LP2951
Fixed 5.0V or Adjustable 100mA Voltage Regulator

POWER MANAGEMENT

Description

The LP2951 low power voltage regulator has low quiescent current and low dropout voltage. The quiescent current increases minimally during dropout conditions thereby extending battery life.

Available in the 8 lead SOIC package, the LP2951 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 1.235 volts and 29 volts using external resistor pairs.

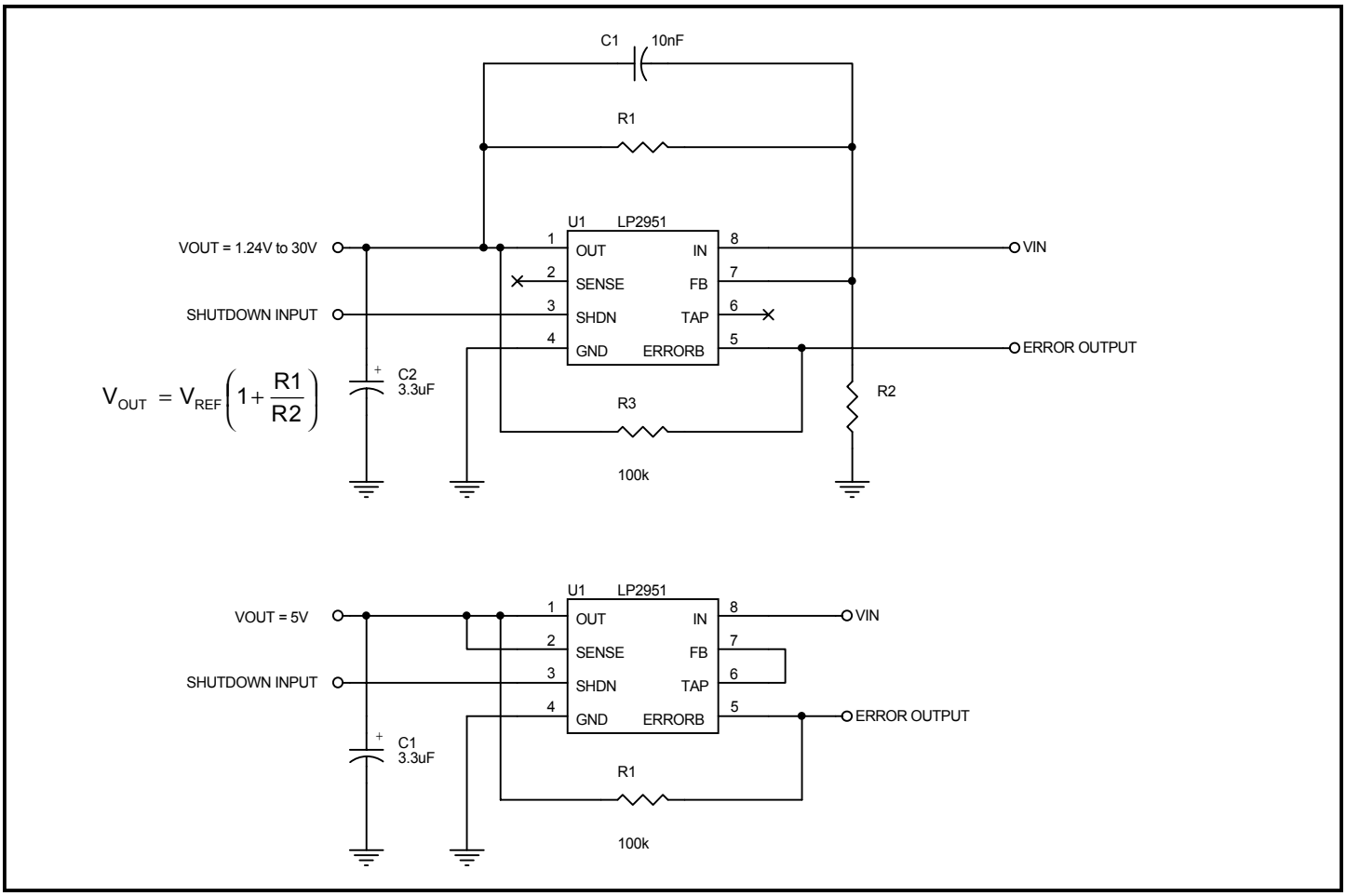
Features

- Guaranteed 100mA current
- Adjustable output voltage - 1.235V to 29V
- Accurate 1.235V reference
- Internally set 5V output optional
- Low dropout voltage - 300mV @ 100mA
- Regulator or reference functions
- Full industrial temperature range
- SO-8 package

Applications

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

Typical Application Circuits



Absolute Maximum Ratings

Exceeding the specifications below may result in permanent damage to the device, or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not implied.

