RICOH

R5326x SERIES

Automatic Mode Shift Dual 150mA LDO

NO.EA-138-120404

OUTLINE

The R5326x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, Typ. 5.5µA 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 (Discontinued) and DFN(PLP)1820-6, and chip size package, WLCSP-6-P1 (Limited), dual LDO regulators are included in each package, high density mounting of the ICs on boards is possible.

FEATURES

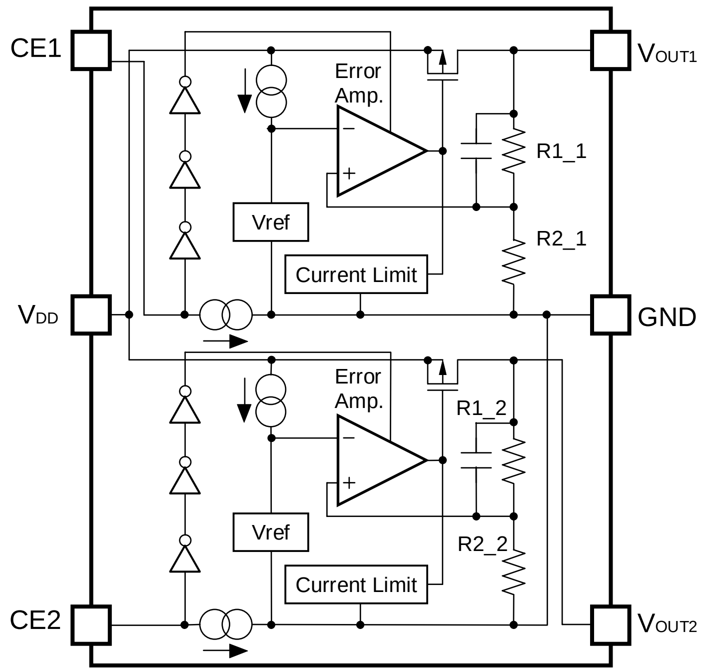
- Supply Current (Low Power Mode)..................Typ. 5.5µA×2 (VR1&VR2) (I_{OUT}=0mA)
- Supply Current (Fast Mode).............................Typ. 50µA×2 (VR1&VR2) (I_{OUT}=10mA)
- Standby Current ....Typ. 0.1µA (VR1&VR2)
- Dropout Voltage ....Typ. 0.19V (I_{OUT}=150mA, V_{OUT}=2.8V)
- Ripple Rejection ....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..................................±1.0% (V_{OUT}>1.5V)
- Line Regulation ....Typ. 0.02%/V
- Packages ....WLCSP-6-P1 (Limited), DFN(PLP)1820-6,
  SOT-23-6 (Discontinued)
- Built-in fold-back protection circuit ....Typ. 50mA (Current at short mode)
- Ceramic Capacitor is recommended. ....1.0µF to 3.3µF
  (Depending on V_{IN} and set V_{OUT}. Refer to the electrical characteristics table.)

APPLICATIONS

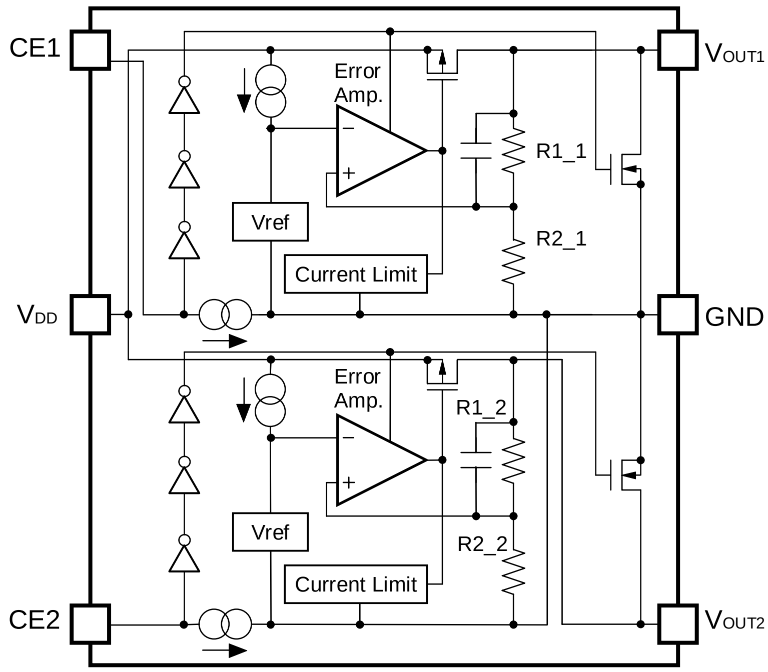
- Power source for handheld communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

R5326xxxxA



R5326xxxxB



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 (Limited)	5,000 pcs	Yes	Yes
R5326Kxxx∗-TR	DFN(PLP)1820-6	5,000 pcs	Yes	Yes
R5326Nxxx∗-TR-FE	SOT-23-6 (Discontinued)	3,000 pcs	Yes	Yes

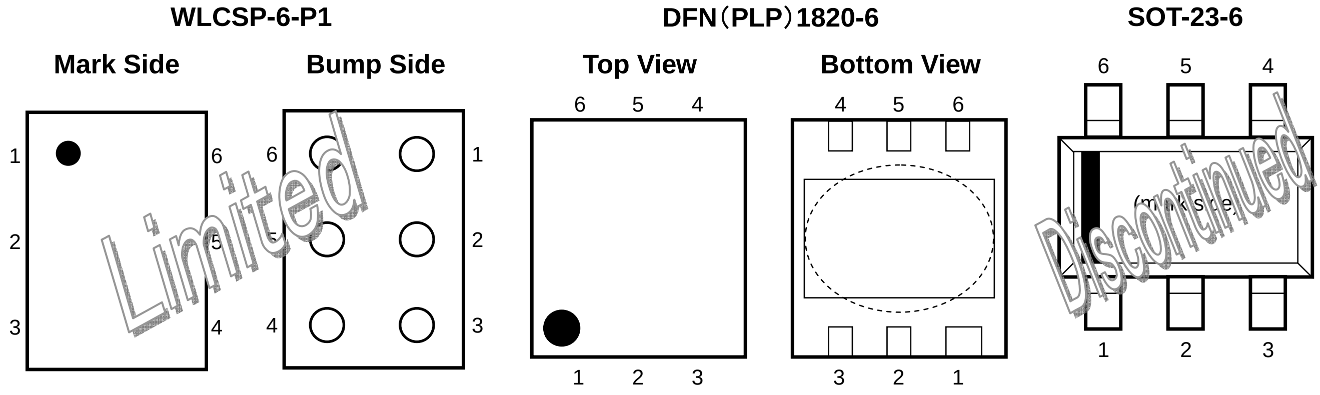
xxx : The combination of output voltage for each channel can be designated by serial numbers. (from 001)
The output voltage for each channel can be set in the range from 0.8V to 4.2V in 0.1V steps.
(For details, please refer to MARK INFORMATIONS.)

∗ : 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

The products scheduled to be discontinued (be sold to limited customer) : "Limited"

These products will be discontinued in the future. You can not select these products newly.
We will provide these products to the customer who has been using or has ordered them before.
But we recommend changing to other products as soon as possible.

PIN CONFIGURATIONS



PIN DESCRIPTIONS

- **WLCSP-6-P1 (Limited), SOT-23-6 (Discontinued)**

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.

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) *(Limited)	633	mW
	Power Dissipation (DFN(PLP)1820-6) *	880	
	Power Dissipation (SOT-23-6) * (Discontinued)	420	
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.

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.

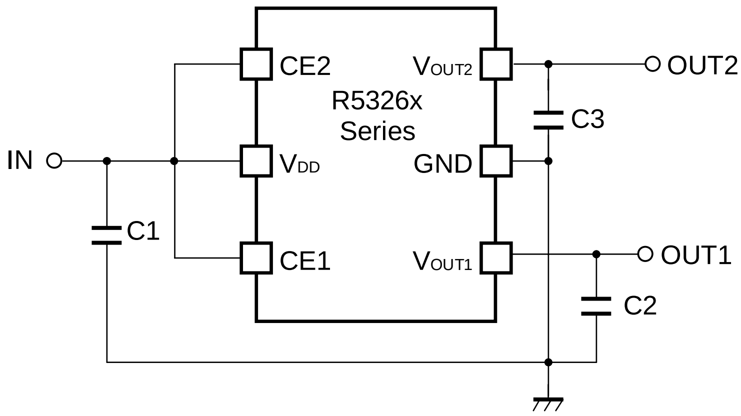
ELECTRICAL CHARACTERISTICS

- **R5326xxxxA/B**

VR1/VR2 Topt=25°C

Symbol	Item	Conditions		MIN.	TYP.	MAX.	Unit
V_{OUT}	Output Voltage	$V_{IN}-V_{OUT}=1V$ $I_{OUT}=1mA$	$V_{OUT} > 1.5V$	×0.99		×1.01	V
			$V_{OUT} \leqq 1.5V$	−15		+15	mV
I_{OUT}	Output Current	$V_{IN}-V_{OUT}=1V$		150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	$V_{IN}-V_{OUT}=1V$ $1mA \leqq I_{OUT} \leqq 150mA$				80	mV
V_{DIF}	Dropout Voltage	$I_{OUT}=150mA$	$0.8V \leqq V_{OUT}<0.9V$		0.62	0.87	V
			$0.9V \leqq V_{OUT}<1.0V$		0.58	0.78	
			$1.0V \leqq V_{OUT}<1.2V$		0.48	0.69	
			$1.2V \leqq V_{OUT}<1.5V$		0.40	0.59	
			$1.5V \leqq V_{OUT}<2.0V$		0.31	0.48	
			$2.0V \leqq V_{OUT}<2.8V$		0.22	0.37	
			$2.8 \leqq V_{OUT}$		0.19	0.27	
I_{SS1}	Supply Current (Low Power Mode)	$V_{IN}-V_{OUT}=1V$, $I_{OUT}=0mA$			5.5	16	μA
I_{SS2}	Supply Current (Fast Mode)	$V_{IN}-V_{OUT}=1V$, $I_{OUT}=10mA$			50	105	μA
$I_{standby}$	Standby Current	$V_{IN}=6V$, $V_{CE1}=V_{CE2}=GND$			0.1	1.0	μA
I_{OUTL}	Low Power Mode Current threshold	$V_{IN}-V_{OUT}=1V$, $I_{OUT}=30mA$ to $1\mu A$			0.6		mA
I_{OUTH}	Fast Response Mode Current threshold	$V_{IN}-V_{OUT}=1V$, $I_{OUT}=1\mu A$ to 30mA			3		mA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$V_{OUT}+0.5V \leqq V_{IN} \leqq 6V$ $I_{OUT}=30mA$ (*$V_{IN} \geqq 1.8V$)			±0.02	±0.2	%/V
RR	Ripple Rejection	Ripple 0.2Vp-p, $V_{IN}-V_{OUT}=1V$, $I_{OUT}=30mA$ (In case that $V_{OUT}<1.5V$, $V_{IN}-V_{OUT}=1.5V$)	f=1kHz		70		dB
			f=10kHz		60		
V_{IN}	Input Voltage			1.4		6.0	V
$\Delta V_{OUT}/\Delta T_{opt}$	Output Voltage Temperature Coefficient	$I_{OUT}=30mA$, $-40°C \leqq T_{opt} \leqq 85°C$			±100		ppm/°C
I_{SC}	Short Current Limit	$V_{OUT}=0V$			50		mA
I_{PD}	CE Pull-down Current			0.15	0.30	0.45	μA
V_{CEH}	CE Input Voltage "H"			1.0		6.0	V
V_{CEL}	CE 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)				40		Ω

TYPICAL APPLIATION



(External Components)
Capacitor; Ceramic Type
C1 : 1.0μF Ceramic
C2, C3 : Refer to the following table

Recommended Ceramic capacitor for Output (C2, C3)

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

Output Capacitors
3.3μF (Murata) GRM219B31A335KE18B
2.2μF (Murata) GRM155B30J225M
1.0μF (Murata) GRM155B31A105KE15

TECHNICAL NOTES

When using these ICs, consider the following points:

Mounting on PCB

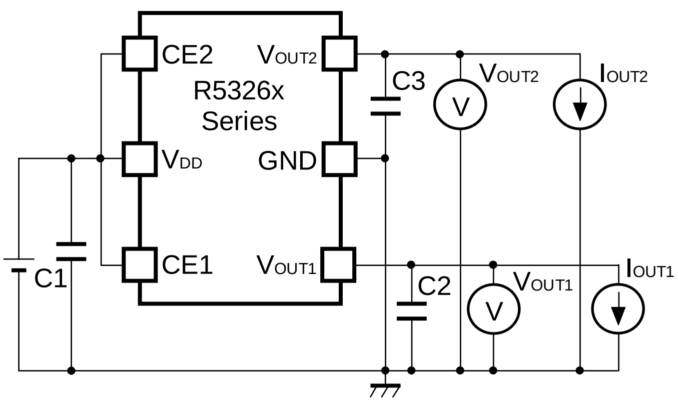
Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor with a capacitance value as much as 1.0μF or more as C1 between V_{DD} and GND pin, and as close as possible to the pins.

