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

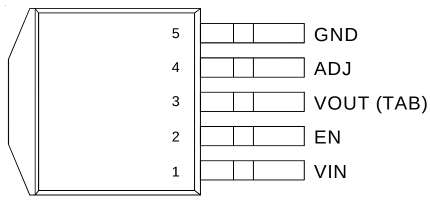
- **Ultra Fast Response in Line/Load Transient**
- **< 1μA Shutdown Current**
- **Low Dropout : 520mV at 2A**
- **Wide Operating Voltage Ranges : 2.5V to 5.5V**
- **TTL-Logic-Controlled Shutdown Input**
- **Current Limiting Protection**
- **Thermal Shutdown Protection**
- **Low-ESR Ceramic Output Capacitor 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

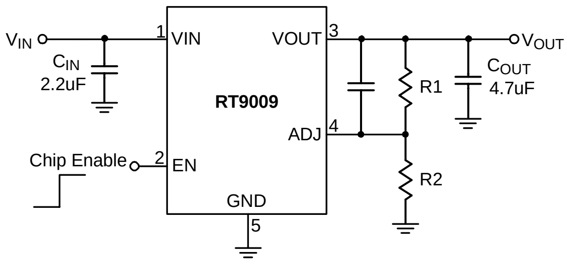
Pin Configurations

(TOP VIEW)



TO-263S-5

Typical Application Circuit



$$V_{OUT} = 1.25 \times (1+\frac{R1}{R2}) \text{ Volts}$$

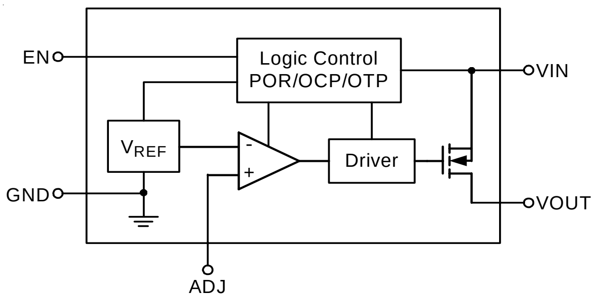
Note: The value of R2 should be less than 80k to maintain regulation.

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 : $V_{OUT} = 1.25 \times (1+\frac{R_1}{R_2})$ Volts
5	GND	Ground.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage ---------- 6V
- EN Input Voltage ---------- 6V
- Power Dissipation, P_D @ T_A = 25°C
  TO-263S-5 ---------- 3.448W
- Package Thermal Resistance (Note 2)
  TO-263S-5, θ_{JA} ---------- 29°C/W
  TO-263S-5, θ_{JC} ---------- 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_{IN} = 3.3V, V_{EN} = V_{IN}, C_{IN} = 2.2μF (Ceramic), C_{OUT} = 4.7μF (Ceramic), T_A = 25°C unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage		V_{IN}		2.5	--	5.5	V
Output Voltage Range (Adjustable)		V_{OUT_Adj}		1.25	--	4.5	V
Quiescent Current		I_Q	$V_{EN} \geq V_{IH}$, I_{OUT} = 0mA	--	380	500	μA
Shutdown Current		I_{STBY}	$V_{EN} \leq V_{IL}$, V_{IN} = 3.3V	--	0.1	1	μA
Current Limit		I_{LIM}		2.6	3.2	--	A
Dropout Voltage		V_{DROP}	V_{OUT} = 2.8V, I_{OUT} = 2A	--	520	790	mV
Load Regulation		ΔV_{LOAD}	10mA < I_{OUT} < 2A	--	0.4	2	%
Line Regulation		ΔV_{LINE}	V_{IN} = 2.5V to 5.5V, I_{OUT} = 5mA	--	--	1	%
EN Threshold	Logic-Low Voltage	V_{IL}		--	--	0.6	V
	Logic-High Voltage	V_{IH}		1.8	--	--	
Enable Pin Current		I_{EN}	Enable	--	0.1	1	μA
Power Supply Rejection Rate		PSRR	I_{OUT} = 300mA, f = 100Hz	--	60	--	dB
Thermal Shutdown Temperature		T_{SD}		--	155	--	°C
Thermal Shutdown Hysteresis		ΔT_{SD}		--	30	--	
ADJ							
Reference Voltage Tolerance		V_{REF}		1.225	1.25	1.275	V
ADJ Pin Current		I_{ADJ}	V_{ADJ} = V_{REF}	--	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.

