1μA I_Q, 250mA Low-Dropout Linear Regulator

General Description

The RT9073A is a low-dropout (LDO) voltage regulators with enable function that operates from 1.2V to 5.5V. It provides up to 250mA of output current and offers low-power operation in miniaturized packaging.

The features of low quiescent current as low as 1μA and almost zero disable current is ideal for powering the battery equipment to a longer service life. The RT9073A is stable with the ceramic output capacitor over its wide input range from 1.2V to 5.5V and the entire range of output load current (0mA to 250mA).

Ordering Information

RT9073A-□□□□

- Package Type
  - QZ : ZQFN-4L 1x1 (Z-Type) (ZDFN-4L 1x1)
  - Y : SC-82
- Lead Plating System
  - G : Green (Halogen Free and Pb Free)
- Output Voltage
  - 09 : 0.9V
  - 1K : 1.05V
  - 12 : 1.2V
  - 15 : 1.5V
  - 18 : 1.8V
  - 19 : 1.9V
  - 25 : 2.5V
  - 27 : 2.7V
  - 28 : 2.8V
  - 29 : 2.9V
  - 30 : 3.0V
  - 33 : 3.3V
  - Special Request: Any Voltage Between 0.9V and 3.3V under specific business agreement

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

- **1μA Ground Current at no Load**
- **PSRR = 75dB at 1kHz**
- **±2% Output Accuracy**
- **250mA (V_{IN} ≥ 2.3V) Output Current with EN**
- **Low (0.1μA) Disable Current**
- **1.2V to 5.5V Operating Input Voltage**
- **Dropout Voltage : 0.45V (typ.) at 250mA when V_{OUT} ≥ 3V**
- **Support Fixed Output Voltage 0.9V, 1.05V, 1.2V, 1.5V, 1.8V, 1.9V, 2.5V, 2.7V, 2.8V, 2.9V, 3V, 3.3V**
- **Stable with Ceramic or Tantalum Capacitor**
- **Current Limit Protection**
- **Over Temperature Protection**
- **ZQFN-4L 1x1 (ZDFN-4L 1x1), SC-82 Packages Available**

Applications

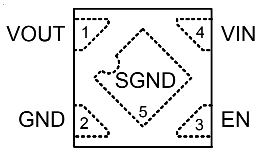
- Portable, Battery Powered Equipment
- Ultra Low Power Microcontrollers
- Notebook Computers

Marking Information

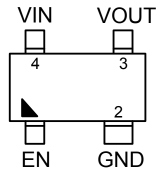
For marking information, contact our sales representative directly or through a Richtek distributor located in your area.

Pin Configuration

(TOP VIEW)



ZQFN-4L 1x1 (ZDFN-4L 1x1)

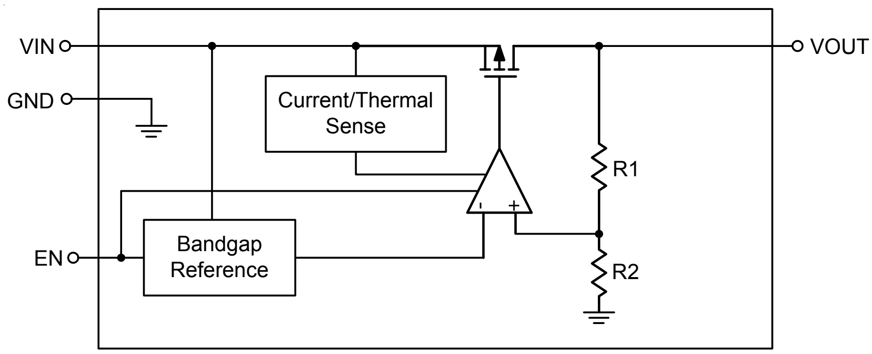


SC-82 (SSOT-24)

Functional Pin Description

Pin No.		Pin Name	Pin Function
ZQFN-4L 1x1 (ZDFN-4L 1x1)	SC-82 (SSOT-24)		
1	3	VOUT	Output of the regulator.
2	2	GND	Ground.
3	1	EN	Enable control input.
4	4	VIN	Supply voltage input.
5 (Exposed Pad)	--	SGND	Substrate of chip. Leave floating or tie to GND.

Functional Block Diagram



Operation

Basic operation

The RT9073A is a low quiescent current linear regulator designed especially for low external components system. The input voltage range is from 1.2V to 5.5V.

The minimum required output capacitance for stable operation is 1μF effective capacitance after consideration of the temperature and voltage coefficient of the capacitor.

Output Transistor

The RT9073A builds in a P-MOSFET output transistor which provides a low switch-on resistance for low dropout voltage applications.

Error Amplifier

The Error Amplifier compares the internal reference voltage with the output feedback voltage from the internal divider, and controls the Gate voltage of P-MOSFET to support good line regulation and load regulation at output voltage.

Enable

The RT9073A delivers the output power when it is set to enable state. When it works in disable state, there is no output power and the operation quiescent current is almost zero.

Current Limit Protection

The RT9073A provides current limit function to prevent the device from damages during over-load or shorted-circuit condition. This current is detected by an internal sensing transistor.

