

3-MODE 300mA LDO REGULATOR

NO.EA-182-090714

OUTLINE

The RP200x Series consist of CMOS-based voltage regulator ICs with high output voltage accuracy, low dropout voltage and low supply current. These ICs perform with the chip enable function and realize a standby mode with ultra low supply current. To prevent the destruction by over current, the current limit circuit is included. The RP200x Series have 3-mode. One is standby mode with CE pin. Other two modes are realized with ECO Function. Fast Response Mode (Fast Mode) and Fast and Low Power auto-change Mode (Auto ECO Mode) are alternative with Auto Eco pin (AE pin). Supply current of IC itself at light load is automatically reduced at Auto ECO Mode compared with Fast Mode. The output voltage is maintained between Fast Mode and Auto ECO Mode.

Without AE pin type is also available. It is an LDO regulator with Auto ECO mode. (RP200Z in WLCSP.)

Since the packages for these ICs are SOT-23-5, SC-88A, thin DFN(PLP)1212-6, and WLCSP-4-P5, high density mounting of the ICs on boards is possible. RP200Q (SC-88A), RP200K (DFN(PLP)1212-6) and RP200N (SOT-23-5) has AE pin, then if the AE pin is "H", Fast Mode is available. If the AE pin is set at "L" level, Auto ECO Mode operation is available.

FEATURES

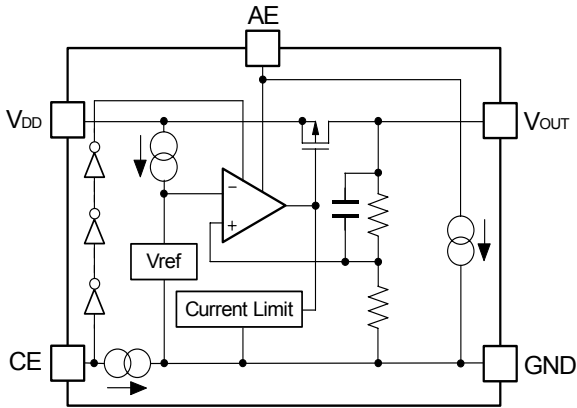
- Supply Current (Low power Mode) Typ. 1.0 μ A ($V_{OUT} \leq 1.85V$)
- Supply Current (Fast Mode)..... Typ. 55 μ A
- Supply Current (Standby Mode)..... Typ. 0.1 μ A
- Ripple Rejection Typ. 70dB (f=1kHz)
- Input Voltage Range 1.4V to 5.25V
- Output Voltage Range..... 0.8V to 4.0V
- Output Voltage Accuracy..... $\pm 1.0\%$ ($V_{OUT} > 2.0V$, $T_{opt}=25^{\circ}C$)
- Temperature-Drift Coefficient of Output Voltage Typ. $\pm 50ppm/^{\circ}C$
- Dropout Voltage Typ. 0.23V ($I_{OUT}=300mA$, $V_{OUT}=2.8V$)
- Line Regulation Typ. 0.02%/V
- Packages DFN(PLP)1212-6, SOT-23-5, SC-88A, WLCSP-4-P5
- Built-in Fold Back Protection Circuit Typ. 50mA (Current at short mode)
- Ceramic capacitors are recommended 1.0 μ F

APPLICATIONS

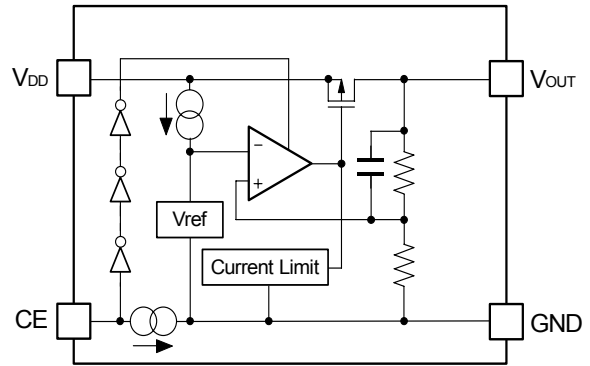
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

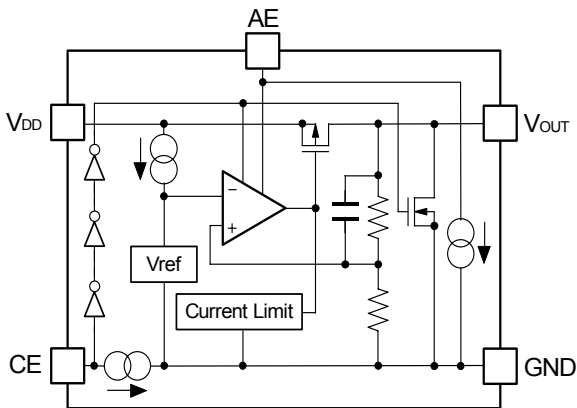
RP200K/N/QxxxB



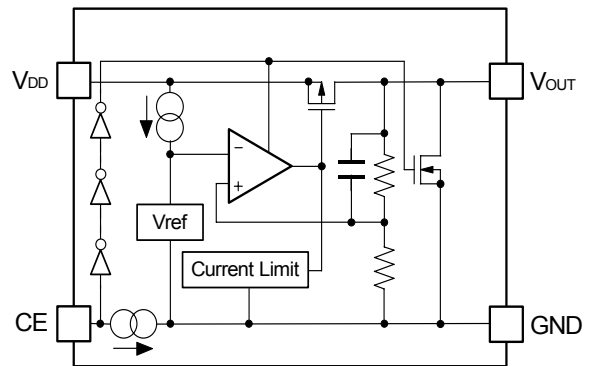
RP200Zxx1B



RP200K/N/QxxxD



RP200Zxx1D



SELECTION GUIDE

The output voltage, auto discharge function*, and the taping type for the ICs can be selected at the user's request.

The selection can be made with designating the part number as shown below;

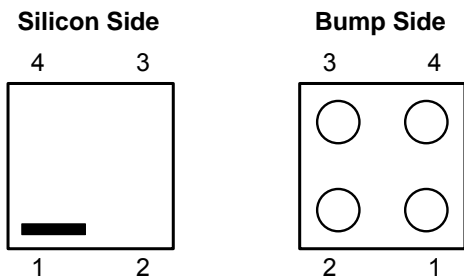
RP200xxxxx-xx-x ←Part Number
 ↑ ↑ ↑ ↑ ↑ ↑
 a b a'c d e

| Code | Contents |
|-------|---|
| a, a' | Designation of Package Type: WLCSP-4-P5 : RP200Zxx1x-xx-x DFN(PLP)1212-6 : RP200Kxx1x-xx-x SC-88A : RP200Qxx2x-xx-x SOT-23-5 : RP200Nxx1x-xx-x |
| b | Setting Output Voltage (V _{OUT}): Stepwise setting with a step of 0.1V in the range of 0.8V to 4.0V is possible. |
| c | Designation of Mask Option B : active high, without auto discharge function* at OFF state. D : active high, with auto discharge function* at OFF state. |
| d | Designation of Taping Type: Ex. TR (Refer to Taping Specifications; TR type is the standard direction.) |
| e | Designation of composition of pin plating: -F: Lead free solder plating (SC-88A, SOT-23-5, WLCSP-4-P5) None: Au plating (DFN(PLP)1212-6) |

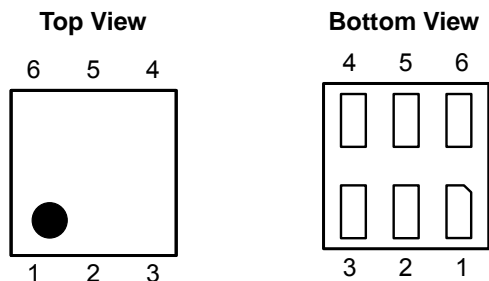
*) When the mode is into standby with CE signal, auto discharge transistor turns on, and it makes the turn-off speed faster than normal type.

PIN CONFIGURATIONS

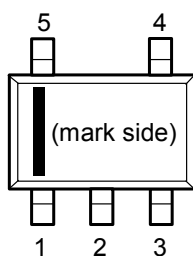
• WLCSP-4-P5



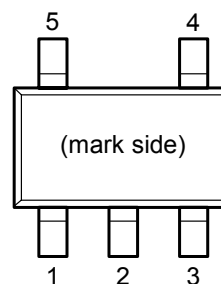
• DFN(PLP)1212-6



• SC-88A



• SOT-23-5



PIN DESCRIPTIONS

• WLCSP-4-P5

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

• DFN(PLP)1212-6

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

• SC-88A

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

• SOT-23-5

| Pin No. | Symbol | Description |
|---------|------------------|------------------------------|
| 1 | V _{DD} | Input Pin |
| 2 | GND | Ground Pin |
| 3 | CE | Chip Enable Pin ("H" Active) |
| 4 | AE | Auto ECO Pin |
| 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) | -0.3 to 6.0 | V |
| V_{AE} | Input Voltage (AE Pin) | -0.3 to 6.0 | V |
| V_{OUT} | Output Voltage | -0.3 to $V_{IN}+0.3$ | V |
| I_{OUT} | Output Current | 400 | mA |
| P_D | Power Dissipation (WLCSP-4-P5) * | 278 | mW |
| | Power Dissipation (DFN(PLP)1212-6) * | 400 | |
| | Power Dissipation (SC-88A) * | 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 to be described.

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} =Set V_{OUT} +1V, I_{OUT} =1mA, C_{IN} = C_{OUT} =1 μ F, unless otherwise noted.

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

• RP200x

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

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit | |
|-----------------------------------|--|---|--|--|---|--|-------------------------|
| V_{OUT} | Output Voltage (Fast Mode) | $I_{OUT}=5\text{mA}$ $T_{opt}=25^{\circ}\text{C}$ | $V_{OUT} > 2.0\text{V}$ | $\times 0.99$ | | $\times 1.01$ | V |
| | | | $V_{OUT} \leq 2.0\text{V}$ | -20 | | 20 | mV |
| | | $I_{OUT}=5\text{mA}$ $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$ | $V_{OUT} > 2.0\text{V}$ | ×0.975 | | ×1.015 | V |
| | | | $V_{OUT} \leq 2.0\text{V}$ | -50 | | 30 | mV |
| I_{OUT} | Output Current | | 300 | | | mA | |
| $\Delta V_{OUT} / \Delta I_{OUT}$ | Load Regulation | $1\text{mA} \leq I_{OUT} \leq 10\text{mA}$ | $V_{OUT} > 2.0\text{V}$ | -1.0 | | 1.0 | % |
| | | | $V_{OUT} \leq 2.0\text{V}$ | -20 | | 20 | mV |
| | | $10\text{mA} \leq I_{OUT} \leq 300\text{mA}$ | | | 35 | 80 | mV |
| V_{DIF} | Dropout Voltage | $I_{OUT}=300\text{mA}$ | $0.8\text{V} \leq V_{OUT} < 0.9\text{V}$ | | 0.62 | 0.85 | V |
| | | | $0.9\text{V} \leq V_{OUT} < 1.0\text{V}$ | | 0.55 | 0.78 | |
| | | | $1.0\text{V} \leq V_{OUT} < 1.5\text{V}$ | | 0.48 | 0.70 | |
| | | | $1.5\text{V} \leq V_{OUT} < 2.6\text{V}$ | | 0.34 | 0.50 | |
| | | | $2.6\text{V} \leq V_{OUT} \leq 4.0\text{V}$ | | 0.23 | 0.35 | |
| I_{SS1} | Supply Current (Low Power Mode) *1 | $I_{OUT}=0\text{mA}$ | $V_{OUT} \leq 1.85\text{V}$ | | 1.0 | 4.0 | μA |
| | | | $V_{OUT} > 1.85\text{V}$ | | 1.5 | 4.0 | |
| I_{SS2} | Supply Current (Fast Mode) | $I_{OUT}=10\text{mA}$ | | | 55 | | μA |
| Istandby | Standby Current | $V_{CE}=\text{GND}$ | | | 0.1 | 1.0 | μA |
| I_{OUTH} | Fast Mode switch-over current | $I_{OUT}=\text{Light load to Heavy load}$ | | | | 8.0 | mA |
| I_{OUTL} | Low Power Mode switch-over current | $I_{OUT}=\text{Heavy load to Light load}$ | | | 1.0 | 2.0 | mA |
| $\Delta V_{OUT} / \Delta V_{IN}$ | Line Regulation | $V_{OUT}+0.5\text{V} \leq V_{IN} \leq 5.0\text{V}$, $V_{IN} \geq 1.4\text{V}$ | $I_{OUT}=1\text{mA}$ (Low Power Mode) | | | 0.50 | %V |
| | | | $I_{OUT}=10\text{mA}$ (Fast Mode) | | 0.02 | 0.20 | |
| RR | Ripple Rejection (Fast Mode) | $f=1\text{kHz}$, Ripple 0.2Vp-p $V_{IN}=V_{OUT}+1\text{V}$, $I_{OUT}=30\text{mA}$ (In case that $V_{OUT} \leq 1.2\text{V}$, $V_{IN}=2.2\text{V}$) | | | 70 | | dB |
| V_{IN} | Input Voltage *2 | | 1.40 | | | 5.25 | V |
| $\Delta V_{OUT} / \Delta T_{opt}$ | Output Voltage Temperature Coefficient | $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$ | | | ± 50 | | ppm/ $^{\circ}\text{C}$ |
| I_{lim} | Short Current Limit | $V_{OUT}=0\text{V}$ | | | 50 | | mA |
| I_{CEPD} | CE Pull-down Constant Current | | | | 0.1 | | μA |
| V_{CEH} | CE Input Voltage "H" | | 1.0 | | | | V |

