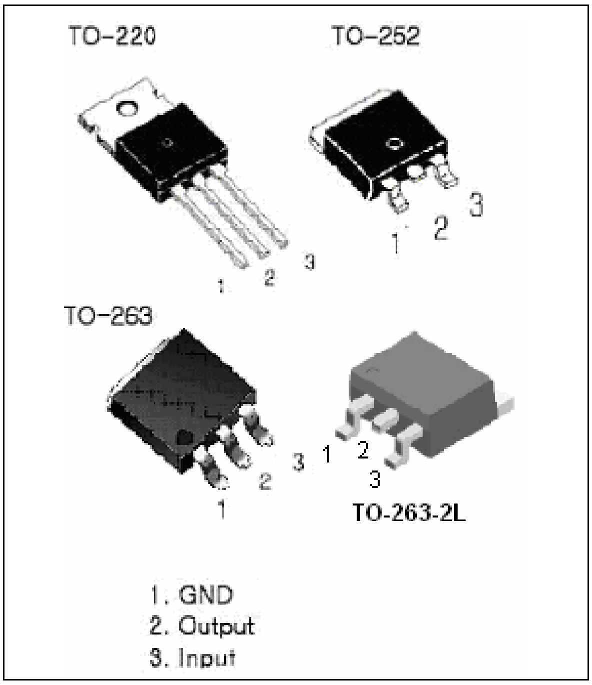
2.7 A Low Dropout Positive Regulator

IK1589

Description

The IK1589 is a low dropout three-terminal regulator with 2.7A output current capability. This device has been optimized for V_{TT} bus termination, where transient response and minimum input voltage are critical. The IK1589 offers fixed 1.2V with 2.7A current capability for a GTL+ bus V_{TT} termination. Current limit is trimmed to ensure specified output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload and ambient temperature that would create excessive junction temperatures.

The IK1589 is available in the industry-standard TO-220, TO-263-3L, TO-263-2L and TO-252 (DPAK) power packages.



Features

- Output Current : 2.7 A
- Maximum Input Voltage : 7V
- Current Limiting and Thermal Protection
- Standard TO-220, TO-263, TO-252 (DPAK) power packages

Ordering Information

IK1589KB	TO-220 Tube
IK1589DOT	TO-252 T&R
IK1589D2	TO-263 Tube
IK1589D2T	TO-263 T&R

Applications

- A GTL + bus supply VRM 8.5
- Low voltage logic supply
- Post regulator switching supply

Absolute Maximum Ratings (note1)

Parameter	Min.	Max.	Unit
V_{IN}		7	V
Operating Junction Temperature Range	0	155	°C
Storage Temperature Range	-65	150	°C
Lead Temperature (Soldering, 10 sec.)		300	°C

Power Dissipation (Note2) Internally Limited

Operating Ratings

Juncton Temperature Range (Note3) -10°C to 125°C

Electrical Characteristics

Typical and limits appearing in normal type apply Tj=+25°C

Symbol	Parameter	Conditions	Min (Note5)	Typ (Note4)	Max (Note5)	Units
Vout	Output voltage (Note 6)	3.3V ≤ Vin ≤ 7V	1.176	1.200	1.224	V
ΔVout	Line Regulation (Note 7)	(Vout + 1.5V) ≤ Vin ≤ 7V Iout = 10 mA			0.2	%
ΔVout	Load Regulation (Note 7)	(Vin – Vout) = 3V 10mA ≤ Iout ≤ 2.7A			1.5	%
ΔV	Dropout Voltage (Note 8)	ΔVref=1%, Iout = 2.7A	-		1.3	V
Ilimit	Current Limit	(Vin-Vout) = 2V		4.5		A
Io(min)	Minimum Load Current	1.5V ≤ (Vin-Vout) ≤ 5.75V			10	mA
RR	Ripple Rejection	f_{RIPLE} = 120HZ, C_{OUT}=25µF Tantalum, Iout=5A;V_{IN}=Vout+2V	60	-	-	dB
S	Temperature Stability		-	0.5	-	%

NOTES 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Rating indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

NOTES 2: Power Dissipation is kept in a safe range by current limiting circuitry.

NOTES 3: The maximum power dissipation is a function of $Tj_{(MAX)}$, Θ_{iA} and T_A . The maximum allowable power dissipation at any ambient temperature is $P_D=(Tj_{(MAX)} - T_A)\Theta_{iA}$.

