

## 2.5A, Ultra-Low Dropout, Ultra-Fast CMOS LDO Regulator

### General Description

The RT9009 is a high performance, 2.5A LDO regulator, offering extremely high PSRR and ultra-low dropout. Ideal for portable RF and wireless applications with demanding performance and space requirements.

Regulator ground current increases only slightly in dropout, further prolonging the battery life. The RT9009 also works with low-ESR ceramic capacitors, reducing the amount of board space necessary for power applications that is critical in hand-held wireless devices.

The RT9009 consumes less than 1µA in shutdown mode and has fast turn-on time of less than 400µs. The other features include ultra-low dropout voltage, high output accuracy, current limiting protection, and high ripple rejection ratio. The RT9009 is available in the TO-263S-5 package.

### Ordering Information

RT9009□□

- Package Type  
MS5 : TO-263S-5
- Lead Plating System  
P : Pb Free  
G : Green (Halogen Free and Pb Free)

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.

### Features

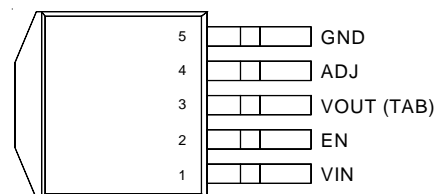
- Ultra Fast Response in Line/Load Transient
- < 1µA Shutdown Current
- Low Dropout : 520mV at 2A
- Wide Operating Voltage Ranges : 2.5V to 5.5V
- TTL-Logic-Controlled Shutdown Input
- Current Limiting Protection
- Thermal Shutdown Protection
- Low-ESR Ceramic Output Capacitor Required for Stability
- High Power Supply Rejection Ratio
- RoHS Compliant and 100% Lead (Pb)-Free

### Applications

- Game Console
- CDMA/GSM Cellular Handsets
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments
- Mini PCI & PCI-Express Cards
- PCMCIA & New Cards
- Portable Information Appliances

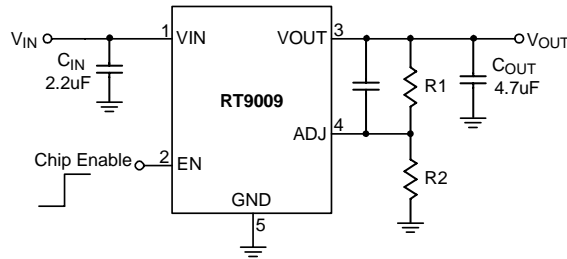
### Pin Configurations

(TOP VIEW)



TO-263S-5

Typical Application Circuit



$$V_{OUT} = 1.25 \times \left(1 + \frac{R_1}{R_2}\right) \text{ Volts}$$

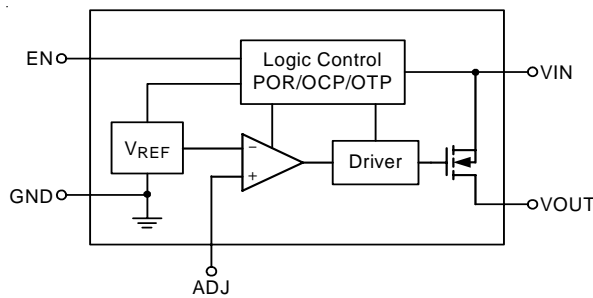
**Note:** The value of R2 should be less than 80k to maintain regulation.

Figure 1. Adjustable Operation

Function Pin Description

Pin No.	Pin Name	Pin Function
1	VIN	Power Supply Input.
2	EN	Chip Enable (Active High). When the EN goes to a logic low, the device will be shutdown.
3	VOUT	Regulator Output.
4	ADJ	Output Voltage Feedback Input. If external feedback resistors are applied, the output voltage will be : $V_{OUT} = 1.25 \times \left(1 + \frac{R_1}{R_2}\right) \text{ Volts}$
5	GND	Ground.

