

TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TCR3UF series

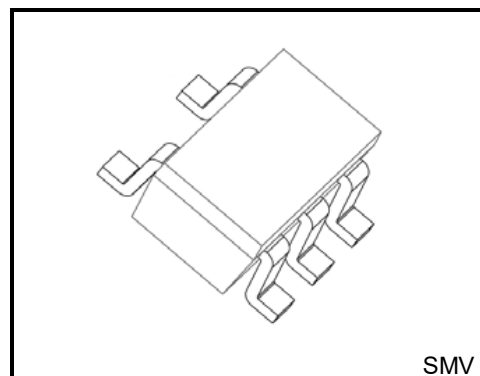
Ultra low quiescent current, Fast Load Transient 300 mA CMOS Low Dropout Regulator

## 1. Description

The TCR3UF series are CMOS process 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 5.0 V and capable of driving up to 300 mA. They feature Overcurrent protection, thermal shutdown function and auto-discharge option.

The TCR3UF series is offered in general purpose package SMV (2.9 mm x 2.8 mm; t 1.1 mm (typ.)) and has a low dropout voltage of 206 mV (3.3 V output,  $I_{OUT} = 300$  mA). As small ceramic input and output capacitors 1  $\mu$ F can be used with the TCR3UF series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones, IoT equipment and wearable devices.



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

## 2. Applications

Power IC developed for portable applications, IoT equipment and wearable devices

## 3. Features

- Low quiescent bias current (  $I_B = 0.34 \mu\text{A}$  (typ.) at  $I_{OUT} = 0$  mA, output voltage up to 1.5 V)
- High Ripple rejection ratio 70 dB at 0.8 V output
- Fast Load transient response -51/+36 mV at 0.8 V output,  $I_{OUT} = 1$  mA  $\Leftrightarrow$  50 mA
- Low dropout voltage  
VDO = 206 mV (typ.) at 3.3 V output,  $I_{OUT} = 300$  mA
- Wide range output voltage line up (  $V_{OUT} = 0.8$  to 5.0 V )
- High  $V_{OUT}$  accuracy  $\pm 1.0\%$  (  $1.8 \text{ V} \leq V_{OUT}$  )
- Auto-discharge (TCR3UFxxA series)/ Non-discharge (TCR3UFxxB series) line up
- Overcurrent protection
- Thermal shutdown
- Inrush current reduction
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used ( $C_{IN} = 1 \mu\text{F}$ ,  $C_{OUT} = 1 \mu\text{F}$ )
- General purpose package SMV(SOT-25) (SC-74A)

Start of commercial production  
2019-09

### 4. Absolute Maximum Ratings (Ta = 25°C)

| Characteristics           | Symbol           | Rating                              | Unit |
|---------------------------|------------------|-------------------------------------|------|
| Input voltage             | V <sub>IN</sub>  | -0.3 to 6.0                         | V    |
| Control voltage           | V <sub>CT</sub>  | -0.3 to V <sub>IN</sub> + 0.3 ≤ 6.0 | V    |
| Output voltage            | V <sub>OUT</sub> | -0.3 to V <sub>IN</sub> + 0.3 ≤ 6.0 | V    |
| Power dissipation         | P <sub>D</sub>   | 200 (Note1)                         | mW   |
|                           |                  | 580 (Note2)                         |      |
| Junction temperature      | T <sub>j</sub>   | 150                                 | °C   |
| Storage temperature range | T <sub>stg</sub> | -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)

### 5. Operating Ranges

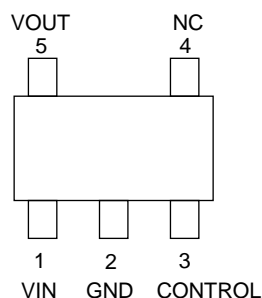
| Characteristics       | Symbol           | Rating               | Unit |
|-----------------------|------------------|----------------------|------|
| Input voltage         | V <sub>IN</sub>  | 1.5 to 5.5 (Note 3)  | V    |
| Control voltage       | V <sub>CT</sub>  | 0 to V <sub>IN</sub> | V    |
| Output voltage        | V <sub>OUT</sub> | 0.8 to 5.0           | V    |
| Output current        | I <sub>OUT</sub> | DC 0 to 300 (Note 4) | mA   |
| Operating Temperature | T <sub>opr</sub> | -40 to 85            | °C   |
| Output Capacitance    | C <sub>OUT</sub> | ≥ 1.0 μF             | —    |
| Input Capacitance     | C <sub>IN</sub>  | ≥ 1.0 μF             | —    |

Note 3: Please refer to Dropout voltage (Page 6) and use it within Absolute Maximum Ratings Junction temperature and Operating Temperature Ranges.

Note 4: Do not operate at or near the maximum ratings of operating ranges for extended periods of time. Exposure to such conditions may adversely impact product reliability and results in failures not covered by warranty.

### 6. Pin Assignment (top view)

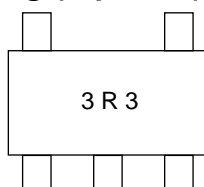
SMV(SOT-25)(SC-74A)



