LP2950/LP2951 150mA Low Drop Out Voltage Regulators

PRODUCT DESCRIPTION

The LP2950 and LP2951 are low power voltage regulators. These devices are an excellent choice for use in battery powered applications such as cordless telephone, radio control systems, and portable computers.

The LP2950 and LP2951 feature very low quiescent current (75µA Typ.) and very low drop output voltage (Typ. 40µV at light load and 380mV at 100mA). This includes a tight initial tolerance of 0.5% typ., extremely good load and line regulation 0.05% typ. and very low output temperature coefficient, making the LP2950/LP2951 useful as a low power voltage reference. Other key additional feature of this unregulated input voltage transient of -20V below ground (reverse battery).

The error flag output feature is used as power-on reset for warn of a low output voltage, due to following batteries on input. Other feature is the logic compatible shutdown input which enabled\s the regulator to be switched on and off. The LP2950 is offered in 3-pin TO-92 package compatible with other 5 volt regulators. The LP2951 is available in 8-pin plastic, SOP-8 package.

The regulator output voltage may be pin-strapped for a 5 volt of programmed from 1.24 volt to 29 volts with external pair of resistors. Using of as design, processing and testing techniques make our LP2950 and LP2951 superior over similar products.

FEATURES

- Output accuracy 5V, 150mA output
- Very low quiescent current
- Low dropout voltage
- Extremely tight load and line regulation
- Very low temperature coefficient
- Need only 1µF for stability
- Unregulated DC input can withstand -20V reverse battery and +60V positive transients
- Direct replacement for LP2950/LP2951 sockets

LP2951 VERSIONS ONLY

- Error flag warns of output dropout
- Logic-Controlled electronic shutdown
- Output programmable from 1.24 to 29V

ORDERING INFORMATION

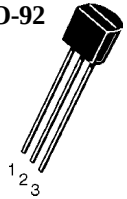
TO-92 3-PIN	PLASTIC SOP 8-PIN	OPER. TEMP.
LP2950CT		IND.
LP2950ACT		IND.
LP2950BCT		IND.
	LP2951CS	IND.
	LP2951ACS	IND.
	LP2951BCS	IND.

APPLICATIONS

- Battery powered systems
- Cordless telephones
- Radio control systems
- Portable/Palmtop/Notebook computers
- Portable consumer equipment
- Portable instrumentation
- Avionics
- Automotive electronics
- SMPS Post-Regulator
- Voltage reference

PIN ARRANGEMENT

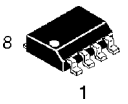
TO-92



PIN: 1. OUTPUT
2. GND
3. INPUT

PIN: 1. OUTPUT
2. SENSE
3. SHUTDOWN
4. GROUND
5. ERROR
6. 5V TAP
7. FEEDBACK
8. INPUT

SOP-8



ABSOLUTE MAXIMUM RATINGS

Power Dissipation ..... Internally Limited
Lead Temp. (Soldering, 5 Seconds) ..... 260°C
Storage Temperature Range ..... -65 to +150°C
Operating Junction Temperature Range
LP2951 ..... -55 to +150°C
LP2950BC/LP2950AC/LP2950C
LP2951BC/LP2951AC/LP2951C ... -40 to +125°C

Input Supply Voltage ..... -20 to +60V
Feedback Input Voltage ..... -1.5 to +30V
Shutdown Input Voltage ..... -0.3 to +30V
Error Comparator Output ..... -0.3 to +30V
ECD Rating is to be determined

ELECTRICAL CHARACTERISTICS (V_{in} = 15V, T_A = 25°C unless otherwise noted)

