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## LOW DROPOUT AND LOW NOISE VOLTAGE REGULATOR

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NO. EA-039-111020

### OUTLINE

The Rx5RZ Series are CMOS-based voltage regulator ICs with high output voltage accuracy, low supply current, low dropout voltage and high ripple rejection. 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.) for A/B version. The output voltage of these ICs is fixed with high accuracy.

In addition to low supply current from CMOS process, the Rx5RZ 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 are the SOT-23-5 package and SOT-89, high density mounting of the ICs on boards is possible.

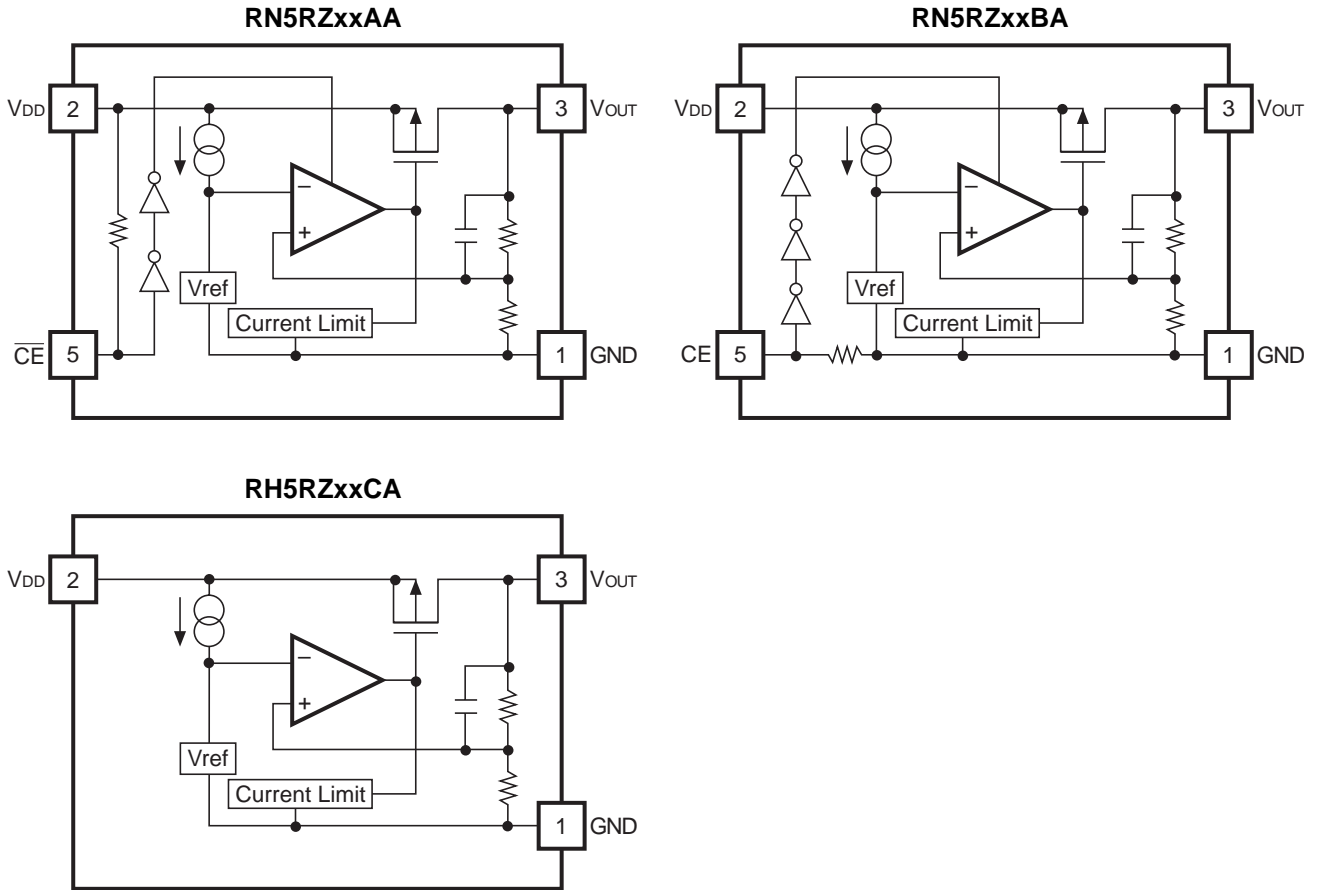
### FEATURES

- Supply Current ..... Typ. 20 $\mu$ A
- Supply Current (Standby) ..... Typ. 0.1 $\mu$ A
- Output Voltage Accuracy..... $\pm$ 2%
- Ripple Rejection ..... Typ. 55dB (f=1kHz)
- Dropout Voltage ..... Typ. 0.2V (I<sub>OUT</sub>=60mA)
- Temperature-Drift Coefficient of Output Voltage ..... Typ.  $\pm$  100ppm/ $^{\circ}$ C
- Line Regulation ..... Typ. 0.05%/V
- Output Voltage Range..... 2.0V to 6.0V (0.1V steps)  
(For other voltages, please refer to MARK INFORMATIONS.)
- Packages ..... SOT-23-5 (Mini-mold), SOT-89 (Mini-power Mold)
- Built-in Fold-Back Protection Circuit ..... Current limit Typ. 50mA

### APPLICATIONS

- Power source for battery-powered equipment
- Power source for hand-held communication equipment, cameras, and VCRs
- Power source for home appliances

## BLOCK DIAGRAMS



## SELECTION GUIDE

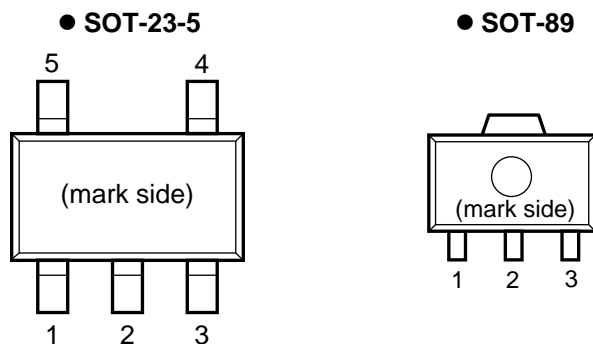
The output voltage and package for the ICs can be selected at the user's request.

| Product Name    | Package  | Quantity per Reel | Pb Free | Halogen Free |
|-----------------|----------|-------------------|---------|--------------|
| RN5RZxx*A-TR-FE | SOT-23-5 | 3,000 pcs         | Yes     | Yes          |
| RH5RZxxCA-T1-FE | SOT-89   | 1,000 pcs         | Yes     | Yes          |

xx: The output voltage can be designated in the range from 2.0V (20) to 6.0V (60) in 0.1V steps.  
(For other voltages, please refer to MARK INFORMATIONS.)

\* : CE pin polarity are options as follows  
 (A) "L" active  
 (B) "H" active  
 (C) without chip enable

## PIN CONFIGURATION



## PIN DESCRIPTION

### ● SOT-23-5

| Pin No | Symbol                       | Pin Description                   |
|--------|------------------------------|-----------------------------------|
| 1      | GND                          | Ground Pin                        |
| 2      | V <sub>DD</sub>              | Input Pin                         |
| 3      | V <sub>OUT</sub>             | Output Pin                        |
| 4      | NC                           | No Connection (Only RN5RZxxA/B)   |
| 5      | $\overline{\text{CE}}$ or CE | Chip Enable Pin (Only RN5RZxxA/B) |

### ● SOT-89

| Pin No | Symbol           | Pin Description |
|--------|------------------|-----------------|
| 1      | GND              | Ground Pin      |
| 2      | V <sub>IN</sub>  | Input Pin       |
| 3      | V <sub>OUT</sub> | Output Pin      |

## ABSOLUTE MAXIMUM RATINGS

| Symbol    | Item                                   | Rating               | Unit |
|-----------|--|----------------------|------|
| $V_{IN}$  | Input Voltage                          | 9.0                  | V    |
| $V_{CE}$  | Input Voltage ( $\overline{CE}$ or CE) | -0.3 to $V_{IN}+0.3$ | V    |
| $V_{OUT}$ | Output Voltage                         | -0.3 to $V_{IN}+0.3$ | V    |
| $I_{OUT}$ | Output Current                         | 150                  | mA   |
| $P_D$     | Power Dissipation* (SOT-23-5)          | 420                  | mW   |
|           | Power Dissipation* (SOT-89)            | 900                  |      |
| $T_{opt}$ | Operating Temperature Range            | -40 to 85            | °C   |
| $T_{stg}$ | Storage Temperature Range              | -55 to 125           | °C   |

\*) For Power Dissipation, please refer to PACKAGE INFORMATION.

### ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field.

The functional operation at or over these absolute maximum ratings is not assured.

### RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

## ELECTRICAL CHARACTERISTICS

## • RN5RZxxA 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<br>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<br>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<br>V <sub>OUT</sub> +0.5V≤V <sub>IN</sub> ≤8.0V                 |       | 0.05 | 0.20  | %/V    |
| RR                                      | Ripple Rejection                          | f=1kHz, Ripple 0.5V <sub>rms</sub><br>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<br>Temperature Coefficient | I <sub>OUT</sub> =30mA<br>-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-up Resistance                     |  | 2.5   | 5.0  | 10.0  | MΩ     |
| V <sub>CEH</sub>                        | CE Input Voltage "H"                      |  | 1.5   |      |       | V      |
| V <sub>CEL</sub>                        | CE Input Voltage "L"                      |  | 0.00  |      | 0.25  | V      |

## • RN5RZxxB Series

T<sub>opt</sub>=25°C

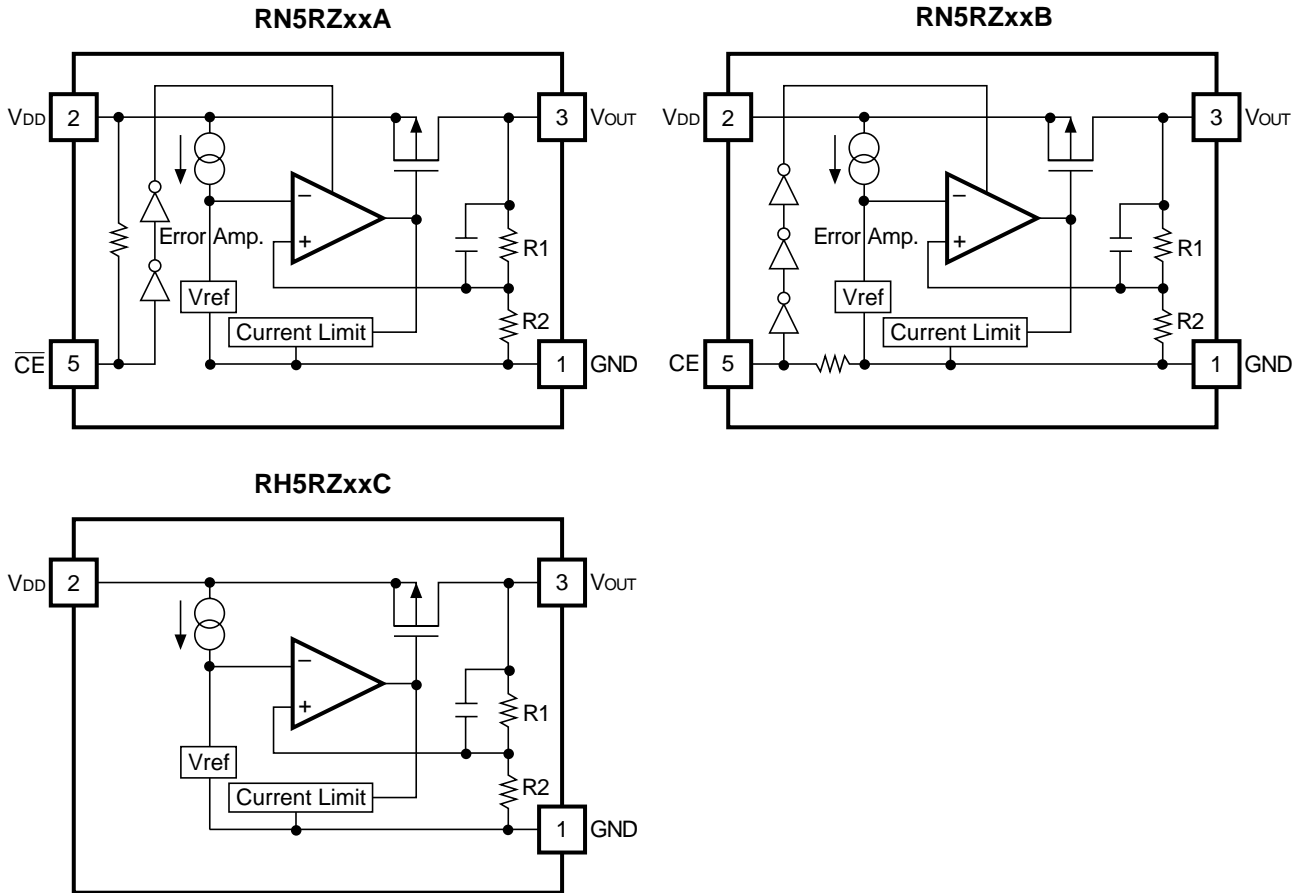
| Symbol                                  | Item                                      | Conditions   | Min.  | Typ. | Max.  | Unit   |
|---|---|--|-------|------|-------|--------|
| V <sub>OUT</sub>                        | Output Voltage                            | V <sub>IN</sub> =V <sub>OUT</sub> +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<br>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<br>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<br>V <sub>OUT</sub> +0.5V≤V <sub>IN</sub> ≤8.0V                 |       | 0.05 | 0.20  | %/V    |
| RR                                      | Ripple Rejection                          | f=1kHz, Ripple 0.5V <sub>rms</sub><br>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<br>Temperature Coefficient | I <sub>OUT</sub> =30mA<br>-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   | 5.0  | 10.0  | MΩ     |
| V <sub>CEH</sub>                        | CE Input Voltage "H"                      |  | 1.5   |      |       | V      |
| V <sub>CEL</sub>                        | CE Input Voltage "L"                      |  | 0.00  |      | 0.25  | V      |

## • RH5RZxxC 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                                       | 100   |      |       | mA     |
| $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$ | Load Regulation                           | V <sub>IN</sub> =V <sub>OUT</sub> +1V<br>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     |
| $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$  | Line Regulation                           | I <sub>OUT</sub> =30mA<br>V <sub>OUT</sub> +0.5V≤V <sub>IN</sub> ≤8.0V      |       | 0.05 | 0.20  | %/V    |
| RR                                      | Ripple Rejection                          | f=1kHz, Ripple 0.5V <sub>rms</sub><br>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<br>Temperature Coefficient | I <sub>OUT</sub> =30mA<br>-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     |

## OPERATION



In these ICs, the 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 protection and a chip enable circuit for standby function are included.

