

TCR2EF series

TCR2EE series

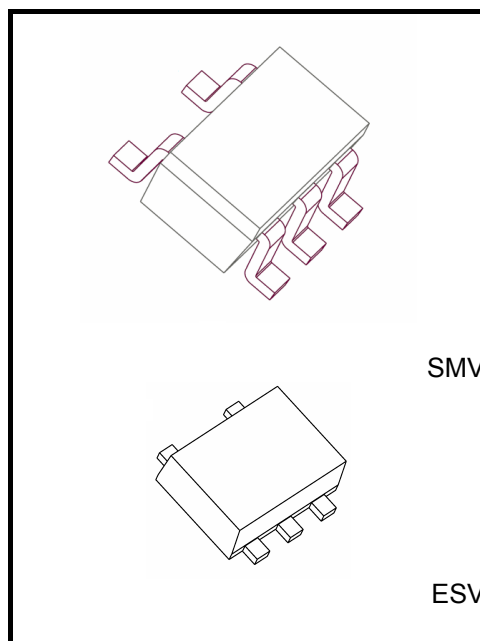
200 mA CMOS Low Drop-Out Regulator with Fast Load Transient Response

The TCR2EF and TCR2EE series are CMOS single-output voltage regulators with an on/off control input, featuring low dropout voltage, low output noise voltage and fast load transient response.

These voltage regulators are available in fixed output voltages between 1.0 V and 5.0 V and capable of driving up to 200 mA. They feature overcurrent protection, an Auto-discharge function.

The TCR2EF and TCR2EE series has a low dropout voltage of 180 mV (2.5 V output, $I_{OUT} = 150$ mA) with low output noise voltage of $35 \mu V_{rms}$ (2.5 V output) and a load transient response of only $\Delta V_{OUT} = \pm 60$ mV ($I_{OUT} = 1$ mA \leftrightarrow 150 mA, $C_{OUT} = 1.0 \mu F$).

Thus, the TCR2EF and TCR2EE series are suitable for sensitive power supply such as Analog and RF applications.



Features

- Low Drop-Out voltage
 $V_{IN}-V_{OUT} = 150$ mV (typ.) at 3.0 V-output, $I_{OUT} = 150$ mA
 $V_{IN}-V_{OUT} = 180$ mV (typ.) at 2.5 V-output, $I_{OUT} = 150$ mA
 $V_{IN}-V_{OUT} = 230$ mV (typ.) at 1.8 V-output, $I_{OUT} = 150$ mA
 $V_{IN}-V_{OUT} = 380$ mV (typ.) at 1.2 V-output, $I_{OUT} = 150$ mA
 $V_{IN}-V_{OUT} = 510$ mV (typ.) at 1.0 V-output, $I_{OUT} = 150$ mA
- Low output noise voltage ($V_{NO} = 35 \mu V_{rms}$ (typ.) at 2.5 V-output, $I_{OUT} = 10$ mA, 10 Hz $< f < 100$ kHz)
- Fast load transient response ($\Delta V_{OUT} = \pm 60$ mV (typ.) at $I_{OUT} = 1$ mA \leftrightarrow 150 mA, $C_{OUT} = 1.0 \mu F$)
- Low quiescent bias current ($I_B = 35 \mu A$ (typ.) at $I_{OUT} = 0$ mA)
- High ripple rejection (R.R = 73 dB (typ.) at 2.5V-output, $I_{OUT} = 10$ mA, $f = 1$ kHz)
- Wide range Output Voltage line up ($V_{OUT} = 1.0$ to 5.0 V)
- High V_{OUT} accuracy $\pm 1.0\%$ ($1.8V \leq V_{OUT}$)
- Overcurrent protection
- Auto-discharge
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used ($C_{IN} = 0.1 \mu F$, $C_{OUT} = 1.0 \mu F$)
- Small package ESV (SOT-553) (1.6 mm x 1.6 mm x 0.55 mm)
General package SMV (SOT-25) (2.8 mm x 2.9 mm x 1.1 mm)

Weight :

SMV (SOT-25)(SC-74A) : 16 mg (typ.)

ESV (SOT-553) : 3.0 mg (typ.)

Start of commercial production
2012-10

Absolute Maximum Ratings (Ta = 25°C)

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|-----------|------------------------|--------------|
| Input voltage | V_{IN} | 6.0 | V |
| Control voltage | V_{CT} | -0.3 to 6.0 | V |
| Output voltage | V_{OUT} | -0.3 to $V_{IN} + 0.3$ | V |
| Output current | I_{OUT} | 200 | mA |
| Power dissipation | P_D | SMV | 200 (Note 1) |
| | | | 580 (Note 2) |
| | | ESV | 150 (Note 1) |
| | | | 320 (Note 3) |
| Operation temperature range | T_{opr} | -40 to 85 | °C |
| Junction temperature | T_j | 150 | °C |
| Storage temperature range | T_{stg} | -55 to 150 | °C |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

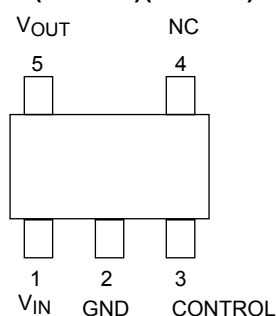
Note 1: Unit Rating

Note 2: Rating at mounting on a board
(FR4 board: 25.4 mm × 25.4 mm × 1.6 mm)

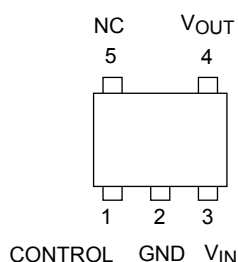
Note 3: Rating at mounting on a board
(FR4 board dimension: 30 mm × 30 mm × 0.8 mm)

Pin Assignment (top view)

SMV(SOT-25)(SC-74A)



ESV(SOT-553)



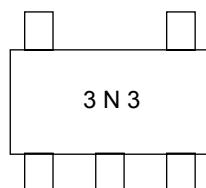
List of Products Number, Output voltage and Marking

| Product No. | | V _{OUT} (V) (typ.) | Marking | Product No. | | V _{OUT} (V) (typ.) | Marking |
|-------------|--------------|--------------------------------|---------|-------------|--------------|--------------------------------|---------|
| SMV(SOT-25) | ESV(SOT-553) | | | SMV(SOT-25) | ESV(SOT-553) | | |
| TCR2EF10 | TCR2EE10 | 1.0 | 1N0 | TCR2EF28 | TCR2EE28 | 2.8 | 2N8 |
| TCR2EF105 | TCR2EE105 | 1.05 | 1NA | TCR2EF285 | TCR2EE285 | 2.85 | 2ND |
| TCR2EF11 | TCR2EE11 | 1.1 | 1N1 | TCR2EF29 | TCR2EE29 | 2.9 | 2N9 |
| TCR2EF115 | TCR2EE115 | 1.15 | 1NB | - | TCR2EE295 | 2.95 | 2NE |
| TCR2EF12 | TCR2EE12 | 1.2 | 1N2 | TCR2EF30 | TCR2EE30 | 3.0 | 3N0 |
| TCR2EF125 | TCR2EE125 | 1.25 | 1NC | - | TCR2EE305 | 3.05 | 3NA |
| TCR2EF13 | TCR2EE13 | 1.3 | 1N3 | TCR2EF31 | TCR2EE31 | 3.1 | 3N1 |
| TCR2EF135 | TCR2EE135 | 1.35 | 1ND | TCR2EF32 | TCR2EE32 | 3.2 | 3N2 |
| TCR2EF14 | TCR2EE14 | 1.4 | 1N4 | TCR2EF33 | TCR2EE33 | 3.3 | 3N3 |
| - | TCR2EE145 | 1.45 | 1NE | - | TCR2EE335 | 3.35 | 3ND |
| TCR2EF15 | TCR2EE15 | 1.5 | 1N5 | - | TCR2EE34 | 3.4 | 3N4 |
| - | TCR2EE17 | 1.7 | 1N7 | TCR2EF36 | TCR2EE36 | 3.6 | 3N6 |
| TCR2EF18 | TCR2EE18 | 1.8 | 1N8 | - | TCR2EE39 | 3.9 | 3N9 |
| - | TCR2EE185 | 1.85 | 1NF | TCR2EF40 | TCR2EE40 | 4.0 | 4N0 |
| TCR2EF19 | TCR2EE19 | 1.9 | 1N9 | TCR2EF41 | TCR2EE41 | 4.1 | 4N1 |
| TCR2EF20 | TCR2EE20 | 2.0 | 2N0 | - | TCR2EE42 | 4.2 | 4N2 |
| - | TCR2EE24 | 2.4 | 2N4 | TCR2EF45 | TCR2EE45 | 4.5 | 4N5 |
| TCR2EF25 | TCR2EE25 | 2.5 | 2N5 | - | TCR2EE48 | 4.8 | 4N8 |
| TCR2EF27 | TCR2EE27 | 2.7 | 2N7 | TCR2EF50 | TCR2EE50 | 5.0 | 5N0 |
| - | TCR2EE275 | 2.75 | 2NF | | | | |

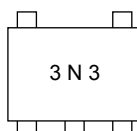
Please ask your local retailer about the devices with other output voltages.

