TEXAS INSTRUMENTS
TPS22914B, TPS22914C, TPS22915B, TPS22915C
JAJSK67E – JUNE 2014 – REVISED OCTOBER 2020

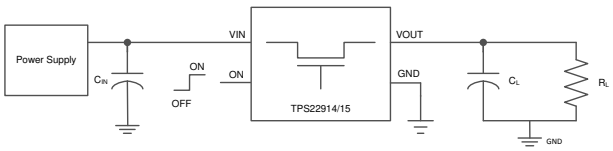
# TPS2291xx 5.5V、2A、37mΩ オン抵抗ロード・スイッチ

## 1 特長

- シングル・チャネル負荷スイッチを内蔵
- 入力電圧範囲:1.05V～5.5V
- 低いオン抵抗 ($R_{ON}$)
  - $V_{IN}$ = 5V で $R_{ON}$ = 37mΩ (標準値)
  - $V_{IN}$ = 3.3V で $R_{ON}$ = 38mΩ (標準値)
  - $V_{IN}$ = 1.8V で $R_{ON}$ = 43mΩ (標準値)
- 最大連続スイッチ電流 2A
- 低い静止電流
  - $V_{IN}$ = 3.3V で 7.7μA (標準値)
- 制御入力スレッショルドが低いため、最低 1V の GPIO が使用可能
- スルーレート制御
  - $t_R$(TPS22914B/15B) = 64μs ($V_{IN}$ = 3.3V の場合)
  - $t_R$(TPS22914C/15C) = 913μs ($V_{IN}$ = 3.3V の場合)
- クイック出力放電 (QOD) (TPS22915 のみ)
- 超小型ウェハー・チップ・スケール・パッケージ
  - 0.78mm × 0.78mm、0.4mm ピッチ、0.5mm 高さ (YFP)
- ESD 性能は JESD 22 に準拠しテスト済み
  - HBM 2kV、CDM 1kV

## 2 アプリケーション

- スマートフォン、携帯電話
- 超薄型 Ultrabook™ / ノート PC
- タブレット PC、ファブレット
- ウェアラブル技術
- ソリッド・ステート・ドライブ
- デジタル・カメラ




概略回路図

## 3 概要

TPS22914/15 は、スルーレート制御機能を備えた小型低 $R_{ON}$ のシングル・チャネル負荷スイッチです。このデバイスには N チャネル MOSFET が搭載され、1.05V～5.5V の入力電圧範囲で動作でき、最大で 2A の連続電流をサポートできます。スイッチはオン / オフ入力により制御され、低電圧の制御信号と直接接続が可能です。

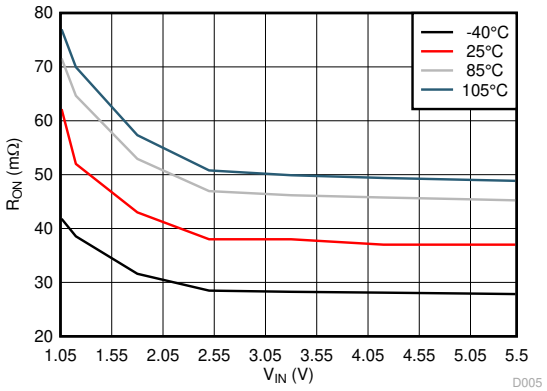
このデバイスは、小型で $R_{ON}$ が小さいため、スペースの制約が厳しいバッテリ駆動アプリケーションで使うのに理想的です。このスイッチは入力電圧範囲が広いため、各種電圧レールのための多用途なソリューションとして使えます。デバイスの立ち上がり時間を制御できるため、大きな負荷容量により発生する突入電流が大幅に減少し、電源ドループが低減、または生じなくなります。TPS22915 は、スイッチがオフになった際に迅速に出力を放電 (QOD) するための 143Ω のプルダウン抵抗を内蔵することで、ソリューション全体のサイズをさらに縮小しています。

TPS22914/15 は、小型で省スペースの 0.78mm × 0.78mm、0.4mm ピッチ、0.5mm 高さの 4 ピン・ウェハー・チップ・スケール (WCSP) パッケージ (YFP) で供給されます。このデバイスは、–40℃～+105℃の周囲温度範囲で動作が規定されています。

**製品情報**(1)

| 部品番号 | パッケージ | 本体サイズ (公称) |
|---|---|---|
| TPS22914B | DSBGA (4) | 0.74mm × 0.74mm |
| TPS22914C | | |
| TPS22915B | | |
| TPS22915C | | |

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




$R_{ON}$ と $V_{IN}$ との関係 ($I_{OUT}$ = –200mA)

# Table of Contents



## 4 Revision History

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

**Changes from Revision D (September 2016) to Revision E (October 2020)** — **Page**

- 文書全体にわたって表、図、相互参照の採番方法を更新 ... 1
- 「製品情報」表の本体サイズを更新 ... 1

**Changes from Revision C (July 2015) to Revision D (September 2016)** — **Page**

- Changed "TPS22915B" only, to "TPS22915B/C only" in the *Electrical Characteristics* table ... 5

**Changes from Revision B (September 2014) to Revision C (July 2015)** — **Page**

- データシートの $T_A$ 定格を 85℃から 105℃に更新 ... 1

**Changes from Revision A (June 2014) to Revision B (September 2014)** — **Page**

- Updated X-axis scales in th Typical Characteristics section. ... 8

**Changes from Revision * (June 2014) to Revision A (June 2014)** — **Page**

- 完全版の初回リリース ... 1

## 5 Device Comparison Table

| DEVICE | $R_{ON}$ at 3.3V (TYPICAL) | $t_R$ at 3.3V (TYPICAL) | QUICK OUTPUT DISCHARGE | MAXIMUM OUTPUT CURRENT | ENABLE |
|---|---|---|---|---|---|
| TPS22914B | 38 mΩ | 64 µs | No | 2 A | Active High |
| TPS22914C | 38 mΩ | 913 µs | No | 2 A | Active High |
| TPS22915B | 38 mΩ | 64 µs | Yes | 2 A | Active High |
| TPS22915C | 38 mΩ | 913 µs | Yes | 2 A | Active High |

## 6 Pin Configuration and Functions

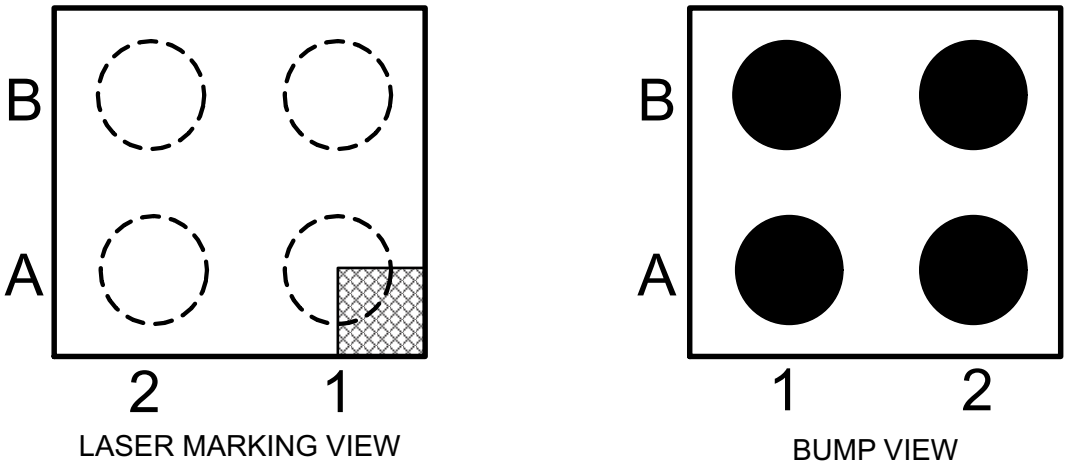



**図 6-1. YFP PACKAGE 4 PIN DSBGA TOP VIEW**

**表 6-1. Pin Description**

| | | |
|---|---|---|
| **B** | ON | GND |
| **A** | VIN | VOUT |
| | **2** | **1** |

**表 6-2. Pin Functions**

| PIN | | TYPE | DESCRIPTION |
|---|---|---|---|
| NO. | NAME | | |
| A1 | VOUT | O | Switch output. Place ceramic bypass capacitor(s) between this pin and GND. See the *Detailed Description* section for more information |
| A2 | VIN | I | Switch input. Place ceramic bypass capacitor(s) between this pin and GND. See the *Detailed Description* section for more information |
| B1 | GND | — | Device ground |
| B2 | ON | I | Active high switch control input. Do not leave floating |

# 7 Specifications

## 7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)(1) (2)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{IN}$ | Input voltage | –0.3 | 6 | V |
| $V_{OUT}$ | Output voltage | –0.3 | 6 | V |
| $V_{ON}$ | ON voltage | –0.3 | 6 | V |
| $I_{MAX}$ | Maximum continuous switch current | | 2 | A |
| $I_{PLS}$ | Maximum pulsed switch current, pulse < 300 µs, 2% duty cycle | | 2.5 | A |
| $T_J$ | Maximum junction temperature | | 125 | °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 *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 terminal.

## 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. 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.

## 7.3 Recommended Operating Conditions

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

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{IN}$ | Input voltage | | 1.05 | 5.5 | V |
| $V_{ON}$ | ON voltage | | 0 | 5.5 | V |
| $V_{OUT}$ | Output voltage | | | $V_{IN}$ | V |
| $V_{IH, ON}$ | High-level input voltage, ON | $V_{IN}$ = 1.05 V to 5.5 V | 1 | 5.5 | V |
| $V_{IL, ON}$ | Low-level input voltage, ON | $V_{IN}$ = 1.05 V to 5.5 V | 0 | 0.5 | V |
| $T_A$ | Operating free-air temperature range(1) | | –40 | 105 | °C |
| $C_{IN}$ | Input Capacitor | | 1(2) | | µF |

(1) 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 [$T_{A(max)}$] is dependent on the maximum operating junction temperature [$T_{J(MAX)}$], the maximum power dissipation of the device in the application [$P_{D(MAX)}$], and the junction-to-ambient thermal resistance of the part/package in the application ($\theta_{JA}$), as given by the following equation: $T_{A(MAX)} = T_{J(MAX)} – (\theta_{JA} \times P_{D(MAX)})$.
(2) Refer to the *Detailed Description* section.

