National Semiconductor

LP2989
Micropower/Low Noise, 500 mA Ultra Low-Dropout Regulator
For Use with Ceramic Output Capacitors

General Description

The LP2989 is a fixed-output 500 mA precision LDO regulator designed for use with ceramic output capacitors.

Output noise can be reduced to 18μV (typical) by connecting an external 10 nF capacitor to the bypass pin.

Using an optimized VIP™ (Vertically Integrated PNP) process, the LP2989 delivers superior performance:

Dropout Voltage: Typically 310 mV @ 500 mA load, and 1 mV @ 100 μA load.

Ground Pin Current: Typically 3 mA @ 500 mA load, and 110 μA @ 100 μA load.

Sleep Mode: The LP2989 draws less than 0.8 μA quiescent current when shutdown pin is pulled low.

Error Flag: The built-in error flag goes low when the output drops approximately 5% below nominal.

Precision Output: Guaranteed output voltage accuracy is 0.75% ("A" grade) and 1.25% (standard grade) at room temperature.

For output voltages < 2V, see LP2989LV datasheet.

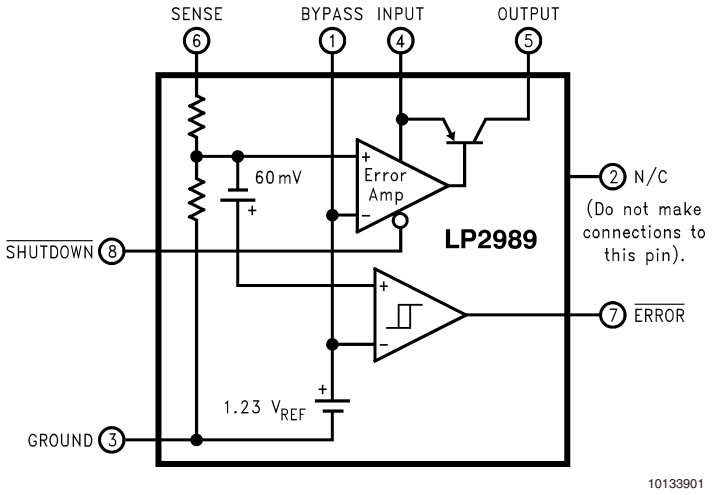
Features

- Ultra low dropout voltage
- Guaranteed 500 mA continuous output current
- Very low output noise with external capacitor
- SO-8, Mini SO-8, 8 Lead LLP surface mount packages
- <0.8 μA quiescent current when shutdown
- Low ground pin current at all loads
- 0.75% output voltage accuracy ("A" grade)
- High peak current capability (800 mA typical)
- Wide supply voltage range (16V max)
- Overtemperature/overcurrent protection
- −40˚C to +125˚C junction temperature range

Applications

- Notebook/Desktop PC
- PDA/Palmtop Computer
- Wireless Communication Terminals
- SMPS Post-Regulator

Block Diagram



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Ordering Information (Continued)

TABLE 1. Package Marking and Ordering Information (Continued)

Output Voltage	Grade	Order Information	Package Marking	Supplied as:
3.3	STD	LP2989IMM-3.3	LA2B	1000 Units on Tape and Reel
3.3	STD	LP2989IMMX-3.3	LA2B	3500 Units on Tape and Reel
5.0	A	LP2989AIMM-5.0	LA4A	1000 Units on Tape and Reel
5.0	A	LP2989AIMMX-5.0	LA4A	3500 Units on Tape and Reel
5.0	STD	LP2989IMM-5.0	LA4B	1000 Units on Tape and Reel
5.0	STD	LP2989IMMX-5.0	LA4B	3500 Units on Tape and Reel
SO-8 (M)				
2.5	A	LP2989AIMX-2.5	LP2989AIM2.5	2500 Units on Tape and Reel
2.5	A	LP2989AIM-2.5	LP2989AIM2.5	Shipped in Anti-Static Rails
2.5	STD	LP2989IMX-2.5	LP2989IM2.5	2500 Units on Tape and Reel
2.5	STD	LP2989IM-2.5	LP2989IM2.5	Shipped in Anti-Static Rails
3.0	A	LP2989AIMX-3.0	LP2989AIM3.0	2500 Units on Tape and Reel
3.0	A	LP2989AIM-3.0	LP2989AIM3.0	Shipped in Anti-Static Rails
3.0	STD	LP2989IMX-3.0	LP2989IM3.0	2500 Units on Tape and Reel
3.0	STD	LP2989IM-3.0	LP2989IM3.0	Shipped in Anti-Static Rails
3.3	A	LP2989AIMX-3.3	LP2989AIM3.3	2500 Units on Tape and Reel
3.3	A	LP2989AIM-3.3	LP2989AIM3.3	Shipped in Anti-Static Rails
3.3	STD	LP2989IMX-3.3	LP2989IM3.3	2500 Units on Tape and Reel
3.3	STD	LP2989IM-3.3	LP2989IM3.3	Shipped in Anti-Static Rails
5.0	A	LP2989AIMX-5.0	LP2989AIM5.0	2500 Units on Tape and Reel
5.0	A	LP2989AIM-5.0	LP2989AIM5.0	Shipped in Anti-Static Rails
5.0	STD	LP2989IMX-5.0	LP2989IM5.0	2500 Units on Tape and Reel
5.0	STD	LP2989IM-5.0	LP2989IM5.0	Shipped in Anti-Static Rails

