TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCR3UF series

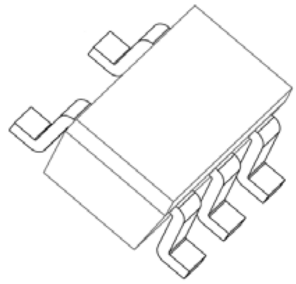
Ultra low quiescent current, Fast Load Transient 300 mA CMOS Low Dropout Regulator

Description

The TCR3UF series are CMOS process 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 5.0 V and capable of driving up to 300 mA. They feature Overcurrent protection, thermal shutdown function and auto-discharge option.

The TCR3UF series is offered in general purpose package SMV (2.9 mm x 2.8 mm; t 1.1 mm (typ)) and has a low dropout voltage of 206 mV (3.3 V output, I_{OUT} = 300 mA). As small ceramic input and output capacitors 1 μF can be used with the TCR3UF series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones, IoT equipment and wearable devices.


SMV

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

Applications

Power IC developed for portable applications, IoT equipment and wearable devices

Features

- Low quiescent bias current (I_B = 0.34 μA (typ.) at I_{OUT} = 0 mA, output voltage up to 1.5 V)
- High Ripple rejection ratio 70 dB at 0.8 V output
- Fast Load transient response -51/+36 mV at 0.8 V output, I_{OUT} = 1 mA ⇔ 50 mA
- Low dropout voltage
  V_{DO} = 206 mV (typ.) at 3.3 V output, I_{OUT} = 300 mA
- Wide range output voltage line up (V_{OUT} = 0.8 to 5.0 V)
- High V_{OUT} accuracy ±1.0 % (1.8 V ≤ V_{OUT})
- Auto-discharge (TCR3UFxxA series)/ Non-discharge (TCR3UFxxB series) line up
- Overcurrent protection
- Thermal shutdown
- Inrush current reduction
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used (C_{IN} = 1 μF, C_{OUT} = 1 μF)
- General purpose package SMV(SOT-25) (SC-74A)

Start of commercial production
2019-09

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Input voltage	V_{IN}	-0.3 to 6.0	V
Control voltage	V_{CT}	-0.3 to V_{IN} + 0.3 ≤ 6.0	V
Output voltage	V_{OUT}	-0.3 to V_{IN} + 0.3 ≤ 6.0	V
Power dissipation	P_D	200 (Note1)	mW
		580 (Note2)	
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: 25.4 mm × 25.4 mm × 1.6 mm)

Operating Ranges

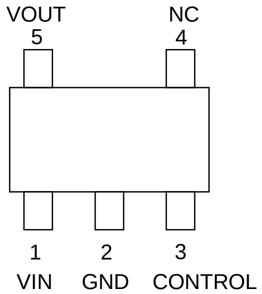
Characteristics	Symbol	Rating		Unit
Input voltage	V_{IN}	1.5 to 5.5 (Note 3)		V
Control voltage	V_{CT}	0 to V_{IN}		V
Output voltage	V_{OUT}	0.8 to 5.0		V
Output current	I_{OUT}	DC	0 to 300 (Note 4)	mA
Operation Temperature	T_{opr}	-40 to 85		°C
Output Capacitance	C_{OUT}	≥ 1.0 μF		—
Input Capacitance	C_{IN}	≥ 1.0 μF		—

Note 3: Please refer to Dropout voltage (Page 6) and use it within Absolute Maximum Ratings Junction temperature and Operation Temperature Ranges.

Note 4: 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)

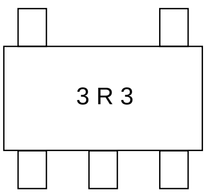
SMV(SOT-25)(SC-74A)



List of Products Number, Output voltage and Marking

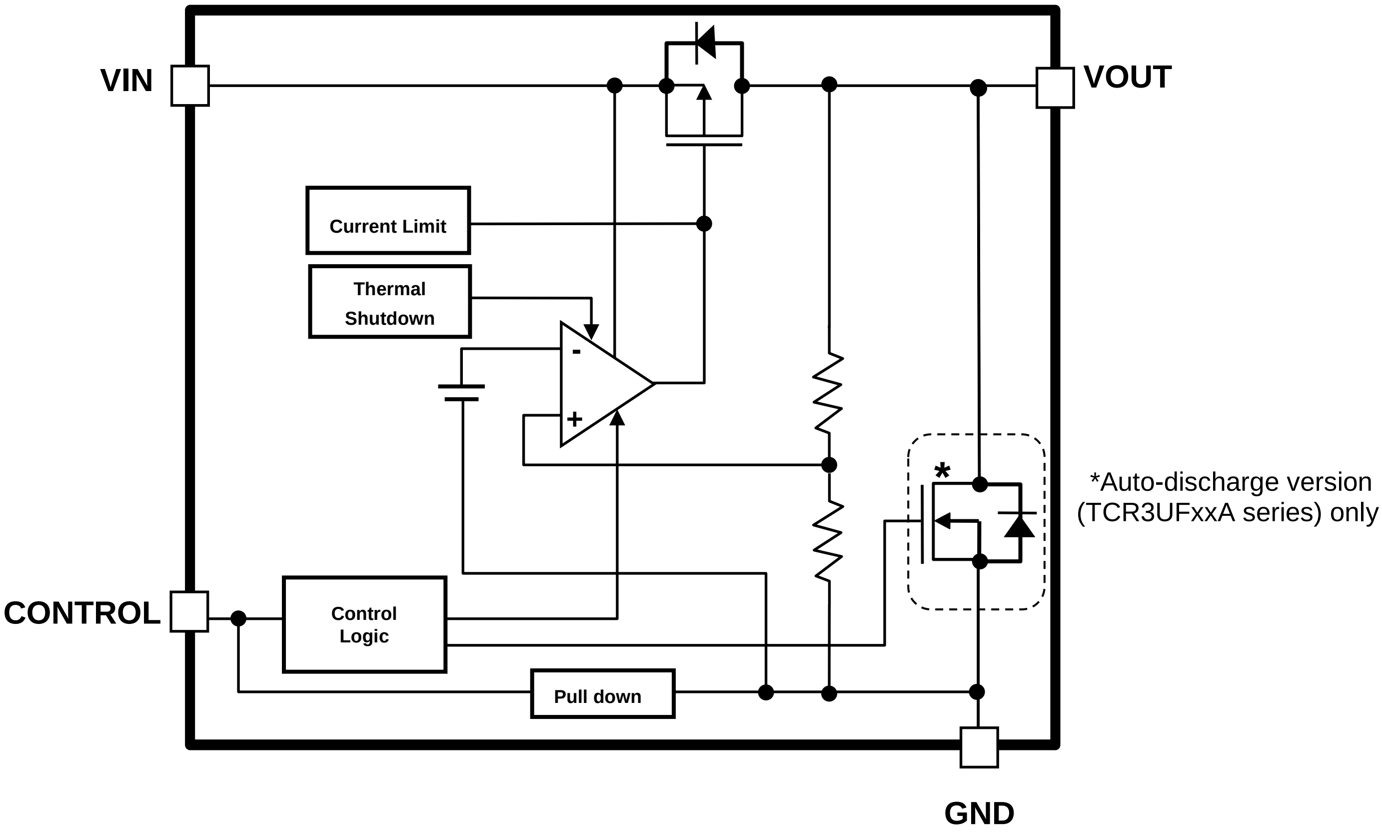
Product No.	Output voltage(V)	Auto-discharge	Marking	Product No.	Output voltage(V)	Auto-discharge	Marking
TCR3UF08A	0.8		0R8	TCR3UF08B	0.8		0T8
TCR3UF085A	0.85		0RA	TCR3UF085B	0.85		0TA
TCR3UF09A	0.9		0R9	TCR3UF09B	0.9		0T9
TCR3UF095A	0.95		0RB	TCR3UF095B	0.95		0TB
TCR3UF10A	1.0		1R0	TCR3UF10B	1.0		1T0
TCR3UF105A	1.05		1RC	TCR3UF105B	1.05		1TC
TCR3UF11A	1.1		1R1	TCR3UF11B	1.1		1T1
TCR3UF115A	1.15		1RE	TCR3UF115B	1.15		1TE
TCR3UF12A	1.2		1R2	TCR3UF12B	1.2		1T2
TCR3UF13A	1.3		1R3	TCR3UF13B	1.3		1T3
TCR3UF135A	1.35		1RF	TCR3UF135B	1.35		1TF
TCR3UF14A	1.4		1R4	TCR3UF14B	1.4		1T4
TCR3UF15A	1.5		1R5	TCR3UF15B	1.5		1T5
TCR3UF16A	1.6		1R6	TCR3UF16B	1.6		1T6
TCR3UF175A	1.75		1RG	TCR3UF175B	1.75		1TG
TCR3UF18A	1.8		1R8	TCR3UF18B	1.8		1T8
TCR3UF1825A	1.825		1RH	TCR3UF1825B	1.825		1TH
TCR3UF185A	1.85		1RJ	TCR3UF185B	1.85		1TJ
TCR3UF19A	1.9	Yes	1R9	TCR3UF19B	1.9	No	1T9
TCR3UF20A	2.0		2R0	TCR3UF20B	2.0		2T0
TCR3UF25A	2.5		2R5	TCR3UF25B	2.5		2T5
TCR3UF26A	2.6		2R6	TCR3UF26B	2.6		2T6
TCR3UF27A	2.7		2R7	TCR3UF27B	2.7		2T7
TCR3UF28A	2.8		2R8	TCR3UF28B	2.8		2T8
TCR3UF285A	2.85		2RK	TCR3UF285B	2.85		2TK
TCR3UF29A	2.9		2R9	TCR3UF29B	2.9		2T9
TCR3UF2925A	2.925		2RL	TCR3UF2925B	2.925		2TL
TCR3UF30A	3.0		3R0	TCR3UF30B	3.0		3T0
TCR3UF31A	3.1		3R1	TCR3UF31B	3.1		3T1
TCR3UF32A	3.2		3R2	TCR3UF32B	3.2		3T2
TCR3UF33A	3.3		3R3	TCR3UF33B	3.3		3T3
TCR3UF35A	3.5		3R5	TCR3UF35B	3.5		3T5
TCR3UF36A	3.6		3R6	TCR3UF36B	3.6		3T6
TCR3UF41A	4.1		4R1	TCR3UF41B	4.1		4T1
TCR3UF42A	4.2		4R2	TCR3UF42B	4.2		4T2
TCR3UF45A	4.5		4R5	TCR3UF45B	4.5		4T5
TCR3UF50A	5.0		5R0	TCR3UF50B	5.0		5T0

