Ultra Low Power, 14V, 200mA Low-Dropout Linear Regulator

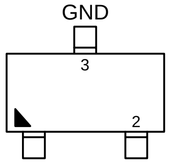
General Description

The RT9064 is a low-dropout (LDO) linear regulator that features high input voltage, low dropout voltage, ultra-low operating current, and miniaturized packaging. With quiescent current as low as 2μA, the RT9064 is ideal for battery-powered equipment.

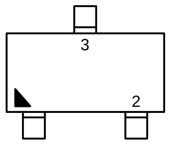
The RT9064's stability requirements are easily met with all types of output capacitors, including tiny ceramic capacitors, over its wide input range (3.5V to 14V) and its load current range (0mA to 200mA). The RT9064 offers standard output voltages of 2.5V, 3.3V and 5V.

Pin Configurations

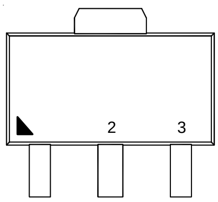
(TOP VIEW)



SOT-23-3



SOT-23-3 (N-Type)



SOT-89-3

Features

- **2μA Quiescent Current**
- **±2% Output Accuracy**
- **200mA Output Current**
- **14V Maximum Operating Input Voltage**
- **Dropout Voltage : 0.4V at 100mA**
- **Fixed Output Voltage : 2.5V/3.3V/5V**
- **Stable with Ceramic or Tantalum Capacitor**
- **Current Limit Protection**
- **Over-Temperature Protection**
- **SOT-23-3, SOT-89-3 Packages**
- **RoHS Compliant and Halogen Free**

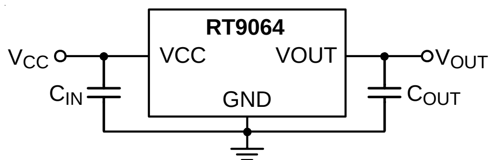
Applications

- Portable, Battery Powered Equipment
- Ultra Low Power Microcontrollers

Ordering and Marking Information

Part Number	Output Voltage	Package	Marking Information
RT9064-25GV	2.5V	SOT-23-3	0D=
RT9064-25GVN		SOT-23-3 (N)	30=
RT9064-25GX		SOT-89-3	04=
RT9064-33GV	3.3V	SOT-23-3	0E=
RT9064-33GVN		SOT-23-3 (N)	2Z=
RT9064-33GX		SOT-89-3	05=
RT9064-50GV	5.0V	SOT-23-3	0F=
RT9064-50GVN		SOT-23-3 (N)	2Y=
RT9064-50GX		SOT-89-3	06=

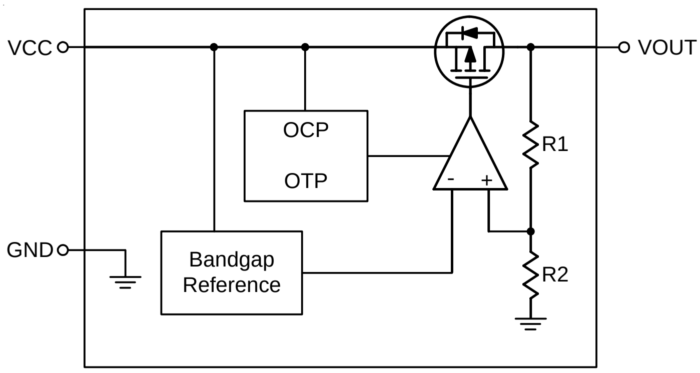
Simplified Application Circuit



Functional Pin Description

Pin No.			Pin Name	Pin Function
SOT-23-3	SOT-23-3 (N-Type)	SOT-89-3		
1	3	1	VCC	Supply Voltage Input.
2	2	3	VOUT	Output of the Regulator.
3	1	2	GND	Ground.

Function Block Diagram



Operation

The RT9064 is a high input voltage linear regulator specifically designed to minimize external components.

Output Transistor

The RT9064 includes a built-in low on-resistance P-MOSFET output transistor for low dropout voltage applications.

Error Amplifier

The Error Amplifier compares the output feedback voltage from an internal feedback voltage divider to an internal reference voltage and controls the P-MOSFET's gate voltage to maintain output voltage regulation.

Current Limit

The RT9064 provides a current limit function to prevent damage during output over-load or shorted-circuit conditions. The output current is detected by an internal sensing transistor.

