TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCR2EF series
TCR2EE series

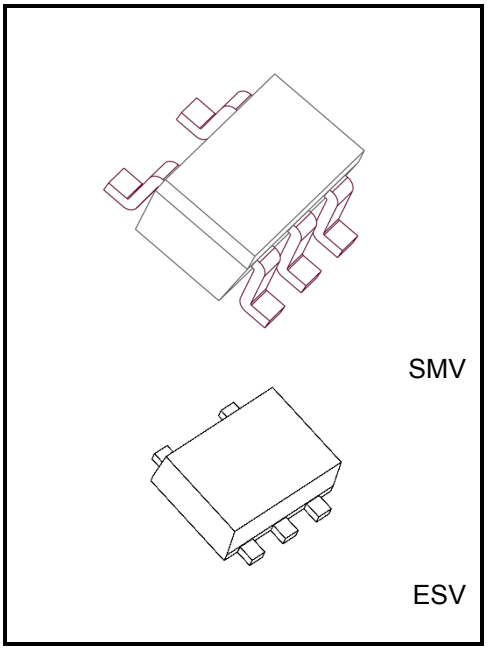
200 mA CMOS Low Dropout Regulator with Fast Load Transient Response

The TCR2EF and TCR2EE series are CMOS single output voltage regulators with an on/off control input, featuring low dropout voltage, low output noise voltage and fast load transient response.

These voltage regulators are available in fixed output voltages between 1.0 V and 5.0 V and capable of driving up to 200 mA. They feature overcurrent protection, an Auto-discharge function.

The TCR2EF and TCR2EE series has a low dropout voltage of 180 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} = ±60 mV (I_{OUT} = 1 mA⇔150 mA, C_{OUT} = 1.0 µF).

Thus, the TCR2EF and TCR2EE series are suitable for sensitive power supply such as Analog and RF applications.



Weight :
SMV (SOT-25)(SC-74A) : 16 mg (typ.)
ESV (SOT-553) : 3.0 mg (typ.)

Features

- Low dropout voltage
  - V_{DO} = 150 mV (typ.) at 3.0 V output, I_{OUT} = 150 mA
  - V_{DO} = 180 mV (typ.) at 2.5 V output, I_{OUT} = 150 mA
  - V_{DO} = 230 mV (typ.) at 1.8 V output, I_{OUT} = 150 mA
  - V_{DO} = 380 mV (typ.) at 1.2 V output, I_{OUT} = 150 mA
  - V_{DO} = 510 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)
- Fast load transient response (ΔV_{OUT} = ±60 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 ratio (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 5.0 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} = 1.0 µF)
- Small package ESV (SOT-553) (1.6 mm x 1.6 mm x 0.55 mm)
  General package SMV (SOT-25) (2.8 mm x 2.9 mm x 1.1 mm)

Start of commercial production
2012-10

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
Power dissipation	P_D	SMV	200	(Note 1)	mW
			580	(Note 2)	
		ESV	150	(Note 1)	
			320	(Note 3)	
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).

Note 1: Unit Rating

Note 2: Rating at mounting on a board
(FR4 board dimension: 25.4 mm × 25.4 mm × 1.6 mm)

Note 3: Rating at mounting on a board
(FR4 board dimension: 30 mm × 30 mm × 0.8 mm)

Operating Ranges

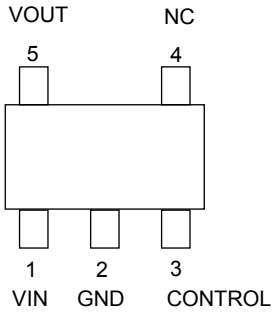
Characteristics	Symbol	Rating			Unit
Input voltage	V_{IN}	1.5 to 5.5 V		(Note 4)	V
Control voltage	V_{CT}	0 to 5.5			V
Output voltage	V_{OUT}	1.0 to 5.0			V
Output current	I_{OUT}	DC	200	(Note 5)	mA
Operation Temperature	T_{opr}	-40 to 85			°C
Output Capacitance	C_{OUT}	≥ 1.0 μF			—
Input Capacitance	C_{IN}	≥ 0.1 μF			—

Note 4: I_{OUT} = 1 mA.
Please refer to Dropout voltage (Page 5) and use it within Absolute Maximum Ratings Junction temperature and Operation Temperature Ranges.

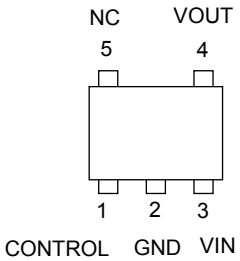
Note 5: Do not operate at or near the maximum ratings of operating ranges for extended periods of time. Exposure to such conditions may adversely impact product reliability and results in failures not covered by warranty.

Pin Assignment (top view)

SMV(SOT-25)(SC-74A)



ESV(SOT-553)



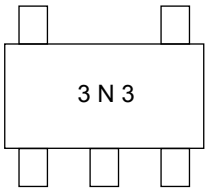
List of Products Number, Output voltage and Marking

Product No.		V_{OUT} (V) (typ.)	Marking	Product No.		V_{OUT} (V) (typ.)	Marking
SMV(SOT-25)	ESV(SOT-553)			SMV(SOT-25)	ESV(SOT-553)		
TCR2EF10	TCR2EE10	1.0	1N0	TCR2EF28	TCR2EE28	2.8	2N8
TCR2EF105	TCR2EE105	1.05	1NA	TCR2EF285	TCR2EE285	2.85	2ND
TCR2EF11	TCR2EE11	1.1	1N1	TCR2EF29	TCR2EE29	2.9	2N9
TCR2EF115	TCR2EE115	1.15	1NB	-	TCR2EE295	2.95	2NE
TCR2EF12	TCR2EE12	1.2	1N2	TCR2EF30	TCR2EE30	3.0	3N0
TCR2EF125	TCR2EE125	1.25	1NC	-	TCR2EE305	3.05	3NA
TCR2EF13	TCR2EE13	1.3	1N3	TCR2EF31	TCR2EE31	3.1	3N1
TCR2EF135	TCR2EE135	1.35	1ND	TCR2EF32	TCR2EE32	3.2	3N2
TCR2EF14	TCR2EE14	1.4	1N4	TCR2EF33	TCR2EE33	3.3	3N3
-	TCR2EE145	1.45	1NE	-	TCR2EE335	3.35	3ND
TCR2EF15	TCR2EE15	1.5	1N5	-	TCR2EE34	3.4	3N4
-	TCR2EE17	1.7	1N7	-	TCR2EE35	3.5	3N5
TCR2EF18	TCR2EE18	1.8	1N8	TCR2EF36	TCR2EE36	3.6	3N6
-	TCR2EE185	1.85	1NF	-	TCR2EE39	3.9	3N9
TCR2EF19	TCR2EE19	1.9	1N9	TCR2EF40	TCR2EE40	4.0	4N0
TCR2EF20	TCR2EE20	2.0	2N0	TCR2EF41	TCR2EE41	4.1	4N1
-	TCR2EE24	2.4	2N4	-	TCR2EE42	4.2	4N2
TCR2EF25	TCR2EE25	2.5	2N5	TCR2EF45	TCR2EE45	4.5	4N5
TCR2EF27	TCR2EE27	2.7	2N7	-	TCR2EE48	4.8	4N8
-	TCR2EE275	2.75	2NF	TCR2EF50	TCR2EE50	5.0	5N0

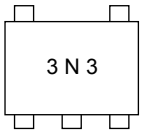
Please ask your local retailer about the devices with other output voltages.

