

## **150mA, Low Input Voltage, Low Dropout, Low Noise Ultra-Fast Without Bypass Capacitor CMOS LDO Regulator**

### **General Description**

The RT9030 is a high-performance, 150mA LDO regulator, offering extremely high PSRR and ultra-low dropout. Ideal for portable RF and wireless applications with demanding performance and space requirements.

The RT9030 quiescent current as low as 25 $\mu$ A, further prolonging the battery life. The RT9030 also works with low-ESR ceramic capacitors, reducing the amount of board space necessary for power applications, critical in hand-held wireless devices.

The RT9030 consumes typical 0.7 $\mu$ A in shutdown mode and has fast turn-on time less than 40 $\mu$ s. The other features include ultra-low dropout voltage, high output accuracy, current limiting protection, and high ripple rejection ratio. Available in the SC-70-5 and WDFN-6L 1.6x1.6 package.

### **Ordering Information**

|                                      |  |
|--------------------------------------|--|
| RT9030-□□□□                          |  |
| Package Type                         |  |
| U5 : SC-70-5                         |  |
| QW : WDFN-6L 1.6x1.6 (W-Type)        |  |
| Lead Plating System                  |  |
| G : Green (Halogen Free and Pb Free) |  |
| Fixed Output Voltage                 |  |
| 10 : 1.0V                            |  |
| 11 : 1.1V                            |  |
| :                                    |  |
| 32 : 3.2V                            |  |
| 33 : 3.3V                            |  |
| 1B : 1.25V                           |  |
| 1H : 1.85V                           |  |
| 2H : 2.85V                           |  |
| 1K : 1.05V                           |  |
| 1C : 1.15V                           |  |

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**

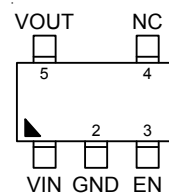
- Wide Operating Voltage Ranges : 1.65V to 5.5V
- Output Voltage Ranges : 1V to 3.3V
- Low Dropout : 100mV at 150mA
- Ultra-Low-Noise for RF Application
- Ultra-Fast Response in Line/Load Transient
- Current Limiting Protection
- Thermal Shutdown Protection
- High Power Supply Rejection Ratio
- Only 1 $\mu$ F Output Capacitor Required for Stability
- TTL-Logic-Controlled Shutdown Input
- RoHS Compliant and Halogen Free

### **Applications**

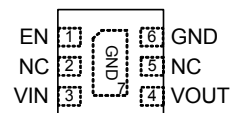
- CDMA/GSM Cellular Handsets
- Portable Information Appliances
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments
- Mini PCI & PCI-Express Cards
- PCMCIA & New Cards

### **Pin Configuration**

(TOP VIEW)



