

LOW ON RESISTANCE / LOW VOLTAGE 1A LDO

NO.EA-174-100401

OUTLINE

The RP131x Series are voltage-regulators with a built-in low ON-resistance transistor and output current is 1A capability. These ICs are capable of the low input voltage (Min.1.6V) and also the minimum output voltage can be set from 0.8V. (The output voltage is fixed in the IC.)

Each of these ICs consists of a voltage reference unit, an error amplifier, a resistor net for setting output voltage, a chip enable circuit, current limit circuits for over-current and short, and a thermal-shutdown circuit.

A standby mode with ultra low supply current can be realized with the chip enable function.

The packages for these ICs are DFN(PLP)1820-6 which is suitable high density mounting of the ICs on boards, SOT-89-5, HSOP-6J and TO-252-5-P2 with high power dissipation.

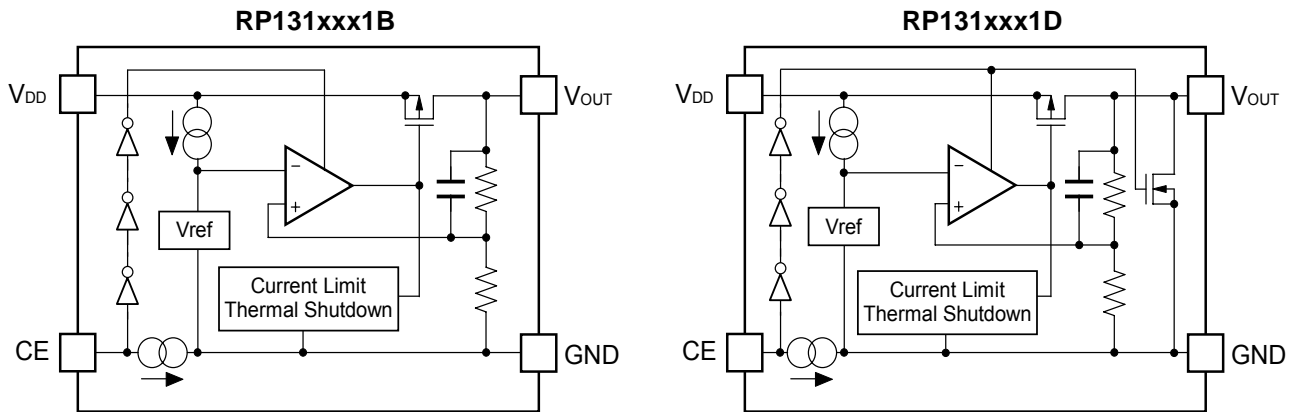
FEATURES

- Output Current Min. 1A
- Supply Current Typ. 65 μ A
- Standby Current Typ. 0.15 μ A
- Input Voltage Range 1.6V to 6.5V
- Output Voltage Range 0.8V to 5.0V (0.1V steps)
(For other voltages, please refer to MARK INFORMATIONS.)
- Dropout Voltage..... Typ. 0.5V ($V_{OUT}=2.8V$, $I_{OUT}=1A$)
- Ripple Rejection Typ. 70dB ($f=1kHz$, $V_{OUT}=2.8V$)
- Output Voltage Accuracy $\pm 1.0\%$
- Temperature-Drift Coefficient of Output Voltage Typ. $\pm 100ppm/^{\circ}C$
- Line Regulation Typ. 0.05%/V
- Load Regulation Typ. 20mV at $I_{OUT}=300mA$, Typ. 80mV at $I_{OUT}=1A$
- Packages DFN(PLP)1820-6, SOT-89-5, HSOP-6J, TO-252-5-P2
- Built-in Inrush current limit circuit Typ. 500mA
- Built-in Fold-Back Protection Circuit Typ. 250mA (Current at short mode)
- Built-in Thermal Shutdown Circuit Thermal Shutdown Temperature ; Typ. 165 $^{\circ}C$
Released Temperature ; Typ. 135 $^{\circ}C$
- Built-in Auto Discharge Function D version
- Ceramic capacitors are recommended to be used with this IC 2.2 μ F or more ($V_{OUT}\leq 3.6V$)
4.7 μ F or more ($V_{OUT}> 3.6V$)

APPLICATIONS

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

BLOCK DIAGRAMS



SELECTION GUIDE

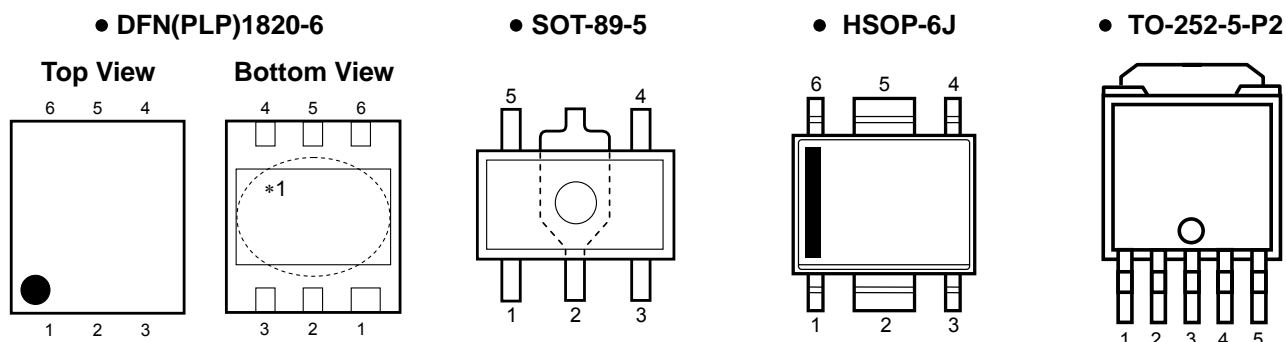
The output voltage, auto discharge function, package for the ICs can be selected at the user's request.

| Product Name | Package | Quantity per Reel | Pb Free | Halogen Free |
|------------------|----------------|-------------------|---------|--------------|
| RP131Kxx1*-TR | DFN(PLP)1820-6 | 5,000 pcs | Yes | Yes |
| RP131Hxx1*-T1-FE | SOT-89-5 | 1,000 pcs | Yes | Yes |
| RP131Sxx1*-E2-FE | HSOP-6J | 1,000 pcs | Yes | Yes |
| RP131Jxx1*-T1-FE | TO-252-5-P2 | 3,000 pcs | Yes | Yes |

xx : The output voltage can be designated in the range from 0.8V(08) to 5.0V(50) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

* : The auto discharge function at off state are options as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state

PIN CONFIGURATIONS



PIN DESCRIPTIONS

• DFN(PLP)1820-6

| Pin No. | Symbol | Pin Description |
|---------|-----------|------------------------------|
| 1 | V_{OUT} | Output Pin *2 |
| 2 | V_{OUT} | Output Pin *2 |
| 3 | GND | Ground Pin |
| 4 | CE | Chip Enable Pin ("H" Active) |
| 5 | V_{DD} | Input Pin *2 |
| 6 | V_{DD} | Input Pin *2 |

*1) 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.

*2) When you use this IC, please make sure be wired with 1pin with 2pin and 5pin with 6pin.

• SOT-89-5

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

• HSOP-6J

| Pin No. | Symbol | Pin Description |
|---------|-----------|------------------------------|
| 1 | V_{OUT} | Output Pin |
| 2 | GND | Ground Pin *3 |
| 3 | NC | No Connection |
| 4 | CE | Chip Enable Pin ("H" Active) |
| 5 | GND | Ground Pin *3 |
| 6 | V_{DD} | Input Pin |

*3) When you use this IC, please make sure be wired with 2pin and 5pin.

RP131x

• TO-252-5-P2

| Pin No. | Symbol | Pin Description |
|---------|------------------|------------------------------|
| 1 | V _{OUT} | Output Pin |
| 2 | GND | Ground Pin *4 |
| 3 | GND | Ground Pin *4 |
| 4 | CE | Chip Enable Pin ("H" Active) |
| 5 | V _{DD} | Input Pin |

*4) When you use this IC, please make sure be wired with 2pin and 3pin.

ABSOLUTE MAXIMUM RATINGS

| Symbol | Item | Rating | Unit |
|------------------|-------------------------------------|------------------------------|------|
| V _{IN} | Input Voltage | 7.0 | V |
| V _{CE} | Input Voltage (CE Pin) | -0.3 to 7.0 | V |
| V _{OUT} | Output Voltage | -0.3 to V _{IN} +0.3 | V |
| P _D | Power Dissipation (DFN(PLP)1820-6)* | 880 | mW |
| | Power Dissipation (SOT-89-5)* | 900 | |
| | Power Dissipation (HSOP-6J)* | 1700 | |
| | Power Dissipation (TO-252-5-P2)* | 1900 | |
| 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

$V_{IN} = \text{Set } V_{OUT} + 1V$

The specification in is checked and guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$, unless otherwise noted.

