

## TPS7H2201-SP 和 TPS7H2201-SEP 耐辐射 1.5V 至 7V、6A 电子保险丝

### 1 特性

- 提供标准微型电路，[SMD 5962R17220](#)
- 提供供应商项目图，[VID V62/23608](#)
- 辐射性能：
  - 耐辐射保障 (RHA) 高达 TID 100krad(Si)
  - 单粒子锁定 (SEL)、单粒子烧毁 (SEB) 和单粒子栅穿 (SEGR) 对于 LET 的抗扰度 = 75MeV-cm<sup>2</sup>/mg
  - SEFI/SET 对于 LET 的额定抗扰度 = 75MeV-cm<sup>2</sup>/mg
- 集成式单通道电子保险丝
- 输入电压范围：1.5V 至 7V
- 低导通电阻 (R<sub>ON</sub>)：
  - 对于 CFP 和 KGD 封装，在 25°C 且 V<sub>IN</sub> = 5V 时的最大值为 35mΩ
  - 对于 HTSSOP 封装，在 25°C 且 V<sub>IN</sub> = 5V 时的最大值为 23mΩ
- 6A 最大持续开关电流
- 低控制输入阈值支持使用 1.2V、1.8V、2.5V 和 3.3V 逻辑电平
- 可配置上升时间 (软启动)
- 反向电流保护
- 可编程和内部电流限制 (快速跳变)
- 可编程故障计时器 (电流限制和重试模式)
- 热关断
- 带散热焊盘的陶瓷和塑料封装

### 2 应用

- 航天卫星电源管理和配电
- 耐辐射和抗辐射电源树应用
- 支持军用 ( - 55°C 至 125°C ) 温度范围

### 3 说明

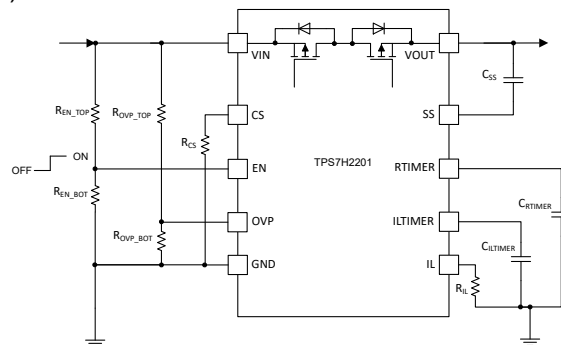
TPS7H2201 是一款单通道电子保险丝，可提供用于更大限度地降低浪涌电流的可配置上升时间和反向电流保护。该器件包含一个可在 1.5V 至 7V 输入电压范围内运行的 P 沟道 MOSFET，并且支持 6A 的最大持续电流。开关由可与低压控制信号直接连接的打开和关闭输入 (EN) 控制。

TPS7H2201 采用具有集成散热焊盘的陶瓷和塑料封装，可支持高功率耗散。该器件在自然通风环境下的额定运行温度范围为 - 55°C 至 125°C。

#### 器件信息

| 器件型号 <sup>(1)</sup> | 等级                    | 封装                                                         |
|---------------------|-----------------------|------------------------------------------------------------|
| 5962R1722001VXC     | 飞行等级 RHA 100krad (Si) | 16 引脚 CDFP<br>11.00 × 9.60mm<br>重量：1.56g <sup>(3)</sup>    |
| 5962-1722001VXC     | 飞行等级 QMLV             |                                                            |
| TPS7H2201HKR/EM     | 工程样片 <sup>(2)</sup>   |                                                            |
| TPS7H2201MDAPTSEP   | 9 月                   | 32 引脚 HTSSOP<br>6.10 × 11.00mm<br>重量：0.191g <sup>(3)</sup> |
| TPS7H2201EVM-CVAL   | 陶瓷评估板                 | EVM                                                        |

- (1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。另请参阅[器件选项](#)。
- (2) 这些器件仅适用于工程评估。器件按照不合规的流程进行加工处理。这些器件不适用于鉴定、量产、辐射测试或飞行。也不保证这些器件在 MIL 规定的 - 55°C 至 125°C 完整温度范围内或运行寿命中的性能。
- (3) 尺寸和质量值为标称值。



简化原理图



## Table of Contents

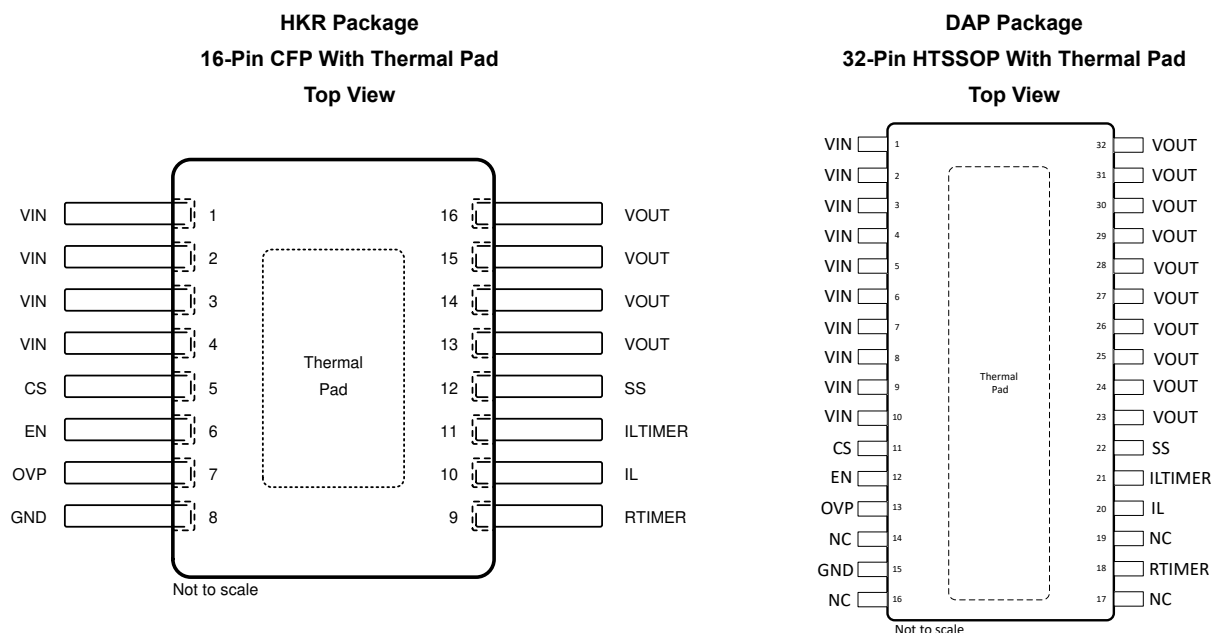
|                                                         |           |                                                                  |           |
|---------------------------------------------------------|-----------|------------------------------------------------------------------|-----------|
| <b>1 特性</b> .....                                       | <b>1</b>  | 8.2 Functional Block Diagram.....                                | <b>20</b> |
| <b>2 应用</b> .....                                       | <b>1</b>  | 8.3 Feature Description.....                                     | <b>21</b> |
| <b>3 说明</b> .....                                       | <b>1</b>  | 8.4 Device Functional Modes.....                                 | <b>30</b> |
| <b>4 Device Options</b> .....                           | <b>3</b>  | <b>9 Application and Implementation</b> .....                    | <b>31</b> |
| <b>5 Pin Configuration and Functions</b> .....          | <b>4</b>  | 9.1 Application Information.....                                 | <b>31</b> |
| <b>6 Specifications</b> .....                           | <b>8</b>  | 9.2 Typical Applications.....                                    | <b>31</b> |
| 6.1 Absolute Maximum Ratings.....                       | <b>8</b>  | 9.3 Power Supply Recommendations.....                            | <b>36</b> |
| 6.2 ESD Ratings.....                                    | <b>8</b>  | 9.4 Layout.....                                                  | <b>36</b> |
| 6.3 Recommended Operating Conditions.....               | <b>8</b>  | <b>10 Device and Documentation Support</b> .....                 | <b>37</b> |
| 6.4 Thermal Information.....                            | <b>9</b>  | 10.1 Documentation Support.....                                  | <b>37</b> |
| 6.5 Electrical Characteristics: All Devices.....        | <b>9</b>  | 10.2 Receiving Notification of Documentation Updates..           | <b>37</b> |
| 6.6 Electrical Characteristics: CFP and KGD Options.... | <b>11</b> | 10.3 支持资源.....                                                   | <b>37</b> |
| 6.7 Electrical Characteristics: HTSSOP Option.....      | <b>12</b> | 10.4 Trademarks.....                                             | <b>37</b> |
| 6.8 Switching Characteristics (All Devices).....        | <b>13</b> | 10.5 静电放电警告.....                                                 | <b>37</b> |
| 6.9 Quality Conformance Inspection.....                 | <b>13</b> | 10.6 术语表.....                                                    | <b>37</b> |
| 6.10 Typical Characteristics.....                       | <b>14</b> | <b>11 Revision History</b> .....                                 | <b>38</b> |
| <b>7 Parameter Measurement Information</b> .....        | <b>18</b> | <b>12 Mechanical, Packaging, and Orderable Information</b> ..... | <b>38</b> |
| <b>8 Detailed Description</b> .....                     | <b>20</b> |                                                                  |           |
| 8.1 Overview.....                                       | <b>20</b> |                                                                  |           |

## 4 Device Options

| GENERIC PART NUMBER | RADIATION RATING <sup>(1)</sup>                                   | GRADE <sup>(2)</sup>             | PACKAGE           | ORDERABLE PART NUMBER |
|---------------------|-------------------------------------------------------------------|----------------------------------|-------------------|-----------------------|
| TPS7H2201-SP        | TID of 100 krad(Si) RLAT, DSEE free to 75 MeV-cm <sup>2</sup> /mg | QMLV-RHA                         | 16-pin HKR CFP    | 5962R1722001VXC       |
|                     |                                                                   | QMLP-RHA                         | 32-pin DAP HTSSOP | 5962R1722002PYE       |
|                     |                                                                   | KGD (QMLV-RHA)                   | Die               | 5962R1722001V9A       |
|                     | None                                                              | Engineering Model <sup>(3)</sup> | 16-pin HKR CFP    | PTS7H2201HKR/EM       |
|                     |                                                                   |                                  | Die               | TPS7H2201Y/EM         |
| TPS7H2201-SEP       | TID of 50 krad(Si) RLAT, DSEE free to 43 MeV-cm <sup>2</sup> /mg  | Space Enhanced Plastic           | 32-pin DAP HTSSOP | TPS7H2201MDAPTSEP     |

- (1) TID is total ionizing dose and DSEE is destructive single event effects. Additional information is available in the associated TID reports and SEE reports for each product.
- (2) For additional information about part grade, view [SLYB235](#).
- (3) These units are intended for engineering evaluation only. They are processed to a non-compliant flow (such as no burn-in and only 25°C testing). These units are not suitable for qualification, production, radiation testing, or flight use. Parts are not warranted as to performance over temperature or operating life.

## 5 Pin Configuration and Functions



**表 5-1. Pin Functions**

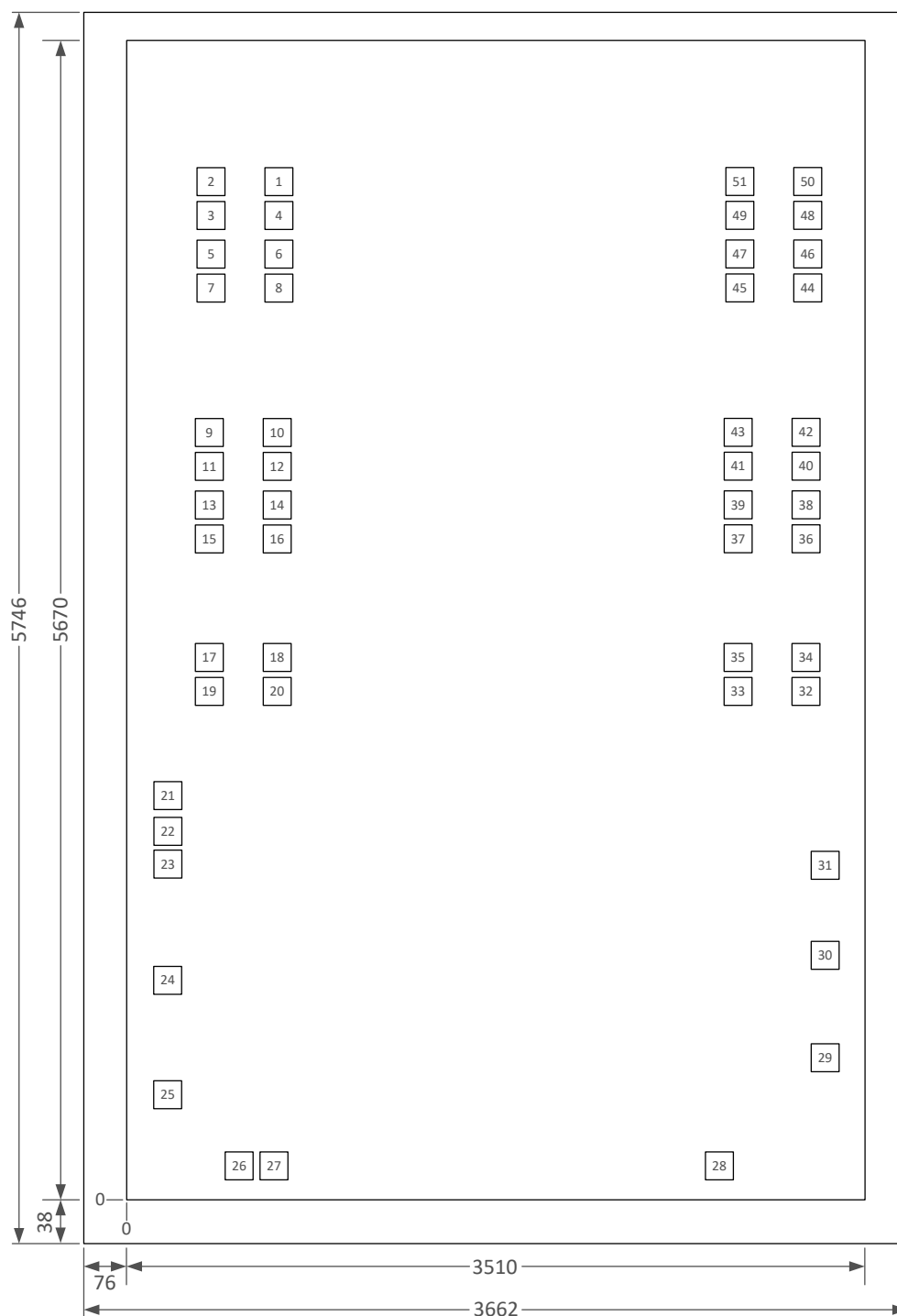
| PIN   |              |                  | I/O <sup>(1)</sup> | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------|--------------|------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       | HKR (16) NO. | PW (32) NO. NAME |                    |                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1-4   | 1-10         | VIN              | I                  | Switch input. Input bypass capacitor recommended for minimizing $V_{IN}$ dip.                                                                                                                                                                                                                                                                                                                                       |
| 5     | 11           | CS               | O                  | Current sense pin proportional to output current. Connect a resistor to GND.                                                                                                                                                                                                                                                                                                                                        |
| 6     | 12           | EN               | I                  | Active high switch control input. Do not leave floating.                                                                                                                                                                                                                                                                                                                                                            |
| 7     | 13           | OVP              | I                  | Overvoltage protection. Programmable using an external resistor divider. If no OVP is desired, this pin should be connected to GND.                                                                                                                                                                                                                                                                                 |
| 8     | 15           | GND              | —                  | Device ground. <sup>(2)</sup>                                                                                                                                                                                                                                                                                                                                                                                       |
| 9     | 18           | RTIMER           | I/O                | Capacitor programmed fault timer control during disabled and retry mode. Connecting this pin to GND holds the switch disabled until the EN pin is cycled. Do not float this pin or connect it to VIN.                                                                                                                                                                                                               |
| 10    | 20           | IL               | I/O                | Current limiter control. Programmable using an external resistor to GND. Do not float this pin.                                                                                                                                                                                                                                                                                                                     |
| 11    | 21           | ILTIMER          | I                  | Capacitor programmed fault timer control during current limiting mode. Connecting this pin to VIN uses the internal current limit timer and connecting this pin to GND disables the internal timer functionality for the ILTIMER as well as retry mode. In this case, the device will remain at programmed current limit indefinitely in the event of a short without going into retry mode. Do not float this pin. |
| 12    | 22           | SS               | I/O                | Switch slew rate control. See the <a href="#">§ 8.3.2</a> section for more information.                                                                                                                                                                                                                                                                                                                             |
| 13-16 | 23-32        | VOUT             | O                  | Switch output. A minimum 10- $\mu$ F output capacitor is recommended.                                                                                                                                                                                                                                                                                                                                               |
|       | 14,16,17,19  | NC               | —                  | No connect. This pin is not internally connected. It is recommended to connect these pins to GND to prevent charge buildup; however, these pins can also be left open or tied to any voltage between GND and VIN.                                                                                                                                                                                                   |
|       | —            | Thermal Pad      | —                  | Thermal pad (exposed center pad) for heat dissipation purposes. Thermal pad is internally connected to seal ring and GND.                                                                                                                                                                                                                                                                                           |

(1) I = Input, O = Output, I/O = Input or Output, — = Other

(2) Thermal pad is internally connected to the seal ring and GND for HKR option.

**表 5-2. Bare Die Information**

| DIE THICKNESS | BACKSIDE FINISH        | BACKSIDE POTENTIAL | BOND PAD METALLIZATION COMPOSITION | BOND PAD THICKNESS |
|---------------|------------------------|--------------------|------------------------------------|--------------------|
| 15 mils       | Silicon with backgrind | Ground             | ALCU                               | 1050 nm            |



1. All dimensions in microns ( $\mu\text{m}$ ).
2. The inner rectangle is the die and the outer rectangle is the die plus scribe lines.

表 5-3. Bond Pad Coordinates in Microns

| DESCRIPTION | PAD NUMBER | X MIN   | Y MIN   | X MAX   | Y MAX   |
|-------------|------------|---------|---------|---------|---------|
| VIN         | 1          | 611.78  | 4976.1  | 751.73  | 5116.05 |
| VIN         | 2          | 258.17  | 4976.1  | 398.12  | 5116.05 |
| VIN         | 3          | 258.17  | 4809.15 | 398.12  | 4949.1  |
| VIN         | 4          | 611.78  | 4809.15 | 751.73  | 4949.1  |
| VIN         | 5          | 258.17  | 4641.39 | 398.12  | 4781.34 |
| VIN         | 6          | 611.78  | 4641.39 | 751.73  | 4781.34 |
| VIN         | 7          | 258.17  | 4473.59 | 398.12  | 4613.54 |
| VIN         | 8          | 611.78  | 4473.59 | 751.73  | 4613.54 |
| VIN         | 9          | 258.17  | 3647.7  | 398.12  | 3787.65 |
| VIN         | 10         | 611.78  | 3647.7  | 751.73  | 3787.65 |
| VIN         | 11         | 258.17  | 3480.75 | 398.12  | 3620.7  |
| VIN         | 12         | 611.78  | 3480.75 | 751.73  | 3620.7  |
| VIN         | 13         | 258.17  | 3312.99 | 398.12  | 3452.94 |
| VIN         | 14         | 611.78  | 3312.99 | 751.73  | 3452.94 |
| VIN         | 15         | 258.17  | 3145.19 | 398.12  | 3285.14 |
| VIN         | 16         | 611.78  | 3145.19 | 751.73  | 3285.14 |
| VIN         | 17         | 258.17  | 2315.57 | 398.12  | 2455.52 |
| VIN         | 18         | 611.78  | 2315.57 | 751.73  | 2455.52 |
| VIN         | 19         | 258.17  | 2146.37 | 398.12  | 2286.32 |
| VIN         | 20         | 611.78  | 2146.37 | 751.73  | 2286.36 |
| AVDD        | 21         | 54.99   | 1842.03 | 194.94  | 1981.98 |
| AVDD        | 22         | 54.99   | 1671.48 | 194.94  | 1811.43 |
| CS          | 23         | 54.99   | 1480.77 | 194.94  | 1620.72 |
| EN          | 24         | 54.99   | 972.68  | 194.94  | 1112.63 |
| OVP         | 25         | 54.99   | 406.26  | 194.94  | 546.21  |
| GND         | 26         | 407.21  | 54.99   | 547.16  | 194.94  |
| GND         | 27         | 577.76  | 54.99   | 717.71  | 194.94  |
| RTIMER      | 28         | 2792.88 | 54.99   | 2932.83 | 194.94  |
| IL          | 29         | 3315.06 | 587.43  | 3455.01 | 727.38  |
| ILTIMER     | 30         | 3315.06 | 1099.26 | 3455.01 | 1239.21 |
| SS          | 31         | 3315.06 | 1544.09 | 3455.01 | 1684.04 |
| VOUT        | 32         | 3111.66 | 2146.37 | 3251.61 | 2286.32 |
| VOUT        | 33         | 2758.05 | 2146.37 | 2898    | 2286.32 |
| VOUT        | 34         | 3111.66 | 2315.57 | 3251.61 | 2455.52 |
| VOUT        | 35         | 2758.05 | 2315.57 | 2898    | 2455.52 |
| VOUT        | 36         | 3111.66 | 3145.19 | 3251.61 | 3285.14 |
| VOUT        | 37         | 2758.05 | 3145.19 | 2898    | 3285.14 |
| VOUT        | 38         | 3111.66 | 3312.99 | 3251.61 | 3452.94 |
| VOUT        | 39         | 2758.05 | 3312.99 | 2898    | 3452.94 |
| VOUT        | 40         | 3111.66 | 3480.75 | 3251.61 | 3620.7  |
| VOUT        | 41         | 2758.05 | 3480.75 | 2898    | 3620.7  |
| VOUT        | 42         | 3111.66 | 3647.7  | 3251.61 | 3787.65 |
| VOUT        | 43         | 2758.05 | 3647.7  | 2898    | 3787.65 |
| VOUT        | 44         | 3111.66 | 4473.59 | 3251.61 | 4613.54 |
| VOUT        | 45         | 2758.05 | 4473.59 | 2898    | 4613.54 |

**表 5-3. Bond Pad Coordinates in Microns (续)**

| DESCRIPTION | PAD NUMBER | X MIN   | Y MIN   | X MAX   | Y MAX   |
|-------------|------------|---------|---------|---------|---------|
| VOUT        | 46         | 3111.66 | 4641.39 | 3251.61 | 4781.34 |
| VOUT        | 47         | 2758.05 | 4641.39 | 2898    | 4781.34 |
| VOUT        | 48         | 3111.66 | 4809.15 | 3251.61 | 4949.1  |
| VOUT        | 49         | 2758.05 | 4809.15 | 2898    | 4949.1  |
| VOUT        | 50         | 3111.66 | 4976.1  | 3251.61 | 5116.05 |
| VOUT        | 51         | 2758.05 | 4976.1  | 2898    | 5116.05 |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1) (2)</sup>

|                         |                                                                                    | MIN   | MAX                   | UNIT |
|-------------------------|------------------------------------------------------------------------------------|-------|-----------------------|------|
| V <sub>IN</sub>         | Input voltage                                                                      | – 0.3 | 7.5                   | V    |
| V <sub>OUT</sub>        | Output voltage                                                                     | – 0.3 | 7.5                   | V    |
| EN, OVP                 | Enable and over voltage protection pins                                            | – 0.3 | 7.5                   | V    |
| CS, ILTMR, RTMR, IL, SS | Current sense, current limit timer, retry timer, current limit and soft start pins | – 0.3 | V <sub>IN</sub> + 0.3 | V    |
| I <sub>MAX</sub>        | Maximum continuous switch current                                                  |       | 9                     | A    |
| I <sub>PLS</sub>        | Maximum pulsed switch current (t ≤ 5μs)                                            |       | 45                    | A    |
| T <sub>J</sub>          | Maximum junction temperature                                                       | – 55  | 150                   | °C   |
| T <sub>stg</sub>        | Storage temperature                                                                | – 65  | 150                   | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to network ground pin.