## TEST CIRCUITS

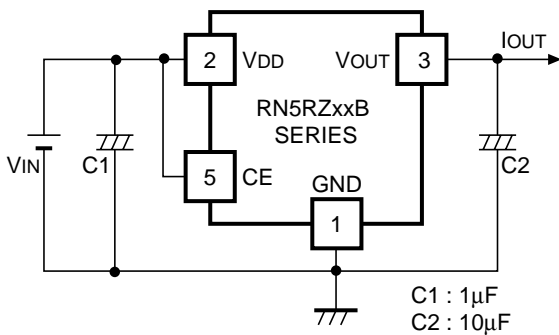


Fig.1 Standard Test Circuit

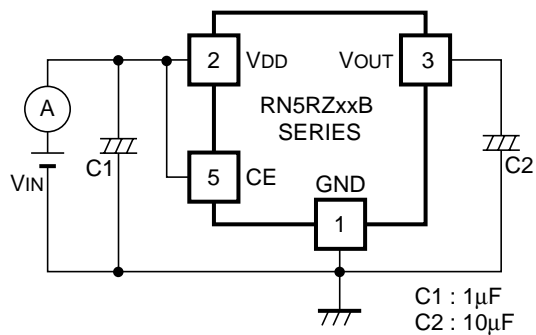
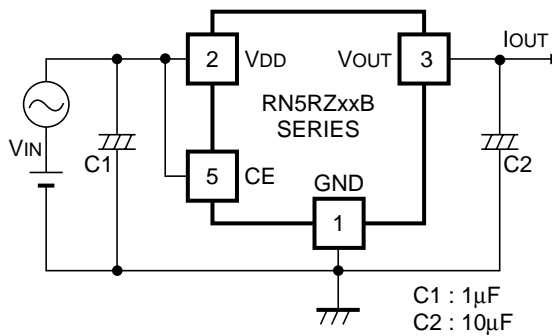
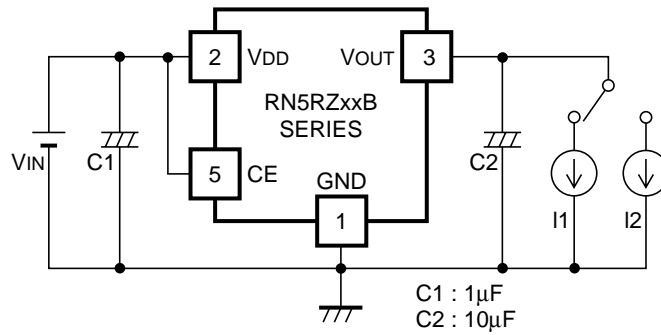
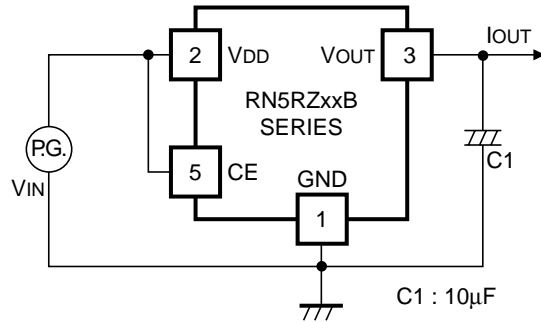


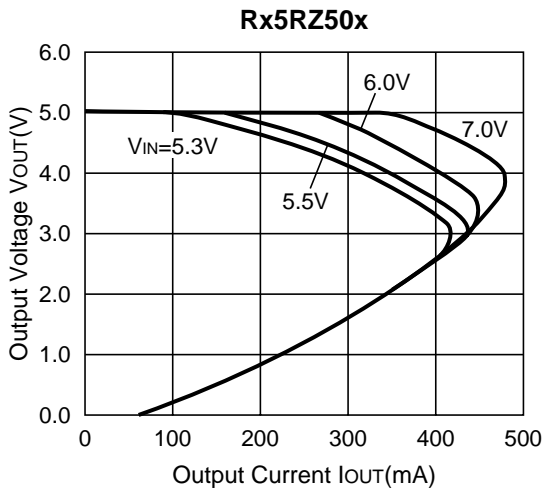
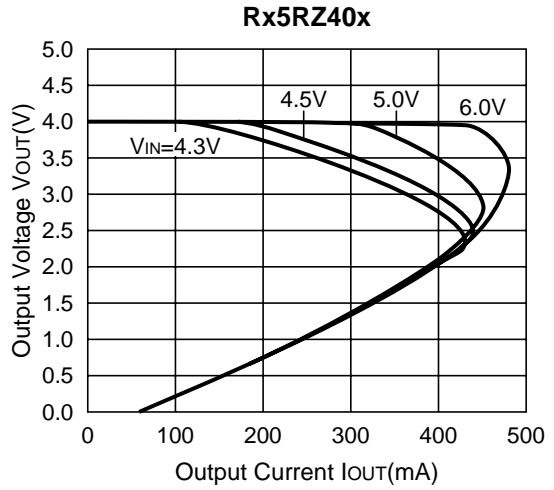
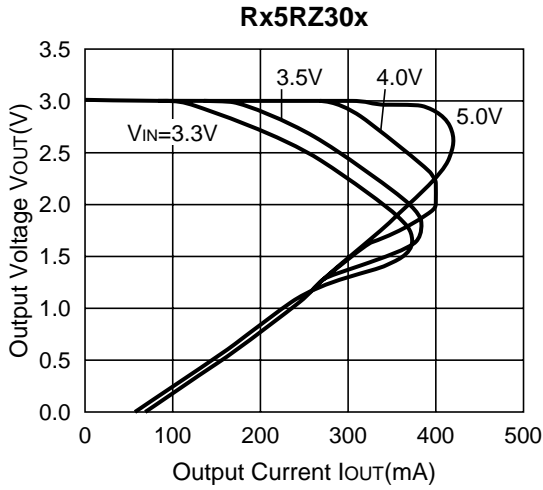
Fig.2 Supply Current Test Circuit



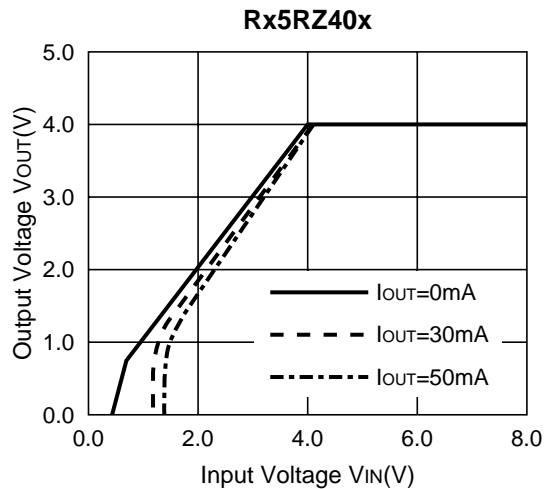
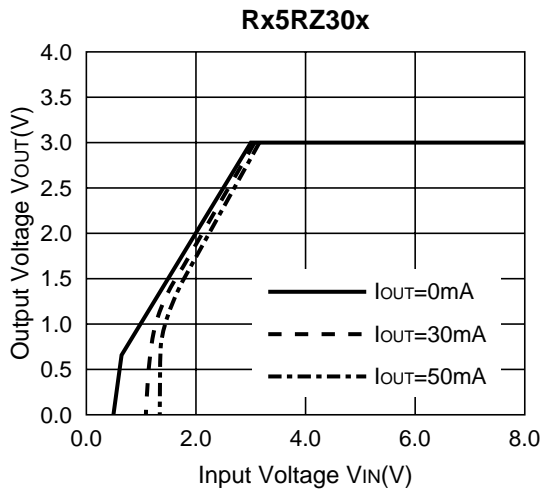


