

TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

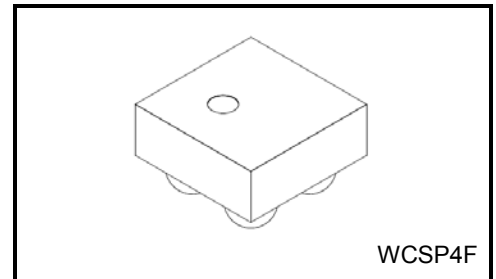
# TCR3UG series

Ultra low quiescent current, Fast Load Transient 300 mA CMOS Low Drop-Out Regulator in ultra small package

The TCR3UG 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 5.0 V and capable of driving up to 300 mA. They feature Over-current protection, Thermal Shutdown function and Auto-discharge option.

The TCR3UG series is offered in the ultra small plastic mold package WCSP4F (0.645 mm x 0.645 mm; t 0.33 mm (max)) and has a low dropout voltage of 155 mV (3.3 V output,  $I_{OUT} = 300$  mA). As small ceramic input and output capacitors 1  $\mu$ F can be used with the TCR3UG series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones, IoT equipment and wearable devices.



Weight: 0.26 mg (typ.)

## Applications

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

## Features

- Ultra small package WCSP4F (0.645 mm x 0.645 mm; t 0.33 mm (max)).
- 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  $\pm 60$  mV at 0.8 V-output,  $I_{OUT} = 1$  mA  $\leftrightarrow$  50 mA
- Low dropout voltage  
 $V_{DO} = V_{IN} - V_{OUT} = 155$  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 (TCR3UGxxA series)/ Non-discharge (TCR3UGxxB series) line up
- Overcurrent protection
- Thermal shutdown function
- Inrush current protection circuit
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used ( $C_{IN} = 1 \mu\text{F}$ ,  $C_{OUT} = 1 \mu\text{F}$ )

Start of commercial production  
2017-10

### 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>   | 800 (Note1)                         | mW   |
| 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).

Note1: Rating at mounting on a board

Glass epoxy (FR4) board dimension: 40 mm x 40 mm (both sides of board), t = 1.6 mm

Metal pattern ratio: a surface approximately 50 %, the reverse side approximately 50 %

Through hole : diameter 0.5 mm x 24

### Operating Ranges

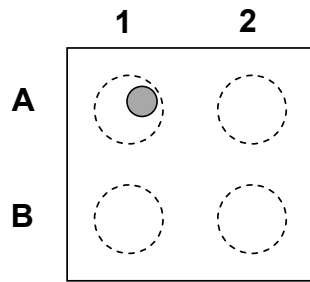
| Characteristics       | Symbol           | Rating               | Unit |
|-----------------------|------------------|----------------------|------|
| Input voltage         | V <sub>IN</sub>  | 1.5 to 5.5 (Note 2)  | V    |
| Control voltage       | V <sub>CT</sub>  | 0 to V <sub>IN</sub> | V    |
| Output voltage        | V <sub>OUT</sub> | 0.8 to 5.0           | V    |
| Output current        | I <sub>OUT</sub> | DC 300 (Note 3)      | mA   |
| Operation 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 2: I<sub>OUT</sub> = 1 mA.

Please refer to Dropout Voltage (Page 10) and use it within Absolute Maximum Ratings Junction temperature and Operation Temperature Ranges.

Note 3: 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.

### Pin Assignment (top view)



|   | 1       | 2    |
|---|---------|------|
| A | VIN     | VOUT |
| B | CONTROL | GND  |

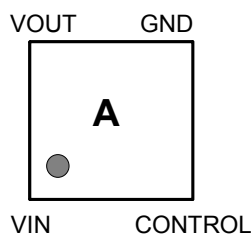
### List of Products Number, Output voltage and Marking

| Product No. | Output voltage(V) | Auto dis-charge | Marking | Product No. | Output voltage(V) | Auto dis-charge | Marking** |
|-------------|-------------------|-----------------|---------|-------------|-------------------|-----------------|-----------|
| TCR3UG08A   | 0.8               | Yes             | A       | TCR3UG08B   | 0.8               | No              | A         |
| TCR3UG085A  | 0.85              |                 | B       | TCR3UG085B  | 0.85              |                 | B         |
| TCR3UG09A   | 0.9               |                 | C       | TCR3UG09B   | 0.9               |                 | C         |
| TCR3UG095A  | 0.95              |                 | D       | TCR3UG095B  | 0.95              |                 | D         |
| TCR3UG10A   | 1.0               |                 | E       | TCR3UG10B   | 1.0               |                 | E         |
| TCR3UG105A  | 1.05              |                 | F       | TCR3UG105B  | 1.05              |                 | F         |
| TCR3UG11A   | 1.1               |                 | H       | TCR3UG11B   | 1.1               |                 | H         |
| TCR3UG115A  | 1.15              |                 | J       | TCR3UG115B  | 1.15              |                 | J         |
| TCR3UG12A   | 1.2               |                 | K       | TCR3UG12B   | 1.2               |                 | K         |
| TCR3UG13A   | 1.3               |                 | L       | TCR3UG13B   | 1.3               |                 | L         |
| TCR3UG135A  | 1.35              |                 | M       | TCR3UG135B  | 1.35              |                 | M         |
| TCR3UG15A   | 1.5               |                 | N       | TCR3UG15B   | 1.5               |                 | N         |
| TCR3UG175A  | 1.75              |                 | P       | TCR3UG175B  | 1.75              |                 | P         |
| TCR3UG18A   | 1.8               |                 | R       | TCR3UG18B   | 1.8               |                 | R         |
| TCR3UG185A  | 1.85              |                 | S       | TCR3UG185B  | 1.85              |                 | S         |
| TCR3UG19A   | 1.9               |                 | T       | TCR3UG19B   | 1.9               |                 | T         |
| TCR3UG25A   | 2.5               |                 | U       | TCR3UG25B   | 2.5               |                 | U         |
| TCR3UG26A   | 2.6               |                 | V       | TCR3UG26B   | 2.6               |                 | V         |
| TCR3UG27A   | 2.7               |                 | W       | TCR3UG27B   | 2.7               |                 | W         |
| TCR3UG28A   | 2.8               |                 | X       | TCR3UG28B   | 2.8               |                 | X         |
| TCR3UG285A  | 2.85              |                 | Y       | TCR3UG285B  | 2.85              |                 | Y         |
| TCR3UG30A   | 3.0               |                 | 0       | TCR3UG30B   | 3.0               |                 | 0         |
| TCR3UG31A   | 3.1               |                 | 1       | TCR3UG31B   | 3.1               |                 | 1         |
| TCR3UG32A   | 3.2               |                 | 2       | TCR3UG32B   | 3.2               |                 | 2         |
| TCR3UG33A   | 3.3               |                 | 3       | TCR3UG33B   | 3.3               |                 | 3         |
| TCR3UG35A   | 3.5               |                 | 4       | TCR3UG35B   | 3.5               |                 | 4         |
| TCR3UG36A   | 3.6               |                 | 5       | TCR3UG36B   | 3.6               |                 | 5         |
| TCR3UG41A   | 4.1               |                 | 9       | TCR3UG41B   | 4.1               |                 | 9         |
| TCR3UG42A   | 4.2               |                 | 6       | TCR3UG42B   | 4.2               |                 | 6         |
| TCR3UG45A   | 4.5               |                 | 7       | TCR3UG45B   | 4.5               |                 | 7         |
| TCR3UG50A   | 5.0               |                 | 8       | TCR3UG50B   | 5.0               |                 | 8         |

