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TPS768xxQ

SLVS211L–JUNE 1999–REVISED JANUARY 2006

FAST TRANSIENT RESPONSE, 1-A LOW-DROPOUT VOLTAGE REGULATORS

FEATURES

- Input Voltage Range: 2.7 V to 10 V
- Low-Dropout Voltage: 230 mV typical at 1 A (TPS76850)
- 2% Tolerance Over Specified Conditions for Fixed-Output Versions
- Open Drain Power Good (See **TPS767xx** for Power-On Reset With 200-ms Delay Option)
- Ultralow 85 μ A Typical Quiescent Current
- Available in 1.5-V, 1.8-V, 2.5-V, 2.7-V, 2.8-V, 3.0-V, 3.3-V, 5.0-V Fixed Output and Adjustable (1.2 V to 5.5 V) Versions
- Fast Transient Response
- Thermal Shutdown Protection
- SOIC-8 (D) and TSSOP-20 (PWP) Package

DESCRIPTION

This device is designed to have a fast transient response and be stable with 10 μ F capacitors. This combination provides high performance at a reasonable cost.

Since the PMOS device behaves as a low-value resistor, the dropout voltage is very low (typically 230 mV at an output current of 1 A for the TPS76850) and is directly proportional to the output current. Additionally, because the PMOS pass element is a voltage-driven device, the quiescent current is very low and independent of output loading (typically 85 μ A over the full range of output current, 0 mA to 1 A). These two key specifications yield a significant improvement in operating life for battery-powered systems. This LDO family also features a shutdown mode; applying a TTL high signal to $\overline{\text{EN}}$ (enable) shuts down the regulator, reducing the quiescent current to less than 1 μ A at $T_J = 25^\circ\text{C}$.

Power good (PG) is an active high output, which can be used to implement a power-on reset or a low-battery indicator.

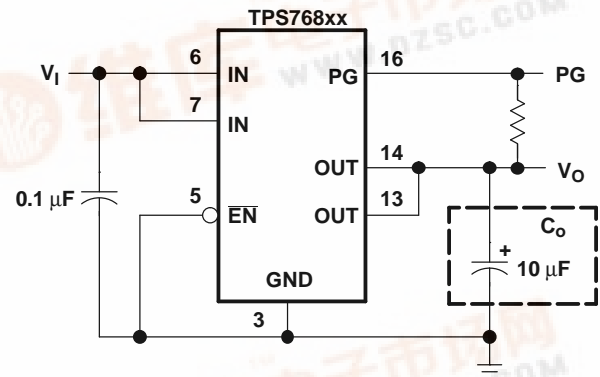
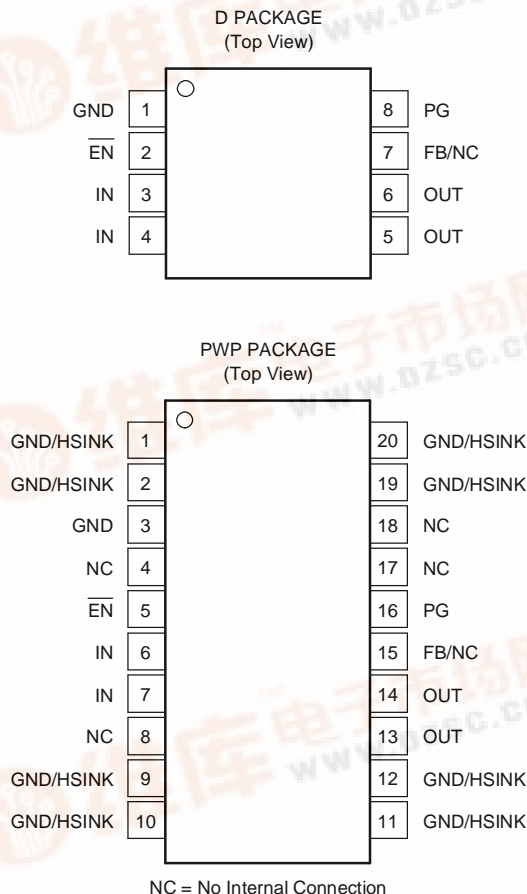


Figure 1. Typical Application Configuration
(For Fixed Output Options)



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

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

ORDERING INFORMATION⁽¹⁾

| PRODUCT | V _{OUT} ⁽²⁾ |
|---------------|---|
| TPS768xxQyyyz | XX is nominal output voltage (for example, 28 = 2.8 V, 285 = 2.85 V, 01 = Adjustable). YYY is package designator. Z is package quantity. |

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.
 (2) Custom output voltages are available; minimum order quantities may apply. Contact factory for details and availability.

ABSOLUTE MAXIMUM RATINGS

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

| | VALUE |
|--|----------------------------------|
| Input voltage range, V _I ⁽²⁾ | –0.3 V to 13.5 V |
| Voltage range at $\overline{\text{EN}}$ | –0.3 V to V _I + 0.3 V |
| Maximum PG voltage | 16.5 V |
| Peak output current | Internally limited |
| Continuous total power dissipation | See Dissipation Rating Table |
| Output voltage, V _O (OUT, FB) | 7 V |
| Operating junction temperature range, T _J | –40°C to +125°C |
| Storage temperature range, T _{stg} | –65°C to +150°C |
| ESD rating, HBM | 2 kV |

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

DISSIPATION RATING TABLE—FREE-AIR TEMPERATURES

| PACKAGE | AIR FLOW (CFM) | T _A < +25°C POWER RATING | DERATING FACTOR ABOVE T _A = +25°C | T _A = +70°C POWER RATING | T _A = +85°C POWER RATING |
|--------------------|----------------|--|---|--|--|
| D | 0 | 568.18 mW | 5.6818 mW/°C | 312.5 mW | 227.27 mW |
| | 250 | 904.15 mW | 9.0415 mW/°C | 497.28 mW | 361.66 mW |
| PWP ⁽¹⁾ | 0 | 3.1 W | 30.7 mW/°C | 1.7 W | 1.2 W |
| | 250 | 4.1 W | 41.2 mW/°C | 2.3 W | 1.6 W |

- (1) This parameter is measured with the recommended copper heat sink pattern on a 4-layer, 5-in × 5-in PCB, 1 oz. copper, 4-in × 4-in coverage (4 in²).

RECOMMENDED OPERATING CONDITIONS

| | MIN | MAX | UNIT |
|---|-----|------|------|
| Input voltage, V _I ⁽¹⁾ | 2.7 | 10 | V |
| Output voltage range, V _O | 1.2 | 5.5 | V |
| Output current, I _O ⁽²⁾ | 0 | 1.0 | A |
| Operating junction temperature, T _J ⁽²⁾ | –40 | +125 | °C |

- (1) Minimum V_{IN} = V_{OUT} + V_{DO} or 2.7 V, whichever is greater.
 (2) Continuous current and operating junction temperature are limited by internal protection circuitry, but it is not recommended that the device operate under conditions beyond those specified in this table for extended periods of time.

ELECTRICAL CHARACTERISTICS

over recommended operating free-air temperature range, $V_I = V_{O(\text{typ})} + 1 \text{ V}$, $I_O = 1 \text{ mA}$, $\overline{\text{EN}} = 0 \text{ V}$, $C_O = 10 \mu\text{F}$ (unless otherwise noted).

