

TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

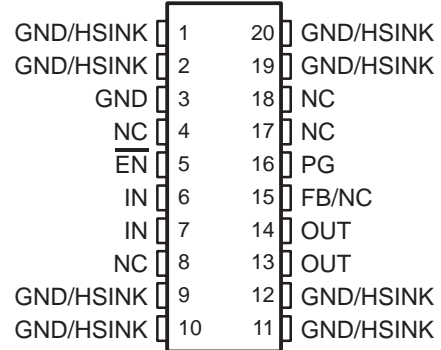
SLVS211B – JUNE 1999 – REVISED JULY 1999

- 1 A Low-Dropout Voltage Regulator
- 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 Versions
- Dropout Voltage Down to 230 mV at 1 A (TPS76850)
- Ultra Low 85 μ A Typical Quiescent Current
- Fast Transient Response
- 2% Tolerance Over Specified Conditions for Fixed-Output Versions
- Open Drain Power Good (See TPS767xx for Power-On Reset With 200-ms Delay Option)
- 8-Pin SOIC and 20-Pin TSSOP (PWP) Package
- Thermal Shutdown Protection

description

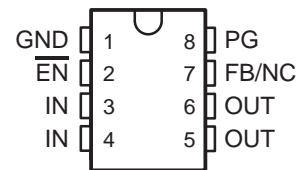
This device is designed to have a fast transient response and be stable with 10- μ F low ESR capacitors. This combination provides high performance at a reasonable cost.

**PWP PACKAGE
(TOP VIEW)**

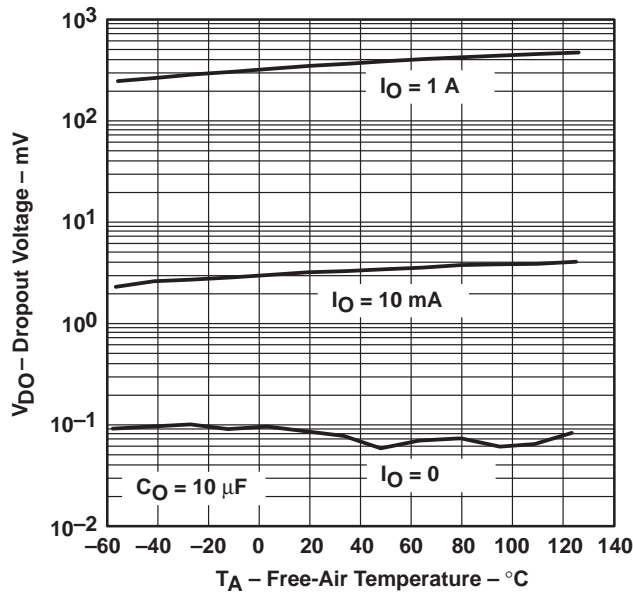


NC – No internal connection

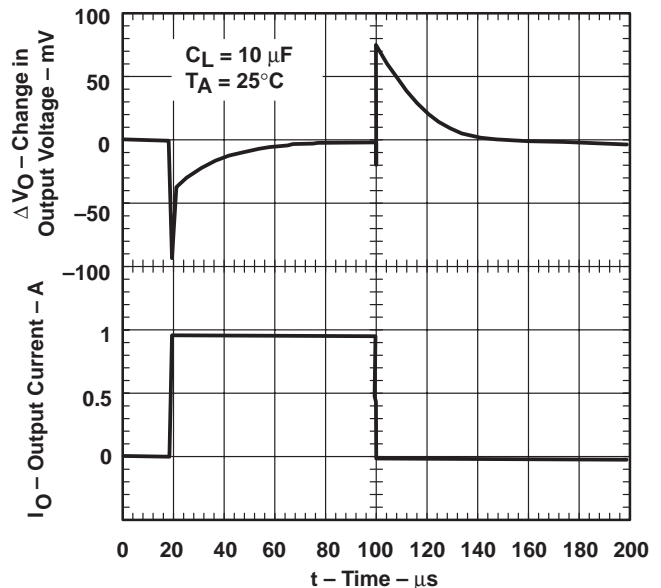
**D PACKAGE
(TOP VIEW)**



**TPS76833
DROPOUT VOLTAGE
vs
FREE-AIR TEMPERATURE**



LOAD TRANSIENT RESPONSE



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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1999, Texas Instruments Incorporated

**TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
 FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS**

SLVS211B – JUNE 1999 – REVISED JULY 1999

description (continued)

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

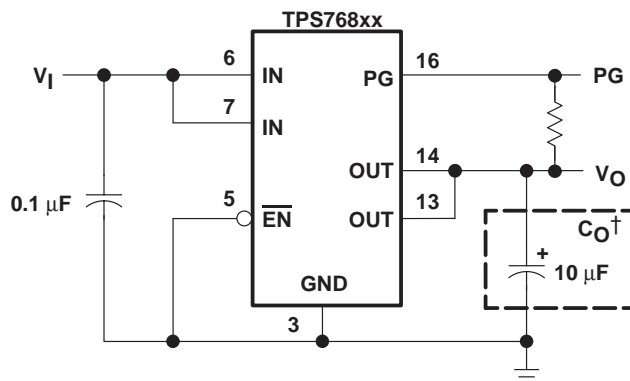
Power good (PG) is an active high output, which can be used to implement a power-on reset or a low-battery indicator.

The TPS768xx is offered in 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 fixed-voltage versions and in an adjustable version (programmable over the range of 1.2 V to 5.5 V). Output voltage tolerance is specified as a maximum of 2% over line, load, and temperature ranges. The TPS768xx family is available in 8 pin SOIC and 20 pin PWP packages.

AVAILABLE OPTIONS

T_J	OUTPUT VOLTAGE (V)	PACKAGED DEVICES	
	TYP	TSSOP (PWP)	SOIC (D)
-40°C to 125°C	5.0	TPS76850Q	TPS76850Q
	3.3	TPS76833Q	TPS76833Q
	3.0	TPS76830Q	TPS76830Q
	2.8	TPS76828Q	TPS76828Q
	2.7	TPS76827Q	TPS76827Q
	2.5	TPS76825Q	TPS76825Q
	1.8	TPS76818Q	TPS76818Q
	1.5	TPS76815Q	TPS76815Q
	Adjustable 1.2 V to 5.5 V	TPS76801Q	TPS76801Q

The TPS76801 is programmable using an external resistor divider (see application information). The D and PWP packages are available taped and reeled. Add an R suffix to the device type (e.g., TPS76801QDR).



† See application information section for capacitor selection details.

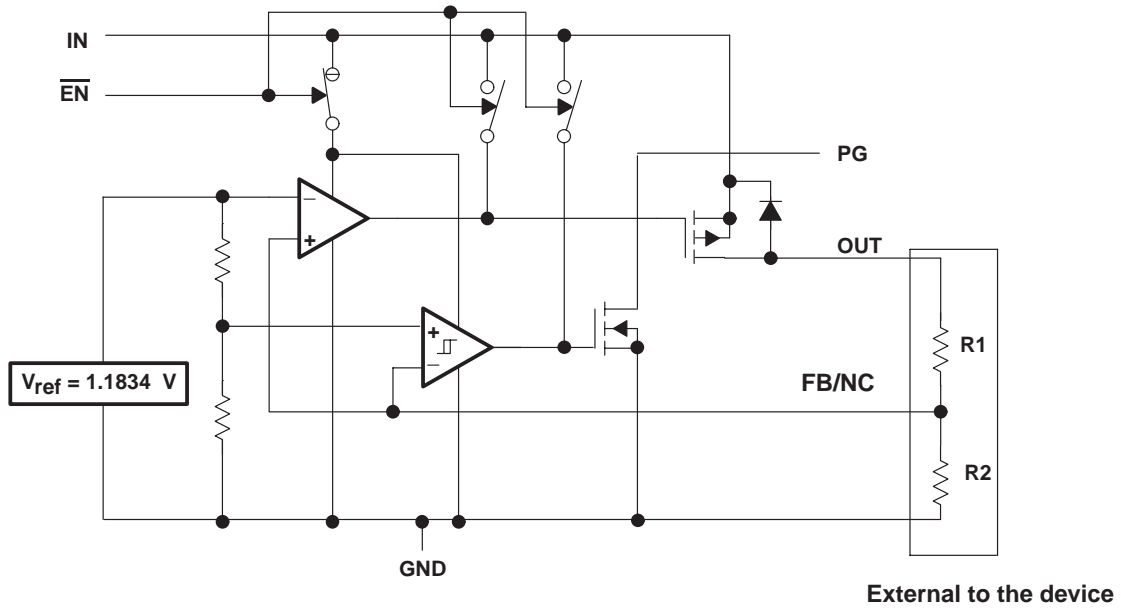
Figure 1. Typical Application Configuration (For Fixed Output Options)



