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# RP173x Series

## 11 V Input 150 mA LDO

## OUTLINE

The RP173x is a voltage regulator featuring 150 mA output and low supply current of Typ. 2.0 $\mu$A. It consists of a voltage reference unit, an error amplifier, a resistor-net for voltage setting, a current limit circuit, a chip enable circuit and a Reverse Current Protection Circuit. RP173x is suitable for the power source such as the equipment being in the standby-mode. The A version with CE input pin has reduced CE pull-up resistance to make its supply current ultra low.

The RP173x has Max.11 V Input voltage and is applicable to the portable communication equipment that requires the 2-cell Li-ion battery. Also it is applicable to the non-portable communication equipments. As the RP173x includes Reverse Current Protection Circuit, there is little leakage current, if it is used as back-up circuit.

Packages are available in SOT-23-5, SC-88A, and 1-mm square DFN(PLP)1010-4 packages. High density mounting of the ICs on boards is possible.

## FEATURES

- Output Current ............................................................ Typ. 150 mA
- Supply Current ............................................................ Typ. 2.0 $\mu$A
- Standby Current .......................................................... Typ. 0.2 $\mu$A
- Dropout Voltage .......................................................... Typ. 0.13 V ($I_{OUT}$ = 30 mA, $V_{OUT}$ = 3.0 V)
  Typ. 0.90 V ($I_{OUT}$ = 150 mA, $V_{OUT}$ = 3.0 V)
- Output Voltage Accuracy.............................................. ±1.0% (1.5 V < $V_{OUT}$ ≤ 5.5 V, Ta = 25°C)
- Line Regulation ........................................................... Typ. 0.02%/V
- Packages .................................................................... DFN(PLP)1010-4, SC-88A, SOT-23-5
- Input Voltage Range .................................................... 2.5 V to Set $V_{OUT}$ + 6.5 V (Max. 11 V)
- Output Voltage Range.................................................. 1.2 V to 5.5 V (0.1 V step)
- Built-in Reverse Current Protection Circuit
- Short Current Limit....................................................... Typ. 45 mA
- Built-in Peak Current Limit Circuit
- Output capacitors........................................................ 0.1 $\mu$F or more

## APPLICATIONS

- Power source for portable communication equipments.
- Power source for battery-powered equipments.
- Power source for electrical appliances such as cameras, VSRs and camcorders.
- Power source for digital home appliances.

# SELECTION GUIDE

The output voltage, the auto-discharge function[1], and the package for the ICs are user-selectable options.

**Selection Guide**

| Product Name | Package | Quantity per Reel | Pb Free | Halogen Free |
|---|---|---|---|---|
| RP173Kxx1∗-TR | DFN(PLP)1010-4 | 10,000 pcs | Yes | Yes |
| RP173Qxx2∗-TR-FE | SC-88A | 3,000 pcs | Yes | Yes |
| RP173Nxx1∗-TR-FE | SOT-23-5 | 3,000 pcs | Yes | Yes |

xx: The output voltage can be designated in the range of 1.2 V (12) to 5.5 V (55) in 0.1 V step.

∗ : The auto discharge function at off state are options as follows.
    (A) "L" active, without auto discharge function at off state (Pull-up resistance is not built-in)
    (B) "H" active, without auto discharge function at off state
    (D) "H" active, with auto discharge function at off state

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[1] Auto-discharge function quickly lowers the output voltage to 0 V, when the chip enable signal is switched from the active mode to the standby mode, by releasing the electrical charge accumulated in the external capacitor.

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# BLOCK DIAGRAMS

**RP173xxxxA**



(Pull-up resistance is not built-in.)

**RP173xxxxB**



**RP173xxxxD**

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# PIN DESCRIPTIONS

**Top View**

4    3

1    2

**Bottom View**

3    4

2    1

5    4

(mark side)

1    2    3

5    4

(mark side)

1    2    3
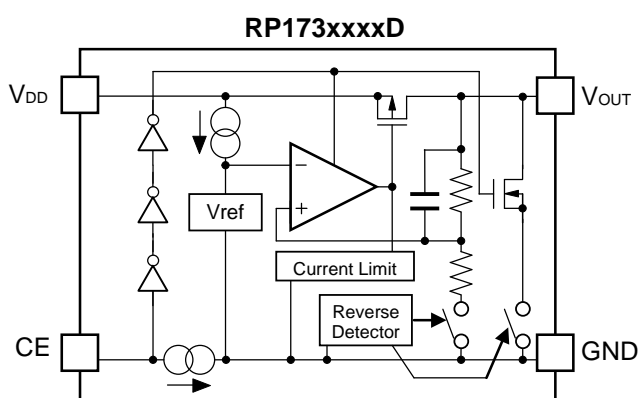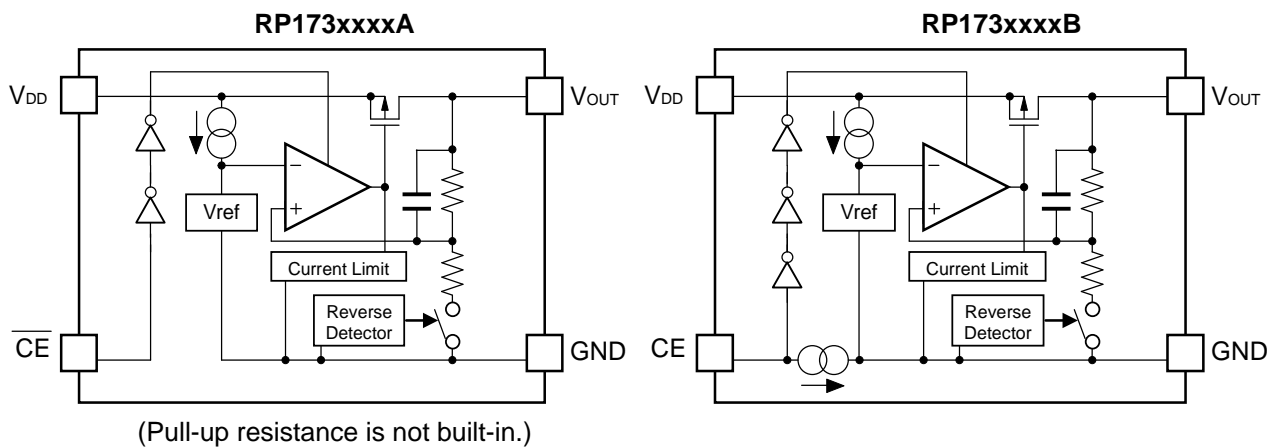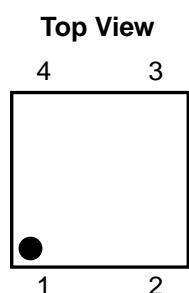
**RP173K [DFN(PLP)1010-4]**
**Pin Configuration**
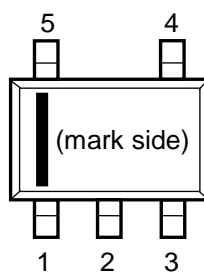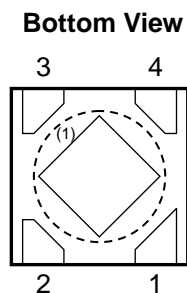
**RP173Q (SC-88A)**
**Pin Configuration**
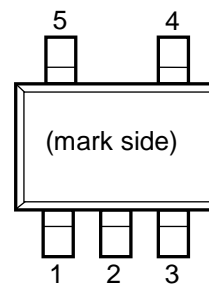
**RP173N (SOT-23-5)**
**Pin Configuration**

**RP173K Pin Descriptions**

| Pin No. | Symbol | Description |
|---------|--------|-------------|
| 1 | $V_{OUT}$ | Output Pin |
| 2 | GND | Ground Pin |
| 3 | $\overline{CE}$ /CE | Chip Enable Pin |
| 4 | $V_{DD}$ | Input Pin |

**RP173Q Pin Descriptions**

| Pin No. | Symbol | Description |
|---------|--------|-------------|
| 1 | $\overline{CE}$ /CE | Chip Enable Pin |
| 2[2] | NC | No Connection |
| 3 | GND | Ground Pin |
| 4 | $V_{OUT}$ | Output Pin |
| 5 | $V_{DD}$ | Input Pin |

**RP173N Pin Descriptions**

| Pin No. | Symbol | Description |
|---------|--------|-------------|
| 1 | $V_{DD}$ | Input Pin |
| 2 | GND | Ground Pin |
| 3 | $\overline{CE}$ /CE | Chip Enable Pin |
| 4 | NC | No Connection |
| 5 | $V_{OUT}$ | Output Pin |

[1] The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left floating.

[2] Pin No. 2 is connected to the bottom of the IC. It is recommended that the pin be connected to the ground plane on the board, or otherwise be left floating so that there is no contact with other potentials.

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# ABSOLUTE MAXIMUM RATINGS

**Absolute Maximum Ratings**

| Symbol | Item | | | Rating | Unit |
|---|---|---|---|---|---|
| $V_{IN}$ | Input Voltage | | | 12 | V |
| $V_{CE}$ | Input Voltage (CE pin) | | | 12 | V |
| $V_{OUT}$ | Output Voltage | | | −0.3 to 6.0 | V |
| $I_{OUT}$ | Output Current | | | 165 | mA |
| $P_D$ | Power Dissipation[1] | DFN(PLP)1010-4 | JEDEC STD. 51-7 Test Land Pattern | 800 | mW |
| | | SC-88A | Standard Test Land Pattern | 380 | |
| | | SOT-23-5 | JEDEC STD. 51-7 Test Land Pattern | 660 | |
| Tj | Junction Temperature Range | | | −40 to 125 | °C |
| Tstg | Storage Temperature Range | | | −55 to 125 | °C |

| ABSOLUTE MAXIMUM RATINGS |
|---|
| Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured. |

# RECOMMENDED OPERATING CONDITIONS

**Recommended Operating Conditions**

| Symbol | Item | Rating | Unit |
|---|---|---|---|
| $V_{IN}$ | Input Voltage | 2.5 to 11.0[2] | V |
| Ta | Operating Temperature Range | −40 to 85 | °C |

| RECOMMENDED OPERATING CONDITIONS |
|---|
| 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. |

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[1] Refer to *POWER DISSIPATION* for detailed information.
[2] $V_{SET}$ + 6.5 V ≤ 11.0 V

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# ELECTRICAL CHARACTERISTICS

Unless otherwise noted, $V_{IN}$ = Set $V_{OUT}$ + 1.0 V, $I_{OUT}$ = 1 mA, $C_{IN}$ = $C_{OUT}$ = 0.1 μF.

The specifications surrounded by ☐ are guaranteed by design engineering at −40°C ≤ Ta ≤ 85°C.

