# TPS2290x 具有受控开通功能的 3.6V、500mA、78mΩ 导通电阻负载开关

## 1 特性

- 集成 P 沟道负载开关
- 低输入电压：1V 至 3.6V
- 导通电阻（典型值）
  - $V_{IN}$ = 3.6V 时，$r_{ON}$ = 78mΩ
  - $V_{IN}$ = 2.5V 时，$r_{ON}$ = 93mΩ
  - $V_{IN}$ = 1.8V 时，$r_{ON}$ = 109mΩ
  - $V_{IN}$ = 1.2V 时，$r_{ON}$ = 146mΩ
- 500mA 最大持续开关电流
- 静态电流：1.8V 时为 82nA
- 关断电流：1.8V 时为 44nA
- 低控制输入阈值支持使用 1.2V、1.8V、2.5V 和 3.3V 逻辑
- 受控转换率，可避免浪涌电流
  - $V_{IN}$ = 1.8V 时 $t_r$ = 40μs (TPS22901/2)
  - $V_{IN}$ = 1.8V 时 $t_r$ = 220μs (TPS22902B)
- 快速输出放电 (TPS22902/2B)
- ESD 性能测试符合 JESD 22 标准
  - 2000V 人体放电模型{42}（A114-B，II 类）
  - 1000V 充电器件模型 (C101)
- 四引脚晶圆芯片级 DSBGA 封装
  - 0.8mm × 0.8mm，间距 0.4mm，高 0.5mm (YFP)

## 2 应用

- 个人数字助理 (PDA)
- 手机
- 全球卫星定位 (GPS) 设备
- MP3 播放器
- 数码照相机
- 外设端口
- 便携式仪表
- 射频模块

## 3 说明

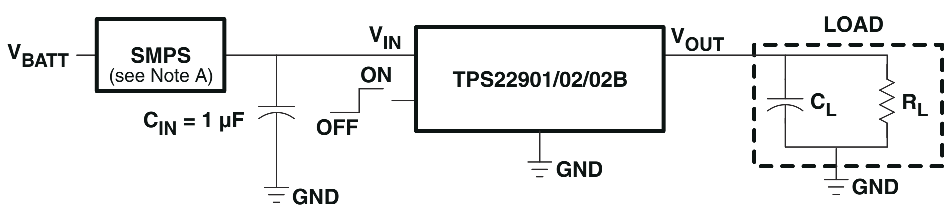
TPS22901、TPS22902 和 TPS22902B 是具有受控开通功能的小型低导通电阻 ($r_{ON}$) 负载开关。这些器件包含一个 P 沟道 MOSFET，该 MOSFET 可在 1.0V 至 3.6V 的输入电压范围内运行。此开关由一个导通/关断输入 (ON) 控制，可与低电压控制信号直接连接。在 TPS22902 和 TPS22902B 中添加了一个 88Ω 片上负载电阻器，用于在开关关闭时进行快速输出放电。

TPS22901、TPS22902 和 TPS22902B 采用节省空间的 0.4mm 间距 4 引脚 DSBGA (YFP) 封装。这些器件在自然通风环境下的额定运行温度范围为 –40°C 至 85°C。

器件信息

| 器件型号 | 封装[(1)] | 封装尺寸（标称值） |
|---|---|---|
| TPS22901 | DSBGA (4) | 0.80mm × 0.80mm |
| TPS22902 | | |
| TPS22902B | | |

(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。




A. 开关模式电源

典型应用原理图

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## 4 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 D (January 2015) to Revision E (September 2020) | Page |
|---|---|
| • 更新了整个文档的表、图和交叉参考的编号格式。 | 1 |

| Changes from Revision C (December 2012) to Revision D (January 2015) | Page |
|---|---|
| • 添加了 *ESD 等级* 表、*特性说明* 部分、*器件功能模式*、*应用和实现* 部分、*电源相关建议* 部分、*布局* 部分、*器件和文档支持* 部分以及*机械、封装和可订购信息* 部分。 | 1 |
| • Deleted the *ORDERING INFORMATION* table | 3 |

| Changes from Revision B (March 2009) to Revision C (December 2012) | Page |
|---|---|
| • Changed the *ORDERING INFORMATION* table | 3 |

## 5 Device Comparison Table

| | $R_{ON}$ at 1.8 V (TYP) | RISE TIME (TYP at 1.8 V) | QUICK OUTPUT DISCHARGE(1) | MAX OUTPUT CURRENT | ENABLE |
|---|---|---|---|---|---|
| TPS22901 | 109 mΩ | 40 µs | No | 500 mA | Active high |
| TPS22902 | | | Yes | | |
| TPS22902B | | 220 µs | Yes | | |

(1) This feature discharges the output of the switch to ground through an 88 Ω resistor, preventing the output from floating.

## 6 Pin Configuration and Functions

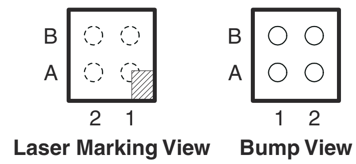



**图 6-1. YFP Package 4-Pin DSBGA**

**Pin Assignments**

| | | |
|---|---|---|
| **B** | ON | GND |
| **A** | $V_{IN}$ | $V_{OUT}$ |
| | **2** | **1** |

**Pin Functions**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NO. | NAME | | |
| A1 | $V_{OUT}$ | O | Switch output |
| A2 | $V_{IN}$ | I | Switch input, bypass this input with a ceramic capacitor to ground |
| B1 | GND | - | Ground |
| B2 | ON | I | Switch control input, active high |

# 7 Specifications

## 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)[1]

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{IN}$ | Input voltage | –0.3 | 4 | V |
| $V_{OUT}$ | Output voltage | | $V_{IN}$ + 0.3 | V |
| $V_{ON}$ | Input voltage | –0.3 | 4 | V |
| P | Power dissipation at $T_A$ = 25°C | | 0.48 | W |
| $I_{MAX}$ | Maximum continuous switch current | | 500 | mA |
| $T_A$ | Operating free-air temperature | –40 | 85 | °C |
| $T_{lead}$ | Maximum lead temperature (10-s soldering time) | | 300 | °C |
| $T_{stg}$ | 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 *节 7.3*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## 7.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001[1] | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101[2] | ±1000 | |

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

## 7.3 Recommended Operating Conditions

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{IN}$ | Input voltage | 1 | 3.6 | V |
| $V_{OUT}$ | Output voltage | | $V_{IN}$ | V |
| $V_{IH}$ | High-level input voltage, ON | 0.85 | 3.6 | V |
| $V_{IL}$ | Low-level input voltage, ON | | 0.4 | V |
| $C_{IN}$ | Input capacitor | See [1] | | μF |

(1) See *节 10.1.1*.

## 7.4 Thermal Information

| THERMAL METRIC[1] | | TPS2290X | UNIT |
|---|---|---|---|
| | | YFP (DSBGA) | |
| | | 4 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 192.1 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 2.3 | |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 35.8 | |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 11.8 | |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 35.6 | |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

### 7.5 Electrical Characteristics

$V_{IN}$ = 1.0 V to 3.6 V, $T_A$ = –40°C to 85°C (unless otherwise noted). Typical values are for $T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | | $T_A$ | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $I_Q$ | Quiescent current | $I_{OUT}$ = 0, $V_{IN}$ = $V_{ON}$ | $V_{IN}$ = 1.1 V | Full | | 37 | 120 | nA |
| | | | $V_{IN}$ = 1.8 V | Full | | 82 | 235 | |
| | | | $V_{IN}$ = 3.6 V | Full | | 204 | 880 | |
| $I_{IN(OFF)}$ | OFF-state supply current | $V_{ON}$ = GND, $V_{OUT}$ = Open | $V_{IN}$ = 1.1 V | Full | | 22 | 210 | nA |
| | | | $V_{IN}$ = 1.8 V | Full | | 44 | 260 | |
| | | | $V_{IN}$ = 3.6 V | Full | | 137 | 700 | |
| $I_{IN(LEAKAGE)}$ | OFF-state switch current | $V_{ON}$ = GND, $V_{OUT}$ = 0 V | $V_{IN}$ = 1.1 V | Full | | 22 | 140 | nA |
| | | | $V_{IN}$ = 1.8 V | Full | | 45 | 230 | |
| | | | $V_{IN}$ = 3.6 V | Full | | 137 | 610 | |
| $r_{ON}$ | ON-state resistance | $I_{OUT}$ = - 200 mA | $V_{IN}$ = 3.6 V | 25°C | | 78 | 95 | mΩ |
| | | | | Full | | | 95 | |
| | | | $V_{IN}$ = 2.5 V | 25°C | | 93 | 110 | |
| | | | | Full | | | 110 | |
| | | | $V_{IN}$ = 1.8 V | 25°C | | 109 | 130 | |
| | | | | Full | | | 130 | |
| | | | $V_{IN}$ = 1.2 V | 25°C | | 146 | 200 | |
| | | | | Full | | | 200 | |
| | | | $V_{IN}$ = 1.1 V | 25°C | | 174 | 330 | |
| | | | | Full | | | 330 | |
| $r_{PD}$ | Output pulldown resistance | $V_{IN}$ = 3.3 V, $V_{ON}$ = 0, $I_{OUT}$ = 30 mA (TPS22902/TPS22902B only) | | 25°C | | 88 | 120 | Ω |
| $I_{ON}$ | ON input leakage current | $V_{ON}$ = 1.1 V to 3.6 V or GND | | Full | | | 25 | nA |

## 7.6 Switching Characteristics ($V_{IN}$ = 1.1 V)

$V_{IN}$ = 1.1 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | TPS22901 | | | TPS22902[1] | | | TPS22902B[1] | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{ON}$ | Turn-ON time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 108 | | | 108 | | | 531 | | µs |
| | | | $C_L$ = 1 µF | | 131 | | | 131 | | | 596 | | |
| | | | $C_L$ = 3.3 µF | | 153 | | | 153 | | | 659 | | |
| $t_{OFF}$ | Turn-OFF time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 39 | | | 11 | | | 11 | | µs |
| | | | $C_L$ = 1 µF | | 317 | | | 69 | | | 67 | | |
| | | | $C_L$ = 3.3 µF | | 1105 | | | 238 | | | 225 | | |
| $t_r$ | $V_{OUT}$ rise time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 70 | | | 70 | | | 365 | | µs |
| | | | $C_L$ = 1 µF | | 78 | | | 78 | | | 367 | | |
| | | | $C_L$ = 3.3 µF | | 92 | | | 92 | | | 395 | | |
| $t_f$ | $V_{OUT}$ fall time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 107 | | | 18 | | | 21 | | µs |
| | | | $C_L$ = 1 µF | | 966 | | | 175 | | | 189 | | |
| | | | $C_L$ = 3.3 µF | | 3532 | | | 632 | | | 565 | | |