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|--------------------|---|--|------|------|------|------|
| V _{CEL} | CE Input Voltage "L" | | | | 0.4 | V |
| I _{AE PD} | AE Pull-down Constant Current*3 | | | 0.1 | | μA |
| V _{AEH} | AE Input Voltage "H"*3 | | 1.0 | | | V |
| V _{AEL} | AE Input Voltage "L"*3 | | | | 0.4 | V |
| R _{LOW} | Low Output Nch Tr. ON Resistance (of D version) | V _{IN} =4.0V, V _{CE} =0V | | 50 | | Ω |

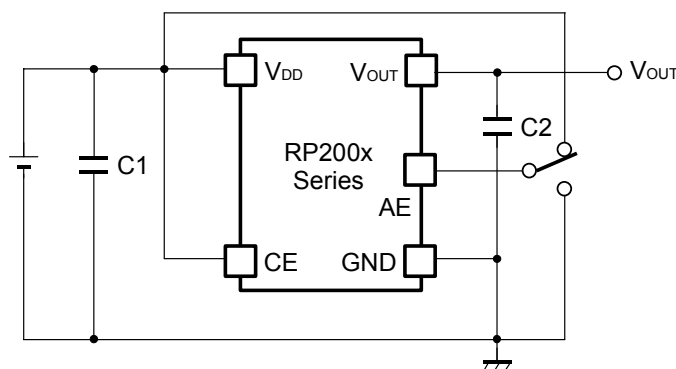
All of units are tested and specified under load conditions such that $T_j \approx T_{opt} = 25^\circ\text{C}$ except for Ripple Rejection, Output Voltage Temperature Coefficient.

- *1) The value of supply current is excluding the Pull-down constant current of CE Pin and AE Pin.
- *2) The maximum Input Voltage of the ELECTRICAL CHARACTERISTICS is 5.25V. In case of exceeding this specification, the IC must be operated on condition that the Input Voltage is up to 5.5V and the total operating time is within 500hrs.
- *3) Applied to RP200K/N/Q

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)

C1, C2 : Ceramic Capacitor 1.0 μ F MURATA: GRM155B31A105KE15

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 1.0 μ F or more and good 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

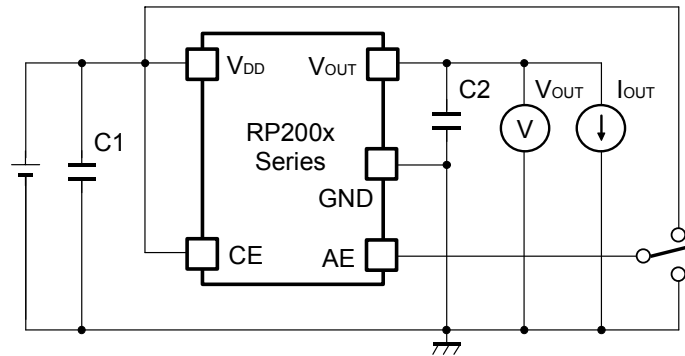
Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 1.0 μ F or more between V_{DD} and GND pin, and as close as possible to the pins.

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

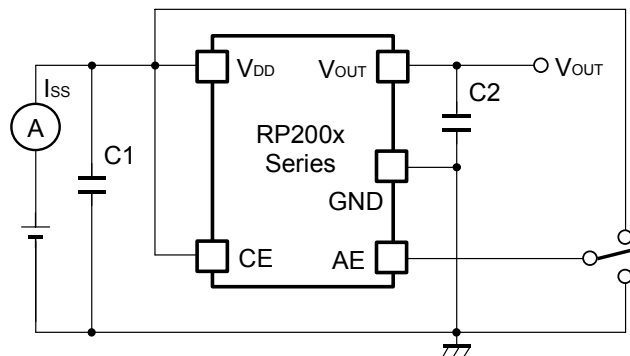
Impedance of Input Pin (CE Pin and AE Pin)

In those ICs, there is a pull-down constant current in the CE Pin and the AE Pin. However, if those pins are floating and wired long that produce the noise environment, it might miss-operation of ICs. For this purpose, please make sure enough evaluation of ICs.

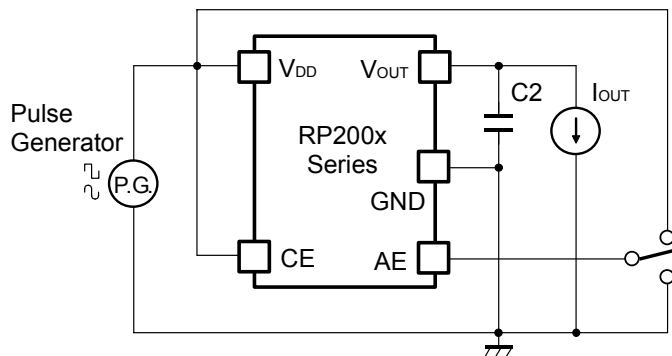
TEST CIRCUITS



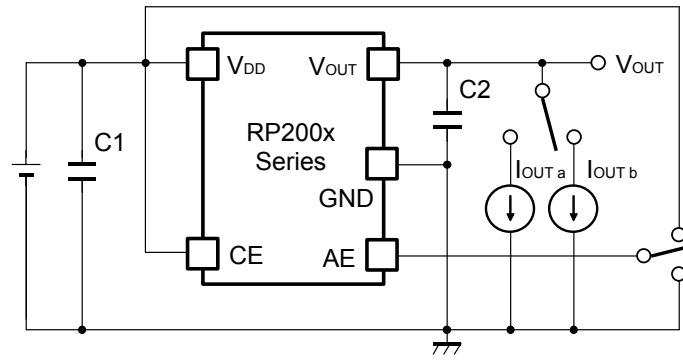
Basic Test Circuit



Test Circuit for Supply Current



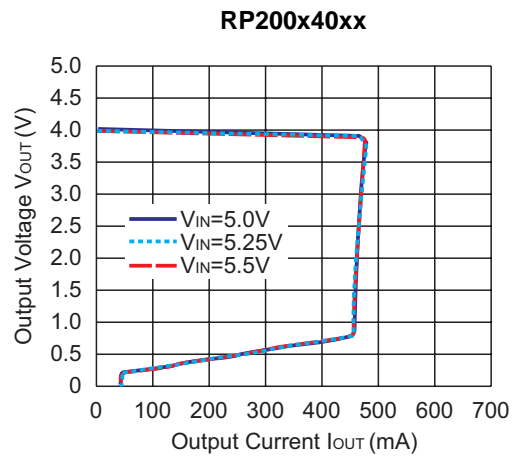
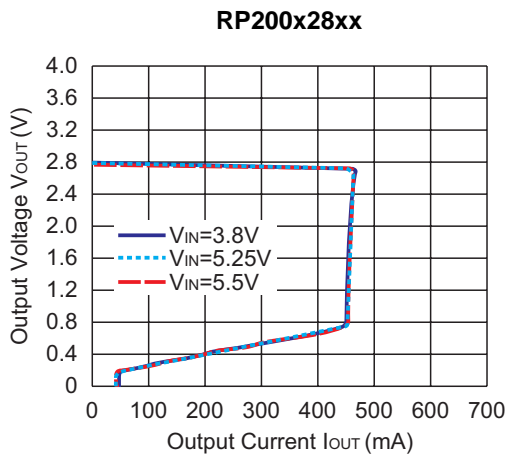
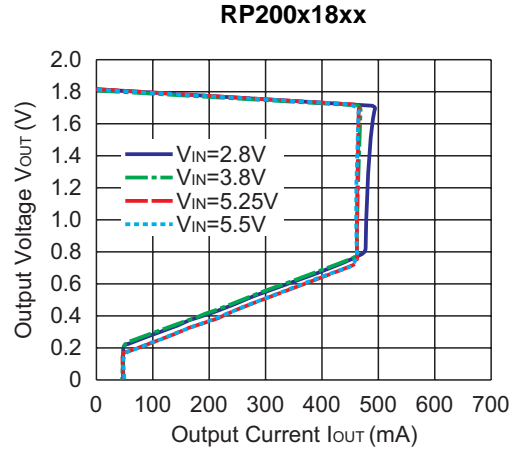
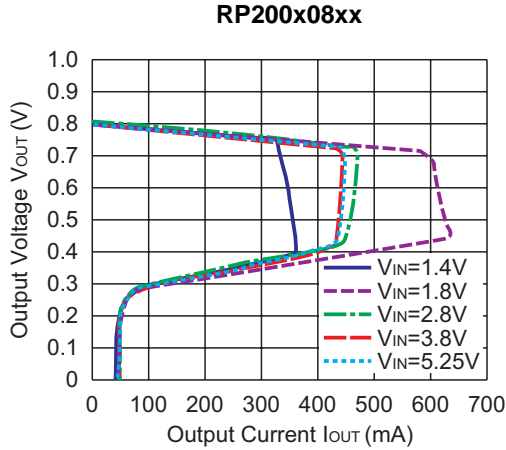
Test Circuit for Ripple Rejection



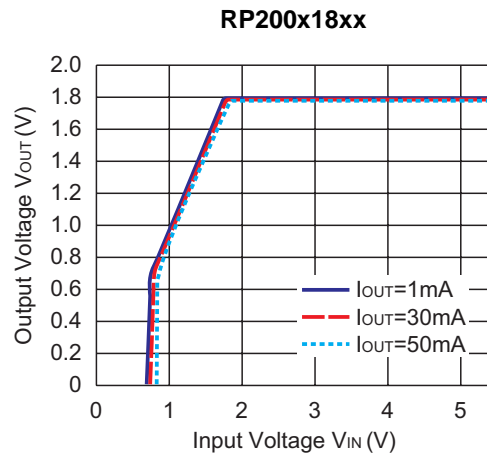
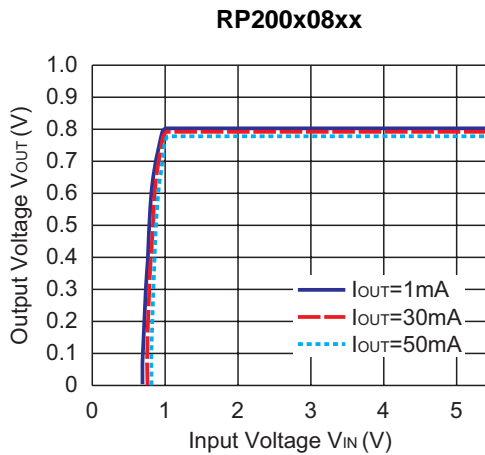
Test Circuit for Load Transient Response

