TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

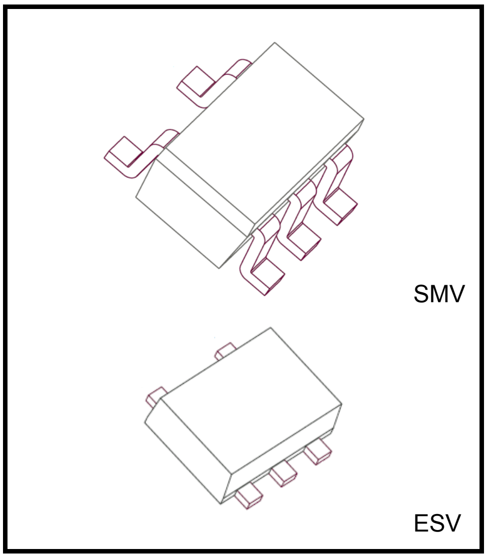
TCR2BF series
TCR2BE series

200 mA CMOS Low Drop-Out Regulator with Auto-discharge

The TCR2BF series and TCR2BE series are CMOS general-purpose single-output voltage regulators with an on/off control input, featuring low dropout voltage and low quiescent bias current. These voltage regulators can be enabled and disabled via the CONTROL pin.

These voltage regulators are available in fixed output voltages between 1.0 V and 5.0 V in SMV package, 1.0 to 3.6V in ESV package, and capable of driving up to 200 mA. They feature overcurrent protection and auto-discharge function.

The TCR2BF series and TCR2BE series are offered in the compact SMV (SOT-25)(SC-74A) and ESV (SOT-553) and allow the use of small ceramic input and output capacitors. Thus, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



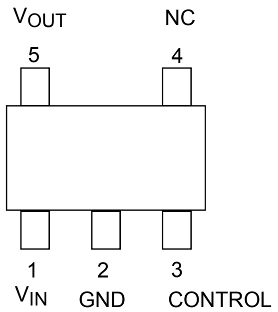
Weight:
SMV (SOT-25)(SC-74A) : 16 mg (typ.)
ESV (SOT-553) : 3.0 mg (typ.)

Features

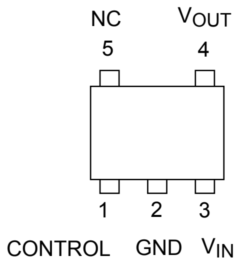
- Wide fixed output voltage line up
  TCR2BF series (SMV package) : V_{OUT} = 1.0 to 5.0 V
  TCR2BE series (ESV package) : V_{OUT} = 1.0 to 3.6 V
- Low output noise voltage (V_{NO} = 50 μV_{rms} (typ.) at 2.8 V-output, I_{OUT} = 10 mA, 10 Hz $\leqq$ f $\leqq$ 100 kHz)
- Low quiescent bias current (I_B = 75 μA (max) at I_{OUT} = 0 mA)
- Low stand-by current ($I_{B(OFF)}$ = 0.1 μA (typ.) at Stand-by mode)
- High ripple rejection (R.R. = 70 dB (typ.) at I_{OUT} = 10 mA, f =1kHz)
- Overcurrent protection
- Auto-discharge
- Pull-down connection at CONTROL
- Ceramic capacitors can be used (C_{IN} = 0.1μF, C_{OUT} =1.0 μF)
- Small package, SMV (SOT-25) (SC-74A) and ESV (SOT-553)

Pin Assignment (top view)

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



ESV (SOT-553)



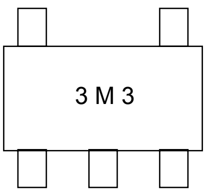
List of Products Number, Output Voltage, and Marking

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)		
TCR2BF10	TCR2BE10	1.0	1M0	TCR2BF29*	TCR2BE29*	2.9	2M9
TCR2BF105*	TCR2BE105*	1.05	1MA	TCR2BF295*	TCR2BE295*	2.95	2ME
TCR2BF11*	TCR2BE11*	1.1	1M1	TCR2BF30	TCR2BE30	3.0	3M0
TCR2BF115	TCR2BE115	1.15	1MB	TCR2BF31	TCR2BE31	3.1	3M1
TCR2BF12	TCR2BE12	1.2	1M2	TCR2BF32	TCR2BE32	3.2	3M2
TCR2BF125	TCR2BE125	1.25	1MC	TCR2BF33	TCR2BE33	3.3	3M3
TCR2BF13*	TCR2BE13*	1.3	1M3	TCR2BF34*	TCR2BE34*	3.4	3M4
TCR2BF14*	TCR2BE14*	1.4	1M4	TCR2BF35*	TCR2BE35*	3.5	3M5
TCR2BF15	TCR2BE15	1.5	1M5	TCR2BF36	TCR2BE36	3.6	3M6
TCR2BF16*	TCR2BE16*	1.6	1M6	TCR2BF37*	—	3.7	3M7
TCR2BF17*	TCR2BE17*	1.7	1M7	TCR2BF38*	—	3.8	3M8
TCR2BF175*	TCR2BE175*	1.75	1MF	TCR2BF39*	—	3.9	3M9
TCR2BF18	TCR2BE18	1.8	1M8	TCR2BF40	—	4.0	4M0
TCR2BF19*	TCR2BE19*	1.9	1M9	TCR2BF41*	—	4.1	4M1
TCR2BF20*	TCR2BE20*	2.0	2M0	TCR2BF42*	—	4.2	4M2
TCR2BF21*	TCR2BE21*	2.1	2M1	TCR2BF43*	—	4.3	4M3
TCR2BF22*	TCR2BE22*	2.2	2M2	TCR2BF44*	—	4.4	4M4
TCR2BF23*	TCR2BE23*	2.3	2M3	TCR2BF45	—	4.5	4M5
TCR2BF24*	TCR2BE24*	2.4	2M4	TCR2BF46*	—	4.6	4M6
TCR2BF25	TCR2BE25	2.5	2M5	TCR2BF47*	—	4.7	4M7
TCR2BF26*	TCR2BE26*	2.6	2M6	TCR2BF48*	—	4.8	4M8
TCR2BF27	TCR2BE27	2.7	2M7	TCR2BF49*	—	4.9	4M9
TCR2BF28	TCR2BE28	2.8	2M8	TCR2BF50	—	5.0	5M0
TCR2BF285*	TCR2BE285*	2.85	2MD				

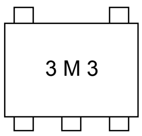
Please contact your local Toshiba representative if you are interested in products with * sign

Marking (top view)

Example: TCR2BF33 (3.3 V output)



Example: TCR2BE33 (3.3 V output)



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	SMV	200 (Note 1)	mW
			380 (Note 2)	
		ESV	150 (Note 1)	
			320 (Note 3)	
Operation temperature range	T_{opr}	−40 to 85		°C
Junction temperature	T_j	150		°C
Storage temperature range	T_{stg}	−55 to150		°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
(Glass epoxy board dimension: 30 mm × 30 mm, Copper area: 50 mm^2)

Note 3: Rating at mounting on a board
(Glass epoxy board dimension: 30 mm × 30 mm, Copper area: 20 mm^2)