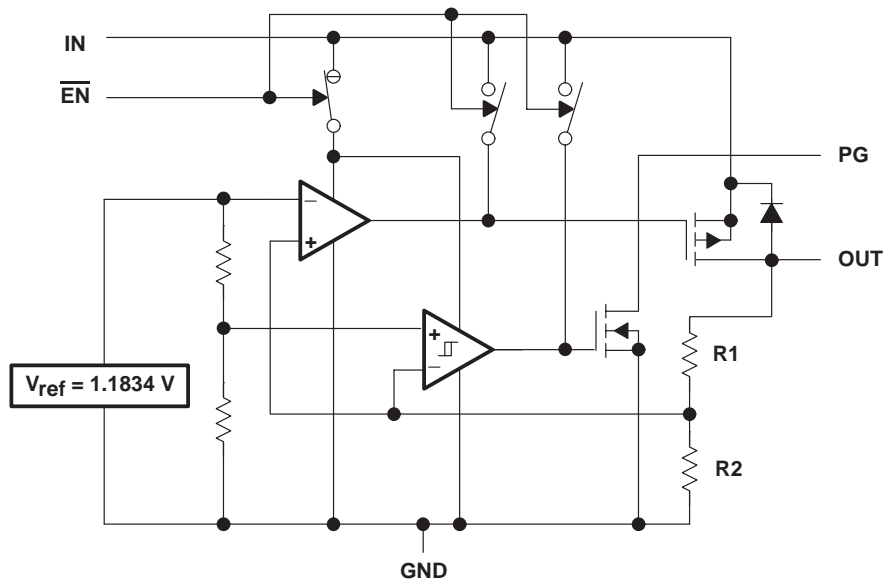
TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

SLVS211B – JUNE 1999 – REVISED JULY 1999

functional block diagram—adjustable version



functional block diagram—fixed-voltage version



TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

SLVS211B – JUNE 1999 – REVISED JULY 1999

Terminal Functions – SOIC Package

TERMINAL NAME	NO.	I/O	DESCRIPTION
GND	1		Regulator ground
$\overline{\text{EN}}$	2	I	Enable input
IN	3	I	Input voltage
IN	4	I	Input voltage
OUT	5	O	Regulated output voltage
OUT	6	O	Regulated output voltage
FB/NC	7	I	Feedback input voltage for adjustable device (no connect for fixed options)
PG	8	O	PG output

Terminal Functions – PWP Package

TERMINAL NAME	NO.	I/O	DESCRIPTION
GND/HSINK	1		Ground/heatsink
GND/HSINK	2		Ground/heatsink
GND	3		LDO ground
NC	4		No connect
$\overline{\text{EN}}$	5	I	Enable input
IN	6	I	Input
IN	7	I	Input
NC	8		No connect
GND/HSINK	9		Ground/heatsink
GND/HSINK	10		Ground/heatsink
GND/HSINK	11		Ground/heatsink
GND/HSINK	12		Ground/heatsink
OUT	13	O	Regulated output voltage
OUT	14	O	Regulated output voltage
FB/NC	15	I	Feedback input voltage for adjustable device (no connect for fixed options)
PG	16	O	PG output
NC	17		No connect
NC	18		No connect
GND/HSINK	19		Ground/heatsink
GND/HSINK	20		Ground/heatsink



TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

SLVS211B – JUNE 1999 – REVISED JULY 1999

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Input voltage range‡, V_I	–0.3 V to 13.5 V
Voltage range at \overline{EN}	–0.3 V to $V_I + 0.3$ V
Maximum PG voltage	16.5 V
Peak output current	Internally limited
Continuous total power dissipation	See dissipation rating tables
Output voltage, V_O (OUT, FB)	7 V
Operating virtual junction temperature range, T_J	–40°C to 125°C
Storage temperature range, T_{stg}	–65°C to 150°C
ESD rating, HBM	2 kV

† 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.

‡ All voltage values are with respect to network terminal ground.

DISSIPATION RATING TABLE 1 – FREE-AIR TEMPERATURES

PACKAGE	AIR FLOW (CFM)	$T_A < 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ 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

DISSIPATION RATING TABLE 2 – FREE-AIR TEMPERATURES

PACKAGE	AIR FLOW (CFM)	$T_A < 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING
PWP#	0	2.9 W	23.5 mW/°C	1.9 W	1.5 W
	300	4.3 W	34.6 mW/°C	2.8 W	2.2 W
PWP	0	3 W	23.8 mW/°C	1.9 W	1.5 W
	300	7.2 W	57.9 mW/°C	4.6 W	3.8 W

This parameter is measured with the recommended copper heat sink pattern on a 1-layer PCB, 5-in × 5-in PCB, 1 oz. copper, 2-in × 2-in coverage (4 in²).

|| This parameter is measured with the recommended copper heat sink pattern on a 8-layer PCB, 1.5-in × 2-in PCB, 1 oz. copper with layers 1, 2, 4, 5, 7, and 8 at 5% coverage (0.9 in²) and layers 3 and 6 at 100% coverage (6 in²). For more information, refer to TI technical brief SLMA002.

recommended operating conditions

	MIN	MAX	UNIT
Input voltage, V_I ★	2.7	10	V
Output voltage range, V_O	1.2	5.5	V
Output current, I_O (Note 1)	0	1.0	A
Operating virtual junction temperature, T_J (Note 1)	–40	125	°C

★ To calculate the minimum input voltage for your maximum output current, use the following equation: $V_{I(\min)} = V_{O(\max)} + V_{DO(\max \text{ load})}$.

NOTE 1: 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.



**TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
 FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS**

SLVS211B – JUNE 1999 – REVISED JULY 1999

**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
Output voltage (10 μA to 1 A load) (see Note 2)	TPS76801	$5.5 \text{ V} \geq V_O \geq 1.2 \text{ V}$, $T_J = 25^\circ\text{C}$		V_O		
		$5.5 \text{ V} \geq V_O \geq 1.2 \text{ V}$, $T_J = -40^\circ\text{C}$ to 125°C	$0.98V_O$		$1.02V_O$	
	TPS76815	$T_J = 25^\circ\text{C}$, $2.7 \text{ V} < V_{\text{IN}} < 10 \text{ V}$		1.5		
		$T_J = -40^\circ\text{C}$ to 125°C , $2.7 \text{ V} < V_{\text{IN}} < 10 \text{ V}$	1.470		1.530	
	TPS76818	$T_J = 25^\circ\text{C}$, $2.8 \text{ V} < V_{\text{IN}} < 10 \text{ V}$		1.8		
		$T_J = -40^\circ\text{C}$ to 125°C , $2.8 \text{ V} < V_{\text{IN}} < 10 \text{ V}$	1.764		1.836	
	TPS76825	$T_J = 25^\circ\text{C}$, $3.5 \text{ V} < V_{\text{IN}} < 10 \text{ V}$		2.5		
		$T_J = -40^\circ\text{C}$ to 125°C , $3.5 \text{ V} < V_{\text{IN}} < 10 \text{ V}$	2.450		2.550	
	TPS76827	$T_J = 25^\circ\text{C}$, $3.7 \text{ V} < V_{\text{IN}} < 10 \text{ V}$		2.7		
		$T_J = -40^\circ\text{C}$ to 125°C , $3.7 \text{ V} < V_{\text{IN}} < 10 \text{ V}$	2.646		2.754	
	TPS76828	$T_J = 25^\circ\text{C}$, $3.8 \text{ V} < V_{\text{IN}} < 10 \text{ V}$		2.8		
		$T_J = -40^\circ\text{C}$ to 125°C , $3.8 \text{ V} < V_{\text{IN}} < 10 \text{ V}$	2.744		2.856	
	TPS76830	$T_J = 25^\circ\text{C}$, $4.0 \text{ V} < V_{\text{IN}} < 10 \text{ V}$		3.0		
		$T_J = -40^\circ\text{C}$ to 125°C , $4.0 \text{ V} < V_{\text{IN}} < 10 \text{ V}$	2.940		3.060	
	TPS76833	$T_J = 25^\circ\text{C}$, $4.3 \text{ V} < V_{\text{IN}} < 10 \text{ V}$		3.3		
		$T_J = -40^\circ\text{C}$ to 125°C , $4.3 \text{ V} < V_{\text{IN}} < 10 \text{ V}$	3.234		3.366	
	TPS76850	$T_J = 25^\circ\text{C}$, $6.0 \text{ V} < V_{\text{IN}} < 10 \text{ V}$		5.0		
		$T_J = -40^\circ\text{C}$ to 125°C , $6.0 \text{ V} < V_{\text{IN}} < 10 \text{ V}$	4.900		5.100	
Quiescent current (GND current) $\overline{\text{EN}} = 0 \text{ V}$, (see Note 2)		$10 \mu\text{A} < I_O < 1 \text{ A}$, $T_J = 25^\circ\text{C}$		85		μA
		$I_O = 1 \text{ A}$, $T_J = -40^\circ\text{C}$ to 125°C			125	
Output voltage line regulation ($\Delta V_O/V_O$) (see Notes 2 and 3)		$V_O + 1 \text{ V} < V_I \leq 10 \text{ V}$, $T_J = 25^\circ\text{C}$		0.01		%/V
Load regulation				3		mV
Output noise voltage		BW = 300 Hz to 50 kHz, $C_O = 10 \mu\text{F}$, $T_J = 25^\circ\text{C}$		190		μV_{rms}
Output current Limit		$V_O = 0 \text{ V}$		1.7	2	A
Thermal shutdown junction temperature				150		$^\circ\text{C}$
Standby current		$\overline{\text{EN}} = V_I$, $T_J = 25^\circ\text{C}$, $2.7 \text{ V} < V_I < 10 \text{ V}$		1		μA
		$\overline{\text{EN}} = V_I$, $T_J = -40^\circ\text{C}$ to 125°C , $2.7 \text{ V} < V_I < 10 \text{ V}$			10	μA
FB input current	TPS76801	FB = 1.5 V		2		nA
High level enable input voltage				1.7		V
Low level enable input voltage					0.9	V
Power supply ripple rejection (see Note 2)		f = 1 KHz, $C_O = 10 \mu\text{F}$, $T_J = 25^\circ\text{C}$		60		dB
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_O
	Hysteresis voltage	Measured at V_O		0.5		% V_O
	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
Input current (EN)		$\overline{\text{EN}} = 0 \text{ V}$	-1	0	1	μA
		$\overline{\text{EN}} = V_I$	-1		1	