• RP131xxx1B/D

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

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit | |
|---|---|---|--|--------------------------------|------------------------------|--------------------------------|----|
| V_{OUT} | Output Voltage | $T_{\text{opt}} = 25^{\circ}\text{C}$ | $V_{\text{OUT}} > 1.5\text{V}$ | $\times 0.99$ | | $\times 1.01$ | V |
| | | | $V_{\text{OUT}} \leq 1.5\text{V}$ | -15 | | 15 | mV |
| | | $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$ | $V_{\text{OUT}} > 1.5\text{V}$ | <input type="checkbox"/> 0.974 | | <input type="checkbox"/> 1.018 | V |
| | | | $V_{\text{OUT}} \leq 1.5\text{V}$ | <input type="checkbox"/> -40 | | <input type="checkbox"/> 27 | mV |
| $\frac{\Delta V_{\text{OUT}}}{\Delta I_{\text{OUT}}}$ | Load Regulation | $0.1\text{mA} \leq I_{\text{OUT}} \leq 300\text{mA}$ | | 20 | <input type="checkbox"/> 40 | mV | |
| | | $0.1\text{mA} \leq I_{\text{OUT}} \leq 1\text{A}$ | | 80 | <input type="checkbox"/> 120 | | |
| V_{DIF} | Dropout Voltage | Refer to the following table | | | | | |
| I_{SS} | Supply Current | $I_{\text{OUT}} = 0\text{mA}$ ($V_{\text{IN}} = 6.5\text{V}$) | | 65 | <input type="checkbox"/> 90 | μA | |
| I_{standby} | Standby Current | $V_{\text{CE}} = 0\text{V}$, $V_{\text{IN}} = 6.5\text{V}$ | | 0.15 | 0.60 | μA | |
| $\frac{\Delta V_{\text{OUT}}}{\Delta V_{\text{IN}}}$ | Line Regulation | Set $V_{\text{OUT}} + 0.5\text{V} \leq V_{\text{IN}} \leq 6.5\text{V}$ *If $V_{\text{OUT}} \leq 1.1\text{V}$, $V_{\text{IN}} = 1.6\text{V}$ | | 0.05 | <input type="checkbox"/> 0.1 | %/V | |
| RR | Ripple Rejection | Ripple 0.2Vp-p $I_{\text{OUT}} = 100\text{mA}$ | $f = 1\text{kHz}$ ($V_{\text{OUT}} \leq 3.3\text{V}$) | | 70 | dB | |
| | | | $f = 1\text{kHz}$ ($V_{\text{OUT}} > 3.3\text{V}$) | | 60 | | |
| V_{IN} | Input Voltage | | <input type="checkbox"/> 1.6 | | <input type="checkbox"/> 6.5 | V | |
| $\frac{\Delta V_{\text{OUT}}}{\Delta T_{\text{opt}}}$ | Output Voltage Temperature Coefficient | $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$ | | ± 100 | | ppm/ $^{\circ}\text{C}$ | |
| I_{LIM} | Output Current Limit | | <input type="checkbox"/> 1 | | | A | |
| I_{SC} | Short Current Limit | $V_{\text{OUT}} = 0\text{V}$ | | 250 | | mA | |
| I_{PD} | CE Pull-down Current | | | 0.3 | | μA | |
| V_{CEH} | CE Input Voltage "H" | | <input type="checkbox"/> 1.0 | | | V | |
| V_{CEL} | CE Input Voltage "L" | | | | <input type="checkbox"/> 0.4 | V | |
| e_{n} | Output Noise | $\text{BW} = 10\text{Hz to } 100\text{kHz}$, $I_{\text{OUT}} = 1\text{mA}$ | | 45 | | μV_{rms} | |
| T_{TSD} | Thermal Shutdown Temperature | Junction Temperature | | 165 | | $^{\circ}\text{C}$ | |
| T_{TSR} | Thermal Shutdown Released Temperature | Junction Temperature | | 135 | | $^{\circ}\text{C}$ | |
| R_{LOW} | Low Output Nch Tr. ON Resistance (of D version) | $V_{\text{IN}} = 4.0\text{V}$, $V_{\text{CE}} = 0\text{V}$ | | 30 | | Ω | |

The specification in is checked and guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$, unless otherwise noted.

All of unit are tested and specified under load conditions such that $T_j \approx T_{\text{opt}} = 25^{\circ}\text{C}$ except for Output Noise, Ripple Rejection, Output Voltage Temperature Coefficient, Dropout Voltage at 1A Output Current and Thermal Shutdown items.

• Dropout Voltage by Output Voltage

T_{opt}=25°C

| Output Voltage V _{OUT} (V) | Dropout Voltage V _{DIF} (V) | | | | | |
|--|--------------------------------------|-------|-------|----------------------|-------|-------|
| | Condition | Typ. | Max. | Condition | Typ. | Max. |
| 0.8 ≤ V _{OUT} < 0.9 | I _{OUT} =300mA | 0.600 | 0.780 | I _{OUT} =1A | 1.100 | 1.650 |
| 0.9 ≤ V _{OUT} < 1.0 | | 0.550 | 0.690 | | 1.050 | 1.500 |
| 1.0 ≤ V _{OUT} < 1.1 | | 0.450 | 0.610 | | 1.000 | 1.450 |
| 1.1 ≤ V _{OUT} < 1.2 | | 0.340 | 0.540 | | 0.930 | 1.420 |
| 1.2 ≤ V _{OUT} < 1.5 | | 0.290 | 0.500 | | 0.900 | 1.380 |
| 1.5 ≤ V _{OUT} < 2.6 | | 0.230 | 0.310 | | 0.700 | 1.100 |
| 2.6 ≤ V _{OUT} < 3.3 | | 0.150 | 0.180 | | 0.500 | 0.750 |
| 3.3 ≤ V _{OUT} ≤ 5.0 | | 0.140 | 0.170 | | 0.450 | 0.650 |

The specification in is checked and guaranteed by design engineering at -40°C ≤ T_{opt} ≤ 85°C, unless otherwise noted.

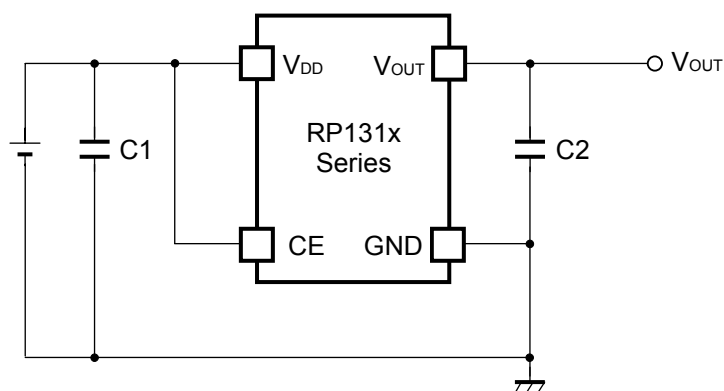
All of unit are tested and specified under load conditions such that T_j ≈ T_{opt} = 25°C except for Output Noise, Ripple Rejection, Output Voltage Temperature Coefficient, Dropout Voltage at 1A Output Current and Thermal Shutdown items.

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



Recommendation value of the external capacitors

| V_{OUT} | Capacitors | |
|---------------------|------------|--|
| $V_{OUT} \leq 3.6V$ | C1 | Kyocera 2.2 μ F (size:1005) [CM05X5R225M04AB] |
| | C2 | Kyocera 2.2 μ F (size:1608) [CM105X5R225K06AB] |
| $V_{OUT} > 3.6V$ | C1 | Kyocera 2.2 μ F (size:1608) [CM105X5R225K06AB] |
| | C2 | Kyocera 4.7 μ F (size:1608) [CM105X5R475M06AB] |

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).

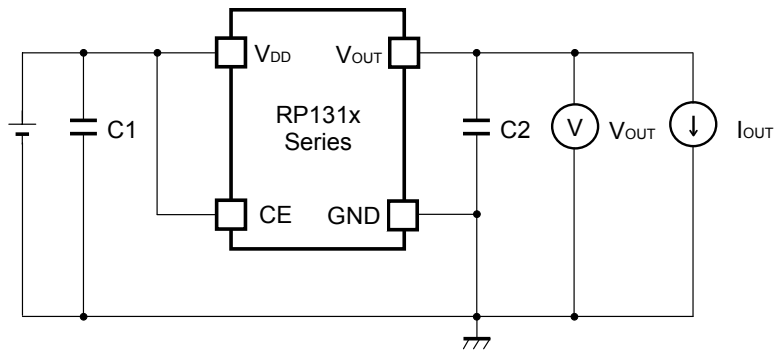
If a tantalum capacitor is used, and its ESR of C2 is large, the loop oscillation may result. Because of this, select C2 carefully considering its frequency characteristics.

PCB Layout

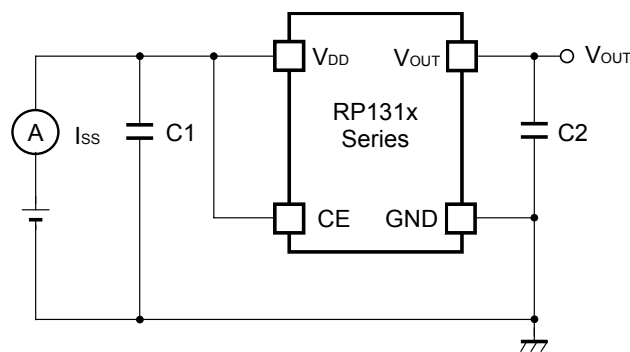
Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 between V_{DD} and GND pin with a capacitance value as "Recommendation value of the external capacitors" above or more, and as close as possible to the pins.

