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## 150mA ULTRA LOW SUPPLY CURRENT LDO REGULATOR

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NO.EA-150-130417

### OUTLINE

The RP104x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, extremely low supply current and low ON-resistance. Each of these ICs consists of a voltage reference unit, an error amplifier, resistor-net for voltage setting, a current limit circuit and a chip enable circuit.

These ICs perform with ultra low supply current (Typ.1.0 $\mu$ A), which prolong the battery life.

Since the packages for these ICs are DFN(PLP)1010-4, SOT-23-5 and SC-82AB (**Non-promotion**), therefore high density mounting of the ICs on boards is possible.

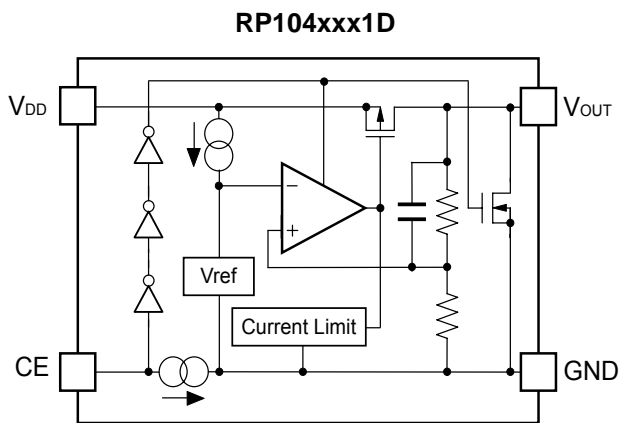
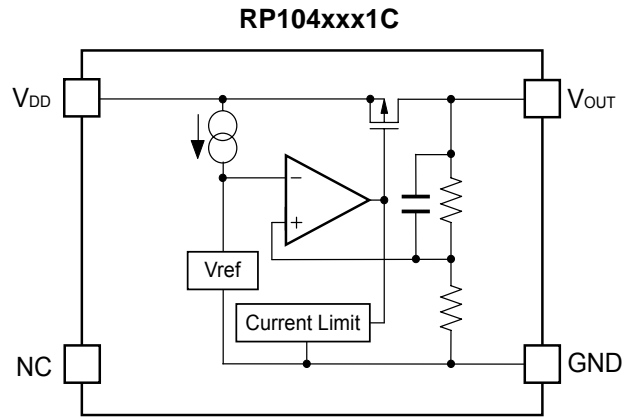
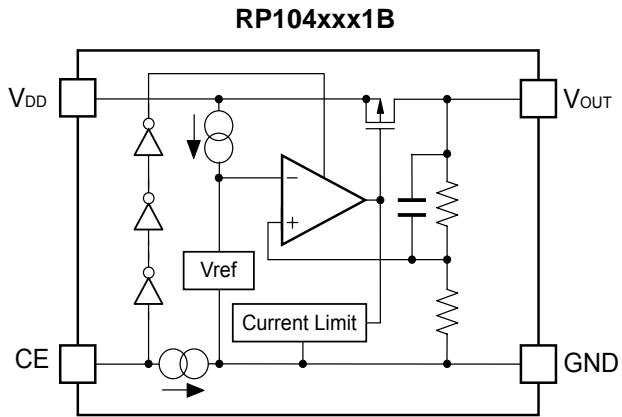
### FEATURES

- Supply Current ..... Typ. 1.0 $\mu$ A  
(Except the current through CE pull down circuit)
- Standby Current ..... Typ. 0.1 $\mu$ A
- Dropout Voltage..... Typ. 0.24V ( $I_{OUT}=150\text{mA}$ ,  $V_{OUT}=2.8\text{V}$ )
- Temperature-Drift Coefficient of Output Voltage ..... Typ.  $\pm 40\text{ppm}/^\circ\text{C}$
- Line Regulation ..... Typ. 0.02%/V
- Output Voltage Accuracy .....  $\pm 0.8\%$
- Packages..... DFN(PLP)1010-4, SC-82AB (**Non-promotion**) ,  
SOT-23-5
- Input Voltage Range..... 1.7V to 5.25V
- Output Voltage Range ..... 1.2V to 3.3V (0.1V steps)  
(For other voltages, please refer to MARK INFORMATION.)
- Built-in Fold Back Protection Circuit..... Typ. 40mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC .... 0.1 $\mu$ F or more

### APPLICATIONS

- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

## BLOCK DIAGRAMS



## SELECTION GUIDE

The output voltage, chip enable circuit, auto discharge function, package, and the taping type, etc. for the ICs can be selected at the user's request.

| Product Name     | Package                    | Quantity per Reel | Pb Free | Halogen Free |
|------------------|----------------------------|-------------------|---------|--------------|
| RP104Kxx1*-TR    | DFN(PLP)1010-4             | 10,000 pcs        | Yes     | Yes          |
| RP104Qxx1*-TR-FE | SC-82AB<br>(Non-promotion) | 3,000 pcs         | Yes     | Yes          |
| RP104Nxx1*-TR-FE | SOT-23-5                   | 3,000 pcs         | Yes     | Yes          |

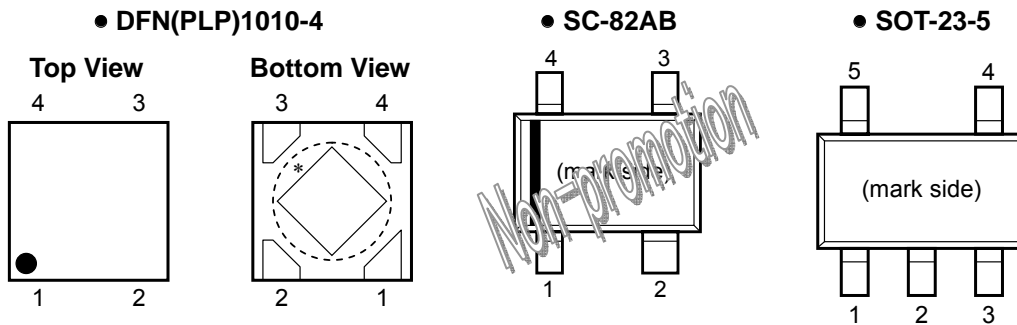
xx: The output voltage can be designated in the range from 1.2V(12) to 3.3V(33) in 0.1V steps.  
(For other voltages, please refer to MARK INFORMATIONS.)

\* : CE pin polarity and auto discharge function at off state are options as follows.  
 (B) "H" active, without auto discharge function at off state  
 (C) without chip enable circuit  
 (D) "H" active, with auto discharge function at off state

**The products scheduled to be discontinued : "Non-promotion"**

These products will be discontinued in the future. We advise you to select other products.

## PIN CONFIGURATIONS



## PIN DESCRIPTIONS

### • DFN(PLP)1010-4

| Pin No | Symbol    | Pin Description                               |
|--------|-----------|---|
| 1      | $V_{OUT}$ | Output Pin                                    |
| 2      | GND       | Ground Pin                                    |
| 3      | CE / NC   | Chip Enable Pin ("H" Active) or No Connection |
| 4      | $V_{DD}$  | Input Pin                                     |

\*) Tab is GND level. (They are connected to the reverse side of this IC.)  
 The tab is better to be connected to the GND, but leaving it open is also acceptable.

### • SC-82AB (Non-promotion)

| Pin No | Symbol    | Pin Description                               |
|--------|-----------|---|
| 1      | CE / NC   | Chip Enable Pin ("H" Active) or No Connection |
| 2      | GND       | Ground Pin                                    |
| 3      | $V_{OUT}$ | Output Pin                                    |
| 4      | $V_{DD}$  | Input Pin                                     |

### • SOT-23-5

| Pin No | Symbol    | Pin Description                               |
|--------|-----------|---|
| 1      | $V_{DD}$  | Input Pin                                     |
| 2      | GND       | Ground Pin                                    |
| 3      | CE / NC   | Chip Enable Pin ("H" Active) or No Connection |
| 4      | NC        | No Connection                                 |
| 5      | $V_{OUT}$ | Output Pin                                    |

## ABSOLUTE MAXIMUM RATINGS

| Symbol    | Item   | Rating               | Unit |
|-----------|--|----------------------|------|
| $V_{IN}$  | Input Voltage                                | 6.0                  | V    |
| $V_{CE}$  | Input Voltage (CE Pin)                       | 6.0                  | V    |
| $V_{OUT}$ | Output Voltage                               | -0.3 to $V_{IN}+0.3$ | V    |
| $I_{OUT}$ | Output Current                               | 200                  | mA   |
| $P_D$     | Power Dissipation (DFN(PLP)1010-4)*          | 400                  | mW   |
|           | Power Dissipation (SC-82AB)* (Non-promotion) | 380                  |      |
|           | Power Dissipation (SOT-23-5)*                | 420                  |      |
| $T_{opt}$ | 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.

## ELECTRICAL CHARACTERISTICS

### • RP104xxx1B/C/D

$V_{IN}$ =Set  $V_{OUT}+1V$  for  $V_{OUT}$  options greater than 1.5V.  $V_{IN}=2.5V$  for  $V_{OUT} \leq 1.5V$ .

$I_{OUT}=1mA$ ,  $C_{IN}=C_{OUT}=0.1\mu F$ , unless otherwise noted.

   values indicate  $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ , unless otherwise noted.

