

# LP2960 Adjustable Micropower 0.5A Low-Dropout Regulators

## General Description

The LP2960 is a micropower voltage regulator with very low dropout voltage (12 mV typical at 1 mA load and 470 mV typical at 500 mA load) and very low quiescent current (450  $\mu$ A typical at 1 mA load).

The LP2960 is ideally suited for battery-powered systems: the quiescent current increases only slightly at dropout, which prolongs battery life.

The LP2960 retains all the desirable characteristics of the LP2953, and offers increased output current.

The error flag goes low any time the output drops more than 5% out of regulation.

Reverse battery protection is provided.

The LP2960 requires only 10  $\mu$ F of output capacitance for stability (5V version).

The internal voltage reference is made available for external use, providing a low-T.C. reference with very good regulation characteristics.

The parts are available in 16-pin plastic DIP and 16-pin surface mount packages.

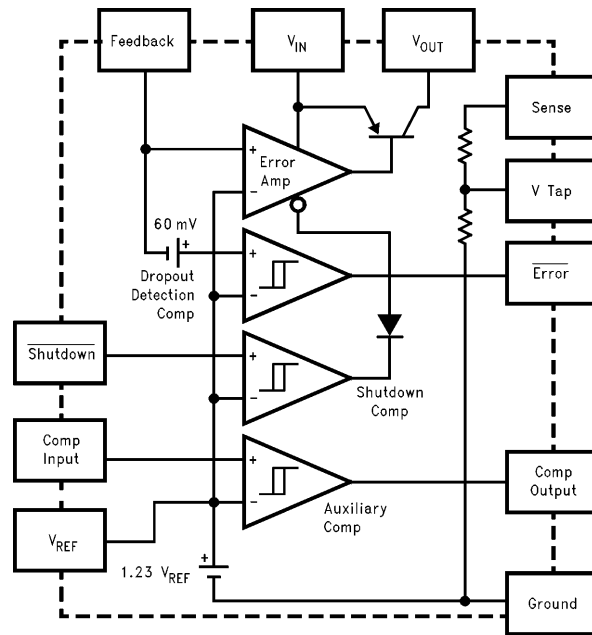
## Features

- Output voltage adjusts from 1.23V–29V
- Guaranteed 500 mA output current
- 5V and 3.3V versions available
- 16-pin DIP and 16-pin SO packages
- Low dropout voltage
- Low quiescent current
- Tight line and load regulation
- Low temperature coefficient
- Current limiting and thermal protection
- Logic-level shutdown
- Can be wired for snap-ON and snap-OFF
- Reverse battery protection

## Applications

- High-efficiency linear regulator
- Regulator with under-voltage shutdown
- Low dropout battery-powered regulator
- Cellular telephones

## Block Diagram



TL/H/11962-1

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature Range	-65°C to +150°C
Operating Junction Temperature Range LP2960AI/LP2960I	-40°C to +125°C

Lead Temperature (Soldering, 5 sec.)	260°C
Power Dissipation (Note 2)	Internally Limited
Input Supply Voltage	-20V to +30V
Feedback Input Voltage (Note 3)	-0.3V to +5V
Comparator Input Voltage (Note 4)	-0.3V to +30V
Comparator Output Voltage (Note 4)	-0.3V to +30V
ESD Rating (Note 15)	1.5 kV

**Electrical Characteristics** Limits in standard typeface are for  $T_J = 25^\circ\text{C}$ , and limits in **boldface type** apply over the full operating temperature range. Unless otherwise specified:  $C_{IN} = 4.7 \mu\text{F}$ ,  $V_{IN} = V_O(\text{NOM}) + 1\text{V}$ ,  $I_L = 1 \text{mA}$ ,  $C_{OUT} = 10 \mu\text{F}$  for 5V parts or  $C_{OUT} = 22 \mu\text{F}$  for 3.3V parts, Feedback pin is tied to  $V_{TAP}$  pin, Output pin is tied to Sense pin,  $V_{SD} = 2\text{V}$ .

Symbol	Parameter	Conditions	Typ	LP2960AI (Note 14)		LP2960I (Note 14)		Units
				Min	Max	Min	Max	
$V_O$	Output Voltage (5V Versions)	$1 \text{mA} \leq I_L \leq 500 \text{mA}$	5.0	4.962 <b>4.930</b>	5.038 <b>5.070</b>	4.925 <b>4.880</b>	5.075 <b>5.120</b>	V
	Output Voltage (3.3V Versions)	$1 \text{mA} \leq I_L \leq 500 \text{mA}$	3.3	3.275 <b>3.254</b>	3.325 <b>3.346</b>	3.250 <b>3.221</b>	3.350 <b>3.379</b>	
$\frac{\Delta V_O}{\Delta T}$	Output Voltage Temperature Coefficient	(Note 5)	<b>20</b>		<b>130</b>		<b>160</b>	ppm/°C
$\frac{\Delta V_O}{V_O}$	Output Voltage Line Regulation	$V_{IN} = [V_O(\text{NOM}) + 1\text{V}] \text{ to } 30\text{V}$	0.06		0.2 <b>0.5</b>		0.4 <b>0.8</b>	%
$\frac{\Delta V_O}{V_O}$	Output Voltage Load Regulation	(Note 6)	0.08		0.16 <b>0.30</b>		0.20 <b>0.40</b>	%
$V_{IN-V_O}$	Dropout Voltage (Note 7)	$I_L = 1 \text{mA}$	12		30 <b>50</b>		30 <b>50</b>	mV
		$I_L = 100 \text{mA}$	180		250 <b>350</b>		250 <b>350</b>	
		$I_L = 200 \text{mA}$	260		350 <b>450</b>		350 <b>450</b>	
		$I_L = 500 \text{mA}$	470		600 <b>800</b>		600 <b>800</b>	
$I_{GND}$	Ground Pin Current (Note 8)	$I_L = 1 \text{mA}$	450		600 <b>750</b>		600 <b>750</b>	$\mu\text{A}$
		$I_L = 100 \text{mA}$	2.6		4.0 <b>5.0</b>		4.0 <b>5.0</b>	
		$I_L = 200 \text{mA}$	5.5		8 <b>10</b>		8 <b>10</b>	mA
		$I_L = 500 \text{mA}$	21		35 <b>40</b>		35 <b>40</b>	
$I_{GND}$	Ground Pin Current at Dropout (Note 8)	$V_{IN} = V_O(\text{NOM}) - 0.5\text{V}$ $I_L = 100 \mu\text{A}$	1.8		3 <b>5</b>		3 <b>5</b>	mA
	Ground Pin Current at Shutdown (Note 8)	$V_{SD} \leq 1.1\text{V}$	300		400		400	$\mu\text{A}$
$I_{LIMIT}$	Current Limit	$R_L = 0.5\Omega$	1000		1500 <b>1600</b>		1500 <b>1600</b>	mA
$\frac{\Delta V_O}{P_D}$	Thermal Regulation	(Note 10)	0.05		0.2		0.2	%/W

