

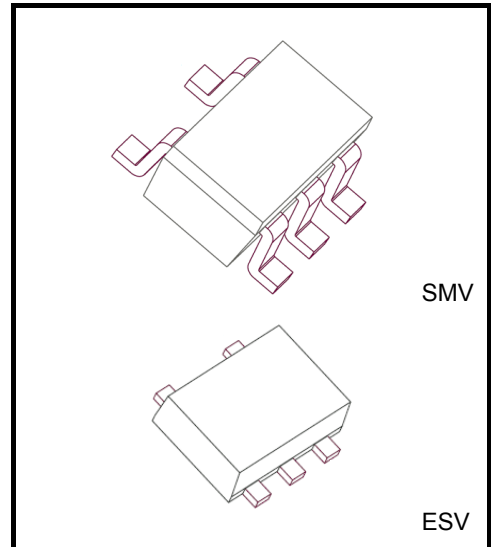
TCR2BF series TCR2BE series

200 mA CMOS Low Drop-Out Regulator with Auto-discharge

The TCR2BF series and TCR2BE series are CMOS general-purpose single-output voltage regulators with an on/off control input, featuring low dropout voltage and low quiescent bias current. These voltage regulators can be enabled and disabled via the CONTROL pin.

These voltage regulators are available in fixed output voltages between 1.0 V and 5.0 V in SMV package, 1.0 to 3.6V in ESV package, and capable of driving up to 200 mA. They feature overcurrent protection and auto-discharge function.

The TCR2BF series and TCR2BE series are offered in the compact SMV (SOT-25)(SC-74A) and ESV (SOT-553) and allow the use of small ceramic input and output capacitors. Thus, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



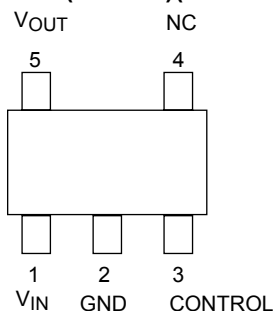
Weight:
SMV (SOT-25)(SC-74A) : 16 mg (typ.)
ESV (SOT-553) : 3.0 mg (typ.)

Features

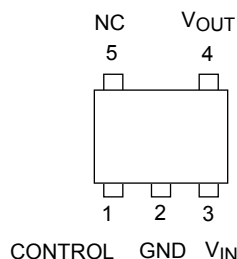
- Wide fixed output voltage line up
TCR2BF series (SMV package) : $V_{OUT} = 1.0$ to 5.0 V
TCR2BE series (ESV package) : $V_{OUT} = 1.0$ to 3.6 V
- Low output noise voltage ($V_{NO} = 50 \mu V_{RMS}$ (typ.) at 2.8 V-output, $I_{OUT} = 10$ mA, $10 \text{ Hz} \leq f \leq 100 \text{ kHz}$)
- Low quiescent bias current ($I_B = 75 \mu A$ (max) at $I_{OUT} = 0$ mA)
- Low stand-by current ($I_{B(OFF)} = 0.1 \mu A$ (typ.) at Stand-by mode)
- High ripple rejection (R.R. = 70 dB (typ.) at $I_{OUT} = 10$ mA, $f = 1 \text{ kHz}$)
- Overcurrent protection
- Auto-discharge
- Pull-down connection at CONTROL
- Ceramic capacitors can be used ($C_{IN} = 0.1 \mu F$, $C_{OUT} = 1.0 \mu F$)
- Small package, SMV (SOT-25) (SC-74A) and ESV (SOT-553)

Pin Assignment (top view)

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



ESV (SOT-553)



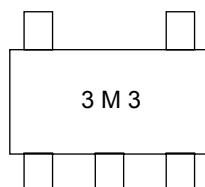
List of Products Number, Output Voltage, and Marking

| 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) | | |
| TCR2BF10 | TCR2BE10 | 1.0 | 1M0 | TCR2BF29* | TCR2BE29* | 2.9 | 2M9 |
| TCR2BF105* | TCR2BE105* | 1.05 | 1MA | TCR2BF295* | TCR2BE295* | 2.95 | 2ME |
| TCR2BF11* | TCR2BE11* | 1.1 | 1M1 | TCR2BF30 | TCR2BE30 | 3.0 | 3M0 |
| TCR2BF115 | TCR2BE115 | 1.15 | 1MB | TCR2BF31 | TCR2BE31 | 3.1 | 3M1 |
| TCR2BF12 | TCR2BE12 | 1.2 | 1M2 | TCR2BF32 | TCR2BE32 | 3.2 | 3M2 |
| TCR2BF125 | TCR2BE125 | 1.25 | 1MC | TCR2BF33 | TCR2BE33 | 3.3 | 3M3 |
| TCR2BF13* | TCR2BE13* | 1.3 | 1M3 | TCR2BF34* | TCR2BE34* | 3.4 | 3M4 |
| TCR2BF14* | TCR2BE14* | 1.4 | 1M4 | TCR2BF35* | TCR2BE35* | 3.5 | 3M5 |
| TCR2BF15 | TCR2BE15 | 1.5 | 1M5 | TCR2BF36 | TCR2BE36 | 3.6 | 3M6 |
| TCR2BF16* | TCR2BE16* | 1.6 | 1M6 | TCR2BF37* | — | 3.7 | 3M7 |
| TCR2BF17* | TCR2BE17* | 1.7 | 1M7 | TCR2BF38* | — | 3.8 | 3M8 |
| TCR2BF175* | TCR2BE175* | 1.75 | 1MF | TCR2BF39* | — | 3.9 | 3M9 |
| TCR2BF18 | TCR2BE18 | 1.8 | 1M8 | TCR2BF40 | — | 4.0 | 4M0 |
| TCR2BF19* | TCR2BE19* | 1.9 | 1M9 | TCR2BF41* | — | 4.1 | 4M1 |
| TCR2BF20* | TCR2BE20* | 2.0 | 2M0 | TCR2BF42* | — | 4.2 | 4M2 |
| TCR2BF21* | TCR2BE21* | 2.1 | 2M1 | TCR2BF43* | — | 4.3 | 4M3 |
| TCR2BF22* | TCR2BE22* | 2.2 | 2M2 | TCR2BF44* | — | 4.4 | 4M4 |
| TCR2BF23* | TCR2BE23* | 2.3 | 2M3 | TCR2BF45 | — | 4.5 | 4M5 |
| TCR2BF24* | TCR2BE24* | 2.4 | 2M4 | TCR2BF46* | — | 4.6 | 4M6 |
| TCR2BF25 | TCR2BE25 | 2.5 | 2M5 | TCR2BF47* | — | 4.7 | 4M7 |
| TCR2BF26* | TCR2BE26* | 2.6 | 2M6 | TCR2BF48* | — | 4.8 | 4M8 |
| TCR2BF27 | TCR2BE27 | 2.7 | 2M7 | TCR2BF49* | — | 4.9 | 4M9 |
| TCR2BF28 | TCR2BE28 | 2.8 | 2M8 | TCR2BF50 | — | 5.0 | 5M0 |
| TCR2BF285* | TCR2BE285* | 2.85 | 2MD | | | | |

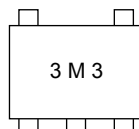
Please contact your local Toshiba representative if you are interested in products with * sign

Marking (top view)

Example: TCR2BF33 (3.3 V output)



Example: TCR2BE33 (3.3 V output)



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) | mW |
| | | | 380 (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
(Glass epoxy board dimension: 30 mm × 30 mm, Copper area: 50 mm²)