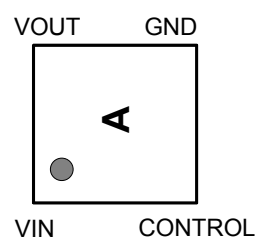
\*\*Marking is rotated 90 degrees to the left.

### Top Marking (top view)

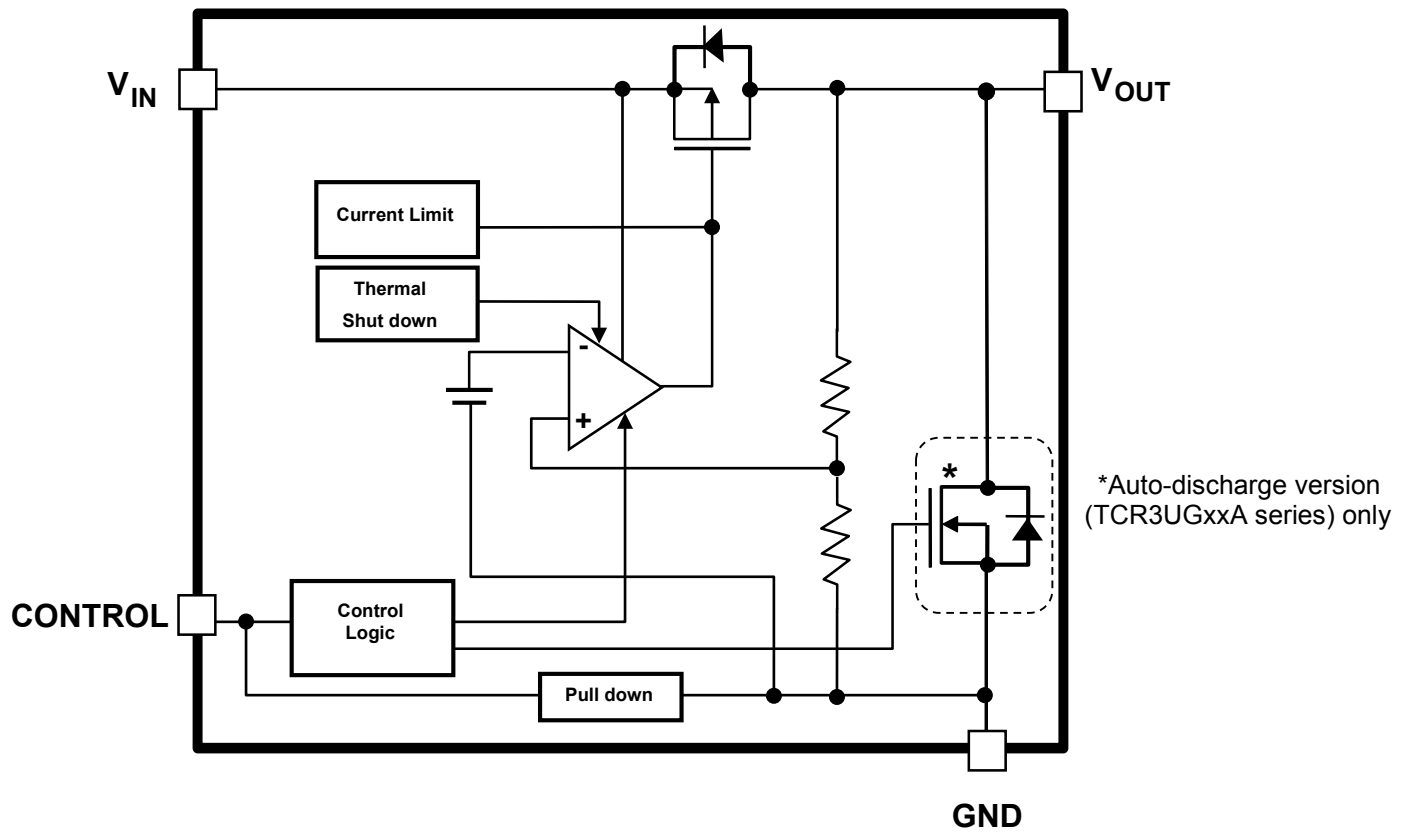
Example: TCR3UG08A (0.8 V output)