Marking (top view)

Example: TCR2EF33 (3.3 V output)



Example: TCR2EE33 (3.3 V output)



Electrical Characteristics

(Unless otherwise specified,

 $V_{IN} = V_{OUT} + 1\text{ V}$, $I_{OUT} = 50\text{ mA}$, $C_{IN} = 0.1\text{ }\mu\text{F}$, $C_{OUT} = 1.0\text{ }\mu\text{F}$, $T_j = 25^\circ\text{C}$)

| Characteristics | Symbol | Test Condition | | Min | Typ. | Max | Unit |
|-------------------------|-----------------------------------|---|--------------------------|------|------|------|-------------------|
| Output voltage accuracy | V _{OUT} | I _{OUT} = 50 mA (Note 4) | V _{OUT} < 1.8 V | -18 | — | +18 | mV |
| | | | 1.8 V ≤ V _{OUT} | -1.0 | — | +1.0 | % |
| Input voltage | V _{IN} | I _{OUT} = 1 mA | | 1.5 | — | 5.5 | V |
| Line regulation | Reg·line | V _{OUT} + 0.5 V ≤ V _{IN} ≤ 5.5 V, I _{OUT} = 1 mA | | — | 1 | 15 | mV |
| Load regulation | Reg·load | 1 mA ≤ I _{OUT} ≤ 150 mA | | — | 15 | 30 | mV |
| Quiescent current | I _B | I _{OUT} = 0 mA | | — | 35 | 60 | μA |
| Stand-by current | I _B (OFF) | V _{CT} = 0 V | | — | 0.1 | 1.0 | μA |
| Drop-out voltage | V _{IN} -V _{OUT} | I _{OUT} = 150 mA (Note 5) | | — | 180 | 230 | mV |
| Temperature coefficient | T _{CVO} | -40°C ≤ T _{opr} ≤ 85°C | | — | 100 | — | ppm/°C |
| Output noise voltage | V _{NO} | V _{IN} = V _{OUT} + 1 V, I _{OUT} = 10 mA, 10 Hz ≤ f ≤ 100 kHz, T _a = 25°C (Note 5) | | — | 35 | — | μV _{rms} |
| Ripple rejection ratio | R.R. | V _{IN} = V _{OUT} + 1 V, I _{OUT} = 10 mA, f = 1 kHz, V _{Ripple} = 500 mV _{p-p} , T _a = 25°C (Note 5) | | — | 73 | — | dB |
| Load transient response | ΔV _{OUT} | I _{OUT} = 1 mA⇔150mA, C _{OUT} = 1.0 μF | | — | ±60 | — | mV |
| Control voltage (ON) | V _{CT} (ON) | — | | 1.0 | — | 5.5 | V |
| Control voltage (OFF) | V _{CT} (OFF) | — | | 0 | — | 0.4 | V |

 Note 4: Stable state with fixed I_{OUT} condition

Note 5: The 2.5 V output product

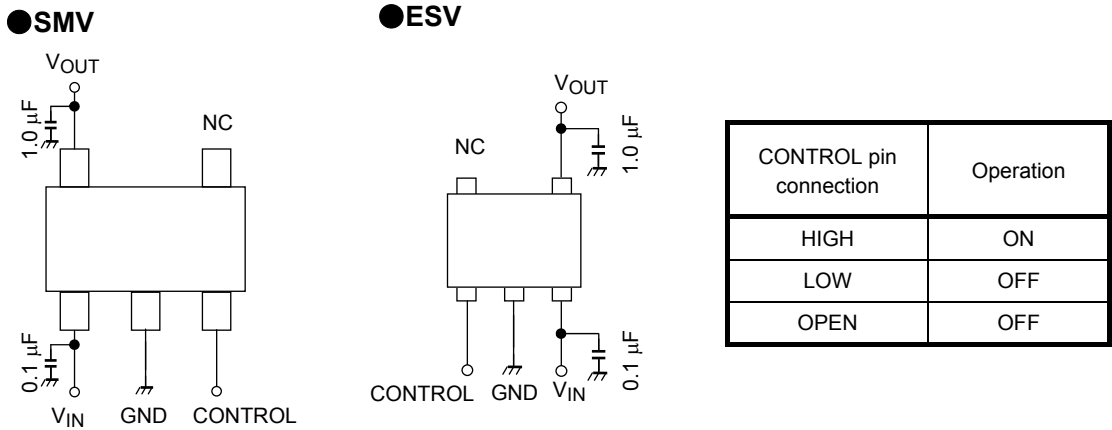
 Note 6: All characteristics of over 4.5V output products are measured at $V_{IN} = V_{OUT} + 0.5\text{ V}$ conditions.

Drop-out voltage ($I_{OUT} = 150\text{ mA}$, $C_{IN} = 0.1\text{ }\mu\text{F}$, $C_{OUT} = 1.0\text{ }\mu\text{F}$, $T_j = 25^\circ\text{C}$)

| Output voltages | Symbol | Min | Typ. | Max | Unit |
|---|--------------------|-----|------|-----|------|
| 1.0 V, 1.05 V | $V_{IN} - V_{OUT}$ | — | 510 | 770 | mV |
| 1.1 V, 1.15 V | | — | 440 | 670 | |
| 1.2 V, 1.25 V | | — | 380 | 570 | |
| 1.3 V | | — | 350 | 470 | |
| 1.4 V | | — | 310 | 420 | |
| $1.5\text{ V} \leq V_{OUT} < 1.8\text{ V}$ | | — | 290 | 390 | |
| $1.8\text{ V} \leq V_{OUT} < 2.5\text{ V}$ | | — | 230 | 310 | |
| $2.5\text{ V} \leq V_{OUT} < 3.0\text{ V}$ | | — | 180 | 230 | |
| $3.0\text{ V} \leq V_{OUT} \leq 5.0\text{ V}$ | | — | 150 | 200 | |

Application Note

1. Recommended Application Circuit

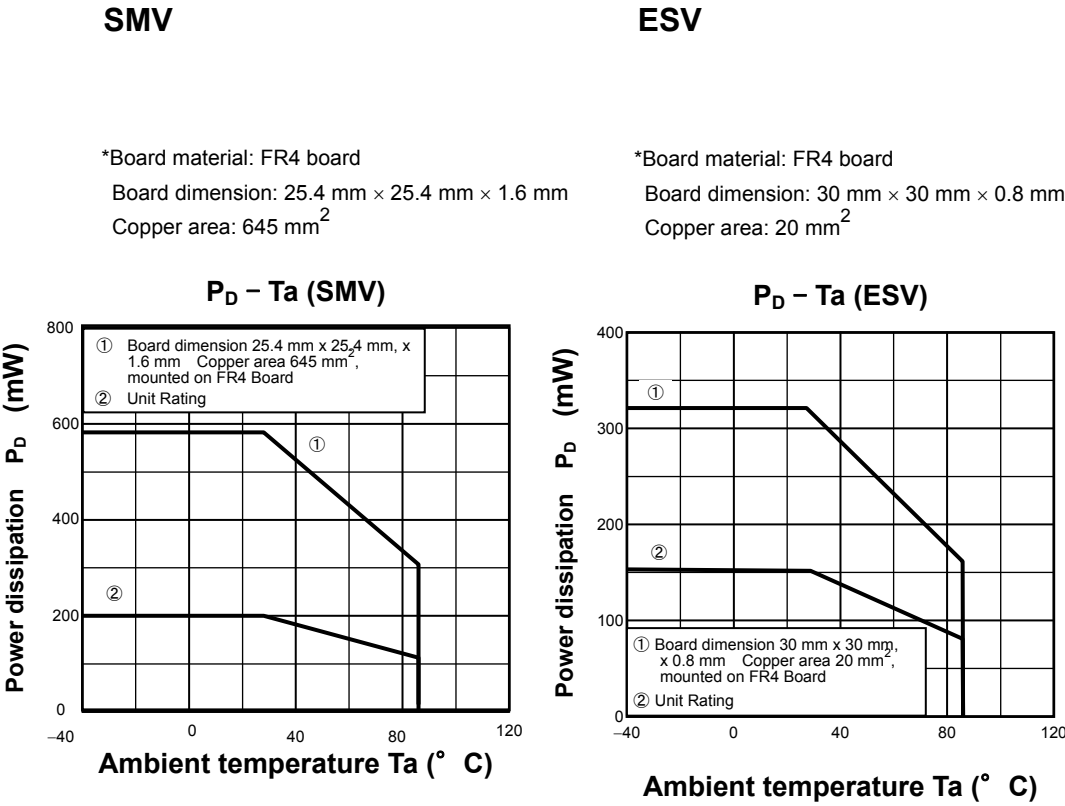


The figure above shows the recommended configuration for using a Low-Dropout regulator. Insert a capacitor at V_{OUT} and V_{IN} pins for stable input/output operation. (Ceramic capacitors can be used).