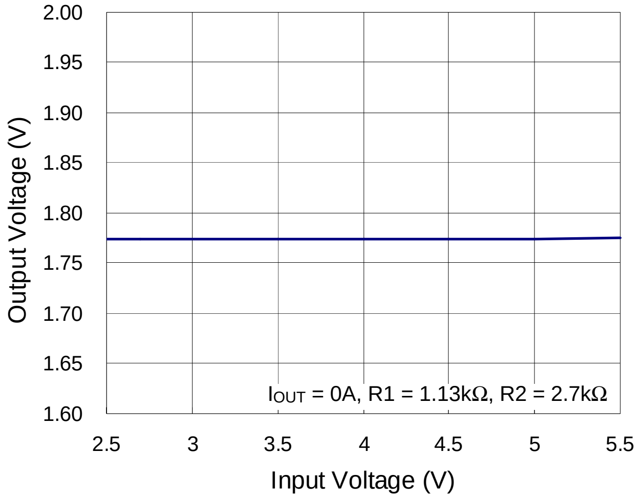
Note 2. θ_{JA} is measured in the natural convection at $T_A = 25°C$ on a high effective four layers thermal conductivity test board of JEDEC 51-7 thermal measurement standard. The case point of θ_{JC} is on the exposed pad for the package. The copper area as heat sink is $225mm^2$.

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

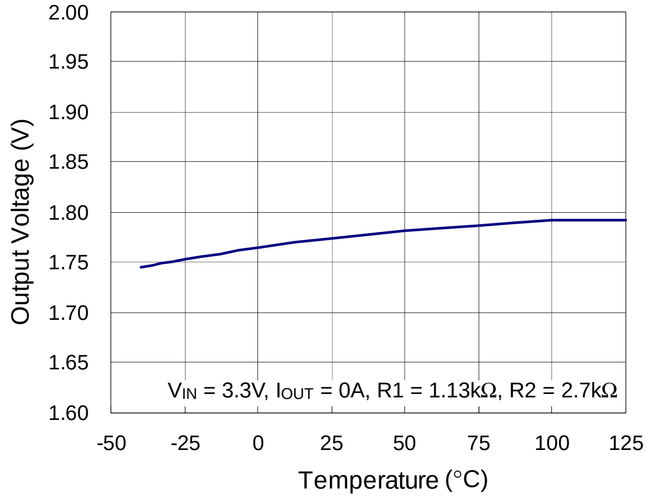
Note 4. The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

