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# **LOW DROP-OUT AND LOW NOISE VOLTAGE REGULATOR**

**RN5RZ SERIES**

**APPLICATION MANUAL**

**RICOH**

**ELECTRONIC DEVICES DIVISION**

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June 1995

# RN5RZ SERIES

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## APPLICATION MANUAL

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### RN5RZ SERIES

#### OUTLINE

The RN5RZ Series are voltage regulator ICs with high output voltage accuracy, low supply current, low dropout voltage and high ripple rejection developed through the use of a CMOS process. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, output voltage setting resistors, a current limit circuit and a chip enable circuit. (Provided two types of chip enable circuit ; "H" active and "L" active, that can be selected when order.)

The output voltage of these ICs is fixed with high accuracy.

In addition to low supply current from CMOS process, the RN5RZ Series may lengthen battery life through low dropout voltage and chip enable function thanks to the built-in low ON resistance transistor. Also when compared with conventional regulators that employ CMOS process, these ICs have superior ripple rejection, input transient response characteristic and load transient response characteristic thus making these product suitable for power supply for hand-held communication equipment.

Since the package for these ICs is the SOT-23-5 package, high density mounting of the ICs on boards is possible.

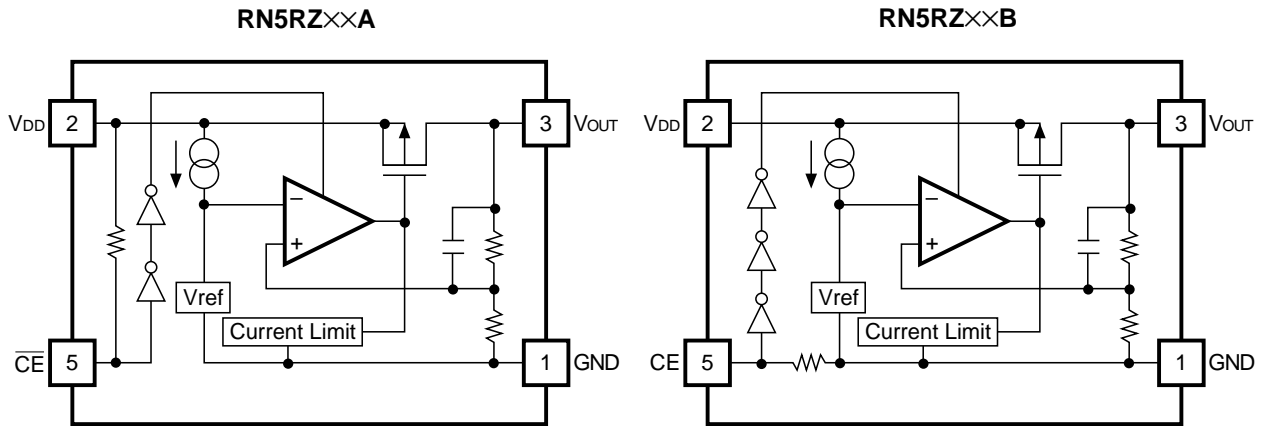
#### FEATURES

- Ultra-Low Supply Current.....TYP. 20 $\mu$ A
- Ultra-Low Supply Current (Standby).....TYP. 0.1 $\mu$ A
- High Accuracy Output Voltage..... $\pm$ 2.0%
- High Ripple Rejection .....TYP.55dB (f=1kHz)
- Low Dropout Voltage .....TYP. 0.2V (I<sub>OUT</sub>=60mA)
- Low Temperature-Drift Coefficient of Output Voltage.....TYP.  $\pm$ 100ppm/ $^{\circ}$ C
- Excellent Line Regulation.....TYP. 0.05%/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).
- Built-in Short Current Limit Circuit.....TYP. 50mA
- Small Package .....SOT-23-5 (Mini-mold)

#### APPLICATIONS

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

## BLOCK DIAGRAMS



## SELECTION GUIDE

The output voltage, the active type of the chip enable circuit, the packing type, and the taping type for the ICs can be selected at the user's request.

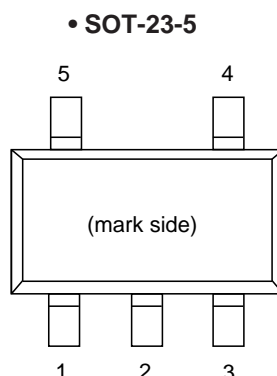
These selections can be made by designating the part number as shown below:

RN5RZ ~~xxxx~~ ~~xx~~ Part Number  
 ↑ ↑ ↑ ↑  
 a b c d

Code	Contents
a	Setting Output Voltage (V <sub>OUT</sub> ) : Stepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible.
b	Designation of Active Type of The Chip Enable Circuit : A : "L" active type B : "H" active type
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 the standard direction.)

For example, the product with Output Voltage of 5.0V, Specified Polarity of Chip Enable is "H" active and Taping Type TR is designated by Part Number RN5RZ50BA-TR.

## PIN CONFIGURATION



## PIN DESCRIPTION

Pin No.	Symbol	Description
1	GND	Ground Pin
2	VDD	Input Pin
3	VOUT	Output Pin
4	NC	No Connection
5	CE or $\overline{\text{CE}}$	Chip Enable Pin

## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Ratings	Unit
V <sub>IN</sub>	Input Voltage	9	V
V <sub>CE</sub>	Input Voltage (CE or $\overline{\text{CE}}$ Pin)	-0.3 to V <sub>IN</sub> +0.3	V
V <sub>OUT</sub>	Output Voltage	-0.3 to V <sub>IN</sub> +0.3	V
I <sub>OUT</sub>	Output Current	200	mA
P <sub>D</sub>	Power Dissipation	250	mW
T <sub>opt</sub>	Operating Temperature	-40 to +85	°C
T <sub>stg</sub>	Storage Temperature	-55 to +125	°C

### 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

• RN5RZxA Series

T<sub>opt</sub>=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> =V <sub>OUT</sub> +1V, I <sub>OUT</sub> =30mA	×0.98		×1.02	V
I <sub>OUT</sub>	Output Current	V <sub>IN</sub> =V <sub>OUT</sub> +1V When V <sub>OUT</sub> =V <sub>OUT</sub> -0.1V	100			mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V <sub>IN</sub> =V <sub>OUT</sub> +1V 1mA≤I <sub>OUT</sub> ≤80mA		20	40	mV
V <sub>DIF</sub>	Dropout Voltage	I <sub>OUT</sub> =60mA		0.2	0.3	V
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> =V <sub>OUT</sub> +1V		20	40	μA
I <sub>standby</sub>	Supply Current (Standby)	V <sub>IN</sub> =V <sub>CE</sub> =V <sub>OUT</sub> +1V		0.1	1.0	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I <sub>OUT</sub> =30mA V <sub>OUT</sub> +0.5V≤V <sub>IN</sub> ≤8V		0.05	0.20	%/V
RR	Ripple Rejection	f=1kHz, Ripple 0.5Vrms V <sub>IN</sub> =V <sub>OUT</sub> +1V		55		dB
V <sub>IN</sub>	Input Voltage				8	V
$\frac{\Delta V_{OUT}}{\Delta T_{opt}}$	Output Voltage Temperature Coefficient	I <sub>OUT</sub> =30mA -40°C≤T <sub>opt</sub> ≤85°C		±100		ppm/°C
I <sub>lim</sub>	Short Current Limit	V <sub>OUT</sub> =0V		50		mA
R <sub>PU</sub>	$\overline{CE}$ Pull-up Resistance		2.5	5	10	MΩ
V <sub>CEH</sub>	$\overline{CE}$ Input Voltage “H”		1.5			V
V <sub>CEL</sub>	$\overline{CE}$ Input Voltage “L”		0		0.25	V

