TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCR2EN series

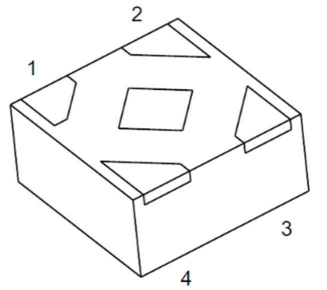
200 mA CMOS Low Dropout Regulator in ultra small package

The TCR2EN series are CMOS general-purpose single-output voltage regulators with an on/off control input, featuring low dropout voltage, low quiescent bias current and fast load transient response.

These voltage regulators are available in fixed output voltages between 1.0 V and 3.6 V and capable of driving up to 200 mA. They feature overcurrent protection and an Auto-discharge function.

The TCR2EN series is offered in the ultra small plastic mold package SDFN4/SDFN4E (0.8 mm x 0.8 mm x 0.38 mm). It has a low dropout voltage of 160 mV (2.5 V output, I_{OUT} = 150 mA) with low output noise voltage of 35 μV_{rms} (2.5 V output) and a load transient response of only ΔV_{OUT} = ±55 mV (I_{OUT} = 1 mA⇔150 mA, C_{OUT} = 1.0 μF).

As small ceramic input and output capacitors can be used with the TCR2EN series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



BOTTOM VIEW ILLUSTRATION
SDFN4/SDFN4E

Weight: 0.6 mg (typ.)

Features

- Low Dropout voltage
  - V_{DO} = 160 mV (typ.) at 2.5 V-output, I_{OUT} = 150 mA
  - V_{DO} = 210 mV (typ.) at 1.8 V-output, I_{OUT} = 150 mA
  - V_{DO} = 360 mV (typ.) at 1.2 V-output, I_{OUT} = 150 mA
  - V_{DO} = 490 mV (typ.) at 1.0 V-output, I_{OUT} = 150 mA
- Low output noise voltage
  - V_{NO} = 35 μV_{rms} (typ.) at 2.5 V-output, I_{OUT} = 10 mA, 10 Hz < f < 100 kHz
  - V_{NO} = 30 μV_{rms} (typ.) at 1.8 V-output, I_{OUT} = 10 mA, 10 Hz < f < 100 kHz
  - V_{NO} = 23 μV_{rms} (typ.) at 1.2 V-output, I_{OUT} = 10 mA, 10 Hz < f < 100 kHz
  - V_{NO} = 18 μV_{rms} (typ.) at 1.0 V-output, I_{OUT} = 10 mA, 10 Hz < f < 100 kHz
- Fast load transient response (ΔV_{OUT} = ±55 mV (typ.) at I_{OUT} = 1 mA ⇔ 150 mA, C_{OUT} =1.0 μF)
- Low quiescent bias current (I_B = 35 μA (typ.) at I_{OUT} = 0 mA)
- High ripple rejection (R.R = 73 dB (typ.) at 2.5 V-output, I_{OUT} = 10 mA, f = 1 kHz)
- Wide range Output Voltage line up (V_{OUT} = 1.0 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} = 0.1μF, C_{OUT} =1.0 μF)
- Ultra Small package SDFN4/SDFN4E (0.8 mm x 0.8 mm x 0.38 mm)

Start of commercial production
2013-11

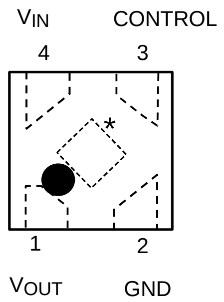
Absolute Maximum Ratings (Ta = 25°C)

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 x 1.6 mm, both sides of board.
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

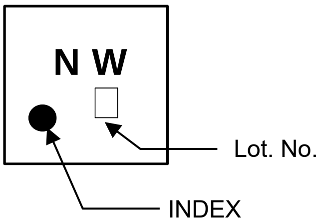
List of Products Number, Output voltage and Marking

Product No.	Output voltage(V) (typ.)	Marking	Product No.	Output voltage(V) (typ.)	Marking
TCR2EN10	1.0	NJ	TCR2EN27	2.7	NO
TCR2EN105	1.05	NU	TCR2EN28	2.8	NP
TCR2EN11	1.1	N2	TCR2EN285	2.85	N7
TCR2EN115	1.15	NC	TCR2EN29	2.9	NR
TCR2EN12	1.2	N3	TCR2EN30	3.0	NS
TCR2EN125	1.25	NQ	TCR2EN31	3.1	NT
TCR2EN13	1.3	N4	TCR2EN32	3.2	NV
TCR2EN15	1.5	NA	TCR2EN33	3.3	NW
TCR2EN18	1.8	NE	TCR2EN34	3.4	NX
TCR2EN19	1.9	NF	TCR2EN35	3.5	NY
TCR2EN21	2.1	NH	TCR2EN36	3.6	NZ
TCR2EN25	2.5	NM			

Please ask your local retailer about the devices with other output voltages.

Marking (top view)

Example: TCR2EN33 (3.3 V output)



Electrical Characteristics
(Unless otherwise specified,
V_{IN} = V_{OUT} + 1 V, I_{OUT} = 50 mA, C_{IN} = 0.1 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 (Note2)	V_{OUT} < 1.8 V	-18	—	+18	mV
			1.8 V ≤ V_{OUT}	-1.0	—	+1.0	%
Input voltage	V_{IN}	I_{OUT} = 1 mA		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		—	35	60	μA
Stand-by current	$I_{B (OFF)}$	V_{CT} = 0 V		—	0.1	1.0	μA
Dropout voltage	V_{DO}	I_{OUT} = 150 mA (Note 3)		—	160	210	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)		—	35	—	$μV_{rms}$
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)		—	73	—	dB
Load transient response	ΔV_{OUT}	I_{OUT} = 1mA⇔150mA, C_{OUT} = 1.0 μF		—	±55	—	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

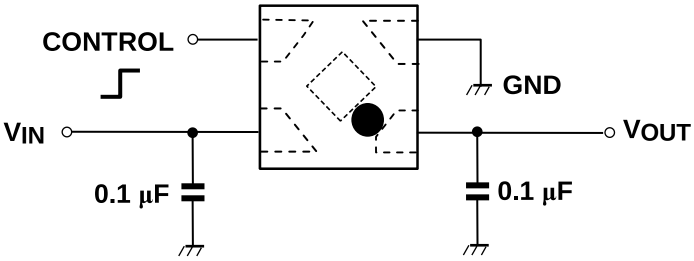
Note 3: The 2.5 V output product

Dropout voltage for different output voltages
(I_{OUT} = 150 mA, C_{IN} = 0.1 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}	—	490	750	mV
1.1 V, 1.15 V		—	420	650	
1.2 V, 1.25 V		—	360	550	
1.3 V		—	330	450	
1.4 V		—	290	400	
1.5 V ≤ V_{OUT} < 1.8 V		—	270	370	
1.8 V ≤ V_{OUT} < 2.5 V		—	210	290	
2.5 V ≤ V_{OUT} < 3.0 V		—	160	210	
3.0 V ≤ V_{OUT} ≤ 3.6 V		—	130	180	

