TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

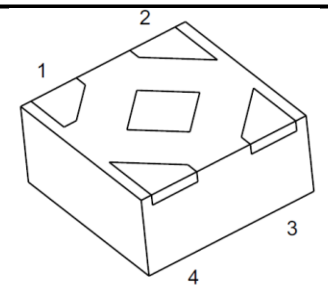
TCR2LN series

Ultra low quiescent current
200 mA CMOS Low Dropout Regulator in ultra small package

The TCR2LN series are CMOS general purpose single output voltage regulators with an on/off control input, featuring ultra low quiescent bias current and low dropout voltage.

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

The TCR2LN series is offered in the ultra small plastic mold package SDFN4/SDFN4E (0.8 mm x 0.8 mm x 0.38 mm) and has a low dropout voltage of 250 mV (2.5 V output, I_{OUT} = 150 mA). As small ceramic input and output capacitors 0.1 μF can be used with the TCR2LN series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



SDFN4/SDFN4E

Weight : 0.6 mg (typ.)

Features

- Low quiescent bias current (I_B = 2 μA (max) at I_{OUT} = 0 mA, T_j = -40 to 85 °C)
- Low dropout voltage
  V_{DO} = 250 mV (typ.) at 2.5 V-output, I_{OUT} = 150 mA
- Wide range output voltage line up (V_{OUT} = 0.8 to 3.6 V)
- High V_{OUT} accuracy ±1.0 % (1.8 V ≤ V_{OUT})
- Overcurrent protection
- Auto-discharge
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used (C_{IN} = 0.1 μF, C_{OUT} = 0.1 μF)
- Ultra small package SDFN4 (0.8 mm x 0.8 mm x 0.38 mm)

Start of commercial production
2014-08

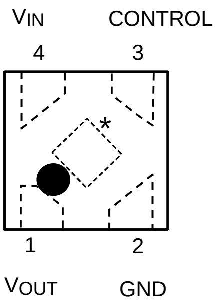
Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Input voltage	V_{IN}	6.0	V
Control voltage	V_{CT}	-0.3 to 6.0	V
Output voltage	V_{OUT}	-0.3 to V_{IN} + 0.3	V
Output current	I_{OUT}	200	mA
Power dissipation	P_D	300 (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: 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

Pin Assignment (top view)



*Center electrode should be connected to GND or Open

List of Products Number, Output voltage and Marking

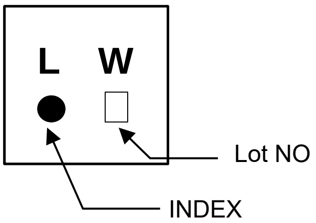
Output Auto discharge type

Product No.	Output voltage(V)	Marking	Product No.	Output voltage(V)	Marking
TCR2LN08	0.8	L8	TCR2LN19	1.9	LF
TCR2LN085	0.85	KS	TCR2LN20	2.0	LG
TCR2LN09	0.9	L9	TCR2LN21	2.1	LH
TCR2LN095	0.95	KT	TCR2LN25	2.5	LM
TCR2LN10	1.0	LJ	TCR2LN27	2.7	LO
TCR2LN105	1.05	LU	TCR2LN28	2.8	LP
TCR2LN11	1.1	L2	TCR2LN285	2.85	L7
TCR2LN115	1.15	LC	TCR2LN30	3.0	LS
TCR2LN12	1.2	L3	TCR2LN31	3.1	LT
TCR2LN13	1.3	L4	TCR2LN32	3.2	LV
TCR2LN15	1.5	LA	TCR2LN33	3.3	LW
TCR2LN18	1.8	LE	TCR2LN36	3.6	LZ

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

Top Marking

Example: TCR2LN33 (3.3 V output)



Electrical Characteristics

(Unless otherwise specified,

V_{IN} = V_{OUT}+1 V (V_{OUT} > 1.5 V), V_{IN} = 2.5 V (V_{OUT} ≤ 1.5 V), I_{OUT} = 50 mA, C_{IN} = 0.1 μF, C_{OUT} = 0.1 μF)

Characteristics	Symbol	Test Condition		T_j = 25°C			T_j = -40 to 85°C		Unit
				Min	Typ.	Max	Min	Max	
Output voltage	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} = 1 mA		1.5	—	5.5	1.5	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} ≤ 150 mA		—	15	30	—	—	mV
Quiescent current	I_B	I_{OUT} = 0 mA (Note 3)		—	1.0	—	—	2.0	μA
Stand-by current	$I_{B (OFF)}$	V_{CT} = 0 V		—	0.1	—	—	1.0	μA
Control pull down current	I_{CT}	—		—	0.1	—	—	—	μA
Dropout voltage	V_{DO}	I_{OUT} = 150 mA	V_{OUT} = 1.8 V	—	350	—	—	600	mV
			V_{OUT} = 3.0 V	—	200	—	—	280	mV
Temperature coefficient	T_{CVO}	−40°C ≤ T_{opr} ≤ 85°C		—	75	—	—	—	ppm/°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}	—		—	20	—	—	—	Ω

Note 2: Stable state with fixed I_{OUT} condition
Note 3: Except Control pull down current

Dropout voltage

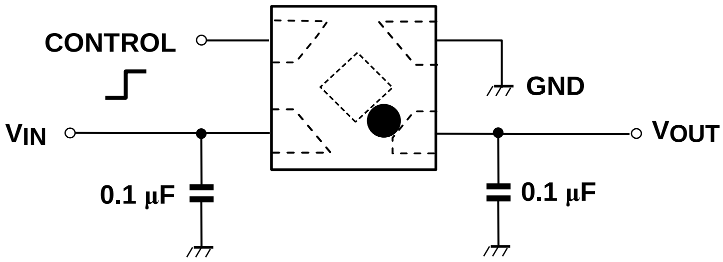
(I_{OUT} = 150 mA, C_{IN} = 0.1 μF, C_{OUT} = 0.1 μF, T_j = 25°C)

Output voltages	Symbol	Min	Typ.	Max(Note 4)	Unit
0.8 V ≤ V_{OUT} < 0.9 V	V_{DO}	—	1000	1560	mV
0.9 V ≤ V_{OUT} < 1.0 V		—	920	1460	
1.0 V ≤ V_{OUT} < 1.1 V		—	840	1380	
1.1 V ≤ V_{OUT} < 1.2 V		—	760	1280	
1.2 V ≤ V_{OUT} < 1.3 V		—	680	1230	
1.3 V ≤ V_{OUT} < 1.6 V		—	600	1110	
1.6 V ≤ V_{OUT} < 1.8 V		—	450	840	
1.8 V ≤ V_{OUT} < 2.0 V		—	350	600	
2.0 V ≤ V_{OUT} < 2.5 V		—	300	540	
2.5 V ≤ V_{OUT} < 3.0 V		—	250	360	
3.0 V ≤ V_{OUT} ≤ 3.6 V		—	200	280	