NOTES 4: Typical Values represent the most likely parametric norm

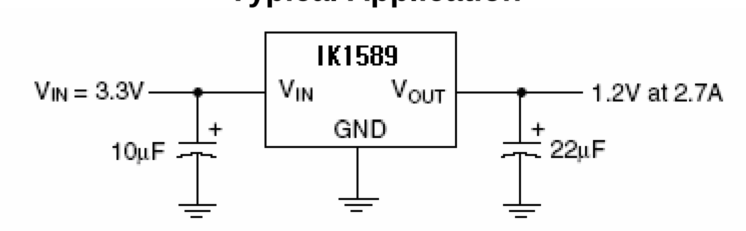
NOTES 5: All limits are guaranteed by testing or statistical analysis

NOTES 6: $I_{FULL\ LOAD}$ is defind in the current limit curves . The $I_{FULL\ LOAD}$ curve defines the current limit as a function of input-to-output voltage .

NOTES 7: Load and Line regulation are measured at constant junction temperature , and are guaranteed up to the maximum power dissipation of 30W.Power dissipation is determined by the input/output differential and the output current. Guaranteed maximum power dissipation will not be available over the full input/output range.

NOTES 8: Dropout voltage is specified over the full output current range of the device.

Typical Application



Typical Performance Characteristics

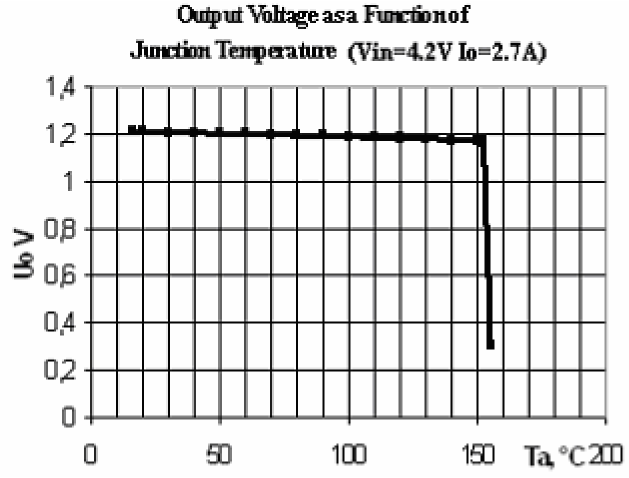


Figure 1.

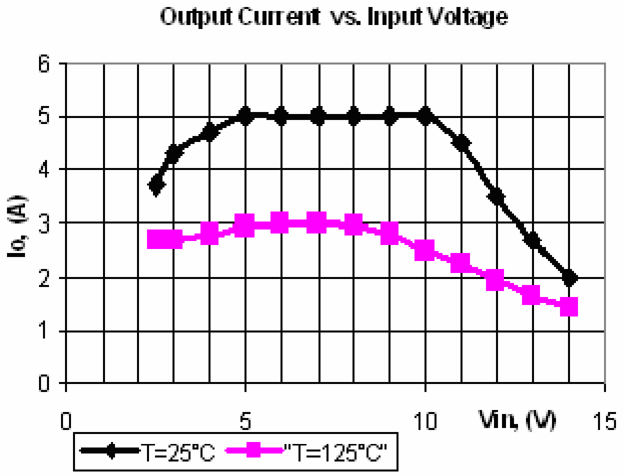


Figure 2.

Figure 3.

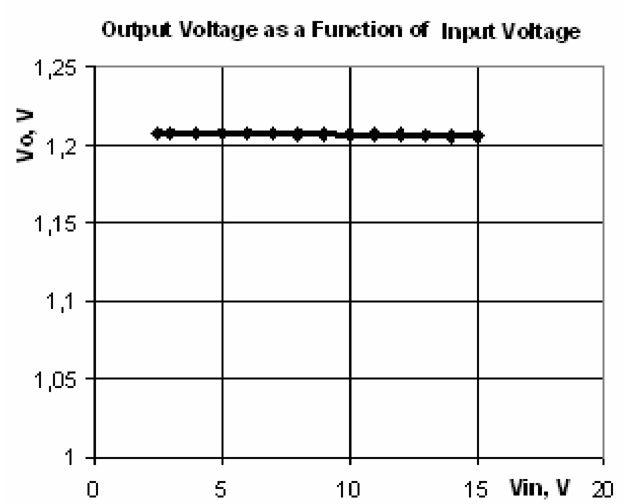


Figure 4.

