

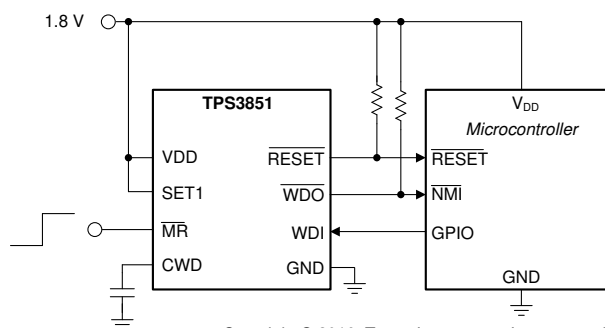
# TPS3851 Precision Voltage Supervisor with Integrated Watchdog Timer

## 1 Features

- Input voltage range:  $V_{DD} = 1.6\text{ V to }6.5\text{ V}$
- 0.8% Voltage threshold accuracy
- Low quiescent current:  $I_{DD} = 10\ \mu\text{A}$  (typical)
- User-programmable watchdog timeout
- Open-drain outputs
- Precision undervoltage monitoring:
  - Supports common rails from 1.8 V to 5.0 V
  - 4% and 7% Undervoltage thresholds available
  - 0.5% Hysteresis
- Watchdog disable feature
- Factory-programmed precision watchdog and reset timers
- Manual reset input ( $\overline{\text{MR}}$ )
- Available in a small 3-mm × 3-mm, 8-Pin VSON package
- Junction operating temperature range:  $-40^\circ\text{C to }+125^\circ\text{C}$

## 2 Applications

- [WLAN/Wi-Fi access point](#)
- [Wireless security camera](#)
- [IP network camera](#)
- [String inverter](#)
- [Blood pressure monitor](#)
- [Electricity meter](#)



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**Fully Integrated Microcontroller Supervisory Circuit**

## 3 Description

The TPS3851 combines a precision voltage supervisor with a programmable watchdog timer. The TPS3851 comparator achieves a 0.8% accuracy ( $-40^\circ\text{C to }+125^\circ\text{C}$ ) for the undervoltage ( $V_{ITN}$ ) threshold on the VDD pin. The TPS3851 also includes accurate hysteresis on the undervoltage threshold making the device ideal for use with tight tolerance systems. The supervisor  $\overline{\text{RESET}}$  delay features a 15% accuracy, high-precision delay timing.

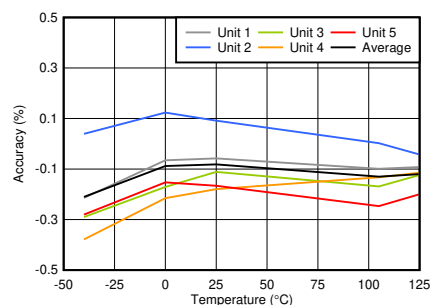
The TPS3851 includes a programmable watchdog timer for a wide variety of applications. The dedicated watchdog output ( $\overline{\text{WDO}}$ ) enables increased resolution to help determine the nature of fault conditions. The watchdog timeouts can be programmed either by an external capacitor, or by factory-programmed default delay settings. The watchdog can be disabled via logic pins to avoid undesired watchdog timeouts during the development process.

TPS3851 is available in a small 3.00-mm × 3.00-mm, 8-pin VSON package.

### Device Information

| PART NUMBER | PACKAGE (1) | BODY SIZE (NOM)   |
|-------------|-------------|-------------------|
| TPS3851     | VSON (8)    | 3.00 mm × 3.00 mm |

- (1) For all available packages, see the orderable addendum at the end of the data sheet.



**Undervoltage Threshold ( $V_{ITN}$ ) Accuracy vs Temperature**



## Table of Contents

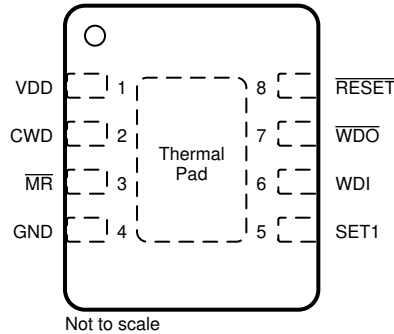
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|--|----|--|----|
| <b>1 Features</b> .....                        | 1  | 7.4 Device Functional Modes.....                                 | 14 |
| <b>2 Applications</b> .....                    | 1  | <b>8 Application and Implementation</b> .....                    | 15 |
| <b>3 Description</b> .....                     | 1  | 8.1 Application Information.....                                 | 15 |
| <b>4 Revision History</b> .....                | 2  | 8.2 Typical Application.....                                     | 18 |
| <b>5 Pin Configuration and Functions</b> ..... | 3  | <b>9 Power Supply Recommendations</b> .....                      | 21 |
| <b>6 Specifications</b> .....                  | 4  | <b>10 Layout</b> .....   | 22 |
| 6.1 Absolute Maximum Ratings.....              | 4  | 10.1 Layout Guidelines.....                                      | 22 |
| 6.2 ESD Ratings.....                           | 4  | 10.2 Layout Example.....   | 22 |
| 6.3 Recommended Operating Conditions.....      | 4  | <b>11 Device and Documentation Support</b> .....                 | 23 |
| 6.4 Thermal Information.....                   | 5  | 11.1 Device Support.....   | 23 |
| 6.5 Electrical Characteristics.....            | 5  | 11.2 Documentation Support.....                                  | 23 |
| 6.6 Timing Requirements.....                   | 6  | 11.3 Receiving Notification of Documentation Updates..           | 23 |
| 6.7 Timing Diagrams.....                       | 7  | 11.4 Support Resources.....                                      | 23 |
| 6.8 Typical Characteristics.....               | 8  | 11.5 Trademarks.....   | 23 |
| <b>7 Detailed Description</b> .....            | 11 | 11.6 Electrostatic Discharge Caution.....                        | 23 |
| 7.1 Overview.....                              | 11 | 11.7 Glossary.....   | 23 |
| 7.2 Functional Block Diagram.....              | 11 | <b>12 Mechanical, Packaging, and Orderable Information</b> ..... | 24 |
| 7.3 Feature Description.....                   | 11 |  |    |

## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| <b>Changes from Revision * (November 2016) to Revision A (September 2021)</b>                         | <b>Page</b> |
|---|-------------|
| • Updated the numbering format for tables, figures, and cross-references throughout the document..... | 1           |
| • Removed "±15% Accurate WDT and RST Delays".....   | 1           |
| • Added "on the VDD pin".....   | 1           |
| • Changed $V_{ESD}$ values to ±4000 V and ±1000 V.....  | 4           |
| • Changed $I_{CWD}$ min and max spec .....  | 5           |
| • Changed $V_{CWD}$ min and max spec .....  | 5           |
| • Added a footnote to for $t_{INIT}$ .....  | 6           |
| • Updated $t_{WDU}$ min and max multipliers from 0.85 and 1.15 to 0.905 and 1.095 respectively.....   | 16          |
| • Updated $t_{WDU}$ min and max values for all capacitors.....  | 16          |
| • Updated equation 6 and 7 to replace 0.85 and 1.15 with 0.905 and 1.095 respectively.....            | 19          |

## 5 Pin Configuration and Functions



**Figure 5-1. DRB Package: TPS3851**  
**3-mm × 3-mm VSON-8**  
**Top View**

**Table 5-1. Pin Functions**

| NAME        | NO. | I/O | DESCRIPTION  |
|-------------|-----|-----|--|
| CWD         | 2   | I   | Programmable watchdog timeout input. The watchdog timeout is set by connecting a capacitor between this pin and ground. Connecting via a 10-kΩ resistor to V <sub>DD</sub> or leaving unconnected further enables the selection of the preset watchdog timeouts; see the <i>CWD Functionality</i> section. The TPS3851 determines the watchdog timeout using either Equation 1 or Equation 2 with standard or extended timing, respectively.   |
| GND         | 4   | —   | Ground pin   |
| MR          | 3   | I   | Manual reset pin. A logical low on this pin issues a $\overline{\text{RESET}}$ . This pin is internally pulled up to V <sub>DD</sub> . $\overline{\text{RESET}}$ remains low for a fixed reset delay (t <sub>RST</sub> ) time after MR is deasserted (high).   |
| RESET       | 8   | O   | Reset output. Connect $\overline{\text{RESET}}$ using a 1-kΩ to 100-kΩ resistor to the correct pullup voltage rail (V <sub>PU</sub> ). $\overline{\text{RESET}}$ goes low when V <sub>DD</sub> goes below the undervoltage threshold (V <sub>ITN</sub> ). When V <sub>DD</sub> is within the normal operating range, the $\overline{\text{RESET}}$ timeout-counter starts. At completion, $\overline{\text{RESET}}$ goes high. During startup, the state of $\overline{\text{RESET}}$ is undefined below the specified power-on-reset (POR) voltage (V <sub>POR</sub> ). Above POR, $\overline{\text{RESET}}$ goes low and remains low until the monitored voltage is within the correct operating range (above V <sub>ITN</sub> +V <sub>HYST</sub> ) and the $\overline{\text{RESET}}$ timeout is complete. |
| SET1        | 5   | I   | Logic input. Grounding the SET1 pin disables the watchdog timer. SET1 and CWD select the watchdog timeouts; see the <i>SET1</i> section.   |
| VDD         | 1   | I   | Supply voltage pin. For noisy systems, connecting a 0.1-μF bypass capacitor is recommended.  |
| WDI         | 6   | I   | Watchdog input. A falling edge must occur at WDI before the timeout (t <sub>WD</sub> ) expires. When the watchdog is not in use, the SET1 pin can be used to disable the watchdog. WDI is ignored when $\overline{\text{RESET}}$ or $\overline{\text{WDO}}$ are low (asserted) and when the watchdog is disabled. If the watchdog is disabled, WDI cannot be left unconnected and must be driven to either VDD or GND.   |
| WDO         | 7   | O   | Watchdog output. Connect $\overline{\text{WDO}}$ with a 1-kΩ to 100-kΩ resistor to the correct pullup voltage rail (V <sub>PU</sub> ). $\overline{\text{WDO}}$ goes low (asserts) when a watchdog timeout occurs. $\overline{\text{WDO}}$ only asserts when $\overline{\text{RESET}}$ is high. When a watchdog timeout occurs, $\overline{\text{WDO}}$ goes low (asserts) for the set $\overline{\text{RESET}}$ timeout delay (t <sub>RST</sub> ). When $\overline{\text{RESET}}$ goes low, $\overline{\text{WDO}}$ is in a high-impedance state.  |
| Thermal pad |     | —   | Connect the thermal pad to a large-area ground plane. The thermal pad is internally connected to GND.  |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

|                                    |   | MIN                             | MAX                                  | UNIT |
|------------------------------------|---|---------------------------------|--------------------------------------|------|
| Supply voltage range               | VDD   | -0.3                            | 7                                    | V    |
| Output voltage range               | RESET, WDO  | -0.3                            | 7                                    | V    |
| Voltage ranges                     | SET1, WDI, MR                                     | -0.3                            | 7                                    | V    |
|                                    | CWD   | -0.3                            | V <sub>DD</sub> + 0.3 <sup>(3)</sup> |      |
| Output pin current                 | RESET, WDO  |                                 | ±20                                  | mA   |
| Input current (all pins)           |   |                                 | ±20                                  | mA   |
| Continuous total power dissipation |   | See <a href="#">Section 6.4</a> |                                      |      |
| Temperature                        | Operating junction, T <sub>J</sub> <sup>(2)</sup> | -40                             | 150                                  | °C   |
|                                    | Operating free-air, T <sub>A</sub> <sup>(2)</sup> | -40                             | 150                                  |      |
|                                    | Storage, T <sub>stg</sub>                         | -65                             | 150                                  |      |

(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) Assume that T<sub>J</sub> = T<sub>A</sub> as a result of the low dissipated power in this device.

(3) The absolute maximum rating is V<sub>DD</sub> + 0.3 V or 7.0 V, whichever is smaller.

### 6.2 ESD Ratings

|  |  | VALUE | UNIT |
|--|--|-------|------|
| V <sub>(ESD)</sub> Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | ±4000 | V    |
|  | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | ±1000 |      |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.

