TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCR3DM series

300 mA CMOS Low Dropout Regulator with inrush current protection circuit

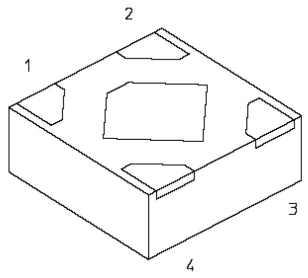
The TCR3DM series are CMOS general-purpose single-output voltage regulators with an on/off control input, featuring low dropout voltage, low output noise voltage and low inrush current.

These voltage regulators are available in fixed output voltages between 1.0 V and 4.5 V and capable of driving up to 300 mA.

They feature over-current protection, over-temperature protection, Inrush current protection circuit and Auto-discharge function.

The TCR3DM series are offered in the ultra small plastic mold package DFN4/DFN4E (1.0 mm x 1.0 mm; t 0.58 mm). It has a low dropout voltage of 210 mV (2.5 V output, I_{OUT} = 300 mA) with low output noise voltage of 38 μVrms (2.5 V output) and a load transient response of only ΔV_{OUT} = ±80 mV (I_{OUT} = 1 mA⇔300 mA, C_{OUT} =1.0 μF).

As small ceramic input and output capacitors can be used with the TCR3DM series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



BOTTOM VIEW ILLUSTRATION

DFN4/DFN4E

Weight : 1.3 mg (typ.)

Features

- Low Dropout voltage
  - V_{DO} = 210 mV (typ.) at 2.5 V-output, I_{OUT} = 300 mA
  - V_{DO} = 270 mV (typ.) at 1.8 V-output, I_{OUT} = 300 mA
  - V_{DO} = 490 mV (typ.) at 1.2 V-output, I_{OUT} = 300 mA
- Low output noise voltage
  - V_{NO} = 38 μV_{rms} (typ.) at 2.5 V-output, I_{OUT} = 10 mA, 10 Hz ≤ f ≤ 100 kHz
- Fast load transient response (ΔV_{OUT} = ±80 mV (typ.) at I_{OUT} = 1 mA ⇔ 300 mA, C_{OUT} =1.0 μF)
- High ripple rejection (R.R = 70 dB (typ.) at 2.5 V-output, I_{OUT} = 10 mA, f =1 kHz)
- Overcurrent protection
- Over-temperature protection
- Inrush current protection circuit
- Auto-discharge
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used (C_{IN} = 1.0 μF, C_{OUT} =1.0 μF)
- Ultra small package DFN4/DFN4E (1.0 mm x 1.0 mm ; t 0.58 mm)

Start of commercial production
2013-03

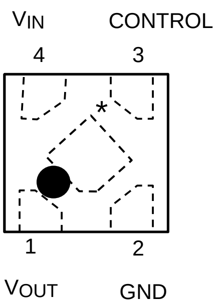
Absolute Maximum Ratings (Ta = 25°C)

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}	300	mA
Power dissipation	P_D	420 (Note1)	mW
Operating 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).

Note1: Rating at mounting on a board
Glass epoxy(FR4) board dimension: 40mm x 40mm x 1.6mm, both sides of board.
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%
Through hole hall: diameter 0.5mm x 24

Pin Assignment (top view)



*Center electrode should be connected to GND or Open

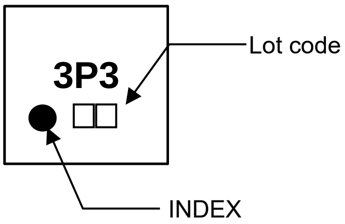
List of Products Number, Output voltage and Marking

Product No.	Output voltage(V)	Marking	Product No.	Output voltage(V)	Marking
TCR3DM10	1.0	1P0	TCR3DM28	2.8	2P8
TCR3DM105	1.05	1PA	TCR3DM285	2.85	2PD
TCR3DM11	1.1	1P1	TCR3DM30	3.0	3P0
TCR3DM12	1.2	1P2	TCR3DM32	3.2	3P2
TCR3DM13	1.3	1P3	TCR3DM33	3.3	3P3
TCR3DM135	1.35	1PD	TCR3DM35	3.5	3P5
TCR3DM15	1.5	1P5	TCR3DM36	3.6	3P6
TCR3DM18	1.8	1P8	TCR3DM45	4.5	4P5
TCR3DM25	2.5	2P5			

Please contact your local Toshiba representative if you are interested in products with other output voltages.

Top Marking (top view)

Example: TCR3DM33 (3.3 V output)



Electrical Characteristics

(Unless otherwise specified, V_{IN} = V_{OUT} + 1 V, I_{OUT} = 50 mA, C_{IN} = 1.0 μF, C_{OUT} = 1.0 μF, T_j = 25°C)

Characteristics	Symbol	Test Condition		Min	Typ.	Max	Unit
Output voltage accuracy	V_{OUT}	I_{OUT} = 50 mA (Note 2)	V_{OUT} <1.8 V	-18	—	+18	mV
			1.8V ≤ V_{OUT}	-1.0	—	+1.0	%
Input voltage	V_{IN}	I_{OUT} = 300 mA		1.75	—	5.5	V
Line regulation	Reg·line	V_{OUT} + 0.5 V ≤ V_{IN} ≤ 5.5 V, I_{OUT} = 1 mA		—	1	15	mV
Load regulation	Reg·load	1 mA ≤ I_{OUT} ≤ 300 mA		—	18	35	mV
Quiescent current	I_B	I_{OUT} = 0 mA	V_{OUT} = 1.0 V	—	65	—	μA
			V_{OUT} = 1.8 V	—	65	—	
			V_{OUT} = 2.5 V	—	68	—	
			V_{OUT} = 4.5 V	—	78	125	
Stand-by current	$I_{B (OFF)}$	V_{CT} = 0 V		—	0.1	1	μA
Dropout voltage	V_{DO}	I_{OUT} = 300 mA (Note 3)		—	210	290	mV
Temperature coefficient	T_{CVO}	-40°C ≤ T_{opr} ≤ 85°C		—	75	—	ppm/°C
Output noise voltage	V_{NO}	V_{IN} = V_{OUT} + 1 V, I_{OUT} = 10 mA, 10 Hz ≤ f ≤ 100 kHz, Ta = 25°C (Note 3)		—	38	—	μVrms
Ripple rejection ratio	R.R.	V_{IN} = V_{OUT} + 1 V, I_{OUT} = 10 mA, f = 1 kHz, V_{Ripple} = 500 mV_{p-p}, Ta = 25°C (Note 3)		—	70	—	dB
Load transient response	ΔV_{OUT}	I_{OUT} = 1 mA⇔300mA, C_{OUT} = 1.0 μF		—	±80	—	mV
Control voltage (ON)	$V_{CT (ON)}$	—		1.0	—	5.5	V
Control voltage (OFF)	$V_{CT (OFF)}$	—		0	—	0.4	V

Note 2: Stable state with fixed I_{OUT} condition.

Note 3: The 2.5 V output product.

