

TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

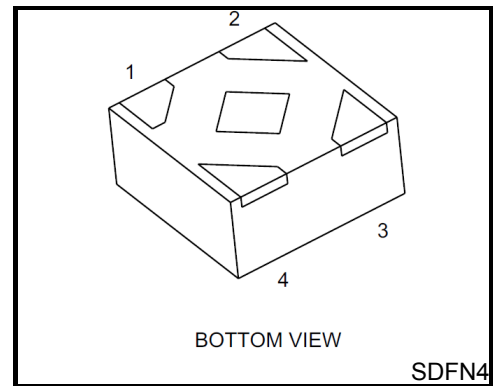
# TCR2LN series

## Ultra low quiescent current 200 mA CMOS Low Drop-Out Regulator in ultra small package

The TCR2LN series are CMOS general-purpose 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 3.6 V and capable of driving up to 200 mA. They feature overcurrent protection and Auto-discharge option.

The TCR2LN series is offered in the ultra small plastic mold package SDFN4 (0.8 mm x 0.8 mm x 0.38 mm) and has a low dropout voltage of 250 mV ( 2.5 V output,  $I_{OUT} = 150$  mA). As small ceramic input and output capacitors 0.1  $\mu$ F can be used with the TCR2LN series, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



Weight : 0.6 mg ( typ.)

## Features

- Low quiescent bias current (  $I_B = 2 \mu\text{A}$  (max) at  $I_{OUT} = 0$  mA,  $T_j = -40$  to  $85^\circ\text{C}$ )
- Low Drop-Out voltage  
 $V_{IN} - V_{OUT} = 250$  mV (typ.) at 2.5 V-output,  $I_{OUT} = 150$  mA
- Wide range output voltage line up (  $V_{OUT} = 0.8$  to  $3.6$  V )
- High  $V_{OUT}$  accuracy  $\pm 1.0\%$  (  $1.8\text{V} \leq V_{OUT}$  )
- Overcurrent protection
- Auto-discharge
- Pull down connection between CONTROL and GND
- Ceramic capacitors can be used (  $C_{IN} = 0.1 \mu\text{F}$ ,  $C_{OUT} = 0.1 \mu\text{F}$  )
- Ultra small package SDFN4 (0.8 mm x 0.8 mm x 0.38 mm )

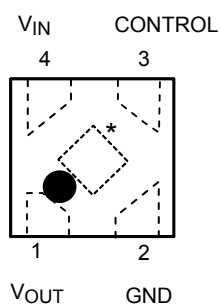
## Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Input voltage	V <sub>IN</sub>	6.0	V
Control voltage	V <sub>CT</sub>	-0.3 to 6.0	V
Output voltage	V <sub>OUT</sub>	-0.3 to V <sub>IN</sub> + 0.3	V
Output current	I <sub>OUT</sub>	200	mA
Power dissipation	P <sub>D</sub>	300 (Note1)	mW
Operation temperature range	T <sub>opr</sub>	-40 to 85	°C
Junction temperature	T <sub>j</sub>	150	°C
Storage temperature range	T <sub>stg</sub>	-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: 40mm x 40mm x 1.6mm, both sides of board  
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%  
Through hole hall: diameter 0.5mm x 24

## Pin Assignment (top view)



\*Center electrode should be connected to GND or Open

## List of Products Number, Output voltage and Marking

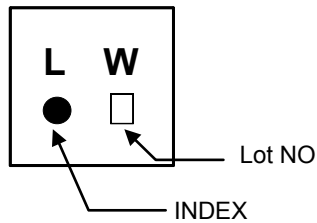
### Output Auto discharge type

Product No.	Output voltage(V)	Marking	Product No.	Output voltage(V)	Marking
TCR2LN08	0.8	L8	TCR2LN19	1.9	LF
TCR2LN085	0.85	KS	TCR2LN20	2.0	LG
TCR2LN09	0.9	L9	TCR2LN21	2.1	LH
TCR2LN095	0.95	KT	TCR2LN25	2.5	LM
TCR2LN10	1.0	LJ	TCR2LN27	2.7	LO
TCR2LN105	1.05	LU	TCR2LN28	2.8	LP
TCR2LN11	1.1	L2	TCR2LN285	2.85	L7
TCR2LN115	1.15	LC	TCR2LN30	3.0	LS
TCR2LN12	1.2	L3	TCR2LN31	3.1	LT
TCR2LN13	1.3	L4	TCR2LN32	3.2	LV
TCR2LN15	1.5	LA	TCR2LN33	3.3	LW
TCR2LN18	1.8	LE	TCR2LN36	3.6	LZ

\* Please contact local Toshiba representative if you are interested in product that output voltage is not in the list.

### Top Marking

Example: TCR2LN33 (3.3 V output)



## Electrical Characteristics

(Unless otherwise specified,

$V_{IN} = V_{OUT} + 1\text{ V}$  ( $V_{OUT} > 1.5\text{ V}$ ),  $V_{IN} = 2.5\text{ V}$  ( $V_{OUT} \leq 1.5\text{ V}$ ),  $I_{OUT} = 50\text{ mA}$ ,  $C_{IN} = 0.1\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ )

Characteristics	Symbol	Test Condition	$T_j = 25^\circ\text{C}$			$T_j = -40\text{ to }85^\circ\text{C}$		Unit	
			Min	Typ.	Max	Min	Max		
Output voltage	$V_{OUT}$	$I_{OUT} = 50\text{ mA}$ (Note 2)	$V_{OUT} < 1.8\text{ V}$	-18	—	+18	—	—	mV
			$1.8\text{ V} \leq V_{OUT}$	-1.0	—	+1.0	—	—	%
Input voltage	$V_{IN}$	$I_{OUT} = 1\text{ mA}$	1.5	—	5.5	1.5	5.5	V	
Line regulation	Reg·line	$V_{OUT} + 0.5\text{ V} \leq V_{IN} \leq 5.5\text{ V}$ , $I_{OUT} = 1\text{ mA}$	—	1	15	—	—	mV	
Load regulation	Reg·load	$1\text{ mA} \leq I_{OUT} \leq 150\text{ mA}$	—	15	30	—	—	mV	
Quiescent current	$I_B$	$I_{OUT} = 0\text{ mA}$ (Note 3)	—	1.0	—	—	2.0	$\mu\text{A}$	
Stand-by current	$I_B(\text{OFF})$	$V_{CT} = 0\text{ V}$	—	0.1	—	—	1.0	$\mu\text{A}$	
Control pull down current	$I_{CT}$	—	—	0.1	—	—	—	$\mu\text{A}$	
Drop-out voltage	$V_{IN}-V_{OUT}$	$I_{OUT} = 150\text{ mA}$	$V_{OUT} = 1.8\text{ V}$	—	350	—	—	640	mV
			$V_{OUT} = 3.0\text{ V}$	—	200	—	—	280	mV
Temperature coefficient	$T_{CVO}$	$-40^\circ\text{C} \leq T_{opr} \leq 85^\circ\text{C}$	—	75	—	—	—	ppm/ $^\circ\text{C}$	
Control voltage (ON)	$V_{CT}(\text{ON})$	—	1.0	—	5.5	1.0	5.5	V	
Control voltage (OFF)	$V_{CT}(\text{OFF})$	—	0	—	0.4	0	0.4	V	
Discharge on resistance	$R_{SD}$	—	—	20	—	—	—	$\Omega$	

