300mA, Low Noise, Ultra-Fast CMOS LDO Regulator

General Description

The RT9037 is designed for portable RF and wireless applications with demanding performance and space requirements. The RT9037 performance is optimized for battery-powered systems to deliver ultra low noise and low quiescent current. Regulator ground current increases only slightly in dropout, further prolonging the battery life. The RT9037 also works with low-ESR ceramic capacitors, reducing the amount of board space necessary for power applications, critical in hand-held wireless devices. The RT9037 consumes less than 0.01uA in shutdown mode and has fast turn-on time less than 50us. The other features include ultra low dropout voltage, high output accuracy, current limiting protection, and high ripple rejection ratio. Available in the SOT-23-5 package, the RT9037 also offers a wide output voltage range from 3.3V to 5V with 0.1V per step.

Ordering Information

RT9037□□□□

Package Type
B : SOT- 23-5
BR : SOT- 23-5 (R-Type)

Lead Plating System
G : Green (Halogen Free and Pb Free)

Output Voltage
33 : 3.3V
34 : 3.4V
:
49 : 4.9V
50 : 5.0V
1H : 1.85V
2H : 2.85V
4G : 4.75V

Note :

Richtek products are :

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes.

Marking Information

For marking information, contact our sales representative directly or through a Richtek distributor located in your area.

Features

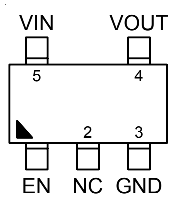
- Low-Noise for RF Application
- Fast Response in Line/Load Transient
- Quick Start-Up (Typically 50us)
- < 0.01uA Standby Current When Shutdown
- Low Dropout : 220mV @ 300mA
- Wide Operating Voltage Ranges : 2.5V to 5.5V
- TTL-Logic-Controlled Shutdown Input
- Low Temperature Coefficient
- Current Limiting Protection
- Thermal Shutdown Protection
- Only 1uF Output Capacitor Required for Stability
- High Power Supply Rejection Ratio
- Custom Voltage Available
- RoHS Compliant and Halogen Free

Applications

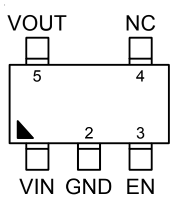
- CDMA/GSM Cellular Handsets
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments
- PCMCIA Cards
- Portable Information Appliances

Pin Configurations

(TOP VIEW)

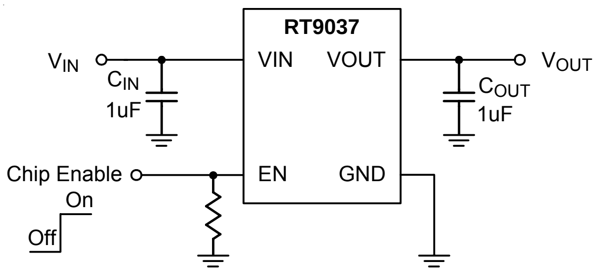


SOT-23-5



SOT-23-5 (R-Type)

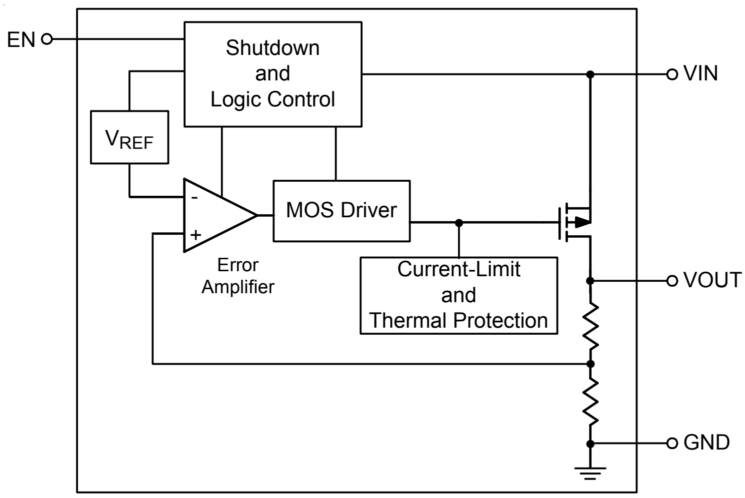
Typical Application Circuit



Functional Pin Description

Pin Name	Pin Function
EN	Chip Enable (Active High). Note that this pin is high impedance. There should be a pull low 100kΩ resistor connected to GND when the control signal is floating.
NC	No Internal Connection.
GND	Ground.
VOUT	Output Voltage.
VIN	Input Voltage.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage ---------- 6V
- Power Dissipation, P_D @ T_A = 25°C
  SOT-23-5 ---------- 400mW
- Package Thermal Resistance (Note 2)
  SOT-23-5, θ_{JA} ---------- 250°C/W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 3)
  HBM (Human Body Mode) ---------- 2kV
  MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note 4)