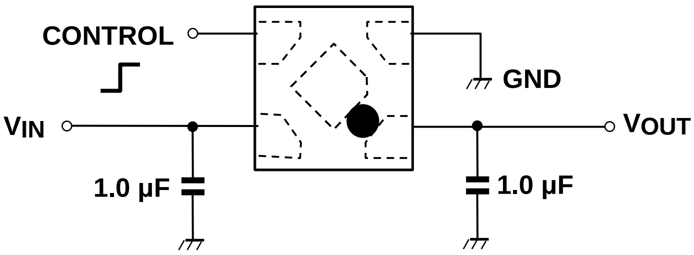
Dropout voltage

(I_{OUT} = 300 mA, C_{IN} = 1.0 μF, C_{OUT} = 1.0 μF, T_j = 25°C)

Output voltages	Symbol	Min	Typ.	Max	Unit
1.0 V, 1.05 V	V_{DO}	—	590	750	mV
1.1 V		—	550	650	
1.2 V		—	490	600	
1.3 V		—	450	550	
1.35V, 1.4 V		—	390	520	
1.5 V ≤ V_{OUT} < 1.8 V		—	350	450	
1.8 V ≤ V_{OUT} < 2.1 V		—	270	380	
2.1 V ≤ V_{OUT} < 2.5 V		—	240	330	
2.5 V ≤ V_{OUT} < 2.8 V		—	210	290	
2.8 V ≤ V_{OUT} < 3.2 V		—	200	250	
3.2 V ≤ V_{OUT} < 3.6 V		—	180	230	
3.6 V ≤ V_{OUT} ≤ 4.5 V		—	150	200	

Application Note

1. Example of Application Circuit



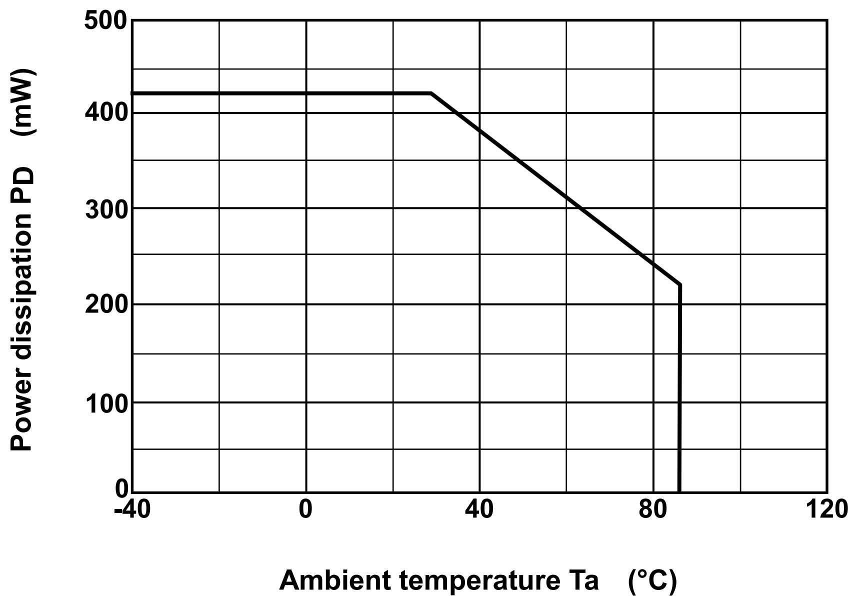
CONTROL voltage	Output voltage
HIGH	ON
LOW	OFF
OPEN	OFF

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

2. Power Dissipation

Board-mounted power dissipation ratings for TCR3DM series 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 hall: 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 recommends the ESR of ceramic capacitor is under 10 Ω.

- Mounting
  The long distance between IC and output capacitor might affect phase compensation 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.

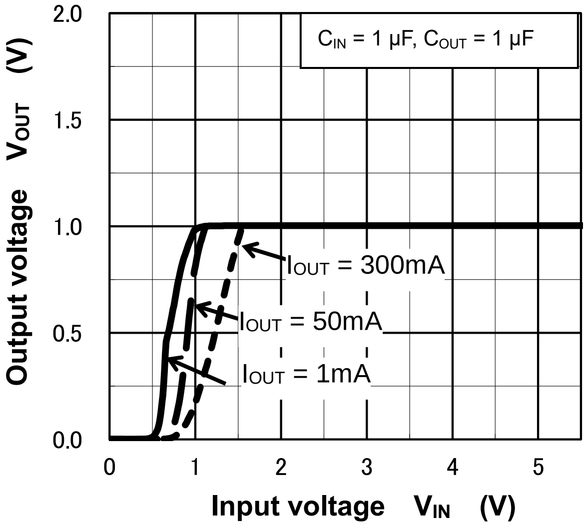
- Permissible Loss
  Please have enough design patterns for expected maximum permissible loss. And under consideration of ambient temperature, input voltage, output current etc., we recommend proper dissipation ratings for maximum permissible loss; in general maximum dissipation rating is 70 to 80 percent.

- 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 be 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.