**RP173xxxxA** (Ta = 25°C)

| Symbol | Item | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{OUT}$ | Output Voltage | Ta = 25°C | $V_{OUT}$ > 1.5 V | x0.99 | | x1.01 | V |
| | | | $V_{OUT}$ ≤ 1.5 V | −15 | | 15 | mV |
| | | −40°C ≤ Ta ≤ 85°C | $V_{OUT}$ > 1.5 V | x0.982 | | x1.018 | V |
| | | | $V_{OUT}$ ≤ 1.5 V | −28 | | 27 | mV |
| $I_{OUT}$ | Output Current | | | 150 | | | mA |
| $\Delta V_{OUT}/\Delta I_{OUT}$ | Load Regulation | 0.1 mA ≤ $I_{OUT}$ ≤ 150 mA | | −30 | −3 | 35 | mV |
| $V_{DIF}$ | Dropout Voltage | $I_{OUT}$ = 150 mA | | Refer to the *PRODUCT-SPECIFIC ELECTRICAL CHARACTERISTICS* | | | |
| $I_{SS}$ | Supply Current | $I_{OUT}$ = 0 mA | | | 2.0 | 3.7 | μA |
| Istandby | Standby Current | $V_{IN}$ = $V_{IN}$ (Max.) $V_{CE}$ = $V_{IN}$ | | | 0.2 | 0.6 | μA |
| $\Delta V_{OUT}/\Delta V_{IN}$ | Load Regulation | Set $V_{OUT}$ + 0.5 V ≤ $V_{IN}$ ≤ $V_{IN}$ (Max.) When $V_{OUT}$ ≤ 2.0 V, 2.5 V ≤ $V_{IN}$ ≤ $V_{IN}$ (Max.) | | | 0.02 | 0.20 | %/V |
| RR | Ripple Rejection | f = 1 kHz, Ripple 0.2 Vp–p, $I_{OUT}$ = 10 mA *When $V_{OUT}$ < 2.0 V, $V_{IN}$ = 3.0 V | | | 30 | | dB |
| $V_{IN}$ | Input Voltage | 1.2 ≤ $V_{OUT}$ < 4.5 | | 2.5 | | Vset + 6.5 | V |
| | | 4.5 ≤ $V_{OUT}$ ≤ 5.5 | | 2.5 | | 11 | |
| $I_{SC}$ | Short Current Limit Circuit | $V_{OUT}$ = 0 V | | | 45 | | mA |
| $V_{CEH}$ | $\overline{CE}$ Input Voltage "H" | | | 1.7 | | | V |
| $V_{CEL}$ | $\overline{CE}$ Input Voltage "L" | | | | | 0.8 | V |
| $I_{REV}$ | Reverse Current | 0 ≤ $V_{IN}$ ≤ 11.0 V, $V_{OUT}$ ≥ 1.5 V | | | 0 | 0.16 | μA |
| $V_{REV\_DET}$[1] | Reverse Current Protection Mode Detection Offset, $V_{REV}$ = $V_{DD}$ - $V_{OUT}$ | 0 ≤ $V_{IN}$ ≤ 11.0 V, $V_{OUT}$ ≥ 1.5 V | | | 55 | 100 | mV |
| $V_{REV\_REL}$[1] | Reverse Current Protection Mode Release Offset | 0 ≤ $V_{IN}$ ≤ 11.0 V, $V_{OUT}$ ≥ 1.5 V | | | 70 | 120 | mV |

All of units are tested and specified under the pulse load conditions such that Tj ≈ Ta = 25°C except for Ripple Rejection.

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[1] The operation coverage of the Reverse Current Protection Circuit is $V_{OUT}$ ≥ 1.5 V. However, under the condition of $V_{IN}$ = $V_{OUT}$ = 0 V, always the Reverse Current Protection Circuit is operating.

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Unless otherwise noted, $V_{IN}$ = Set $V_{OUT}$ + 1.0 V, $I_{OUT}$ = 1 mA, $C_{IN}$ = $C_{OUT}$ = 0.1 μF.
The specifications surrounded by ☐ are guaranteed by design engineering at −40°C ≤ Ta ≤ 85°C.

**RP173xxxxB/D** (Ta = 25°C)

| Symbol | Item | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{OUT}$ | Output Voltage | Ta = 25°C | $V_{OUT} > 1.5$ V | x0.99 | | x1.01 | V |
| | | | $V_{OUT} \leq 1.5$ V | −15 | | 15 | mV |
| | | −40°C ≤ Ta ≤ 85°C | $V_{OUT} > 1.5$ V | x0.982 | | x1.018 | V |
| | | | $V_{OUT} \leq 1.5$ V | −28 | | 27 | mV |
| $I_{OUT}$ | Output Current | | | 150 | | | mA |
| $\Delta V_{OUT}/\Delta I_{OUT}$ | Load Regulation | 0.1 mA ≤ $I_{OUT}$ ≤ 150 mA | | −30 | −3 | 35 | mV |
| $V_{DIF}$ | Dropout Voltage | $I_{OUT}$ = 150 mA | | Refer to the *PRODUCT-SPECIFIC ELECTRICAL CHARACTERISTICS* | | | |
| $I_{SS}$ | Supply Current | $I_{OUT}$ = 0 mA | | | 2.0 | 3.7 | μA |
| Istandby | Standby Current | $V_{IN}$ = $V_{IN}$ (Max.) $V_{CE}$ = 0 V | | | 0.2 | 0.6 | μA |
| $\Delta V_{OUT}/\Delta V_{IN}$ | Load Regulation | Set $V_{OUT}$ + 0.5 V ≤ $V_{IN}$ ≤ $V_{IN}$ (Max.) When $V_{OUT}$ ≤ 2.0 V, 2.5 V ≤ $V_{IN}$ ≤ $V_{IN}$ (Max.) | | | 0.02 | 0.20 | %/V |
| RR | Ripple Rejection | f = 1kHz, Ripple 0.2 Vp-p, $I_{OUT}$ = 10 mA *When $V_{OUT}$ < 2.0 V, $V_{IN}$ = 3.0 V | | | 30 | | dB |
| $V_{IN}$ | Input Voltage | 1.2 ≤ $V_{OUT}$ < 4.5 | | 2.5 | | Vset + 6.5 | V |
| | | 4.5 ≤ $V_{OUT}$ ≤ 5.5 | | 2.5 | | 11 | |
| $I_{SC}$ | Short Current Limit Circuit | $V_{OUT}$ = 0 V | | | 45 | | mA |
| $I_{PD}$ | CE Pull-down Current | | | | 0.30 | 0.90 | μA |
| $V_{CEH}$ | CE Input Voltage "H" | | | 1.7 | | | V |
| $V_{CEL}$ | CE Input Voltage "L" | | | | | 0.8 | V |
| $I_{REV}$ | Reverse Current | 0 ≤ $V_{IN}$ ≤ 11.0 V, $V_{OUT}$ ≥ 1.5 V | | | 0 | 0.16 | μA |
| $V_{REV\_DET}$[1] | Reverse Current Protection Mode Detection Offset, $V_{REV}$ = $V_{DD}$ - $V_{OUT}$ | 0 ≤ $V_{IN}$ ≤ 11.0 V, $V_{OUT}$ ≥ 1.5 V | | | 55 | 100 | mV |
| $V_{REV\_REL}$[1] | Reverse Current Protection Mode Release Offset | 0 ≤ $V_{IN}$ ≤ 11.0 V, $V_{OUT}$ ≥ 1.5 V | | | 70 | 120 | mV |
| $R_{LOW}$ | Auto-discharge Nch Tr. ON Resistance (RP173xxxxD only) | $V_{IN}$ = 7.0 V, $V_{CE}$ = 0 V | | | 380 | | Ω |

All of units are tested and specified under the pulse load conditions such that Tj ≈ Ta = 25°C except for Ripple Rejection.

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[1] The operation coverage of the Reverse Current Protection Circuit is $V_{OUT}$ ≥ 1.5 V. However, under the condition of $V_{IN}$ = $V_{OUT}$ = 0 V, always the Reverse Current Protection Circuit is operating.

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**PRODUCT-SPECIFIC ELECTRICAL CHARACTERISTICS**

**RP173x Product-specific Electrical Characteristics**

| Product Name | $V_{OUT}$ | | | | | | $V_{DIF}$ | |
|---|---|---|---|---|---|---|---|---|
| | Ta = 25°C | | | −40°C ≤ Ta ≤ 85°C | | | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. | Typ. | Max. |
| RP173x12xx | 1.185 | 1.200 | 1.215 | 1.172 | 1.200 | 1.227 | 1.680 | 2.590 |
| RP173x12xx5 | 1.235 | 1.250 | 1.265 | 1.222 | 1.250 | 1.277 | 1.680 | 2.590 |
| RP173x13xx | 1.285 | 1.300 | 1.315 | 1.272 | 1.300 | 1.327 | 1.630 | 2.490 |
| RP173x14xx | 1.385 | 1.400 | 1.415 | 1.372 | 1.400 | 1.427 | 1.630 | 2.490 |
| RP173x15xx | 1.485 | 1.500 | 1.515 | 1.472 | 1.500 | 1.527 | 1.480 | 2.230 |
| RP173x16xx | 1.584 | 1.600 | 1.616 | 1.571 | 1.600 | 1.629 | 1.480 | 2.230 |
| RP173x17xx | 1.683 | 1.700 | 1.717 | 1.669 | 1.700 | 1.731 | 1.480 | 2.230 |
| RP173x17xx5 | 1.733 | 1.750 | 1.768 | 1.719 | 1.750 | 1.782 | 1.480 | 2.230 |
| RP173x18xx | 1.782 | 1.800 | 1.818 | 1.768 | 1.800 | 1.832 | 1.160 | 2.190 |
| RP173x18xx5 | 1.832 | 1.850 | 1.869 | 1.817 | 1.850 | 1.883 | 1.160 | 2.190 |
| RP173x19xx | 1.881 | 1.900 | 1.919 | 1.866 | 1.900 | 1.934 | 1.160 | 2.190 |
| RP173x20xx | 1.980 | 2.000 | 2.020 | 1.964 | 2.000 | 2.036 | 1.160 | 2.190 |
| RP173x21xx | 2.079 | 2.100 | 2.121 | 2.062 | 2.100 | 2.138 | 1.160 | 2.190 |
| RP173x22xx | 2.178 | 2.200 | 2.222 | 2.160 | 2.200 | 2.240 | 1.160 | 2.190 |
| RP173x23xx | 2.277 | 2.300 | 2.323 | 2.259 | 2.300 | 2.341 | 0.900 | 1.470 |
| RP173x24xx | 2.376 | 2.400 | 2.424 | 2.357 | 2.400 | 2.443 | 0.900 | 1.470 |
| RP173x25xx | 2.475 | 2.500 | 2.525 | 2.455 | 2.500 | 2.545 | 0.900 | 1.470 |
| RP173x26xx | 2.574 | 2.600 | 2.626 | 2.553 | 2.600 | 2.647 | 0.900 | 1.470 |
| RP173x27xx | 2.673 | 2.700 | 2.727 | 2.651 | 2.700 | 2.749 | 0.900 | 1.470 |
| RP173x28xx | 2.772 | 2.800 | 2.828 | 2.750 | 2.800 | 2.850 | 0.900 | 1.470 |
| RP173x28xx5 | 2.822 | 2.850 | 2.879 | 2.799 | 2.850 | 2.901 | 0.900 | 1.470 |
| RP173x29xx | 2.871 | 2.900 | 2.929 | 2.848 | 2.900 | 2.952 | 0.900 | 1.470 |
| RP173x30xx | 2.970 | 3.000 | 3.030 | 2.946 | 3.000 | 3.054 | 0.610 | 1.050 |
| RP173x31xx | 3.069 | 3.100 | 3.131 | 3.044 | 3.100 | 3.156 | 0.610 | 1.050 |
| RP173x32xx | 3.168 | 3.200 | 3.232 | 3.142 | 3.200 | 3.258 | 0.610 | 1.050 |
| RP173x33xx | 3.267 | 3.300 | 3.333 | 3.241 | 3.300 | 3.359 | 0.610 | 1.050 |
| RP173x34xx | 3.366 | 3.400 | 3.434 | 3.339 | 3.400 | 3.461 | 0.610 | 1.050 |
| RP173x35xx | 3.465 | 3.500 | 3.535 | 3.437 | 3.500 | 3.563 | 0.610 | 1.050 |
| RP173x36xx | 3.564 | 3.600 | 3.636 | 3.535 | 3.600 | 3.665 | 0.610 | 1.050 |
| RP173x37xx | 3.663 | 3.700 | 3.737 | 3.633 | 3.700 | 3.767 | 0.610 | 1.050 |
| RP173x38xx | 3.762 | 3.800 | 3.838 | 3.732 | 3.800 | 3.868 | 0.610 | 1.050 |
| RP173x39xx | 3.861 | 3.900 | 3.939 | 3.830 | 3.900 | 3.970 | 0.610 | 1.050 |
| RP173x40xx | 3.960 | 4.000 | 4.040 | 3.928 | 4.000 | 4.072 | 0.390 | 0.760 |
| RP173x41xx | 4.059 | 4.100 | 4.141 | 4.026 | 4.100 | 4.174 | 0.390 | 0.760 |
| RP173x42xx | 4.158 | 4.200 | 4.242 | 4.124 | 4.200 | 4.276 | 0.390 | 0.760 |
| RP173x43xx | 4.257 | 4.300 | 4.343 | 4.223 | 4.300 | 4.377 | 0.390 | 0.760 |
| RP173x44xx | 4.356 | 4.400 | 4.444 | 4.321 | 4.400 | 4.479 | 0.390 | 0.760 |
| RP173x45xx | 4.455 | 4.500 | 4.545 | 4.419 | 4.500 | 4.581 | 0.390 | 0.760 |
| RP173x46xx | 4.554 | 4.600 | 4.646 | 4.517 | 4.600 | 4.683 | 0.390 | 0.760 |
| RP173x47xx | 4.653 | 4.700 | 4.747 | 4.615 | 4.700 | 4.785 | 0.390 | 0.760 |
| RP173x48xx | 4.752 | 4.800 | 4.848 | 4.714 | 4.800 | 4.886 | 0.390 | 0.760 |
| RP173x49xx | 4.851 | 4.900 | 4.949 | 4.812 | 4.900 | 4.988 | 0.390 | 0.760 |
| RP173x50xx | 4.950 | 5.000 | 5.050 | 4.910 | 5.000 | 5.090 | 0.390 | 0.760 |
| RP173x51xx | 5.049 | 5.100 | 5.151 | 5.008 | 5.100 | 5.192 | 0.390 | 0.760 |
| RP173x52xx | 5.148 | 5.200 | 5.252 | 5.106 | 5.200 | 5.294 | 0.390 | 0.760 |
| RP173x53xx | 5.247 | 5.300 | 5.353 | 5.205 | 5.300 | 5.395 | 0.390 | 0.760 |
| RP173x54xx | 5.346 | 5.400 | 5.454 | 5.303 | 5.400 | 5.497 | 0.390 | 0.760 |
| RP173x55xx | 5.445 | 5.500 | 5.555 | 5.401 | 5.500 | 5.599 | 0.390 | 0.760 |

