AT1117

1A Low Dropout Precision Regulator

Immense Advance Tech.

FEATURES

- Space Saving SOT-223 Surface Mount Package
- 3-Terminal Adjustable or Fixed 1.5V, 1.8V, 2.5V, 3.3V, 5V
- Output Current of 1A
- Guaranteed Dropout Voltage at Multiple Current Levels
- Fast Transient Response
- Built-in Thermal Limiting
- Good Noise Rejection

APPLICATION

- High Efficiency Linear Regulators
- Post Regulators for Switching Supplies
- Microprocessor Supply
- Hard Drive Controllers
- Battery Chargers
- Adjustable Power Supply

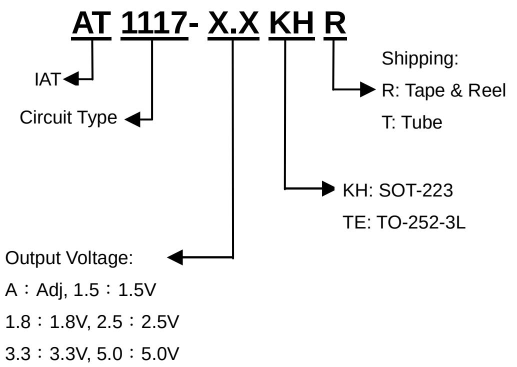
DESCRIPTION

The AT1117 is a positive low dropout regulator designed to provide up to 1A of output current. The device is available in an adjustable version and fixed output voltages of 1.5V to 5V. All internal circuitry is designed to operate down to 1.2V input to output differential. Dropout voltage is guaranteed at a typical of 1.2V at 1A, decreasing at lower load currents. On chip trimming adjusts the reference/output voltage to within ±2%. Current limit is also trimmed in order to minimize the stress on both the regulator and the power source circuitry under overload conditions.

The low profile surface mount SOT-223 package allows the device to be used in applications where space is limited. The AT1117 requires a output capacitance for stability. Output capacitors of this size or larger are normally included in most regulator designs.

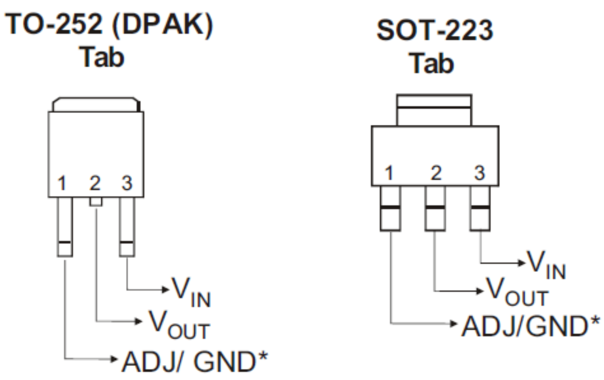
Unlike PNP type regulators where up to 10% of the output current is wasted as quiescent current, the quiescent current of the AT1117 flows into the load, increasing efficiency.

ORDER INFORMATION



PIN CONFIGURATIONS (TOP VIEW)

TAB IS OUTPUT

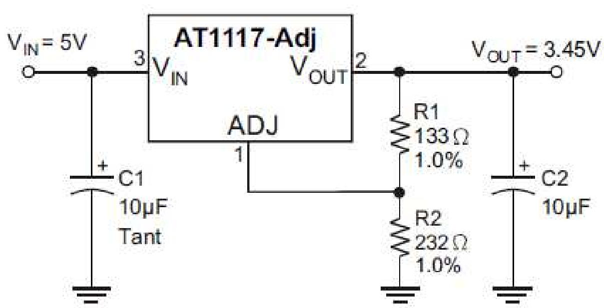


PIN DESCRIPTIONS

Pin Name	Pin Description
ADJ	Feedback for setting the output voltage, connect external resistors network for adjustable output. $V_{OUT}=V_{REF}\times(1+\frac{R2}{R1})+IADJ\times R2$
GND	Reference ground.
V_{OUT}	The output of the regulator. A minimum of 10μF capacitor (0.15Ω ≤ESR≤20Ω)must be connected from this pin to ground to insure stability.
VIN	The input pin of regulator. Typically a large storage capacitor(0.15Ω ≤ESR≤20Ω) is connected from this pin to ground to insure that the input voltage does not sag below the minimum dropout voltage during the load transient response. This pin must always be 1.5V higher than V_{OUT} in order for the device to regulate properly