TYPICAL CHARACTERISTICS

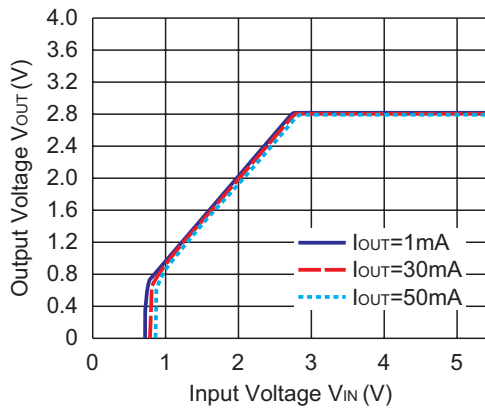
1) Output Voltage vs. Output Current ($C_1=1.0\mu\text{F}$, $C_2=1.0\mu\text{F}$, $T_{\text{opt}}=25^\circ\text{C}$)



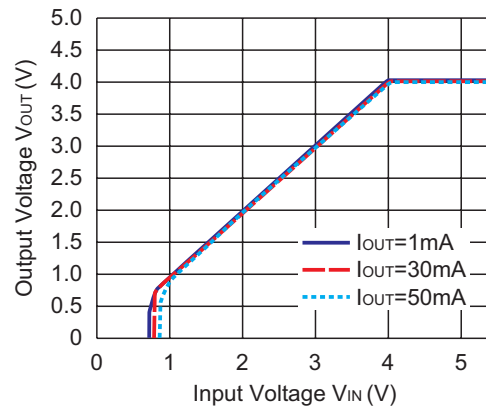
2) Output Voltage vs. Input Voltage ($C_1=1.0\mu\text{F}$, $C_2=1.0\mu\text{F}$, $T_{\text{opt}}=25^\circ\text{C}$)



RP200x28xx

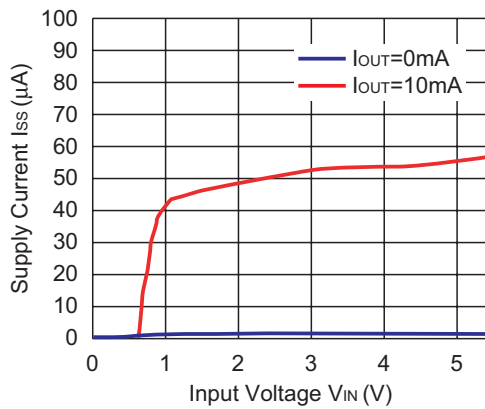


RP200x40xx

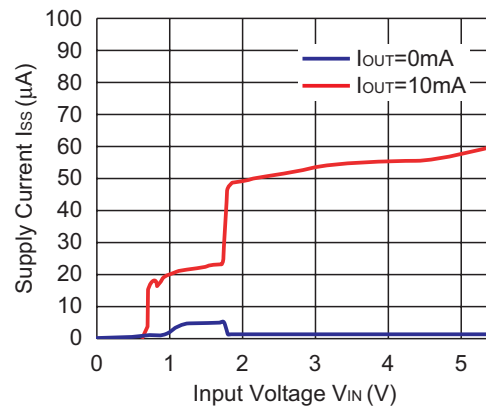


3) Supply Current vs. Input Voltage (C1=1.0μF, C2=1.0μF, T_{opt}=25°C)

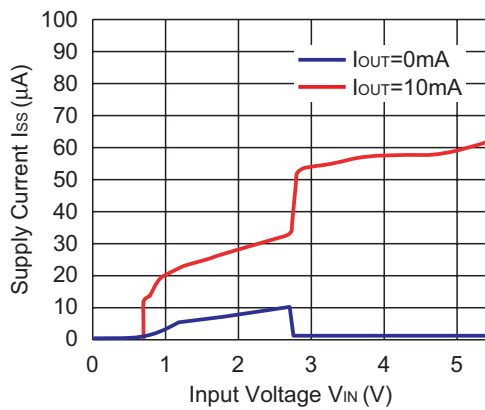
RP200x08xx



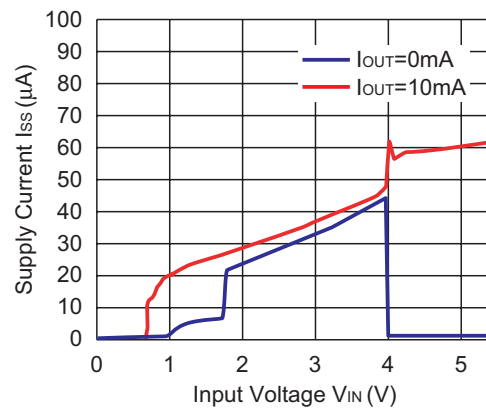
RP200x18xx



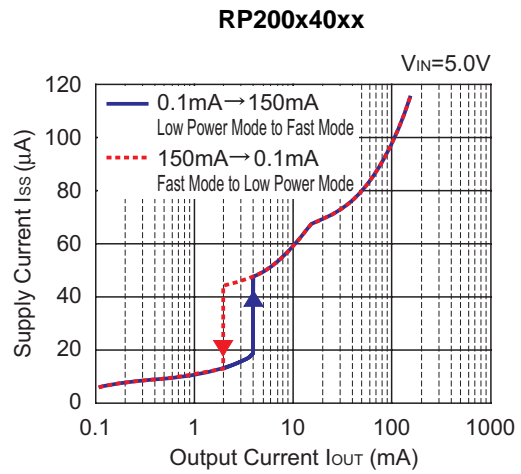
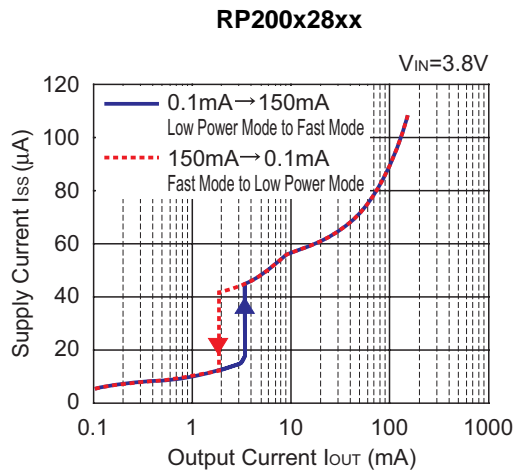
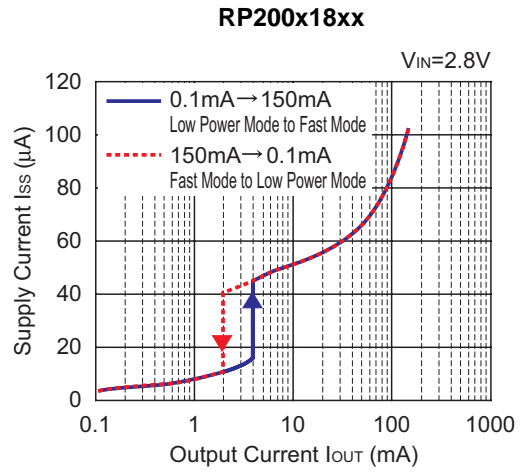
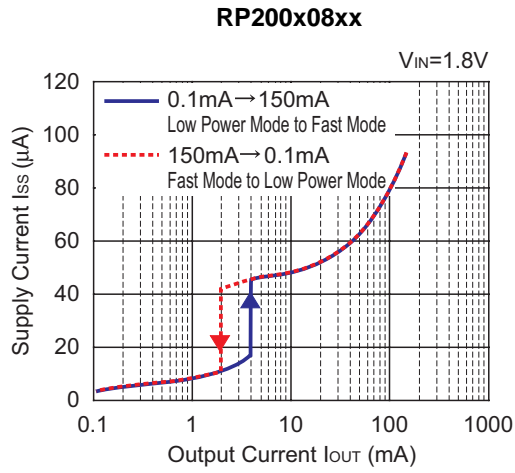
RP200x28xx



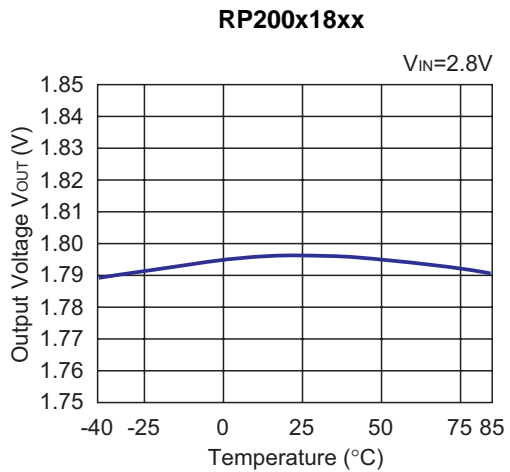
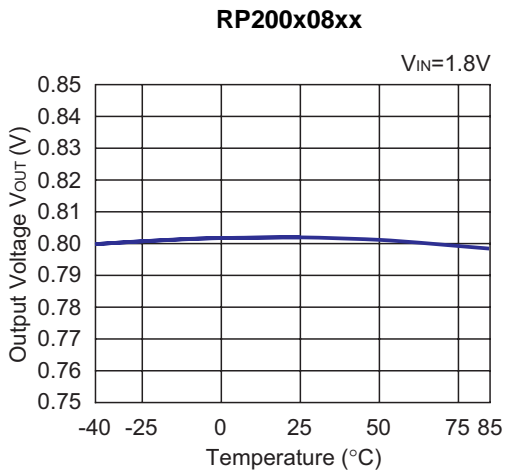
RP200x40xx



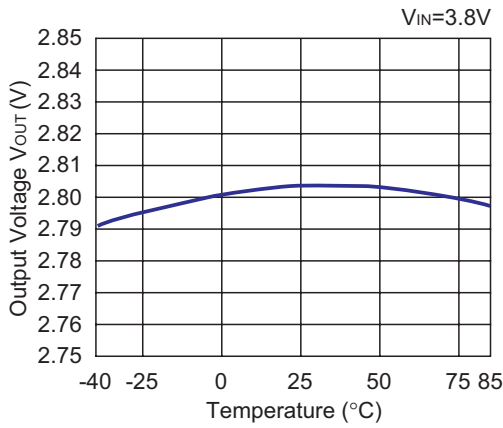
4) Supply Current vs. Output Current ($C_1=1.0\mu\text{F}$, $C_2=1.0\mu\text{F}$, $T_{\text{opt}}=25^\circ\text{C}$)



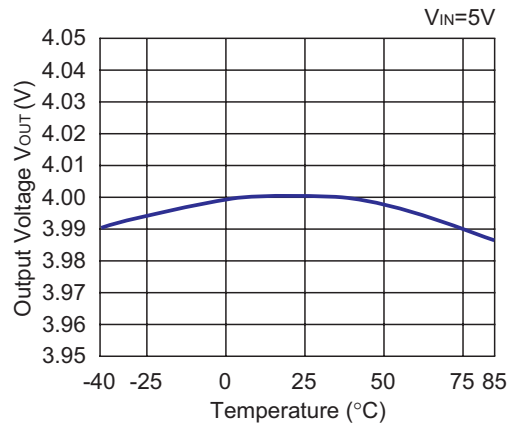
5) Output Voltage vs. Temperature ($C_1=1.0\mu\text{F}$, $C_2=1.0\mu\text{F}$, $I_{\text{OUT}}=5\text{mA}$)



