1A Ultra Low-Dropout Linear Regulator

DESCRIPTION

The EUP7961 is a 1A low-dropout linear regulator that provides a low voltage, high current output with a minimum of external components. It offers high precision, ultra-low dropout, and low ground current.

The EUP7961 operates from an input of 2.5V to 5.5V. This regulator uses small, 1µF ceramic input capacitors and 4.7µF ceramic output capacitors to deliver 1A output current. High bandwidth provides excellent transient response. It is designed to drive digital circuits requiring low voltage at high currents (i.e., PLDs, DSPs, microcontrollers, etc.).

Other features include thermal and current limit protection, a logic-control shutdown mode and an error flag output that goes low when the output voltage drops 10% below nominal value.

It is available in fixed output voltages of 1.5V, 1.8V, 2.5V, 3.3V and as an adjustable device with a 0.8V reference voltage. The adjustable output voltage can be set from 0.8V to 4.5V.

FEATURES

- 1A Guaranteed Output Current
- 300mV Dropout Voltage at 1A Output
- Stable with Ceramic Capacitors
- ±1.8% Output Voltage Accuracy
- 300µA Low-Ground Pin Current
  0.1µA Quiescent Current in Shutdown Mode
- Excellent Line and Load Regulation
- Thermal Shutdown and Current Limit Protection
- Error Flag Indication
- Available in SOT223, SOP-8 and SOT-89 Packages
- RoHS Compliant and 100% Lead (Pb)-Free

APPLICATIONS

- LDO Linear Regulator for Low-Voltage Digital IC
- PC Add-In Cards
- High Efficiency Linear Power Supplies
- Post Regulator

Typical Application Circuit

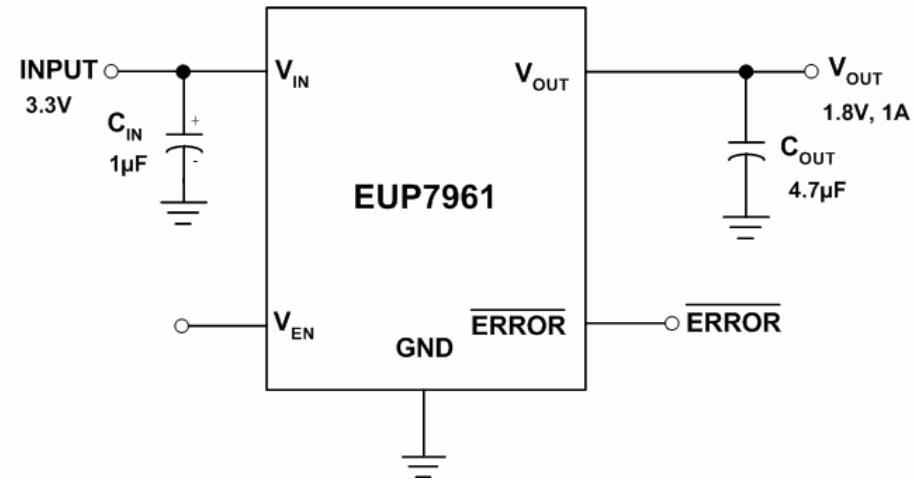


Figure1.

