TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCR3DF series

300 mA CMOS Low Dropout Regulator with inrush current protection circuit

1. Description

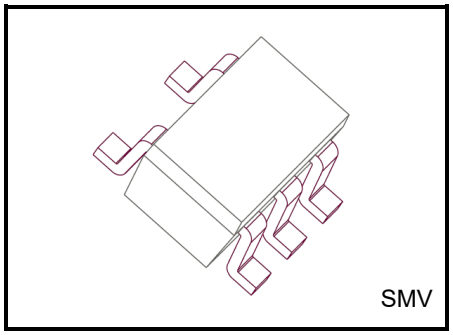
The TCR3DF series are CMOS general-purpose single-output voltage regulators with an on/off control input, featuring low dropout voltage, low output noise voltage and low inrush current.

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, over-temperature protection, Inrush current protection circuit and Auto-discharge function.

The TCR3DF series has a low dropout voltage of 230 mV (2.5 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 $\triangle V_{OUT}$ = ±85 mV (I_{OUT} = 1 mA⇔300 mA, C_{OUT} =1.0 µF).

Thus, the TCR3DF series are suitable for sensitive power supply such as Analog and RF applications.



Weight:
SMV (SOT-25) (SC-74A) : 16 mg (Typ.)

2. Features

- Low Drop-Out voltage
  V_{IN}-V_{OUT} = 230 mV (typ.) at 2.5 V-output, I_{OUT} = 300 mA
  V_{IN}-V_{OUT} = 290 mV (typ.) at 1.8 V-output, I_{OUT} = 300 mA
  V_{IN}-V_{OUT} = 510 mV (typ.) at 1.2 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 (ΔV_{OUT} = ±85 mV (typ.) at I_{OUT} = 1 ⇔ 300 mA, C_{OUT} =1.0 µF)
- High ripple rejection (R.R = 70 dB (typ.) at 2.5 V-output, I_{OUT} = 10 mA, f = 1kHz)
- Over-current protection
- Over-temperature protection
- Inrush current protection circuit
- Auto-discharge function
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used (C_{IN} = 1.0 µF, C_{OUT} = 1.0 µF)
- General purpose package SMV(SOT-25) (SC-74A)

Start of commercial production
2013-11

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3. Absolute Maximum Ratings (Note) (Ta = 25 °C)

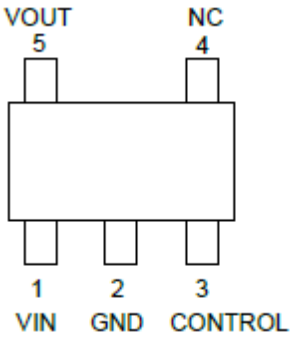
Characteristics	Symbol	Rating	Unit
Input voltage	V_{IN}	6.0	V
Control voltage	V_{CT}	-0.3 to 6.0	V
Output voltage	V_{OUT}	-0.3 to V_{IN} + 0.3	V
Output current	I_{OUT}	300	mA
Power dissipation	P_D	200 (Note1)	mW
		580 (Note2)	
Operation temperature range	T_{opr}	40 to 85	°C
Junction temperature	T_j	150	°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: Unit Rating

Note2: Rating at mounting on a board (FR4 board: 25.4 mm x 25.4 mm x 1.6 mm)

4. Pin Assignment (top view)



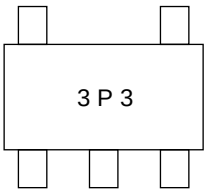
5. List of Products Number, Output voltage and Marking

Product No.	Output voltage(V)	Marking	Product No.	Output voltage(V)	Marking
TCR3DF10	1.0	1P0	TCR3DF275	2.75	2PF
TCR3DF105	1.05	1PA	TCR3DF28	2.8	2P8
TCR3DF11	1.1	1P1	TCR3DF285	2.85	2PD
TCR3DF12	1.2	1P2	TCR3DF29	2.9	2P9
TCR3DF125	1.25	1PC	TCR3DF295	2.95	2PE
TCR3DF13	1.3	1P3	TCR3DF30	3.0	3P0
TCR3DF15	1.5	1P5	TCR3DF31	3.1	3P1
TCR3DF17	1.7	1P7	TCR3DF32	3.2	3P2
TCR3DF18	1.8	1P8	TCR3DF33	3.3	3P3
TCR3DF185	1.85	1PF	TCR3DF335	3.35	3PD
TCR3DF19	1.9	1P9	TCR3DF36	3.6	3P6
TCR3DF24	2.4	2P4	TCR3DF39	3.9	3P9
TCR3DF25	2.5	2P5	TCR3DF40	4.0	4P0
TCR3DF27	2.7	2P7	TCR3DF45	4.5	4P5

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

Marking (top view)

Example: TCR3DF33 (3.3 V output)



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6. 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, T_j = 25 °C)

Characteristics	Symbol	Test Condition		Min	Typ.	Max	Unit
Output voltage accuracy	V_{OUT}	I_{OUT} = 50 mA (Note 3)	V_{OUT} <1.8 V	-18	—	+18	mV
			1.8V ≤ V_{OUT}	-1.0	—	+1.0	%
Input voltage	V_{IN}	I_{OUT} = 300 mA		1.8	—	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		—	30	50	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 4)		—	230	310	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 4)		—	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 4)		—	70	—	dB
Load transient response	ΔV_{OUT}	I_{OUT} = 1⇔300 mA, C_{OUT} = 1.0 µF		—	±85	—	mV
Control voltage (ON)	$V_{CT\ (ON)}$	—		1.0	—	5.5	V
Control voltage (OFF)	$V_{CT\ (OFF)}$	—		0	—	0.4	V

Note 3: Stable state with fixed I_{OUT} condition.
Note 4: The 2.5 V output product.