Note 4: T_j = -40 to 85°C

Application Note

1. Example of Application Circuit



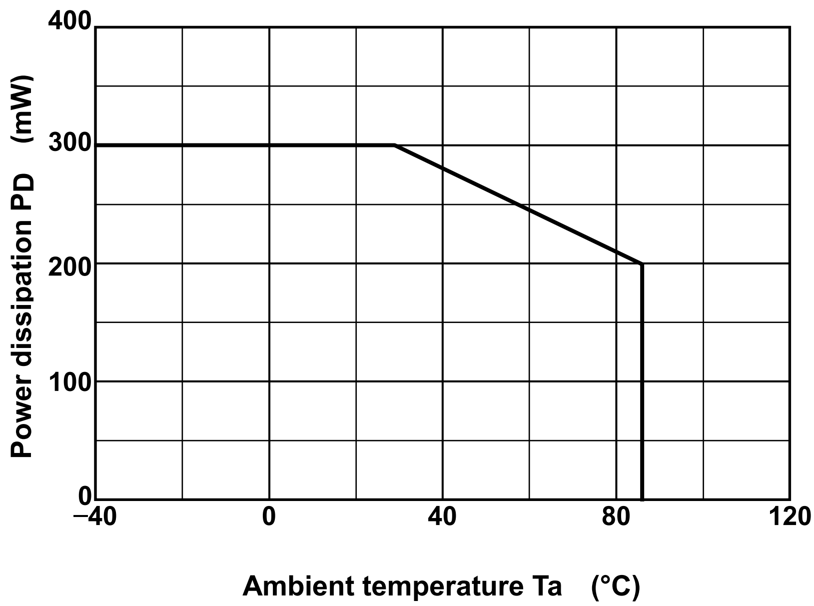
CONTROL voltage	Output voltage
HIGH	ON
LOW	OFF
OPEN	OFF

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 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 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 V_{IN} and GND pattern need to be large and make the wire impedance small as possible.

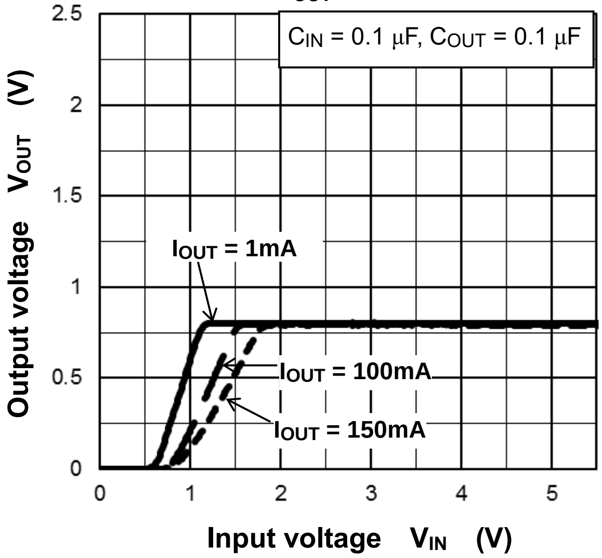
- Permissible Loss
  Please have enough design patterns for expected maximum permissible loss. And under consideration of ambient temperature, input voltage, output current etc., we recommend proper dissipation ratings for maximum permissible loss; in general maximum dissipation rating is 70 to 80 %.

- Overcurrent Protection
  Overcurrent protection is designed in these products, but this does not assure for the suppression of uprising device operation. If output pins and GND pins are shorted out, these products might break down.
  In use of these products, please read through and understand dissipation idea for absolute maximum ratings from the above mention or our 'Semiconductor Reliability Handbook'. Then use these products under absolute maximum ratings in any condition. Furthermore, Toshiba recommends inserting failsafe system into the design.

