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150mA ADJUSTABLE VOLTAGE REGULATOR

LP2951A

March 17, 1998

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DESCRIPTION

The LP2951A is an improved version of the LP2951 and features tighter tolerance on the output voltage and reference voltage specifications. Both the LP2951 and LP2951A feature 150mA output current capability. The LP2951 series of low power voltage regulators have low quiescent current and low dropout voltage. The quiescent current increases minimally during dropout conditions thereby extending battery life.

Available in the eight lead SOIC package, the LP2951 series includes features such as shutdown and low output voltage detect (typically due to low battery conditions) . This function may also be used as a power on reset function when triggered by CMOS or TTL inputs. The circuit can be used as a fixed voltage 5 volt regulator or adjusted between 1.24 volts and 29 volts using external resistor pairs.

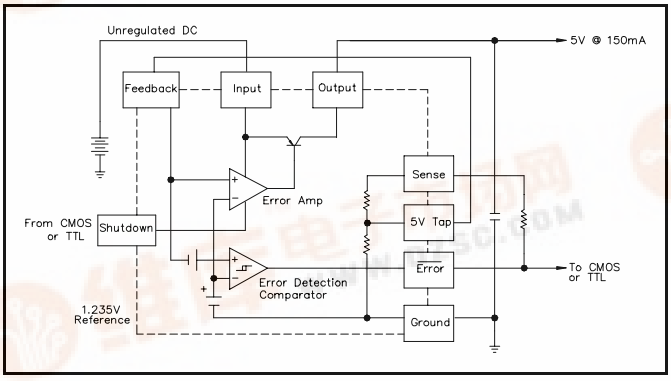
FEATURES

- Guaranteed 150mA current
- Adjustable output voltage - 1.24V to 29V
- Accurate 5V output @150mA
- Low dropout voltage - 450mV @ 150mA
- Regulator or reference functions
- Direct replacement for LP2951AC, MIC2951-02, AS2951AC

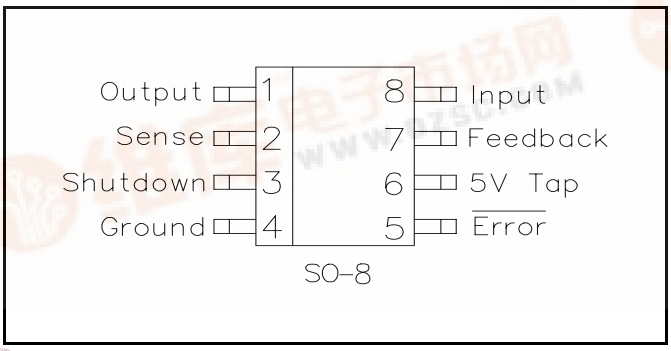
APPLICATIONS

- Microcontroller supplies
- Linear regulators
- Adjustable supplies
- Switching power supplies - post-regulation
- Portable modems
- Battery powered systems
- Cellular telephones
- Voltage references

BLOCK DIAGRAM



PIN CONFIGURATION



ORDERING INFORMATION

DEVICE(1)	V_{OUT} VOLTS	PACKAGE
LP2951ACM	ADJ	SO-8

Note:
(1) Add suffix 'TR' for tape and reel.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Maximum	Units
Supply Voltage	V_{IN}	-0.3 to 30	V
Shutdown Input Voltage		-0.3 to 30	V
Error Comp. Output Voltage		-0.3 to 30	V
Power Dissipation	P_D	Internally Limited	W
Operating Junction Temperature Range	T_J	-40 to 125	°C
Storage Temperature Range	T_{STG}	-65 to 150	°C
Lead Temperature (Soldering) 5 Sec	T_{LEAD}	260	°C

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ELECTRICAL CHARACTERISTICS

Unless specified, limits are over operating temperature range ($T_J = T_A$), $V_{IN} = V_{OUT(NOM)} + 1V$, $I_L = 100\mu A$, $C_L = 1\mu F$

