

Low Voltage 3-Mode Dual 150mA LDO

NO.EA-139-111025

OUTLINE

The R5328K Series are dual 150mA voltage regulator ICs with 3-mode. The 3-mode describes that they are the inactive standby, the active fast mode, and the active low power mode. The two active modes can be switched over with ECO pin. With this function, the output voltage maintains the level, and the mode can be switched over.

The minimum operating voltage is 1.4V, and the output voltage range is from 0.8V to 4.0V.

Since the package for these ICs is DFN(PLP)2020-8, high density mounting of the ICs on boards is possible.

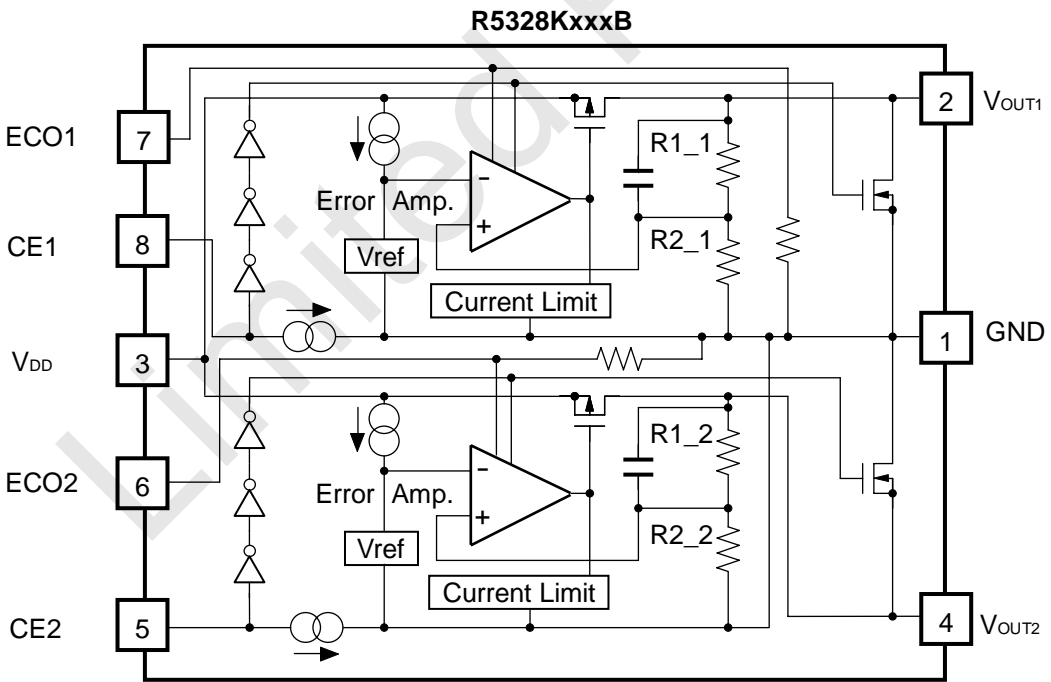
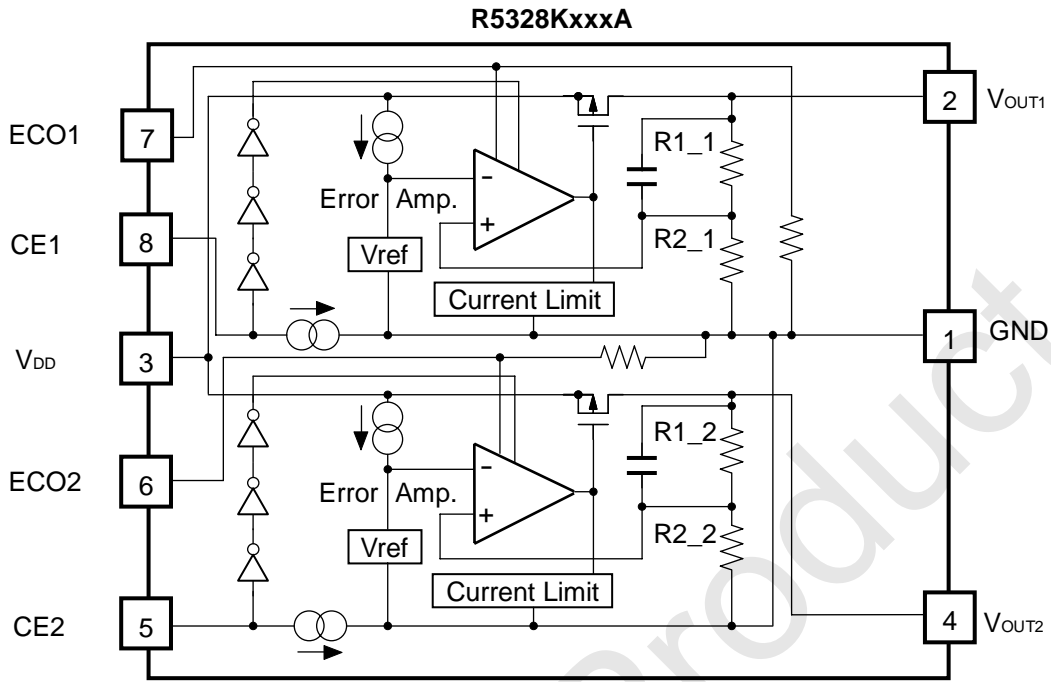
FEATURES

- Supply Current (Low Power Mode)..... Typ. 2.0 μ A \times 2 (VR1&VR2) ($V_{OUT}<2.0V$)
Typ. 2.5 μ A \times 2 (VR1&VR2) ($V_{OUT} \geq 2.0V$)
- Supply Current (Fast Mode)..... Typ. 75 μ A \times 2 (VR1&VR2) ($V_{OUT}<2.0V$)
Typ. 65 μ A \times 2 (VR1&VR2) ($V_{OUT} \geq 2.0V$)
- Standby Mode Typ. 0.1 μ A (VR1&VR2)
- Input Voltage 1.4V to 6.0V
- Output Voltage Range..... 0.8V to 4.0V (0.1V steps)
(For details, please refer to MARK INFORMATION.)
- Dropout Voltage Typ. 0.25V ($I_{OUT}=150mA$, $V_{OUT}=2.8V$)
- Ripple Rejection (Fast Mode) Typ. 70dB ($f=1kHz$)
- Line Regulation (Fast Mode)..... Typ. 0.02%/V
- Output Voltage Accuracy (Fast Mode) $\pm 1.0\%$
- Output Voltage Accuracy (Low Power Mode) $\pm 1.2\%$
- Temperature-drift Coefficient of Output Voltage.... Typ. $\pm 100ppm/^{\circ}C$
- Package DFN(PLP)2020-8
- Built-in fold-back protection circuit Typ. 50mA (Current at short mode)
- Ceramic Capacitor is recommended. 1.0 μ F
- Built-in chip enable circuit (A/B: active high)
(Depending on V_{IN} and set V_{OUT} . Refer to the electrical characteristics table.)

APPLICATIONS

- Power source for handheld communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS



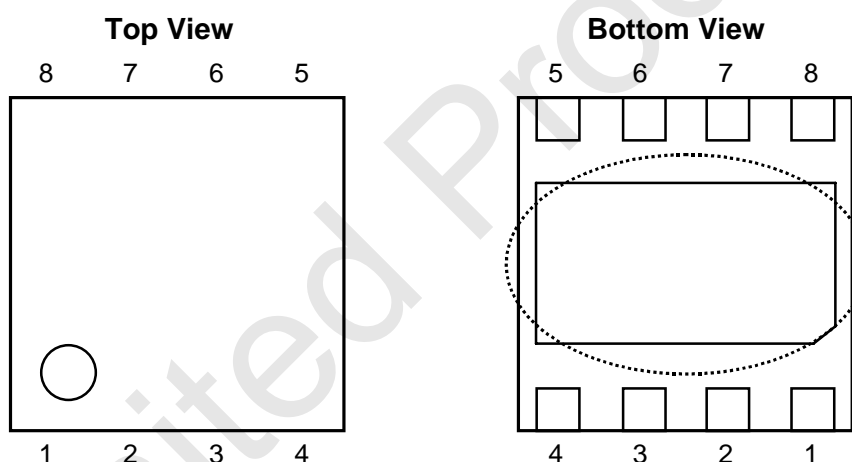
SELECTION GUIDE

The output voltage, auto discharge function, etc. for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5328Kxxx*-TR	DFN(PLP)2020-8	5,000 pcs	Yes	Yes
xxx : The combination of output voltage for each channel can be designated by serial numbers. (from 001) The output voltage for each channel can be set in the range from 0.8V to 4.0V in 0.1V steps. (For details, please refer to MARK INFORMATION.)				
* : The auto discharge function at off state are options as follows. (A) without auto discharge function at off state (B) with auto discharge function at off state				

PIN CONFIGURATION

• DFN(PLP)2020-8



PIN DESCRIPTIONS

• DFN(PLP)2020-8

Pin No.	Symbol	Description
1	GND	Ground Pin
2	V _{OUT1}	Output Pin 1
3	V _{DD}	Input Pin
4	V _{OUT2}	Output Pin 2
5	CE2	Chip Enable Pin 2 ("H" Active)
6	ECO2	Low Power/ Fast Mode Changer Pin2
7	ECO1	Low Power/ Fast Mode Changer Pin1
8	CE1	Chip Enable Pin 1 ("H" Active)

*) Tab is GND level. (They are connected to the reverse side of this IC.)

The tab is better to be connected to the GND, but leaving it open is also acceptable.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
V_{CE1}, V_{CE2} V_{ECO1}, V_{ECO2}	Input Voltage (CE/ECO Pin)	-0.3 to 6.5	V
V_{OUT1}, V_{OUT2}	Output Voltage	-0.3 to $V_{IN}+0.3$	V
I_{OUT1}, I_{OUT2}	Output Current	160	mA
P_D	Power Dissipation (DFN(PLP)2020-8)*	880	mW
T_{opt}	Operating Temperature Range	-40 to 85	°C
T_{stg}	Storage Temperature Range	-55 to 125	°C

*) For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field.

The functional operation at or over these absolute maximum ratings is not assured.

ELECTRICAL CHARACTERISTICS

• R5328KxxxA/B

VR1/VR2

T_{opt}=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit	
V _{OUT}	Output Voltage (Fast Mode)	V _{IN} -V _{OUT} =1.0V I _{OUT} =1mA V _{ECO} =V _{IN}	V _{OUT} >1.5V	×0.99		×1.01	V
			V _{OUT} ≤ 1.5V	-15		+15	mV
	Output Voltage (Low Power Mode)	V _{IN} -V _{OUT} =1.0V I _{OUT} =1mA V _{ECO} =GND	V _{OUT} >1.5V	×0.988		×1.012	V
			V _{OUT} ≤ 1.5V	-18		+18	mV
I _{OUT}	Output Current	V _{IN} -V _{OUT} =1.0V	150			mA	
ΔV _{OUT} / ΔI _{OUT}	Load Regulation (Fast Mode)	V _{IN} -V _{OUT} =1.0V, V _{ECO} =V _{IN} 1mA ≤ I _{OUT} ≤ 150mA		20	40	mV	
	Load Regulation (Low Power Mode)	V _{IN} -V _{OUT} =1.0V, V _{ECO} =GND 1mA ≤ I _{OUT} ≤ 150mA		25	45	mV	
V _{DIF}	Dropout Voltage	Refer to the following table					
I _{SS1}	Supply Current (Fast Mode)	V _{IN} -V _{OUT} =1.0V, V _{ECO} =V _{IN}	V _{OUT} <2.0V		75	95	μA
			V _{OUT} ≥ 2.0V		65	95	
I _{SS2}	Supply Current (Low Power Mode)	V _{IN} -V _{OUT} =1.0V, V _{ECO} =GND, Except CE pull-down current	V _{OUT} <2.0V		2	4	μA
			V _{OUT} ≥ 2.0V		2.5	4	
I _{standby}	Standby Current	V _{IN} =6.0V, V _{CE} =GND		0.1	1	μA	
ΔV _{OUT} / ΔV _{IN}	Line Regulation (Fast Mode)	I _{OUT} =1mA V _{OUT} +0.5V ≤ V _{IN} ≤ 6V	V _{ECO} =V _{IN}		0.02	0.1	%V
	Line Regulation (Low Power Mode)	If V _{OUT} ≤ 0.9V: 1.5V ≤ V _{IN} ≤ 6V	V _{ECO} =GND		0.1	0.2	
RR	Ripple Rejection (Fast Mode)	f=1kHz, Ripple 0.2Vp-p, V _{IN} -V _{OUT} =1.0V, I _{OUT} =30mA V _{ECO} =V _{IN}		70		dB	
V _{IN}	Input Voltage		1.4		6.0	V	
ΔV _{OUT} / ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =1mA, -40°C ≤ T _{opt} ≤ 85°C		±100		ppm/ °C	
I _{SC}	Short Current Limit	V _{OUT} =0V		50		mA	
I _{PD}	CE Pull-down Constant Current			0.3	0.8	μA	
R _{PDE}	ECO Pull-down Resistance		2.4	5	15	MΩ	
V _{CEH} , V _{ECOH}	CE, ECO Input Voltage "H"		1		6	V	
V _{CEL} , V _{ECOL}	CE, ECO Input Voltage "L"		0		0.4	V	
en	Output Noise	BW=10Hz to 100kHz		30		μVrms	
R _{LOW}	Low Output Nch Tr. ON Resistance (of B version)	V _{CE} =0V		50		Ω	

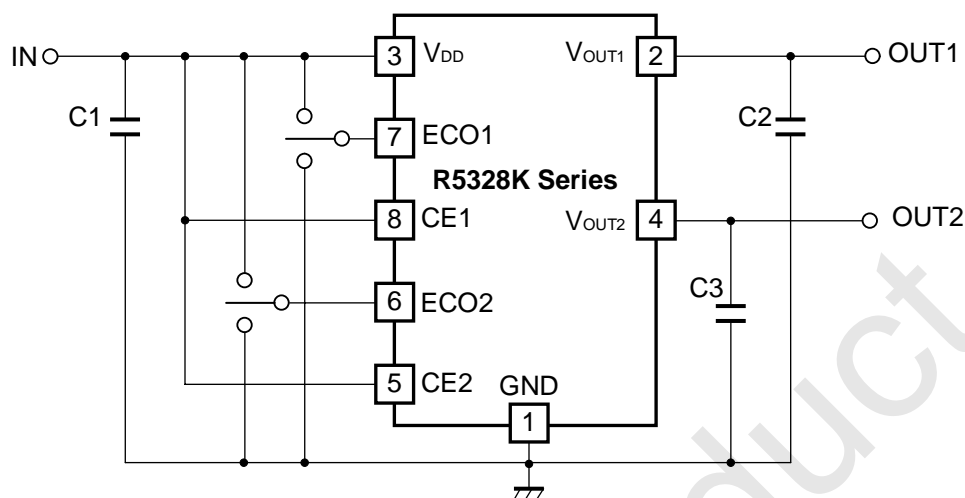
• Dropout Voltage by Output Voltage

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (mV)				
	Condition	ECO="H"		ECO="L"	
		Typ.	Max.	Typ.	Max.
$0.8V \leq V_{OUT} < 0.9V$	$I_{OUT}=150mA$	755	1100	795	1100
$0.9V \leq V_{OUT} < 1.0V$		675	950	715	960
$1.0V \leq V_{OUT} < 1.2V$		600	890	645	930
$1.2V \leq V_{OUT} < 1.5V$		490	730	520	770
$1.5V \leq V_{OUT} < 2.0V$		395	610	415	640
$2.0V \leq V_{OUT} < 2.8V$		310	440	315	445
$2.8V \leq V_{OUT} \leq 4.0V$		250	350	255	350

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

TYPICAL APPLICATION



(External Components)

1.0 μ F	CM05X5R105K06AB	(Kyocera)
	C1005JB0J105K	(TDK)
	GRM155B30J105KE18B	(Murata)

TECHNICAL NOTES

When using these ICs, consider the following points:

Phase Compensation

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 and C3 with good frequency characteristics and ESR (Equivalent Series Resistance).

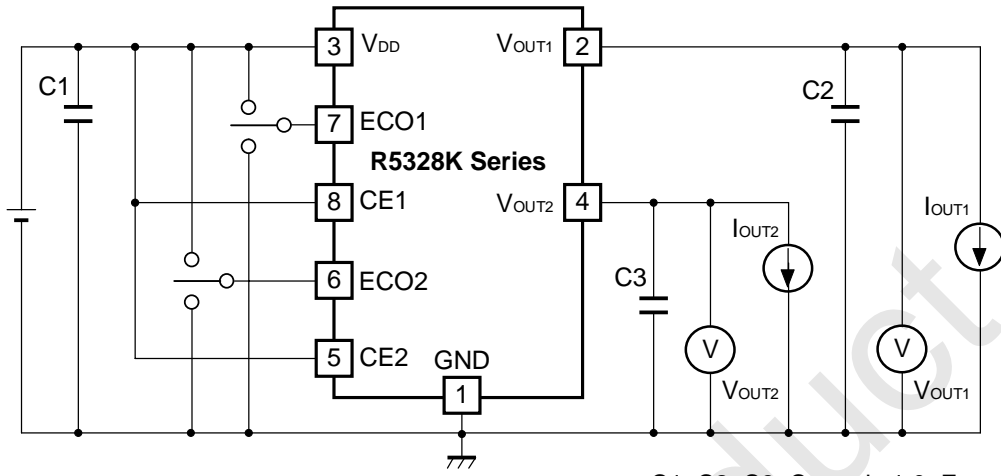
(Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 1.0 μ F or more between V_{DD} and GND pin, and as close as possible to the pins.

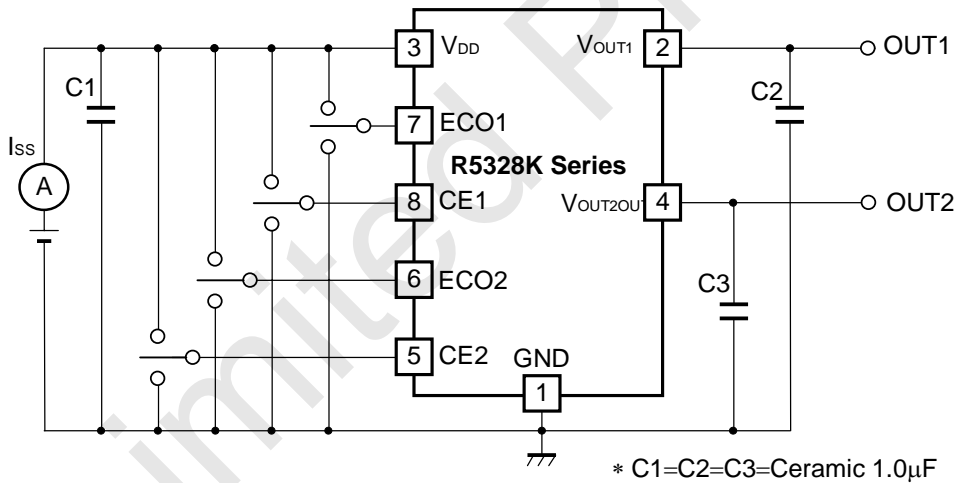
Set external components, especially the output capacitor C2 and C3, as close as possible to the ICs, and make wiring as short as possible.