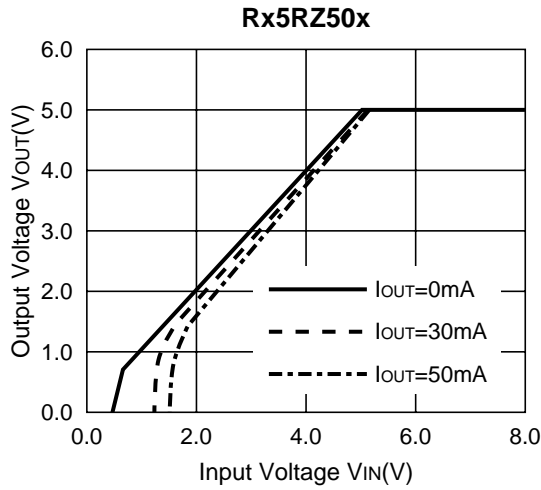
# TYPICAL CHARACTERISTICS

## 1) Output Voltage vs. Output Current

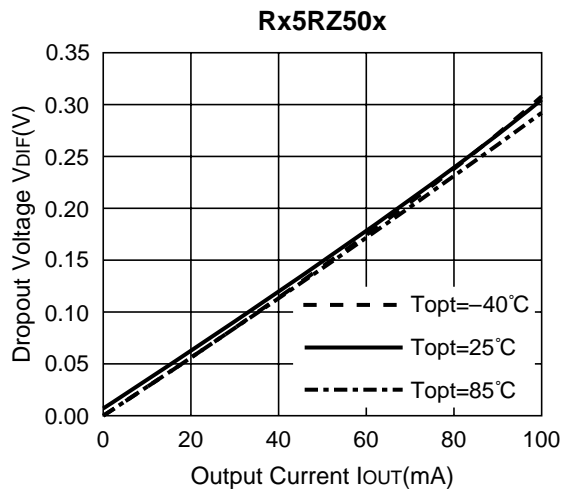
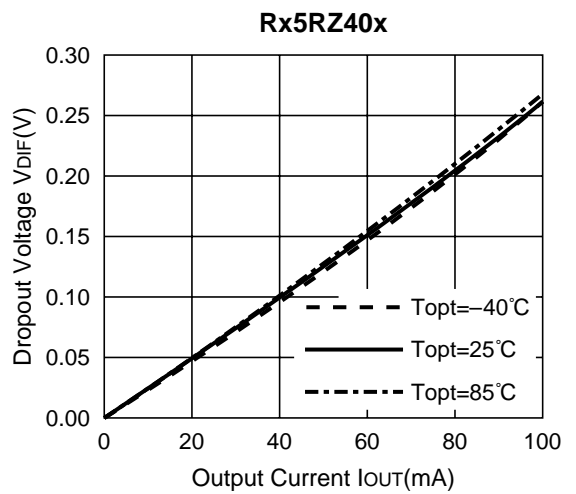
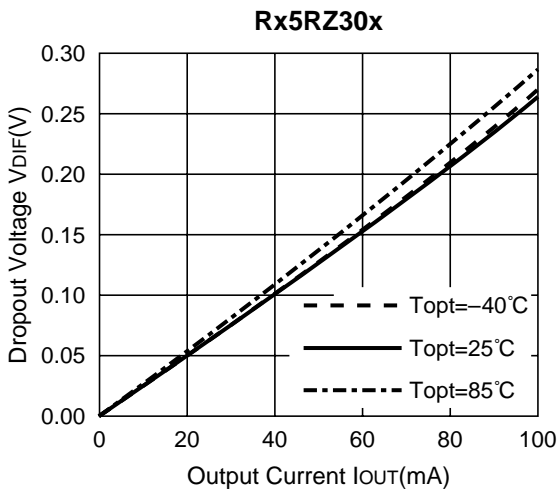


## 2) Output Voltage vs. Input Voltage

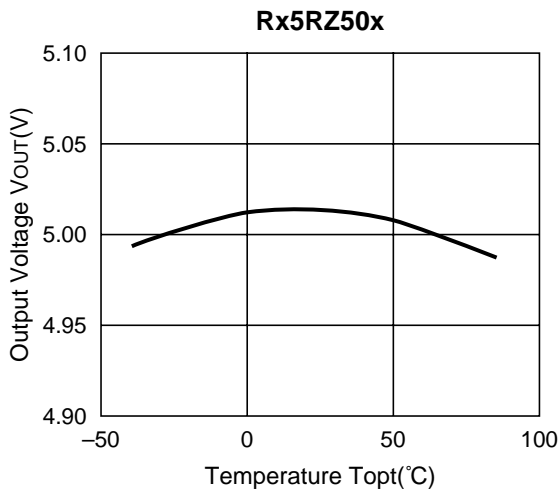
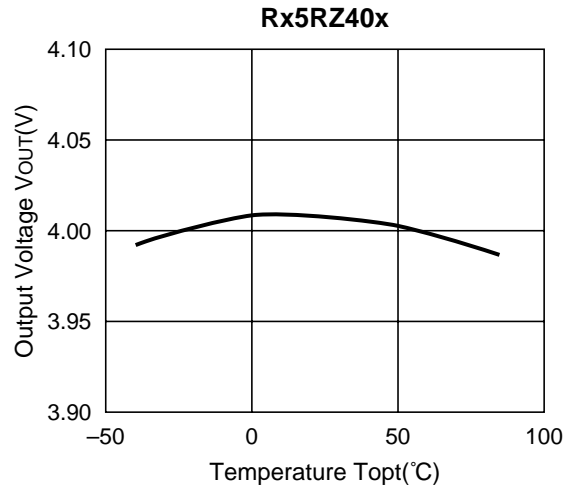
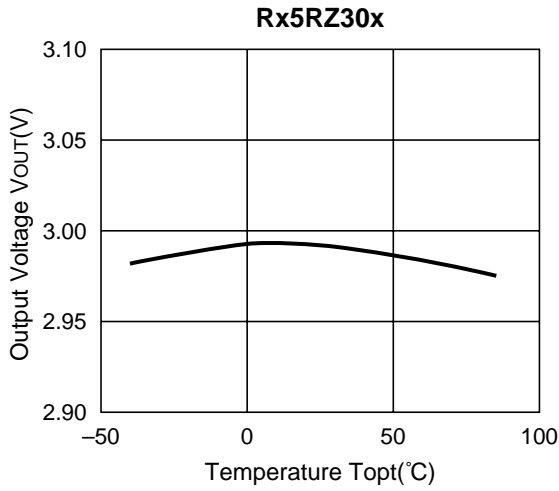




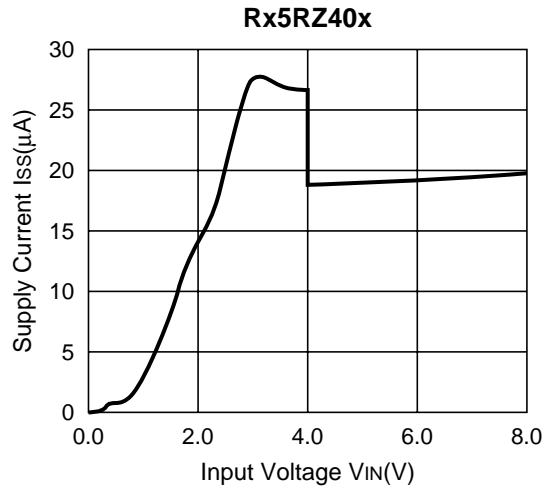
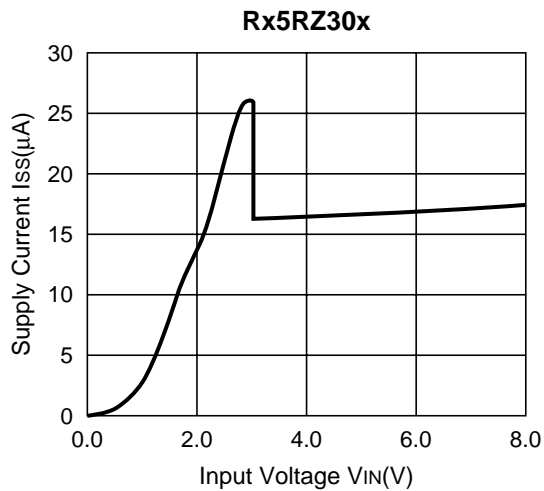
**3) Dropout Voltage vs. Output Current**

