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 25µA, 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 0.7µA in shutdown mode and has fast turn-on time less than 40µs. 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.

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 1µF 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

(Ordering Information)

RT9030-

- Package Type
  - U5: SC-70-5
  - WQ: 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.

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

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

Functional Block Diagram
**Absolute Maximum Ratings**  
(Note 1)
- Supply Input Voltage  
  6V  
- EN Input Voltage  
  6V  
- Power Dissipation, $P_D@T_A = 25°C$
  - 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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Noise Voltage</td>
<td>$V_{ON}$</td>
<td>$I_{OUT} = 0mA$</td>
<td>--</td>
<td>30</td>
<td>--</td>
<td>$\mu V_{RMS}$</td>
</tr>
<tr>
<td>Output Voltage Accuracy</td>
<td>$\Delta V_{OUT}$</td>
<td>$I_{OUT} = 150mA$</td>
<td>−2</td>
<td>0</td>
<td>2</td>
<td>%</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>$I_Q$</td>
<td>$I_{OUT} = 0mA$</td>
<td>--</td>
<td>25</td>
<td>50</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Shutdown Current</td>
<td>$I_{SHDN}$</td>
<td>$V_{EN} = 0V$</td>
<td>--</td>
<td>0.7</td>
<td>1.5</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Current Limit</td>
<td>$I_{LIM}$</td>
<td>$R_{LOAD} = 0Ω$, 1.65V $\leq V_{IN} &lt; 5.5V$</td>
<td>170</td>
<td>285</td>
<td>400</td>
<td>mA</td>
</tr>
<tr>
<td>Dropout Voltage</td>
<td>$V_{DROP}$</td>
<td>$V_{OUT} = 1.7V$ to 2.4V, $I_{OUT} = 150mA$, 1.65V $\leq V_{IN} &lt; 5.5V$</td>
<td>50</td>
<td>--</td>
<td>200</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{OUT} = 2.5V$ to 3.3V, $I_{OUT} = 150mA$, 1.65V $\leq V_{IN} &lt; 5.5V$</td>
<td>20</td>
<td>--</td>
<td>150</td>
<td>mV</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>$\Delta V_{LOAD}$</td>
<td>$1mA &lt; I_{OUT} &lt; 150mA$, 1.65V $\leq V_{IN} &lt; 5.5V$</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>%</td>
</tr>
<tr>
<td>EN Threshold</td>
<td>$V_L$</td>
<td>--</td>
<td>0</td>
<td>--</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{IH}$</td>
<td>--</td>
<td>1.6</td>
<td>--</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Enable Pin Current</td>
<td>$I_{EN}$</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>3</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Power Supply Rejection Rate</td>
<td>$f = 1kHz$, $PSRR$</td>
<td>--</td>
<td>--</td>
<td>−67</td>
<td>--</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>$f = 10kHz$</td>
<td>--</td>
<td>--</td>
<td>−55</td>
<td>--</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>$f = 100kHz$</td>
<td>--</td>
<td>--</td>
<td>−40</td>
<td>--</td>
<td>dB</td>
</tr>
<tr>
<td>Parameter</td>
<td>Symbol</td>
<td>Test Conditions</td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Unit</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------</td>
<td>-------------------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td>Line Regulation</td>
<td>$\Delta V_{\text{LINE}}$</td>
<td>$V_{\text{IN}} = (V_{\text{OUT}} + 0.5)$ to 5.5V, $I_{\text{OUT}} = 1\text{mA to } 150\text{mA}$</td>
<td>--</td>
<td>0.01</td>
<td>0.2</td>
<td>%/V</td>
</tr>
<tr>
<td>Thermal Shutdown Temperature</td>
<td>$T_{\text{SD}}$</td>
<td></td>
<td>--</td>
<td>150</td>
<td>--</td>
<td>°C</td>
</tr>
<tr>
<td>Thermal Shutdown Hysteresis</td>
<td>$\Delta T_{\text{SD}}$</td>
<td></td>
<td>--</td>
<td>20</td>
<td>--</td>
<td>°C</td>
</tr>
</tbody>
</table>

**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 $I_Q = I_{\text{IN}} - I_{\text{OUT}}$ 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 $V_{\text{OUT}(\text{NORMAL})} - 100\text{mV}$.

**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

Power On from EN

Power Off from EN
**Lines Transient Response**

- **VIN** (V)
  - 4.5
  - 3.5

- **VOUT (10mV/Div)**

- Time (100μs/Div)

- **RT9030-17GU5, VIN = 3.5V to 4.5V, ILOAD = 10mA**

**Load Transient Response**

- **IOUT (50mA/Div)**

- **VOUT (50mV/Div)**

- Time (100μs/Div)

- **RT9030-17GU5, VIN = 3V, ILOAD = 1mA to 50mA**

**Noise**

- **VOUT (100μV/Div)**

- Time (10ms/Div)

- **RT9030-17GU5, VIN = 4.5V (Battery), ILOAD = 50mA**

**PSRR**

- **RT9030-17GU5, VIN = 3.3V ±50mV**

- **IOUT = 120mA**
- **IOUT = 50mA**
- **IOUT = 10mA**

**Frequency (Hz)**

- 10
- 100
- 1000
- 10000
- 100000
- 1000000

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DS9030-05 November 2016
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 1μF 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 1μF 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 0.7μA 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 \( T_A = 25°C \) can be calculated by following formula:

\[ P_{D(MAX)} = (125°C - 25°C) / (165°C/W) = 0.606W \]

For WDFN-6L 1.6x1.6 packages

\[ P_{D(MAX)} = (125°C - 25°C) / (333°C/W) = 0.300W \]

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...
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.

$C_{IN}$ should be placed as close as possible to VIN pin for good filtering.

$C_{OUT}$ should be placed as close as possible to VOUT pin for good filtering.

The through hole of the GND pin is recommended to be as many as possible.

**Figure 4**

**Figure 3. Derating Curve of Maximum Power Dissipation**
### Outline Dimension

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimensions In Millimeters</th>
<th>Dimensions In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.800 to 1.100</td>
<td>0.031 to 0.044</td>
</tr>
<tr>
<td>A1</td>
<td>0.000 to 0.100</td>
<td>0.000 to 0.004</td>
</tr>
<tr>
<td>B</td>
<td>1.150 to 1.350</td>
<td>0.045 to 0.054</td>
</tr>
<tr>
<td>b</td>
<td>0.150 to 0.400</td>
<td>0.006 to 0.016</td>
</tr>
<tr>
<td>C</td>
<td>1.800 to 2.450</td>
<td>0.071 to 0.096</td>
</tr>
<tr>
<td>D</td>
<td>1.800 to 2.250</td>
<td>0.071 to 0.089</td>
</tr>
<tr>
<td>e</td>
<td>0.650</td>
<td>0.026</td>
</tr>
<tr>
<td>H</td>
<td>0.080 to 0.260</td>
<td>0.003 to 0.010</td>
</tr>
<tr>
<td>L</td>
<td>0.210 to 0.460</td>
<td>0.008 to 0.018</td>
</tr>
</tbody>
</table>

**SC-70-5 Surface Mount Package**
Symbol | Dimensions In Millimeters | Dimensions In Inches
---|---|---
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

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

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