General Description
The RT9069 is a low-dropout (LDO) voltage regulators with enable function offering the benefits of high input voltage, low-dropout voltage, low-power consumption, and miniaturized packaging.
The features of low quiescent current as low as 2μA and zero disable current is ideal for powering the battery equipment to a longer service life. The RT9069 is stable with the ceramic output capacitor over its wide input range from 3.5V to 36V and the entire range of output load current.

Applications
• Portable, Battery Powered Equipments
• Extra Low Voltage Microcontrollers
• Notebook Computers

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

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
• 2μA Ground Current at no Load
• ±2% Output Accuracy
• 100mA Continuous Output Current
• Zero Disable Current
• Maximum Operating Input Voltage 36V
• Dropout Voltage: 0.2V at 10mA/ VIN 5V
• Support Fixed Output Voltage 2.5V, 3V, 3.3V, 5V, 9V, 12V
• Stable with Ceramic or Tantalum Capacitor
• Current Limit Protection
• Over-Temperature Protection
• RoHS Compliant and Halogen Free

Ordering Information
RT9069-

Package Type
SP : SOP-8 (Exposed Pad-Option 1)
B : SOT-23-5
X5 : SOT-89-5
QU : UDFN-6L 1.6x1.6 (U-type)

Lead Plating System
G : Green (Halogen Free and Pb Free)

Output Voltage
25 : 2.5V
30 : 3V
33 : 3.3V
50 : 5V
90 : 9V
C0 : 12V

Special Request: Any Voltage between 2.5V and 12V under specific business agreement

Simplified Application Circuit

---

Copyright © 2018 Richtek Technology Corporation. All rights reserved. Richtek is a registered trademark of Richtek Technology Corporation.
Pin Configuration

(TOP VIEW)

SOP-8 (Exposed Pad)  SOT-23-5  SOT-89-5  UDFN-6L 1.6x1.6

VCC  NC  VOUT  NC  EN  GND  NC  NC  GND
1  2  3  4  5  6  7  8

SOP-8 (Exposed Pad)  SOT-23-5  SOT-89-5  UDFN-6L 1.6x1.6

VCC  NC  VOUT  NC  EN  GND  NC  NC  GND
1  2  3  4  5  6  7  8

SOP-8 (Exposed Pad)  SOT-23-5  SOT-89-5  UDFN-6L 1.6x1.6

VCC  NC  VOUT  NC  EN  GND  NC  NC  GND
1  2  3  4  5  6  7  8

Functional Pin Description

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Name</th>
<th>Pin Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOP-8 (Exposed Pad)</strong></td>
<td><strong>SOT-23-5</strong></td>
<td><strong>SOT-89-5</strong></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2, 4, 5, 6</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>7, 9 (Exposed Pad)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>
Operation

Basic Operation
The RT9069 is a high input voltage linear regulator designed especially for low external component systems. The input voltage range is from 3.5V to 36V. 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 RT9069 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 RT9069 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 zero.

Current Limit Protection
The RT9069 provides current limit function to prevent the device from damages during over-load or shorted-circuit conditions. This current is detected by an internal sensing transistor.

Over-Temperature Protection
The over-temperature protection function turns off the P-MOSFET when the junction temperature exceeds 150°C (typ.) and the output current exceeds 4mA. Once the junction temperature cools down by approximately 20°C, the regulator automatically resumes operation.
Absolute Maximum Ratings  (Note 1)
- VCC, EN to GND ────────────────────────────────────────────────────── −0.3V to 40V
- VOUT to VCC ────────────────────────────────────────────────────── −40V to 0.3V
- VOUT to GND
  RT9069-90/RT9069-C0 ────────────────────────────────── −0.3V to 15V
  RT9069-25/RT9069-30/RT9069-33/RT9069-50 ─────────── −0.3V to 6V
- Power Dissipation, PD @ TA = 25°C
  SOP-8 (Exposed Pad) ───────────────────────────── 3.26W
  SOT-23-5 ─────────────────────────── 0.45W
  SOT-89-5 ───────────────────── 0.87W
  UDFN-6L 1.6x1.6 ───────────── 2.15W
- Package Thermal Resistance (Note 2)
  SOP-8 (Exposed Pad), θJA ───────────────────────────── 30.6°C/W
  SOP-8 (Exposed Pad), θJC ─────────────────────────── 3.4°C/W
  SOT-23-5, θJA ─────────────────── 218.1°C/W
  SOT-23-5, θJC ─────────── 28.5°C/W
  SOT-89-5, θJA ─────────── 113.9°C/W
  SOT-89-5, θJC ───────── 6.9°C/W
  UDFN-6L 1.6x1.6, θJA ───────── 46.5°C/W
  UDFN-6L 1.6x1.6, θJC ───── 18.6°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