Over Temperature Protection

The over temperature protection function will turn off the P-MOSFET when the junction temperature exceeds 150°C (typ.), $V_{IN} \geq 1.5V$ 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)

- VIN, VOUT, EN to GND ---------- –0.3V to 6.5V
- VOUT to VIN ---------- –6.5V to 0.3V
- Power Dissipation, P_D @ T_A = 25°C
  ZQFN-4L 1x1 (ZDFN-4L 1x1) ---------- 0.44W
  SC-82 ---------- 0.28W
- Package Thermal Resistance (Note 2)
  ZQFN-4L 1x1 (ZDFN-4L 1x1), θ_{JA} ---------- 226°C/W
  ZQFN-4L 1x1 (ZDFN-4L 1x1), θ_{JC} ---------- 43°C/W
  SC-82, θ_{JA} ---------- 345.6°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)

- Input Voltage, VIN ---------- 1.2V to 5.5V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{OUT} + 1 < V_{IN} < 5.5V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage Range	V_{OUT}		0.9	--	3.3	V
DC Output Accuracy		I_{LOAD} = 1mA	–2	--	2	%
Dropout Voltage (I_{LOAD} = 50mA) (Note 5)	V_{DROP}	0.9V ≤ V_{OUT} < 1.2V	--	0.5	0.65	V
		1.2V ≤ V_{OUT} < 1.5V	--	0.3	0.4	
		1.5V ≤ V_{OUT} < 1.8V	--	0.2	0.24	
		1.8V ≤ V_{OUT} < 2.5V	--	0.15	0.18	
		2.5V ≤ V_{OUT} < 3V	--	0.1	0.15	
		3V ≤ V_{OUT}	--	0.08	0.12	
Dropout Voltage (I_{LOAD} = 250mA) (Note 5)	V_{DROP}	0.9V ≤ V_{OUT} < 1.2V	--	1.25	1.45	V
		1.2V ≤ V_{OUT} < 1.5V	--	1	1.2	
		1.5V ≤ V_{OUT} < 1.8V	--	0.81	0.9	
		1.8V ≤ V_{OUT} < 2.5V	--	0.68	0.8	
		2.5V ≤ V_{OUT} < 3V	--	0.51	0.6	
		3V ≤ V_{OUT}	--	0.45	0.6	
V_{CC} Consumption Current	I_Q	I_{LOAD} = 0mA, V_{OUT} ≤ 5.5V V_{IN} ≥ V_{OUT} + V_{DROP}	--	1	3	μA

Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
Shutdown GND Current		V_{EN} = 0V		--	0.1	0.5	μA
Shutdown Leakage Current		V_{EN} = 0V, V_{OUT} = 0V		--	0.1	0.5	μA
EN Input Current	I_{EN}	V_{EN} = 5.5V		--	--	0.1	μA
Line Regulation	ΔLINE	I_{LOAD} = 10mA	$1.2V \le V_{IN} < 1.5V$	--	--	0.6	%
Line Regulation	ΔLINE	I_{LOAD} = 10mA	$1.5V \le V_{IN} < 1.8V$	--	--	0.3	%
Line Regulation	ΔLINE	I_{LOAD} = 10mA	$1.8V \le V_{IN} < 2.1V$	--	--	0.1	%
Line Regulation	ΔLINE	I_{LOAD} = 10mA	$2.1V \le V_{IN} \le 5.5V$	--	--	0.15	%
Load Regulation	ΔLOAD	1mA < I_{LOAD} < 200mA		--	--	1	%
Power Supply Rejection Ratio	PSRR	V_{IN} = 3V, I_{LOAD} = 50mA, C_{OUT} = 1μF, V_{OUT} = 2.5V, f = 1kHz		--	75	--	dB
Output Voltage Noise		C_{OUT} = 1μF, I_{LOAD} = 30mA, BW = 10Hz to 100kHz, V_{IN} = V_{OUT} + 2V	V_{OUT} = 0.9V	--	39	--	μV_{RMS}
Output Voltage Noise		C_{OUT} = 1μF, I_{LOAD} = 30mA, BW = 10Hz to 100kHz, V_{IN} = V_{OUT} + 2V	V_{OUT} = 1.2V	--	46	--	μV_{RMS}
Output Voltage Noise		C_{OUT} = 1μF, I_{LOAD} = 30mA, BW = 10Hz to 100kHz, V_{IN} = V_{OUT} + 2V	V_{OUT} = 1.8V	--	48	--	μV_{RMS}
Output Voltage Noise		C_{OUT} = 1μF, I_{LOAD} = 30mA, BW = 10Hz to 100kHz, V_{IN} = V_{OUT} + 2V	V_{OUT} = 3.3V	--	58	--	μV_{RMS}
Output Current Limit	I_{LIM}	Peak output current		260	350	500	mA
Fold-Back Current Limit		V_{OUT} = 0.5 x $V_{OUT(normal)}$		190	270	350	mA
Enable Input Voltage: Logic-High	V_{IH}	V_{IN} = 5V		1.2	--	--	V
Enable Input Voltage: Logic-Low	V_{IL}	V_{IN} = 5V		--	--	0.4	V
Thermal Shutdown Temperature	T_{SD}	I_{LOAD} = 30mA, $V_{IN} \ge 1.5V$		--	150	--	°C
Thermal Shutdown Hysteresis	ΔT_{SD}			--	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 in the natural convection at T_A = 25°C on a two-layer Richtek Evaluation Board for ZQFN-4L 1x1 (ZDFN-4L 1x1) Package.