Example: TCR3UG08B (0.8 V output)



### Block Diagram



### 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   | $T_j = 25^\circ\text{C}$    |      |     | $T_j = -40\text{ to }85^\circ\text{C}$<br>(Note 9) |      | Unit                       |    |
|---------------------------|------------------|--|-----------------------------|------|-----|--|------|----------------------------|----|
|                           |                  |  | Min                         | Typ. | Max | Min  | Max  |                            |    |
| Output voltage accuracy   | $V_{OUT}$        | $I_{OUT} = 50\text{ mA}$<br>(Note 4)   | $V_{OUT} < 1.8\text{ V}$    | -18  | —   | +18  | —    | —                          | mV |
|                           |                  |  | $1.8\text{ V} \leq V_{OUT}$ | -1.0 | —   | +1.0   | —    | —                          | %  |
| Input voltage             | $V_{IN}$         | $I_{OUT} = 1\text{ mA}$  | 1.5                         | —    | 5.5 | 1.5  | 5.5  | V                          |    |
| Line regulation           | Reg. line        | $I_{OUT} = 1\text{ mA}$ (Note 5)   | —                           | 1    | 15  | —  | —    | mV                         |    |
| Load regulation           | Reg. load        | $1\text{ mA} \leq I_{OUT} \leq 300\text{ mA}$ (Note 6)   | —                           | 10   | 30  | —  | —    | mV                         |    |
| Quiescent current         | $I_{B(ON1)}$     | $I_{OUT} = 0\text{ mA}$ , $V_{OUT} \leq 1.5\text{ V}$ (Note 7)   | —                           | 0.34 | —   | —  | 0.58 | $\mu\text{A}$              |    |
|                           | $I_{B(ON2)}$     | $I_{OUT} = 0\text{ mA}$ ,<br>$1.75\text{ V} \leq V_{OUT} \leq 5\text{ V}$ (Note 7)   | —                           | 0.38 | —   | —  | 0.68 | $\mu\text{A}$              |    |
| Stand-by current          | $I_{B(OFF1)}$    | $V_{CT} = 0\text{ V}$ , $V_{IN} = 2.5\text{ V}$  | —                           | 0.03 | —   | —  | 0.16 | $\mu\text{A}$              |    |
|                           | $I_{B(OFF2)}$    | $V_{CT} = 0\text{ V}$ , $V_{IN} = 5.5\text{ V}$  | —                           | 0.03 | —   | —  | 0.20 | $\mu\text{A}$              |    |
| Control pull down current | $I_{CT}$         | —  | —                           | 0.1  | —   | —  | —    | $\mu\text{A}$              |    |
| Drop-out voltage          | $V_{DO}$         | $I_{OUT} = 300\text{ mA}$  | $V_{OUT} = 1.8\text{ V}$    | —    | 335 | —  | —    | 457                        | mV |
|                           |                  |  | $V_{OUT} = 3.3\text{ V}$    | —    | 140 | —  | —    | 273                        | mV |
| Output noise voltage      | $V_{NO}$         | $I_{OUT} = 10\text{ mA}$ ,<br>$10\text{ Hz} \leq f \leq 100\text{ kHz}$ , $T_a = 25^\circ\text{C}$<br>(Note 6)                             | —                           | 50   | —   | —  | —    | $\mu\text{V}_{\text{rms}}$ |    |
| Ripple rejection ratio    | R.R.             | $I_{OUT} = 10\text{ mA}$ ,<br>$f = 1\text{ kHz}$ , $V_{\text{Ripple}} = 200\text{ mV}_{\text{p-p}}$ ,<br>$T_a = 25^\circ\text{C}$ (Note 6) | —                           | 70   | —   | —  | —    | dB                         |    |
| Load transient response   | $\Delta V_{OUT}$ | $I_{OUT} = 1\text{ mA} \rightarrow 50\text{ mA}$ (Note 8)  | —                           | -60  | —   | —  | —    | mV                         |    |
|                           |                  | $I_{OUT} = 50\text{ mA} \rightarrow 1\text{ mA}$ (Note 8)  | —                           | +60  | —   | —  | —    | mV                         |    |
| Temperature coefficient   | $T_{CVO}$        | $-40^\circ\text{C} \leq T_{\text{opr}} \leq 85^\circ\text{C}$  | —                           | 75   | —   | —  | —    | ppm/ $^\circ\text{C}$      |    |
| Control voltage (ON)      | $V_{CT(ON)}$     | —  | 1.0                         | —    | 5.5 | 1.0  | 5.5  | V                          |    |
| Control voltage (OFF)     | $V_{CT(OFF)}$    | —  | 0                           | —    | 0.4 | 0  | 0.4  | V                          |    |
| Discharge on resistance   | $R_{SD}$         | —  | —                           | 10   | —   | —  | —    | $\Omega$                   |    |

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

Note 5:  $V_{OUT} \leq 1.5\text{ V}$ ,  $2.5\text{ V} \leq V_{IN} \leq 5.5\text{ V}$

$1.75\text{ V} \leq V_{OUT} \leq 4.2\text{ V}$ ,  $V_{OUT} + 1\text{ V} \leq V_{IN} \leq 5.5\text{ V}$

$V_{OUT} = 4.5\text{ V}$ ,  $V_{OUT} = 5.0\text{ V}$ , not applicable

Note 6:  $V_{OUT} = 0.8\text{ V}$

Note 7: except Control pull down current ( $I_{CT}$ )