## 7.4 Thermal Information

| THERMAL METRIC(1) | | TPS2291x YFP (DSBGA) 4 PINS | UNIT |
|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 193 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 2.3 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 36 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 12 | °C/W |

## 7.4 Thermal Information (continued)

| THERMAL METRIC[1] | | TPS2291x YFP (DSBGA) 4 PINS | UNIT |
|---|---|---|---|
| $\psi_{JB}$ | Junction-to-board characterization parameter | 36 | °C/W |

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

## 7.5 Electrical Characteristics

Unless otherwise noted, the specification in the following table applies over the operating ambient temperature –40°C ≤ $T_A$ ≤ +105°C. **Typical values are for $T_A$ = 25°C.**

| PARAMETER | | TEST CONDITION | | $T_A$ | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $I_{Q, VIN}$ | Quiescent current (TPS22914B/15B) | $V_{ON}$ = 5 V, $I_{OUT}$ = 0 A | $V_{IN}$ = 5.5 V | –40°C to +85°C | | 7.7 | 10.8 | µA |
| | | | | –40°C to +105°C | | | 12.1 | |
| | | | $V_{IN}$ = 5 V | –40°C to +85°C | | 7.6 | 9.6 | |
| | | | | –40°C to +105°C | | | 11.9 | |
| | | | $V_{IN}$ = 3.3 V | –40°C to +85°C | | 7.7 | 9.6 | |
| | | | | –40°C to +105°C | | | 12 | |
| | | | $V_{IN}$ = 1.8 V | –40°C to +85°C | | 8.4 | 11 | |
| | | | | –40°C to +105°C | | | 13.5 | |
| | | | $V_{IN}$ = 1.2 V | –40°C to +85°C | | 7.4 | 10.4 | |
| | | | | –40°C to +105°C | | | 13.9 | |
| | | | $V_{IN}$ = 1.05 V | –40°C to +85°C | | 6.7 | 10.9 | |
| | | | | –40°C to +105°C | | | 11.7 | |
| | Quiescent current (TPS22914C/15C) | $V_{ON}$ = 5 V, $I_{OUT}$ = 0 A | $V_{IN}$ = 5.5 V | –40°C to +85°C | | 7.7 | 11.5 | µA |
| | | | | –40°C to +105°C | | | 14.1 | |
| | | | $V_{IN}$ = 5 V | –40°C to +85°C | | 7.6 | 11.1 | |
| | | | | –40°C to +105°C | | | 13.7 | |
| | | | $V_{IN}$ = 3.3 V | –40°C to +85°C | | 7.7 | 10.7 | |
| | | | | –40°C to +105°C | | | 13.3 | |
| | | | $V_{IN}$ = 1.8 V | –40°C to +85°C | | 8.4 | 11.7 | |
| | | | | –40°C to +105°C | | | 13.4 | |
| | | | $V_{IN}$ = 1.2 V | –40°C to +85°C | | 7.4 | 11 | |
| | | | | –40°C to +105°C | | | 12.8 | |
| | | | $V_{IN}$ = 1.05 V | –40°C to +85°C | | 6.7 | 10.9 | |
| | | | | –40°C to +105°C | | | 10.9 | |
| $I_{SD, VIN}$ | Shutdown current | $V_{ON}$ = 0 V, $V_{OUT}$ = 0 V | $V_{IN}$ = 5.5 V | –40°C to +85°C | | 0.5 | 2 | µA |
| | | | | –40°C to +105°C | | | 3 | |
| | | | $V_{IN}$ = 5.0 V | –40°C to +85°C | | 0.5 | 2 | |
| | | | | –40°C to +105°C | | | 3 | |
| | | | $V_{IN}$ = 3.3 V | –40°C to +85°C | | 0.5 | 2 | |
| | | | | –40°C to +105°C | | | 3 | |
| | | | $V_{IN}$ = 1.8 V | –40°C to +85°C | | 0.5 | 2 | |
| | | | | –40°C to +105°C | | | 3 | |
| | | | $V_{IN}$ = 1.2 V | –40°C to +85°C | | 0.4 | 2 | |
| | | | | –40°C to +105°C | | | 3 | |
| | | | $V_{IN}$ = 1.05 V | –40°C to +85°C | | 0.4 | 2 | |
| | | | | –40°C to +105°C | | | 3 | |

## 7.5 Electrical Characteristics (continued)

Unless otherwise noted, the specification in the following table applies over the operating ambient temperature –40°C ≤ $T_A$ ≤ +105°C. **Typical values are for $T_A$ = 25°C.**

| PARAMETER | | TEST CONDITION | $T_A$ | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{ON}$ | ON pin input leakage current | $V_{IN}$ = 5.5 V, $I_{OUT}$ = 0 A | –40°C to +105°C | | | 0.1 | µA |
| $R_{ON}$ | On-resistance | $V_{IN}$ = 5.5 V, $I_{OUT}$ = –200 mA | 25°C | | 37 | 40 | mΩ |
| | | | –40°C to +85°C | | | 51 | |
| | | | –40°C to +105°C | | | 57 | |
| | | $V_{IN}$ = 5 V, $I_{OUT}$ = –200 mA | 25°C | | 37 | 41 | mΩ |
| | | | –40°C to +85°C | | | 51 | |
| | | | –40°C to +105°C | | | 57 | |
| | | $V_{IN}$ = 4.2 V, $I_{OUT}$ = –200 mA | 25°C | | 37 | 41 | mΩ |
| | | | –40°C to +85°C | | | 52 | |
| | | | –40°C to +105°C | | | 58 | |
| | | $V_{IN}$ = 3.3 V, $I_{OUT}$ = –200 mA | 25°C | | 38 | 41 | mΩ |
| | | | –40°C to +85°C | | | 52 | |
| | | | –40°C to +105°C | | | 59 | |
| | | $V_{IN}$ = 2.5 V, $I_{OUT}$ = –200 mA | 25°C | | 38 | 42 | mΩ |
| | | | –40°C to +85°C | | | 53 | |
| | | | –40°C to +105°C | | | 58 | |
| | | $V_{IN}$ = 1.8 V, $I_{OUT}$ = –200 mA | 25°C | | 43 | 48 | mΩ |
| | | | –40°C to +85°C | | | 59 | |
| | | | –40°C to +105°C | | | 66 | |
| | | $V_{IN}$ = 1.2 V, $I_{OUT}$ = –200 mA | 25°C | | 52 | 61 | mΩ |
| | | | –40°C to +85°C | | | 73 | |
| | | | –40°C to +105°C | | | 85 | |
| | | $V_{IN}$ = 1.05 V, $I_{OUT}$ = –200 mA | 25°C | | 63 | 96 | mΩ |
| | | | –40°C to +85°C | | | 102 | |
| | | | –40°C to +105°C | | | 107 | |
| $V_{HYS}$ | ON pin hysteresis | $V_{IN}$ = 5.5 V | 25°C | | 102 | | mV |
| | | $V_{IN}$ = 5 V | | | 100 | | |
| | | $V_{IN}$ = 3.3 V | | | 98 | | |
| | | $V_{IN}$ = 2.5 V | | | 96 | | |
| | | $V_{IN}$ = 1.8 V | | | 96 | | |
| | | $V_{IN}$ = 1.2 V | | | 94 | | |
| | | $V_{IN}$ = 1.05 V | | | 92 | | |
| $R_{PD}$ (1) | Output pull down resistor | $V_{IN}$ = $V_{OUT}$ = 3.3 V, $V_{ON}$ = 0 V | –40°C to +105°C | | 143 | 200 | Ω |

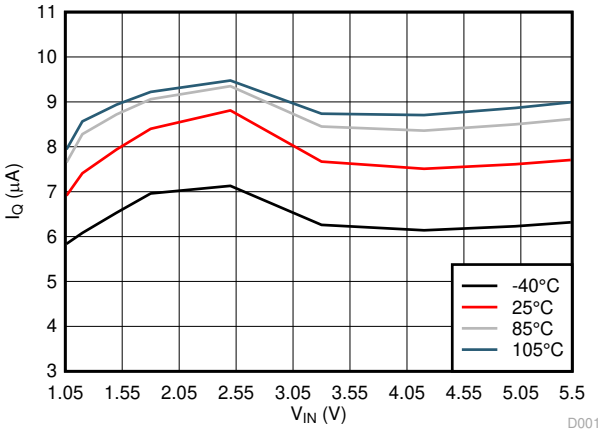
(1) TPS22915B/C only.

## 7.6 Switching Characteristics

Refer to the timing test circuit in 図 8-1 (unless otherwise noted) for references to external components used for the test condition in the switching characteristics table. Switching characteristics shown below are only valid for the power-up sequence where VIN is already in steady state condition before the ON pin is asserted high.

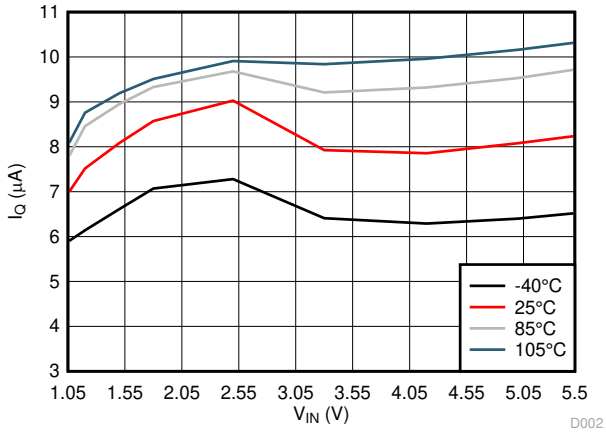
| PARAMETER | | TEST CONDITION | TYP (TPS22914B/15B) | TYP (TPS22914C/15C) | UNIT |
|---|---|---|---|---|---|
| **$V_{IN}$ = 5 V, $V_{ON}$ = 5 V, $T_A$ = 25°C (unless otherwise noted)** | | | | | |
| $t_{ON}$ | Turnon time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 104 | 1300 | µs |
| $t_{OFF}$ | Turnoff time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 2 | 2 | µs |
| $t_R$ | $V_{OUT}$ rise time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 89 | 1277 | µs |
| $t_F$ | $V_{OUT}$ fall time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 2 | 2 | µs |
| $t_D$ | Delay time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 59 | 663 | µs |
| **$V_{IN}$ = 3.3 V, $V_{ON}$ = 5 V, $T_A$ = 25°C (unless otherwise noted)** | | | | | |
| $t_{ON}$ | Turnon time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 83 | 1077 | µs |
| $t_{OFF}$ | Turnoff time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 2 | 2 | µs |
| $t_R$ | $V_{OUT}$ rise time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 64 | 913 | µs |
| $t_F$ | $V_{OUT}$ fall time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 2 | 2 | µs |
| $t_D$ | Delay time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 52 | 622 | µs |
| **$V_{IN}$ = 1.05 V, $V_{ON}$ = 5 V, $T_A$ = 25°C (unless otherwise noted)** | | | | | |
| $t_{ON}$ | Turnon time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 61 | 752 | µs |
| $t_{OFF}$ | Turnoff time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 3 | 3 | µs |
| $t_R$ | $V_{OUT}$ rise time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 28 | 409 | µs |
| $t_F$ | $V_{OUT}$ fall time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 2 | 2 | µs |
| $t_D$ | Delay time | $R_L$ = 10 Ω, $C_{IN}$ = 1 µF, $C_{OUT}$ = 0.1 µF | 47 | 547 | µs |