Top Marking (top view)



Example: TCR3UF33A (3.3 V output)

Block Diagram



Electrical Characteristics

(Unless otherwise specified,

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

Characteristics	Symbol	Test Condition		Tj = 25°C Min	Tj = 25°C Typ.	Tj = 25°C Max	Tj = -40 to 85°C (Note 10) Min	Tj = -40 to 85°C (Note 10) Max	Unit
Output voltage accuracy	V_{OUT}	$I_{OUT} = 50$ mA (Note 5)	$V_{OUT} < 1.8$ V	-18	—	+18	—	—	mV
			$1.8\text{ V} \leq V_{OUT}$	-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	$I_{OUT} = 1$ mA (Note 6)		—	1	15	—	—	mV
Load regulation	Reg·load	$1\text{ mA} \leq I_{OUT} \leq 300$ mA (Note 7)		—	21	30	—	—	mV
Quiescent current	$I_{B(ON1)}$	$I_{OUT} = 0$ mA, $V_{OUT} \leq 1.5$ V (Note 8)		—	0.34	—	—	0.58	μA
	$I_{B(ON2)}$	$I_{OUT} = 0$ mA, $1.75\text{ V} \leq V_{OUT} \leq 5$ V (Note 8)		—	0.38	—	—	0.68	μA
Stand-by current	$I_{B(OFF1)}$	$V_{CT} = 0$ V, $V_{IN} = 2.5$ V		—	0.03	—	—	0.16	μA
	$I_{B(OFF2)}$	$V_{CT} = 0$ V, $V_{IN} = 5.5$ V		—	0.03	—	—	0.20	μA
Control pull down current	I_{CT}	—		—	0.1	—	—	—	μA
Dropout voltage	V_{DO}	$I_{OUT} = 300$ mA	$V_{OUT} = 1.8$ V	—	341	—	—	464	mV
			$V_{OUT} = 3.3$ V	—	206	—	—	287	mV
Output current limit	I_{CL}	$V_{OUT} = V_{OUT(NOM)} \times 90\%$ (Note 10)		—	545	—	400	—	mA
Output noise voltage	V_{NO}	$I_{OUT} = 10$ mA, $10\text{ Hz} \leq f \leq 100$ kHz, Ta = 25°C (Note 7)		—	41	—	—	—	μV_{rms}
Ripple rejection ratio	R.R.	$I_{OUT} = 10$ mA, f = 1 kHz, $V_{Ripple} = 200\ mV_{p\text{-}p}$, Ta = 25°C (Note 7)		—	70	—	—	—	dB
Load transient response	ΔV_{OUT}	$I_{OUT} = 1$ mA → 50 mA (Note 9)		—	-51	—	—	—	mV
		$I_{OUT} = 50$ mA → 1 mA (Note 9)		—	+36	—	—	—	mV
Temperature coefficient	T_{CVO}	$-40°C \leq T_{opr} \leq 85°C$		—	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}	$V_{CT} = 0$ V, $V_{IN} = 5.5$ V		—	7	—	5	20	Ω
Thermal shutdown temperature	T_{SD}	(Note 10) (Note 11)		—	158	—	—	—	°C
Thermal shutdown hysteresis	T_{SDH}	(Note 10) (Note 11)		—	28	—	—	—	°C

Note 5: stable state with fixed I_{OUT} condition
Note 6: $V_{OUT} \leq 1.5$ V, $2.5\text{ V} \leq V_{IN} \leq 5.5$ V
$1.75\text{ V} \leq V_{OUT} \leq 4.2$ V, $V_{OUT} + 1\text{ V} \leq V_{IN} \leq 5.5$ V
$V_{OUT} = 4.5$ V, $V_{OUT} = 5.0$ V, not applicable
Note 7: $V_{OUT} = 0.8$V
Note 8: except Control pull down current (I_{CT})
Note 9: $V_{OUT} = 0.8$ V, $V_{IN} = 3.3$ V
Note 10: This parameter is warranted by design
Note 11: $V_{OUT} = 0.8$ V, $V_{IN} = 2.5$V

Dropout voltage

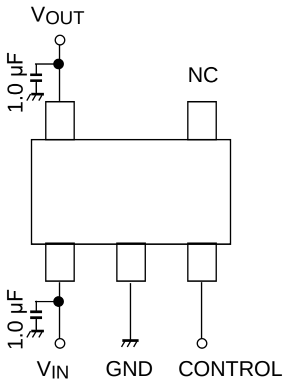
(I_{OUT} = 300 mA, C_{IN} = C_{OUT} = 1 μF)