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

Phase Compensation

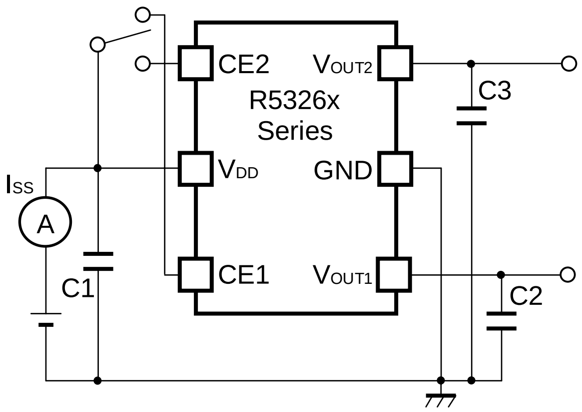
In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use capacitors C2 and C3 which are shown below table “Recommended Ceramic capacitor for output “If you use a tantalum type capacitor and ESR value of the capacitor is large, output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

TEST CIRCUITS



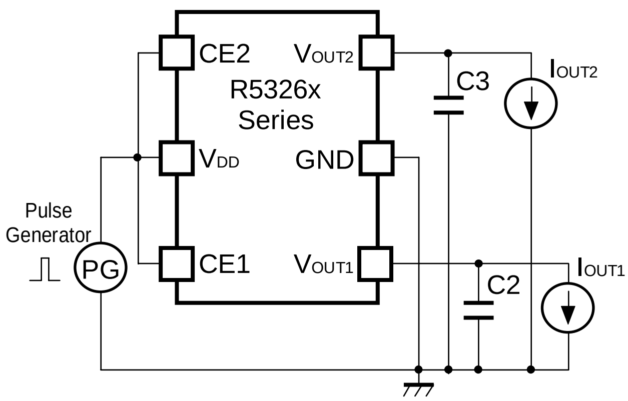
C1=Ceramic 1.0μF
C2,C3=refer to the term of the external capacitors

Fig.1 Standard test Circuit



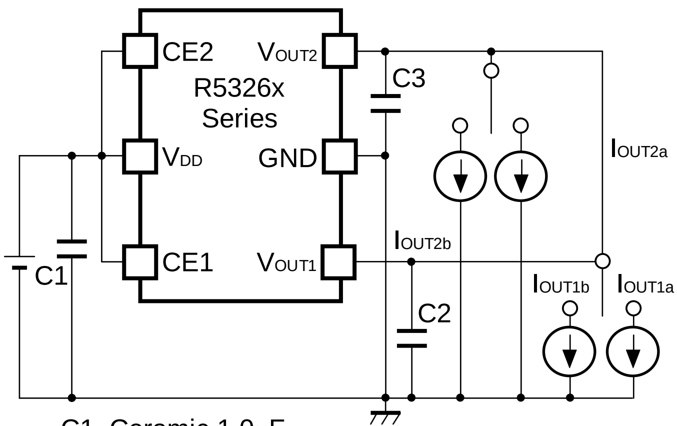
C1=Ceramic 1.0μF
C2,C3=refer to the term of the external capacitors

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



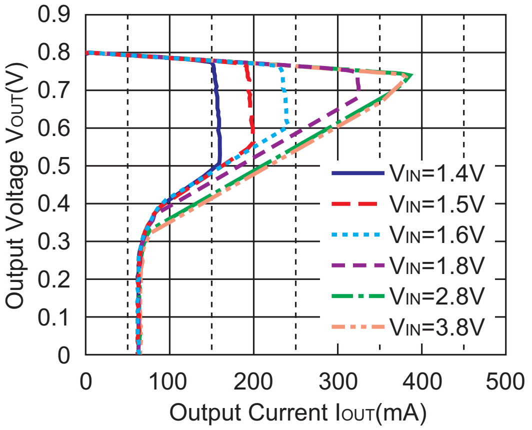
C1=Ceramic 1.0μF
C2,C3= refer to the term of the external capacitors

Fig.4 Load Transient Response Test Circuit

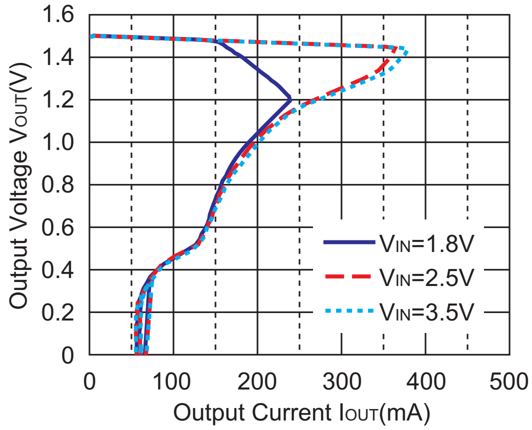
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

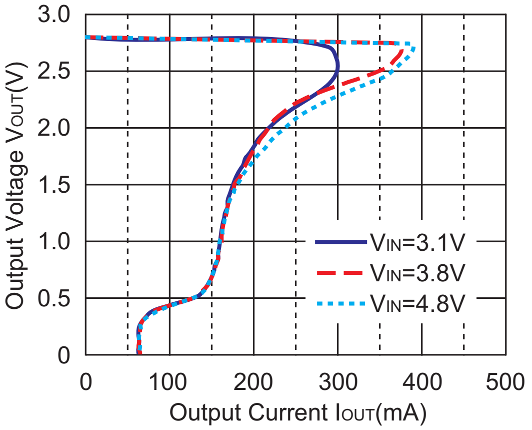
0.8V(VR1/VR2)



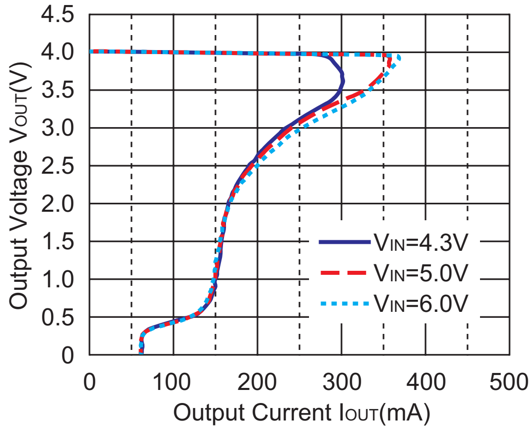
1.5V(VR1/VR2)



2.8V(VR1/VR2)

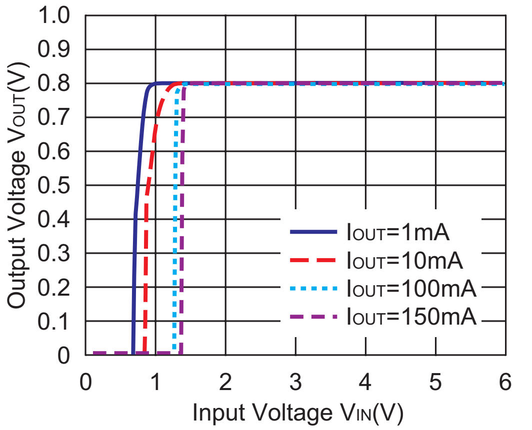


4.0V(VR1/VR2)

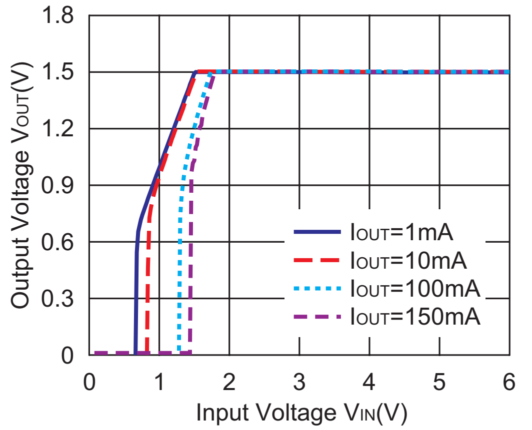


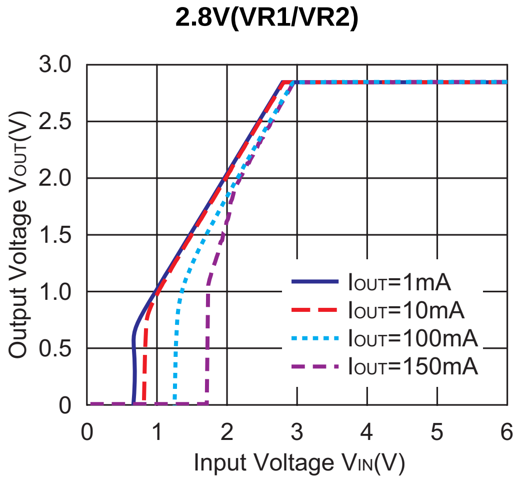
2) Input Voltage vs. Output Voltage

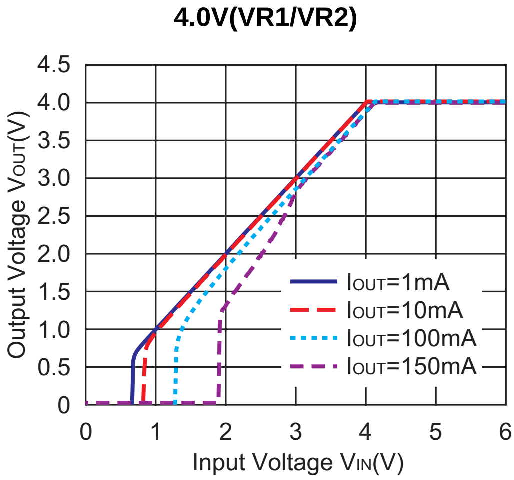
0.8V(VR1/VR2)



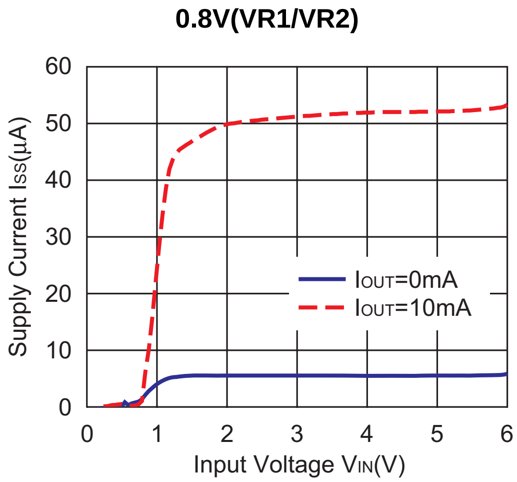
1.5V(VR1/VR2)