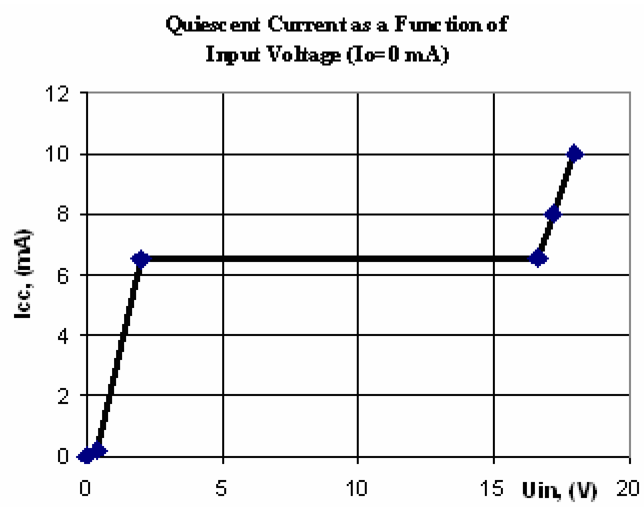


Figure 5.

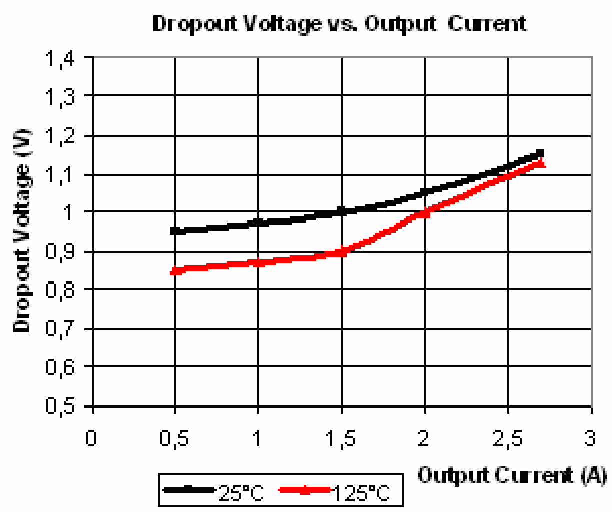


Figure 6.

Applications Information

General

The IK1589 is a three-terminal regulator optimized for a GTL+ V_{TT} termination applications. It is short-circuit protected, and offers thermal shutdown to turn off the regulator when the junction temperature exceeds about 150°C. The IK1589 provides low dropout voltage and fast transient response. Frequency compensation uses capacitors with low ESR while still maintaining stability. This is critical in addressing the needs of low voltage high speed microprocessor buses like a GTL+.

Stability

The IK1589 requires an output capacitor as a part of the frequency compensation. It is recommended to use a 22μF solid tantalum or a 100μF aluminum electrolytic on the output to ensure stability. The frequency compensation of these devices optimizes the frequency response with low ESR capacitors. In general, it is suggested to use capacitors with an ESR of <1Ω.

Protection Diodes

In normal operation, the IK1589 does not require any protection diodes.

A protection diode between the input and output pins is usually not needed. An internal diode between the input and output pins on the IK1589 can handle microsecond surge currents of 50A to 100A. Even with large value output capacitors it is difficult to obtain those values of surge currents in normal operation. Only with large values of output capacitance, such as 1000 μF to 5000 μF, and with the input pin instantaneously shorted to ground can damage occur. A crowbar circuit at the input can generate those levels of current; a diode from output to input is then recommended, as shown in Figure 7. Usually, normal power supply cycling or system “hot plugging and unplugging” will not generate current large enough to do any damage.

As with any IC regulator, exceeding the maximum input-tooutput voltage differential causes the internal transistors to break down and none of the protection circuitry is then functional.