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

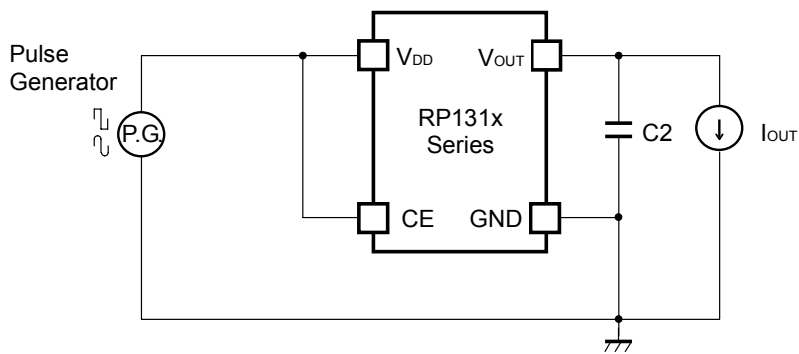
TEST CIRCUITS



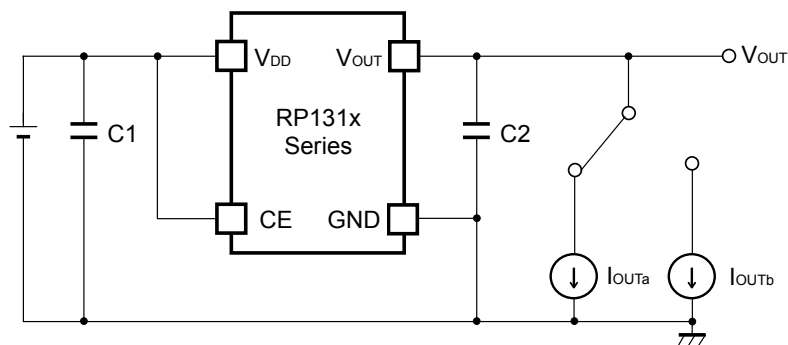
Basic Test Circuit



Test Circuit for Supply Current



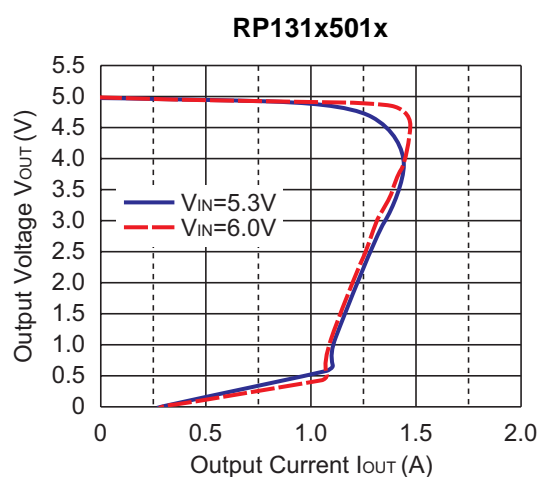
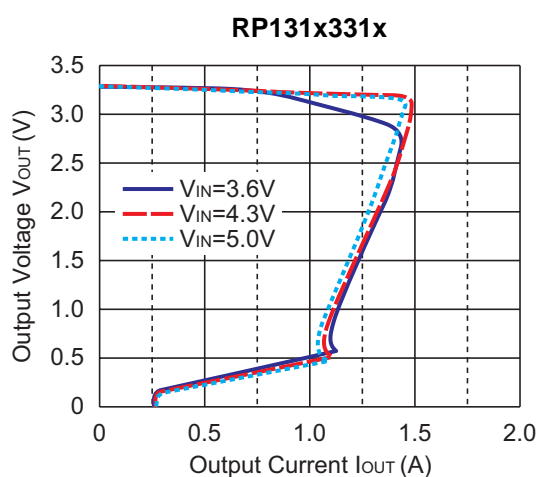
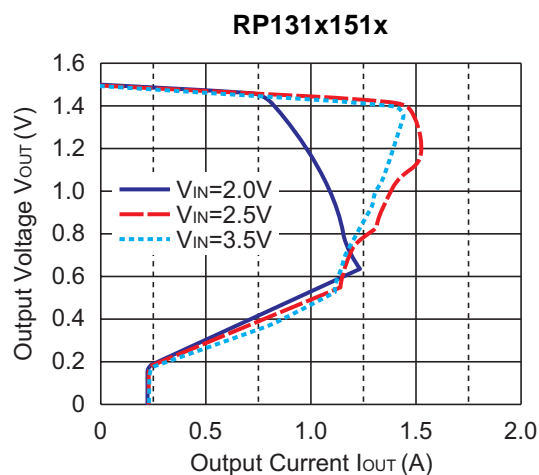
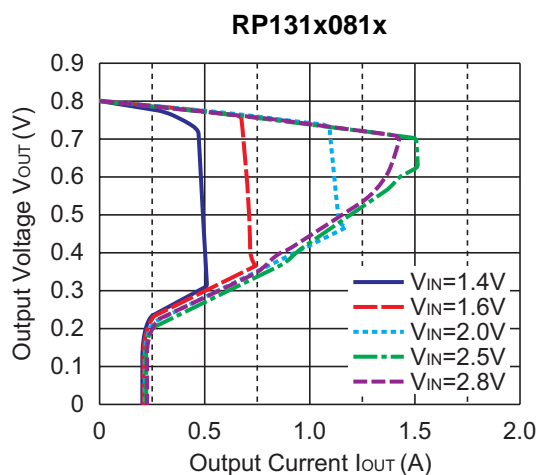
Test Circuit for Ripple Rejection



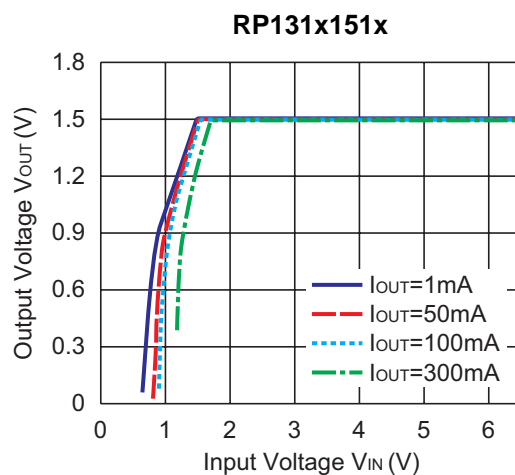
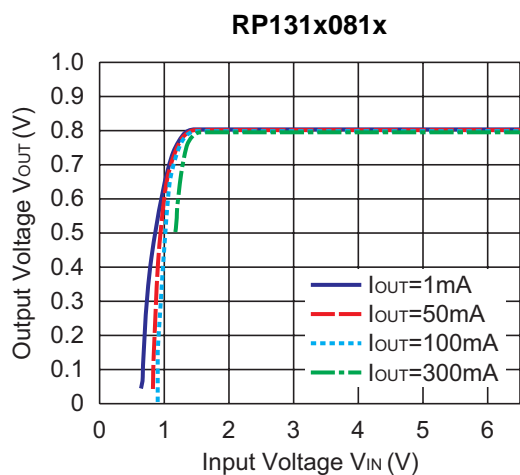
Test Circuit for Load Transient Response

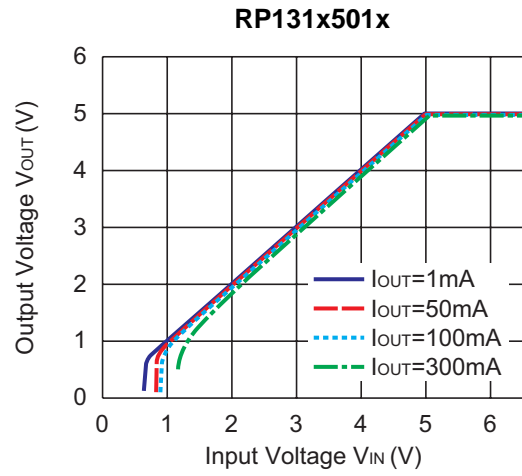
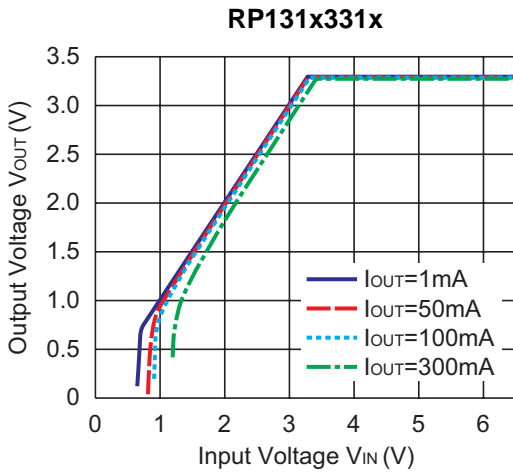
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current ($T_{opt}=25^{\circ}\text{C}$)

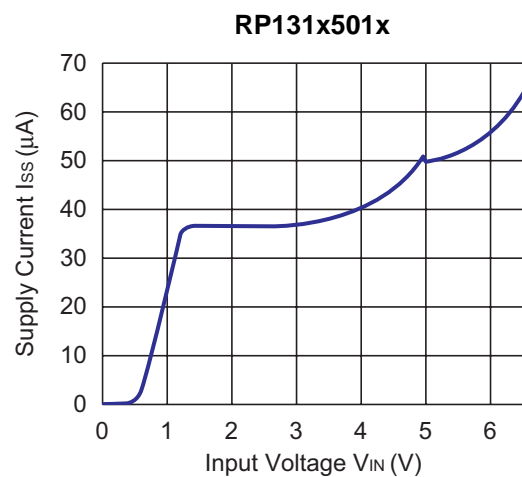
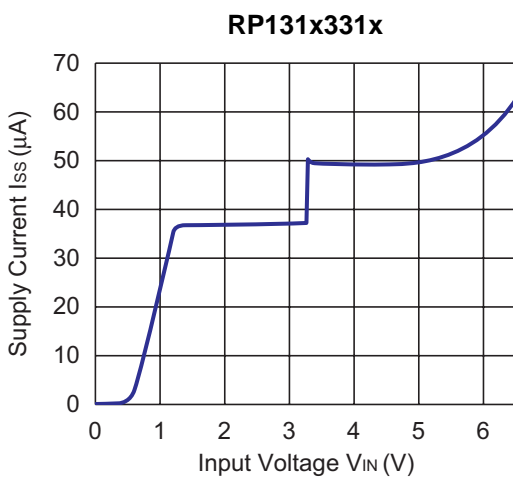
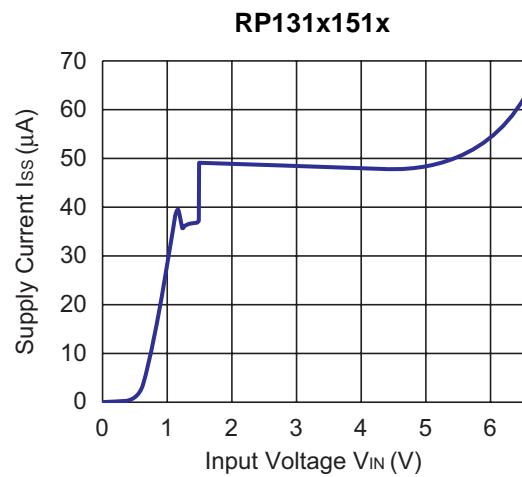
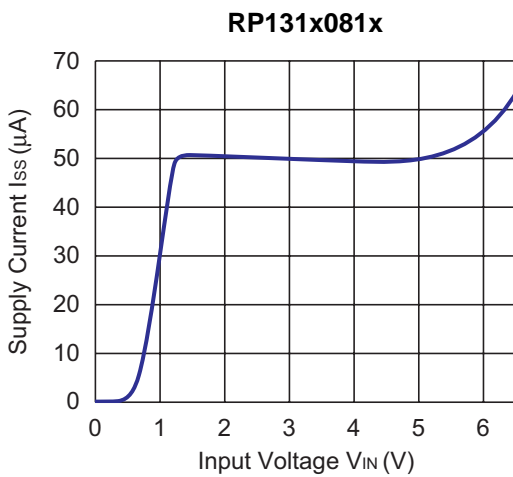