- Supply Input Voltage ---------- 2.5V to 5.5V
- EN Input Voltage ---------- 0V to 5.5V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{IN} = V_{OUT} + 1V, C_{IN} = C_{OUT} = 1uF, T_A = 25°C, unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage Accuracy		ΔV_{OUT}	I_{OUT} = 1mA	–2	--	+2	%
Current Limit		I_{LIM}	R_{LOAD} = 1Ω	360	400	--	mA
Quiescent Current		I_Q	V_{EN} ≧ 1.2V, I_{OUT} = 0mA	--	90	130	uA
Dropout Voltage (Note 5)		V_{DROP}	I_{OUT} = 200mA	--	170	200	mV
			I_{OUT} = 300mA	--	220	330	
Line Regulation		ΔV_{LINE}	V_{IN} = (V_{OUT} + 1V) to 5.5V, I_{OUT} = 1mA	--	--	0.3	%
Load Regulation		ΔV_{LOAD}	1mA < I_{OUT} < 300mA	--	--	0.6	%
Shutdown Current		I_{SHDN}	V_{EN} = GND, Shutdown	--	0.01	1	uA
EN Input Bias Current		I_{IBEN}	V_{EN} = GND or V_{IN}	--	0	100	nA
EN Threshold	Logic-Low Voltage	V_{IL}	V_{IN} = 3V to 5.5V, Shutdown	--	--	0.4	V
	Logic-High Voltage	V_{IH}	V_{IN} = 3V to 5.5V, Enable	1.2	--	–	
Power Supply Rejection Rate	f = 100Hz	PSRR	C_{OUT} = 1uF, I_{OUT} = 100mA	--	–60	--	dB
	f = 10kHz			--	–30	--	
Thermal Shutdown Temperature		T_{SD}		--	165	–	°C
Thermal Shutdown Temperature Hysteresis		ΔT_{SD}		--	30	--	°C

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. 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 for extended periods may remain possibility to affect device reliability.

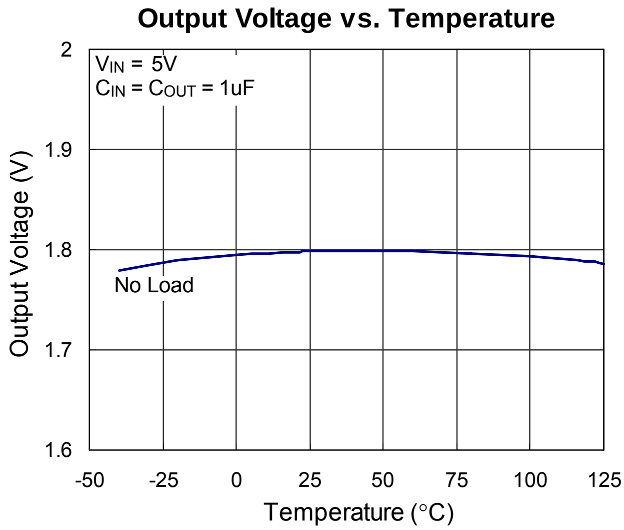
Note 2. θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single layers thermal conductivity test board of JEDEC 51-3 thermal measurement standard. The case point of θ_{JC} is on the exposed pad for the package.

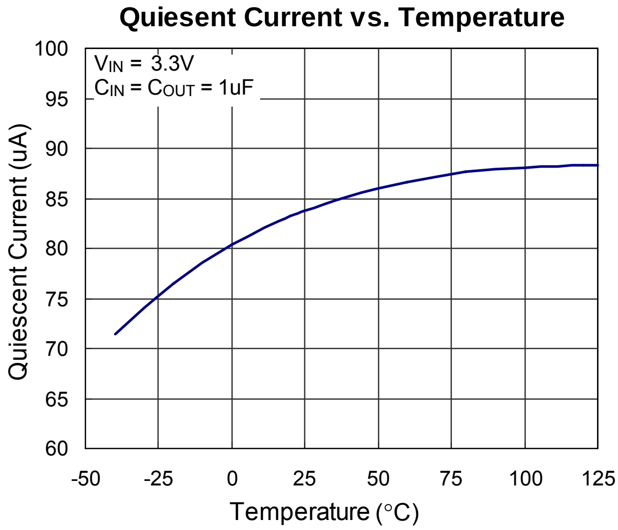
Note 3. Devices are ESD sensitive. Handling precaution is recommended.