TEST CIRCUITS



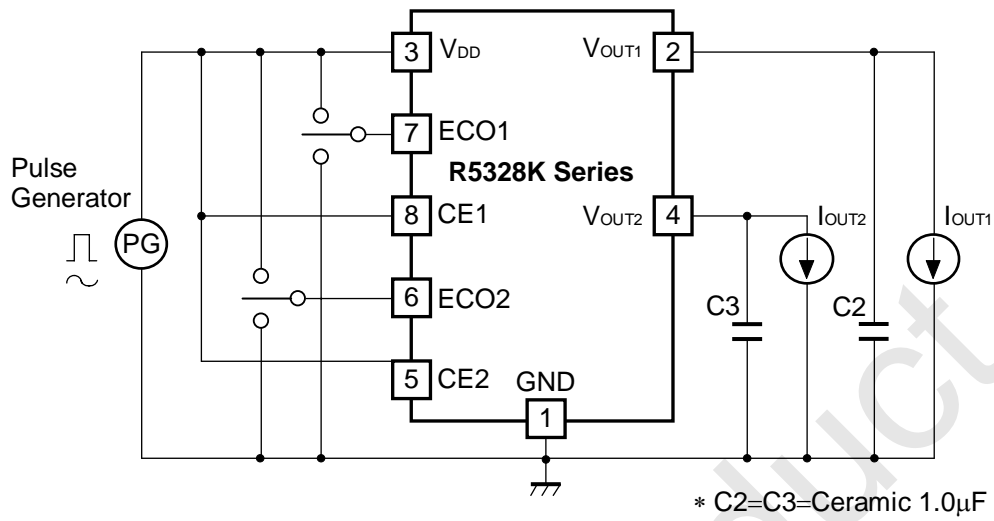
* C1=C2=C3=Ceramic 1.0 μ F

Standard test Circuit

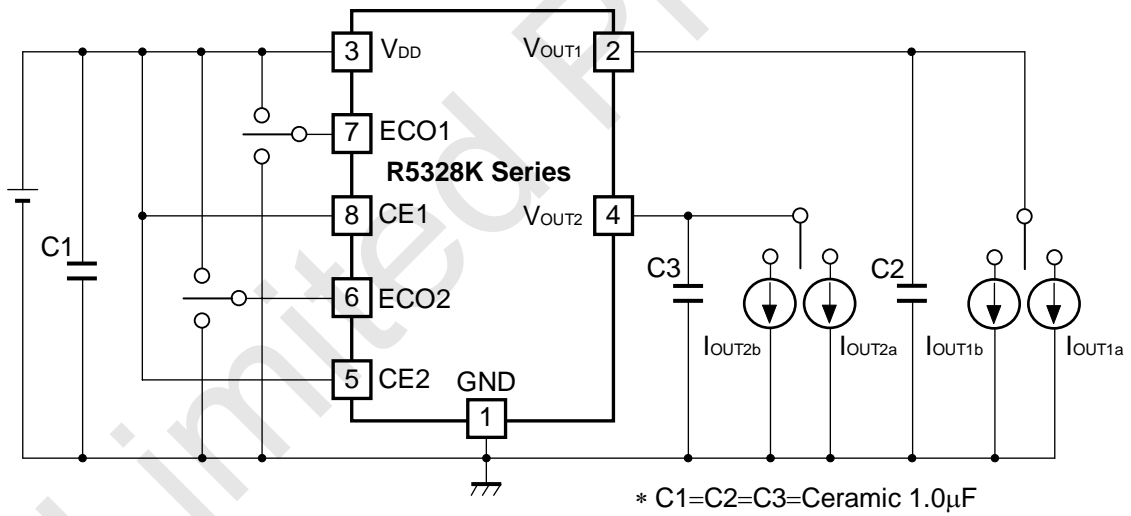


* C1=C2=C3=Ceramic 1.0 μ F

Supply Current Test Circuit



Ripple Rejection, Line Transient Response Test Circuit

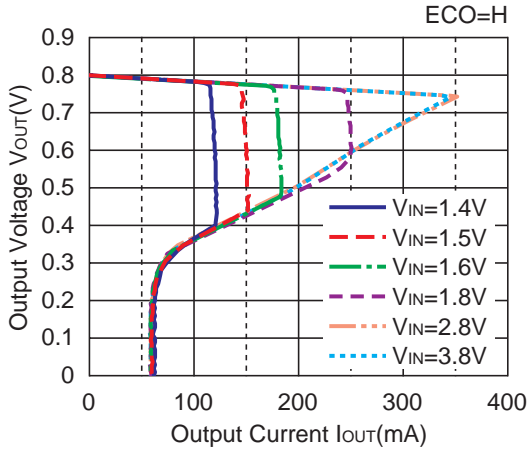


Load Transient Response Test Circuit

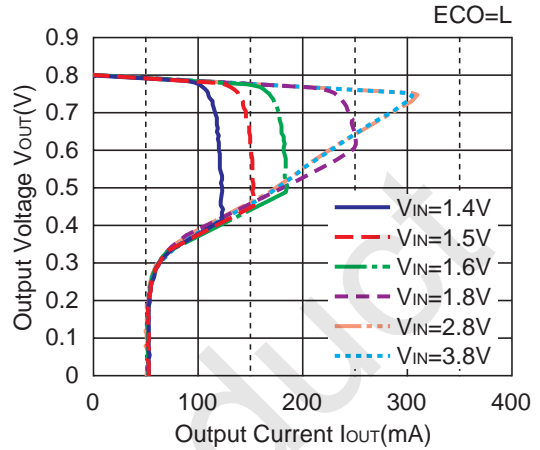
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (Topt=25°C)

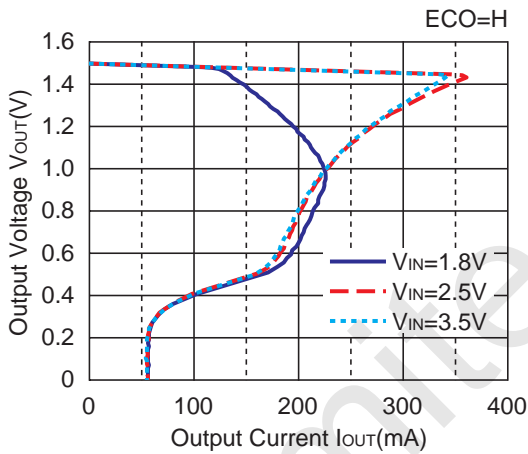
0.8 V(VR1/VR2)



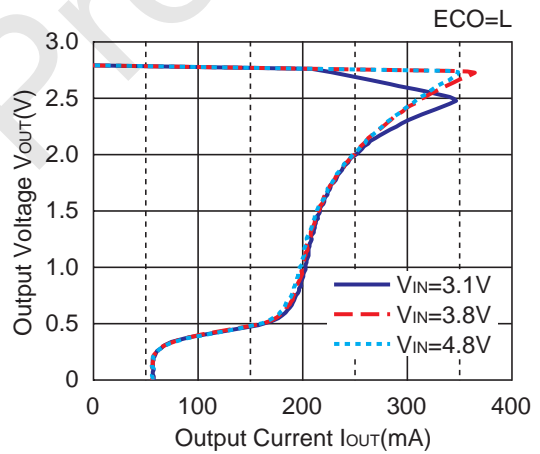
0.8V (VR1/VR2)



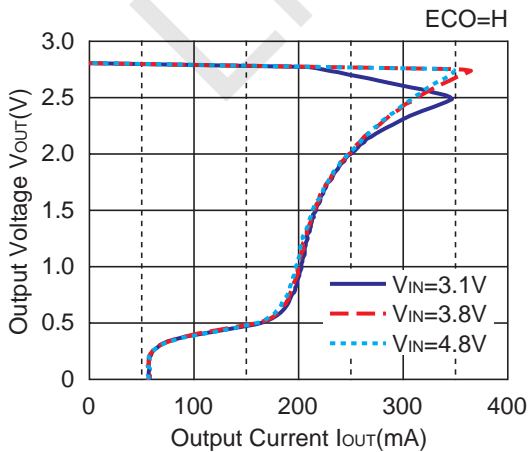
1.5V (VR1/VR2)



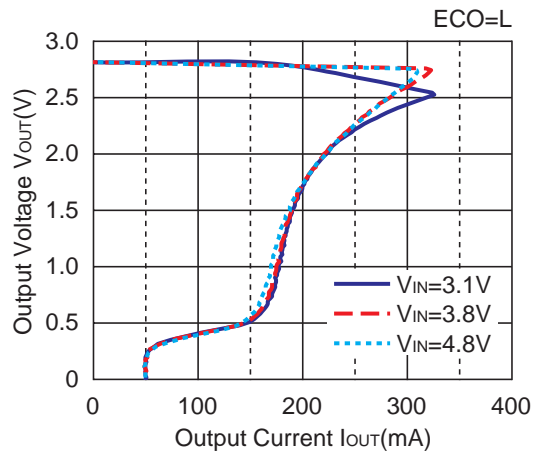
1.5V (VR1/VR2)



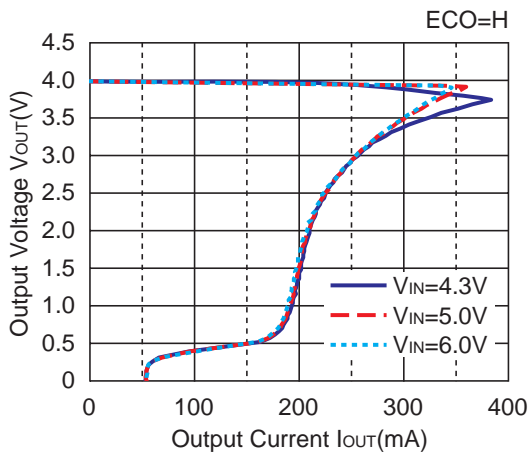
2.8V (VR1/VR2)



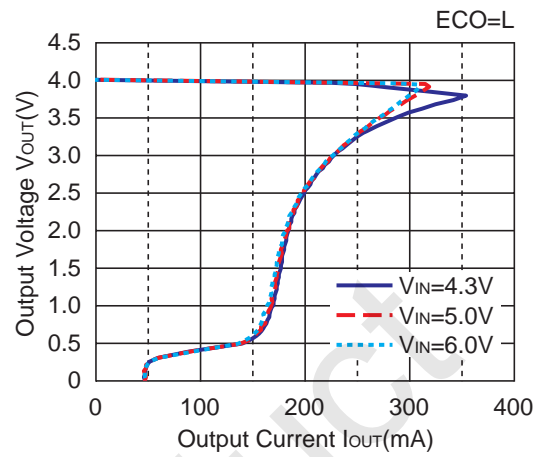
2.8V (VR1/VR2)



4.0V (VR1/VR2)

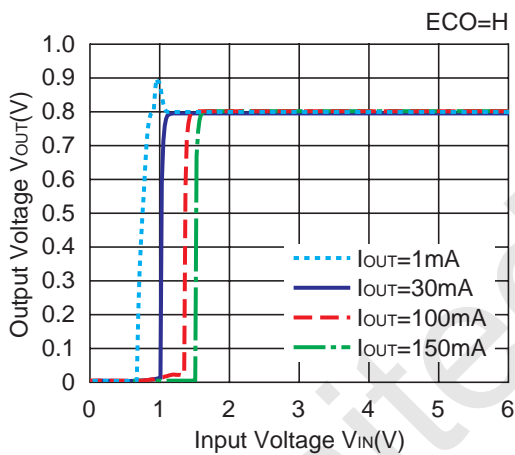


4.0V (VR1/VR2)

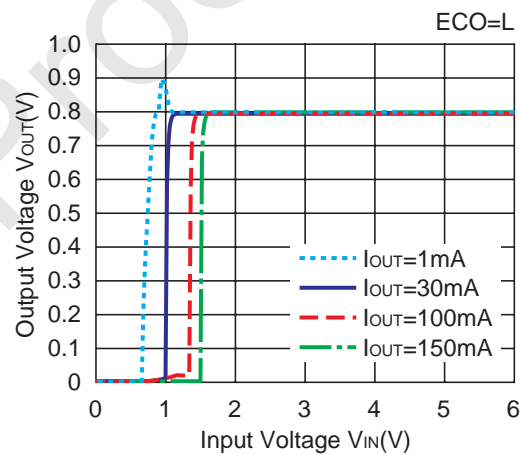


2) Output Voltage vs. Input Voltage ($T_{opt}=25^{\circ}C$)

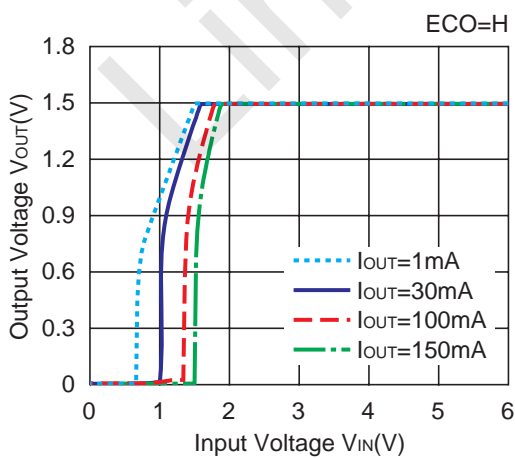
0.8V (VR1/VR2)



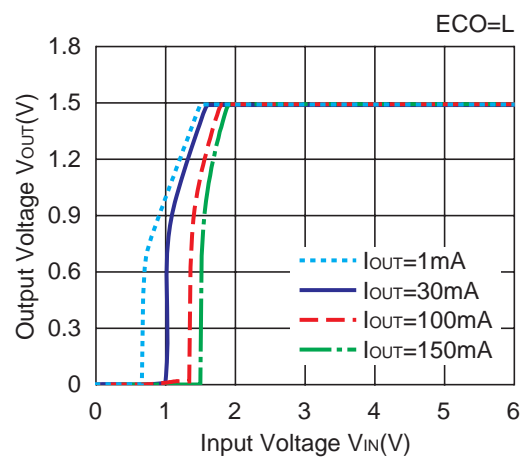
0.8V (VR1/VR2)

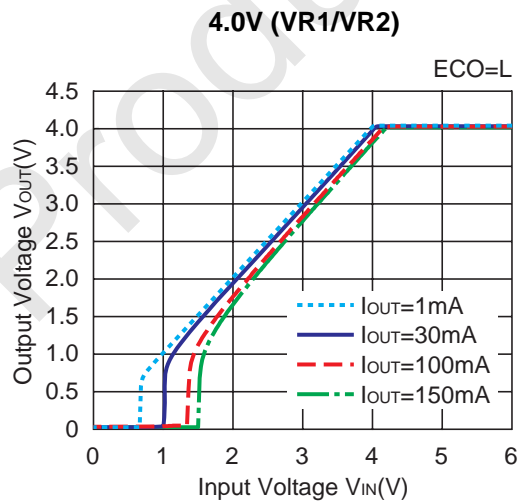
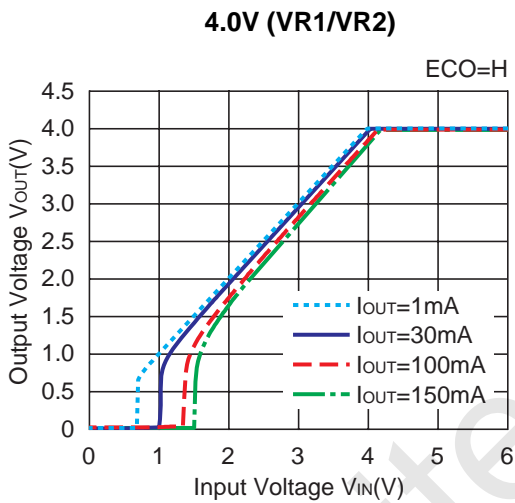
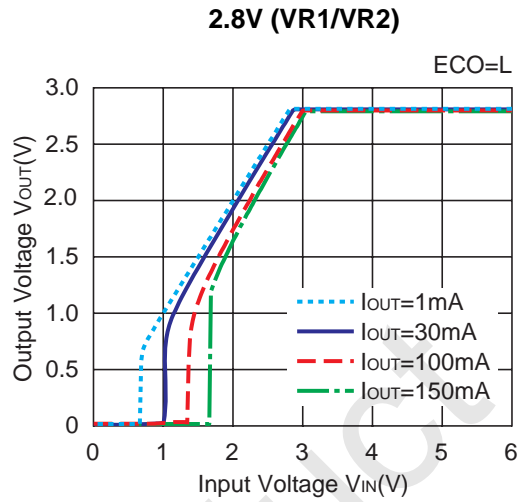
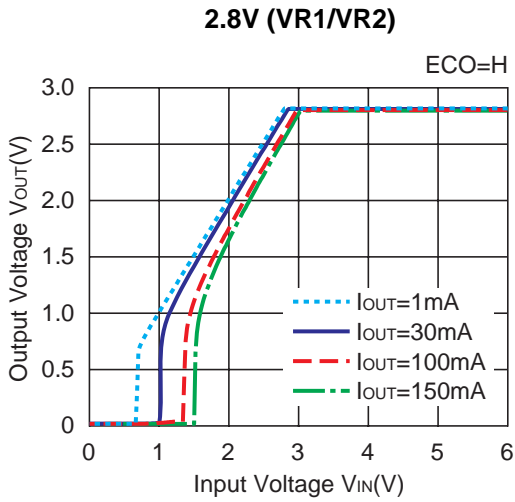


1.5V (VR1/VR2)

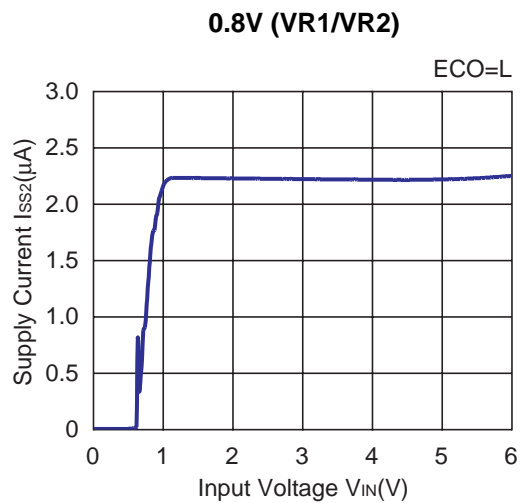
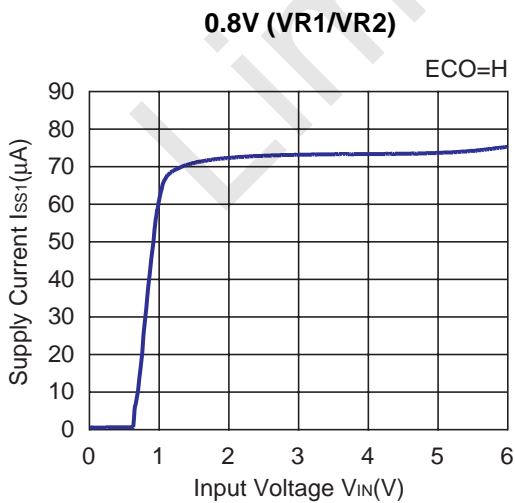


1.5V (VR1/VR2)

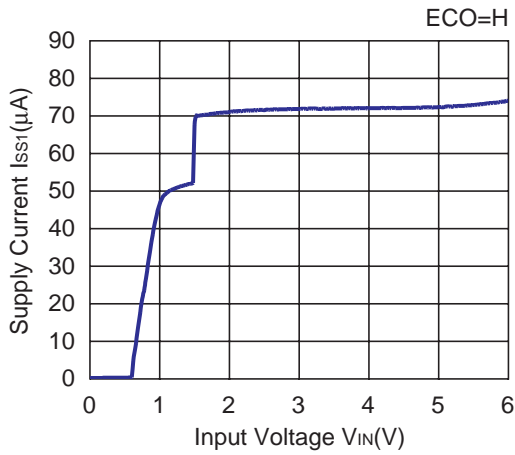




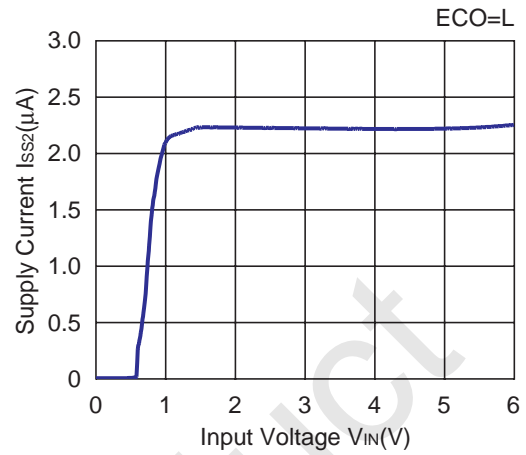
3) Supply Current vs. Input Voltage ($T_{opt}=25^{\circ}C$)



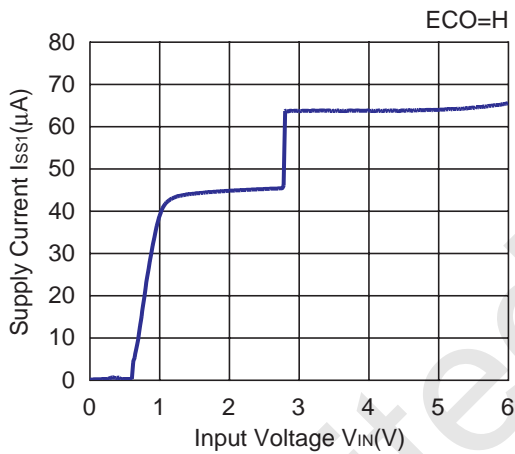
1.5V (VR1/VR2)



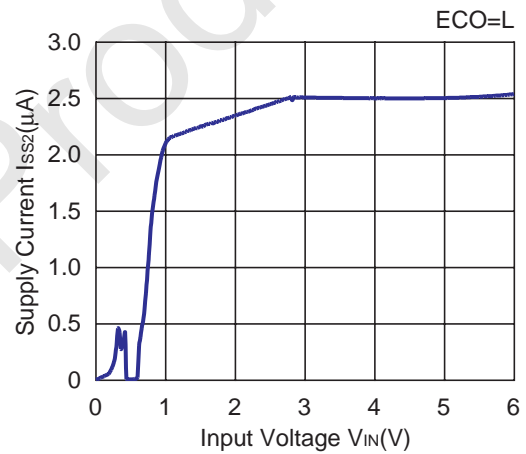
1.5V (VR1/VR2)