### 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> | ±750  |      |

- (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  | MAX              | UNIT |
|-------------------|-----------------------------------------------|------|------------------|------|
| V <sub>IN</sub>   | Input voltage                                 | 1.5  | 7                | V    |
| SR <sub>VIN</sub> | Input voltage slew rate                       |      | 0.01             | V/μs |
| V <sub>OUT</sub>  | Output voltage                                | 0    | 7 <sup>(1)</sup> | V    |
| I <sub>MAX</sub>  | Maximum continuous switch current             |      | 6                | A    |
| T <sub>J</sub>    | Operating junction temperature <sup>(2)</sup> | – 55 | 125              | °C   |

- (1) This maximum V<sub>OUT</sub> voltage is only applicable when the device is disabled (EN = Low). When the device is enabled (EN = High), the maximum V<sub>OUT</sub> voltage is the input voltage, V<sub>IN</sub>.
- (2) In applications where high power dissipation and/or poor package thermal resistance is present, the maximum ambient temperature may have to be derated. Maximum ambient temperature [T<sub>A(max)</sub>] is dependent on the maximum operating junction temperature [T<sub>J(max)</sub>], the maximum power dissipation of the device in the application [P<sub>D(max)</sub>], and the junction-to-ambient thermal resistance of the part/package in the application (θ<sub>JA</sub>), as given by the equation: T<sub>A(max)</sub> = T<sub>J(max)</sub> – (θ<sub>JA</sub> × P<sub>D(max)</sub>).



## 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                              | TPS7H2201-SP | TPS7H2201-SEP | UNIT |
|-------------------------------|----------------------------------------------|--------------|---------------|------|
|                               |                                              | HKR (CFP)    | DAP (HTSSOP)  |      |
|                               |                                              | 16 PINS      | 32 PINS       |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 72.3         | 23.5          | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 96.1         | 11.2          |      |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 42.1         | 5.4           |      |
| $\psi_{JT}$                   | Junction-to-top characterization parameter   | 3.3          | 0.1           |      |
| $\psi_{JB}$                   | Junction-to-board characterization parameter | 42.5         | 5.4           |      |
| $R_{\theta JC(bot)}$          | Junction-to-case (bottom) thermal resistance | 0.6          | 0.5           |      |

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

## 6.5 Electrical Characteristics: All Devices

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

| PARAMETER                                       |                                     | TEST CONDITIONS                                                                     |                                               | SUBGROUP<br>(1) | MIN  | TYP  | MAX  | UNIT  |
|-------------------------------------------------|-------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------|-----------------|------|------|------|-------|
| POWER SUPPLIES AND CURRENTS                     |                                     |                                                                                     |                                               |                 |      |      |      |       |
| V <sub>INHUVLO</sub>                            | Internal VIN UVLO voltage, rising   |                                                                                     |                                               |                 |      | 1.32 |      | V     |
| V <sub>INLUVLO</sub>                            | Internal VIN UVLO voltage, falling  |                                                                                     |                                               |                 |      | 1.23 |      | V     |
| HYST <sub>VIN-UVLO</sub>                        | Internal VIN UVLO hysteresis        |                                                                                     |                                               |                 |      | 92   |      | mV    |
| I <sub>Q</sub>                                  | Quiescent current                   | I <sub>OUT</sub> = 0 mA,<br>V <sub>IN</sub> = EN = 5 V, CS resistor of 20 kΩ to GND |                                               | 1, 2, 3         |      | 2.4  | 6.5  | mA    |
| I <sub>F</sub>                                  | VIN to VOUT forward leakage current | EN = VOUT = GND, measured VOUT current                                              | 1.5 V ≤ VIN ≤ 7 V                             | 1, 2, 3         |      |      | 250  | μA    |
|                                                 |                                     |                                                                                     | VIN =1.5 V                                    | 1, 2, 3         |      | 3.27 |      |       |
|                                                 |                                     |                                                                                     | VIN = 1.8 V                                   | 1, 2, 3         |      | 3.35 |      |       |
|                                                 |                                     |                                                                                     | VIN= 3.3 V                                    | 1, 2, 3         |      | 3.62 |      |       |
|                                                 |                                     |                                                                                     | VIN = 5 V                                     | 1, 2, 3         |      | 4.11 |      |       |
|                                                 |                                     |                                                                                     | VIN = 7 V                                     | 1, 2, 3         |      | 6.82 |      |       |
| I <sub>SD</sub> VIN                             | VIN off-state supply current        | EN = GND,<br>I <sub>OUT</sub> = 0 mA, measured VIN current                          | VIN = 5 V                                     | 1, 2, 3         |      | 0.4  | 3    | mA    |
|                                                 |                                     |                                                                                     | VIN = 3.3 V                                   | 1, 2, 3         |      | 0.3  | 3    |       |
|                                                 |                                     |                                                                                     | VIN = 1.8 V                                   | 1, 2, 3         |      | 0.2  | 3    |       |
|                                                 |                                     |                                                                                     | After TID = 100 krad, VIN = 1.8, 3.3, and 5 V | 1               |      |      | 3.1  |       |
| SOFT START                                      |                                     |                                                                                     |                                               |                 |      |      |      |       |
| I <sub>SS</sub>                                 | Soft start charge current           | 1 V on SS pin                                                                       |                                               | 1, 2, 3         |      | 65   | 83   | μA    |
| SR <sub>SS</sub>                                | Soft start slew rate                | SS pin floating, COUT = 10 μF                                                       |                                               |                 |      | 295  |      | mV/μs |
| ENABLE AND UNDERVOLTAGE LOCKOUT (EN/UVLO) INPUT |                                     |                                                                                     |                                               |                 |      |      |      |       |
| V <sub>IHEN</sub>                               | EN/UVLO threshold voltage, rising   |                                                                                     |                                               | 1, 2, 3         | 0.56 | 0.61 | 0.65 | V     |
| V <sub>ILEN</sub>                               | EN/UVLO threshold voltage, falling  |                                                                                     |                                               | 1, 2, 3         | 0.47 | 0.51 | 0.55 | V     |
| HYST <sub>EN</sub>                              | EN/UVLO hysteresis voltage          |                                                                                     |                                               | 1, 2, 3         |      | 93   | 124  | mV    |
| t <sub>LOW</sub>                                | EN signal low time during cycling   | RTIMER = GND, IL = 1 A, I <sub>VOUT</sub> = 2 A                                     | See 图 7-1                                     | 9, 10, 11       | 20   |      |      | μs    |
| VIN <sub>EN</sub>                               | VIN percentage for enable(2)        |                                                                                     |                                               | 4, 5, 6         | 75%  |      |      |       |
| I <sub>EN</sub>                                 | EN pin input leakage current        | EN = VIN = 5 V                                                                      |                                               | 1, 2, 3         |      |      | 12   | nA    |

## 6.5 Electrical Characteristics: All Devices (续)

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

| PARAMETER                                   |                                       | TEST CONDITIONS                                  | SUBGROUP<br>(1) | MIN                     | TYP  | MAX       | UNIT |
|---------------------------------------------|---------------------------------------|--------------------------------------------------|-----------------|-------------------------|------|-----------|------|
| OVERVOLTAGE PROTECTION (OVP)                |                                       |                                                  |                 |                         |      |           |      |
| V <sub>OVPR</sub>                           | OVPR threshold voltage, rising        |                                                  | 1, 2, 3         | 0.52                    | 0.57 | 0.63      | V    |
| V <sub>OVPF</sub>                           | OVPF threshold voltage, falling       |                                                  | 1, 2, 3         | 0.5                     | 0.55 | 0.59      | V    |
| HYST <sub>OVP</sub>                         | OVP hysteresis voltage                | 1.6 V < VIN < 7 V                                | 1, 2, 3         |                         | 20   | 55        | mV   |
| I <sub>OVP</sub>                            | OVP pin input leakage current         |                                                  | 1, 2, 3         |                         |      | 15        | nA   |
| CURRENT LIMIT AND CURRENT SENSE             |                                       |                                                  |                 |                         |      |           |      |
| t <sub>CSEN</sub>                           | Time for valid CS output after enable | C <sub>SS</sub> = 120 nF                         | 9, 10, 11       |                         |      | 5         | ms   |
| Minimum VOUT current for valid CS output    |                                       |                                                  | 1, 2, 3         | 750                     |      |           | mA   |
| VOUT current change to CS change delay time |                                       | 0.5-A rising step, 100 mA/μs, 1.5 V ≤ VIN ≤ 7 V  | 9, 10, 11       |                         | 16   | 74        | μs   |
| VOUT current change to CS change delay time |                                       | 0.5-A falling step, 100 mA/μs, 1.5 V ≤ VIN ≤ 7 V | 9, 10, 11       |                         | 16   | 73        | μs   |
| CS pin accuracy                             |                                       | 0.75 A ≤ I <sub>VOUT</sub> ≤ 7.5 A               | 4, 5, 6         | - 10%                   |      | 10%       |      |
| CS pin voltage                              |                                       | 0.75 A ≤ I <sub>VOUT</sub> ≤ 7.5 A, no OCP       | 1, 2, 3         |                         |      | VIN - 0.4 | V    |
| Current limit setting, I <sub>IL</sub>      |                                       | I <sub>VOUT</sub> ≤ 1 A                          | 1, 2, 3         | I <sub>VOUT</sub> + 0.5 |      |           | A    |
|                                             |                                       | 1A < I <sub>VOUT</sub> ≤ 3 A                     | 1, 2, 3         | I <sub>VOUT</sub> + 1   |      |           |      |
|                                             |                                       | I <sub>VOUT</sub> > 3 A                          | 1, 2, 3         | I <sub>VOUT</sub> + 1.5 |      |           |      |
| Programmable current limit accuracy         |                                       | 1.5 V ≤ VIN ≤ 7 V                                | 4, 5, 6         | - 20%                   |      | 20%       |      |
| Fast trip off current limit                 |                                       | VIN = 5 V, 10-mΩ short in 10 μs                  |                 |                         | 22   |           | A    |
| TIMERS                                      |                                       |                                                  |                 |                         |      |           |      |
| I <sub>LTIMER</sub>                         | LTIMER charge current                 |                                                  | 1, 2, 3         | 0.7                     | 1    | 1.38      | μA   |
| PD <sub>LTIMER</sub>                        | LTIMER internal pull-down resistance  | 40 mV on LTIMER pin                              | 1, 2, 3         |                         | 38   | 153       | Ω    |
| I <sub>RTIMER</sub>                         | RTIMER charge current                 |                                                  | 1, 2, 3         | 0.7                     | 1    | 1.38      | μA   |
| PD <sub>RTIMER</sub>                        | RTIMER internal pull-down resistance  | 40 mV on RTIMER pin                              | 1, 2, 3         |                         | 38   | 153       | Ω    |
| THERMAL SHUTDOWN                            |                                       |                                                  |                 |                         |      |           |      |
| Thermal shutdown                            |                                       | VIN = 5 V                                        |                 |                         | 175  |           | °C   |
| Thermal shutdown hysteresis                 |                                       | VIN = 5 V                                        |                 |                         | 20   |           | °C   |

(1) For subgroup definitions, see [Quality Conformance Inspection](#) table.

(2)  $V_{IN}$  must be  $\geq 75\%$  of its final value before EN is asserted only if  $V_{IN_{SR}} > V_{OUT_{SR}}$ .

## 6.6 Electrical Characteristics: CFP and KGD Options

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

| PARAMETER                                                                 |                                            | TEST CONDITIONS                                                                   | SUBGROUP <sup>(1)</sup> | MIN    | TYP  | MAX | UNIT |    |
|---------------------------------------------------------------------------|--------------------------------------------|-----------------------------------------------------------------------------------|-------------------------|--------|------|-----|------|----|
| POWER SUPPLIES AND CURRENTS                                               |                                            |                                                                                   |                         |        |      |     |      |    |
| I <sub>RCP</sub>                                                          | Reverse current protection leakage current | EN = 0 V, VIN = 0 to 7 V, VOUT = 0 to 7 V for VOUT > VIN                          | 1, 2, 3                 |        | 0.45 | 2.5 | mA   |    |
|                                                                           |                                            | EN = 7 V, VIN = 0 V, VOUT = 0 to 7 V                                              |                         |        |      |     |      |    |
| CURRENT LIMIT AND CURRENT SENSE                                           |                                            |                                                                                   |                         |        |      |     |      |    |
| Fast trip off off-time <sup>(2)</sup>                                     |                                            | VIN = 5 V, C <sub>SS</sub> = 2.7 nF                                               | 9, 10, 11               |        | 61   | 158 | μs   |    |
| Internal current limit timer (fast trip off current limit) <sup>(2)</sup> |                                            | VIN = 5 V, I <sub>VOUT</sub> = 3 A, IL = 6 A, ILTIMER = VIN, 10-mΩ short in 10 μs | 9, 10, 11               |        | 15   | 35  |      |    |
| RESISTANCE CHARACTERISTICS                                                |                                            |                                                                                   |                         |        |      |     |      |    |
| R <sub>ON</sub>                                                           | ON-state resistance, lead length = 2.5 mm  | VIN = 7 V, I <sub>IL</sub> = 7.5 A                                                | 1, 2, 3                 | - 55°C |      | 24  | mΩ   |    |
|                                                                           |                                            |                                                                                   |                         | - 40°C |      | 26  |      |    |
|                                                                           |                                            |                                                                                   |                         | 25°C   |      | 31  |      | 34 |
|                                                                           |                                            |                                                                                   |                         | 85°C   |      | 37  |      | 40 |
|                                                                           |                                            |                                                                                   |                         | 125°C  |      | 41  |      | 45 |
|                                                                           |                                            | VIN = 5 V, I <sub>IL</sub> = 7.5 A                                                | 1, 2, 3                 | - 55°C |      | 26  |      |    |
|                                                                           |                                            |                                                                                   |                         | - 40°C |      | 27  |      |    |
|                                                                           |                                            |                                                                                   |                         | 25°C   |      | 32  |      | 35 |
|                                                                           |                                            |                                                                                   |                         | 85°C   |      | 39  |      | 42 |
|                                                                           |                                            |                                                                                   |                         | 125°C  |      | 43  |      | 47 |
|                                                                           |                                            | VIN = 3.3 V, I <sub>IL</sub> = 7.5 A                                              | 1, 2, 3                 | - 55°C |      | 28  |      |    |
|                                                                           |                                            |                                                                                   |                         | - 40°C |      | 30  |      |    |
|                                                                           |                                            |                                                                                   |                         | 25°C   |      | 35  |      | 38 |
|                                                                           |                                            |                                                                                   |                         | 85°C   |      | 42  |      | 46 |
|                                                                           |                                            |                                                                                   |                         | 125°C  |      | 47  |      | 52 |
|                                                                           |                                            | VIN = 1.8 V, I <sub>IL</sub> = 7.5 A                                              | 1, 2, 3                 | - 55°C |      | 36  |      |    |
|                                                                           |                                            |                                                                                   |                         | - 40°C |      | 39  |      |    |
|                                                                           |                                            |                                                                                   |                         | 25°C   |      | 45  |      | 51 |
|                                                                           |                                            |                                                                                   |                         | 85°C   |      | 55  |      | 62 |
|                                                                           |                                            |                                                                                   |                         | 125°C  |      | 61  |      | 70 |
|                                                                           |                                            | VIN = 1.5 V, I <sub>IL</sub> = 7.5 A                                              | 1, 2, 3                 | - 55°C |      | 44  |      |    |
|                                                                           |                                            |                                                                                   |                         | - 40°C |      | 48  |      |    |
|                                                                           |                                            |                                                                                   |                         | 25°C   |      | 52  |      | 63 |
|                                                                           |                                            |                                                                                   |                         | 85°C   |      | 63  |      | 77 |
|                                                                           |                                            |                                                                                   |                         | 125°C  |      | 70  |      | 87 |

(1) For subgroup definitions, see [Quality Conformance Inspection](#) table.

