# 且采用小型封装的 TLV759P 1A 高精度可调节 LDO

## 1 特性

- 输入电压范围：1.5V 至 6.0V
- 可调节输出电压：
  - 0.55V 至 5.5V
- 极低压降：
  - 1A 电流时为 225mV（最大值）($3.3V_{OUT}$)
- 高输出精度：
  - 典型值为 0.7%
  - 过温 (85°C) 条件下的最大值为 1%
- $I_Q$：25µA（典型值）
- 内置软启动功能，具有单调 $V_{OUT}$ 上升
- 封装：
  - 2mm × 2mm 6 引脚 WSON (DRV)
- 有源输出放电

## 2 应用

- 机顶盒和游戏机
- 家庭影院和娱乐
- 台式机、笔记本电脑、超极本
- 打印机
- 服务器
- 恒温器和照明控制
- 电子销售点 (EPOS)

## 3 说明

TLV759P 是一款可调 1A 低压降 (LDO) 稳压器。该器件采用小型 6 引脚
2mm × 2mm WSON 封装并具有极低的静态电流，可提供快速的线路和负载瞬态性能。TLV759P 具有 225mV 的超低压降（1A 电流情况下），这有助于提高系统的功效。

TLV759P 针对各种 应用 进行了优化：支持 1.5V 至 6.0V 的输入电压范围以及 0.55V 至 5.5V 的外部可调输出范围。这种低输出电压使得该 LDO 能够为具有较低内核电压的现代微控制供电。此外，TLV759P 具备带有使能功能的低 $I_Q$，从而可将待机功耗降至最低。该器件 具有 内部软启动功能，旨在降低浪涌电流，该电流将为负载提供受控电压并在启动过程中最大程度地降低输入电压压降。

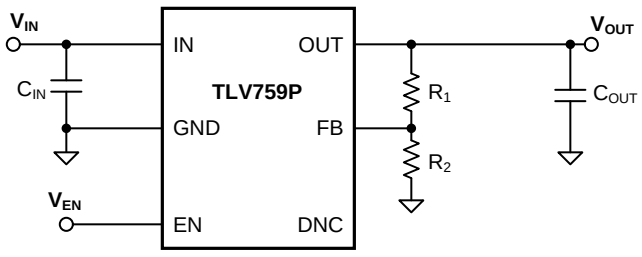
TLV759P 在与支持小尺寸总体解决方案的小型陶瓷输出电容器搭配使用时，可保持稳定。一个精密带隙和误差放大器具有高精度特性，在 25ºC 时提供 0.7%（最大值）的精度，在过温 (85ºC) 条件下提供 1%（最大值）的精度。该器件包括集成的热关断、电流限制和欠压锁定 (UVLO) 功能的刷式直流电机。TLV759P 包含一个内部折返电流限制，有助于在短路事件中减少热耗散。

器件信息(1)

| 器件型号 | 封装 | 封装尺寸（标称值） |
|---|---|---|
| TLV759P | WSON (6) | 2.00mm × 2.00mm |

(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。

典型应用



# 目录



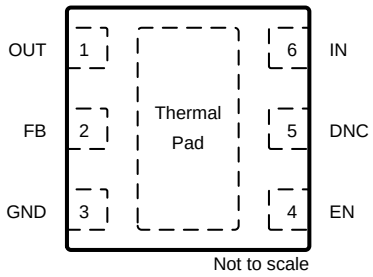
## 4 修订历史记录

**Changes from Original (April 2018) to Revision A** **Page**

- 已更改 文档状态从“预告信息”改为“生产数据” ..... 1

# 5 Pin Configuration and Functions

**DRV Package**
**6-Pin Adjustable WSON**
**Top View**




Not to scale

**Pin Functions**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NAME | NO. | | |
| DNC | 5 | — | Do not connect |
| EN | 4 | Input | Enable pin. Drive EN greater than $V_{EN(HI)}$ to turn on the regulator. Drive EN less than $V_{EN(LO)}$ to put the LDO into shutdown mode. |
| FB | 2 | — | This pin is used as an input to the control loop error amplifier and is used to set the output voltage of the LDO. |
| GND | 3 | — | Ground pin |
| IN | 6 | Input | Input pin. For best transient response and to minimize input impedance, use the recommended value or larger ceramic capacitor from IN to ground as listed in the *Recommended Operating Conditions* table and the *Input and Output Capacitor Selection* section. Place the input capacitor as close to the output of the device as possible. |
| OUT | 1 | Output | Regulated output voltage pin. A capacitor is required from OUT to ground for stability. For best transient response, use the nominal recommended value or larger ceramic capacitor from OUT to ground; see the *Recommended Operating Conditions* table and the *Input and Output Capacitor Selection* section. Place the output capacitor as close to output of the device as possible. |
| Thermal pad | Pad | — | Connect the thermal pad to a large area GND plane for improved thermal performance. |

# 6 Specifications

## 6.1 Absolute Maximum Ratings

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

| | MIN | MAX | UNIT |
|---|---|---|---|
| Supply voltage, $V_{IN}$ | –0.3 | 6.5 | V |
| Enable voltage, $V_{EN}$ | –0.3 | 6.5 | V |
| Output voltage, $V_{OUT}$ | –0.3 | $V_{IN}$ + 0.3(2) | V |
| Operating junction temperature, $T_J$ | –40 | 150 | °C |
| Storage temperature, $T_{stg}$ | –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) The absolute maximum rating is $V_{IN}$ + 0.3 V or 6.0 V, whichever is smaller

## 6.2 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) | ±500 | |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.

## 6.3 Recommended Operating Conditions

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

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{IN}$ | Input voltage | 1.5 | | 6.0 | V |
| $V_{OUT}$ | Output voltage | 0.55 | | 5.5 | V |
| $I_{OUT}$ | Output current | 0 | | 1 | A |
| $C_{IN}$ | Input capacitor | 1 | | | µF |
| $C_{OUT}$ | Output capacitor (1) | 1 | | 220 | µF |
| $V_{EN}$ | Enable voltage | 0 | | 6.0 | V |
| $f_{EN}$ | Enable toggle frequency | | | 10 | kHz |
| $T_J$ | Junction temperature | –40 | | 125 | °C |

(1) Minimun derated capacitance of 0.47 µF is required for stability

## 6.4 Thermal Information

| THERMAL METRIC (1) | | TLV759 DRV (WSON) 6 PINS | UNIT |
|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 80.3 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 98.7 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 44.8 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 6.1 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 45.0 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | 20.8 | °C/W |

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

## 6.5 Electrical Characteristics

at operating temperature range ($T_J$ = –40°C to 125°C), $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF, unless otherwise noted. All typical values at $T_J$ = 25°C.

| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $V_{FB}$ | Feedback voltage | $T_J$ = 25°C | | | 0.55 | | V |
| | Output accuracy (1) | $T_J$ = 25°C | | –0.7% | | 0.7% | |
| | | –40°C ≤ $T_J$ ≤ +85°C | | –1% | | 1% | |
| | | –40°C ≤ $T_J$ ≤ +125°C | | –1.5% | | 1.5% | |
| | Line regulation | $V_{OUT(NOM)}$ + 0.5 V (2) ≤ $V_{IN}$ ≤ 6.0 V | | | 2 | 7.5 | mV |
| | Load regulation | 0.1 mA ≤ $I_{OUT}$ ≤ 1 A, $V_{IN}$ ≥ 2.0 V | | | 0.03 | | V/A |
| $I_{GND}$ | Ground current | $I_{OUT}$ = 0 mA | $T_J$ = 25°C | 10 | 25 | 31 | µA |
| | | | –40°C ≤ $T_J$ ≤ +125°C | | | 35 | |
| $I_{SHDN}$ | Shutdown current | $V_{EN}$ ≤ 0.3 V, 1.5 V ≤ $V_{IN}$ ≤ 6.0 V | | | 0.1 | 1 | µA |

(1) When the device is connected to external feedback resistors at the FB pin, external resistor tolerances are not included
(2) $V_{IN}$ = 1.5V for $V_{OUT}$ < 1.0 V

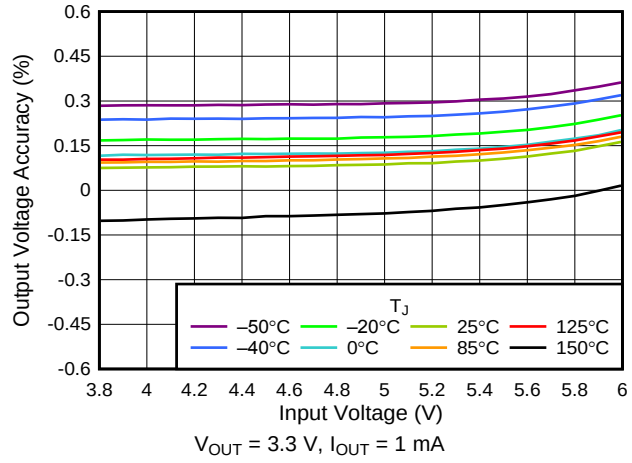
## Electrical Characteristics (continued)

at operating temperature range ($T_J$ = –40°C to 125°C), $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF, unless otherwise noted. All typical values at $T_J$ = 25°C.

| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{FB}$ | Feedback pin current | | | | 0.01 | 0.1 | µA |
| $I_{CL}$ | Output current limit | $V_{IN}$ = $V_{OUT(NOM)}$ + 1.0 V | $V_{OUT}$ = $V_{OUT(NOM)}$ - 0.2 V, $V_{OUT}$ < 1.5 V | 1.22 | 1.44 | 1.83 | A |
| | | | $V_{OUT}$ = 0.9 x $V_{OUT(NOM)}$, $V_{OUT}$ ≥ 1.5 V | 1.22 | 1.44 | 1.83 | |
| $I_{SC}$ | Short-circuit current limit | $V_{IN}$ = $V_{OUT(NOM)}$ + 1.0 V | $V_{OUT}$ = 0 V | | 770 | | mA |
| $V_{DO}$ | Dropout voltage | $I_{OUT}$ = 1 A, –40°C ≤ $T_J$ ≤ +125°C, $V_{OUT}$ = 0.95 × $V_{OUT(NOM)}$ | 0.65 V ≤ $V_{OUT}$ < 0.8 V | | 896 | 1050 | mV |
| | | | 0.8 V ≤ $V_{OUT}$ < 0.9 V | | 765 | 920 | |
| | | | 0.9 V ≤ $V_{OUT}$ < 1.0 V | | 700 | 850 | |
| | | | 1.0 V ≤ $V_{OUT}$ < 1.2 V | | 600 | 750 | |
| | | | 1.2 V ≤ $V_{OUT}$ < 1.5 V | | 464 | 585 | |
| | | | 1.5 V ≤ $V_{OUT}$ < 1.8 V | | 332 | 440 | |
| | | | 1.8 V ≤ $V_{OUT}$ < 2.5 V | | 264 | 360 | |
| | | | 2.5 V ≤ $V_{OUT}$ < 3.3 V | | 193 | 270 | |
| | | | 3.3 V ≤ $V_{OUT}$ ≤ 5.5 V | | 161 | 225 | |
| PSRR | Power-supply rejection ratio | $V_{IN}$ = $V_{OUT(NOM)}$ + 1 V, $I_{OUT}$ = 50 mA | f = 1 kHz | | 50 | | dB |
| | | | f = 100 kHz | | 45 | | |
| | | | f = 1 MHz | | 30 | | |
| $V_n$ | Output noise voltage | BW = 10 Hz to 100 kHz, $V_{OUT}$ = 0.9 V | | | 53 | | $\mu V_{RMS}$ |
| $V_{UVLO}$ | Undervoltage lockout | $V_{IN}$ rising | | 1.21 | 1.33 | 1.47 | V |
| | | $V_{IN}$ falling | | 1.17 | 1.29 | 1.42 | |
| $V_{UVLO, HYST}$ | Undervoltage lockout hysteresis | $V_{IN}$ hysteresis | | | 40 | | mV |
| $t_{STR}$ | Startup time | From EN low-to-high transition to $V_{OUT}$ = $V_{OUT(NOM)}$ x 95% | | | 500 | | µs |
| $V_{EN(HI)}$ | EN pin high voltage | | | 1.0 | | | V |
| $V_{EN(LO)}$ | EN pin low voltage | | | | | 0.3 | V |
| $I_{EN}$ | Enable pin current | $V_{IN}$ = $V_{EN}$ = 6.0 V | | | 10 | | nA |
| $R_{PULLDOWN}$ | Pulldown resistance | $V_{IN}$ = 6.0 V | | | 95 | | Ω |
| $T_{SD}$ | Thermal shutdown | Shutdown, temperature increasing | | | 170 | | °C |
| | | Reset, temperature decreasing | | | 155 | | |

