

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

### FEATURES

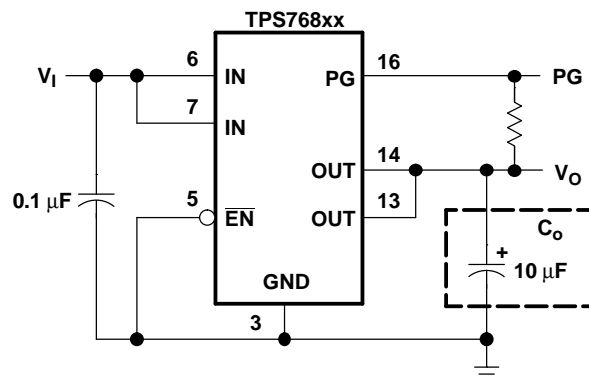
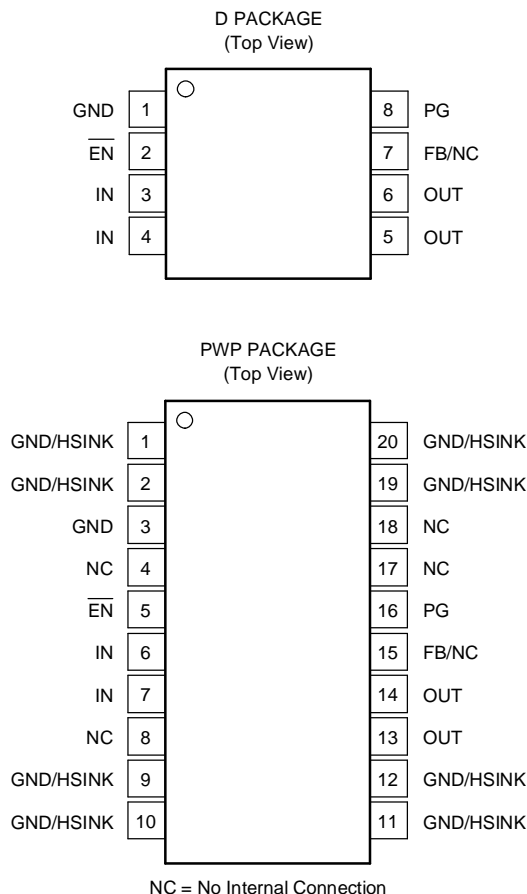
- **Input Voltage Range:** 2.7 V to 10 V
- **Low-Dropout Voltage:** 230 mV typical at 1 A (TPS76850)
- **2% Tolerance Over Specified Conditions for Fixed-Output Versions**
- **Open Drain Power Good (See TPS767xx for Power-On Reset With 200-ms Delay Option)**
- **Ultralow 85  $\mu$ A Typical Quiescent 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  $\mu$ 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  $\mu$ 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  $\mu$ 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)**



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.



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<sup>(1)</sup>

PRODUCT	V <sub>OUT</sub> <sup>(2)</sup>
TPS768xxQyyyzz	<b>XX</b> is nominal output voltage (for example, 28 = 2.8 V, 285 = 2.85 V, 01 = Adjustable). <b>YYY</b> is package designator. <b>Z</b> 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](http://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) <sup>(1)</sup>

	VALUE
Input voltage range, V <sub>I</sub> <sup>(2)</sup>	–0.3 V to 13.5 V
Voltage range at $\overline{\text{EN}}$	–0.3 V to V <sub>I</sub> + 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 <sub>O</sub> (OUT, FB)	7 V
Operating junction temperature range, T <sub>J</sub>	–40°C to +125°C
Storage temperature range, T <sub>stg</sub>	–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 <sub>A</sub> < +25°C POWER RATING	DERATING FACTOR ABOVE T <sub>A</sub> = +25°C	T <sub>A</sub> = +70°C POWER RATING	T <sub>A</sub> = +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 <sup>(1)</sup>	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 in<sup>2</sup>).

### RECOMMENDED OPERATING CONDITIONS

	MIN	MAX	UNIT
Input voltage, V <sub>I</sub> <sup>(1)</sup>	2.7	10	V
Output voltage range, V <sub>O</sub>	1.2	5.5	V
Output current, I <sub>O</sub> <sup>(2)</sup>	0	1.0	A
Operating junction temperature, T <sub>J</sub> <sup>(2)</sup>	–40	+125	°C

- (1) Minimum V<sub>IN</sub> = V<sub>OUT</sub> + V<sub>DO</sub> 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

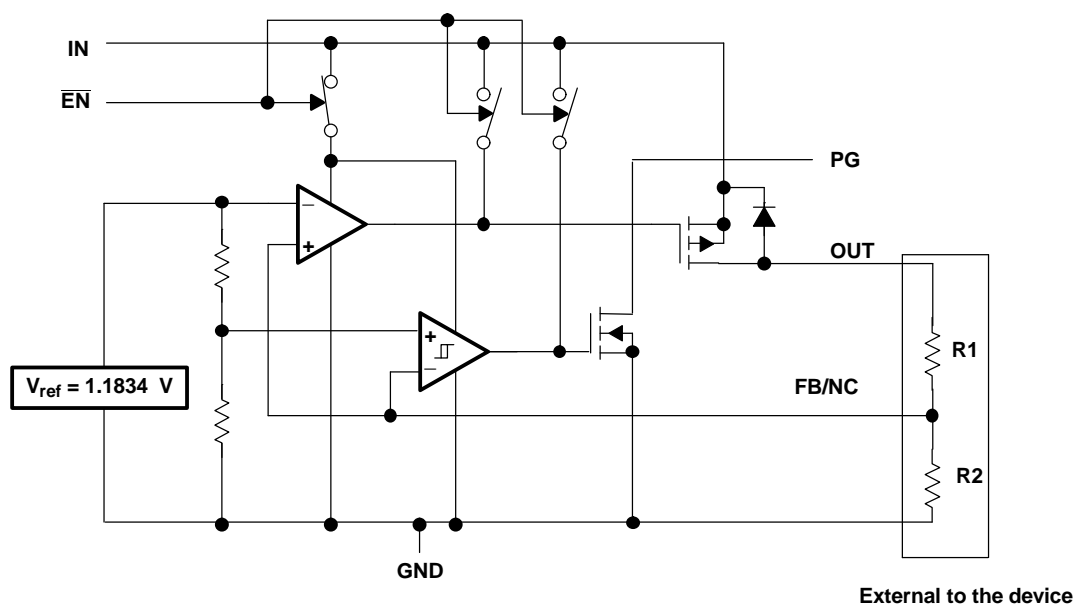
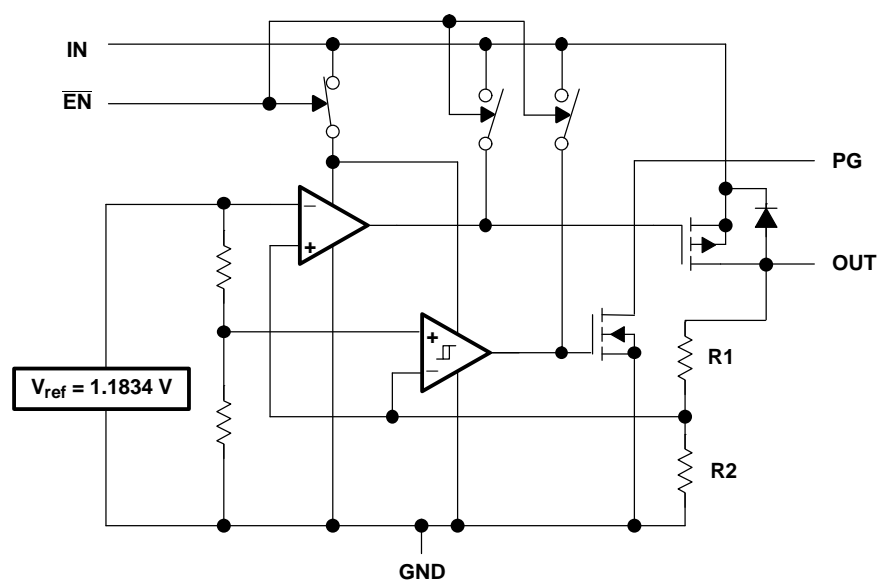
over recommended operating free-air temperature range,  $V_I = V_{O(\text{typ})} + 1 \text{ V}$ ,  $I_O = 1 \text{ mA}$ ,  $\overline{\text{EN}} = 0 \text{ V}$ ,  $C_O = 10 \mu\text{F}$  (unless otherwise noted).

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

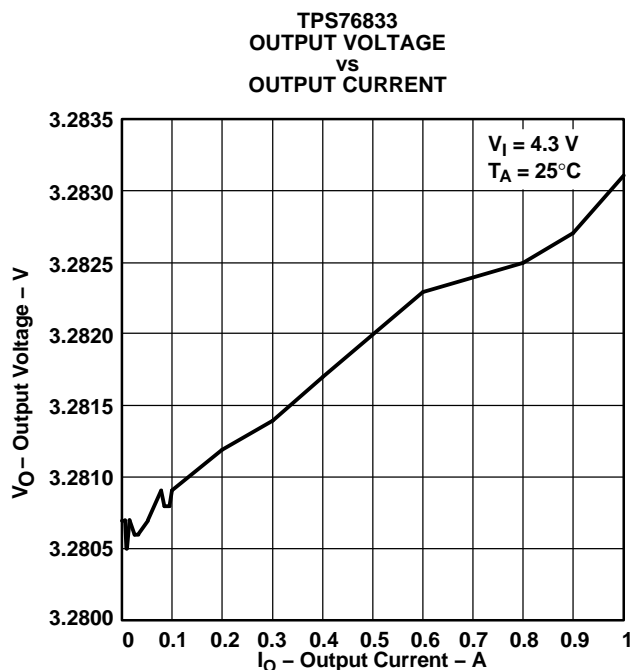


Figure 2.