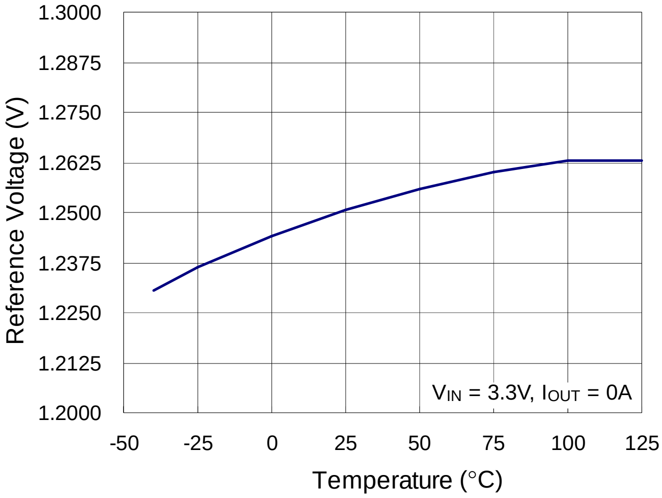
Output Voltage vs. Input Voltage



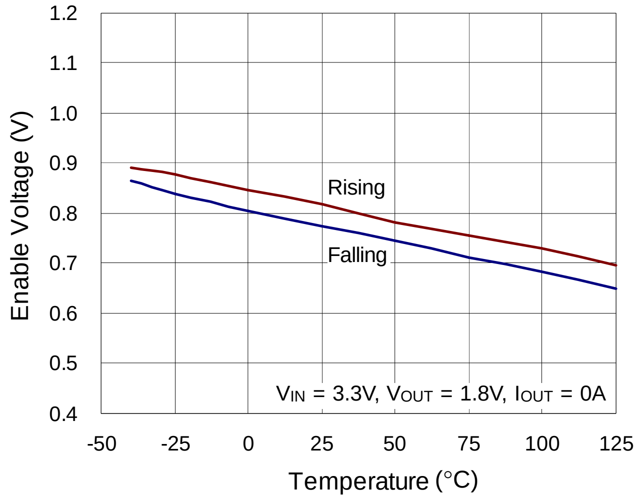
Output Voltage vs. Temperature



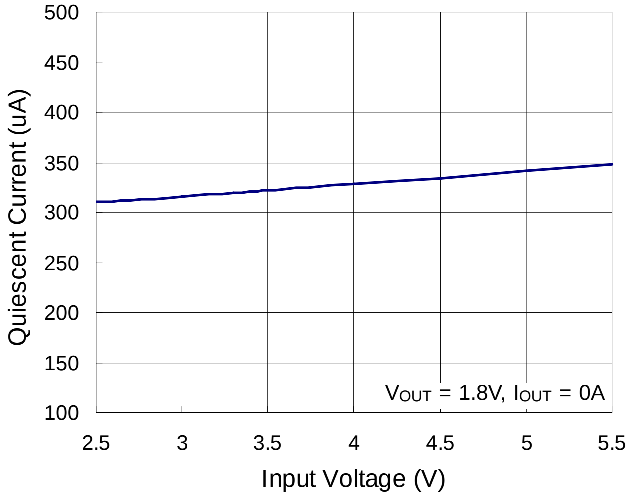
Reference Voltage vs. Temperature



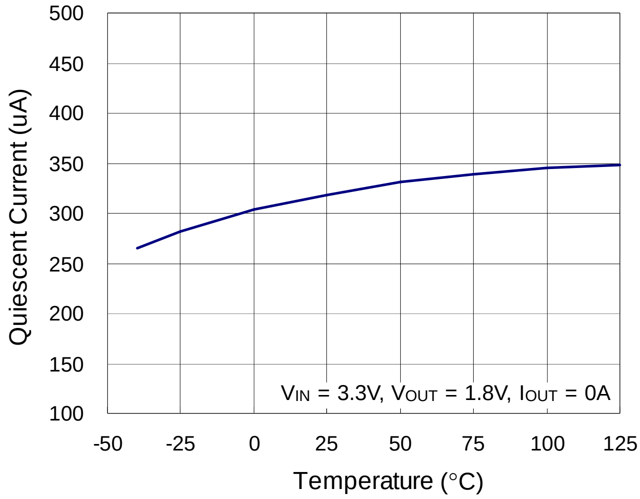
Enable Voltage vs. Temperature

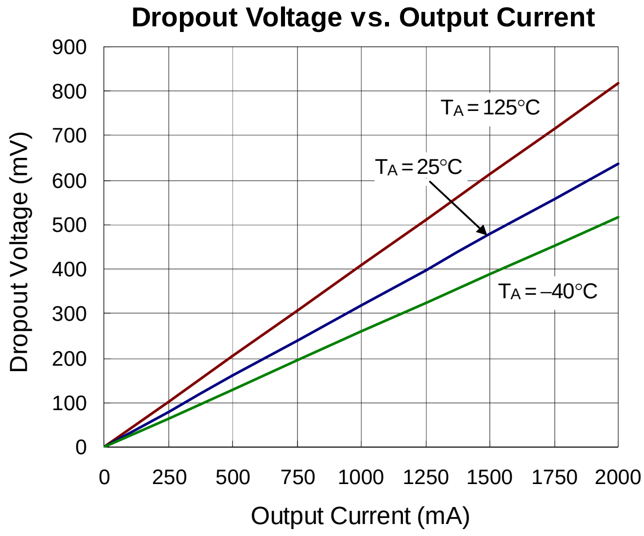


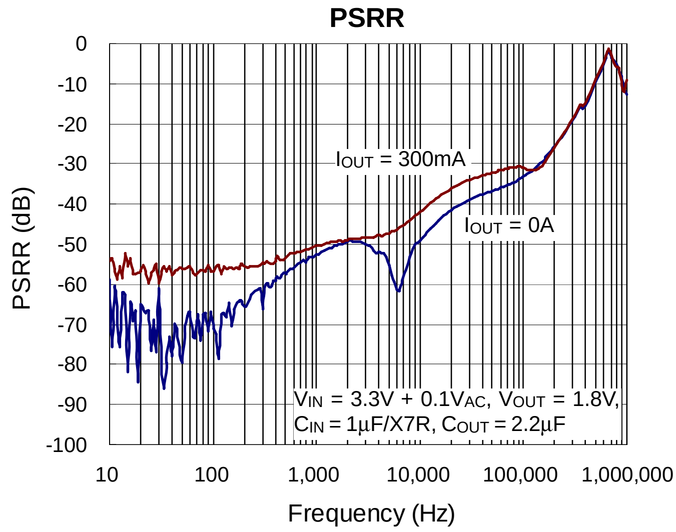
Quiescent Current vs. Input Voltage

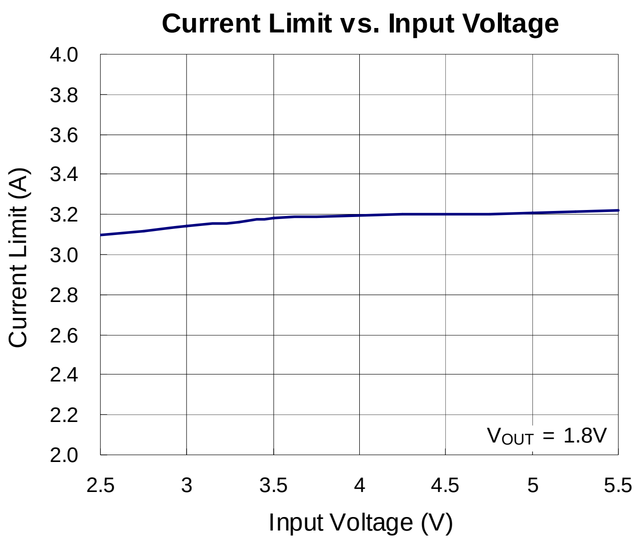


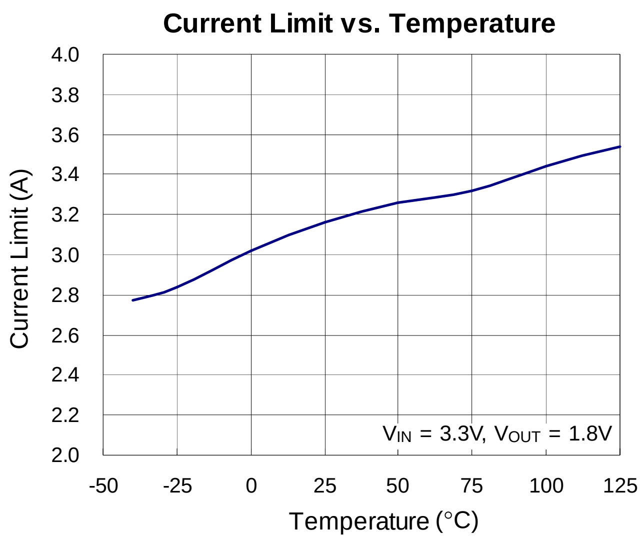