Output voltages	Symbol	Min	Typ. T_j = 25°C	Max (Note 12)	Unit
0.8 V ≤ V_{OUT} < 0.9 V	V_{DO}	—	1020	1257	mV
0.9 V ≤ V_{OUT} < 1.0 V		—	933	1157	
1.0 V ≤ V_{OUT} < 1.1 V		—	848	1057	
1.1 V ≤ V_{OUT} < 1.2 V		—	760	957	
1.2 V ≤ V_{OUT} < 1.3 V		—	667	857	
1.3 V ≤ V_{OUT} < 1.5 V		—	580	757	
1.5 V ≤ V_{OUT} < 1.6 V		—	462	617	
1.6 V ≤ V_{OUT} < 1.8 V		—	420	537	
1.8 V ≤ V_{OUT} < 2.0 V		—	341	464	
2.0 V ≤ V_{OUT} < 2.5 V		—	297	412	
2.5 V ≤ V_{OUT} < 3.0 V		—	226	342	
3.0 V ≤ V_{OUT} < 3.6 V		—	206	287	
3.6 V ≤ V_{OUT} < 4.5 V		—	184	245	
4.5 V ≤ V_{OUT} ≤ 5.0 V		—	159	224	

Note 12: T_j = -40 to 85 °C. This parameter is warranted by design

Application Note

1. Example of Application Circuit



CONTROL voltage	VOUT 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

Both unit and board-mounted power dissipation ratings for TCR3UF series are available in the Absolute Maximum Ratings table.

Power dissipation is measured on the board shown below.

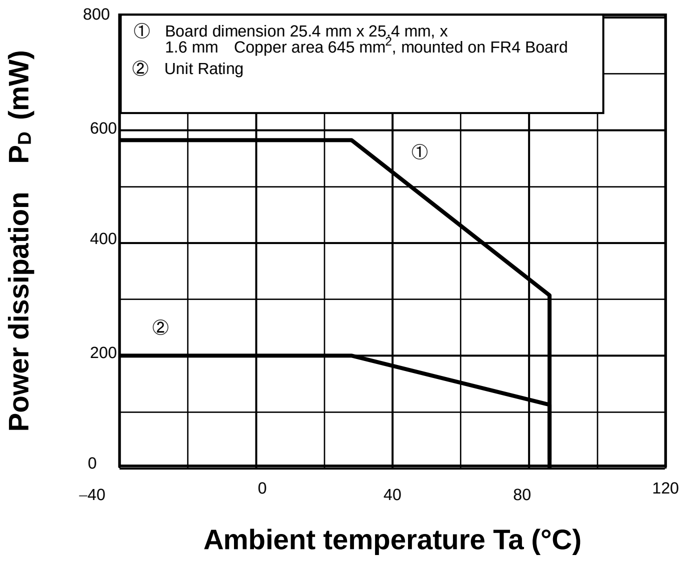
[The Board Condition]

Board material: FR4 board

Board dimension: 25.4 mm × 25.4 mm × 1.6 mm

Copper area: 645 mm^2

P_D − Ta (SMV)



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. For stable operation, we recommend over 1 μF.

- Mounting
  The long distance between IC and input output capacitor might affect phase compensation by impedance in wire and inductor. For stable power supply, input 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.

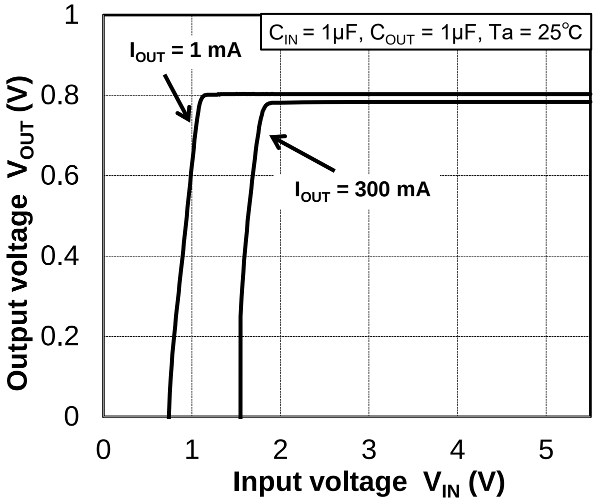
- Permissible Loss
  Please have enough design patterns for expected maximum permissible loss. And under consideration of ambient temperature, input voltage, and output current etc., we recommend proper dissipation ratings for maximum permissible loss; in general maximum dissipation rating is 70 to 80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

- Over current Protection and Thermal shutdown function
  Over current protection and Thermal shutdown 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 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 recommends inserting failsafe system into the design.

