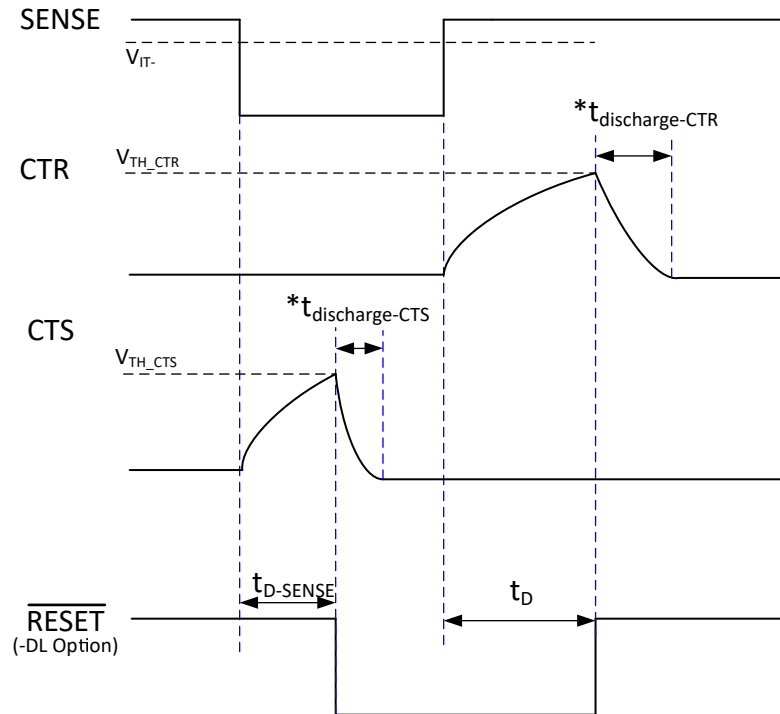
The sense or reset delay varies according to three variables: the external capacitor ( $C_{CT\_EXT}$ ), CTS and CTR pin internal resistance ( $R_{CT}$ ) provided in the Electrical Characteristics table, and a constant. The minimum and maximum variance due to the constant is show in 式 6 and 式 7 .

$$t_{D-SENSE(min)} = -\ln(0.29) \times R_{CT(min)} \times C_{CT\_EXT(min)} + t_{D(no \text{ cap, min})} \quad (6)$$

$$t_{D-SENSE(max)} = -\ln(0.25) \times R_{CT(max)} \times C_{CT\_EXT(max)} + t_{D(no \text{ cap, max})} \quad (7)$$

The recommended maximum sense and reset delay capacitors for the TPS3899 is limited to 10 $\mu$ F as this makes sure there is enough time for either capacitors to fully discharge when a voltage fault occurs. When a voltage fault occurs, the previously charged up capacitor discharges and if the monitored voltage returns from the fault condition before either delay capacitors discharges completely, both delays can be shorter than expected. The capacitors can begin charging from a voltage above zero and resulting in shorter than expected time delays. Larger delay capacitors can be used so long as the capacitors have enough time to fully discharge during the duration of the voltage fault. To make sure the capacitors are fully discharged, the time period or duration of the voltage fault needs to be greater than 10% of the programmed reset time delay.

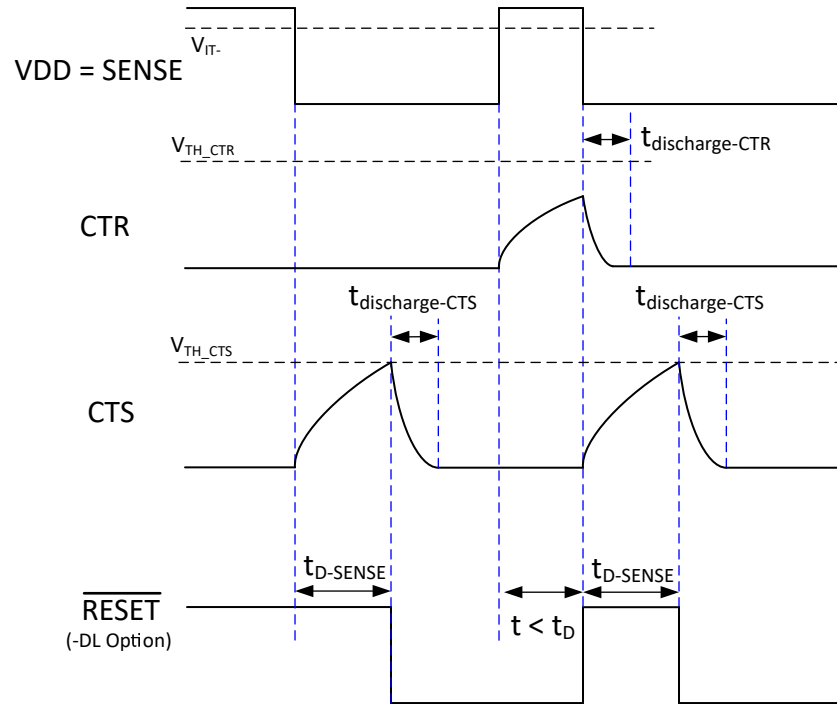
Figure 6-2 shows the charge and discharge behavior on CTS and CTR that defines the sense and reset delays respectively. When SENSE transitions below  $V_{IT-}$ , the capacitor connected to CTS begins to charge. Once the CTS capacitor charges to an internal threshold shown as  $V_{TH\_CTS}$ ,  $\overline{RESET}$  transitions to active-low logic state and the CTS capacitor then begins to discharge immediately. When SENSE transitions above  $V_{IT-} + V_{HYS}$ , the capacitor connected to CTR begins to charge. Once the CTR capacitor charges to the internal threshold  $V_{TH\_CTR}$ ,  $\overline{RESET}$  releases back to inactive logic high state and the CTR capacitor begins to discharge immediately. Please note that for active-high variants,  $\overline{RESET}$  follows the inverse behavior of  $\overline{RESET}$ .



