![GAMMA MICROELECTRONICS logo]

1A PRECISION LINEAR REGULATORS

- **Adjustable or Fixed Output**
- **Output Current of 1A**
- **Dropout Voltage (typical) 1.0V @ 1.0A**
- **Line Regulation 0.2% max.**
- **Load Regulation 0.4% max.**
- **Fast Transient Response**
- **Current Limit Protection**
- **Thermal Shutdown Protection**

The GM6601 series of positive adjustable and fixed regulators are designed to provide 1A output with low dropout voltage performance. On-chip trimming adjusts the reference voltage to 1%. 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 GM6601's are available in TO-220, TO-252 and surface-mount TO-263 and SOT-223 packages.
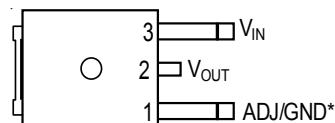
Applications:

- **High Efficiency Linear Regulators**
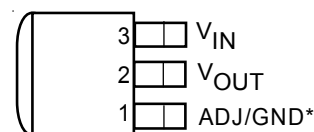- **Post Regulators for Switching Supplies**
- **Microprocessor Supply**
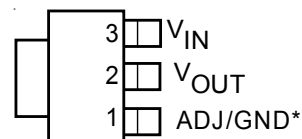
CONNECTION DIAGRAMS (Top View)

TO-220 3-LEAD
- 3 V_{IN}
- 2 V_{OUT}
- 1 ADJ / GND

TO-252 (D-PAK)
- 3 V_{IN}
- 2 V_{OUT}
- 1 ADJ/GND*
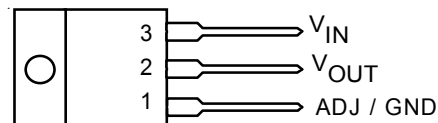
TO-263 (D2PAK)
- 3 V_{IN}
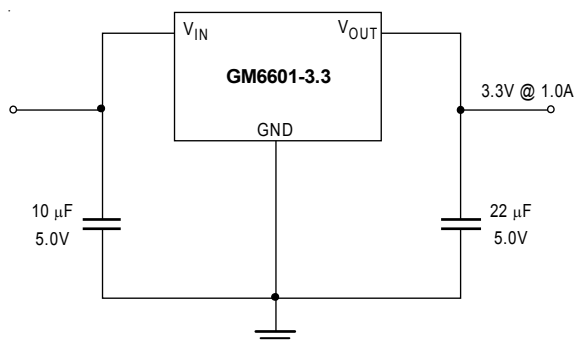- 2 V_{OUT}
- 1 ADJ/GND*

SOT-223
- 3 V_{IN}
- 2 V_{OUT}
- 1 ADJ/GND*

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

TYPICAL APPLICATION CIRCUITS

(Fixed Version)

GM6601-3.3
V_{IN} — V_{OUT} — GND
3.3V @ 1.0A
10 µF 5.0V
22 µF 5.0V

(Adjustable Version)

GM6601-A
V_{IN} — V_{OUT} — ADJ
5.0V
3.3V @ 1.0A
10 µF 5.0V
0.1µF 5.0V Tant
124Ω 1.0%
200Ω 1.0%
22 µF 5.0V
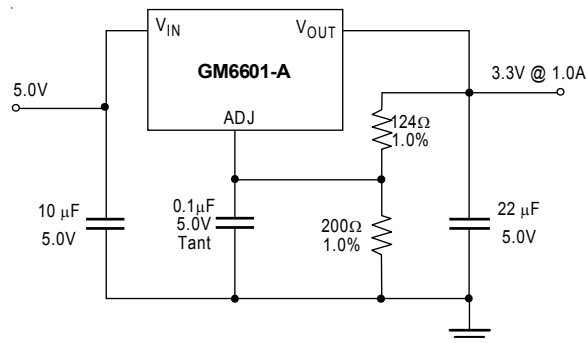
ABSOLUTE MAXIMUM RATINGS

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

BLOCK DIAGRAM
(Fixed Version)