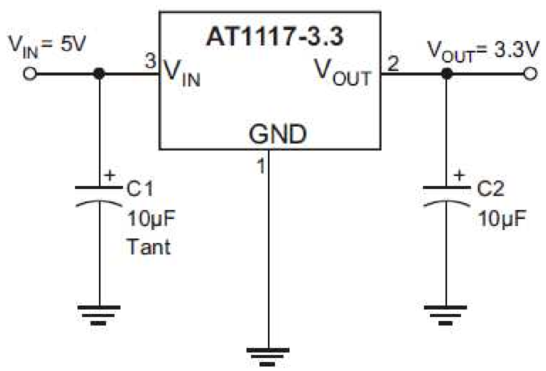
TYPICAL APPLICATION CIRCUITS

(Adjustable Version)



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

(Fixed Version)



Note 1:C1 needed device is far from filter capacitors.

Note 2:C2 minimum value required for stability.

BLOCK DIAGRAM

(1) CMOS Output

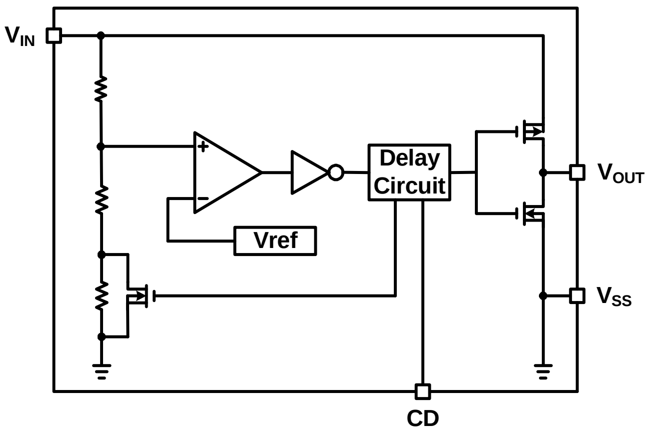


Figure 1.(Fixed Version)

(2) N-ch Open Drain Output

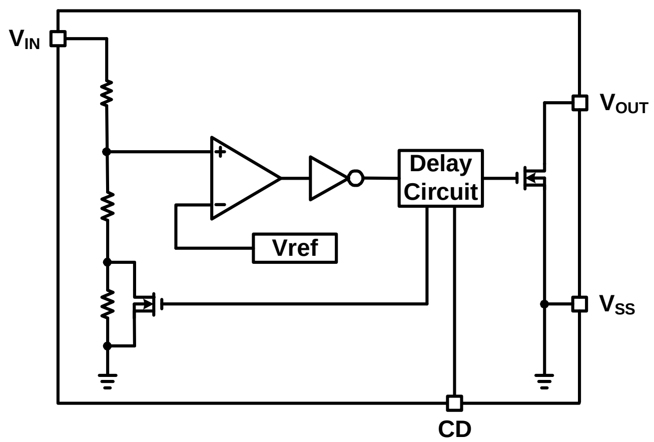


Figure 2.(Adjustable Version)

ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Max Value	Unit
Input Supply Voltage (Note 3)		V_{IN}	-0.3 to 15	V
Lead Temperature(Soldering, 10sec)		T_{LEAD}	260	℃
Storage Temperature Range		T_{STG}	-65 to 150	℃
Operating Junction Temperature Range		T_J	0 to 125	℃
Power Dissipation PD @ TA=25℃ (Note 4)	SOT-223	P_D	850	mW
	TO-252		1050	
Thermal Resistance Junction to Ambient	SOT-223	θ_{JA}	117	℃/W
	TO-252		92	
Thermal Resistance Junction to Case	SOT-223	θ_{JC}	15	℃/W
	TO-252		10	
ESD Rating (Human Body Model) (Note 5)		V_{ESD}	2	kV

Note 3: Consider thermal condition on application which output current would be limited at High Input Supply Voltage.
Note 4: No heat sink, no air flow.
Note 5: Devices are ESD sensitive. Handling precaution recommended.