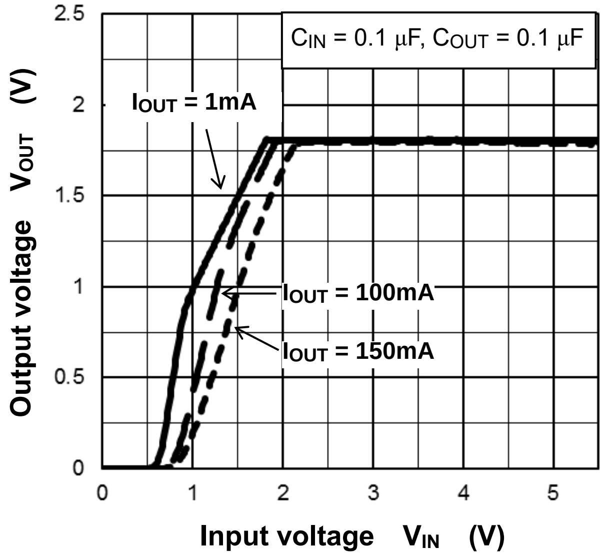
Representative Typical Characteristics

1) Output voltage vs. Input voltage

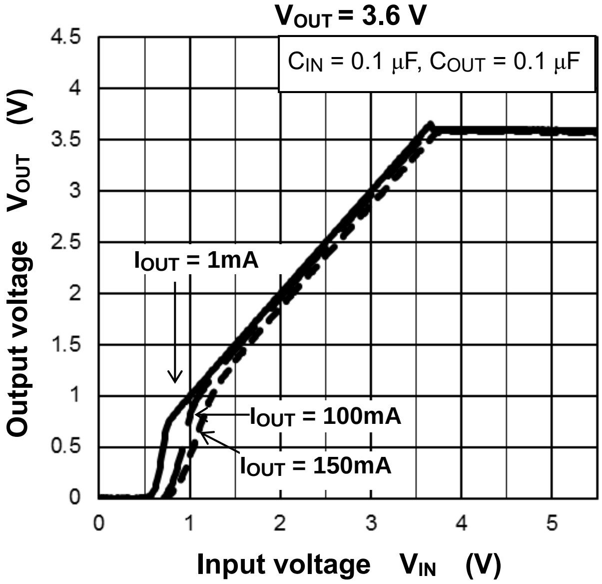
V_{OUT} = 0.8 V



V_{OUT} = 1.8 V

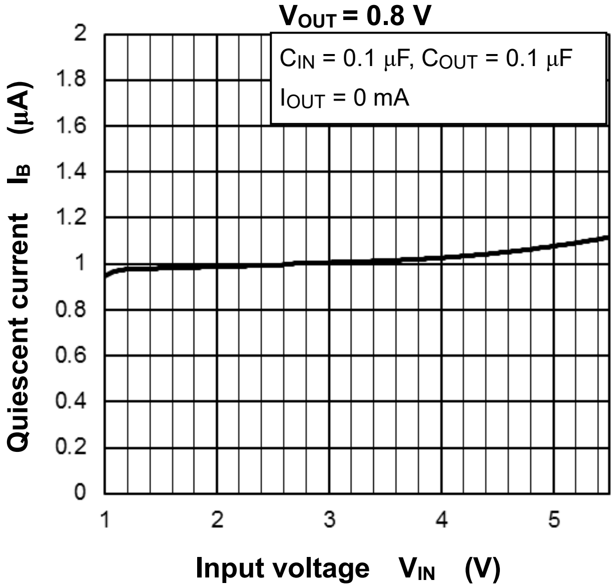


V_{OUT} = 3.6 V

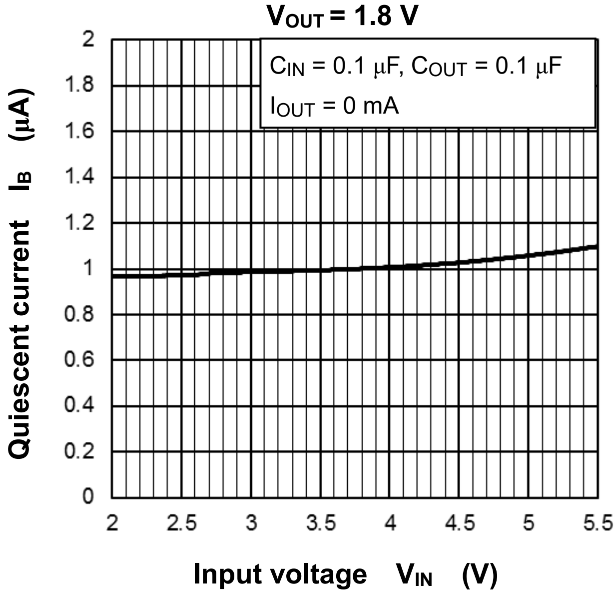


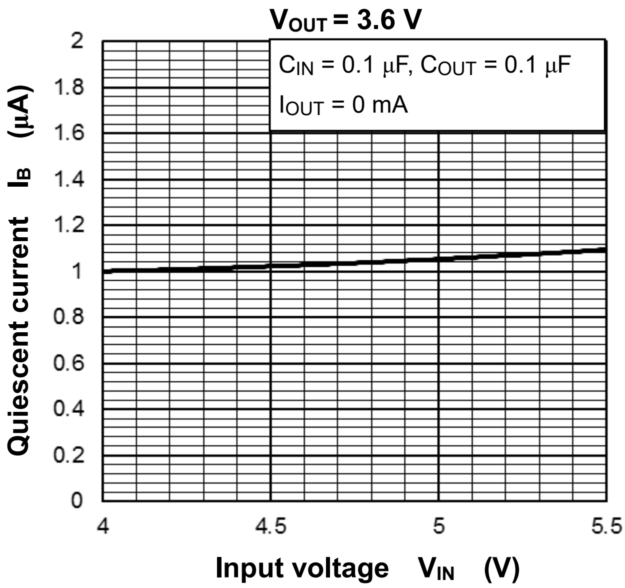
2) Quiescent current vs. Input voltage

V_{OUT} = 0.8 V