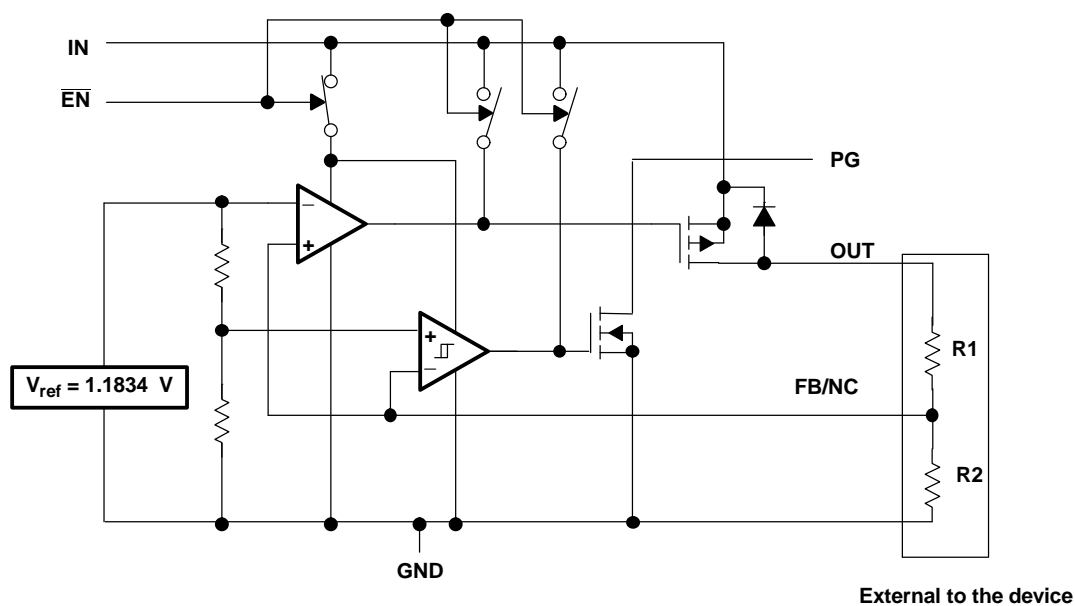
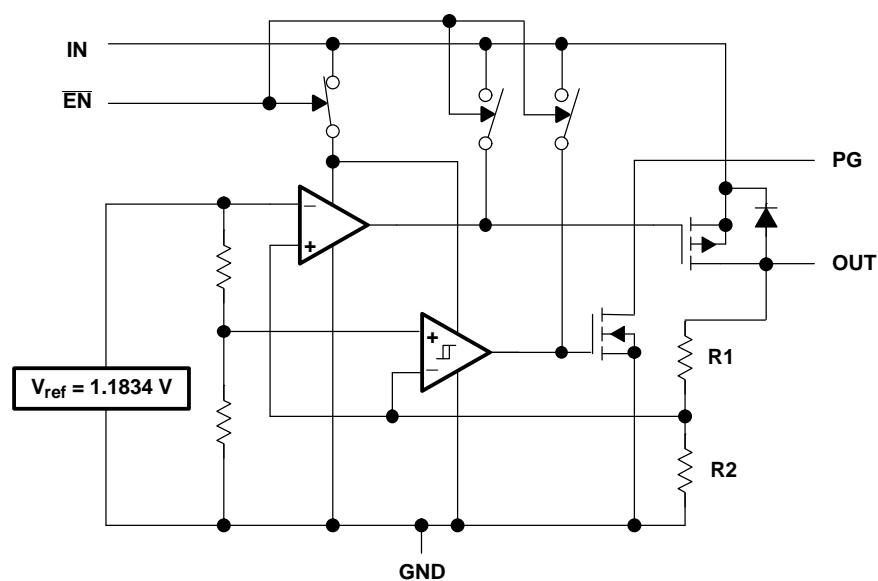
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|------------------------------------|--|----------------------|----------------|----------------------|-------------------|
| V _{OUT} Accuracy | | −40°C ≤ T _J ≤ +125°C, V _O + 1 V ≤ V _{IN} ≤ 10V ⁽¹⁾ , 10 μA ≤ I _O ≤ 1 A | (0.98)V _O | V _O | (1.02)V _O | V |
| Quiescent current (GND current) $\overline{\text{EN}}$ = 0V ⁽¹⁾ | | 10 μA < I _O < 1 A, T _J = +25°C | 85 | | | μA |
| | | I _O = 1 A, T _J = −40°C to +125°C | 125 | | | |
| Output voltage line regulation (ΔV _O /V _O) ⁽¹⁾⁽²⁾ | | V _O + 1 V < V _I ≤ 10 V, T _J = +25°C | 0.01 | | | %/V |
| Load regulation | | | 3 | | | mV |
| Output noise voltage (TPS76818) | | BW = 200 Hz to 100 kHz, C _O = 10 μF, I _C = 1 A, T _J = +25°C | 55 | | | μV _{rms} |
| Output current limit | | V _O = 0 V | 1.2 | 1.7 | 2 | A |
| Thermal shutdown junction temperature | | | 150 | | | °C |
| Standby current | | $\overline{V_{\text{EN}}} = V_{\text{I}}$, T _J = +25°C, 2.7 V < V _I < 10 V | 1 | | | μA |
| | | $\overline{V_{\text{EN}}} = V_{\text{I}}$, T _J = −40°C to +125°C, 2.7 V < V _I < 10 V | 10 | | | μA |
| FB pin current, I _{FB} | TPS76801 | V _{FB} = 1.5 V | 2 | | | nA |
| High-level enable input voltage | | | 1.7 | | | V |
| Low-level enable input voltage | | | 0.9 | | | V |
| Power-supply ripple rejection ⁽¹⁾ | | f = 1 kHz, C _O = 10 μF, T _J = +25°C | 60 | | | dB |
| Power Good (PG) | Minimum input voltage for valid PG | I _{O(PG)} = 300 μA | 1.1 | | | V |
| | Trip threshold voltage | V _O decreasing | 92 | | 98 | %V _O |
| | Hysteresis voltage | Measured at V _O | 0.5 | | | %V _O |
| | Output low voltage | V _I = 2.7 V, I _{O(PG)} = 1 mA | 0.15 | | 0.4 | V |
| | Leakage current | V _(PG) = 5 V | 1 | | | μA |
| Enable pin current (I _{EN}) | | $\overline{V_{\text{EN}}} = 0 \text{ V}$ | 1 | 0 | 1 | μA |
| | | $\overline{V_{\text{EN}}} = V_{\text{I}}$ | 1 | | 1 | |
| Dropout voltage ⁽³⁾ | TPS76828 | I _O = 1 A, T _J = +25°C | 500 | | | mV |
| | | I _O = 1 A, T _J = −40°C to +125°C | 825 | | | |
| | TPS76830 | I _O = 1 A, T _J = +25°C | 450 | | | |
| | | I _O = 1 A, T _J = −40°C to +125°C | 675 | | | |
| | TPS76833 | I _O = 1 A, T _J = +25°C | 350 | | | |
| | | I _O = 1 A, T _J = −40°C to +125°C | 575 | | | |
| | TPS76850 | I _O = 1 A, T _J = +25°C | 230 | | | |
| | | I _O = 1 A, T _J = −40°C to +125°C | 380 | | | |

(1) Minimum IN operating voltage is 2.7 V or $V_{O(\text{typ})} + 1 \text{ V}$, whichever is greater. Maximum IN voltage 10 V.

(2) If $V_O \leq 1.8 \text{ V}$ then $V_{\text{Imax}} = 10 \text{ V}$, $V_{\text{Imin}} = 2.7 \text{ V}$: $\text{Line Reg. (mV)} = (\% / \text{V}) \times V_O \frac{(V_{\text{Imax}} - 2.7 \text{ V})}{100} \times 1000$

If $V_O \geq 2.5 \text{ V}$ then $V_{\text{Imax}} = 10 \text{ V}$, $V_{\text{Imin}} = V_O + 1 \text{ V}$: $\text{Line Reg. (mV)} = (\% / \text{V}) \times V_O \frac{(V_{\text{Imax}} - (V_O + 1 \text{ V}))}{100} \times 1000$

(3) IN voltage equals $V_{O(\text{typ})} - 100 \text{ mV}$; TPS76801 output voltage set to 3.3 V nominal with external resistor divider. TPS76815, TPS76818, TPS76825, and TPS76827 dropout voltage limited by input voltage range limitations (that is, TPS76830 input voltage must drop to 2.9 V for the purpose of this test).

FUNCTIONAL BLOCK DIAGRAM—Adjustable Version**FUNCTIONAL BLOCK DIAGRAM—Fixed-Voltage Version****Terminal Functions**

| NAME | SOIC-8 (D) PIN NO. | TSSOP-20 (PWP) PIN NO. | DESCRIPTION |
|------------------------|-----------------------|---------------------------|---|
| GND | 1 | 3 | Regulator ground |
| GND/HSINK | — | 1, 2, 9-12, 19, 20 | Regulator ground and heatsink |
| NC | — | 4, 8, 17, 18 | No connect |
| $\overline{\text{EN}}$ | 2 | 5 | Enable input |
| IN | 3, 4 | 6, 7 | Input voltage |
| OUT | 5, 6 | 13, 14 | Regulated output voltage |
| FB/NC | 7 | 15 | Feedback input voltage for adjustable device (no connect for fixed options) |
| PG | 8 | 16 | PG output |

TYPICAL CHARACTERISTICS

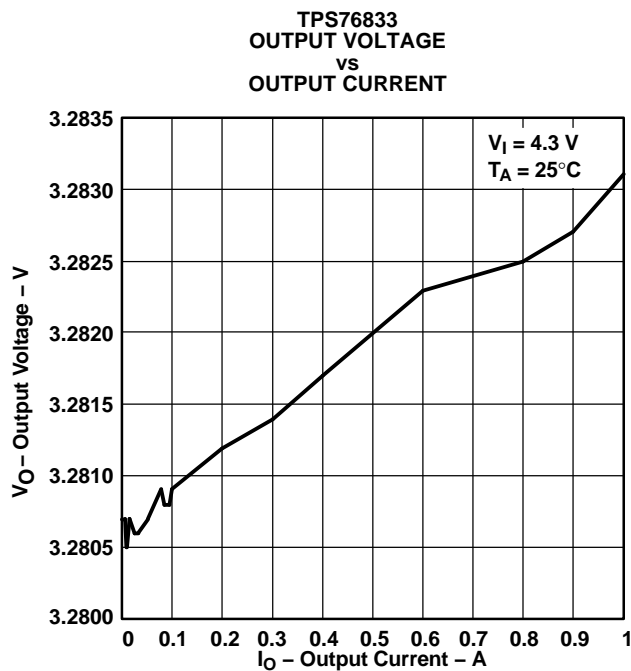


Figure 2.

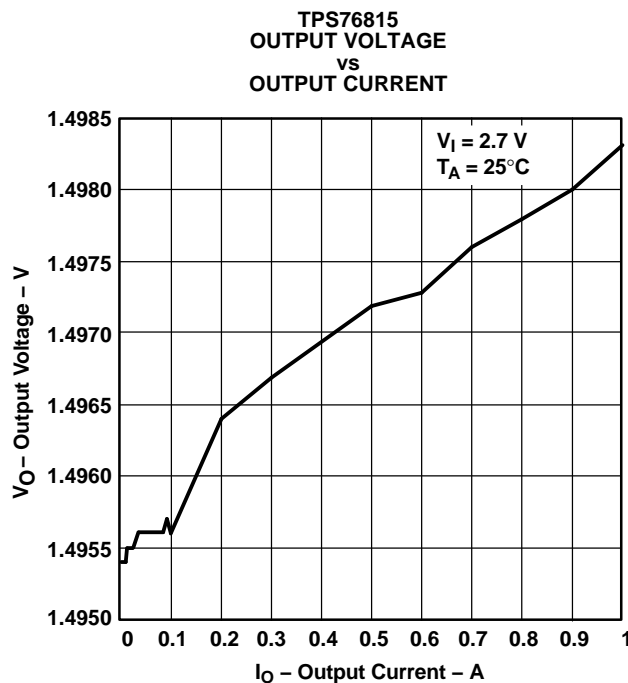


Figure 3.

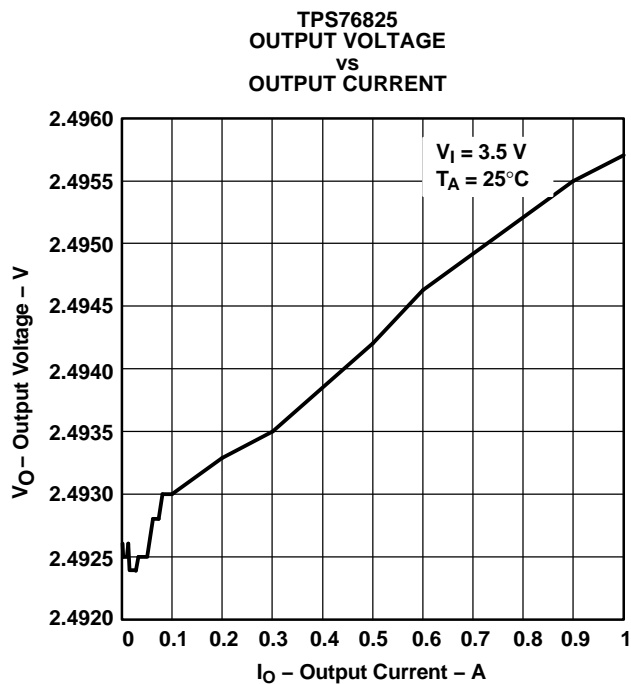


Figure 4.