## 7.7 Typical DC Characteristics



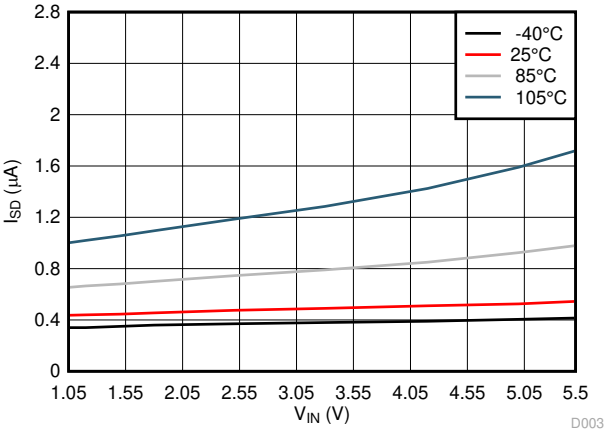

$V_{ON}$ = 5 V $I_{OUT}$ = 0 A

**図 7-1. $I_Q$ vs $V_{IN}$ (TPS22914B/15B)**



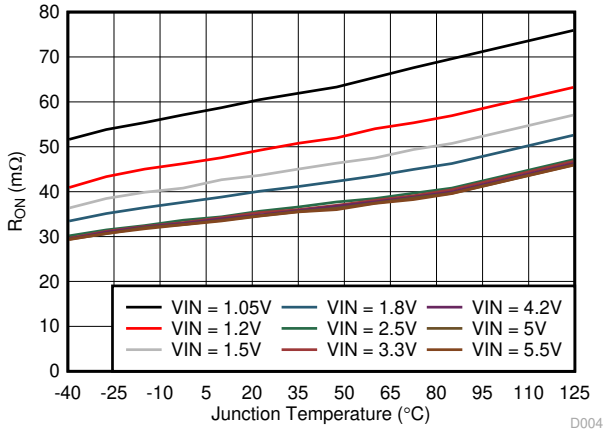

$V_{ON}$ = 5 V $I_{OUT}$ = 0 A

**図 7-2. $I_Q$ vs $V_{IN}$ (TPS22914C/15C)**



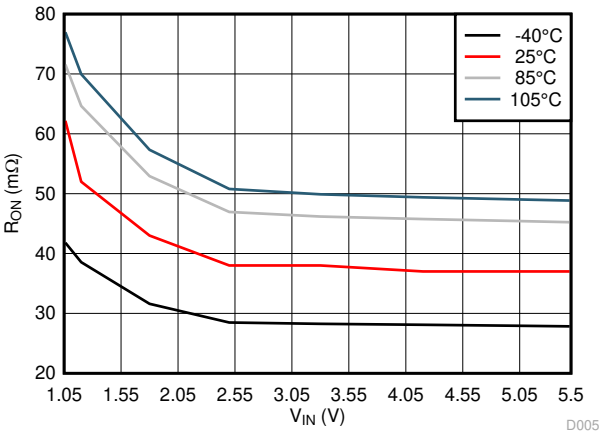

$V_{ON}$ = 0 V $I_{OUT}$ = 0 A

**図 7-3. $I_{SD}$ vs $V_{IN}$**



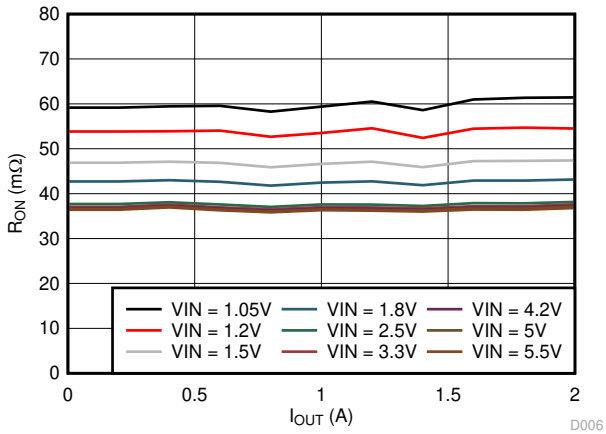

$V_{ON}$ = 5 V $I_{OUT}$ = –200 mA

**図 7-4. $R_{ON}$ vs $T_J$**



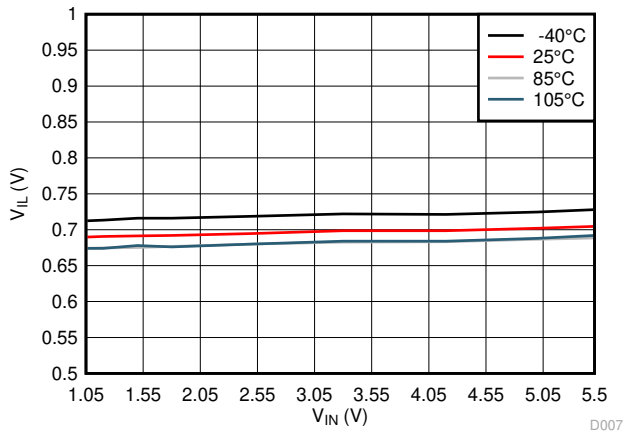

$V_{ON}$ = 5 V $I_{OUT}$ = –200 mA

**図 7-5. $R_{ON}$ vs $V_{IN}$**



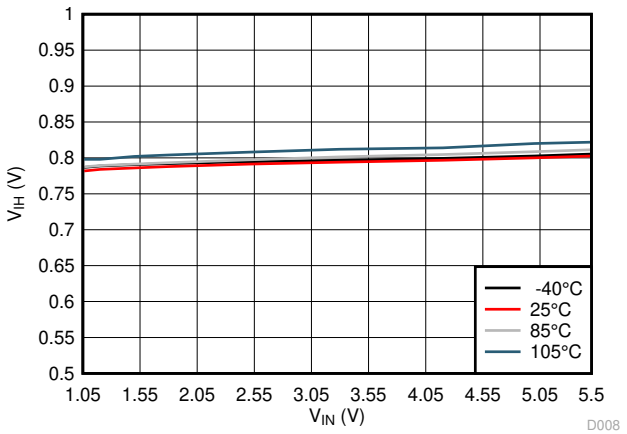

$V_{ON}$ = 5 V $T_A$ = 25°C

**図 7-6. $R_{ON}$ vs $I_{OUT}$**



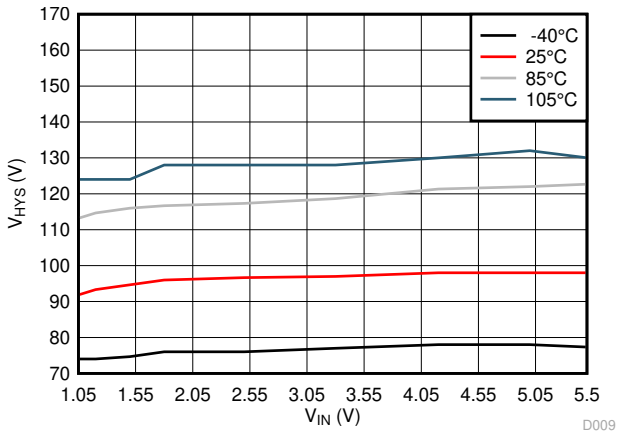

$I_{OUT}$ = 0 A

**図 7-7. $V_{IL}$ vs $V_{IN}$**



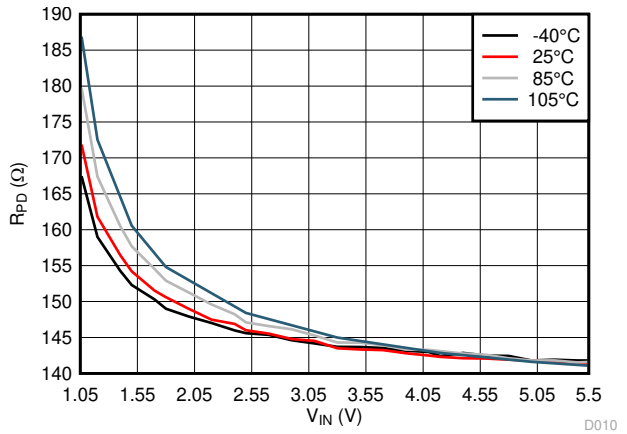

$I_{OUT}$ = 0 A

**図 7-8. $V_{IH}$ vs $V_{IN}$**




$I_{OUT}$ = 0 A

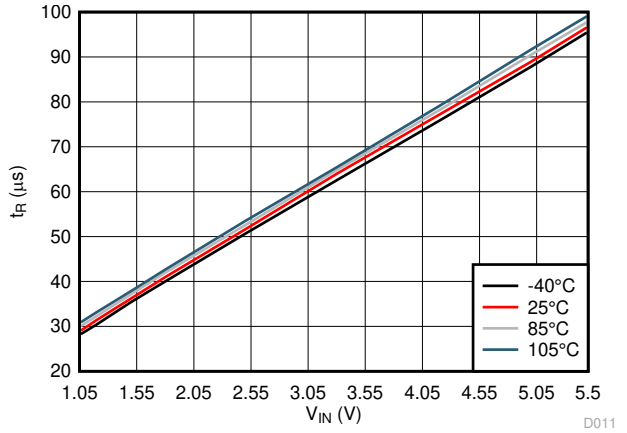
**図 7-9. $V_{HYS}$ vs $V_{IN}$**




$V_{IN}$ = $V_{OUT}$ $V_{ON}$ = 0 V

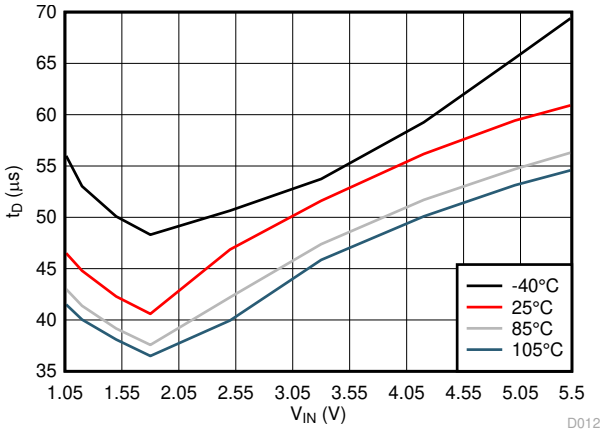
**図 7-10. $R_{PD}$ vs $V_{IN}$**

## 7.8 Typical AC Characteristics (TPS22914B/15B)



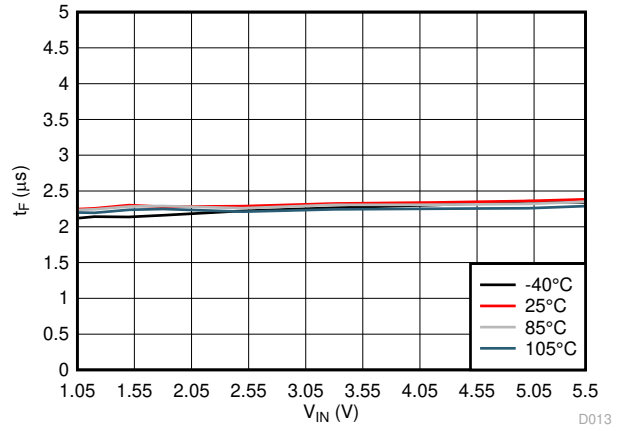