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	V_{OUT}	—	V_{OUT} ≦ 1.4 V	-30	—	+30	mV
			1.5V ≦ V_{OUT}	-2	—	+2	%
Line regulation	Reg·line	V_{OUT} + 0.5 V ≦ V_{IN} ≦ 6 V, I_{OUT} = 1 mA		—	1	15	mV
Load regulation	Reg·load	1 mA ≦ I_{OUT} ≦ 150 mA		—	10	30	mV
Quiescent current	I_B	I_{OUT} = 0 mA		—	40	75	μA
Stand-by current	$I_{B\ (OFF)}$	V_{CT} = 0 V		—	0.1	1.0	μA
Dropout voltage	V_{IN}-V_{OUT}	Please refer to the Dropout voltage table					
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, Ta = 25°C (Note 4)		—	50	—	μV_{rms}
Input voltage	V_{IN}	—	V_{OUT} : 1.0V	1.55	—	6.0	V
			V_{OUT} : 1.05V to 1.1V	V_{OUT} + 0.50 V	—	6.0	
			V_{OUT} : 1.15V to 1.2V	1.58	—	6.0	
			V_{OUT} : 1.25V	1.59	—	6.0	
			V_{OUT} : 1.3V	1.63	—	6.0	
			V_{OUT} : 1.4V	1.68	—	6.0	
			V_{OUT} : 1.5V to 1.75V	V_{OUT} +0.25 V	—	6.0	
			V_{OUT} : 1.8V to 2.4V	V_{OUT} +0.20 V	—	6.0	
			V_{OUT} : 2.5V to 5.0V	V_{OUT} +0.15 V	—	6.0	
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		—	70	—	dB
Control voltage (ON)	$V_{CT\ (ON)}$	—		1.1	—	6.0	V
Control voltage (OFF)	$V_{CT\ (OFF)}$	—		0	—	0.4	V

Note 4: The 2.8V output product.

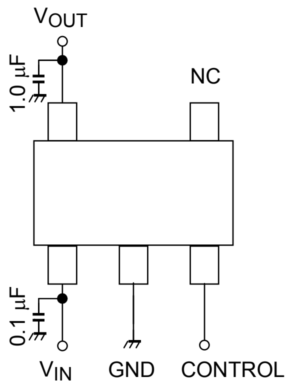
Dropout Voltage
(I_{OUT} = 50 mA, C_{IN} = 0.1 μF, C_{OUT} = 1.0 μF, T_j = 25°C)

Output voltage	Symbol	Min	Typ.	Max	Unit
V_{OUT} : 1.0V	V_{IN}-V_{OUT}	—	350	550	mV
V_{OUT} : 1.05V		—	340	500	
V_{OUT} : 1.1V		—	310	500	
V_{OUT} : 1.15V		—	290	430	
V_{OUT} : 1.2V		—	260	380	
V_{OUT} : 1.25V		—	250	340	
V_{OUT} : 1.3V		—	230	330	
V_{OUT} : 1.4V		—	190	280	
V_{OUT} : 1.5V to 1.75V		—	160	250	
V_{OUT} : 1.8V to 2.4V		—	130	200	
V_{OUT} : 2.5V to 5.0V		—	100	150	

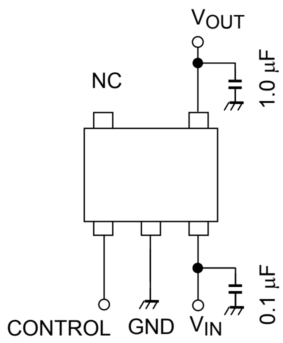
Application Note

1. Recommended Application Circuit

●SMV



●ESV



CONTROL pin connection	Operation
HIGH	ON
LOW	OFF
OPEN	OFF

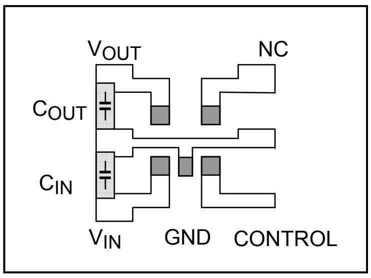
The figure above shows the recommended configuration for using a Low-Dropout regulator. Insert a capacitor at V_{OUT} and V_{IN} pins for stable input/output operation. (Ceramic capacitors can be used).

2. Power Dissipation

Power dissipation is measured on the board shown below.

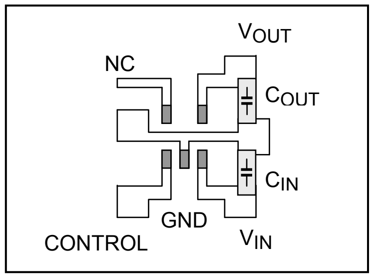
Testing Board of Thermal Resistance

SMV



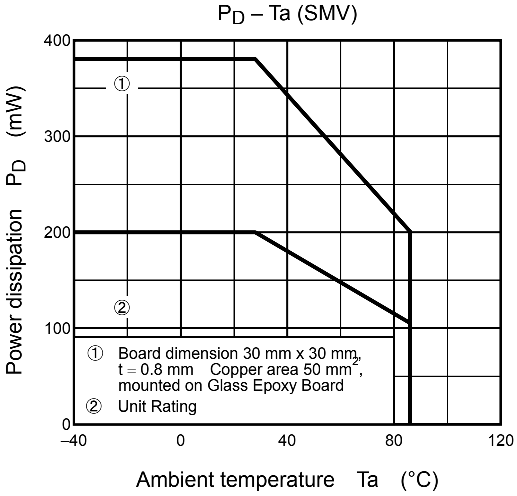
*Board material: Glass Epoxy
Board dimension: 30 mm × 30 mm
Copper area: 50 mm^2、 t = 0.8 mm

ESV

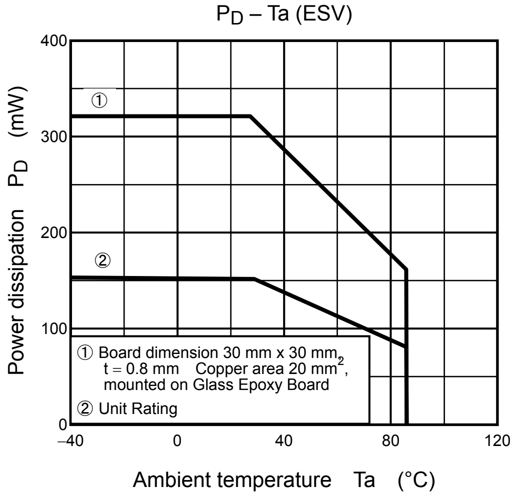


*Board material: Glass Epoxy
Board dimension: 30 mm × 30 mm
Copper area: 20 mm^2, t = 0.8 mm

P_D – Ta (SMV)



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 recommend the ESR of ceramic capacitor is under 10 Ω.

