LP2951

100 mA Low-Dropout Voltage Regulator

Features

- High Accuracy 5V, Guaranteed 100 mA Output
- Extremely Low Quiescent Current
- Low-Dropout Voltage
- Extremely Tight Load and Line Regulation
- Very Low Temperature Coefficient
- Use as Regulator or Reference
- Needs Only 1 µF for Stability
- Current and Thermal Limiting
- Error Flag Warns of Output Dropout
- Logic-Controlled Electronic Shutdown
- Output Programmable from 1.24V to 29V

Applications

- Automotive Electronics
- Voltage Reference
- Avionics

General Description

The LP2951 is micropower voltage regulators with very low dropout voltage (typically 40 mV at light loads and 380 mV at 100 mA), and very low quiescent current (75 µA typical). The quiescent current of the LP2951 increases only slightly in dropout, thus prolonging battery life. This feature, among others, makes the LP2951 ideally suited for use in battery-powered systems.

Available system functions, such as programmable output voltage and logic-controlled shutdown, are available as well.

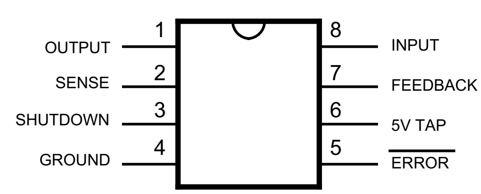
Additional features available with the LP2951 also include an error flag output that warns of a low output voltage, which is often due to failing batteries on the input. This may also be used as a power-on reset. A logic-compatible shutdown input is also available which enables the regulator to be switched on and off. This part may also be pin-strapped for a 5V output, or programmed from 1.24V to 29V with the use of two external resistors.

The LP2951 is available as either a -02 or -03 version. The -02 and -03 versions are guaranteed for junction temperatures from -40°C to +125°C; the -02 version has a tighter output and reference voltage specification range over temperature.

The LP2951 have a tight initial tolerance (0.5% typical), a very low output voltage temperature coefficient which allows use as a low-power voltage reference, and extremely good load and line regulation (0.05% typical). This greatly reduces the error in the overall circuit, and is the result of careful design techniques and process control.

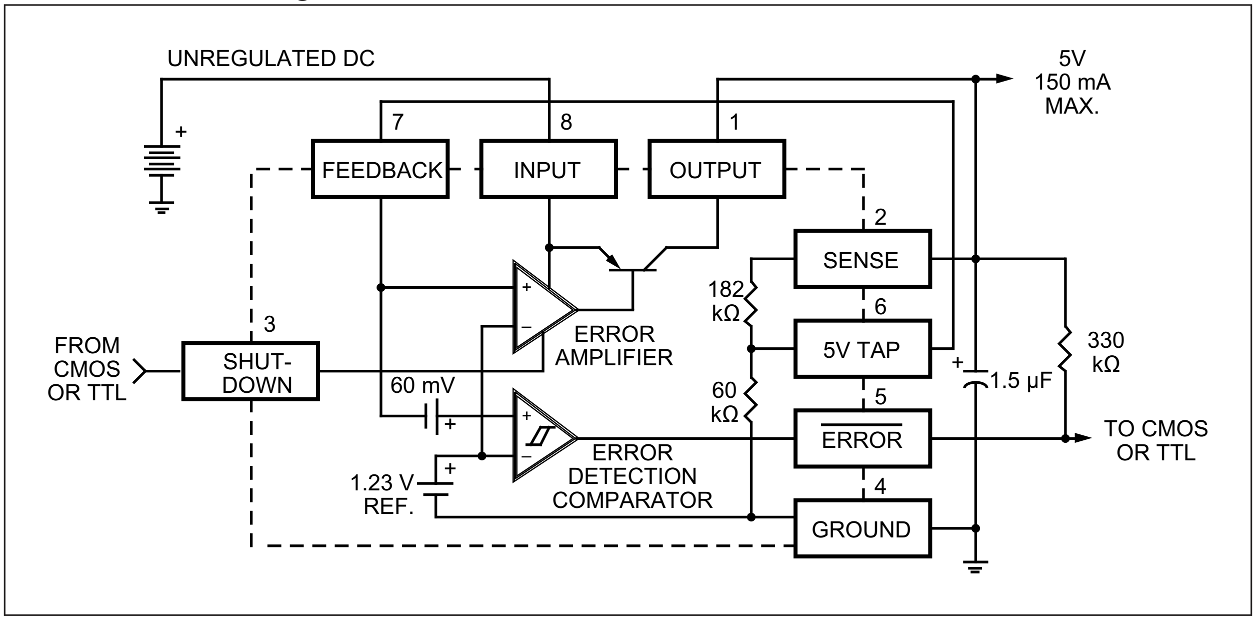
Package Types

LP2951
DIP & SOIC
Top View

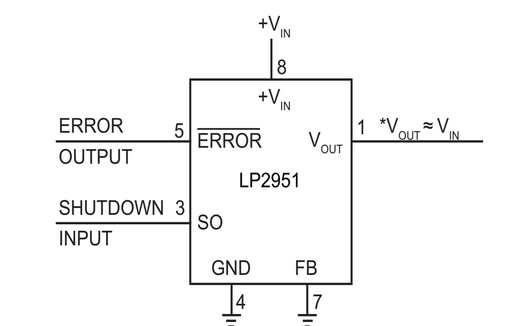


* See MIC2950 for a part with: 1) higher output (150 mA), 2) transient protection (60V), and 3) reverse input protection to –20V.

Functional Block Diagram

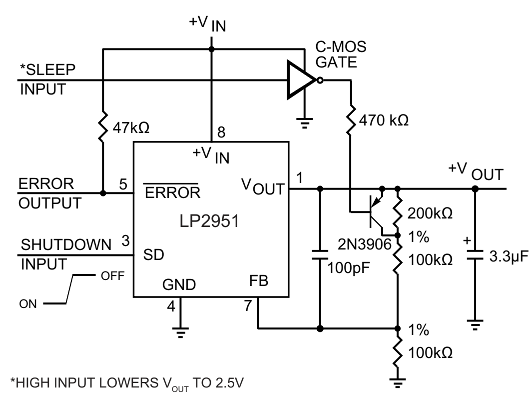


Typical Application Diagrams



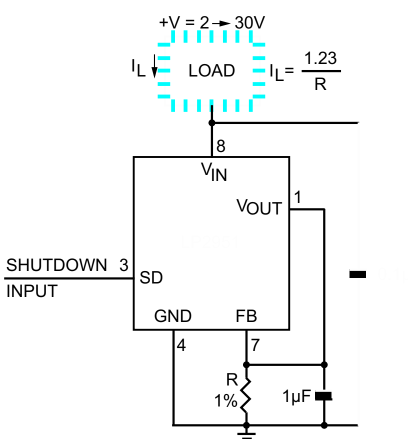
*MINIMUM INPUT-OUTPUT VOLTAGE RANGES FROM 40 mV TO 400 mV, DEPENDING ON LOAD CURRENT. CURRENT LIMIT IS TYPICALLY 160 mA.

WIDE INPUT VOLTAGE RANGE CURRENT LIMITER



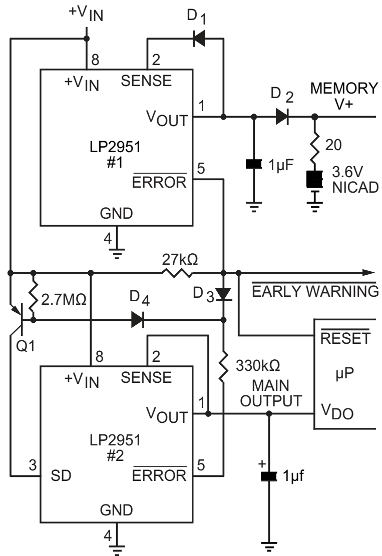
*HIGH INPUT LOWERS V_{OUT} TO 2.5V

5V REGULATOR WITH 2.5V SLEEP FUNCTION



LOW DRIFT CURRENT SOURCE

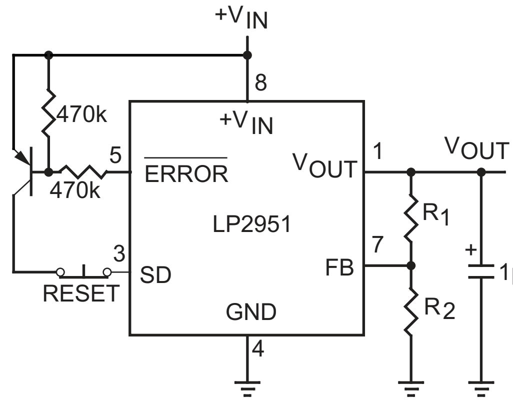
Typical Application Diagrams



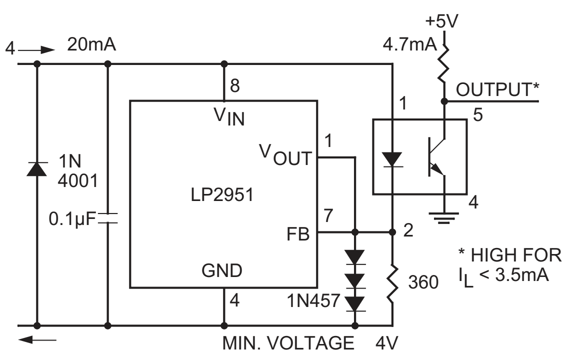
- EARLY WARNING FLAG ON LOW INPUT VOLTAGE
- MAIN OUTPUT LATCHES OFF AT LOWER INPUT VOLTAGES
- BATTERY BACKUP ON AUXILIARY OUTPUT

