

## 1.5A PRECISION LINEAR REGULATORS

- Adjustable or Fixed Output
- Output Current of 1.5A
- Typical Dropout Voltage 1.1V @ 1.5A
- Maximum Line Regulation 0.2%
- Maximum Load Regulation 0.4%
- Fast Transient Response
- Current Limit Protection
- Thermal Shutdown Protection

The GM66015 series of positive adjustable and fixed regulators are designed to provide 1.5A output with low dropout voltage performance. On-chip trimming adjusts the reference voltage to 1.5%. Put them to work in post regulators or microprocessor power supplies where low voltage operation and fast transient response are required.

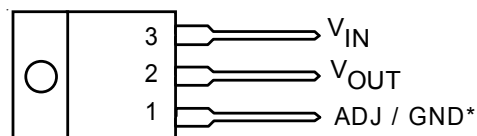
Pin-to-pin compatible with the LT1086 family of regulators, the GM66015's are available in TO-252, TO-220 and surface-mount TO-263 packages.

### Applications:

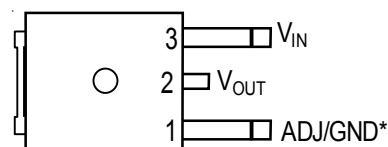
- High Efficiency Linear Regulators
- Post Regulators for Switching Supplies
- Battery Chargers

### CONNECTION DIAGRAMS

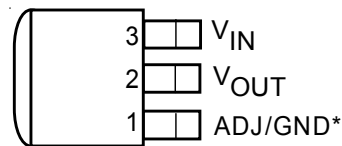
(Top View)



**TO-220 3-LEAD**



**TO-252 (D-PAK)**

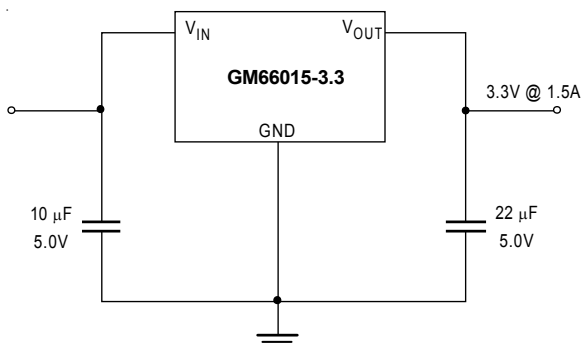


**TO-263 (D2PAK)**

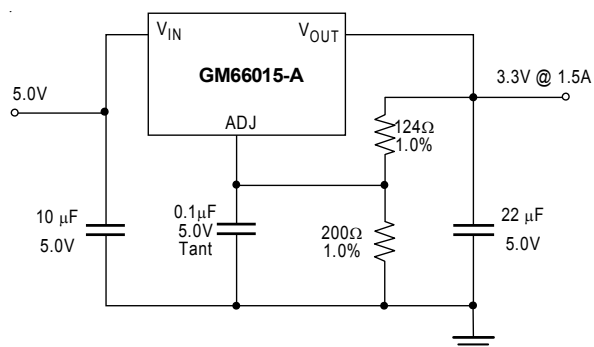
\* On fixed versions Pin1=GND, on adjustable versions Pin1=ADJ

### TYPICAL APPLICATION CIRCUITS

(Fixed Version)



(Adjustable Version)