### 6.3 Recommended Operating Conditions

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

|                    |                                | MIN                    | TYP | MAX                     | UNIT |
|--------------------|--------------------------------|------------------------|-----|-------------------------|------|
| V <sub>DD</sub>    | Supply pin voltage             | 1.6                    |     | 6.5                     | V    |
| V <sub>SET1</sub>  | SET1 pin voltage               | 0                      |     | 6.5                     | V    |
| C <sub>CWD</sub>   | Watchdog timing capacitor      | 0.1 <sup>(1) (2)</sup> |     | 1000 <sup>(1) (2)</sup> | nF   |
| CWD                | Pullup resistor to VDD         | 9                      | 10  | 11                      | kΩ   |
| R <sub>PU</sub>    | Pullup resistor, RESET and WDO | 1                      | 10  | 100                     | kΩ   |
| I <sub>RESET</sub> | RESET pin current              |                        |     | 10                      | mA   |
| I <sub>WDO</sub>   | Watchdog output current        |                        |     | 10                      | mA   |
| T <sub>J</sub>     | Junction temperature           | -40                    |     | 125                     | °C   |

(1) Using standard timing with a C<sub>CWD</sub> capacitor of 0.1 nF or 1000 nF gives a t<sub>WD(typ)</sub> of 0.704 ms or 3.23 seconds, respectively.

(2) Using extended timing with a C<sub>CWD</sub> capacitor of 0.1 nF or 1000 nF gives a t<sub>WD(typ)</sub> of 62.74 ms or 77.45 seconds, respectively.

## 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | TPS3851    |      |
|-------------------------------|--|------------|------|
|                               |  | DRB (VSON) |      |
|                               |  | 8 PINS     |      |
|                               |  |            | UNIT |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 50.7       | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 51.6       | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 25.8       | °C/W |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 1.3        | °C/W |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 25.8       | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance | 7.1        | °C/W |

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

## 6.5 Electrical Characteristics

at  $V_{ITN} + V_{HYST} \leq V_{DD} \leq 6.5$  V over the operating temperature range of  $-40^{\circ}\text{C} \leq T_A, T_A \leq 125^{\circ}\text{C}$  (unless otherwise noted); the open-drain pullup resistors are 10 kΩ for each output; typical values are at  $T_A = 25^{\circ}\text{C}$

| PARAMETER                              | TEST CONDITIONS   | MIN  | TYP                     | MAX                     | UNIT  |     |     |    |
|--|---|--|-------------------------|-------------------------|-------|-----|-----|----|
| <b>GENERAL CHARACTERISTICS</b>         |   |  |                         |                         |       |     |     |    |
| V <sub>DD</sub> <sup>(1) (2) (3)</sup> | Supply voltage  | 1.6  |                         | 6.5                     | V     |     |     |    |
| I <sub>DD</sub>                        | Supply current  |  | 10                      | 19                      | μA    |     |     |    |
| <b>RESET FUNCTION</b>                  |   |  |                         |                         |       |     |     |    |
| V <sub>POR</sub> <sup>(2)</sup>        | Power-on reset voltage                                    | I <sub>RESET</sub> = 15 μA, V <sub>OL(MAX)</sub> = 0.25 V  |                         |                         | 0.8   | V   |     |    |
| V <sub>UVLO</sub> <sup>(1)</sup>       | Undervoltage lockout voltage                              |  | 1.35                    |                         | V     |     |     |    |
| V <sub>ITN</sub>                       | Undervoltage threshold accuracy, entering RESET           | V <sub>DD</sub> falling  | V <sub>ITN</sub> - 0.8% | V <sub>ITN</sub> + 0.8% |       |     |     |    |
| V <sub>HYST</sub>                      | Hysteresis voltage  | V <sub>DD</sub> rising   | 0.2%                    | 0.5%                    | 0.8%  |     |     |    |
| I <sub>MR</sub>                        | $\overline{\text{MR}}$ pin internal pullup current        | V <sub>MR</sub> = 0 V  | 500                     | 620                     | 700   | nA  |     |    |
| <b>WATCHDOG FUNCTION</b>               |   |  |                         |                         |       |     |     |    |
| I <sub>CWD</sub>                       | CWD pin charge current                                    | CWD = 0.5 V  |                         |                         | 347   | 375 | 403 | nA |
| V <sub>CWD</sub>                       | CWD pin threshold voltage                                 |  | 1.196                   | 1.21                    | 1.224 | V   |     |    |
| V <sub>OL</sub>                        | RESET, WDO output low                                     | V <sub>DD</sub> = 5 V, I <sub>SINK</sub> = 3 mA  |                         |                         | 0.4   | V   |     |    |
| I <sub>D</sub>                         | RESET, WDO output leakage current, open-drain             | V <sub>DD</sub> = V <sub>ITN</sub> + V <sub>HYST</sub> , V <sub>RESET</sub> = V <sub>WDO</sub> = 6.5 V |                         |                         | 1     | μA  |     |    |
| V <sub>IL</sub>                        | Low-level input voltage ( $\overline{\text{MR}}$ , SET1)  |  |                         | 0.25                    | V     |     |     |    |
| V <sub>IH</sub>                        | High-level input voltage ( $\overline{\text{MR}}$ , SET1) |  | 0.8                     |                         | V     |     |     |    |
| V <sub>IL(WDI)</sub>                   | Low-level input voltage (WDI)                             |  |                         | 0.3 × V <sub>DD</sub>   | V     |     |     |    |
| V <sub>IH(WDI)</sub>                   | High-level input voltage (WDI)                            |  | 0.8 × V <sub>DD</sub>   |                         | V     |     |     |    |

- (1) When V<sub>DD</sub> falls below V<sub>UVLO</sub>,  $\overline{\text{RESET}}$  is driven low.
- (2) When V<sub>DD</sub> falls below V<sub>POR</sub>,  $\overline{\text{RESET}}$  and  $\overline{\text{WDO}}$  are undefined.
- (3) During power-on, V<sub>DD</sub> must be a minimum 1.6 V for at least 300 μs before  $\overline{\text{RESET}}$  correlates with V<sub>DD</sub>.

## 6.6 Timing Requirements

at  $V_{ITN} + V_{HYST} \leq V_{DD} \leq 6.5$  V over the operating temperature range of  $-40^{\circ}\text{C} \leq T_A, T_A \leq 125^{\circ}\text{C}$  (unless otherwise noted); the open-drain pullup resistors are 10 k $\Omega$  for each output; typical values are at  $T_A = 25^{\circ}\text{C}$

|                          |   | MIN   | NOM               | MAX  | UNIT          |    |
|--------------------------|---|---|-------------------|------|---------------|----|
| <b>GENERAL</b>           |   |   |                   |      |               |    |
| $t_{INIT}$               | CWD pin evaluation period <sup>(1)</sup>  |   | 381               |      | $\mu\text{s}$ |    |
|                          | Minimum $\overline{\text{MR}}$ , SET1 pin pulse duration                        |   | 1                 |      | $\mu\text{s}$ |    |
|                          | Startup delay <sup>(2)</sup>  |   | 300               |      | $\mu\text{s}$ |    |
| <b>RESET FUNCTION</b>    |   |   |                   |      |               |    |
| $t_{RST}$                | Reset timeout period  | 170   | 200               | 230  | ms            |    |
| $t_{RST-DEL}$            | $V_{DD}$ to $\overline{\text{RESET}}$ delay                                     | $V_{DD} = V_{ITN} + V_{HYST} + 2.5\%$               | 35                |      | $\mu\text{s}$ |    |
|                          |   | $V_{DD} = V_{ITN} - 2.5\%$                          | 17                |      |               |    |
| $t_{MR-DEL}$             | $\overline{\text{MR}}$ to $\overline{\text{RESET}}$ delay                       |   | 200               |      | ns            |    |
| <b>WATCHDOG FUNCTION</b> |   |   |                   |      |               |    |
| $t_{WD}$                 | Watchdog timeout <sup>(3)</sup>   | CWD = NC, SET1 = 0 <sup>(4)</sup>                   | Watchdog disabled |      |               |    |
|                          |   | CWD = NC, SET1 = 1 <sup>(4)</sup>                   | 1360              | 1600 | 1840          | ms |
|                          |   | CWD = 10 k $\Omega$ to VDD, SET1 = 0 <sup>(4)</sup> | Watchdog disabled |      |               |    |
|                          |   | CWD = 10 k $\Omega$ to VDD, SET1 = 1 <sup>(4)</sup> | 170               | 200  | 230           | ms |
| $t_{WD-setup}$           | Setup time required for device to respond to changes on WDI after being enabled |   | 150               |      | $\mu\text{s}$ |    |
|                          |   | Minimum WDI pulse duration                          |                   | 50   |               | ns |
| $t_{WD-del}$             | WDI to WDO delay  |   | 50                |      | ns            |    |

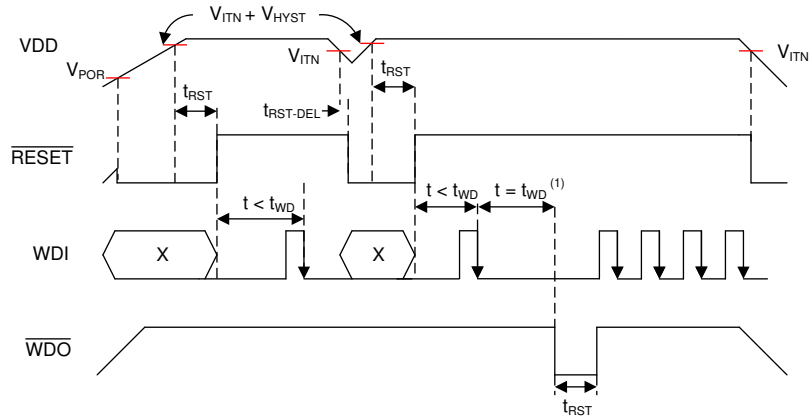
(1) Refer to [Section 8.1.1.2](#)

(2) During power-on,  $V_{DD}$  must be a minimum 1.6 V for at least 300  $\mu\text{s}$  before  $\overline{\text{RESET}}$  correlates with  $V_{DD}$

(3) The fixed watchdog timing covers both standard and extended versions.

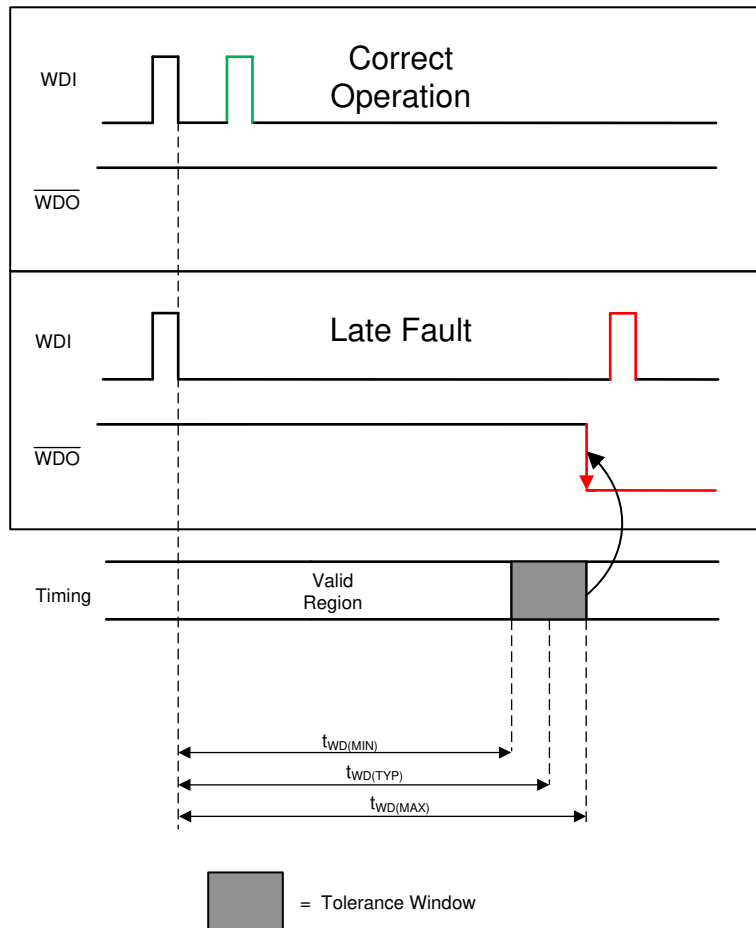
(4) SET1 = 0 means  $V_{SET1} < V_{IL}$ ; SET1 = 1 means  $V_{SET1} > V_{IH}$ .