(2) Bench verified; not tested in production

## 6.7 Electrical Characteristics: HTSSOP Option

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

| PARAMETER                                                  |                                            | TEST CONDITIONS                                                                   |                            | SUBGROUP <sup>(1)</sup> | MIN  | TYP  | MAX | UNIT |    |    |
|------------------------------------------------------------|--------------------------------------------|-----------------------------------------------------------------------------------|----------------------------|-------------------------|------|------|-----|------|----|----|
| POWER SUPPLIES AND CURRENTS                                |                                            |                                                                                   |                            |                         |      |      |     |      |    |    |
| I <sub>RCP</sub>                                           | Reverse current protection leakage current | EN = 0 V, VIN = 0 to 7 V, VOUT = 0 to 7 V for VOUT > VIN                          | SEP                        | 1, 2, 3                 | 0.45 | 2.5  | mA  |      |    |    |
|                                                            |                                            |                                                                                   | QMLP pre TID               |                         |      |      |     |      |    |    |
|                                                            |                                            |                                                                                   | QMLP, after TID = 100 krad |                         |      |      |     |      |    |    |
|                                                            |                                            | EN = 7 V, VIN = 0 V, VOUT = 0 to 7 V                                              | SEP                        |                         | 0.45 | 2.5  |     |      |    |    |
|                                                            |                                            |                                                                                   | QMLP pre TID               |                         |      |      |     |      |    |    |
|                                                            |                                            |                                                                                   | QMLP, after TID = 100 krad |                         |      |      |     | 0.45 | 20 |    |
| CURRENT LIMIT AND CURRENT SENSE                            |                                            |                                                                                   |                            |                         |      |      |     |      |    |    |
| Fast trip off off-time                                     |                                            | VIN = 5 V, C <sub>SS</sub> = 2.7 nF                                               |                            | 9, 10, 11               |      | 61   |     |      |    | μs |
| Internal current limit timer (fast trip off current limit) |                                            | VIN = 5 V, I <sub>VOUT</sub> = 3 A, IL = 6 A, ILTIMER = VIN, 10-mΩ short in 10 μs |                            | 9, 10, 11               |      | 15   |     |      |    |    |
| RESISTANCE CHARACTERISTICS                                 |                                            |                                                                                   |                            |                         |      |      |     |      |    |    |
| R <sub>ON</sub>                                            | ON-state resistance                        | VIN = 7 V, I <sub>IL</sub> = 7.5 A                                                | - 55°C                     | 1, 2, 3                 |      | 15.9 | 17  | mΩ   |    |    |
|                                                            |                                            |                                                                                   | - 40°C                     |                         |      | 16.9 |     |      |    |    |
|                                                            |                                            |                                                                                   | 25°C                       |                         |      | 19.9 | 21  |      |    |    |
|                                                            |                                            |                                                                                   | 85°C                       |                         |      | 22.9 |     |      |    |    |
|                                                            |                                            |                                                                                   | 125°C                      |                         |      | 25   | 27  |      |    |    |
|                                                            |                                            | VIN = 5 V, I <sub>IL</sub> = 7.5 A                                                | - 55°C                     | 1, 2, 3                 |      | 17   | 18  |      |    |    |
|                                                            |                                            |                                                                                   | - 40°C                     |                         |      | 18   |     |      |    |    |
|                                                            |                                            |                                                                                   | 25°C                       |                         |      | 21.4 | 23  |      |    |    |
|                                                            |                                            |                                                                                   | 85°C                       |                         |      | 24.8 |     |      |    |    |
|                                                            |                                            |                                                                                   | 125°C                      |                         |      | 27   | 29  |      |    |    |
|                                                            |                                            | VIN = 3.3 V, I <sub>IL</sub> = 7.5 A                                              | - 55°C                     | 1, 2, 3                 |      | 19.2 | 21  |      |    |    |
|                                                            |                                            |                                                                                   | - 40°C                     |                         |      | 20.4 |     |      |    |    |
|                                                            |                                            |                                                                                   | 25°C                       |                         |      | 24.5 | 26  |      |    |    |
|                                                            |                                            |                                                                                   | 85°C                       |                         |      | 28.5 |     |      |    |    |
|                                                            |                                            |                                                                                   | 125°C                      |                         |      | 31.2 | 33  |      |    |    |
|                                                            |                                            | VIN = 1.8 V, I <sub>IL</sub> = 7.5 A                                              | - 55°C                     | 1, 2, 3                 |      | 27.1 | 29  |      |    |    |
|                                                            |                                            |                                                                                   | - 40°C                     |                         |      | 28.7 |     |      |    |    |
|                                                            |                                            |                                                                                   | 25°C                       |                         |      | 34.9 | 37  |      |    |    |
|                                                            |                                            |                                                                                   | 85°C                       |                         |      | 41   |     |      |    |    |
|                                                            |                                            |                                                                                   | 125°C                      |                         |      | 44.9 | 48  |      |    |    |
|                                                            |                                            | VIN = 1.5 V, I <sub>IL</sub> = 7.5 A                                              | - 55°C                     | 1, 2, 3                 |      | 33   | 36  |      |    |    |
|                                                            |                                            |                                                                                   | - 40°C                     |                         |      | 35   |     |      |    |    |
|                                                            |                                            |                                                                                   | 25°C                       |                         |      | 42.7 | 46  |      |    |    |
|                                                            |                                            |                                                                                   | 85°C                       |                         |      | 46.2 |     |      |    |    |
|                                                            |                                            |                                                                                   | 125°C                      |                         |      | 55   | 59  |      |    |    |

(1) For subgroup definitions, see [Quality Conformance Inspection](#) table.

## 6.8 Switching Characteristics (All Devices)

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

| PARAMETER                                                              |                   | TEST CONDITIONS                                                          | MIN | TYP  | MAX | UNIT |
|------------------------------------------------------------------------|-------------------|--------------------------------------------------------------------------|-----|------|-----|------|
| <b>VIN = EN = 5 V, T<sub>A</sub> = 25°C (unless otherwise noted)</b>   |                   |                                                                          |     |      |     |      |
| t <sub>ON</sub>                                                        | Turn-on time      | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 208  |     | μs   |
| t <sub>OFF</sub>                                                       | Turn-off time     | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 60   |     | μs   |
| t <sub>F</sub>                                                         | VOOUT fall time   | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 90   |     | μs   |
| t <sub>ASSERT</sub>                                                    | OVP assert time   | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 4.5  |     | μs   |
| t <sub>DEASSERT</sub>                                                  | OVP deassert time | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 9.6  |     | μs   |
| <b>VIN = EN = 1.5 V, T<sub>A</sub> = 25°C (unless otherwise noted)</b> |                   |                                                                          |     |      |     |      |
| t <sub>ON</sub>                                                        | Turn-on time      | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 173  |     | μs   |
| t <sub>OFF</sub>                                                       | Turn-off time     | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 64   |     | μs   |
| t <sub>F</sub>                                                         | VOOUT fall time   | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 70   |     | μs   |
| t <sub>ASSERT</sub>                                                    | OVP assert time   | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 2.65 |     | μs   |
| t <sub>DEASSERT</sub>                                                  | OVP deassert time | R <sub>L</sub> = 10 Ω, C <sub>L</sub> = 10 μF, C <sub>SS</sub> = 1000 pF |     | 6.56 |     | μs   |

## 6.9 Quality Conformance Inspection

MIL-STD-883, Method 5005 - Group A

| SUBGROUP | DESCRIPTION         | TEMP (°C) |
|----------|---------------------|-----------|
| 1        | Static tests at     | 25        |
| 2        | Static tests at     | 125       |
| 3        | Static tests at     | – 55      |
| 4        | Dynamic tests at    | 25        |
| 5        | Dynamic tests at    | 125       |
| 6        | Dynamic tests at    | – 55      |
| 7        | Functional tests at | 25        |
| 8A       | Functional tests at | 125       |
| 8B       | Functional tests at | – 55      |
| 9        | Switching tests at  | 25        |
| 10       | Switching tests at  | 125       |
| 11       | Switching tests at  | – 55      |

## 6.10 Typical Characteristics

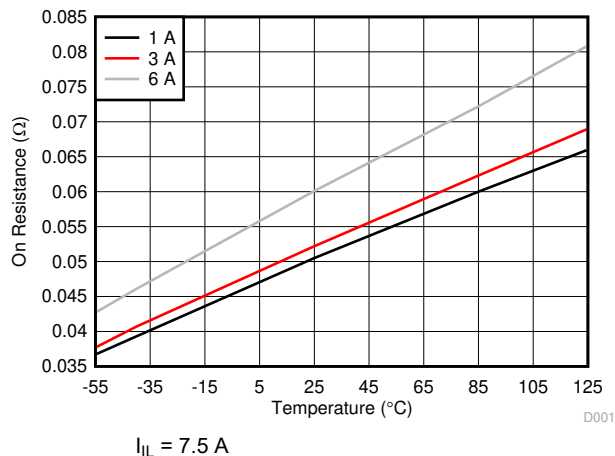


图 6-1. On-Resistance vs Temperature Across Loads for CFP and KGD at  $V_{IN} = 1.5 \text{ V}$

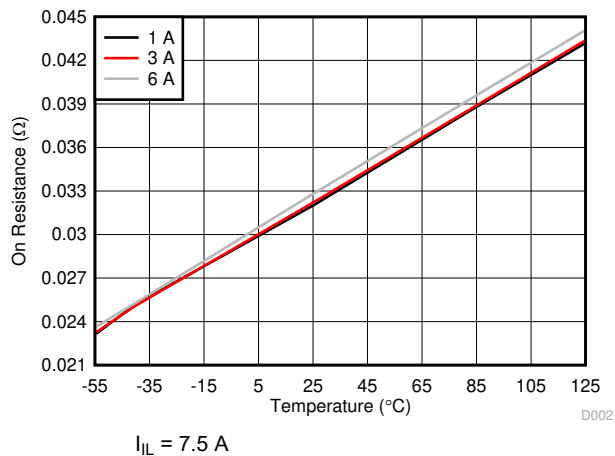


图 6-2. On-Resistance vs Temperature Across Loads for CFP and KGD at  $V_{IN} = 5 \text{ V}$

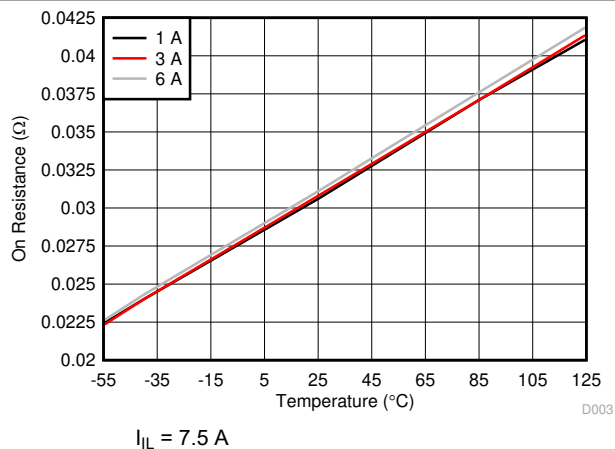


图 6-3. On-Resistance vs Temperature Across Loads for CFP and KGD at  $V_{IN} = 7 \text{ V}$

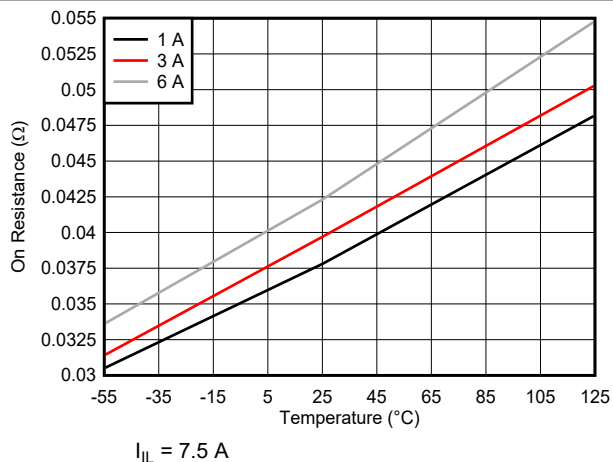


图 6-4. On-Resistance vs Temperature Across Loads for HTSSOP at  $V_{IN} = 1.5 \text{ V}$

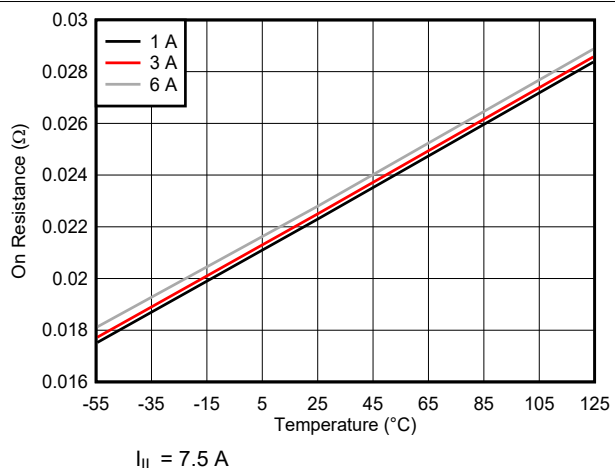


图 6-5. On-Resistance vs Temperature Across Loads for HTSSOP at  $V_{IN} = 5 \text{ V}$

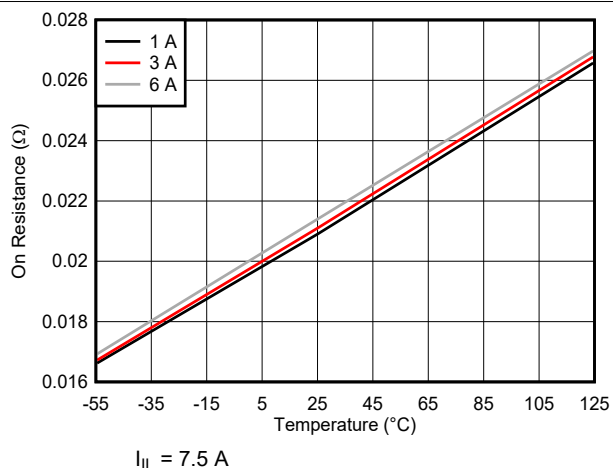


图 6-6. On-Resistance vs Temperature Across Loads for HTSSOP at  $V_{IN} = 7 \text{ V}$

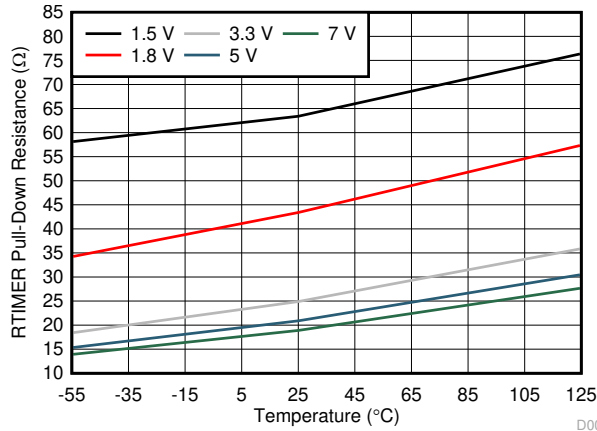


图 6-7. RTIMER Pull-Down Resistance vs Temperature Across VIN

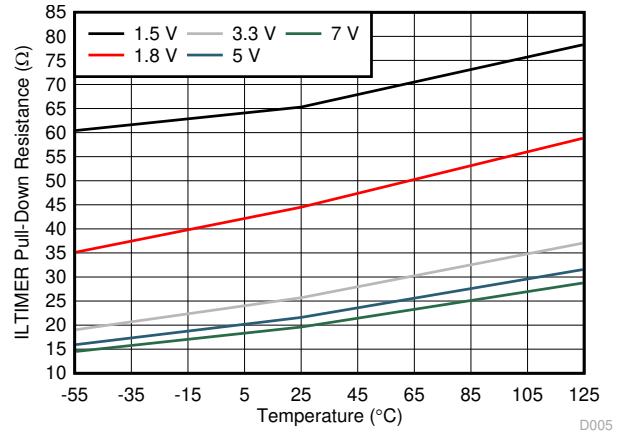


图 6-8. ILTIMER Pull-Down Resistance vs Temperature Across VIN

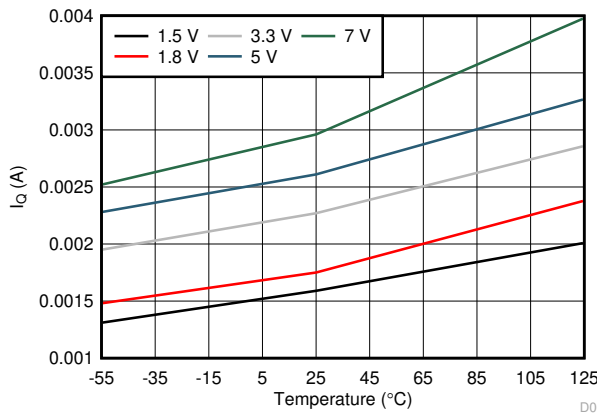


图 6-9.  $I_Q$  vs Temperature Across VIN

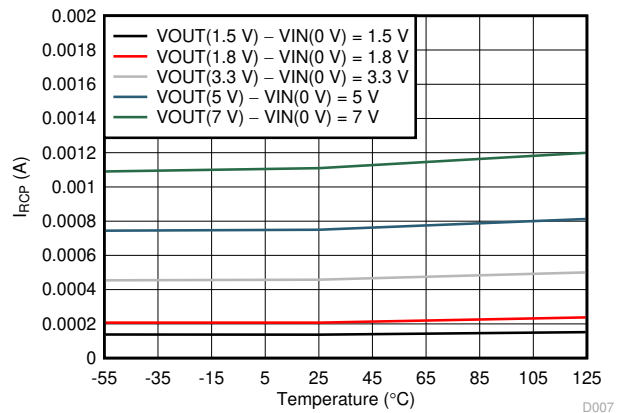


图 6-10.  $I_{RCP}$  vs Temperature With EN = 7 V

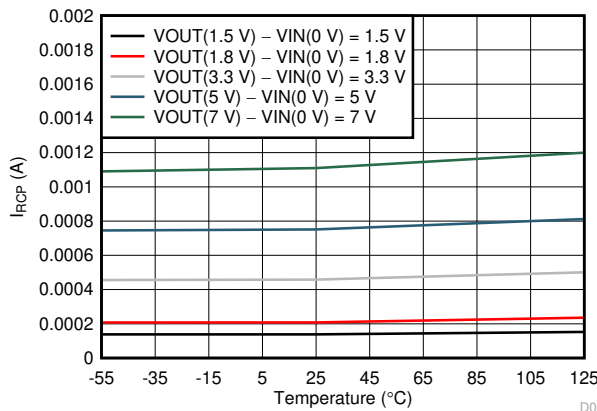


图 6-11.  $I_{RCP}$  vs Temperature With EN = GND

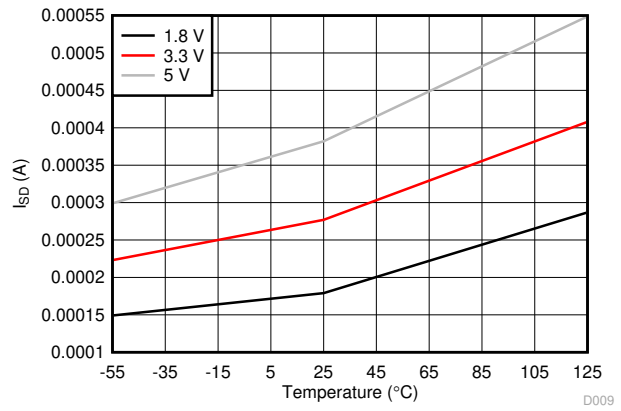


图 6-12.  $I_{SD VIN}$  vs Temperature Across VIN

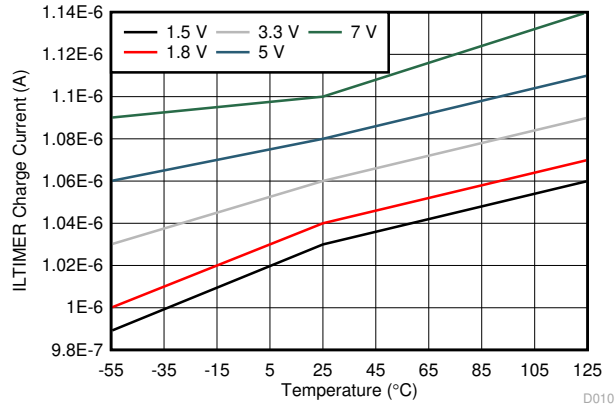


图 6-13. ILTIMER Charge Current vs Temperature Across VIN

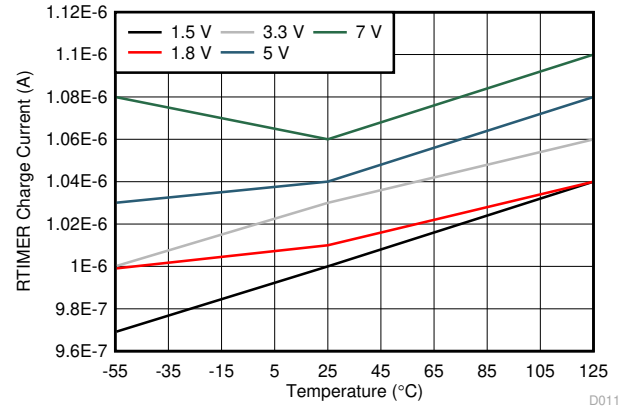


图 6-14. RTIMER Charge Current vs Temperature Across VIN

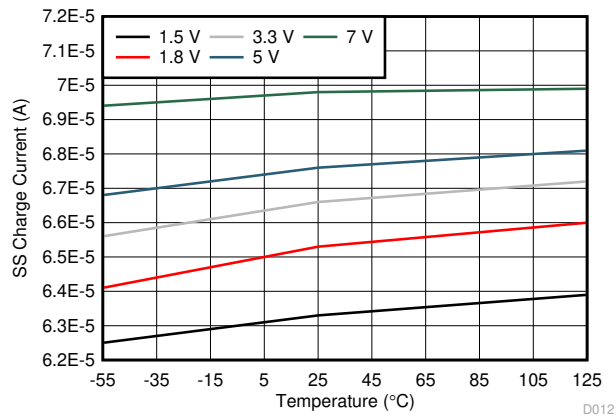
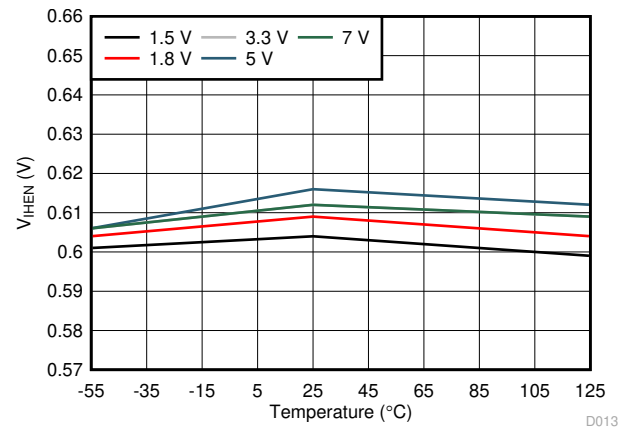
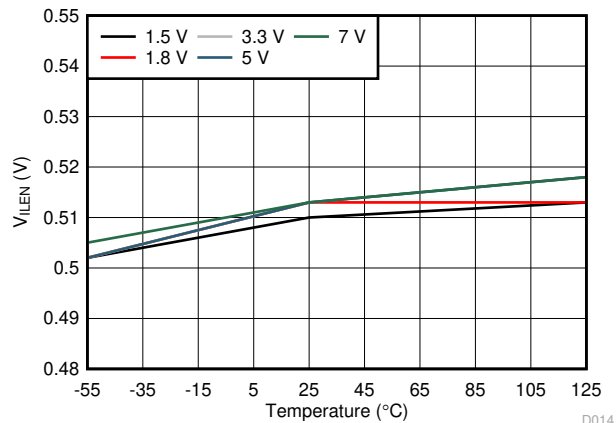