OPERATION: REG. #1'S V_{OUT} IS PROGRAMMED ONE DIODE DROP ABOVE 5V. ITS ERROR FLAG BECOMES ACTIVE WHEN $V_{IN} \leq 5.7V$. WHEN V_{IN} DROPS BELOW 5.3V, THE ERROR FLAG OF REG. #2 BECOMES ACTIVE AND VIA Q1 LATCHES THE MAIN OUTPUT OFF. WHEN V_{IN} AGAIN EXCEEDS 5.7V REG. #1 IS BACK IN REGULATION AND THE EARLY WARNING SIGNAL RISES, UNLATCHING REG. #2 VIA D3.

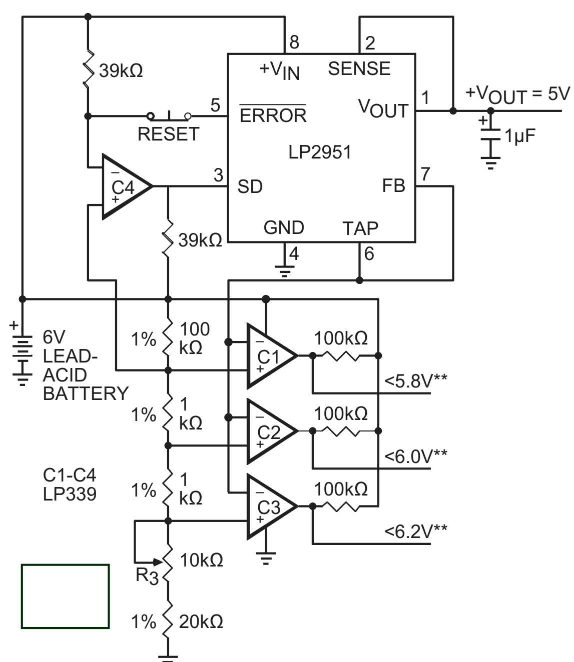
REGULATOR WITH EARLY WARNING AND AUXILIARY OUTPUT



LATCH-OFF WHEN ERROR FLAG OCCURS



OPEN CIRCUIT DETECTOR FOR 4 mA TO 20 mA CURRENT LOOP

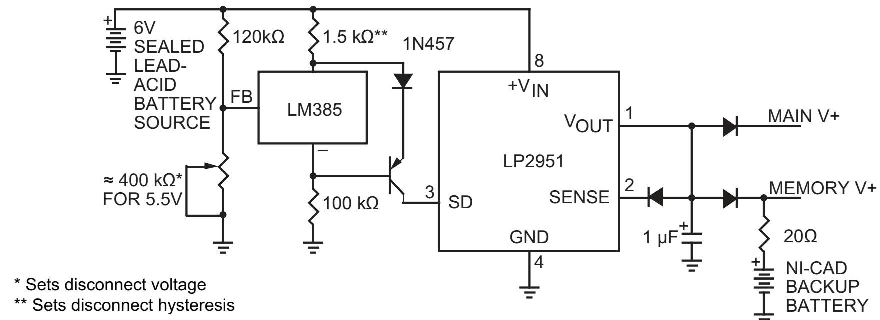


C1 TO C4 ARE COMPARATORS (LP339 OR EQUIVALENT)

*OPTIONAL LATCH OFF WHEN DROP OUT OCCURS. ADJUST R3 FOR C2 SWITCHING WHEN V_{IN} IS 6.0V

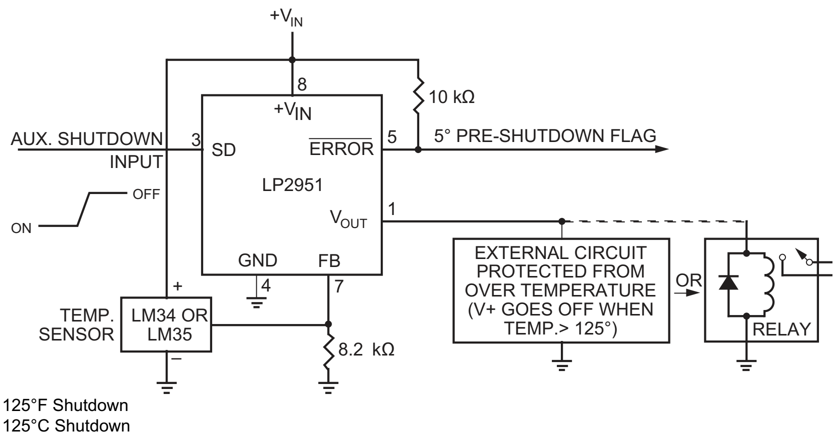
**OUTPUTS GO LOW WHEN V_{IN} DROPS BELOW DESIGNATED THRESHOLDS.

REGULATOR WITH STATE-OF-CHARGE INDICATOR



For values shown, Regulator shuts down when V_{IN} < 5.5V and turns on again at 6.0V. Current drain in disconnected mode is 150 µA.

LOW BATTERY DISCONNECT



SYSTEM OVER TEMPERATURE PROTECTION CIRCUIT

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings † ††

Power Dissipation .... Internally Limited
Lead Temperature (soldering, 5 sec.) .... 260°C
Storage Temperature .... –65°C to +150°C
Operating Junction Temperature Range(Note 1)
LP2951 .... –40°C to +125°C
Input Supply Voltage .... –0.3 to +30V
Feedback Input Voltage(Note 2, 3) .... –1.5 to +30V
Shutdown Input Voltage(Note 2) .... –0.3 to +30V
Error Comparator Output Voltage(Note 2) .... –0.3 to +30V

† Notice: Boldface limits apply at temperature extremes.

†† Notice: If Military/Aerospace specified devices are required, contact your local representative/distributor for availability and specifications.

Note 1: The thermal resistance of the 8-pin DIP package is 105°C/W junction-to-ambient when soldered directly to a PC board. Junction-to-ambient thermal resistance for the SOIC (M) package is 160°C/W.

2: May exceed input supply voltage.

3: When used in dual-supply systems where the output terminal sees loads returned to a negative supply, the output voltage should be diode-clamped to ground.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Output Voltage T_J = 25°C		4.975	5.000	5.025	V	LP2951-02 (±0.5%)
		4.950	5.000	5.050	V	LP2951-03 (±1%)
		4.802	4.850	4.899	V	LP2951-4.8 (±1%)

Note 1: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

3: Line regulation for the LP2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Characteristics for line regulation versus temperature and load current.

4: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

5: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

6: Comparator thresholds are expressed in terms of a voltage differential at the Feedback terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} =(R1 + R2)/R2. For example, at a programmed output voltage of 5V, the Error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

7: $V_{REF} \le V_{OUT} \le (V_{IN} – 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 100 mA, $T_J \le T_{JMAX}$.

8: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

9: $V_{SHUTDOWN}$ ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with Feedback pin tied to 5V Tap.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Output Voltage –25°C ≤ T_J ≤ +85°C		4.950	—	5.050	V	LP2951-02 (±0.5%)
		4.925	—	5.075	V	LP2951-03 (±1%)
		4.777	—	4.872	V	LP2951-4.8 (±1%)
Output Voltage Over Full Temperature Range –40°C to +125°C		**4.940**	—	**5.060**	V	LP2951-02 (±0.5%)
		4.900	—	**5.100**	V	LP2951-03 (±1%)
		4.753	—	**4.947**	V	LP2951-4.8 (±1%)
Output Voltage Over Load Variation		**4.930**	—	**5.070**	V	LP2951-02 (±0.5%), 100 µA ≤ I_L ≤ 100 mA, $T_J \le T_{J(max)}$
		4.880	—	**5.120**	V	LP2951-03 (±1%), 100 µA ≤ I_L ≤ 100 mA, $T_J \le T_{J(max)}$
		4.733	—	**4.967**	V	LP2951-4.8 (±1%), 100 µA ≤ I_L ≤ 100 mA, $T_J \le T_{J(max)}$
Output Voltage Temperature Coefficient		—	**20**	**100**	ppm/°C	LP2951-02 (±0.5%), Note 1
		—	**50**	**150**	ppm/°C	LP2951-03 (±1%), Note 1
		—	**50**	**150**	ppm/°C	LP2951-4.8 (±1%), Note 1

Note 1: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

3: Line regulation for the LP2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Characteristics for line regulation versus temperature and load current.