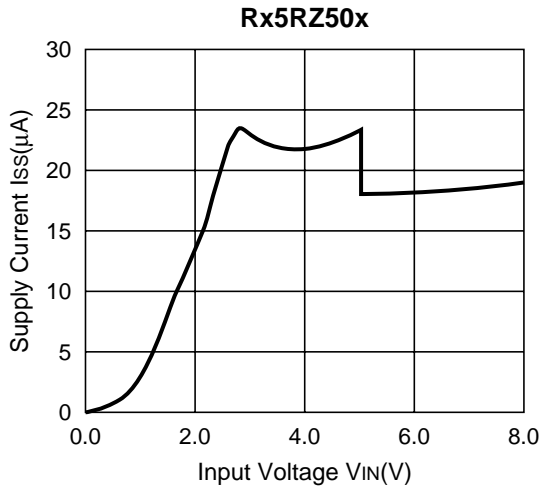


4) Output Voltage vs. Temperature

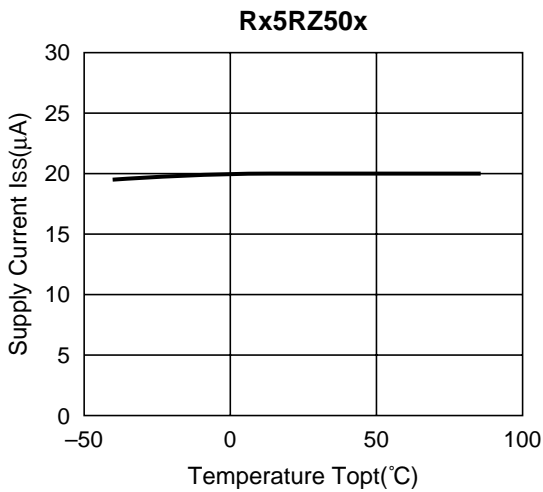
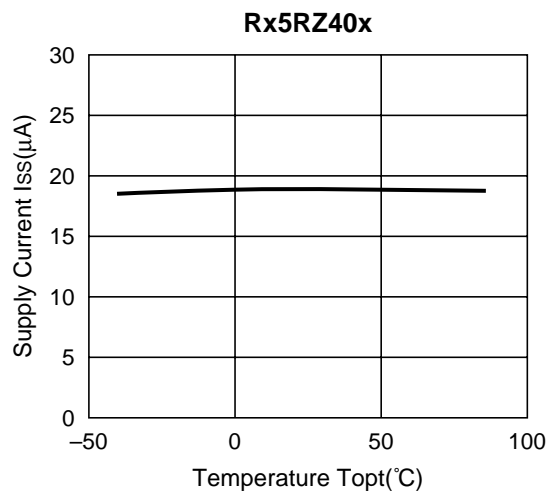
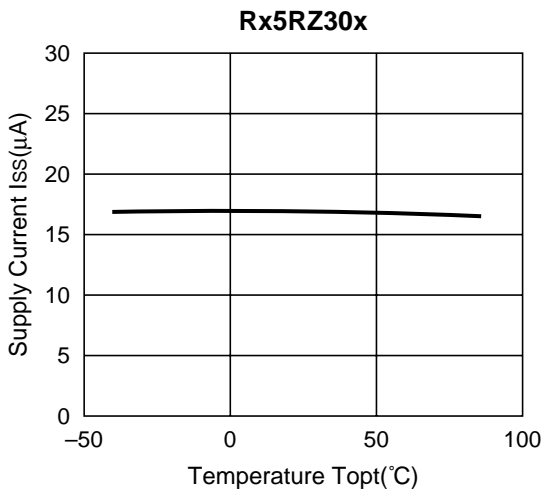


5) Supply Current vs. Input Voltage



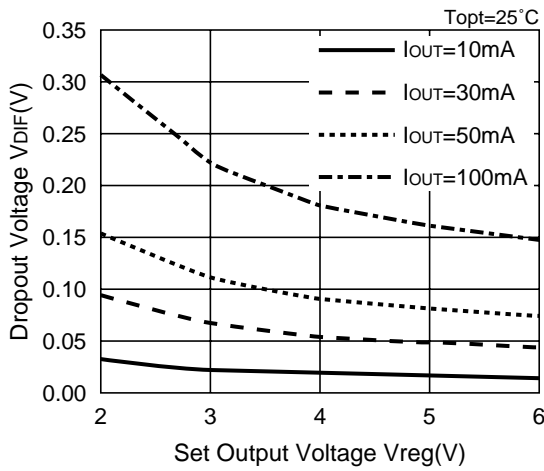


**6) Supply Current vs. Temperature**



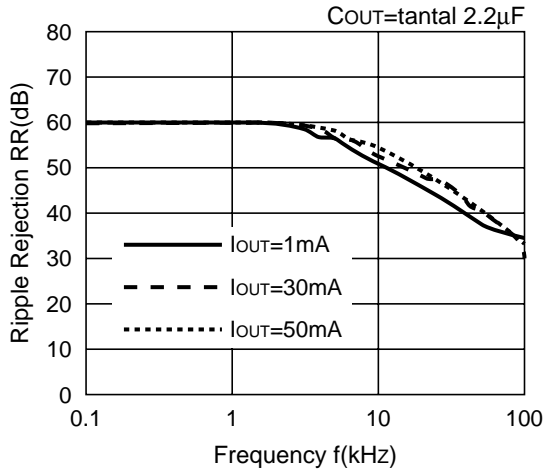
7) Dropout Voltage vs. Set Output Voltage

