GL2950/ GL2951

100mA LOW DROPOUT VOLTAGE REGULATOR

Description

The GL2950 and GL2951 are low power voltage regulators. These device excellent choice for use in battery powered application such as cordless telephone, radio control systems, and portable computers.

The GL2950/GL2951 features very low quiescent current (75uA Typ.) and very low drop output voltage (Typ. 40mV at light load and 380mV at 100mA). This includes a tight initial tolerance of 0.5% typ., extremely good load and line regulation of 0.05% typ., and very low output temperature coefficient, making the GL2950/ GL2951 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 GL2951 is available in 8-pin plastic packages. The regulator output voltage may be pin-strapped for a -XX volt or programmed from 1.24 volt to 29 volts with external pair of resistors.

The GL2950 is offered in 3-pin TO-92 package compatible with other fixed regulator.

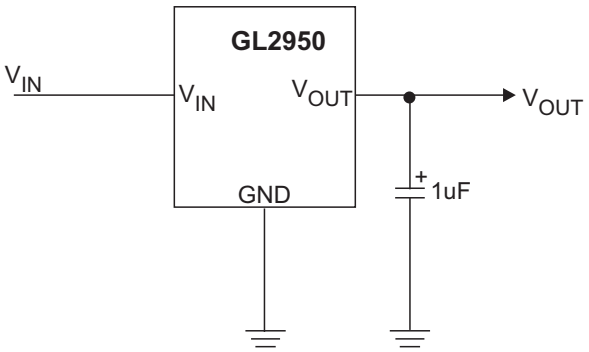
Features

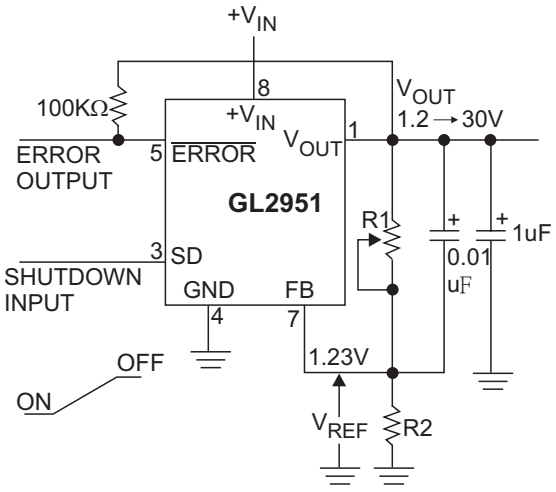
- High accuracy output voltage
- Guaranteed 100mA output
- Very low quiescent current
- Low dropout voltage
- Extremely tight load and line regulation
- Very low temperature coefficient
- Needs only 1uF for stability
- Error Flag warns of output dropout
- Logic-Controlled electronic shutdown
- Output programmable from 1.24 to 29V

Application

Battery powered systems
Cordless telephones
Radio control systems
Portable/Palm top/Notebook computers
Portable consumer equipment
Portable Instrumentation
Avionics
Automotive Electronics
SMPS Post-Regulator
Voltage Reference

TYPICAL APPLICATION



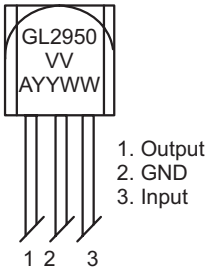


Pins 2 and 6 Are Left open

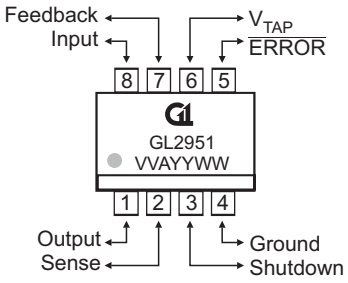
$V_{OUT} = V_{REF}(1 + \frac{R1}{R2})$

◆ MARKING INFORMATION & PIN CONFIGURATIONS (TOP VIEW)

TO- 92



SOP-8(SO-8)



A = Assembly Location
VV = Output Voltage
YY = Year
W W = Weekly

◆ ORDERING INFORMATION (Green Package Products are available now!)