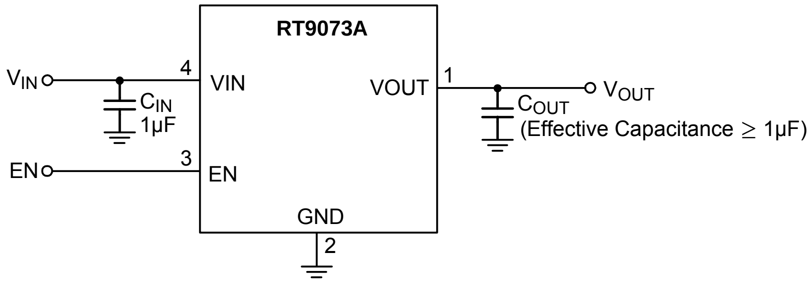
θ_{JA} is measured at T_A = 25°C on a high effective thermal conductivity four-layer test board per JEDEC 51-7 for SC-82 Package.

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

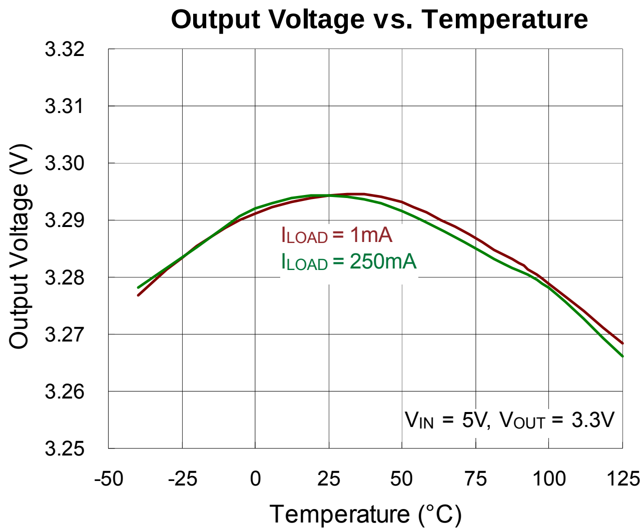
Note 4. The device is not guaranteed to function outside its operating conditions.

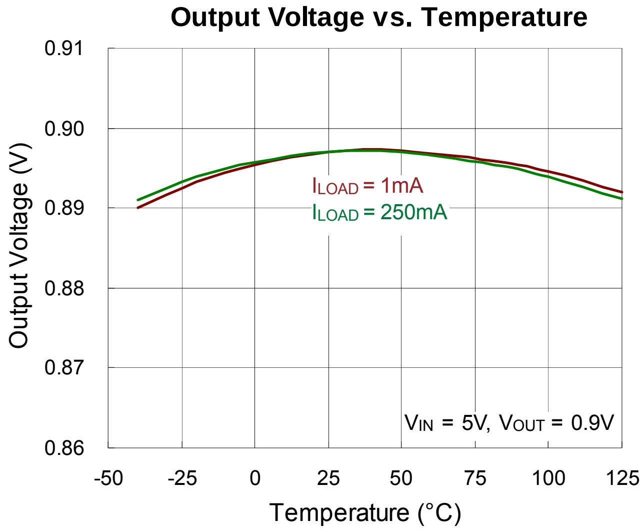
Note 5. The dropout voltage is defined as $V_{IN} - V_{OUT}$, when V_{OUT} is 98% of the normal value of V_{OUT}.