### 7. List of Products Number, Output voltage and Marking

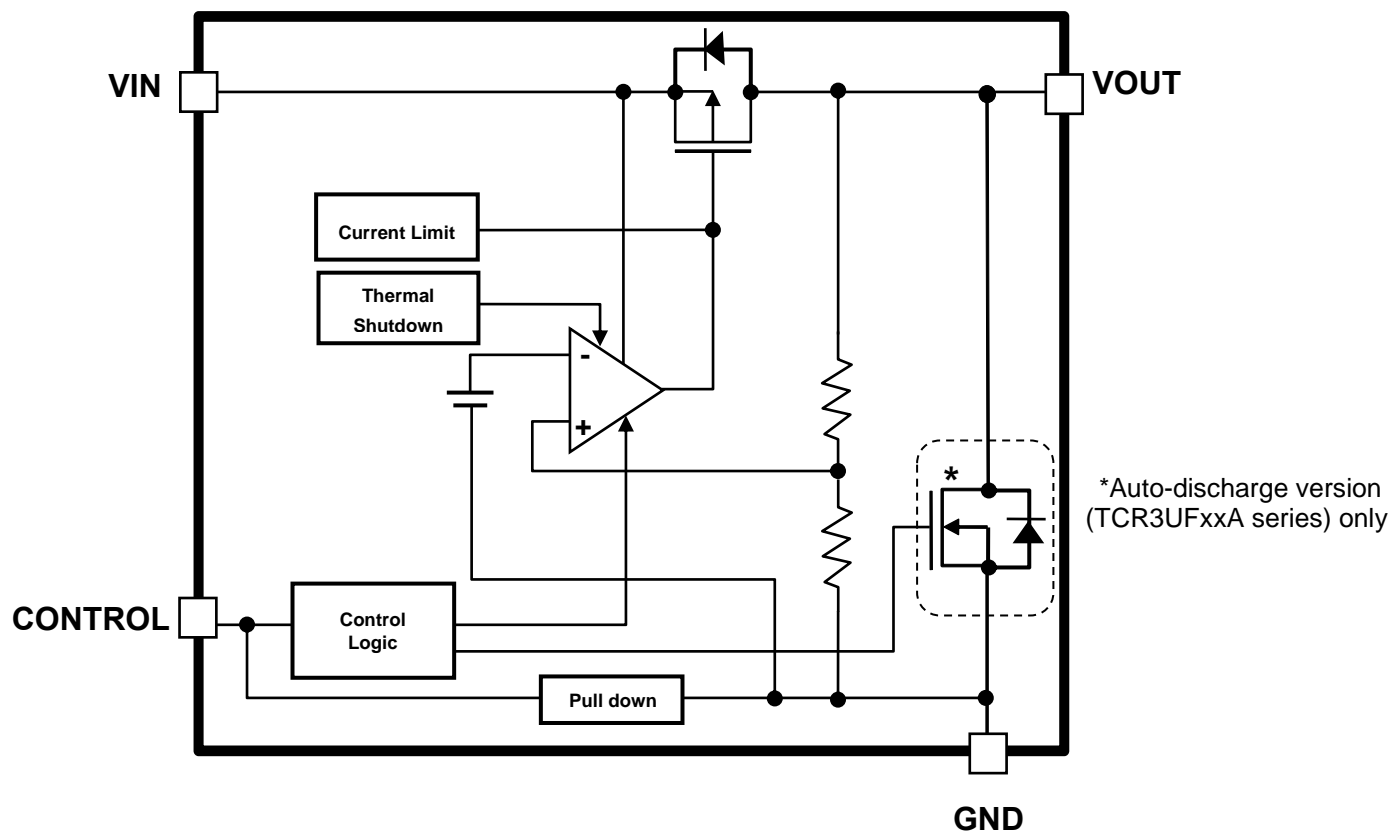
| Product No. | Output voltage(V) | Auto-discharge | Marking | Product No. | Output voltage(V) | Auto-discharge | Marking |
|-------------|-------------------|----------------|---------|-------------|-------------------|----------------|---------|
| TCR3UF08A   | 0.8               | Yes            | 0R8     | TCR3UF08B   | 0.8               | No             | 0T8     |
| TCR3UF085A  | 0.85              |                | 0RA     | TCR3UF085B  | 0.85              |                | 0TA     |
| TCR3UF09A   | 0.9               |                | 0R9     | TCR3UF09B   | 0.9               |                | 0T9     |
| TCR3UF095A  | 0.95              |                | 0RB     | TCR3UF095B  | 0.95              |                | 0TB     |
| TCR3UF10A   | 1.0               |                | 1R0     | TCR3UF10B   | 1.0               |                | 1T0     |
| TCR3UF105A  | 1.05              |                | 1RC     | TCR3UF105B  | 1.05              |                | 1TC     |
| TCR3UF11A   | 1.1               |                | 1R1     | TCR3UF11B   | 1.1               |                | 1T1     |
| TCR3UF115A  | 1.15              |                | 1RE     | TCR3UF115B  | 1.15              |                | 1TE     |
| TCR3UF12A   | 1.2               |                | 1R2     | TCR3UF12B   | 1.2               |                | 1T2     |
| TCR3UF13A   | 1.3               |                | 1R3     | TCR3UF13B   | 1.3               |                | 1T3     |
| TCR3UF135A  | 1.35              |                | 1RF     | TCR3UF135B  | 1.35              |                | 1TF     |
| TCR3UF14A   | 1.4               |                | 1R4     | TCR3UF14B   | 1.4               |                | 1T4     |
| TCR3UF15A   | 1.5               |                | 1R5     | TCR3UF15B   | 1.5               |                | 1T5     |
| TCR3UF16A   | 1.6               |                | 1R6     | TCR3UF16B   | 1.6               |                | 1T6     |
| TCR3UF175A  | 1.75              |                | 1RG     | TCR3UF175B  | 1.75              |                | 1TG     |
| TCR3UF18A   | 1.8               |                | 1R8     | TCR3UF18B   | 1.8               |                | 1T8     |
| TCR3UF1825A | 1.825             |                | 1RH     | TCR3UF1825B | 1.825             |                | 1TH     |
| TCR3UF185A  | 1.85              |                | 1RJ     | TCR3UF185B  | 1.85              |                | 1TJ     |
| TCR3UF19A   | 1.9               |                | 1R9     | TCR3UF19B   | 1.9               |                | 1T9     |
| TCR3UF20A   | 2.0               |                | 2R0     | TCR3UF20B   | 2.0               |                | 2T0     |
| TCR3UF25A   | 2.5               |                | 2R5     | TCR3UF25B   | 2.5               |                | 2T5     |
| TCR3UF26A   | 2.6               |                | 2R6     | TCR3UF26B   | 2.6               |                | 2T6     |
| TCR3UF27A   | 2.7               |                | 2R7     | TCR3UF27B   | 2.7               |                | 2T7     |
| TCR3UF28A   | 2.8               |                | 2R8     | TCR3UF28B   | 2.8               |                | 2T8     |
| TCR3UF285A  | 2.85              |                | 2RK     | TCR3UF285B  | 2.85              |                | 2TK     |
| TCR3UF29A   | 2.9               |                | 2R9     | TCR3UF29B   | 2.9               |                | 2T9     |
| TCR3UF2925A | 2.925             |                | 2RL     | TCR3UF2925B | 2.925             |                | 2TL     |
| TCR3UF30A   | 3.0               |                | 3R0     | TCR3UF30B   | 3.0               |                | 3T0     |
| TCR3UF31A   | 3.1               |                | 3R1     | TCR3UF31B   | 3.1               |                | 3T1     |
| TCR3UF32A   | 3.2               |                | 3R2     | TCR3UF32B   | 3.2               |                | 3T2     |
| TCR3UF33A   | 3.3               |                | 3R3     | TCR3UF33B   | 3.3               |                | 3T3     |
| TCR3UF35A   | 3.5               |                | 3R5     | TCR3UF35B   | 3.5               |                | 3T5     |
| TCR3UF36A   | 3.6               |                | 3R6     | TCR3UF36B   | 3.6               |                | 3T6     |
| TCR3UF41A   | 4.1               |                | 4R1     | TCR3UF41B   | 4.1               |                | 4T1     |
| TCR3UF42A   | 4.2               |                | 4R2     | TCR3UF42B   | 4.2               |                | 4T2     |
| TCR3UF45A   | 4.5               |                | 4R5     | TCR3UF45B   | 4.5               |                | 4T5     |
| TCR3UF50A   | 5.0               |                | 5R0     | TCR3UF50B   | 5.0               |                | 5T0     |

#### Top Marking (top view)



Example: TCR3UF33A (3.3 V output)

### 8. Block Diagram



### 9. Electrical Characteristics

(Unless otherwise specified,

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

| Characteristics              | Symbol                | Test Condition  |                          | T <sub>j</sub> = 25°C |      |      | T <sub>j</sub> = -40 to 85°C<br>(Note 10) |      | Unit              |
|------------------------------|-----------------------|---|--------------------------|-----------------------|------|------|---|------|-------------------|
|                              |                       |   |                          | Min                   | Typ. | Max  | Min                                       | Max  |                   |
| Output voltage accuracy      | V <sub>OUT</sub>      | I <sub>OUT</sub> = 50 mA<br>(Note 5)  | V <sub>OUT</sub> < 1.8 V | -18                   | —    | +18  | —   | —    | mV                |
|                              |                       |   | 1.8 V ≤ 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              | I <sub>OUT</sub> = 1 mA (Note 6)  |                          | —                     | 1    | 15   | —   | —    | mV                |
| Load regulation              | Reg·load              | 1 mA ≤ I <sub>OUT</sub> ≤ 300 mA (Note 7)   |                          | —                     | 21   | 30   | —   | —    | mV                |
| Quiescent current            | I <sub>B(ON1)</sub>   | I <sub>OUT</sub> = 0 mA, V <sub>OUT</sub> ≤ 1.5 V (Note 8)  |                          | —                     | 0.34 | —    | —   | 0.58 | μA                |
|                              | I <sub>B(ON2)</sub>   | I <sub>OUT</sub> = 0 mA,<br>1.75 V ≤ V <sub>OUT</sub> ≤ 5 V (Note 8)  |                          | —                     | 0.38 | —    | —   | 0.68 | μA                |
| Stand-by current             | I <sub>B (OFF1)</sub> | V <sub>CT</sub> = 0 V, V <sub>IN</sub> = 2.5 V  |                          | —                     | 0.03 | —    | —   | 0.16 | μA                |
|                              | I <sub>B (OFF2)</sub> | V <sub>CT</sub> = 0 V, V <sub>IN</sub> = 5.5 V  |                          | —                     | 0.03 | —    | —   | 0.20 | μA                |
| Control pull down current    | I <sub>CT</sub>       | —   |                          | —                     | 0.1  | —    | —   | —    | μA                |
| Dropout voltage              | V <sub>DO</sub>       | I <sub>OUT</sub> = 300 mA   | V <sub>OUT</sub> = 1.8 V | —                     | 341  | —    | —   | 464  | mV                |
|                              |                       |   | V <sub>OUT</sub> = 3.3 V | —                     | 206  | —    | —   | 287  | mV                |
| Output current limit         | I <sub>CL</sub>       | V <sub>OUT</sub> = V <sub>OUT(NOM)</sub> × 90%<br>(Note 10)   |                          | —                     | 545  | —    | 400                                       | —    | mA                |
| Output noise voltage         | V <sub>NO</sub>       | I <sub>OUT</sub> = 10 mA,<br>10 Hz ≤ f ≤ 100 kHz, T <sub>a</sub> = 25°C<br>(Note 7)                                     |                          | —                     | 41   | —    | —   | —    | μV <sub>rms</sub> |
| Ripple rejection ratio       | R.R.                  | I <sub>OUT</sub> = 10 mA,<br>f = 1 kHz, V <sub>Ripple</sub> = 200 mV <sub>p-p</sub> ,<br>T <sub>a</sub> = 25°C (Note 7) |                          | —                     | 70   | —    | —   | —    | dB                |
| Load transient response      | ΔV <sub>OUT</sub>     | I <sub>OUT</sub> = 1 mA → 50 mA (Note 9)  |                          | —                     | -51  | —    | —   | —    | mV                |
|                              |                       | I <sub>OUT</sub> = 50 mA → 1 mA (Note 9)  |                          | —                     | +36  | —    | —   | —    | mV                |
| Temperature coefficient      | T <sub>CVO</sub>      | -40°C ≤ T <sub>opr</sub> ≤ 85°C   |                          | —                     | 75   | —    | —   | —    | ppm/°C            |
| Control voltage (ON)         | V <sub>CT (ON)</sub>  | —   |                          | 1.0                   | —    | 5.5  | 1.0                                       | 5.5  | V                 |
| Control voltage (OFF)        | V <sub>CT (OFF)</sub> | —   |                          | 0                     | —    | 0.4  | 0   | 0.4  | V                 |
| Discharge on resistance      | R <sub>SD</sub>       | V <sub>CT</sub> = 0 V, V <sub>IN</sub> = 5.5 V  |                          | —                     | 7    | —    | 5   | 20   | Ω                 |
| Thermal shutdown temperature | T <sub>SD</sub>       | (Note 10) (Note 11)   |                          | —                     | 158  | —    | —   | —    | °C                |
| Thermal shutdown hysteresis  | T <sub>SDH</sub>      | (Note 10) (Note 11)   |                          | —                     | 28   | —    | —   | —    | °C                |