PARAMETER	CONDITIONS (Note 2)	LP2950BC LP2951BC			LP2950AC LP2951AC			LP2950C LP2951C			UNITS
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Output Voltage	T_J = 25°C -25°C ≤ T_J ≤ 85°C Full Operating Temp.	4.98 4.95 4.94	5.0	5.02 5.05 5.06	4.975 4.95 4.94	5.0	5.025 5.05 5.06	4.95 4.93 4.94	5.0	5.05 5.075 5.085	V
Output Voltage	100µA ≤ I_L ≤ 100mA T_J ≤ T_{JMAX}	4.93		5.07	4.93		5.07	4.925		5.075	V
Output Voltage Temperature Coefficient	(Note 1)		20			20			50		ppm/°C
Line Regulation (Note 3)	6V ≤ V_{in} ≤ 30V (Note 4)		0.03	0.2		0.03	0.2		0.04	0.2	%
Load Regulation (Note 3)	100µA ≤ I_L ≤ 100mA		0.04	0.1		0.04	0.1		0.1	0.2	%
Dropout Voltage (Note 5)	I_L = 100µA I_L = 100mA I_L = 150mA		40 250 300	80 300 450		40 250 300	80 300 450		40 250 300	80 300 450	mV mV mV
Ground Current	I_L = 100µA I_L = 100mA I_L = 150mA		75 1.7 4	120 2.5 6		75 1.7 4	120 2.5 6		75 1.7 4	120 2.5 6	µA mA mA
Dropout Ground Current	V_{in} = 4.5V I_L = 100µA		110	170		110	170		110	170	µA
Current Limit	V_{out} = 0		160	200		160	200		160	200	mA
Thermal Regulation			0.05	0.2		0.05	0.2		0.05	0.2	%W
Output Noise, 10Hz to 100kHz	C_L = 1µF I_L = 200µF I_L = 13.3µF (Bypass = 0.01µF pins 7 to 1 (LP2951))		430 160 100			430 160 100			430 160 100		µVms
8-Pin Versions only			LP2951BC			LP2951AC			LP2951C		
Reference Voltage		1.22	1.235	1.25	1.22	1.235	1.25	1.216	1.235	1.254	V
Reference Voltage	Over Temp. (Note 6)	1.19		1.27	1.19		1.27	1.18		1.28	V
Feedback Pin Bias Current			20	40		20	40		20	40	nA
Reference Voltage Temperature Coefficient	(Note 7)		20			20			50		ppm/°C
Feedback Pin Bias Current Temperature Coefficient			0.1			0.1			0.1		nA/°C

PARAMETER	CONDITIONS (Note 2)	LP2950BC LP2951BC			LP2950AC LP2951AC			LP2950C LP2951C			UNITS
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
ERROR Comparator											
Output Leakage Current	V_{oh} = 30V		0.01	1		0.01	1			1	µA
Output Low Voltage	V_{in} = 4.5V I_{ol} = 400µA		150	250		150	250		150	250	mV
Upper Threshold Voltage	(Note 8)	40	60		40	60		40	60		mV
Power Threshold Voltage	(Note 8)		75	95		75	95		75	95	mV
Hysteresis	(Note 8)		15			15			15		mV
Shutdown Input											
Output Logic Voltage	Low (Regulator ON) High (Regulator OFF)	2	1.3	0.7	2	1.3	0.7	2	1.3	0.7	V
Shutdown Pin Input Current	V_S = 2.4V V_S = 30V		30 450	50 600		30 450	50 600		30 450	50 600	µA
Regulator Output Current in Shutdown	V_{out} = 0		3	10		3	10		3	00	µA

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

Note 2: Unless otherwise specified all limits guaranteed for T_J=25°C, V_{in}=6V, I_L=100µA and C_L=100µF. Additional conditions for the 8-pin versions are feedback tied to 5V tap output Sense (V_{out}=5V) and $V_{shutdown}$≤0.8V.

Note 3: 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 under the specification for thermal regulation.

Note 4: Line regulation for the LP2951 is tested at 150°C for I_L=1mA. For I_L=100µA and T_J=150°C, line regulation is guaranteed by design to 0.2%. See typical performance characteristics for line regulation versus temperature and load current.

Note 5: Dropout Voltage is defined as the input to output differential at which the output voltage drops 100mV below its nominal value measured at 1V differential at very low value of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

Note 6: $V_{ref} \leq V_{out} \leq (V_{in}-1V)$, $2.3V \leq V_{in} \leq 30V$, $100\mu A \leq I_L \leq 100mA$, $T_J \leq T_{JMAX.}$

Note 7: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 8: Comparator thresholds are expressed in terms of a voltage differential at the feedbackterminal 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=Vout/Vref=(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 95mV X 5V/1.235=384mV. Thresholds remain constant as a percent of Vout as Vout is varied with the dropout warning occuring at typically 5% below nominal, 7.5% guaranteed.

Note 9: $V_{shutdown} \geq 2V$, $V_{in} \leq 30V$, V_{out} = 0, Feedback pin tied to 5V Tap.

APPLICATION HINTS EXTERNAL CAPACITORS

External Capacitors

For the stability of the LP2950/LP2951 requires a 1.0 μF or greater capacitor between output and ground. Oscillation could occur without this capacitor. The tantalum or aluminum electrolytic works fine; could use the fiLP type but are not cost efficient. For the operation of below -25℃ solid tantalum is recommended since the many aluminum type have electrolytes the freeze at about -30℃. The ESR of about 5Ω or less and resonant frequency above 500kHz are most important parameter in the value of Capacitor. The Capacitors value can be increased without any limit.