ELECTRICAL CHARACTERISTICS

T_J = +25℃ unless otherwise specified.

Parameter	Device	Test Conditions	Min	Typ	Max	Unit
Operation Input Voltage	All		2.75	—	12	V
Reference Voltage	ADJ	V_{IN}=2.75V,I_{OUT}=10mA	1.225	1.250	1.275	V
Output Voltage	All Fixed Versions	I_{OUT}=10mA V_{IN}=VOUT+1.5V to 12V	-2	—	+2	%
Line Regulation(Note 6,7)		I_{OUT} =10mA,(1.5 V +V_{OUT})≤V_{IN}≤ 12V	—	0.2	0.5	%
Load Regulation(Note 6,7)	All	V_{IN} = V_{OUT}+ 1.5V I_{OUT} =10mA to 1A	—	0.4	1	%
	All Fixed Versions	V_{IN} =3V,10mA<I_{OUT}<1A	—	12	15	mV
		V_{IN} =3.3V,10mA<I_{OUT}<1A	—	15	18	
		V_{IN} =4V,10mA<I_{OUT}<1A	—	20	58	
		V_{IN} =5V,10mA<I_{OUT}<1A	—	26	33	
		V_{IN} =6.5V,10mA<I_{OUT}<1A	—	40	50	
Dropout Voltage(Note 6、8)	All	I_{OUT}=1A	—	1.3	1.5	V
Current Limit	All	V_{IN}-V_{OUT} =3V	1.1	—	—	A
Minimum Load Current	ADJ	V_{IN}=5V, V_{ADJ} = 0V	—	5	10	mA
Ground Current	All Fixed Versions	0℃ ≤TJ≤125℃	—	7	12	mA
Adjust Pin Current	ADJ	I_{OUT}=10mA, 2.75V≤V_{IN}≤12V	—	50	100	μA
Temp. Coefficient	All	I_{OUT}=10mA	—	0.5	—	%
Ripple Rejection	All	V_{IN}-V_{OUT} =3.0V, F=120Hz,Cout=10μF	60	70	—	dB

Note 6: See thermal regulation specifications for changes in output voltage due to heating effects. Line and load regulation are measured at a constant junction temperature by low duty cycle pulse testing. Load regulation is measured at the output lead = 1/18" from the package.

Note 7: Line and load regulation are guaranteed up to the maximum power dissipation of 15W. Power dissipation is determined by the difference between input and output differential and the output current. Guaranteed maximum power dissipation will not be available over the full input/output range

Note 8: △V_{OUT}、△V_{REF} = 1%.