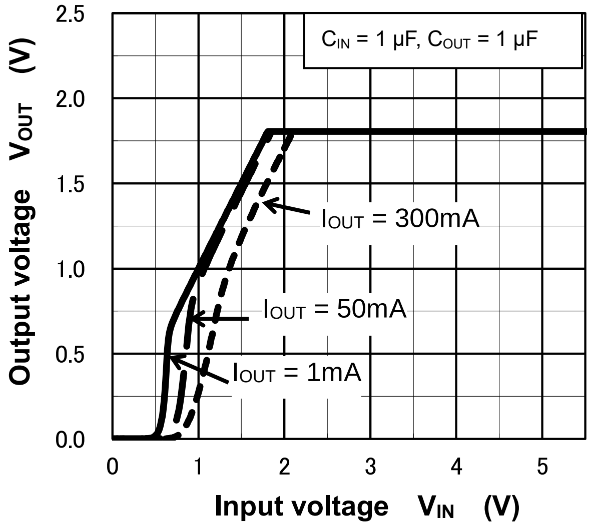
Representative Typical Characteristics

Output Voltage vs. Input Voltage

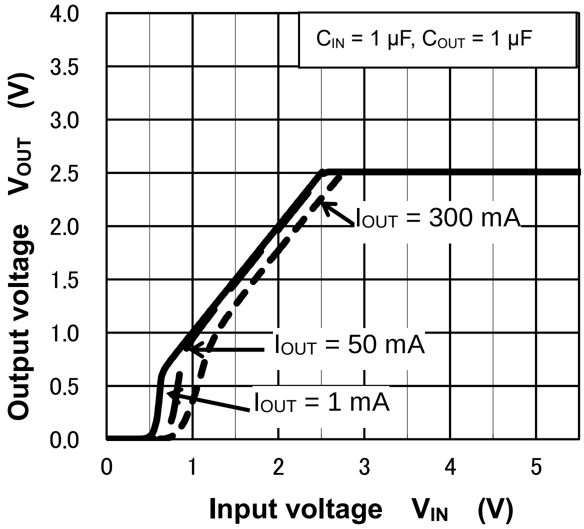
V_{OUT} = 1.0 V



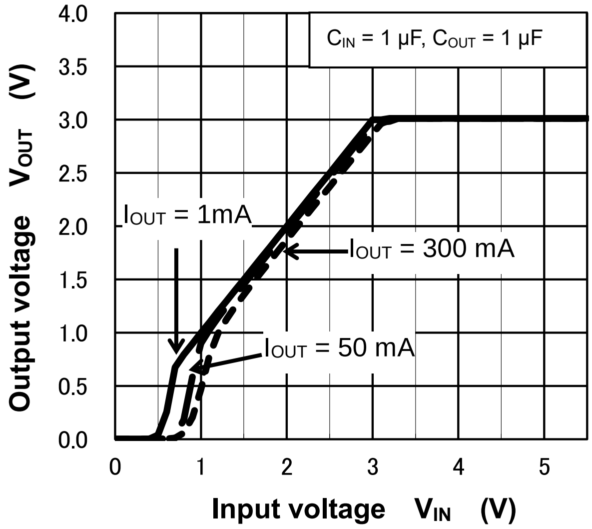
V_{OUT} = 1.8 V



V_{OUT} = 2.5 V

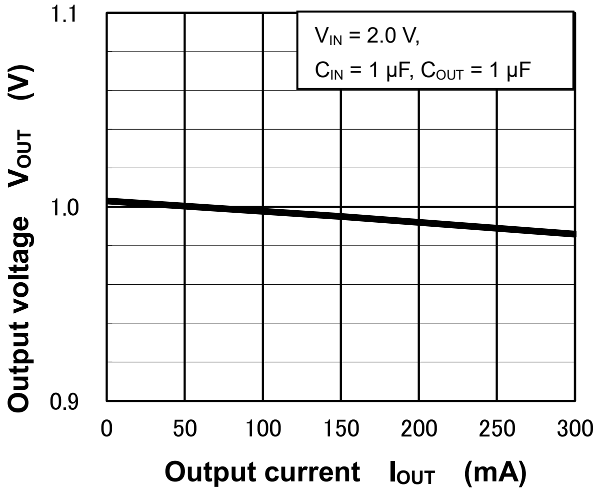


V_{OUT} = 3.0 V

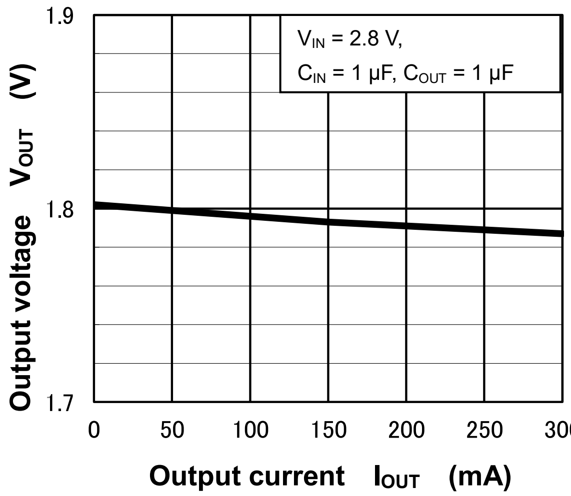


Output Voltage vs. Output Current

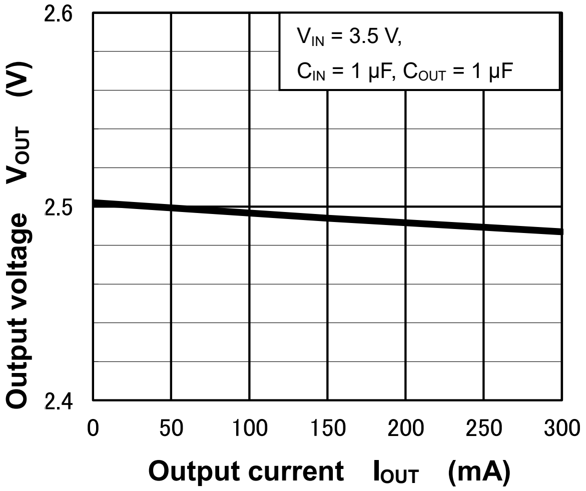
V_{OUT} = 1.0 V



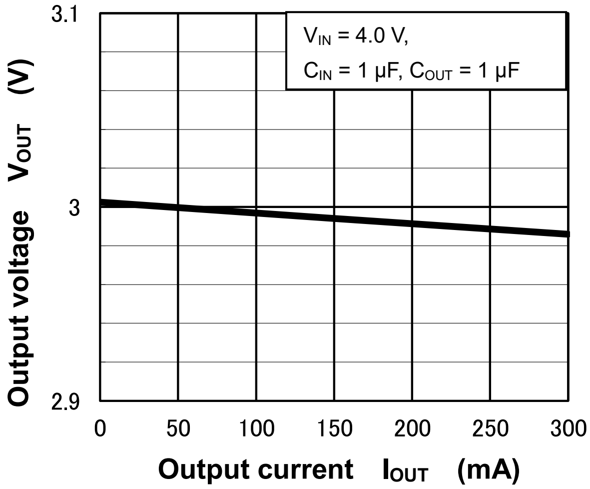