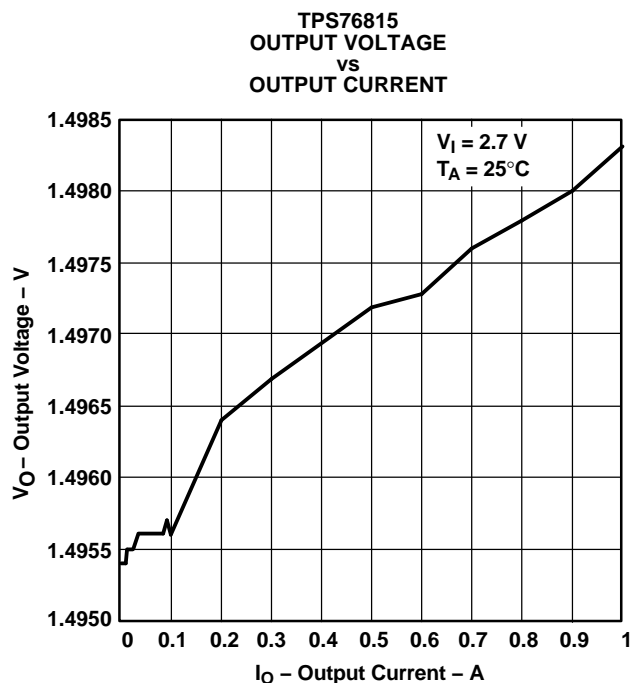


Figure 3.

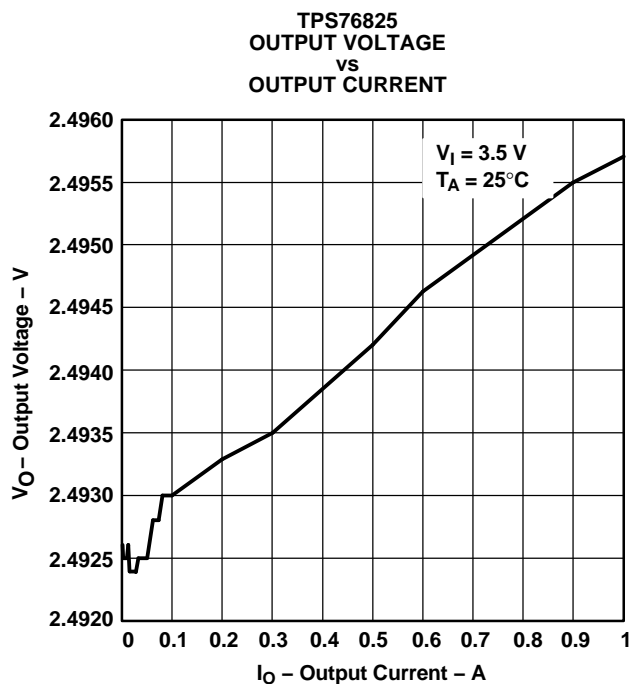


Figure 4.

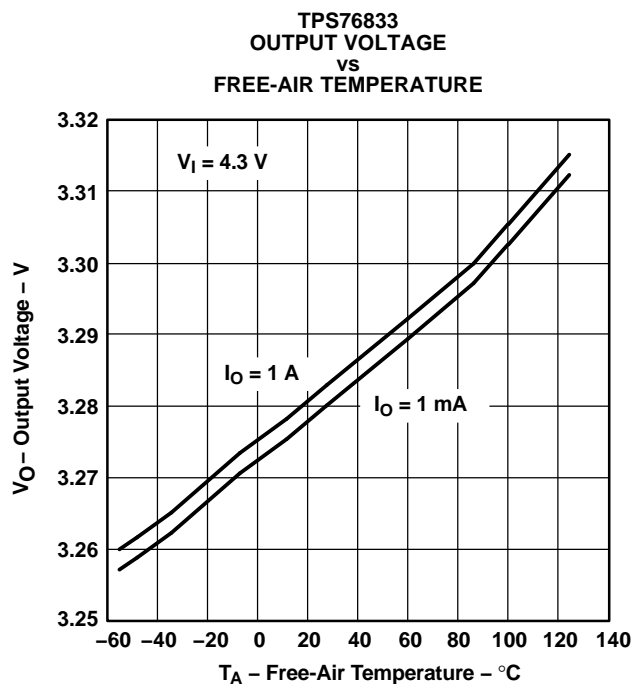


Figure 5.

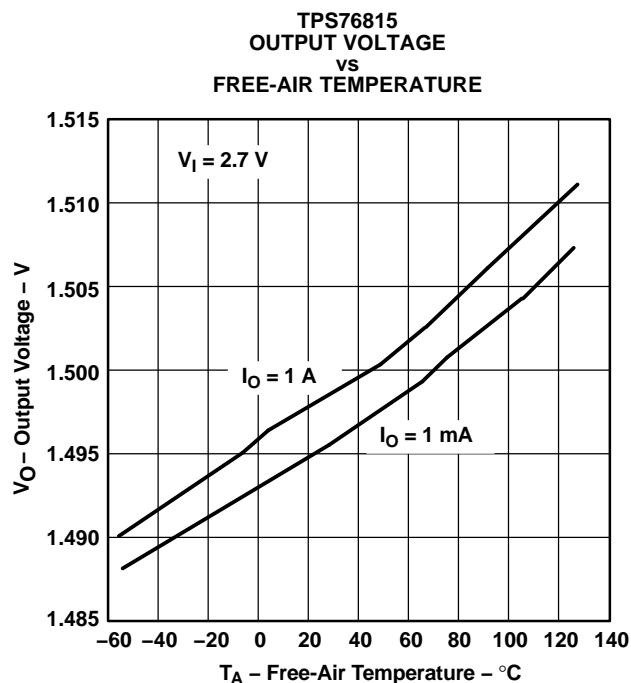
**TYPICAL CHARACTERISTICS (continued)**

Figure 6.

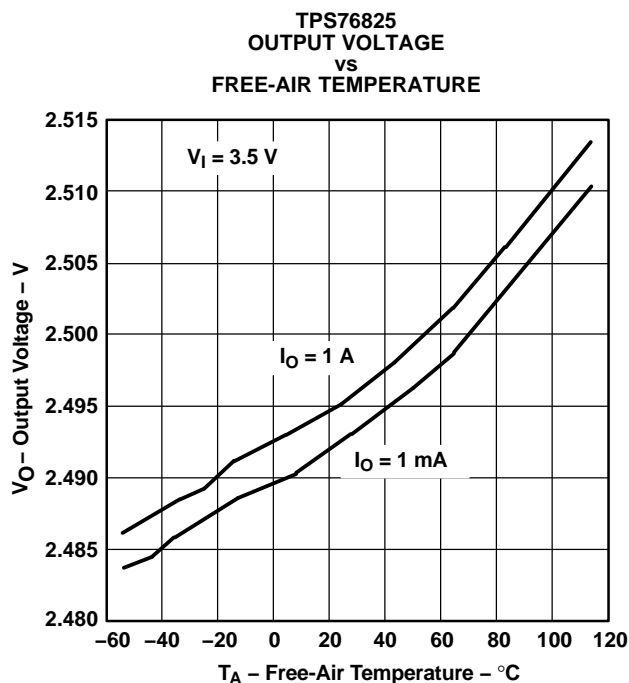


Figure 7.

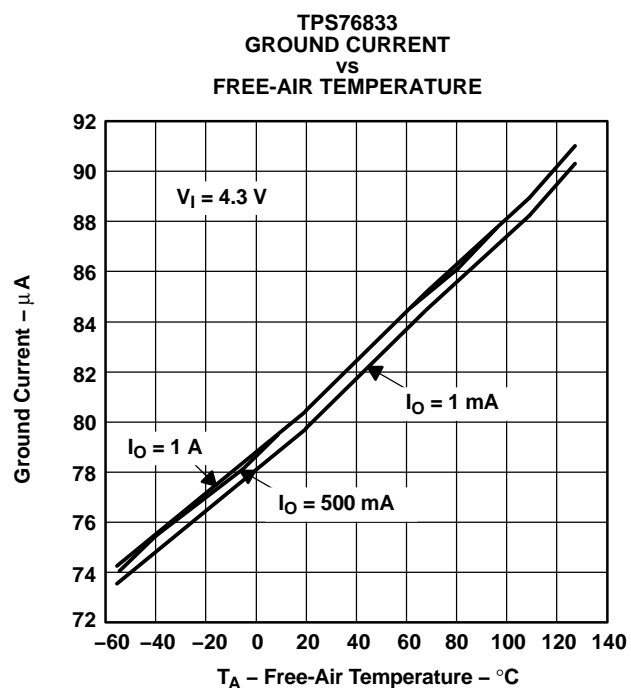


Figure 8.