**Electrical Characteristics** Limits in standard typeface are for  $T_J = 25^\circ\text{C}$ , and limits in **boldface type** apply over the full operating temperature range. Unless otherwise specified:  $C_{IN} = 4.7\ \mu\text{F}$ ,  $V_{IN} = V_O(\text{NOM}) + 1\text{V}$ ,  $I_L = 1\ \text{mA}$ ,  $C_{OUT} = 10\ \mu\text{F}$  for 5V parts or  $C_{OUT} = 22\ \mu\text{F}$  for 3.3V parts, Feedback pin is tied to  $V_{TAP}$  pin, Output pin is tied to Sense pin,  $V_{S/D} = 2\text{V}$ . (Continued)

Symbol	Parameter	Conditions	Typ	LP2960AI (Note 14)		LP2960I (Note 14)		Units
				Min	Max	Min	Max	
$e_n$	Output Noise Voltage @ $I_L = 100\ \text{mA}$ (10 Hz–100 kHz)	$C_{OUT} = 10\ \mu\text{F}$	300					$\mu\text{V RMS}$
		$C_{OUT} = 47\ \mu\text{F}$	210					
		$C_{OUT} = 47\ \mu\text{F}$ (Note 11)	130					
$V_{REF}$	Reference Voltage		1.235	1.220 <b>1.210</b>	1.250 <b>1.265</b>	1.210 <b>1.195</b>	1.260 <b>1.275</b>	V
$\frac{\Delta V_{REF}}{V_{REF}}$	Reference Voltage Line Regulation	(Note 13)	0.05		0.1 <b>0.30</b>		0.2 <b>0.4</b>	%
$\frac{\Delta V_{REF}}{V_{REF}}$	Reference Voltage Load Regulation	$I_{REF} = 0\text{--}200\ \mu\text{A}$	0.45		0.6 <b>0.9</b>		1.2 <b>1.5</b>	%
$\frac{\Delta V_{REF}}{\Delta T}$	Reference Voltage Temperature Coefficient	(Note 5)	<b>20</b>					ppm/ $^\circ\text{C}$
$I_B(\text{FB})$	Feedback Pin Bias Current		-20	-50 <b>-70</b>		-50 <b>-70</b>		nA
<b>DROPOUT DETECTION COMPARATOR</b>								
$I_{OH}$	Output HIGH Leakage	$V_{OH} = 30\text{V}$	0.01		1 <b>2</b>		1 <b>2</b>	$\mu\text{A}$
$V_{OL}$	Output LOW Voltage	$V_{IN} = V_O(\text{NOM}) - 1\text{V}$ $I_{O}(\text{COMP}) = 400\ \mu\text{A}$	125		250 <b>400</b>		250 <b>400</b>	mV
$V_{THR}(\text{max})$	Upper Threshold Voltage	(Note 9)	-60	-80 <b>-100</b>	-35 <b>-25</b>	-80 <b>-100</b>	-35 <b>-25</b>	mV
$V_{THR}(\text{min})$	Lower Threshold Voltage	(Note 9)	-85	-130 <b>-200</b>	-70 <b>-35</b>	-130 <b>-200</b>	-70 <b>-35</b>	mV
HYST	Hysteresis	(Note 9)	25					mV
<b>SHUTDOWN INPUT</b>								
$V_{OS}$	Input Offset Voltage	(Referred to $V_{REF}$ )	$\pm 5$	-18 <b>-24</b>	18 <b>24</b>	-18 <b>-24</b>	18 <b>24</b>	mV
HYST	Hysteresis	(Referred to $V_{REF}$ )	10					mV
$I_B$	Input Bias Current	$V_{S/D} = 0\text{--}5\text{V}$	-20	-60 <b>-100</b>	60 <b>100</b>	-60 <b>-100</b>	60 <b>100</b>	nA
$I_{OUT}(\text{S/D})$	Regulator Output Current in Shutdown	(Note 12)	3		12 <b>20</b>		12 <b>20</b>	$\mu\text{A}$
<b>AUXILIARY COMPARATOR</b>								
$V_{OS}$	Input Offset Voltage	(Referred to $V_{REF}$ )	$\pm 5$	-15 <b>-20</b>	15 <b>20</b>	-15 <b>-20</b>	15 <b>20</b>	mV
HYST	Hysteresis	(Referred to $V_{REF}$ )	10					mV
$I_B$	Input Bias Current	$V_{COMP} = 0\text{--}5\text{V}$	-20	-60 <b>-100</b>	60 <b>100</b>	-60 <b>-100</b>	60 <b>100</b>	nA
$I_{OH}$	Output HIGH Leakage	$V_{OH} = 30\text{V}$ $V_{COMP} = 1.3\text{V}$	0.01		1 <b>2</b>		1 <b>2</b>	$\mu\text{A}$
$V_{OL}$	Output LOW Voltage	$V_{COMP} = 1.1\text{V}$ $I_O = 400\ \mu\text{A}$	125		250 <b>400</b>		250 <b>400</b>	mV

## Electrical Characteristics (Continued)

**Note 1:** Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions.

**Note 2:** The maximum allowable power dissipation is a function of the maximum junction temperature,  $T_J$  (max), the junction-to-ambient thermal resistance,  $\theta_{J-A}$ , and the ambient temperature,  $T_A$ . The maximum allowable power dissipation at any ambient temperature is calculated using:

$$P(\text{max}) = \frac{T_J(\text{max}) - T_A}{\theta_{J-A}}$$

Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. See APPLICATION HINTS for additional information on heatsinking and thermal resistance.

