TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCR3DG series

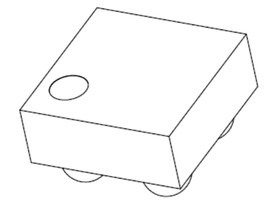
300 mA CMOS Low Drop-Out Regulator with inrush current protection circuit

The TCR3DG 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, thermal shut down function, Inrush current protection circuit and Auto-discharge function.

The TCR3DG series are offered in the ultra small package WCSP4E(0.645mm x 0.645mm; t 0.40mm). It has a low dropout voltage of 160 mV (3.2 V output, I_{OUT} = 300 mA) with low output noise voltage of 38 μV_{rms} (2.5 V output) and a load transient response of only ⊿V_{OUT} = ±80 mV (I_{OUT} = 1 mA⇔300 mA, C_{OUT} =1.0 μF).



Weight : 0.34 mg (Typ.)

As small ceramic input and output capacitors can be used with the TCR3DG series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.

Features

- Low Drop-Out voltage
  V_{IN}-V_{OUT} = 160 mV (Typ.) at 3.2 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 (⊿V_{OUT} = ±80 mV (Typ.) at I_{OUT} = 1 ⇔ 300 mA, C_{OUT} =1.0 μF)
- High ripple rejection (R.R = 70 dB (Typ.) at 2.5V-output, I_{OUT} = 10 mA, f =1kHz)
- Over current protection
- Thermal shut down function
- Inrush current protection circuit
- Auto-discharge function
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used (C_{IN} = 1.0μF, C_{OUT} =1.0 μF)
- Ultra small package WCSP4E (0.645 mm x 0.645 mm ; t 0.40 mm)

Start of commercial production
2016-03

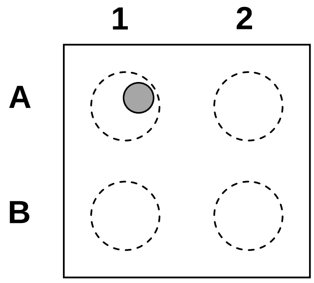
Absolute Maximum Ratings (Ta = 25°C)

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	800 (Note1)	mW
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).

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

Pin Assignment (Top view)



	1	2
A	VIN	VOUT
B	CONTROL	GND

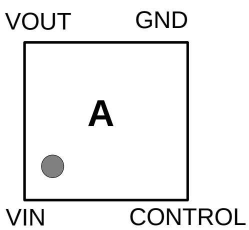
List of Products Number, Output voltage and Marking

Product No.	Output voltage (V)(Typ.)	Marking	Product No.	Output voltage (V)(Typ.)	Marking
TCR3DG10	1.0	E	TCR3DG285*	2.85	R
TCR3DG11*	1.1	F	TCR3DG30*	3.0	T
TCR3DG12	1.2	H	TCR3DG31*	3.1	U
TCR3DG13*	1.3	J	TCR3DG32	3.2	A
TCR3DG135*	1.35	K	TCR3DG33	3.3	B
TCR3DG18*	1.8	L	TCR3DG35*	3.5	V
TCR3DG25*	2.5	P	TCR3DG36*	3.6	C
TCR3DG28*	2.8	W	TCR3DG45*	4.5	D

Please ask your local retailer about the devices with (*) or other output voltages.

Top Marking (top view)

Example: TCR3DG32 (3.2 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, Ta = 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		—	8	35	mV
Quiescent current	I_B	I_{OUT} = 0 mA	V_{OUT} = 1.0V	—	65	—	μA
			V_{OUT} = 1.8V	—	65	—	
			V_{OUT} = 2.5V	—	68	—	
			V_{OUT} = 4.5V	—	78	125	
Stand-by current	$I_{B\ (OFF)}$	V_{CT} = 0 V		—	0.1	1	μA
Drop-out voltage	V_{IN}-V_{OUT}	I_{OUT} = 300 mA (Note 3)		—	195	275	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	—	$μV_{rms}$
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	⊿V_{OUT}	I_{OUT} = 1⇔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.

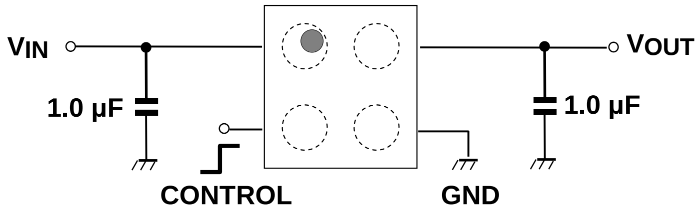
Note 3: The 2.5 V output product.

Drop-out voltage
(I_{OUT} = 300 mA, C_{IN} = 1.0 μF, C_{OUT} = 1.0 μF, Ta = 25°C)

Output voltages	Symbol	Min	Typ.	Max	Unit
1.0 V, 1.05 V	V_{IN}-V_{OUT}	—	570	750	mV
1.1 V		—	530	650	
1.2 V		—	470	600	
1.3 V		—	430	550	
1.35V		—	390	530	
1.4 V		—	370	520	
1.5 V ≤ V_{OUT} < 1.8 V		—	330	450	
1.8 V ≤ V_{OUT} < 2.1 V		—	250	365	
2.1 V ≤ V_{OUT} < 2.5 V		—	220	315	
2.5 V ≤ V_{OUT} < 2.8 V		—	190	275	
2.8 V ≤ V_{OUT} < 3.2 V		—	180	235	
3.2 V ≤ V_{OUT} < 3.6 V		—	160	215	
3.6 V ≤ V_{OUT} ≦ 4.5 V		—	130	185	

Application Note

1. Recommended Application Circuit



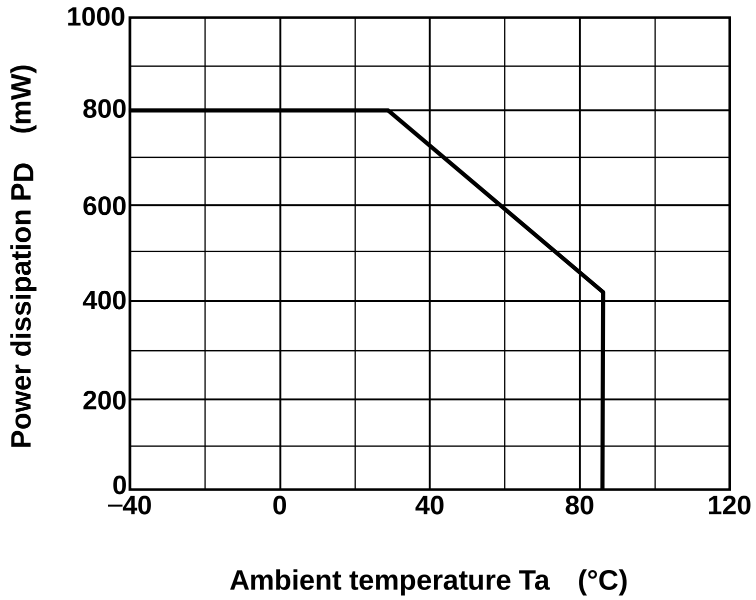
CONTROL voltage	Output voltage
HIGH	ON
LOW	OFF
OPEN	OFF

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

2. Power Dissipation

Board-mounted power dissipation ratings for TCR3DG 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: 40mm x 40mm (both sides of board), t= 1.6mm
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%
Through hole: diameter 0.5mm 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 Ω. For stable operation, please use over 1.0μF.