Note 5: stable state with fixed  $I_{OUT}$  condition

Note 6:  $V_{OUT} \leq 1.5\text{ V}$ ,  $2.5\text{ V} \leq V_{IN} \leq 5.5\text{ V}$   
 $1.75\text{ V} \leq V_{OUT} \leq 4.2\text{ V}$ ,  $V_{OUT} + 1\text{ V} \leq V_{IN} \leq 5.5\text{ V}$   
 $V_{OUT} = 4.5\text{ V}$ ,  $V_{OUT} = 5.0\text{ V}$ , not applicable

Note 7:  $V_{OUT} = 0.8\text{ V}$

Note 8: except Control pull down current ( $I_{CT}$ )

Note 9:  $V_{OUT} = 0.8\text{ V}$ ,  $V_{IN} = 3.3\text{ V}$

Note 10: This parameter is warranted by design

Note 11:  $V_{OUT} = 0.8\text{ V}$ ,  $V_{IN} = 2.5\text{ V}$

### 10. Dropout voltage

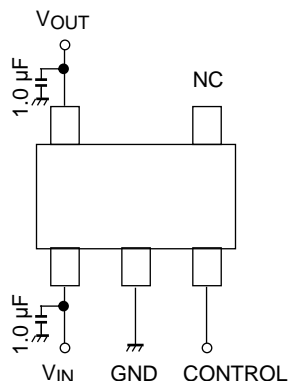
( $I_{OUT} = 300 \text{ mA}$ ,  $C_{IN} = C_{OUT} = 1 \text{ } \mu\text{F}$ )

| Output voltages                                 | Symbol          | Min | Typ.<br>$T_j = 25^\circ\text{C}$ | Max<br>(Note 12) | Unit |
|---|-----------------|-----|----------------------------------|------------------|------|
| $0.8 \text{ V} \leq V_{OUT} < 0.9 \text{ V}$    | V <sub>DO</sub> | —   | 1020                             | 1257             | mV   |
| $0.9 \text{ V} \leq V_{OUT} < 1.0 \text{ V}$    |                 | —   | 933                              | 1157             |      |
| $1.0 \text{ V} \leq V_{OUT} < 1.1 \text{ V}$    |                 | —   | 848                              | 1057             |      |
| $1.1 \text{ V} \leq V_{OUT} < 1.2 \text{ V}$    |                 | —   | 760                              | 957              |      |
| $1.2 \text{ V} \leq V_{OUT} < 1.3 \text{ V}$    |                 | —   | 667                              | 857              |      |
| $1.3 \text{ V} \leq V_{OUT} < 1.5 \text{ V}$    |                 | —   | 580                              | 757              |      |
| $1.5 \text{ V} \leq V_{OUT} < 1.6 \text{ V}$    |                 | —   | 462                              | 617              |      |
| $1.6 \text{ V} \leq V_{OUT} < 1.8 \text{ V}$    |                 | —   | 420                              | 537              |      |
| $1.8 \text{ V} \leq V_{OUT} < 2.0 \text{ V}$    |                 | —   | 341                              | 464              |      |
| $2.0 \text{ V} \leq V_{OUT} < 2.5 \text{ V}$    |                 | —   | 297                              | 412              |      |
| $2.5 \text{ V} \leq V_{OUT} < 3.0 \text{ V}$    |                 | —   | 226                              | 342              |      |
| $3.0 \text{ V} \leq V_{OUT} < 3.6 \text{ V}$    |                 | —   | 206                              | 287              |      |
| $3.6 \text{ V} \leq V_{OUT} < 4.5 \text{ V}$    |                 | —   | 184                              | 245              |      |
| $4.5 \text{ V} \leq V_{OUT} \leq 5.0 \text{ V}$ |                 | —   | 159                              | 224              |      |

Note 12:  $T_j = -40$  to  $85^\circ\text{C}$ . This parameter is warranted by design

## 11. Application Note

### 11.1. Example of Application Circuit



| CONTROL voltage | VOUT voltage |
|-----------------|--------------|
| HIGH            | ON           |
| LOW             | OFF          |
| OPEN            | OFF          |

The figure above shows the Example of configuration for using a Low dropout regulator. Insert a capacitor at VOUT and VIN pins for stable input/output operation. (Ceramic capacitors can be used.)

### 11.2. Power Dissipation

Both unit and board-mounted power dissipation ratings for TCR3UF series are available in the Absolute Maximum Ratings table.

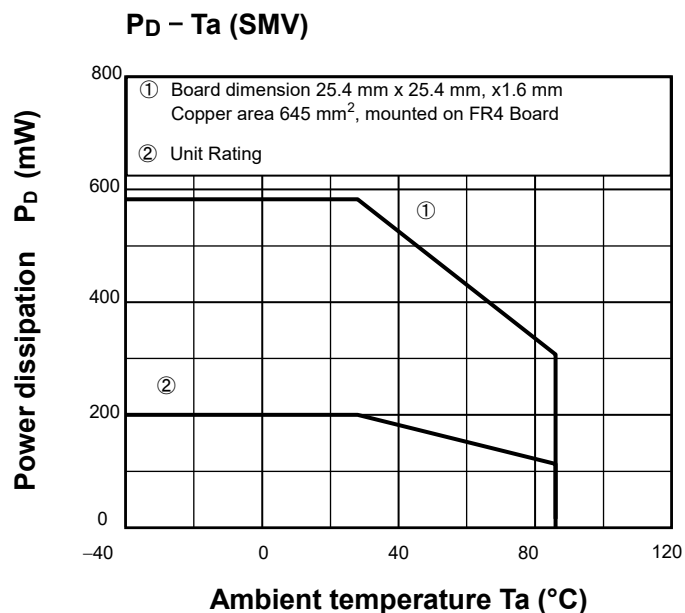
Power dissipation is measured on the board shown below.