Note 8:  $V_{OUT} = 0.8\text{ V}$ ,  $V_{IN} = 3.3\text{ V}$

Note 9: This parameter is warranted by design

### Dropout voltage

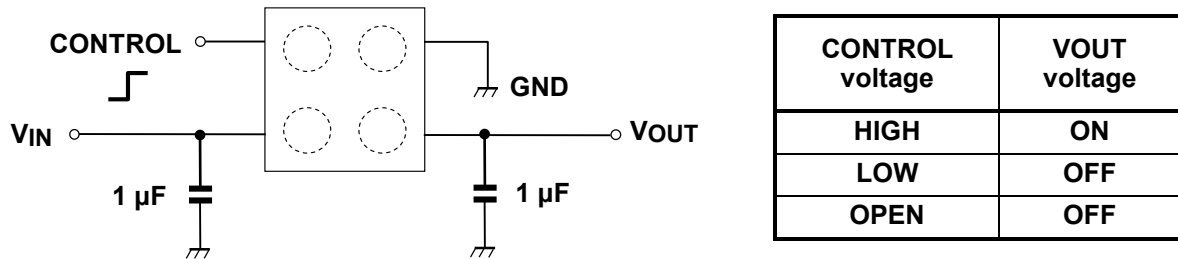
( $I_{OUT} = 300 \text{ mA}$ ,  $C_{IN} = C_{OUT} = 1 \mu\text{F}$ )

| Output voltages                                 | Symbol          | Min | Typ.<br>$T_j = 25^\circ\text{C}$ | Max<br>(Note 10) | Unit |
|---|-----------------|-----|----------------------------------|------------------|------|
| $0.8 \text{ V} \leq V_{OUT} < 0.9 \text{ V}$    | V <sub>DO</sub> | —   | 1025                             | 1257             | mV   |
| $0.9 \text{ V} \leq V_{OUT} < 1.0 \text{ V}$    |                 | —   | 930                              | 1157             |      |
| $1.0 \text{ V} \leq V_{OUT} < 1.1 \text{ V}$    |                 | —   | 835                              | 1057             |      |
| $1.1 \text{ V} \leq V_{OUT} < 1.2 \text{ V}$    |                 | —   | 740                              | 957              |      |
| $1.2 \text{ V} \leq V_{OUT} < 1.3 \text{ V}$    |                 | —   | 660                              | 857              |      |
| $1.3 \text{ V} \leq V_{OUT} < 1.5 \text{ V}$    |                 | —   | 580                              | 757              |      |
| $1.5 \text{ V} \leq V_{OUT} < 1.6 \text{ V}$    |                 | —   | 450                              | 617              |      |
| $1.6 \text{ V} \leq V_{OUT} < 1.8 \text{ V}$    |                 | —   | 400                              | 537              |      |
| $1.8 \text{ V} \leq V_{OUT} < 2.0 \text{ V}$    |                 | —   | 335                              | 457              |      |
| $2.0 \text{ V} \leq V_{OUT} < 2.5 \text{ V}$    |                 | —   | 260                              | 405              |      |
| $2.5 \text{ V} \leq V_{OUT} < 3.0 \text{ V}$    |                 | —   | 185                              | 327              |      |
| $3.0 \text{ V} \leq V_{OUT} < 3.6 \text{ V}$    |                 | —   | 140                              | 273              |      |
| $3.6 \text{ V} \leq V_{OUT} < 4.5 \text{ V}$    |                 | —   | 130                              | 228              |      |
| $4.5 \text{ V} \leq V_{OUT} \leq 5.0 \text{ V}$ |                 | —   | 120                              | 195              |      |

Note 10:  $T_j = -40$  to  $85^\circ\text{C}$ . This parameter is warranted by design

### Application Note

#### 1. Example of Application Circuit



The figure above shows the Example of 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

Board-mounted power dissipation ratings are available in the Absolute Maximum Ratings table. Power dissipation is measured on the board condition shown below.

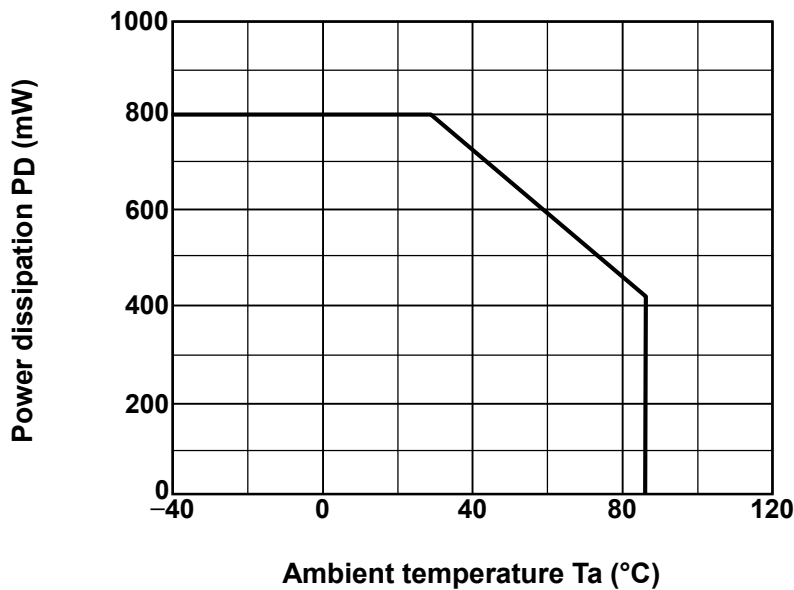
[The Board Condition]

Board material: Glass epoxy (FR4)

Board dimension: 40 mm x 40 mm (both sides of board),  $t = 1.6$  mm

Metal pattern ratio: a surface approximately 50 %, the reverse side approximately 50 %