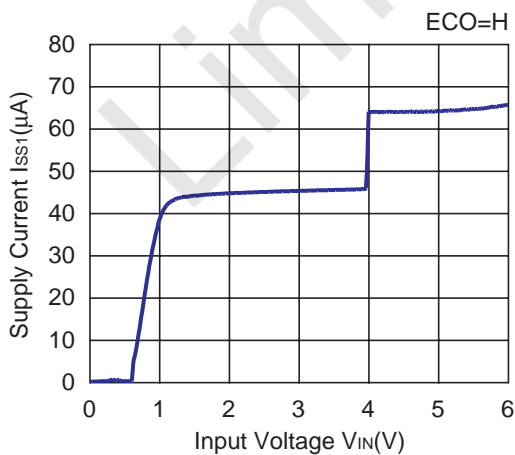
2.8V (VR1/VR2)



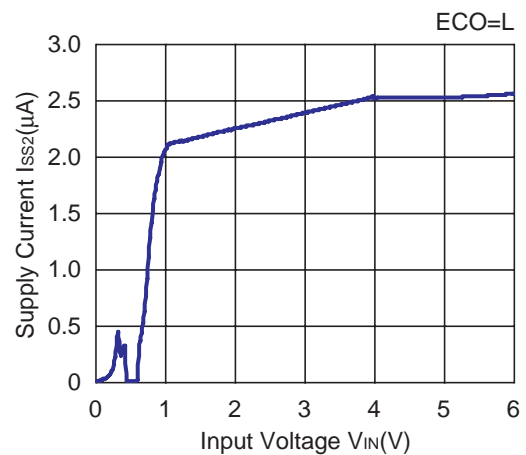
2.8V (VR1/VR2)



4.0V (VR1/VR2)

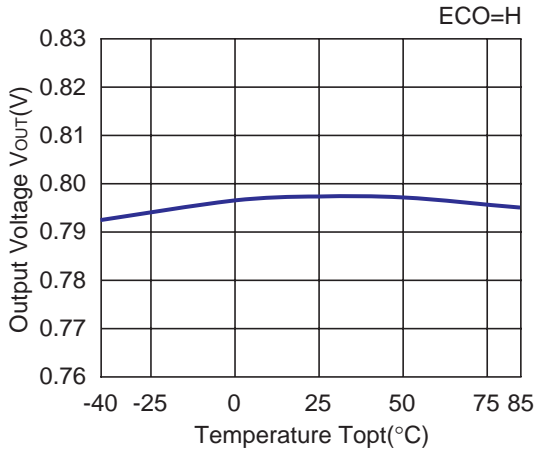


4.0V (VR1/VR2)

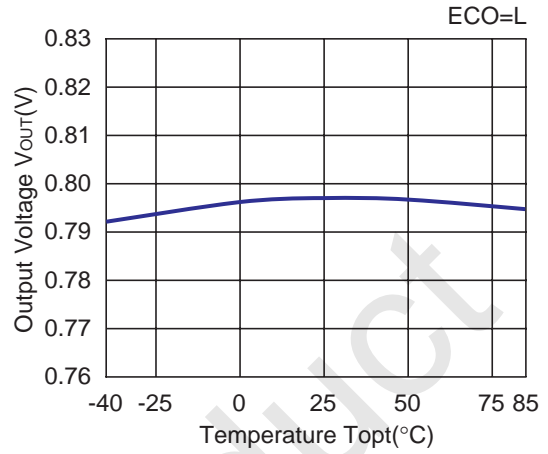


4) Output Voltage vs. Temperature

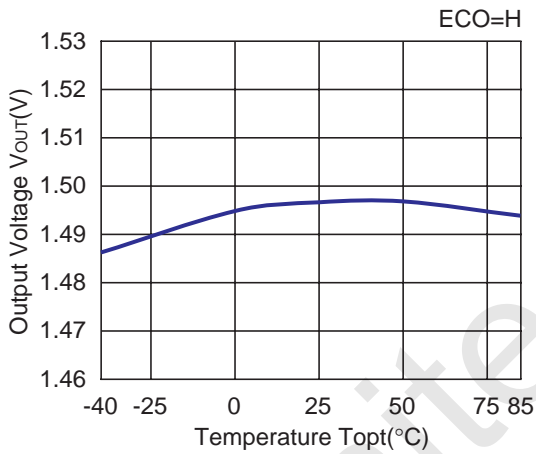
0.8V (VR1/VR2)



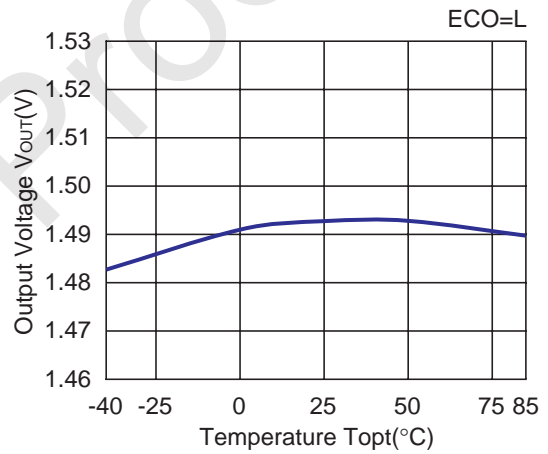
0.8V (VR1/VR2)



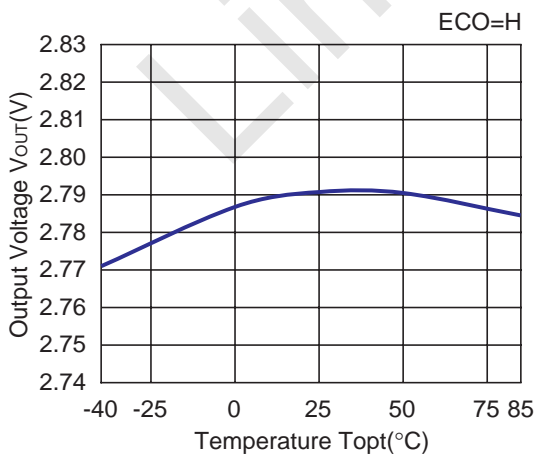
1.5V (VR1/VR2)



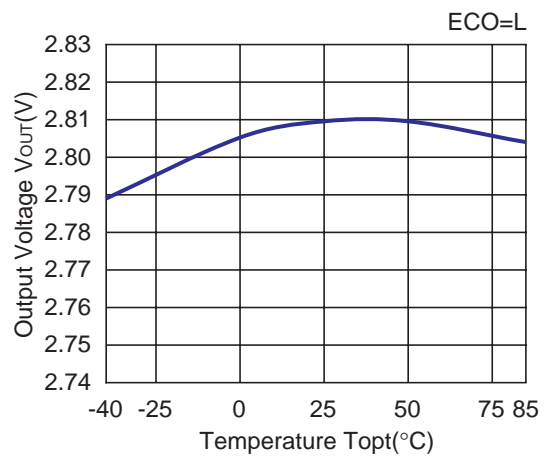
1.5V (VR1/VR2)



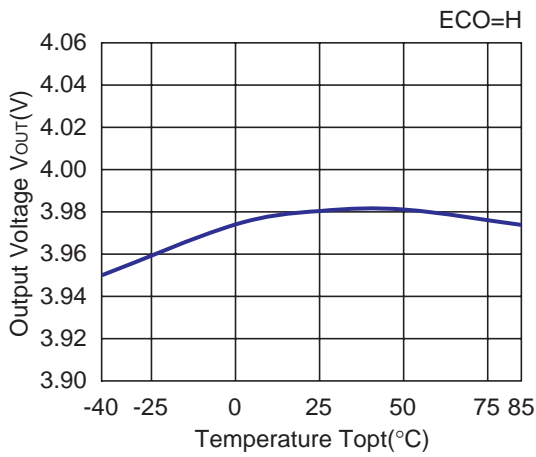
2.8V (VR1/VR2)



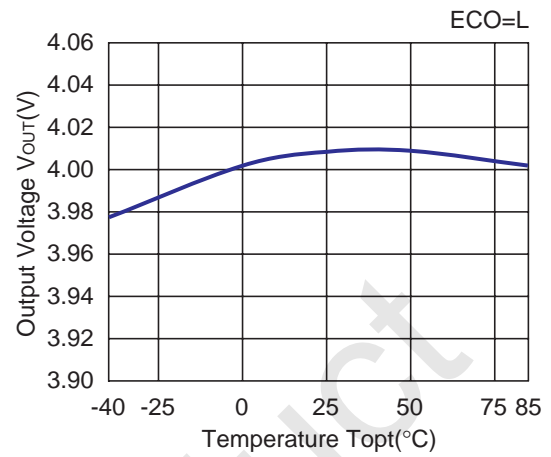
2.8V (VR1/VR2)



4.0V (VR1/VR2)

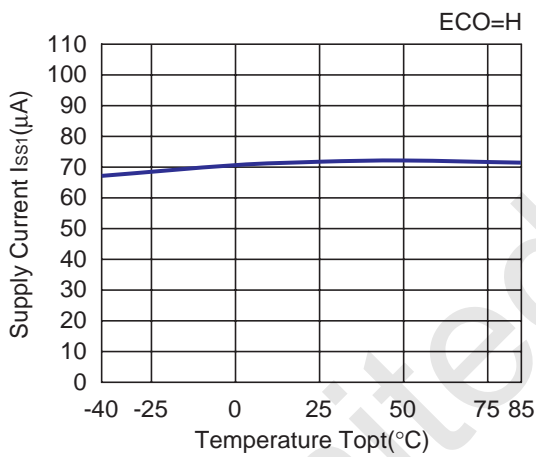


4.0V (VR1/VR2)

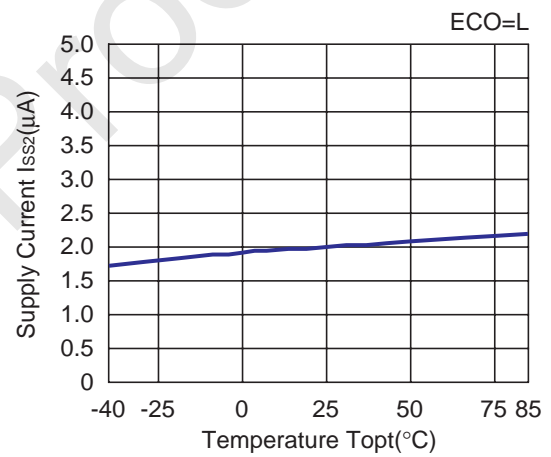


5) Supply Current vs. Temperature

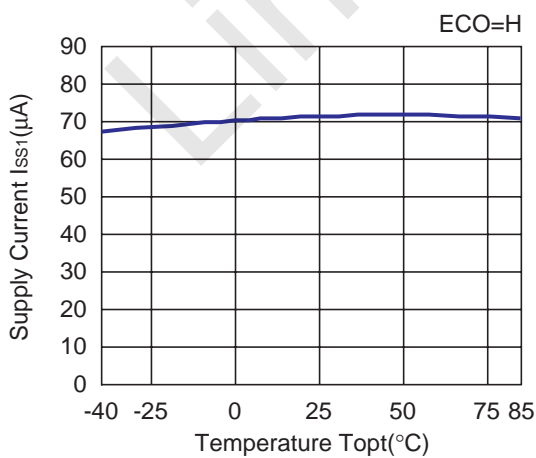
0.8V (VR1/VR2)



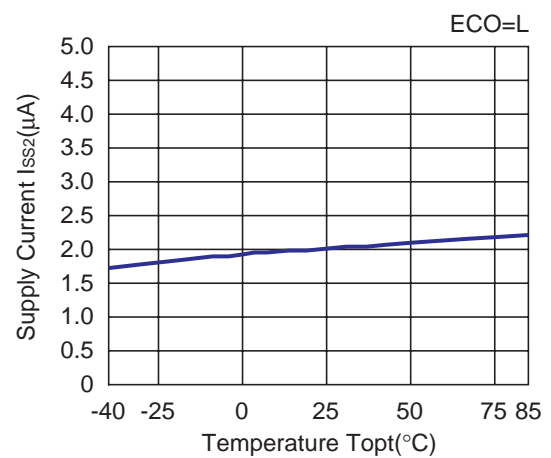
0.8V (VR1/VR2)



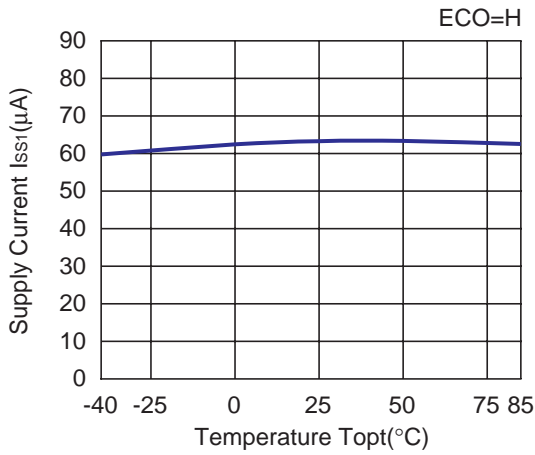
1.5V (VR1/VR2)



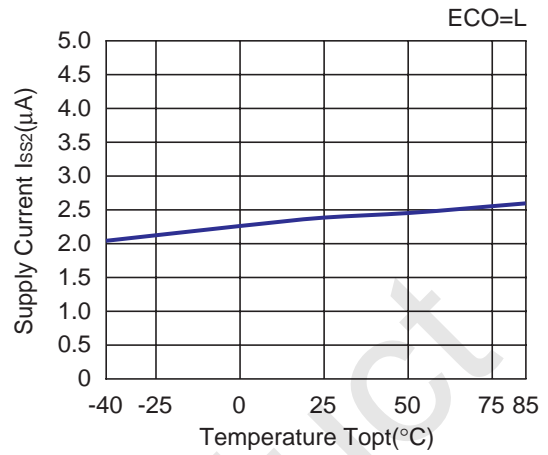
1.5V (VR1/VR2)



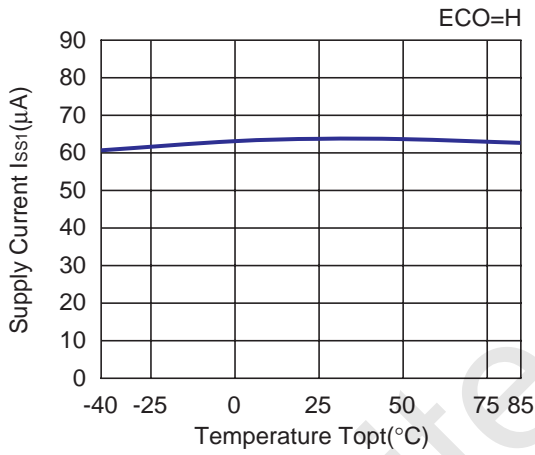
2.8V (VR1/VR2)



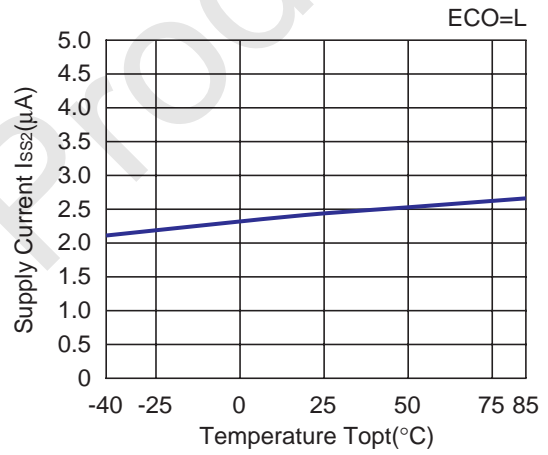
2.8V (VR1/VR2)



4.0V (VR1/VR2)

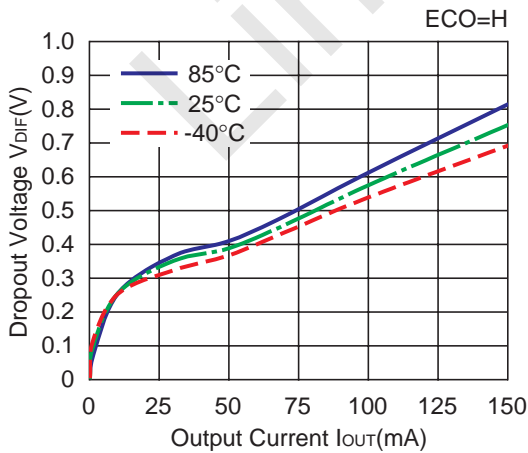


4.0V (VR1/VR2)

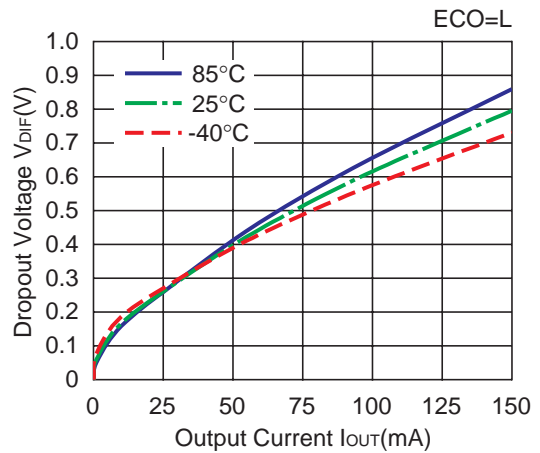


6) Dropout Voltage vs. Output Current

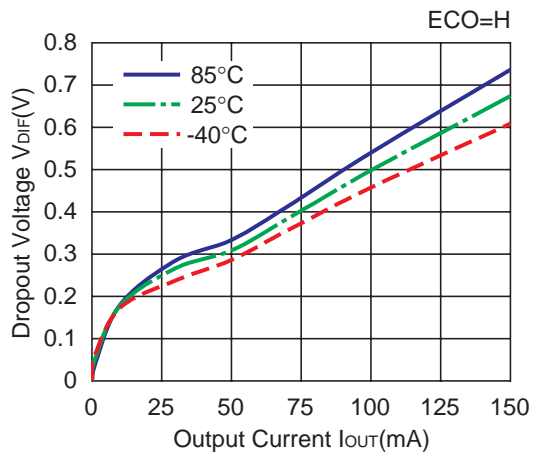
0.8V (VR1/VR2)



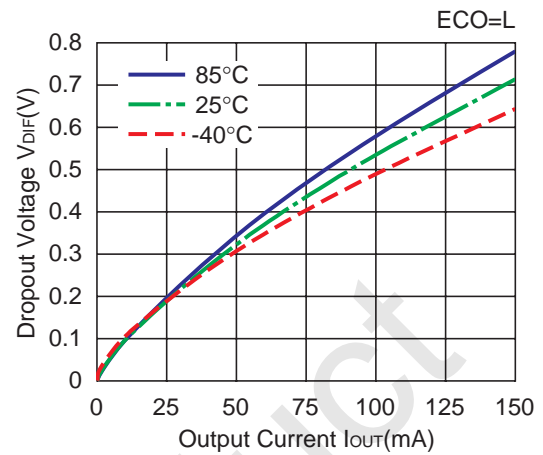
0.8V (VR1/VR2)



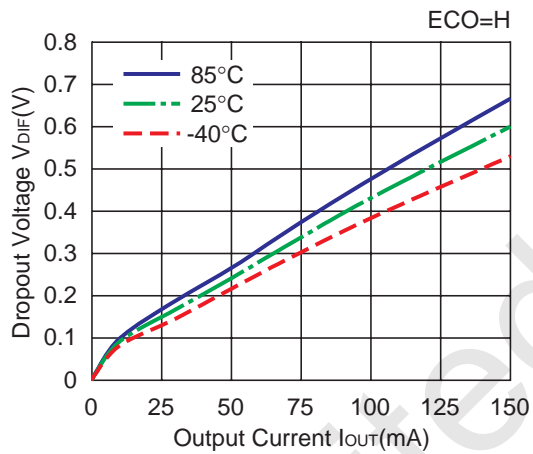
0.9V (VR1/VR2)



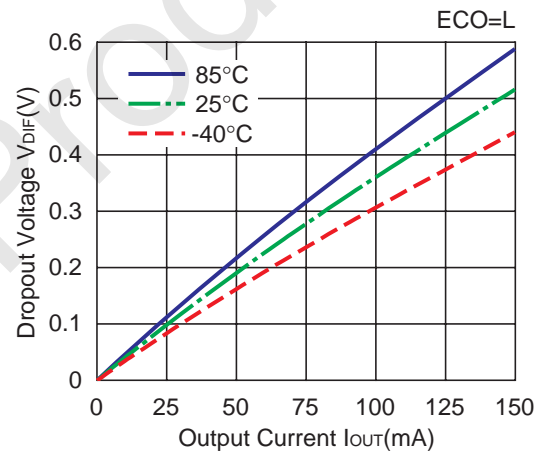
0.9V (VR1/VR2)