V_{OUT} = 1.8 V



V_{OUT} = 2.5 V

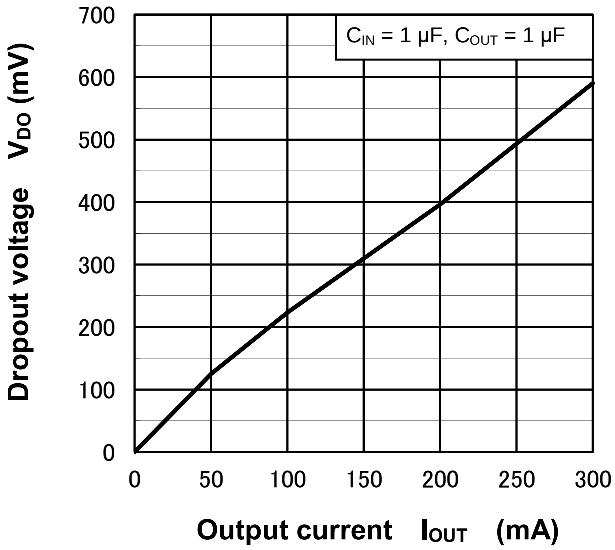


V_{OUT} = 3.0 V

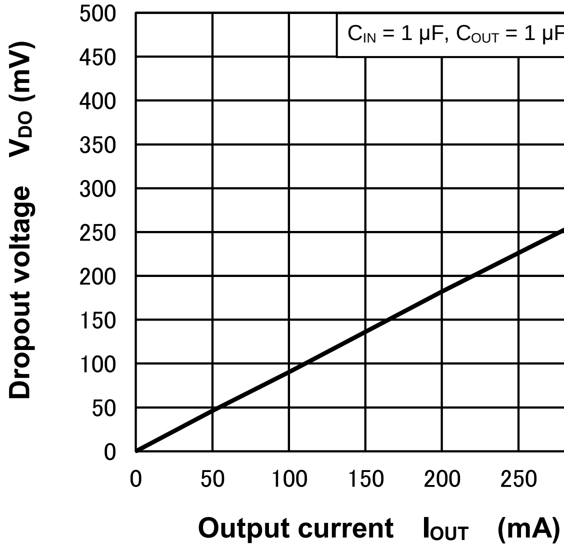


Dropout Voltage vs. Output Current

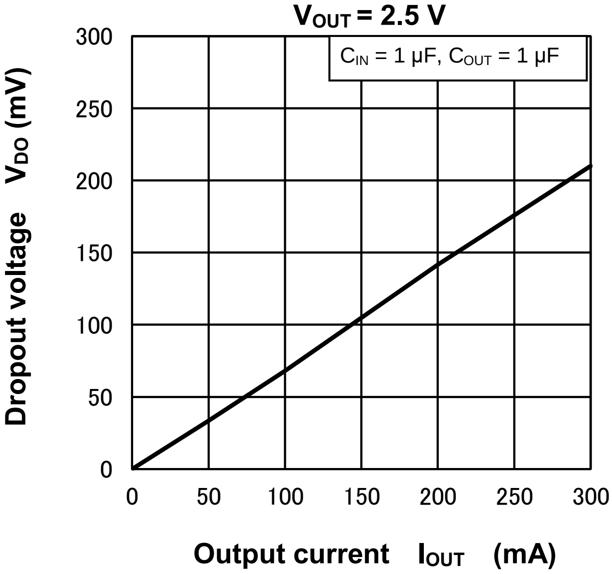
V_{OUT} = 1.0 V



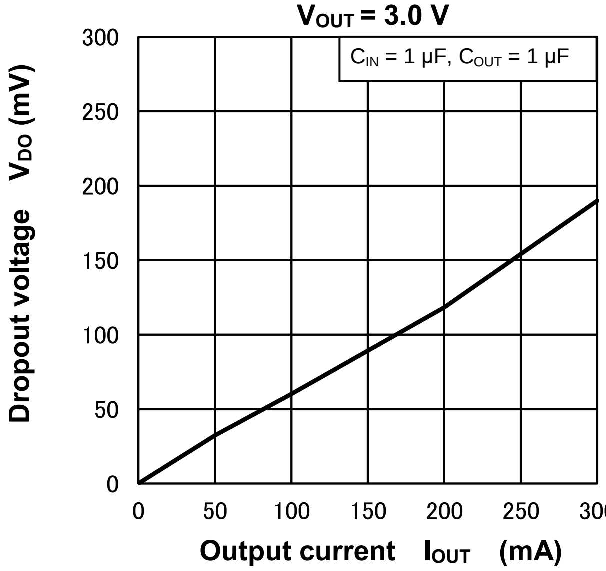
V_{OUT} = 1.8 V



V_{OUT} = 2.5 V

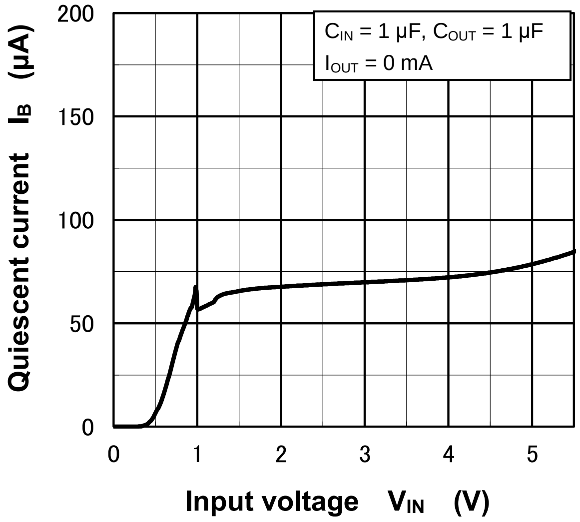


V_{OUT} = 3.0 V

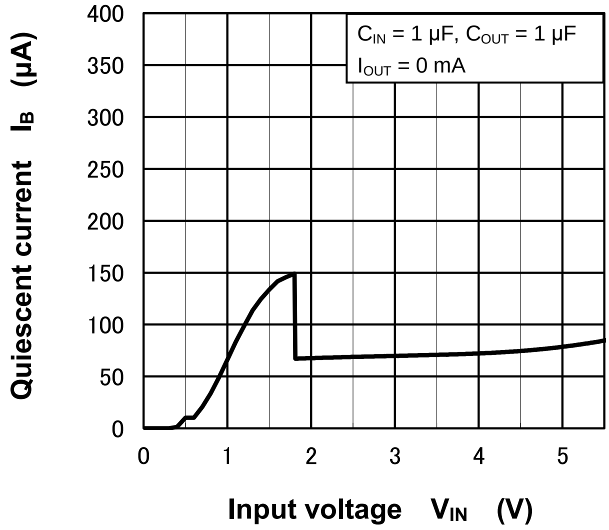


Quiescent Current vs. Input Voltage