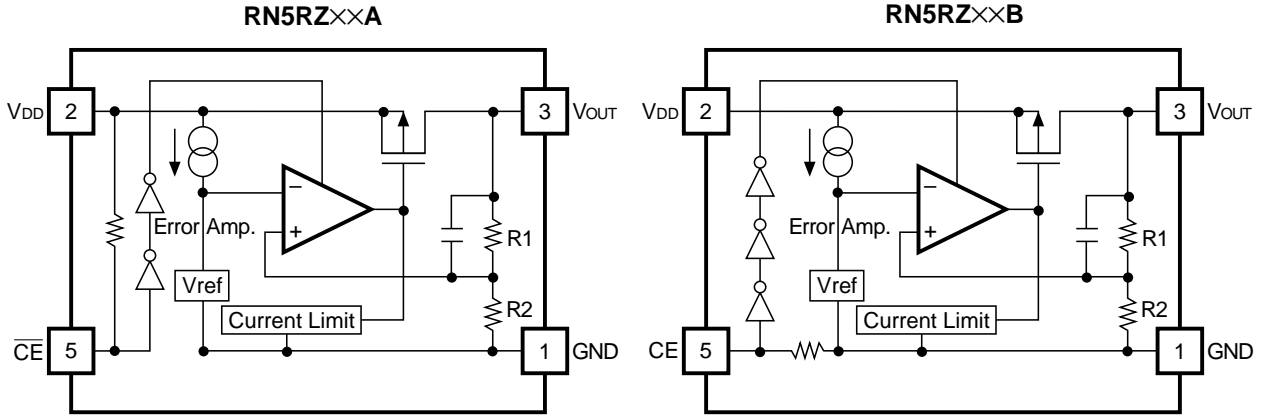
## • RN5RZ×B Series

T<sub>opt</sub>=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> =V <sub>OUT</sub> +1V, I <sub>OUT</sub> =30mA	×0.98		×1.02	V
I <sub>OUT</sub>	Output Current	V <sub>IN</sub> =V <sub>OUT</sub> +1V When V <sub>OUT</sub> =V <sub>OUT</sub> -0.1V	100			mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V <sub>IN</sub> =V <sub>OUT</sub> +1V 1mA≤I <sub>OUT</sub> ≤80mA		20	40	mV
V <sub>DIF</sub>	Dropout Voltage	I <sub>OUT</sub> =60mA		0.2	0.3	V
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> =V <sub>OUT</sub> +1V		20	40	μA
I <sub>standby</sub>	Supply Current (Standby)	V <sub>IN</sub> =V <sub>OUT</sub> +1V, V <sub>CE</sub> =GND		0.1	1.0	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I <sub>OUT</sub> =30mA V <sub>OUT</sub> +0.5V≤V <sub>IN</sub> ≤8V		0.05	0.20	%/V
RR	Ripple Rejection	f=1kHz, Ripple 0.5V <sub>rms</sub> V <sub>IN</sub> =V <sub>OUT</sub> +1V		55		dB
V <sub>IN</sub>	Input Voltage				8	V
$\frac{\Delta V_{OUT}}{\Delta T_{opt}}$	Output Voltage Temperature Coefficient	I <sub>OUT</sub> =30mA -40°C≤T <sub>opt</sub> ≤85°C		±100		ppm/°C
I <sub>lim</sub>	Short Current Limit	V <sub>OUT</sub> =0V		50		mA
R <sub>PU</sub>	CE Pull-down Resistance		2.5	5	10	MΩ
V <sub>CEH</sub>	CE Input Voltage "H"		1.5			V
V <sub>CEL</sub>	CE Input Voltage "L"		0		0.25	V



## OPERATION



In these ICs, Output Voltage  $V_{OUT}$  is detected by Feed-back Registers R1, R2, and the detected Output Voltage is compared with a reference voltage by an Error Amplifier, so that a constant voltage is output.

A current limit circuit working for Short Protect and a chip enable circuit for standby function are included.

## TEST CIRCUITS

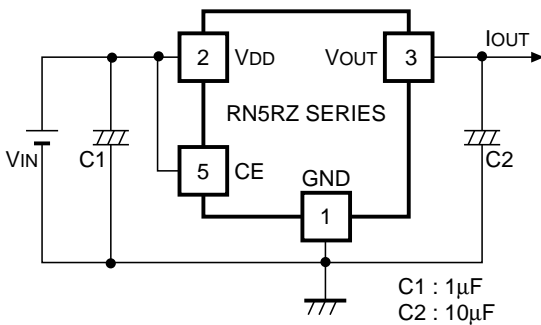


Fig.1 Standard Test Circuit

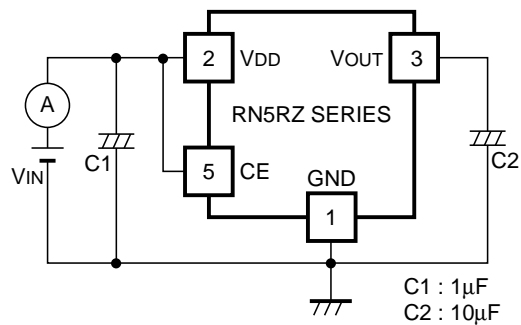


Fig.2 Supply Current Test Circuit

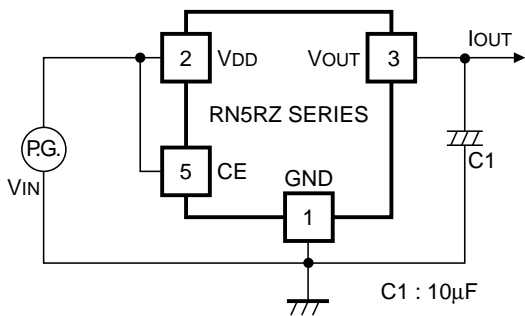


Fig.3 Line Transient Response Test Circuit

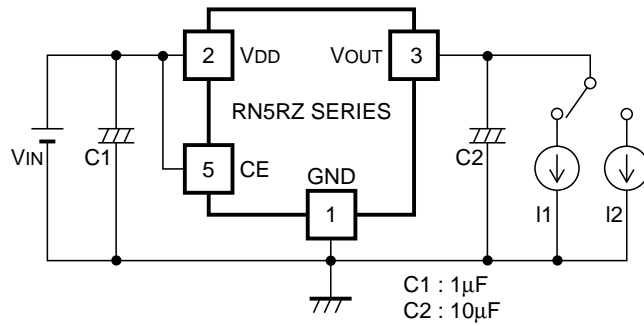


Fig.4 Load Transient Response Test Circuit

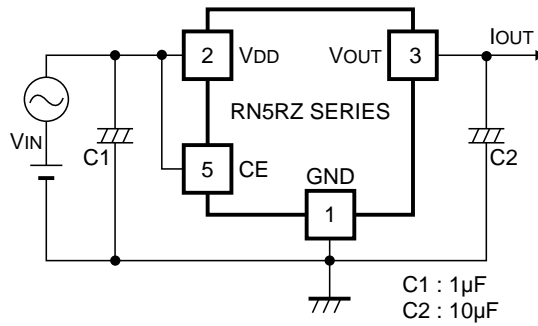
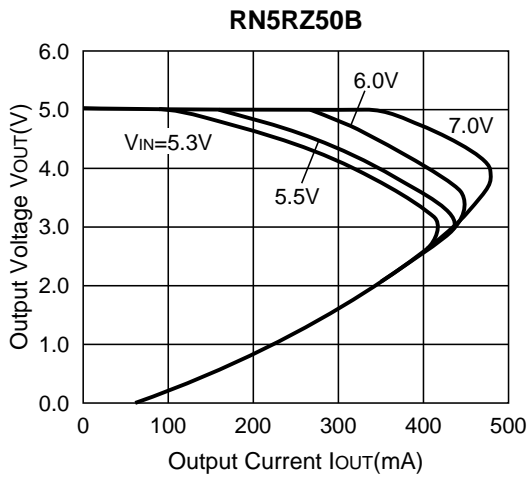
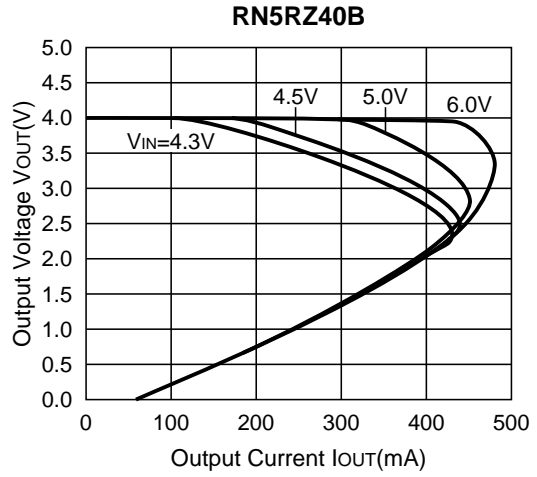
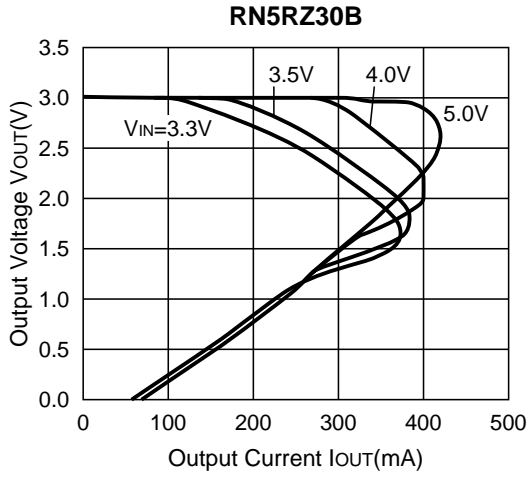