Marking (top view)

Example: TCR2EF33 (3.3 V output)



Example: TCR2EE33 (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 (Note 6)	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 7)		—	180	230	mV
Temperature coefficient	T_{CVO}	−40°C ≤ T_{opr} ≤ 85°C		—	100	—	ppm/°C
Output noise voltage	V_{NO}	V_{IN} = V_{OUT} + 1 V, I_{OUT} = 10 mA, 10 Hz ≤ f ≤ 100 kHz (Note 7)		—	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} (Note 7)		—	73	—	dB
Load transient response	ΔV_{OUT}	I_{OUT} = 1 mA⇔150 mA, C_{OUT} = 1.0 µF		—	±60	—	mV
Control voltage (ON)	$V_{CT\ (ON)}$	—		1.0	—	5.5	V
Control voltage (OFF)	$V_{CT\ (OFF)}$	—		0	—	0.4	V

Note 6: Stable state with fixed I_{OUT} condition

Note 7: The 2.5 V output product

Note 8: All characterisitcs of over 4.5 V output products are measured at V_{IN} = V_{OUT} + 0.5 V conditions.

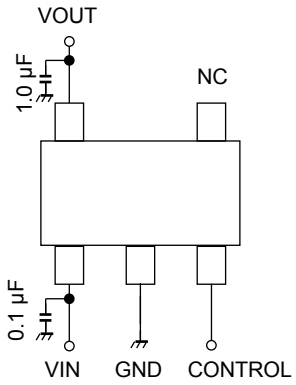
Dropout voltage (I_{OUT} = 150 mA, C_{IN} = 0.1 µF, C_{OUT} = 1.0 µF, T_j = 25°C)

Output voltages	Symbol	Min	Typ.	Max	Unit
1.0 V, 1.05 V	V_{DO}	—	510	770	mV
1.1 V, 1.15 V		—	440	670	
1.2 V, 1.25 V		—	380	570	
1.3 V		—	350	470	
1.4 V		—	310	420	
1.5 V ≤ V_{OUT} < 1.8 V		—	290	390	
1.8 V ≤ V_{OUT} < 2.5 V		—	230	310	
2.5 V ≤ V_{OUT} < 3.0 V		—	180	230	
3.0 V ≤ V_{OUT} ≤ 5.0 V		—	150	200	

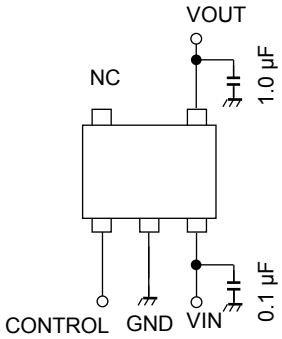
Application Note

1. Examples of Application Circuit

SMV



ESV



CONTROL pin connection	Operation
HIGH	ON
LOW	OFF
OPEN	OFF

The figures above show the examples 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

Both unit and board mounted power dissipation ratings for TCR2EF series and TCR2EE series are available in the Absolute Maximum Ratings table.

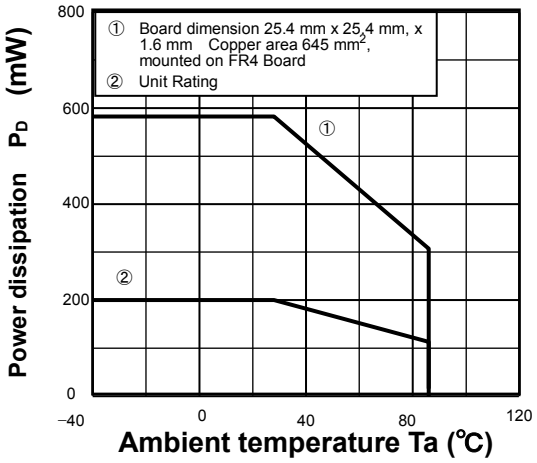
Power dissipation is measured on the board shown below.

Test Board for Thermal Resistance

SMV

*Board material: FR4 board
Board dimension: 25.4 mm × 25.4 mm × 1.6 mm
Copper area: 645 mm^2

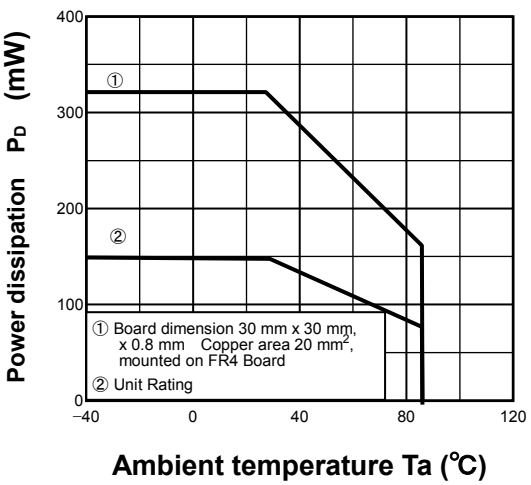
P_D − Ta (SMV)



ESV

*Board material: FR4 board
Board dimension: 30 mm × 30 mm × 0.8 mm
Copper area: 20 mm^2

P_D − Ta (ESV)



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 be 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.

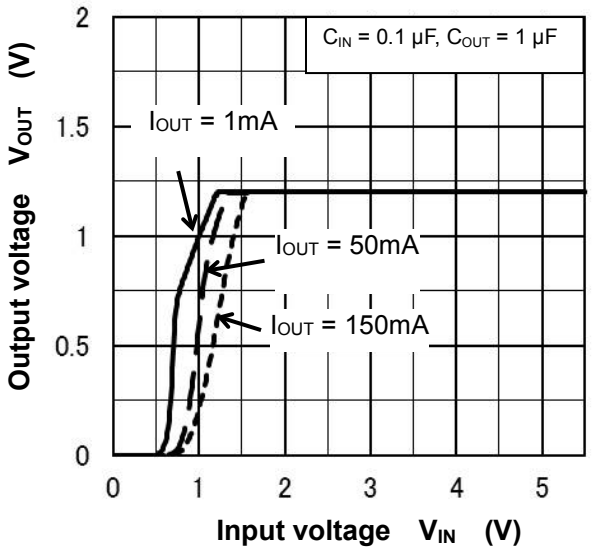
- Permissible Loss
  Please have enough design patterns for expected maximum permissible loss. And under consideration of ambient temperature, input voltage, and output current etc., we recommend proper dissipation ratings for maximum permissible loss; in general maximum dissipation rating is 70 to 80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

- 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.

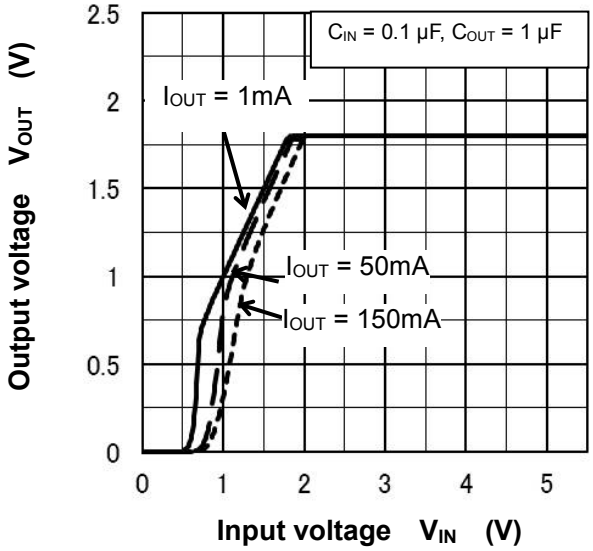
Representative Typical Characteristics(Note)

