RICOH

R5328K SERIES

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

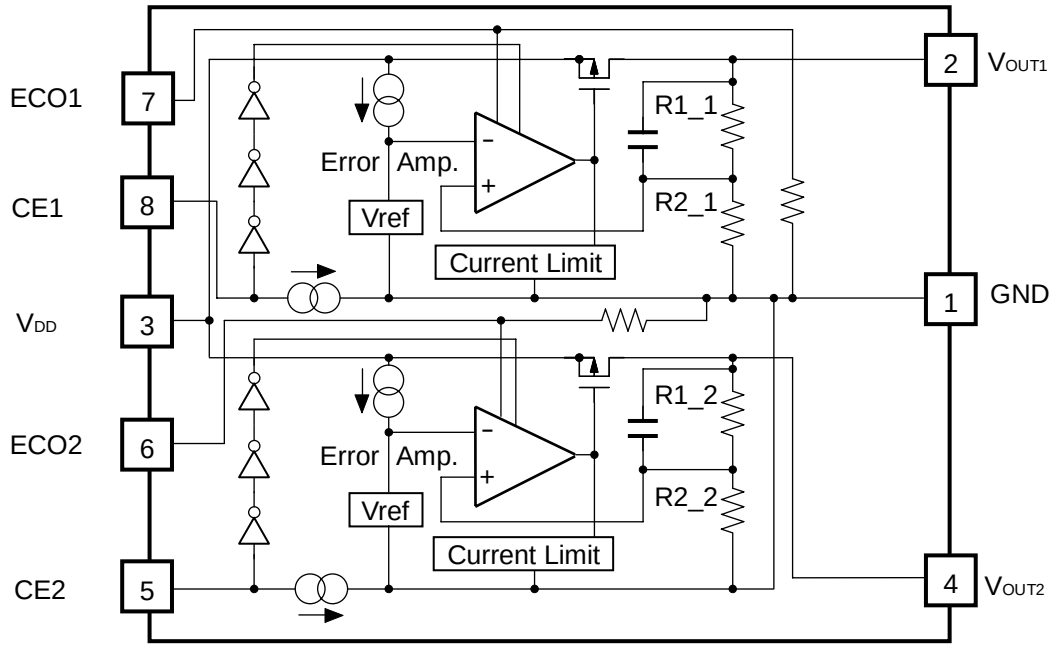
- Supply Current (Low Power Mode)..... Typ. 2.0μA×2 (VR1&VR2) (V_{OUT}<2.0V)
  Typ. 2.5μA×2 (VR1&VR2) ($V_{OUT} \geqq$ 2.0V)
- Supply Current (Fast Mode)..... Typ. 75μA×2 (VR1&VR2) (V_{OUT}<2.0V)
  Typ. 65μA×2 (VR1&VR2) ($V_{OUT} \geqq$ 2.0V)
- Standby Mode ..... Typ. 0.1μA (VR1&VR2)
- Input Voltage ..... 1.4V to 6.0V
- Output Voltage Range..... 0.8V to 4.0V (0.1V steps)
  (For details, please refer to MARK INFORMATIONS.)
- 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) ..... ±1.0%
- Output Voltage Accuracy (Low Power Mode) ..... ±1.2%
- Temperature-drift Coefficient of Output Voltage.... Typ. ±100ppm/°C
- Package ..... DFN(PLP)2020-8
- Built-in fold-back protection circuit ..... Typ. 50mA (Current at short mode)
- Ceramic Capacitor is recommended. 1.0μF
- Built-in chip enable circuit (A/B: active high)
  (Depending on V_{IN} and set V_{OUT}. Refer to the electrical characteristics table.)

APPLICATIONS

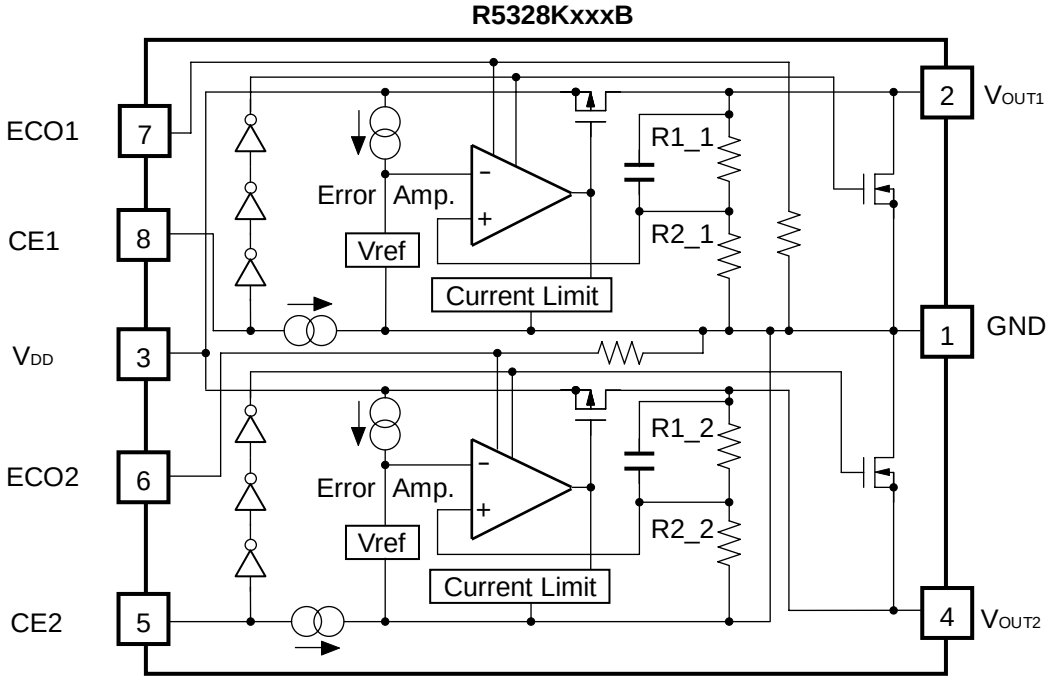
- Power source for handheld communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

R5328KxxxA



R5328KxxxB



SELECTION GUIDE

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

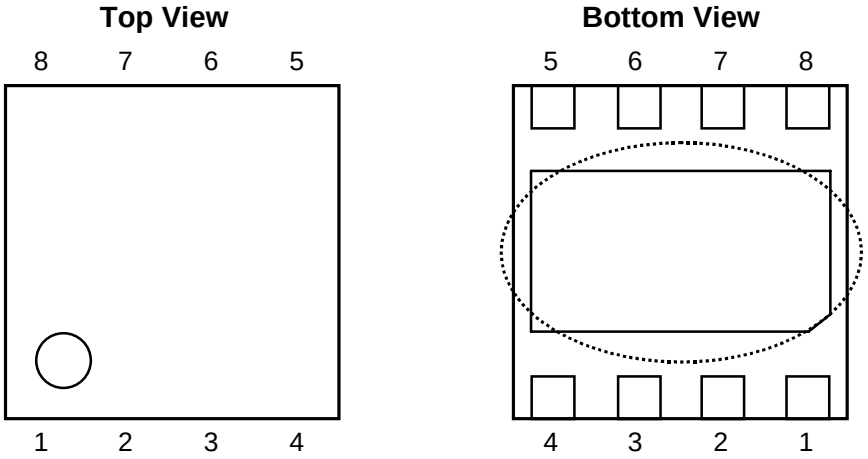
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5328Kxxx∗-TR	DFN(PLP)2020-8	5,000 pcs	Yes	Yes

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 INFORMATIONS.)

∗ : 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
Topt	Operating Temperature Range	−40 to 85	°C
Tstg	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 Topt=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
$\Delta V_{OUT}/\Delta I_{OUT}$	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	
Istandby	Standby Current	V_{IN}=6.0V, V_{CE}=GND			0.1	1	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation (Fast Mode)	I_{OUT}=1mA, V_{OUT}+0.5V ≦ V_{IN} ≦ 6V, If V_{OUT} ≦ 0.9V: 1.5V ≦ V_{IN} ≦ 6V	V_{ECO}=V_{IN}		0.02	0.1	%/V
	Line Regulation (Low Power Mode)		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
$\Delta V_{OUT}/\Delta Topt$	Output Voltage Temperature Coefficient	I_{OUT}=1mA, −40°C ≦ Topt ≦ 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

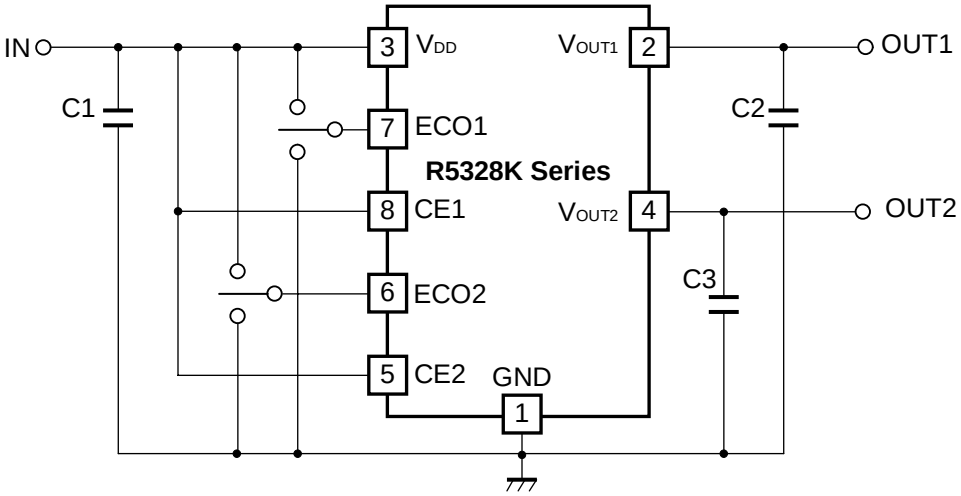
- **Dropout Voltage by Output Voltage**

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



(External Components)

1.0μF	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).

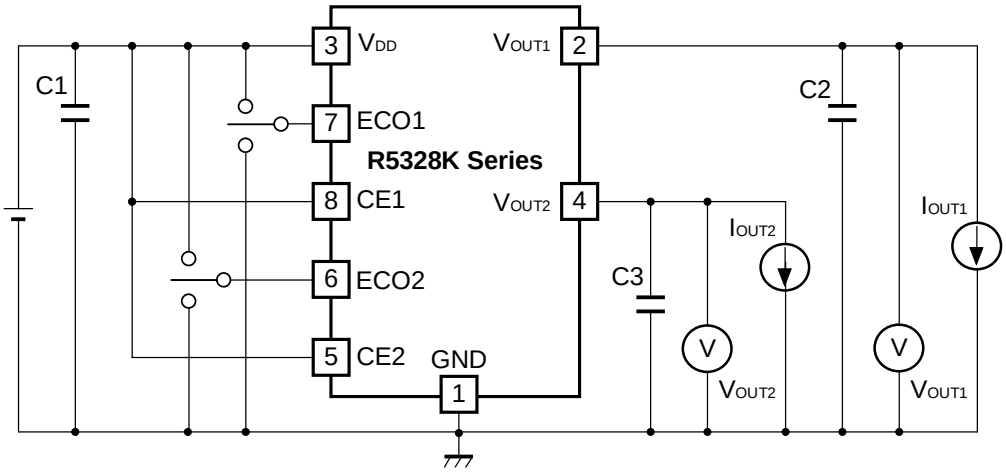
(Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

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 1.0μF or more between V_{DD} and GND pin, and as close as possible to the pins.

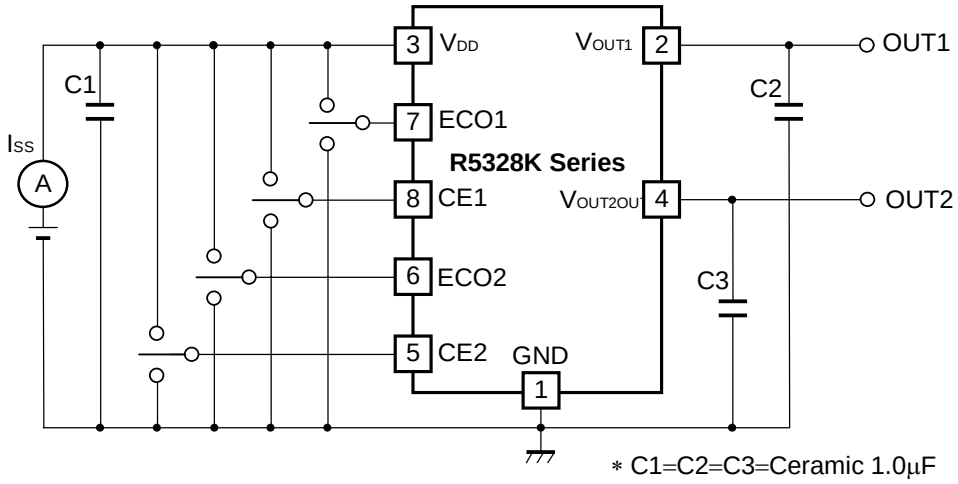
Set external components, especially the output capacitor C2 and C3, as close as possible to the ICs, and make wiring as short as possible.

TEST CIRCUITS



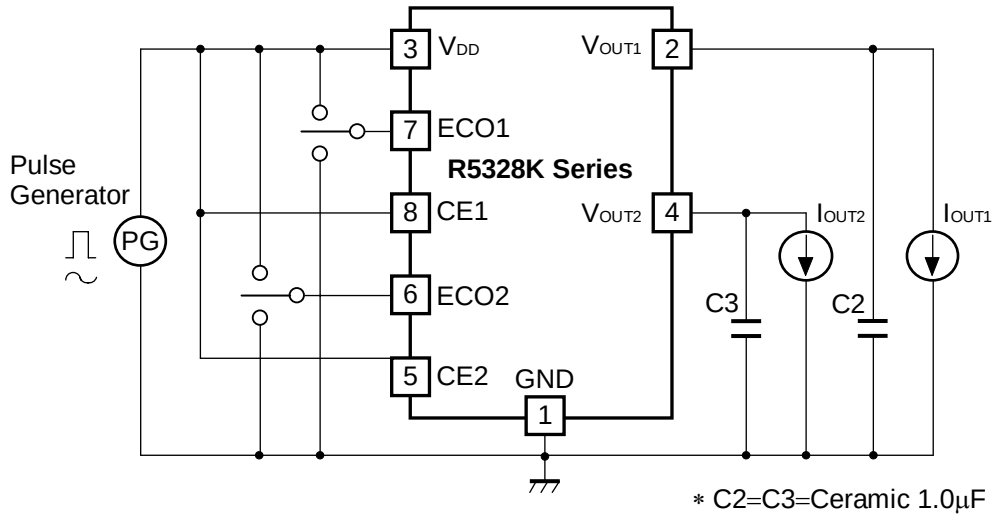
∗ C1=C2=C3=Ceramic 1.0μF

Standard test Circuit

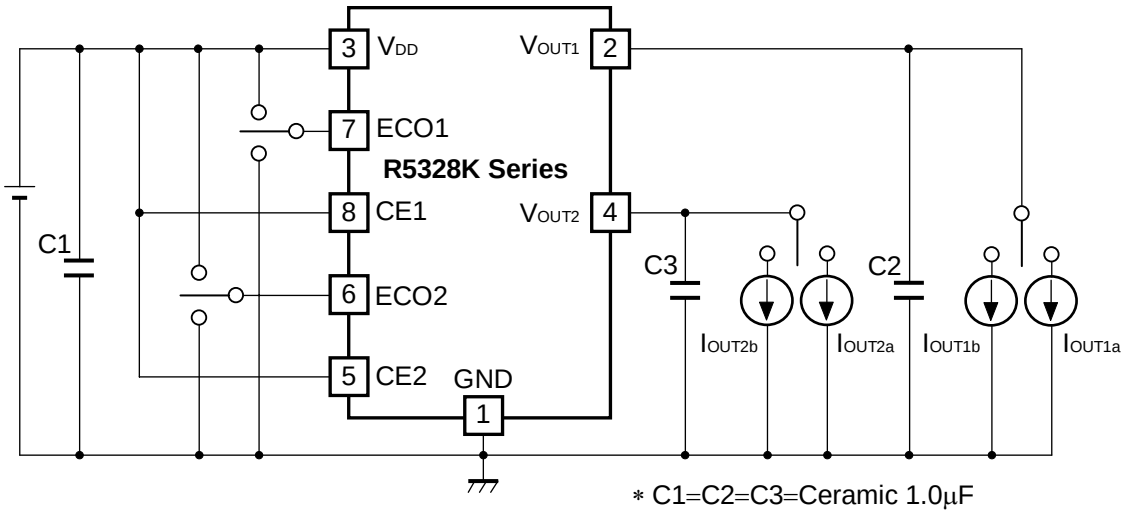


∗ C1=C2=C3=Ceramic 1.0μF

Supply Current Test Circuit



Ripple Rejection, Line Transient Response Test Circuit

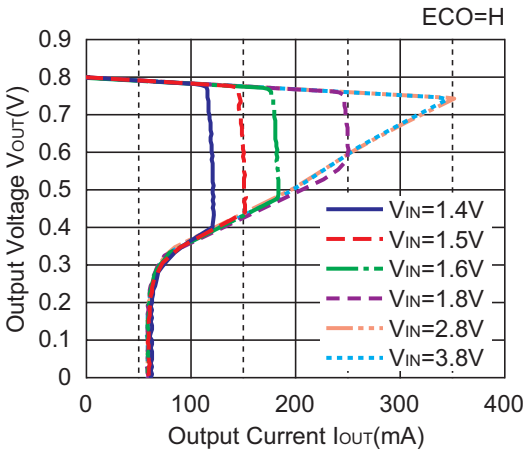


Load Transient Response Test Circuit

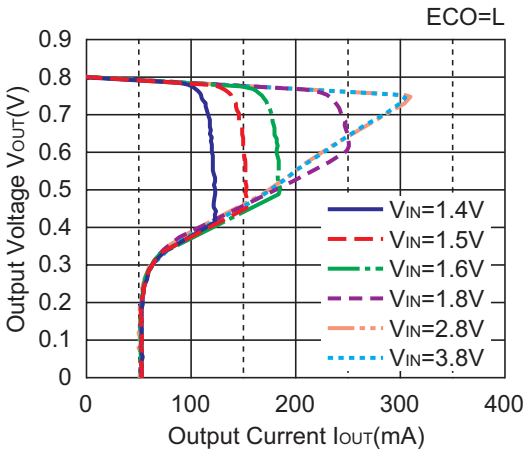
TYPICAL CHARACTERISTICS

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

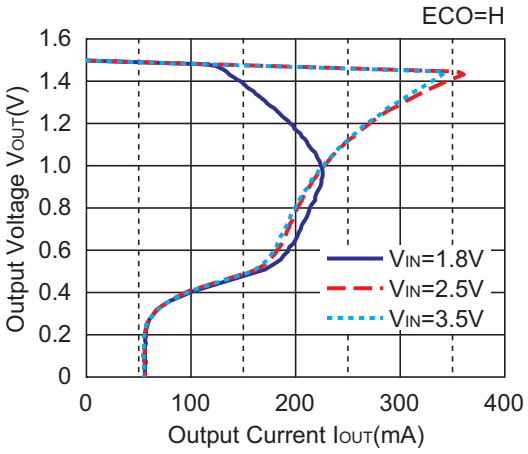
0.8 V(VR1/VR2)



