

\* R5326N (SOT-23-6) and R5326Z (WLCSP-6-P1) are the discontinued product. As of June in 2016.



## R5326x SERIES

### Automatic Mode Shift Dual 150mA LDO

NO.EA-138-140530

#### OUTLINE

The R5326x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, Typ. 5.5 $\mu$ A low supply current, and remarkably improved transient response compared with the conventional low supply current voltage regulators. The supply current of IC itself is automatically shifts between fast mode and low power mode depending on the load current. (The current threshold is fixed internally.) Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, resistors for setting the output voltage, a current limit circuit for preventing from the destruction by an over current, and so on.

The chip enable function realizes the standby mode with ultra low supply current.

Since the packages for these ICs are SOT-23-6 and DFN(PLP)1820-6, and chip size package, WLCSP-6-P1, dual LDO regulators are included in each package, high density mounting of the ICs on boards is possible.

#### FEATURES

- Supply Current (Low Power Mode).....Typ. 5.5 $\mu$ A $\times$ 2 (VR1&VR2) ( $I_{OUT}$ =0mA)
- Supply Current (Fast Mode).....Typ. 50 $\mu$ A $\times$ 2 (VR1&VR2) ( $I_{OUT}$ =10mA)
- Standby Current.....Typ. 0.1 $\mu$ A (VR1&VR2)
- Dropout Voltage .....Typ. 0.19V ( $I_{OUT}$ =150mA,  $V_{OUT}$ =2.8V)
- Ripple Rejection.....Typ. 70dB ( $f$ =1kHz)  
Typ. 60dB ( $f$ =10kHz)
- Input Voltage Range .....1.4V to 6.0V
- Output Voltage Range.....0.8V to 4.2V (0.1V steps)  
(For details, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy..... $\pm$ 1.0% ( $V_{OUT}$ >1.5V)
- Line Regulation .....Typ. 0.02%/V
- Packages .....WLCSP-6-P1, DFN(PLP)1820-6,  
SOT-23-6
- Built-in fold-back protection circuit.....Typ. 50mA (Current at short mode)
- Ceramic Capacitor is recommended. ....1.0 $\mu$ F to 3.3 $\mu$ F  
(Depending on  $V_{IN}$  and set  $V_{OUT}$ . Refer to the electrical characteristics table.)

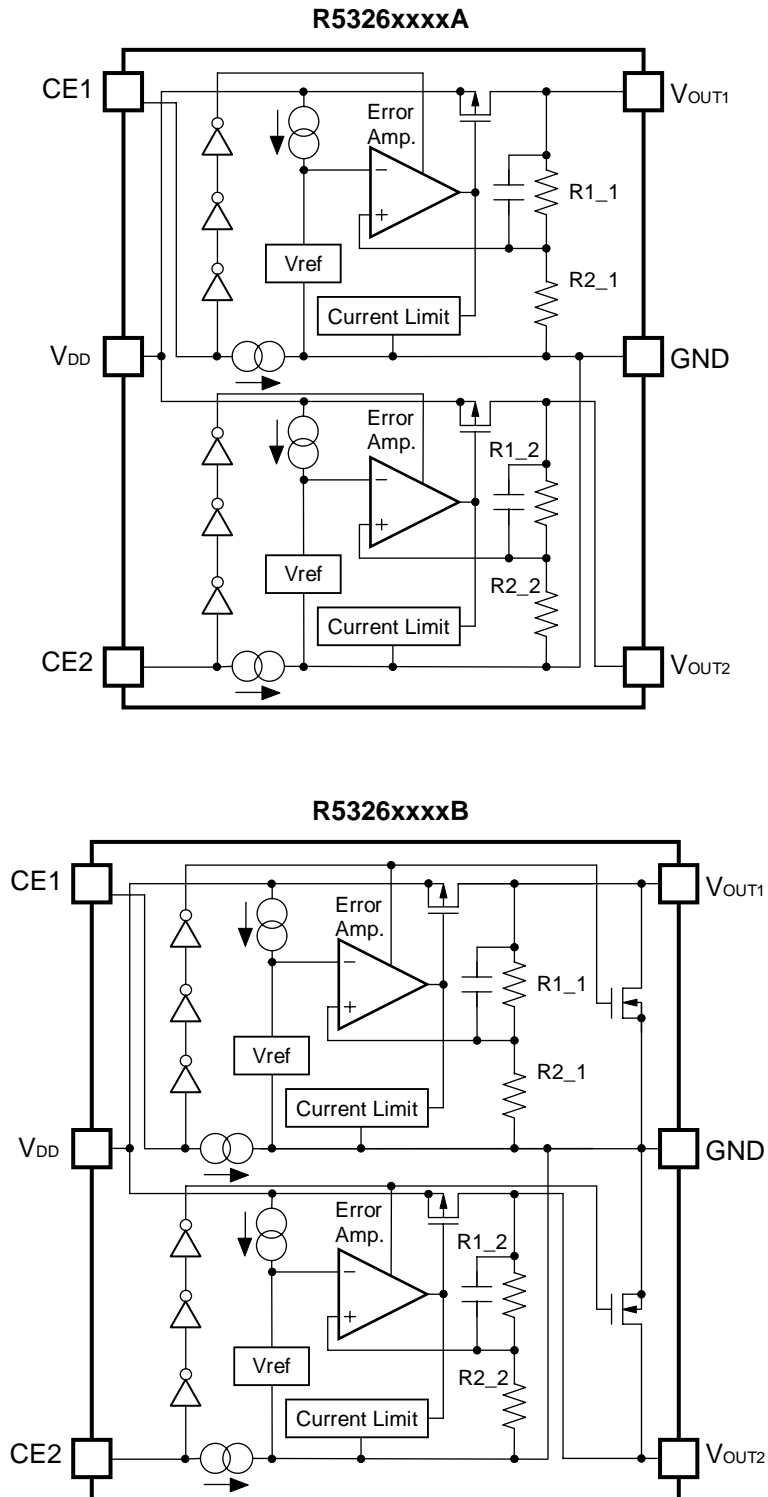
#### APPLICATIONS

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

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### BLOCK DIAGRAMS



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## SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5326Zxxx*-E2-F	WLCSP-6-P1	5,000 pcs	Yes	Yes
R5326Kxxx*-TR	DFN(PLP)1820-6	5,000 pcs	Yes	Yes
R5326Nxxx*-TR-FE	SOT-23-6	3,000 pcs	Yes	Yes

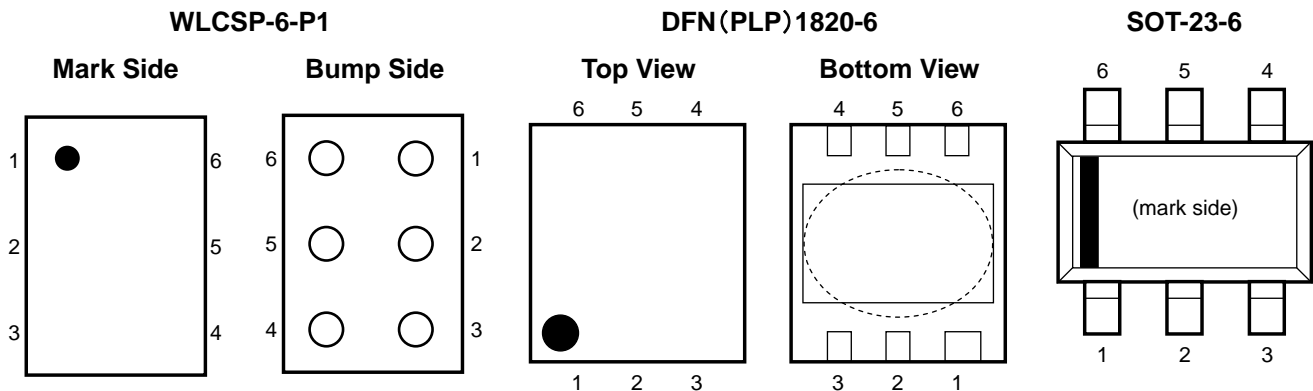
xxx : The combination of output voltage for each channel can be designated by serial numbers. (from 001)  
The output voltage for each channel can be set in the range from 0.8V to 4.2V in 0.1V steps.  
(For details, please refer to MARK INFORMATION.)

\* : 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

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## R5326x

### PIN CONFIGURATIONS



### PIN DESCRIPTIONS

- WLCSP-6-P1, SOT-23-6

Pin No	Symbol	Pin Description
1	$V_{OUT1}$	Output Pin 1
2	$V_{DD}$	Input Pin
3	$V_{OUT2}$	Output Pin 2
4	CE2	Chip Enable Pin 2 ("H" Active)
5	GND	Ground Pin
6	CE1	Chip Enable Pin 1 ("H" Active)

- DFN(PLP)1820-6

Pin No	Symbol	Pin Description
1	$V_{OUT2}$	Output Pin 2
2	$V_{DD}$	Input Pin
3	$V_{OUT1}$	Output Pin 1
4	CE1	Chip Enable Pin 1 ("H" Active)
5	GND	Ground Pin
6	CE2	Chip Enable Pin 2 ("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.

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## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
$V_{IN}$	Input Voltage	6.5	V
$V_{CE}$	Input Voltage (CE Pin)	-0.3 to 6.5	V
$V_{OUT}$	Output Voltage	-0.3 to $V_{IN}+0.3$	V
$I_{OUT1}, I_{OUT2}$	Output Current	200	mA
$P_D$	Power Dissipation (WLCSP-6-P1) *	633	mW
	Power Dissipation (DFN(PLP)1820-6) *	880	
	Power Dissipation (SOT-23-6) *	420	
$T_{opt}$	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.

### 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.

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# ELECTRICAL CHARACTERISTICS

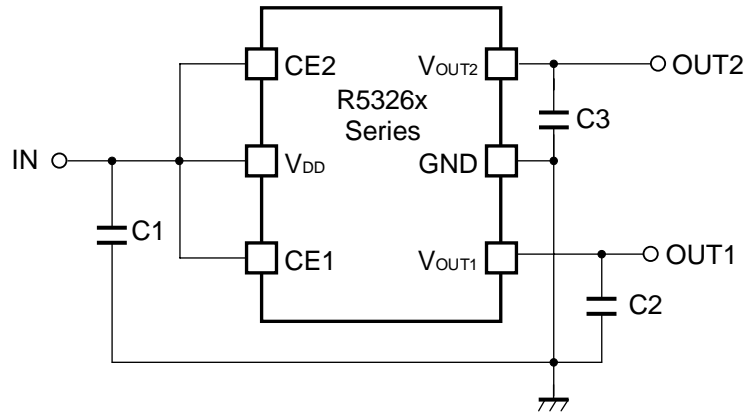
### • R5326xxxxA/B

VR1/VR2

T<sub>opt</sub>=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit	
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> -V <sub>OUT</sub> =1V I <sub>OUT</sub> =1mA	V <sub>OUT</sub> > 1.5V	×0.99		×1.01	V
			V <sub>OUT</sub> ≤ 1.5V	-15		+15	mV
I <sub>OUT</sub>	Output Current	V <sub>IN</sub> -V <sub>OUT</sub> =1V	150			mA	
ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub>	Load Regulation	V <sub>IN</sub> -V <sub>OUT</sub> =1V 1mA ≤ I <sub>OUT</sub> ≤ 150mA			80	mV	
V <sub>DIF</sub>	Dropout Voltage	I <sub>OUT</sub> =150mA	0.8V ≤ V <sub>OUT</sub> <0.9V		0.62	0.87	V
			0.9V ≤ V <sub>OUT</sub> <1.0V		0.58	0.78	
			1.0V ≤ V <sub>OUT</sub> <1.2V		0.48	0.69	
			1.2V ≤ V <sub>OUT</sub> <1.5V		0.40	0.59	
			1.5V ≤ V <sub>OUT</sub> <2.0V		0.31	0.48	
			2.0V ≤ V <sub>OUT</sub> <2.8V		0.22	0.37	
			2.8 ≤ V <sub>OUT</sub>		0.19	0.27	
I <sub>SS1</sub>	Supply Current (Low Power Mode)	V <sub>IN</sub> -V <sub>OUT</sub> =1V, I <sub>OUT</sub> =0mA		5.5	16	μA	
I <sub>SS2</sub>	Supply Current (Fast Mode)	V <sub>IN</sub> -V <sub>OUT</sub> =1V, I <sub>OUT</sub> =10mA		50	105	μA	
I <sub>standby</sub>	Standby Current	V <sub>IN</sub> =6V, V <sub>CE1</sub> =V <sub>CE2</sub> =GND		0.1	1.0	μA	
I <sub>OUTL</sub>	Low Power Mode Current threshold	V <sub>IN</sub> -V <sub>OUT</sub> =1V, I <sub>OUT</sub> =30mA to 1μA		0.6		mA	
I <sub>OUTH</sub>	Fast Response Mode Current threshold	V <sub>IN</sub> -V <sub>OUT</sub> =1V, I <sub>OUT</sub> =1μA to 30mA		3		mA	
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line Regulation	V <sub>OUT</sub> +0.5V ≤ V <sub>IN</sub> ≤ 6V I <sub>OUT</sub> =30mA (*V <sub>IN</sub> ≥ 1.8V)		±0.02	±0.2	%/V	
RR	Ripple Rejection	Ripple 0.2Vp-p, V <sub>IN</sub> -V <sub>OUT</sub> =1V, I <sub>OUT</sub> =30mA (In case that V <sub>OUT</sub> <1.5V, V <sub>IN</sub> -V <sub>OUT</sub> =1.5V)	f=1kHz		70	dB	
			f=10kHz		60		
V <sub>IN</sub>	Input Voltage		1.4		6.0	V	
ΔV <sub>OUT</sub> /ΔT <sub>opt</sub>	Output Voltage Temperature Coefficient	I <sub>OUT</sub> =30mA, -40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm/°C	
I <sub>sc</sub>	Short Current Limit	V <sub>OUT</sub> =0V		50		mA	
I <sub>PD</sub>	CE Pull-down Current		0.15	0.30	0.45	μA	
V <sub>CEH</sub>	CE Input Voltage "H"		1.0		6.0	V	
V <sub>CEL</sub>	CE Input Voltage "L"		0		0.4	V	
en	Output Noise	BW=10Hz to 100kHz		30		μVrms	
R <sub>LOW</sub>	Low Output Nch Tr. ON Resistance (of B version)			40		Ω	