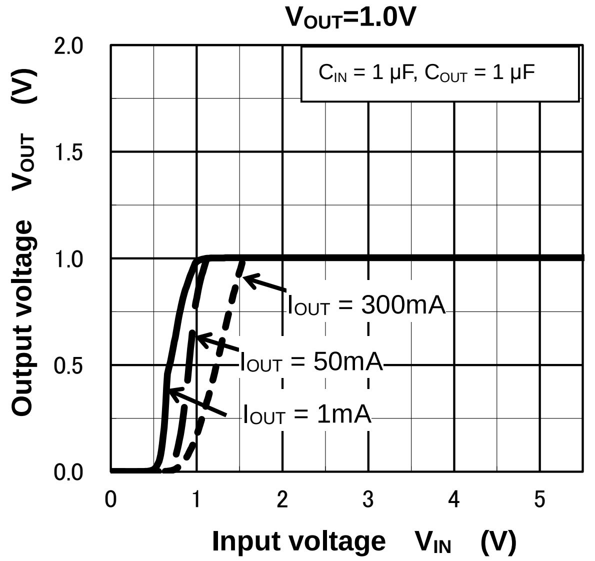
- Mounting
  The long distance between IC and output capacitor might affect phase assurance by impedance in wire and inductor. For stable power supply, output capacitor need to mount near IC as much as possible. Also VIN and GND pattern need to be large and make the wire impedance small as possible.

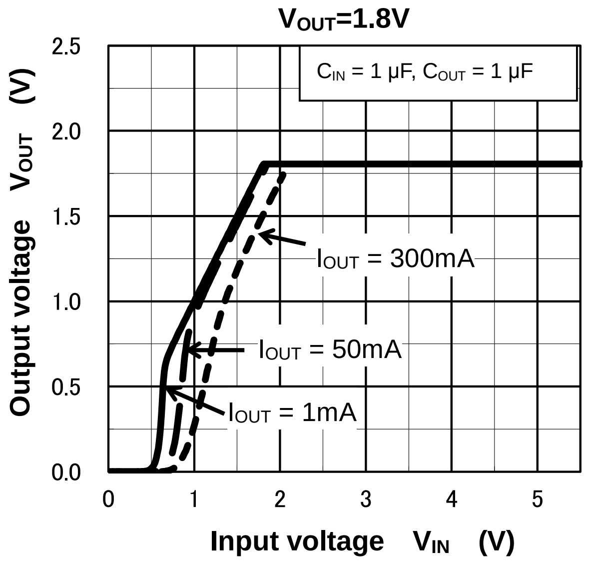
- Power Dissipation
  Please have enough design patterns for expected maximum power dissipation. And under consideration of surrounding temperature, input voltage, and output current etc, we recommend proper dissipation ratings for maximum power dissipation; in general maximum dissipation rating is 70 to 80 percent.

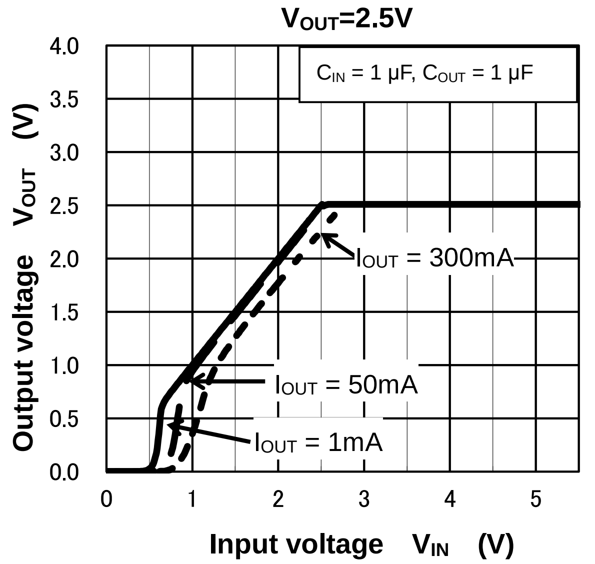
- Over current Protection and Thermal shut down function
  Over current protection and Thermal shut down function are designed in these products, but these are not designed to constantly ensure the suppression of the device within operation limits. Depending on the condition during actual usage, it could affect the electrical characteristic specification and reliability. Also note that if output pins and GND pins are not completely shorted out, these products might 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 recommend inserting failsafe system into the design.

