LP2950-3.3/LP2951-3.3 150mA Low Drop Out Voltage Regulator

The LP2950-3.3 and LP2951-3.3 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 LP2950-3.3 and LP2951-3.3 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 LP2950-3.3/LP2951-3.3 useful as a low power voltage reference. 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 enable the regulator to be switched on and off. The LP2950-3.3 is offered in 3-pin TO-92 package compatible with other 3.3 volt regulators. The LP2951-3.3 is available in 8-pin plastic, SOP-8 package.

The regulator output voltage may be pin-strapped for a 3.3 volt of programmed from 1.24 volt to 29 volts with external pair of resistor. Using of as design, processing and testing techniques make our LP2950-3.3 and LP2951-3.3 superior over similar products.

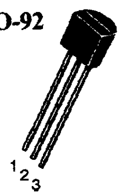
FEATURES

Output accuracy 3.3V, 150mA output
Very low quiescent current
Low dropout voltage
Extremely tight load and line regulation
Very low temperature coefficient
Need only 1μF for stability
Error Flag warns of output dropout
Logic-Controlled electronic shutdown
Output programmable from 1.24 to 29V

APPLICATIONS

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

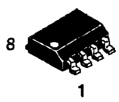
TO-92



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℃
Storage Temperature Range .... -65 to +150℃
Input Supply Voltage ....-0.3 to +30V
Feedback Input Voltage .... -1.5 to +30V
Shutdown Input Voltage .... -0.3 to +30V
Error Comparator Output........................ -0.3 to +30V

ELECTRICAL CHARACTERISTICS(Vin=15V, T_A=25℃,unless otherwise noted)

PARAMETER	CONDITIONS	LP2950-3.3BC LP2951-3.3BC			LP2950-3.3AC LP2951-3.3AC			LP2950-3.3C LP2951-3.3C			UNITS
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Output Voltage	T_J=25℃ -25℃≦T_J≦85℃ Full Operating Temp	3.283 3.267 3.26	3.3	3.317 3.333 3.340	3.267 3.267 3.26	3.3	3.333 3.333 3.340	3.250 3.234 3.234	3.3	3.35 3.366 3.366	V
Output Voltage	100μA≦I_L≦100mA T_J≦T_{JMAX}	3.218		3.350	3.218		3.350	3.218		3.379	V
Output Voltage Temperature Coefficient	(Note 1)		50	150		50	150		50	150	ppm/℃
Line Regulation (Note 3)	4.3V≦Vin≦30V (Note 4)		0.04	0.4		0.04	0.4		0.04	0.4	%
Load Regulation (Note 3)	100μA≦I_L≦100mA		0.1	0.3		0.1	0.3		0.1	0.3	%
Dropout Voltage (Note 5)	I_L=100μA I_L=100mA		50 380	80 450		50 380	80 450		50 380	80 450	mV
Ground Current	I_L=100μA I_L=100mA		75 8	120 12		75 8	120 12		75 8	120 12	μA mA
Dropout Ground Current	Vin=2.8V, I_L=100μA		110	170		110	170		110	170	μA
Current Limit	Vout=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~100KHz	C_L=1μF C_L=200μF C_L=3.3μF (Bypass=0.01μF, Pin 7 to Pin 1 LP2951-3.3)		430 160 100			430 160 100			430 160 100		μVrms
8-Pin Version Only		**LP2951BC**			**LP2951AC**			**LP2951C**			
Reference Voltage		1.21	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	
Feedback Pin Bias Current			20	40		20	40		20	40	nA

Reference Voltage Temperature Coefficient	(Note 7)		50			50			50		ppm/℃
Feedback Pin Bias Current Temperature Coefficient			0.1			0.1			0.1		nA/℃
ERROR Comparator											
Output Leakage Current	Voh=30V		0.01	1.0		0.01	1.0		0.01	1.0	μA
Output Low Voltage	Vin=4.5V I_{OL}=400μA		150	250		150	250		150	250	mV
Upper Threshold Voltage	(Note 8)	40	60		40	60		40	60		mV
Lower Threshold Voltage	(Note 8)		75	95		75	95		75	95	mV
Hysteresis	(Note 8)		15			15			15		mV
Shutdown Input											
Input Logic Voltage	Low (Regulator on) High(Regulator off)	 2	1.3	0. 7		1.3	0.7		1.3	0.7	V
Shutdown Pin Input Current	Vs=2.4V Vs=30V		30 450	50 600		30 450	50 600		30 450	50 600	μA
Regulator Output Current in Shutdown	Vout=0		3	10		3	10		3	10	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 ail limits guaranteed for T_J=25℃, Vin=4.3V,I_L=100μA and C_L=100μF. Additional conditions for the 8-pin versions are feedback tied to 3.3V tap output Sense (V_{out}=3.3V) and $V_{shutdown}$≦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 LP2951-3.3 is tested at 150℃ for 1mA. For I_L=100μA and T_J=150℃, 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}≦V_{out}≦(V_{in}-1V), 2.3V≦V_{in}≦30V,100μA≦I_L≦100mA, T_J≦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 feedback terminal below the nominal reference voltage measured at 4.3V input . To express these thresholds in terms of output voltage change, multiply by the error amplifier gain=V_{out}/V_{ref}=$(R_1+R_2)/R_2$. For example, at a programmed output voltage of 5V, the Error output is guaranteed to go low when the output drops by 95mVX5V/1.235=384 m V. 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.