**Note 3:** When used in dual-supply systems where the regulator load is returned to a negative supply, the output voltage must be diode-clamped to ground.

**Note 4:** May exceed the input supply voltage.

**Note 5:** Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

**Note 6:** Output voltage load regulation is measured at constant junction temperature using low duty cycle pulse testing. Two separate tests are performed, one for the load current range of 100  $\mu\text{A}$  to 1 mA and one for the 1 mA to 500 mA range. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

**Note 7:** Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below the value measured with a 1V differential. At very low values of programmed output voltage, the input voltage minimum of 2V (**2.3V over temperature**) must be observed.

**Note 8:** Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the ground pin current, output load current, and current through the external resistive divider (if used).

**Note 9:** Dropout detection comparator threshold voltages are expressed in terms of a voltage differential measured at the Feedback terminal below the *nominal* reference voltage, which is the reference voltage measured with  $V_{IN} = V_O(\text{NOM}) + 1\text{V}$ . To express these thresholds in terms of output voltage change, multiply by the error amplifier gain which is  $V_O/V_{REF} = (R1 + R2)/R2$  (see *Basic Application Circuit*).

**Note 10:** Thermal regulation is the change in output voltage at a time T after a change in power dissipation, excluding load or line regulation effects. Specifications are for a 400 mA load pulse at  $V_{IN} = V_O(\text{NOM}) + 15\text{V}$  (6W pulse) for  $T = 10\text{ms}$ .

**Note 11:** Connect a 0.1  $\mu\text{F}$  capacitor from the output to the feedback pin.

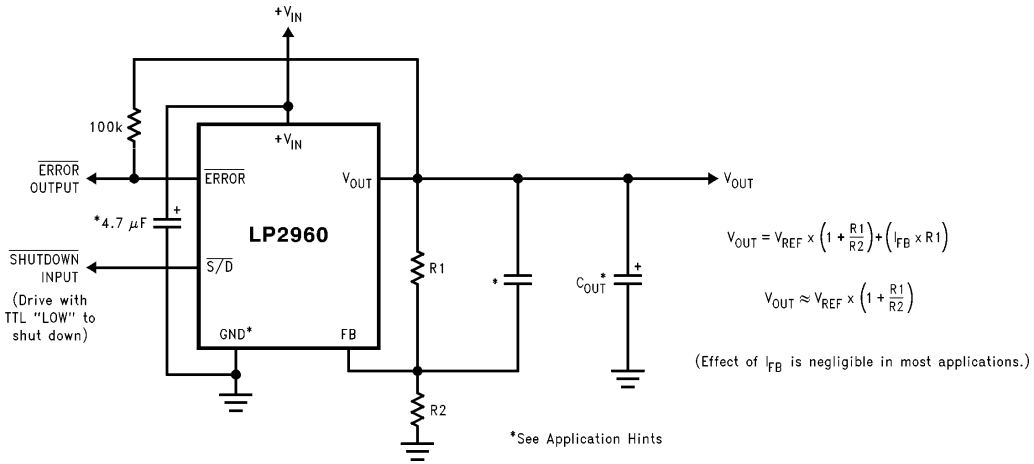
**Note 12:**  $V_{\text{shutdown}} \leq 1.1\text{V}$ ,  $V_{IN} < 30\text{V}$ ,  $V_{\text{OUT}} = 0\text{V}$ .

**Note 13:** Two separate tests are performed for reference voltage line regulation, one covering  $2.5\text{V} \leq V_{IN} \leq V_O(\text{NOM}) + 1\text{V}$  and the other test for  $V_O(\text{NOM}) + 1\text{V} \leq V_{IN} \leq 30\text{V}$ .

**Note 14:** All room temperature limits are 100% production tested. All limits at **temperature extremes** are guaranteed via correlation using standard Statistical Quality Control (SQC) methods. All limits are used to calculate Average Outgoing Quality Level.

**Note 15:** Human Body Model, 200 pF discharged through 1.5 k $\Omega$ .

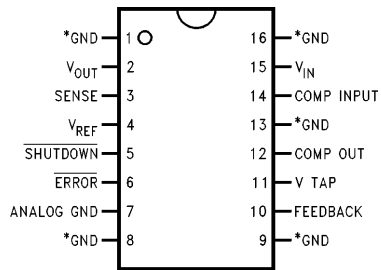
## Basic Application Circuit



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## Connection Diagrams and Ordering Information

### 16-Pin Surface Mount Package



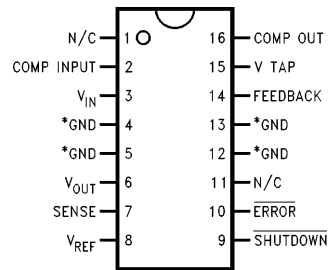
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\*Internally Connected to Power Ground

Top View

Order Number LP2960IM-5.0, LP2960AIM-5.0,  
LP2960IM-3.3 or LP2960AIM-3.3  
See NS Package Number M16A