Application Note

1. Example of Application Circuit



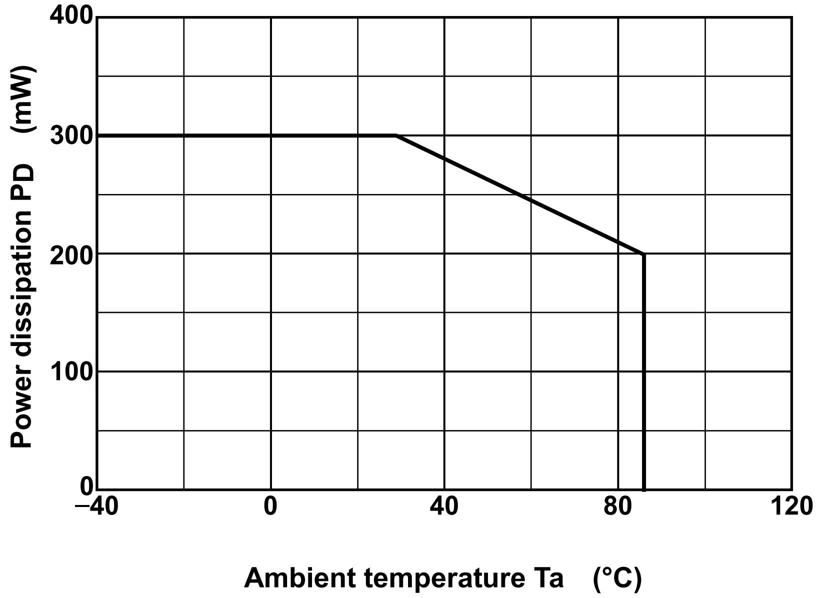
CONTROL voltage	Output voltage
HIGH	ON
LOW	OFF
OPEN	OFF

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

2. Power Dissipation

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 VIN and GND pattern need to be large and make the wire impedance small as possible.

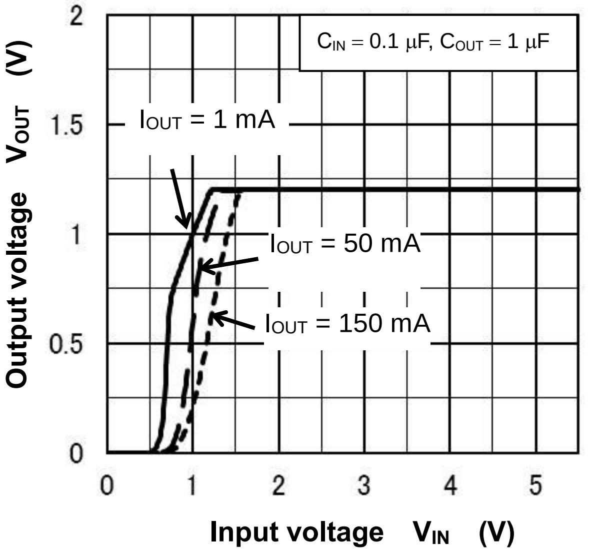
- Permissible Loss
  Please have enough design patterns for expected maximum permissible loss. And under consideration of ambient temperature, input voltage, output current, etc., we recommend proper dissipation ratings for maximum permissible loss; in general maximum dissipation rating is 70 to 80 percent.

- Overcurrent Protection Circuit
  Overcurrent protection circuit 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 be 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.