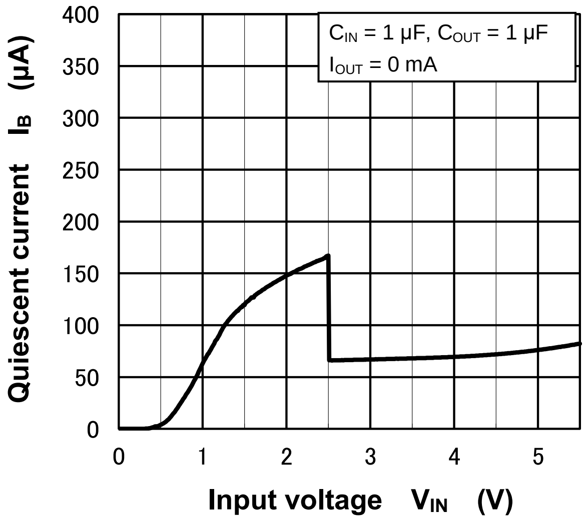
V_{OUT} = 1.0 V



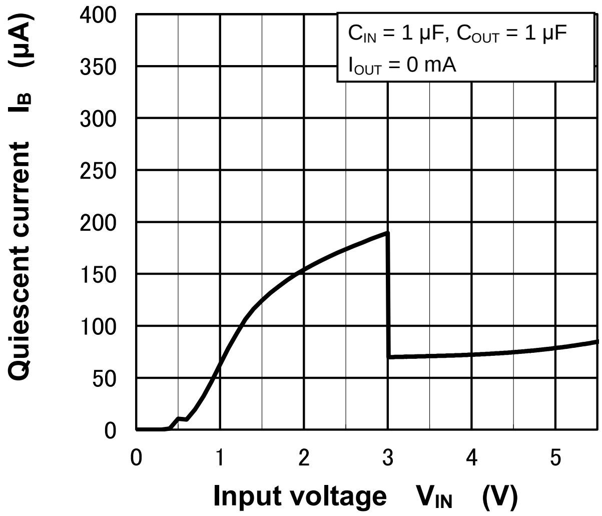
V_{OUT} = 1.8 V



V_{OUT} = 2.5 V

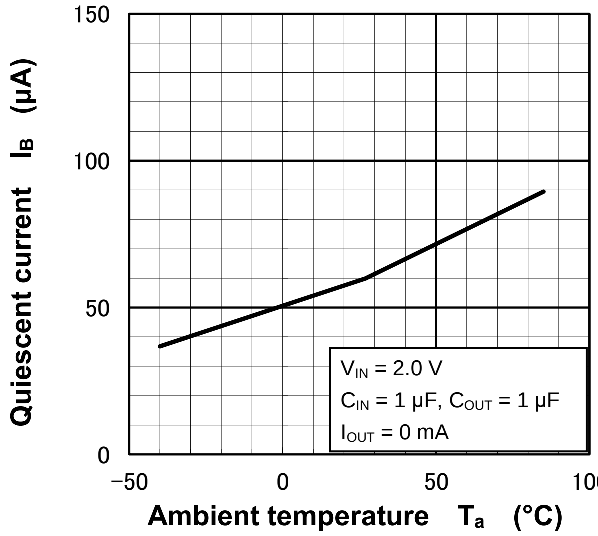


V_{OUT} = 3.0 V

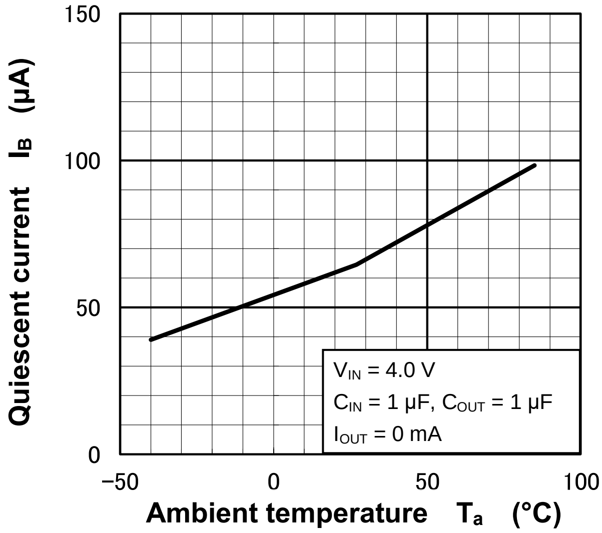


Quiescent Current vs. Ambient Temperature

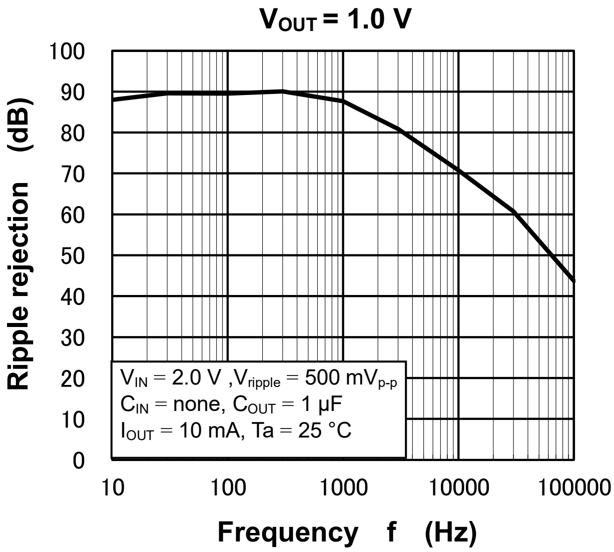
V_{OUT} = 1.0 V

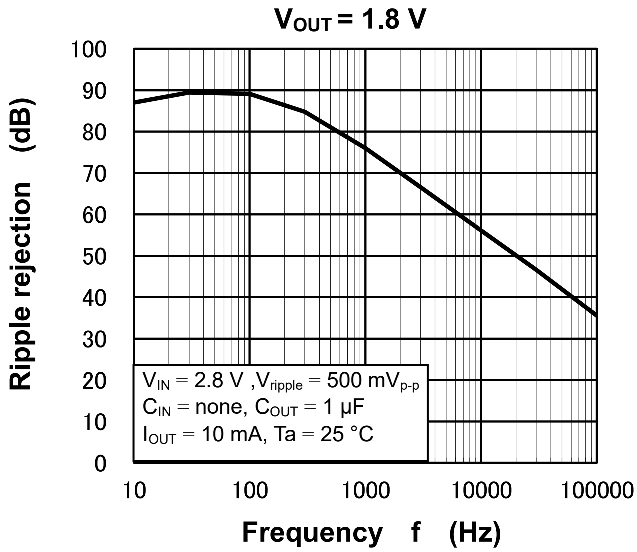


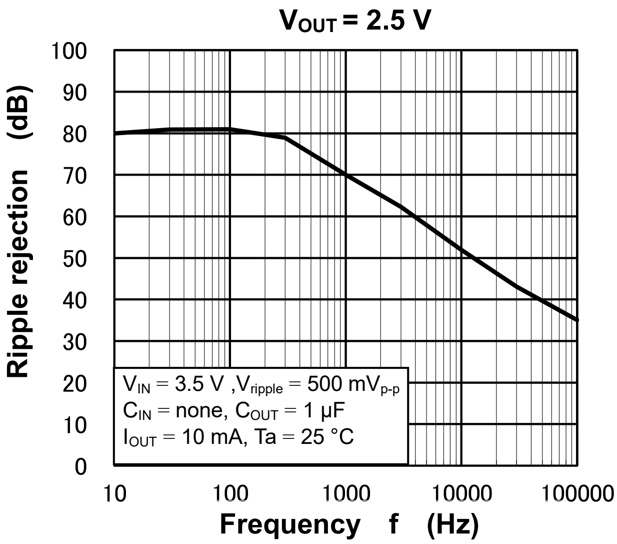
V_{OUT} = 3.0 V

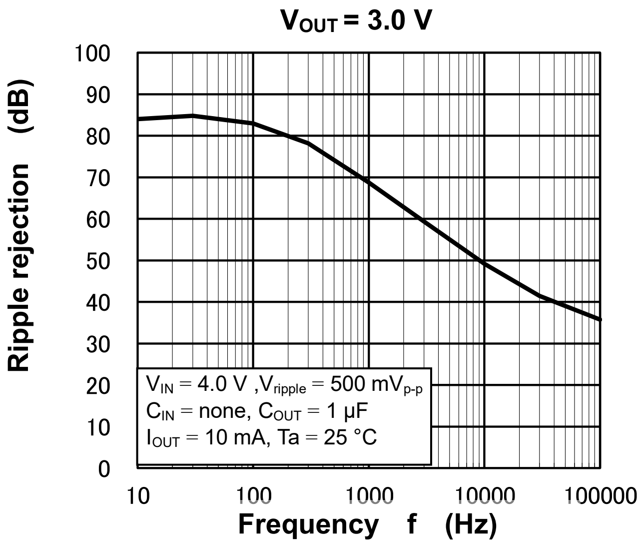