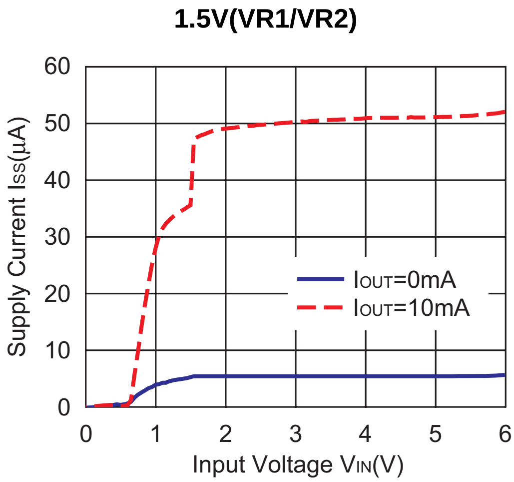


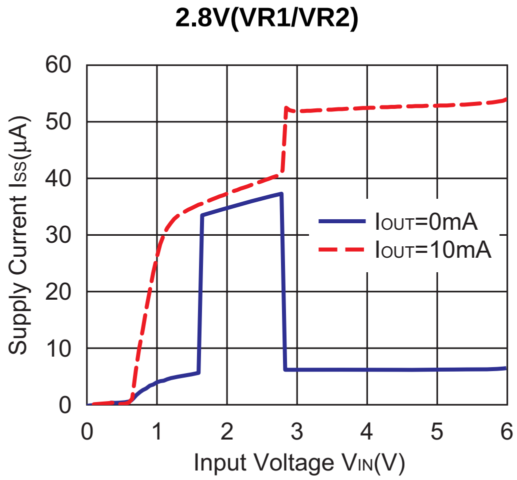


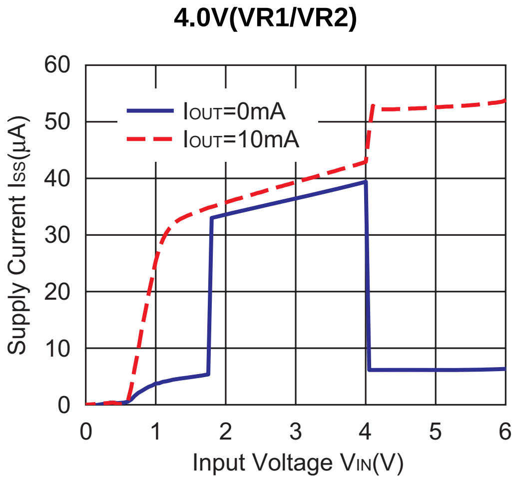


3) Supply Current vs. Input Voltage

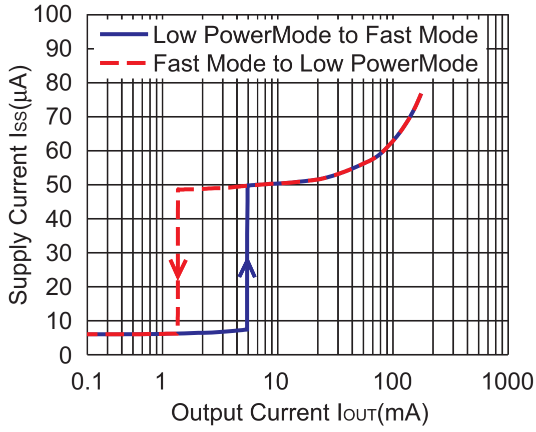




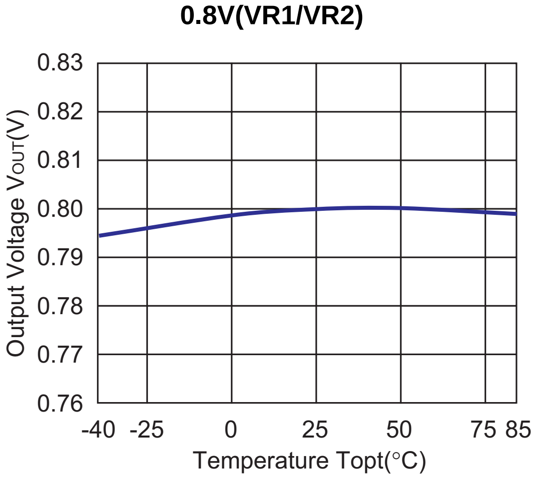


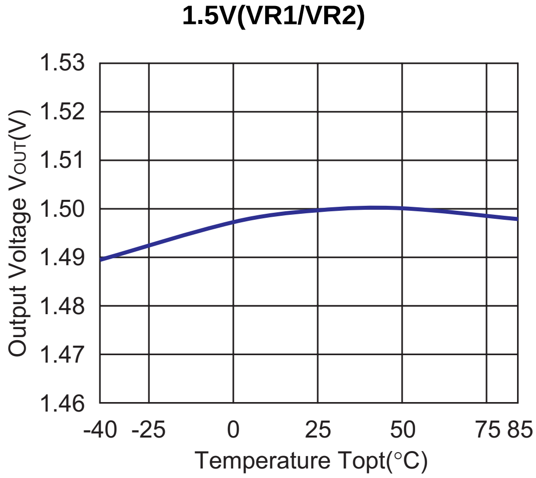


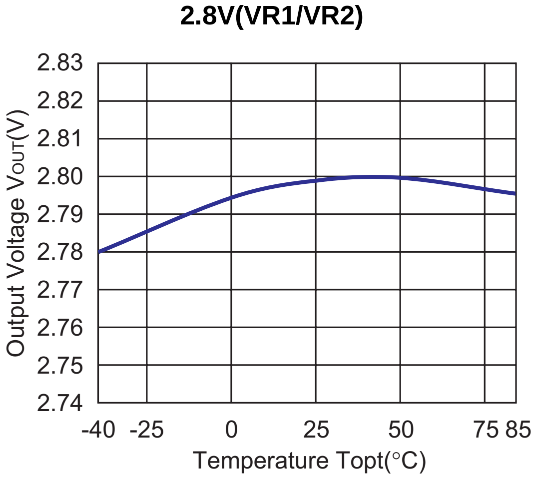
4) Supply current vs. Output current

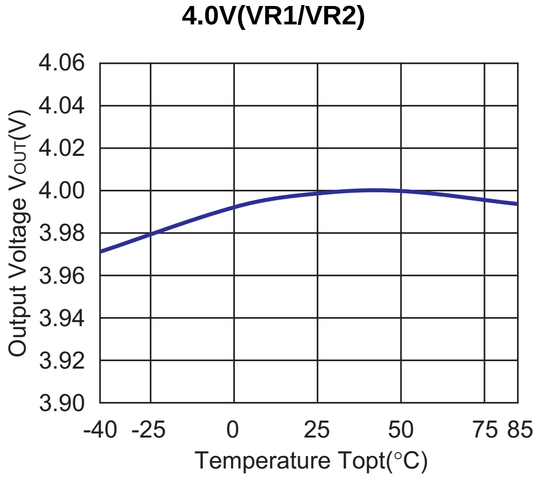


5) Output Voltage vs. Temperature

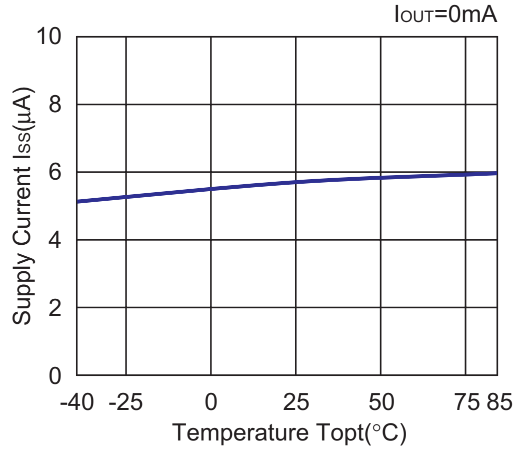






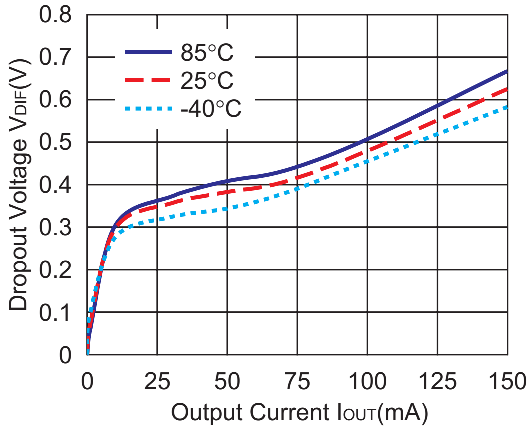


6) Supply Current vs. Temperature

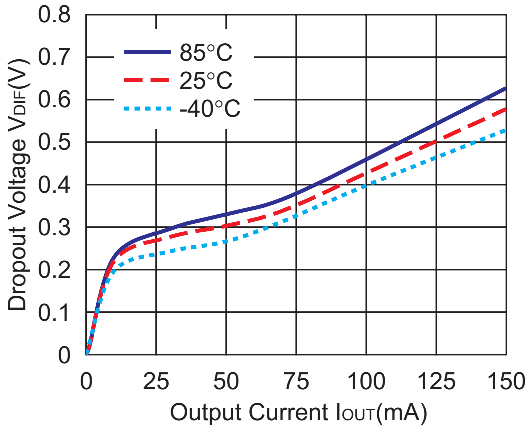


7) Dropout Voltage vs. Output Current

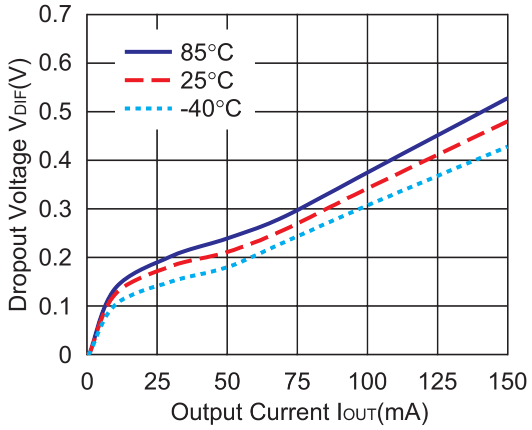
0.8V(VR1/VR2)



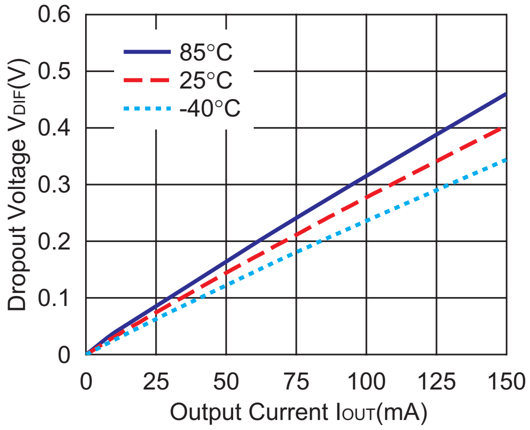
0.9V(VR1/VR2)



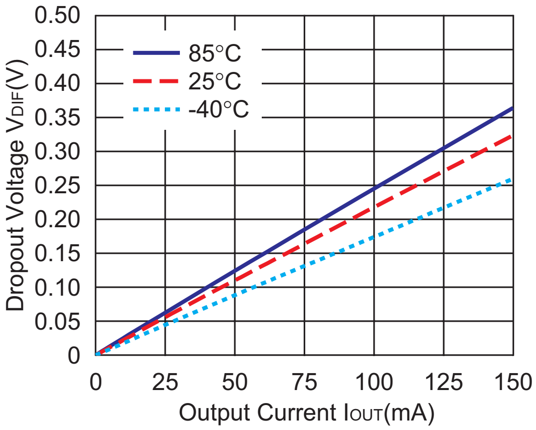
1.0V(VR1/VR2)



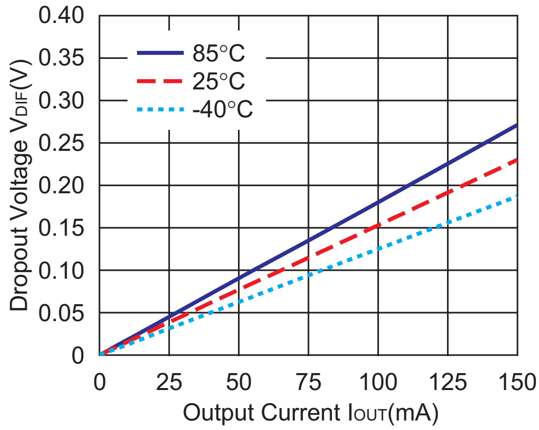
1.2V(VR1/VR2)



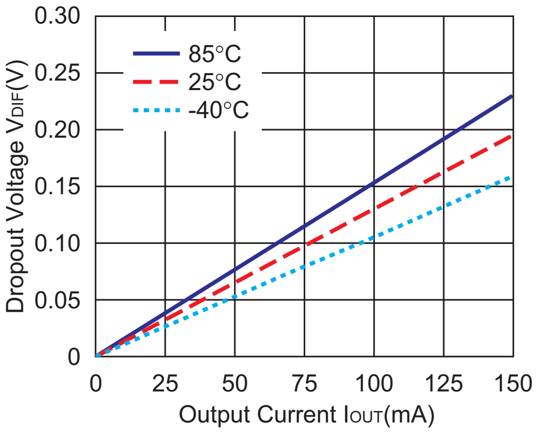
1.5V(VR1/VR2)



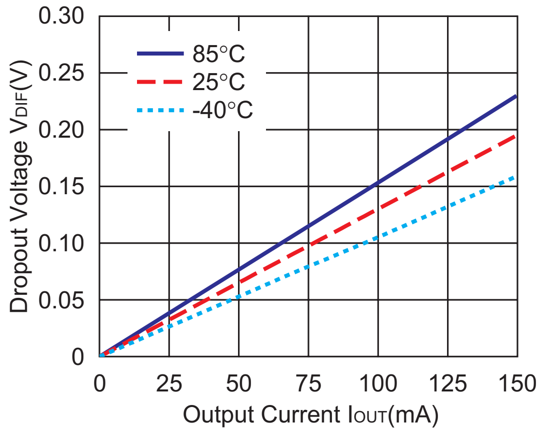
2.0V(VR1/VR2)



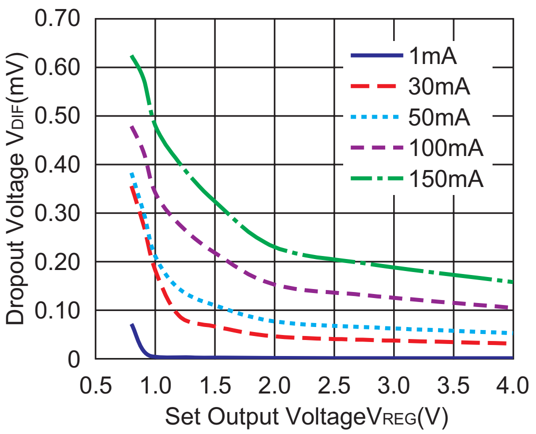
2.8V(VR1/VR2)



4.0V(VR1/VR2)