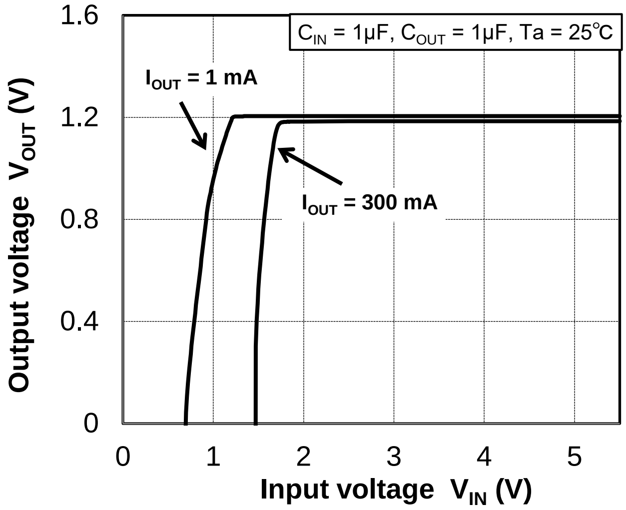
Representative Typical Characteristics

Output Voltage vs. Input Voltage

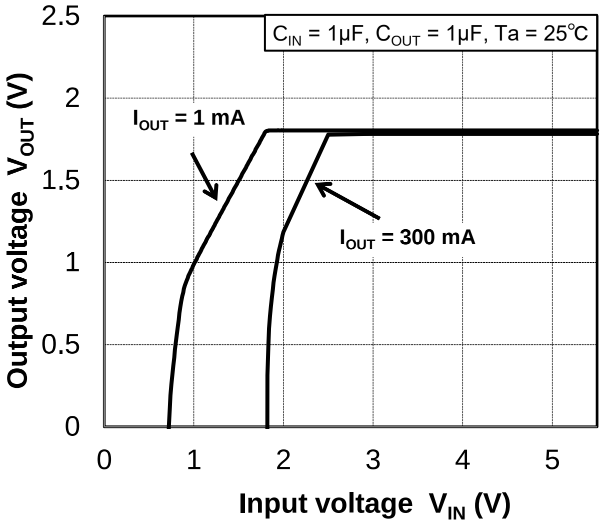
V_{OUT} = 0.8 V



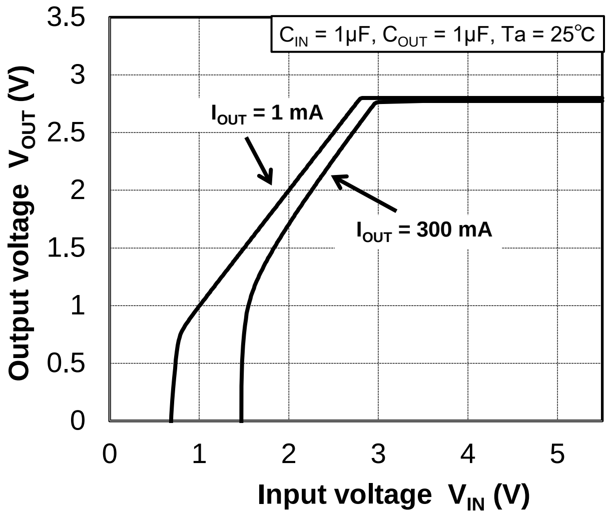
V_{OUT} = 1.2 V



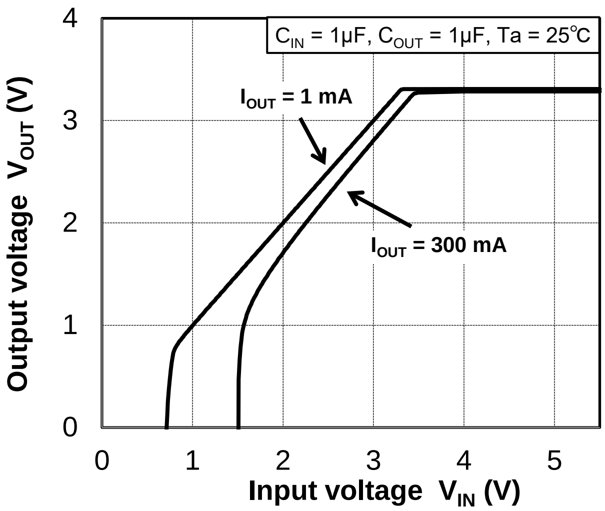
V_{OUT} = 1.8 V



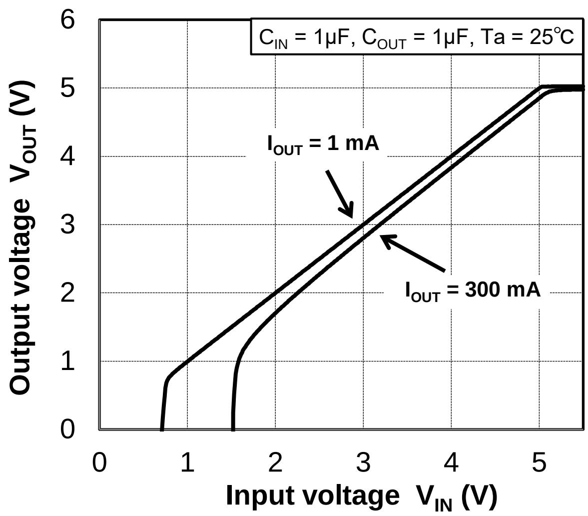
V_{OUT} = 2.8 V



V_{OUT} = 3.3 V

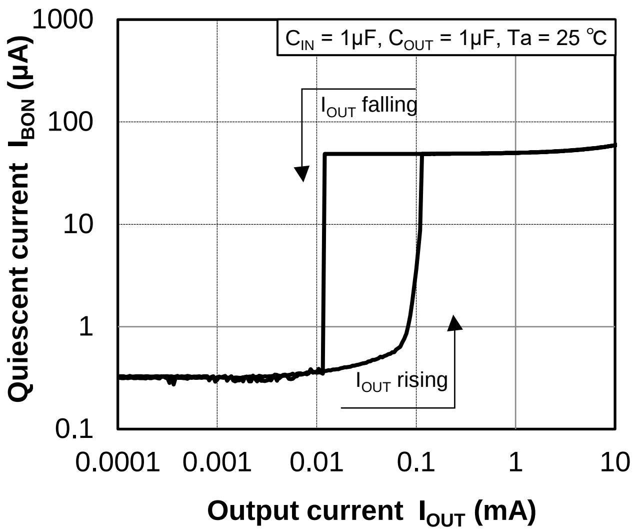


V_{OUT} = 5.0 V

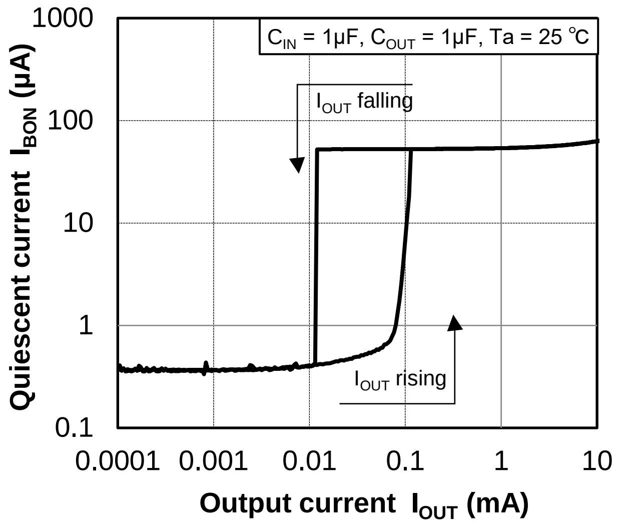


Quiescent Current vs. Output Current