2) Output Voltage vs. Input Voltage ($T_{opt}=25^{\circ}\text{C}$)

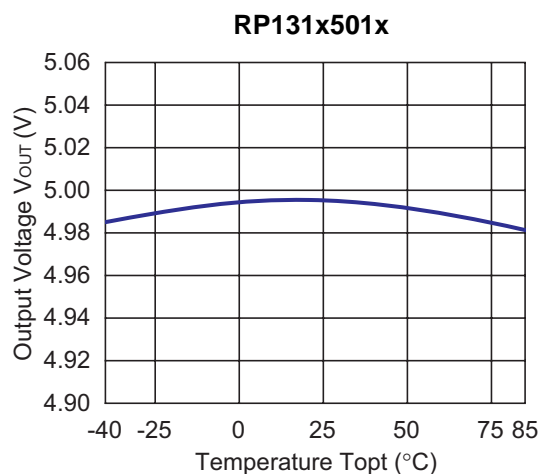
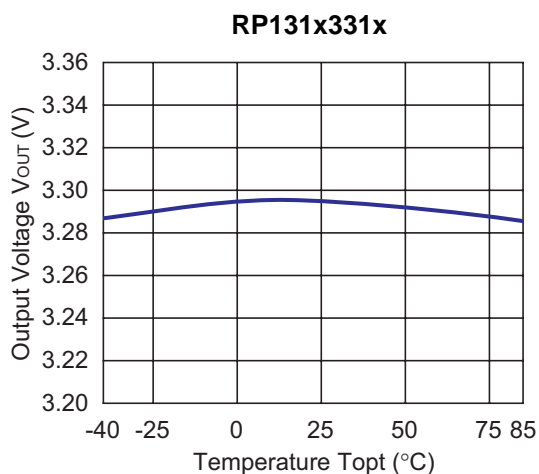
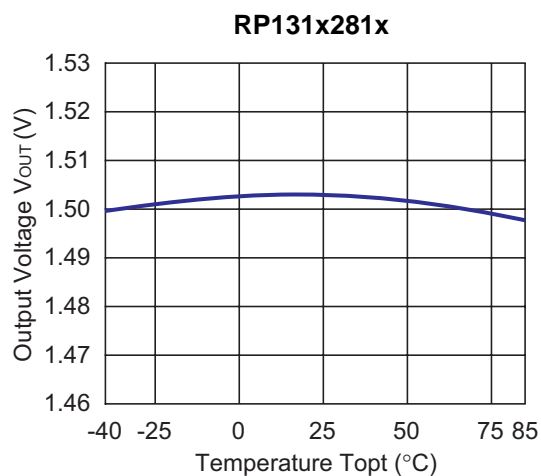
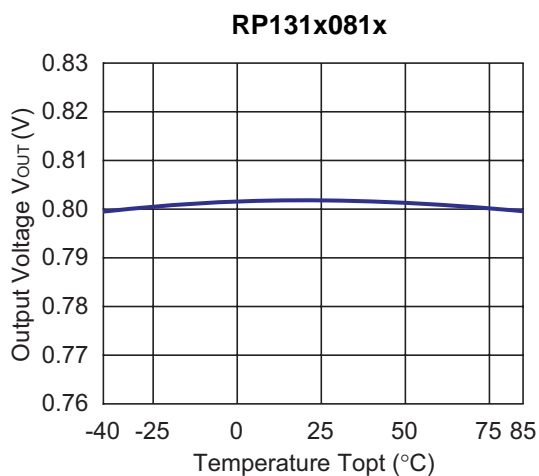




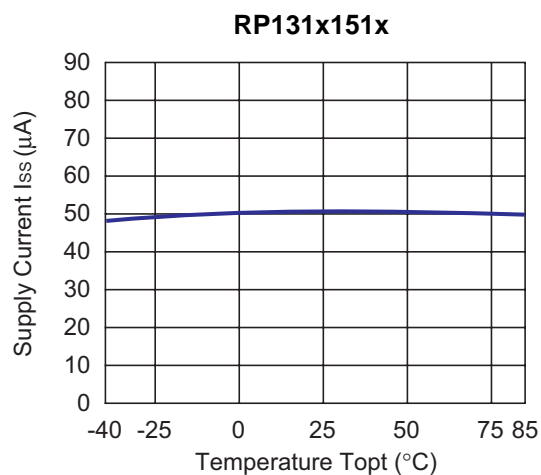
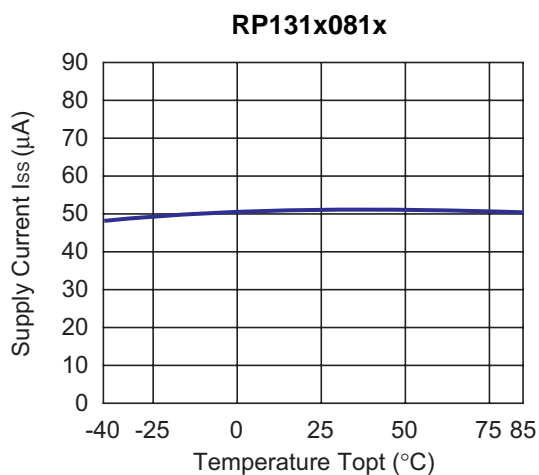
3) Supply Current vs. Input Voltage ($T_{opt}=25^{\circ}\text{C}$)



