OUTLINE

The RN5RY202 Series are CMOS-based VFM (chopper) Control ICs for step-up DC/DC converter with an external power transistor featuring high output voltage accuracy and low supply current. Each of the RN5RY202 Series ICs consists of a voltage reference unit, an error amplifier, an oscillator, a VFM control circuit and feedback resistors. Output voltage is fixed at 2V in the IC.

A low ripple, high efficiency step-up DC/DC converter can be constructed by simply adding an inductor, a diode, a capacitor, and a drive transistor and feedback resistors.

Although the series have no CE pins unlike RN5RYxx1A, high voltage (VOUT=30V) can be also output by using external feedback resistors.

FEATURES

- Low Supply Current ............................................................................Typ. 3µA
- Low Temperature-Drift Coefficient of Output Voltage ...................Typ. ±50ppm/˚C
- High Accuracy Output Voltage .........................................................±2.5%
- Low Oscillation Start-up Voltage (no load) ......................................Max. 0.8V
- Any output voltage can be set with external resistors
- Small Package SOT-23-5 (Mini-Mold)

APPLICATIONS

- Constant voltage power source for battery-powered instruments.
- Constant power source for cameras, camcorders, pagers, and other hand-held communication tools.
- Constant power source for devices that require higher voltages than battery voltages.

BLOCK DIAGRAM
SELECTION GUIDE

In the RN5RY202 Series, the taping type for the ICs can be selected at the user's request. These selections can be made by designating the part number as shown below:

```
RN5RY202 x–xx ← Part Number
```

<table>
<thead>
<tr>
<th>Code</th>
<th>Contents</th>
</tr>
</thead>
</table>
| a    | 20. Designation of Output Voltage (\(V_{OUT}\))
      | \(V_{OUT}\) is fixed at 2.0V. |
| b    | 2 |
| c    | Designation of Packing Type:
      | A : Taping |
      | C : Antistatic bag (for Samples only) |
| d    | Designation of Taping Type:
      | Ex. TR, TL (refer to Taping Specifications; TR type is prescribed as a standard.) |

For example, Taping Type TR, is designated by Part Number RN5RY202A-TR.

PIN CONFIGURATION

- SOT-23-5

![PIN CONFIGURATION Diagram]
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>EXT</td>
<td>External Transistor Drive Pin (CMOS Output)</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>No Connection</td>
</tr>
<tr>
<td>5</td>
<td>VOUT</td>
<td>Internal Voltage Output Pin (fixed at 2V)</td>
</tr>
</tbody>
</table>

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD</td>
<td>Input Voltage</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>VOUT</td>
<td>Output Pin Voltage</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>VEXT</td>
<td>EXT Pin Output Voltage</td>
<td>–0.3 to VDD+0.3</td>
<td>V</td>
</tr>
<tr>
<td>IEXT</td>
<td>EXT Pin 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</td>
<td>–40 to +85</td>
<td>℃</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature</td>
<td>–55 to +125</td>
<td>℃</td>
</tr>
<tr>
<td>Tsolder</td>
<td>Lead Temperature (Soldering)</td>
<td>260℃ 10s (Lead part)</td>
<td></td>
</tr>
</tbody>
</table>
### ELECTRICAL CHARACTERISTICS

- **RN5RY202**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOUT</td>
<td>Output Voltage</td>
<td>VIN=VDD=1.9V</td>
<td>1.950</td>
<td>2.000</td>
<td>2.050</td>
<td>V</td>
</tr>
<tr>
<td>VIN</td>
<td>Input Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>IDD1</td>
<td>Supply Current 1</td>
<td>EXT No load, VDD=1.9V</td>
<td>15</td>
<td>25</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VOUT=1.9V, Test circuit1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IDD2</td>
<td>Supply Current 2</td>
<td>EXT No load, VDD=1.9V</td>
<td>3</td>
<td>5</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VOUT=2.1V, Test circuit1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fosc</td>
<td>Maximum Oscillator Frequency</td>
<td>VDD=1.9V, VOUT=1.9V</td>
<td>180</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test circuit2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duty</td>
<td>Oscillator Duty Cycle</td>
<td>VDD=1.9V, VOUT=1.9V</td>
<td>65</td>
<td>75</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EXT “H” side, Test circuit2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vstart</td>
<td>Oscillator Start-up Voltage</td>
<td>EXT No load, Test circuit2</td>
<td>0.7</td>
<td>0.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>∆VOUT</td>
<td>Output Voltage</td>
<td>IOUT=10mA</td>
<td>±50</td>
<td></td>
<td></td>
<td>ppm/°C</td>
</tr>
<tr>
<td>∆Topt</td>
<td>Temperature Coefficient</td>
<td>~40° ≤Topt≤85°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEXTH</td>
<td>EXT “H” Output Current</td>
<td>VDD=1.9V, VOUT=1.9V, VEXT=GND, Test circuit3</td>
<td>-1.5</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>IEXTL</td>
<td>EXT “L” Output Current</td>
<td>VDD=1.9V, VOUT=1.9V, VEXT=1.9V, Test circuit4</td>
<td>1.5</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>RSET</td>
<td>Voltage Set Resistor</td>
<td>VDD=2V, VOUT=10V, Test circuit5</td>
<td>2</td>
<td></td>
<td></td>
<td>MΩ</td>
</tr>
</tbody>
</table>
TEST CIRCUIT