## TYPICAL APPLICATION



(External Components)  
 Capacitor; Ceramic Type  
 C1 : 1.0 $\mu$ F Ceramic  
 C2, C3 : Refer to the following table

### Recommended Ceramic capacitor for Output (C2, C3)

Output Voltage Range	Minimum Input Voltage	
	$1.4V \leq V_{IN} < 1.65V$	$1.65V \leq V_{IN}$
$0.8V \leq V_{OUT} < 1.2V$	3.3 $\mu$ F or more	2.2 $\mu$ F or more
$1.2V \leq V_{OUT} \leq 4.2V$	3.3 $\mu$ F or more	1.0 $\mu$ F or more

#### Output Capacitors

3.3 $\mu$ F (Murata) GRM219B31A335KE18B

2.2 $\mu$ F (Murata) GRM155B30J225M

1.0 $\mu$ F (Murata) GRM155B31A105KE15

## R5326x

### TECHNICAL NOTES

When using these ICs, consider the following points:

#### Mounting on PCB

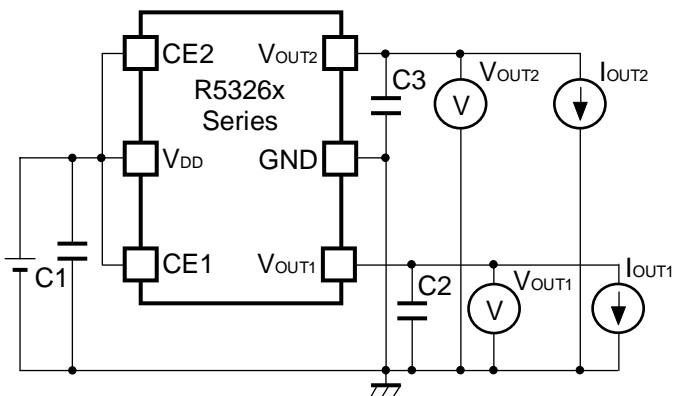
Make  $V_{DD}$  and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor with a capacitance value as much as  $1.0\mu\text{F}$  or more as C1 between  $V_{DD}$  and GND pin, and as close as possible to the pins.

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

#### Phase Compensation

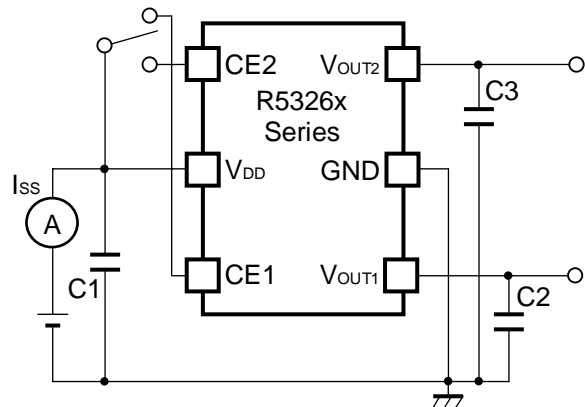
In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use capacitors C2 and C3 which are shown below table "Recommended Ceramic capacitor for output". If you use a tantalum type capacitor and ESR value of the capacitor is large, output might be unstable. Evaluate your circuit with considering frequency characteristics.

### TEST CIRCUITS



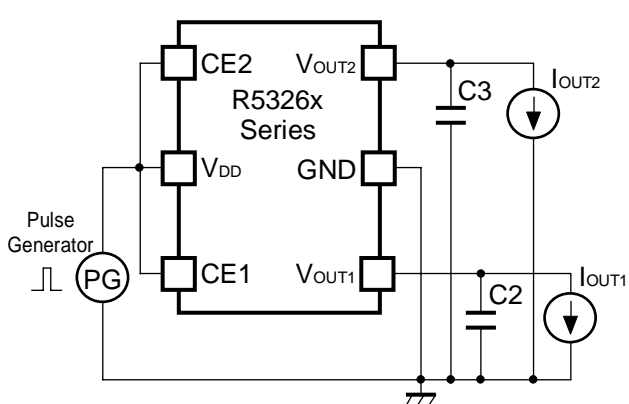
C1=Ceramic  $1.0\mu\text{F}$   
C2,C3=refer to the term of the external capacitors

**Fig.1 Standard test Circuit**



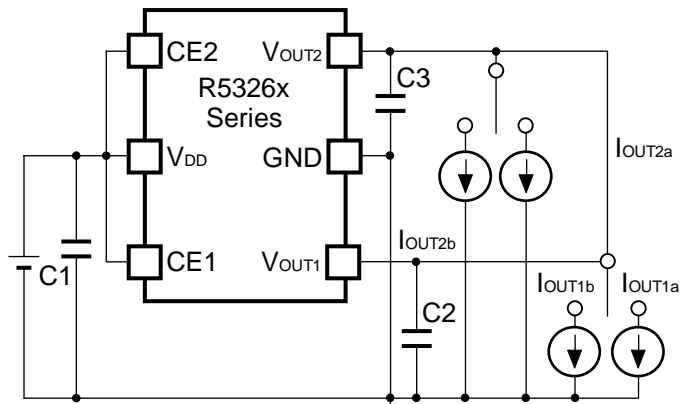
C1=Ceramic  $1.0\mu\text{F}$   
C2,C3=refer to the term of the external capacitors

**Fig.2 Supply Current Test Circuit**



C2,C3= refer to the term of the external capacitors

**Fig.3 Ripple Rejection, Line Transient Response Test Circuit**



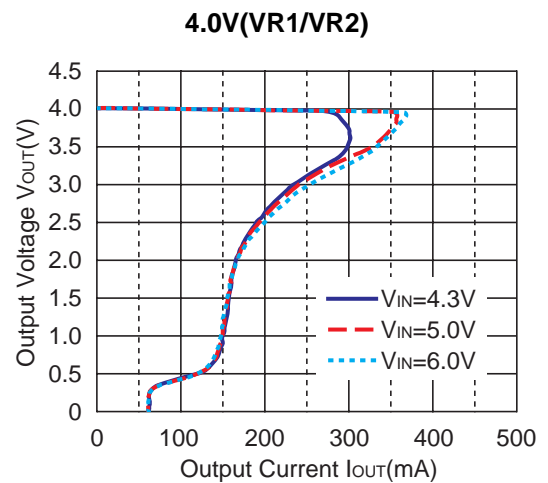
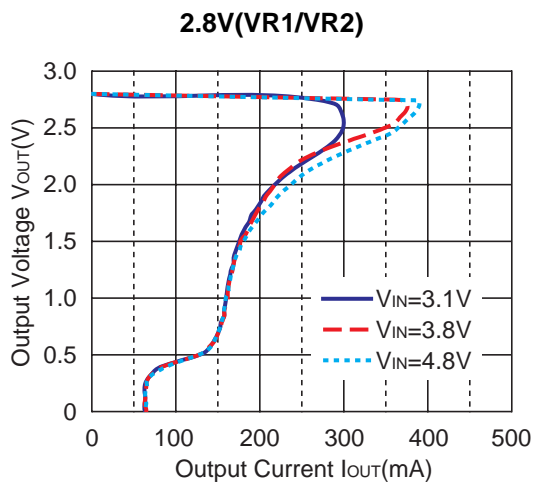
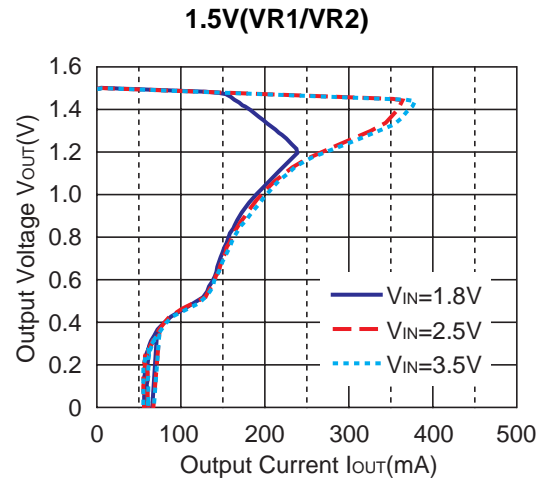
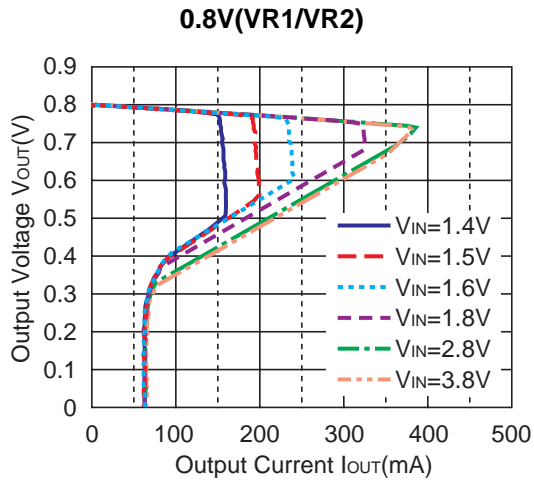
C1=Ceramic  $1.0\mu\text{F}$   
C2,C3= refer to the term of the external capacitors

**Fig.4 Load Transient Response Test Circuit**

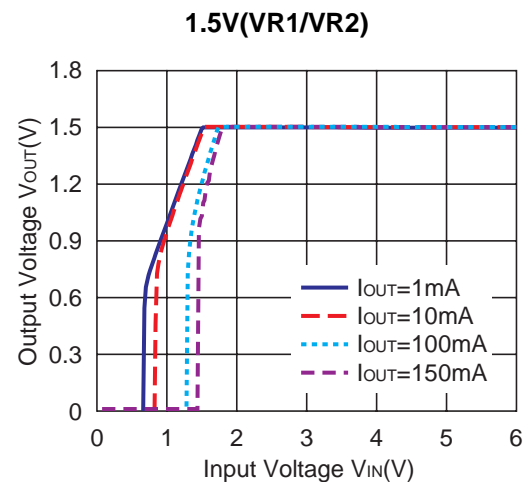
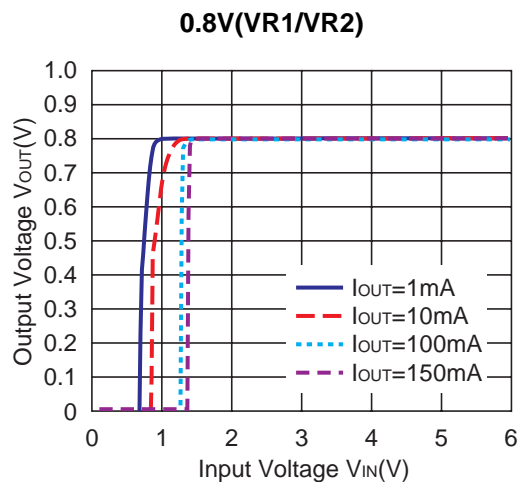


## TYPICAL CHARACTERISTICS

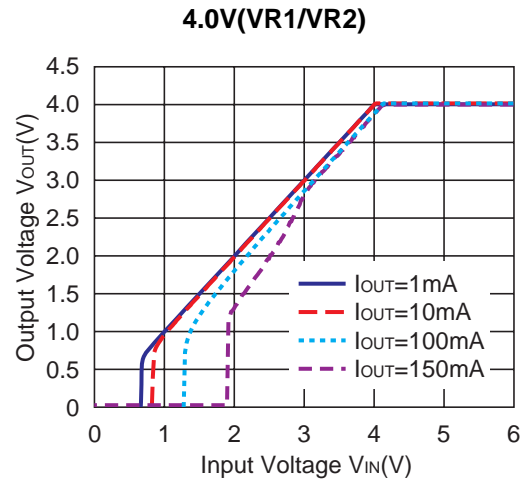
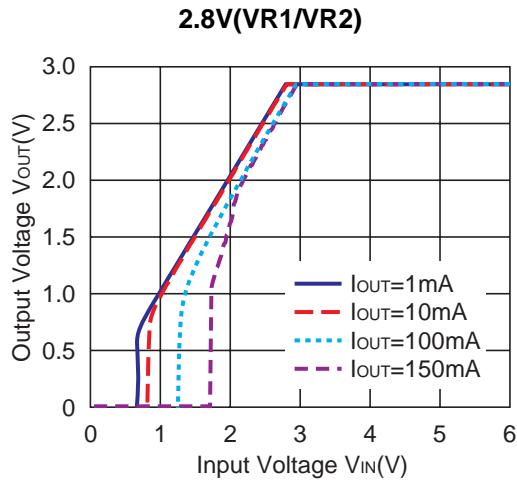
### 1) Output Voltage vs. Output Current



