

# 300mA Low-Noise Ultra Low-Dropout CMOS Regulator

## DESCRIPTION

The EUP7987 low-noise, low-dropout, linear regulator operates from a 2.5V to 5.5V input and is guaranteed to deliver 300mA.

The EUP7987 is stable with small 2.2 $\mu$ F ceramic capacitor. Its performance suits battery powered applications because of its shutdown mode (60 nA typ), low quiescent current (110 $\mu$ A typ), and LDO voltage (140mV typ). The low dropout voltage allows for more utilization of a battery's available energy by operating closer to its end-of-life voltage.

The EUP7987 is available in 1.8V, 2.5v, 2.8V, 3V, 3.3V, and adjustable versions.

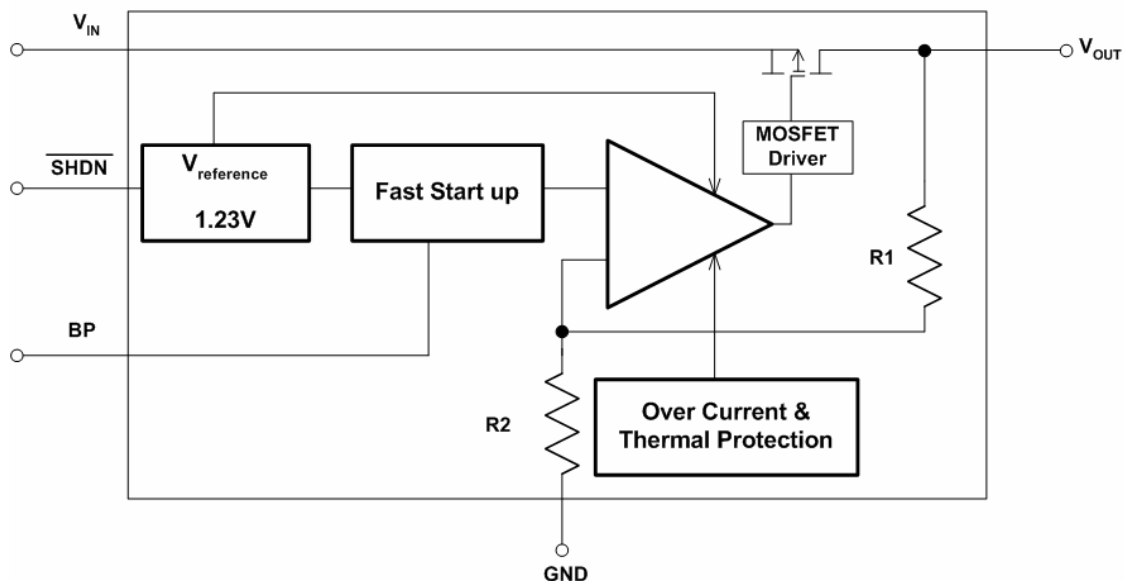
## FEATURE

- 300mA Guaranteed Output Current (500mA for Pulsed Loads)
- 60dB PSRR at 1kHz
- 50 $\mu$  V<sub>RMS</sub> Output Voltage Noise
- 140mV Dropout at 300mA Load
- Low 110 $\mu$ A No-Load Supply Current
- $\leq$  1 $\mu$ A Shutdown Current
- Fast Start-up Time
- Stable With 2.2 $\mu$ F Ceramic Output Capacitors
- Thermal Shutdown and Short-Circuit Protection
- SOT23-5 and SOT23-6 Package
- RoHS Compliant and 100% Lead (Pb)-Free

## APPLICATIONS

- Wireless Handsets
- DSP Core Power
- Battery Powered Electronics
- Portable Information Appliances