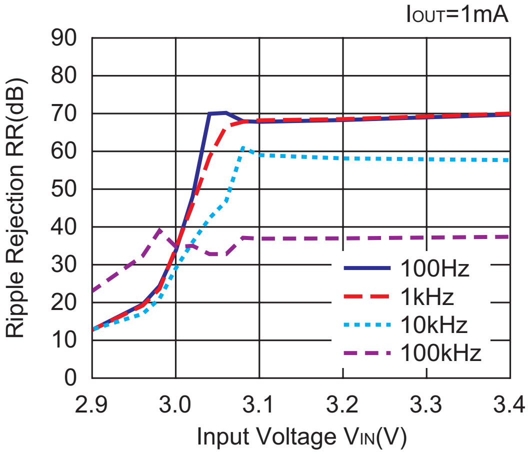
8) Dropout Voltage vs. Set Output Voltage



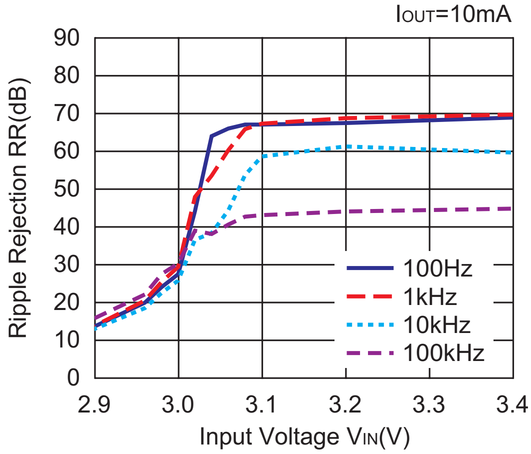
9) Ripple Rejection vs. Input Voltage

(Topt=25°C, Ripple 0.5Vp-p, C_{IN}=none, C_{OUT}=Ceramic 1.0µF)

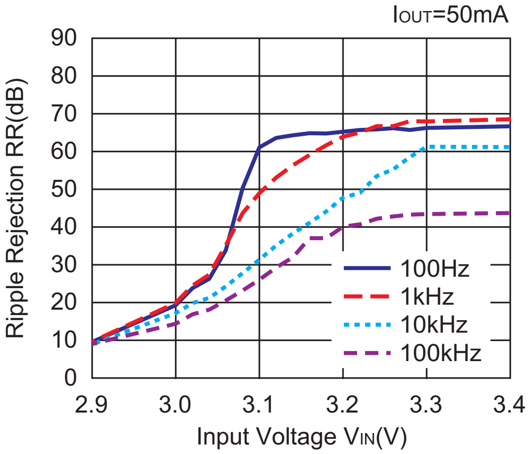
2.8V(VR1/VR2)



2.8V(VR1/VR2)

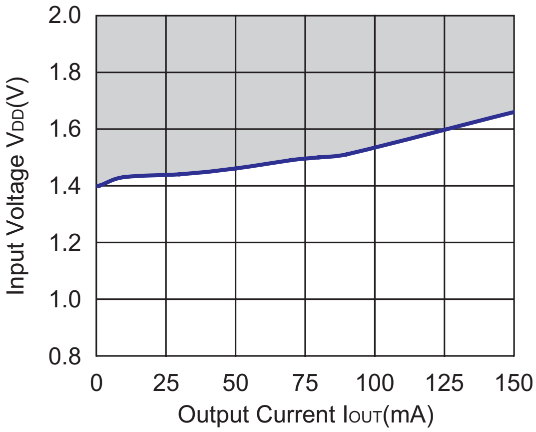


2.8V(VR1/VR2)



10) Minimum Operating Voltage

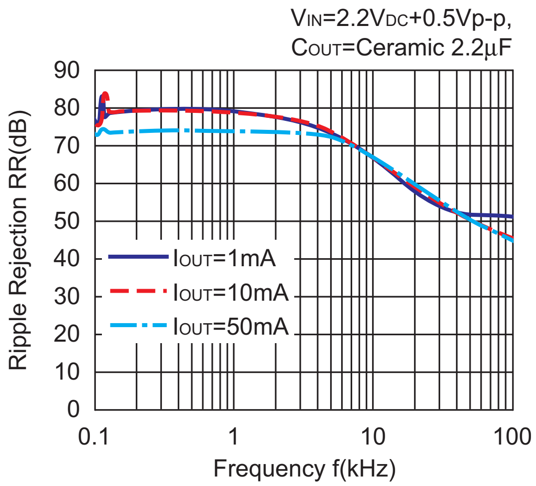
0.8V(VR1/VR2)



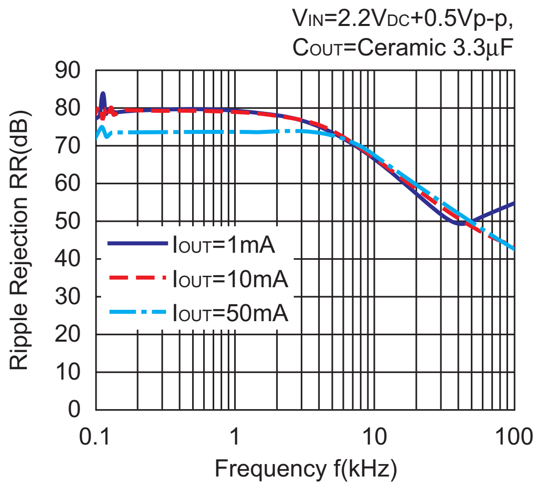
Hatched area is available for 0.8V output

11) Ripple Rejection vs Frequency (CIN=none)

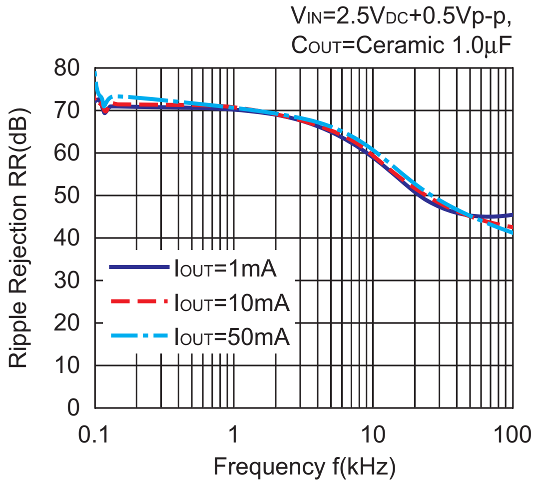
0.8V(VR1/VR2)



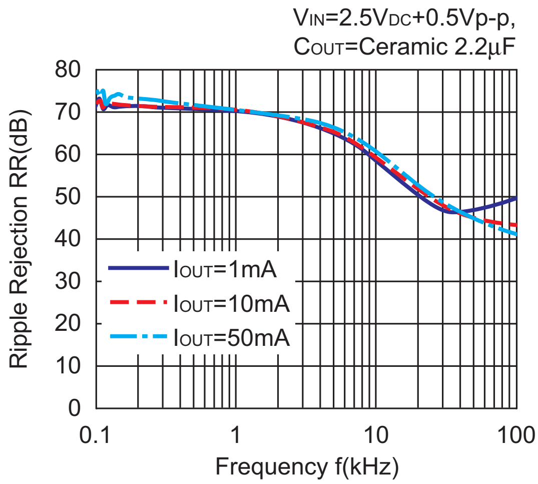
0.8V(VR1/VR2)



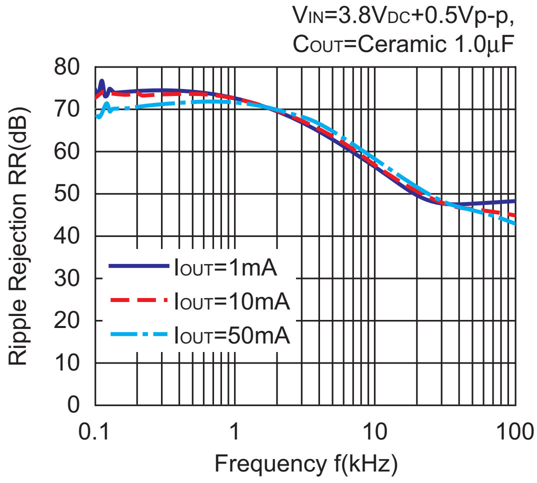
1.5V(VR1/VR2)



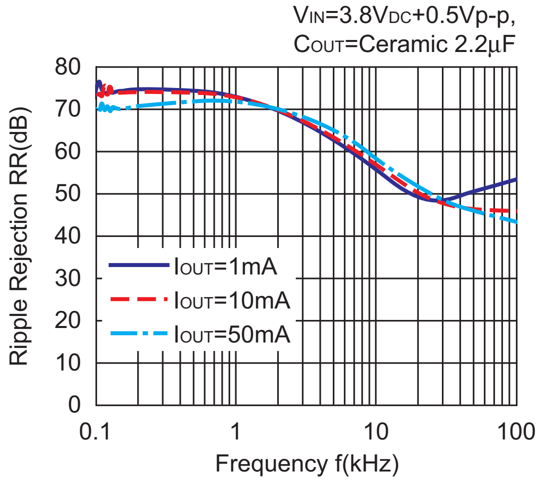
1.5V(VR1/VR2)



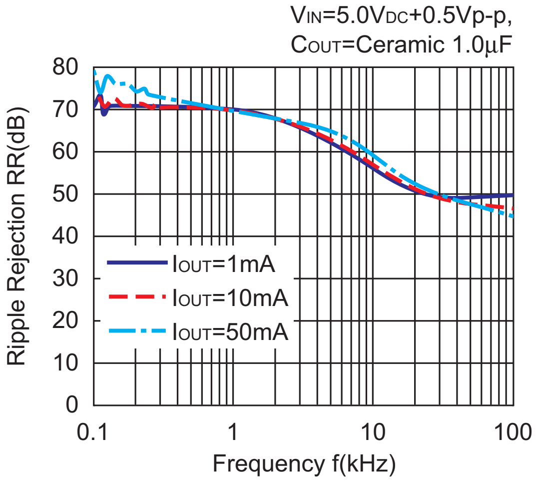
2.8V(VR1/VR2)



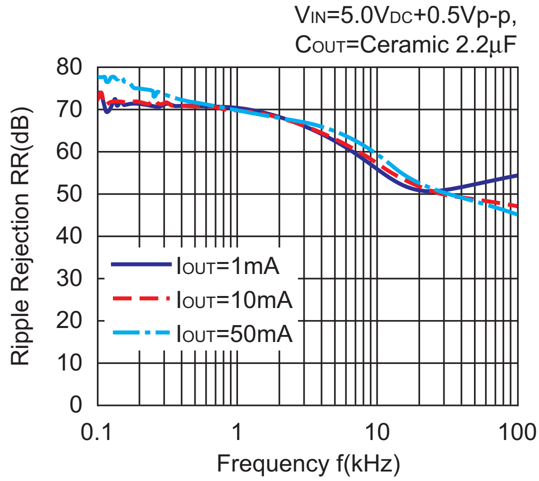
2.8V(VR1/VR2)



4.0V(VR1/VR2)

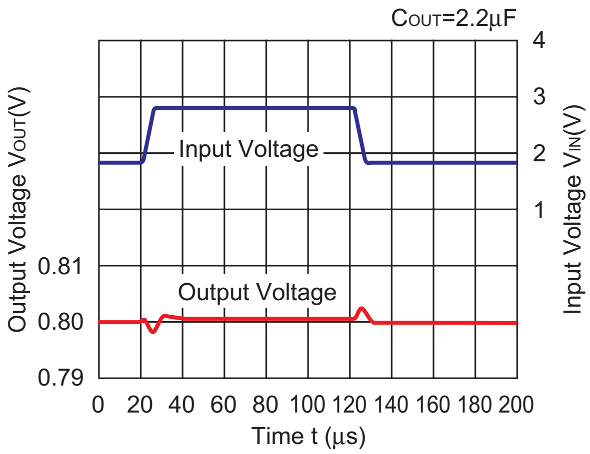


4.0V(VR1/VR2)

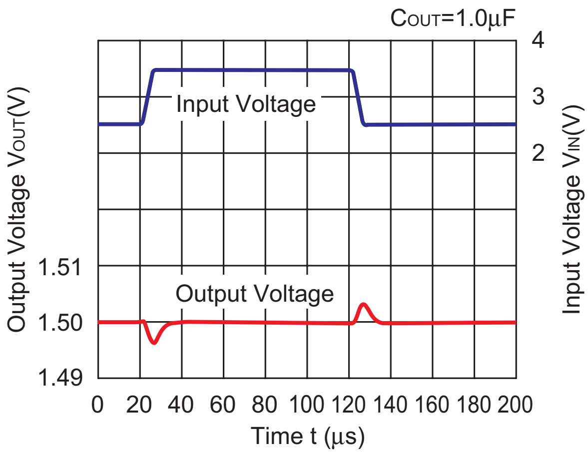


12) Input Transient Response (I_{OUT}=30mA,tr=tf=5µs, C_{IN}=none)