### 16-Pin DIP Package

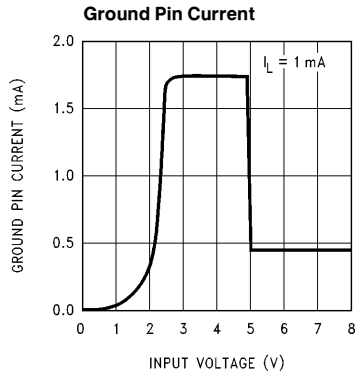


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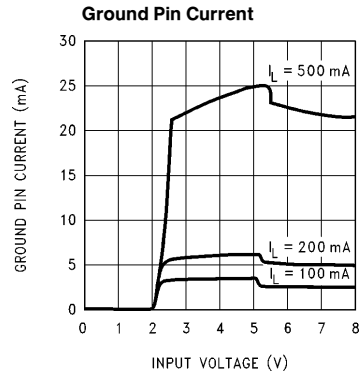
Top View

Order Number LP2960IN-5.0, LP2960AIN-5.0,  
LP2960IN-3.3 or LP2960AIN-3.3  
See NS Package Number N16G

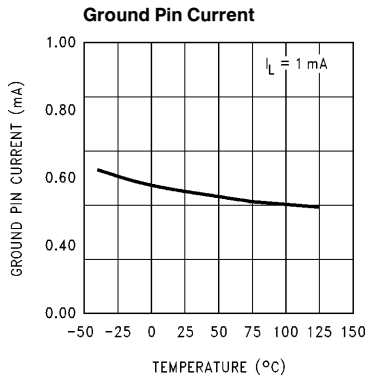
**Typical Performance Characteristics** Unless otherwise specified:  $C_{IN} = 4.7 \mu\text{F}$ ,  $V_{IN} = 6\text{V}$ ,  $I_L = 1\text{mA}$ ,  $C_{OUT} = 10 \mu\text{F}$ , Feedback pin is tied to  $V_{TAP}$  pin, Output pin is tied to Sense pin,  $V_{S/D} = 2\text{V}$ ,  $V_{OUT} = 5\text{V}$ .



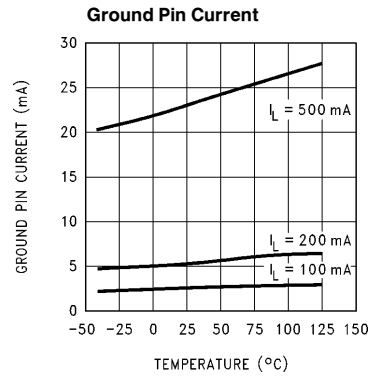
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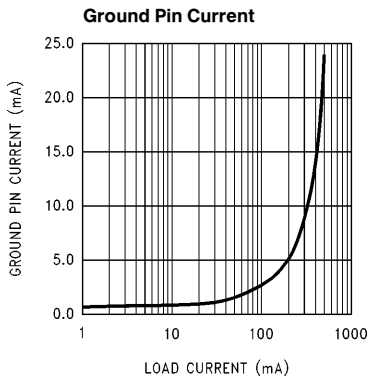
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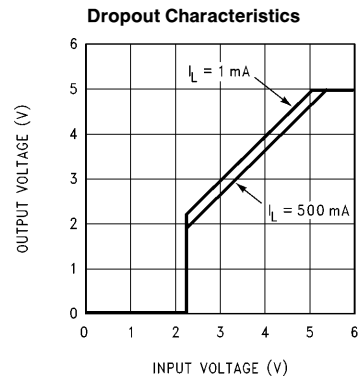
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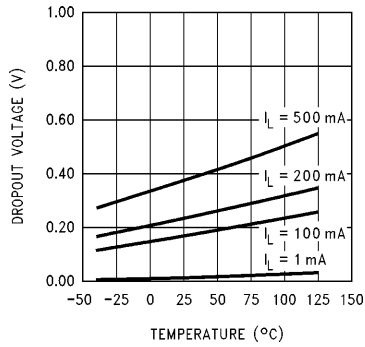
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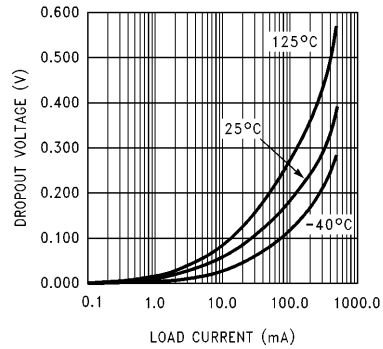
**Typical Performance Characteristics** Unless otherwise specified:  $C_{IN} = 4.7 \mu\text{F}$ ,  $V_{IN} = 6\text{V}$ ,  $I_L = 1 \text{ mA}$ ,  $C_{OUT} = 10 \mu\text{F}$ , Feedback pin is tied to  $V_{TAP}$  pin, Output pin is tied to Sense pin,  $V_{S/D} = 2\text{V}$ ,  $V_{OUT} = 5\text{V}$ . (Continued)

**Dropout Voltage vs Temperature**



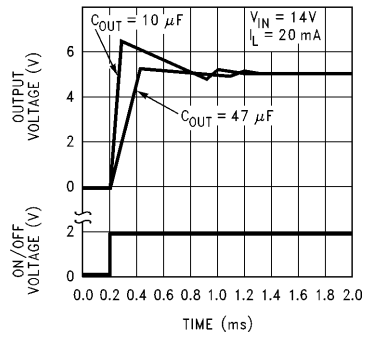
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**Dropout Voltage vs Load Current**



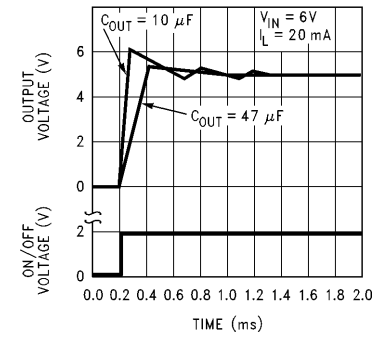
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**Enable Transient**



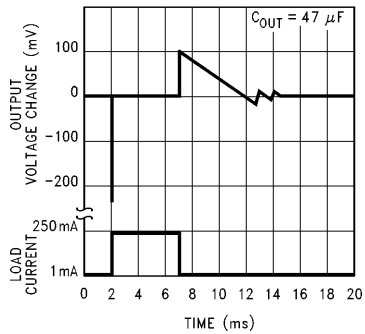
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**Enable Transient**