## 6.7 Timing Diagrams



A. See Figure 6-2 for WDI timing requirements.

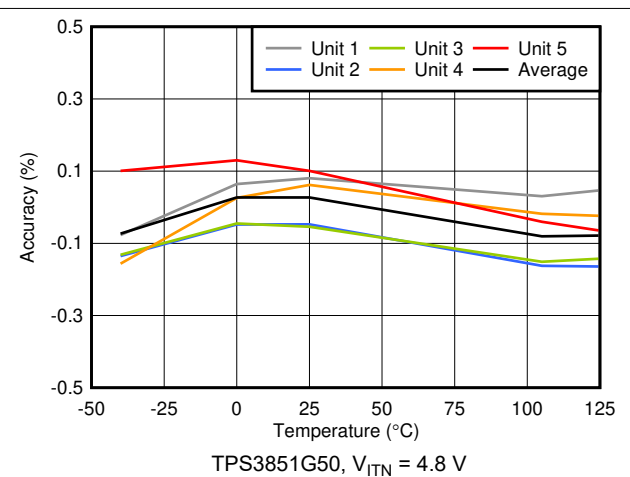
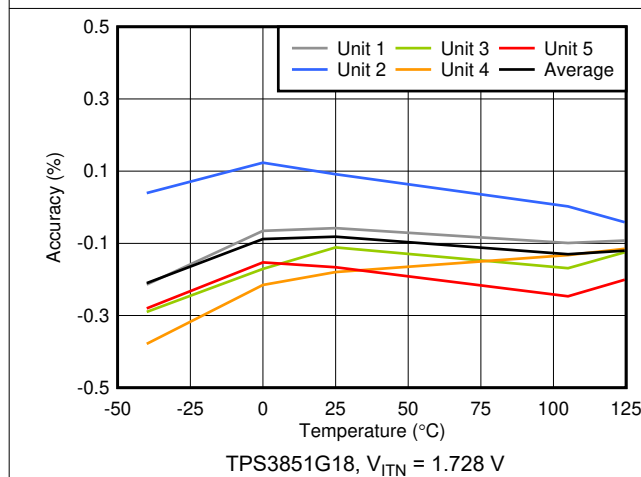
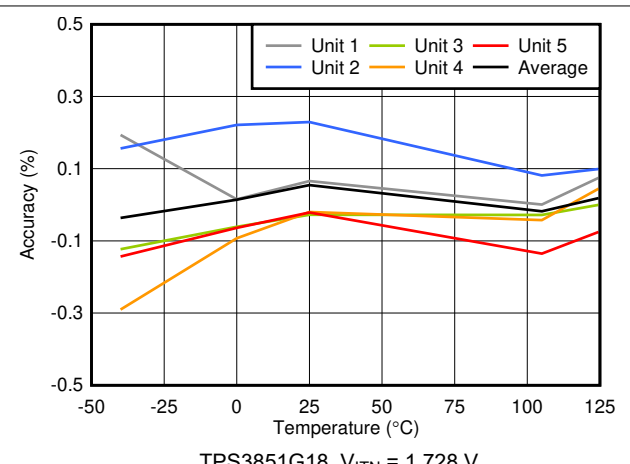
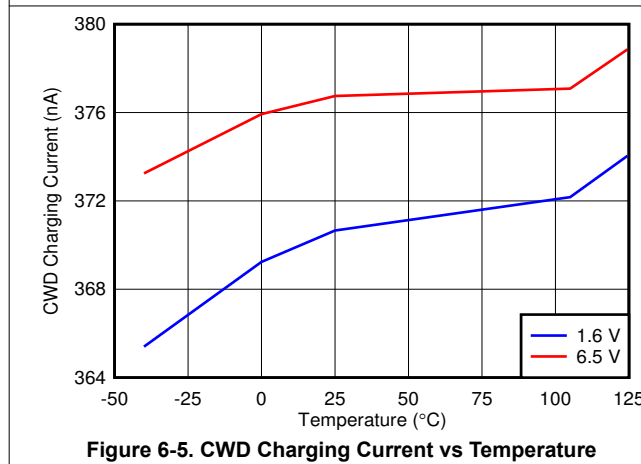
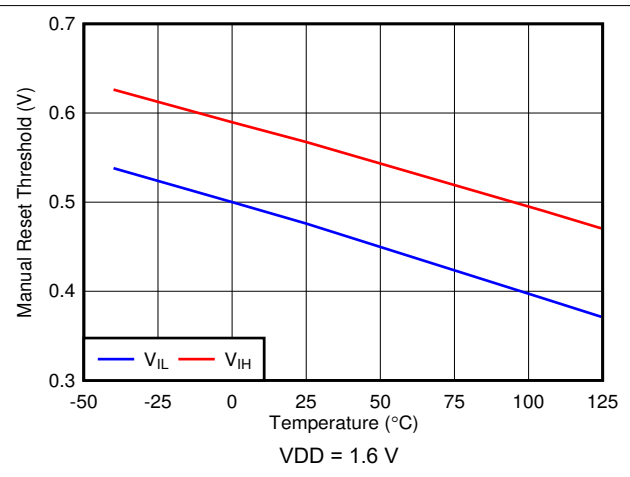
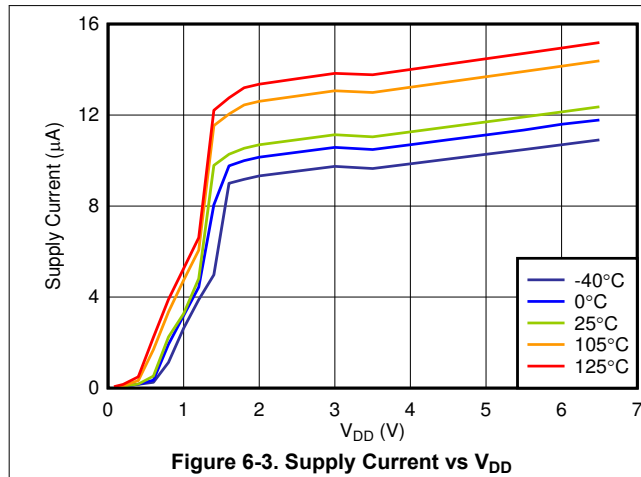
**Figure 6-1. Timing Diagram**



**Figure 6-2. Watchdog Timing Diagram**

## 6.8 Typical Characteristics

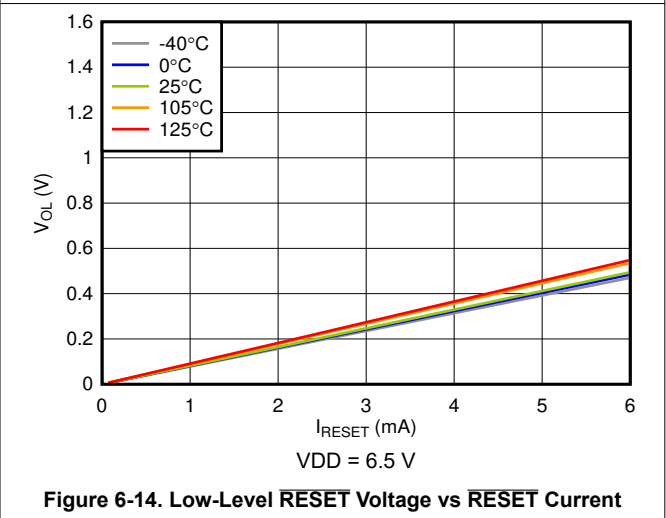
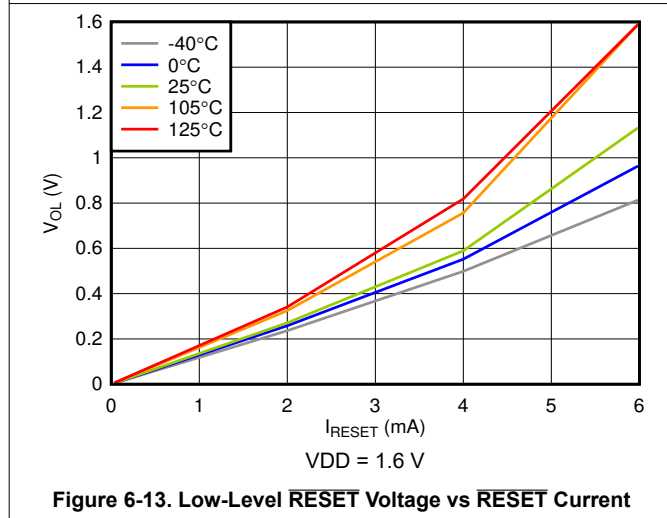
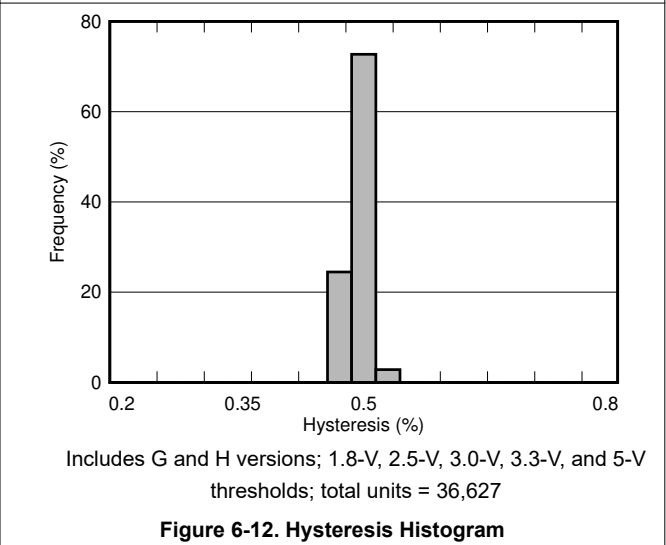
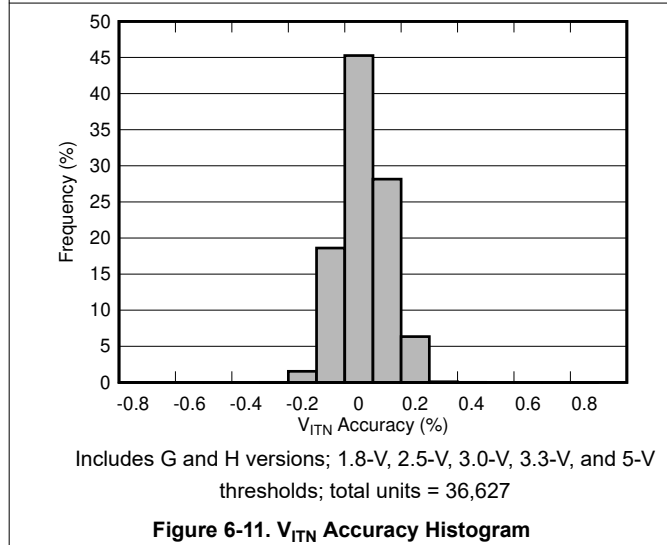
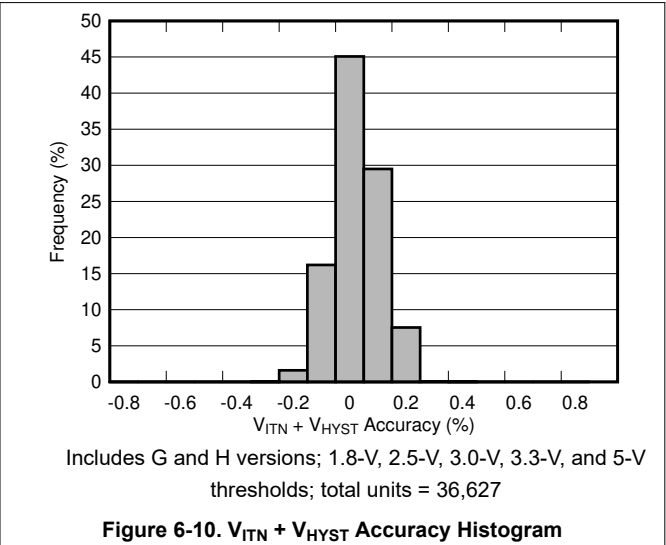
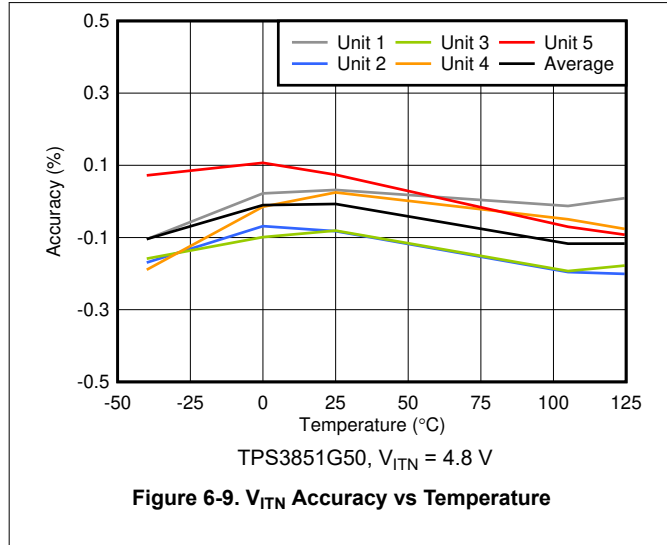
all typical characteristics curves are taken at 25°C with 1.6 V ≤ VDD ≤ 6.5 V (unless other wise noted)