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

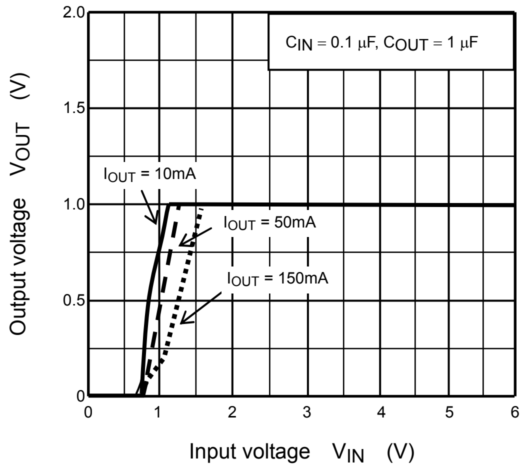
- Permissible Loss
  Please have enough design patterns for expected maximum permissible loss. And under consideration of surrounding temperature, input voltage, and output current etc, we recommend proper dissipation ratings for maximum permissible loss; in general maximum dissipation rating is 70 to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

- Overcurrent Protection 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 recommend inserting failsafe system into the design.

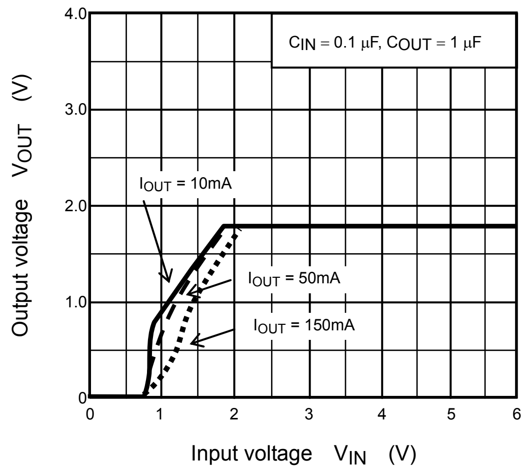
Representative Typical Characteristics

1) Output Voltage vs. Input Voltage

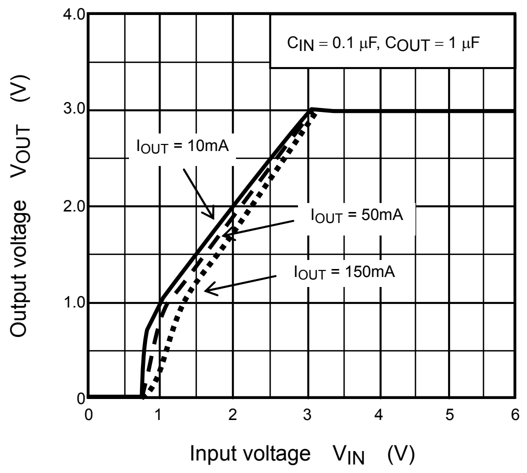
V_{OUT}=1.0V



V_{OUT}=1.8V

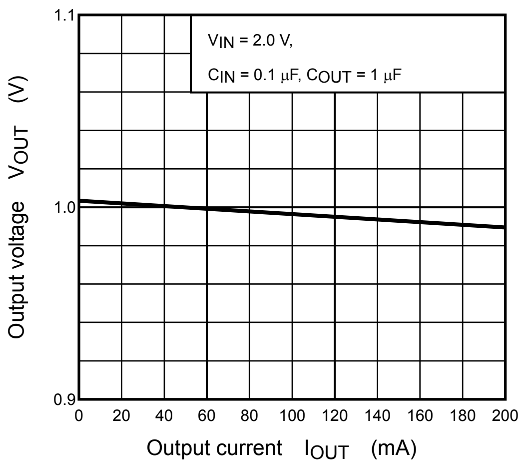


V_{OUT}=3.0V

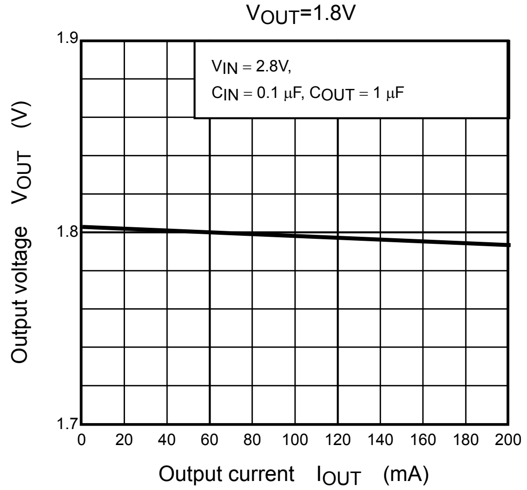


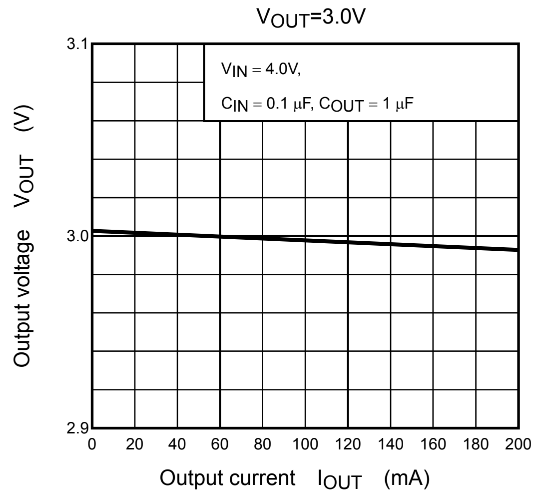
2) Output Voltage vs. Output Current

V_{OUT}=1.0V

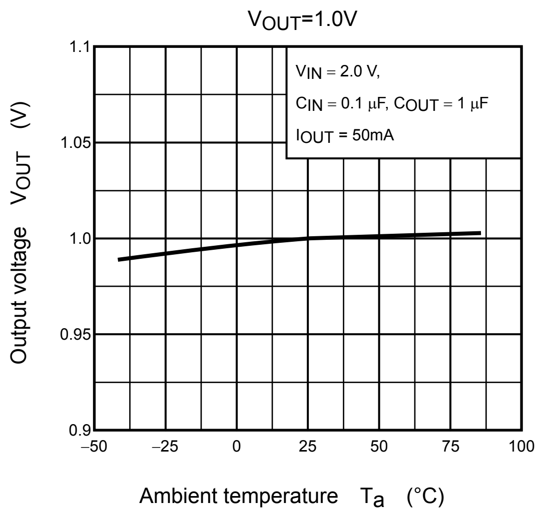


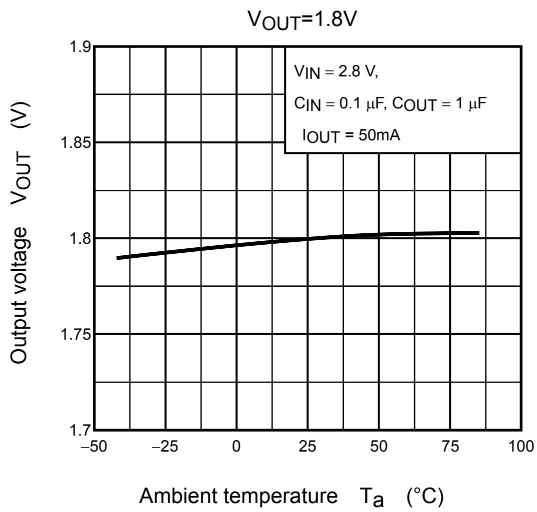
V_{OUT}=1.8V

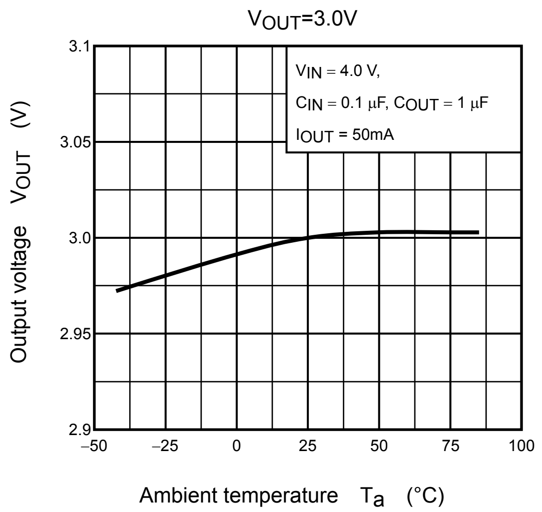




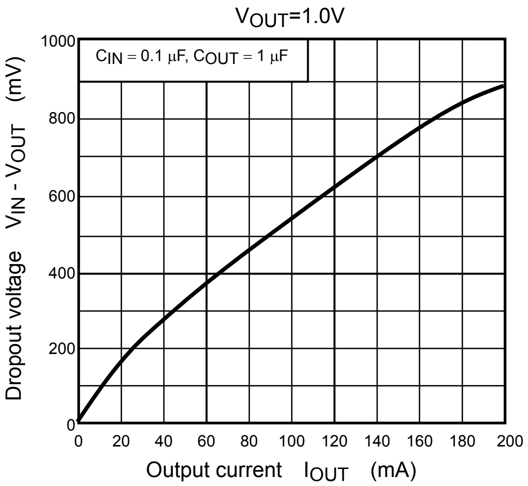
3) Output Voltage vs. Ambient Temperature