At lower values of output current, less output capacitance is required for stability. For the currents below 10 mA the value of capacitor can be reduce to 0.33μ F and 0.1μ F for 1mA. More output capacitance needed for the 8-pin version at voltage below 5V since it runs the error amplifier at lower gain. At worst case 3.3μ F or greater must be used for condition of 100mA load at 1.235V output .

The LP2950 not like other low dropout regulators will remain stable and regulation with no load in addition to the internal voltage divider. This feature very important in application like CMOS RAM keep-alive. The LP2951 output voltage setting with minimum load of 1 μ A and external resistors.

If at the input of LP2950/LP 2951 connected to battery or between AC filter capacitor and input is 10 inches wire then 1μ F tantalum or aluminum electrolytic capacitor should be connected between input and ground .

Instability can occur if stray capacitor to feedback terminal pin 7 of the LP2951. This could cues more problem more when using higher value of external to set the output voltage . To fix this problem the 100 pF capacitor between output and feedback and increasing output capacitance to 3.3μ F.

ERROR DETECTION COMPARATOR OUTPUT

The Compactor produces a logic low output whenever the LP2951 output falls of regulation by more than around 5% . This is around 60 mV offset divided by the 1.235 reference voltage. Thus trip remains 5% below nominal regardless of the programmed output voltage of the regulator . the figure 1 shows the timing diagram depicting the ERROR signal and the regulator output voltage as the LP2951 input is ramped up and down . the ERROR signal becomes low at around 1.3 V input , it goes high around 5Volt input , (input voltage at which Vout = 4.75). The LP2951 dropout voltage depending on the load , the input voltage trip point around 5 volt will vary with load current. The output voltage trip point is around 4.75 volt it does not change with load.

The error comparator has an open-collector output which requires an external pull-up resistor. Depending on the system requirement the resistor maybe returned to 5 volt output or other supply voltage depending to the system requirements. For determining the size of the resistor, note that the output is sinking 400μ A , this value adds to battery drain in a low better condition, recommended values 100K to 1MΩ. If the output is unused this resistor is not required.

PROGRAMMING THE OUTPUT VOLTAGE OF LP2951

The LP2951 output voltage is programmable for any value from it's reference voltage of 1.235 volt and it maximum rating of 30 volt . For example for 5 volt needs to pin-strapped and using the internal voltage divider by tying pin 1 to 2 and pin 7 to pin 6. Refer to Figure 2, there are two external resistor required for this programming .

Refer to the below equation for the programming the output voltage:

Volt = V_{ref} x (1+R_1\R_2)+$I_{FB}R_1$

The V_{ref} is 1.235 and I_{FB} is the feedback bias current , nominally -20 nA. The minimum recommended load current of 1 μ A forces an upper limit of 1.2MΩ on value of R_2 , If no load presented the I_{FB} produces error of typically 2% in Vout which maybe eliminated at room temperature by trimming R_1 . To improve the accuracy chooses the value of R2 =100K and this reduces the error by 0.17% and increases the resistor program current by 12 μ A . The LP2951 typically draw 60 μ A at no load with pin 2 open-circuit,and this value does not look much .

REDUCING OUTPUT NOISE

It could be an advantage to reduce the AC noise present at the output One way is to reduce the regulator bandwidth by increasing the value of the output capacitor . this is the only method that noise could reduce on the LP 2950 but is relatively inefficient , as increasing capacitor from 1 μ F to 220 μ F only decreases the noise from 430 μ V to 160 μ V rms . for a 100 kHz bandwidth at 5 volt output .

Noise could be also reduce by fourfold by a bypass capacitor across R_1 since it reduces the high frequency gain from 4 to unity . pick CBYPASS = 1 / 2π R1 x 200Hz or choose 0.01 μ F . When doing this, the output capacitor must be increased to 3.3 μ F to maintain stability . These changes the output noise from 430 μ V rms . for a 100 kHz bandwidth 5 volt output . With the bypass capacitor added , noise no longer scales with output voltage so that improvements are more dramatic higher output voltage .