1) Output voltage vs. Input voltage

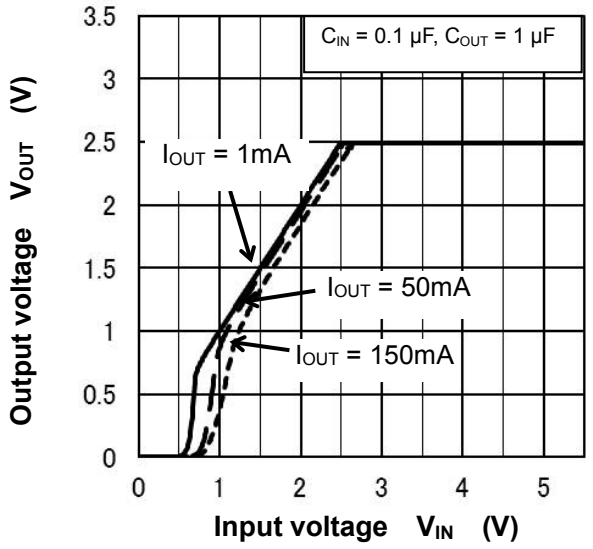
V_{OUT} = 1.2 V



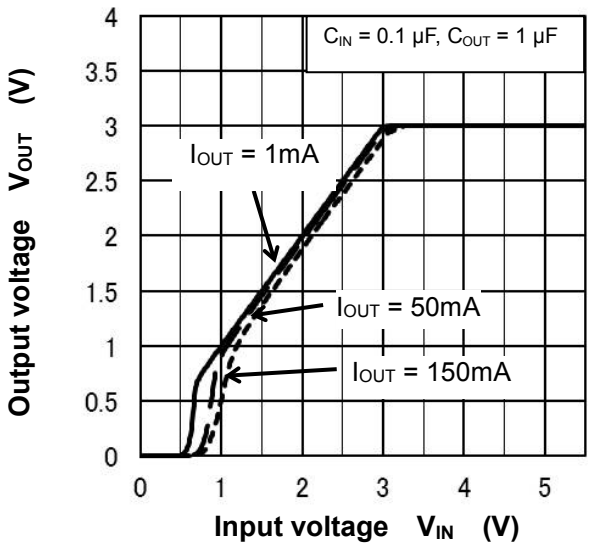
V_{OUT} = 1.8 V



V_{OUT} = 2.5 V

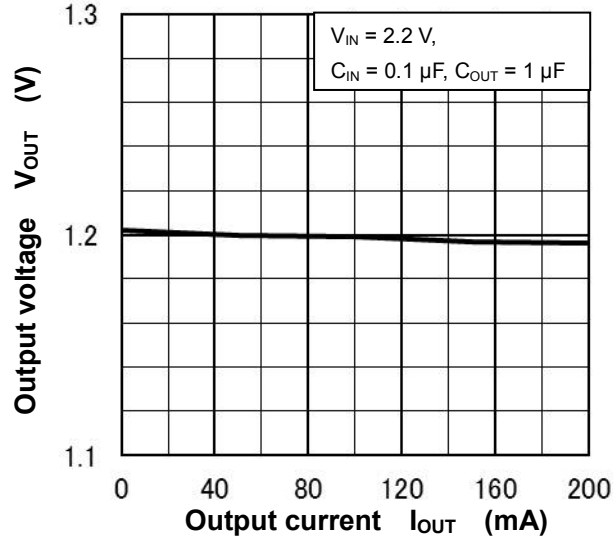


V_{OUT} = 3.0 V

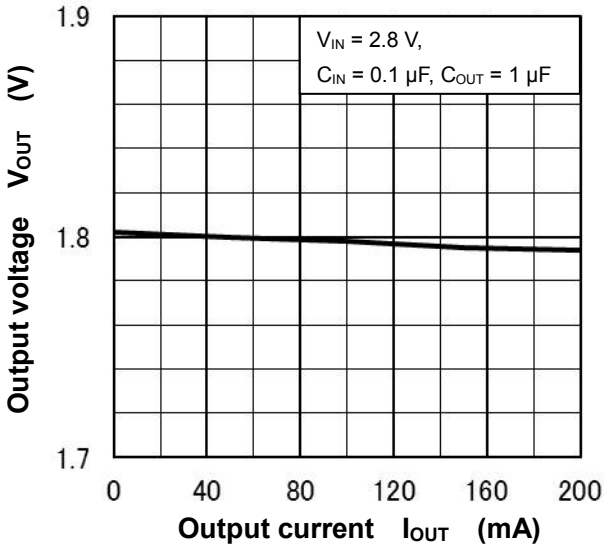


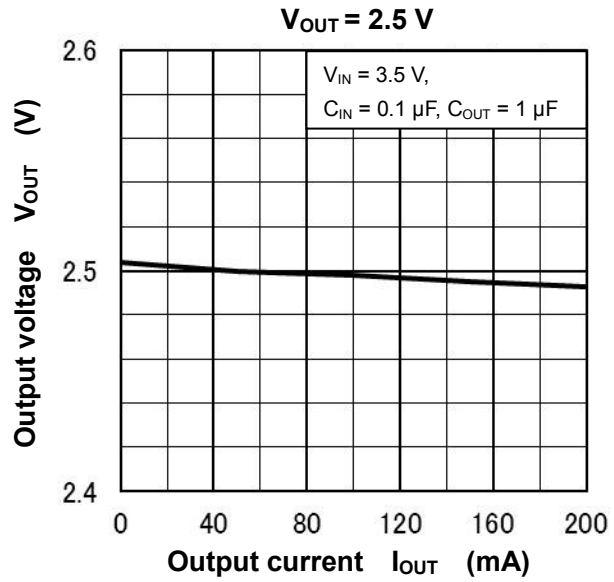
2) Output voltage vs. Output current

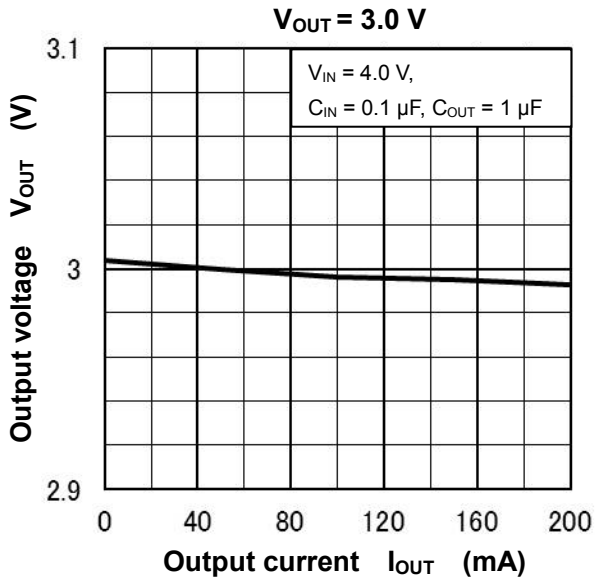
V_{OUT} = 1.2 V