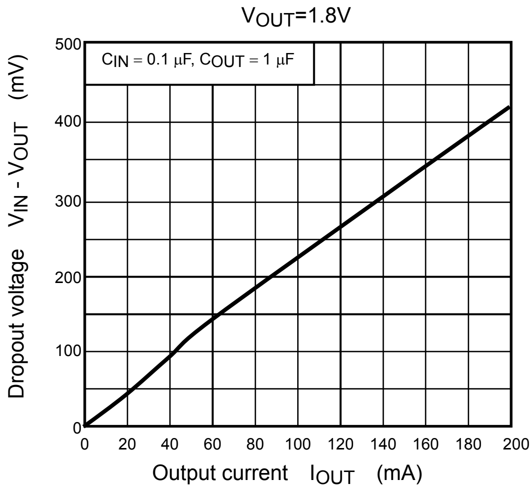


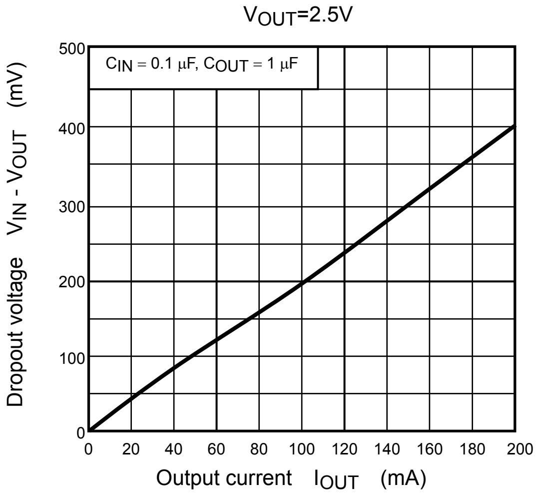




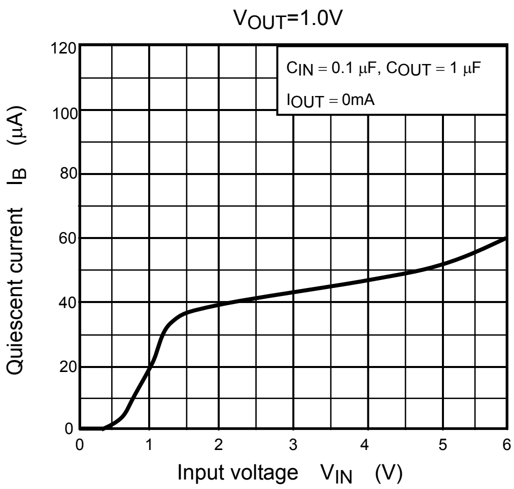
4) Dropout Voltage vs. Output Current

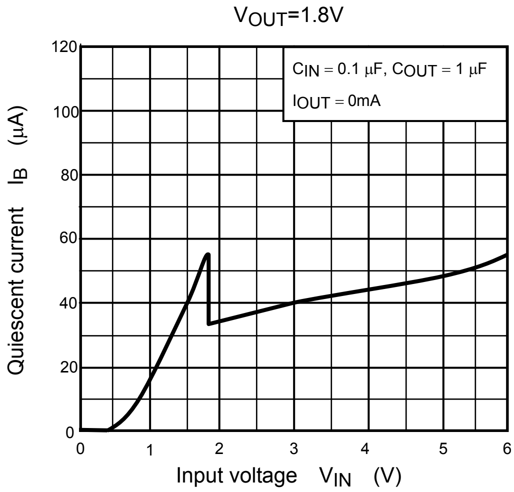




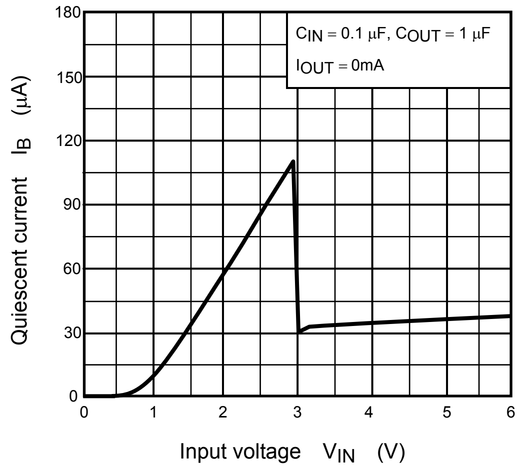


5) Quiescent Current vs. Input Voltage



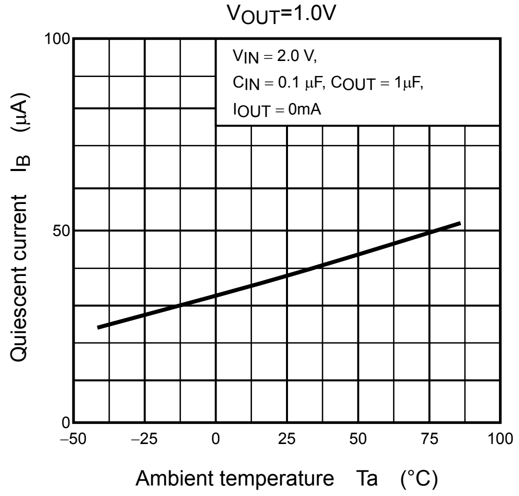


V_{OUT}=3.0V

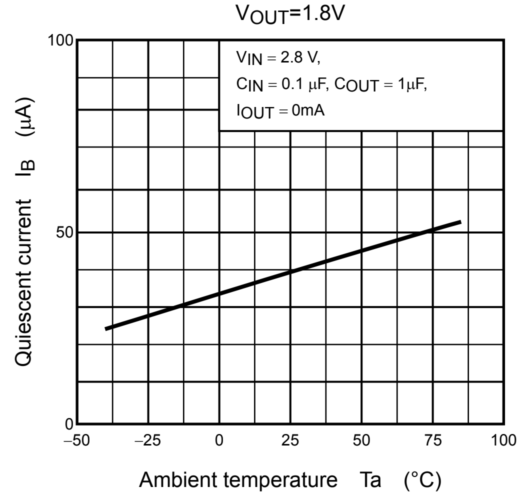


6) Quiescent Current vs.Ambient Temperature

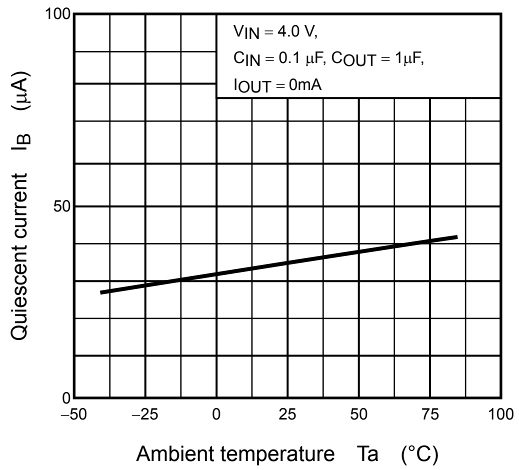
V_{OUT}=1.0V



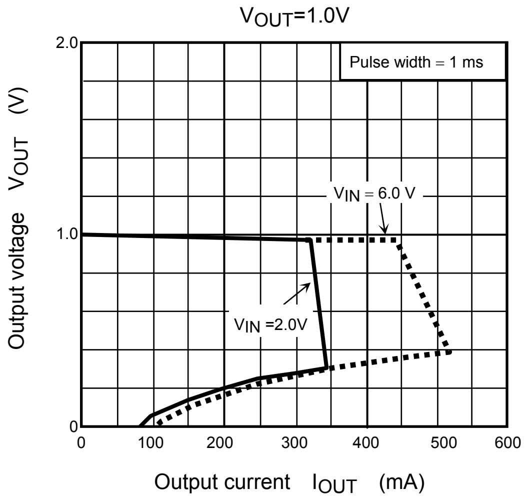