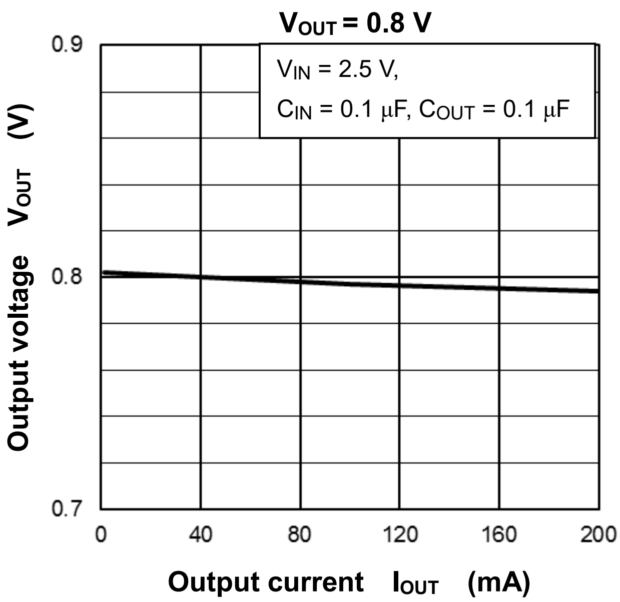


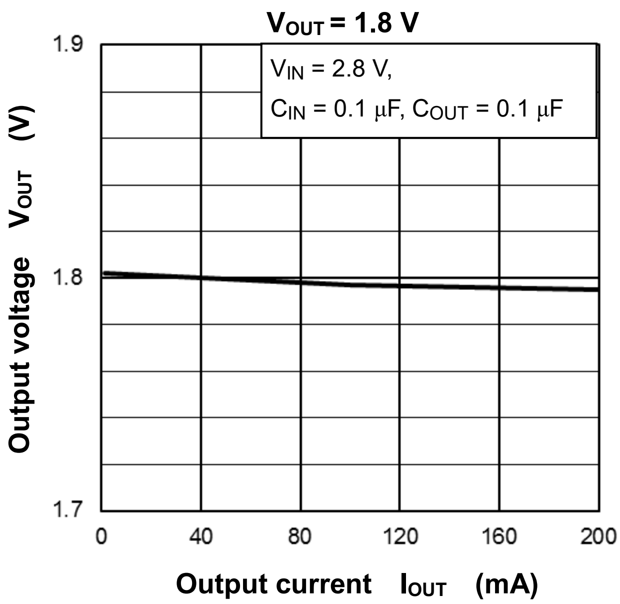
V_{OUT} = 1.8 V

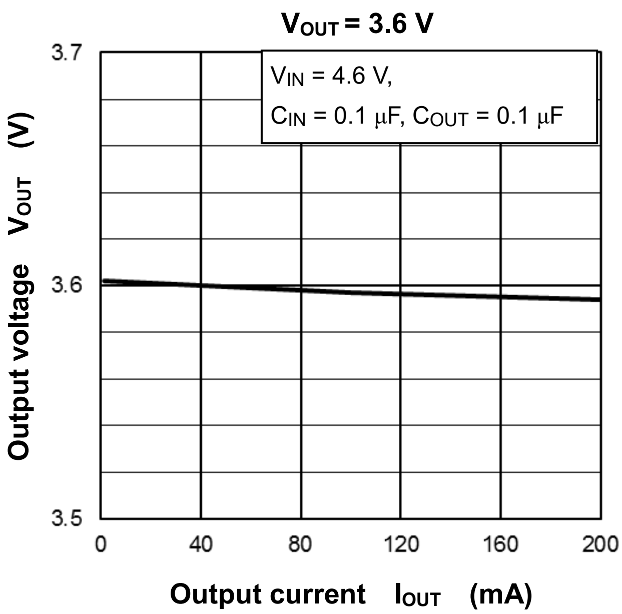




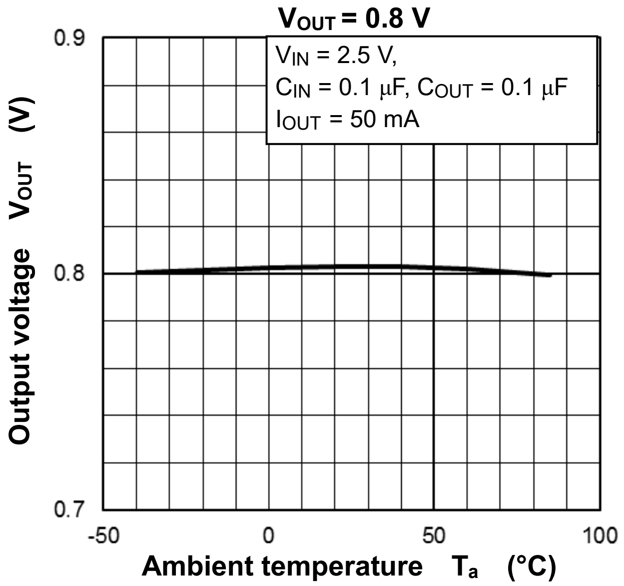
3) Output voltage vs. Output current

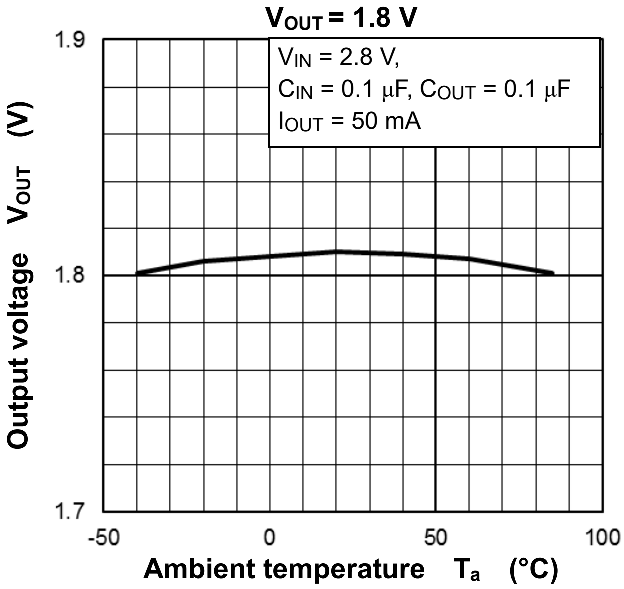


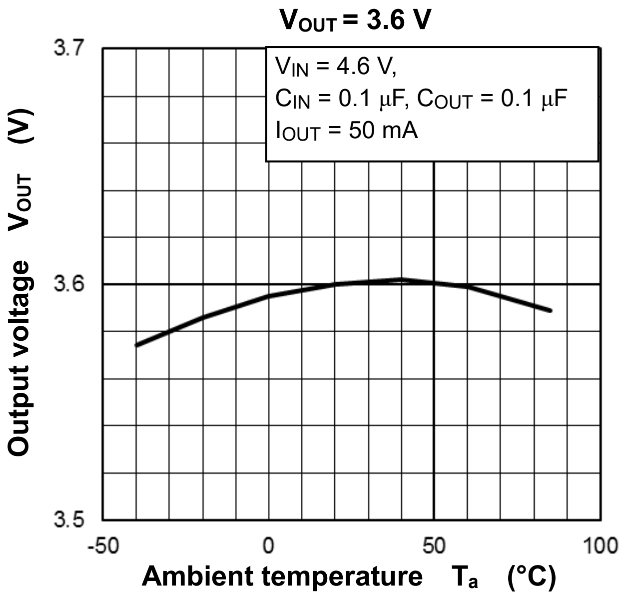




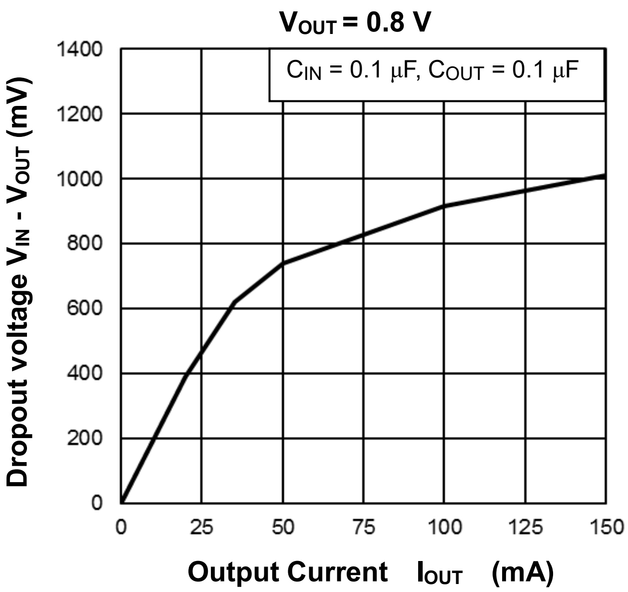
4) Output voltage vs. Ambient temperature