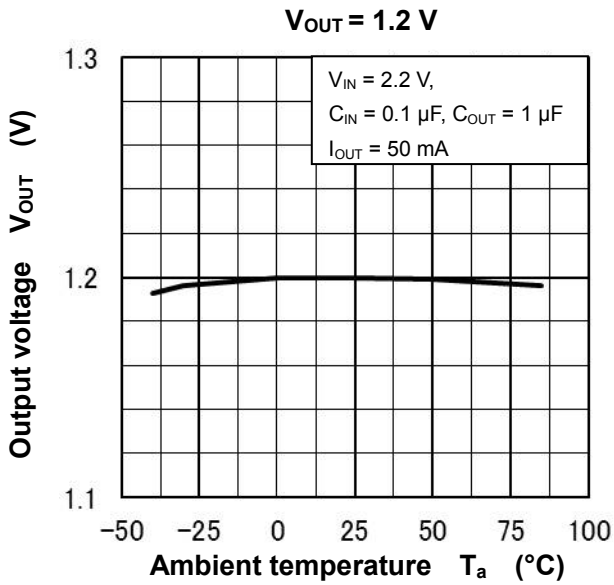
V_{OUT} = 1.8 V

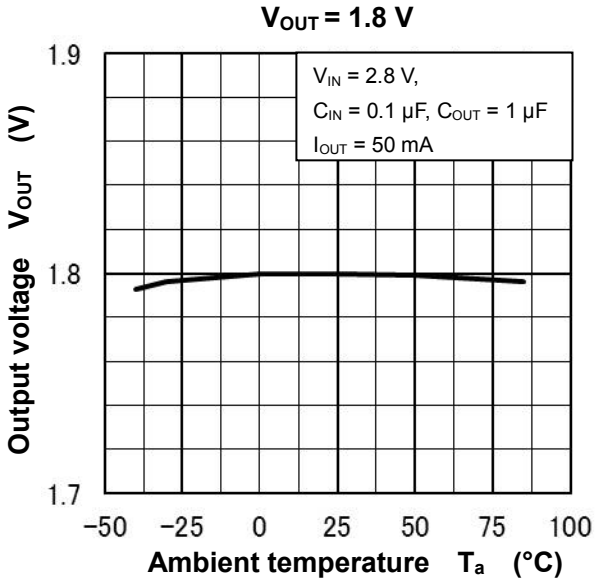


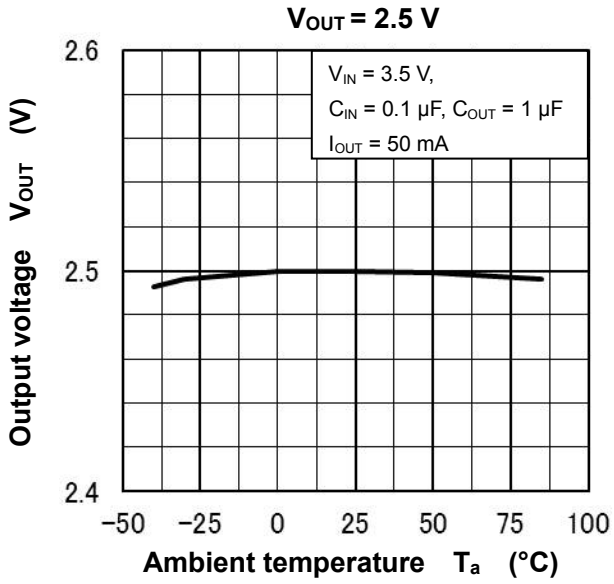


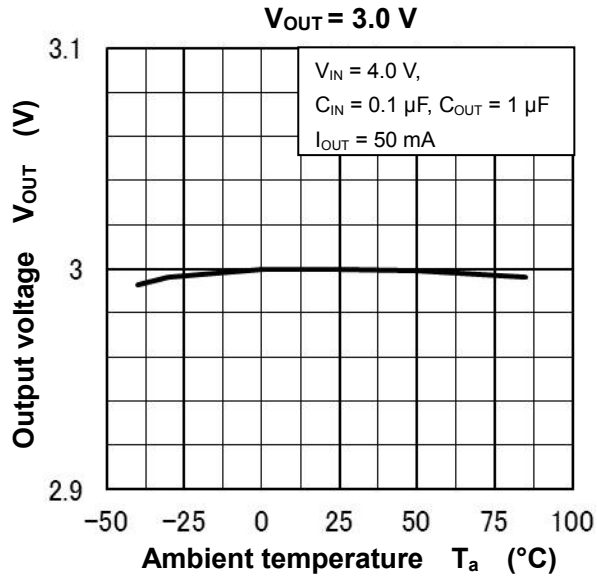


3) Output voltage vs. Ambient temperature

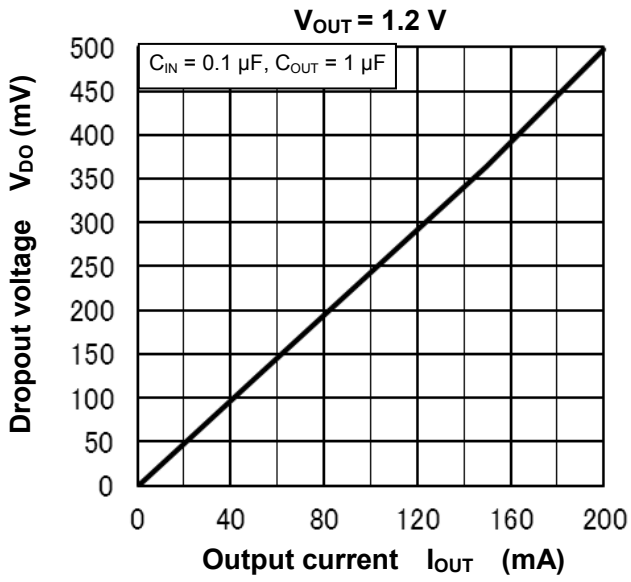


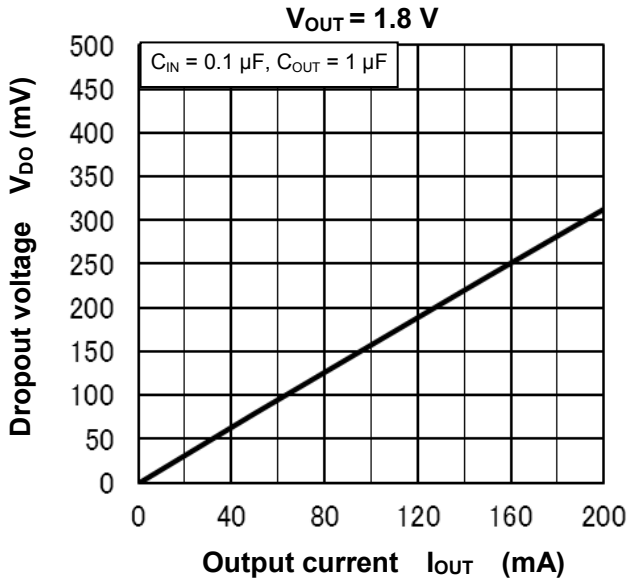


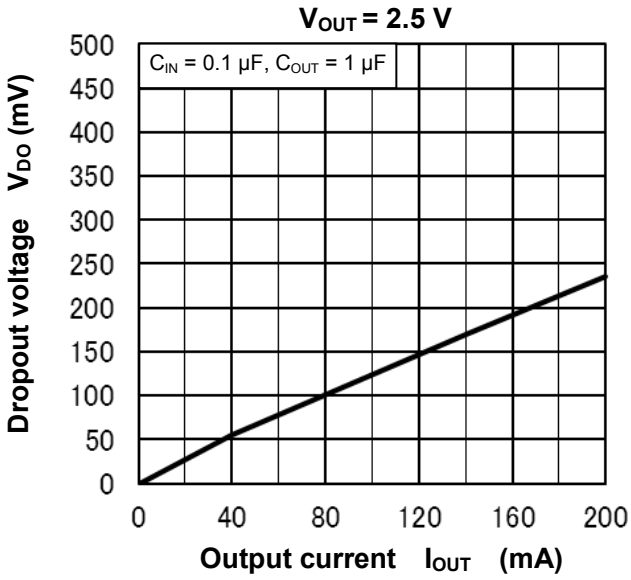


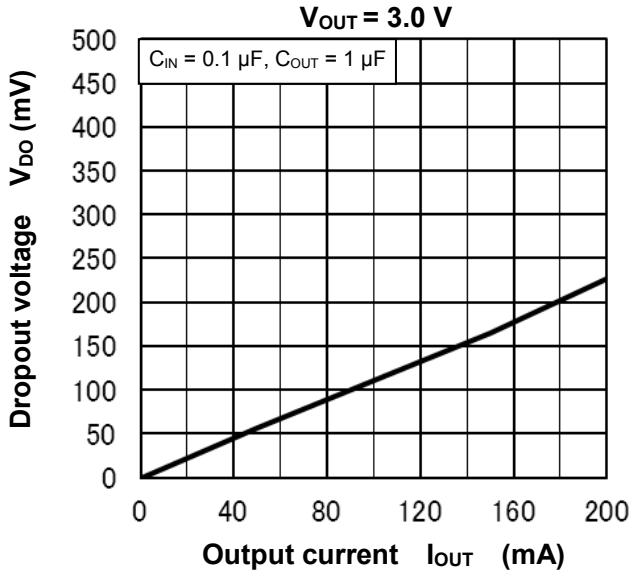


4) Dropout voltage vs. Output current

