RICOH R5323x SERIES

150mA Dual LDO REGULATOR

NO.EA-089-120404

OUTLINE

The R5323x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, low supply current, low dropout, and high ripple rejection. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, resistors for setting Output Voltage, a current limit circuit, and a chip enable circuit.

These ICs perform with low dropout voltage due to built-in transistor with low ON resistance, and a chip enable function prolongs the battery life of each system. The line transient response and load transient response of the R5323x Series are excellent, thus these ICs are very suitable for the power supply for hand-held communication equipment.

The output voltage of these ICs is internally fixed with high accuracy. Since the packages for these ICs are SOT-23-6 (Limited), DFN(PLP)1820-6 and WLCSP-6-P1 package, dual LDO regulators are included in each package, high density mounting of the ICs on boards is possible.

FEATURES

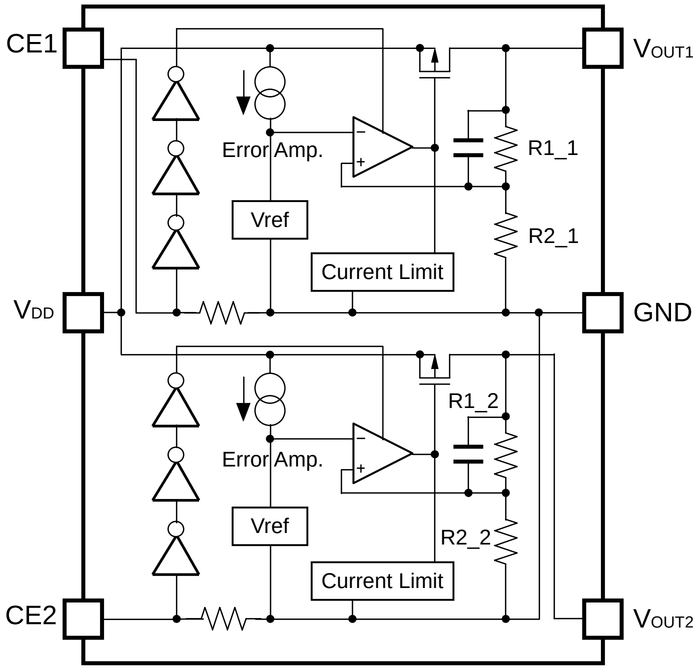
- Supply Current .... Typ. 90μA (VR1, VR2)
- Standby Mode .... Typ. 0.1μA (VR1, VR2)
- Dropout Voltage .... Typ. 0.22V (I_{OUT}=150mA , V_{OUT}=3.0V)
- Ripple Rejection .... Typ.75dB($V_{OUT} \leqq$ 2.4V),Typ.70dB($V_{OUT} \geqq$ 2.5V), (f=1kHz)
  Typ.65dB($V_{OUT} \leqq$ 2.4V),Typ.60dB($V_{OUT} \geqq$ 2.5V), (f=10kHz)
- Input Voltage Range .... 2.0V to 6.0V
- Output Voltage Range... 1.5V to 4.0V (0.1V steps)
  .... (For details, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy... ±2.0%
- Temperature-drift Coefficient of Output Voltage....... Typ. ±100ppm/°C
- Line Regulation Typ.0.02%/V
- Built-in fold-back protection circuit .... Typ. 40mA (Current at short mode)
- Packages .... WLCSP-6-P1, DFN(PLP)1820-6, SOT-23-6 (Limited)
- Ceramic Capacitor is recommended....................... 1.0μF or more
- Built-in chip enable circuit (A/B: active high)

APPLICATIONS

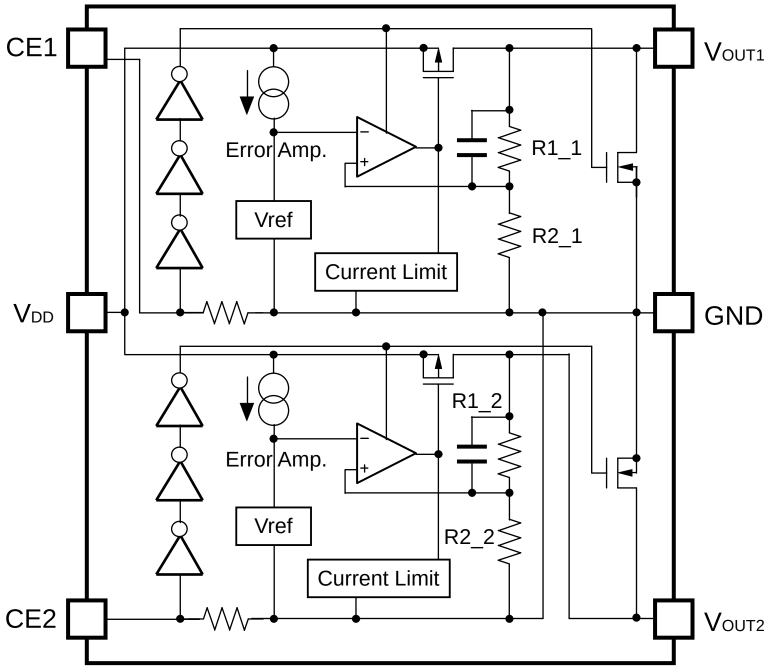
- Power source for handheld communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

R5323xxxxA



R5323xxxxB



SELECTION GUIDE

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

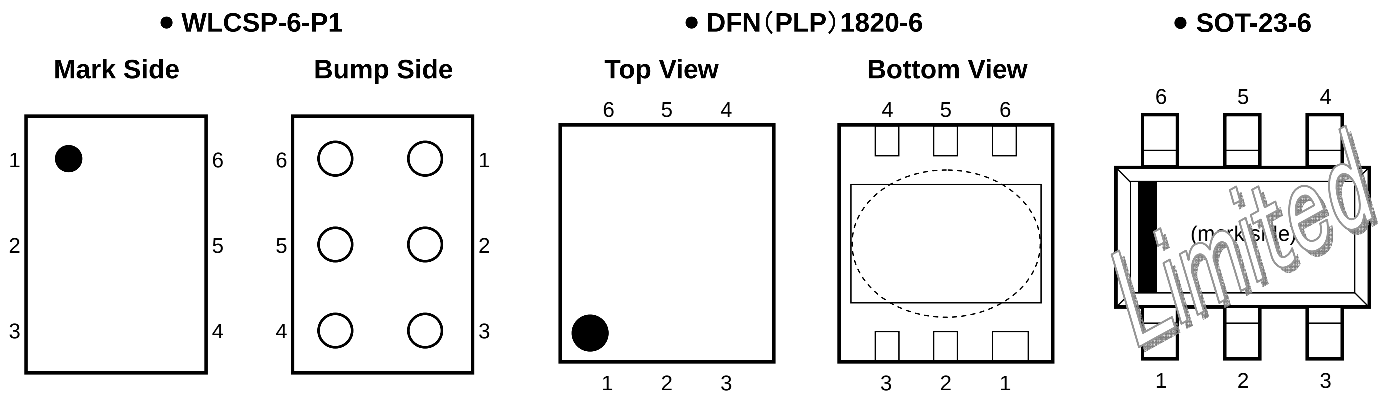
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5323Zxxx*-TR-F	WLCSP-6-P1	3,000 pcs	Yes	Yes
R5323Kxxx*-TR	DFN(PLP)1820-6	3,000 pcs	Yes	Yes
R5323Nxxx*-TR-FE	SOT-23-6 (Limited)	3,000 pcs	Yes	Yes

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 1.5V 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

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 CONFIGURATION



PIN DESCRIPTIONS

- **WLCSP-6-P1**

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	GND	Ground Pin
5	CE1	Chip Enable Pin 1 ("H" Active)
6	CE2	Chip Enable Pin 2 ("H" Active)

*）パッケージ裏面のタブの電位は基板電位(GND)です。
GND端子と接続する(推奨)か、オープンとしてください。

- **SOT-23-6 (Limited)**

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)

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}	Output Current 1	200	mA
I_{OUT2}	Output Current 2	200	mA
P_D	Power Dissipation (WLCSP-6-P1)	633	mW
	Power Dissipation (DFN(PLP)1820-6) *	880	
	Power Dissipation (SOT-23-6) (Limited)*	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