(1) Quick Output Discharge

## 7.7 Switching Characteristics ($V_{IN}$ = 1.2 V)

$V_{IN}$ = 1.2 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | TPS22901 | | | TPS22902[1] | | | TPS22902B[1] | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{ON}$ | Turn-ON time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 96 | | | 96 | | | 471 | | µs |
| | | | $C_L$ = 1 µF | | 116 | | | 116 | | | 527 | | |
| | | | $C_L$ = 3.3 µF | | 135 | | | 135 | | | 587 | | |
| $t_{OFF}$ | Turn-OFF time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 39 | | | 10 | | | 10 | | µs |
| | | | $C_L$ = 1 µF | | 317 | | | 62 | | | 61 | | |
| | | | $C_L$ = 3.3 µF | | 1110 | | | 210 | | | 199 | | |
| $t_r$ | $V_{OUT}$ rise time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 62 | | | 62 | | | 324 | | µs |
| | | | $C_L$ = 1 µF | | 69 | | | 69 | | | 325 | | |
| | | | $C_L$ = 3.3 µF | | 81 | | | 81 | | | 350 | | |
| $t_f$ | $V_{OUT}$ fall time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 109 | | | 17 | | | 20 | | µs |
| | | | $C_L$ = 1 µF | | 995 | | | 163 | | | 175 | | |
| | | | $C_L$ = 3.3 µF | | 3650 | | | 587 | | | 523 | | |

(1) Quick Output Discharge

### 7.8 Switching Characteristics ($V_{IN}$ = 1.8 V)

$V_{IN}$ = 1.8 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | TPS22901 MIN | TPS22901 TYP | TPS22901 MAX | TPS22902[(1)] MIN | TPS22902[(1)] TYP | TPS22902[(1)] MAX | TPS22902B[(1)] MIN | TPS22902B[(1)] TYP | TPS22902B[(1)] MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $t_{ON}$ | Turn-ON time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 61 | | | 61 | | | 302 | | µs |
| | | | $C_L$ = 1 µF | | 72 | | | 72 | | | 335 | | |
| | | | $C_L$ = 3.3 µF | | 83 | | | 83 | | | 367 | | |
| $t_{OFF}$ | Turn-OFF time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 38 | | | 8 | | | 8 | | µs |
| | | | $C_L$ = 1 µF | | 317 | | | 49 | | | 49 | | |
| | | | $C_L$ = 3.3 µF | | 1135 | | | 169 | | | 167 | | |
| $t_r$ | $V_{OUT}$ rise time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 40 | | | 40 | | | 220 | | µs |
| | | | $C_L$ = 1 µF | | 45 | | | 45 | | | 220 | | |
| | | | $C_L$ = 3.3 µF | | 53 | | | 53 | | | 235 | | |
| $t_f$ | $V_{OUT}$ fall time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 111 | | | 15 | | | 15 | | µs |
| | | | $C_L$ = 1 µF | | 1020 | | | 140 | | | 159 | | |
| | | | $C_L$ = 3.3 µF | | 3700 | | | 517 | | | 481 | | |

(1) Quick Output Discharge

### 7.9 Switching Characteristics ($V_{IN}$ = 2.5 V)

$V_{IN}$ = 2.5 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | TPS22901 MIN | TPS22901 TYP | TPS22901 MAX | TPS22902[(1)] MIN | TPS22902[(1)] TYP | TPS22902[(1)] MAX | TPS22902B[(1)] MIN | TPS22902B[(1)] TYP | TPS22902B[(1)] MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $t_{ON}$ | Turn-ON time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 45 | | | 45 | | | 223 | | µs |
| | | | $C_L$ = 1 µF | | 53 | | | 53 | | | 246 | | |
| | | | $C_L$ = 3.3 µF | | 61 | | | 61 | | | 268 | | |
| $t_{OFF}$ | Turn-OFF time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 38 | | | 7 | | | 7 | | µs |
| | | | $C_L$ = 1 µF | | 314 | | | 46 | | | 47 | | |
| | | | $C_L$ = 3.3 µF | | 1140 | | | 161 | | | 158 | | |
| $t_r$ | $V_{OUT}$ rise time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 32 | | | 32 | | | 175 | | µs |
| | | | $C_L$ = 1 µF | | 35 | | | 35 | | | 175 | | |
| | | | $C_L$ = 3.3 µF | | 41 | | | 41 | | | 187 | | |
| $t_f$ | $V_{OUT}$ fall time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 113 | | | 14 | | | 18 | | µs |
| | | | $C_L$ = 1 µF | | 1040 | | | 139 | | | 185 | | |
| | | | $C_L$ = 3.3 µF | | 3795 | | | 516 | | | 471 | | |

(1) Quick Output Discharge

### 7.10 Switching Characteristics ($V_{IN}$ = 3.0 V)

$V_{IN}$ = 3.0 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | TPS22901 | | | TPS22902[(1)] | | | TPS22902B[(1)] | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{ON}$ | Turn-ON time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 38 | | | 38 | | | 191 | | µs |
| | | | $C_L$ = 1 µF | | 45 | | | 45 | | | 211 | | |
| | | | $C_L$ = 3.3 µF | | 53 | | | 53 | | | 231 | | |
| $t_{OFF}$ | Turn-OFF time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 38 | | | 7 | | | 7 | | µs |
| | | | $C_L$ = 1 µF | | 320 | | | 46 | | | 46 | | |
| | | | $C_L$ = 3.3 µF | | 1145 | | | 53 | | | 156 | | |
| $t_r$ | $V_{OUT}$ rise time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 28 | | | 28 | | | 159 | | µs |
| | | | $C_L$ = 1 µF | | 31 | | | 31 | | | 160 | | |
| | | | $C_L$ = 3.3 µF | | 37 | | | 37 | | | 170 | | |
| $t_f$ | $V_{OUT}$ fall time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 114 | | | 14 | | | 17 | | µs |
| | | | $C_L$ = 1 µF | | 1045 | | | 139 | | | 160 | | |
| | | | $C_L$ = 3.3 µF | | 3815 | | | 509 | | | 473 | | |

(1) Quick Output Discharge

### 7.11 Switching Characteristics ($V_{IN}$ = 3.6 V)

$V_{IN}$ = 3.6 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | TPS22901 | | | TPS22902[(1)] | | | TPS22902B[(1)] | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{ON}$ | Turn-ON time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 33 | | | 33 | | | 166 | | µs |
| | | | $C_L$ = 1 µF | | 39 | | | 39 | | | 183 | | |
| | | | $C_L$ = 3.3 µF | | 46 | | | 46 | | | 201 | | |
| $t_{OFF}$ | Turn-OFF time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 38 | | | 7 | | | 7 | | µs |
| | | | $C_L$ = 1 µF | | 322 | | | 46 | | | 45 | | |
| | | | $C_L$ = 3.3 µF | | 1145 | | | 156 | | | 155 | | |
| $t_r$ | $V_{OUT}$ rise time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 25 | | | 25 | | | 146 | | µs |
| | | | $C_L$ = 1 µF | | 28 | | | 28 | | | 146 | | |
| | | | $C_L$ = 3.3 µF | | 34 | | | 34 | | | 156 | | |
| $t_f$ | $V_{OUT}$ fall time | $R_L$ = 500 Ω | $C_L$ = 0.1 µF | | 116 | | | 14 | | | 17 | | µs |
| | | | $C_L$ = 1 µF | | 1060 | | | 139 | | | 161 | | |
| | | | $C_L$ = 3.3 µF | | 3840 | | | 512 | | | 475 | | |

(1) Quick Output Discharge

## 7.12 Typical Characteristics

### 7.12.1 Typical DC Characteristics

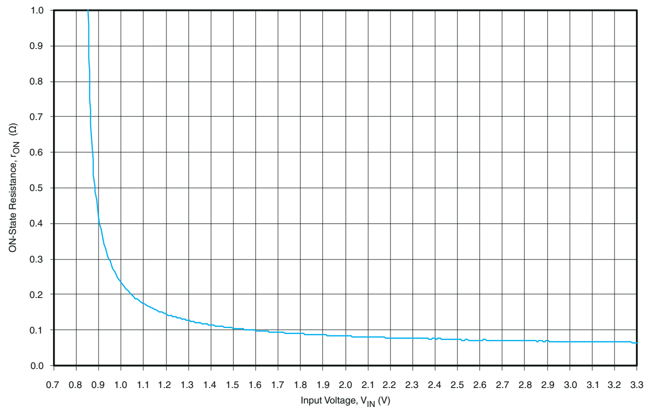



图 7-1. $r_{ON}$ vs $V_{IN}$

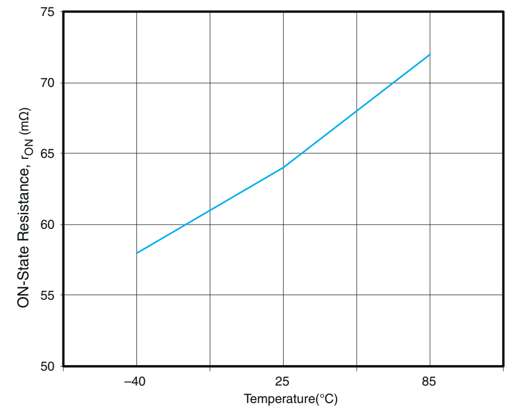



图 7-2. $r_{ON}$ vs Temperature ($V_{IN}$ = 3.3 V)

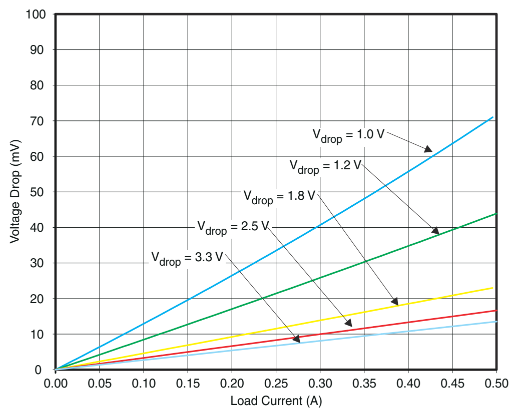



图 7-3. Voltage Drop vs. Load Current

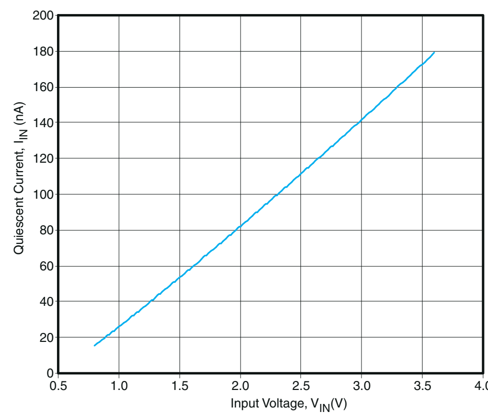



图 7-4. Quiescent Current vs $V_{IN}$ ($V_{ON}$ = $V_{IN}$, $I_{OUT}$ = 0)

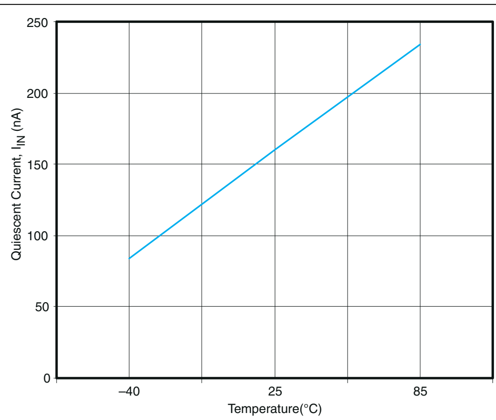



图 7-5. Quiescent Current vs Temperature ($V_{IN}$ = 3.3 V, $I_{OUT}$ = 0)