Block Diagram

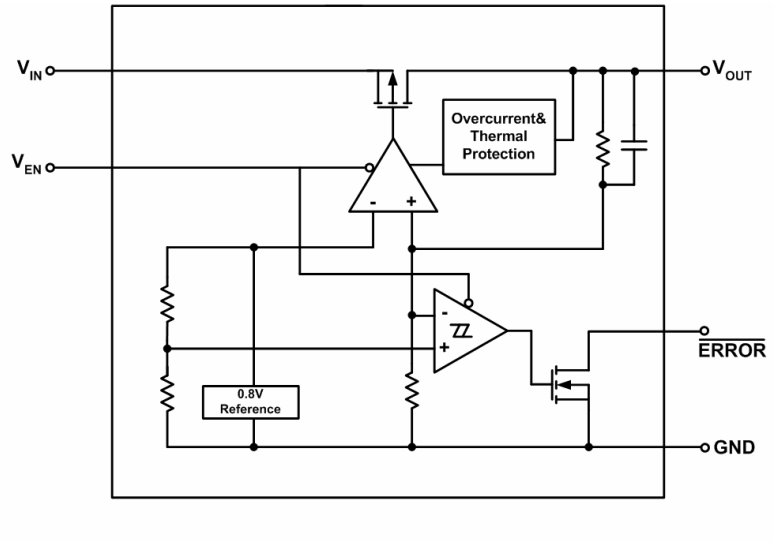
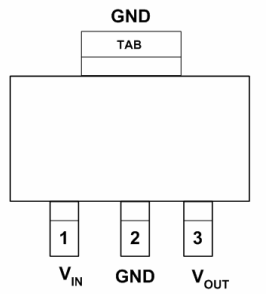
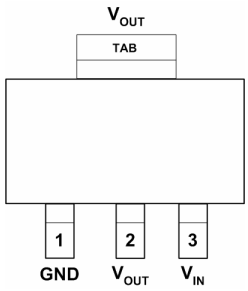
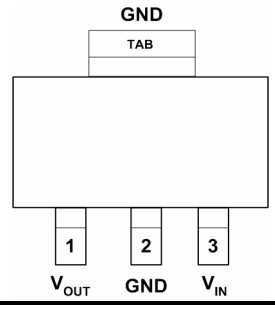
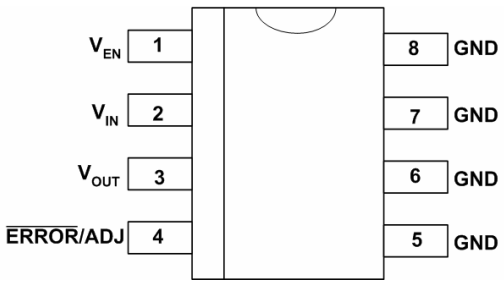


Figure2.

Pin Configurations

Package Type	Pin Configurations	Package Type	Pin Configurations
SOT223-3		SOT223-3 (B)	
SOT-89		SOP-8	

Pin Description

PIN	SOT-223	SOT-223 (B)	SOT-89	SOP-8	DESCRIPTION
V_{EN}	-	-	-	1	Enable Input. Logic high=enable, Logic low=shutdown
V_{IN}	1	3	3	2	Input Voltage of the LDO
GND	2	1	2	5,6,7,8	Ground: TAB is connected to ground
V_{OUT}	3	2	1	3	Output voltage of the LDO
$\overline{ERROR}$	-	-	-	4	$\overline{ERROR}$ Flag Output. Active-low indicated an output fault condition
ADJ					Adjustable Regulator Feedback Input. Connect to resistor voltage divider

Ordering Information

Order Number	Package Type	Marking	Operating Temperature range
EUP7961-15BIR1	SOT223	xxxx P7961C	-40 °C to 125°C
EUP7961-18BIR1	SOT223	xxxx P7961D	-40 °C to 125°C
EUP7961-25BIR1	SOT223	xxxx P7961B	-40 °C to 125°C
EUP7961-33BIR1	SOT223	xxxx P7961H	-40 °C to 125°C
EUP7961B-15BIR1	SOT223	xxxx 7961CB	-40 °C to 125°C
EUP7961B-18BIR1	SOT223	xxxx 7961DB	-40 °C to 125°C
EUP7961B-25BIR1	SOT223	xxxx 7961BB	-40 °C to 125°C
EUP7961B-33BIR1	SOT223	xxxx 7961HB	-40 °C to 125°C
EUP7961-15CIR1	SOT-89	xxxx P7961C	-40 °C to 125°C
EUP7961-18CIR1	SOT-89	xxxx P7961D	-40 °C to 125°C
EUP7961-25CIR1	SOT-89	xxxx P7961B	-40 °C to 125°C
EUP7961-33CIR1	SOT-89	xxxx P7961H	-40 °C to 125°C
EUP7961-15DIR1	SOP-8	xxxx EUP7961 C	-40 °C to 125°C
EUP7961-18DIR1	SOP-8	xxxx EUP7961 D	-40 °C to 125°C
EUP7961-25DIR1	SOP-8	xxxx EUP7961 B	-40 °C to 125°C
EUP7961-33DIR1	SOP-8	xxxx EUP7961 H	-40 °C to 125°C
EUP7961DIR1	SOP-8	xxxx EUP7961 A	-40 °C to 125°C