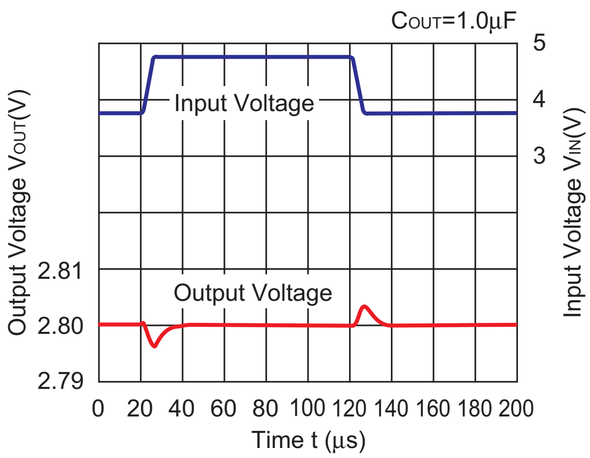
0.8V(VR1/VR2)



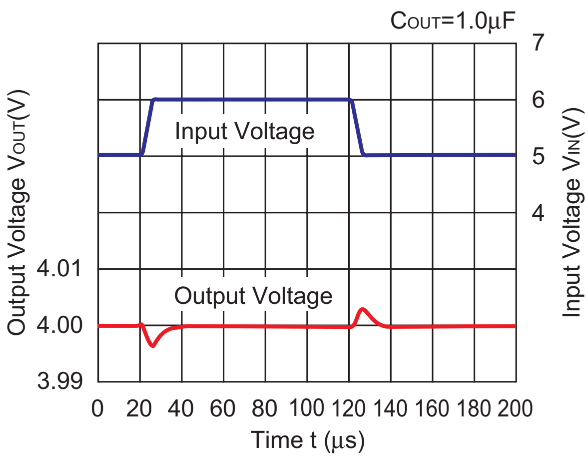
1.5V(VR1/VR2)



2.8V(VR1/VR2)

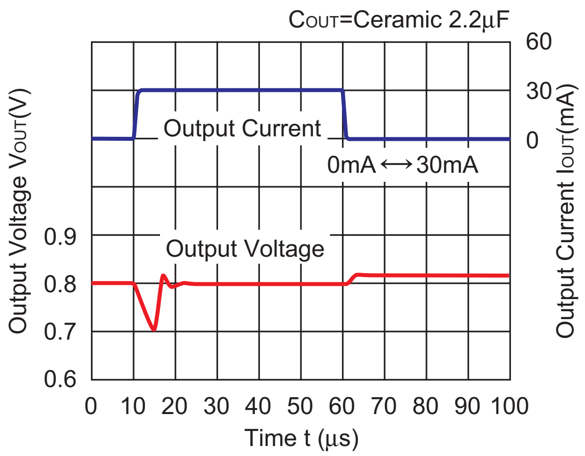


4.0V(VR1/VR2)

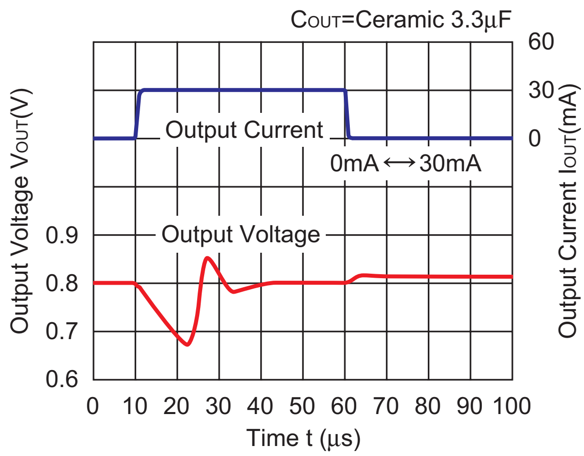


13) Load Transient Response1 (tr=tf=0.5µs, CIN=1.0µF)

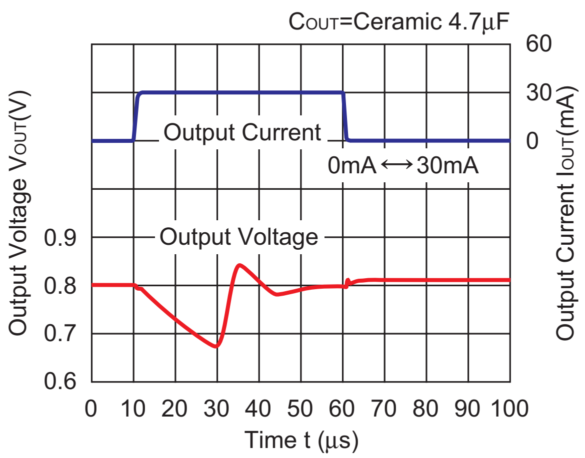
0.8V(VR1/VR2)



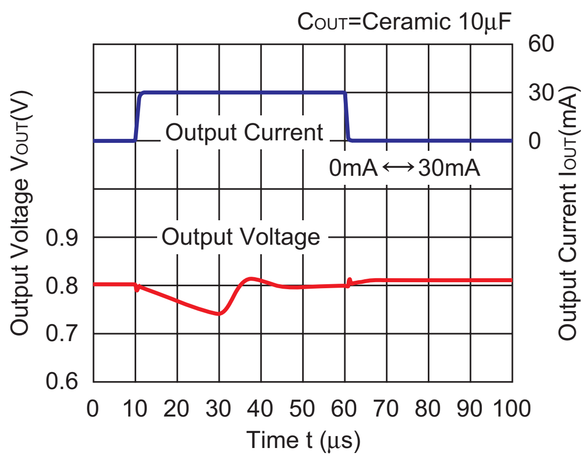
0.8V(VR1/VR2)



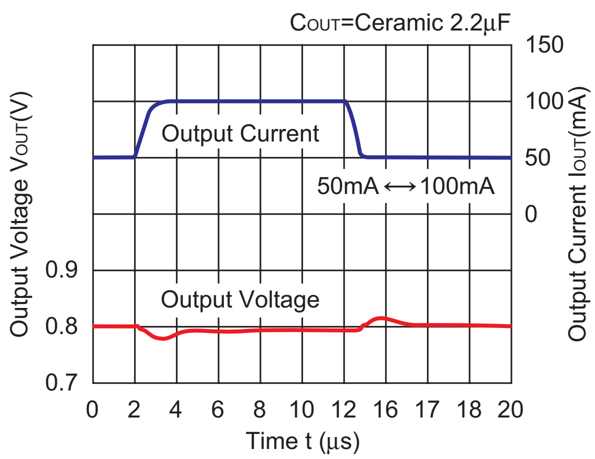
0.8V(VR1/VR2)



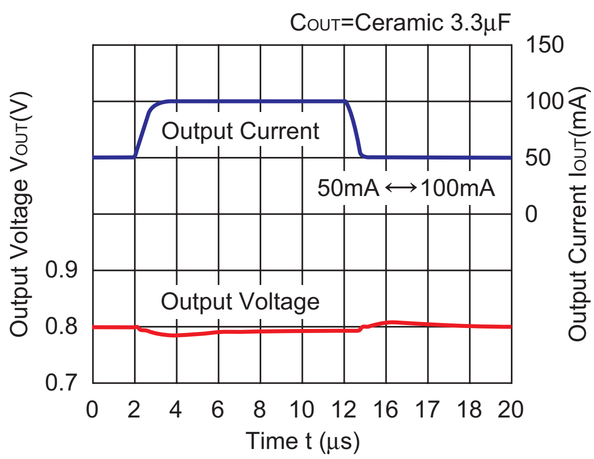
0.8V(VR1/VR2)



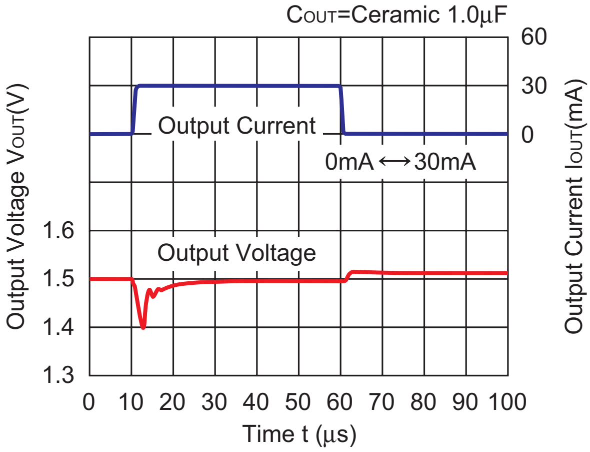
0.8V(VR1/VR2)



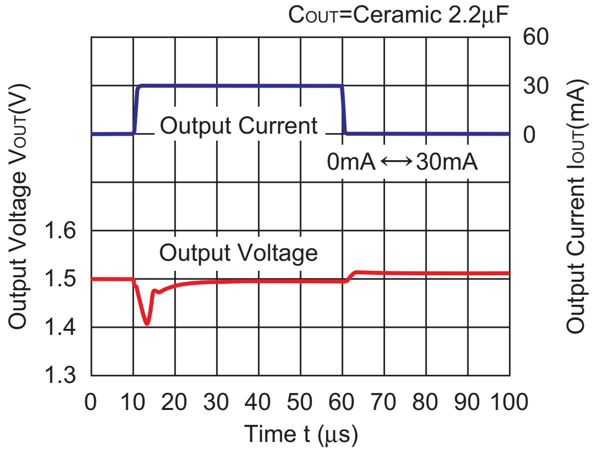
0.8V(VR1/VR2)



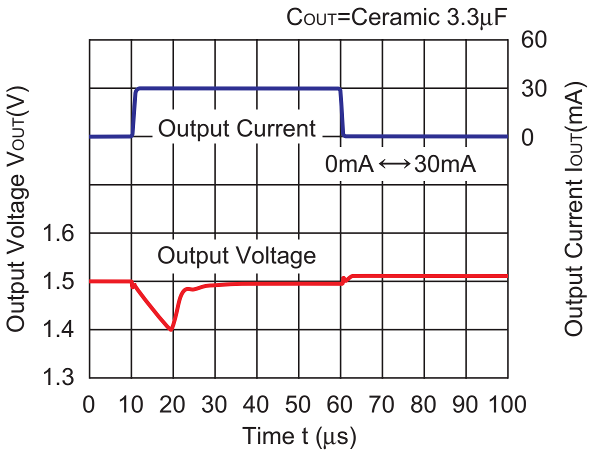
1.5V (VR1/VR2)



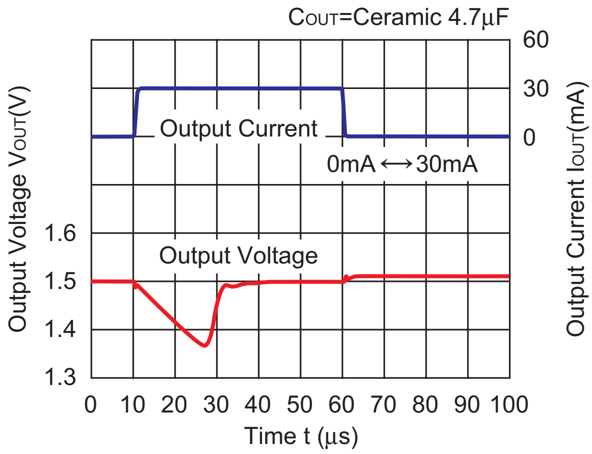
1.5V (VR1/VR2)



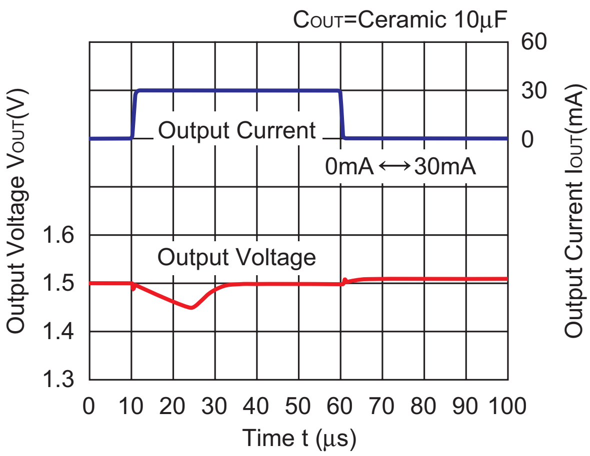
1.5V (VR1/VR2)



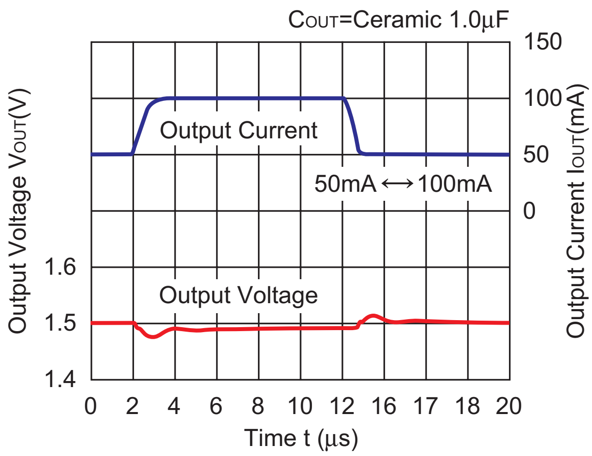
1.5V (VR1/VR2)