$T_{opt}=25^{\circ}C$

| Symbol                          | Item  | Conditions                                   | Min.  | Typ.   | Max.   | Unit   |    |
|---------------------------------|---|--|---|--|--|--|----|
| $V_{OUT}$                       | Output Voltage                                  | $T_{opt}=25^{\circ}C$                        | $V_{OUT} > 2.0V$  | $\times 0.992$   |  | $\times 1.008$   | V  |
|                                 |   |  | $V_{OUT} \leq 2.0V$   | -16  |  | +16  | mV |
|                                 |   | $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ | $V_{OUT} > 2.0V$  | <span style="border: 1px solid black; padding: 0 2px;">×0.985</span> |  | <span style="border: 1px solid black; padding: 0 2px;">×1.015</span> | V  |
|                                 |   |  | $V_{OUT} \leq 2.0V$   | <span style="border: 1px solid black; padding: 0 2px;">-30</span>    |  | <span style="border: 1px solid black; padding: 0 2px;">+30</span>    | mV |
| $I_{OUT}$                       | Output Current                                  |  | <span style="border: 1px solid black; padding: 0 2px;">150</span> |  |  | mA   |    |
| $\Delta V_{OUT}/\Delta I_{OUT}$ | Load Regulation                                 | $1mA \leq I_{OUT} \leq 150mA$                |   | 10   | <span style="border: 1px solid black; padding: 0 2px;">20</span>   | mV   |    |
| $V_{DIF}$                       | Dropout Voltage                                 | $I_{OUT}=150mA$                              | $1.2V \leq V_{OUT} < 1.5V$  |  | 0.76   | <span style="border: 1px solid black; padding: 0 2px;">1.05</span>   | V  |
|                                 |   |  | $1.5V \leq V_{OUT} < 1.7V$  |  | 0.53   | <span style="border: 1px solid black; padding: 0 2px;">0.80</span>   |    |
|                                 |   |  | $1.7V \leq V_{OUT} < 2.0V$  |  | 0.44   | <span style="border: 1px solid black; padding: 0 2px;">0.65</span>   |    |
|                                 |   |  | $2.0V \leq V_{OUT} < 2.5V$  |  | 0.34   | <span style="border: 1px solid black; padding: 0 2px;">0.50</span>   |    |
|                                 |   |  | $2.5V \leq V_{OUT} < 2.8V$  |  | 0.28   | <span style="border: 1px solid black; padding: 0 2px;">0.40</span>   |    |
|                                 |   |  | $2.8V \leq V_{OUT} \leq 3.3V$                                     |  | 0.24   | <span style="border: 1px solid black; padding: 0 2px;">0.32</span>   |    |
| $I_{SS}$                        | Supply Current                                  | $I_{OUT}=0mA$                                |   | 1.0  | <span style="border: 1px solid black; padding: 0 2px;">1.5</span>  | $\mu A$  |    |
| $I_{standby}$                   | Standby Current                                 | $V_{CE}=0V$                                  |   | 0.1  | 1.0  | $\mu A$  |    |
| $\Delta V_{OUT}/\Delta V_{IN}$  | Line Regulation                                 | Set $V_{OUT}+0.5V \leq V_{IN} \leq 5.0V$     |   | 0.02   | <span style="border: 1px solid black; padding: 0 2px;">0.10</span> | %/V  |    |
| $V_{IN}$                        | Input Voltage*                                  |  | <span style="border: 1px solid black; padding: 0 2px;">1.7</span> |  | <span style="border: 1px solid black; padding: 0 2px;">5.25</span> | V  |    |
| $\Delta V_{OUT}/\Delta T_{opt}$ | Output Voltage Temperature Coefficient          | $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ |   | $\pm 40$   |  | ppm/ $^{\circ}C$   |    |
| $I_{SC}$                        | Short Current Limit                             | $V_{OUT}=0V$                                 |   | 40   |  | mA   |    |
| $I_{PD}$                        | CE Pull-down Current                            |  |   | 0.3  |  | $\mu A$  |    |
| $V_{CEH}$                       | CE Input Voltage "H"                            |  | <span style="border: 1px solid black; padding: 0 2px;">1.5</span> |  |  | V  |    |
| $V_{CEL}$                       | CE Input Voltage "L"                            |  |   |  | <span style="border: 1px solid black; padding: 0 2px;">0.3</span>  | V  |    |
| $R_{LOW}$                       | Low Output Nch Tr. ON Resistance (of D version) | $V_{IN}=4.0V$<br>$V_{CE}=0V$                 |   | 30   |  | $\Omega$   |    |

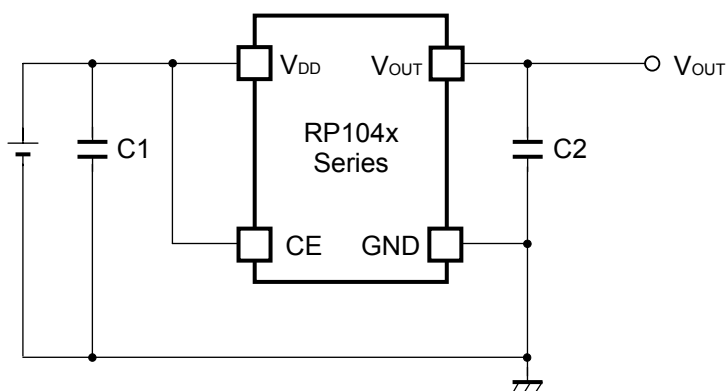
All of units are tested and specified under load conditions such that  $T_j \approx T_{opt}=25^{\circ}C$  except for Output Voltage Temperature Coefficient.

\*) When Input Voltage is 5.5V, the total operational time must be within 500hrs.

#### 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.

## TYPICAL APPLICATION



(External Components)

C2 0.1 $\mu$ F MURATA: GRM155B31C104KA87B

## TECHNICAL NOTES

When using these ICs, consider the following points:

### Phase Compensation

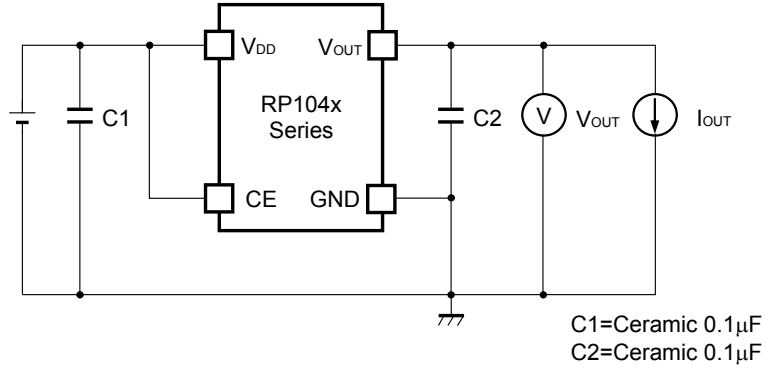
In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 with good frequency characteristics and ESR (Equivalent Series Resistance). (Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

### PCB Layout

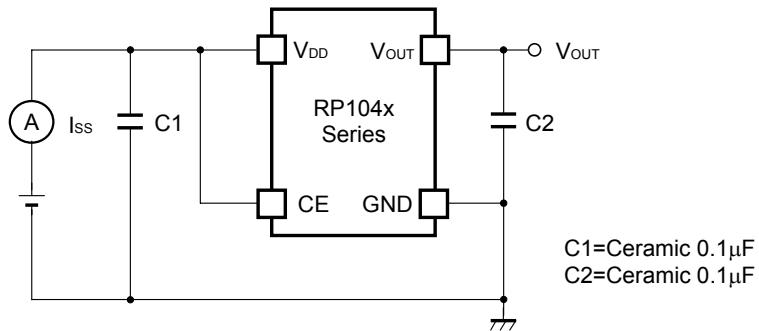
Make  $V_{DD}$  and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 0.1 $\mu$ F or more between  $V_{DD}$  and GND pin, and as close as possible to the pins.

Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

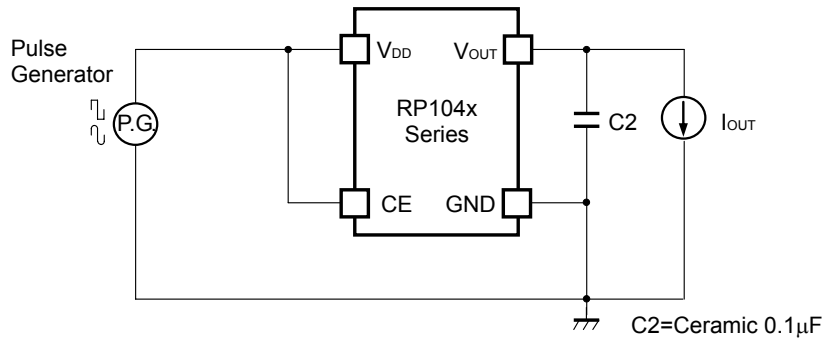
TEST CIRCUITS



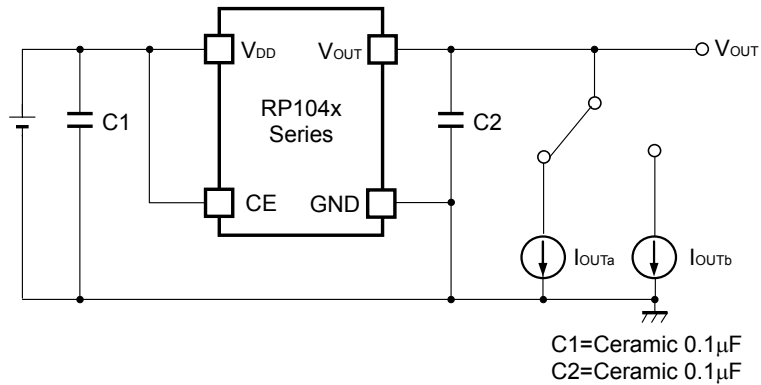
Basic Test Circuit



Test Circuit for Supply Current



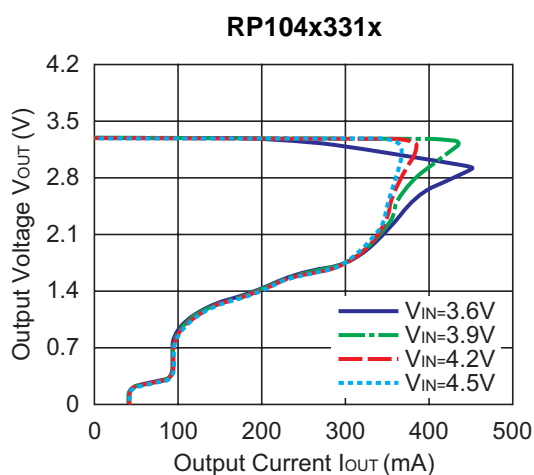
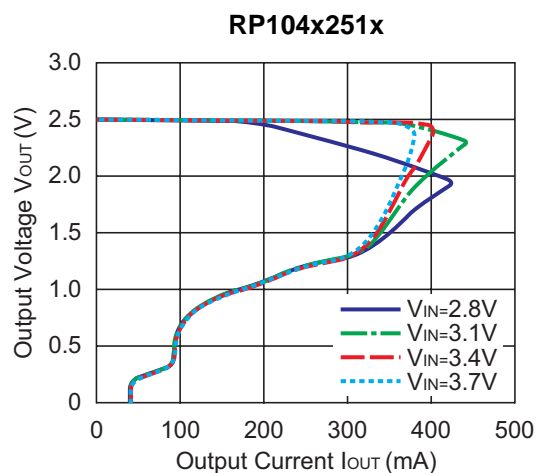
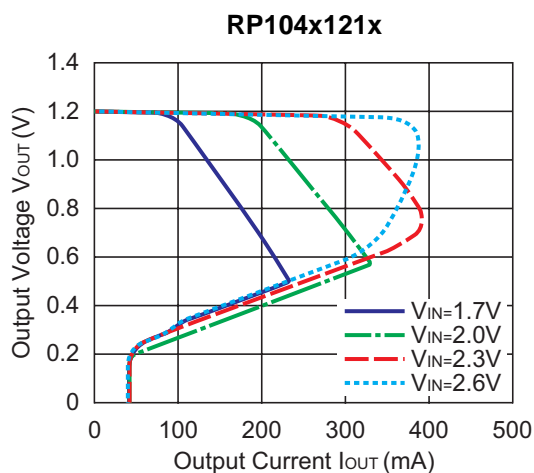
Test Circuit for Ripple Rejection