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-11. $t_R$ vs $V_{IN}$**



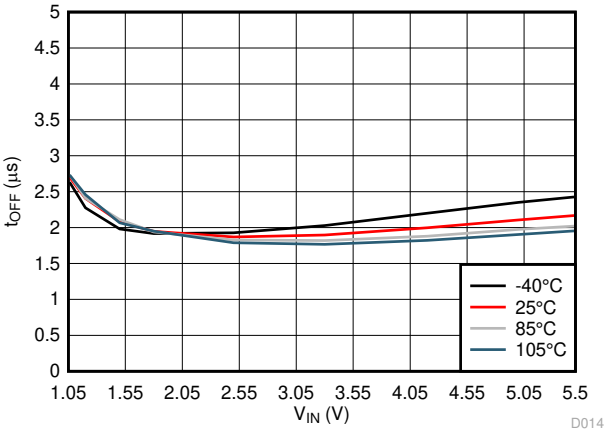

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-12. $t_D$ vs $V_{IN}$**



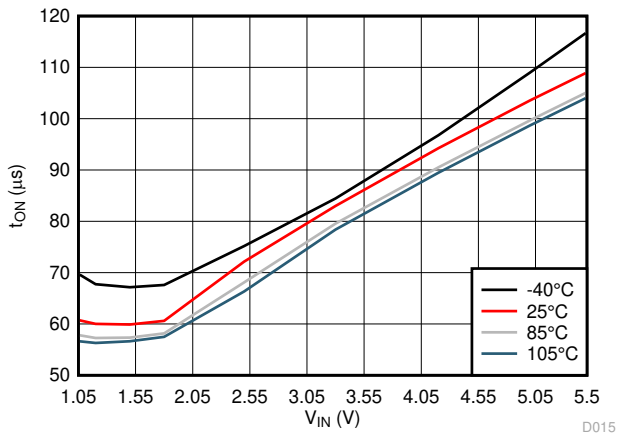

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-13. $t_F$ vs $V_{IN}$**



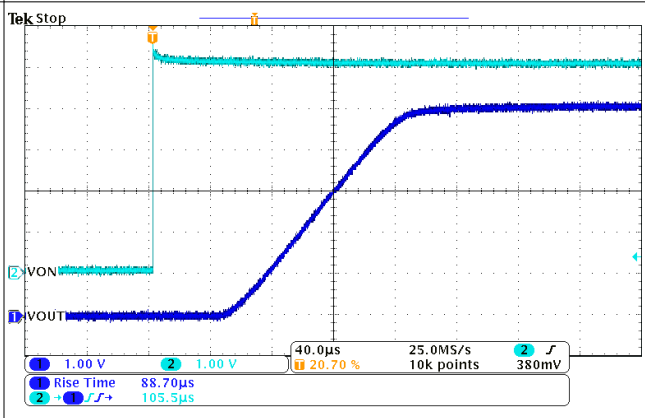

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-14. $t_{OFF}$ vs $V_{IN}$**



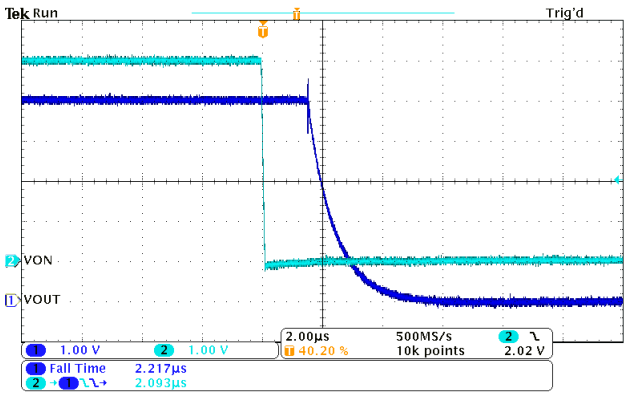

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-15. $t_{ON}$ vs $V_{IN}$**



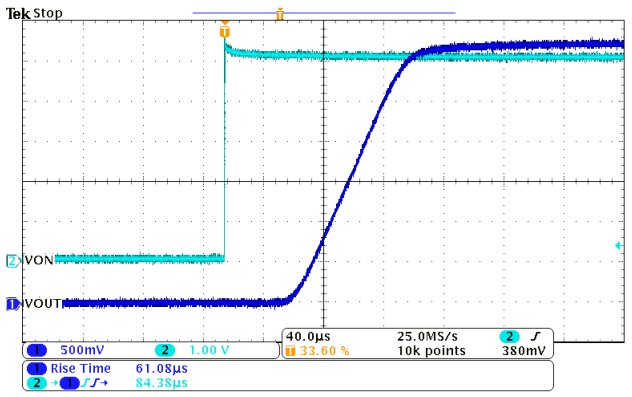

$V_{IN}$ = 5 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-16. $t_R$ at $V_{IN}$ = 5 V**



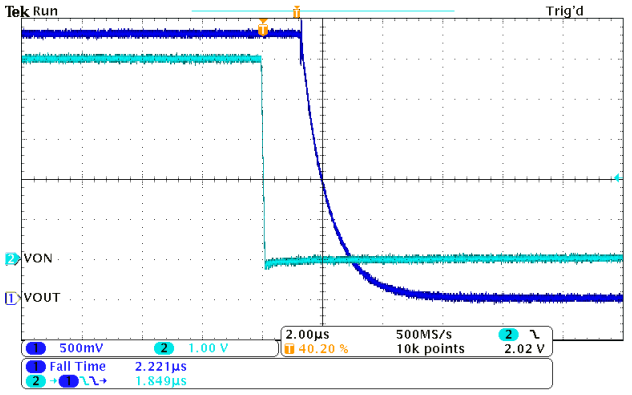

$V_{IN}$ = 5 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-17. $t_F$ at $V_{IN}$ = 5 V**



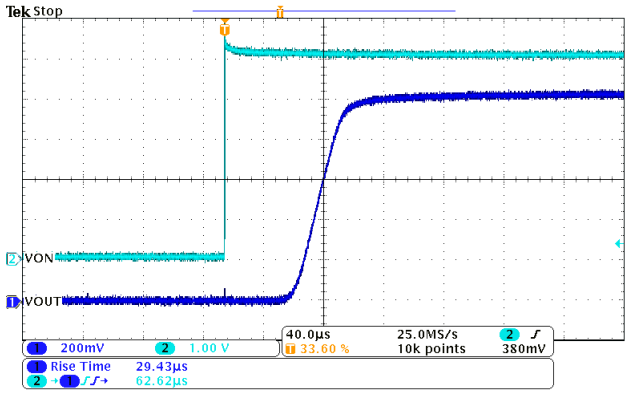

$V_{IN}$ = 3.3 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-18. $t_R$ at $V_{IN}$ = 3.3 V**



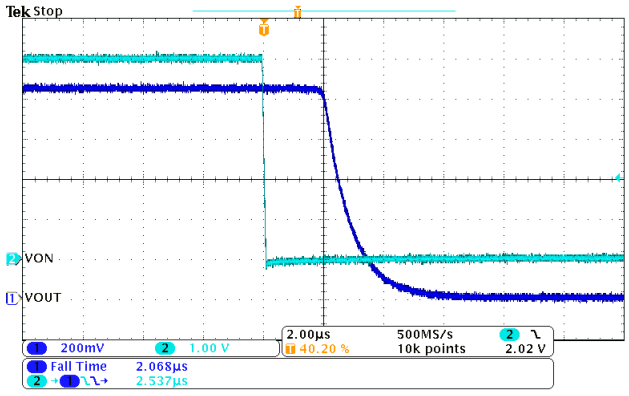

$V_{IN}$ = 3.3 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-19. $t_F$ at $V_{IN}$ = 3.3V**