7. Dropout Voltage Table

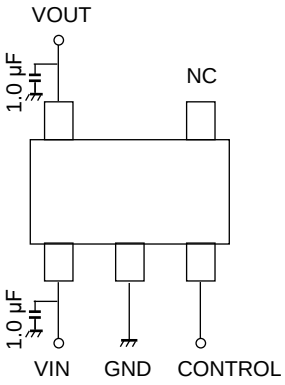
(I_{OUT} = 300 mA, C_{IN} = 1.0 µF, C_{OUT} = 1.0 µF, T_j = 25°C)

Output voltages	Symbol	Min	Typ.	Max	Unit
1.0 V, 1.05 V	V_{IN}-V_{OUT}	—	610	770	mV
1.1 V, 1.15 V		—	570	670	
1.2 V, 1.25 V		—	510	620	
1.3 V		—	470	570	
1.4 V		—	410	540	
1.5 V ≦ V_{OUT} < 1.8 V		—	370	470	
1.8 V ≦ V_{OUT} < 2.1 V		—	290	400	
2.1 V ≦ V_{OUT} < 2.5 V		—	260	350	
2.5 V ≦ V_{OUT} < 2.8 V		—	230	310	
2.8 V ≦ V_{OUT} < 3.2 V		—	220	270	
3.2 V ≦ V_{OUT} < 3.6 V		—	200	250	
3.6 V ≦ V_{OUT} ≦ 4.5 V		—	170	220	

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8. Application Note

8.1. Application Circuit



Control Voltage	Output Voltage
HIGH	ON
LOW	OFF
OPEN	OFF

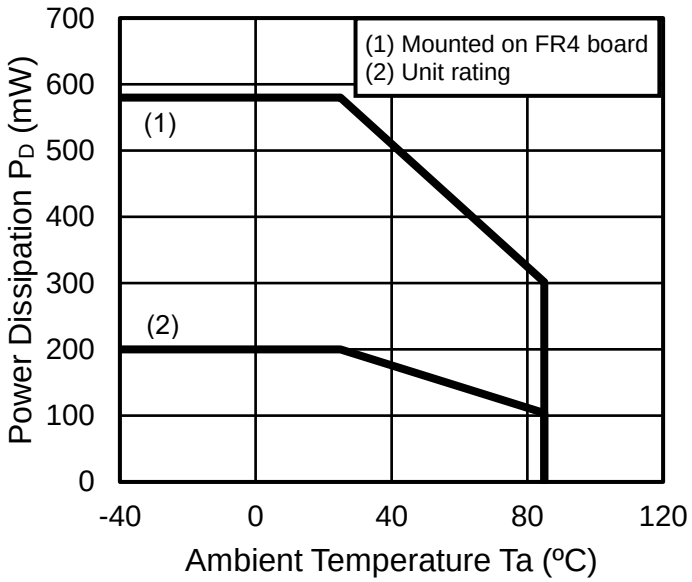
The figure above shows the recommended configuration for using a Low-Dropout regulator. Insert a capacitor at V_{OUT} and V_{IN} pins for stable input/output operation. (Ceramic capacitors can be used).

8.2. Power Dissipation

Both unit and board-mounted power dissipation ratings for TCR3DF series are available in the Absolute Maximum Ratings table.

Power dissipation is measured on the board shown below.

[The Board Condition]
Board material: Glass epoxy (FR4)
Board dimension: 25.4mm x 25.4mm x 1.6 mm
Copper area: 645 mm^2



8.3. 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 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 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.

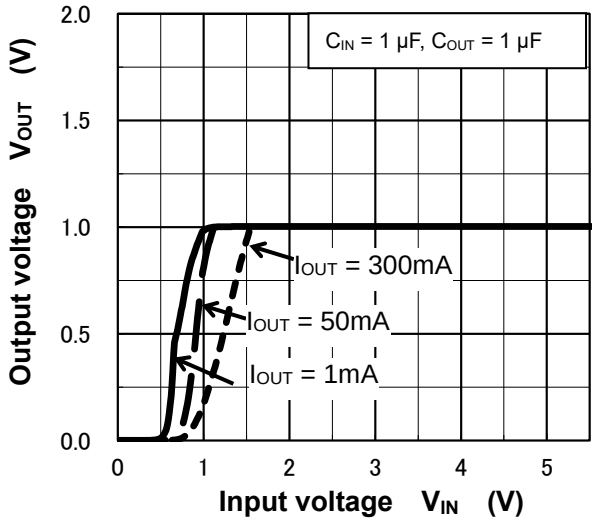
- Over current Protection and Thermal shut down function
  Over current protection and Thermal shut down function are designed in these products, but these are not designed to constantly ensure the suppression of the device within operation limits. Depending on the condition during actual usage, it could 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.

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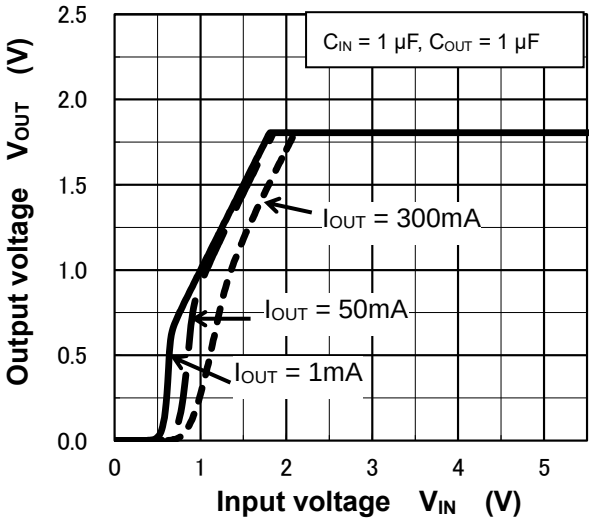
9. Representative Typical Characteristics (Note)