\*  $t_{discharge-CTS}$  and  $t_{discharge-CTR}$ : To ensure the capacitors are fully discharged, the time period or duration of the voltage fault needs to be greater than 10% of the programmed reset time delay.

Figure 6-2. CTS and CTR Charge and Discharge Behavior Relative to SENSE and  $\overline{RESET}$

Figure 6-3 shows the charge and discharge behavior on CTS and CTR where the monitored voltage is VDD. Similar to Figure 6-2, Figure 6-3 illustrates a SENSE signal that is transitioning below  $V_{IT-}$  before the CTR capacitor reaches to an internal threshold voltage  $V_{TH\_CTR}$  and  $t < t_D$ . The result of the CTR capacitor not reaching the internal threshold voltage  $V_{TH\_CTR}$  is  $\overline{\text{RESET}}$  becomes deasserted. Once  $\overline{\text{RESET}}$  is deasserted, charging begins for the CTS capacitor. When the CTS voltage reaches the internal threshold  $V_{TH\_CTS}$ ,  $\overline{\text{RESET}}$  becomes asserted. This phenomenon is caused by the SENSE falling edge triggering the discharging of the CTR capacitor and producing a deassert signal on the  $\overline{\text{RESET}}$  output.



\*  $t_{\text{discharge-CTS}}$  and  $t_{\text{discharge-CTR}}$ : To ensure the capacitors are fully discharged, the time period or duration of the voltage fault needs to be greater than 10% of the programmed reset time delay.

### Figure 6-3. CTS and CTR Charge and Discharge Behavior Relative to VDD, SENSE and $\overline{\text{RESET}}$

#### 6.3.3 $\overline{\text{RESET}}$ /RESET Output

Upon power up,  $\overline{\text{RESET}}$ /RESET begins asserted and remains asserted until the SENSE pin voltage rises above the positive voltage threshold  $V_{IT-} + V_{HYS}$  for the duration of the reset delay set by CTR. After the SENSE pin voltage is above  $V_{IT-} + V_{HYS}$  for the reset delay,  $\overline{\text{RESET}}$ /RESET deasserts.  $\overline{\text{RESET}}$ /RESET remains deasserted long as the SENSE pin voltage is above the positive threshold. If the SENSE pin voltage falls below the negative threshold ( $V_{IT-}$ ) for the duration of the sense delay set by CTS, then  $\overline{\text{RESET}}$ /RESET is asserted.

An external pull-up resistor is required for the open-drain variants. Connect the external pull-up resistor to the proper voltage rail to enable the outputs to be connected to other devices at the correct interface voltage level.  $\overline{\text{RESET}}$ /RESET can be pulled up to any voltage up to 6.0V, independent of the device supply voltage.

#### 6.3.4 SENSE Input

The SENSE input can vary from 0V to 6.0V, regardless of the device supply voltage used. The SENSE pin is used to monitor a critical voltage rail or push-button input. If the voltage on this pin drops below  $V_{IT-}$ , then  $\overline{\text{RESET}}$ /RESET is asserted after the sense delay time set by CTS. When the voltage on the SENSE pin rises above the positive threshold voltage  $V_{IT-} + V_{HYS}$ ,  $\overline{\text{RESET}}$ /RESET deasserts after the reset delay time set by CTR. The internal comparator has built-in hysteresis to make sure well-defined  $\overline{\text{RESET}}$ /RESET assertions and deassertions even when there are small changes on the voltage rail being monitored.

The TPS3899 device is relatively immune to short transients on the SENSE pin. Glitch immunity ( $t_{GI\_V_{IT\_SENSE}}$ ), found in セクション 5.6, is dependent on threshold overdrive, as illustrated in 図 5-7. Although not required in most cases, for noisy applications, good analog design practice is to place a 10nF to 100nF bypass capacitor at the SENSE input to reduce sensitivity to transient voltages on the monitored signal.

### 6.3.4.1 Immunity to SENSE Pin Voltage Transients

The TPS3899 is immune to short voltage transient spikes on the input pins. To further improve the noise immunity on the SENSE pin, placing a 10nF to 100nF capacitor between the SENSE pin and GND can reduce the sensitivity to transient voltages on the monitored signal.