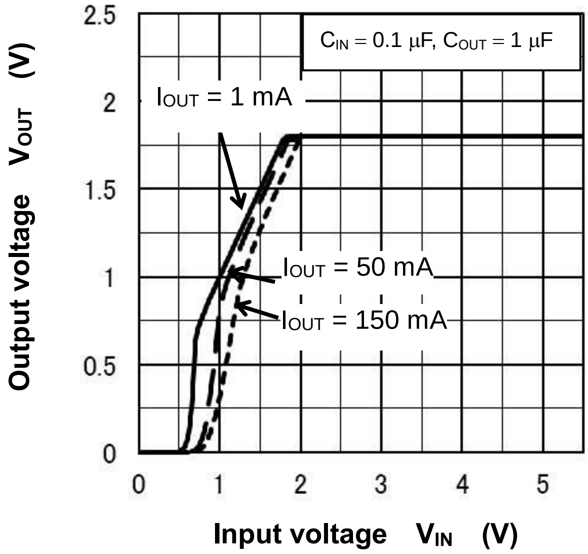
Representative Typical Characteristics

1) Output Voltage vs. Input Voltage

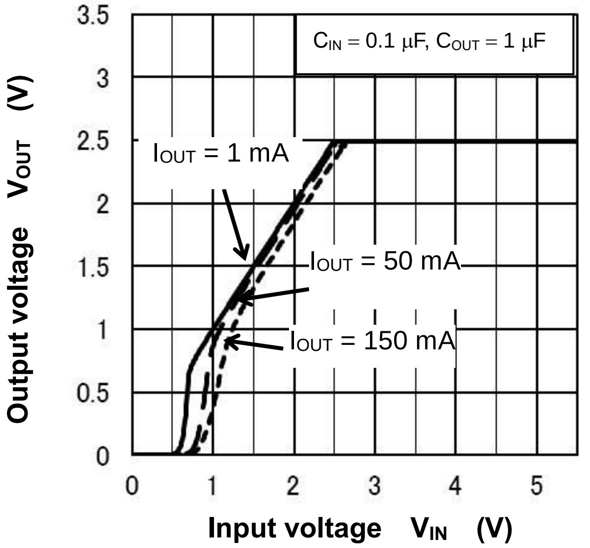
V_{OUT} = 1.2 V



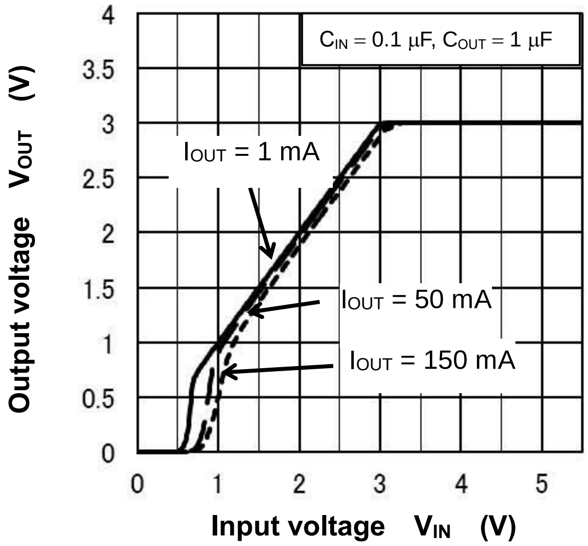
V_{OUT} = 1.8 V



V_{OUT} = 2.5 V

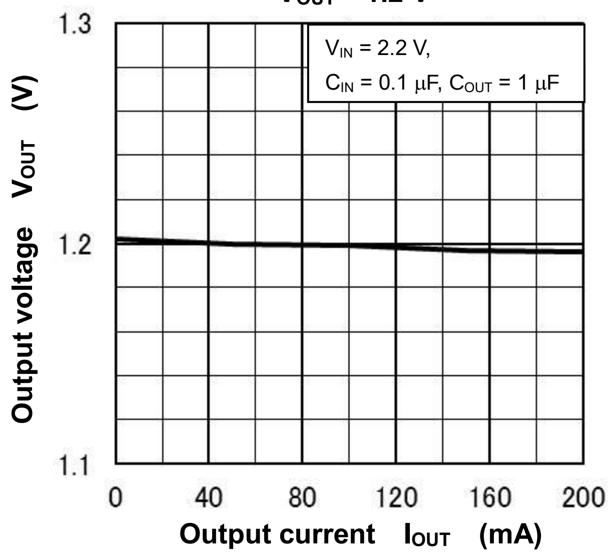


V_{OUT} = 3.0 V

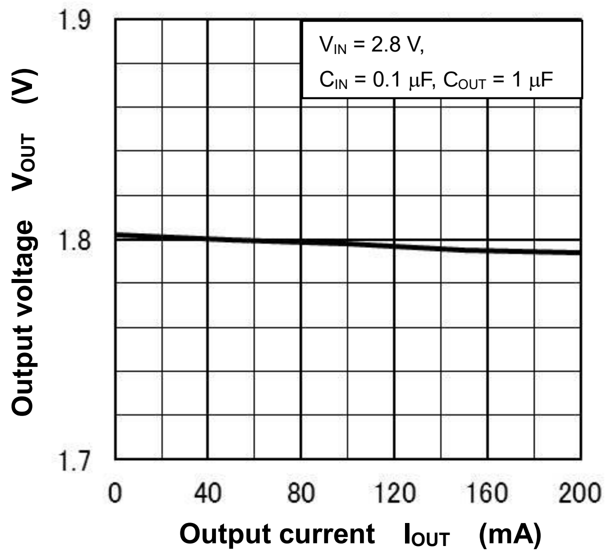


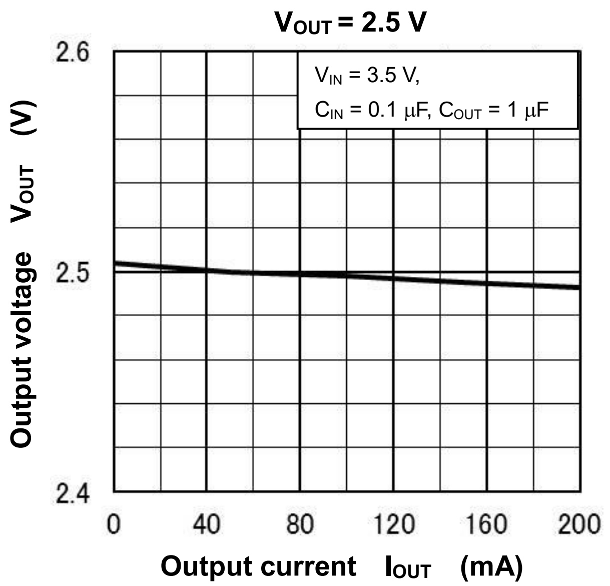
2) Output Voltage vs. Output Current

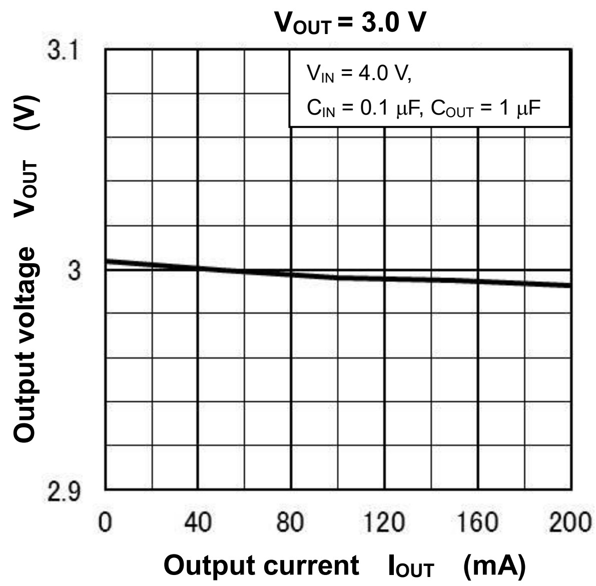