RP200x28xx

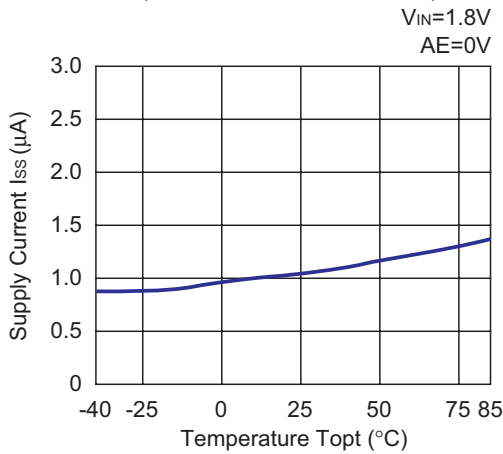


RP200x40xx

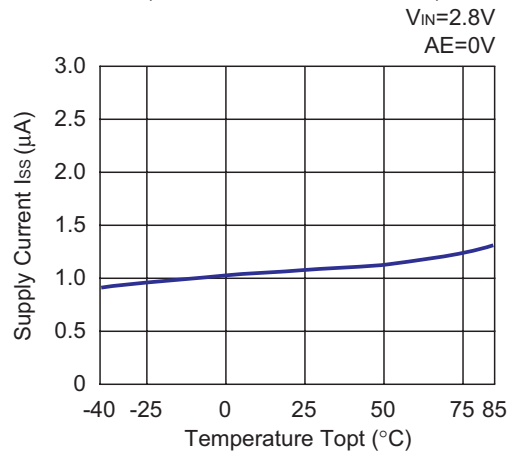


6) Supply Current vs. Temperature (C1=1.0μF, C2=1.0μF)

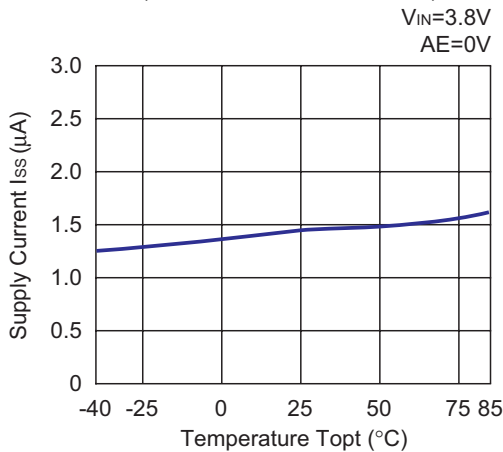
RP200x08xx
(Auto ECO Low Power Mode)



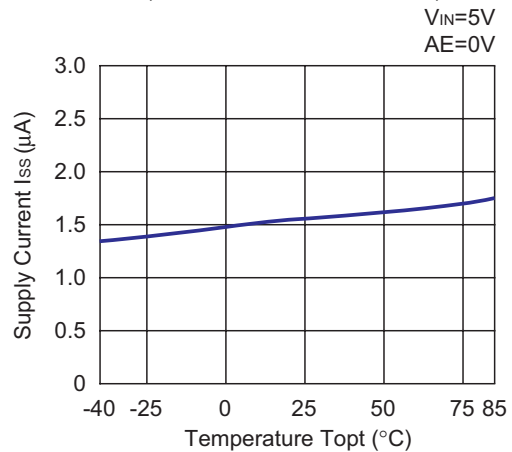
RP200x18xx
(Auto ECO Low Power Mode)



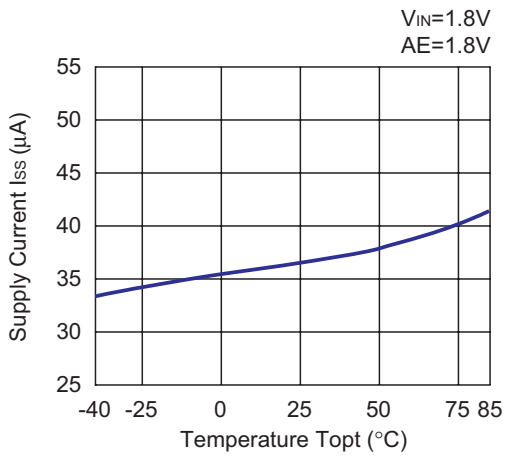
RP200x28xx
(Auto ECO Low Power Mode)



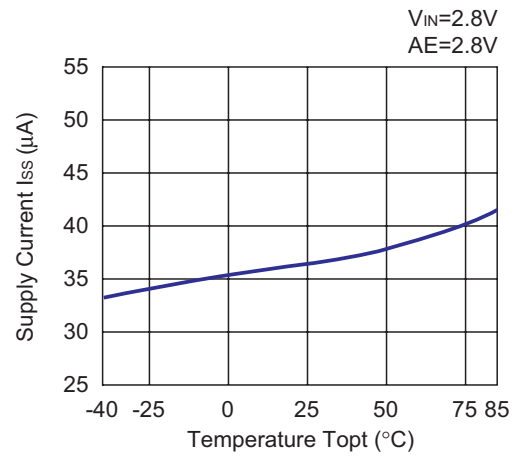
RP200x40xx
(Auto ECO Low Power Mode)



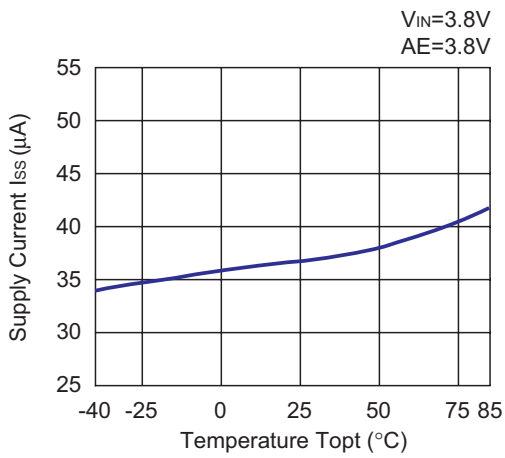
RP200x08xx (Fixed Fast Mode)



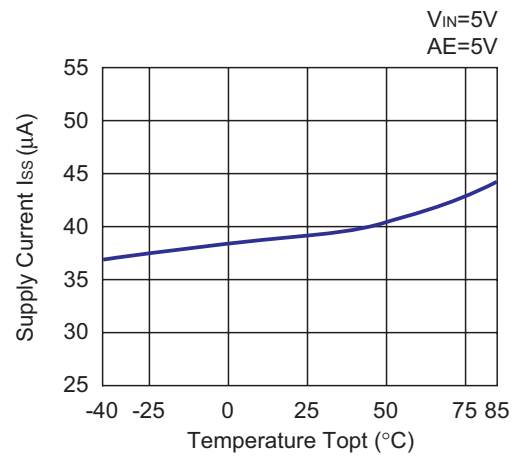
RP200x18xx (Fixed Fast Mode)



RP200x28xx (Fixed Fast Mode)

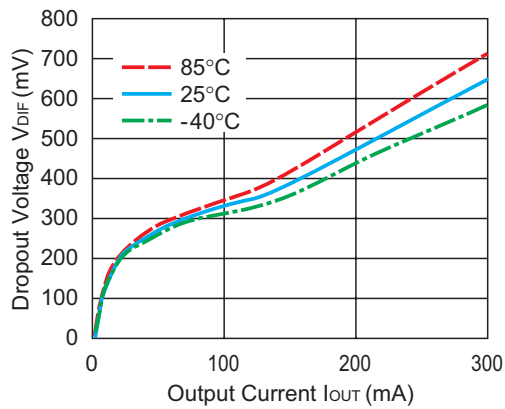


RP200x40xx (Fixed Fast Mode)

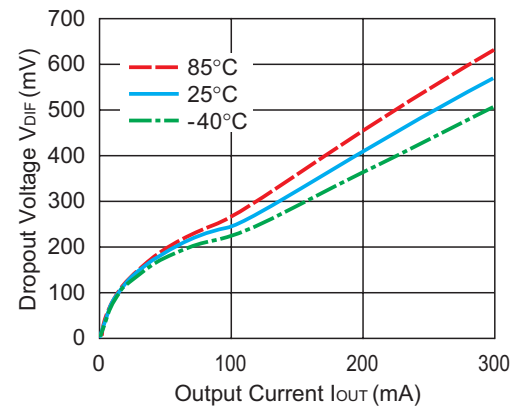


7) Dropout Voltage vs. Output Current (C1=1.0µF, C2=1.0µF)

