

# TCR2LF series

# TCR2LE series

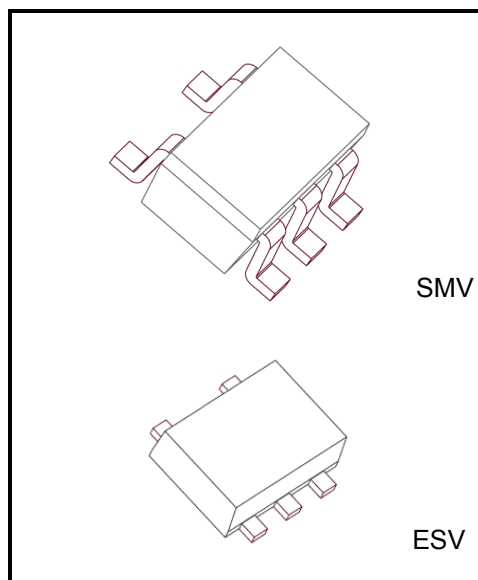
## Ultra low quiescent current 200 mA CMOS Low Drop-Out Regulator in ultra small package

The TCR2LF and TCR2LE series are CMOS general-purpose single-output voltage regulators with an on/off control input, featuring ultra low quiescent bias current and low dropout voltage.

These voltage regulators are available in fixed output voltages between 0.8 V and 3.6 V and capable of driving up to 200 mA. They feature overcurrent protection and Auto-discharge function.

The package is general SMV(SOT-25) (2.8 mm x 2.9 mm x 1.1 mm ) and ESV(SOT-553) (1.6 mm x 1.6 mm x 0.55 mm ), and has a low dropout voltage of 270 mV ( 2.5 V output, I<sub>OUT</sub> = 150 mA).

As small ceramic input and output capacitors 0.1μF can be used with the TCR2LF and TCR2LE series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



## Features

- Low quiescent bias current (  $I_B = 2 \mu A$  (max) at  $I_{OUT} = 0$  mA,  $T_j = -40$  to  $85^\circ C$  )
- Low Drop-Out voltage  
 $V_{IN}-V_{OUT} = 270$  mV (typ.) at 2.5 V-output,  $I_{OUT} = 150$  mA
- Wide range output voltage line up (  $V_{OUT} = 0.8$  to  $3.6$  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 (  $C_{IN} = 0.1 \mu F$ ,  $C_{OUT} = 0.1 \mu F$  )
- General package SMV(SOT-25) (2.8 mm x 2.9 mm x 1.1 mm ) and ESV(SOT-553) (1.6 mm x 1.6 mm x 0.55 mm )

Weight :

SMV (SOT-25)(SC-74A) : 16.0 mg ( typ.)

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

## 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 (Note1)  | mW   |
|                             |           |                        | 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).

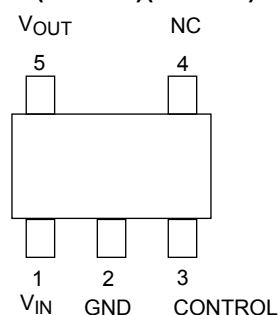
Note 1: Unit Rating

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

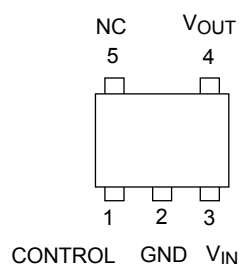
Note 3: Rating at mounting on a board  
(FR4 board dimension: 30 mm × 30 mm × 0.8 mm)

## Pin Assignment (top view)

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



### ESV(SOT-553)



## List of Products Number, Output voltage and Marking

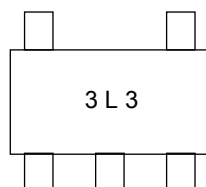
### TCR2LF and TCR2LE series

| Product No. |              | V <sub>OUT</sub> (V)<br>(typ.) | Marking | Product No. |              | V <sub>OUT</sub> (V)<br>(typ.) | Marking |
|-------------|--------------|--------------------------------|---------|-------------|--------------|--------------------------------|---------|
| SMV(SOT-25) | ESV(SOT-553) |                                |         | SMV(SOT-25) | ESV(SOT-553) |                                |         |
| TCR2LF08    | TCR2LE08     | 0.8                            | 0L8     | TCR2LF19    | TCR2LE19     | 1.9                            | 1L9     |
| TCR2LF085   | TCR2LE085    | 0.85                           | 0LD     | TCR2LF20    | TCR2LE20     | 2.0                            | 2L0     |
| TCR2LF09    | TCR2LE09     | 0.9                            | 0L9     | TCR2LF21    | TCR2LE21     | 2.1                            | 2L1     |
| TCR2LF095   | TCR2LE095    | 0.95                           | 0LE     | TCR2LF25    | TCR2LE25     | 2.5                            | 2L5     |
| TCR2LF10    | TCR2LE10     | 1.0                            | 1L0     | TCR2LF27    | TCR2LE27     | 2.7                            | 2L7     |
| TCR2LF105   | TCR2LE105    | 1.05                           | 1LA     | TCR2LF28    | TCR2LE28     | 2.8                            | 2L8     |
| TCR2LF11    | TCR2LE11     | 1.1                            | 1L1     | TCR2LF285   | TCR2LE285    | 2.85                           | 2LD     |
| TCR2LF115   | TCR2LE115    | 1.15                           | 1LB     | TCR2LF30    | TCR2LE30     | 3.0                            | 3L0     |
| TCR2LF12    | TCR2LE12     | 1.2                            | 1L2     | TCR2LF31    | TCR2LE31     | 3.1                            | 3L1     |
| TCR2LF13    | TCR2LE13     | 1.3                            | 1L3     | TCR2LF32    | TCR2LE32     | 3.2                            | 3L2     |
| TCR2LF15    | TCR2LE15     | 1.5                            | 1L5     | TCR2LF33    | TCR2LE33     | 3.3                            | 3L3     |
| TCR2LF18    | TCR2LE18     | 1.8                            | 1L8     | TCR2LF36    | TCR2LE36     | 3.6                            | 3L6     |

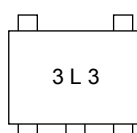
\* Please contact local Toshiba representative if you are interested in product that output voltage is not in the list.

### Marking (top view)

Example: TCR2LF33 (3.3 V output)



Example: TCR2LE33 (3.3 V output)



## Electrical Characteristics

(Unless otherwise specified,

$V_{IN} = V_{OUT} + 1\text{ V}$  ( $V_{OUT} > 1.5\text{ V}$ ),  $V_{IN} = 2.5\text{ V}$  ( $V_{OUT} \leq 1.5\text{ V}$ ),  $I_{OUT} = 50\text{ mA}$ ,  $C_{IN} = 0.1\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ )

| Characteristics           | Symbol                            | Test Condition   |                          | T <sub>j</sub> = 25°C |      |      | T <sub>j</sub> = -40 to 85°C |     | Unit   |
|---------------------------|-----------------------------------|--|--------------------------|-----------------------|------|------|------------------------------|-----|--------|
|                           |                                   |  |                          | Min                   | Typ. | Max  | Min                          | Max |        |
| Output voltage accuracy   | V <sub>OUT</sub>                  | I <sub>OUT</sub> = 50 mA<br>(Note 4)   | V <sub>OUT</sub> < 1.8 V | -18                   | —    | +18  | —                            | —   | mV     |
|                           |                                   |  | 1.8V ≤ V <sub>OUT</sub>  | -1.0                  | —    | +1.0 | —                            | —   | %      |
| Input voltage             | V <sub>IN</sub>                   | I <sub>OUT</sub> = 1 mA  |                          | 1.5                   | —    | 5.5  | 1.5                          | 5.5 | V      |
| Line regulation           | Reg·line                          | V <sub>OUT</sub> + 0.5 V ≤ V <sub>IN</sub> ≤ 5.5 V,<br>I <sub>OUT</sub> = 1 mA |                          | —                     | 1    | 15   | —                            | —   | mV     |
| Load regulation           | Reg·load                          | 1 mA ≤ I <sub>OUT</sub> ≤ 150 mA   |                          | —                     | 15   | 30   | —                            | —   | mV     |
| Quiescent current         | I <sub>B</sub>                    | I <sub>OUT</sub> = 0 mA (Note 5)   |                          | —                     | 1.0  | —    | —                            | 2.0 | μA     |
| Stand-by current          | I <sub>B</sub> (OFF)              | V <sub>CT</sub> = 0 V  |                          | —                     | 0.1  | —    | —                            | 1.0 | μA     |
| Control pull down current | I <sub>CT</sub>                   | —  |                          | —                     | 0.1  | —    | —                            | —   | μA     |
| Drop-out voltage          | V <sub>IN</sub> -V <sub>OUT</sub> | I <sub>OUT</sub> = 150 mA  | V <sub>OUT</sub> = 1.8V  | —                     | 370  | —    | —                            | 620 | mV     |
|                           |                                   |  | V <sub>OUT</sub> = 3.0V  | —                     | 220  | —    | —                            | 300 | mV     |
| Temperature coefficient   | T <sub>CVO</sub>                  | -40°C ≤ T <sub>opr</sub> ≤ 85°C  |                          | —                     | 75   | —    | —                            | —   | ppm/°C |
| Control voltage (ON)      | V <sub>CT</sub> (ON)              | —  |                          | 1.0                   | —    | 5.5  | 1.0                          | 5.5 | V      |
| Control voltage (OFF)     | V <sub>CT</sub> (OFF)             | —  |                          | 0                     | —    | 0.4  | 0                            | 0.4 | V      |
| Discharge on resistance   | R <sub>SD</sub>                   | —  |                          | —                     | 20   | —    | —                            | —   | Ω      |

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

Note 5: Except Control pull down current

## Drop-out voltage

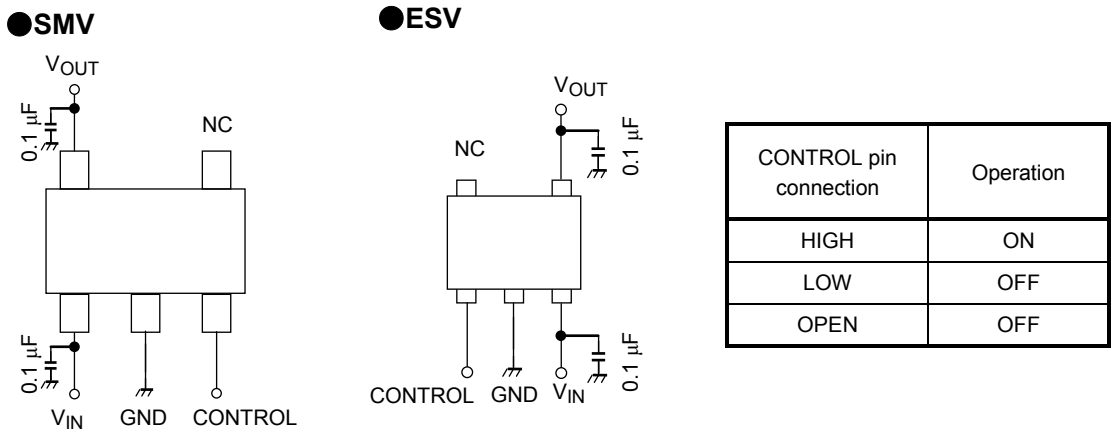
( $I_{OUT} = 150\text{ mA}$ ,  $C_{IN} = 0.1\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ ,  $T_j = 25^\circ\text{C}$ )

| Output voltages                               | Symbol             | Min | Typ. | Max(Note 6) | Unit |
|---|--------------------|-----|------|-------------|------|
| $0.8\text{ V} \leq V_{OUT} < 0.9\text{ V}$    | $V_{IN} - V_{OUT}$ | —   | 1020 | 1580        | mV   |
| $0.9\text{ V} \leq V_{OUT} < 1.0\text{ V}$    |                    | —   | 940  | 1480        |      |
| $1.0\text{ V} \leq V_{OUT} < 1.1\text{ V}$    |                    | —   | 860  | 1400        |      |
| $1.1\text{ V} \leq V_{OUT} < 1.2\text{ V}$    |                    | —   | 780  | 1300        |      |
| $1.2\text{ V} \leq V_{OUT} < 1.3\text{ V}$    |                    | —   | 700  | 1250        |      |
| $1.3\text{ V} \leq V_{OUT} < 1.6\text{ V}$    |                    | —   | 620  | 1130        |      |
| $1.6\text{ V} \leq V_{OUT} < 1.8\text{ V}$    |                    | —   | 470  | 860         |      |
| $1.8\text{ V} \leq V_{OUT} < 2.0\text{ V}$    |                    | —   | 370  | 620         |      |
| $2.0\text{ V} \leq V_{OUT} < 2.5\text{ V}$    |                    | —   | 320  | 560         |      |
| $2.5\text{ V} \leq V_{OUT} < 3.0\text{ V}$    |                    | —   | 270  | 380         |      |
| $3.0\text{ V} \leq V_{OUT} \leq 3.6\text{ V}$ |                    | —   | 220  | 300         |      |

Note 6:  $T_j = -40\text{ to }85^\circ\text{C}$

Application Note

1. Recommended Application Circuit



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

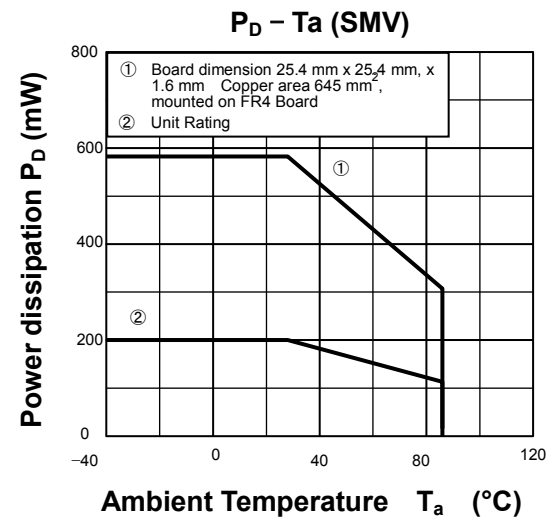
2. Power Dissipation

Both unit and board-mounted power dissipation ratings for TCR2LF series and TCR2LE series are available in the Absolute Maximum Ratings table.  
Power dissipation is measured on the board shown below.