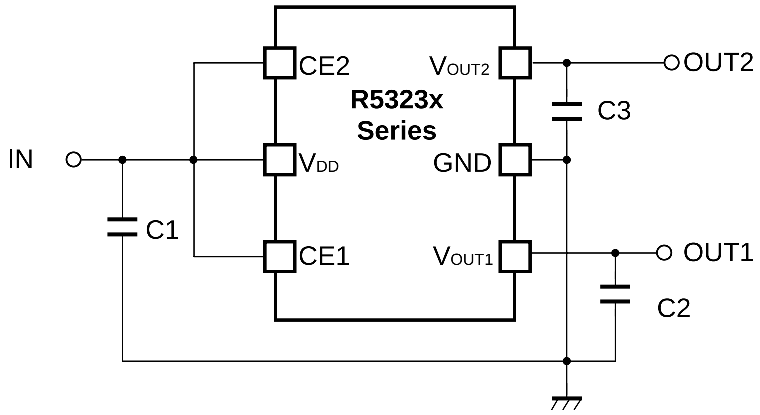
- **R5323xxxxA/B**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output voltage	$V_{IN}-V_{OUT}$=1.0V 1mA ≦ I_{OUT} ≦ 30mA	×0.98		×1.02	V
I_{OUT}	Output Current	$V_{IN}-V_{OUT}$=1.0V	150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load regulation	V_{IN}=Set V_{OUT}+1V 1mA ≦ I_{OUT} ≦ 150mA		15	40	mV
V_{DIF}	Dropout Voltage	I_{OUT}=150mA, V_{OUT}=1.5		0.38	0.70	V
		I_{OUT}=150mA, V_{OUT}=1.6		0.35	0.65	
		I_{OUT}=150mA, V_{OUT}=1.7		0.33	0.60	
		I_{OUT}=150mA, 1.8V ≦ V_{OUT} ≦ 2.0V		0.32	0.55	
		I_{OUT}=150mA, 2.1V ≦ V_{OUT} ≦ 2.7V		0.28	0.50	
		I_{OUT}=150mA, 2.8V ≦ V_{OUT} ≦ 4.0V		0.22	0.35	
I_{SS}	Supply Current	$V_{IN}-V_{OUT}$=1.0V		90	120	μA
$I_{standby}$	Standby Current	$V_{IN}-V_{OUT}$=1.0V V_{CE}=GND		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line regulation	Set V_{OUT}+0.5V ≦ V_{IN} ≦ 6.0V I_{OUT}=30mA		0.02	0.10	%/V
RR	Ripple Rejection	Ripple 0.5Vp-p $V_{IN}-V_{OUT}$=1.0V, I_{OUT}=30mA (In case that V_{OUT} ≦ 1.7V, $V_{IN}-V_{OUT}$=1.2V, I_{OUT}=30mA) f=1kHz		75 ∗Note1		dB
		f=10kHz		65 ∗Note2		
V_{IN}	Input Voltage		2.0		6.0	V
$\Delta V_{OUT}/\Delta Topt$	Output Voltage Temperature Coefficient	I_{OUT}=30mA −40°C ≦ Topt ≦ 85°C		±100		ppm/°C
I_{SC}	Short Current Limit	V_{OUT}=0V		40		mA
R_{PD}	Pull-down resistance for CE pin		0.7	2.0	8.0	MΩ
V_{CEH}	CE Input Voltage "H"		1.5		6.0	V
V_{CEL}	CE Input Voltage "L"		0		0.3	V
en	Output Noise	BW=10Hz to 100kHz		30		μVrms
R_{LOW}	Low Output Nch Tr. ON Resistance (of B version)	V_{CE}=0V		60		Ω

∗Note1: f=1kHz, 70dB as to V_{OUT} ≧ 2.5V Output type.
∗Note2: f=10kHz, 60dB as to V_{OUT} ≧ 2.5V Output type.

TYPICAL APPLIATION



C1=C2=C3=Ceramic 1.0μF

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 CIRCUIT

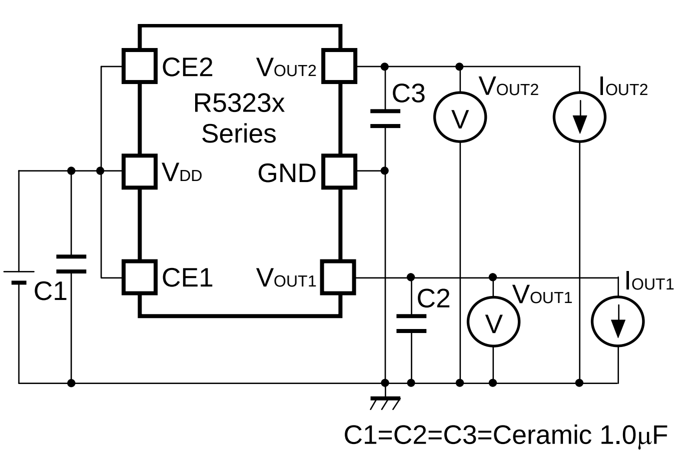


Fig.1 Standard test Circuit

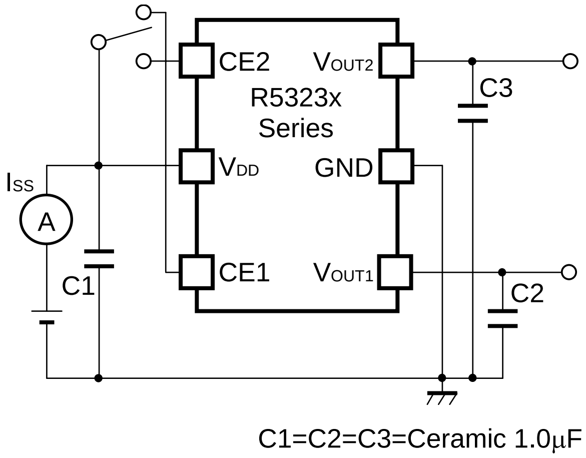


Fig.2 Supply Current Test Circuit

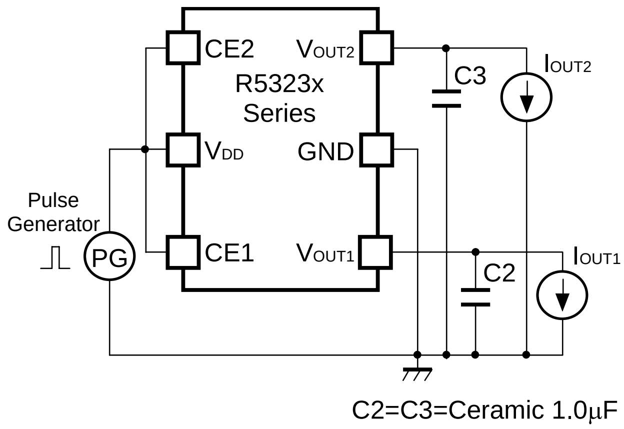


Fig.3 Ripple Rejection, Line Transient Response Test Circuit

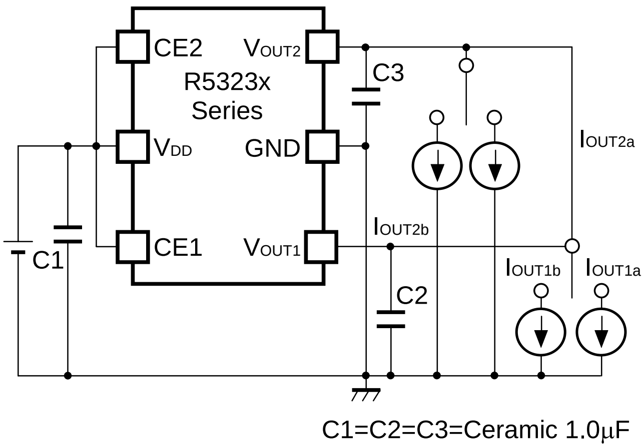
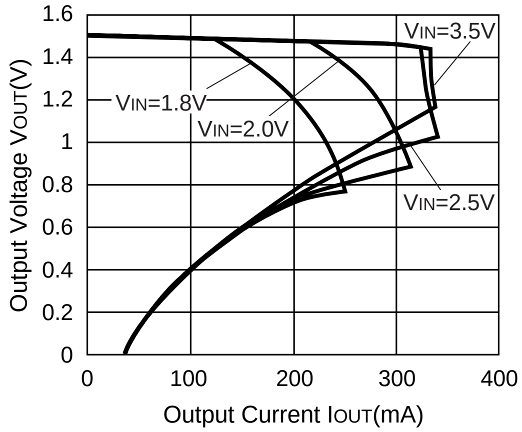