Recommended Operating Conditions  (Note 4)
- Supply Input Voltage ── 3.5V to 36V
- Junction Temperature Range ─── −40°C to 125°C
- Ambient Temperature Range ── −40°C to 85°C

Electrical Characteristics
(CIN = 1µF, TA = 25°C, for each LDO unless otherwise specified)

<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>Supply Voltage</td>
<td>VCC</td>
<td></td>
<td>3.5</td>
<td>--</td>
<td>36</td>
<td>V</td>
</tr>
<tr>
<td>Output Voltage Range</td>
<td>VOUT</td>
<td></td>
<td>2.5</td>
<td>--</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>DC Output Accuracy</td>
<td>ΔVOUT</td>
<td>ILOAD = 10mA</td>
<td>−2</td>
<td>--</td>
<td>+2</td>
<td>%</td>
</tr>
<tr>
<td>Dropout Voltage</td>
<td>VDROP</td>
<td>ILOAD = 10mA, VCC &gt; 5V</td>
<td>--</td>
<td>0.2</td>
<td>0.36</td>
<td>V</td>
</tr>
</tbody>
</table>

Copyright © 2018 Richtek Technology Corporation. All rights reserved. RICHTEK is a registered trademark of Richtek Technology Corporation.
<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>V\text{\textsubscript{CC}} Consumption Current</td>
<td>I\text{\textsubscript{Q}}</td>
<td>I\text{\textsubscript{LOAD}} = 0mA, V\text{\textsubscript{OUT}} \leq 5.5V</td>
<td>--</td>
<td>2</td>
<td>3.5</td>
<td>\mu\text{A}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I\text{\textsubscript{LOAD}} = 0mA, V\text{\textsubscript{OUT}} &gt; 5.5V, V\text{\textsubscript{CC}} = 15V</td>
<td>--</td>
<td>3.5</td>
<td>5</td>
<td>\mu\text{A}</td>
</tr>
<tr>
<td>Shutdown Current</td>
<td>V\text{\textsubscript{EN}} = 0V</td>
<td>--</td>
<td>0.1</td>
<td>--</td>
<td>\mu\text{A}</td>
<td></td>
</tr>
<tr>
<td>Shutdown Leakage Current</td>
<td>V\text{\textsubscript{EN}} = 0V, V\text{\textsubscript{OUT}} = 0V</td>
<td>--</td>
<td>0.1</td>
<td>--</td>
<td>\mu\text{A}</td>
<td></td>
</tr>
<tr>
<td>EN Input Current</td>
<td>I\text{\textsubscript{EN}}</td>
<td>V\text{\textsubscript{EN}} = 36V</td>
<td>--</td>
<td>0.1</td>
<td>--</td>
<td>\mu\text{A}</td>
</tr>
<tr>
<td>Line Regulation</td>
<td>\Delta V\text{\textsubscript{LINE}}</td>
<td>I\text{\textsubscript{LOAD}} = 1mA, V\text{\textsubscript{OUT}} + 1 &lt; V\text{\textsubscript{CC}} &lt; 36V, V\text{\textsubscript{OUT}} &gt; 3.3V</td>
<td>--</td>
<td>0.04</td>
<td>0.5</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I\text{\textsubscript{LOAD}} = 1mA, V\text{\textsubscript{OUT}} + 1 &lt; V\text{\textsubscript{CC}} &lt; 36V, V\text{\textsubscript{OUT}} \leq 3.3V</td>
<td>--</td>
<td>0.04</td>
<td>0.6</td>
<td>%</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>\Delta V\text{\textsubscript{LOAD}}</td>
<td>0mA &lt; I\text{\textsubscript{LOAD}} &lt; 100mA</td>
<td>-1</td>
<td>--</td>
<td>1</td>
<td>%</td>
</tr>
<tr>
<td>Output Current Limit</td>
<td>I\text{\textsubscript{LIM}}</td>
<td>V\text{\textsubscript{OUT}} = 0.5 x V\text{\textsubscript{OUT(normal)}}</td>
<td>200</td>
<td>350</td>
<td>--</td>
<td>mA</td>
</tr>
<tr>
<td>Enable Input Voltage</td>
<td>Logic-High V\text{\textsubscript{IH}}</td>
<td>--</td>
<td>--</td>
<td>1.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Logic-Low V\text{\textsubscript{IL}}</td>
<td>0.6</td>
<td>--</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal Shutdown Temperature</td>
<td>T\text{\textsubscript{SD}}</td>
<td>I\text{\textsubscript{LOAD}} = 30mA</td>
<td>--</td>
<td>150</td>
<td>--</td>
<td>°C</td>
</tr>
<tr>
<td>Thermal Shutdown Hysteresis</td>
<td>AT\text{\textsubscript{SD}}</td>
<td>--</td>
<td>20</td>
<td>--</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

