National Semiconductor

LP2987/LP2988
Micropower, 200 mA Ultra Low-Dropout Voltage Regulator with Programmable Power-On Reset Delay; Low Noise Version Available (LP2988)

General Description

The LP2987/8 are fixed-output 200 mA precision LDO voltage regulators with power-ON reset delay which can be implemented using a single external capacitor.

The LP2988 is specifically designed for noise-critical applications. A single external capacitor connected to the Bypass pin reduces regulator output noise.

Using an optimized VIP™ (Vertically Integrated PNP) process, these regulators deliver superior performance:

Dropout Voltage: 180 mV @ 200 mA load, and 1 mV @ 1 mA load (typical).

Ground Pin Current: 1 mA @ 200 mA load, and 200 µA @ 10 mA load (typical).

Sleep Mode: The LP2987/8 draws less than 2 µA quiescent current when shutdown pin is held low.

Error Flag/Reset: The error flag goes low when the output drops approximately 5% below nominal. This pin also provides a power-ON reset signal if a capacitor is connected to the DELAY pin.

Precision Output: Standard product versions of the LP2987 and LP2988 are available with output voltages of 5.0V, 3.8V, 3.3V, 3.2V, 3.0V, or 2.8V, with guaranteed accuracy of 0.5% ("A" grade) and 1% (standard grade) at room temperature.

Features

■ Ultra low dropout voltage
■ Power-ON reset delay requires only one component
■ Bypass pin for reduced output noise (LP2988)
■ Guaranteed continuous output current 200 mA
■ Guaranteed peak output current > 250 mA
■ SO-8 and mini SO-8 surface mount packages
■ <2 µA quiescent current when shutdown
■ Low ground pin current at all loads
■ 0.5% output voltage accuracy ("A" grade)
■ Wide supply voltage range (16V max)
■ Overtemperature/overcurrent protection
■ −40˚C to +125˚C junction temperature range

Applications

■ Cellular Phone
■ Palmtop/Laptop Computer
■ Camcorder, Personal Stereo, Camera

Block Diagrams

10001701

10001702

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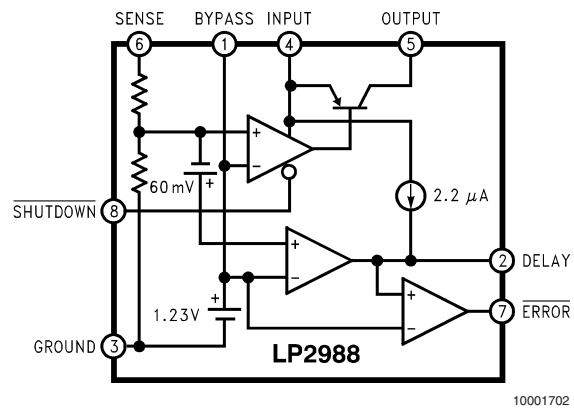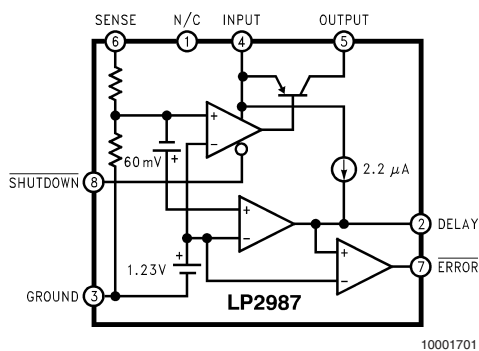
Ordering Information (LP2988) (Continued)

TABLE 2. Package Marking and Ordering Information (Continued)