NOTE: 2. Minimum IN operating voltage is 2.7 V or $V_{O(\text{typ})} + 1 \text{ V}$, whichever is greater. Maximum IN voltage 10 V.



**TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS**

SLVS211B – JUNE 1999 – REVISED JULY 1999

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
Dropout voltage (See Note 4)	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	

NOTES: 3. If $V_O \leq 1.8 \text{ V}$ then $V_{i\text{max}} = 10 \text{ V}$, $V_{i\text{min}} = 2.7 \text{ V}$:

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

If $V_O \geq 2.5 \text{ V}$ then $V_{i\text{max}} = 10 \text{ V}$, $V_{i\text{min}} = V_O + 1 \text{ V}$:

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

4. 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 (i.e., TPS76830 input voltage needs to drop to 2.9 V for purpose of this test).

Table of Graphs

			FIGURE
V_O	Output voltage	vs Output current	2, 3, 4
		vs Free-air temperature	5, 6, 7
	Ground current	vs Free-air temperature	8, 9
	Power supply ripple rejection	vs Frequency	10
	Output noise	vs Frequency	11
Z_O	Output impedance	vs Frequency	12
V_{DO}	Dropout voltage	vs Free-air temperature	13
	Line transient response		14, 16
	Load transient response		15, 17
	Output voltage	vs Time	18
	Dropout voltage	vs Input voltage	19
	Equivalent series resistance (ESR)	vs Output current	21 – 24

TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

SLVS211B – JUNE 1999 – REVISED JULY 1999

TYPICAL CHARACTERISTICS

TPS76833
 OUTPUT VOLTAGE
 vs
 OUTPUT CURRENT

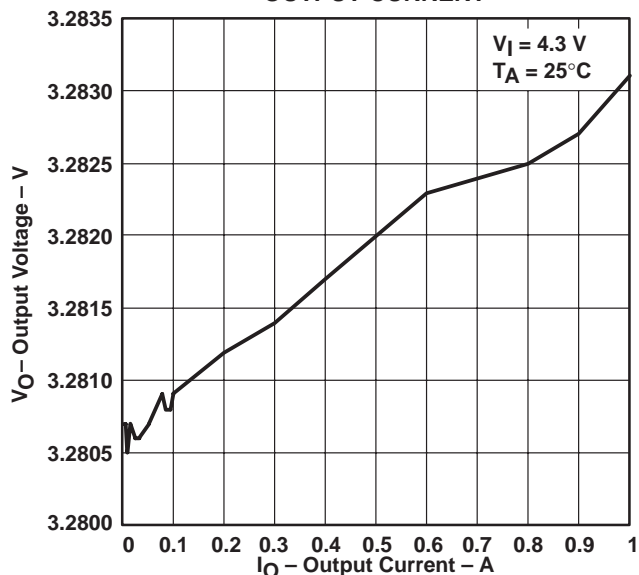


Figure 2

TPS76815
 OUTPUT VOLTAGE
 vs
 OUTPUT CURRENT

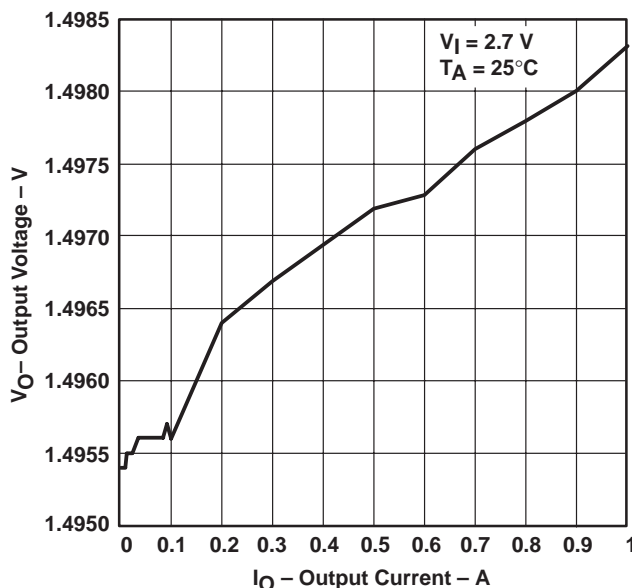


Figure 3

TPS76825
 OUTPUT VOLTAGE
 vs
 OUTPUT CURRENT

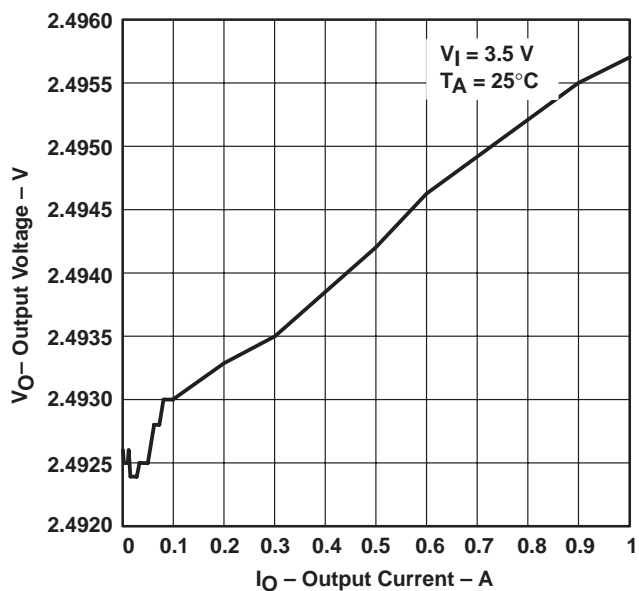


Figure 4

TPS76833
 OUTPUT VOLTAGE
 vs
 FREE-AIR TEMPERATURE

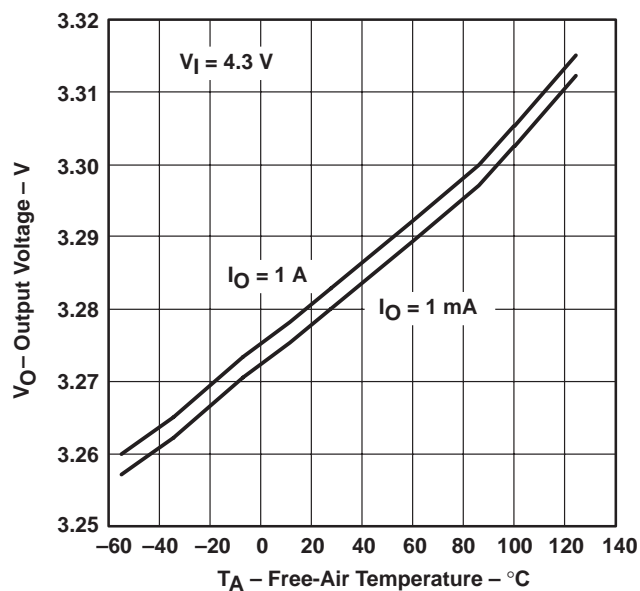


Figure 5



TYPICAL CHARACTERISTICS

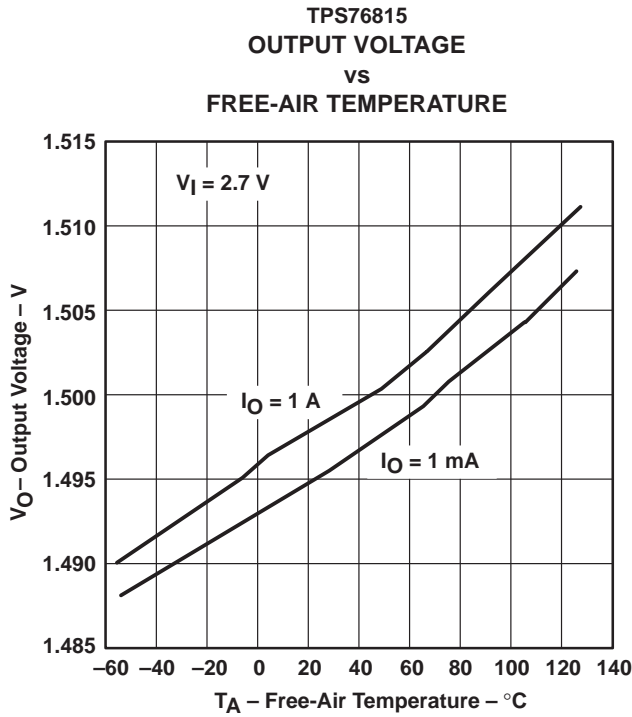


Figure 6

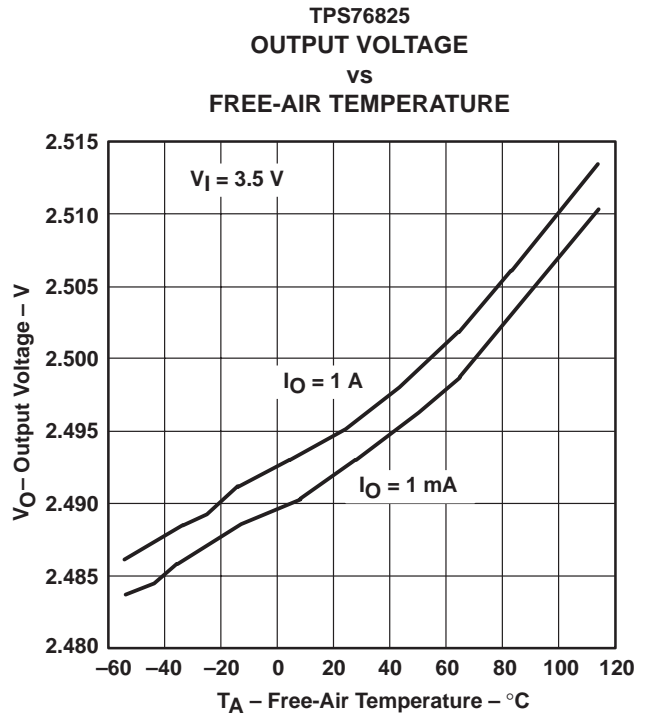