#### [The Board Condition]

Board material: FR4 board

Board dimension: 25.4 mm × 25.4 mm × 1.6 mm

Copper area: 645 mm<sup>2</sup>



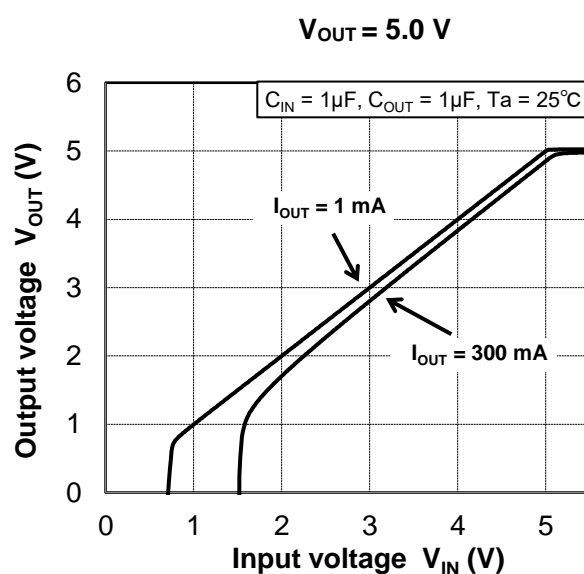
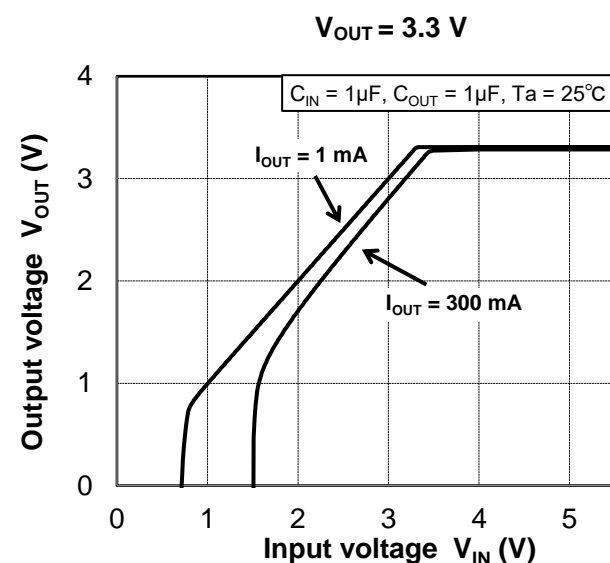
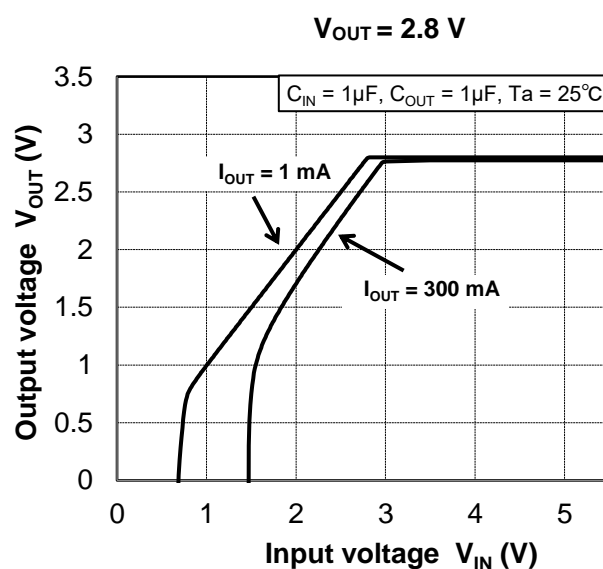
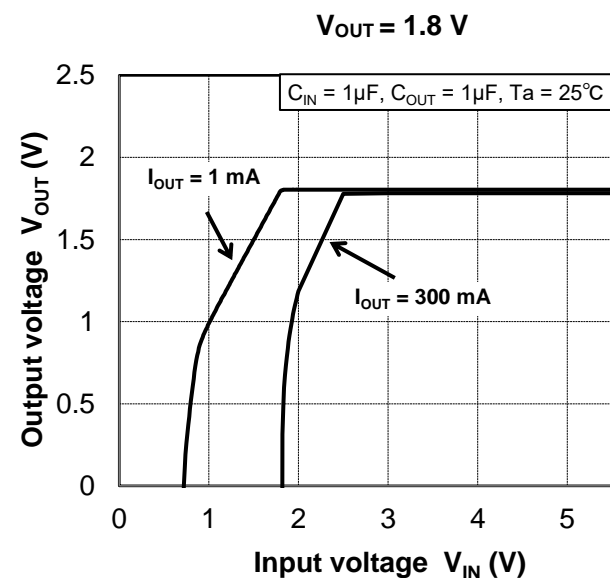
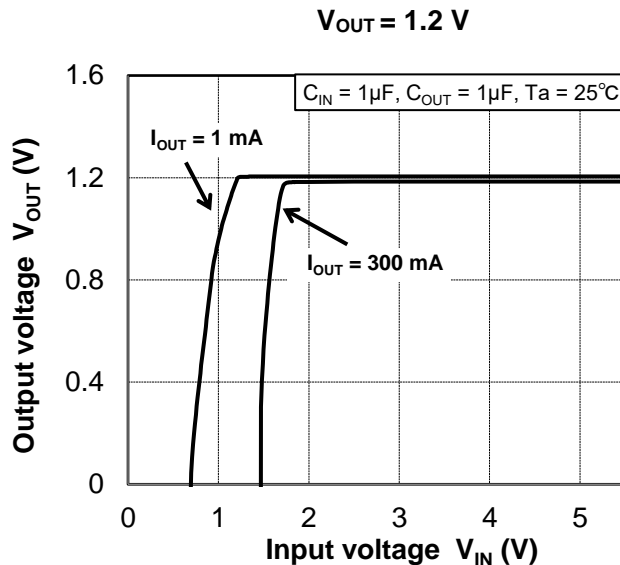
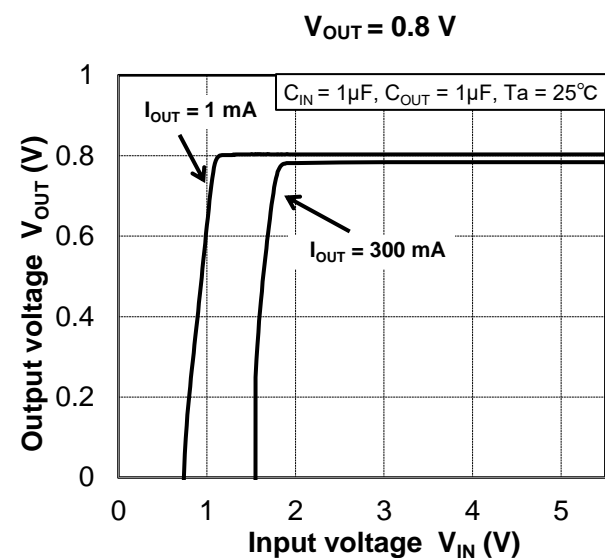
## Attention in Use

- **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 recommends the ESR of ceramic capacitor is under 10  $\Omega$ . For stable operation, we recommend over 1  $\mu\text{F}$ .
- **Mounting**  
The long distance between IC and input output capacitor might affect phase compensation by impedance in wire and inductor. For stable power supply, input output capacitor need to mount near IC as much as possible. Also  $V_{\text{IN}}$  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 ambient 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 %.
- **Over current Protection and Thermal shutdown function**  
Over current protection and Thermal shutdown function are designed in these products, but these are not designed to constantly ensure the suppression of the device within operation limits. Depending on the condition during actual usage, it could affect the electrical characteristic specification and reliability. Also note that if output pins and GND pins are not completely shorted out, these products might break down.  
When using these products, please read through and understand the concept of dissipation 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 recommends inserting failsafe system into the design.