Through hole: diameter 0.5 mm x 24





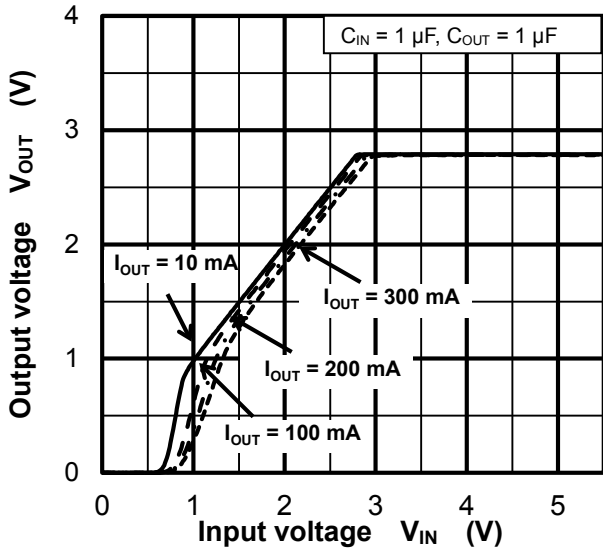
### Attention in Use

- **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  $\Omega$ . 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 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 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 shut down function**  
Over current protection and Thermal shut down 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.