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# THEORY OF OPERATION

### REVERSE CURRENT PROTECTION CIRCUIT

The RP173 Series include a Reverse Current Protection Circuit, which stops the reverse current from $V_{OUT}$ pin to $V_{DD}$ pin or to GND pin when $V_{OUT}$ becomes higher than $V_{IN}$.

Usually, the LDO using Pch output transistor contains a parasitic diode between $V_{DD}$ pin and $V_{OUT}$ pin. Therefore, if $V_{OUT}$ is higher than $V_{IN}$, the parasitic diode becomes forward direction. As a result, the current flows from $V_{OUT}$ pin to $V_{DD}$ pin.

The ICs of this series switches the mode to the reverse current protection mode before $V_{IN}$ becomes lower than $V_{OUT}$ by connecting the parasitic diode of Pch output transistor to the backward direction, and connecting the gate to $V_{OUT}$ pin. As a result, the Pch output transistor is turned off and the all the current pathways from $V_{OUT}$ pin to GND pin are shut down to maintain the reverse current lower than [$I_{REV}$] of the Electrical Characteristics.

Switching to either the normal mode or to the reverse current protection mode is determined by the magnitude of $V_{IN}$ voltage and $V_{OUT}$ voltage. For the stable operation, offset and hysteresis are set as the threshold. The detection/ release thresholds of both normal and reverse current protection modes are specified by [$V_{REV\_DET}$] and [$V_{REV\_REL}$] of the Electrical Characteristics. Therefore, the minimum dropout voltage under the small load current condition is restricted by the value of [$V_{REV\_REL}$].

Fig.1 and Fig.2 show the diagrams of each mode, and Fig.3 shows the load characteristics of each mode. When giving the $V_{OUT}$ pin a constant-voltage and decreasing the $V_{IN}$ voltage, the dropout voltage will become lower than the [$V_{REV\_DET}$]. As a result, the reverse current protection starts to function to stop the load current. By increasing the dropout voltage higher than the [$V_{REV\_REL}$], the protection mode will be released to let the load current to flow. If the dropout voltage to be used is lower than [$V_{REV\_REL}$], the detection and the release may be repeated.

The operation coverage of the Reverse Current Protection Circuit is $V_{OUT} \geq 1.5V$. However, under the condition of $V_{IN}=0V$, always the reverse current protection mode is operating.
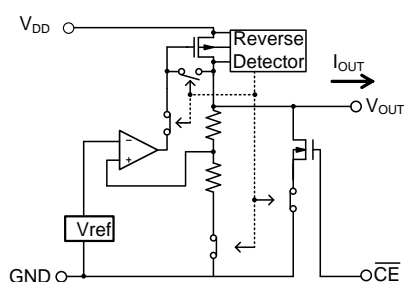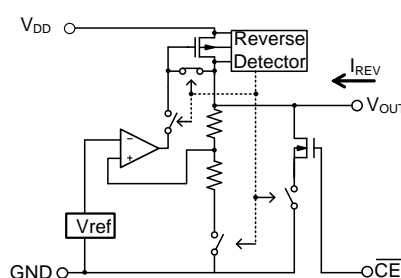


**Fig. 1 Normal Mode**          **Fig. 2 Reverse Current Protection Mode**

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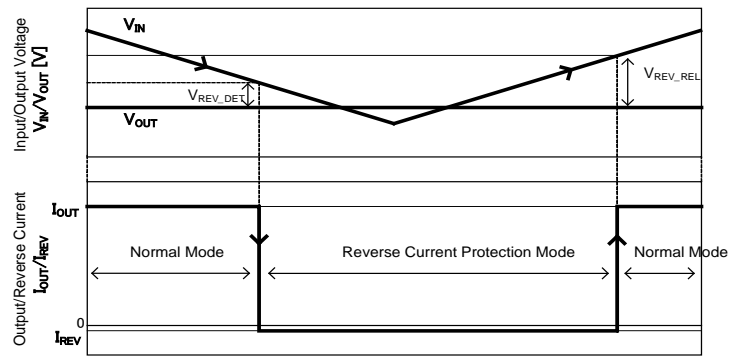
Fig. 3   Reverse Current Protection Mode Detection/ Release &
Reverse Current/ Output Current Characteristics

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# APPLICATION INFORMATION

### TYPICAL APPLICATIONS
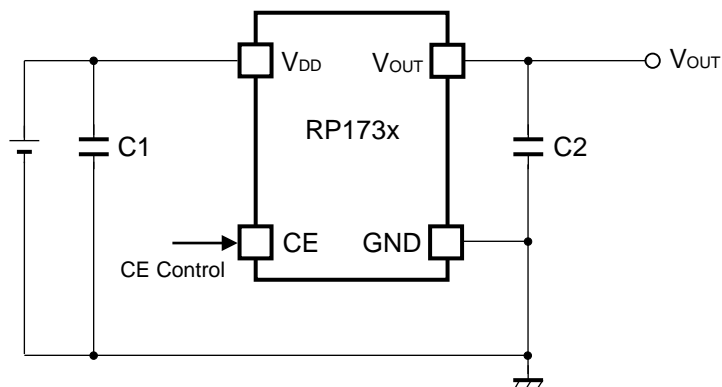


### Recommended External Components

| Symbol | Description |
|---|---|
| C2 (C$_{OUT}$) | 0.1 μF, GRM155B31C104KA87D, MURATA |

### NOTES ON SELECTING EXTERNAL COMPONENTS

**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 0.1μF or more capacitor C2.

In case of using a tantalum capacitor, the output may be unstable due to inappropriate ESR. Therefore, the full range of operating conditions for the capacitor in the application should be considered.

**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 0.1μF 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.

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# TECHNICAL NOTES

## POWER ACTIVATION

If the ICs are started up with $V_{IN}$ and $V_{CE}$ under the no-load condition, the both pin voltages have to be started up with faster than 2.0V/s. If the IC is started up with slower than 2.0V/s under the no-load condition, start up the IC only with $V_{CE}$.

## 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 µV (Avg.) are marked as the hatched area in the graph.

### Measurement Conditions

Frequency Band: 10 Hz to 2 MHz
Temperature     : −40°C to 85°C
C1, C2          : 0.1 µF

**RP173x0121x**

$V_{IN}=2.5V\sim7.7V$



**RP173x301x**

$V_{IN}=3.0V\sim9.5V$



**RP173x551x**

$V_{IN}=5.5V\sim11V$

**RICOH**
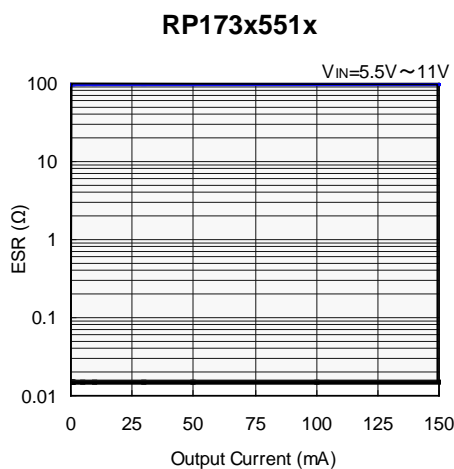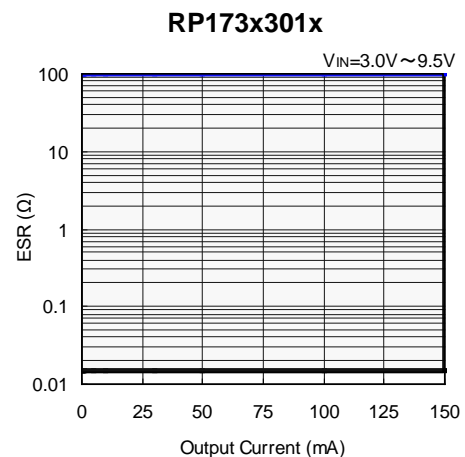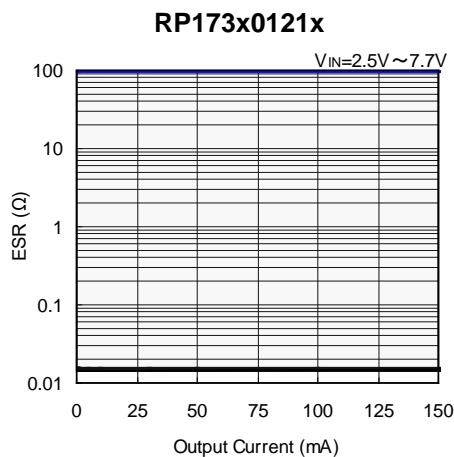
# TYPICAL CHARACTERISTICS

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

**1) Output Voltage vs. Output Current (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF, Ta = 25°C)**
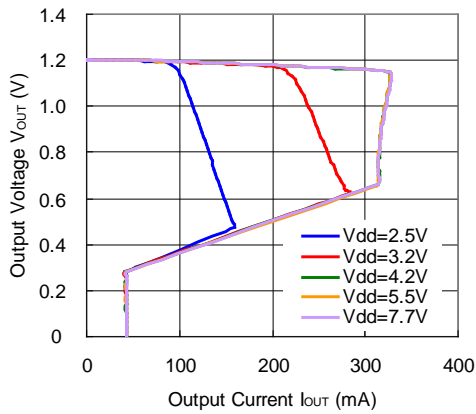
### RP173x12xx
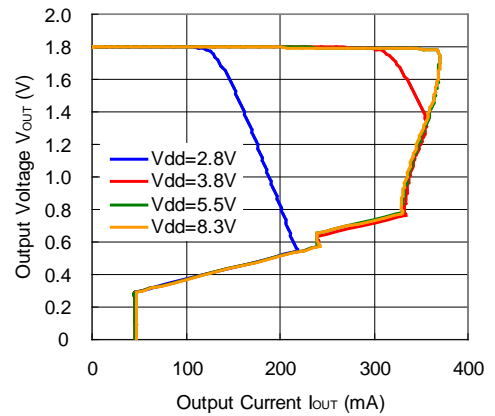