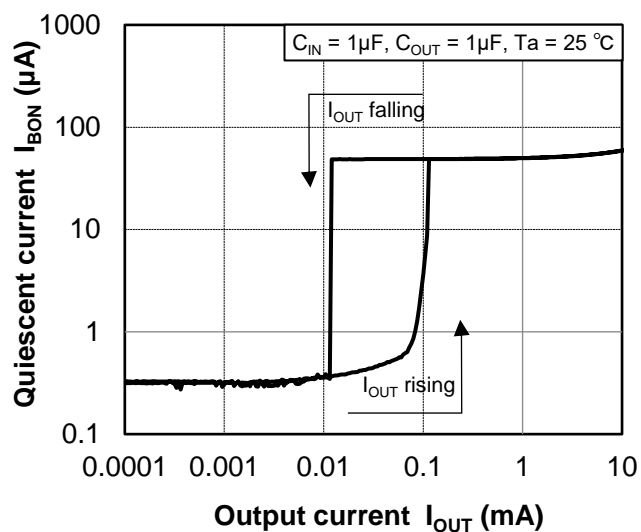
### 12. Representative Typical Characteristics

#### 12.1. Output Voltage vs. Input Voltage

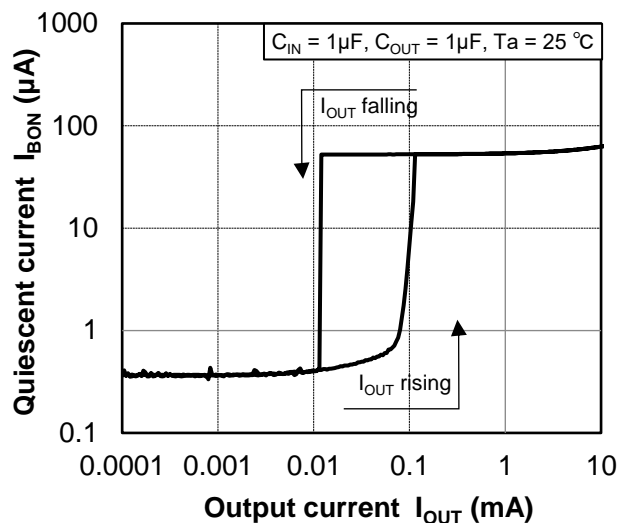


### 12.2. Quiescent Current vs. Output Current

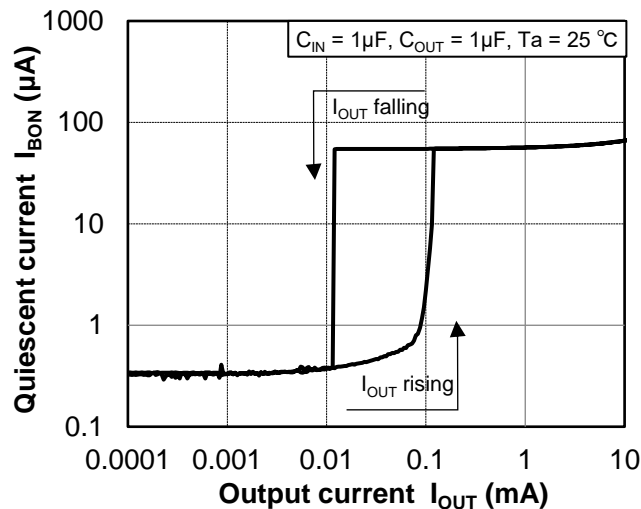
$V_{OUT} = 0.8\text{ V}$



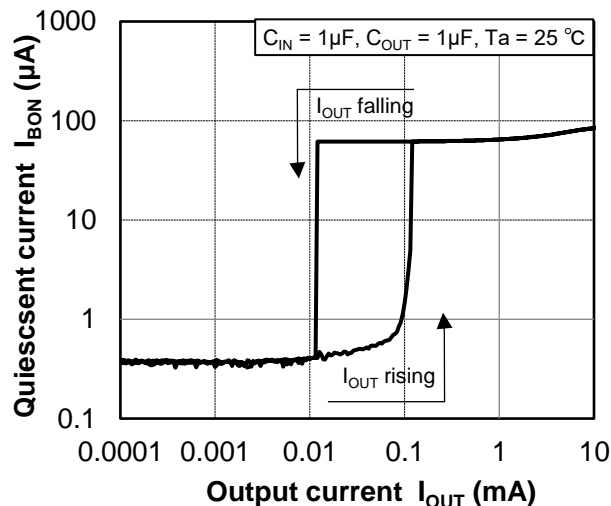
$V_{OUT} = 1.2\text{ V}$



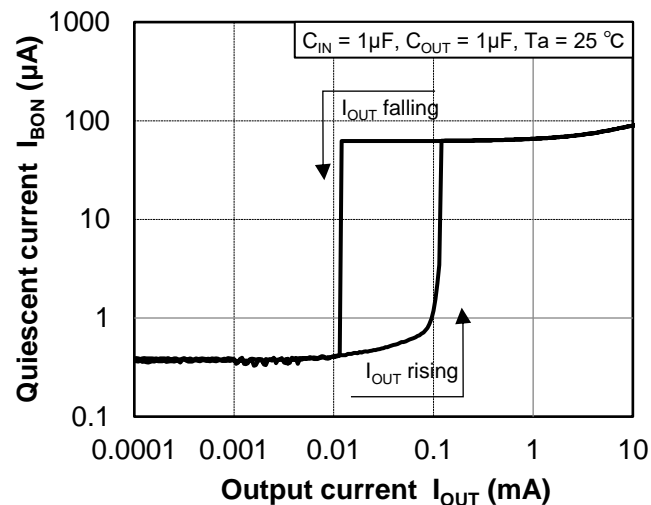