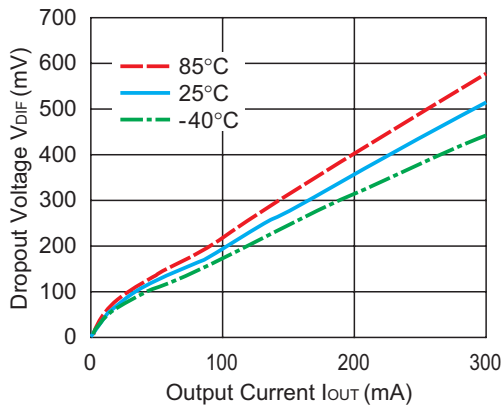
RP200x08xx



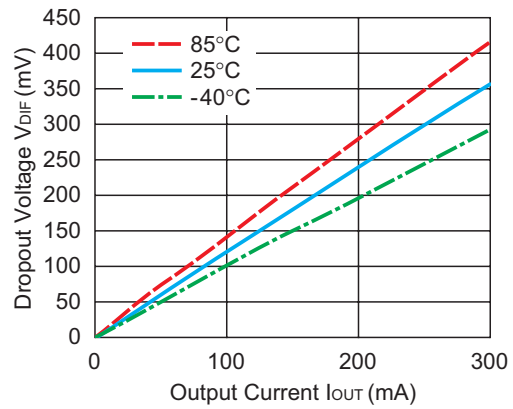
RP200x09xx



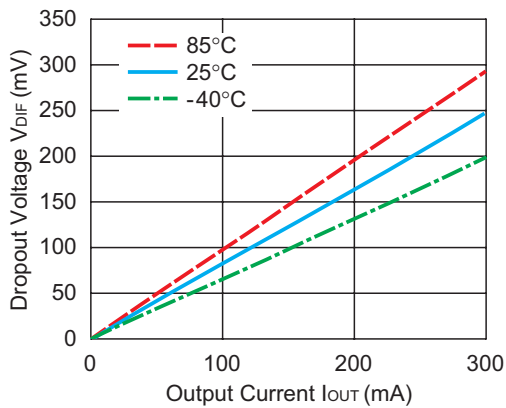
RP200x10xx



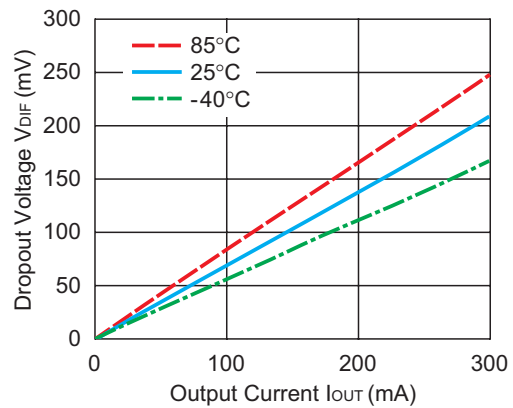
RP200x15xx



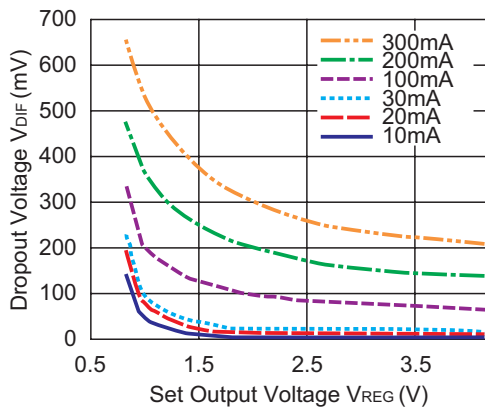
RP200x26xx



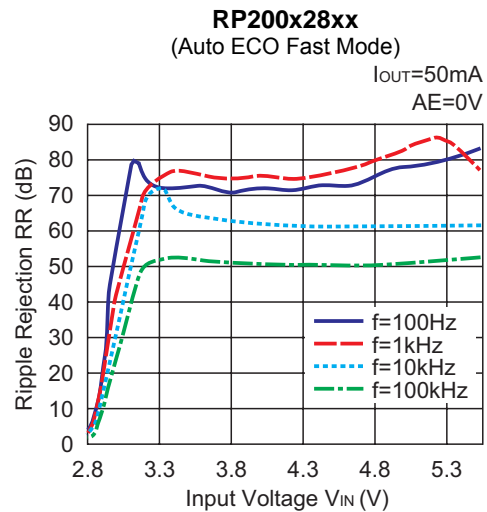
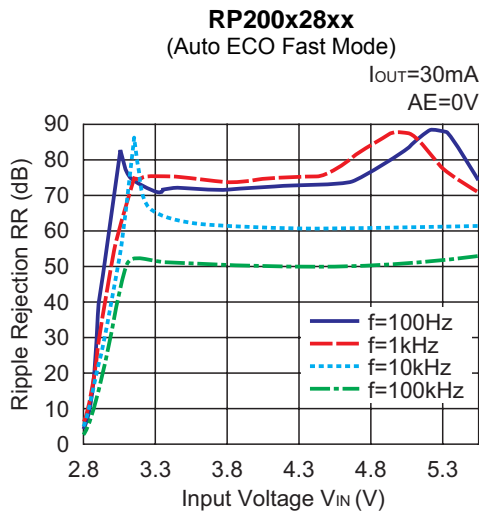
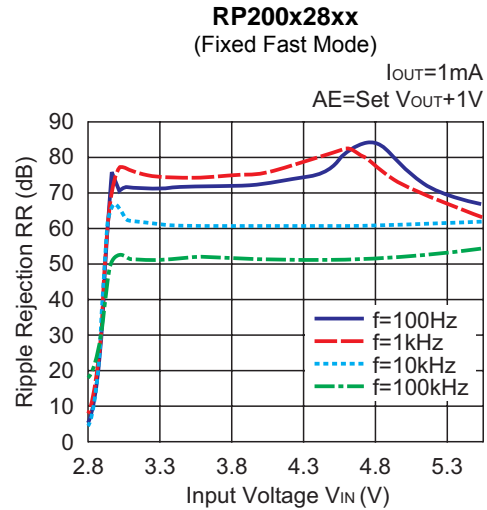
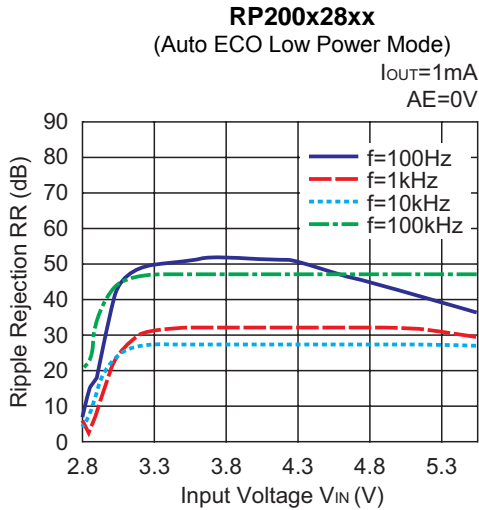
RP200x40xx



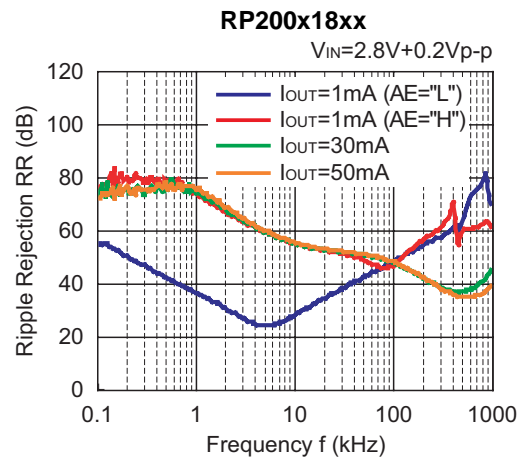
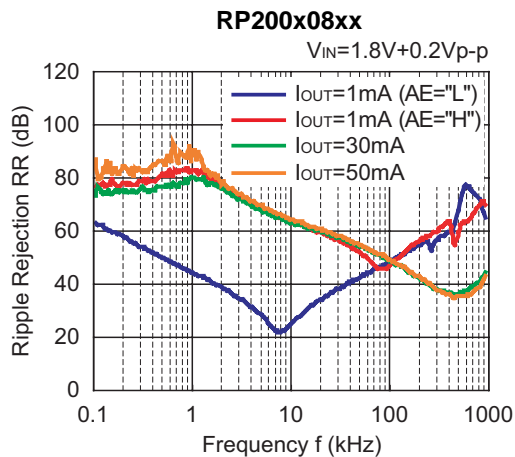
8) Dropout Voltage vs Set Output Voltage

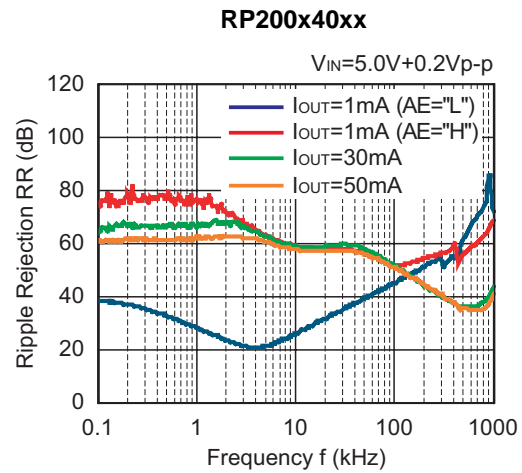
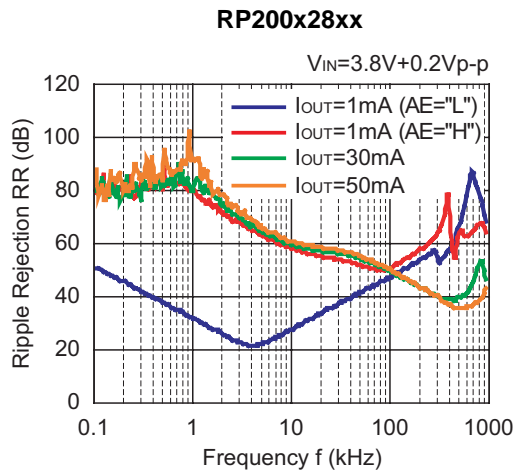


9) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=1.0μF, Ripple=0.2Vp-p, T_{opt}=25°C)

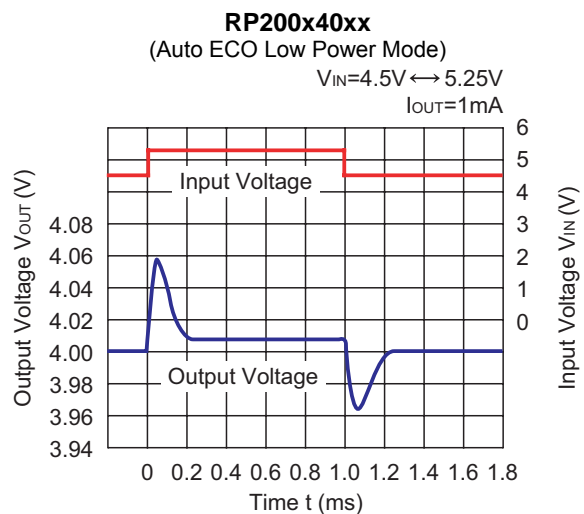
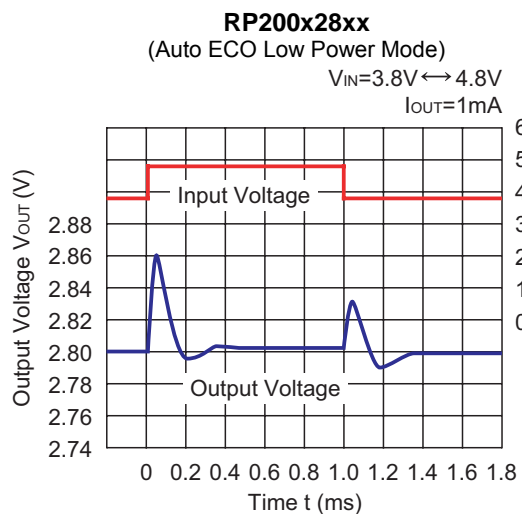
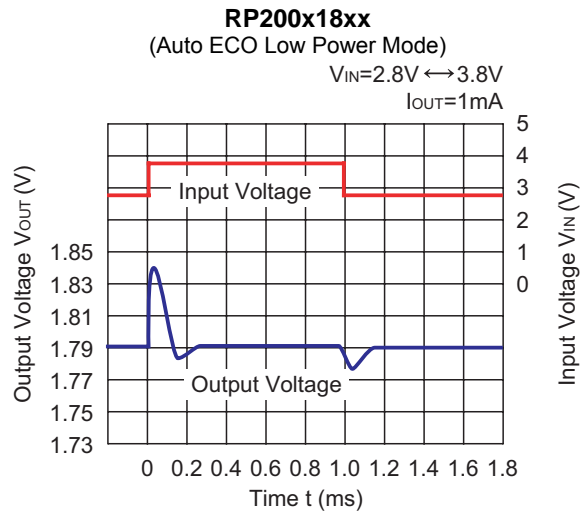
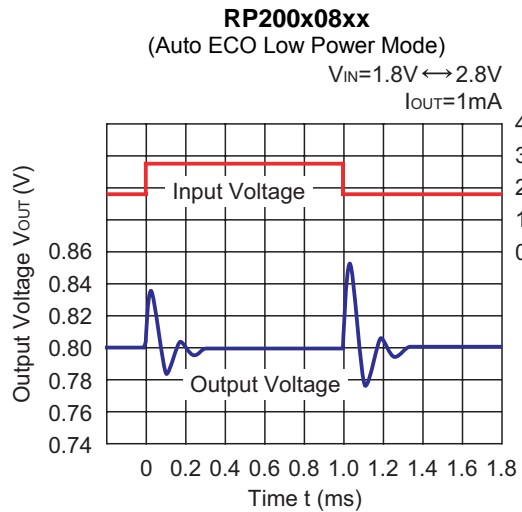


10) Ripple Rejection vs. Frequency (C1=none, C2=1.0μF, Ripple=0.2Vp-p, T_{opt}=25°C)

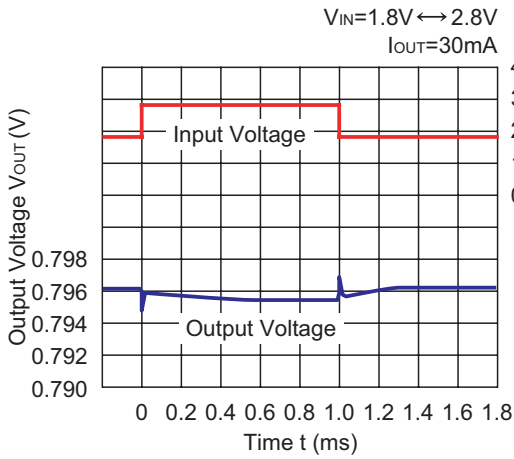




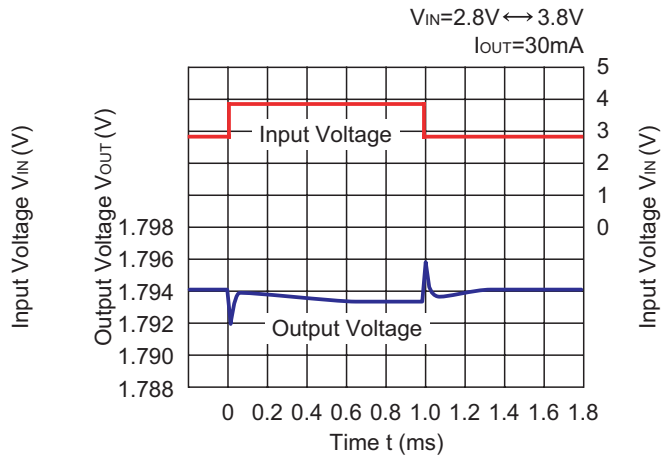
11) Input Transient Response (C1=none, C2=1.0 μ F, $t_r=t_f=5\mu s$, $T_{opt}=25^\circ C$)