V_{OUT}=1.8V

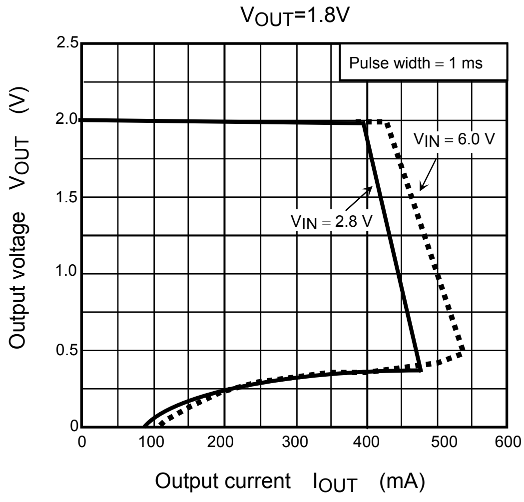


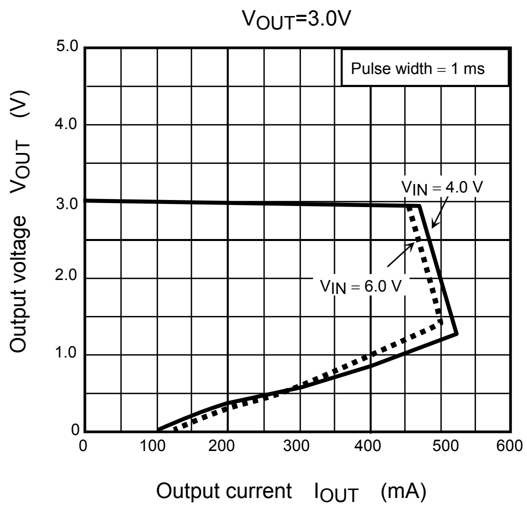
V_{OUT}=3.0V



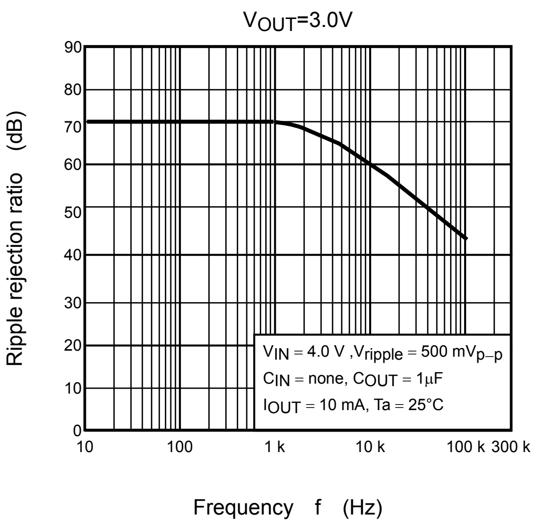
7) Overcurrent protection characteristics (Overcurrent protection characteristic does not assure for the suppression of uprising device operation. We recommend proper dissipation ratings for maximum permissible loss.)





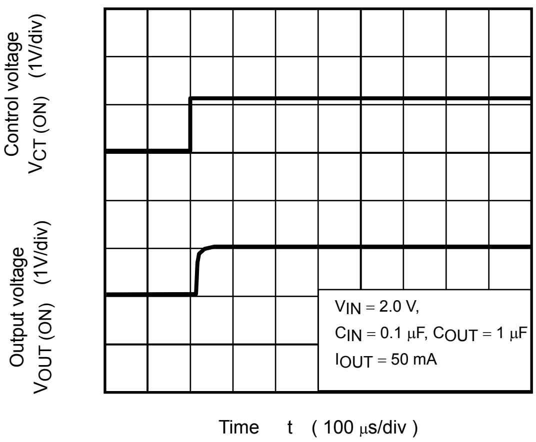


8) Ripple Rejection Ratio vs. Frequency

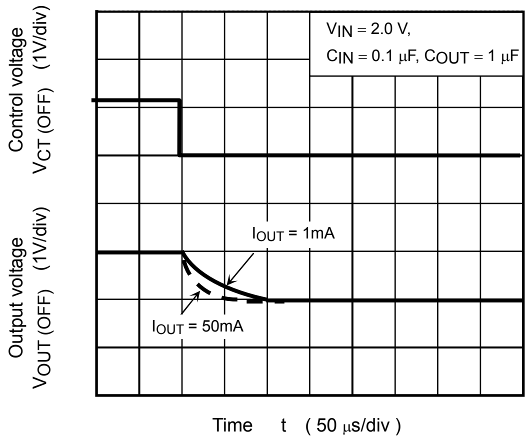


9) Control Transient Response (Auto-Discharge)