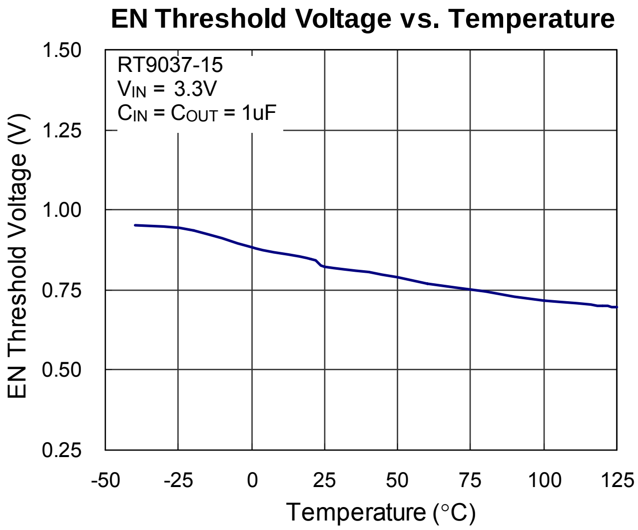
Note 4. The device is not guaranteed to function outside its operating conditions.

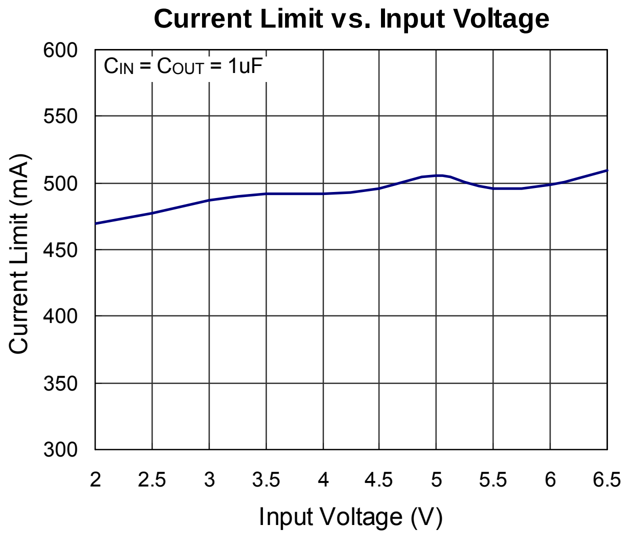
Note 5. The dropout voltage is defined as V_{IN} -V_{OUT}, which is measured when V_{OUT} is $V_{OUT(NORMAL)}$ − 100mV.