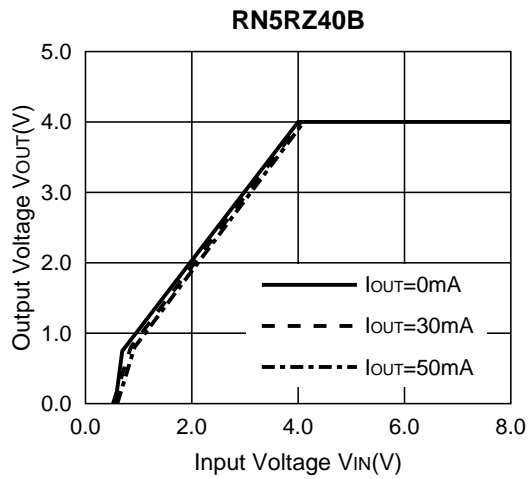
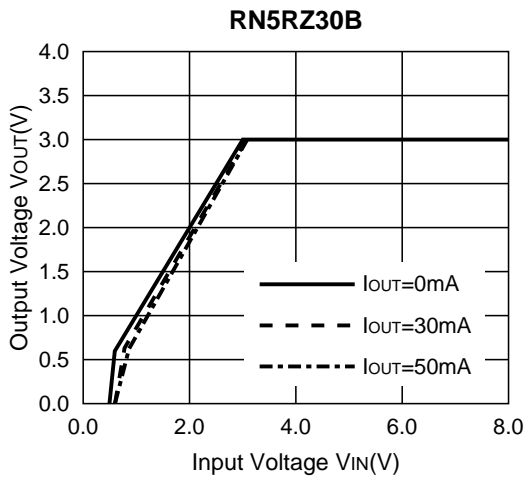
Fig.5 Ripple Rejection Test Circuit

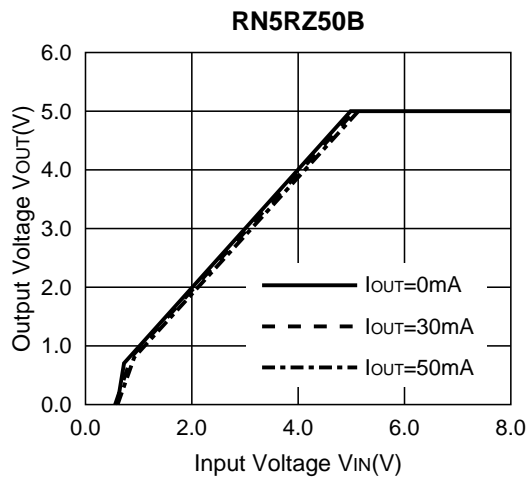
## TYPICAL CHARACTERISTICS

### 1) Output Voltage vs. Output Current

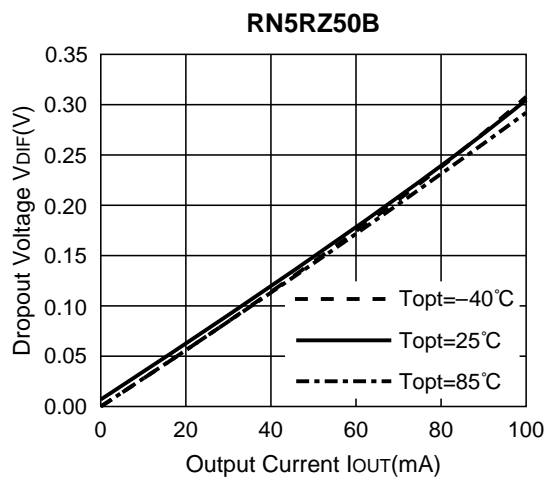
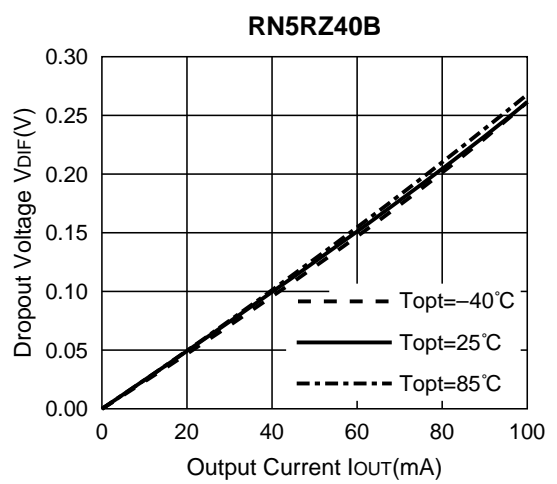
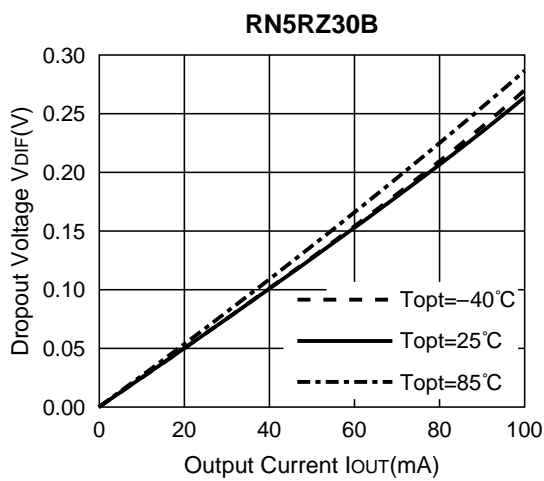