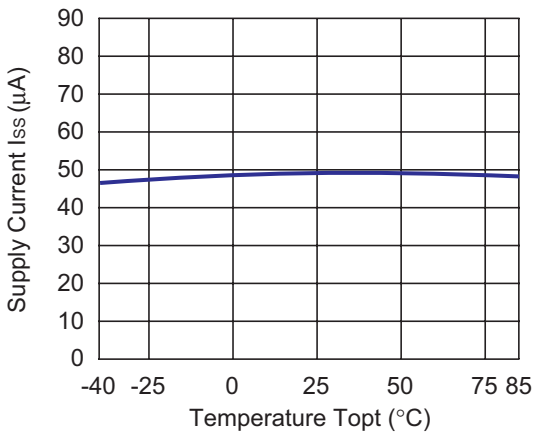
4) Output Voltage vs. Temperature



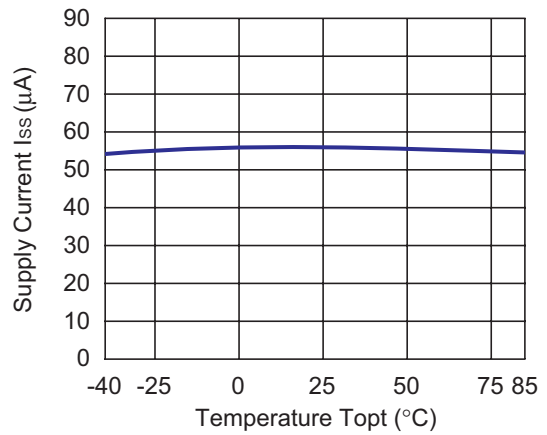
5) Supply Current vs. Temperature



RP131x331x

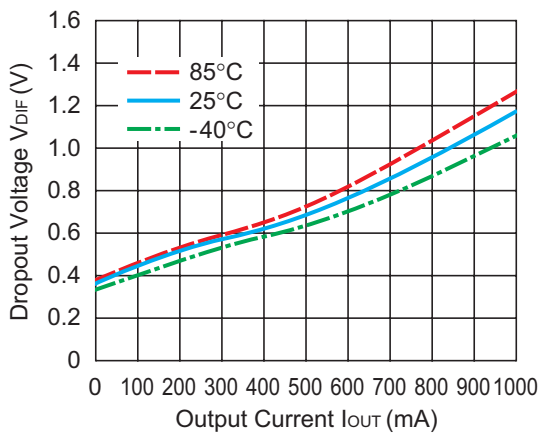


RP131x501x

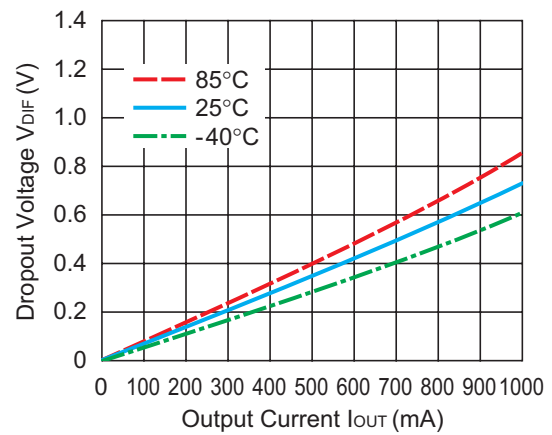


6) Dropout Voltage vs. Output Current

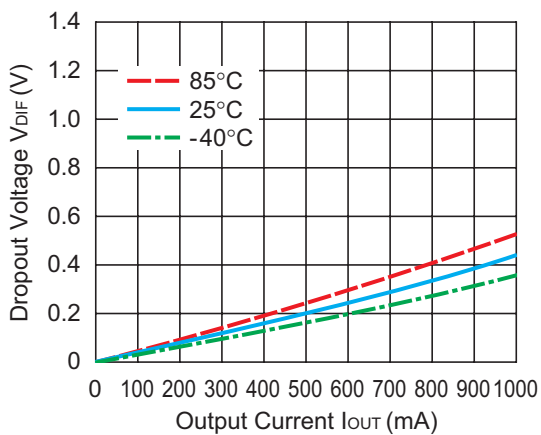
RP131x081x



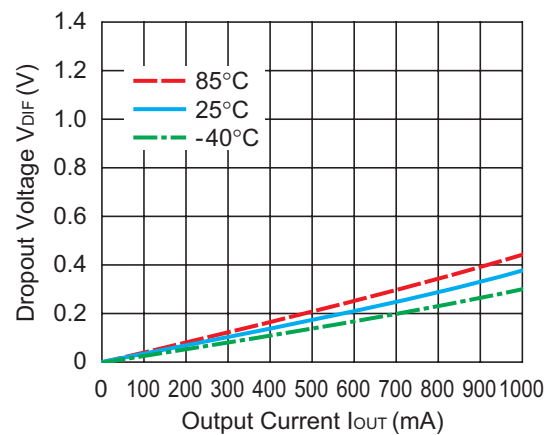
RP131x151x



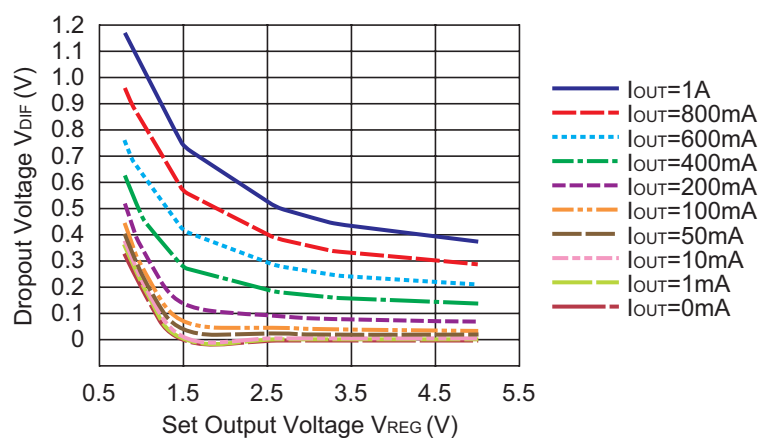
RP131x331x



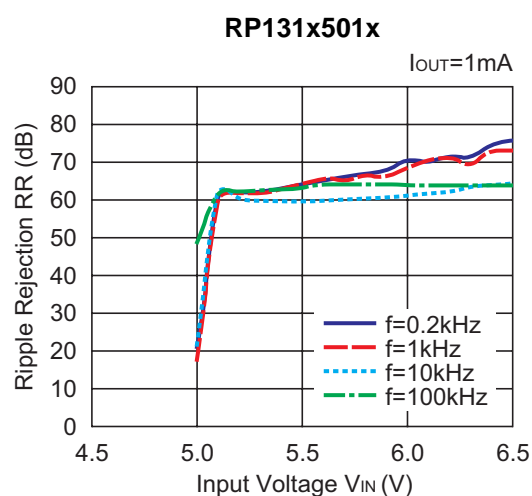
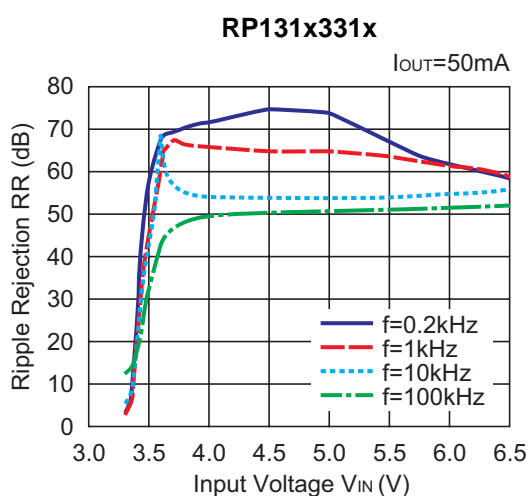
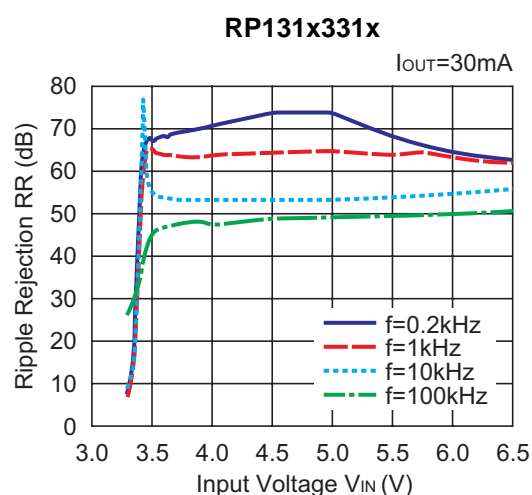
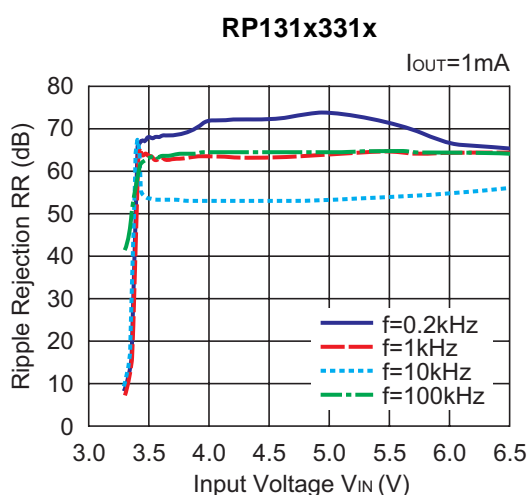
RP131x501x

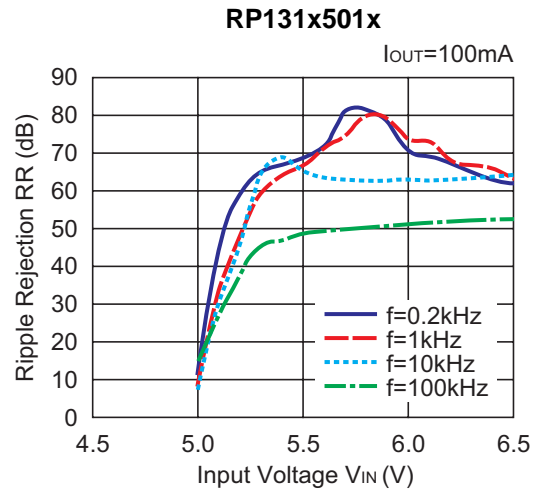
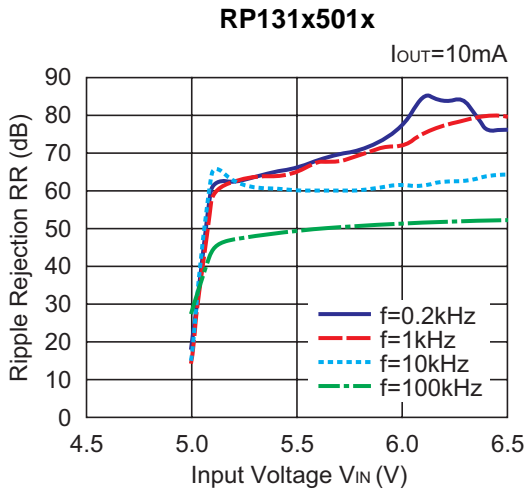


7) Dropout Voltage vs. Set Output Voltage

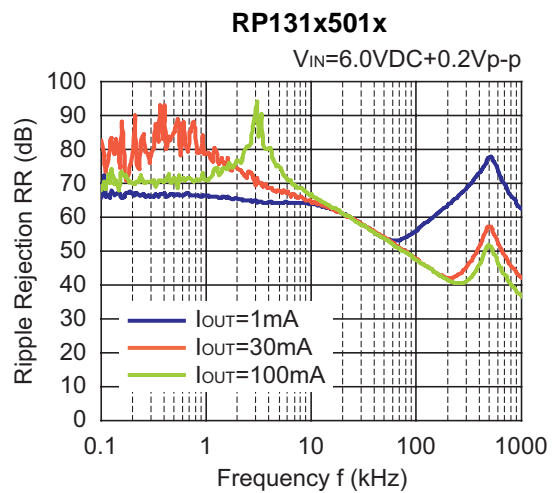
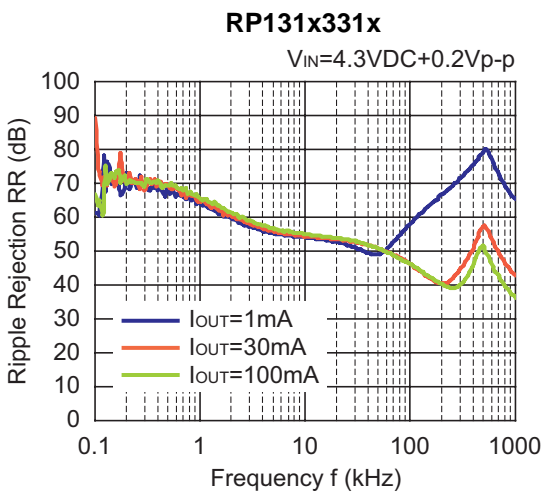
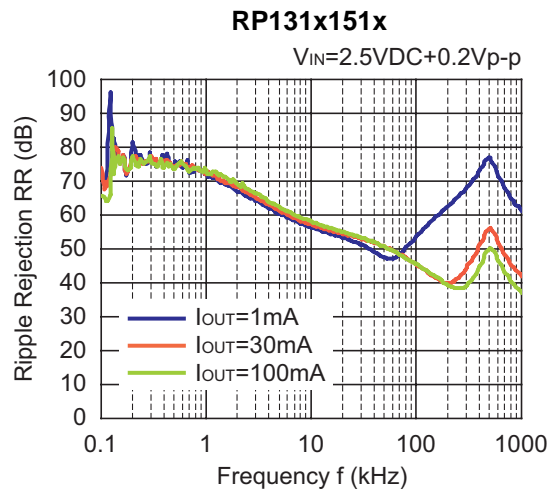
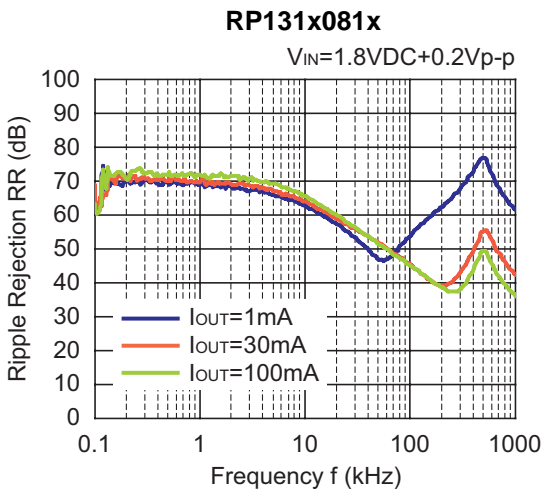