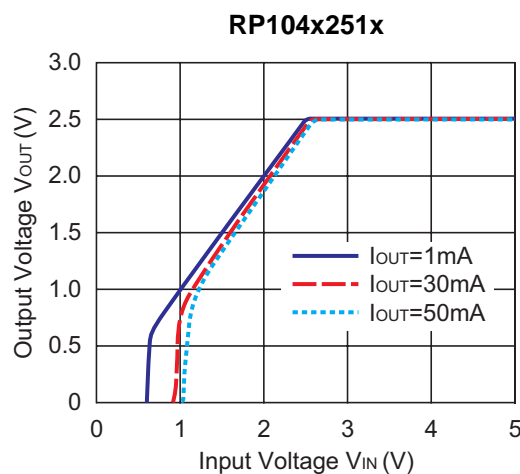
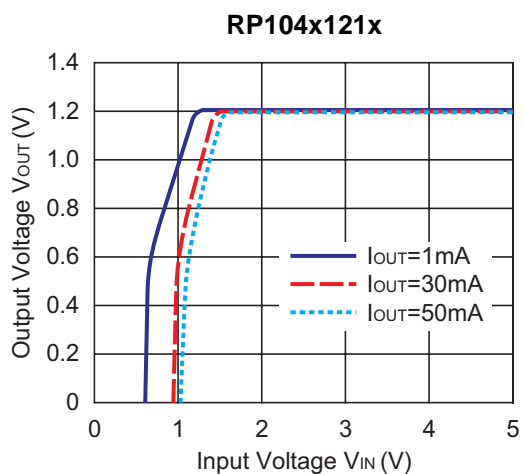
Test Circuit for Load Transient Response

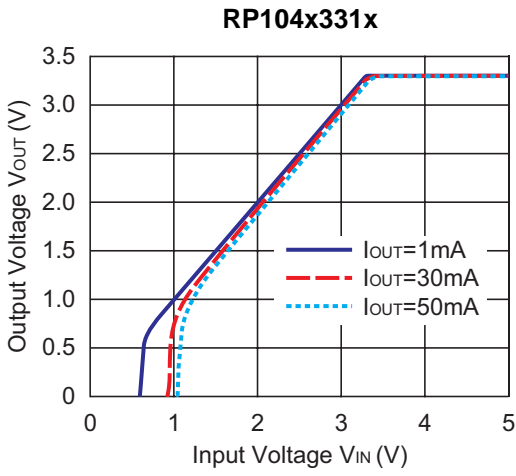
## TYPICAL CHARACTERISTICS

### 1) Output Voltage vs. Output Current (C1=Ceramic 0.1 $\mu$ F, C2=Ceramic 0.1 $\mu$ F, T<sub>opt</sub>=25°C)

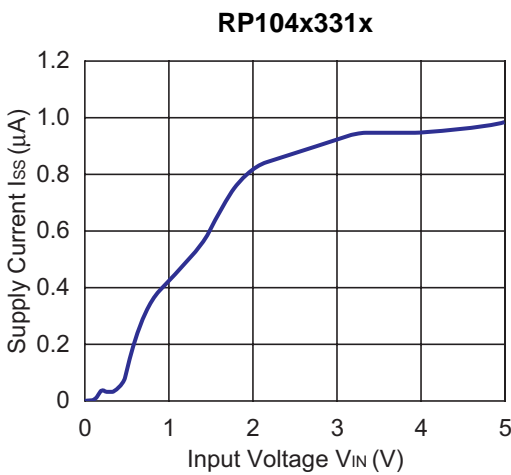
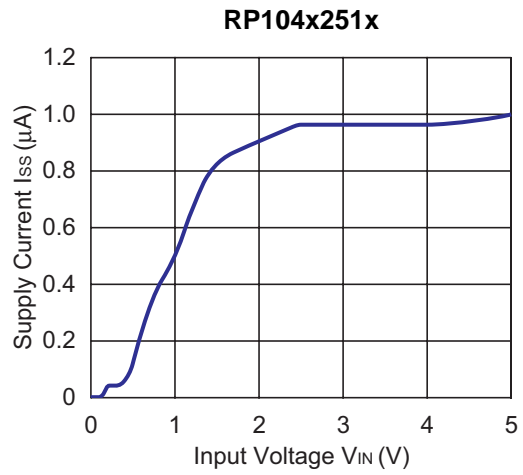
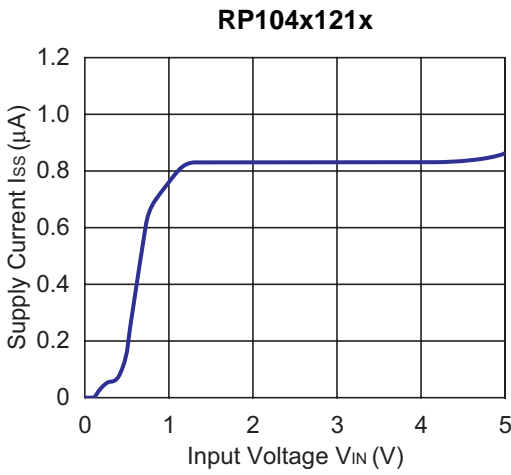


### 2) Output Voltage vs. Input Voltage (C1=Ceramic 0.1 $\mu$ F, C2=Ceramic 0.1 $\mu$ F, T<sub>opt</sub>=25°C)

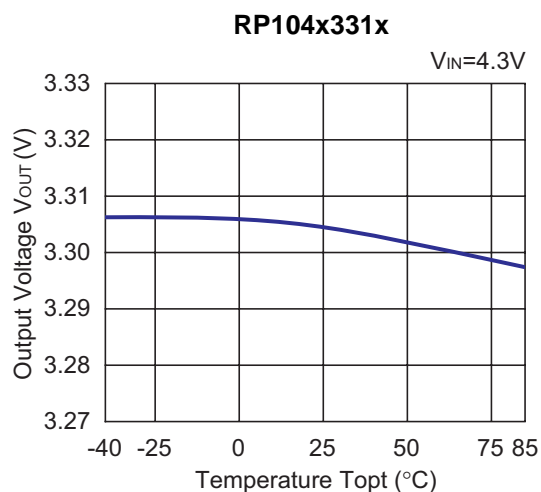
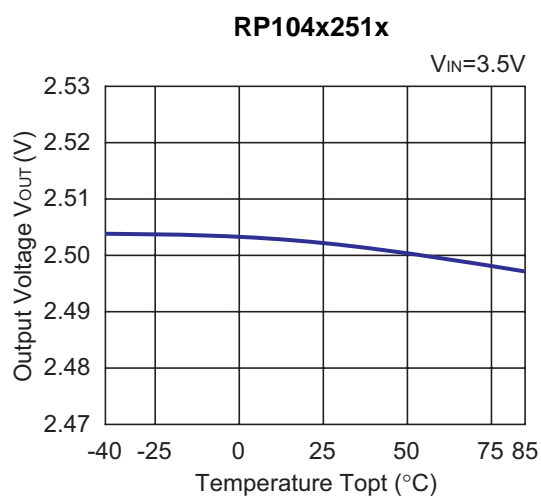
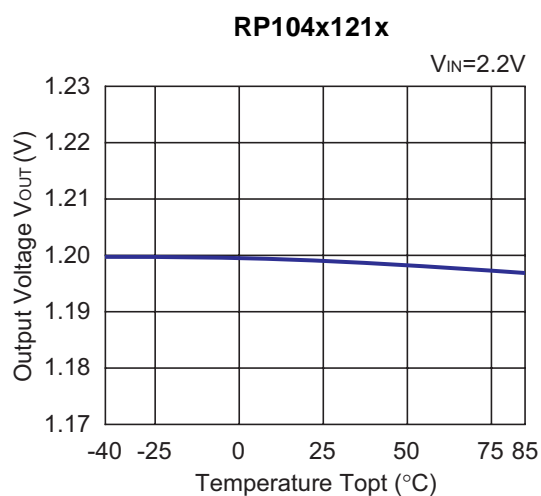




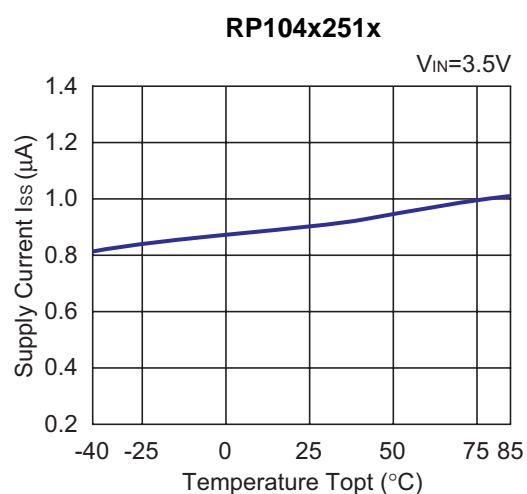
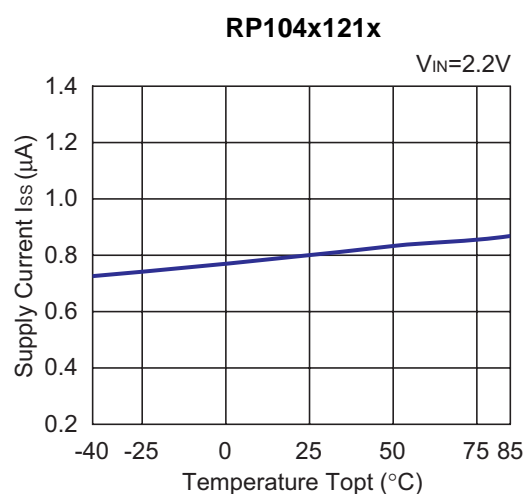
**3) Supply Current vs. Input Voltage (C1=Ceramic 0.1 $\mu$ F, C2=Ceramic 0.1 $\mu$ F,  $T_{opt}=25^{\circ}$ C)**



4) Output Voltage vs. Temperature (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, I<sub>OUT</sub>=1mA)

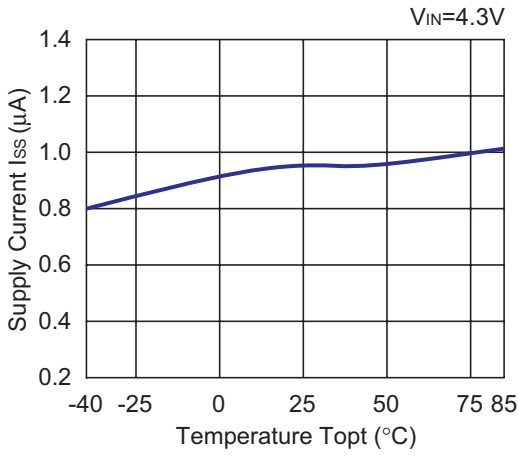


5) Supply Current vs. Temperature (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF)