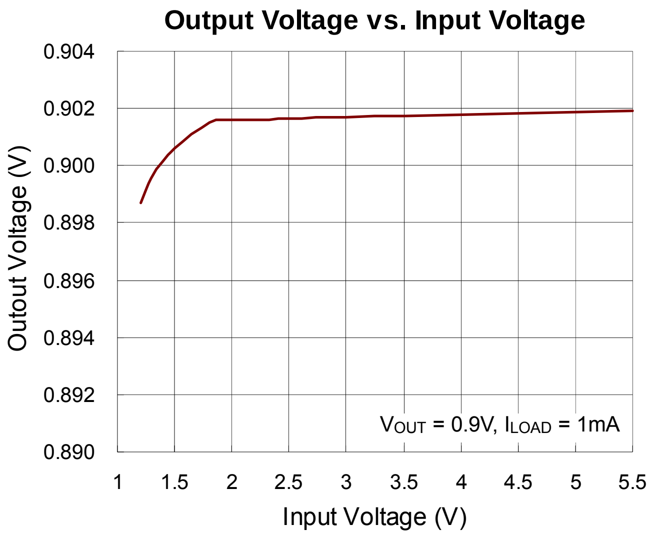
Typical Application Circuit

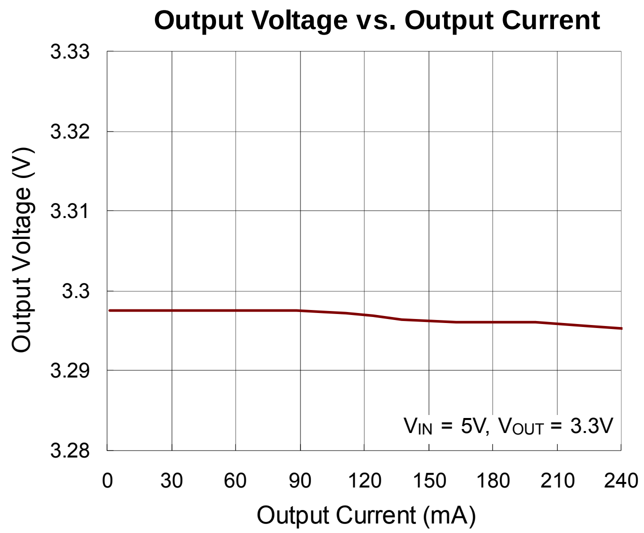


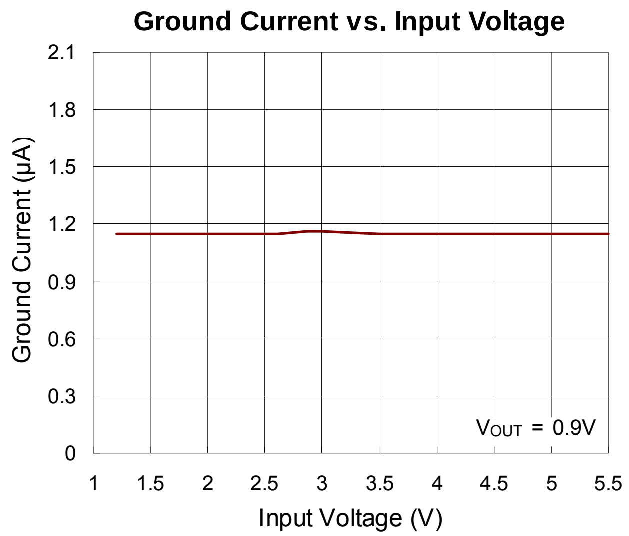
Typical Operating Characteristics

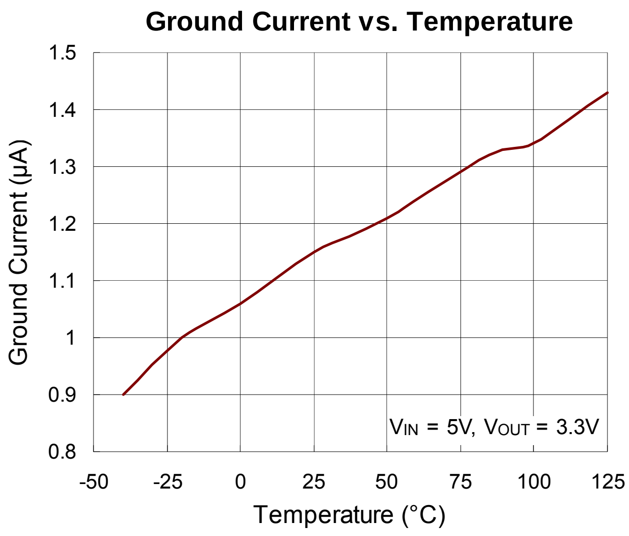




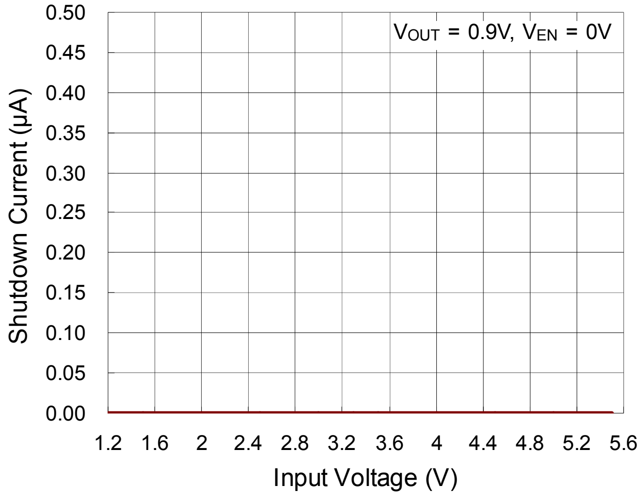




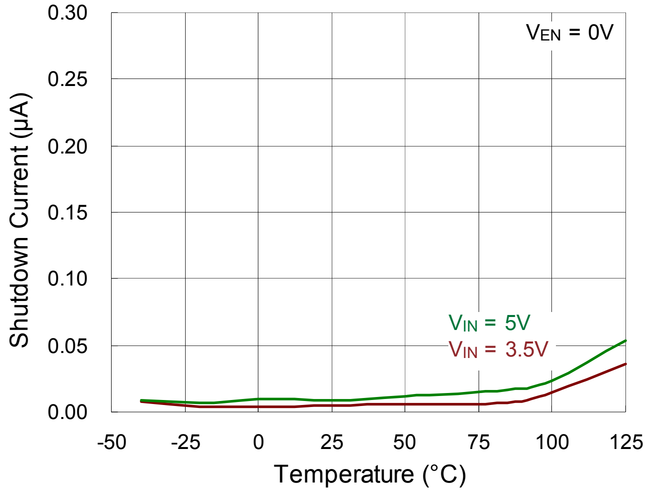




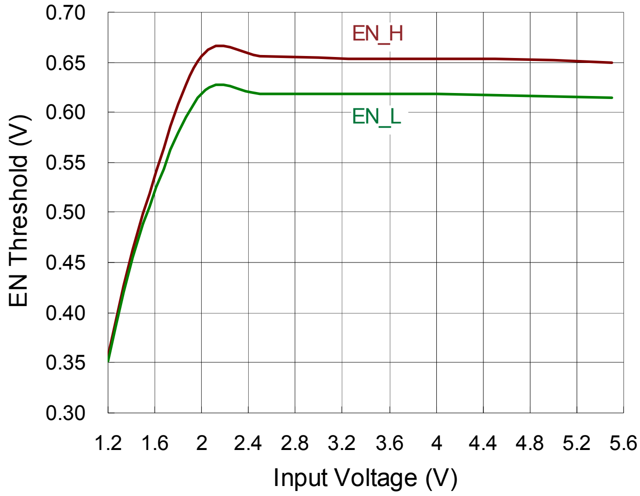
Shutdown Current vs. Input Voltage



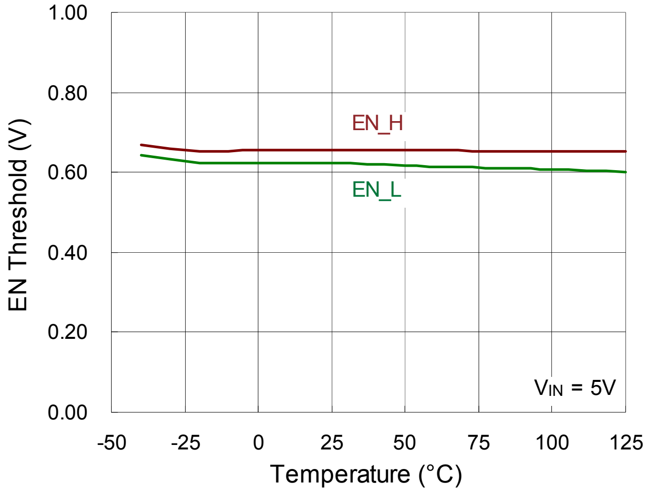
Shutdown Current vs. Temperature



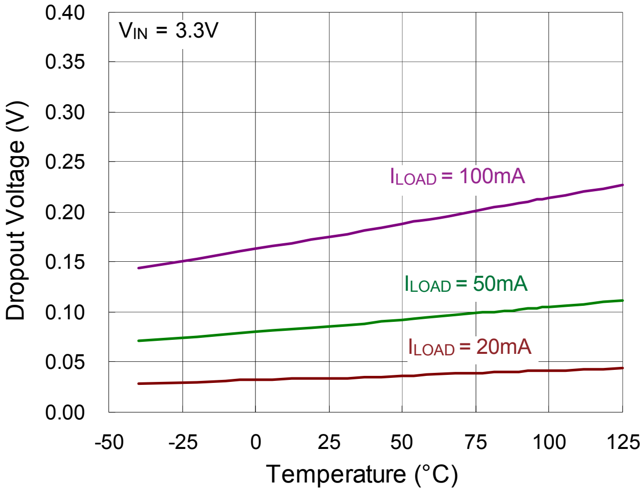