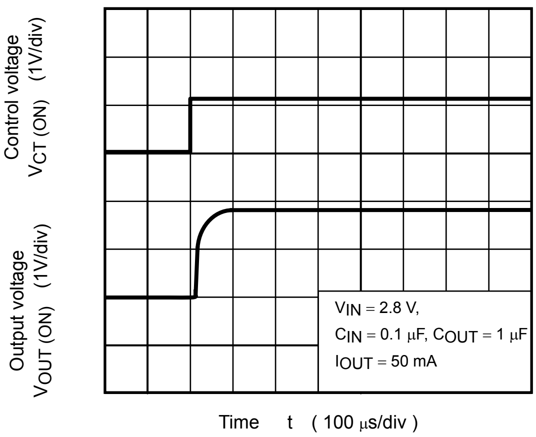
V_{OUT}=1.0V (Turn on waveform)



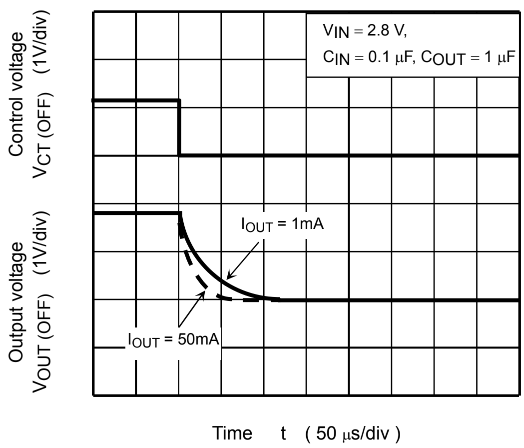
V_{OUT}=1.0V (Turn off waveform)



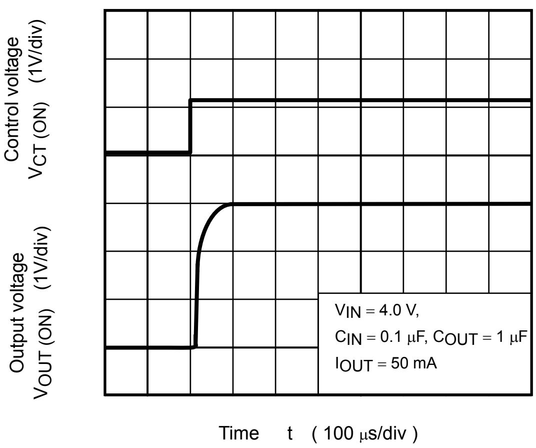
V_{OUT}=1.8V (Turn on waveform)



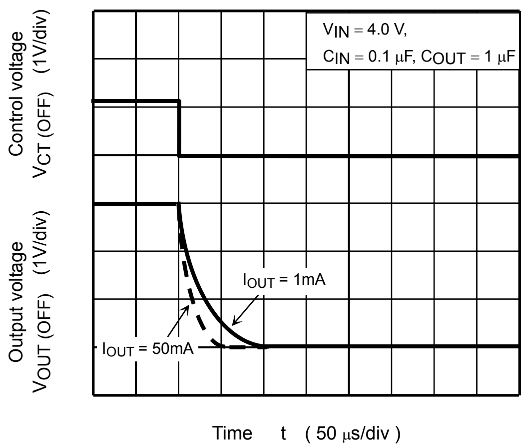
V_{OUT}=1.8V (Turn off waveform)



V_{OUT}=3.0V (Turn on waveform)

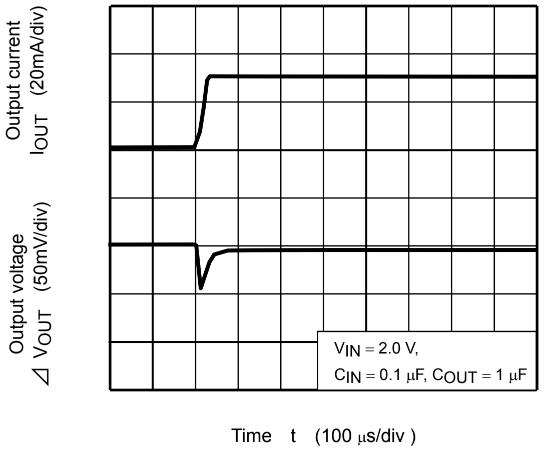


V_{OUT}=3.0 V (Turn off waveform)

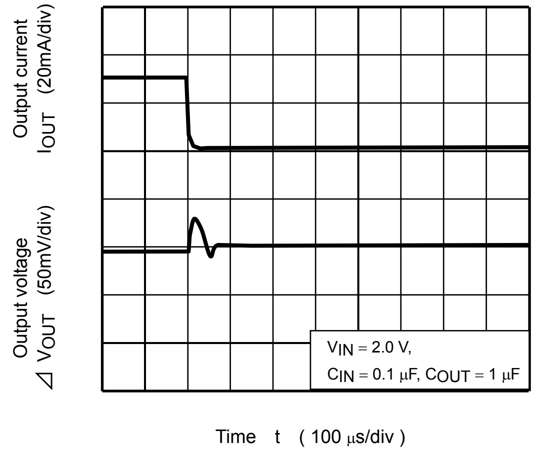


10) Load Transient Response

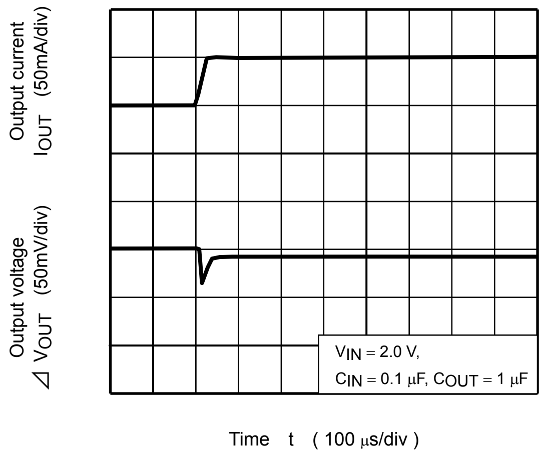
V_{OUT}=1.0V
(I_{OUT} = 1mA to 30mA)



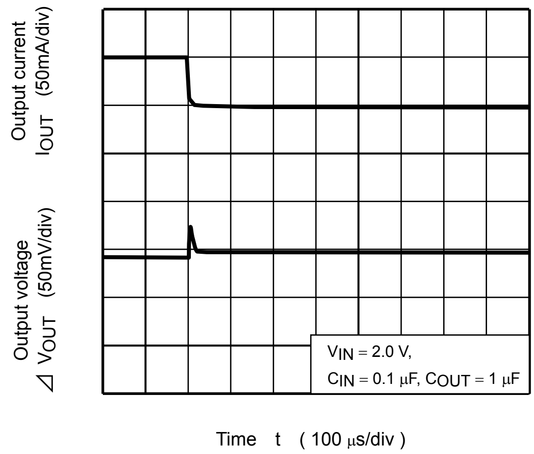
V_{OUT}=1.0V
(I_{OUT} = 30mA to 1mA)