Note 2: Stable state with fixed  $I_{OUT}$  condition

Note 3: Except Control pull down current

## Drop-out voltage

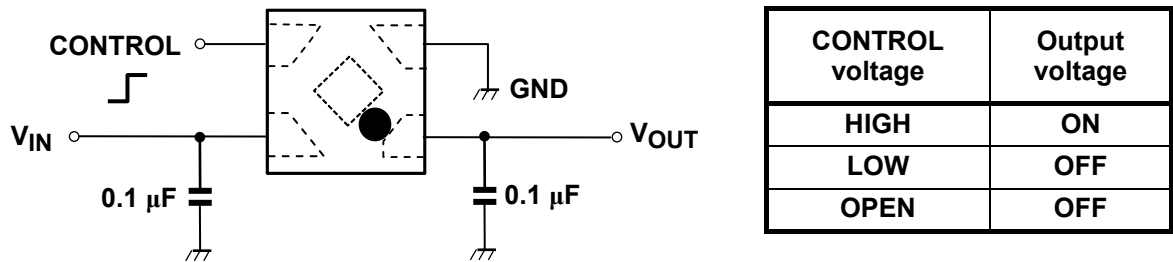
( $I_{OUT} = 150\text{ mA}$ ,  $C_{IN} = 0.1\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ ,  $T_j = 25^\circ\text{C}$ )

Output voltages	Symbol	Min	Typ.	Max(Note 4)	Unit
$0.8\text{ V} \leq V_{OUT} < 0.9\text{ V}$	$V_{IN}-V_{OUT}$	—	1000	1550	mV
$0.9\text{ V} \leq V_{OUT} < 1.0\text{ V}$		—	920	1450	
$1.0\text{ V} \leq V_{OUT} < 1.1\text{ V}$		—	840	1370	
$1.1\text{ V} \leq V_{OUT} < 1.2\text{ V}$		—	760	1280	
$1.2\text{ V} \leq V_{OUT} < 1.3\text{ V}$		—	680	1190	
$1.3\text{ V} \leq V_{OUT} < 1.6\text{ V}$		—	600	1100	
$1.6\text{ V} \leq V_{OUT} < 1.8\text{ V}$		—	450	830	
$1.8\text{ V} \leq V_{OUT} < 2.0\text{ V}$		—	350	640	
$2.0\text{ V} \leq V_{OUT} < 2.5\text{ V}$		—	300	460	
$2.5\text{ V} \leq V_{OUT} < 3.0\text{ V}$		—	250	340	
$3.0\text{ V} \leq V_{OUT} \leq 3.6\text{ V}$		—	200	280	

Note 4:  $T_j = -40\text{ to }85^\circ\text{C}$

**Application Note**

**1. Recommended Application Circuit**



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**

Board-mounted power dissipation ratings are available in the Absolute Maximum Ratings table. Power dissipation is measured on the board condition shown below.

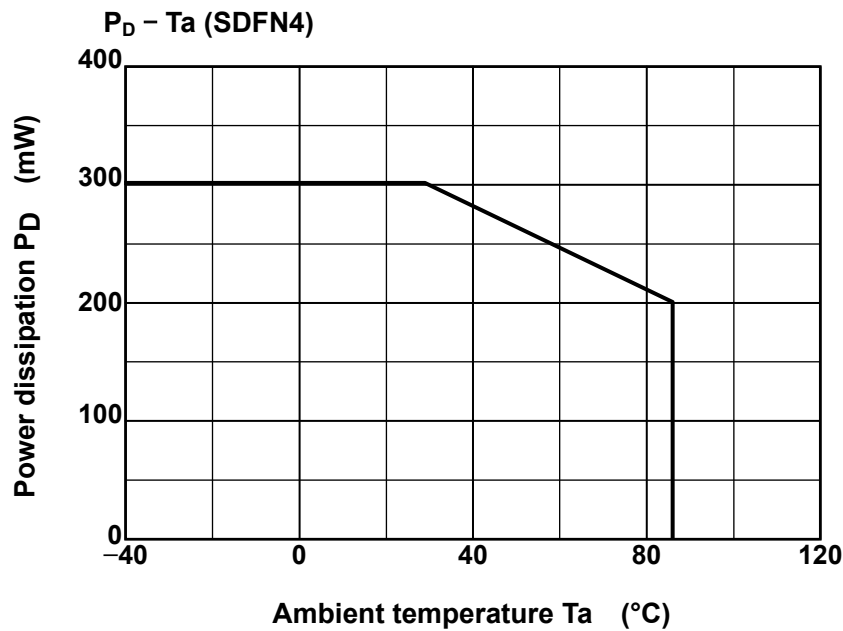
[The Board Condition]

Board material: Glass epoxy(FR4)

