GAMMA
MICROELECTRONICS

3.0A PRECISION LINEAR REGULATORS

■ **Adjustable or Fixed Output**
■ **Output Current of 3.0A**
■ **Dropout Voltage (typical) 1.2V @ 3.0A**
■ **Typical Line Regulation 0.015%**
■ **Typical Load Regulation 0.05%**
■ **Fast Transient Response**
■ **Current Limit Protection**
■ **Thermal Shutdown Protection**

The GM6603 series of positive adjustable and fixed regulators are designed to provide 3.0A output with low dropout voltage performance.

On-chip trimming adjusts the reference voltage to 2.0%. Put them to work in post regulators or microprocessor power supplies where low voltage operation and fast transient response are required.

Device includes over-current protection and thermal shutdown protection as well.

Pin-to-pin compatible with the LT1085 family of regulators, the GM6603's are available in TO-252, TO-220 and surface-mount TO263 packages.

Applications:
■ **Microprocessor Supply**
■ **Post Regulators for Switching Supplies**
■ **Telecommunication Systems**
■ **Printer Supplies**
■ **Motherboards**

CONNECTION DIAGRAMS

(Top View)

TO-252 (D-PAK)

(Top View)

TO-220 3-LEAD

(Top View)

TO-263 (D2PAK)
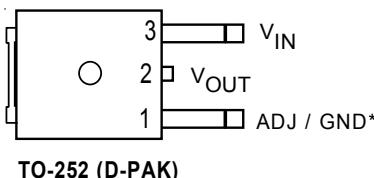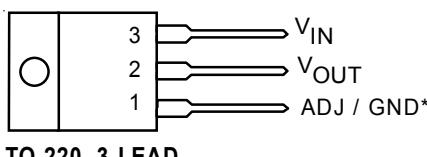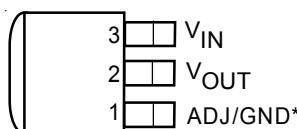
* On fixed versions Pin1=GND,
  on adjustable versions Pin1=ADJ

TYPICAL APPLICATION CIRCUITS

(Fixed Version)
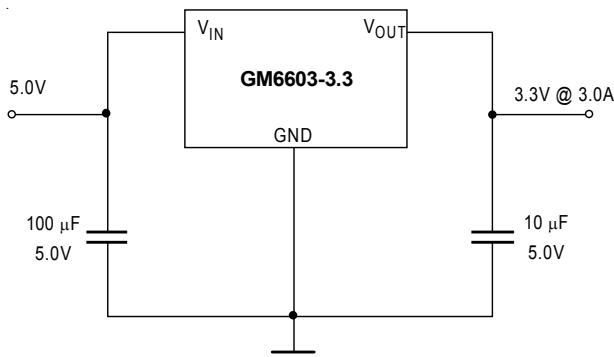
(Adjustable Version)
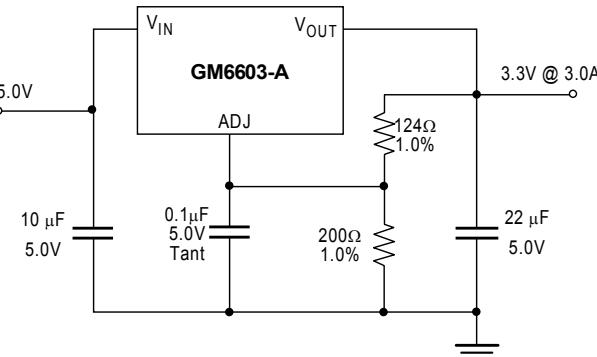
3.0A PRECISION LINEAR REGULATORS

■ **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
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

(Adjustable Version)