SC-70-5

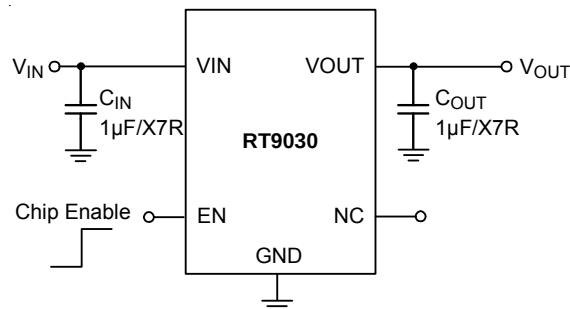


WDFN-6L 1.6x1.6

### **Marking Information**

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

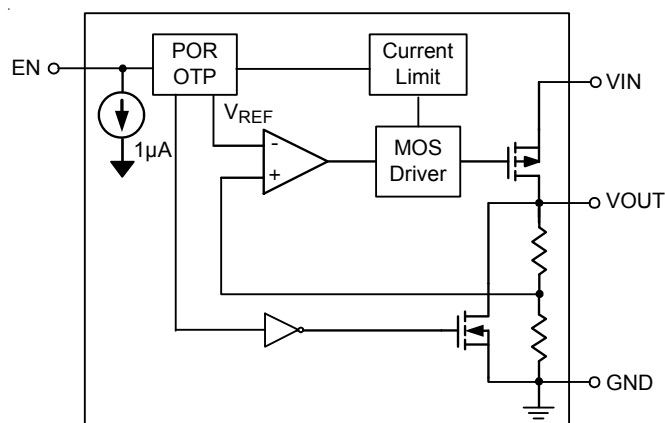
## Typical Application Circuit



## Functional Pin Description

| Pin Number |                    | Pin Name | Pin Function                                                                                                |
|------------|--------------------|----------|-------------------------------------------------------------------------------------------------------------|
| SC-70-5    | WDFN-6L 1.6x1.6    |          |                                                                                                             |
| 5          | 4                  | VOUT     | Regulator output.                                                                                           |
| 4          | 2, 5               | NC       | No internal connection.                                                                                     |
| 2          | 6, 7 (Exposed Pad) | GND      | Ground. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation. |
| 3          | 1                  | EN       | Enable input Logic, active high. When the EN pin is open it will be pulled to low internally.               |
| 1          | 3                  | VIN      | Supply input.                                                                                               |

## Functional Block Diagram



## Absolute Maximum Ratings (Note 1)

|                                                       |                |
|-------------------------------------------------------|----------------|
| • Supply Input Voltage                                | 6V             |
| • EN Input Voltage                                    | 6V             |
| • Power Dissipation, $P_D$ @ $T_A = 25^\circ\text{C}$ |                |
| SC-70-5                                               | 0.3W           |
| WDFN-6L 1.6x1.6                                       | 0.571W         |
| • Package Thermal Resistance (Note 2)                 |                |
| SC-70-5, $\theta_{JA}$                                | 333°C/W        |
| WDFN-6L 1.6x1.6, $\theta_{JA}$                        | 175°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 Range        | 1.65V to 5.5V  |
| • Junction Temperature Range | -40°C to 125°C |
| • Ambient Temperature Range  | -40°C to 85°C  |

## Electrical Characteristics

( $V_{IN} = V_{OUT} + 0.5V$ ,  $V_{EN} = V_{IN}$ ,  $C_{IN} = C_{OUT} = 1\mu\text{F}/X5R$  (Ceramic),  $T_A = 25^\circ\text{C}$ , unless otherwise specified)

| Parameter                                          | Symbol              | Test Conditions                                                                          | Min | Typ | Max | Unit                       |
|----------------------------------------------------|---------------------|------------------------------------------------------------------------------------------|-----|-----|-----|----------------------------|
| Output Noise Voltage                               | $V_{ON}$            | $I_{OUT} = 0\text{mA}$                                                                   | --  | 30  | --  | $\mu\text{V}_{\text{RMS}}$ |
| Output Voltage Accuracy<br>(Fixed Output Voltage)  | $\Delta V_{OUT}$    | $I_{OUT} = 150\text{mA}$                                                                 | -2  | 0   | 2   | %                          |
| Quiescent Current (Note 5)                         | $I_Q$               | $I_{OUT} = 0\text{mA}$                                                                   | --  | 25  | 50  | $\mu\text{A}$              |
| Shutdown Current                                   | $I_{SHDN}$          | $V_{EN} = 0V$                                                                            | --  | 0.7 | 1.5 | $\mu\text{A}$              |
| Current Limit                                      | $I_{LIM}$           | $R_{LOAD} = 0\Omega$ , $1.65V \leq V_{IN} < 5.5V$                                        | 170 | 285 | 400 | mA                         |
| Dropout Voltage (Note 6)                           | $V_{DROP}$          | $V_{OUT} = 1.7V$ to $2.4V$ ,<br>$I_{OUT} = 150\text{mA}$ , $1.65V \leq V_{IN} \leq 5.5V$ | 50  | --  | 200 | mV                         |
|                                                    |                     | $V_{OUT} = 2.5V$ to $3.3V$ ,<br>$I_{OUT} = 150\text{mA}$ , $1.65V \leq V_{IN} \leq 5.5V$ | 20  | --  | 150 |                            |
| Load Regulation (Note 7)<br>(Fixed Output Voltage) | $\Delta V_{LOAD}$   | $1\text{mA} < I_{OUT} < 150\text{mA}$<br>$1.65V \leq V_{IN} \leq 5.5V$                   | --  | --  | 1   | %                          |
| EN Threshold                                       | Logic-Low Voltage   | $V_{IL}$                                                                                 | 0   | --  | 0.3 | V                          |
|                                                    | Logic-High Voltage  | $V_{IH}$                                                                                 | 1.6 | --  | 5.5 |                            |
| Enable Pin Current                                 | $I_{EN}$            |                                                                                          | --  | 1   | 3   | $\mu\text{A}$              |
| Power Supply<br>Rejection Rate                     | $f = 1\text{kHz}$   | PSRR                                                                                     | --  | -67 | --  | dB                         |
|                                                    | $f = 10\text{kHz}$  |                                                                                          | --  | -55 | --  |                            |
|                                                    | $f = 100\text{kHz}$ |                                                                                          | --  | -40 | --  |                            |