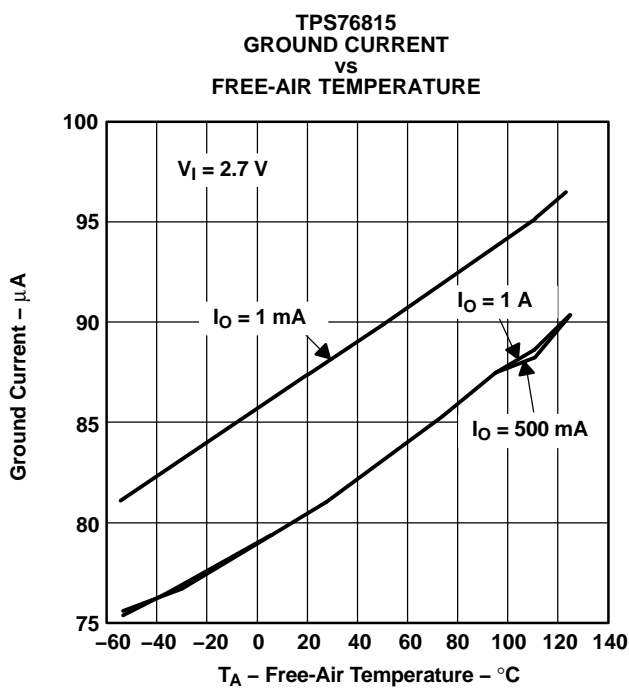


Figure 9.

# TYPICAL CHARACTERISTICS (continued)

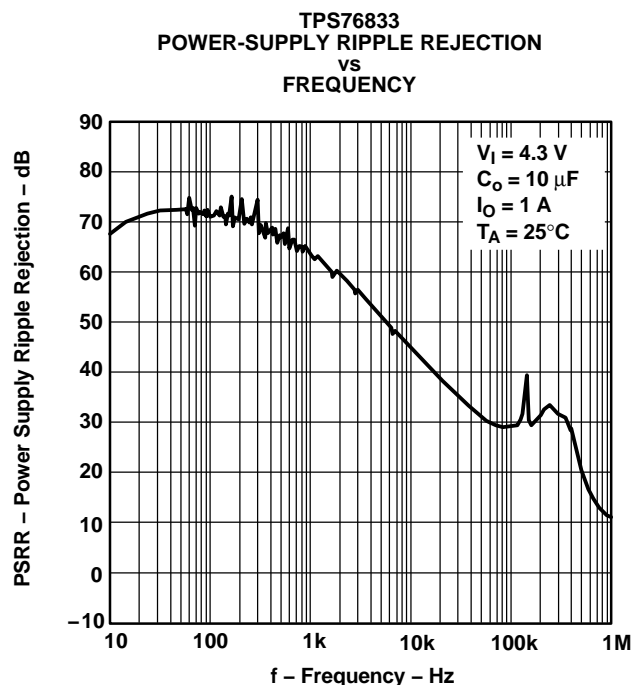


Figure 10.

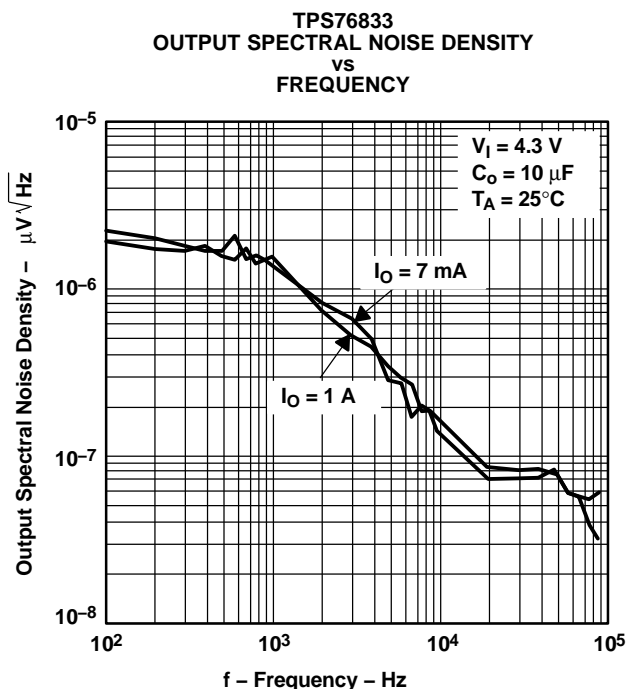


Figure 11.

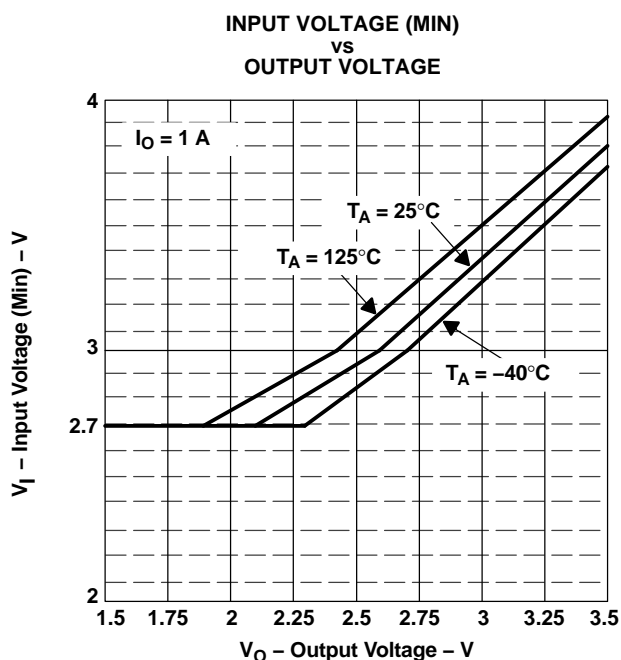


Figure 12.

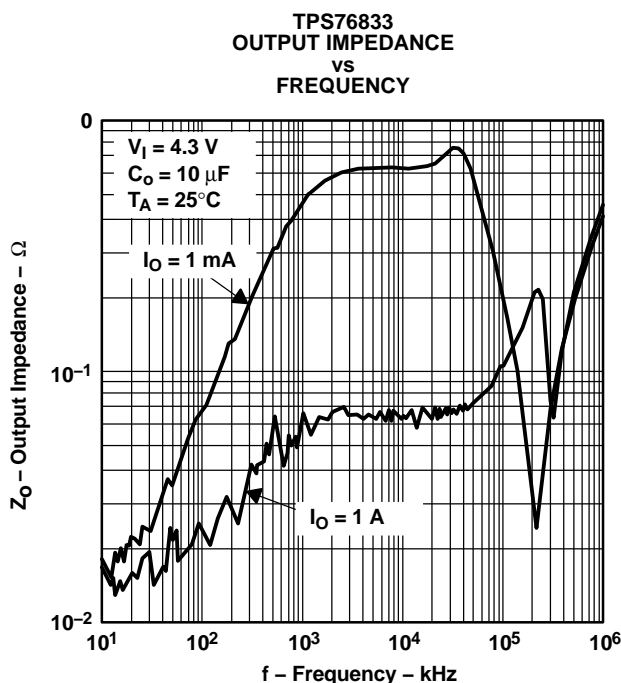


Figure 13.

## TYPICAL CHARACTERISTICS (continued)

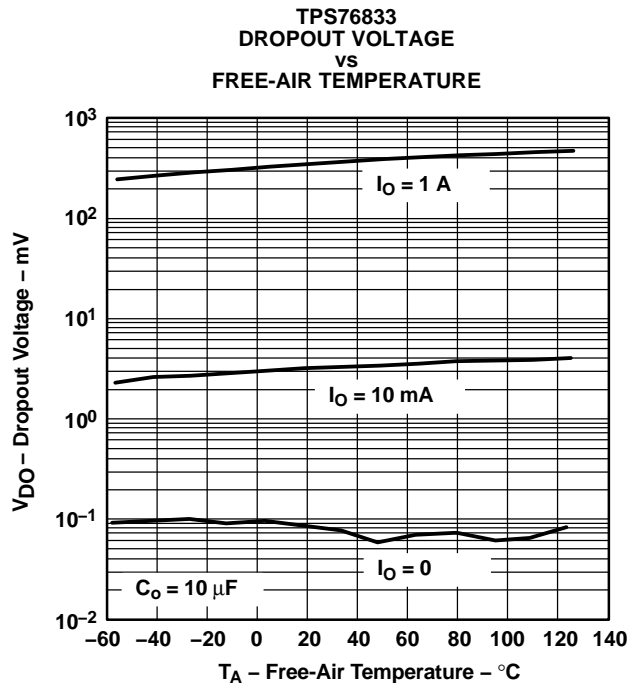


Figure 14.