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Output Voltage	V_{OUT}	T_J=25°C, I_L = 100µA	4.975	5.000	5.025	V
Temp Coefficient(1)	T_C	0°C ≤ T_J ≤ 70°C		20	120	ppm/°C
Line Regulation	$REG_{(LINE)}$	6V ≤ V_{IN} ≤ 30V		0.1	0.5	%
Load Regulation	$REG_{(LOAD)}$	100µA ≤ I_L ≤ 150mA		0.1	0.4	%
Dropout Voltage	V_D	I_L = 100µA		80	150	mV
		I_L = 150mA		380	600	
Ground Current	I_{GND}	I_L = 100µA		120	160	µA
		I_L = 150mA		8	14	mA
Dropout Ground Current	$I_{GND(D)}$	V_{IN} = 4.5V, I_L = 100µA		110	250	µA
Current Limit	I_{CL}	V_{OUT} = 0		200	250	mA
Reference Voltage	V_{REF}	V_{REF} ≤ V_{OUT} ≤ (V_{IN} - 1V), T_J = 25°C, 100µA ≤ I_L ≤ 100mA	1.22	1.235	1.25	V
Feedback Bias Current	I_{FB}			20	60	nA
Error Comparator						
Output High Leakage Current		V_{OH} = 30V			2	µA
Output Low Voltage		V_{IN} = 4.5V, I_{OL} = 400µA		150	400	mV
Threshold Voltage		Upper	25	60		mV
		Lower		75	140	
Hysteresis				15		mV
Shutdown Input						
Input Logic Voltage	V_{SD}	Low			0.6	V
		High	2.0			V
Input Current	I_{SD}	$V_{SHUTDOWN}$ = 2.4V			100	µA
		$V_{SHUTDOWN}$ = 30V			750	
Regulator Shutdown Output Current	$I_{O(SD)}$	$V_{SHUTDOWN}$ ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, Feedback pin to Tap 5V			20	µA

NOTES:

(1) Temperature coefficient is defined as the worst case voltage change divided by total temperature range.

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PRINCIPLES OF OPERATION (LP2951 AND LP2951A)

Setting the Output Voltage

The LP2951(A) can be set to deliver any output voltage from 1.24V to 30V by using an external voltage divider. In addition, an internal voltage divider is provided if a 5V output is desired. To use the internal voltage divider, simply connect the sense pin to the output and the tap pin to the feedback pin (see block diagram). When using an external divider the sense and tap pins are left open, and the divider is installed from the output to ground, with its center connected to the feedback pin (see Adjustable Regulator figure below). When using an external voltage divider, resistances can be calculated from the following formula:

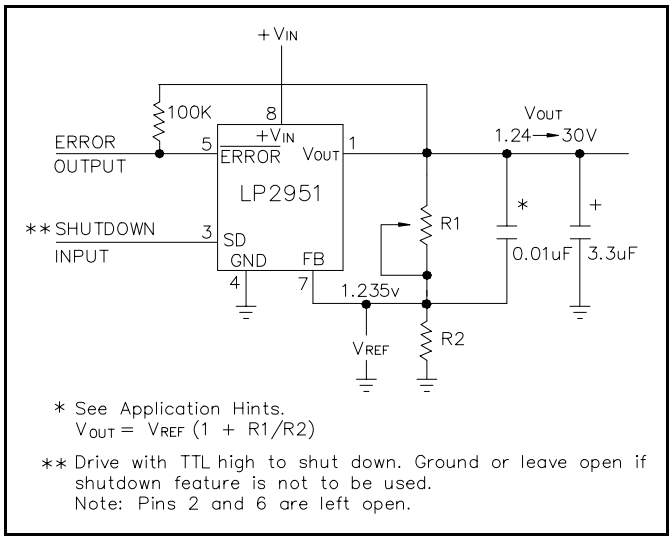
$$V_{OUT} = \left[\left(\frac{1.235}{R2} + 20x10^{-9}\right) x\ R1\right] + 1.235\,V$$

An upper limit of values for R2 occurs at ~1.2MΩ if the regulator is to be operated when completely unloaded, as this allows the feedback divider to provide the 1µA minimum load recommended for the LP2951(A). If the regulator always has a load of 1µA or more connected externally, higher resistor values can be used, but attention must be paid to the -20nA (typical) bias current required by the feedback pin. Using a 1.2MΩ resistor for R2, this bias current will already cause a 2% shift in output voltage between full load and no load. Larger values of R2 exacerbate the problem. Using a 120KΩ resistor for R2 reduces the error caused by feedback bias current to 0.2% while still only requiring 10µA to feed the divider string.

Output Filtering

An output filter capacitor is always necessary with the LP2951(A) in order to assure output stability. The size of this capacitor varies with output voltage (smaller at higher output voltages) and output current (smaller at lower output currents). For 5V operation 1µF is sufficient. For regulator operation at a minimum output voltage, (1.24V) and output currents of 100mA, the required filter increases to 3.3µF. Any type of capacitor may be used, although if aluminum electrolytics are chosen, the equivalent series resistance (ESR) should be held to 5Ω or less. For small load currents the capacitance can be reduced. 0.33µF will be satisfactory for output currents of 10mA or less, and 0.1µF will work if output current is below 1mA.

Theoretically, it is also possible for the regulator to become unstable if very large capacitances (>10,000µF) are connected to the output, but this has not been observed in practice. It is also important that the capacitance be mounted close (1cm or less) to the output pin of the regulator.



Adjustable Regulator

If the lead inductance between the input of the LP2951(A) and its power source exceeds ~500nH (approximately 10”/25cm of 0.031”/0.78mm trace) it may also be necessary to add a filter capacitor between the input terminal and ground. A 1µF tantalum or aluminum capacitor is usually sufficient. Lower values can be used if load currents are small. Noise injection into the feedback terminal of the LP2951(A) from nearby noise sources can also upset the output. Generally this can be cured by the addition of 100pF or so from the feedback terminal to the output.