Test Circuit 1

Test Circuit 2

Test Circuit 3

Test Circuit 4

Test Circuit 5
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

![Graph of Output Voltage vs. Output Current for 2SK2054(NEC)](image1)

![Graph of Output Voltage vs. Output Current for 2SK1470(Sanyo)](image2)

2) Efficiency vs. Output Current

![Graph of Efficiency vs. Output Current for 2SK2054(NEC)](image3)

![Graph of Efficiency vs. Output Current for 2SK1470(Sanyo)](image4)

*) V_{in}=3.6V

**) For test circuit details, see "TYPICAL APPLICATIONS".
TEST CIRCUIT

Components:
- Inductor (L1): CD54 (15µH)
- Diode (D1): RB111C (Rohm)
- Capacitor (C): 47µF (Tantalum type)
- Transistor (Q1): 2SK2054 (NEC) or 2SK1470 (Sanyo)
- Output voltage setting resistor (R1): 150kΩ
- Output voltage setting resistor (R2): 10kΩ

TYPICAL APPLICATIONS
## NOTES ON EXTERNAL COMPONENTS

- If input voltage is high enough, higher efficiency may be obtained by using MOSFET in the driver transistor, in which case no resistors and condensers are necessary.
- Always keep the absolute maximum ratings (\(V_{DS}\) and \(V_{CE}\)) since spike voltage higher than output voltage may be applied to the driver transistor. We recommend that you use transistors with absolute maximum ratings more than twice of the output setting voltage.
- Use capacitor with an allowable voltage which is at least one and a half times as much as the setting output voltage.
- Use output voltage setting resistors with resistance much smaller than IC internal resistor (Min. 2MΩ). Be careful not to allow larger resistance, which will result in larger error in setting voltage. We recommend resistors up to several tens of kΩ.
- Select an inductor with small DC resistance and enough permissible current and less tendency to magnetic saturation.
- Select a diode of a Schottky type with a faster switching speed. Also pay attention to current capacity.

(External components) Reference

- **Inductors**
  - CD54, CD73, CD104 (Sumida)
- **Driver transistors**
  - 2SD1628 (Sanyo)
  - 2SK1470 (Sanyo)
  - 2SK1959 (NEC)
  - 2SK2054 (NEC)
- **Diodes**
  - RB111C (Rohm)
  - D1FS4A (Shindengen)
- **Output capacitor**
  - Tantalum type
Output setting voltage is determined using the following formulas:

\[ I_2 = I_{IC} + I_3 \] .................................................. (1)

\[ I_3 = \frac{2.0}{R_3} \] .................................................. (2)

From (1) and (2) above,

\[ I_2 = I_{IC} + \frac{2.0}{R_3} \] .................................................. (3)

\[ V_{OUT} = 2.0 + R_2 \times I_2 \] .................................................. (4)

By substituting (3) into the above formula

\[ V_{OUT} = 2.0 + R_2 \times (I_{IC} + \frac{2.0}{R_3}) \]

\[ = 2.0 \times (1 + \frac{R_2}{R_3}) + R_2 \times I_{IC} \] ................................................. (5)

The second term, \( R_2 \times I_{IC} \) in the formula (5) above may cause a voltage setting error. Here, consider the formula in terms of \( I_{IC} \),

\[ I_{IC} = \frac{2.0}{R_{IC}} \] .................................................. (6)

then \( R_2 \times I_{IC} \) that causes the error will be as shown below:

\[ R_2 \times I_{IC} = R_2 \times \frac{2.0}{R_{IC}} \] .................................................. (7)

Thus, when \( R_2 << R_{IC} \) the error can be minimized.
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