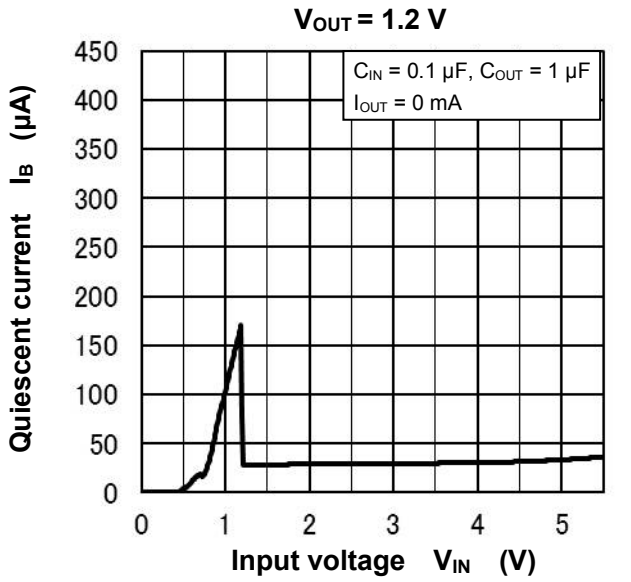


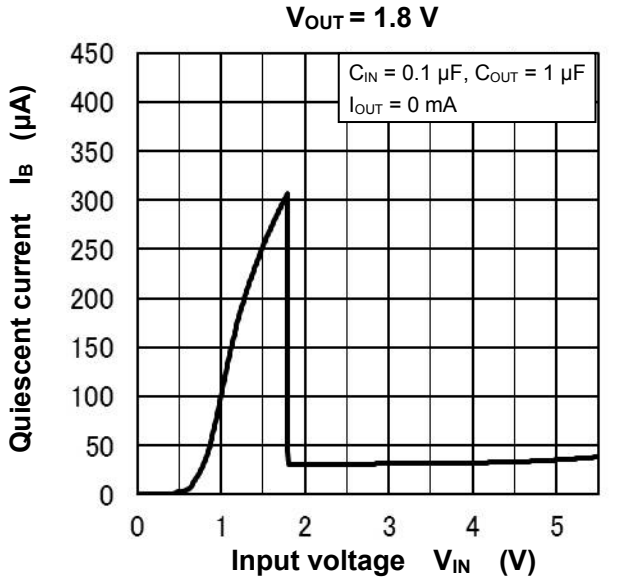


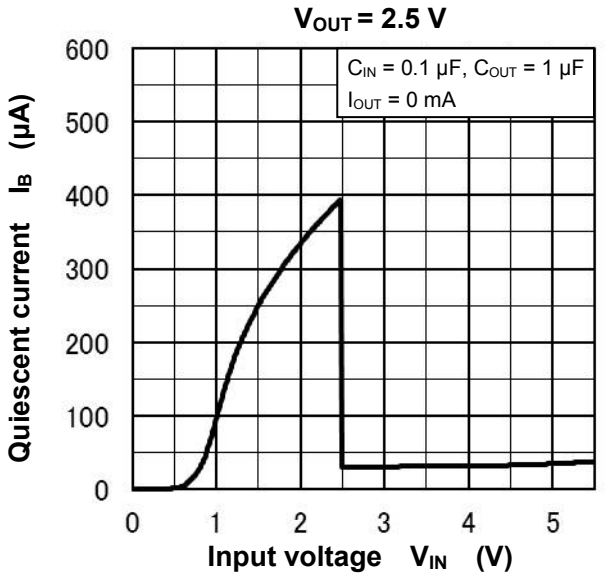


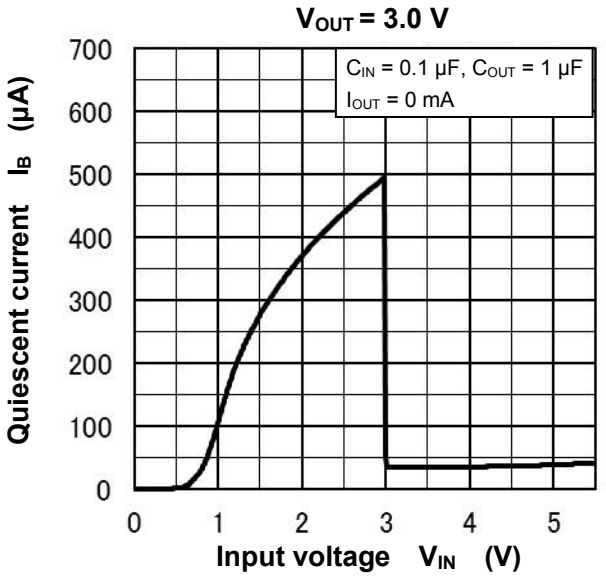


5) Quiescent current vs. Input voltage

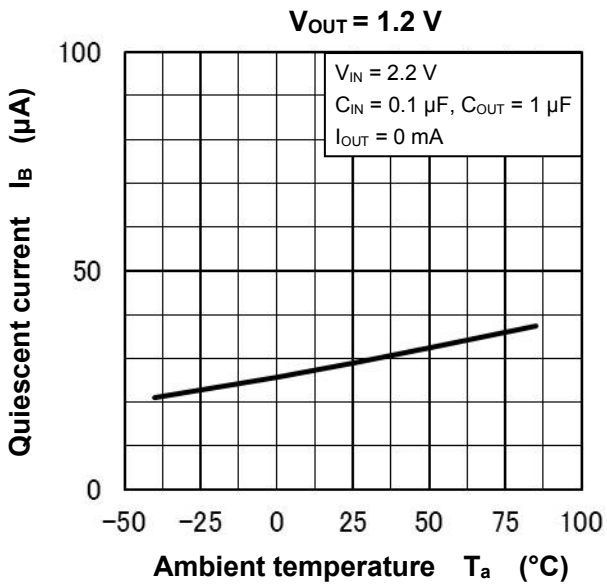


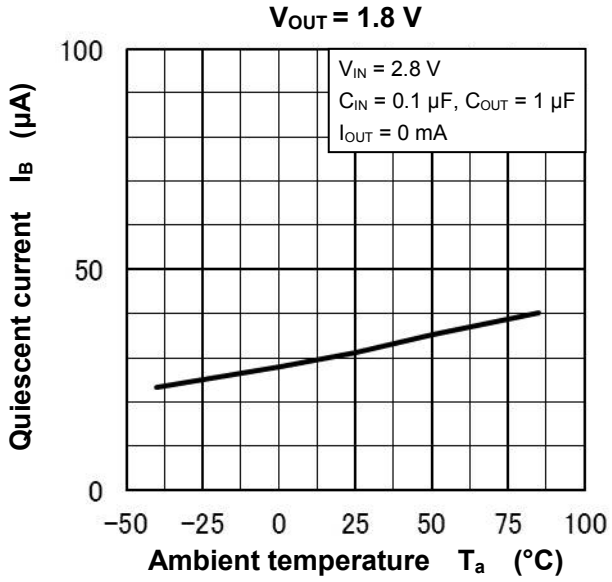


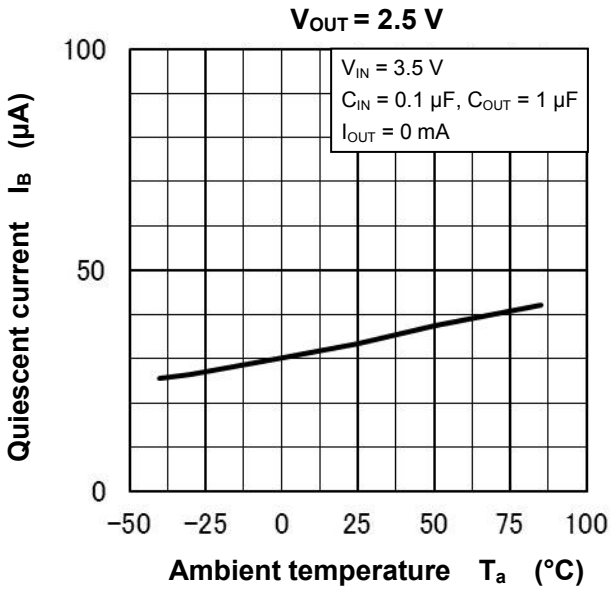


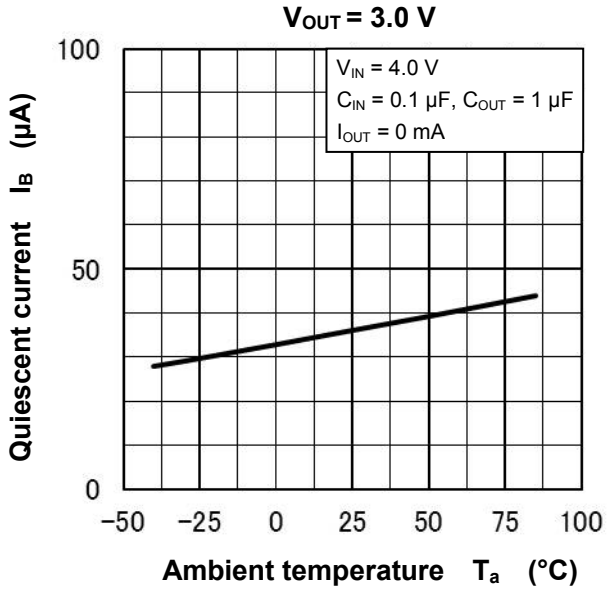