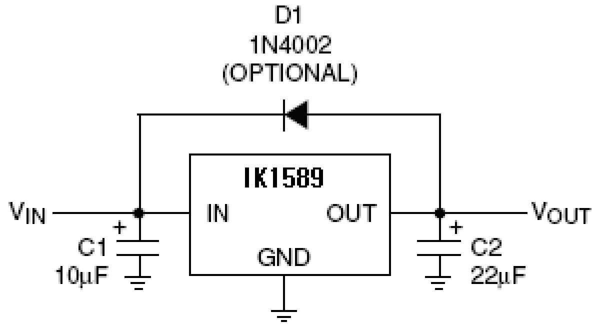


Figure 7. Optional Protection

Load Regulation

It is not possible to provide true remote load sensing because the IK1589 is a three-terminal device. Load regulation is limited by the resistance of the wire connecting the regulators to the load. Load regulation per the data sheet specification is measured at the bottom of the package.

For fixed voltage devices, negative side sensing is a true Kelvin connection with the ground pin of the device returned to the negative side of the load. This is illustrated in Figure 8.

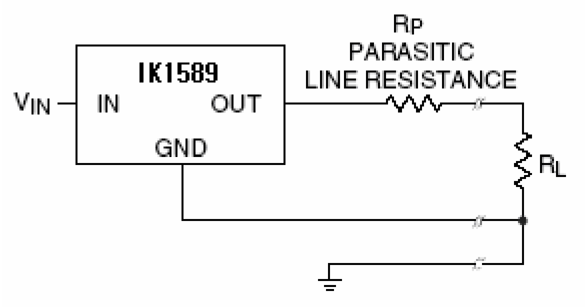


Figure 8. Connection for Best Load Regulation

Thermal Considerations

The IK1589 protects itself under overload conditions with internal power and thermal limiting circuitry. However, for normal continuous load conditions, do not exceed maximum junction temperature ratings. It is important to consider all sources of thermal resistance from junction-to-ambient. These sources include the junction-to-case resistance, the case-to-heat sink interface resistance, and the heat sink resistance. Thermal resistance specifications have been developed to more accurately reflect device temperature and ensure safe operating temperatures. For example, look at using an IK1589 to generate 2.7A @ 1.2V ±2% from a 3.3V source (3.2V to 3.6V).

Assumptions:

- V_{IN}= 3.6V worst case
- V_{OUT} = 1.176V worst case
- I_{OUT} = 2.7A continuous
- T_A = 70°C
- $\theta_{Case\text{-}to\text{-}Ambient}$ = 3°C/W (assuming both a heatsink and a thermally conductive material) The power dissipation in this application is:

$P_D = (V_{IN} – V_{OUT}) * (I_{OUT}) = (3.6 – 1.18) * (2.7) = 6.53W$

From the specification table:

$T_J = T_A + (P_D) * (\theta_{Case\text{-}to\text{-}Ambient} + \theta_{JC}) = 70 + (6.53) * (3 + 3) = 109°C$

The junction temperature is below the maximum rating.

Junction-to-case thermal resistance is specified from the IC junction to the bottom of the case directly below the die. This is the lowest resistance path for heat flow. Proper mounting ensures the best thermal flow from this area of the package to the heat sink. Use of a thermally conductive material at the case-to-heat sink interface is recommended. Use a thermally conductive spacer if the case of the device must be electrically isolated and include its contribution to the total thermal resistance. The case of the IK1589 is directly connected to the output of the device.