2. Power Dissipation

Both unit and board-mounted power dissipation ratings for TCR2EF series and TCR2EE series are available in the Absolute Maximum Ratings table.
Power dissipation is measured on the board shown below.

Testing Board of Thermal Resistance



Attention in Use● **Output Capacitors**

Ceramic capacitors can be used for these devices. However, because of the type of the capacitors, there might be unexpected thermal features. Please consider application condition for selecting capacitors. And Toshiba recommend the ESR of ceramic capacitor is under 10 Ω .

● **Mounting**

The long distance between IC and output capacitor might affect phase assurance by impedance in wire and inductor. For stable power supply, output capacitor need to mount near IC as much as possible. Also VIN and GND pattern need to be large and make the wire impedance small as possible.

● **Permissible Loss**

Please have enough design patterns for expected maximum permissible loss. And under consideration of surrounding temperature, input voltage, and output current etc, we recommend proper dissipation ratings for maximum permissible loss; in general maximum dissipation rating is 70 to 80 percent.

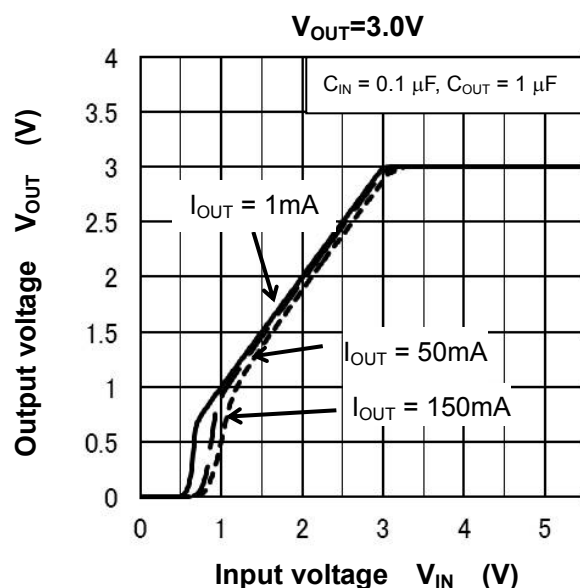
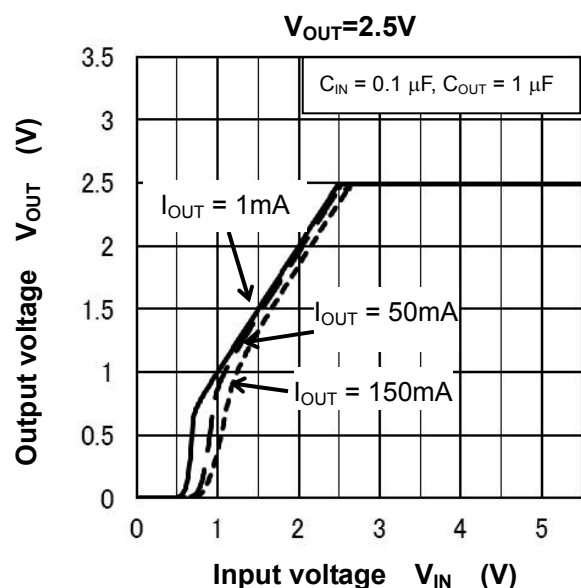
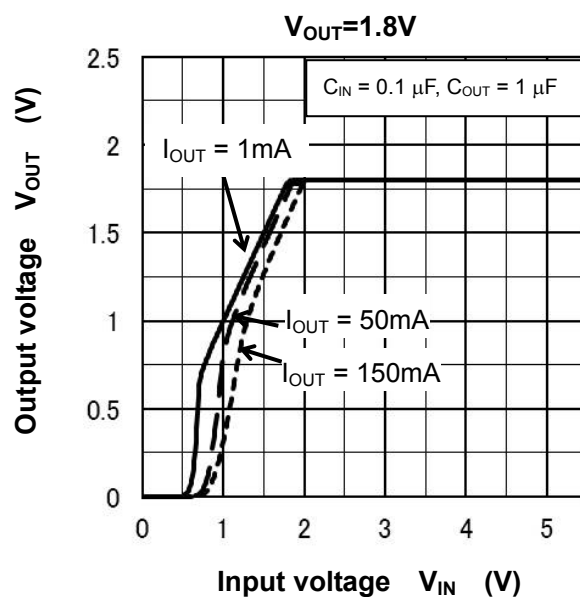
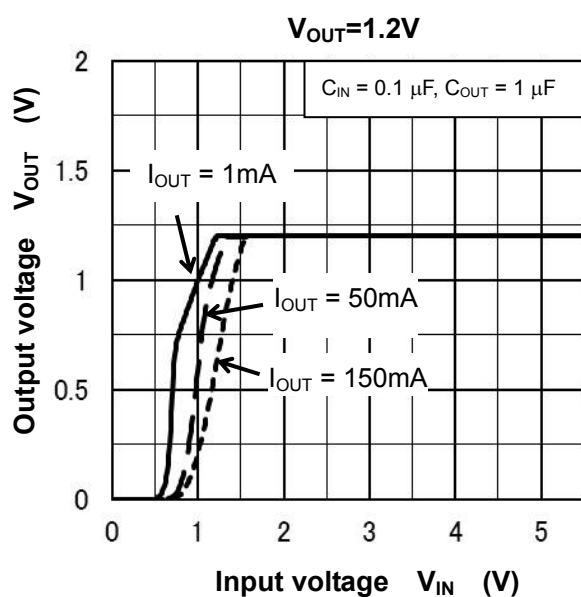
● **Overcurrent Protection Circuit**

Overcurrent protection circuit is designed in these products, but this does not assure for the suppression of uprising device operation. If output pins and GND pins are shorted out, these products might be break down.

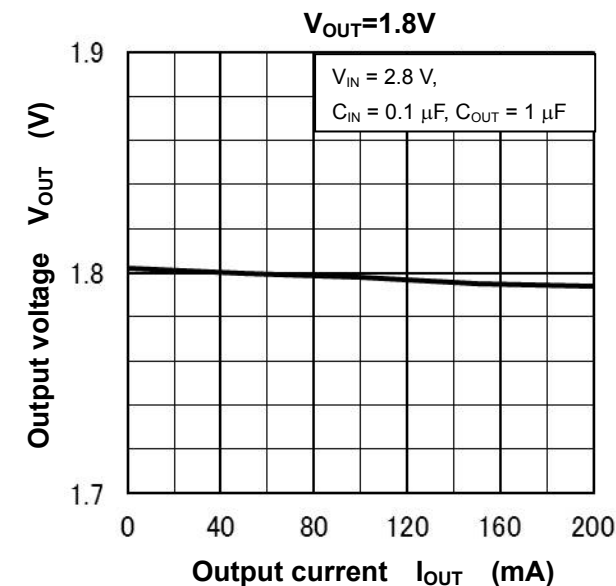
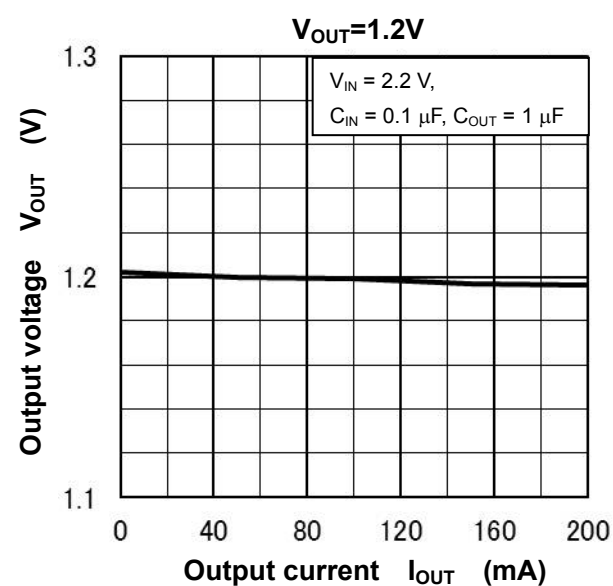
In use of these products, please read through and understand dissipation idea for absolute maximum ratings from the above mention or our 'Semiconductor Reliability Handbook'. Then use these products under absolute maximum ratings in any condition. Furthermore, Toshiba recommend inserting failsafe system into the design.