Over-Temperature Protection

The over-temperature protection function will turn off the P-MOSFET when the internal junction temperature exceeds 150°C (typ.) and the output current exceeds 30mA. Once the junction temperature cools down by approximately 20°C, the regulator will automatically resume operation.

Absolute Maximum Ratings (Note 1)

- VCC to GND ---------- −0.3V to 15V
- VOUT to VCC ---------- −14V to 0.3V
- VOUT to GND ---------- −0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  SOT-23-3 ---------- 0.41W
  SOT-89-3 ---------- 0.59W
- Package Thermal Resistance (Note 2)
  SOT-23-3, θ_{JA} ---------- 243.3°C/W
  SOT-89-3, θ_{JA} ---------- 167.7°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- −65°C to 150°C
- ESD Susceptibility (Note 3)
  HBM (Human Body Model) ---------- 2kV
  MM (Machine Model) ---------- 200V

Recommended Operating Conditions (Note 4)

- Supply Input Voltage, VCC ---------- 3.5V to 14V
- Junction Temperature Range ---------- −40°C to 125°C
- Ambient Temperature Range ---------- −40°C to 85°C

Electrical Characteristics

((V_{OUT} + 1V) < V_{CC} < 14V, T_A = 25°C, unless otherwise specified.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage Range	V_{OUT}		2.5	--	5	V
DC Output Accuracy		I_{LOAD} = 1mA, V_{CC} = V_{OUT} + 0.5V	−2	--	2	%
Dropout Voltage	V_{Drop}	I_{LOAD} = 100mA, $V_{OUT} \geq$ 4.5V	--	0.4	1.2	V
		I_{LOAD} =100mA, V_{OUT} < 4.5V	--	--	1.5	
Quiescent Current	I_Q	V_{CC} = 5V, I_{LOAD} = 0A	--	2	4	μA
Line Regulation	V_{LINE}	I_{LOAD} = 1mA, 3.5V ≤ V_{CC} < 5.5V	--	0.1	0.2	%
		I_{LOAD} = 1mA, 5.5V ≤ V_{CC} ≤ 14V	--	0.1	0.3	
Load Regulation	V_{LOAD}	I_{LOAD} = 1mA to 200mA	--	0.5	1	%
Output Current Limit	I_{LIM}	V_{OUT} = 0.5 x $V_{OUT(Normal)}$, V_{CC} = 5V	240	320	400	mA
Power Supply Rejection Ratio	PSRR	f = 100Hz, I_{LOAD} = 100mA	--	−60	--	dB
		f = 10kHz, I_{LOAD} = 100mA	--	−40	--	
Output Noise Voltage	V_{ON}	BW = 10Hz to 100kHz , C_{OUT} = 1μF	--	27 x V_{OUT}	--	μV_{RMS}
Startup Time	t_{STR}	V_{OUT} = 3V, R_L = 30Ω	--	500	--	μs
OTP Threshold			--	150	--	°C
OTP Hysteresis			--	20	--	°C

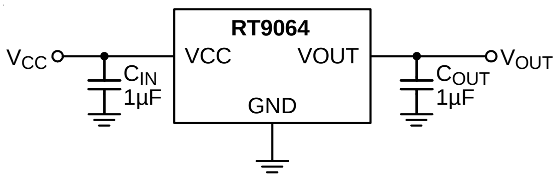
Note 1. Stresses beyond those listed "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Note 2. θ_{JA} is measured at $T_A = 25°C$ on a high effective thermal conductivity four-layer test board per JEDEC 51-7.

Note 3. Devices are ESD sensitive. Handling precaution is recommended.

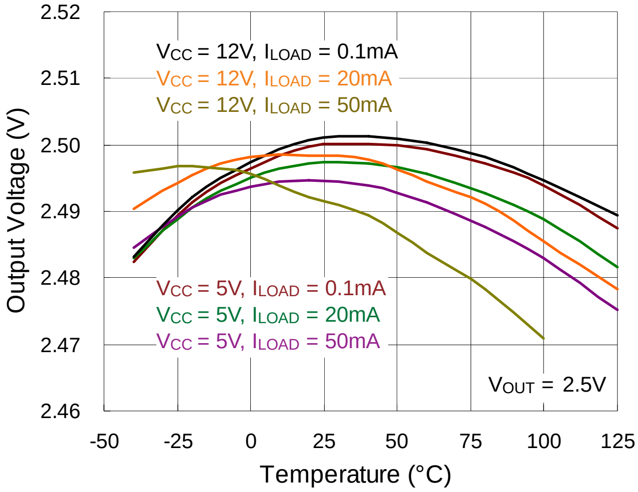
Note 4. The device is not guaranteed to function outside its operating conditions.