EUP7961- □□ □ □ □ □ □

Lead Free Code
1: Lead Free 0: Lead

Packing
R: Tape & Reel

Operating temperature range
I: Industry Standard

Package Type:
B: SOT223 C: SOT89 D: SOP

Output Voltage

Absolute Maximum Ratings

- Supply Voltage V_{IN} ---------- 5.5V
- Package Thermal Resistance
  - SOT-223, θ_{JA} ---------- 115°C /W
  - SOP-8, θ_{JA} ---------- 125°C /W
- Power Dissipation, PD@TA=25°C
  - SOT-223 ---------- 0.87W
  - SOP-8 ---------- 0.8W
- Junction Temperature ---------- 150°C
- Storage Temperature ---------- -65°C to +150°C
- Lead Temp ---------- 260°C
- ESD Rating
  - Human Body Model ---------- 2kV

Operating Ratings

- Supply Voltage V_{IN} ---------- 2.5 to 5.5V
- Enable Input Voltage ---------- 0V to 5.5V
- Junction Temperature ---------- -40°C to +125°C

Electrical Characteristics

Limits in standard typeface are for T_J=25°C. Unless otherwise specified: V_{IN}= $V_{OUT(nom)}$ +1V, I_L=10mA,C_{OUT}=4.7µF

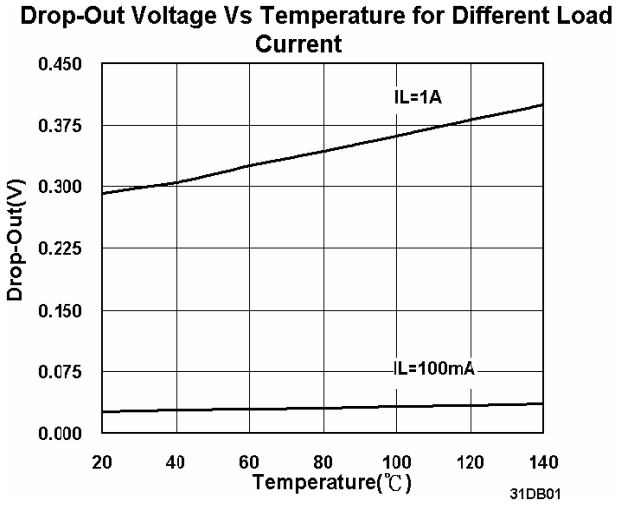
Symbol	Parameter	Conditions	EUP7961			Unit
			Min	Typ	Max.	
ΔV_{OUT}	Output Voltage Tolerance	V_{OUT}+1V ≤ V_{IN} ≤ 5.5V 10mA ≤ I_L ≤ 1A	-1.8		1.8	%
	Line Regulation	V_{OUT}+1V ≤ V_{IN} ≤ 5.5V		0.1	0.24	%
	Load Regulation	10mA ≤ I_L ≤ 1A		0.08	0.32	%
V_{IN} -V_{OUT}	Dropout Voltage	I_L = 100mA		35	50	mV
		I_L = 1A		300	500	
I_{GND}	Ground Pin Current in Normal Operation Mode	I_L = 10mA		300		µA
		I_L = 1A		500		
	Ground Pin Current in Shutdown Mode	V_{EN} ≤ 0.3V	0.01		10	µA
$I_{O(PK)}$	Peak Output Current	V_O ≥ $V_{O(NOM)}$ -4%		1.5		A
Short Circuit Protection						
I_{SC}	Short Circuit Current			1.7		A