Output Voltage	Grade	Order Information	Package Marking	Supplied as:
3.2	STD	LP2988IMMX-3.2	L67B	3500 Units on Tape and Reel
3.2	STD	LP2988IMM-3.2	L67B	1000 Units on Tape and Reel
3.0	A	LP2988AIMMX-3.0	L49A	3500 Units on Tape and Reel
3.0	A	LP2988AIMM-3.0	L49A	1000 Units on Tape and Reel
3.0	STD	LP2988IMMX-3.0	L49B	3500 Units on Tape and Reel
3.0	STD	LP2988IMM-3.0	L49B	1000 Units on Tape and Reel
2.8	A	LP2988AIMMX-2.8	L0IA	3500 Units on Tape and Reel
2.8	A	LP2988AIMM-2.8	L0IA	1000 Units on Tape and Reel
2.8	STD	LP2988IMMX-2.8	L0IB	3500 Units on Tape and Reel
2.8	STD	LP2988IMM-2.8	L0IB	1000 Units on Tape and Reel
2.7	A	LP2988AIMMX-2.7	LCVA	3500 Units on Tape and Reel
2.7	A	LP2988AIMM-2.7	LCVA	1000 Units on Tape and Reel
2.7	STD	LP2988IMMX-2.7	LCVB	3500 Units on Tape and Reel
2.7	STD	LP2988IMM-2.7	LCVB	1000 Units on Tape and Reel
2.5	A	LP2988AIMMX-2.5	L99A	3500 Units on Tape and Reel
2.5	A	LP2988AIMM-2.5	L99A	1000 Units on Tape and Reel
2.5	STD	LP2988IMMX-2.5	L99B	3500 Units on Tape and Reel
2.5	STD	LP2988IMM-2.5	L99B	1000 Units on Tape and Reel
5.0	A	LP2988AIMX-5.0	2988AIM5.0	2500 Units on Tape and Reel
5.0	A	LP2988AIM-5.0	2988AIM5.0	Shipped in Anti-Static Rails
5.0	STD	LP2988IMX-5.0	2988IM5.0	2500 Units on Tape and Reel
5.0	STD	LP2988IM-5.0	2988IM5.0	Shipped in Anti-Static Rails
3.8	A	LP2988AIMX-3.8	2988AIM3.8	2500 Units on Tape and Reel
3.8	A	LP2988AIM-3.8	2988AIM3.8	Shipped in Anti-Static Rails
3.8	STD	LP2988IMX-3.8	2988IM3.8	2500 Units on Tape and Reel

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
Shutdown Pin	−0.3V 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	LM2987/8AI-X.X (Note 6)		LM2987/8I-X.X (Note 6)		Units
				Min	Max	Min	Max	
ΔV_O	Output Voltage Tolerance			−0.5	0.5	−1.0	1.0	%V_{NOM}
		0.1 mA < I_L < 200 mA		−0.8	0.8	−1.6	1.6	
				−1.8	**1.8**	**−2.8**	**2.8**	
$\dfrac{\Delta V_0}{\Delta V_{IN}}$	Output Voltage Line Regulation	$V_O(NOM) + 1V \leq V_{IN} \leq$ 16V	0.007		0.014		0.014	%/V
					0.032		**0.032**	
$V_{IN}-V_O$	Dropout Voltage (Note 7)	$I_L = 100$ µA	1		2.0		2.0	mV
					3.5		**3.5**	
		$I_L = 75$ mA	90		120		120	
					170		**170**	
		$I_L = 200$ mA	180		230		230	
					350		**350**	
I_{GND}	Ground Pin Current	$I_L = 100$ µA	100		120		120	µA
					150		**150**	
		$I_L = 75$ mA	500		800		800	
					1400		**1400**	
		$I_L = 200$ mA	1		2.1		2.1	mA
					3.7		**3.7**	
		$V_{S/D} < 0.3V$	0.05		**1.5**		**1.5**	µA
$I_O(PK)$	Peak Output Current	$V_{OUT} \geq V_O(NOM) - 5\%$	400	250		250		mA
$I_O(MAX)$	Short Circuit Current	$R_L = 0$ (Steady State) (Note 10)	400					
e_n	LP2987 Output Noise Voltage (RMS)	BW = 300 Hz to 50 kHz, $V_{OUT} = 3.3V$ $C_{OUT} = 10$ µF	100					µV(RMS)
	LP2988 Output Noise Voltage (RMS)	BW = 300 Hz to 50 kHz, $V_{OUT} = 3.3V$ $C_{OUT} = 10$ µF $C_{BYPASS} = .01$ µF	20					
$\dfrac{\Delta V_{OUT}}{\Delta V_{IN}}$	Ripple Rejection	f = 1 kHz, $C_{OUT} = 10$ µF $C_{BYP} = 0$ (LP2988)	65					dB
$\dfrac{\Delta V_{OUT}}{\Delta T}$	Output Voltage Temperature Coefficient	(Note 9)	20					ppm/°C