Fig.4 Load Transient Response Test Circuit

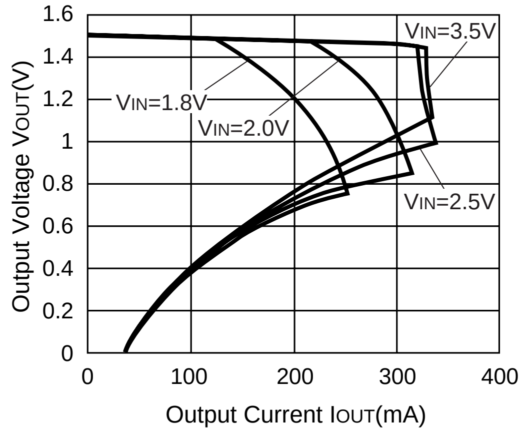
TYPICAL CHARACTERISTICS

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

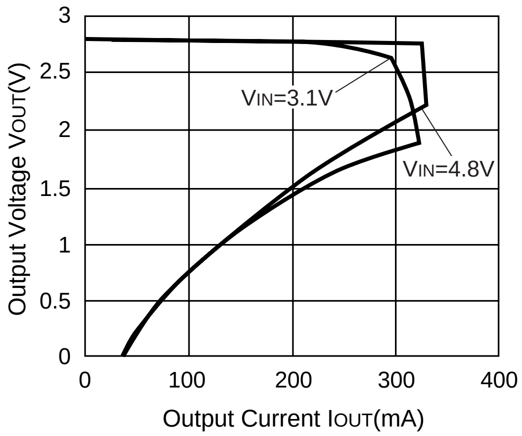
1.5V (VR1)



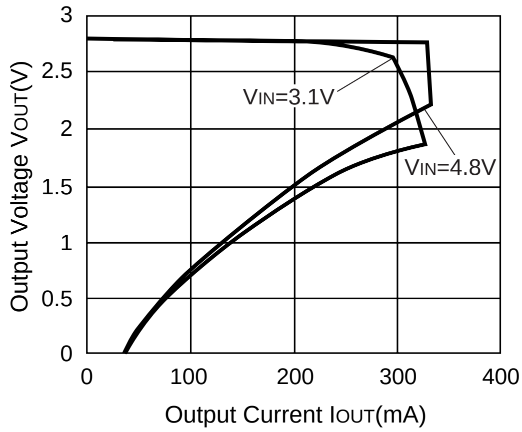
1.5V (VR2)



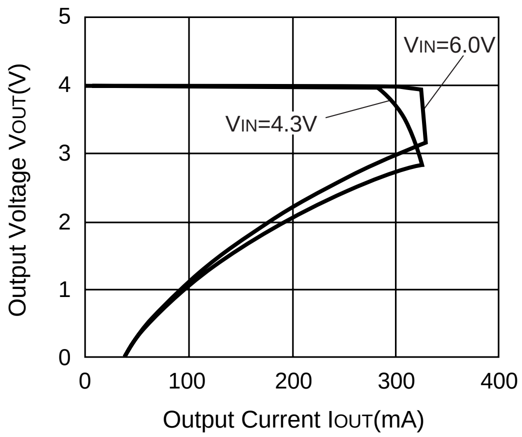
2.8V (VR1)



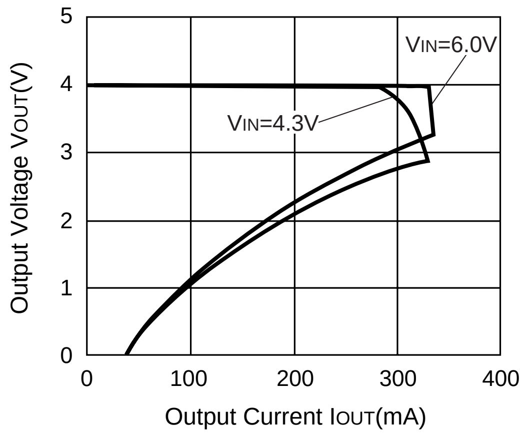
2.8V (VR2)



4.0V (VR1)

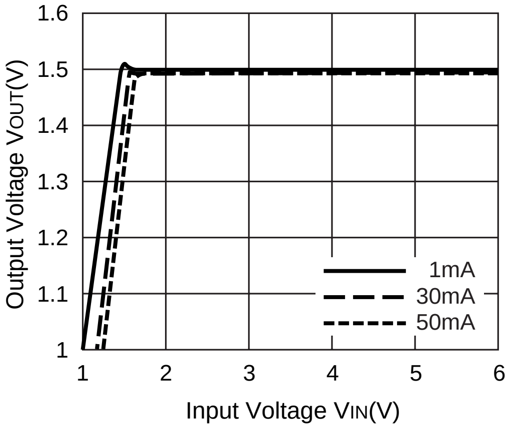


4.0V (VR2)

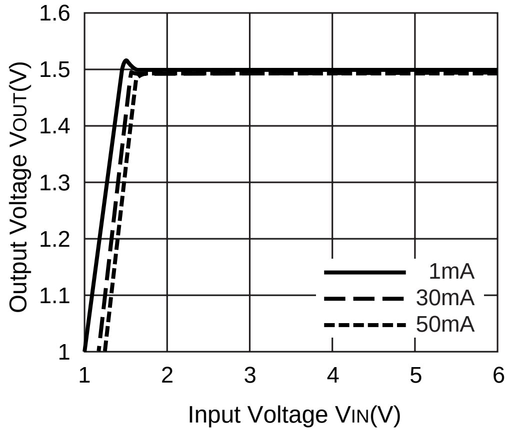


2) Output Voltage vs. Input Voltage (Topt=25°C)

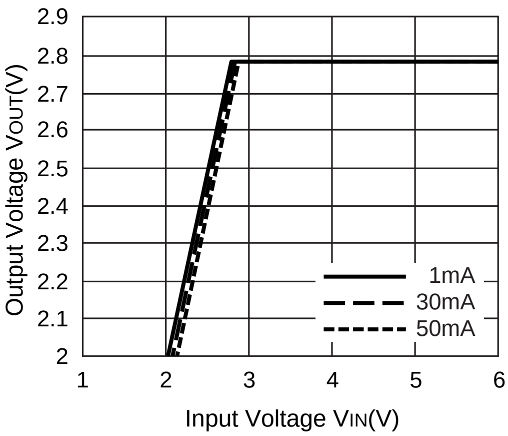
1.5V (VR1)



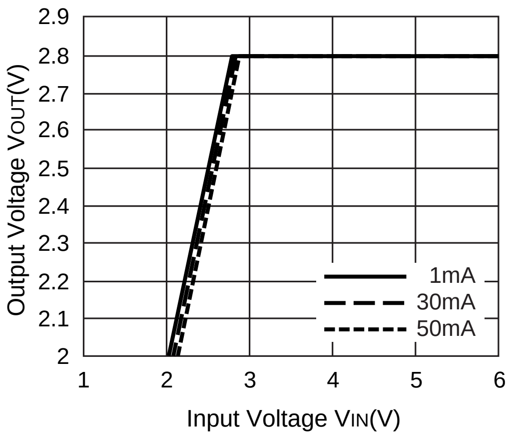
1.5V (VR2)



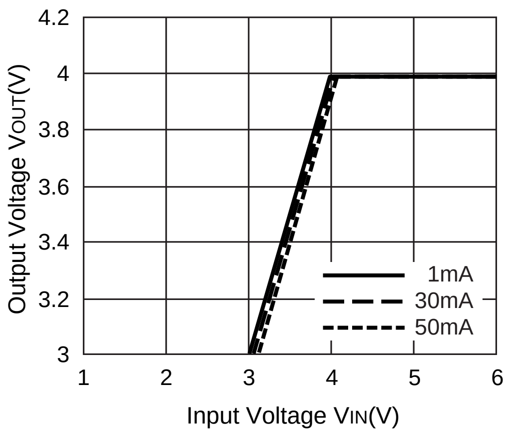
2.8V (VR1)



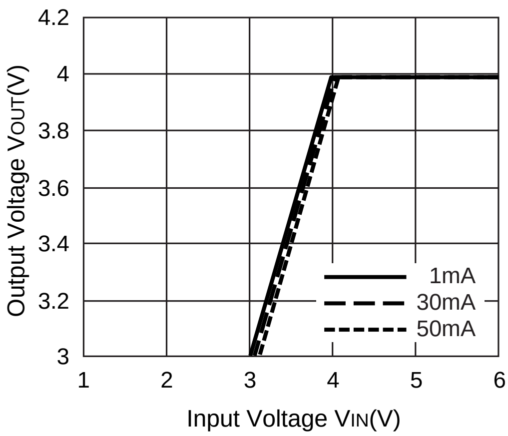
2.8V (VR2)



4.0V (VR1)