Testing Board of Thermal Resistance

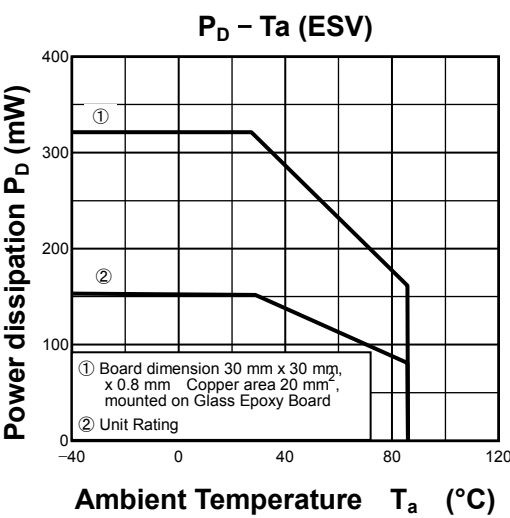
SMV

\*Board material: FR4 board  
Board dimension: 25.4 mm × 25.4 mm × 1.6 mm  
Copper area: 645 mm<sup>2</sup>



ESV

\*Board material: FR4  
Board dimension: 30 mm × 30 mm × 0.8 mm  
Copper area: 20 mm<sup>2</sup>



**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  $\Omega$ .

## ● 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.

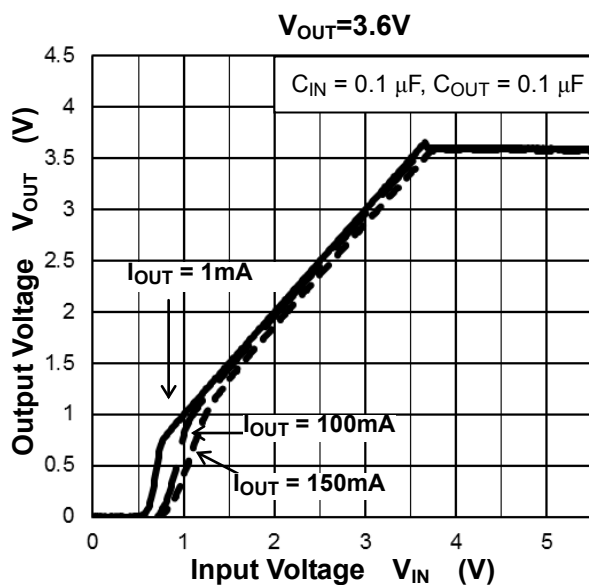
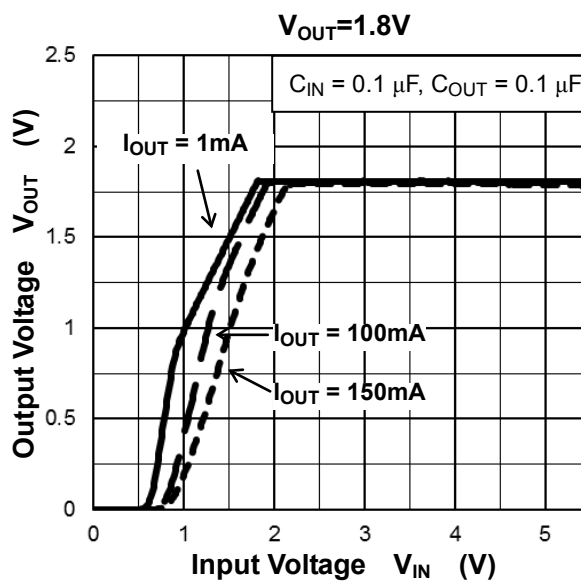
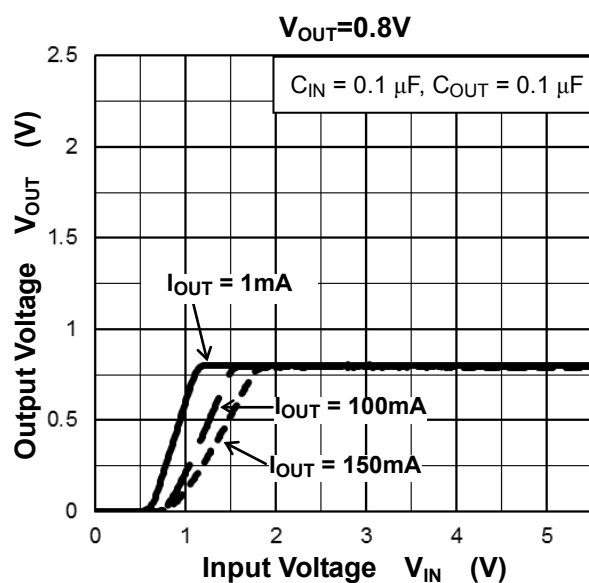
## ● Overcurrent Protection Circuit

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.

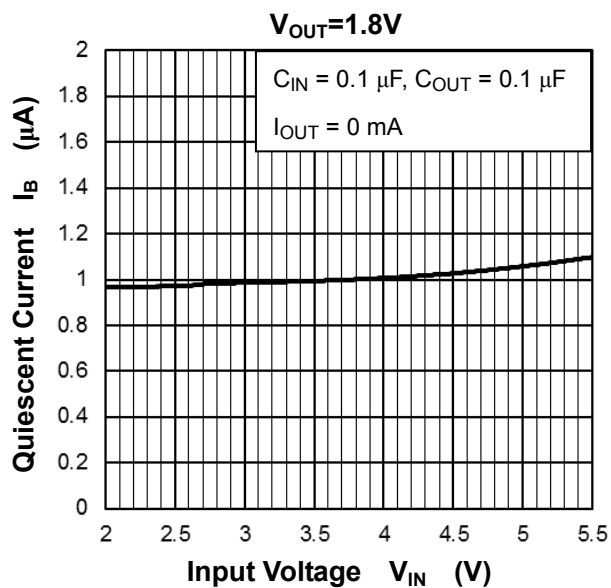
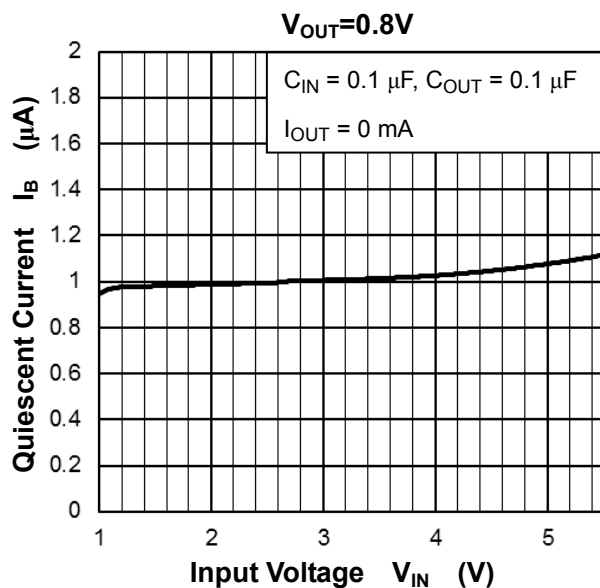
In use of these products, please read through and understand dissipation idea for absolute maximum ratings from the above mention or our 'Semiconductor Reliability Handbook'. Then use these products under absolute maximum ratings in any condition. Furthermore, Toshiba recommend inserting failsafe system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

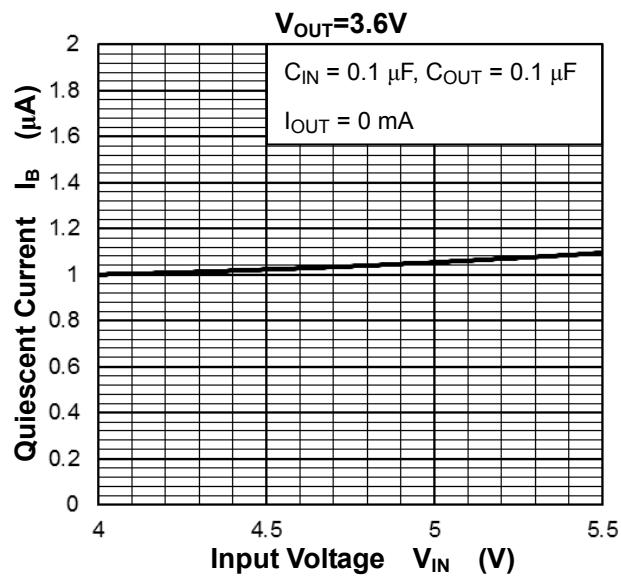
## Representative Typical Characteristics