$V_{OUT} = 1.8\text{ V}$



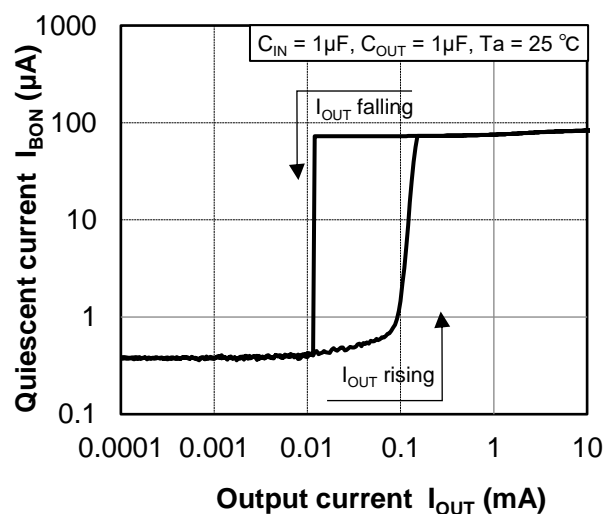
$V_{OUT} = 2.8\text{ V}$



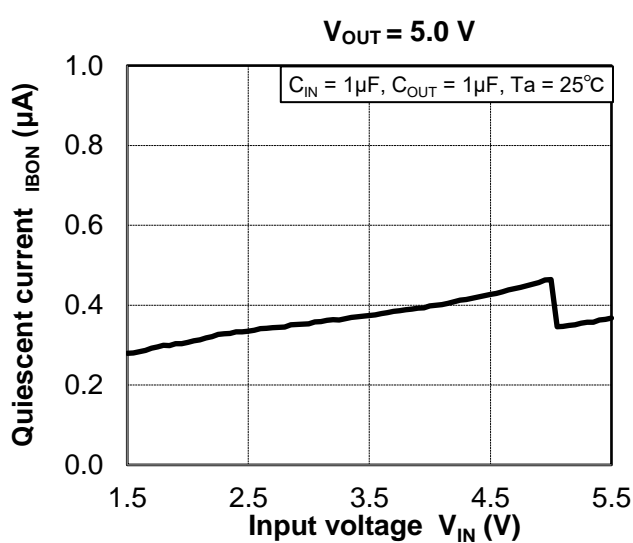
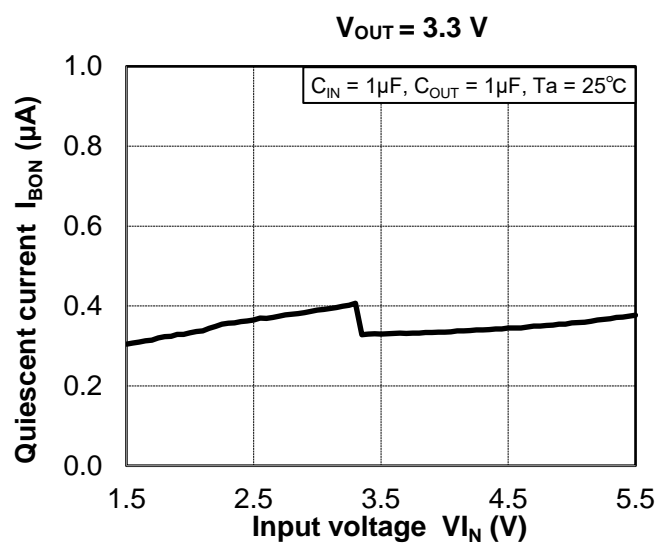
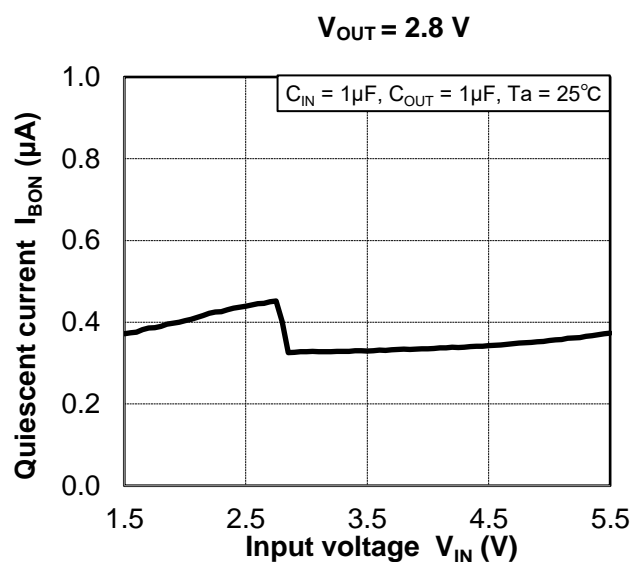
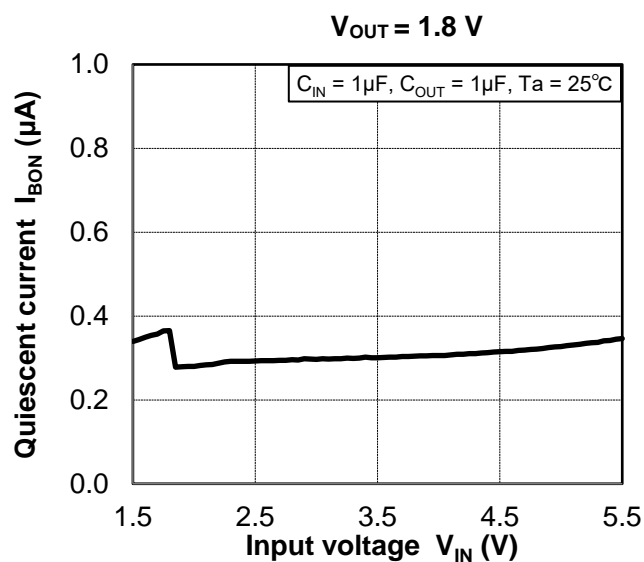
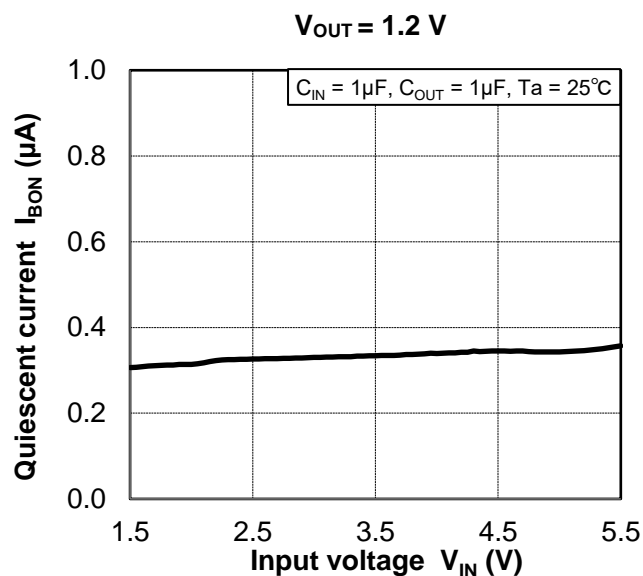
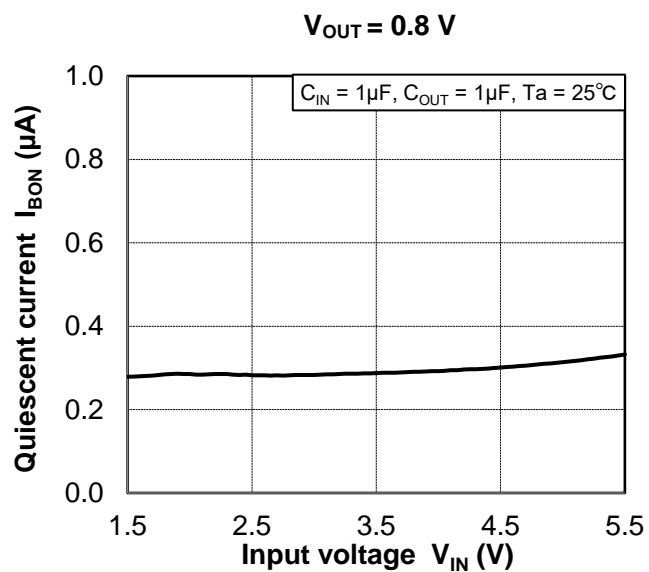
$V_{OUT} = 3.3\text{ V}$