For output voltages < 2V, see LP2989LV datasheet.

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Storage Temperature Range	−65˚C to +150˚C
Operating Junction Temperature Range	−40˚C to +125˚C
Lead Temperature (Soldering, 5 seconds)	260˚C
ESD Rating (Note 2)	2 kV
Power Dissipation (Note 3)	Internally Limited
Input Supply Voltage (Survival)	−0.3V to +16V
Input Supply Voltage (Operating)	2.1V to +16V
Sense Pin	−0.3V to +6V
Output Voltage (Survival) (Note 4)	−0.3V to +16V
I_{OUT} (Survival)	Short Circuit Protected
Input-Output Voltage (Survival) (Note 5)	−0.3V to +16V

Electrical Characteristics

Limits in standard typeface are for T_J = 25˚C, and limits in **boldface type** apply over the full operating temperature range. Unless otherwise specified: $V_{IN} = V_O(NOM) + 1V$, I_L = 1 mA, C_{OUT} = 4.7 µF, C_{IN} = 2.2 µF, $V_{S/D}$ = 2V.

Symbol	Parameter	Conditions	Typical	LP2989AI-X.X (Note 6)		LP2989I-X.X (Note 6)		Units
				Min	Max	Min	Max	
V_O	Output Voltage Tolerance			−0.75	0.75	−1.25	1.25	$\%V_{NOM}$
		1 mA < I_L < 500 mA $V_O(NOM) + 1V \le V_{IN} \le 16V$		−1.5	1.5	−2.5	2.5	
				−4.0	**2.5**	**−5.0**	**3.5**	
		1 mA < I_L < 500 mA $V_O(NOM) + 1V \le V_{IN} \le 16V$ $-25˚C \le T_J \le 125˚C$		**−3.5**	**2.5**	**−4.5**	**3.5**	
$\frac{\Delta V_0}{\Delta V_{IN}}$	Output Voltage Line Regulation	$V_O(NOM) + 1V \le V_{IN} \le 16V$	0.005		0.014		0.014	%/V
					0.032		**0.032**	
$\frac{\Delta V_0}{\Delta I_L}$	Load Regulation	1 mA < I_L < 500 mA	0.4					$\%V_{NOM}$
$V_{IN}-V_O$	Dropout Voltage (Note 7)	I_L = 100 µA	1		3		3	mV
					4		**4**	
		I_L = 200 mA	150		200		200	
					300		**300**	
		I_L = 500 mA	310		425		425	
					650		**650**	
I_{GND}	Ground Pin Current	I_L = 100 µA	110		175		175	µA
					200		**200**	
		I_L = 200 mA	1		2		2	mA
					3.5		**3.5**	
		I_L = 500 mA	3		6		6	
					9		**9**	
		$V_{S/D}$ < 0.18V	**0.5**		**2**		**2**	µA
		$V_{S/D}$ < 0.4V	0.05		0.8		0.8	
$I_O(PK)$	Peak Output Current	$V_{OUT} \ge V_O(NOM) - 5\%$	800	600		600		mA
$I_O(MAX)$	Short Circuit Current	R_L = 0 (Steady State) (Note 9)	1000					
e_n	Output Noise Voltage (RMS)	BW = 100 Hz to 100 kHz, C_{OUT} = 10 µF C_{BYPASS} = .01 µF V_{OUT} = 2.5V	18					µV(RMS)

Electrical Characteristics (Continued)

Limits in standard typeface are for T_J = 25˚C, and limits in **boldface type** apply over the full operating temperature range. Unless otherwise specified: $V_{IN} = V_O(NOM) + 1V$, I_L = 1 mA, C_{OUT} = 4.7 µF, C_{IN} = 2.2 µF, $V_{S/D}$ = 2V.