### 2) Output Voltage vs. Input Voltage

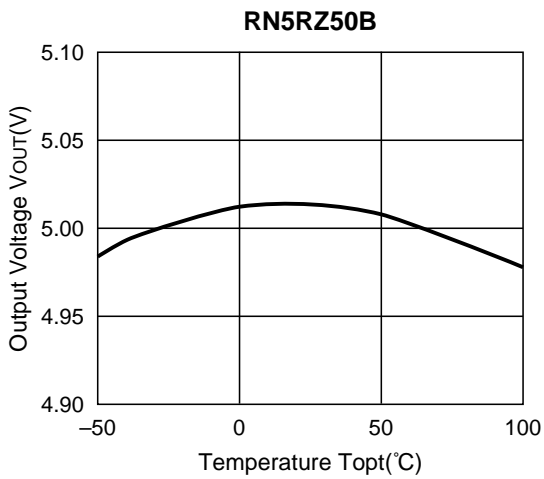
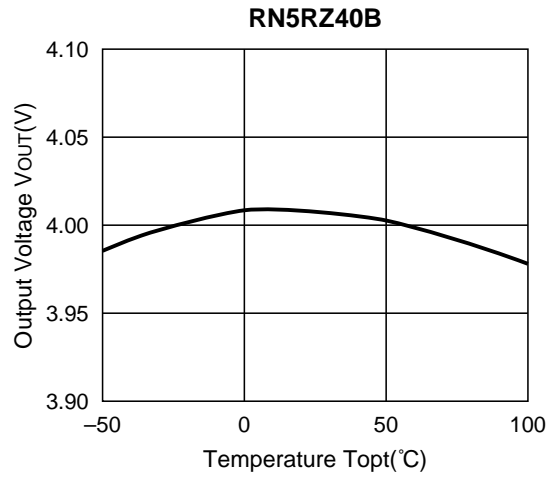
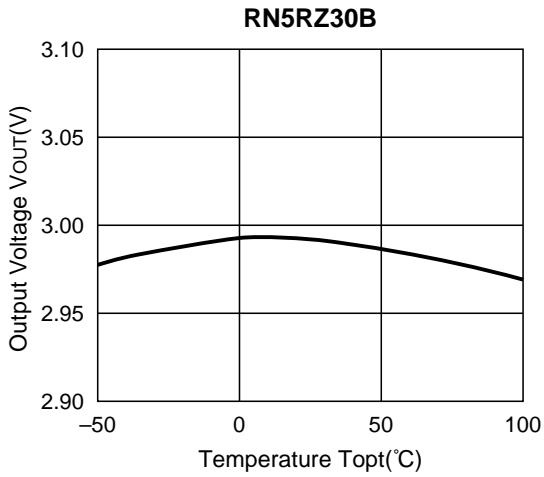




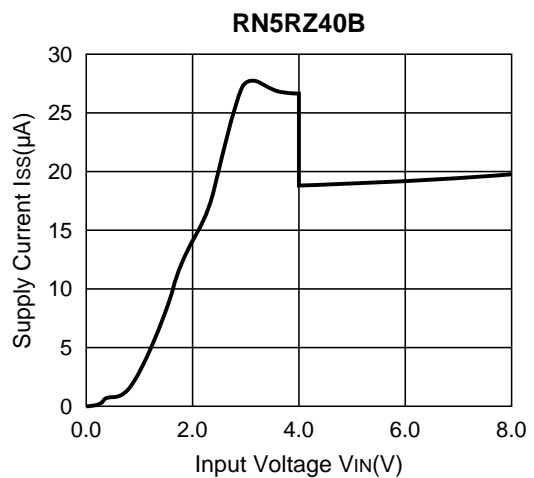
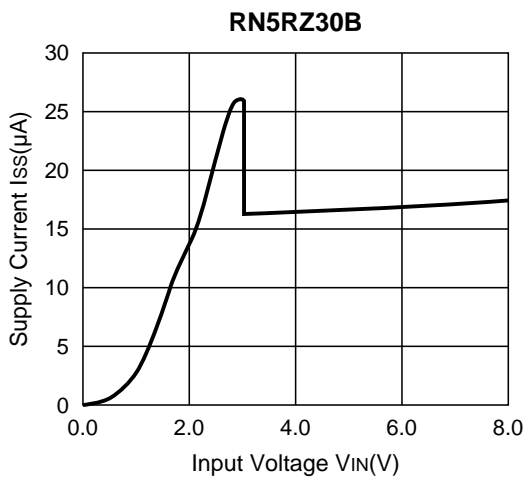
**3) Dropout Voltage vs. Output Current**

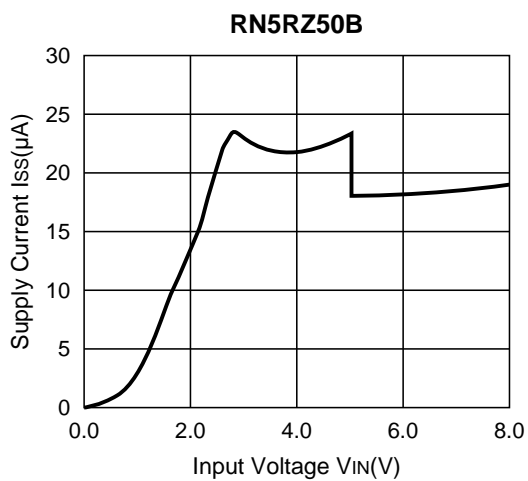


**4) Output Voltage vs. Temperature**

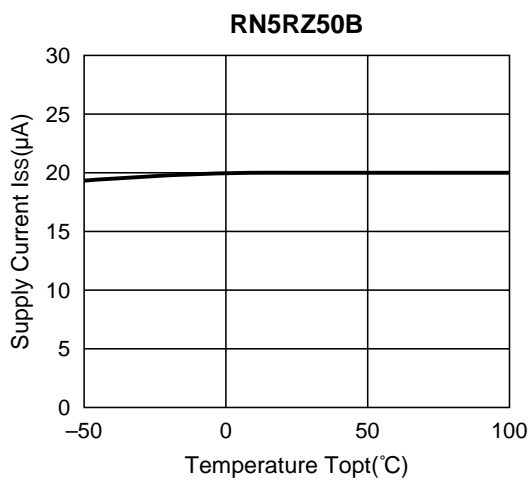
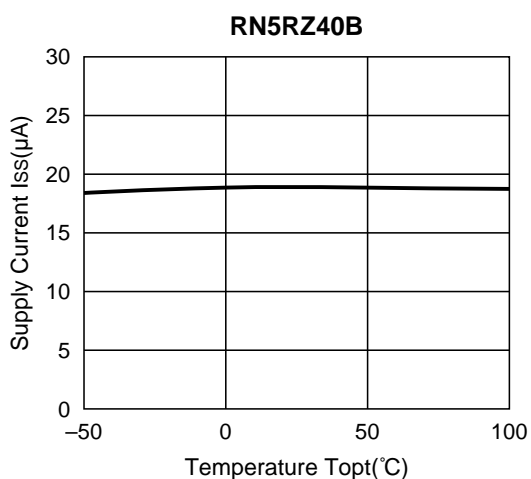
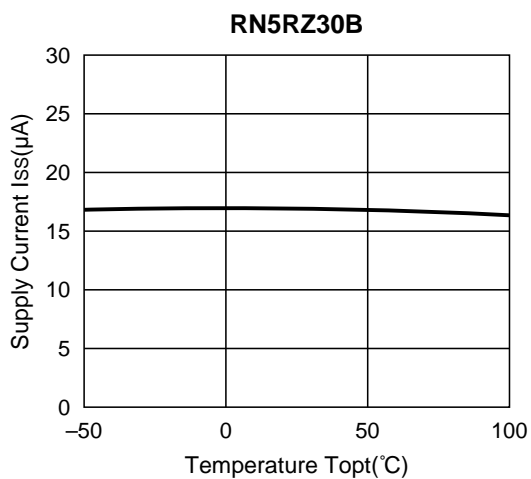