图 6-15. SS Charge Current vs Temperature Across VIN



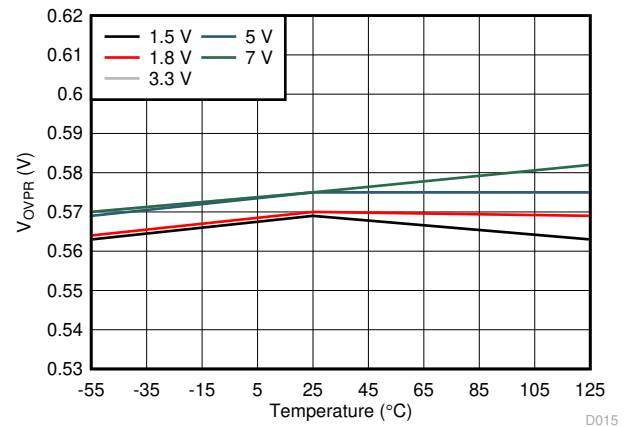
EN pin driven directly

图 6-16.  $V_{IHEN}$  vs Temperature Across VIN



EN pin driven directly

图 6-17.  $V_{ILEN}$  vs Temperature Across VIN



OVP pin driven directly

Waveform at 3.3 V is obscured by the 5 V

图 6-18.  $V_{OVPR}$  vs Temperature Across VIN



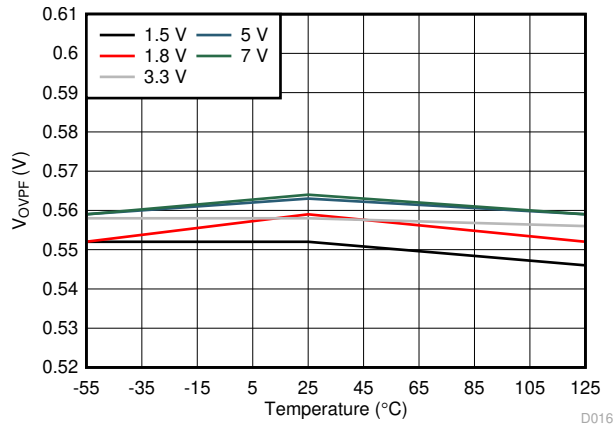


图 6-19.  $V_{OVPF}$  vs Temperature Across VIN

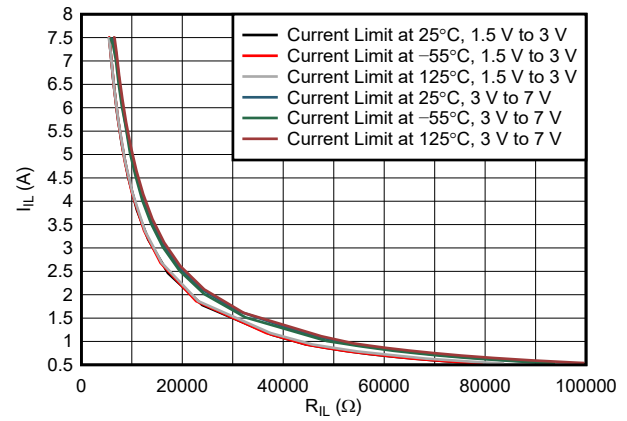


图 6-20.  $I_{IL}$  vs  $R_{IL}$  Across Temperature

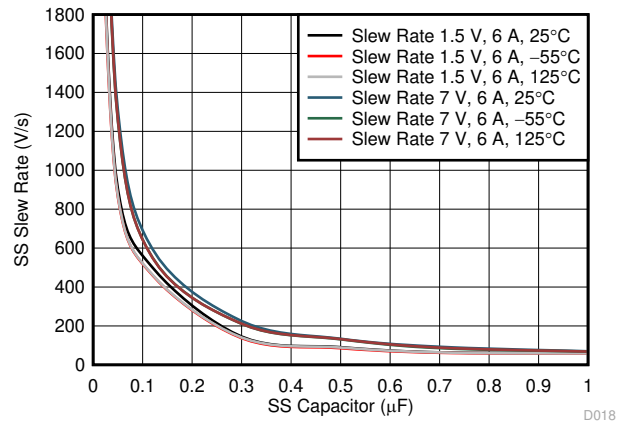


图 6-21. SS Slew Rate vs SS Capacitor Across Temperature

## 7 Parameter Measurement Information

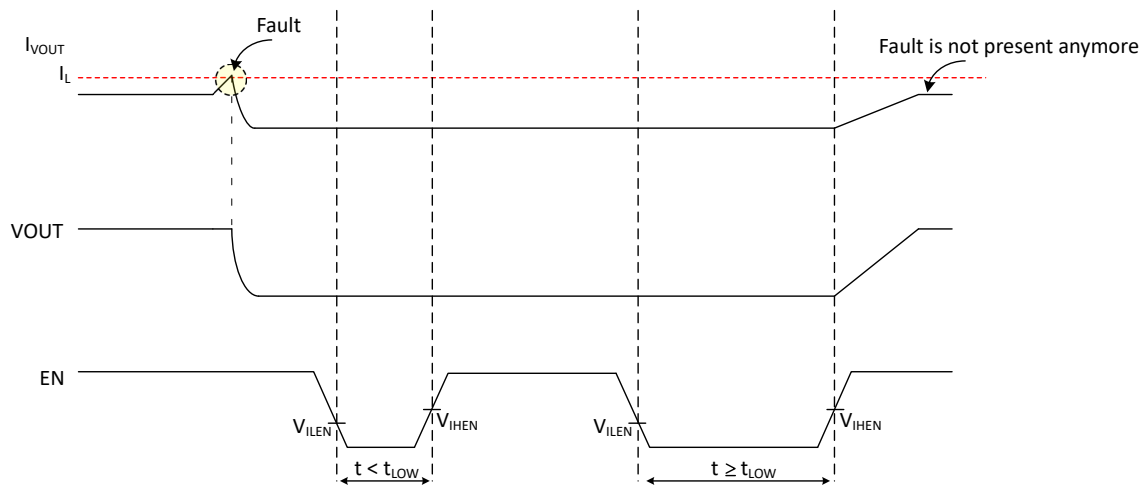


图 7-1. EN Signal Low Time to Restart Device ( $t_{LOW}$ )

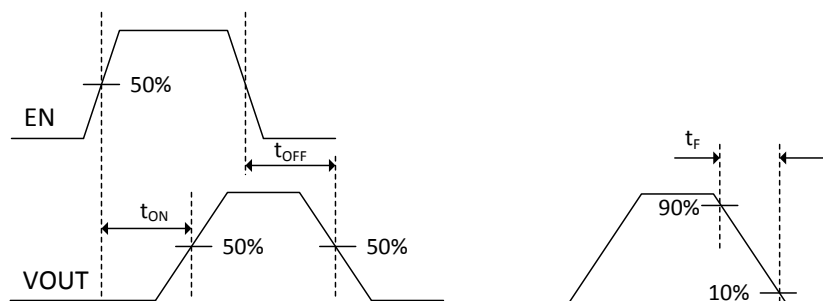


图 7-2. Turn-On ( $t_{ON}$ ), Turn-Off ( $t_{OFF}$ ) and VOUT Fall Time ( $t_F$ ) Waveforms

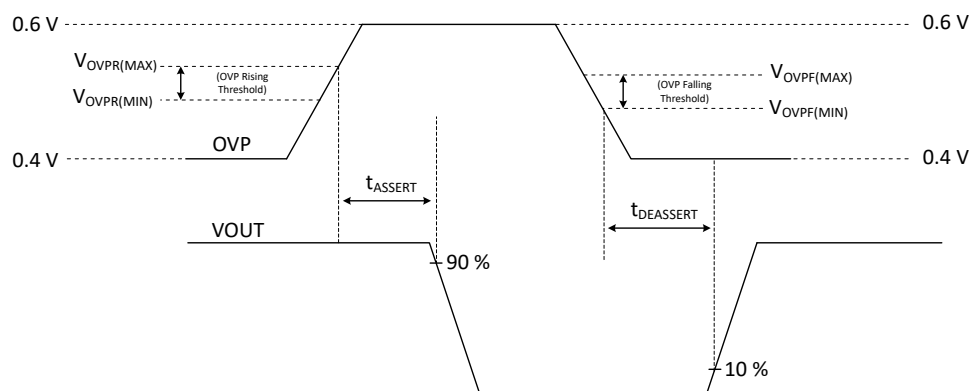


图 7-3. OVP Assert ( $t_{ASSERT}$ ) and OVP Deassert ( $t_{DEASSERT}$ ) Waveforms

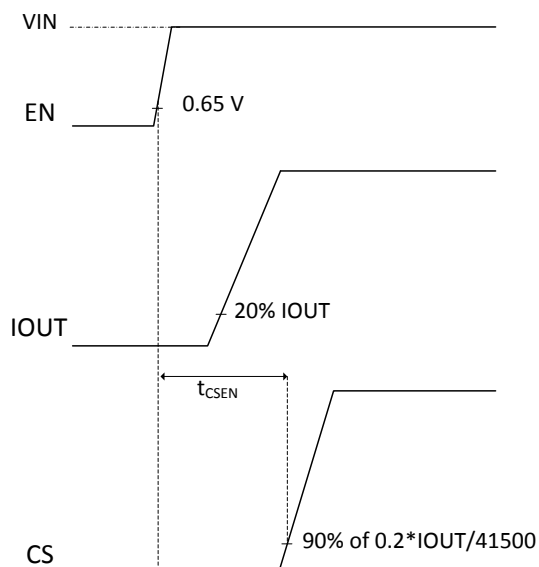


图 7-4.  $t_{CSEN}$  Waveforms

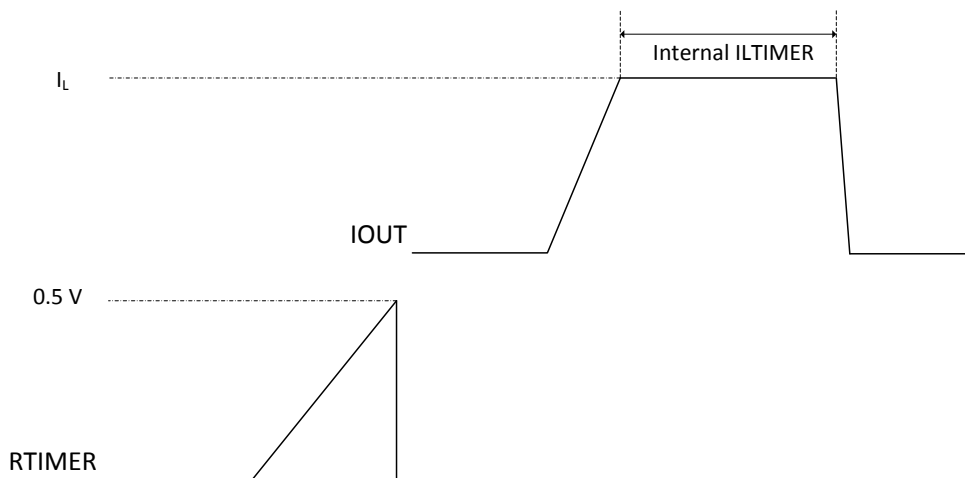


图 7-5. Internal ILTIMER Waveforms

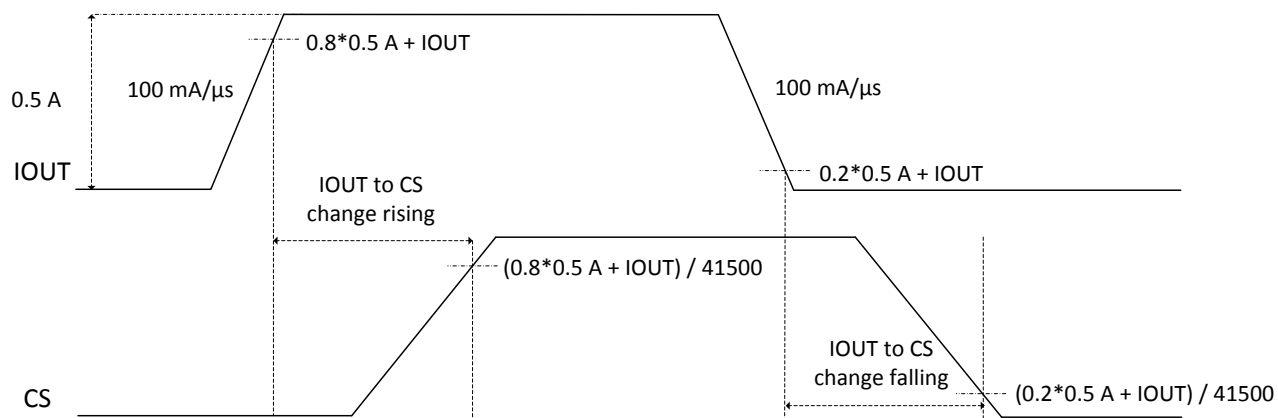


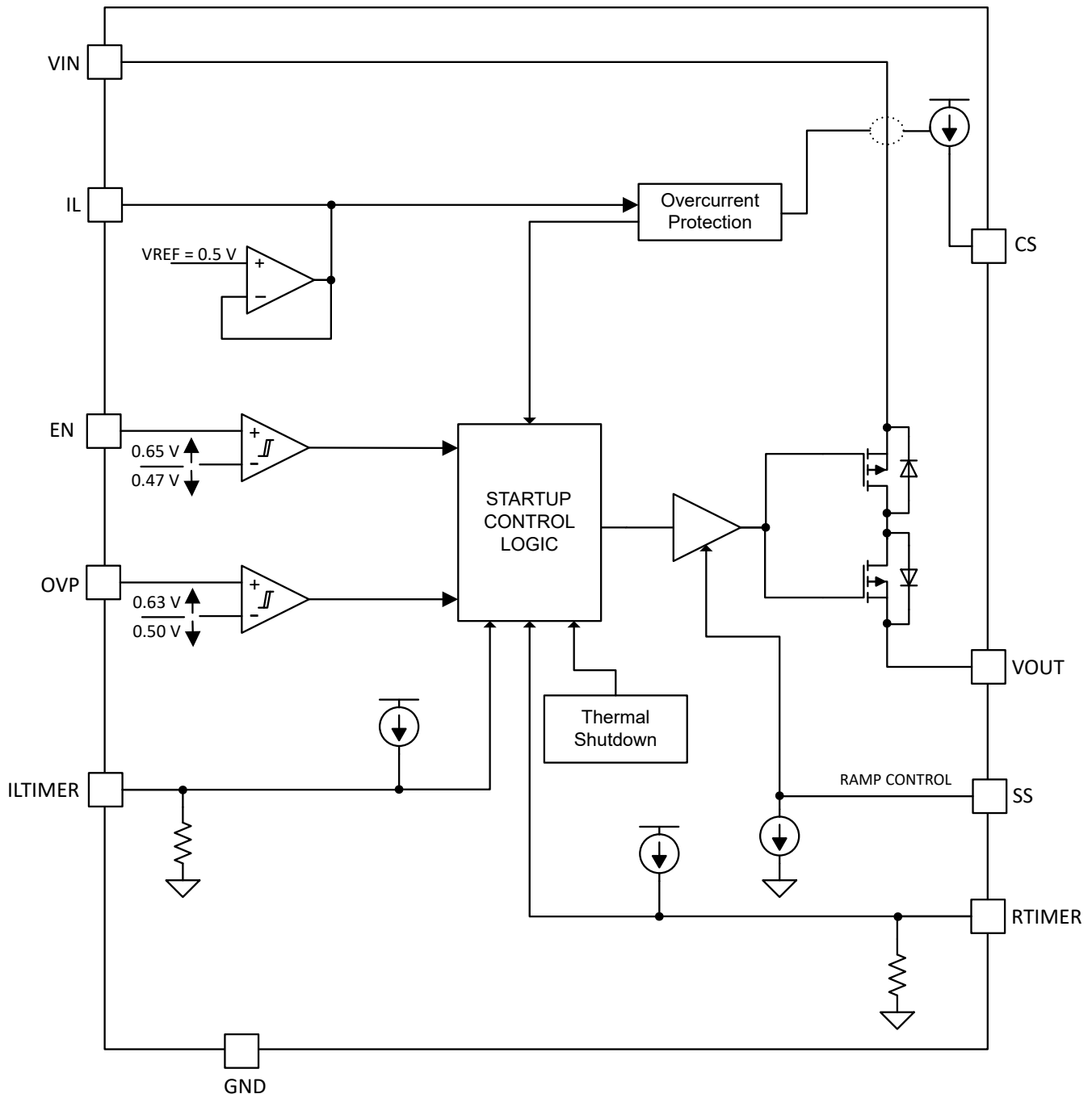
图 7-6. VOUT Current to CS Change Delay Time

## 8 Detailed Description

## 8.1 Overview

The TPS7H2201 device is a single channel, 6-A eFuse with a programmable slew rate for applications that require specific rise-time as well as programmable current limit for protection purposes. In addition, the TPS7H2201 features a reverse current protection capability for power distribution applications.

## 8.2 Functional Block Diagram



## 8.3 Feature Description

### 8.3.1 Enable, Undervoltage, and Overvoltage Protection

图 8-1 shows how resistor dividers from VIN connected to the EN and OVP pins can be used to set the UVLO and OVP trip voltages. The EN pin controls the ON and OFF state of the internal FET. A voltage at this pin greater than  $V_{IHEN}$  turns on the FET and a voltage less than  $V_{ILEN}$  turns it off. The addition of an external resistor divider from VIN allows the EN pin to configure a different enable rising voltage or an undervoltage monitor (UVLO) based on the  $V_{IHEN}$  and  $V_{ILEN}$  specifications respectively. Typically, applications are optimized to either configure the enable rising voltage or the UVLO threshold. As an example, 方程式 1 can be used to calculate the UVLO trip point fixing  $R_{TOP\_EN} = 100\text{ k}\Omega$ .

In a similar way to the EN pin, the overvoltage protection (OVP) feature of the device can be configured using a resistor divider from VIN connected to the OVP pin. The trip voltage for the OVP has to be less than the absolute maximum VIN voltage. A voltage at the OVP pin greater than  $V_{OVPR}$  will trip the OVP feature and will turn off the FET and a voltage less than  $V_{OVPF}$  will keep the FET on. If this feature is not desired, the OVP pin should be grounded. 方程式 2 can be used to calculate the rising OVP trip point fixing  $R_{TOP\_OVP} = 100\text{ k}\Omega$ .