8) Ripple Rejection vs. Input Bias Voltage (C_1 =none, C_2 =Ceramic $1.0\mu F$, Ripple= $0.2V_{pp}$, $T_{opt}=25^\circ C$)

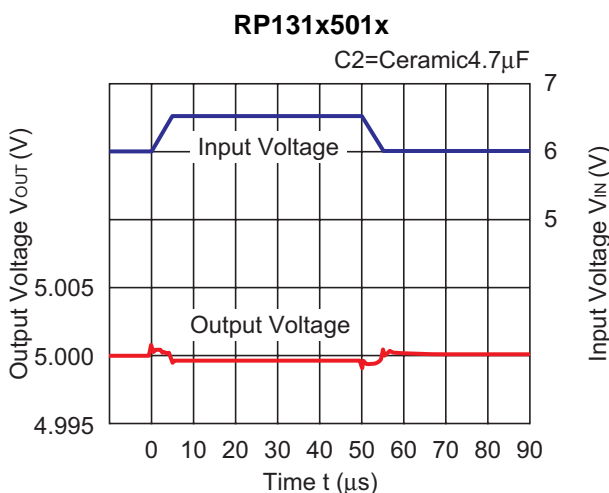
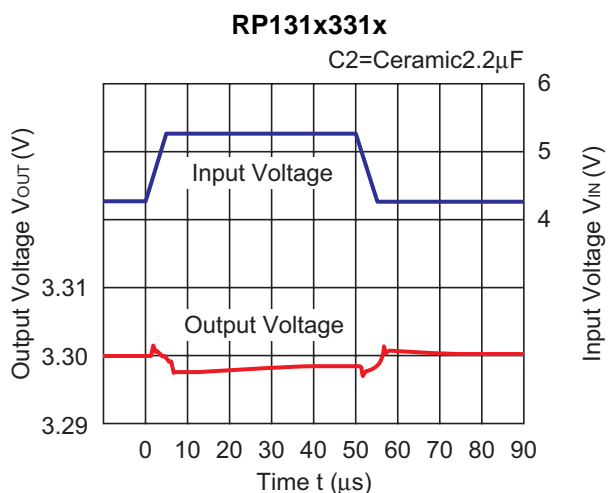
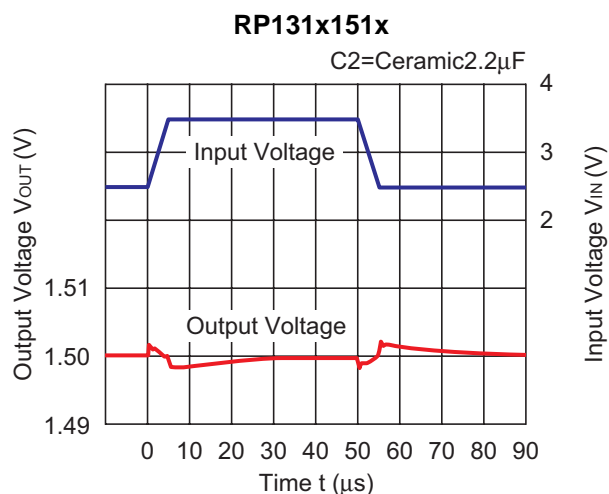
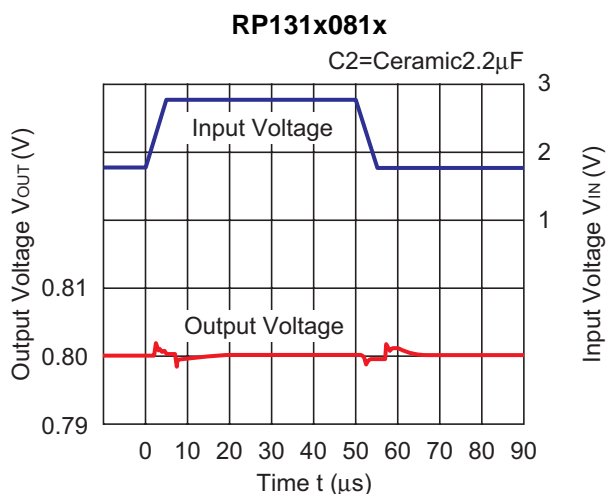




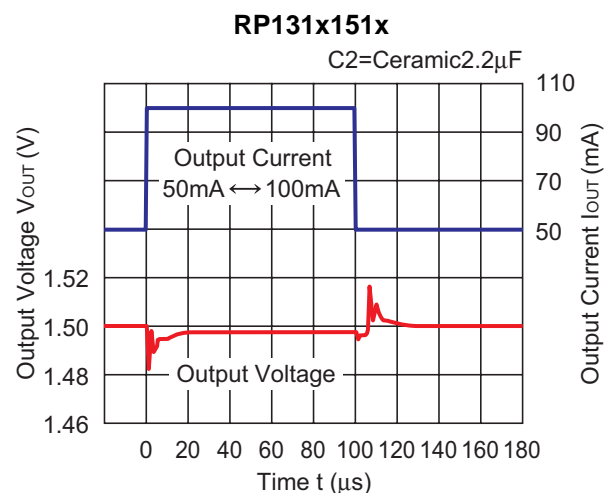
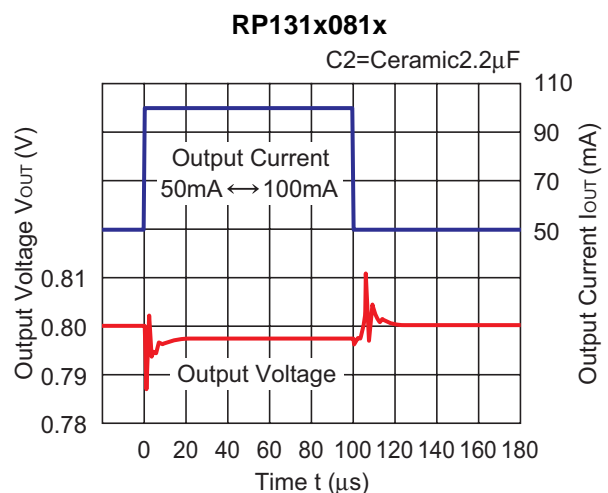
9) Ripple Rejection vs. Frequency ($C1=none$, $C2=Ceramic\ 4.7\mu F$, $T_{opt}=25^{\circ}C$)