4: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

5: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

6: Comparator thresholds are expressed in terms of a voltage differential at the Feedback terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} =(R1 + R2)/R2. For example, at a programmed output voltage of 5V, the Error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

7: $V_{REF} \le V_{OUT} \le (V_{IN} – 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 100 mA, $T_J \le T_{JMAX}$.

8: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

9: $V_{SHUTDOWN}$ ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with Feedback pin tied to 5V Tap.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Line Regulation		—	0.03	0.10	%	LP2951-02 (±0.5%), Note 2, 3
		—	—	**0.20**	%	
		—	0.04	0.20	%	LP2951-03 (±1%), Note 2, 3
		—	—	**0.40**	%	
		—	0.04	0.20	%	LP2951-4.8 (±1%), Note 2, 3
		—	—	**0.40**	%	
Load Regulation		—	0.04	0.10	%	LP2951-02 (±0.5%), Note 2, 100 µA ≤ I_L ≤ 100 mA
		—	—	**0.20**	%	
		—	0.10	0.20	%	LP2951-03 (±1%), Note 2, 100 µA ≤ I_L ≤ 100 mA
		—	—	**0.30**	%	
		—	0.10	0.20	%	LP2951-4.8 (±1%), Note 2, 100 µA ≤ I_L ≤ 100 mA
		—	—	**0.30**	%	
Dropout Voltage		—	50	80	mV	Note 4, I_L = 100 µA
		—	—	150	mV	
		—	380	450	mV	Note 4, I_L = 100 mA
		—	—	600	mV	
Ground Current		—	100	150	µA	I_L = 100 µA
		—	—	200	µA	
		—	8	12	mA	I_L = 100 mA
		—	—	14	mA	

Note 1: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

3: Line regulation for the LP2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Characteristics for line regulation versus temperature and load current.

4: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

5: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

6: Comparator thresholds are expressed in terms of a voltage differential at the Feedback terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} =(R1 + R2)/R2. For example, at a programmed output voltage of 5V, the Error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

7: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\text{ V})$, $2.3V \le V_{IN} \le 30V$, $100\ \mu A < I_L \le 100$ mA, $T_J \le T_{JMAX}$.

8: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

9: $V_{SHUTDOWN} \ge 2V$, $V_{IN} \le 30V$, $V_{OUT} = 0$, with Feedback pin tied to 5V Tap.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Dropout Current		—	180	250 310	µA µA	V_{IN} = 4.5V, I_L = 100 µA
Current Limit		—	160	220 220	mA mA	V_{OUT} = 0V
Thermal Regulation		—	0.05	0.20	%/W	Note 5
Output Noise		—	430	—	μV_{RMS}	10 Hz to 100 kHz, C_L = 1 µF
		—	160	—	μV_{RMS}	10 Hz to 100 kHz, C_L = 200 µF
		—	100	—	μV_{RMS}	10 Hz to 100 kHz, C_L = 3.3 µF, 0.01 µF bypass Feedback to Output
Reference Voltage		1.220	1.235	1.25	V	LP2951-02 (±0.5%)
		1.200	—	**1.260**	V	
		1.210	1.235	1.260	V	LP2951-03 (±1%)
		1.200	—	**1.270**	V	
		1.210	1.235	1.260	V	LP2951-4.8 (±1%)
		1.200	—	1.270	V	
Reference Voltage		1.190	—	1.270	V	LP2951-02 (±0.5%), Note 7
		1.185	—	1.285	V	LP2951-03 (±1%), Note 7
		1.185	—	1.285	V	LP2951-4.8 (±1%), Note 7

Note 1: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

3: Line regulation for the LP2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Characteristics for line regulation versus temperature and load current.

4: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

5: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

6: Comparator thresholds are expressed in terms of a voltage differential at the Feedback terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} =(R1 + R2)/R2. For example, at a programmed output voltage of 5V, the Error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

7: $V_{REF} \le V_{OUT} \le (V_{IN} – 1 V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 100 mA, $T_J \le T_{JMAX}$.

8: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

9: $V_{SHUTDOWN}$ ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with Feedback pin tied to 5V Tap.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Feedback Bias Current		—	20	40	nA	—
		—	—	60		
Reference Voltage		—	20	—	ppm/°C	LP2951-02 (±0.5%), Note 8
		—	50	—	ppm/°C	LP2951-03 (±1%), Note 8
		—	50	—	ppm/°C	LP2951-4.8 (±1%), Note 8
Feedback Bias Current Temperature Coefficient		—	0.1	—	nA/°C	
Output Leakage Current		—	0.01	1.00	µA	V_{OH} = 30V
		—	—	**2.00**	µA	
Output Low Voltage (Flag)		—	150	250	mV	V_{IN} = 4.5V, I_{OL} = 200µA
		—	—	400	mV	
Upper Threshold Voltage		40	60	—	mV	Note 6
		25		—	mV	
Lower Threshold Voltage		—	75	95	mV	Note 6
		—	—	140	mV	
Hysteresis		—	15	—	mV	Note 6

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3: Line regulation for the LP2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Characteristics for line regulation versus temperature and load current.

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7: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\ V)$, $2.3V \le V_{IN} \le 30V$, $100\ µA < I_L \le 100\ mA$, $T_J \le T_{JMAX}$.

8: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

9: $V_{SHUTDOWN} \ge 2V$, $V_{IN} \le 30V$, $V_{OUT} = 0$, with Feedback pin tied to 5V Tap.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Input Logic Voltage		—	1.3	—	V	LP2951-02 (±0.5%)
		—	—	0.7	V	Low
		2.0	—	—	V	High
		—	1.3	—	V	LP2951-03 (±1%)
		—	—	0.7	V	Low
		2.0	—	—	V	High
		—	1.3	—	V	LP2951-4.8 (±1%)
		—	—	0.7	V	Low
		2.0	—	—	V	High

Note 1: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

3: Line regulation for the LP2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Characteristics for line regulation versus temperature and load current.

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7: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 100 mA, $T_J \le T_{JMAX}$.

8: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

9: $V_{SHUTDOWN}$ ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with Feedback pin tied to 5V Tap.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Shutdown Input Current		—	30	50	µA	$V_{SHUTDOWN}$ = 2.4V
		—	—	100	µA	
		—	450	600	µA	$V_{SHUTDOWN}$ = 30V
		—	—	700	µA	
Regulator Output Current in Shutdown		—	3	10	µA	Note 9
		—	—	20	µA	

Note 1: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

3: Line regulation for the LP2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Characteristics for line regulation versus temperature and load current.

4: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

5: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

6: Comparator thresholds are expressed in terms of a voltage differential at the Feedback terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} =(R1 + R2)/R2. For example, at a programmed output voltage of 5V, the Error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

7: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 100 mA, $T_J \le T_{JMAX}$.

8: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

9: $V_{SHUTDOWN}$ ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with Feedback pin tied to 5V Tap.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Lead Temperature Range	—	—	260	—	°C	
Junction Operating Temperature	T_J	–40	—	+125	°C	
Storage Temperature Range	T_A	–65	—	+125	°C	
Package Thermal Resistances						
Thermal Resistance, DIP Package	θ_{JA}	—	105	—	°C/W	Soldered directly to a PC board
	θ_{JC}	—	40	—	°C/W	
Thermal Resistance, SOIC Package	θ_{JA}	—	160	—	°C/W	Typically mounting on a 1" square copper-clad FR4 circuit board
	θ_{JC}	—	25	—	°C/W	