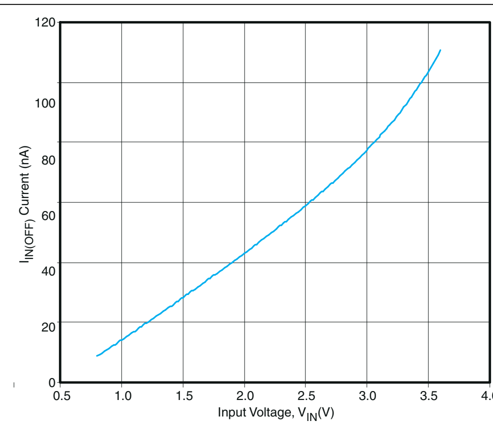



图 7-6. $I_{IN(OFF)}$ vs $V_{IN}$ ($V_{ON}$ = 0 V)

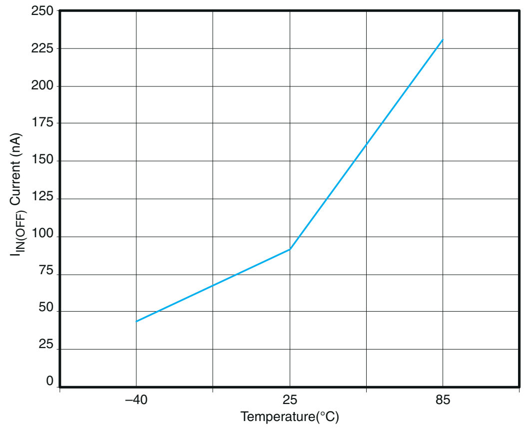



图 7-7. $I_{IN(OFF)}$ vs Temperature ($V_{IN}$ = 3.3 V)

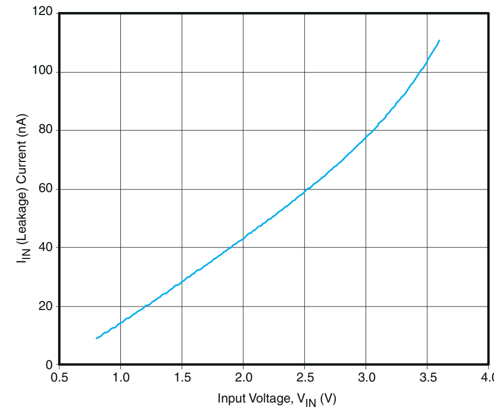



图 7-8. $I_{IN}$(Leakage) vs $V_{IN}$ ($I_{OUT}$ = 0)

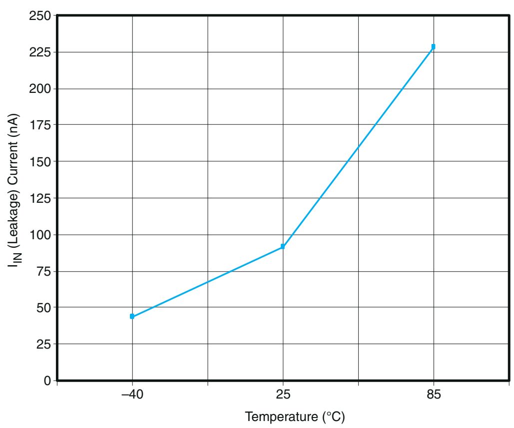



图 7-9. $I_{IN}$ (Leakage) vs Temperature ($V_{IN}$ = 3.3 V)