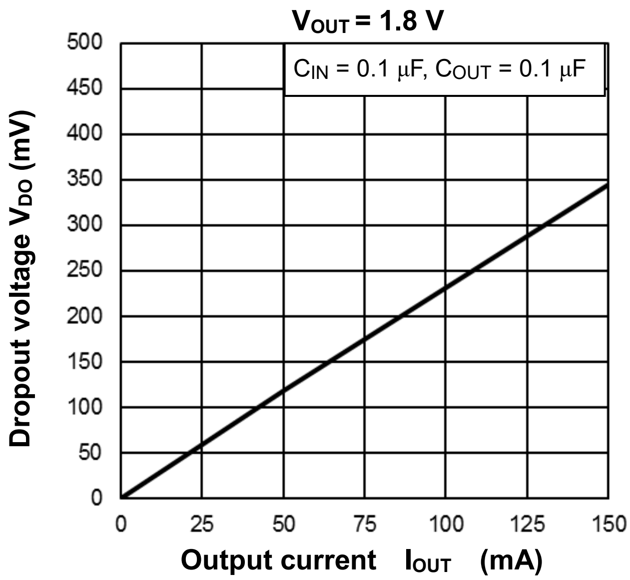


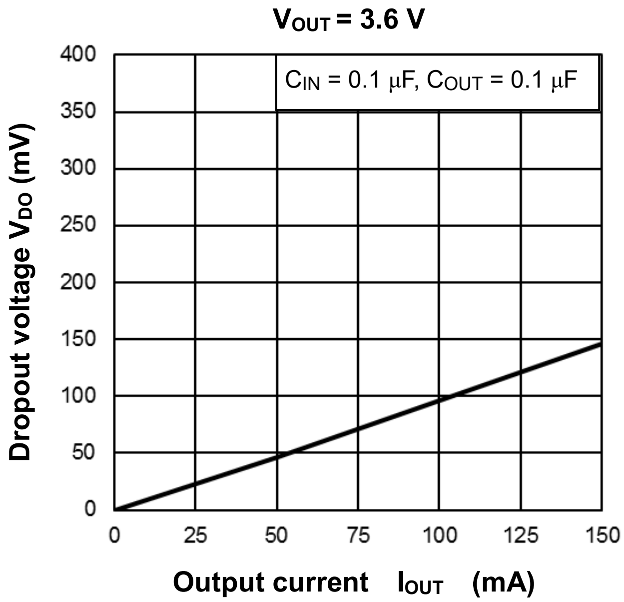




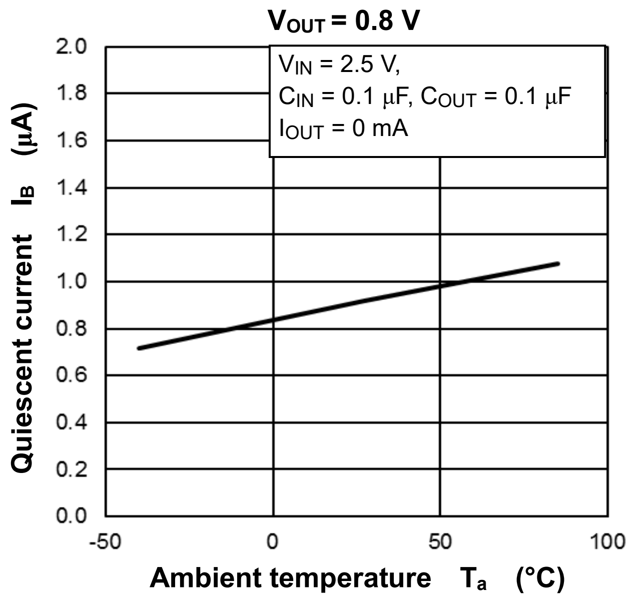
5) Dropout voltage vs. Output current

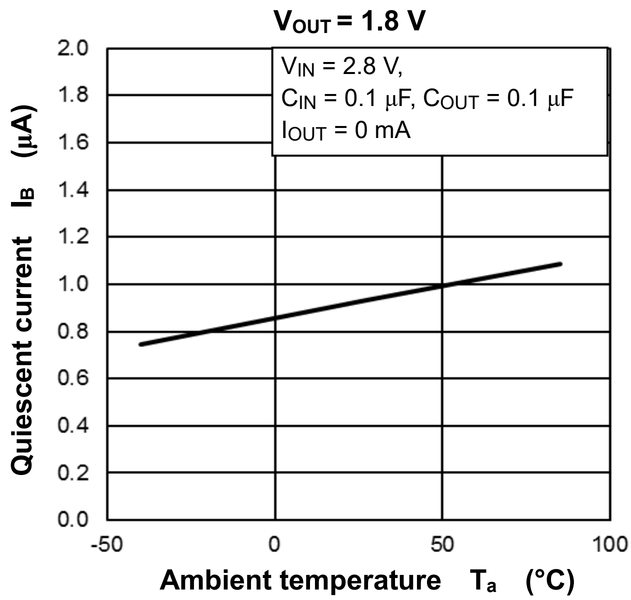


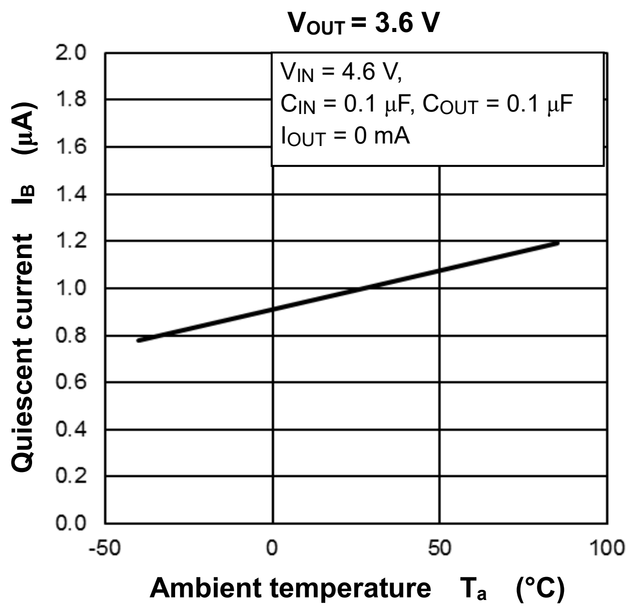




6) Quiescent current vs. Ambient temperature

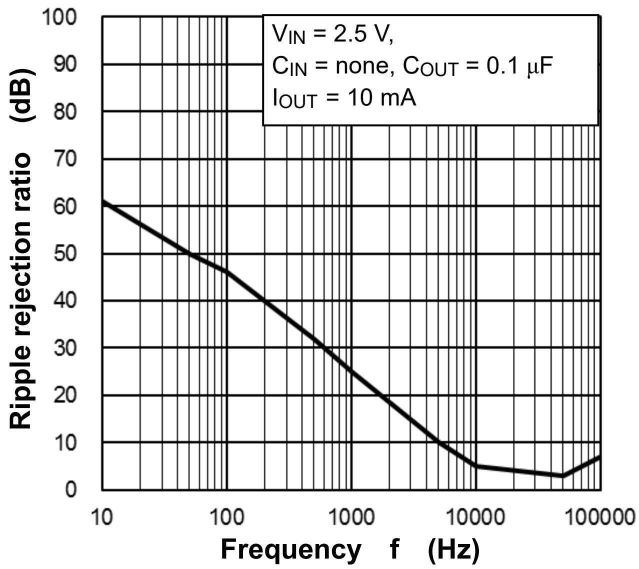




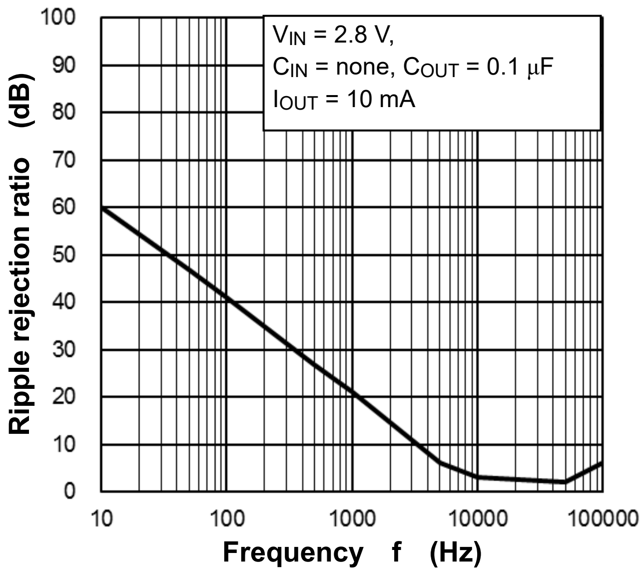


7) Ripple rejection ratio vs. Frequency

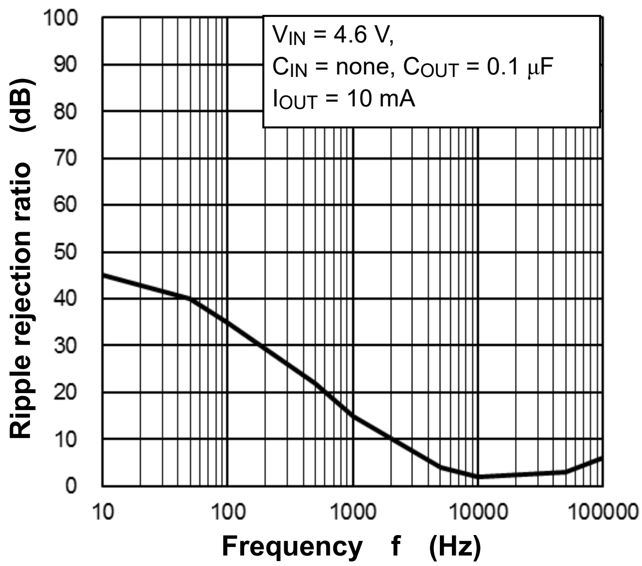