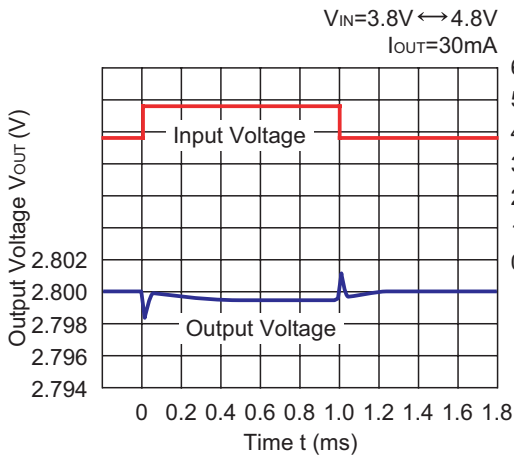
RP200x08xx (Fixed Fast Mode)



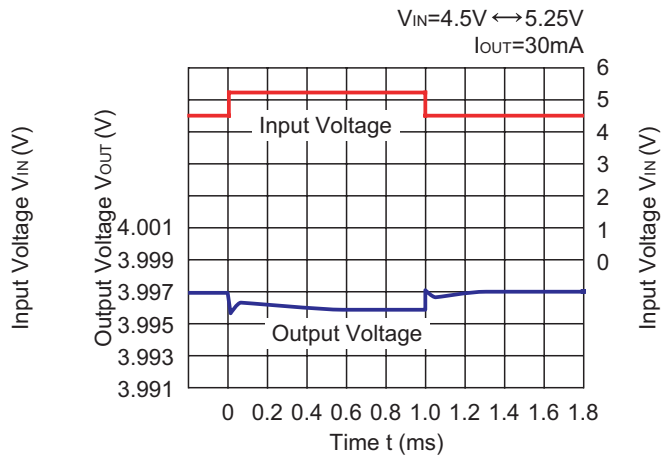
RP200x18xx (Fixed Fast Mode)



RP200x28xx (Fixed Fast Mode)



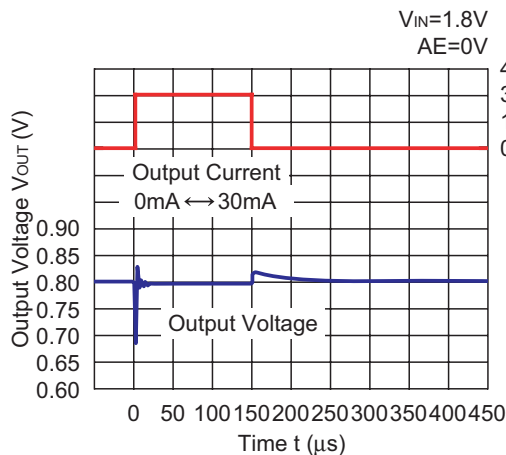
RP200x40xx (Fixed Fast Mode)



12) Load Transient Response ($C1=1.0\mu F$, $C2=1.0\mu F$, $t_r=t_f=0.5\mu s$, $T_{opt}=25^\circ C$)

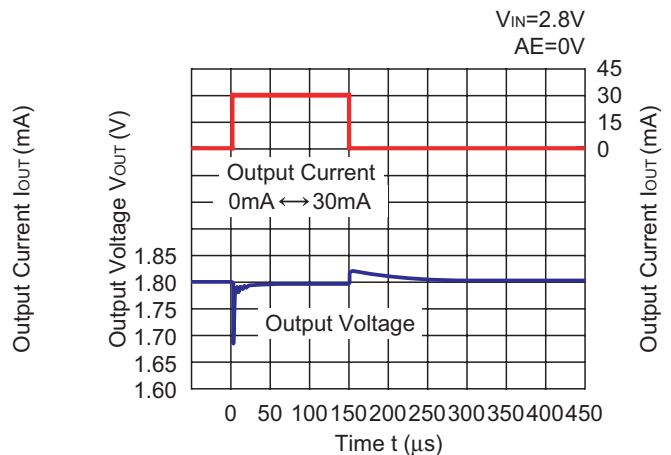
RP200x08xx

Auto ECO (Low Power Mode \leftrightarrow Fast Mode)

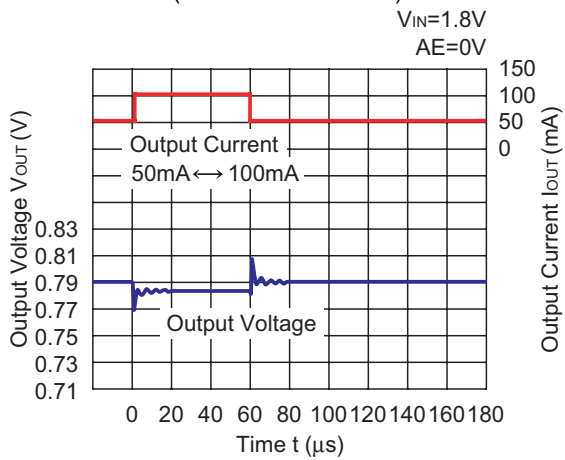


RP200x18xx

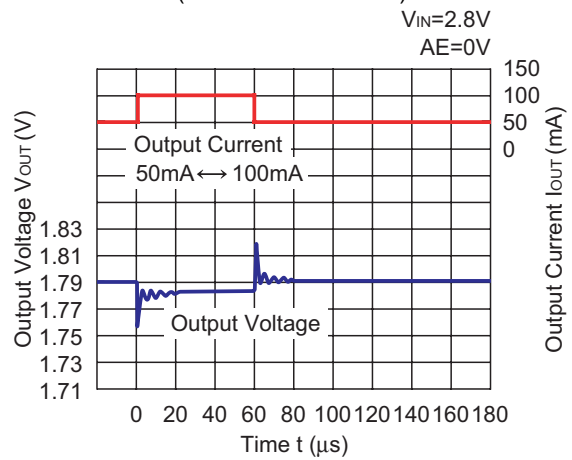
Auto ECO (Low Power Mode \leftrightarrow Fast Mode)



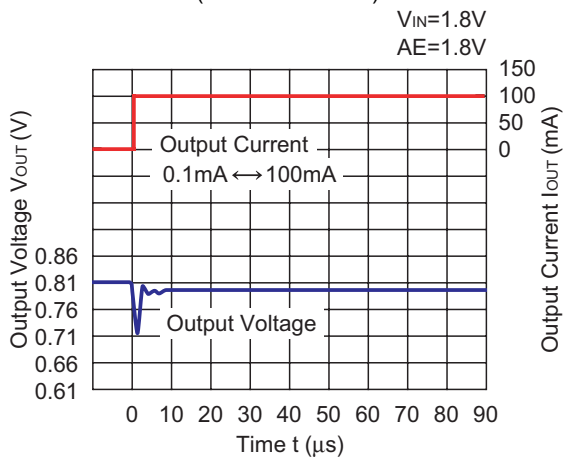
RP200x08xx
(Auto ECO Fast Mode)



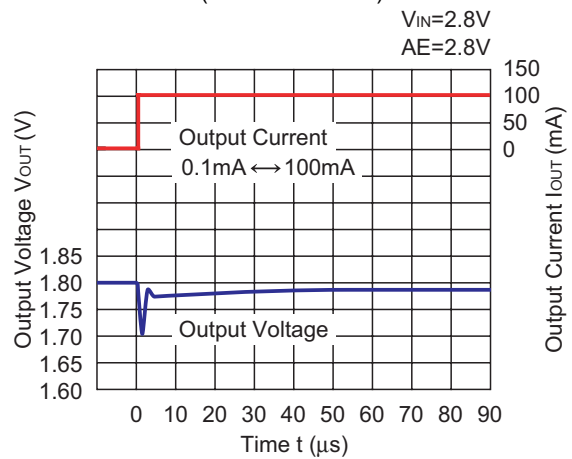
RP200x18xx
(Auto ECO Fast Mode)



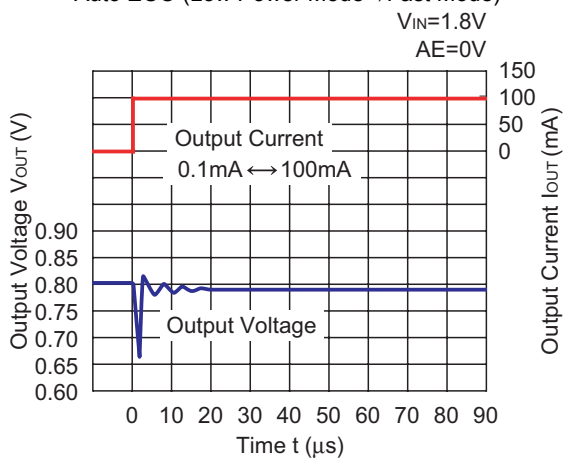
RP200x08xx
(Fixed Fast Mode)



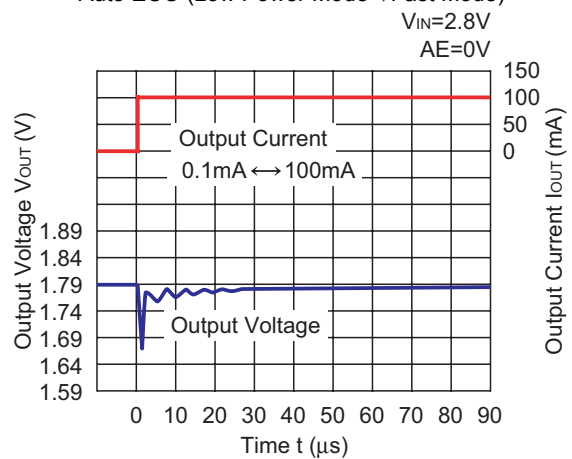
RP200x18xx
(Fixed Fast Mode)



RP200x08xx
Auto ECO (Low Power Mode → Fast Mode)

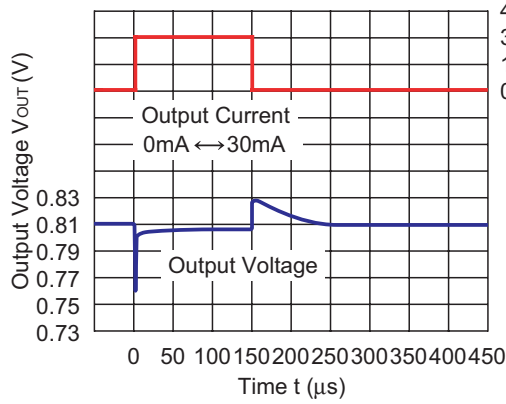


RP200x18xx
Auto ECO (Low Power Mode → Fast Mode)



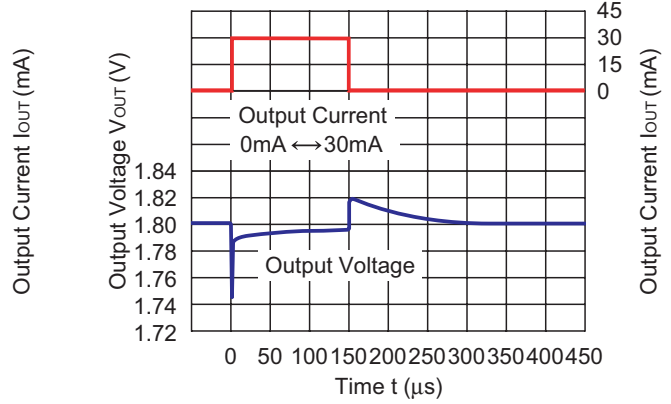
RP200x08xx
(Fixed Fast Mode)

$V_{IN}=1.8V$
 $AE=1.8V$



RP200x18xx
(Fixed Fast Mode)