Function Block Diagram



**Absolute Maximum Ratings** (Note 1)

- Supply Input Voltage ----- 6V
- EN Input Voltage ----- 6V
- Power Dissipation, P<sub>D</sub> @ T<sub>A</sub> = 25°C
  - TO-263S-5 ----- 3.448W
- Package Thermal Resistance (Note 2)
  - TO-263S-5, θ<sub>JA</sub> ----- 29°C/W
  - TO-263S-5, θ<sub>JC</sub> ----- 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 ----- 2kV
  - MM ----- 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<sub>IN</sub> = 3.3V, V<sub>EN</sub> = V<sub>IN</sub>, C<sub>IN</sub> = 2.2μF (Ceramic), C<sub>OUT</sub> = 4.7μF (Ceramic), T<sub>A</sub> = 25°C unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage		V <sub>IN</sub>		2.5	--	5.5	V
Output Voltage Range (Adjustable)		V <sub>OUT_Adj</sub>		1.25	--	4.5	V
Quiescent Current		I <sub>Q</sub>	V <sub>EN</sub> ≥ V <sub>IH</sub> , I <sub>OUT</sub> = 0mA	--	380	500	μA
Shutdown Current		I <sub>STBY</sub>	V <sub>EN</sub> ≤ V <sub>IL</sub> , V <sub>IN</sub> = 3.3V	--	0.1	1	μA
Current Limit		I <sub>LIM</sub>		2.6	3.2	--	A
Dropout Voltage		V <sub>DROP</sub>	V <sub>OUT</sub> = 2.8V, I <sub>OUT</sub> = 2A	--	520	790	mV
Load Regulation		ΔV <sub>LOAD</sub>	10mA < I <sub>OUT</sub> < 2A	--	0.4	2	%
Line Regulation		ΔV <sub>LINE</sub>	V <sub>IN</sub> = 2.5V to 5.5V, I <sub>OUT</sub> = 5mA	--	--	1	%
EN Threshold	Logic-Low Voltage	V <sub>IL</sub>		--	--	0.6	V
	Logic-High Voltage	V <sub>IH</sub>		1.8	--	--	
Enable Pin Current		I <sub>EN</sub>	Enable	--	0.1	1	μA
Power Supply Rejection Rate		PSRR	I <sub>OUT</sub> = 300mA, f = 100Hz	--	60	--	dB
Thermal Shutdown Temperature		T <sub>SD</sub>		--	155	--	°C
Thermal Shutdown Hysteresis		ΔT <sub>SD</sub>		--	30	--	
<b>ADJ</b>							
Reference Voltage Tolerance		V <sub>REF</sub>		1.225	1.25	1.275	V
ADJ Pin Current		I <sub>ADJ</sub>	V <sub>ADJ</sub> = V <sub>REF</sub>	--	10	100	nA

**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.

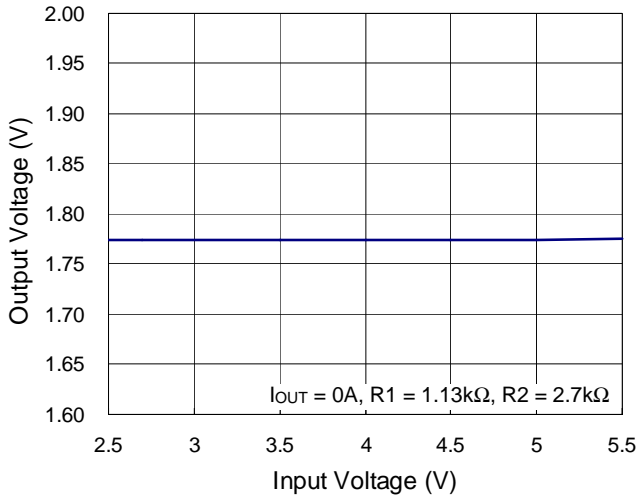
**Note 2.**  $\theta_{JA}$  is measured in the natural convection at  $T_A = 25^\circ\text{C}$  on a high effective four layers thermal conductivity test board of JEDEC 51-7 thermal measurement standard. The case point of  $\theta_{JC}$  is on the exposed pad for the package. The copper area as heat sink is  $225\text{mm}^2$ .