V_{OUT} = 0.8 V



V_{OUT} = 1.8 V

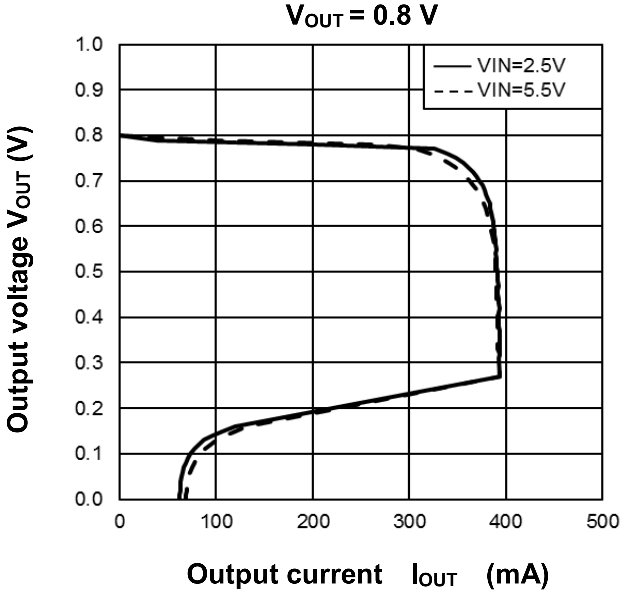


V_{OUT} = 3.6 V

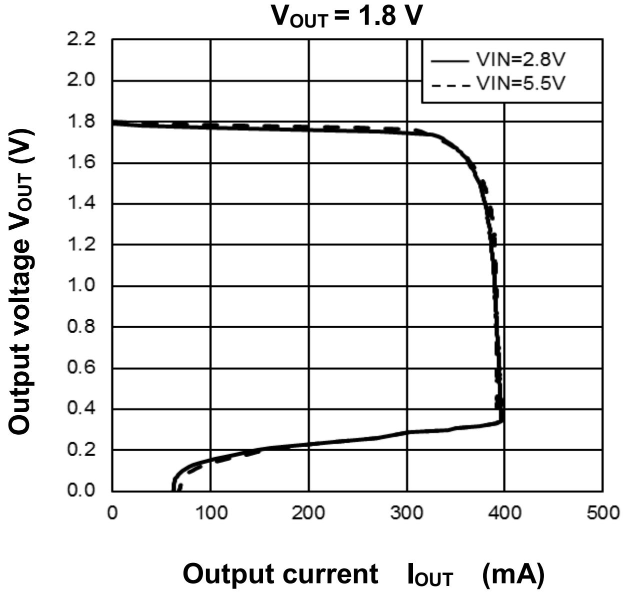


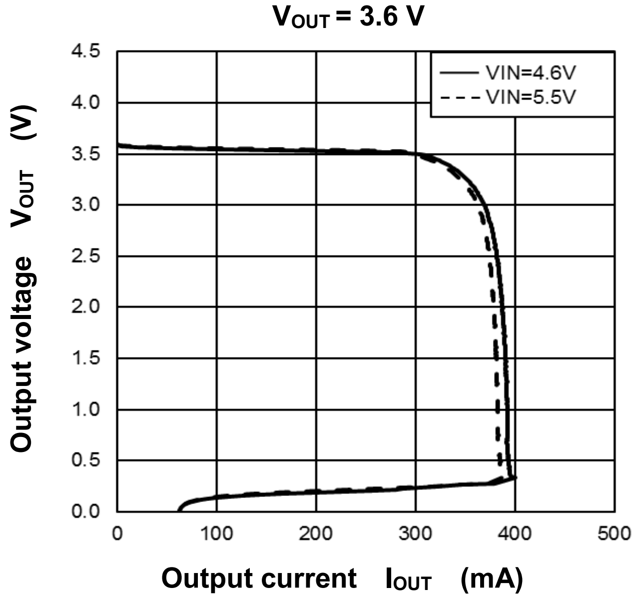
8) Output voltage vs. Output current

V_{OUT} = 0.8 V

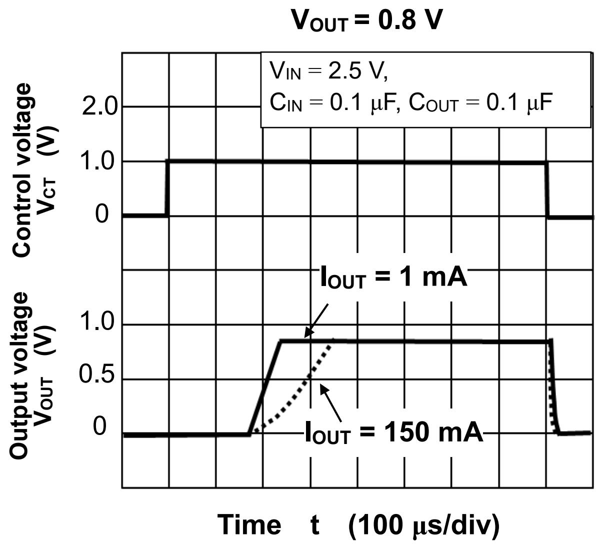


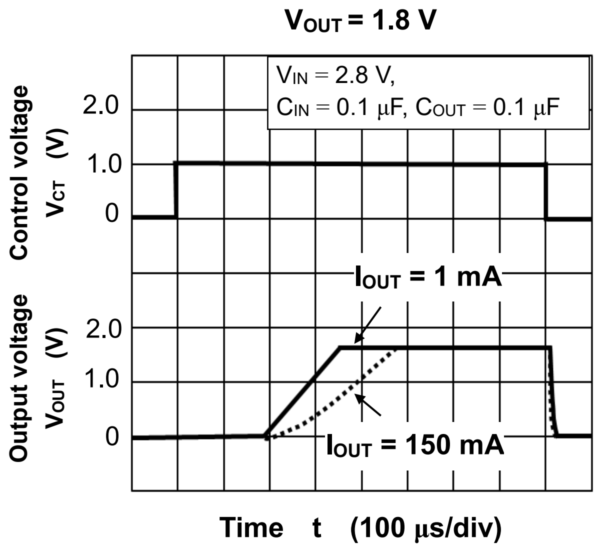
V_{OUT} = 1.8 V

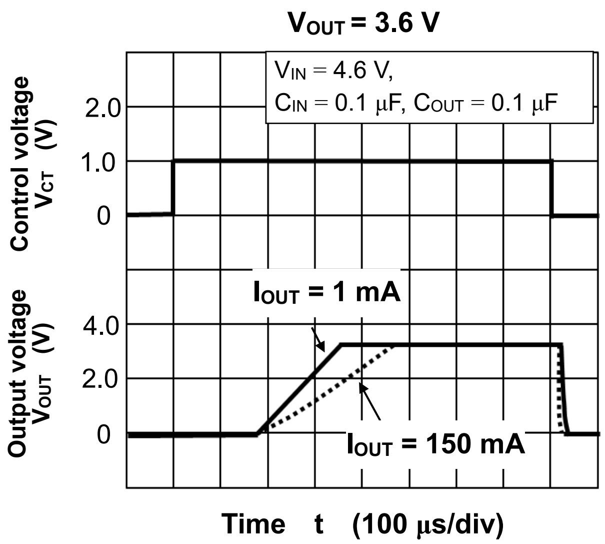




9) Control Transient vs. Response

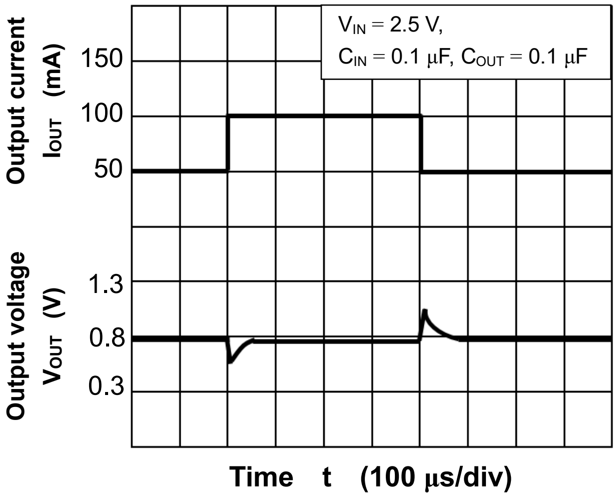