Ripple Rejection Ratio vs. Frequency

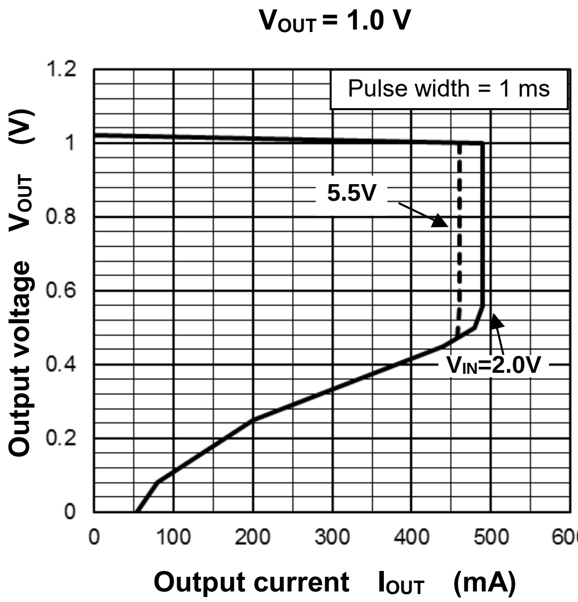


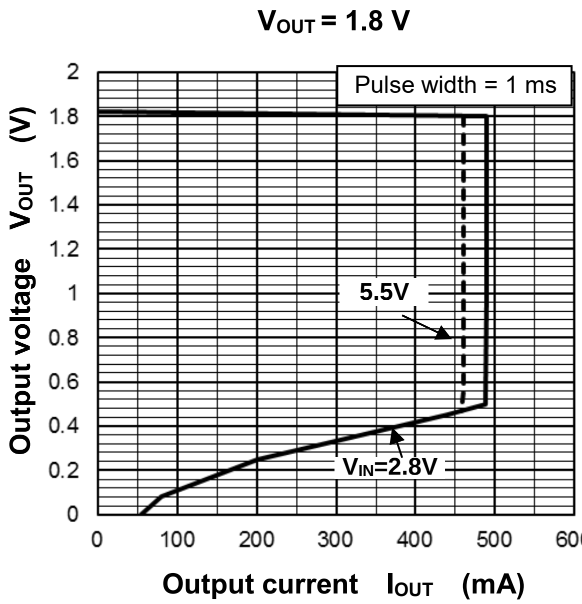




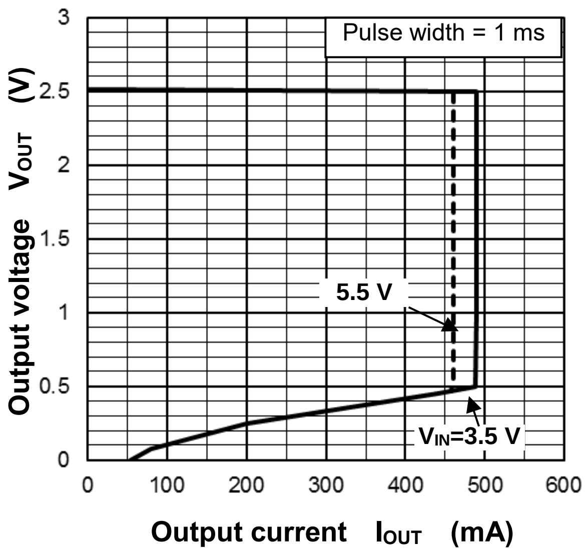


Output Voltage vs. Output Current

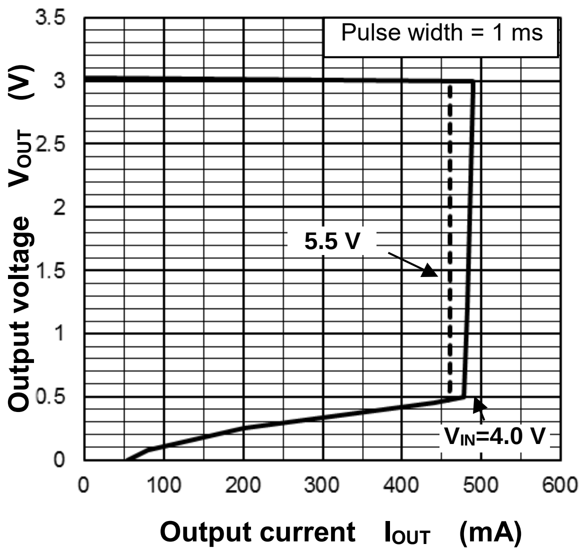




V_{OUT} = 2.5 V

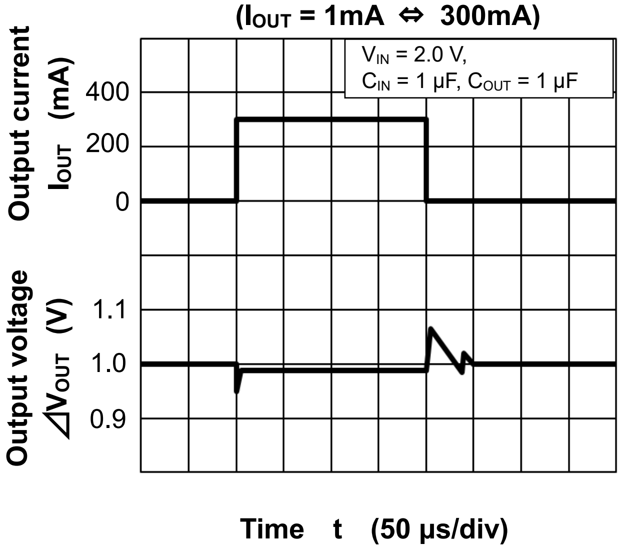


V_{OUT} = 3.0 V

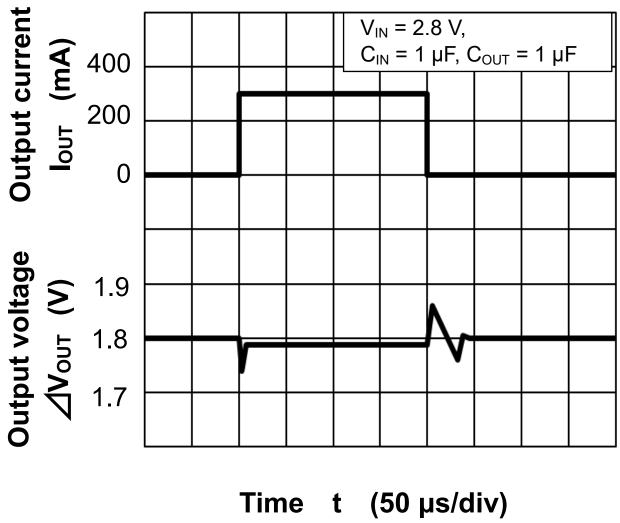


Load Transient Response

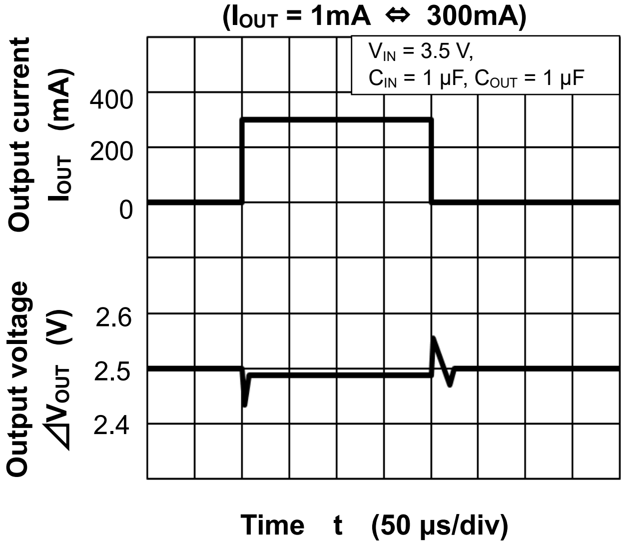
V_{OUT} = 1.0 V
(I_{OUT} = 1mA ⇔ 300mA)



