

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

### FEATURES

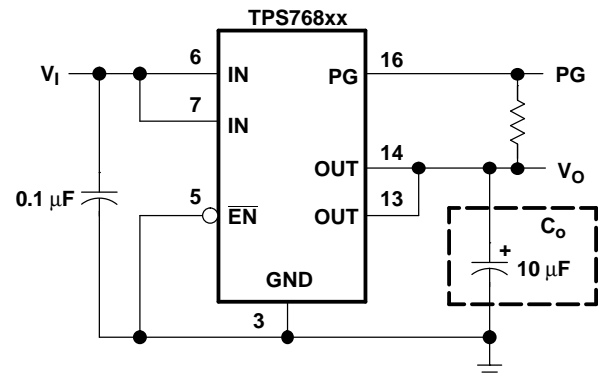
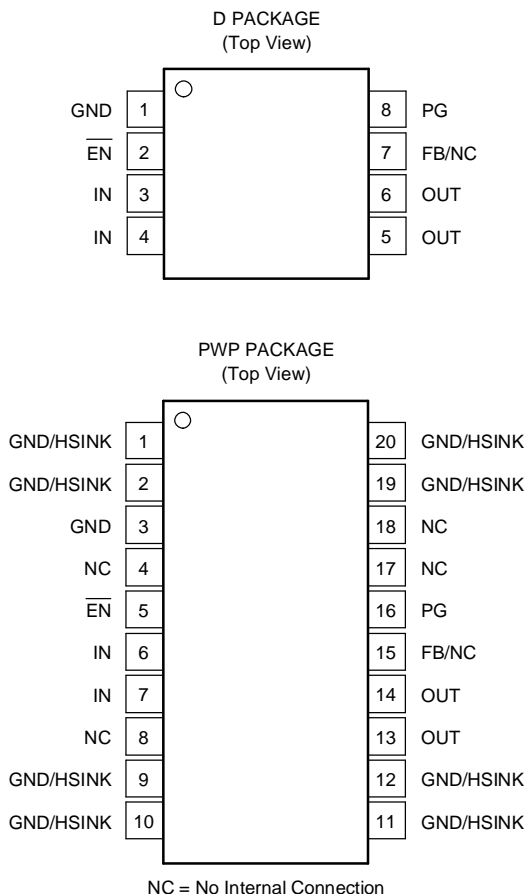
- **Input Voltage Range: 2.7 V to 10 V**
- **Low-Dropout Voltage: 230 mV typical at 1 A (TPS76850)**
- **2% Tolerance Over Specified Conditions for Fixed-Output Versions**
- **Open Drain Power Good (See TPS767xx for Power-On Reset With 200-ms Delay Option)**
- **Ultralow 85  $\mu$ A Typical Quiescent 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>
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](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 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		$-40^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$ , $V_O + 1 \text{ V} \leq V_{\text{IN}} \leq 10\text{V}^{(1)}$ , $10 \mu\text{A} \leq I_O \leq 1\text{A}$	(0.98)V <sub>O</sub>	V <sub>O</sub>	(1.02)V <sub>O</sub>	V
Quiescent current (GND current) $\overline{\text{EN}} = 0\text{V}^{(1)}$		$I_O = 1 \text{ A}$ , $T_J = +25^\circ\text{C}$	85			μA
		$I_O = 1 \text{ A}$ , $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$	125			
Output voltage line regulation ( $\Delta V_O/V_O$ ) <sup>(1)(2)</sup>		$V_O + 1 \text{ V} < V_I \leq 10 \text{ V}$ , $T_J = +25^\circ\text{C}$	0.01			%/V
Load regulation			3			mV
Output noise voltage (TPS76818)		BW = 200 Hz to 100 kHz, $C_O = 10 \mu\text{F}$ , $I_C = 1 \text{ A}$ , $T_J = +25^\circ\text{C}$	55			μVrms
Output current limit		$V_O = 0 \text{ V}$	1.2	1.7	2	A
Thermal shutdown junction temperature			150			°C
Standby current		$V_{\overline{\text{EN}}} = V_I$ , $T_J = +25^\circ\text{C}$ , $2.7 \text{ V} < V_I < 10 \text{ V}$	1			μA
		$V_{\overline{\text{EN}}} = V_I$ , $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$ , $2.7 \text{ V} < V_I < 10 \text{ V}$	10			
FB pin current, I <sub>FB</sub>	TPS76801	$V_{\text{FB}} = 1.5 \text{ V}$	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>		$f = 1 \text{ kHz}$ , $C_O = 10 \mu\text{F}$ , $T_J = +25^\circ\text{C}$	60			dB
Power Good (PG)	Minimum input voltage for valid PG	$I_{O(\text{PG})} = 300 \mu\text{A}$	1.1			V
	Trip threshold voltage	$V_O$ decreasing	92	98		%V <sub>O</sub>
	Hysteresis voltage	Measured at $V_O$	0.5			%V <sub>O</sub>
	Output low voltage	$V_I = 2.7 \text{ V}$ , $I_{O(\text{PG})} = 1 \text{ mA}$	0.15	0.4		V
	Leakage current	$V_{(\text{PG})} = 5 \text{ V}$	1			μA
Enable pin current (I <sub>EN</sub> )		$V_{\overline{\text{EN}}} = 0 \text{ V}$	1	0	1	μA
		$V_{\overline{\text{EN}}} = V_I$	1	1		
Dropout voltage <sup>(3)</sup>	TPS76828	$I_O = 1 \text{ A}$ , $T_J = +25^\circ\text{C}$	500			mV
		$I_O = 1 \text{ A}$ , $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$	825			
	TPS76830	$I_O = 1 \text{ A}$ , $T_J = +25^\circ\text{C}$	450			
		$I_O = 1 \text{ A}$ , $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$	675			
	TPS76833	$I_O = 1 \text{ A}$ , $T_J = +25^\circ\text{C}$	350			
		$I_O = 1 \text{ A}$ , $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$	575			
	TPS76850	$I_O = 1 \text{ A}$ , $T_J = +25^\circ\text{C}$	230			
		$I_O = 1 \text{ A}$ , $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$	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  $V_{\text{Imax}} = 10 \text{ V}$ ,  $V_{\text{Imin}} = 2.7 \text{ V}$ :  

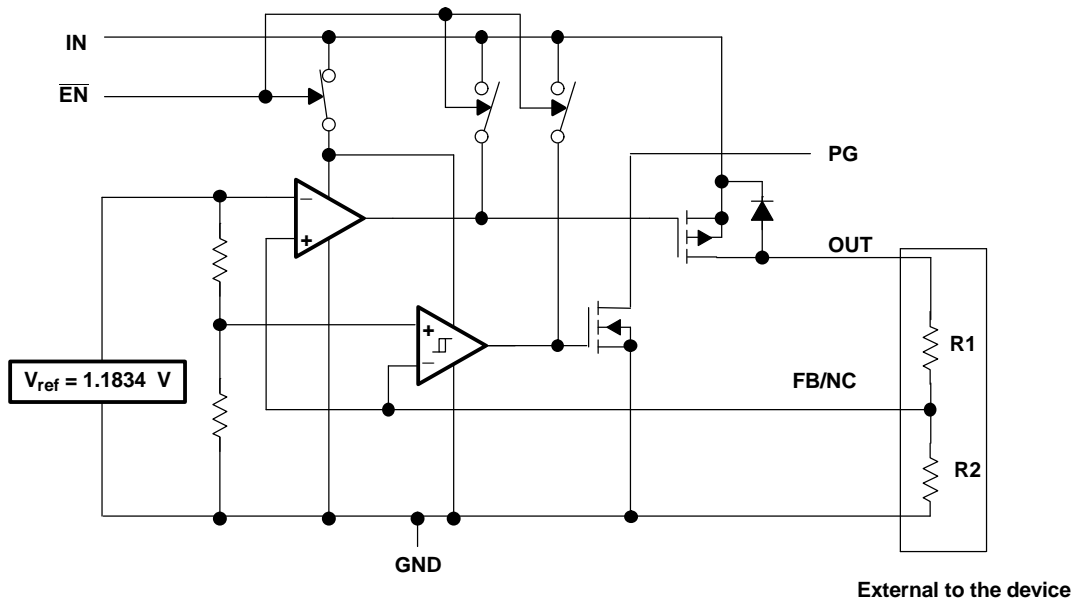
$$\text{Line Reg. (mV)} = (\% / \text{V}) \times V_O \frac{(V_{\text{Imax}} - 2.7\text{V})}{100} \times 1000$$