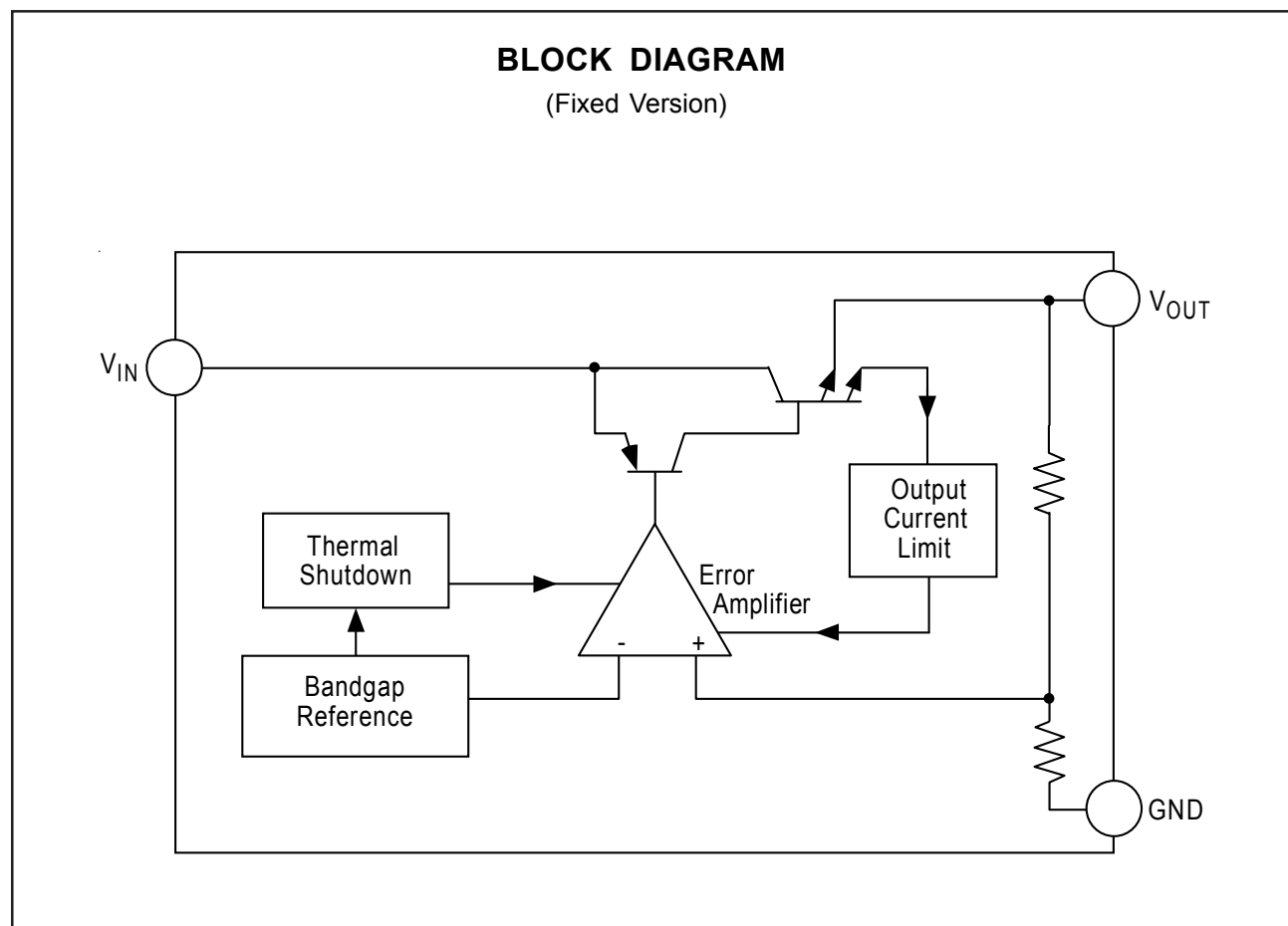
## 1.5A PRECISION LINEAR REGULATORS

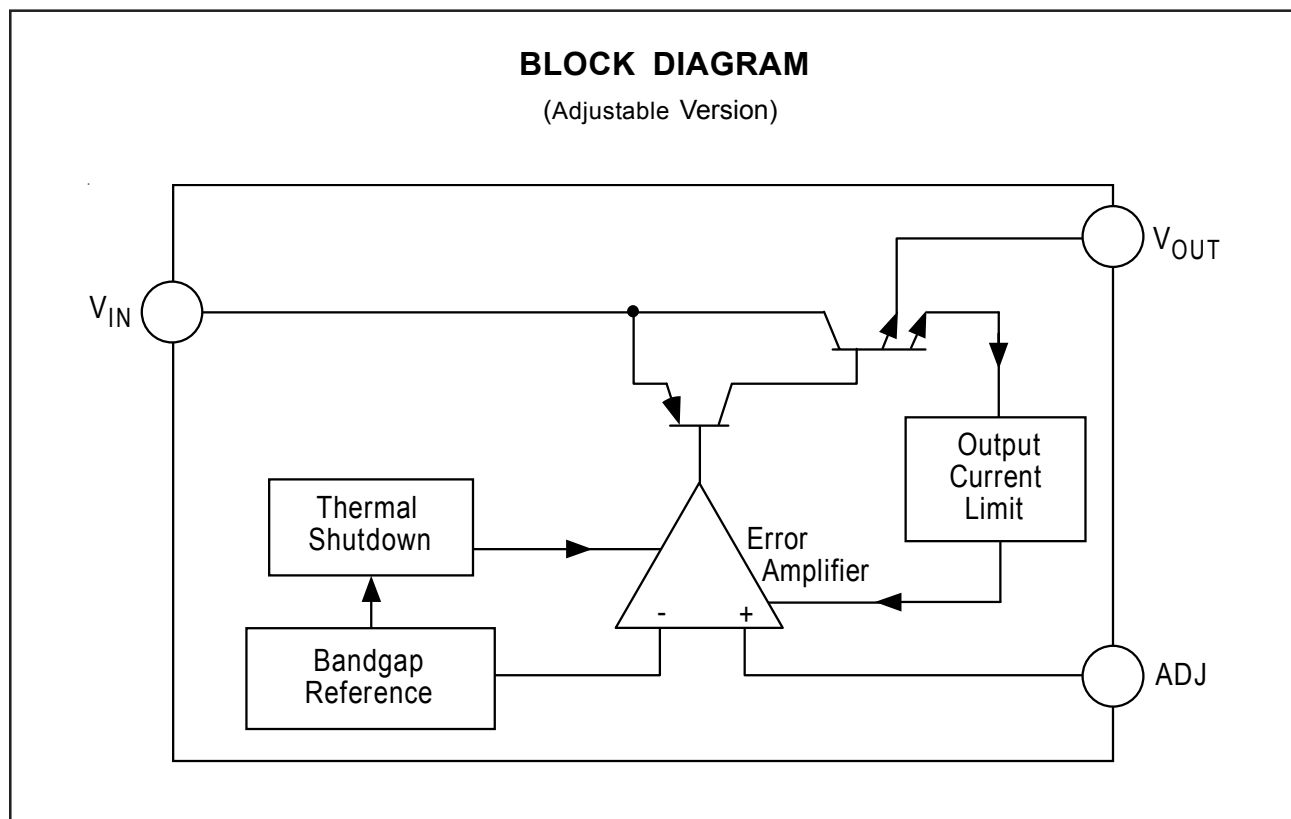
### ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Power Dissipation	$P_D$	Internally limited	W
Input Voltage	$V_{IN}$	7.0 max.	V
Junction Temperature	$T_J$	+150	°C
Lead Temperature (Soldering, 10 sec)	$T_{LEAD}$	300	°C
Operating Temperature Range	$T_A$	-40 to +70	°C
Storage Temperature Range	$T_{STG}$	-65 to +150	°C
ESD Damage Threshold	ESD	2.0	kV

### BLOCK DIAGRAM

(Fixed Version)



**1.5A PRECISION LINEAR REGULATORS**

**■ ORDERING INFORMATION**

	PACKAGE	Output Voltage				
		ADJ.	1.8V	2.5V	3.3V	5.0V
<b>GM66015</b>	TO-263-3	GM66015-ATA3	GM66015-1.8TA3	GM66015-2.5TA3	GM66015-3.3TA3	GM66015-5.0TA3
	TO-220-3	GM66015-ATB3	GM66015-1.8TB3	GM66015-2.5TB3	GM66015-3.3TB3	GM66015-5.0TB3
	TO-252-3	GM66015-ATC3	GM66015-1.8TC3	GM66015-2.5TC3	GM66015-3.3TC3	GM66015-5.0TC3

Note: other fixed versions are available:  $V_{OUT} = 1.5V$  to  $5.0V$

## 1.5A PRECISION LINEAR REGULATORS

### ELECTRICAL CHARACTERISTICS

Unless otherwise specified: Adjustable:  $V_{IN} = 2.75V$  to  $7.0V$  and  $I_O = 10mA$  to  $1.5A$ . Fixed:  $I_O = 0mA$  to  $1.5A$ ,  $V_{IN} = 4.75V$  to  $7.0V$ .