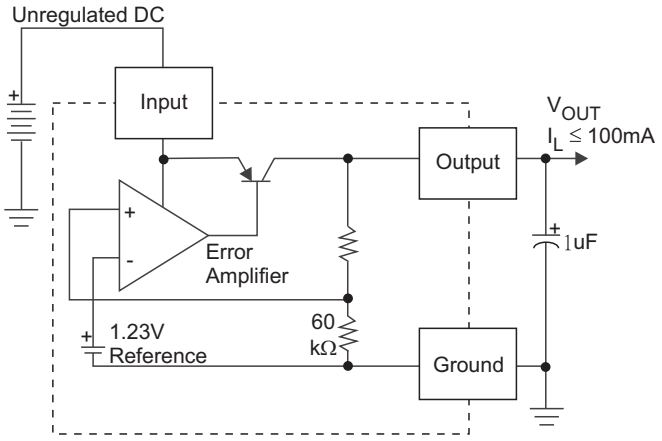
Pro Number	V_{OUT}	Package
GL2950	2.85V	TO-92
	3.0V	TO-92
	3.3V	TO-92
	5.0V	TO-92
GL2951	2.85V	SOP-8
	3.0V	SOP-8
	3.3V	SOP-8
	5.0V	SOP-8

* For detail ordering number identification, please see last page.

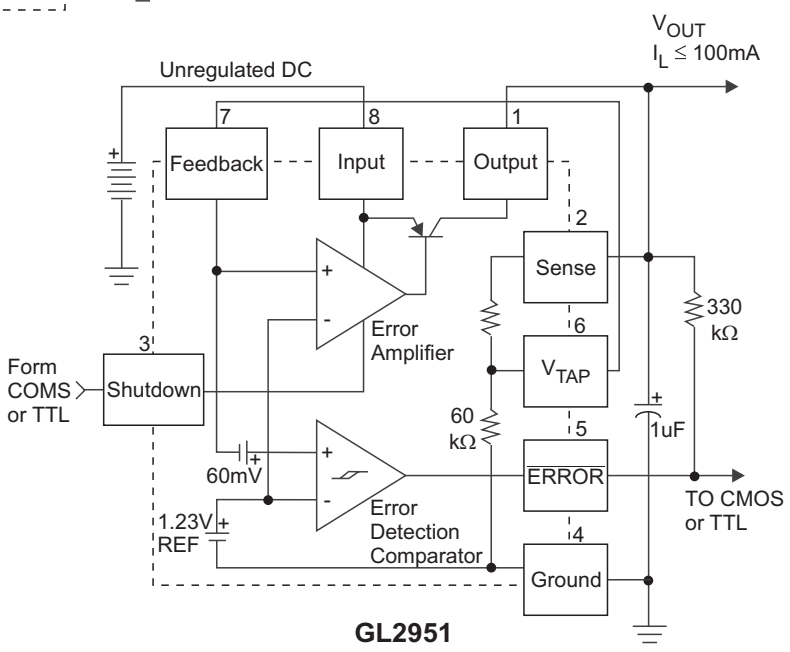
◆ ABSOLUTE MAXIMUM RATINGS

PARAMETER	VALUE	UNITS
Lead Temperature (Soldering, 5 seconds)	260	℃
Storage Temperature Range	-65 to +150	℃
Operating Junction Temperature Range	-55 to +150	℃
Input Supply Voltage	-0.3 to +30	V
Feedback Input Voltage	-1.5 to +30	V
Shutdown Input Voltage	-0.3 to +30	V
Error Comparator Output	-0.3 to +30	V

◆ BLOCK DIAGRAM



GL2950



GL2951

ELECTRICAL CHARACTERISTICS

(At T_A =25C, V_{IN} =15V;unless otherwise noted)