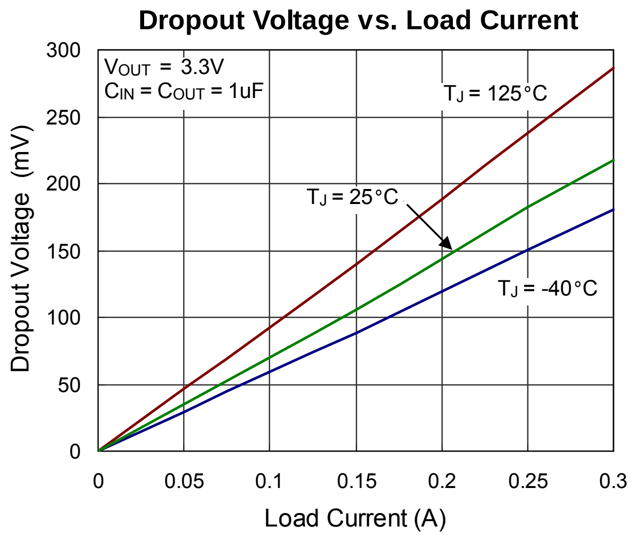
Typical Operating Characteristics

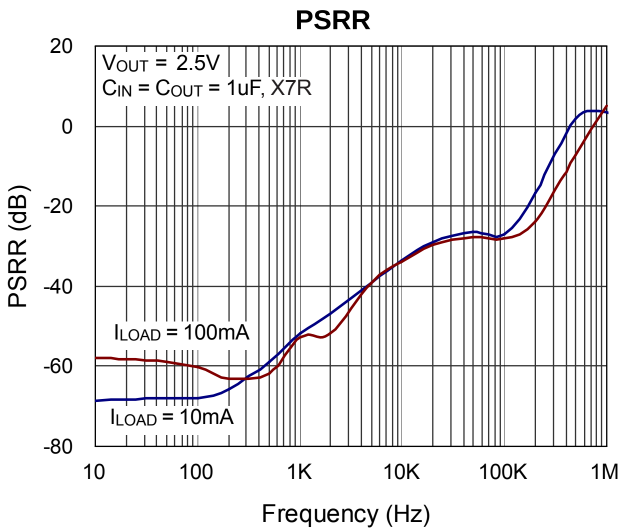




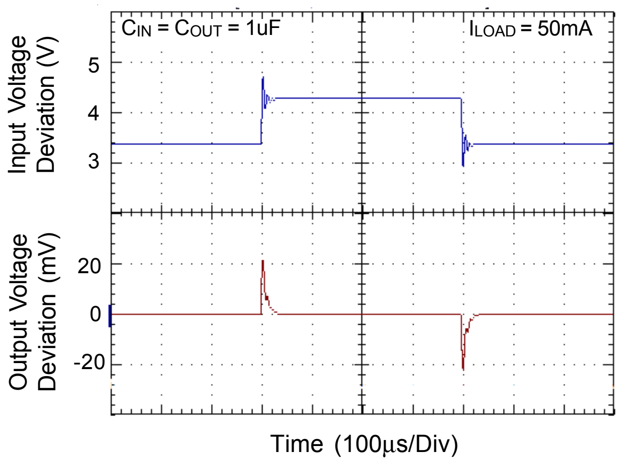




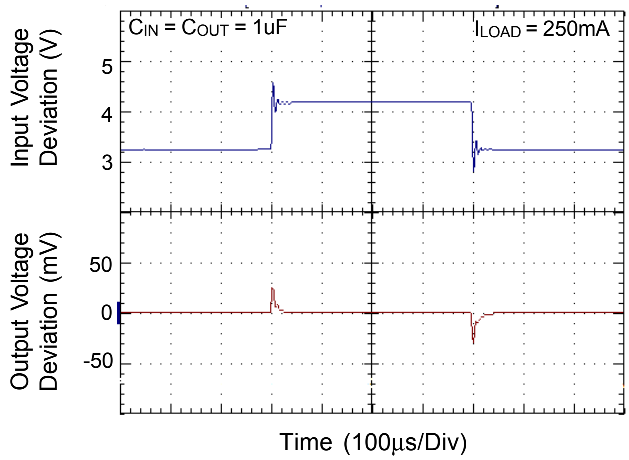




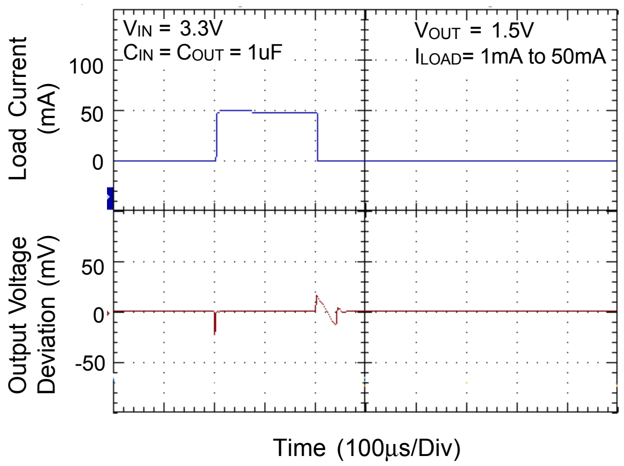
Line Transient Response



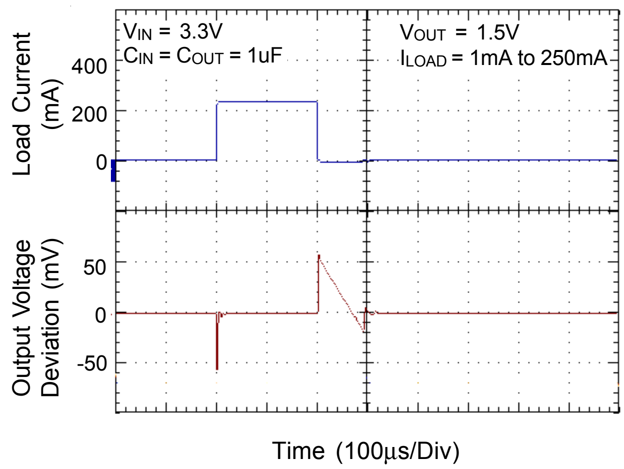
Line Transient Response



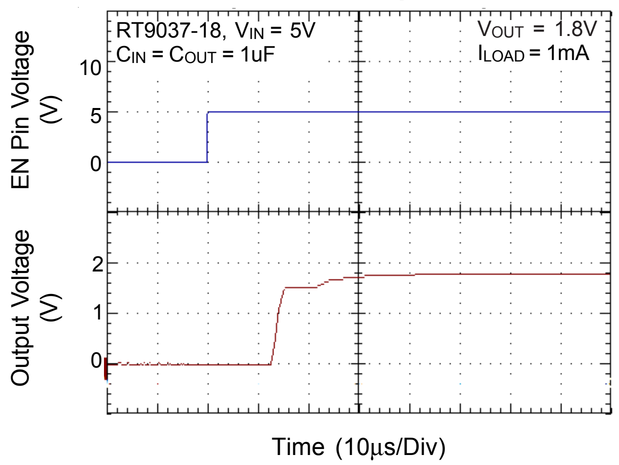
Load Transient Response



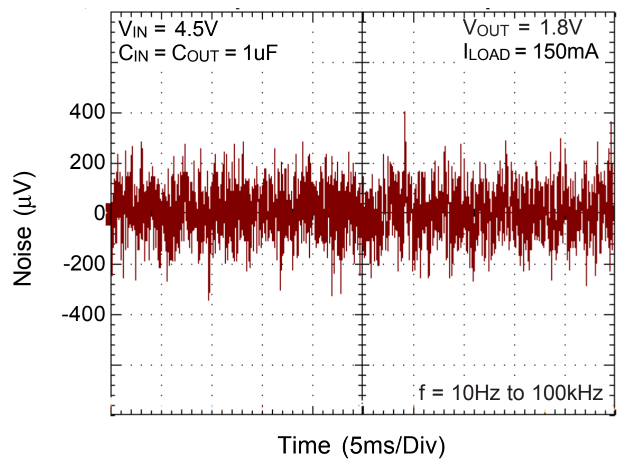
Load Transient Response



Start Up



Noise



Applications Information

Like any low-dropout regulator, the external capacitors used for the RT9037 must be carefully selected for regulator stability and performance. Using a capacitor whose value is > 1uF on the RT9037 input and the amount of capacitance can be increased without limit. The input capacitor must be located at a distance of not more than 0.5 inch from the input pin of the IC and returned to a clean analog ground. Any good quality ceramic or tantalum can be used for this capacitor. The capacitor with larger value and lower ESR (equivalent series resistance) provides better PSRR and line-transient response.

The output capacitor must meet both requirements for minimum amount of capacitance and ESR in all LDOs application. The RT9037 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor whose value is at least 1uF with ESR is more than 20mΩ on the RT9037 output ensures stability. The RT9037 still works well with output capacitor of other types due to the wide stable ESR range. Figure 1. shows the curves of allowable ESR range as a function of load current for various output capacitor values. Output capacitor of larger capacitance can reduce noise and improve load transient response, stability, and PSRR. The output capacitor should be located with in 0.5 inch from the V_{OUT} pin of the RT9037 and returned to a clean analog ground.