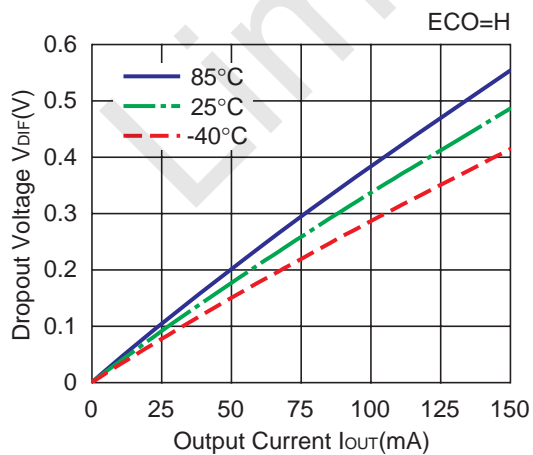
1.0V (VR1/VR2)



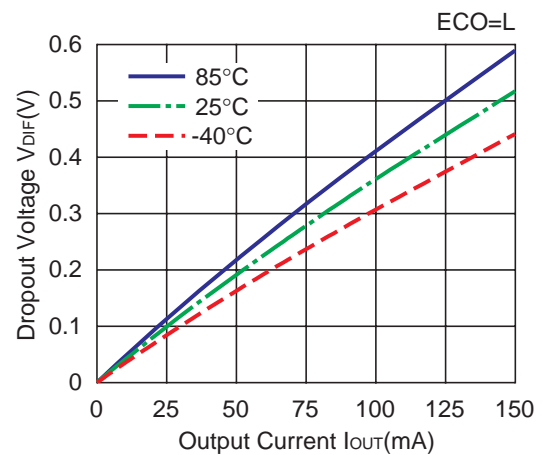
1.0V (VR1/VR2)



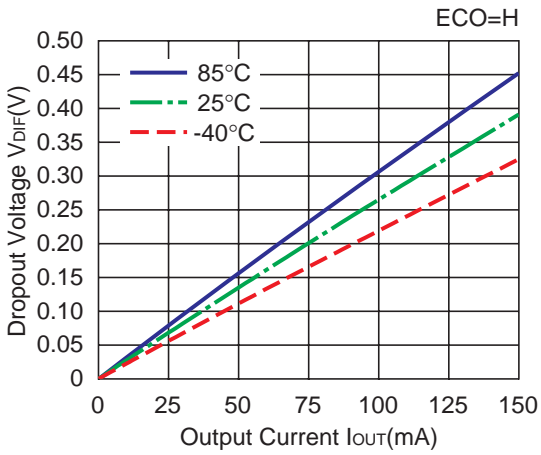
1.2V (VR1/VR2)



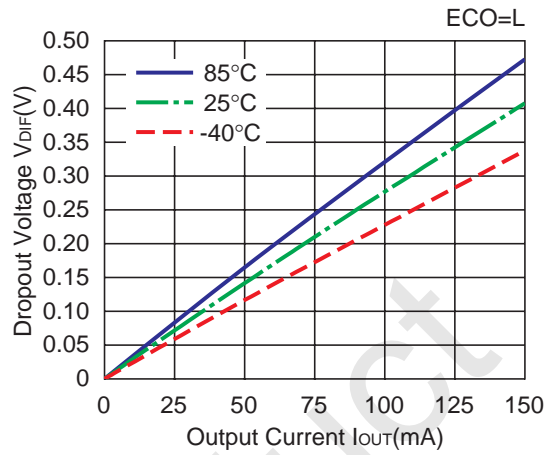
1.2V (VR1/VR2)



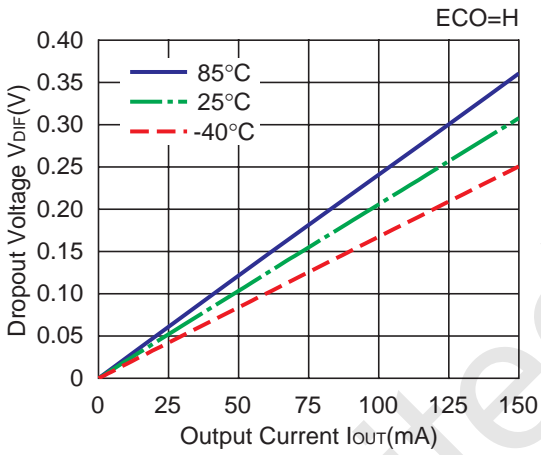
1.5V (VR1/VR2)



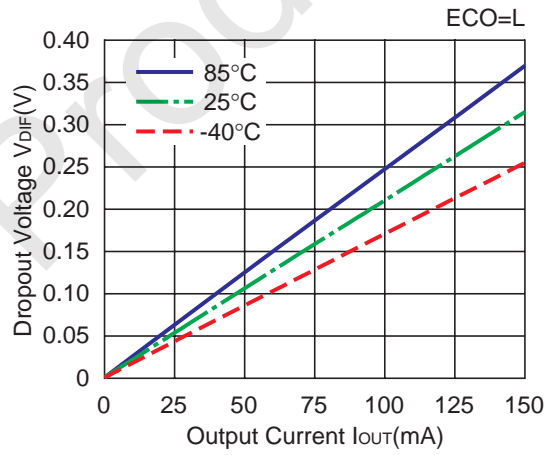
1.5V (VR1/VR2)



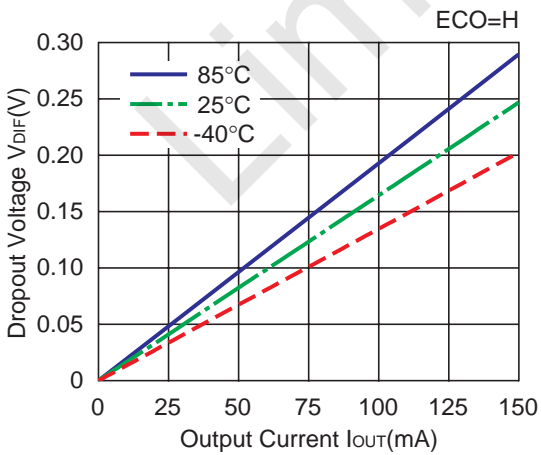
2.0V (VR1/VR2)



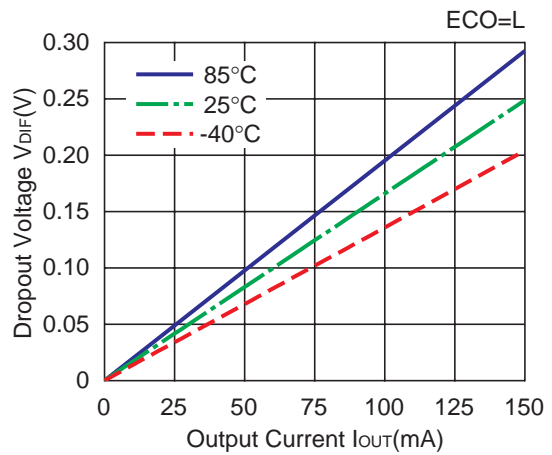
2.0V (VR1/VR2)



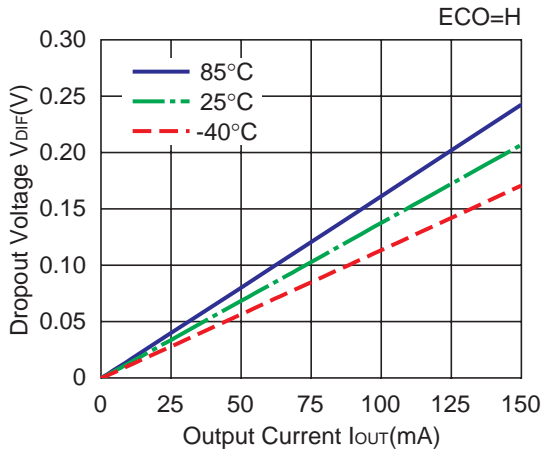
2.8V (VR1/VR2)



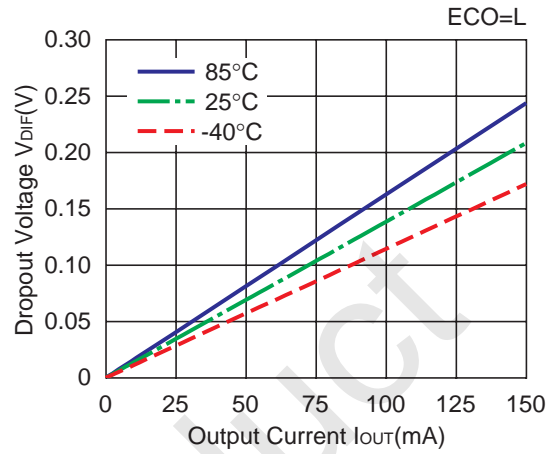
2.8V (VR1/VR2)



4.0V (VR1/VR2)

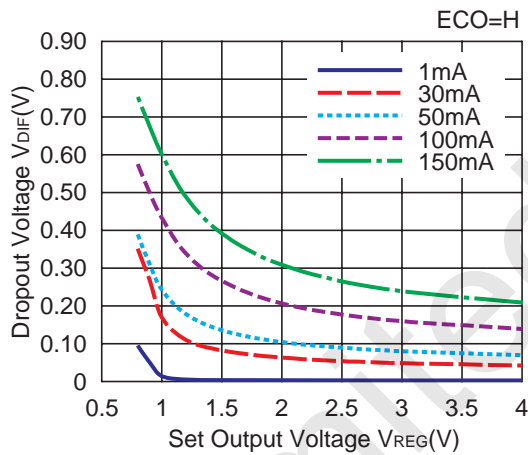


4.0V (VR1/VR2)

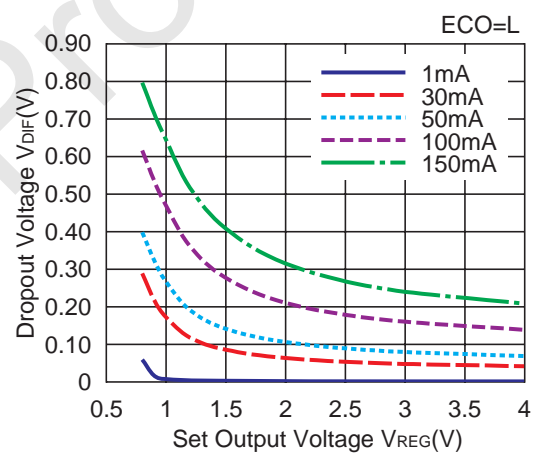


7) Dropout Voltage vs. Set Output Voltage (T_{opt}=25°C)

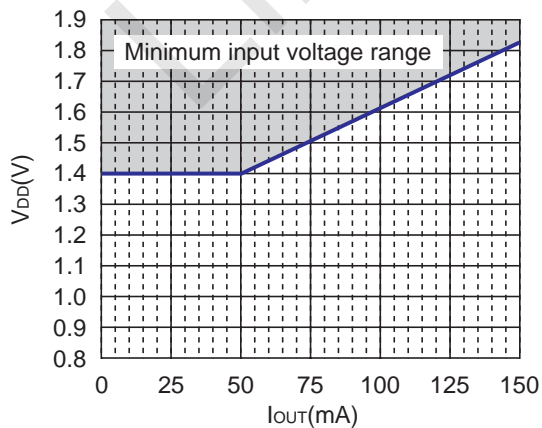
R5328K (VR1/VR2)



R5328K (VR1/VR2)

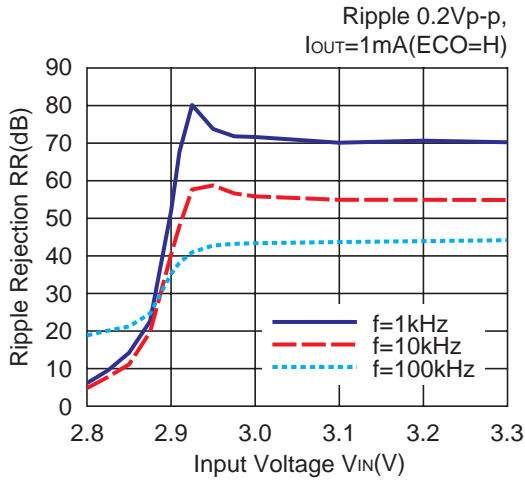


8) 0.8V (VR1/VR2) type minimum input voltage limit (T_{opt}=25°C)

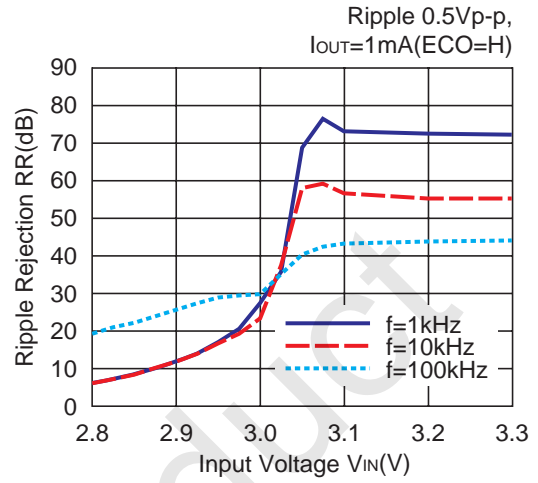


9) Ripple Rejection vs. Input Bias Voltage (T_{opt}=25°C, C_{IN}=none, C_{OUT}=Ceramic 1.0μF, ECO=H)

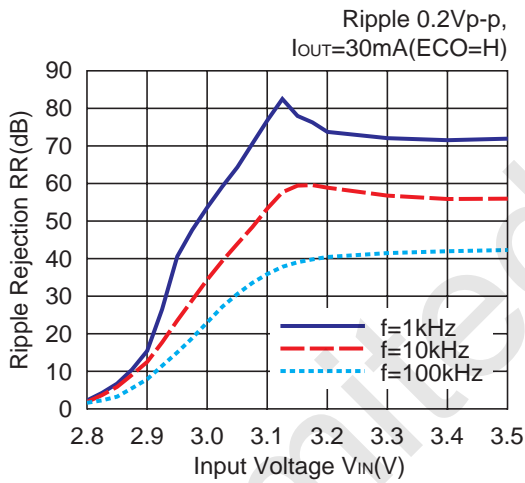
2.8V (VR1/VR2)



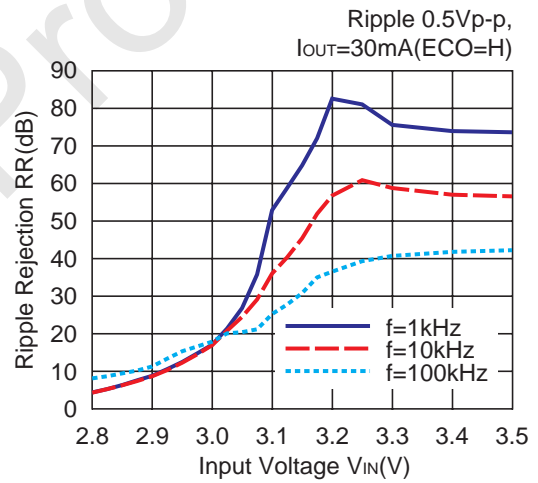
2.8V (VR1/VR2)



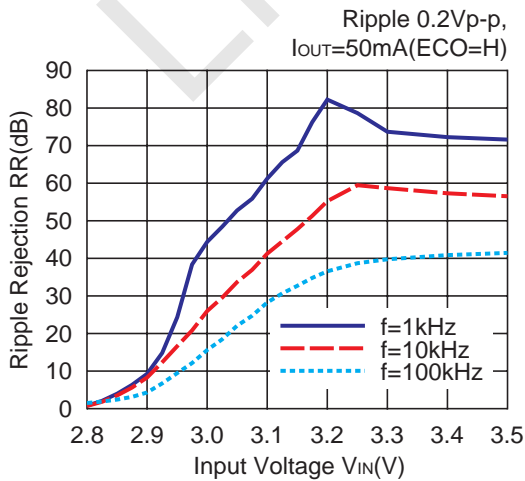
2.8V (VR1/VR2)



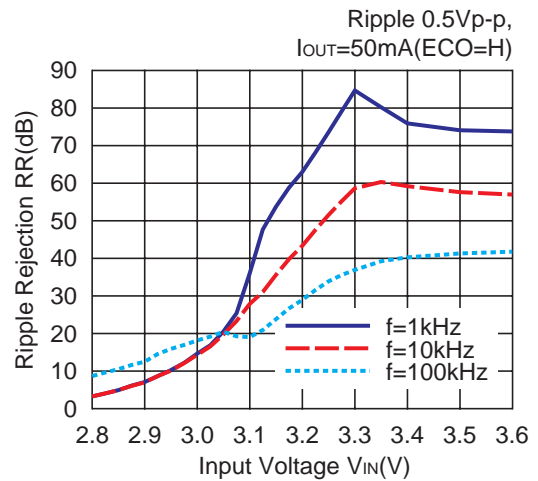
2.8V (VR1/VR2)



2.8V (VR1/VR2)

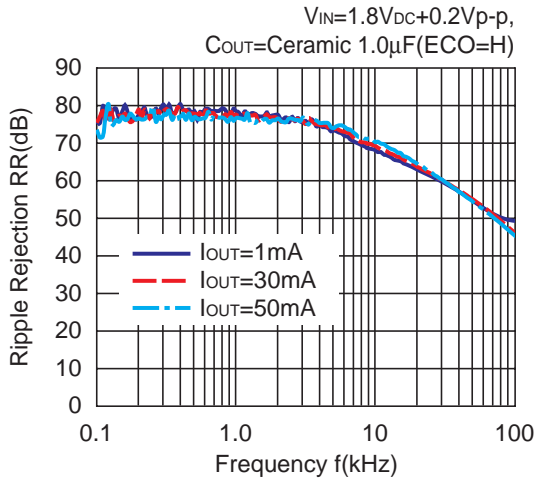


2.8V (VR1/VR2)

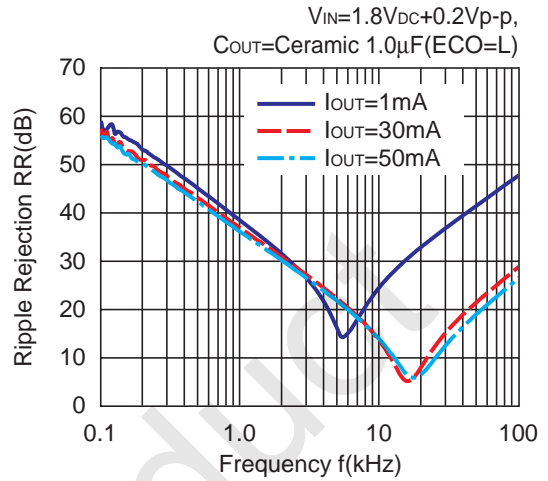


10) Ripple Rejection vs. Frequency (Topt=25°C, Cin=none)

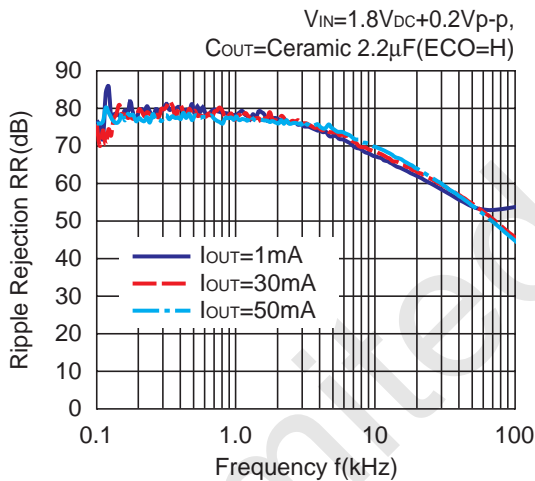
0.8V (VR1/VR2)



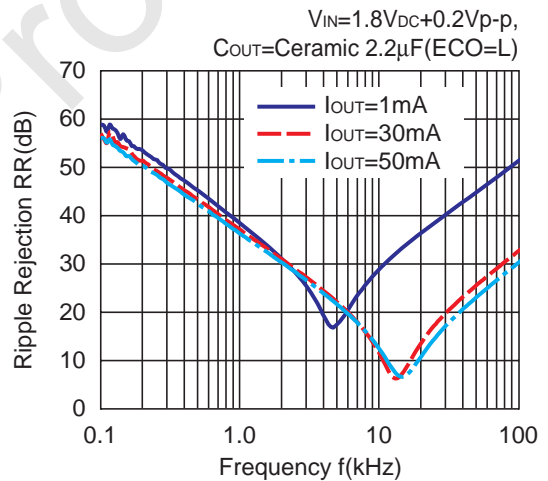
0.8V (VR1/VR2)