Note 9: $V_{shuntdown}$≧2V, V_{in}≦30V, V_{out} = 0, Feedback pin tied to 3.3V Tap.

APPLICATION HINTS EXTERNAL CAPACITORS

For the stability of the LP2950/LP2951 requires a 1.0μF or greater capacitor between output and ground. Oscillation could occur without this capacitor. The tantalum or aluminum electrolytic works fine; could use the film 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 50Ω 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 0.33μF and 0.1μF 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 For 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 1μA and external resistors.

If at the input of LP2950/LP2951 connected to battery or between AC filter capacitor and input is 10 inches wire then 1μF 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 100pF capacitor between output and feedback and increasing output capacitance to 3.3μF.

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 60mV 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 400μA , 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 $=V_{ref} \times (I+R_1/R_2)+I_{FB}R_1$ .The V_{ref} is 1.235 and I_{FB} is the feedback bias current, nominally -20nA. The minimum recommended load current of 1μA 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 R_2 =100K and this reduces the error by 0.17% and increases the resistor program current by 12μA. The LP2951 typically draw 60μA 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 1μF to 220μF only decreases the noise from 430μV to 160 μVrms 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= $1 / 2\pi R_1 \times 200$Hz or choose 0.01 μF . When doing this the output capacitor must be increased to 3.3 μF to maintain stability. These-changes the output noise from 430 μVrms 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.