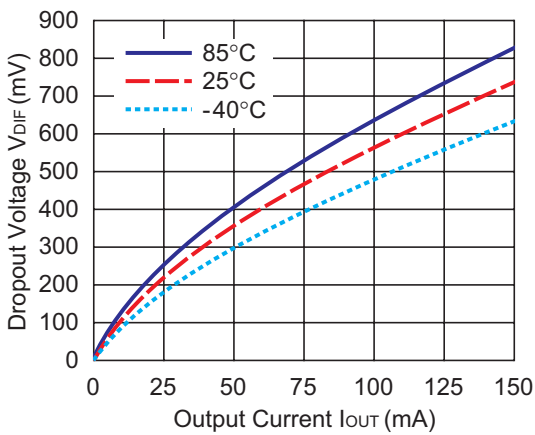
# RP104x

## RP104x331x

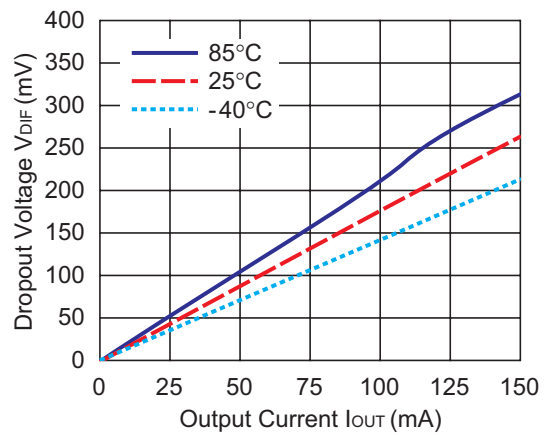


### 6) Dropout Voltage vs. Output Current ( $C1=Ceramic\ 0.1\mu F$ , $C2=Ceramic\ 0.1\mu F$ , $T_{opt}=25^{\circ}C$ )

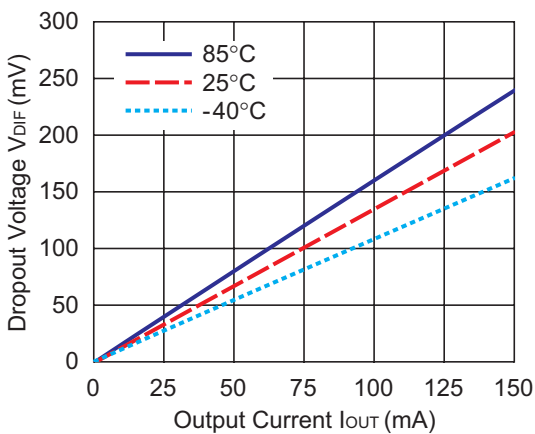
#### RP104x121x



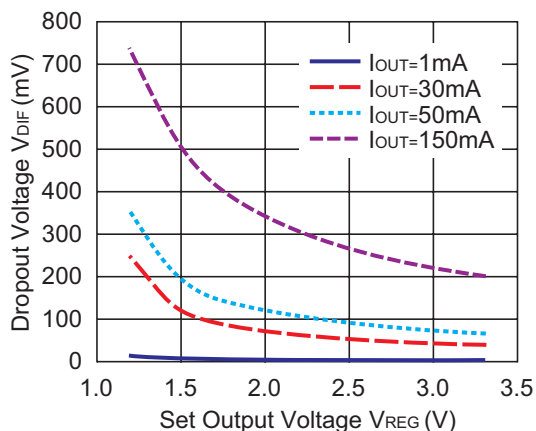
#### RP104x251x



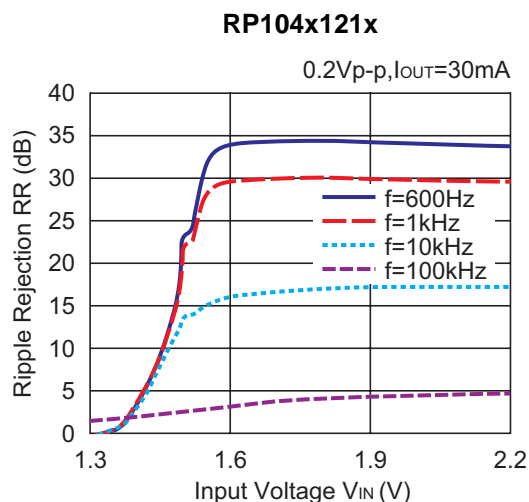
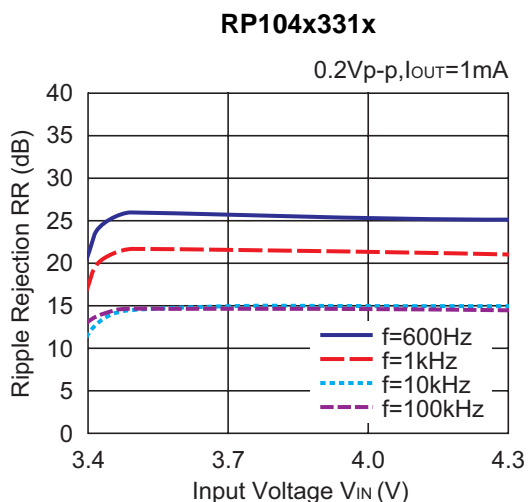
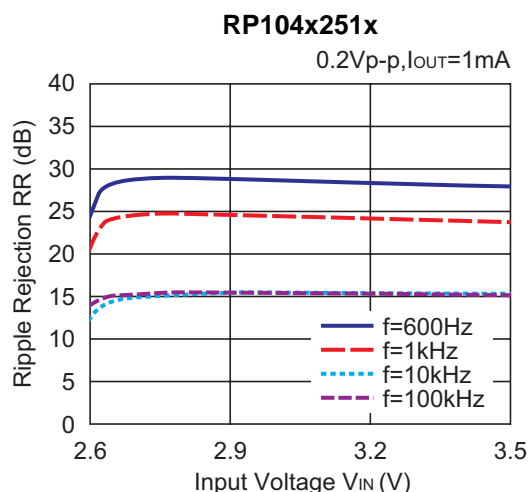
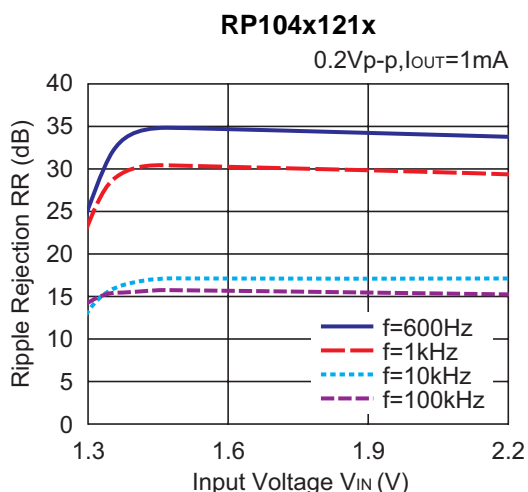
#### RP104x331x



7) Dropout Voltage vs. Set Output Voltage (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, T<sub>opt</sub>=25°C)

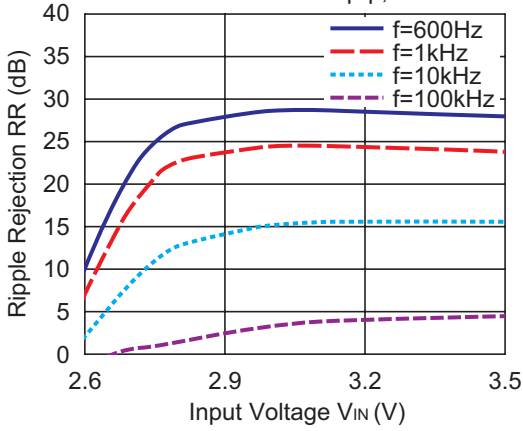


8) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=Ceramic 0.1μF, T<sub>opt</sub>=25°C)



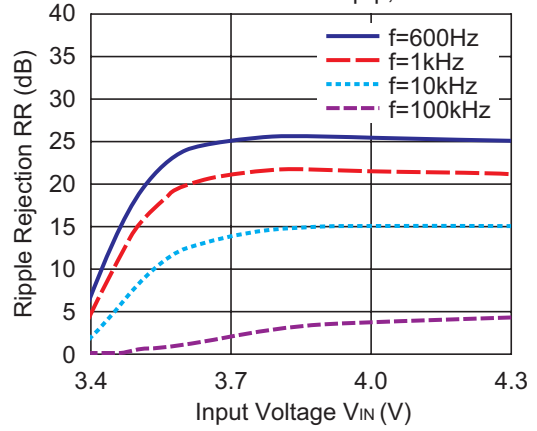
RP104x251x

0.2Vp-p, I<sub>OUT</sub>=30mA



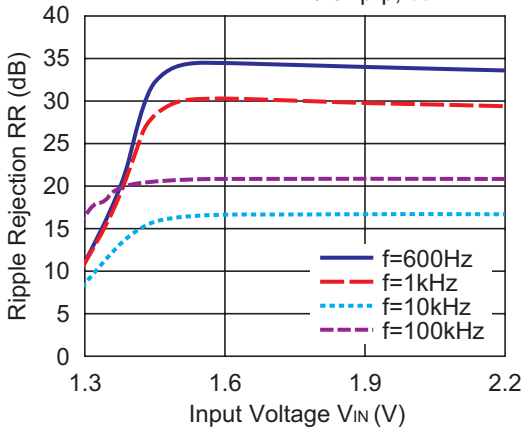
RP104x331x

0.2Vp-p, I<sub>OUT</sub>=30mA



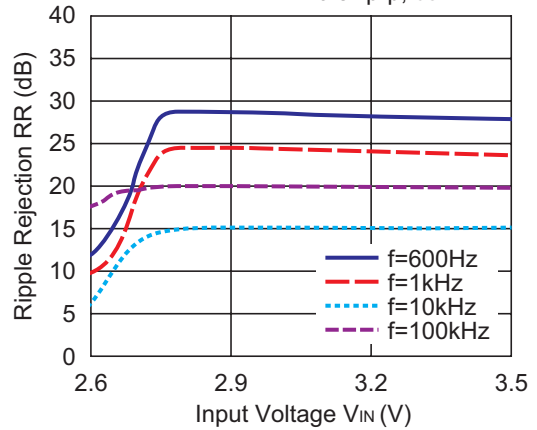
RP104x121x

0.5Vp-p, I<sub>OUT</sub>=1mA



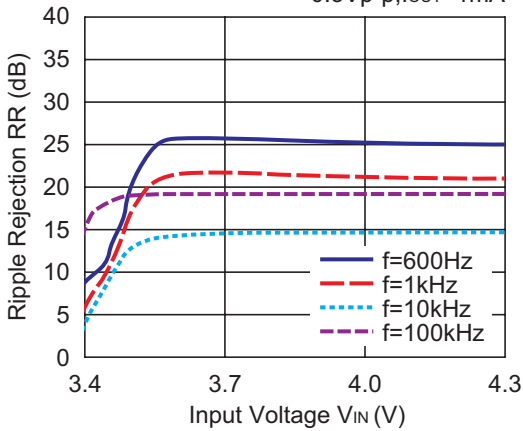
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0.5Vp-p, I<sub>OUT</sub>=1mA