PARAMETER	CONDITIONS	Min	Typ	Max	Units
Output Voltage	-25C ≤ T_J≤ 85C Full Operating Temperature	0.985 IV_0I 0.98 IV_0I	V_0	1.015 IV_0I 1.02 IV_0I	V
Output Voltage	100uA ≤ I_L≤ 100mA, T_J≤T_{JMAX}	0.976 IV_0I	V_0	1.024 IV_0I	
Output Voltage Temperature Coefficient	(Note 1)		50	150	ppm/C
Line Regulation (Note 3)	V_0 + 1V≤ V_{IN} ≤ 30V (Note 4)		0.04	0.4	%
Load Regulation (Note 3)	100uA ≤ I_L≤ 100mA		0.1	0.3	%
Dropout Voltage (Note 5)	I_L = 100uA I_L = 100mA		50 380	80 450	mV
Ground Current	I_L = 100uA I_L = 100mA		75 8	120 12	uA mA
Dropout Ground Current	V_{IN} = V_0 - 0.5V, I_L = 100A		110	170	uA
Current Limit	V_{OUT} = 0		160	200	mA
Thermal Regulation			0.05	0.2	%/ W
Output Noise, 10Hz to 100KHz	C_L = 1uF C_L = 200uF C_L = 3.3uF (Bypass = 0.01uF pins 7 tol 2951-XX)		430 160 100		uVrms
8- pin Versions Only					
Reference Voltage		1.21	1.235	1.26	V
Reference Voltage	Over Temperature (Note 6)	1.185		1.285	
Feedback Pin Bias Current			20	40	nA
Reference Voltage Temperature Coefficient	(Note 7)		50		ppm/C
Feedback Pin Bias Current Temperature Coefficient			0.1		nA/C
Error Comparator					
Output Leakage Current	V_{OH} =30V		0.01	1.0	uA
Output Low Voltage	V_{IN} = 4.5V, I_{OL} = 400A		150	250	mV
Upper Threshold Voltage	(Note 8)	40	60		
Lower Threshold Voltage	(Note 8)		75	95	
Hysteresis	(Note 8)		15		

ELECTRICAL CHARACTERISTICS

(At T_A =25C, V_{IN} =15V;unless otherwise noted)

PARAMETER	CONDITIONS	Min	Typ	Max	Units
Shutdown Input					
Input Logic Voltage	Low (Regulator ON) High(Regulator OFF)	2	1.3	0.7	V
Shutdown Pin Input Current	V_S = 2.4V V_S = 30V		30 450	50 600	UA
Regulator Output Current in Shutdown	(Note 9)				UA
	V_{OUT} = 5.0V		3	10	UA
	3.3V≤ V_{OUT} < 5.0V			20	UA
	2.0V≤ V_{OUT} < 3.3V			30	UA

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 = 25C, V_{IN} = V_0 + 1V, I_L = 100uA and C_L = 1F. Additional conditions for the 8-pin versions are feedback tied to -XX V tap and output tied to output Sense (V_{OUT} = XX V) and $V_{shutdown}$ ≤ 0.8 V

Note 3: Regulations 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 GL2951-XX is tested at 150C for I_L = 1mA. For I_L = 100uA and T_J = 125C, 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 values 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, 100uA ≤ 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 tempera ture range

Note 8: Comparator thresholds are expressed in terms of a voltage differential at the feedback terminal below the nominal reference voltage measured at V_0 + 1V 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 95mV x 5V/ 1.235V=384mV. 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: $V_{shutdown}$ ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, Feed-back pin tied to -XX V Tap.