$V_{IN}$ = 1.05 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

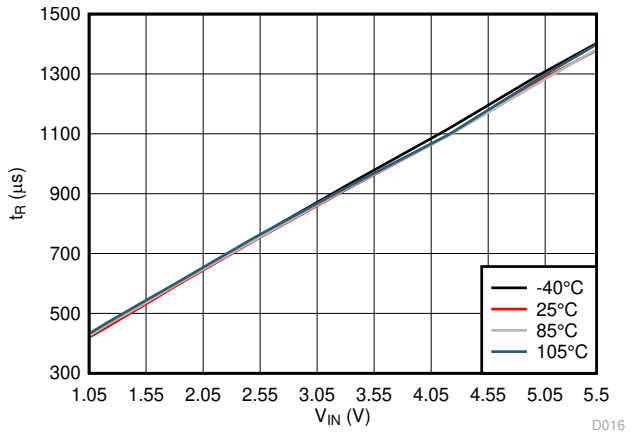
**図 7-20. $t_R$ at $V_{IN}$ = 1.05V**




$V_{IN}$ = 1.05 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

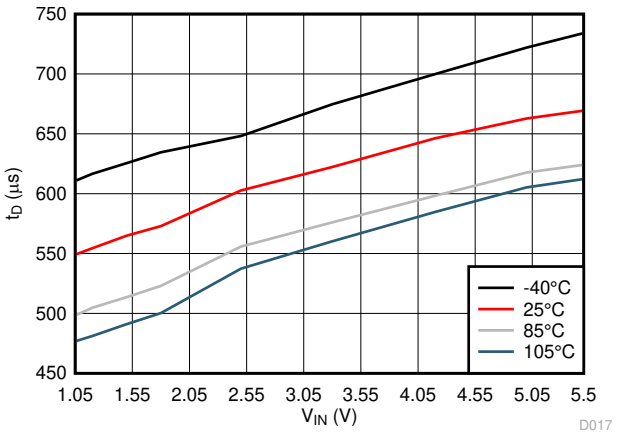
**図 7-21. $t_F$ at $V_{IN}$ = 1.05 V**

## 7.9 Typical AC Characteristics (TPS22914C/15C)



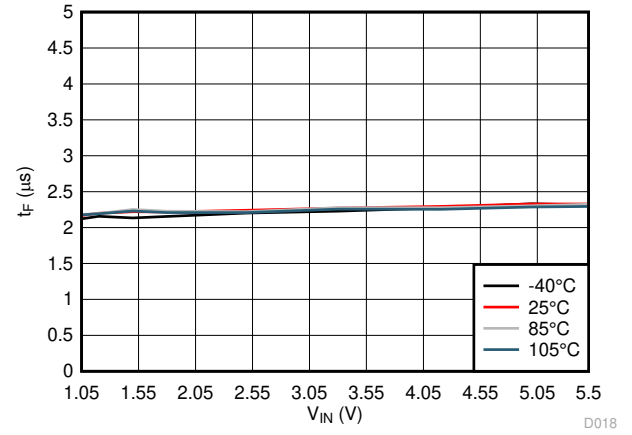

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-22. $t_R$ vs $V_{IN}$**



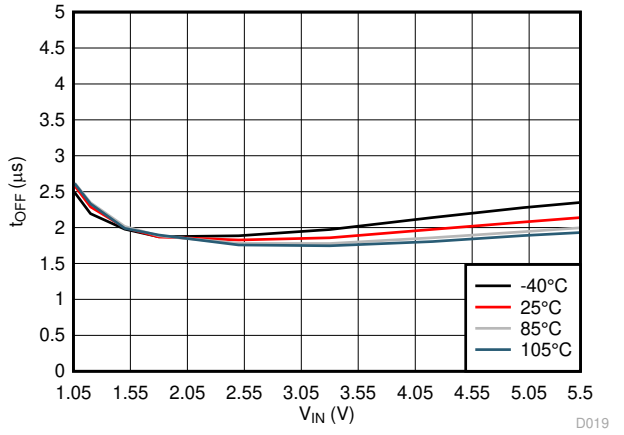

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-23. $t_D$ vs $V_{IN}$**



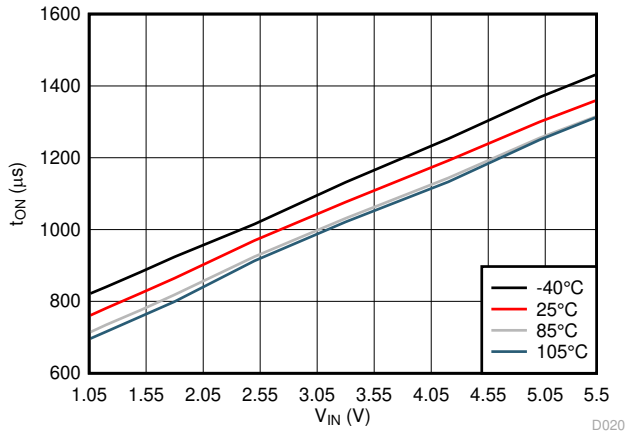

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-24. $t_F$ vs $V_{IN}$**



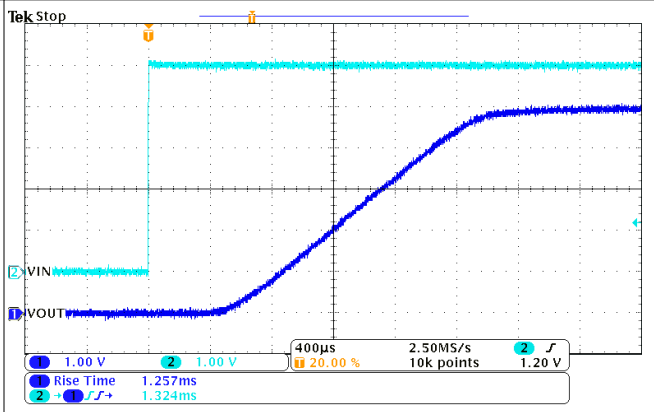

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-25. $t_{OFF}$ vs $V_{IN}$**



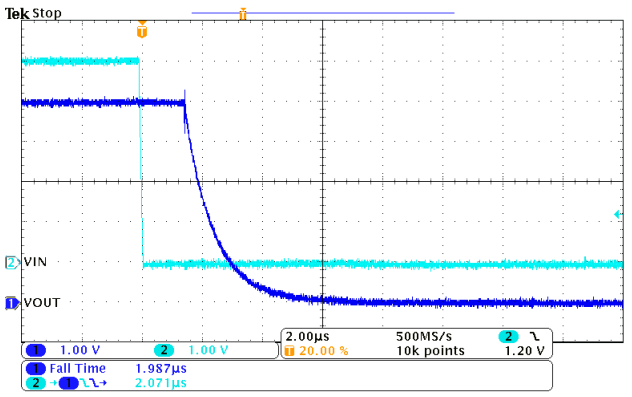

$C_{IN}$ = 1 µF $R_L$ = 10 Ω $C_L$ = 0.1 µF

**図 7-26. $t_{ON}$ vs $V_{IN}$**



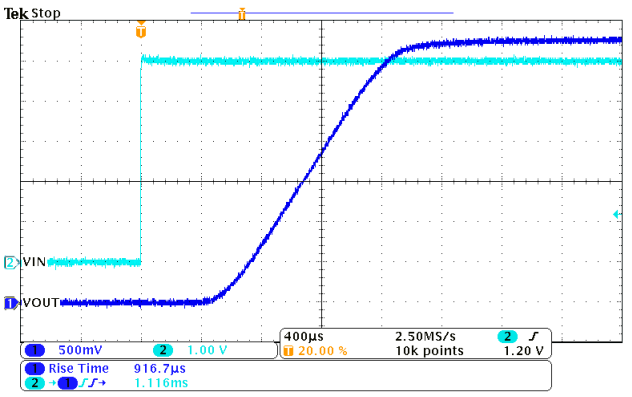

$V_{IN}$ = 5 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-27. $t_R$ at $V_{IN}$ = 5 V**



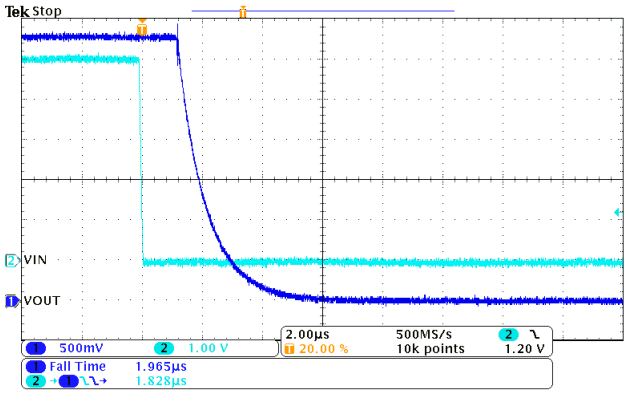

$V_{IN}$ = 5 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-28. $t_F$ at $V_{IN}$ = 5 V**



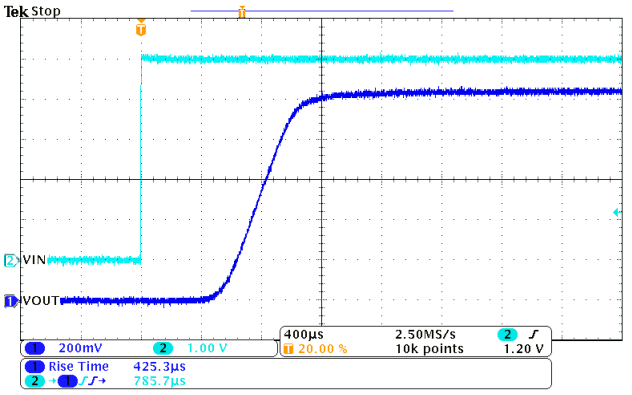

$V_{IN}$ = 3.3 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-29. $t_R$ at $V_{IN}$ = 3.3 V**



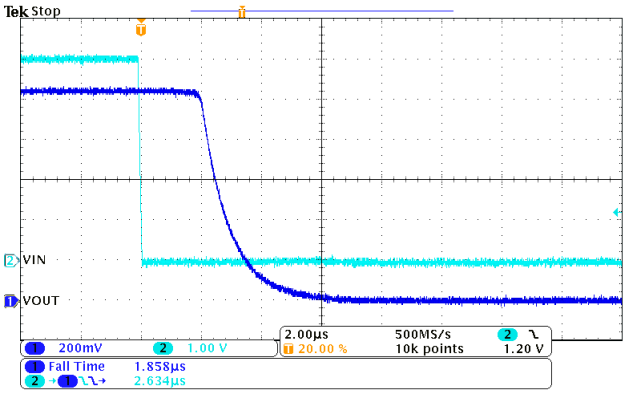

$V_{IN}$ = 3.3 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-30. $t_F$ at $V_{IN}$ = 3.3 V**