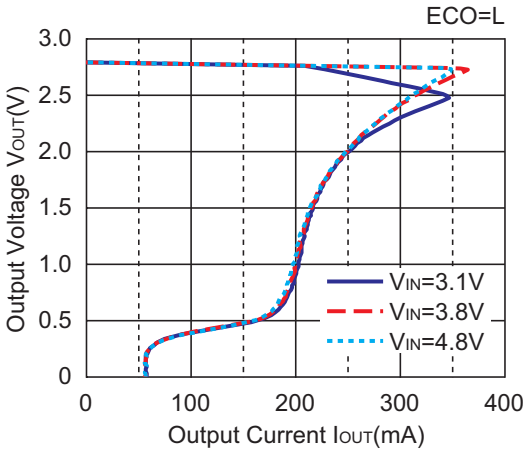
0.8V (VR1/VR2)



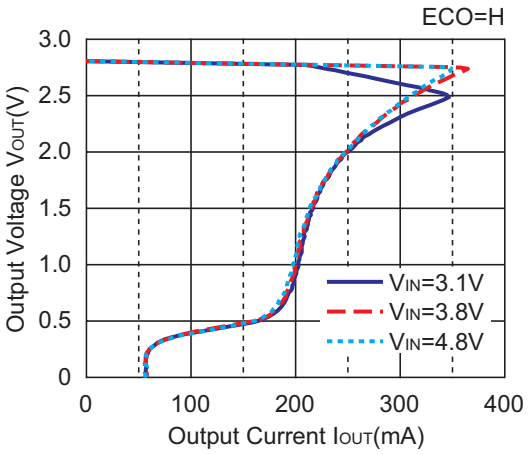
1.5V (VR1/VR2)



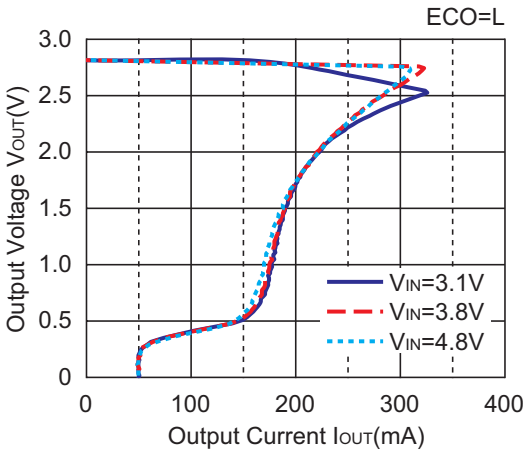
1.5V (VR1/VR2)



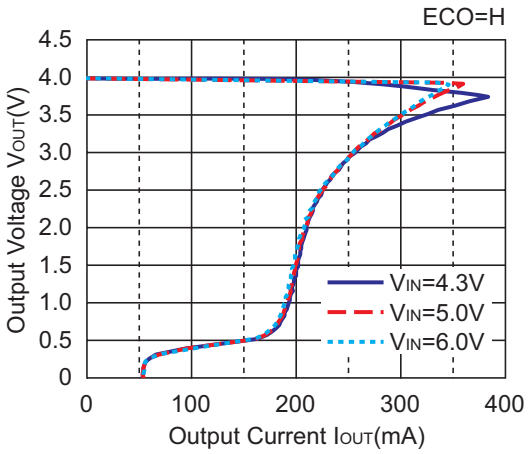
2.8V (VR1/VR2)



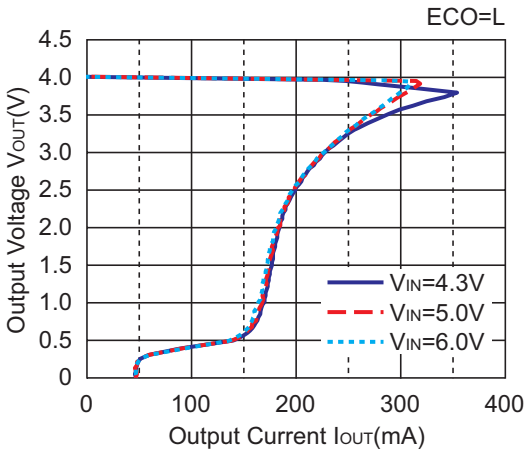
2.8V (VR1/VR2)



4.0V (VR1/VR2)

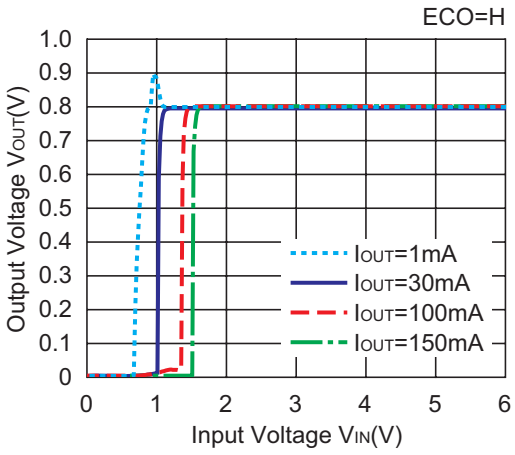


4.0V (VR1/VR2)

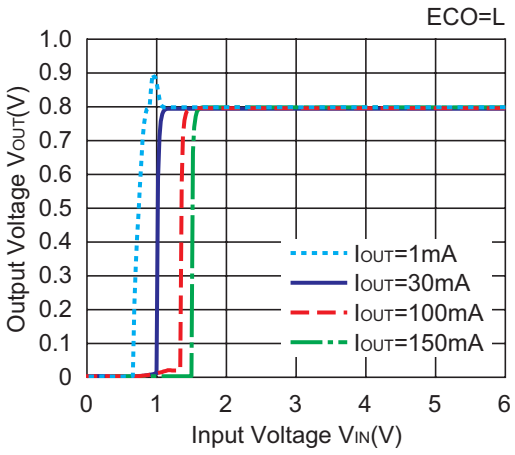


2) Output Voltage vs. Input Voltage (Topt=25°C)

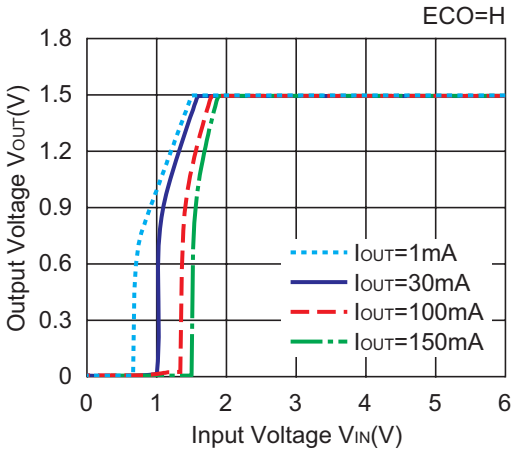
0.8V (VR1/VR2)



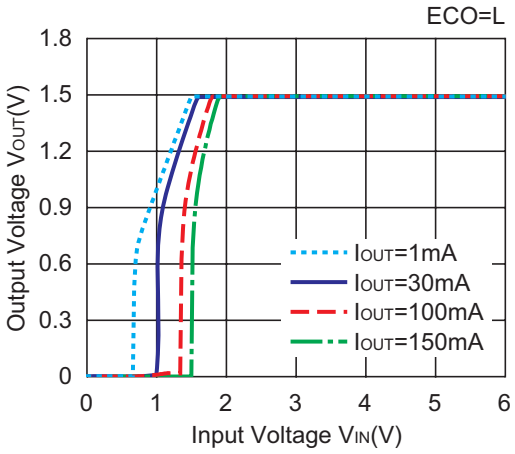
0.8V (VR1/VR2)



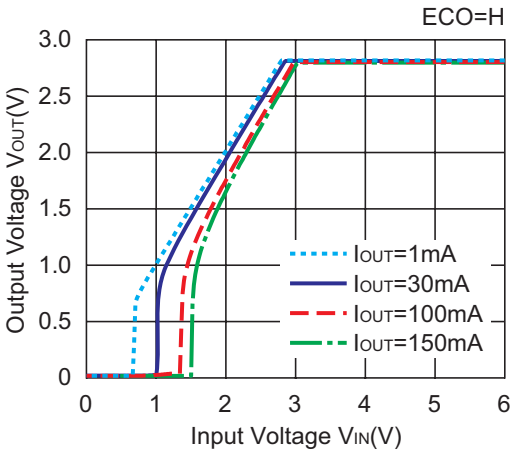
1.5V (VR1/VR2)



1.5V (VR1/VR2)



2.8V (VR1/VR2)



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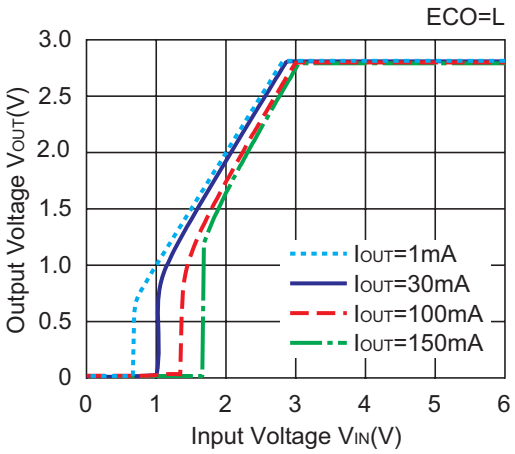
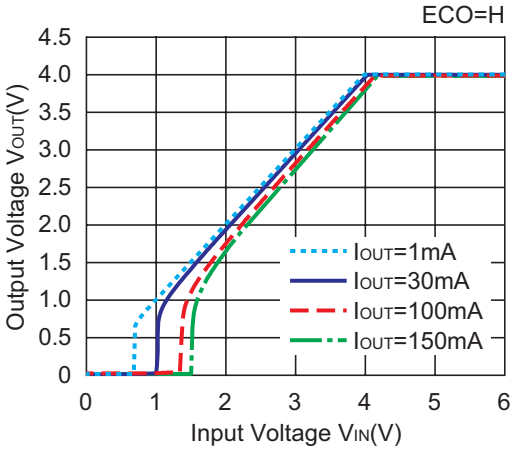
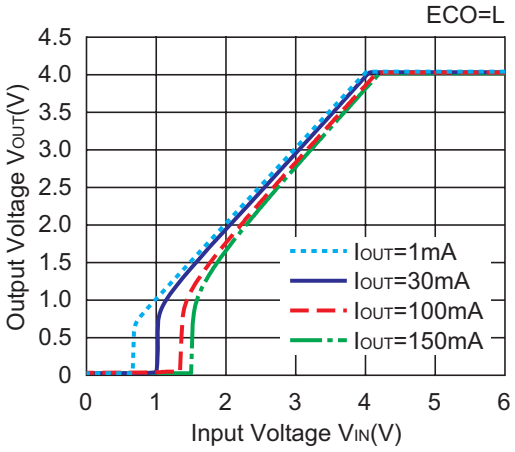


4.0V (VR1/VR2)

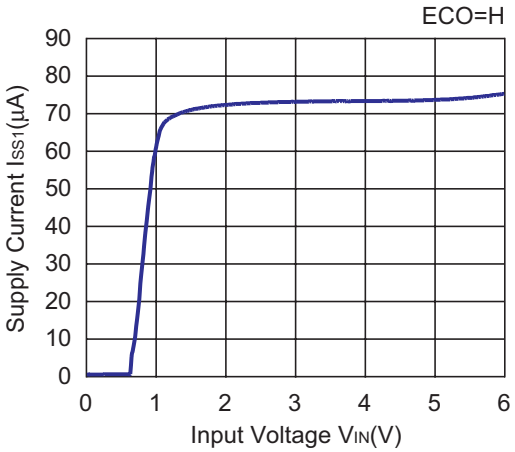


4.0V (VR1/VR2)

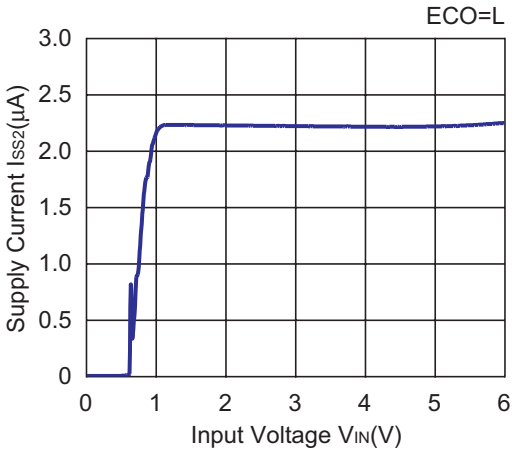


3) Supply Current vs. Input Voltage (Topt=25°C)

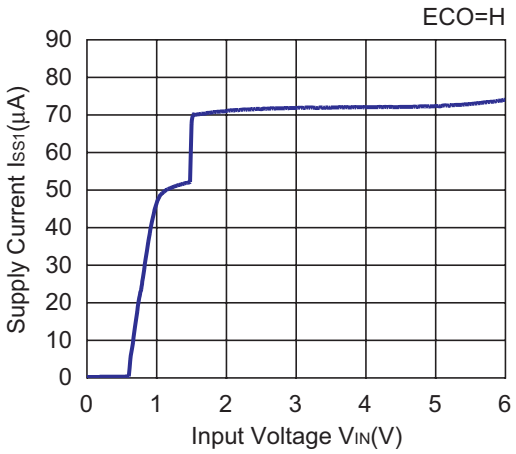
0.8V (VR1/VR2)



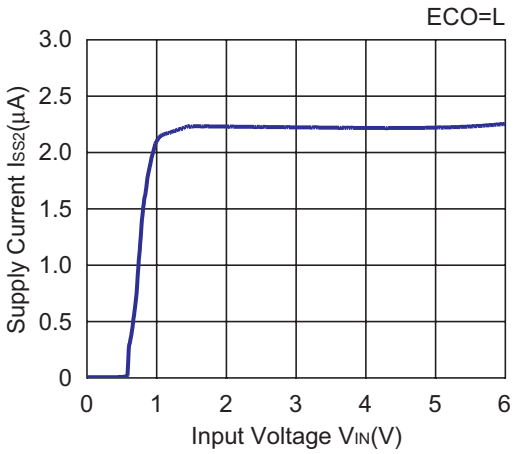
0.8V (VR1/VR2)



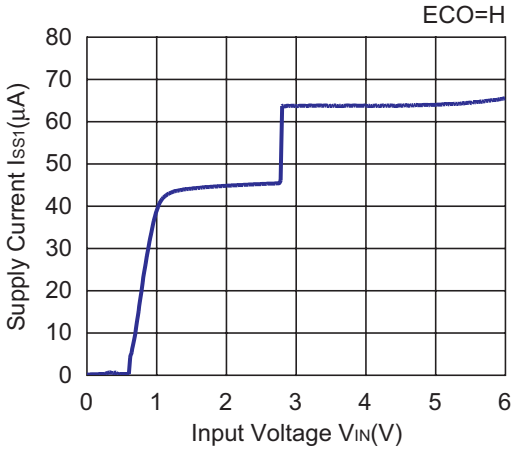
1.5V (VR1/VR2)



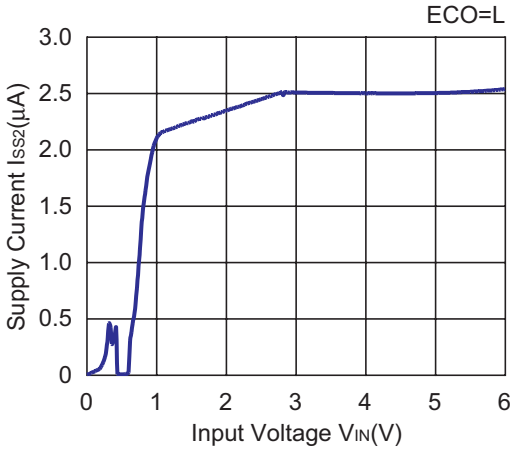
1.5V (VR1/VR2)



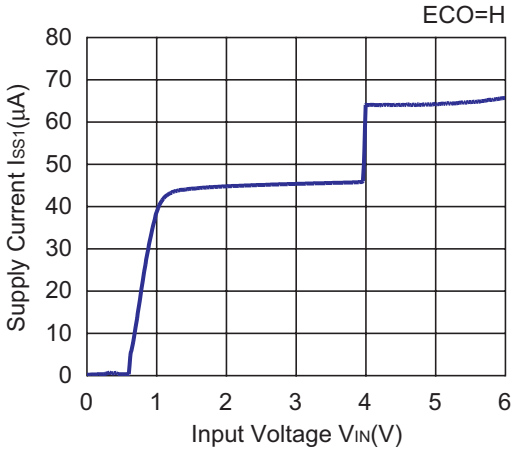
2.8V (VR1/VR2)



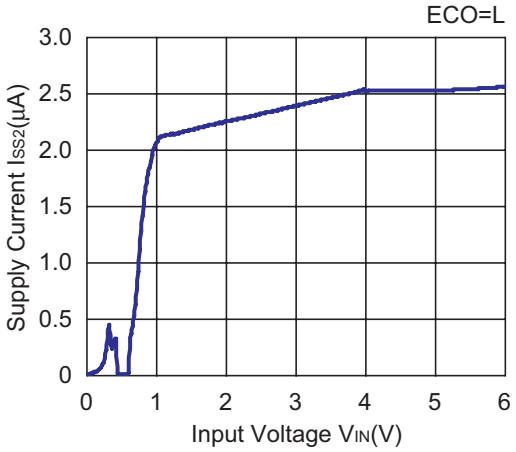
2.8V (VR1/VR2)



4.0V (VR1/VR2)

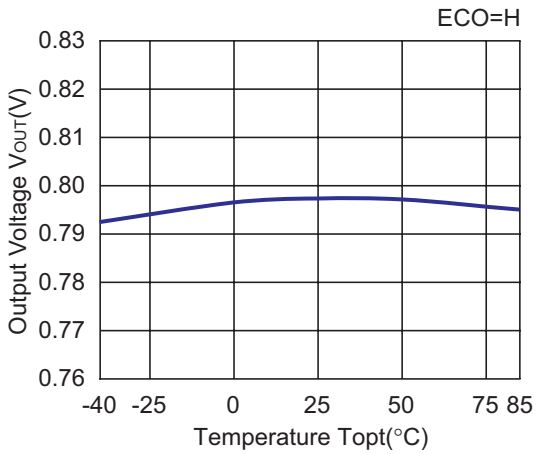


4.0V (VR1/VR2)

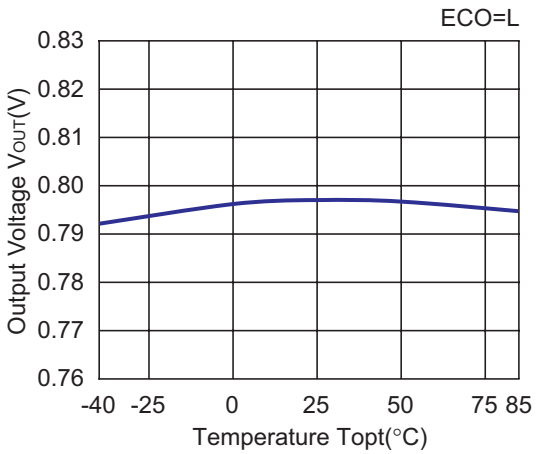


4) Output Voltage vs. Temperature

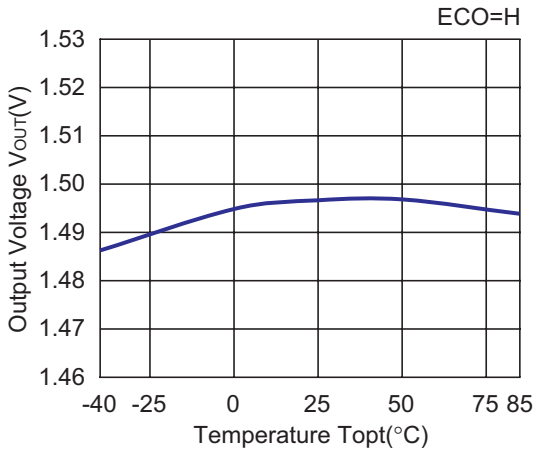
0.8V (VR1/VR2)



