OUTLINE

The RN5RG Series are CMOS-based voltage regulator ICs with an external power transistor with high output voltage accuracy and lowest supply current. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier and resistors.

These ICs are suitable for constructing regulators with ultra-low dropout voltage and an output current in the range of several tens mA to several hundreds mA.

Furthermore, these ICs have a chip enable function, so that the supply current on standby can be minimized. Since the package for these ICs is SOT-23-5 (Mini-mold) package, high density mounting of the ICs on boards is possible.

FEATURES

- Ultra-Low Supply Current ....................Typ. 50µA
- Standby Mode.............................Typ. 0.2µA
- Ultra-Low Dropout Voltage ..................Typ. 0.1V (IOUT=100mA : dependent on External Tr.)
- Low Temperature-Drift Coefficient of Output Voltage ...........Typ. ±100 ppm/˚C
- Excellent Line Regulation ......................Typ. 0.1%/V
- Output Voltage ................................Stepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible (refer to Selection Guide).
- High Accuracy Output Voltage ..........±2.5%
- Small Package..........................SOT-23-5(Mini-Mold)

APPLICATIONS

- Power source for battery-powered equipment.
- Power source for cameras, VCRs, camcorders, hand-held audio instruments, and hand-held communication equipment.
- Power source for domestic appliances.

BLOCK DIAGRAM

![Block Diagram of RN5RG Series Voltage Regulator ICs](image-url)
SELECTION GUIDE

The output voltage, the version, the packing type, and the taping type for the ICs can be selected at the user’s request.

The selection can be made by designating the part number as shown below:

RN5RGxxxx – xx ← Part Number
   ↑↑  ↑
   a  bc  d

<table>
<thead>
<tr>
<th>Code</th>
<th>Contents</th>
</tr>
</thead>
</table>
| a    | Setting Output Voltage (VOUT):  
       |   Stepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible. |
| b    | A        |
| c    | Designation of Packing Type:  
       |   A:  Taping  
       |   C:  Antistatic bag for samples |
| d    | Designation of Taping Type:  
       |   Ex.  TR, TL  
       |   (refer to Taping Specifications)  
       |   “TR” is prescribed as a standard. |

For example, the product with Output Voltage 5.0V, Version A, and Taping Type TR is designated by Part Number RN5RG50AA-TR.
PIN CONFIGURATION

PIN DESCRIPTION

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>2</td>
<td>VDD</td>
<td>Input Pin</td>
</tr>
<tr>
<td>3</td>
<td>VOUT</td>
<td>Output Pin</td>
</tr>
<tr>
<td>4</td>
<td>EXT</td>
<td>External Transistor Drive Pin (Nch Open Drain Output)</td>
</tr>
<tr>
<td>5</td>
<td>CE</td>
<td>Chip Enable Pin</td>
</tr>
</tbody>
</table>

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Input Voltage</td>
<td>+12</td>
<td>V</td>
</tr>
<tr>
<td>VCE</td>
<td>Input Voltage (CE Pin)</td>
<td>–0.3 to VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VEXT</td>
<td>EXT Output Voltage</td>
<td>+12</td>
<td>V</td>
</tr>
<tr>
<td>IEXT</td>
<td>EXT Output Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>PD</td>
<td>Power Dissipation</td>
<td>150</td>
<td>mW</td>
</tr>
<tr>
<td>Topt</td>
<td>Operating Temperature Range</td>
<td>–40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature Range</td>
<td>–55 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Tsolder</td>
<td>Lead Temperature (Soldering)</td>
<td>260°C, 10s</td>
<td></td>
</tr>
</tbody>
</table>