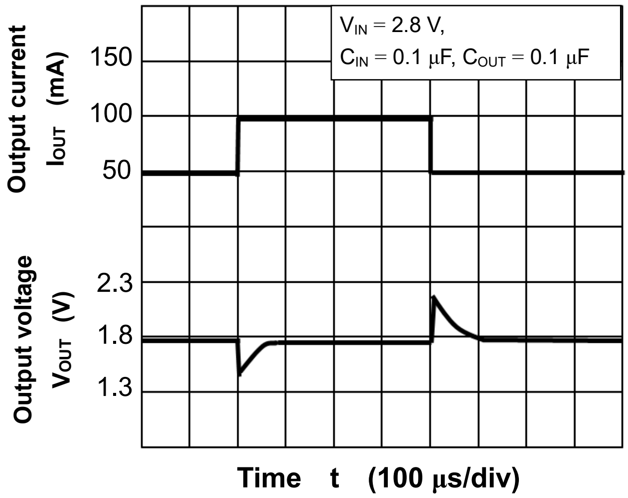


10) **Load Transient Response**

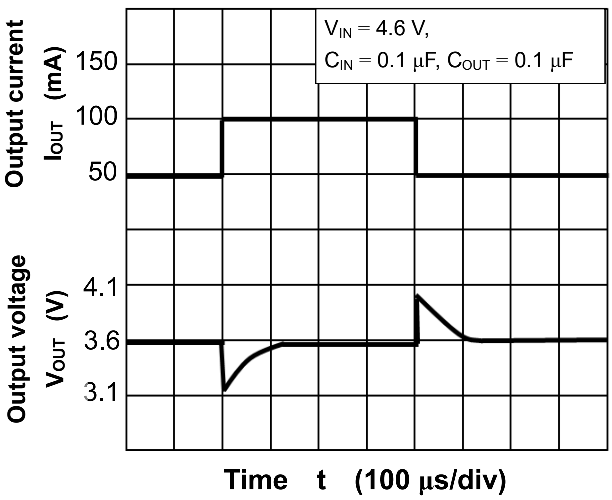
V_{OUT} = 0.8 V
(I_{OUT} = 50 mA ⇔ 100 mA)



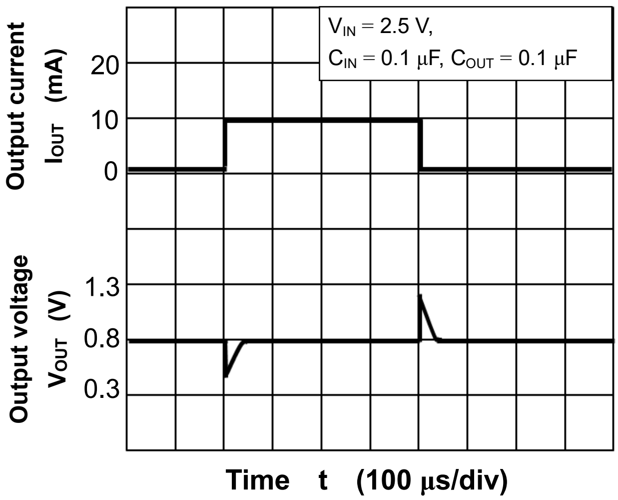
V_{OUT} = 1.8 V
(I_{OUT} = 50 mA ⇔ 100 mA)



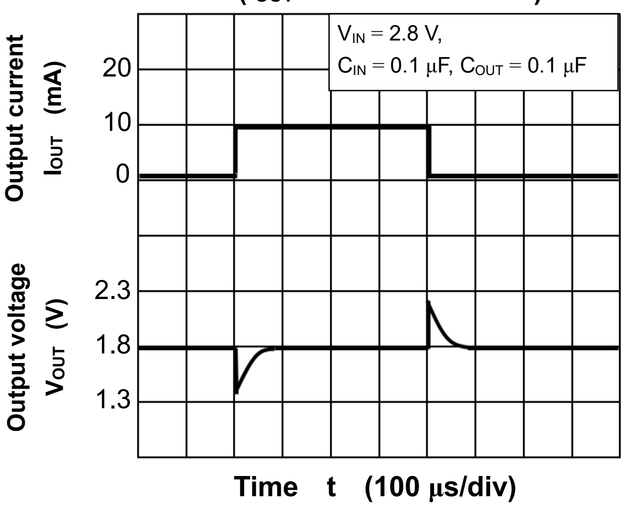
V_{OUT} = 3.6 V
(I_{OUT} = 50 mA ⇔ 100 mA)



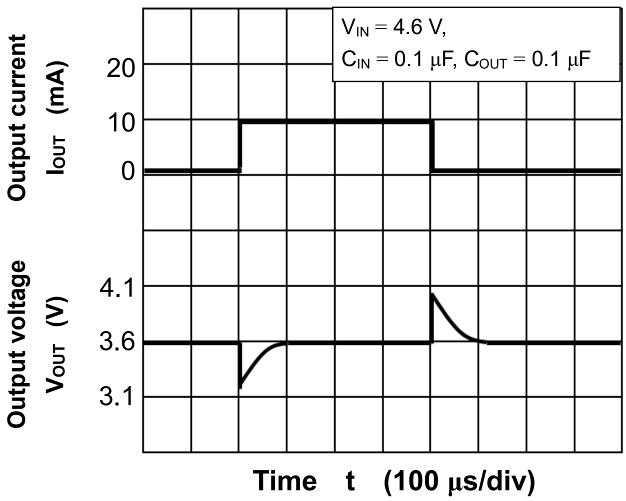
V_{OUT} = 0.8 V
(I_{OUT} = 1 mA ⇔ 10 mA)



V_{OUT} = 1.8 V
(I_{OUT} = 1 mA ⇔ 10 mA)