9.1. Output Voltage vs. Input Voltage

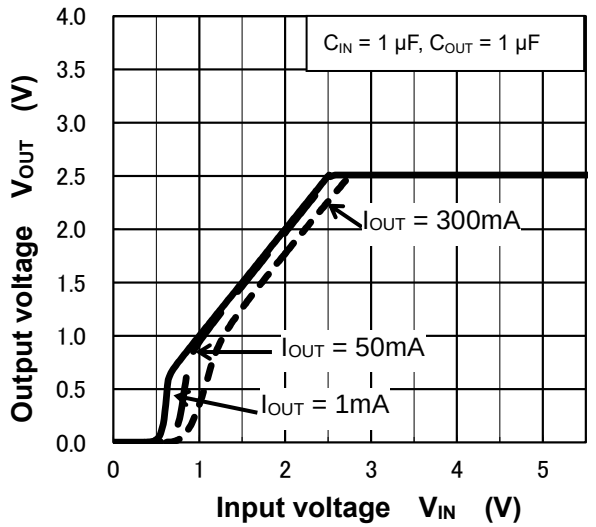
V_{OUT}=1.0 V



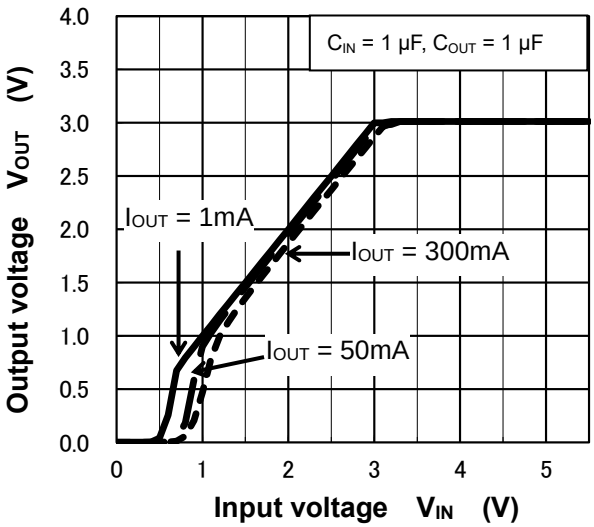
V_{OUT}=1.8 V



V_{OUT}=2.5 V

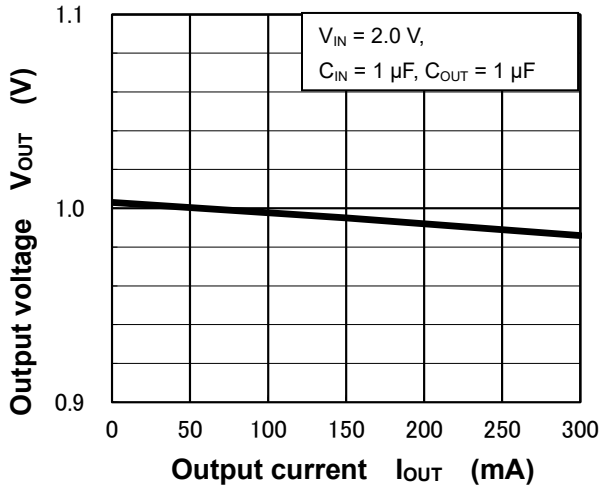


V_{OUT}=3.0 V

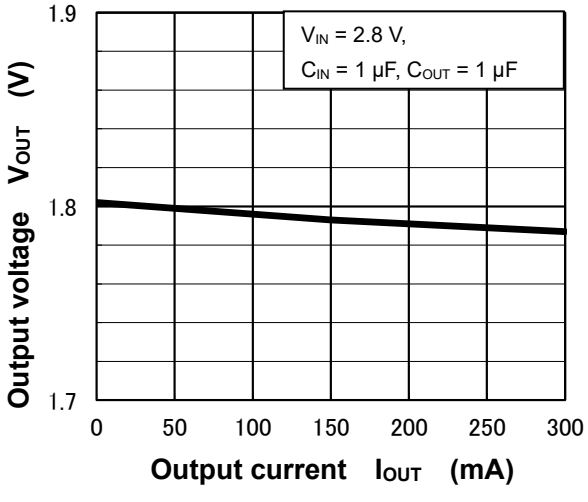


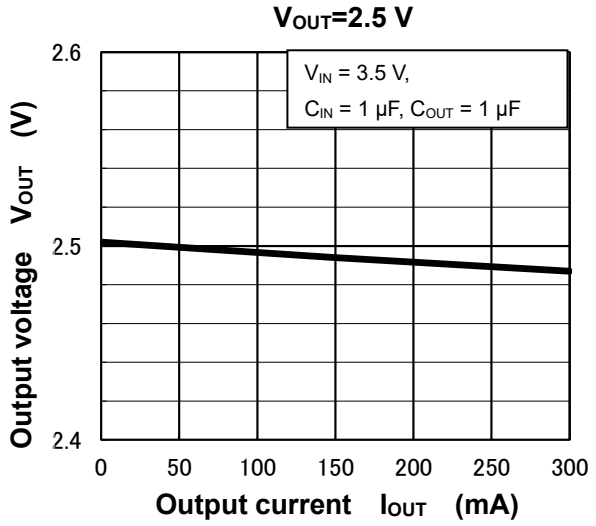
9.2. Output Voltage vs. Output Current