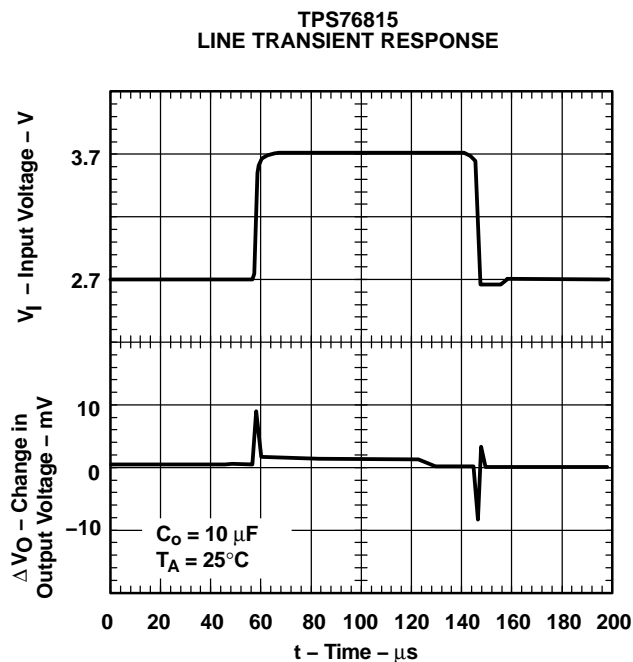


Figure 15.

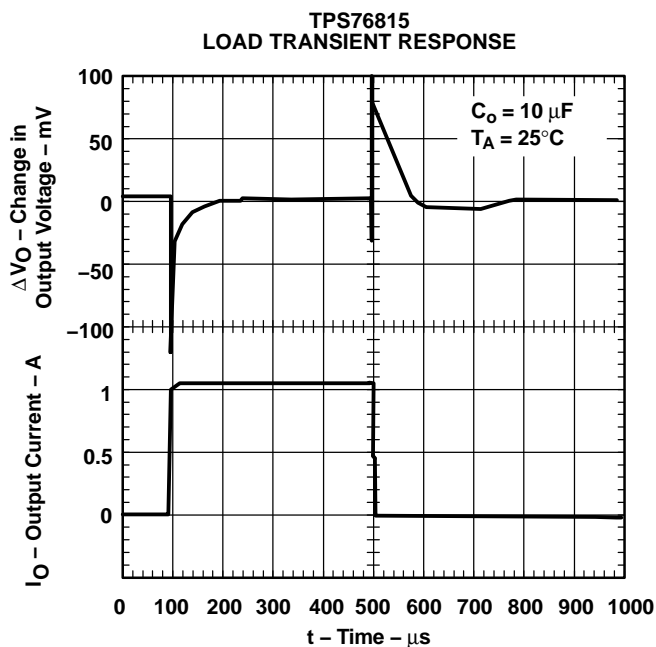


Figure 16.

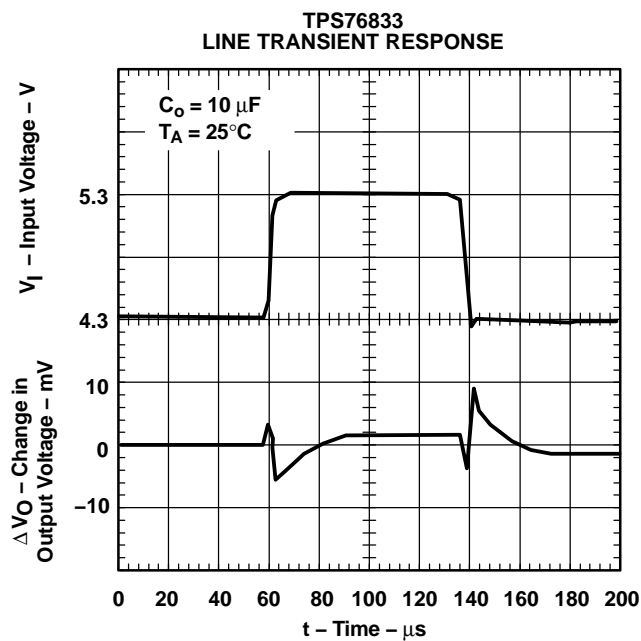


Figure 17.



# TYPICAL CHARACTERISTICS (continued)

TPS76833  
LOAD TRANSIENT RESPONSE

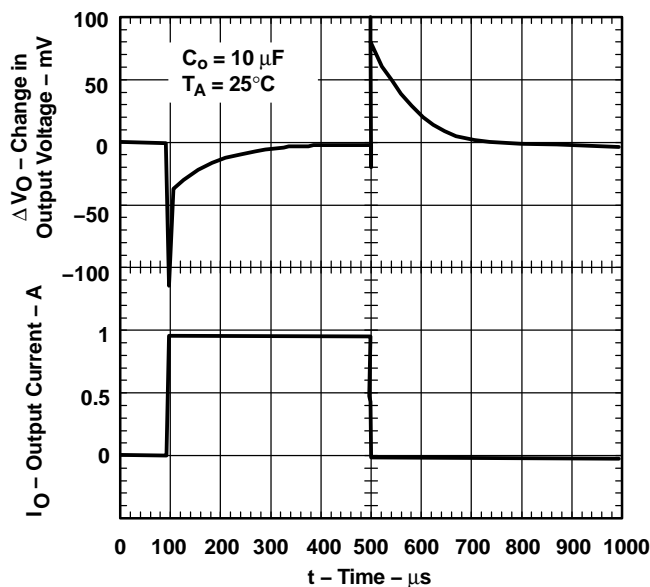


Figure 18.

TPS76833  
OUTPUT VOLTAGE  
vs  
TIME (AT START-UP)

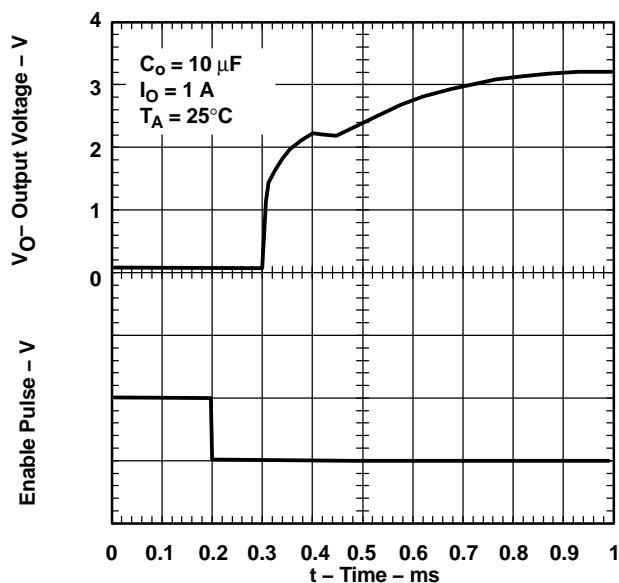


Figure 19.

TPS76801  
DROPOUT VOLTAGE  
vs  
INPUT VOLTAGE

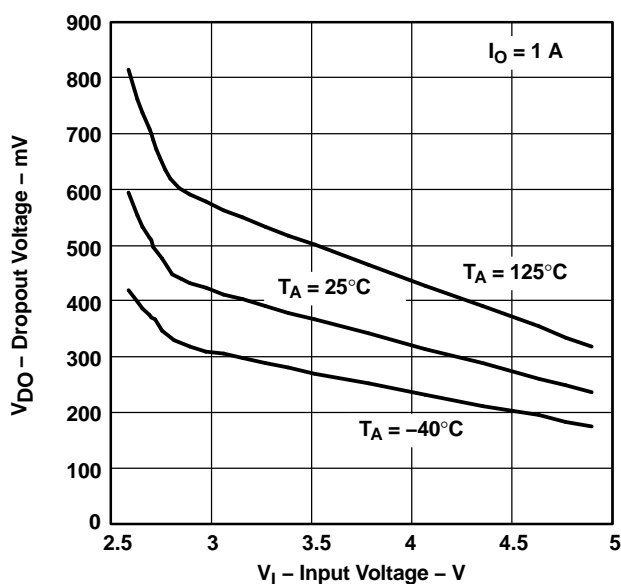


Figure 20.