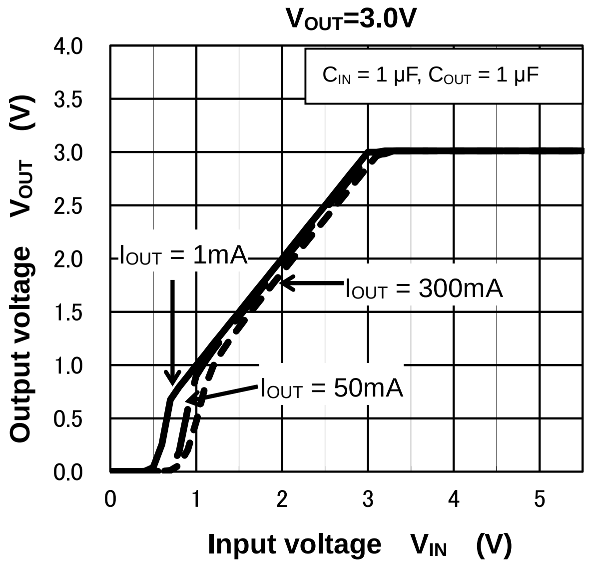
Representative Typical Characteristics

Output Voltage vs. Input Voltage

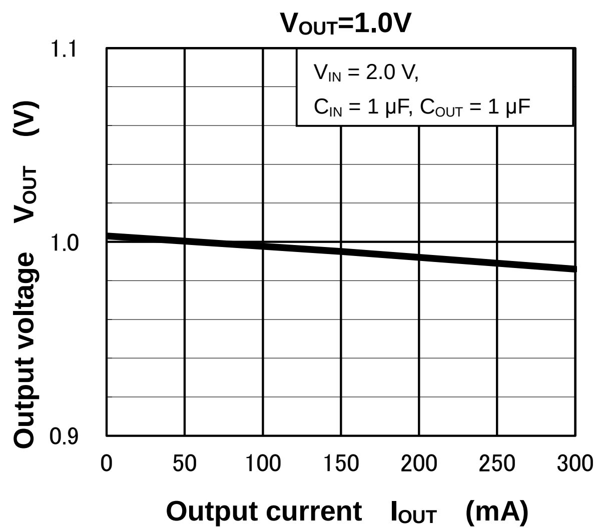


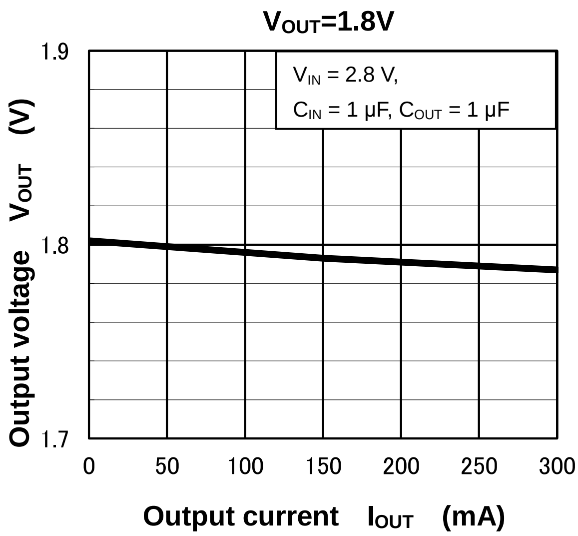


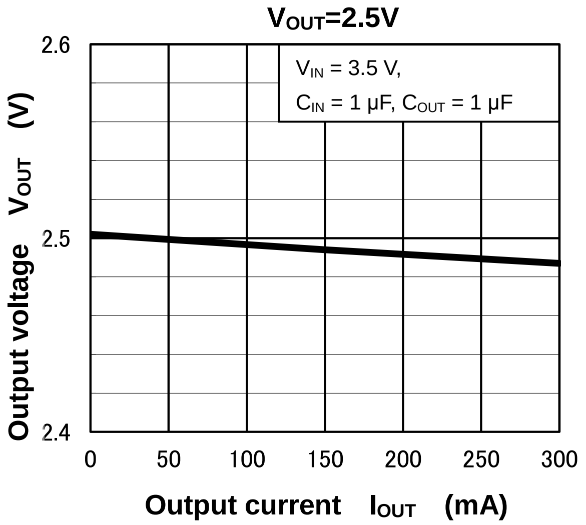


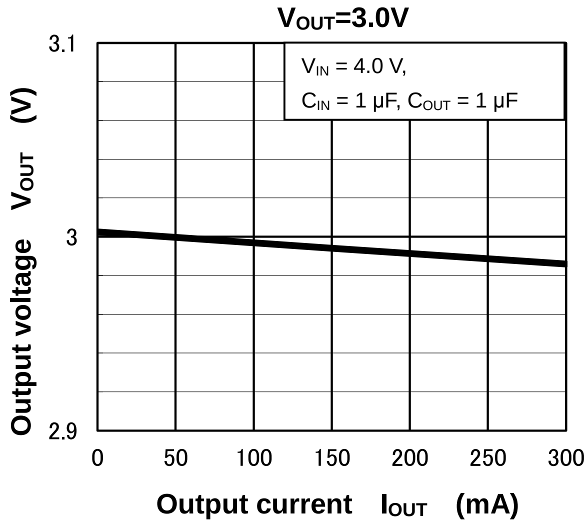


Output Voltage vs. Output Current