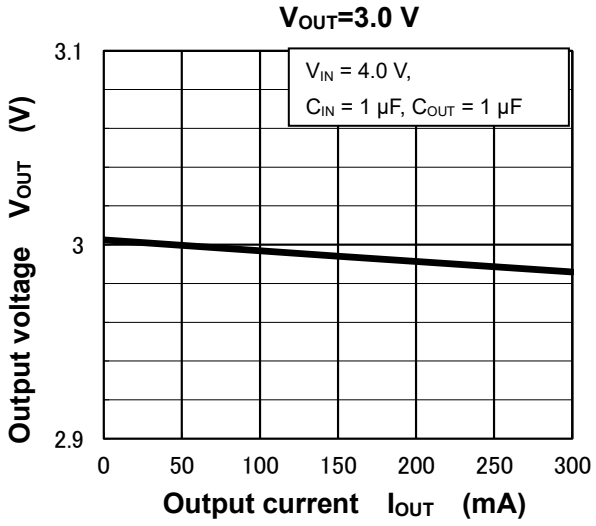
V_{OUT}=1.0 V



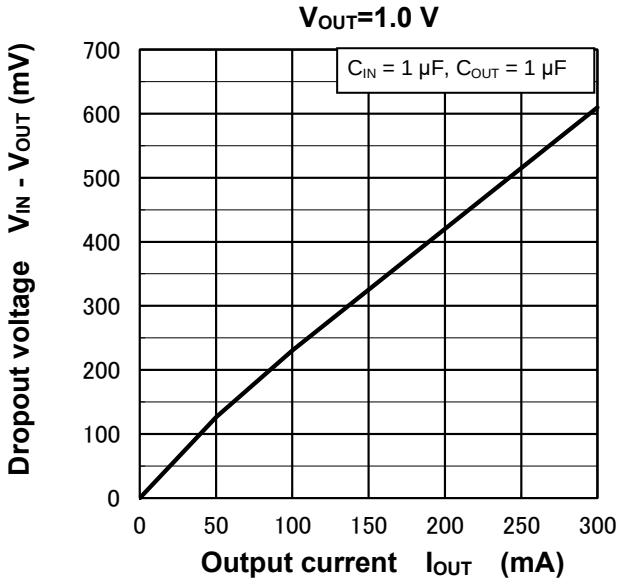
V_{OUT}=1.8 V

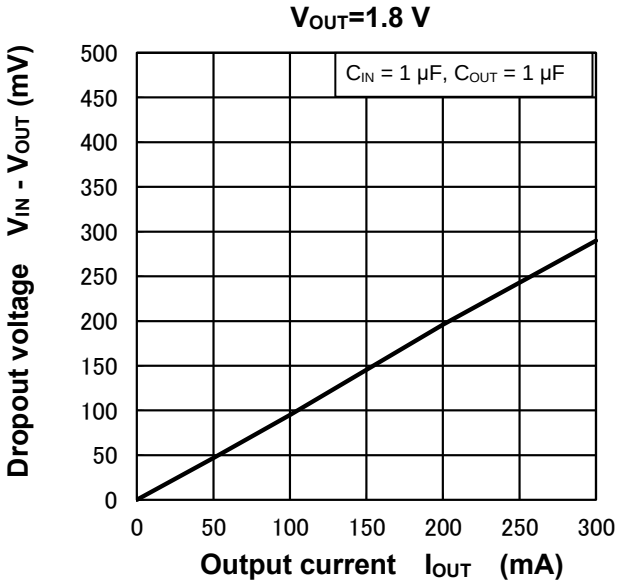


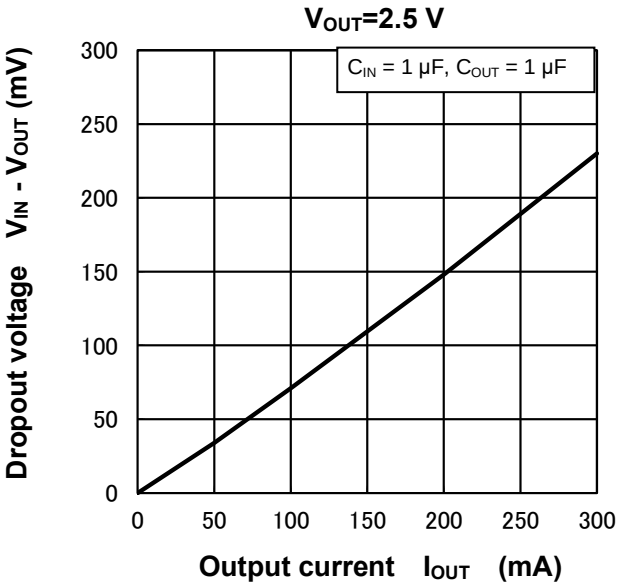


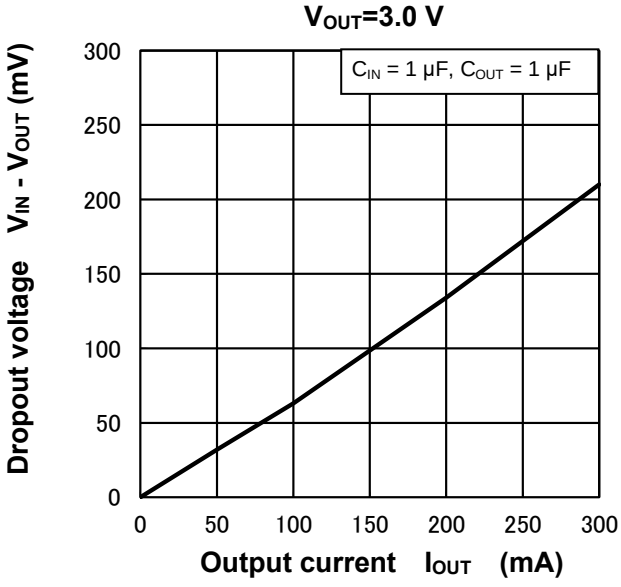


9.3. Dropout Voltage vs. Output Current



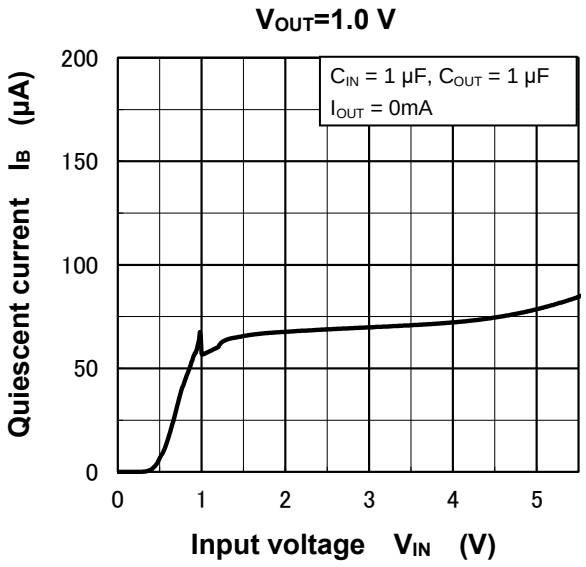


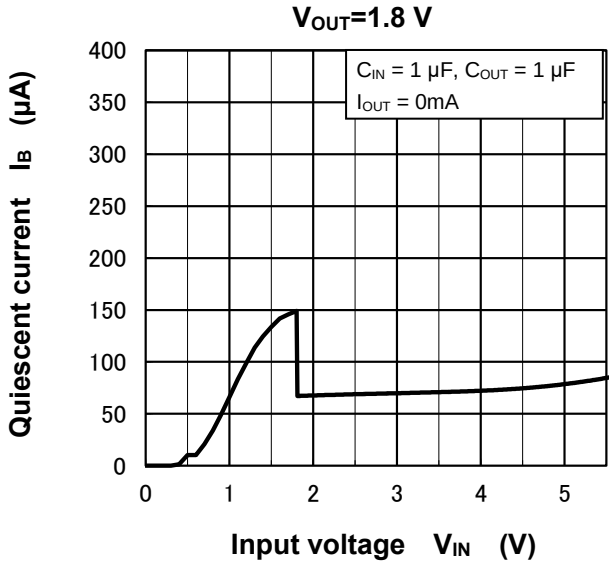