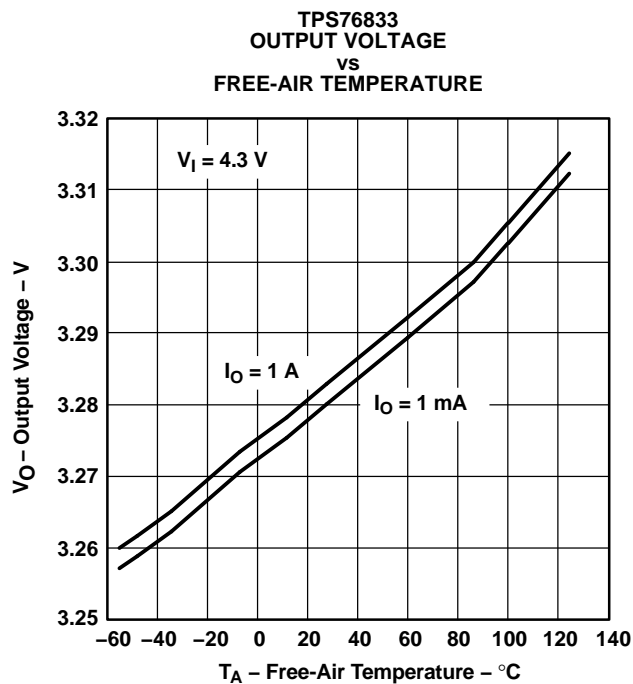


Figure 5.

TYPICAL CHARACTERISTICS (continued)

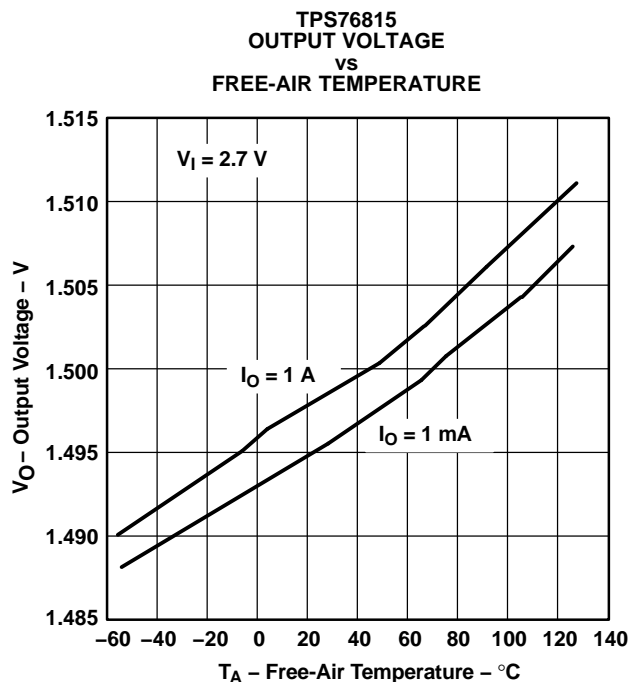


Figure 6.

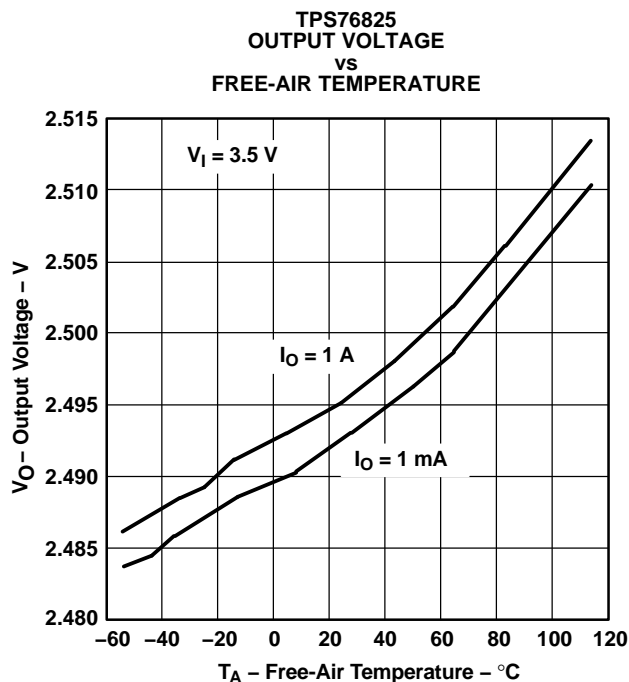


Figure 7.

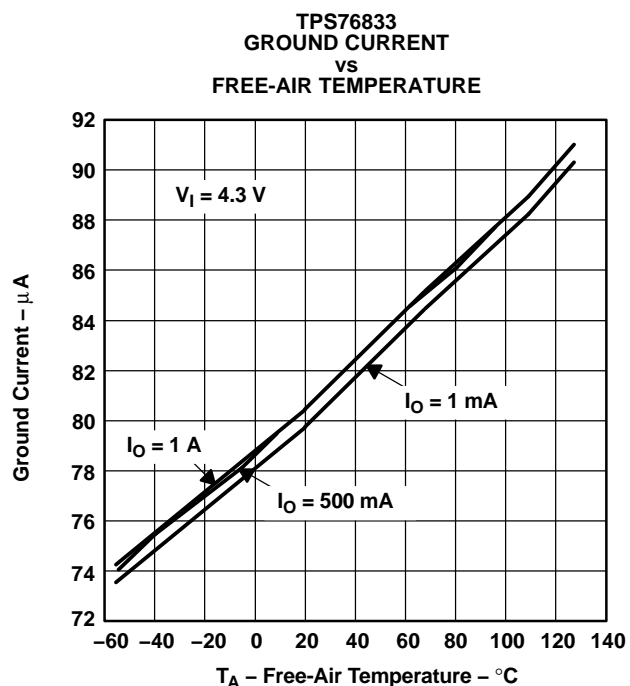


Figure 8.

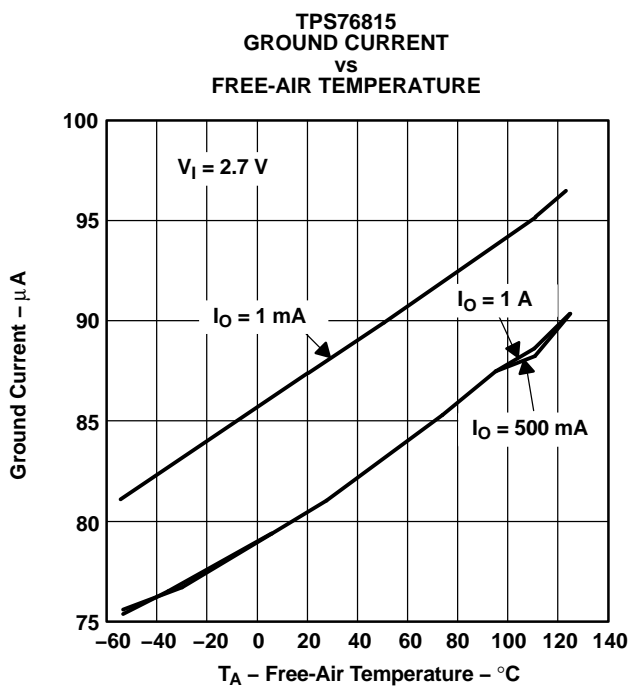


Figure 9.

TYPICAL CHARACTERISTICS (continued)

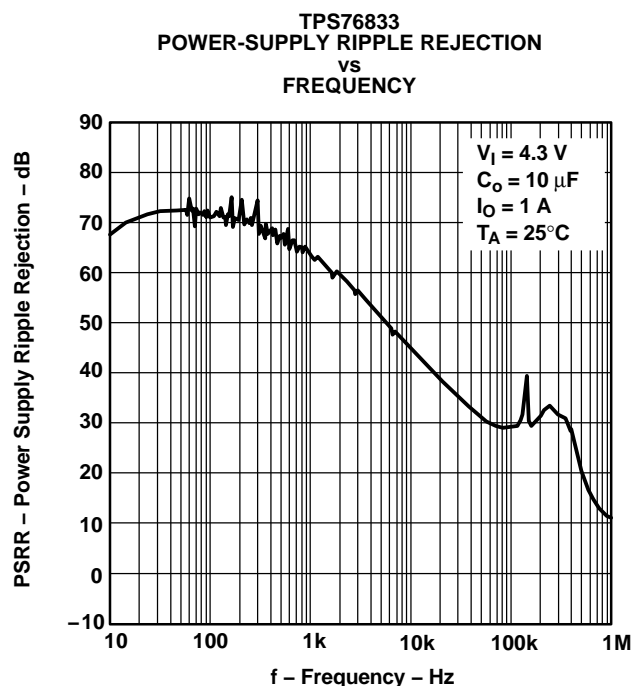


Figure 10.

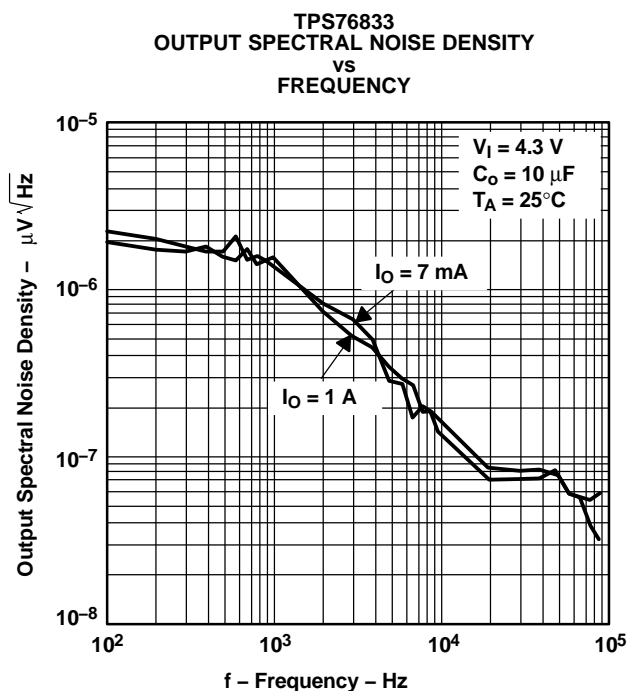


Figure 11.