V_{OUT} = 1.2 V



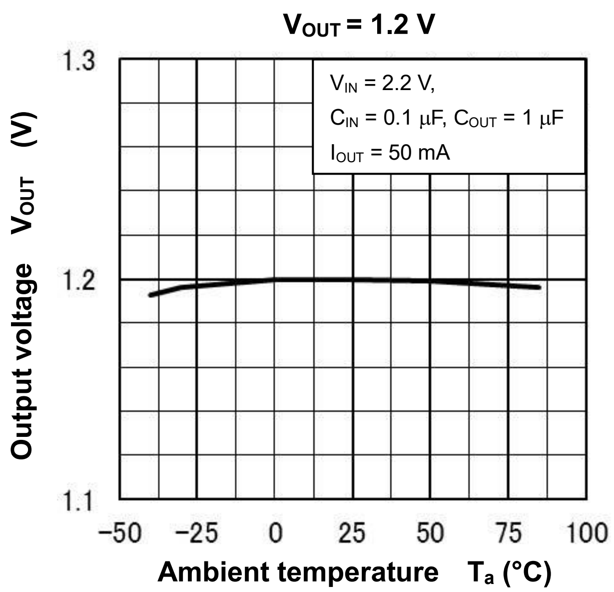
V_{OUT} = 1.8 V

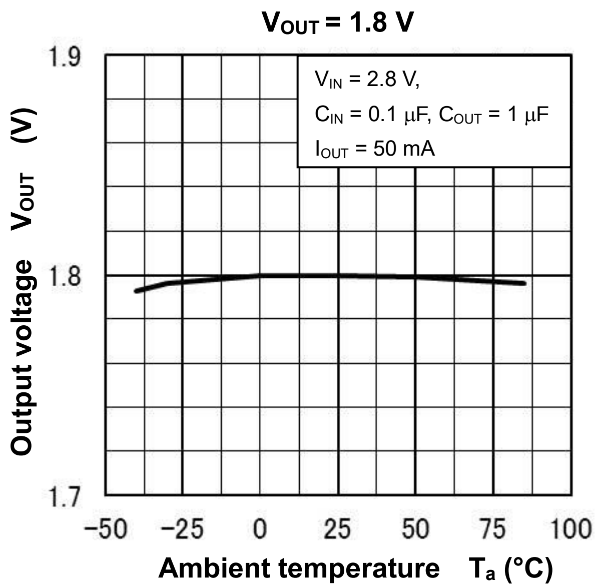


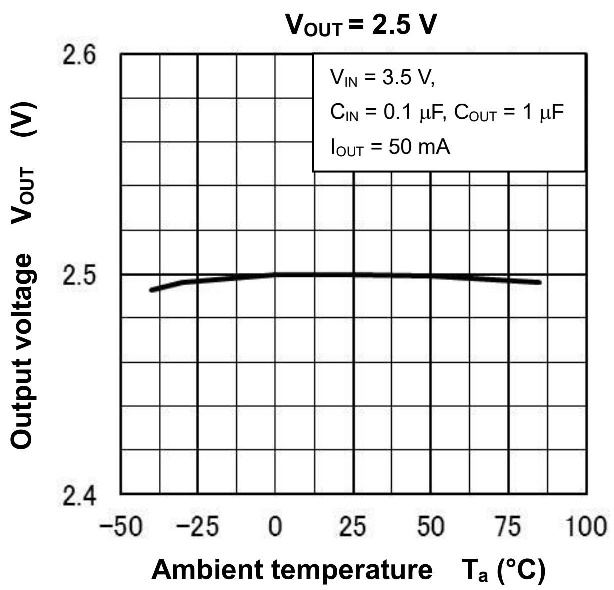


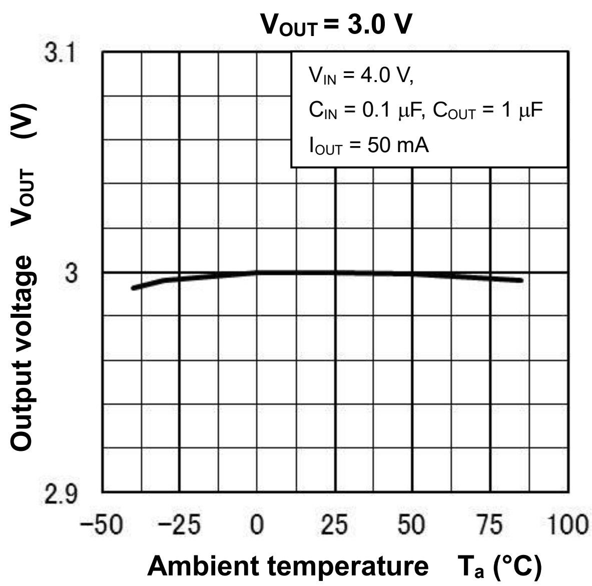


3) Output Voltage vs. Ambient Temperature

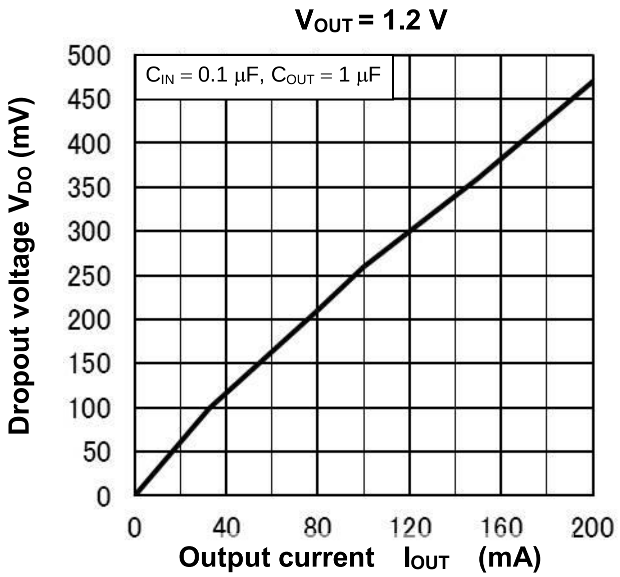


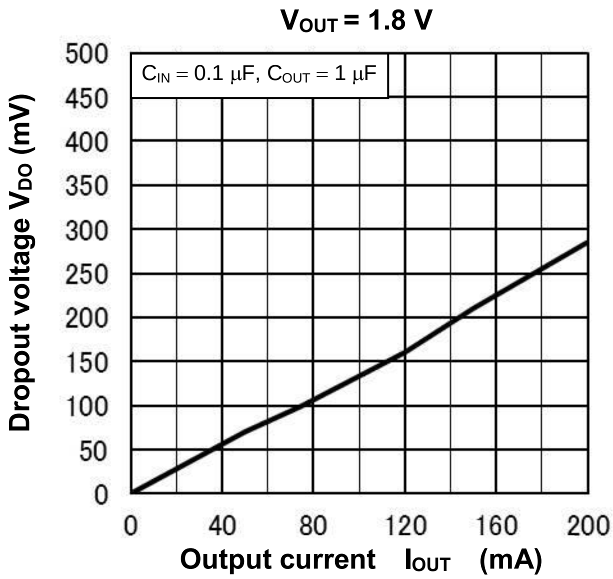


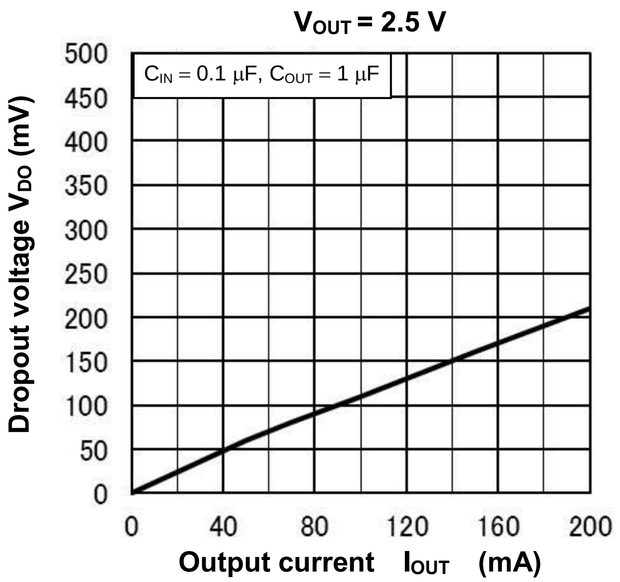


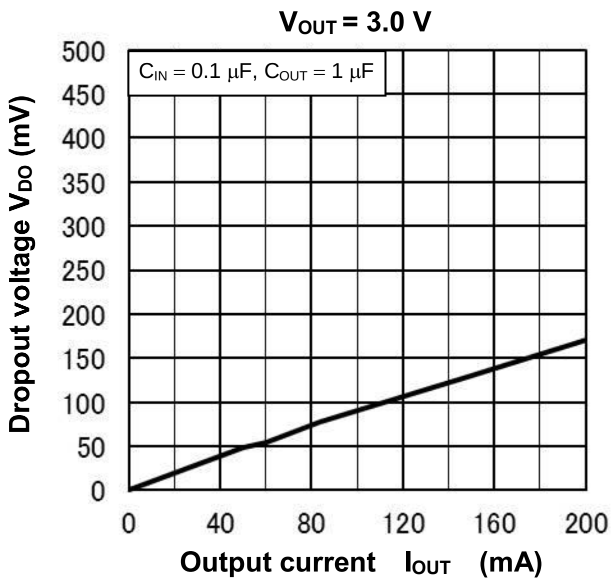


4) Dropout Voltage vs. Output Current