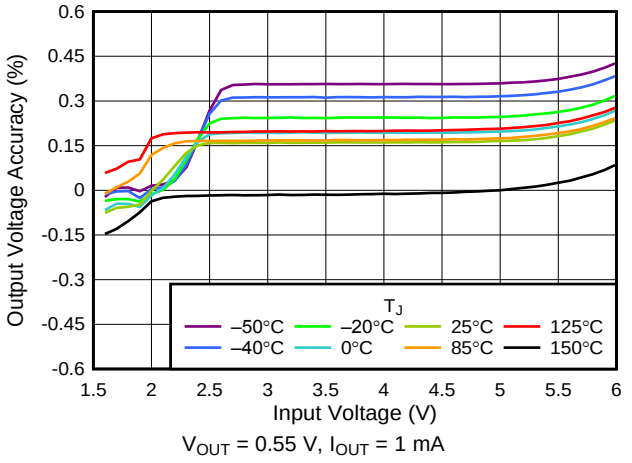
## 6.6 Typical Characteristics

at operating temperature range $T_J$ = 25°C, $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF (unless otherwise noted)



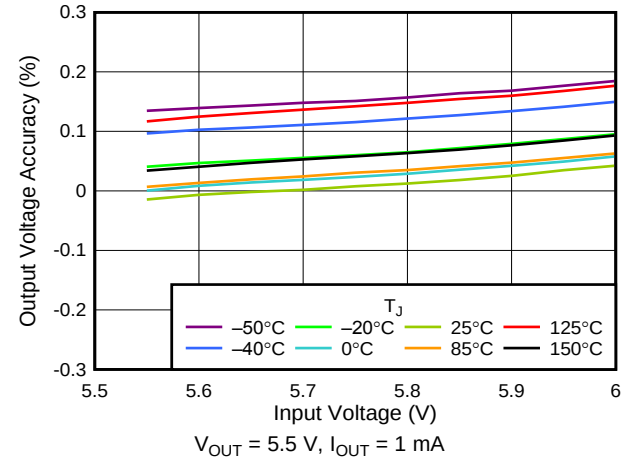

$V_{OUT}$ = 3.3 V, $I_{OUT}$ = 1 mA

**图 1. 3.3-V Line Regulation vs $V_{IN}$**




$V_{OUT}$ = 0.55 V, $I_{OUT}$ = 1 mA

**图 2. 0.55-V Line Regulation vs $V_{IN}$**




$V_{OUT}$ = 5.5 V, $I_{OUT}$ = 1 mA

**图 3. 5.5-V Line Regulation vs $V_{IN}$**

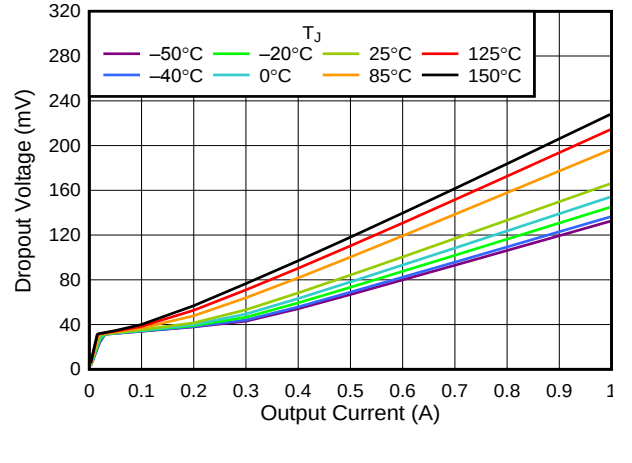



**图 4. 3.3-V Dropout Voltage vs $I_{OUT}$**

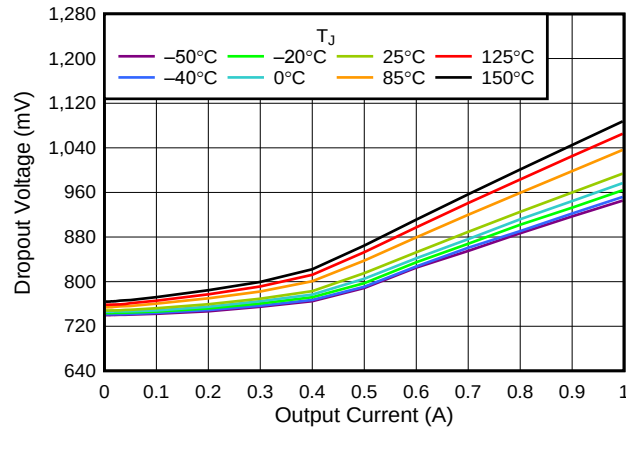



**图 5. 0.55-V Dropout Voltage vs $I_{OUT}$**

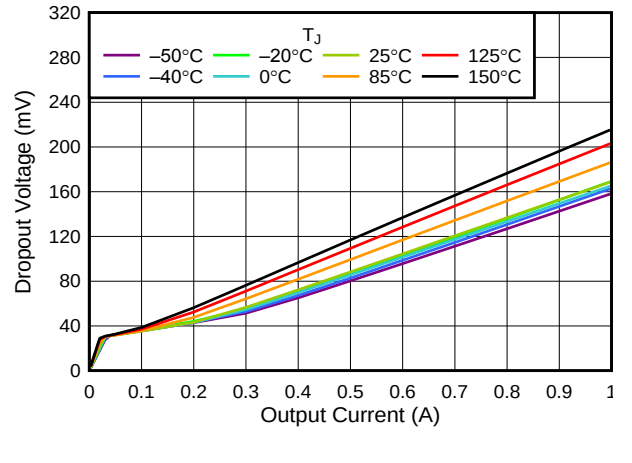



**图 6. 5.5-V Dropout Voltage vs $I_{OUT}$**

## Typical Characteristics (接下页)

at operating temperature range $T_J$ = 25°C, $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF (unless otherwise noted)

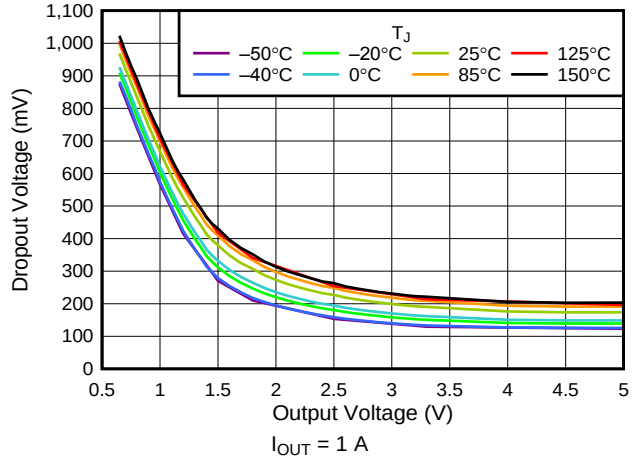



**图 7. $V_{DO}$ vs $V_{OUT}$**

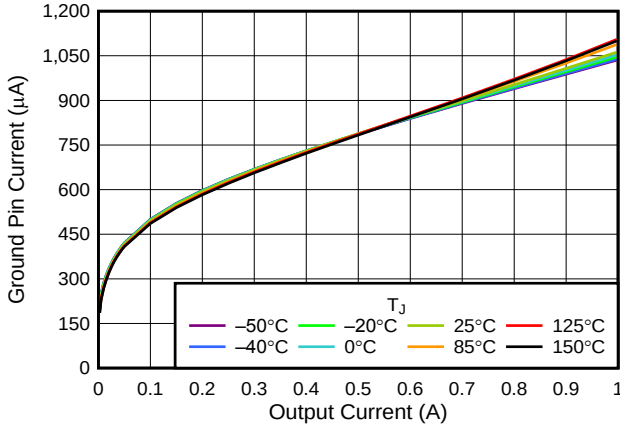



**图 8. $I_{GND}$ vs $I_{OUT}$**

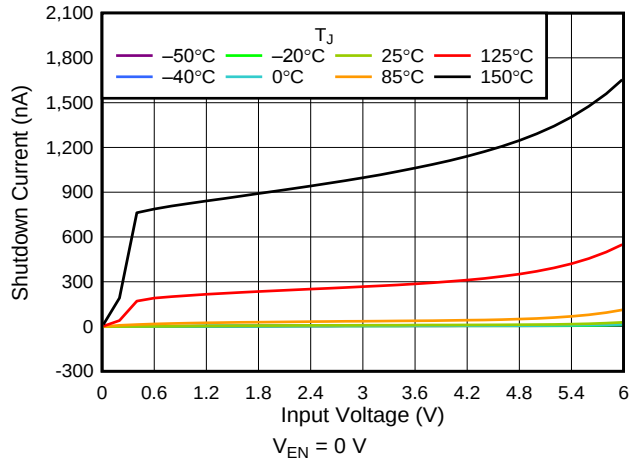



**图 9. $I_{SHDN}$ vs $V_{IN}$**

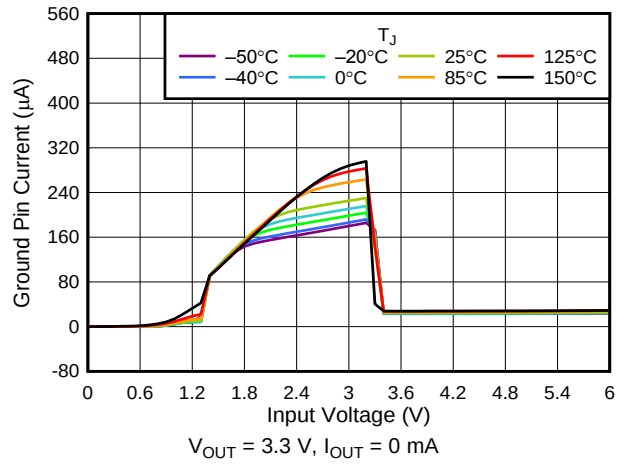



**图 10. $I_Q$ vs $V_{IN}$**

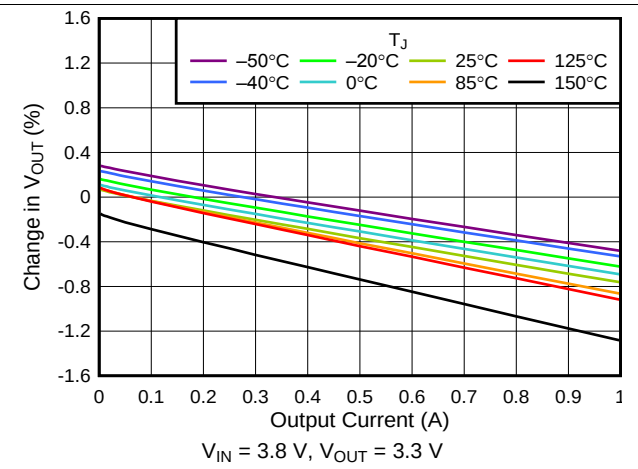



**图 11. 3.3-V Load Regulation vs $I_{OUT}$**

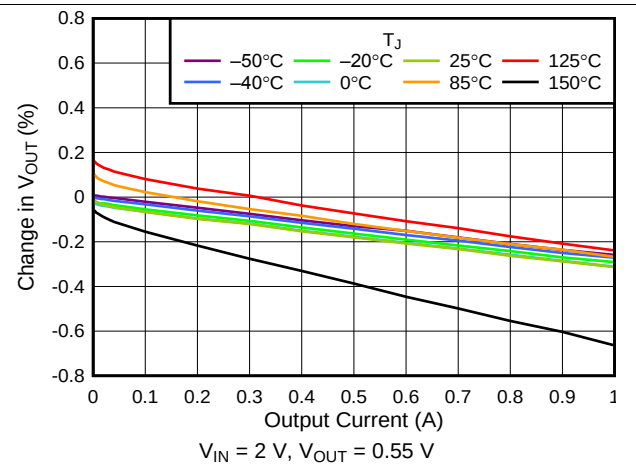



**图 12. 0.55-V Load Regulation vs $I_{OUT}$**

## Typical Characteristics (接下页)

at operating temperature range $T_J$ = 25°C, $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF (unless otherwise noted)