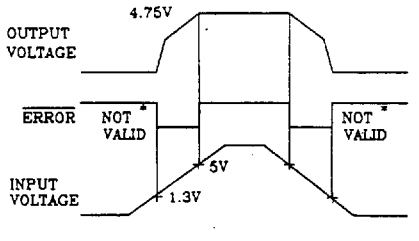


FIGURE 1. $\overline{\text{ERROR}}$ Output Timing

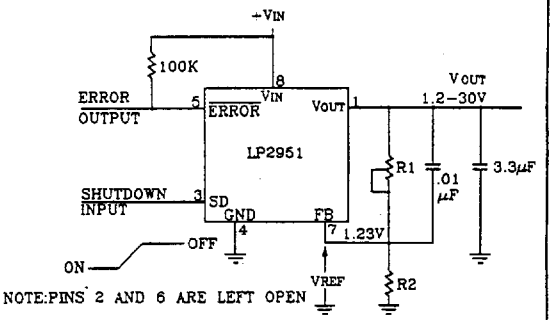
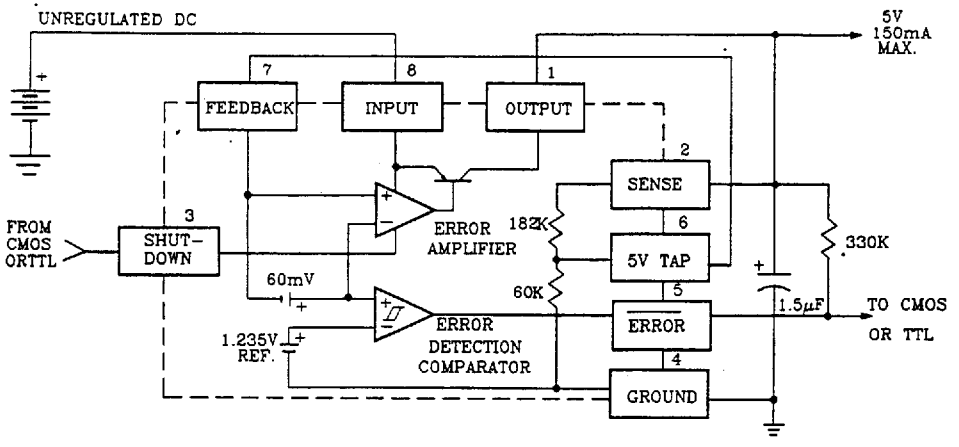


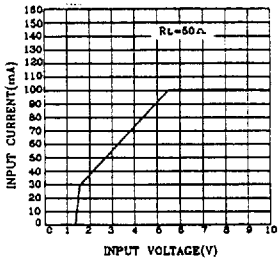
FIGURE 2.Adjustable Regulator

BLOCK DIAGRAM AND TYPICAL APPLICATIONS

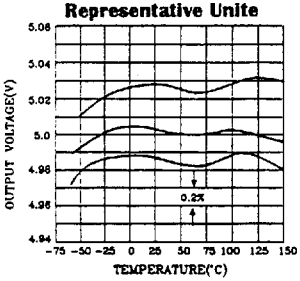


Typical Performance Characteristics

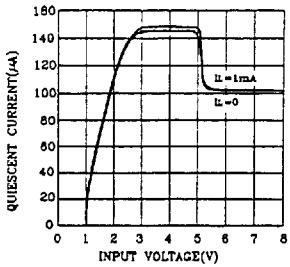
Input Current



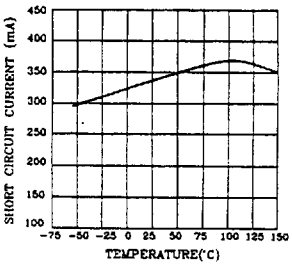
Output Voltage vs. Temperature of 3 Representative Units