Absolute Maximum ratings are threshold limit values that must not be exceeded even for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.
### ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOUT</td>
<td>Output Voltage</td>
<td>( V_{\text{IN}=8.0V} ) ( V_{\text{OUT}} ) ( \times0.975 )</td>
<td>VOUT</td>
<td>VOUT</td>
<td>VOUT</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>IOUT</td>
<td>Output Current</td>
<td>( V_{\text{IN}}-V_{\text{OUT}}=1.0V )</td>
<td>1000</td>
<td>mA</td>
<td></td>
<td></td>
<td>Note</td>
</tr>
<tr>
<td>IEXT</td>
<td>EXT Current</td>
<td>( V_{\text{IN}=4.0V, V_{\text{EXT}=2.0V}} )</td>
<td>10</td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta V_{\text{OUT}} / \Delta I_{\text{OUT}} )</td>
<td>Load Regulation</td>
<td>( V_{\text{IN}}-V_{\text{OUT}}=1.0V ) ( 1mA \leq I_{\text{OUT}} \leq 100mA )</td>
<td>-60</td>
<td>60</td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDIF</td>
<td>Dropout Voltage</td>
<td>( I_{\text{OUT}}=100mA )</td>
<td>100</td>
<td>200</td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISS</td>
<td>Supply Current</td>
<td>( V_{\text{IN}}=8V ) ( V_{\text{OUT}}=1.0V ) ( I_{\text{OUT}}=0mA ) (at no load)</td>
<td>50</td>
<td>80</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Istandby</td>
<td>Supply Current (Standby)</td>
<td>( V_{\text{IN}}=8V )</td>
<td>0.01</td>
<td>0.20</td>
<td>1.00</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>IEXTleak</td>
<td>EXT Leakage Current</td>
<td></td>
<td>0.5</td>
<td>µA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta V_{\text{OUT}} / \Delta V_{\text{IN}} )</td>
<td>Line Regulation</td>
<td>( I_{\text{OUT}}=50mA ) ( V_{\text{OUT}}+0.5V \leq V_{\text{IN}} \leq 8V )</td>
<td>0.0</td>
<td>0.1</td>
<td>0.3</td>
<td>%/V</td>
<td></td>
</tr>
<tr>
<td>VIN</td>
<td>Input Voltage</td>
<td></td>
<td>8</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEXT</td>
<td>EXT Output Voltage</td>
<td></td>
<td>8</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta V_{\text{OUT}} / \Delta T_{\text{OPT}} )</td>
<td>Output Voltage Temperature Coefficient</td>
<td>( I_{\text{OUT}}=10mA ) ( -40^\circ C \leq T_{\text{OPT}} \leq 85^\circ C )</td>
<td>±100</td>
<td>ppm/°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VCEH</td>
<td>CE Input Voltage “H”</td>
<td></td>
<td>1.5</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VCEL</td>
<td>CE Input Voltage “L”</td>
<td></td>
<td>0.25</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICEH</td>
<td>CE Input Current “H”</td>
<td></td>
<td>0.0</td>
<td>0.1</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICEL</td>
<td>CE Input Current “L”</td>
<td></td>
<td>-5.0</td>
<td>-3.0</td>
<td>-0.1</td>
<td>µA</td>
<td></td>
</tr>
</tbody>
</table>

(Note) The output current depends upon the performance of External PNP Transistor. Use External PNP Transistor of a low saturation type, with an \( h_{FE} \) of 100 or more.

*) With respect to Test Circuits, refer to the Typical Application.
**OPERATION**

In these ICs, the output voltage $V_{OUT}$ is detected by feedback registers RA, RB, and the detected output voltage is compared with a reference voltage by error Amplifier, so that the base current of an external PNP transistor is adjusted and the output voltage $V_{OUT}$ is regulated.

**SELECTION GUIDE FOR EXTERNAL COMPONENTS**

1. **External PNP Transistor**

   Select an external PNP transistor from the viewpoints of output current, input voltage and power dissipation.

   Generally external PNP transistor with low $V_{CE}$ (SAT) and high $h_{FE}$ is suitable.