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	LM2987/8AI-X.X (Note 6)		LM2987/8I-X.X (Note 6)		Units
				Min	Max	Min	Max	
I_{DELAY}	Delay Pin Current Source		2.2	1.6	2.8	1.6	2.8	μA
				1.4	**3.0**	**1.4**	**3.0**	
SHUTDOWN INPUT								
$V_{S/D}$	S/D Input Voltage (Note 8)	V_H = O/P ON	1.4	**1.6**		**1.6**		V
		V_L = O/P OFF	0.55		**0.18**		**0.18**	
$I_{S/D}$	S/D Input Current	$V_{S/D} = 0$	0		**−1**		**−1**	μA
		$V_{S/D} = 5V$	5		**15**		**15**	
ERROR COMPARATOR								
I_{OH}	Output "HIGH" Leakage	$V_{OH} = 16V$	0.01		1		1	μA
					2		**2**	
V_{OL}	Output "LOW" Voltage	$V_{IN} = V_O(NOM) − 0.5V$, $I_O(COMP) = 300$ μA	150		220		220	mV
					350		**350**	
V_{THR} (MAX)	Upper Threshold Voltage		−4.6	−5.5	−3.5	−5.5	−3.5	%V_{OUT}
				−7.7	**−2.5**	**−7.7**	**−2.5**	
V_{THR} (MIN)	Lower Threshold Voltage		−6.6	−8.9	−4.9	−8.9	−4.9	
				−13.0	**−3.3**	**−13.0**	**−3.3**	
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: The ESD rating of the Bypass pin is 500V (LP2988 only). The ESD rating of the V_{IN} pin is 1kV and the Delay pin is ESD rated at 1.5kV.

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 LM2987/8 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: To prevent mis-operation, the Shutdown input must be driven by a signal that swings above V_H and below V_L with a slew rate not less than 40 mV/μs (see Application Hints).

Note 9: Temperature coefficient is defined as the maximum (worst-case) change divided by the total temperature range.

Note 10: See Typical Performance Characteristics curves.

.118±.004
[3±0.1]

.193±.006
[4.9±0.15]

.118±.004
[3±0.1]

PIN 1 IDENT

6X .0256
[0.65]

(8X .040)
[1.02]

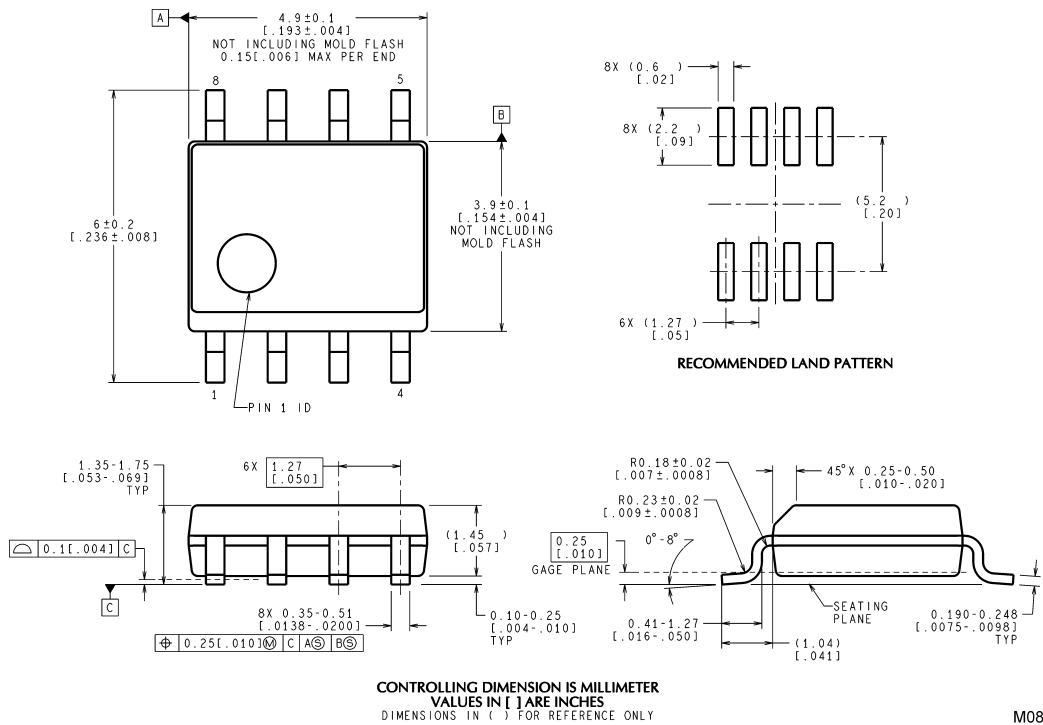(.189)
[4.8]

(8X .016)
[0.41]

(6X .0256)
[0.65]

LAND PATTERN RECOMMENDATION

.043 MAX
[1.09]

(.034)
[0.86]

.004 [0.1] A

.002-.006
[0.06-0.15]
TYP

8X .012+.004
-.002
[0.3+0.10
-0.05]