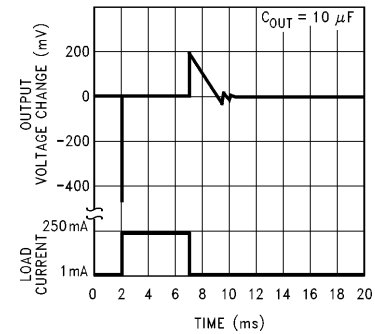
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**Load Transient**



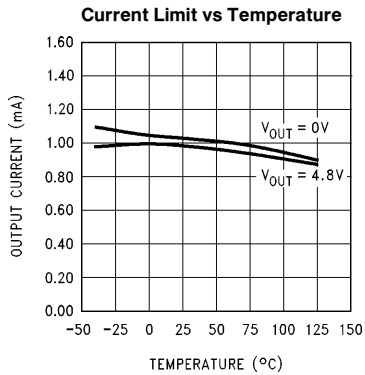
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**Load Transient**

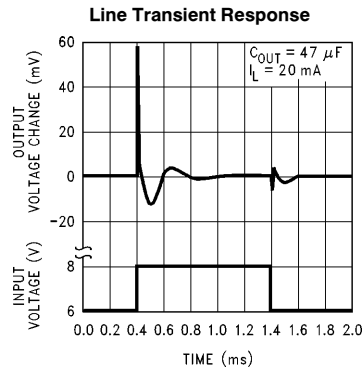


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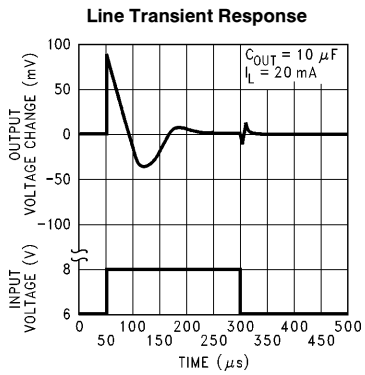
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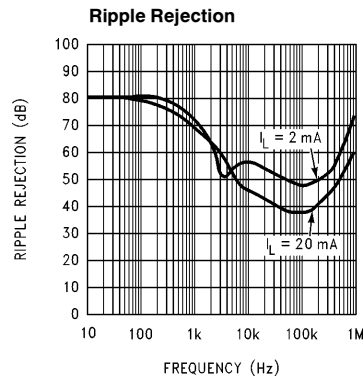
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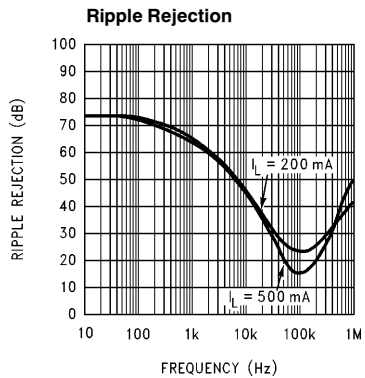
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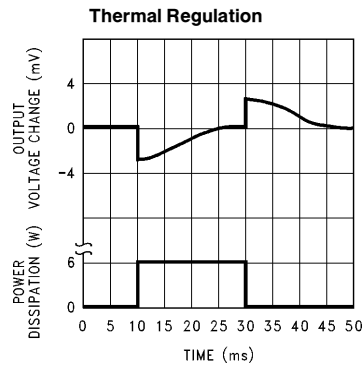
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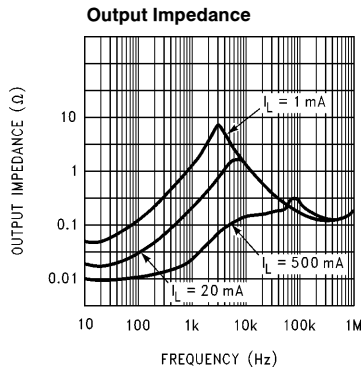
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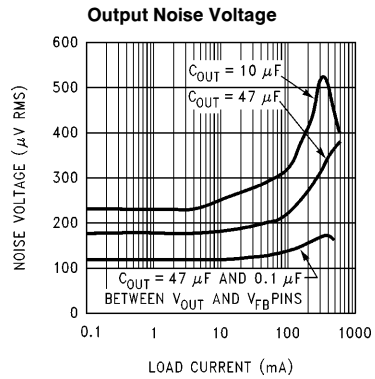
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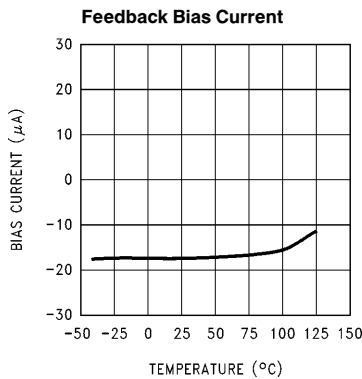
**Typical Performance Characteristics** Unless otherwise specified:  $C_{IN} = 4.7 \mu F$ ,  $V_{IN} = 6V$ ,  $I_L = 1 \text{ mA}$ ,  $C_{OUT} = 10 \mu F$ , Feedback pin is tied to  $V_{TAP}$  pin, Output pin is tied to Sense pin,  $V_{S/D} = 2V$ ,  $V_{OUT} = 5V$ . (Continued)