**Note 1.** Stresses beyond those listed under “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.** \(\theta\text{\textsubscript{JA}}\) is measured at \(T\text{\textsubscript{A}} = 25°C\) on a high effective thermal conductivity four-layer test board per JEDEC 51-7. \(\theta\text{\textsubscript{JC}}\) is measured at the exposed pad of the package.

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

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

Note (1): All the input and output capacitors are the suggested values, referring to the effective capacitances, subject to any de-rating effect, like a DC bias.
Typical Operating Characteristics

**Output Voltage vs. Temperature**

- $V_{CC} = 12V$, Load = 0.1mA
- $V_{CC} = 12V$, Load = 20mA
- $V_{CC} = 36V$, Load = 0.1mA
- $V_{CC} = 36V$, Load = 20mA

**Output Voltage vs. Output Current**

- $V_{CC} = 36V$
- $V_{CC} = 24V$
- $V_{CC} = 12V$

**Output Voltage vs. Supply Voltage**

- Load = 0mA
- Load = 0.1mA
- Load = 10mA
- Load = 20mA

- $V_{CC} = 3.5V$ to 36V, $V_{OUT} = 2.5V$

**Quiescent Current vs. Supply Voltage**

- $V_{CC} = 36V$
- $V_{CC} = 12V$

**Quiescent Current vs. Temperature**

- $V_{CC} = 36V$
- $V_{CC} = 12V$

**SHDN Input Leakage Current vs. $V_{CC}$**

- $EN = 0V$

---

Copyright © 2018 Richtek Technology Corporation. All rights reserved. Richtek is a registered trademark of Richtek Technology Corporation.

DS9069-09 November 2018 www.richtek.com
**SHDN Leakage Input Current vs. Temp.**

- **V_{CC} = 36V**
- **V_{CC} = 3.5V**

**Enable Threshold vs. Supply Voltage**

- **High Threshold**
- **Low Threshold**

**Enable Threshold vs. Temperature**

- **High Threshold**
- **Low Threshold**

**Dropout Voltage vs. Temperature**

- **Load = 10mA**

**Current Limit vs. Temperature**

- **V_{CC} = 12V**
- **V_{CC} = 36V**

**PSRR vs. Frequency**

- **V_{OUT} = 2.5V, I_{LOAD} = 50mA**
- **V_{CC} = 5V**
- **V_{CC} = 12V**
Ground Current vs. Load Current

Rising, $T_A = 125^\circ C$
Rising, $T_A = 25^\circ C$
Rising, $T_A = -40^\circ C$

Load Transient Response

$V_{OUT, ac}$ (50mV/Div)
$I_{Load}$ (50mA/Div)