Sensitivity to transients depends on both transient duration and overdrive (amplitude) of the transient. Overdrive is defined by how much  $V_{SENSE}$  exceeds the specified threshold, and is important to know because the smaller the overdrive, the slower the response of the outputs. Threshold overdrive is calculated as a percent of the threshold in question, as shown in 式 8.

$$\text{Overdrive} = |((V_{SENSE} / V_{IT-}) - 1) \times 100\%| \quad (8)$$

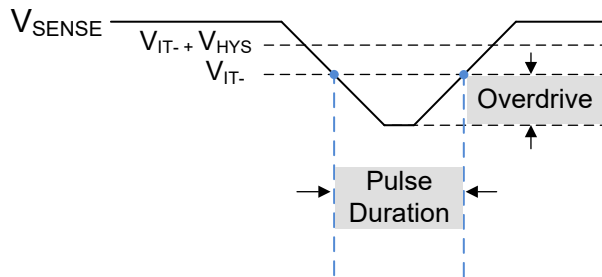


図 6-4. Overdrive vs Pulse Duration

## 6.4 Device Functional Modes

表 6-1 summarizes the various functional modes of the device.

表 6-1. Truth Table

| $V_{DD}$  | SENSE <sup>(1)</sup>            | RESET     | RESET     |
|---|---------------------------------|-----------|-----------|
| $V_{DD} < V_{POR}$                              | —                               | Undefined | Undefined |
| $V_{POR} < V_{DD} < V_{DD(MIN)}$ <sup>(2)</sup> | —                               | L         | H         |
| $V_{DD} \geq V_{DD(MIN)}$                       | $V_{SENSE} < V_{IT-}$           | L         | H         |
| $V_{DD} \geq V_{DD(MIN)}$                       | $V_{SENSE} > V_{IT-} + V_{HYS}$ | H         | L         |

- (1) SENSE pin voltage must be less than  $V_{IT-}$  for the sense delay set by CTS or greater than  $V_{IT-} + V_{HYS}$  for the reset delay set by CTR before RESET transitions
- (2) When  $V_{DD}$  falls below  $V_{DD(MIN)}$ , undervoltage-lockout (UVLO) takes effect and  $\overline{\text{RESET}}$  is held logic low (RESET is held logic high) until  $V_{DD}$  falls below  $V_{POR}$  at which the  $\overline{\text{RESET}}$ /RESET output is undefined.

### 6.4.1 Normal Operation ( $V_{DD} > V_{DD(min)}$ )

When  $V_{DD}$  is greater than  $V_{DD(min)}$ , the  $\overline{\text{RESET}}$ /RESET pin is determined by the voltage on the SENSE pin and the sense delay and reset delay set by CTS and CTR respectively.

### 6.4.2 Above Power-On-Reset But Less Than $V_{DD(min)}$ ( $V_{POR} < V_{DD} < V_{DD(min)}$ )

When the voltage on  $V_{DD}$  is less than the  $V_{DD(min)}$  voltage, and greater than the power-on-reset voltage  $V_{POR}$ , the  $\overline{\text{RESET}}$ /RESET signal is asserted regardless of the voltage on the SENSE pin.

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

When the voltage on  $V_{DD}$  is lower than  $V_{POR}$ , the device does not have enough voltage to internally pull the asserted  $\overline{RESET}$  output low and  $\overline{RESET}$  is undefined.  $\overline{RESET}$  is also undefined and can pull up to  $V_{DD}$  or to the pull-up voltage. Neither output can be relied upon for proper device function.

## 7 Application and Implementation

### 注

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.

### 7.1 Application Information

The following sections describe in detail how to properly use this device, depending on the requirements of the final application.

### 7.2 Typical Application

#### Design 1: Adjustable Voltage Supervisor with Push-Button Functionality

A typical application for the TPS3899 is voltage rail monitoring with push-button functionality and specific timing requirements.

In this design application, the TPS3899DL01 is being used to monitor a 3.3V power rail and triggers a reset when the voltage drops below 2.9V or when the push-button is pressed. The reset output connects to an MCU for system resetting or servicing the push-button.

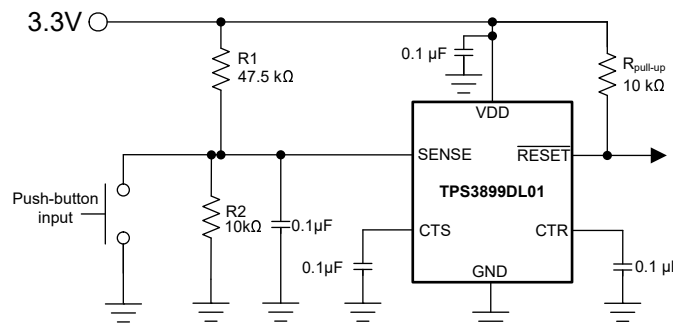


図 7-1. Design 1 - Adjustable Voltage Supervisor with Push-Button Functionality Circuit