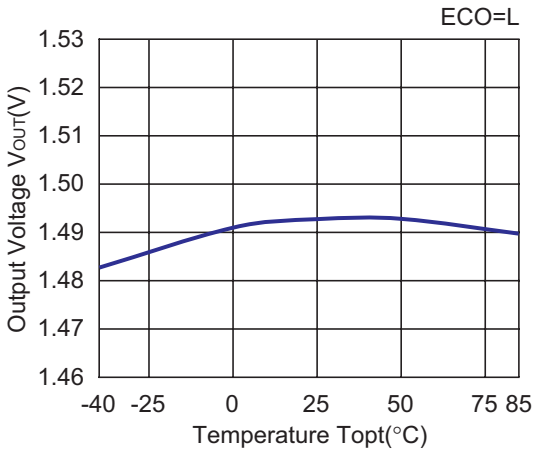
0.8V (VR1/VR2)



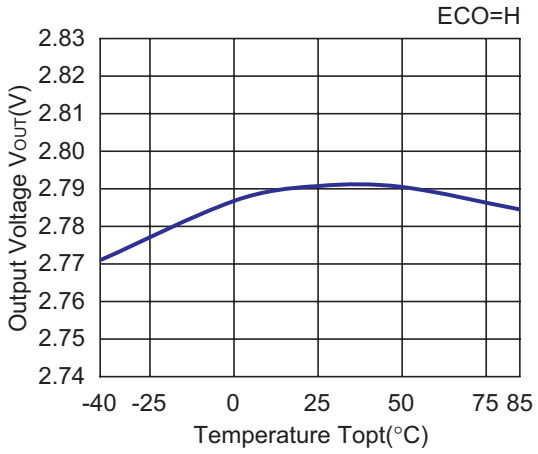
1.5V (VR1/VR2)



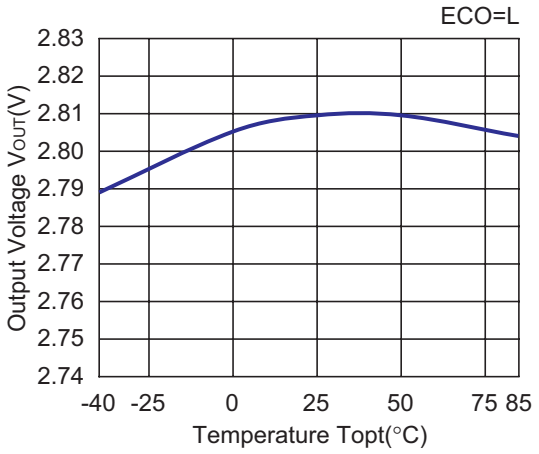
1.5V (VR1/VR2)



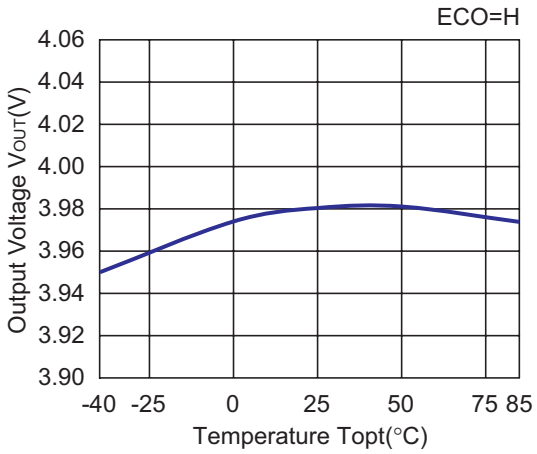
2.8V (VR1/VR2)



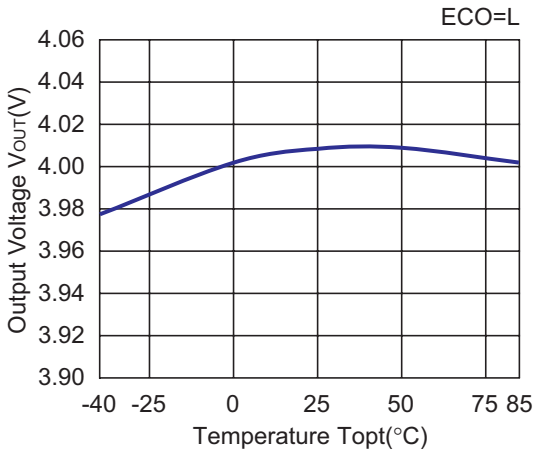
2.8V (VR1/VR2)



4.0V (VR1/VR2)

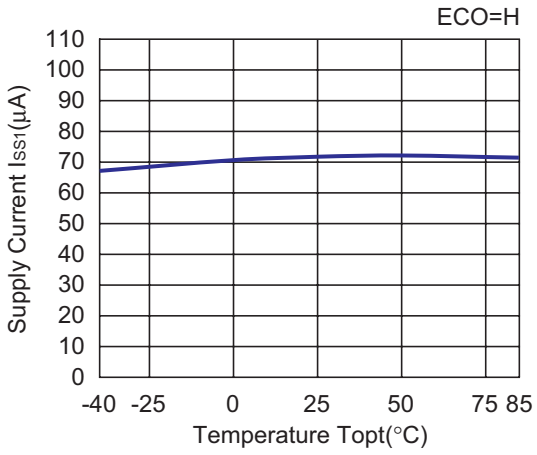


4.0V (VR1/VR2)

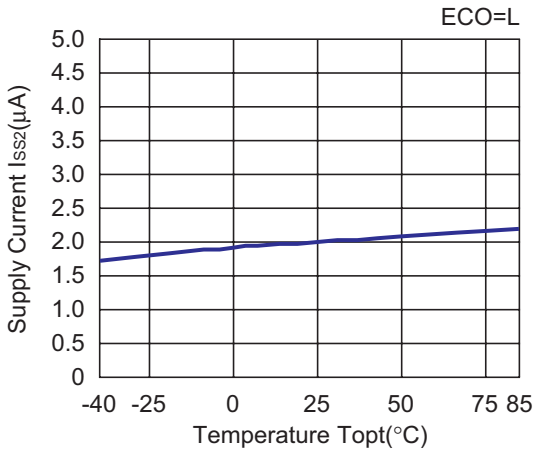


5) Supply Current vs. Temperature

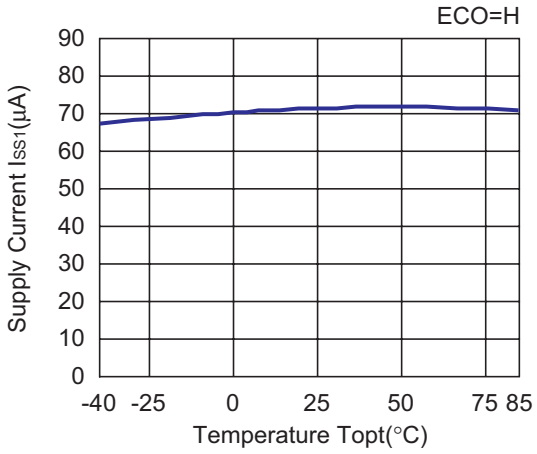
0.8V (VR1/VR2)



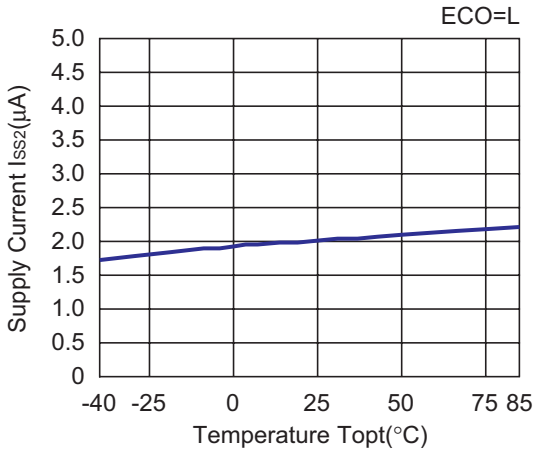
0.8V (VR1/VR2)



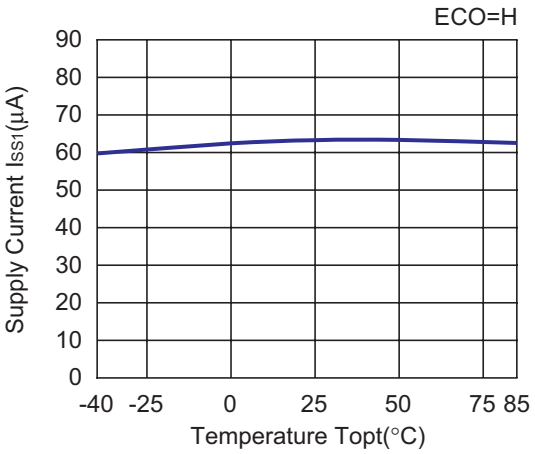
1.5V (VR1/VR2)



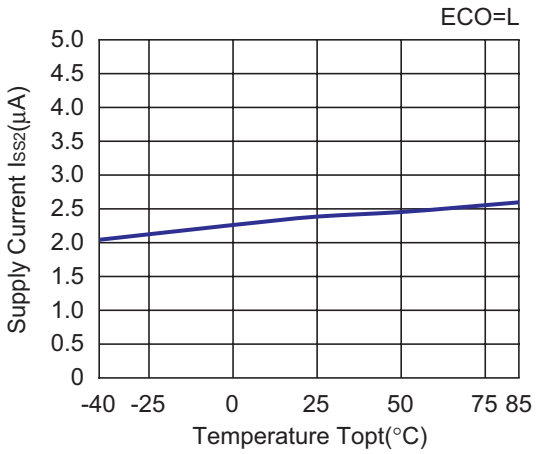
1.5V (VR1/VR2)



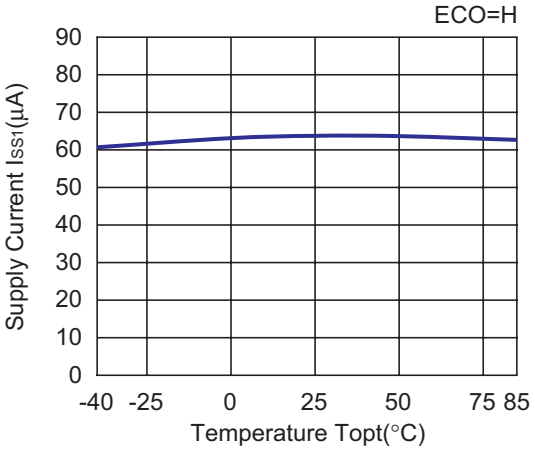
2.8V (VR1/VR2)



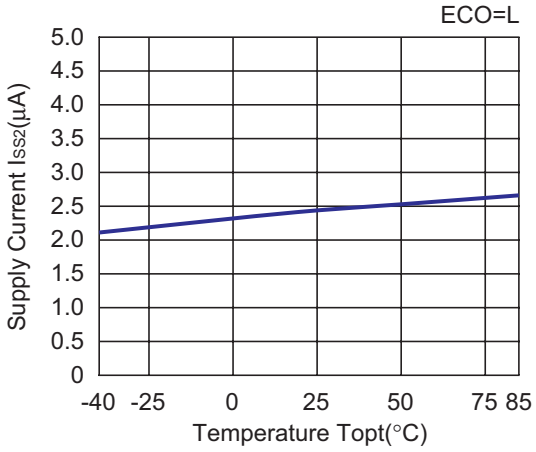
2.8V (VR1/VR2)



4.0V (VR1/VR2)

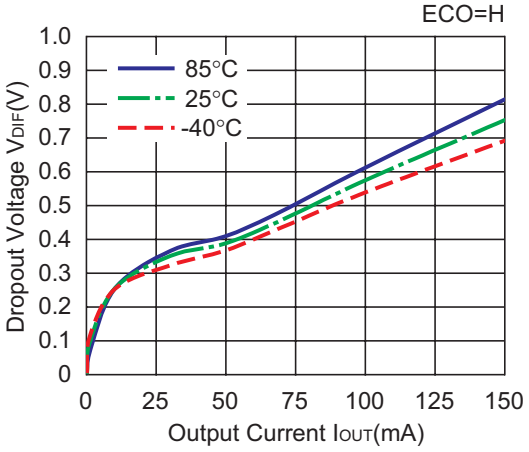


4.0V (VR1/VR2)

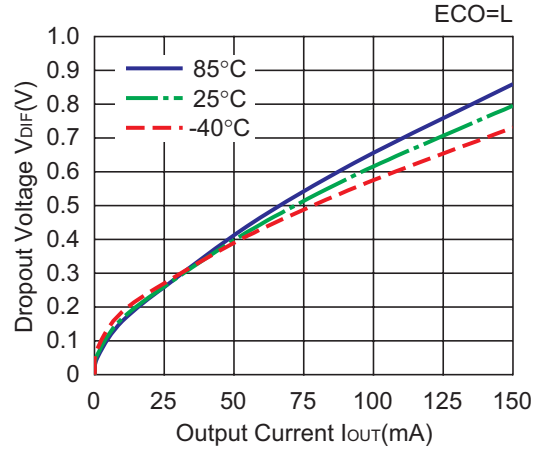


6) Dropout Voltage vs. Output Current

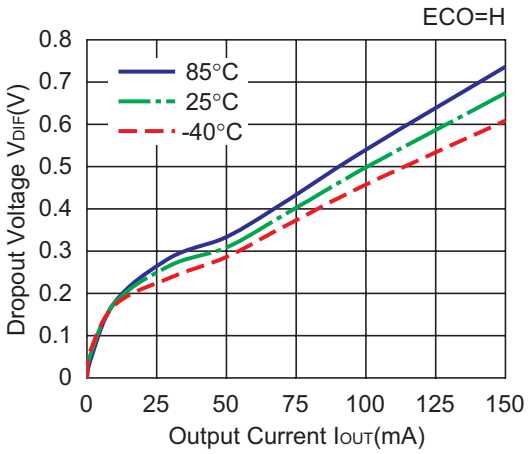
0.8V (VR1/VR2)



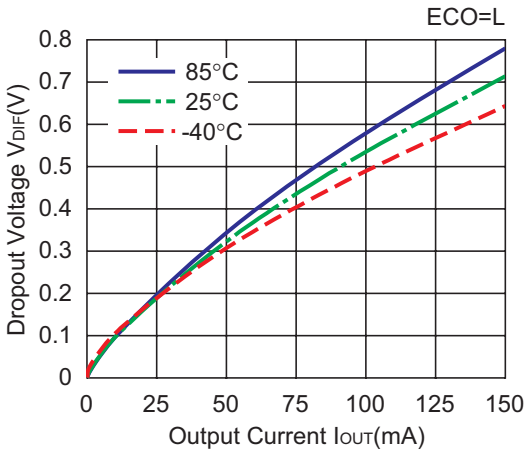
0.8V (VR1/VR2)



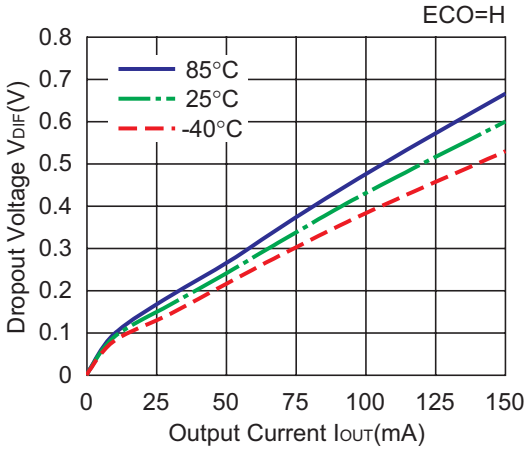
0.9V (VR1/VR2)



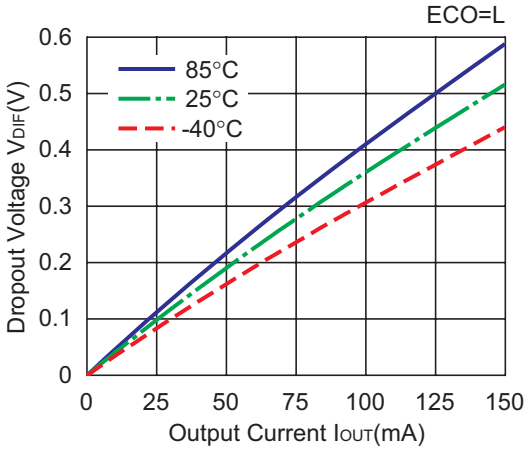
0.9V (VR1/VR2)



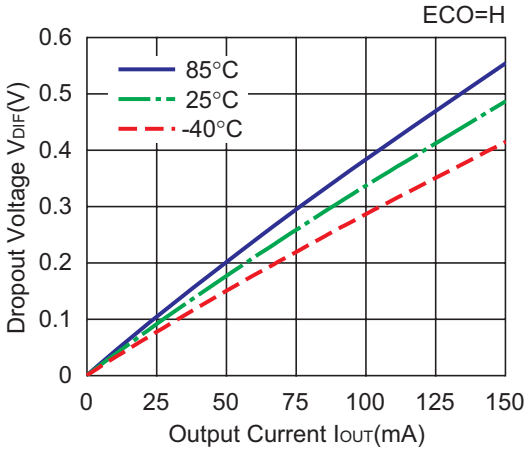
1.0V (VR1/VR2)



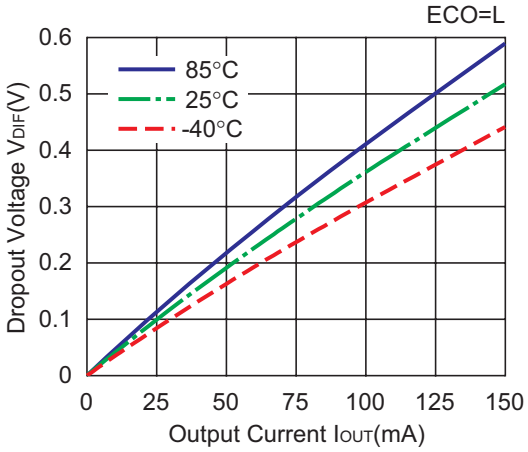
1.0V (VR1/VR2)



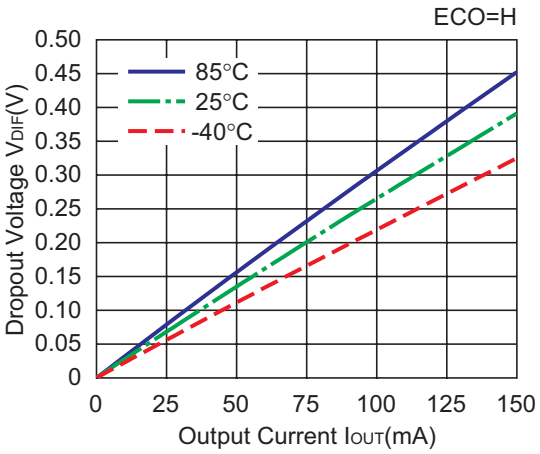
1.2V (VR1/VR2)