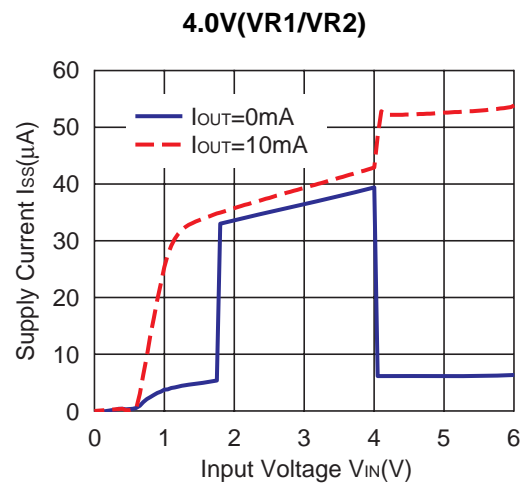
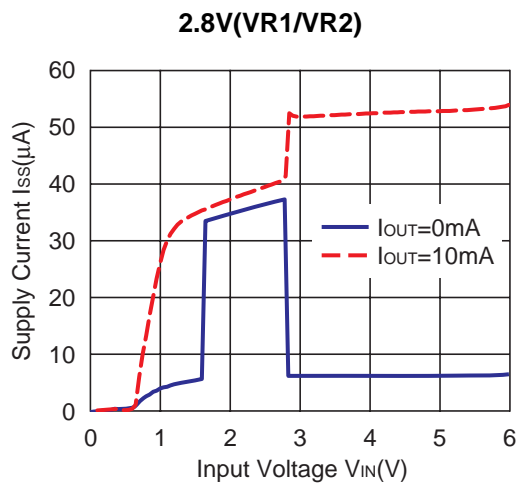
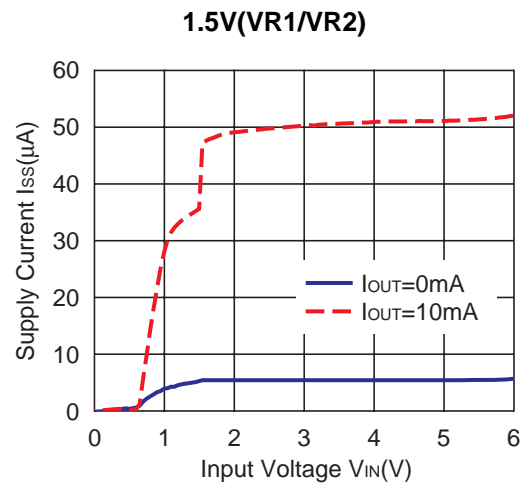
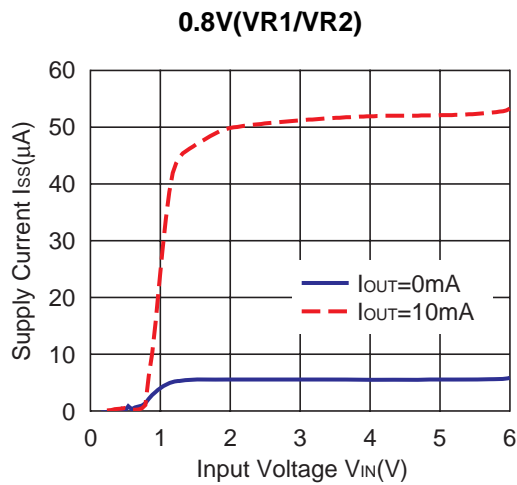
### 2) Input Voltage vs. Output Voltage



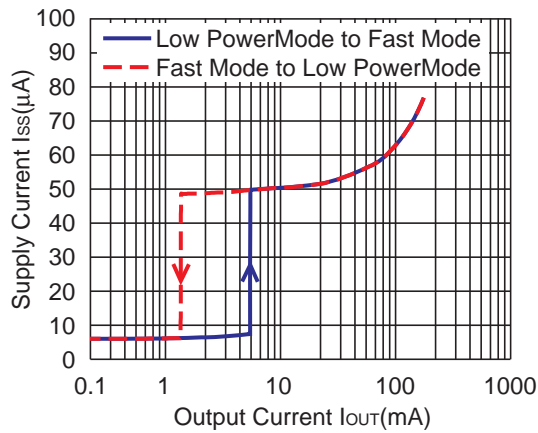
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**3) Supply Current vs. Input Voltage**

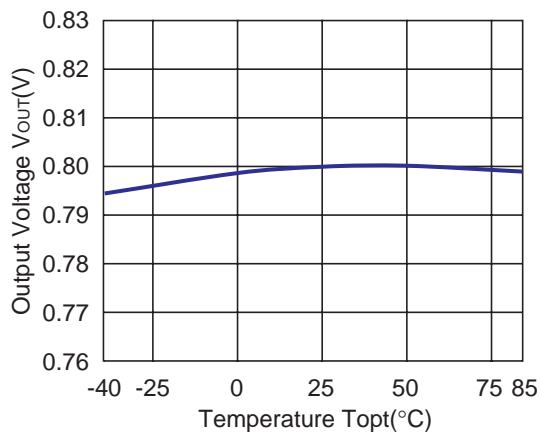


#### 4) Supply current vs. Output current

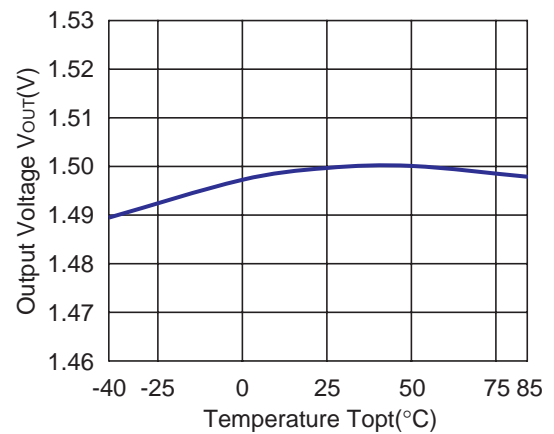


#### 5) Output Voltage vs. Temperature

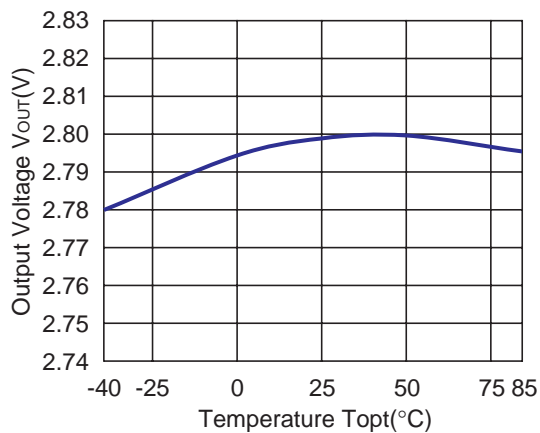
0.8V(VR1/VR2)



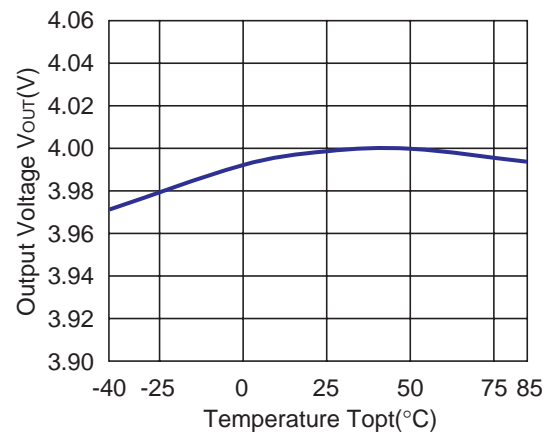
1.5V(VR1/VR2)



2.8V(VR1/VR2)



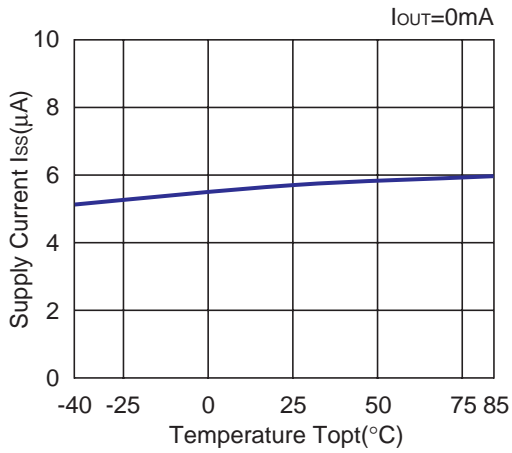
4.0V(VR1/VR2)



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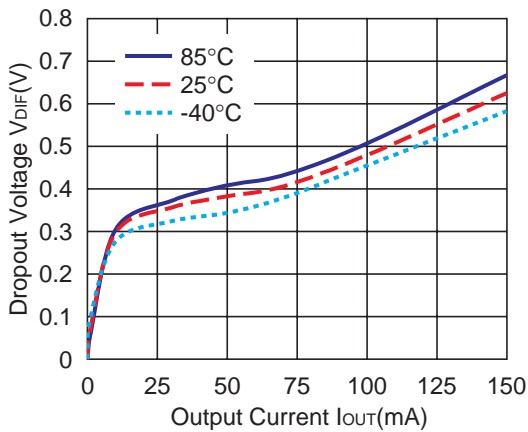
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### 6) Supply Current vs. Temperature

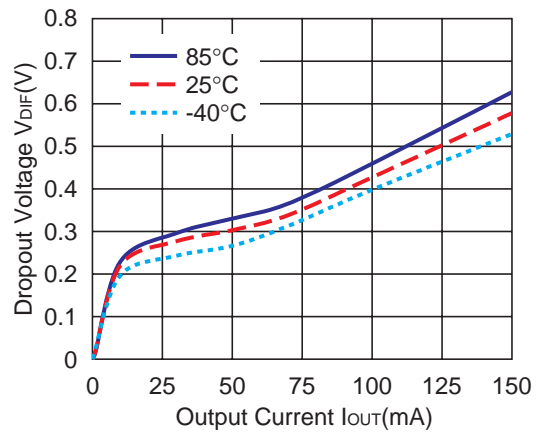


### 7) Dropout Voltage vs. Output Current

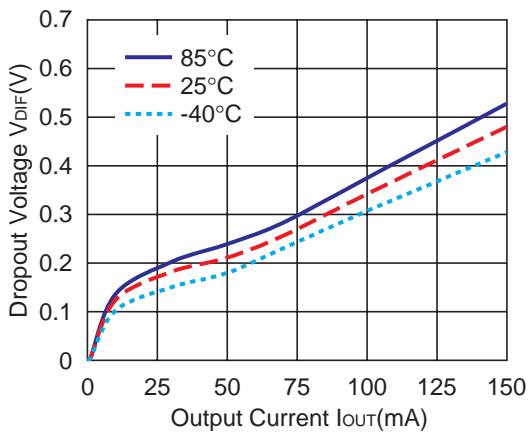
0.8V(VR1/VR2)



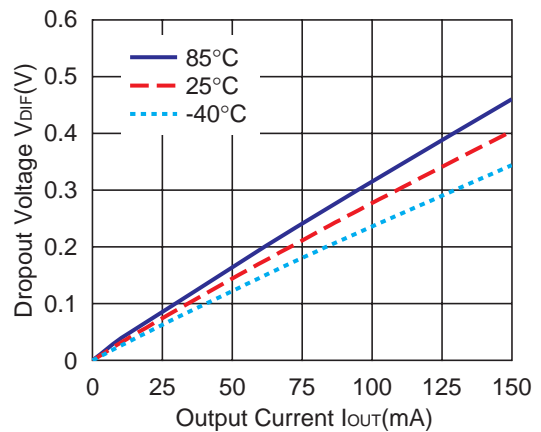
0.9V(VR1/VR2)

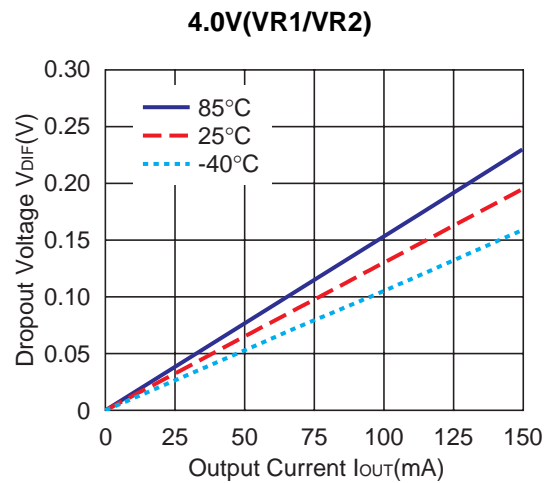
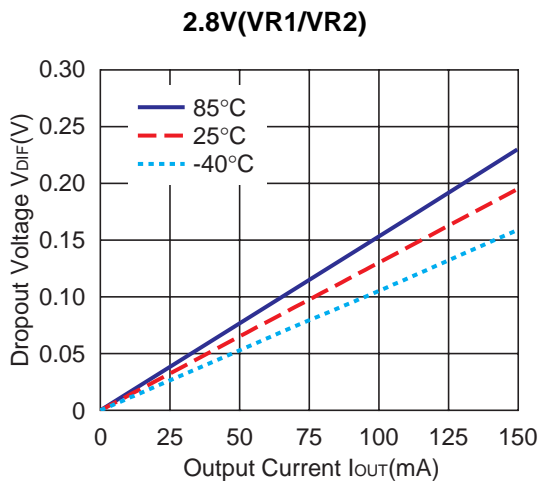
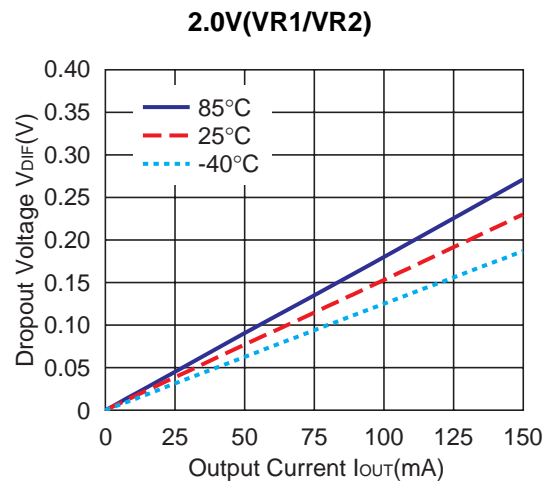
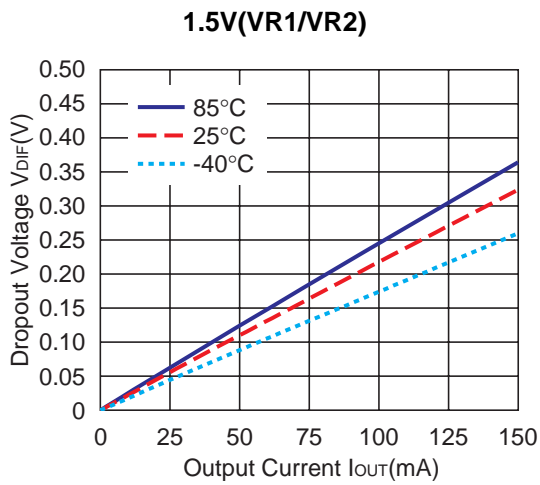