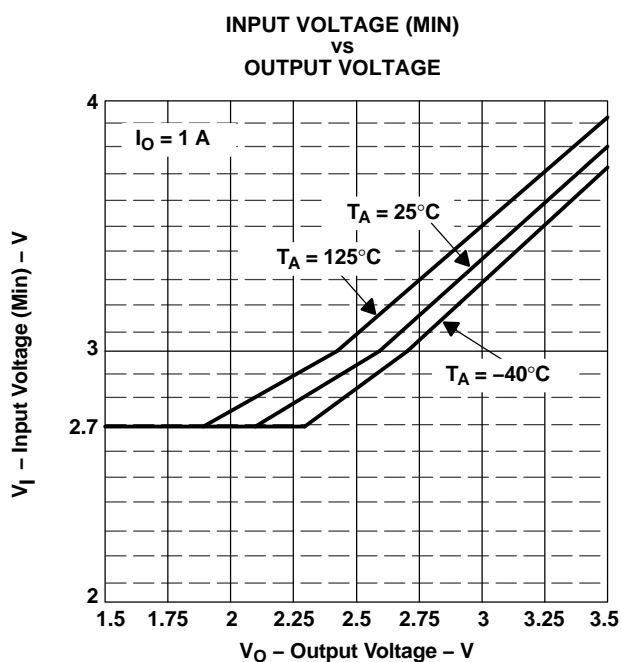


Figure 12.

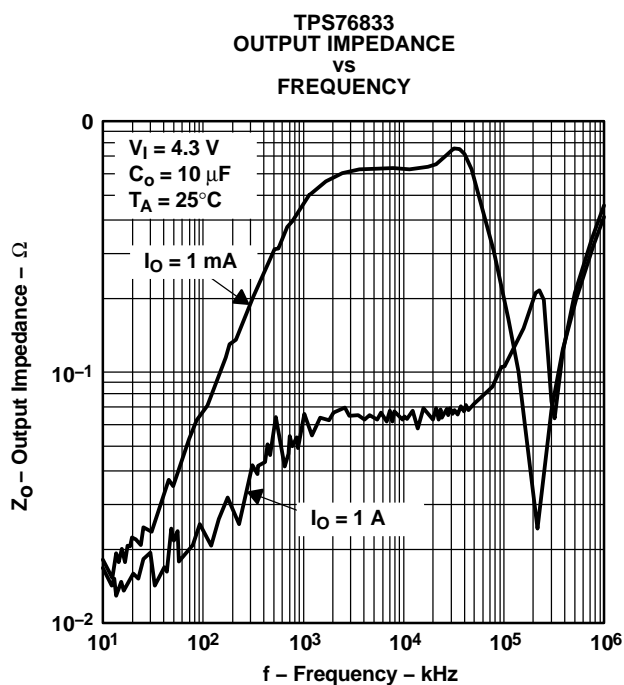


Figure 13.

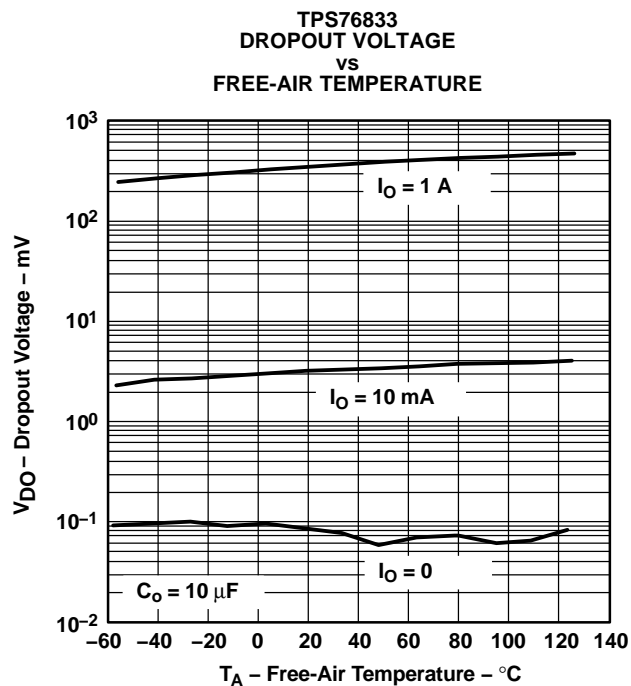
TYPICAL CHARACTERISTICS (continued)

Figure 14.

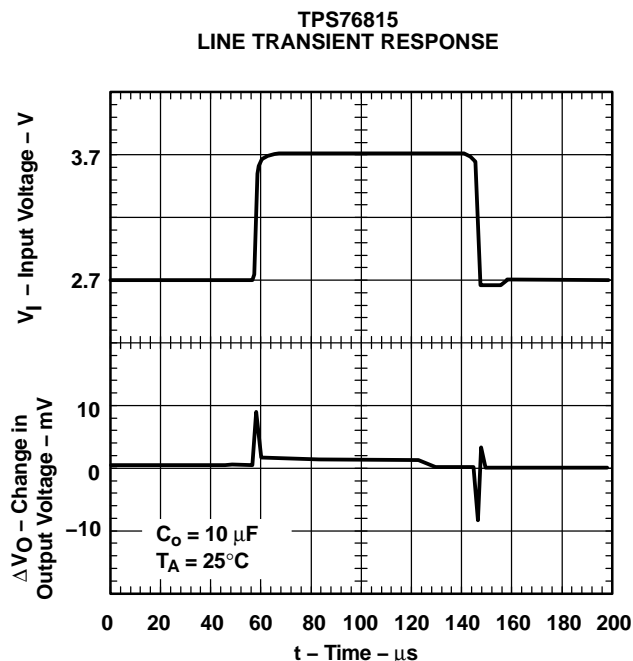


Figure 15.

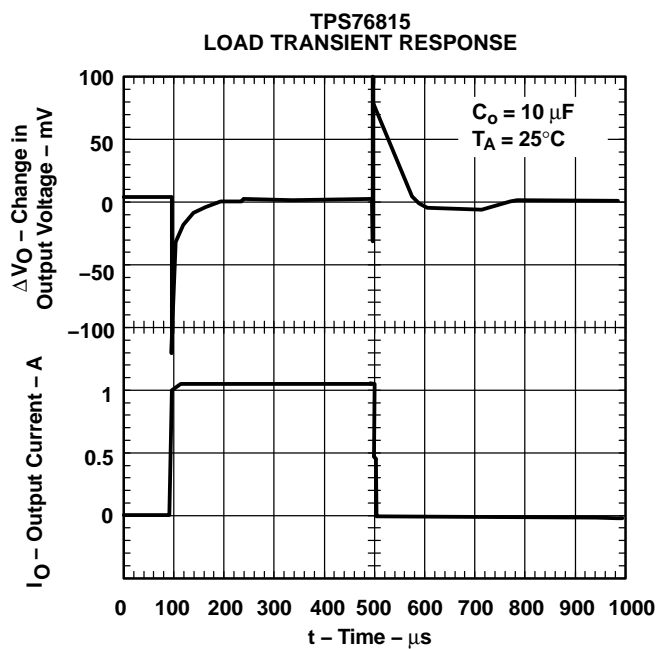


Figure 16.

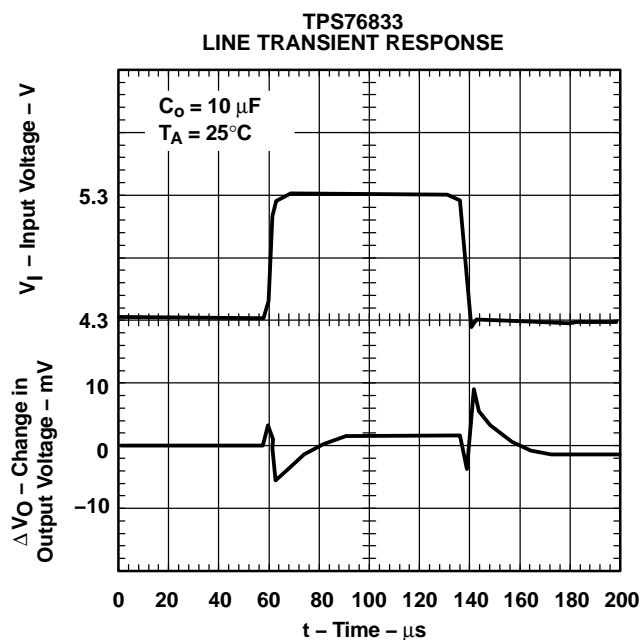


Figure 17.

TYPICAL CHARACTERISTICS (continued)

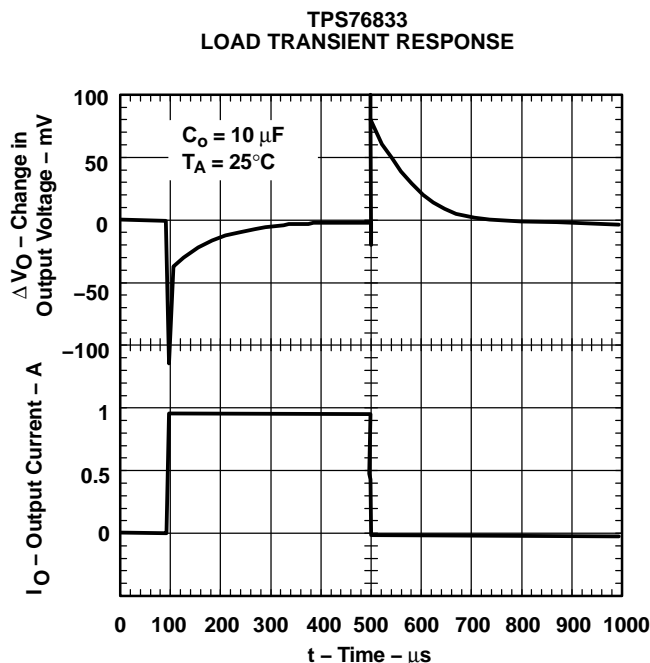


Figure 18.