### RP173x18xx



### RP173x30xx
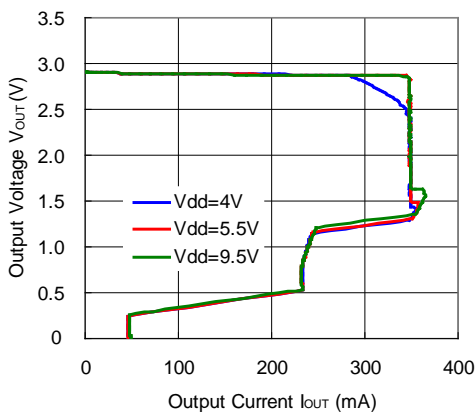


### RP173x55xx
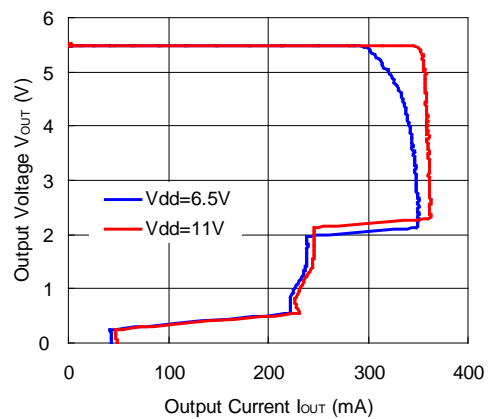


**2) Output Voltage vs. Input Voltage (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF, Ta = 25°C)**

### RP173x12xx



### RP173x18xx

**RICOH**
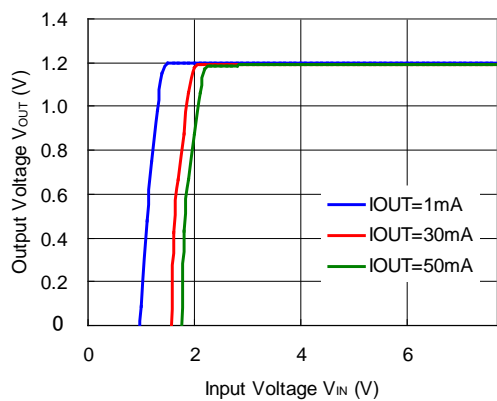
**RP173x30xx**
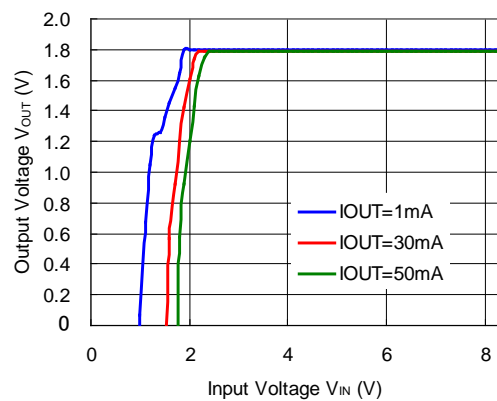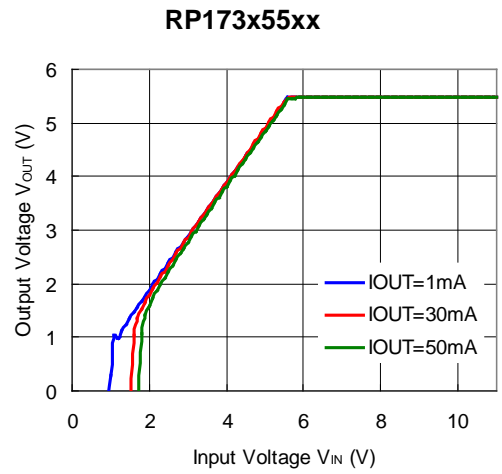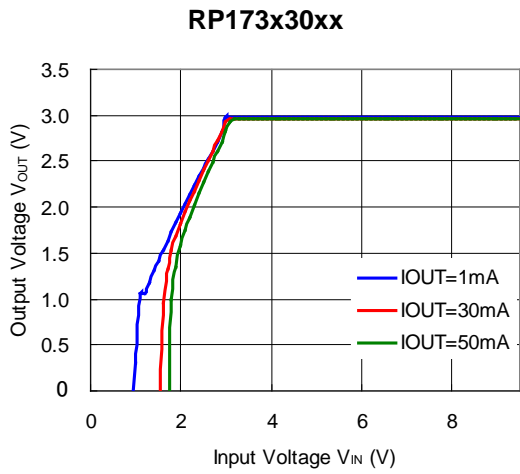


**RP173x55xx**



### 3) Supply Current vs. Input Voltage (C1 = Ceramic 0.1 µF, C2 = Ceramic 0.1 µF, Ta = 25°C)

**RP173x12xx**



**RP173x18xx**



**RP173x30xx**



**RP173x55xx**

**RICOH**
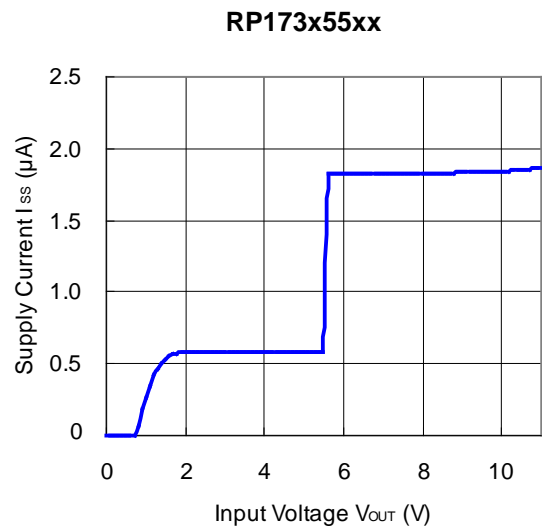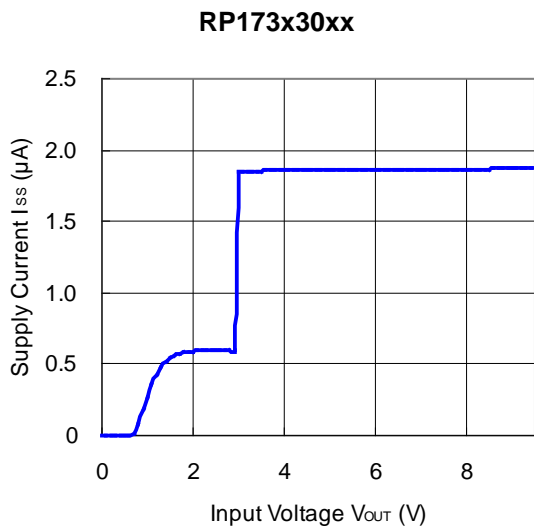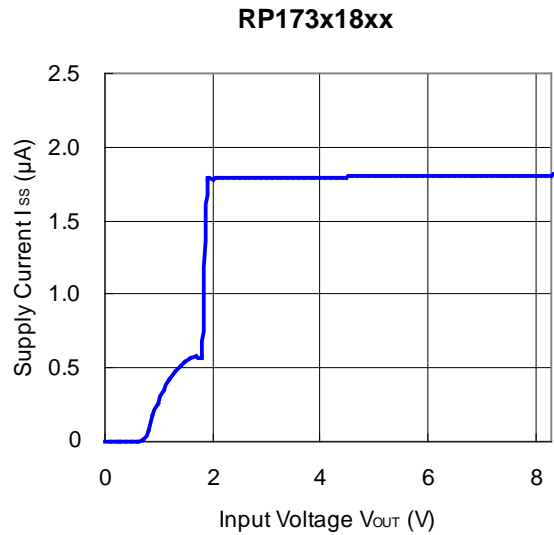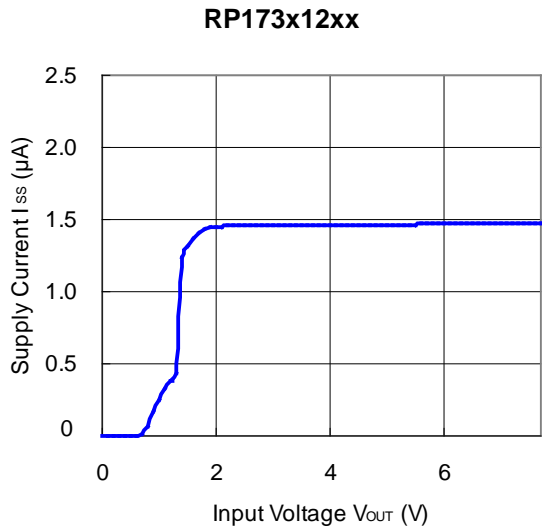
**4) Output Voltage vs. Temperature (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF, I$_{OUT}$ = 1 mA)**

**RP173x12xx**
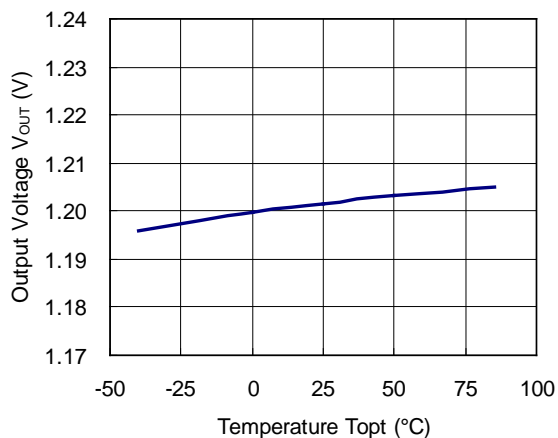


**RP173x18xx**
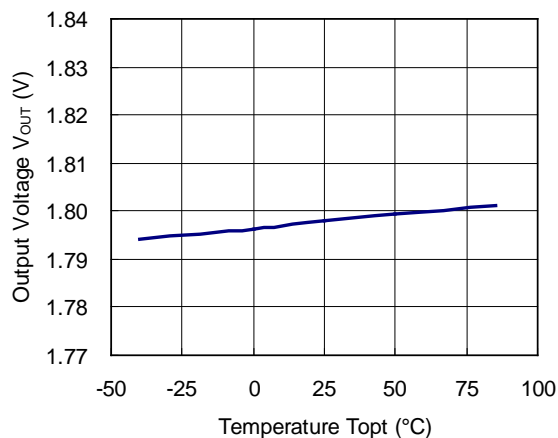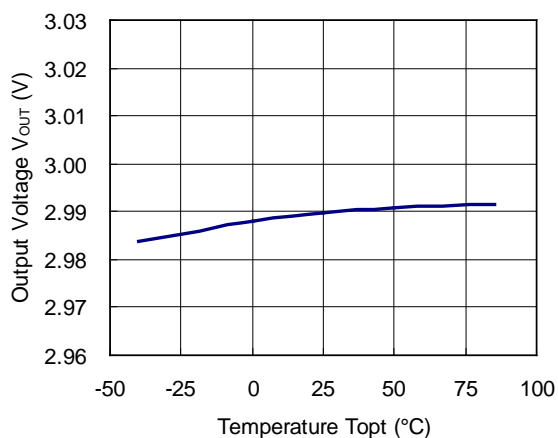


**RP173x30xx**
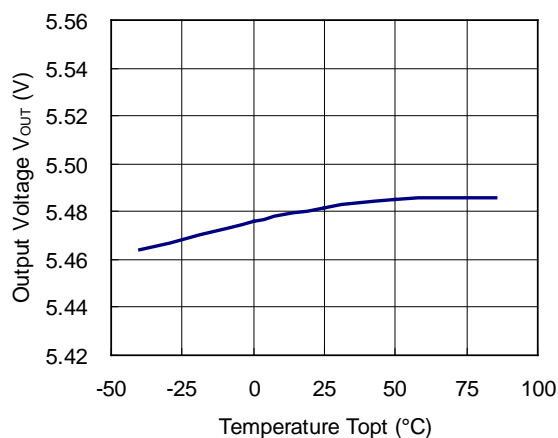


**RP173x55xx**



**5) Dropout Voltage vs. Output Current (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF)**

**RP173x12xx**



**RP173x30xx**

**RICOH**
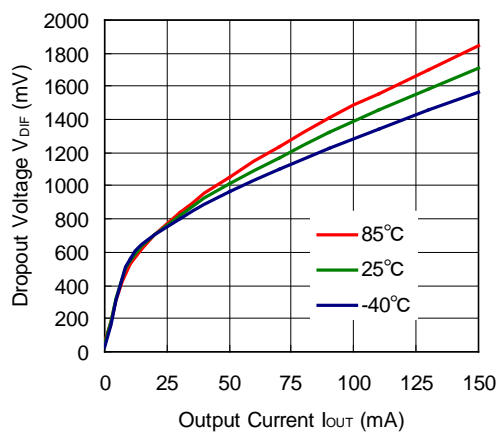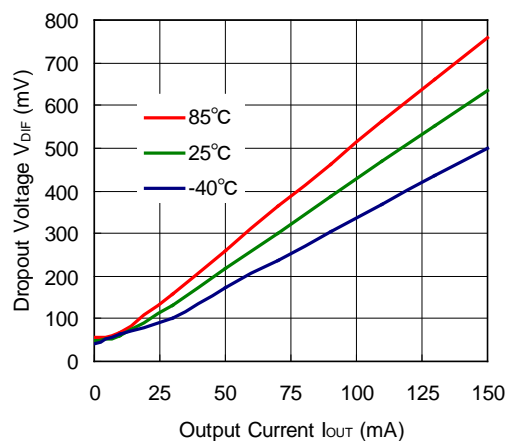
**RP173x55xx**
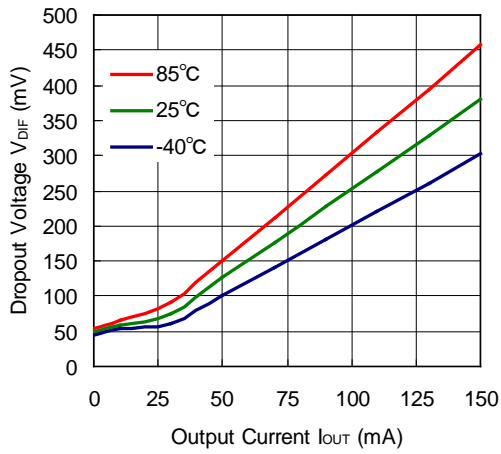