Board dimension: 40mm x 40mm (both sides of board), t=1.6mm

Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%

Through hole: diameter 0.5mm x 24

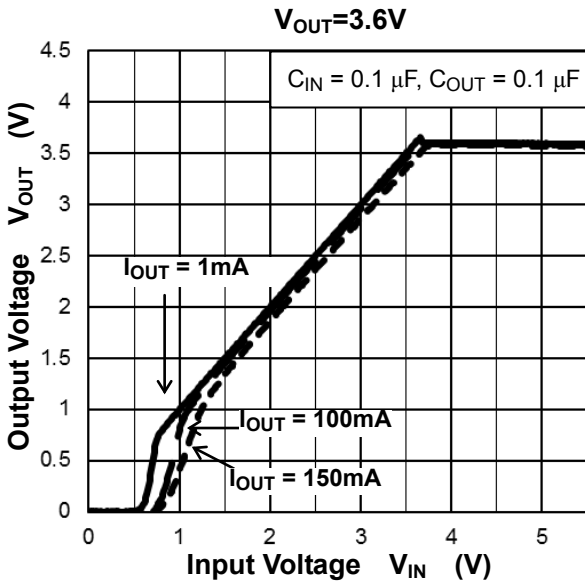
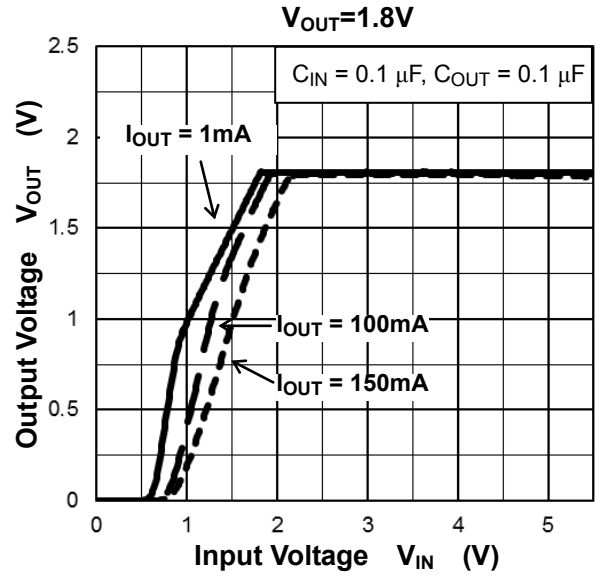
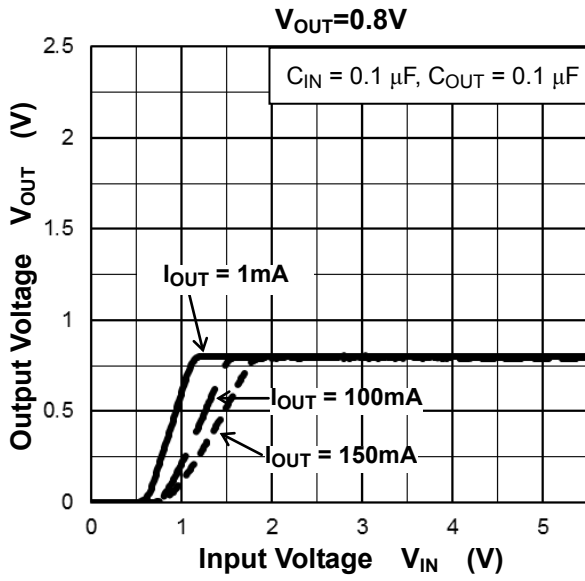


**Attention in Use**

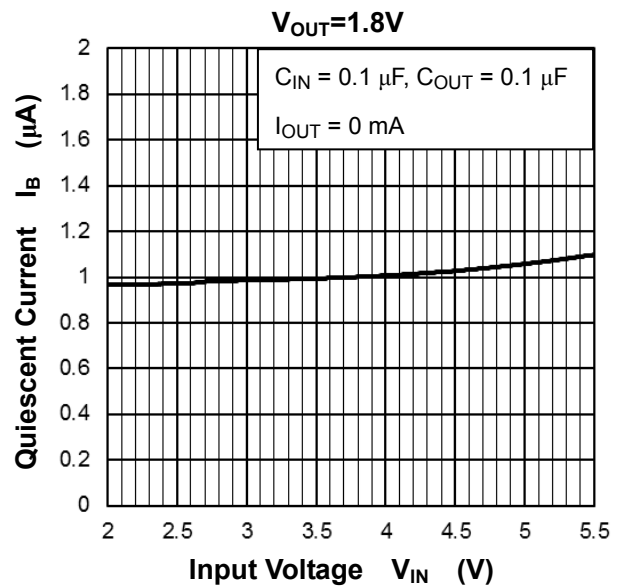
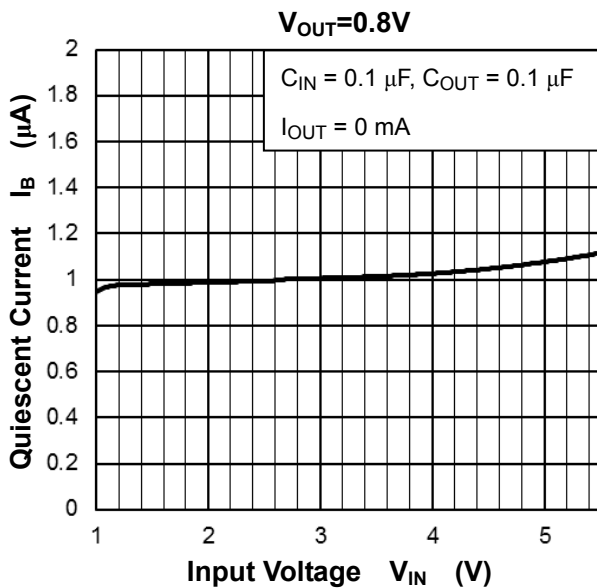
- **Output Capacitors**  
Ceramic capacitors can be used for these devices. However, because of the type of the capacitors, there might be unexpected thermal features. Please consider application condition for selecting capacitors. And Toshiba recommend the ESR of ceramic capacitor is under 10  $\Omega$ .
  
- **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 %.
  
- **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.

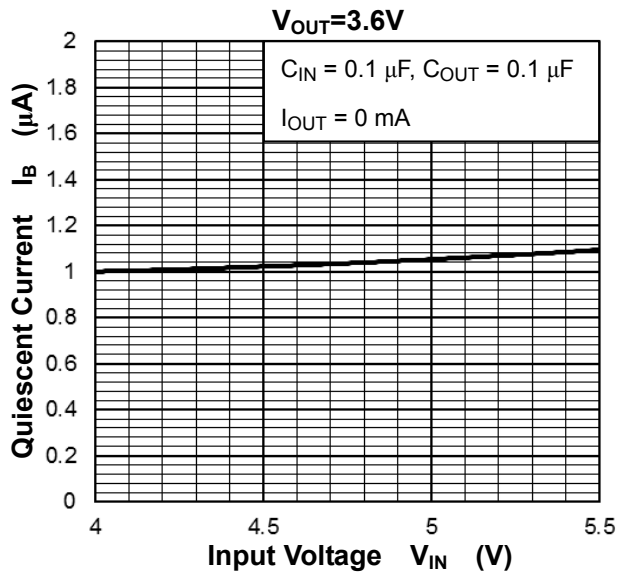
**Representative Typical Characteristics**