#### 7.2.1 Design Requirements

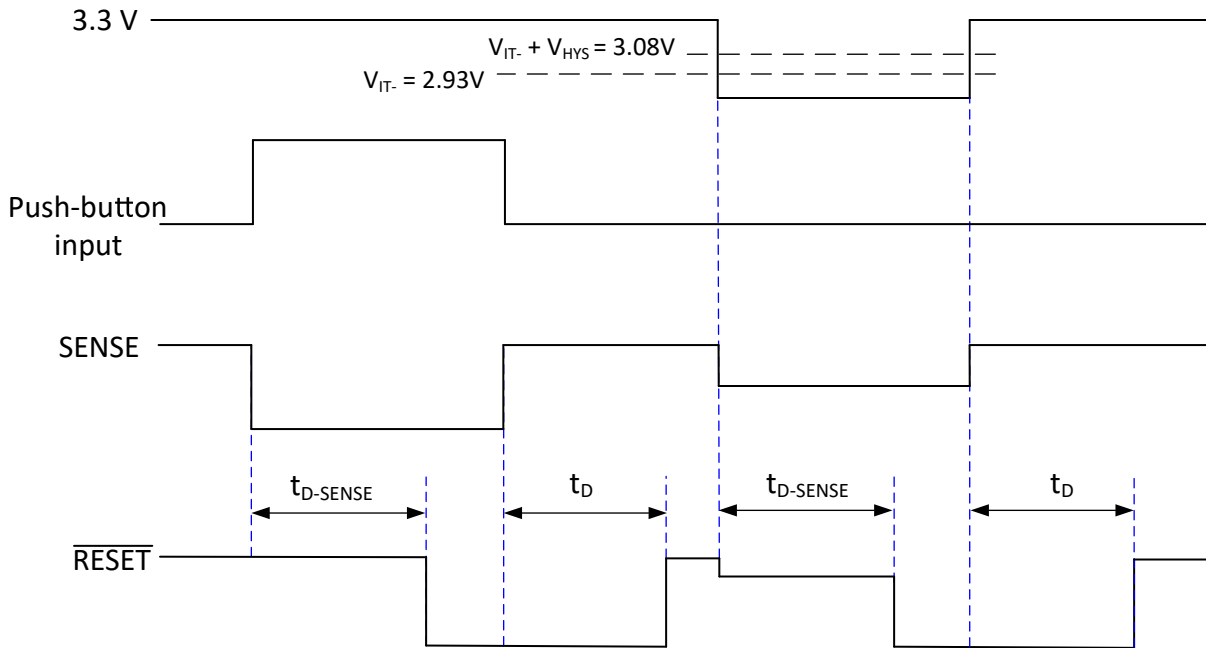
The design requirements, described in 表 7-1, for this design has a defined reset threshold voltage of 2.9V, a sense delay of 60ms, a reset delay of 60ms, and an output current no larger than 500μA.

表 7-1. Design Requirements

| PARAMETER              | DESIGN REQUIREMENTS  | DESIGN RESULTS   |
|------------------------|--|--|
| Reset Asserting        | Reset needs to assert when under the reset condition of a button press or $V_{DD} \leq 2.9V$ .                                     | Reset asserts when under the reset condition of a button press or $V_{DD} \leq 2.93V$ .                          |
| Reset Asserting Timing | Reset output needs to assert when the reset conditions are met for 60ms, and needs to de-assert after 60ms of no reset conditions. | Reset output asserts when the reset conditions are met for 62ms and deasserts after 62ms of no reset conditions. |
| Output Current         | The output current must not exceed 500μA.  | The output current is 300μA under the reset condition.   |

## 7.2.2 Detailed Design Procedure

The TPS3899DL01 can monitor any voltage above 0.505V using an external voltage divider. This device has a negative going input threshold voltage of 0.505V; however, the design needs to assert a reset when VDD drops below 2.9V. By using a resistor divider ( $R1 = 47.5k\Omega$ ,  $R2 = 10k\Omega$ ) the negative going threshold voltage becomes 2.93V. The device's positive going voltage threshold is  $V_{IT-} + V_{HYS}$ . The typical  $V_{HYS}$  is 25.5mV. This in combination with the resistor divider makes the design's positive going threshold voltage equal to 3.08V. If VDD falls below 2.93V for the duration of sense delay ( $t_{D-SENSE}$ ), the reset asserts. If VDD rises above 3.08V for the duration of reset delay ( $t_D$ ), the reset deasserts. See [Figure 7-2](#) for a timing diagram detailing the voltage levels and reset assertion/deassertion conditions.



**Figure 7-2. Design 1 Timing Diagram**

This design also enters a reset condition when the push-button (PB) is asserted. The push-button is tied to ground and when pressed drops the SENSE voltage to 0V, making the device assert a reset. As a good analog practice, a 0.1 $\mu$ F capacitor was also placed on VDD.

The desired reset timing conditions are sense delay time of 60ms (the time to trigger a reset) and a reset delay time of 60ms (the time to recover from a reset). Using [Equation 4](#) and [Equation 5](#), respectively, to solve for CTS and CTR capacitor values, CTS = 0.1 $\mu$ F and CTR = 0.1 $\mu$ F. These capacitor values give a nominal sense delay time of 62ms and nominal reset delay time of 62ms. [Figure 7-3](#) and

[Figure 7-4](#) are the results of the described application where the measured sense and reset delay time are shown respectively.