◆ TYPICAL CHARACTERISTICS

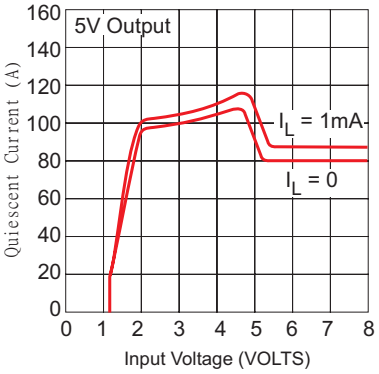


Figure 1. Quiescent Current

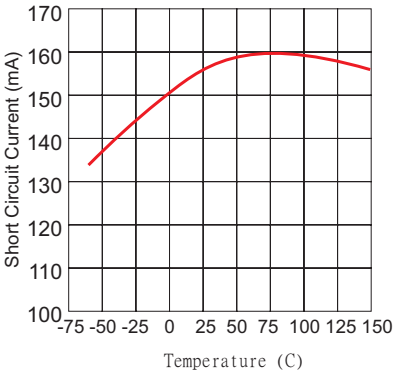


Figure 2. Short Circuit Current

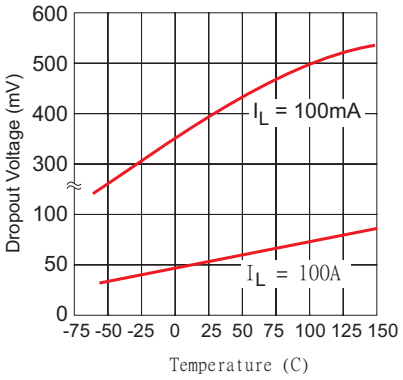


Figure 3. Dropout Voltage

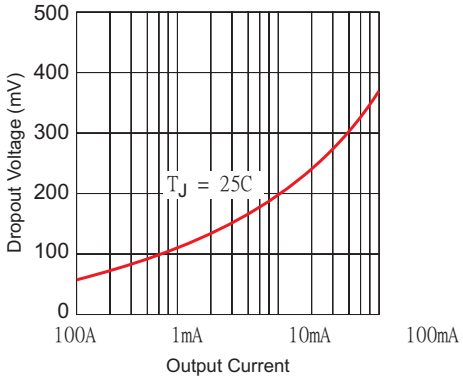


Figure 4. Dropout Voltage

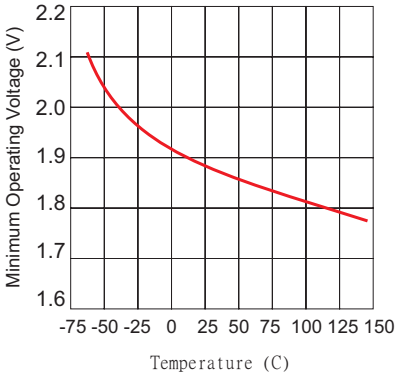


Figure 5. Minimum Operating Voltage (GL2951)

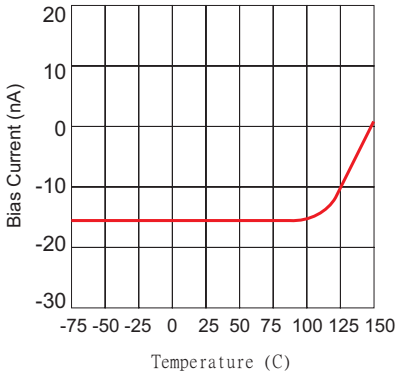


Figure 6. Feedback Bias Current (GL2951)

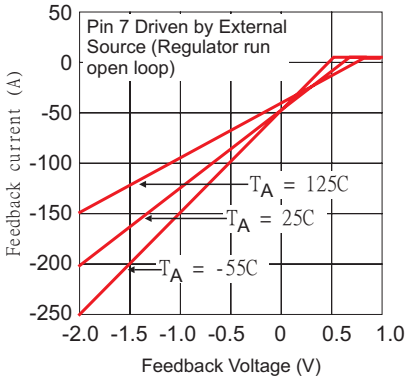


Figure 7. Feedback Pin Current (GL2950)

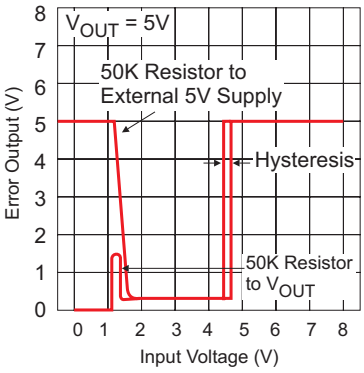


Figure 8. Error Comparator Output (GL2951)

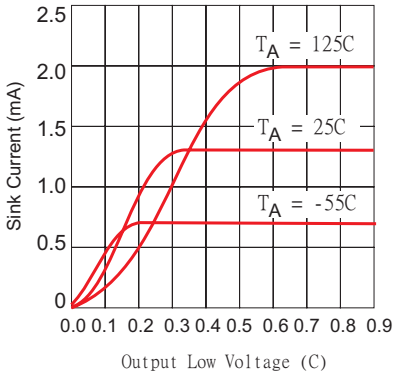


Figure 9. Comparator Sink Current (GL2951)