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

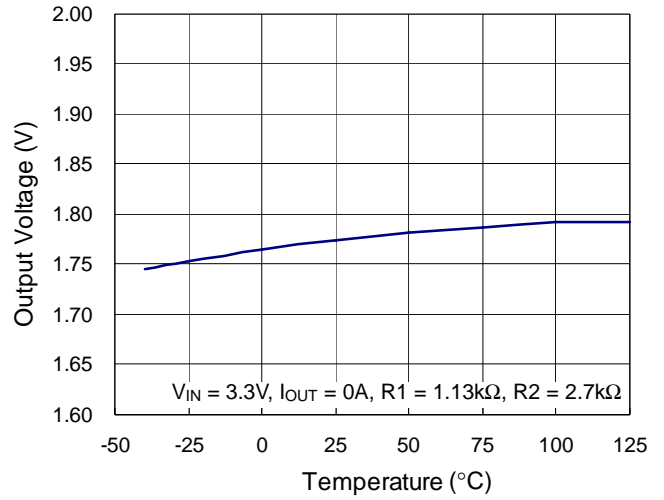
**Note 4.** The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

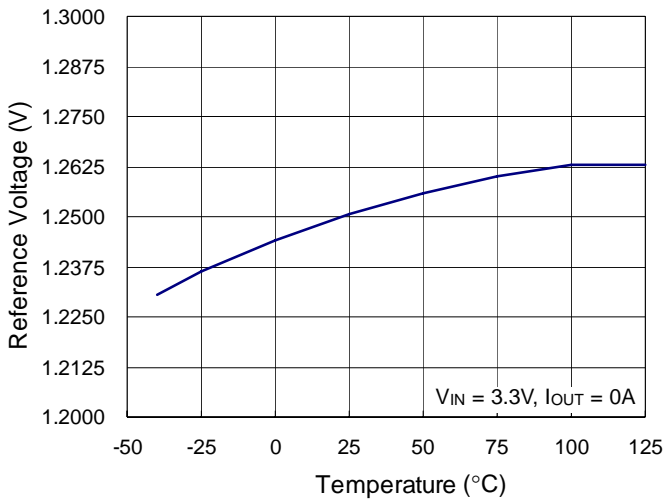
Output Voltage vs. Input Voltage