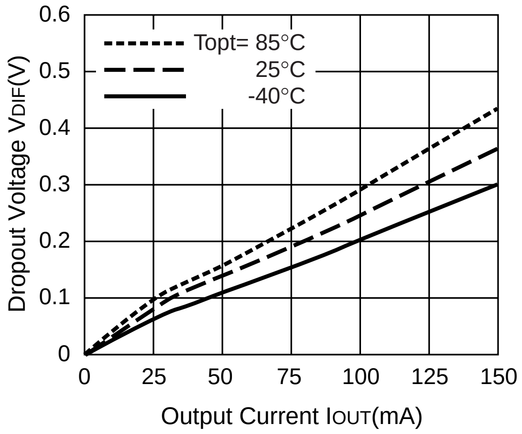


4.0V (VR2)

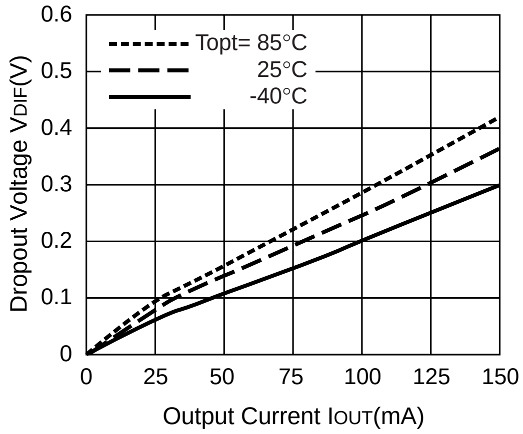


3) Dropout Voltage vs. Output Current

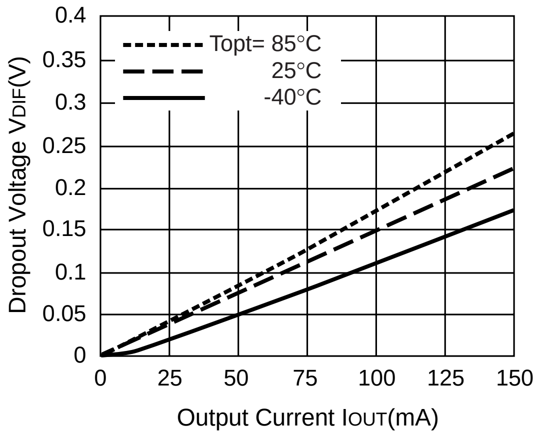
1.5V (VR1)



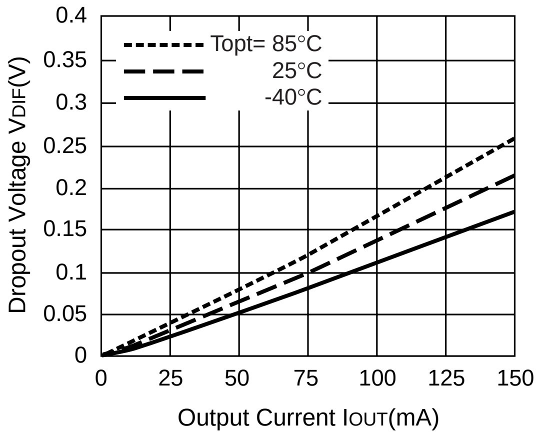
1.5V (VR2)



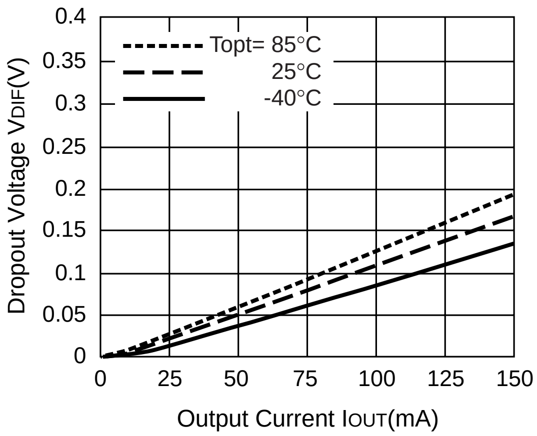
2.8V (VR1)



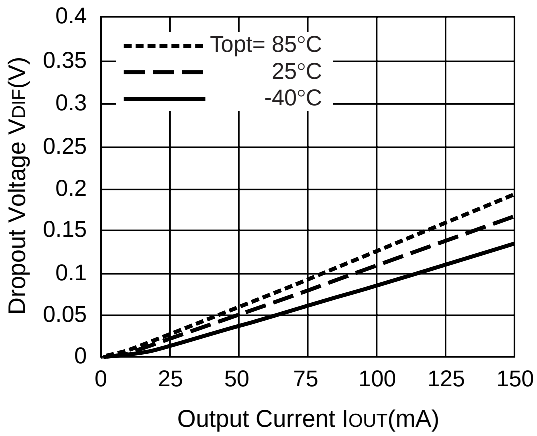
2.8V (VR2)



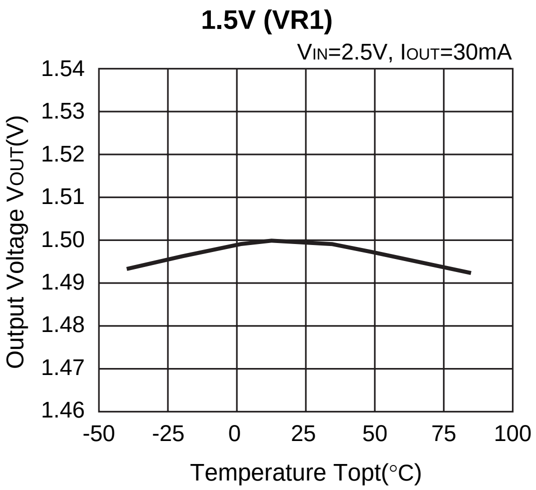
4.0V (VR1)

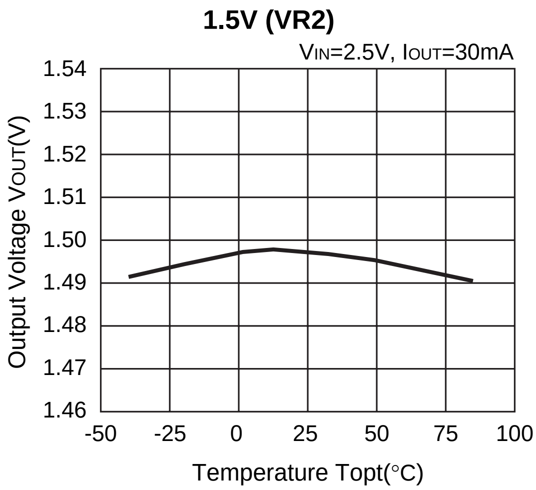


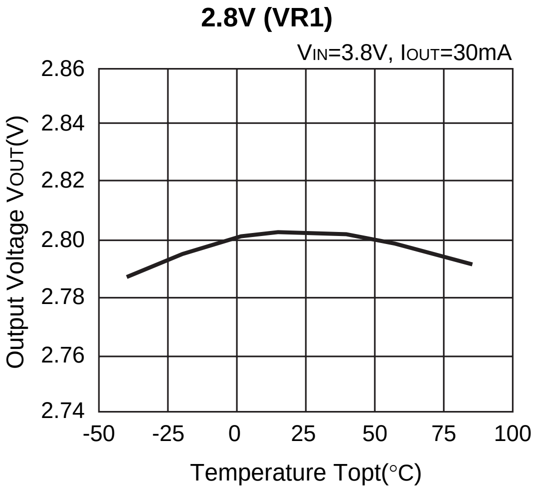
4.0V (VR2)