TYPICAL OPERATING CHARACTERISTICS

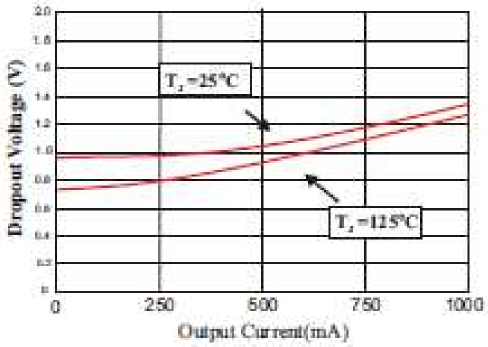


Figure 3.Dropout Voltage vs Output Current

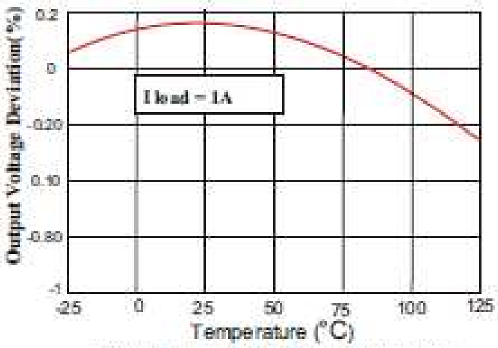


Figure 4.Load Regulation vs Temperature

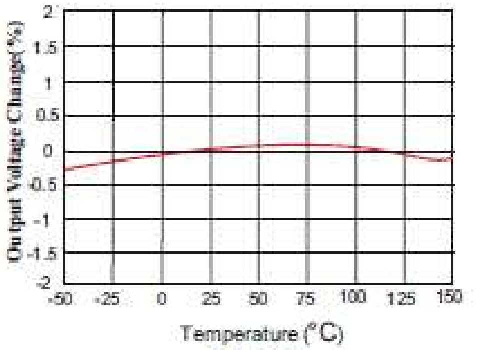
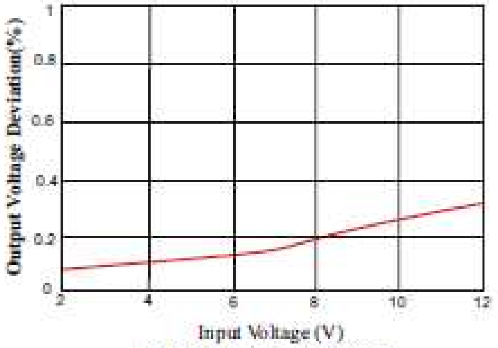


Figure 5.
Percent Chang in Output Voltage vs Temperature



Figuare 6. Lin Regulation

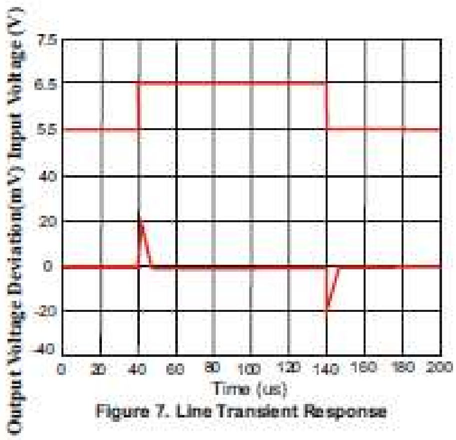


Figure 7. Line Transient Response

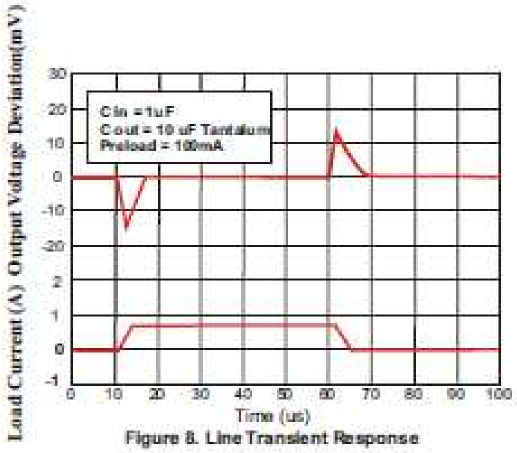


Figure 8. Line Transient Response

APPLICATION INFORMATION

AT1117 linear regulators provide fixed and adjustable output voltages at currents up to 1A. These regulators are protected against overcurrent conditions and include thermal shutdown protection. The AT1117's have a composite PNP-NPN output transistor and require an output capacitor for stability. A detailed procedure for selecting this capacitor follows.

Adjustable Operation

The AT1117 has an output voltage range of 1.25 V to 5.0 V. An external resistor divider sets the output voltage as shown in Figure 9.The regulator maintains a fixed 1.25V (typical) reference between the output pin and the adjust pin.

A resistor divider network R1 and R2 causes a fixed current to flow to ground. This current creates a voltage across R2 that adds to the 1.25 V across R1 and sets the overall output voltage. The adjust pin current (typically 40µA) also flows through R2 and adds a small error that should be taken into account if precise adjustment of VOUT is necessary.