Symbol	Parameter	Conditions	Typical	LP2989AI-X.X (Note 6)		LP2989I-X.X (Note 6)		Units
				Min	Max	Min	Max	
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Ripple Rejection	f = 1 kHz, C_{OUT} = 10 µF	60					dB
$\frac{\Delta V_{OUT}}{\Delta T}$	Output Voltage Temperature Coefficient	(Note 8)	**20**					ppm/˚C
SHUTDOWN INPUT								
$V_{S/D}$	S/D Input Voltage	V_H = O/P ON	1.4	**1.6**		**1.6**		V
		V_L = O/P OFF $I_{IN} \leq 2$ µA	0.50		**0.18**		**0.18**	
$I_{S/D}$	S/D Input Current	$V_{S/D}$ = 0	0.001		**–1**		**–1**	µA
		$V_{S/D}$ = 5V	5		**15**		**15**	
ERROR COMPARATOR								
I_{OH}	Output “HIGH” Leakage	V_{OH} = 16V	0.001		1		1	µA
					2		**2**	
V_{OL}	Output “LOW” Voltage	$V_{IN} = V_O(NOM) - 0.5V$, $I_O(COMP)$ = 150 µA	150		220		220	mV
					350		**350**	
V_{THR} (MAX)	Upper Threshold Voltage		–4.8	–6.0	–3.5	–6.0	–3.5	$\%V_{OUT}$
				–8.3	**–2.5**	**–8.3**	**–2.5**	
V_{THR} (MIN)	Lower Threshold Voltage		–6.6	–8.9	–4.9	–8.9	–4.9	
				–13.0	**–3.0**	**–13.0**	**–3.0**	
HYST	Hysteresis		2.0					

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions.

Note 2: ESD testing was performed using Human Body Model, a 100 pF capacitor discharged through a 1.5 kΩ resistor.

Note 3: The maximum allowable power dissipation is a function of the maximum junction temperature, T_J(MAX), the junction-to-ambient thermal resistance, θ_{J-A}, and the ambient temperature, T_A. The maximum allowable power dissipation at any ambient temperature is calculated using:

$$P(MAX) = \frac{T_J(MAX) - T_A}{\theta_{J-A}}$$

The value of θ_{J-A} for the SO-8 (M) package is 160˚C/W and the mini SO-8 (MM) package is 200˚C/W. The value θ_{J-A} for the LLP (LD) package is specifically dependent on PCB trace area, trace material, and the number of layers and thermal vias. For improved thermal resistance and power dissipation for the LLP package, refer to Application Note AN-1187. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown.

Note 4: If used in a dual-supply system where the regulator load is returned to a negative supply, the LP2989 output must be diode-clamped to ground.

Note 5: The output PNP structure contains a diode between the V_{IN} and V_{OUT} terminals that is normally reverse-biased. Forcing the output above the input will turn on this diode and may induce a latch-up mode which can damage the part (see Application Hints).

Note 6: Limits are 100% production tested at 25˚C. Limits over the operating temperature range are guaranteed through correlation using Statistical Quality Control (SQC) methods. The limits are used to calculate National’s Average Outgoing Quality Level (AOQL).