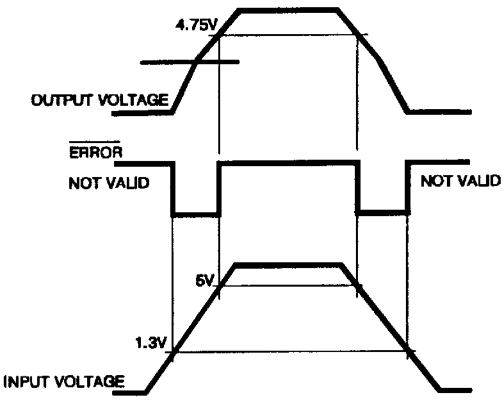


Figure 1. ERROR Output Timing

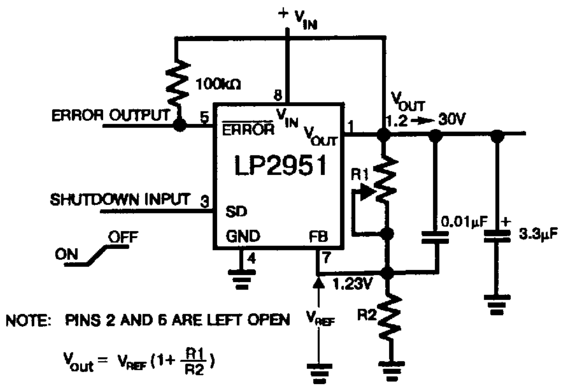


Figure 2. Adjustable Regulator

TYPICAL PERFORMANCE CHARACTERISTICS

Figure 1. Quiescent Current

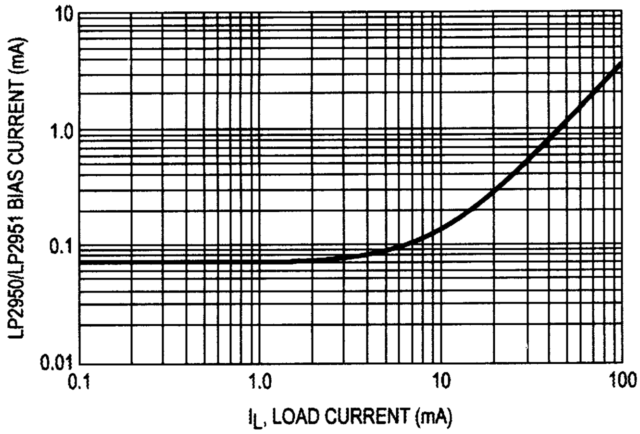


Figure 2. Dropout Characteristics

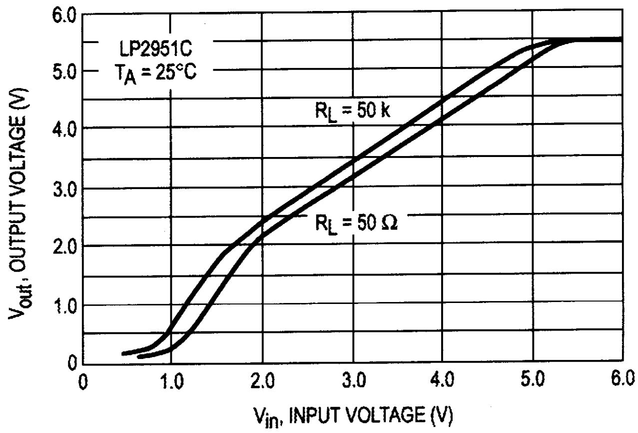


Figure 3. Input Current

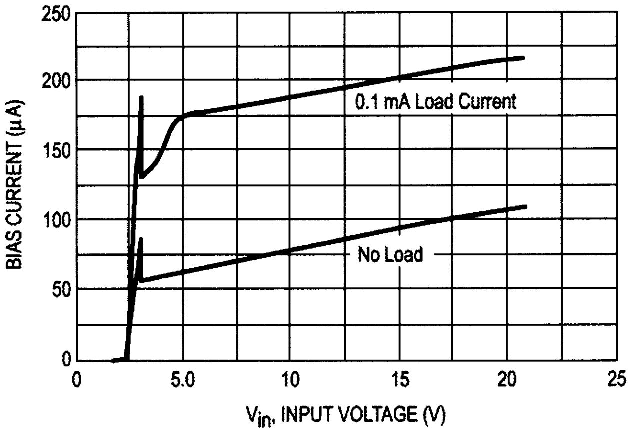


Figure 4. Output Voltage versus Temperature

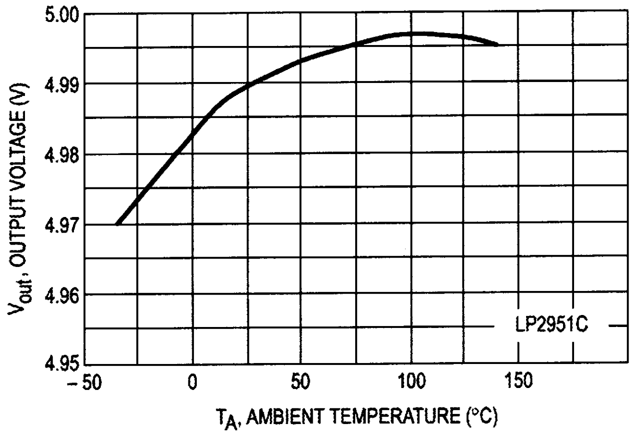