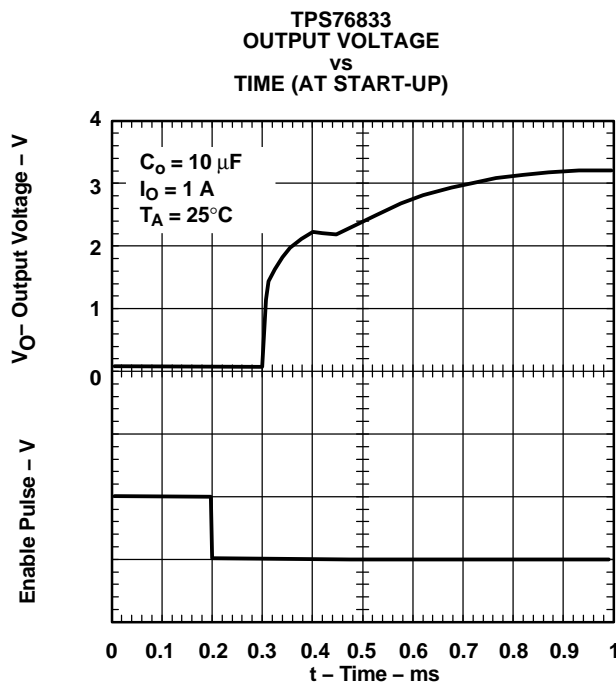


Figure 19.

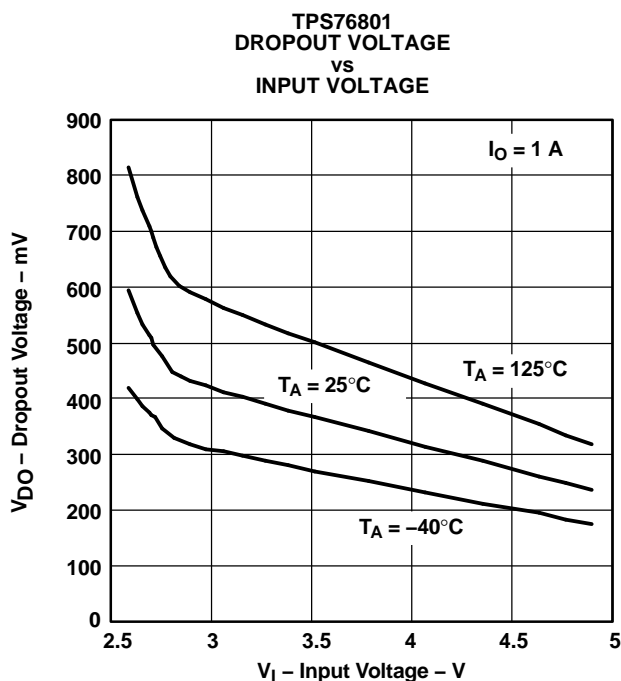


Figure 20.

TEST CIRCUIT FOR TYPICAL REGIONS OF STABILITY (Figure 22 through Figure 25) (Fixed Output Options)

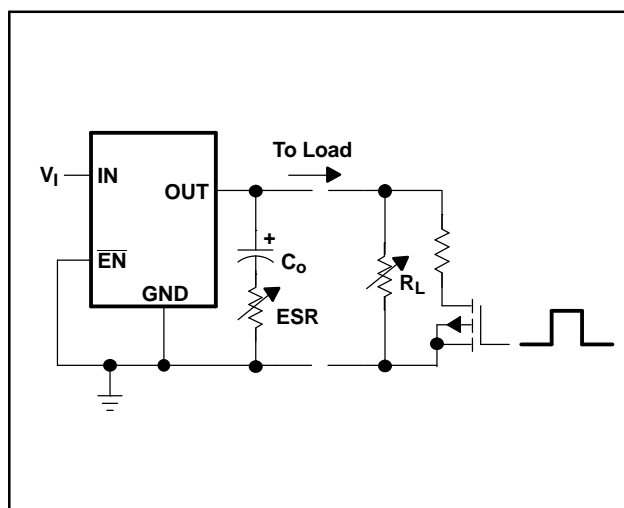


Figure 21.

TYPICAL CHARACTERISTICS (continued)

Equivalent series resistance (ESR) refers to the total series resistance, including the ESR of the capacitor, any series resistance added externally, and PWB trace resistance to C_O .

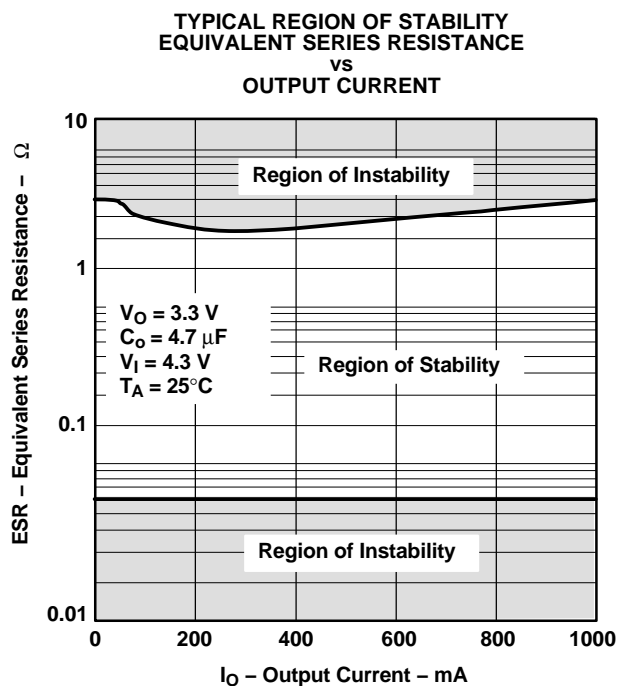


Figure 22.

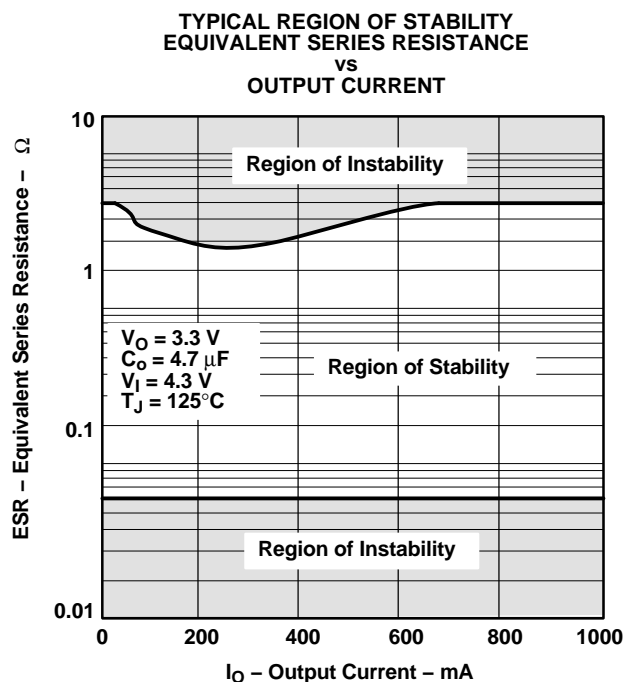


Figure 23.

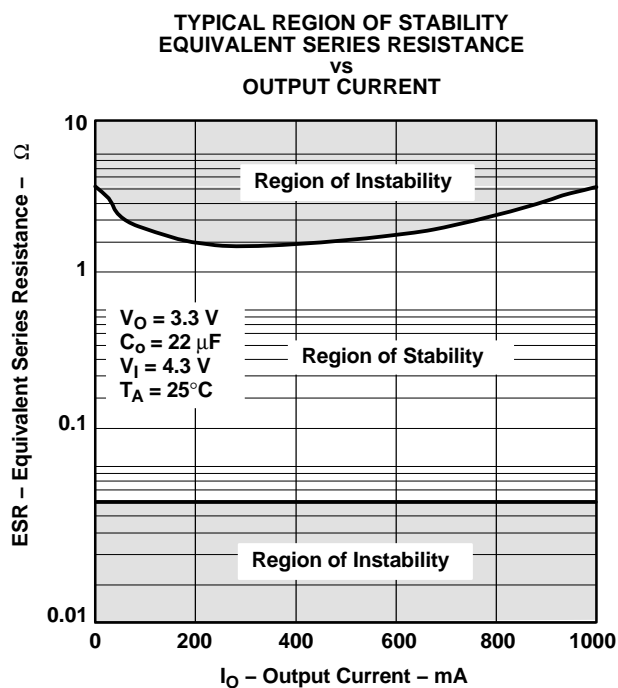


Figure 24.

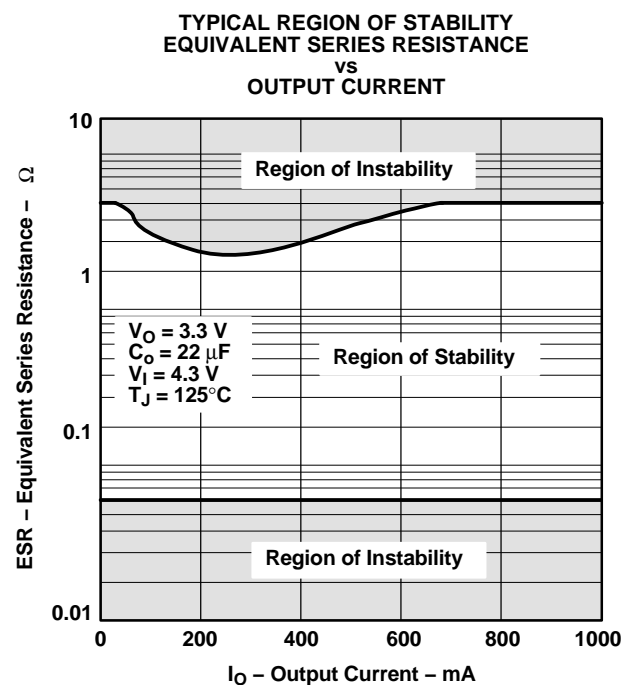


Figure 25.