## Block Diagram



**Figure1.**

Typical Application Circuit

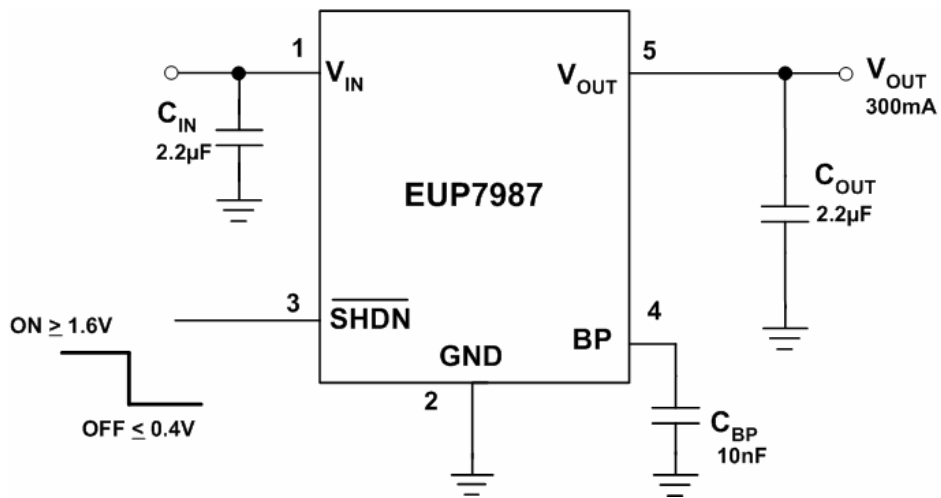


Figure2. Fixed-Voltage LDO Regulator

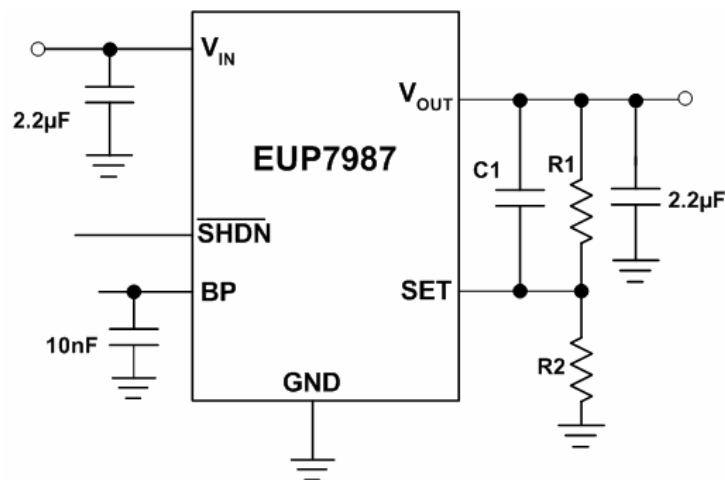


Figure3 Adjustable LDO Regulator Programming

**Pin Configurations**

Part Number	Pin Configurations
<p>EUP7987 SOT23-5 The set pin is internally disconnected for the fixed versions</p>	
<p>EUP7987 SOT23-6</p>	

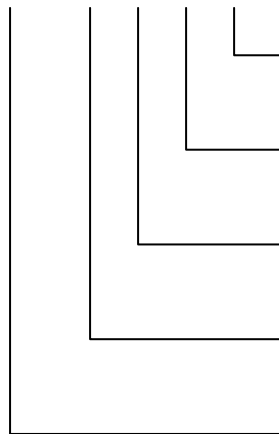
**Pin Description**

PIN	SOT23-5	SOT23-6	DESCRIPTION
V <sub>IN</sub>	1	1	Input voltage of the LDO
GND	2	2	Common Ground
SHDN	3	3	SHDN places the entire device in shutdown mode when held low.
BP	4	4	Compensation capacitor for noise reduction
SET		5	Output voltage set. Not externally connected for the fixed versions. Connect to resistor-divider for adjustable output voltage.
V <sub>OUT</sub>	5	6	Output voltage of the LDO

## Ordering Information

Order Number	Package Type	Marking	Operating Temperature range
EUP7987-18VIR1 EUP7987-18VIR0	SOT23-5	J1	-40°C to 85°C
EUP7987-25VIR1 EUP7987-25VIR0	SOT23-5	J2	-40°C to 85°C
EUP7987-28VIR1 EUP7987-28VIR0	SOT23-5	J6	-40°C to 85°C
EUP7987-30VIR1 EUP7987-30VIR0	SOT23-5	J5	-40°C to 85°C
EUP7987-33VIR1 EUP7987-33VIR0	SOT23-5	J3	-40°C to 85°C
EUP7987VIR1 EUP7987VIR0	SOT23-6	JA	-40°C to 85°C

EUP7987



Lead Free Code  
1: Lead Free 0: Lead

Packing  
R: Tape & Reel

Operating temperature range  
I: Industry Standard  
C: Commercial

Package Type  
V: SOT23

Output Voltage  
18: 1.8V  
25: 2.5V  
28: 2.8V  
30: 3.0V  
33: 3.3V  
Blank: Adjustable