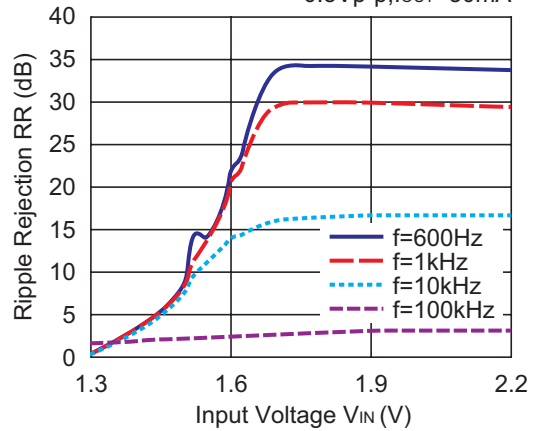
RP104x331x

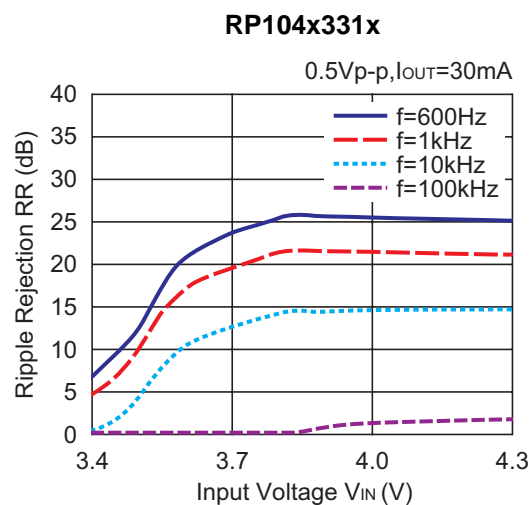
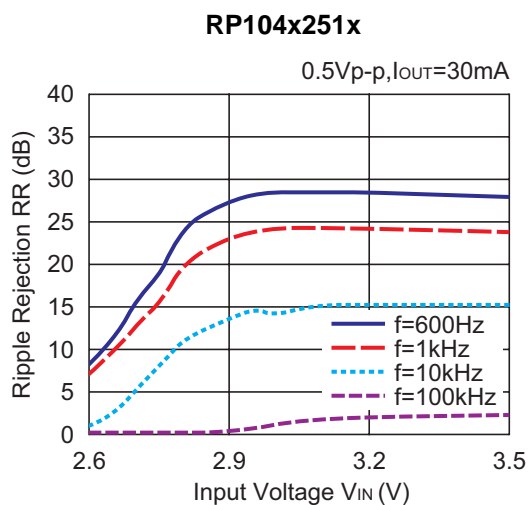
0.5Vp-p, I<sub>OUT</sub>=1mA



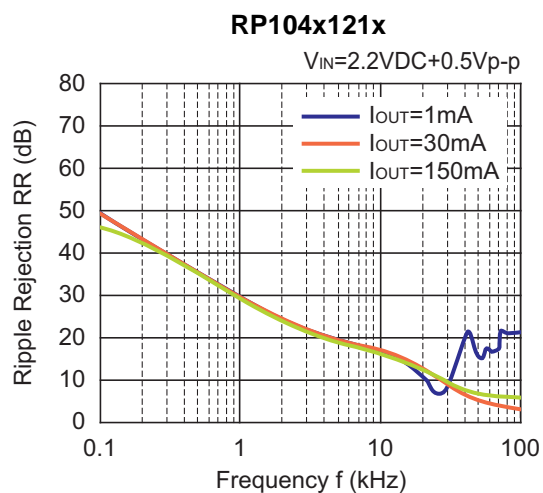
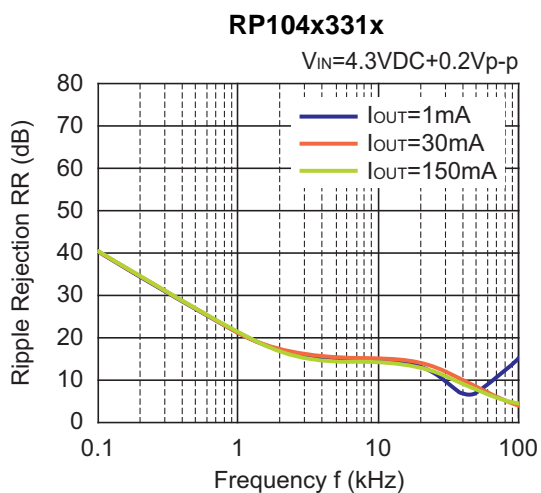
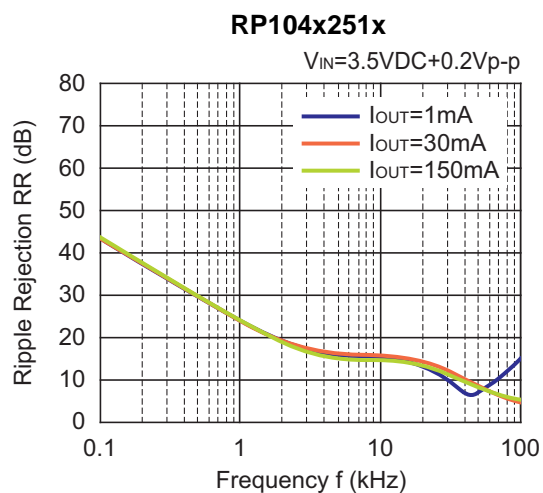
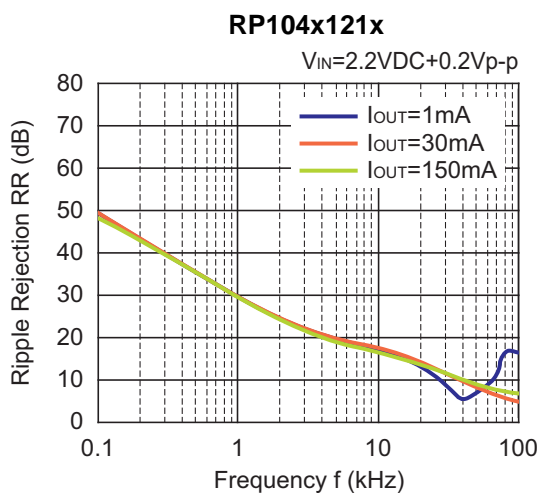
RP104x121x

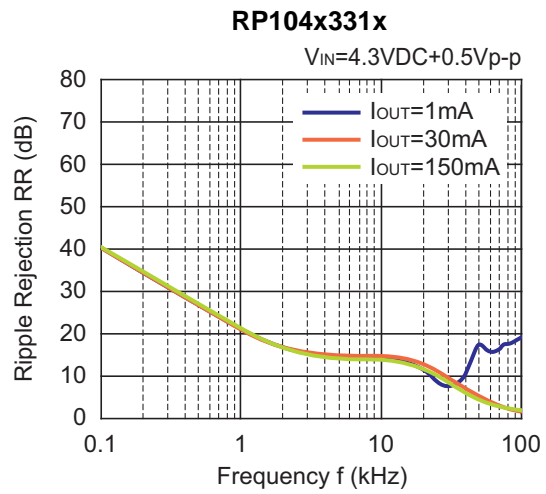
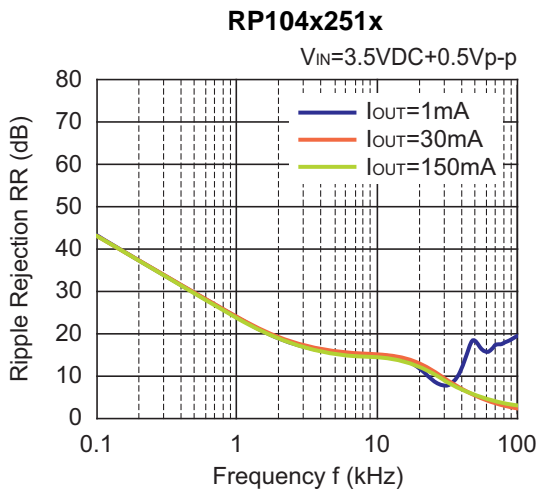
0.5Vp-p, I<sub>OUT</sub>=30mA



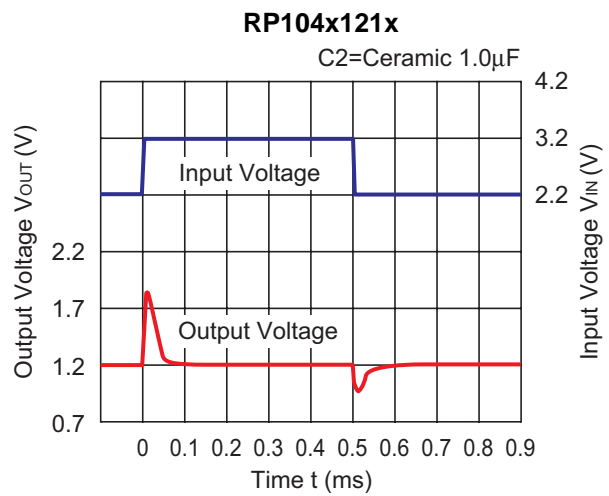
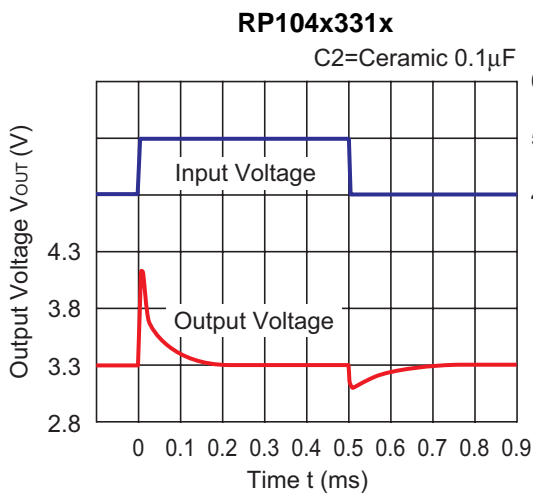
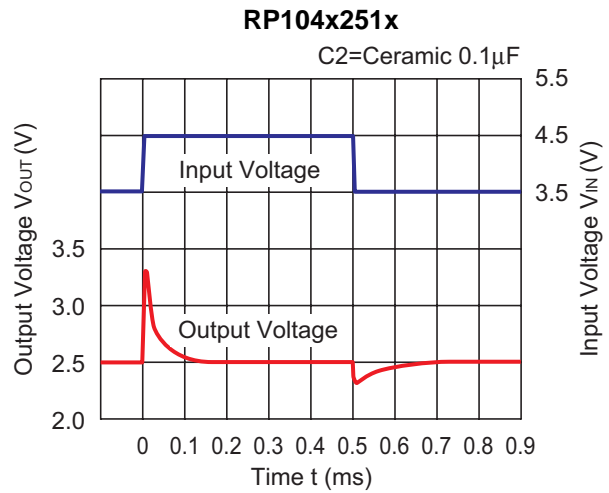
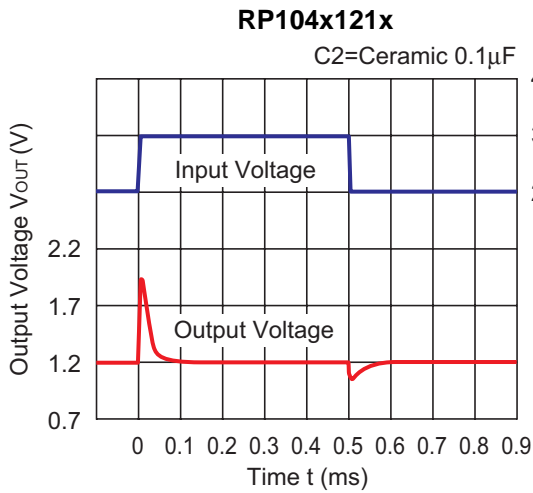