1.0V(VR1/VR2)

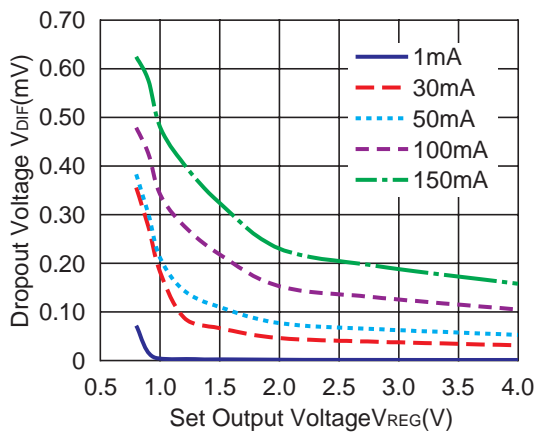


1.2V(VR1/VR2)





**8) Dropout Voltage vs. Set Output Voltage**

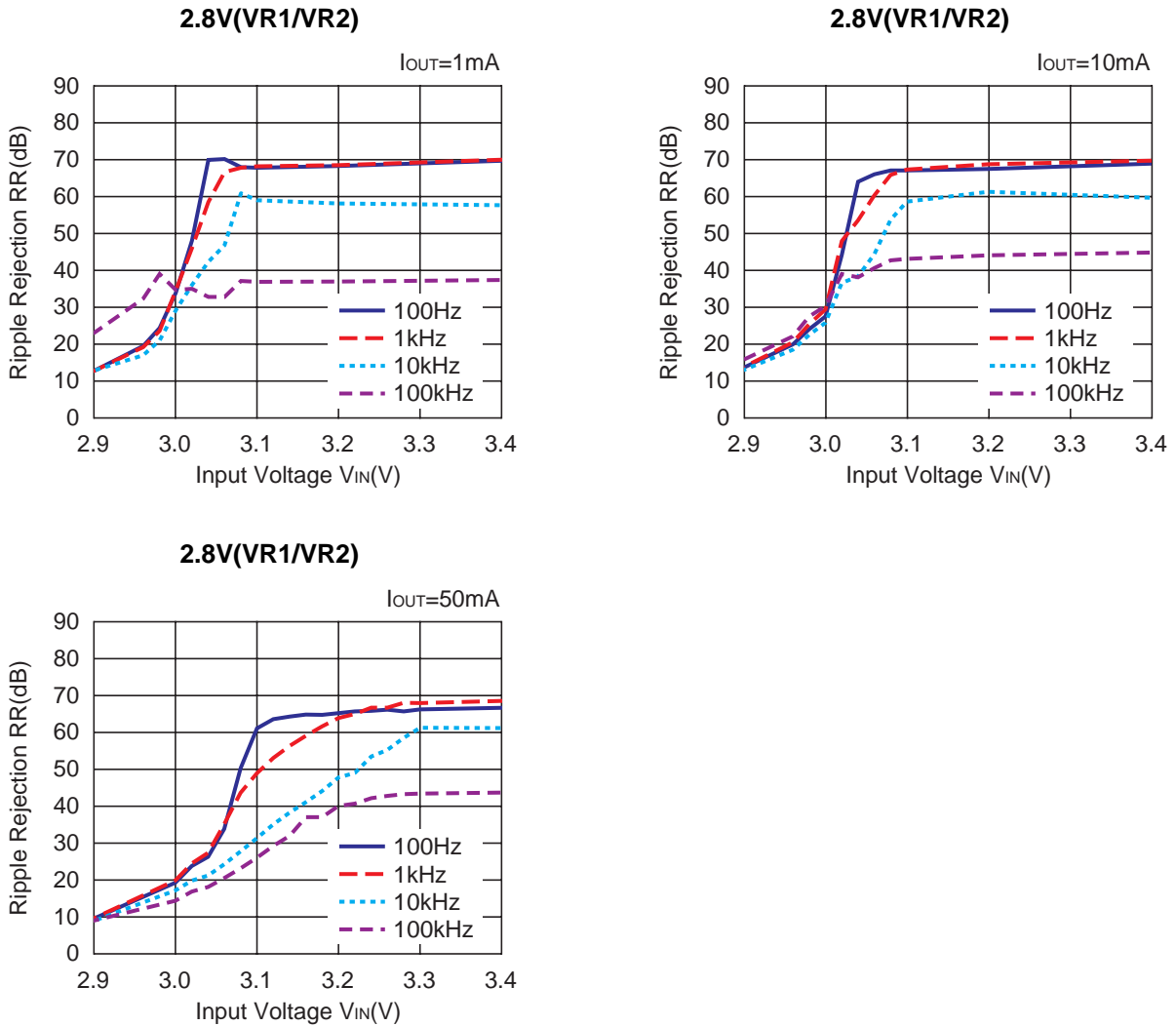


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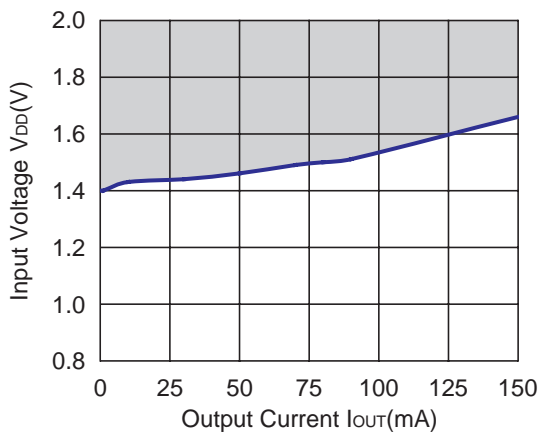
**9) Ripple Rejection vs. Input Voltage**

(Topt=25°C, Ripple 0.5Vp-p, CIN=none, COUT=Ceramic 1.0μF)



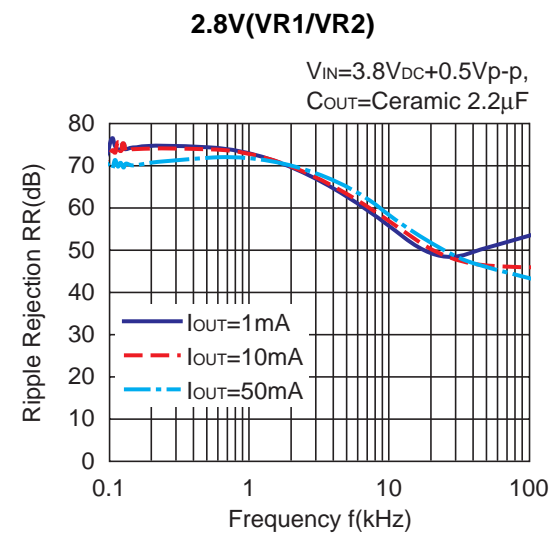
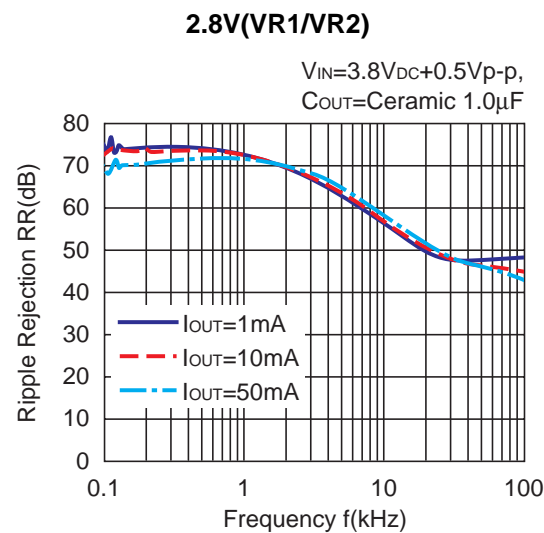
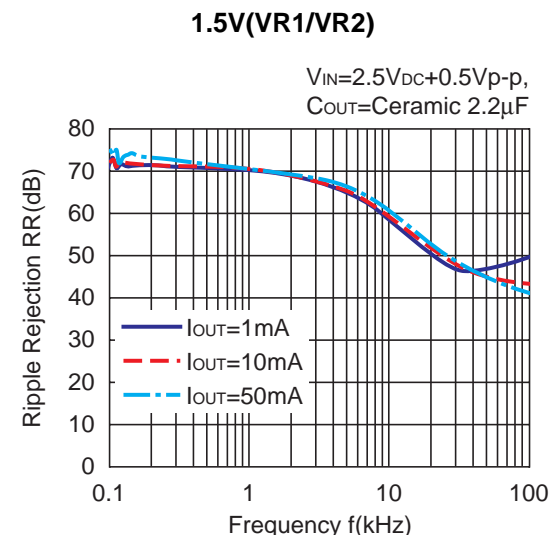
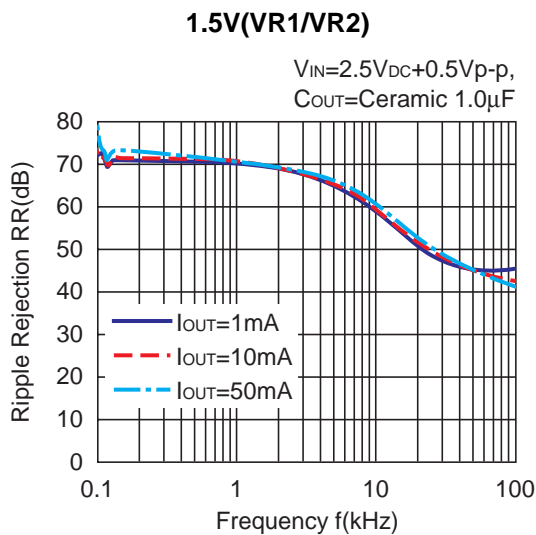
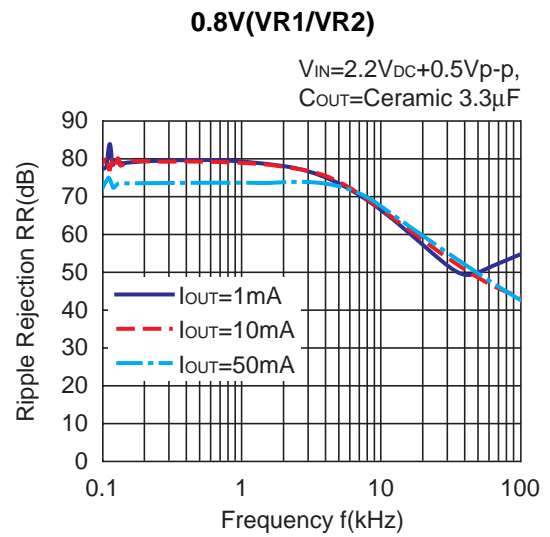
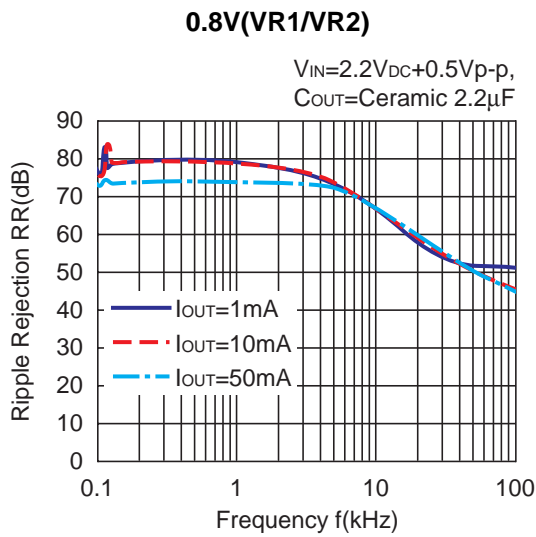
**10) Minimum Operating Voltage**

0.8V(VR1/VR2)



Hatched area is available for 0.8V output

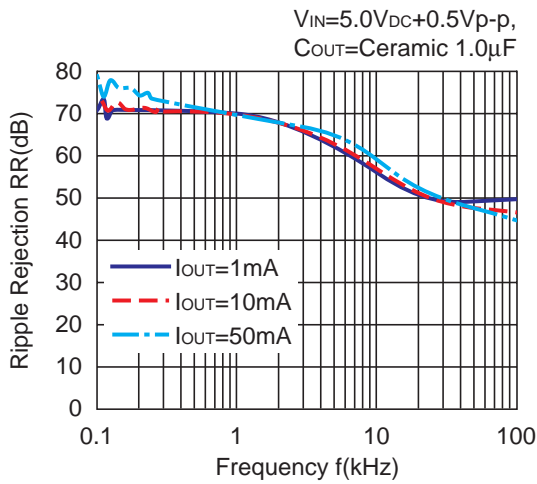
11) Ripple Rejection vs Frequency (C<sub>IN</sub>=none)