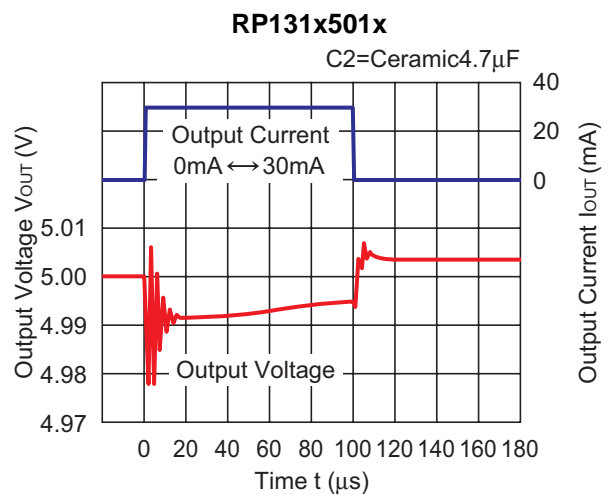
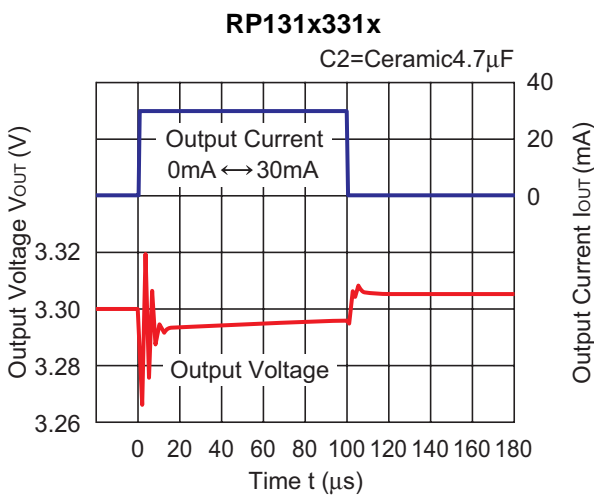
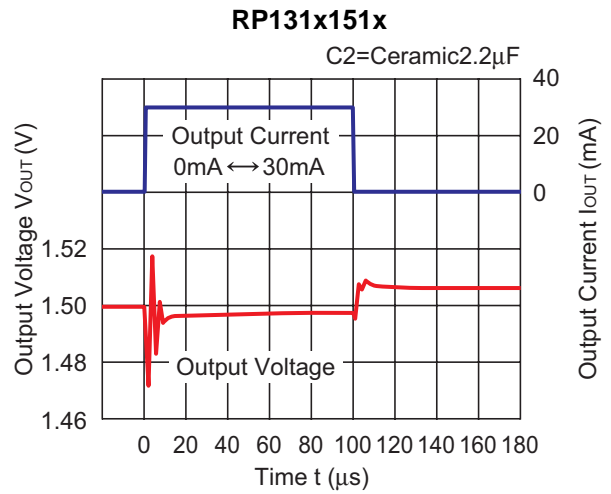
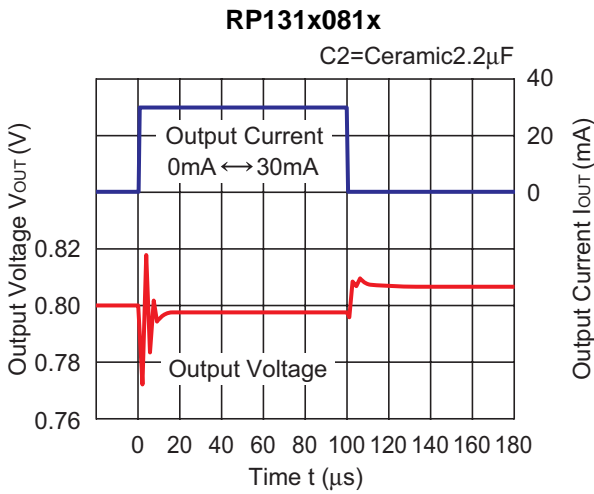
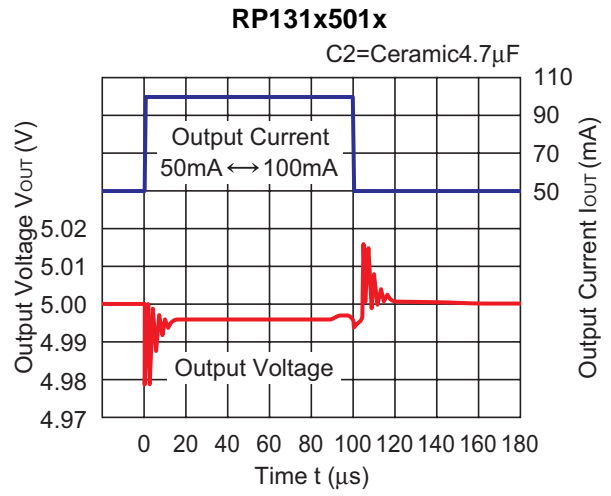
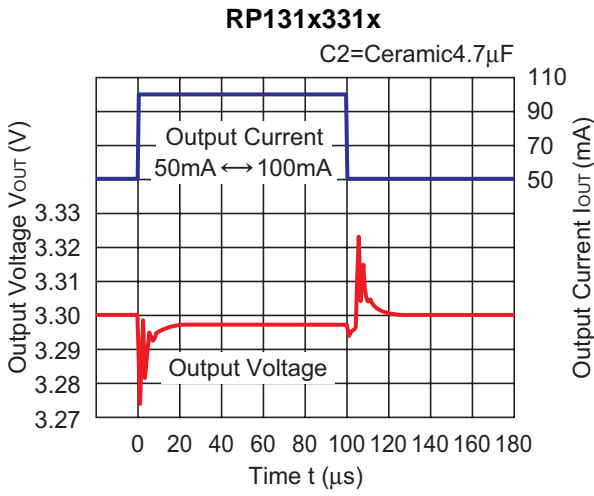


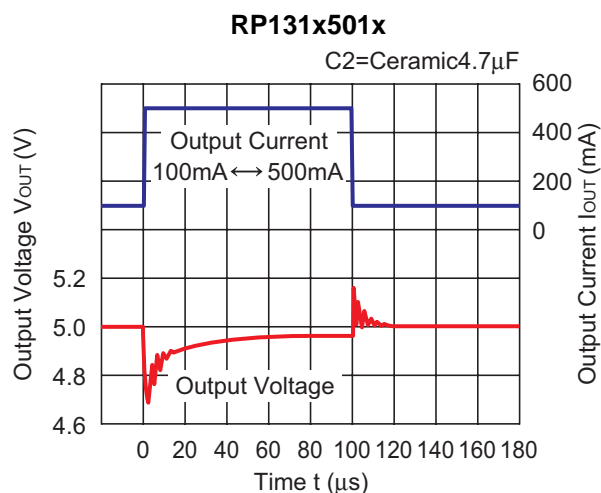
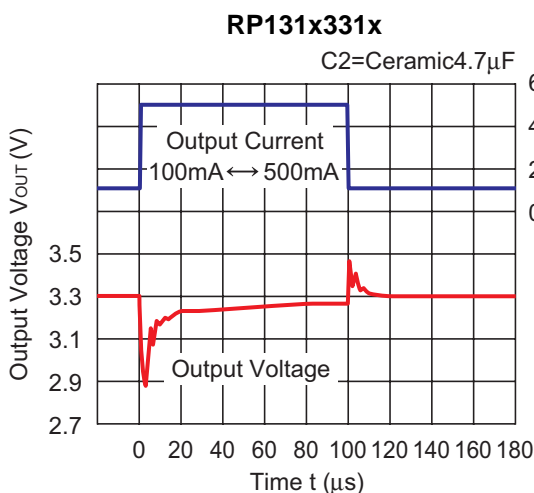
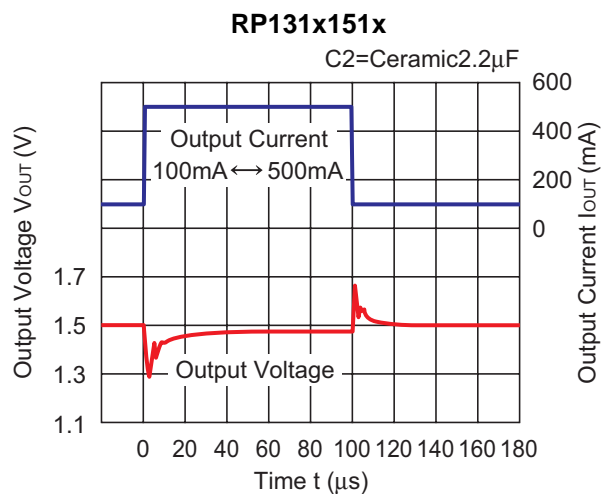
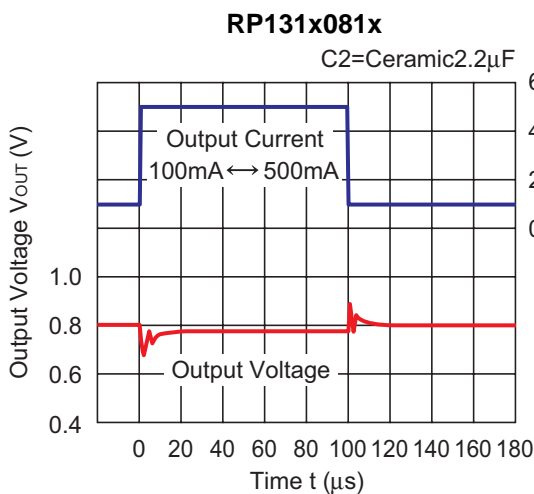
10) Input Transient Response ($I_{OUT}=100mA$, $t_r=t_f=5\mu s$, $C_1=none$, $T_{opt}=25^\circ C$)



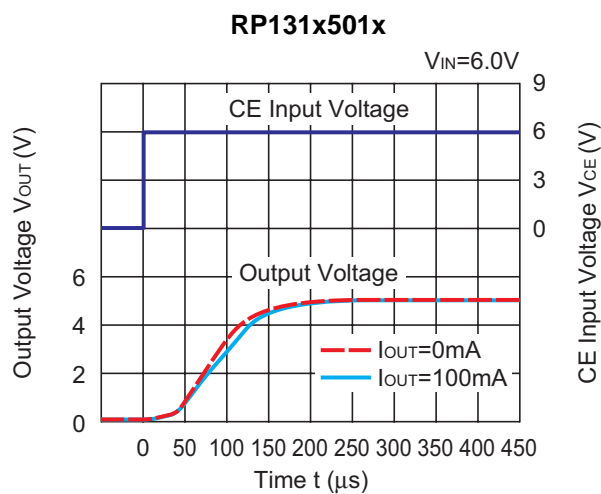
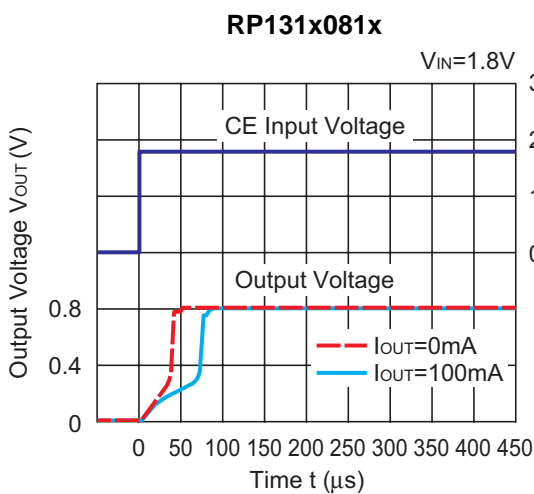
11) Load Transient Response ($t_r=t_f=0.5\mu s$, $C_1=Ceramic\ 2.2\mu F$, $V_{IN}=V_{OUT}+1.0V$, $T_{opt}=25^\circ C$)