$V_{IN}$ = 1.05 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

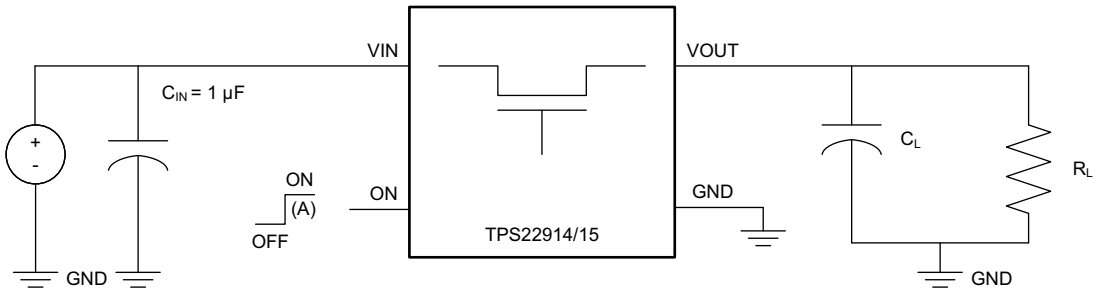
**図 7-31. $t_R$ at $V_{IN}$ = 1.05 V**




$V_{IN}$ = 1.05 V $C_{IN}$ = 1 µF $C_L$ = 0.1 µF
$R_L$ = 10 Ω

**図 7-32. $t_F$ at $V_{IN}$ = 1.05 V**

# 8 Parameter Measurement Information




A. Rise and fall times of the control signal is 100ns

**図 8-1. Test Circuit**

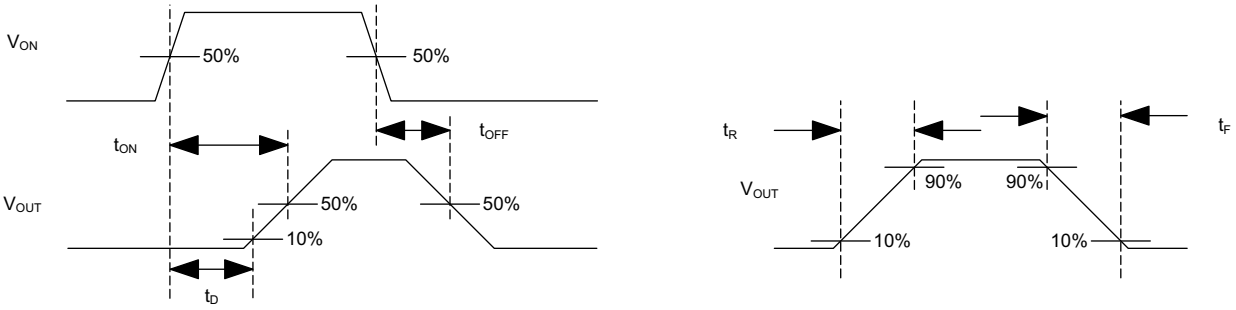



**図 8-2. Timing Waveforms**

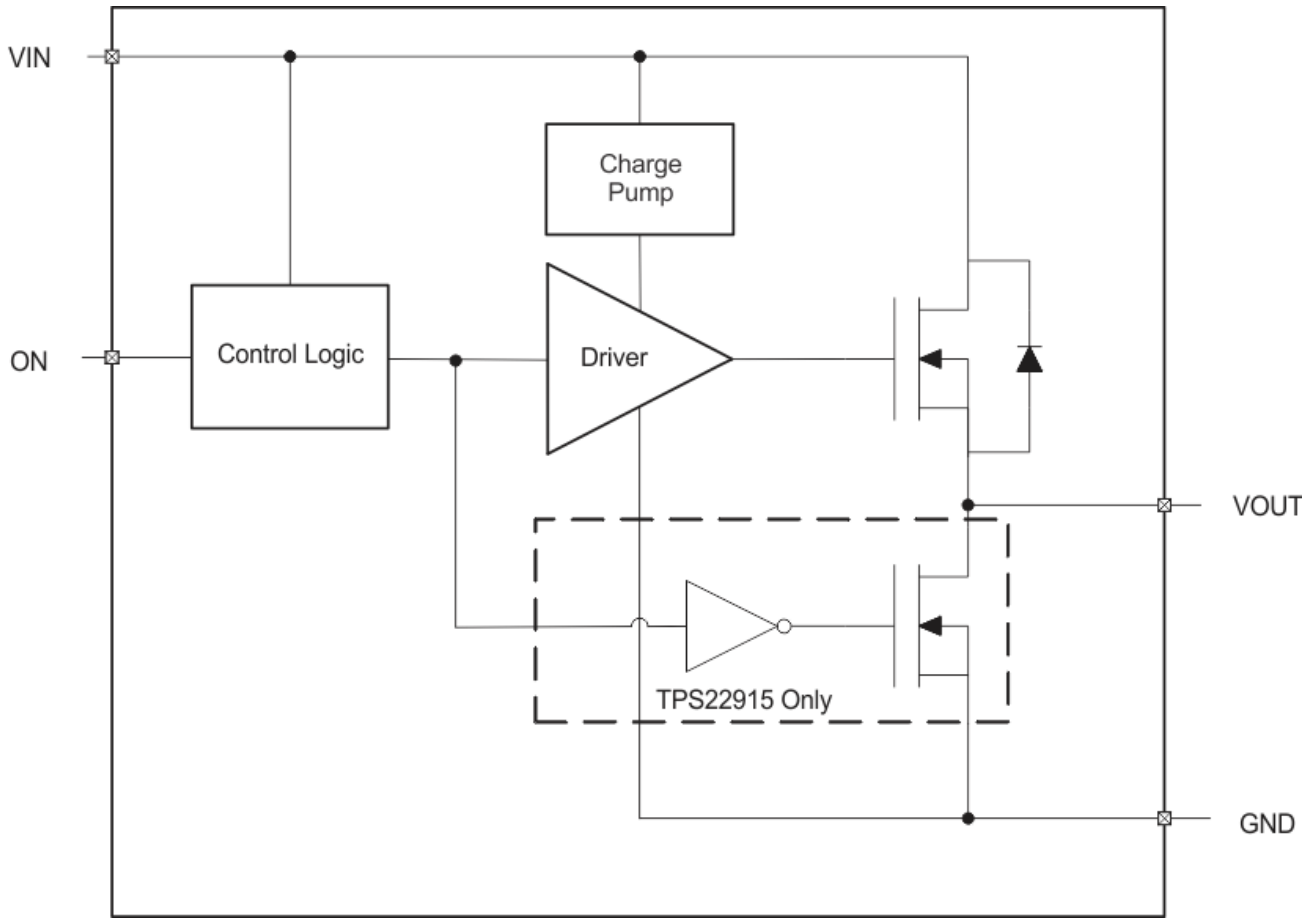
# 9 Detailed Description

## 9.1 Overview

The device is a 5.5-V, 2-A load switch in a 4-pin YFP package. To reduce voltage drop for low voltage and high current rails, the device implements an ultra-low resistance N-channel MOSFET which reduces the drop out voltage through the device.

The device has a controlled and fixed slew rate which helps reduce or eliminate power supply droop due to large inrush currents. During shutdown, the device has very low leakage currents, thereby reducing unnecessary leakages for downstream modules during standby. Integrated control logic, driver, charge pump, and output discharge FET eliminates the need for any external components, which reduces solution size and bill of materials (BOM) count.

## 9.2 Functional Block Diagram




## 9.3 Feature Description

### 9.3.1 On and Off Control

The ON pins control the state of the switch. Asserting ON high enables the switch. 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. It can be used with any microcontroller with 1 V or higher GPIO voltage. This pin cannot be left floating and must be driven either high or low for proper functionality.

### 9.3.2 Input Capacitor ($C_{IN}$)

To limit the voltage drop on the input supply caused by transient in-rush currents when the switch turns on into a discharged load capacitor or short-circuit, a capacitor needs to be placed between VIN and GND. A 1-µF ceramic capacitor, $C_{IN}$, placed close to the pins, is usually sufficient. Higher values of $C_{IN}$ can be used to further

reduce the voltage drop during high-current application. When switching heavy loads, it is recommended to have an input capacitor about 10 times higher than the output capacitor to avoid excessive voltage drop.

### 9.3.3 Output Capacitor ($C_L$)

Due to the integrated body diode in the MOSFET, 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 VOUT to VIN. A $C_{IN}$ to $C_L$ ratio of 10 to 1 is recommended for minimizing $V_{IN}$ dip caused by inrush currents during startup.

## 9.4 Device Functional Modes

表 9-1 describes the connection of the VOUT pin depending on the state of the ON pin.

**表 9-1. VOUT Connection**

| ON | TPS22914 | TPS22915 |
|---|---|---|
| L | Open | GND |
| H | VIN | VIN |

# 10 Application and Implementation

**Note**

以下のアプリケーション情報は、TI の製品仕様に含まれるものではなく、TI ではその正確性または完全性を保証いたしません。個々の目的に対する製品の適合性については、お客様の責任で判断していただくことになります。お客様は自身の設計実装を検証しテストすることで、システムの機能を確認する必要があります。

## 10.1 Application Information

This section highlights some of the design considerations when implementing this device in various applications. A PSPICE model for this device is also available in the product page of this device.

## 10.2 Typical Application

This typical application demonstrates how the TPS22914 and TPS22915 can be used to power downstream modules.

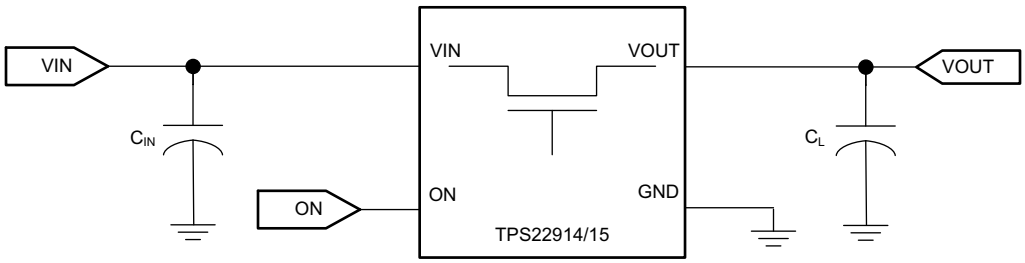



**図 10-1. Typical Application Schematic**

### 10.2.1 Design Requirements

For this design example, use the input parameters shown in 表 10-1.

**表 10-1. Design Parameters**

| DESIGN PARAMETER | EXAMPLE VALUE |
|---|---|
| $V_{IN}$ | 5 V |
| Load current | 2 A |

### 10.2.2 Detailed Design Procedure

To begin the design process, the designer needs to know the following:

- $V_{IN}$ voltage
- Load Current

#### *10.2.2.1 VIN to VOUT Voltage Drop*

The VIN to VOUT voltage drop in the device is determined by the $R_{ON}$ of the device and the load current. The $R_{ON}$ of the device depends upon the VIN conditions of the device. Refer to the $R_{ON}$ specification of the device in the *Electrical Characteristics* table of this datasheet. Once the $R_{ON}$ of the device is determined based upon the VIN conditions, use 式 1 to calculate the VIN to VOUT voltage drop.

$$\Delta V = I_{LOAD} \times R_{ON} \tag{1}$$

where

- $\Delta V$ = voltage drop from VIN to VOUT
- $I_{LOAD}$ = load current
- $R_{ON}$ = On-resistance of the device for a specific $V_{IN}$

An appropriate $I_{LOAD}$ must be chosen such that the $I_{MAX}$ specification of the device is not violated.

#### *10.2.2.2 Inrush Current*

To determine how much inrush current is caused by the $C_L$ capacitor, use 式 2.

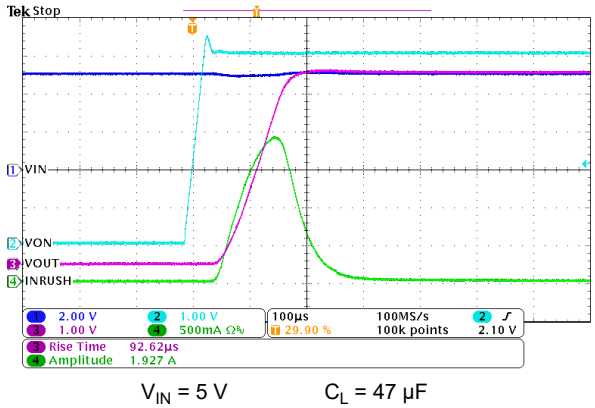
$$I_{INRUSH} = C_L \times \frac{dV_{OUT}}{dt} \tag{2}$$

where

- $I_{INRUSH}$ = amount of inrush caused by $C_L$
- $C_L$ = capacitance on VOUT
- dt = rise time in VOUT during the ramp up of VOUT when the device is enabled
- $dV_{OUT}$ = change in VOUT during the ramp up of VOUT when the device is enabled

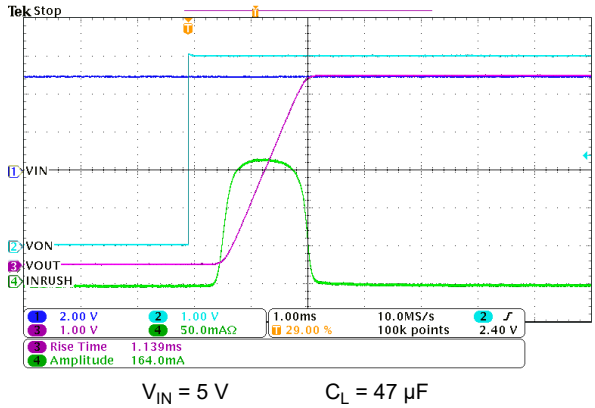
An appropriate $C_L$ value must be placed on VOUT such that the $I_{MAX}$ and $I_{PLS}$ specifications of the device are not violated.