Region of Stable C_{OUT} ESR vs. Load Current

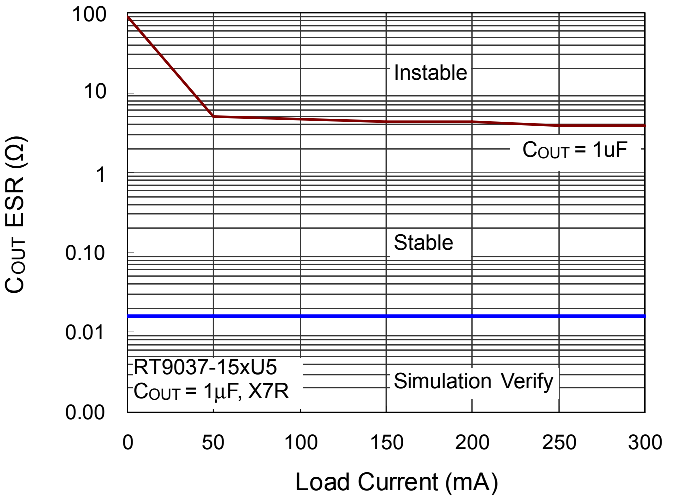


Figure 1

Enable Function

The RT9037 features an LDO regulator enable/disable function.

To assure the RT9037 LDO regulator will switch on, the EN turn on control level must be greater than 1.2V. The RT9037 LDO regulator will go into shutdown mode when the voltage on the EN pin falls below 0.4V. If the enable function is not needed in a specific application, it may be tied to GND/VIN to keep the LDO regulator in a continuously on state.

Thermal Considerations

Thermal protection limits power dissipation in the RT9037. When the operating junction temperature exceeds 165°C, the OTP circuit starts the thermal shutdown function and turns the pass element off. The pass element turns on again after the junction temperature cools by 30°C.

For continuous operation, do not exceed absolute maximum operatiog junction temperature 125°C. The power dissipation definition in device is shown as following formula :

$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_Q$

The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surroundings airflow and temperature difference between junction to ambient. The maximum power dissipation can be calculated by following formula :

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

Where $T_{J(MAX)}$ is the maximum operating junction temperature 125°C, T_A is the ambient temperature and the θ_{JA} is the junction to ambient thermal resistance.

For recommended operating conditions specification of the RT9037, the maximum junction temperature of the die is 125°C. The junction to ambient thermal resistance (θ_{JA} is layout dependent) for SOT-23-5 package is 250°C/W on standard JEDEC 51-3 thermal test board. The maximum power dissipation at T_A = 25°C can be calculated by following formula :

$P_{D(MAX)}$ = (125°C – 25°C)/250 = 400mW (SOT-23-5)

The maximum power dissipation depends on operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance θ_{JA}. For the RT9037 packages, the Figure 2. of derating curves allows the designer to see the effect of rising ambient temperature on the maximum power allowed.

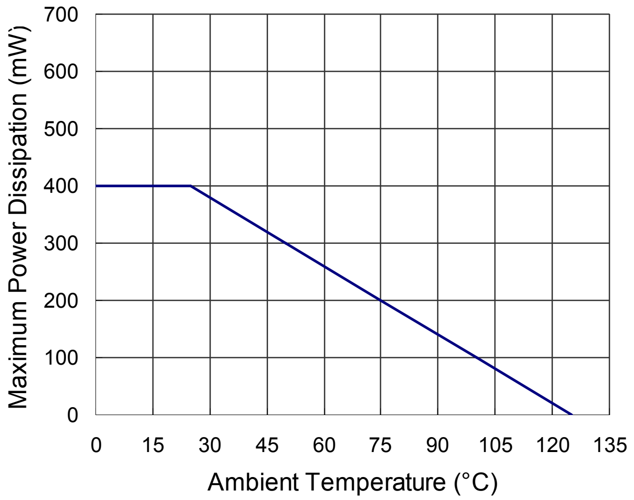
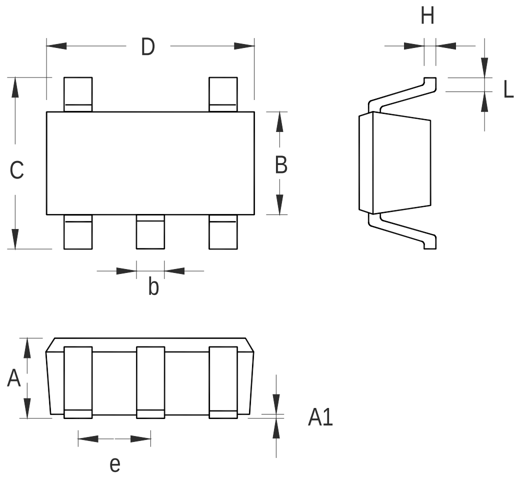


Figure 2. Derating Curve for Packages

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	0.559	0.014	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

SOT-23-5 Surface Mount Package

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