Rx5RZxxx

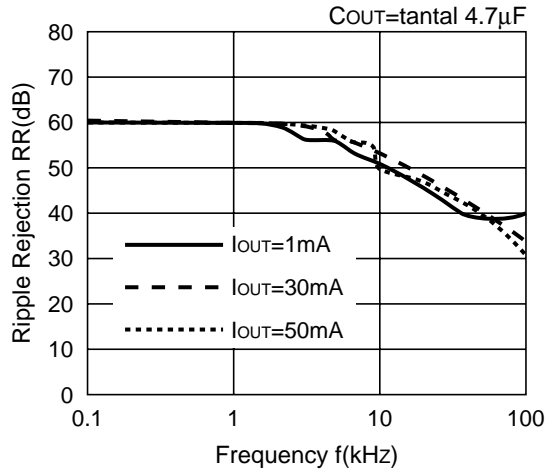


8) Ripple Rejection vs. Frequency

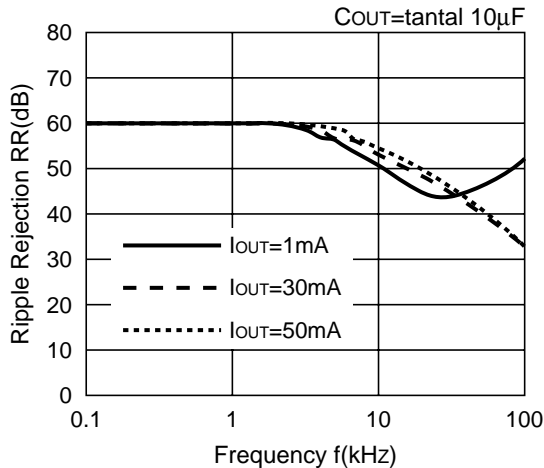
Rx5RZ30x



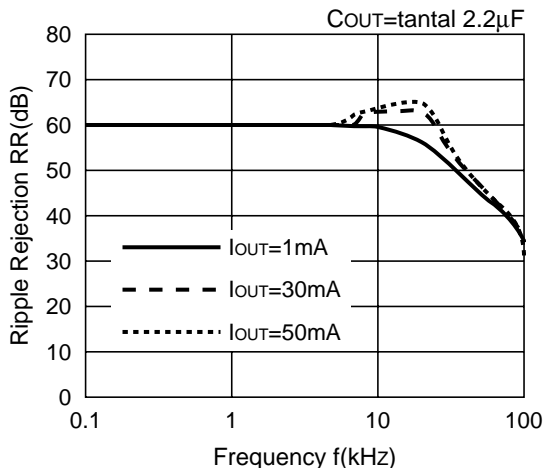
Rx5RZ30x

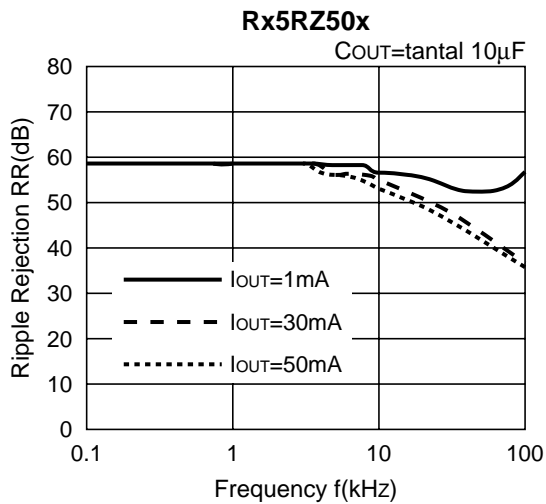
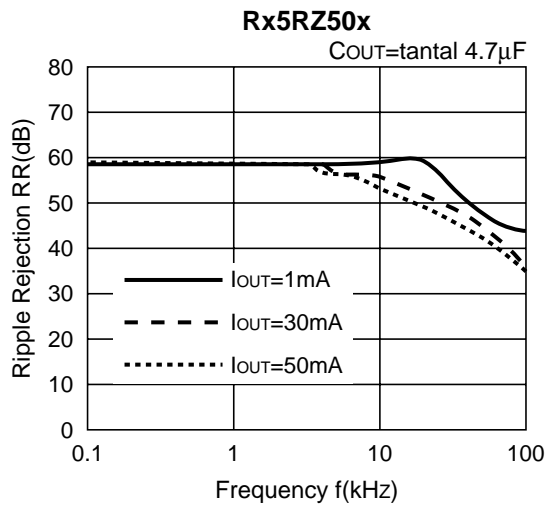
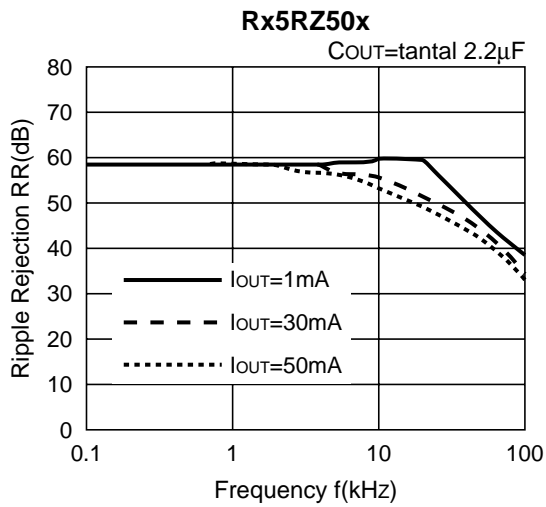
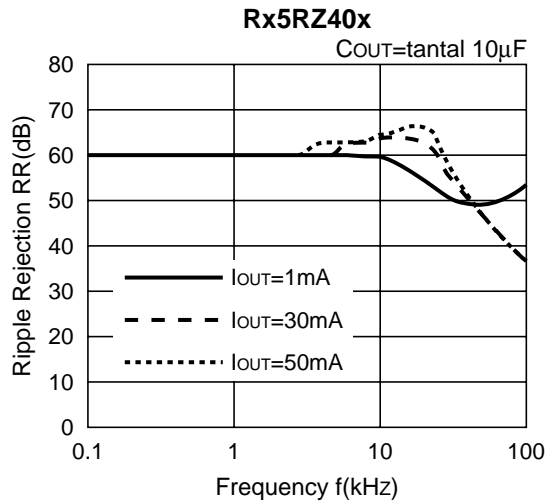
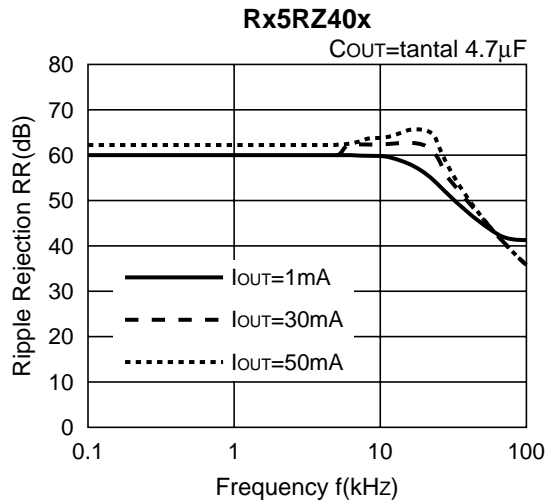


Rx5RZ30x

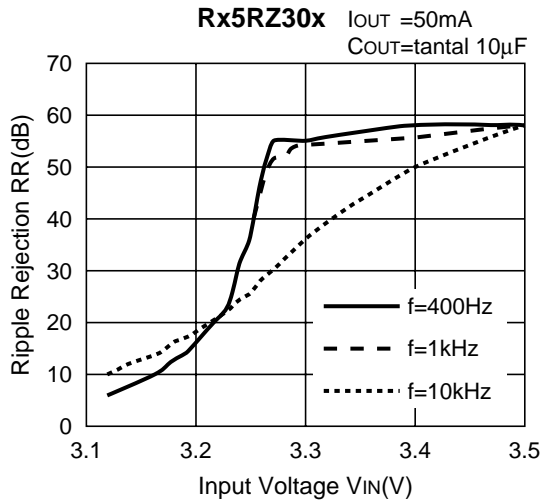
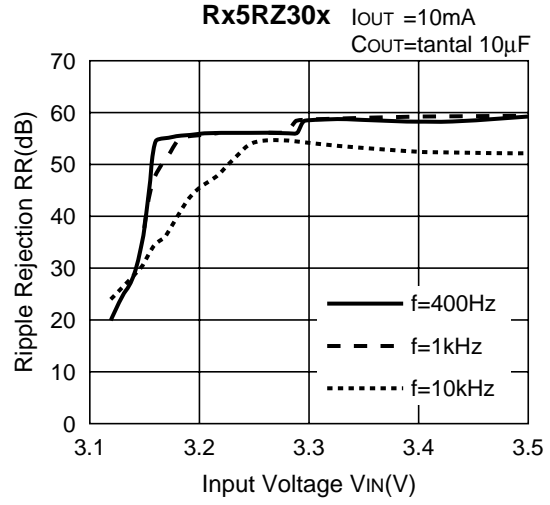
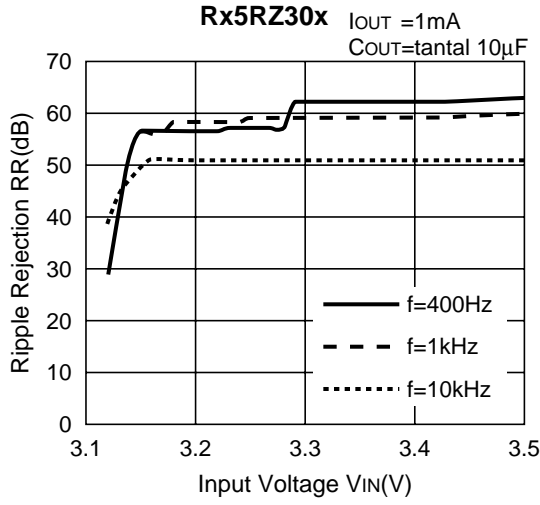