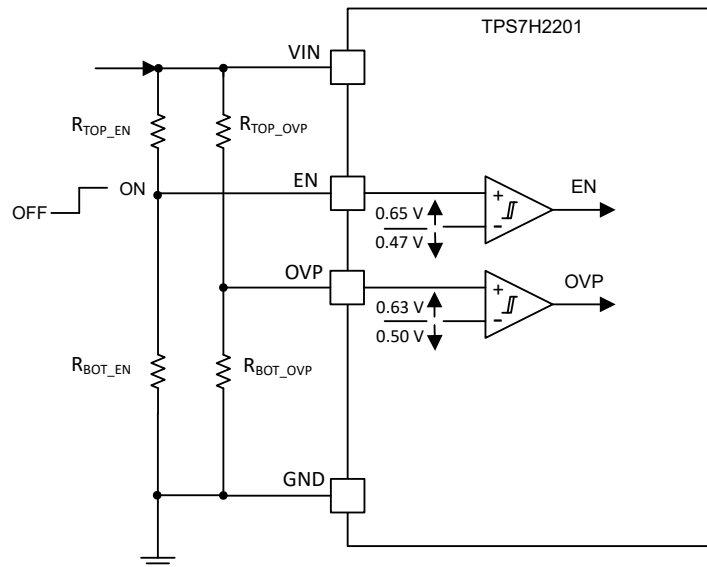


图 8-1. UVLO and OVP Thresholds Set by Resistor Dividers

$$R_{BOT\_EN} (k\Omega) \leq \frac{47}{V_{UVLO\_TRIP} (V) - 0.47} \quad (1)$$

$$R_{BOT\_OVP} (k\Omega) \geq \frac{63}{V_{OVP\_TRIP} (V) - 0.63} \quad (2)$$

### 8.3.2 Adjustable Rise Time

An external capacitor,  $C_{SS}$ , connected between the VOUT and SS pins sets the slew rate. The desired slew rate  $VOUT_{SR}$  is determined by  $t_r$ , the rise time in seconds, and  $\Delta V$ , the change in VOUT voltage in Volts as shown in 方程式 3.

$$VOUT_{SR} (V/s) = \frac{\Delta V_{OUT} (V)}{t_r (s)} \quad (3)$$

In order to avoid false trips due to the programmable current limit, the desired slew rate must be less than  $V_{OUTSR,MAX}$  as shown in 方程式 4, where  $I_L$  is the programmed current limit,  $I_{VOUT}$  is the normal operation current flowing through the switch, and  $C_{OUT}$  is the output capacitor.

$$V_{OUTSR,MAX} (V/s) < \frac{0.8 \times I_L (A) - 0.95 \times I_{VOUT} (A)}{C_{OUT} (F)} \quad (4)$$

Once the slew rate has been calculated and meeting the constraint in 方程式 4, the  $C_{SS}$  capacitor is then calculated using 方程式 5 for  $V_{IN} < 3V$  and  $I_{OUT} \geq 3A$  applications. For all other applications, use 方程式 6.

$$C_{SS} (\mu F) = \frac{45}{V_{OUTSR} (V/s)} \quad (5)$$

for  $V_{IN} < 3V$  and  $I_{OUT} \geq 3A$

$$C_{SS} (\mu F) = \frac{65}{V_{OUTSR} (V/s)} \quad (6)$$

for all other conditions

### 8.3.3 Programmable Current Limiting

A current limit can be programmed using an external resistor connected from the IL pin to GND. This programmed current limit ( $\pm 20\%$  accurate) refers to the continuous current through the device and therefore, when operated at its maximum current rating (6 A), the programmed current limit needs to be set 20% higher. As shown in 图 8-2, a current limit event of this nature is defined as a soft short. The resistor value  $R_{IL}$ , can be calculated using 方程式 7 for  $V_{IN} \leq 3V$ , and 方程式 8 for  $V_{IN} > 3V$ , where  $I_L$  is the programmed current limit value in amperes. This programmable current limiting feature is different from the internal current limiting activated during fast trip mode as shown in 图 8-3. A current limit event in this case is defined as a hard short and this current limit (typical of 22 A) cannot be programmed.

$$R_{IL} (\Omega) = \frac{45500}{I_L (A)} \quad (7)$$

for  $V_{IN} \leq 3V$

$$R_{IL} (\Omega) = \frac{49000}{I_L (A)} \quad (8)$$

for  $V_{IN} > 3V$

### 8.3.4 Programmable Fault Timer

A capacitor connected from the ILTIMER pin to GND determines the programmable current limit fault time duration. The ILTIMER pin will charge the capacitor to 0.5 V during an overload condition and will discharge it otherwise through an internal pull down resistance. The time that the device will be in current limit before turning off is configured by  $C_{ILTIMER}$  and the time can be calculated using 方程式 9. Connecting this pin to  $V_{IN}$  will cause the device to be disabled once the internal current limit timer expires as shown in 图 7-5. However, connecting it to GND will disable the internal timer functionality completely and therefore, in the case of a short, the device will remain at the programmed current limit indefinitely. When using the internal timer, the programmable current limit may not have time to settle to its programmed value. Because of this, the programmable current limit could briefly fall outside of its defined accuracy threshold. The fast trip off current limit, however, will remain valid.

$$t(\mu s) = \frac{C(pF)}{2} \quad (9)$$

The time that the device remains disabled after the current limit timer expires is configurable through a capacitor connected from the RTIMER pin to GND. The RTIMER pin will charge the capacitor to 0.5 V after the switch is turned off and will discharge it otherwise. The time can be calculated using [方程式 9](#). Connecting this pin to GND will keep the device disabled and it will require the device to be enabled by cycling the EN pin (Refer to [EN Signal Low Time to Restart Device \(t<sub>LOW</sub>\)](#)). The behavior of the ILTIMER and RTIMER pins for a soft short, hard short and internal timer conditions are shown in [图 8-2](#), [图 8-3](#), and [图 8-4](#), respectively. Please notice that [图 8-2](#) and [图 8-3](#) assume the fault is not present after the switch has been disabled and enabled again (retry mode). If the fault is present after the retry mode, the device will go into current limit mode and this cycle will repeat until the fault is no longer present.

[表 8-1](#) 和 [表 8-2](#) summarizes the fault duration time and retry time based on the pin conditions.

**表 8-1. Fault Time Duration for ILTIMER Pin Conditions**

| ILTIMER Pin Condition                    | Fault Time Duration During Overload |
|------------------------------------------|-------------------------------------|
| VIN                                      | 15 $\mu$ s (typ), 35 $\mu$ s (max)  |
| GND                                      | Indefinitely                        |
| Capacitor to GND (C <sub>ILTIMER</sub> ) | <a href="#">方程式 9</a>               |
| Float                                    | Not valid (do not float pin)        |

**表 8-2. Time to Retry During an Overload Condition for RTIMER Pin Conditions**

| RTIMER Pin Condition                    | Time to Retry During an Overload                                            |
|-----------------------------------------|-----------------------------------------------------------------------------|
| GND                                     | Disabled (switch off) until EN is low for t > t <sub>LOW</sub> (20 $\mu$ s) |
| Capacitor to GND (C <sub>RTIMER</sub> ) | <a href="#">方程式 9</a>                                                       |
| Float                                   | Not valid (do not float pin)                                                |

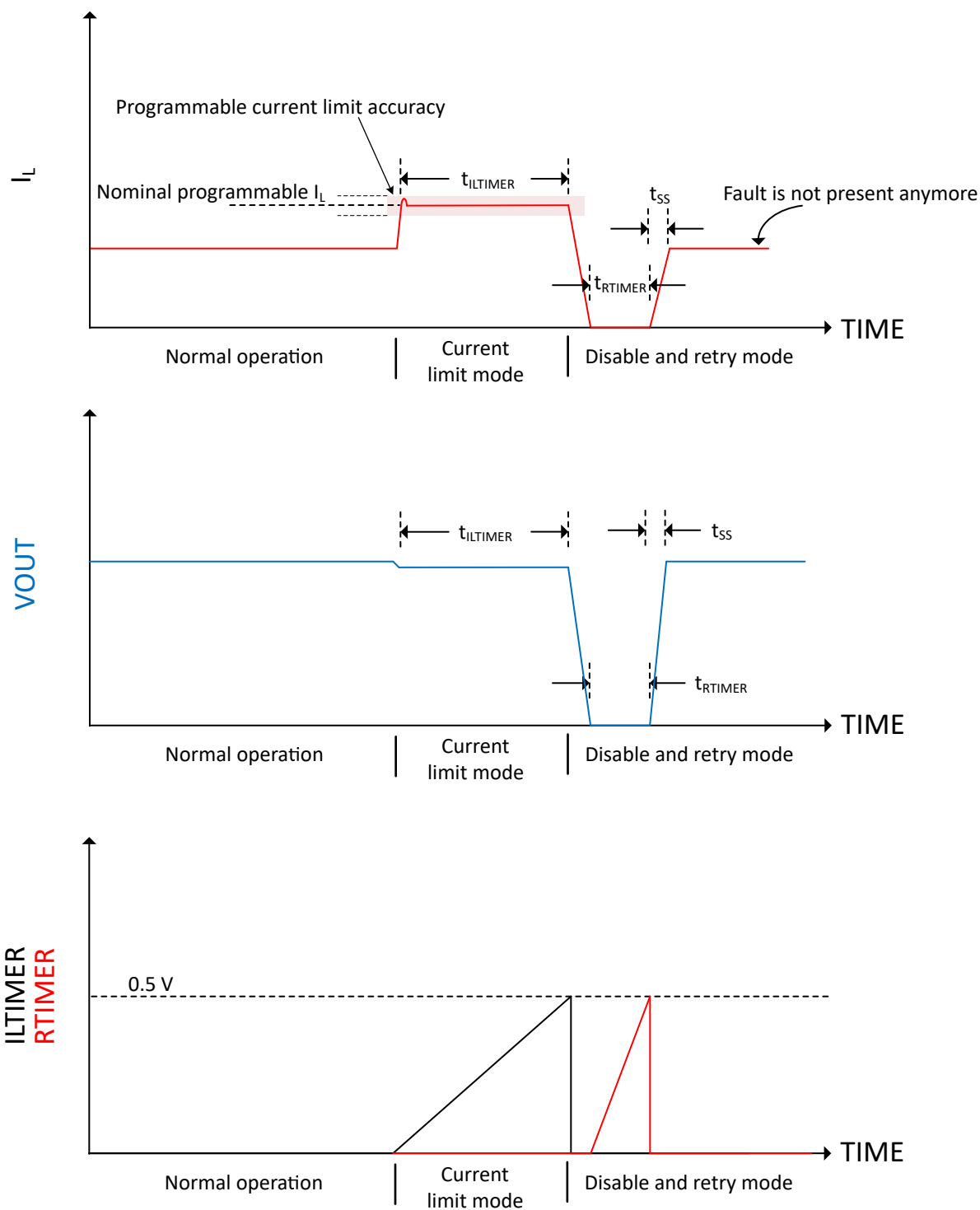


图 8-2. Soft Short Programmable Fault Timer Operation Connecting Capacitors to ILTIMER and RTIMER Pins



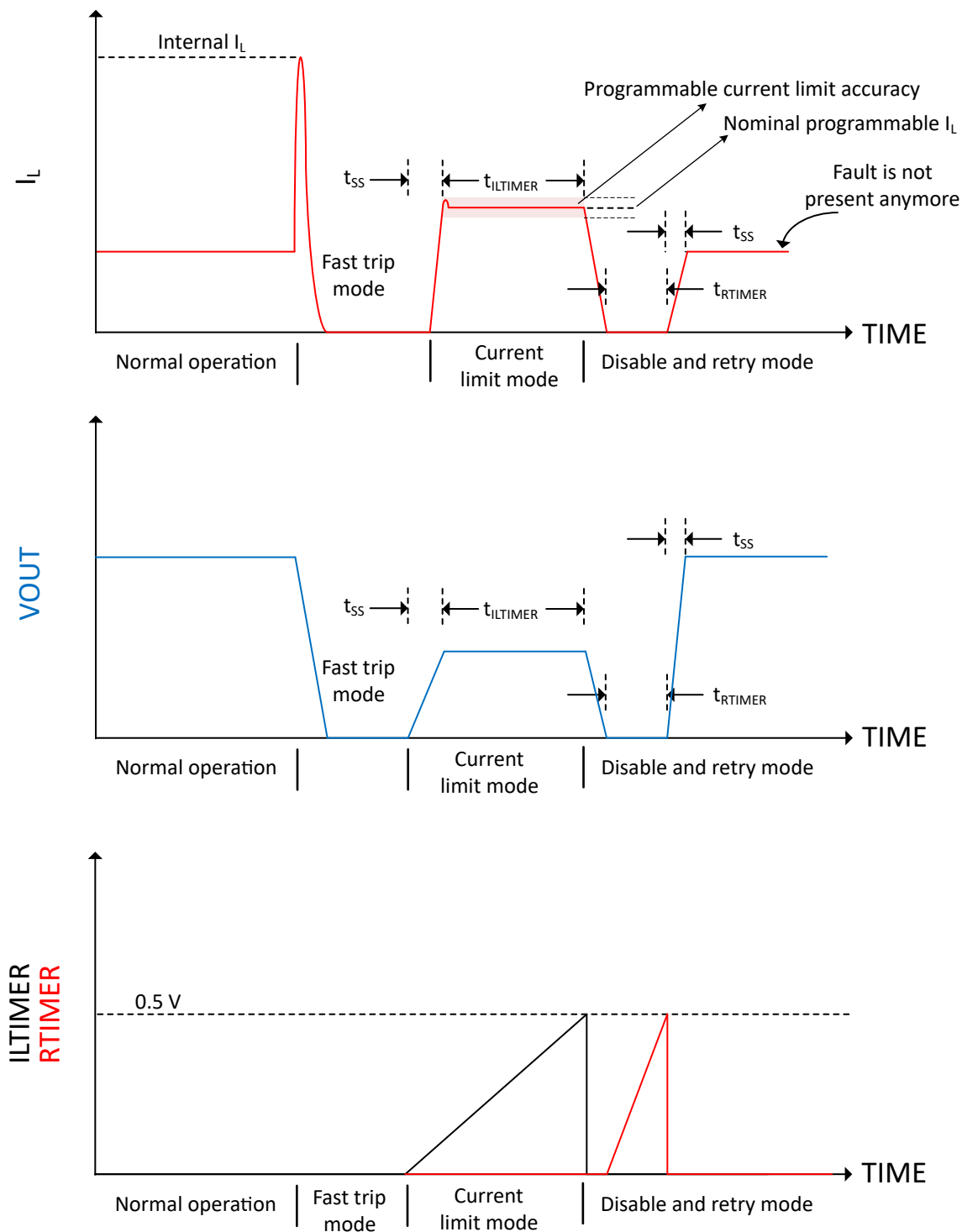
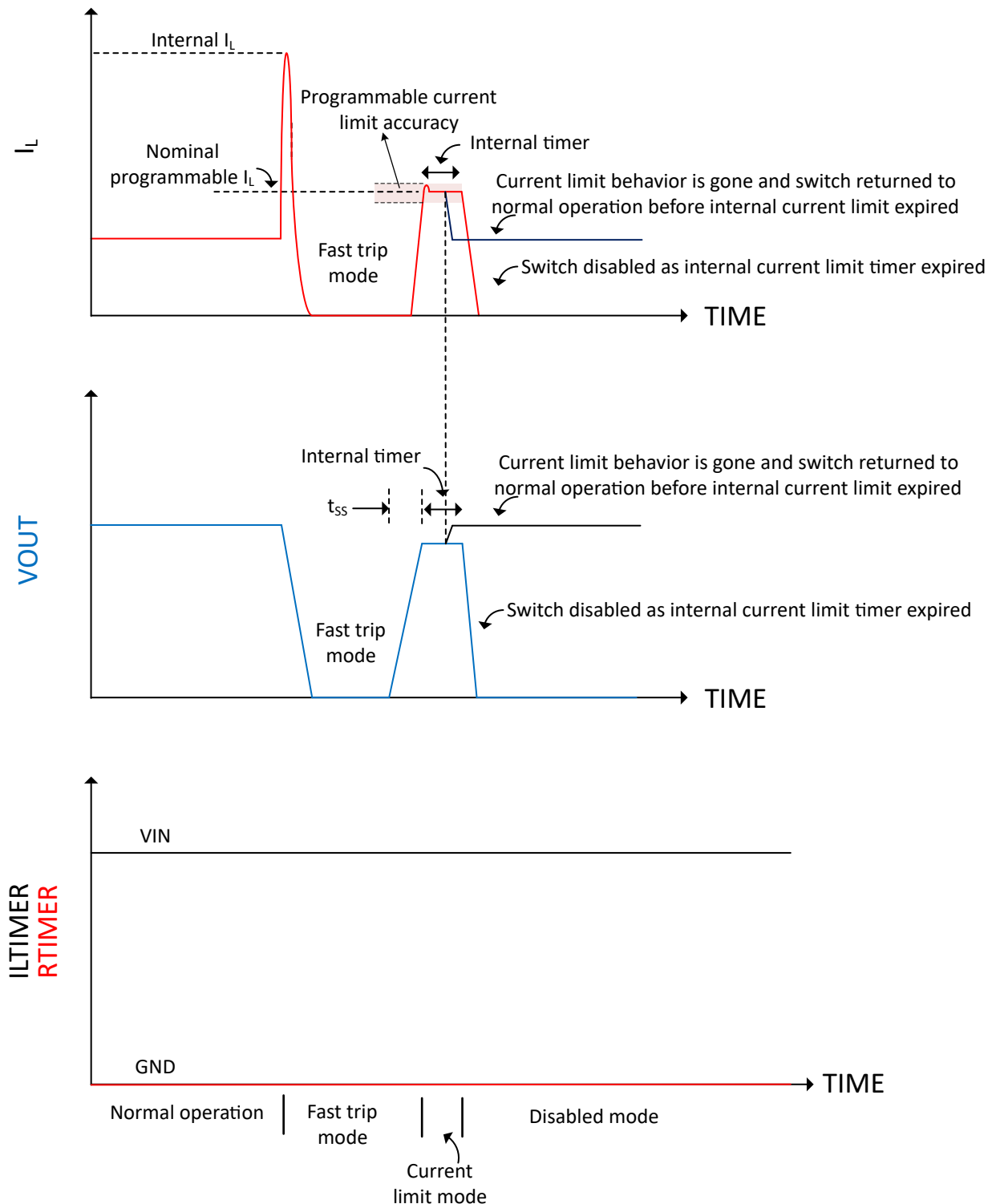


图 8-3. Hard Short Programmable Fault Timer Operation Connecting Capacitors to ILTIMER and RTIMER Pins



**图 8-4. Programmable Fault Timer Operation Using the Internal Current Limit Timer and Disabling the Retry Mode**

The programmable fault timers, ILTIMER and RTIMER, should be set in such a way that the capacitor for one timer is discharged before the other timer expires to ensure proper operation. In the specific case of using the internal ILTIMER, the RTIMER capacitor should be sized such that it is discharged before the internal ILTIMER

expires, assuming the fault is still present. 图 8-5 shows a situation where this constraint is not met as the RTIMER is much larger than the ILTIMER and therefore, the CRTIMER is not discharged before the CILTIMER reaches 0.5 V, which is when the ILTIMER will expire. In order to avoid this situation, the constraint shown in 方程式 10 must be met. Using this equation, once a capacitor for a timer has been selected (C<sub>1</sub> in 方程式 10), the maximum value for the capacitor of the second timer can be determined. The internal pull-down resistance for each of the timers can be found in the *Electrical Characteristics: All Devices* table. For the situation shown in 图 8-5, C<sub>1</sub> and R<sub>PD1</sub> in 方程式 10 correspond to the RTIMER.

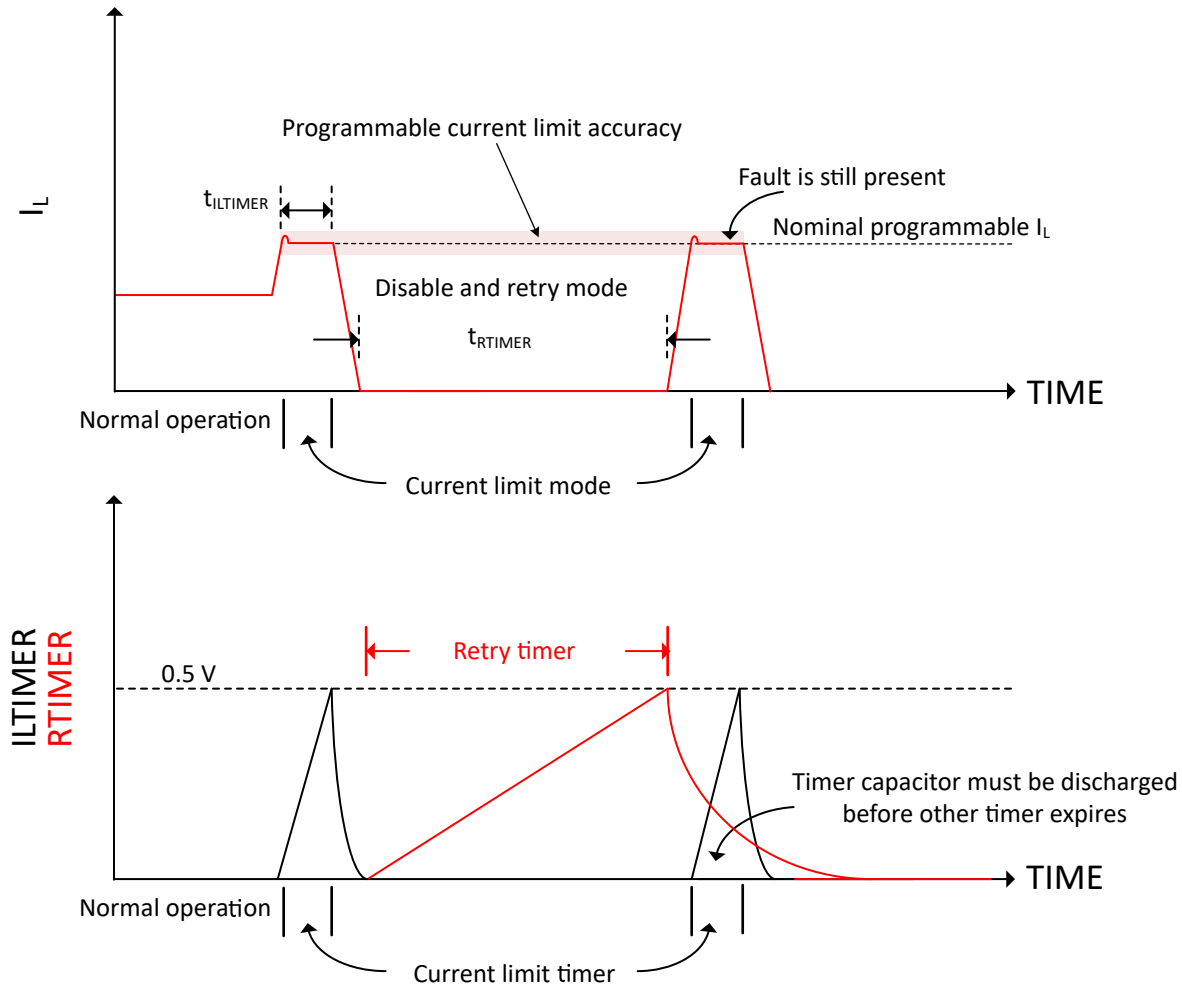


图 8-5. Programmable Fault Timer Capacitors Constraint

$$C_1(\mu\text{F}) < \frac{C_2(\text{pF})}{8 \times R_{PD1}(\Omega)} \quad (10)$$

### 8.3.5 Current Sense

This pin will output a current proportional to the output current of the switch for current sensing applications. A resistor to GND will convert this current to voltage for current sensing purposes. The output current will be the switch current divided by 41,500. The CS pin will have a valid output 5 ms after the device has been enabled. To operate the current sense in the linear region, the voltage at the CS pin at the application maximum load, should not exceed the CS pin voltage specification (V<sub>IN</sub> - 400 mV).