Note 3: Rating at mounting on a board
(Glass epoxy board dimension: 30 mm × 30 mm, Copper area: 20 mm²)

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 | V_{OUT} | — | $V_{OUT} \leq 1.4\text{ V}$ | -30 | — | +30 | mV |
| | | | $1.5\text{ V} \leq V_{OUT}$ | -2 | — | +2 | % |
| Line regulation | Reg·line | $V_{OUT} + 0.5\text{ V} \leq V_{IN} \leq 6\text{ V}$, $I_{OUT} = 1\text{ mA}$ | — | 1 | 15 | mV | |
| Load regulation | Reg·load | $1\text{ mA} \leq I_{OUT} \leq 150\text{ mA}$ | — | 10 | 30 | mV | |
| Quiescent current | I_B | $I_{OUT} = 0\text{ mA}$ | — | 40 | 75 | μA | |
| Stand-by current | I_B (OFF) | $V_{CT} = 0\text{ V}$ | — | 0.1 | 1.0 | μA | |
| Dropout voltage | $V_{IN}-V_{OUT}$ | Please refer to the Dropout voltage table | | | | | |
| Temperature coefficient | T_{CVO} | $-40^\circ\text{C} \leq T_{opr} \leq 85^\circ\text{C}$ | — | 100 | — | ppm/ $^\circ\text{C}$ | |
| Output noise voltage | V_{NO} | $V_{IN} = V_{OUT} + 1\text{ V}$, $I_{OUT} = 10\text{ mA}$, $10\text{ Hz} \leq f \leq 100\text{ kHz}$, $T_a = 25^\circ\text{C}$ (Note 4) | — | 50 | — | μV_{rms} | |
| Input voltage | V_{IN} | — | $V_{OUT} : 1.0\text{V}$ | 1.55 | — | 6.0 | V |
| | | | $V_{OUT} : 1.05\text{V to } 1.1\text{V}$ | $V_{OUT} + 0.50\text{ V}$ | — | 6.0 | |
| | | | $V_{OUT} : 1.15\text{V to } 1.2\text{V}$ | 1.58 | — | 6.0 | |
| | | | $V_{OUT} : 1.25\text{V}$ | 1.59 | — | 6.0 | |
| | | | $V_{OUT} : 1.3\text{V}$ | 1.63 | — | 6.0 | |
| | | | $V_{OUT} : 1.4\text{V}$ | 1.68 | — | 6.0 | |
| | | | $V_{OUT} : 1.5\text{V to } 1.75\text{V}$ | $V_{OUT} + 0.25\text{ V}$ | — | 6.0 | |
| | | | $V_{OUT} : 1.8\text{V to } 2.4\text{V}$ | $V_{OUT} + 0.20\text{ V}$ | — | 6.0 | |
| | | | $V_{OUT} : 2.5\text{V to } 5.0\text{V}$ | $V_{OUT} + 0.15\text{ V}$ | — | 6.0 | |
| Ripple rejection ratio | R.R. | $V_{IN} = V_{OUT} + 1\text{ V}$, $I_{OUT} = 10\text{ mA}$, $f = 1\text{ kHz}$, $V_{Ripple} = 500\text{ mV}_{p-p}$, $T_a = 25^\circ\text{C}$ | — | 70 | — | dB | |
| Control voltage (ON) | V_{CT} (ON) | — | 1.1 | — | 6.0 | V | |
| Control voltage (OFF) | V_{CT} (OFF) | — | 0 | — | 0.4 | V | |

Note 4: The 2.8V output product.

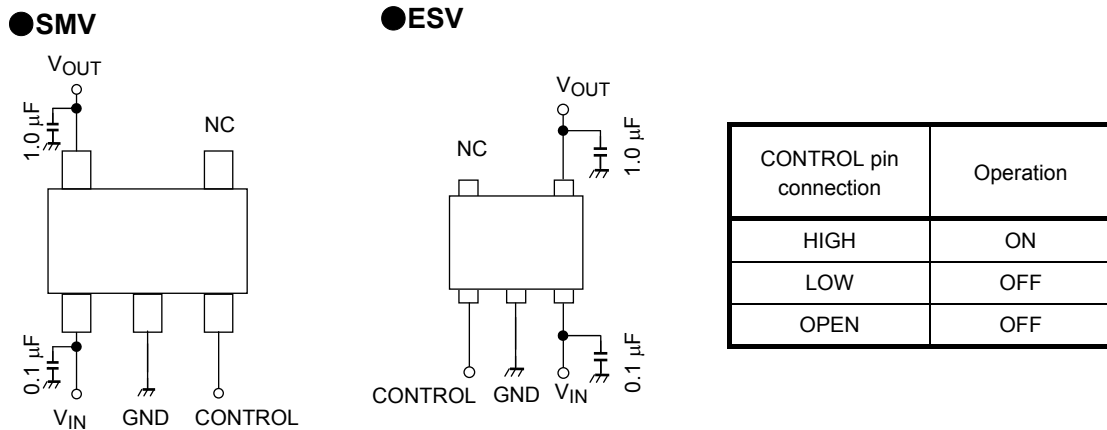
Dropout Voltage

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

| Output voltage | Symbol | Min | Typ. | Max | Unit |
|------------------------------------------|------------------|-----|------|-----|------|
| $V_{OUT} : 1.0\text{V}$ | $V_{IN-V_{OUT}}$ | — | 350 | 550 | mV |
| $V_{OUT} : 1.05\text{V}$ | | — | 340 | 500 | |
| $V_{OUT} : 1.1\text{V}$ | | — | 310 | 500 | |
| $V_{OUT} : 1.15\text{V}$ | | — | 290 | 430 | |
| $V_{OUT} : 1.2\text{V}$ | | — | 260 | 380 | |
| $V_{OUT} : 1.25\text{V}$ | | — | 250 | 340 | |
| $V_{OUT} : 1.3\text{V}$ | | — | 230 | 330 | |
| $V_{OUT} : 1.4\text{V}$ | | — | 190 | 280 | |
| $V_{OUT} : 1.5\text{V to } 1.75\text{V}$ | | — | 160 | 250 | |
| $V_{OUT} : 1.8\text{V to } 2.4\text{V}$ | | — | 130 | 200 | |
| $V_{OUT} : 2.5\text{V to } 5.0\text{V}$ | | — | 100 | 150 | |

Application Note

1. Recommended Application Circuit

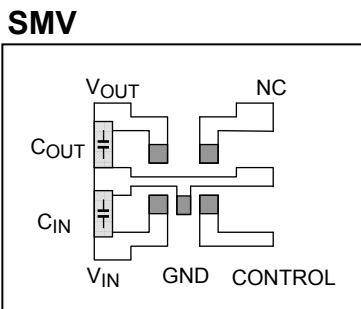


The figure above shows the recommended configuration for using a Low-Dropout regulator. Insert a capacitor at V_{OUT} and V_{IN} pins for stable input/output operation. (Ceramic capacitors can be used).

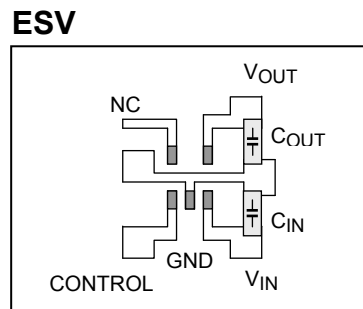
2. Power Dissipation

Power dissipation is measured on the board shown below.