Rx5RZ40x

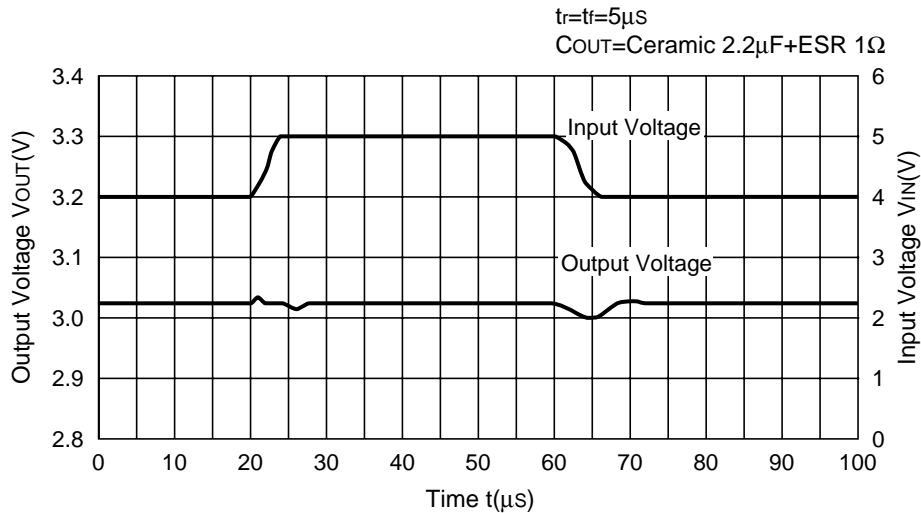


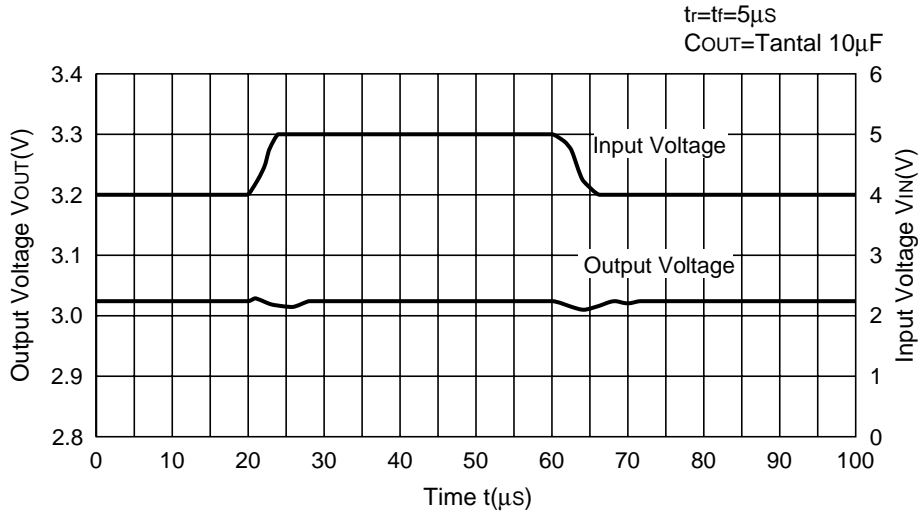
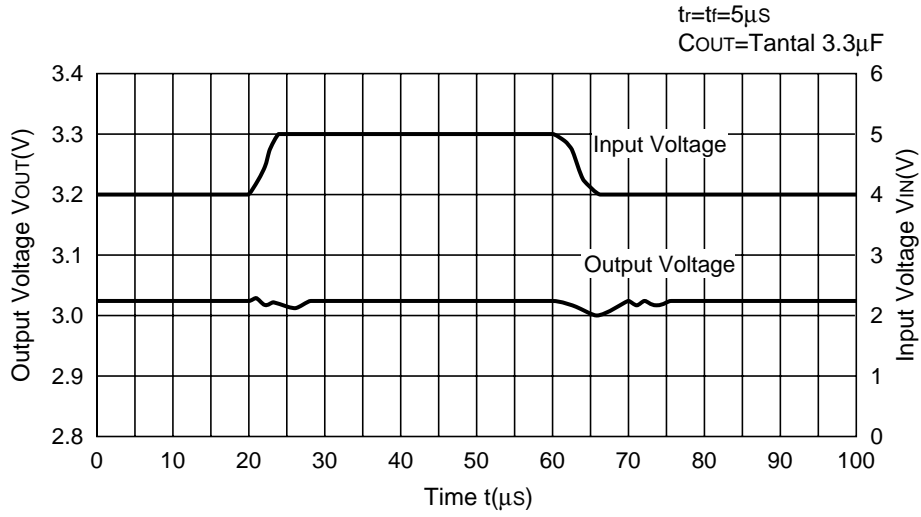


9) Ripple Rejection vs. Input Voltage (DC bias)

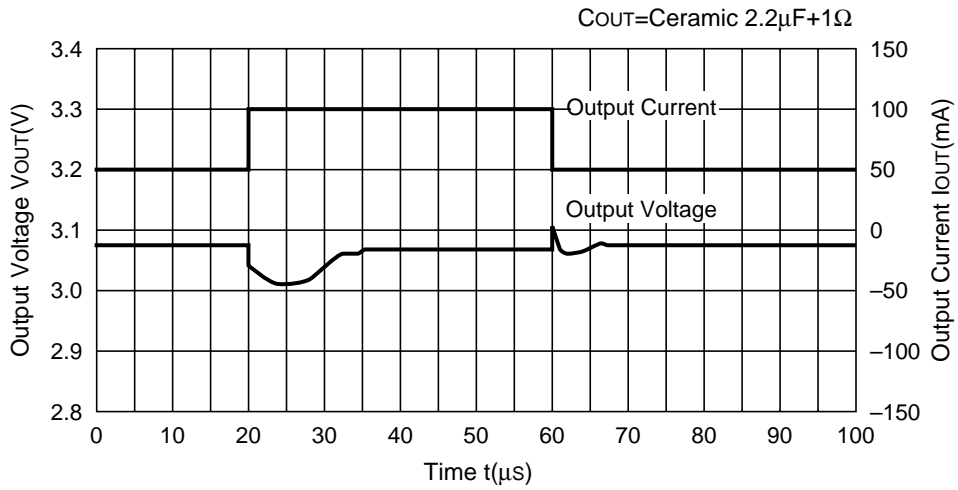


10) Line Transient Response

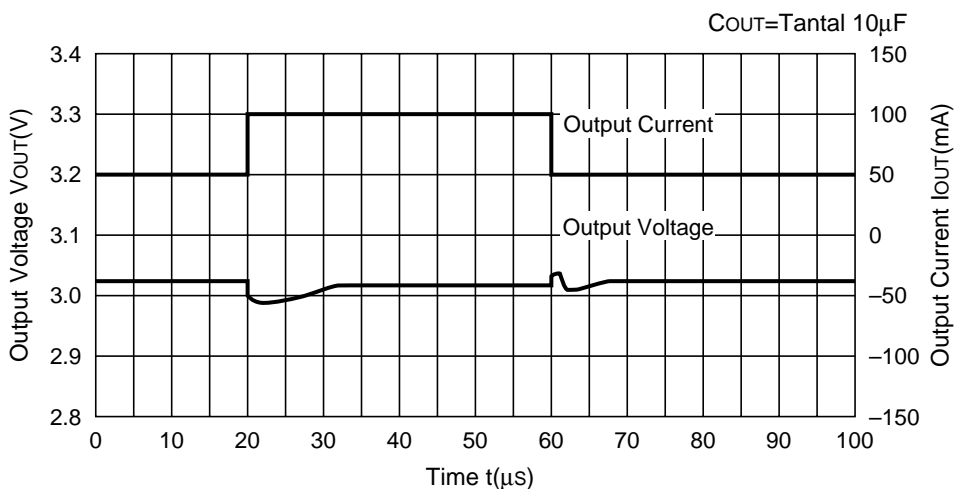
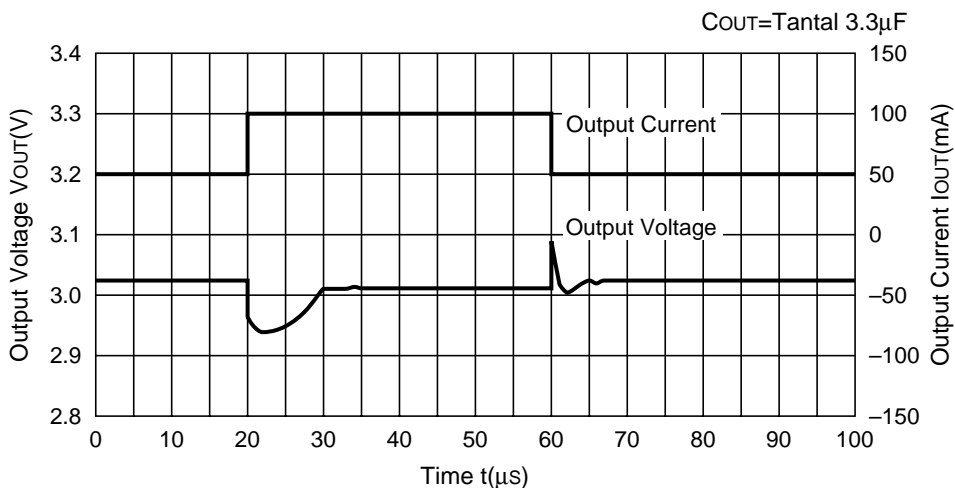
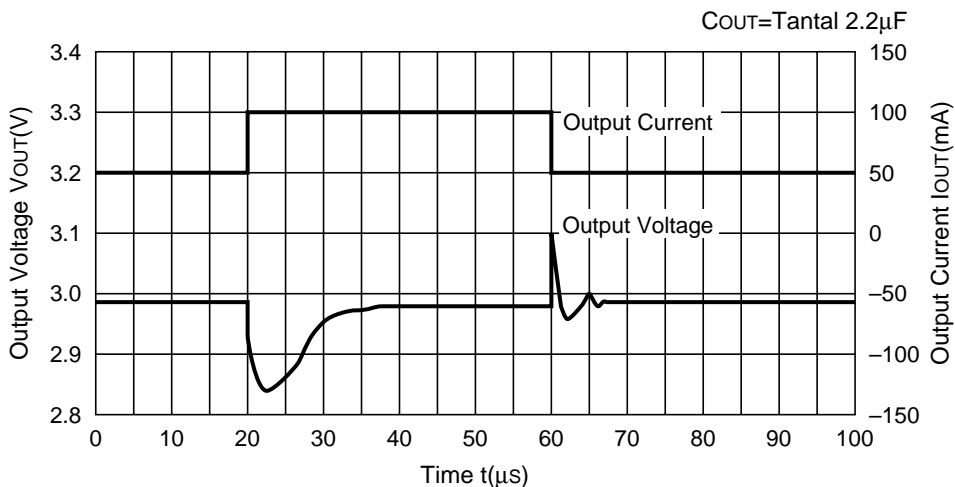