Parameter	Symbol	$V_{IN}$	$I_O$	$T_J^{(5)}$	Min	Typ	Max	Unit
Output Voltage <sup>(1)</sup> (Fixed Versions)	$V_O$	5V	0mA	25°C	-1%	$V_O$	+1%	V
				O.T.	-2%		+2%	
Reference Voltage <sup>(1)</sup> (Adjustable Version)	$V_{REF}$	5V	10mA	25°C	1.238	1.250	1.262	V
				O.T.	1.225		1.275	
Line Regulation <sup>(1)</sup>	$REG_{(LINE)}$		10mA	O.T.	-	0.045	0.20	%
Load Regulation <sup>(1)</sup>	$REG_{(LOAD)}$	5V		O.T.	-	0.15	0.40	%
Dropout Voltage <sup>(1)(2)</sup>	$V_D$		1.5A	O.T.	-	1.1	1.3	V
Current Limit	$I_{CL}$			O.T.	1.5	3.1	-	A
Quiescent Current (fixed version)	$I_Q$			O.T.	-	5	10	mA
Temperature Coefficient	$T_C$			O.T.	-	0.005	-	%/°C
Adjust Pin Current	$I_{ADJ}$			O.T.	-	55	90	μA
Adjust Pin Current Change	$\Delta I_{ADJ}$			O.T.	-	0.20	5	μA
Temperature Stability	$T_S$	5V	0.5A	O.T.	-	0.50	-	%
Minimum Load Current (Adj. version)	$I_O$	5V		O.T.	-	5	10	mA
RMS Output Noise <sup>(3)</sup>	$V_N$			25°C	-	0.003	-	% $V_O$
Ripple Rejection Ratio <sup>(4)</sup>	$R_A$	5V	1.5A	O.T.	60	80	-	dB

#### NOTES:

- (1) Low duty cycle pulse testing with Kelvin connections required
- (2)  $\Delta V_{OUT}, \Delta V_{REF} = 1\%$
- (3) Bandwidth of 10 Hz to 10 kHz
- (4) 120Hz input ripple ( $C_{ADJ}$  for ADJ = 25μF)
- (5) O.T. = over specified operating junction temperature range

## 1.5A PRECISION LINEAR REGULATORS

### APPLICATIONS INFORMATION

The GM66015 series linear regulators provide fixed and adjustable output voltages at currents up to 1.5 A. These regulators are protected against overcurrent conditions and include thermal shutdown protection. The GM66015's have a composite PNP–NPN output transistor and require an output capacitor for stability. A detailed procedure for selecting this capacitor follows.

#### Stability Considerations

The output compensation capacitor helps to determine three main characteristics of a linear regulator's performance: start-up delay, load transient response, and loop stability. The capacitor value and type is based on cost, availability, size and temperature constraints. A tantalum or aluminum electrolytic capacitor is preferred, as a film or ceramic capacitor with almost zero ESR can cause instability. An aluminum electrolytic capacitor is the least expensive type, but when the circuit operates at low temperatures, both the value and ESR of the capacitor will vary widely. For optimum performance over the full operating temperature range, a tantalum capacitor is best. A 22  $\mu$ F tantalum capacitor will work fine in most applications, but with high current regulators such as the GM66015 higher capacitance values will improve the transient response and stability. Most applications for the GM66015's involve large changes in load current, so the output capacitor must supply instantaneous load current. The ESR of the output capacitor causes an immediate drop in output voltage given by:

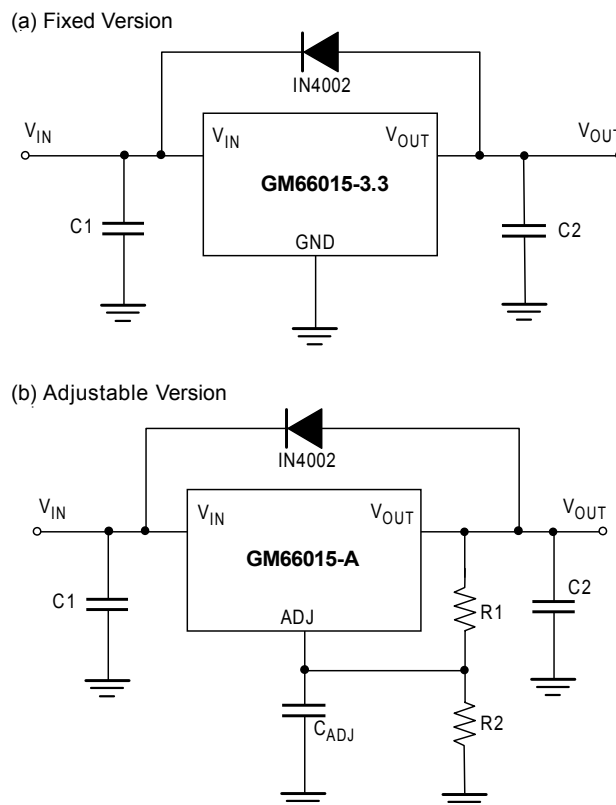
$$\Delta V = \Delta I \times \text{ESR}$$

In microprocessor applications an output capacitor network of several tantalum and ceramic capacitors in parallel is commonly used. This reduces overall ESR and minimizes the instantaneous output voltage drop under transient load conditions. The output capacitor network should be placed as close to the load as possible for the best results.

#### 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  $V_{IN}$  drops.

**FIGURE 1(a),(b) Protection Diode Scheme for Large Output Capacitors**

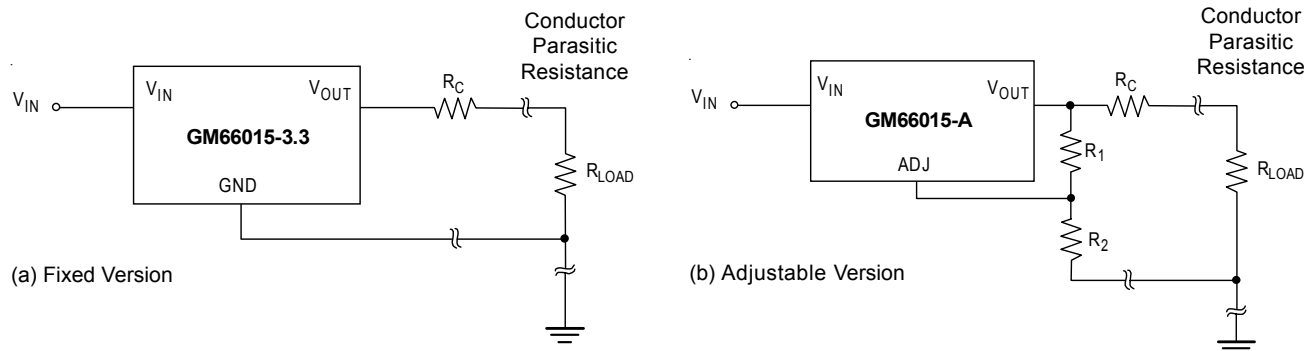


In the GM66015 linear regulators, the discharge path is through a large junction, and protection diodes are normally not needed. However, if the regulator is used with large output capacitance values and the input voltage is instantaneously shorted to ground, damage can occur. In this case, a diode connected as shown above in Figure 1.

## 1.5A PRECISION LINEAR REGULATORS

### Output Voltage Sensing

The GM66015 series are three terminal regulators, so 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 GM66015 should be connected as shown in Figure 2.



**FIGURE 2(a),(b) Conductor Parasitic Resistance Effects are Minimized by this Grounding Scheme For Fixed and Adjustable Output Regulators**

### Calculating Power Dissipation and Heat Sink Requirements

The GM66015 series precision linear regulators include thermal shutdown and current limit circuitry to protect the devices. However, high power regulators normally operate at high junction temperatures so it is important to calculate the power dissipation and junction temperatures accurately to be sure that you use an adequate heat sink. The case is connected to  $V_{OUT}$  on the GM66015, so electrical isolation may be required for some applications. Thermal compound should always be used with high current regulators like the GM66015.