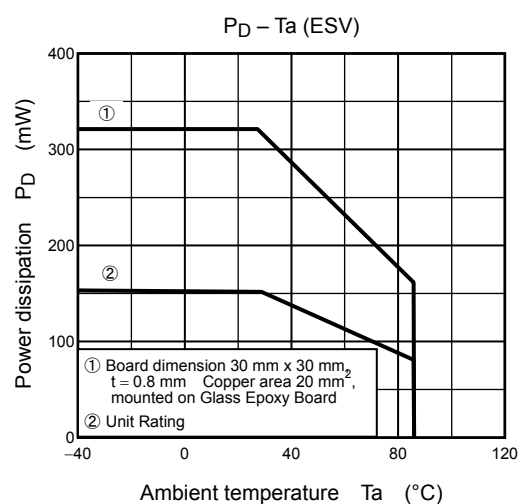
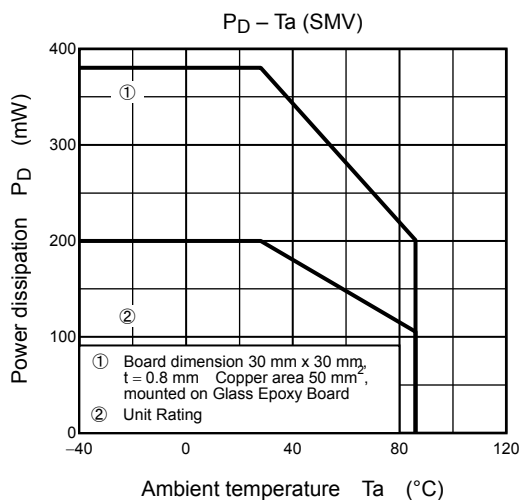
Testing Board of Thermal Resistance



*Board material: Glass Epoxy
 Board dimension: 30 mm × 30 mm
 Copper area: 50 mm², t = 0.8 mm



*Board material: Glass Epoxy
 Board dimension: 30 mm × 30 mm
 Copper area: 20 mm², t = 0.8 mm



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 .

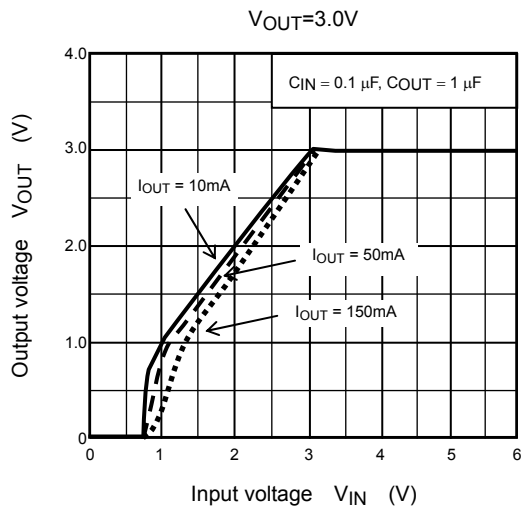
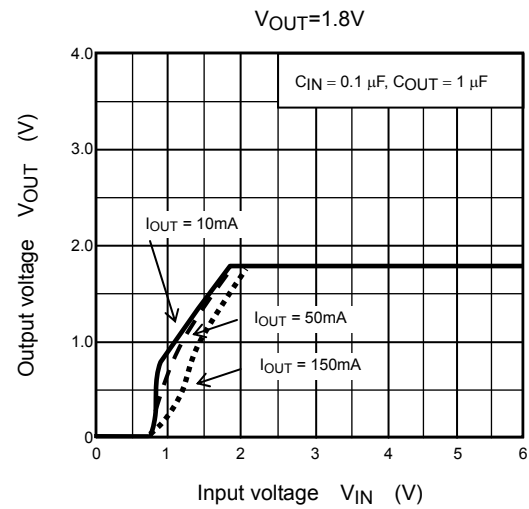
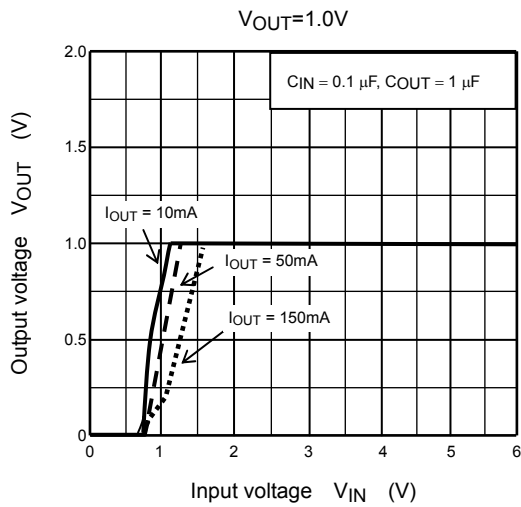
- **Mounting**
The long distance between IC and output capacitor might affect phase assurance by impedance in wire and inductor. For stable power supply, output capacitor need to mount near IC as much as possible. Also GND pattern need to be large and make the wire impedance small as possible.

- **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.

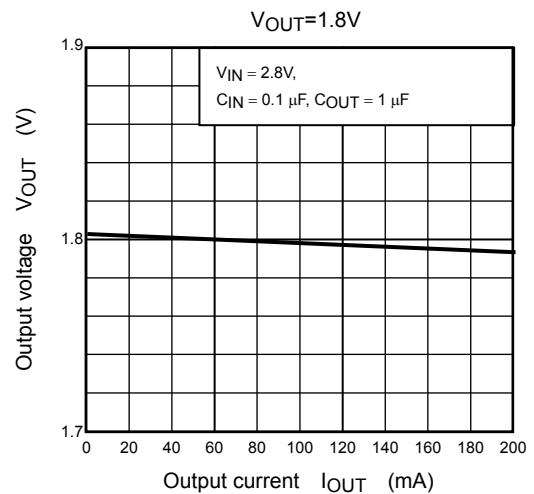
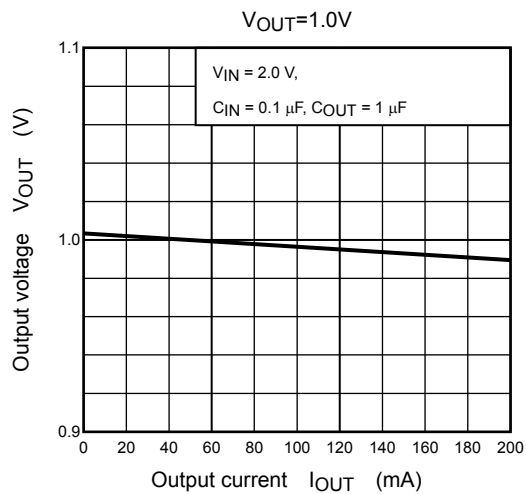
- **Overcurrent Protection Circuit**
Overcurrent protection circuit is designed in these products, but this does not assure for the suppression of uprising device operation. If output pins and GND pins are shorted out, these products might be break down. In use of these products, please read through 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.