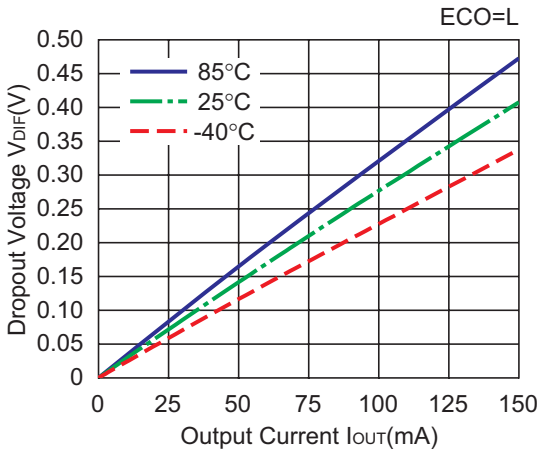
1.2V (VR1/VR2)



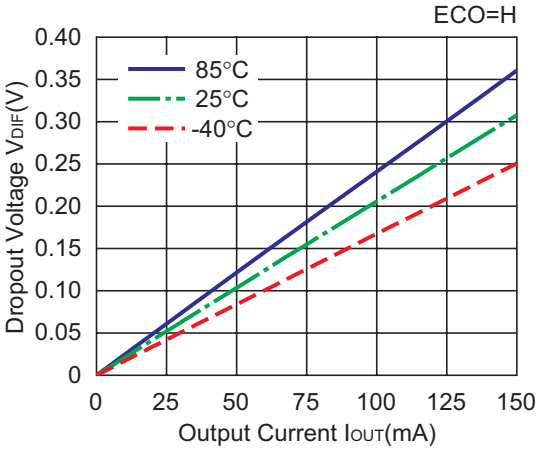
1.5V (VR1/VR2)



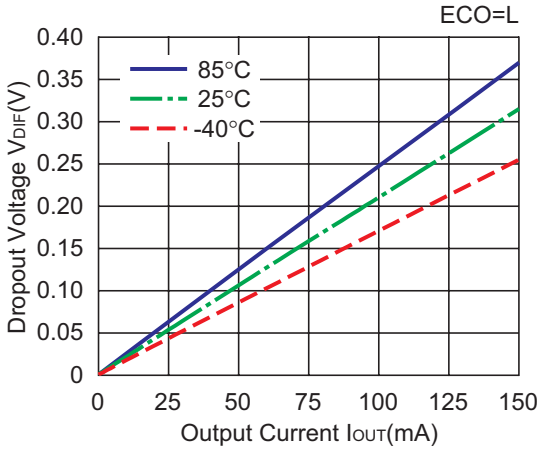
1.5V (VR1/VR2)



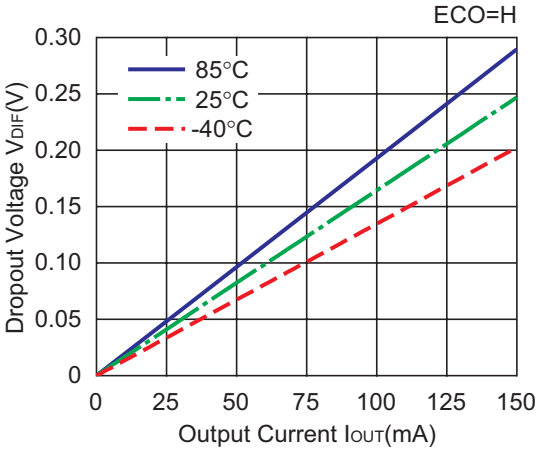
2.0V (VR1/VR2)



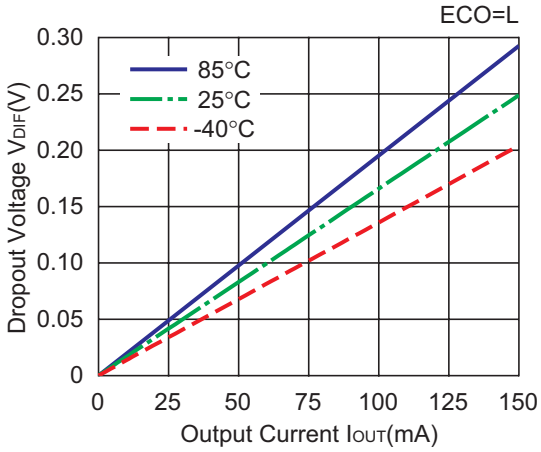
2.0V (VR1/VR2)



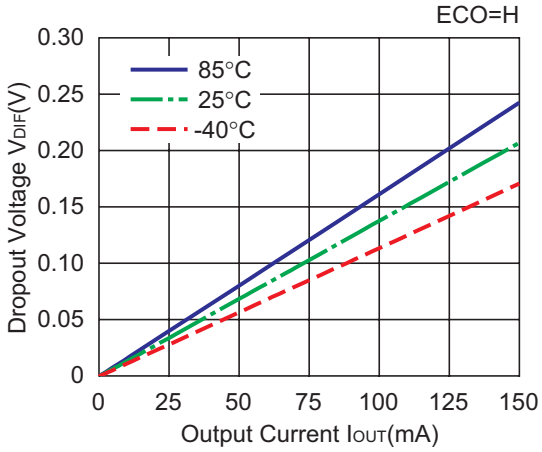
2.8V (VR1/VR2)



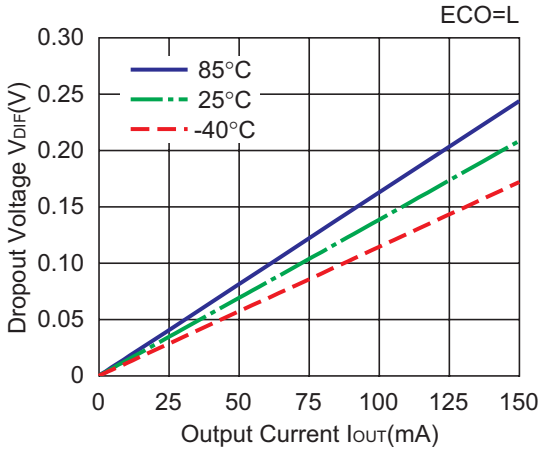
2.8V (VR1/VR2)



4.0V (VR1/VR2)

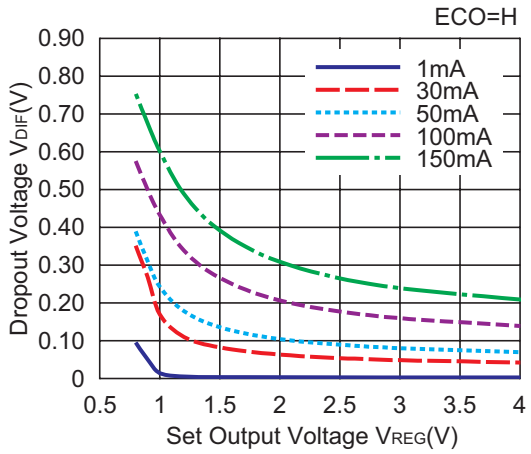


4.0V (VR1/VR2)

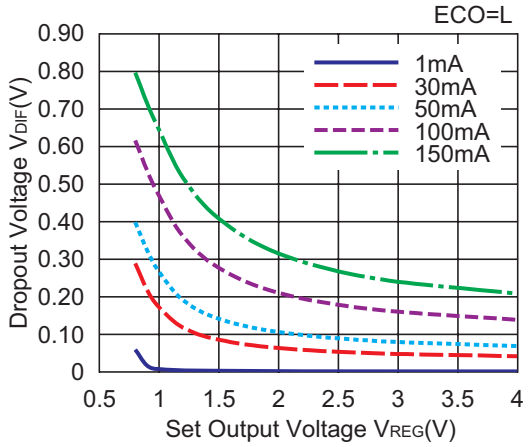


7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)

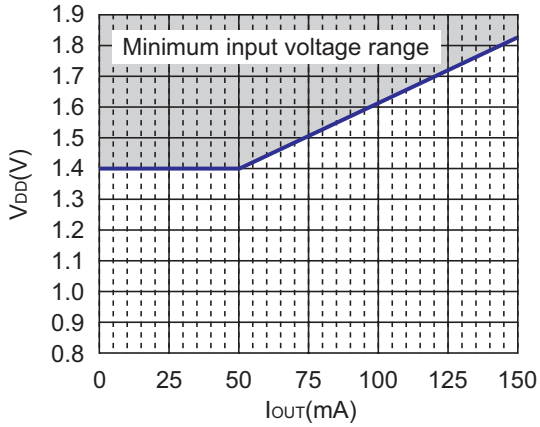
R5328K (VR1/VR2)



R5328K (VR1/VR2)

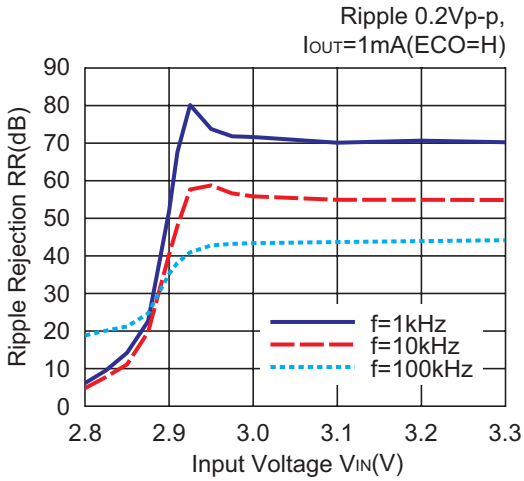


8) 0.8V (VR1/VR2) type minimum input voltage limit (Topt=25°C)

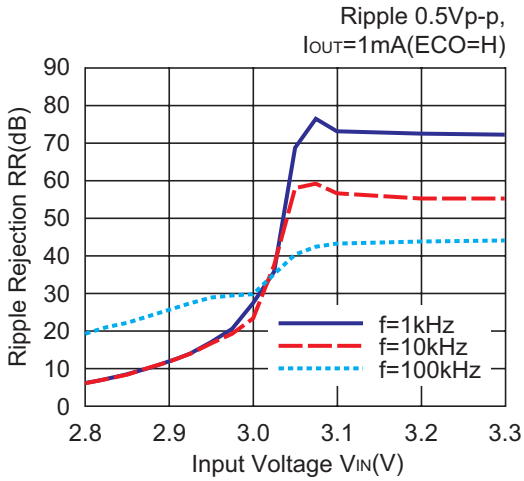


9) Ripple Rejection vs. Input Bias Voltage (Topt=25°C, CIN=none, COUT=Ceramic 1.0µF, ECO=H)

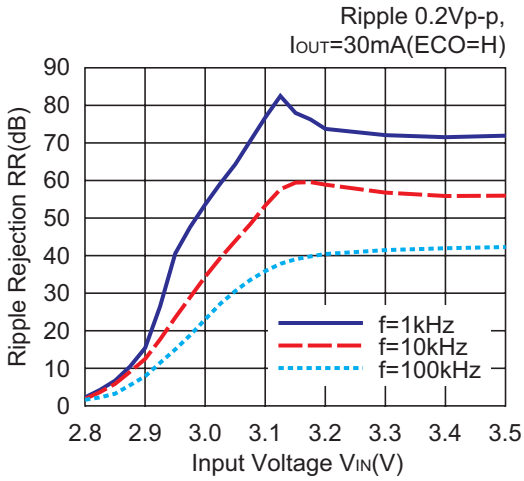
2.8V (VR1/VR2)



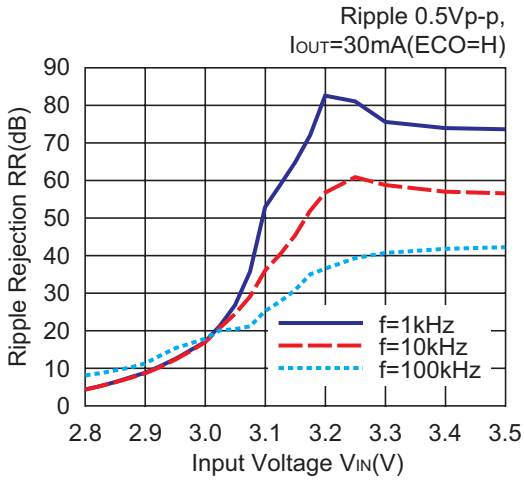
2.8V (VR1/VR2)



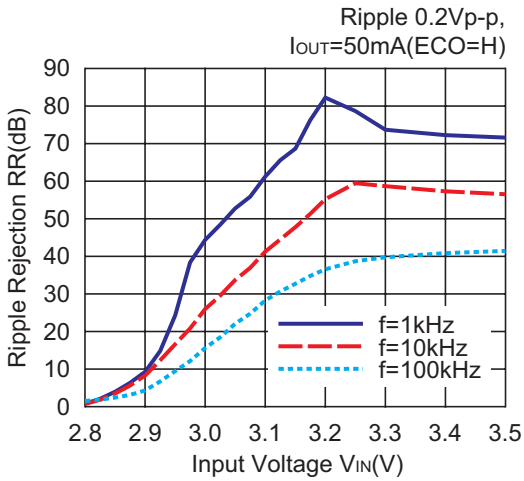
2.8V (VR1/VR2)



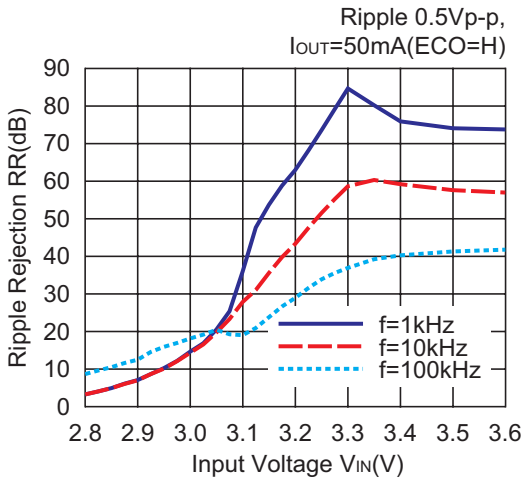
2.8V (VR1/VR2)



2.8V (VR1/VR2)

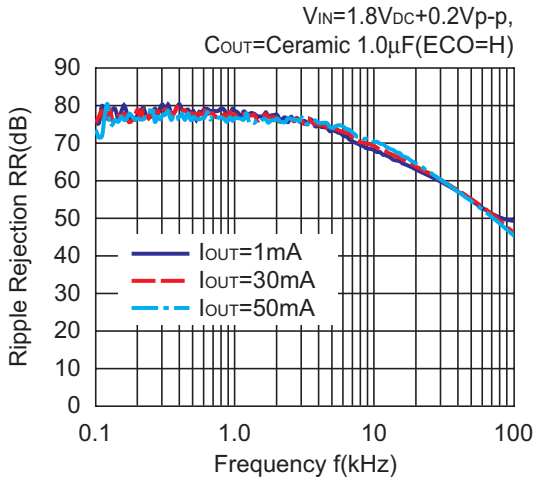


2.8V (VR1/VR2)

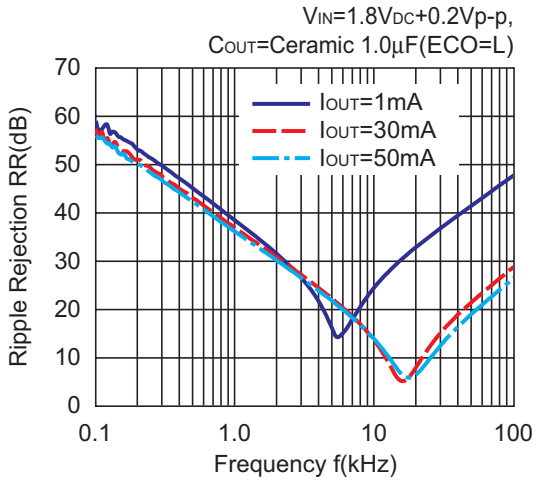


10) Ripple Rejection vs. Frequency (Topt=25°C, CIN=none)

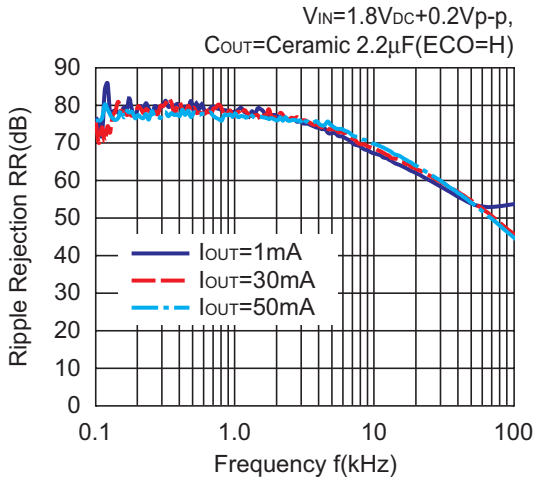
0.8V (VR1/VR2)



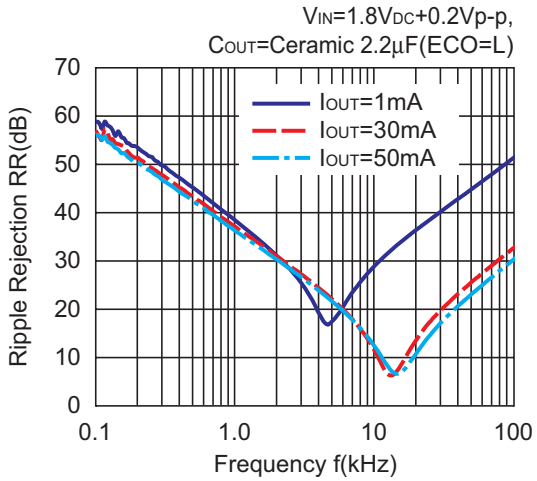
0.8V (VR1/VR2)



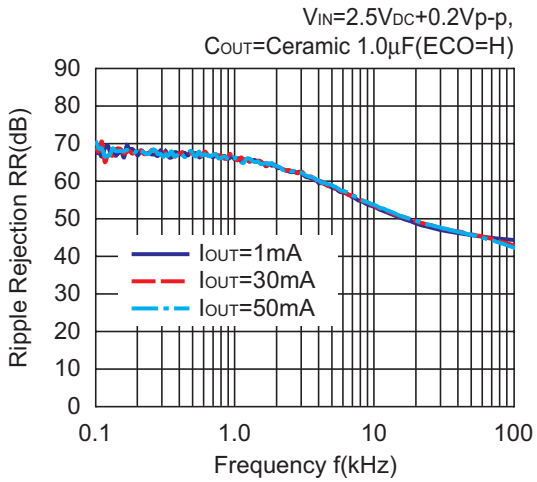
0.8V (VR1/VR2)



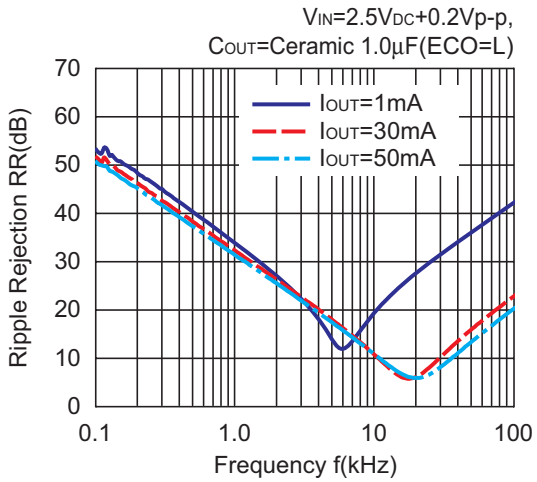
0.8V (VR1/VR2)