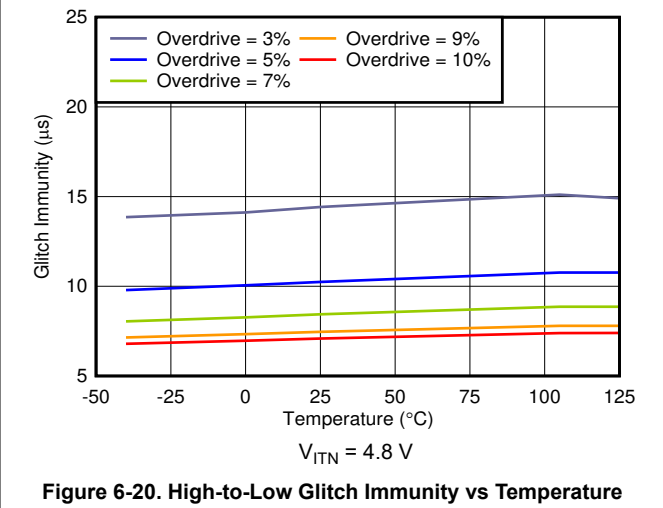
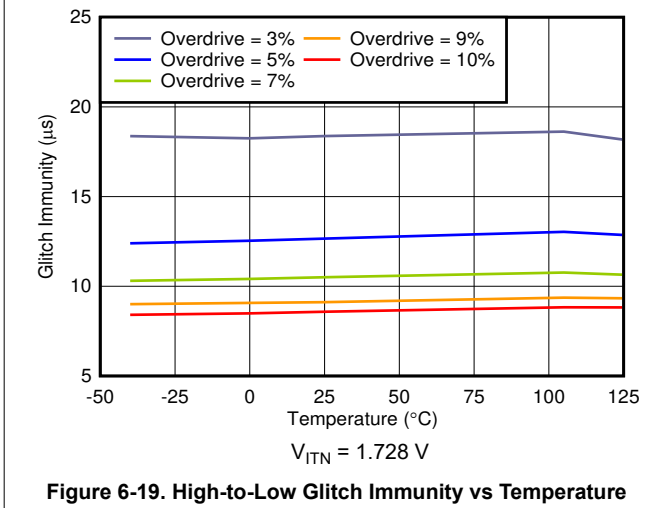
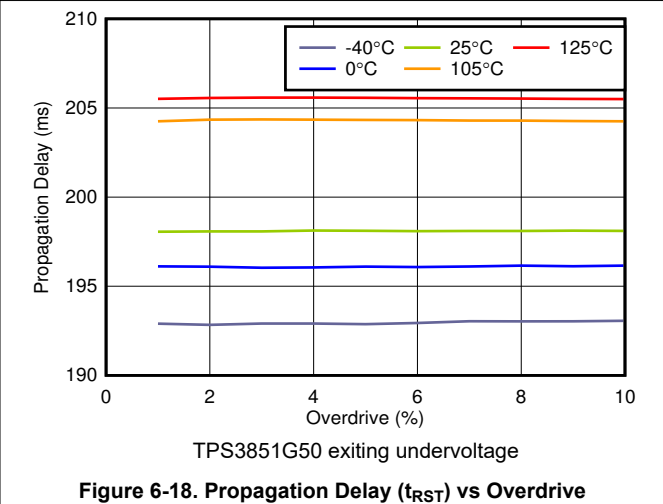
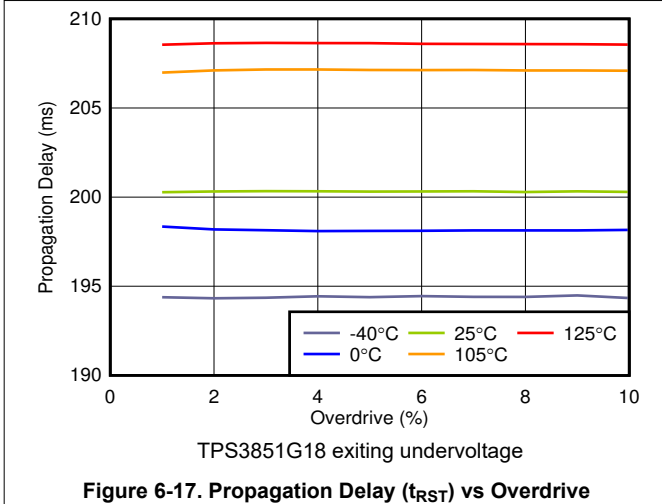
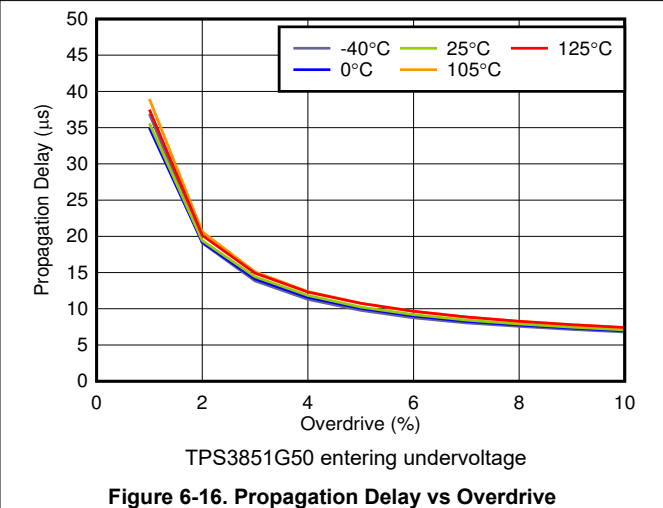
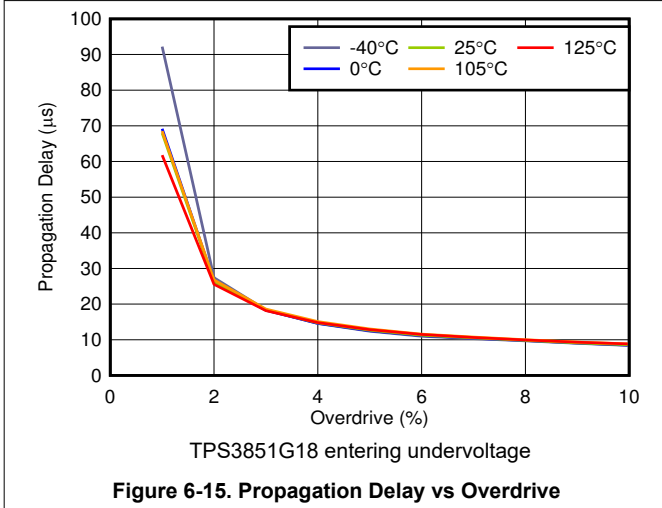
## 6.8 Typical Characteristics (continued)

all typical characteristics curves are taken at 25°C with 1.6 V ≤ VDD ≤ 6.5 V (unless other wise noted)



### 6.8 Typical Characteristics (continued)

all typical characteristics curves are taken at 25°C with 1.6 V ≤ VDD ≤ 6.5 V (unless other wise noted)

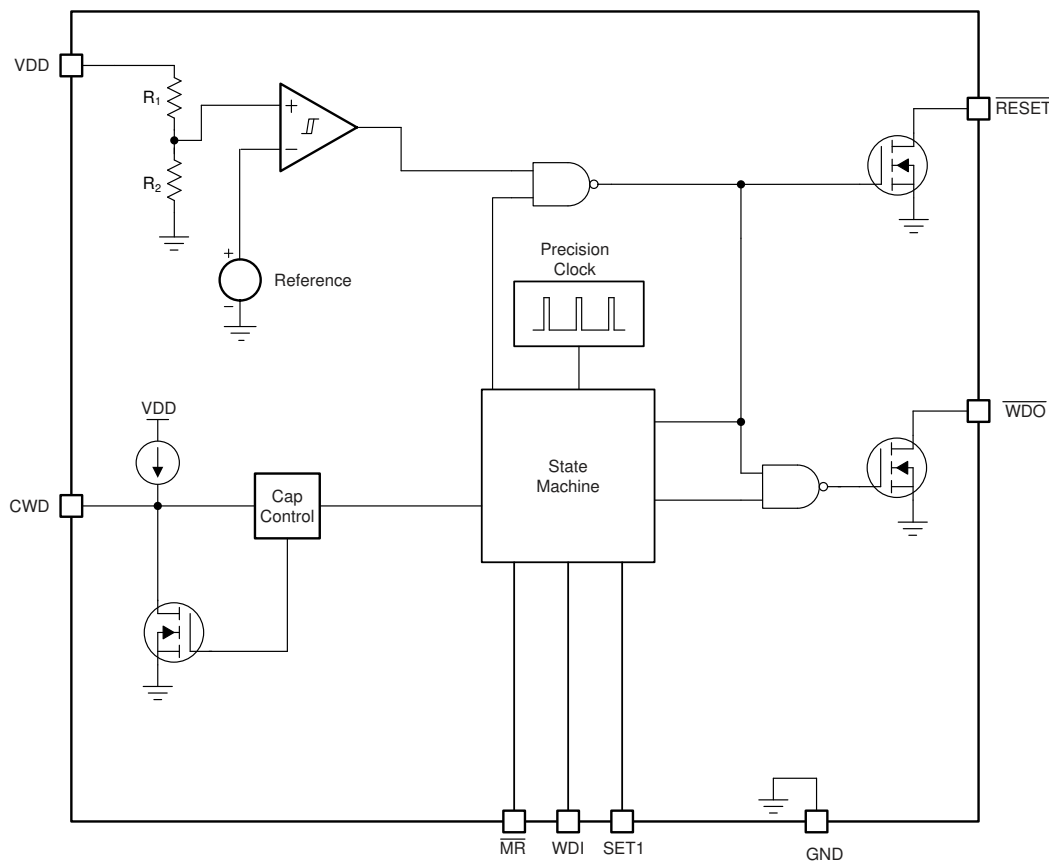


## 7 Detailed Description

### 7.1 Overview

The TPS3851 is a high-accuracy voltage supervisor with an integrated watchdog timer. This device includes a precision undervoltage supervisor with a threshold that achieves 0.8% accuracy over the specified temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . In addition, the TPS3851 includes accurate hysteresis on the threshold, making the device ideal for use with tight tolerance systems where voltage supervisors must ensure a  $\overline{\text{RESET}}$  before the minimum supply tolerance of the microprocessor or system-on-a-chip (SoC) is reached. There are two options for the watchdog timing standard and extended timing. To get standard timing use the TPS3851Xyy(y)S, for extended timing use the TPS3851Xyy(y)E.