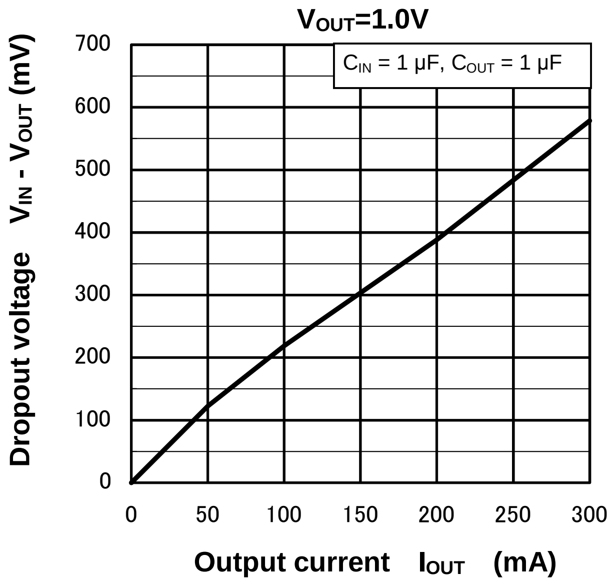


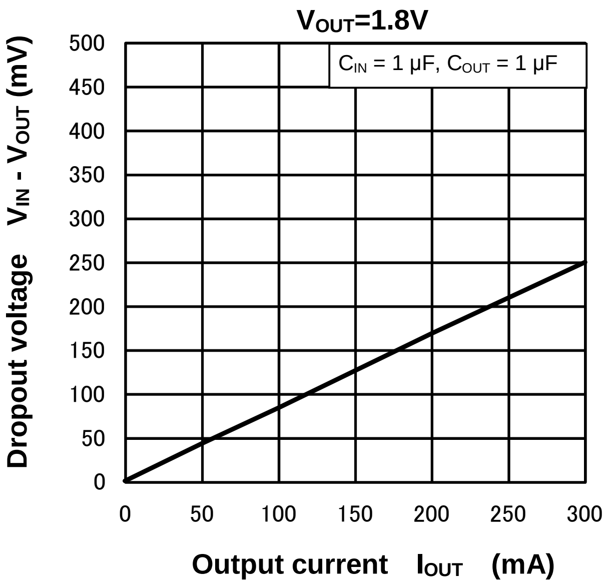


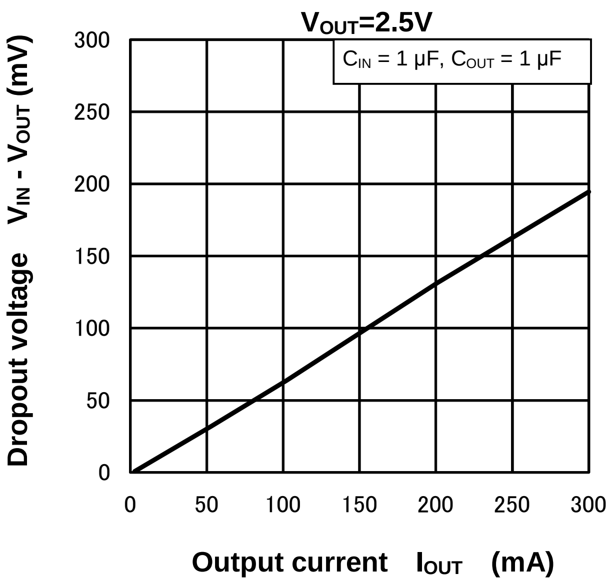


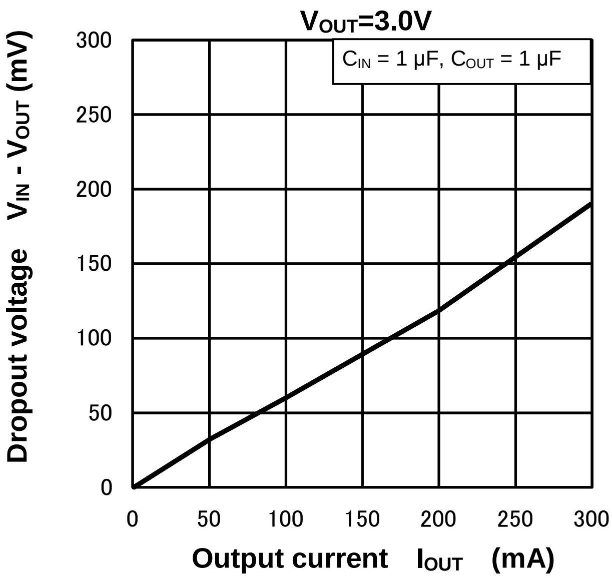


Dropout Voltage vs. Output Current

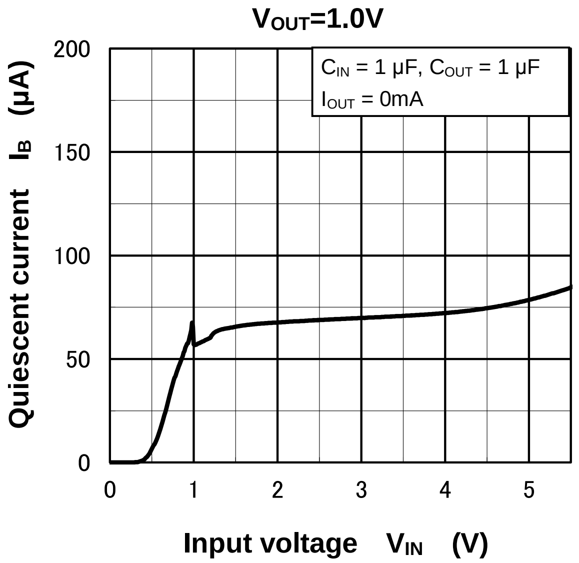


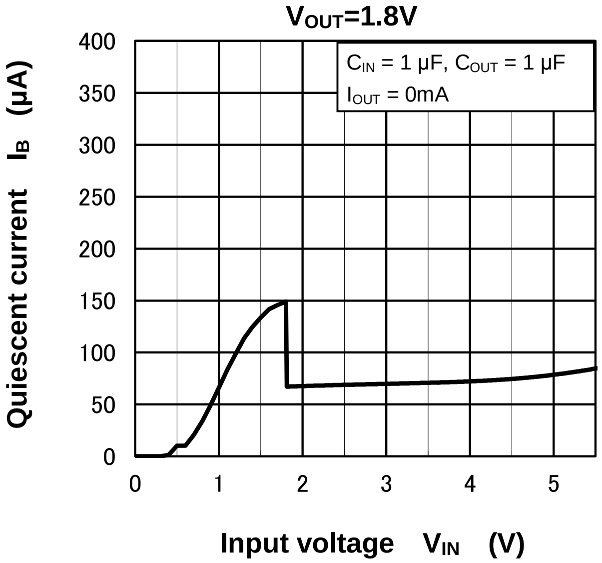