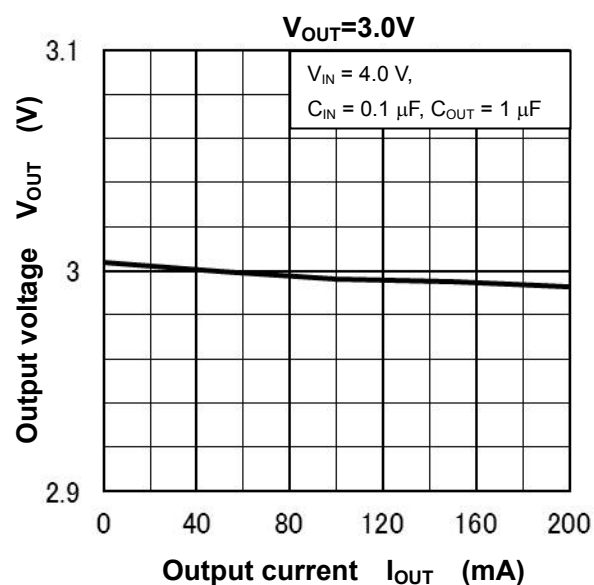
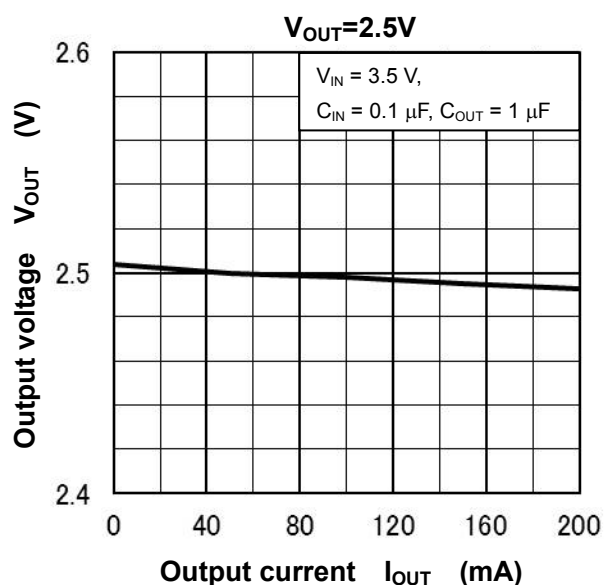
Representative Typical Characteristics

1) Output Voltage vs. Input Voltage

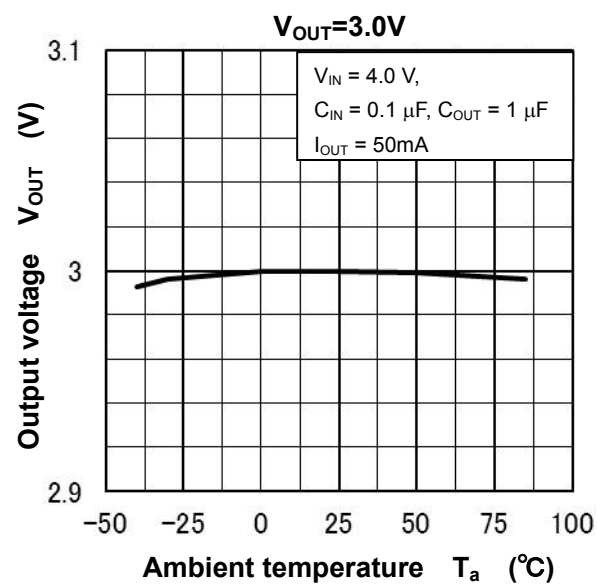
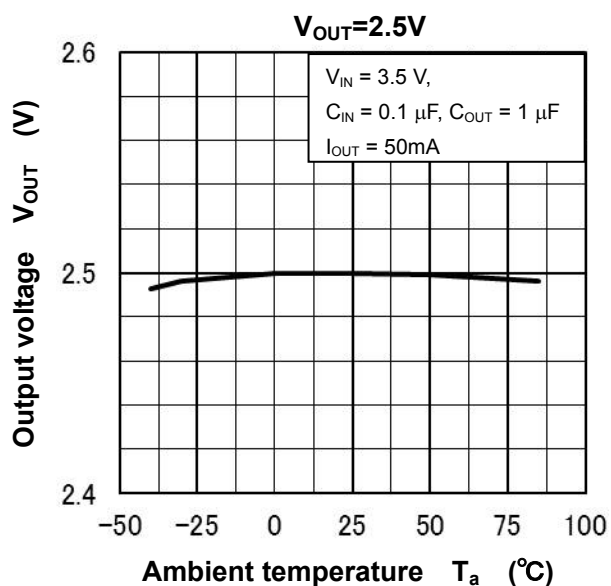
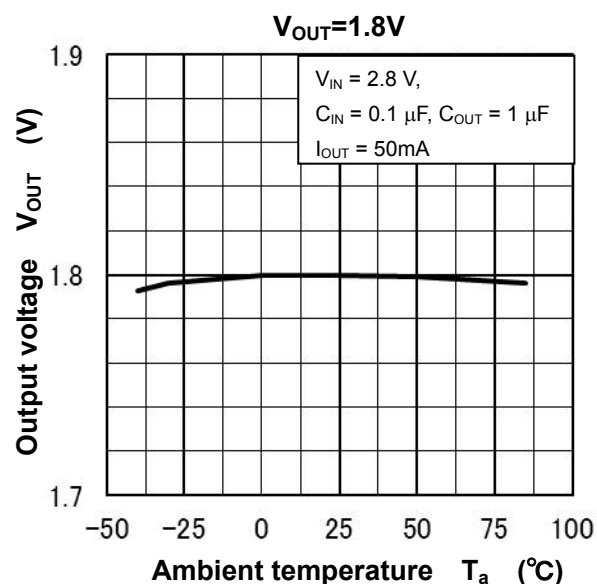
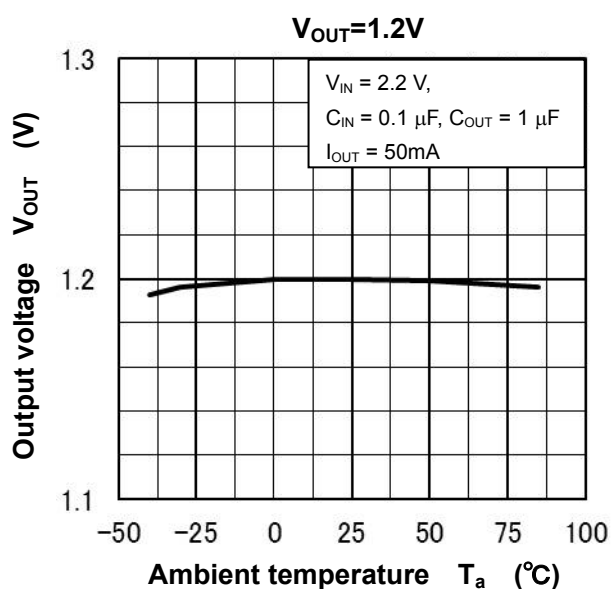