6) **Dropout Voltage vs. Set Output Voltage (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF, Ta = 25°C)**
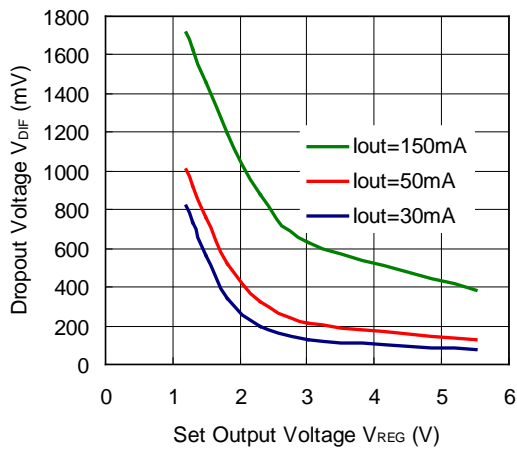
**RP173x**



7) **Minimum Operating Voltage (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF, Ta = −40 to 85°C)**

**RICOH**
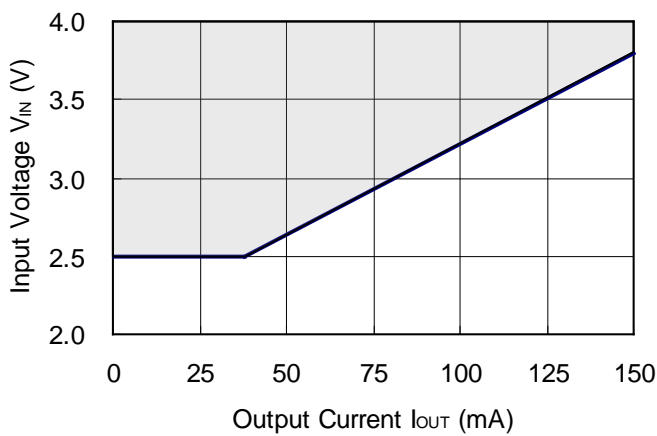
**8) Ripple Rejection vs. Input Bias Voltage (C1 = none, C2 = Ceramic 0.1 μF, Ripple = 0.2 Vp-p, Ta = 25°C)**

**RP173x28xx**



$I_{OUT}$=1mA

Legend: 100Hz, 1kHz, 10kHz, 100kHz

**RP173x28xx**



$I_{OUT}$=30mA

Legend: 100Hz, 1kHz, 10kHz, 100kHz

**RP173x28xx**



$I_{OUT}$=50mA

Legend: 100Hz, 1kHz, 10kHz, 100kHz
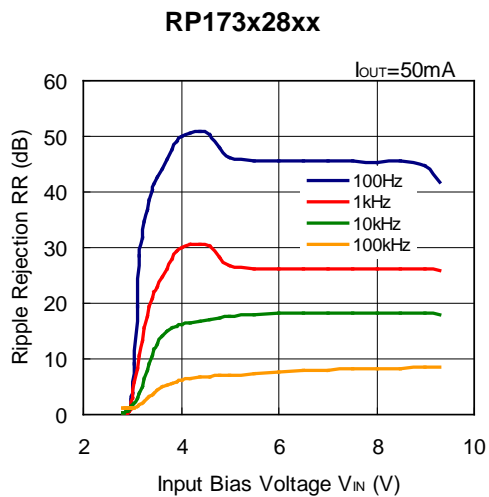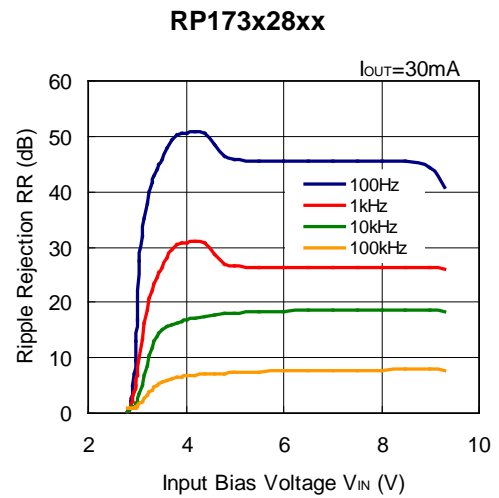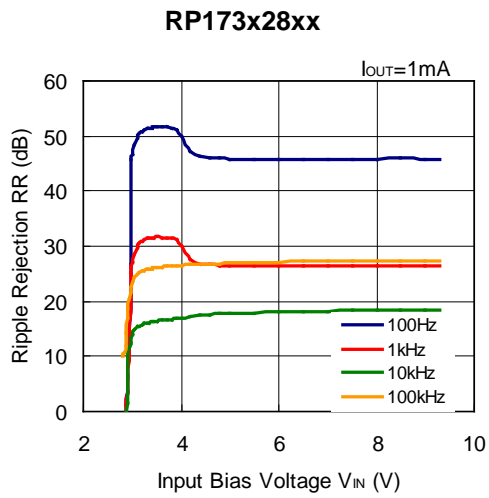
**9) Ripple Rejection vs. Temperature (C1 = none, C2 = Ceramic 0.1 μF, Ripple = 0.2 Vp-p, Ta = 25°C)**

**RP173x12xx**



$V_{IN}$=2.5V

Legend: Iout=1mA, Iout=30mA, Iout=50mA

**RP173x18xx**



$V_{IN}$=2.8V

Legend: Iout=1mA, Iout=30mA, Iout=50mA

**RICOH**
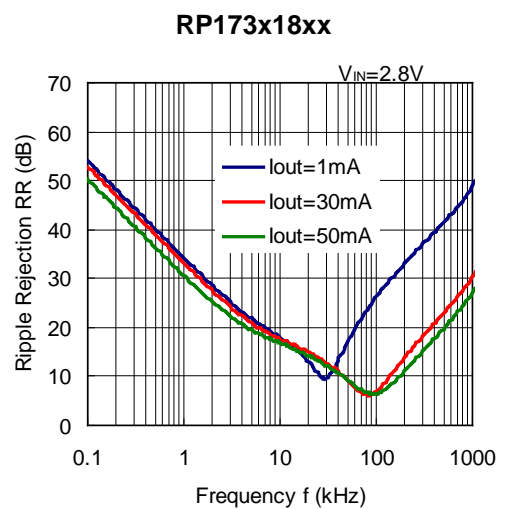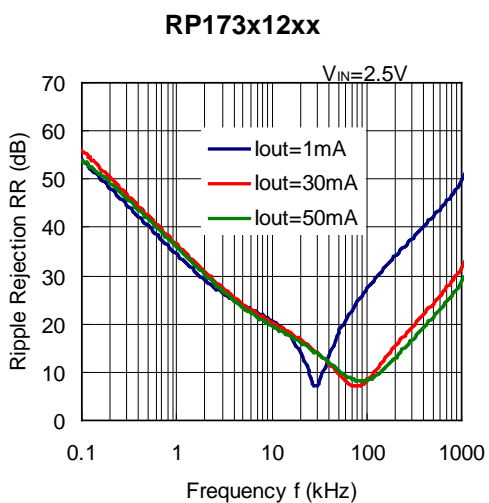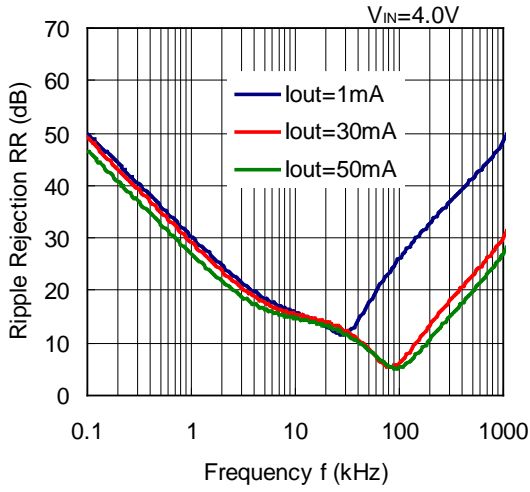
**RP173x30xx**
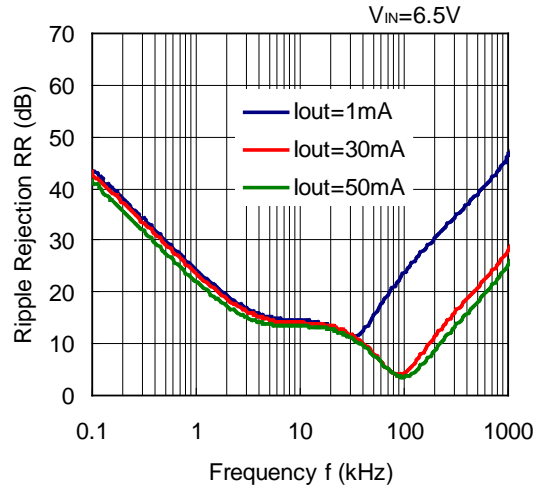


**RP173x55xx**



**10) Input Transient Response (C1 = none, C2 = Ceramic 0.1 μF, tr = tf = 5.0 μs, Ta = 25°C)**
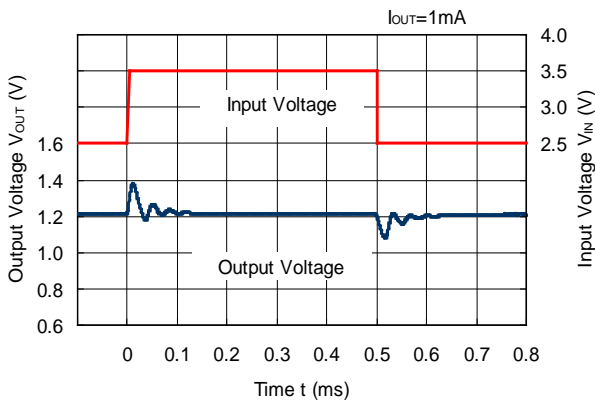
**RP173x12xx**