**9) Ripple Rejection vs. Frequency (C1=none, C2=Ceramic 0.1μF, T<sub>opt</sub>=25°C)**

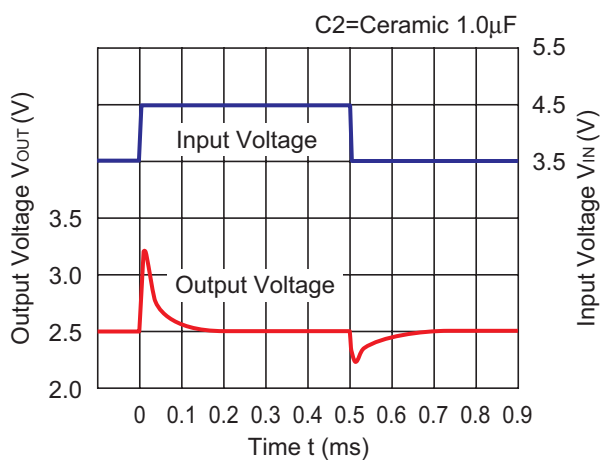




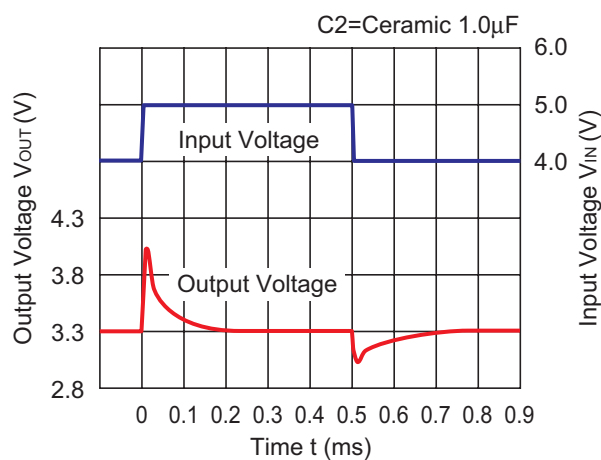
**10) Input Transient Response ( $C1=none$ ,  $I_{OUT}=30mA$ ,  $T_{opt}=25^{\circ}C$ )**



RP104x251x

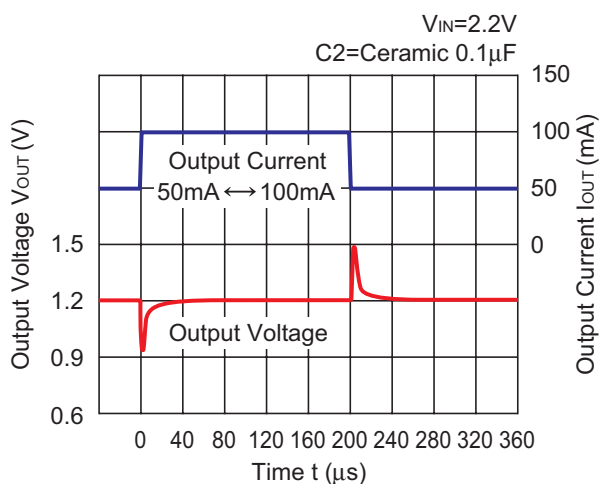


RP104x331x

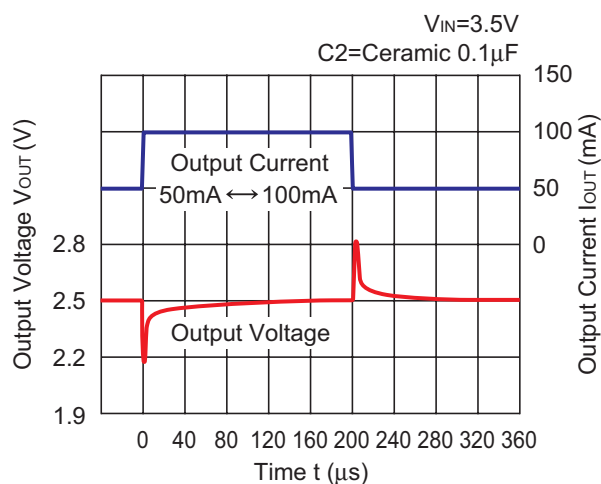


11) Load Transient Response (C1=Ceramic 0.1 $\mu$ F,  $T_{opt}$ =25 $^{\circ}$ C)