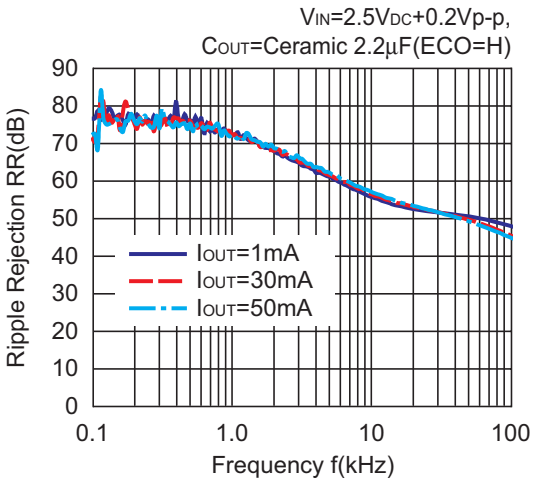
1.5V (VR1/VR2)



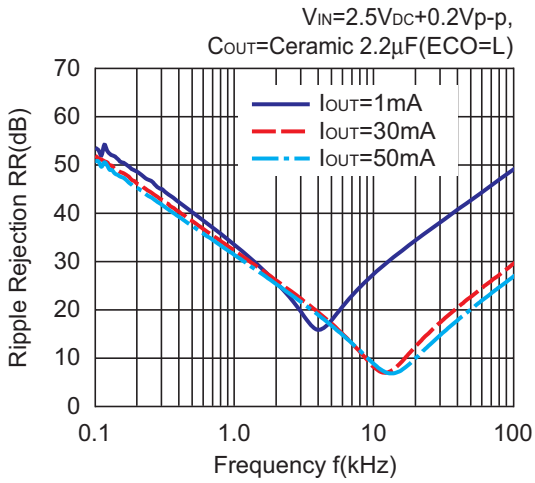
1.5V (VR1/VR2)



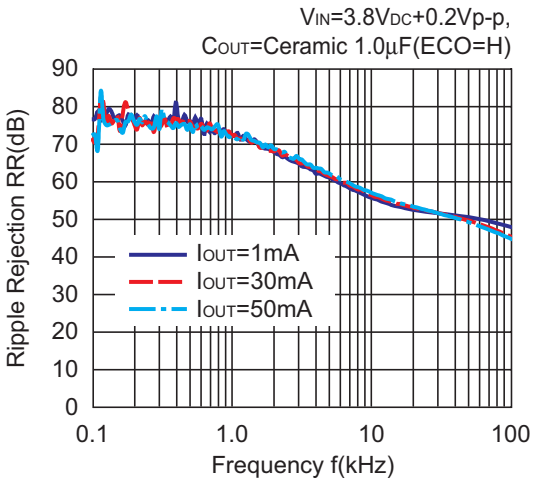
1.5V (VR1/VR2)



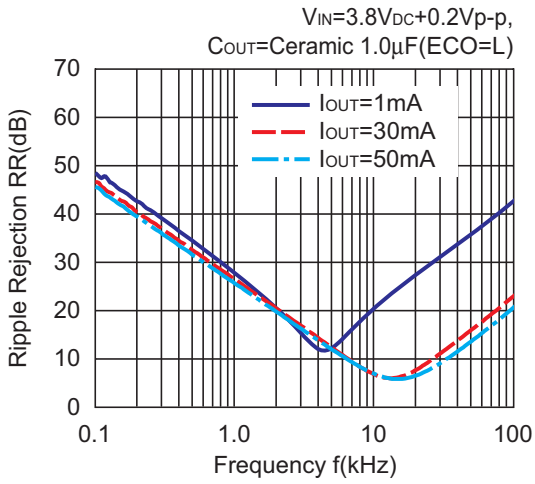
1.5V (VR1/VR2)



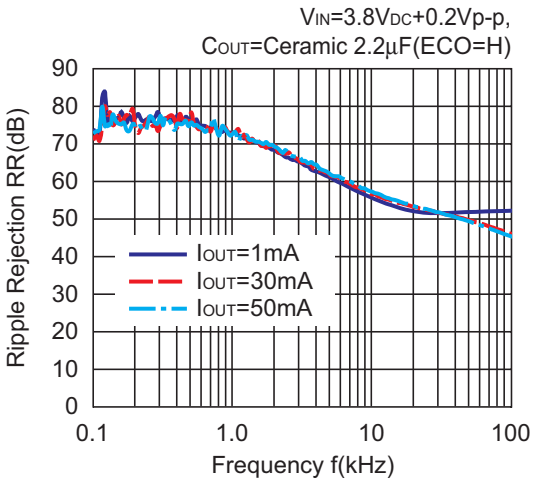
2.8V (VR1/VR2)



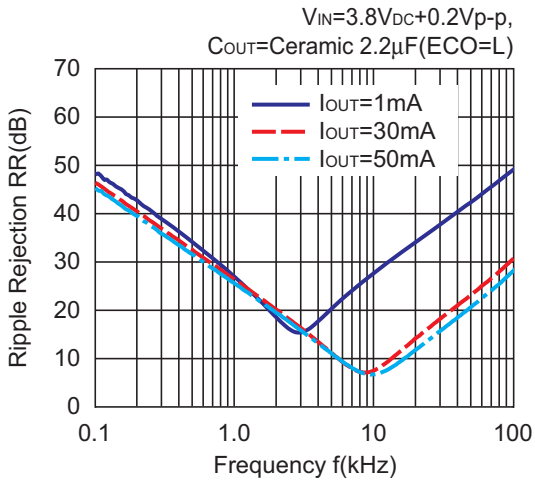
2.8V (VR1/VR2)



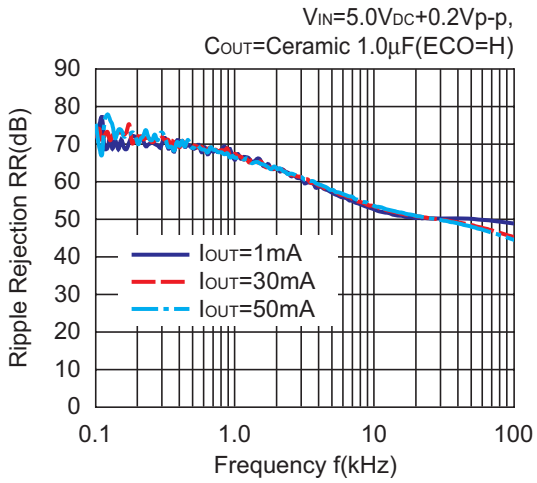
2.8V (VR1/VR2)



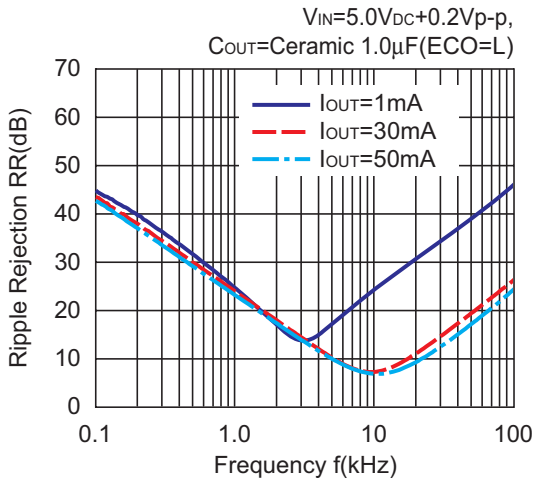
2.8V (VR1/VR2)



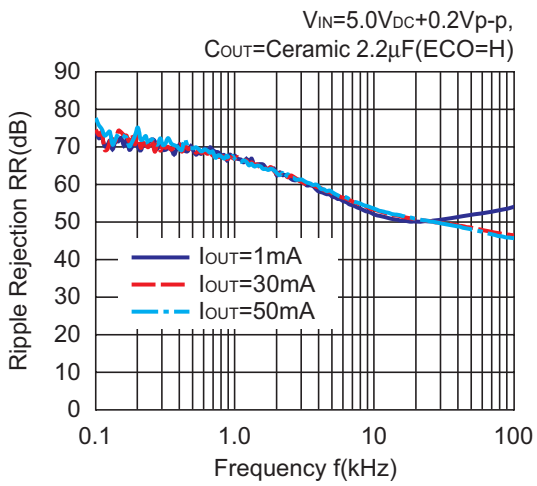
4.0V (VR1/VR2)



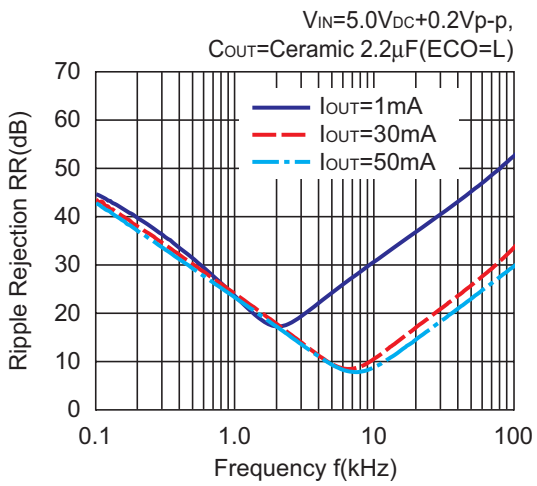
4.0V (VR1/VR2)



4.0V (VR1/VR2)

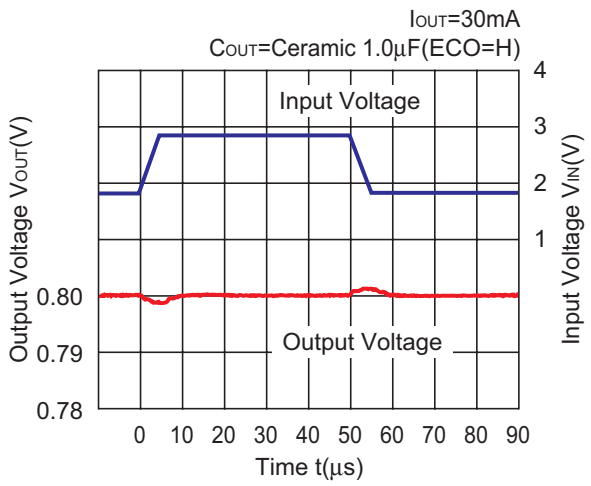


4.0V (VR1/VR2)

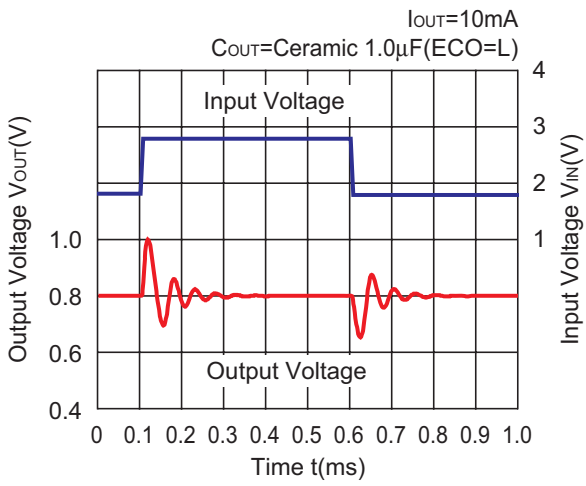


11) Input Transient Response (CIN=none)

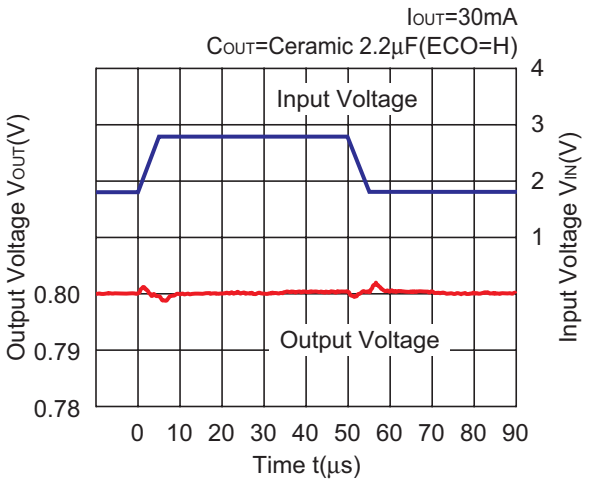
0.8V (VR1/VR2)



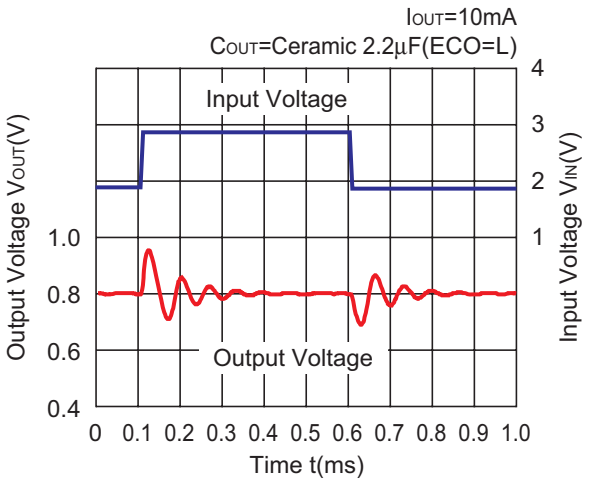
0.8V (VR1/VR2)



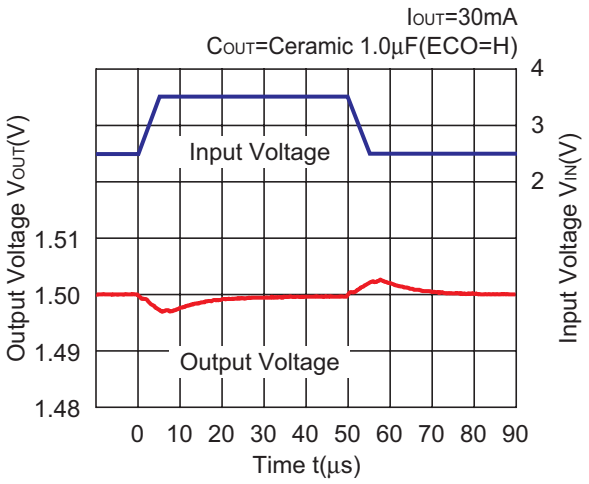
0.8V (VR1/VR2)



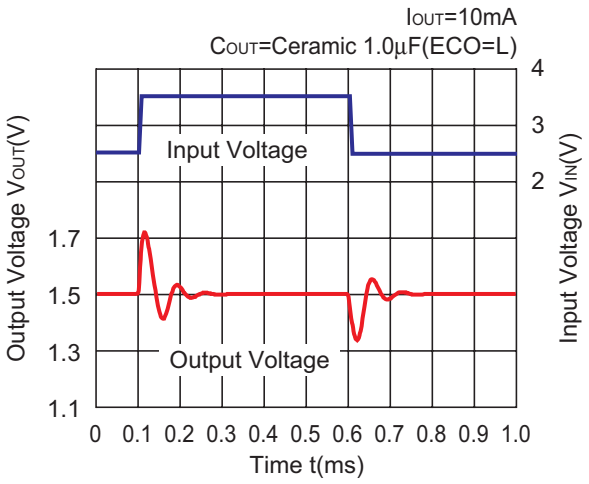
0.8V (VR1/VR2)



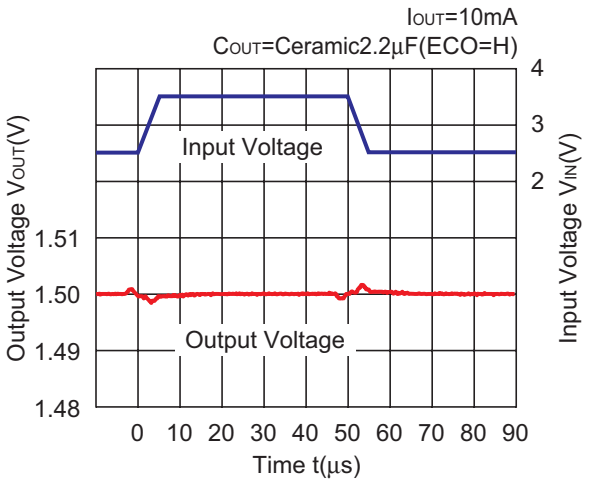
1.5V (VR1/VR2)



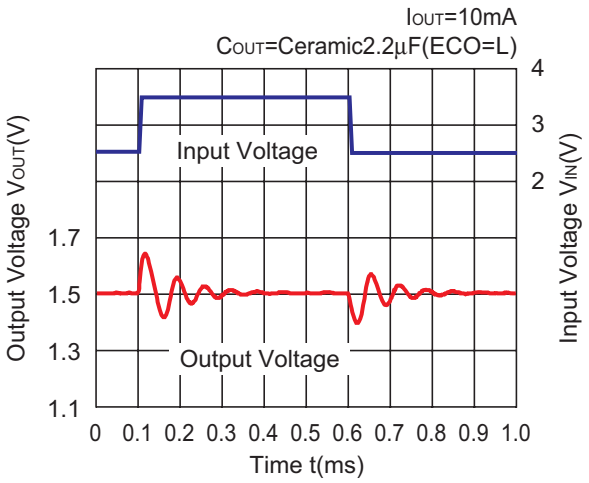
1.5V (VR1/VR2)



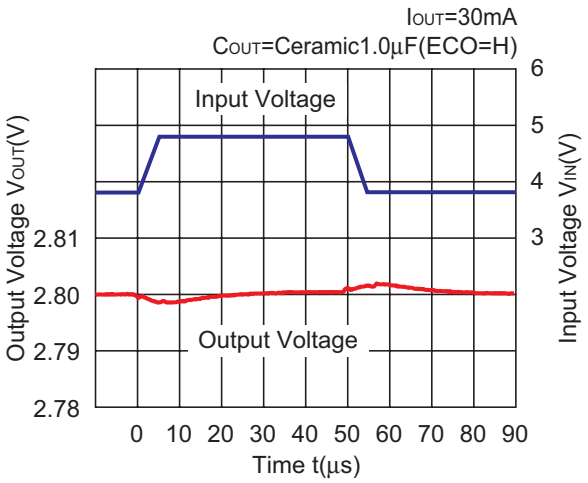
1.5V (VR1/VR2)



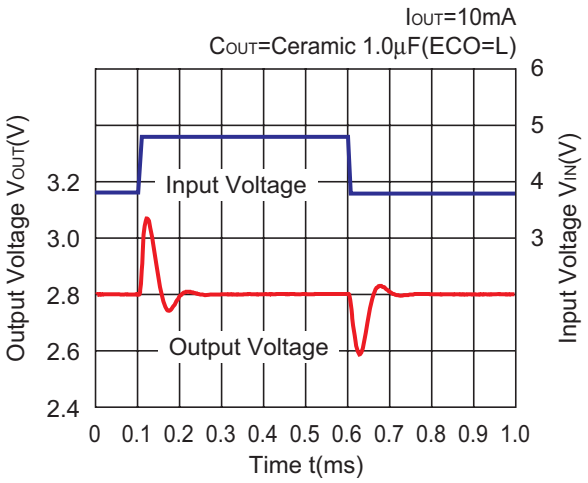
1.5V (VR1/VR2)



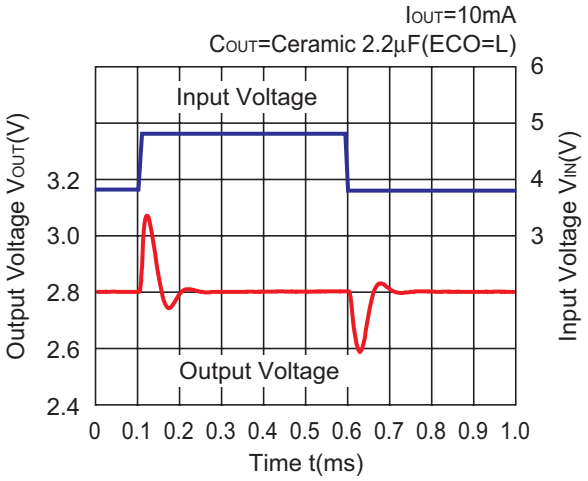
2.8V (VR1/VR2)