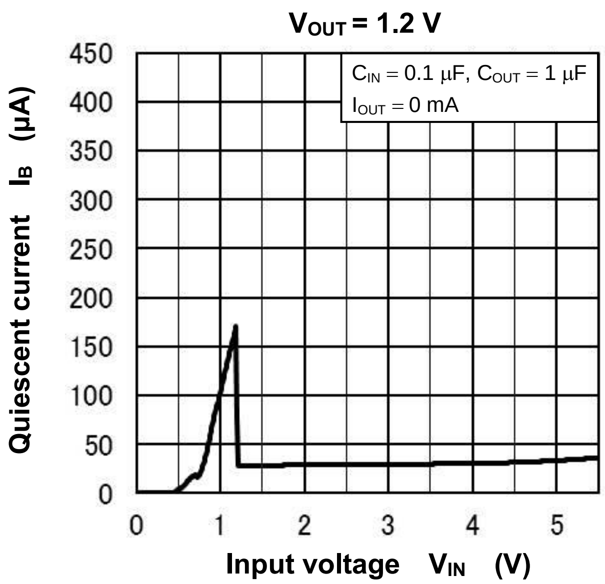


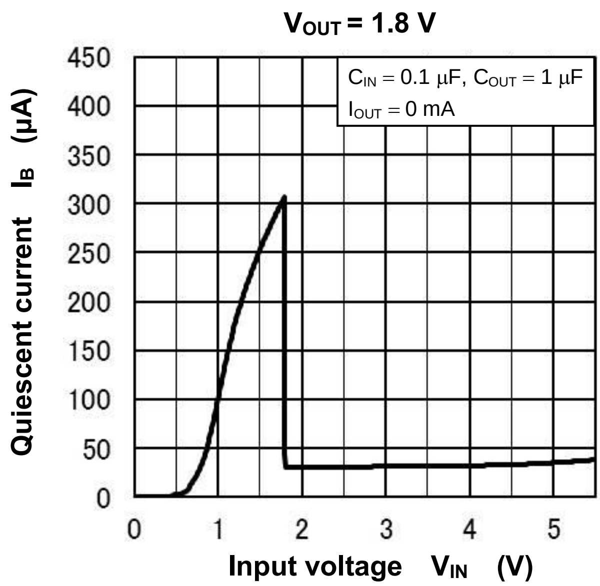


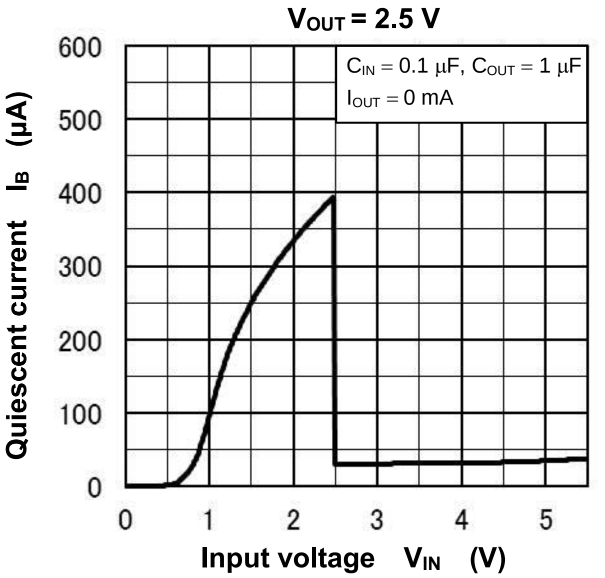


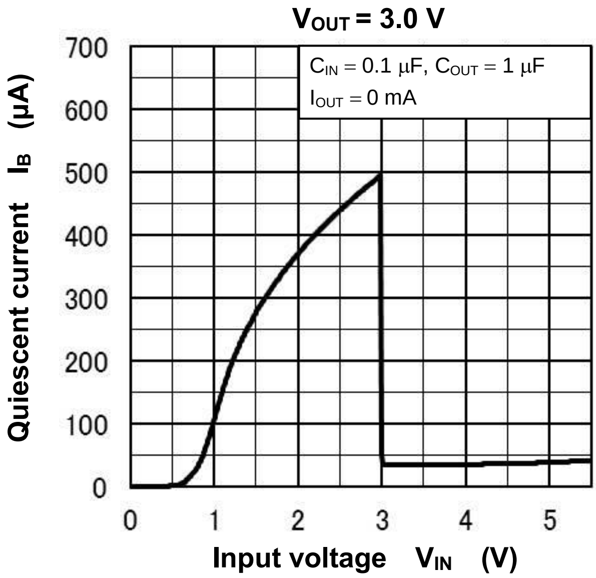


5) Quiescent Current vs. Input Voltage

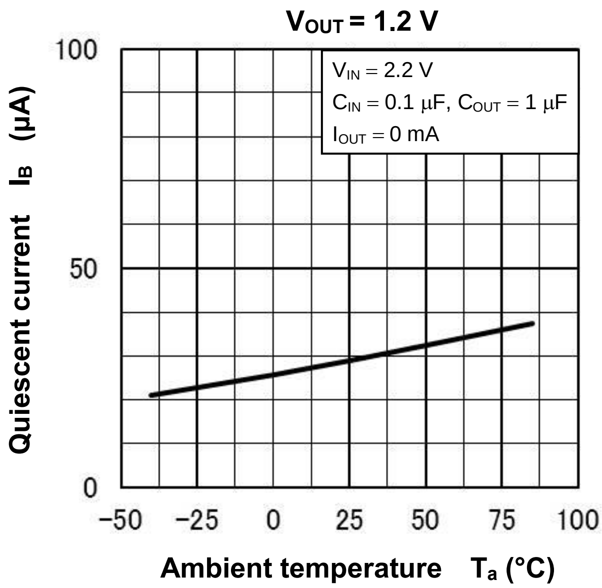


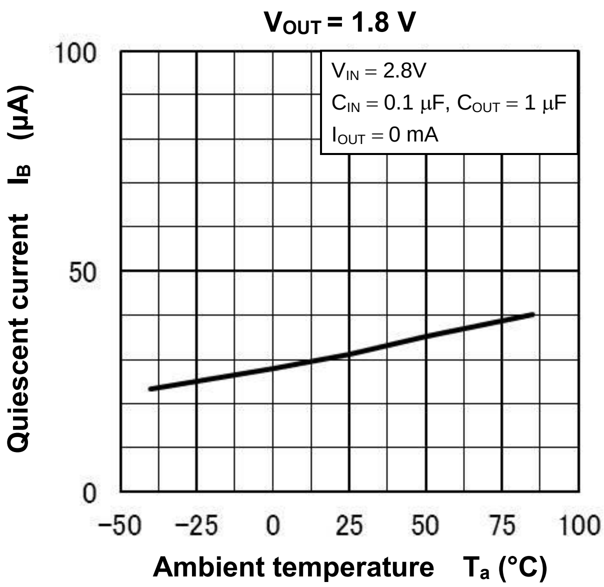


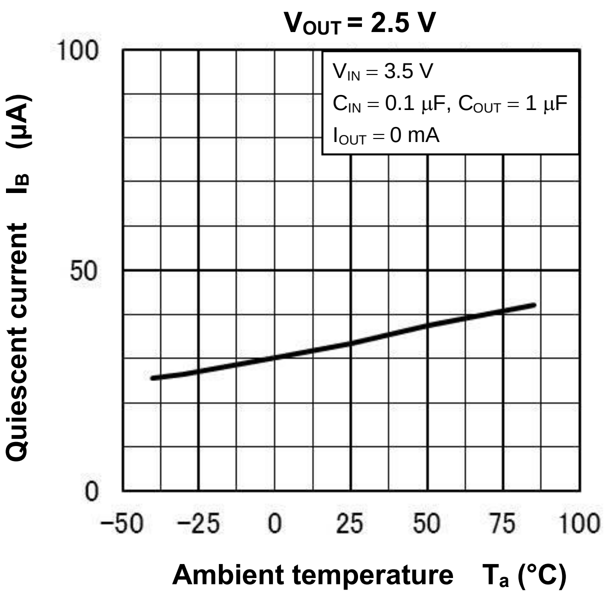


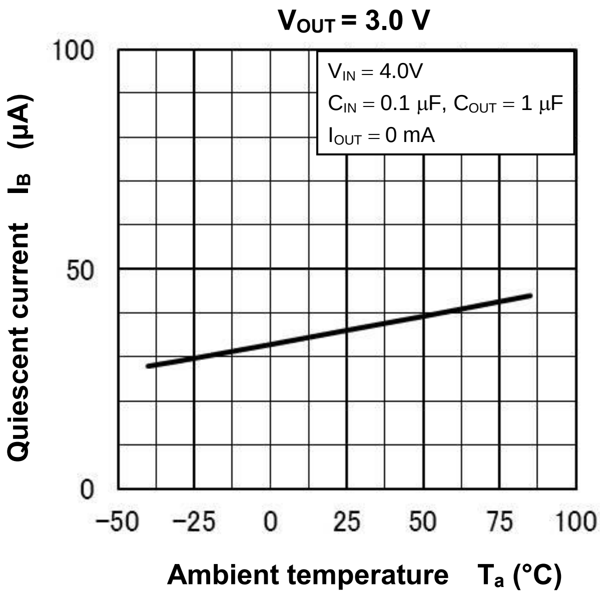


6) **Quiescent Current vs. Ambient Temperature**

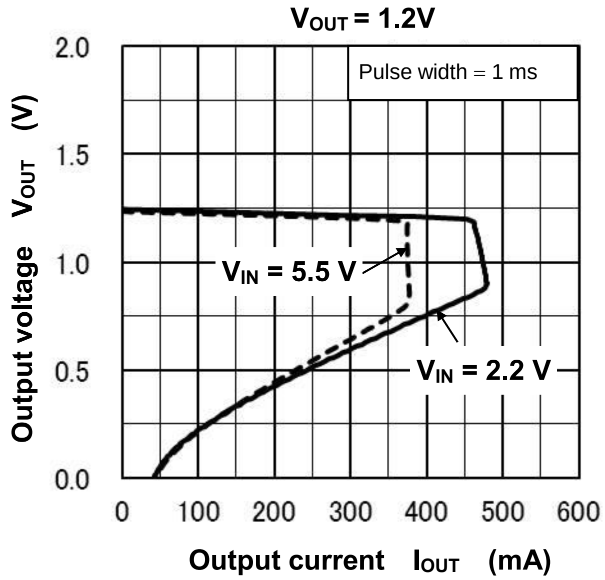