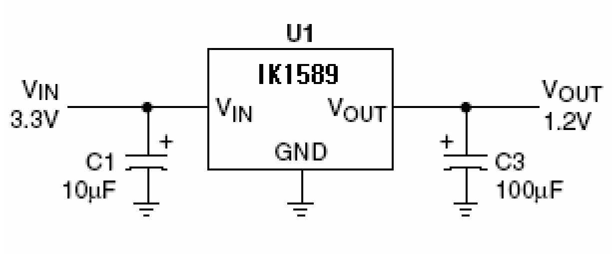
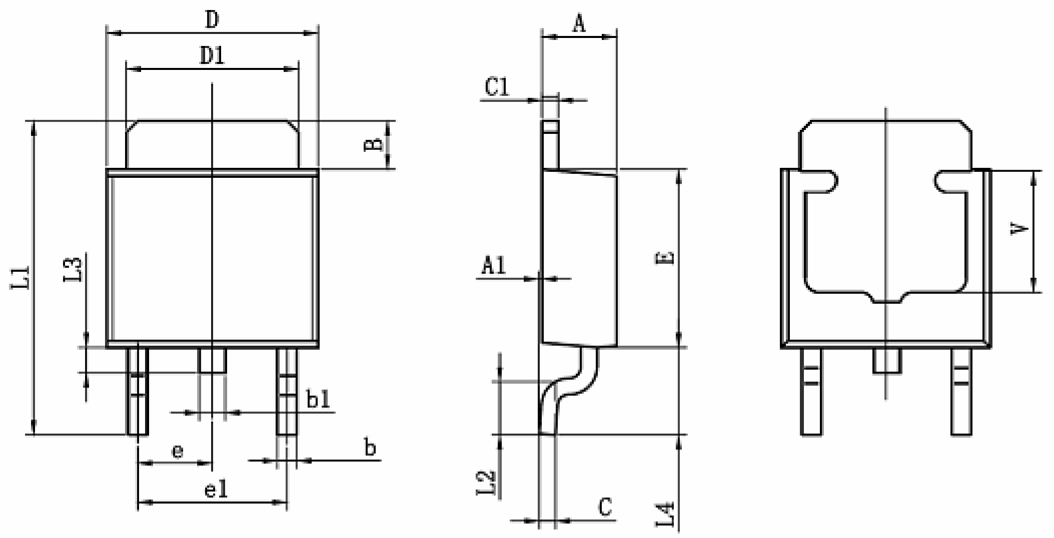


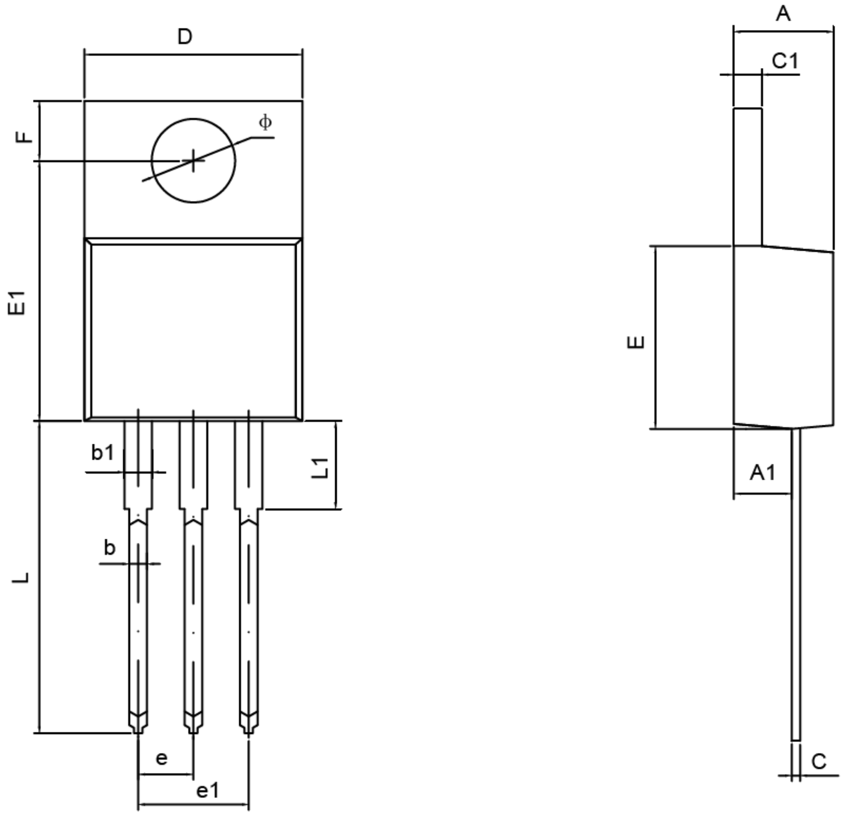
Figure 9. Application Circuit (IK1589)