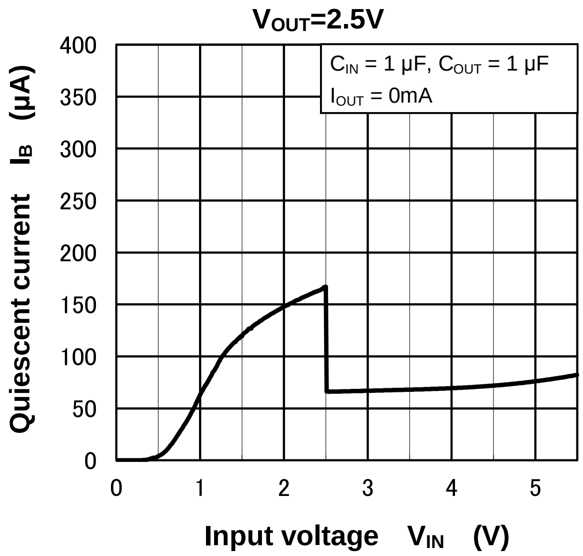


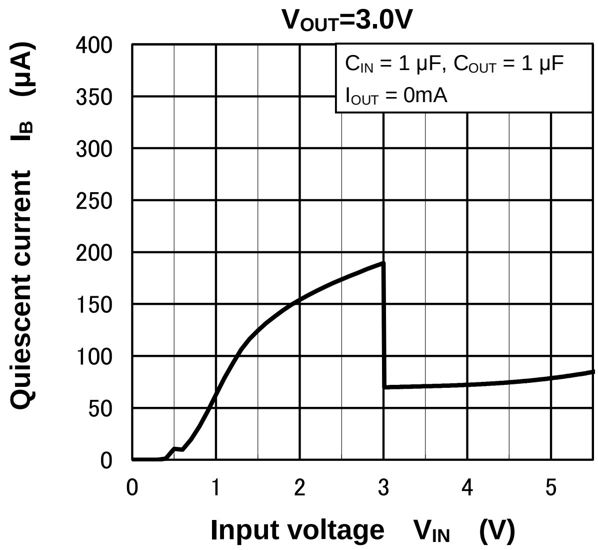


Quiescent Current vs. Input Voltage

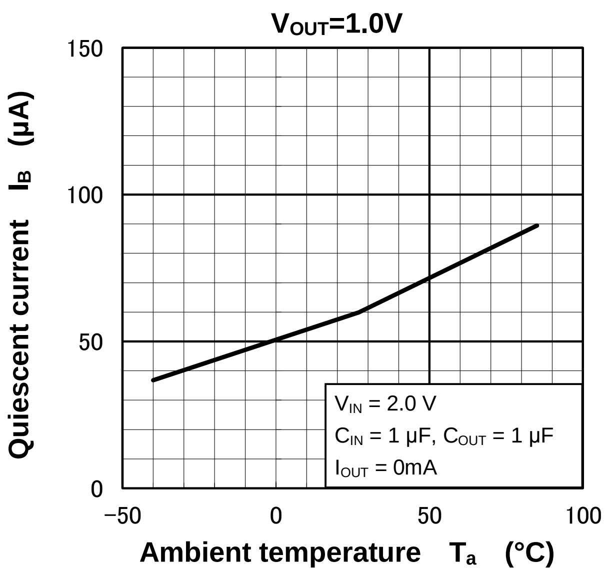


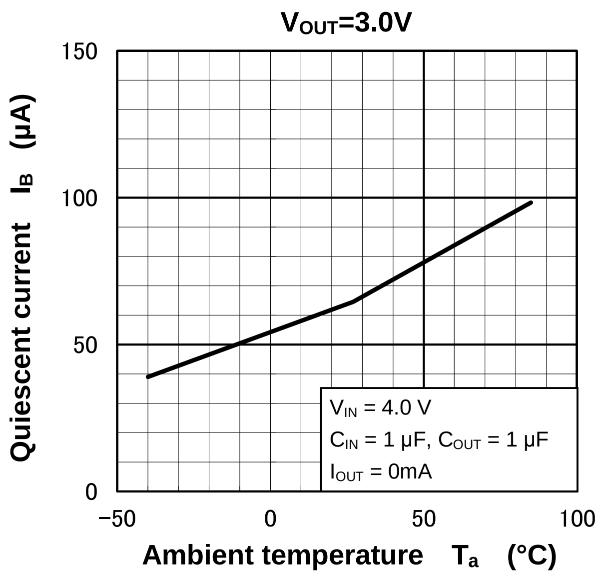




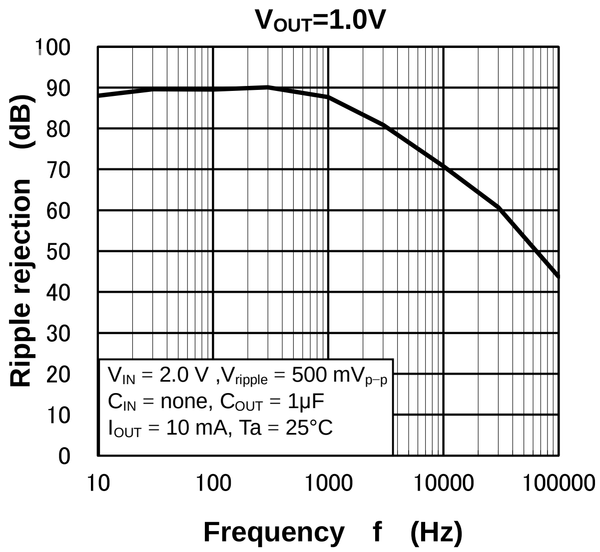


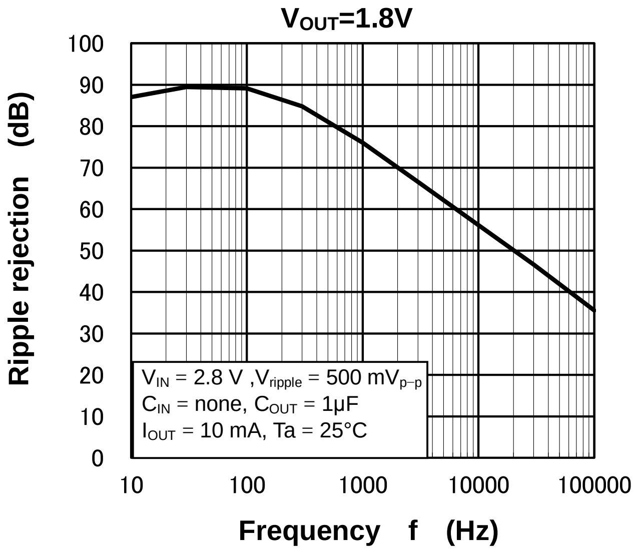
Quiescent Current vs. Ambient Temperature