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BLOCK DIAGRAM

(Adjustable Version)
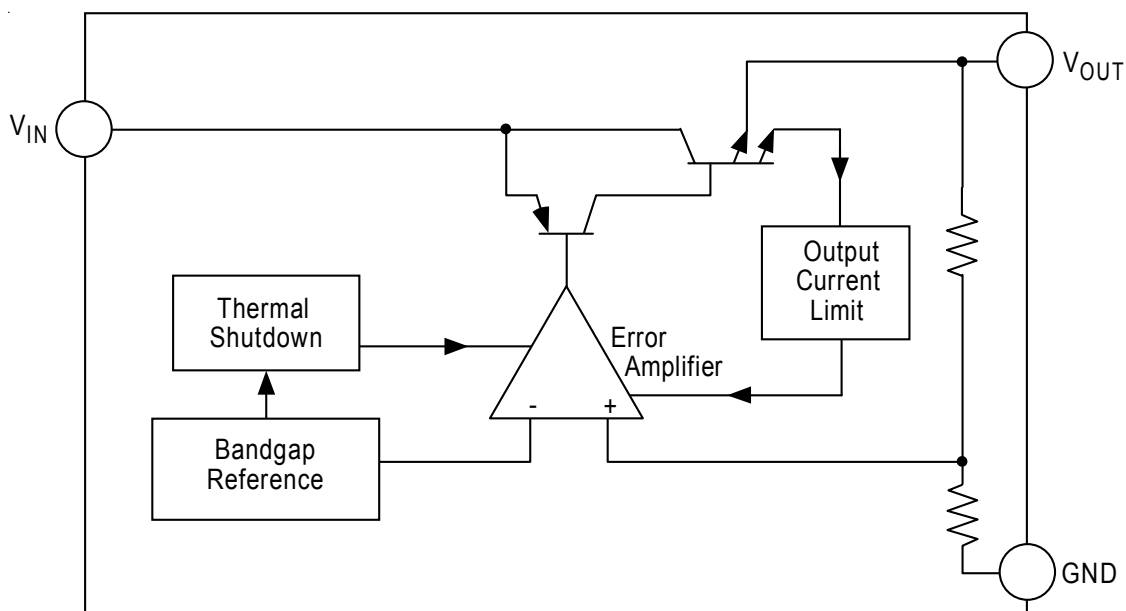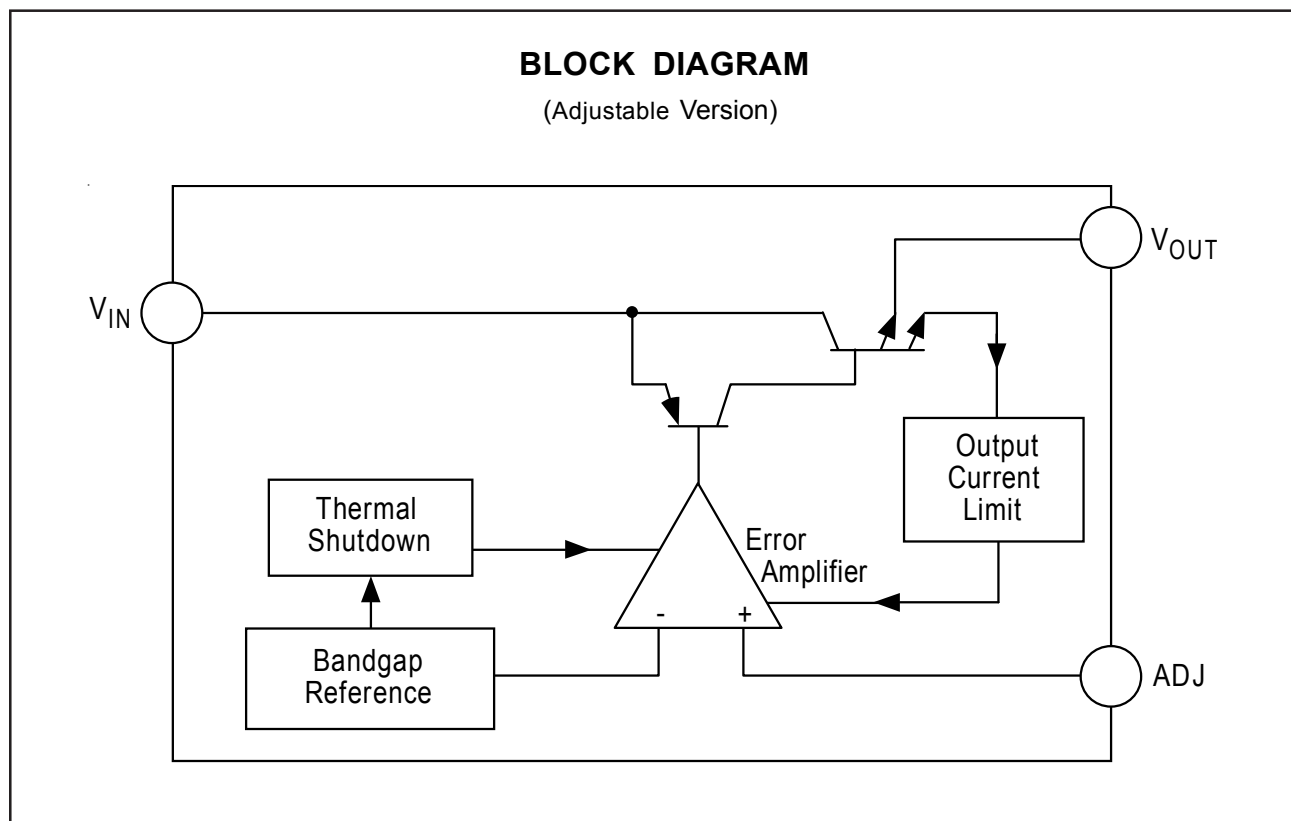
■   **ORDERING INFORMATION**