.002 [0.05] M B S C S

R.005 TYP
[0.13]

R.005 TYP
[0.13]

.007±.002 TYP
[0.18±0.05]

.021±.005
[0.53±0.12]
TYP

(.0375 TYP)
[0.953]

GAGE PLANE

.010
[0.25]

A

0°-6° TYP

SEATING PLANE

CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

MUA08A (Rev E)
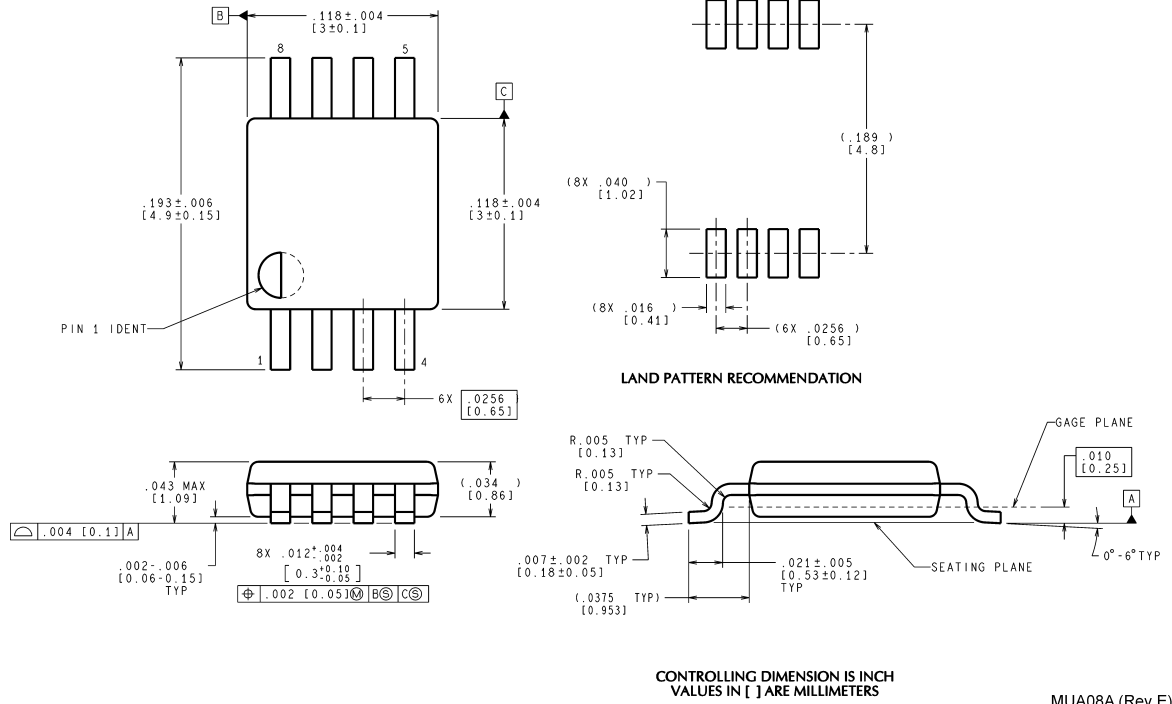
Mini SO-8 Package Type MM
NS Package Number MUA08A

4.9±0.1
[.193±.004]
NOT INCLUDING MOLD FLASH
0.15[.006] MAX PER END

6±0.2
[.236±.008]

3.9±0.1
[.154±.004]
NOT INCLUDING
MOLD FLASH

PIN 1 ID

8X (0.6)
[.02]

8X (2.2)
[.09]

(5.2)
[.20]

6X (1.27)
[.05]

RECOMMENDED LAND PATTERN

1.35-1.75
[.053-.069]
TYP

6X 1.27
[.050]

(1.45)
[.057]

0.1[.004] C

C

8X 0.35-0.51
[.0138-.0200]

0.25[.010] M C A S B S

0.10-0.25
[.004-.010]
TYP

R0.18±0.02
[.007±.0008]

R0.23±0.02
[.009±.0008]

0.25
[.010]
GAGE PLANE

0°-8°

45° X 0.25-0.50
[.010-.020]

SEATING
PLANE

0.41-1.27
[.016-.050]

(1.04)
[.041]

0.190-0.248
[.0075-.0098]
TYP

CONTROLLING DIMENSION IS MILLIMETER
VALUES IN [ ] ARE INCHES
DIMENSIONS IN ( ) FOR REFERENCE ONLY

M08A (Rev K)

SO-8 Package Type M
NS Package Number M08A

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