**1) Output Voltage vs. Input Voltage**

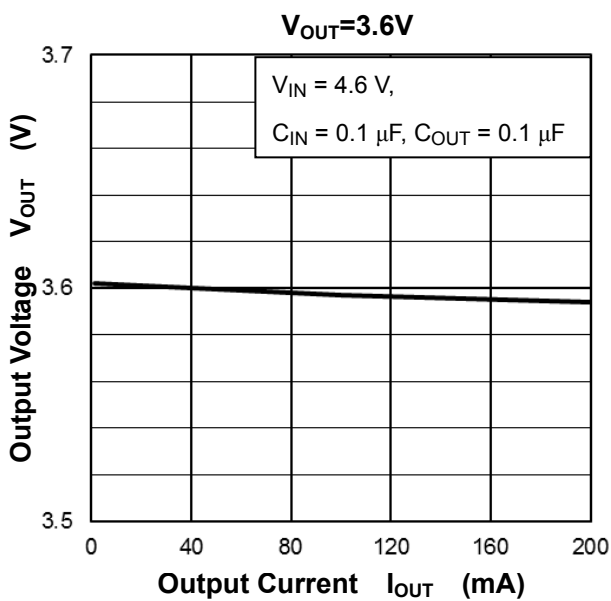
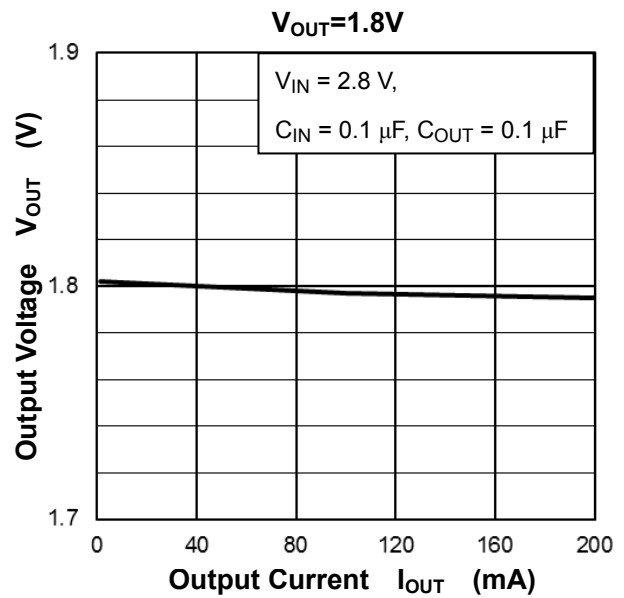
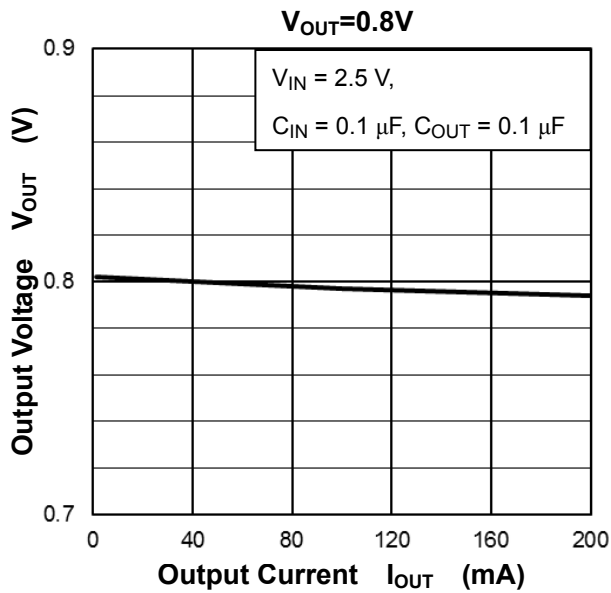


**2) Quiescent Current vs. Input Voltage**



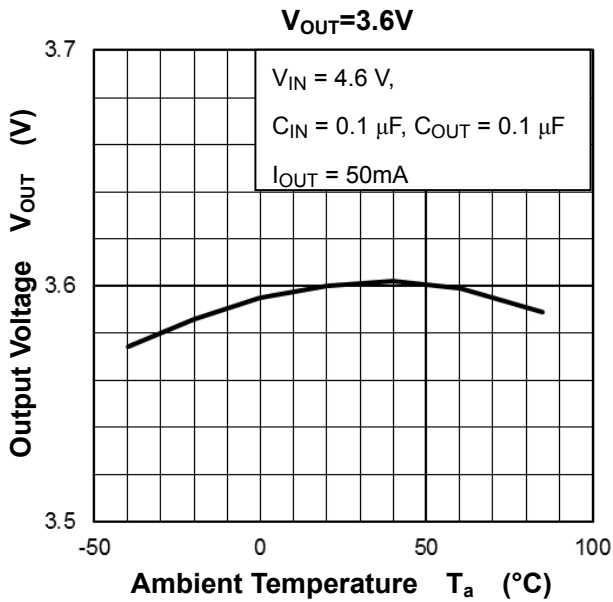
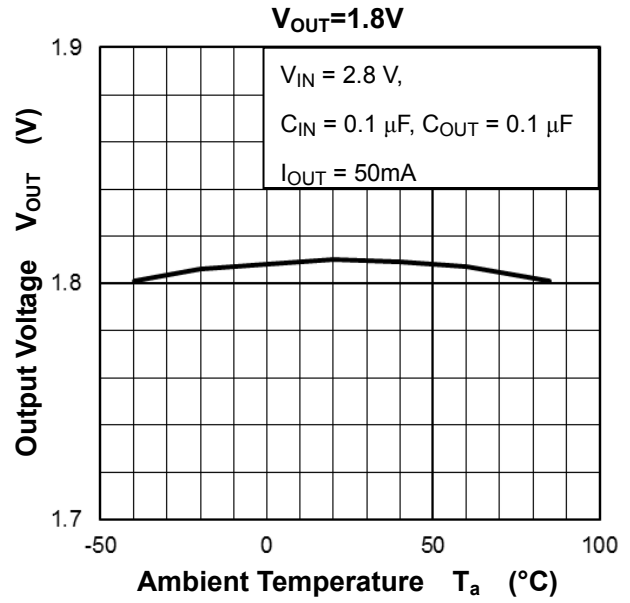
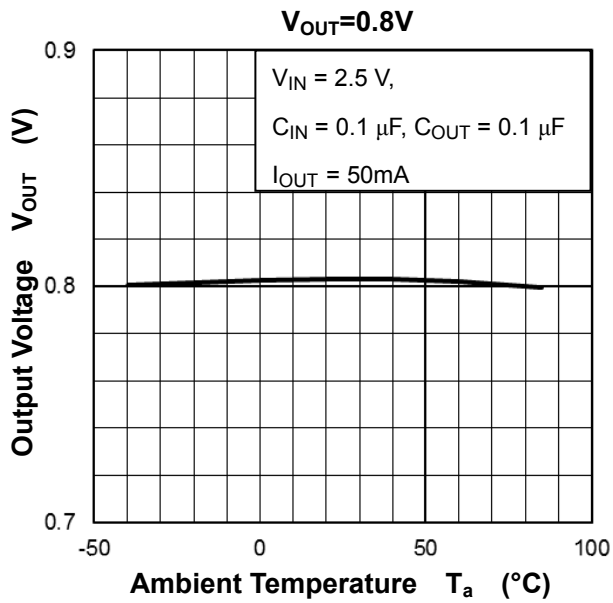