APPLICATION INFORMATION

The TPS768xxQ family includes eight fixed-output voltage regulators (1.5 V, 1.8 V, 2.5 V, 2.7 V, 2.8 V, 3.0 V, 3.3 V, and 5.0 V), and offers an adjustable device, the TPS76801 (adjustable from 1.2 V to 5.5 V).

DEVICE OPERATION

The TPS768xxQ features very low quiescent current, which remains virtually constant even with varying loads. Conventional LDO regulators use a PNP pass element, the base current of which is directly proportional to the load current through the regulator ($I_B = I_C/\beta$). The TPS768xxQ uses a PMOS transistor to pass current; because the gate of the PMOS is voltage driven, operating current is low and invariable over the full load range.

Another pitfall associated with the PNP-pass element is its tendency to saturate when the device goes into dropout. The resulting drop in β forces an increase in I_B to maintain the load. During power up, this translates to large start-up currents. Systems with limited supply current may fail to start up. In battery-powered systems, it means rapid battery discharge when the voltage decays below the minimum required for regulation. The TPS768xxQ quiescent current remains low even when the regulator drops out, eliminating both problems.

The TPS768xxQ family also features a shutdown mode that places the output in the high-impedance state (essentially equal to the feedback-divider resistance) and reduces quiescent current to 2 μ A. If the shutdown feature is not used, $\overline{\text{EN}}$ should be tied to ground.

MINIMUM LOAD REQUIREMENTS

The TPS768xxQ family is stable even at zero load; no minimum load is required for operation.

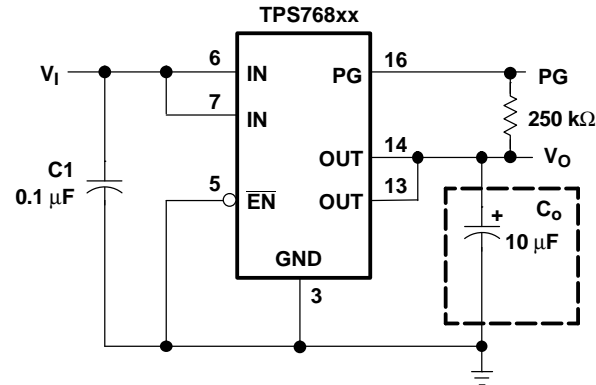
FB - PIN CONNECTION (ADJUSTABLE VERSION ONLY)

The FB pin is an input pin to sense the output voltage and close the loop for the adjustable option. The output voltage is sensed through a resistor divider network to close the loop as shown in [Figure 27](#). Normally, this connection should be as short as possible; however, the connection can be made near a critical circuit to improve performance at that point. Internally, FB connects to a high-impedance wide-bandwidth amplifier and noise pickup feeds through to the regulator output. Routing the FB connection to minimize/avoid noise pickup is essential.

EXTERNAL CAPACITOR REQUIREMENTS

An input capacitor is not usually required; however, a ceramic bypass capacitor (0.047 μ F or larger) improves load transient response and noise rejection if the TPS768xxQ is located more than a few inches from the power supply. A higher-capacitance electrolytic capacitor may be necessary if large (hundreds of milliamps) load transients with fast rise times are anticipated.

Like all low dropout regulators, the TPS768xxQ requires an output capacitor connected between OUT and GND to stabilize the internal control loop. The minimum recommended capacitance value is 10 μ F and the ESR (equivalent series resistance) must be between 60 m Ω and 1.5 Ω . Capacitor values 10 μ F or larger are acceptable, provided the ESR is less than 1.5 Ω . Solid tantalum electrolytic, aluminum electrolytic, and multilayer ceramic capacitors are all suitable, provided they meet the requirements described above.

APPLICATION INFORMATION (continued)**Figure 26. Typical Application Circuit (Fixed Versions)**

The output voltage of the TPS76801 adjustable regulator is programmed using an external resistor divider as shown in [Figure 27](#). The output voltage is calculated using:

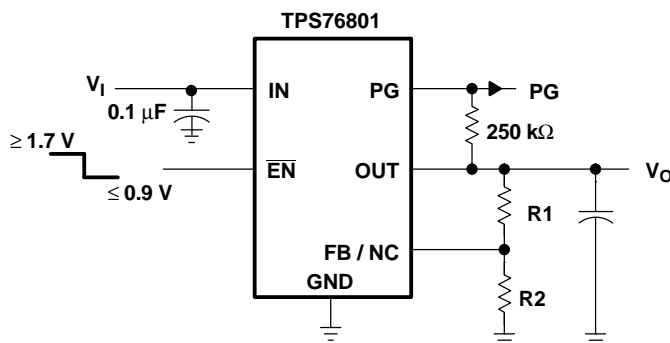
$$V_O = V_{\text{ref}} \times \left(1 + \frac{R1}{R2}\right)$$

where:

$$V_{\text{ref}} = 1.1834 \text{ V typ (the internal reference voltage)} \quad (1)$$

Resistors R1 and R2 should be chosen for approximately 50-μA divider current. Lower value resistors can be used but offer no inherent advantage and waste more power. Higher values should be avoided as leakage currents at FB increase the output voltage error. The recommended design procedure is to choose R2 = 30.1 kΩ to set the divider current at 50 μA and then calculate R1 using:

$$R1 = \left(\frac{V_O}{V_{\text{ref}}} - 1\right) \times R2 \quad (2)$$

**Figure 27. TPS76801 Adjustable LDO Regulator Programming****OUTPUT VOLTAGE
PROGRAMMING GUIDE**

| OUTPUT VOLTAGE | R1 | R2 | UNIT |
|----------------|------|------|------|
| 2.5 V | 33.2 | 30.1 | kΩ |
| 3.3 V | 53.6 | 30.1 | kΩ |
| 3.6 V | 61.9 | 30.1 | kΩ |
| 4.75 V | 90.8 | 30.1 | kΩ |

POWER-GOOD INDICATOR

The TPS768xxQ features a power-good (PG) output that can be used to monitor the status of the regulator. The internal comparator monitors the output voltage: when the output drops to between 92% and 98% of its nominal regulated value, the PG output transistor turns on, taking the signal low. The open-drain output requires a pullup resistor. If not used, it can be left floating. PG can be used to drive power-on reset circuitry or used as a low-battery indicator. PG does not assert itself when the regulated output voltage falls out of the specified 2% tolerance, but instead reports an output voltage low, relative to its nominal regulated value.

APPLICATION INFORMATION (continued)

REGULATOR PROTECTION

The TPS768xxQ PMOS-pass transistor has a built-in back diode that conducts reverse currents when the input voltage drops below the output voltage (for example, during power-down). Current is conducted from the output to the input and is not internally limited. When extended reverse voltage is anticipated, external limiting may be appropriate.

The TPS768xxQ also features internal current limiting and thermal protection. During normal operation, the TPS768xxQ limits output current to approximately 1.7 A. When current limiting engages, the output voltage scales back linearly until the overcurrent condition ends. While current limiting is designed to prevent gross device failure, care should be taken not to exceed the power dissipation ratings of the package. If the temperature of the device exceeds +150°C (typ), thermal-protection circuitry shuts it down. Once the device has cooled below +130°C (typ), regulator operation resumes.

POWER DISSIPATION AND JUNCTION TEMPERATURE

Specified regulator operation is assured to a junction temperature of +125°C; the maximum junction temperature should be restricted to +125°C under normal operating conditions. This restriction limits the power dissipation the regulator can handle in any given application. To ensure the junction temperature is within acceptable limits, calculate the maximum allowable dissipation, P_{Dmax} , and the actual dissipation, P_D , which must be less than or equal to P_{Dmax} .

The maximum-power-dissipation limit is determined using the following equation:

$$P_{Dmax} = \frac{T_{Jmax} - T_A}{R_{\theta JA}} \quad (3)$$

Where:

- T_{Jmax} is the maximum allowable junction temperature.
- $R_{\theta JA}$ is the thermal resistance junction-to-ambient for the package; that is, 172°C/W for the 8-pin SOIC (D) and 32.6°C/W for the 20-pin TSSOP (PWP) with no airflow.
- T_A is the ambient temperature.

The regulator dissipation is calculated using:

$$P_D = (V_I - V_O) \times I_O \quad (4)$$

Power dissipation resulting from quiescent current is negligible. Excessive power dissipation will trigger the thermal protection circuit.