APPLICATIONS INFORMATION

EXTERNAL CAPACITORS

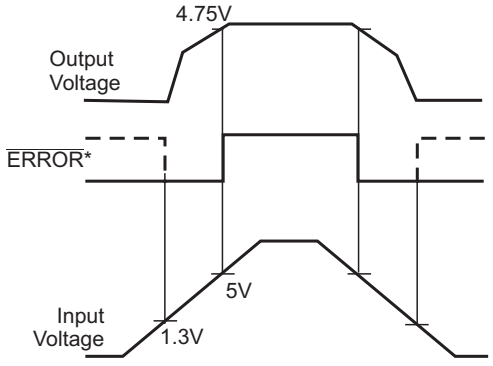
A 1.0uF (or greater) capacitor is required between the output and ground for stability at output voltages of 5V or more. At lower output voltages, more capacitance is required (2.2uF or more is recommended for 3V and 3.3V versions). Without this capacitor, the part will oscillate. Most types of tantalum or aluminum electrolytics work fine here; even film types work but are not recommended for reasons of cost. Many aluminum electrolytics have electrolytes that freeze at about -30C, so solid tantalums are recommended for operation below -25C. The important parameters of the capacitor are an ESR of about 5W 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 stability. The capacitor can be reduced to
0.33uF for currents below 10 mA or 0.1uF for currents below 1 mA. Using the adjustable 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 3.3uF (or greater) capacitor should be used. Unlike many other regulators, the GL2950 will remain stable and in regulation with no load in addition to the internal voltage divider. This is especially important in CMOS RAM keep-alive applications. When setting the output voltage of the GL2951 versions with external resistors, a minimum load of 100uA is recommended.

A 1uF tantalum or aluminum electrolytic capacitor should be placed from the GL2950/GL2951 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 GL2951 Feedback terminal 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 3.3uF will fix this problem.

ERROR DETECTION COMPARATOR OUTPUT
The comparator produces a logic low output whenever the GL2951 output falls out of regulation by more than approximately 5%. This figure is the comparators built-in offset of about 60 mV divided by the 1.235V reference voltage. (Refer to the block diagram in the front of the datasheet.) This trip level remains 5% below normal regardless of the programmed output voltage of the GL2951. 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 either to due low input voltage, current limiting, or thermal limiting. Figure 10. Below gives a timing diagram depicting the $\overline{\text{ERROR}}$ signal and the regulated output voltage as the GL2951 input is ramped up and down. For 5V versions, the $\overline{\text{ERROR}}$ 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 GL2951 s dropout voltage is load-dependent (see curve in typical performance characteristics), the input voltage trip point (about 5V) will be vary with the current loaded. The output voltage trip point (approx. 4.75V) does not vary with current loaded.

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



*When $V_{IN} \leq 1.3V$, the error flag pin becomes a high impedance, and the error flag voltage rises to its pull-up voltage. Using V_{OUT} as the pull-up voltage (see Figure 11), rather than an external 5V source, will keep the error flag voltage under 1.2V (typ.) in this condition. The user may wish to divide down the error flag voltage using equal-value resistors (10 kΩ suggested), to ensure a low-level logic signal during any fault condition, while still allowing a valid high logic level during normal operation.

Figure10. $\overline{\text{ERROR}}$ Output Timing

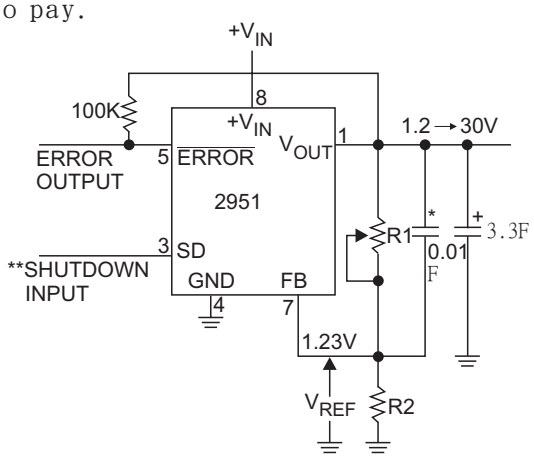
PROGRAMMING THE OUTPUT VOLTAGE (GL2951)

The GL2951 may be pin-strapped for the nominal fixed output voltage using its internal voltage divider by tying the output and sense pins together, and also tying the feedback and V_{TAP} pins together. Alternatively, it may be programmed for any output voltage between its 1.235V reference and 30V maximum rating. As seen in Figure 11, an external pair of resistorsis required.