6) Quiescent current vs. Ambient temperature

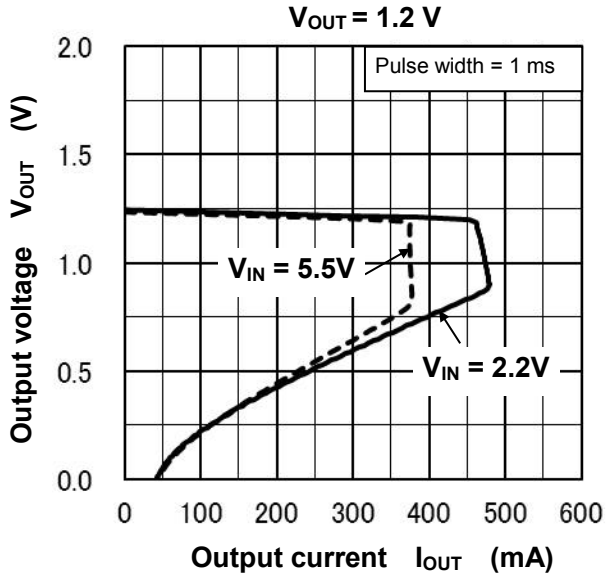


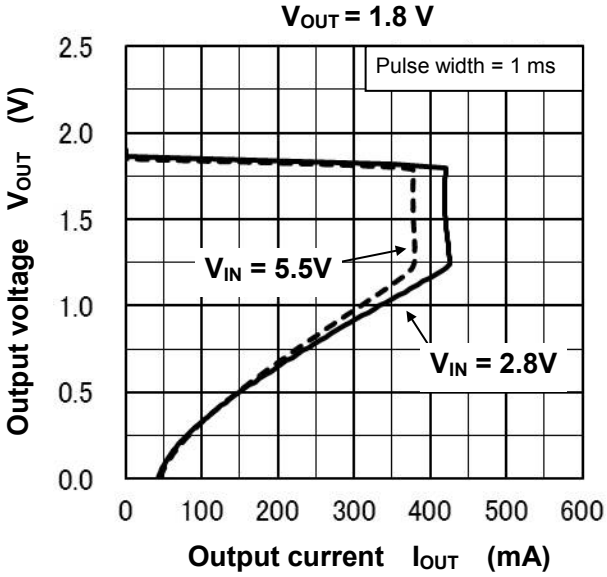


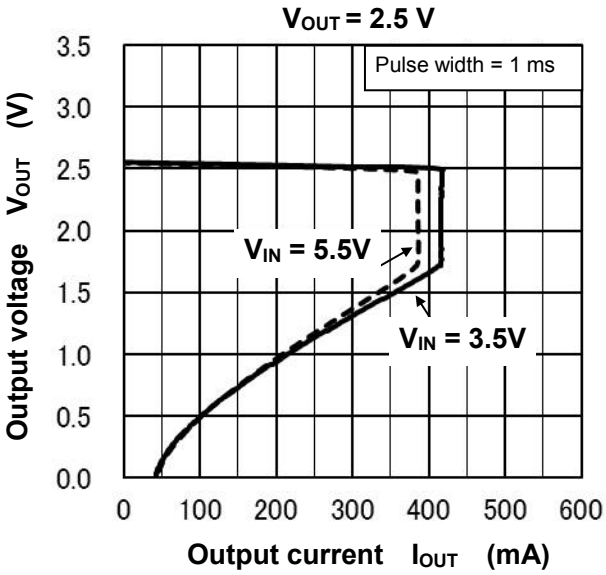


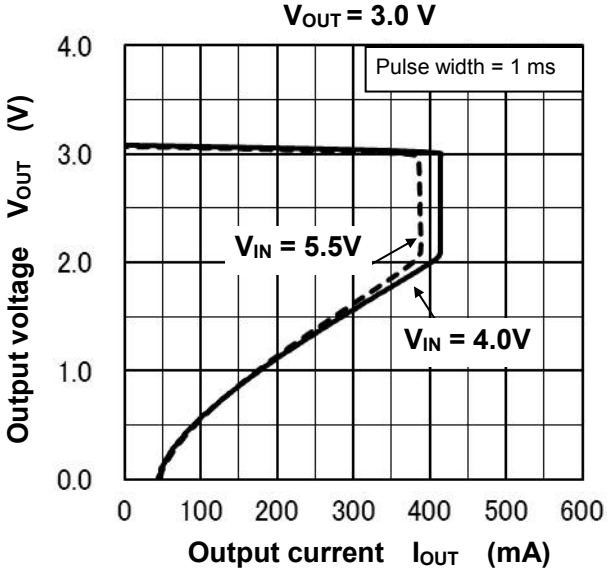


7) Output voltage vs. Output current

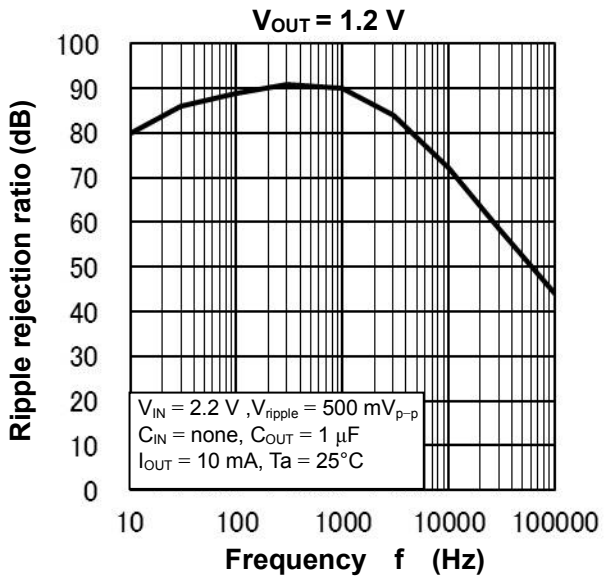


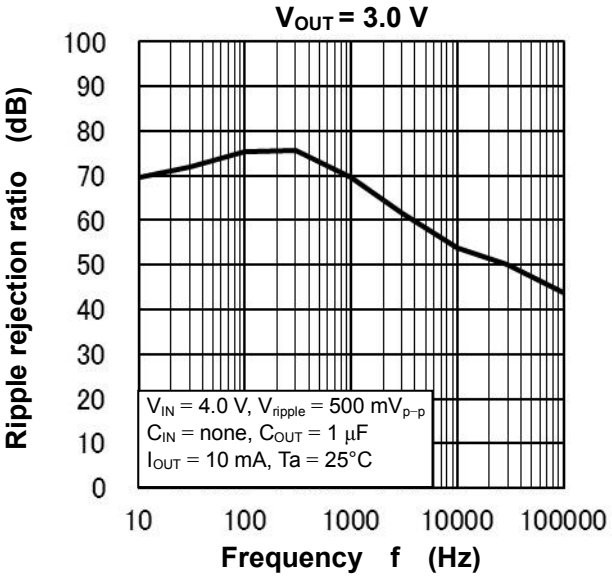






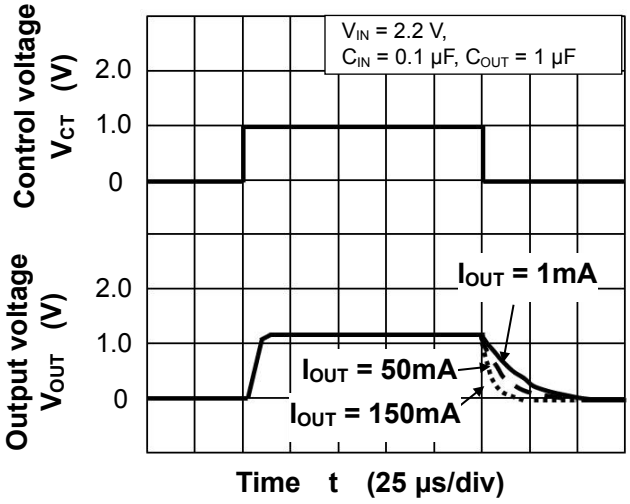
8) Ripple rejection ratio vs. Frequency