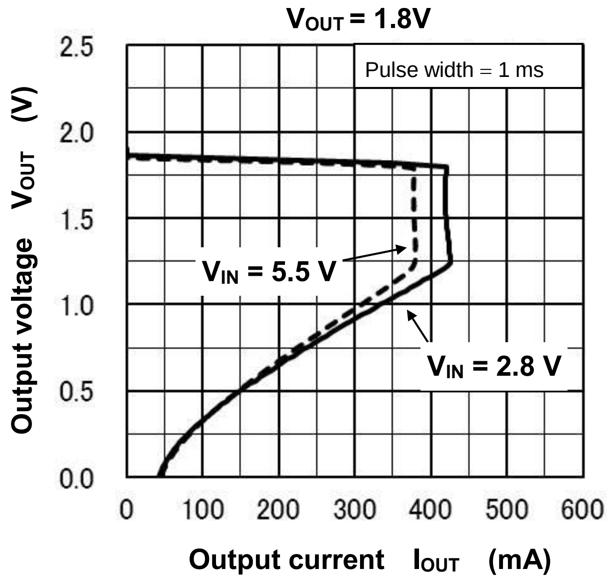


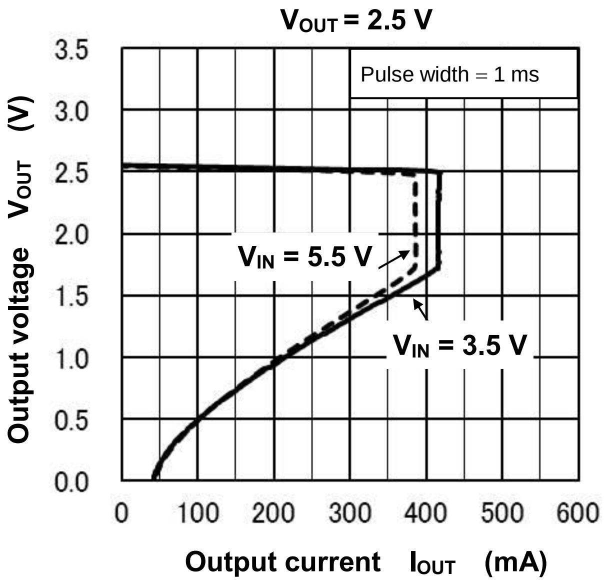


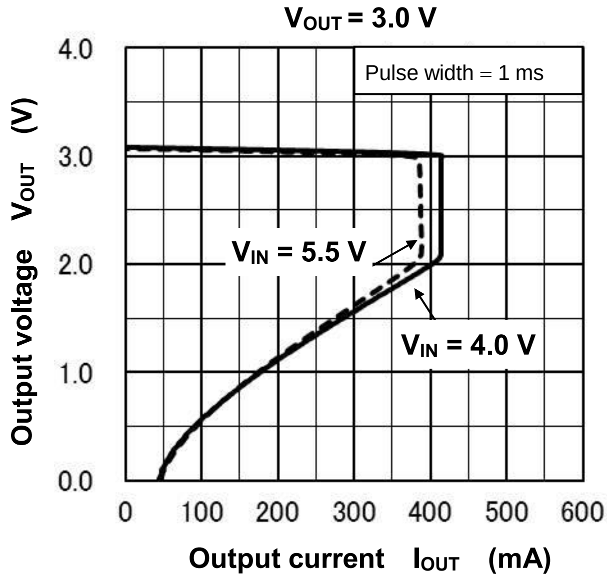


7) Output Voltage vs. Output Current

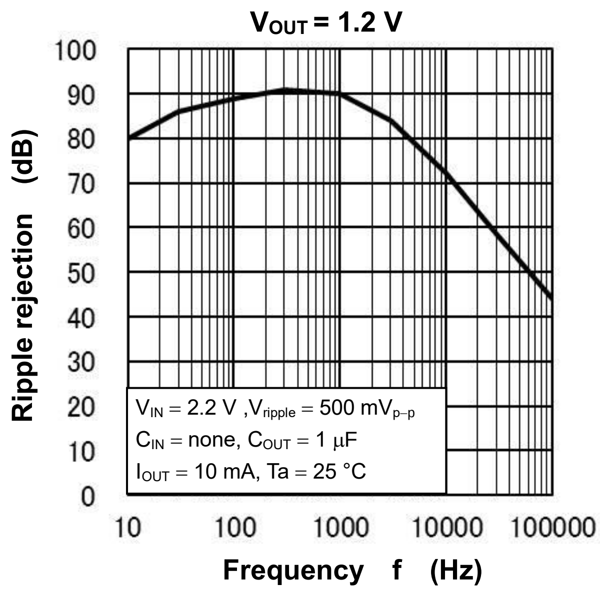


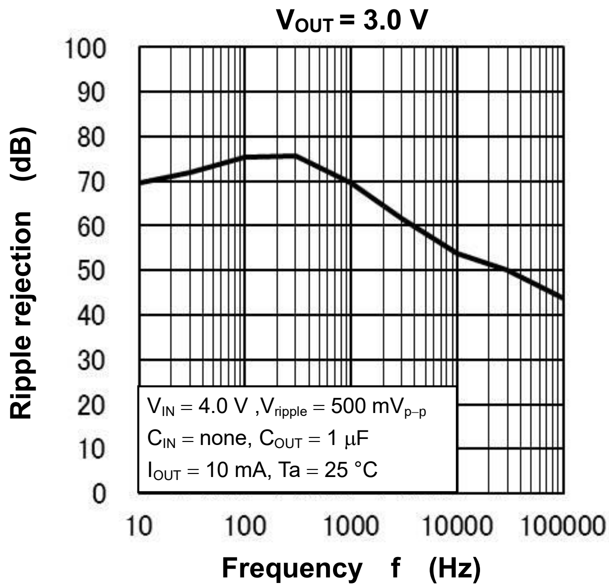






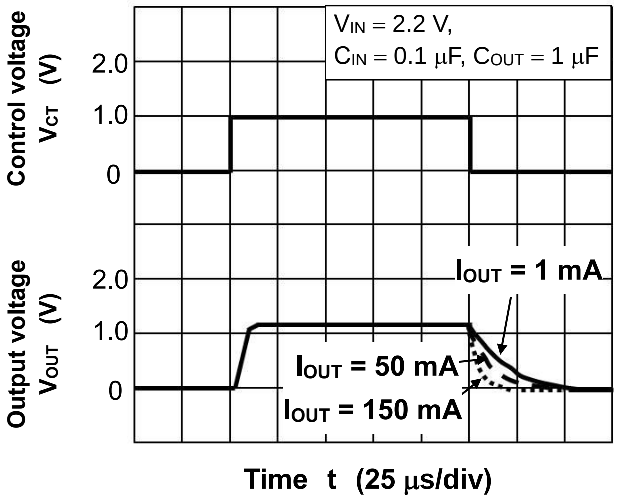
8) Ripple Rejection Ratio vs. Frequency



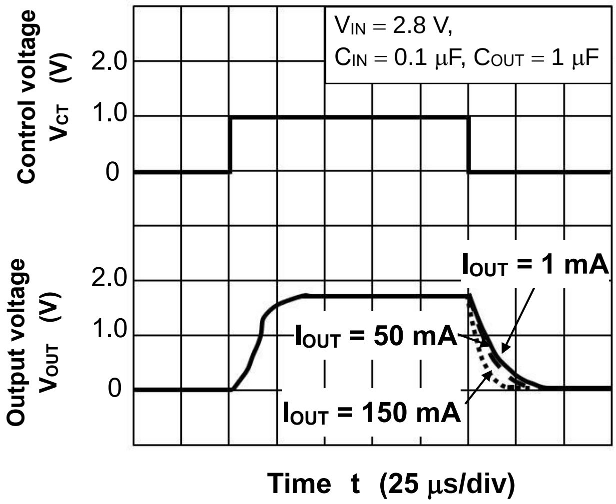


9) Control Transient Response

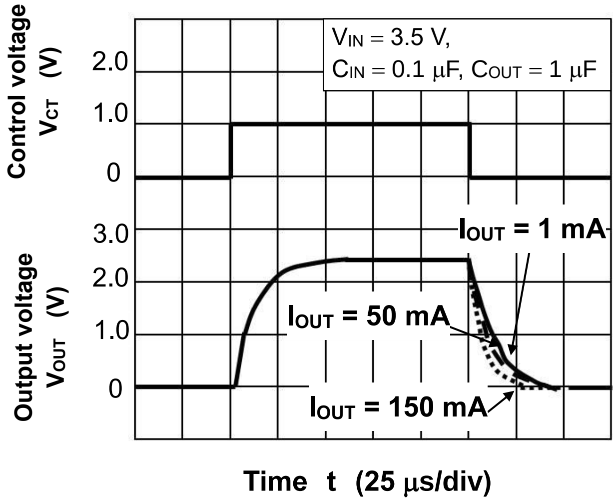
V_{OUT} = 1.2 V