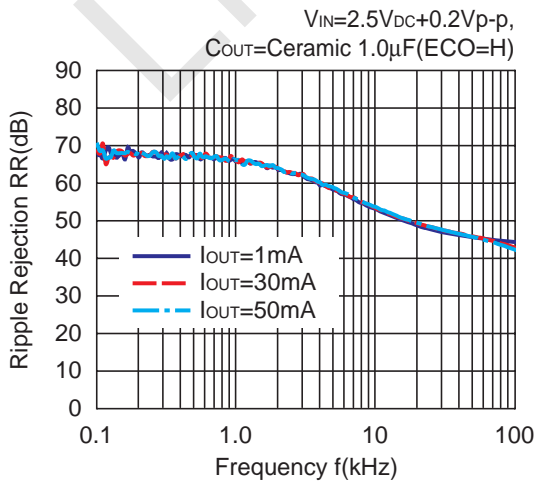
0.8V (VR1/VR2)



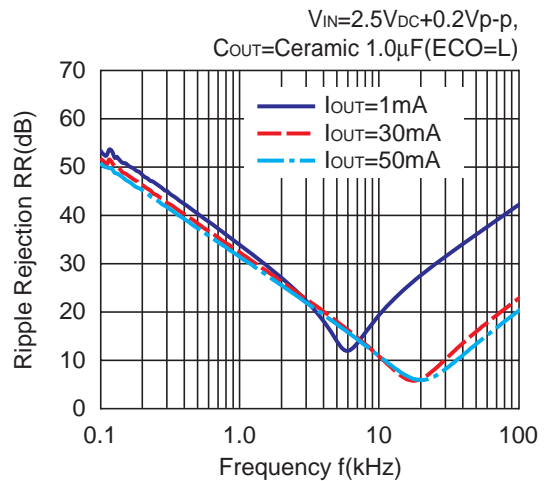
0.8V (VR1/VR2)



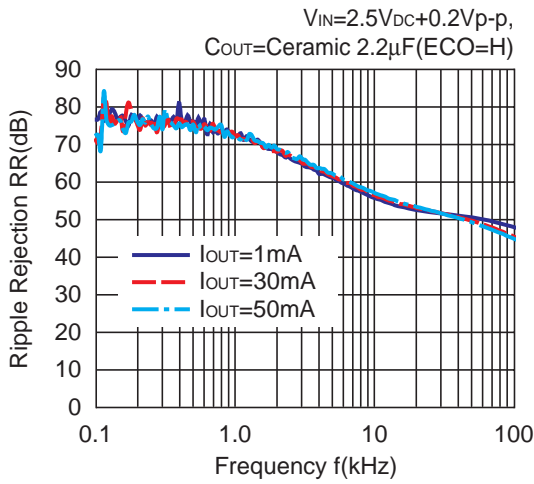
1.5V (VR1/VR2)



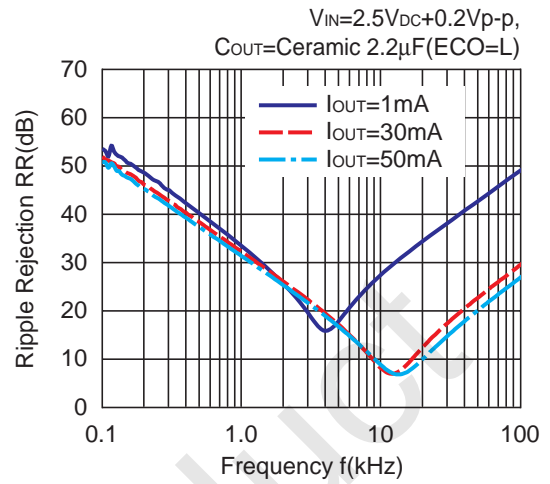
1.5V (VR1/VR2)



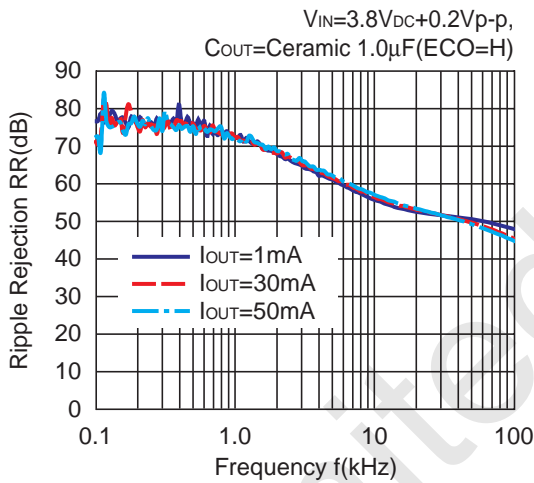
1.5V (VR1/VR2)



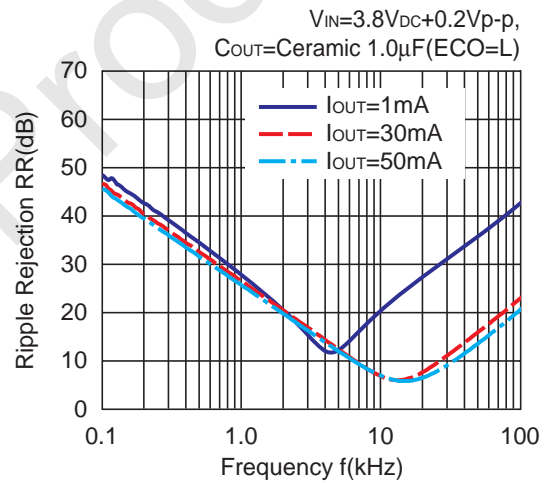
1.5V (VR1/VR2)



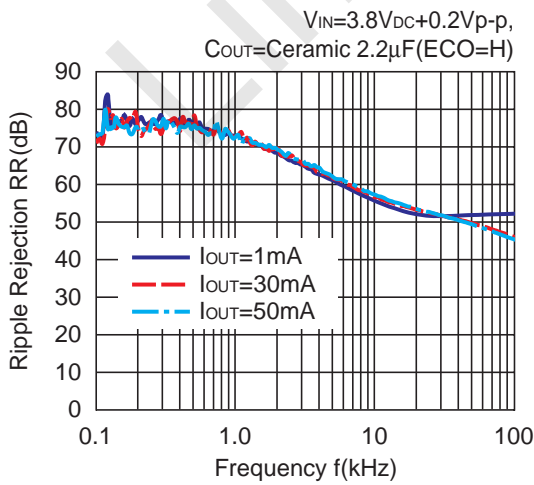
2.8V (VR1/VR2)



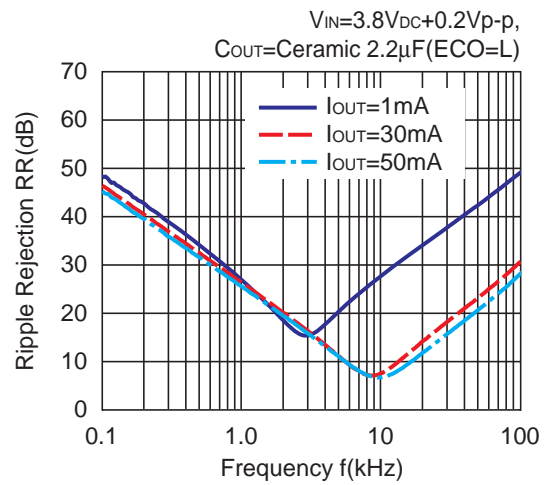
2.8V (VR1/VR2)



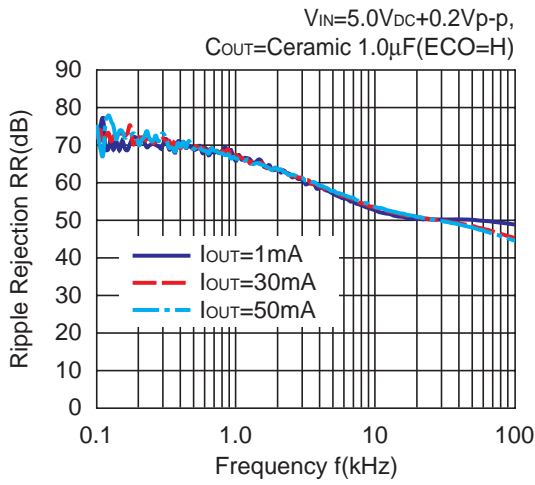
2.8V (VR1/VR2)



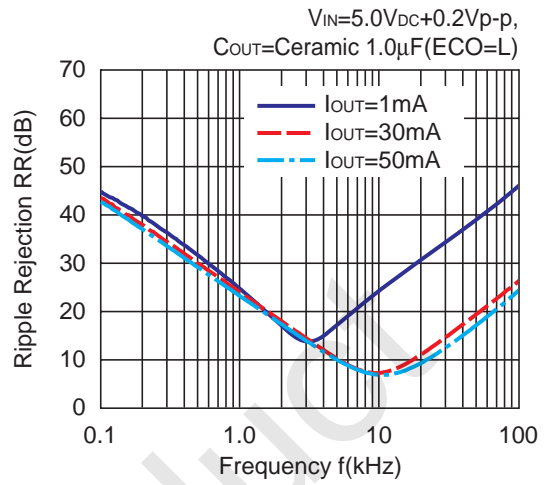
2.8V (VR1/VR2)



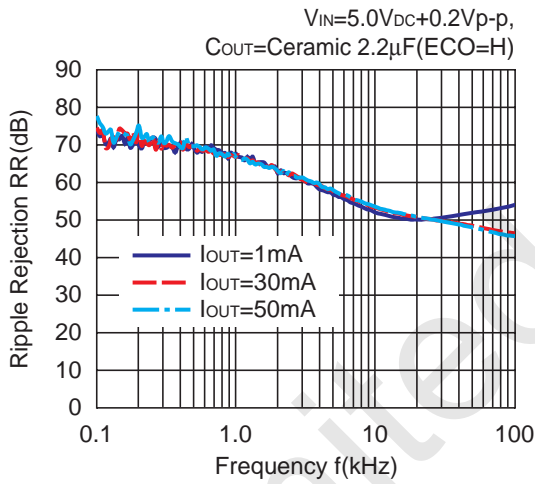
4.0V (VR1/VR2)



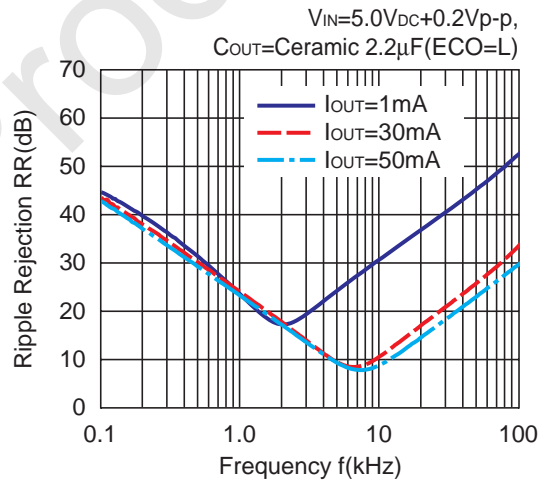
4.0V (VR1/VR2)



4.0V (VR1/VR2)

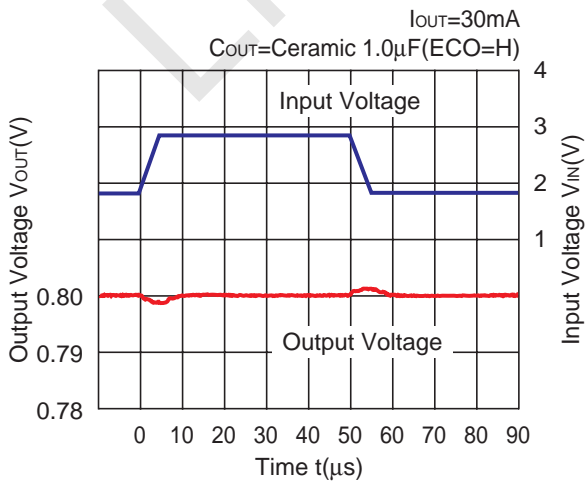


4.0V (VR1/VR2)

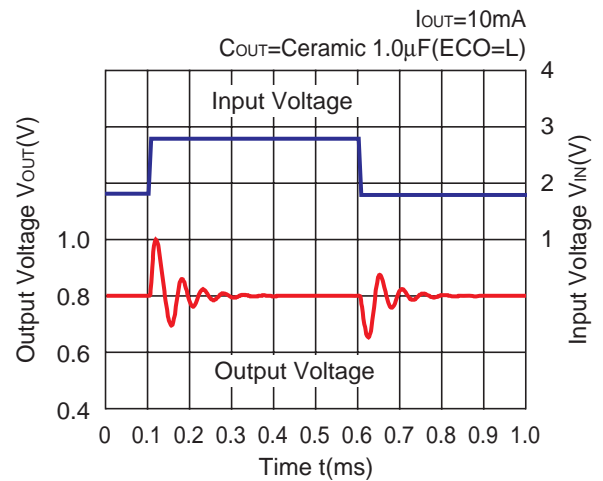


11) Input Transient Response ($C_{IN}=\text{none}$)

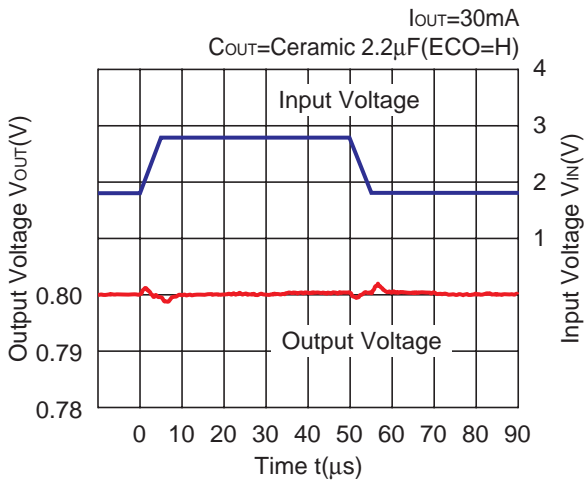
0.8V (VR1/VR2)



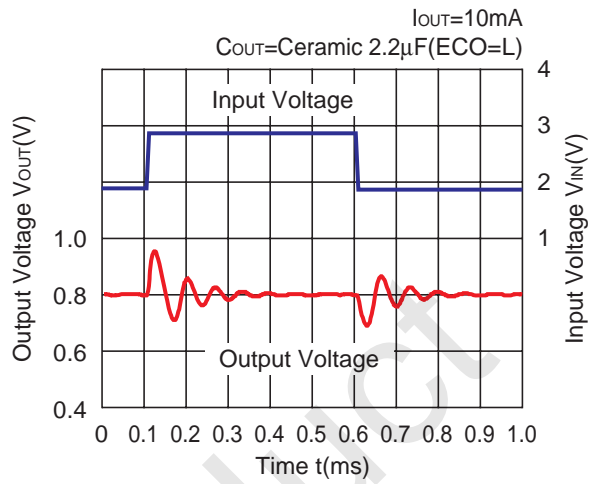
0.8V (VR1/VR2)



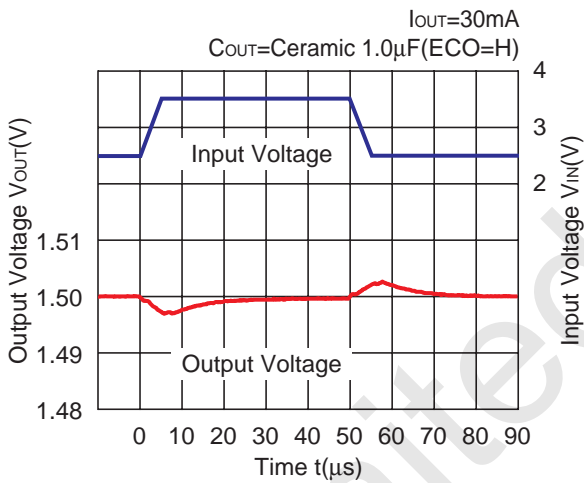
0.8V (VR1/VR2)



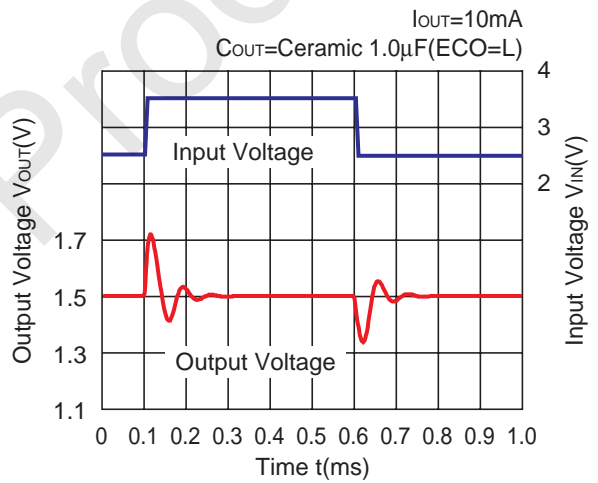
0.8V (VR1/VR2)



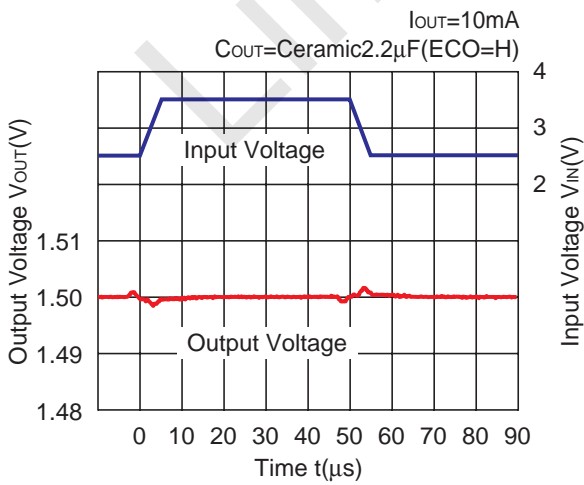
1.5V (VR1/VR2)



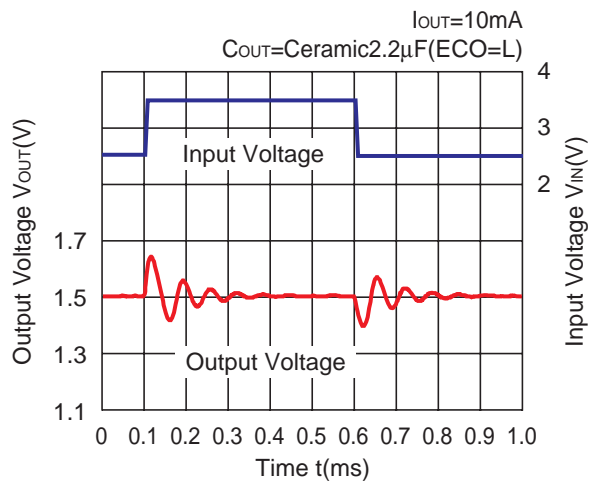
1.5V (VR1/VR2)



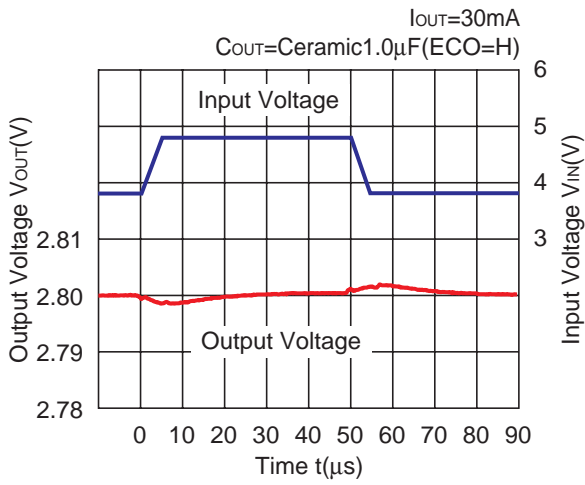
1.5V (VR1/VR2)



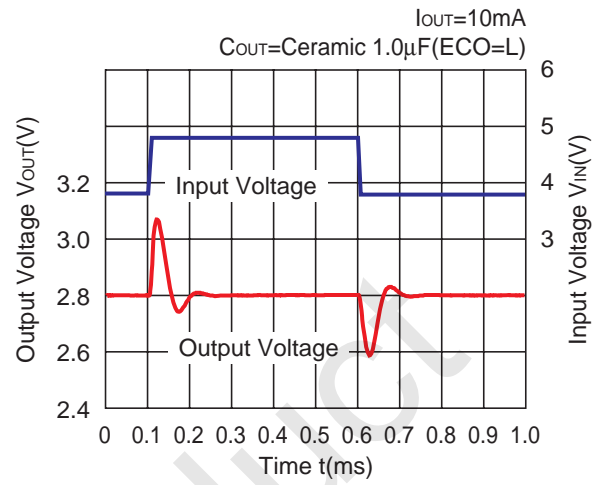
1.5V (VR1/VR2)