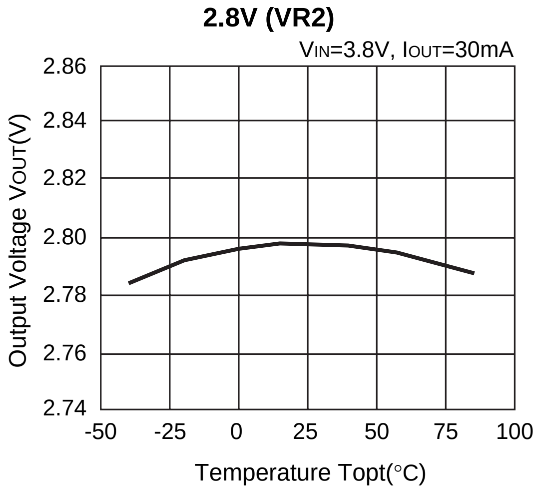


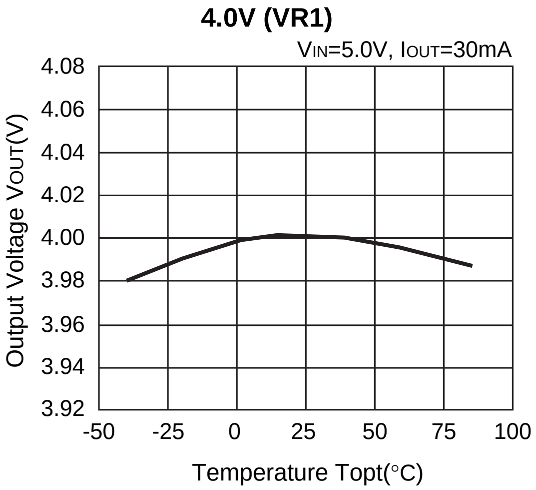
4) Output Voltage vs. Temperature

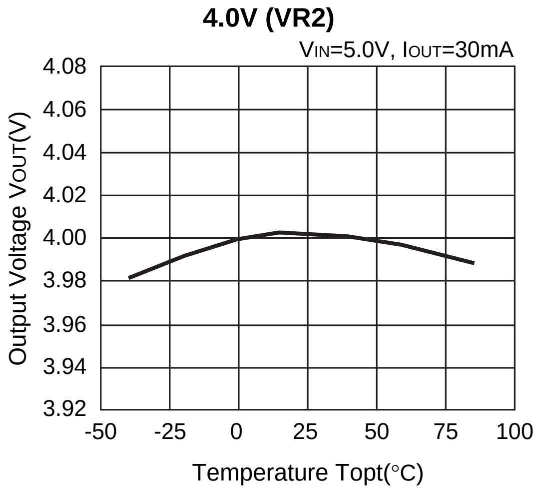




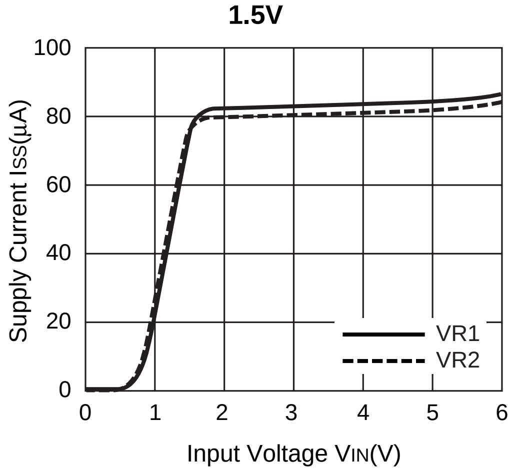


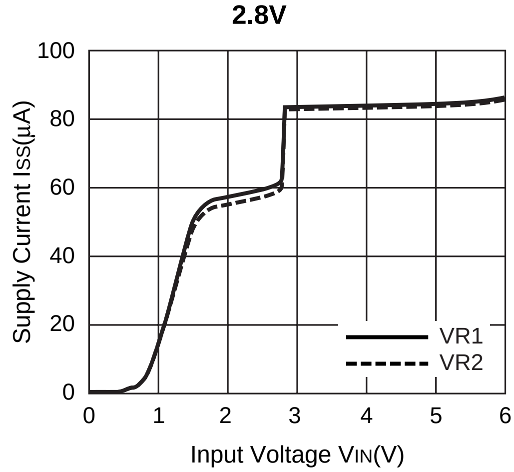


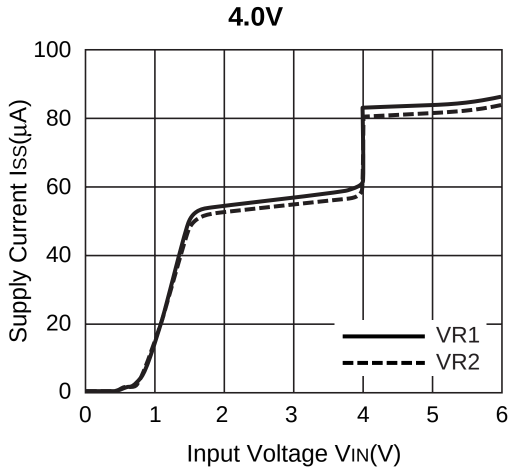




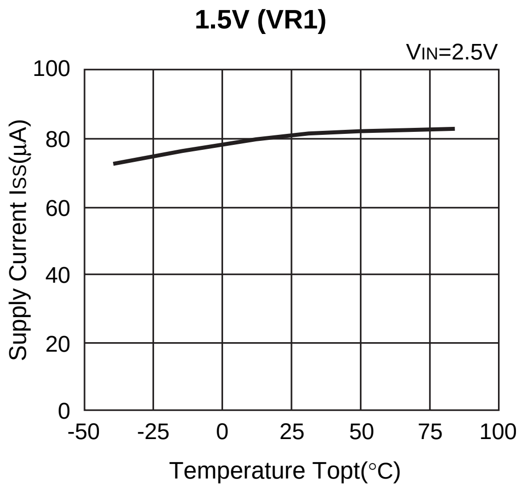
5) Supply Current vs. Input Voltage (Topt=25°C)

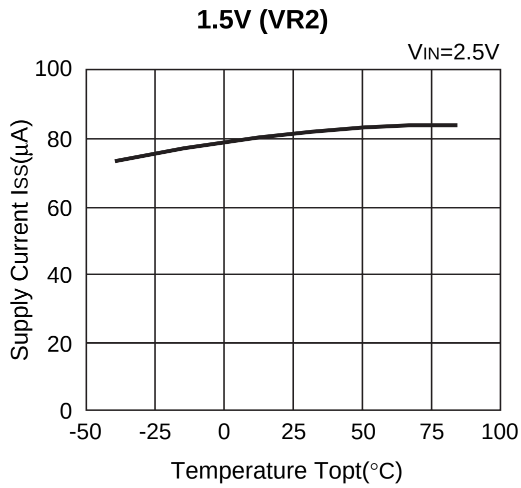




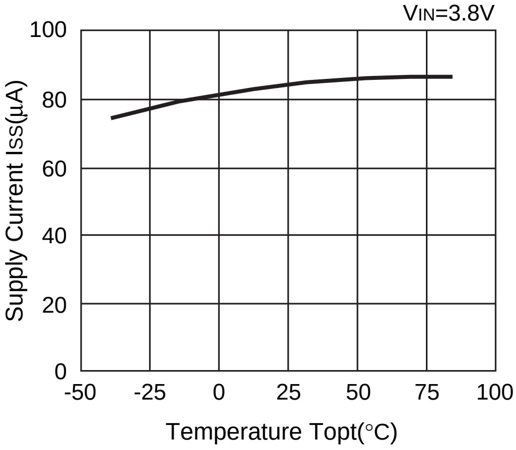


6) Supply Current vs. Temperature

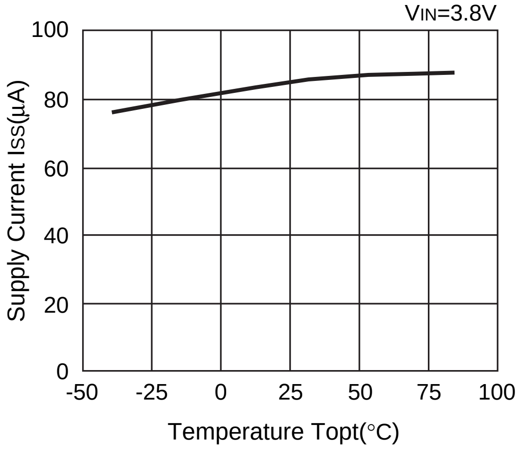




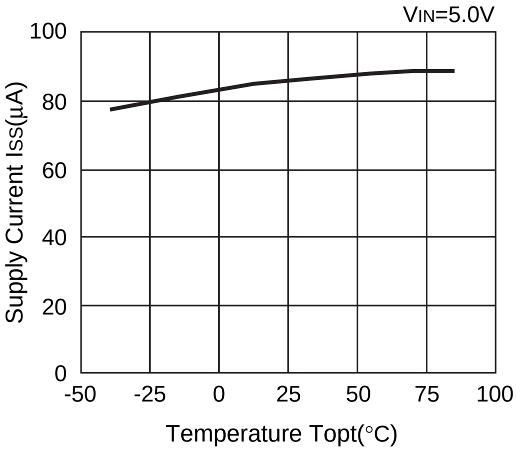
2.8V (VR1)



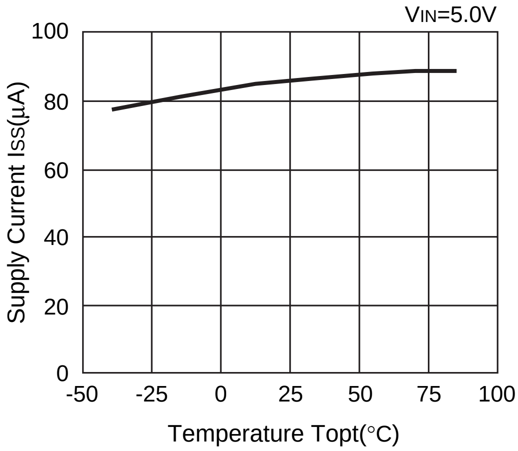
2.8V (VR2)