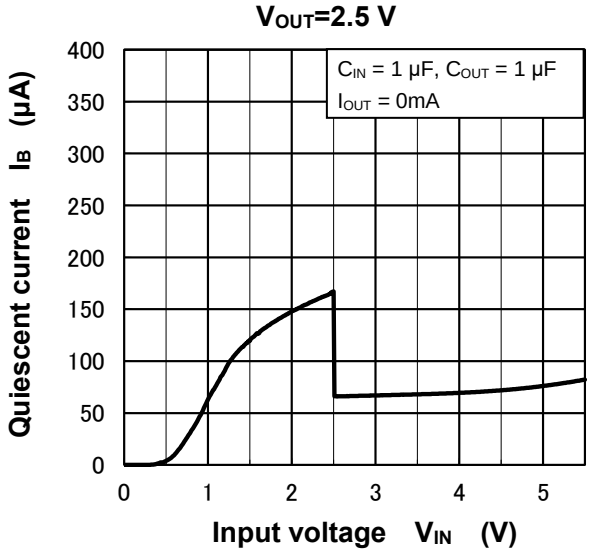


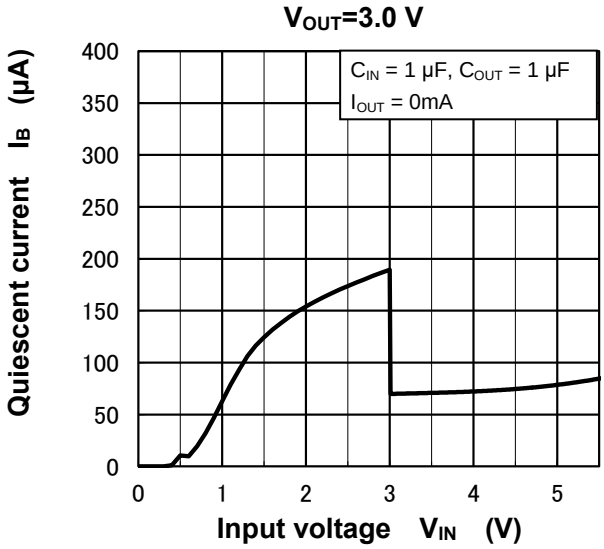
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9.4. Quiescent Current vs. Input Voltage

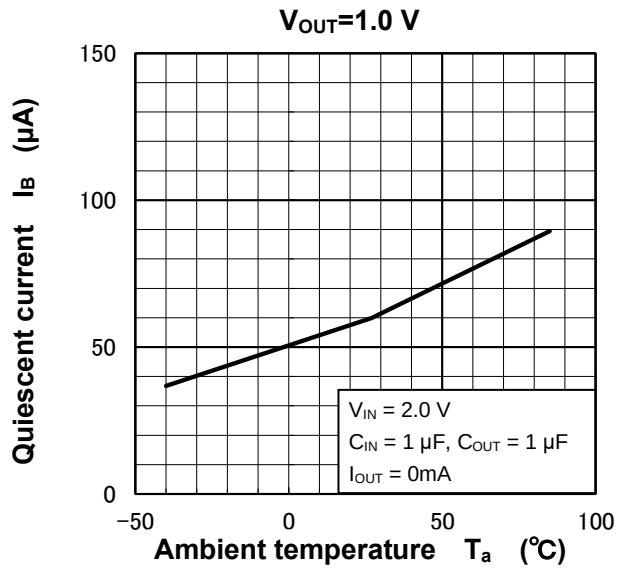


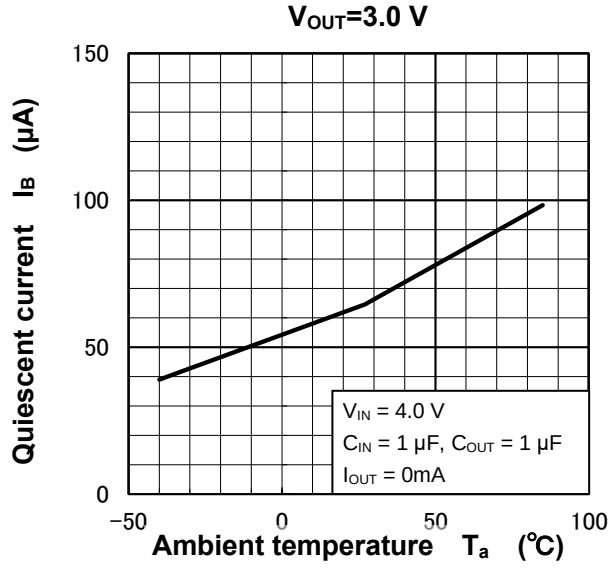






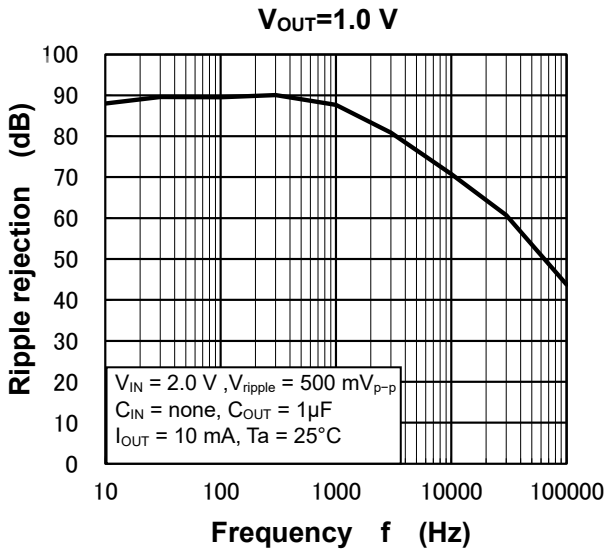
9.5. Quiescent Current vs. Ambient Temperature