Typical Application Circuit

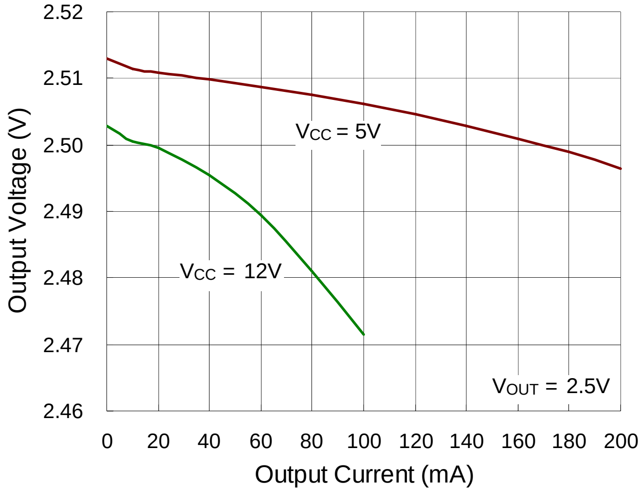


Typical Operating Characteristics

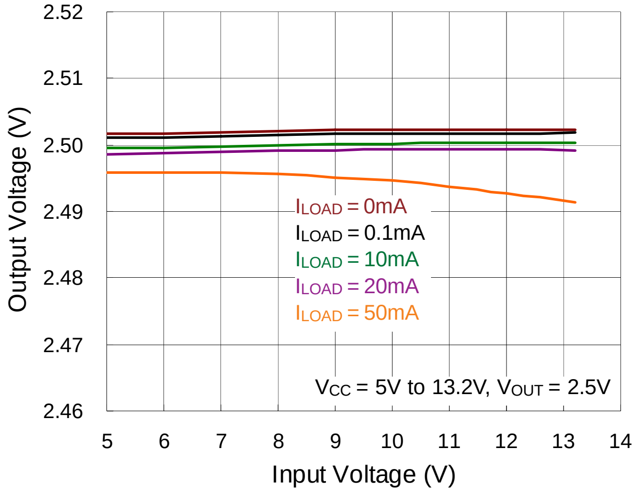
Output Voltage vs. Temperature



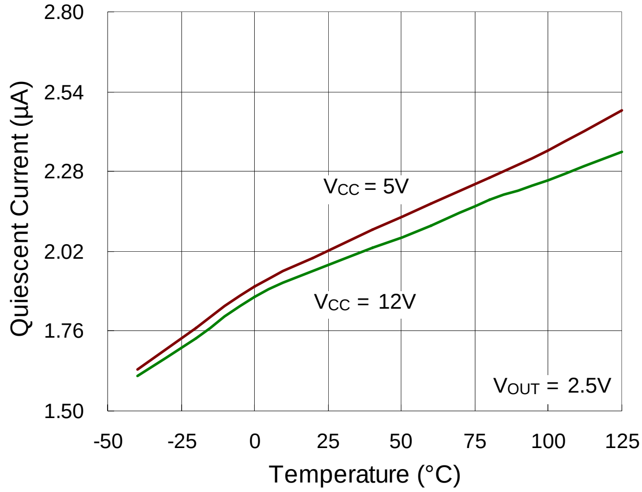
Output Voltage vs. Output Current



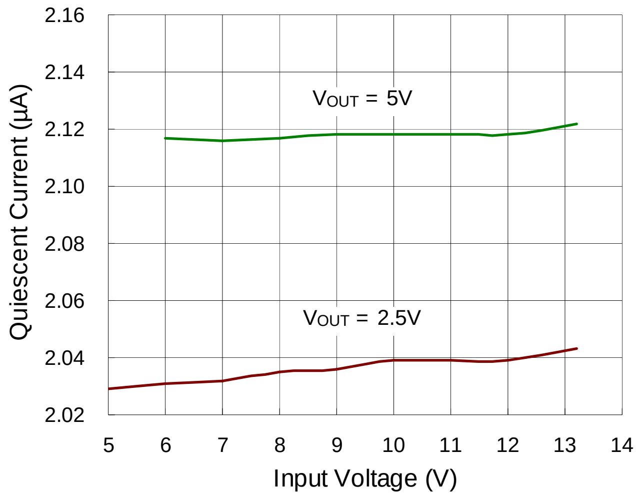
Output Voltage vs. Input Voltage



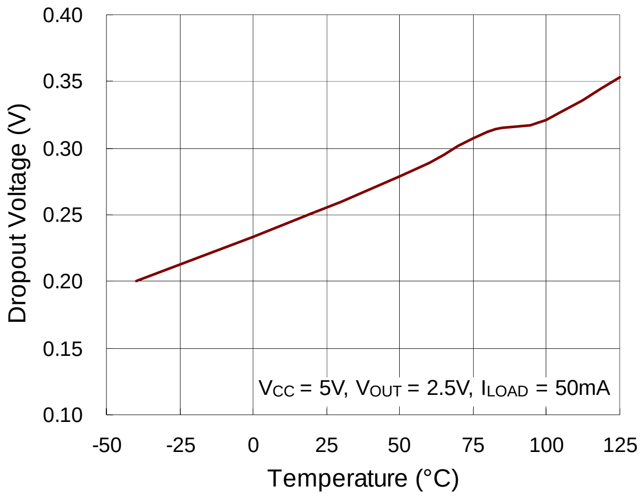
Quiescent Current vs. Temperature



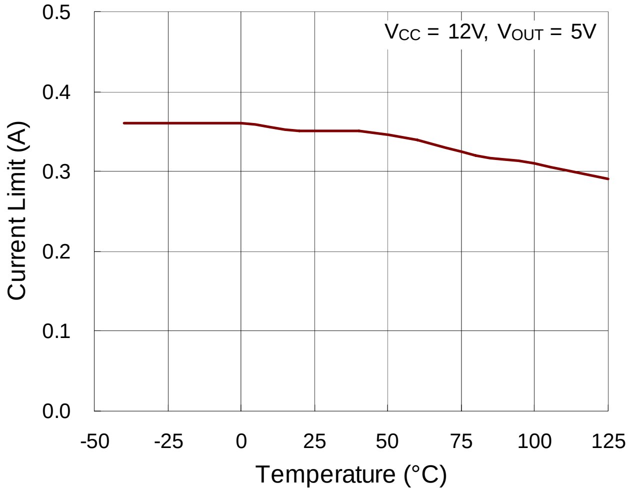
Quiescent Current vs. Input Voltage



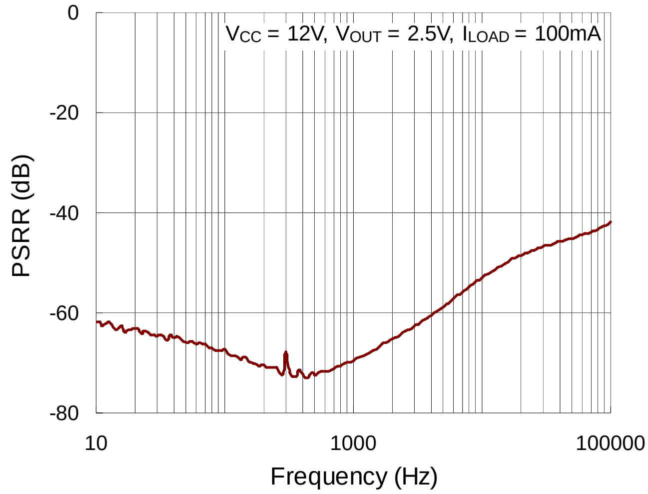
Dropout Voltage vs. Temperature



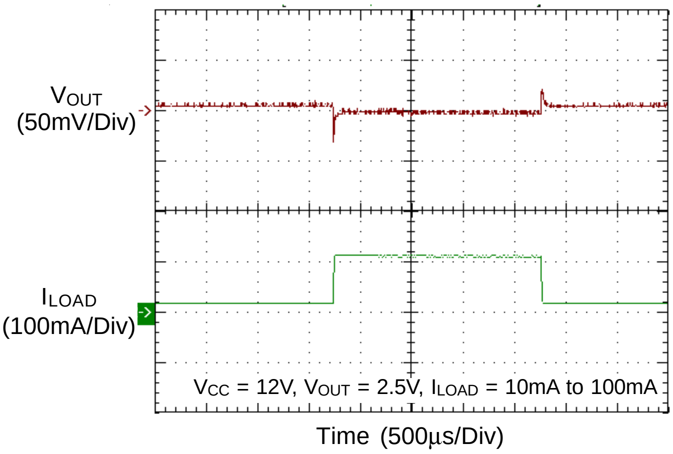