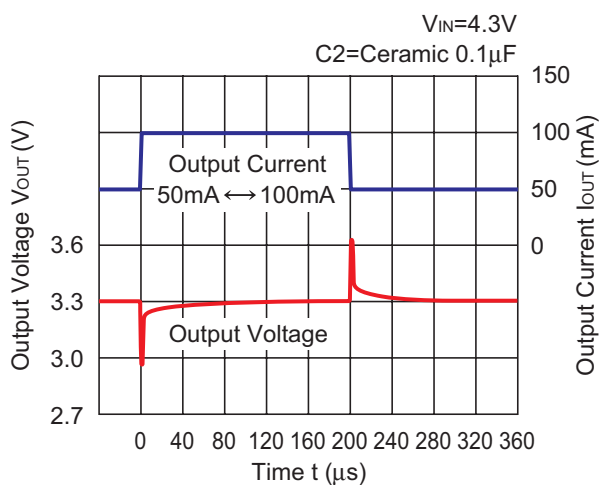
RP104x121x



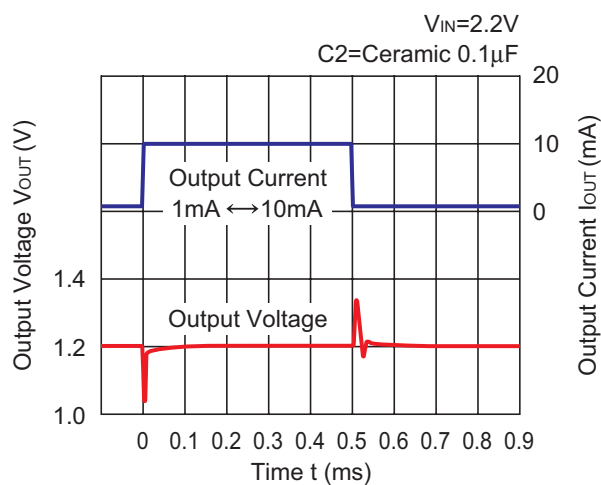
RP104x251x



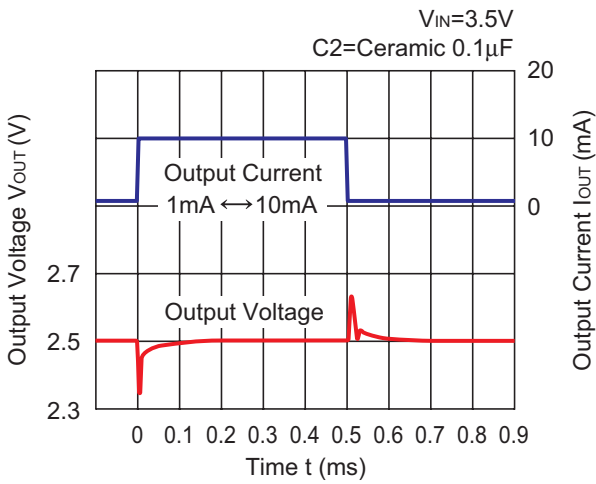
RP104x331x



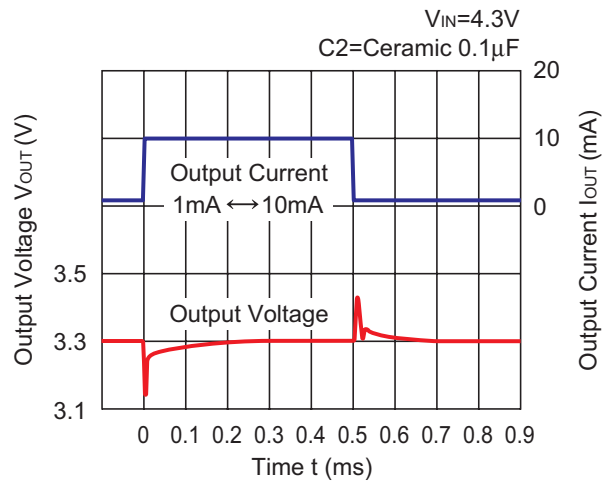
RP104x121x



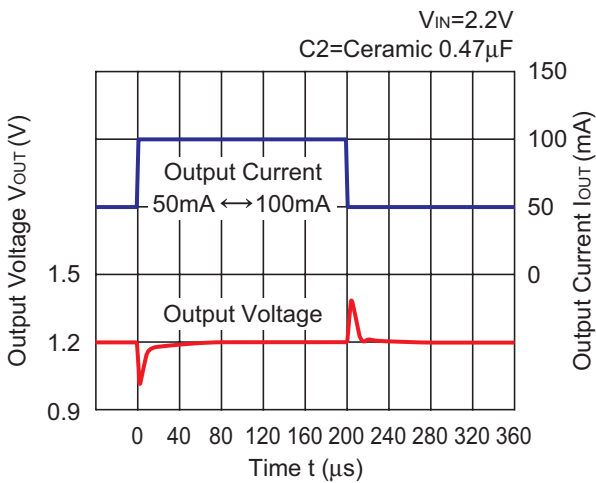
**RP104x251x**



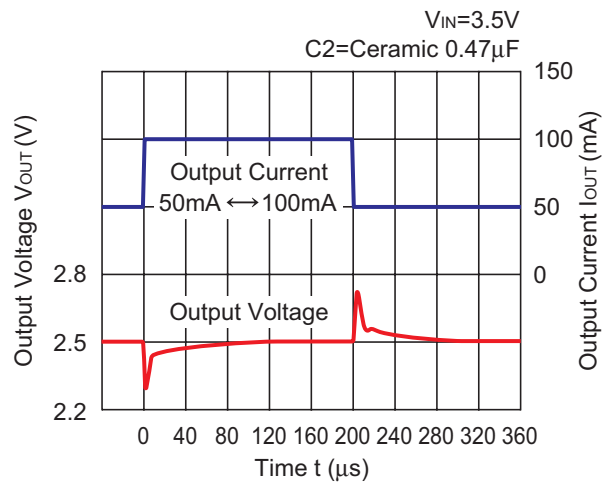
**RP104x331x**



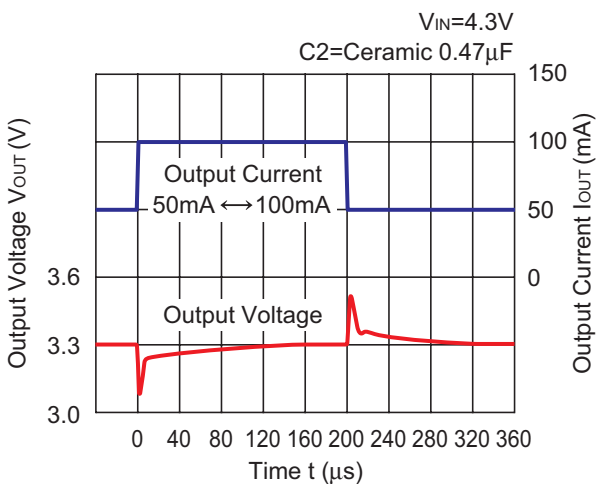
**RP104x121x**



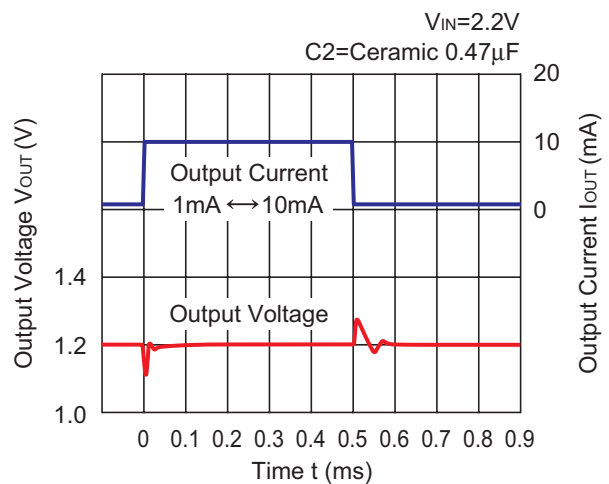
**RP104x251x**



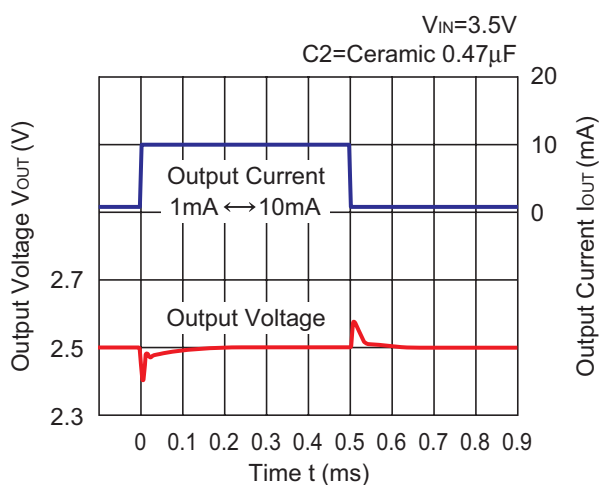
**RP104x331x**



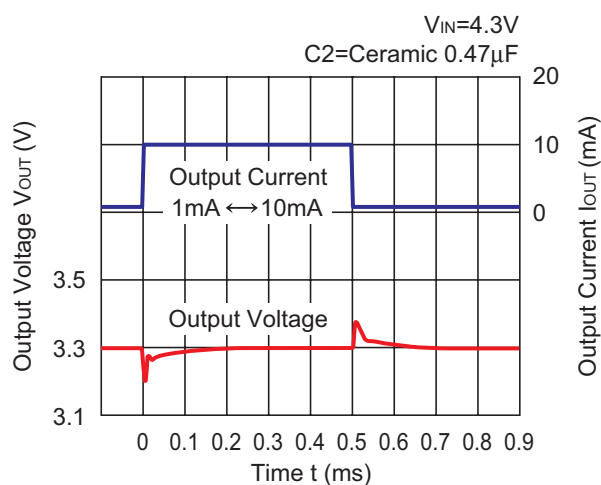
**RP104x121x**



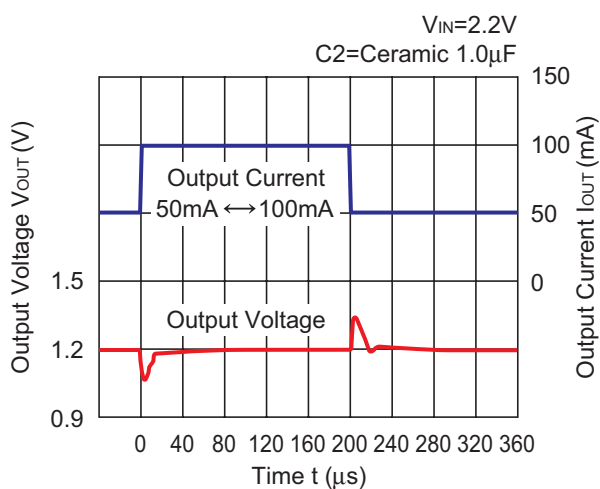
**RP104x251x**



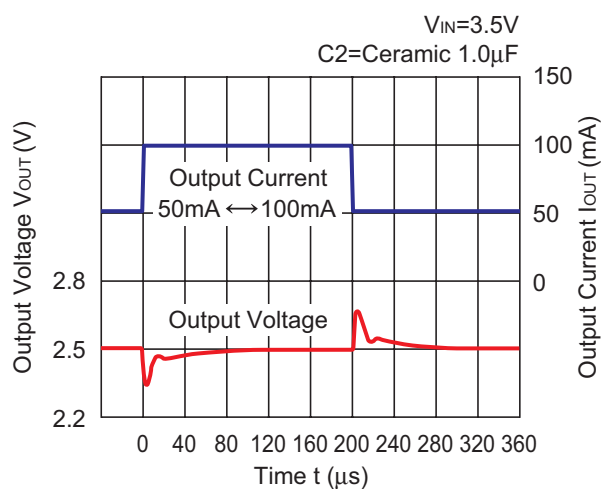
**RP104x331x**



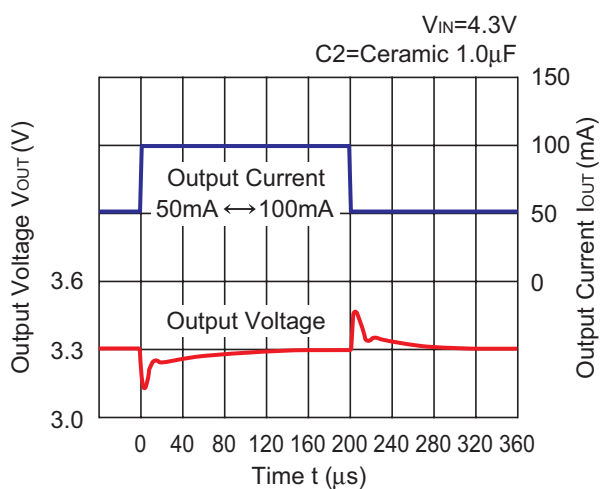
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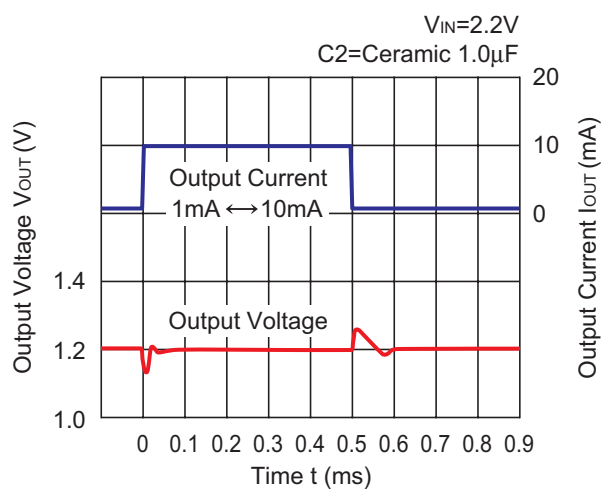
**RP104x251x**



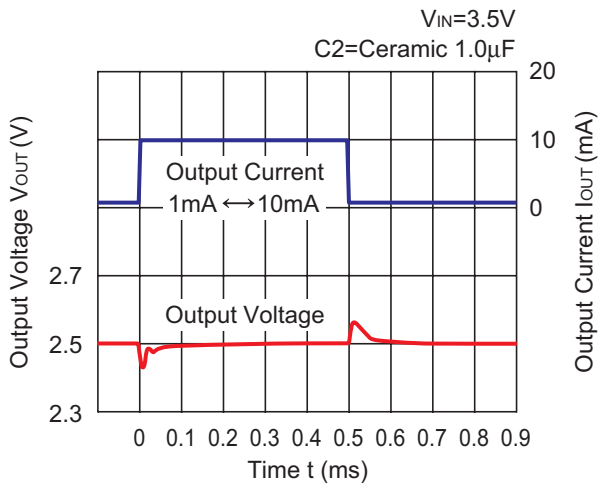
**RP104x331x**



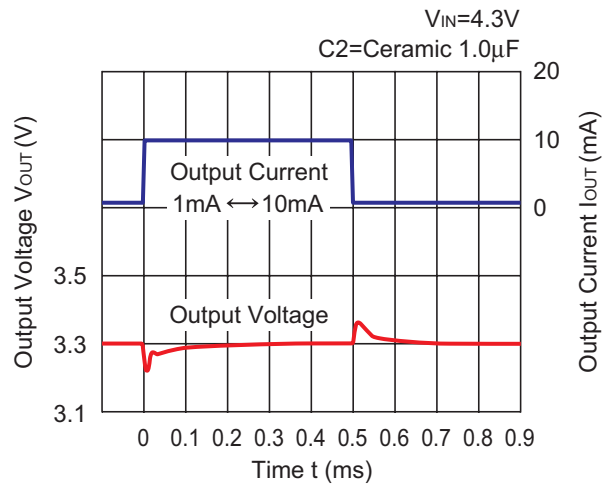
**RP104x121x**



RP104x251x

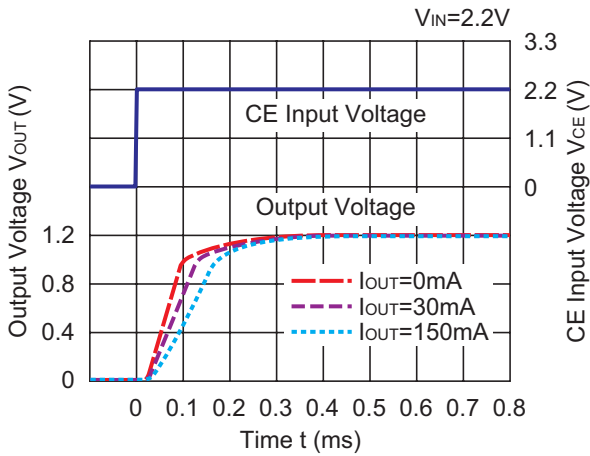


RP104x331x

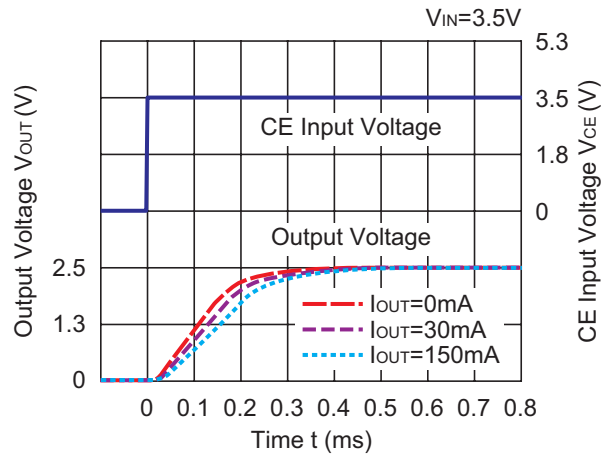


12) Turn On Speed with CE pin (C1=Ceramic  $0.1\mu F$ , C2=Ceramic  $0.1\mu F$ ,  $T_{opt}=25^{\circ}C$ )