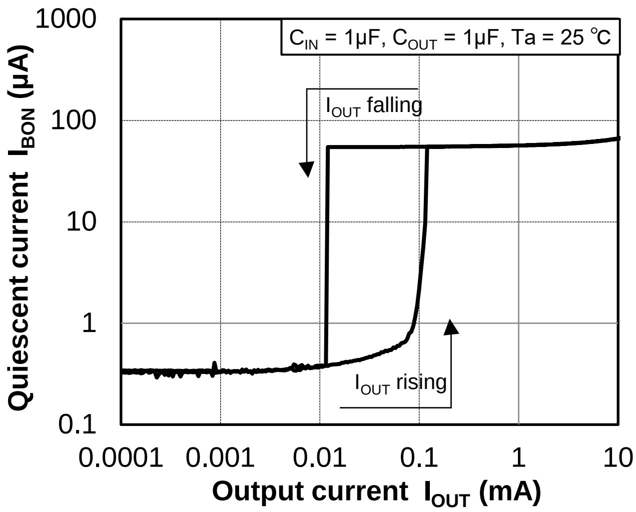
V_{OUT} = 0.8 V



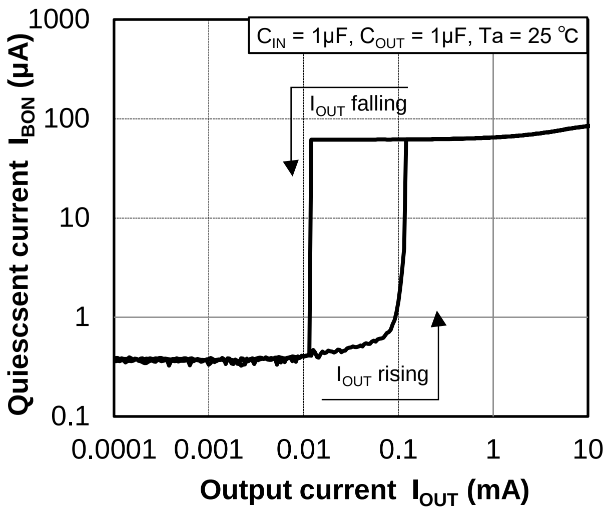
V_{OUT} = 1.2 V



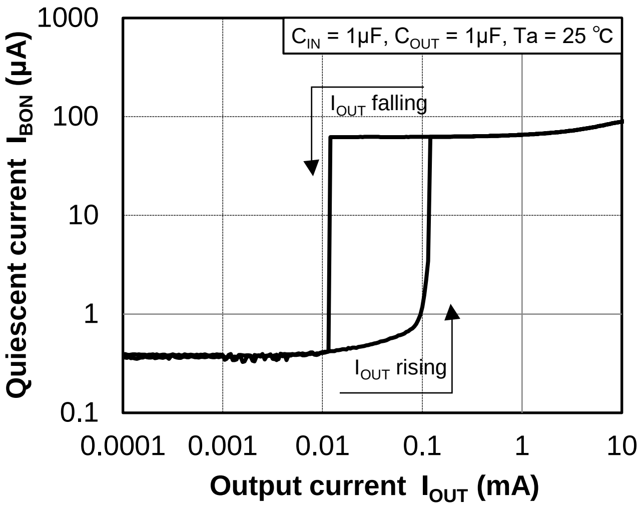
V_{OUT} = 1.8 V



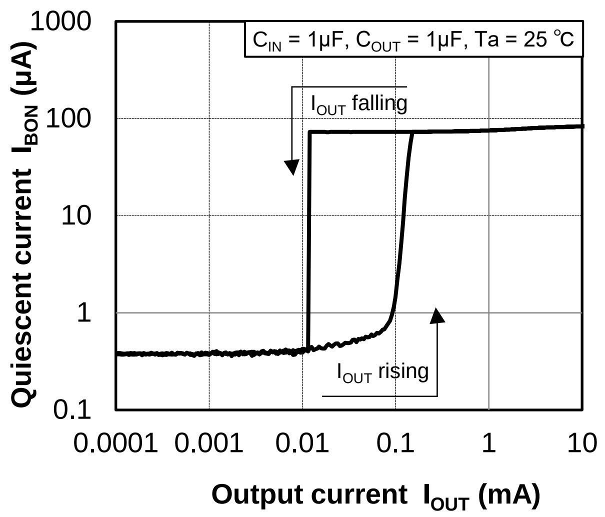
V_{OUT} = 2.8 V



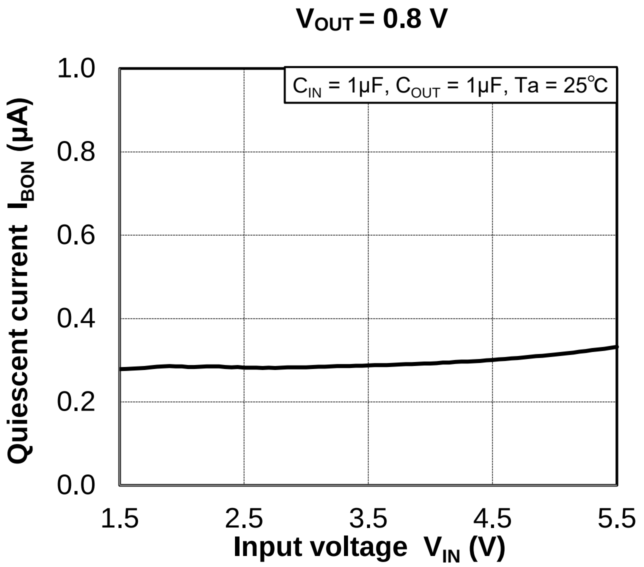
V_{OUT} = 3.3 V

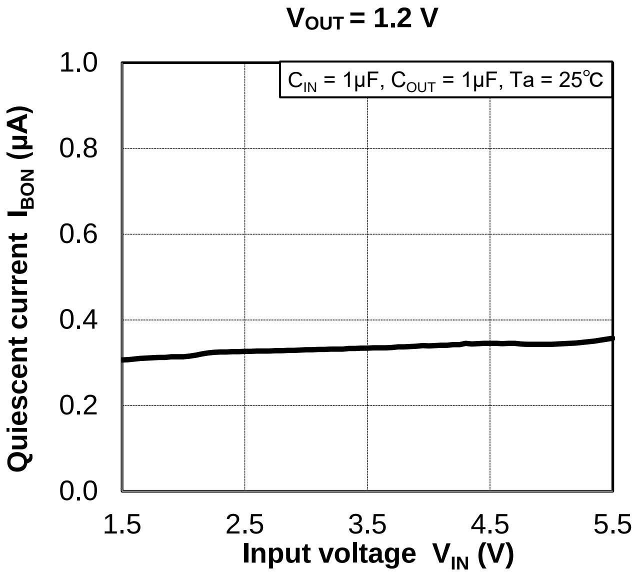


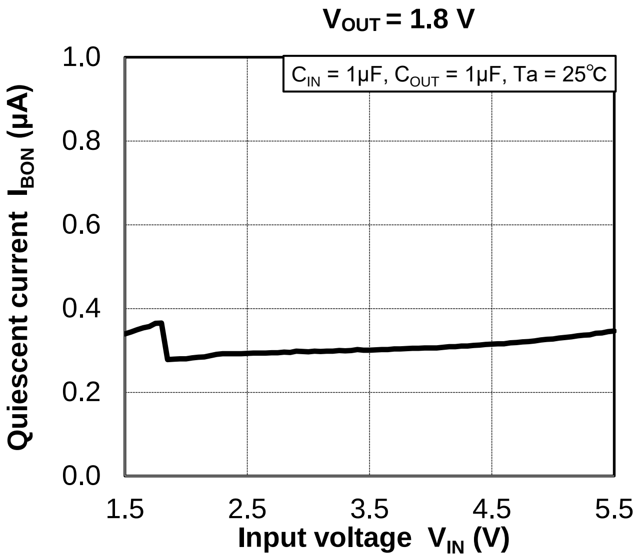
V_{OUT} = 5.0 V

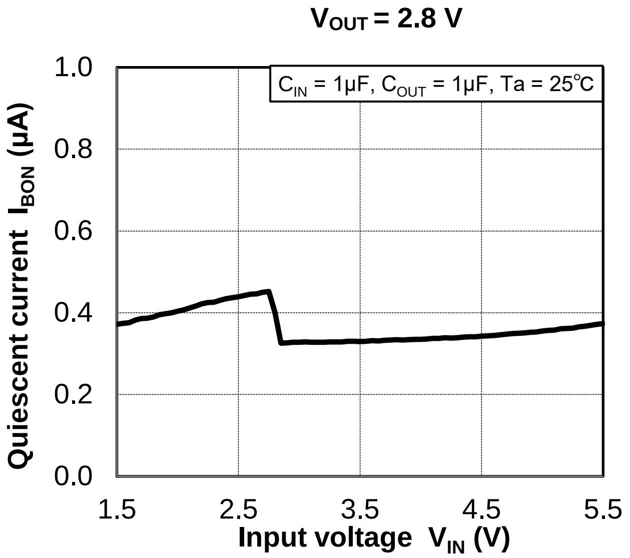


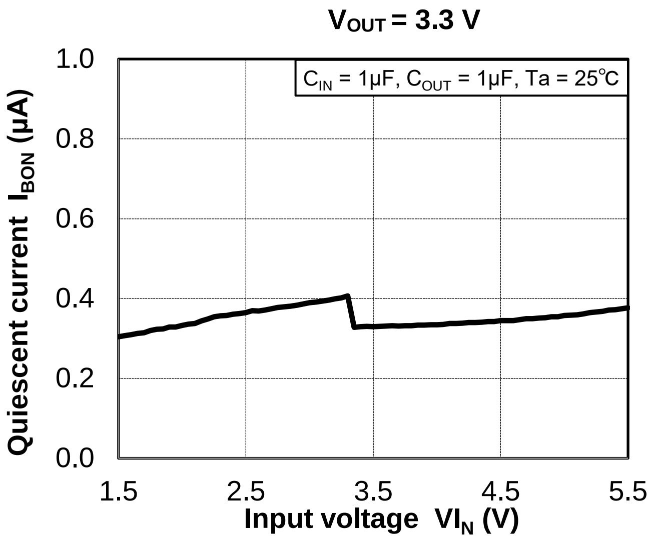