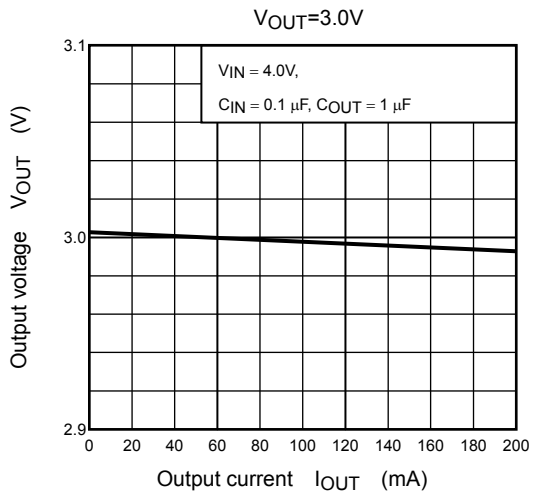
Representative Typical Characteristics

1) Output Voltage vs. Input Voltage

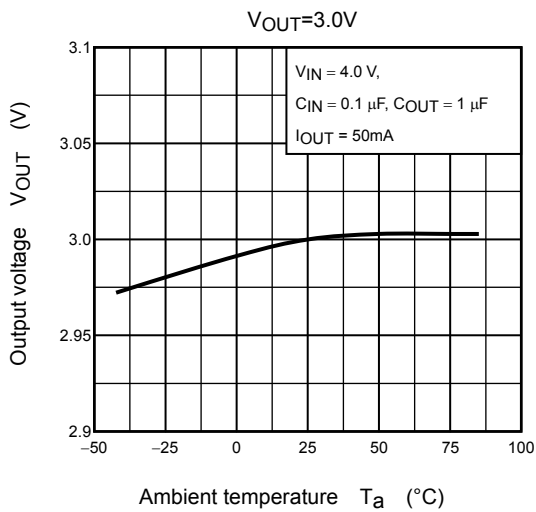
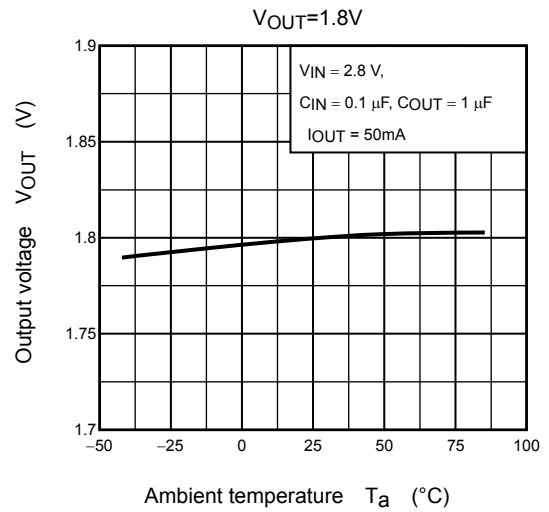
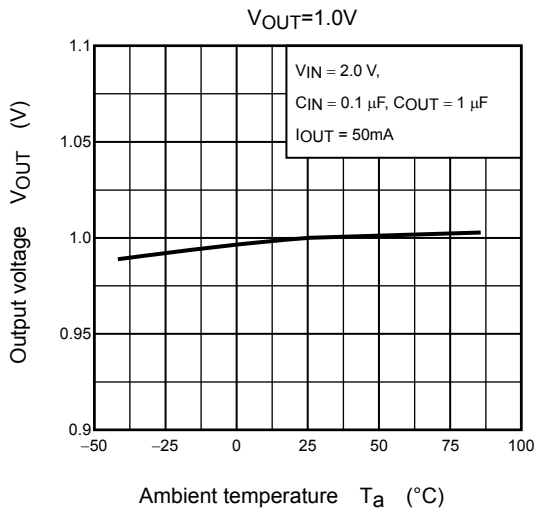


2) Output Voltage vs. Output Current

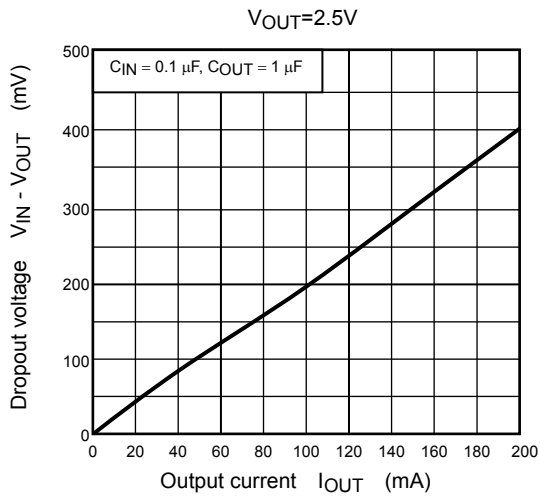
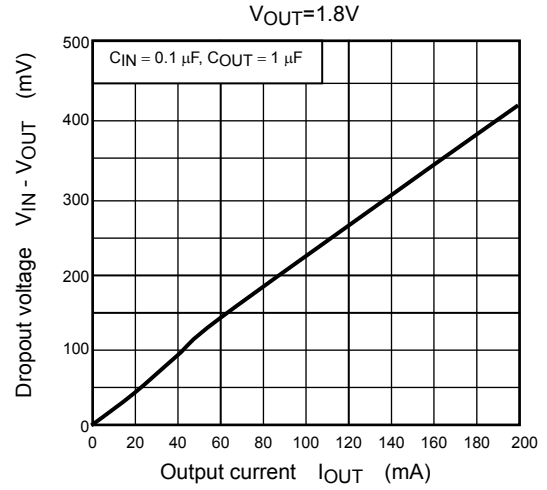
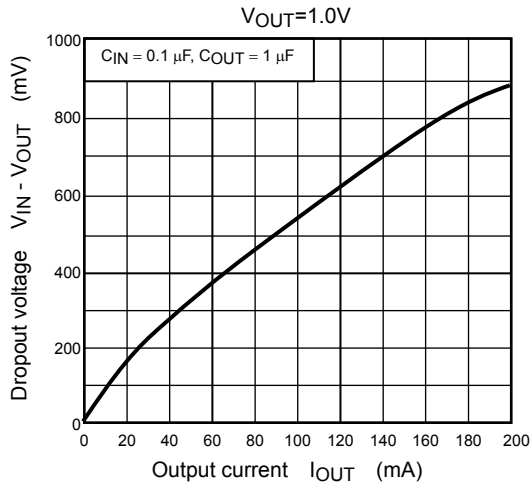




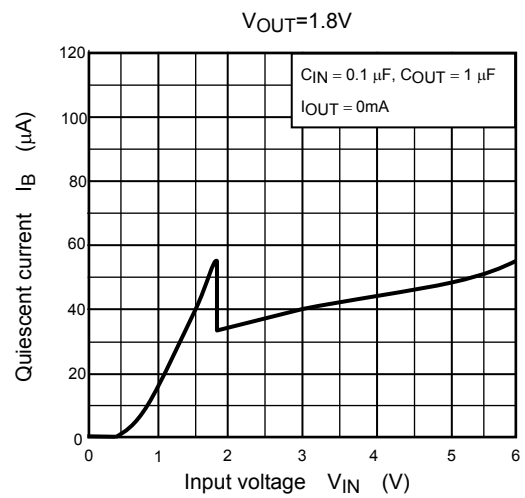
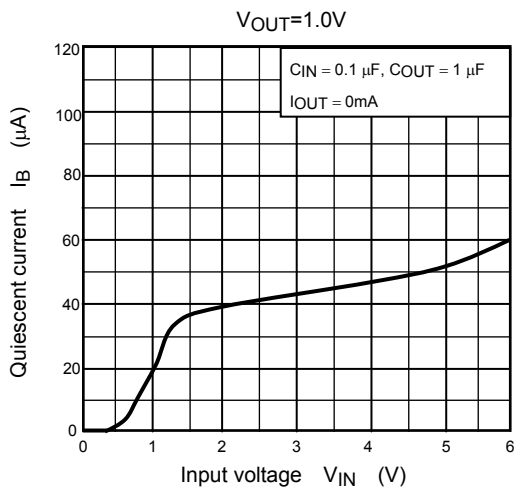
3) Output Voltage vs. Ambient Temperature