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PRINCIPLES OF OPERATION (LP2951 and LP2951A) (cont.)

Reducing Output Noise

In ultra-quiet systems, or when the LP2951(A) is being used as a reference, it may be desirable to perform additional output filtering to reduce noise. While this can be done simply using larger capacitors on the output, that solution tends to be bulky and expensive, and eventually, with huge capacitors (>1,000µF) may cause instability in the regulator. Generally, it is more cost-effective to let the regulator regulate output noise away. This can be done by bypassing the upper resistor in the feedback divider with a small capacitor to provide a more direct path for AC feedback. The size of this capacitor can be calculated from the formula:

$$C_{BYPASS} = \frac{1}{2\pi R_1 f_{corner}}$$

where R1 is the upper resistor of the feedback divider and f_{corner} is the frequency above which the increased AC feedback is to become active. Because the gain of the error amplifier in the LP2951(A) begins to roll off at about 300 Hz, this is generally an optimum choice for corner frequency.

The reduction of the output noise will be proportional to the ratio of the two resistors in the feedback divider,

$$\frac{R1}{R1+R2}$$

and will increase 20 dB per decade at frequencies above the corner frequency chosen, up to the frequency where the error amplifier's gain has rolled off to 1 (≈100KHz). In order to maintain regulator stability when using a noise-reducing bypass capacitor, it will also be necessary to increase the size of the output filter capacitor by the ratio

$$\frac{R1}{R1+R2}$$

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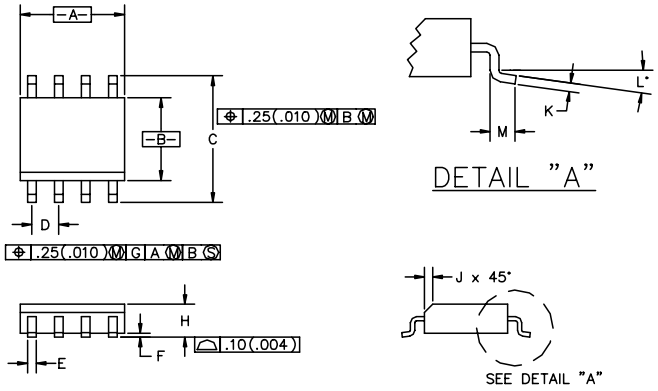
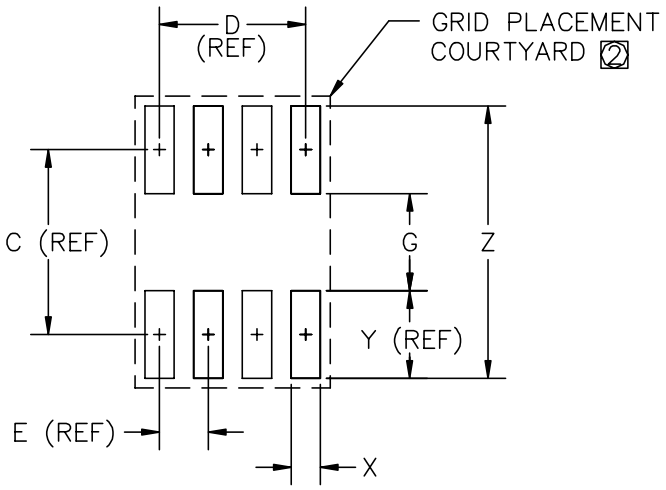
OUTLINE DRAWING SO-8



DIMENSIONS					
DIM	INCHES		MM		NOTE
	MIN	MAX	MIN	MAX	
A	.188	.197	4.80	5.00	
B	.149	.158	3.80	4.00	
C	.228	.244	5.80	6.20	
D	.050	BSC	1.27	BSC	
E	.013	.020	0.33	0.51	
F	.004	.010	0.10	0.25	
H	.053	.069	1.35	1.75	
J	.011	.019	0.28	0.48	
K	.007	.010	.19	.25	
L	0°	8°	0°	8°	
M	.016	.050	0.40	1.27	

LAND PATTERN SO-8



DIMENSIONS (1)					
DIM	INCHES		MM		NOTE
	MIN	MAX	MIN	MAX	
C	–	.19	–	5.00	–
D	–	.15	–	3.81	–
E	–	.05	–	1.27	–
G	.10	.11	2.60	2.80	–
X	.02	.03	.60	.80	–
Y	–	.09	–	2.40	–
Z	–	.29	7.20	7.40	–

(2) GRID PLACEMENT COURTYARD IS 12x16 ELEMENTS (6 mm X 8mm) IN ACCORDANCE WITH THE INTERNATIONAL GRID DETAILED IN IEC PUBLICATION 97.

(1) CONTROLLING DIMENSION: MILLIMETERS