Parameter	Symbol	Maximum	Units
Supply Voltage	V_{IN}	-0.3 to 30	V
Shutdown Input Voltage	V_{SHDN}	-0.3 to 30	V
Error Comp. Output Voltage		-0.3 to 30	V
Power Dissipation	P_D	Internally Limited	W
Thermal Resistance Junction to Case	θ_{JC}	47	°C/W
Thermal Resistance Junction to Ambient(1)	θ_{JA}	65	°C/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}	300	°C

Note:

(1) 2 inch square of 1/16" FR4, double sided, 1oz. minimum copper weight.

Electrical Characteristics(3)

Unless specified: $(V_{OUT(NOM)} + 1V) \le V_{IN} \le 30V$, $100\mu A \le I_{OUT} \le 100mA$, $C_{OUT} = 3.3\mu F$, $T_A = 25°C$.
Values in **bold** apply over full operating temperature range.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Output Voltage	V_{OUT}	V_{IN} = 6V, I_{OUT} = 100µA		5.000		V
Line Regulation	$REG_{(LINE)}$	V_{IN} = 2.235V to 30V, I_{OUT} = 100µA		0.1	**0.8**	%
Load Regulation	$REG_{(LOAD)}$	V_{IN} = 2.235V, I_{OUT} = 100µA to 100mA		0.15	**0.40**	%
Dropout Voltage	V_D	I_{OUT} = 100µA		50	**150**	mV
		I_{OUT} = 100mA		300	**600**	
Ground Pin Current	I_{GND}	V_{IN} = 2.235V, I_{OUT} = 100µA		130	**200**	µA
		V_{IN} = 2.235V, I_{OUT} = 100mA		8	**20**	mA
Dropout Ground Pin Current	$I_{GND(D)}$	$V_{IN} = (V_{OUT(NOM)} - 0.5V)$, I_{OUT} = 100µA		175	**250**	µA
Short Circuit Current Limit	I_{SC}	V_{OUT} = 0V			**250**	mA
Reference Voltage	V_{REF}	V_{IN} = 2.235V, I_{OUT} = 100µA	-1%	1.2350	+1%	V
			-2.5%		**+2.5%**	
Temperature Coefficient(1)(2)	$T_{C(REF)}$	V_{IN} = 2.235V, I_{OUT} = 100µA		**20**	**120**	ppm/°C
Feedback Bias Current(1)	I_{FB}			5	**60**	nA

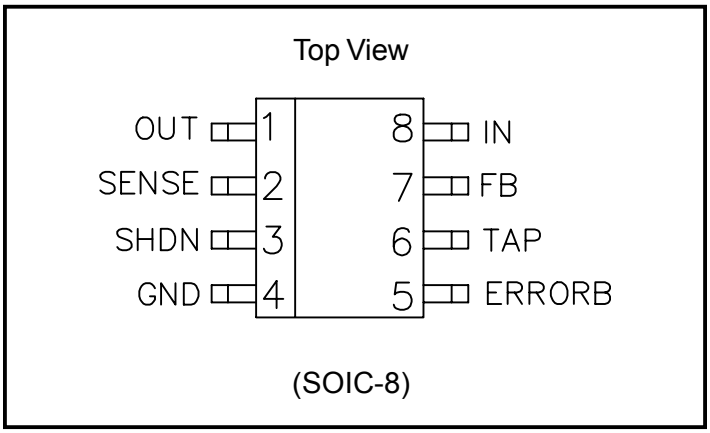
Electrical Characteristics(3) (Cont.)

Unless specified: $(V_{OUT(NOM)} + 1V) \le V_{IN} \le 30V$, $100\mu A \le I_{OUT} \le 100mA$, $C_{OUT} = 3.3\mu F$, $T_A = 25°C$.
Values in **bold** apply over full operating temperature range.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Error Comparator						
Output High Leakage Current	$I_{L(OH)}$	$V_{OH} = 30V$		0.1	**2**	µA
Output Low Voltage	V_{OL}	$V_{IN} = (V_{OUT(NOM)} - 0.5V)$, $I_{OL} = 400\mu A$		225	**500**	mV
Threshold Voltage	V_{TH}	Upper	**25**	90		mV
		Lower		95	**175**	
Hysteresis	V_{HYST}			5		mV
Shutdown Input						
Input Logic Voltage	V_{SHDN}	Low			**0.6**	V
		High	**2.2**			V
Input Current	I_{SHDN}	$V_{SHDN} = 2.4V$		25	**100**	µA
		$V_{SHDN} = 30V$		450	**1000**	
Regulator Shutdown Output Current	$I_{OUT(SHDN)}$	$V_{SHDN} \ge 2V$, $V_{IN} \le 30V$, $V_{OUT} = 0V$, Feedback pin to Tap			**30**	µA

Notes:
(1) Guaranteed by design.
(2) Temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
(3) This device is ESD sensitive. Use of standard ESD handling precautions is required.