For the requirement of a maximum output current, an external pull-up resistor needs to be selected so that the current through the external pull-up resistor exceeds no more than 500 $\mu$ A. When the reset output is low, the voltage drop across the external pull-up resistor is equal to VDD. Ohm's law is used to calculate the minimum resistor value. The resistor needs to be greater than 6k $\Omega$  to pull less than 500 $\mu$ A in the reset asserted low condition. A resistor value of 10k $\Omega$  was selected to accomplish this.

Note that this design does not account for tolerances.

### 7.2.3 Application Curves



図 7-3. Sense Delay

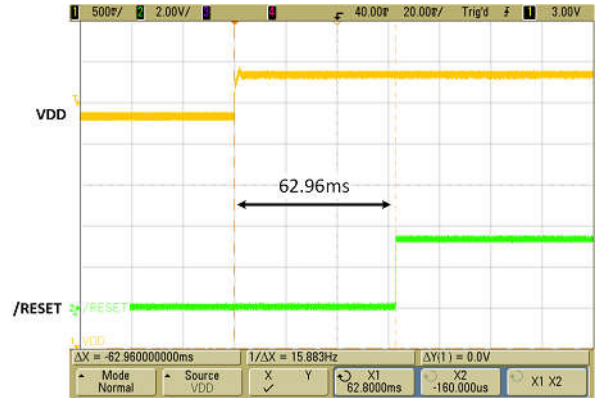


図 7-4. Reset Delay

## 7.2.4 Power Supply Recommendations

The TPS3899 is designed to operate from an input supply with a voltage range between 0.85V and 6V. An input supply capacitor is not required for this device; however, if the input supply is noisy, then good analog practice is to place a 0.1 $\mu$ F capacitor between the VDD pin and the GND pin. Also, placing a 10nF to 100nF capacitor between the SENSE pin and GND can reduce the sensitivity to transient voltages on the monitored signal. This device has a 6.5V absolute maximum rating on the VDD pin. If the voltage supply providing power to VDD is susceptible to any large voltage transient that can exceed 6.5V, additional precautions must be taken.

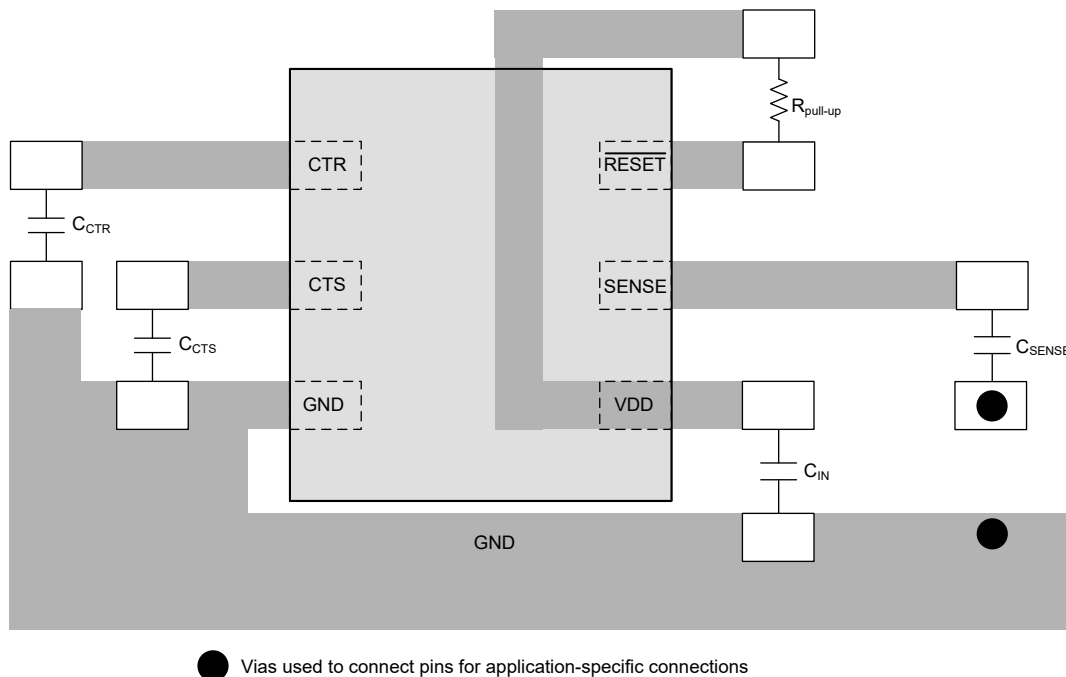
## 7.2.5 Layout

### 7.2.5.1 Layout Guidelines

Make sure that the connection to the VDD pin is low impedance. Good analog design practice is to place a 0.1 $\mu$ F ceramic capacitor near the VDD pin. If a capacitor is not connected to the CTS or CTS pins, then minimize parasitic capacitance on this pin so the sense delay or reset delay times are not adversely affected. For fixed voltage threshold devices, good analog design practice is to place a 0.1 $\mu$ F ceramic capacitor near the SENSE pin.