**Absolute Maximum Ratings**

- $V_{IN}, V_{OUT}, \overline{V_{SHDN}}, V_{SET}, V_{CC},$  ----- -0.3V to 6V
- Storage Temperature Range ----- -65°C to 160°C
- Junction Temperature (TJ) ----- 150°C
- Lead Temperature (10 sec.) ----- 260°C

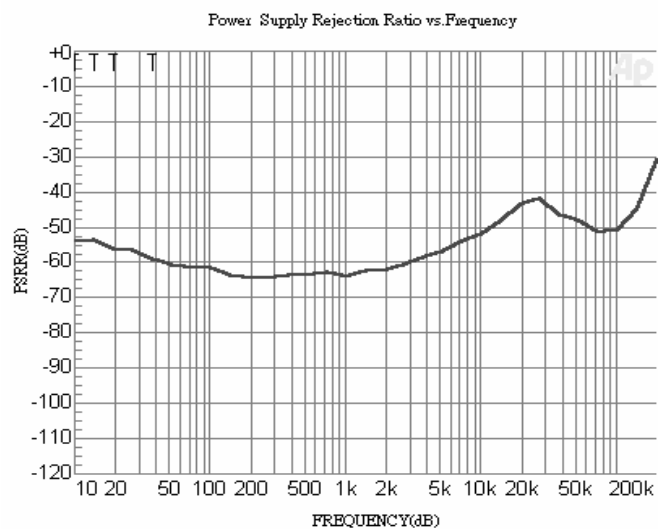
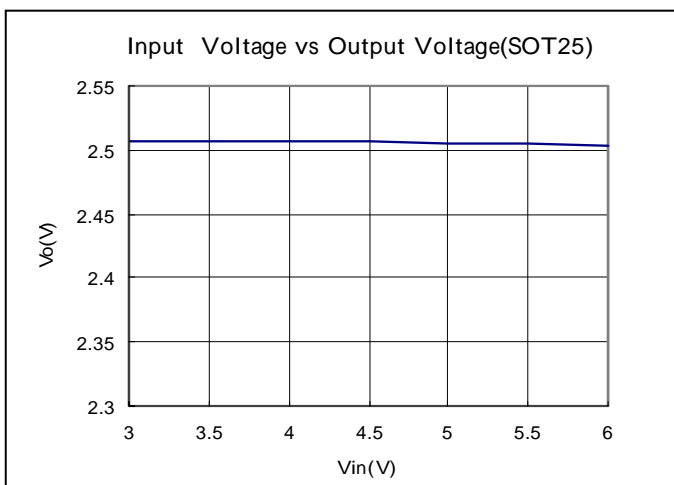
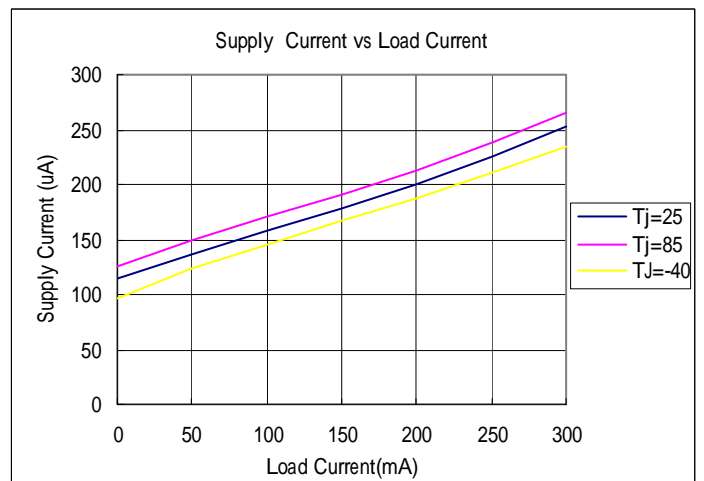
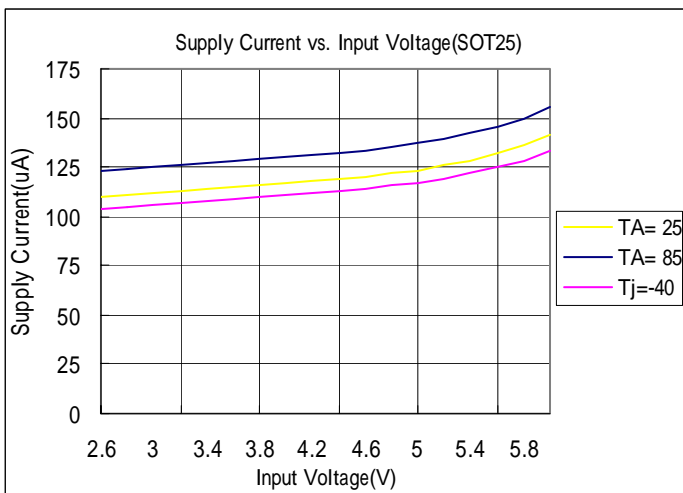
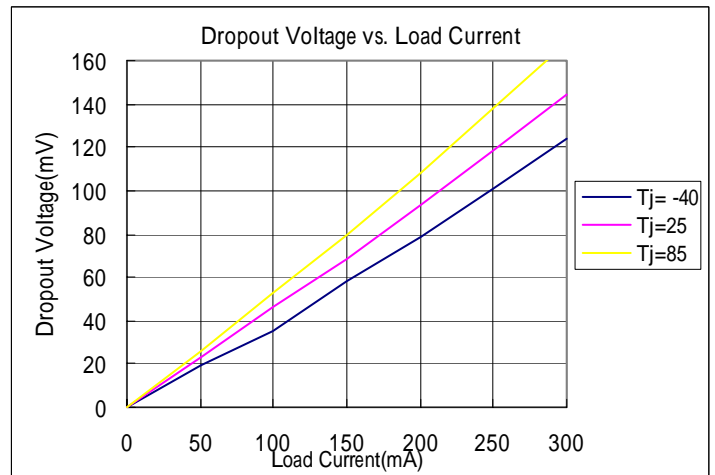
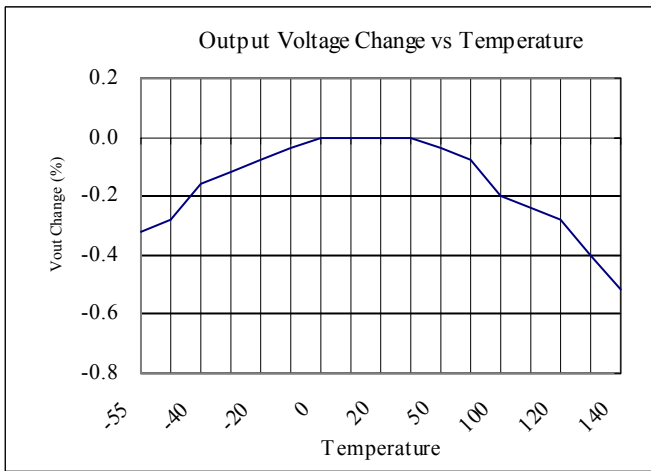
**Electrical Characteristics**