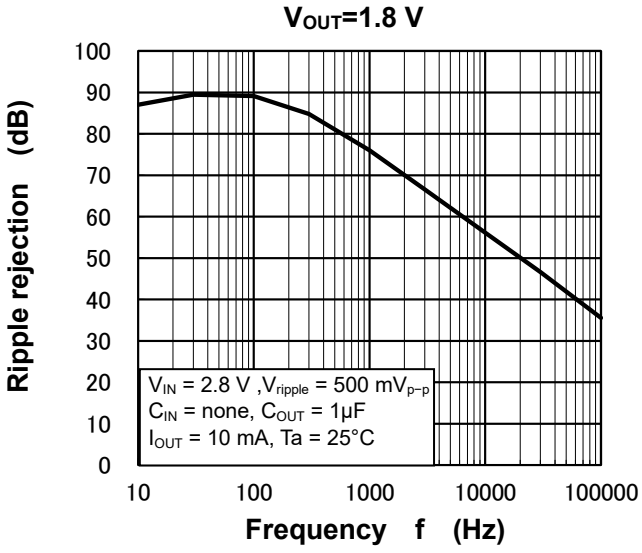


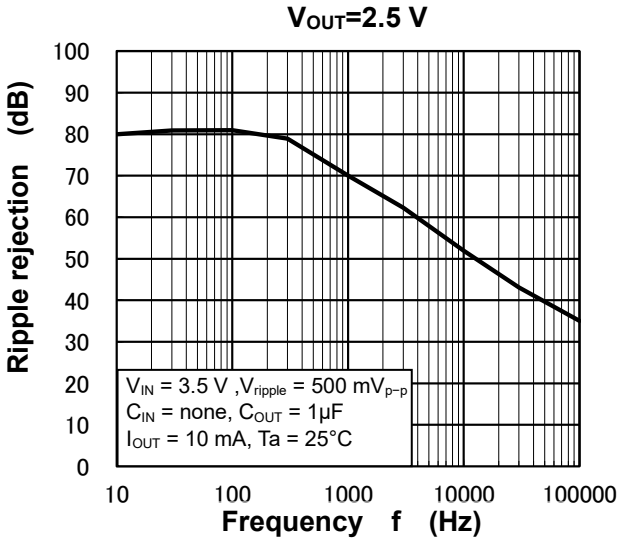


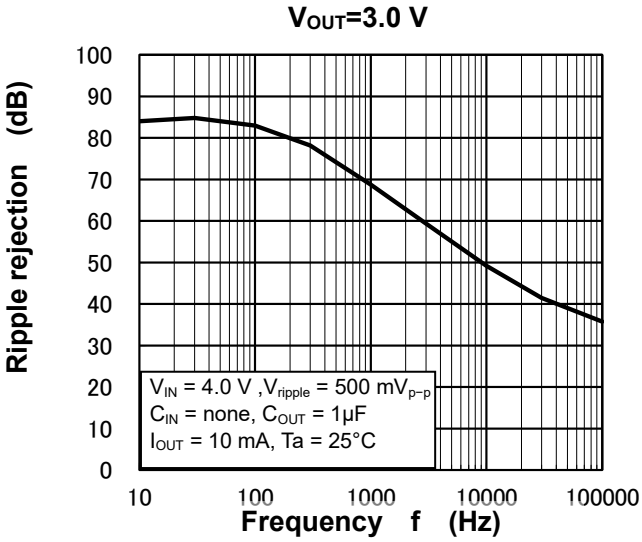
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9.6. Ripple Rejection Ratio vs. Frequency