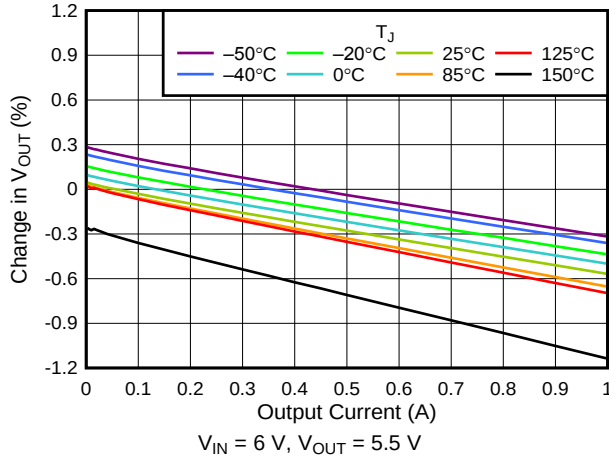



**图 13. 5-V Load Regulation vs $I_{OUT}$**

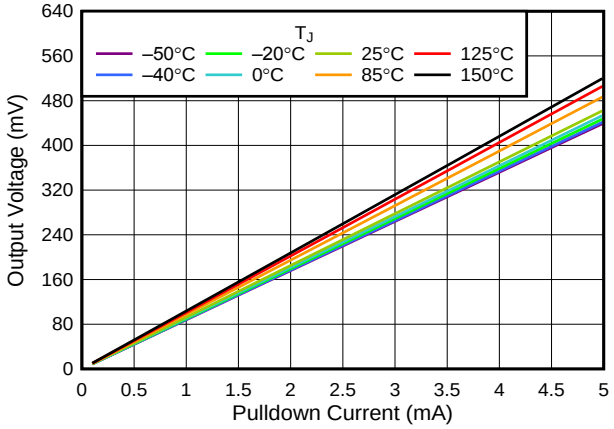



**图 14. $V_{OUT}$ vs $I_{OUT}$ Pulldown Resistor**

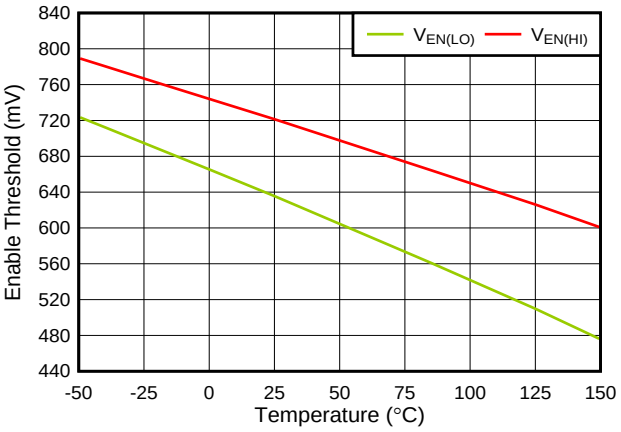



**图 15. $V_{EN(HI)}$ and $V_{EN(LO)}$ vs Temperature**

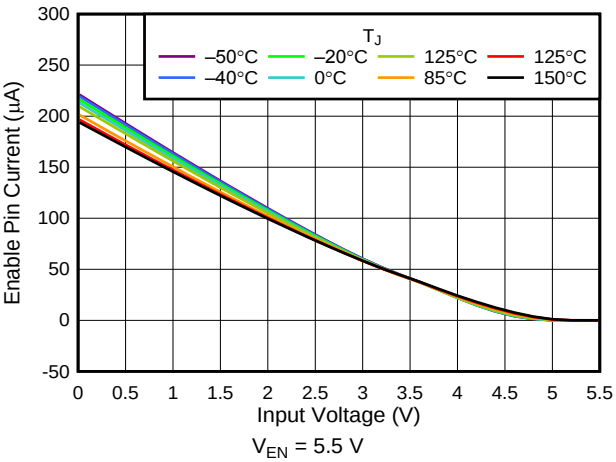



**图 16. $I_{EN}$ vs $V_{IN}$**

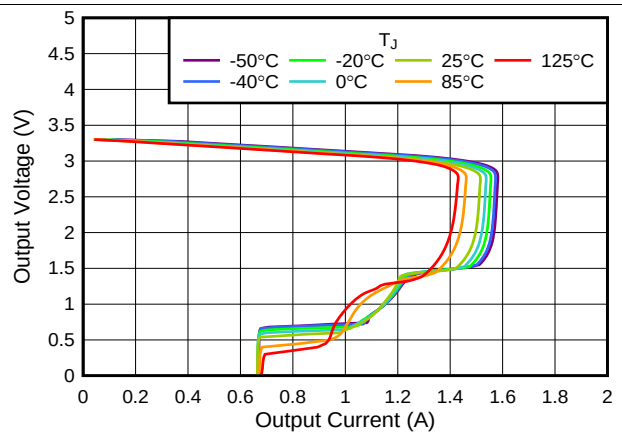



**图 17. 3.3-V Foldback Current Limit vs $I_{OUT}$**

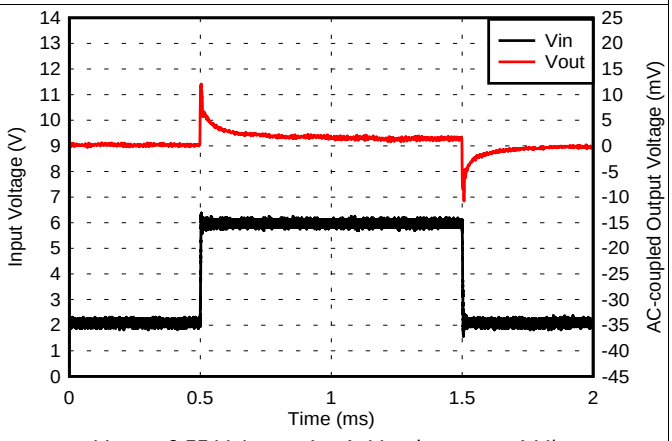
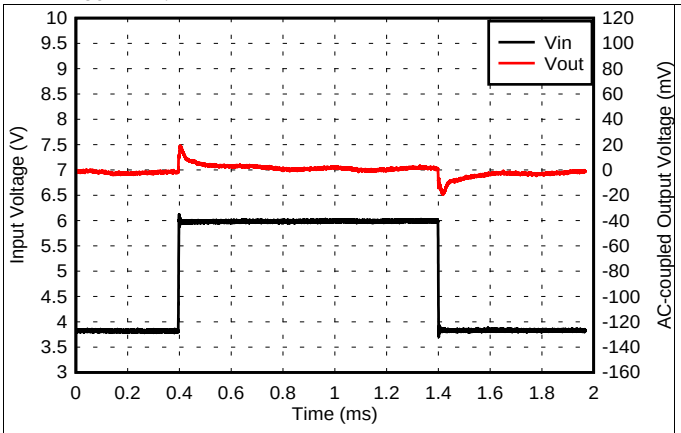



**图 18. 0.55-V Line Transient**

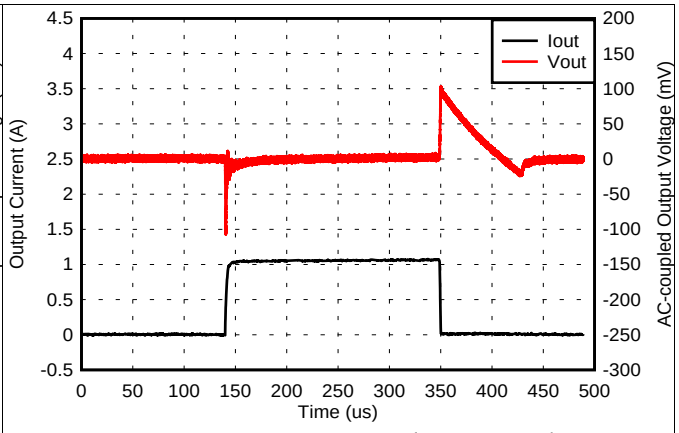
## Typical Characteristics (接下页)

at operating temperature range $T_J$ = 25°C, $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF (unless otherwise noted)