Figure 5. Dropout Voltage versus Output Current

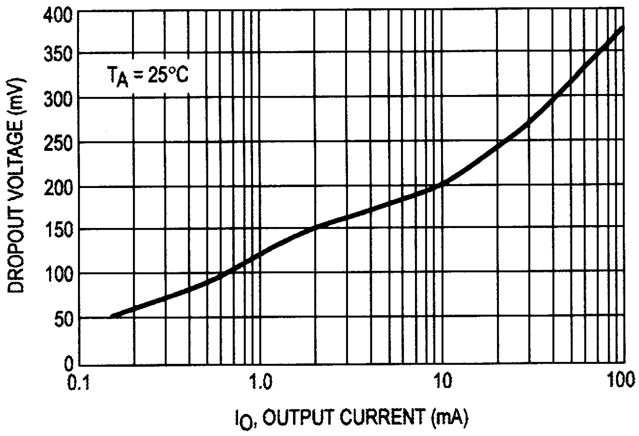


Figure 6. Dropout Voltage versus Temperature

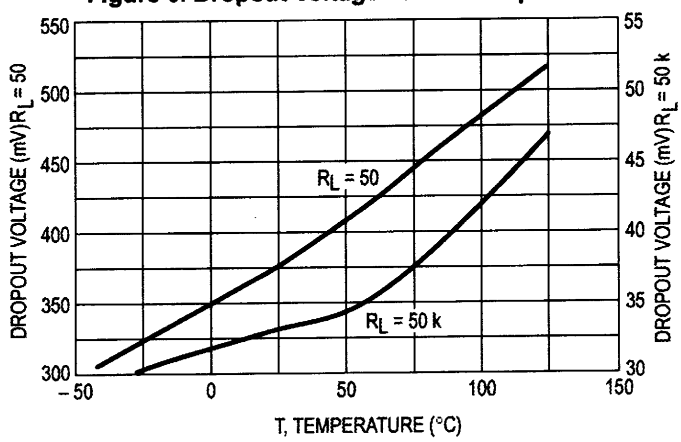


Figure 7. Error Comparator Output

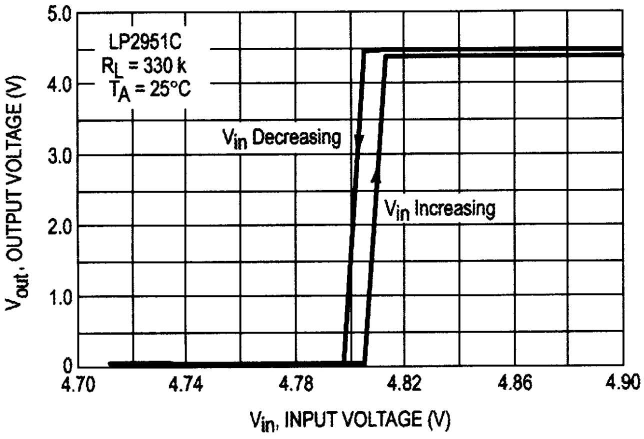


Figure 8. Line Transient Response

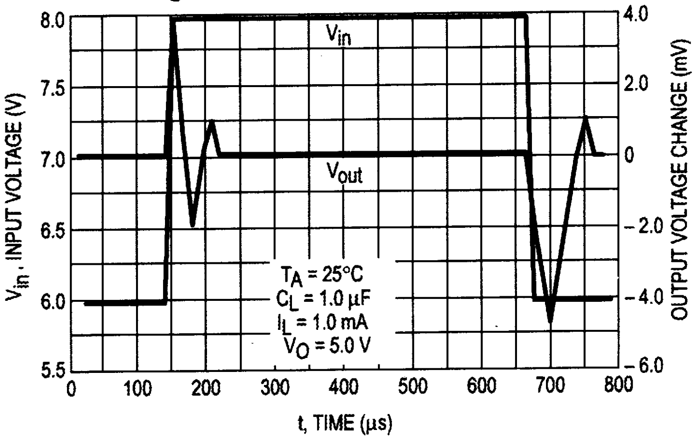


Figure 9. LP2951 Enable Transient

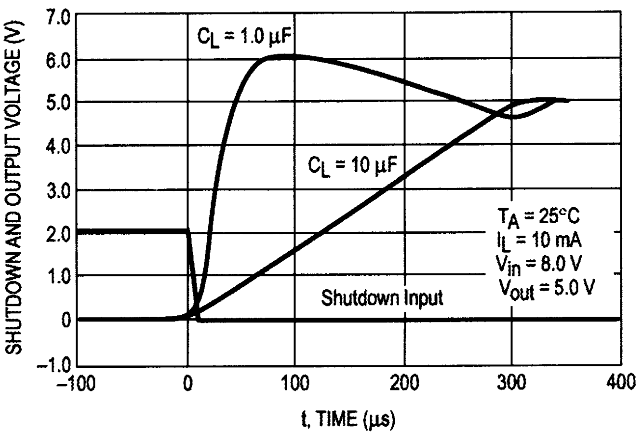


Figure 10. Load Transient Response

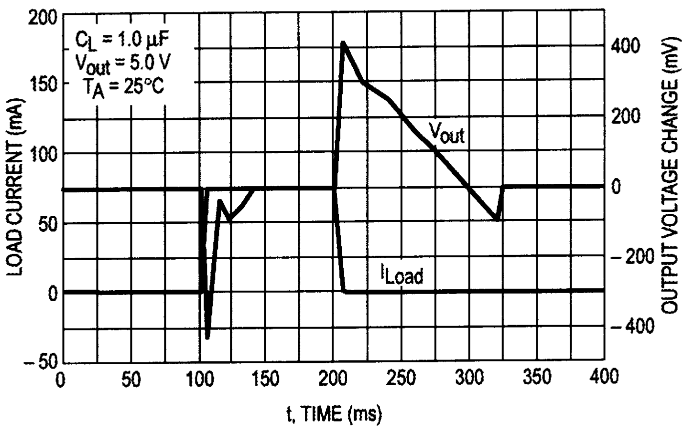


Figure 11. Ripple Rejection