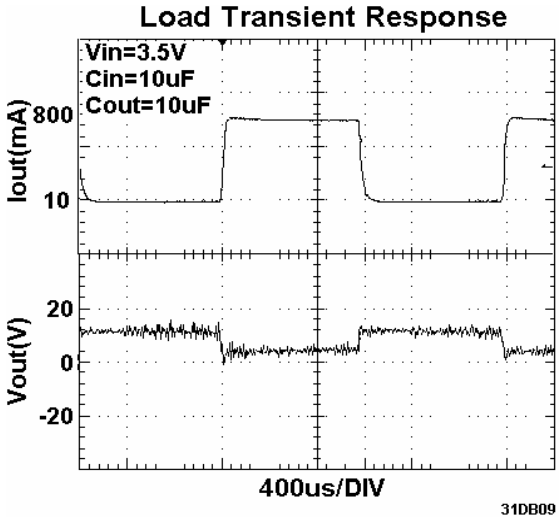
Electrical Characteristics

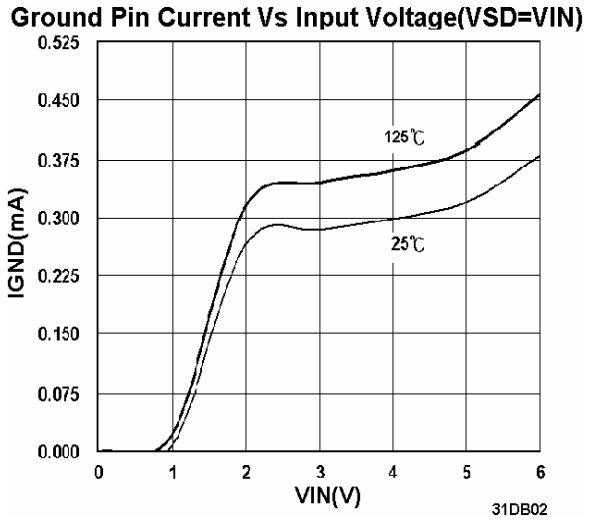
Limits in standard typeface are for T_J=25°C. Unless otherwise specified: V_{IN}= $V_{OUT(nom)}$ +1V, I_L=10mA,C_{OUT}=4.7µF

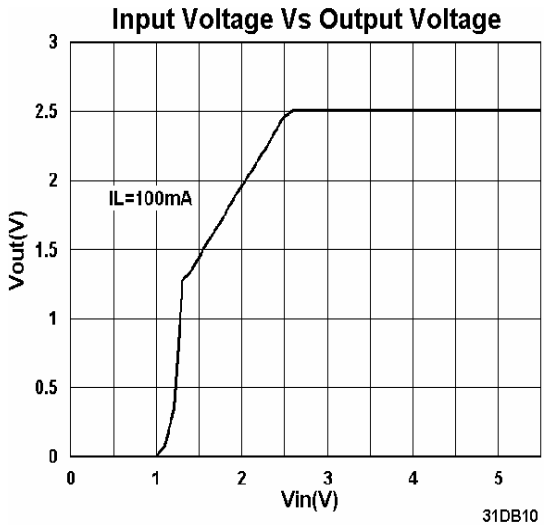
Symbol	Parameter	Conditions	EUP7961			Unit
			Min	Typ	Max.	
V_{IH}	Enable Threshold	Output = High	**1.4**	V_{IN}		V
V_{IL}		Output = Low		0	**0.3**	
T_{dOFF}	Turn-off delay	I_L = 1A		20		µs
T_{dON}	Turn-on delay	I_L = 1A		20		
I_{EN}	V_{EN} Pin Input Current	V_{EN}=V_{IN}		0.1	1	µA
$\overline{\text{ERROR}}$ **Flag**						
V_T	Threshold			10		%
V_{TH}	Threshold Hysteresis			5		%
$V_{EF(Sat)}$	$\overline{\text{ERROR}}$ Flag Saturation	I_{SINK}=100µA		0.02	**0.1**	V
Td	Flag Reset Delay			1		µs
I_{IK}	$\overline{\text{ERROR}}$ Flag Pin Leakage Current			1		nA
I_{max}	$\overline{\text{ERROR}}$ Flag Pin Sink Current	V_{Error}=0.5V		3.8		mA
AC Parameters						
PSRR	Ripple Rejection	V_{IN}=V_{OUT}+1V C_{OUT}=10uF V_{OUT}=3.3V, f=120Hz		60		dB
e_n	Output Noise Voltage	BW=10Hz -100kHz V_{OUT}=2.5V		150		µV(rms)
Over Temperature Protection						
TSH(t)	Shutdown Threshold			150		°C
TSH(h)	Thermal Shutdown Hysteresis			10		°C