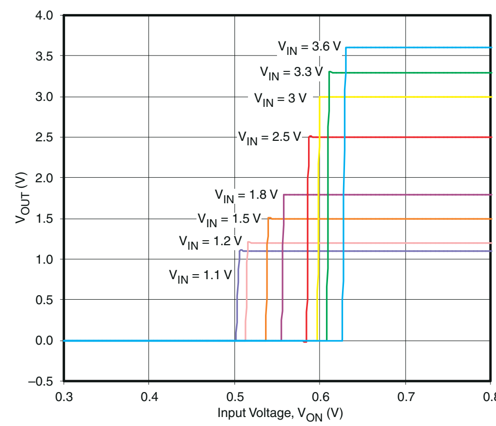



图 7-10. ON-Input Threshold

### 7.12.2 Typical AC Characteristics

#### *7.12.2.1 TPS22901*

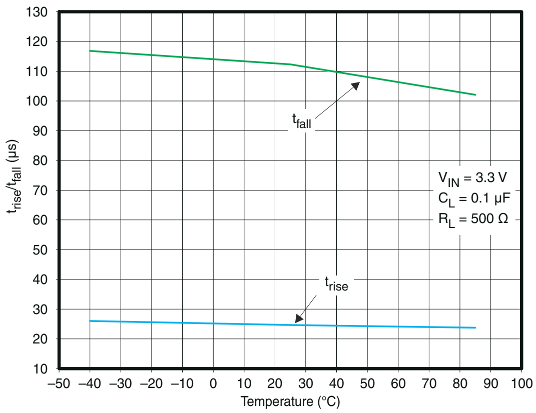



图 7-11. $t_{rise}/t_{fall}$ vs Temperature

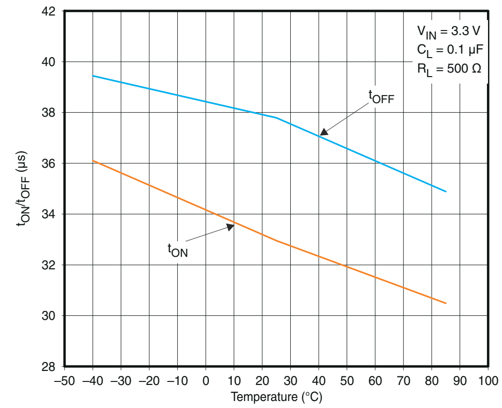



图 7-12. $t_{ON}/t_{OFF}$ vs Temperature

#### *7.12.2.2 TPS22902*

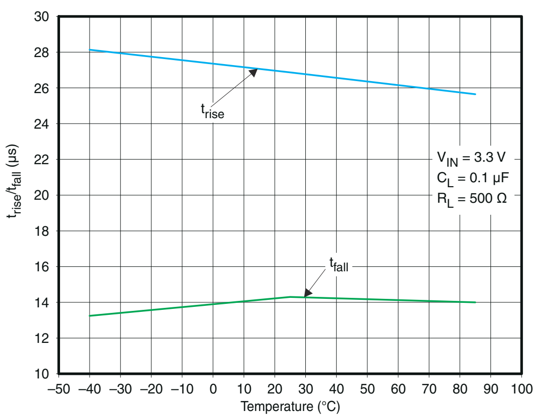



图 7-13. $t_{rise}/t_{fall}$ vs Temperature

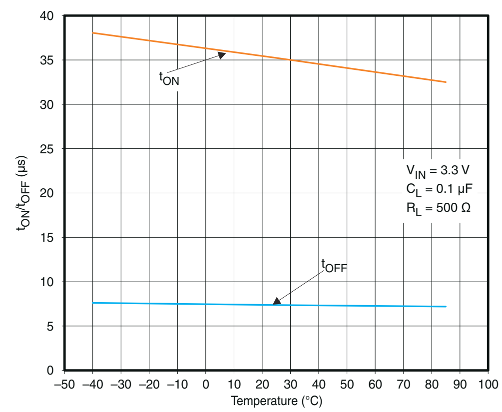



图 7-14. $t_{ON}/t_{OFF}$ vs Temperature

#### *7.12.2.3 TPS22902B*

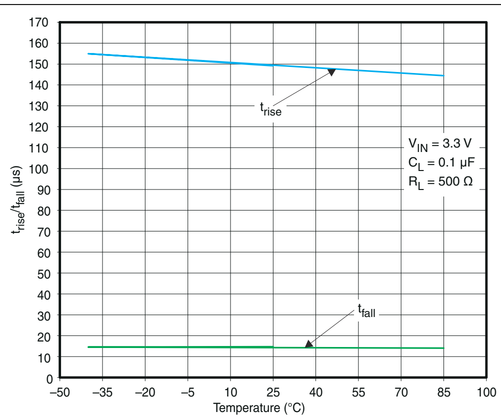



图 7-15. $t_{rise}/t_{fall}$ vs Temperature

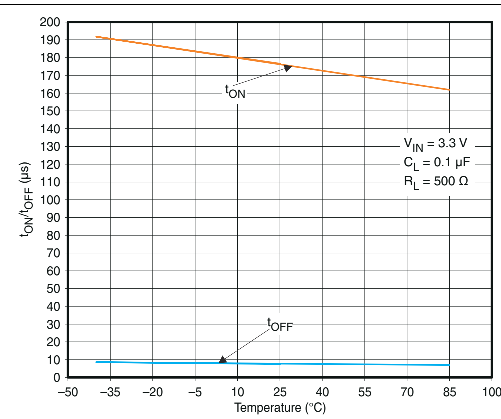



图 7-16. $t_{ON}/t_{OFF}$ vs Temperature

### 7.12.2.4 TPS22901 and TPS22902

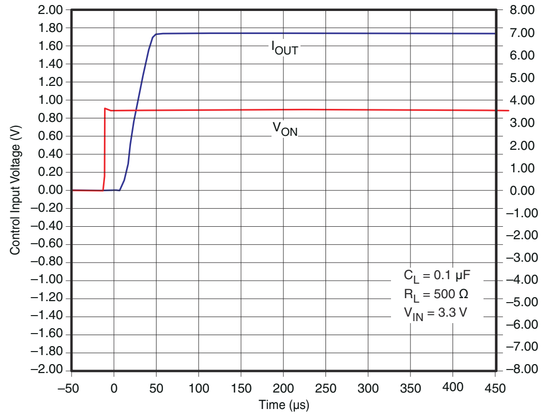



图 7-17. $t_{ON}$ Response

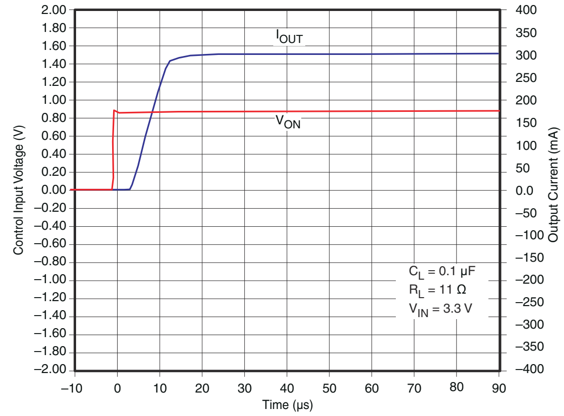



图 7-18. $t_{ON}$ Response

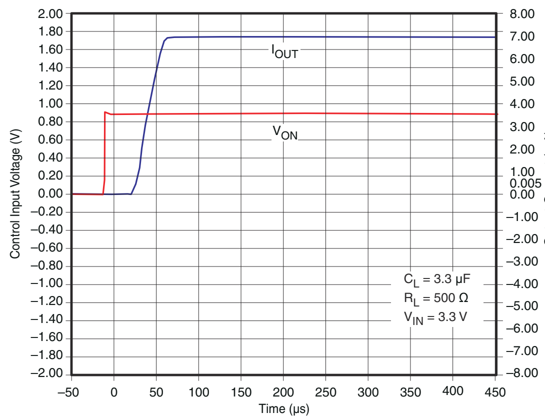



图 7-19. $t_{ON}$ Response

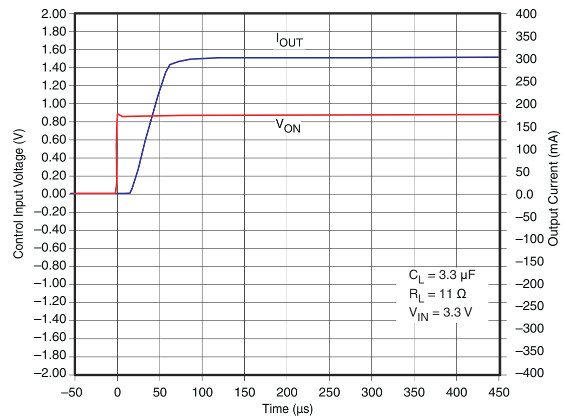



图 7-20. $t_{ON}$ Response

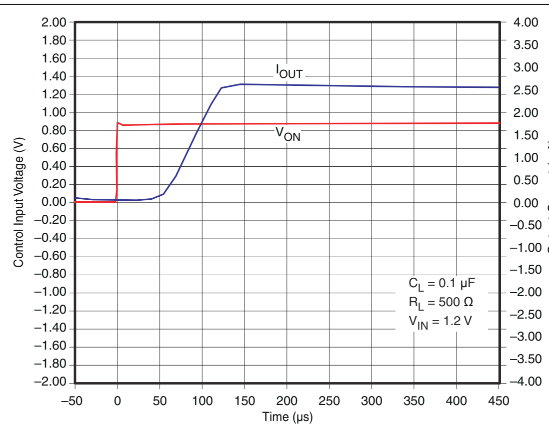



图 7-21. $t_{ON}$ Response

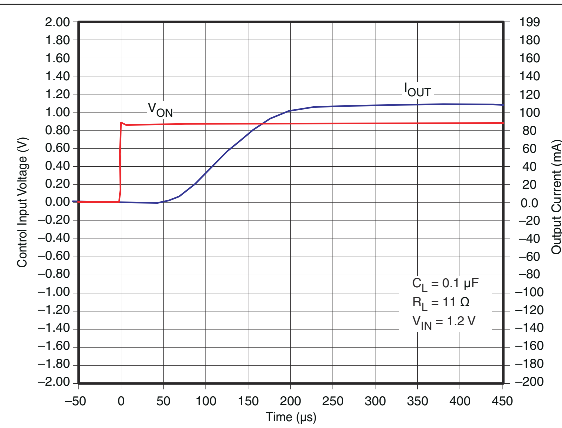



图 7-22. $t_{ON}$ Response

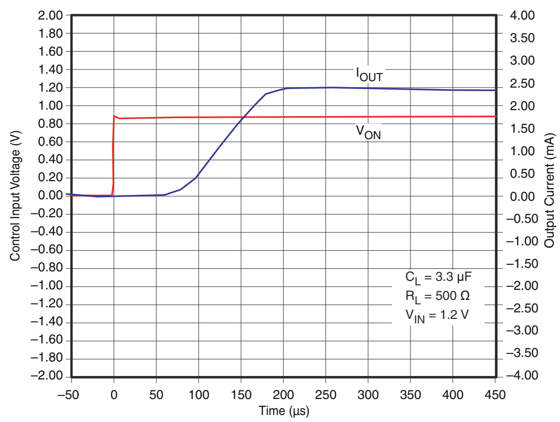



图 7-23. $t_{ON}$ Response

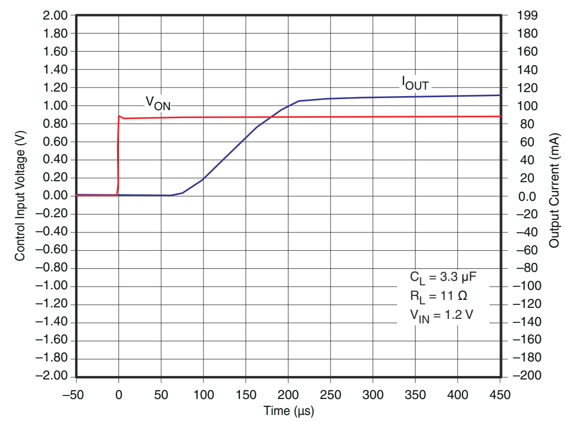



图 7-24. $t_{ON}$ Response

### *7.12.2.5 TPS22901*

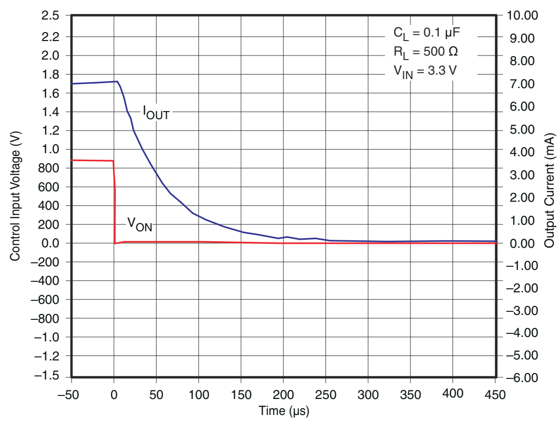



图 7-25. $t_{OFF}$ Response

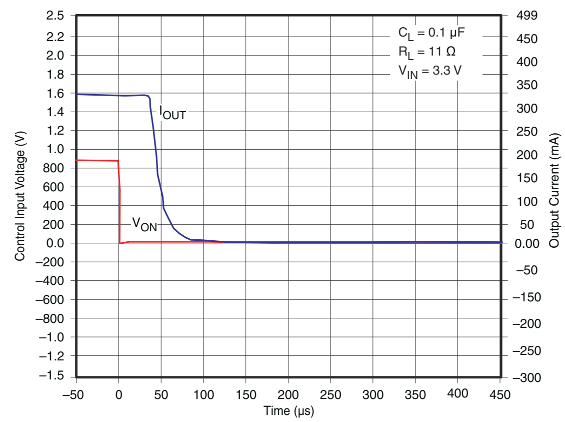



图 7-26. $t_{OFF}$ Response