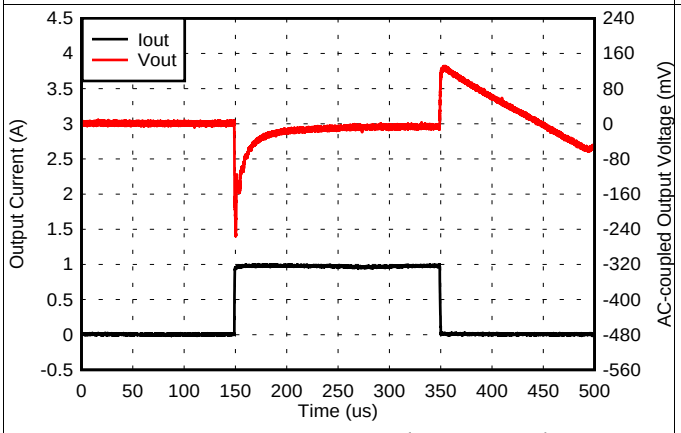

$V_{OUT}$ = 3.3 V, $I_{OUT}$ = 1 mA, $V_{IN}$ slew rate = 1 V/µs

**图 19. 3.3-V Line Transient**



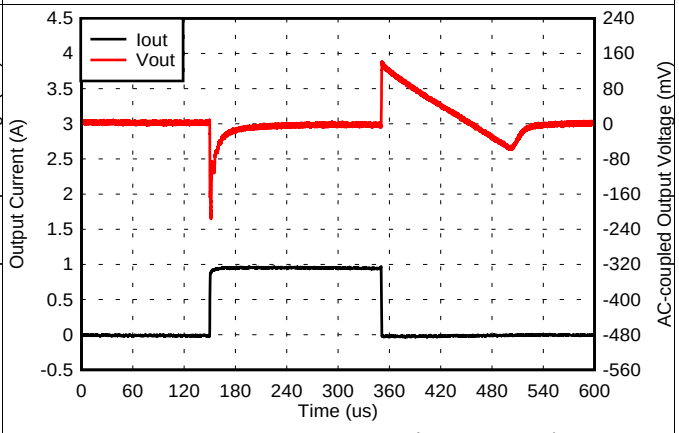

$V_{OUT}$ = 0.55 V, $V_{IN}$ = 2 V, $I_{OUT}$ slew rate = 1 A/µs

**图 20. 1-mA to 1-A Load Transient (0.55 V)**



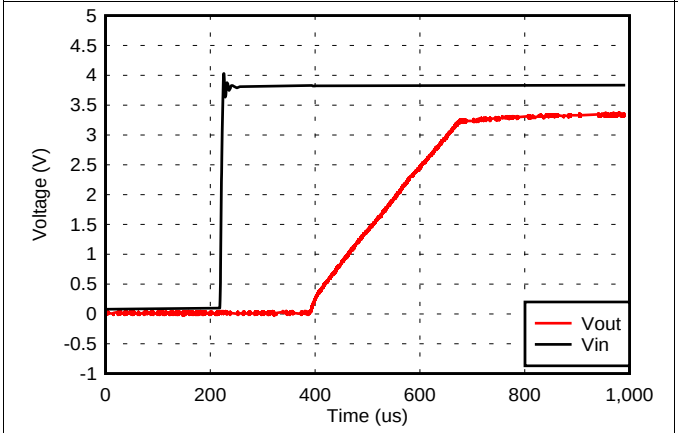

$V_{OUT}$ = 5 V, $V_{IN}$ = 5.5 V, $I_{OUT}$ slew rate = 1 A/µs

**图 21. 1-mA to 1-A Load Transient (5 V)**



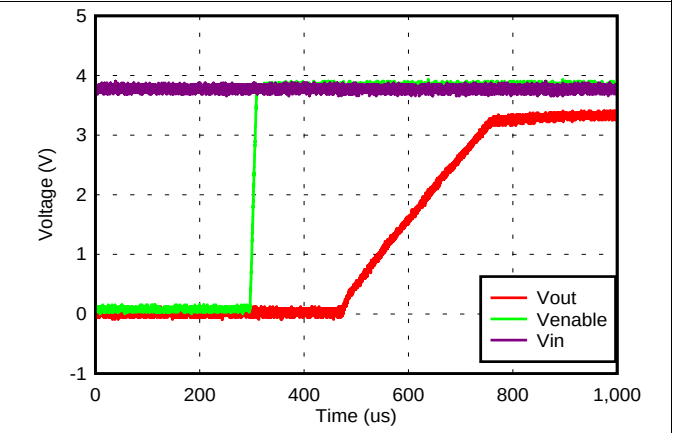

$V_{OUT}$ = 3.3 V, $V_{IN}$ = 3.8 V, $I_{OUT}$ slew rate = 1 A/µs

**图 22. 1-mA to 1-A Load Transient (3.3 V)**




$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 1 mA

**图 23. $V_{IN}$ Power-Up**

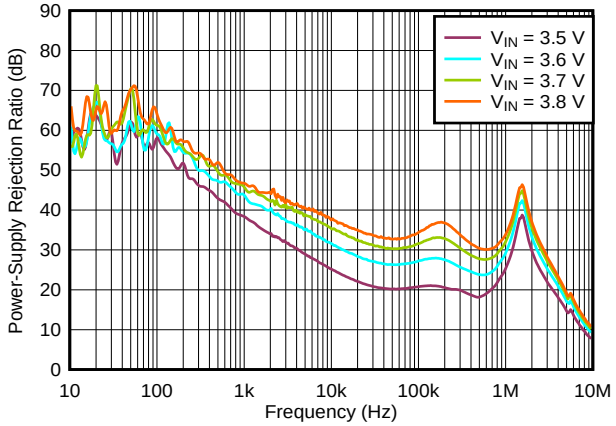



$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 1 mA

**图 24. Startup With EN**

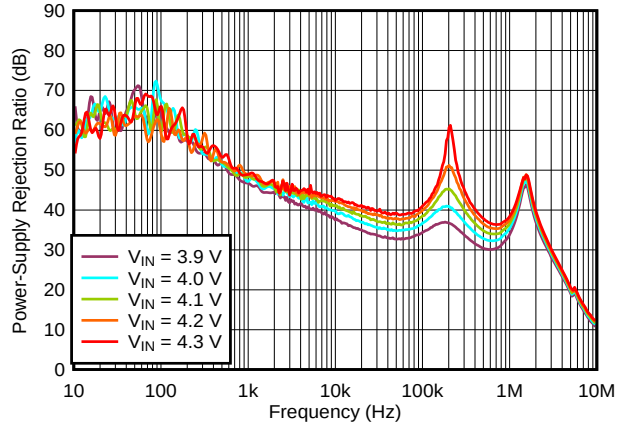
## Typical Characteristics (接下页)

at operating temperature range $T_J$ = 25°C, $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF (unless otherwise noted)



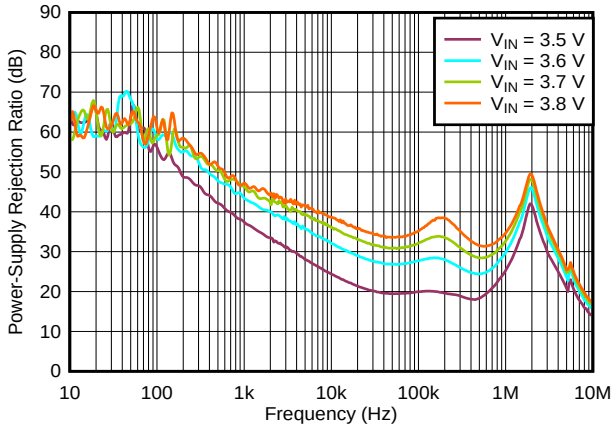

$V_{OUT}$ = 3.3 V, $I_{OUT}$ = 500 mA, $C_{OUT}$ = 2.2 µF

**图 25. PSRR vs Frequency and $V_{IN}$**



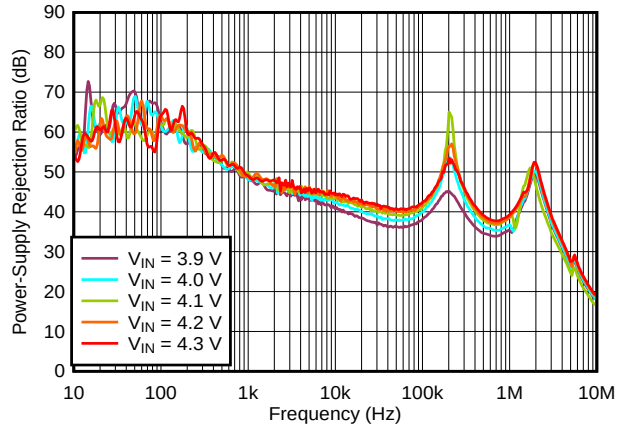

$V_{OUT}$ = 3.3 V, $I_{OUT}$ = 500 mA, $C_{OUT}$ = 2.2 µF

**图 26. PSRR vs Frequency and $V_{IN}$**



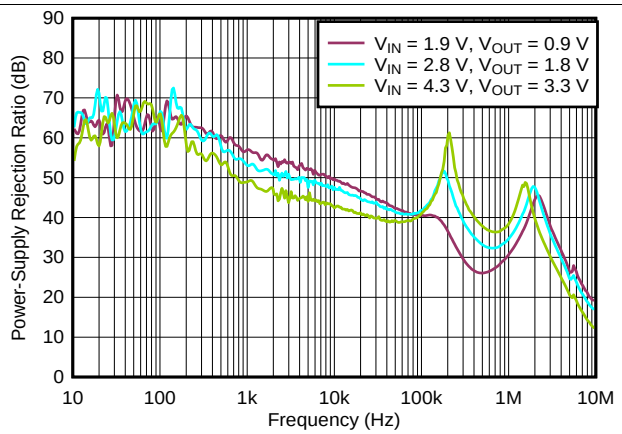

$V_{OUT}$ = 3.3 V, $I_{OUT}$ = 250 mA, $C_{OUT}$ = 2.2 µF

**图 27. PSRR vs Frequency and $V_{IN}$**



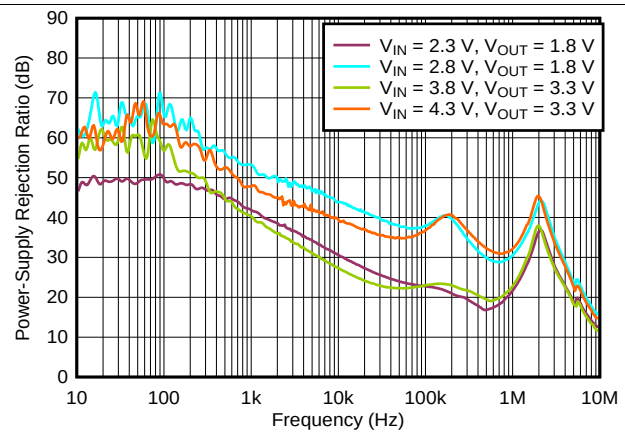

$V_{OUT}$ = 3.3 V, $I_{OUT}$ = 250 mA, $C_{OUT}$ = 2.2 µF

**图 28. PSRR vs Frequency and $V_{IN}$**




$I_{OUT}$ = 500 mA, $C_{OUT}$ = 2.2 µF

**图 29. PSRR vs Frequency**

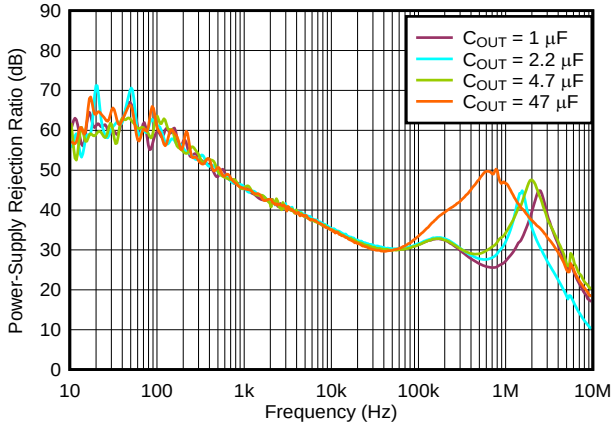



$I_{OUT}$ = 1 A, $C_{OUT}$ = 2.2 µF

**图 30. PSRR vs Frequency**

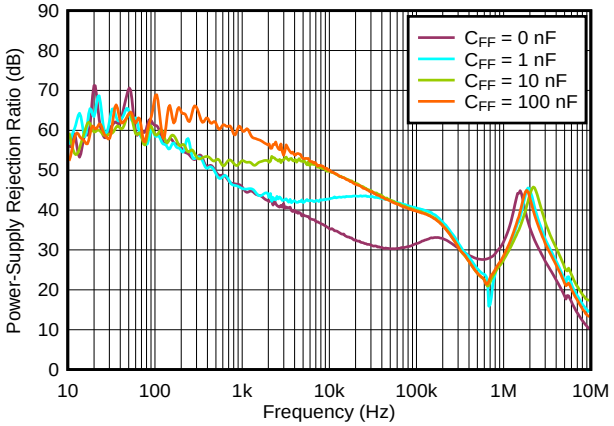
## Typical Characteristics (接下页)

at operating temperature range $T_J$ = 25°C, $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF (unless otherwise noted)



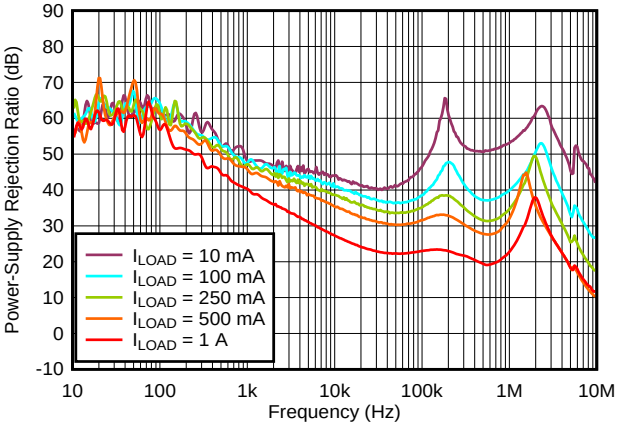

$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 500 mA

**图 31. PSRR vs Frequency and $C_{OUT}$**



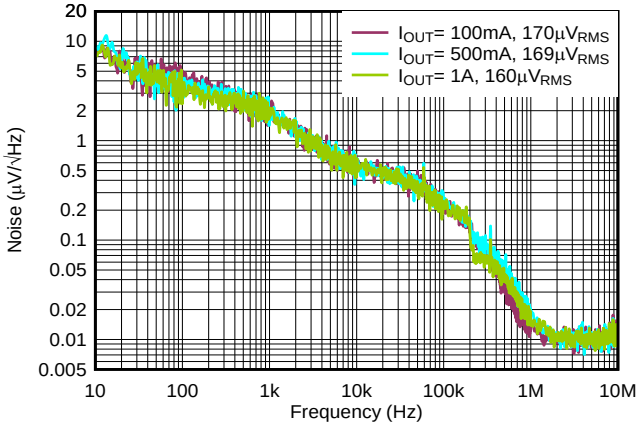

$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 500 mA

**图 32. PSRR vs Frequency and $C_{FF}$**



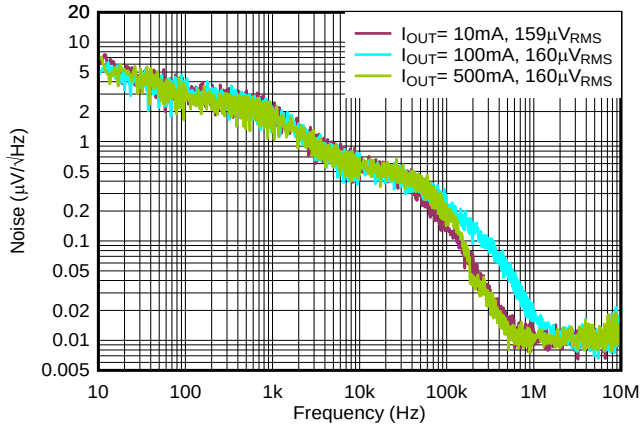

$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $C_{OUT}$ = 2.2 µF

**图 33. PSRR vs Frequency and $I_{LOAD}$**



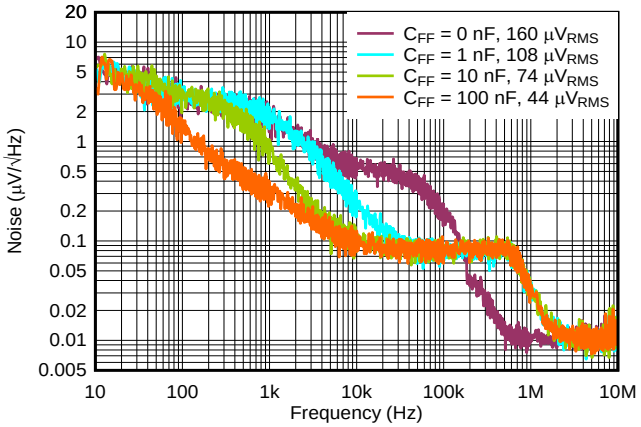

$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $C_{OUT}$ = 4.7 µF,
$V_{RMS}$ BW = 10 Hz to 100 kHz