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TPS76801QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76801QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76801QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76801QDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76801QPWP | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76801QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76801QPWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76801QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76815QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76815QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76815QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76815QDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76815QPWP | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76815QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76815QPWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76815QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76818QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76818QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76818QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76818QDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76818QPWP | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76818QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76818QPWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76818QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76825QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TPS76825QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76825QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76825QDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76825QPWP | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76825QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76825QPWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76825QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76827QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76827QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76827QDRG4 | ACTIVE | SOIC | D | 8 | | TBD | Call TI | Call TI |
| TPS76827QPWP | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76827QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76827QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | | TBD | Call TI | Call TI |
| TPS76828QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76828QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76828QDRG4 | ACTIVE | SOIC | D | 8 | | TBD | Call TI | Call TI |
| TPS76828QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | | TBD | Call TI | Call TI |
| TPS76828QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | | TBD | Call TI | Call TI |
| TPS76830QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76830QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76830QDRG4 | ACTIVE | SOIC | D | 8 | | TBD | Call TI | Call TI |
| TPS76830QPWP | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76830QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76830QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | | TBD | Call TI | Call TI |
| TPS76833QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76833QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76833QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76833QDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76833QPWP | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| | | | | | | no Sb/Br) | | |
| TPS76833QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76833QPWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76833QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76850QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76850QDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76850QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76850QDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TPS76850QPWP | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76850QPWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76850QPWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TPS76850QPWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |

⁽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⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

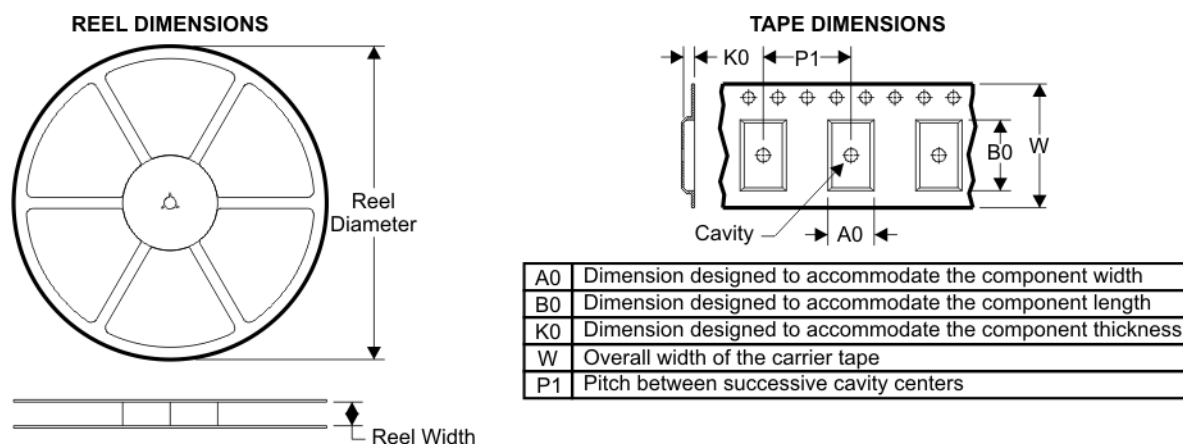
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

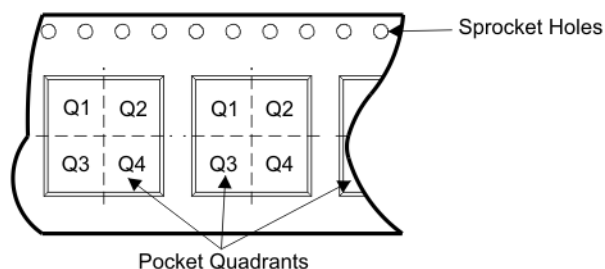
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TAPE AND REEL BOX INFORMATION

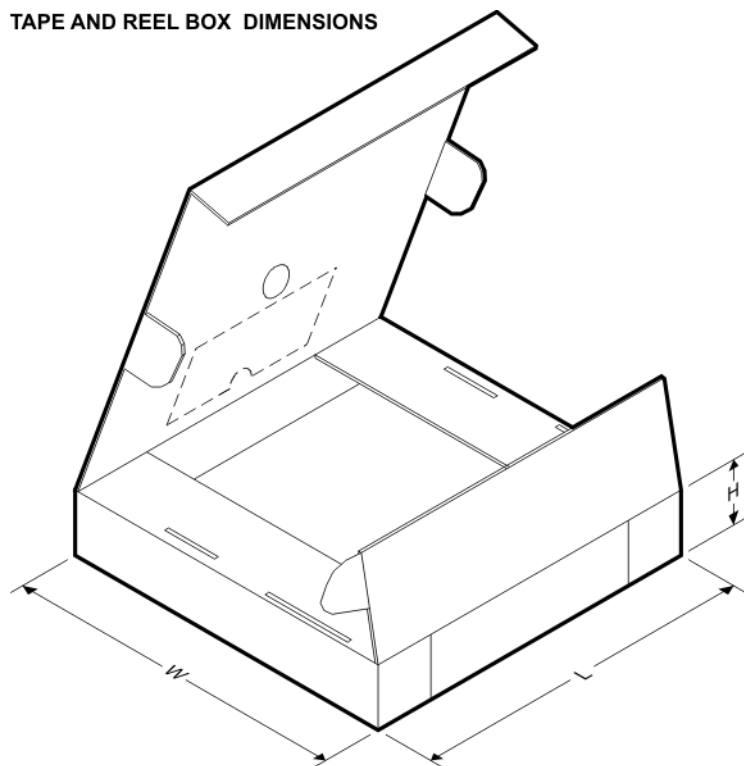


QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



| Device | Package | Pins | Site | Reel Diameter (mm) | Reel Width (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|---------|------|---------|--------------------|-----------------|---------|---------|---------|---------|--------|---------------|
| TPS76801QDR | D | 8 | SITE 60 | 330 | 12 | 6.4 | 5.2 | 2.1 | 8 | 12 | Q1 |
| TPS76801QPWPR | PWP | 20 | SITE 60 | 330 | 16 | 6.95 | 7.1 | 1.6 | 8 | 16 | Q1 |
| TPS76815QDR | D | 8 | SITE 60 | 330 | 12 | 6.4 | 5.2 | 2.1 | 8 | 12 | Q1 |
| TPS76815QPWPR | PWP | 20 | SITE 60 | 330 | 16 | 6.95 | 7.1 | 1.6 | 8 | 16 | Q1 |
| TPS76818QDR | D | 8 | SITE 60 | 330 | 12 | 6.4 | 5.2 | 2.1 | 8 | 12 | Q1 |
| TPS76818QPWPR | PWP | 20 | SITE 60 | 330 | 16 | 6.95 | 7.1 | 1.6 | 8 | 16 | Q1 |
| TPS76825QDR | D | 8 | SITE 60 | 330 | 12 | 6.4 | 5.2 | 2.1 | 8 | 12 | Q1 |
| TPS76825QPWPR | PWP | 20 | SITE 60 | 330 | 16 | 6.95 | 7.1 | 1.6 | 8 | 16 | Q1 |
| TPS76833QDR | D | 8 | SITE 60 | 330 | 12 | 6.4 | 5.2 | 2.1 | 8 | 12 | Q1 |
| TPS76833QPWPR | PWP | 20 | SITE 60 | 330 | 16 | 6.95 | 7.1 | 1.6 | 8 | 16 | Q1 |
| TPS76850QDR | D | 8 | SITE 60 | 330 | 12 | 6.4 | 5.2 | 2.1 | 8 | 12 | Q1 |
| TPS76850QPWPR | PWP | 20 | SITE 60 | 330 | 16 | 6.95 | 7.1 | 1.6 | 8 | 16 | Q1 |

TAPE AND REEL BOX DIMENSIONS



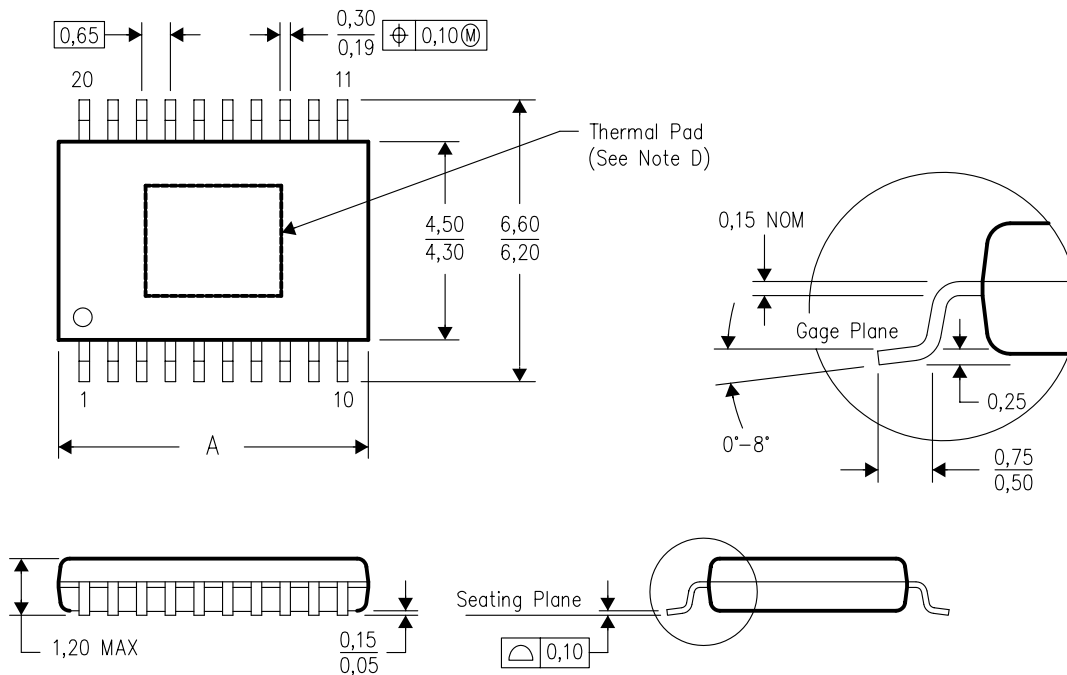
| Device | Package | Pins | Site | Length (mm) | Width (mm) | Height (mm) |
|---------------|---------|------|---------|-------------|------------|-------------|
| TPS76801QDR | D | 8 | SITE 60 | 346.0 | 346.0 | 29.0 |
| TPS76801QPWPR | PWP | 20 | SITE 60 | 346.0 | 346.0 | 33.0 |
| TPS76815QDR | D | 8 | SITE 60 | 346.0 | 346.0 | 29.0 |
| TPS76815QPWPR | PWP | 20 | SITE 60 | 346.0 | 346.0 | 33.0 |
| TPS76818QDR | D | 8 | SITE 60 | 346.0 | 346.0 | 29.0 |
| TPS76818QPWPR | PWP | 20 | SITE 60 | 346.0 | 346.0 | 33.0 |
| TPS76825QDR | D | 8 | SITE 60 | 346.0 | 346.0 | 29.0 |
| TPS76825QPWPR | PWP | 20 | SITE 60 | 346.0 | 346.0 | 33.0 |
| TPS76833QDR | D | 8 | SITE 60 | 346.0 | 346.0 | 29.0 |
| TPS76833QPWPR | PWP | 20 | SITE 60 | 346.0 | 346.0 | 33.0 |
| TPS76850QDR | D | 8 | SITE 60 | 346.0 | 346.0 | 29.0 |
| TPS76850QPWPR | PWP | 20 | SITE 60 | 346.0 | 346.0 | 33.0 |