Quiescent Current vs. Input Voltage

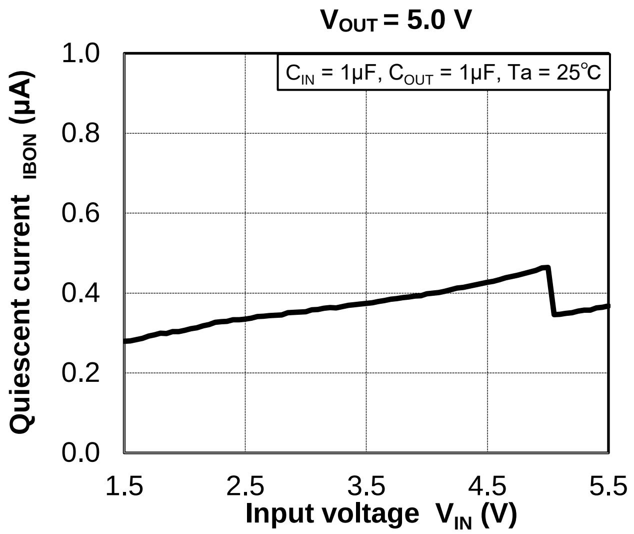






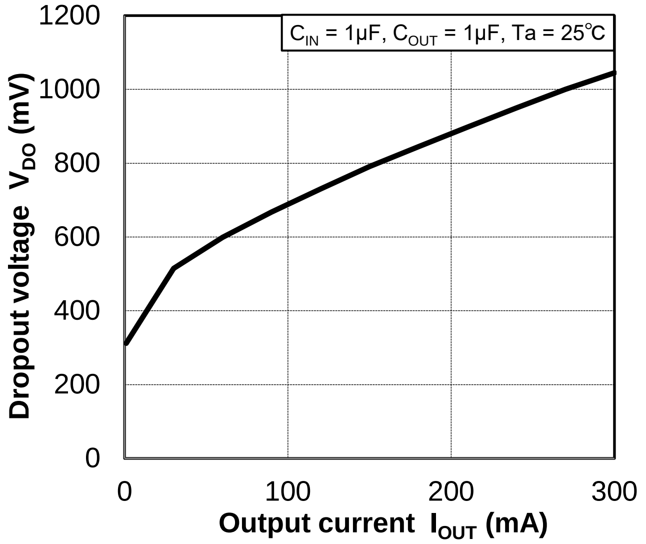




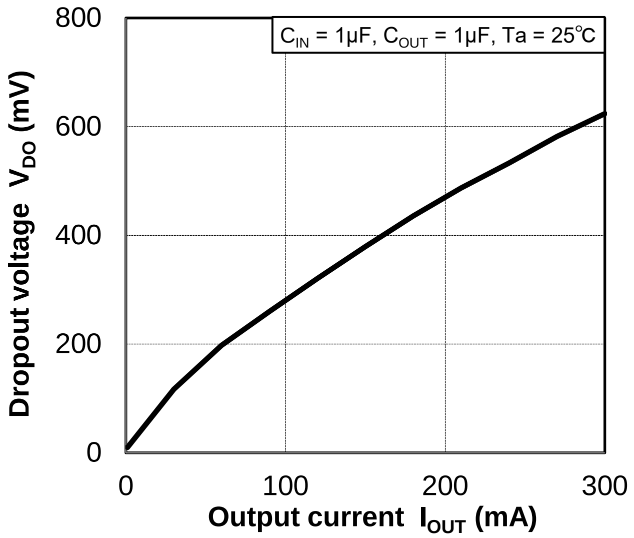


Dropout Voltage vs. Output Current

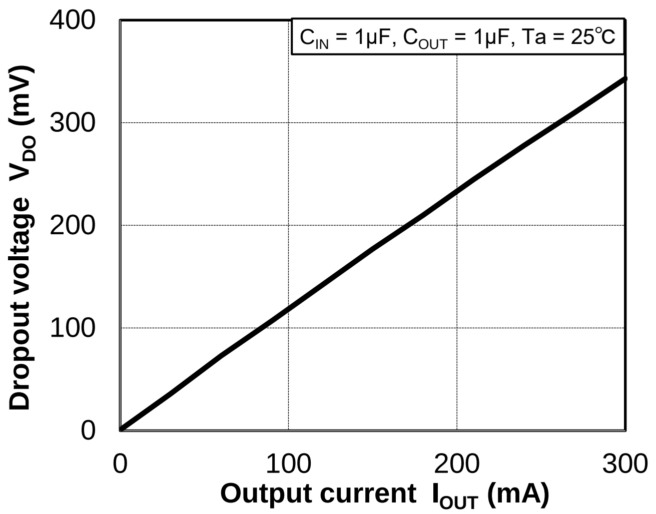
V_{OUT} = 0.8 V



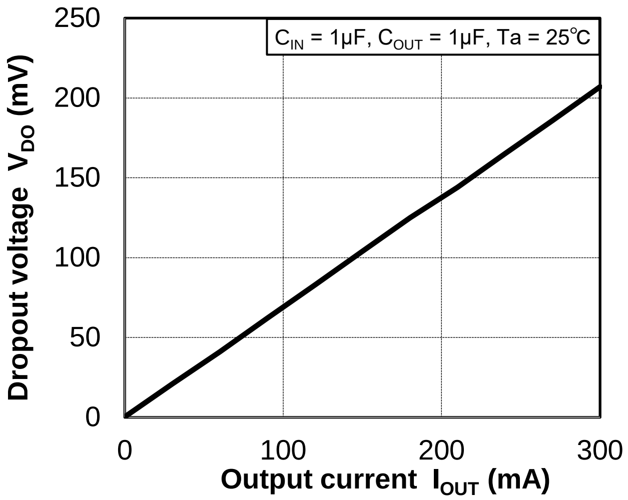
V_{OUT} = 1.2 V



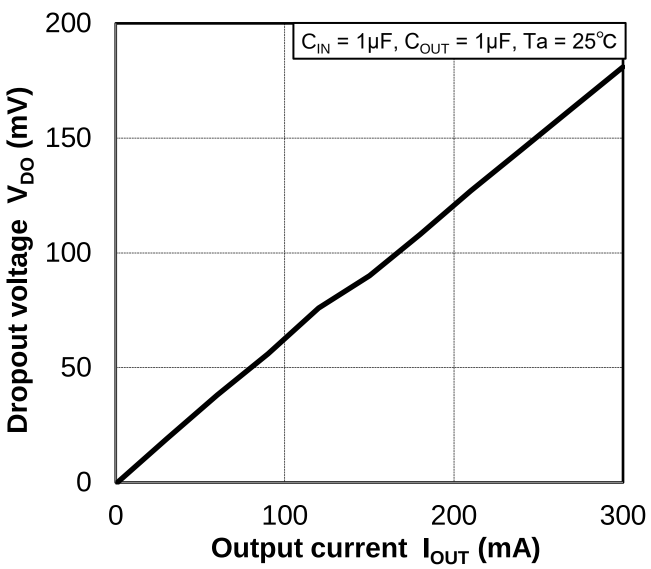
V_{OUT} = 1.8 V



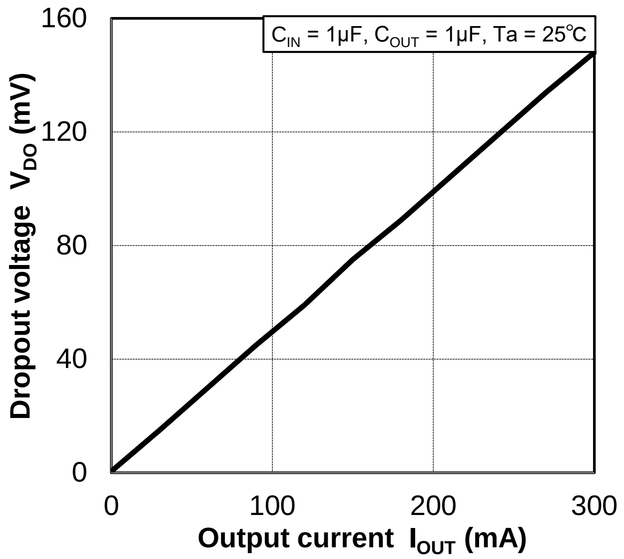
V_{OUT} = 2.8 V



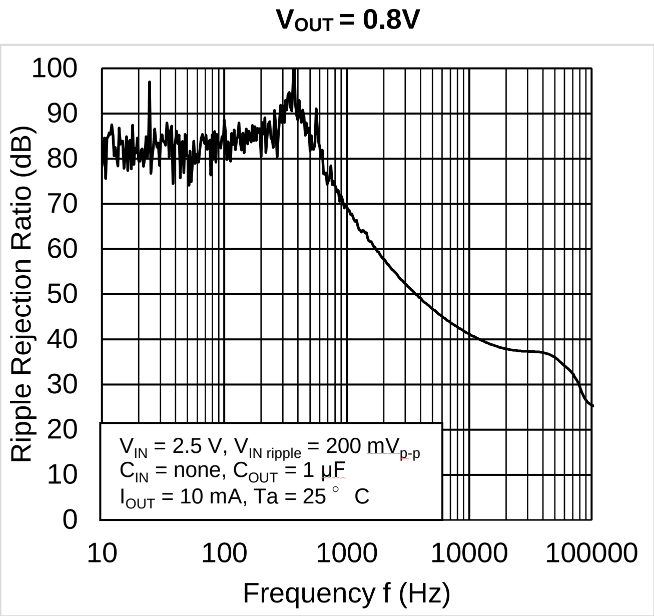
V_{OUT} = 3.3 V