If  $V_O \geq 2.5 \text{ V}$  then  $V_{\text{Imax}} = 10 \text{ V}$ ,  $V_{\text{Imin}} = V_O + 1 \text{ V}$ :  

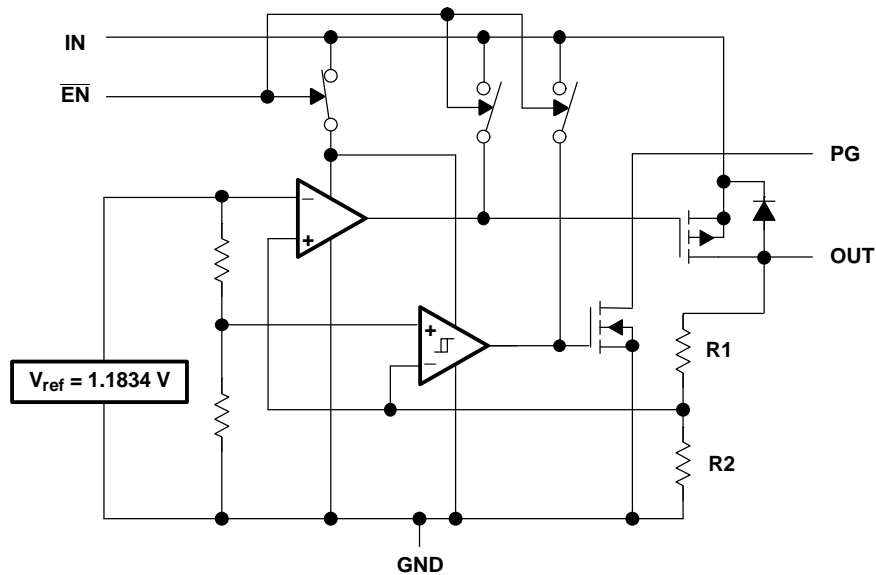
$$\text{Line Reg. (mV)} = (\% / \text{V}) \times V_O \frac{(V_{\text{Imax}} - (V_O + 1\text{V}))}{100} \times 1000$$

(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
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**

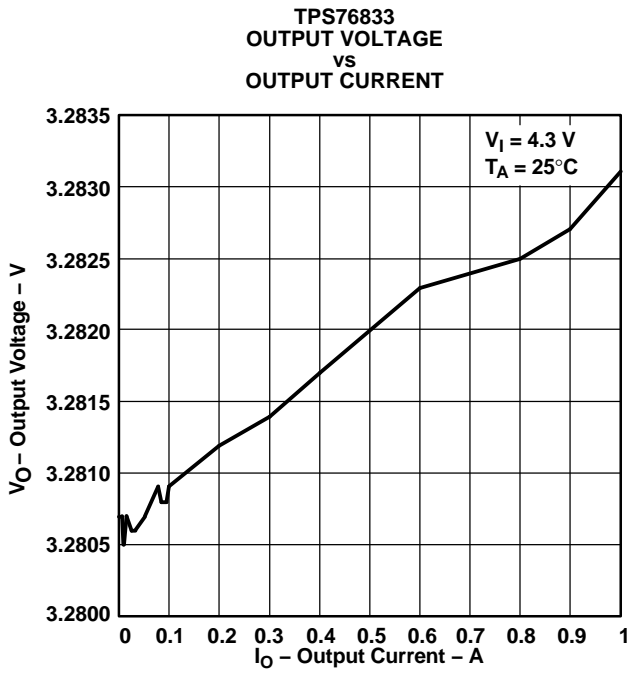


Figure 2.

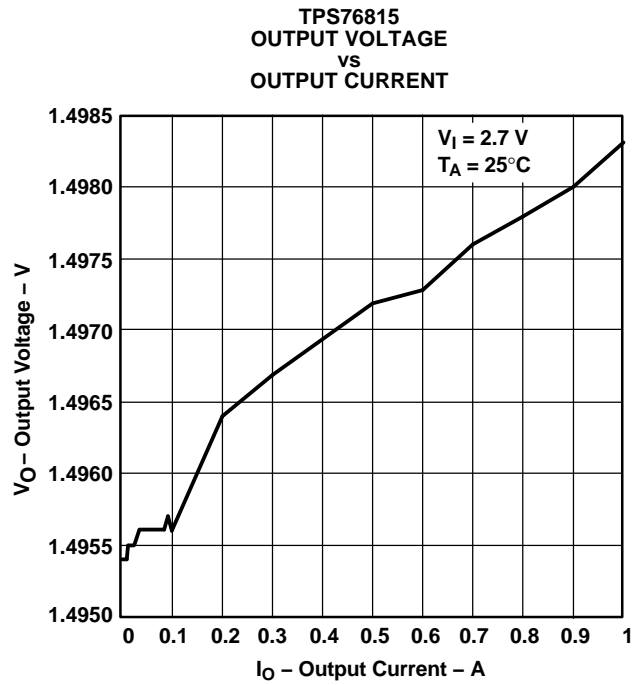


Figure 3.

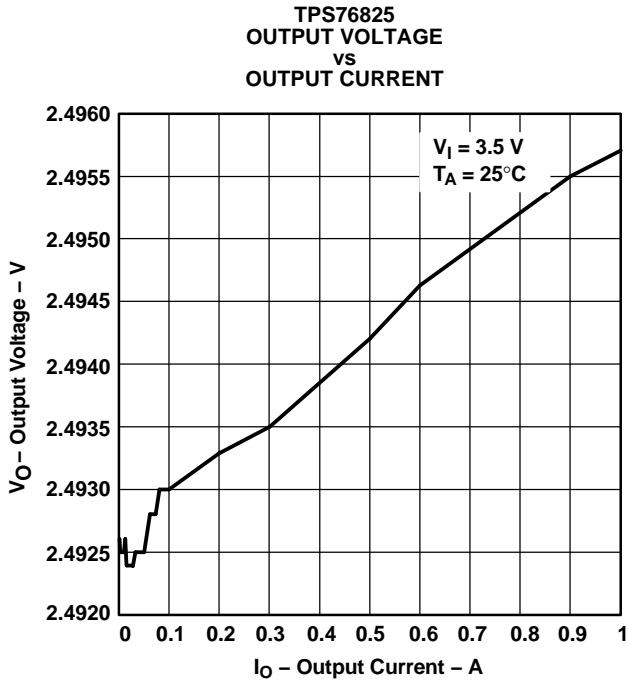


Figure 4.