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

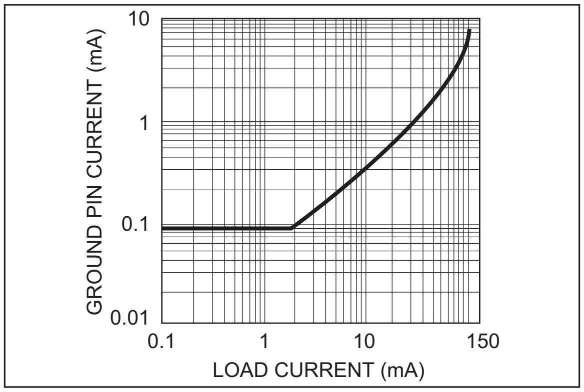


FIGURE 2-1: *Quiescent Current.*

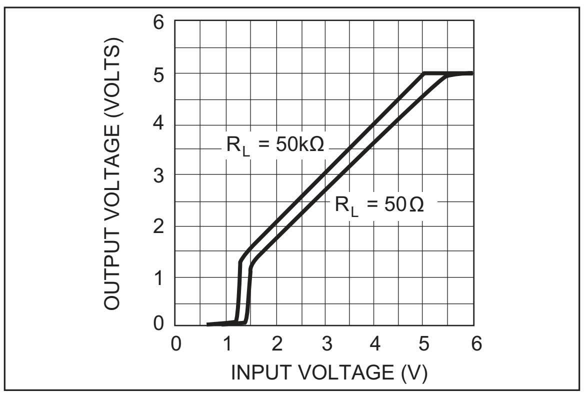


FIGURE 2-2: *Dropout Characteristics.*

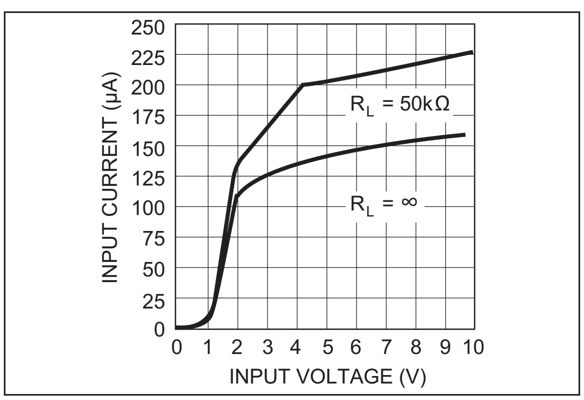


FIGURE 2-3: *Input Current.*

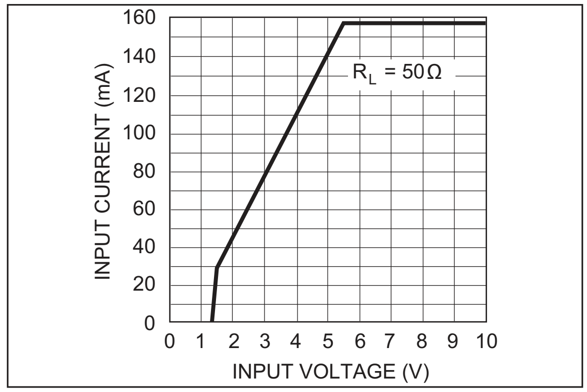


FIGURE 2-4: *Input Current.*

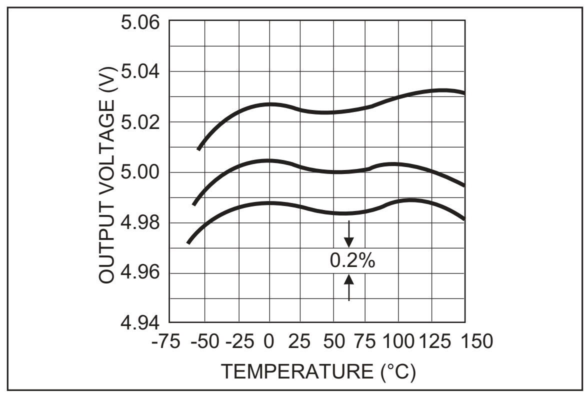


FIGURE 2-5: *Output Voltage vs. Temperature of 3 Representative Units.*

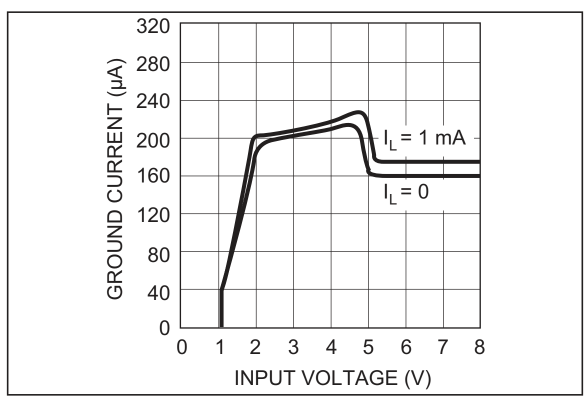


FIGURE 2-6: *Ground Current.*

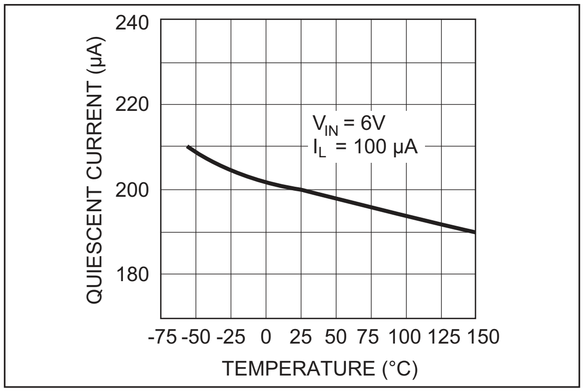


FIGURE 2-7: *Quiescent Current.*

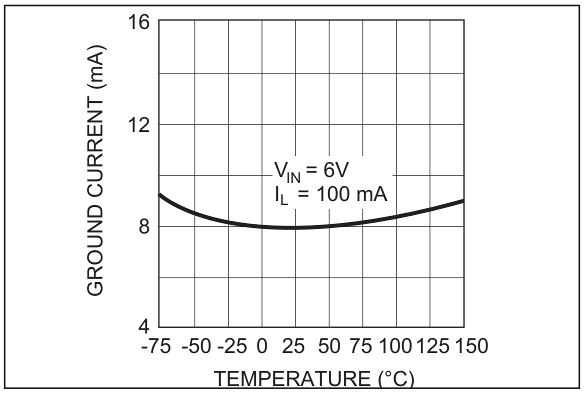


FIGURE 2-8: *Ground Current.*

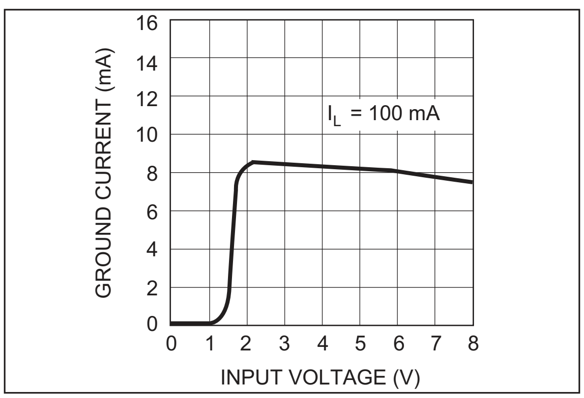


FIGURE 2-9: *Ground Current.*

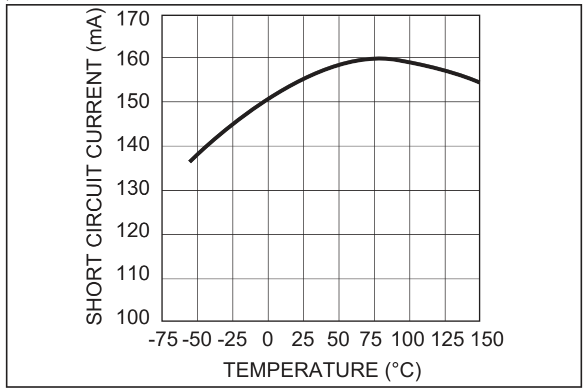


FIGURE 2-10: *Short Circuit Current.*

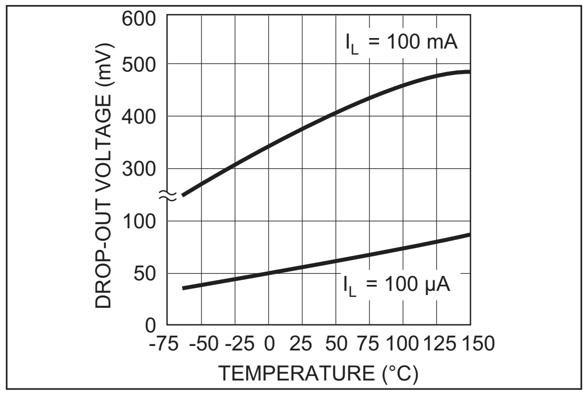


FIGURE 2-11: *Dropout Voltage.*

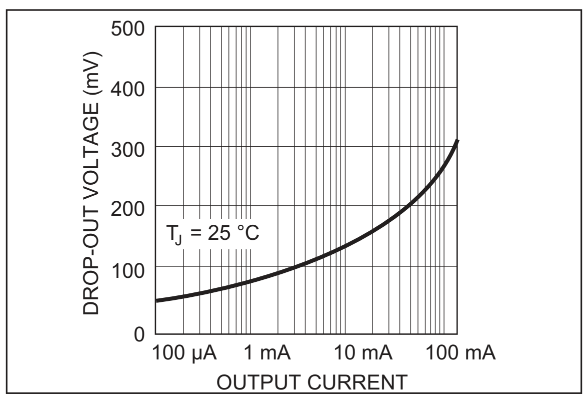


FIGURE 2-12: *Dropout Voltage.*

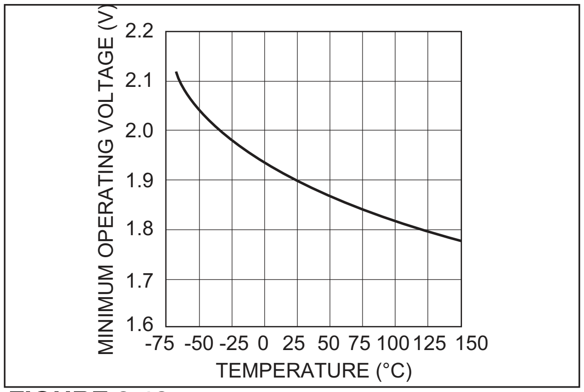


FIGURE 2-13: *Minimum Operating Voltage.*

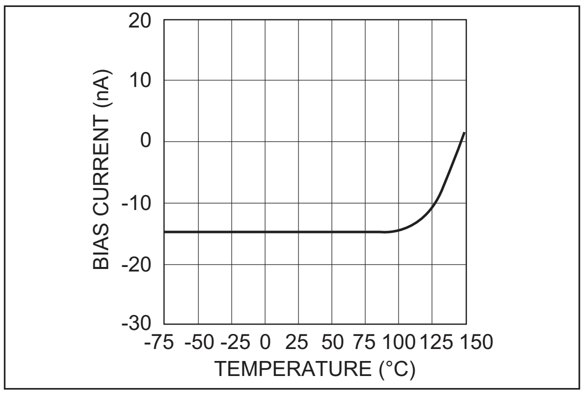


FIGURE 2-14: *Feedback Bias Current.*

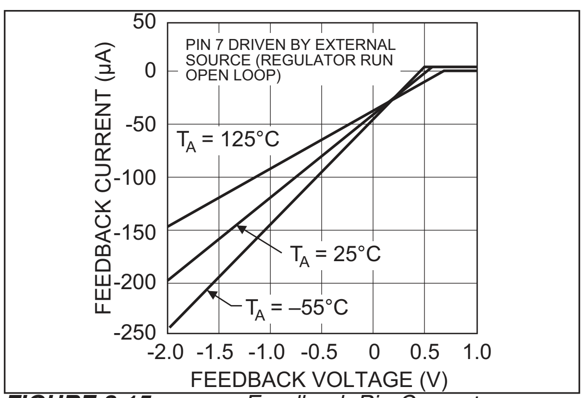


FIGURE 2-15: *Feedback Pin Current.*

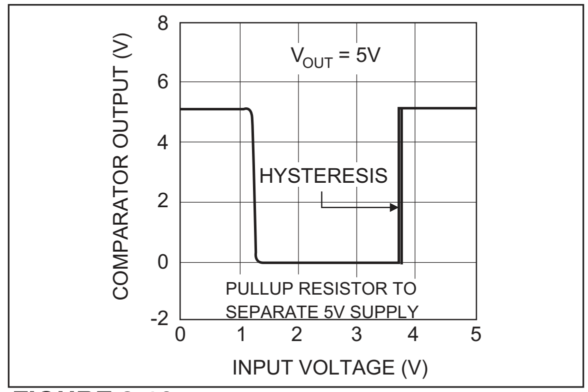


FIGURE 2-16: *Error Comparator Output.*

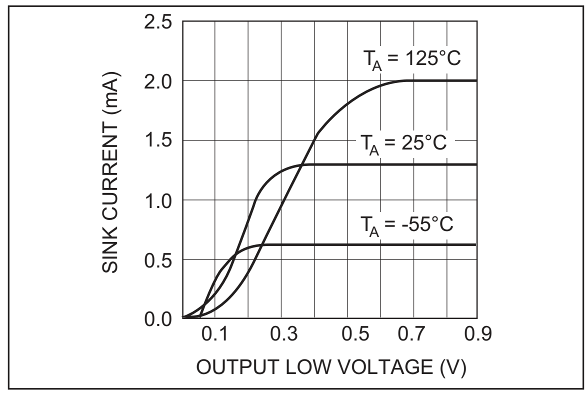


FIGURE 2-17: *Comparator Sink Current.*

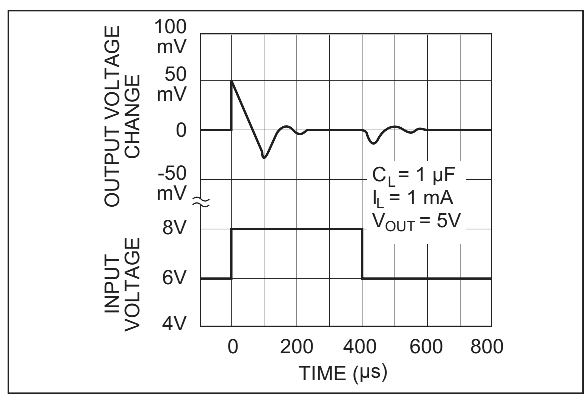


FIGURE 2-18: *Line Transient Response.*

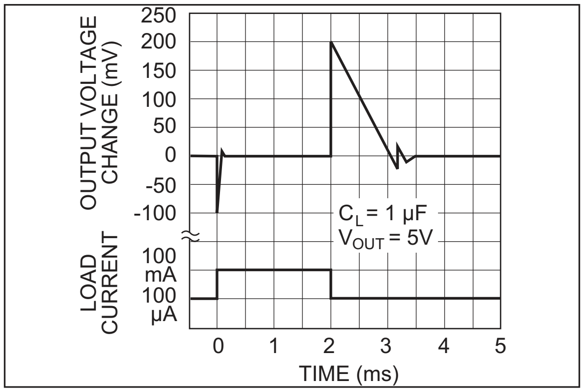


FIGURE 2-19: *Load Transient Response.*

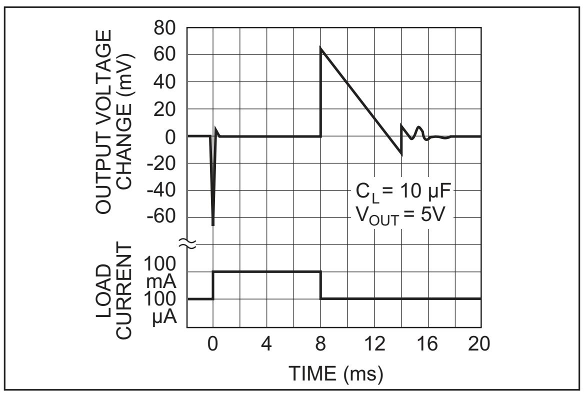


FIGURE 2-20: *Load Transient Response.*

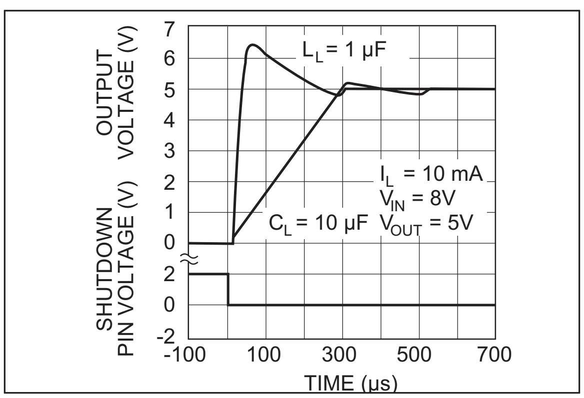


FIGURE 2-21: *Enable Transient.*

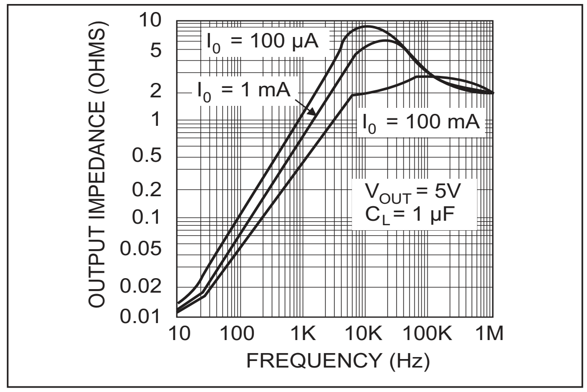