EN Threshold vs. Input Voltage



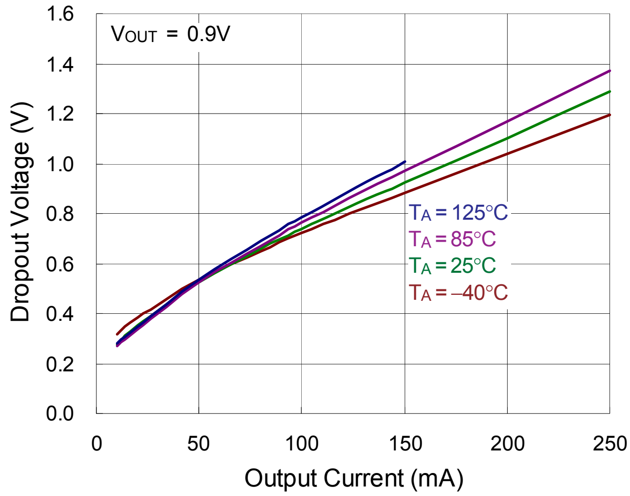
EN Threshold vs. Temperature



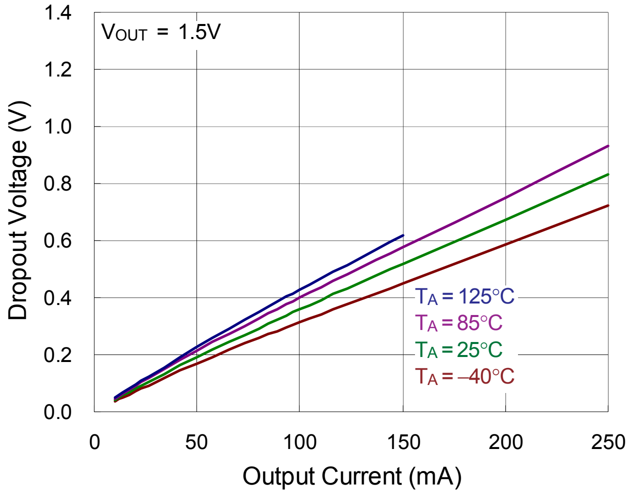
Dropout Voltage vs. Temperature



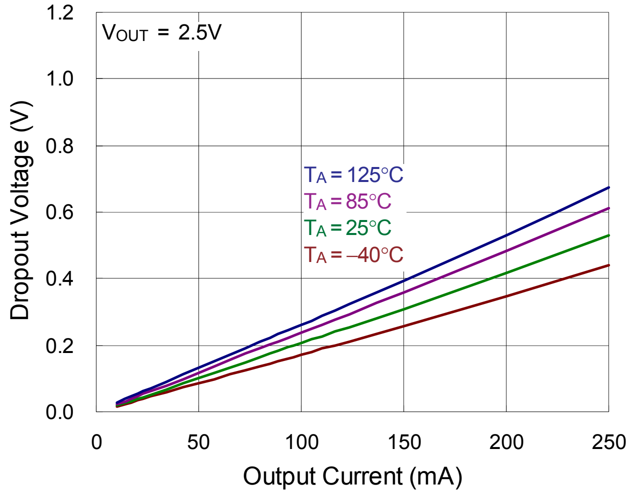
Dropout Voltage vs. Output Current



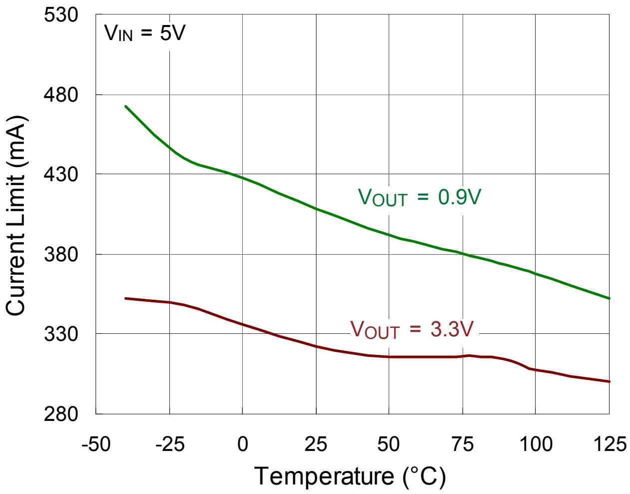
Dropout Voltage vs. Output Current



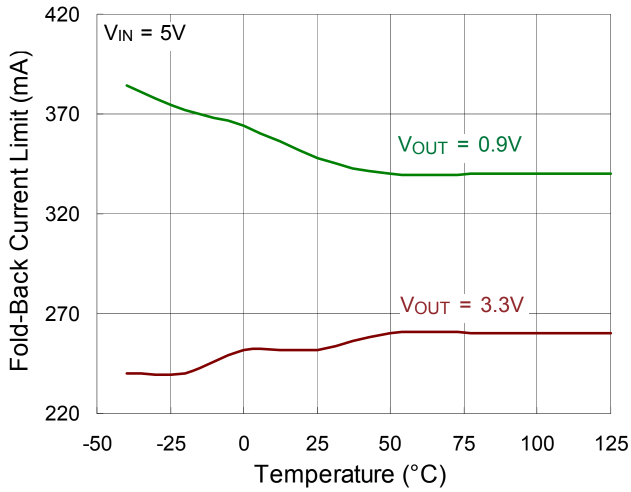
Dropout Voltage vs. Output Current



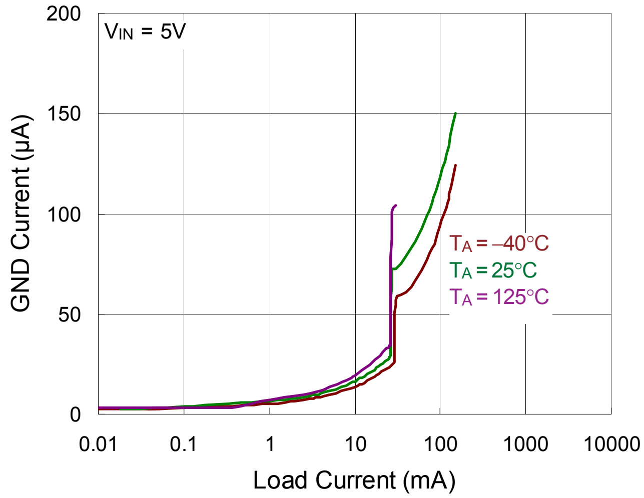
Current Limit vs. Temperature



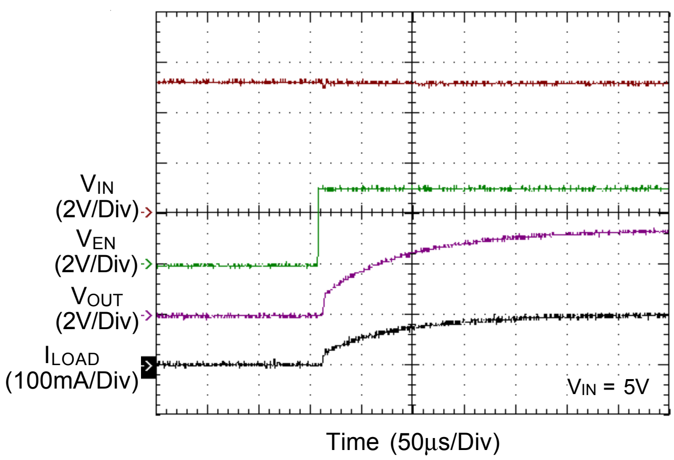