Unless otherwise specified, all limits guaranteed for  $V_{IN}=V_O+0.5V, \overline{V_{SHDN}}=V_{IN}, C_{IN}=C_{OUT}=2.2\mu F, C_{CC}=22nF, T_J=25^\circ C.$  (Boldface limits apply for the operating temperature extremes: -40°C and 85°C)

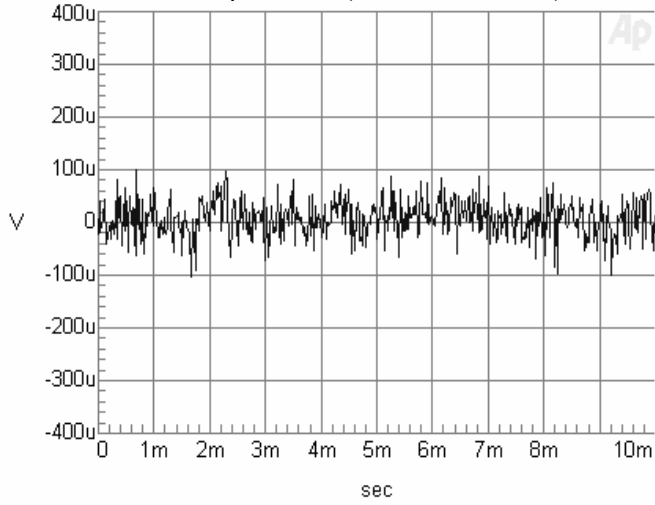
Symbol	Parameter	Conditions	EUP7987			Unit
			Min	Typ	Max.	
$V_{IN}$	Input Voltage		<b>2.5</b>		<b>5.5</b>	V
$\Delta V_O$	Output Voltage Tolerance	$100\mu A \leq I_{OUT} \leq 300mA$ $V_{IN}=V_O+0.5V,$ SET= OUT for the Adjust Versions	-2 <b>-3</b>		+2 <b>+3</b>	% of $V_{OUT(NOM)}$
$V_O$	Output Adjust Range	Adjust Version Only	<b>1.25</b>		<b>5.5</b>	V
$I_O$	Maximum Output Current	Continuous	<b>300</b>			mA
		10ms pulse		500		mA
$I_{LIMIT}$	Output Current Limit			600		mA
$I_Q$	Supply Current	$I_{OUT}=0mA$ $I_{OUT}=300mA$		110 240	<b>200</b>	$\mu A$
	Shutdown Supply Current	$V_O=0V, \overline{SHDN}=GND$		0.06	1	
$V_{DO}$	Dropout Voltage	$I_{OUT}=1mA$		0.4		mV
		$I_{OUT}=200mA$		90	<b>200</b>	
		$I_{OUT}=300mA$		140		
$\Delta V_O$	Line Regulation	$I_{OUT}=1mA, (V_O+0.5V) \leq V_I \leq 5.5V$	<b>-0.1</b>	0.05	<b>0.1</b>	%/V
	Load Regulation	$100\mu A \leq I_{OUT} \leq 300mA$		0.002		%/mA
$e_n$	Output Voltage Noise	$I_{OUT}=10mA, 10Hz \leq f \leq 100kHz$		50		$\mu V_{RMS}$
$\overline{V_{SHDN}}$	SHDN Input Threshold	$V_{IH,(VO+0.5V)} \leq V_I \leq 5.5V$	1.6			V
		$V_{IL,(VO+0.5V)} \leq V_I \leq 5.5V$			<b>0.4</b>	
$\overline{I_{SHDN}}$	SHDN Input Bias Current	$\overline{SHDN}=GND$ or IN		0.1	100	nA
$I_{SET}$	SET Input Leakage	SET = 1.3V, Adjust Version Only		0.1	2.5	nA
$T_{SD}$	Thermal Shutdown Temperature			160		°C
	Thermal Shutdown Hysteresis			20		
$T_{ON}$	Start-Up Time	$C_{OUT}=10\mu F, V_O$ at 90% of Final Value		80		$\mu s$
PSRR	Power Supply Rejection Ratio	$V_{IN}=V_{OUT}+0.5V, f=1kHz$		60		dB

**Typical Operating Characteristics**

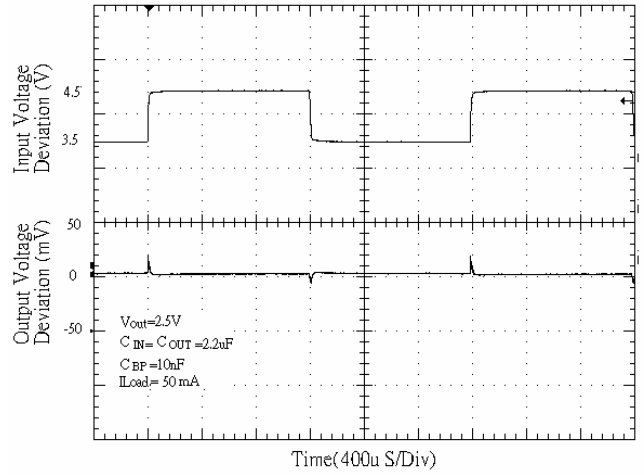
Unless otherwise specified,  $V_{IN} = V_O + 0.5V$ ,  $C_{IN}=C_{OUT} = 2.2 \mu F$ ,  $C_{CC}= 22 nF$ ,  $T_J= 25^\circ C$ ,  $V_{SHDN}=V_{IN}$