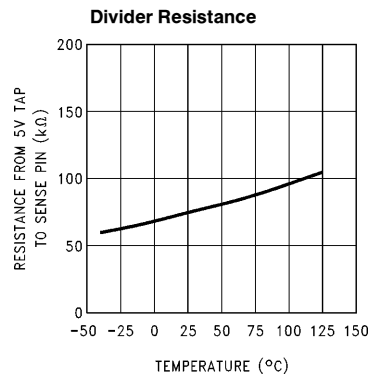
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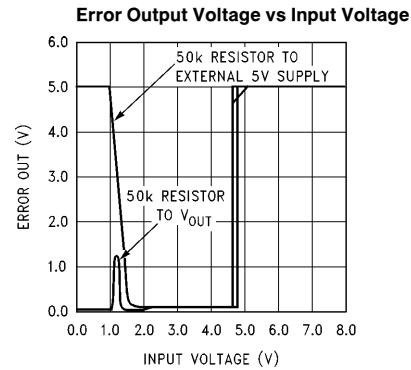
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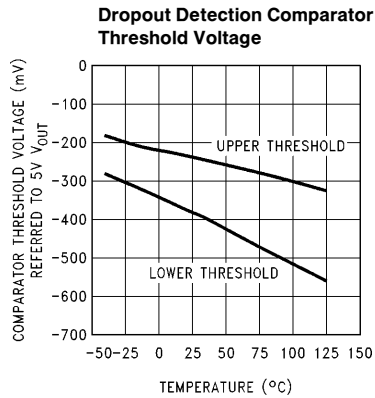
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## Application Hints

### EXTERNAL CAPACITORS

Bypass capacitors on the input and output of the LP2960 are required: without these capacitors, *the part will oscillate*.

A capacitor (whose value is *at least* 4.7 $\mu$ F) must be connected from the  $V_{IN}$  pin to ground. If the input capacitor is located more than one inch away from the LP2960, the capacitor may have to be increased to 22  $\mu$ F to assure stability. A capacitor is also required between  $V_{OUT}$  and Ground, and the minimum amount of capacitance required here depends on output voltage.

If the output voltage of the LP2960 is set to 5V, a minimum of 10  $\mu$ F is needed in output capacitance. At 3.3V output, at least 22  $\mu$ F is required to assure stability.

**ESR LIMIT:** The ESR of the capacitor used on the LP2960 must be less than 0.7 $\Omega$  *throughout the entire operating temperature range* to assure stability.

The ESR of an aluminum electrolytic capacitor is typically only specified at 25°C, and does not reflect the maximum ESR that can be expected to occur over the entire temperature range of the capacitor.

Aluminum electrolytics show a marked increase in ESR at low temperatures (ESR can increase by a factor of 30 or more when going from 25°C to -30°C) which could lead to oscillation problems in applications with very low ambient temperatures. Solid tantalum capacitors are recommended for use in such cases.

Regulator instability can be caused by stray (board layout) capacitance appearing at the Feedback terminal. Oscillations from this effect are most likely to occur when very high value resistors are used to set the output voltage.

Adding a 100 pF capacitor between the Output and Feedback pins and increasing the output capacitor to at least 22  $\mu$ F will stop the oscillations.

### MINIMUM LOAD

The internal resistive divider in the LP2960 provides sufficient output loading for proper regulation. If external resistors are used to set the LP2960 output voltage, a minimum current of 5  $\mu$ A through the external resistive divider is recommended.

It should be noted that a minimum load current is specified in several of the test conditions listed under *Electrical Characteristics*, and this value of load current must be used to get correlation on these test limits.

### PROGRAMMING THE OUTPUT VOLTAGE

The LP2960 regulator may be pin-strapped for operation at the nominal output voltage using its internal resistive 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 voltage between the 1.23V reference and the 30V maximum rating using an external pair of resistors (see Basic Application Circuit).

The complete equation for the output voltage is:

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

The term  $V_{REF}$  is the 1.23V reference and  $I_{FB}$  is the Feedback pin bias current (-20 nA typical). The minimum recommended load current of 5  $\mu$ A sets an upper limit of 240 k $\Omega$  on the value of R2 in cases where the regulator must work with no load (see *Minimum Load*).

For best output accuracy, choosing R2 = 100 k $\Omega$  will reduce the error resulting from  $I_{FB}$  to 0.17% while increasing the resistive divider current to 12  $\mu$ A. Since the typical quiescent current of the LP2960 is 450  $\mu$ A, this added current through R2 is negligible.

### DROPOUT VOLTAGE

The dropout voltage of the regulator is defined as the minimum input-to-output voltage differential required for the output voltage to stay within 100 mV of the output voltage measured with a 1V differential. The dropout voltage is independent of the programmed output voltage.

### OUTPUT ISOLATION

If the LP2960 output is connected to an active voltage source (such as a battery) the regulator input should not be shorted to ground, as this will cause a large current to flow from the battery into the LP2960 output lead.

If the LP2960 input is *left floating* with the output connected to a battery, a small current (a few mA) will flow into the output lead.

The "reverse" current flowing from the battery into the LP2960 output can be prevented by using a blocking diode between the output and the battery.

### REDUCING OUTPUT NOISE

In reference applications it may be desirable to reduce the AC noise present on the output. One method is to reduce regulator bandwidth by increasing output capacitance. This is relatively inefficient, since large increases in capacitance are required to get significant improvement.

Noise can be reduced more effectively by a bypass capacitor placed across R1 (refer to *Basic Application Circuit*).

A 0.1  $\mu$ F capacitor connected across R1 will reduce the high frequency gain of the circuit to unity, lowering the RMS output noise voltage from 210  $\mu$ V to 130  $\mu$ V (typical) using a 10 Hz-100 kHz bandwidth test measurement.

Also, output noise is no longer proportional to the output voltage, so improvements are more pronounced at higher output voltages.

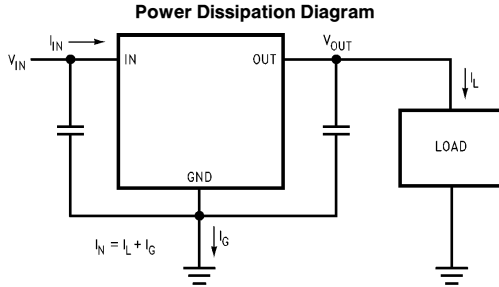
**IMPORTANT:** Since the 0.1  $\mu$ F capacitor reduces the AC gain of the LP2960 to unity, the output capacitance must be increased to at least 33  $\mu$ F to assure regulator stability.