| Parameter                    | Symbol                   | Test Conditions                                                                                                      | Min | Typ  | Max | Unit |
|------------------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| Line Regulation              | $\Delta V_{\text{LINE}}$ | $V_{\text{IN}} = (V_{\text{OUT}} + 0.5) \text{ to } 5.5\text{V}$ ,<br>$I_{\text{OUT}} = 1\text{mA to } 150\text{mA}$ | --  | 0.01 | 0.2 | %/V  |
| Thermal Shutdown Temperature | $T_{\text{SD}}$          |                                                                                                                      | --  | 150  | --  | °C   |
| Thermal Shutdown Hysteresis  | $\Delta T_{\text{SD}}$   |                                                                                                                      | --  | 20   | --  |      |

**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.**  $\theta_{\text{JA}}$  is measured at  $T_{\text{A}} = 25^{\circ}\text{C}$  on a low effective thermal conductivity single-layer test board per JEDEC 51-3.

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

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

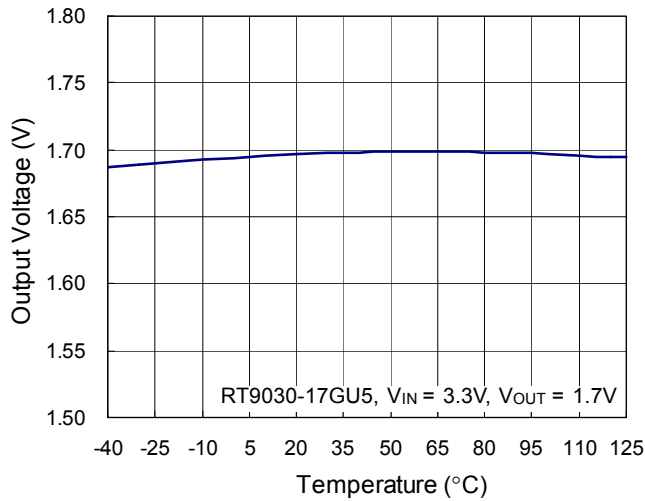
**Note 5.** Quiescent, or ground current, is the difference between input and output currents. It is defined by  $I_{\text{Q}} = I_{\text{IN}} - I_{\text{OUT}}$  under no load condition ( $I_{\text{OUT}} = 0\text{mA}$ ). The total current drawn from the supply is the sum of the load current plus the ground pin current.

**Note 6.** The dropout voltage is defined as  $V_{\text{IN}} - V_{\text{OUT}}$ , which is measured when  $V_{\text{OUT}}$  is  $V_{\text{OUT(NORMAL)}} - 100\text{mV}$ .