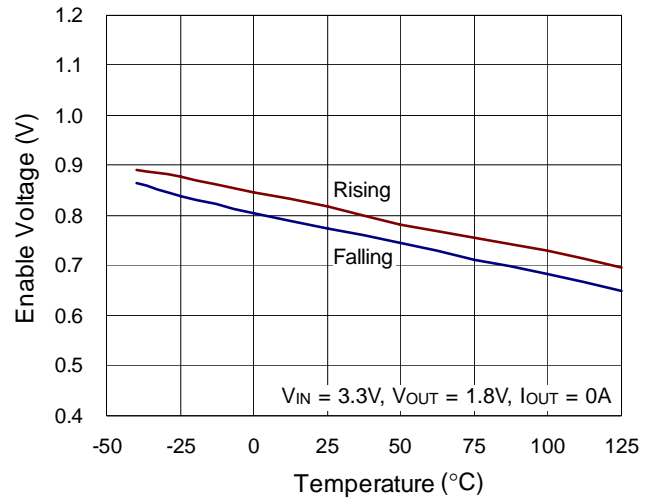
Output Voltage vs. Temperature



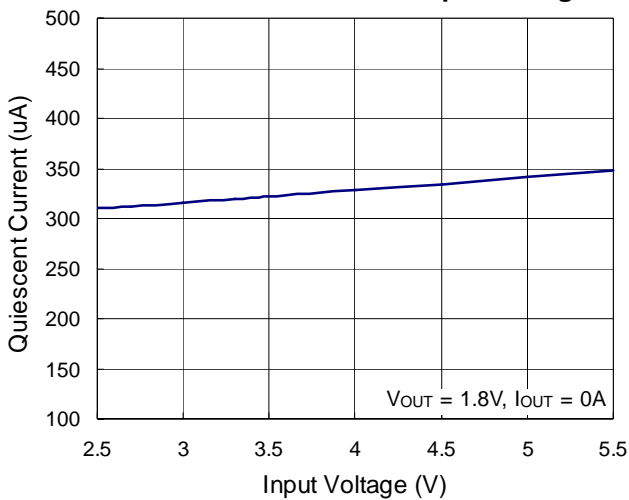
Reference Voltage vs. Temperature



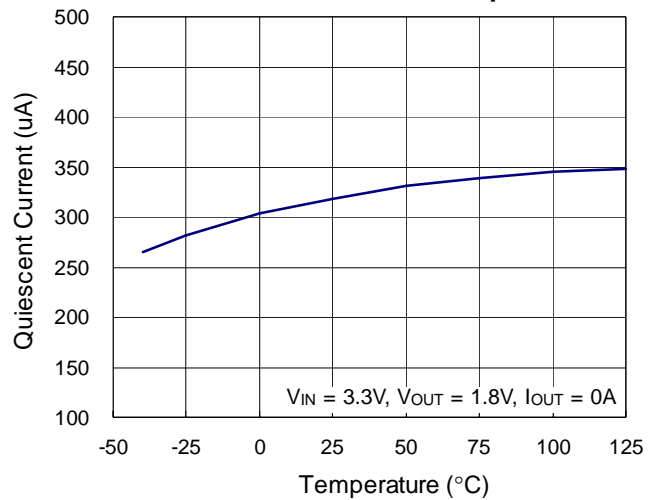
Enable Voltage vs. Temperature