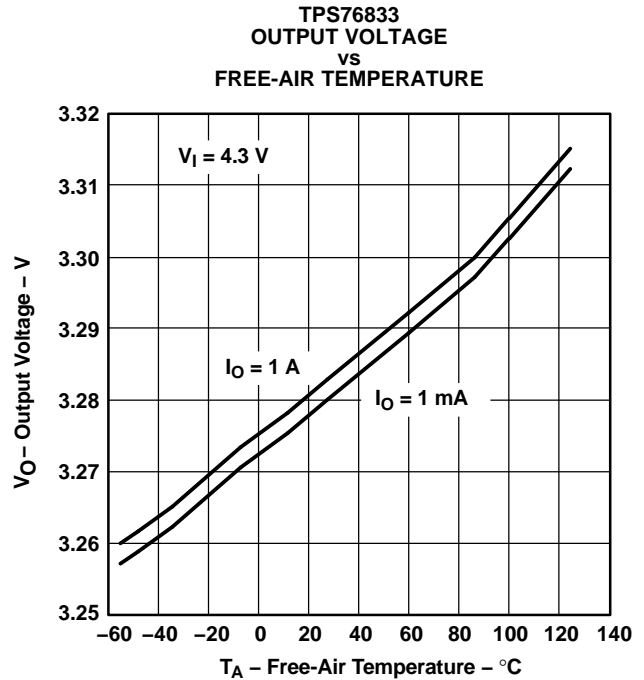


Figure 5.

TYPICAL CHARACTERISTICS (continued)

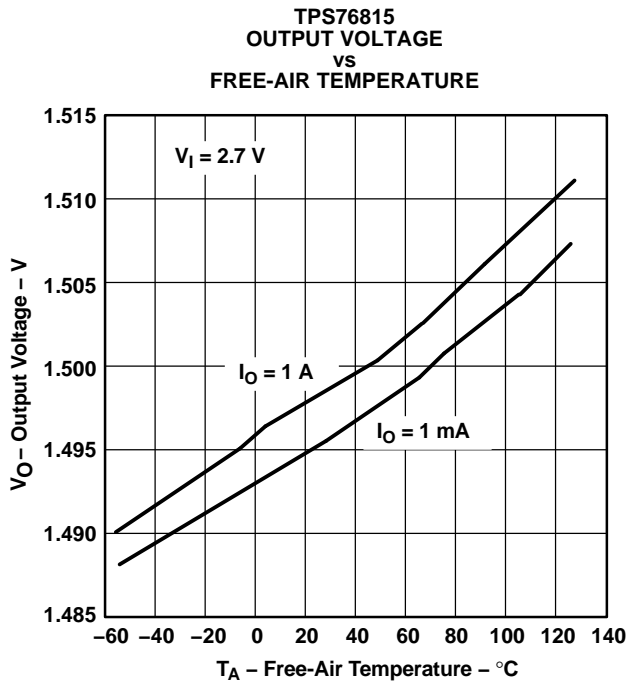


Figure 6.

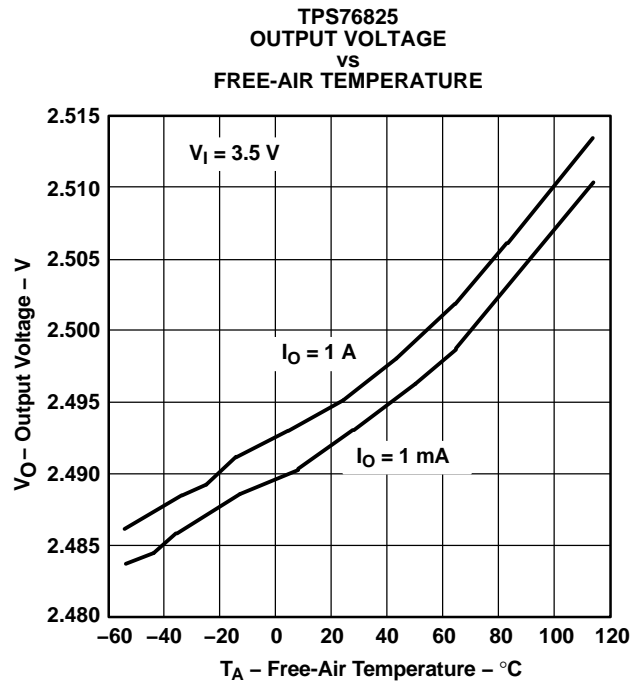


Figure 7.

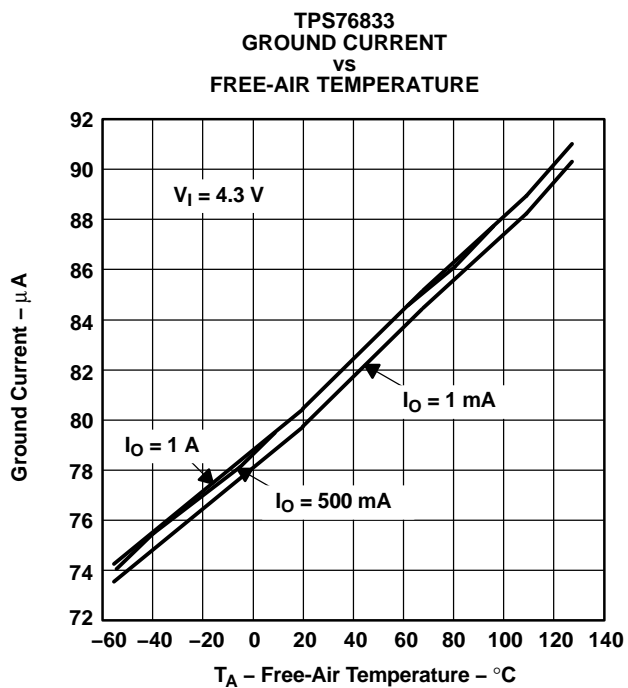


Figure 8.

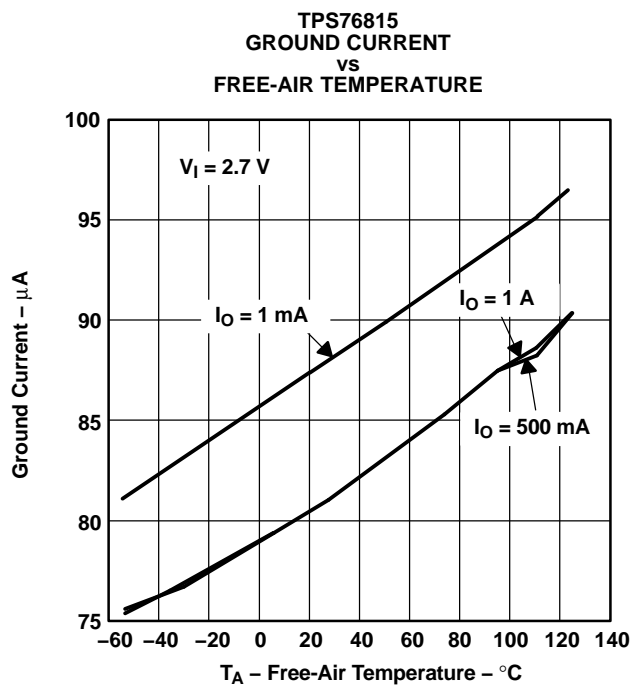


Figure 9.