**3) Output Voltage vs. Output Current**

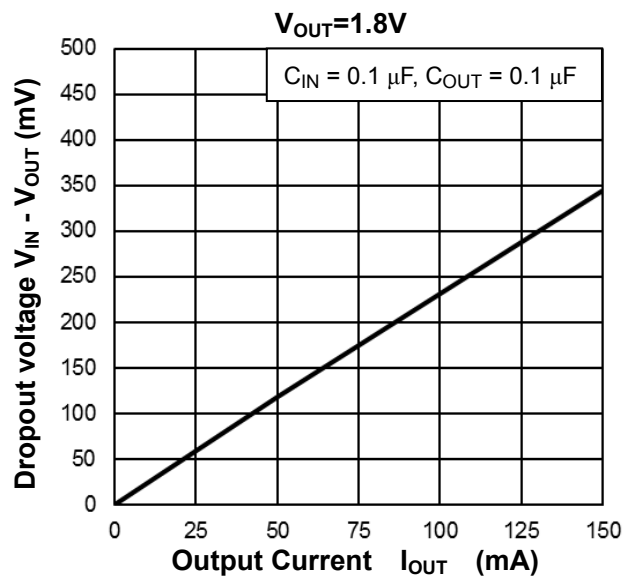
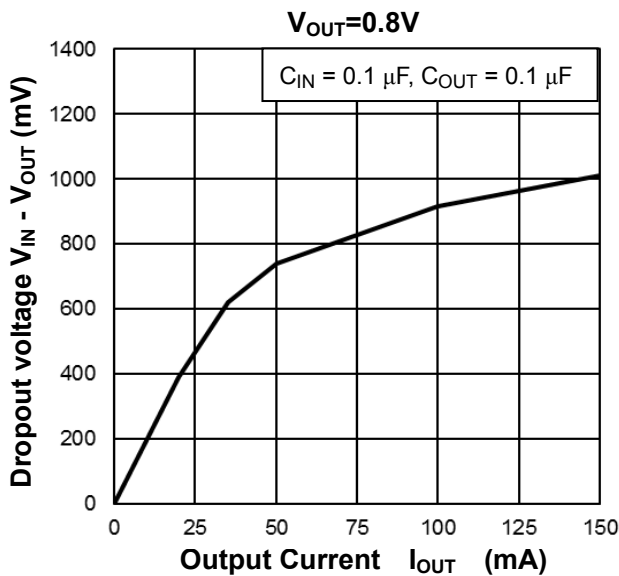


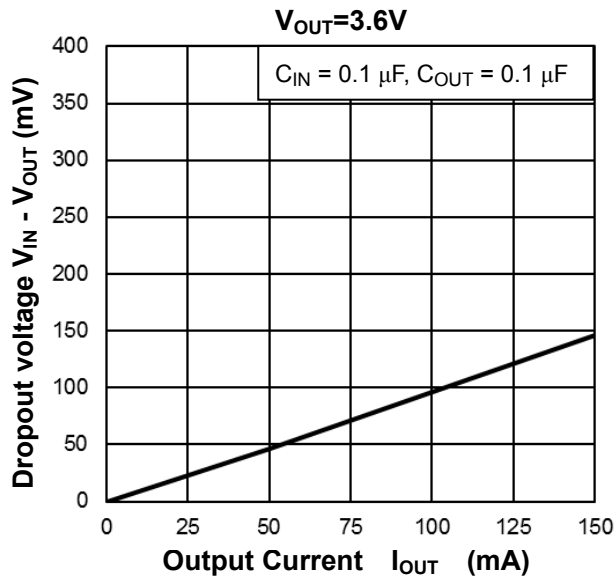


### 4) Output Voltage vs. Ambient Temperature

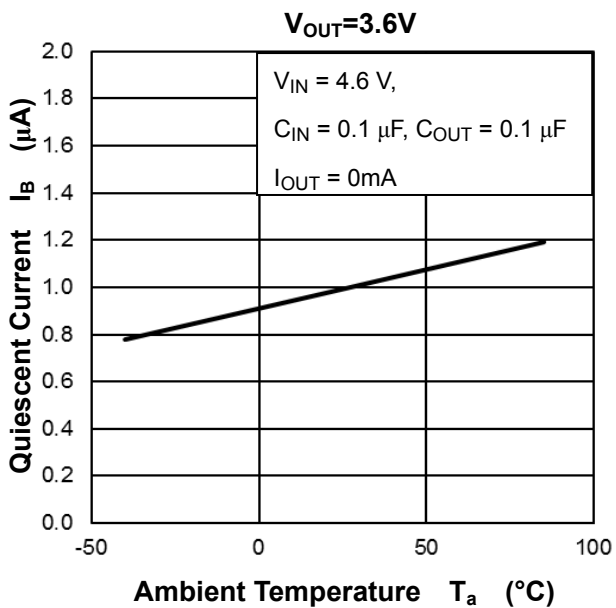
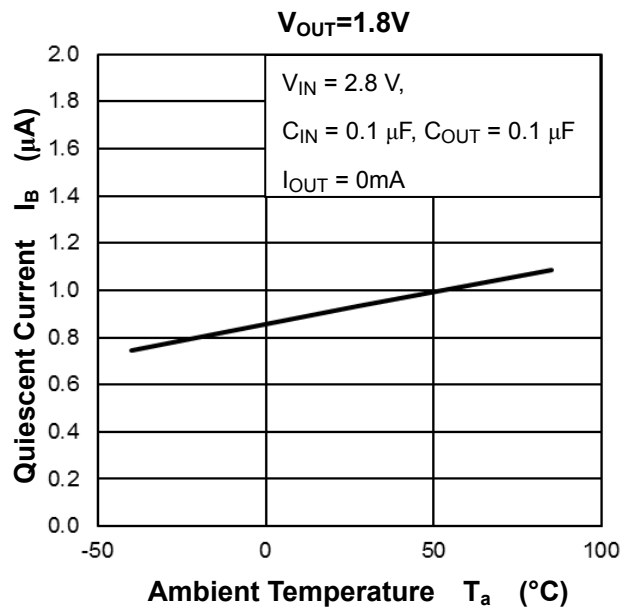
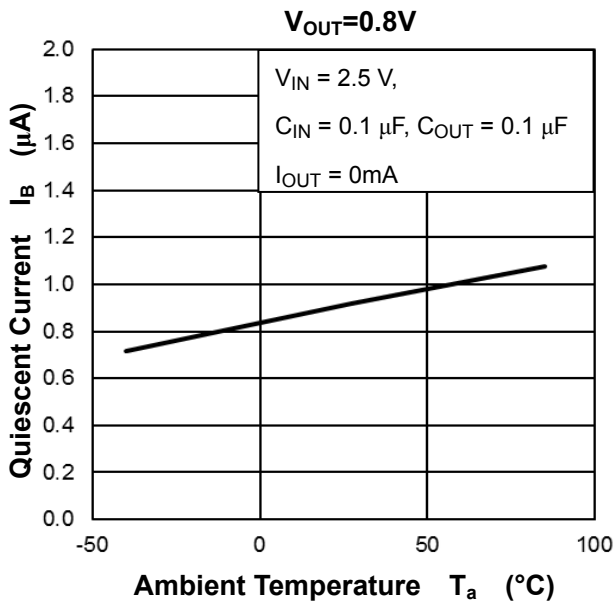