4.0V (VR1)

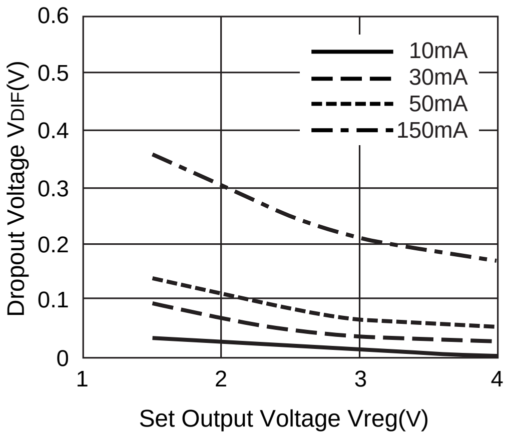


4.0V (VR2)

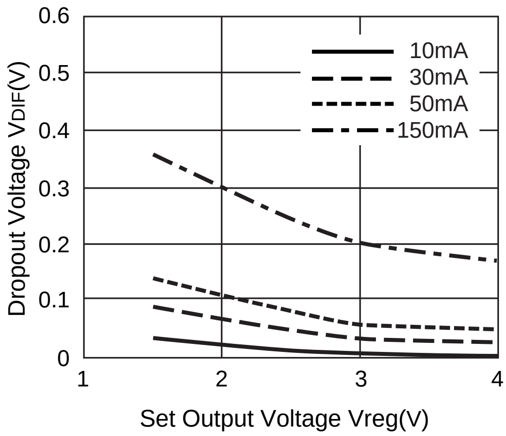


7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)

VR1

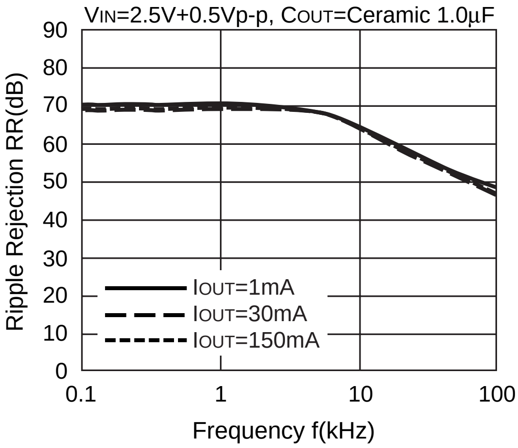


VR2

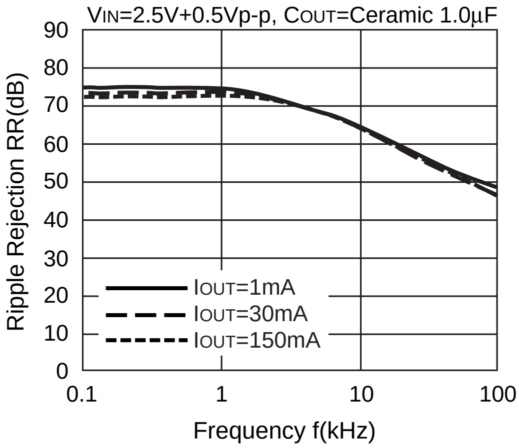


8) Ripple Rejection vs. Frequency (Topt=25°C)

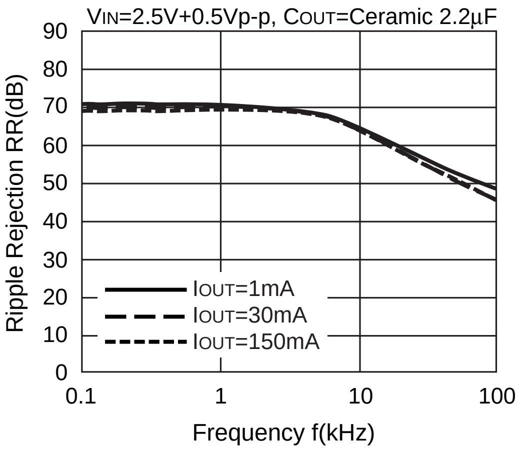
1.5V (VR1)



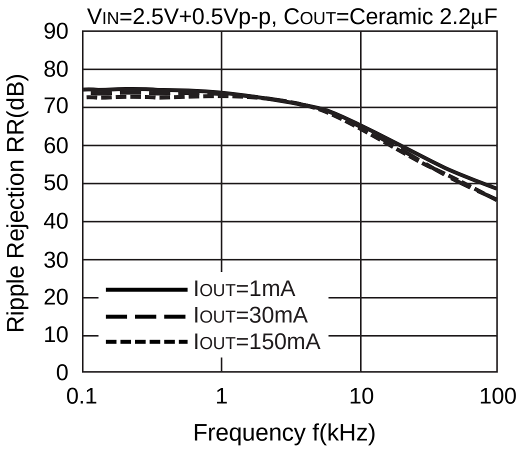
1.5V (VR2)



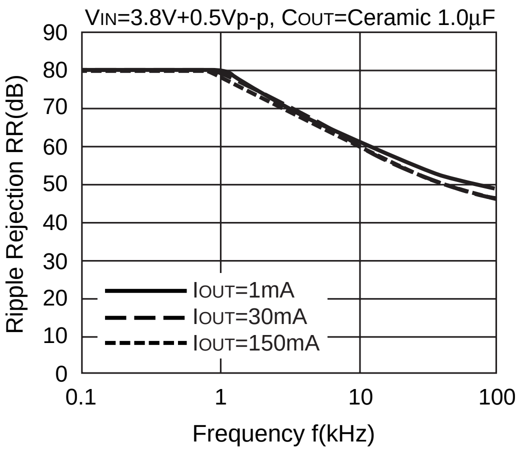
1.5V (VR1)



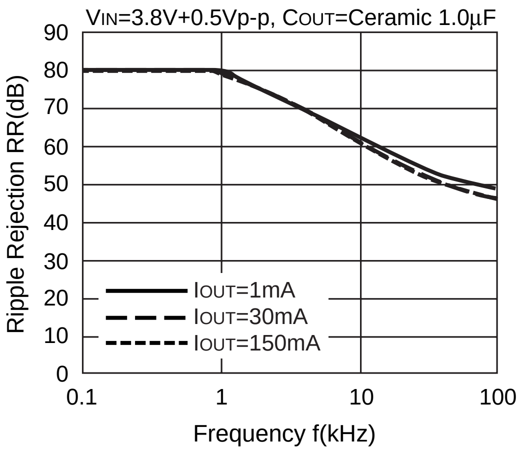
1.5V (VR2)



2.8V (VR1)

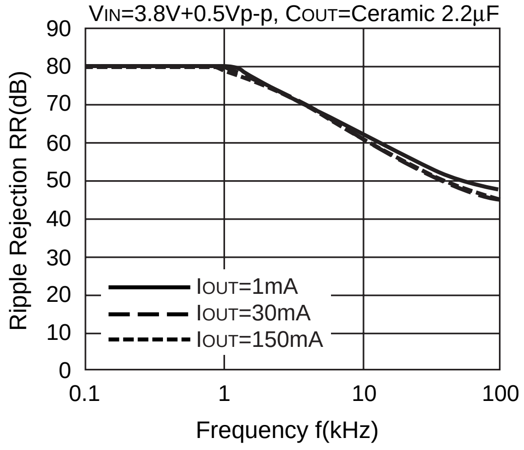


2.8V (VR2)



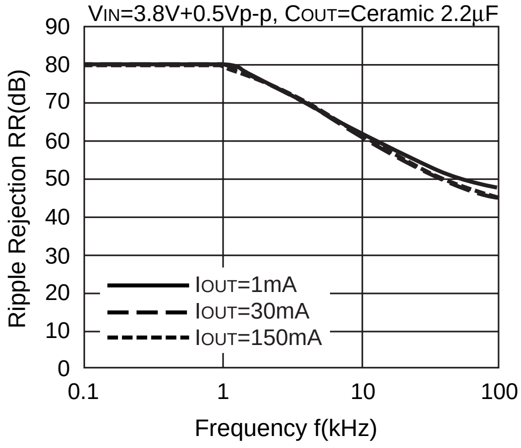
2.8V (VR1)