Fold-Back Current Limit vs. Temperature



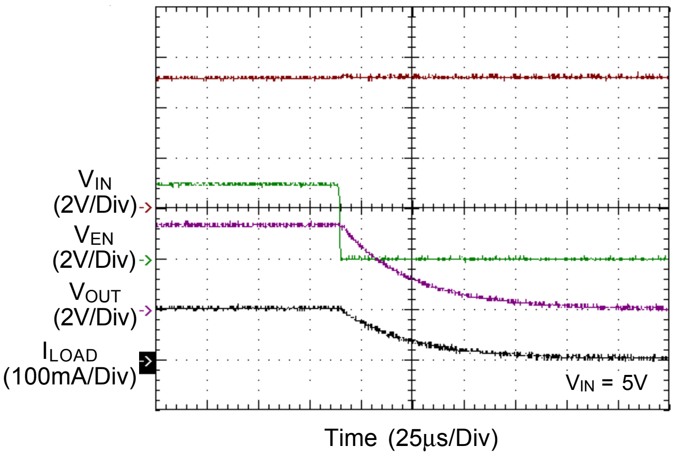
Ground Current vs. Load Current



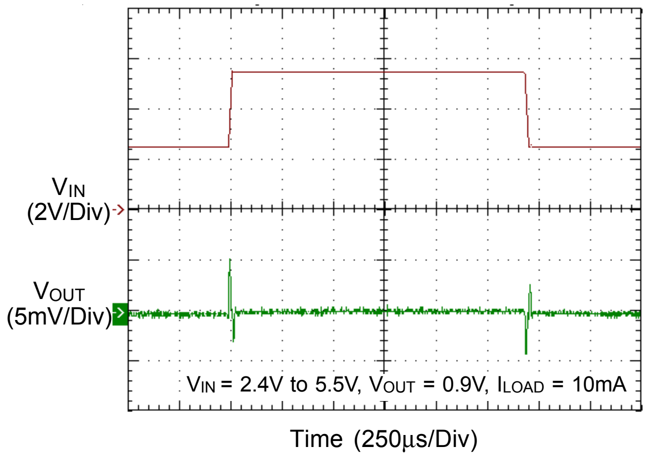
Power On from EN



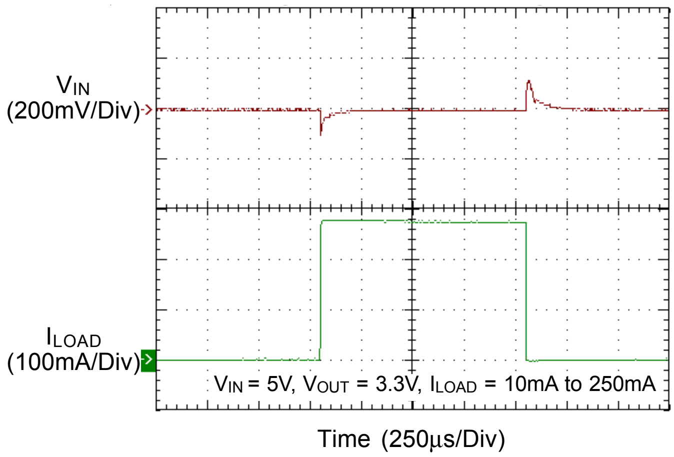
Power Off from EN



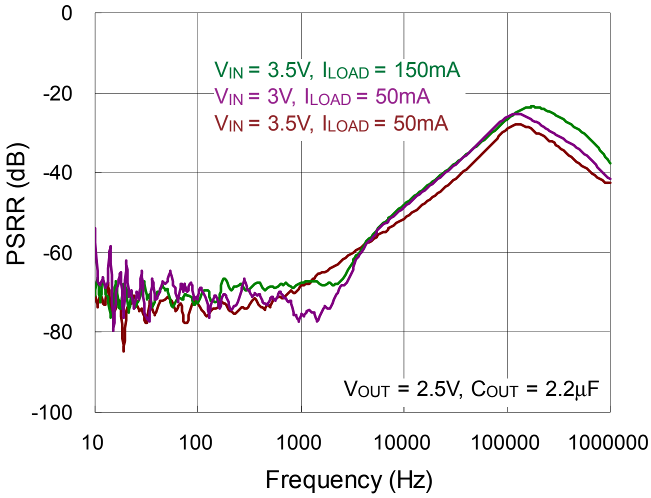
Line Transient



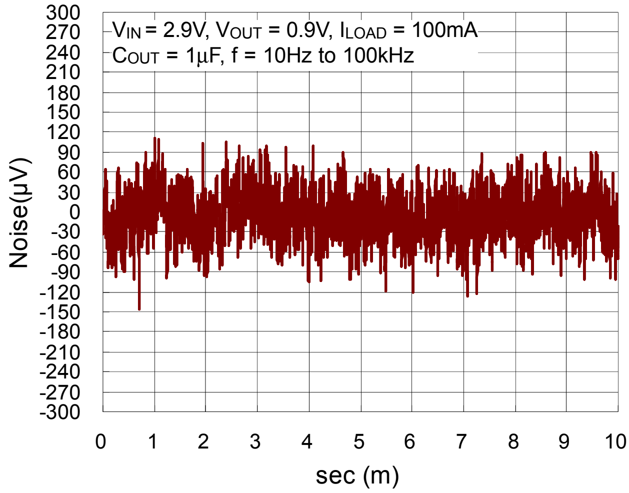
Load Transient



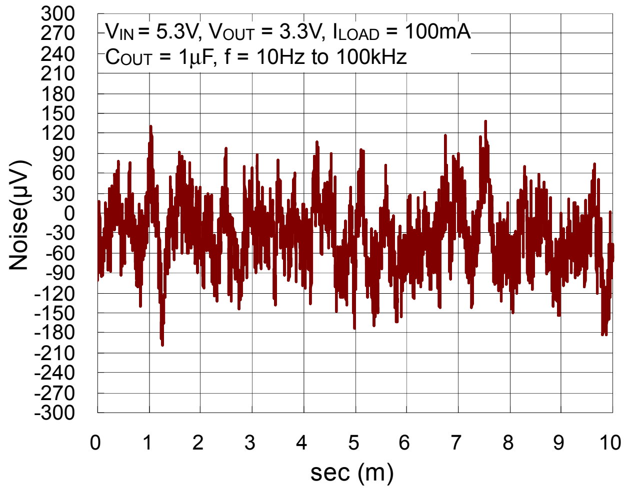
PSRR vs. Frequency



Output Noise



Output Noise



Application Information

Like any low dropout linear regulator, the RT9073A'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 VIN and GND pins. Any output capacitor meeting the minimum 1mΩ ESR (Equivalent Series Resistance) and effective capacitance larger than 1μF 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.

Enable

The RT9073A has an EN pin to turn on or turn off the regulator, When the EN pin is in logic high, the regulator will be turned on. The shutdown current is almost 0μA typical. The EN pin may be directly tied to V_{IN} to keep the part on. The Enable input is CMOS logic and cannot be left floating.