### 7.2 Functional Block Diagram



A. Note:  $R_1 + R_2 = 4.5 \text{ M}\Omega$ .

### 7.3 Feature Description

#### 7.3.1 $\overline{\text{RESET}}$

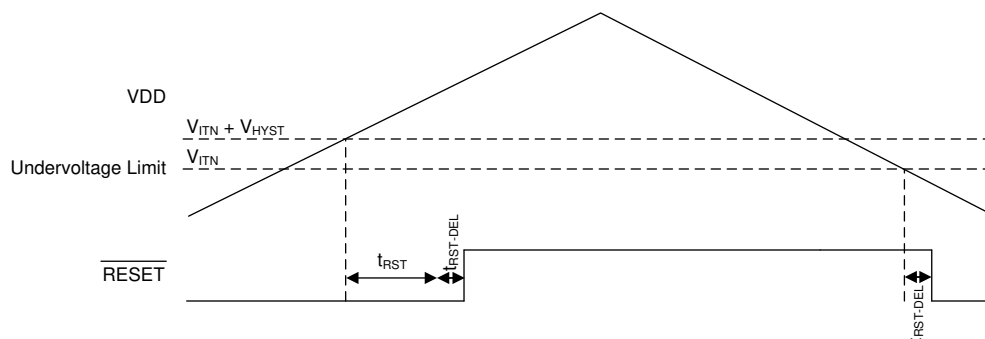
Connect  $\overline{\text{RESET}}$  to  $V_{\text{PU}}$  through a 1-k $\Omega$  to 100-k $\Omega$  pullup resistor.  $\overline{\text{RESET}}$  remains high (deasserted) when  $V_{\text{DD}}$  is greater than the negative threshold voltage ( $V_{\text{ITN}}$ ). If  $V_{\text{DD}}$  falls below the negative threshold ( $V_{\text{ITN}}$ ), then  $\overline{\text{RESET}}$  is asserted, driving the  $\overline{\text{RESET}}$  pin to low impedance. When  $V_{\text{DD}}$  rises above  $V_{\text{ITN}} + V_{\text{HYST}}$ , a delay circuit is enabled that holds  $\overline{\text{RESET}}$  low for a specified reset delay period ( $t_{\text{RST}}$ ). When the reset delay has elapsed, the  $\overline{\text{RESET}}$  pin goes to a high-impedance state and uses a pullup resistor to hold  $\overline{\text{RESET}}$  high. The pullup resistor must be connected to the proper voltage rail to allow other devices to be connected at the correct interface voltage. To ensure proper voltage levels, give some consideration when choosing the pullup resistor values. The pullup resistor value is determined by output logic low voltage ( $V_{\text{OL}}$ ), capacitive loading, leakage current ( $I_{\text{D}}$ ), and the current through the  $\overline{\text{RESET}}$  pin  $I_{\overline{\text{RESET}}}$ .

### 7.3.2 Manual Reset $\overline{\text{MR}}$

The manual reset ( $\overline{\text{MR}}$ ) input allows a processor or other logic circuits to initiate a reset. A logic low on  $\overline{\text{MR}}$  causes  $\overline{\text{RESET}}$  to assert. After  $\overline{\text{MR}}$  returns to a logic high and  $V_{\text{DD}}$  is above  $V_{\text{ITN}} + V_{\text{HYST}}$ ,  $\overline{\text{RESET}}$  is deasserted after the reset delay time ( $t_{\text{RST}}$ ). If  $\overline{\text{MR}}$  is not controlled externally, then  $\overline{\text{MR}}$  can either be connected to  $V_{\text{DD}}$  or left floating because the  $\overline{\text{MR}}$  pin is internally pulled up.

### 7.3.3 UV Fault Detection

The TPS3851 features undervoltage detection for common rails between 1.8 V and 5 V. The voltage is monitored on the input rail of the device. If  $V_{\text{DD}}$  drops below  $V_{\text{ITN}}$ , then  $\overline{\text{RESET}}$  is asserted (driven low). When  $V_{\text{DD}}$  is above  $V_{\text{ITN}} + V_{\text{HYST}}$ ,  $\overline{\text{RESET}}$  deasserts after  $t_{\text{RST}}$ , as shown in Figure 7-1. The internal comparator has built-in hysteresis that provides some noise immunity and ensures stable operation. Although not required in most cases, for noisy applications, good analog design practice is to place a 1-nF to 100-nF bypass capacitor close to the VDD pin to reduce sensitivity to transient voltages on the monitored signal.



**Figure 7-1. Undervoltage Detection**

### 7.3.4 Watchdog Mode

This section provides information for the watchdog mode of operation.

#### 7.3.4.1 CWD

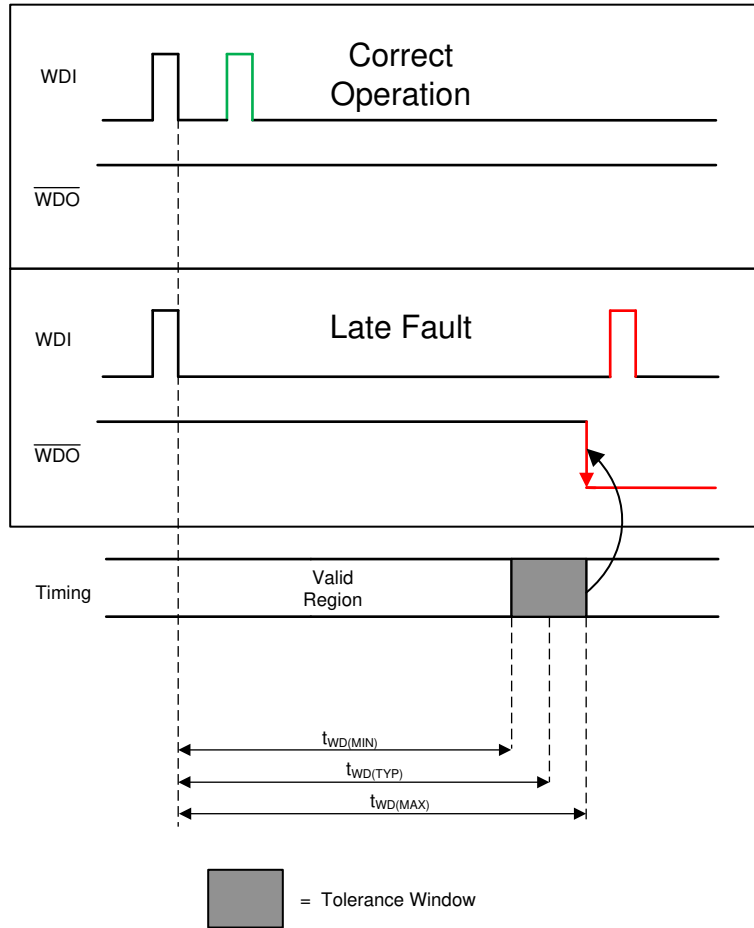
The CWD pin provides the user the functionality of both high-precision, factory-programmed watchdog timing options and user-programmable watchdog timing. The TPS3851 features three options for setting the watchdog timer: connecting a capacitor to the CWD pin, connecting a pullup resistor to  $V_{\text{DD}}$ , and leaving the CWD pin unconnected. The configuration of the CWD pin is evaluated by the device every time  $V_{\text{DD}}$  enters the valid region ( $V_{\text{ITN}} + V_{\text{HYST}} < V_{\text{DD}}$ ). The pin evaluation is controlled by an internal state machine that determines which option is connected to the CWD pin. The sequence of events typically takes 381  $\mu\text{s}$  ( $t_{\text{INIT}}$ ) to determine if the CWD pin is left unconnected, pulled-up through a resistor, or connected to a capacitor. If the CWD pin is being pulled up to  $V_{\text{DD}}$ , a 10-k $\Omega$  resistor is required.

#### 7.3.4.2 Watchdog Input $\overline{\text{WDI}}$

$\overline{\text{WDI}}$  is the watchdog timer input that controls the  $\overline{\text{WDO}}$  output. The  $\overline{\text{WDI}}$  input is triggered by the falling edge of the input signal. To ensure proper functionality of the watchdog timer, always issue the  $\overline{\text{WDI}}$  pulse before  $t_{\text{WD(min)}}$ . If the pulse is issued in this region, then  $\overline{\text{WDO}}$  remains unasserted. Otherwise, the device asserts  $\overline{\text{WDO}}$ , putting the  $\overline{\text{WDO}}$  pin into a low-impedance state.

The watchdog input ( $\overline{\text{WDI}}$ ) is a digital pin. To ensure there is no increase in  $I_{\text{DD}}$ , drive the  $\overline{\text{WDI}}$  pin to either  $V_{\text{DD}}$  or GND at all times. Putting the pin to an intermediate voltage can cause an increase in supply current ( $I_{\text{DD}}$ ) because of the architecture of the digital logic gates. When  $\overline{\text{RESET}}$  is asserted, the watchdog is disabled and all signals input to  $\overline{\text{WDI}}$  are ignored. When  $\overline{\text{RESET}}$  is no longer asserted, the device resumes normal operation and no longer ignores the signal on  $\overline{\text{WDI}}$ . If the watchdog is disabled, drive the  $\overline{\text{WDI}}$  pin to either  $V_{\text{DD}}$  or GND.

Figure 7-2 shows the valid region for a  $\overline{\text{WDI}}$  pulse to be issued to prevent  $\overline{\text{WDO}}$  from being triggered and pulled low.



**Figure 7-2. Watchdog Timing Diagram**

### 7.3.4.3 Watchdog Output $\overline{WDO}$

The TPS3851 features a watchdog timer with an independent watchdog output ( $\overline{WDO}$ ). The independent watchdog output provides the flexibility to flag a fault in the watchdog timing without performing an entire system reset. When  $\overline{RESET}$  is not asserted (high), the  $\overline{WDO}$  signal maintains normal operation. When asserted,  $\overline{WDO}$  remains low for  $t_{RST}$ . When the  $\overline{RESET}$  signal is asserted (low), the  $\overline{WDO}$  pin goes to a high-impedance state. When  $\overline{RESET}$  is unasserted, the watchdog timer resumes normal operation.

### 7.3.4.4 SET1

The SET1 pin can enable and disable the watchdog timer. If SET1 is set to GND, the watchdog timer is disabled and WDI is ignored. If the watchdog timer is disabled, drive the WDI pin to either GND or VDD to ensure that there is no increase in I<sub>DD</sub>. When SET1 is logic high, the watchdog operates normally. The SET1 pin can be changed dynamically; however, if the watchdog is going from disabled to enabled there is a 150-μs setup time where the watchdog does not respond to changes on WDI, as shown in Figure 7-3.

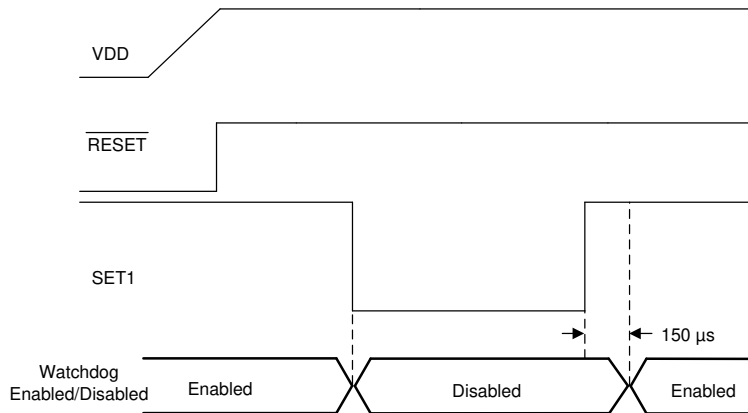


Figure 7-3. Enabling and Disabling the Watchdog

## 7.4 Device Functional Modes

Table 7-1 summarises the functional modes of the TPS3851.