**图 34. Output Spectral Noise Density**




$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $C_{OUT}$ = 2.2 µF,
$V_{RMS}$ BW = 10 Hz to 100 kHz

**图 35. Output Spectral Noise Density**

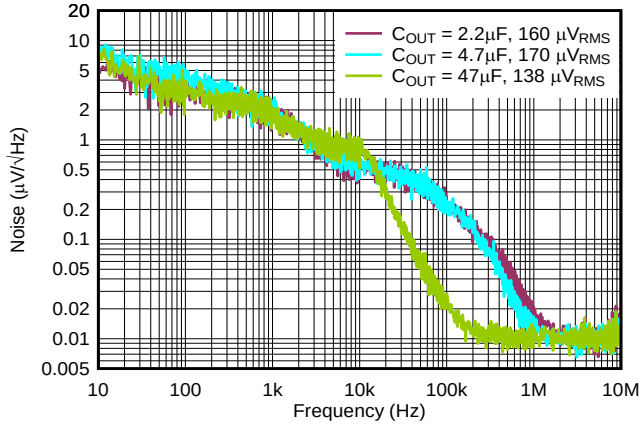



$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 500 mA, $C_{OUT}$ = 2.2 µF,
$V_{RMS}$ BW = 10 Hz to 100 kHz

**图 36. Output Spectral Noise Density vs Frequency and $C_{FF}$**

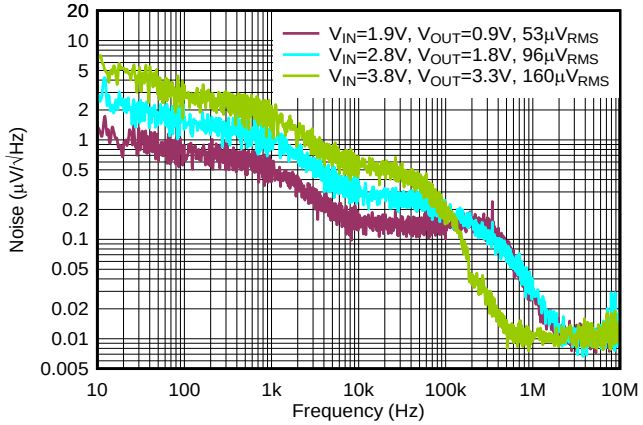
## Typical Characteristics (接下页)

at operating temperature range $T_J$ = 25°C, $V_{IN}$ = $V_{OUT(NOM)}$ + 0.5 V or 1.5 V (whichever is greater), $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, and $C_{IN}$ = $C_{OUT}$ = 1 µF (unless otherwise noted)




$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 100 mA, $C_{FF}$ = 0 µF, $V_{RMS}$ BW = 10 Hz to 100 kHz

**图 37. Output Spectral Noise Density vs Frequency and $C_{OUT}$**




$I_{OUT}$ = 500 mA, $C_{OUT}$ = 2.2 µF, $V_{RMS}$ BW = 10 Hz to 100 kHz

**图 38. Output Spectral Noise Density vs Frequency**

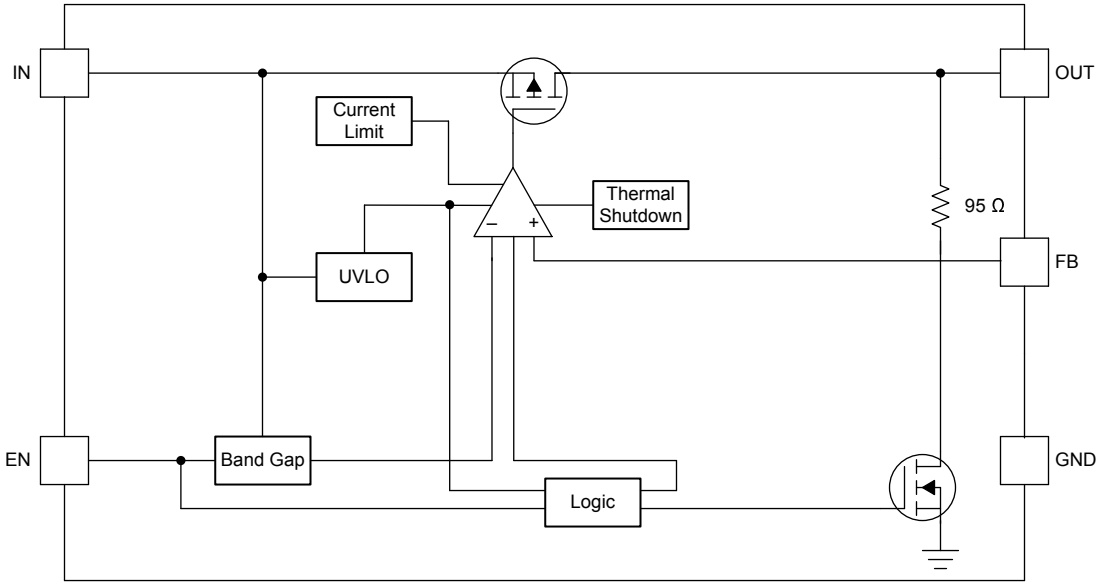
# 7 Detailed Description

## 7.1 Overview

The TLV759P is a next-generation, low-dropout regulator (LDO). This device consumes low quiescent current and delivers excellent line and load transient performance. These characteristics, combined with low noise and good PSRR with low dropout voltage, make this device ideal for portable consumer applications.

This regulator offers foldback current limit, shutdown, and thermal protection. The operating junction temperature for this device is –40°C to +125°C.

## 7.2 Functional Block Diagram




## 7.3 Feature Description

### 7.3.1 Undervoltage Lockout (UVLO)

The TLV759P uses an undervoltage lockout (UVLO) circuit that disables the output until the input voltage is greater than the rising UVLO voltage ($V_{UVLO}$). This circuit ensures that the device does not exhibit any unpredictable behavior when the supply voltage is lower than the operational range of the internal circuitry. When $V_{IN}$ is less than $V_{UVLO}$, the output is connected to ground with a pulldown resistor ($R_{PULLDOWN}$).

### 7.3.2 Shutdown

The enable pin (EN) is active high. Enable the device by forcing the EN pin to exceed $V_{EN(HI)}$. Turn off the device by forcing the EN pin to drop below $V_{EN(LO)}$. If shutdown capability is not required, connect EN to IN.

The TLV759P has an internal pulldown MOSFET that connects an $R_{PULLDOWN}$ resistor to ground when the device is disabled. The discharge time after disabling depends on the output capacitance ($C_{OUT}$) and the load resistance ($R_L$) in parallel with the pulldown resistor ($R_{PULLDOWN}$). 公式 1 calculates the time constant:

$$\tau = ( R_{PULLDOWN} \times R_L) / (R_{PULLDOWN} + R_L) \quad (1)$$

## Feature Description (continued)

### 7.3.3 Foldback Current Limit

The device has an internal current limit circuit that protects the regulator during transient high-load current faults or shorting events. The current limit is a hybrid brickwall-foldback scheme. The current limit transitions from a brickwall scheme to a foldback scheme at the foldback voltage ($V_{FOLDBACK}$). In a high-load current fault with the output voltage above $V_{FOLDBACK}$, the brickwall scheme limits the output current to the current limit ($I_{CL}$). When the voltage drops below $V_{FOLDBACK}$, a foldback current limit activates that scales back the current as the output voltage approaches GND. When the output is shorted, the device supplies a typical current called the short-circuit current limit ($I_{SC}$). $I_{CL}$ and $I_{SC}$ are listed in the *Electrical Characteristics* table.

For this device, $V_{FOLDBACK} = 0.4\ V \times V_{OUT(NOM)}$.

The output voltage is not regulated when the device is in current limit. When a current limit event occurs, the device begins to heat up because of the increase in power dissipation. When the device is in brickwall current limit, the pass transistor dissipates power [$(V_{IN} – V_{OUT}) \times I_{CL}$]. When the device output is shorted and the output is below $V_{FOLDBACK}$, the pass transistor dissipates power [$(V_{IN} – V_{OUT}) \times I_{SC}$]. If thermal shutdown is triggered, the device turns off. After the device cools down, the internal thermal shutdown circuit turns the device back on. If the output current fault condition continues, the device cycles between current limit and thermal shutdown. For more information on current limits, see the *Know Your Limits* application report.

Figure 39 shows a diagram of the foldback current limit.

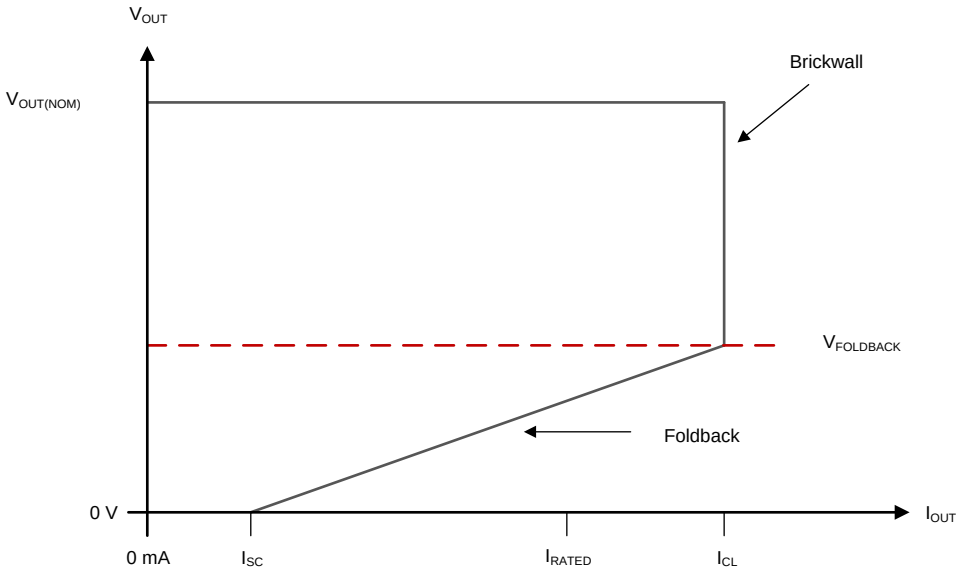



**Figure 39. Foldback Current Limit**

### 7.3.4 Thermal Shutdown

Thermal shutdown protection disables the output when the junction temperature rises to approximately 170°C. Disabling the device eliminates the power dissipated by the device, allowing the device to cool. When the junction temperature cools to approximately 155°C, the output circuitry is again enabled. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This cycling limits regulator dissipation, protecting the LDO from damage as a result of overheating.

Activating the thermal shutdown feature usually indicates excessive power dissipation as a result of the product of the ($V_{IN} – V_{OUT}$) voltage and the load current. For reliable operation, limit junction temperature to 125°C maximum. To estimate the margin of safety in a complete design, increase the ambient temperature until the thermal protection is triggered; use worst-case loads and signal conditions.

## Feature Description (continued)

The TLV759P internal protection circuitry protects against overload conditions but is not intended to be activated in normal operation. Continuously running the TLV759P into thermal shutdown degrades device reliability.

## 7.4 Device Functional Modes

### 7.4.1 Device Functional Mode Comparison

The *Device Functional Mode Comparison* table shows the conditions that lead to the different modes of operation. See the *Electrical Characteristics* table for parameter values.