2. **Base Resistor R2**

   EXT Pin of these ICs is protected by a current limit circuit from the destruction caused by excess current. However, since this current limit circuit is provided for the purpose of protecting the IC, use a resistor R2 for the protection of the External Transistor, although this IC can be operated without such a resistor. It is required that the resistance of the Resistor R2 be determined with the input voltage, output voltage, output current, temperature, and the $h_{FE}$ value taken into consideration and the dispersion of these values. Before making such a determination, check the characteristics by calculating the respective values by using the following formula:

   $$\frac{V_{IN} [\text{Min.}] - 1.2(V)}{R2} - \frac{0.7(V)}{R1} \times \frac{I_{OUT} [\text{Max.}]}{h_{FE}} > 0$$

3. **Phase Compensation**

   In these ICs, phase compensation is made for securing stable operation even when the load current is varied. For this purpose, be sure to use a capacitor $C_L$ (tantalum type) with a capacitance of 10µF or more and a resistor R1 with a resistance of about 10kΩ between the base and the emitter. There may be the case the loop oscillation takes place when a tantalum capacitor $C_L$ with a large ESR is used, so select the $C_L$ carefully including the frequency characteristics.
TEST CIRCUITS

Test Circuit 1: Typical Characteristics 1) to 4)

Test Circuit 2: Typical Characteristics 5) to 7)

Test Circuit 3: Typical Characteristics 8) to 10)

Test Circuit 4: Typical Characteristics 11)
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Input Voltage

2) Output Voltage vs. Output Current

3) Dropout Voltage vs. Output Current
4) Output Voltage vs. Temperature

![Graph showing output voltage vs. temperature for RN5RG30A and RN5RG50A with different input voltages and output currents.]

5) Supply Current vs. Input Voltage

![Graph showing supply current vs. input voltage for RN5RG30A and RN5RG50A with different output currents.]

6) Supply Current vs. Temperature

![Graph showing supply current vs. temperature for RN5RG30A and RN5RG50A with different input voltages and output currents.]

Limited Product
7) Standby Current vs. Input Voltage

**RN5RG30A**

- **Standby Current** $I_{\text{standby}}$ ($\mu$A)
  - 0
  - 0.15
  - 0.35
  - 0.3
  - 0.25
  - 0.2
  - 0.45
  - 0.1
  - 0.05

- **Temperature** $T_{\text{opt}}$ ($\degree C$)
  - 85
  - 40
  - 25

8) Ripple Rejection

**RN5RG50A**

- **Ripple Rejection** $R_{\text{ripp}}$ (dB)
  - 10
  - 20
  - 30
  - 40
  - 50

- **Frequency** $f$ (Hz)
  - 10
  - 100
  - 1k
  - 10k
  - 100k

9) Line Transient Response (1)

**RN5RG50A**

- **Input Voltage** $V_{\text{in}}$ (V)
  - 20
  - 40
  - 60
  - 80
  - 100

- **Output Voltage Deviation** $V_{\text{out}}$ (V)
  - 0
  - 10
  - 20
  - 30
  - 40
  - 50

- **Time** $t$ (µs)
  - 0
  - 10
  - 20
  - 30
  - 40

10) Line Transient Response (2)

**RN5RG50A**

- **Input Voltage** $V_{\text{in}}$ (V)
  - 20
  - 40
  - 60
  - 80

- **Output Voltage Deviation** $V_{\text{out}}$ (V)
  - 0
  - 10
  - 20
  - 30
  - 40
  - 50

- **Time** $t$ (µs)
  - 0
  - 10
  - 20
  - 30

11) Load Transient Response

**RN5RG50A**

- **Output Current** $I_{\text{out}}$ (mA)
  - 10
  - 100
  - 1k
  - 10k
  - 100k

- **Output Voltage Deviation** $V_{\text{out}}$ (mV)
  - 0
  - 100
  - 200
  - 300
  - 400
  - 500

- **Time** $t$ (ms)
  - 0
  - 10
  - 20
  - 30
  - 40

**Limited Product**
TYPICAL APPLICATION

Parts Transistor: 2SA1213
Resistor: 10kΩ
Capacitor: 10µF (tantalum type)
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