FIGURE 2-22: *Output Impedance.*

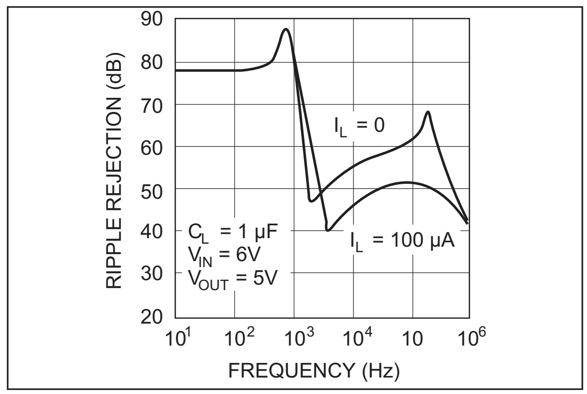


FIGURE 2-23: *Ripple Rejection.*

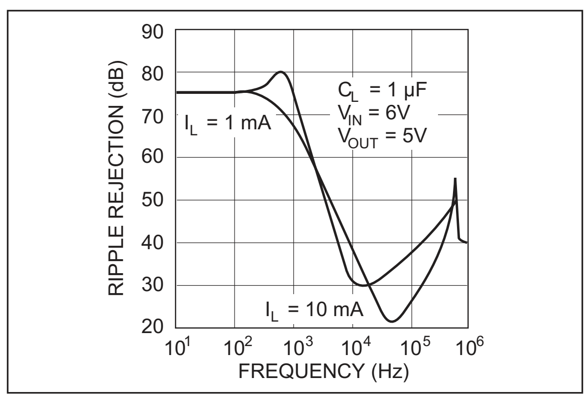


FIGURE 2-24: *Ripple Rejection.*

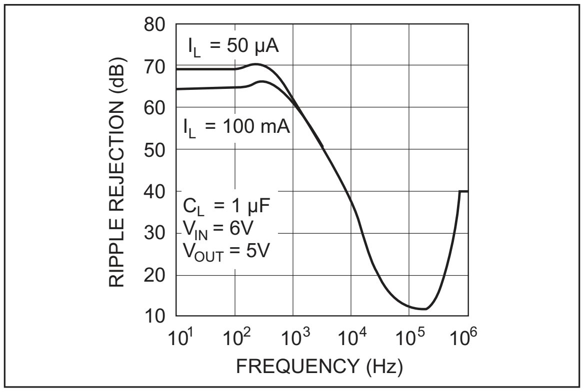


FIGURE 2-25: *Ripple Rejection.*

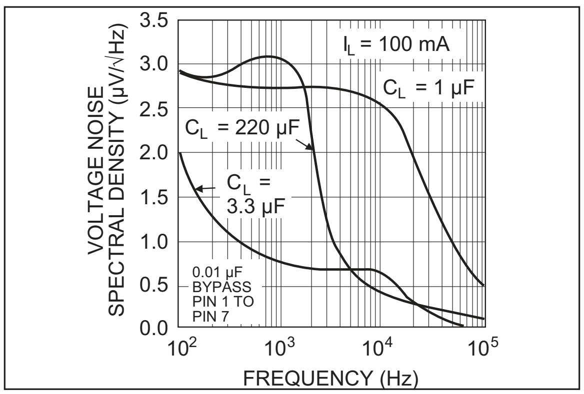


FIGURE 2-26: *Output Noise.*

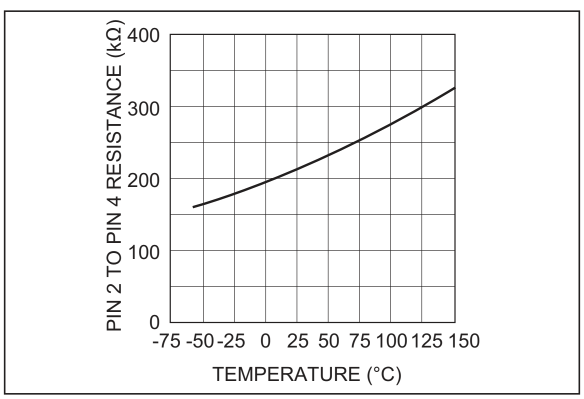


FIGURE 2-27: *Divider Resistance.*

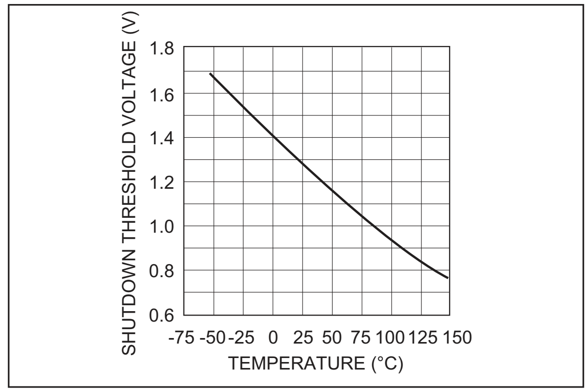


FIGURE 2-28: *Shutdown Threshold Voltage.*

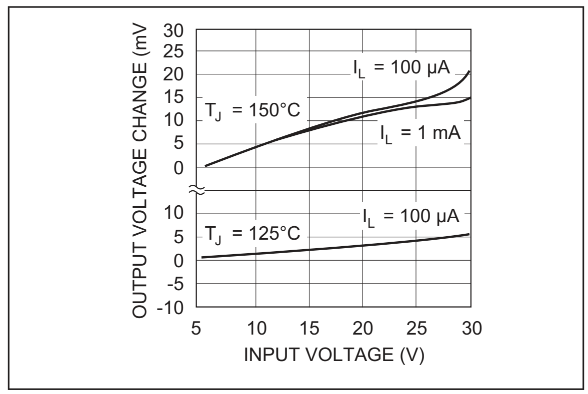


FIGURE 2-29: *Line Regulation.*

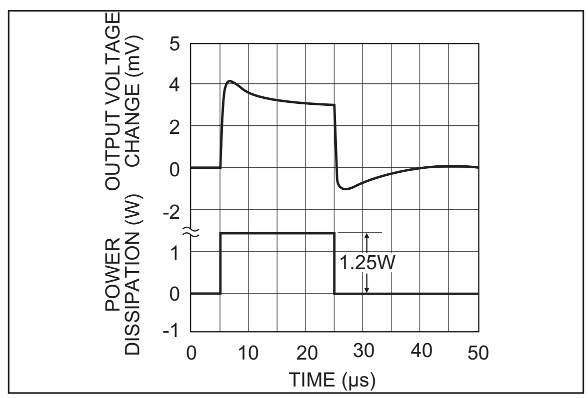


FIGURE 2-30: *Thermal Response.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: DIP AND SOIC PIN FUNCTION TABLE

LP2951	Symbol	Description
1	V_{OUT}	Regulated voltage output.
2	SENSE	Output Voltage Sense.
3	SHDN	Shutdown Input.
4	GND	Ground Terminal.
5	ERROR	Error Output.
6	5V TAP	Internal Resistor Divider for 5V Output.
7	FB	Voltage Feedback Input.
8	V_{IN}	Unregulated Supply Voltage.

4.0 APPLICATION INFORMATION

4.1 External Capacitors

A 1.0 µF (or greater) capacitor is required between the LP2951 output and ground to prevent oscillations due to instability. Most types of tantalum or aluminum electrolytics will be adequate; film types will work, but are costly and therefore not recommended. Many aluminum electrolytics have electrolytes that freeze at about –30°C, so solid tantalum capacitors are recommended for operation below –25°C. The important parameters of the capacitor are an effective series resistance of about 5Ω or less and a resonant frequency above 500 kHz. The value of this capacitor may be increased without limit.