### 5) Dropout Voltage vs. Output Current

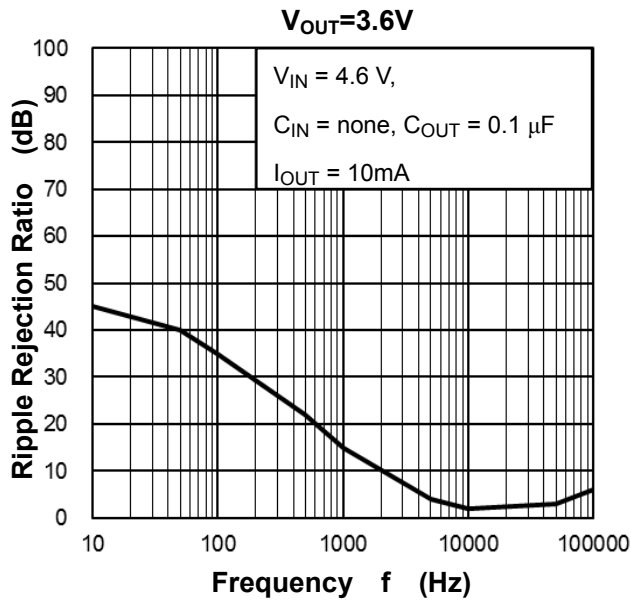
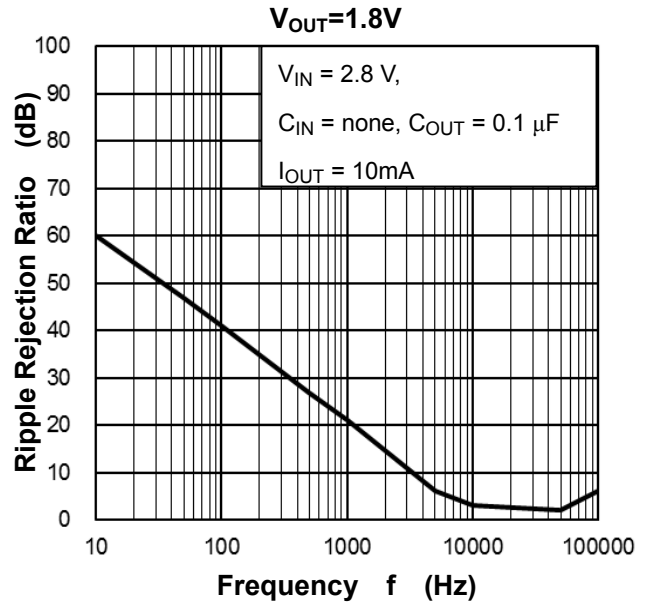
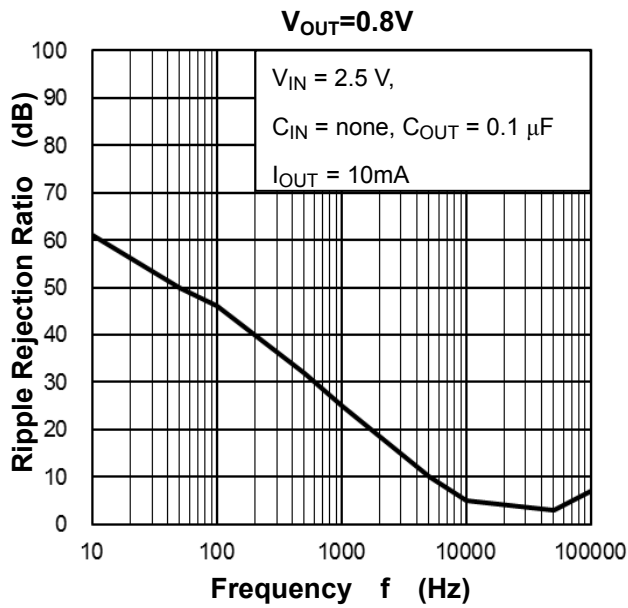