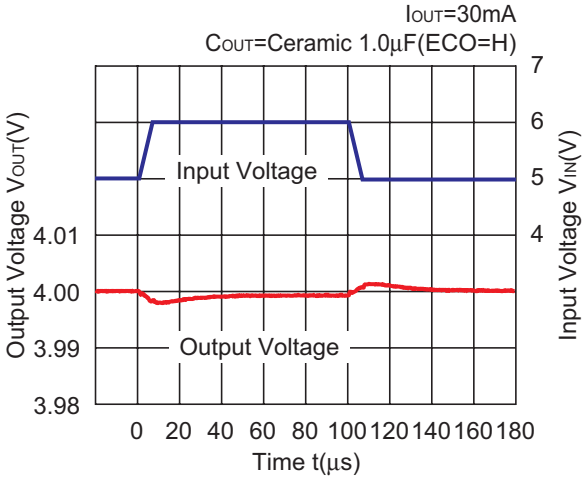
2.8V (VR1/VR2)



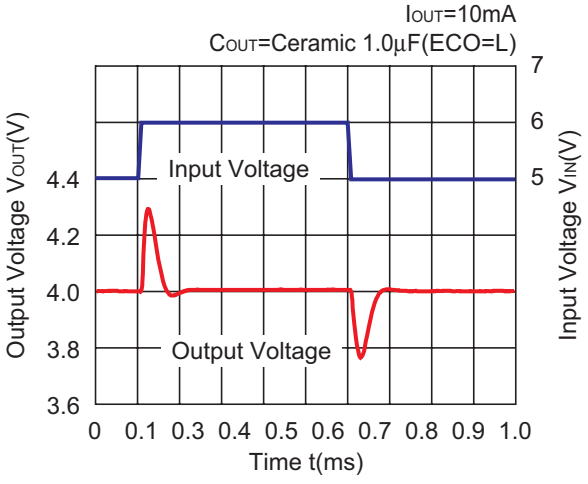
2.8V (VR1/VR2)



4.0V (VR1/VR2)

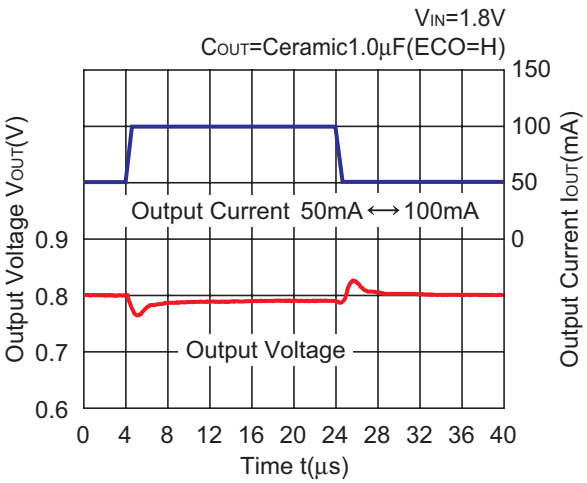


4.0V (VR1/VR2)

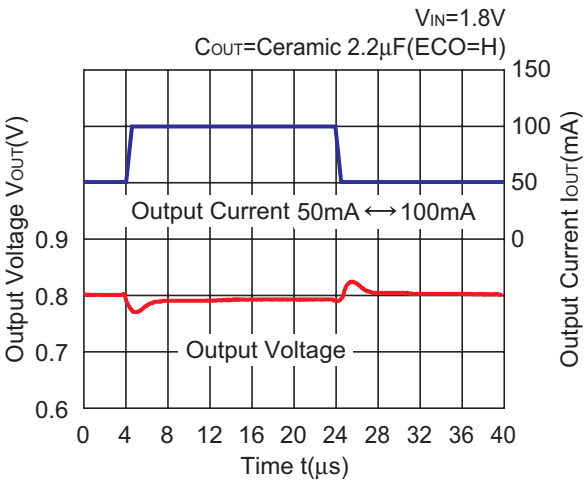


12) Load Transient Response (C_{IN}=Ceramic 1.0µF)

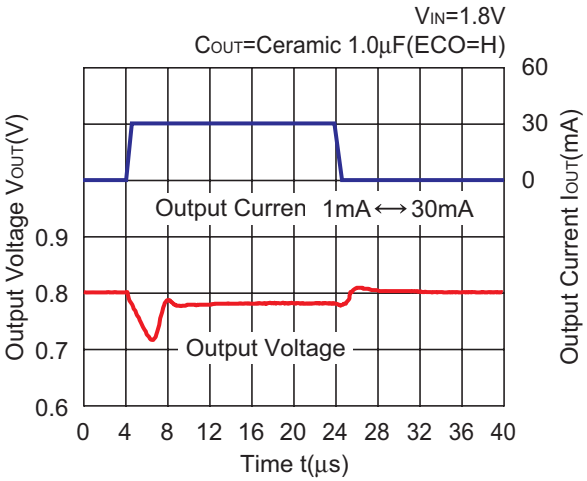
0.8V (VR1/VR2)



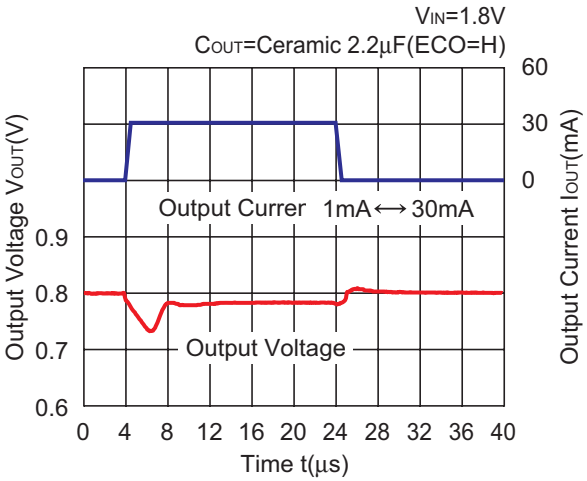
0.8V (VR1/VR2)



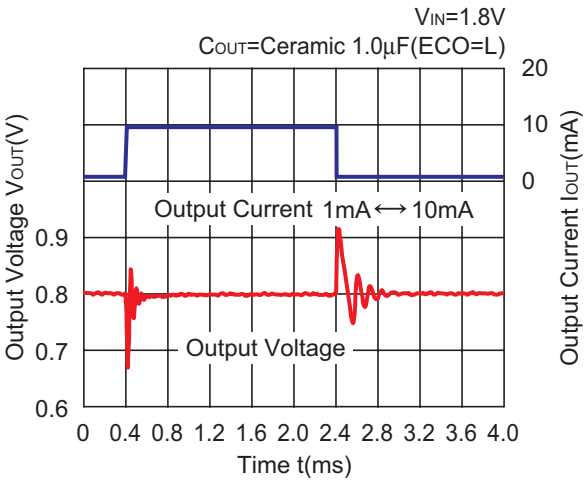
0.8V (VR1/VR2)



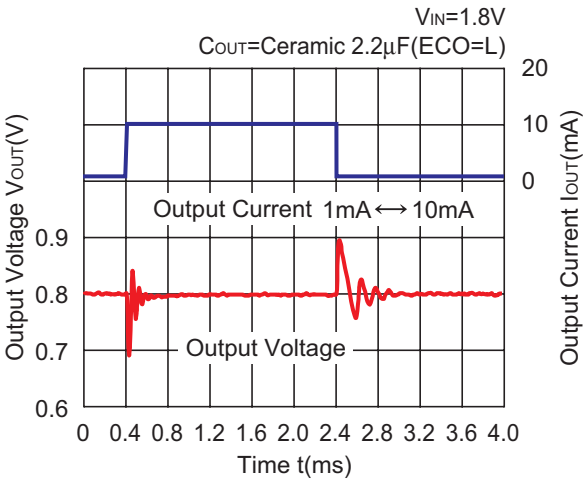
0.8V (VR1/VR2)



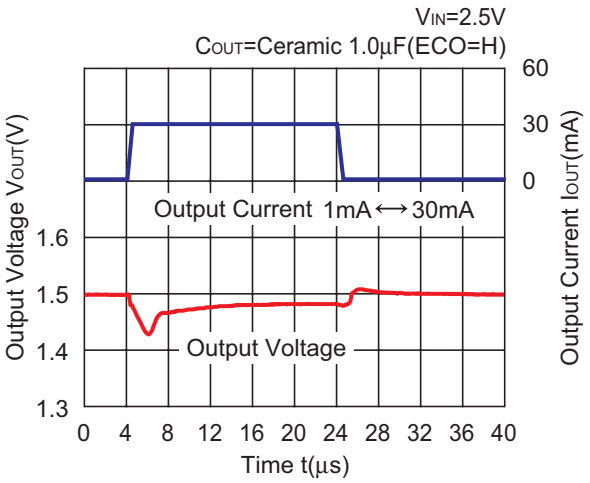
0.8V (VR1/VR2)



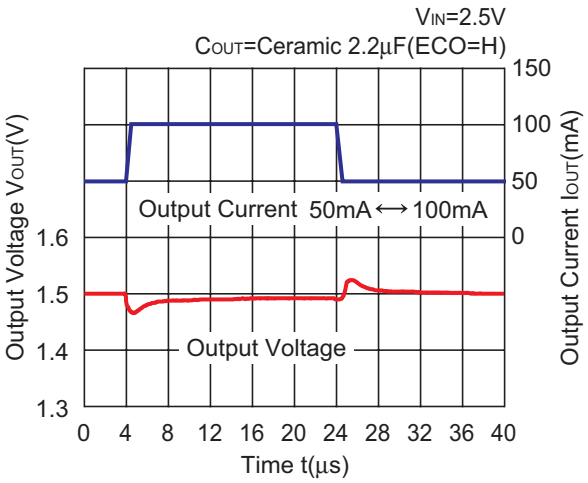
0.8V (VR1/VR2)



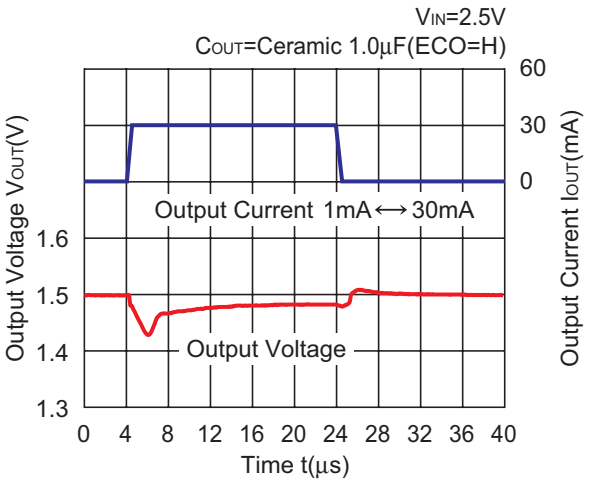
1.5V (VR1/VR2)



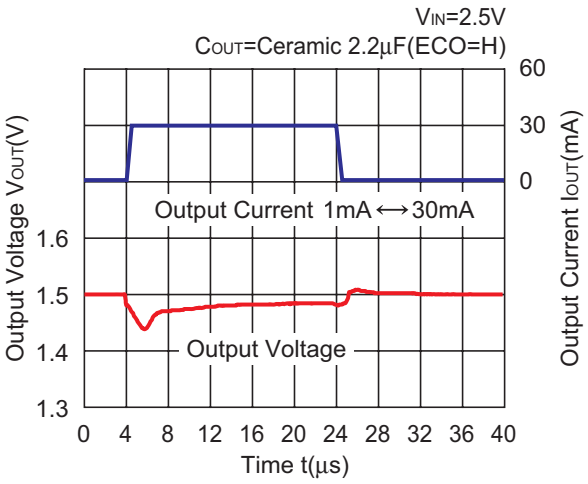
1.5V (VR1/VR2)



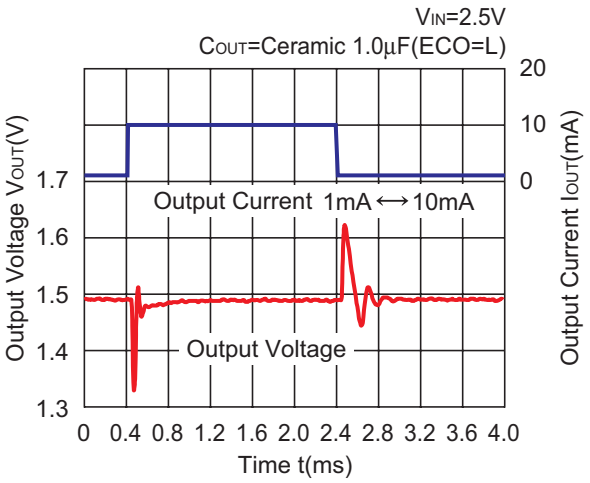
1.5V (VR1/VR2)



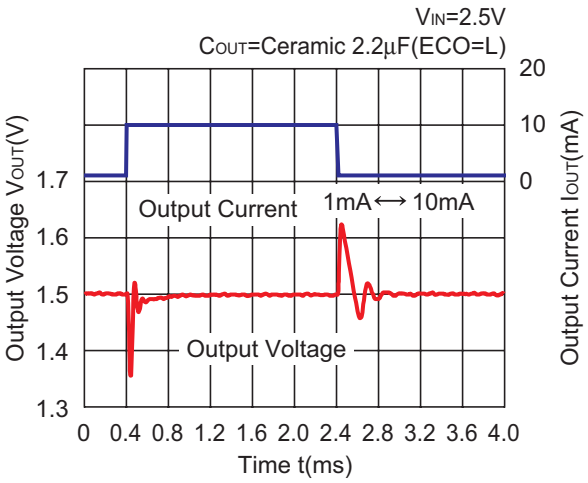
1.5V (VR1/VR2)



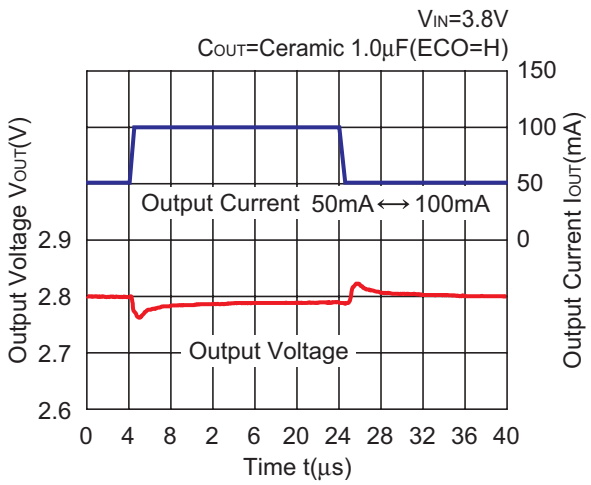
1.5V (VR1/VR2)



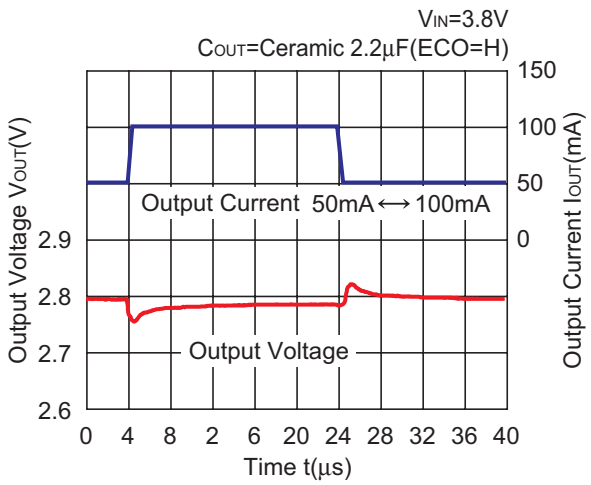
1.5V (VR1/VR2)



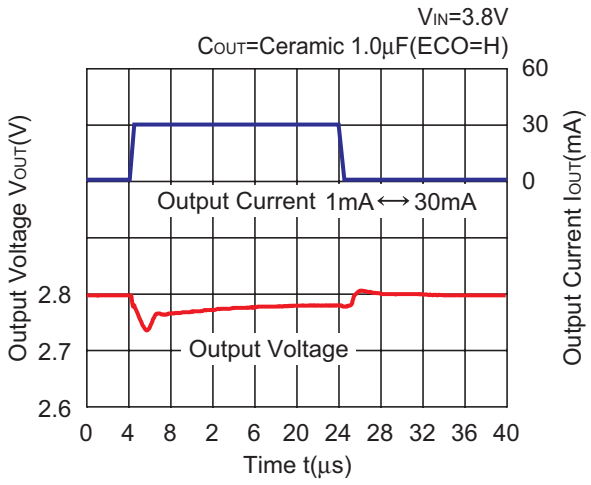
2.8V (VR1/VR2)



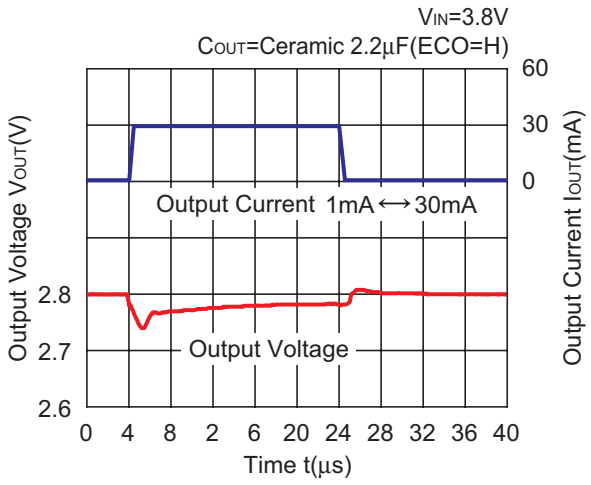
2.8V (VR1/VR2)



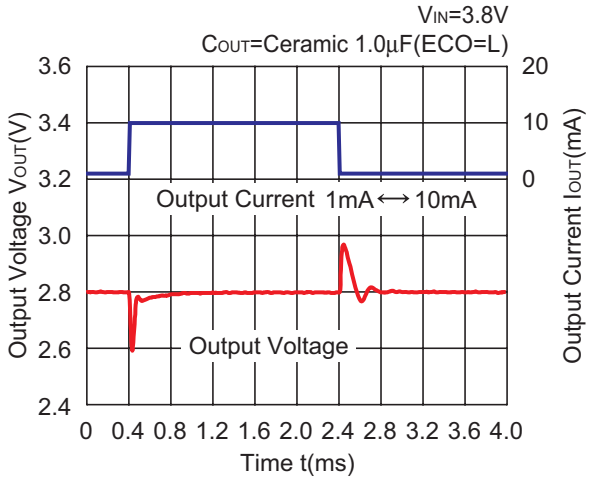
2.8V (VR1/VR2)



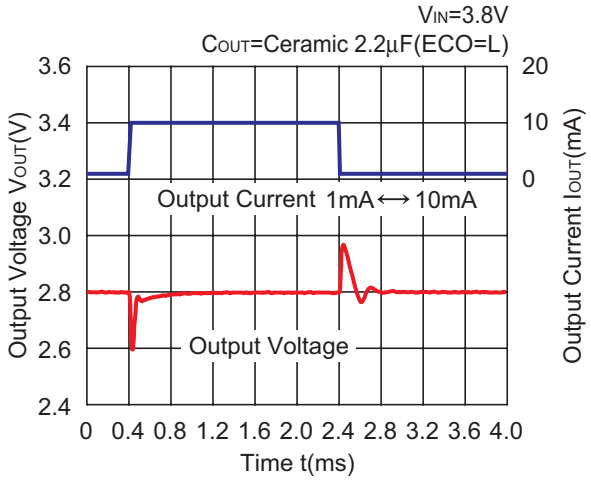
2.8V (VR1/VR2)