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

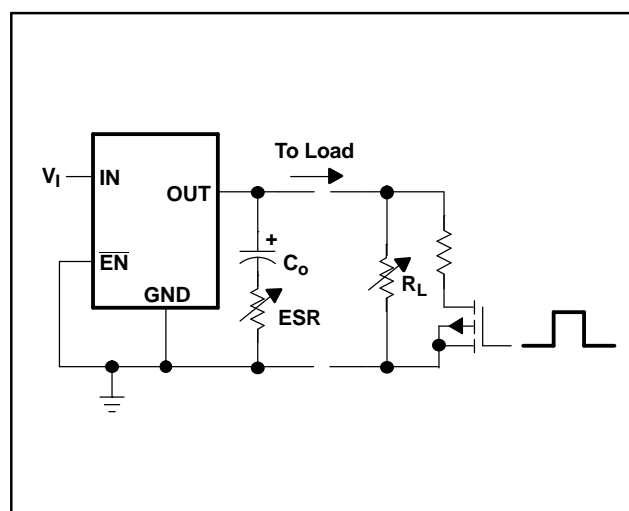
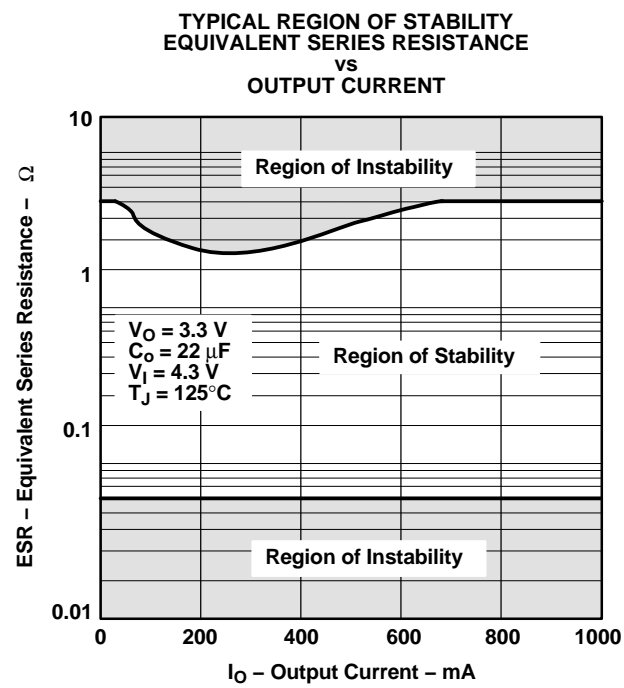
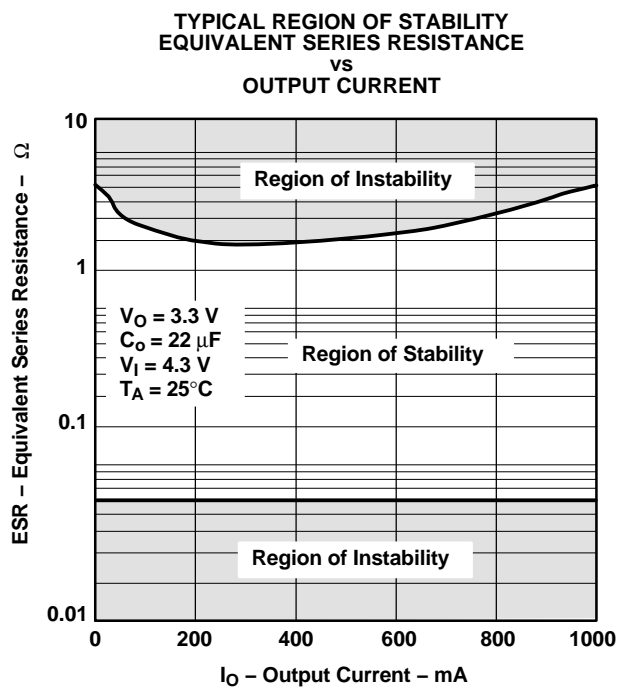
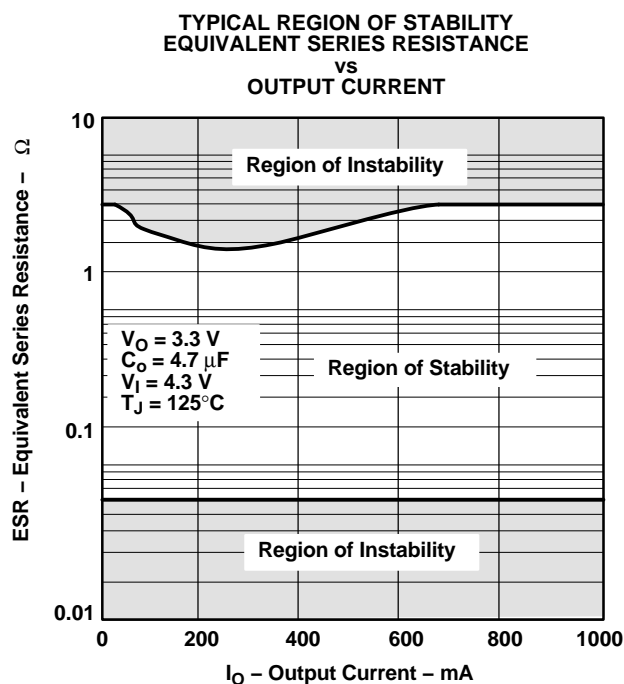
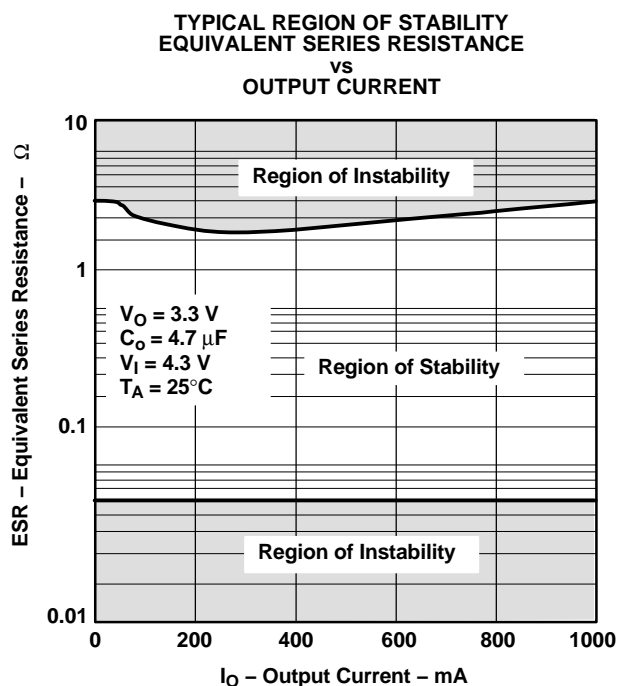


Figure 21.

**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  $C_O$ .



## 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 ( $I_B = I_O/\beta$ ). 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  $\beta$  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  $\mu$ A. If the shutdown feature is not used,  $\overline{EN}$  should be tied to ground.

### MINIMUM LOAD REQUIREMENTS

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

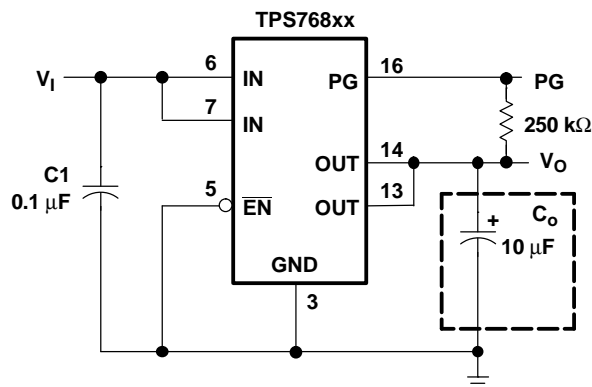
### FB - PIN CONNECTION (ADJUSTABLE VERSION ONLY)

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  $\mu$ 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  $\mu$ F and the ESR (equivalent series resistance) must be between 60 m $\Omega$  and 1.5  $\Omega$ . Capacitor values 10  $\mu$ F or larger are acceptable, provided the ESR is less than 1.5 $\Omega$ . 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:

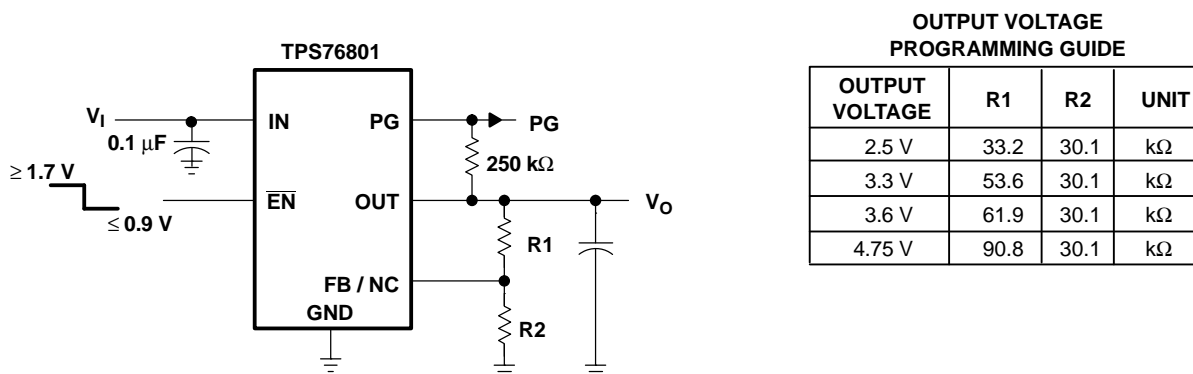
$$V_O = V_{\text{ref}} \times \left(1 + \frac{R1}{R2}\right)$$