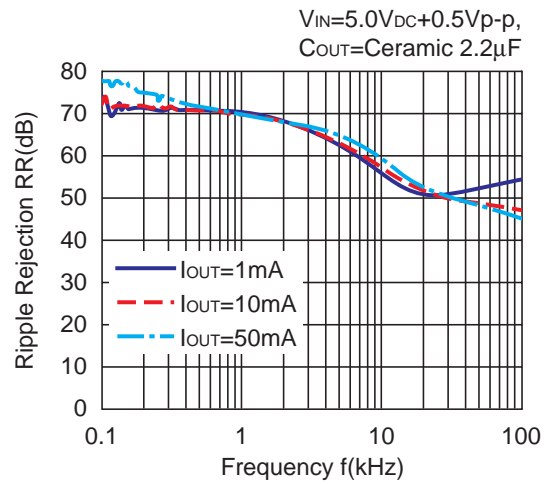
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**R5326x**

**4.0V(VR1/VR2)**

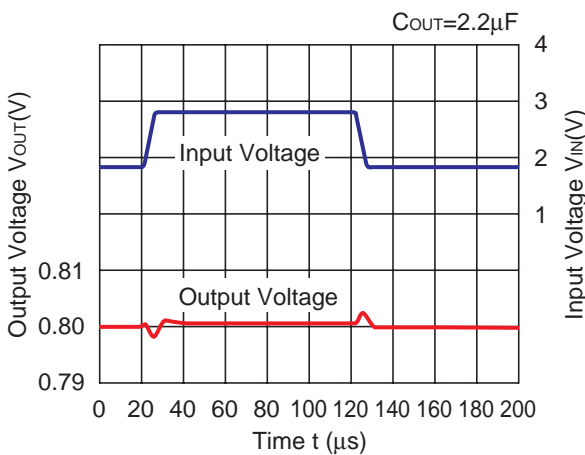


**4.0V(VR1/VR2)**

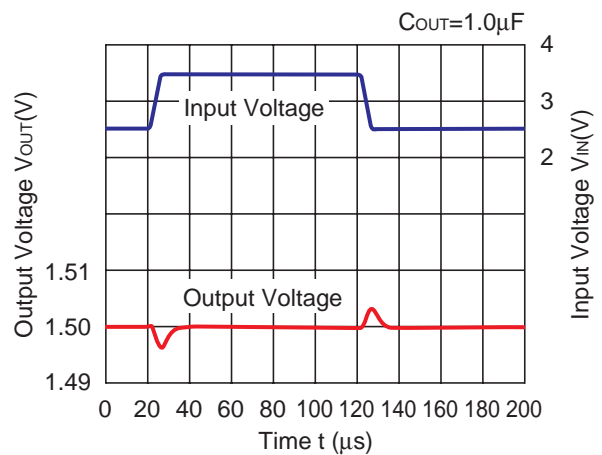


**12) Input Transient Response ( $I_{OUT}=30\text{mA}$ ,  $t_r=t_f=5\mu\text{s}$ ,  $C_{IN}=\text{none}$ )**

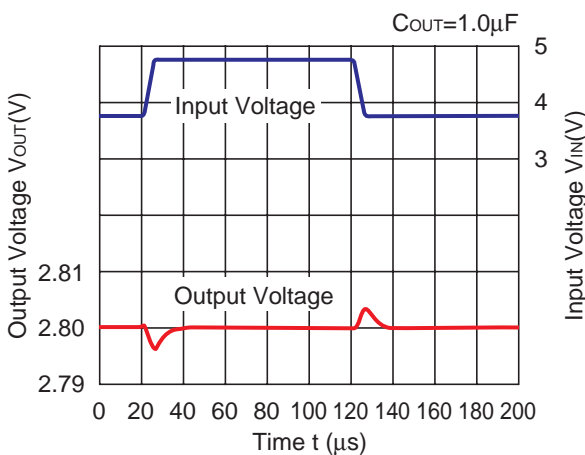
**0.8V(VR1/VR2)**



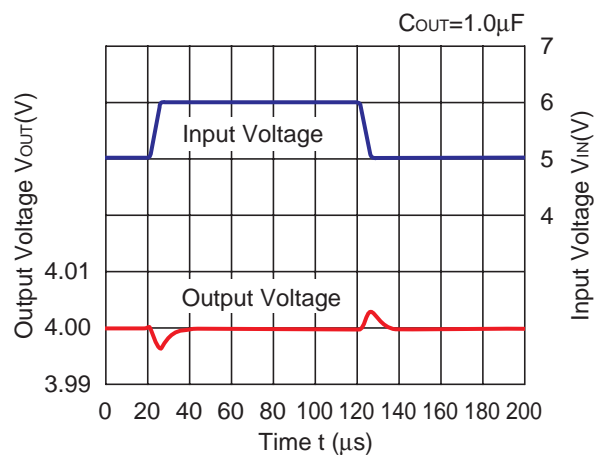
**1.5V(VR1/VR2)**



**2.8V(VR1/VR2)**

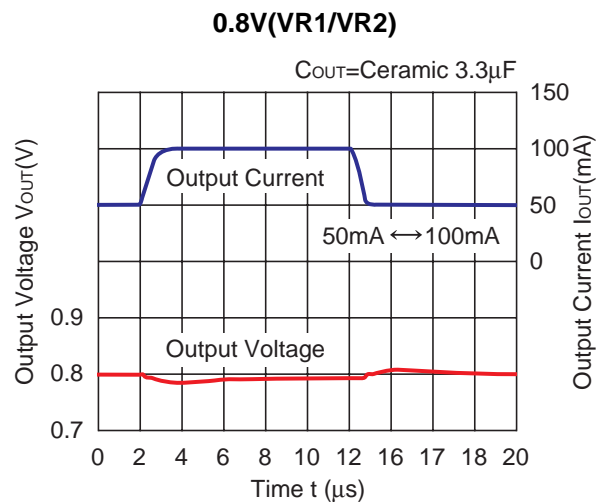
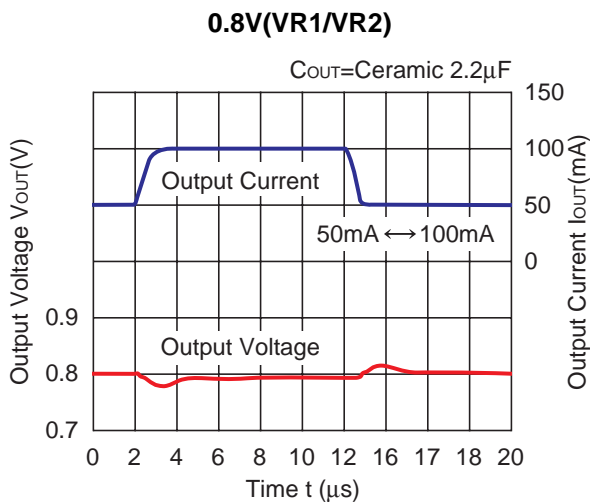
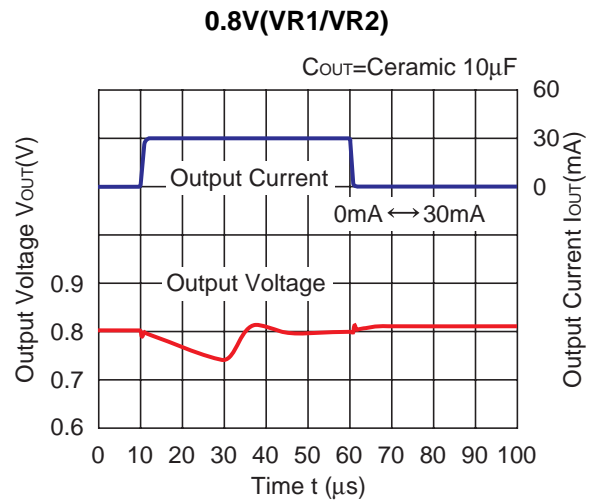
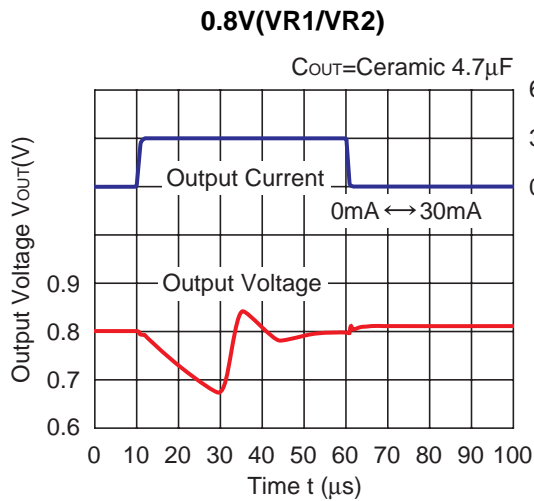
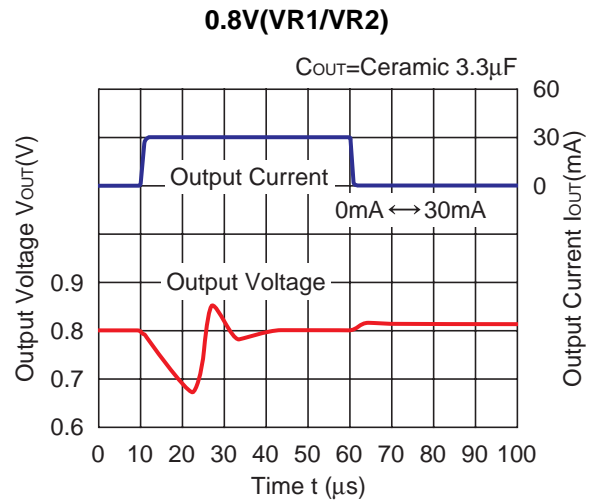
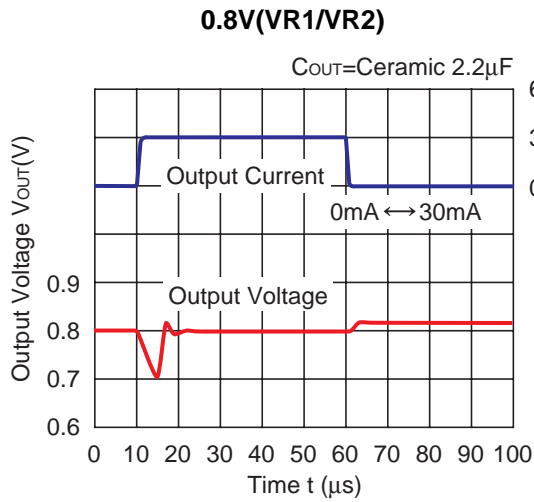


**4.0V(VR1/VR2)**





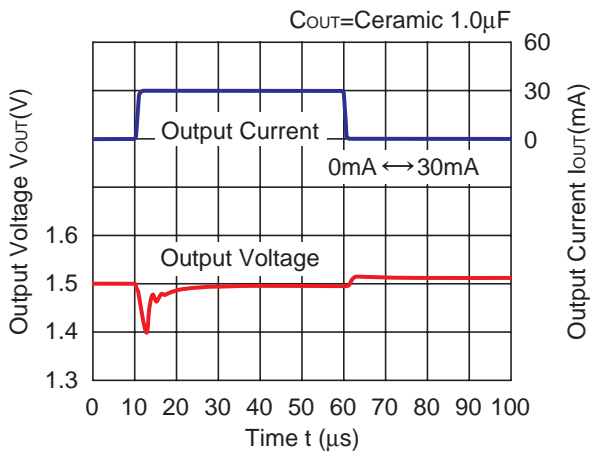
13) Load Transient Response1 ( $t_r=t_f=0.5\mu s$ ,  $C_{IN}=1.0\mu F$ )



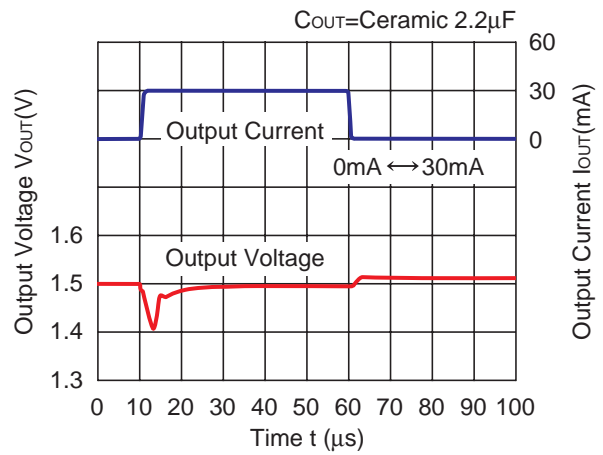
\* R5326N (SOT-23-6) and R5326Z (WLCSP-6-P1) are the discontinued product. As of June in 2016.