## Application Hints (Continued)

To determine if a heatsink is required, the power dissipated by the regulator,  $P_D$ , must be calculated.

The figure below shows the voltages and currents which are present in the circuit, as well as the formula for calculating the power dissipated in the regulator:



$$P_D = (V_{IN} - V_{OUT}) I_L + (V_{IN}) I_G$$

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The next parameter which must be calculated is the maximum allowable temperature rise,  $T_R$  (max). This is calculated by using the formula:

$$T_R (\text{max}) = T_J (\text{max}) - T_A (\text{max})$$

where:

$T_J$  (max) is the maximum allowable junction temperature, which is 125°C for commercial grade parts.

$T_A$  (max) is the maximum ambient temperature which will be encountered in the application.

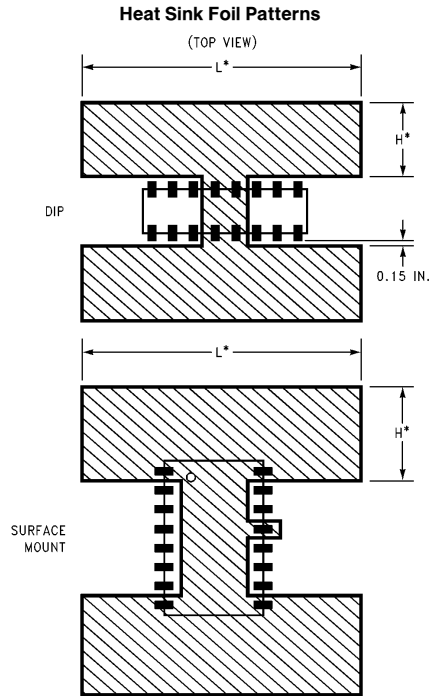
Using the calculated values for  $T_R$  (max) and  $P_D$ , the maximum allowable value for the junction-to-ambient thermal resistance,  $\theta_{(J-A)}$ , can now be found:

$$\theta_{(J-A)} = T_R (\text{max}) / P_D$$

The heatsink for the LP2960 is made using the PC board copper, with the heat generated on the die being conducted through the lead frame and out to the pins which are soldered to the PC board.

The GND pins are the only ones capable of conducting any significant amount of heat, as they are internally attached to the lead frame on which the die is mounted.

The figure below shows recommended copper foil patterns to be used for heatsinking the DIP and Surface Mount packages:



\* FOR BEST RESULTS, USE  $L = 2H$

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The table below shows measured values of  $\theta_{(J-A)}$  for a PC board with 1 ounce copper weight:

Package	L (in.)	H (in.)	$\theta_{J-A}$ (°C/W)
DIP	1	0.5	50
	2	0.2	52
Surface Mount	1	0.5	72
	2	0.2	74

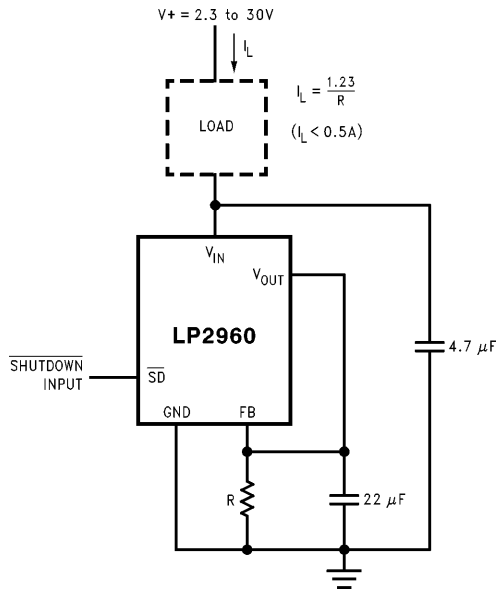
As the heat must transfer from the copper to the surrounding air, best results (lowest  $\theta_{J-A}$ ) will be obtained by using a *surface* copper layer with the solder resist opened up over the heatsink area.

If an *internal* copper layer of a multi-layer board is used for heatsinking, the board material acts as an insulator, inhibiting heat transfer and increasing  $\theta_{J-A}$ .

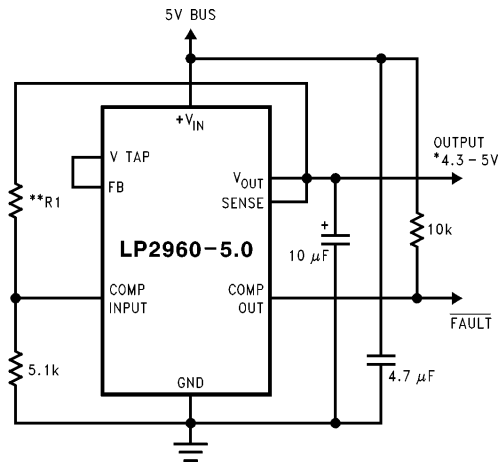
As with any heatsink, increasing the airflow across the board will significantly improve the heat transfer.

## Typical Applications

### Low T.C. Current Sink



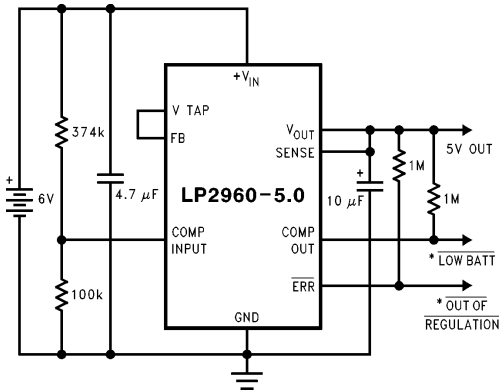
### 5V Bus Current Limiter with Load Fault Indicator



\*Output voltage equals  $+V_{IN}$  minus dropout voltage, which varies with output current. Current limits at a maximum of 1000 mA (typical).

\*\*Select R1 so that the comparator input voltage is 1.23V at the output voltage which corresponds to the desired fault current value.