### 7.2.5.2 Layout Example

The layout example in [Figure 7-5](#) shows how the TPS3899 is laid out on a printed circuit board (PCB) with a user-defined sense delay and reset delay.



**Figure 7-5. Recommended Layout**

## 8 Device and Documentation Support

### 8.1 Device Support

#### 8.1.1 Device Nomenclature

☒ 4-1 in [Device Comparison](#) shows how to decode the function of the device based on its part number shown in [表 8-1](#).

**表 8-1. Device Naming Convention**

| ORDERABLE DEVICE NAME       |                            |                             | THRESHOLD VOLTAGE (V) |
|-----------------------------|----------------------------|-----------------------------|-----------------------|
| -DL (OPEN-DRAIN ACTIVE-LOW) | -PL (PUSH-PULL ACTIVE-LOW) | -PH (PUSH-PULL ACTIVE-HIGH) |                       |
| TPS3899DL01DSE              | TPS3899PL01DSE             | TPS3899PH01DSE              | 0.505                 |
| TPS3899DL08DSE              | TPS3899PL08DSE             | N/A                         | 0.80                  |
| TPS3899DL09DSE              | TPS3899PL09DSE             | N/A                         | 0.90                  |
| TPS3899DL10DSE              | TPS3899PL10DSE             | N/A                         | 1.00                  |
| TPS3899DL11DSE              | TPS3899PL11DSE             | TPS3899PH11DSE              | 1.10                  |
| TPS3899DL12DSE              | TPS3899PL12DSE             | TPS3899PH12DSE              | 1.20                  |
| TPS3899DL13DSE              | TPS3899PL13DSE             | TPS3899PH13DSE              | 1.30                  |
| TPS3899DL14DSE              | TPS3899PL14DSE             | TPS3899PH14DSE              | 1.40                  |
| TPS3899DL15DSE              | TPS3899PL15DSE             | TPS3899PH15DSE              | 1.50                  |
| TPS3899DL16DSE              | TPS3899PL16DSE             | TPS3899PH16DSE              | 1.60                  |
| TPS3899DL17DSE              | TPS3899PL17DSE             | TPS3899PH17DSE              | 1.70                  |
| TPS3899DL18DSE              | TPS3899PL18DSE             | TPS3899PH18DSE              | 1.80                  |
| TPS3899DL19DSE              | TPS3899PL19DSE             | TPS3899PH19DSE              | 1.90                  |
| TPS3899DL20DSE              | TPS3899PL20DSE             | TPS3899PH20DSE              | 2.00                  |
| TPS3899DL21DSE              | TPS3899PL21DSE             | TPS3899PH21DSE              | 2.10                  |
| TPS3899DL22DSE              | TPS3899PL22DSE             | TPS3899PH22DSE              | 2.20                  |
| TPS3899DL23DSE              | TPS3899PL23DSE             | TPS3899PH23DSE              | 2.30                  |
| TPS3899DL24DSE              | TPS3899PL24DSE             | TPS3899PH24DSE              | 2.40                  |
| TPS3899DL25DSE              | TPS3899PL25DSE             | TPS3899PH25DSE              | 2.50                  |
| TPS3899DL26DSE              | TPS3899PL26DSE             | TPS3899PH26DSE              | 2.60                  |
| TPS3899DL27DSE              | TPS3899PL27DSE             | TPS3899PH27DSE              | 2.70                  |
| TPS3899DL28DSE              | TPS3899PL28DSE             | TPS3899PH28DSE              | 2.80                  |
| TPS3899DL29DSE              | TPS3899PL29DSE             | TPS3899PH29DSE              | 2.90                  |
| TPS3899DL30DSE              | TPS3899PL30DSE             | TPS3899PH30DSE              | 3.00                  |
| TPS3899DL31DSE              | TPS3899PL31DSE             | TPS3899PH31DSE              | 3.10                  |
| TPS3899DL32DSE              | TPS3899PL32DSE             | TPS3899PH32DSE              | 3.20                  |
| TPS3899DL33DSE              | TPS3899PL33DSE             | TPS3899PH33DSE              | 3.30                  |
| TPS3899DL34DSE              | TPS3899PL34DSE             | TPS3899PH34DSE              | 3.40                  |
| TPS3899DL35DSE              | TPS3899PL35DSE             | TPS3899PH35DSE              | 3.50                  |
| TPS3899DL36DSE              | TPS3899PL36DSE             | TPS3899PH36DSE              | 3.60                  |
| TPS3899DL37DSE              | TPS3899PL37DSE             | TPS3899PH37DSE              | 3.70                  |
| TPS3899DL38DSE              | TPS3899PL38DSE             | TPS3899PH38DSE              | 3.80                  |