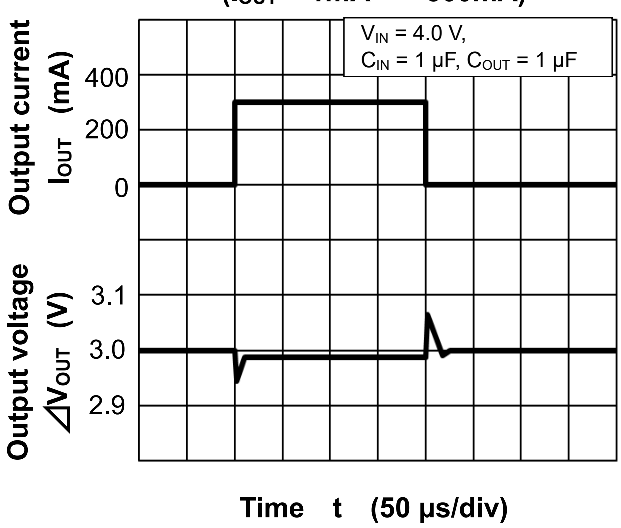
V_{OUT} = 1.8 V
(I_{OUT} = 1mA ⇔ 300mA)



V_{OUT} = 2.5 V
(I_{OUT} = 1mA ⇔ 300mA)

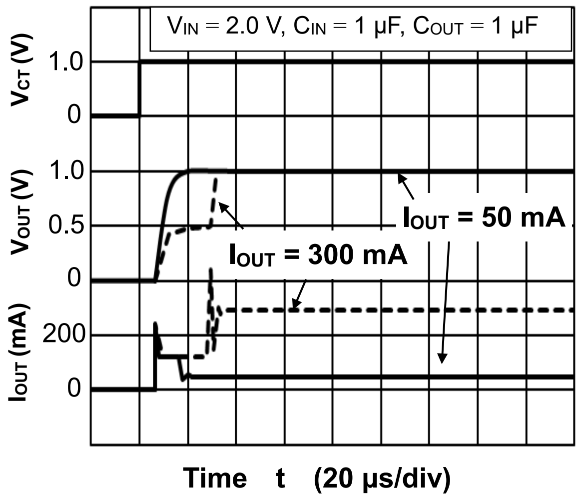


V_{OUT} = 3.0 V
(I_{OUT} = 1mA ⇔ 300mA)