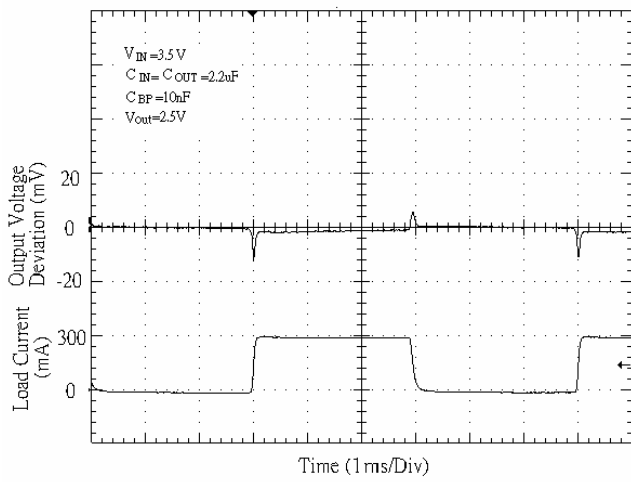
Output Noise (10kHz to 100kHz)



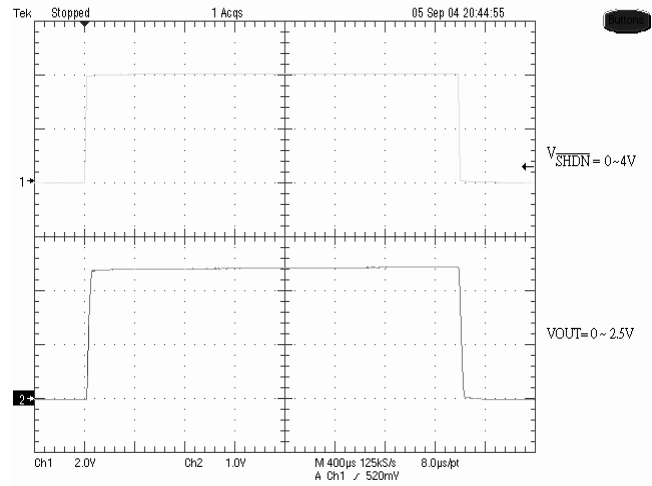
Line Transient Response



Load Transient Response



Shutdown Response



## Application Information

### External Capacitors

Like any low-dropout regulator, the EUP7987 requires external capacitors for regulator stability. The EUP7987 is specifically designed for portable applications requiring minimum board space and smallest components. These capacitors must be correctly selected for good performance.

### Input Capacitor

A minimum input capacitance of 1 $\mu$ F is required between the EUP7987 input pin and ground (the amount of the capacitance may be increased without limit). This capacitor must be located a distance of not more than 1cm from the input pin and returned to a clean analog ground.

Any good quality ceramic, tantalum, or film capacitor may be used at the input. If a tantalum capacitor is used at the input, it must be guaranteed by the manufacturer to have a surge current rating sufficient for the application.

### No-Load Stability

The EUP7987 will remain stable and in regulation with no external load. This is specially important in CMOS RAM keep-alive applications.

### Output Capacitance

The EUP7987 is specifically designed to employ ceramic output capacitors as low as 2.2 $\mu$ F. Ceramic capacitors below 10 $\mu$ F offer significant cost and space savings, along with high frequency noise filtering. Higher values and other types and of capacitor may be used, but their equivalent series resistance (ESR) should be maintained below 0.5 $\Omega$ . Ceramic capacitor of the value required by the EUP7987 are available in the following dielectric types: Z5U, Y5V, X5R, and X7R. The Z5U and Y5V types exhibit a 50% or more drop in capacitance value as their temperature increase from 25 $^{\circ}$ C, an important consideration. The X5R generally maintain their capacitance value within  $\pm 20\%$ . The X7R type are desirable for their tighter tolerance of 10% over temperature.

### Noise Bypass Capacitor

An external 10nF bypass capacitor at BP pin conjunction with an internal resistor creates lowpass filter. Increasing the capacitance will decrease the output noise. This cap is connected directly to a high impedance node in the bandgap reference circuit. Any significant loading on this node will cause a change on the regulated output voltage. For this reason, DC leakage current through this pin must be kept as low as possible for best output voltage accuracy. The types of capacitors best suited for the noise bypass capacitor are ceramic and film.

Unlike many other LDO's, addition of a noise reduction capacitor does not effect the load transient response of the device. However, it does affect start-up time. The smaller the capacitance value, the quicker the start-up time.