Table 7-1. Device Functional Modes

| V <sub>DD</sub>  | WDI  | WDO  | RESET     |
|--|--|------|-----------|
| V <sub>DD</sub> < V <sub>POR</sub>   | ---  | ---  | Undefined |
| V <sub>POR</sub> ≤ V <sub>DD</sub> < V <sub>DD(min)</sub>                                    | Ignored  | High | Low       |
| V <sub>DD(min)</sub> ≤ V <sub>DD</sub> ≤ V <sub>ITN</sub> + V <sub>HYST</sub> <sup>(1)</sup> | Ignored  | High | Low       |
| V <sub>DD</sub> > V <sub>ITN</sub> <sup>(2)</sup>  | t <sub>PULSE</sub> < t <sub>WD(min)</sub> <sup>(3)</sup> | High | High      |
| V <sub>DD</sub> > V <sub>ITN</sub> <sup>(2)</sup>  | t <sub>PULSE</sub> > t <sub>WD(min)</sub> <sup>(3)</sup> | Low  | High      |

(1) Only valid before V<sub>DD</sub> has gone above V<sub>ITN</sub> + V<sub>HYST</sub>.

(2) Only valid after V<sub>DD</sub> has gone above V<sub>ITN</sub> + V<sub>HYST</sub>.

(3) Where t<sub>pulse</sub> is the time between the falling edges on WDI.

### 7.4.1 V<sub>DD</sub> is Below V<sub>POR</sub> (V<sub>DD</sub> < V<sub>POR</sub>)

When V<sub>DD</sub> is less than V<sub>POR</sub>, RESET is undefined and can be either high or low. The state of RESET largely depends on the load that the RESET pin is experiencing.

### 7.4.2 Above Power-On-Reset, But Less Than V<sub>DD(min)</sub> (V<sub>POR</sub> ≤ V<sub>DD</sub> < V<sub>DD(min)</sub>)

When the voltage on V<sub>DD</sub> is less than V<sub>DD(min)</sub>, and greater than or equal to V<sub>POR</sub>, the RESET signal is asserted (logic low). When RESET is asserted, the watchdog output WDO is in a high-impedance state regardless of the WDI signal that is input to the device.

### 7.4.3 Normal Operation (V<sub>DD</sub> ≥ V<sub>DD(min)</sub>)

When V<sub>DD</sub> is greater than or equal to V<sub>DD(min)</sub>, the RESET signal is determined by V<sub>DD</sub>. When RESET is asserted, WDO goes to a high-impedance state. WDO is then pulled high through the pullup resistor.

## 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, as well as validating and testing their design implementation to confirm system functionality.

### 8.1 Application Information

The following sections describe in detail proper device implementation, depending on the final application requirements.

#### 8.1.1 CWD Functionality

The TPS3851 features three options for setting the watchdog timer: connecting a capacitor to the CWD pin, connecting a pullup resistor to VDD, and leaving the CWD pin unconnected. Figure 8-1 shows a schematic drawing of all three options. If this pin is connected to VDD through a 10-k $\Omega$  pullup resistor or left unconnected (high impedance), then the factory-programmed watchdog timeouts are enabled; see the Section 8.1.1.1 section. Otherwise, the watchdog timeout can be adjusted by placing a capacitor from the CWD pin to ground.

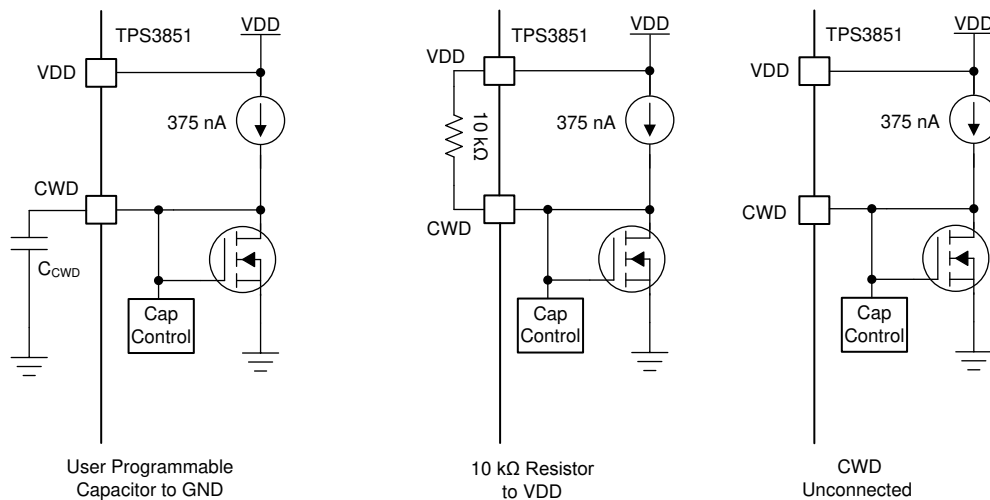


Figure 8-1. CWD Charging Circuit

#### 8.1.1.1 Factory-Programmed Timing Options

If using the factory-programmed timing options (listed in Table 8-1), the CWD pin must either be unconnected or pulled up to VDD through a 10-k $\Omega$  pullup resistor. Using these options enables high-precision, 15% accurate watchdog timing.

Table 8-1. Factory Programmed Watchdog Timing

| INPUT                |      | STANDARD AND EXTENDED TIMING WDT ( $t_{wd}$ ) |      |      | UNIT |
|----------------------|------|---|------|------|------|
| CWD                  | SET1 | MIN   | TYP  | MAX  |      |
| NC                   | 0    | Watchdog disabled                             |      |      |      |
| NC                   | 1    | 1360  | 1600 | 1840 | ms   |
| 10 k $\Omega$ to VDD | 0    | Watchdog disabled                             |      |      |      |
| 10 k $\Omega$ to VDD | 1    | 170   | 200  | 230  | ms   |

### 8.1.1.2 Adjustable Capacitor Timing

Adjustable capacitor timing is achievable by connecting a capacitor to the CWD pin. If a capacitor is connected to CWD, then a 375-nA, constant-current source charges  $C_{CWD}$  until  $V_{CWD} = 1.21$  V. [Table 8-2](#) shows how to calculate  $t_{WD}$  using [Equation 1](#) and [Equation 2](#) and the SET1 pin. The TPS3851 determines the watchdog timeout with the formulas given in [Equation 1](#) and [Equation 2](#), where  $C_{CWD}$  is in nanofarads and  $t_{WD}$  is in milliseconds.

$$t_{WD(\text{standard})} (\text{ms}) = 3.23 \times C_{CWD} (\text{nF}) + 0.381 (\text{ms}) \quad (1)$$

$$t_{WD(\text{extended})} (\text{ms}) = 77.4 \times C_{CWD} (\text{nF}) + 55 (\text{ms}) \quad (2)$$

The TPS3851 is designed and tested using  $C_{CWD}$  capacitors between 100 pF and 1  $\mu\text{F}$ . Note that [Equation 1](#) and [Equation 2](#) are for ideal capacitors, capacitor tolerances vary the actual device timing. For the most accurate timing, use ceramic capacitors with COG dielectric material. If a  $C_{CWD}$  capacitor is used, [Equation 1](#) can be used to set  $t_{WD}$  for standard timing. Use [Equation 2](#) to calculate  $t_{WD}$  for extended timing. [Table 8-3](#) shows the minimum and maximum calculated  $t_{WD}$  values using an ideal capacitor for both the standard and extended timing.

**Table 8-2. Programmable CWD Timing**

| INPUT     |      | STANDARD TIMING WDT ( $t_{WD}$ )  |                            |                                   | EXTENDED TIMING WDT ( $t_{WD}$ )  |                            |                                   | UNIT |
|-----------|------|-----------------------------------|----------------------------|-----------------------------------|-----------------------------------|----------------------------|-----------------------------------|------|
| CWD       | SET1 | MIN                               | TYP                        | MAX                               | MIN                               | TYP                        | MAX                               |      |
| $C_{CWD}$ | 0    | Watchdog disabled                 |                            |                                   | Watchdog disabled                 |                            |                                   |      |
| $C_{CWD}$ | 1    | $t_{WD(\text{std})} \times 0.905$ | $t_{WD(\text{std})}^{(1)}$ | $t_{WD(\text{std})} \times 1.095$ | $t_{WD(\text{ext})} \times 0.905$ | $t_{WD(\text{ext})}^{(2)}$ | $t_{WD(\text{ext})} \times 1.095$ | ms   |

(1) Calculated from [Equation 1](#) using an ideal capacitor.

(2) Calculated from [Equation 2](#) using an ideal capacitor.

**Table 8-3.  $t_{WD}$  Values for Common Ideal Capacitor Values**

| $C_{CWD}$       | STANDARD TIMING WDT ( $t_{WD}$ ) |       |                    | EXTENDED TIMING WDT ( $t_{WD}$ ) |       |                    | UNIT |
|-----------------|----------------------------------|-------|--------------------|----------------------------------|-------|--------------------|------|
|                 | MIN <sup>(1)</sup>               | TYP   | MAX <sup>(1)</sup> | MIN <sup>(1)</sup>               | TYP   | MAX <sup>(1)</sup> |      |
| 100 pF          | 0.637                            | 0.704 | 0.771              | 56.77                            | 62.74 | 68.7               | ms   |
| 1 nF            | 3.268                            | 3.611 | 3.954              | 119.82                           | 132.4 | 144.98             | ms   |
| 10 nF           | 29.58                            | 32.68 | 35.79              | 750                              | 829   | 908                | ms   |
| 100 nF          | 292.7                            | 323.4 | 354.1              | 7054                             | 7795  | 8536               | ms   |
| 1 $\mu\text{F}$ | 2923                             | 3230  | 3537               | 70096                            | 77455 | 84814              | ms   |

(1) The minimum and maximum values are calculated using an ideal capacitor.



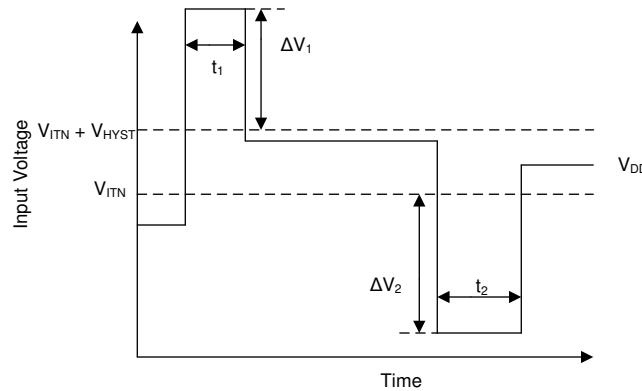
### 8.1.2 Overdrive Voltage

Forcing a  $\overline{\text{RESET}}$  is dependent on two conditions: the amplitude  $V_{DD}$  is beyond the trip point ( $\Delta V_1$  and  $\Delta V_2$ ), and the length of time that the voltage is beyond the trip point ( $t_1$  and  $t_2$ ). If the voltage is just under the trip point for a long period of time,  $\overline{\text{RESET}}$  asserts and the output is pulled low. However, if  $V_{DD}$  is just under the trip point for a few nanoseconds,  $\overline{\text{RESET}}$  does not assert and the output remains high. The length of time required for  $\overline{\text{RESET}}$  to assert can be changed by increasing the amount  $V_{DD}$  goes under the trip point. If  $V_{DD}$  is under the trip point by 10%, the amount of time required for the comparator to respond is much faster and causes  $\overline{\text{RESET}}$  to assert much quicker than when barely under the trip point voltage. Equation 3 shows how to calculate the percentage overdrive.

$$\text{Overdrive} = |((V_{DD} / V_{ITX}) - 1) \times 100\%| \tag{3}$$

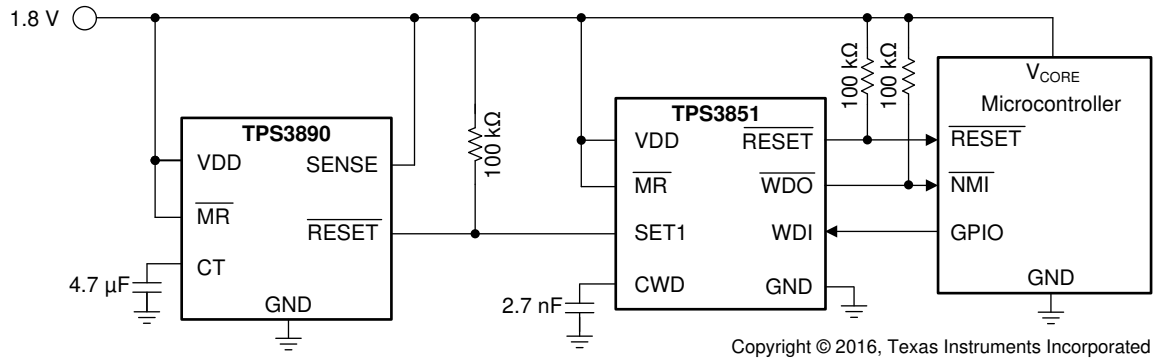
In Equation 3,  $V_{ITX}$  corresponds to the threshold trip point. If  $V_{DD}$  is exceeding the positive threshold,  $V_{ITN} + V_{HYST}$  is used.  $V_{ITN}$  is used when  $V_{DD}$  is falling below the negative threshold. In Figure 8-2,  $t_1$  and  $t_2$  correspond to the amount of time that  $V_{DD}$  is over the threshold; the propagation delay versus overdrive for  $V_{ITN}$  and  $V_{ITN} + V_{HYST}$  is illustrated in Figure 6-16 and Figure 6-18, respectively.