表 8-1. Device Naming Convention (続き)

| ORDERABLE DEVICE NAME       |                            |                             | THRESHOLD VOLTAGE (V) |
|-----------------------------|----------------------------|-----------------------------|-----------------------|
| -DL (OPEN-DRAIN ACTIVE-LOW) | -PL (PUSH-PULL ACTIVE-LOW) | -PH (PUSH-PULL ACTIVE-HIGH) |                       |
| TPS3899DL39DSE              | TPS3899PL39DSE             | TPS3899PH39DSE              | 3.90                  |
| TPS3899DL40DSE              | TPS3899PL40DSE             | TPS3899PH40DSE              | 4.00                  |
| TPS3899DL41DSE              | TPS3899PL41DSE             | TPS3899PH41DSE              | 4.10                  |
| TPS3899DL42DSE              | TPS3899PL42DSE             | TPS3899PH42DSE              | 4.20                  |
| TPS3899DL43DSE              | TPS3899PL43DSE             | TPS3899PH43DSE              | 4.30                  |
| TPS3899DL44DSE              | TPS3899PL44DSE             | TPS3899PH44DSE              | 4.40                  |
| TPS3899DL45DSE              | TPS3899PL45DSE             | TPS3899PH45DSE              | 4.50                  |
| TPS3899DL46DSE              | TPS3899PL46DSE             | TPS3899PH46DSE              | 4.60                  |
| TPS3899DL47DSE              | TPS3899PL47DSE             | TPS3899PH47DSE              | 4.70                  |
| TPS3899DL48DSE              | TPS3899PL48DSE             | TPS3899PH48DSE              | 4.80                  |
| TPS3899DL49DSE              | TPS3899PL49DSE             | TPS3899PH49DSE              | 4.90                  |
| TPS3899DL50DSE              | TPS3899PL50DSE             | TPS3899PH50DSE              | 5.00                  |
| TPS3899DL51DSE              | TPS3899PL51DSE             | TPS3899PH51DSE              | 5.10                  |
| TPS3899DL52DSE              | TPS3899PL52DSE             | TPS3899PH52DSE              | 5.20                  |
| TPS3899DL53DSE              | TPS3899PL53DSE             | TPS3899PH53DSE              | 5.30                  |
| TPS3899DL54DSE              | TPS3899PL54DSE             | TPS3899PH54DSE              | 5.40                  |

## 8.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

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## 8.6 用語集

### テキサス・インスツルメンツ用語集

この用語集には、用語や略語の一覧および定義が記載されています。

## 9 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

### Changes from Revision B (January 2022) to Revision C (January 2024) Page

- Updated equations in User-Programmable Sense and Reset Time Delay section..... 14
- 

### Changes from Revision A (December 2020) to Revision B (January 2022) Page

- 機能安全対応を追加.....1
  - Changed IDD from 1.2μA to 1μA.....5
- 

### Changes from Revision \* (September 2020) to Revision A (November 2020) Page

- APL から RTM へのリリース..... 1
- 

## 10 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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**PACKAGING INFORMATION**

| Orderable part number           | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|---------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">TPS3899DL01DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU   NIPDAUAG                    | Level-1-260C-UNLIM                | -40 to 125   | KH                  |
| TPS3899DL01DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | KH                  |
| TPS3899DL01DSER.G4              | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | KH                  |
| TPS3899DL01DSER.G4.A            | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | KH                  |
| <a href="#">TPS3899DL08DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LJ                  |
| TPS3899DL08DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LJ                  |
| <a href="#">TPS3899DL09DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | M3                  |
| TPS3899DL09DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | M3                  |
| <a href="#">TPS3899DL10DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LS                  |
| TPS3899DL10DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LS                  |
| <a href="#">TPS3899DL11DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LZ                  |
| TPS3899DL11DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LZ                  |
| <a href="#">TPS3899DL13DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LX                  |
| TPS3899DL13DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LX                  |
| <a href="#">TPS3899DL14DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LN                  |
| TPS3899DL14DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LN                  |
| <a href="#">TPS3899DL15DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LL                  |
| TPS3899DL15DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LL                  |
| <a href="#">TPS3899DL20DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | M1                  |
| TPS3899DL20DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | M1                  |
| <a href="#">TPS3899DL22DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LP                  |
| TPS3899DL22DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LP                  |
| <a href="#">TPS3899DL26DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LV                  |
| TPS3899DL26DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LV                  |
| <a href="#">TPS3899DL28DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LI                  |
| TPS3899DL28DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LI                  |
| <a href="#">TPS3899DL29DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LK                  |
| TPS3899DL29DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LK                  |
| <a href="#">TPS3899DL30DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LM                  |

| Orderable part number           | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|---------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| TPS3899DL30DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LM                  |
| <a href="#">TPS3899DL31DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | M6                  |
| TPS3899DL31DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | M6                  |
| <a href="#">TPS3899DL35DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LT                  |
| TPS3899DL35DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LT                  |
| <a href="#">TPS3899DL41DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LU                  |
| TPS3899DL41DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LU                  |
| <a href="#">TPS3899DL43DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | M2                  |
| TPS3899DL43DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | M2                  |
| <a href="#">TPS3899PL31DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LH                  |
| TPS3899PL31DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LH                  |
| <a href="#">TPS3899PL42DSER</a> | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LG                  |
| TPS3899PL42DSER.A               | Active        | Production           | WSON (DSE)   6 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | LG                  |