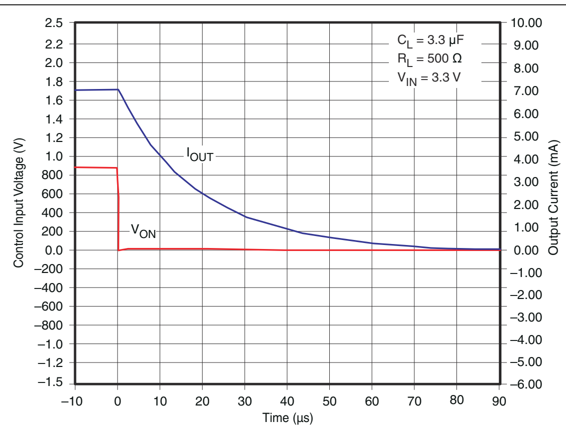



图 7-27. $t_{OFF}$ Response

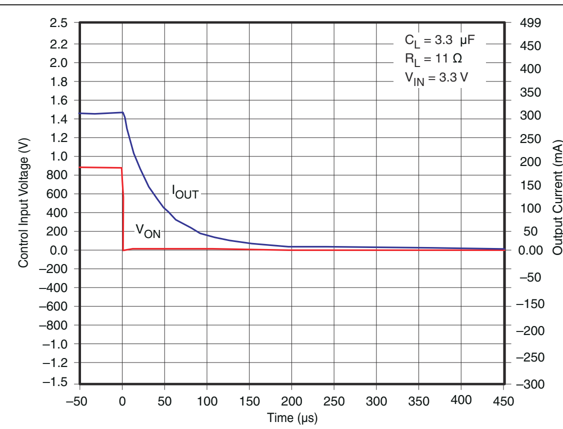



图 7-28. $t_{OFF}$ Response

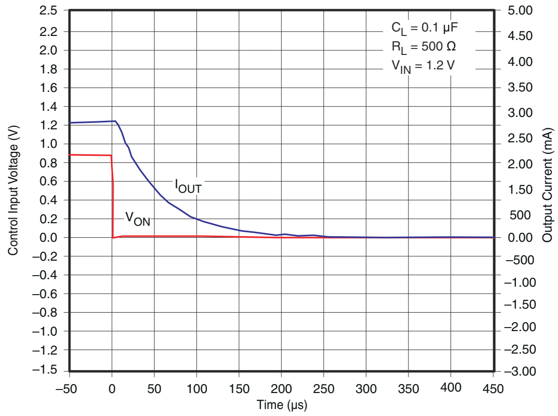



图 7-29. $t_{OFF}$ Response

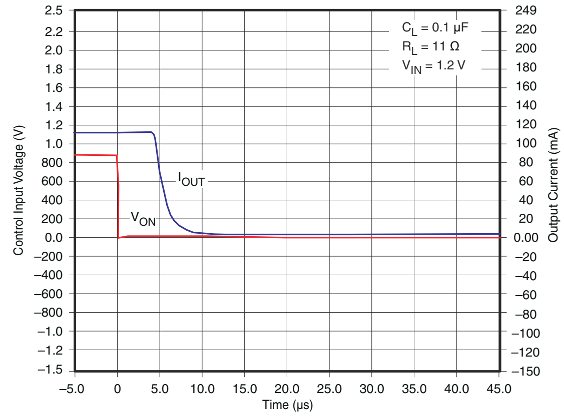



图 7-30. $t_{OFF}$ Response

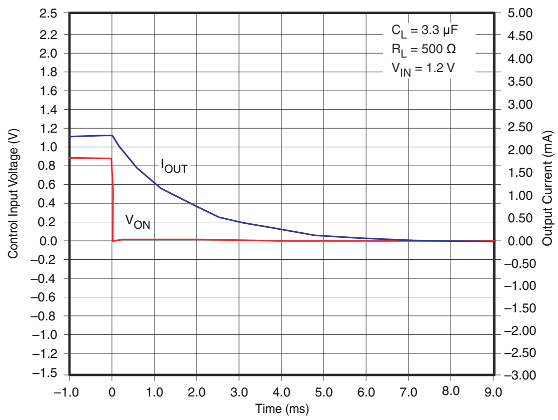



图 7-31. $t_{OFF}$ Response

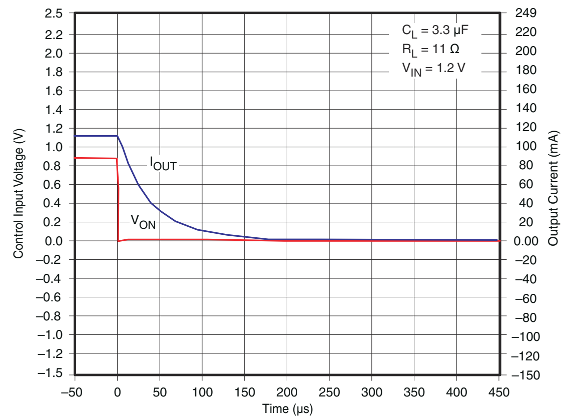



图 7-32. $t_{OFF}$ Response

#### 7.12.2.6 TPS22902

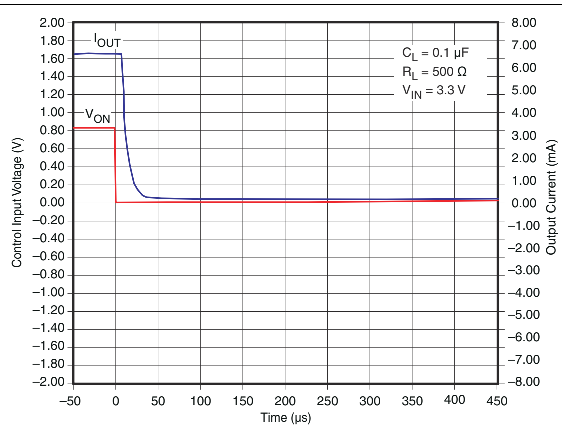



图 7-33. $t_{OFF}$ Response

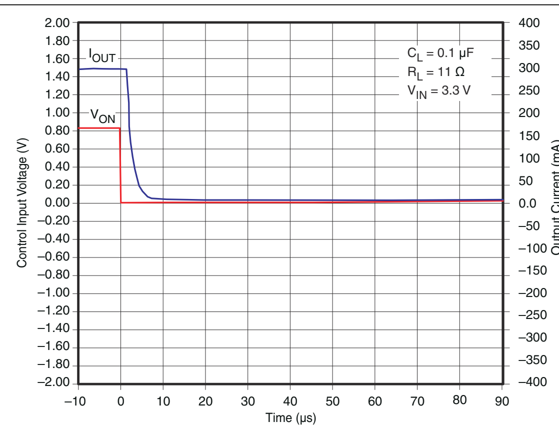



图 7-34. $t_{OFF}$ Response

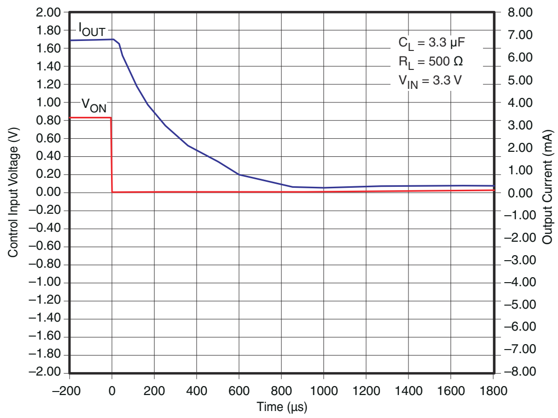



图 7-35. $t_{OFF}$ Response

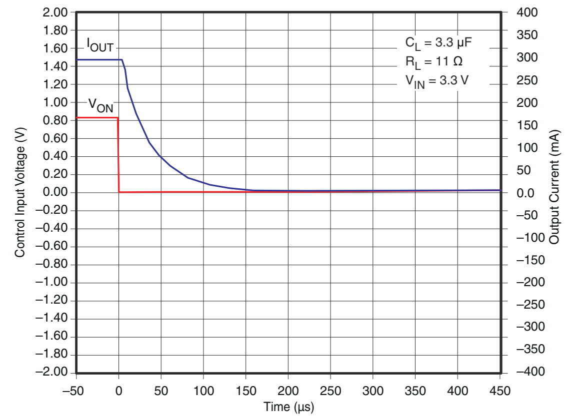



图 7-36. $t_{OFF}$ Response

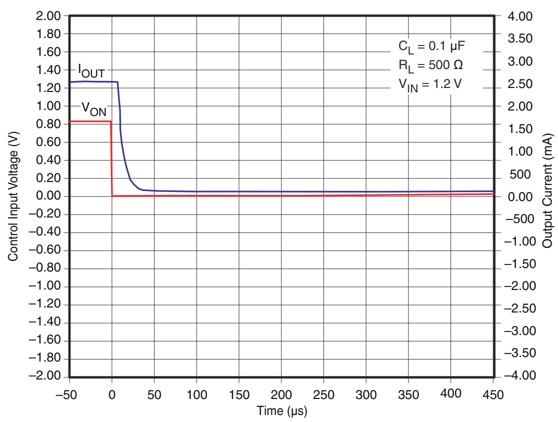



图 7-37. $t_{OFF}$ Response

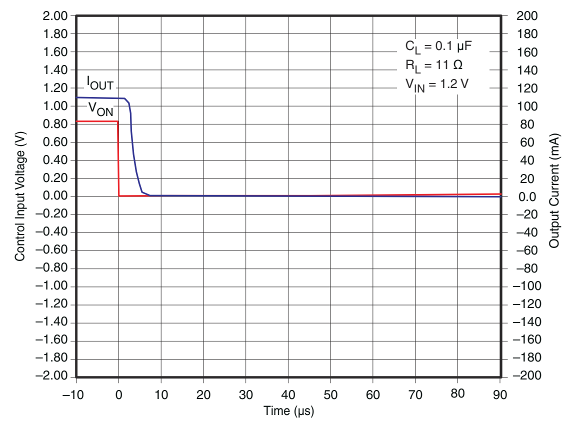



图 7-38. $t_{OFF}$ Response

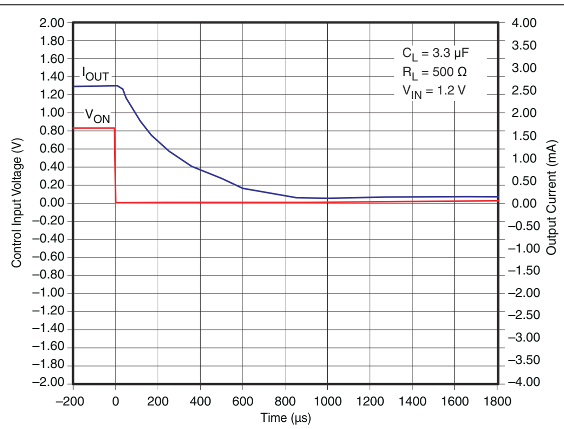



图 7-39. $t_{OFF}$ Response

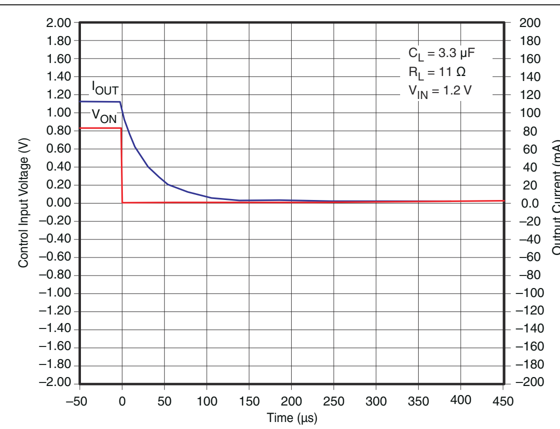



图 7-40. $t_{OFF}$ Response

### 7.12.2.7 TPS22902B

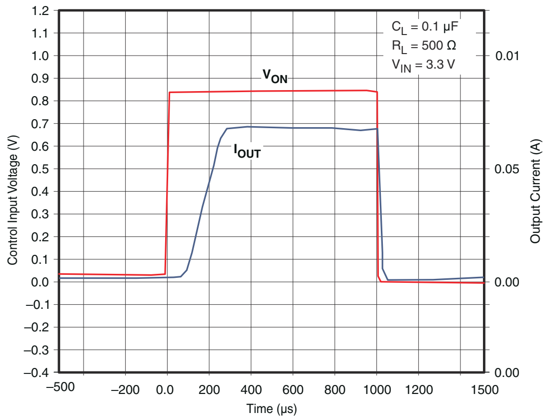



图 7-41. $t_{ON}$ Response

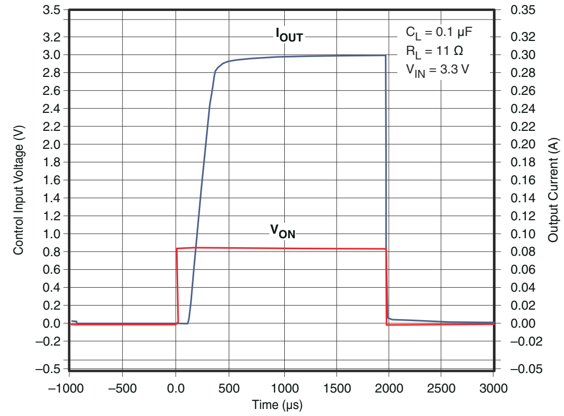



图 7-42. $t_{ON}$ Response

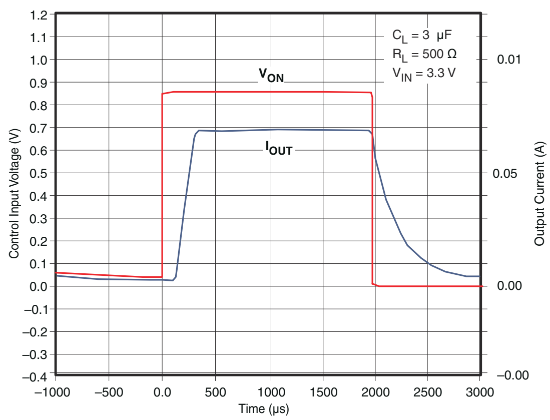



图 7-43. $t_{ON}$ Response

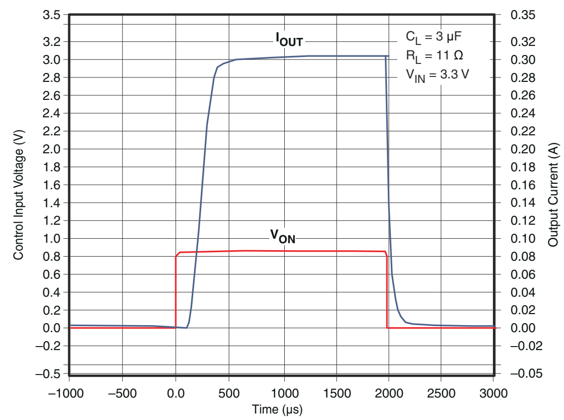



图 7-44. $t_{ON}$ Response

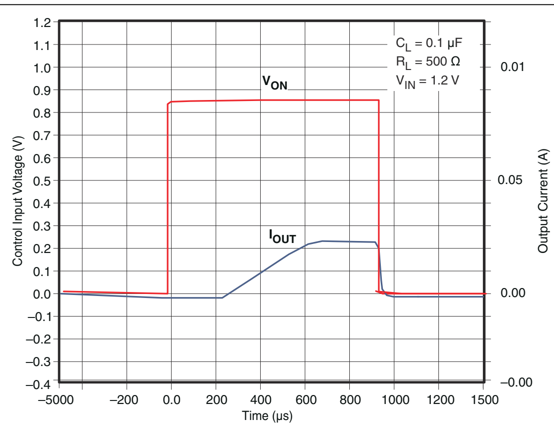



图 7-45. $t_{ON}$ Response

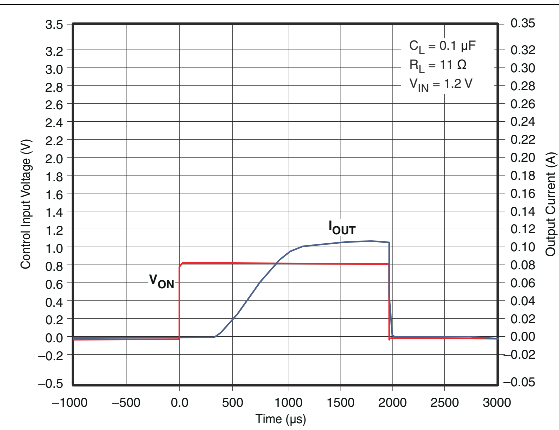