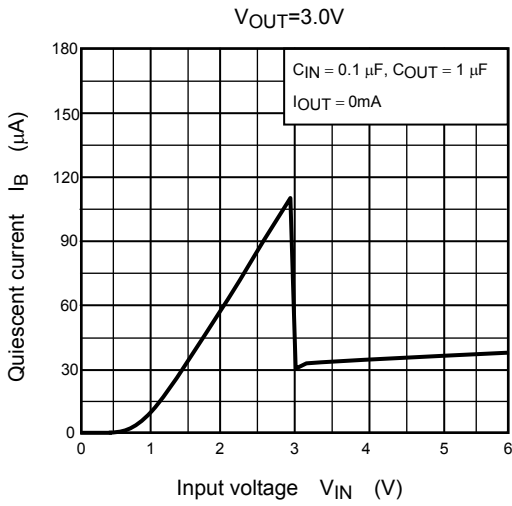


4) Dropout Voltage vs. Output Current

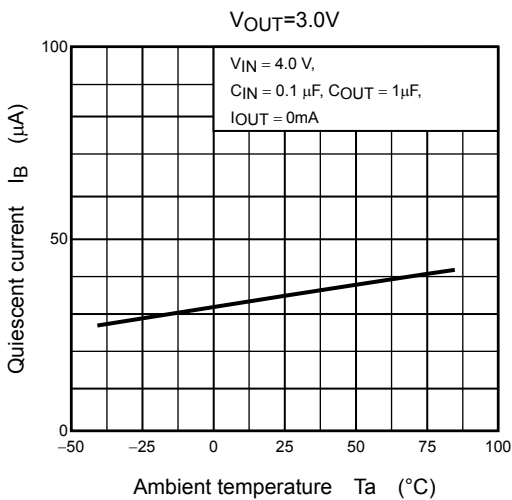
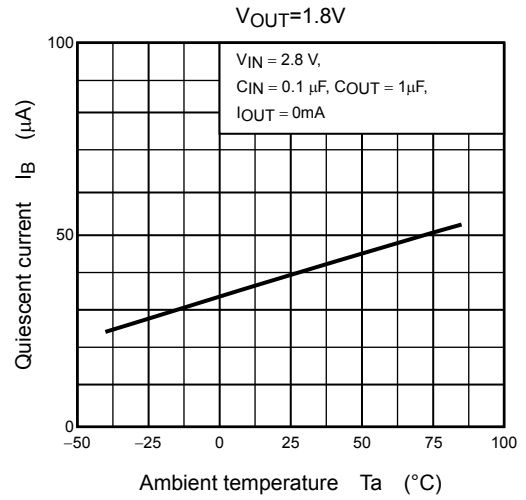
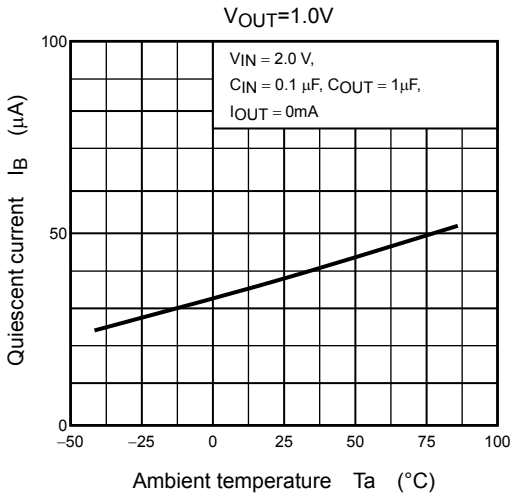


5) Quiescent Current vs. Input Voltage

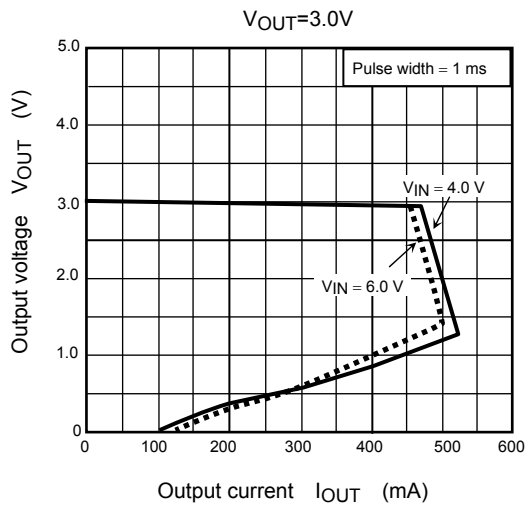
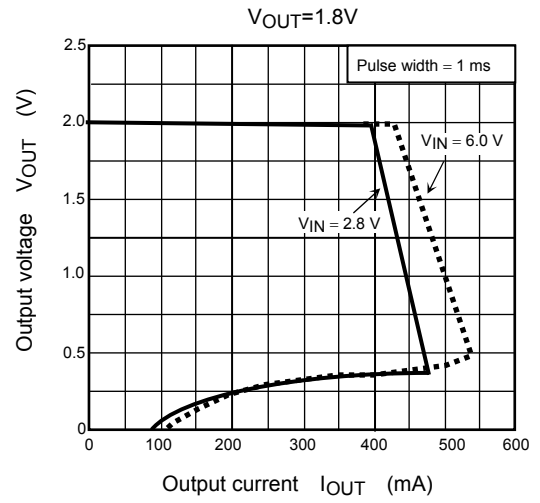
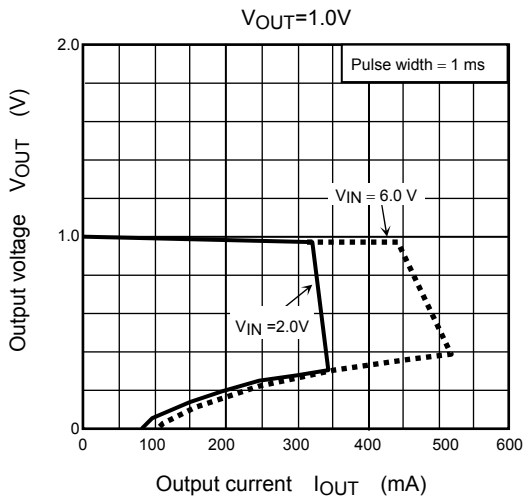




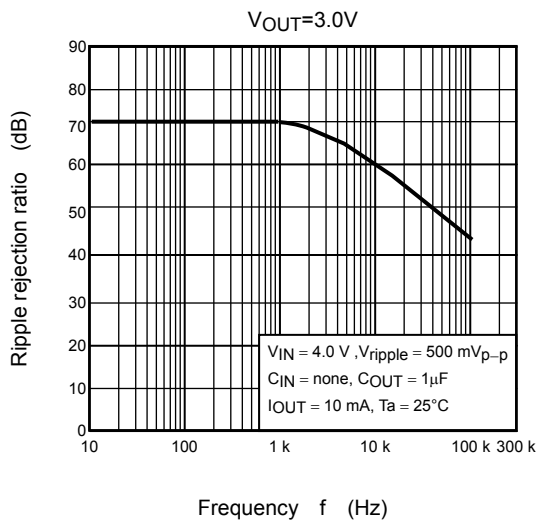
6) Quiescent Current vs.Ambient Temperature



7) Overcurrent protection characteristics (Overcurrent protection characteristic does not assure for the suppression of uprising device operation. We recommend proper dissipation ratings for maximum permissible loss.)