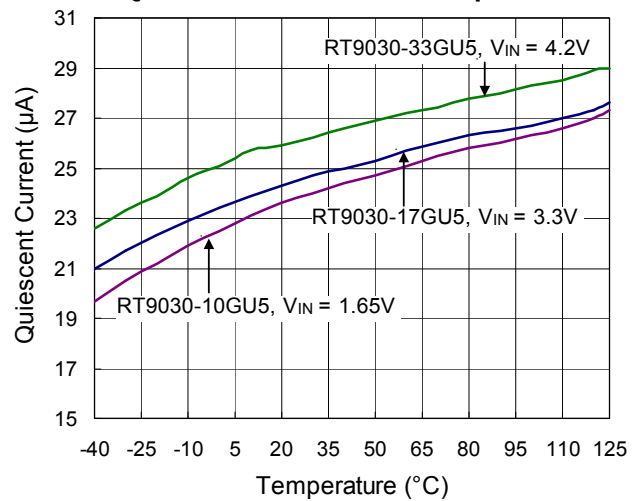
**Note 7.** Regulation is measured at constant junction temperature by using a 2ms current pulse. Devices are tested for load regulation in the load range from 10mA to 120mA.

## Typical Operating Characteristics

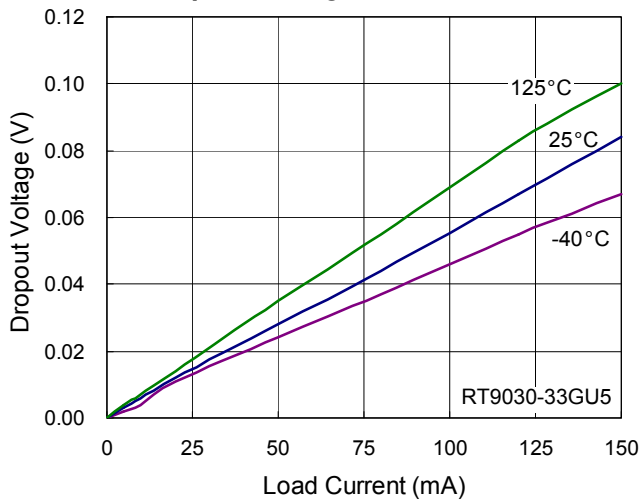
**Output Voltage vs. Temperature**



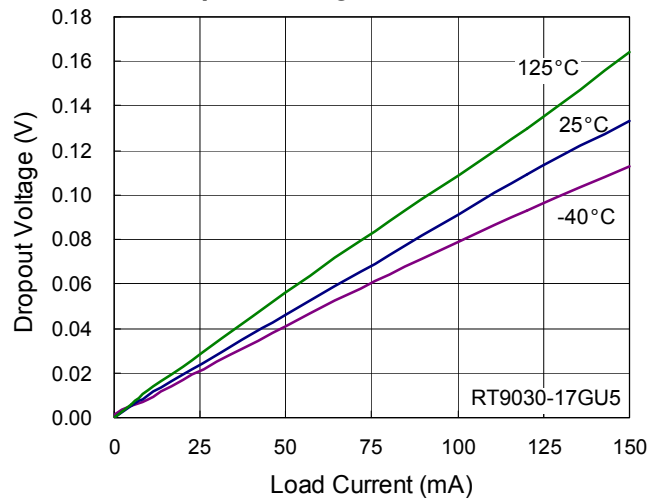
**Quiescent Current vs. Temperature**



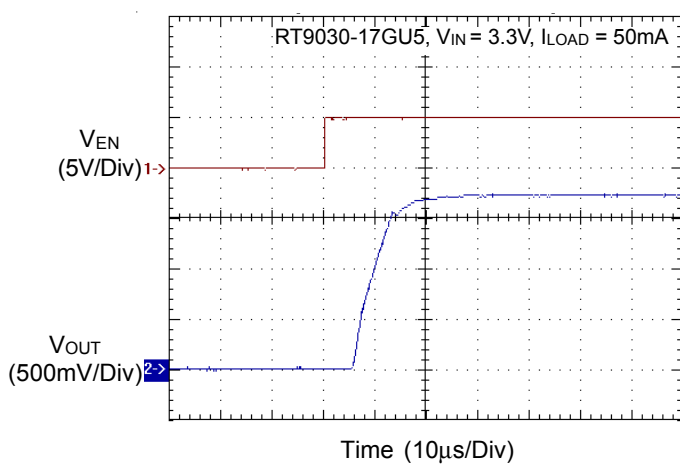
**Dropout Voltage vs. Load Current**



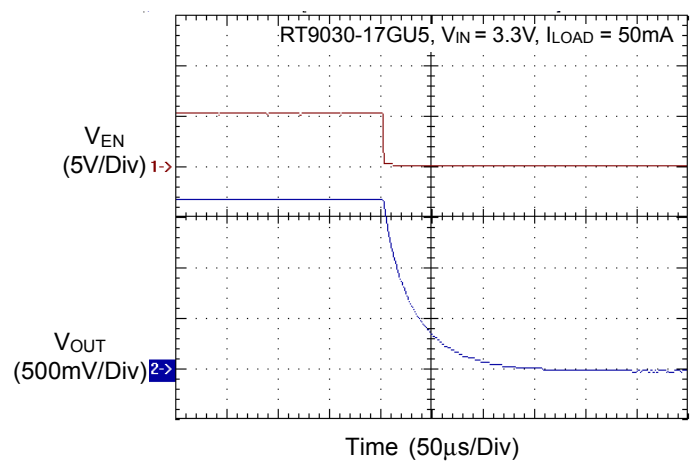
**Dropout Voltage vs. Load Current**



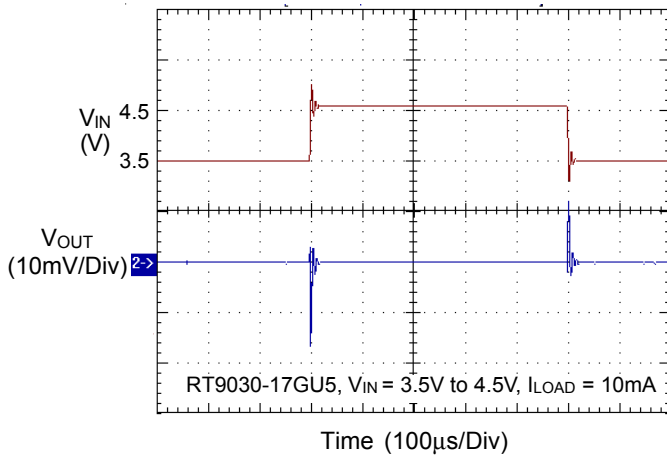
**Power On from EN**



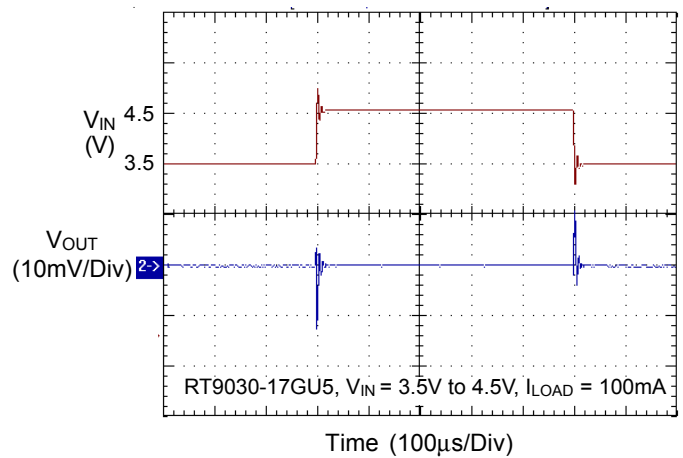