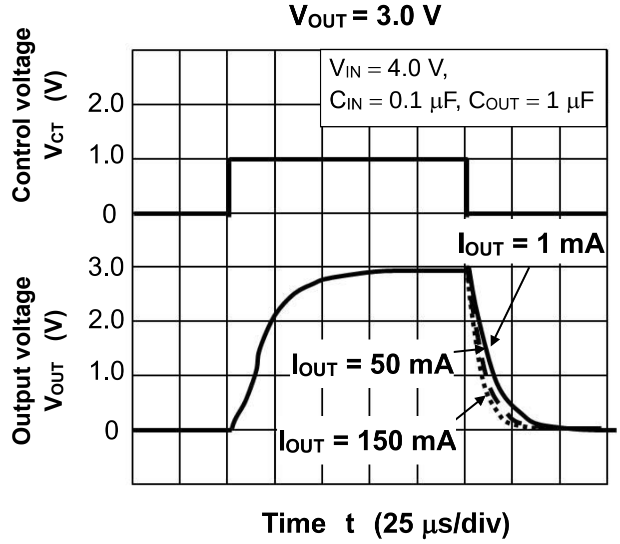
V_{OUT} = 1.8 V



V_{OUT} = 2.5 V

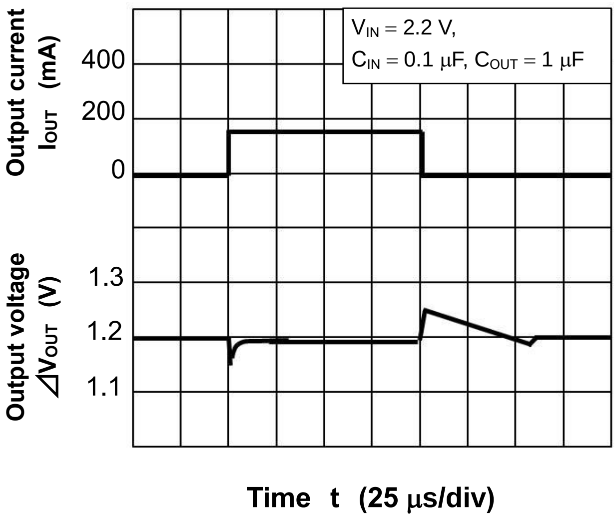


V_{OUT} = 3.0 V

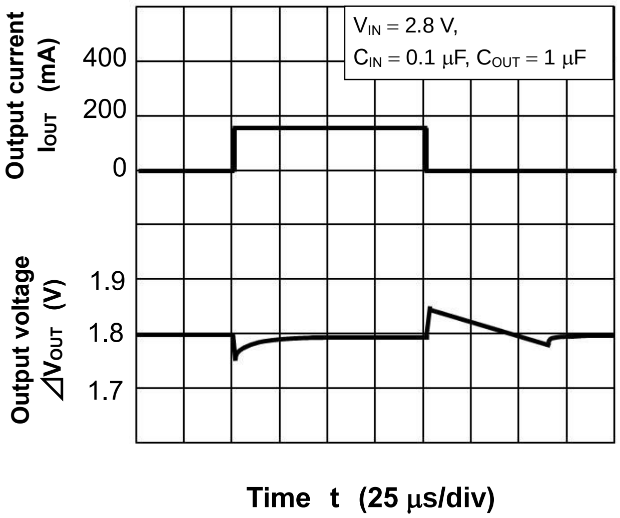


10) Load Transient Response

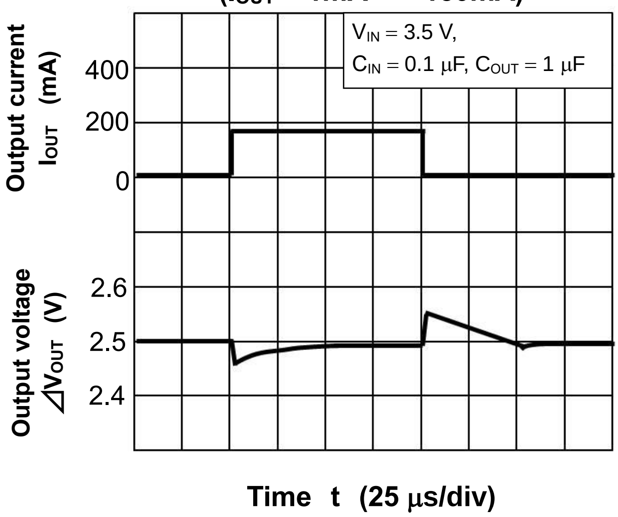
V_{OUT} = 1.2 V
(I_{OUT} = 1mA ⇔ 150mA)



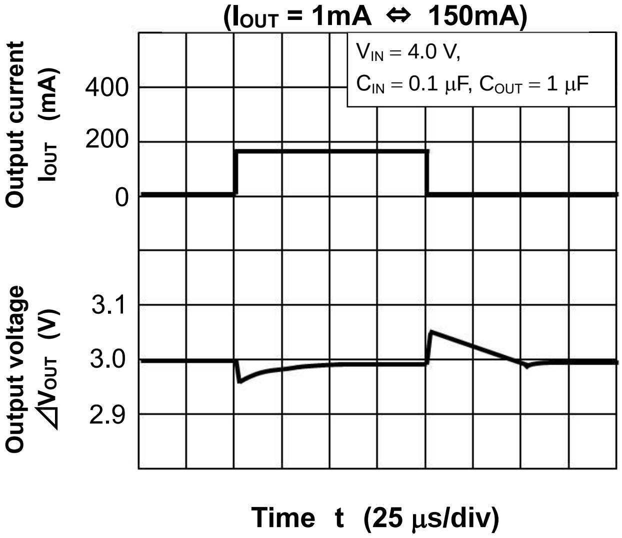
V_{OUT} = 1.8 V
(I_{OUT} = 1mA ⇔ 150mA)



V_{OUT} = 2.5 V
(I_{OUT} = 1mA ⇔ 150mA)



V_{OUT} = 3.0 V
(I_{OUT} = 1mA ⇔ 150mA)