Current Limit vs. Temperature



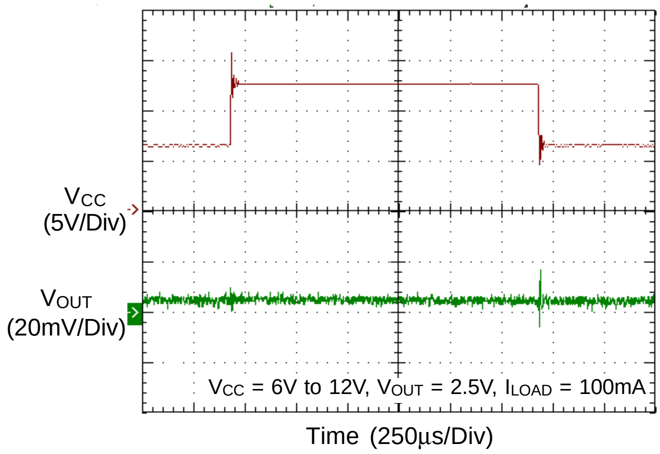
PSRR vs. Frequency



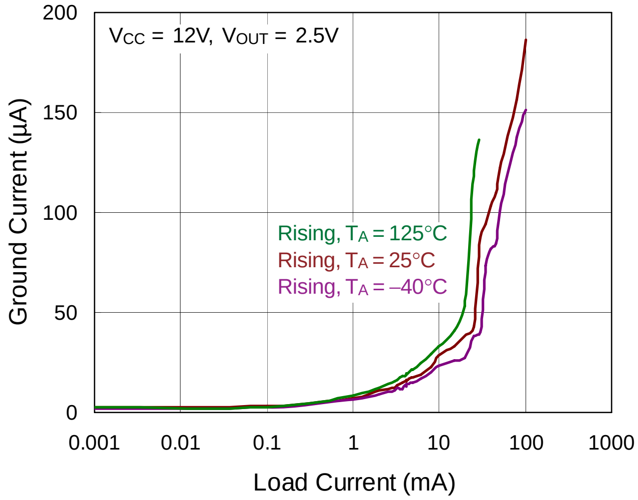
Load Transient Response



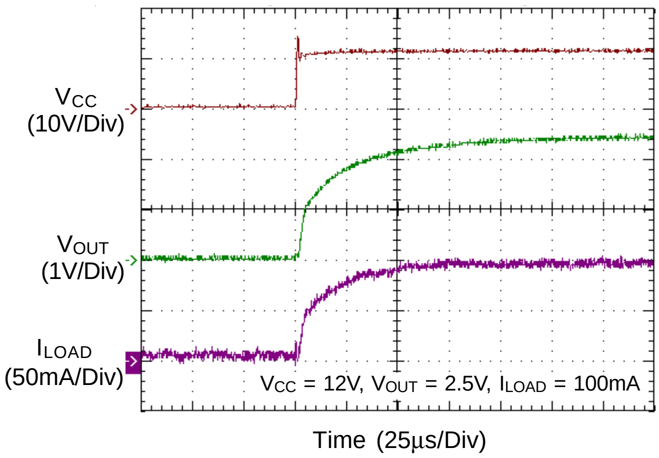
Line Transient Response



Ground Current vs. Load Current



Power Up Response



Applications Information

Like any low dropout linear regulator, the RT9064's external input and output capacitors must be properly selected for stability and performance. Use a 1μF or larger input capacitor and place it close to the IC's VCC and GND pins.

Any output capacitor meeting the minimum 1mΩ ESR (Equivalent Series Resistance) requirement may be used. Place the output capacitor close to the IC's VOUT and GND pins. Increasing capacitance and decreasing ESR can improve the circuit's PSRR and line transient response.

Thermal Considerations

For continuous operation, do not exceed absolute the maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and the allowed difference between the junction and ambient temperatures. The maximum power dissipation can be calculated by the following formula :

$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$

where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction to ambient thermal resistance.