At lower values of output current, less output capacitance is required for output stability. The capacitor can be reduced to 0.33 µF for current below 10 mA or 0.1 µF for currents below 1 mA. Using the 8-pin versions at voltages below 5V runs the error amplifier at lower gains so that more output capacitance is needed. For the worst-case situation of a 100 mA load at 1.23V output (Output shorted to Feedback) a 3.3 µF (or greater) capacitor should be used.

When the 5V Tap pin and Feedback pin are connected together for 5V output voltage, the LP2951 will remain stable and in regulation with no load in addition to the internal voltage divider, unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications. When setting the output voltage of the LP2951 with external resistors, a minimum load of 1 µA is recommended.

A 0.1 µF capacitor should be placed from the LP2951 input to ground if there is more than 10 inches of wire between the input and the AC filter capacitor or if a battery is used as the input.

Stray capacitance to the LP2951 Feedback terminal (pin 7) can cause instability. This may especially be a problem when using high value external resistors to set the output voltage. Adding a 100 pF capacitor between Output and Feedback and increasing the output capacitor to at least 3.3 µF will remedy this.

4.2 Error Detection Comparator Output

A logic low output will be produced by the comparator whenever the LP2951 output falls out of regulation by more than approximately 5%. This figure is the comparator's built-in offset of about 60mV divided by the 1.235V reference voltage. (Refer to the block diagram on Page 1). This trip level remains "5% below normal" regardless of the programmed output voltage of the LP2951. For example, the error flag trip level is typically 4.75V for a 5V output or 11.4V for a 12V output. The out of regulation condition may be due either to low input voltage, current limiting, or thermal limiting.