**RP173x18xx**



**RP173x30xx**



**RP173x55xx**

**RICOH**

**RP173x12xx**



$I_{OUT}$=30mA

**RP173x18xx**



$I_{OUT}$=30mA

**RP173x30xx**



$I_{OUT}$=30mA

**RP173x55xx**



$I_{OUT}$=30mA
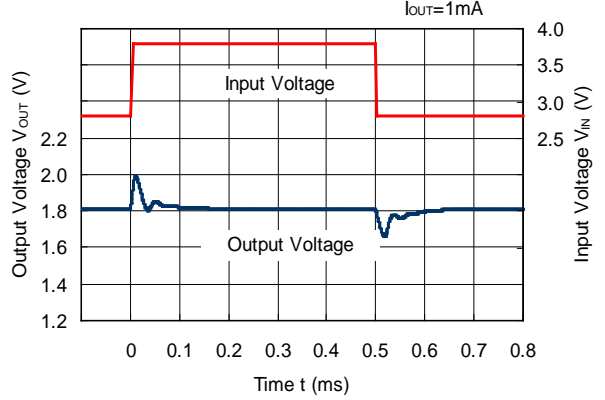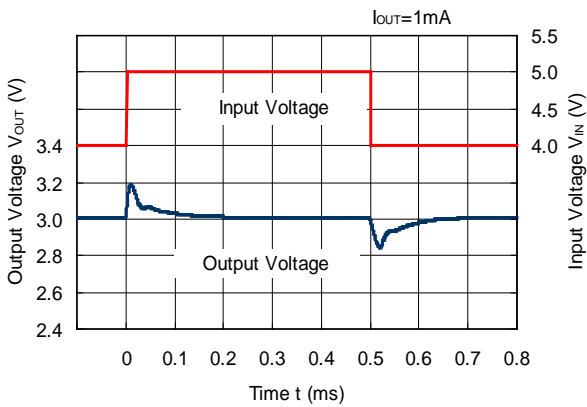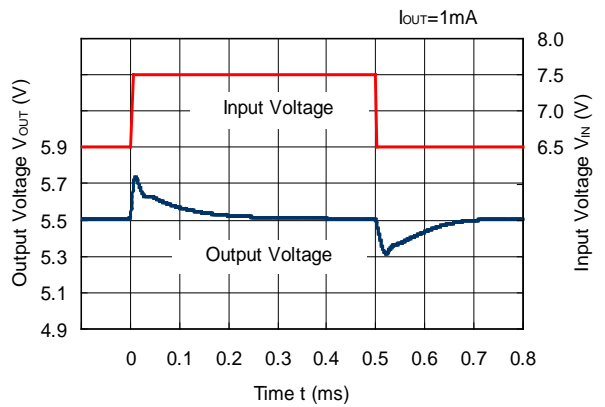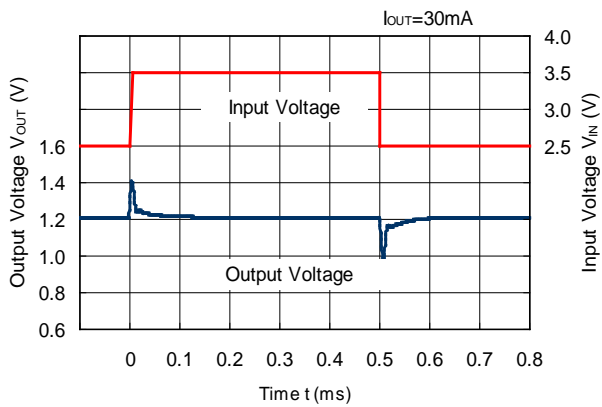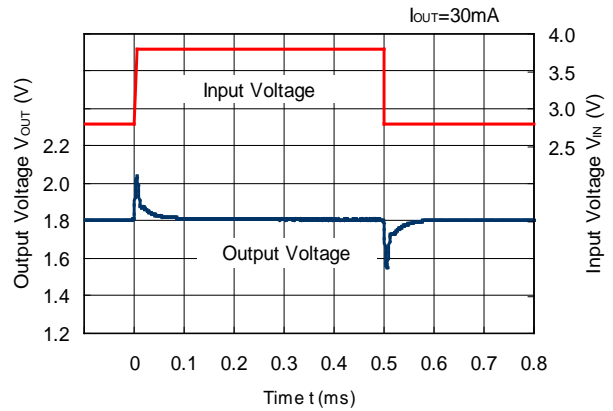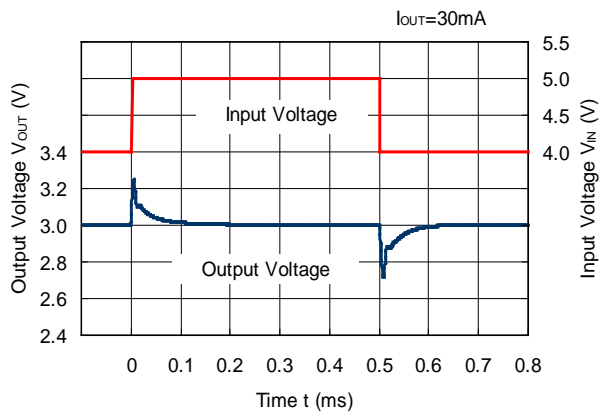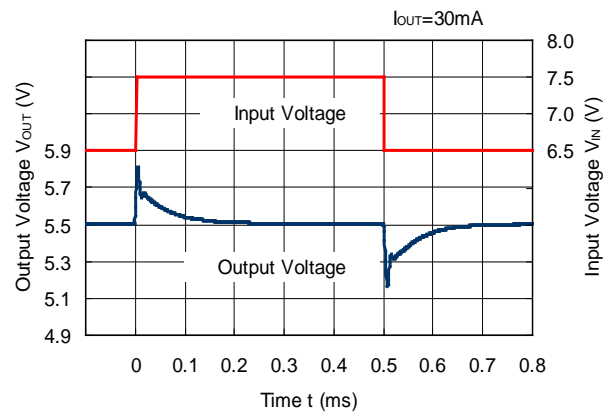
**11) Load Transient Response (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF, tr = tf = 0.5 μs, Ta = 25°C)**
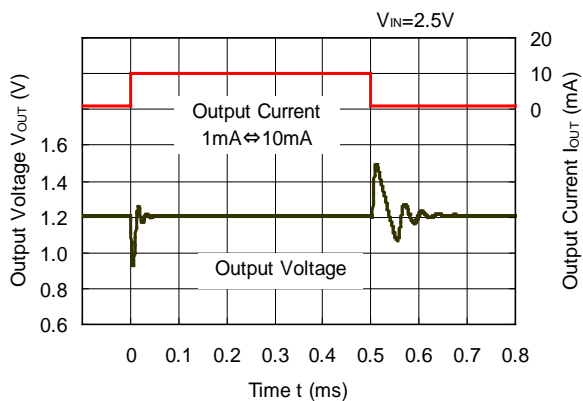
**RP173x12xx**



$V_{IN}$=2.5V

**RP173x18xx**



$V_{IN}$=2.8V

**RICOH**

**RP173x30xx**

V<sub>IN</sub>=4.0V $V_{IN}=4.0V$



**RP173x55xx**

$V_{IN}=6.5V$



**RP173x12xx**

$V_{IN}=4.0V$



**RP173x18xx**

$V_{IN}=4.0V$



**RP173x30xx**

$V_{IN}=4.0V$



**RP173x55xx**

$V_{IN}=6.5V$

**RICOH**
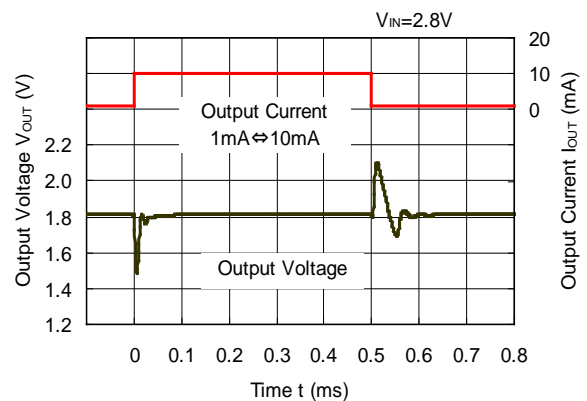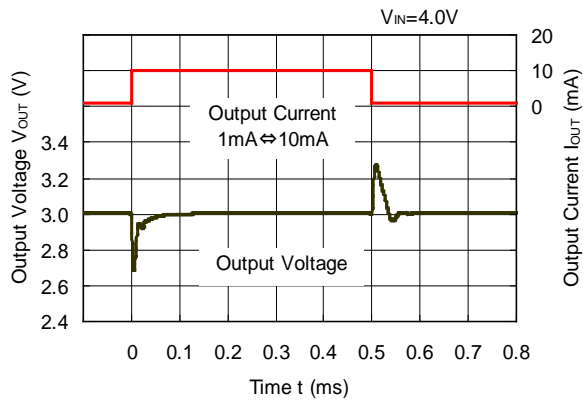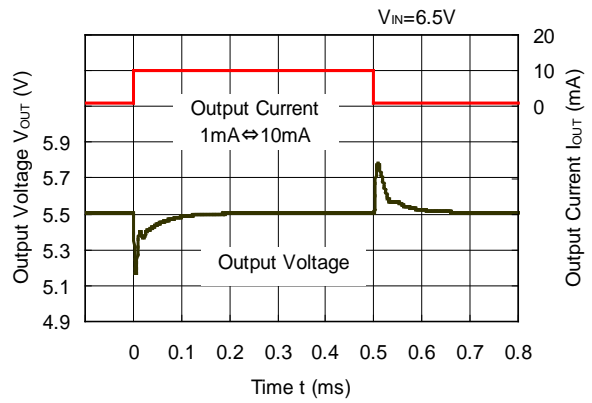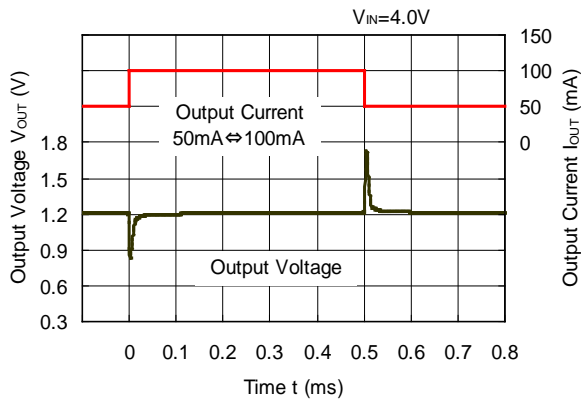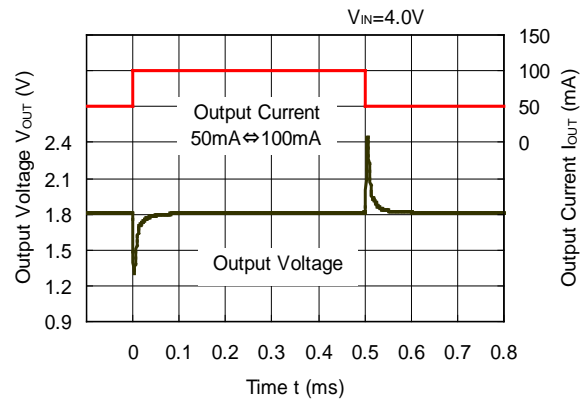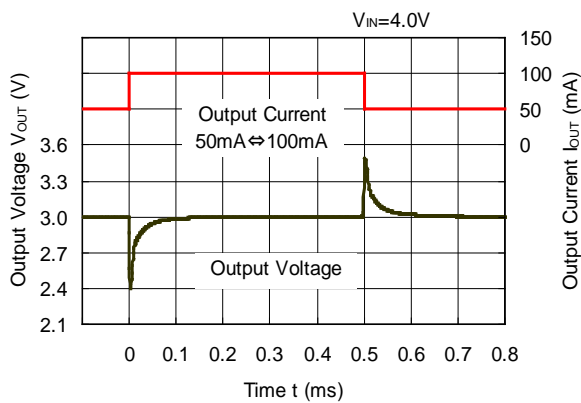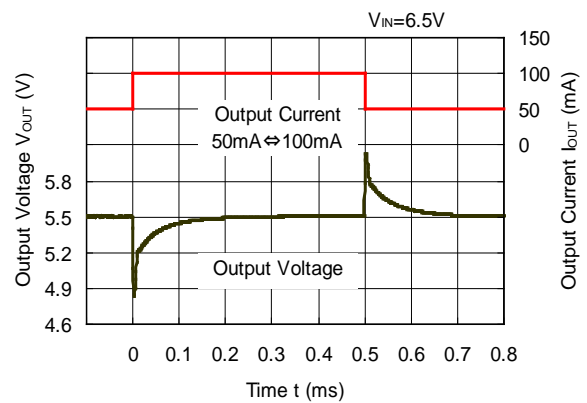
## 12) Turn on Speed (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF, Ta = 25°C)
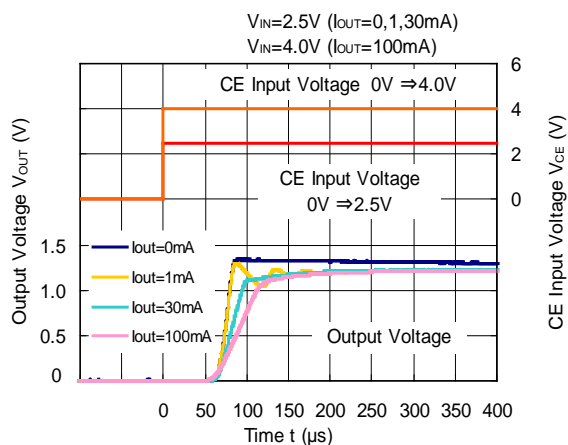
### RP173x12xx
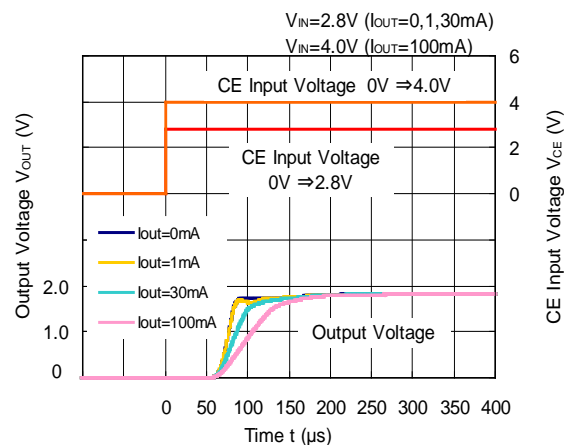