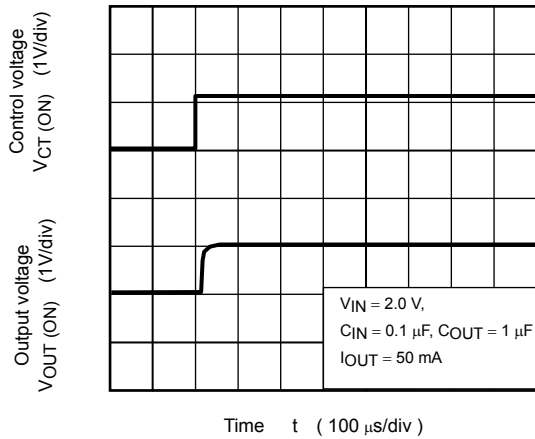


8) Ripple Rejection Ratio vs. Frequency

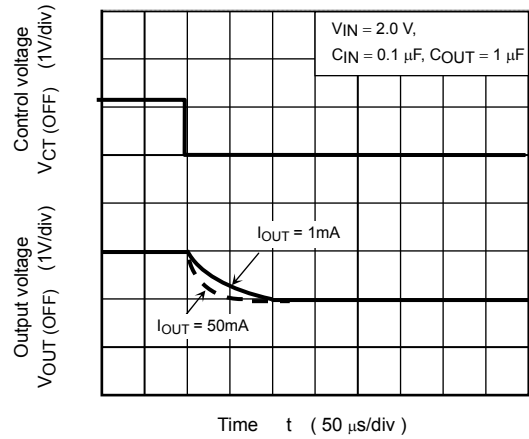


9) Control Transient Response (Auto-Discharge)

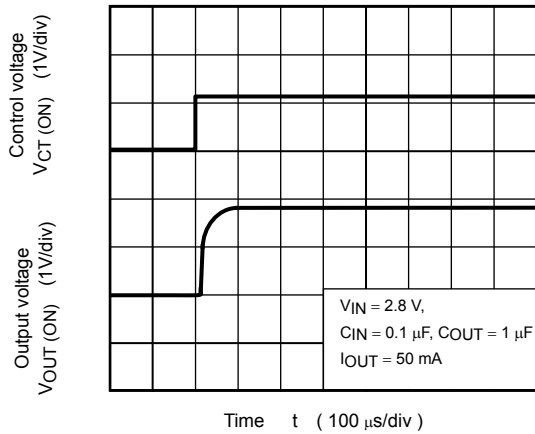
$V_{OUT}=1.0V$ (Turn on waveform)



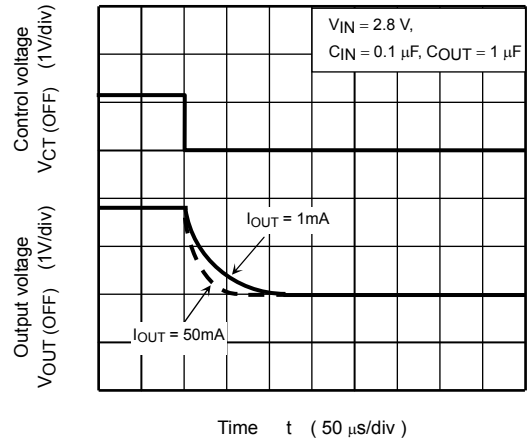
$V_{OUT}=1.0V$ (Turn off waveform)



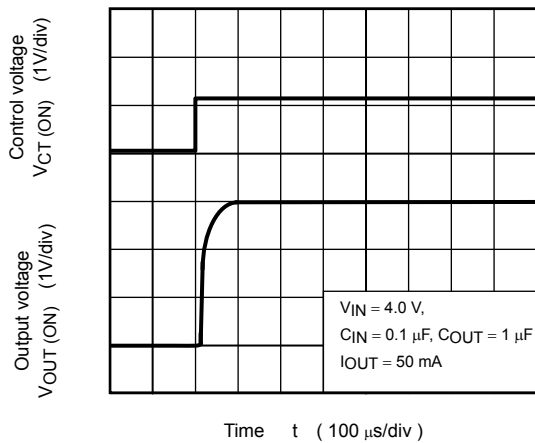
$V_{OUT}=1.8V$ (Turn on waveform)



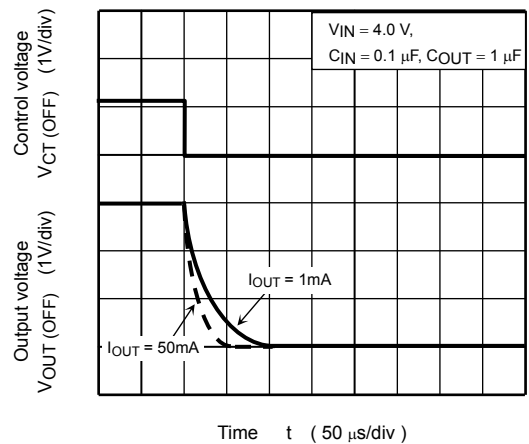
$V_{OUT}=1.8V$ (Turn off waveform)



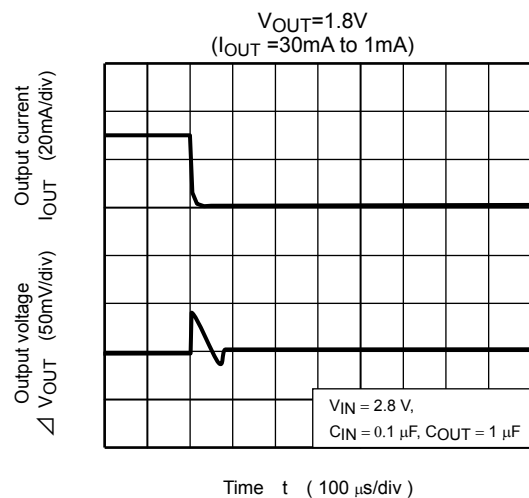
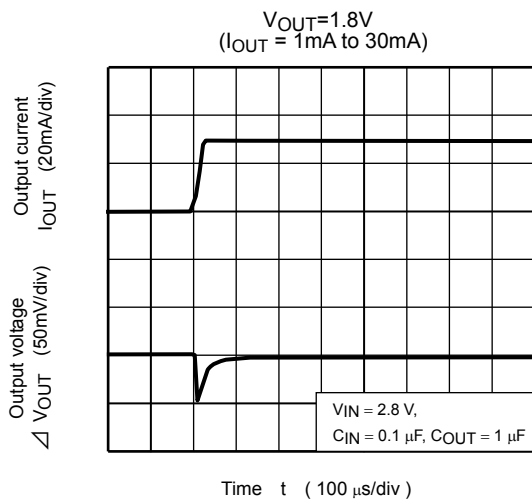
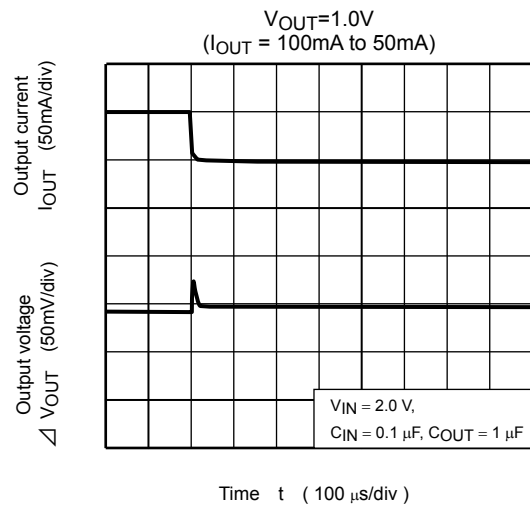
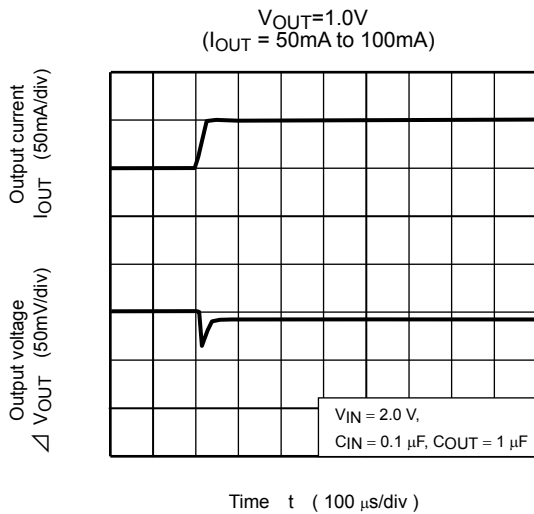
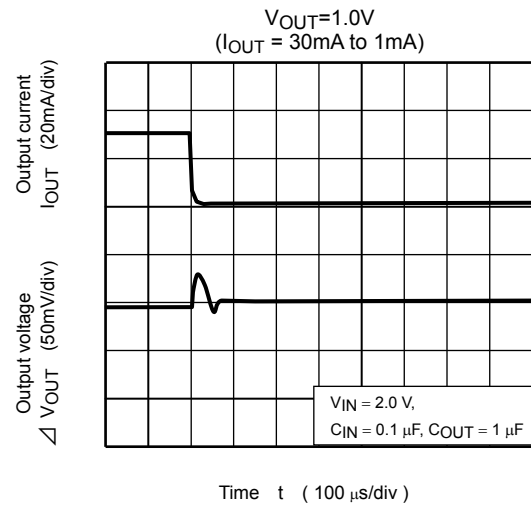
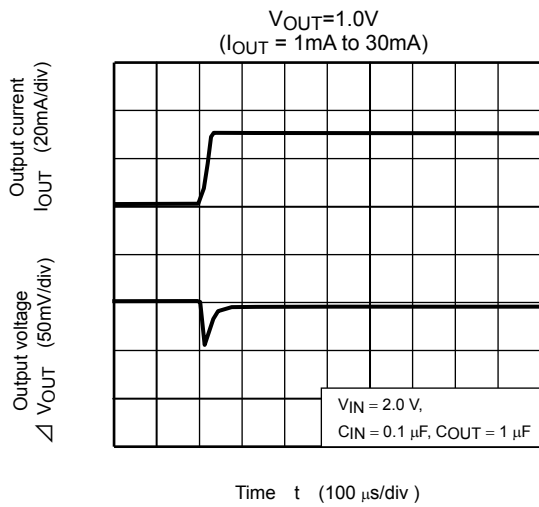
$V_{OUT}=3.0V$ (Turn on waveform)