**11) Load Transient Response**

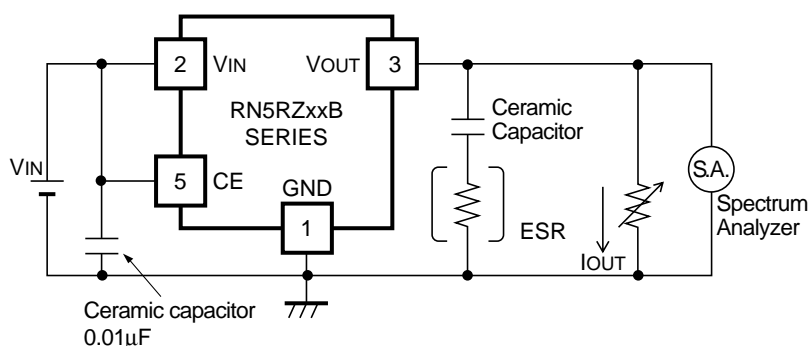






## FOR STABLE OPERATION

### • Countermeasure for Noise



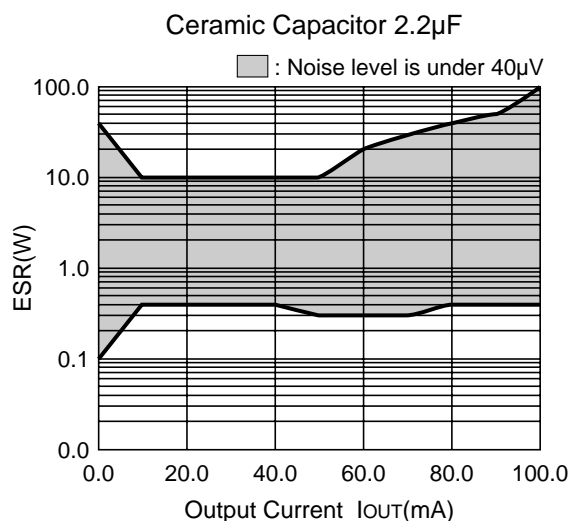
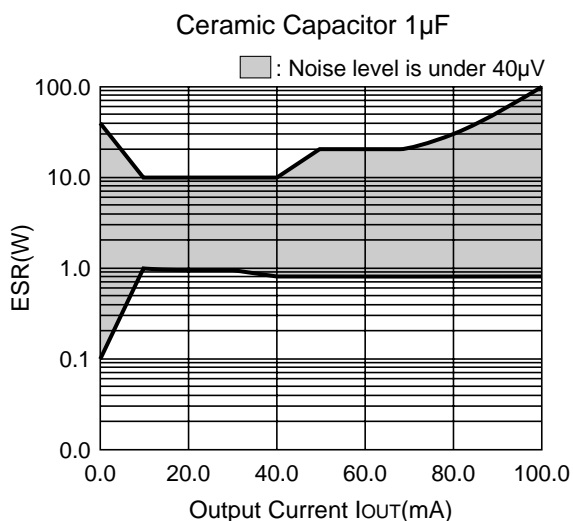
Measuring circuit for white noise ; RN5RZ30B

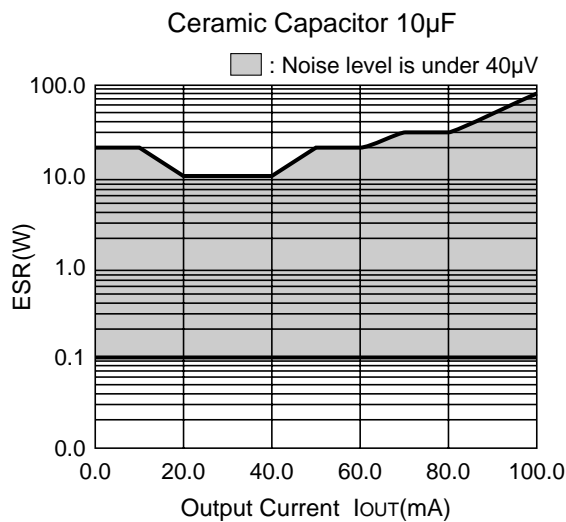
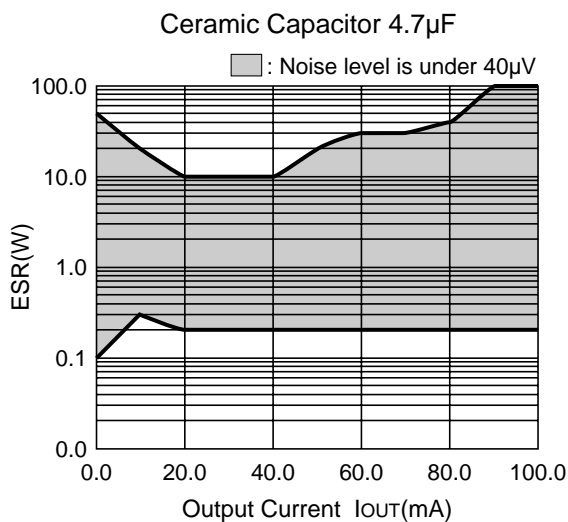
The relationship between output current ( $I_{OUT}$ ) and Equivalent Series Resistance (ESR) in the output capacitor is described in the graphs below. The conditions when the noise level is under  $40\mu\text{V}$  (Avg.) are indicated by the hatched area in the graph.

[Measuring conditions]

Frequency band : 0Hz to 1MHz

Temperature :  $25^\circ\text{C}$





## 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  $C_{OUT}$  with good frequency characteristics and ESR in the range described above.
- Make  $V_{DD}$  and GND lines sufficient. If their impedance is high, the noise picked up or unstable operation may result.
- Connect the capacitor with a capacitance of about 1 $\mu$ F between  $V_{DD}$  and GND with wiring as short as possible.
- Set external components as close as possible to the ICs and make wiring as short as possible.



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2-3, Shin-Yokohama 3-chome, Kohoku-ku, Yokohama-shi, Kanagawa, 222-8530, Japan  
Phone: +81-50-3814-7687 Fax: +81-45-474-0074

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Prof. W.H. Keesomlaan 1, 1183 DJ Amstelveen, The Netherlands  
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3F, Haesung Bldg, 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea  
Phone: +82-2-2135-5700 Fax: +82-2-2051-5713

##### **Ricoh Electronic Devices Shanghai Co., Ltd.**

Room 403, No.2 Building, No.690 Bibo Road, Pu Dong New District, Shanghai 201203,  
People's Republic of China  
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

##### **Ricoh Electronic Devices Shanghai Co., Ltd.**

##### **Shenzhen Branch**

1205, Block D (Jinlong Building), Kingkey 100, Hongbao Road, Luohu District,  
Shenzhen, China  
Phone: +86-755-8348-7600 Ext 225

##### **Ricoh Electronic Devices Co., Ltd.**

##### **Taipei office**

Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)  
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623

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