### 8.3.6 Parallel Operation

The TPS7H2201 can be configured in parallel operation either to increase the current capability, up to 12 A, or to reduce the on-state resistance. In this case, all pins are shared as shown in 图 8-6, except the current limit resistor ( $R_{IL}$ ) for proper operation of the internal current limit loop. The current limiting resistors must be sized as described in the [Programmable Current Limiting](#) section.

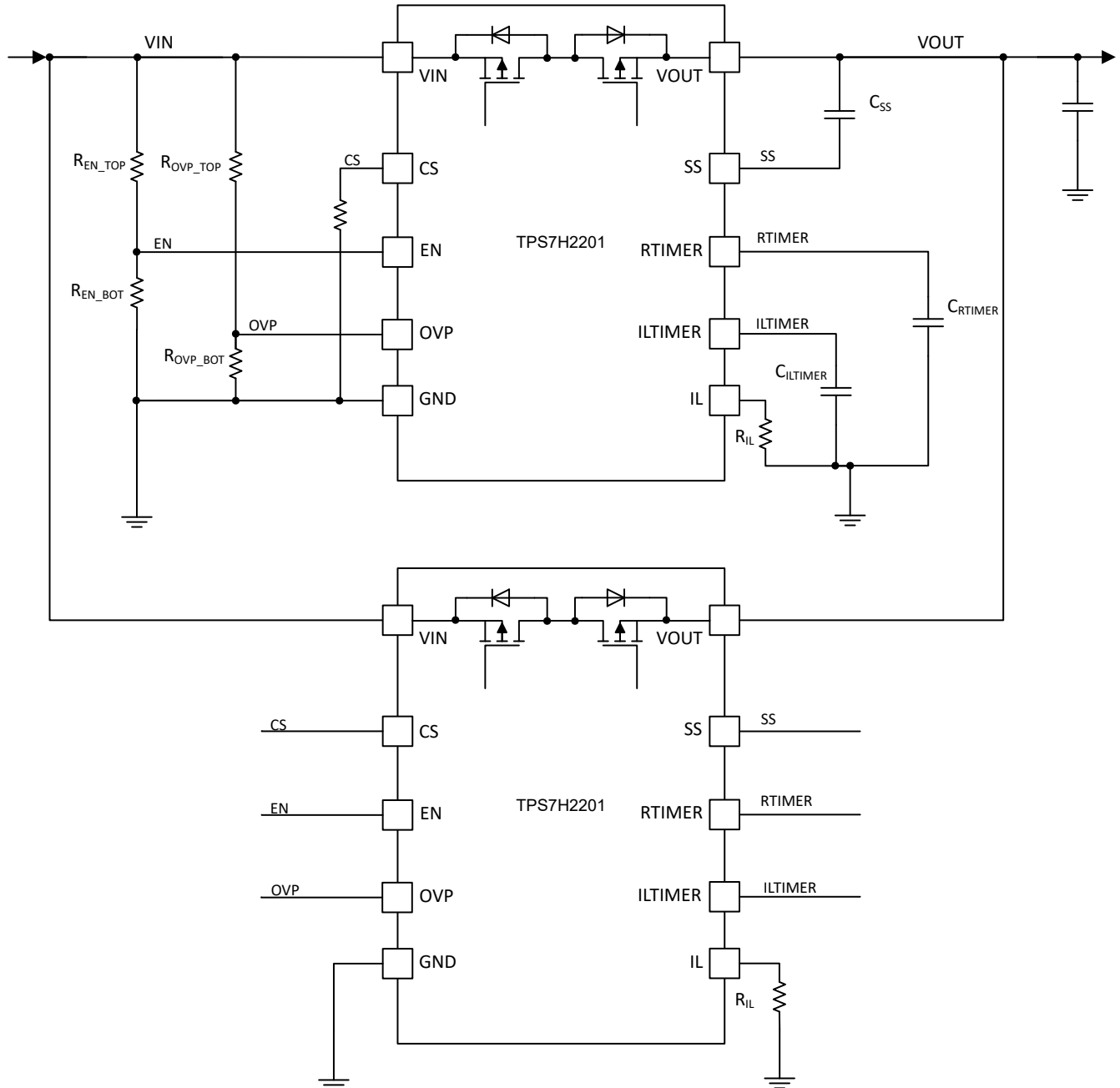


图 8-6. Parallel Configuration to Reduce Resistance or Increase Current Capability

### 8.3.7 Reverse Current Protection

The TPS72201 eFuse features back to back FETs to prevent current flow from VIN to VOUT and from VOUT to VIN when the switch is disabled (excluding leakage currents). This supports cold sparing (redundancy) applications. For example, VOUT may be up to 7 V while VIN is between 0 V and 7 V. In all cases, only small leakage current will result.

### 8.3.8 Forward Leakage Current

When VIN is powered but the TPS7H2201 is disabled (EN is low), the internal FETs are disabled, creating a high impedance path from VIN to VOUT. However, there are parasitic leakage paths that can cause VOUT to slowly charge. The forward leakage current,  $I_F$ , indicates how much current flows from VIN to VOUT during this situation. The maximum forward of the TPS7H2201-SP current is specified at 250  $\mu$ A across voltage, temperature and radiation.

Some applications need to pay particular attention to this behavior. Is particularly relevant when VOUT is a high impedance node (and therefore the leakage current goes entirely to charging VOUT instead of being dissipated). By using the basic capacitor equation shown in [方程式 11](#), the time for the voltage to rise to a given value can be theoretically calculated.

$$\Delta t = \Delta V_{OUT} \times C_{OUT} / I_F \quad (11)$$

where

- $\Delta t$  = time to charge to final value
- $\Delta V_{OUT}$  = change in output voltage; for a 0 V starting voltage, use  $V_{IN}$

For example, with a 7-V input voltage and a 220- $\mu$ F output capacitance, VOUT typically charge to 7 V in approximately 6.2 seconds (using  $I_F = 150 \mu$ A,  $\Delta V_{OUT} = 7$  V,  $C_{OUT} = 220 \mu$ F).

If the output voltage must remain below a certain value, a pull-down resistor can be utilized with a value as calculated by using [方程式 12](#).

$$V_{OUT\_LKG\_MAX} = I_F \times R_{PULL\_DOWN} \quad (12)$$

where

- $V_{OUT\_LKG\_MAX}$  = maximum output voltage due to leakage current,  $I_F$
- $R_{PULL\_DOWN}$  = external pull-down resistor from VOUT to GND

For example, placing a 2.6-k $\Omega$  resistor between VOUT and ground makes sure VOUT does not rise above 0.65-V worst case due to the  $I_F$  current. The resistor need to be able to handle the worst case power dissipation when the switch is enabled and  $V_{OUT} \approx V_{IN}$ .

## 8.4 Device Functional Modes

**VOUT Connection due to  $V_{EN}$  and  $V_{OVP}$**  lists the VOUT pin state as determined by the EN and OVP pin voltages.

表 8-3. VOUT Connection due to  $V_{EN}$  and  $V_{OVP}$

| EN PIN           | OVP PIN          | TPS7H2201-SP and TPS7H2201-SEP <sup>(5) (6)</sup> |
|------------------|------------------|---------------------------------------------------|
| 0 <sup>(1)</sup> | 0 <sup>(3)</sup> | Open                                              |
| 0                | 1 <sup>(4)</sup> | Open                                              |
| 1 <sup>(2)</sup> | 0                | VIN                                               |
| 1                | 1                | Open                                              |

(1)  $V_{EN} < V_{IHEN(MIN)} = 0$

(2)  $V_{EN} > V_{IHEN(MAX)} = 1$

(3)  $V_{OVP} < V_{OVPF(MIN)} = 0$

(4)  $V_{OVP} > V_{OVPR(MAX)} = 1$

(5) Refer to [Turn-On \( \$t\_{ON}\$ \), Turn-Off \( \$t\_{OFF}\$ \) and VOUT Fall Time \( \$t\_F\$ \) Waveforms](#) for more details.

(6) Refer to [OVP Assert \( \$t\_{ASSERT}\$ \) and OVP Deassert \( \$t\_{DEASSERT}\$ \) Waveforms](#) for more details.

## 9 Application and Implementation

### 备注

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.

### 9.1 Application Information

The TPS7H2201 device is a single channel, 6-A eFuse with multiple programmable features such as current limit, undervoltage and overvoltage, current limit and retry timers, and soft start. In addition, the TPS7H2201 features a reverse current protection capability for power distribution applications and current sensing for load monitoring purpose. The TPS7H2201-SP user's guide is available on the TI website, [TPS7H2201EVM-CVAL Evaluation Module \(EVM\) User's Guide](#). The guide highlights standard EVM configurations, test results, schematic, and BOM for reference.

### 9.2 Typical Applications

In addition to the standard power management applications where a power switch can be used, there are 2 main applications in which the TPS7H2201 can be used in space power applications:

- Redundancy for primary and secondary voltage rails common in satellite applications
- Protection for critical or SEL sensitive loads

#### 9.2.1 Redundancy

In applications where primary and secondary (redundant) power rails are present, the TPS7H2201 is ideal to implement redundancy because of its reverse current blocking capability. In this case, since the eFuse is placed at the input of the point of load regulator, the on-resistance of the switch is not as critical.

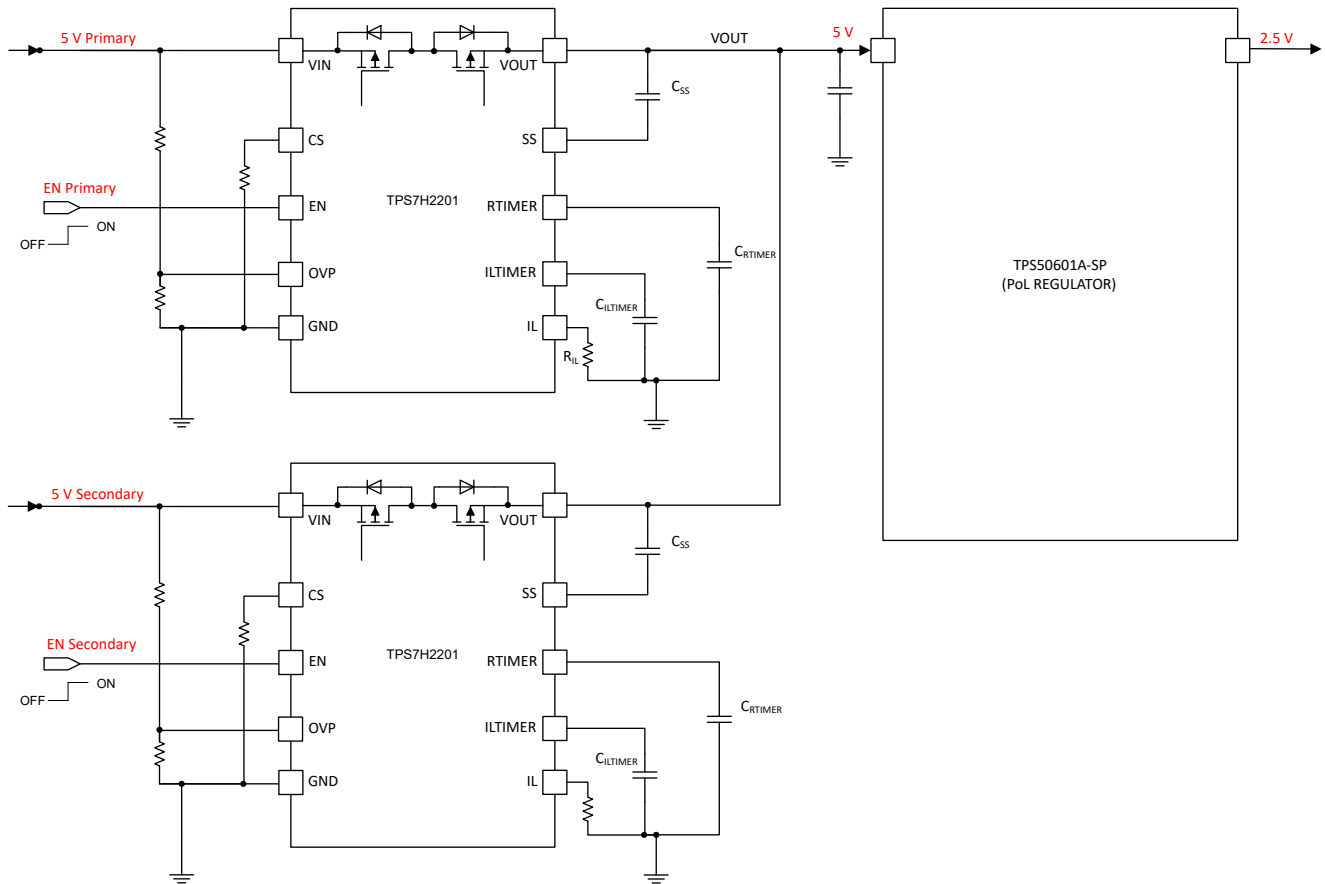


图 9-1. Redundancy Example Using the TPS7H2201

### 9.2.2 Protection

The protection features of the TPS7H2201 can also be used for SEL sensitive loads. In such case, the on-resistance of the switch might be more relevant as it is placed after the point of load regulator but in such case, two eFuse can be placed in parallel to reduce the on-resistance if needed. The main advantages of using the eFuse at this location is faster response to SEL events and automatic recovery due to the retry mode of the programmable fault timer.



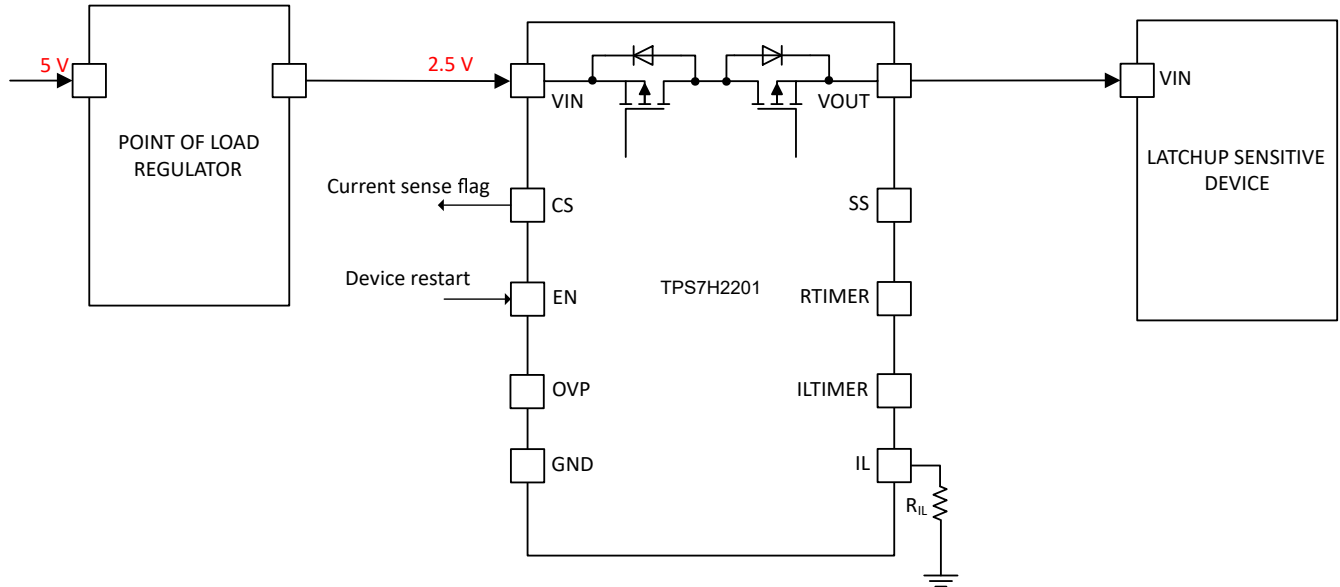


图 9-2. Protection Example Using the TPS7H2201

### 9.2.3 Design Requirements

图 9-3 shows a typical application schematic that is applicable to both the redundancy and the protection applications previously discussed.

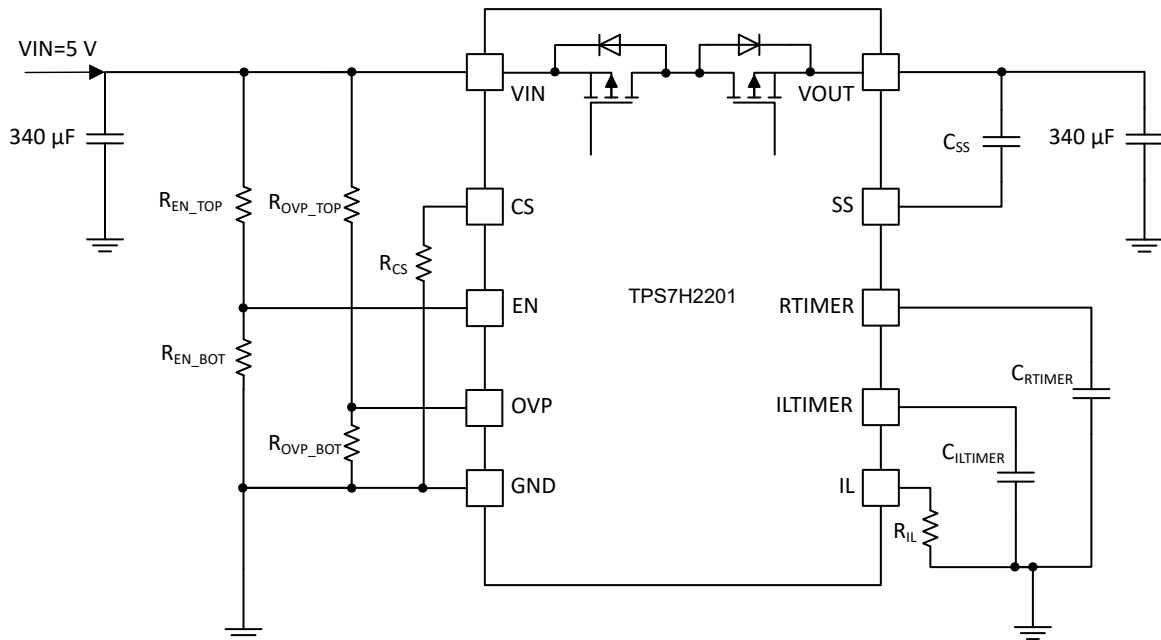


图 9-3. Typical Application Schematic

表 9-1 shows the design parameters.

表 9-1. Design Parameters

| DESIGN PARAMETER               | EXAMPLE VALUE |
|--------------------------------|---------------|
| VIN                            | 5 V           |
| Undervoltage lockout set point | 3.5 V         |

表 9-1. Design Parameters (续)

| DESIGN PARAMETER                 | EXAMPLE VALUE |
|----------------------------------|---------------|
| Overvoltage protection set point | 6.5 V         |
| Output current                   | 6 A           |
| Current limit                    | 7.5 A         |
| Current limit timer              | 1 ms          |
| Retry timer                      | 1 ms          |
| Soft start time                  | 9 ms          |
| Input and output capacitors      | 340 µF        |

## 9.2.4 Detailed Design Procedure

### 9.2.4.1 Undervoltage Lockout

The undervoltage lockout set point is configured using the resistor divider,  $R_{EN\_TOP}$  and  $R_{EN\_BOT}$  connected to the EN pin. Set the  $R_{EN\_TOP} = 100\text{ k}\Omega$  and, using 方程式 1, calculate the value for  $R_{EN\_BOT}$ . For an  $UVLO = 3.5\text{ V}$ ,  $R_{EN\_BOT} = 15.5\text{ k}\Omega$ . When choosing the UVLO set point, the resistor divider must ensure that the device will still get enabled for the VIN used in the application. This is achieved by making sure that the  $V_{IHEN}$  requirement is still met with the chosen resistor divider and that the VIN needed to meet the requirement is smaller than the VIN used in the application. 方程式 13 shows this VIN and  $V_{IHEN}$  requirement to set the UVLO point. For this particular application, the requirement is met as the result is 4.84 V.

$$V_{IHEN} \times \frac{R_{EN\_TOP} + R_{EN\_BOT}}{R_{EN\_BOT}} \leq VIN \quad (13)$$

### 9.2.4.2 Overvoltage Protection

In a similar way to the UVLO set point, the overvoltage protection set point is configured using the resistor divider,  $R_{OVP\_TOP}$  and  $R_{OVP\_BOT}$  connected to the OVP pin. Set the  $R_{OVP\_TOP} = 100\text{ k}\Omega$  and, using 方程式 2, calculate the value for  $R_{OVP\_BOT}$ . For an  $OVP = 6.5\text{ V}$ ,  $R_{OVP\_BOT} = 10.7\text{ k}\Omega$ . When choosing the OVP set point, the resistor divider must ensure that the device will still get enabled for the VIN used in the application. This is achieved by making sure that the  $V_{OVPF}$  requirement is still met with the chosen resistor divider and that the VIN needed to meet the requirement is larger than the VIN used in the application. 方程式 14 shows this VIN and  $V_{OVPF}$  requirement to set the OVP point. For this particular application, the requirement is met as the result is 5.16 V.

$$V_{OVPF} \times \frac{R_{OVP\_TOP} + R_{OVP\_BOT}}{R_{OVP\_BOT}} \geq VIN \quad (14)$$

### 9.2.4.3 Current Limit

The current limit is configured using  $R_{IL}$ . Based on the output current for this design, the minimum current limit that can be programmed is  $I_{OUT} + 1.5\text{ A}$  for a total of 7.5 A. As a result, using 方程式 8, the resistor value is  $6.53\text{ k}\Omega$ .