### 1) Output Voltage vs. Input Voltage

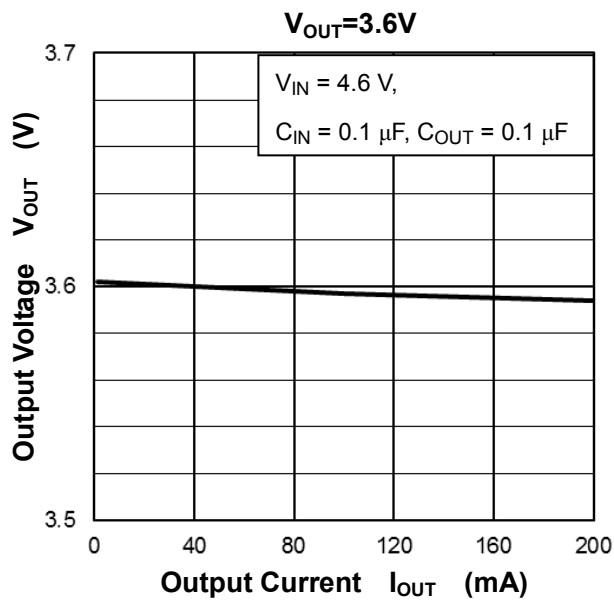
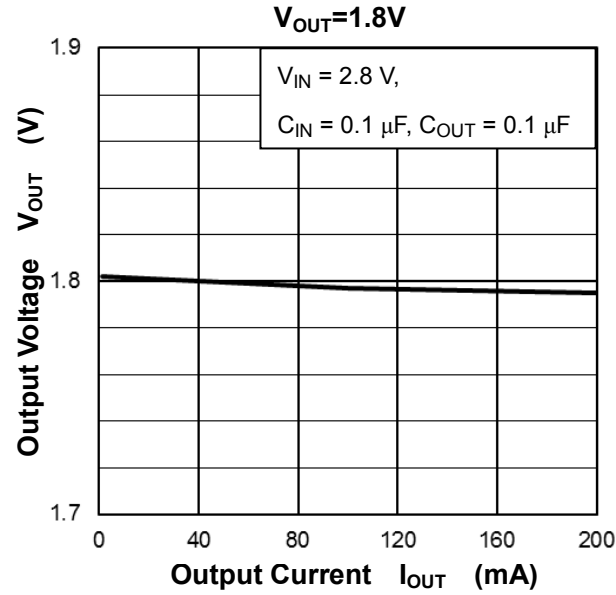
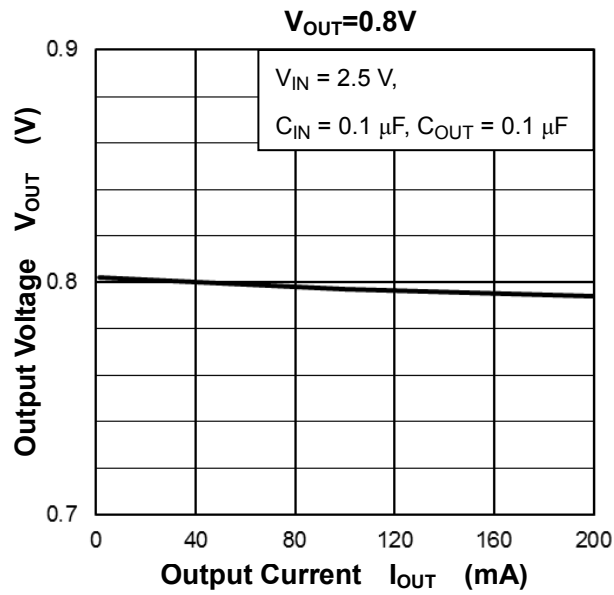


### 2) Quiescent Current vs. Input Voltage



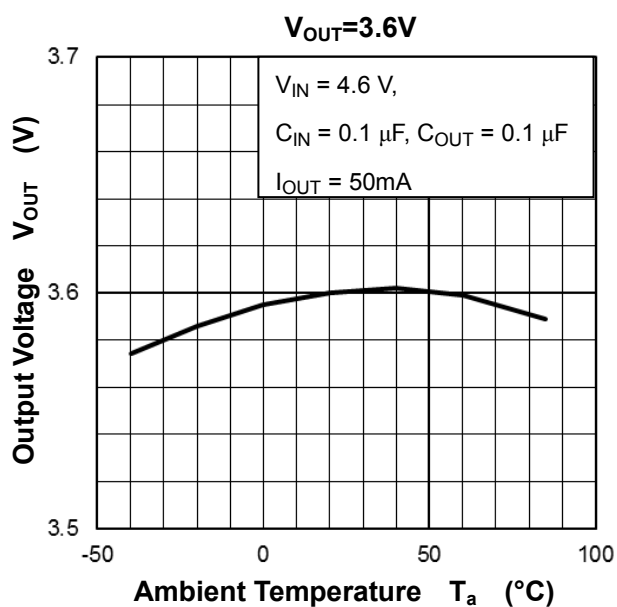
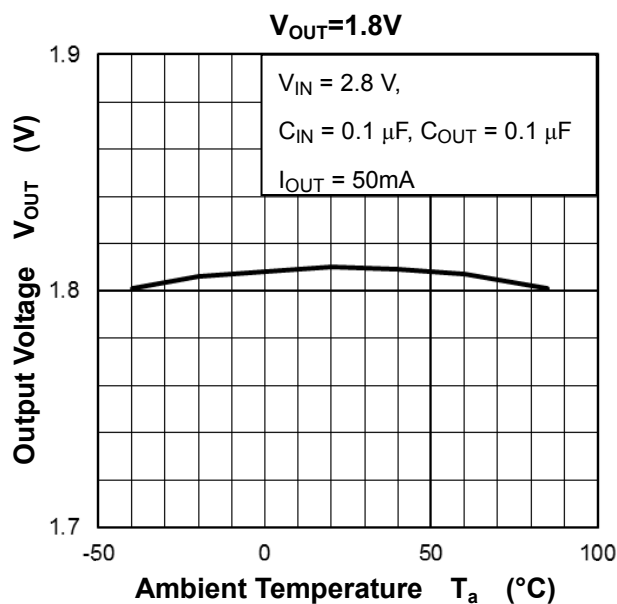
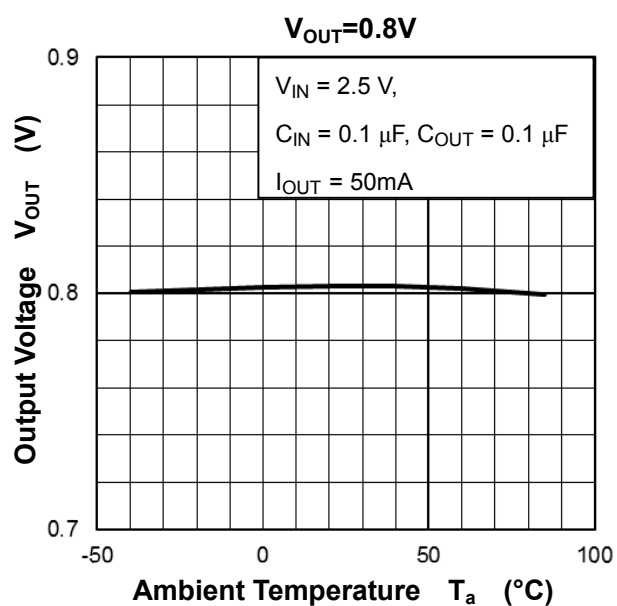