### Representative Typical Characteristics

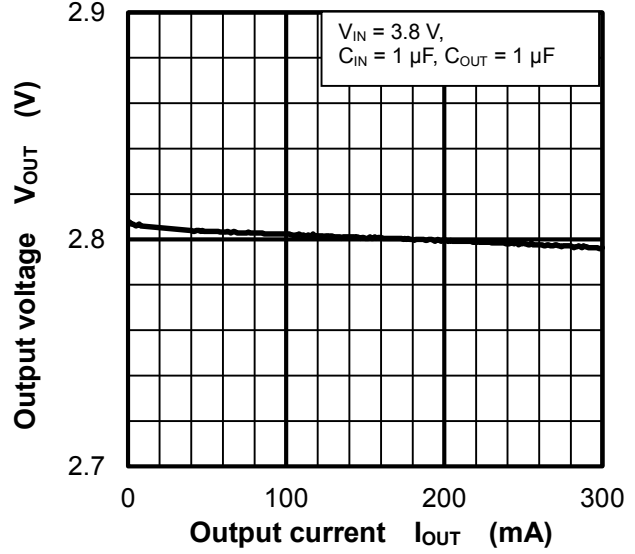
Output Voltage vs. Input Voltage

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



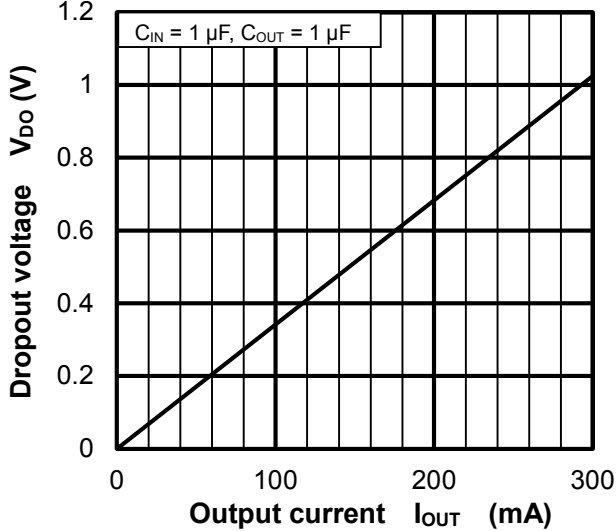
Output Voltage vs. Output Current

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

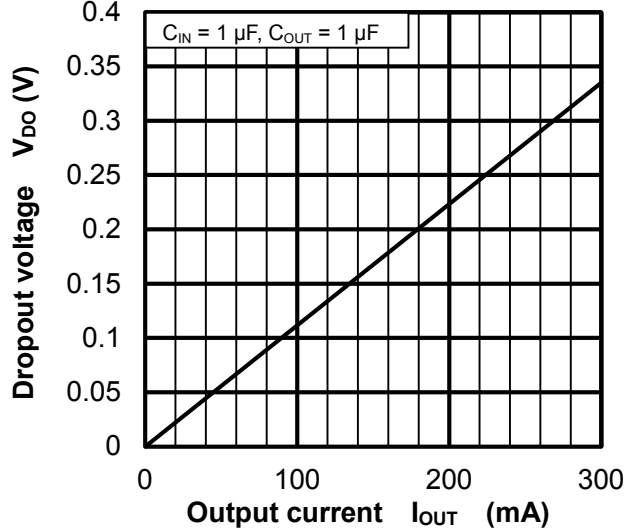


Dropout Voltage vs. Output Current

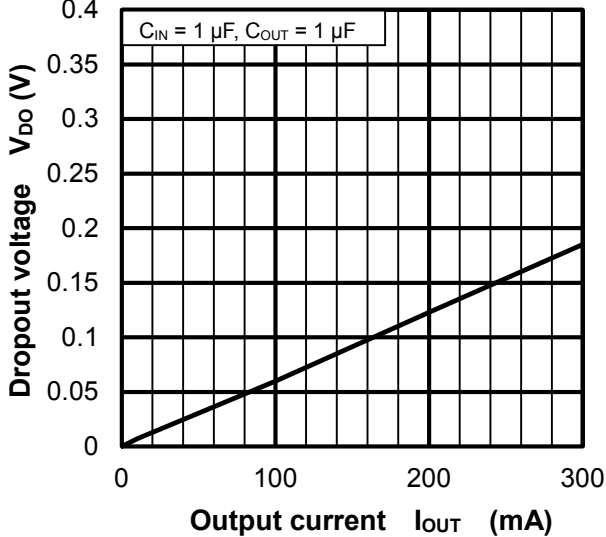
$V_{OUT} = 0.8\text{ V}$



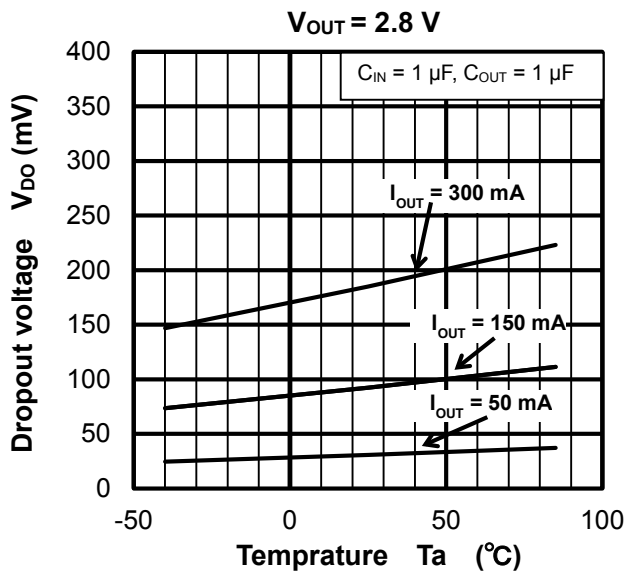
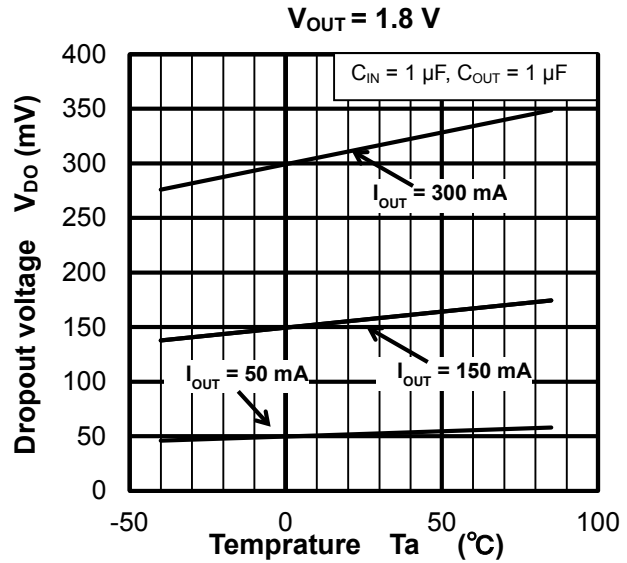
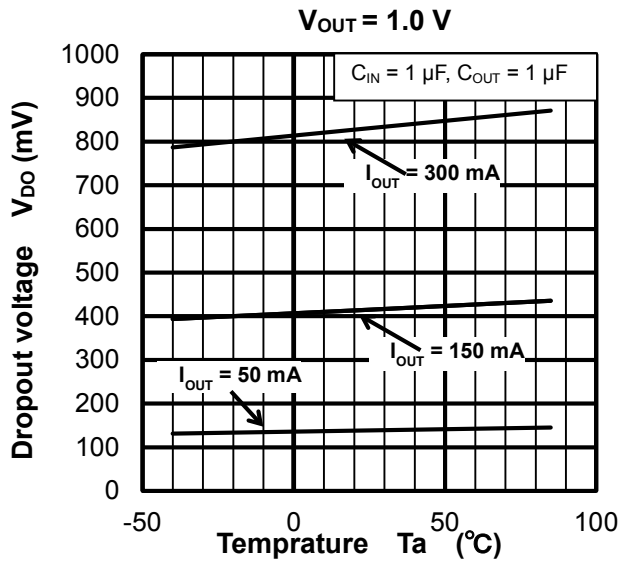
$V_{OUT} = 1.8\text{ V}$