$V_{OUT} = 5.0\text{ V}$

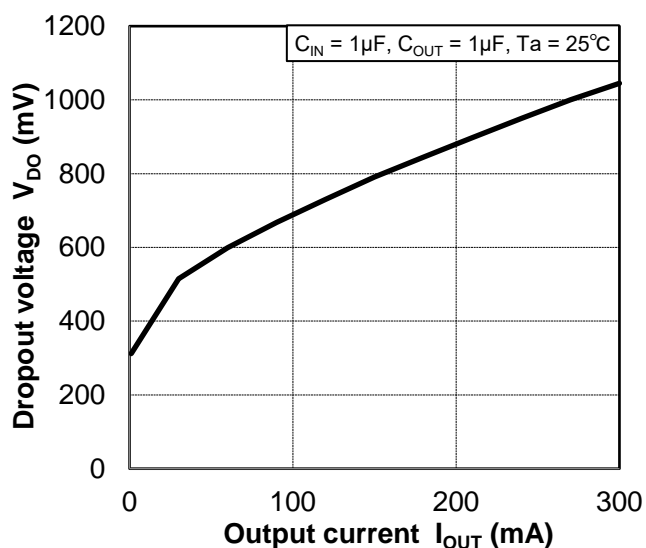


### 12.3. Quiescent Current vs. Input Voltage

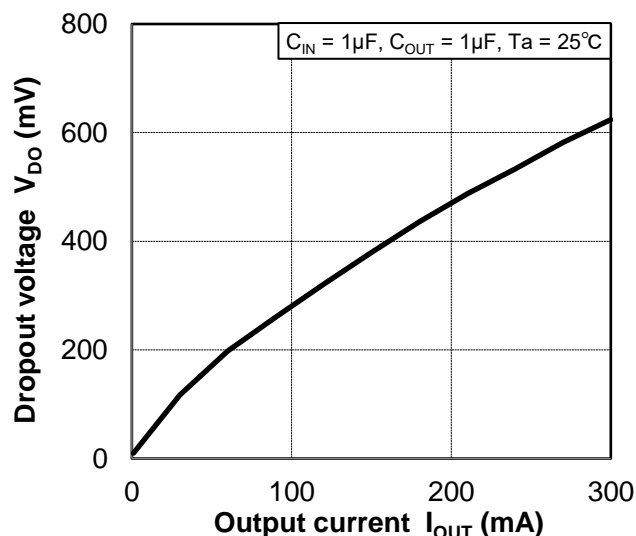


### 12.4. Dropout Voltage vs. Output Current

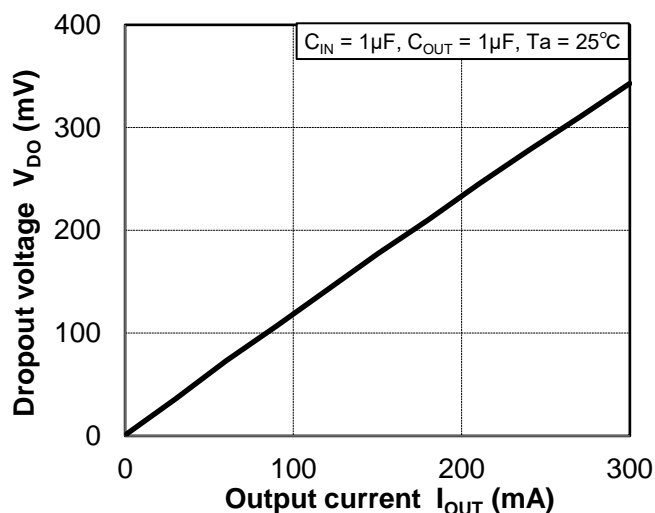
$V_{OUT} = 0.8 \text{ V}$



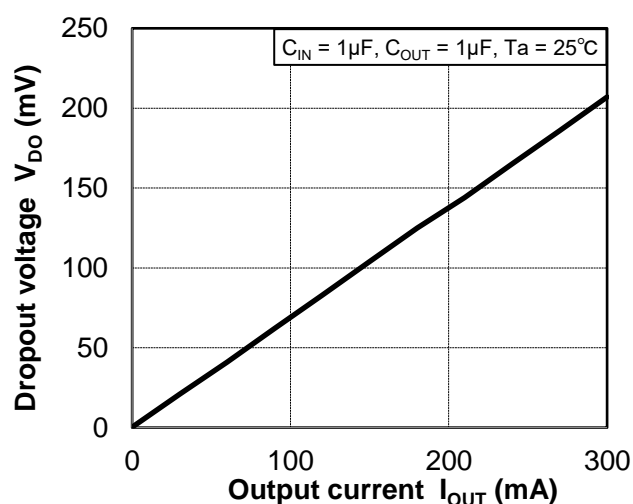
$V_{OUT} = 1.2 \text{ V}$



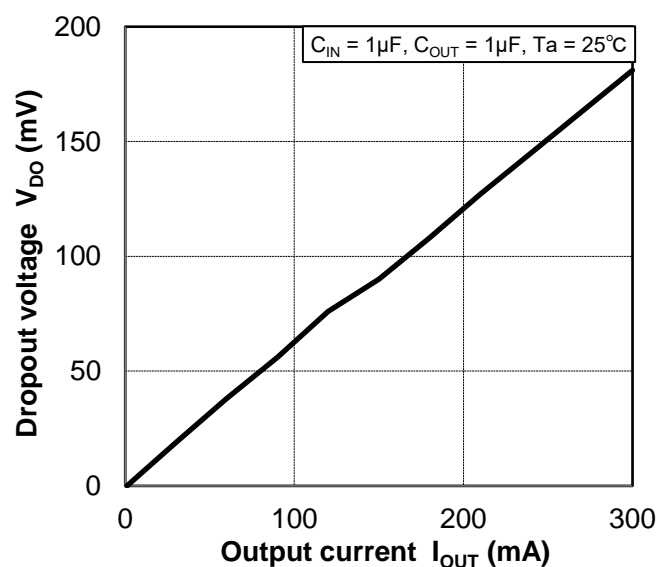
$V_{OUT} = 1.8 \text{ V}$



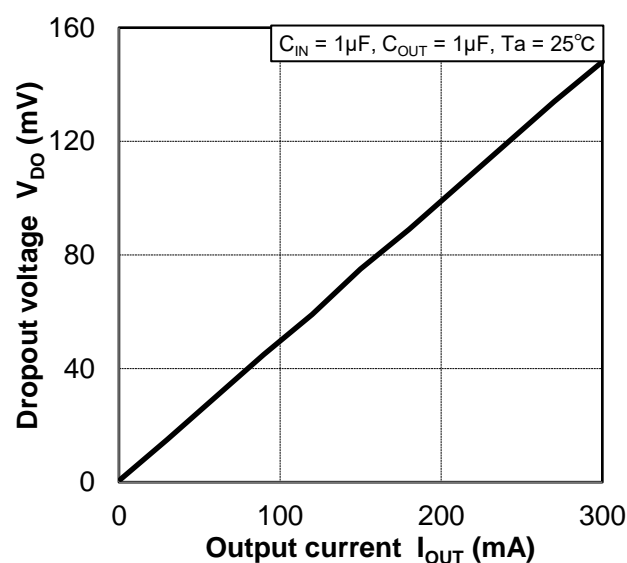
$V_{OUT} = 2.8 \text{ V}$



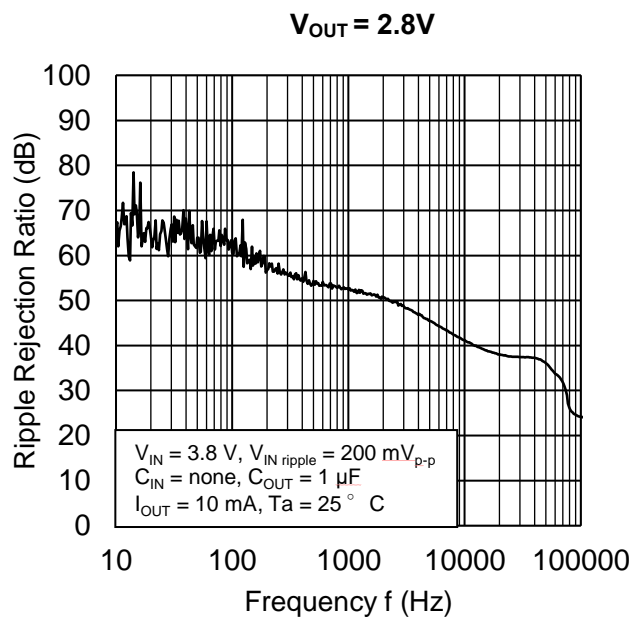
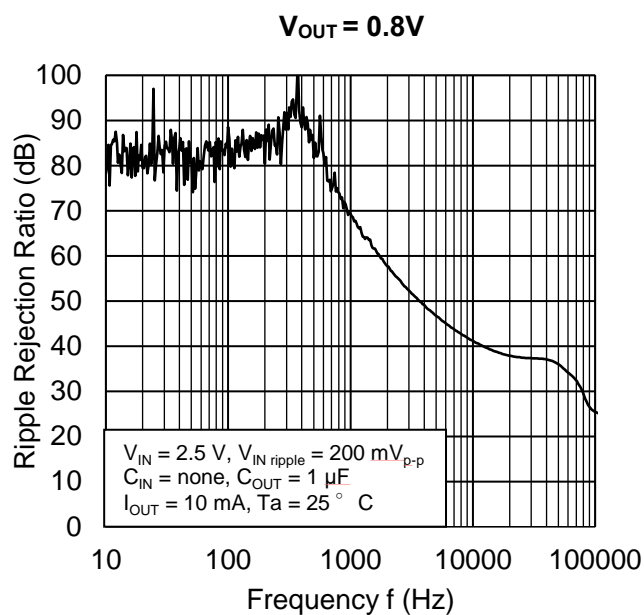
$V_{OUT} = 3.3 \text{ V}$



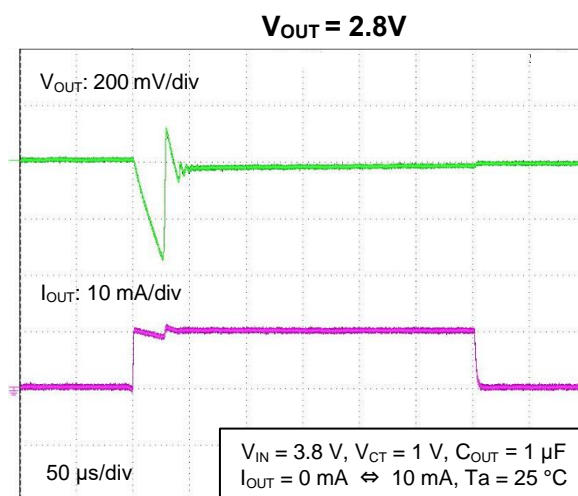
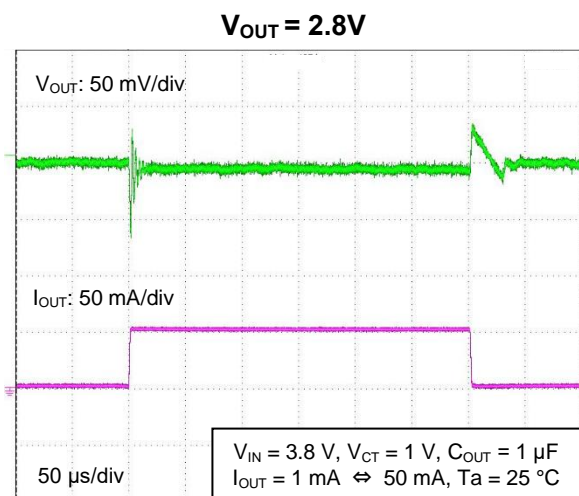
$V_{OUT} = 5.0 \text{ V}$