3) Output Voltage vs. Output Current

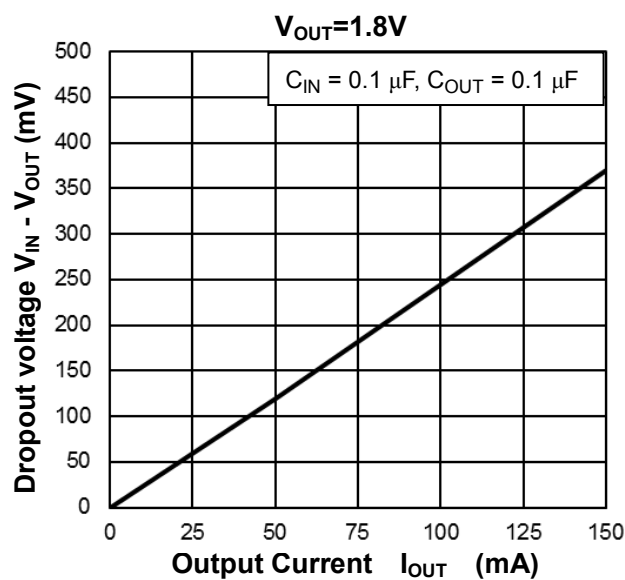
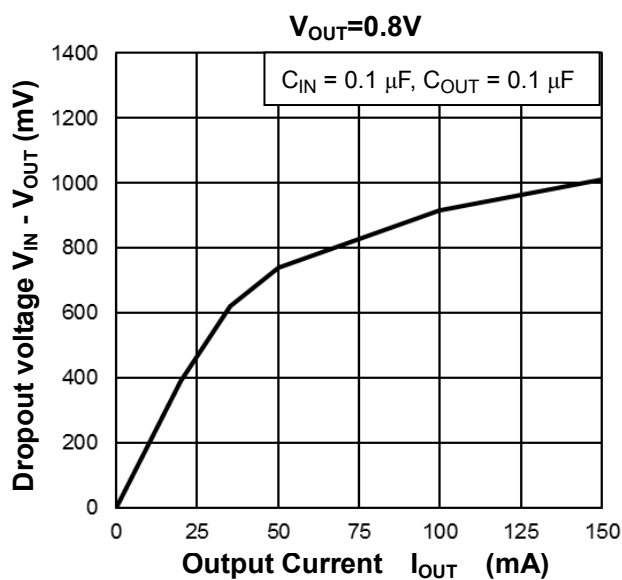


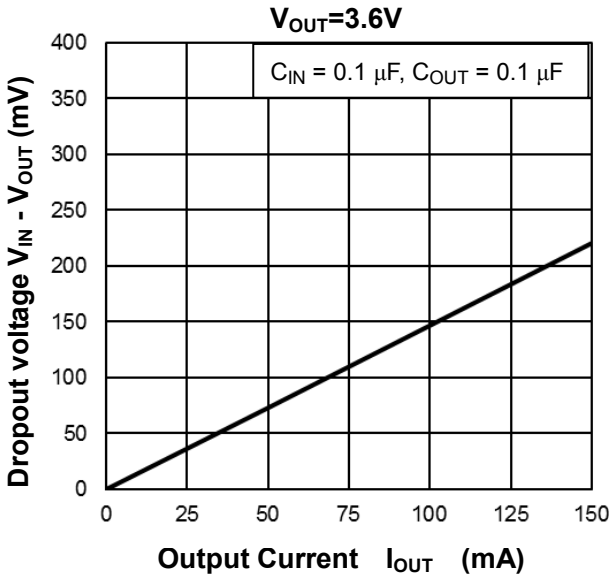


## 4) Output Voltage vs. Ambient Temperature

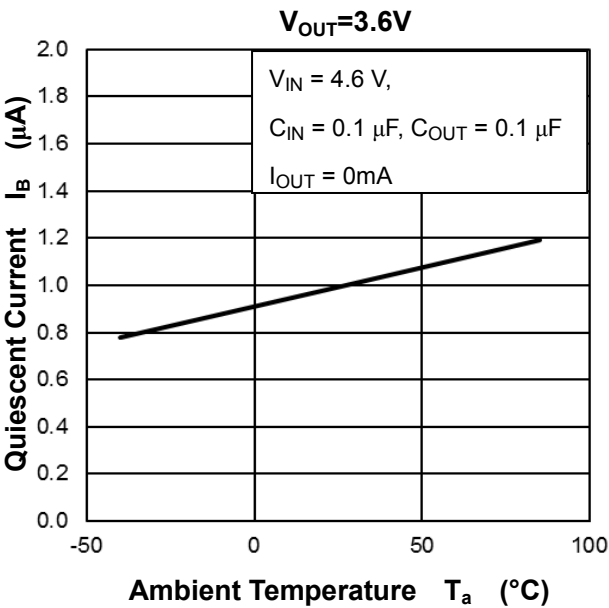
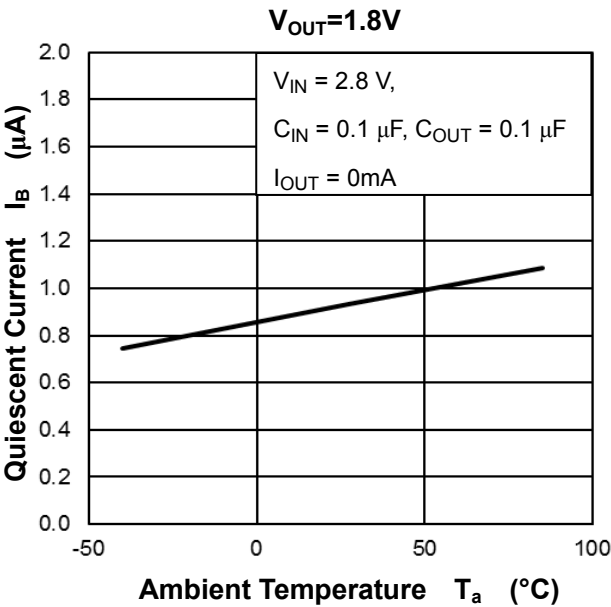
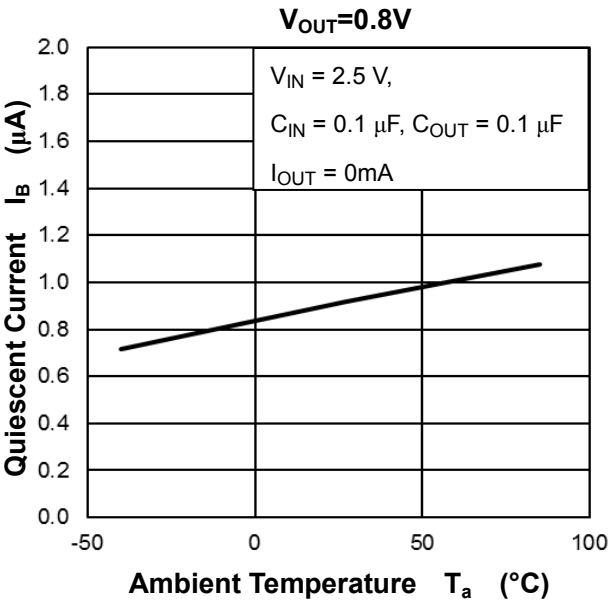