### 9.2.4.4 Programmable Fault Timers

The programmable fault timers are configured using the  $C_{ILTIMER}$  and the  $C_{RTIMER}$  capacitors. For this particular design, both timers are set to 1 ms. Therefore, using 方程式 9, the value for each capacitor is 2000 pF. These capacitor values meet the requirement in 方程式 10.

### 9.2.4.5 Soft Start Time

The soft start time is configured using the  $C_{SS}$  capacitor. In order to calculate the value of the capacitor, the VOUT slew rate needs to be calculated using 方程式 3 to make sure the maximum VOUT slew rate requirement

程式 6, since  $V_{IN} = 5\text{ V}$  for this application.

### 9.2.5 Application Curves

The power-up behavior of this design example is shown in 图 9-4 and the current limit behavior is shown in 图 9-5.

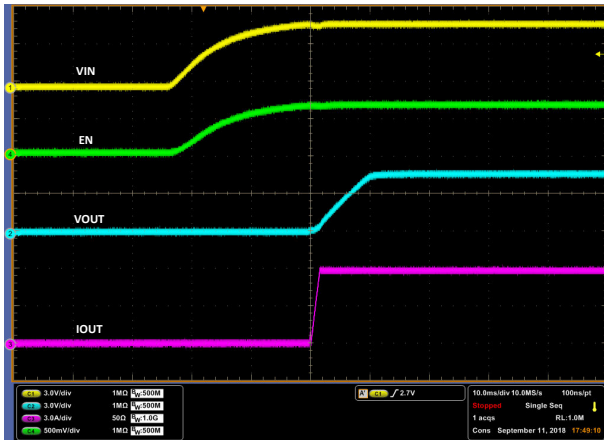
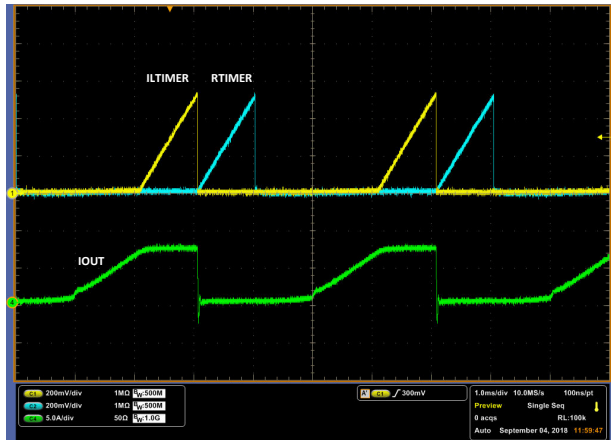


图 9-4. Power-up Behavior of the TPS7H2201-SP



**图 9-5. ILTIMER and RTIMER Waveforms When IL is Set to 7.5 A**

### 9.3 Power Supply Recommendations

The TPS7H2201 is designed to operate from an input voltage supply range between 1.5 V to 7 V. This supply voltage must be well regulated and proper local bypass capacitors should be used for proper electrical performance from VIN to GND. Due to stringent requirements for space applications, typically numerous input bypass capacitors are used and the total capacitance is much larger than for commercial applications. The TPS7H2201-SP Evaluation Module uses one 330- $\mu$ F tantalum capacitor in parallel with one 10- $\mu$ F and one 0.1- $\mu$ F ceramic capacitor.

### 9.4 Layout

#### 9.4.1 Layout Guidelines

For best performance, all traces should be as short as possible. To be most effective, the input and output capacitors should be placed close to the device to minimize the effects that parasitic trace inductances may have on normal operation. Using wide traces for VIN, VOUT, and GND helps minimize the parasitic electrical effects. In general, the components should be placed close to the device such that traces remain as short as possible to avoid parasitic capacitance. In addition, due to the possibility of large power dissipation in fault conditions (short at VOUT), thermal vias should be placed in the PCB for the thermal pad.

#### 9.4.2 Layout Example

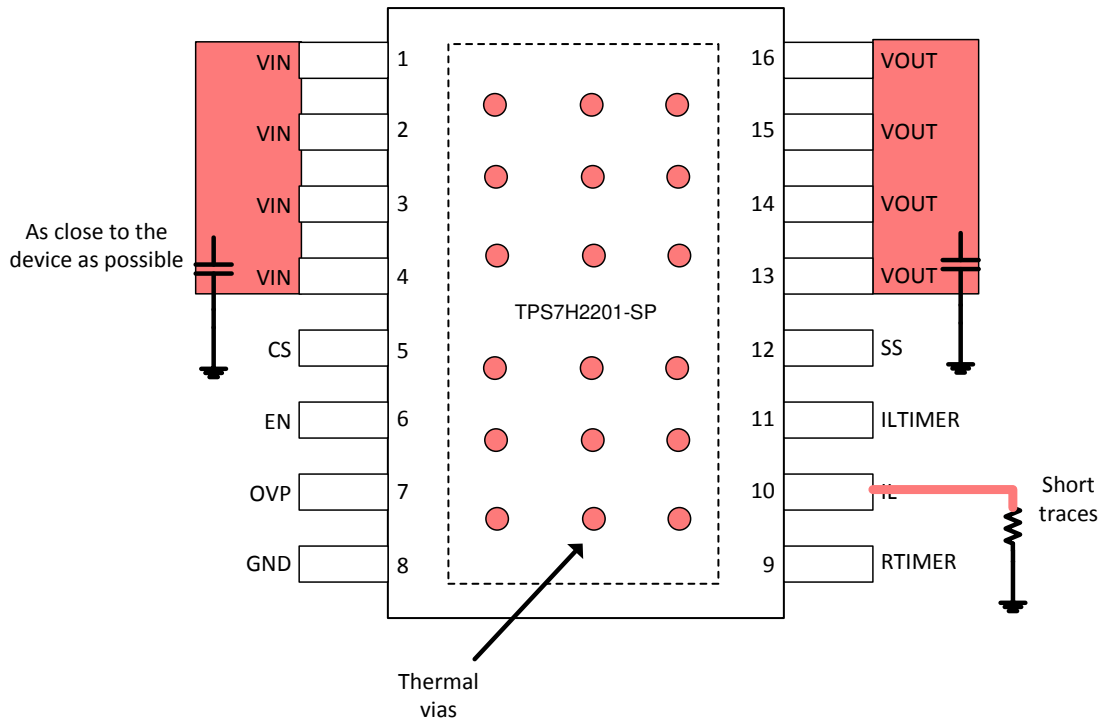


图 9-6. Layout Recommendation

## 10 Device and Documentation Support

### 10.1 Documentation Support

#### 10.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, [TPS7H2201-SP Total Ionizing Dose \(TID\) Report](#)
- Texas Instruments, [TPS7H2201-SEP TID Radiation Report](#)
- Texas Instruments, [Single-Events Effects Test Report of the TPS7H2201-SP eFuse](#)
- Texas Instruments, [Single-Event-Effects Test Report of the TPS7H2201-SEP eFuse](#)
- Texas Instruments, [TPS7H2201-SP Neutron Displacement Damage Characterization](#)
- Texas Instruments, [TPS7H2201EVM-CVAL Evaluation Module \(EVM\) User's Guide](#)
- Texas Instruments, [TPS7H2201EVM Evaluation Module \(EVM\)](#)
- Texas Instruments, [Unencrypted PSpice Transient Model](#)
- Texas Instruments, [Load Switch Thermal Considerations](#)
- Texas Instruments, [Basics of eFuses](#)
- Texas Instruments, [Basics of Load Switches](#)
- [Standard Microcircuit Drawing, 5962R17220](#)
- [Vendor Item Drawing, V6223608](#)

### 10.2 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.

### 10.3 支持资源

TI E2E™ 中文支持论坛是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的[使用条款](#)。

### 10.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

所有商标均为其各自所有者的财产。

### 10.5 静电放电警告



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

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

### 10.6 术语表

TI 术语表      本术语表列出并解释了术语、首字母缩略词和定义。

## 11 Revision History

注：以前版本的页码可能与当前版本的页码不同

| Changes from Revision E (December 2023) to Revision F (March 2024) | Page |
|--------------------------------------------------------------------|------|
|--------------------------------------------------------------------|------|

- |                                                |   |
|------------------------------------------------|---|
| • 删除了说明和器件选项部分中的 TPS7H2201MDAPTSEP 预告信息说明..... | 1 |
|------------------------------------------------|---|

| Changes from Revision D (September 2023) to Revision E (December 2023) | Page |
|------------------------------------------------------------------------|------|
|------------------------------------------------------------------------|------|

- |                                                 |   |
|-------------------------------------------------|---|
| • 在说明和器件选项部分中添加了 TPS7H2201MDAPTSEP 的预告信息说明..... | 1 |
|-------------------------------------------------|---|

## 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 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="#">5962-1722001VXC</a>   | Active        | Production           | CFP (HKR)   16    | 25   TUBE             | ROHS Exempt | NIAU                                 | N/A for Pkg Type                  | -55 to 125   | 5962-1722001VXC<br>TPS7H2201MHKRV |
| 5962R1722001V9A                   | Active        | Production           | XCEPT (KGD)   0   | 25   OTHER            | Yes         | Call TI                              | N/A for Pkg Type                  | -55 to 125   |                                   |
| <a href="#">5962R1722001VXC</a>   | Active        | Production           | CFP (HKR)   16    | 25   TUBE             | ROHS Exempt | NIAU                                 | N/A for Pkg Type                  | -55 to 125   | 5962R1722001VXC<br>TPS7H2201MHKRV |
| 5962R1722001VXC.A                 | Active        | Production           | CFP (HKR)   16    | 25   TUBE             | ROHS Exempt | NIAU                                 | N/A for Pkg Type                  | -55 to 125   | 5962R1722001VXC<br>TPS7H2201MHKRV |
| <a href="#">5962R1722002PYE</a>   | Active        | Production           | HTSSOP (DAP)   32 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -55 to 125   | 1722002PYE                        |
| 5962R1722002PYE.A                 | Active        | Production           | HTSSOP (DAP)   32 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -55 to 125   | 1722002PYE                        |
| <a href="#">TPS7H2201HKR/EM</a>   | Active        | Production           | CFP (HKR)   16    | 25   TUBE             | ROHS Exempt | NIAU                                 | N/A for Pkg Type                  | 25 to 25     | TPS7H2201HKREM                    |
| <a href="#">TPS7H2201MDAPTSEP</a> | Active        | Production           | HTSSOP (DAP)   32 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -55 to 125   | TPS7H2201                         |
| TPS7H2201Y/EM                     | Active        | Production           | XCEPT (KGD)   0   | 5   OTHER             | Yes         | Call TI                              | N/A for Pkg Type                  | 25 to 25     |                                   |
| V62/23608-01XE                    | Active        | Production           | HTSSOP (DAP)   32 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -55 to 125   | TPS7H2201                         |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **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.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **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.

<sup>(5)</sup> **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.

<sup>(6)</sup> **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.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

**OTHER QUALIFIED VERSIONS OF TPS7H2201-SEP, TPS7H2201-SP :**

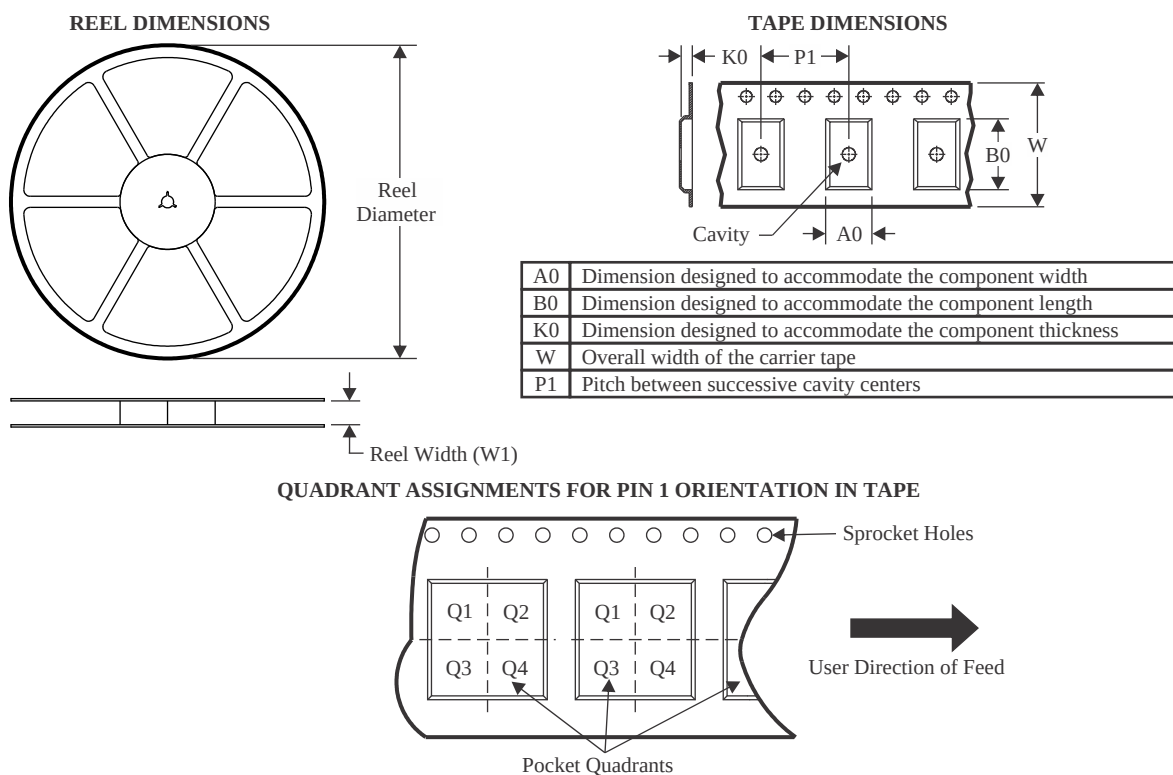
- Catalog : [TPS7H2201-SEP](#)
- Space : [TPS7H2201-SP](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application



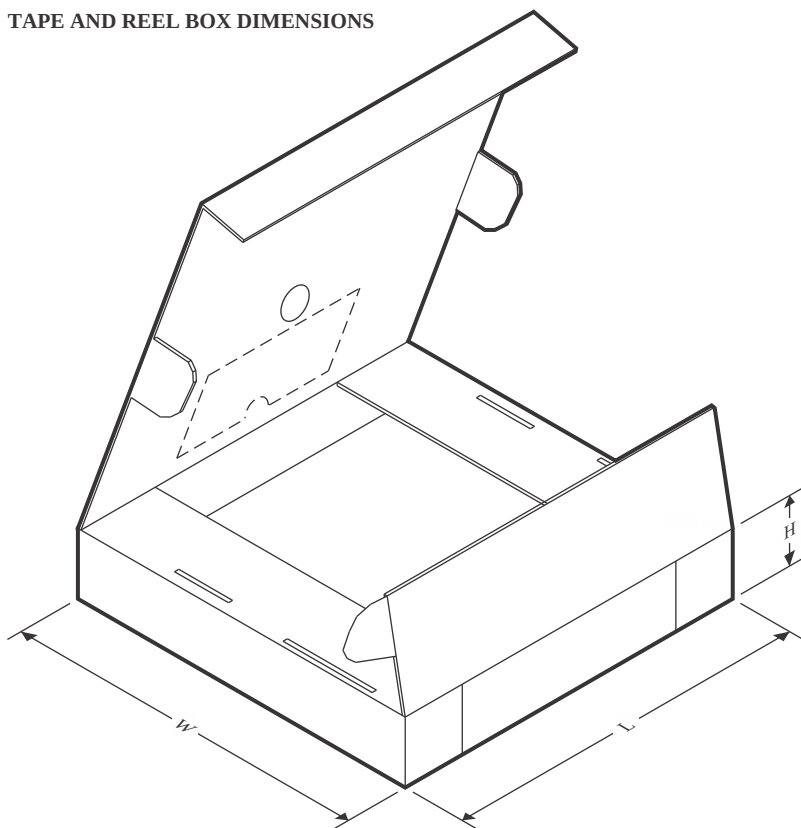
## TAPE AND REEL INFORMATION



\*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 |
|-------------------|--------------|-----------------|------|-----|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| 5962R1722002PYE   | HTSSOP       | DAP             | 32   | 250 | 178.0              | 24.4               | 8.8     | 11.8    | 1.8     | 12.0    | 24.0   | Q1            |
| TPS7H2201MDAPTSEP | HTSSOP       | DAP             | 32   | 250 | 178.0              | 24.4               | 8.8     | 11.8    | 1.8     | 12.0    | 24.0   | Q1            |
| TPS7H2201MDAPTSEP | HTSSOP       | DAP             | 32   | 250 | 330.0              | 24.4               | 8.8     | 11.8    | 1.8     | 12.0    | 24.0   | Q1            |

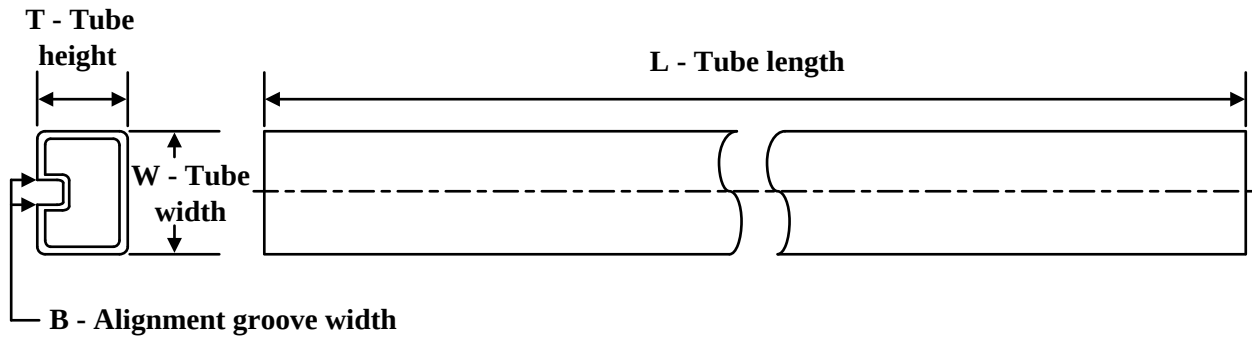
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device            | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------------|--------------|-----------------|------|-----|-------------|------------|-------------|
| 5962R1722002PYE   | HTSSOP       | DAP             | 32   | 250 | 223.0       | 191.0      | 55.0        |
| TPS7H2201MDAPTSEP | HTSSOP       | DAP             | 32   | 250 | 223.0       | 191.0      | 55.0        |
| TPS7H2201MDAPTSEP | HTSSOP       | DAP             | 32   | 250 | 356.0       | 356.0      | 41.0        |

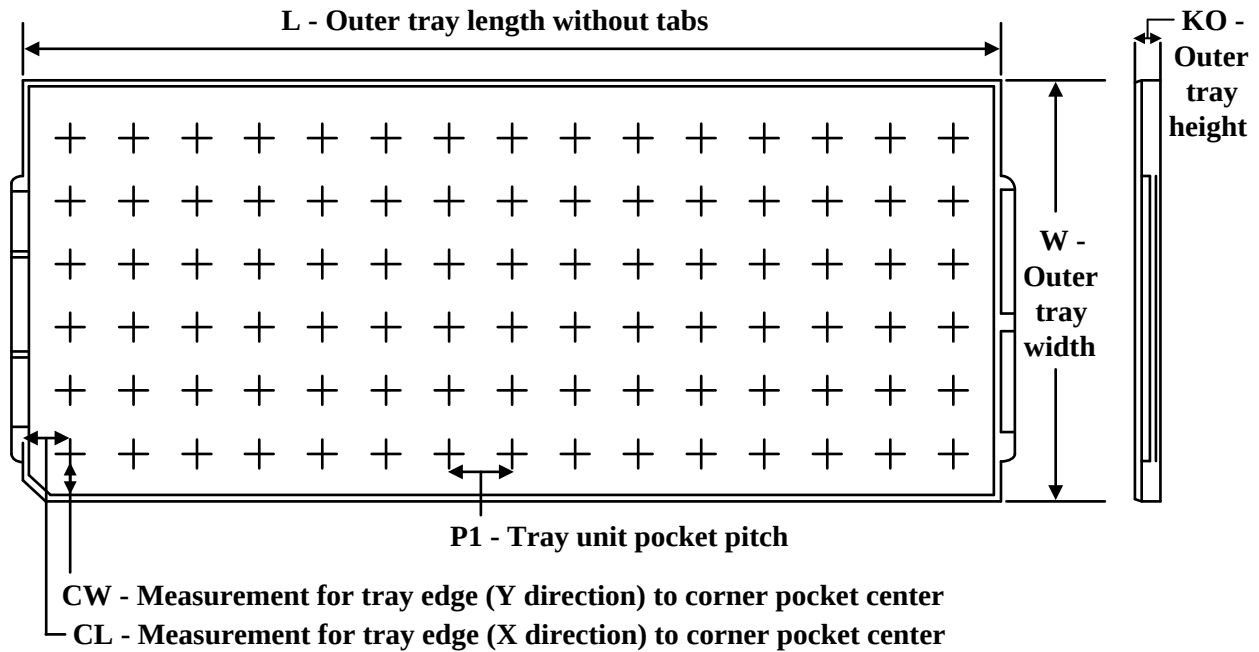
## TUBE



\*All dimensions are nominal

| Device            | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-------------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| 5962-1722001VXC   | HKR          | CFP          | 16   | 25  | 506.98 | 26.16  | 6220   | NA     |
| 5962R1722001VXC   | HKR          | CFP          | 16   | 25  | 506.98 | 26.16  | 6220   | NA     |
| 5962R1722001VXC.A | HKR          | CFP          | 16   | 25  | 506.98 | 26.16  | 6220   | NA     |
| TPS7H2201HKR/EM   | HKR          | CFP          | 16   | 25  | 506.98 | 26.16  | 6220   | NA     |

## TRAY



Chamfer on Tray corner indicates Pin 1 orientation of packed units.