The thermal characteristics of an IC depend on four factors:

1. Maximum Ambient Temperature  $T_A$  ( $^{\circ}\text{C}$ )
2. Power Dissipation  $P_D$  (Watts)
3. Maximum Junction Temperature  $T_J$  ( $^{\circ}\text{C}$ )
4. Thermal Resistance Junction to ambient  $R_{\theta JA}$  ( $^{\circ}\text{C/W}$ )

These relationships of these four factors is expressed by equation (1):

$$T_J = T_A + P_D \times R_{\theta JA}$$

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):

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

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 resistances are summed to determine  $R_{\theta JA}$ , the total thermal resistance between the junction and the air. This is expressed by equation (3):

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CS} + R_{\theta SA}$$

where all of the following are in  $^{\circ}\text{C/W}$ :

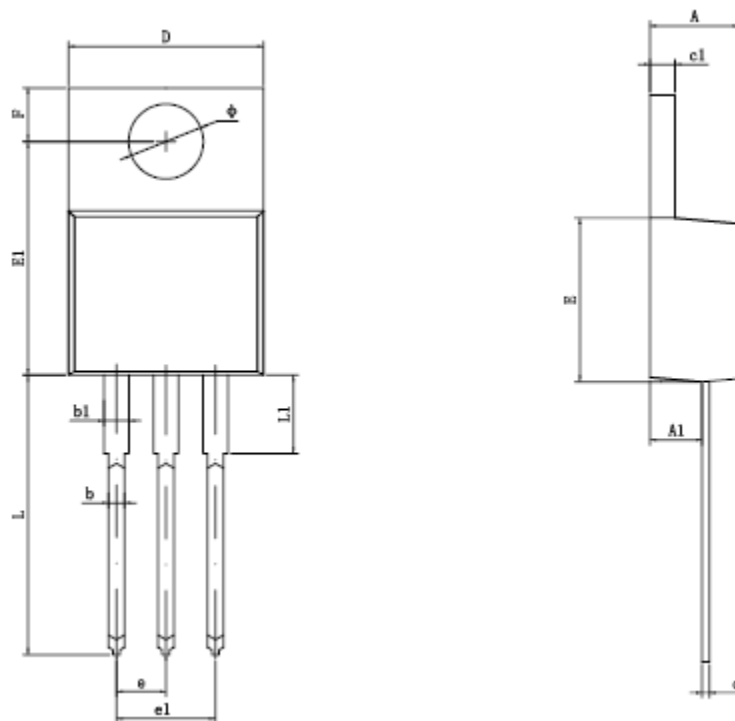
$R_{\theta JC}$  is thermal resistance of junction to case,

$R_{\theta CS}$  is thermal resistance of case to heat sink,

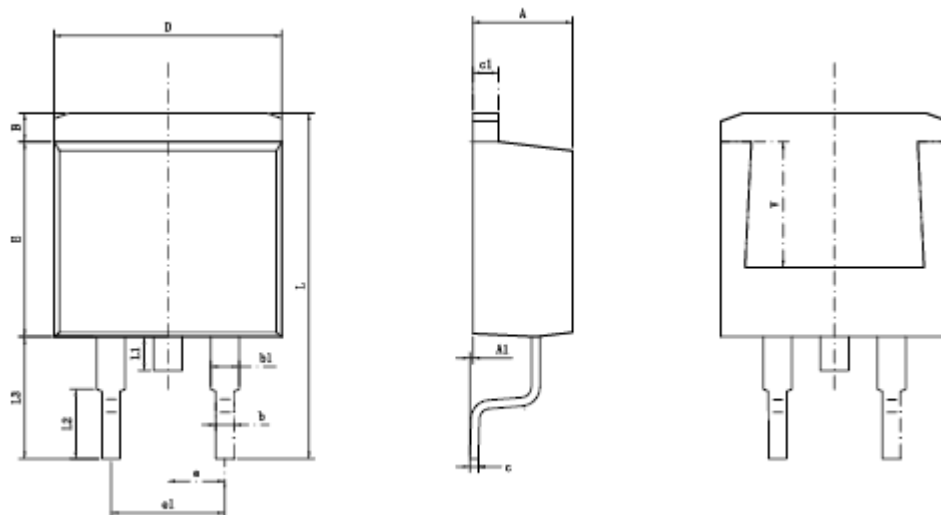
$R_{\theta SA}$  is thermal resistance of heat sink to ambient air