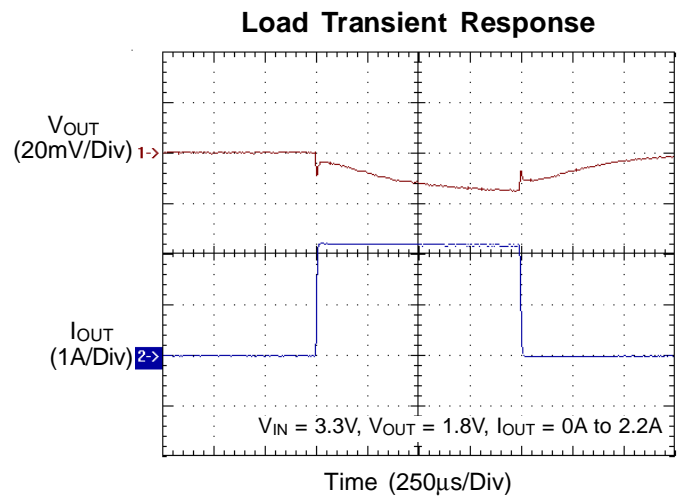
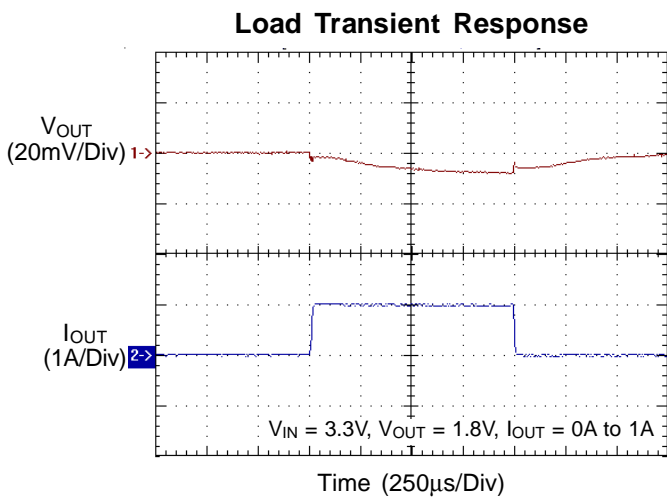
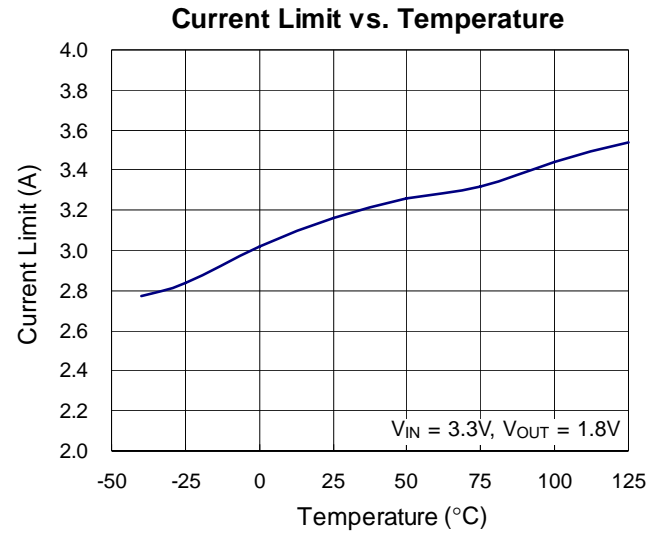
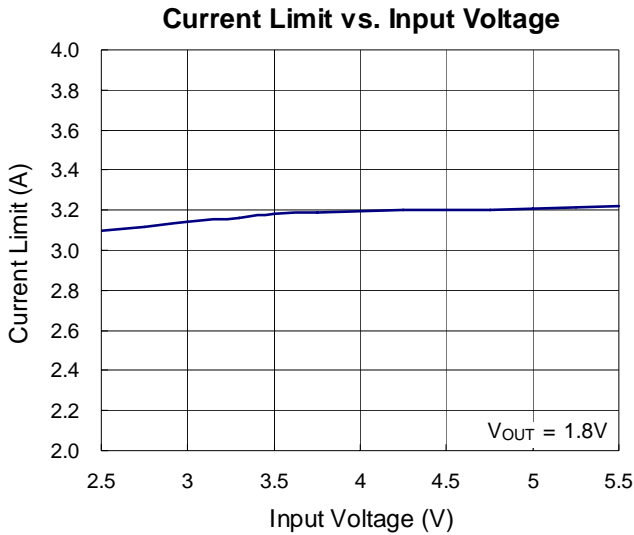
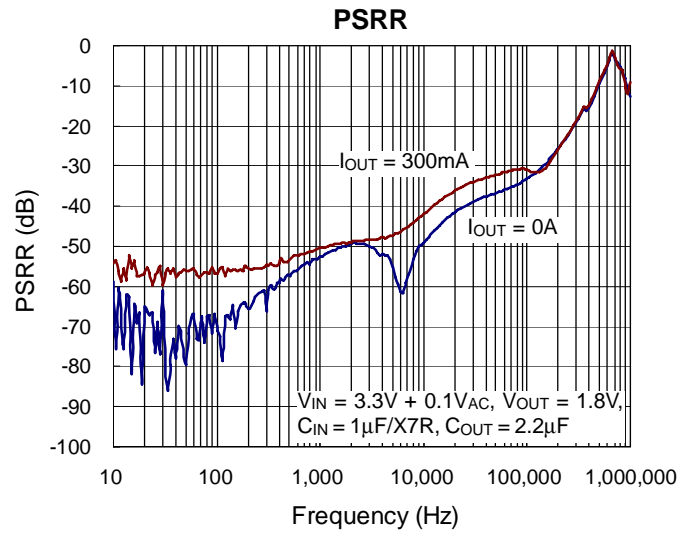
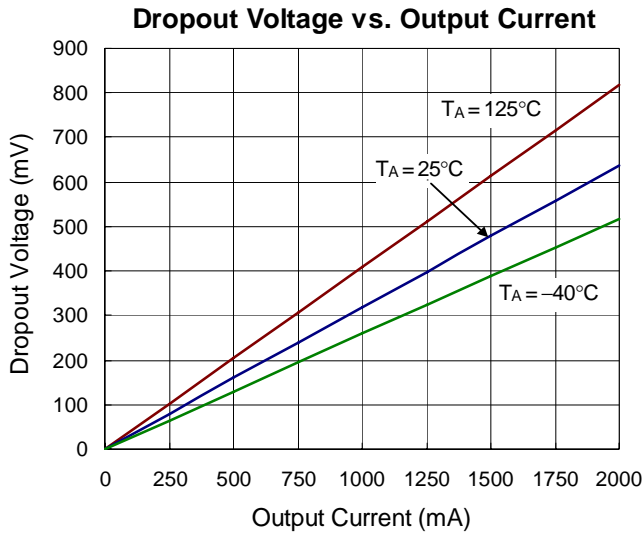