Figure 4-1 is a timing diagram depicting the ERROR signal and the regulated output voltage as the LP2951 input is ramped up and down. The ERROR signal becomes valid (low) at about 1.3V input. It goes high at about 5V input (the input voltage at which V_{OUT} = 4.75V). Since the LP2951's dropout voltage is load-dependent (see curve in Typical Performance Curves), the input voltage trip point (about 5V) will vary with the load current. The output voltage trip point (approximately 4.75V) does not vary with load.

The error comparator has an open-collector output which requires an external pull-up resistor. Depending on system requirements, this resistor may be returned to the 5V output or some other supply voltage. In determining a value for this resistor, note that while the output is rated to sink 400 µA, this sink current adds to battery drain in a low battery condition. Suggested values range from 100 kΩ to 1 MΩ. The resistor is not required if this output is unused.

4.3 Programming the Output Voltage

The LP2951 may be pin-strapped for 5V output voltage using its internal voltage divider, by tying Pin 1 (V_{OUT}) and Pin 2 (SENSE) together, as well as tying Pin 7 (Feedback) and Pin 6 (5V TAP) together. Alternatively, it may be programmed for any output voltage between its 1.235V reference and its 30V maximum rating. An external pair of resistors is required, as shown in Figure 4-2.

The complete equation for the output voltage is:

EQUATION 4-1:

$$V_{OUT} = V_{REF} \times \left\{1 + \frac{R_1}{R_2}\right\} + I_{FB}R_2$$

Where:

V_{REF} = the nominal 1.235 reference voltage

I_{FB} = the feedback pin bias current, nominally 20 nA

The minimum recommended load current of 1 µA forces an upper limit of 1.2 MΩ on the value of R2, if the regulator must work with no load (a condition often found in CMOS in standby), I_{FB} will produce a 2% typical error in V_{OUT} which may be eliminated at room temperature by trimming R1. For better accuracy, choosing R2 = 100 kΩ reduces this error to 0.17% while increasing the resistor program current to 12 µA. Since the LP2951 typically draws 60 µA at no load with Pin 2 open-circuited, this is a small price to pay.

4.4 Reducing Output Noise

In reference applications it may be advantageous to reduce the AC noise present at the output. One method is to reduce the regulator bandwidth by increasing the size of the output capacitor. This method is relatively inefficient, as increasing the capacitor from 1µF to 220 µF only decreases the noise from 430 µV to 160 μV_{rms} for a 100 kHz bandwidth at 5V output.

Noise can be reduced fourfold by a bypass capacitor across R1, since it reduces the high frequency gain from 4 to unity. Pick the resulting frequency from Equation 4-2:

EQUATION 4-2:

$$C_{BYPASS} = \frac{1}{2\pi R_1 \bullet 200Hz}$$

or about 0.01 µF. When doing this, the output capacitor must be increased to 3.3 µF to maintain stability. These changes reduce the output noise from 430 µV to 100 μV_{rms} for a100 kHz bandwidth at 5V output. With the bypass capacitor added, noise no longer scales with output voltage so that improvements are more dramatic at higher output voltages.

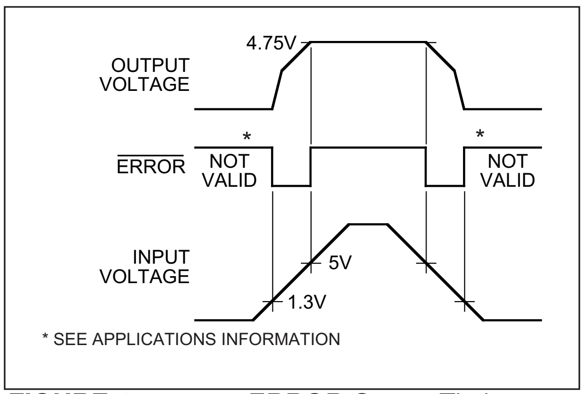


FIGURE 4-1: ERROR Output Timing.

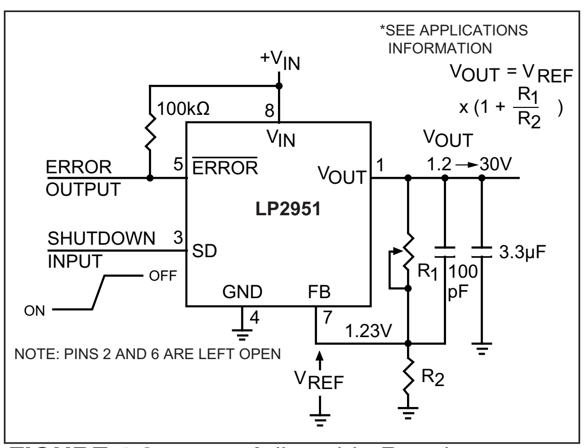


FIGURE 4-2: Adjustable Regulator.

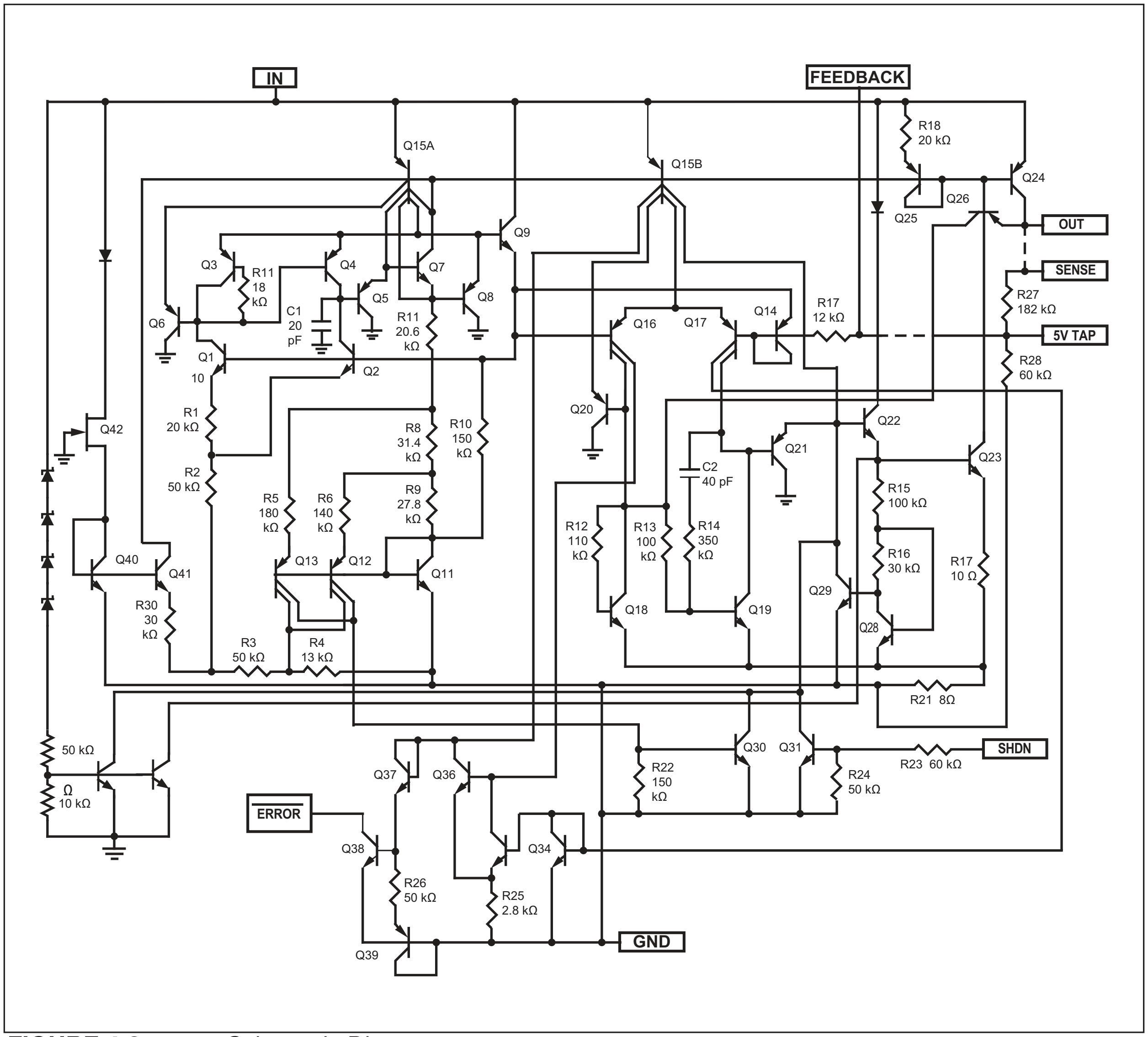
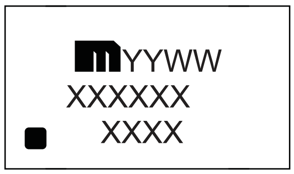


FIGURE 4-3: *Schematic Diagram.*

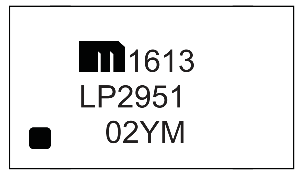
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

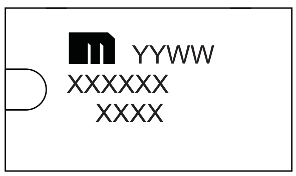
8-Pin SOIC*



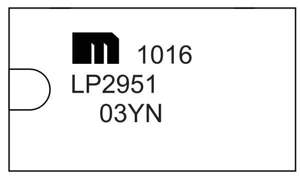
Example



8-Pin Plastic DIP*



Example



Legend:

	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

●, ▲, ▼ Pin one index is identified by a dot, delta up, or delta down (triangle mark).