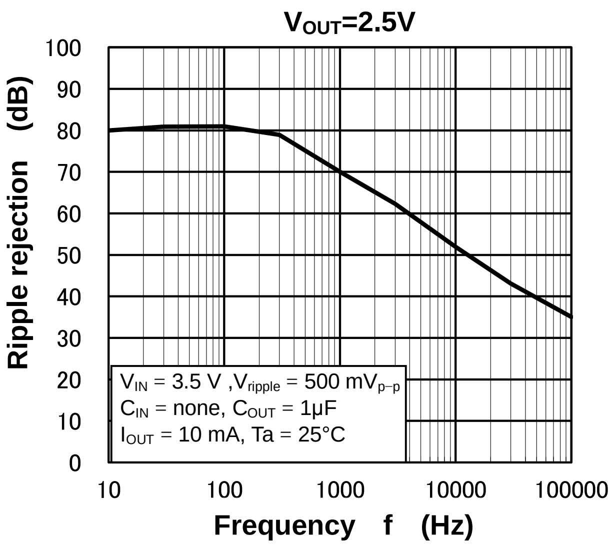


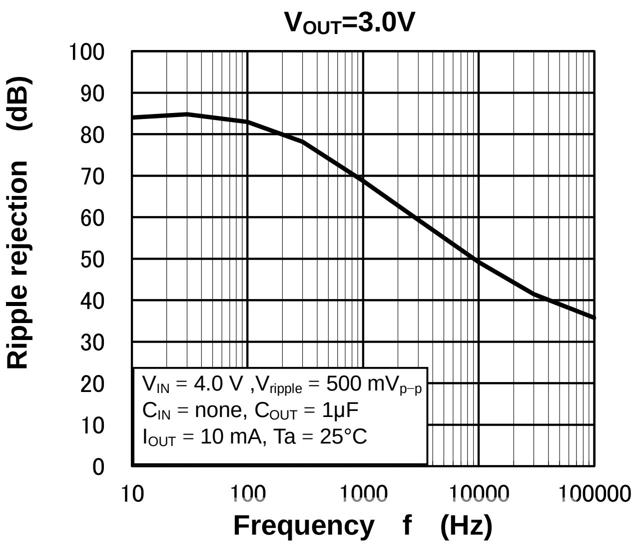


Ripple Rejection Ratio vs. Frequency

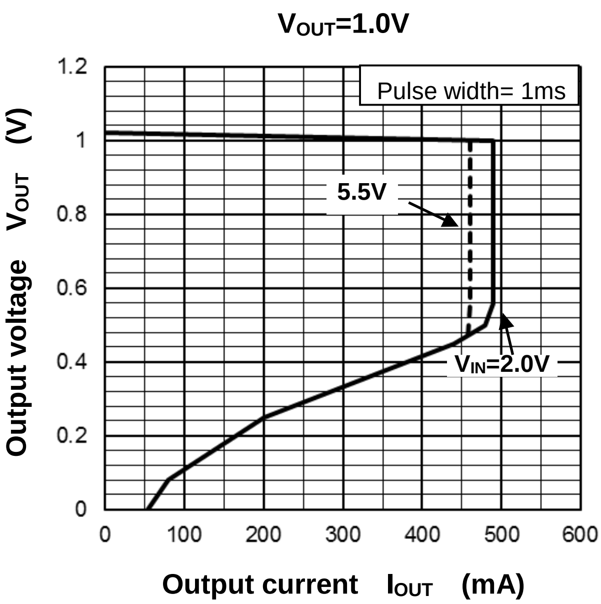


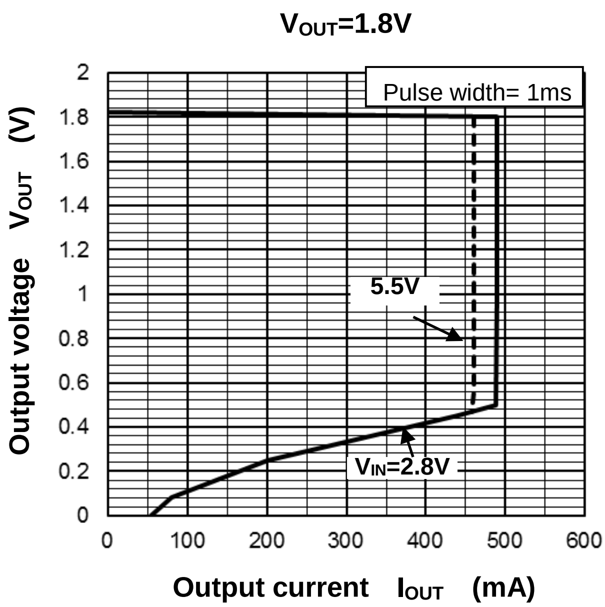




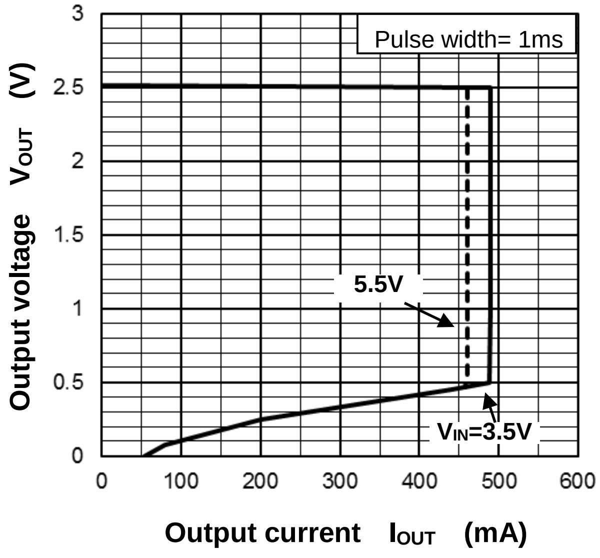


Output Voltage vs. Output Current

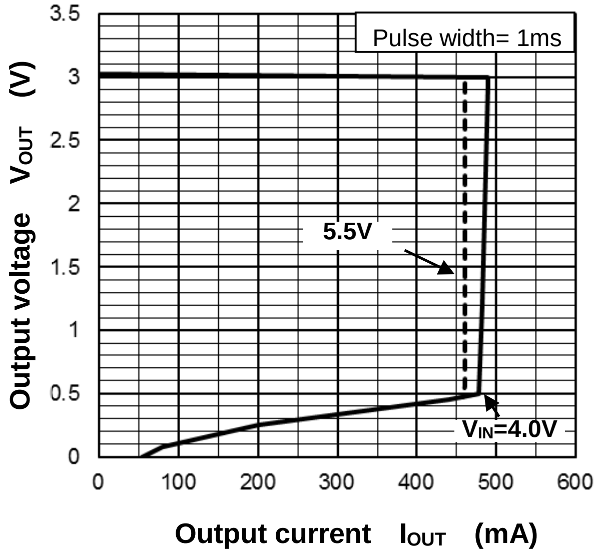




V_{OUT}=2.5V

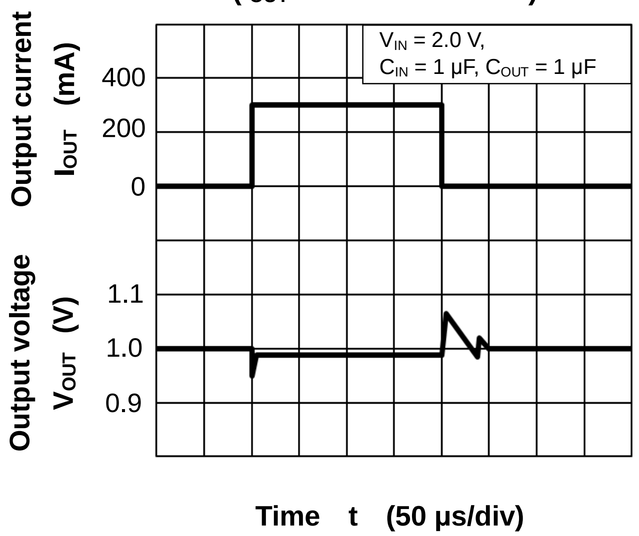