2) Output Voltage vs. Output Current

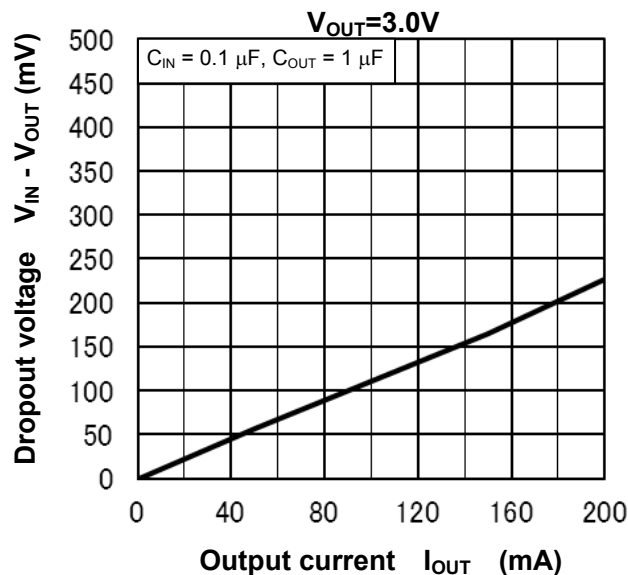
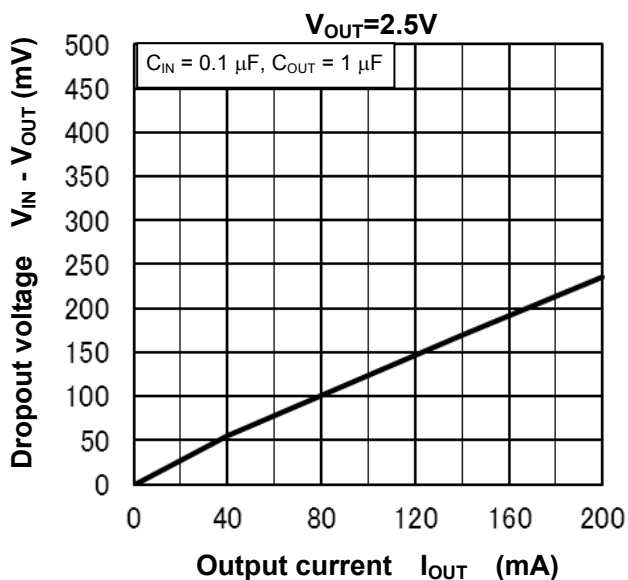
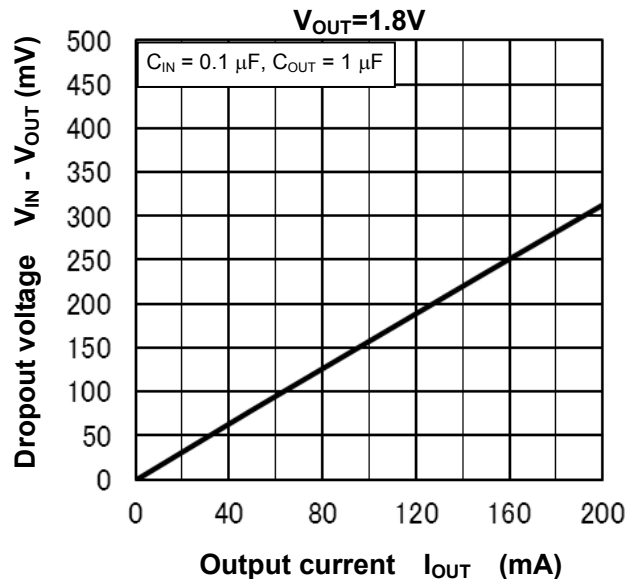
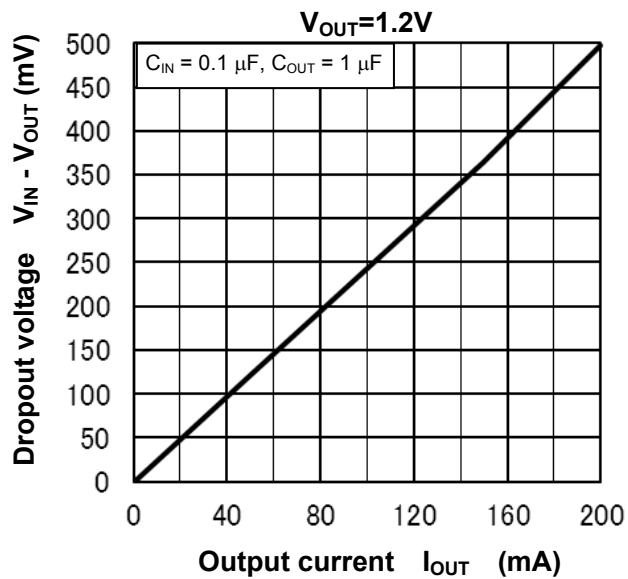




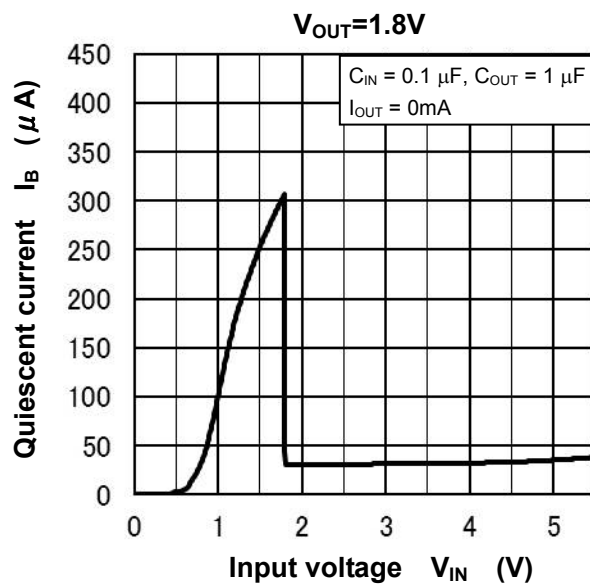
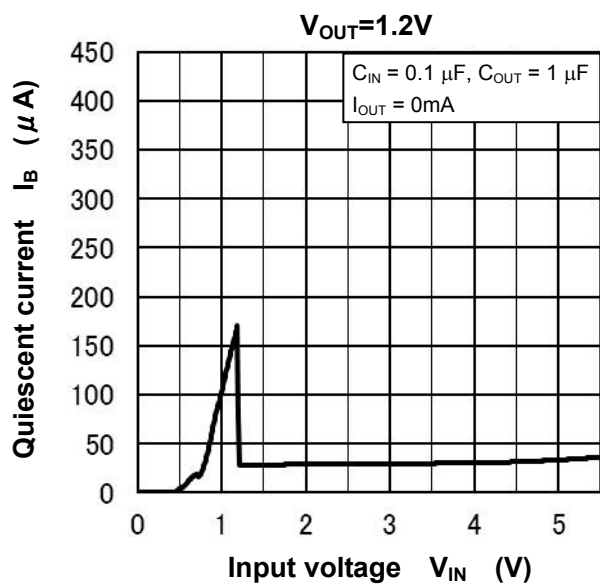
3) Output Voltage vs. Ambient Temperature

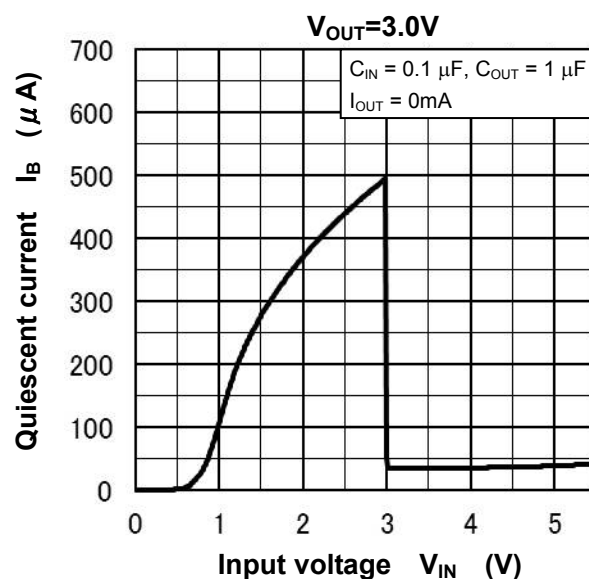
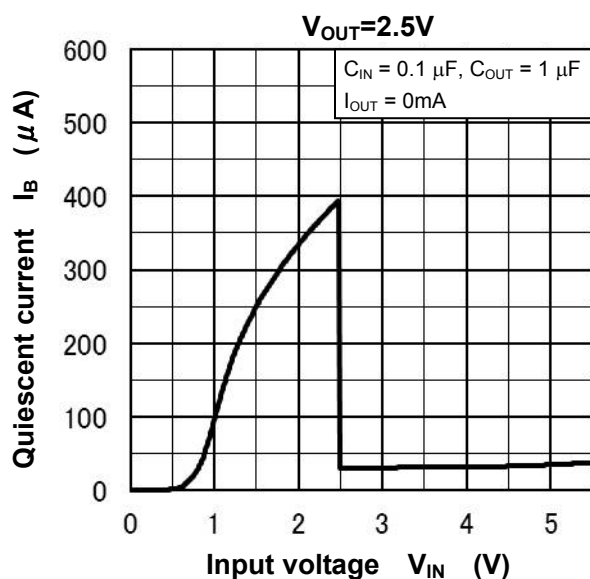