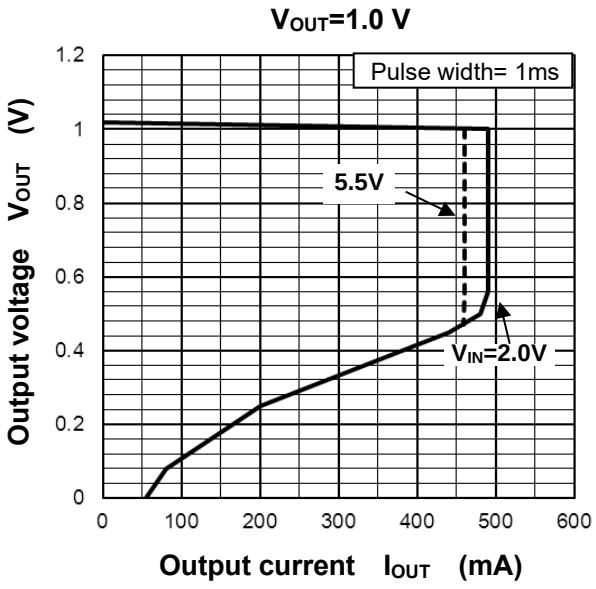


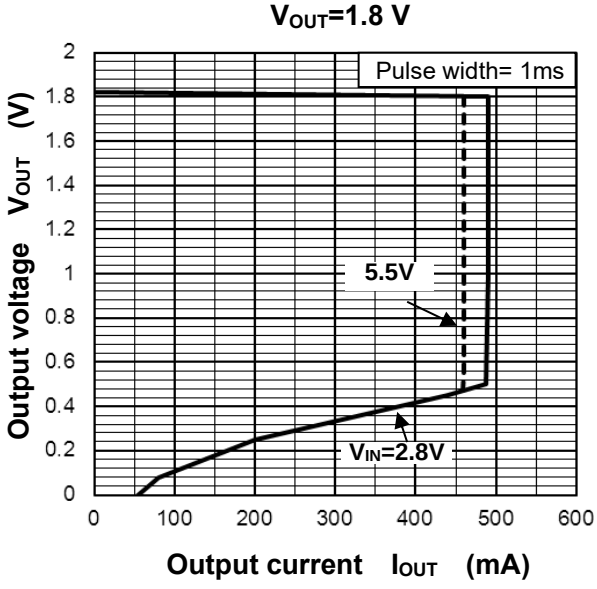




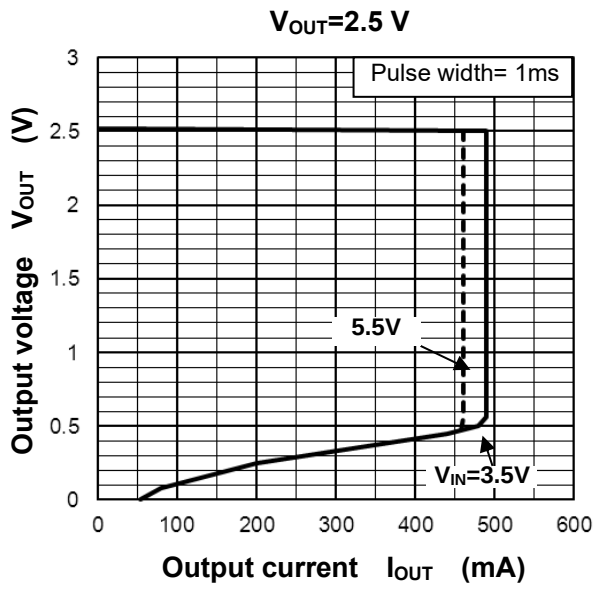


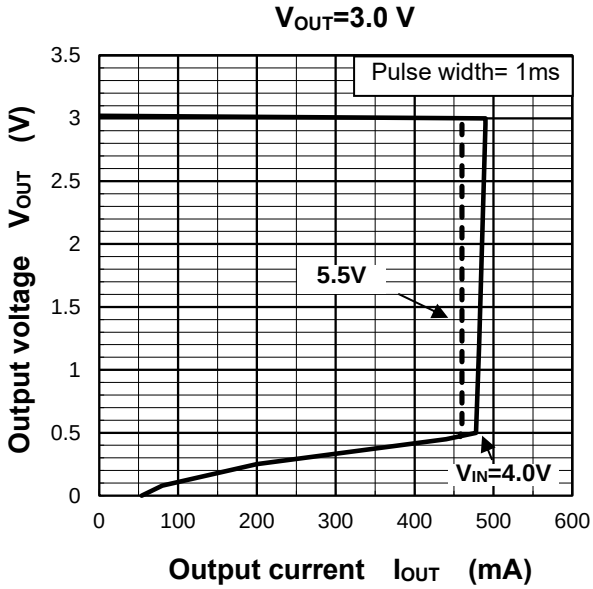
9.7. Output Voltage vs. Output Current



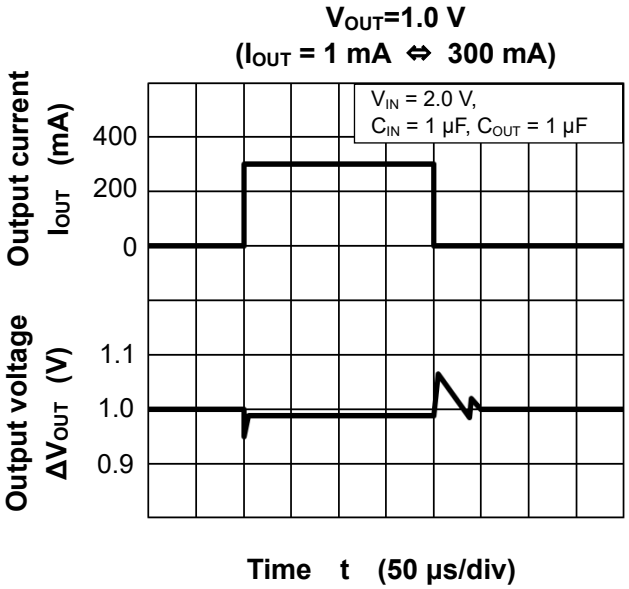


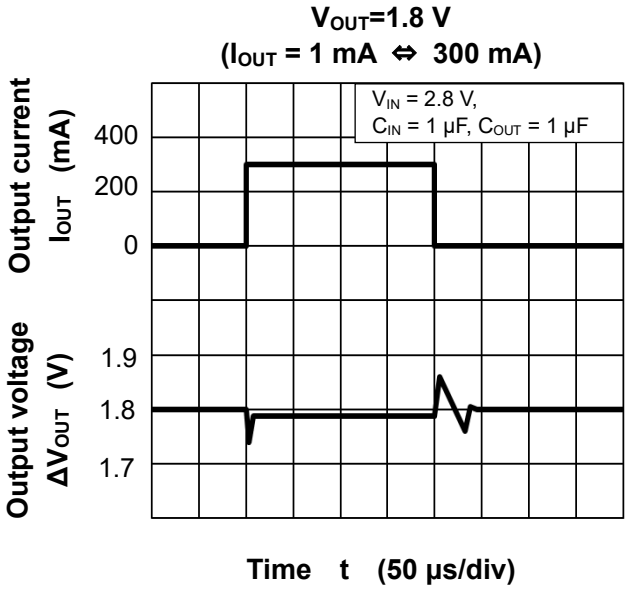
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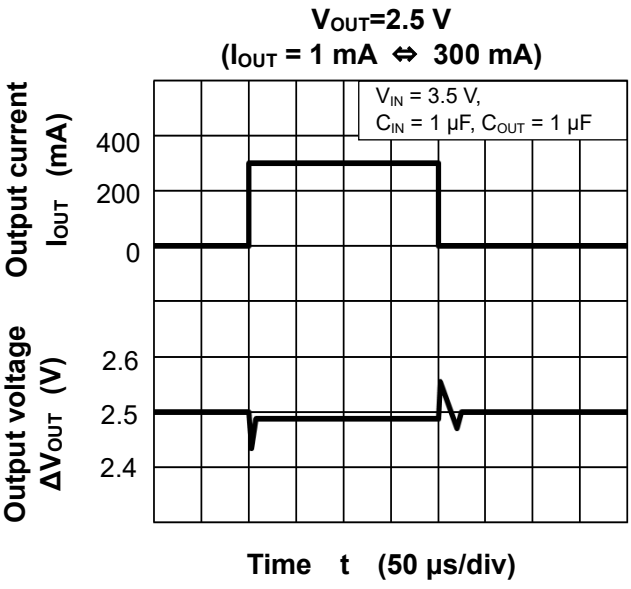


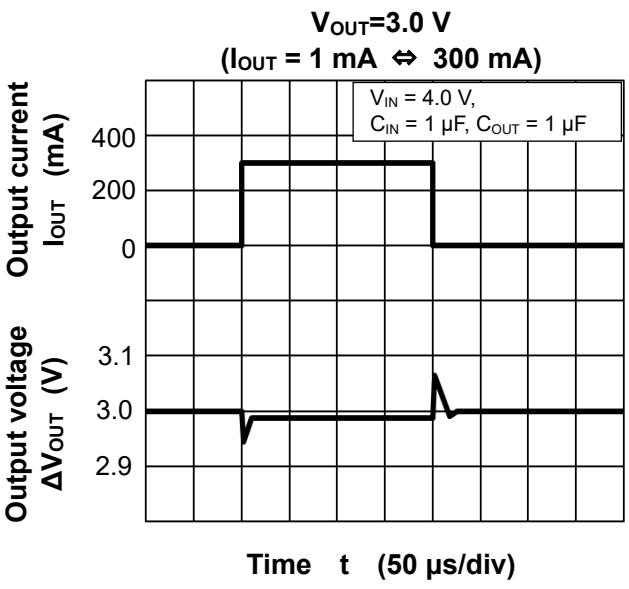


9.8. Load Transient Response





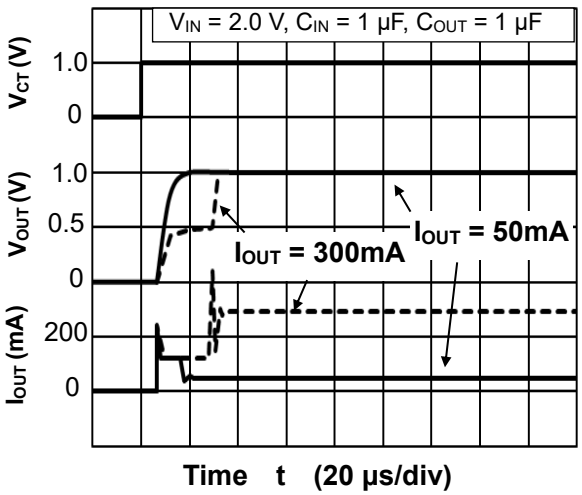




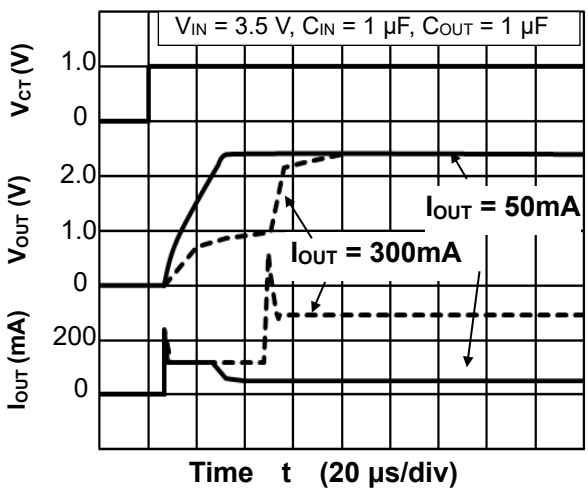
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9.9. t_{ON} Response