### Power Dissipation and Junction Temperature

Specified regulator operation is assured to a junction temperature of 125 $^{\circ}$ C; the maximum junction temperature should be restricted to 125 $^{\circ}$ C under normal operating conditions. This restriction limits the power dissipation the regulator can handle in any given application. To ensure the junction temperature is within acceptable limits, calculate the maximum allowable dissipation,  $P_{D(max)}$ , and the actual dissipation,  $P_D$ , which must be less than or equal to  $P_{D(max)}$ .

The maximum-power-dissipation limit is determined using the following equation:

$$P_{D(max)} = \frac{T_{Jmax} - T_A}{R_{\theta JA}}$$

Where:

$T_{Jmax}$  is the maximum allowable junction temperature.

$R_{\theta JA}$  is the thermal resistance junction-to-ambient for the package

$T_A$  is the ambient temperature.

The regulator dissipation is calculated using:

$$P_D = (V_I - V_O) \times I_O$$

Power dissipation resulting from quiescent current is negligible. Excessive power dissipation triggers the thermal protection circuit.



## Adjustable Operation

The adjustable version of the EUP7987 has an output voltage range of 1.25V to 6V. The output voltage of the EUP7987 adjustable regulator is programmed using an external resistor divider as shown in Figure3. The output voltage is calculated using:

$$V_O = V_{\text{ref}} \times \left(1 + \frac{R_1}{R_2}\right)$$

Where:

Vref=1.23V typ. (the internal reference voltage)

Utilize the following equation for adjusting the output to a particular voltage:

$$P_I = R_2 \left[ \frac{V_O}{1.23V} - 1 \right]$$

Choose R<sub>2</sub>=100k to optimize accuracy, power supply rejection, noise and power consumption.

In order to improve the stability of the adjustable version, it is suggested that a small compensation capacitor C<sub>1</sub> be placed between V<sub>OUT</sub> and SET

## Shutdown

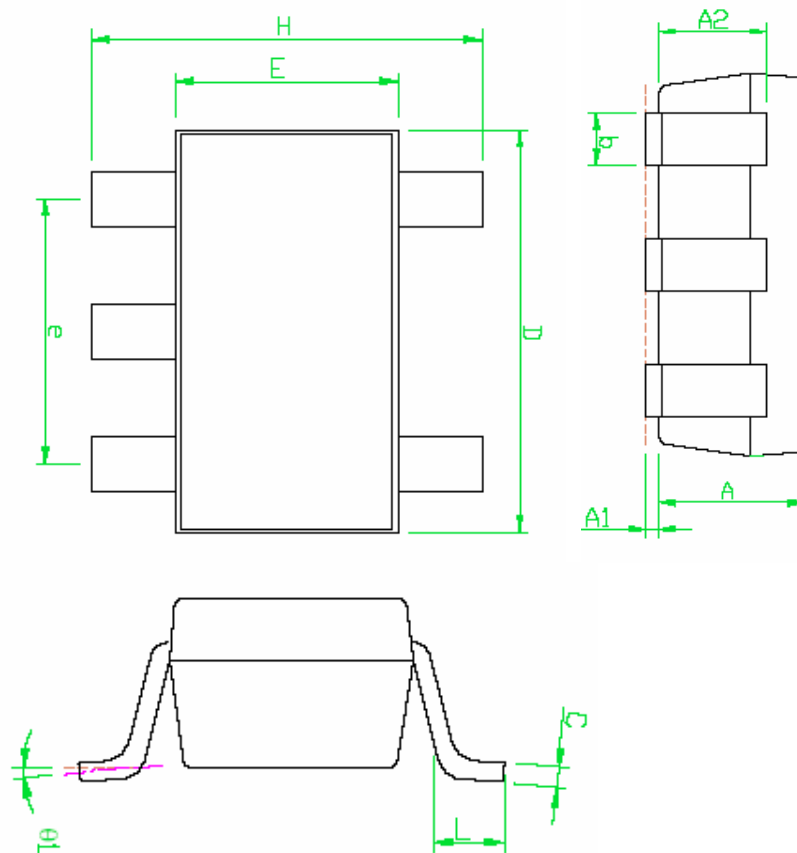
The EUP7987 goes into sleep mode when the  $\overline{\text{SHDN}}$  pin is in a logic low condition. During this condition, the pass transistor, error amplifier, and bandgap are turned off, reducing the supply current to 60nA typical. The  $\overline{\text{SHDN}}$  pin may be directly tied to V<sub>IN</sub> to keep the part on.