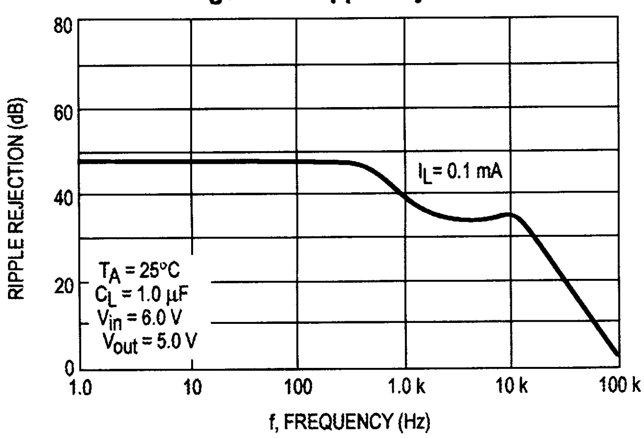


Figure 12. Output Noise

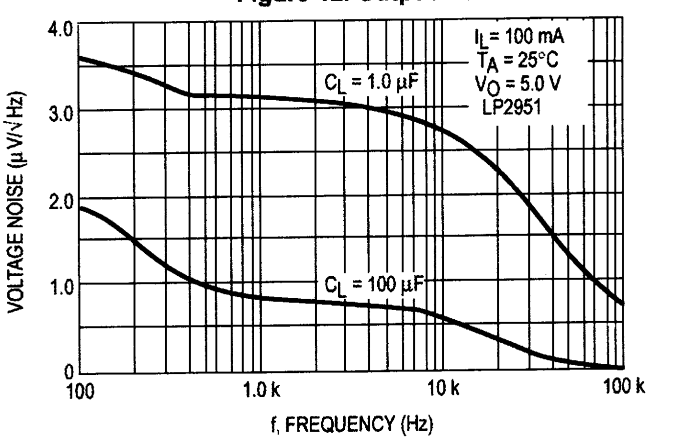


Figure 13. Shutdown Threshold Voltage versus Temperature

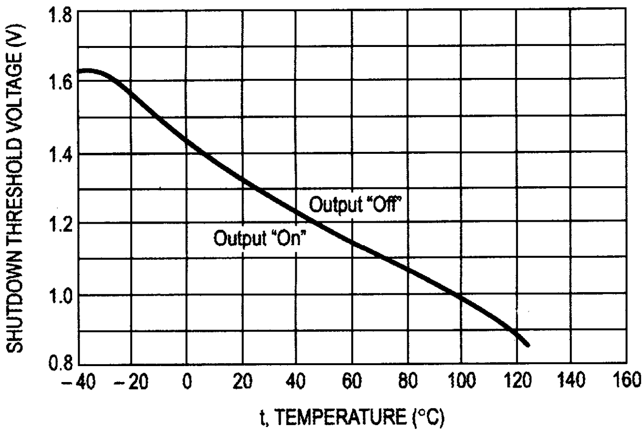
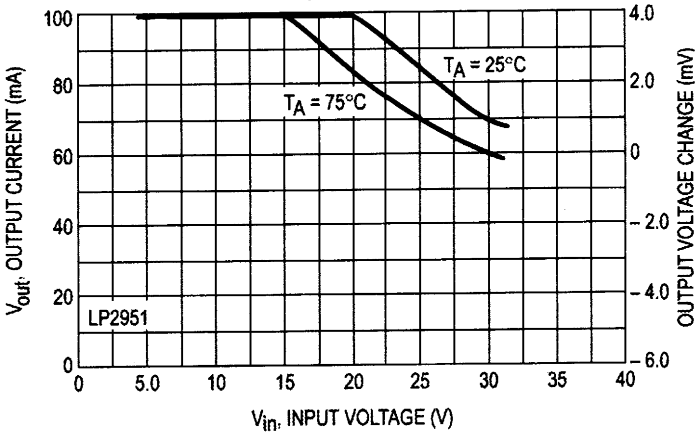


Figure 14. Maximum Rated Output Current



ORDERING INFORMATION

DEVICE	TOLERANCE	OPERATING TEMPERATURE RANGE	PACKAGE
LP2590-3.3BCZ	0.5%	-40℃~125℃	TO-92
LP2950-3.3ACZ	1%		
LP2950-3.3CZ	2%		
LP2951-3.3BCD	0.5%		SOP-8
LP2591-3.3ACD	1%		
LP2951-3.3CD	2%		