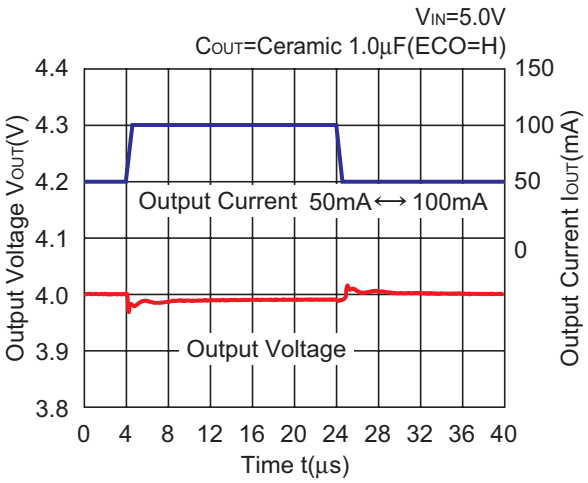
2.8V (VR1/VR2)



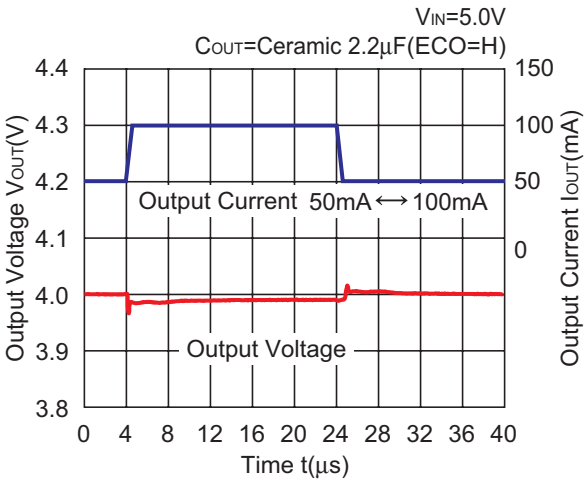
2.8V (VR1/VR2)



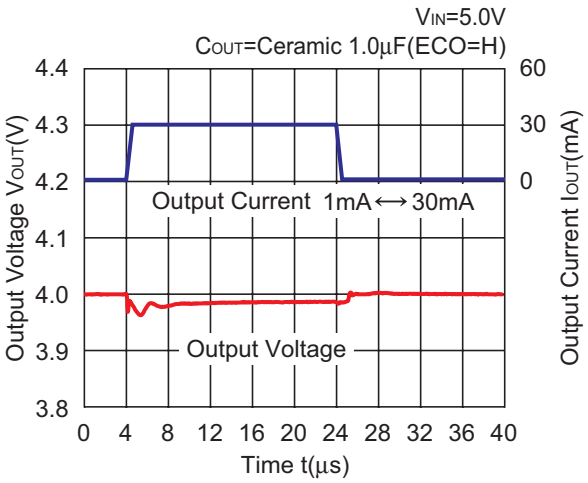
4.0V (VR1/VR2)



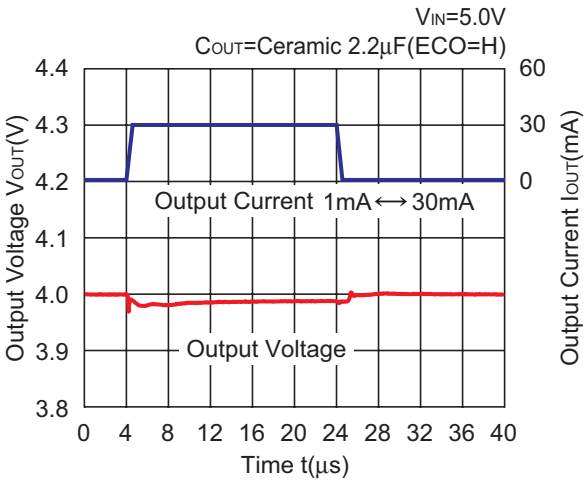
4.0V (VR1/VR2)



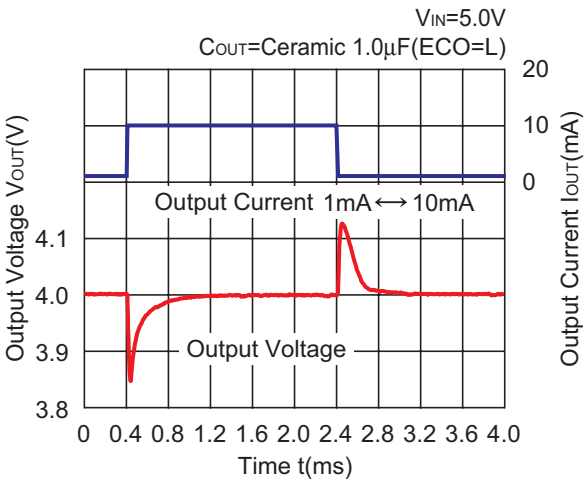
4.0V (VR1/VR2)



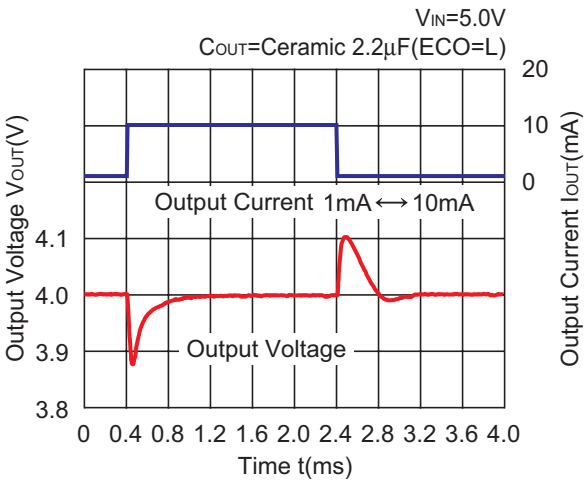
4.0V (VR1/VR2)



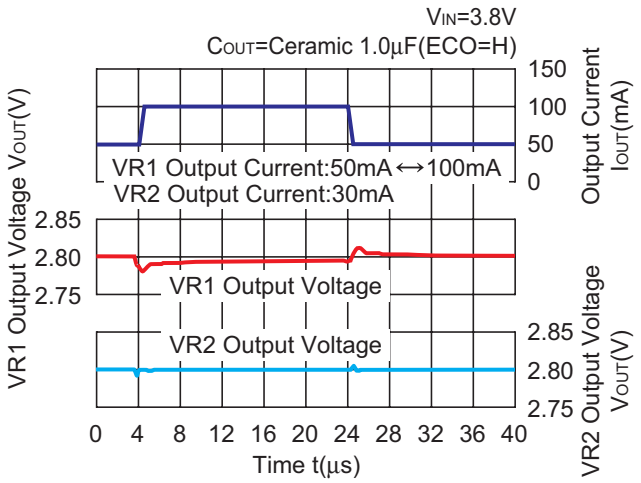
4.0V (VR1/VR2)



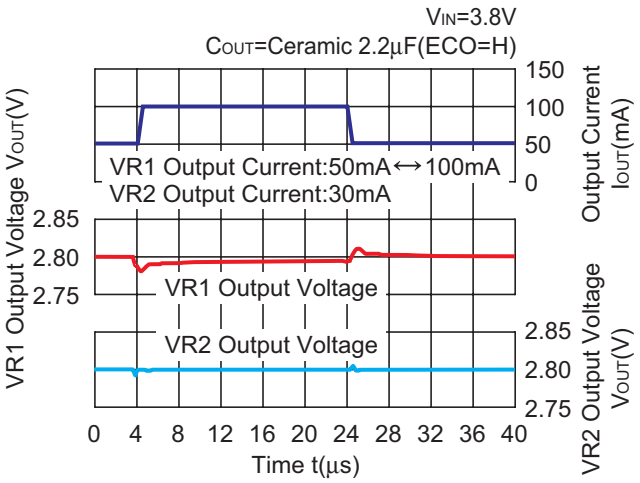
4.0V (VR1/VR2)



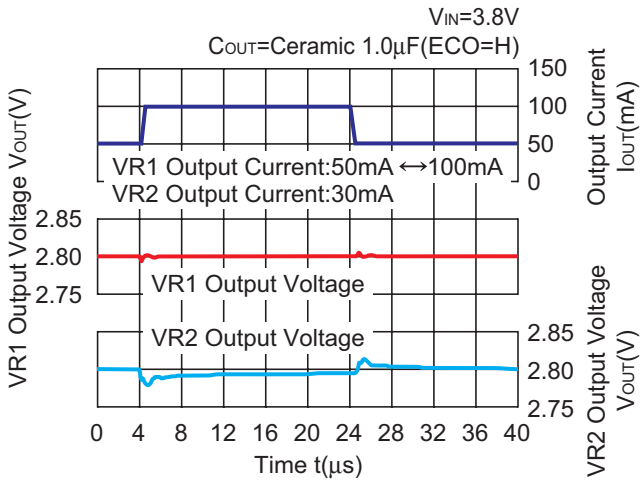
2.8V (VR1/VR2)



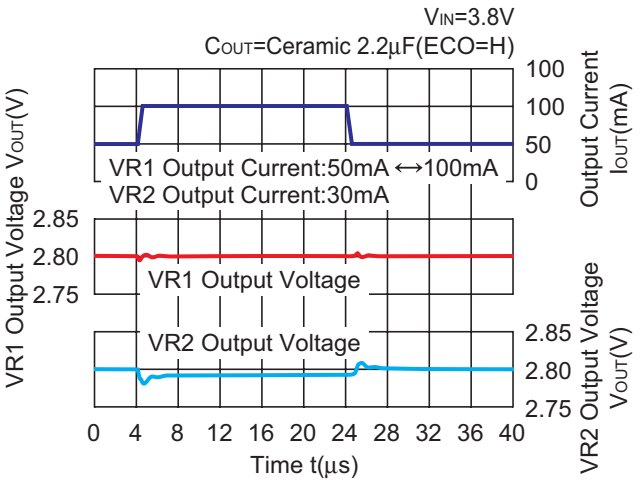
2.8V (VR1/VR2)



2.8V (VR1/VR2)

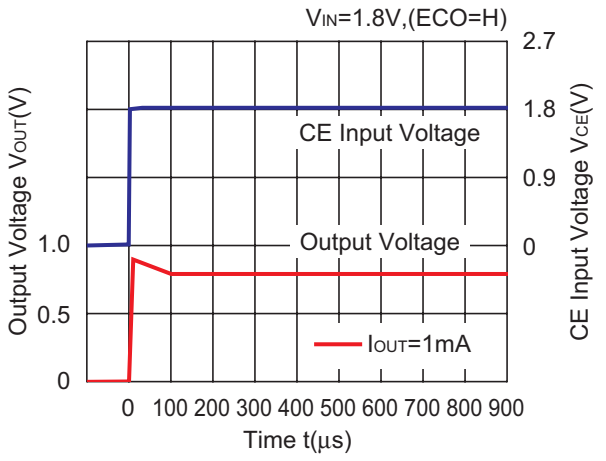


2.8V (VR1/VR2)

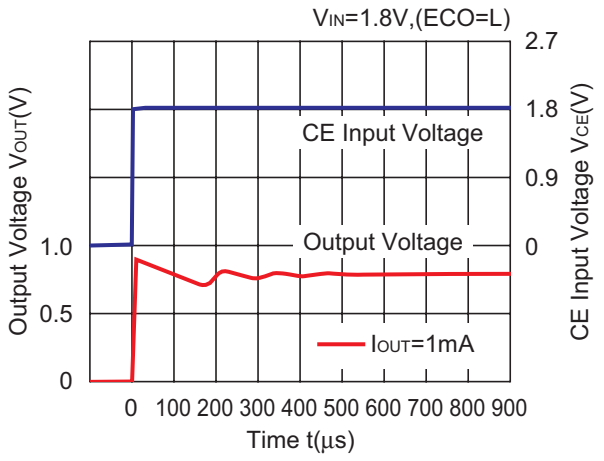


13) Turn on speed by CE pin control (CIN=1.0µF, COUT=Ceramic 1.0µF)

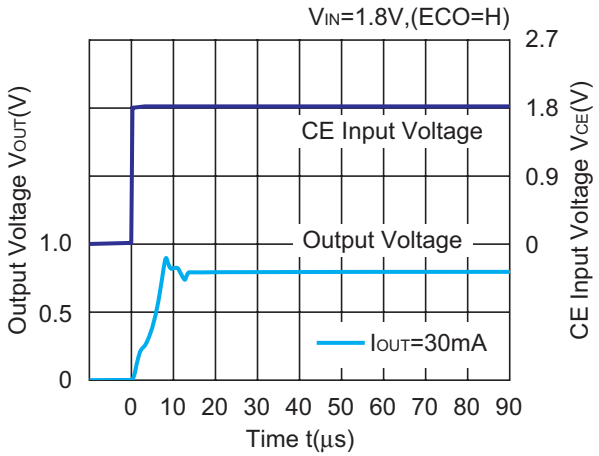
0.8V (VR1/VR2)



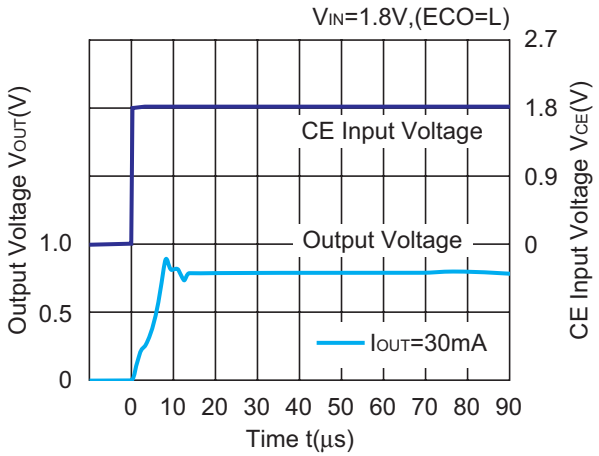
0.8V (VR1/VR2)



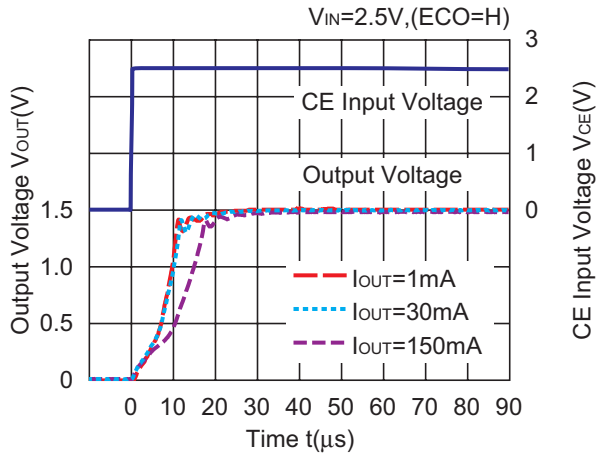
0.8V (VR1/VR2)



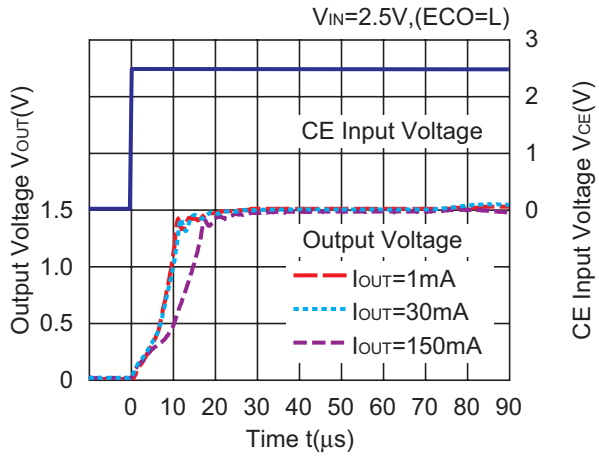
0.8V (VR1/VR2)



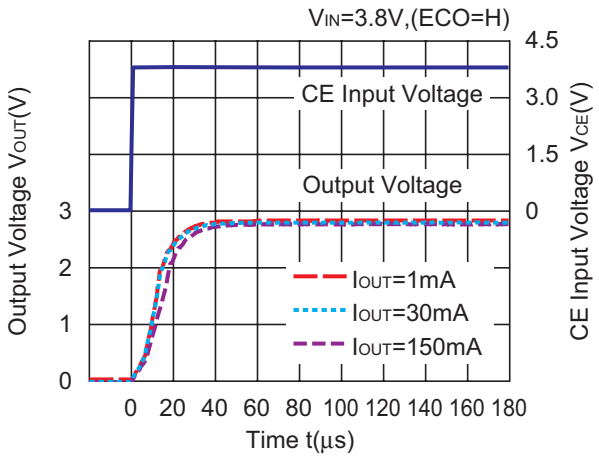
1.5V (VR1/VR2)



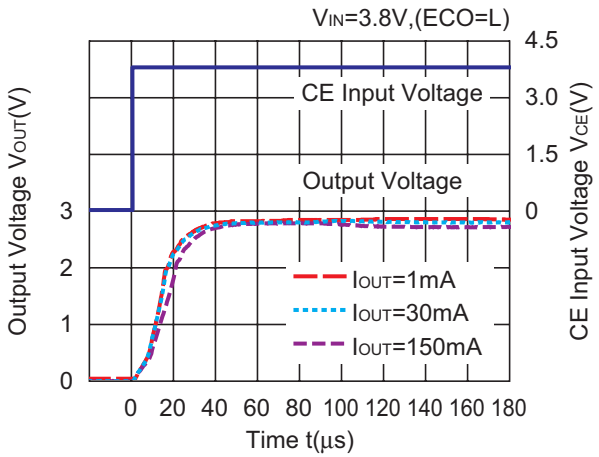
1.5V (VR1/VR2)



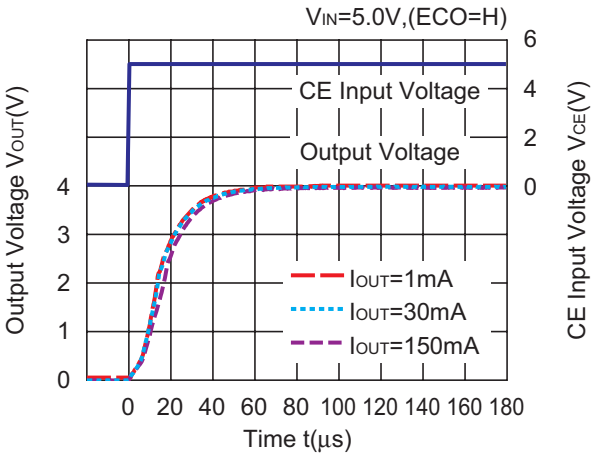
2.8V (VR1/VR2)



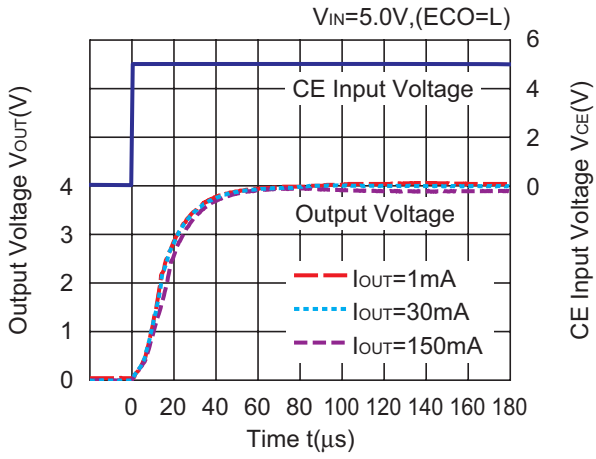
2.8V (VR1/VR2)