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****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 (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS76801QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76801	<a href="#">Samples</a>
TPS76801QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76801	<a href="#">Samples</a>
TPS76801QDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76801	<a href="#">Samples</a>
TPS76801QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76801	<a href="#">Samples</a>
TPS76801QPWP	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76801	<a href="#">Samples</a>
TPS76801QPWPG4	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76801	<a href="#">Samples</a>
TPS76801QPWPR	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76801	<a href="#">Samples</a>
TPS76801QPWPRG4	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76801	<a href="#">Samples</a>
TPS76815QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76815	<a href="#">Samples</a>
TPS76815QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76815	<a href="#">Samples</a>
TPS76815QDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76815	<a href="#">Samples</a>
TPS76815QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76815	<a href="#">Samples</a>
TPS76815QPWP	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76815	<a href="#">Samples</a>
TPS76815QPWPG4	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76815	<a href="#">Samples</a>
TPS76815QPWPR	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76815	<a href="#">Samples</a>
TPS76815QPWPRG4	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76815	<a href="#">Samples</a>
TPS76818QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76818	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS76818QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76818	<a href="#">Samples</a>
TPS76818QDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76818	<a href="#">Samples</a>
TPS76818QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76818	<a href="#">Samples</a>
TPS76818QPWP	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76818	<a href="#">Samples</a>
TPS76818QPWPG4	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76818	<a href="#">Samples</a>
TPS76818QPWPR	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76818	<a href="#">Samples</a>
TPS76825QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76825	<a href="#">Samples</a>
TPS76825QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76825	<a href="#">Samples</a>
TPS76825QDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76825	<a href="#">Samples</a>
TPS76825QPWP	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76825	<a href="#">Samples</a>
TPS76825QPWPG4	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76825	<a href="#">Samples</a>
TPS76825QPWPR	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76825	<a href="#">Samples</a>
TPS76825QPWPRG4	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76825	<a href="#">Samples</a>
TPS76827QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76827	<a href="#">Samples</a>
TPS76828QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76828	<a href="#">Samples</a>
TPS76830QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76830	<a href="#">Samples</a>
TPS76830QPWP	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76830	<a href="#">Samples</a>
TPS76833QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76833	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS76833QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76833	<a href="#">Samples</a>
TPS76833QDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76833	<a href="#">Samples</a>
TPS76833QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76833	<a href="#">Samples</a>
TPS76833QPWP	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76833	<a href="#">Samples</a>
TPS76833QPWPG4	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76833	<a href="#">Samples</a>
TPS76833QPWPR	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76833	<a href="#">Samples</a>
TPS76833QPWPRG4	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76833	<a href="#">Samples</a>
TPS76850QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76850	<a href="#">Samples</a>
TPS76850QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76850	<a href="#">Samples</a>
TPS76850QDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76850	<a href="#">Samples</a>
TPS76850QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	76850	<a href="#">Samples</a>
TPS76850QPWP	ACTIVE	HTSSOP	PWP	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76850	<a href="#">Samples</a>
TPS76850QPWPG4	ACTIVE	HTSSOP	PWP	20		TBD	Call TI	Call TI	-40 to 125		<a href="#">Samples</a>
TPS76850QPWPR	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76850	<a href="#">Samples</a>
TPS76850QPWPRG4	ACTIVE	HTSSOP	PWP	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PT76850	<a href="#">Samples</a>

(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.

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

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

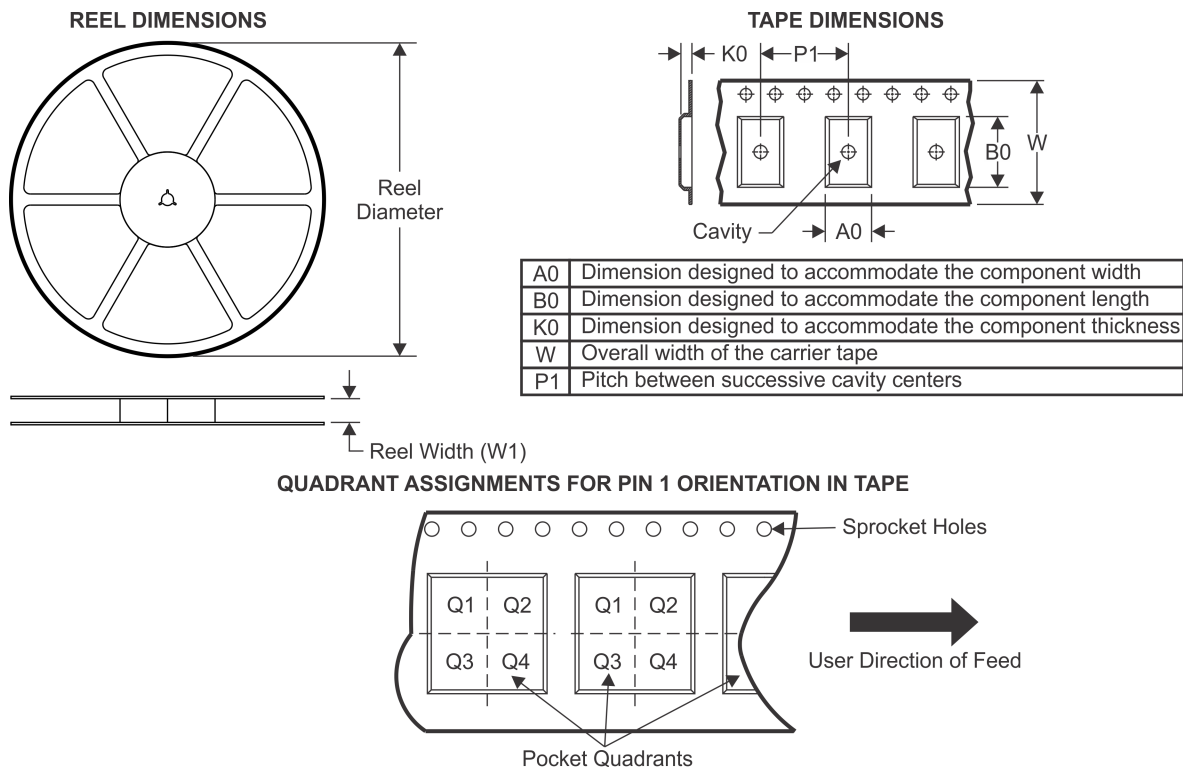
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

#### **OTHER QUALIFIED VERSIONS OF TPS768 :**

- Automotive: [TPS768-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS76801QDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TPS76801QDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TPS76801QPWPR	HTSSOP	PWP	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
TPS76815QDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TPS76815QPWPR	HTSSOP	PWP	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
TPS76818QDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TPS76818QPWPR	HTSSOP	PWP	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
TPS76825QDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TPS76825QPWPR	HTSSOP	PWP	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
TPS76833QDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TPS76833QPWPR	HTSSOP	PWP	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
TPS76850QDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TPS76850QPWPR	HTSSOP	PWP	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1