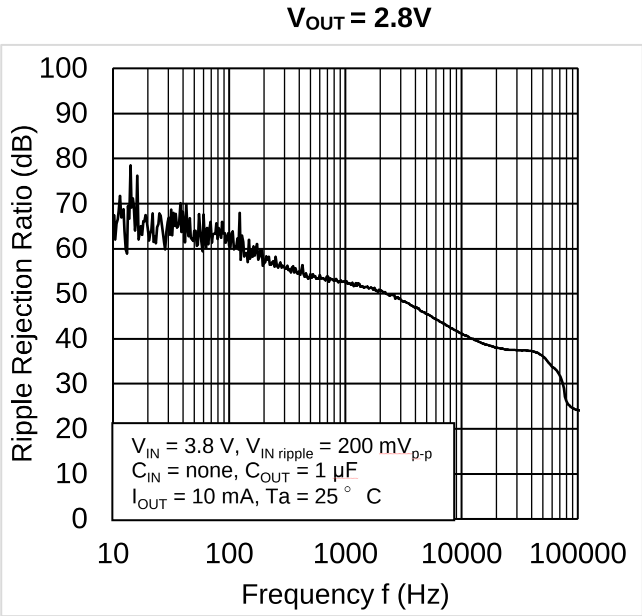


V_{OUT} = 5.0 V



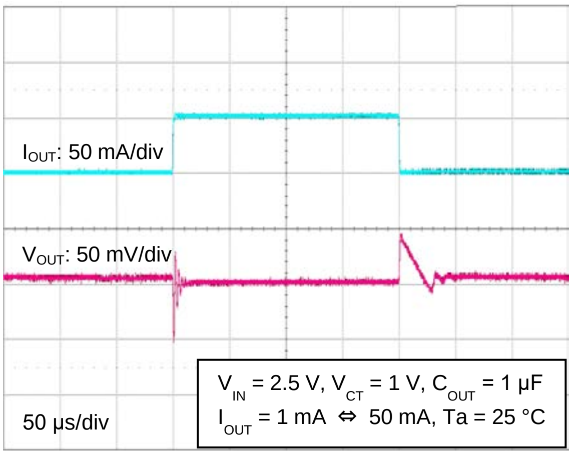
Ripple Rejection Ratio vs. Frequency



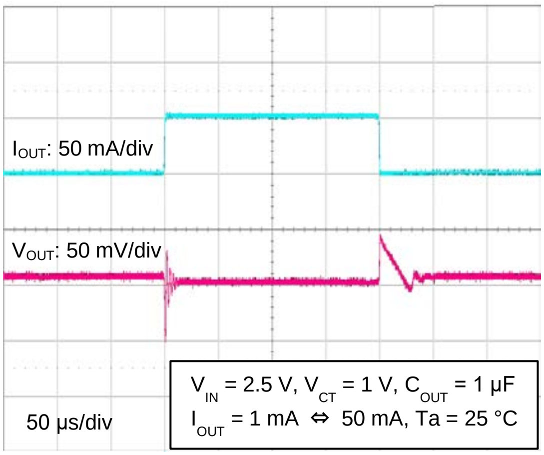


Load Transient Response

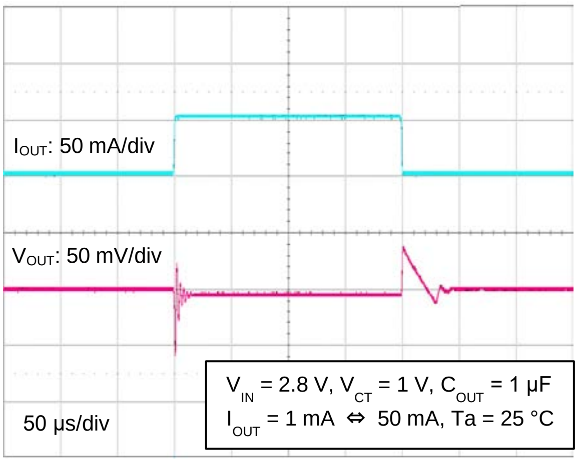
V_{OUT} = 0.8V



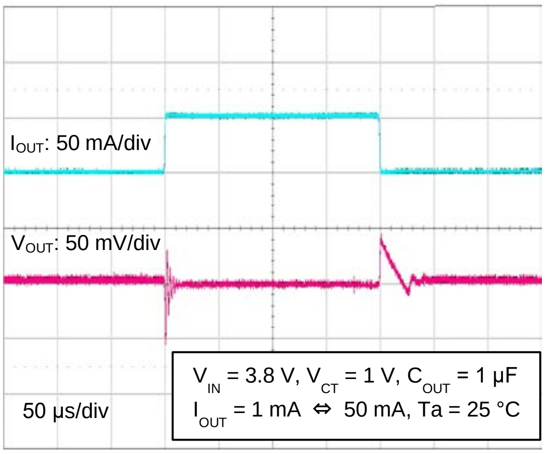
V_{OUT} = 1.2V



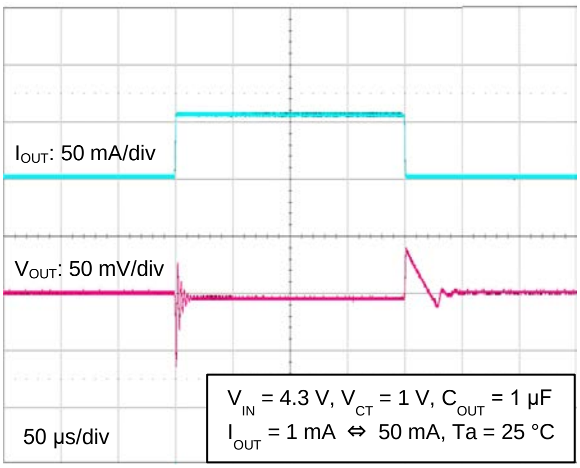
V_{OUT} = 1.8V



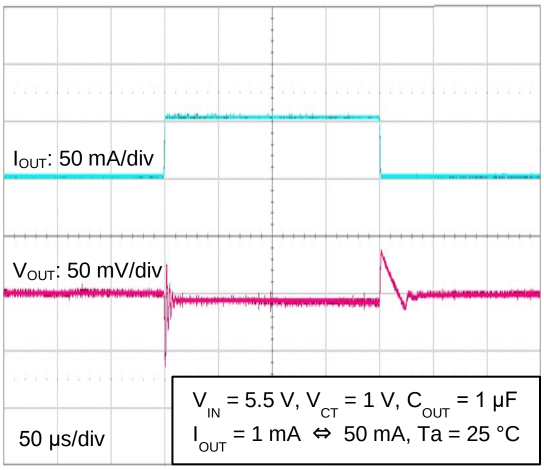
V_{OUT} = 2.8V



V_{OUT} = 3.3V

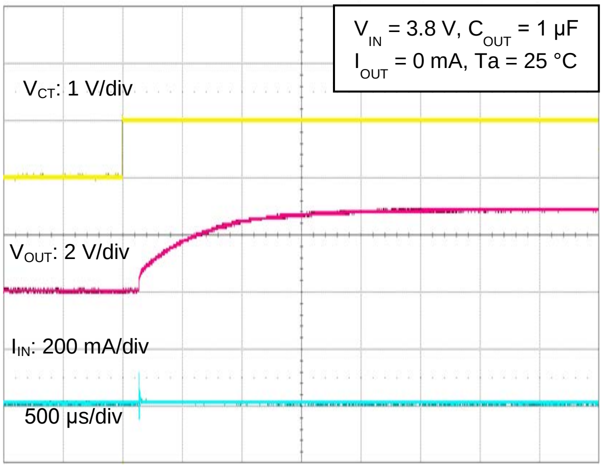


V_{OUT} = 5.0V