BLOCK DIAGRAMS

(Fixed Version)
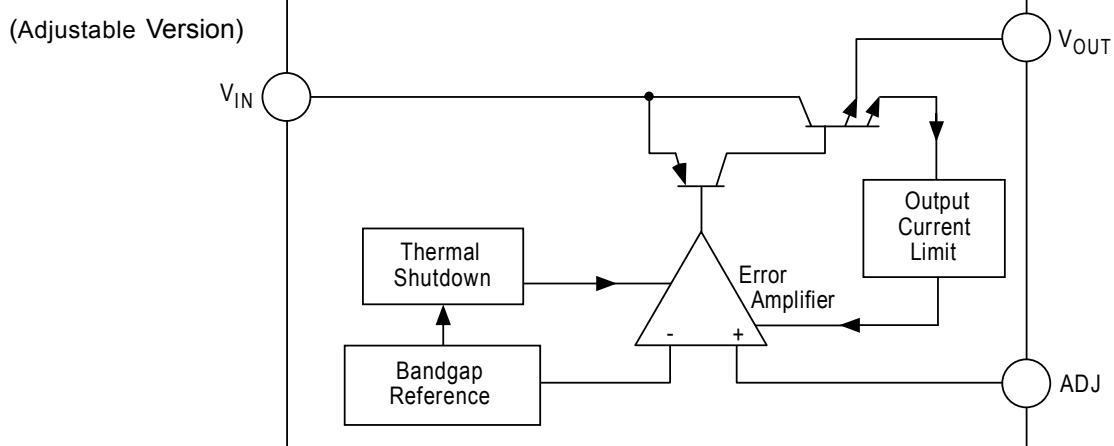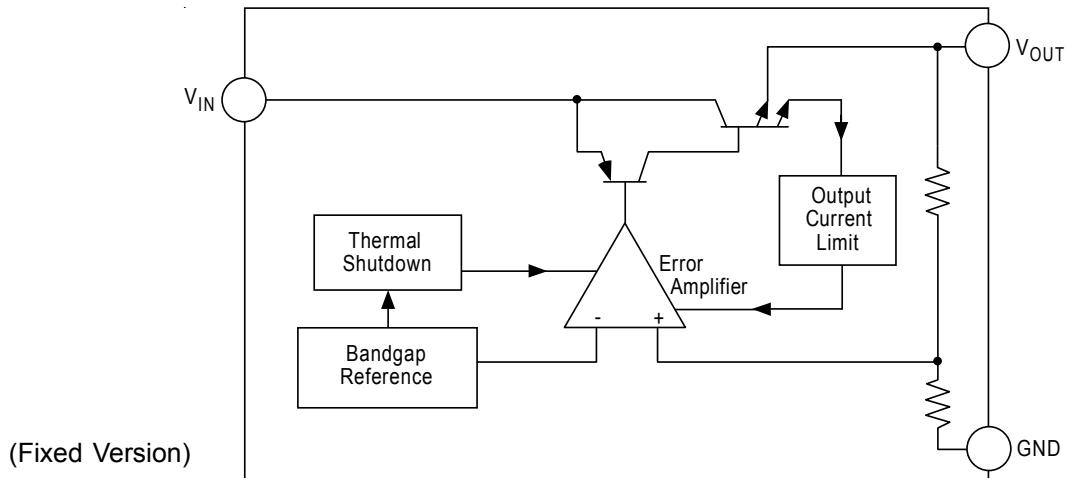
3.0A PRECISION LINEAR REGULATORS

■ ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Reference Voltage	GM6603-Adj	V_{REF}	I_{OUT}=10mA, V_{IN}-V_{OUT}=1.5V	1.238	1.250	1.262	V
			10mA $\leq I_{OUT} \leq$ 3A, 3.3V $\leq V_{IN} \leq$ 7V	1.230	1.250	1.270	
Output Voltage	GM6603-1.8	V_O	I_{OUT}=10mA,V_{IN}=3.3V	1.782	1.800	1.818	V
			10mA $\leq I_{OUT} \leq$ 3A, 3.3V $\leq V_{IN} \leq$ 7V	1.764	1.800	1.836	
	GM6603-2.5		I_{OUT}=10mA,V_{IN}=4V	2.475	2.500	2.525	V
			10mA $\leq I_{OUT} \leq$ 3A, 4V $\leq V_{IN} \leq$ 7V	2.450	2.500	2.550	
	GM6603-3.3		I_{OUT}=10mA,V_{IN}=4.8V	3.267	3.300	3.333	V
			10mA $\leq I_{OUT} \leq$ 3A, 4.8V $\leq V_{IN} \leq$ 7V	3.234	3.300	3.366	
	GM6603-5.0		I_{OUT}=10mA,V_{IN}=6.5V	4.950	5.000	5.050	V
			10mA $\leq I_{OUT} \leq$ 3A, 6.5V $\leq V_{IN} \leq$ 7V	4.900	5.000	5.100	
Line Regulation	GM6603-Adj	REG_{LINE}	I_{OUT}=10mA,				%
	GM6603-1.8		I_{OUT}=10mA, 3.3V $\leq V_{IN} \leq$ 7V		0.04	0.20	
	GM6603-2.5		I_{OUT}=10mA, 4V $\leq V_{IN} \leq$ 7V		0.04	0.20	
	GM6603-3.3		I_{OUT}=10mA, 4.8V $\leq V_{IN} \leq$ 7V		0.04	0.20	
	GM6603-5.0		I_{OUT}=10mA, 6.5V $\leq V_{IN} \leq$ 7V		0.04	0.20	
Load Regulation	GM6603-Adj	REG_{LOAD}	V_{IN}-V_{OUT}=1.5V, 10mA $\leq I_O \leq$ 3A		0.08	0.40	%
	GM6603-1.8		V_{IN}=3.8V, 10mA $\leq I_O \leq$ 3A		0.08	0.40	
	GM6603-2.5		V_{IN}=4.5V, 10mA $\leq I_O \leq$ 3A		0.08	0.40	
	GM6603-3.3		V_{IN}=5.3V, 10mA $\leq I_O \leq$ 3A		0.08	0.40	
	GM6603-5.0		V_{IN}=7V, 10mA $\leq I_O \leq$ 3A		0.08	0.40	
Dropout Voltage		V_D	I_{OUT}=3A		1.15	1.3	V
Current Limit		I_{CL}	V_{IN}-V_{OUT}=3V	3	4		A
Minimum Load Current	GM6603-Adj	$I_{O\ MIN}$	V_{IN}=5V		1.7	5	mA
Quiescent Current	GM6603-1.8	I_Q	V_{IN}=3.3V, 10mA $\leq I_O \leq$ 3A		5	10	mA
	GM6603-2.5		V_{IN}=4.0V, 10mA $\leq I_O \leq$ 3A		5	10	
	GM6603-3.3		V_{IN}=4.8V, 10mA $\leq I_O \leq$ 3A		5	10	
	GM6603-5.0		V_{IN}=6.5V, 10mA $\leq I_O \leq$ 3A		5	10	
Adjust Pin Current	GM6603-Adj	I_{ADJ}	I_{OUT}=10mA, 2.75V $\leq V_{IN} \leq$ 7V		55	90	μA
Temperature Coefficient		T_C	V_{IN}-V_{OUT}=1.5V, I_{OUT}=10mA		0.005		%/°C
Thermal Regulation			T_A=25°C, 30ms pulse		0.003		%/W
Ripple Rejection		R_A	V_{IN}-V_{OUT}=1.5V, I_{OUT}=3A	60	72		dB

3.0A PRECISION LINEAR REGULATORS

■ APPLICATIONS INFORMATION

The GM6603 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 GM6603'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 μF tantalum capacitor will work fine in most applications, but with high current regulators such as the GM6603 higher capacitance values will improve the transient response and stability. Most applications for the GM6603'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
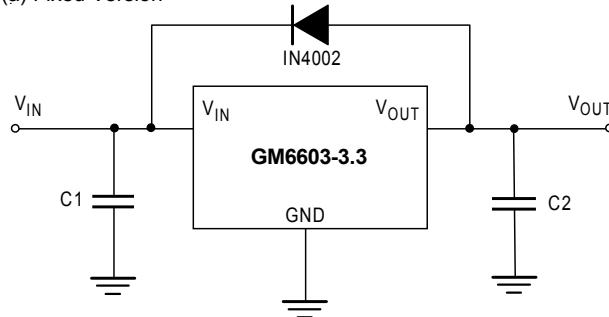
(b) Adjustable Version
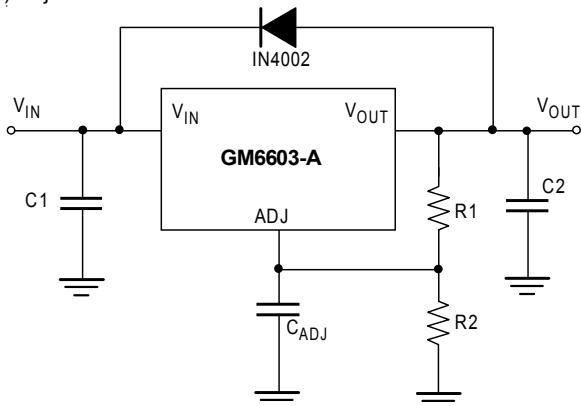
In the GM6603 linear regulators, the discharge path is through a large junction, and protection diodes are normally not needed. However, if the regulator is used with large output capacitance values and the input voltage is instantaneously shorted to ground, damage can occur. In this case, a diode connected as shown above in Figure 1.