## TAPE AND REEL BOX DIMENSIONS

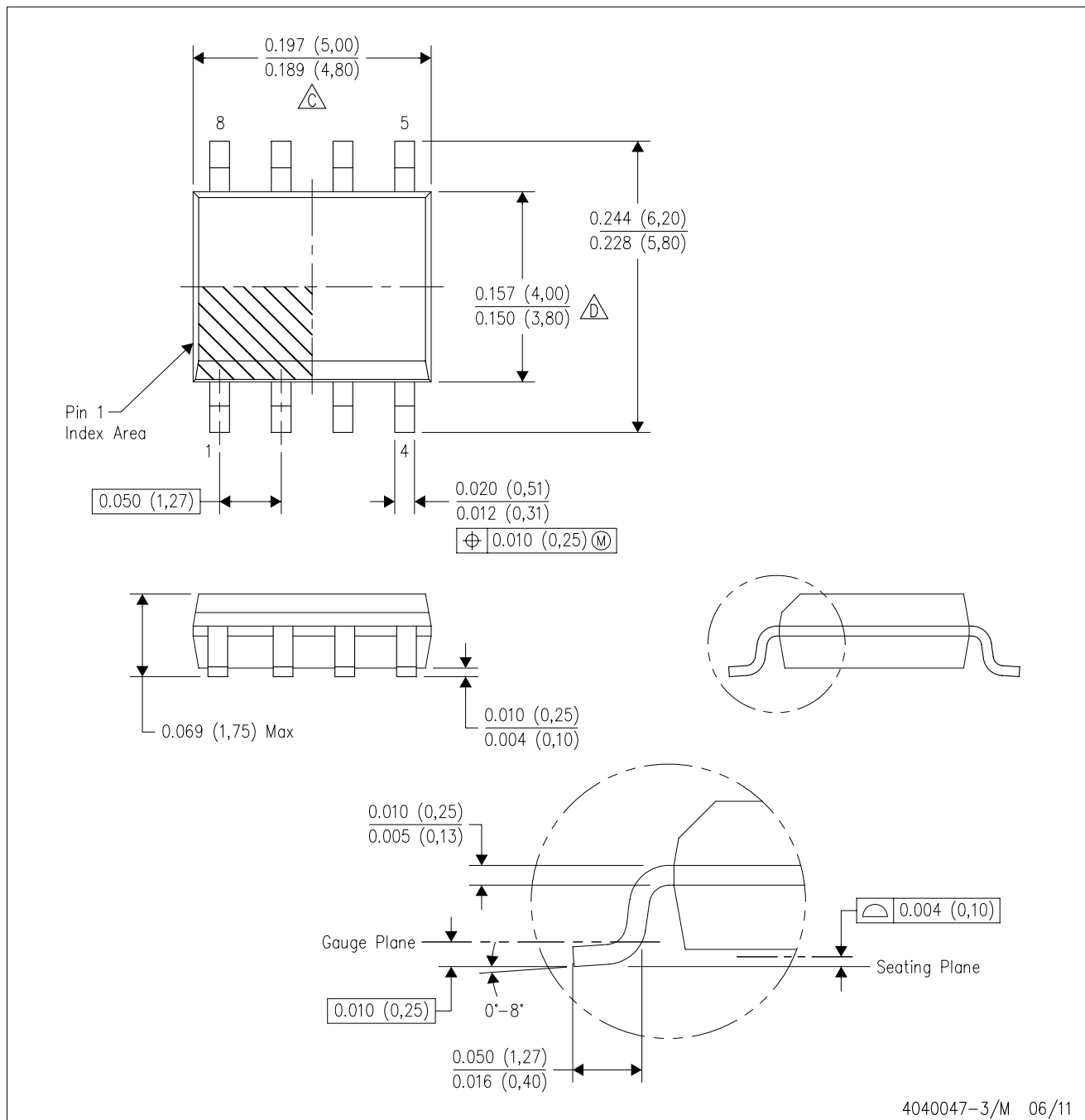


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS76801QDR	SOIC	D	8	2500	367.0	367.0	38.0
TPS76801QDR	SOIC	D	8	2500	367.0	367.0	35.0
TPS76801QPWPR	HTSSOP	PWP	20	2000	367.0	367.0	38.0
TPS76815QDR	SOIC	D	8	2500	367.0	367.0	38.0
TPS76815QPWPR	HTSSOP	PWP	20	2000	367.0	367.0	38.0
TPS76818QDR	SOIC	D	8	2500	367.0	367.0	38.0
TPS76818QPWPR	HTSSOP	PWP	20	2000	367.0	367.0	38.0
TPS76825QDR	SOIC	D	8	2500	367.0	367.0	38.0
TPS76825QPWPR	HTSSOP	PWP	20	2000	367.0	367.0	38.0
TPS76833QDR	SOIC	D	8	2500	367.0	367.0	38.0
TPS76833QPWPR	HTSSOP	PWP	20	2000	367.0	367.0	38.0
TPS76850QDR	SOIC	D	8	2500	367.0	367.0	38.0
TPS76850QPWPR	HTSSOP	PWP	20	2000	367.0	367.0	38.0

D (R-PDSO-G8)

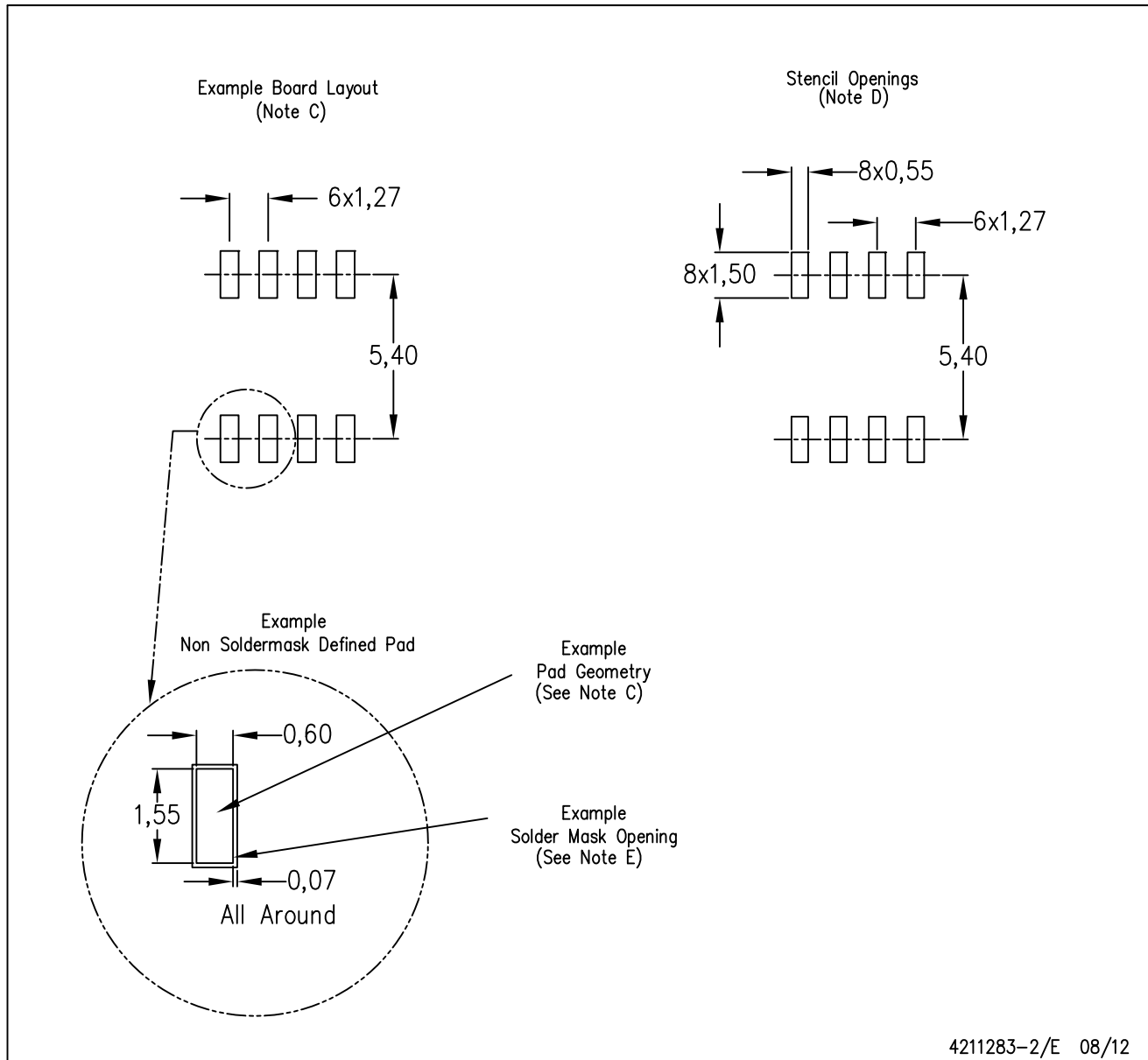
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AA.

D (R-PDSO-G8)

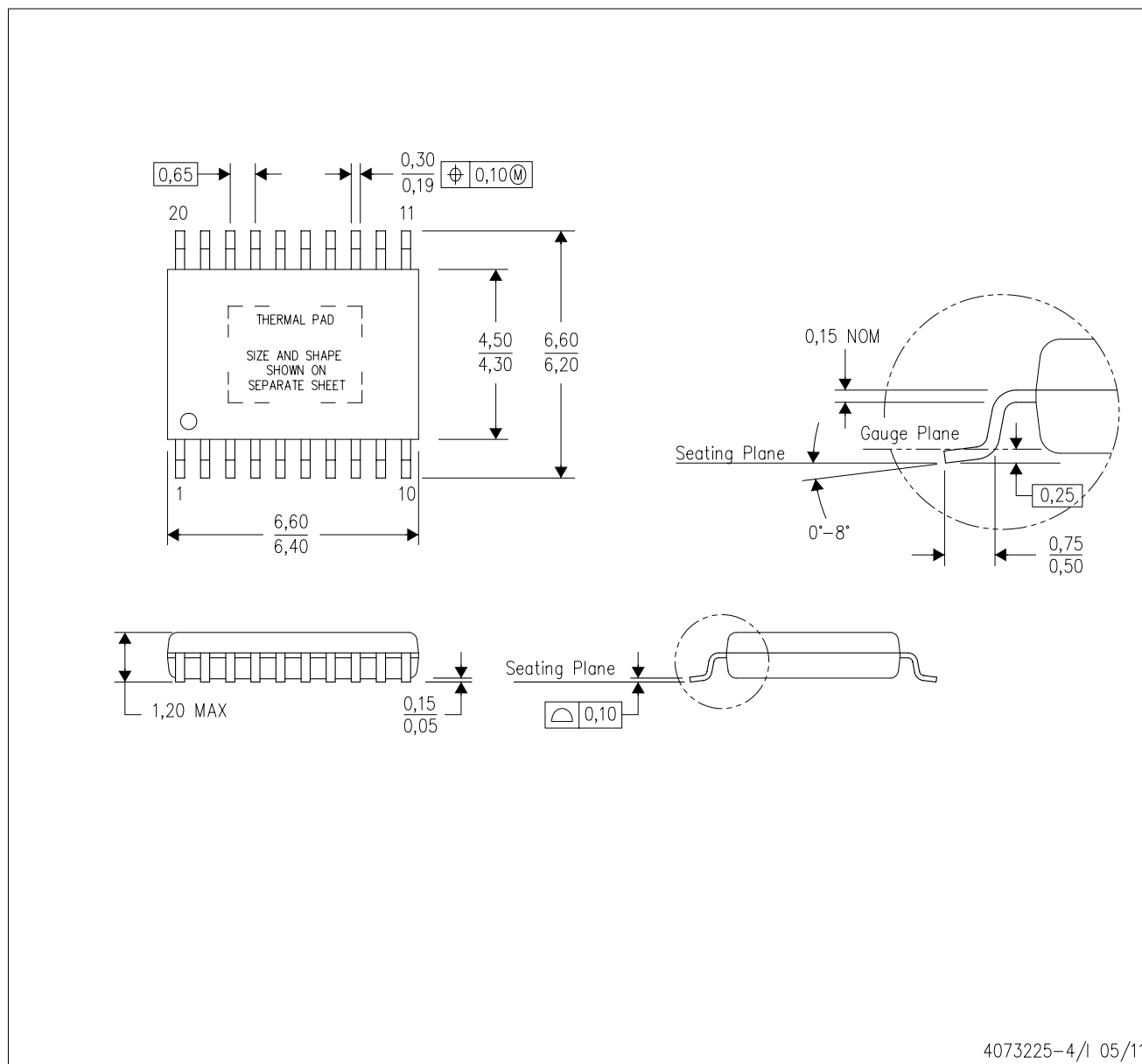
PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - 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. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

PWP (R-PDSO-G20)

PowerPAD™ PLASTIC SMALL OUTLINE



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) <<http://www.ti.com>>.
- See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
- Falls within JEDEC MO-153

PowerPAD is a trademark of Texas Instruments.