TYPICAL CHARACTERISTICS (continued)

TPS76833  
 POWER-SUPPLY RIPPLE REJECTION  
 VS  
 FREQUENCY

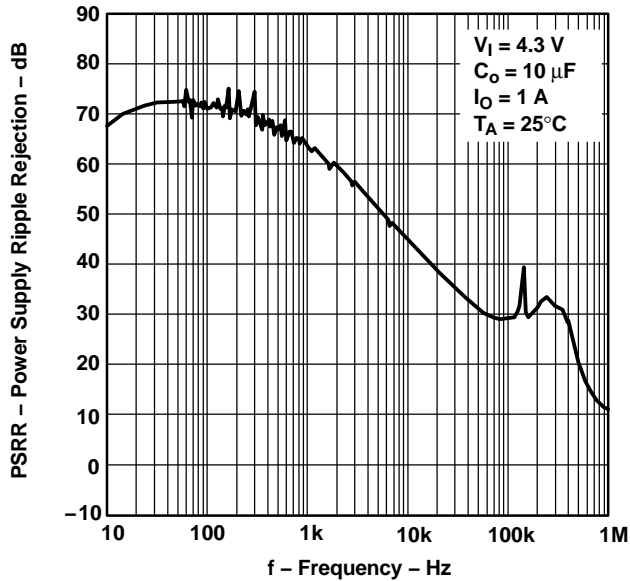


Figure 10.

TPS76833  
 OUTPUT SPECTRAL NOISE DENSITY  
 VS  
 FREQUENCY

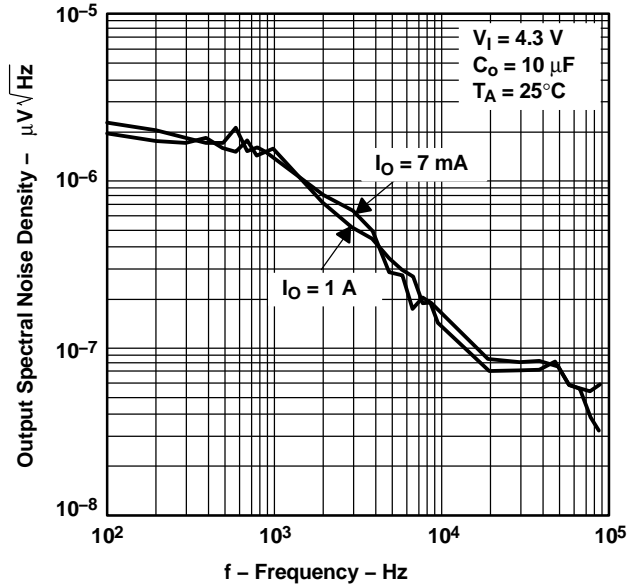


Figure 11.

INPUT VOLTAGE (MIN)  
 VS  
 OUTPUT VOLTAGE

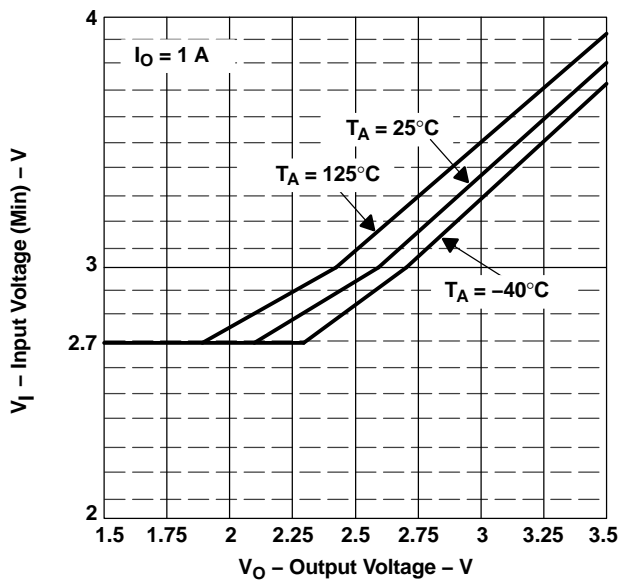


Figure 12.

TPS76833  
 OUTPUT IMPEDANCE  
 VS  
 FREQUENCY

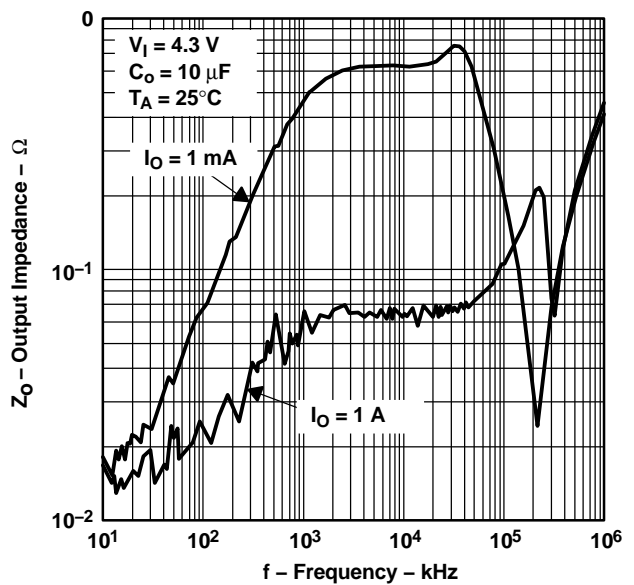
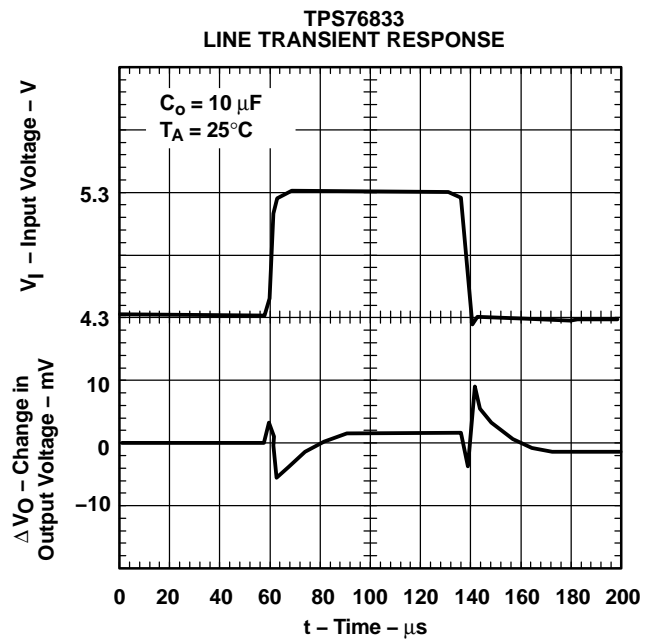
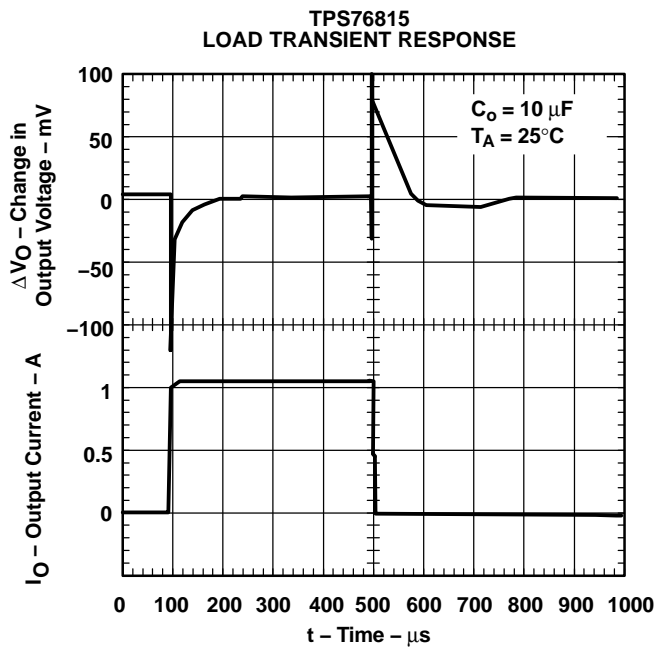
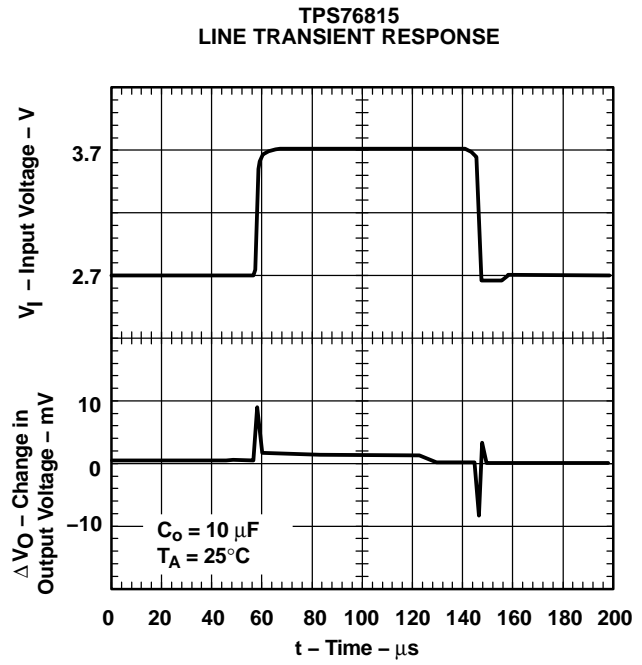
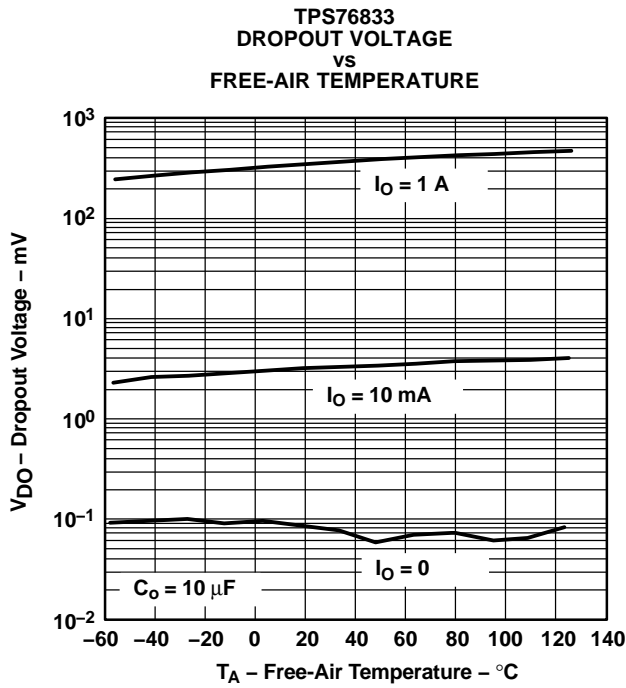