V_{OUT}=1.0 V

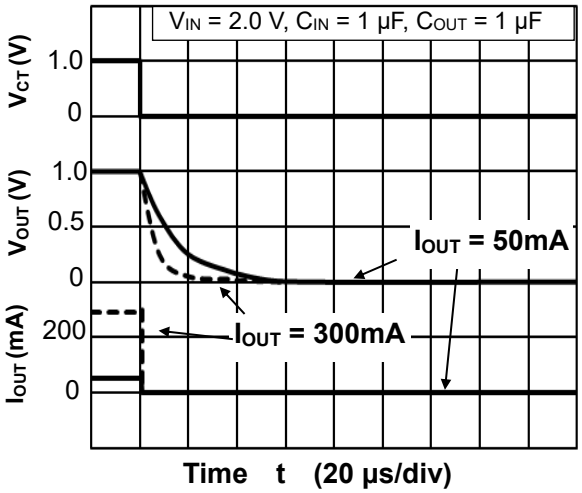


V_{OUT}=2.5 V

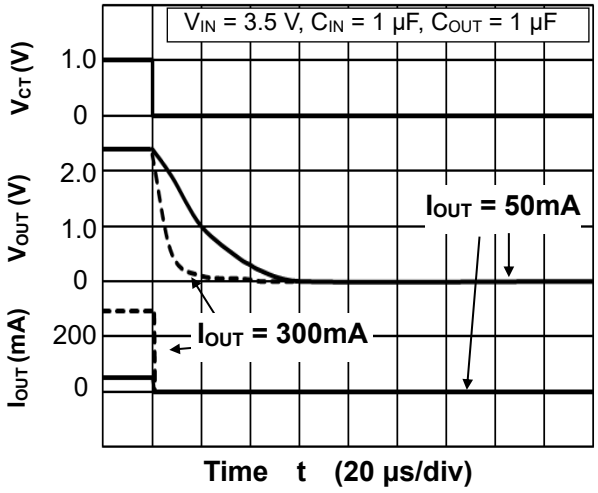


9.10. t_{OFF} Response

V_{OUT}=1.0 V



V_{OUT}=2.5 V

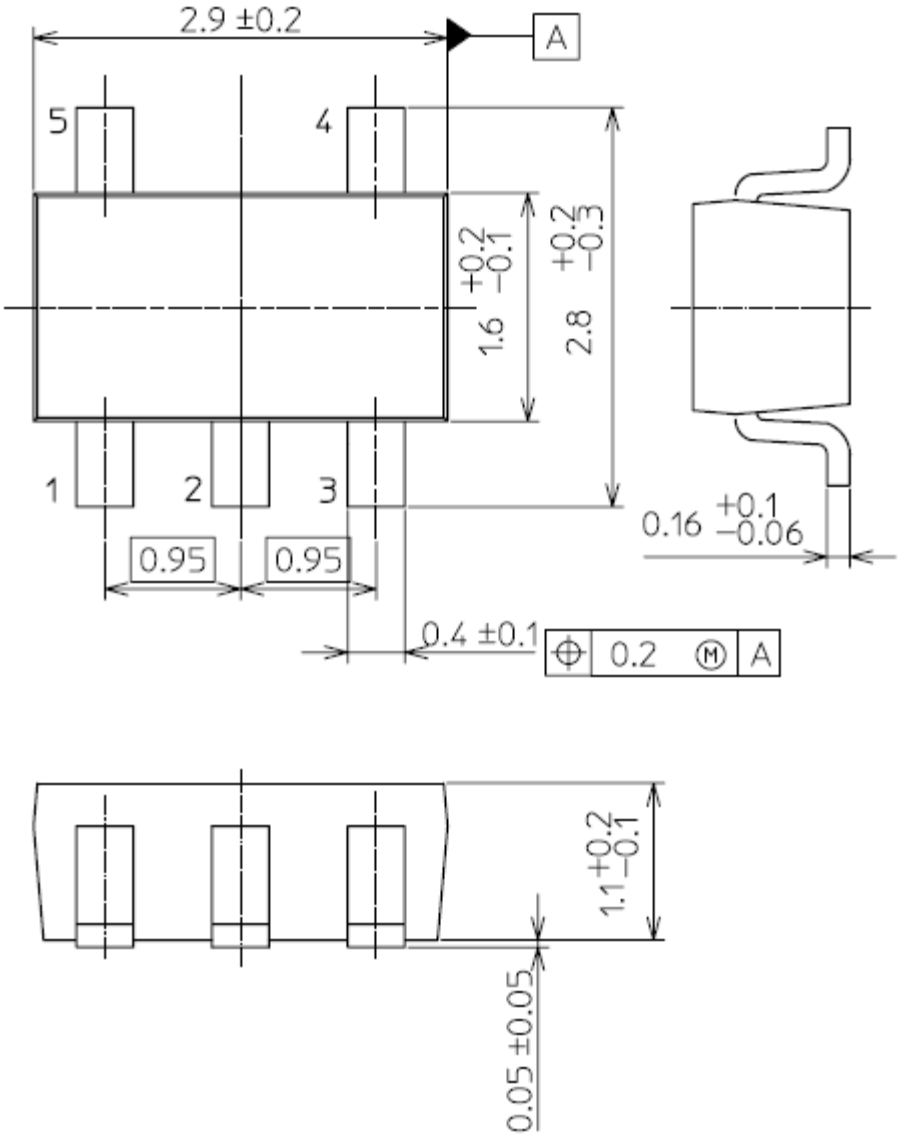


Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

10. Package Information

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

Unit: mm



Weight: 16 mg (Typ.)

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