4.0V (VR1/VR2)

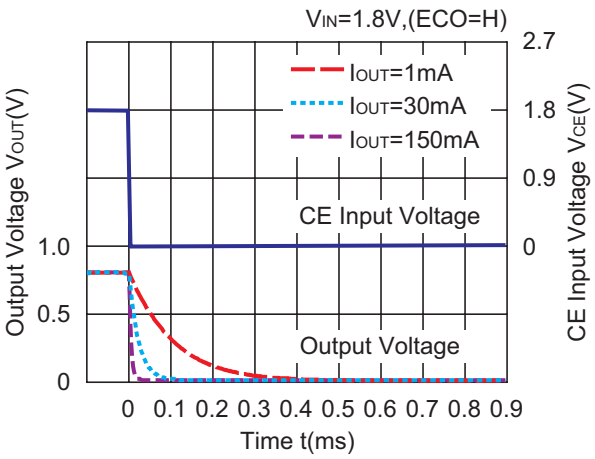


4.0V (VR1/VR2)

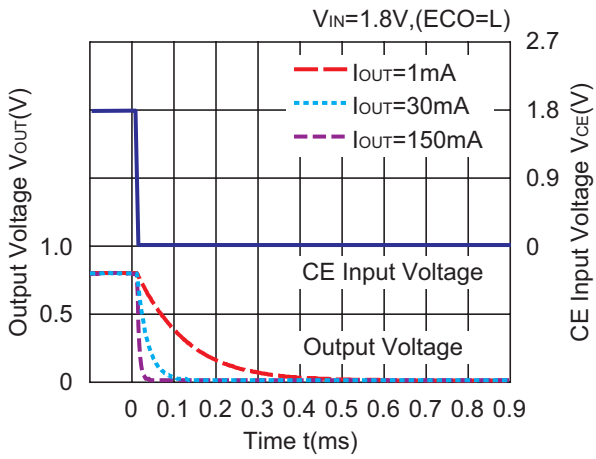


14) Turn off speed by CE pin control (C_{IN}=1.0µF, C_{OUT}=Ceramic 1.0µF)

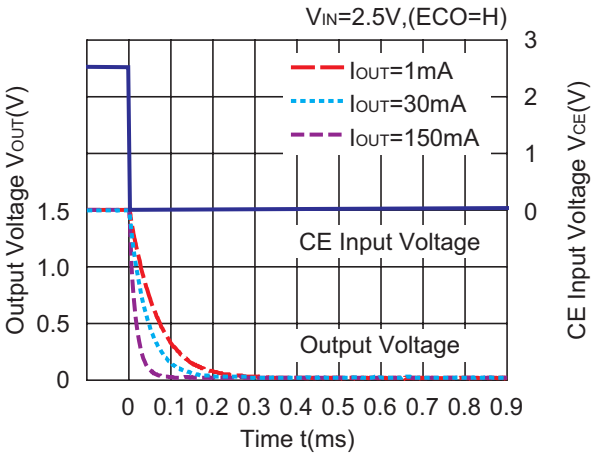
0.8V (VR1/VR2)



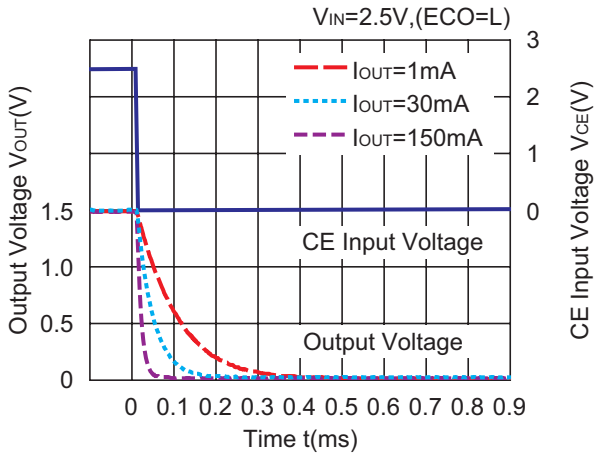
0.8V (VR1/VR2)



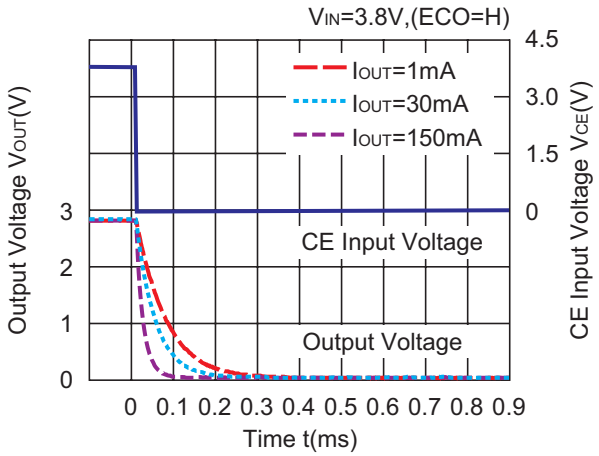
1.5V (VR1/VR2)



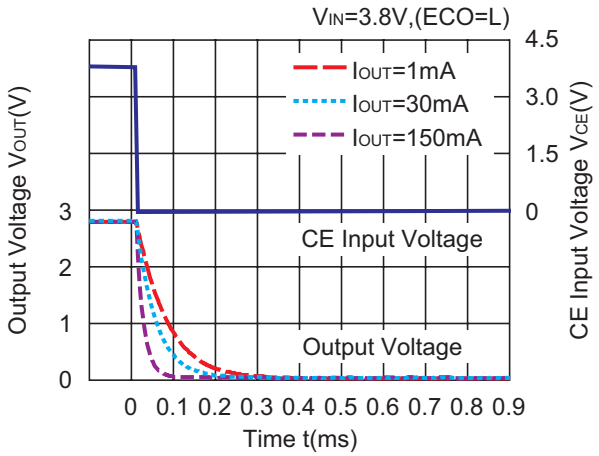
1.5V (VR1/VR2)



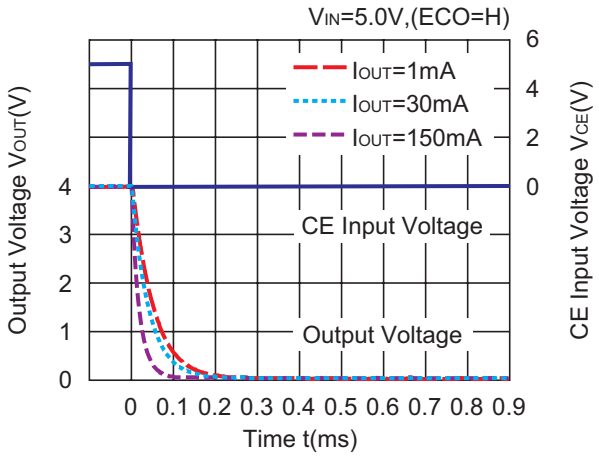
2.8V (VR1/VR2)



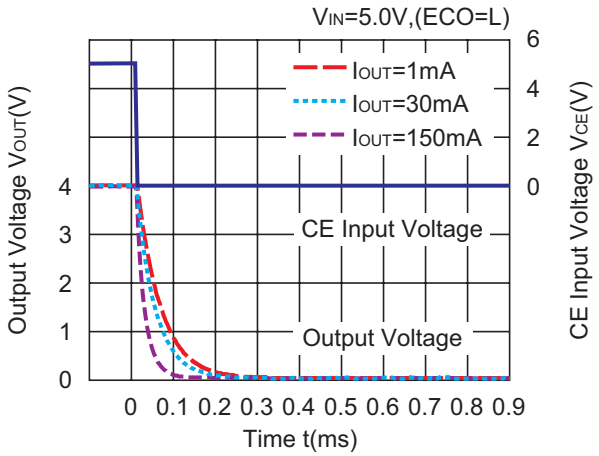
2.8V (VR1/VR2)



4.0V (VR1/VR2)

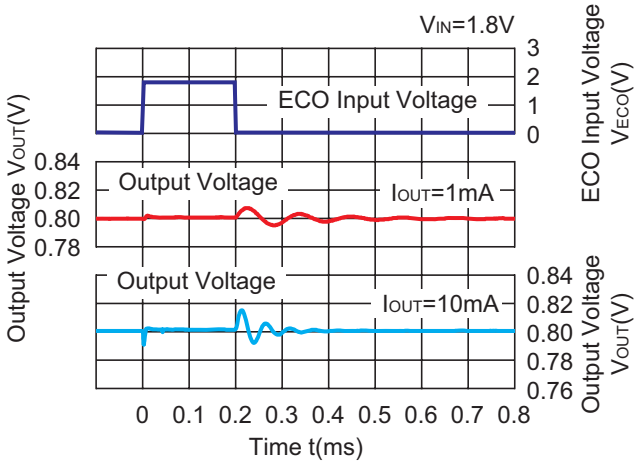


4.0V (VR1/VR2)

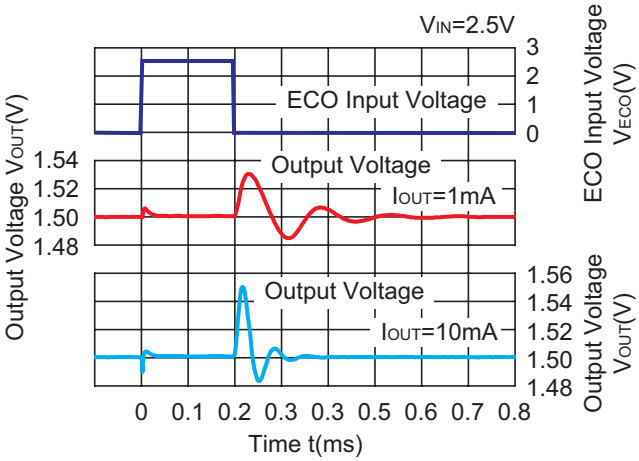


15) Mode Transient Response (CIN=COUT=Ceramic 1.0µF)

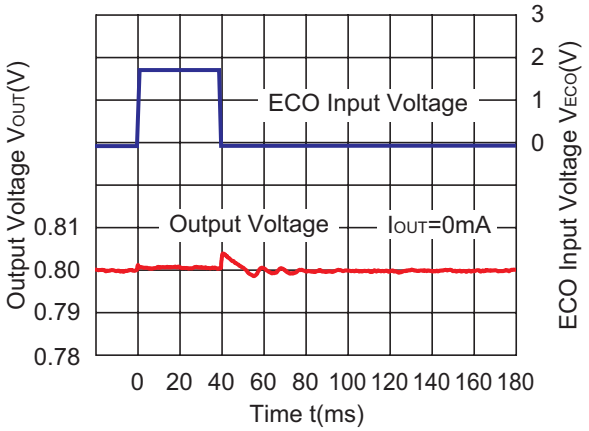
0.8V (VR1/VR2)



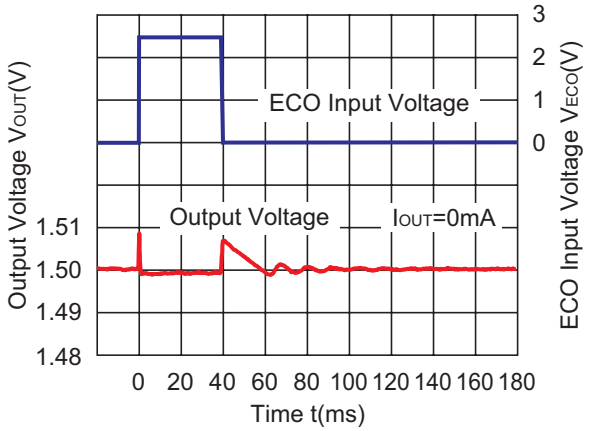
1.5V (VR1/VR2)



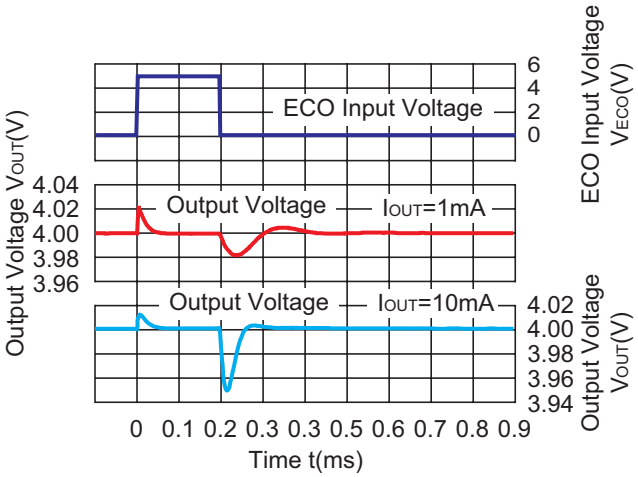
0.8V (VR1/VR2)



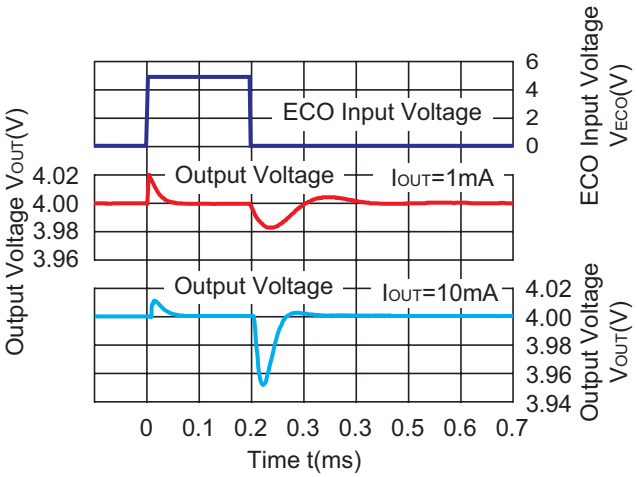
1.5V (VR1/VR2)



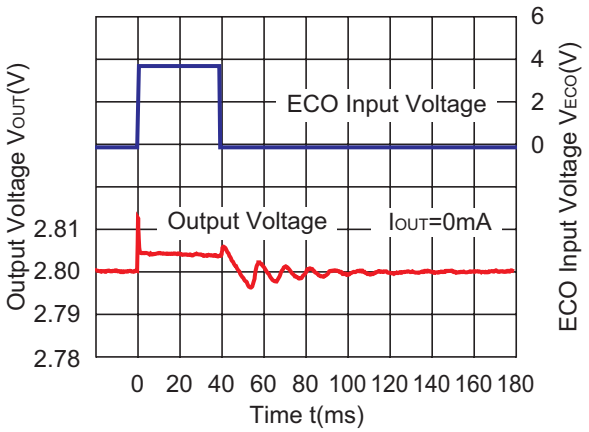
2.8V (VR1/VR2)



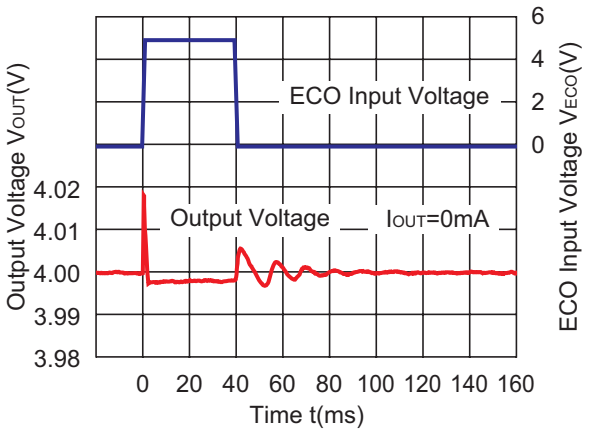
4.0V (VR1/VR2)



2.8V (VR1/VR2)



4.0V (VR1/VR2)



ESR vs. Output Current

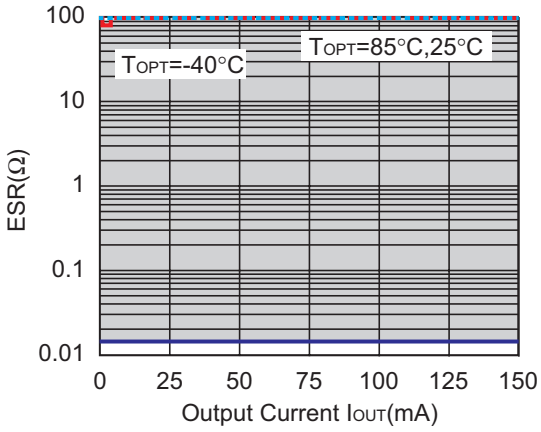
When using these ICs, consider the following points:

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 40μV (Avg.) are marked as the hatched area in the graph.

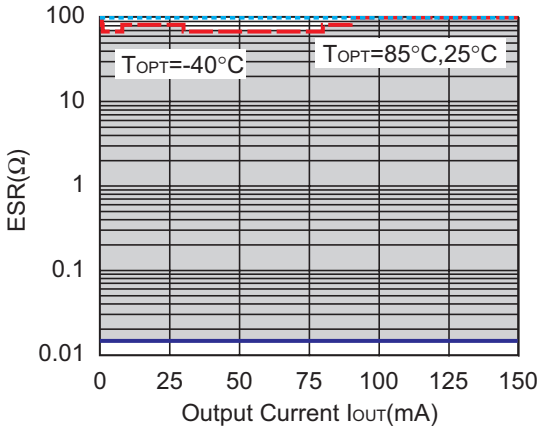
Measurement conditions

Frequency Band : 10Hz to 2MHz
Temperature : −40°C to 85°C

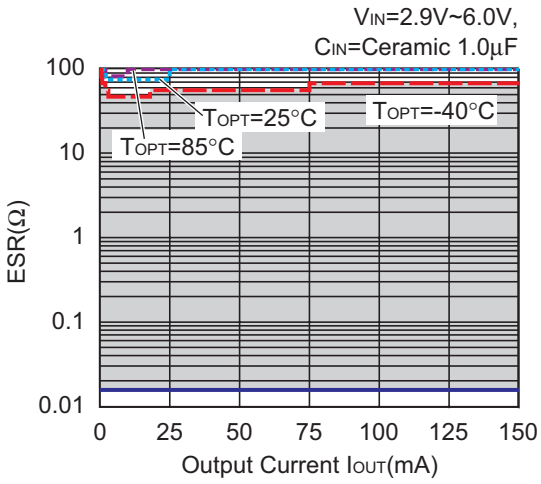
0.8V (VR1/VR2)



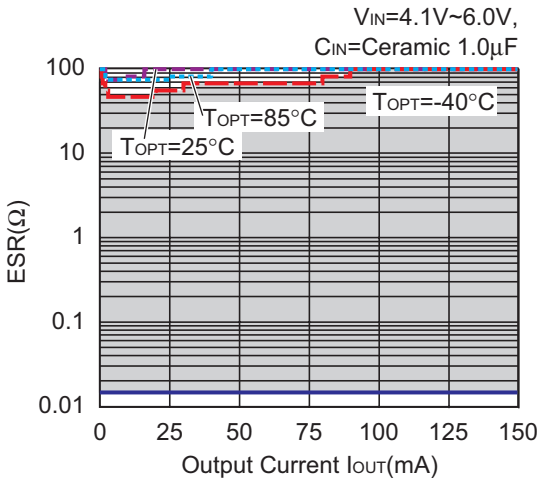
1.5V (VR1/VR2)



2.8V (VR1/VR2)



4.0V (VR1/VR2)



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