4) Dropout Voltage vs. Output Current

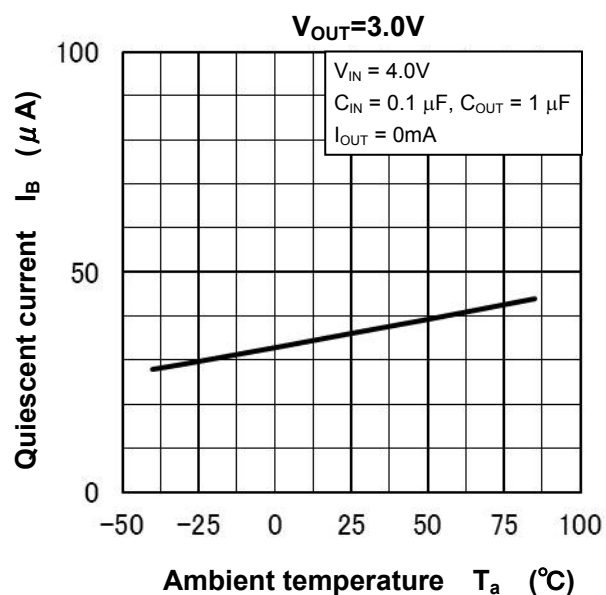
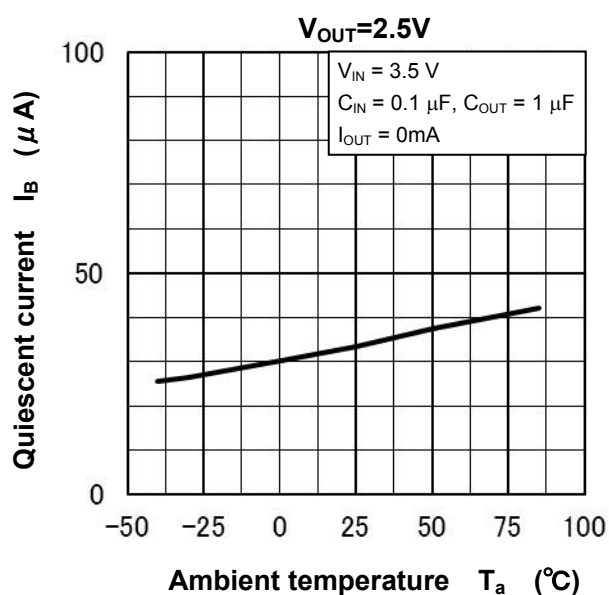
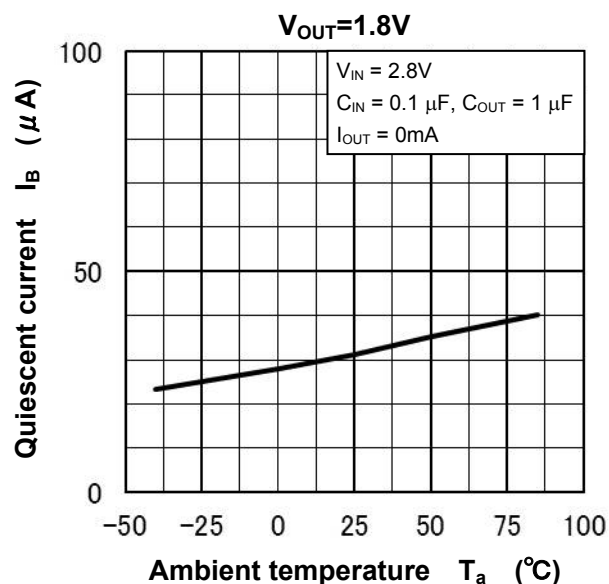
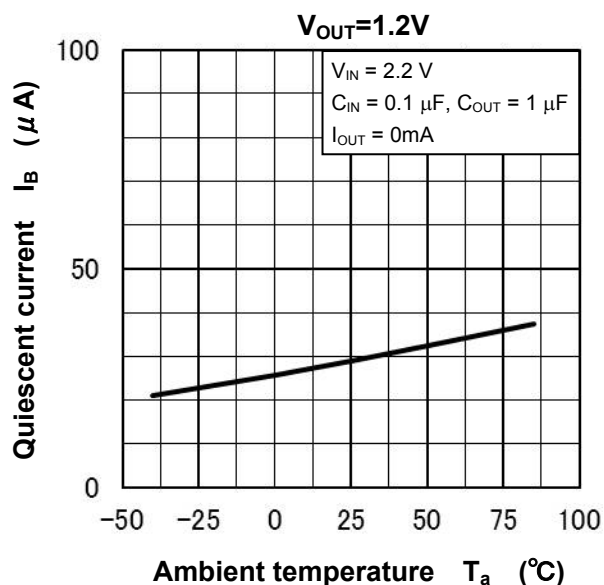


5) Quiescent Current vs. Input Voltage

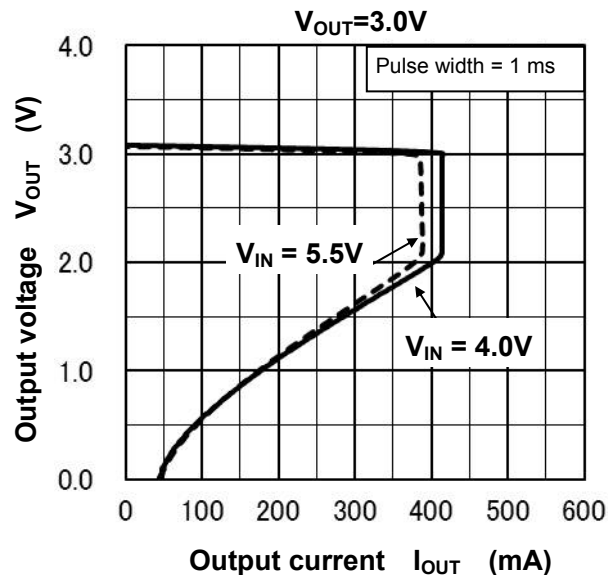
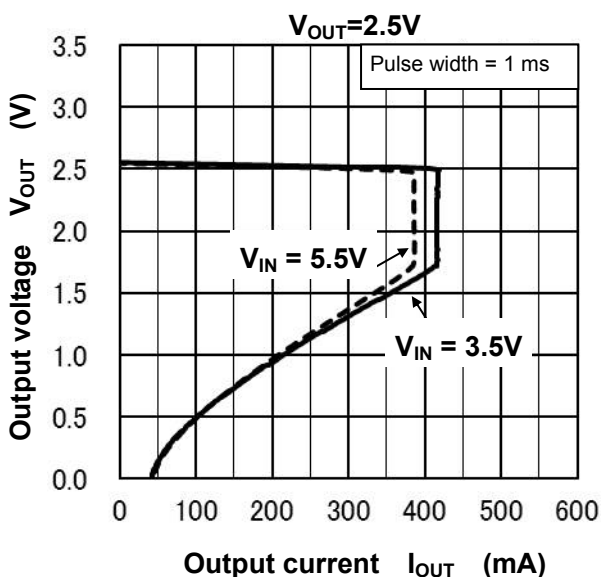
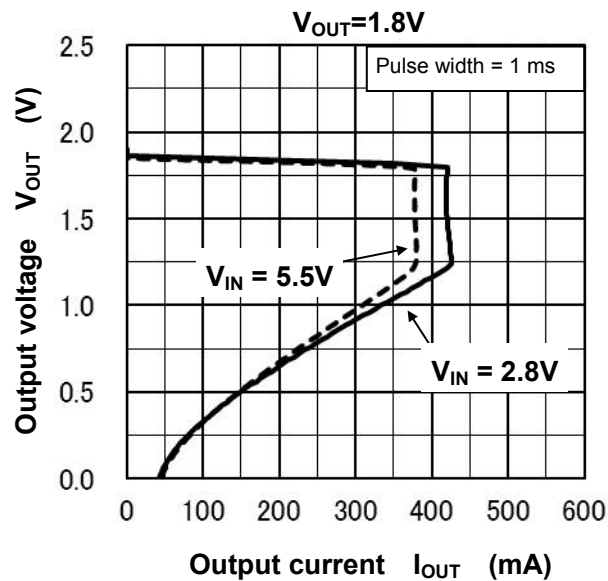
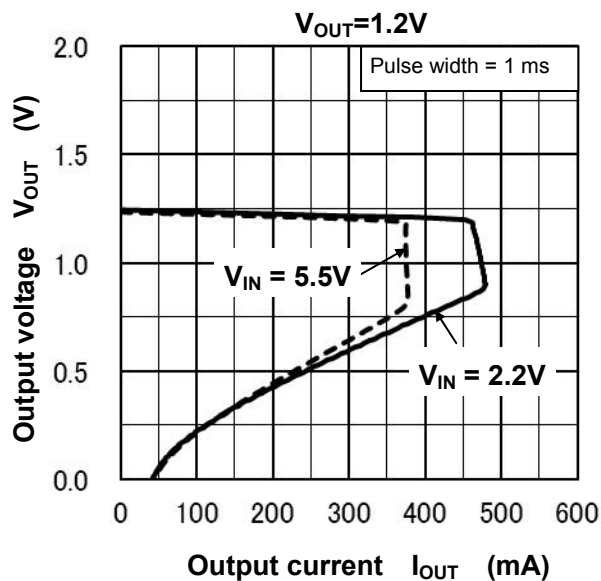