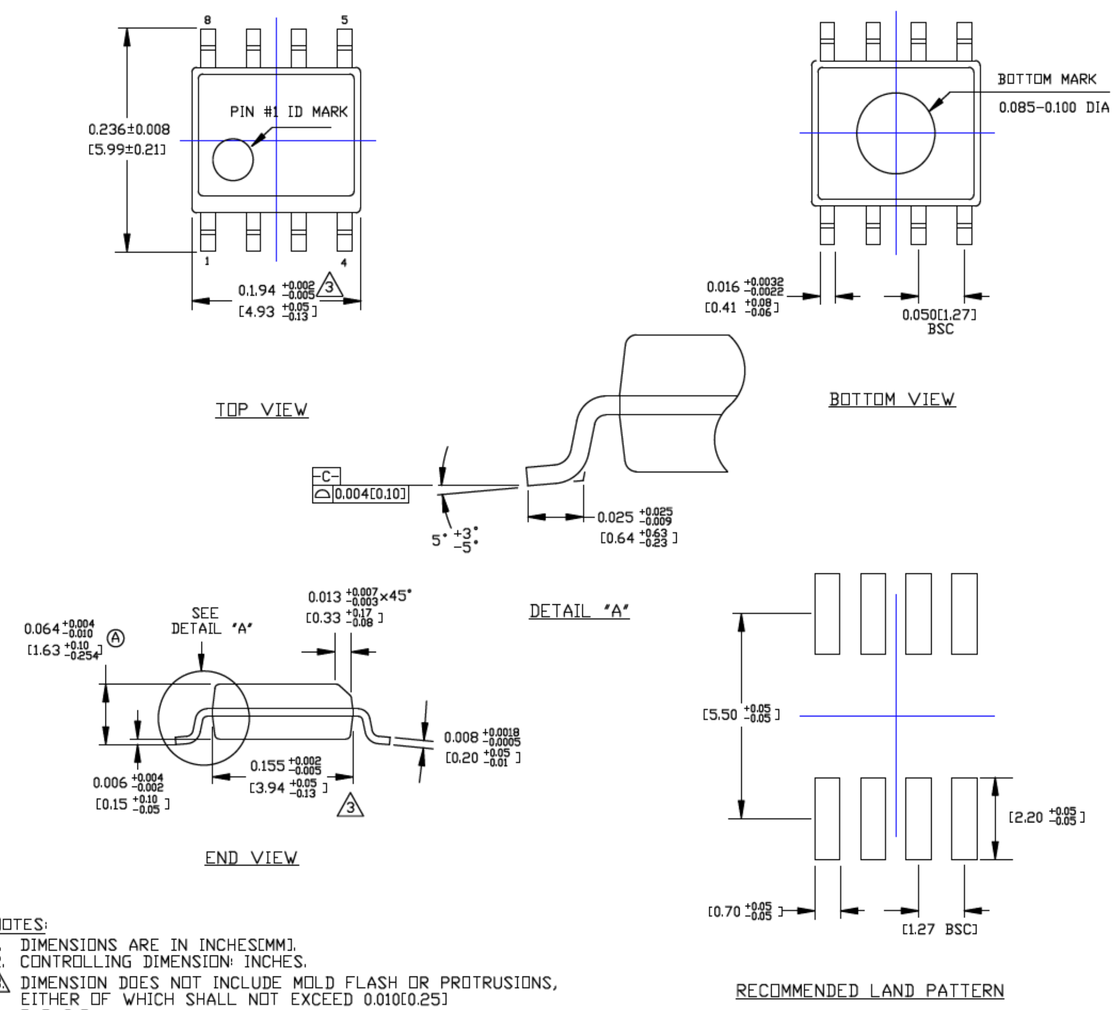
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

TITLE

8 LEAD SOICN PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SOICN-8LD-PL-1	**UNIT**	INCH [MM]



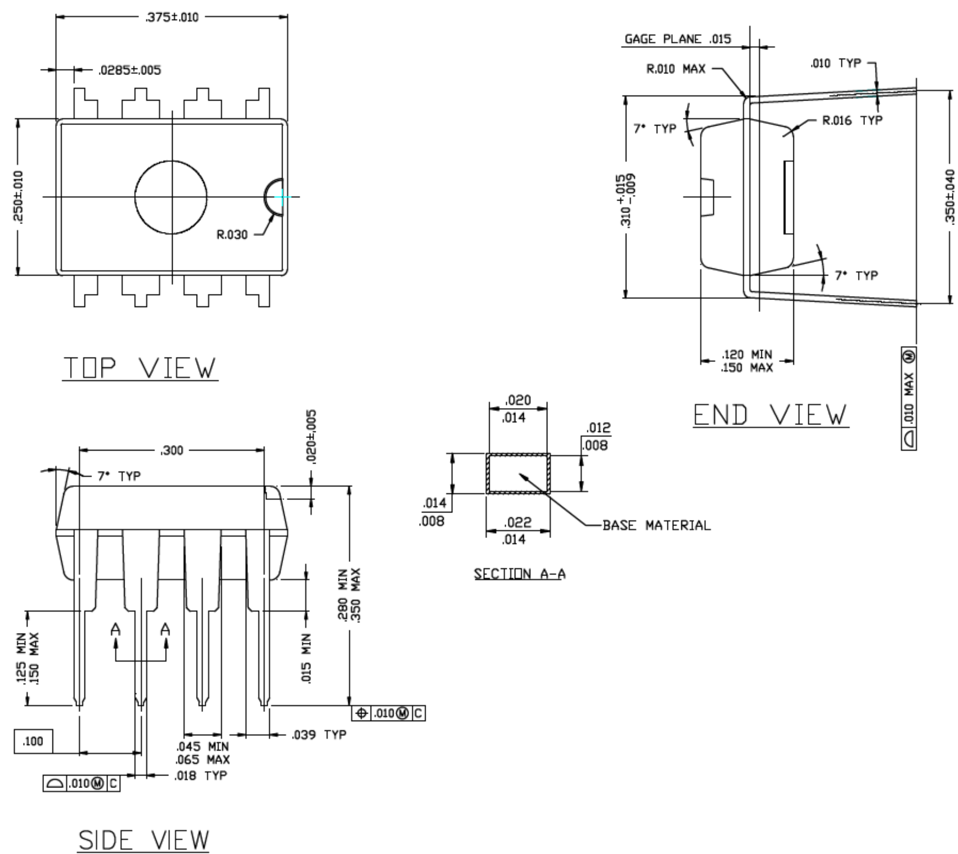
NOTES:

1. DIMENSIONS ARE IN INCHES[MM].
2. CONTROLLING DIMENSION: INCHES.
3. (△3) DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.010[0.25] PER SIDE.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

TITLE
8 LEAD PDIP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	PDIP-8LD-PL-1	**UNIT**	INCH
Lead Frame	Copper	**Lead Finish**	Matte Tin



Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

APPENDIX A: REVISION HISTORY

Revision A (May 2017)

- Converted Micrel document LP2951 to Microchip data sheet template DS20005736A.
- Minor grammatical text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	-X	X	X
Device	Accuracy	Temperature Range	Package

Device:	LP2951:		100 mA Low-Dropout Voltage Regulator
Accuracy:	02 03	= =	0.5% 1.0%
Temperature Range:	Y	=	–40°C to +85°C (RoHS Compliant)
Packages:	M N	= =	8-pin SOIC 8-pin DIP

Examples:

a) LP2951-02YM: 100 mA Low-Dropout Voltage Regulator, 0.5% Accuracy, –40°C to +85°C (RoHS Compliant) 8LD SOIC

b) LP2951-03YM: 100 mA Low-Dropout Voltage Regulator, 1.0% Accuracy, –40°C to +85°C (RoHS Compliant) 8LD SOIC

c) LP2951-02YN: 100 mA Low-Dropout Voltage Regulator, 0.5% Accuracy, –40°C to +85°C (RoHS Compliant) 8LD DIP

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip devices:

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- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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