3.0A PRECISION LINEAR REGULATORS

Output Voltage Sensing

The GM6603 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 GM6603 should be connected as shown in Figure 2.
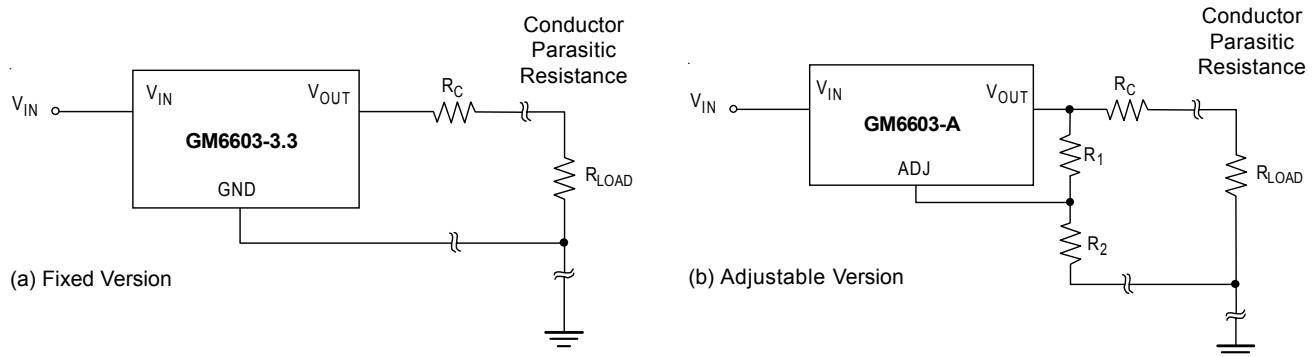

FIGURE 2[(a),(b)] Conductor Parasitic Resistance Effects are Minimized by this Grounding Scheme For Fixed and Adjustable Output Regulators

Calculating Power Dissipation and Heat Sink Requirements

The GM6603 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 GM6603, so electrical isolation may be required for some applications. Thermal compound should always be used with high current regulators like the GM6603.

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 GM6603 the majority of the heat is generated in the power transistor section.

3.0A PRECISION LINEAR REGULATORS

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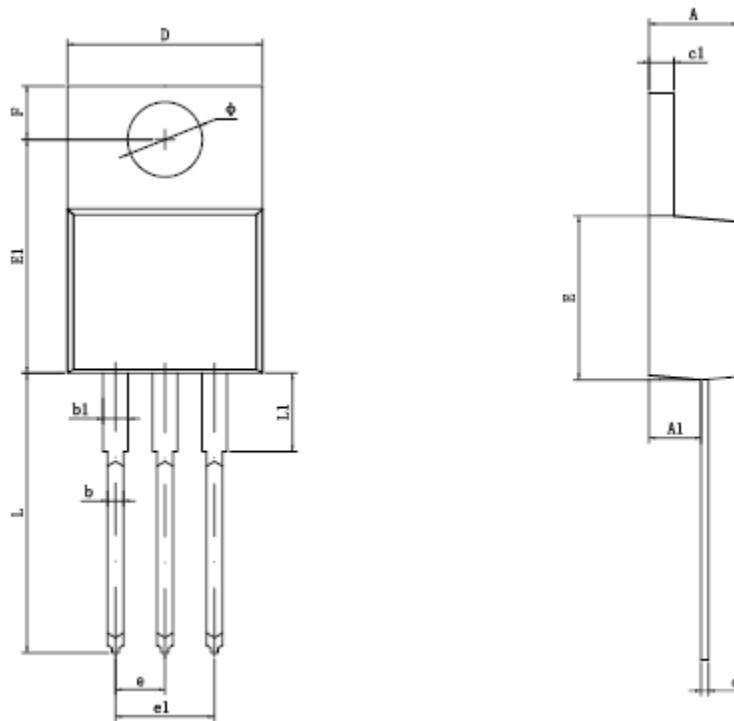
SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.470	4.670	0.176	0.184
A1	2.520	2.820	0.099	0.111
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.500	8.900	0.335	0.350
E1	12.060	12.460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