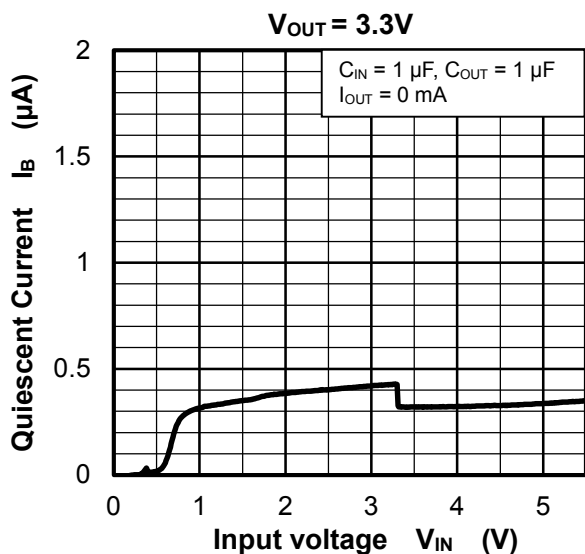
$V_{OUT} = 2.8\text{ V}$



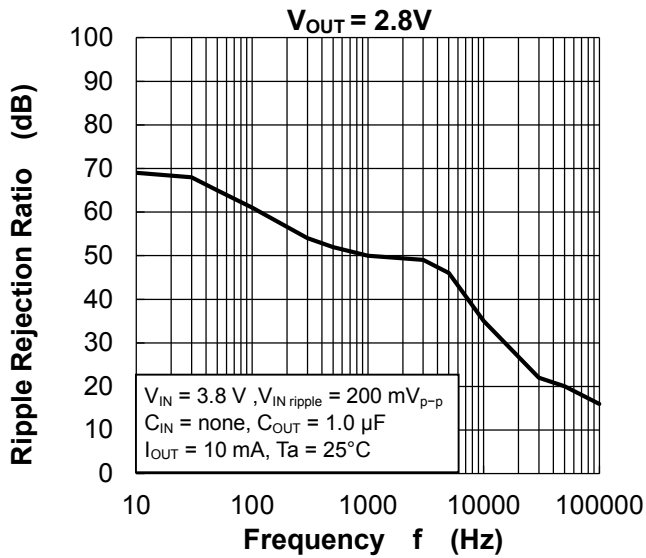
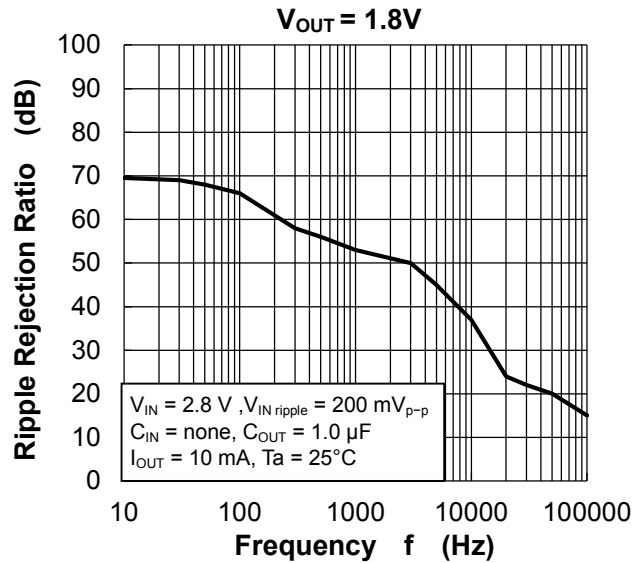
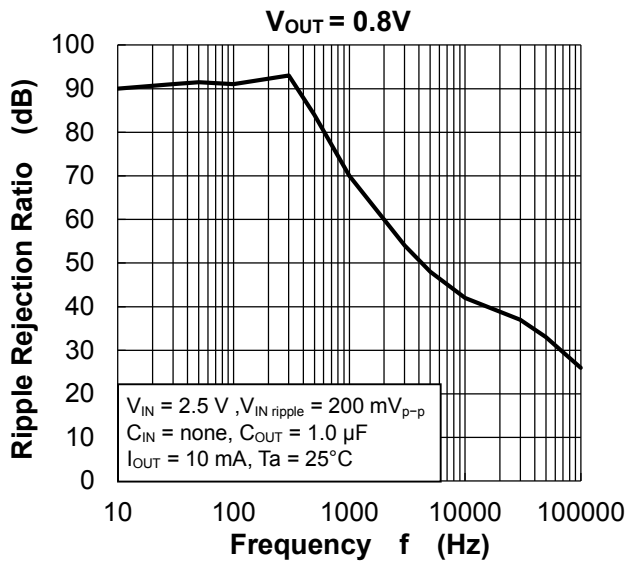
### Dropout Voltage vs. Temperature



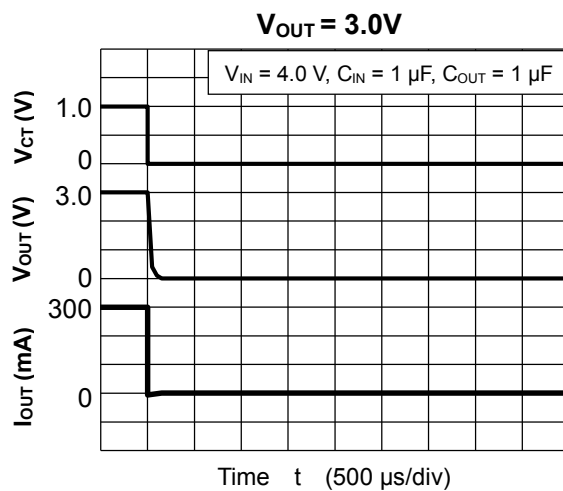
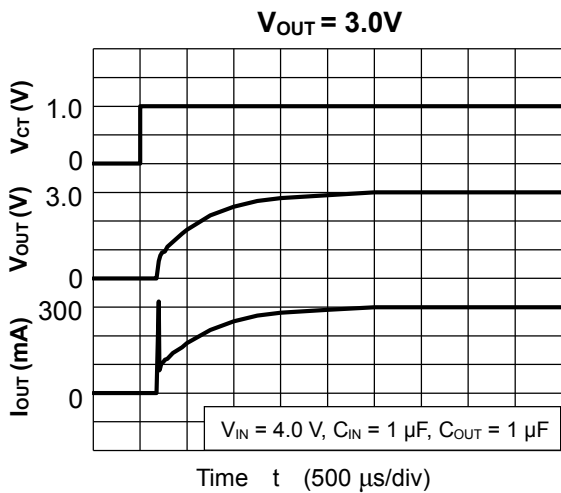
### Quiescent Current vs. Input Voltage



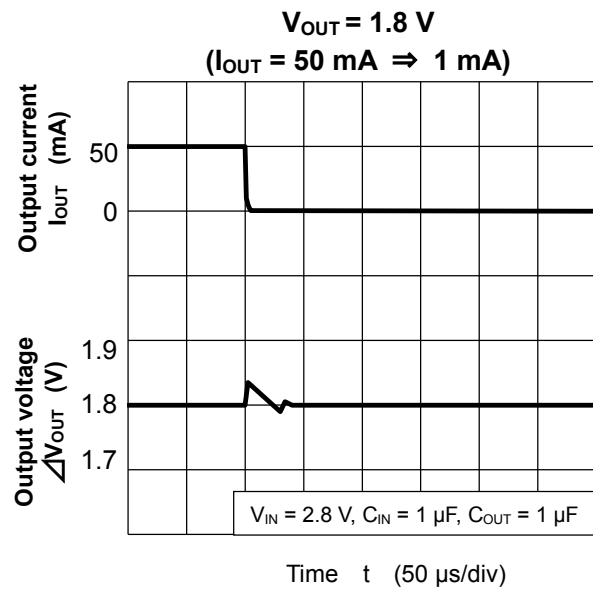
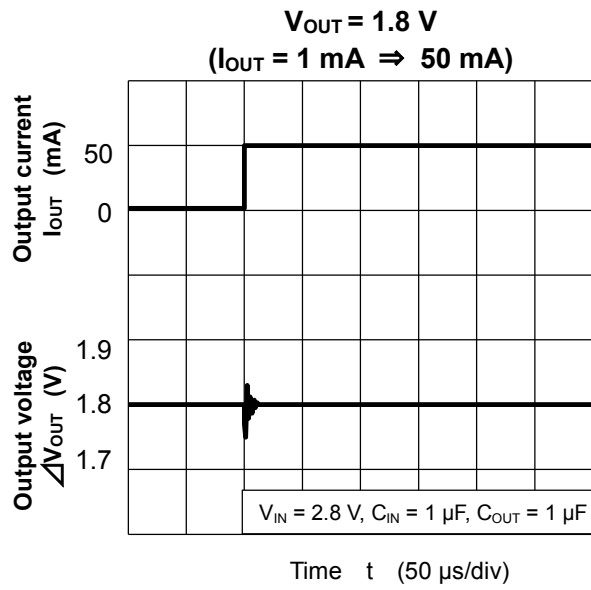
### Ripple Rejection Ratio vs. Frequency