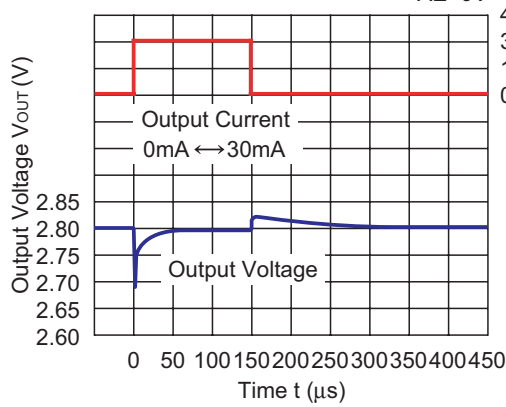
$V_{IN}=2.8V$
 $AE=2.8V$



RP200x28xx

Auto ECO (Low Power Mode↔Fast Mode)

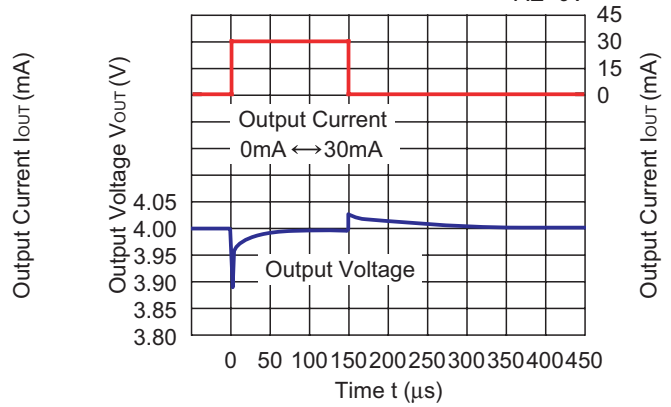
$V_{IN}=3.8V$
 $AE=0V$



RP200x40xx

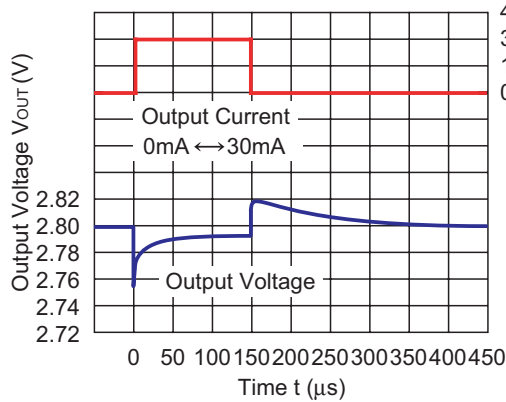
Auto ECO (Low Power Mode↔Fast Mode)

$V_{IN}=5.0V$
 $AE=0V$



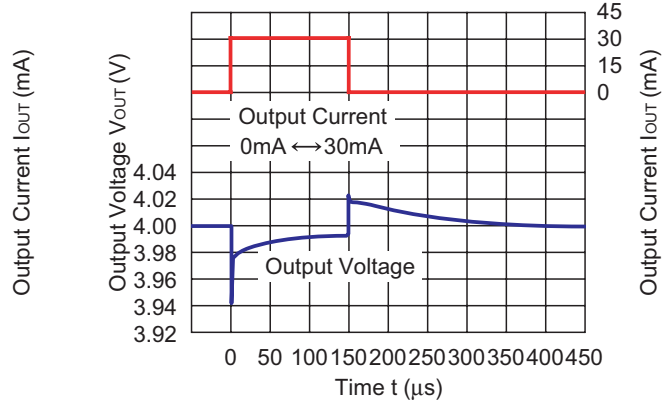
RP200x28xx
(Fixed Fast Mode)

$V_{IN}=3.8V$
 $AE=3.8V$



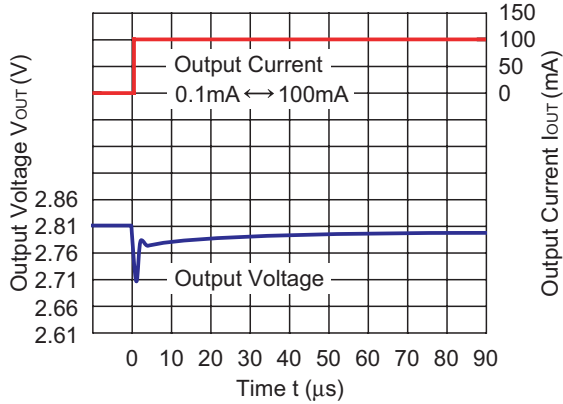
RP200x40xx
(Fixed Fast Mode)

$V_{IN}=5.0V$
 $AE=5.0V$



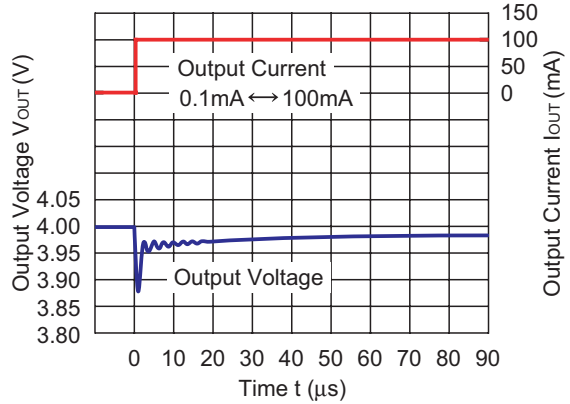
RP200x28xx
(Fixed Fast Mode)

$V_{IN}=3.8V$
 $AE=3.8V$



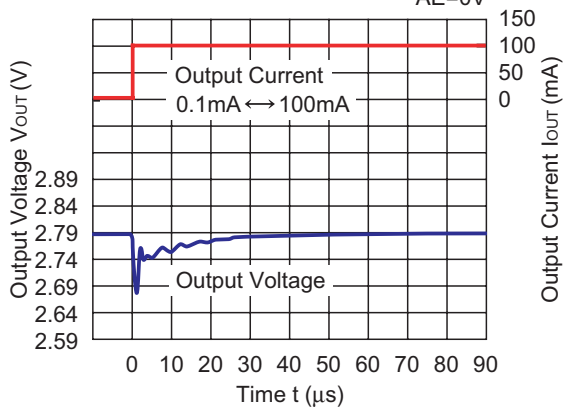
RP200x40xx
(Fixed Fast Mode)

$V_{IN}=5.0V$
 $AE=5.0V$



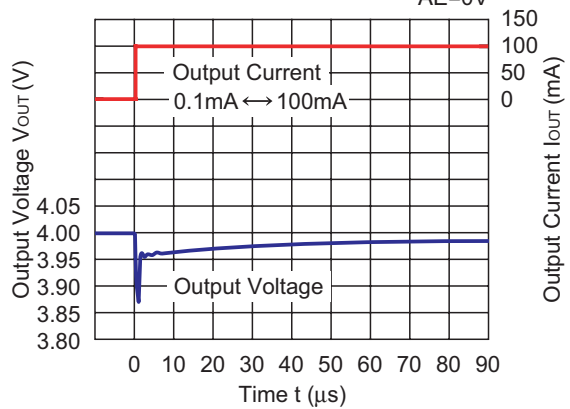
RP200x28xx
Auto ECO (Low Power Mode \rightarrow Fast Mode)

$V_{IN}=3.8V$
 $AE=0V$



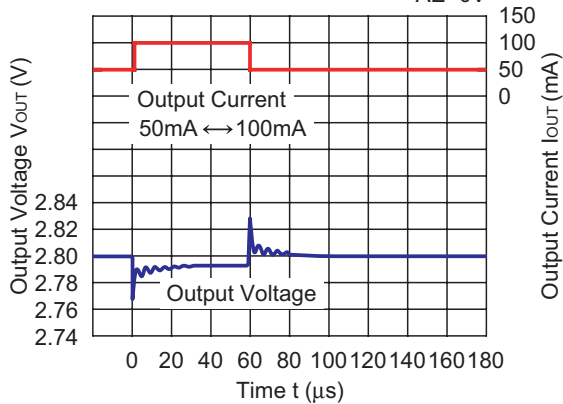
RP200x40xx
Auto ECO (Low Power Mode \rightarrow Fast Mode)

$V_{IN}=5.0V$
 $AE=0V$



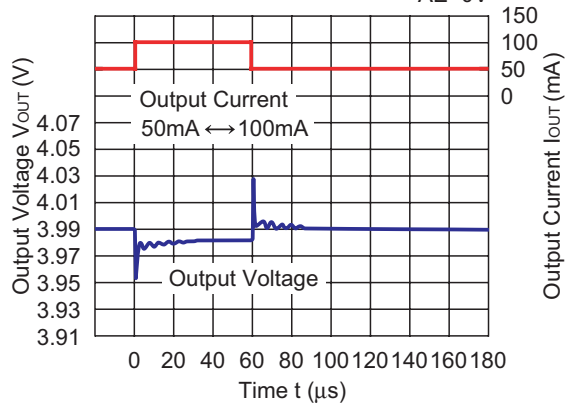
RP200x28xx
(Auto ECO Fast Mode)

$V_{IN}=3.8V$
 $AE=0V$

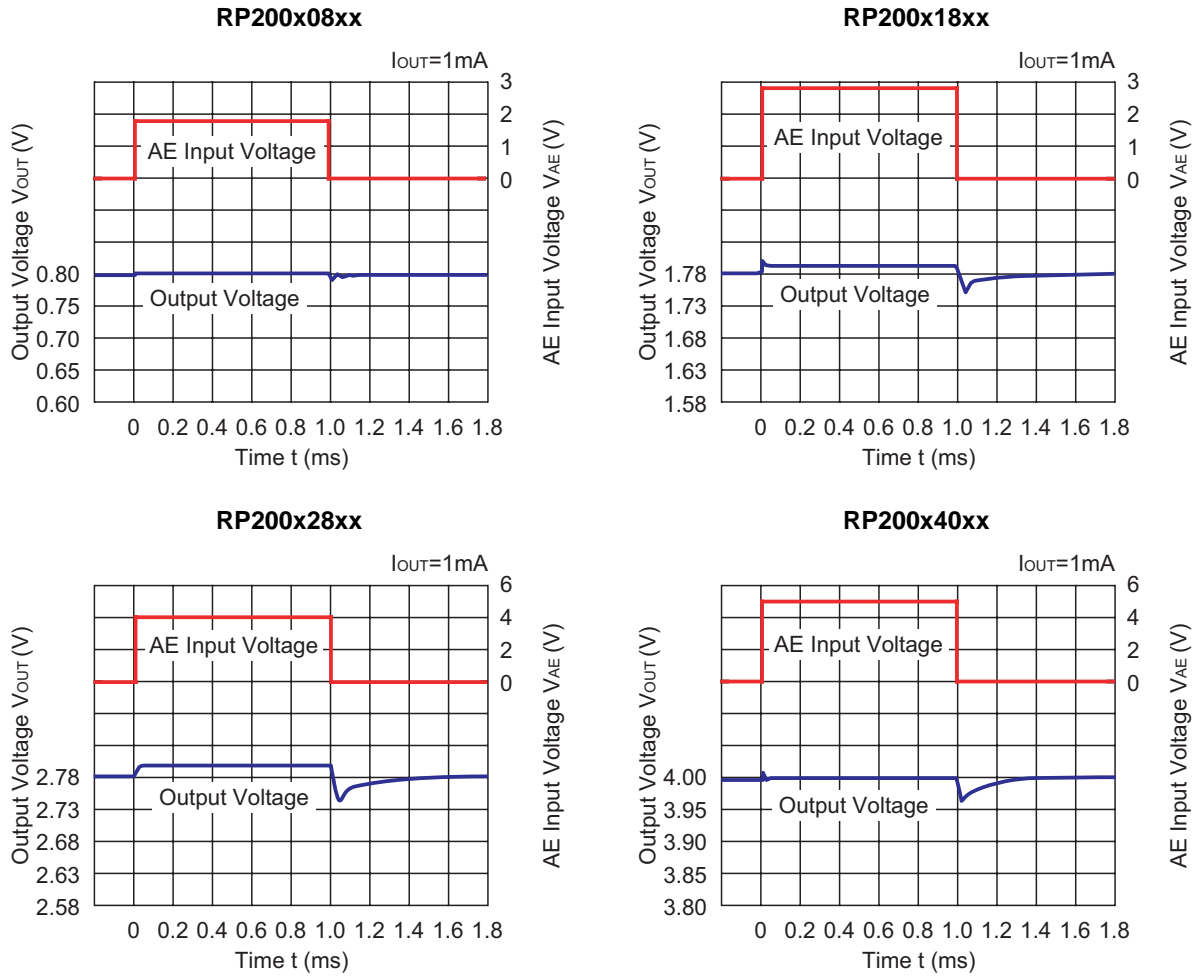


RP200x40xx
(Auto ECO Fast Mode)