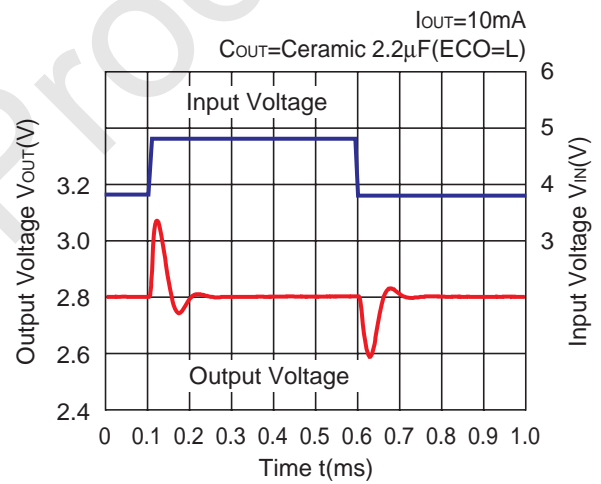
2.8V (VR1/VR2)



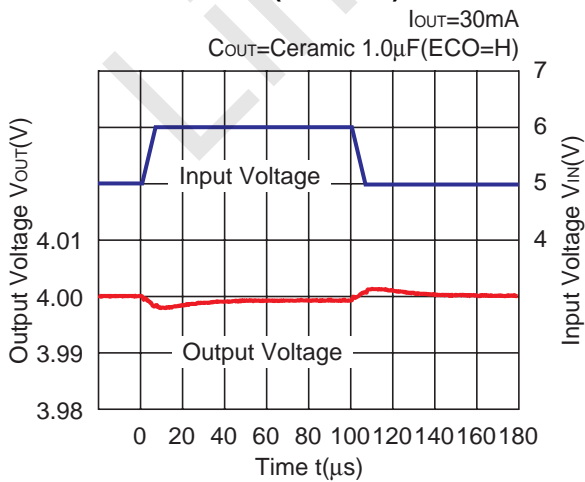
2.8V (VR1/VR2)



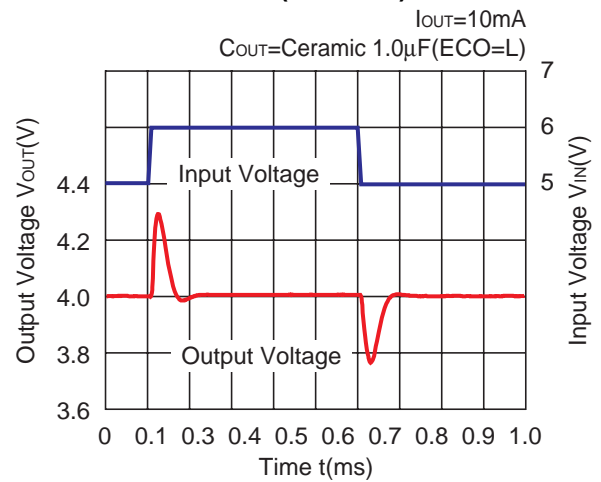
2.8V (VR1/VR2)



4.0V (VR1/VR2)

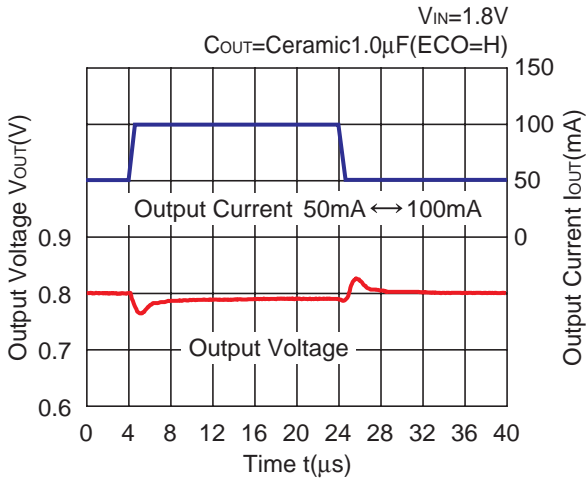


4.0V (VR1/VR2)

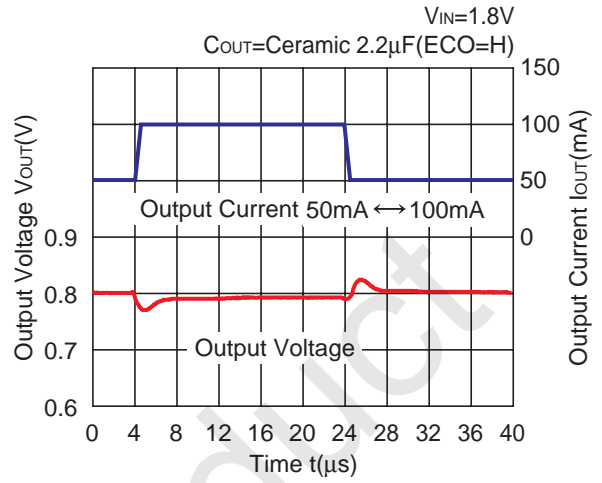


12) Load Transient Response (C_{IN} =Ceramic 1.0 μ F)

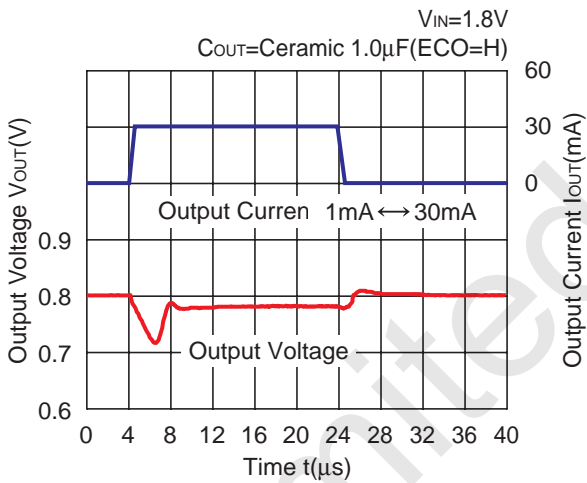
0.8V (VR1/VR2)



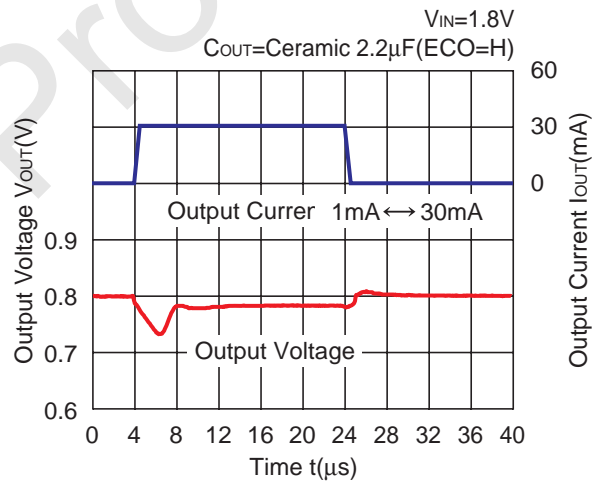
0.8V (VR1/VR2)



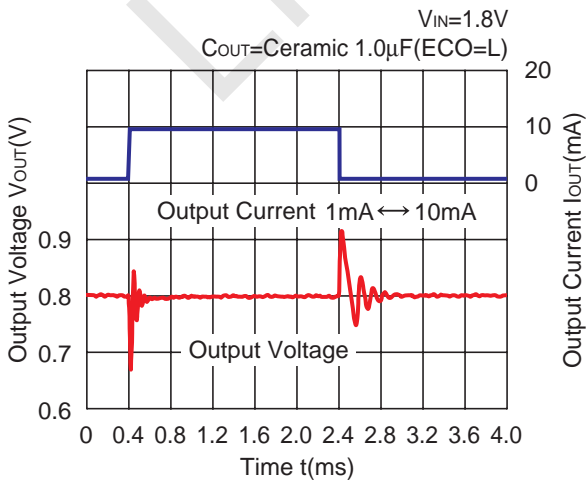
0.8V (VR1/VR2)



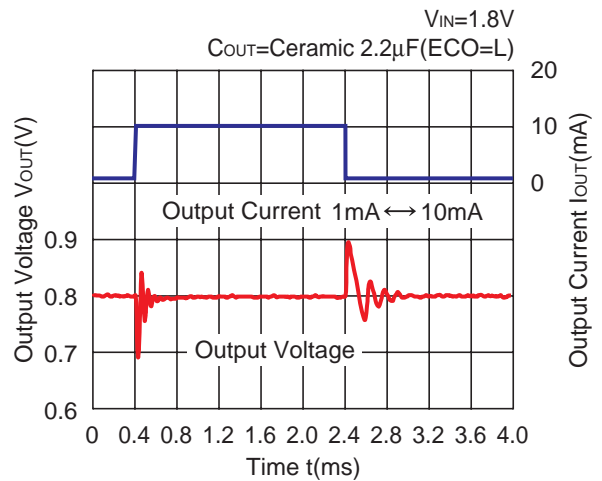
0.8V (VR1/VR2)



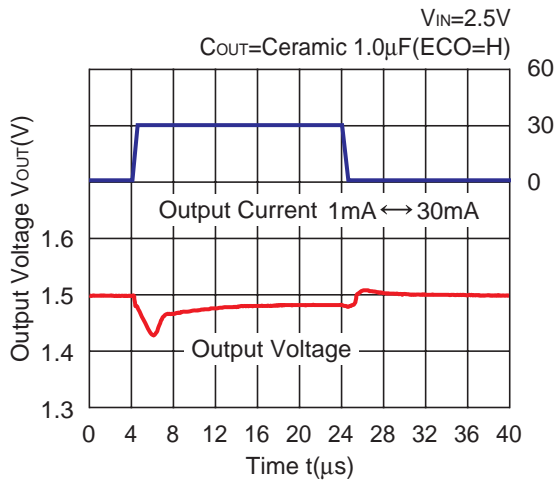
0.8V (VR1/VR2)



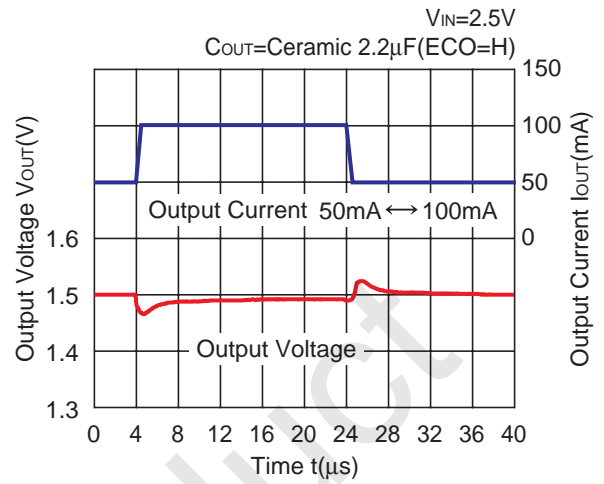
0.8V (VR1/VR2)



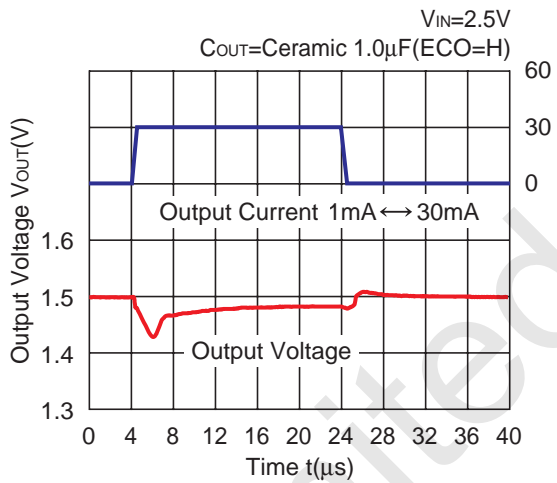
1.5V (VR1/VR2)



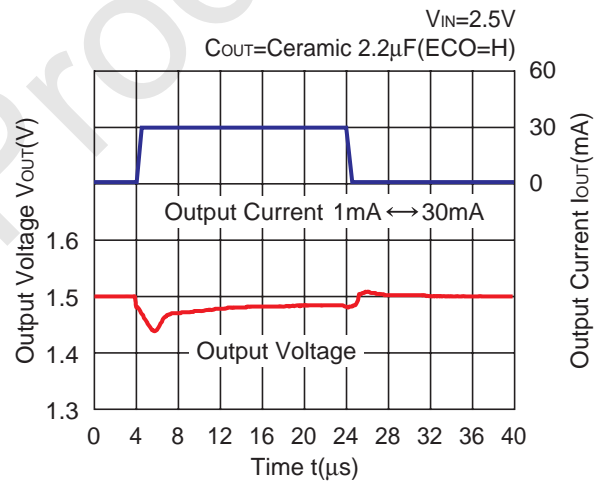
1.5V (VR1/VR2)



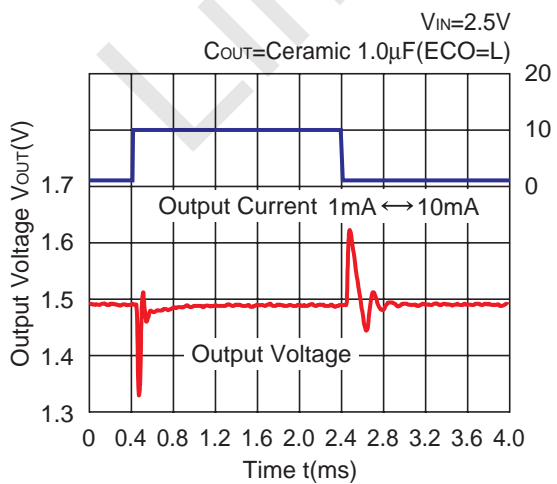
1.5V (VR1/VR2)



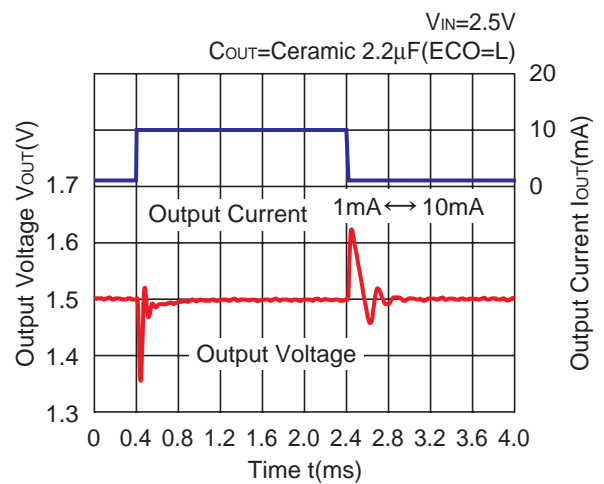
1.5V (VR1/VR2)



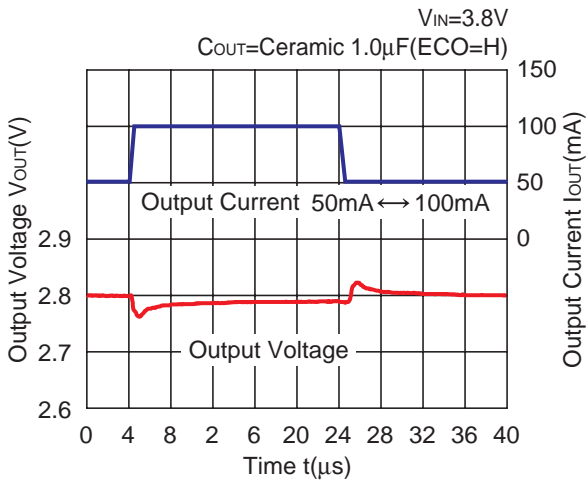
1.5V (VR1/VR2)



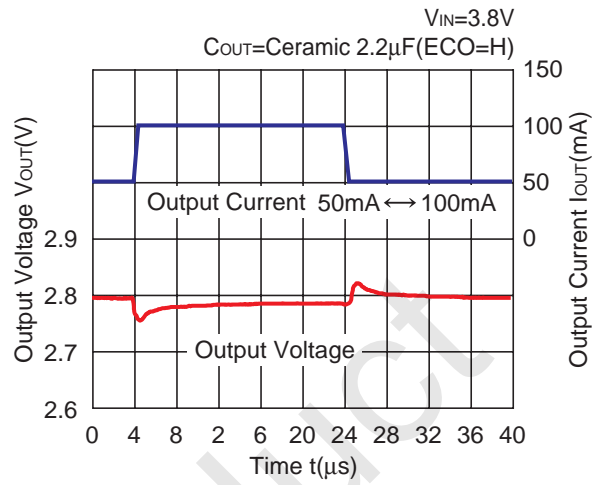
1.5V (VR1/VR2)



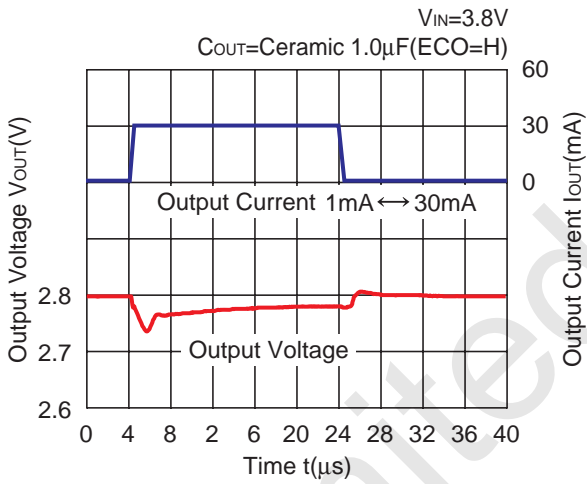
2.8V (VR1/VR2)



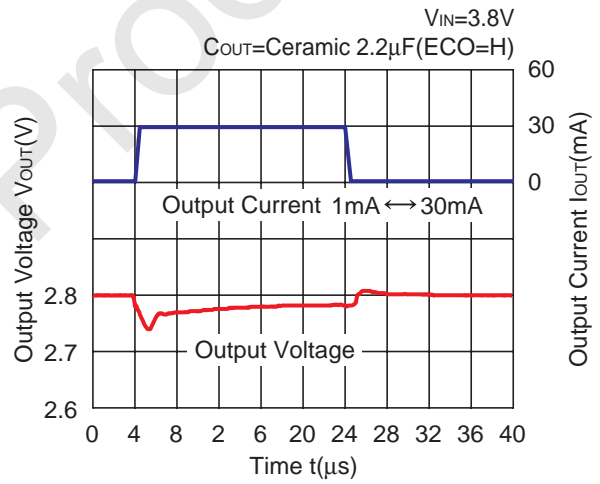
2.8V (VR1/VR2)



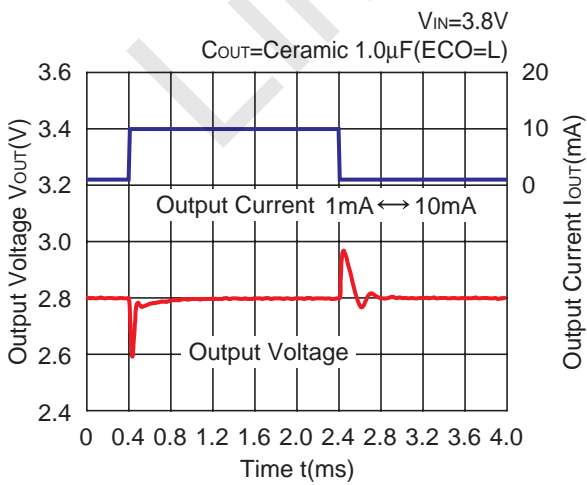
2.8V (VR1/VR2)



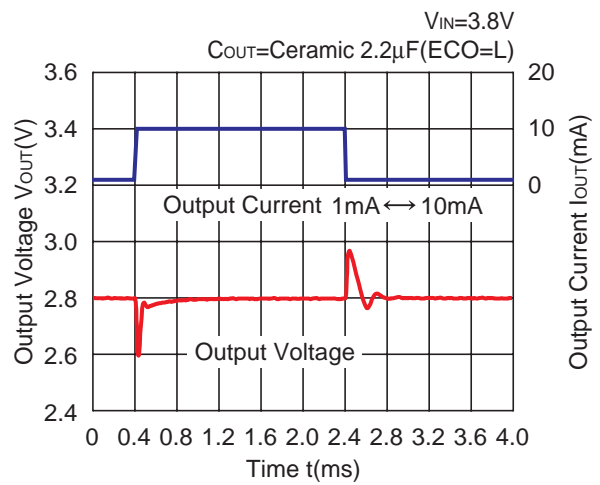
2.8V (VR1/VR2)