V_{OUT}=3.0V

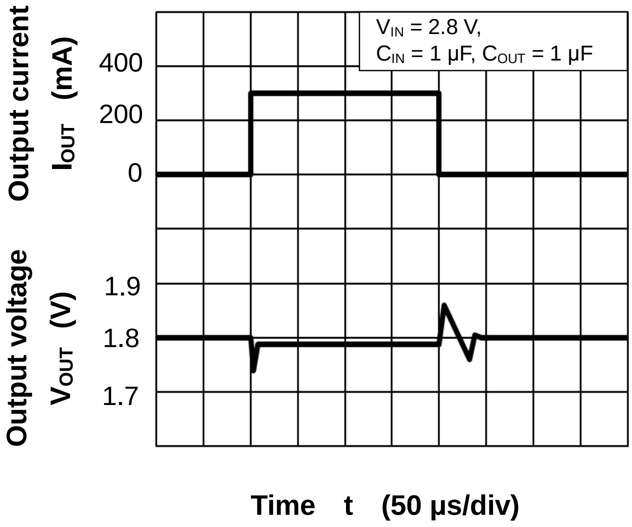


Load Transient Response

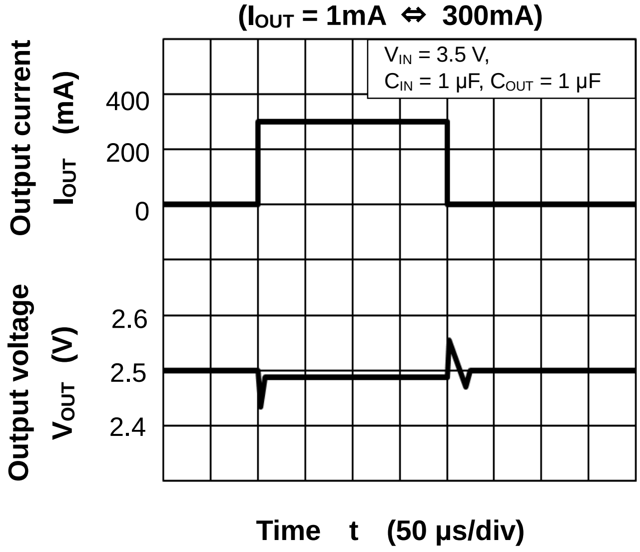
V_{OUT}=1.0V
(I_{OUT} = 1mA ⇔ 300mA)



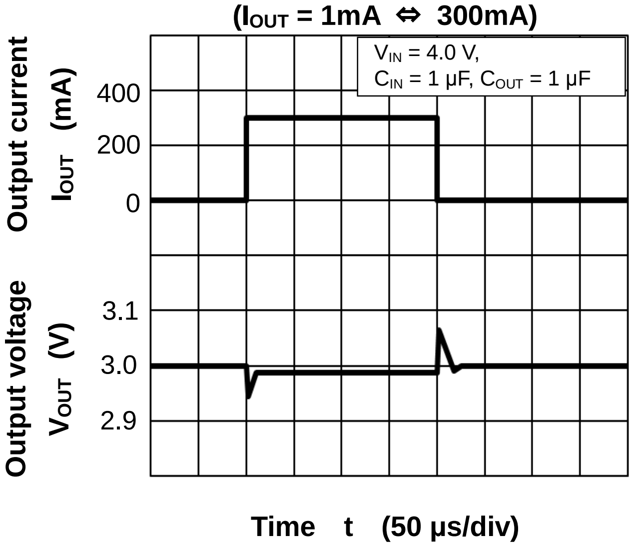
V_{OUT}=1.8V
(I_{OUT} = 1mA ⇔ 300mA)



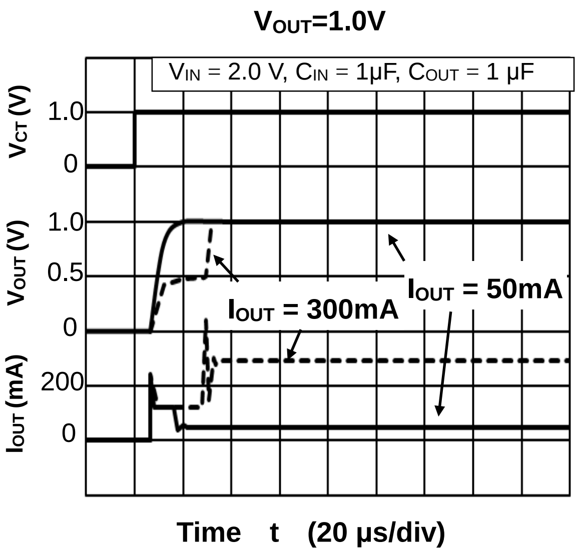
V_{OUT}=2.5V
(I_{OUT} = 1mA ⇔ 300mA)

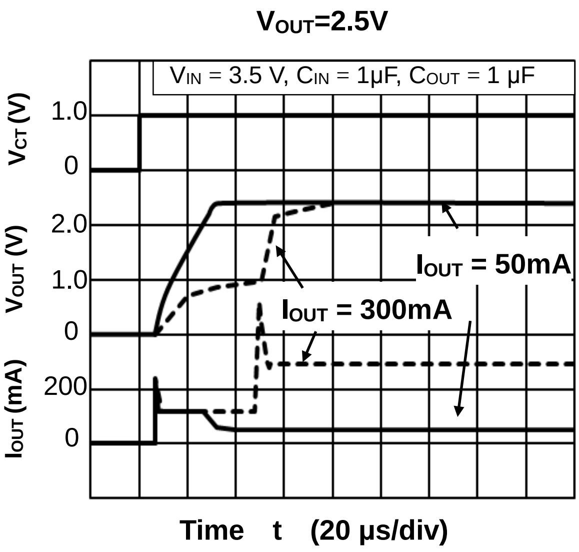


V_{OUT}=3.0V
(I_{OUT} = 1mA ⇔ 300mA)