MECHANICAL DATA

PWP (R-PDSO-G**)

PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE

20 PIN SHOWN



| PINS ** | 14 | 16 | 20 | 24 | 28 |
|---------|------|------|------|------|------|
| DIM | | | | | |
| A MAX | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

4073225/H 12/05

- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusions. Mold flash and protrusion shall not exceed 0.15 per side.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at www.ti.com <<http://www.ti.com>>.
 - Falls within JEDEC MO-153

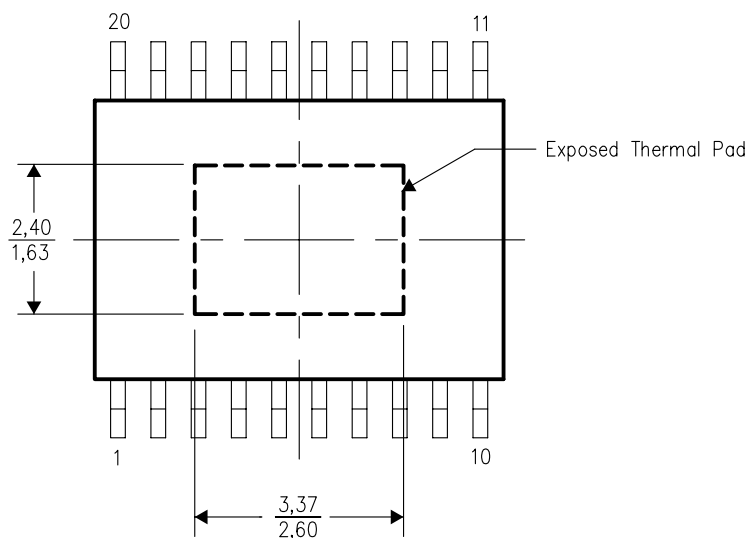
PowerPAD is a trademark of Texas Instruments.

THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For additional information on the PowerPAD package and how to take advantage of its heat dissipating abilities, refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 and Application Brief, PowerPAD Made Easy, Texas Instruments Literature No. SLMA004. Both documents are available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



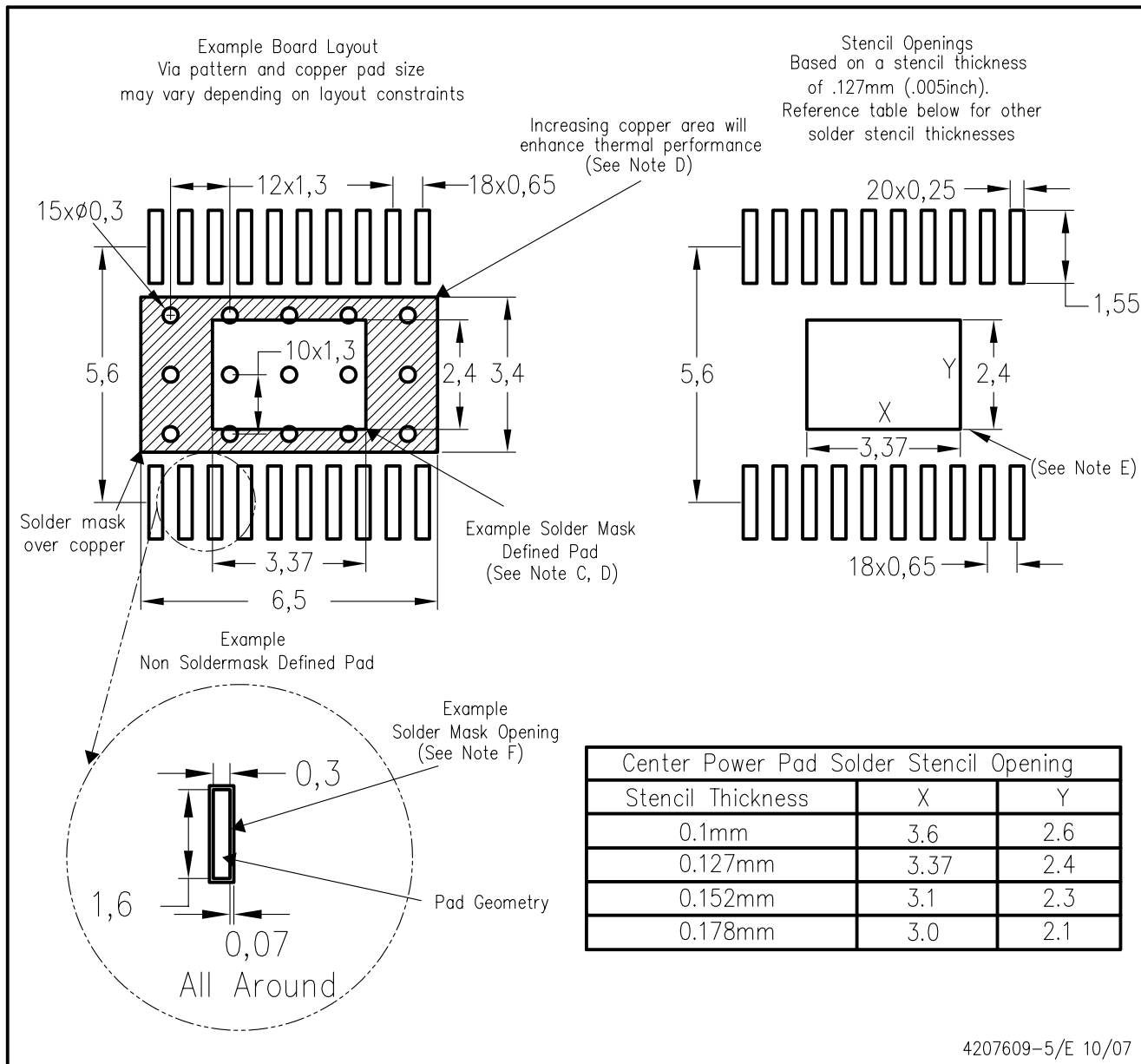
Top View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

LAND PATTERN

PWP (R-PDSO-G20) PowerPAD™



4207609-5/E 10/07

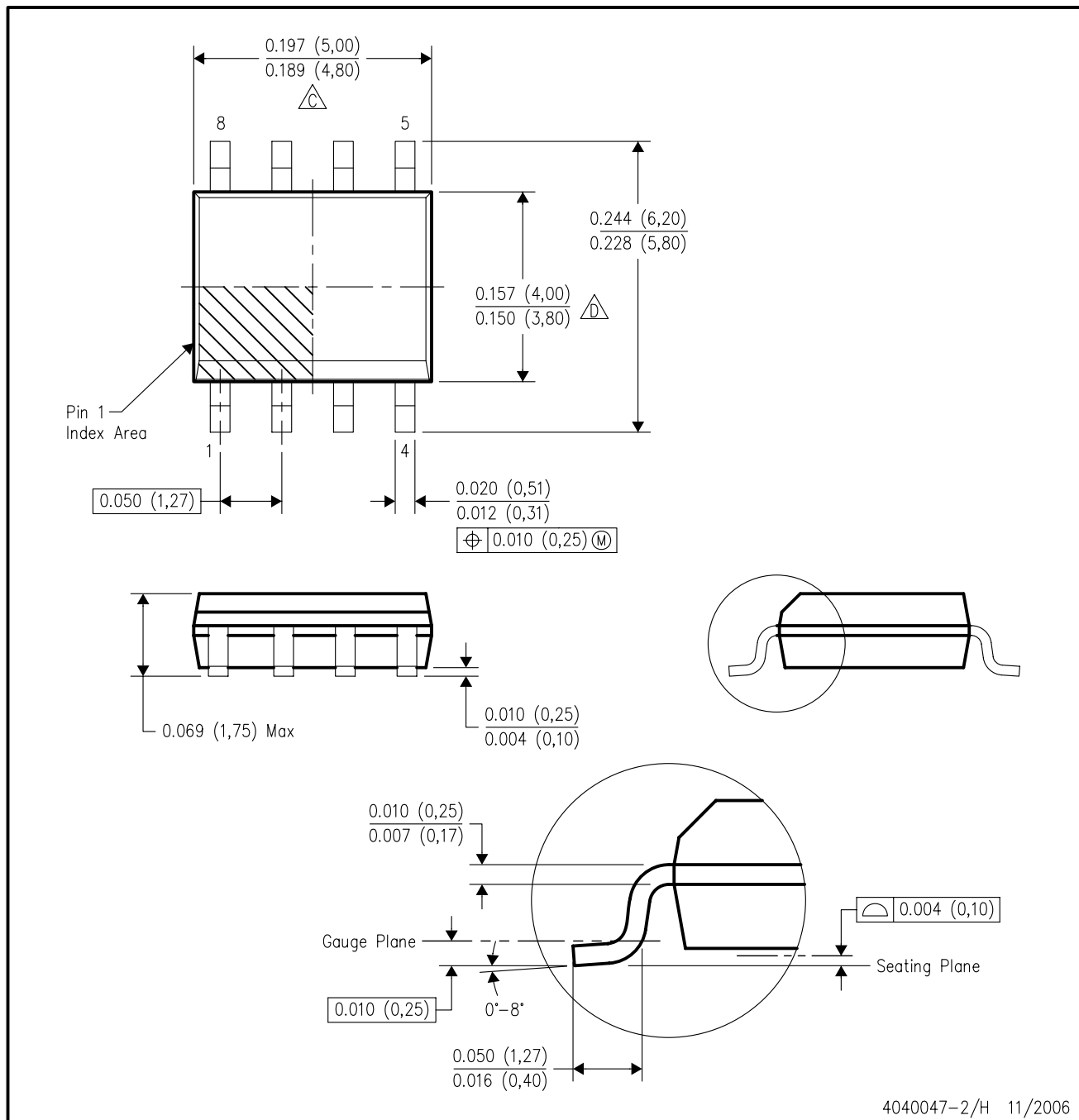
- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002, SLMA004, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>. Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

PowerPAD is a trademark of Texas Instruments.

MECHANICAL DATA

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AA.

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