$V_{CC} = 12V$, $V_{OUT} = 2.5V$, $I_{load} = 10mA$ to 100mA

Time (250μs/Div)

Load Transient Response

$V_{OUT, ac}$ (100mV/Div)
$I_{Load}$ (100mA/Div)

$V_{CC} = 12V$, $V_{OUT} = 2.5V$, $I_{load} = 10mA$ to 200mA

Time (250μs/Div)

Dropout Voltage vs. Output Current

125°C
25°C
-40°C

$V_{OUT} = 5V$

Load Transient Response

$V_{OUT, ac}$ (50mV/Div)
$I_{Load}$ (50mA/Div)

$V_{CC} = 24V$, $V_{OUT} = 2.5V$, $I_{load} = 10mA$ to 100mA

Time (250μs/Div)

Load Transient Response

$V_{OUT, ac}$ (100mV/Div)
$I_{Load}$ (50mA/Div)

$V_{CC} = 12V$, $V_{OUT} = 2.5V$, $I_{Load} = 10mA$ to 100mA

Time (10μs/Div)
Line Transient Response

$V_{OUT_{ac}}$ (20mV/Div)

$VCC$ (5V/Div)

$V_{CC} = 4.4V$ to $15V$, $V_{OUT} = 2.5V$, Load = 100mA

Time (100μs/Div)

Power On from EN

$VCC$ (10V/Div)

$EN$ (2V/Div)

$V_{OUT}$ (1V/Div)

$I_{Load}$ (50mA/Div)

$V_{CC} = 24V$, $V_{OUT} = 2.5V$, Load = 100mA

Time (25μs/Div)

Power Off from EN

$VCC$ (10V/Div)

$EN$ (2V/Div)

$V_{OUT}$ (1V/Div)

$I_{Load}$ (50mA/Div)

$V_{CC} = 24V$, $V_{OUT} = 2.5V$, Load = 100mA

Time (25μs/Div)
Application Information

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:

\[ P_{D(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}} \]

where \( T_{J(MAX)} \) is the maximum junction temperature, \( T_A \) is the ambient temperature, and \( \theta_{JA} \) is the junction to ambient thermal resistance.

For recommended operating condition specifications, the maximum junction temperature is 125°C. The junction to ambient thermal resistance, \( \theta_{JA} \), is layout dependent. For SOP-8 (Exposed Pad) packages, the thermal resistance, \( \theta_{JA} \), is 30.6°C/W on a standard JEDEC 51-7 four-layer thermal test board. For SOT-23-5 package, the thermal resistance, \( \theta_{JA} \), is 218.1°C/W on a standard JEDEC 51-7 four-layer thermal test board. For SOT-89-5 package, the thermal resistance, \( \theta_{JA} \), is 113.9°C/W on a standard JEDEC 51-7 four-layer thermal test board. For UDFN-6L 1.6x1.6 package, the thermal resistance, \( \theta_{JA} \), is 46.5°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:

\[ P_{D(MAX)} = \frac{(125°C - 25°C)}{\theta_{JA}} = 3.2679W \] for SOP-8 (Exposed Pad) package

\[ P_{D(MAX)} = \frac{(125°C - 25°C)}{218.1°C/W} = 0.4585W \] for SOT-23-5 package

\[ P_{D(MAX)} = \frac{(125°C - 25°C)}{113.9°C/W} = 0.8779W \] for SOT-89-5 package

\[ P_{D(MAX)} = \frac{(125°C - 25°C)}{46.5°C/W} = 2.15W \] for UDFN-6L 1.6x1.6 package