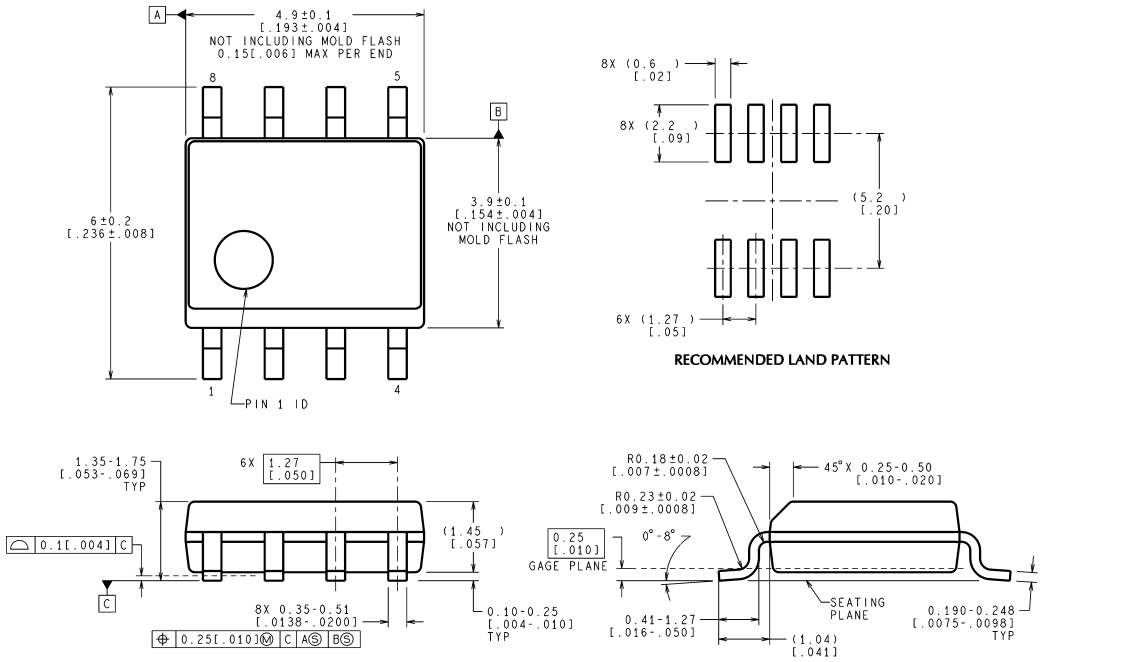
Note 7: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below the value measured with a 1V differential.

Note 8: Temperature coefficient is defined as the maximum (worst-case) change divided by the total temperature range.

Note 9: See Typical Performance Characteristics curves.

Physical Dimensions inches (millimeters)

unless otherwise noted



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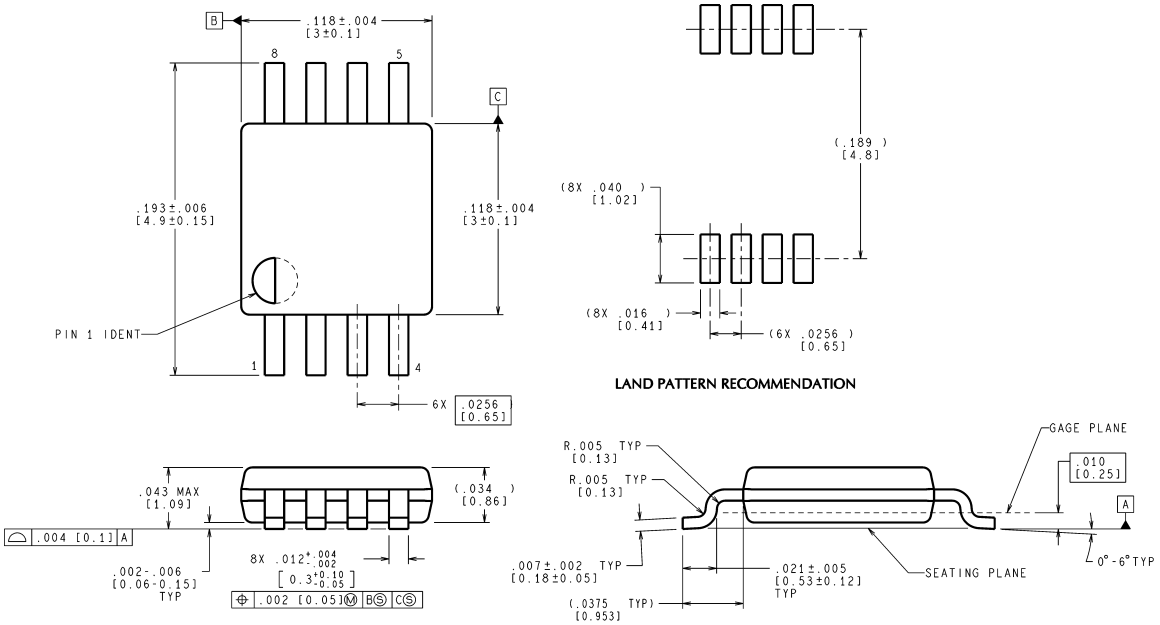
M08A (Rev K)

SO-8 Package
NS Package Number M08A



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MUA08A (Rev E)

Mini SO-8 Package
NS Package Number MUA08A