Current Limit

The RT9073A contains an independent current limiter, which monitors and controls the pass transistor's gate voltage, limiting the output current to 0.35A (typ.). The current limiting level is reduced to around 250mA named fold-back current limit when the output voltage is further decreased. The output can be shorted to ground indefinitely without damaging the part.

Thermal Considerations

For continuous operation, do not exceed absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. 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.

For recommended operating condition specifications the maximum junction temperature is 125°C and T_A is the ambient temperature. The junction to ambient thermal resistance, θ_{JA}, is layout dependent. For ZQFN-4L 1x1 (ZDFN-4L 1x1) package, the thermal resistance, θ_{JA}, is 226°C/W on a two-layer Richtek evaluation board. For SC-82 (SSOT-24) package, the thermal resistance, θ_{JA}, is 345.6°C/W on a standard JEDEC 51-7 four-layer thermal test board. The maximum power dissipation at T_A = 25°C can be calculated by the following formula :

$P_{D(MAX)}$ = (125°C − 25°C) / (226°C/W) = 0.44W for ZQFN-4L 1x1 (ZDFN-4L 1x1) package

$P_{D(MAX)}$ = (125°C − 25°C) / (345.6°C/W) = 0.28W for SC-82 (SSOT-24) package

The maximum power dissipation depends on the operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance, θ_{JA}. The derating curve in Figure 1 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

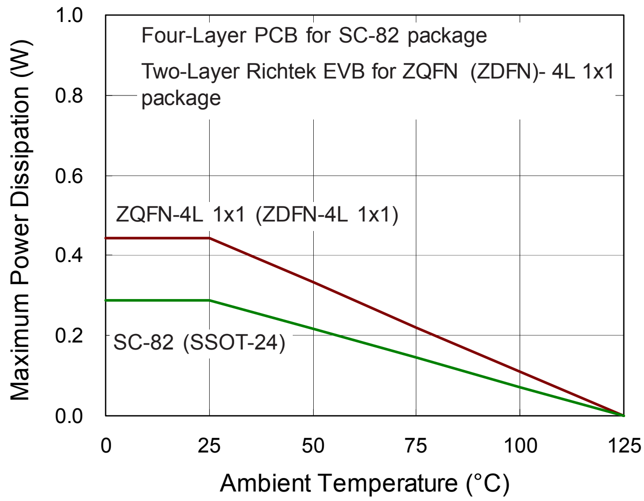
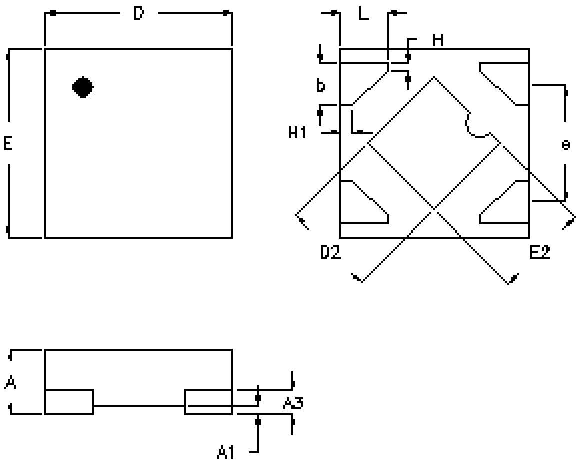
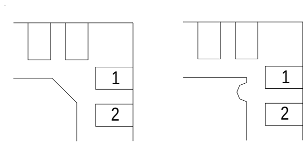


Figure 1. Derating Curve of Maximum Power Dissipation

Outline Dimension





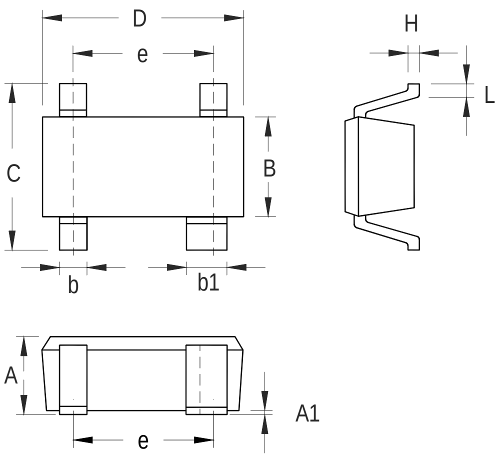
DETAIL A

Pin #1 ID and Tie Bar Mark Options

Note : The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.300	0.400	0.012	0.016
A1	0.000	0.050	0.000	0.002
A3	0.117	0.162	0.005	0.006
b	0.175	0.275	0.007	0.011
D	0.900	1.100	0.035	0.043
D2	0.450	0.550	0.018	0.022
E	0.900	1.100	0.035	0.043
E2	0.450	0.550	0.018	0.022
e	0.625		0.025	
L	0.200	0.300	0.008	0.012
H	0.039		0.002	
H1	0.064		0.003	

Z-Type 4L QFN 1x1 Package



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.100	0.031	0.043
A1	0.000	0.100	0.000	0.004
B	1.150	1.350	0.045	0.053
b	0.150	0.400	0.006	0.016
b1	0.350	0.500	0.014	0.020
C	1.800	2.450	0.071	0.096
D	1.800	2.200	0.071	0.087
e	1.300		0.051	
H	0.080	0.260	0.003	0.010
L	0.200	0.460	0.008	0.018

SC-82 Surface Mount Package

Richtek Technology Corporation

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