## Fast Start-up

The EUP7987 provides fast start-up time for better system efficiency. The start-up speed is maintained when using the optional noise bypass capacitor.

## Packaging Information

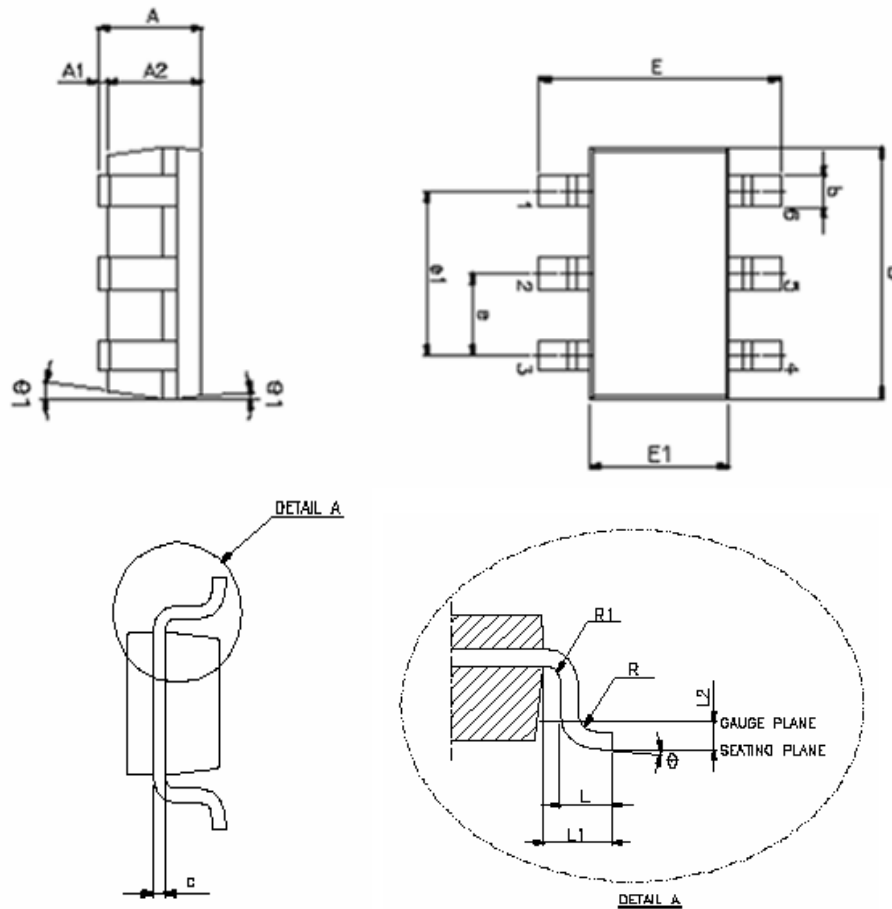
## SOT23-5

**Note:**

1. Package body sizes exclude mold flash protrusions or gate burrs.
2. Tolerance  $\pm 0.1000\text{mm}$  (4 mil) unless otherwise specified.
3. Coplanarity:  $0.1000\text{mm}$
4. Dimension L is measured in gage plane.

Symbols	Dimension in Millimeters		
	Min.	Nom	Max.
A	1.00	1.10	1.30
A1	0.00	-----	0.10
A2	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.15	0.20
D	2.70	2.90	3.10
E	1.50	1.60	1.70
e	-----	1.90(Typ.)	-----
H	2.6	2.8	3.00
L	0.37	-----	-----
1	14	5	9

SOT23-6



SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN.	NOM.	MAX.
A	-----	-----	1.45
A1	-----	-----	0.15
A2	0.90	1.15	1.30
b	0.30	-----	0.50
C	0.08	-----	0.22
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
e	0.95 BSC		
E1	1.90 BSC		
L	0.30	0.45	0.60
L1	0.60 REF		
L2	0.25 BSC		
R	0.10	-----	-----
R1	0.10	-----	0.25
	0°	4°	8°
1	5°	10°	15°