## R5326x

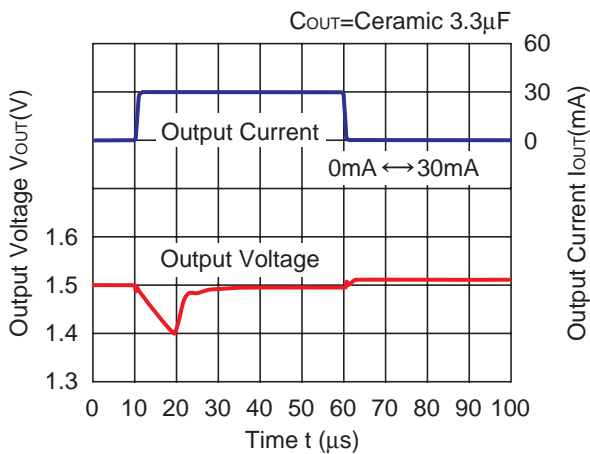
1.5V (VR1/VR2)



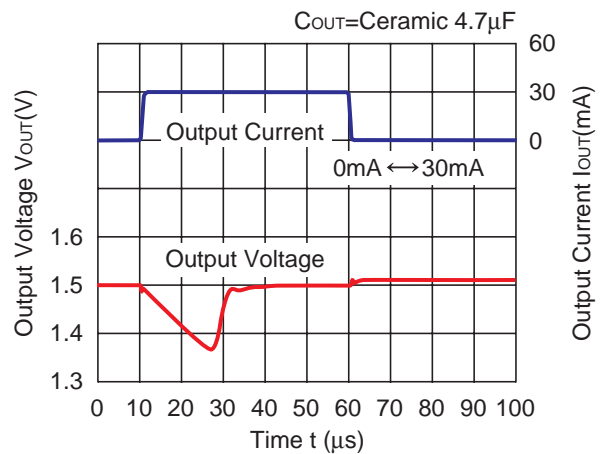
1.5V (VR1/VR2)



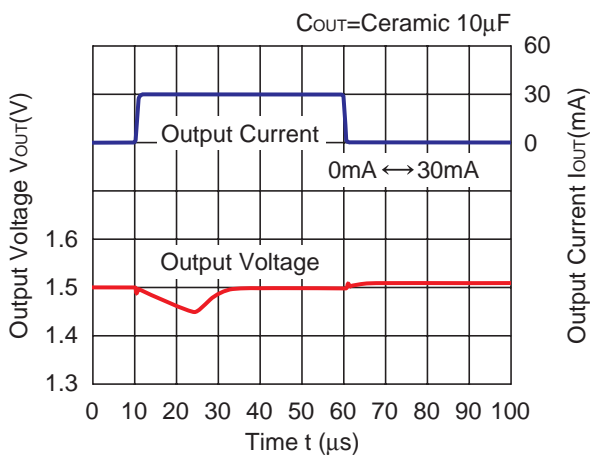
1.5V (VR1/VR2)



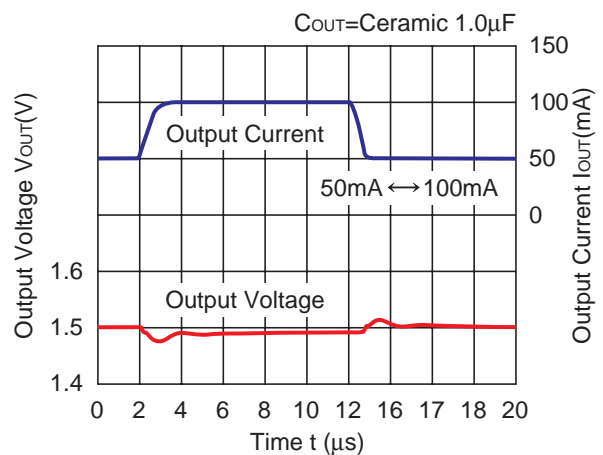
1.5V (VR1/VR2)

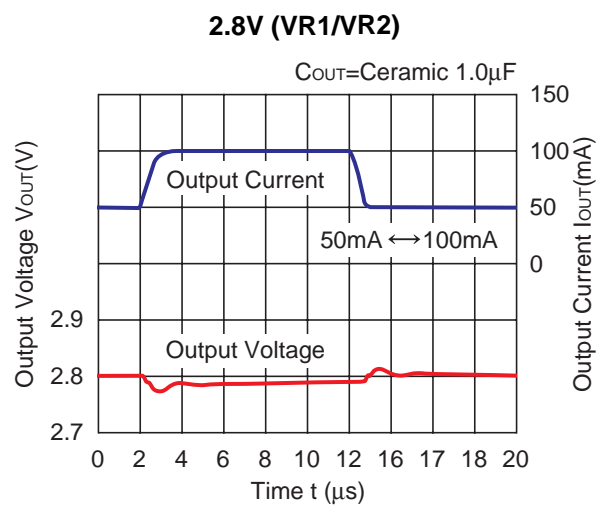
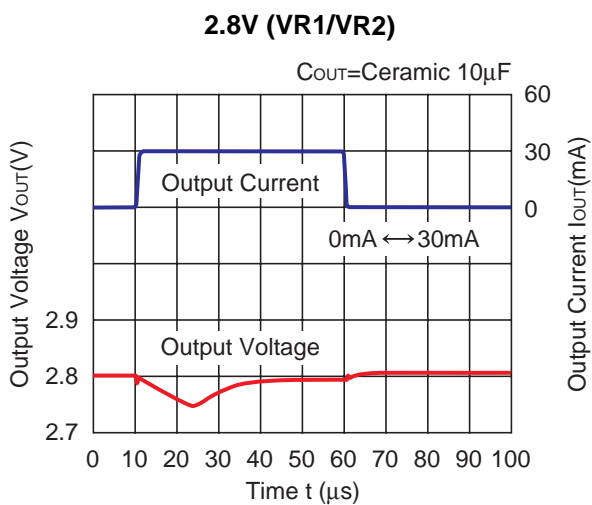
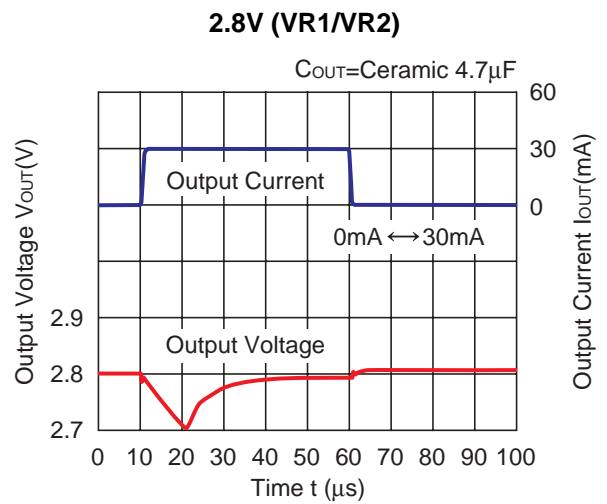
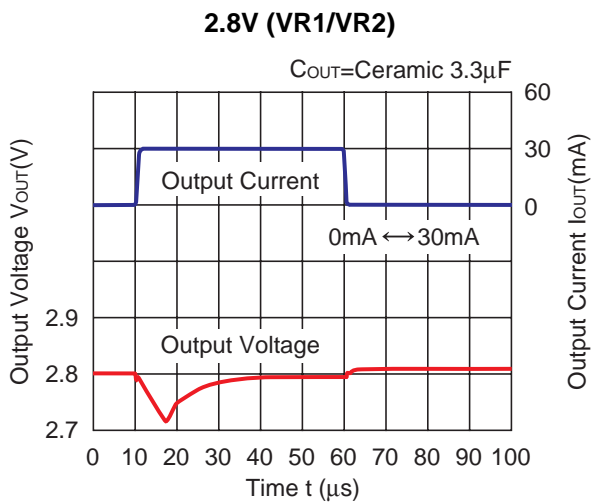
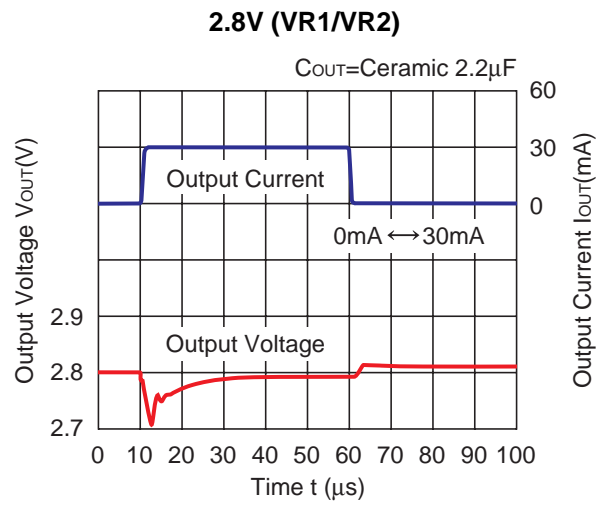
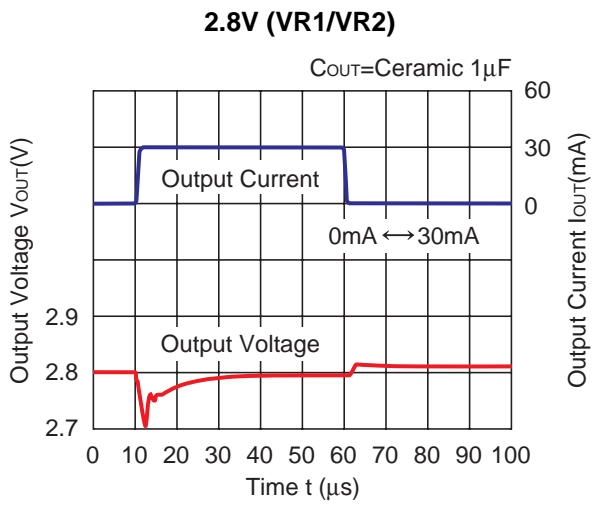


1.5V (VR1/VR2)



1.5V (VR1/VR2)

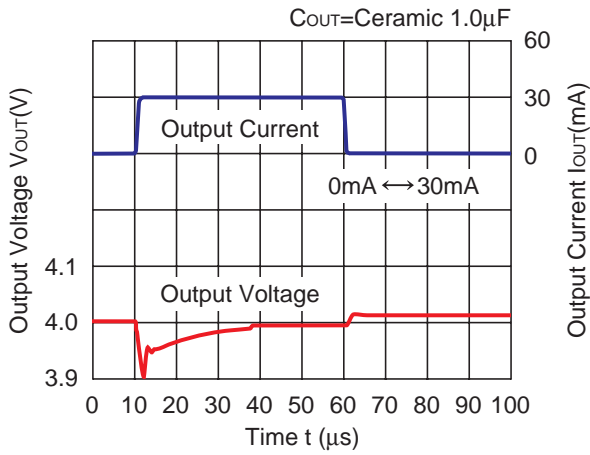




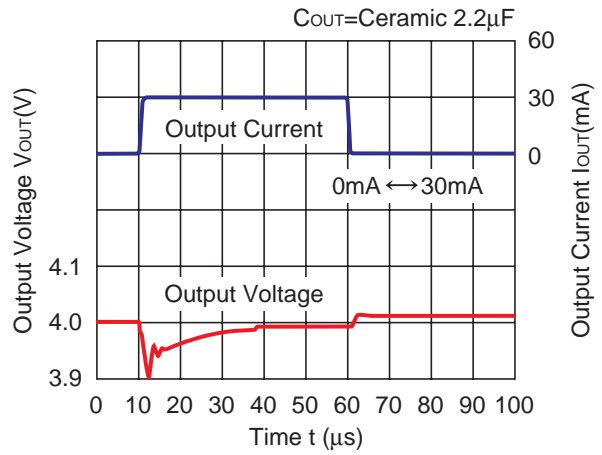
\* R5326N (SOT-23-6) and R5326Z (WLCSP-6-P1) are the discontinued product. As of June in 2016.