图 7-46. $t_{ON}$ Response

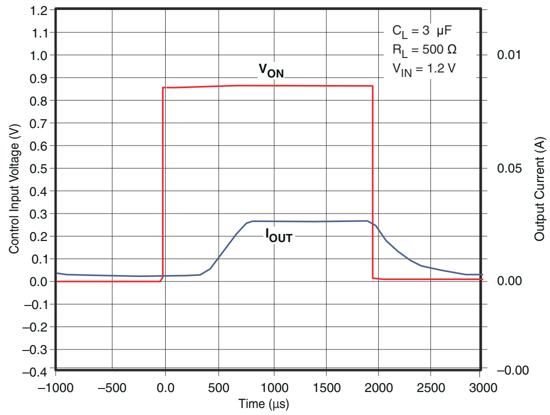



**图 7-47. $t_{ON}$ Response**

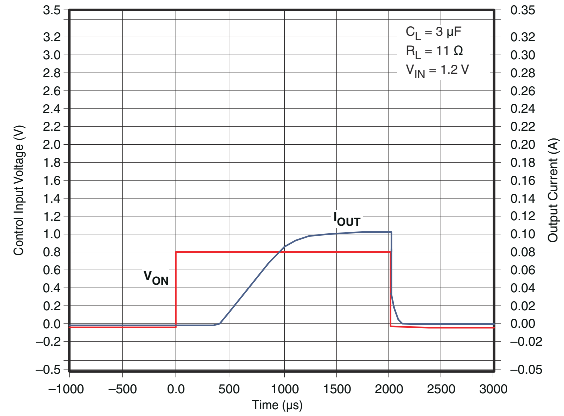



**图 7-48. $t_{ON}$ Response**

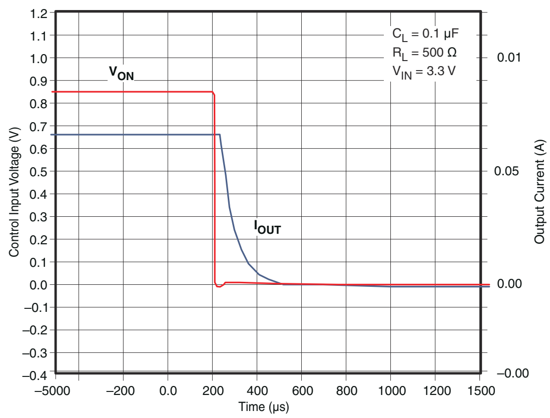



**图 7-49. $t_{OFF}$ Response**

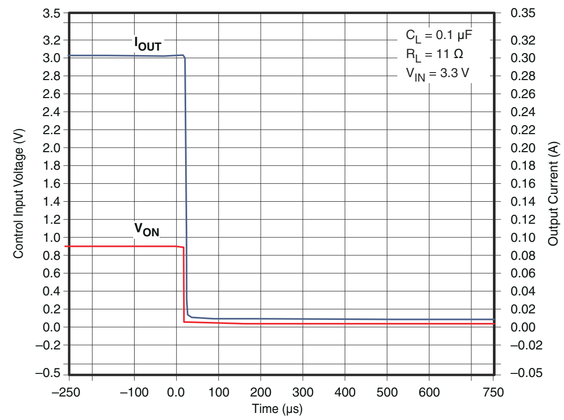



**图 7-50. $t_{OFF}$ Response**

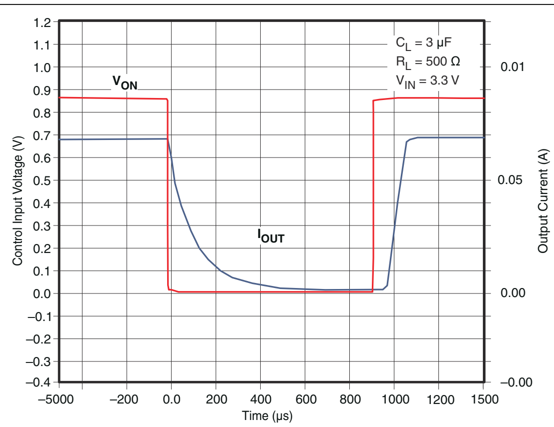



**图 7-51. $t_{OFF}$ Response**

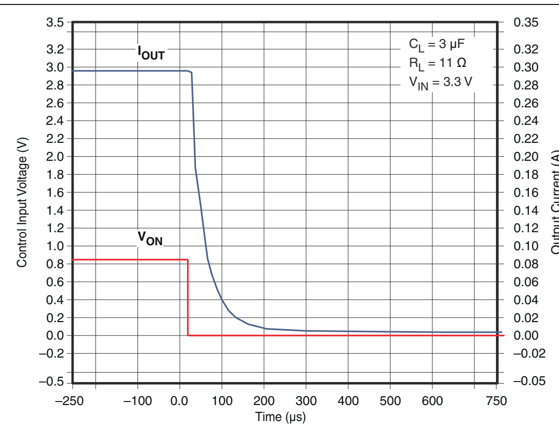



**图 7-52. $t_{OFF}$ Response**

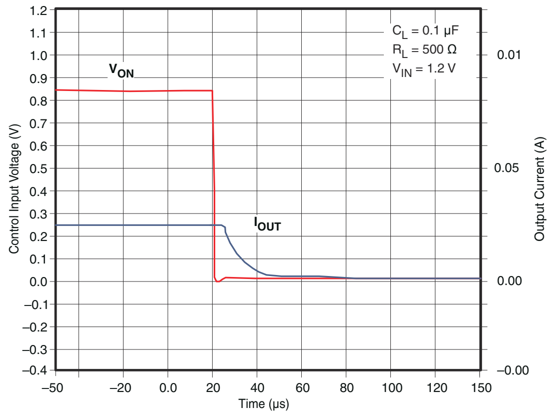



图 7-53. $t_{OFF}$ Response

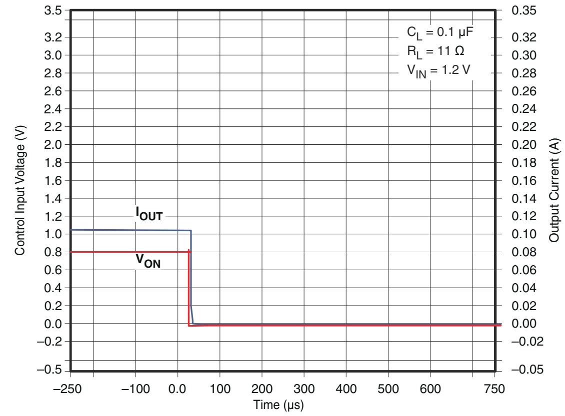



图 7-54. $t_{OFF}$ Response

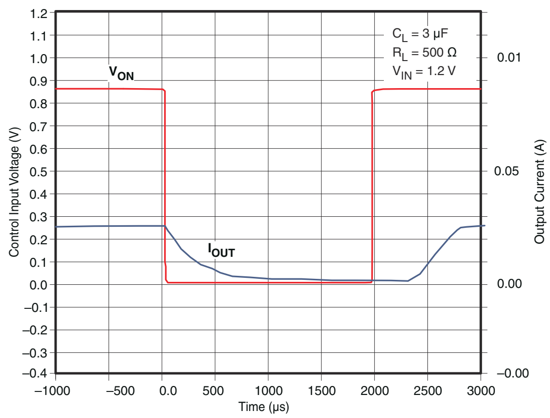



图 7-55. $t_{OFF}$ Response

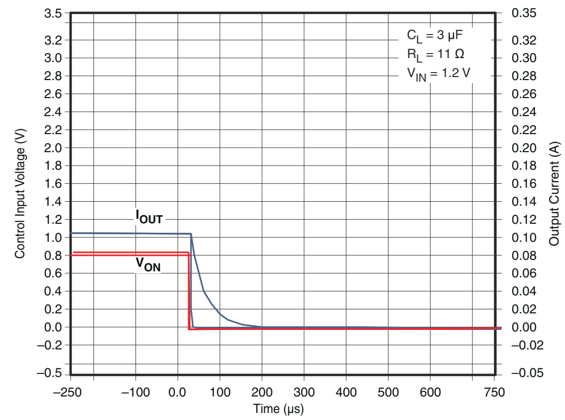
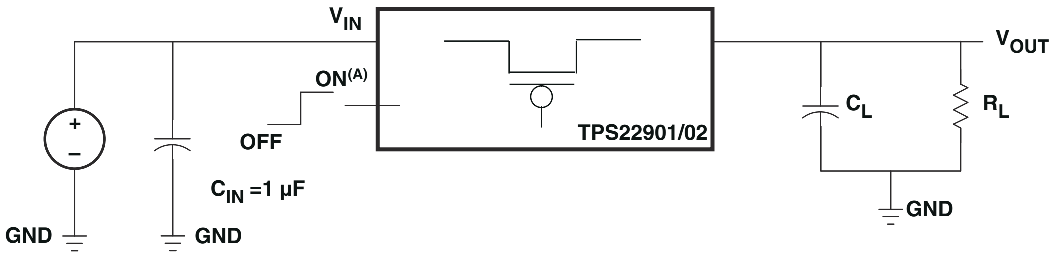
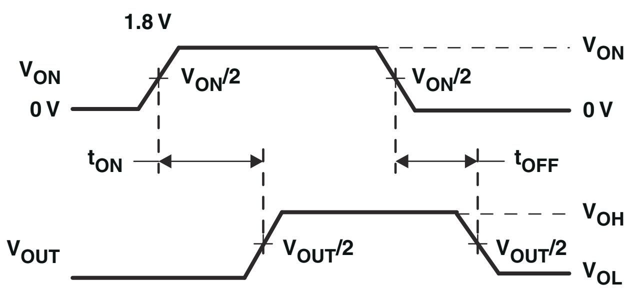


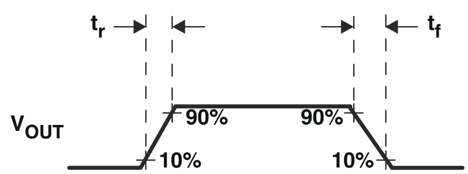

图 7-56. $t_{OFF}$ Response

# 8 Parameter Measurement Information




TEST CIRCUIT




$t_{ON}/t_{OFF}$ WAVEFORMS

A. $t_{rise}$ and $t_{fall}$ of the control signal is 100 ns.

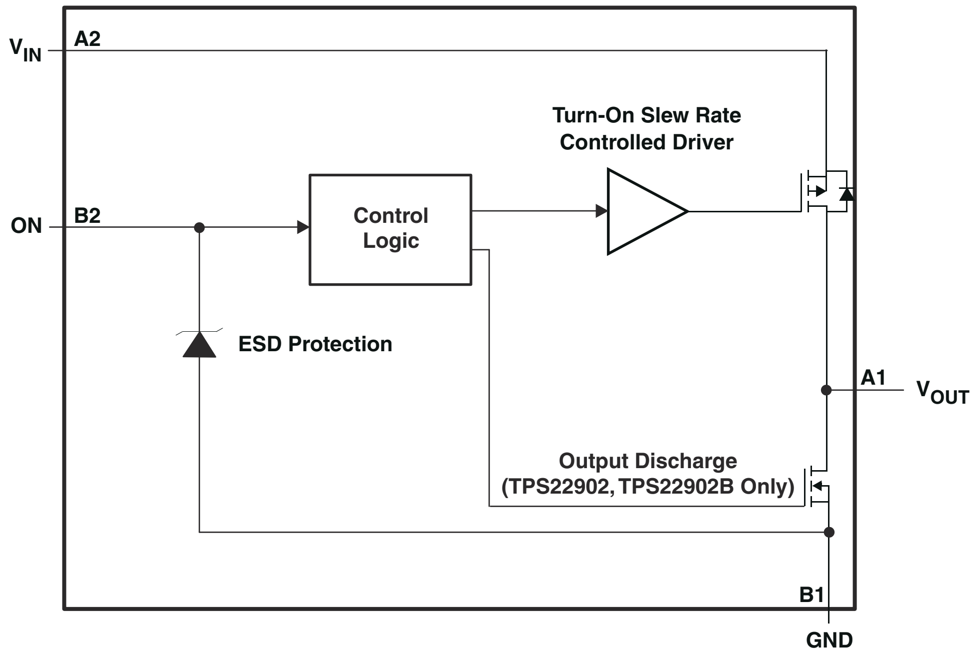
**图 8-1. Test Circuit and $t_{ON}/t_{OFF}$ Waveforms**

# 9 Detailed Description

## 9.1 Overview

The TPS2290x and TPS22902B is a single channel, 500-mA load switch in a small, space-saving DSBGA-4 package. These devices implement a P-channel MOSFET to provide a low ON-resistance for a low voltage drop across the device. A controlled rise time is used in applications to limit the inrush current.