Figure 7

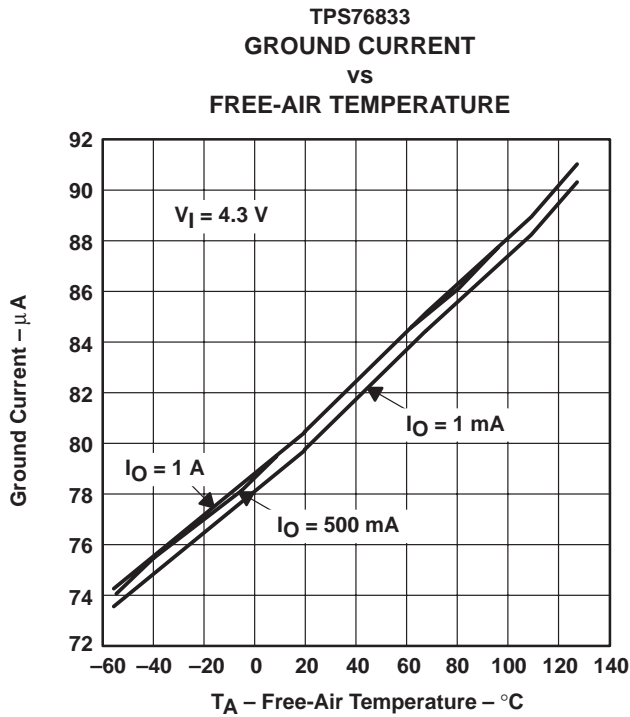


Figure 8

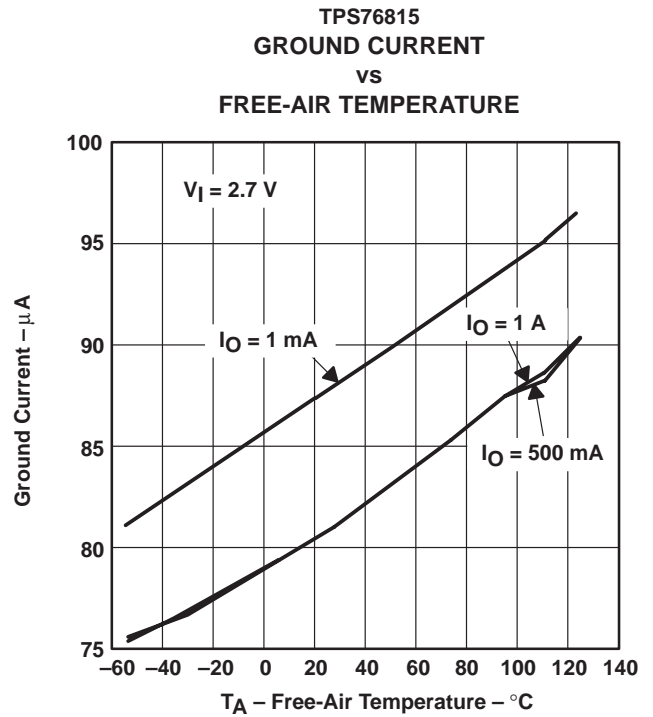


Figure 9

TYPICAL CHARACTERISTICS

TPS76833
**POWER SUPPLY RIPPLE REJECTION
 VS
 FREQUENCY**

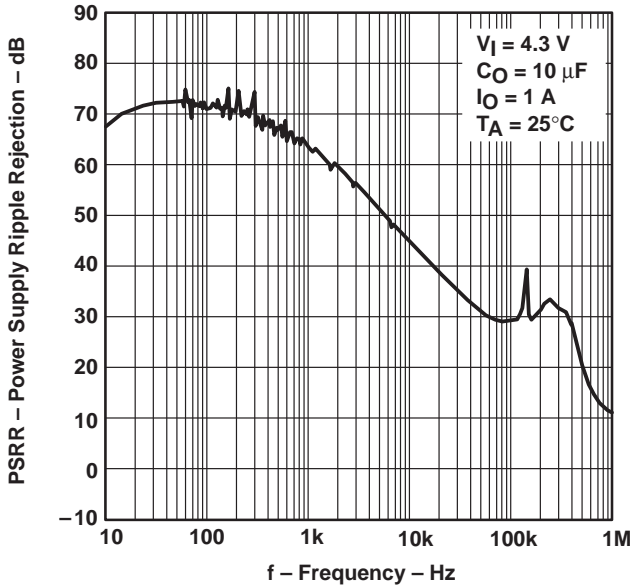


Figure 10

TPS76833
**OUTPUT SPECTRAL NOISE DENSITY
 VS
 FREQUENCY**

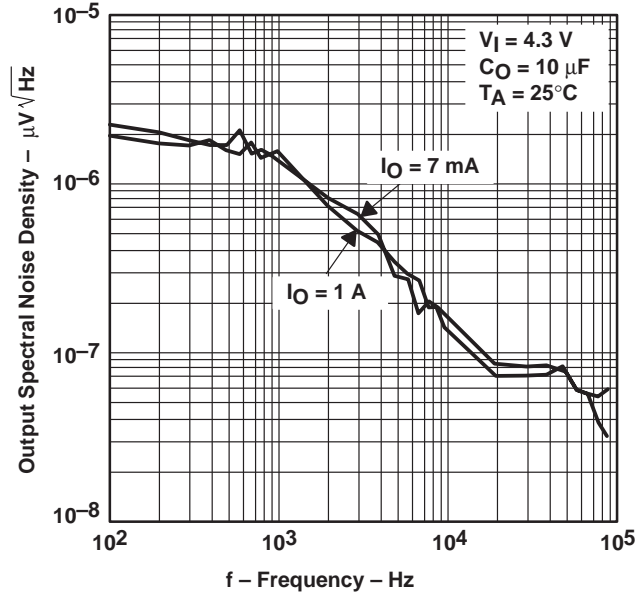


Figure 11

TPS76833
**OUTPUT IMPEDANCE
 VS
 FREQUENCY**

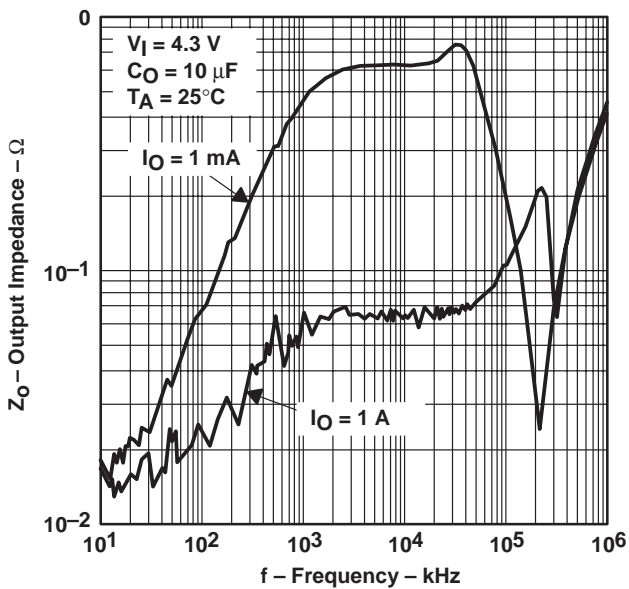


Figure 12

TPS76833
**DROPOUT VOLTAGE
 VS
 FREE-AIR TEMPERATURE**

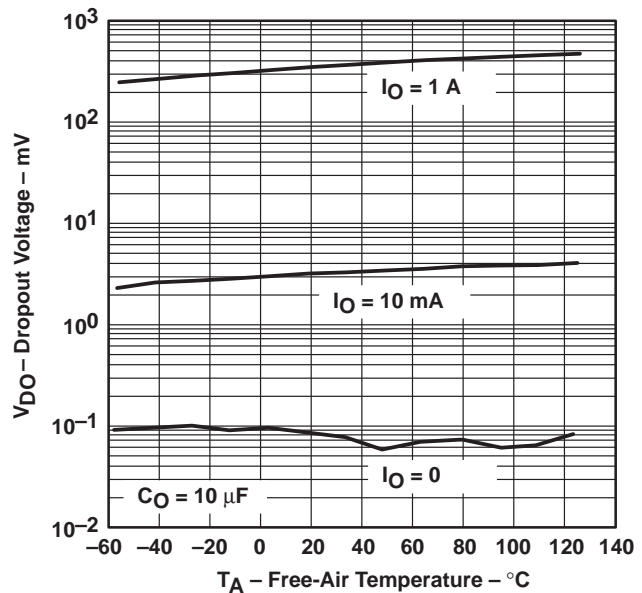


Figure 13

TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