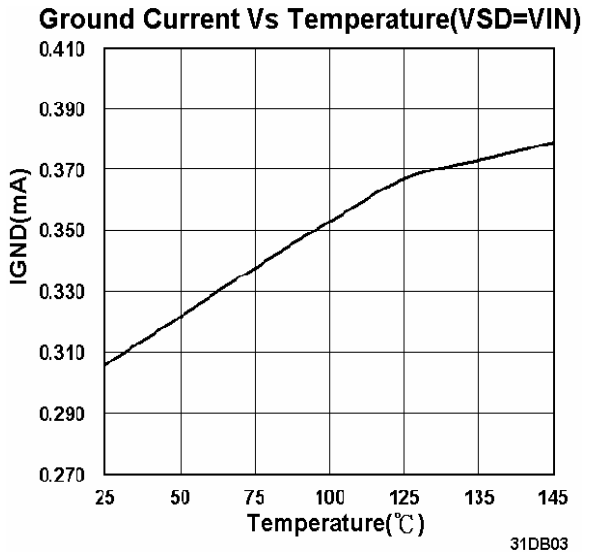
Typical Operating Characteristics

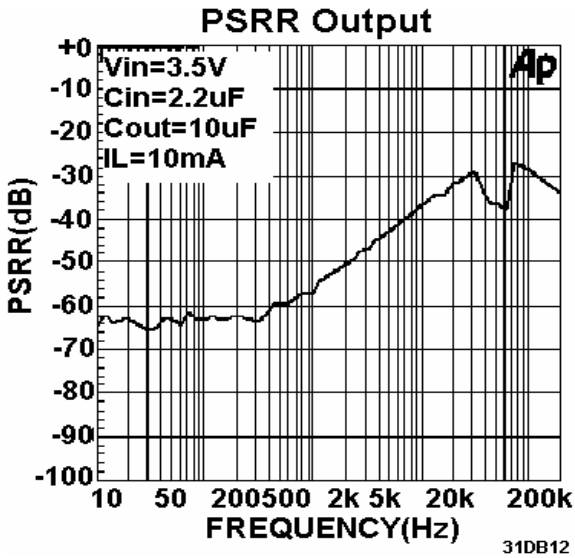


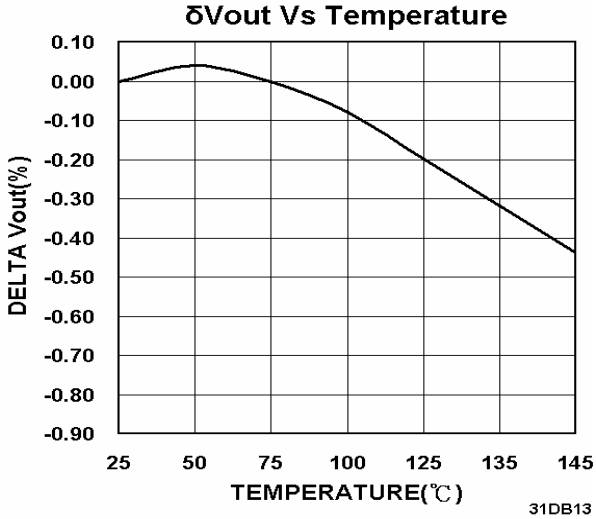


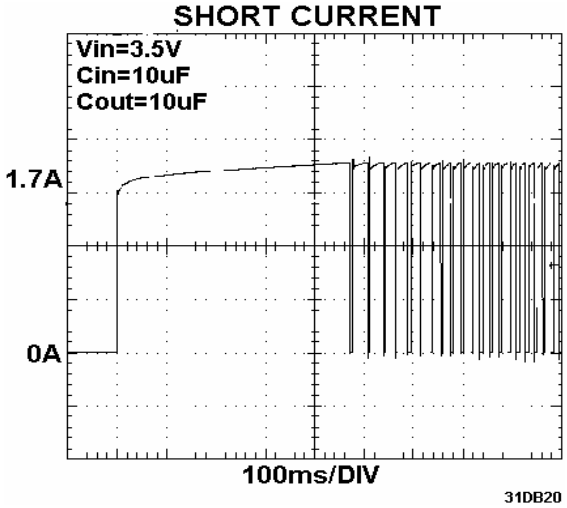


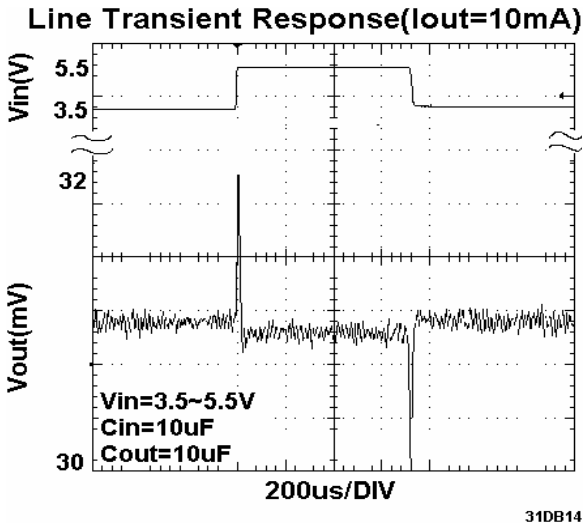


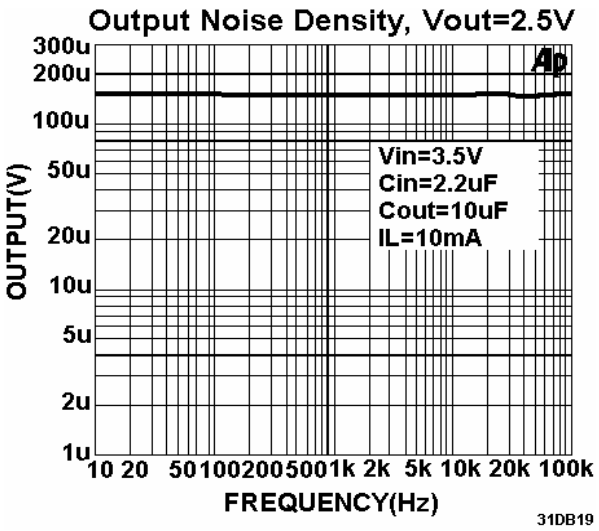





δVout Vs Temperature
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
DELTA Vout(%)
25
50
75
100
125
135
145
TEMPERATURE(℃)
31DB13


SHORT CURRENT
Vin=3.5V
Cin=10uF
Cout=10uF
1.7A
0A
100ms/DIV
31DB20


Line Transient Response(Iout=10mA)
Vin(V)
5.5
3.5
32
Vout(mV)
Vin=3.5~5.5V
Cin=10uF
Cout=10uF
30
200us/DIV
31DB14


Output Noise Density, Vout=2.5V
300u
200u
100u
50u
20u
10u
5u
2u
1u
OUTPUT(V)
Vin=3.5V
Cin=2.2uF
Cout=10uF
IL=10mA
10 20 50 100 200 500 1k 2k 5k 10k 20k 100k
FREQUENCY(Hz)
31DB19

Application Note

External Capacitors

Like any low-dropout regulator, the EUP7961 requires external capacitors for regulator stability. These capacitors must be correctly selected for good performance.

Input Capacitor

An input capacitance of 1µF is required between the EUP7961 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.

There are no requirements for the ESR on the input capacitor, but tolerance and temperature coefficient must be considered when selecting the capacitor to ensure the capacitance will be 1µF over the entire operating temperature range.

Output Capacitor

The EUP7961 is designed specifically to work with very small ceramic output capacitors. A ceramic capacitor (temperature characteristics X7R, X5R, Z5U, or Y5V) in 4.7 to 22µF range with 5mΩ to 200mΩ ESR range is suitable in the EUP7961 application circuit.

The output capacitor must meet the requirement for minimum amount of capacitance and also have an ESR (Equivalent Series Resistance) value which is within a stable range (5mΩ to 200mΩ)

No-Load Stability