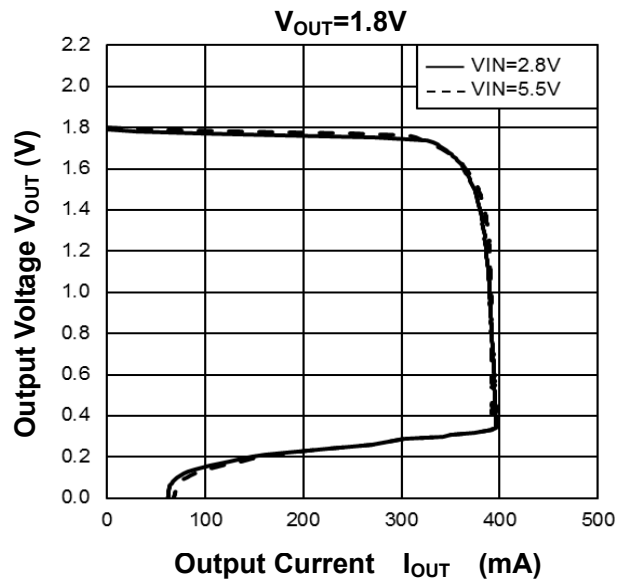
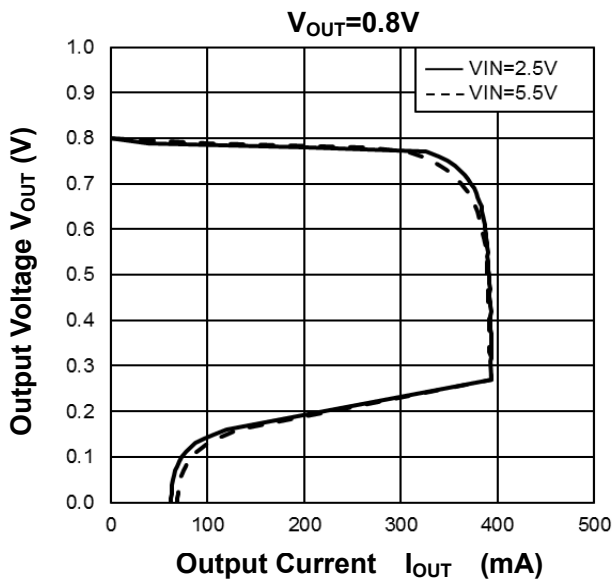
**6) Quiescent Current vs. Ambient Temperature**

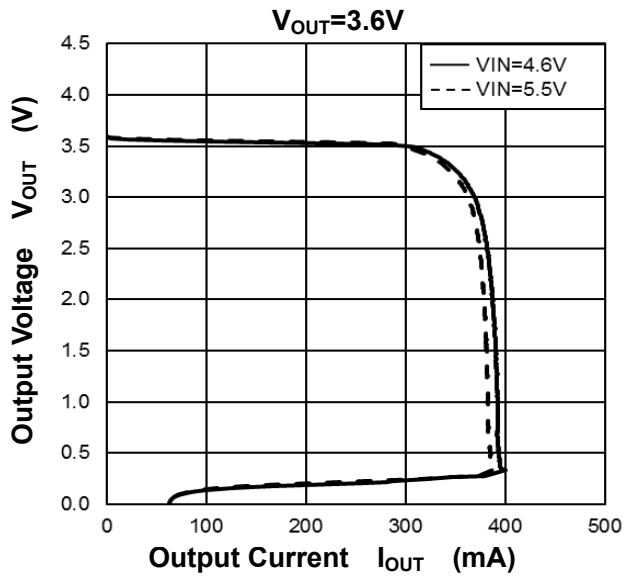


7) Ripple Rejection Ratio vs. Frequency

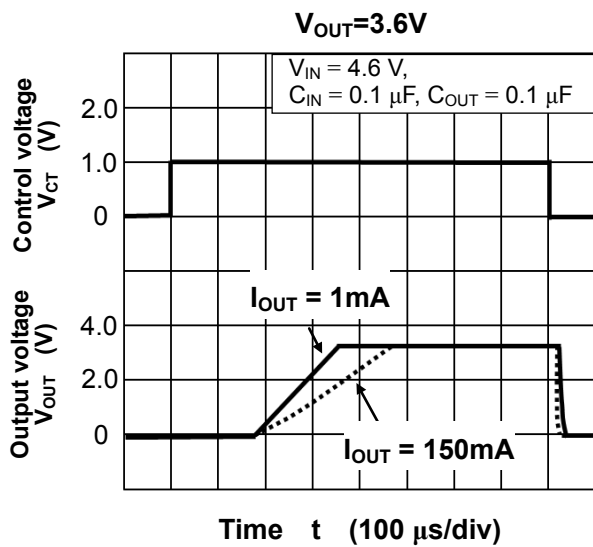
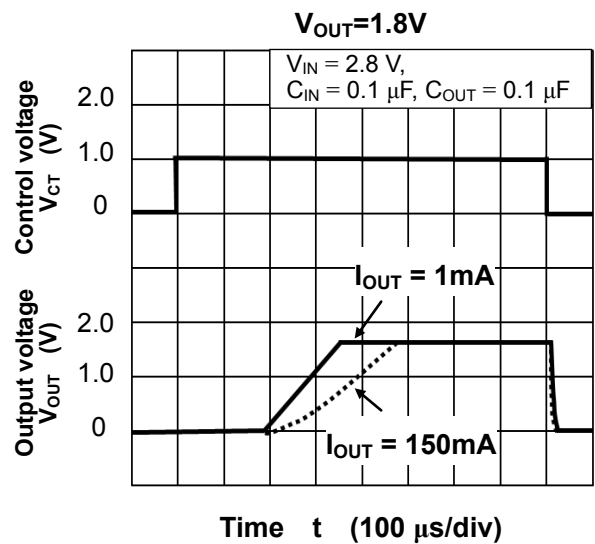
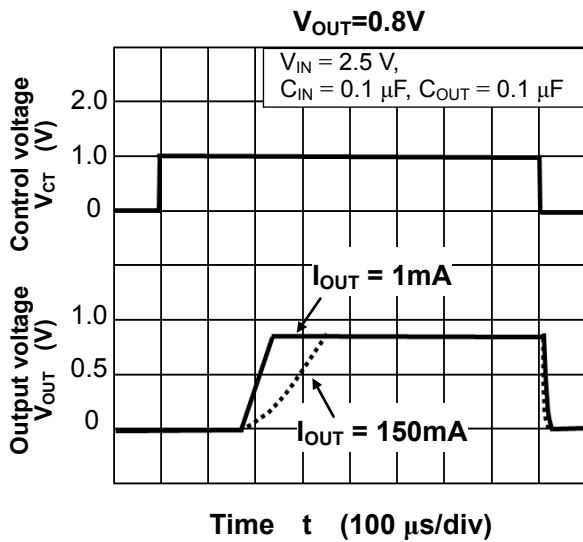