**Table 1. Device Functional Mode Comparison**

| OPERATING MODE | PARAMETER | | | |
|---|---|---|---|---|
| | $V_{IN}$ | $V_{EN}$ | $I_{OUT}$ | $T_J$ |
| Normal operation | $V_{IN} > V_{OUT(nom)} + V_{DO}$ and $V_{IN} > V_{IN(min)}$ | $V_{EN} > V_{EN(HI)}$ | $I_{OUT} < I_{OUT(max)}$ | $T_J < T_{SD(shutdown)}$ |
| Dropout operation | $V_{IN(min)} < V_{IN} < V_{OUT(nom)} + V_{DO}$ | $V_{EN} > V_{EN(HI)}$ | $I_{OUT} < I_{OUT(max)}$ | $T_J < T_{SD(shutdown)}$ |
| Disabled (any true condition disables the device) | $V_{IN} < V_{UVLO}$ | $V_{EN} < V_{EN(LOW)}$ | Not applicable | $T_J > T_{SD(shutdown)}$ |

### 7.4.2 Normal Operation

The device regulates to the nominal output voltage when the following conditions are met:

- The input voltage is greater than the nominal output voltage plus the dropout voltage ($V_{OUT(nom)} + V_{DO}$)
- The output current is less than the current limit ($I_{OUT} < I_{CL}$)
- The device junction temperature is less than the thermal shutdown temperature ($T_J < T_{SD}$)
- The enable voltage has previously exceeded the enable rising threshold voltage and has not yet decreased to less than the enable falling threshold

### 7.4.3 Dropout Operation

If the input voltage is lower than the nominal output voltage plus the specified dropout voltage, but all other conditions are met for normal operation, the device operates in dropout mode. In this mode, the output voltage tracks the input voltage. During this mode, the transient performance of the device becomes significantly degraded because the pass transistor is in the ohmic or triode region, and acts as a switch. Line or load transients in dropout can result in large output-voltage deviations.

When the device is in a steady dropout state (defined as when the device is in dropout, $V_{IN} < V_{OUT(NOM)} + V_{DO}$, directly after being in a normal regulation state, but *not* during startup), the pass transistor is driven into the ohmic or triode region. When the input voltage returns to a value greater than or equal to the nominal output voltage plus the dropout voltage ($V_{OUT(NOM)} + V_{DO}$), the output voltage can overshoot for a short period of time while the device pulls the pass transistor back into the linear region.

### 7.4.4 Disabled

The output of the device can be shutdown by forcing the voltage of the enable pin to less than the maximum EN pin low-level input voltage (see the *Electrical Characteristics* table). When disabled, the pass transistor is turned off, internal circuits are shutdown, and the output voltage is actively discharged to ground by an internal discharge circuit from the output to ground.

# 8 Application and Implementation

**注**

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

## 8.1 Application Information

### 8.1.1 Adjustable Device Feedback Resistors

图 40 shows that the output voltage of the TLV759P can be adjusted from 0.55 V to 5.5 V by using a resistor divider network.

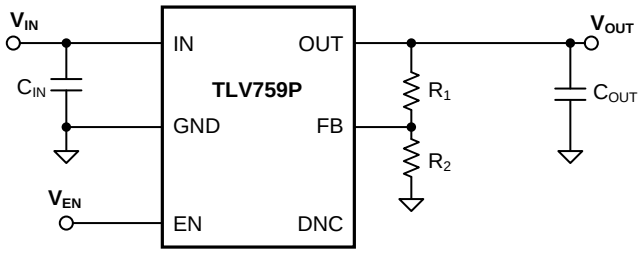



**图 40. Adjustable Operation**

The adjustable-version device requires external feedback divider resistors to set the output voltage. $V_{OUT}$ is set using the feedback divider resistors, $R_1$ and $R_2$, according to the following equation:

$$V_{OUT} = V_{FB} \times (1 + R_1 / R_2) \quad (2)$$

For this device, $V_{FB}$ = 0.55 V.

To ignore the FB pin current error term in the $V_{OUT}$ equation, set the feedback divider current to 100x the FB pin current listed in the *Electrical Characteristics* table. This setting provides the maximum feedback divider series resistance, as shown in the following equation:

$$R_1 + R_2 \leq V_{OUT} / (I_{FB} \times 100) \quad (3)$$

For this device, $I_{FB}$ = 10 nA.

### 8.1.2 Input and Output Capacitor Selection

The TLV759P requires an output capacitance of 0.47 µF or larger for stability. Use X5R- and X7R-type ceramic capacitors because these capacitors have minimal variation in value and equivalent series resistance (ESR) over temperature. When choosing a capacitor for a specific application, pay attention to the dc bias characteristics for the capacitor. Higher output voltages cause a significant derating of the capacitor. For best performance, the maximum recommended output capacitance is 220 µF.

Although an input capacitor is not required for stability, good analog design practice is to connect a capacitor from IN to GND. Some input supplies have a high impedance, thus placing the input capacitor on the input supply helps reduce the input impedance. This capacitor counteracts reactive input sources and improves transient response, input ripple, and PSRR. If the input supply has a high impedance over a large range of frequencies, several input capacitors can be used in parallel to lower the impedance over frequency. Use a higher-value capacitor if large, fast, rise-time load transients are anticipated, or if the device is located several inches from the input power source.

## Application Information (接下页)

### 8.1.3 Dropout Voltage

The TLV759P uses a PMOS pass transistor to achieve low dropout. When ($V_{IN}$ – $V_{OUT}$) is less than the dropout voltage ($V_{DO}$), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the $R_{DS(ON)}$ of the PMOS pass element. $V_{DO}$ scales approximately with output current because the PMOS device behaves like a resistor in dropout mode. As with any linear regulator, PSRR and transient response degrade as ($V_{IN}$ – $V_{OUT}$) approaches dropout operation.

### 8.1.4 Exiting Dropout

Some applications have transients that place the LDO into dropout, such as slower ramps on $V_{IN}$ during start-up. As with other LDOs, the output may overshoot on recovery from these conditions. A ramping input supply causes an LDO to overshoot on start-up, as shown in 图 41, when the slew rate and voltage levels are in the correct range. Use an enable signal to avoid this condition.

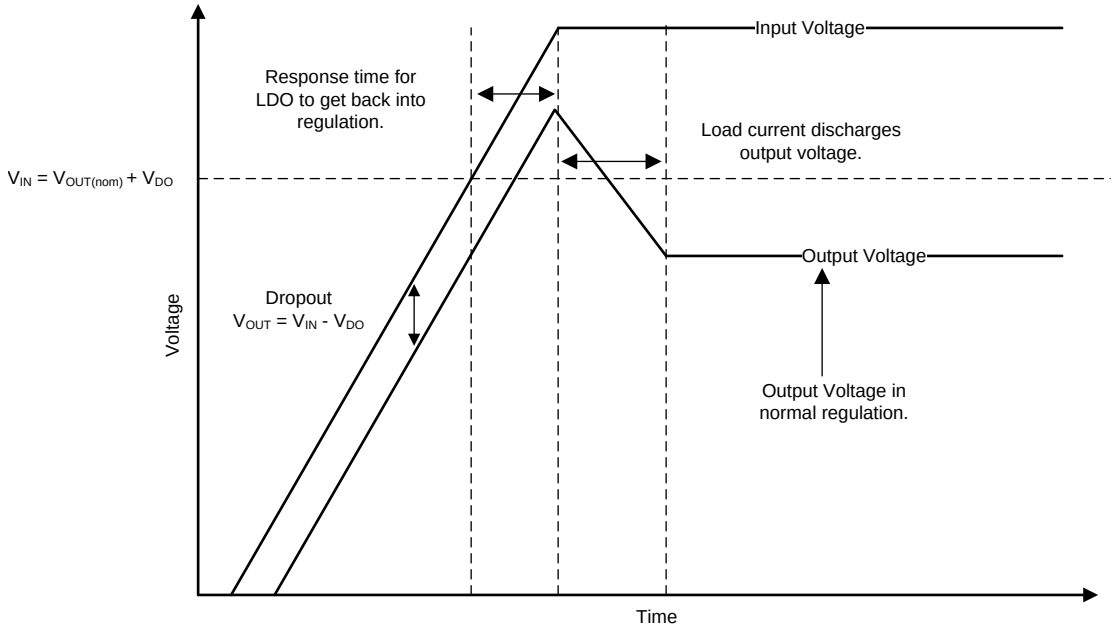



**图 41. Startup Into Dropout**

Line transients out of dropout can also cause overshoot on the output of the regulator. These overshoots are caused by the error amplifier having to drive the gate capacitance of the pass element and bring the gate back to the correct voltage for proper regulation. 图 42 illustrates what is happening internally with the gate voltage and how overshoot can be caused during operation. When the LDO is placed in dropout, the gate voltage (VGS) is pulled all the way down to ground to give the pass device the lowest on-resistance as possible. However, if a line transient occurs when the device is in dropout, the loop is not in regulation and can cause the output to overshoot until the loop responds and the output current pulls the output voltage back down into regulation. If these transients are not acceptable, then continue to add input capacitance in the system until the transient is slow enough to reduce the overshoot.

## Application Information (接下页)

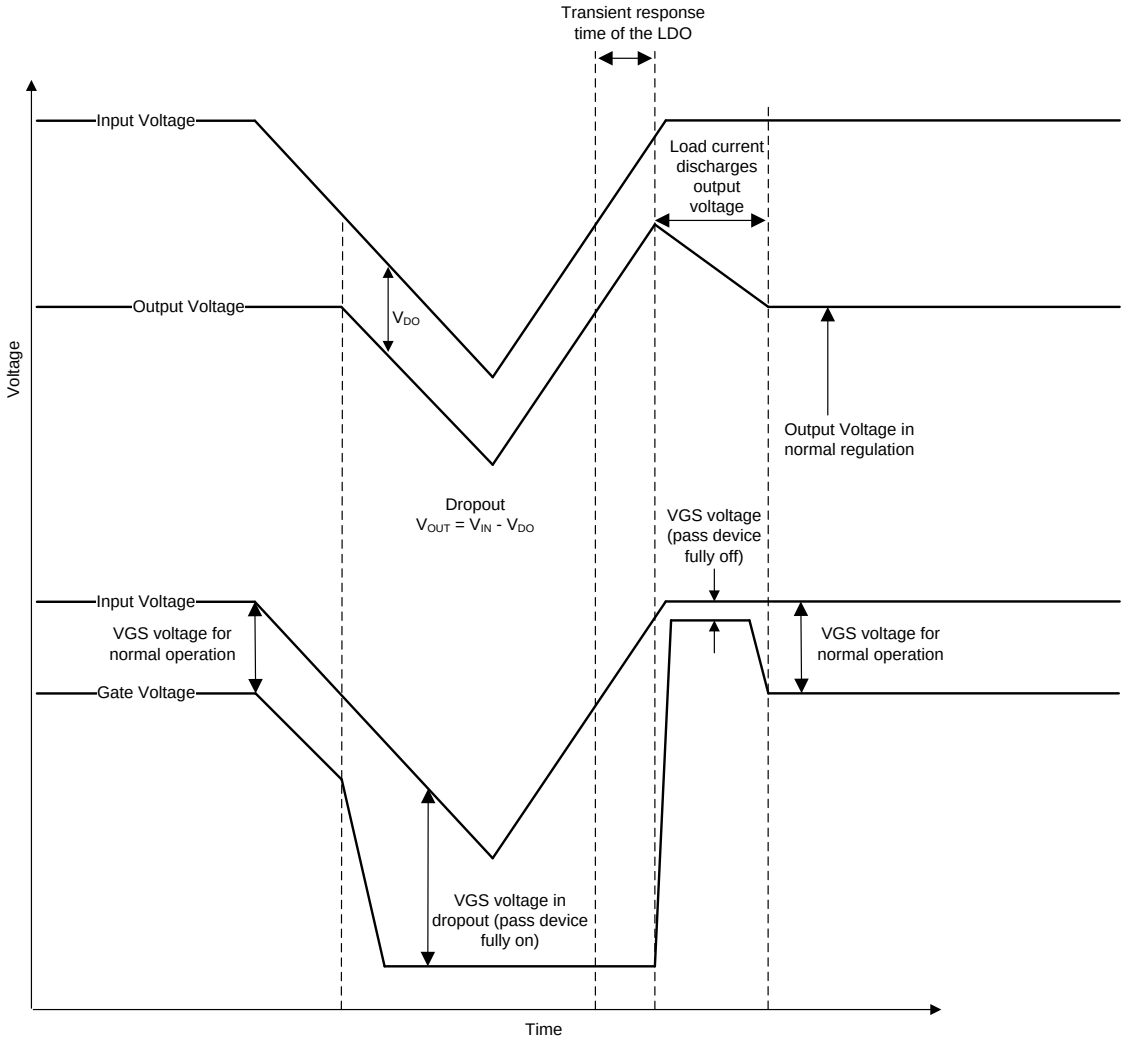



**图 42. Line Transients From Dropout**

### 8.1.5 Reverse Current

As with most LDOs, excessive reverse current can damage this device.