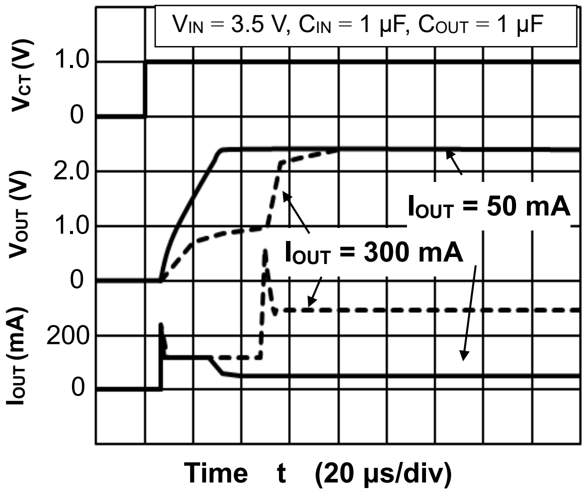


t_{ON} Response

V_{OUT} = 1.0 V

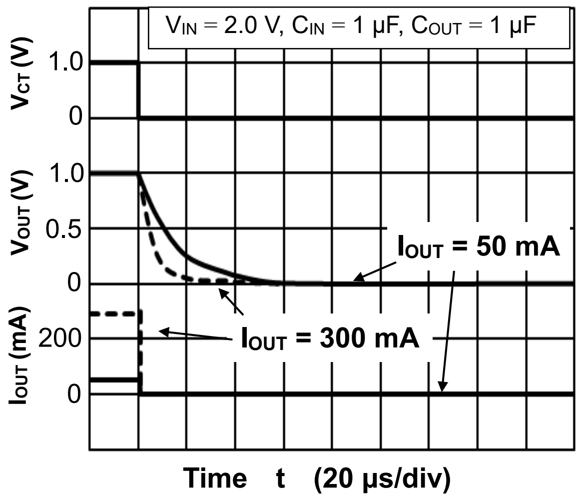


V_{OUT} = 2.5 V

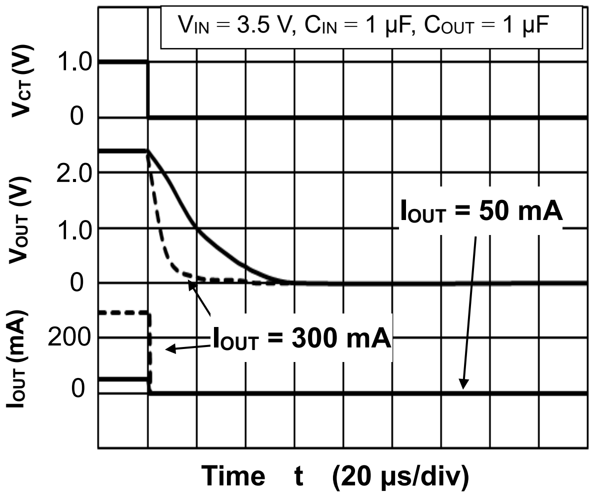


t_{OFF} Response

V_{OUT} = 1.0 V



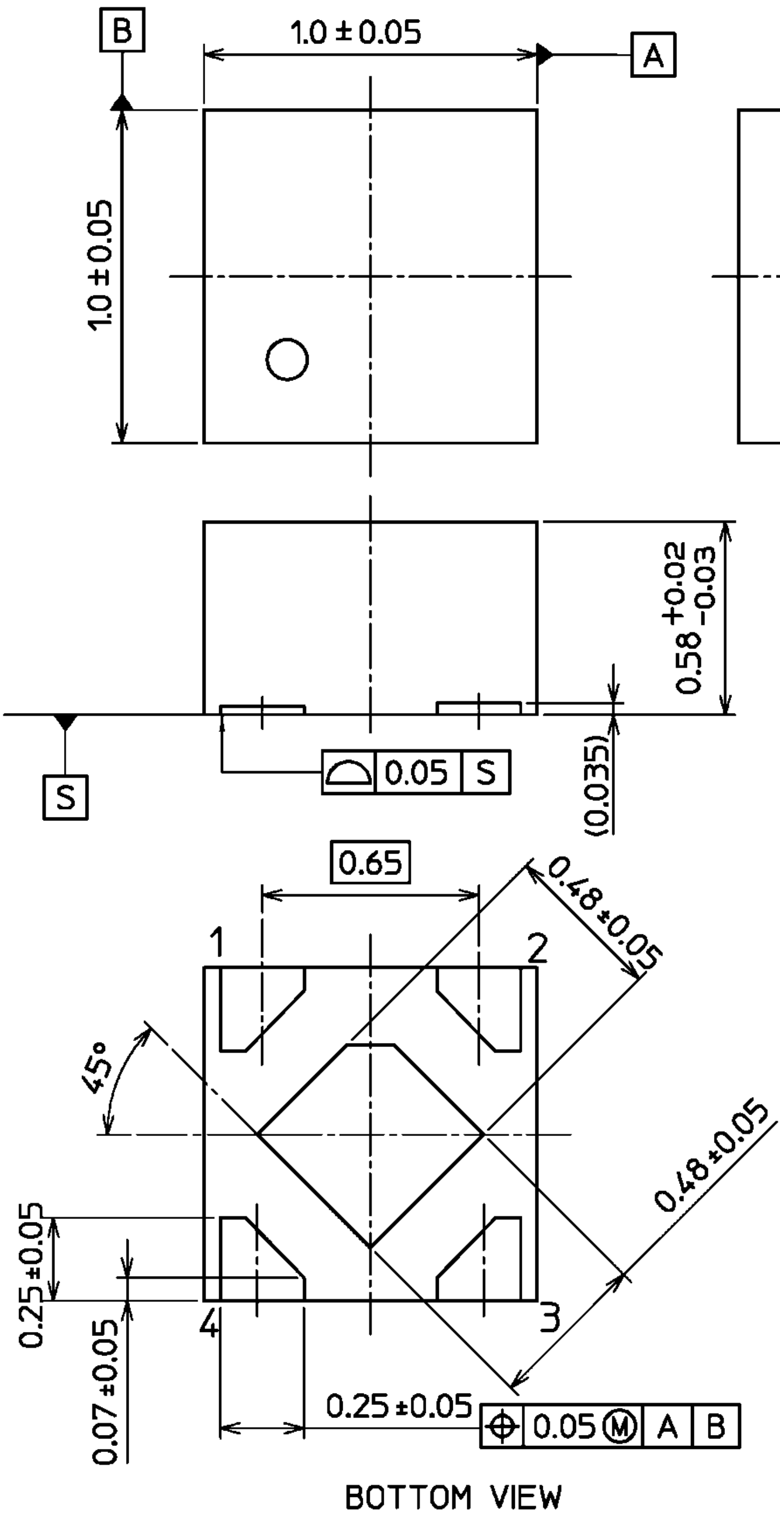
V_{OUT} = 2.5 V



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

Package Dimensions

DFN4 Unit: mm

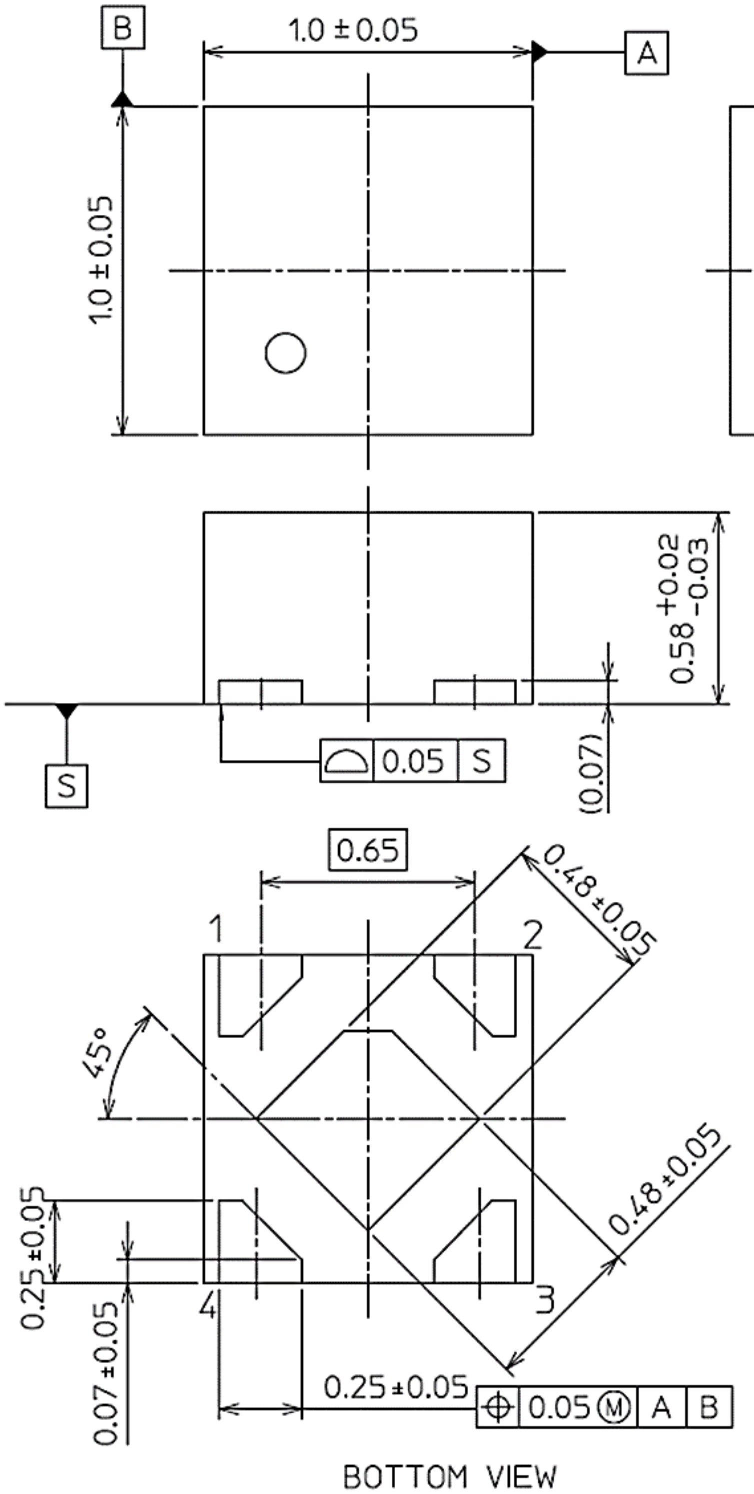


0.04 mm (typ.) unevenness exists along the edges of the back electrode to increase shear after soldering.

Weight : 1.3 mg (typ.)

Package Dimensions

DFN4E Unit: mm



Weight : 1.3 mg (typ.)

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