SLVS211B – JUNE 1999 – REVISED JULY 1999

TYPICAL CHARACTERISTICS

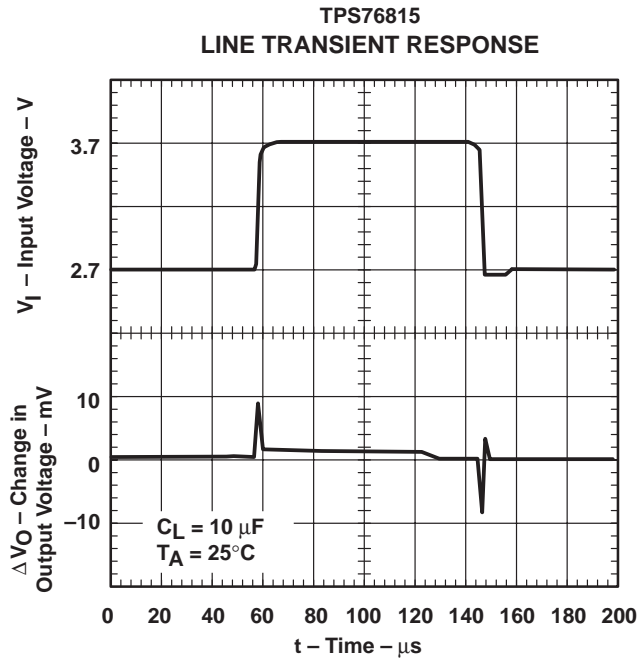


Figure 14

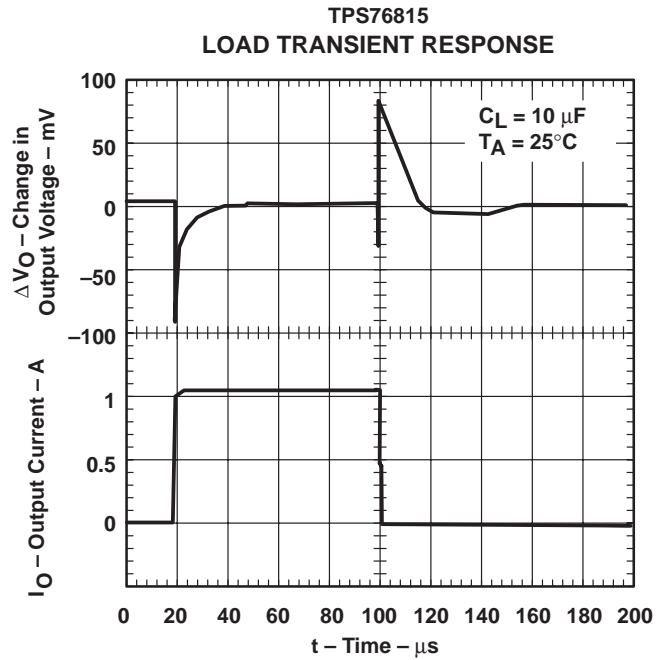


Figure 15

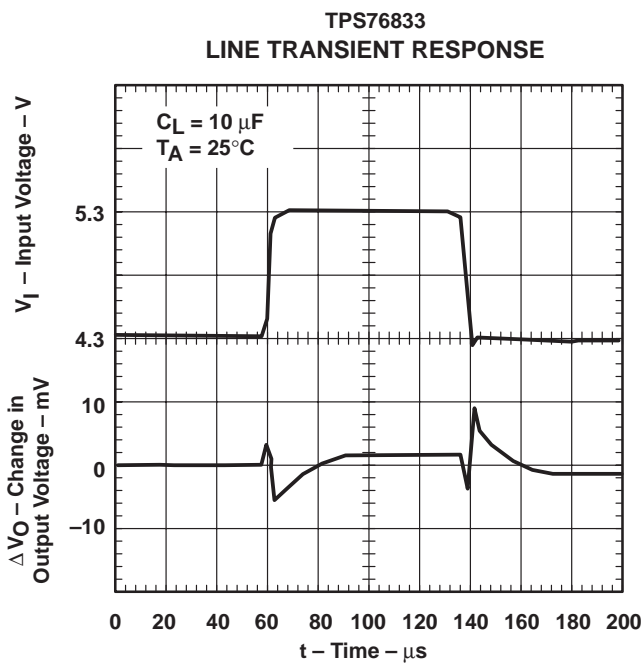


Figure 16

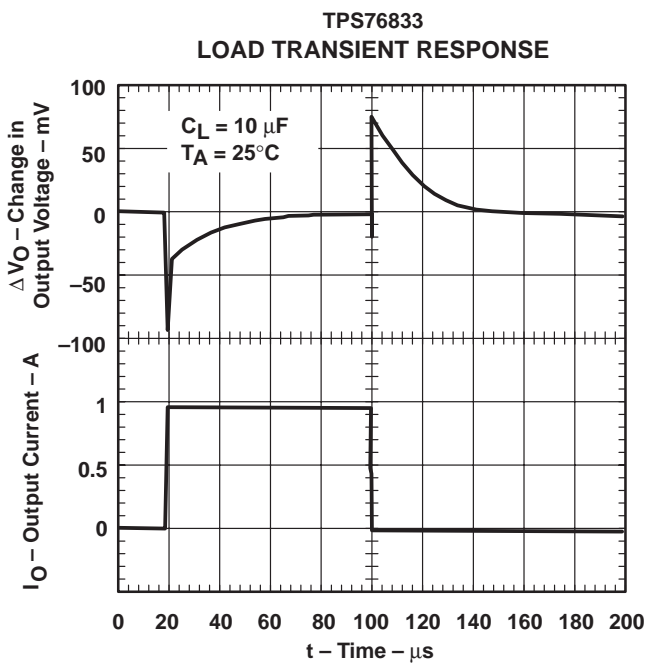


Figure 17

TYPICAL CHARACTERISTICS

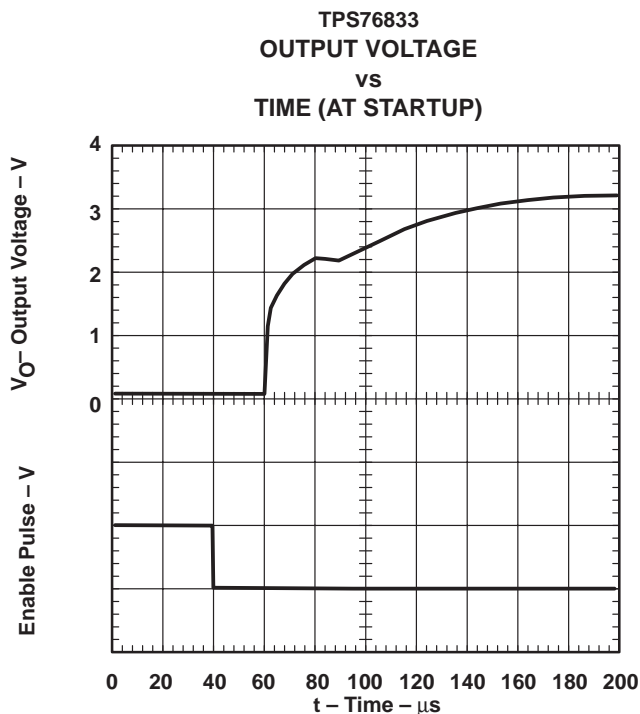


Figure 18

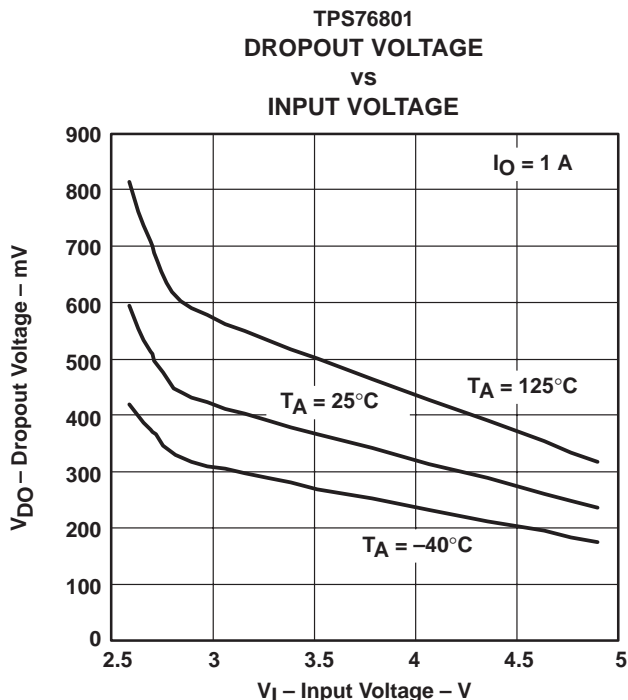


Figure 19

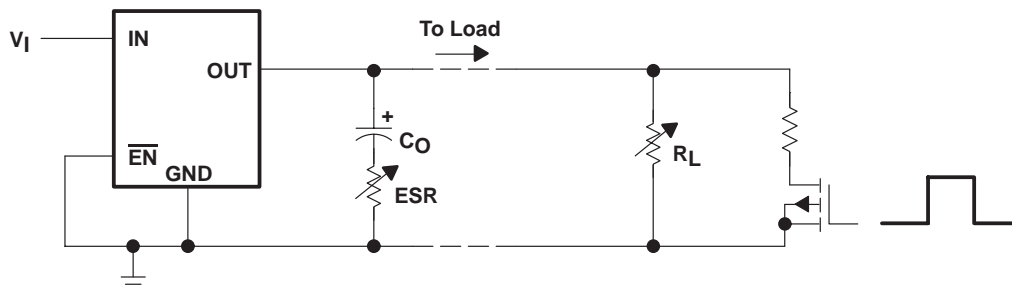


Figure 20. Test Circuit for Typical Regions of Stability (Figures 21 through 24) (Fixed Output Options)

† 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 .