## 5) Dropout Voltage vs. Output Current

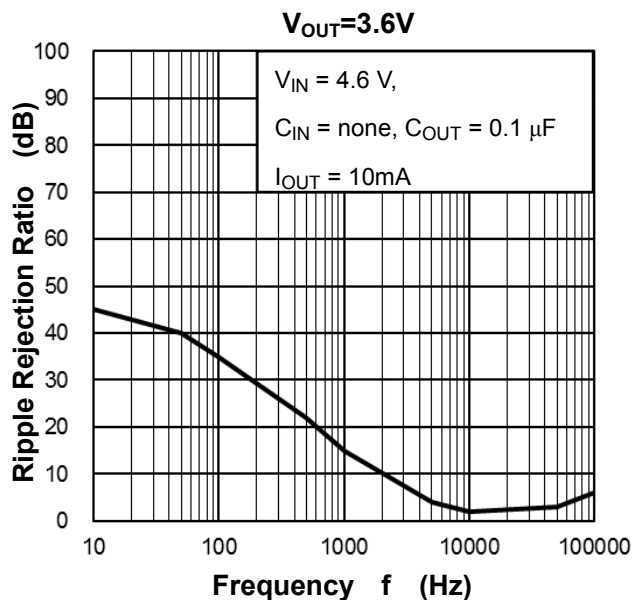
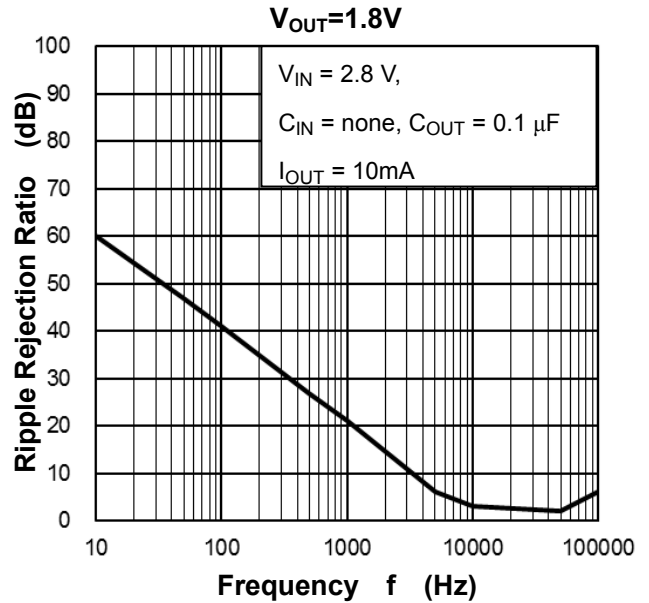
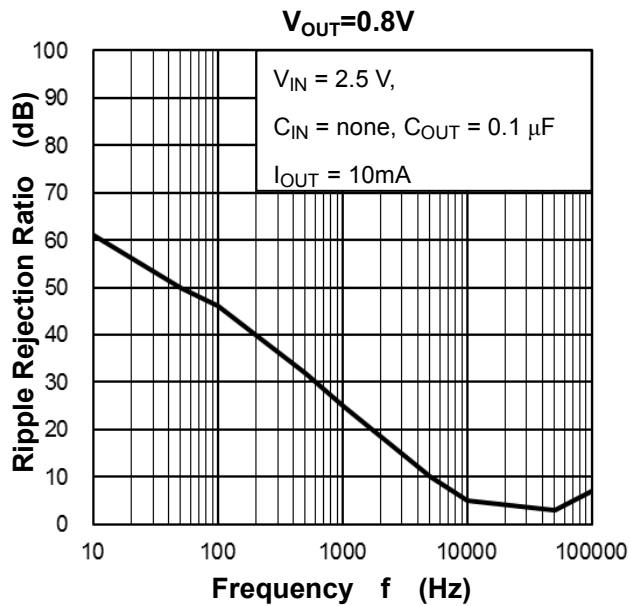




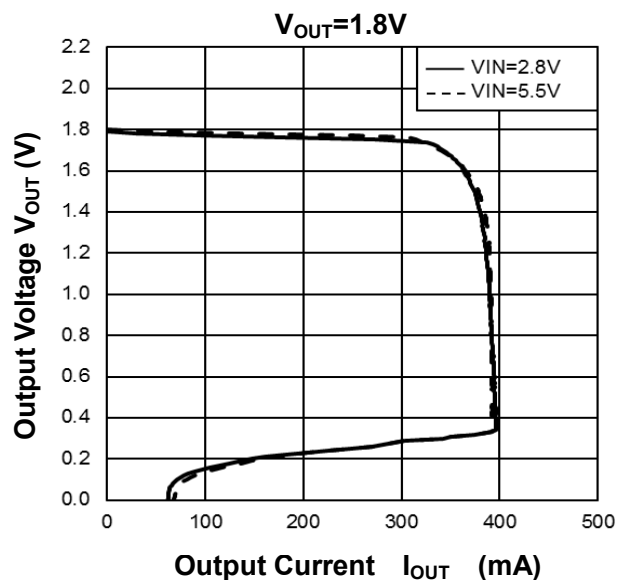
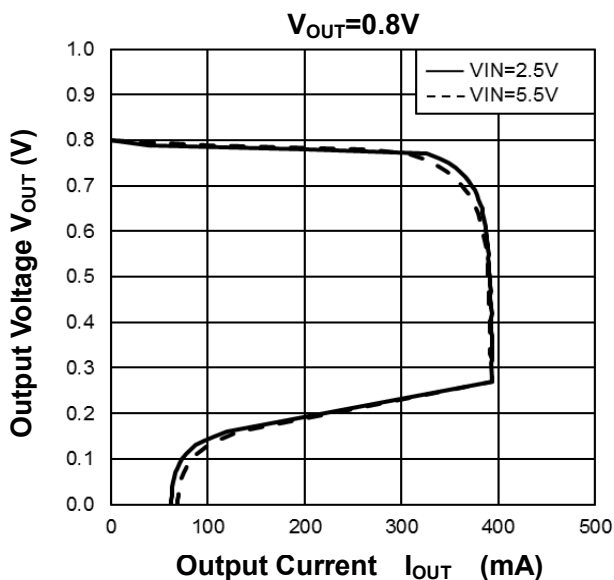
6) Quiescent Current vs. Ambient Temperature