\*All dimensions are nominal

| Device        | Package Name | Package Type | Pins | SPQ | Unit array matrix | Max temperature (°C) | L (mm) | W (mm) | K0 (μm) | P1 (mm) | CL (mm) | CW (mm) |
|---------------|--------------|--------------|------|-----|-------------------|----------------------|--------|--------|---------|---------|---------|---------|
| TPS7H2201Y/EM | KGD          | XCEPT        | 0    | 5   | 5 x 5             | 70                   | 6.35   | 3.81   | 610     | 1.3     | 8.89    | 8.13    |



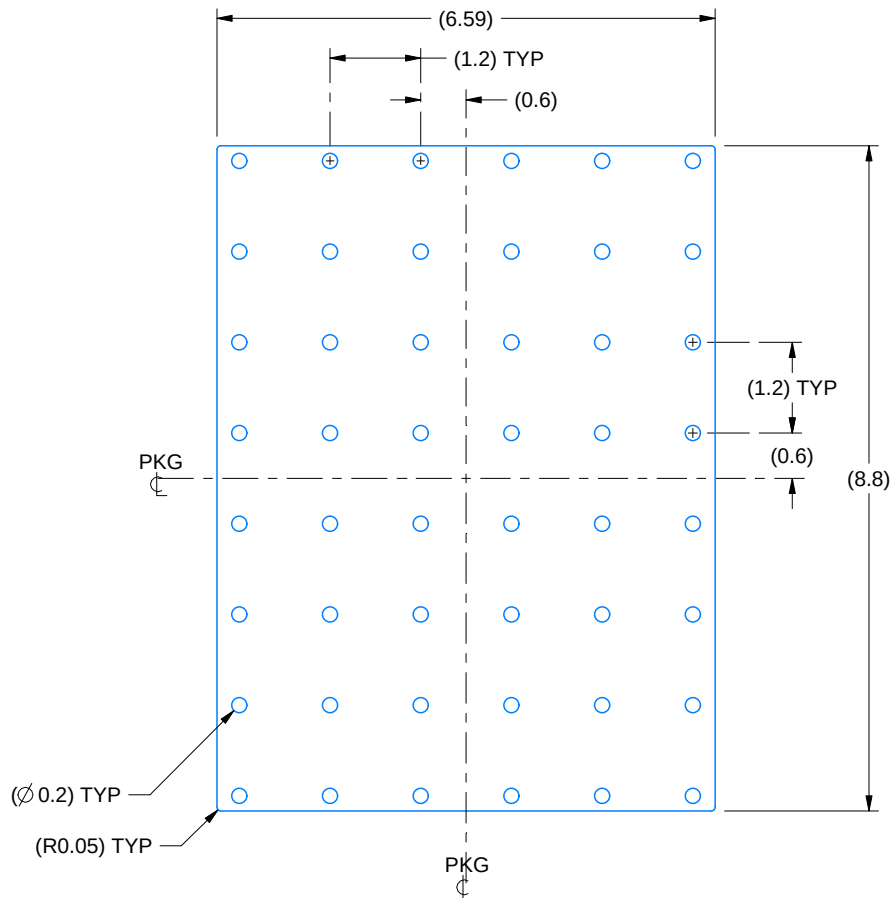
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermetically sealed with a metal lid. Lid is connected to Heatsink.
4. The terminals are gold plated.
5. Falls within MIL-STD-1835 CDEP-F11A.

# EXAMPLE BOARD LAYOUT

HKR0016A

CFP - 2.416 mm max height

CERAMIC DUAL FLATPACK



HEATSINK LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:10X

4226020/C 08/2022

## GENERIC PACKAGE VIEW

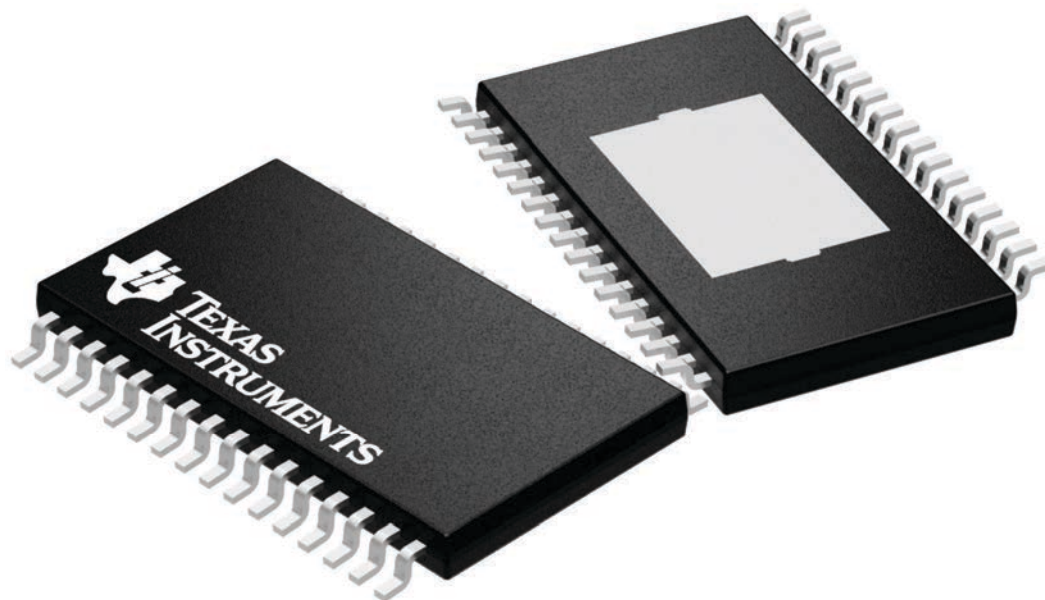
**DAP 32**

**PowerPAD™ TSSOP - 1.2 mm max height**

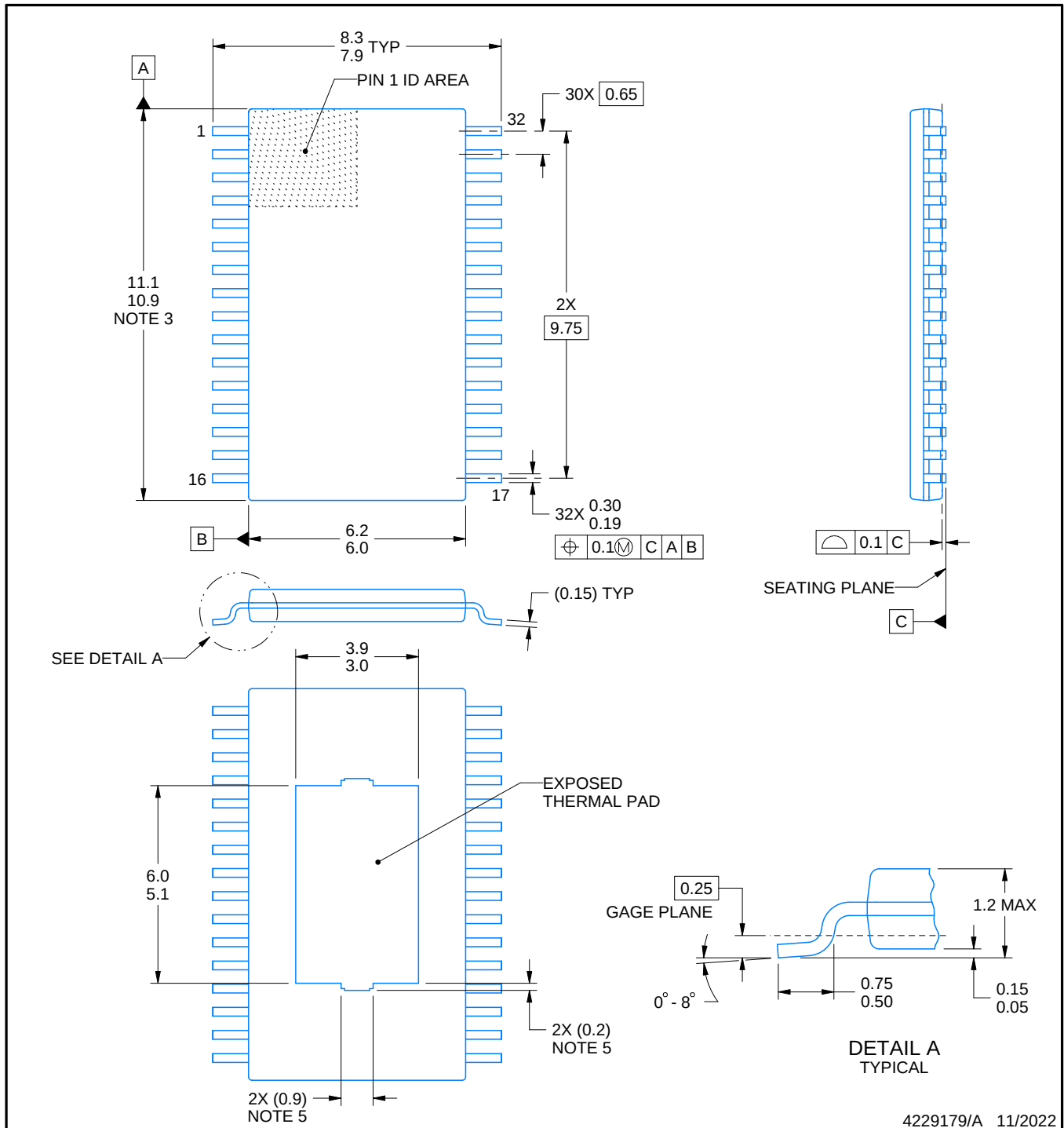
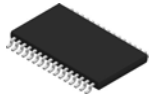
8.1 x 11, 0.65 mm pitch

PLASTIC SMALL OUTLINE

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4225303/A



4229179/A 11/2022

## NOTES:

PowerPAD is a trademark of Texas Instruments.

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. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.
5. Features may differ and may not be present.

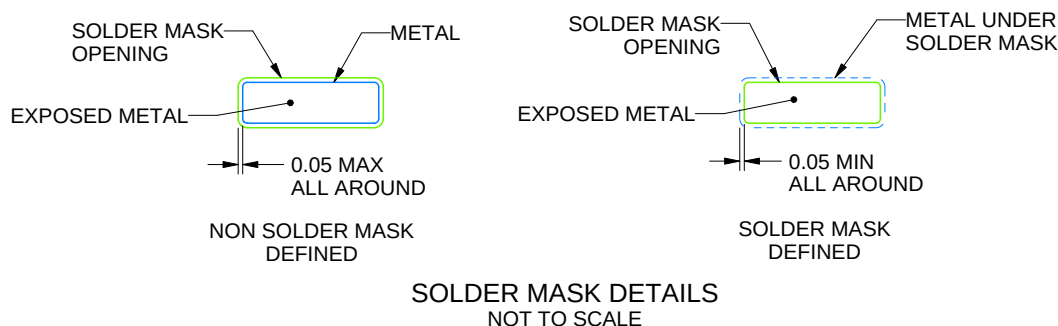
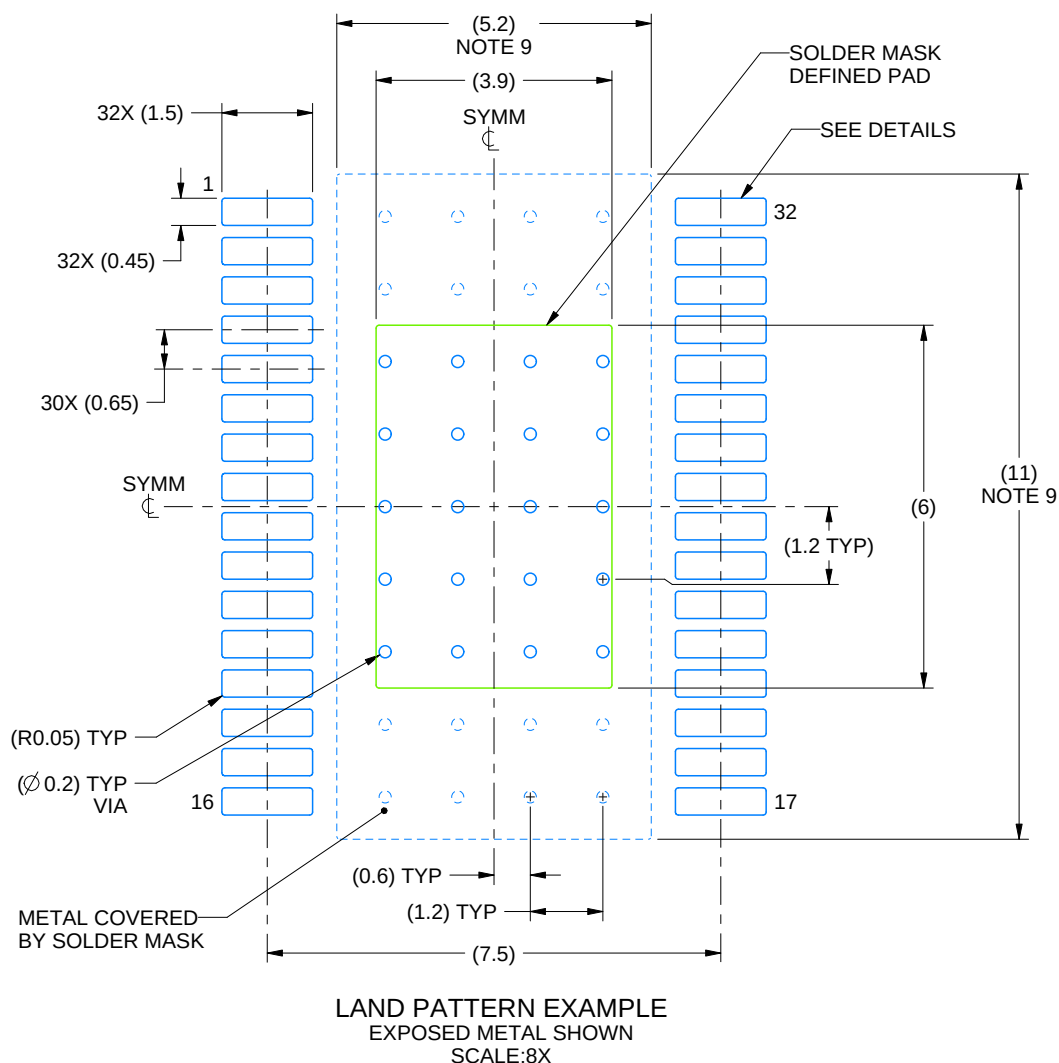


# EXAMPLE BOARD LAYOUT

DAP0032G

PowerPAD™ TSSOP - 1.2 mm max height

PLASTIC SMALL OUTLINE



4229179/A 11/2022

NOTES: (continued)

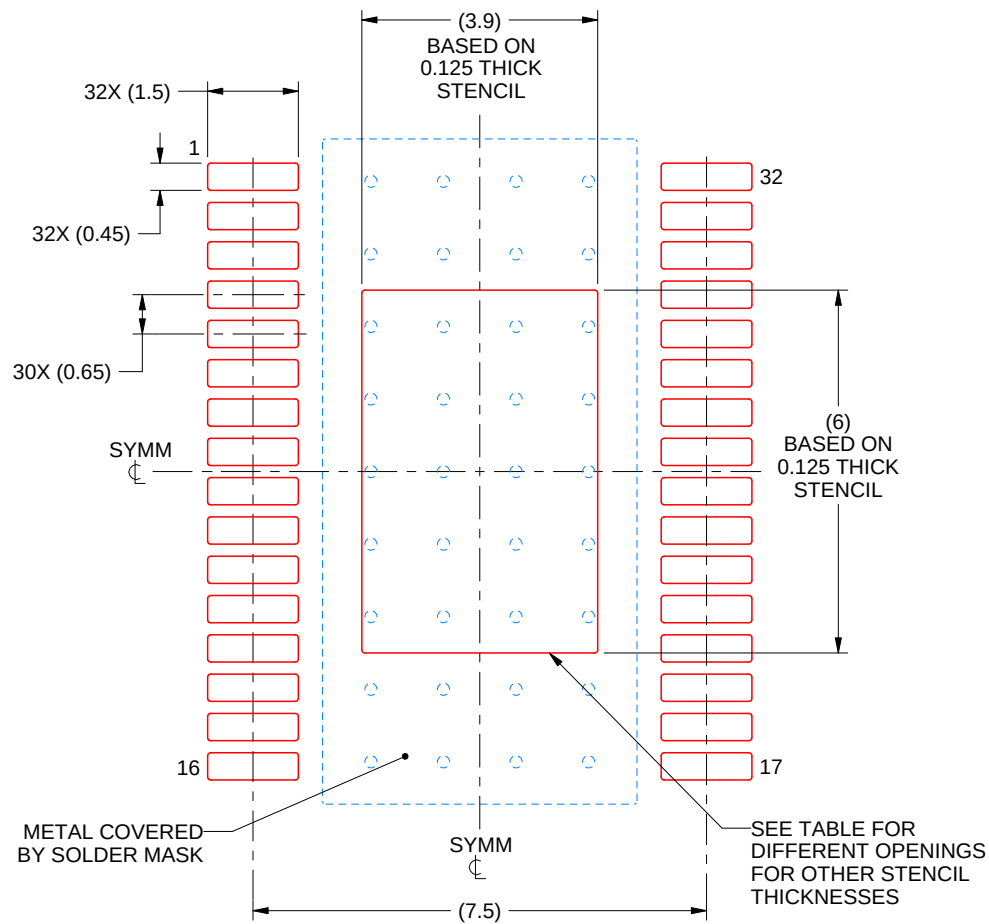
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 ([www.ti.com/lit/slma002](http://www.ti.com/lit/slma002)) and SLMA004 ([www.ti.com/lit/slma004](http://www.ti.com/lit/slma004)).
9. Size of metal pad may vary due to creepage requirement.

# EXAMPLE STENCIL DESIGN

DAP0032G

PowerPAD™ TSSOP - 1.2 mm max height

PLASTIC SMALL OUTLINE



**SOLDER PASTE EXAMPLE**  
EXPOSED PAD  
100% PRINTED SOLDER COVERAGE BY AREA  
SCALE:8X

| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|-------------------|------------------------|
| 0.1               | 4.36 X 6.71            |
| 0.125             | 3.90 X 6.00 (SHOWN)    |
| 0.15              | 3.56 X 5.48            |
| 0.175             | 3.30 X 5.07            |

4229179/A 11/2022

NOTES: (continued)

10. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
11. Board assembly site may have different recommendations for stencil design.

## 重要通知和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做任何明示或暗示的担保，包括但不限于对适销性、某特定用途方面的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他功能安全、信息安全、监管或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的相关应用。严禁以其他方式对这些资源进行复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。您应全额赔偿因在这些资源的使用中对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，TI 对此概不负责。

TI 提供的产品受 [TI 的销售条款](#) 或 [ti.com](#) 上其他适用条款/TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

邮寄地址：Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
版权所有 © 2025，德州仪器 (TI) 公司