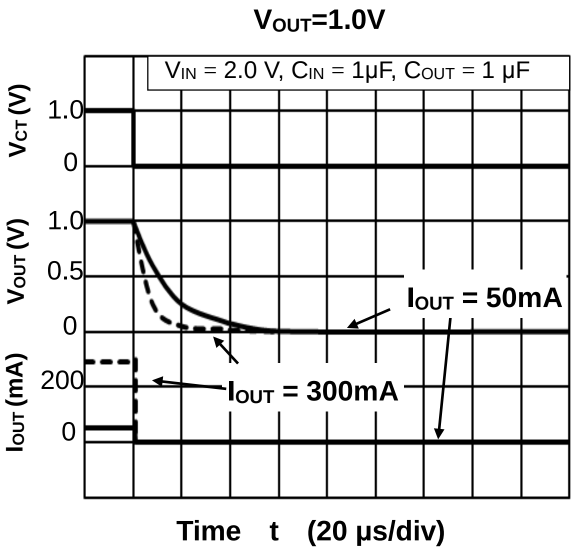


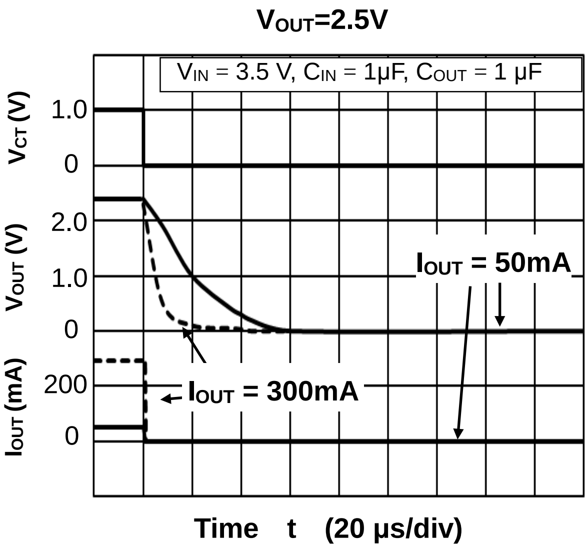
t_{ON} Response





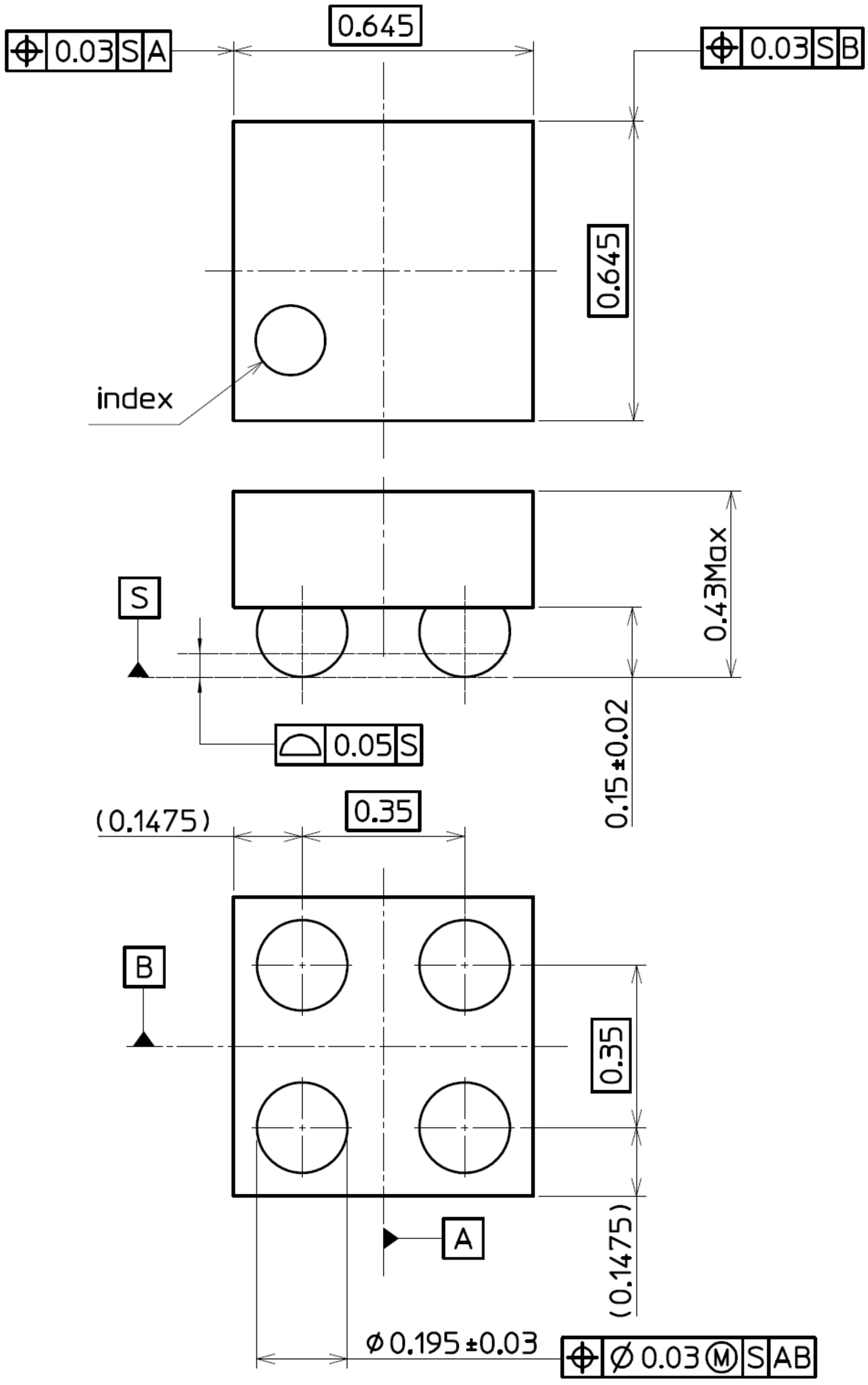
t_{OFF} Response





Package Dimensions

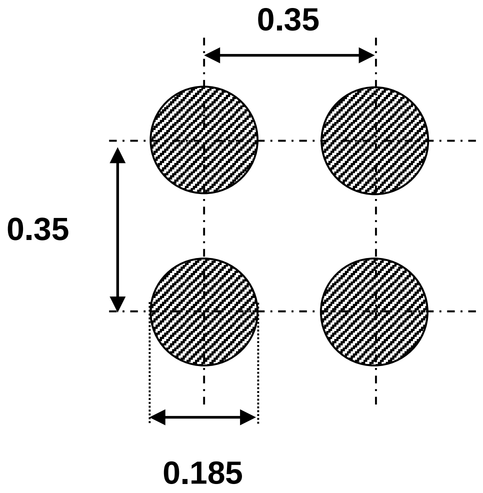
WCSP4E Unit: mm



Weight : 0.34mg(Typ)

Land pattern dimensions for reference only

Unit: mm



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