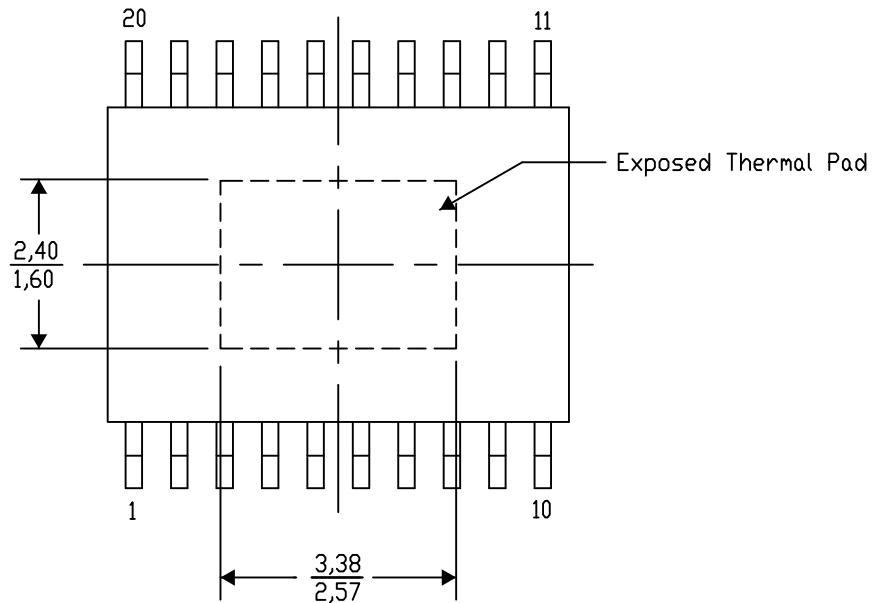
## PWP (R-PDSO-G20) PowerPAD™ SMALL PLASTIC OUTLINE

## THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the 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](http://www.ti.com).

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



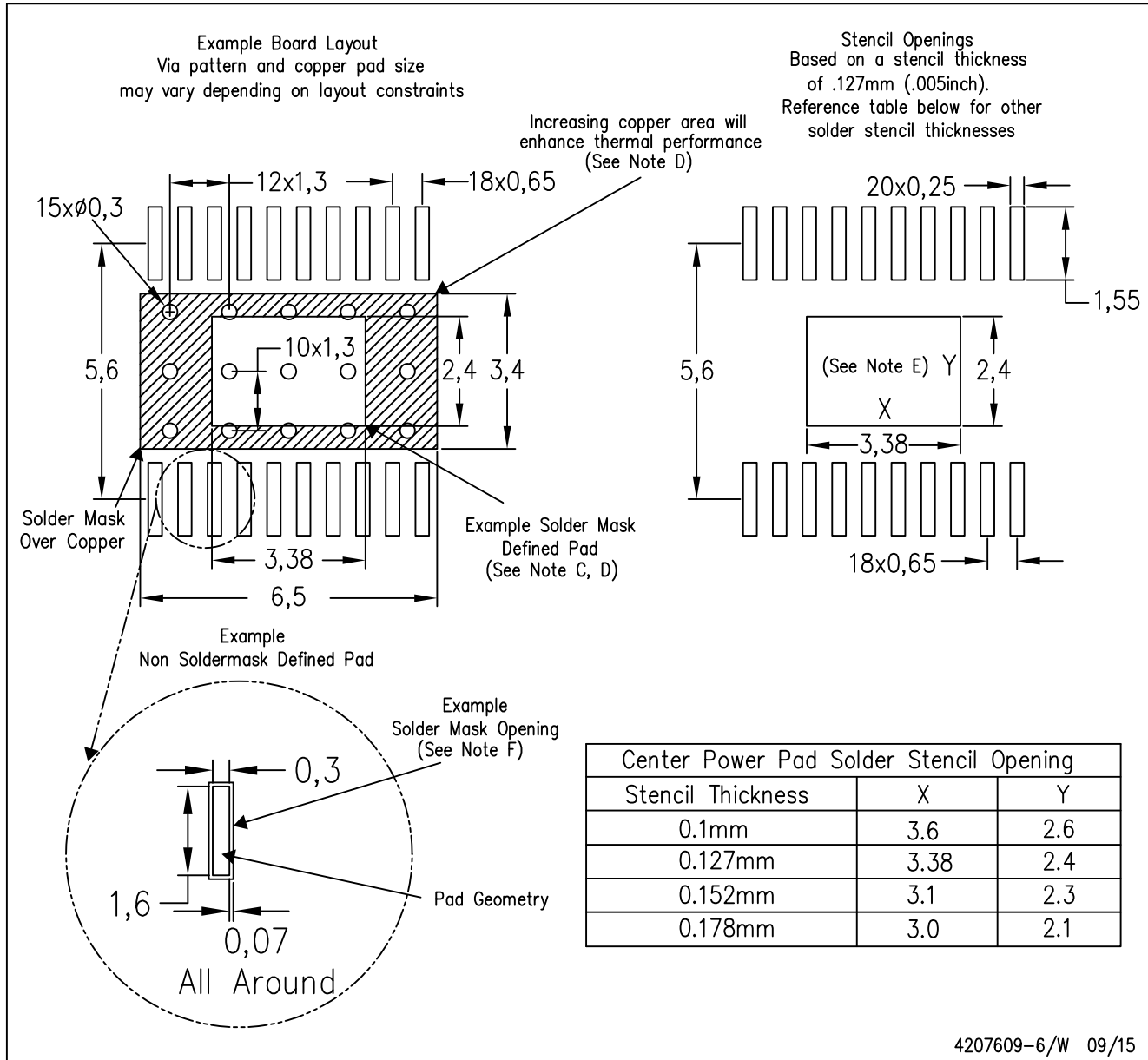
4206332-13/AO 01/16

NOTE: A. All linear dimensions are in millimeters

PowerPAD is a trademark of Texas Instruments

PWP (R-PDSO-G20)

PowerPAD™ PLASTIC SMALL OUTLINE



- 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) <<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.



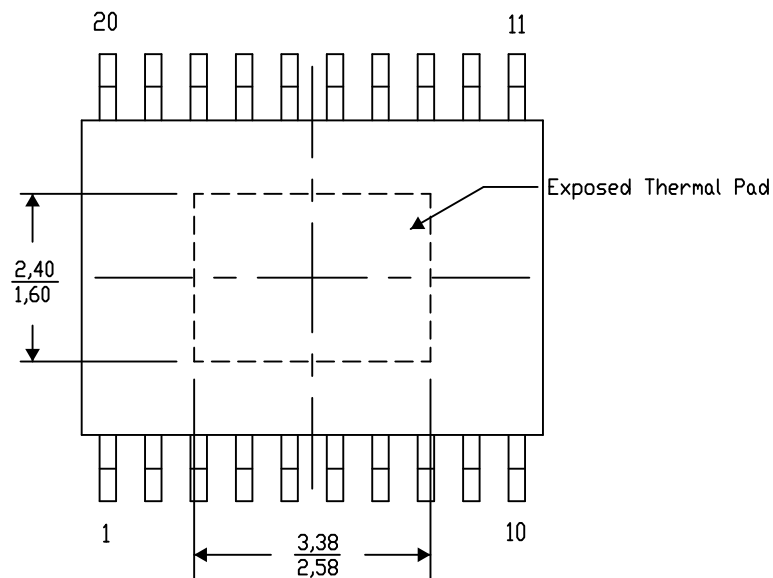
## PWP (R-PDSO-G20) PowerPAD™ SMALL PLASTIC OUTLINE

## THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the 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](http://www.ti.com).

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



Top View

Exposed Thermal Pad Dimensions

4206332-21/AO 01/16

NOTE: A. All linear dimensions are in millimeters

PowerPAD is a trademark of Texas Instruments

## IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated ("TI") technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications that include TI products, you will thoroughly test such applications and the functionality of such TI products as used in such applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your non-compliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include; without limitation, TI's standard terms for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>), [evaluation modules](#), and [samples](http://www.ti.com/sc/docs/sampterm.htm) (<http://www.ti.com/sc/docs/sampterm.htm>).

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2017, Texas Instruments Incorporated