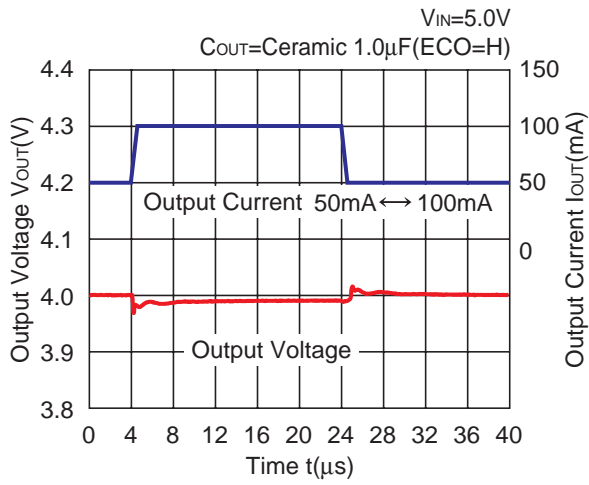
2.8V (VR1/VR2)



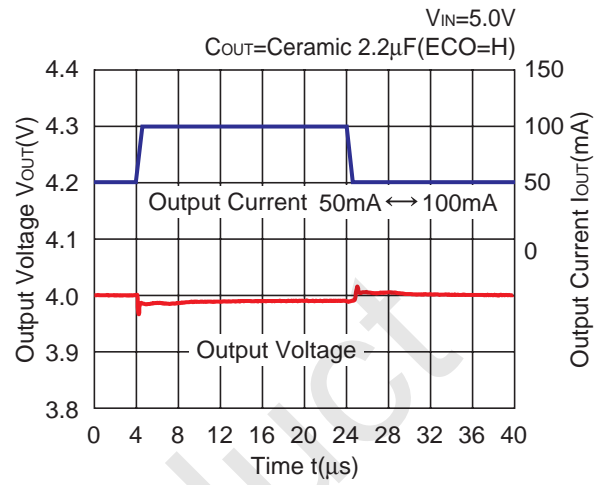
2.8V (VR1/VR2)



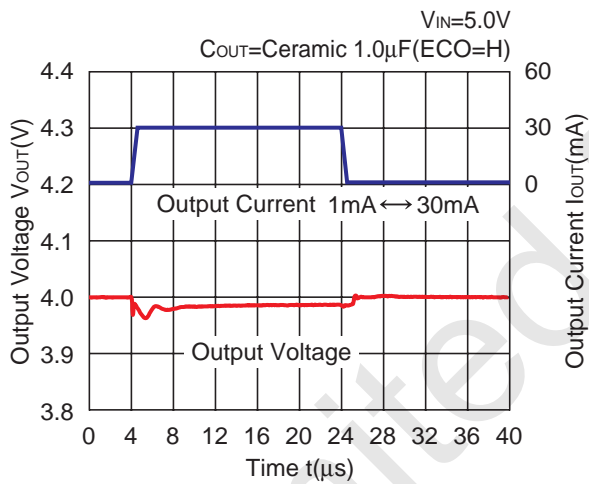
4.0V (VR1/VR2)



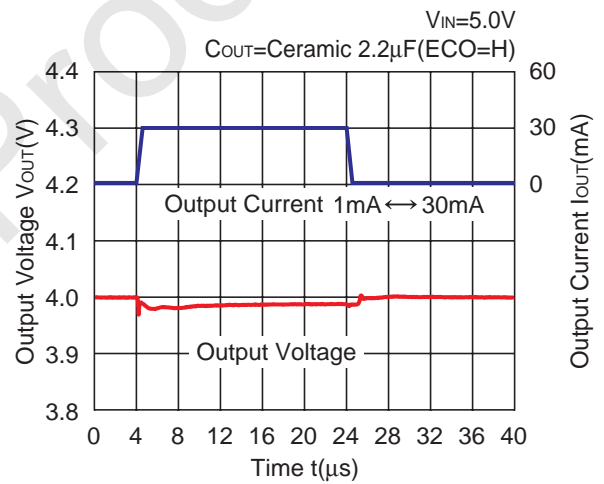
4.0V (VR1/VR2)



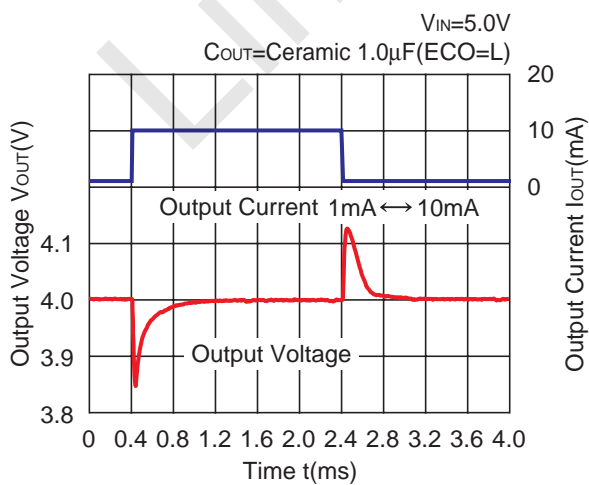
4.0V (VR1/VR2)



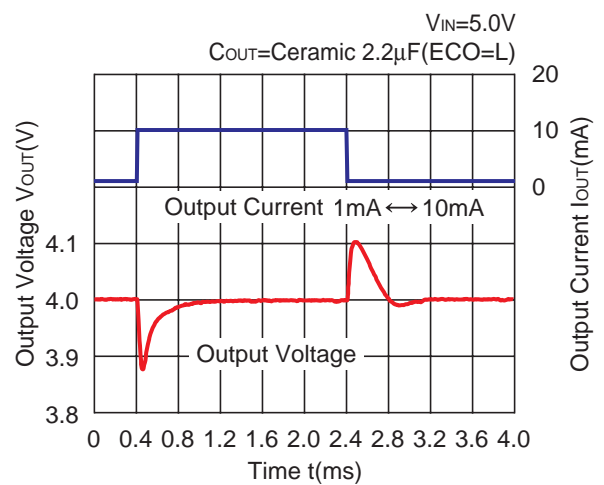
4.0V (VR1/VR2)



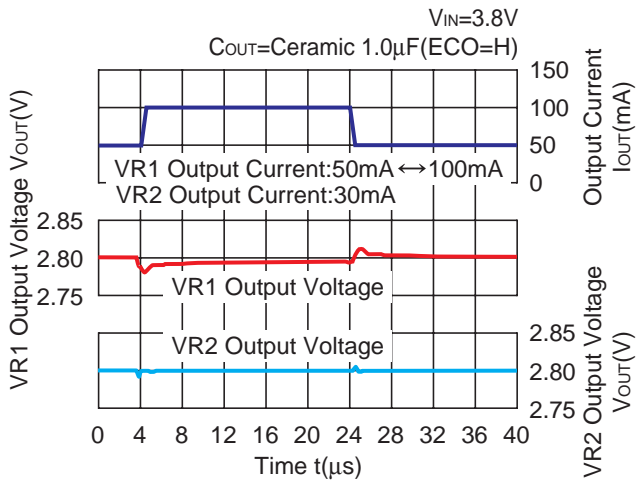
4.0V (VR1/VR2)



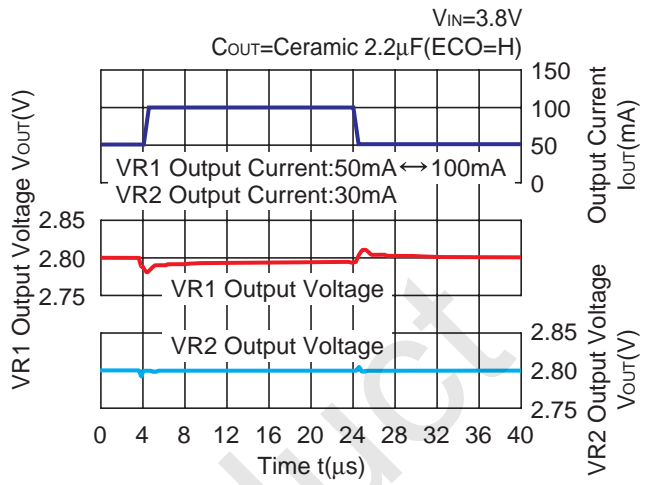
4.0V (VR1/VR2)



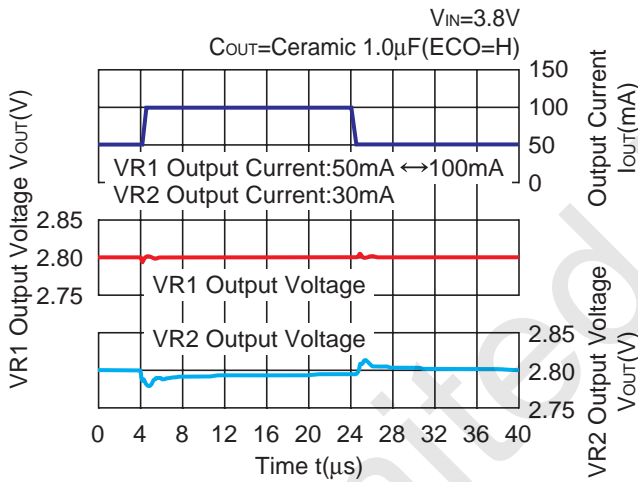
2.8V (VR1/VR2)



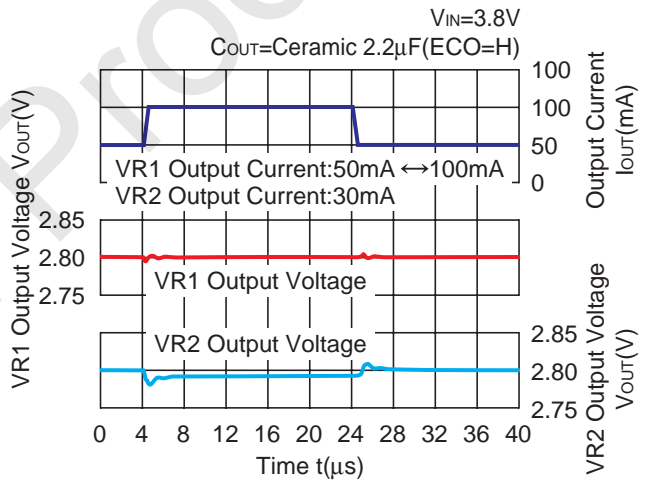
2.8V (VR1/VR2)



2.8V (VR1/VR2)

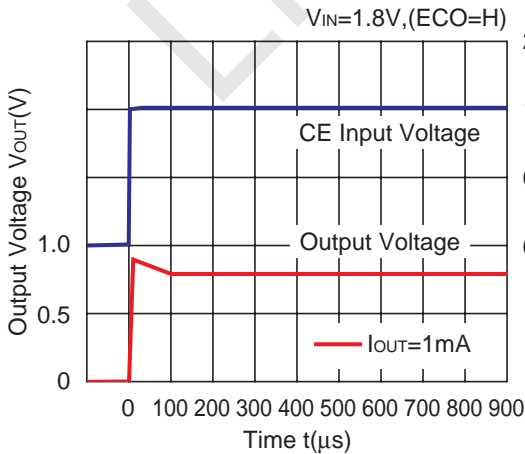


2.8V (VR1/VR2)

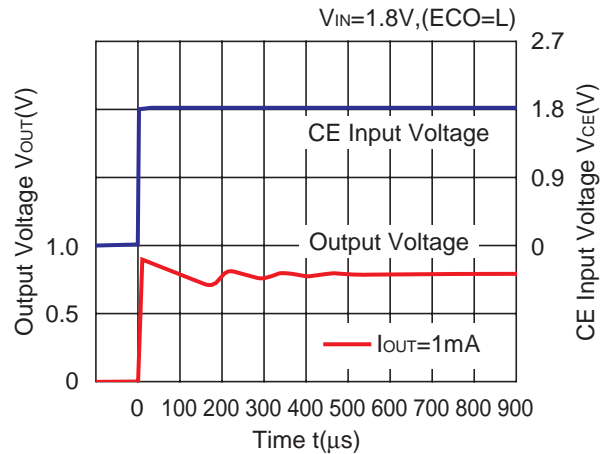


13) Turn on speed by CE pin control (CIN=1.0µF, COUT=Ceramic 1.0µF)

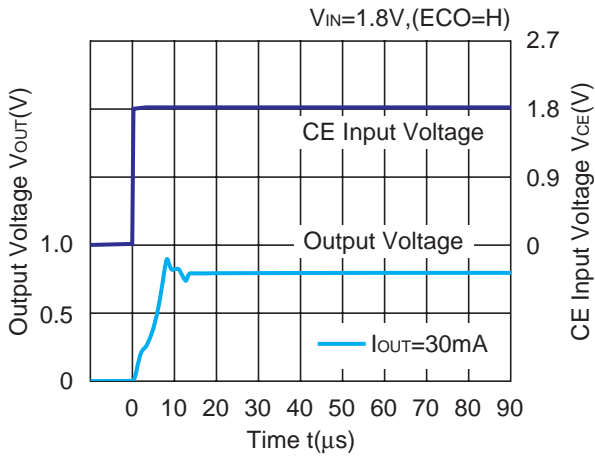
0.8V (VR1/VR2)



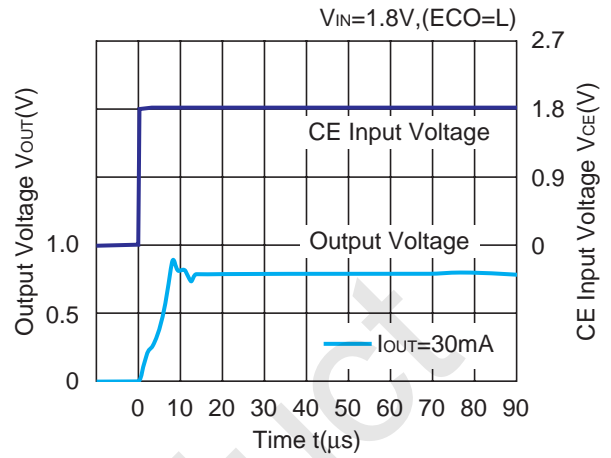
0.8V (VR1/VR2)



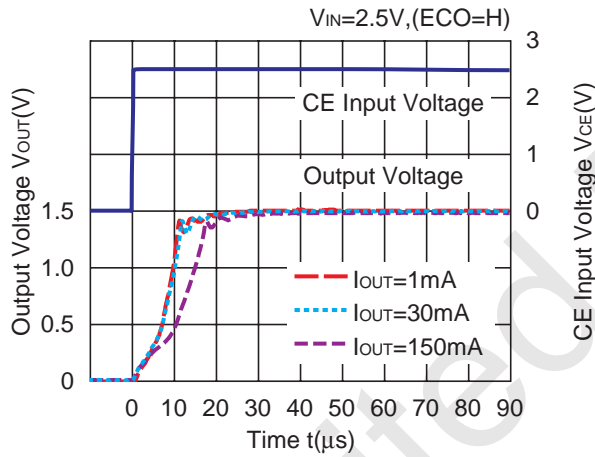
0.8V (VR1/VR2)



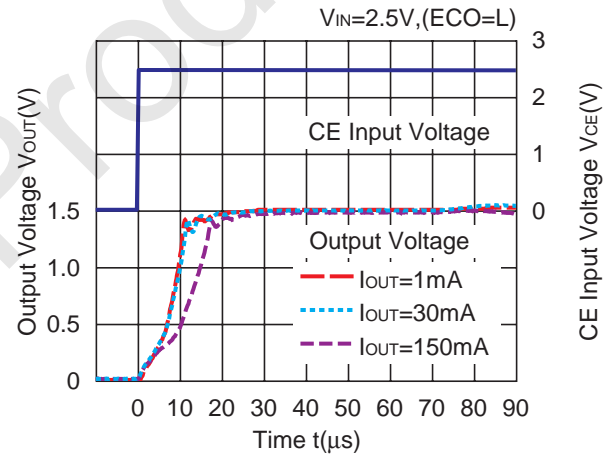
0.8V (VR1/VR2)



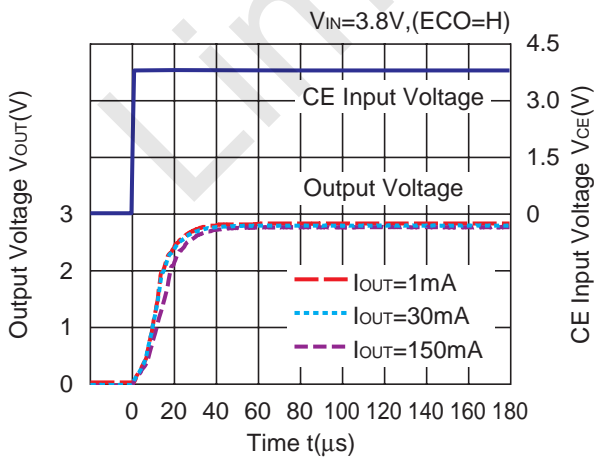
1.5V (VR1/VR2)



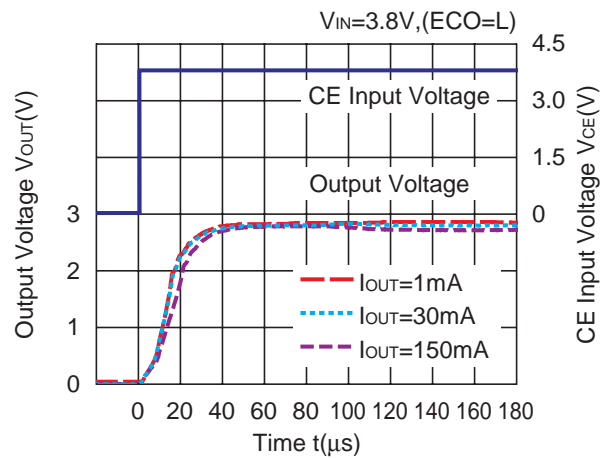
1.5V (VR1/VR2)

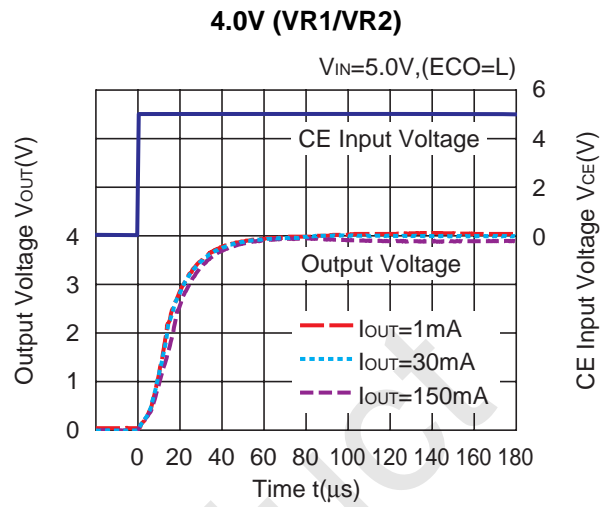
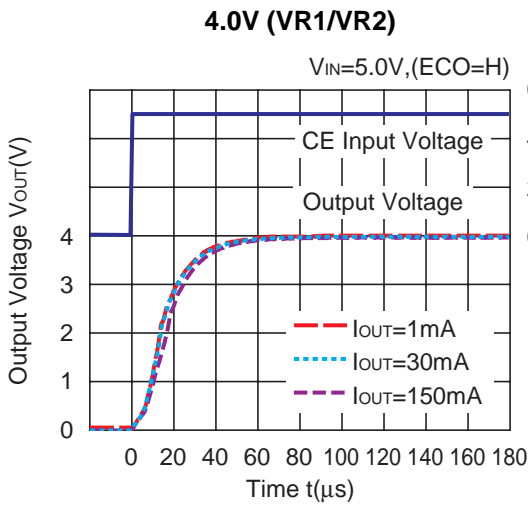


2.8V (VR1/VR2)