### 12.5. Ripple Rejection Ratio vs. Frequency

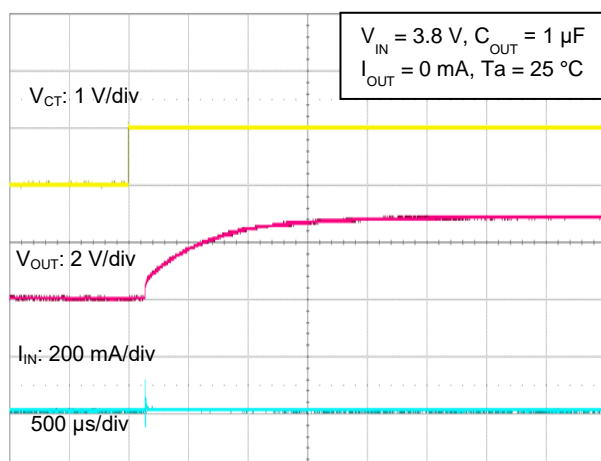


### 12.6. Load Transient Response

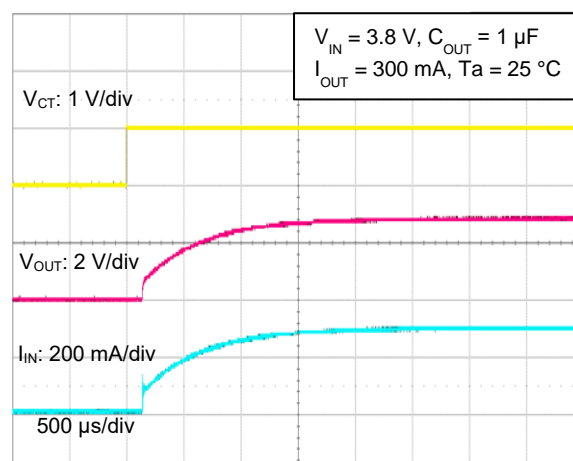


### 12.7. $t_{ON}$ Response

$V_{OUT} = 2.8V$

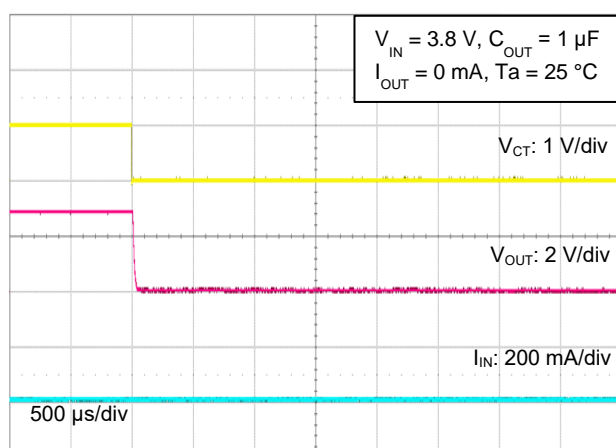


$V_{OUT} = 2.8V$

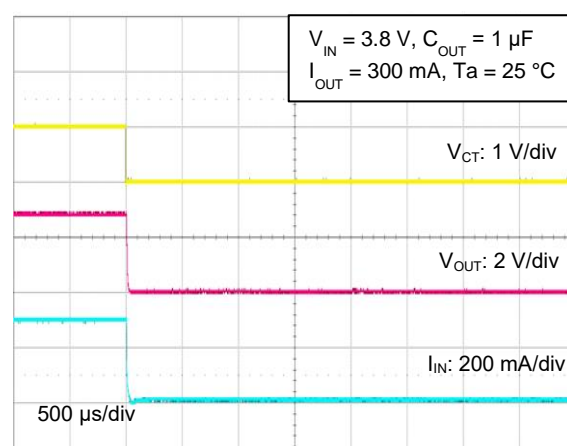


### 12.8. $t_{OFF}$ Response (Auto-discharge)

$V_{OUT} = 2.8V$



$V_{OUT} = 2.8V$

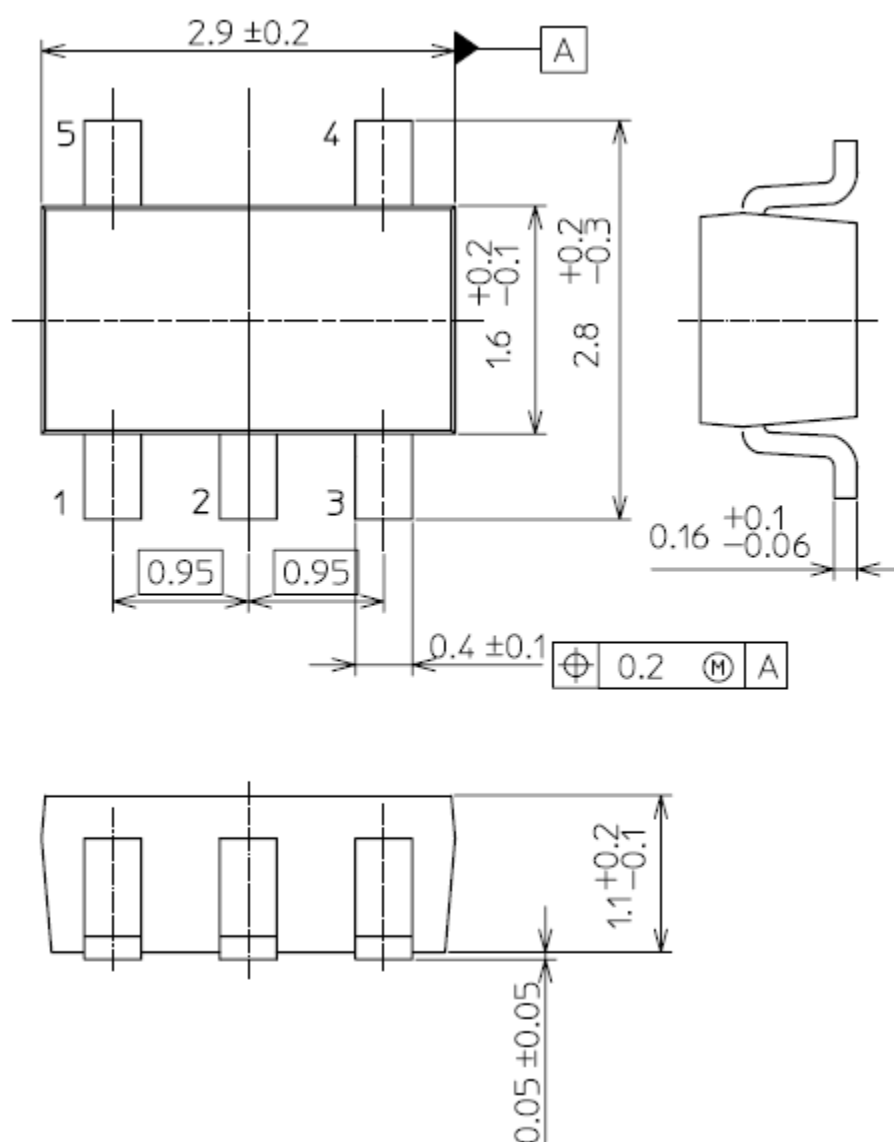


Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

## 13. Package Information

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

Unit: mm



Weight: 16 mg (typ.)

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