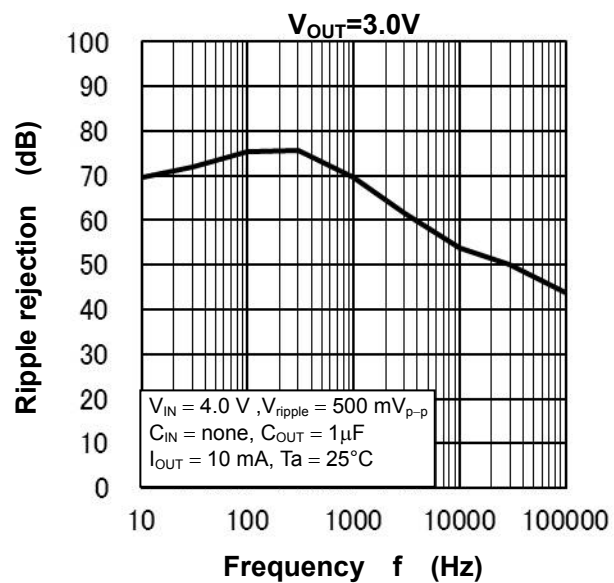
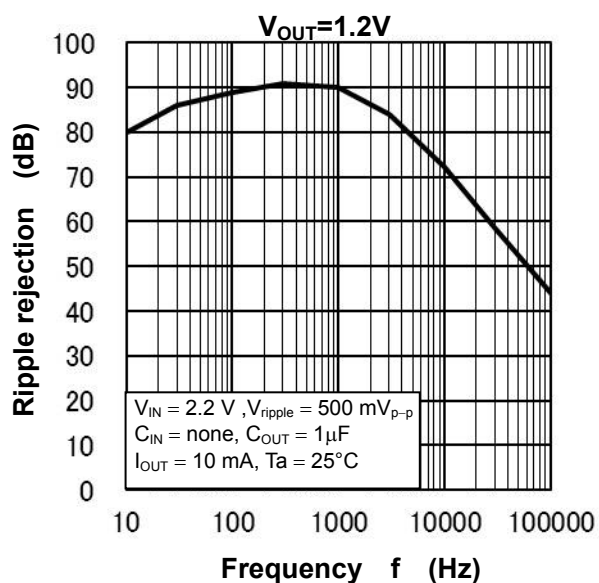
6) Quiescent Current vs. Ambient Temperature



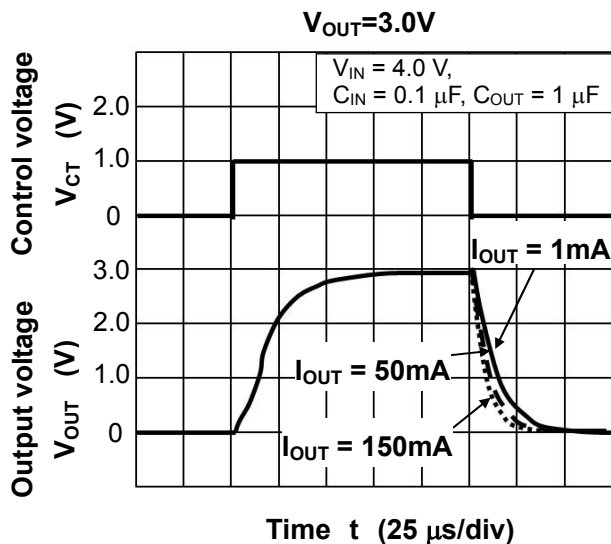
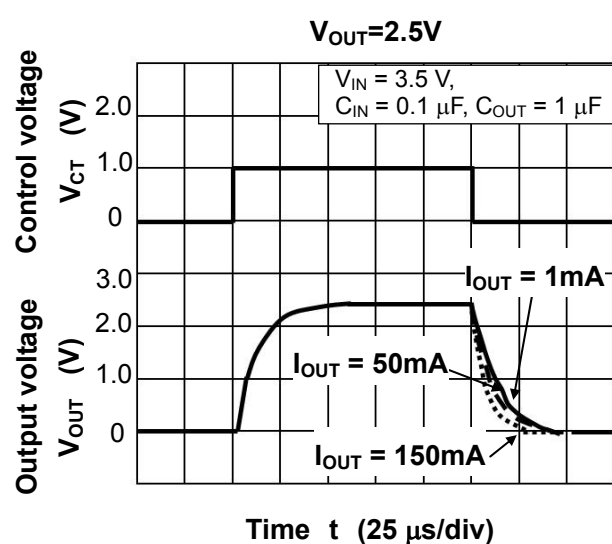
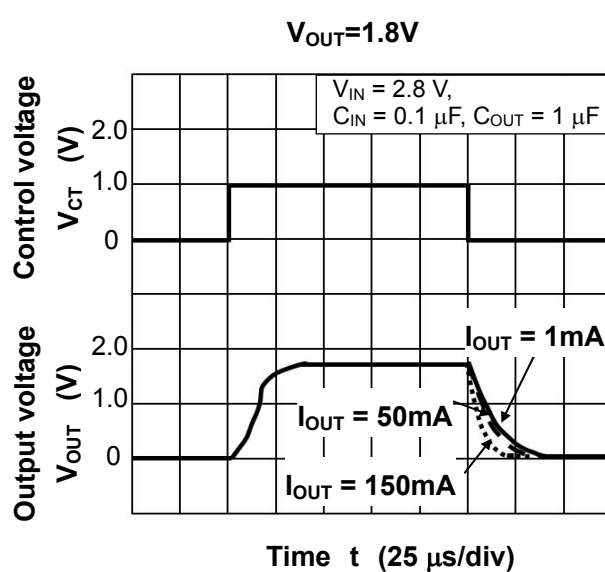
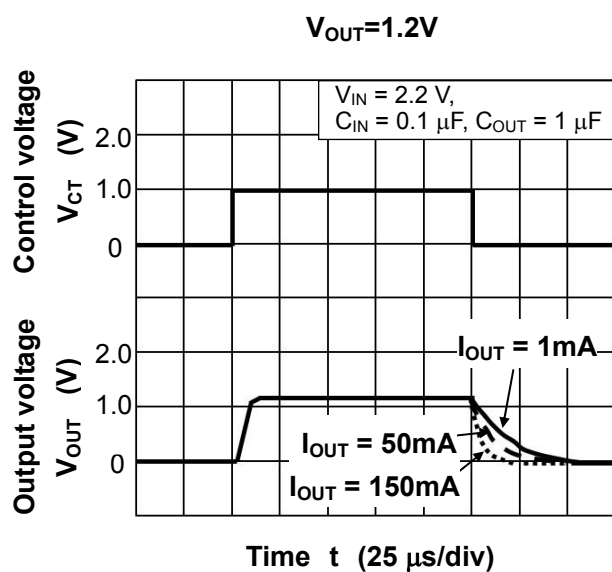
7) Output Voltage vs. Output Current



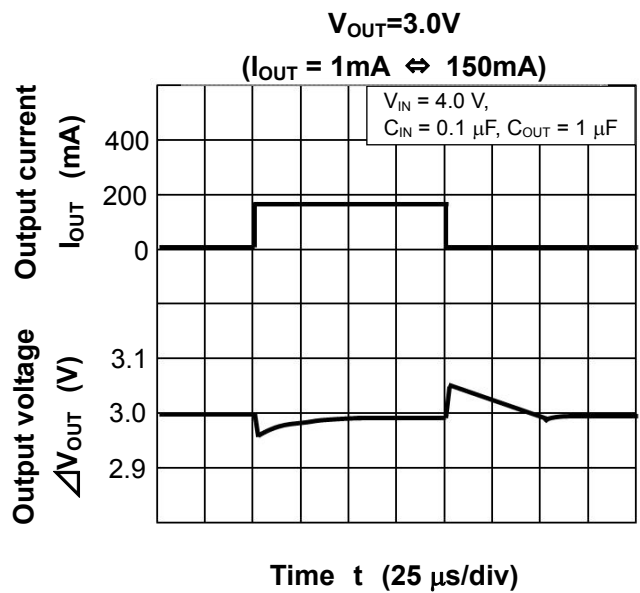
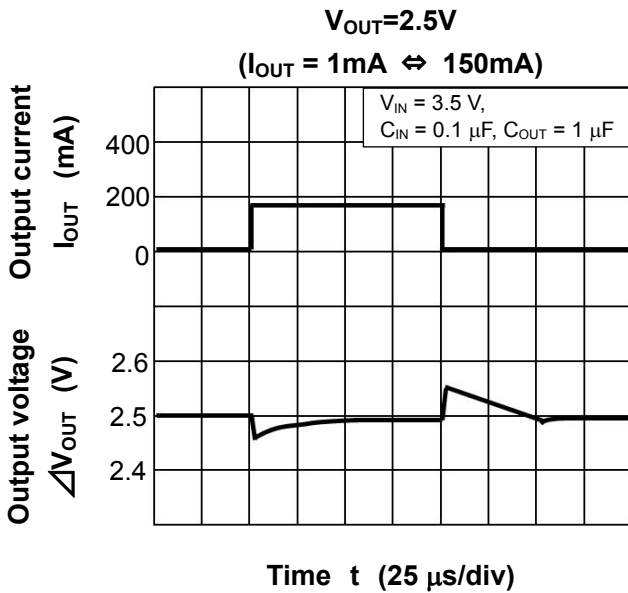
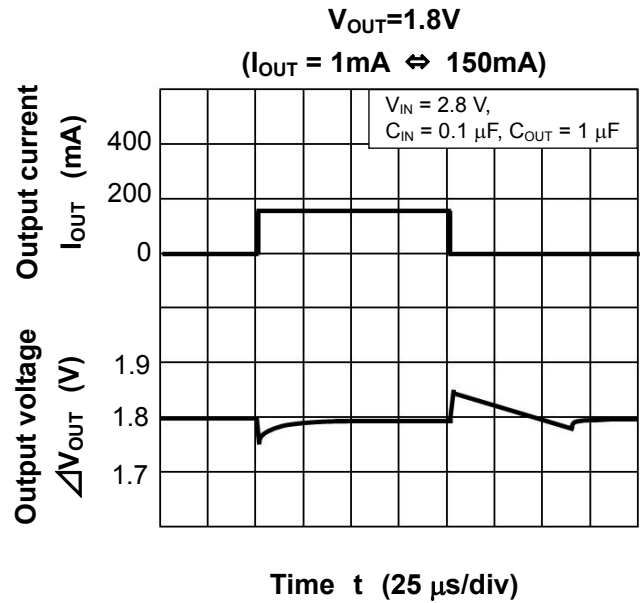
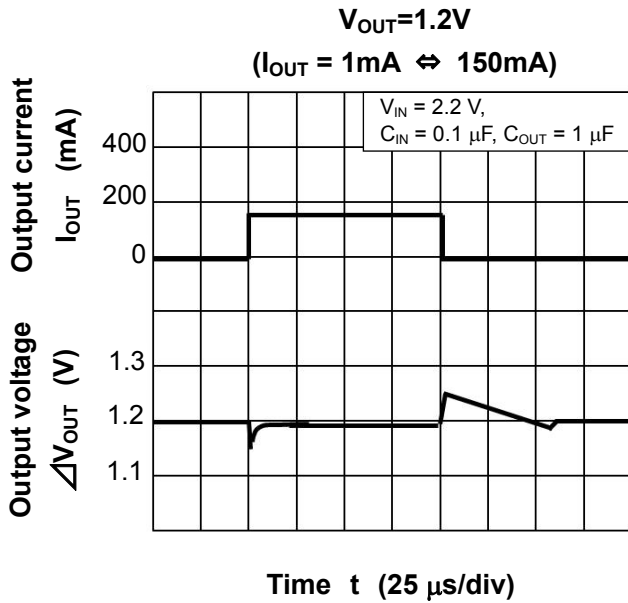
8) Ripple Rejection Ratio vs. Frequency