	PACKAGE	Output Voltage				
		ADJ.	1.8V	2.5V	3.3V	5.0V
GM6601	SOT-223	GM6601-AST3	GM6601-1.8ST3	GM6601-2.5ST3	GM6601-3.3ST3	GM6601-5.0ST3
	TO-263-3	GM6601-ATA3	GM6601-1.8TA3	GM6601-2.5TA3	GM6601-3.3TA3	GM6601-5.0TA3
	TO-220-3	GM6601-ATB3	GM6601-1.8TB3	GM6601-2.5TB3	GM6601-3.3TB3	GM6601-5.0TB3
	TO-252	GM6601-ATC3	GM6601-1.8TC3	GM6601-2.5TC3	GM6601-3.3TC3	GM6601-5.0TC3

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

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ELECTRICAL CHARACTERISTICS

Unless otherwise specified: Adjustable Option: V_{IN} = 2.65V to 7.0V and I_O = 10mA to I_{RATED}. Fixed Options: I_O = 0mA to I_{RATED}, V_{IN} (2.5V) = 3.9V to 7.0V, V_{IN} (2.85V) = 4.25V to 7.0V, V_{IN} (3.3V) = 4.75V to 7.0V.

Parameter	Symbol	V_{IN}	I_O	T_J[5]	Min	Typ	Max	Unit
Output Voltage [1] (Fixed Versions)	V_O	5V	0.0mA	25°C	-1%	V_O	+1%	V
				O.T.	-2%		+2%	
Reference Voltage [1] (Adjustable Version)	V_{REF}	5V	10mA	25°C	1.238	1.250	1.262	V
				O.T.	1.225		1.275	
Line Regulation [1]	$REG_{(LINE)}$		10mA	O.T.		0.035	0.20	%
Load Regulation [1]	$REG_{(LOAD)}$	5V		O.T.		0.20	0.40	%
Dropout Voltage [1][2]	V_D		1.0A	O.T.		1.0	1.2	V
Current Limit	I_{CL}			O.T.	1.0	1.1		A
Quiscent Current (fixed version)	I_Q			O.T.		10	13	mA
Temperature Coefficient	T_C			O.T.		0.005		%/°C
Adjust Pin Current	I_{ADJ}			O.T.		55	90	µA
Adjust Pin Current Change	ΔI_{ADJ}			O.T.		0.20	5	µA
Temperature Stability	T_S			O.T.		0.50		%
Minimum Load Current (Adj. version)	I_O	5V		O.T.		5	10	mA
RMS Output Noise [3]	V_N			25°C		0.003		%V_O
Ripple Rejection Ratio [4]	R_A	5V	I_{RATED}	O.T.	60	75		dB

NOTES:

(1) Low duty cycle pulse testing with Kelvin connections required

(2) ΔV_{OUT}, ΔV_{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

1A PRECISION LINEAR REGULATORS

APPLICATIONS INFORMATION

The GM6601 series linear regulators provide fixed and adjustable output voltages at currents up to 1.0 A. These regulators are protected against overcurrent conditions and include thermal shutdown protection. The GM6601'a 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 μF tantalum capacitor will work fine in most applications, but with high current regulators such as the GM6601 higher capacitance values will improve the transient response and stability. Most applications for the GM6601'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:

$$\Delta V = \Delta I \times ESR$$

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.
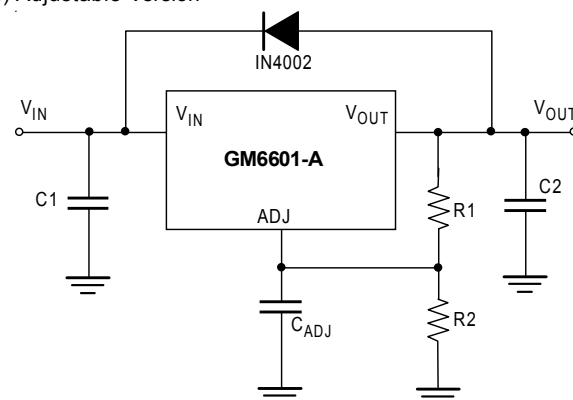
Protection Diodes

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

(a) Fixed Version
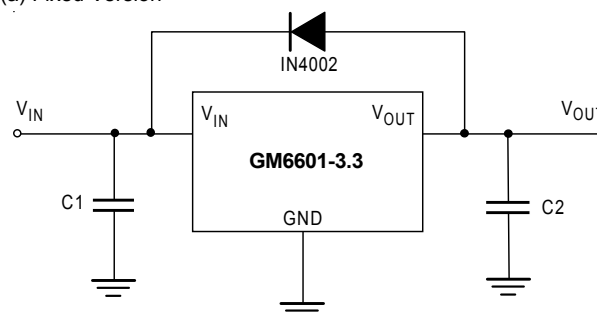
(b) Adjustable Version

In the GM6601 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.

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Output Voltage Sensing

The GM6601 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 GM6601 should be connected as shown in Figure 2.
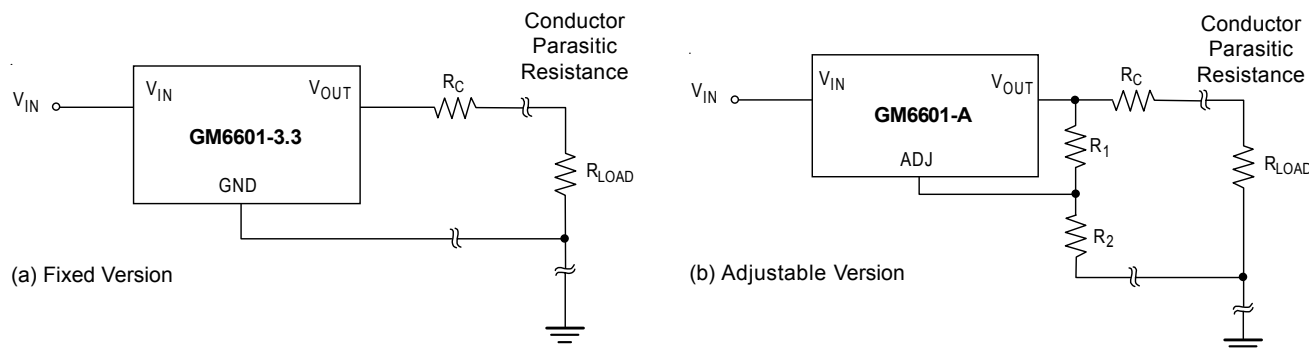

FIGURE 2[(a),(b)] **Conductor Parasitic Resistance Effects are Minimized by this Grounding Scheme For Fixed and Adjustable Output Regulators**

Calculating Power Dissipation and Heat Sink Requirements

The GM6601 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 and adequate heat sink. The case is connected to V_{OUT} on the GM6601, so electrical isolation may be required for some applications. Thermal compound should always be used with high current regulators like the GM6601.

The thermal characteristics of an IC depend four factors:
1. Maximum Ambient Temperature T_A (°C)
2. Power Dissipation P_D (Watts)
3. Maximum Junction Temperature T_J (°C)
4. Thermal Resistance Junction to ambient $R_{\Theta JA}$ (°C/W)

These relationship 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 °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°C/W for a given package type based on an average die size. For a high current regulator such as the GM6601 the majority of the heat is generated in the power transistor section.