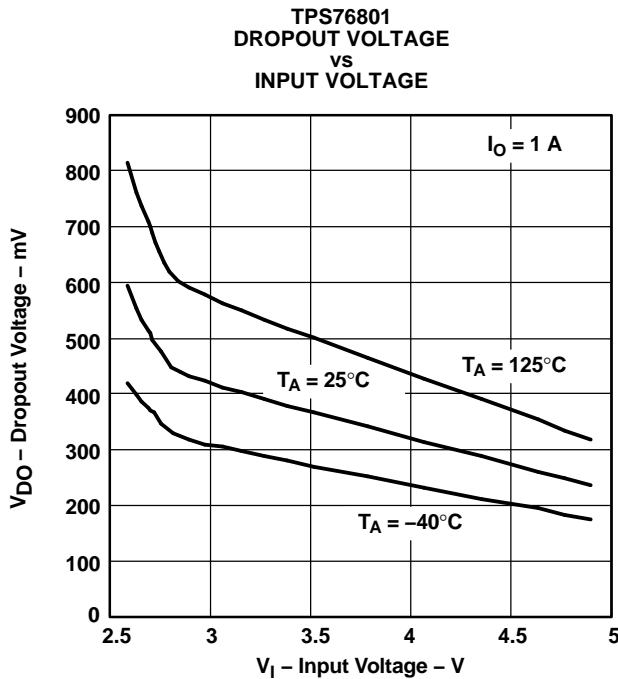
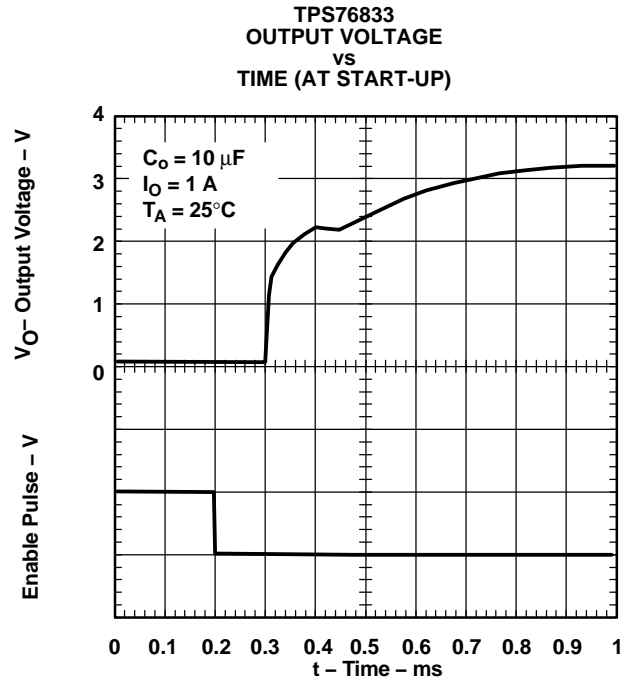
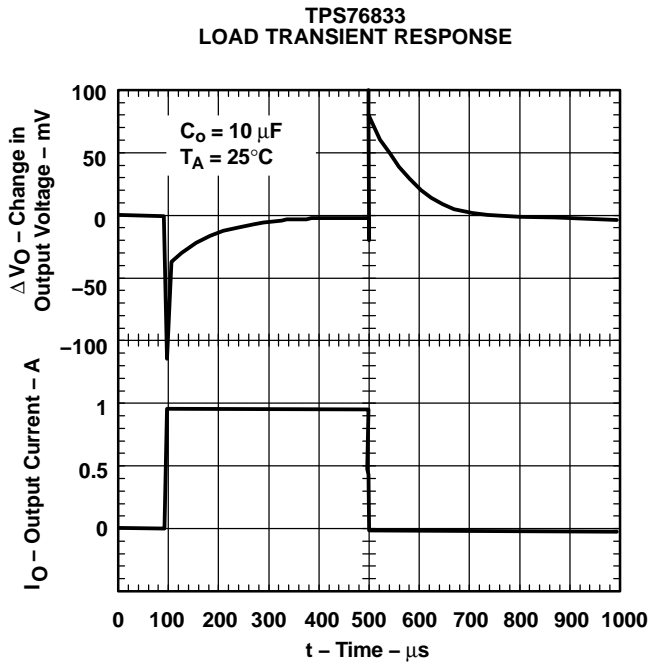
Figure 13.

TYPICAL CHARACTERISTICS (continued)

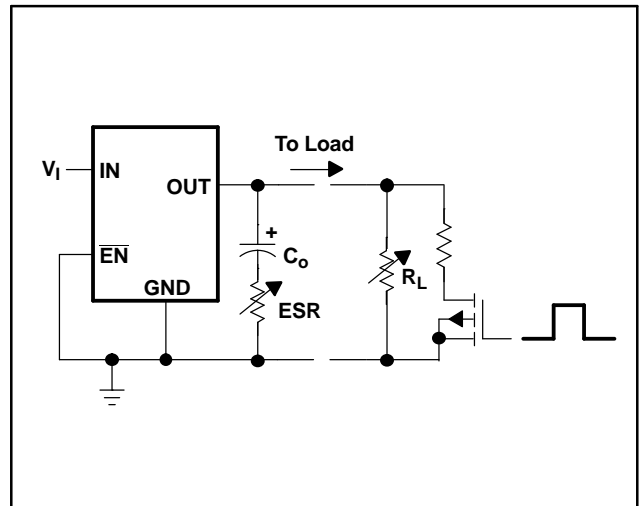




TYPICAL CHARACTERISTICS (continued)



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



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  $C_O$ .