**5) Supply Current vs. Input Voltage**

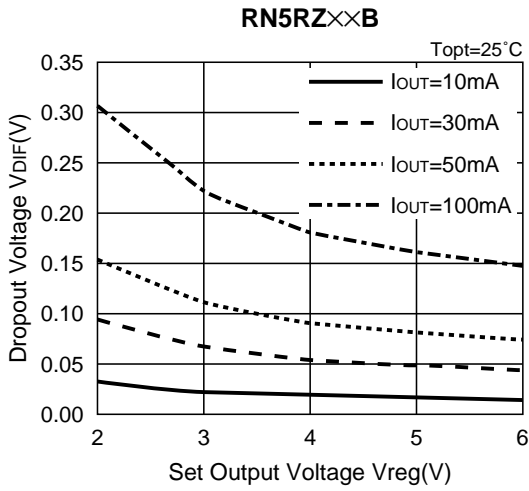




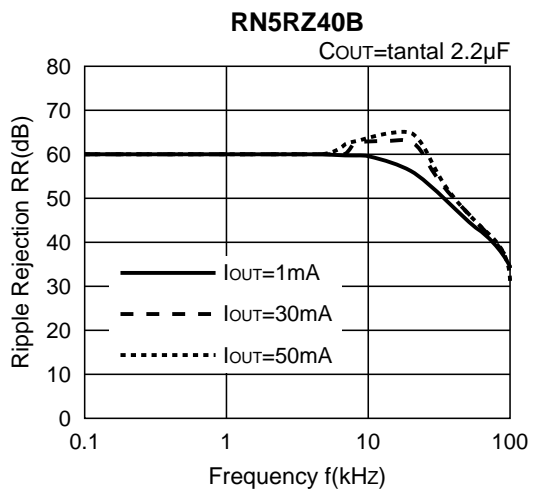
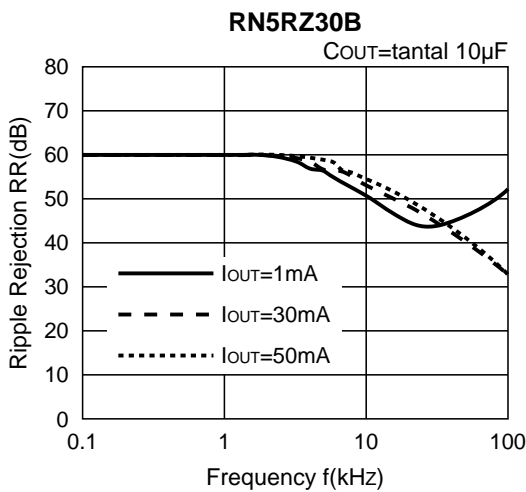
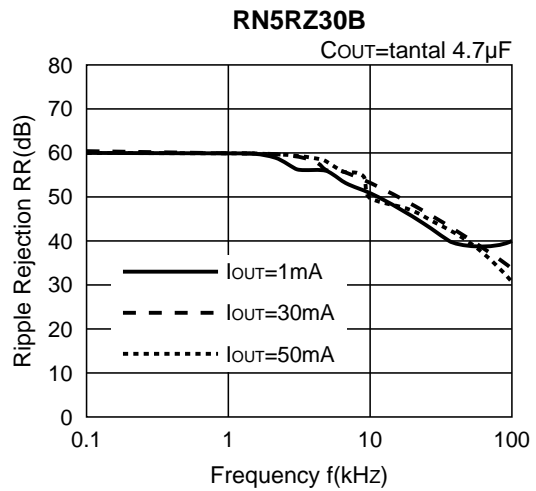
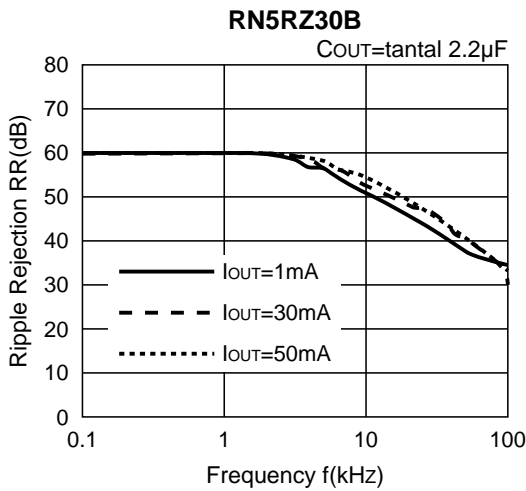
**6) Supply Current vs. Temperature**

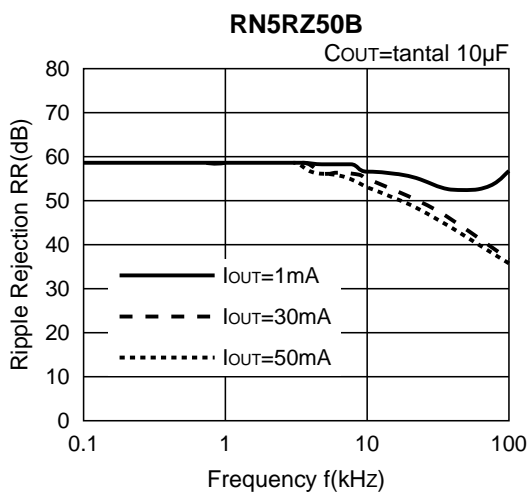
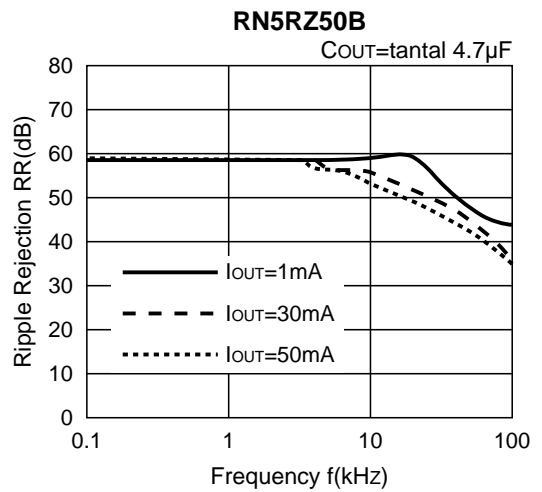
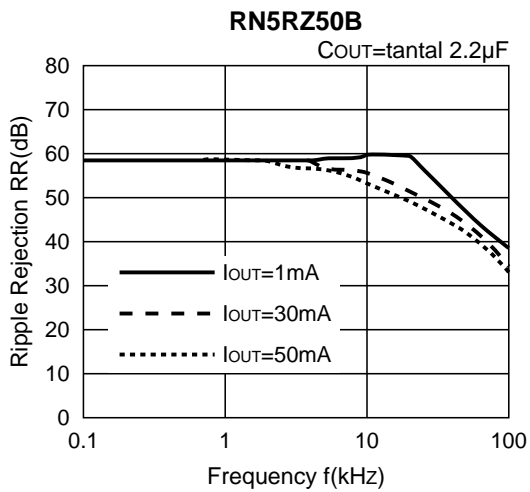
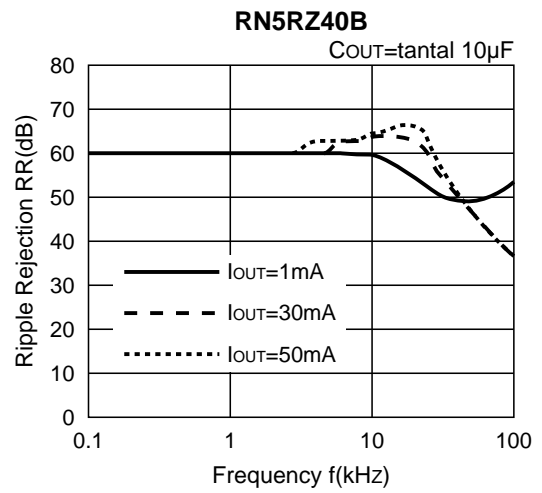
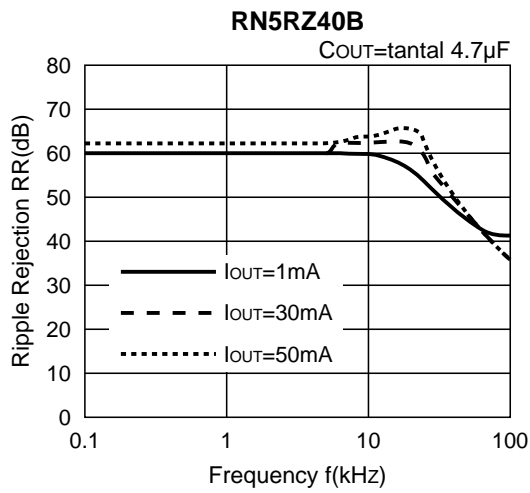