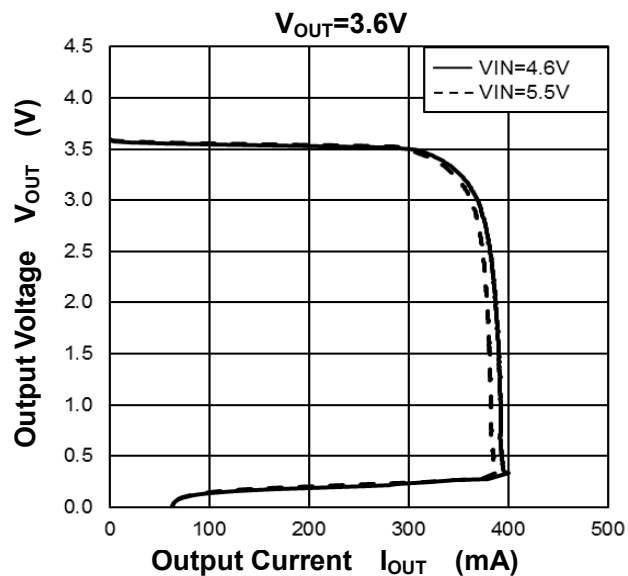


## 7) Ripple Rejection Ratio vs. Frequency

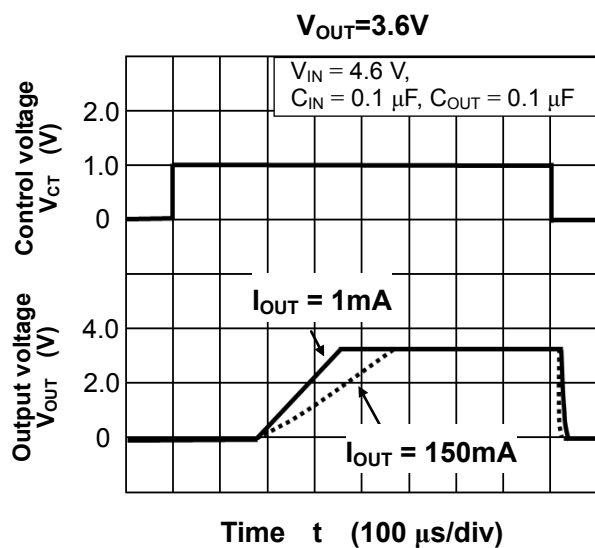
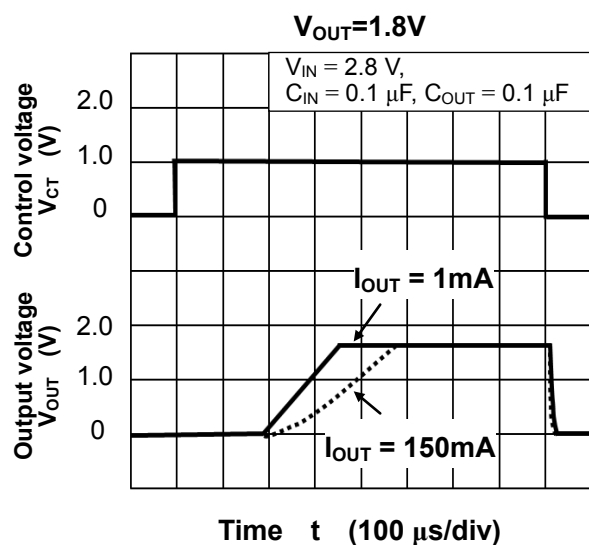
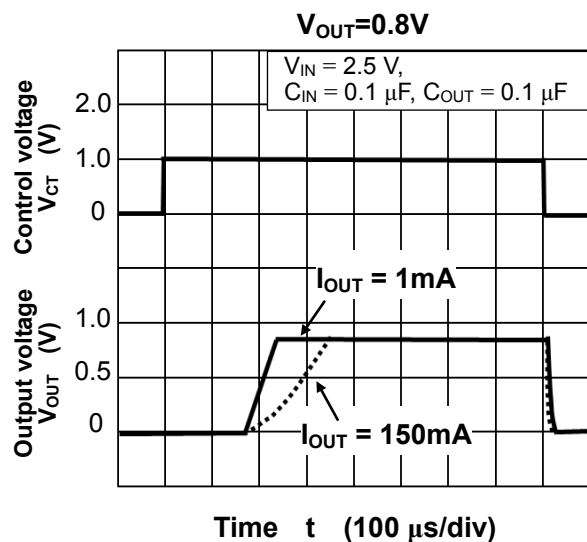


## 8) Output Voltage vs. Output Current

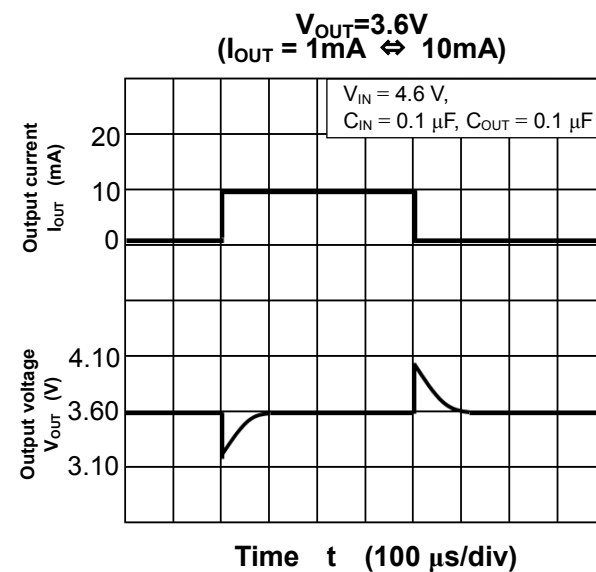
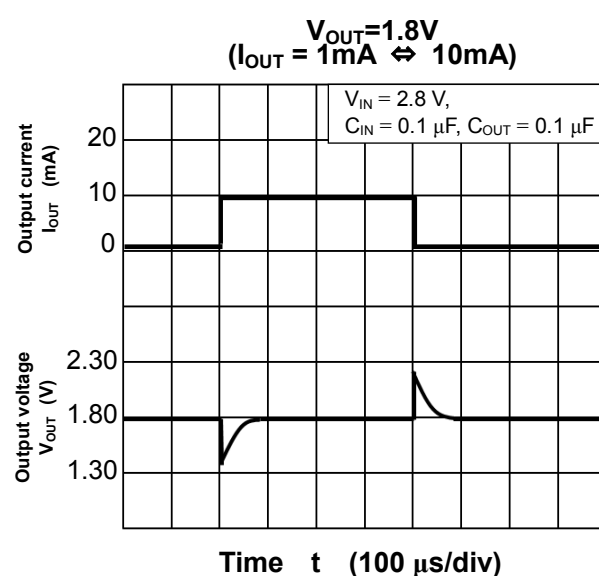
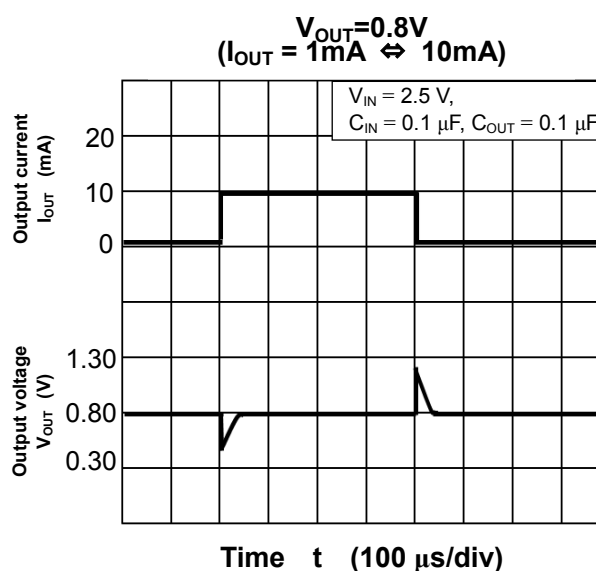
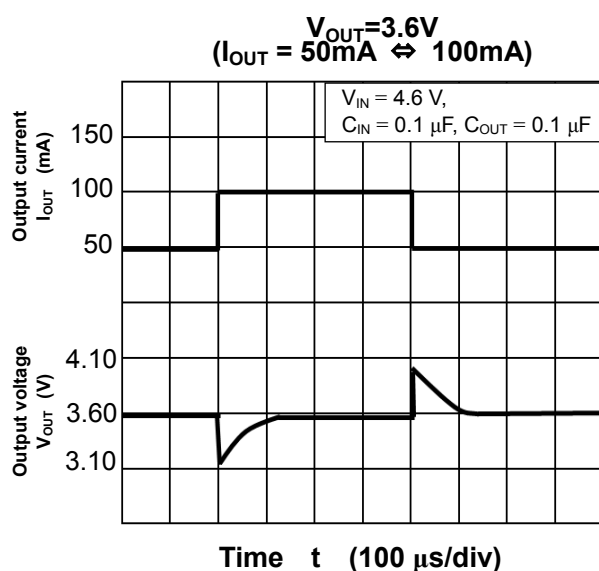
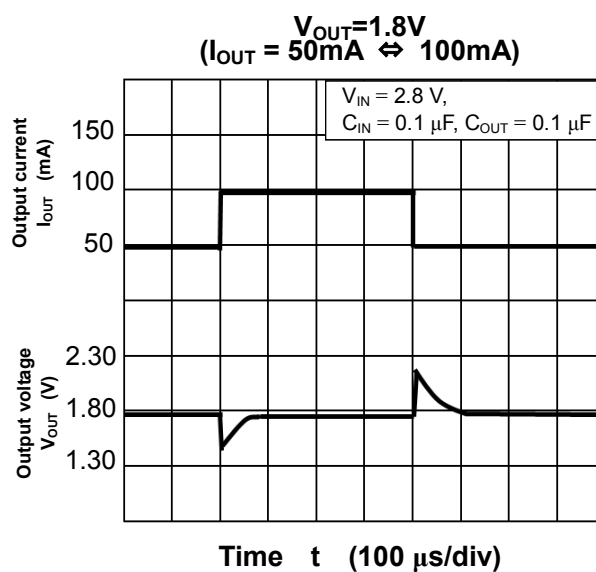
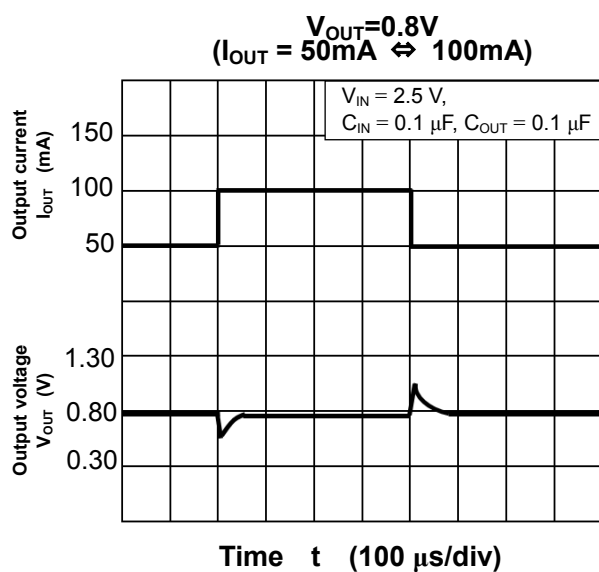