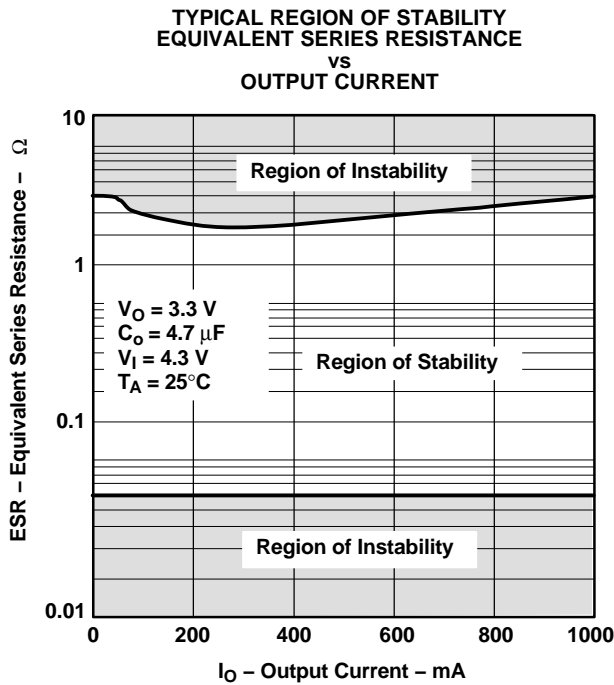


Figure 22.

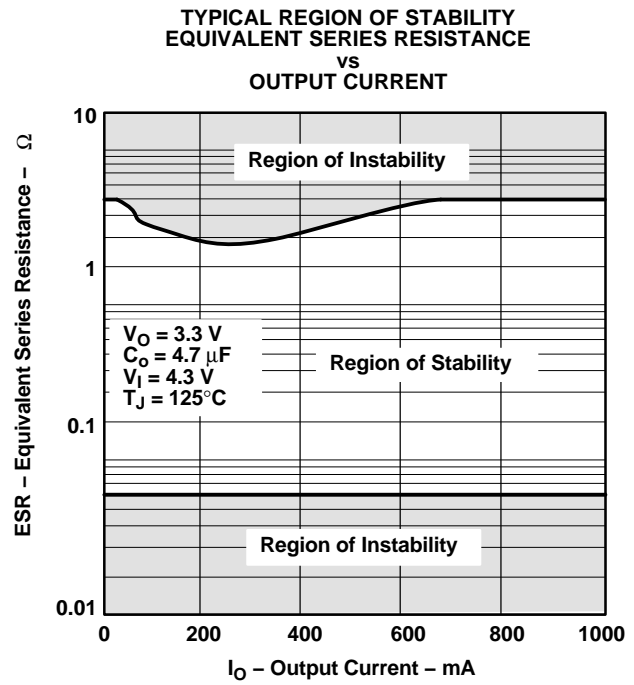


Figure 23.

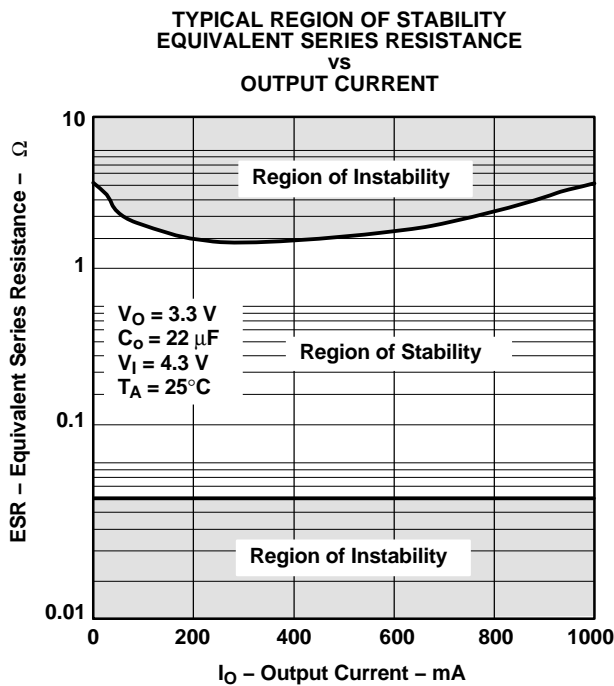


Figure 24.

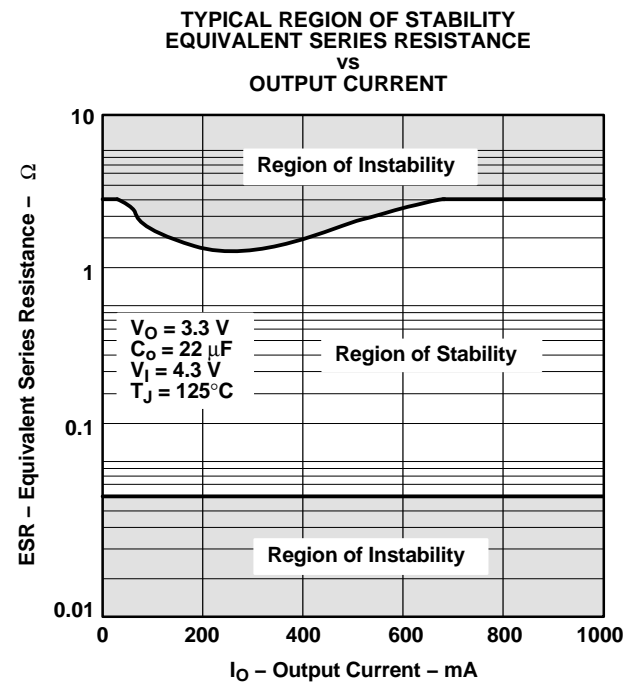


Figure 25.

## 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  $\beta$  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)

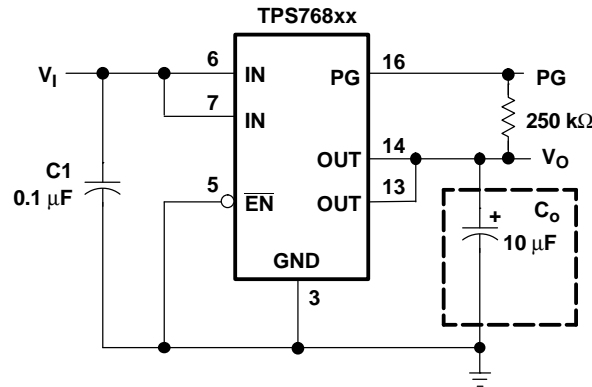


Figure 26. Typical Application Circuit (Fixed Versions)

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:

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

where:

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

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:

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

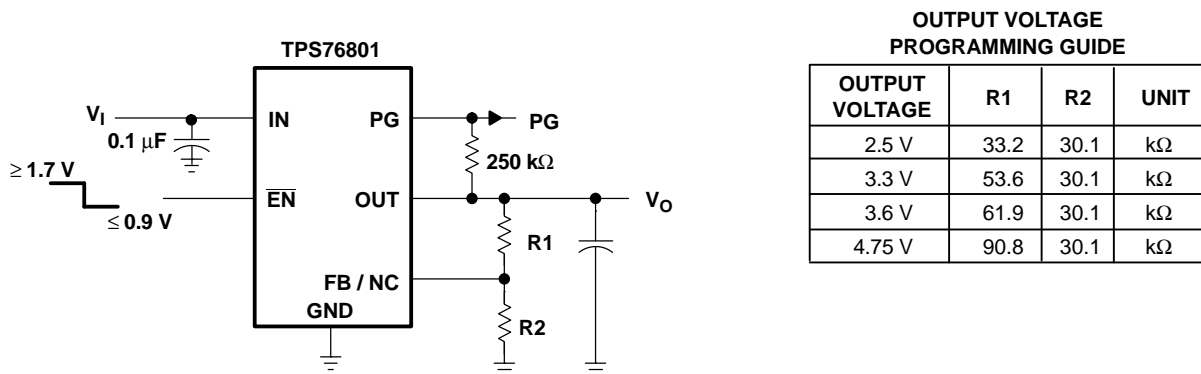


Figure 27. TPS76801 Adjustable LDO Regulator Programming

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,  $P_{D\max}$ , and the actual dissipation,  $P_D$ , which must be less than or equal to  $P_{D\max}$ .