The complete equation for the output voltage is

$$V_{OUT} = V_{REF} \bullet (1 + \frac{R1}{R2}) + I_{FB}R1$$

where V_{REF} is the nominal 1.235 reference voltage and I_{FB} is the feedback pin bias current, nominally -20 nA. The minimum recommended load current of 1A forces an upper limit of 1.2 MW on the value of R_2, 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 R_1. For better accuracy, choosing R_2 = 100k reduces this error to 0.17% while increasing the resistor program current to 12uA. Since the GL2951 typically draws 60uA at no load with Pin 2 open-circuited, this is a small price to pay.



*See Application Hints

$$V_{OUT} = V_{REF}\ (1+ \frac{R1}{R2})$$

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

Figure 11. Adjustable Regulator

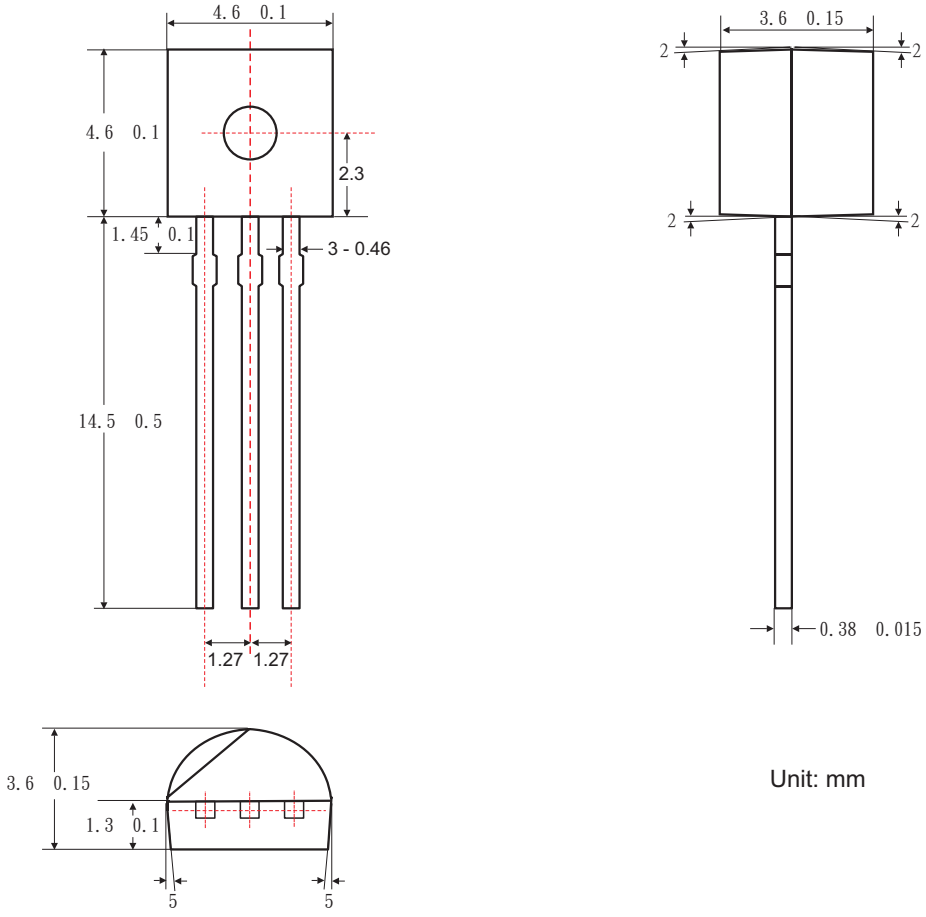
REDUCING OUTPUT NOISE

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 is the only way noise can be reduced on the3 lead GL2950, but is relatively inefficient. As increasing the capacitor from 1uF to 220uF only decreases the noise from 430uV to 160uV rms for a 100 kHz bandwidth at 5V output. Noise can be reduced fourfold by a bypass capacitor across R_1, since it reduces the high frequency gain from 4 to unity. Pick