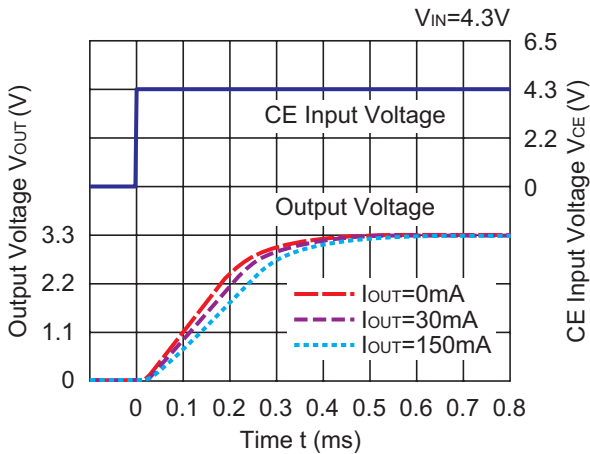
RP104x121B/D



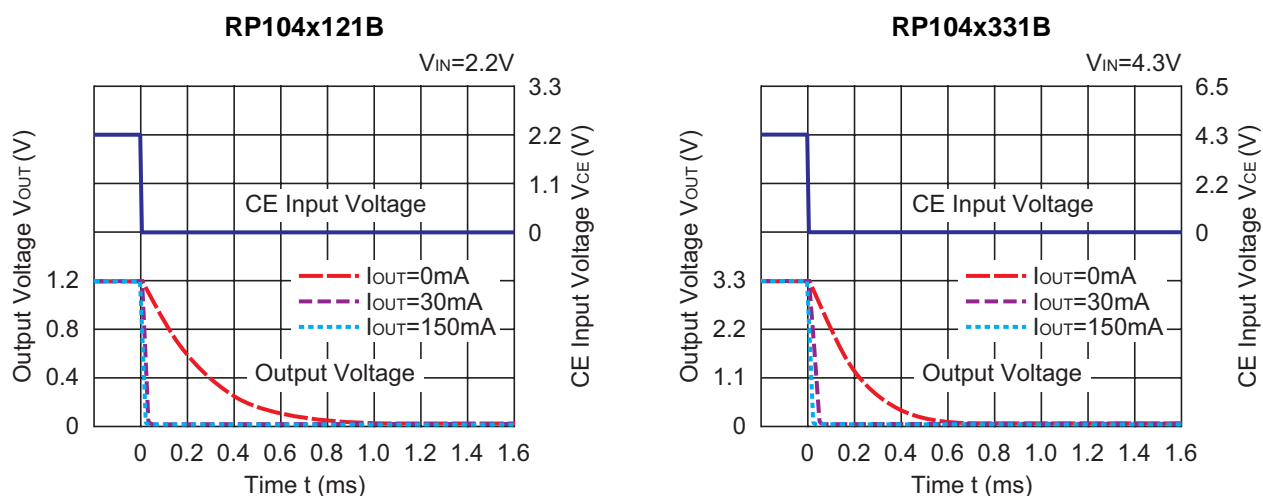
RP104x251B/D



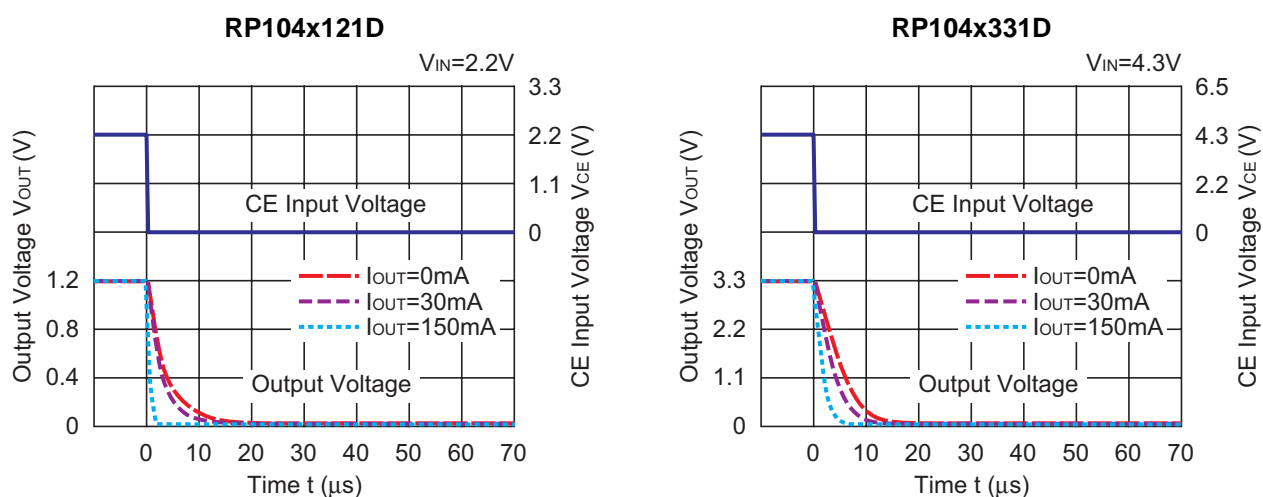
RP104x331B/D



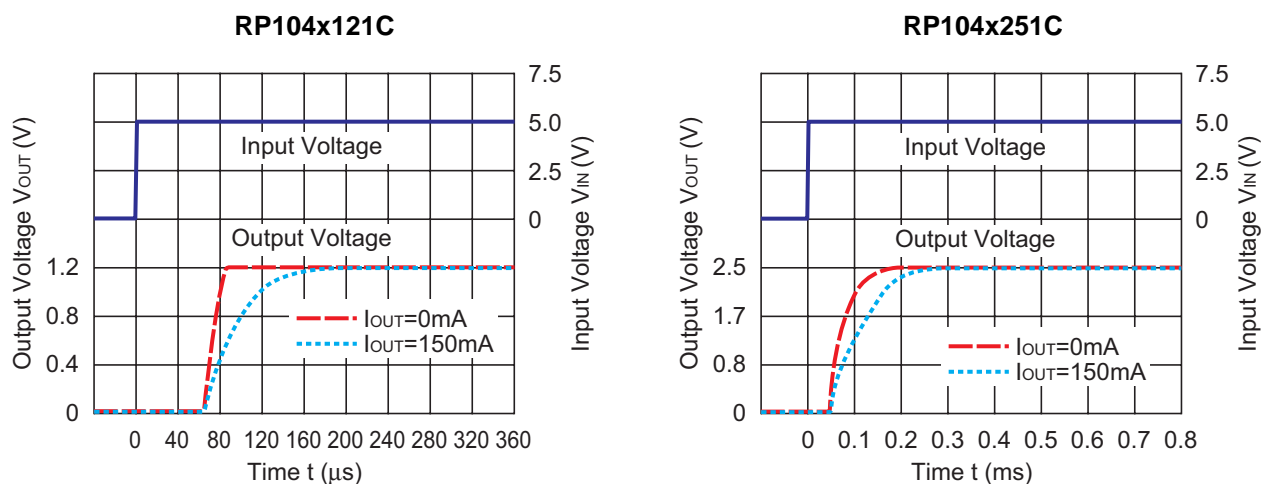
13) Turn Off Speed with CE pin (B Version) (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, T<sub>opt</sub>=25°C)



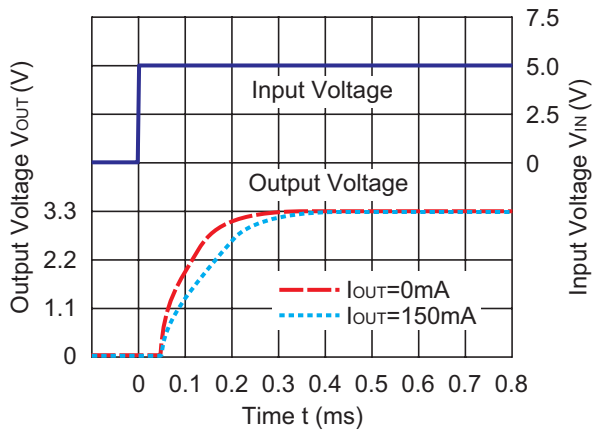
14) Turn Off Speed with CE pin (D Version) (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, T<sub>opt</sub>=25°C)



15) Turn On Speed of C Version (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, V<sub>IN</sub>=5.0V, T<sub>opt</sub>=25°C)



RP104x331C



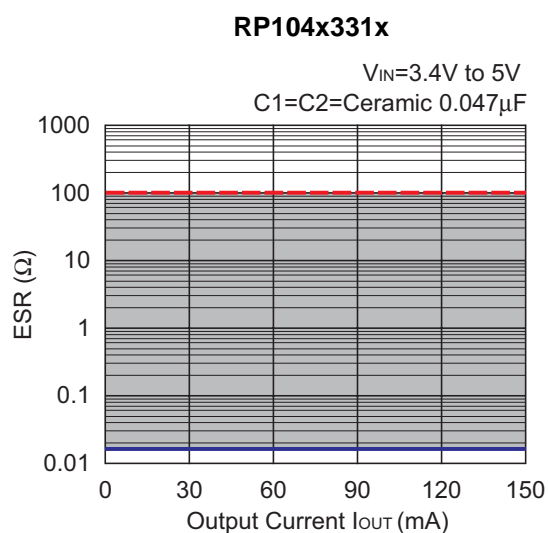
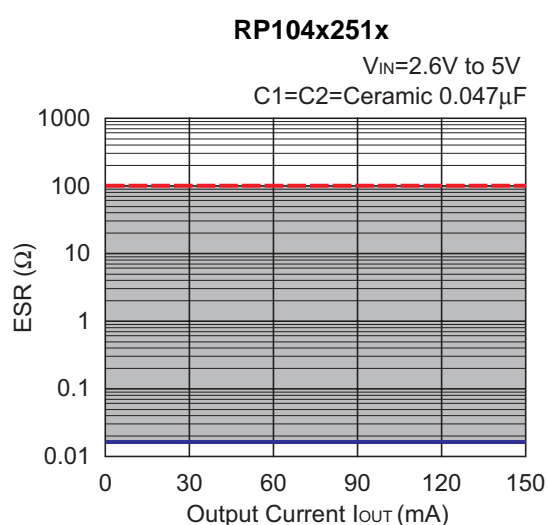
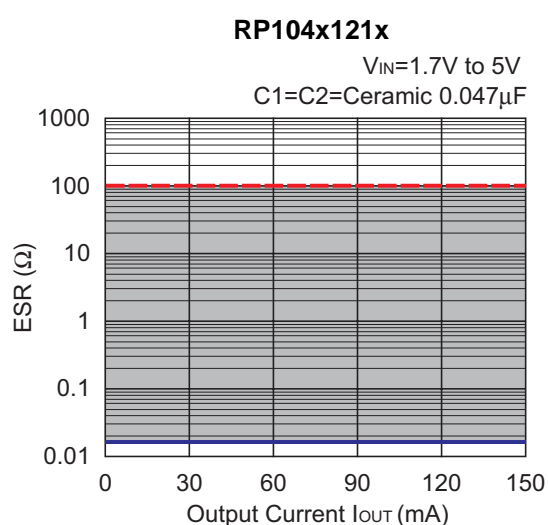
## ESR vs. Output Current

Ceramic type output capacitor is recommended for this series; however, the other output capacitors with low ESR also can be used. The relations between  $I_{OUT}$  (Output Current) and ESR of an output capacitor are shown below. The conditions when the white noise level is under  $40\mu\text{V}$  (Avg.) are marked as the hatched area in the graph.

### Measurement conditions

Frequency Band : 10Hz to 2MHz

Temperature :  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$





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**For the conservation of the global environment, Ricoh is advancing the decrease of the negative environmental impact material.**  
After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive.  
Basically after Apr. 1, 2012, we will ship out the Power Management ICs of the Halogen Free products only. (Ricoh Halogen Free products are also Antimony Free.)

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