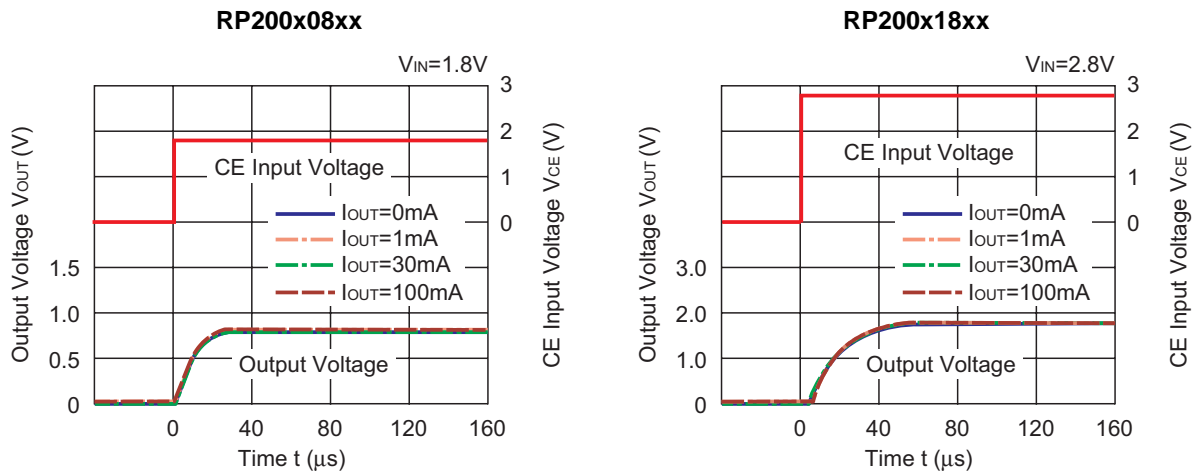
$V_{IN}=5.0V$
 $AE=0V$

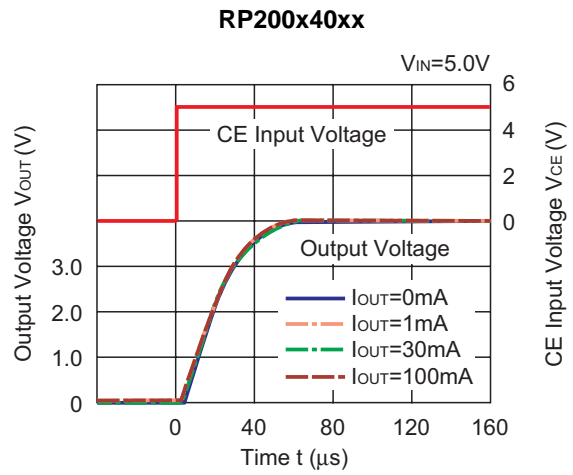
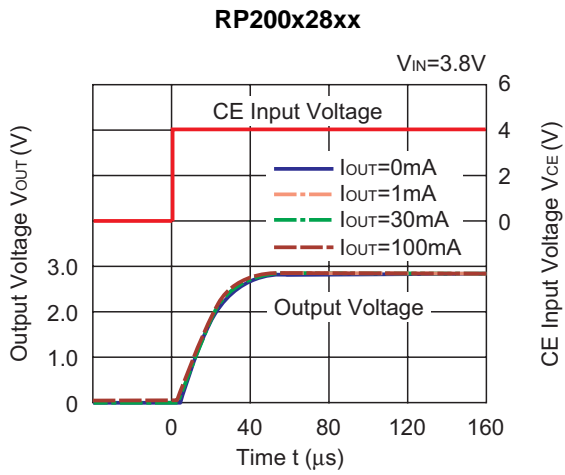


13) AE Switch Transient Response ($C1=1.0\mu F$, $C2=1.0\mu F$, $t_r=t_f=0.5\mu s$, $T_{opt}=25^\circ C$)

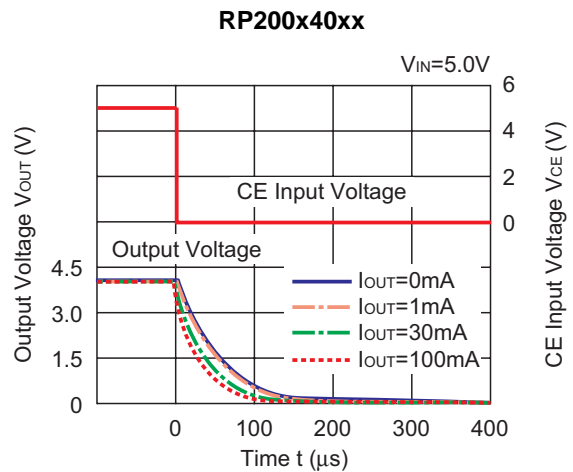
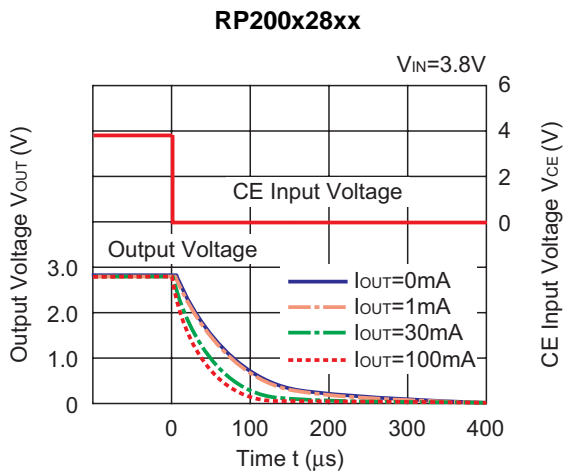
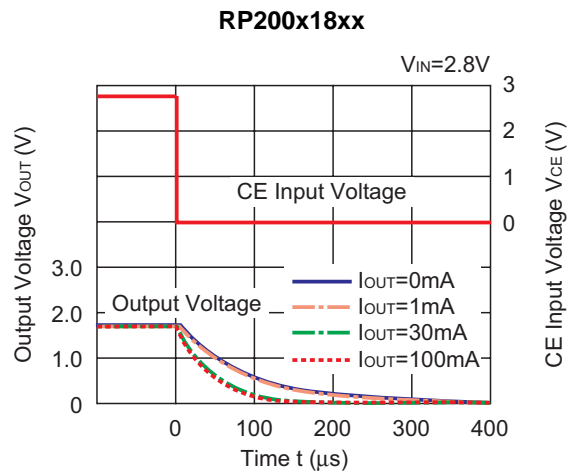
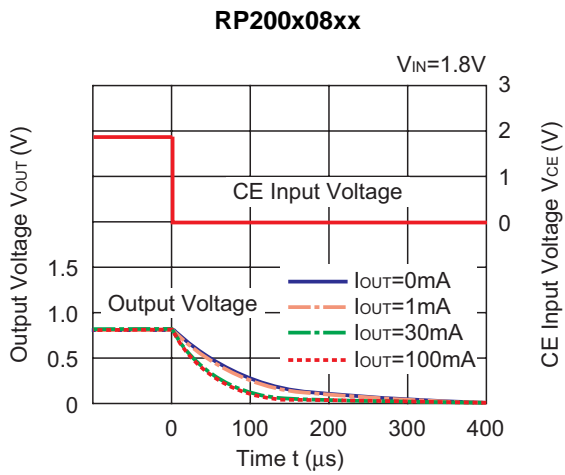


14) Turn On Speed with CE pin ($C1=1.0\mu F$, $C2=1.0\mu F$, $T_{opt}=25^\circ C$)





15) Turn Off Speed with CE pin (D Version) ($C1=1.0\mu F$, $C2=1.0\mu F$, $T_{opt}=25^{\circ}C$)



ESR vs. Output Current

When using these ICs, consider the following points:

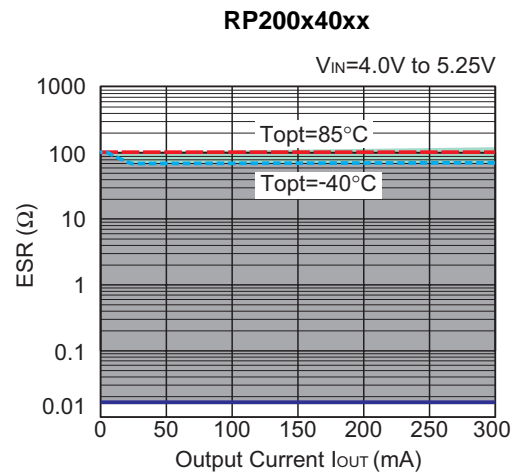
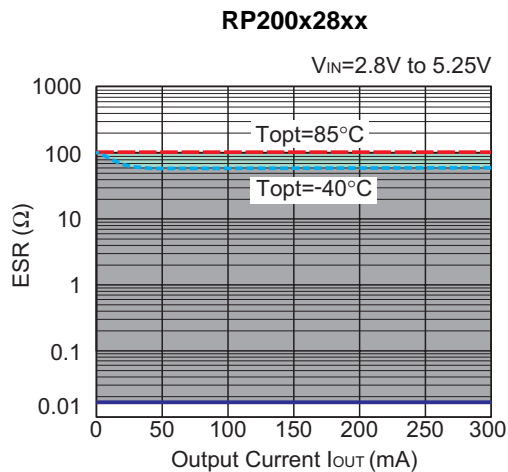
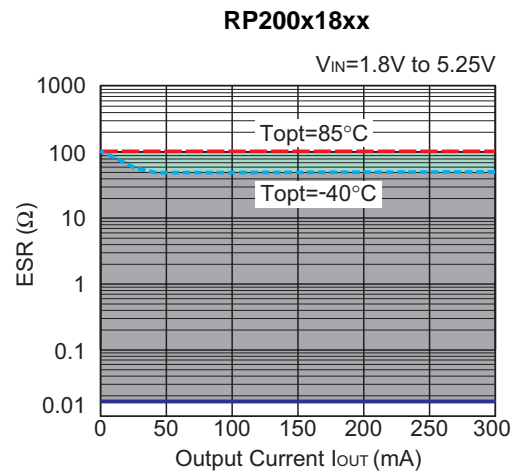
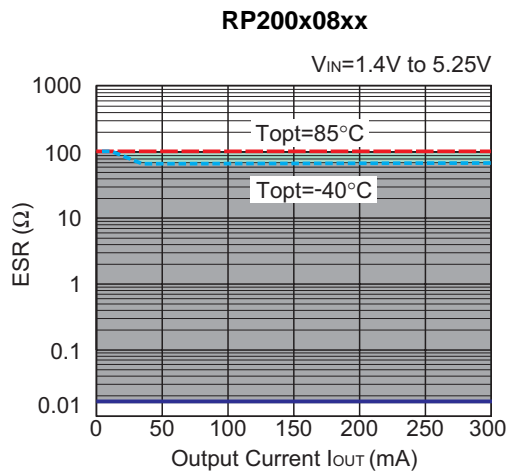
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
 The conditions when the white noise level is under $40\mu\text{V}$ (Avg.) are marked as the hatched area in the graph.

Measurement conditions

Frequency Band: 10Hz to 2MHz

Temperature : -40°C to 85°C

C1, C2 : $1.0\mu\text{F}$





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