### 10.2.3 Application Curves




$V_{IN}$ = 5 V $C_L$ = 47 µF

**図 10-2. TPS22914B/15B Inrush Current**




$V_{IN}$ = 5 V $C_L$ = 47 µF

**図 10-3. TPS22914C/15C Inrush Current**

# 11 Power Supply Recommendations

The device is designed to operate from a VIN range of 1.05 V to 5.5 V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 1-µF bypass capacitor. 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 1 µF may be sufficient.

# 12 Layout

## 12.1 Layout Guidelines

1. VIN and VOUT traces must be as short and wide as possible to accommodate for high current.
2. The VIN pin must be bypassed to ground with low ESR ceramic bypass capacitors. The typical recommended bypass capacitance is 1-µF ceramic with X5R or X7R dielectric. This capacitor must be placed as close to the device pins as possible.
3. The VOUT pin must be bypassed to ground with low ESR ceramic bypass capacitors. The typical recommended bypass capacitance is one-tenth of the VIN bypass capacitor of X5R or X7R dielectric rating. This capacitor must be placed as close to the device pins as possible.

### 12.1.1 Thermal Considerations

For best performance, all traces must be as short as possible. To be most effective, the input and output capacitors must be placed close to the device to minimize the effects that parasitic trace inductances may have on normal and short-circuit operation. Using wide traces for VIN, VOUT, and GND helps minimize the parasitic electrical effects along with minimizing the case to ambient thermal impedance.

The maximum IC junction temperature must be restricted to 125°C under normal operating conditions. To calculate the maximum allowable dissipation, $P_{D(max)}$ for a given output current and ambient temperature, use 式 3.

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}} \tag{3}$$

where

- $P_{D(MAX)}$ = maximum allowable power dissipation
- $T_{J(MAX)}$ = maximum allowable junction temperature (125°C for the TPS22914/15)
- $T_A$ = ambient temperature of the device
- $\theta_{JA}$ = junction to air thermal impedance. Refer to the *Thermal Information* table. This parameter is highly dependent upon board layout.

## 12.2 Layout Example

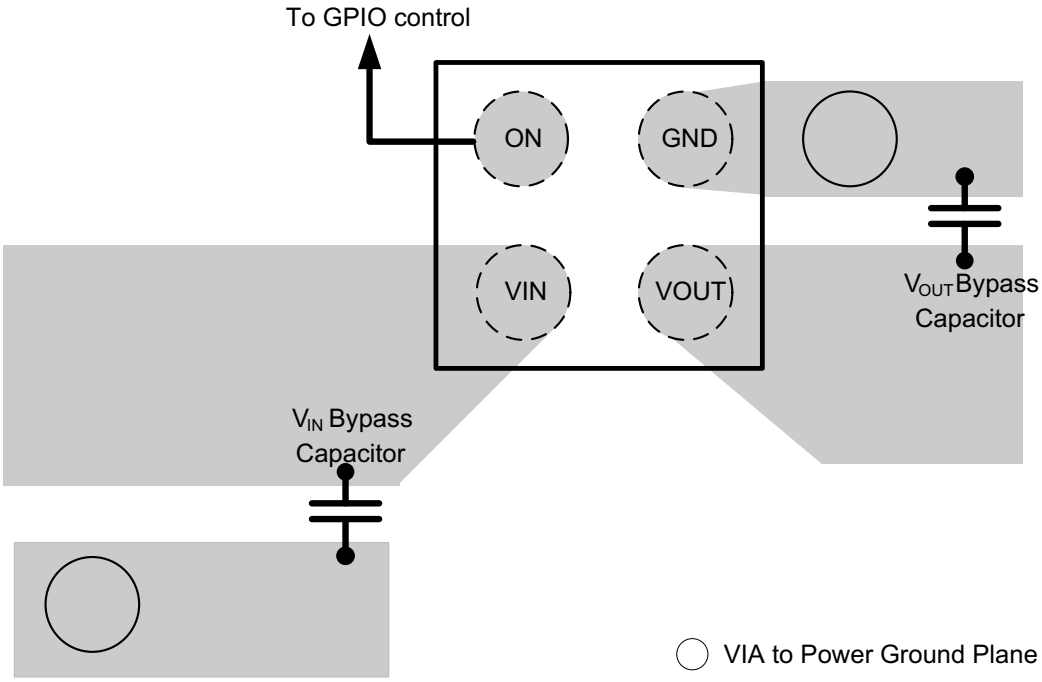



**図 12-1. Recommended Board Layout**

# 13 Device and Documentation Support

## 13.1 Documentation Support

### 13.1.1 Related Documentation

For related documentation see the following:

- *Basics of Load Switches*
- *Managing Inrush Current*
- *Load Switch Thermal Considerations*
- *Using the TPS22915BEVM-078 Single Channel Load Switch IC*
- *Implementing Ship Mode Using the TPS22915B Load Switches*

## 13.2 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.

**表 13-1. Related Links**

| PARTS | PRODUCT FOLDER | SAMPLE & BUY | TECHNICAL DOCUMENTS | TOOLS & SOFTWARE | SUPPORT & COMMUNITY |
|---|---|---|---|---|---|
| TPS22914B | Click here | Click here | Click here | Click here | Click here |
| TPS22914C | Click here | Click here | Click here | Click here | Click here |
| TPS22915B | Click here | Click here | Click here | Click here | Click here |
| TPS22915C | Click here | Click here | Click here | Click here | Click here |

## 13.3 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.com のデバイス製品フォルダを開いてください。*「更新の通知を受け取る」をクリック*して登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

## 13.4 サポート・リソース

TI E2E™ サポート・フォーラムは、エンジニアが検証済みの回答と設計に関するヒントをエキスパートから迅速かつ直接得ることができる場所です。既存の回答を検索したり、独自の質問をしたりすることで、設計で必要な支援を迅速に得ることができます。

リンクされているコンテンツは、該当する貢献者により、現状のまま提供されるものです。これらは TI の仕様を構成するものではなく、必ずしも TI の見解を反映したものではありません。TI の使用条件を参照してください。

## 13.5 Trademarks

Ultrabook™ is a trademark of Intel.
TI E2E™ is a trademark of Texas Instruments.
すべての商標は、それぞれの所有者に帰属します。

## 13.6 静電気放電に関する注意事項

この IC は、ESD によって破損する可能性があります。テキサス・インスツルメンツは、IC を取り扱う際には常に適切な注意を払うことを推奨します。正しい ESD 対策をとらないと、デバイスを破損するおそれがあります。

ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。

## 13.7 用語集

TI 用語集　この用語集には、用語や略語の一覧および定義が記載されています。

## 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 Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TPS22914BYFPR | ACTIVE | DSBGA | YFP | 4 | 3000 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 105 | S3 | Samples |
| TPS22914BYFPT | ACTIVE | DSBGA | YFP | 4 | 250 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 105 | S3 | Samples |
| TPS22914CYFPR | ACTIVE | DSBGA | YFP | 4 | 3000 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 105 | S6 | Samples |
| TPS22914CYFPT | ACTIVE | DSBGA | YFP | 4 | 250 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 105 | S6 | Samples |
| TPS22915BYFPR | ACTIVE | DSBGA | YFP | 4 | 3000 | RoHS & Green | SAC396 \| SNAGCU | Level-1-260C-UNLIM | -40 to 105 | S4 | Samples |
| TPS22915BYFPT | ACTIVE | DSBGA | YFP | 4 | 250 | RoHS & Green | SAC396 \| SNAGCU | Level-1-260C-UNLIM | -40 to 105 | S4 | Samples |
| TPS22915CYFPR | ACTIVE | DSBGA | YFP | 4 | 3000 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 105 | S7 | Samples |
| TPS22915CYFPT | ACTIVE | DSBGA | YFP | 4 | 250 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 105 | S7 | Samples |

(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

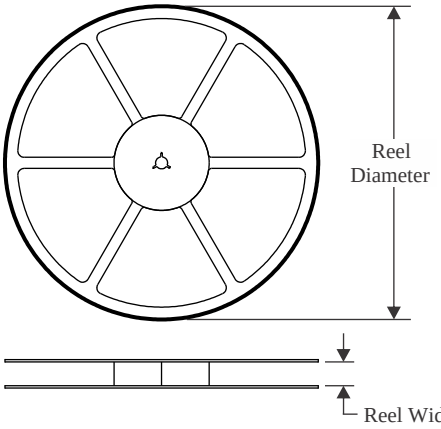
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

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

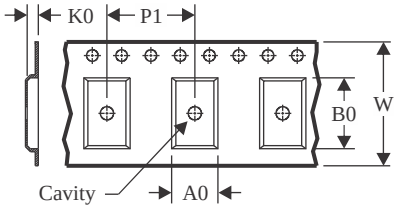
**(6)** Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