**Power Off from EN**



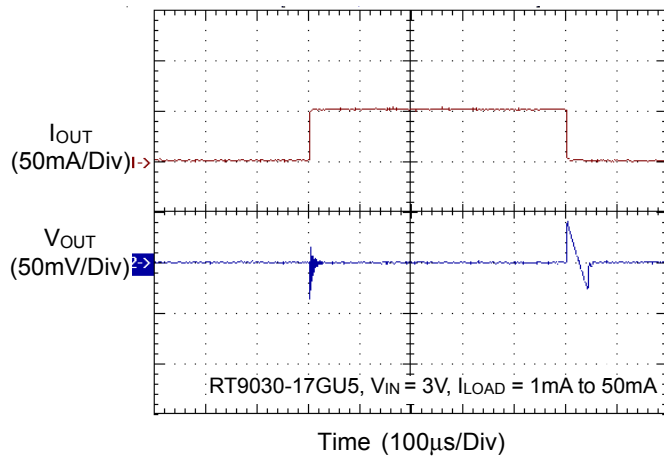
### Line Transient Response



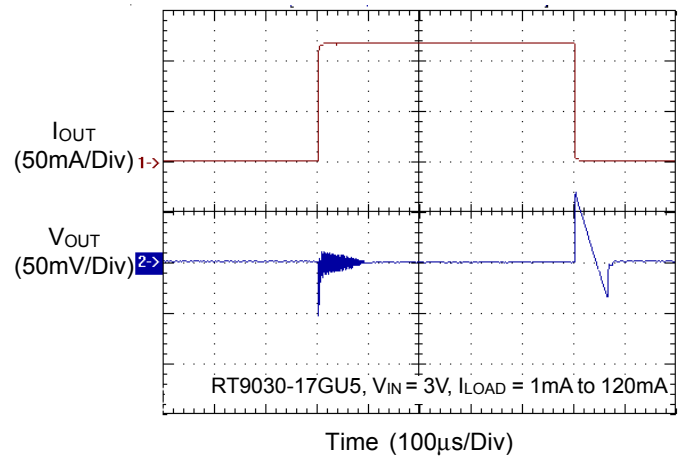
### Line Transient Response



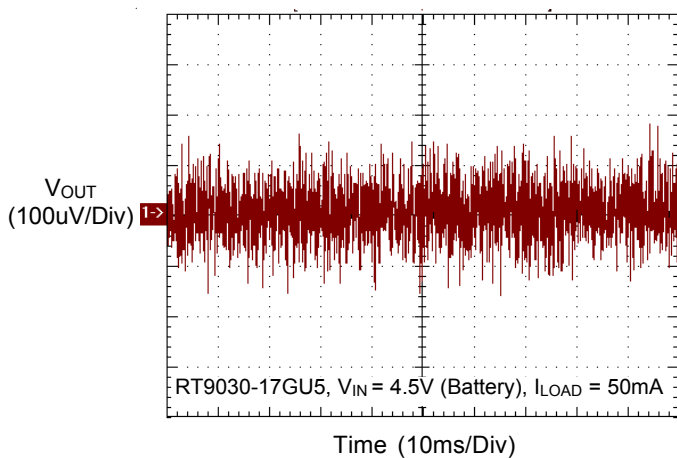
### Load Transient Response



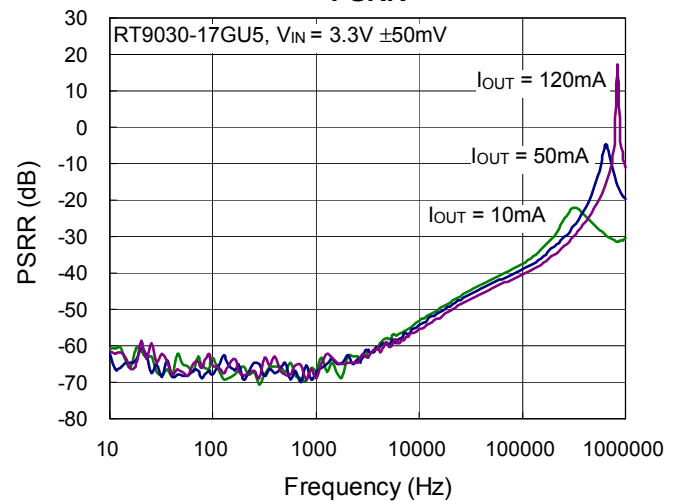
### Load Transient Response



### Noise



### PSRR



## Applications Information

### Capacitor Selection

In order to confirm the regulator stability and performance, X7R/X5R or other better quality ceramic capacitor should be selected.

Like any low-dropout regulator, the external capacitors used with the RT9030 must be carefully selected for regulator stability and performance. Using a capacitor whose value is larger than 1 $\mu$ F on the RT9030 input and the amount of capacitance can be increased without limit. The input capacitor should be located in a distance of no more than 0.5 inch from the input pin of the IC and returned to a clean analog ground. 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 in all LDOs application. The RT9030 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 1 $\mu$ F on the RT9030 output ensures stability. Output capacitor with larger capacitance can reduce noise and improve load transient response, stability, and PSRR. The output capacitor should be located in a distance of no more than 0.5 inch from the VOUT pin of the RT9030 and returned to a clean analog ground.