Pin Configuration

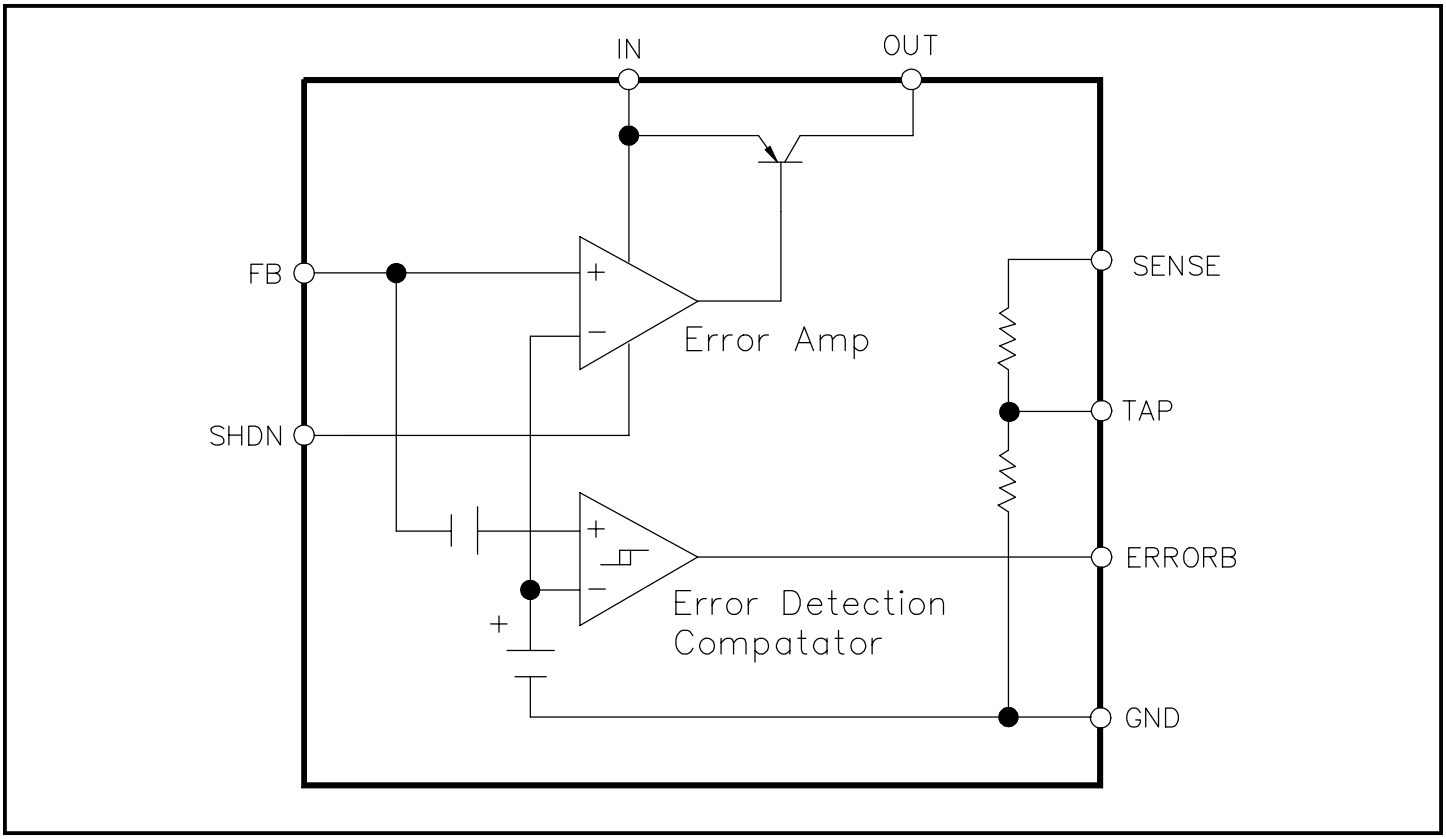


Ordering Information

Device(1)	Output Voltage	Package
LP2951CM.TR	5V/ADJ	SO-8
LP2951CMTRT(2)		

Notes:
(1) Only available in tape and reel packaging. A reel contains 2500 devices.
(2) Lead free product.