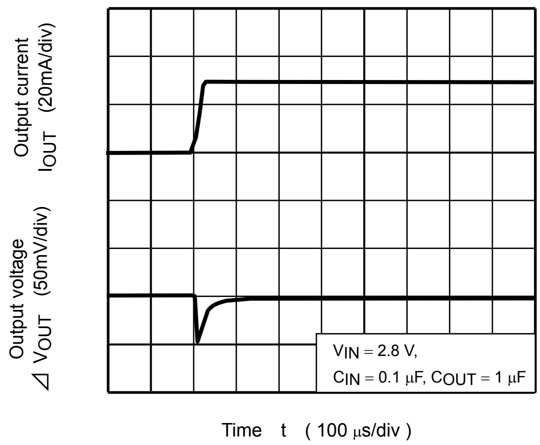
V_{OUT}=1.0V
(I_{OUT} = 50mA to 100mA)



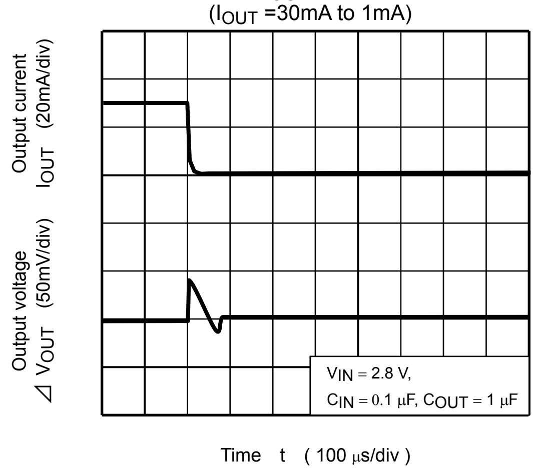
V_{OUT}=1.0V
(I_{OUT} = 100mA to 50mA)



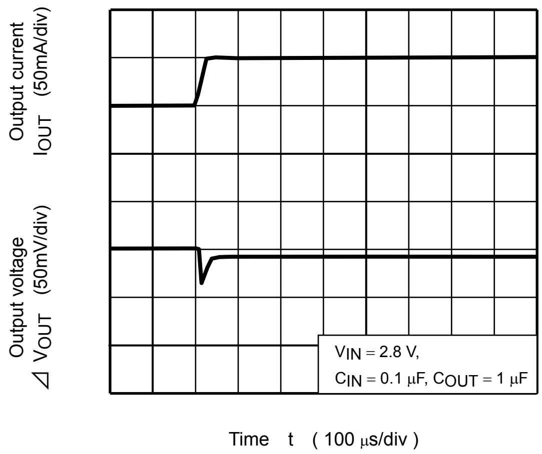
V_{OUT}=1.8V
(I_{OUT} = 1mA to 30mA)



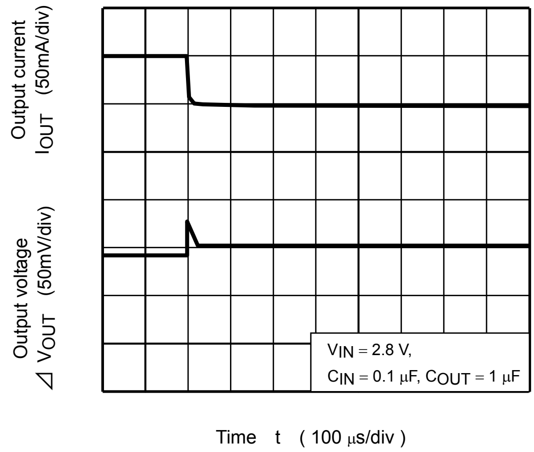
V_{OUT}=1.8V
(I_{OUT} =30mA to 1mA)



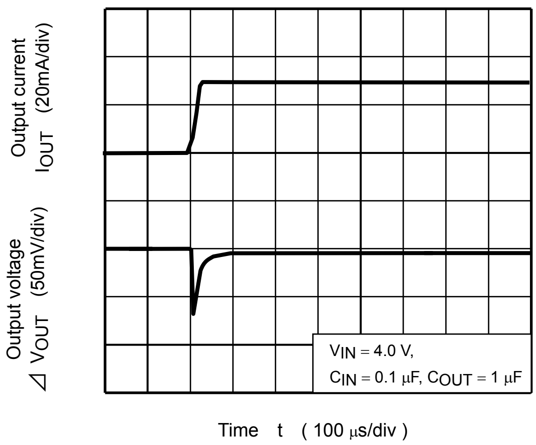
V_{OUT}=1.8V
(I_{OUT} = 50mA to 100mA)



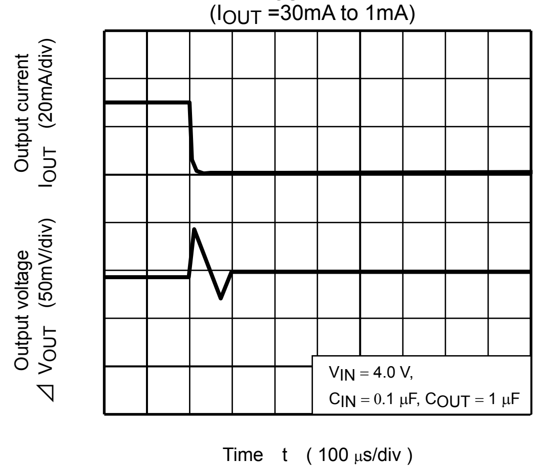
V_{OUT}=1.8V
(I_{OUT} = 100mA to 50mA)



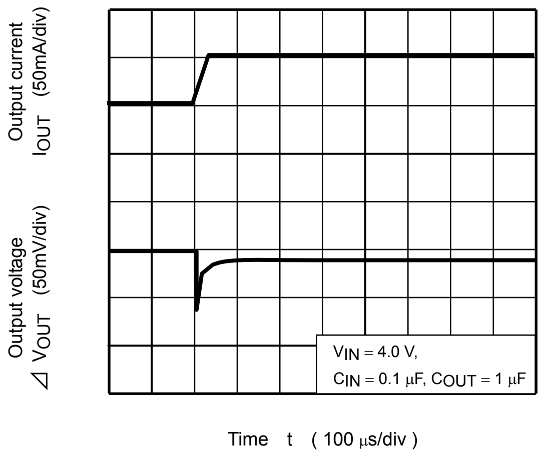
V_{OUT}=3.0V
(I_{OUT} = 1mA to 30mA)



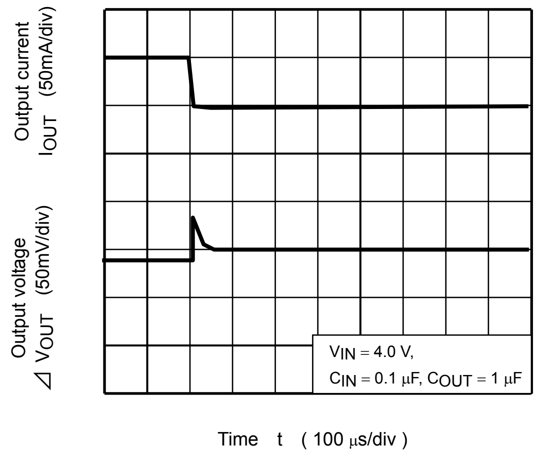
V_{OUT}=3.0V
(I_{OUT} =30mA to 1mA)