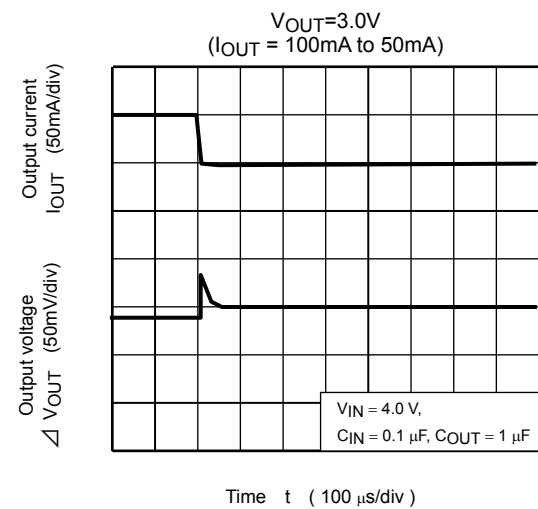
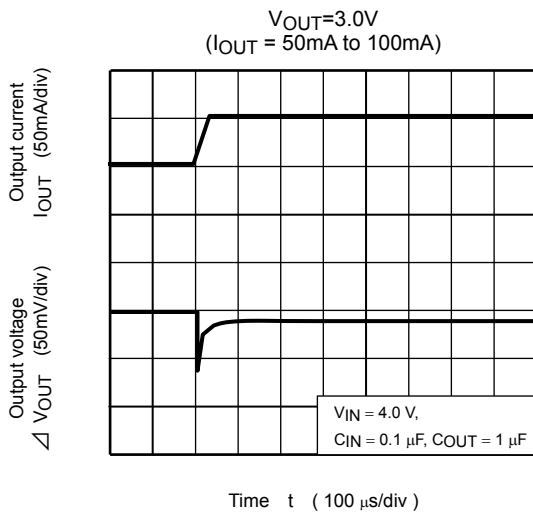
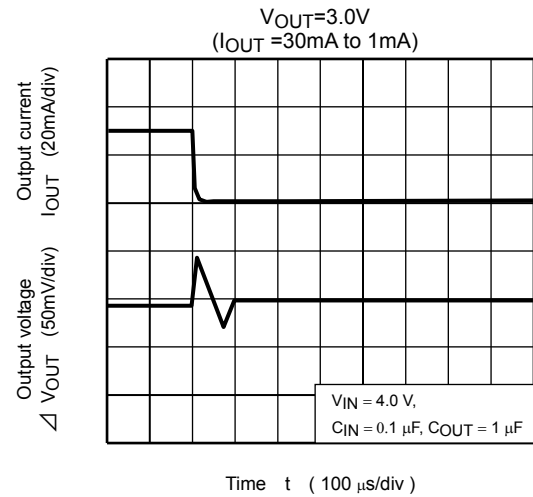
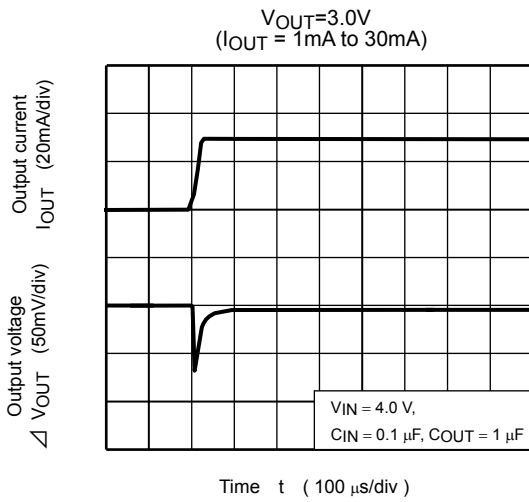
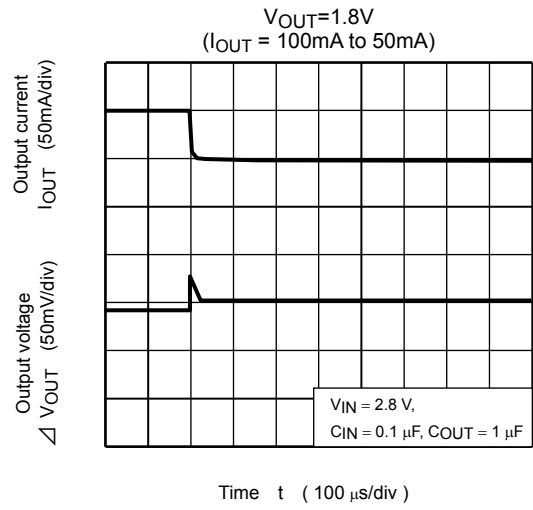
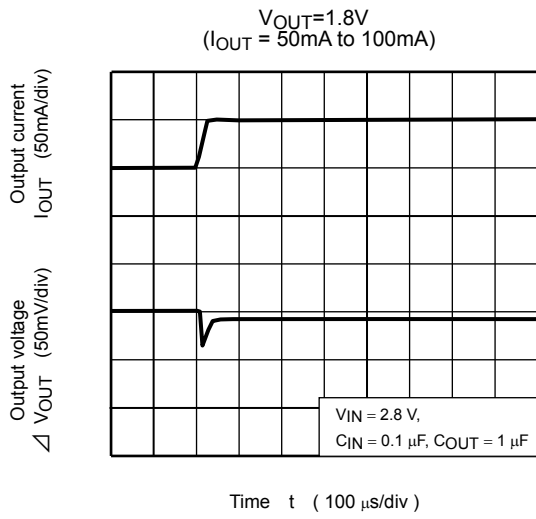