TYPICAL CHARACTERISTICS

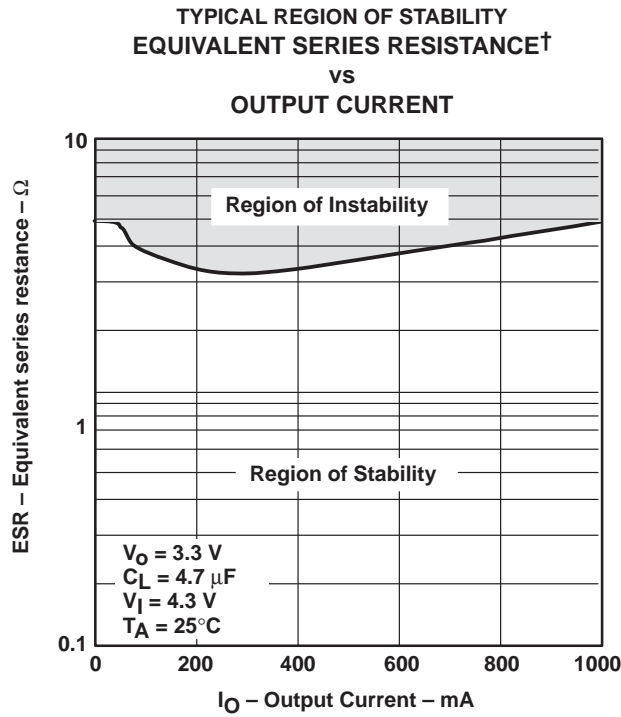


Figure 21

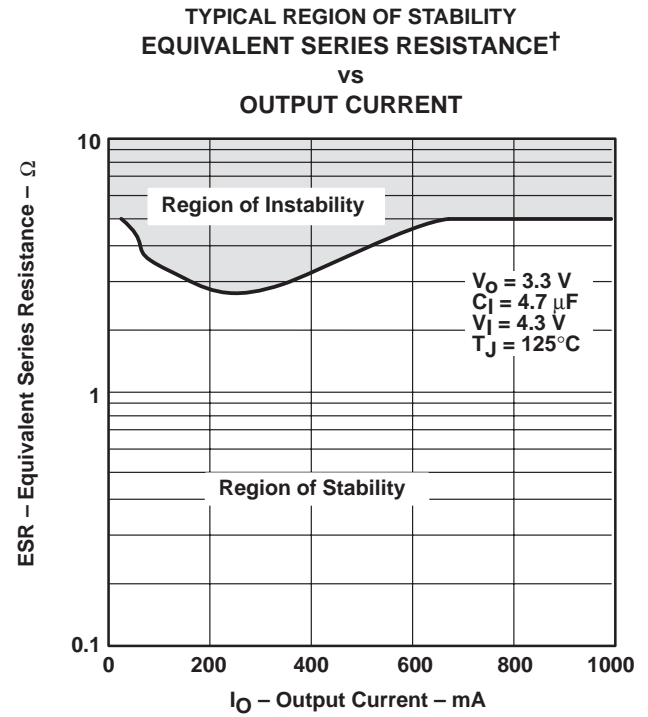


Figure 22

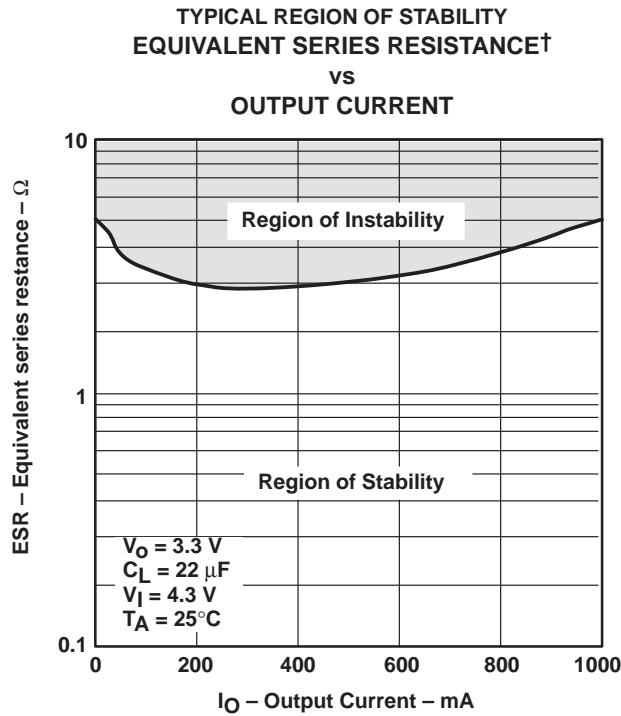


Figure 23

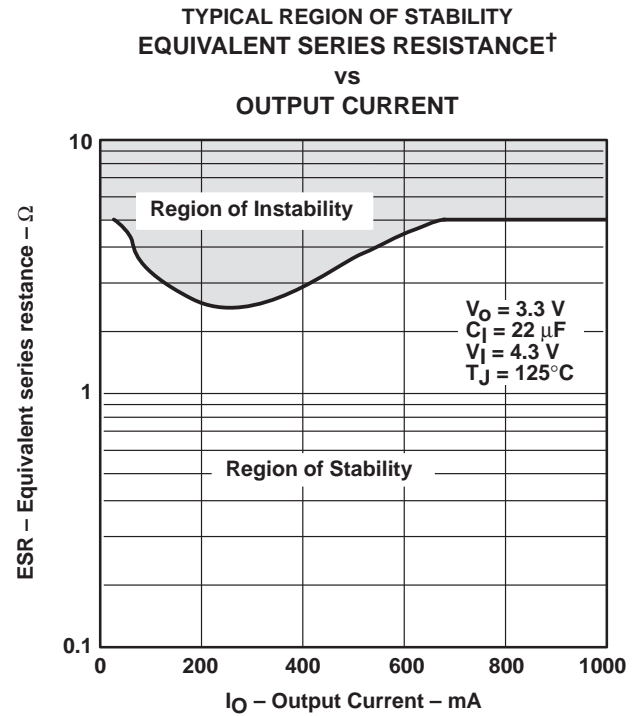


Figure 24

† 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 .

TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

SLVS211B – JUNE 1999 – REVISED JULY 1999

APPLICATION INFORMATION

The TPS768xx 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 TPS768xx 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 TPS768xx uses a PMOS transistor to pass current; because the gate of the PMOS is voltage driven, operating current is low and invariable over the full load range.

Another pitfall associated with the pnp-pass element is its tendency to saturate when the device goes into dropout. The resulting drop in β forces an increase in I_B to maintain the load. During power up, this translates to large start-up currents. Systems with limited supply current may fail to start up. In battery-powered systems, it means rapid battery discharge when the voltage decays below the minimum required for regulation. The TPS768xx quiescent current remains low even when the regulator drops out, eliminating both problems.

The TPS768xx family also features a shutdown mode that places the output in the high-impedance state (essentially equal to the feedback-divider resistance) and reduces quiescent current to 2 μ A. If the shutdown feature is not used, \overline{EN} should be tied to ground. Response to an enable transition is quick; regulated output voltage is reestablished in typically 120 μ s.

minimum load requirements

The TPS768xx 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 it is shown in Figure 26. Normally, this connection should be as short as possible; however, the connection can be made near a critical circuit to improve performance at that point. Internally, FB connects to a high-impedance wide-bandwidth amplifier and noise pickup feeds through to the regulator output. Routing the FB connection to minimize/avoid noise pickup is essential.

external capacitor requirements

An input capacitor is not usually required; however, a ceramic bypass capacitor (0.047 μ F or larger) improves load transient response and noise rejection if the TPS768xx 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 TPS768xx requires an output capacitor connected between OUT and GND to stabilize the internal control loop. The minimum recommended capacitance value is 10 μ F and the ESR (equivalent series resistance) must be between 50 m Ω and 1.5 Ω . Capacitor values 10 μ F or larger are acceptable, provided the ESR is less than 1.5 Ω . Solid tantalum electrolytic, aluminum electrolytic, and multilayer ceramic capacitors are all suitable, provided they meet the requirements described above. Most of the commercially available 10 μ F surface-mount ceramic capacitors, including devices from Sprague and Kemet, meet the ESR requirements stated above.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

APPLICATION INFORMATION

external capacitor requirements (continued)

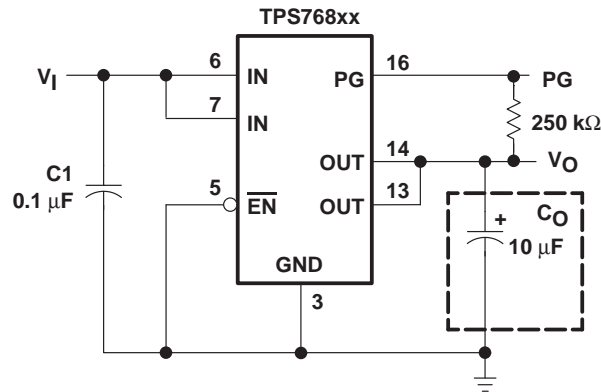


Figure 25. Typical Application Circuit (Fixed Versions)

programming the TPS76801 adjustable LDO regulator

The output voltage of the TPS76801 adjustable regulator is programmed using an external resistor divider as shown in Figure 26. The output voltage is calculated using:

$$V_O = V_{ref} \times \left(1 + \frac{R_1}{R_2} \right) \quad (1)$$

Where

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

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 k Ω to set the divider current at 50 μA and then calculate R1 using:

$$R_1 = \left(\frac{V_O}{V_{ref}} - 1 \right) \times R_2 \quad (2)$$

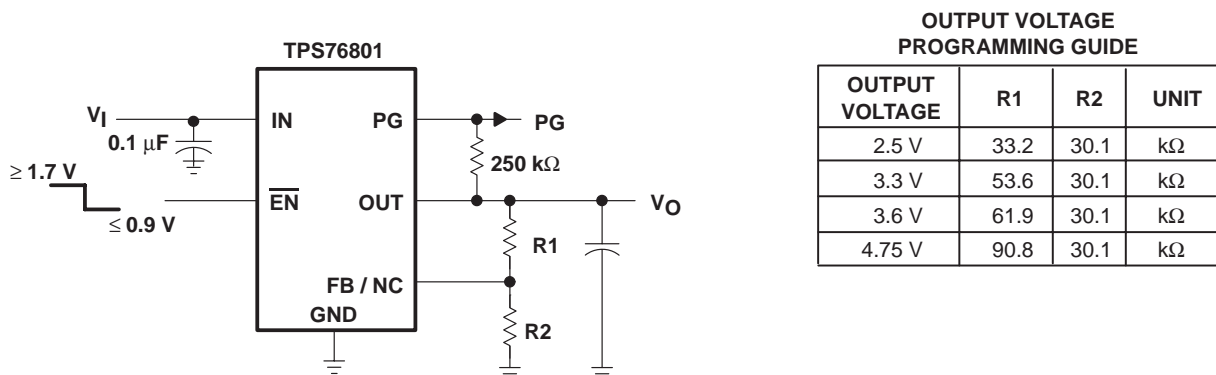


Figure 26. TPS76801 Adjustable LDO Regulator Programming

APPLICATION INFORMATION

power-good indicator

The TPS768xx 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.

regulator protection

The TPS768xx PMOS-pass transistor has a built-in back diode that conducts reverse currents when the input voltage drops below the output voltage (e.g., 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 TPS768xx also features internal current limiting and thermal protection. During normal operation, the TPS768xx 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:

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

Where

T_{Jmax} is the maximum allowable junction temperature

$R_{\theta JA}$ is the thermal resistance junction-to-ambient for the package, i.e., 172°C/W for the 8-terminal SOIC and 32.6°C/W for the 20-terminal PWP with no airflow.

T_A is the ambient temperature.