### RP173x18xx
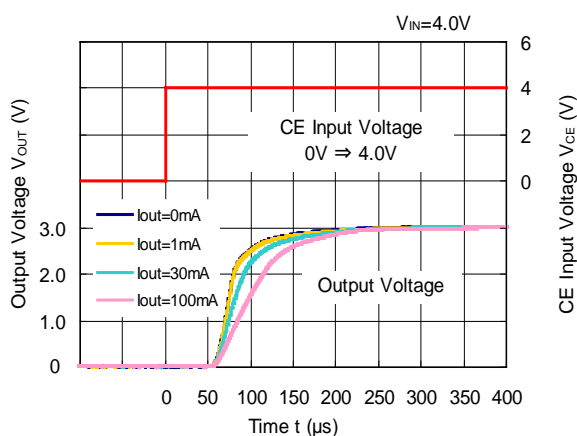


### RP173x30xx
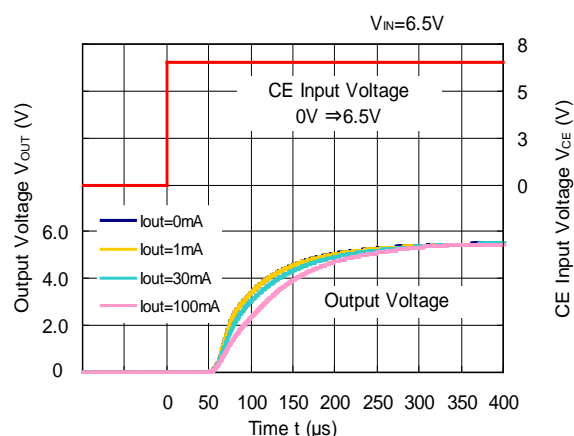


### RP173x55xx



## 13) Turn off Speed with CE pin (C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF, Ta = 25°C)

### RP173x12xx



### RP173x18xx

**RICOH**
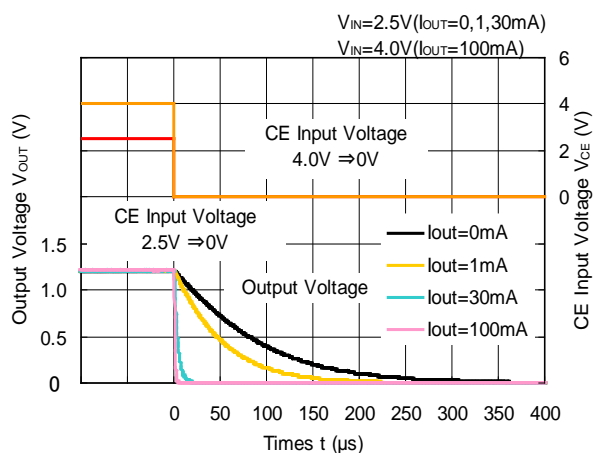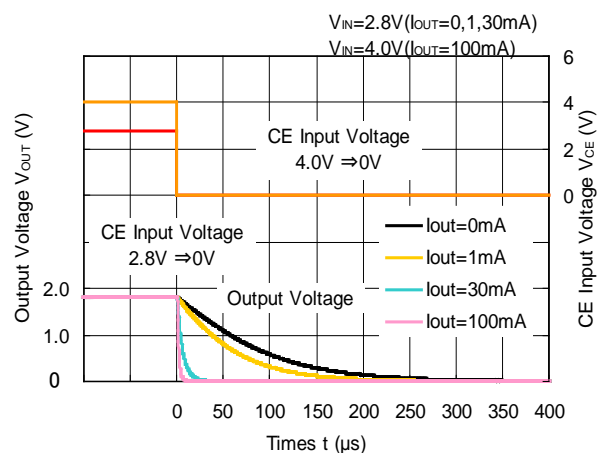
**RP173x30xx**
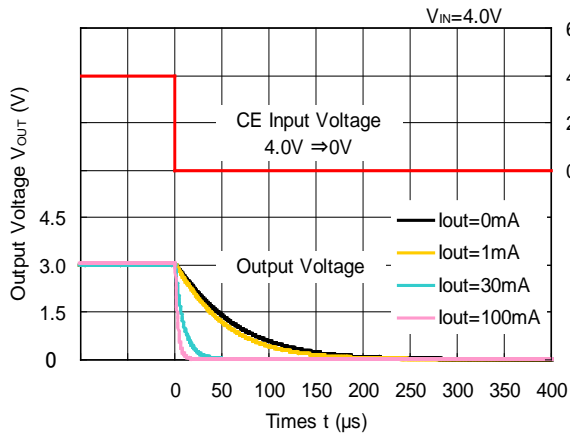


**RP173x55xx**

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions.
The following measurement conditions are based on JEDEC STD. 51-7.

**Measurement Conditions**

| Item | Measurement Conditions |
|---|---|
| Environment | Mounting on Board (Wind Velocity = 0 m/s) |
| Board Material | Glass Cloth Epoxy Plastic (Four-Layer Board) |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm |
| Copper Ratio | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square<br>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes | $\phi$ 0.2 mm × 11 pcs |

**Measurement Result**      (Ta = 25°C, Tjmax = 125°C)

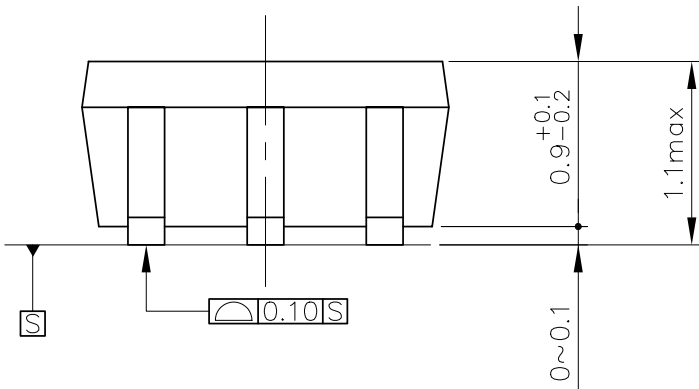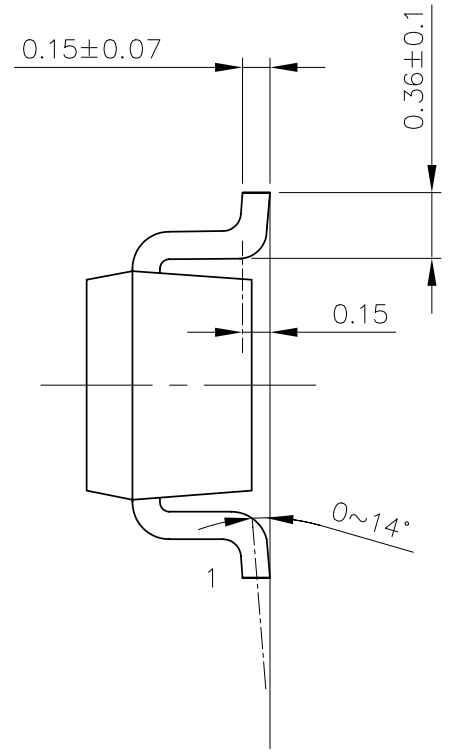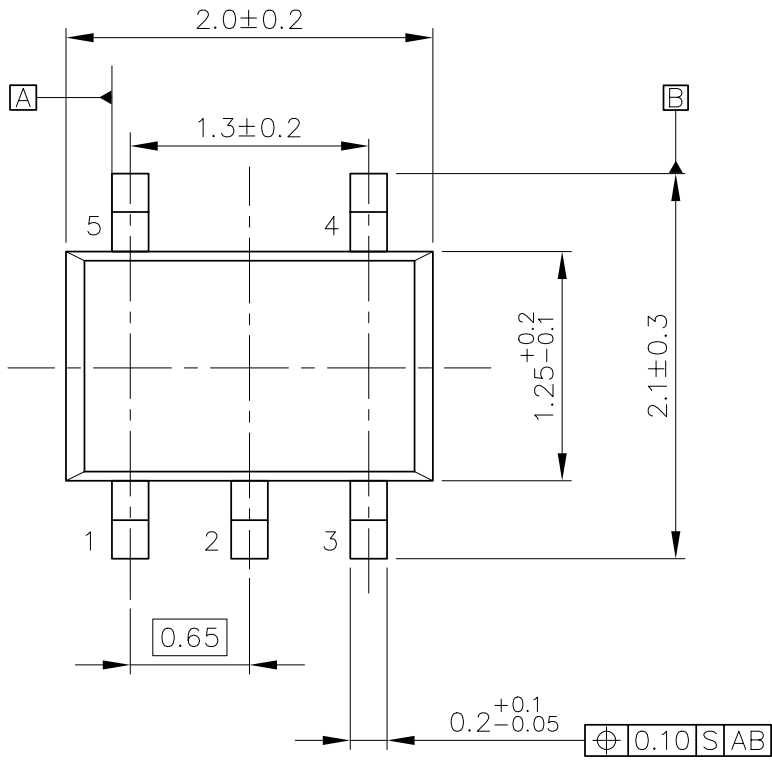| Item | Measurement Result |
|---|---|
| Power Dissipation | 800 mW |
| Thermal Resistance ($\theta$ja) | $\theta$ja = 125°C/W |
| Thermal Characterization Parameter ($\psi$jt) | $\psi$jt = 58°C/W |

$\theta$ja: Junction-to-Ambient Thermal Resistance

$\psi$jt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature        Measurement Board Pattern