Reverse current flows through the body diode on the pass element instead of the normal conducting channel. At high magnitudes, this current flow degrades the long-term reliability of the device, as a result of one of the following conditions:

- Degradation caused by electromigration
- Excessive heat dissipation
- Potential for a latch-up condition

Conditions where reverse current can occur are outlined in this section, all of which can exceed the absolute maximum rating of $V_{OUT} > V_{IN} + 0.3$ V:

- If the device has a large $C_{OUT}$ and the input supply collapses with little or no load current
- The output is biased when the input supply is not established
- The output is biased above the input supply

## Application Information (接下页)

If reverse current flow is expected in the application, external protection must be used to protect the device. 图 43 shows one approach of protecting the device.

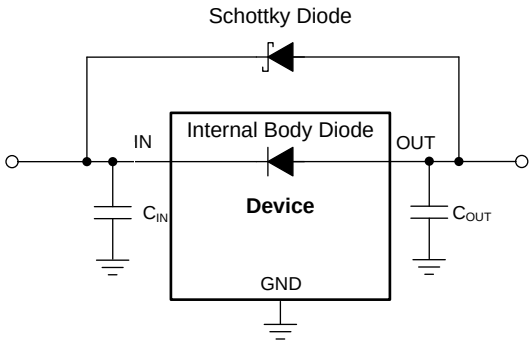



**图 43. Example Circuit for Reverse Current Protection Using a Schottky Diode**

### 8.1.6 Power Dissipation ($P_D$)

Circuit reliability requires consideration of the device power dissipation, location of the circuit on the printed circuit board (PCB), and correct sizing of the thermal plane. The PCB area around the regulator must have few or no other heat-generating devices that cause added thermal stress.

To first-order approximation, power dissipation in the regulator depends on the input-to-output voltage difference and load conditions. Equation 4 calculates power dissipation ($P_D$).

$$P_D = (V_{IN} – V_{OUT}) \times I_{OUT} \quad (4)$$

**NOTE**

Power dissipation can be minimized, and therefore greater efficiency can be achieved, by correct selection of the system voltage rails. For the lowest power dissipation use the minimum input voltage required for correct output regulation.

For devices with a thermal pad, the primary heat conduction path for the device package is through the thermal pad to the PCB. Solder the thermal pad to a copper pad area under the device. This pad area must contain an array of plated vias that conduct heat to additional copper planes for increased heat dissipation.

The maximum power dissipation determines the maximum allowable ambient temperature ($T_A$) for the device. According to Equation 5, power dissipation and junction temperature are most often related by the junction-to-ambient thermal resistance ($R_{\theta JA}$) of the combined PCB and device package and the temperature of the ambient air ($T_A$).

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

Thermal resistance ($R_{\theta JA}$) is highly dependent on the heat-spreading capability built into the particular PCB design, and therefore varies according to the total copper area, copper weight, and location of the planes. The junction-to-ambient thermal resistance listed in the *Thermal Information* table is determined by the JEDEC standard PCB and copper-spreading area, and is used as a relative measure of package thermal performance.

## 8.2 Feed-Forward Capacitor ($C_{FF}$)

For the adjustable-voltage version device, a feed-forward capacitor ($C_{FF}$) can be connected from the OUT pin to the FB pin. $C_{FF}$ improves transient, noise, and PSRR performance, but is not required for regulator stability. Recommended $C_{FF}$ values are listed in the *Recommended Operating Conditions* table. A higher capacitance $C_{FF}$ can be used; however, the startup time increases. For a detailed description of $C_{FF}$ tradeoffs, see the *Pros and Cons of Using a Feedforward Capacitor with a Low-Dropout Regulator* application report.

## 8.3 Typical Application

图 44 shows the typical application circuit for the TLV759P. Input and output capacitances must be at least 1 µF.

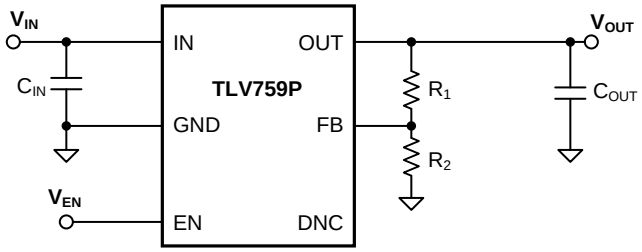



**图 44. TLV759P Typical Application**

### 8.3.1 Design Requirements

Use the parameters listed in 表 2 for typical linear regulator applications.

**表 2. Design Parameters**

| PARAMETER | DESIGN REQUIREMENT |
|---|---|
| Input voltage | 3.8 V |
| Output voltage | 3.3 V, ±1% |
| Input current | 1 A (maximum) |
| Output load | 1-A DC |
| Maximum ambient temperature | 70°C |

### 8.3.2 Detailed Design Procedure

Input and output capacitors are required to achieve the output voltage transient requirements. Capacitance values of 2.2 µF are selected to give the maximum output capacitance in a small, low-cost package; see the *Input and Output Capacitor Selection* section for details.

图 40 illustrates the output voltage of the TLV759P. Set the output voltage using the resistor divider; see the section for details.

#### *8.3.2.1 Input Current*

During normal operation, the input current to the LDO is approximately equal to the output current of the LDO. During startup, the input current is higher as a result of the inrush current charging the output capacitor. Use 公式 6 to calculate the current through the input.

$$I_{OUT(t)} = \left[\frac{C_{OUT} \times dV_{OUT}(t)}{dt}\right] + \left[\frac{V_{OUT}(t)}{R_{LOAD}}\right] \quad (6)$$

where:

- $V_{OUT}(t)$ is the instantaneous output voltage of the turn-on ramp
- $dV_{OUT}(t) / dt$ is the slope of the $V_{OUT}$ ramp
- $R_{LOAD}$ is the resistive load impedance

#### *8.3.2.2 Thermal Dissipation*

The junction temperature can be determined using the junction-to-ambient thermal resistance ($R_{\theta JA}$) and the total power dissipation ($P_D$). Use 公式 7 to calculate the power dissipation. Multiply $P_D$ by $R_{\theta JA}$ as 公式 8 shows and add the ambient temperature ($T_A$) to calculate the junction temperature ($T_J$).

$$P_D = (I_{GND} + I_{OUT}) \times (V_{IN} - V_{OUT}) \quad (7)$$

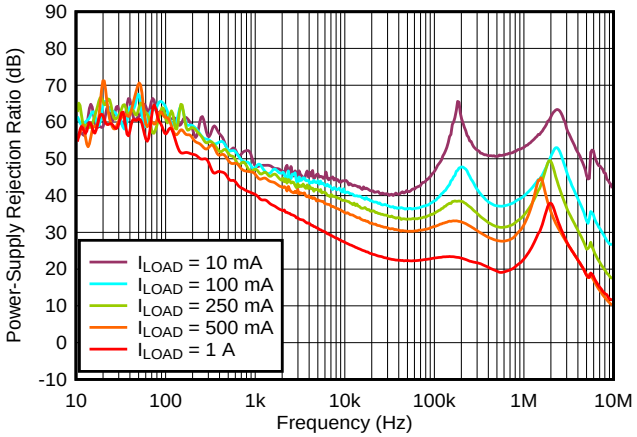
$$T_J = R_{\theta JA} \times P_D + T_A \quad (8)$$

Calculate the maximum ambient temperature as 公式 9 shows if the ($T_{J(MAX)}$) value does not exceed 125°C. 公式 10 calculates the maximum ambient temperature with a value of 84.85°C.

$$T_{A(MAX)} = T_{J(MAX)} – R_{\theta JA} \times P_D \quad (9)$$

$$T_{A(MAX)} = 125°C – 80.3°C/W \times (3.8\ V – 3.3\ V) \times (1\ A) = 84.85°C \quad (10)$$

### 8.3.3 Application Curve




$V_{IN}$ = 3.8 V, $V_{OUT}$ = 3.3 V, $C_{OUT}$ = 2.2 µF

**图 45. PSRR vs Frequency and $I_{LOAD}$**

# 9 Power Supply Recommendations

Connect a low output impedance power supply directly to the IN pin of the TLV759P.

# 10 Layout

## 10.1 Layout Guidelines

- Place input and output capacitors as close to the device as possible.
- Use copper planes for device connections in order to optimize thermal performance.
- Place thermal vias around the device to distribute heat.
- Do not place a thermal via directly beneath the thermal pad of the DRV package. A via can wick solder or solder paste away from the thermal pad joint during the soldering process, leading to a compromised solder joint on the thermal pad.

## 10.2 Layout Example

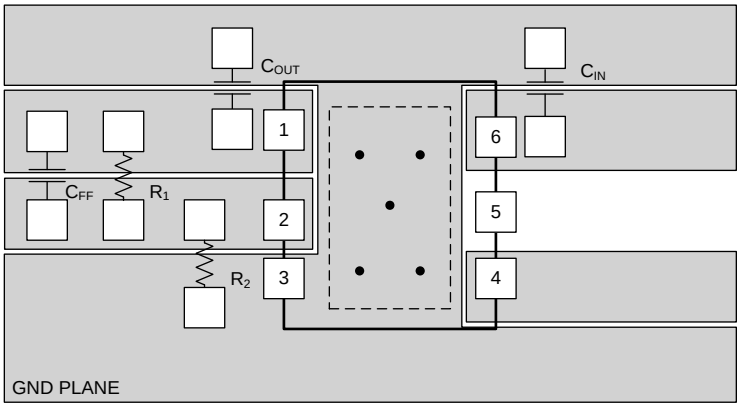



**图 46. Layout Example for the DRV Package**

# 11 器件和文档支持

## 11.1 文档支持

### 11.1.1 相关文档

请参阅如下相关文档：

*《使用前馈电容器和低压降稳压器的优缺点》应用报告*

## 11.2 接收文档更新通知

要接收文档更新通知，请导航至 TI.com.cn 上的器件产品文件夹。单击右上角的*通知我*进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

## 11.3 社区资源

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**设计支持** ***TI 参考设计支持*** **可帮助您快速查找有帮助的 E2E 论坛、设计支持工具以及技术支持的联系信息。**

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## 11.5 静电放电警告

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

## 11.6 术语表

SLYZ022 — *TI 术语表*。

这份术语表列出并解释术语、缩写和定义。

# 12 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。

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## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TLV75901PDRVR | ACTIVE | WSON | DRV | 6 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1MGH | Samples |
| TLV75901PDRVT | ACTIVE | WSON | DRV | 6 | 250 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1MGH | 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.