7) Dropout Voltage vs. Set Output Voltage



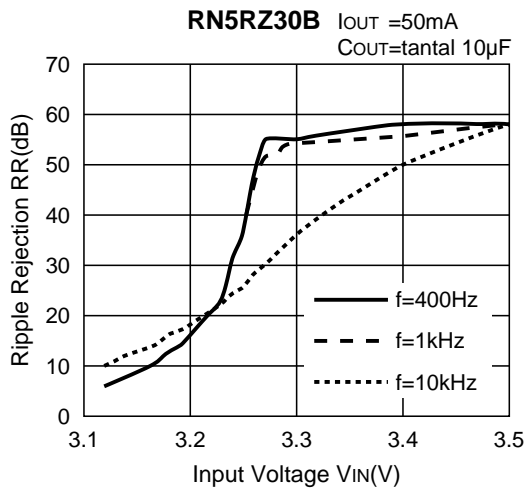
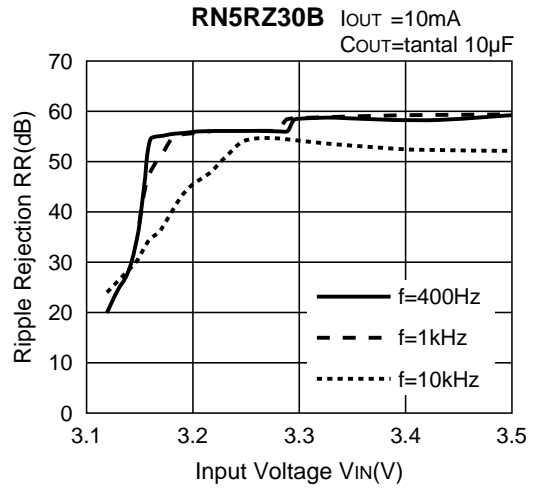
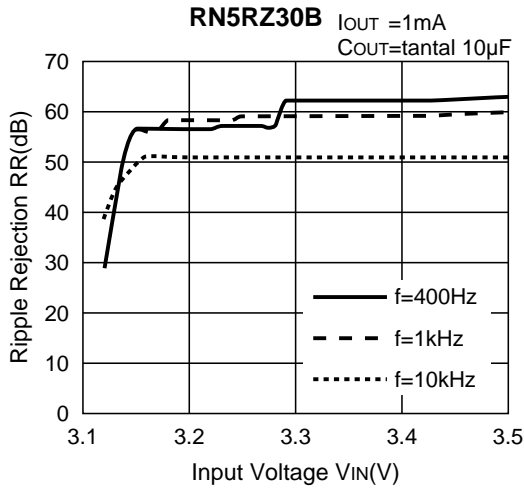
8) Ripple Rejection vs. Frequency



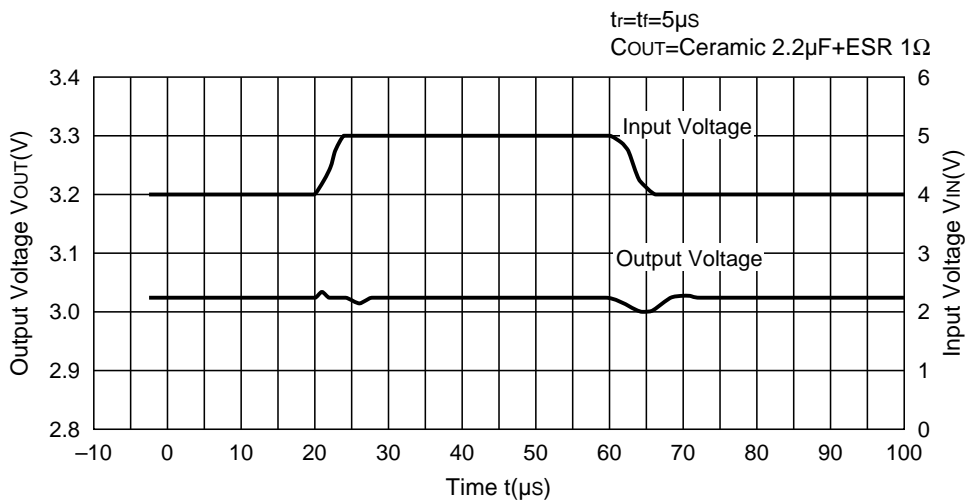


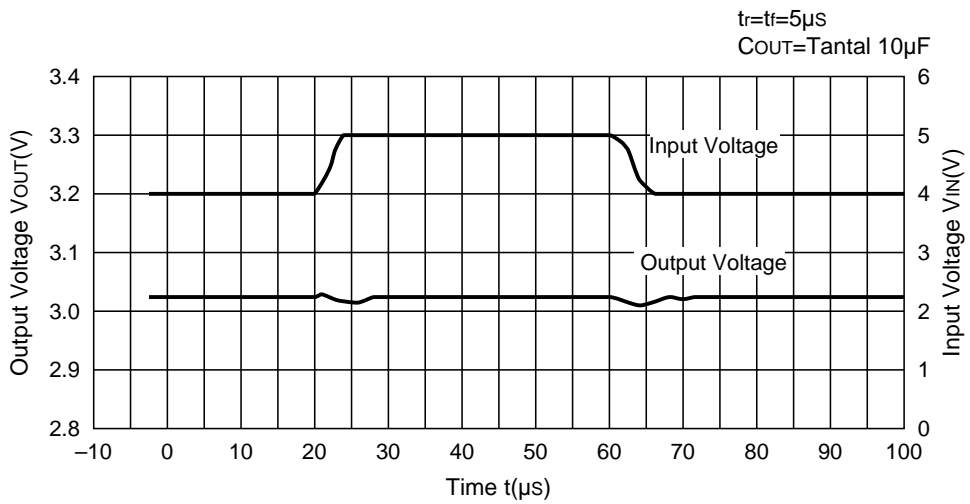
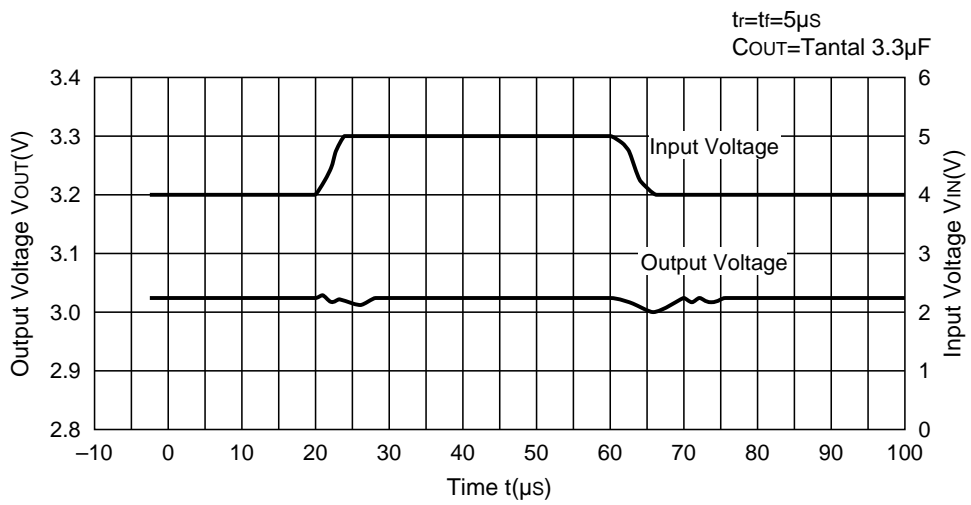


9) Ripple Rejection vs. Input Voltage (DC bias)