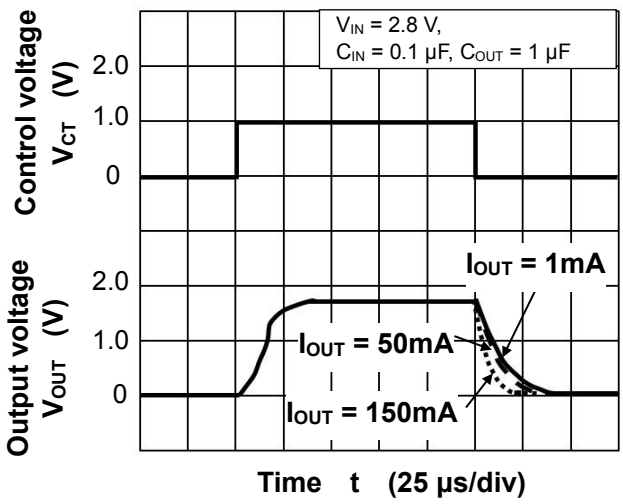


9) Control Transient Response

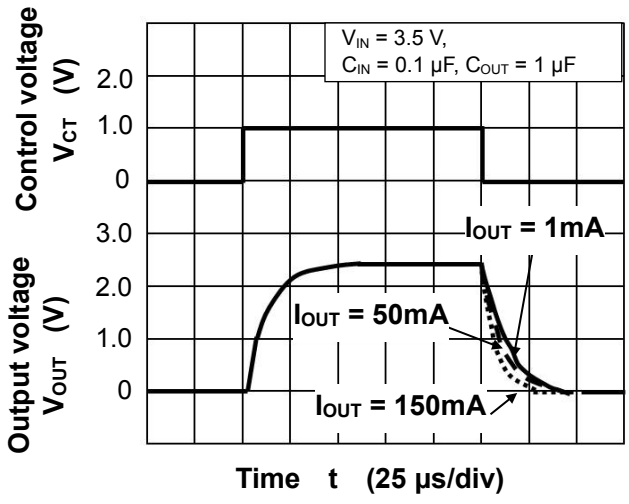
V_{OUT} = 1.2 V



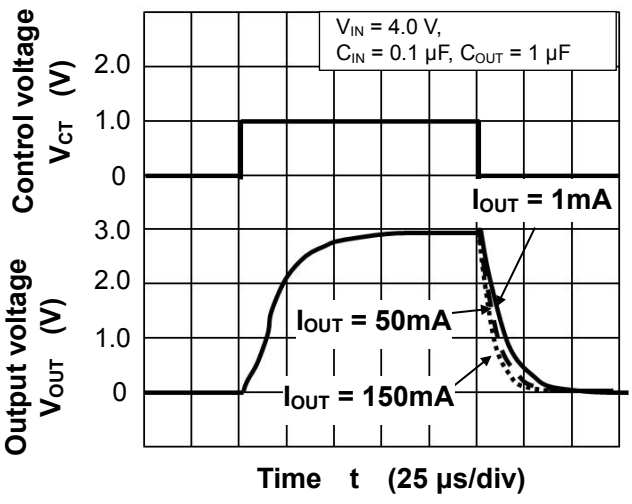
V_{OUT} = 1.8 V



V_{OUT} = 2.5 V

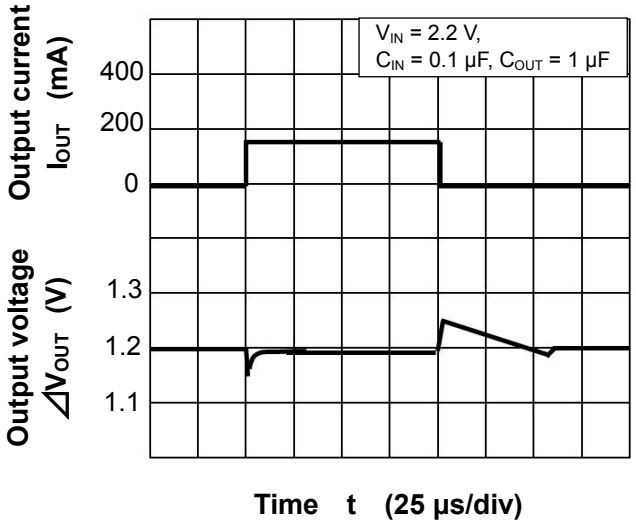


V_{OUT} = 3.0 V

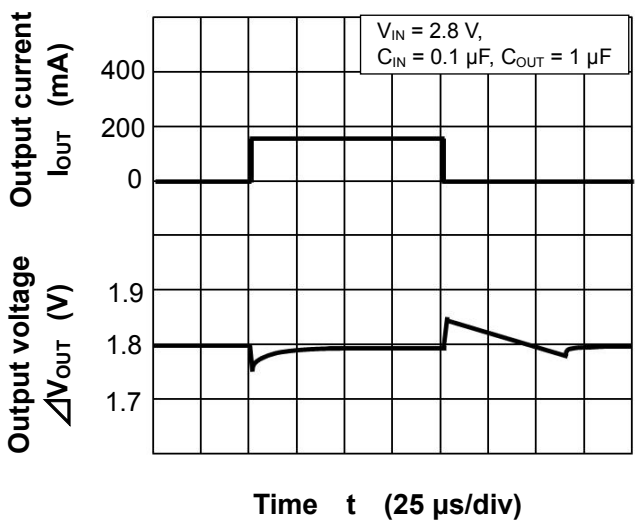


10) Control Transient Response

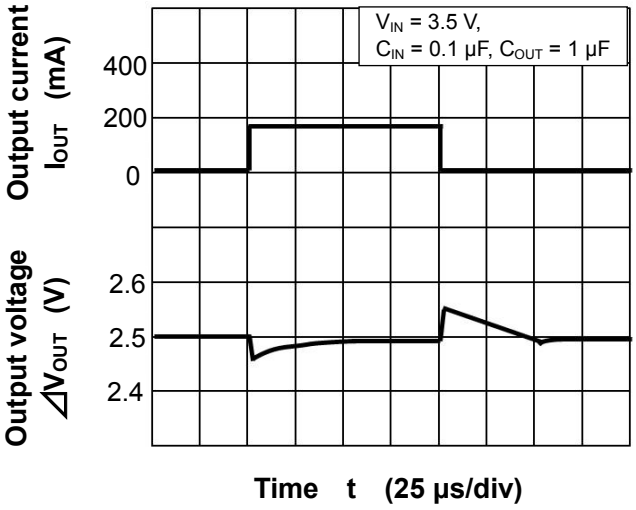
V_{OUT} = 1.2 V
(I_{OUT} = 1 mA ⇔ 150 mA)