The maximum power dissipation depends on the operating ambient temperature for fixed \( T_{J(MAX)} \) and thermal resistance, \( \theta_{JA} \). 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](image)
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimensions In Millimeters</th>
<th>Dimensions In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>A</td>
<td>4.801</td>
<td>5.004</td>
</tr>
<tr>
<td>B</td>
<td>3.810</td>
<td>4.000</td>
</tr>
<tr>
<td>C</td>
<td>1.346</td>
<td>1.753</td>
</tr>
<tr>
<td>D</td>
<td>0.330</td>
<td>0.510</td>
</tr>
<tr>
<td>F</td>
<td>1.194</td>
<td>1.346</td>
</tr>
<tr>
<td>H</td>
<td>0.170</td>
<td>0.254</td>
</tr>
<tr>
<td>I</td>
<td>0.000</td>
<td>0.152</td>
</tr>
<tr>
<td>J</td>
<td>5.791</td>
<td>6.200</td>
</tr>
<tr>
<td>M</td>
<td>0.406</td>
<td>1.270</td>
</tr>
<tr>
<td>Option 1 X</td>
<td>2.000</td>
<td>2.300</td>
</tr>
<tr>
<td>Y</td>
<td>2.000</td>
<td>2.300</td>
</tr>
<tr>
<td>Option 2 X</td>
<td>2.100</td>
<td>2.500</td>
</tr>
<tr>
<td>Y</td>
<td>3.000</td>
<td>3.500</td>
</tr>
</tbody>
</table>

8-Lead SOP (Exposed Pad) Plastic Package
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimensions In Millimeters</th>
<th>Dimensions In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>A</td>
<td>0.889</td>
<td>1.295</td>
</tr>
<tr>
<td>A1</td>
<td>0.000</td>
<td>0.152</td>
</tr>
<tr>
<td>B</td>
<td>1.397</td>
<td>1.803</td>
</tr>
<tr>
<td>b</td>
<td>0.356</td>
<td>0.559</td>
</tr>
<tr>
<td>C</td>
<td>2.591</td>
<td>2.997</td>
</tr>
<tr>
<td>D</td>
<td>2.692</td>
<td>3.099</td>
</tr>
<tr>
<td>e</td>
<td>0.838</td>
<td>1.041</td>
</tr>
<tr>
<td>H</td>
<td>0.080</td>
<td>0.254</td>
</tr>
<tr>
<td>L</td>
<td>0.300</td>
<td>0.610</td>
</tr>
</tbody>
</table>

SOT-23-5 Surface Mount Package
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimensions In Millimeters</th>
<th>Dimensions In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>A</td>
<td>1.400</td>
<td>1.600</td>
</tr>
<tr>
<td>b</td>
<td>0.360</td>
<td>0.508</td>
</tr>
<tr>
<td>B</td>
<td>2.400</td>
<td>2.600</td>
</tr>
<tr>
<td>b1</td>
<td>0.406</td>
<td>0.533</td>
</tr>
<tr>
<td>C</td>
<td>3.937</td>
<td>4.250</td>
</tr>
<tr>
<td>C1</td>
<td>0.800</td>
<td>1.194</td>
</tr>
<tr>
<td>D</td>
<td>4.400</td>
<td>4.600</td>
</tr>
<tr>
<td>D1</td>
<td>1.397</td>
<td>1.700</td>
</tr>
<tr>
<td>e</td>
<td>1.400</td>
<td>1.600</td>
</tr>
<tr>
<td>H</td>
<td>0.356</td>
<td>0.430</td>
</tr>
</tbody>
</table>

5-Lead SOT-89 Surface Mount Package
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimensions In Millimeters</th>
<th>Dimensions In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>A</td>
<td>0.500</td>
<td>0.600</td>
</tr>
<tr>
<td>A1</td>
<td>0.000</td>
<td>0.050</td>
</tr>
<tr>
<td>A3</td>
<td>0.100</td>
<td>0.175</td>
</tr>
<tr>
<td>b</td>
<td>0.200</td>
<td>0.300</td>
</tr>
<tr>
<td>D</td>
<td>1.500</td>
<td>1.700</td>
</tr>
<tr>
<td>D2</td>
<td>0.950</td>
<td>1.050</td>
</tr>
<tr>
<td>E</td>
<td>1.500</td>
<td>1.700</td>
</tr>
<tr>
<td>E2</td>
<td>0.550</td>
<td>0.650</td>
</tr>
<tr>
<td>e</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>0.200</td>
<td>0.300</td>
</tr>
</tbody>
</table>

U-Type 6L DFN 1.6x1.6 Package