3.0A PRECISION LINEAR REGULATORS

■ **TO-263-2L PACKAGE OUTLINE DIMENSIONS**
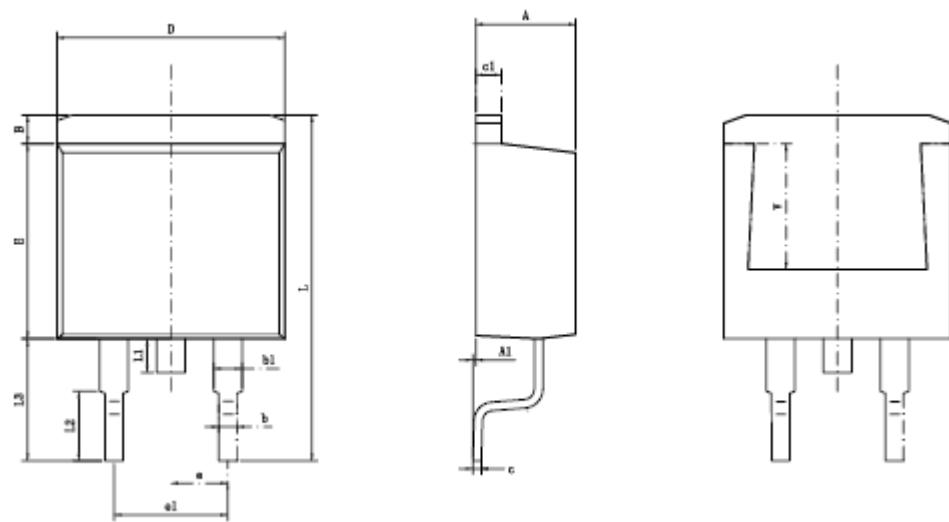
SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.470	4.670	0.176	0.184
A1	0.000	0.150	0.000	0.006
B	1.170	1.370	0.046	0.054
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.500	8.900	0.335	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	

3.0A PRECISION LINEAR REGULATORS

■ **TO-252-2L PACKAGE OUTLINE DIMENSIONS**
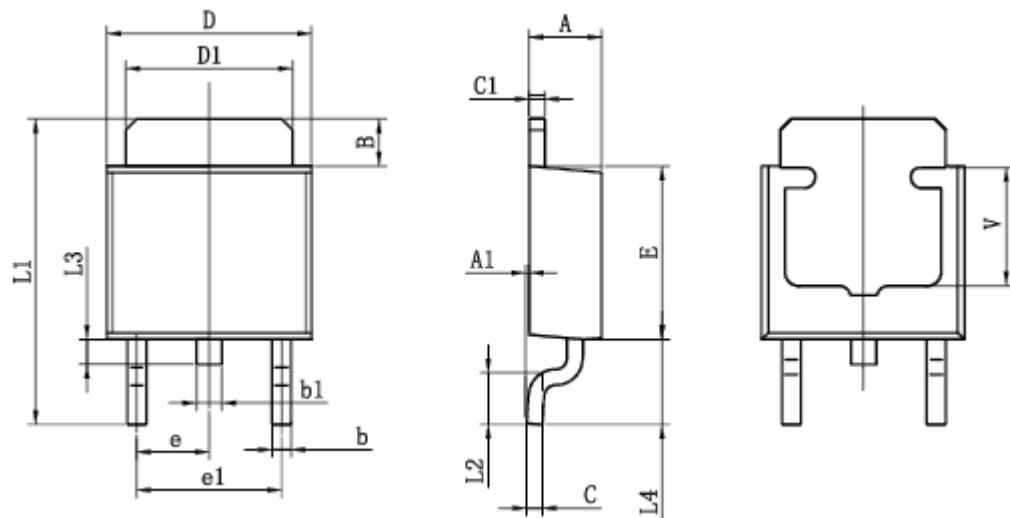
SYMBOL	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	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	

3.0A PRECISION LINEAR REGULATORS

■ **ORDERING INFORMATION**

GM6603	PACKAGE	Output Voltage				
		ADJ.	1.8V	2.5V	3.3V	5.0V
	TO-263	GM6603-ATA3	GM6603-1.8TA3	GM6603-2.5TA3	GM6603-3.3TA3	GM6603-5.0TA3
	TO-220	GM6603-ATB3	GM6603-1.8TB3	GM6603-2.5TB3	GM6603-3.3TB3	GM6603-5.0TB3
	TO-252	GM6603-ATC3	GM6603-1.8TC3	GM6603-2.5TC3	GM6603-3.3TC3	GM6603-5.0TC3

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