### 5V Regulator with Error Flags for LOW BATTERY and OUT OF REGULATION

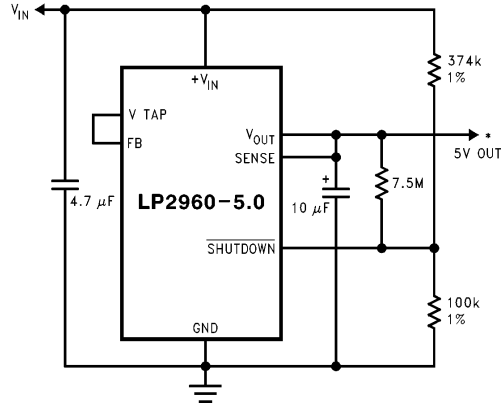


\*Connect to Logic or  $\mu\text{P}$  control inputs.

LOW BATT flag warns the user that the battery has discharged down to about 5.8V, giving the user time to recharge the battery or power-down some hardware with high power requirements. The output is still in regulation at this time.

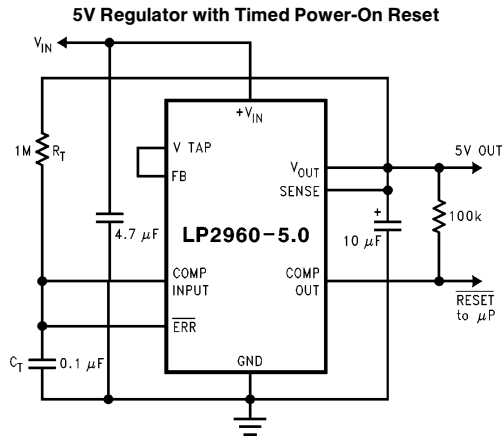
OUT OF REGULATION flag indicates when the battery is almost completely discharged, and can be used to initiate a power-down sequence.

### 5V Regulator with Snap-ON/Snap-OFF Feature and Hysteresis

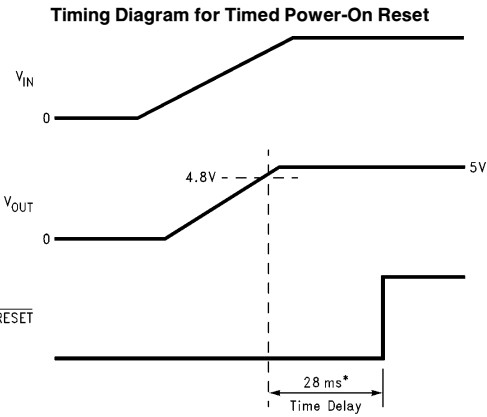


\*Turns ON at  $V_{IN} = 5.87\text{V}$   
Turns OFF at  $V_{IN} = 5.64\text{V}$   
(for component values shown)

## Typical Applications (Continued)



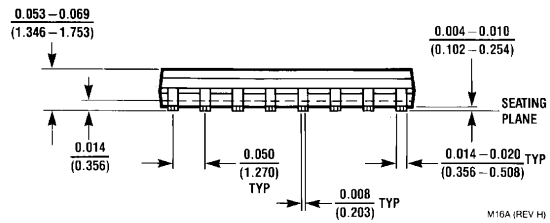
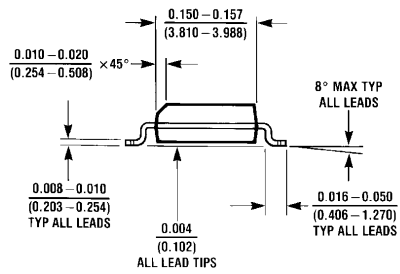
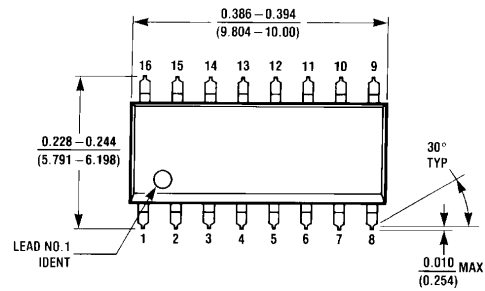
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\* $R_T = 1 \text{ Meg}$ ,  $C_T = 0.1 \mu\text{F}$

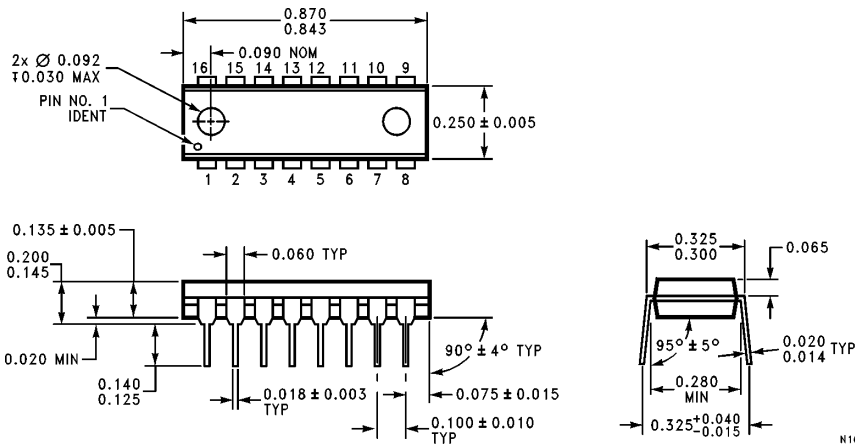
## Physical Dimensions inches (millimeters)



M16A (REV H)

Order Number LP2960IM-5.0, LP2960AIM-5.0,  
LP2960IM-3.3 or LP2960AIM-3.3  
NS Package Number M16A

**Physical Dimensions** inches (millimeters) (Continued)



Order Number LP2960IN-5.0, LP2960AIN-5.0,  
 LP2960IN-3.3 or LP2960AIN-3.3  
 NS Package Number N16G

N16G (REV B)

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