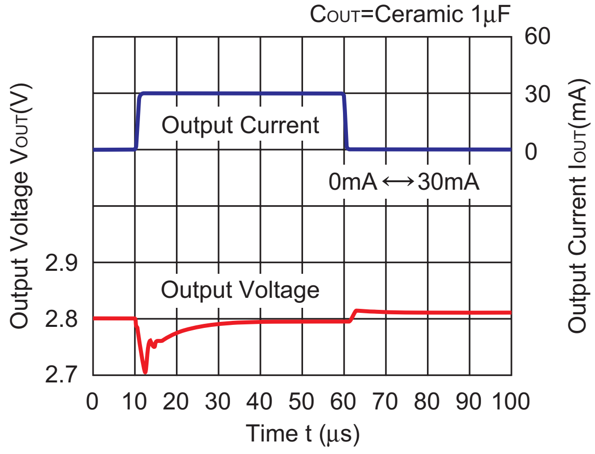
1.5V (VR1/VR2)



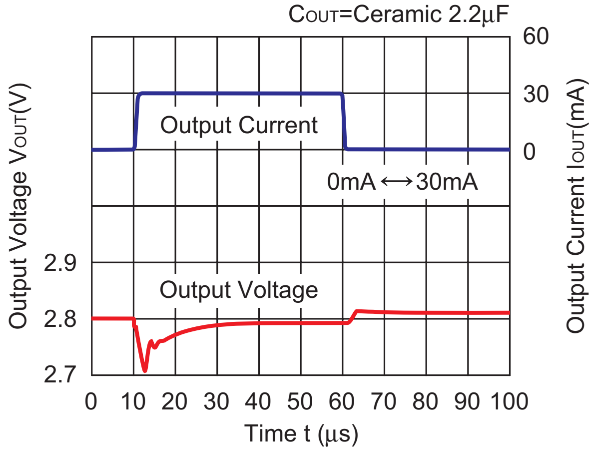
1.5V (VR1/VR2)



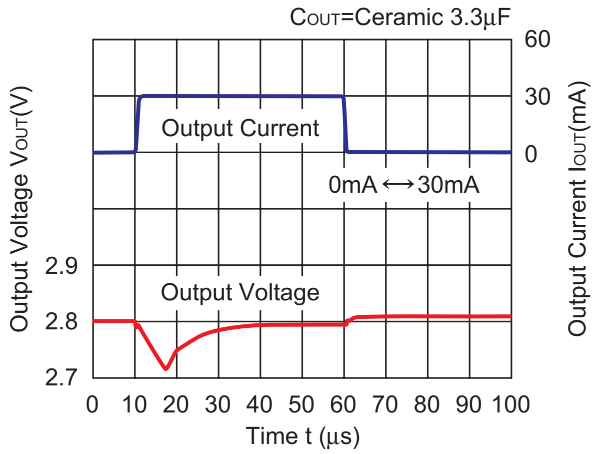
2.8V (VR1/VR2)



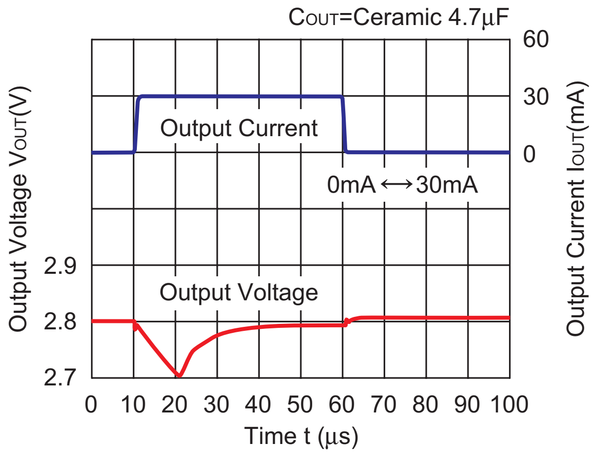
2.8V (VR1/VR2)



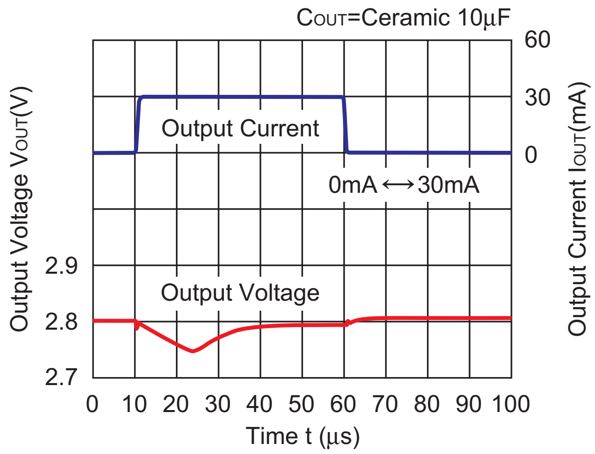
2.8V (VR1/VR2)



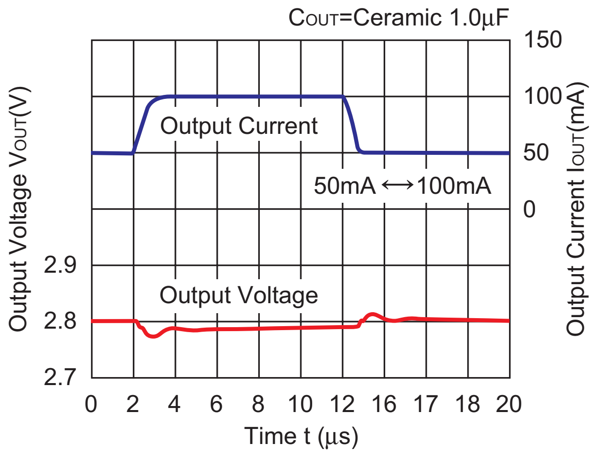
2.8V (VR1/VR2)



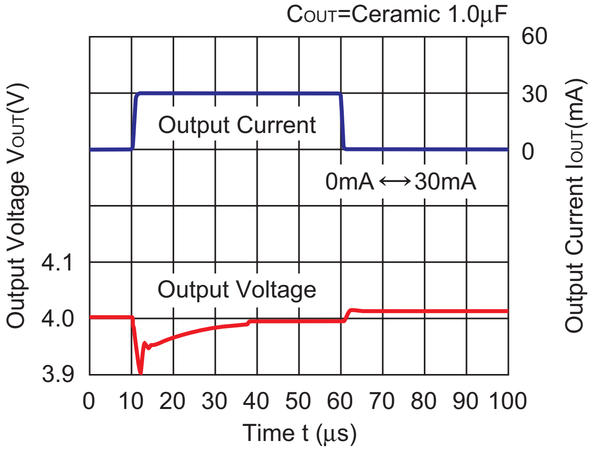
2.8V (VR1/VR2)



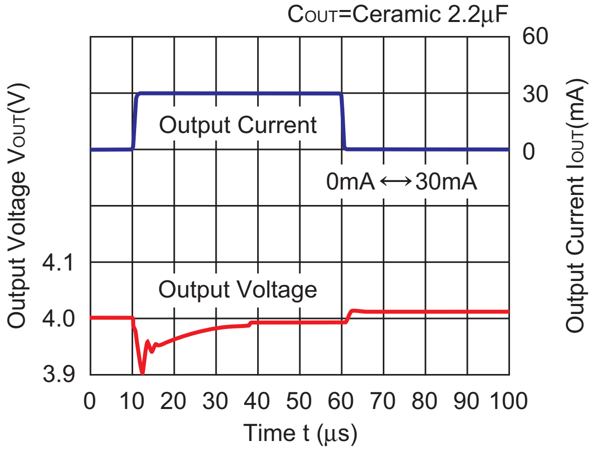
2.8V (VR1/VR2)



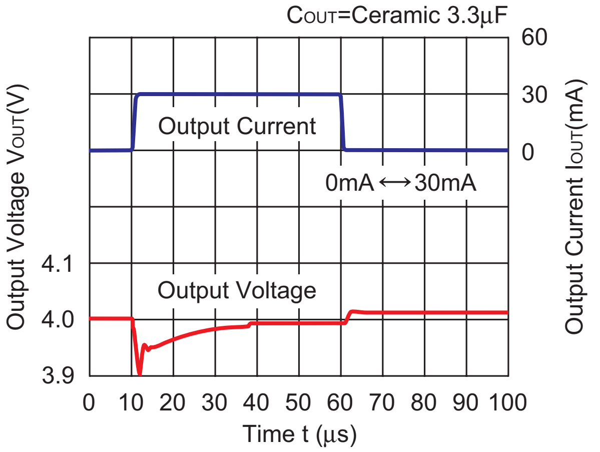
4.0V (VR1/VR2)



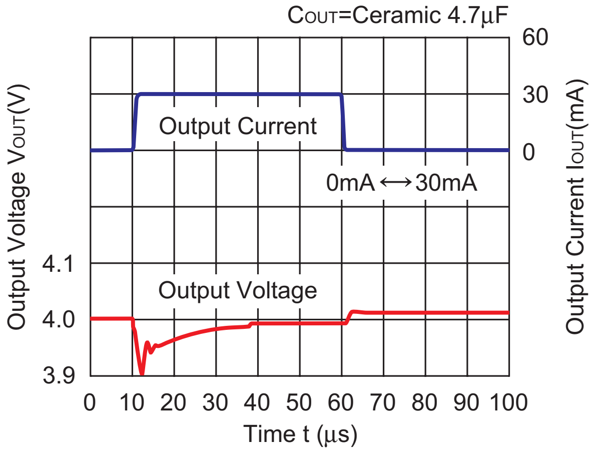
4.0V (VR1/VR2)



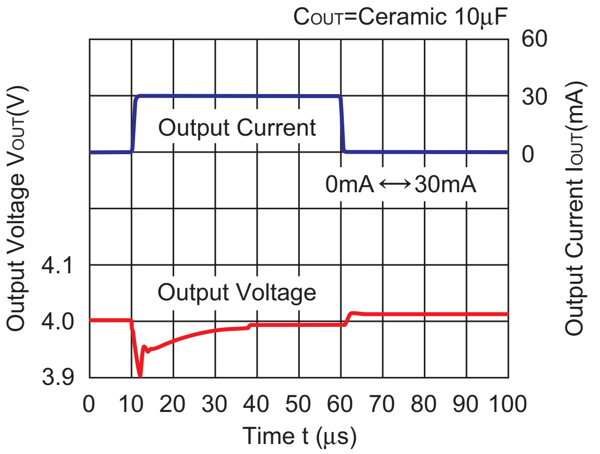
4.0V (VR1/VR2)



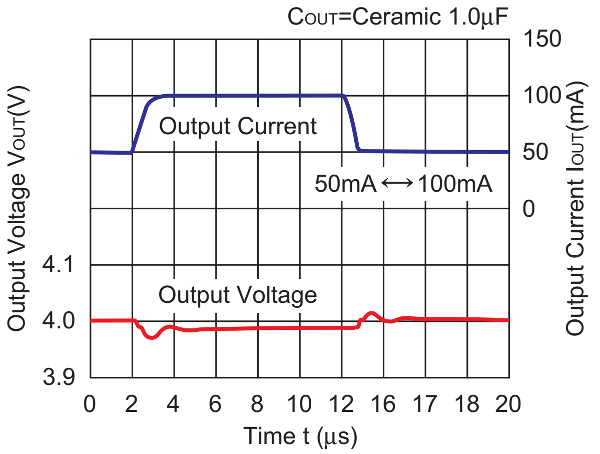
4.0V (VR1/VR2)



4.0V (VR1/VR2)

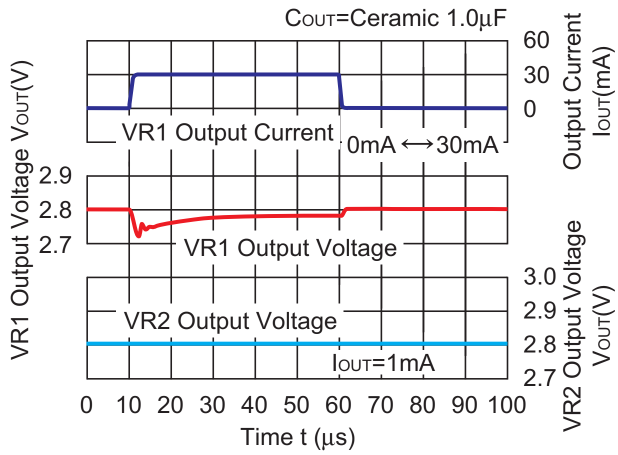


4.0V (VR1/VR2)