Quiescent Current vs. Temperature

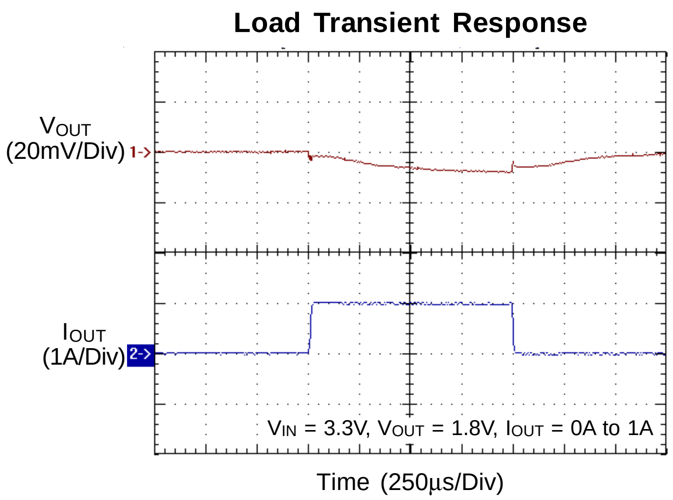


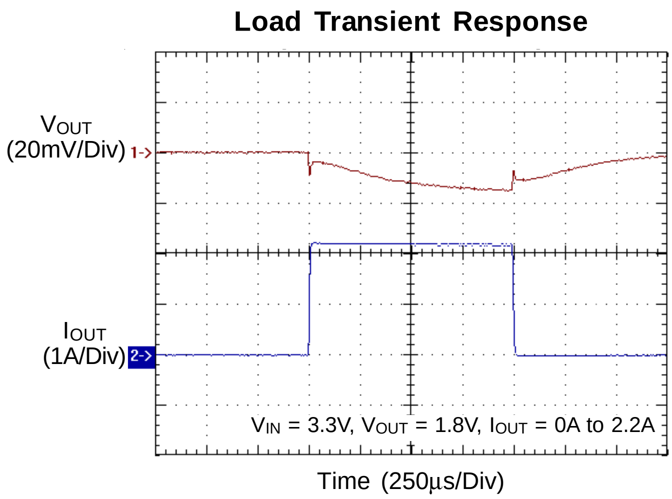

Dropout Voltage vs. Output Current
Dropout Voltage (mV)
900
800
700
600
500
400
300
200
100
0
0 250 500 750 1000 1250 1500 1750 2000
Output Current (mA)
TA = 125°C
TA = 25°C
TA = –40°C


PSRR
PSRR (dB)
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100
10 100 1,000 10,000 100,000 1,000,000
Frequency (Hz)
IOUT = 300mA
IOUT = 0A
VIN = 3.3V + 0.1VAC, VOUT = 1.8V,
CIN = 1μF/X7R, COUT = 2.2μF