## 9.2 Functional Block Diagram




## 9.3 Feature Description

### 9.3.1 ON/OFF Control

The ON pin controls the state of the switch. Activating ON continuously holds the switch in the on state. ON is active-high and has a low threshold, making it capable of interfacing with low-voltage signals. The ON pin is compatible with standard GPIO logic threshold, and it can be used with any microcontroller with 1.2 V, 1.8 V, 2.5 V or 3.3 V GPIOs.

### 9.3.2 Quick Output Discharge

The TPS2290x and TPS22902B includes the Quick Output Discharge (QOD) feature. When the switch is disabled, a discharge resistance with a typical value of 88 Ω is connected between the output and ground. This resistance pulls down the output and prevents it from floating when the device is disabled.

## 9.4 Device Functional Modes

表 9-1 lists the VOUT pin connections for a particular device as determined by the ON pin.

**Table 9-1. VOUT Function Table**

| ON (Control Input) | TPS22901 | TPS22902/2B |
|---|---|---|
| L | Open | GND |
| H | VIN | VIN |

# 10 Application and Implementation

**Note**

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## 10.1 Application Information

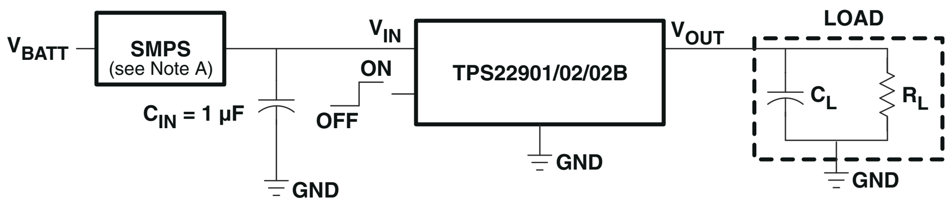
### 10.1.1 Input Capacitor (Optional)

To limit the voltage drop on the input supply caused by transient inrush currents when the switch turns on into a discharged load capacitor, a capacitor needs to be placed between $V_{IN}$ and GND. A 1-µF ceramic capacitor, $C_{IN}$, placed close to the pins is usually sufficient. Higher values of $C_{IN}$ can be use to further reduce the voltage drop during high current application. When switching heavy loads, TI recommends using an input capacitor about 10 times higher than the output capacitor in order to avoid excessive voltage drop.

### 10.1.2 Output Capacitor (Optional)

Because of the integral body diode in the PMOS switch, a $C_{IN}$ greater than $C_L$ is highly recommended. A $C_L$ greater than $C_{IN}$ can cause $V_{OUT}$ to exceed $V_{IN}$ when the system supply is removed. This could result in current flow through the body diode from $V_{OUT}$ to $V_{IN}$.

## 10.2 Typical Application




A. Switched-mode power supply

**图 10-1. Typical Application Schematic**

### 10.2.1 Design Requirements

**Table 10-1. Design Parameters**

| DESIGN PARAMETER | EXAMPLE VALUE |
|---|---|
| $V_{IN}$ | 1.8 V |
| $C_L$ | 4.7 µF |
| Load current | 500 mA |
| Ambient Temperature | 25 °C |
| Maximum inrush current | 200 mA |

### 10.2.2 Detailed Design Procedure

#### *10.2.2.1 Managing Inrush Current*

When the switch is enabled, the output capacitors must be charged up from 0 V to the set value (1.8 V in this example). This charge arrives in the form of inrush current. Inrush current can be calculated using the following equation:

$$I_{INRUSH} = C_L \times \frac{dV_{OUT}}{dt} \quad (1)$$

where:

- $C_L$ = Output capacitance
- $dV_{OUT}$ = Output voltage
- dt = Rise time

The TPS2290x and TPS22902B offers a controlled rise time for minimizing inrush current. This device can be selected based upon the minimum acceptable rise time which can be calculated using the design requirements and the inrush current equation. An output capacitance of 4.7 µF will be used since the amount of inrush current increases with output capacitance:

$$200\ \text{mA} = 4.7\ \mu\text{F} \times 1.8\text{V} / dt \quad (2)$$
$$dt = 42.3\ \mu\text{s}$$

To ensure an inrush current of less than 200 mA, a device with a rise time greater than 42.3 µs must be used. The TPS22902B has a typical rise time of 220 µs at 1.8 V which meets the above design requirements. The TPS22901/2 has a faster rise time of 40 µs at 1.8 V, and this would result in an inrush current larger than desired.

#### *10.2.2.2 VIN to VOUT Voltage Drop*

The voltage drop from VIN to VOUT is determined by the ON-resistance of the device and the load current. $R_{ON}$ can be found in 节 7.5 and is dependent on temperature. When the value of $R_{ON}$ is found, the following equation can be used to calculate the voltage drop across the device:

$$\Delta V = I_{LOAD} \times R_{ON} \quad (3)$$

where:

- $\Delta V$ = Voltage drop across the device
- $I_{LOAD}$ = Load current
- $R_{ON}$ = ON-resistance of the device

At $V_{IN}$ = 1.8 V, the TPS22901/2/2B has an $R_{ON}$ value of 109 mΩ. Using this value and the defined load current, the above equation can be evaluated:

$$\Delta V = 500\ \text{mA} \times 109\ \text{m}\Omega \quad (4)$$
$$\Delta V = 54.5\ \text{mV}$$

Therefore, the voltage drop across the device will be 54.5 mV.

### 10.2.3 Application Curve

图 10-2 shows the expected voltage drop across the device for different load currents and input voltages.

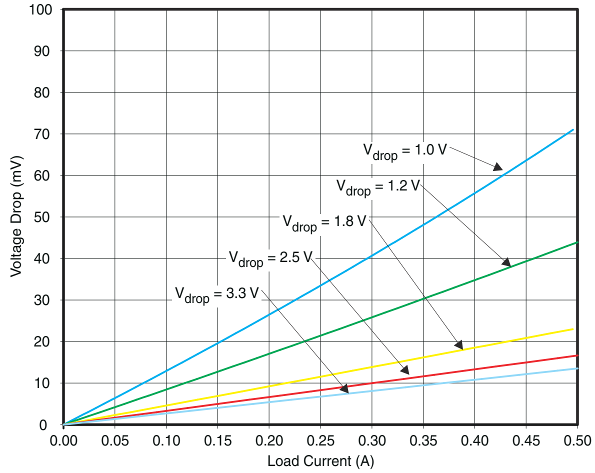



**图 10-2. Voltage Drop vs Load Current**

# 11 Power Supply Recommendations

The device is designed to operate with a VIN range of 1 V to 3.6 V. This supply must be well regulated and placed as close to the device terminals as possible. It must also be able to withstand all transient and load currents, using a recommended input capacitance of 1 µF if necessary. If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 10 µF may be sufficient.

# 12 Layout

## 12.1 Layout Guidelines

For best performance, $V_{IN}$, $V_{OUT}$, and GND traces should be as short and wide as possible to help minimize the parasitic electrical effects. 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.

For higher reliability, the maximum IC junction temperature, $T_{J(max)}$, should be restricted to 125°C under normal operating conditions. Junction temperature is directly proportional to power dissipation in the device and the two are related by

$$T_J = T_A + \theta_{JA} \times P_D \quad (5)$$

where:

- $T_J$ = Junction temperature of the device
- $T_A$ = Ambient temperature
- $P_D$ = Power dissipation inside the device
- $\theta_{JA}$ = Junction to ambient thermal resistance. See Thermal Information section of the datasheet. This parameter is highly dependent on board layout.

## 12.2 Layout Example

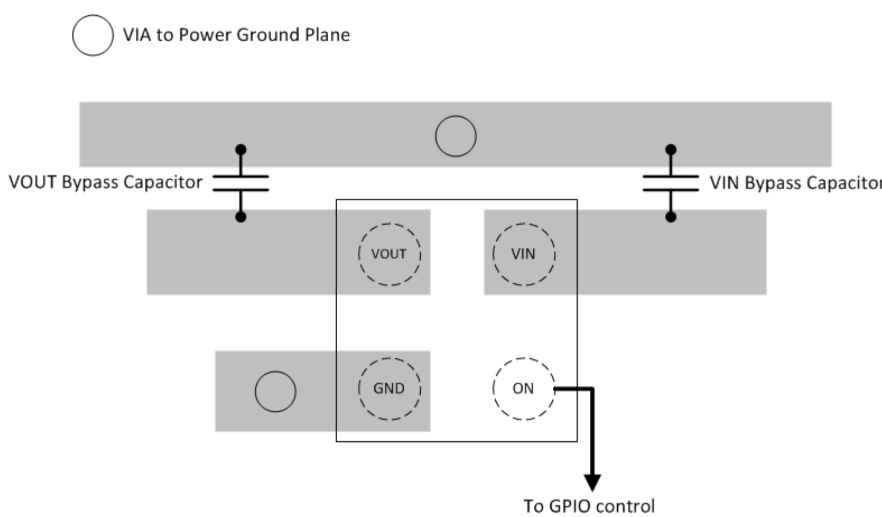



图 12-1. Layout Example Schematic

# 13 Device and Documentation Support

## 13.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

**Table 13-1. Related Links**

| PARTS | PRODUCT FOLDER | SAMPLE & BUY | TECHNICAL DOCUMENTS | TOOLS & SOFTWARE | SUPPORT & COMMUNITY |
|---|---|---|---|---|---|
| TPS22901 | Click here | Click here | Click here | Click here | Click here |
| TPS22902 | Click here | Click here | Click here | Click here | Click here |
| TPS22902B | Click here | Click here | Click here | Click here | Click here |