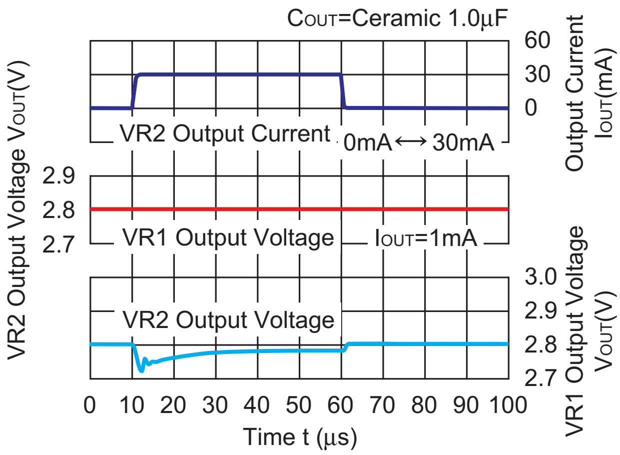


14) Load Transient Response2 (tr=tf=0.5µs, CIN=1.0µF)

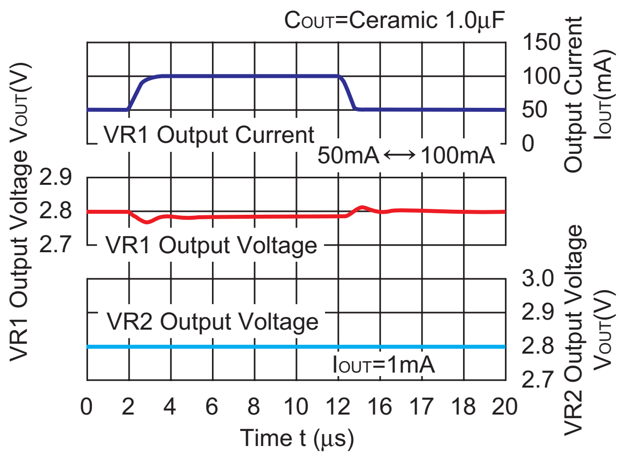
2.8V(VR1/VR2)



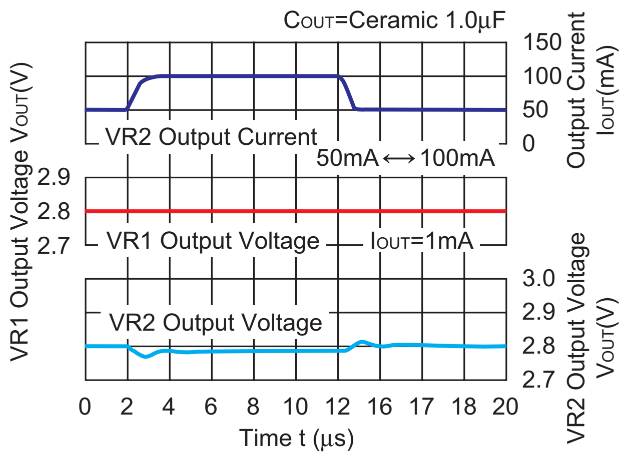
2.8V(VR1/VR2)



2.8V(VR1/VR2)

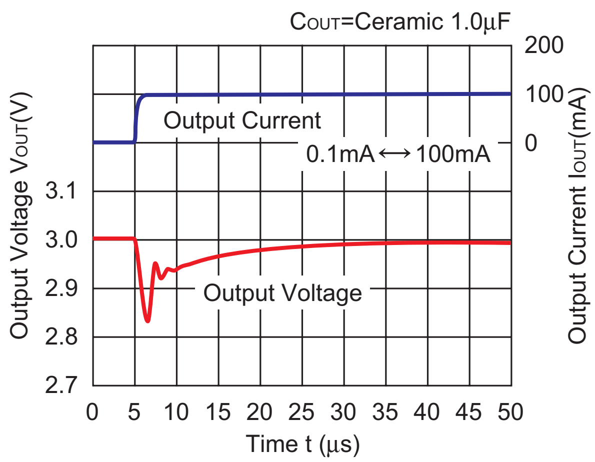


2.8V(VR1/VR2)



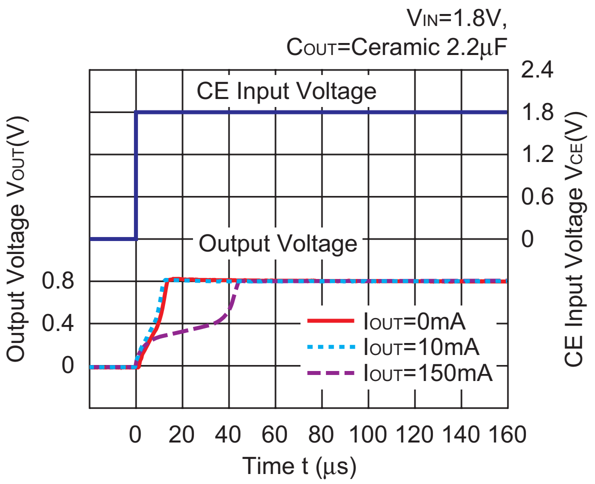
15) Load Transient Response3 (tr=tf=10ns)

3.0V(VR1/VR2)

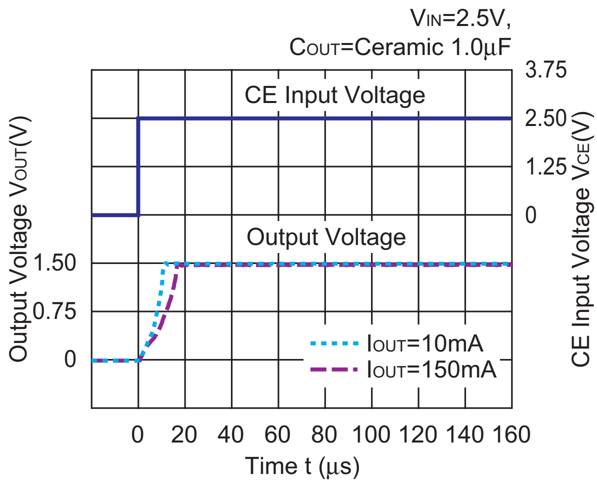


16) Turn on speed with CE Pin (C_{IN}=Ceramic 1.0µF)

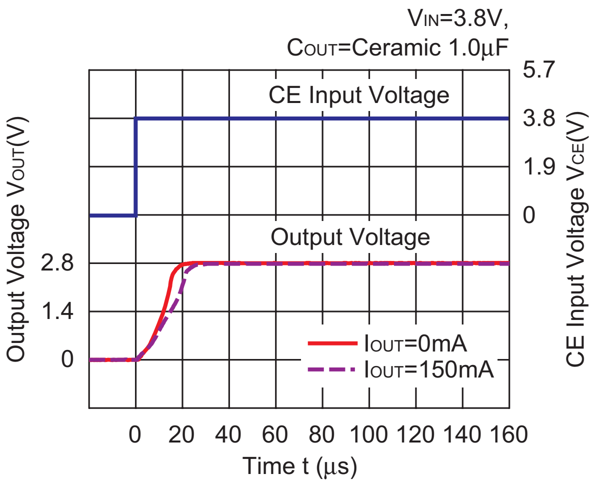
0.8V(VR1/VR2)



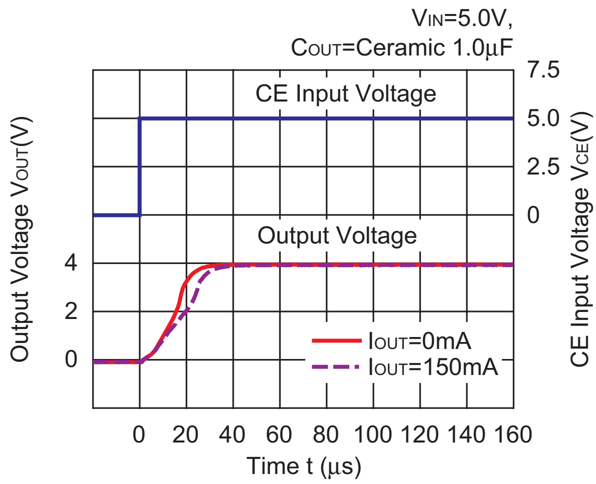
1.5V(VR1/VR2)



2.8V(VR1/VR2)

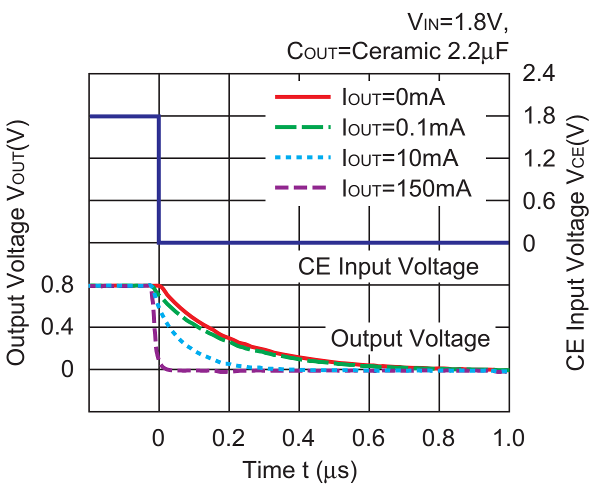


4.0V(VR1/VR2)

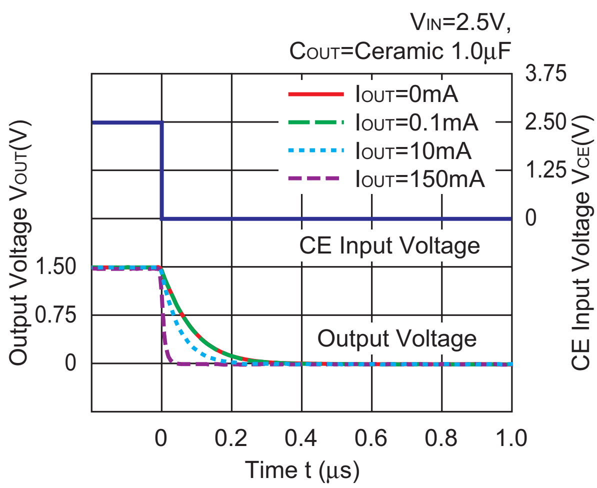


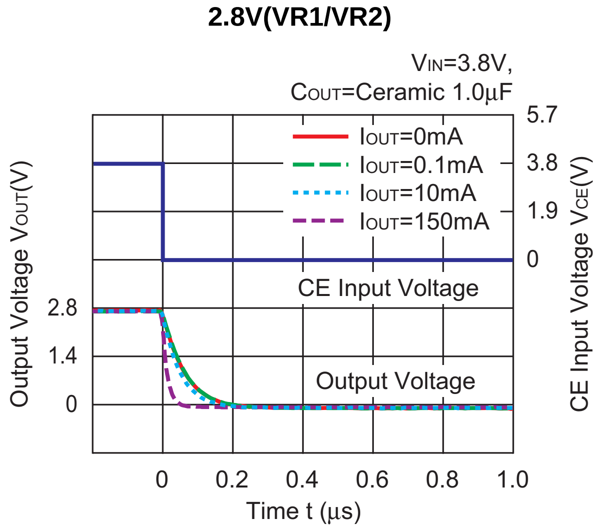
17) Turn off speed with CE Pin (C_{IN}=Ceramic 1.0µF)

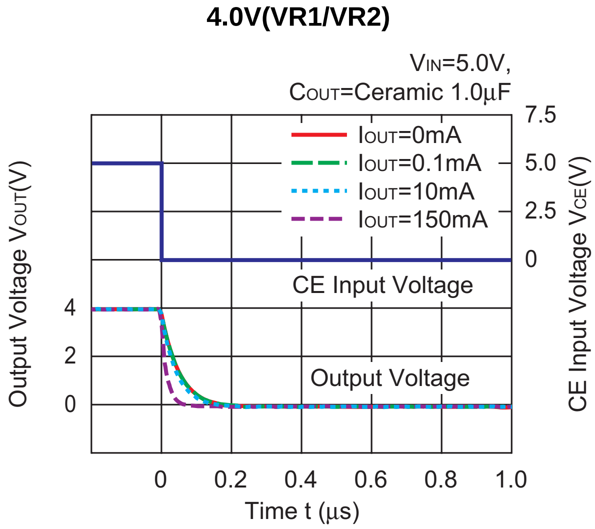
0.8V(VR1/VR2)



1.5V(VR1/VR2)




2.8V(VR1/VR2)
VIN=3.8V,
COUT=Ceramic 1.0µF
IOUT=0mA
IOUT=0.1mA
IOUT=10mA
IOUT=150mA
CE Input Voltage
Output Voltage
Output Voltage VOUT(V)
CE Input Voltage VCE(V)
5.7
3.8
1.9
0
2.8
1.4
0
0 0.2 0.4 0.6 0.8 1.0
Time t (µs)


4.0V(VR1/VR2)
VIN=5.0V,
COUT=Ceramic 1.0µF
IOUT=0mA
IOUT=0.1mA
IOUT=10mA
IOUT=150mA
CE Input Voltage
Output Voltage
Output Voltage VOUT(V)
CE Input Voltage VCE(V)
7.5
5.0
2.5
0
4
2
0
0 0.2 0.4 0.6 0.8 1.0
Time t (µs)

ESR vs. Output Current

When using these ICs, consider the following points:

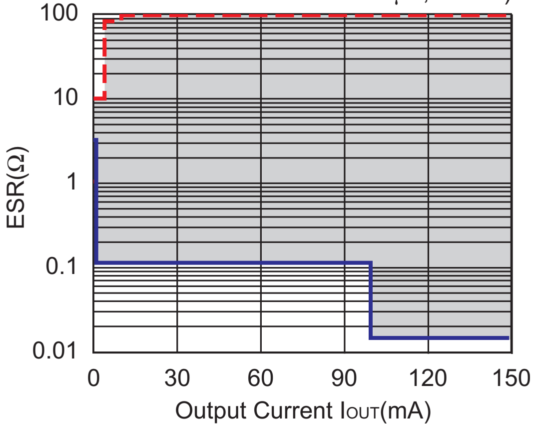
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is under 40µV (Avg.) are marked as the hatched area in the graph.