The output voltage is set according to the formula:

$$V_{OUT} = V_{REF} \times \left(\frac{R1+R2}{R1}\right) + I_{ADJ} \times R2$$

The term IADJ x R2 represents the error added by the adjust pin current.

R1 is chosen so that the minimum load current is at least 3.0 mA. R1 and R2 should be the same type, e.g. metal film for best tracking over temperature. While not required, a bypass capacitor from the adjust pin to ground will improve ripple rejection and transient response. A 0.1µF tantalum capacitor is recommended for "first cut" design. Type and value may be varied to obtain optimum performance vs. Price.

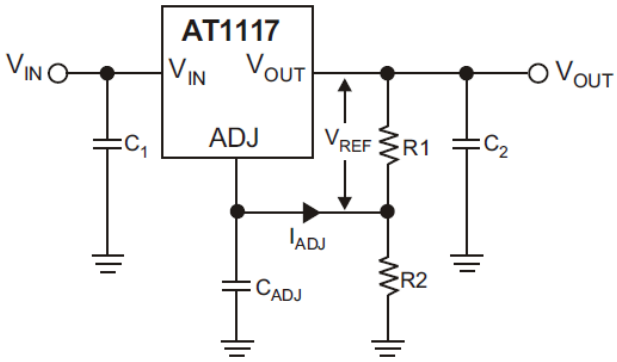


Figure 9. Resistor Divider Scheme

Stability Considerations

The circuit design used in the AT1117 series requires the use of an output capacitor as part of the device frequency compensation.

The addition of 150µF aluminum electrolytic or a 22µF solid tantalum on the output will ensure stability for all operating conditions.

When the adjustment terminal is bypassed with a capacitor to improve the ripple rejection, the requirement for an output capacitor increases. The value of 22µF tantalum or 150µF aluminum covers all cases of bypassing the adjustment terminal. Without bypassing the adjustment terminal smaller capacitors can be used with equally good results.

To ensure good transient response with heavy load current changes capacitor values on the order of 100µF are used in the output of many regulators. To further improve stability and transient response of these devices larger values of output capacitor can be used.

APPLICATION INFORMATION(CONTINUED)

Protection Diodes

When large external capacitors are used with most linear regulator, it is wise to add protection diodes. If the input voltage of the regulator is shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of capacitor, output voltage, and rate at which VIN drops.

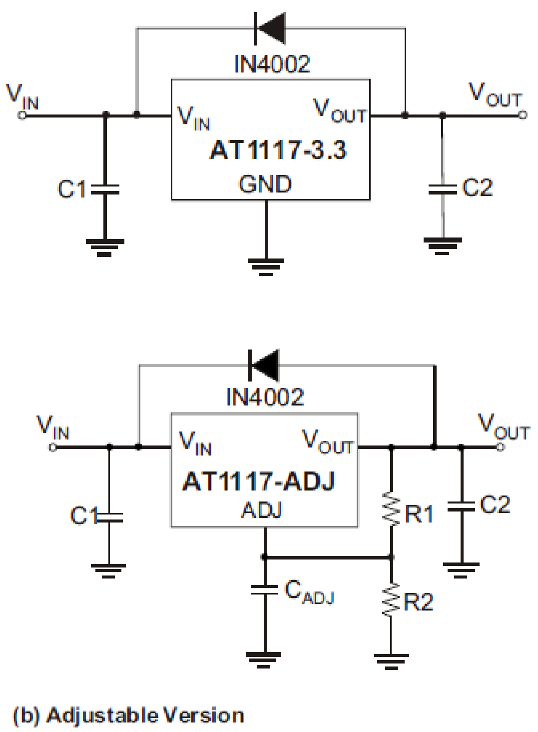


Figure 10.[(a),(b)]Protection Diode Scheme for Large Output Capacitors

In the AT1117 linear regulators, the discharge path is through a large junction, and protection diodes are normally not needed. However, damage can occur if the regulator is used with large output capacitance values and the input voltage is instantaneously shorted to ground. In this case, a diode connected as shown above in Figure 10.