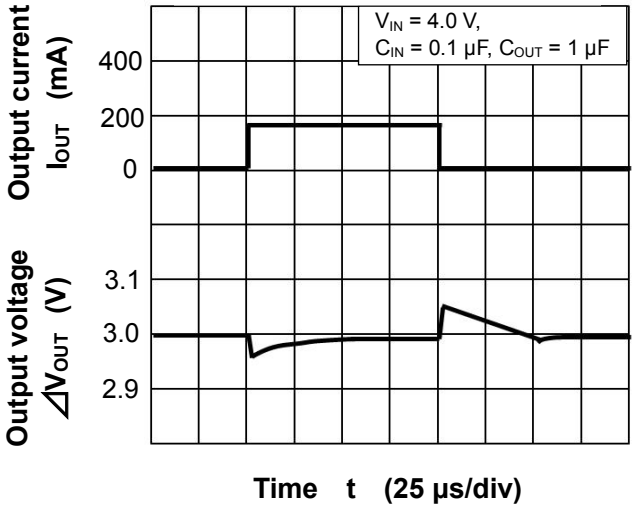
V_{OUT} = 1.8 V
(I_{OUT} = 1 mA ⇔ 150 mA)



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



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

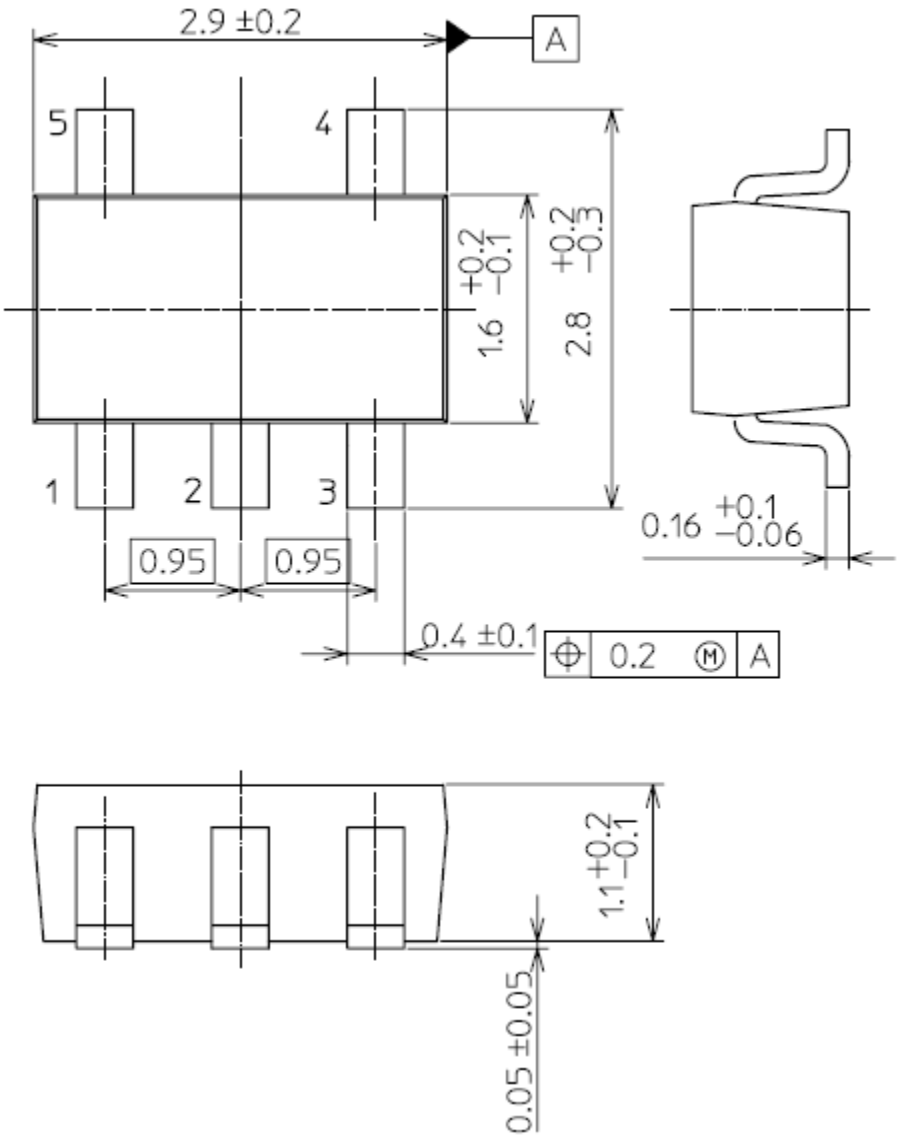


(Note) The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Package Dimensions

SMV (SOT-25)(SC-74A)

Unit: mm

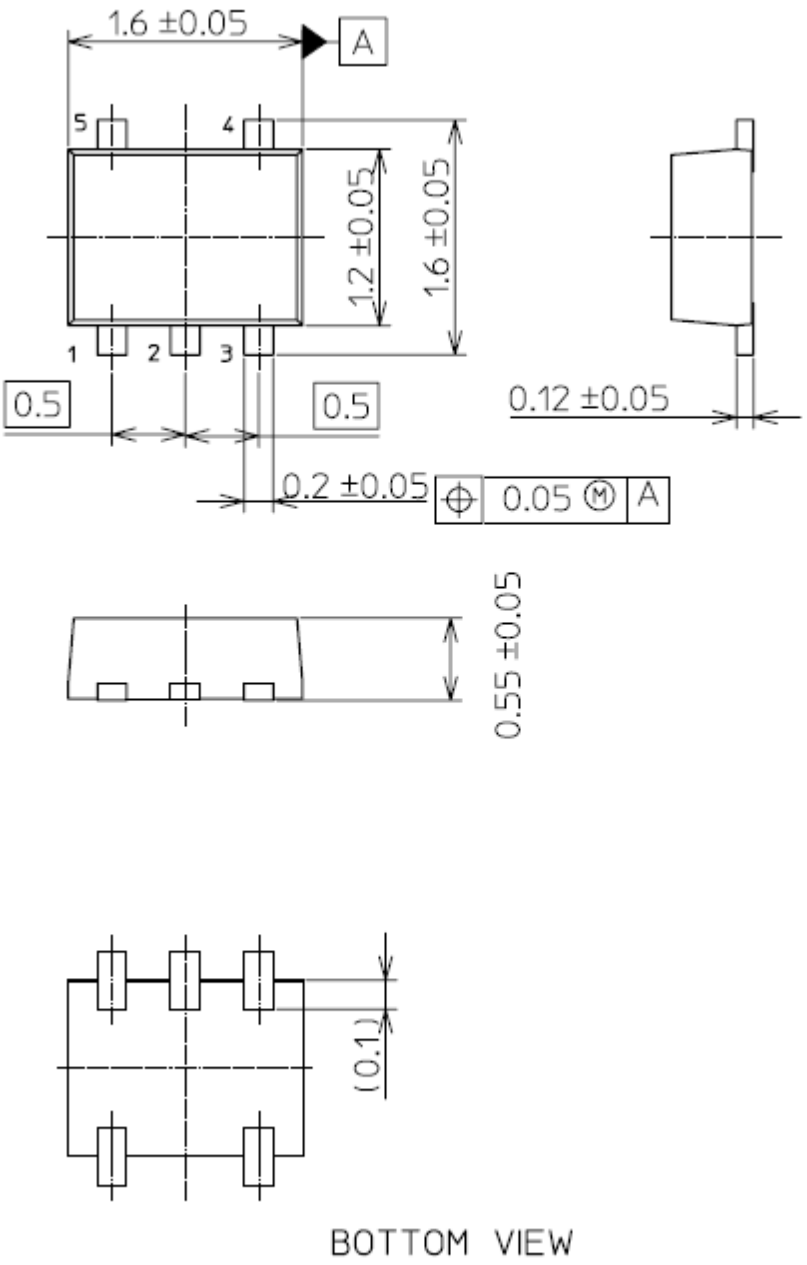


Weight : 16 mg (typ.)

Package Dimensions

ESV (SOT-553)

Unit: mm



Weight: 3.0 mg (typ.)

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