8) Output Voltage vs. Output Current

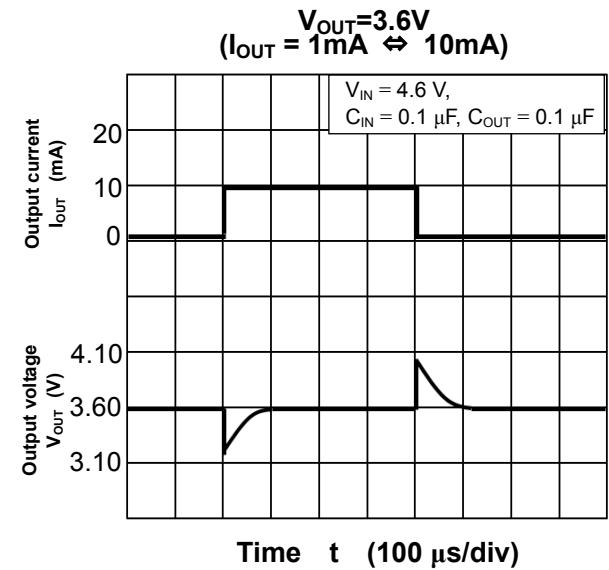
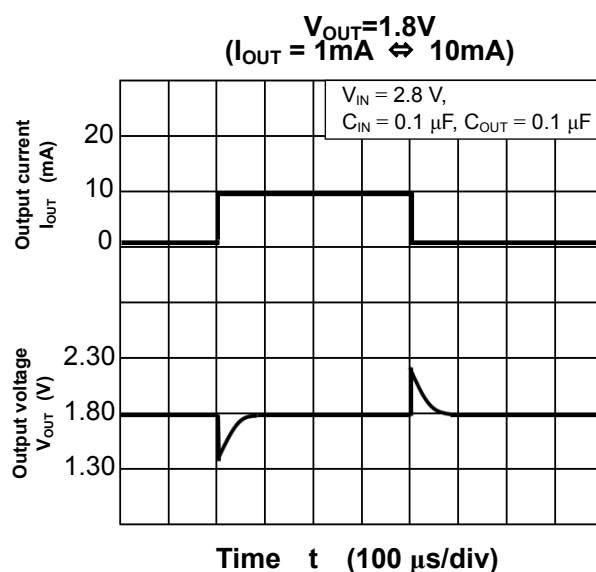
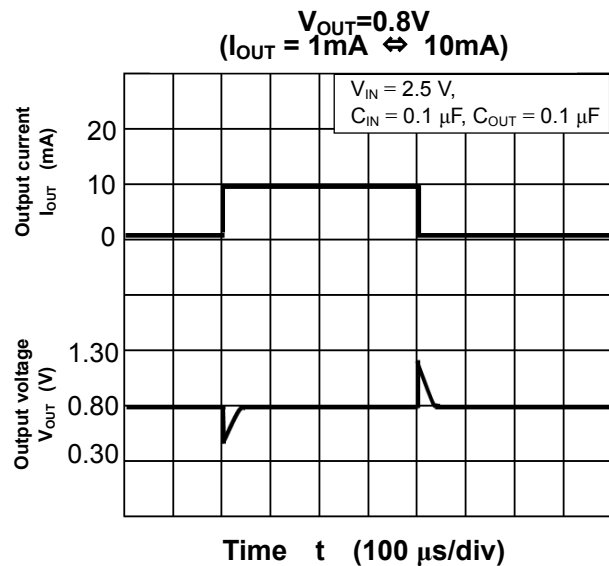
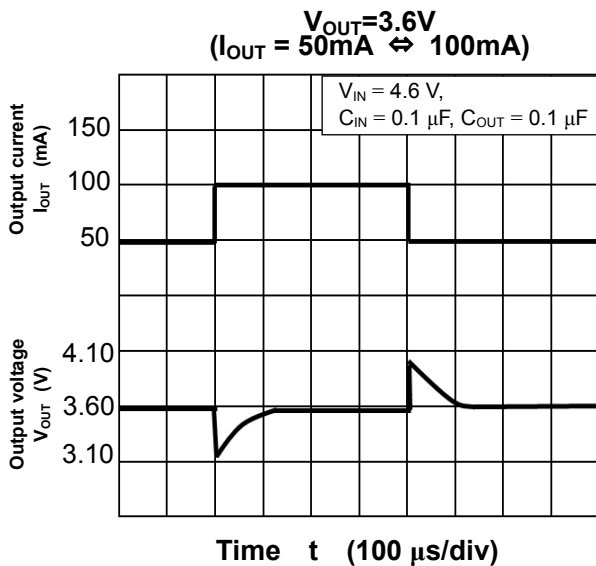
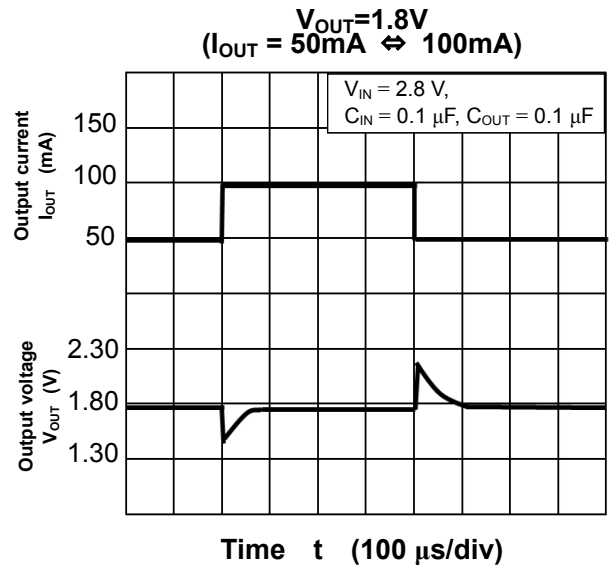
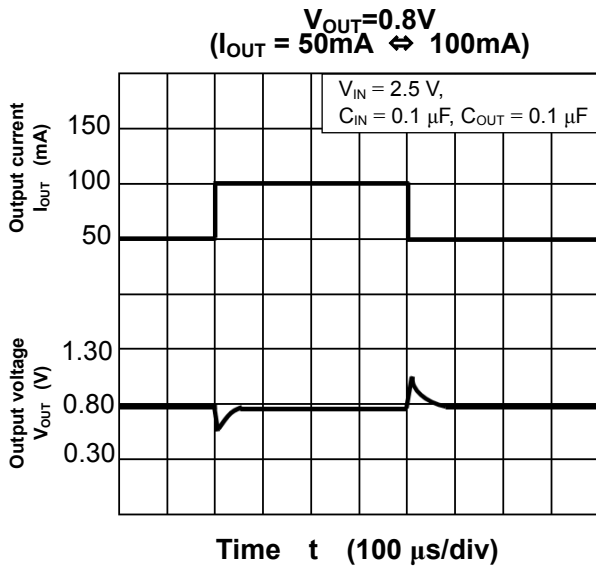




**9) Control Transient vs. Response**



## 10) Load Transient Response





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