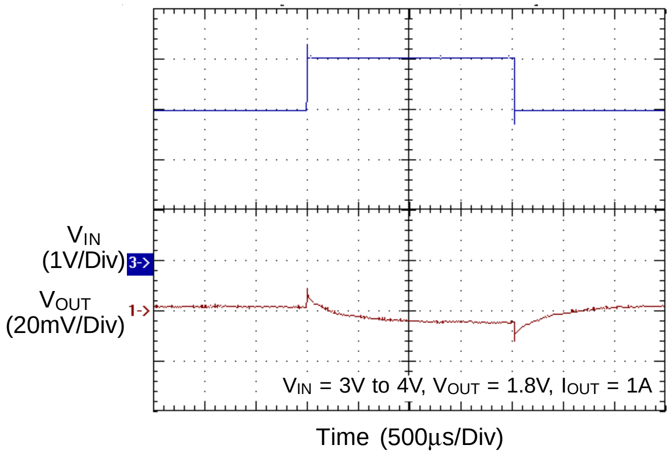

Current Limit vs. Input Voltage
Current Limit (A)
4.0 3.8 3.6 3.4 3.2 3.0 2.8 2.6 2.4 2.2 2.0
2.5 3 3.5 4 4.5 5 5.5
Input Voltage (V)
VOUT = 1.8V


Current Limit vs. Temperature
Current Limit (A)
4.0 3.8 3.6 3.4 3.2 3.0 2.8 2.6 2.4 2.2 2.0
-50 -25 0 25 50 75 100 125
Temperature (°C)
VIN = 3.3V, VOUT = 1.8V

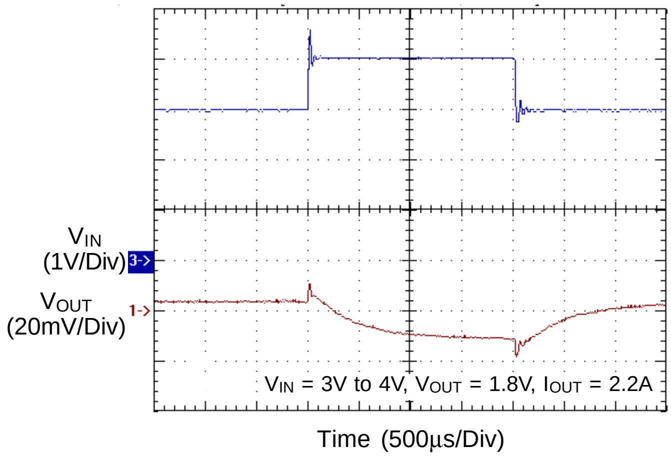

Load Transient Response
VOUT (20mV/Div)
IOUT (1A/Div)
VIN = 3.3V, VOUT = 1.8V, IOUT = 0A to 1A
Time (250μs/Div)