Output Voltage Sensing

The AT1117 are three terminal regulators. For which, they cannot provide true remote load sensing. Load regulation is limited by the resistance of the conductors connecting the regulator to the load. For best results the AT1117 should be connected are as shown in Figure 11.

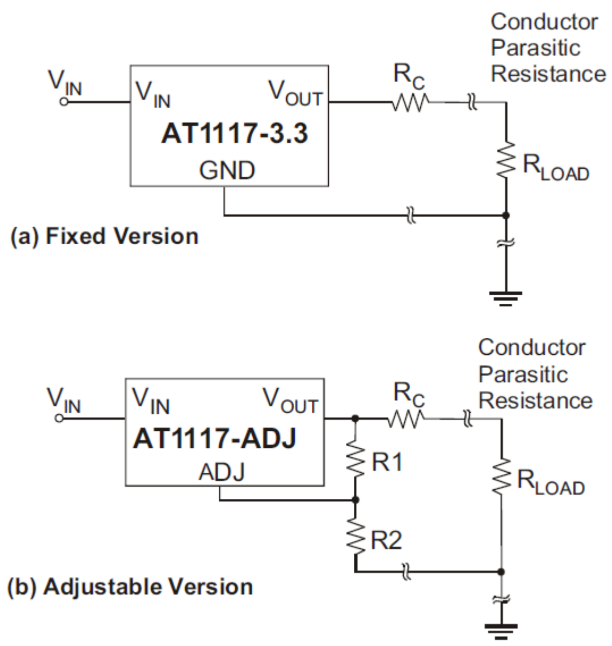


Figure 11.[(a),(b)]Conductor Parasitic Resistance Effects are Minimized by Grounding Scheme For Fixed and Adjustable Output Regulators

Calculating Power Dissipation and Heat Sink Requirements

The AT1117 precision linear regulators include thermal shutdown and current limit circuitry to protect the devices. However, high power regulators normally operate at high junction temperatures. It is important to calculate the power dissipation and junction temperatures accurately to be sure that you use and adequate heat sink. The case is connected to VOUT on the AT1117, and electrical isolation may be required for some applications. Thermal compound should always be used with high current regulators like the AT1117.

The thermal characteristics of an IC depend four factors:

1. Maximum Ambient Temperature T_A (℃)
2. Power Dissipation P_D (Watts)
3. Maximum Junction Temperature T_J (℃)
4. Thermal Resistance Junction to ambient θ_{ja} (℃/W)

The relationship of these four factors is expressed by
equation (1):

$$T_J=T_A+P_D\times\theta_{ja} \text{ ....(1)}$$

Maximum ambient temperature and power dissipation are determined by the design while the maximum junction temperature and thermal resistance depend on the manufacturer and the package type.

The maximum power dissipation for a regulator is expressed by equation (2):

$$P_{D(max)}=\{ V_{IN(max)}-V_{OUT(min)} \}\times I_{OUT(max)}+V_{IN(max)}\times I_Q \text{ .....(2)}$$

Where:

$V_{IN(max)}$ is the maximum input voltage,

$V_{OUT(min)}$ is the minimum output voltage,

$I_{OUT(max)}$ is the maximum output current

I_Q is the maximum quiescent current at $I_{OUT(max)}$.

A heat sink effectively increases the surface area of the package to improve the flow of heat away from the IC into the air. Each material in the heat flow path between the IC and the environment has a thermal resistance. Like series electrical resistances, these resistance are summed to determine θ_{ja}, the total thermal resistance between the junction and the air. This is expressed by equation (3):

$$\theta_{ja}=\theta_{jc}+\theta_{cs}+\theta_{sa} \text{ ....(3)}$$

Where all of the following are in ℃ /W:

θsa is thermal resistance of junction to case,

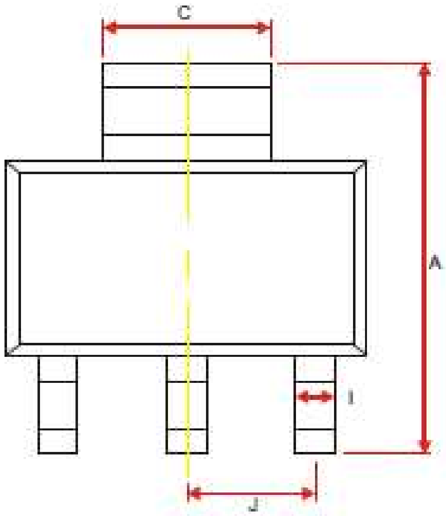
θjc is thermal resistance of case to heat sink,

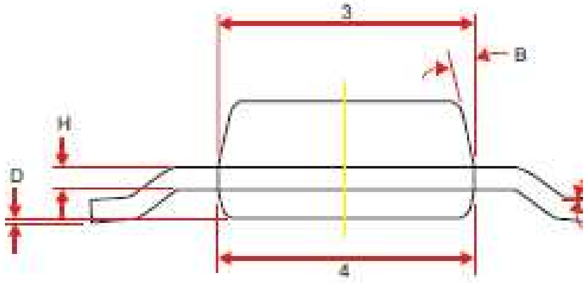
θcs is thermal resistance of heat sink to ambient air.

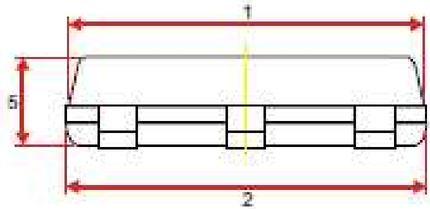
The value for θ_{ja} is calculated using equation (3) and the result can be substituted in equation (1). The value for θjc is 15℃ /W for SOT-223 package type and 10℃ /W for TO-252 based on an average die size. For a high current regulator such as the AT1117 the majority of the heat is generated in the power transistor section.

PACKAGE OUTLINE DIMENSIONS

SOT - 223 PACKAGE OUTLINE DIMENSIONS

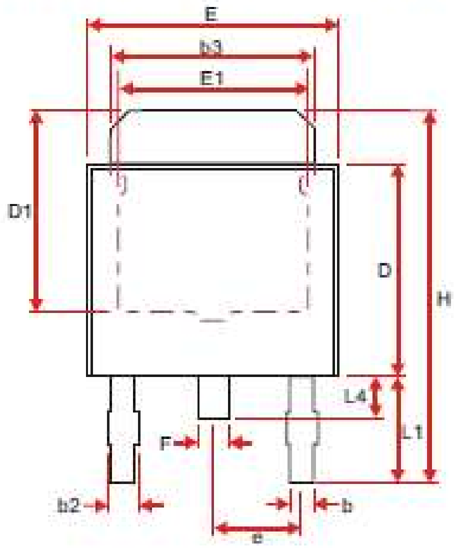


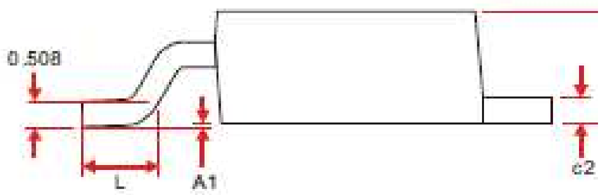




Symbol	Dimensions In Millimeters	
	Min	Max
A	6.70	7.30
C	2.90	3.10
D	0.02	0.10
E	0°	10°
I	0.60	0.80
H	0.25	0.35
B	13° TYP.	
J	2.30 REF.	
1	6.30	6.70
2	6.30	6.70
3	3.30	3.70
4	3.30	3.70
5	1.40	1.80

TO-252-3 PACKAGE OUTLINE DIMENSIONS





Symbol	Dimensions In Millimeters	
	Min	Max
A	2.20	2.40
A1	0	0.15
b	0.50	0.70
b2	0.60	0.90
b3	5.20	5.50
c2	0.45	0.55
D	5.40	5.80
D1	4.57	---
E	6.40	6.80
E1	3.81	---

Note :