### Enable

The RT9030 goes into shutdown mode when the EN pin is in a logic low condition. During this condition, the pass transistor, error amplifier, and bandgap are turned off, reducing the supply current to 0.7 $\mu$ A typical. The EN pin can be directly tied to VIN to keep the part on.

### Current limit

The RT9030 contains an independent current limiter, which monitors and controls the pass transistor's gate voltage, limiting the output current to 285mA (typ.). The output can be shorted to ground indefinitely without damaging the part.

### Thermal Shutdown Protection

As the die temperature is > 150°C, the chip will enter protection mode. The power MOSFET will turn-off during protection mode to prevent abnormal operation.

### Thermal Considerations

Thermal protection limits power dissipation in the RT9030. When the operation junction temperature exceeds 170°C, the OTP circuit starts the thermal shutdown function and turns the pass element off. The pass element turn on again after the junction temperature cools by 30°C.

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

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

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 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 the maximum junction temperature of the die is 125°C. The junction to ambient thermal resistance  $\theta_{JA}$  for WDFN-6L 1.6x1.6 package is 165°C/W and SC-70-5 package is 333°C/W on the standard JEDEC 51-3 single-layer thermal test board. The maximum power dissipation at  $T_A = 25^\circ\text{C}$  can be calculated by following formula :

$$P_{D(MAX)} = (125^\circ\text{C} - 25^\circ\text{C}) / (165^\circ\text{C/W}) = 0.606\text{W for WDFN-6L 1.6x1.6 packages}$$

$$P_{D(MAX)} = (125^\circ\text{C} - 25^\circ\text{C}) / (333^\circ\text{C/W}) = 0.300\text{W for SC-70-5 packages}$$

The maximum power dissipation depends on operating ambient temperature for fixed  $T_{J(MAX)}$  and thermal resistance  $\theta_{JA}$ . The Figure 3 of derating curves allows the

designer to see the effect of rising ambient temperature on the maximum power allowed.

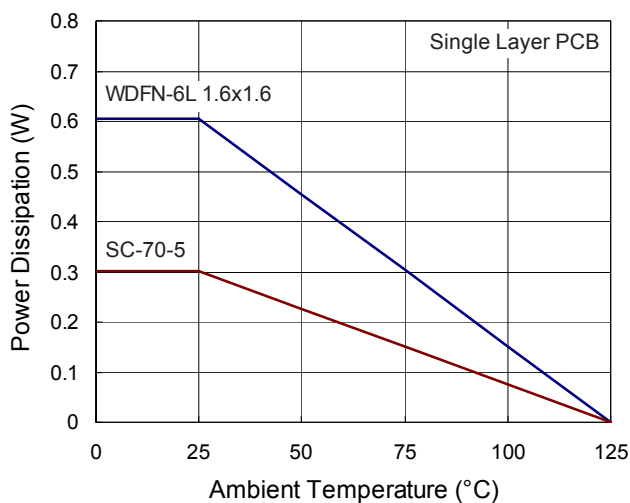


Figure 3. Derating Curve of Maximum Power Dissipation

## Layout Considerations

Careful PCB Layout is necessary for better performance.

The following guidelines should be followed for good PCB layout.

- ▶ Place the input and output capacitors as close as possible to the IC.
- ▶ Keep VIN and VOUT trace as possible as short and wide.
- ▶ Use a large PCB ground plane for maximum thermal dissipation.