Load Transient Response
VOUT (20mV/Div)
IOUT (1A/Div)
VIN = 3.3V, VOUT = 1.8V, IOUT = 0A to 2.2A
Time (250μs/Div)

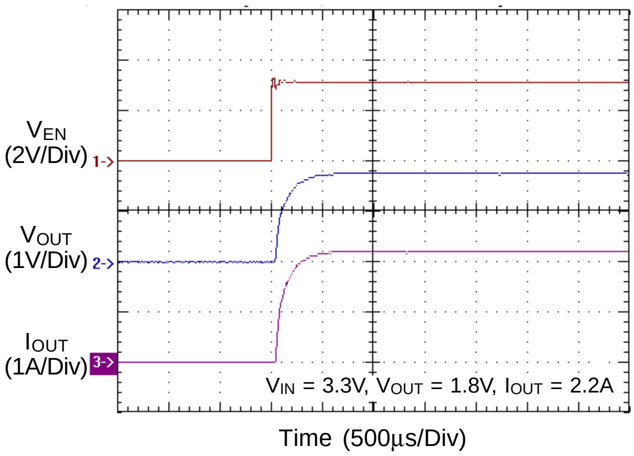
Line Transient Response



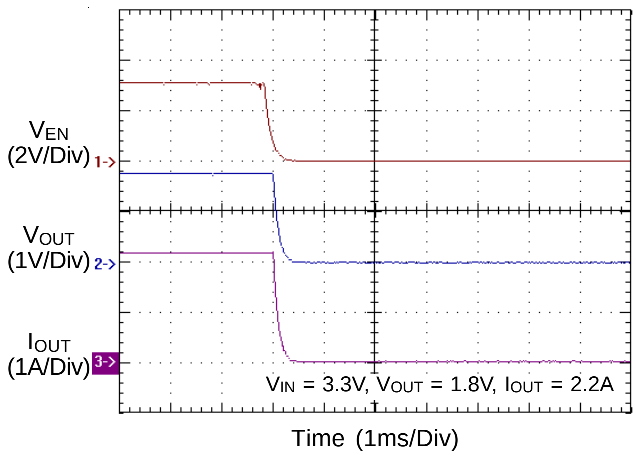
Line Transient Response



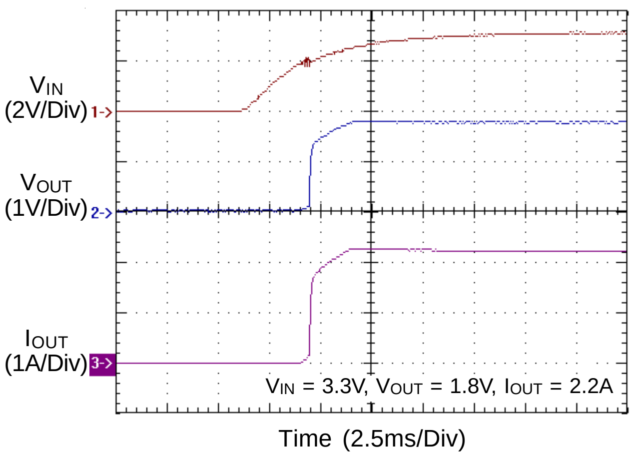
Power On from EN



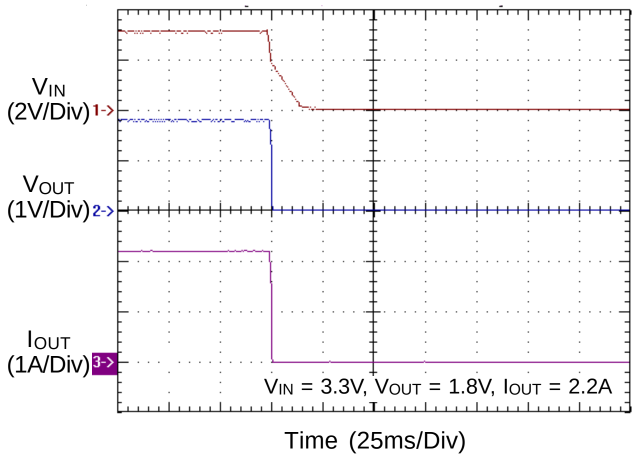
Power Off from EN



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 θ_{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 θ_{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 θ_{JA} is about 29°C/W. The maximum power dissipation at T_A = 25°C can be calculated by following formula :