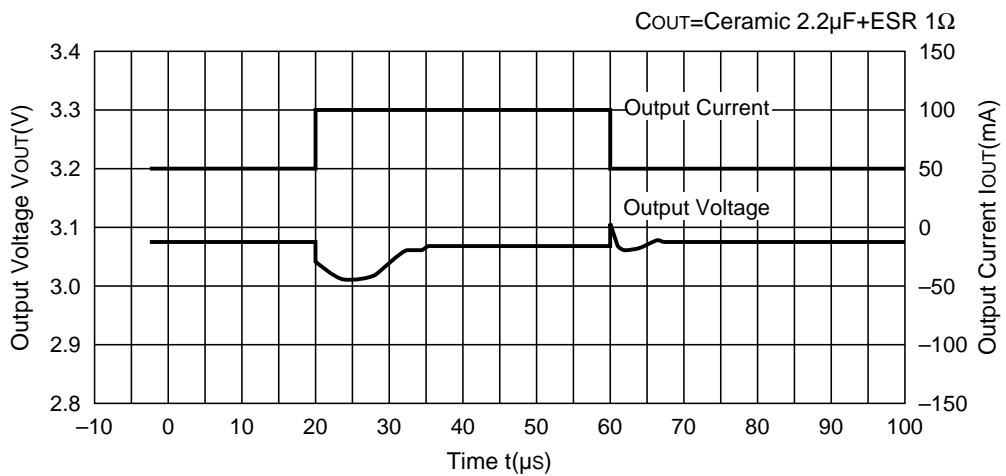


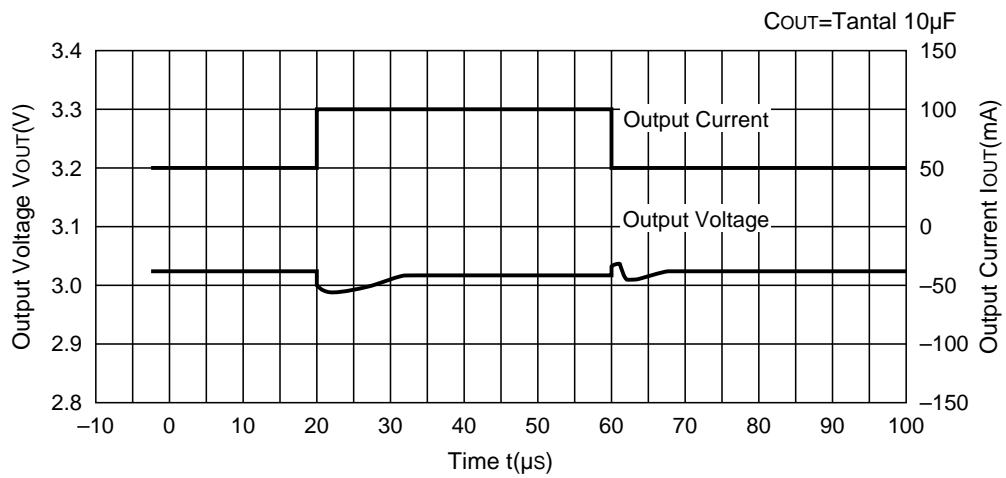
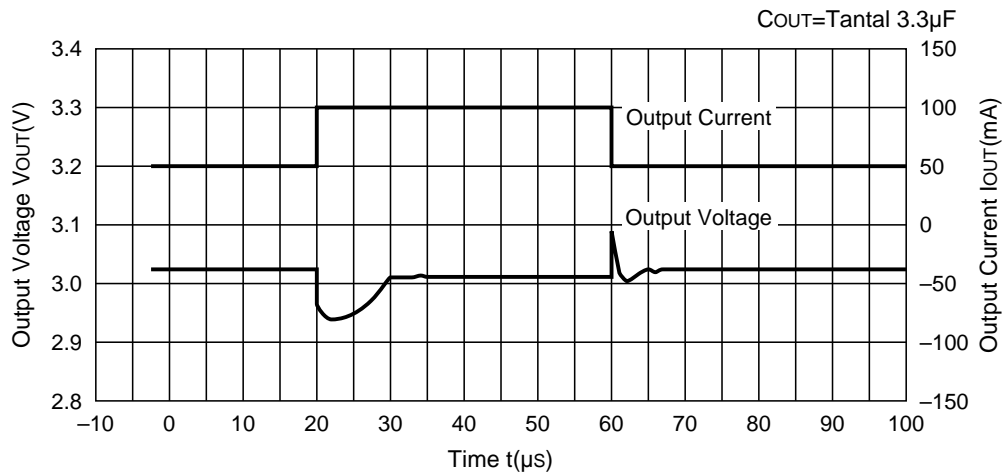
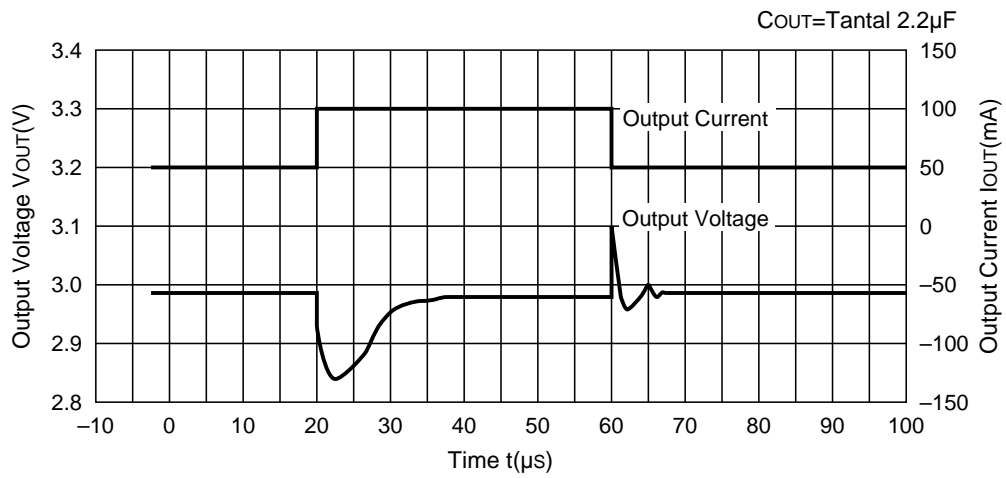
10) Line Transient Response





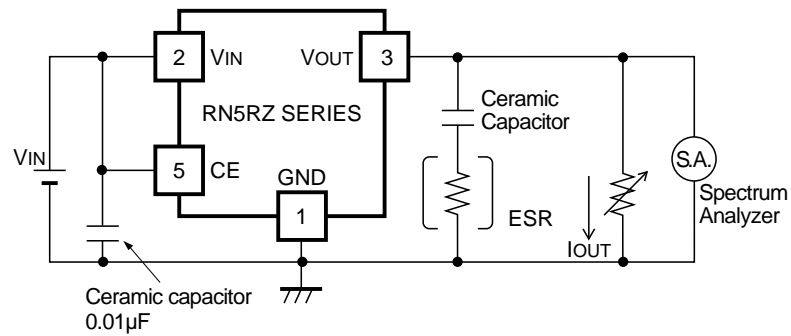
### 11) Load Transient Response





## FOR STABLE OPERATION

• Countermeasure for Noise



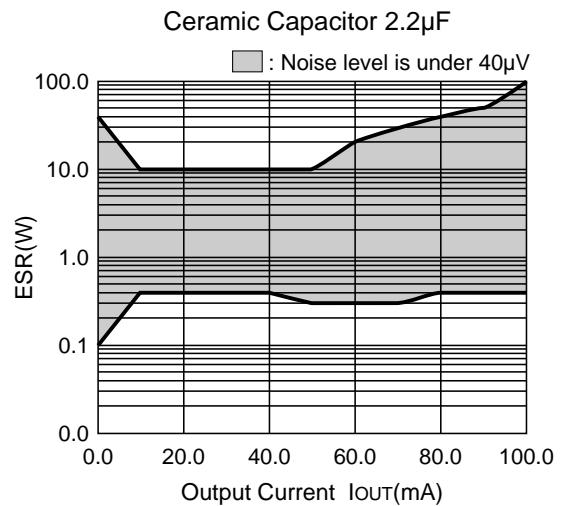
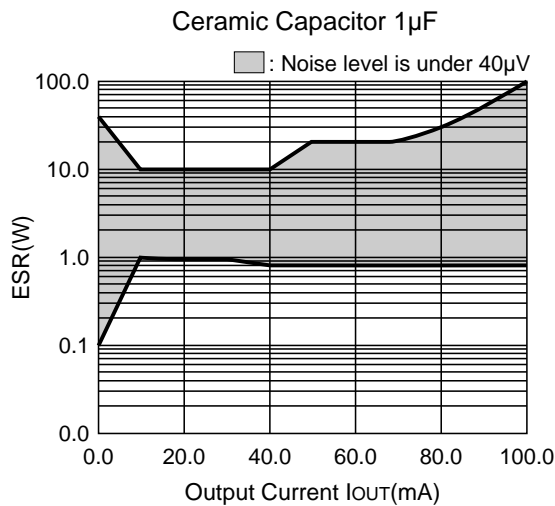
Measuring circuit for white noise ; RN5RZ30B