**R5326x**

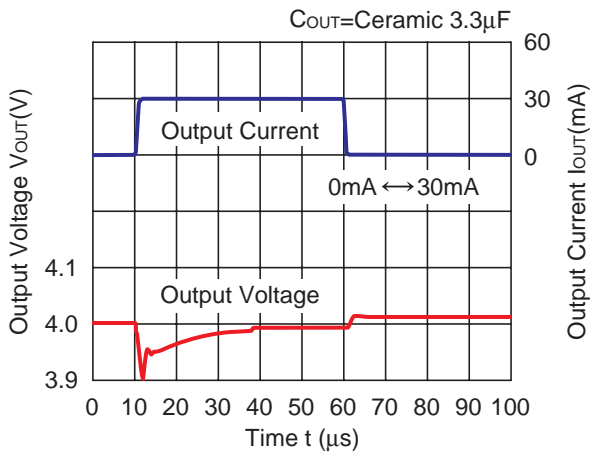
**4.0V (VR1/VR2)**



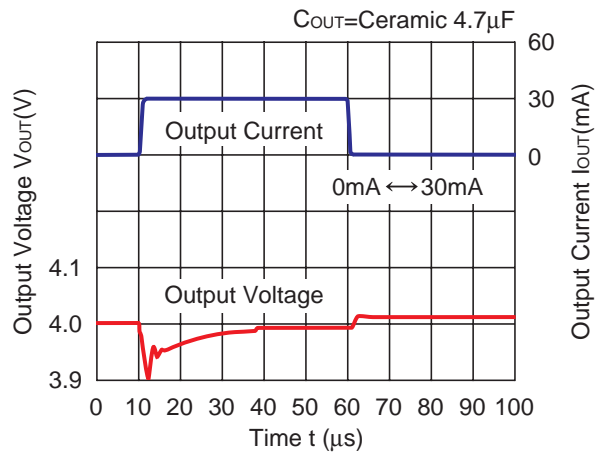
**4.0V (VR1/VR2)**



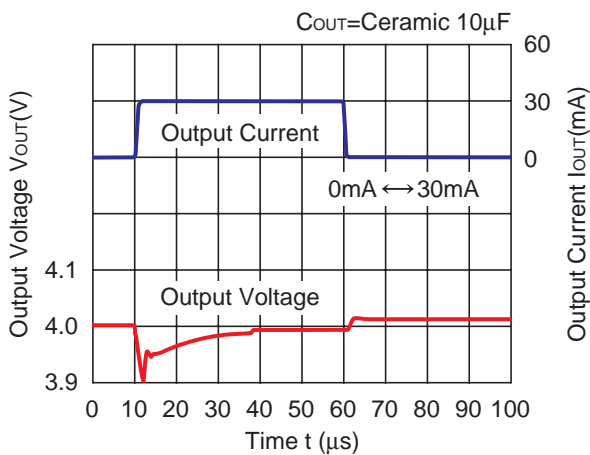
**4.0V (VR1/VR2)**



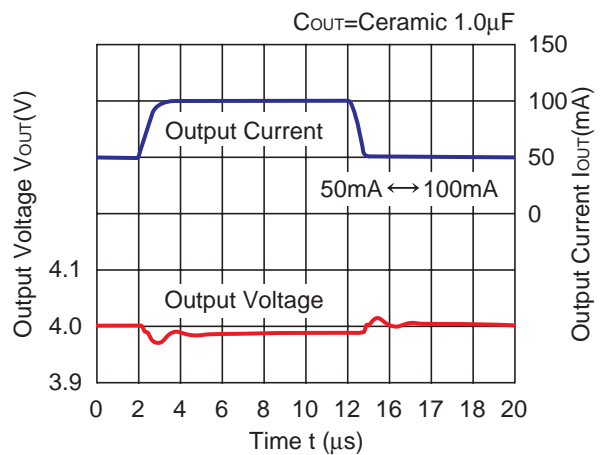
**4.0V (VR1/VR2)**



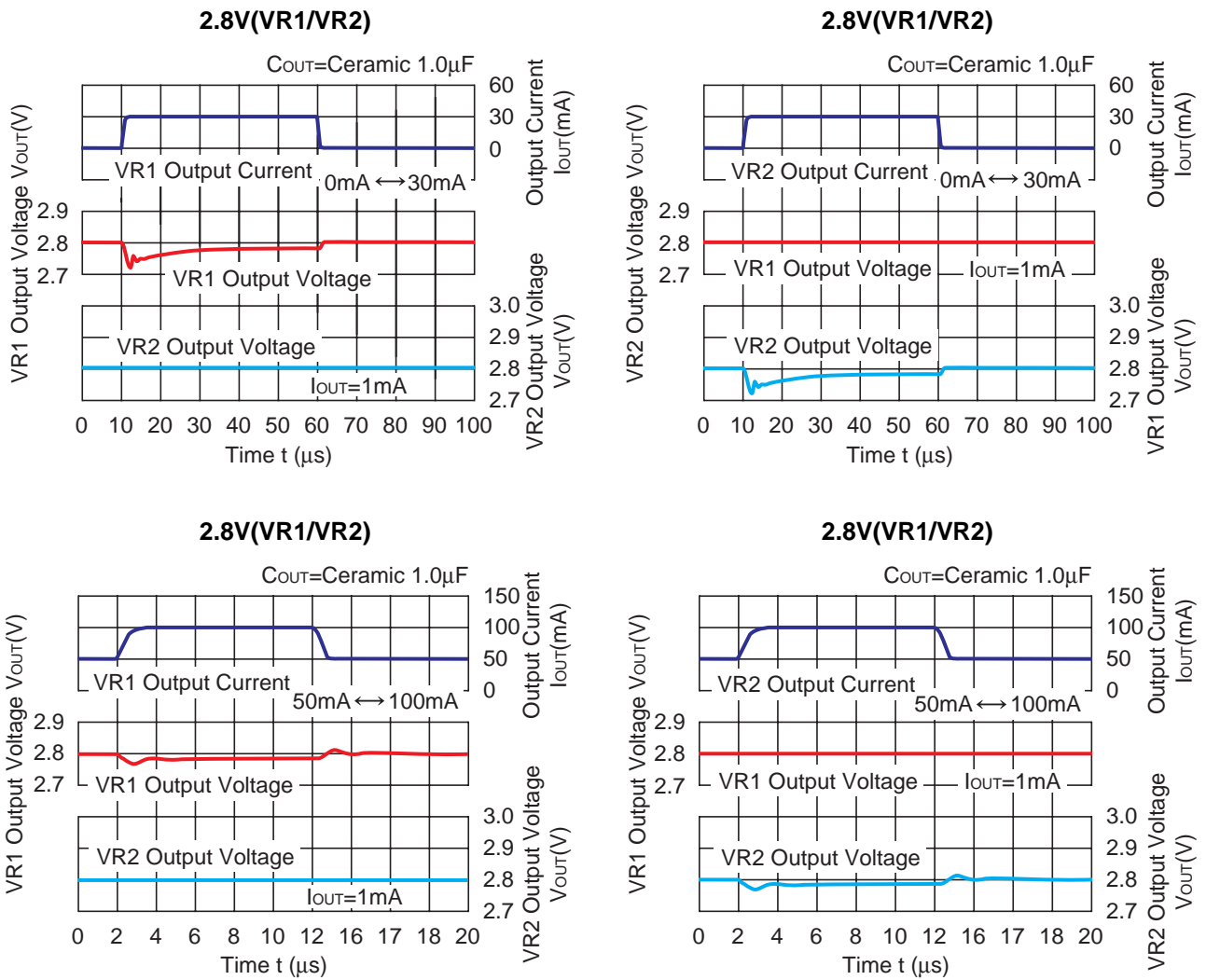
**4.0V (VR1/VR2)**



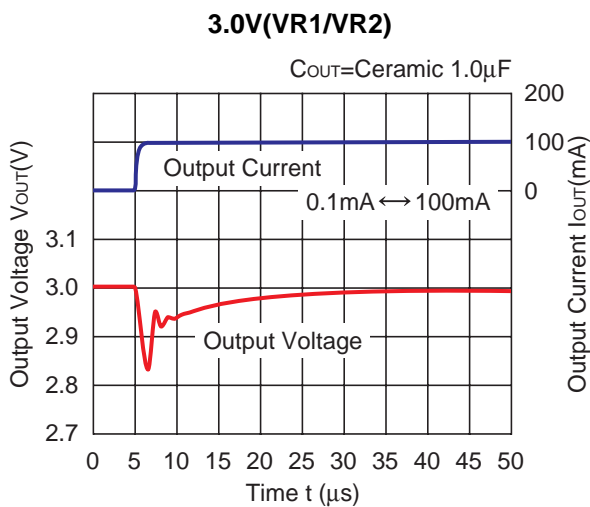
**4.0V (VR1/VR2)**



14) Load Transient Response2 ( $t_r=t_f=0.5\mu s$ ,  $C_{IN}=1.0\mu F$ )



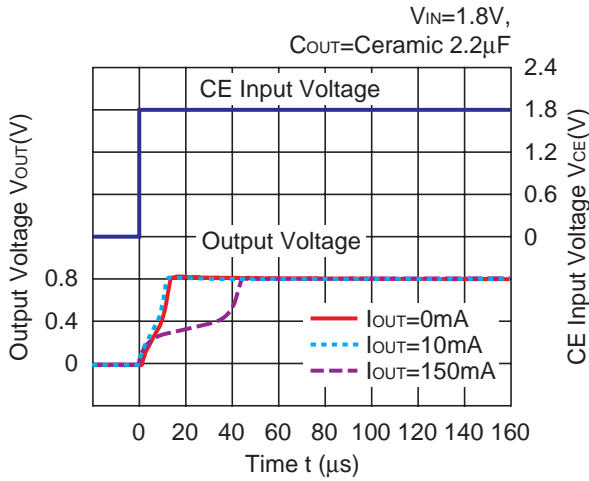
15) Load Transient Response3 ( $t_r=t_f=10ns$ )



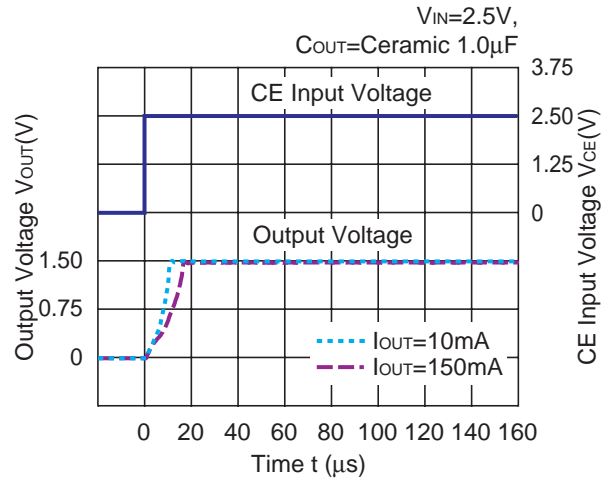
**R5326x**

**16) Turn on speed with CE Pin ( $C_{IN}$ =Ceramic 1.0 $\mu$ F)**

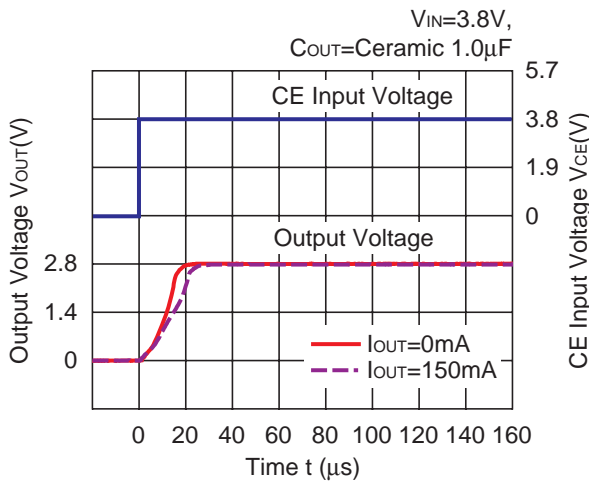
**0.8V(VR1/VR2)**



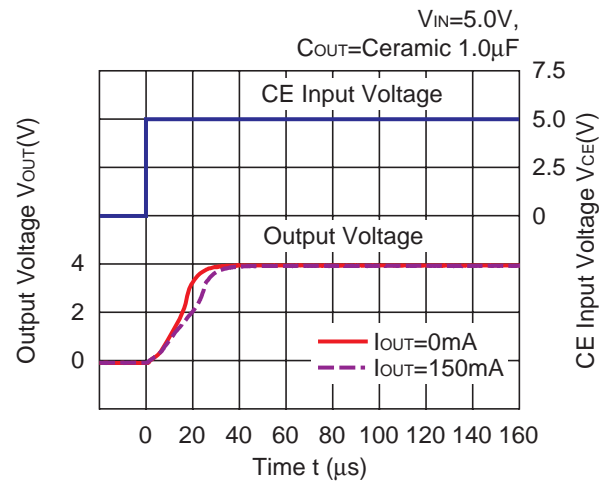
**1.5V(VR1/VR2)**



**2.8V(VR1/VR2)**

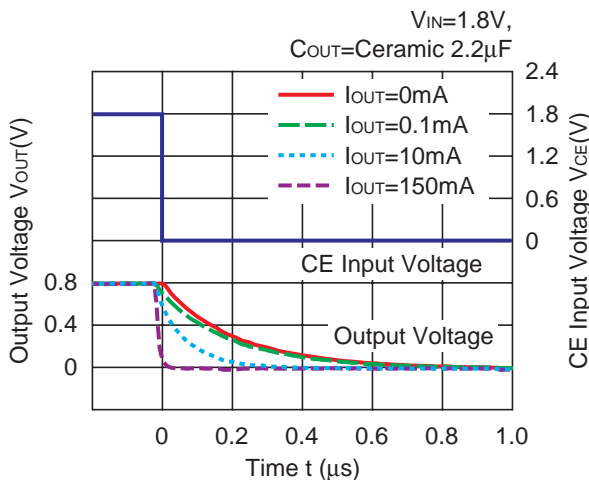


**4.0V(VR1/VR2)**

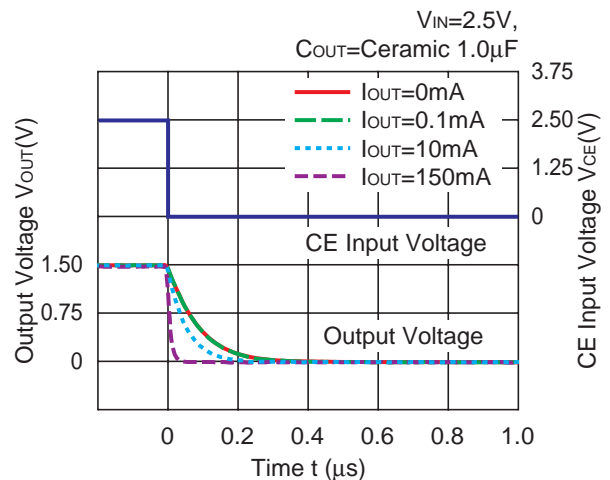


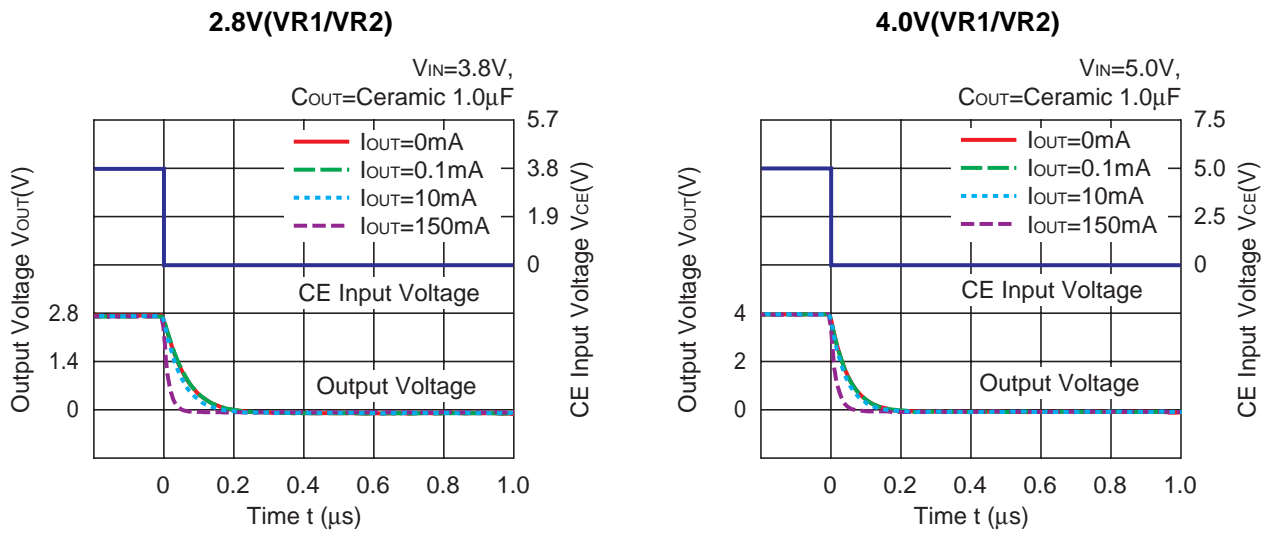
**17) Turn off speed with CE Pin ( $C_{IN}$ =Ceramic 1.0 $\mu$ F)**

**0.8V(VR1/VR2)**



**1.5V(VR1/VR2)**





\* R5326N (SOT-23-6) and R5326Z (WLCSP-6-P1) are the discontinued product. As of June in 2016.