The EUP7961 will remain stable and in regulation with no external load. This is specially important in CMOS RAM keep-alive applications.

On/Off Input Operation

The EUP7961 is turned off by pulling the V_{EN} pin low, and turned on by pulling it high. If this feature is not used, the V_{EN} pin should be tied to V_{IN} to keep the regulator output on at all time. To assure proper operation, the signal source used to drive the V_{EN} input must be able to swing above and below the specified turn-on/off voltage thresholds listed in the Electrical Characteristics section under V_{IL} and V_{IH}.

$\overline{\text{ERROR}}$ Flag Operation

The EUP7961 produces a logic low signal at the $\overline{\text{ERROR}}$ Flag pin when the output drops out of regulation due to low input voltage, current limiting, or thermal limiting. This flag has a built in hysteresis.

The internal $\overline{\text{ERROR}}$ flag comparator has an open drain output stage. Hence, the $\overline{\text{ERROR}}$ pin should be pulled high through a pull up resistor. The $\overline{\text{ERROR}}$ pin must be connected to ground if this function is not used. It should also be noted that when the shutdown pin is pulled low, the $\overline{\text{ERROR}}$ pin is forced to be invalid for reasons of saving power in shutdown mode.

Adjustable Operation

The adjustable version of the EUP7961 has an output voltage range of 0.8V to 4.5V. The output voltage of the EUP7961 adjustable regulator is programmed using an external resistor divider as shown in Figure3. The output voltage is calculated using:

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

Where:

Vref= 0.8V typ. (the internal reference voltage)

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

$$P_I = R_2 \left[\frac{V_O}{0.8V} - 1 \right]$$

Choose R_2=50k to optimize accuracy, power supply rejection, noise and power consumption.