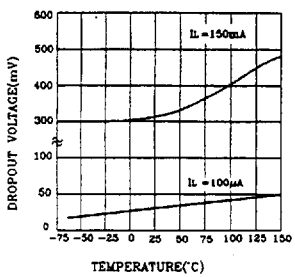
Ground Pin Current



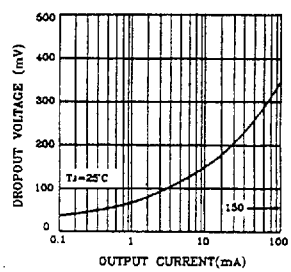
Short Circuit Current



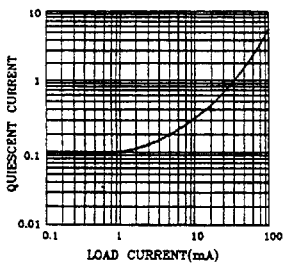
Dropout Voltage



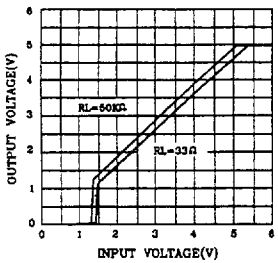
Dropout Voltage



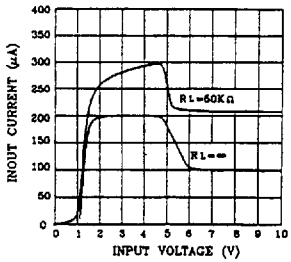
Ground Pin Current



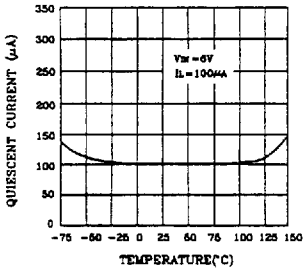
Dropout Characteristics



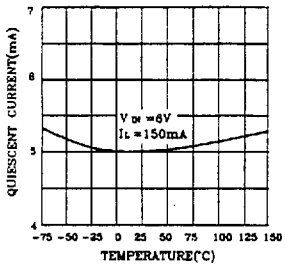
Input Current



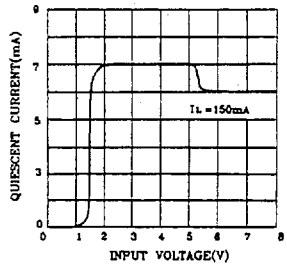
Ground Pin Current



Ground Pin Current

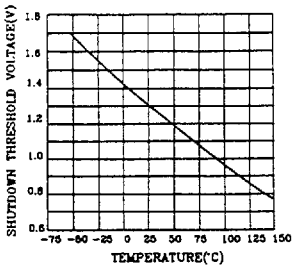


Ground Pin Current

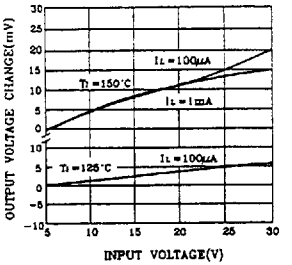


Typical Performance Characteristics

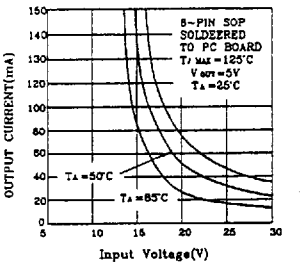
Shutdown Threshold Voltage



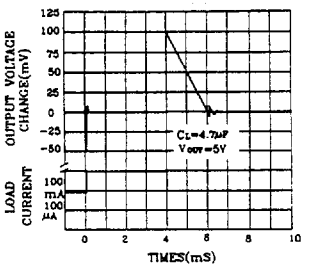
Line Regulation



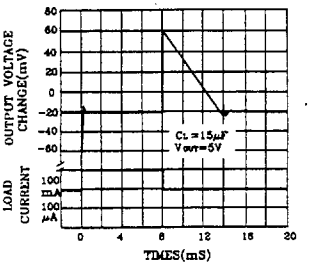
Maximum Rated Output Current



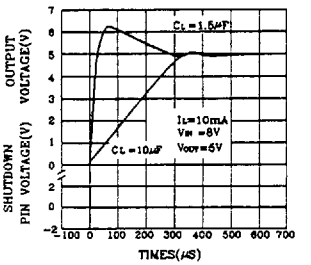
Load Transient Response



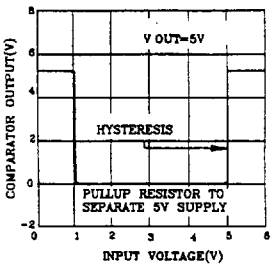
Load Transient Response



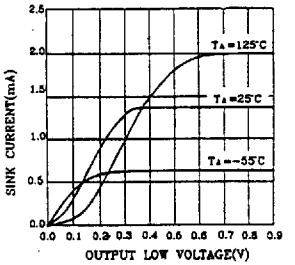
Enable Transient



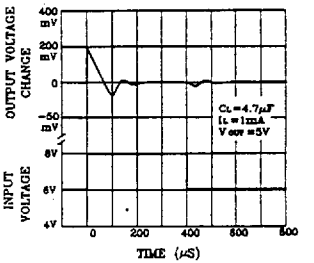
Error Comparator Output



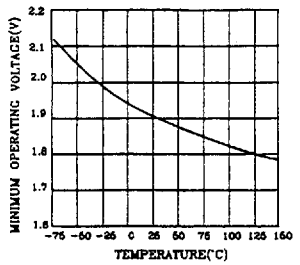
Comparator Sink Current



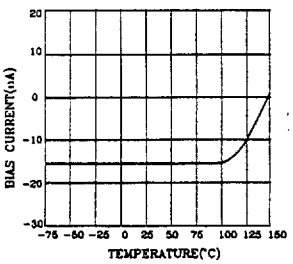
Line Transient Response



Minimum Operating Voltage



Feedback Bias Current



Feedback Pin Current