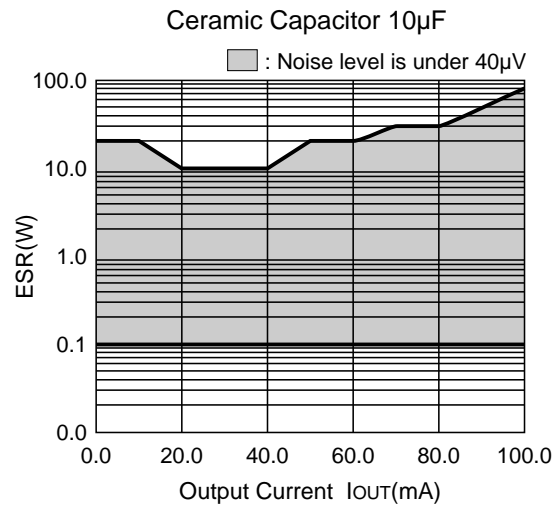
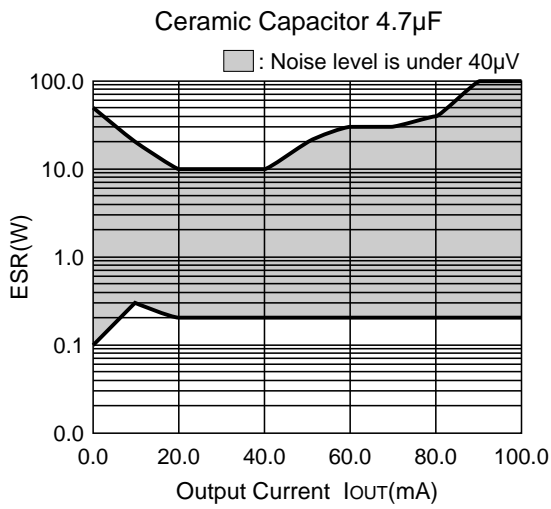
The relation between output current ( $I_{OUT}$ ) and Equivalent Series Resistance (ESR) in the output capacitor are described below. The conditions when the noise level is under  $40\mu V$  (Avg.) are marked as the hatched area in the graph.

[Measuring conditions]

Frequency band : 0Hz to 1MHz

Temperature : 25°C





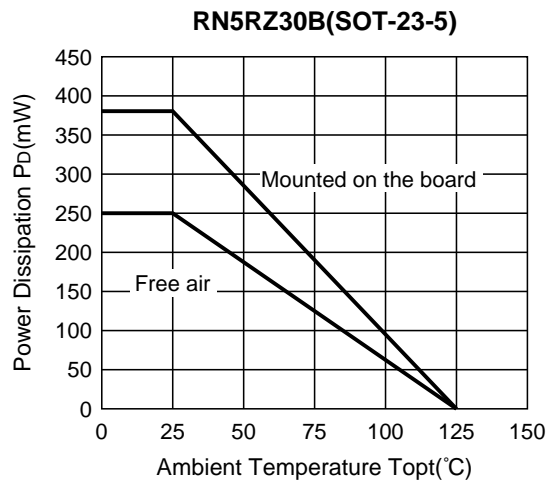
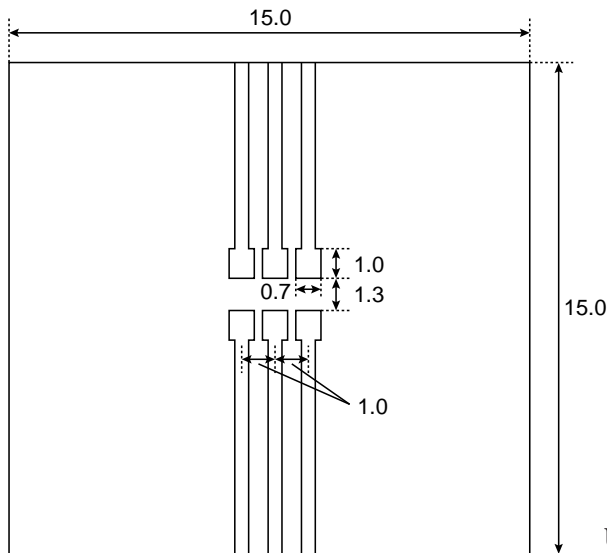
APPLICATION HINTS

When using these ICs, be sure to take care regarding the following points :

- 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<sub>OUT</sub> with good frequency characteristics and ESR in the range described above.
- Make V<sub>DD</sub> and GND line sufficient. When the impedance of these is high, the noise may be picked up or operation may become unstable.
- Connect the capacitor with a capacitance of about 1 $\mu$ F between V<sub>DD</sub> and GND with wiring as short as possible.
- Set external components as close as possible to the ICs and make wiring short.

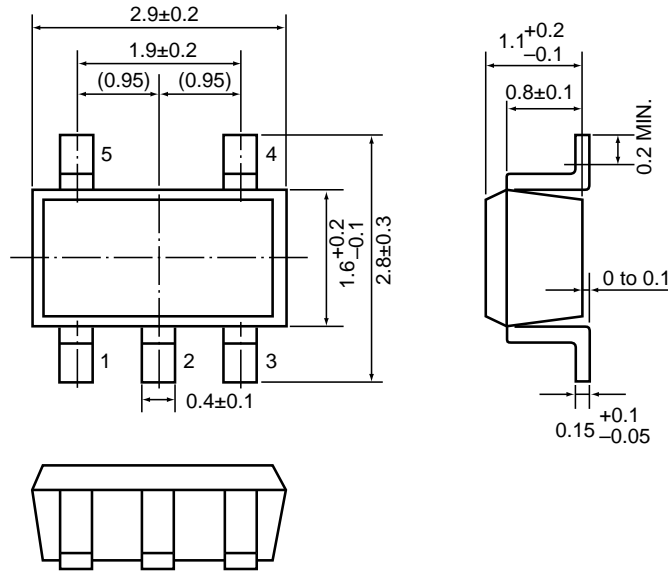
## POWER DISSIPATION

The power dissipation of RN5RZ series (SOT-23-5) is measured. The measuring conditions as follows:



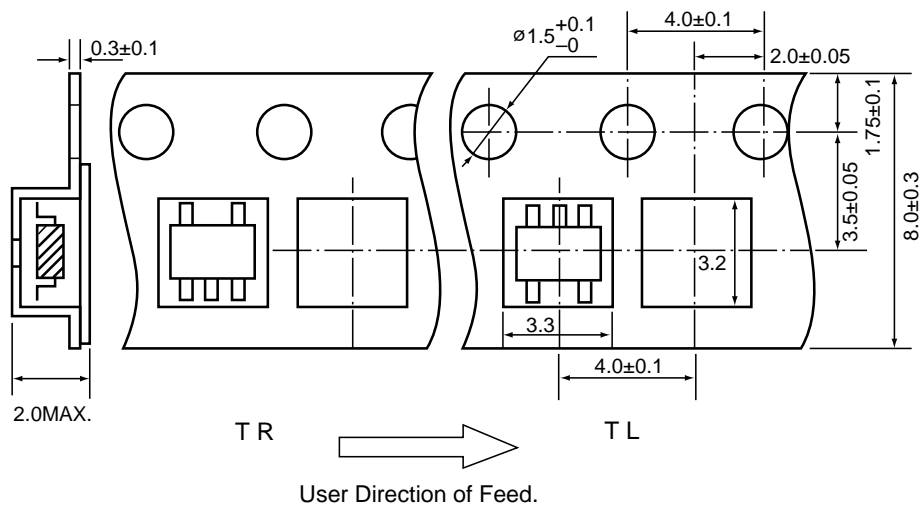
**PACKAGE DIMENSION** (Unit : mm)

• SOT-23-5



**TAPING SPECIFICATION** (Unit : mm)

• SOT-23-5





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