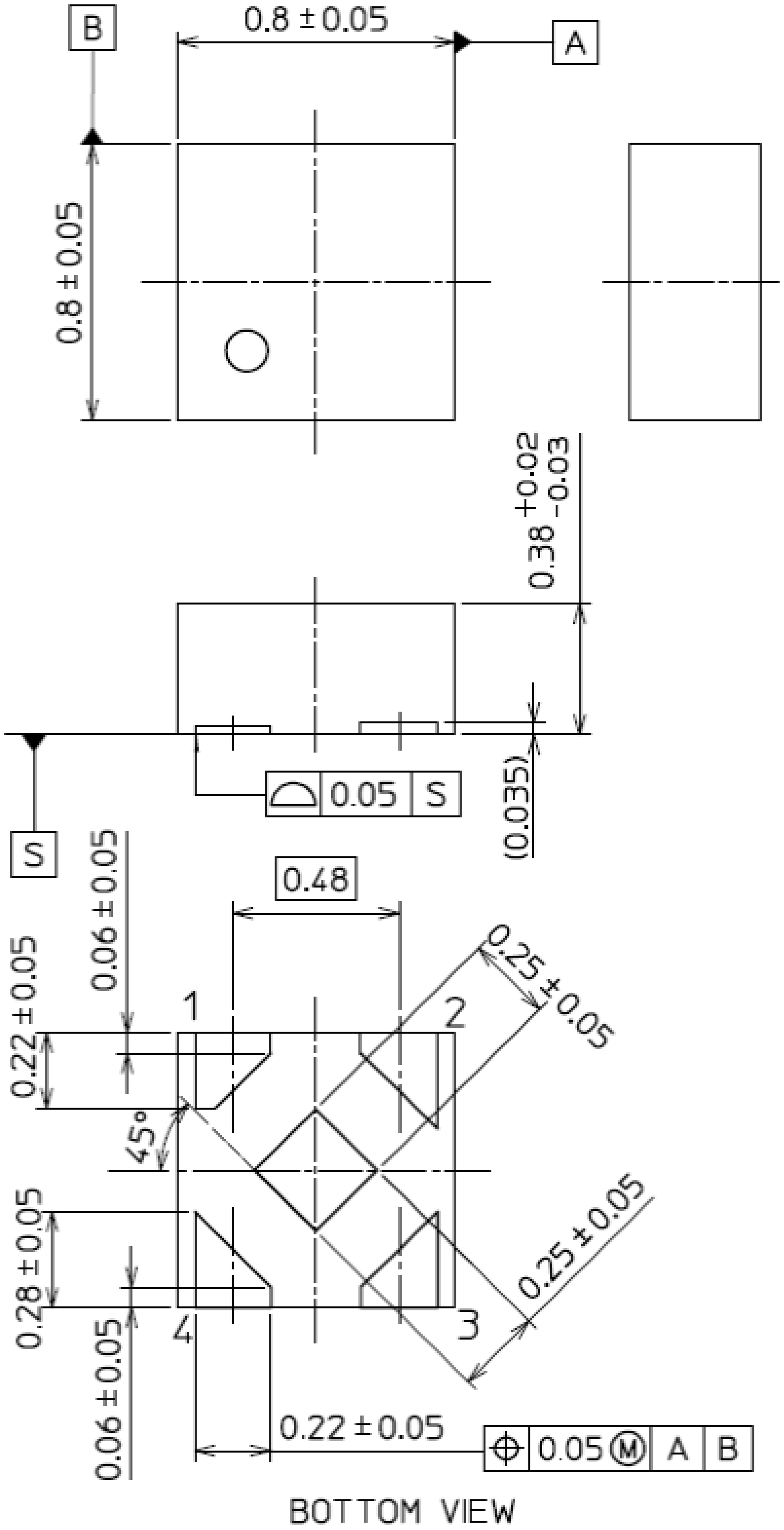


Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Package Dimensions

SDFN4

Unit: mm



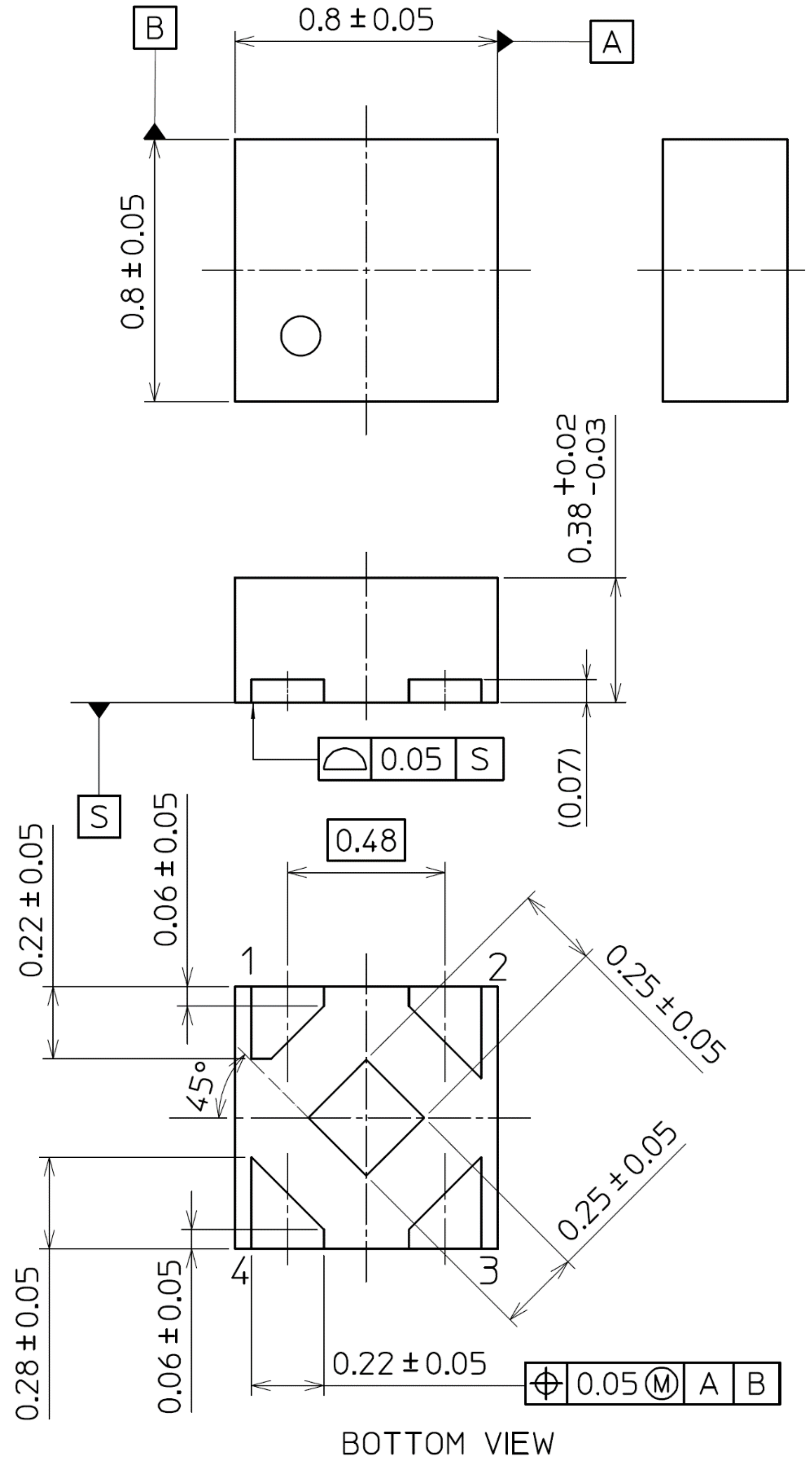
0.04 mm (typ.) unevenness exists along the edges of the back electrode to increase shear after soldering.

Weight : 0.6 mg (typ.)

Package Dimensions

SDFN4E

Unit: mm



Weight : 0.6 mg (typ.)

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