

RICOH

VFM STEP-UP DC/DC CONVERTER CONTROLLER

RN5RY202

NO.EA-042-0006

OUTLINE

The RN5RY202 Series are VFM (chopper) Control ICs for step-up DC/DC converter with an external power transistor featuring high output voltage accuracy and low supply current by CMOS process. Each of the RN5RY202 Series ICs consists of a voltage reference unit, an error amplifier, an oscillator, a VFM control circuit and feed back 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 feed back resistors.

Although the series have no CE pins unlike RN5RY××1A, high voltage ($V_{OUT}=30V$) can be also output by using external feed back resistors.

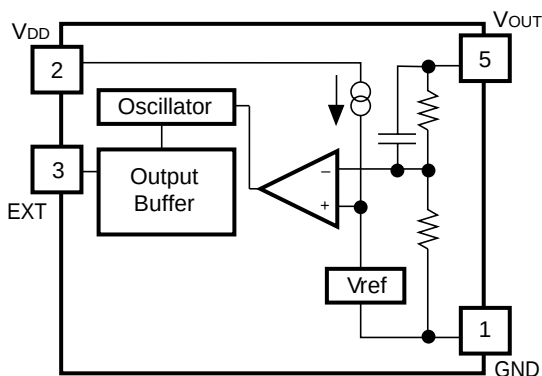
FEATURES

- Low Supply Current.....TYP. $3\mu A$
- Low Temperature-Drift Coefficient of Output VoltageTYP. $\pm 50\text{ppm}/^{\circ}\text{C}$
- High Accuracy Output Voltage $\pm 2.5\%$
- 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×-×× ←Part Number

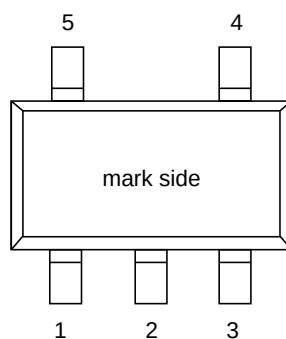
↑↑↑ ↑
a b c d

Code	Contents
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 DESCRIPTION

Pin No.	Symbol	Description
1	GND	Ground Pin
2	V _{DD}	Input Pin
3	EXT	External Transistor Drive Pin (CMOS Output)
4	NC	No Connection
5	V _{OUT}	Internal Voltage Output Pin (fixed at 2V)

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Ratings	Unit
V _{DD}	Input Voltage	12	V
V _{OUT}	Output Pin Voltage	12	V
V _{EXT}	EXT Pin Output Voltage	-0.3 to V _{DD} +0.3	V
I _{EXT}	EXT Pin Output Current	±50	mA
P _D	Power Dissipation	150	mW
T _{opt}	Operating Temperature	-40 to +85	°C
T _{stg}	Storage Temperature	-55 to +125	°C
T _{solder}	Lead Temperature (Soldering)	260°C 10s (Lead part)	

ABSOLUTE MAXIMUM RATINGS

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.

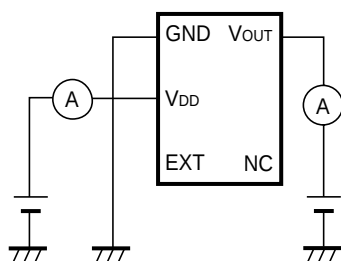
ELECTRICAL CHARACTERISTICS

• RN5RY202

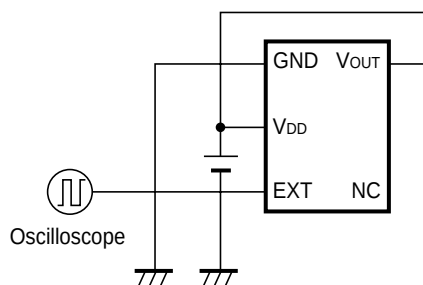
T_{opt}=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V _{OUT}	Output Voltage	V _{IN} =V _{DD} =1.9V	1.950	2.000	2.050	V
V _{IN}	Input Voltage				10	V
I _{DD1}	Supply Current 1	EXT No load, V _{DD} =1.9V V _{OUT} =1.9V, Test circuits1		15	25	μA
I _{DD2}	Supply Curren 2	EXT No load, V _{DD} =1.9V V _{OUT} =2.1V, Test circuits1		3	5	μA
f _{osc}	Maximum Oscillator Frequency	V _{DD} =1.9V, V _{OUT} =1.9V Test circuits2		180		kHz
Duty	Oscillator Duty Cycle	V _{DD} =1.9V, V _{OUT} =1.9V EXT “H” side, Test circuits2	65	75		%
V _{start}	Oscillator Start-up Voltage	EXT No load, Test circuits2		0.7	0.8	v
$\frac{\Delta V_{OUT}}{\Delta T_{opt}}$	Output Voltage Temperature Coefficient	I _{OUT} =10mA -40°C≤T _{opt} ≤85°C		±50		ppm/°C
I _{EXTH}	EXT “H” Output Current	V _{DD} =1.9V, V _{OUT} =1.9V V _{EXT} =GND, Test circuits3			-1.5	mA
I _{EXTL}	EXT “L” Output Current	V _{DD} =1.9V, V _{OUT} =1.9V V _{EXT} =1.9V, Test circuits4	1.5			mA
R _{VSET}	Voltage Set Resistor	V _{DD} =2V, V _{OUT} =10V Test circuits5	2			MΩ