**RICOH**

Ver. A
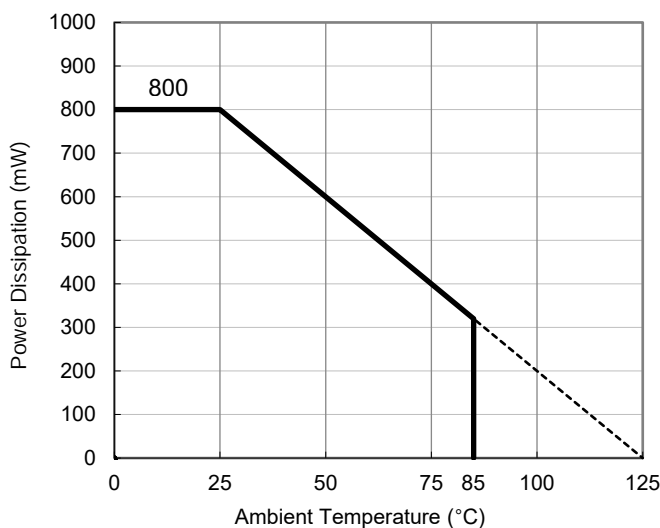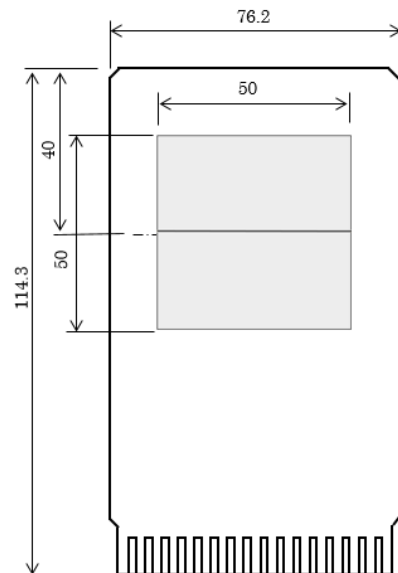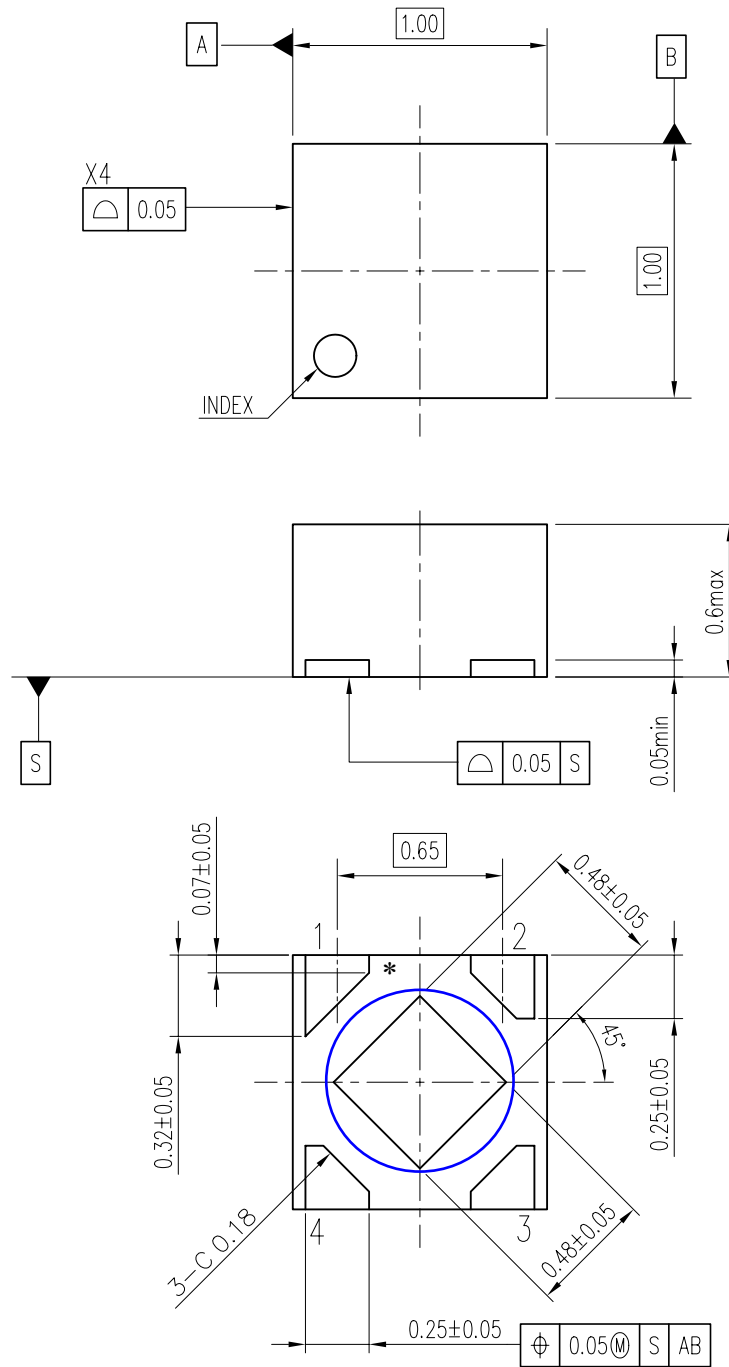


**DFN(PLP)1010-4 Package Dimensions (Unit: mm)**

---

∗ The tab on the bottom of the package shown by blue circle is a substrate potential (GND). It is recommended that this tab be connected to the ground plane on the board but it is possible to leave the tab floating.

**RICOH**

Ver. B

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions.
The following conditions are used in this measurement.

**Measurement Conditions**

| Item | Standard Test Land Pattern |
|------|----------------------------|
| Environment | Mounting on Board (Wind Velocity = 0 m/s) |
| Board Material | Glass Cloth Epoxy Plastic (Double-Sided Board) |
| Board Dimensions | 40 mm × 40 mm × 1.6 mm |
| Copper Ratio | Top Side: Approx. 50% <br> Bottom Side: Approx. 50% |
| Through-holes | $\phi$ 0.5 mm × 44 pcs |

**Measurement Result**      (Ta = 25°C, Tjmax = 125°C)

| Item | Standard Test Land Pattern |
|------|----------------------------|
| Power Dissipation | 380 mW |
| Thermal Resistance ($\theta$ja) | $\theta$ja = 263°C/W |
| Thermal Characterization Parameter ($\psi$jt) | $\psi$jt = 75°C/W |

$\theta$ja: Junction-to-Ambient Thermal Resistance

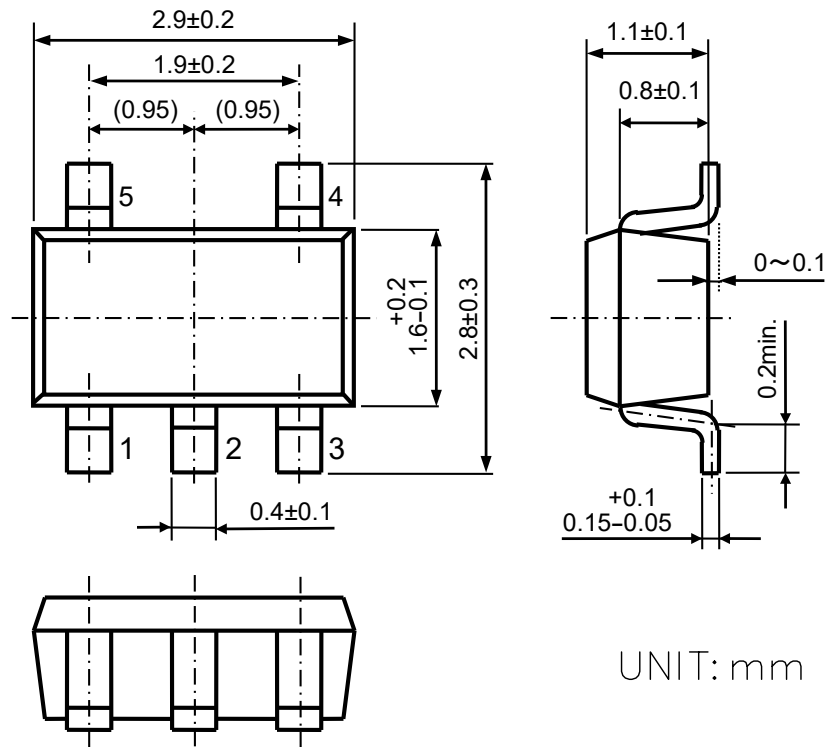$\psi$jt: Junction-to-Top Thermal Characterization Parameter



**Power Dissipation vs. Ambient Temperature**



**Measurement Board Pattern**

**RICOH**

**SC-88A Package Dimensions**

UNIT: mm

Ver. A

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

**Measurement Conditions**

| Item | Measurement Conditions |
|------|------------------------|
| Environment | Mounting on Board (Wind Velocity = 0 m/s) |
| Board Material | Glass Cloth Epoxy Plastic (Four-Layer Board) |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm |
| Copper Ratio | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square<br>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes | $\phi$ 0.3 mm × 7 pcs |

**Measurement Result**                                    (Ta = 25°C, Tjmax = 125°C)

| Item | Measurement Result |
|------|--------------------|
| Power Dissipation | 660 mW |
| Thermal Resistance ($\theta$ja) | $\theta$ja = 150°C/W |
| Thermal Characterization Parameter ($\psi$jt) | $\psi$jt = 51°C/W |

$\theta$ja: Junction-to-Ambient Thermal Resistance

$\psi$jt: Junction-to-Top Thermal Characterization Parameter



**Power Dissipation vs. Ambient Temperature**



**Measurement Board Pattern**

**RICOH**
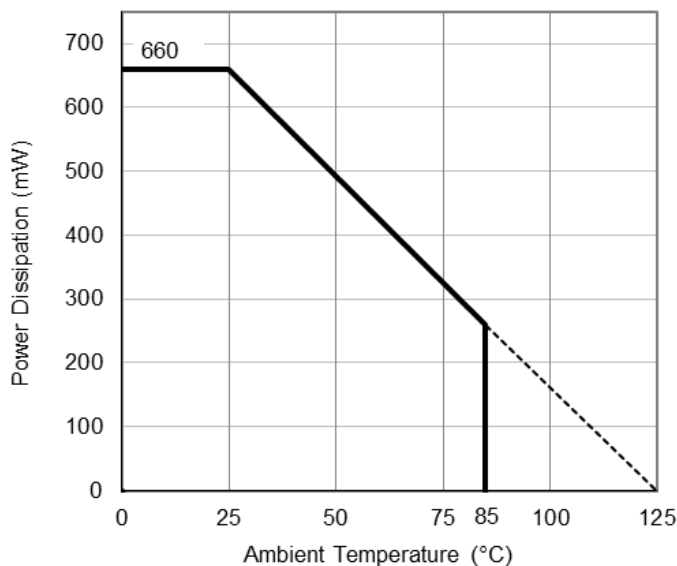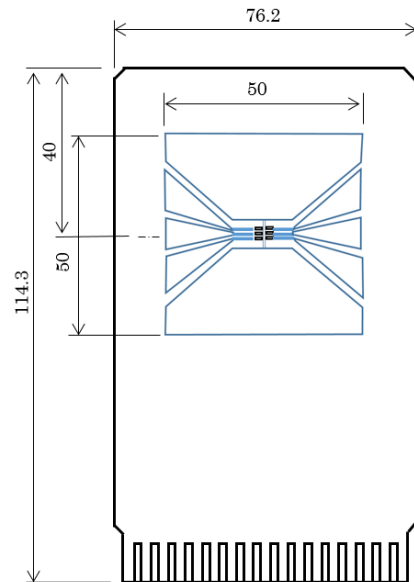
**SOT-23-5 Package Dimensions**

UNIT: mm

**RoHS Compliant** **Halogen Free**

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**Sales & Support Offices**

**Ricoh Electronic Devices Co., Ltd.**
**Shin-Yokohama Office (International Sales)**
2-3, Shin-Yokohama 3-chome, Kohoku-ku, Yokohama-shi, Kanagawa, 222-8530, Japan
Phone: +81-50-3814-7687  Fax: +81-45-474-0074

**Ricoh Americas Holdings, Inc.**
675 Campbell Technology Parkway, Suite 200 Campbell, CA 95008, U.S.A.
Phone: +1-408-610-3105

**Ricoh Europe (Netherlands) B.V.**
**Semiconductor Support Centre**
Prof. W.H. Keesomlaan 1, 1183 DJ Amstelveen, The Netherlands
Phone: +31-20-5474-309

**Ricoh International B.V. - German Branch**
**Semiconductor Sales and Support Centre**
Oberrather Strasse 6, 40472 Düsseldorf, Germany
Phone: +49-211-6546-0

**Ricoh Electronic Devices Korea Co., Ltd.**
3F, Haesung Bldg, 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea
Phone: +82-2-2135-5700  Fax: +82-2-2051-5713

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

**Ricoh Electronic Devices Shanghai Co., Ltd.**
**Shenzhen Branch**
1205, Block D(Jinlong Building), Kingkey 100, Hongbao Road, Luohu District,
Shenzhen, China
Phone: +86-755-8348-7600 Ext 225

**Ricoh Electronic Devices Co., Ltd.**
**Taipei office**
Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan
Phone: +886-2-2313-1621/1622  Fax: +886-2-2313-1623

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RP173K301D-TR  RP173K281D-TR  RP173K501D-TR  RP173N301D-TR-FE  RP173N501B-TR-FE  RP173K301B-TR
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