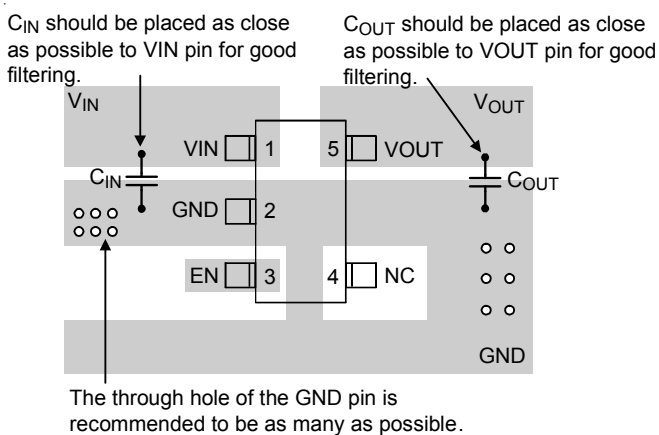
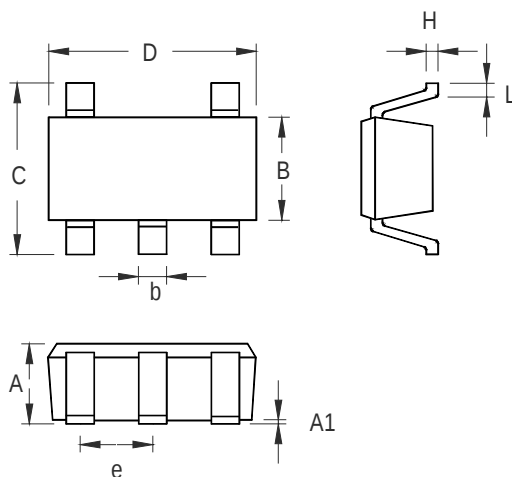


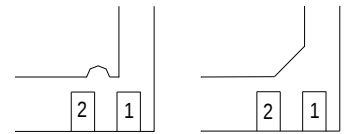
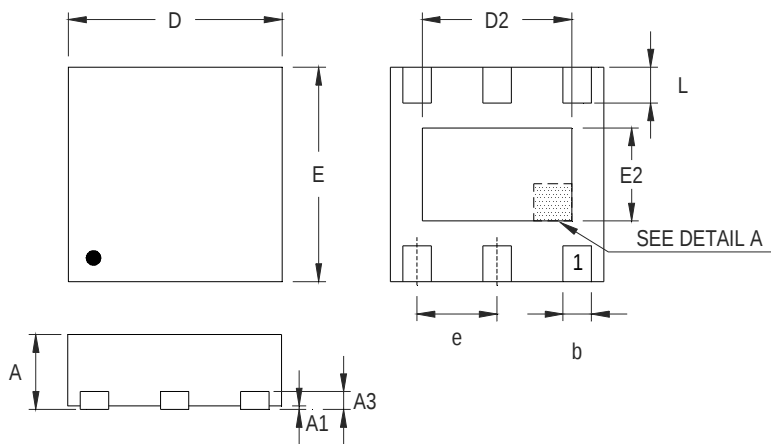
Figure 4

## Outline Dimension



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 0.800                     | 1.100 | 0.031                | 0.044 |
| A1     | 0.000                     | 0.100 | 0.000                | 0.004 |
| B      | 1.150                     | 1.350 | 0.045                | 0.054 |
| b      | 0.150                     | 0.400 | 0.006                | 0.016 |
| C      | 1.800                     | 2.450 | 0.071                | 0.096 |
| D      | 1.800                     | 2.250 | 0.071                | 0.089 |
| e      | 0.650                     |       | 0.026                |       |
| H      | 0.080                     | 0.260 | 0.003                | 0.010 |
| L      | 0.210                     | 0.460 | 0.008                | 0.018 |

**SC-70-5 Surface Mount Package**



## 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      | 0.700                     | 0.800 | 0.028                | 0.031 |
| A1     | 0.000                     | 0.050 | 0.000                | 0.002 |
| A3     | 0.175                     | 0.250 | 0.007                | 0.010 |
| b      | 0.200                     | 0.300 | 0.008                | 0.012 |
| D      | 1.550                     | 1.650 | 0.061                | 0.065 |
| D2     | 0.950                     | 1.050 | 0.037                | 0.041 |
| E      | 1.550                     | 1.650 | 0.061                | 0.065 |
| E2     | 0.550                     | 0.650 | 0.022                | 0.026 |
| e      | 0.500                     |       | 0.020                |       |
| L      | 0.190                     | 0.290 | 0.007                | 0.011 |

W-Type 6L DFN 1.6x1.6 Package

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