## 13.2 Trademarks

所有商标均为其各自所有者的财产。

## 13.3 Electrostatic Discharge Caution

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

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

## 13.4 Glossary

**TI Glossary** This glossary lists and explains terms, acronyms, and definitions.

# 14 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 (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| TPS22901YFPR | Active | Production | DSBGA (YFP) \| 4 | 3000 \| LARGE T&R | Yes | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | 3P<br>(3, 5) |
| TPS22901YFPR.A | Active | Production | DSBGA (YFP) \| 4 | 3000 \| LARGE T&R | Yes | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | 3P<br>(3, 5) |
| TPS22902BYFPR | Active | Production | DSBGA (YFP) \| 4 | 3000 \| LARGE T&R | Yes | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | 3S<br>3 |
| TPS22902BYFPR.A | Active | Production | DSBGA (YFP) \| 4 | 3000 \| LARGE T&R | Yes | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | 3S<br>3 |
| TPS22902YFPR | Active | Production | DSBGA (YFP) \| 4 | 3000 \| LARGE T&R | Yes | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | 3R |
| TPS22902YFPR.A | Active | Production | DSBGA (YFP) \| 4 | 3000 \| LARGE T&R | Yes | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | 3R |

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

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

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

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

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

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

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

**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.

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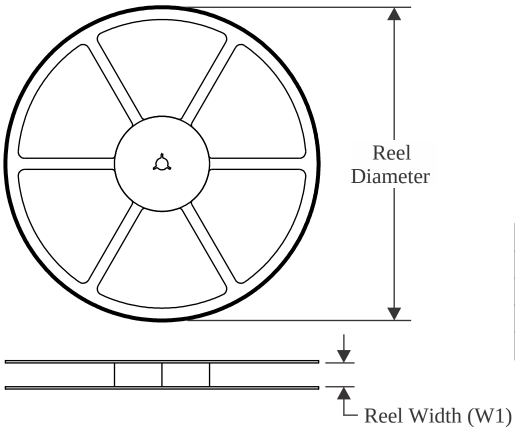
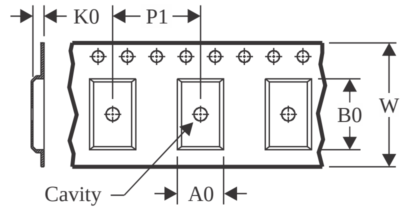
## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

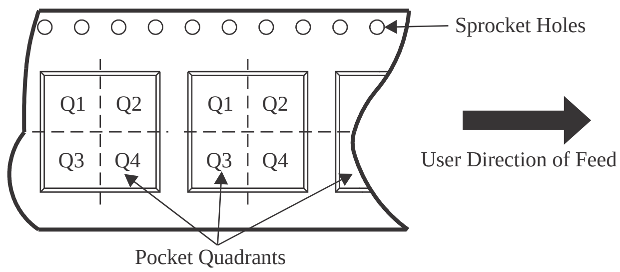



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

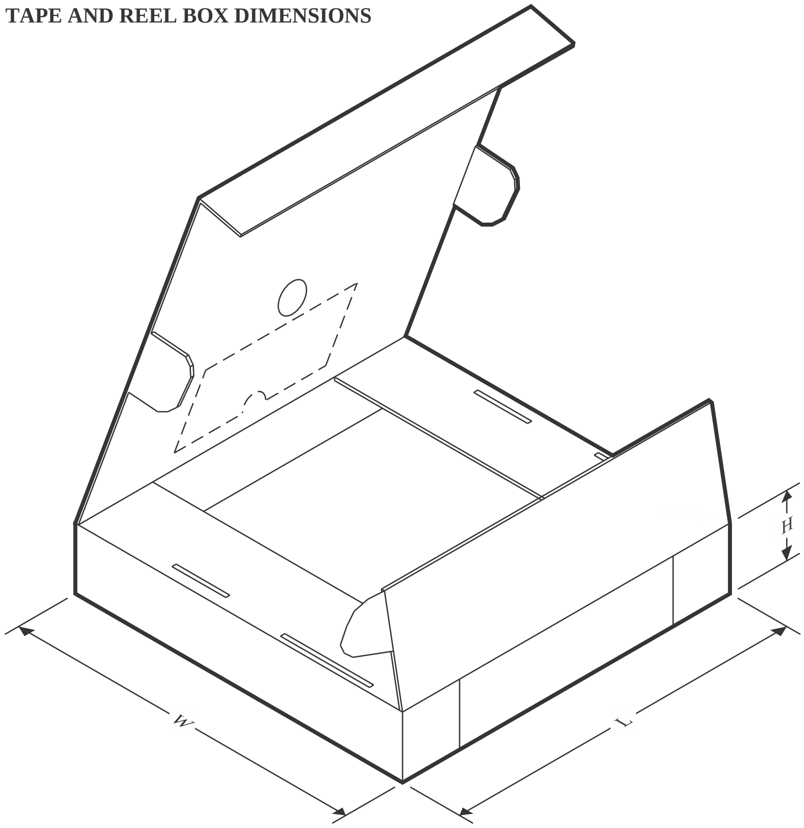
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

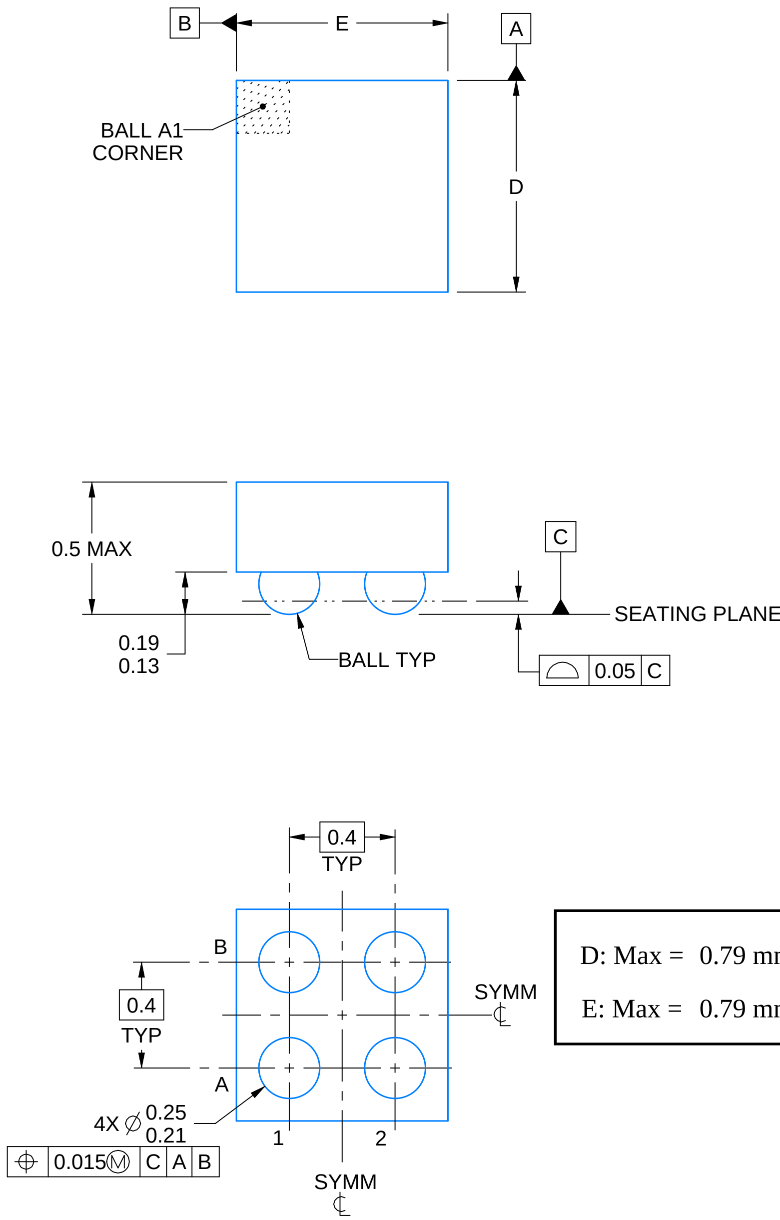
| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPS22901YFPR | DSBGA | YFP | 4 | 3000 | 178.0 | 9.2 | 0.89 | 0.89 | 0.58 | 4.0 | 8.0 | Q1 |
| TPS22902BYFPR | DSBGA | YFP | 4 | 3000 | 180.0 | 8.4 | 0.89 | 0.89 | 0.58 | 4.0 | 8.0 | Q1 |
| TPS22902YFPR | DSBGA | YFP | 4 | 3000 | 180.0 | 8.4 | 0.89 | 0.89 | 0.58 | 4.0 | 8.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TPS22901YFPR | DSBGA | YFP | 4 | 3000 | 220.0 | 220.0 | 35.0 |
| TPS22902BYFPR | DSBGA | YFP | 4 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS22902YFPR | DSBGA | YFP | 4 | 3000 | 182.0 | 182.0 | 20.0 |




| | |
|---|---|
| D: Max = 0.79 mm, Min = 0.73 mm | |
| E: Max = 0.79 mm, Min = 0.73 mm | |

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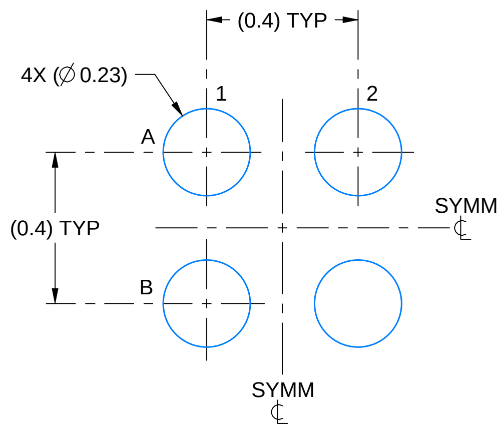
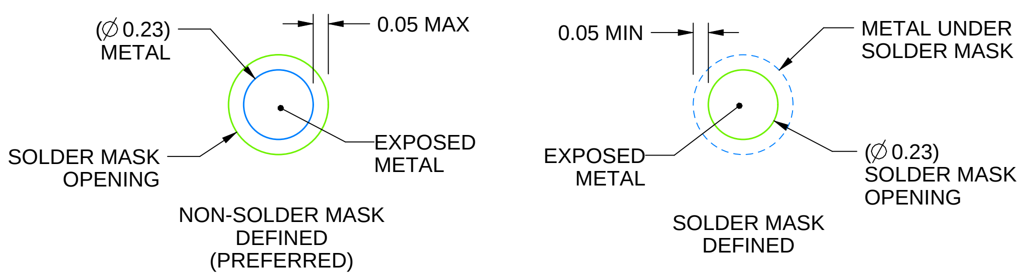
NOTES:

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




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:50X




SOLDER MASK DETAILS
NOT TO SCALE

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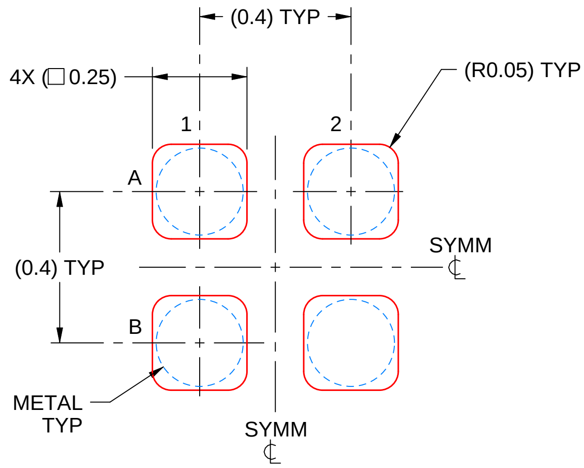
NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
For more information, see Texas Instruments literature number SNVA009 (www.ti.com/lit/snva009).




SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:50X

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NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

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