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■ **TO-220-3L PACKAGE OUTLINE DIMENSIONS**
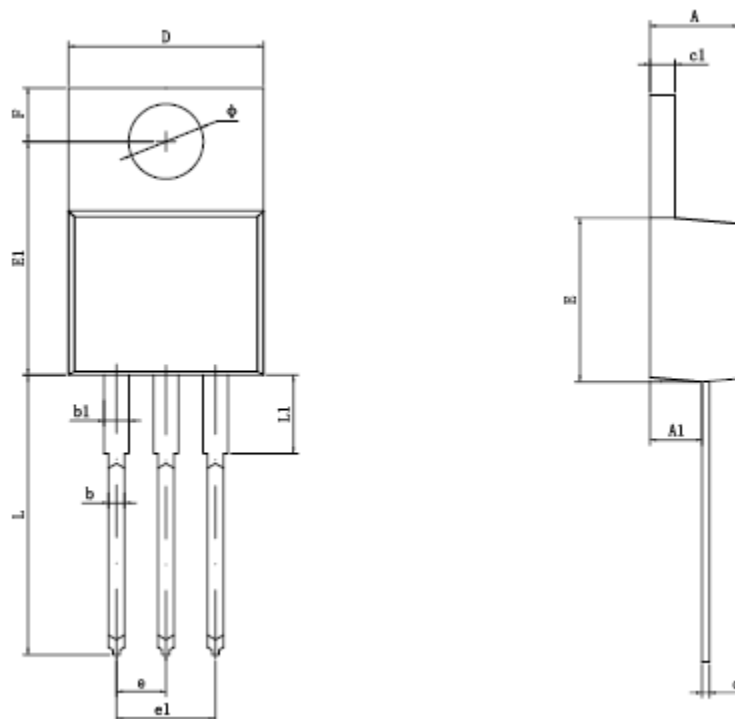
SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.470	4.670	0.176	0.184
A1	2.520	2.820	0.099	0.111
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.500	8.900	0.335	0.350
E1	12.060	12.460	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

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■ **TO-263 PACKAGE OUTLINE DIMENSIONS**
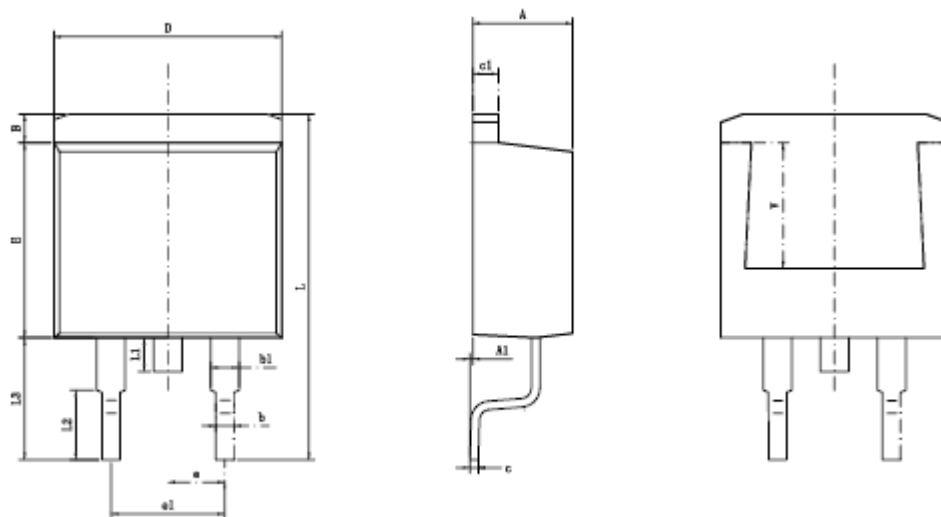
SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.470	4.670	0.176	0.184
A1	0.000	0.150	0.000	0.006
B	1.170	1.370	0.046	0.054
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.500	8.900	0.335	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	