The regulator dissipation is calculated using:

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

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

TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

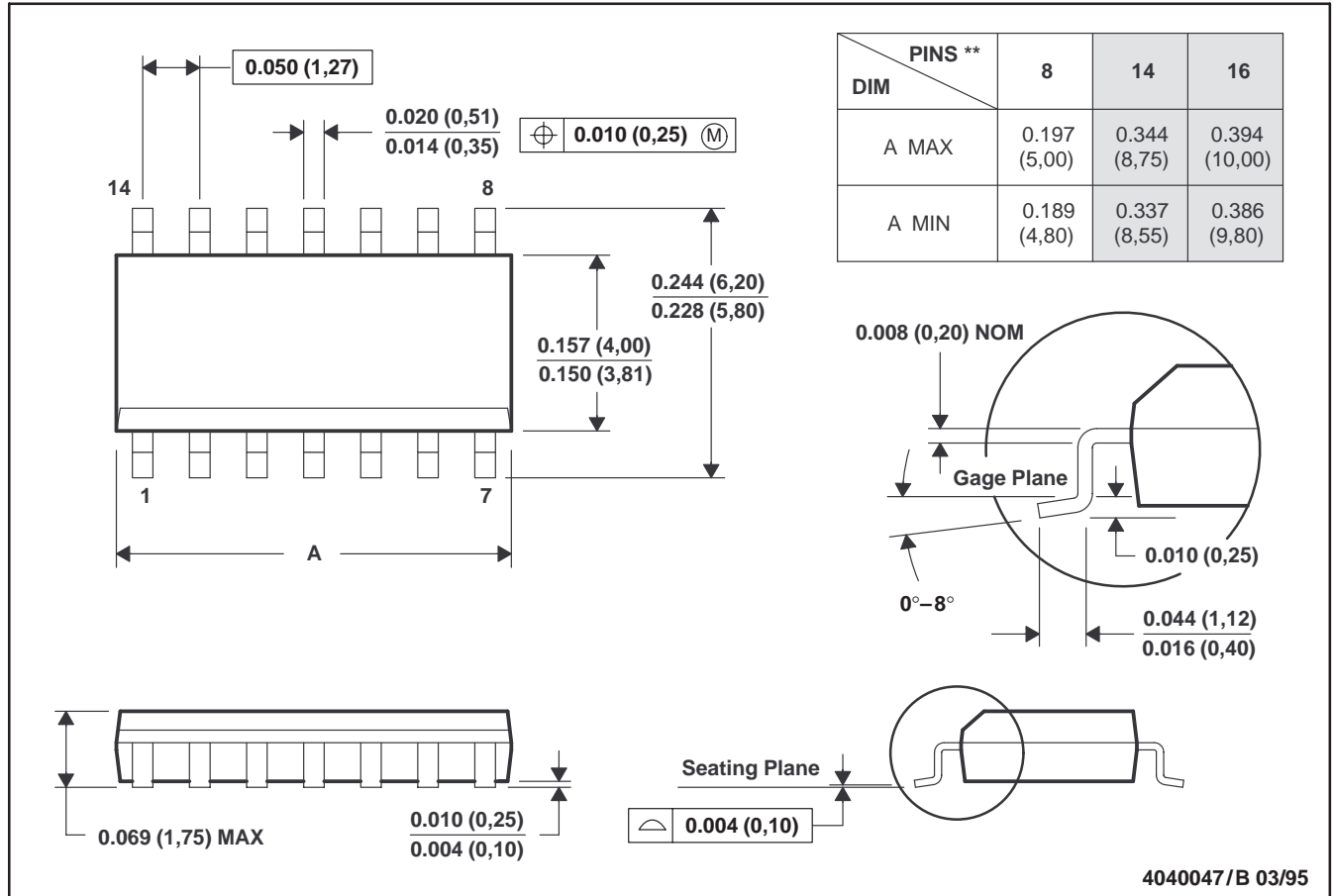
SLVS211B – JUNE 1999 – REVISED JULY 1999

MECHANICAL DATA

D (R-PDSO-G)**

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
 D. Four center pins are connected to die mount pad.
 E. Falls within JEDEC MS-012

TPS76815Q, TPS76818Q, TPS76825Q, TPS76827Q
 TPS76828Q, TPS76830Q, TPS76833Q, TPS76850Q, TPS76801Q
FAST-TRANSIENT-RESPONSE 1-A LOW-DROPOUT VOLTAGE REGULATORS

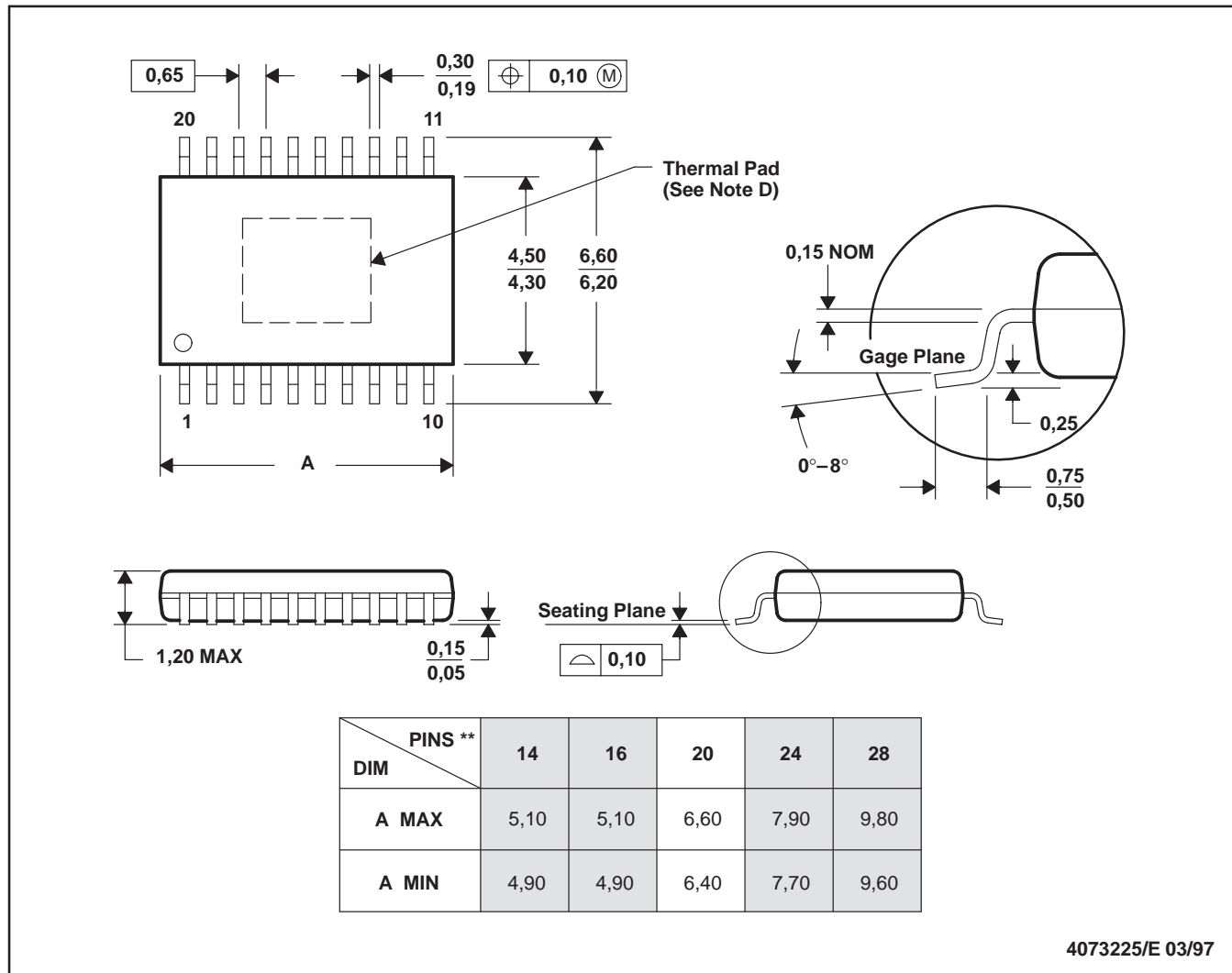
SLVS211B – JUNE 1999 – REVISED JULY 1999

MECHANICAL DATA

PWP (R-PDSO-G)**

PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE

20-PIN SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusions.
 D. The package thermal performance may be enhanced by bonding the thermal pad to an external thermal plane. This pad is electrically and thermally connected to the backside of the die and possibly selected leads.
 E. Falls within JEDEC MO-153

PowerPAD is a trademark of Texas Instruments Incorporated.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

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

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.