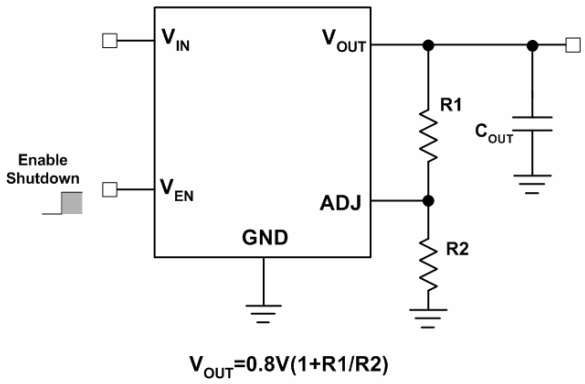


Figure3. Adjustable Regulator with Resistors

Power Dissipation

EUP7961 can deliver a continuous current of 2A over the full operating temperature range. A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The total power dissipation of the device is given by:

$$P_D = (V_{IN} - V_{OUT})I_{OUT} + (V_{IN})I_{GND}$$

Where I_{GND} is the operating ground current of the device (specified under Electrical Characteristics).

The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} - T_{Amax}$$

The maximum allowable value for junction to ambient Thermal Resistance, θ_{JA} , can be calculated using the formula:

$$\theta_{JA} = T_{Rmax}/P_D$$

PCB Layout

Good PC layout practices must be used or instability can be induced because of ground loops and voltages drops. The input and output capacitors must be directly connected to the input, output, and ground pins of the regulator using traces which do not have other currents flowing in them.

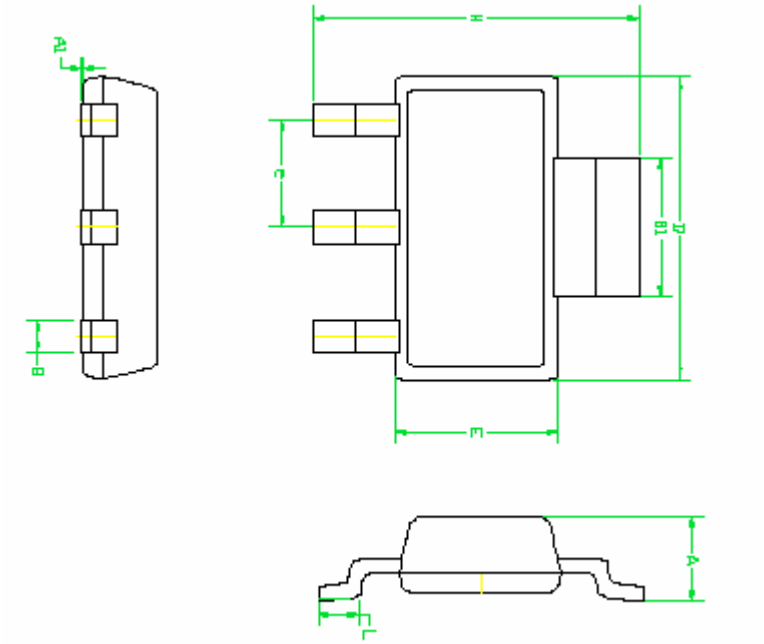
The best way to do this is to lay out C_{IN} and C_{OUT} near the device with short traces to the V_{IN}, V_{OUT}, and ground pins. The regulator ground pin should be connected to the external circuit ground so that the regulator and its capacitors have a “single point ground”.

It should be noted that stability problems have been seen in applications where “vias” to an internal ground plane were used at the ground points of the IC and the input and output capacitors. This was caused by varying ground potentials at these nodes resulting from current flowing through the ground plane. Using a single point ground technique for the regulator and it’s capacitors fixed the problem.

Since high current flows through the traces going into V_{IN} and coming from V_{OUT}, Kelvin connect the capacitor leads to these pins so there is no voltage drop in series with the input and output capacitors.