The TPS3851 is relatively immune to short positive and negative transients on  $V_{DD}$  because of the overdrive voltage curve.



**Figure 8-2. Overdrive Voltage**

## 8.2 Typical Application



**Figure 8-3. Monitoring the Supply Voltage and Watchdog Supervision of a Microcontroller**

### 8.2.1 Design Requirements

| PARAMETER                                  | DESIGN REQUIREMENT   | DESIGN RESULT  |
|--|--|--|
| Watchdog disable for initialization period | Watchdog must remain disabled for 5 seconds until logic enables the watchdog timer | 5.02 seconds (typ)   |
| Output logic voltage                       | 1.8-V CMOS   | 1.8V CMOS  |
| Monitored rail                             | 1.8 V with a 5% threshold  | Worst-case $V_{ITN} = 1.714 \text{ V} - 4.7\%$   |
| Watchdog timeout                           | 10 ms typical  | $t_{WD(\min)} = 7.3 \text{ ms}$ , $t_{WD(\text{TYP})} = 9.1 \text{ ms}$ , $t_{WD(\max)} = 11 \text{ ms}$ |
| Maximum device current consumption         | 50 $\mu\text{A}$   | 37 $\mu\text{A}$ when RESET or $\overline{\text{WDO}}$ is asserted <sup>(1)</sup>                        |

(1) Only includes the TPS3851G18S current consumption.

### 8.2.2 Detailed Design Procedure

#### 8.2.2.1 Monitoring the 1.8-V Rail

The undervoltage comparator allows for precise voltage supervision of common rails between 1.8 V and 5.0 V. This application calls for very tight monitoring of the rail with only 5% of variation allowed on the rail. To ensure this requirement is met, the TPS3851G18S was chosen for its  $-4\%$  threshold. To calculate the worst-case for  $V_{ITN}$ , the accuracy must also be taken into account. The worst-case for  $V_{ITN}$  can be calculated by [Equation 4](#):

$$V_{ITN(\text{Worst Case})} = V_{ITN(\text{typ})} \times 0.992 = 1.8 \times 0.96 \times 0.992 = 1.714 \text{ V} \quad (4)$$

### 8.2.2.2 Calculating $\overline{\text{RESET}}$ and $\overline{\text{WDO}}$ Pullup Resistor

The TPS3851 uses an open-drain configuration for the  $\overline{\text{RESET}}$  circuit, as shown in Figure 8-4. When the FET is off, the resistor pulls the drain of the transistor to VDD and when the FET is turned on, the FET attempts to pull the drain to ground, thus creating an effective resistor divider. The resistors in this divider must be chosen to ensure that  $V_{OL}$  is below the maximum value. To choose the proper pullup resistor, there are three key specifications to keep in mind: the pullup voltage ( $V_{PU}$ ), the recommended maximum  $\overline{\text{RESET}}$  pin current ( $I_{\overline{\text{RESET}}}$ ), and  $V_{OL}$ . The maximum  $V_{OL}$  is 0.4 V, meaning that the effective resistor divider created must be able to bring the voltage on the reset pin below 0.4 V with  $I_{\overline{\text{RESET}}}$  kept below 10 mA. For this example, with a  $V_{PU}$  of 1.8 V, a resistor must be chosen to keep  $I_{\overline{\text{RESET}}}$  below 50  $\mu\text{A}$  because this value is the maximum consumption current allowed. To ensure this specification is met, a pullup resistor value of 100 k $\Omega$  was selected, which sinks a maximum of 18  $\mu\text{A}$  when  $\overline{\text{RESET}}$  or  $\overline{\text{WDO}}$  is asserted. As illustrated in Figure 6-13, the  $\overline{\text{RESET}}$  current is at 18  $\mu\text{A}$  and the low-level output voltage is approximately zero.

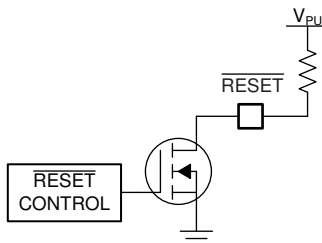


Figure 8-4.  $\overline{\text{RESET}}$  Open-Drain Configuration

### 8.2.2.3 Setting the Watchdog

As illustrated in Figure 8-1 there are three options for setting the watchdog timer. The design specifications in this application require the programmable timing option (external capacitor connected to CWD). When a capacitor is connected to the CWD pin, the watchdog timer is governed by Equation 1 for the standard timing version. Note that only the standard version is capable of meeting this timing requirement. Equation 1 is only valid for ideal capacitors, any temperature or voltage derating must be accounted for separately.

$$C_{\text{CWD}} \text{ (nF)} = (t_{\text{WD}} \text{ (ms)} - 0.0381) / 3.23 = (10 - 0.381) / 3.23 = 2.97 \text{ nF} \quad (5)$$

The nearest standard capacitor value to 2.9 nF is 2.7 nF. Selecting 2.7 nF for the  $C_{\text{CWD}}$  capacitor gives the following minimum timing parameters:

$$t_{\text{WD(MIN)}} = 0.905 \times t_{\text{WD(TYP)}} = 0.905 \times (3.23 \times 2.7 + 0.381) = 8.24 \text{ ms} \quad (6)$$

$$t_{\text{WD(MAX)}} = 1.095 \times t_{\text{WD(TYP)}} = 1.095 \times (3.23 \times 2.7 + 0.381) = 9.97 \text{ ms} \quad (7)$$

Capacitor tolerance also influences  $t_{\text{WD(MIN)}}$  and  $t_{\text{WD(MAX)}}$ . Select a ceramic COG dielectric capacitor for high accuracy. For 2.7 nF, COG capacitors are readily available with 5% tolerances. This selection results in a 5% decrease in  $t_{\text{WD(MIN)}}$  and a 5% increase in  $t_{\text{WD(MAX)}}$ , giving 7.34 ms and 11 ms, respectively. To ensure proper functionality, a falling edge must be issued before  $t_{\text{WD(min)}}$ . Figure 8-6 illustrates that a WDI signal with a period of 5 ms keeps  $\overline{\text{WDO}}$  from asserting.

### 8.2.2.4 Watchdog Disabled During Initialization Period

The watchdog is often needed to be disabled during startup to allow for an initialization period. When the initialization period is over, the watchdog timer is turned back on to allow the microcontroller to be monitored by the TPS3851. To achieve this setup, SET1 must start at GND. In this design, SET1 is controlled by a TPS3890 supervisor. In this application, the TPS3890 was chosen to monitor V<sub>DD</sub> as well, which means that the  $\overline{\text{RESET}}$  on the TPS3890 stays low until V<sub>DD</sub> rises above V<sub>ITN</sub>. When V<sub>DD</sub> comes up, the delay time can be adjusted through the CT capacitor on the TPS3890. With this approach, the  $\overline{\text{RESET}}$  delay can be adjusted from a minimum of 25  $\mu\text{s}$  to a maximum of 30 seconds. For this design, a typical delay of 5 seconds is needed before the watchdog timer is enabled. The CT capacitor calculation (see the TPS3890 data sheet) yields an ideal capacitance of 4.67  $\mu\text{F}$ , giving a closest standard ceramic capacitor value of 4.7  $\mu\text{F}$ . When connecting a 4.7- $\mu\text{F}$  capacitor from CT to GND, the typical delay time is 5 seconds. Figure 8-5 shows that when the watchdog is disabled, the  $\overline{\text{WDO}}$  output remains high. However when SET1 goes high and there is no WDI signal,  $\overline{\text{WDO}}$  begins to assert. See the TPS3890 data sheet for detailed information on the TPS3890.

### 8.2.3 Glitch Immunity

Figure 8-8 shows the high-to-low glitch immunity for the TPS3851G18S with a 7% overdrive with V<sub>DD</sub> starting at 1.8 V. This curve shows that V<sub>DD</sub> can go below the threshold for at least 6  $\mu\text{s}$  before  $\overline{\text{RESET}}$  asserts.

### 8.2.4 Application Curves

Unless otherwise stated, application curves were taken at T<sub>A</sub> = 25°C.

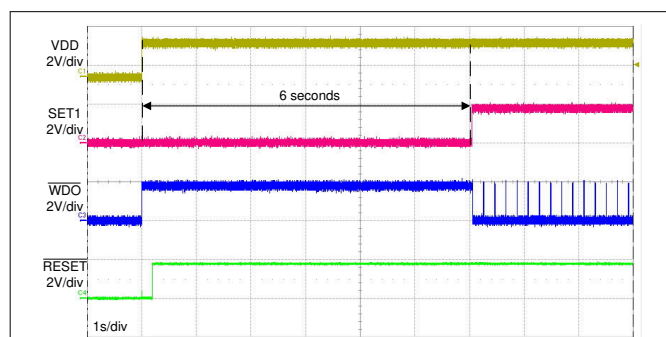


Figure 8-5. Startup Without a WDI Signal

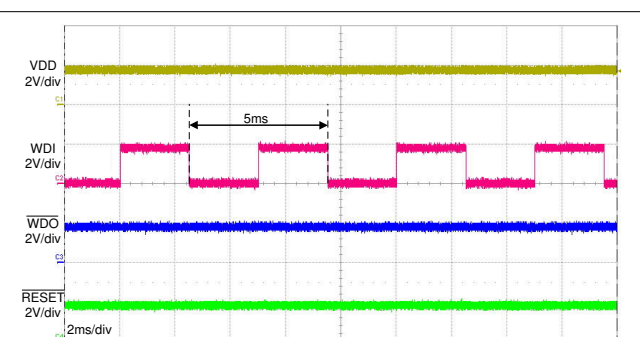


Figure 8-6. Typical WDI Signal

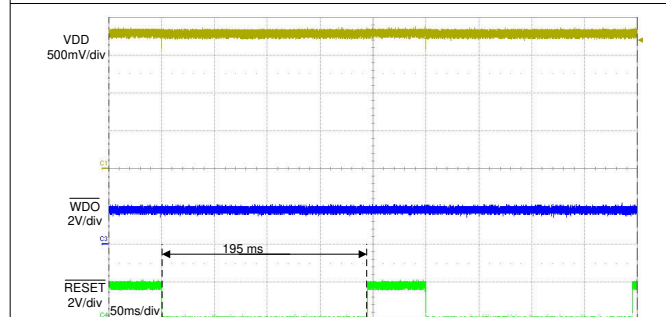


Figure 8-7. Typical  $\overline{\text{RESET}}$  Delay

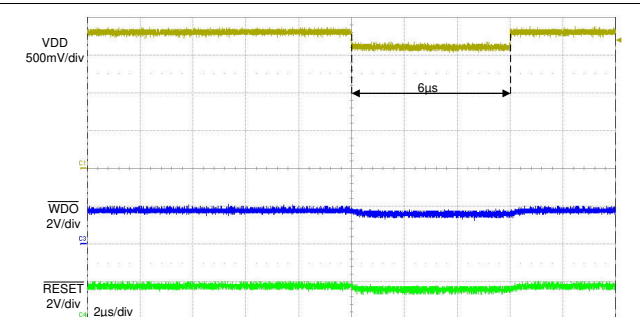


Figure 8-8. High-to-Low Glitch Immunity

## 9 Power Supply Recommendations

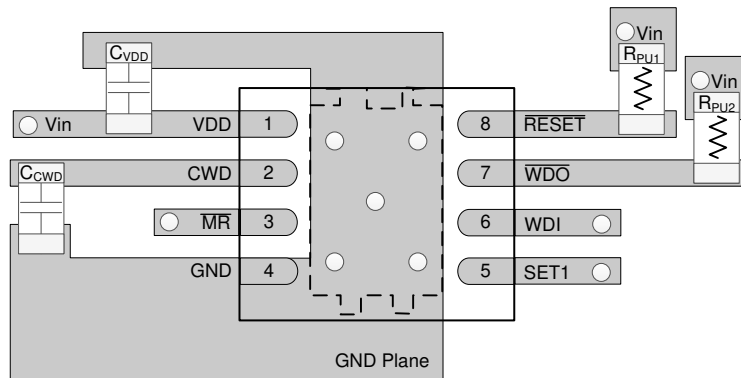
This device is designed to operate from an input supply with a voltage range between 1.6 V and 6.5 V. An input supply capacitor is not required for this device; however, if the input supply is noisy, then good analog practice is to place a 0.1- $\mu$ F capacitor between the VDD pin and the GND pin.