## R5326x

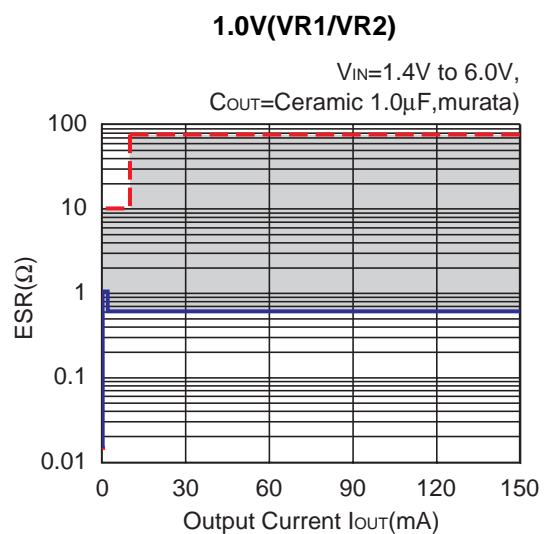
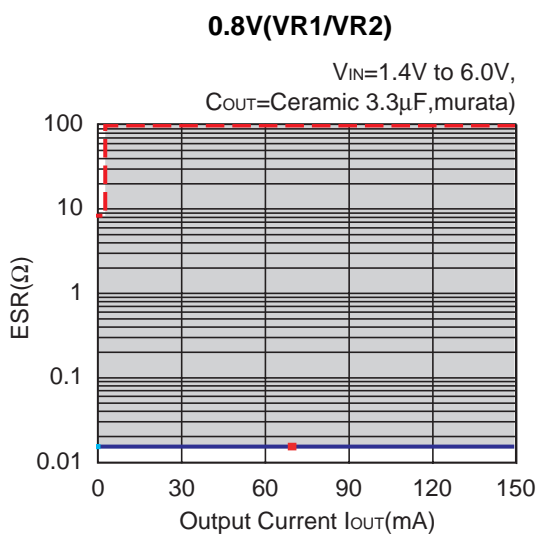
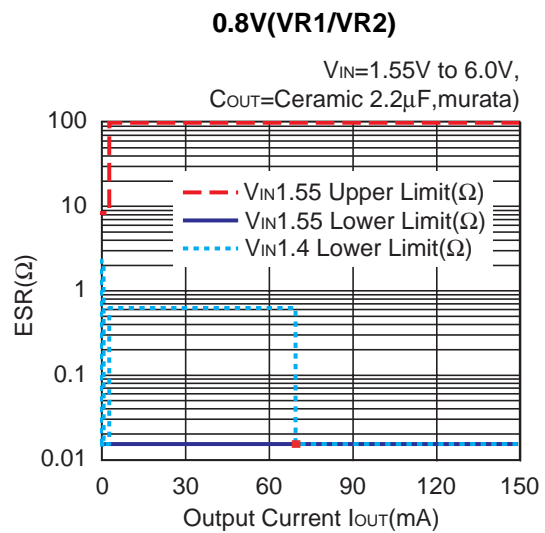
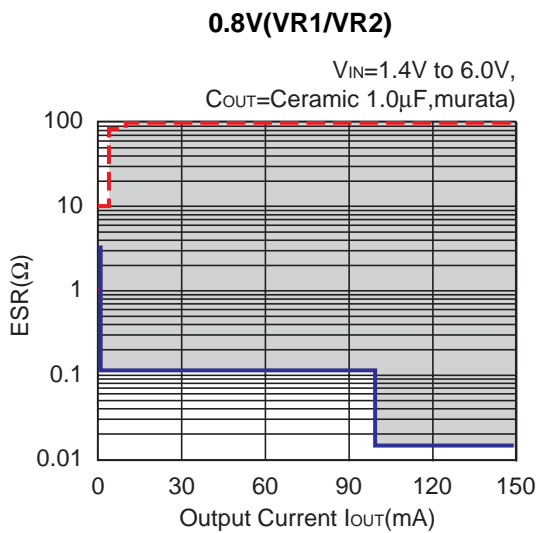
### ESR vs. Output Current

Ceramic type output capacitor is recommended for this series; however, the other output capacitors with low ESR also can be used. 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

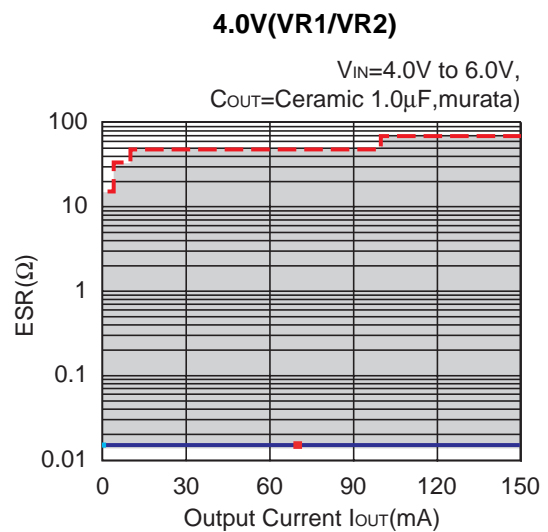
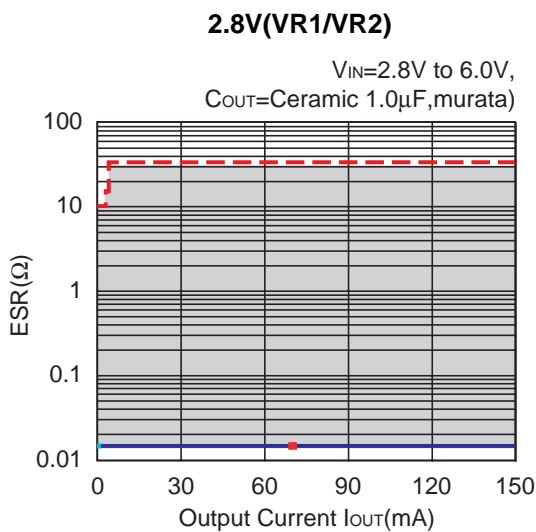
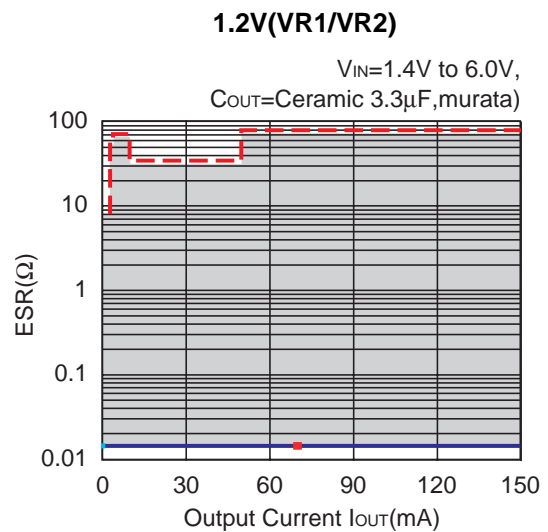
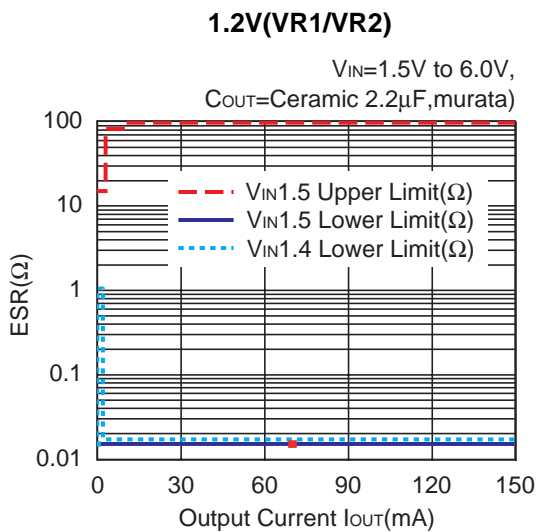
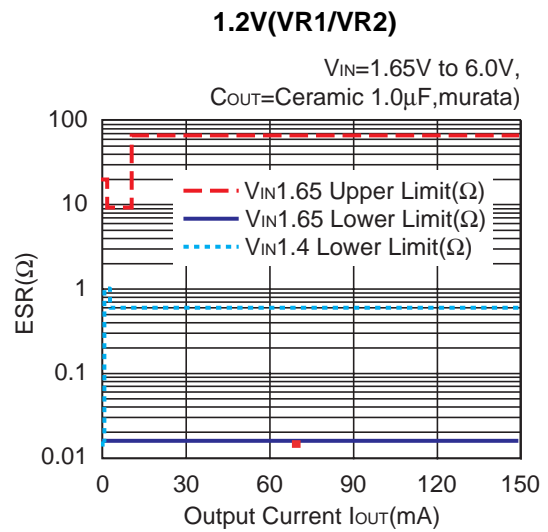
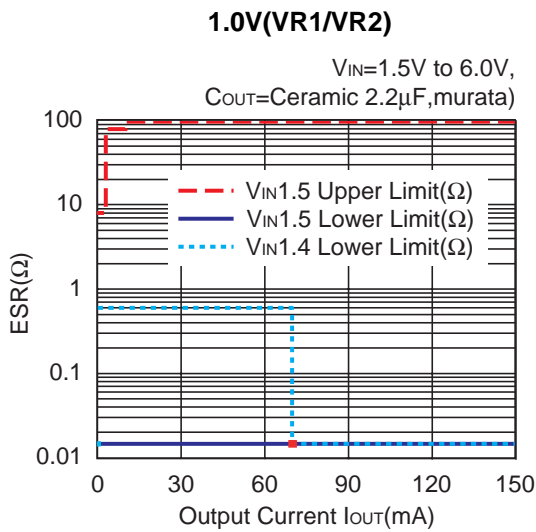
#### Measurement conditions

Frequency Band : 10Hz to 2MHz

Temperature :  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$



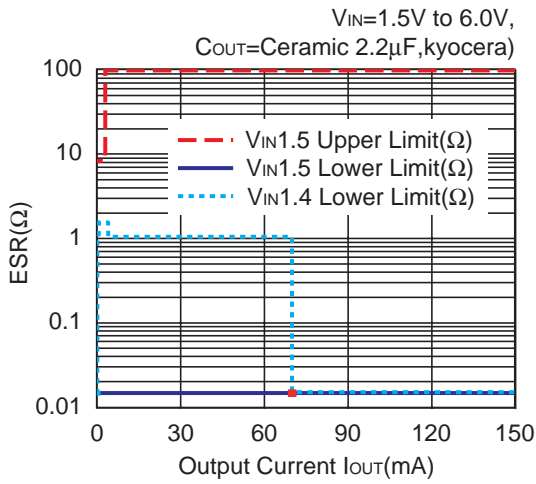




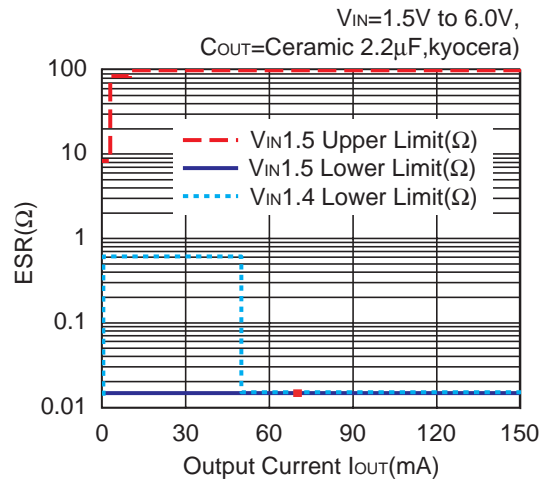
\* R5326N (SOT-23-6) and R5326Z (WLCSP-6-P1) are the discontinued product. As of June in 2016.

**R5326x**

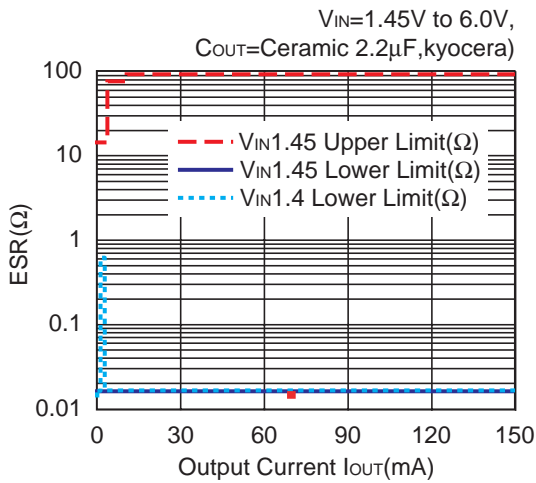
**0.8V(VR1/VR2)**



**1.0V(VR1/VR2)**



**1.2V(VR1/VR2)**





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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 our sales or our distributor before attempting to use AOI.
11. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.



**Nisshinbo Micro Devices Inc.**

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