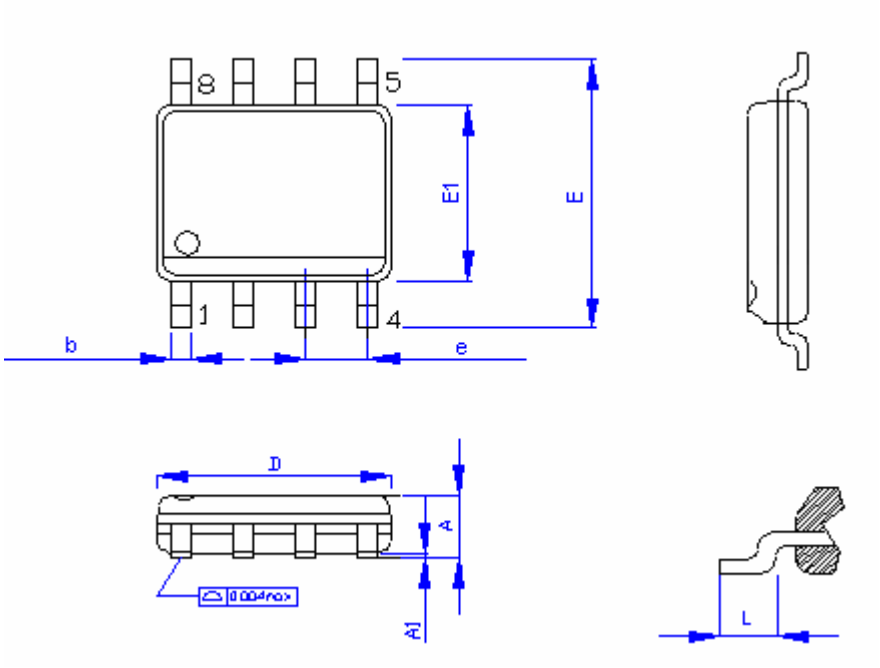
Packaging Information

SOT223-3



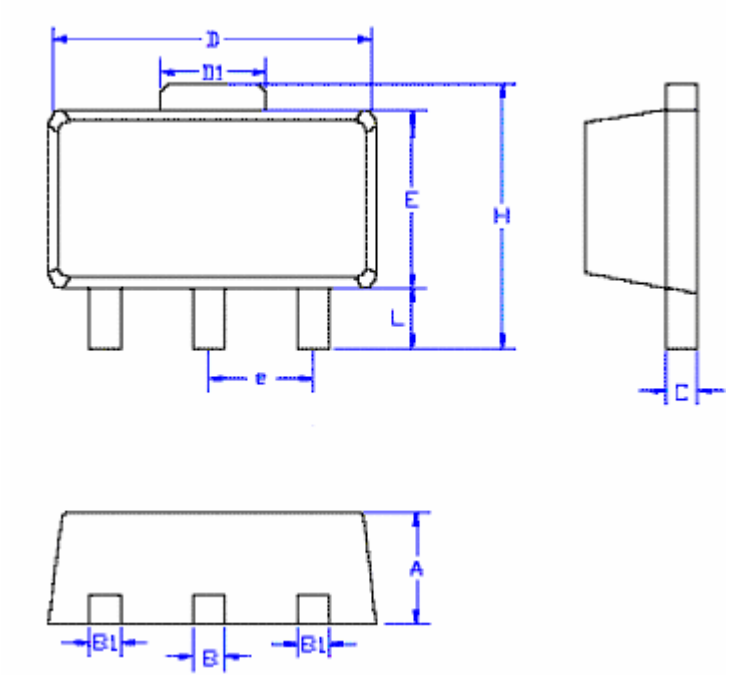
SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	1.50	1.80	0.059	0.071
A1	0.00	0.10	0.000	0.004
B	0.60	0.80	0.024	0.031
B1	2.90	3.10	0.114	0.122
D	6.50		0.256	
E	3.50		0.138	
e	2.30		0.090	
H	6.70	7.30	0.264	0.287
L	0.80	1.10	0.031	0.043

SOP-8



SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	1.35	1.75	0.053	0.069
A1	0.05	0.25	0.002	0.010
D	4.90		0.193	
E1	3.90		0.153	
E	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
b	0.33	0.51	0.013	0.020
e	1.27		0.500	

SOT-89



SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	1.40	1.60	0.055	0.063
L	0.89	1.20	0.035	0.047
B1	0.36	0.48	0.014	0.019
B	0.44	0.56	0.017	0.022
C	0.35	0.44	0.014	0.017
D	4.40	4.60	0.173	0.181
D1	1.35	1.83	0.053	0.072
H	3.94	4.25	0.155	0.167
E	2.29	2.60	0.090	0.102
e	1.50		0.059	