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

$$P_{D\max} = \frac{T_{J\max} - T_A}{R_{\theta JA}} \quad (3)$$

Where:

- $T_{J\max}$  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 <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
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 <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
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
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
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
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
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
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
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

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
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

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

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

**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 TPS76801, TPS76815, TPS76818, TPS76825, TPS76827, TPS76828, TPS76830, TPS76833, TPS76850 :**

● Automotive: [TPS76801-Q1](#), [TPS76815-Q1](#), [TPS76818-Q1](#), [TPS76825-Q1](#), [TPS76827-Q1](#), [TPS76828-Q1](#), [TPS76830-Q1](#), [TPS76833-Q1](#), [TPS76850-Q1](#)

● Enhanced Product: [TPS76801-EP](#), [TPS76815-EP](#), [TPS76818-EP](#), [TPS76825-EP](#), [TPS76833-EP](#), [TPS76850-EP](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications



**TAPE AND REEL INFORMATION**

**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
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**

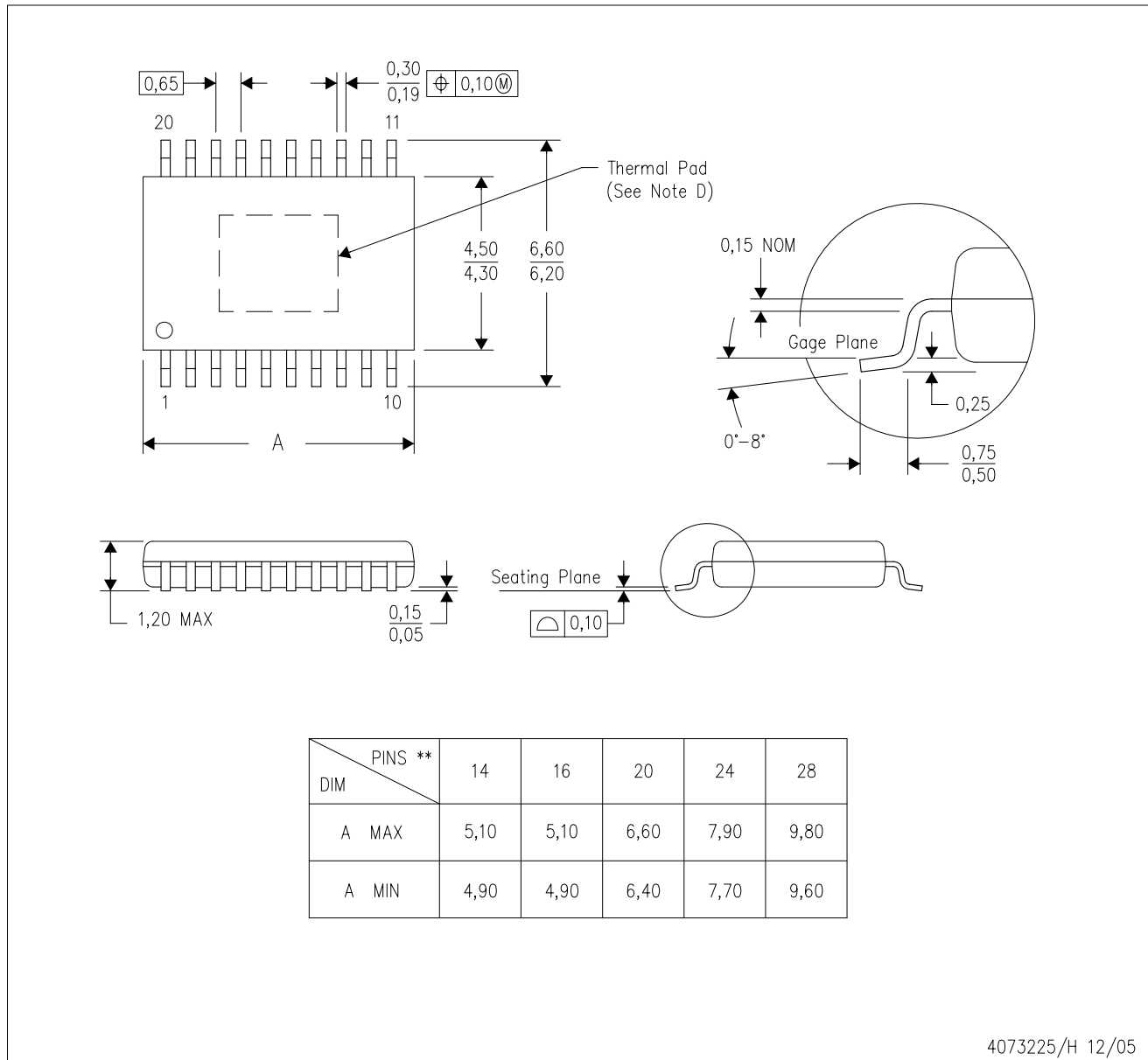

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS76801QDR	SOIC	D	8	2500	346.0	346.0	29.0
TPS76801QPWPR	HTSSOP	PWP	20	2000	346.0	346.0	33.0
TPS76815QDR	SOIC	D	8	2500	346.0	346.0	29.0
TPS76815QPWPR	HTSSOP	PWP	20	2000	346.0	346.0	33.0
TPS76818QDR	SOIC	D	8	2500	346.0	346.0	29.0
TPS76818QPWPR	HTSSOP	PWP	20	2000	346.0	346.0	33.0
TPS76825QDR	SOIC	D	8	2500	346.0	346.0	29.0
TPS76825QPWPR	HTSSOP	PWP	20	2000	346.0	346.0	33.0
TPS76833QDR	SOIC	D	8	2500	346.0	346.0	29.0
TPS76833QPWPR	HTSSOP	PWP	20	2000	346.0	346.0	33.0
TPS76850QDR	SOIC	D	8	2500	346.0	346.0	29.0
TPS76850QPWPR	HTSSOP	PWP	20	2000	346.0	346.0	33.0