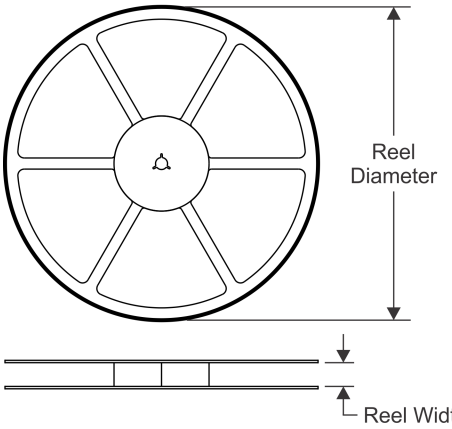
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

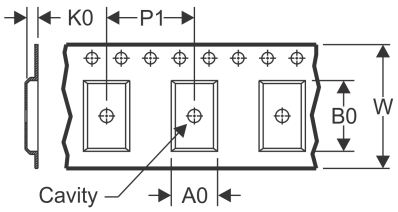
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

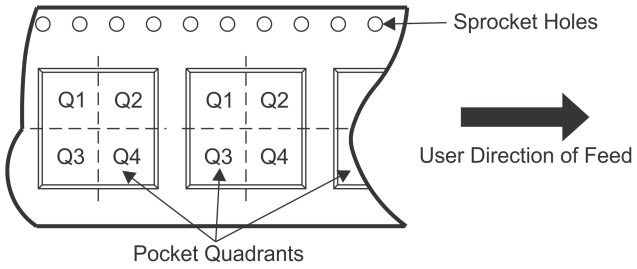



**TAPE DIMENSIONS**




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

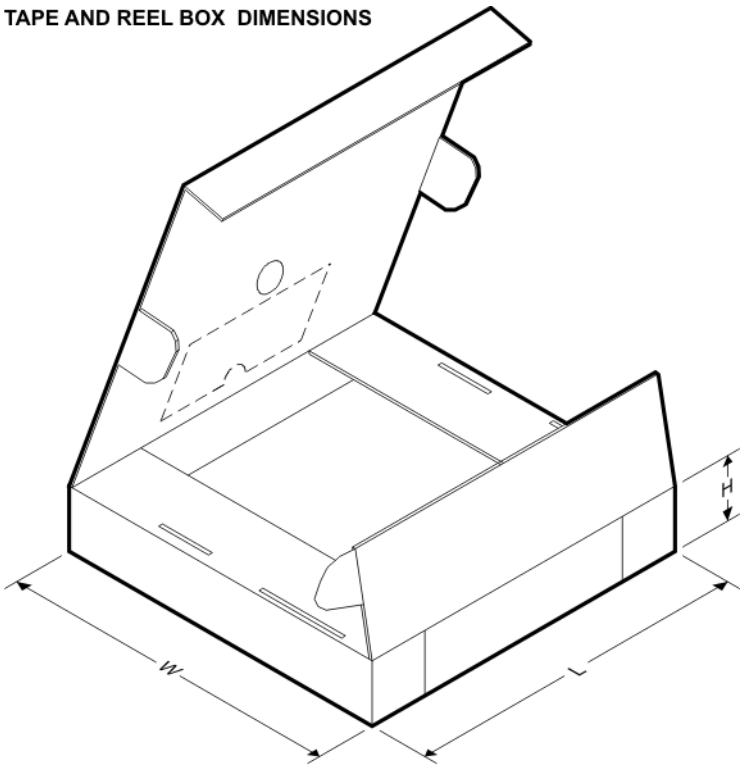
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TLV75901PDRVR | WSON | DRV | 6 | 3000 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| TLV75901PDRVT | WSON | DRV | 6 | 250 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS

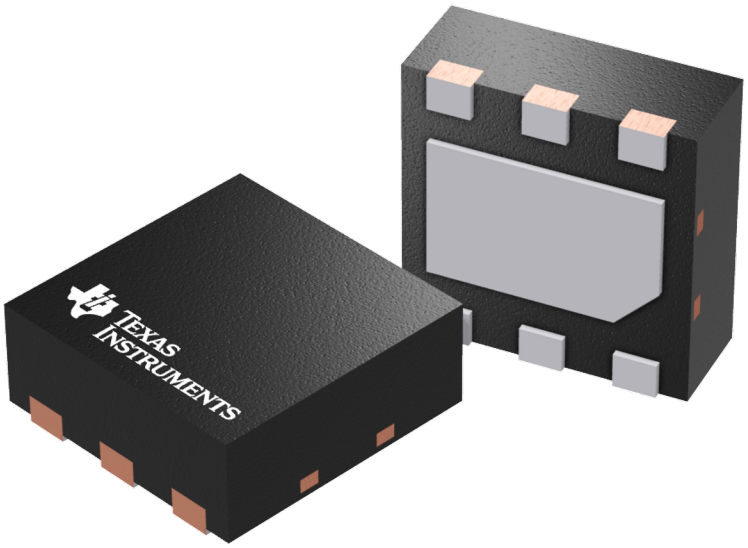



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TLV75901PDRVR | WSON | DRV | 6 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV75901PDRVT | WSON | DRV | 6 | 250 | 210.0 | 185.0 | 35.0 |

# DRV 6 WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



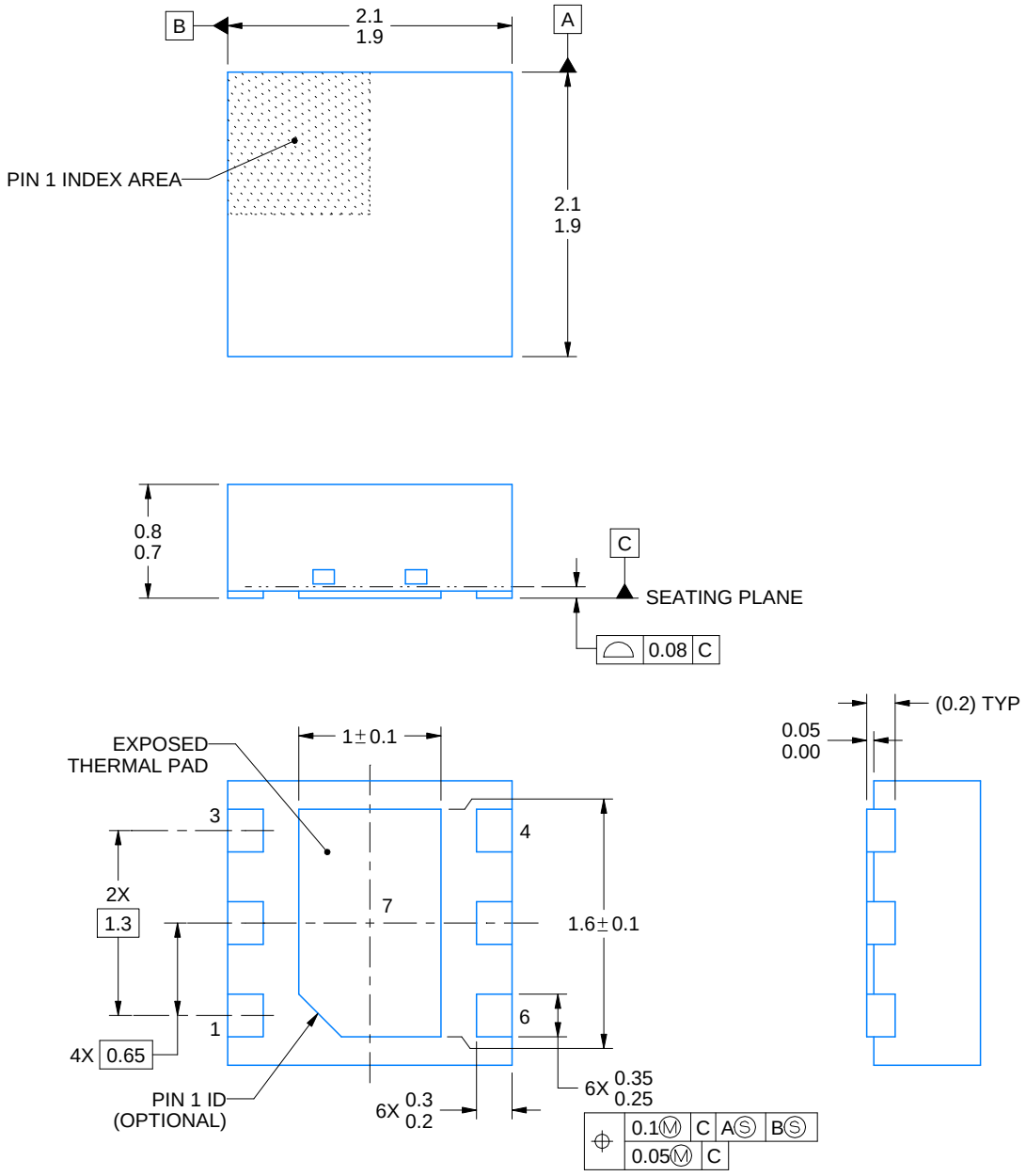

Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

# PACKAGE OUTLINE

## DRV0006A

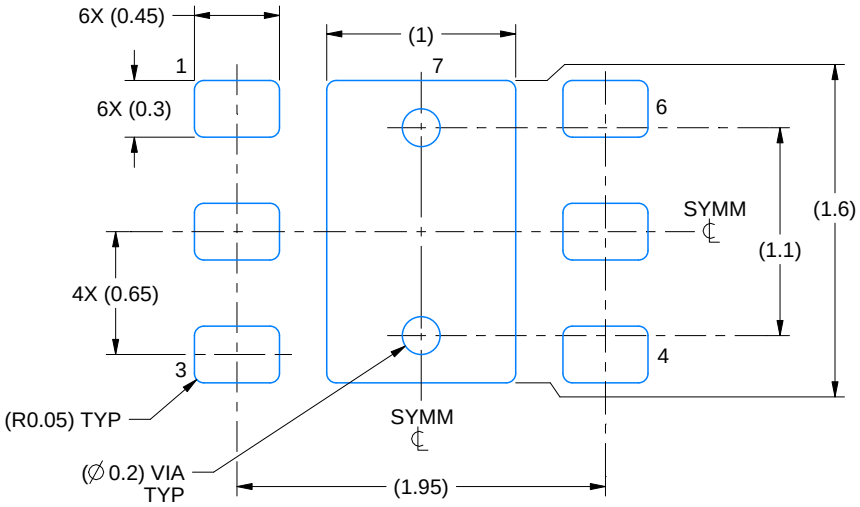
## WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD

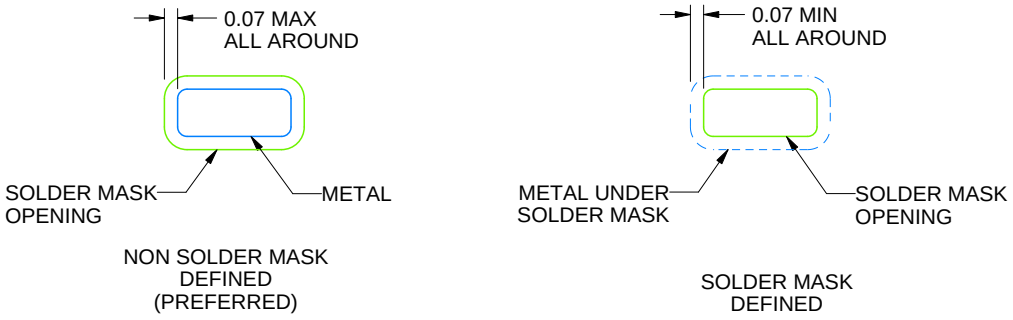



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.




LAND PATTERN EXAMPLE
SCALE:25X




SOLDER MASK DETAILS

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NOTES: (continued)

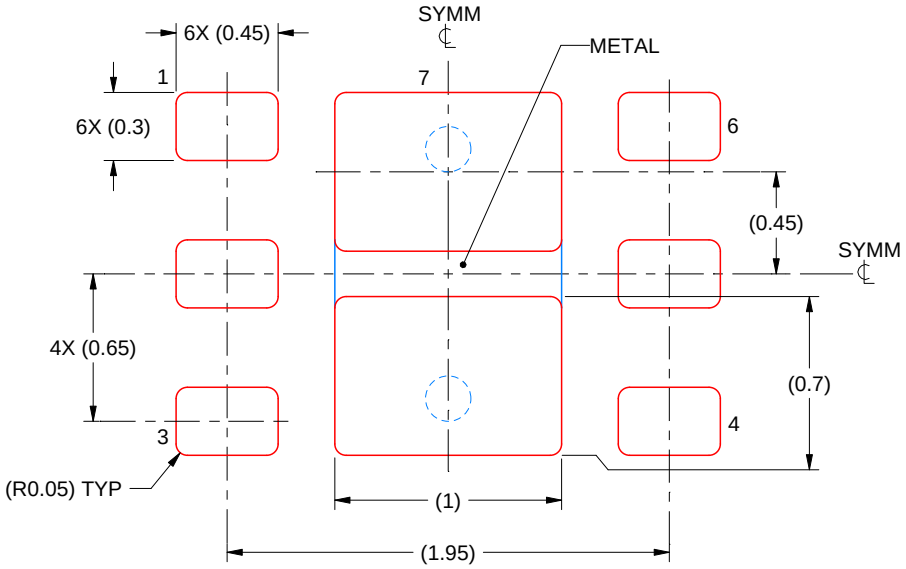
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.

# EXAMPLE STENCIL DESIGN

## DRV0006A

## WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD #7
88% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:30X

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NOTES: (continued)

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

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