V_{IN}=3.8V+0.5Vp-p, C_{OUT}=Ceramic 2.2µF



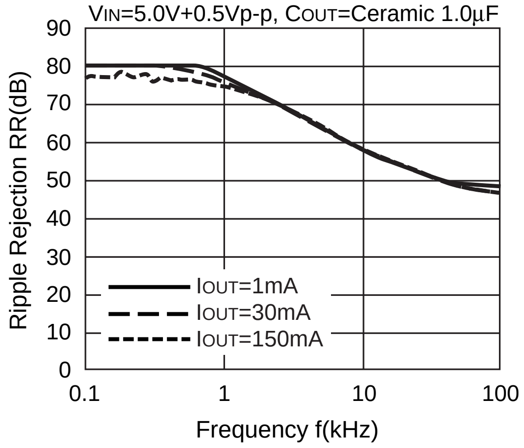
2.8V (VR2)

V_{IN}=3.8V+0.5Vp-p, C_{OUT}=Ceramic 2.2µF



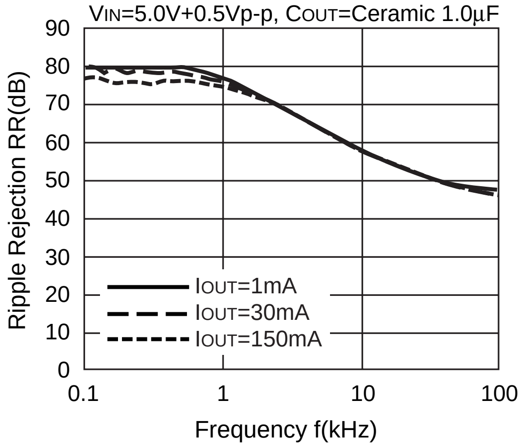
4.0V (VR1)

V_{IN}=5.0V+0.5Vp-p, C_{OUT}=Ceramic 1.0µF



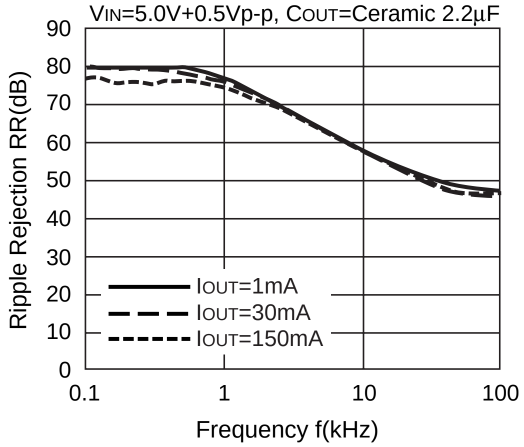
4.0V (VR2)

V_{IN}=5.0V+0.5Vp-p, C_{OUT}=Ceramic 1.0µF



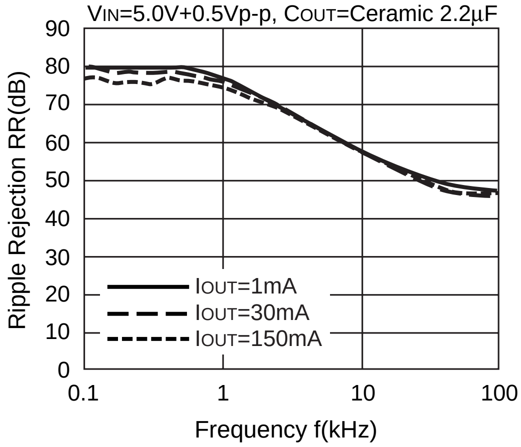
4.0V (VR1)

V_{IN}=5.0V+0.5Vp-p, C_{OUT}=Ceramic 2.2µF



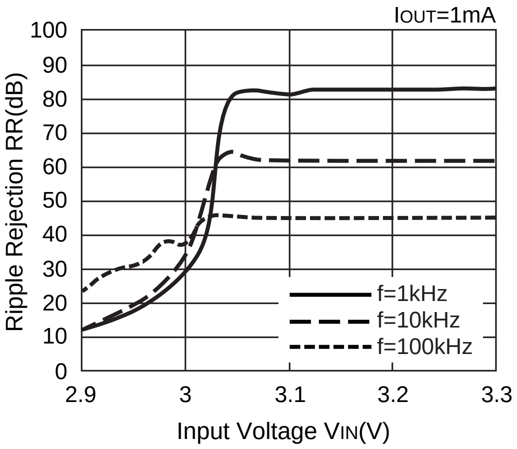
4.0V (VR2)

V_{IN}=5.0V+0.5Vp-p, C_{OUT}=Ceramic 2.2µF

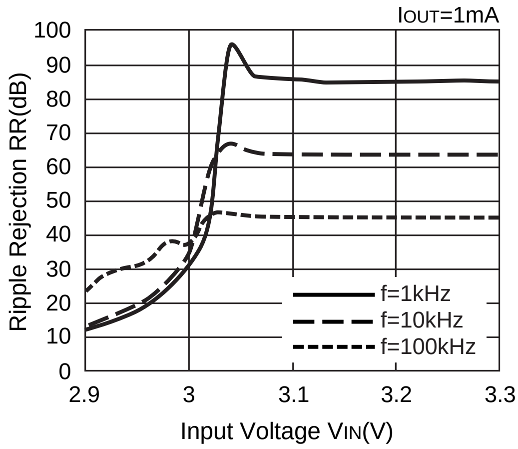


9) Ripple Rejection vs. Input Voltage (DC bias) (C_{OUT}=Ceramic 1.0µF, Topt=25°C)

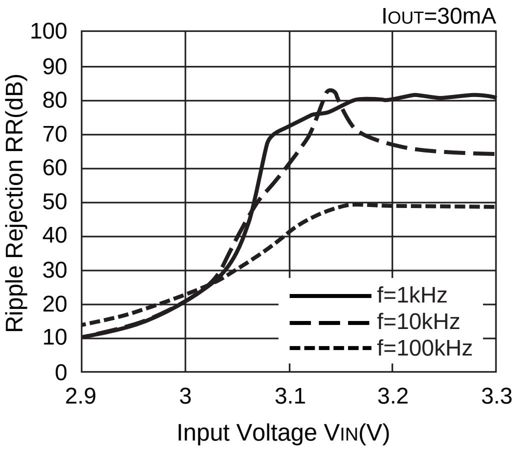
2.8V (VR1)



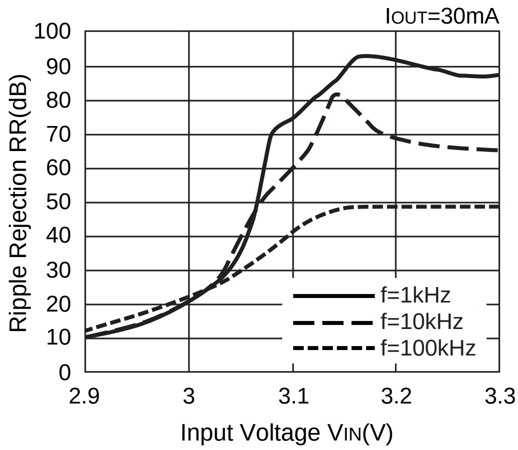
2.8V (VR2)



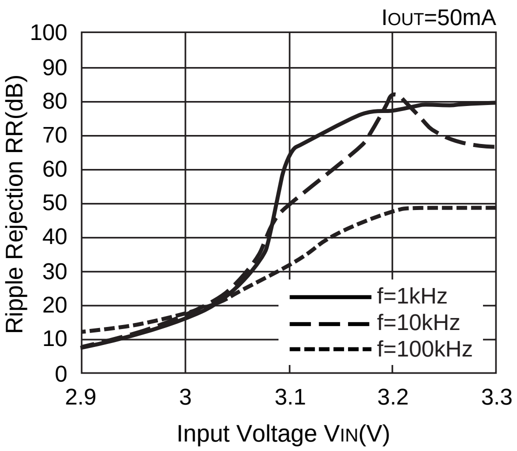
2.8V (VR1)



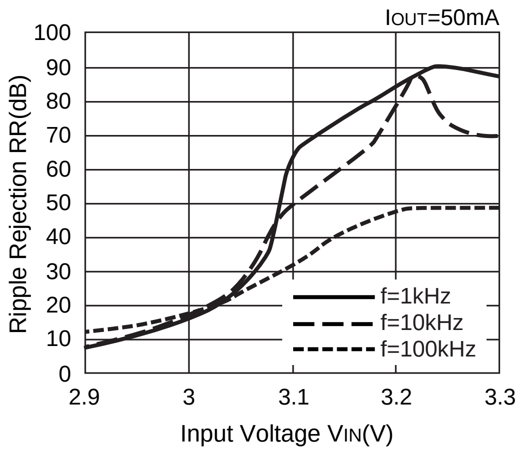
2.8V (VR2)