# MECHANICAL DATA

PWP (R-PDSO-G\*\*) 20 PIN SHOWN

PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE



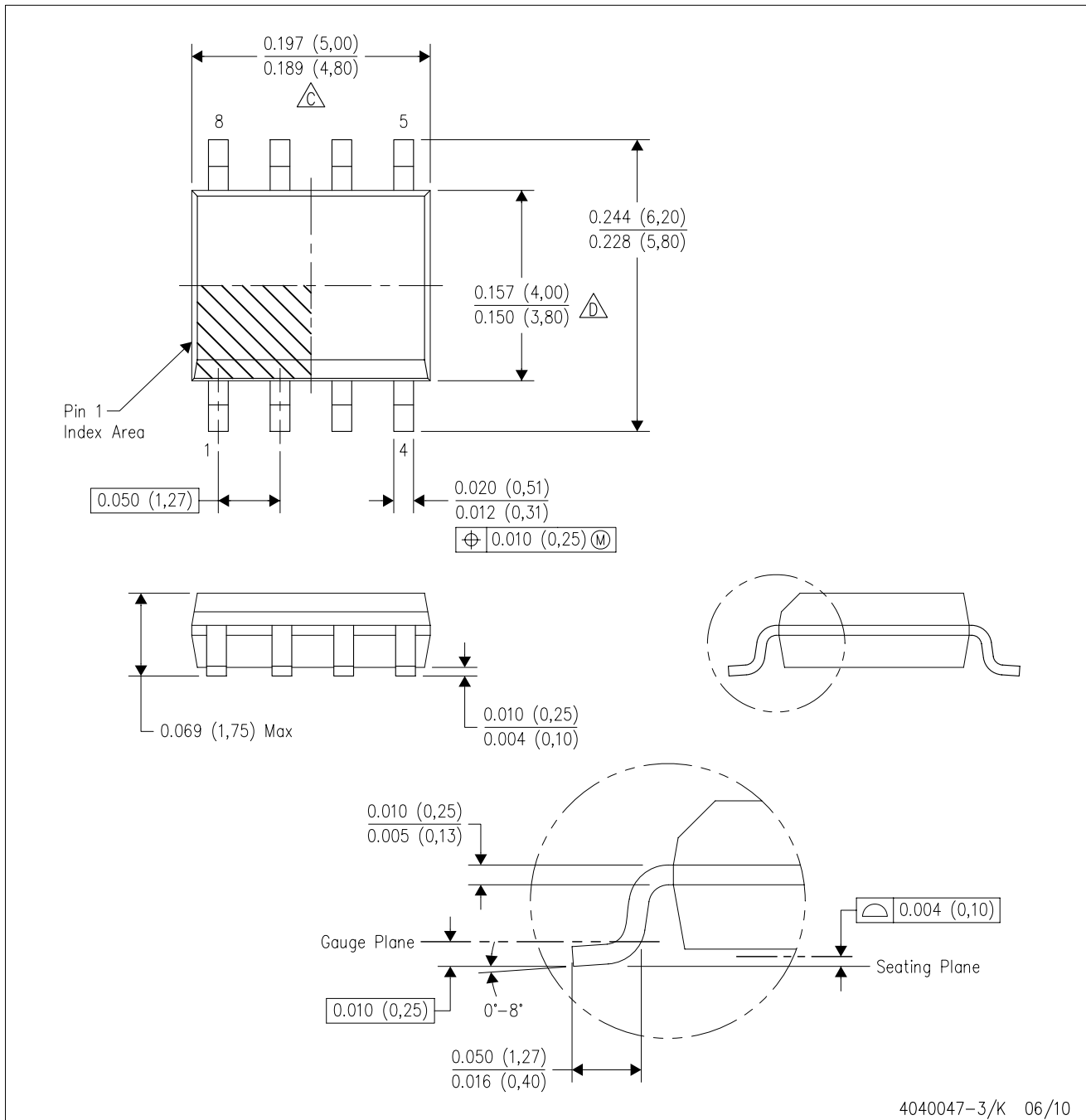
4073225/H 12/05

- 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) <<http://www.ti.com>>.
  - Falls within JEDEC MO-153

PowerPAD is a trademark of Texas Instruments.

D (R-PDSO-G8)

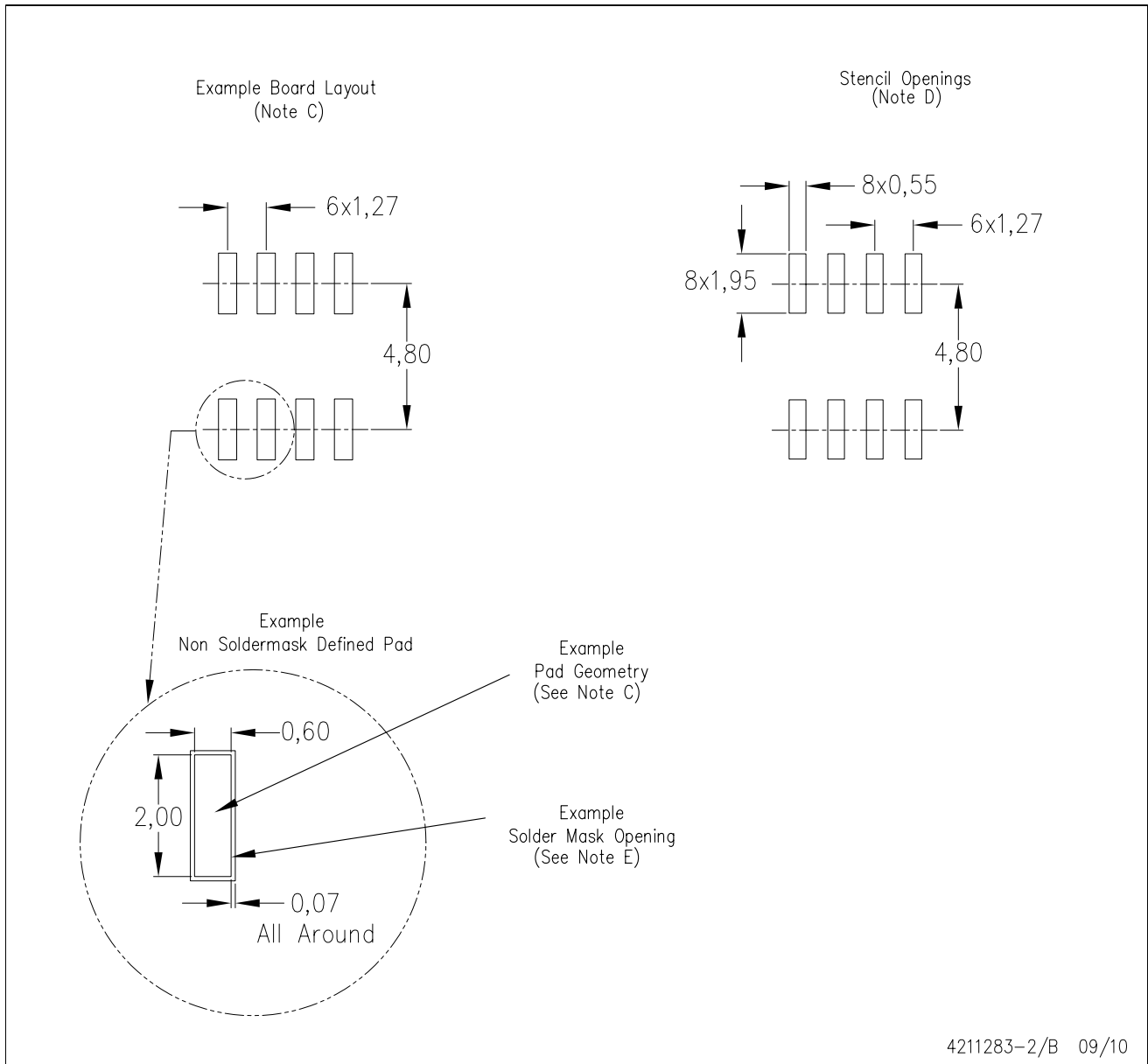
PLASTIC SMALL-OUTLINE PACKAGE



- 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.

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.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information 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.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

<b>Products</b>		<b>Applications</b>	
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>	Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>	Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>	Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Energy	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Space, Avionics & Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>	Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>