$P_{D(MAX)}$ = (125°C − 25°C) / (29°C/W) = 3.448W for TO-263S-5 packages

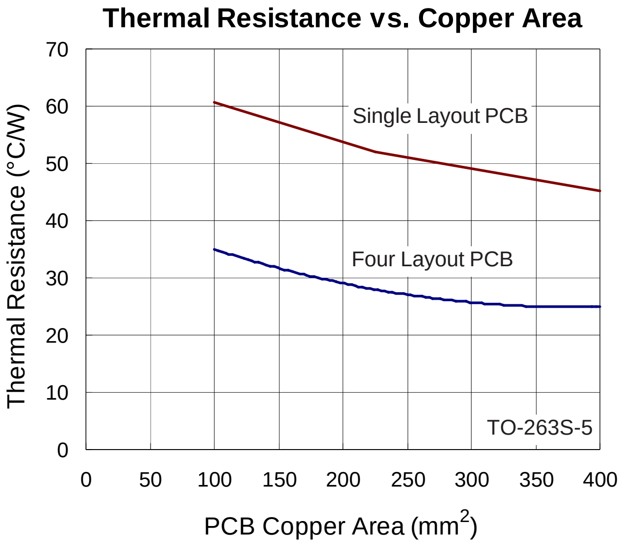


Figure 2. Thermal Resistance θ_{JA} vs. Copper Area of TO-263S-5 Package

The maximum power dissipation depends on operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance θ_{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.

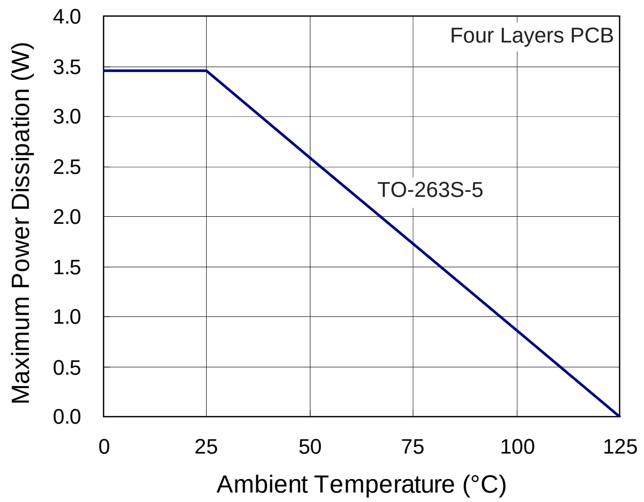
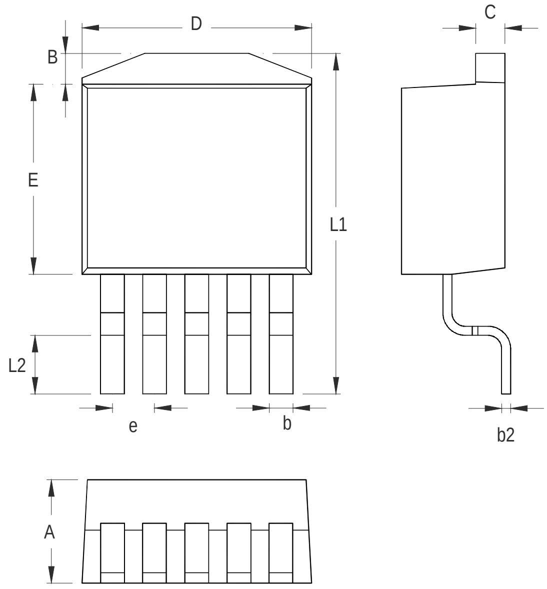


Figure 3. Derating Curve for RT9009 Package

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

Richtek Technology Corporation
Headquarter
5F, No. 20, Taiyuen Street, Chupei City
Hsinchu, Taiwan, R.O.C.
Tel: (8863)5526789 Fax: (8863)5526611

Richtek Technology Corporation
Taipei Office (Marketing)
5F, No. 95, Minchiuan Road, Hsintien City
Taipei County, Taiwan, R.O.C.
Tel: (8862)86672399 Fax: (8862)86672377
Email: marketing@richtek.com