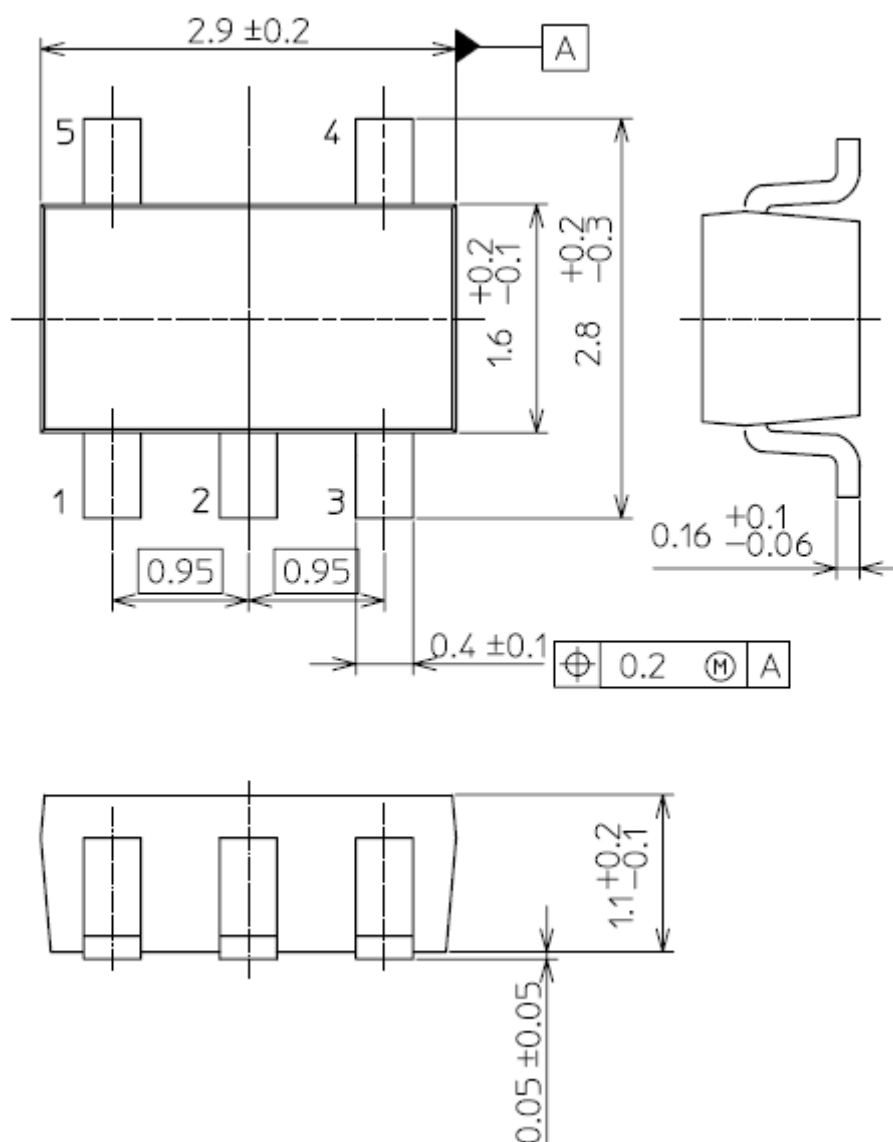


9) Control Transient Response



10) Control Transient Response



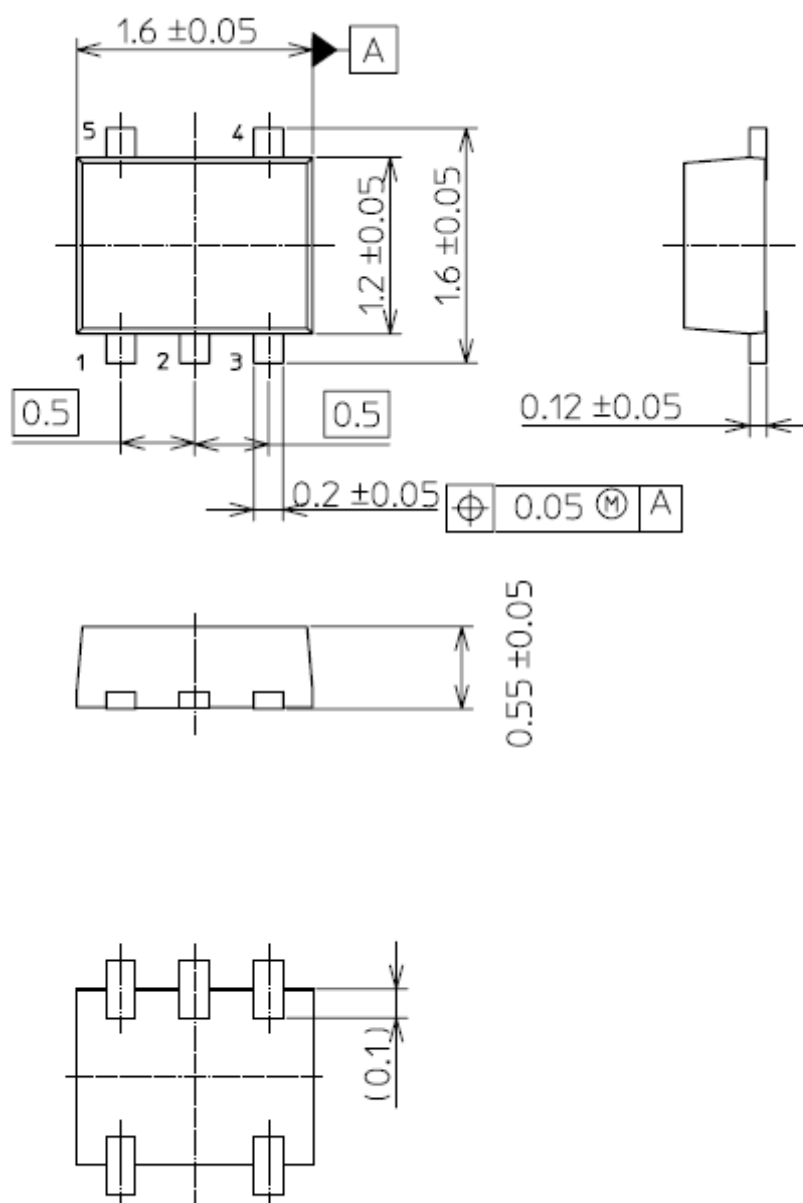
Package Dimensions
SMV (SOT-25)(SC-74A)
Unit: mm


Weight : 16 mg (typ.)

Package Dimensions

ESV (SOT-553)

Unit: mm



BOTTOM VIEW

Weight: 3.0 mg (typ.)

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