TO-252 PACKAGE OUTLINE DIMENSIONS



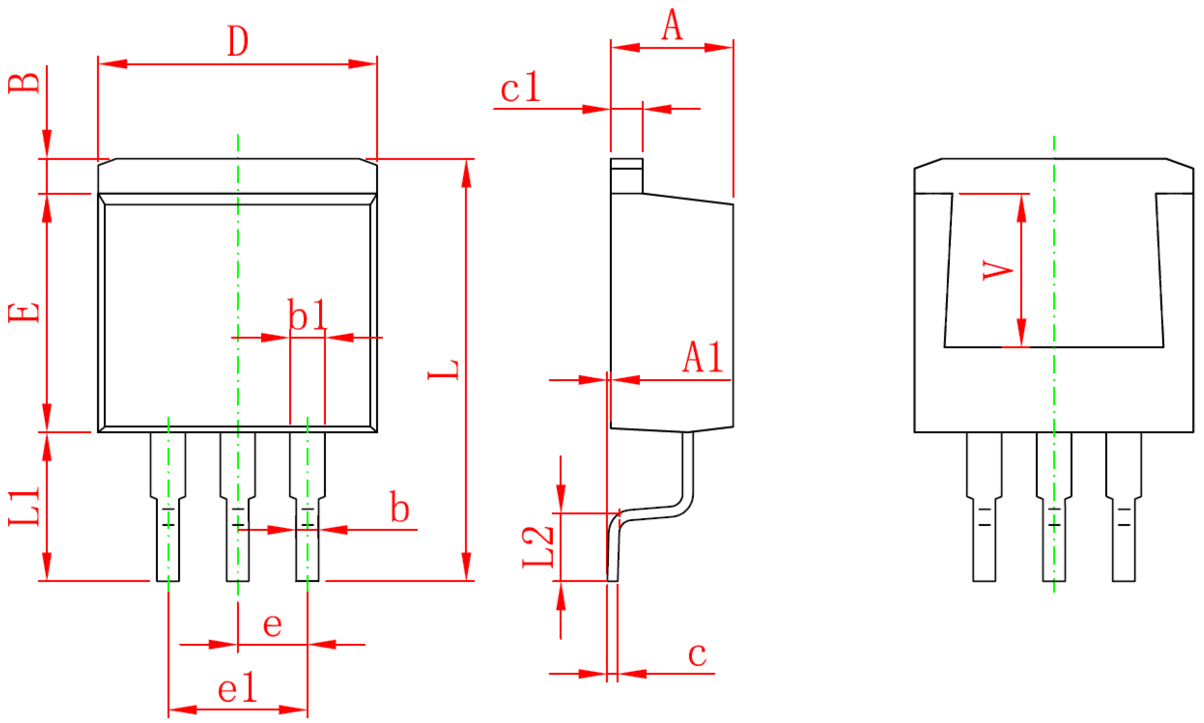
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	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	3.80REF		0.150REF	

TO-220-3L PACKAGE OUTLINE DIMENSIONS



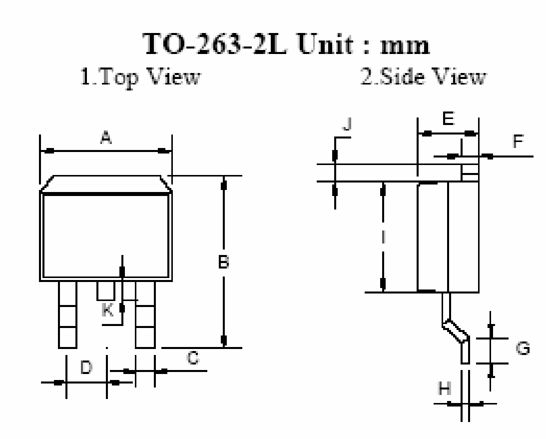
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.470	4.670	1.176	0.184
A1	2.520	2.820	0.099	0.111
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.310	0.530	0.012	0.021
c1	1.710	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.500	8.900	0.335	0.350
E1	12.060	12.460	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

TO-263-3L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.470	4.670	0.176	0.184
A1	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	2.540 TYP		0.100 TYP	
e1	4.980	5.180	0.196	0.204
L	15.050	15.450	0.593	0.608
L1	5.080	5.480	0.200	0.216
L2	2.340	2.740	0.092	0.108
V	5.600 REF		0.220 REF	

TO-263-2L PACKAGE OUTLINE DIMENSION



TO-263-2L DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.00	10.50	0.394	0.413
B	14.60	15.58	0.575	0.625
C	0.68	0.92	0.027	0.036
D	2.42	2.66	0.095	0.105
E	4.31	4.83	0.170	0.190
F	1.14	1.40	0.045	0.055
G	2.28	2.79	0.090	0.110
H	0.45	0.73	0.018	0.029
I	8.28	8.80	0.326	0.346
J	1.14	1.40	0.045	0.055
K	1.48	1.52	0.058	0.060