Quiescent Current vs. Input Voltage

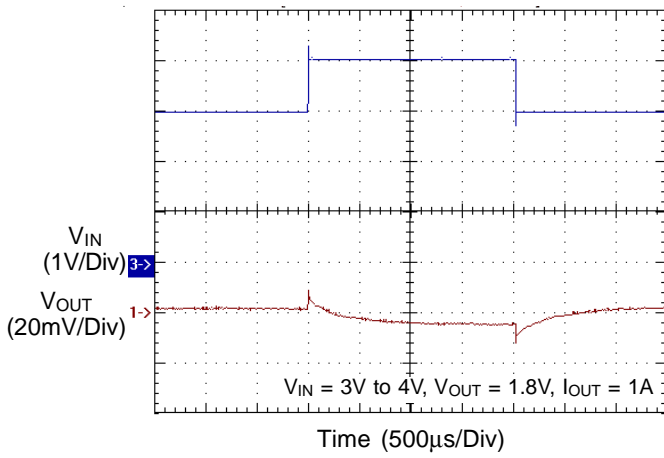


Quiescent Current vs. Temperature

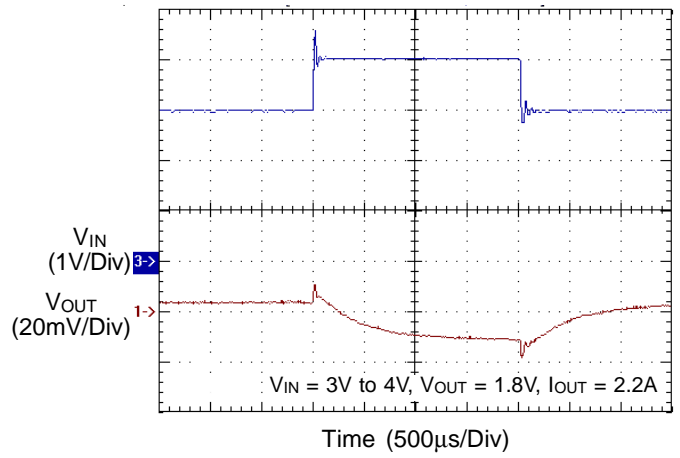




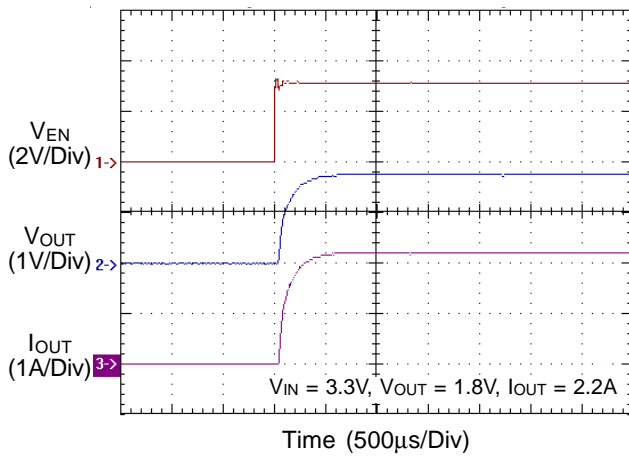
Line Transient Response



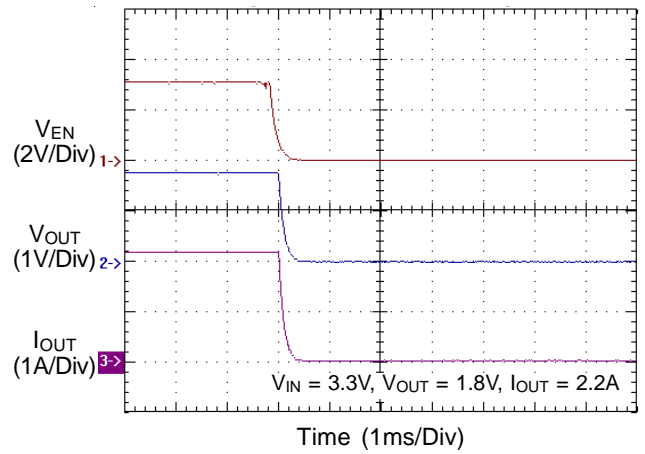
Line Transient Response



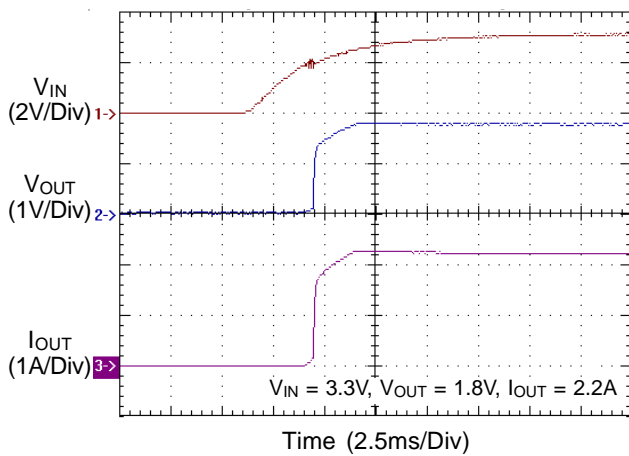
Power On from EN



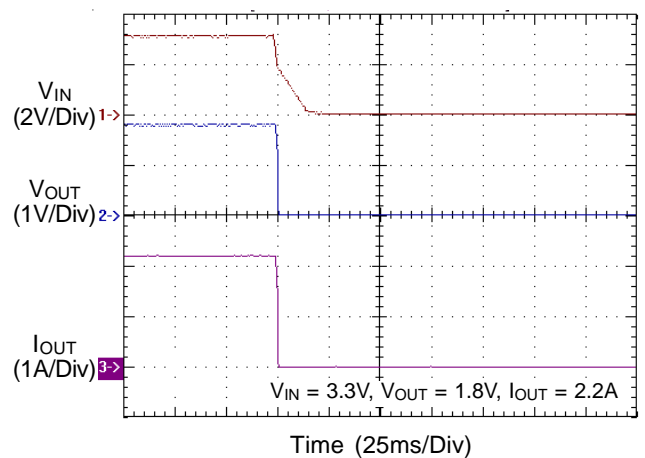
Power Off from EN



Power On from VIN



Power Off from VIN



Applications Information

Thermal Considerations

For continuous operation, do not exceed absolute maximum operation junction temperature. 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 operation junction temperature,  $T_A$  is the ambient temperature and the  $\theta_{JA}$  is the junction to ambient thermal resistance.

For recommended operating conditions specification of RT9009, the maximum operating junction temperature is 125°C. The junction to ambient thermal resistance  $\theta_{JA}$  is layout dependent. As shown in Figure 2, RT9009 TO-263S-5 with 15mm x 15mm PCB copper area on the standard JEDEC 51-7 four layers thermal test board thermal resistance  $\theta_{JA}$  is about 29°C/W. The maximum power dissipation at  $T_A = 25^\circ\text{C}$  can be calculated by following formula :

$$P_{D(MAX)} = (125^\circ\text{C} - 25^\circ\text{C}) / (29^\circ\text{C/W}) = 3.448\text{W for TO-263S-5 packages}$$

The maximum power dissipation depends on operating ambient temperature for fixed  $T_{J(MAX)}$  and thermal resistance  $\theta_{JA}$ . For the RT9009, the Figure 3 of de-rating curve allows the designer to see the effect of rising ambient temperature on the maximum power dissipation allowed.