$V_{OUT}=3.0V$ (Turn off waveform)



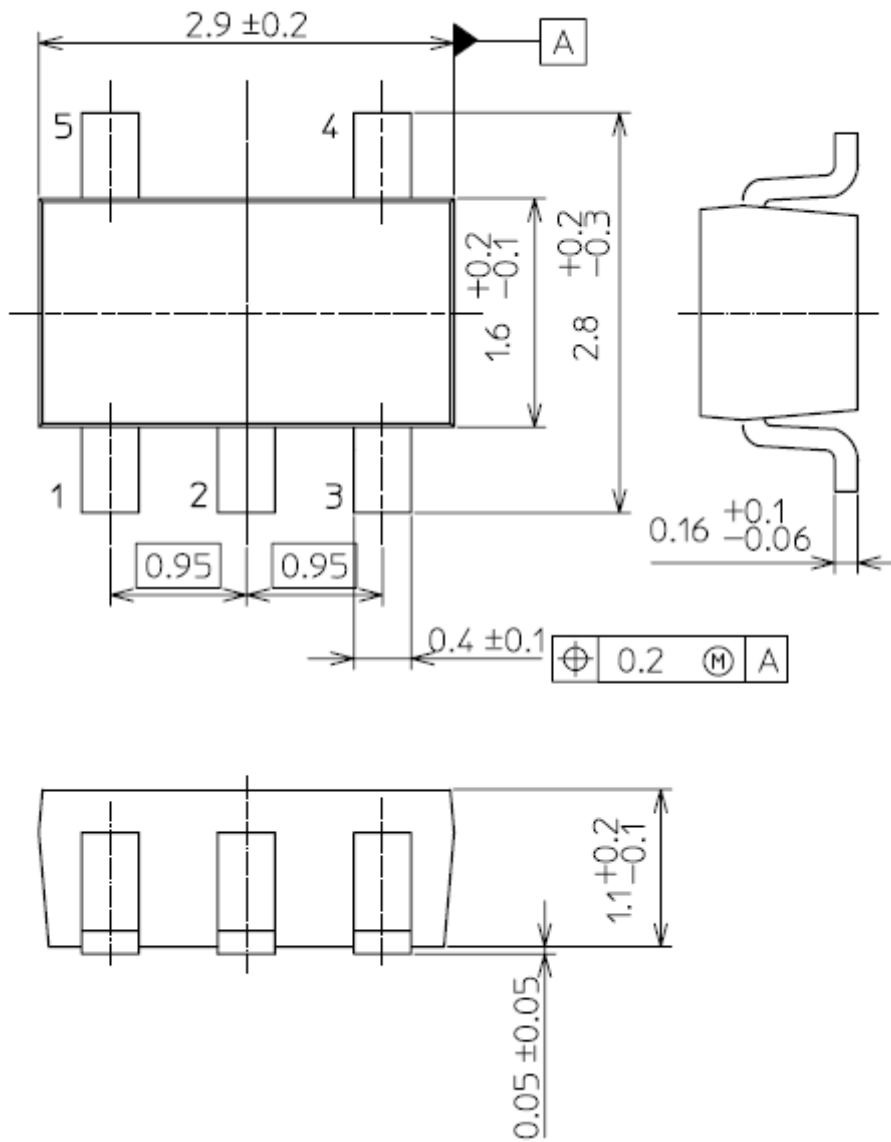
10) Load Transient Response





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

Unit: mm

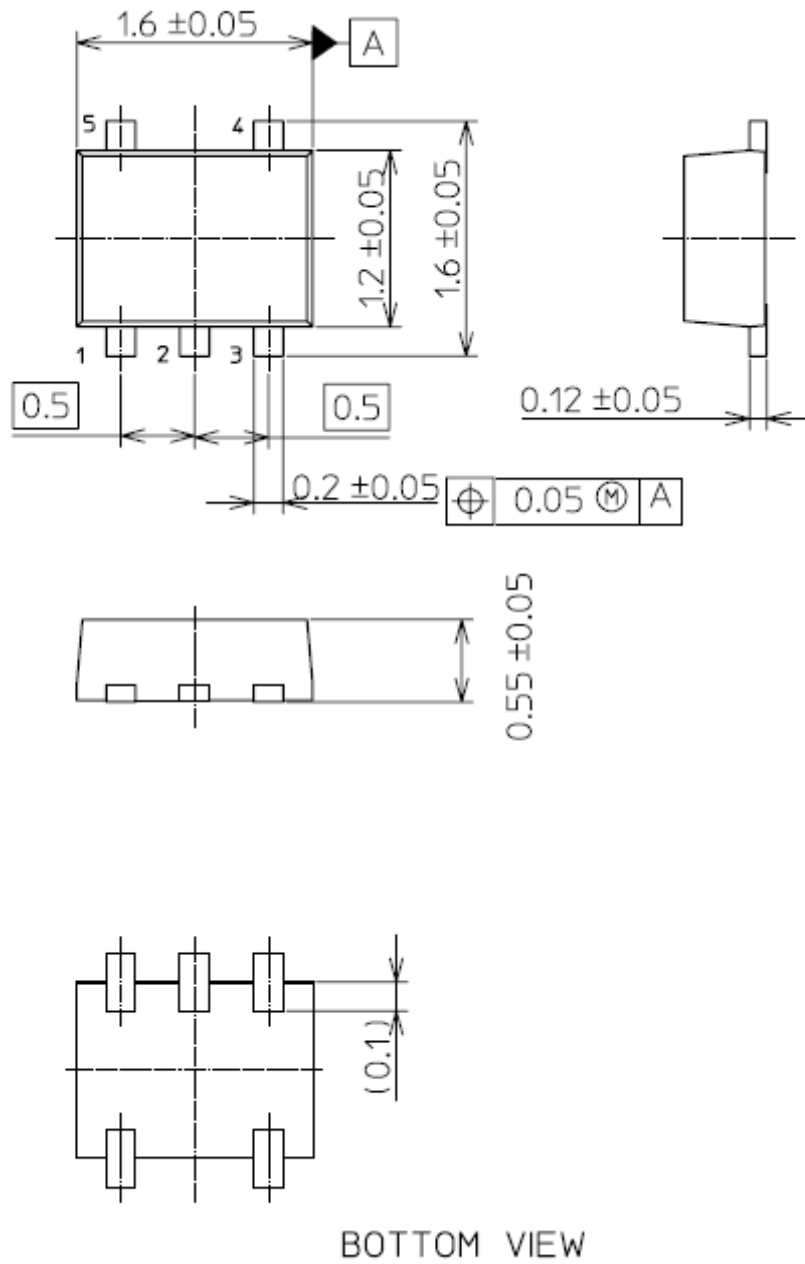


Weight : 16 mg (typ.)

Package Dimensions

ESV (SOT-553)

Unit: mm



Weight: 3.0 mg (typ.)

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