### t<sub>ON</sub> / t<sub>OFF</sub> Response



### Load Transient Response

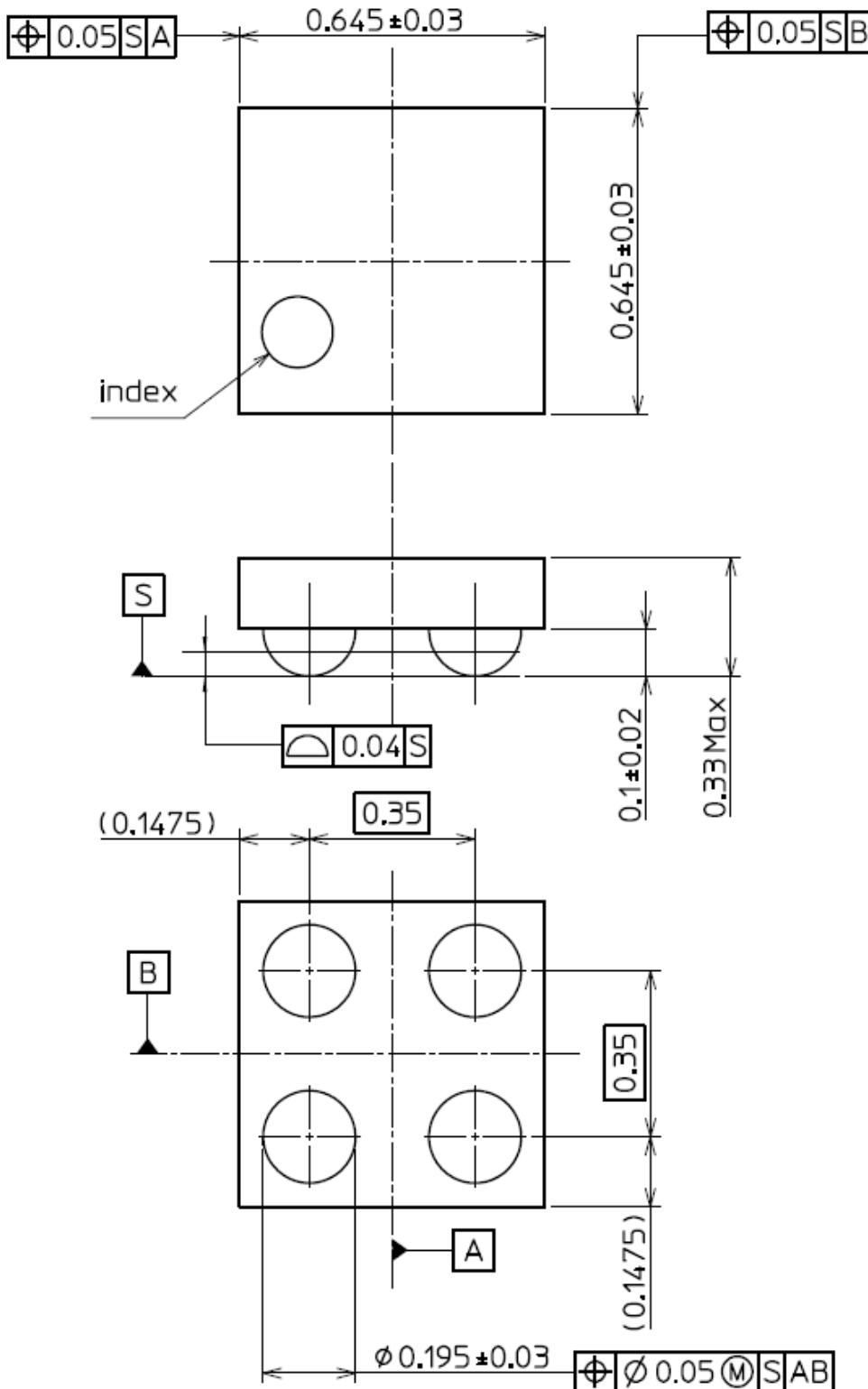


Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

### Package Information

WCSP4F

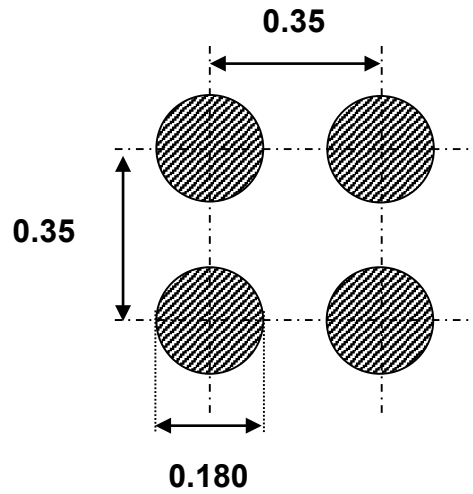
Unit: mm



Weight: 0.26 mg (typ.)

Land pattern dimensions for reference only

Unit: mm



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