## 10 Layout

### 10.1 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 as near as possible to the VDD pin.
- If a  $C_{CWD}$  capacitor or pullup resistor is used, place these components as close as possible to the CWD pin. If the CWD pin is left unconnected, make sure to minimize the amount of parasitic capacitance on the pin.
- Place the pullup resistors on  $\overline{\text{RESET}}$  and  $\overline{\text{WDO}}$  as close to the pin as possible.

### 10.2 Layout Example



○ Denotes a via

**Figure 10-1. TPS3851 Recommended Layout**

## 11 Device and Documentation Support

### 11.1 Device Support

#### 11.1.1 Device Nomenclature

**Table 11-1. Device Nomenclature**

| DESCRIPTION  | NOMENCLATURE | VALUE  |
|--|--------------|--|
| TPS3851<br>(high-accuracy supervisor with watchdog)                    | —            | —  |
| X<br>(nominal threshold as a percent of the nominal monitored voltage) | G            | $V_{ITN} = -4\%$   |
|  | H            | $V_{ITN} = -7\%$   |
| yy(y)<br>(nominal monitored voltage option)                            | 18           | 1.8 V  |
|  | 25           | 2.5 V  |
|  | 30           | 3.0 V  |
|  | 33           | 3.3 V  |
|  | 50           | 5.0 V  |
| z<br>(nominal watchdog timeout period)                                 | S            | $t_{WD} \text{ (ms)} = 3.23 \times C_{WD} \text{ (nF)} + 0.381 \text{ (ms)}$ |
|  | E            | $t_{WD} \text{ (ms)} = 77.4 \times C_{WD} \text{ (nF)} + 55.2 \text{ (ms)}$  |

### 11.2 Documentation Support

#### 11.2.1 Related Documentation

For related documentation see the following:

- [TPS3890 Low Quiescent Current, 1% Accurate Supervisor with Programmable Delay](#) (SLVSD65)
- [TPS3851EVM-780 Evaluation Module](#) (SBVU033)

#### 11.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](http://ti.com). Click on *Subscribe to updates* 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.

#### 11.4 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

#### 11.5 Trademarks

TI E2E™ is a trademark of Texas Instruments.  
All trademarks are the property of their respective owners.

#### 11.6 Electrostatic Discharge Caution



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

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

#### 11.7 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

## 12 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.



**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS3851G18EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851DD                   | <a href="#">Samples</a> |
| TPS3851G18EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851DD                   | <a href="#">Samples</a> |
| TPS3851G18SDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851DC                   | <a href="#">Samples</a> |
| TPS3851G18SDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851DC                   | <a href="#">Samples</a> |
| TPS3851G25EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851ED                   | <a href="#">Samples</a> |
| TPS3851G25EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851ED                   | <a href="#">Samples</a> |
| TPS3851G30EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851FD                   | <a href="#">Samples</a> |
| TPS3851G30EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851FD                   | <a href="#">Samples</a> |
| TPS3851G33EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851GD                   | <a href="#">Samples</a> |
| TPS3851G33EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851GD                   | <a href="#">Samples</a> |
| TPS3851G33SDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851GC                   | <a href="#">Samples</a> |
| TPS3851G33SDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851GC                   | <a href="#">Samples</a> |
| TPS3851G50EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851HD                   | <a href="#">Samples</a> |
| TPS3851G50EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851HD                   | <a href="#">Samples</a> |
| TPS3851G50SDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851HC                   | <a href="#">Samples</a> |
| TPS3851G50SDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851HC                   | <a href="#">Samples</a> |
| TPS3851H18EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851LD                   | <a href="#">Samples</a> |
| TPS3851H18EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851LD                   | <a href="#">Samples</a> |
| TPS3851H25EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851MD                   | <a href="#">Samples</a> |
| TPS3851H25EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851MD                   | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS3851H30EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851ND                   | <a href="#">Samples</a> |
| TPS3851H30EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851ND                   | <a href="#">Samples</a> |
| TPS3851H33EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851PD                   | <a href="#">Samples</a> |
| TPS3851H33EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851PD                   | <a href="#">Samples</a> |
| TPS3851H50EDRBR  | ACTIVE        | SON          | DRB             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851RD                   | <a href="#">Samples</a> |
| TPS3851H50EDRBT  | ACTIVE        | SON          | DRB             | 8    | 250         | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 851RD                   | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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**OTHER QUALIFIED VERSIONS OF TPS3851 :**

- Automotive : [TPS3851-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 |
|-----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS3851G18EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G18EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G18SDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G18SDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G25EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G25EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G30EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G30EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G33EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G33EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G33SDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G33SDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G50EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G50EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G50SDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851G50SDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | 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 |
|-----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS3851H18EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H18EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H25EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H25EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H30EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H30EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H33EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H33EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H50EDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS3851H50EDRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device          | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS3851G18EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851G18EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851G18SDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851G18SDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851G25EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851G25EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851G30EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851G30EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851G33EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851G33EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851G33SDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851G33SDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851G50EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851G50EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851G50SDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851G50SDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851H18EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851H18EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |

---

| Device          | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS3851H25EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851H25EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851H30EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851H30EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851H33EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851H33EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| TPS3851H50EDRBR | SON          | DRB             | 8    | 3000 | 367.0       | 367.0      | 35.0        |
| TPS3851H50EDRBT | SON          | DRB             | 8    | 250  | 210.0       | 185.0      | 35.0        |

**DRB 8**

**GENERIC PACKAGE VIEW**

**VSON - 1 mm max height**

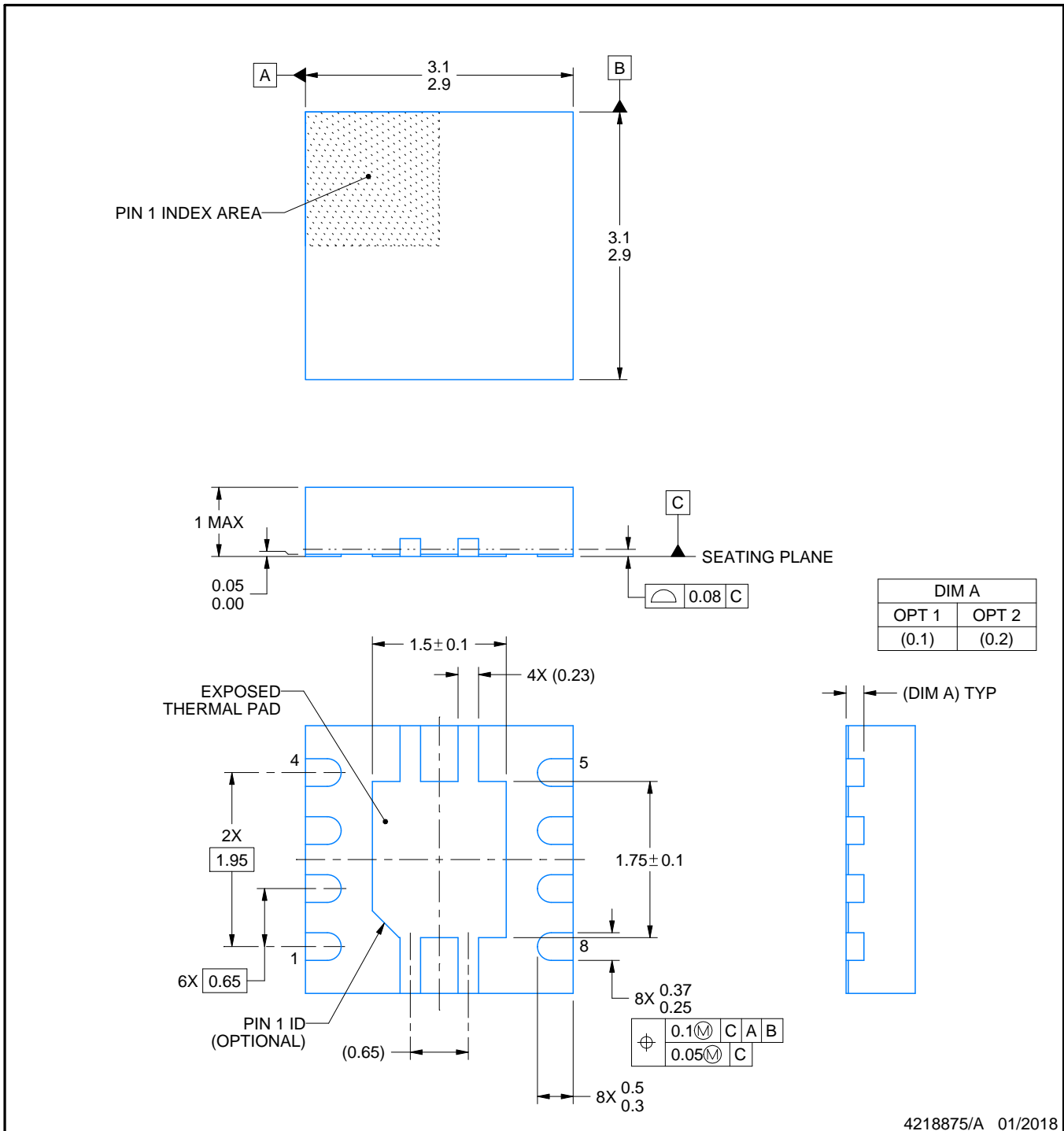
PLASTIC SMALL OUTLINE - NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4203482/L





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.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

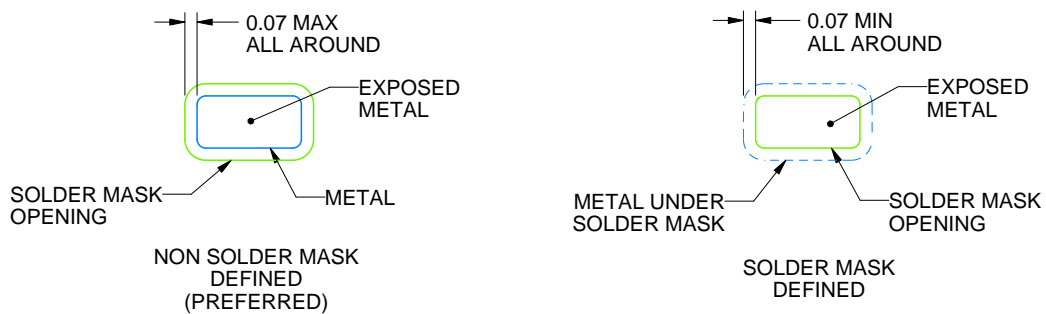
DRB0008A

VSON - 1 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:20X



SOLDER MASK DETAILS

4218875/A 01/2018

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

DRB0008A

VSON - 1 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD  
84% PRINTED SOLDER COVERAGE BY AREA  
SCALE:25X

4218875/A 01/2018

NOTES: (continued)

6. 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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