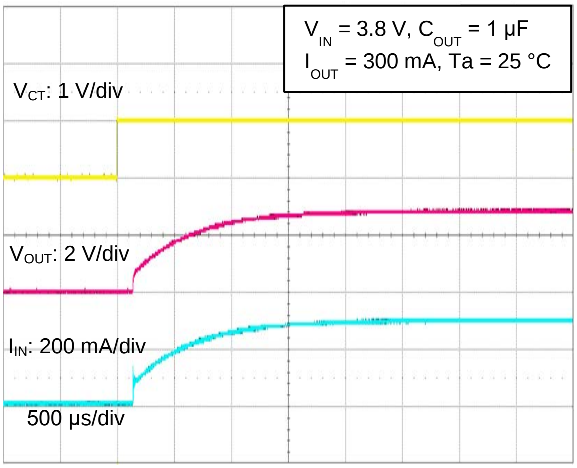


t_{ON} Response

V_{OUT} = 2.8V

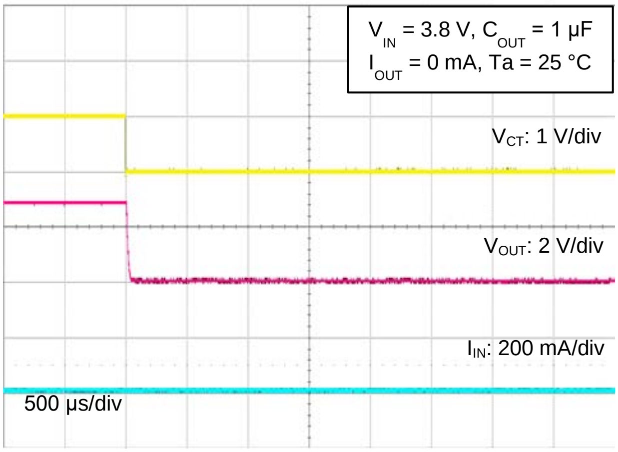


V_{OUT} = 2.8V

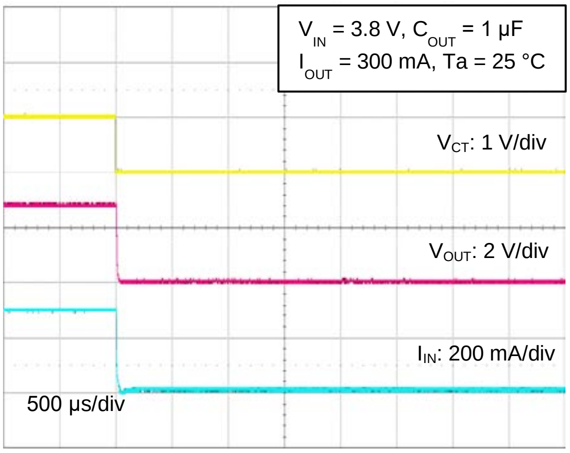


t_{OFF} Response (Auto-discharge)

V_{OUT} = 2.8V



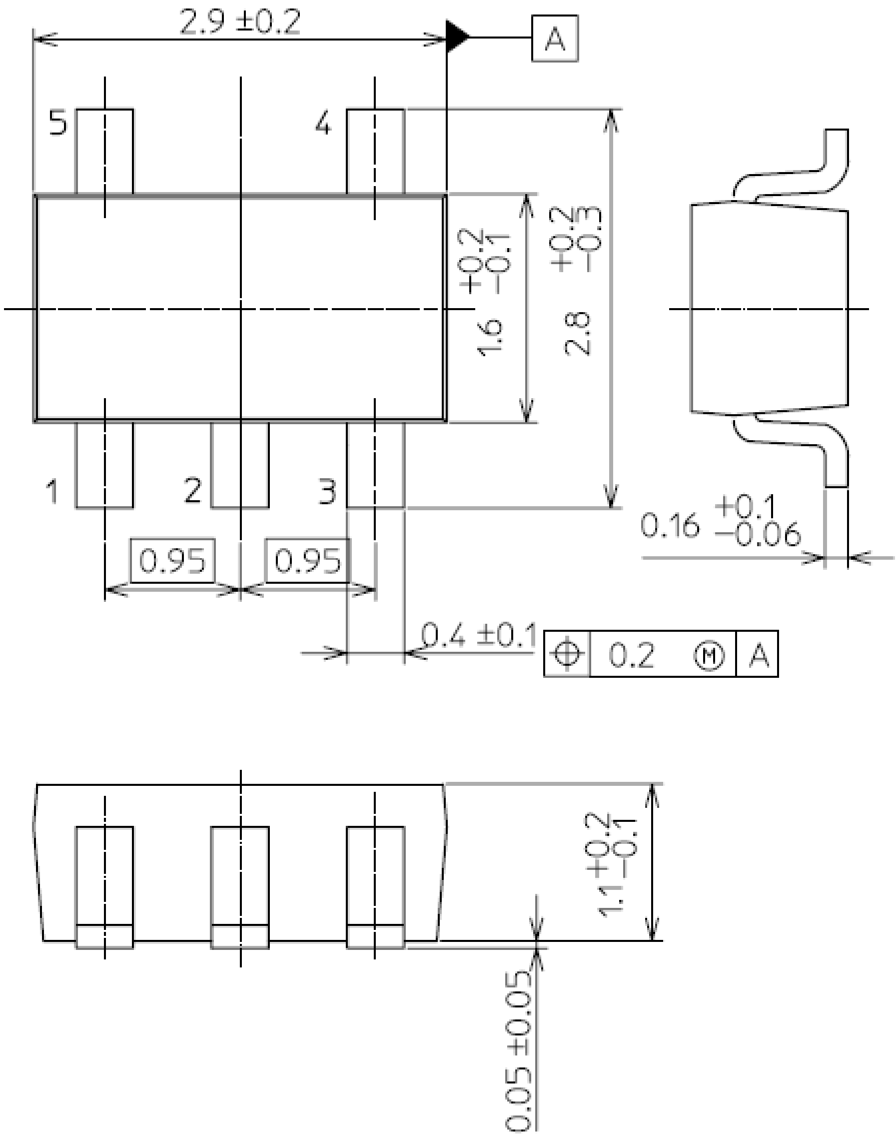
V_{OUT} = 2.8V



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

Package Information

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



Weight: 16 mg (typ.)

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