$$C_{BYPASS} \cong \frac{1}{2\pi R1 \bullet 200Hz}$$

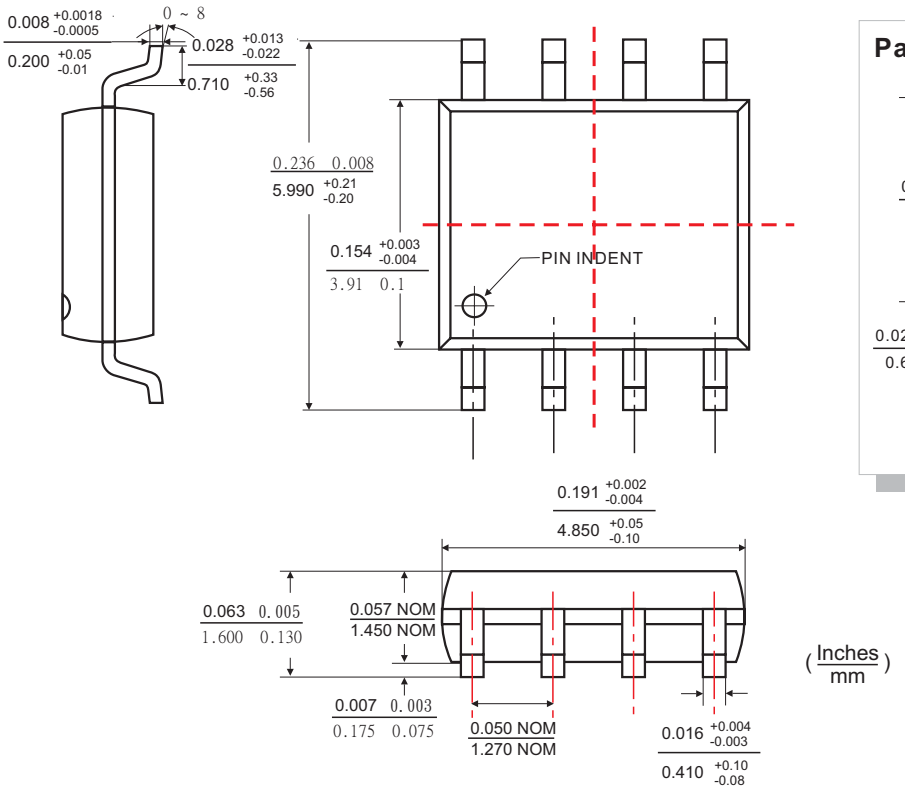
or about 0.01uF. When doing this, the output capacitor must be increased to 3.3uF to maintain stability. These changes reduce the output noise from 430uV to 100uV rms for a 100 kHz bandwidth at 5V output. With the bypass capacitor added, noise no longer scales with output voltage so that improvements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

TO-92 PACKAGE OUTLINE DIMENSIONS



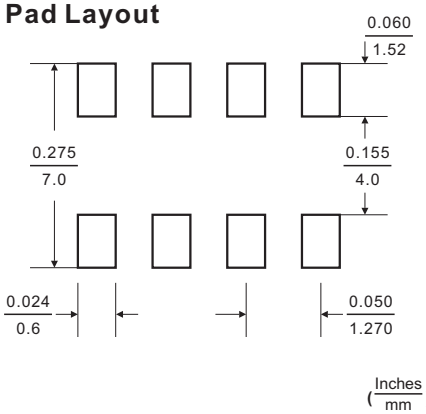
Unit: mm

SOP-8 PACKAGE OUTLINE DIMENSIONS



(Inches / mm)

Pad Layout



◆ ORDERING NUMBER