The value for  $R_{\theta JA}$  is calculated using equation (3) and the result can be substituted in equation (1). The value for  $R_{\theta JC}$  is  $3.5^{\circ}\text{C/W}$  for a given package type based on an average die size. For a high current regulator such as the GM66015 the majority of the heat is generated in the power transistor section.

**1.5A PRECISION LINEAR REGULATORS**

 ■ **TO-220-3L PACKAGE OUTLINE DIMENSIONS**


SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.470	4.670	0.176	0.184
A1	2.520	2.820	0.099	0.111
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.500	8.900	0.335	0.350
E1	12.060	12.460	0.475	0.491
e	2.540TYP		0.100TYP	
e1	4.980	5.180	0.196	0.204
F	2.590	2.890	0.102	0.114
L	13.400	13.800	0.528	0.543
L1	3.560	3.960	0.140	0.156
Φ	3.790	3.890	0.149	0.153

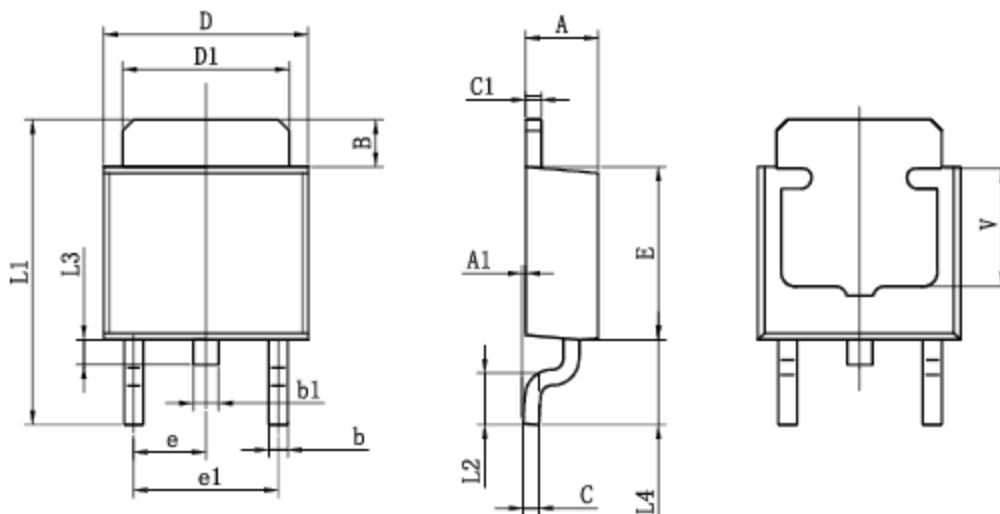
**1.5A PRECISION LINEAR REGULATORS**
**■ TO-263 PACKAGE OUTLINE DIMENSIONS**


SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.470	4.670	0.176	0.184
A1	0.000	0.150	0.000	0.006
B	1.170	1.370	0.046	0.054
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.500	8.900	0.335	0.350
e	2.540TYP		0.100TYP	
e1	4.980	5.180	0.196	0.204
L	15.050	15.450	0.593	0.608
L1	1.300	1.700	0.051	0.067
L2	2.340	2.740	0.092	0.108
L3	5.080	5.480	0.200	0.216
V	5.600REF		0.220REF	



## 1.5A PRECISION LINEAR REGULATORS

### ■ TO-252 PACKAGE OUTLINE DIMENSIONS



SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	0.213
E	5.400	5.700	0.213	0.224
e	2.300TYP		0.091TYP	
e1	4.500	4.700	0.177	0.185
L1	9.500	9.900	0.374	0.390
L2	1.400	1.780	0.055	0.070
L3	0.650	0.950	0.026	0.037
L4	2.550	2.900	0.100	0.114
V	3.800REF		0.150REF	