The recommended operating conditions specify a maximum junction temperature is 125°C. The junction to ambient thermal resistance, θ_{JA}, is layout dependent. On a standard JEDEC 51-7 four-layer thermal test board, the thermal resistance, θ_{JA}, of the SOT-23-3 package is 243.3°C/W. For the SOT-89-3 package, the θ_{JA}, is 167.7°C/W. The maximum power dissipation at T_A = 25°C can be calculated by the following formula :

$P_{D(MAX)}$ = (125°C − 25°C) / (243.3°C/W) = 0.41W for SOT-23-3 package

$P_{D(MAX)}$ = (125°C − 25°C) / (167.7°C/W) = 0.59W for SOT-89-3 package

For a fixed $T_{J(MAX)}$ of 125°C, the maximum power dissipation depends on the operating ambient temperature and the package's thermal resistance, θ_{JA}. The derating curve in Figure 1 shows the effect of rising ambient temperature on the maximum recommended power dissipation.

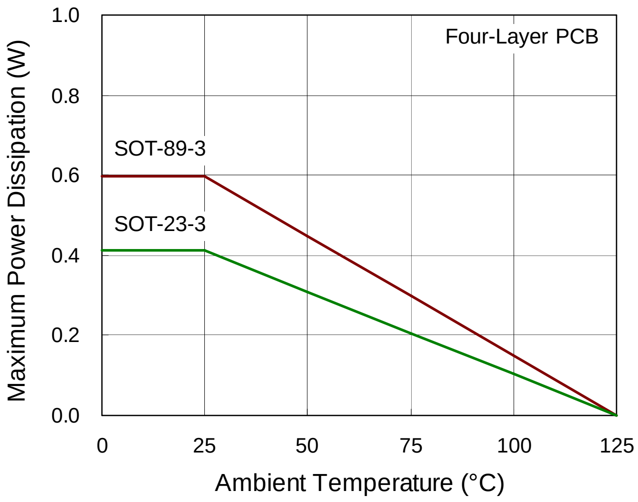
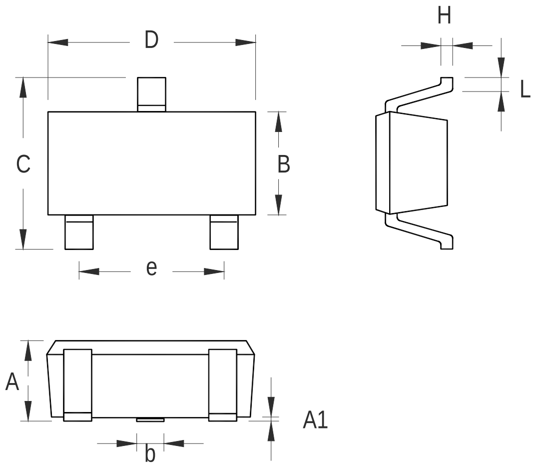


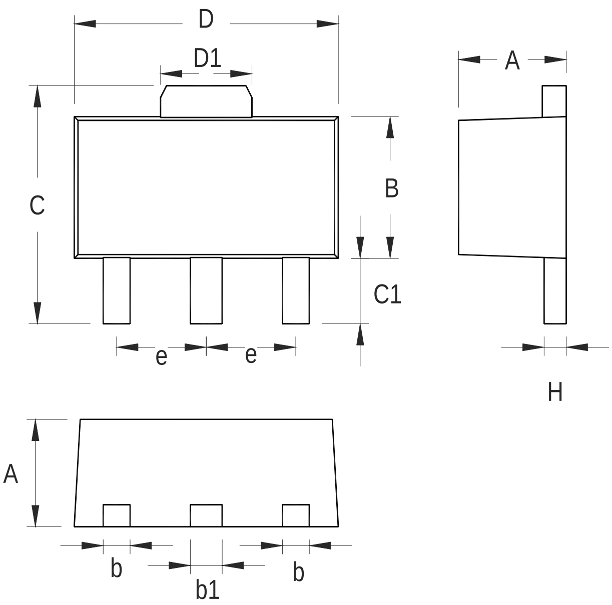
Figure 1. Derating Curve of Maximum Power Dissipation

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.035	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.356	0.508	0.014	0.020
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	1.803	2.007	0.071	0.079
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

SOT-23-3 Surface Mount Package



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.397	1.600	0.055	0.063
b	0.356	0.483	0.014	0.019
B	2.388	2.591	0.094	0.102
b1	0.406	0.533	0.016	0.021
C	3.937	4.242	0.155	0.167
C1	0.787	1.194	0.031	0.047
D	4.394	4.597	0.173	0.181
D1	1.397	1.753	0.055	0.069
e	1.448	1.549	0.057	0.061
H	0.356	0.432	0.014	0.017

3-Lead SOT-89 Surface Mount Package

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