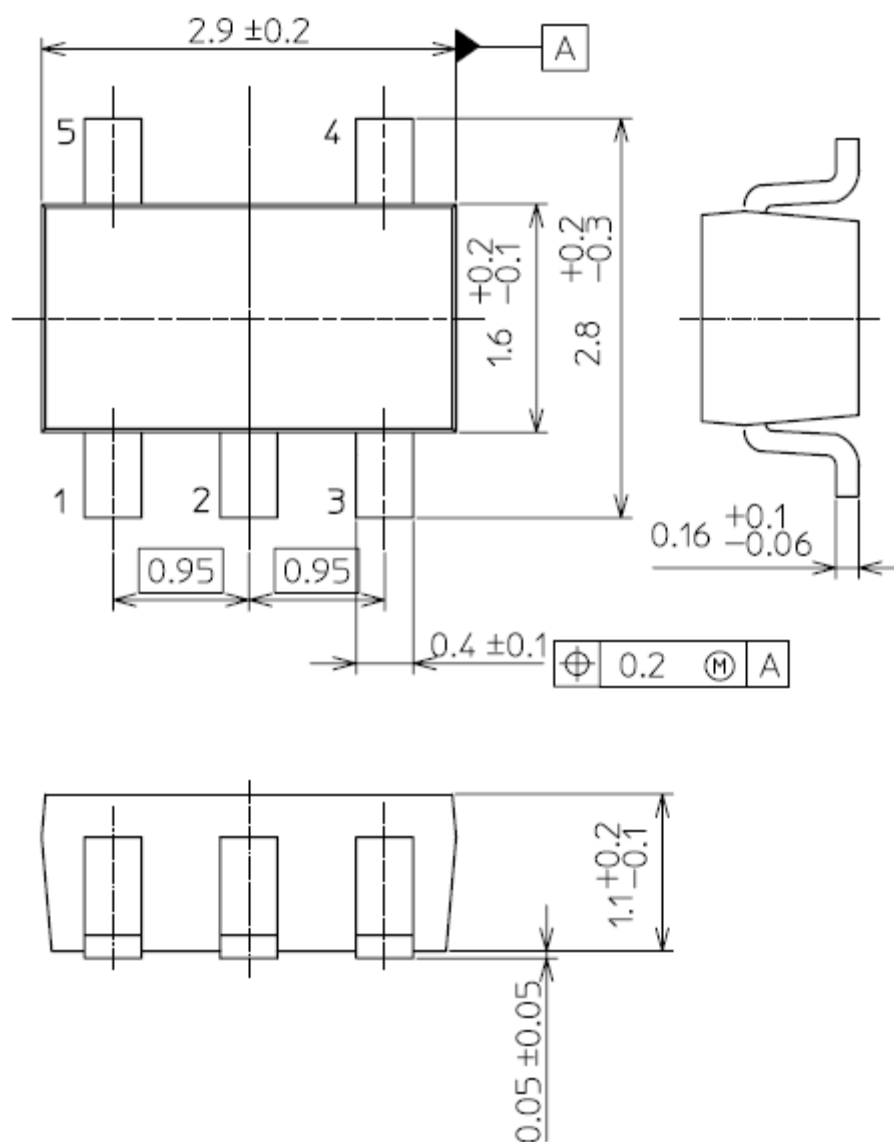


9) Control Transient vs. Response



## 10) Load Transient Response



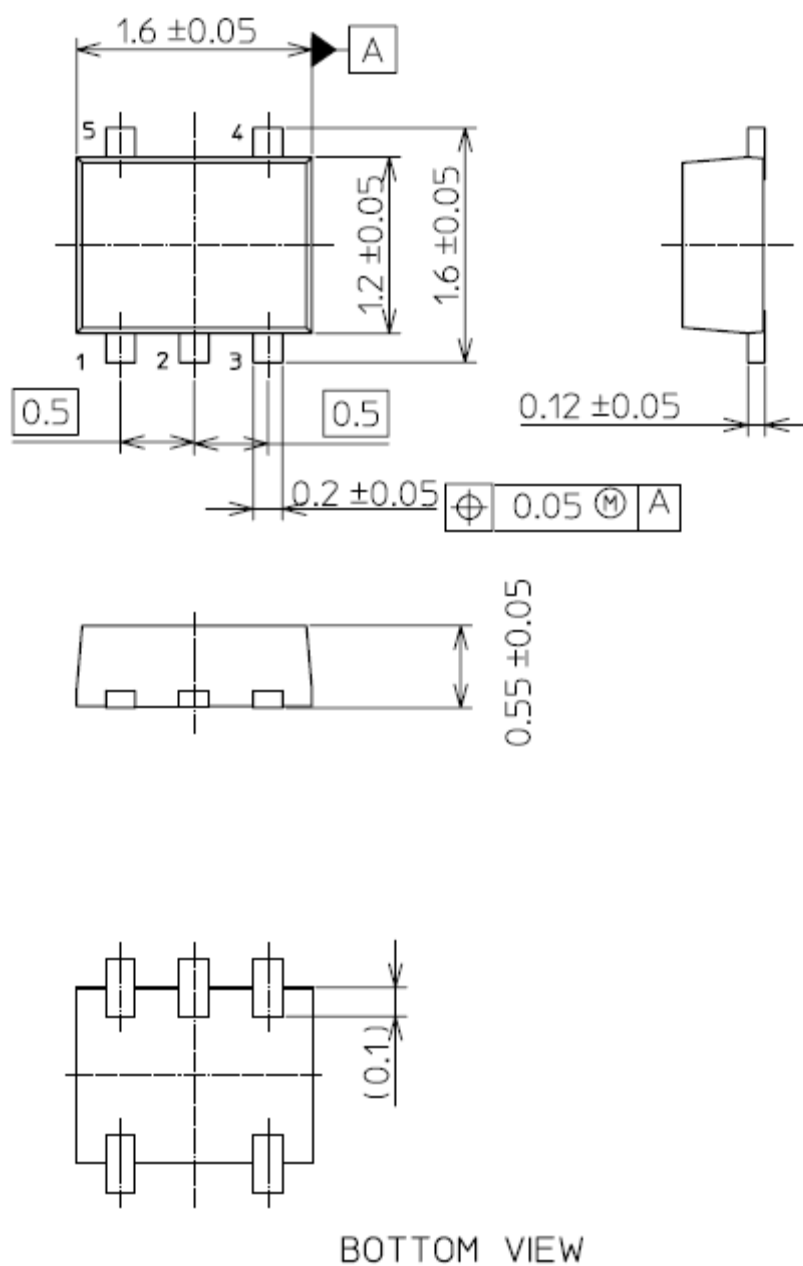
**Package Dimensions**
**SMV (SOT-25)(SC-74A)**
**Unit: mm**


Weight : 16.0 mg (typ.)

## Package Dimensions

## ESV (SOT-553)

Unit: mm



Weight: 3.0 mg (typ.)

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