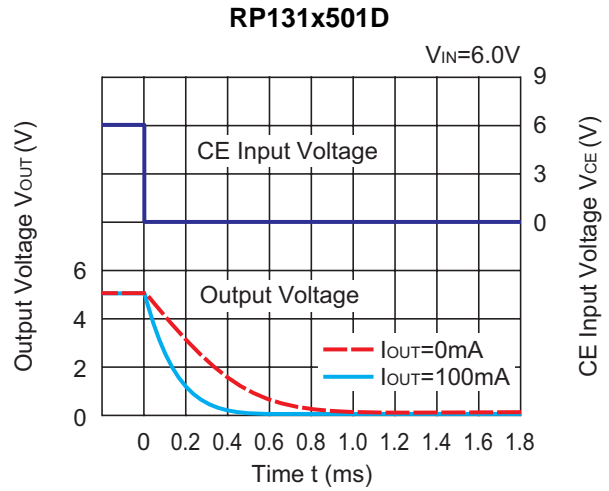
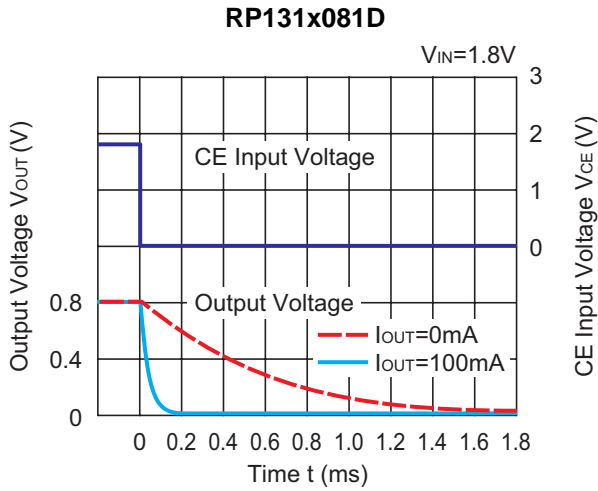


12) Turn On Speed with CE pin (C1=Ceramic 2.2 μ F, C2=Ceramic 4.7 μ F, T_{opt}=25°C)

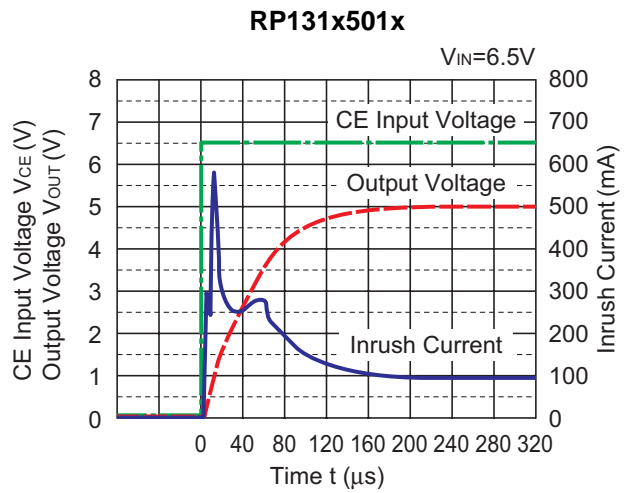
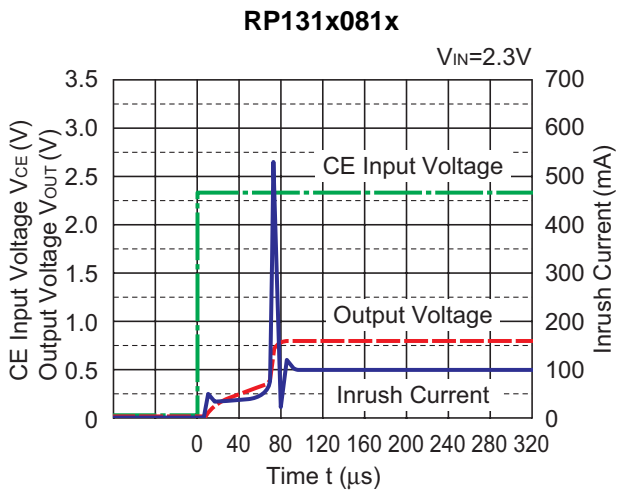


RP131x

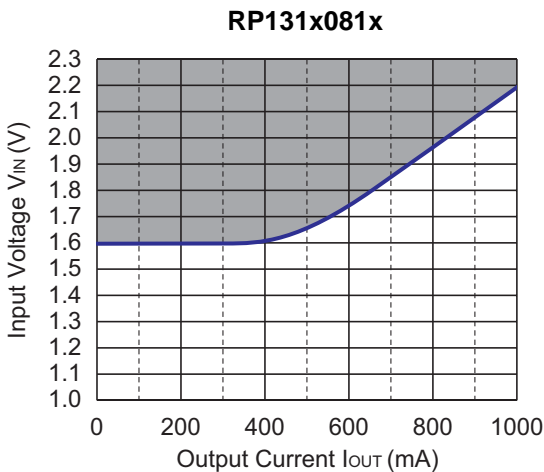
13) Turn Off Speed with CE pin (D Version) (C1=Ceramic 2.2μF, C2=Ceramic 4.7μF, T_{opt}=25°C)



14) Inrush Current at turning on (C1=Ceramic 2.2μF, C2=Ceramic 4.7μF, T_{opt}=25°C)



15) Minimum Operating Voltage



Hatched area is available for 0.8V output.

ESR vs. Output Current

When using these ICs, consider the following points:

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 $40\mu V$ (Avg.) are marked as the hatched area in the graph.

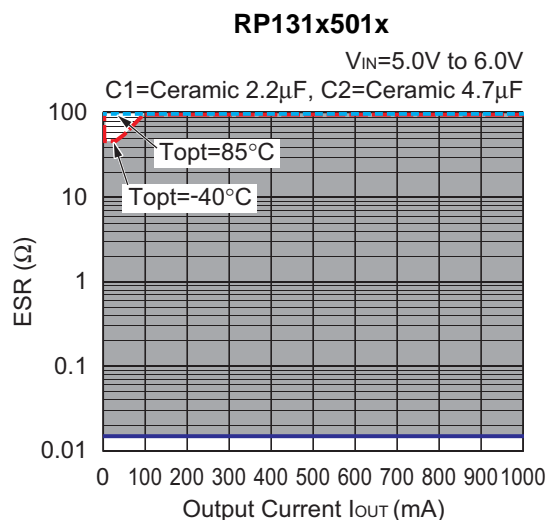
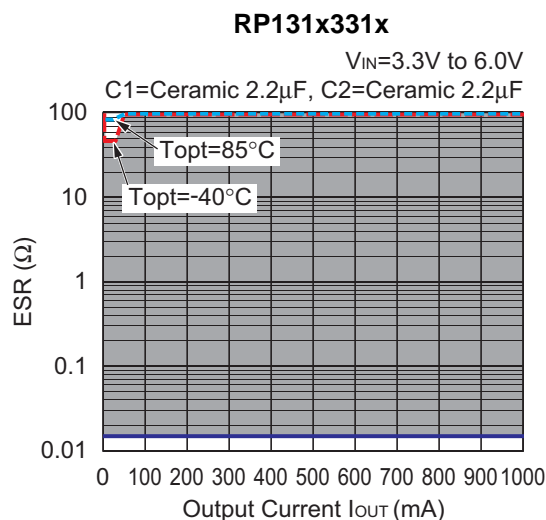
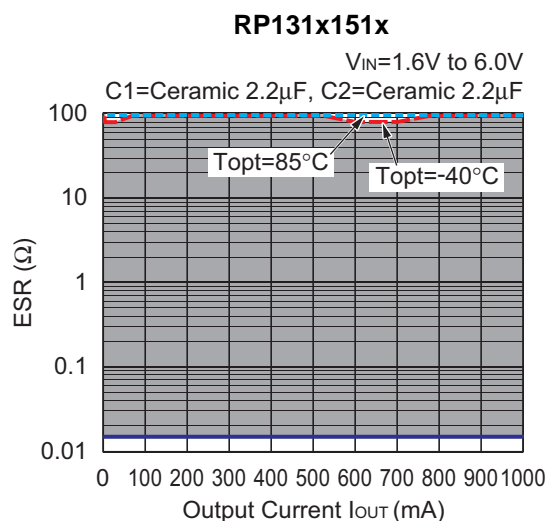
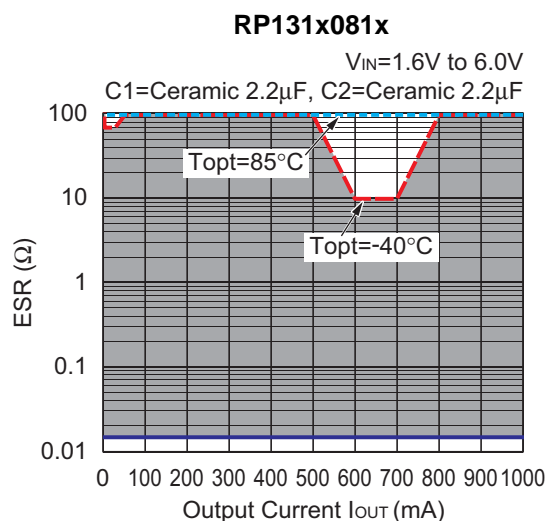
Measurement conditions

Frequency Band : 10Hz to 3MHz

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

C1 : $2.2\mu F$ (Kyocera, CM05X5R225M04AD)

C2 : $2.2\mu F$ (Kyocera, CM105X5R225K06AE)
 $4.7\mu F$ (Kyocera, CM105X5R475M06AB)





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The Ricoh Group was awarded ISO 14001 certification, which is an international standard for environmental management systems, at both its domestic and overseas production facilities. Our current aim is to obtain ISO 14001 certification for all of our business offices.

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RICOH COMPANY, LTD. Electronic Devices Company

● **Shin-Yokohama office (International Sales)**
3-2-3, Shin-Yokohama, Kohoku-ku, Yokohama City, Kanagawa 222-8530, Japan
Phone: +81-45-477-1697 Fax: +81-45-477-1698

RICOH EUROPE (NETHERLANDS) B.V.

● **Semiconductor Support Centre**
Prof. W.H.Keesomlaan 1, 1183 DL Amstelveen, The Netherlands
P.O.Box 114, 1180 AC Amstelveen
Phone: +31-20-5474-309 Fax: +31-20-5474-791

RICOH ELECTRONIC DEVICES KOREA Co., Ltd.

11 floor, Haesung 1 building, 942, Daechidong, Gangnamgu, Seoul, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2135-5705

RICOH ELECTRONIC DEVICES SHANGHAI Co., Ltd.

Room403, No.2 Building, 690#Bi Bo Road, Pu Dong New district, Shanghai 201203,
People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

RICOH COMPANY, LTD. Electronic Devices Company

● **Taipei office**
Room109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623



Ricoh completed the organization of the Lead-free production for all of our products. 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.