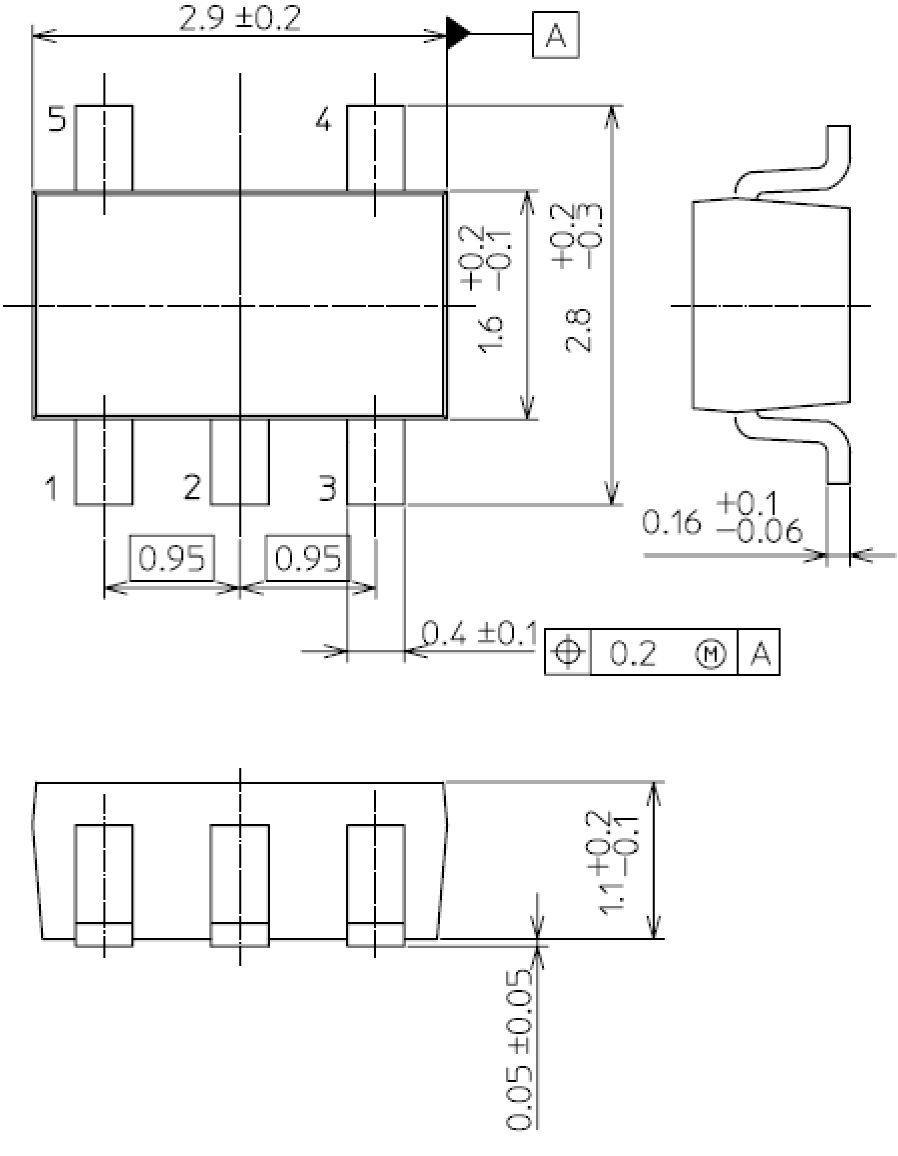
V_{OUT}=3.0V
(I_{OUT} = 50mA to 100mA)



V_{OUT}=3.0V
(I_{OUT} = 100mA to 50mA)



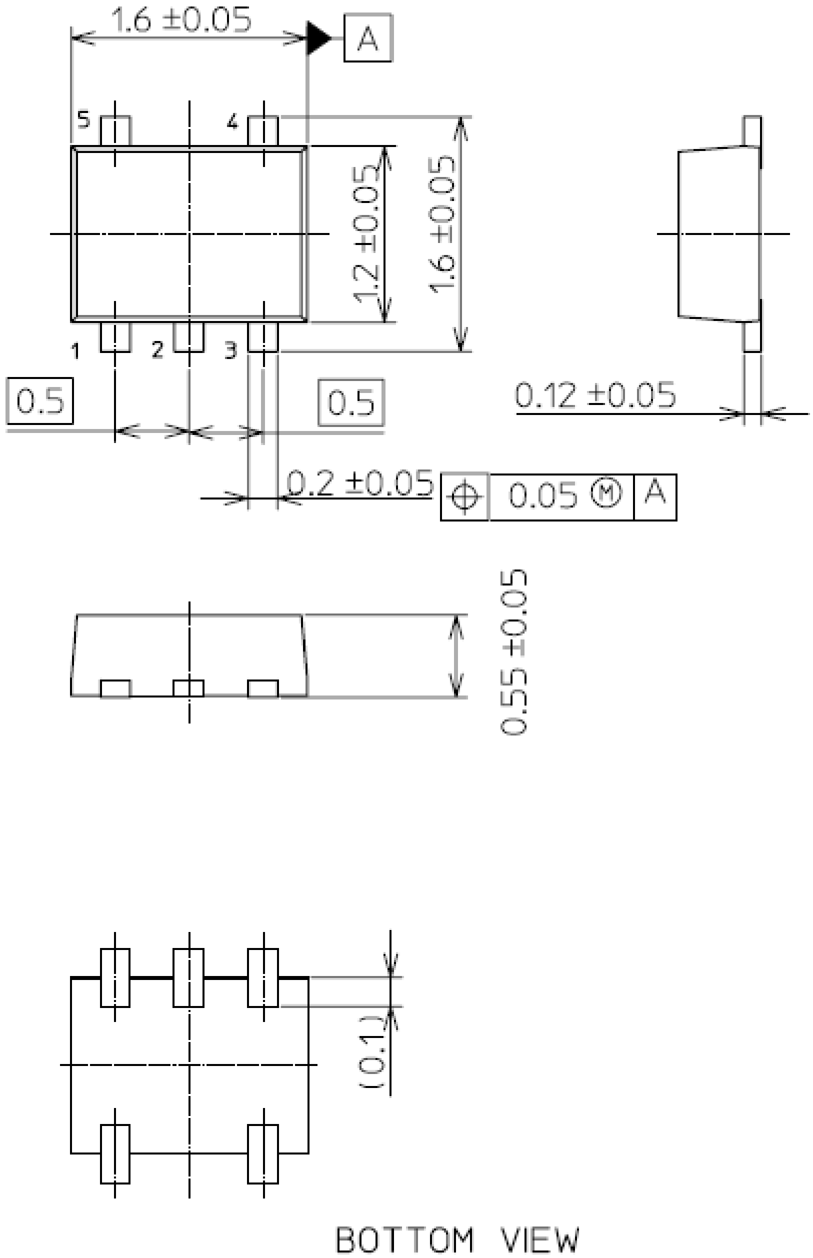
Package Dimensions
SMV (SOT-25)(SC-74A) **Unit: mm**



Weight : 16 mg (typ.)

Package Dimensions

ESV (SOT-553) **Unit: mm**



Weight: 3.0 mg (typ.)

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