Measurement conditions

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

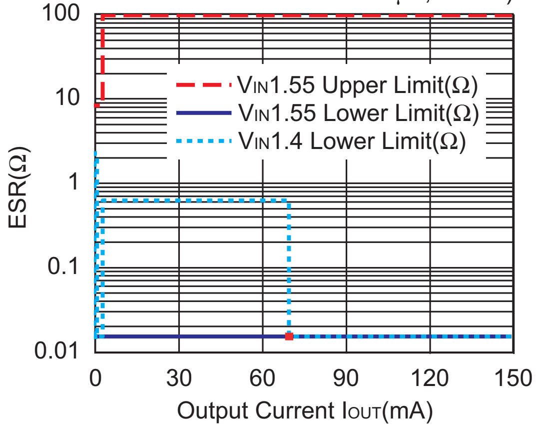
0.8V(VR1/VR2)

V_{IN}=1.4V to 6.0V,
C_{OUT}=Ceramic 1.0µF,murata)



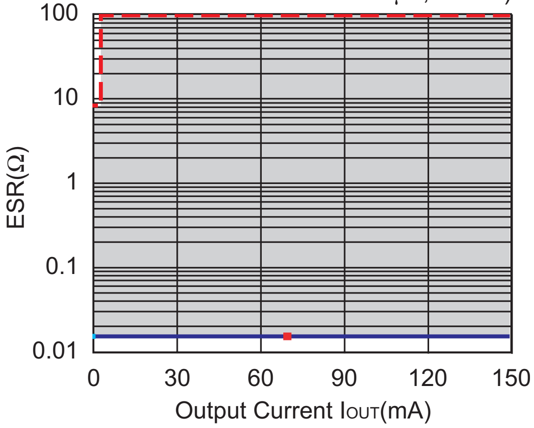
0.8V(VR1/VR2)

V_{IN}=1.55V to 6.0V,
C_{OUT}=Ceramic 2.2µF,murata)



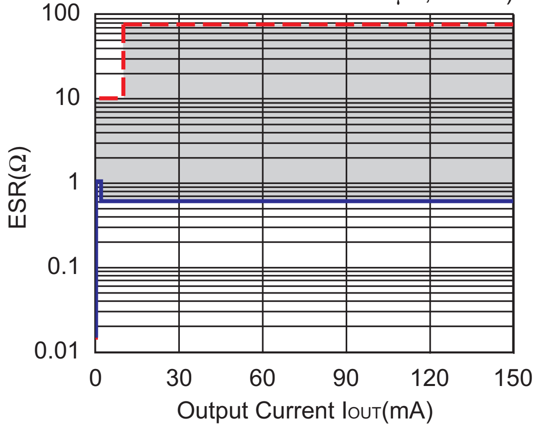
0.8V(VR1/VR2)

V_{IN}=1.4V to 6.0V,
C_{OUT}=Ceramic 3.3µF,murata)



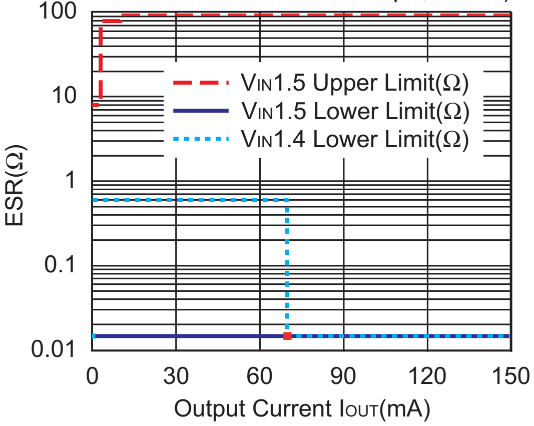
1.0V(VR1/VR2)

V_{IN}=1.4V to 6.0V,
C_{OUT}=Ceramic 1.0µF,murata)



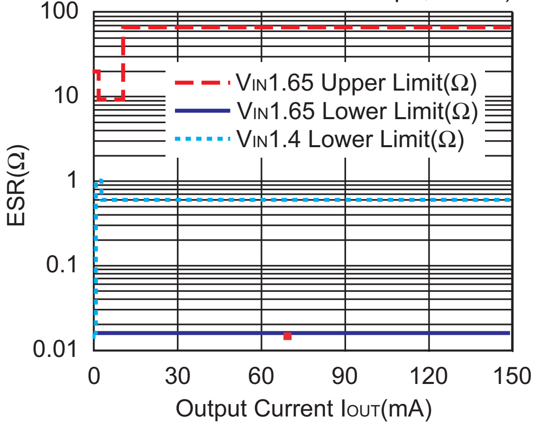
1.0V(VR1/VR2)

V_{IN}=1.5V to 6.0V,
C_{OUT}=Ceramic 2.2µF,murata)



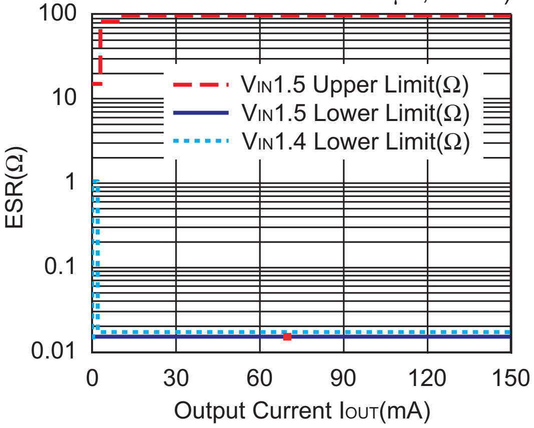
1.2V(VR1/VR2)

V_{IN}=1.65V to 6.0V,
C_{OUT}=Ceramic 1.0µF,murata)



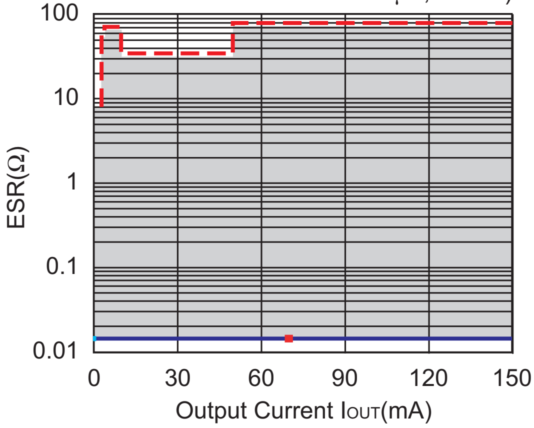
1.2V(VR1/VR2)

V_{IN}=1.5V to 6.0V,
C_{OUT}=Ceramic 2.2µF,murata)



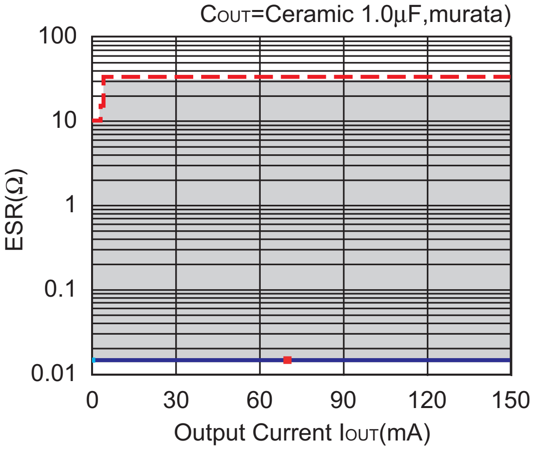
1.2V(VR1/VR2)

V_{IN}=1.4V to 6.0V,
C_{OUT}=Ceramic 3.3µF,murata)



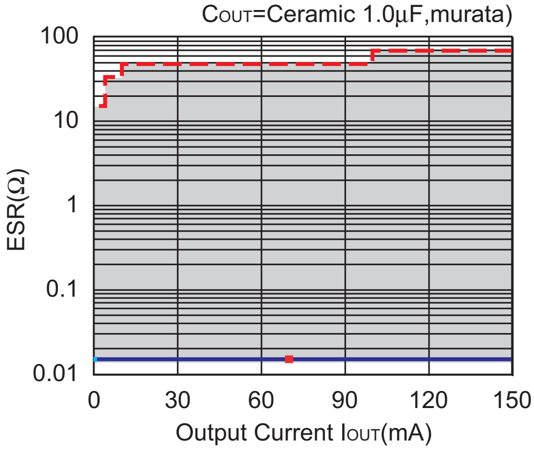
2.8V(VR1/VR2)

V_{IN}=2.8V to 6.0V,
C_{OUT}=Ceramic 1.0µF,murata)



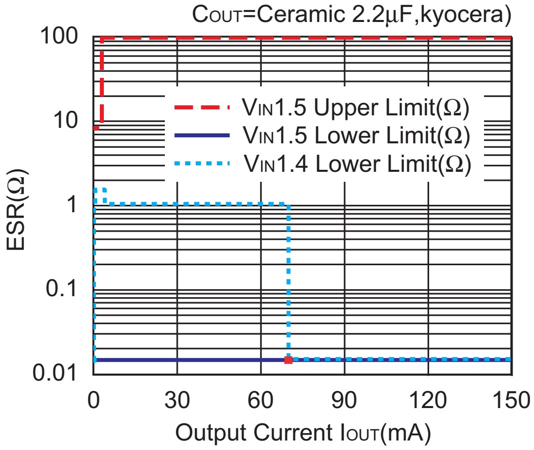
4.0V(VR1/VR2)

V_{IN}=4.0V to 6.0V,
C_{OUT}=Ceramic 1.0µF,murata)



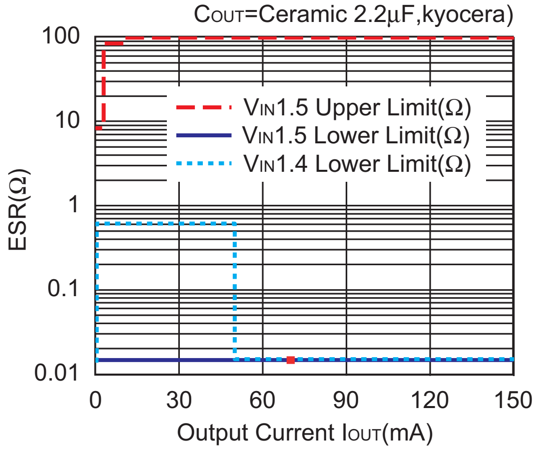
0.8V(VR1/VR2)

V_{IN}=1.5V to 6.0V,
C_{OUT}=Ceramic 2.2µF,kyocera)



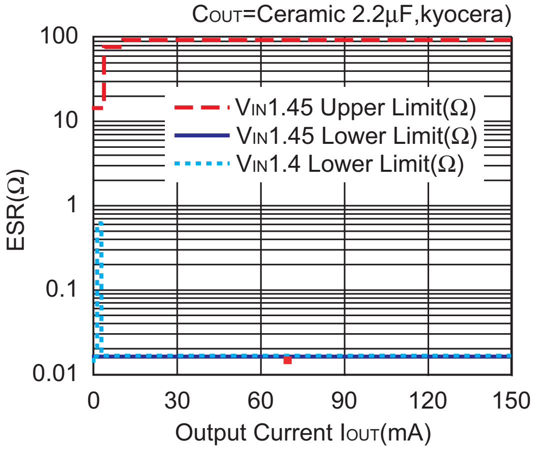
1.0V(VR1/VR2)

V_{IN}=1.5V to 6.0V,
C_{OUT}=Ceramic 2.2µF,kyocera)



1.2V(VR1/VR2)

V_{IN}=1.45V to 6.0V,
C_{OUT}=Ceramic 2.2µF,kyocera)



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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, firecontainment 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. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.

RICOH COMPANY, LTD. Electronic Devices Company

日本経営品質賞 1999年度受賞

■Ricoh presented with the Japan Management Quality Award for 1999.
Ricoh continually strives to promote customer satisfaction, and shares the achievements of its management quality improvement program with people and society.

■Ricoh awarded ISO 14001 certification.
The Ricoh Group was awarded ISO 14001 certification, which is an international standard for environmental management systems, at both its domestic and overseas production facilities. Our current aim is to obtain ISO 14001 certification for all of our business offices.

RoHS Compliant

Ricoh completed the organization of the Lead-free production for all of our products. After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive.

http://www.ricoh.com/LSI/

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