Block Diagram



Applications Information

Setting the Output Voltage

The LP2951 can be set to deliver any output voltage from 1.235V 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 Figure 1). When using an external voltage divider, resistances can be calculated from the following formula:

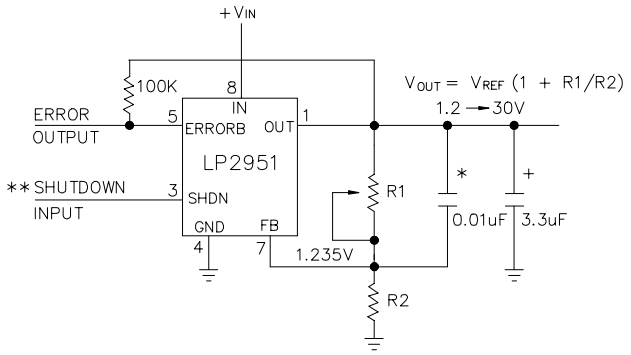
$$V_{OUT} = \left[\left(\frac{1.235}{R2} + 20x10^{-9}\right) x\ R1\right] + 1.235\,V$$

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. 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 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 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, for example, 1µF will be satisfactory for output currents of 30mA or less. Care should be taken to ensure that the minimum capacitance value is maintained over the entire operating temperature range.

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.



* See Reducing Output Noise

** Drive with TTL–high to shut down. Ground or leave open if shutdown feature is not used.
Note: Pins 2 and 6 are left open.

Figure 1: Adjustable Regulator

If the lead inductance between the input of the LP2951 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 electrolytic capacitor is usually sufficient. Lower values can be used if load currents are small. Noise injection into the feedback terminal of the LP2951 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.

Reducing Output Noise

In ultra-quiet systems, or when the LP2951 is being used as a reference, it may be desirable to perform additional output filtering to reduce noise. While this can be done by 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.

Applications Information (Cont.)

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 begins to roll off at about 300Hz, this is generally an optimum choice for corner frequency.

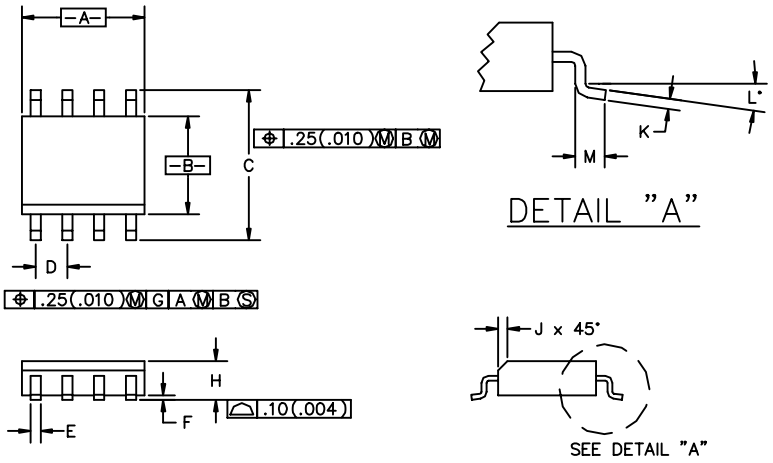
The reduction of the output noise will be proportional to the ratio of the two resistors in the feedback divider:

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

and will increase at a rate of 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:

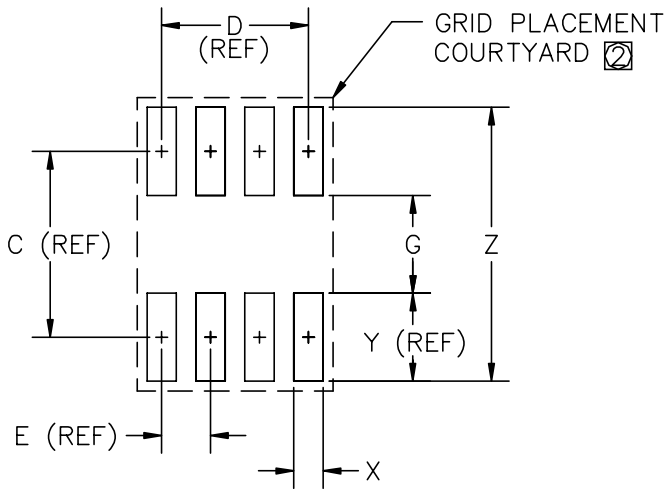
$$\frac{R1}{R1+R2}$$

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

Contact Information

Semtech Corporation
Power Management Products Division
200 Flynn Road, Camarillo, CA 93012
Phone: (805)498-2111 FAX (805)498-3804