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■ **SOT-223 PACKAGE OUTLINE DIMENSIONS**
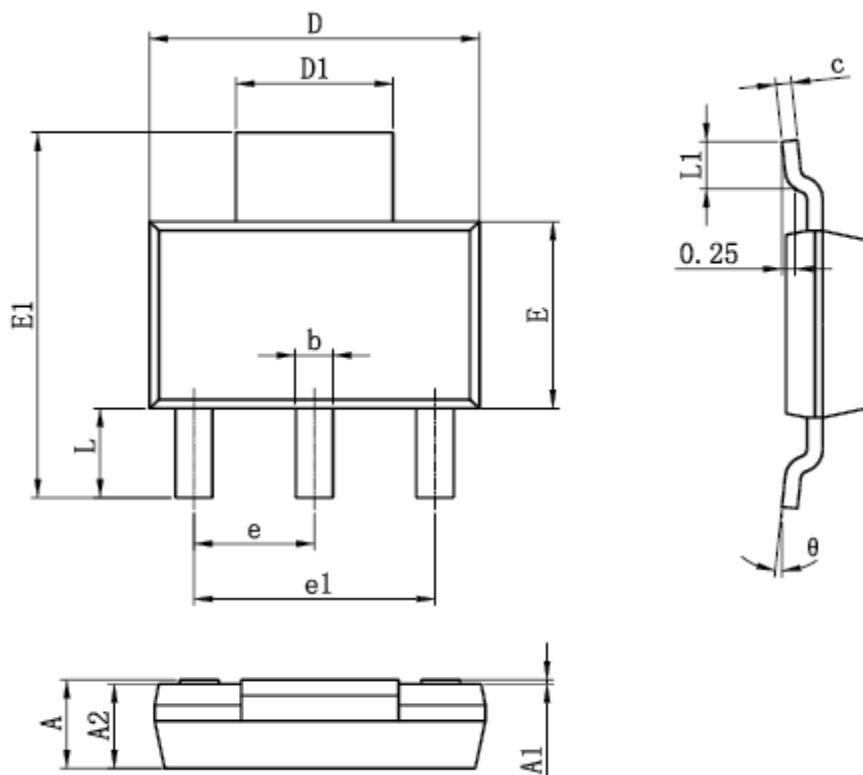
SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.520	1.800	0.060	0.071
A1	0.020	0.100	0.001	0.004
A2	1.500	1.700	0.059	0.067
b	0.610	0.810	0.024	0.032
c	0.250	0.350	0.010	0.014
D	6.300	6.700	0.248	0.264
D1	2.900	3.100	0.114	0.122
E	3.300	3.700	0.130	0.146
E1	6.700	7.300	0.264	0.287
e	2.300TYP		0.091TYP	
e1	4.500	4.700	0.177	0.185
L	1.750TYP		0.069TYP	
L1	0.900	-	0.035	-
θ	0°	10°	0°	10°

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■ **TO-252 PACKAGE OUTLINE DIMENSIONS**
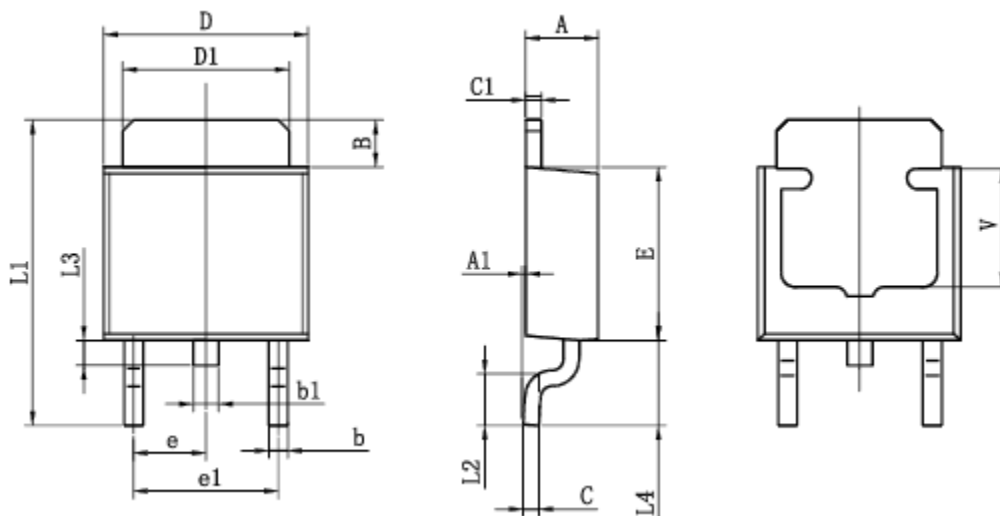
SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	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	