(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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**OTHER QUALIFIED VERSIONS OF TPS3899 :**

- Automotive : [TPS3899-Q1](#)

NOTE: Qualified Version Definitions:

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

## TAPE AND REEL INFORMATION



### 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 |
|-------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS3899DL01DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL01DSER   | WSO          | DSE             | 6    | 3000 | 178.0              | 8.4                | 1.7     | 1.7     | 0.95    | 4.0     | 8.0    | Q2            |
| TPS3899DL01DSERG4 | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL08DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL09DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL10DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL11DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL13DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL14DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL15DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL20DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL22DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL26DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL28DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL29DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL30DSER   | WSO          | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |

| 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 |
|-----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS3899DL31DSER | WSON         | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL35DSER | WSON         | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL41DSER | WSON         | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899DL43DSER | WSON         | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899PL31DSER | WSON         | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |
| TPS3899PL42DSER | WSON         | DSE             | 6    | 3000 | 180.0              | 8.4                | 1.75    | 1.75    | 1.0     | 4.0     | 8.0    | Q2            |

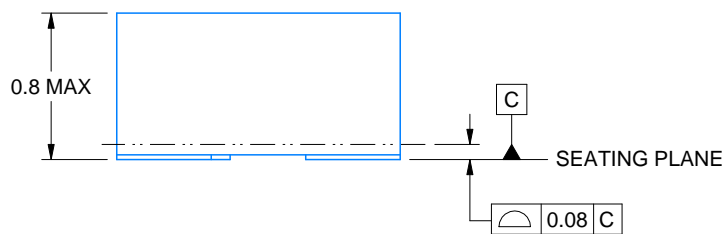
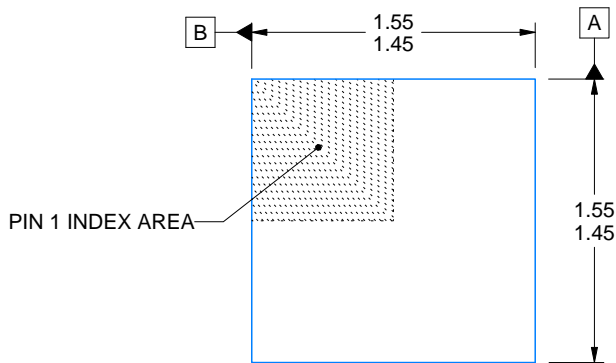
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device             | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS3899DL01DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL01DSER    | WSON         | DSE             | 6    | 3000 | 205.0       | 200.0      | 33.0        |
| TPS3899DL01DSER G4 | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL08DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL09DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL10DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL11DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL13DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL14DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL15DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL20DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL22DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL26DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL28DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL29DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL30DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL31DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS3899DL35DSER    | WSON         | DSE             | 6    | 3000 | 210.0       | 185.0      | 35.0        |

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| <b>Device</b>   | <b>Package Type</b> | <b>Package Drawing</b> | <b>Pins</b> | <b>SPQ</b> | <b>Length (mm)</b> | <b>Width (mm)</b> | <b>Height (mm)</b> |
|-----------------|---------------------|------------------------|-------------|------------|--------------------|-------------------|--------------------|
| TPS3899DL41DSER | WSON                | DSE                    | 6           | 3000       | 210.0              | 185.0             | 35.0               |
| TPS3899DL43DSER | WSON                | DSE                    | 6           | 3000       | 210.0              | 185.0             | 35.0               |
| TPS3899PL31DSER | WSON                | DSE                    | 6           | 3000       | 210.0              | 185.0             | 35.0               |
| TPS3899PL42DSER | WSON                | DSE                    | 6           | 3000       | 210.0              | 185.0             | 35.0               |



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NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

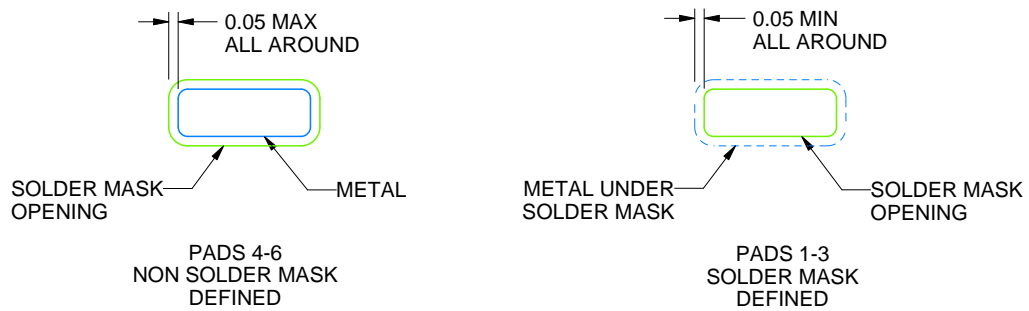
DSE0006A

WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:40X



SOLDER MASK DETAILS

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NOTES: (continued)

3. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).

# EXAMPLE STENCIL DESIGN

DSE0006A

WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:40X

NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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