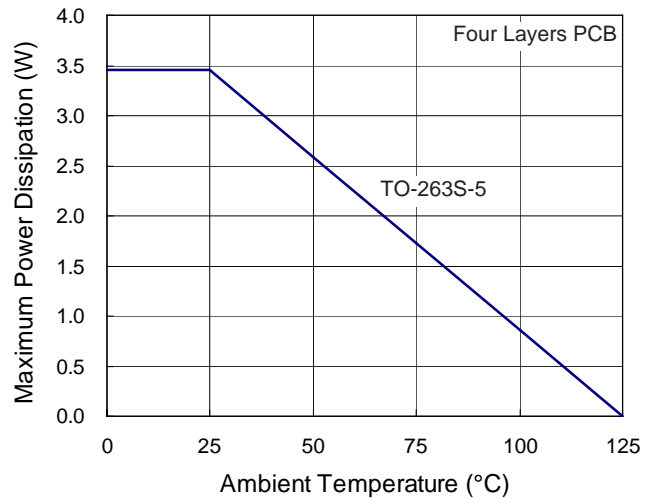


Figure 3. Derating Curve for RT9009 Package

Thermal Resistance vs. Copper Area

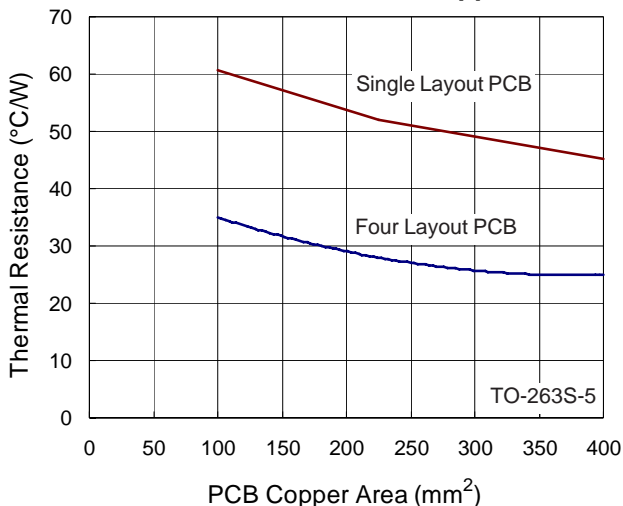
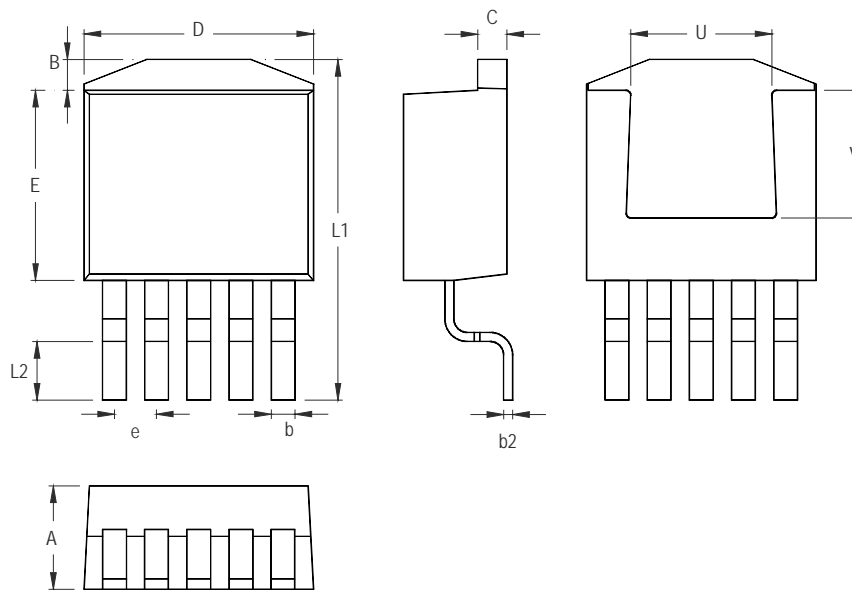


Figure 2. Thermal Resistance  $\theta_{JA}$  vs. Copper Area of TO-263S-5 Package



**Outline Dimension**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.064	4.826	0.160	0.190
B	1.143	1.397	0.045	0.055
b	0.660	0.914	0.026	0.036
b2	0.305	0.584	0.012	0.023
C	1.250	1.450	0.049	0.057
D	9.652	10.668	0.380	0.420
E	8.128	9.652	0.320	0.380
e	1.524	1.829	0.060	0.072
L1	13.000	14.300	0.512	0.563
L2	1.090	1.590	0.043	0.063
U	7.600 Ref.		0.299 Ref.	
V	5.900 Ref.		0.232 Ref.	

**5-Lead TO-263S Surface Mount Package**

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