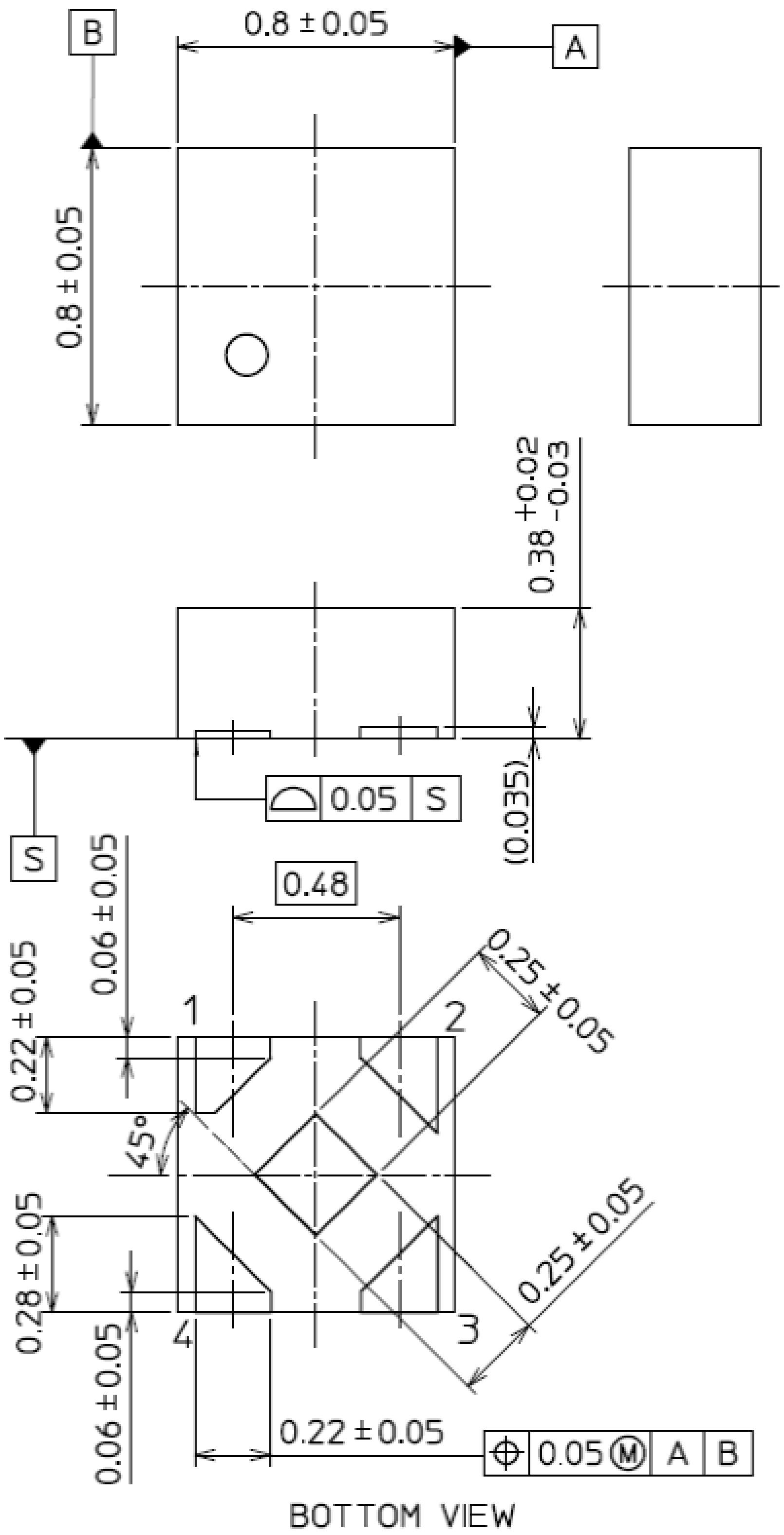
V_{OUT} = 3.6 V
(I_{OUT} = 1 mA ⇔ 10 mA)



Package Dimensions

SDFN4

Unit: mm



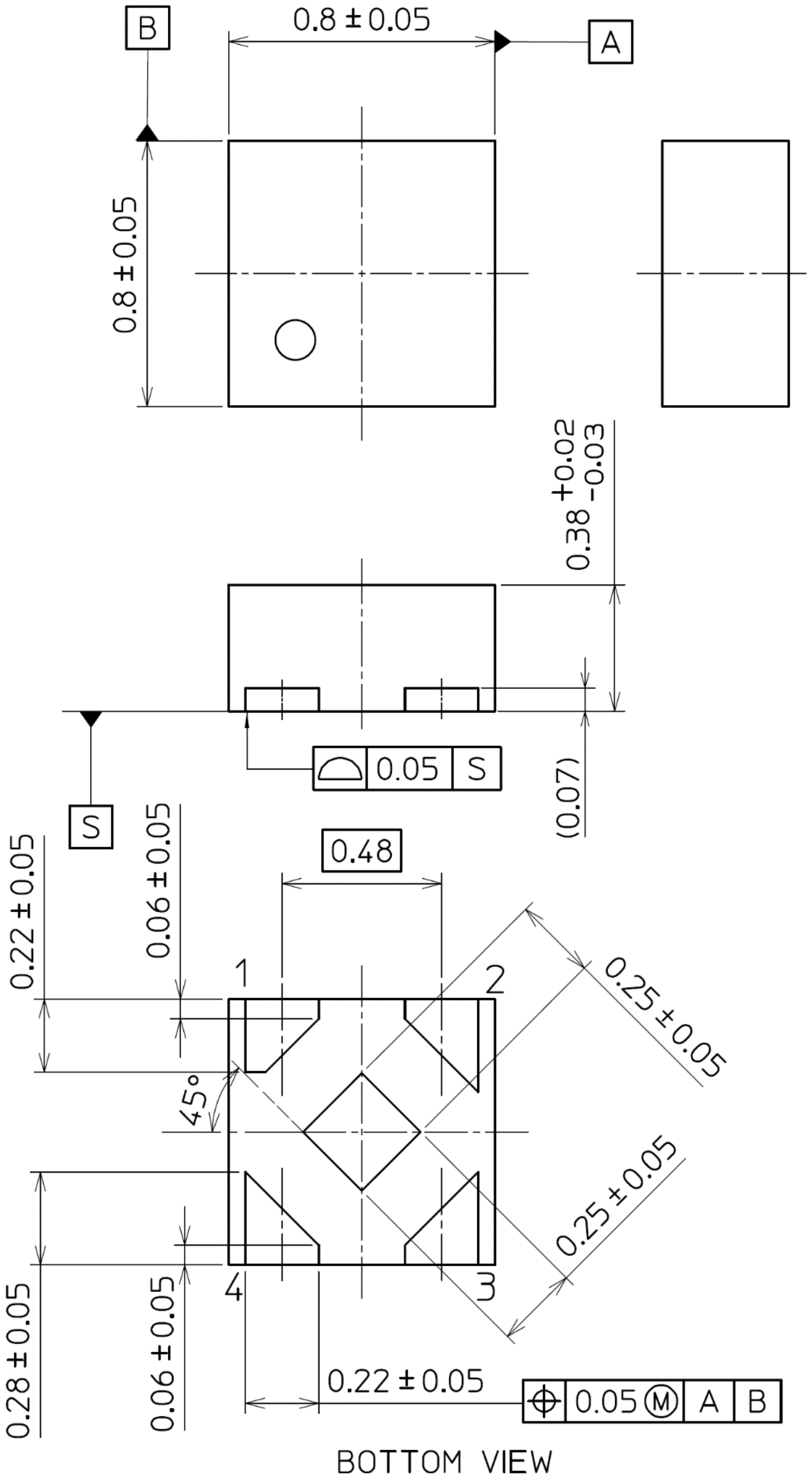
0.04 mm (typ.) unevenness exists along the edges of the back electrode to increase shear after soldering.

Weight : 0.6 mg (typ.)

Package Dimensions

SDFN4E

Unit: mm



Weight : 0.6 mg (typ.)

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