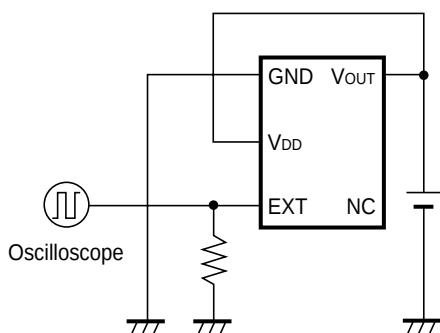
TEST CIRCUIT



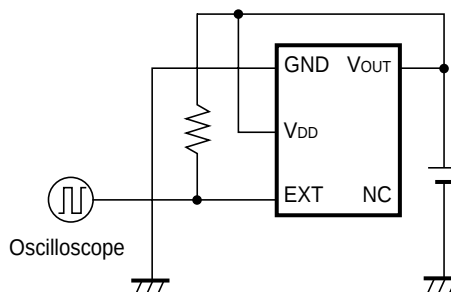
Test Circuit1



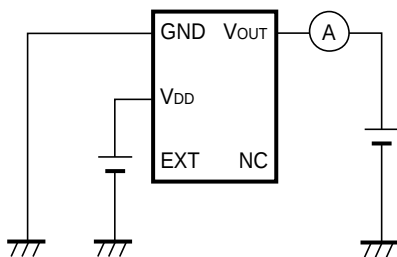
Test Circuit2



Test Circuit3



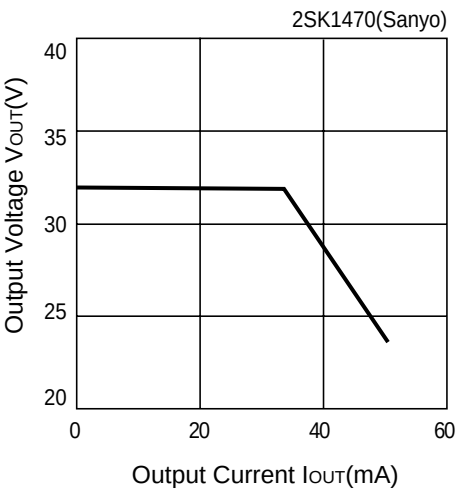
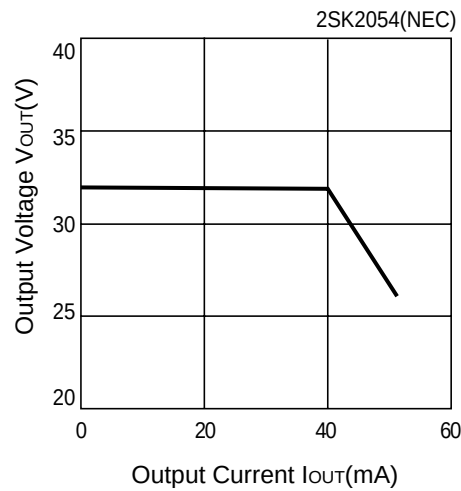
Test Circuit4



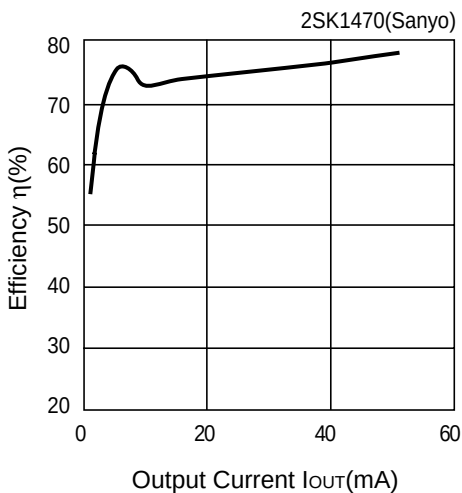
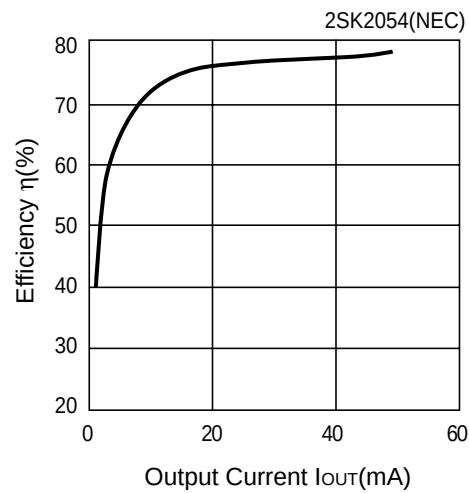
Test Circuit5

TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

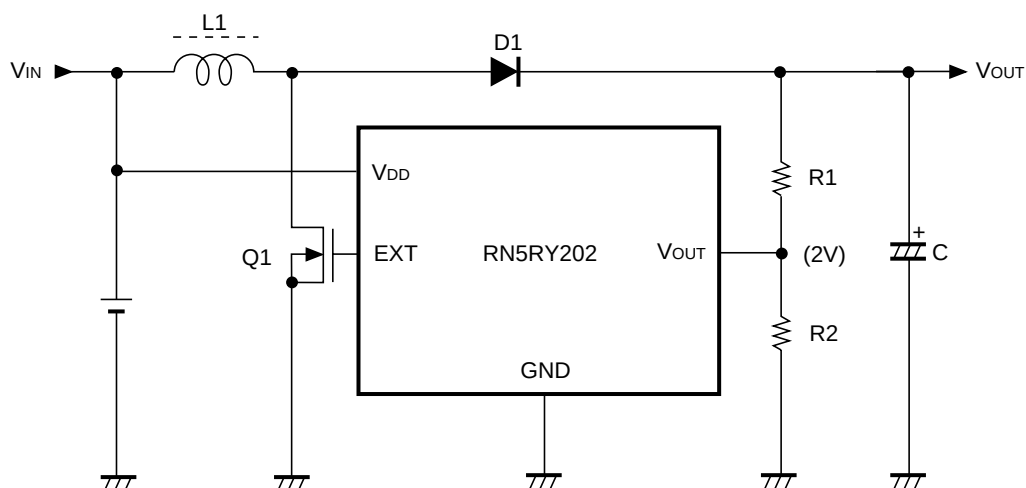


2) Efficiency vs. Output Current



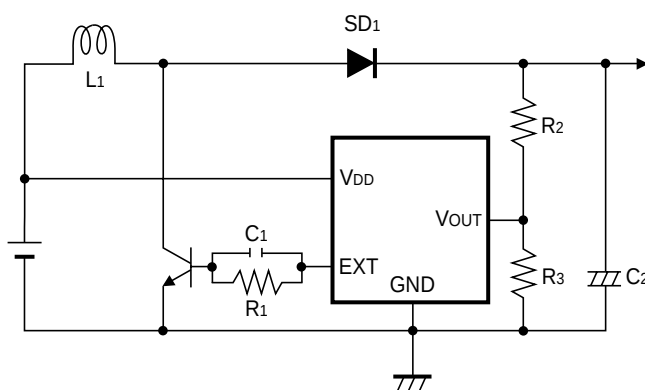
*) $V_{IN}=3.6V$
**) For test circuit details, see "TYPICAL APPLICATIONS".

CHARACTERISTIC 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



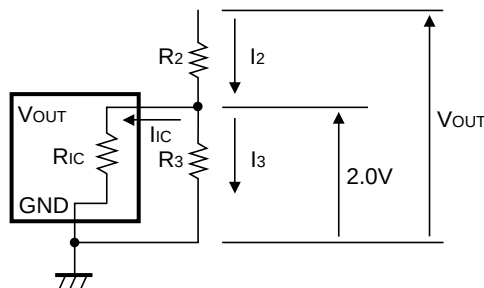
NOTES ON EXTERNAL COMPONENTS

- 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. $2M\Omega$). Be careful not to allow larger resistance, which will result in larger error in setting voltage. We recommend resistors up to several tens of $k\Omega$.
- Select an inductor with small DC resistance and enough permissible current and less tendency to magnetic saturation.
- Select a diode of a shot-key type with a faster switching speed. Also pay attention to current capacity.

(Reference external components)

- Inductor
CD54, CD73, CD104 (Sumida)
- Driver transistor
2SD1628 (Sanyo)
2SK1470 (Sanyo)
2SK1959 (NEC)
2SK2054 (NEC)
- Diode
RB111C (Rohm)
D1FS4A (Shindengen)
- Output condenser
Tantalum type

NOTES ON OUTPUT VOLTAGE SETTINGS



Output setting voltage is determined using the following formulas :

$$I_2 = I_{1C} + I_3 \dots\dots\dots (1)$$

$$I_3 = 2.0/R_3 \dots\dots\dots (2)$$

From (1) and (2) above,

$$I_2 = I_{1C} + 2.0/R_3 \dots\dots\dots (3)$$

$$V_{OUT} = 2.0 + R_2 \times I_2 \dots\dots\dots (4)$$

By substituting (3) into the above formula

$$\begin{aligned} V_{OUT} &= 2.0 + R_2 \times (I_{1C} + 2.0/R_3) \\ &= 2.0 \times (1 + R_2/R_3) + R_2 \times I_{1C} \dots\dots\dots (5) \end{aligned}$$

The second term, $R_2 \times I_{1C}$ in the formula (5) above may cause a voltage setting error.

Here, consider the formula in terms of I_{1C} ,

$$I_{1C} = 2.0/R_{1C} \dots\dots\dots (6)$$

then $R_2 \times I_{1C}$ that causes the error will be as shown below :

$$\begin{aligned} R_2 \times I_{1C} &= R_2 \times 2.0/R_{1C} \\ &= 2.0 \times R_2/R_{1C} \dots\dots\dots (7) \end{aligned}$$

Thus, when $R_2 \ll R_{1C}$ the error can be minimized.