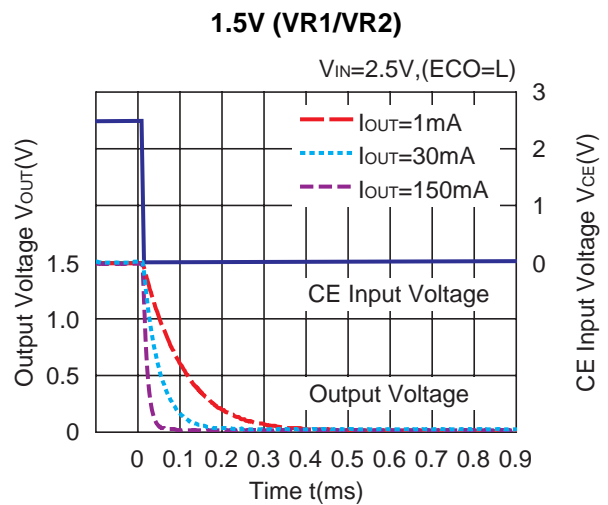
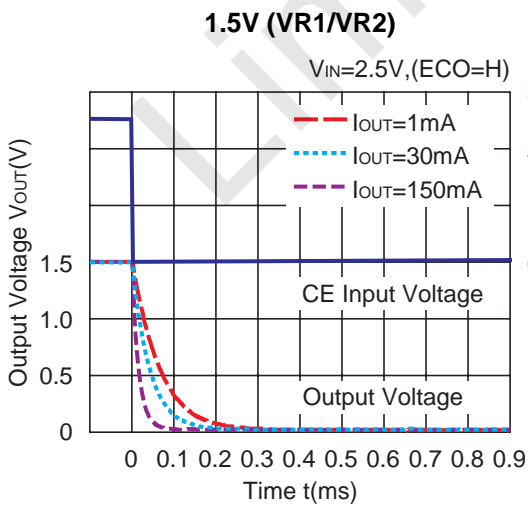
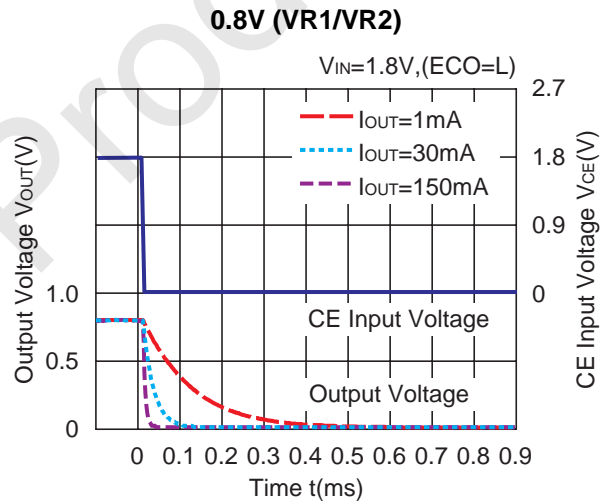
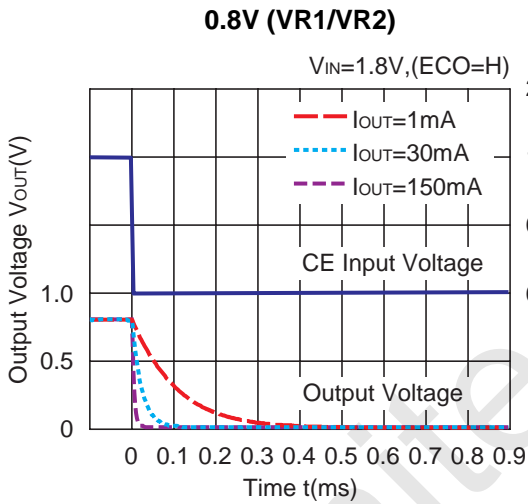


2.8V (VR1/VR2)

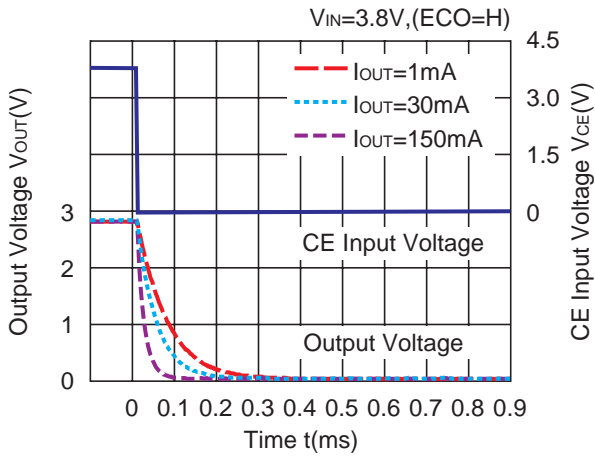




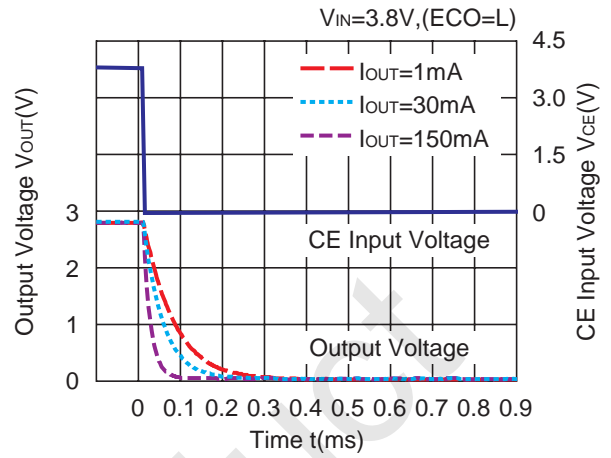
14) Turn off speed by CE pin control ($C_{IN}=1.0\mu F, C_{OUT}=\text{Ceramic } 1.0\mu F$)



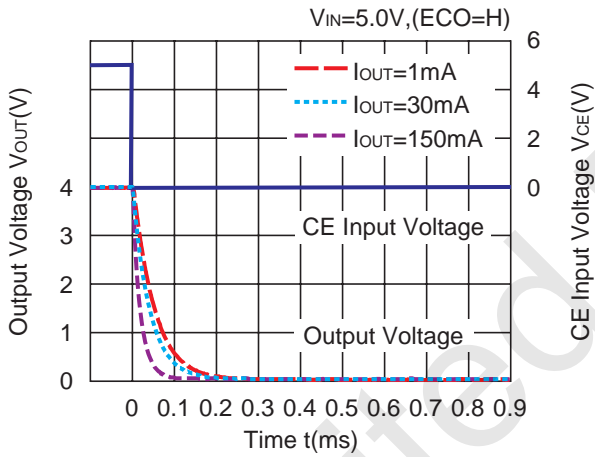
2.8V (VR1/VR2)



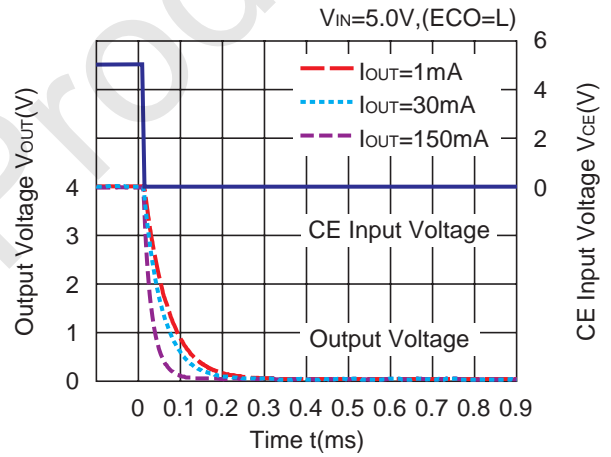
2.8V (VR1/VR2)



4.0V (VR1/VR2)

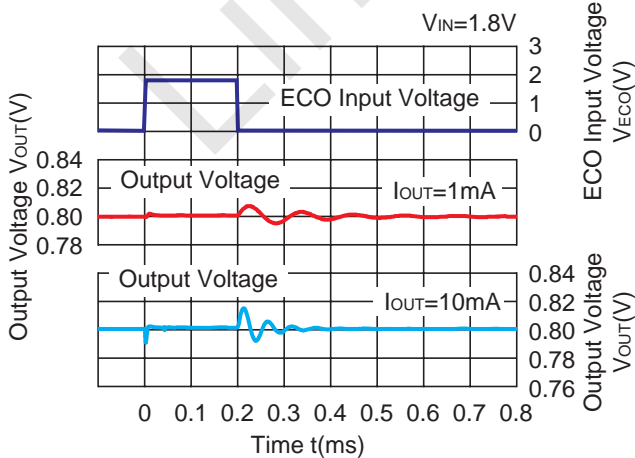


4.0V (VR1/VR2)

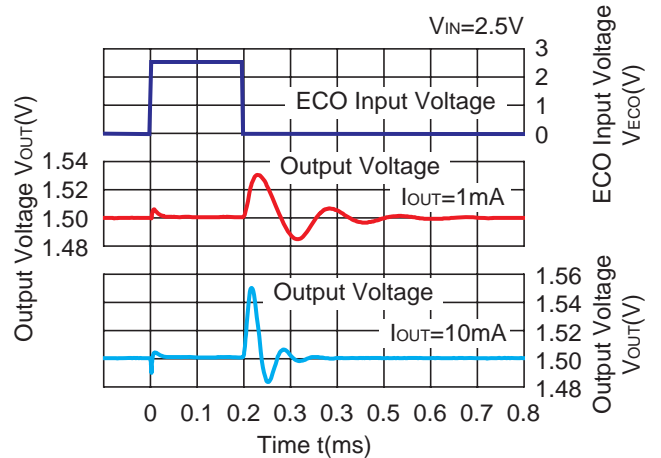


15) Mode Transient Response (C_{IN}=C_{OUT}=Ceramic 1.0μF)

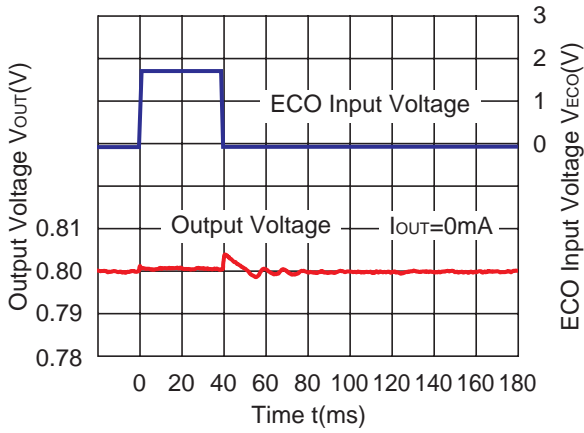
0.8V (VR1/VR2)



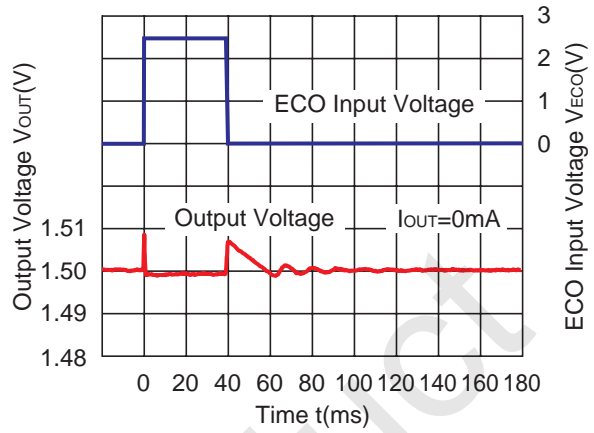
1.5V (VR1/VR2)



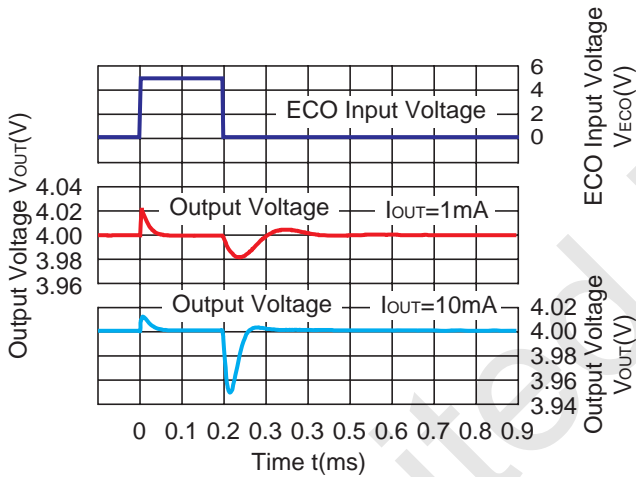
0.8V (VR1/VR2)



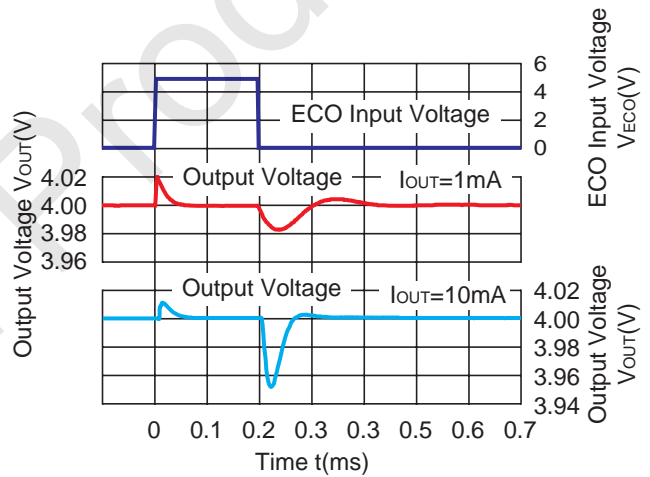
1.5V (VR1/VR2)



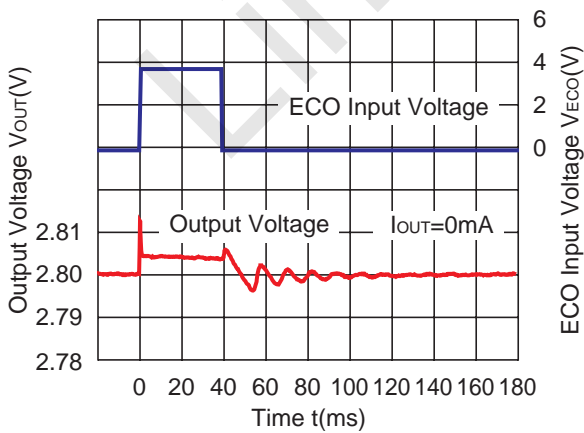
2.8V (VR1/VR2)



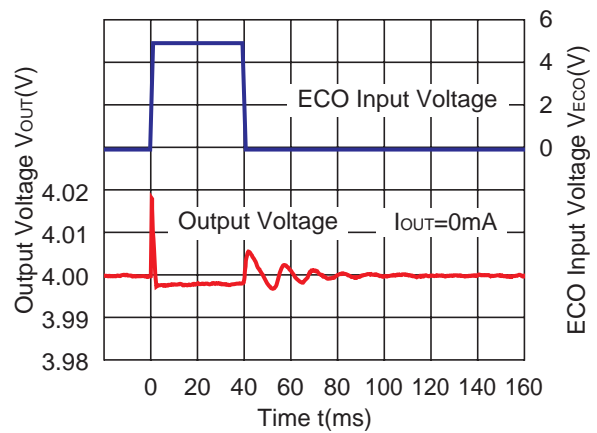
4.0V (VR1/VR2)



2.8V (VR1/VR2)



4.0V (VR1/VR2)



ESR vs. Output Current

When using these ICs, consider the following points:

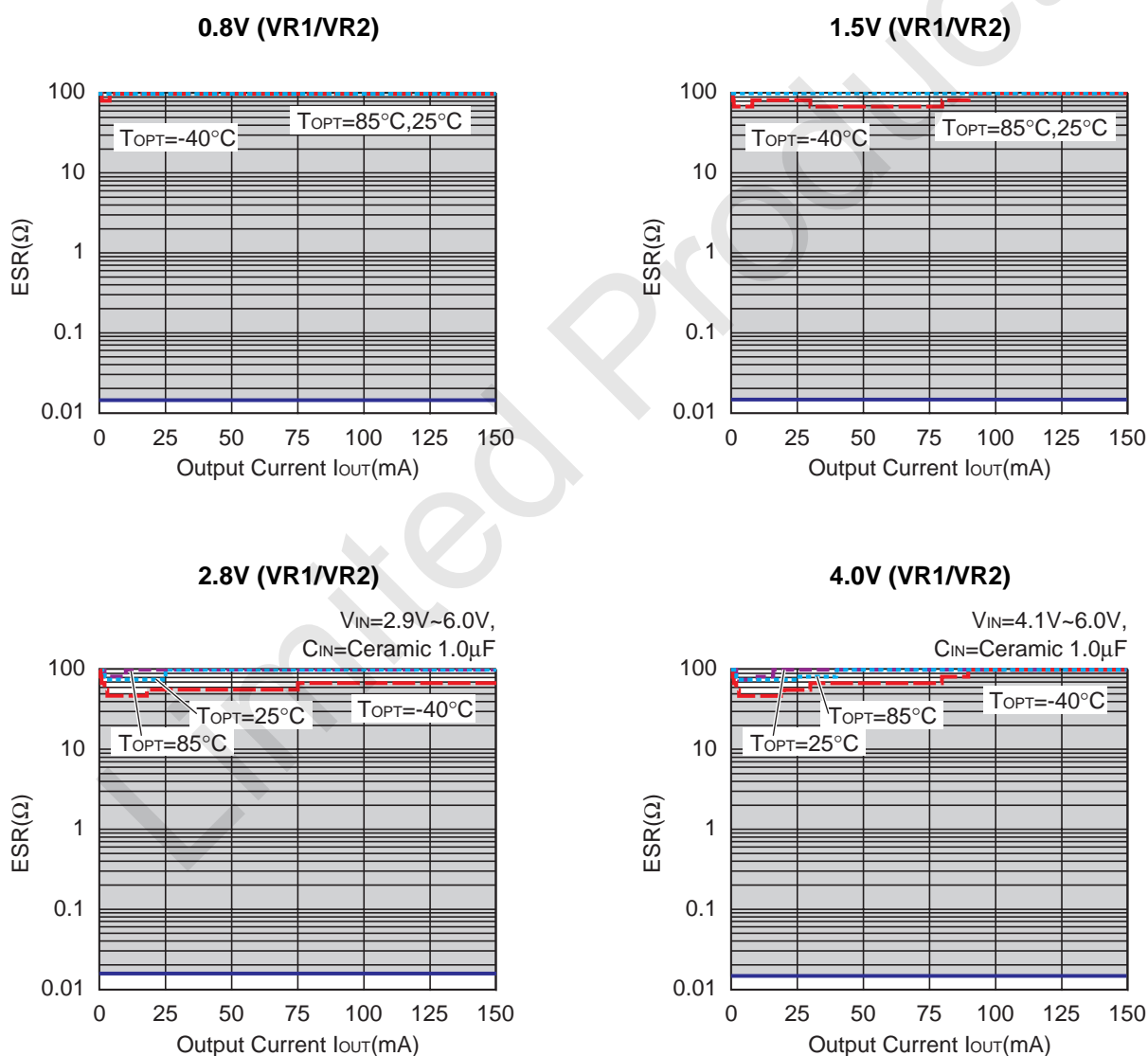
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.

The conditions when the white noise level is under $40\mu\text{V}$ (Avg.) are marked as the hatched area in the graph.

Measurement conditions

Frequency Band : 10Hz to 2MHz

Temperature : -40°C to 85°C





1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.
3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh's or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death (aircraft, spacevehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. Anti-radiation design is not implemented in the products described in this document.
8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
9. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact Ricoh sales or our distributor before attempting to use AOI.
11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.



Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment.

Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

RICOH RICOH ELECTRONIC DEVICES CO., LTD.

<https://www.e-devices.ricoh.co.jp/en/>

Sales & Support Offices

Ricoh Electronic Devices Co., Ltd.

Shin-Yokohama Office (International Sales)

2-3, Shin-Yokohama 3-chome, Kohoku-ku, Yokohama-shi, Kanagawa, 222-8530, Japan
Phone: +81-50-3814-7687 Fax: +81-45-474-0074

Ricoh Americas Holdings, Inc.

675 Campbell Technology Parkway, Suite 200 Campbell, CA 95008, U.S.A.
Phone: +1-408-610-3105

Ricoh Europe (Netherlands) B.V.

Semiconductor Support Centre

Prof. W.H. Keesomlaan 1, 1183 DJ Amstelveen, The Netherlands
Phone: +31-20-5474-309

Ricoh International B.V. - German Branch

Semiconductor Sales and Support Centre

Oberrather Strasse 6, 40472 Düsseldorf, Germany
Phone: +49-211-6546-0

Ricoh Electronic Devices Korea Co., Ltd.

3F, Haesung Bldg, 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2051-5713

Ricoh Electronic Devices Shanghai Co., Ltd.

Room 403, No.2 Building, No.690 Bibo Road, Pu Dong New District, Shanghai 201203,
People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

Ricoh Electronic Devices Shanghai Co., Ltd.

Shenzhen Branch

1205, Block D (Jinlong Building), Kingkey 100, Hongbao Road, Luohu District,
Shenzhen, China
Phone: +86-755-8348-7600 Ext 225

Ricoh Electronic Devices Co., Ltd.

Taipei office

Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623