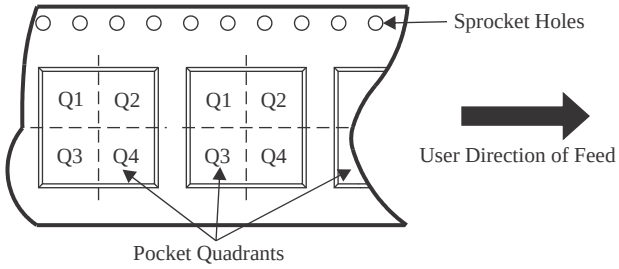



**TAPE DIMENSIONS**




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

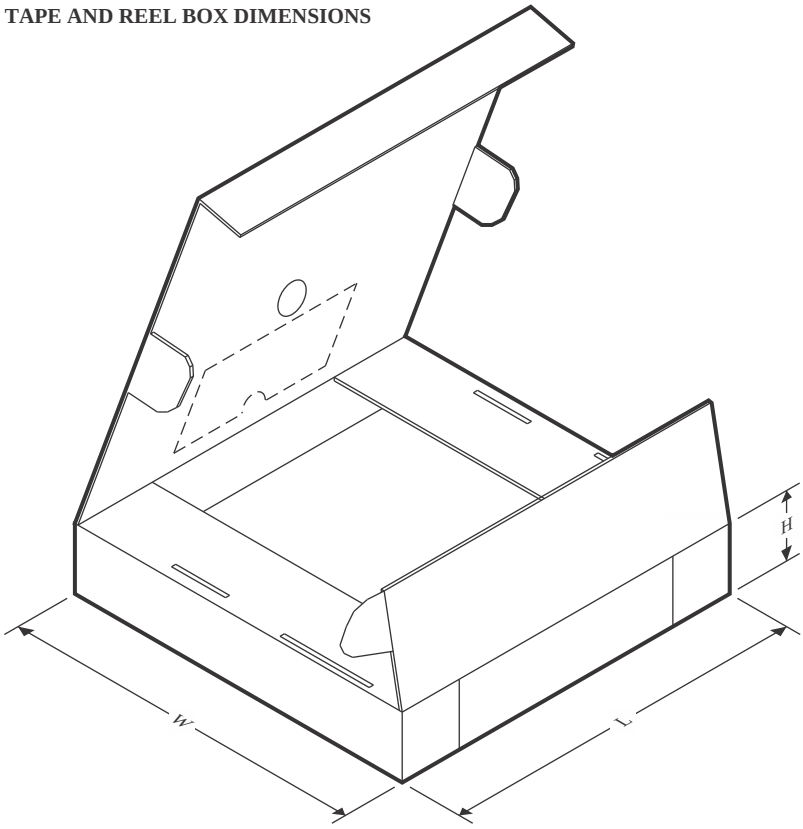
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPS22914BYFPR | DSBGA | YFP | 4 | 3000 | 180.0 | 8.4 | 0.85 | 0.85 | 0.64 | 4.0 | 8.0 | Q1 |
| TPS22914BYFPT | DSBGA | YFP | 4 | 250 | 180.0 | 8.4 | 0.85 | 0.85 | 0.64 | 4.0 | 8.0 | Q1 |
| TPS22914CYFPR | DSBGA | YFP | 4 | 3000 | 180.0 | 8.4 | 0.85 | 0.85 | 0.64 | 4.0 | 8.0 | Q1 |
| TPS22914CYFPT | DSBGA | YFP | 4 | 250 | 180.0 | 8.4 | 0.85 | 0.85 | 0.64 | 4.0 | 8.0 | Q1 |
| TPS22915BYFPR | DSBGA | YFP | 4 | 3000 | 180.0 | 8.4 | 0.85 | 0.85 | 0.64 | 4.0 | 8.0 | Q1 |
| TPS22915BYFPT | DSBGA | YFP | 4 | 250 | 180.0 | 8.4 | 0.85 | 0.85 | 0.64 | 4.0 | 8.0 | Q1 |
| TPS22915CYFPR | DSBGA | YFP | 4 | 3000 | 180.0 | 8.4 | 0.85 | 0.85 | 0.64 | 4.0 | 8.0 | Q1 |
| TPS22915CYFPT | DSBGA | YFP | 4 | 250 | 180.0 | 8.4 | 0.85 | 0.85 | 0.64 | 4.0 | 8.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

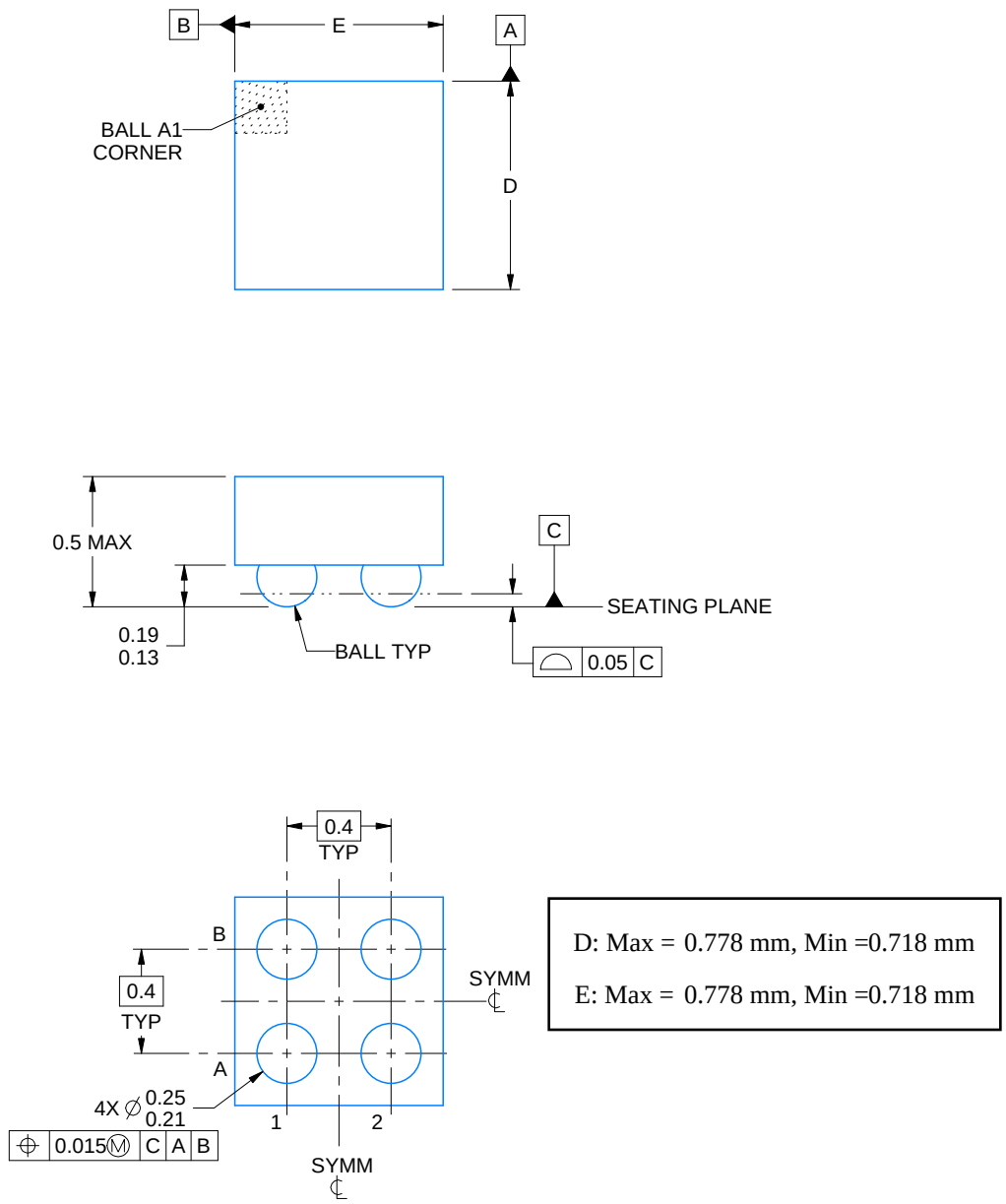
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TPS22914BYFPR | DSBGA | YFP | 4 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS22914BYFPT | DSBGA | YFP | 4 | 250 | 182.0 | 182.0 | 20.0 |
| TPS22914CYFPR | DSBGA | YFP | 4 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS22914CYFPT | DSBGA | YFP | 4 | 250 | 182.0 | 182.0 | 20.0 |
| TPS22915BYFPR | DSBGA | YFP | 4 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS22915BYFPT | DSBGA | YFP | 4 | 250 | 182.0 | 182.0 | 20.0 |
| TPS22915CYFPR | DSBGA | YFP | 4 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS22915CYFPT | DSBGA | YFP | 4 | 250 | 182.0 | 182.0 | 20.0 |

# PACKAGE OUTLINE

## YFP0004

## DSBGA - 0.5 mm max height

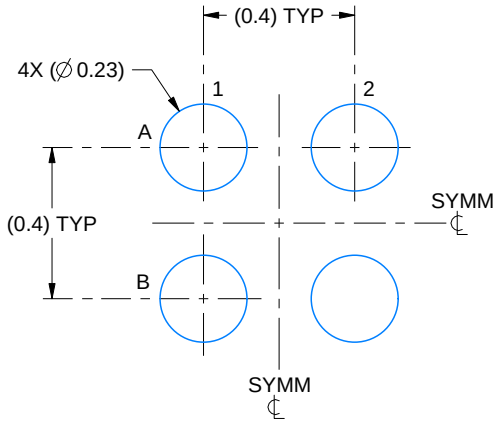
DIE SIZE BALL GRID ARRAY



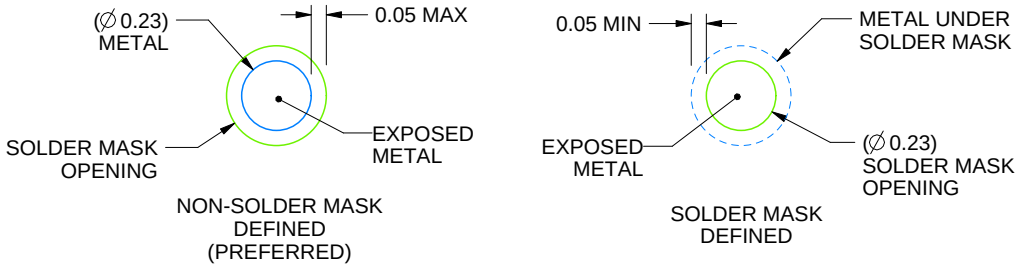

4223507/A 01/2017

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

4223507/A 01/2017

NOTES: (continued)

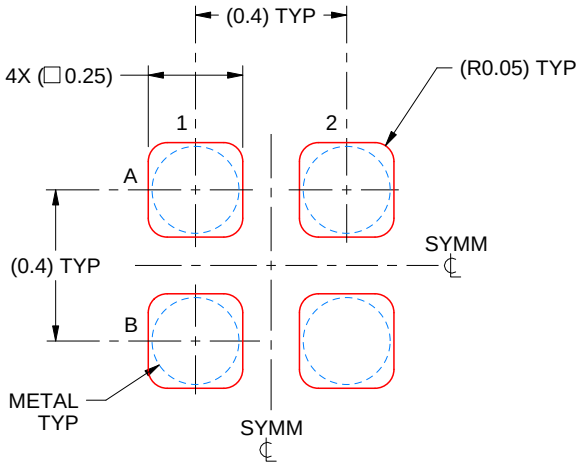
3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
For more information, see Texas Instruments literature number SNVA009 (www.ti.com/lit/snva009).

# EXAMPLE STENCIL DESIGN

## YFP0004

## DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY




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

4223507/A 01/2017

NOTES: (continued)

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

# 重要なお知らせと免責事項

TI は、技術データと信頼性データ (データシートを含みます)、設計リソース (リファレンス· デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとします。

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、TI の販売条件、または ti.com やかかる TI 製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、TI はそれらに異議を唱え、拒否します。

郵送先住所：Texas Instruments, Post Office Box 655303, Dallas, Texas 75265