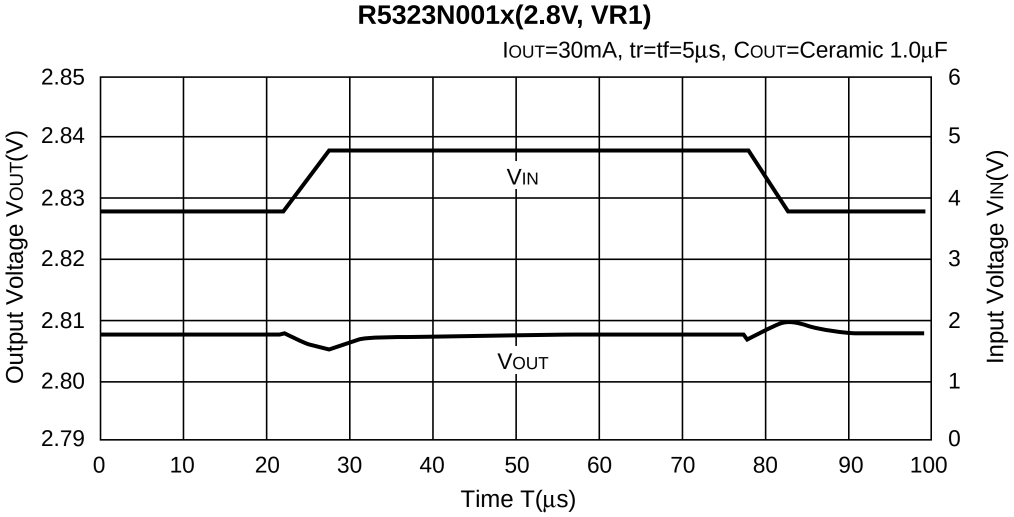
2.8V (VR1)

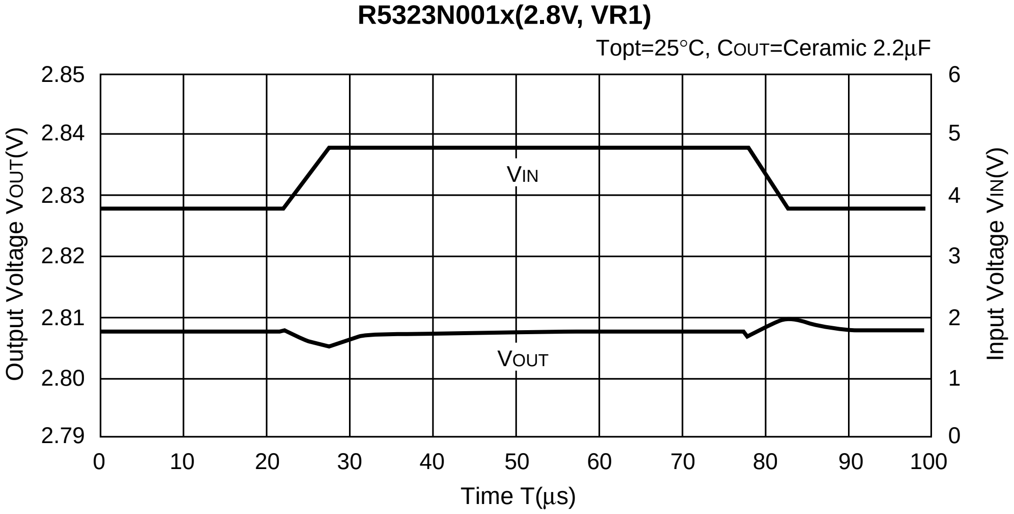


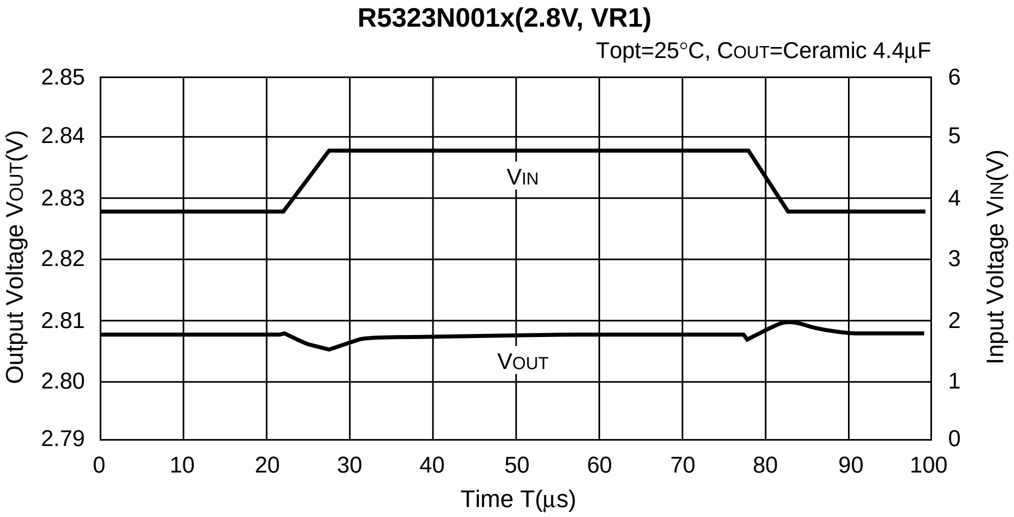
2.8V (VR2)

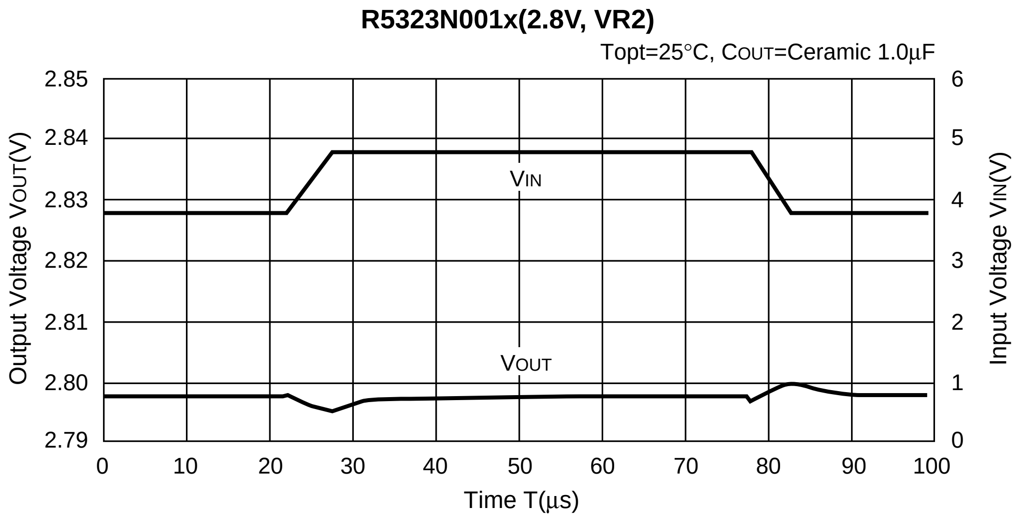


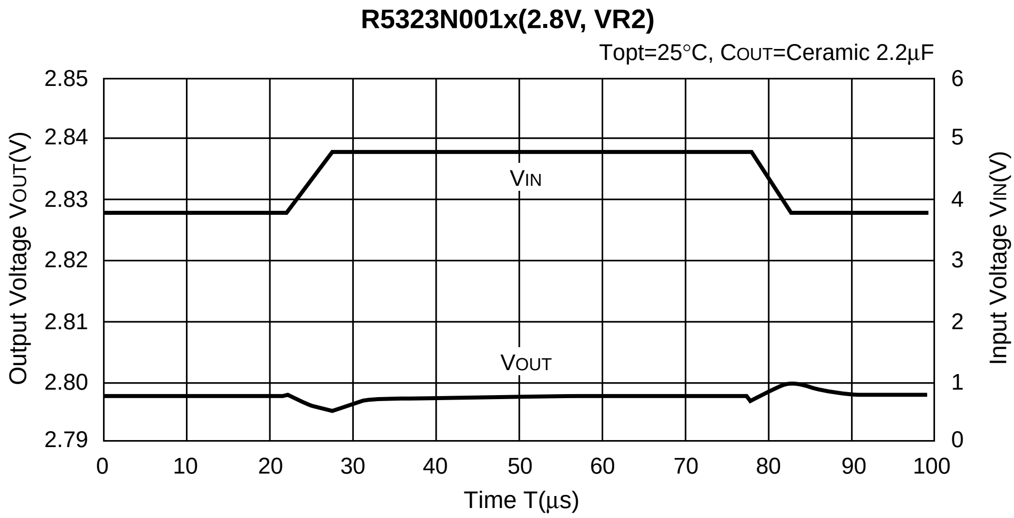
10) Input Transient Response (I_{OUT}=30mA, tr=tf=5µs)

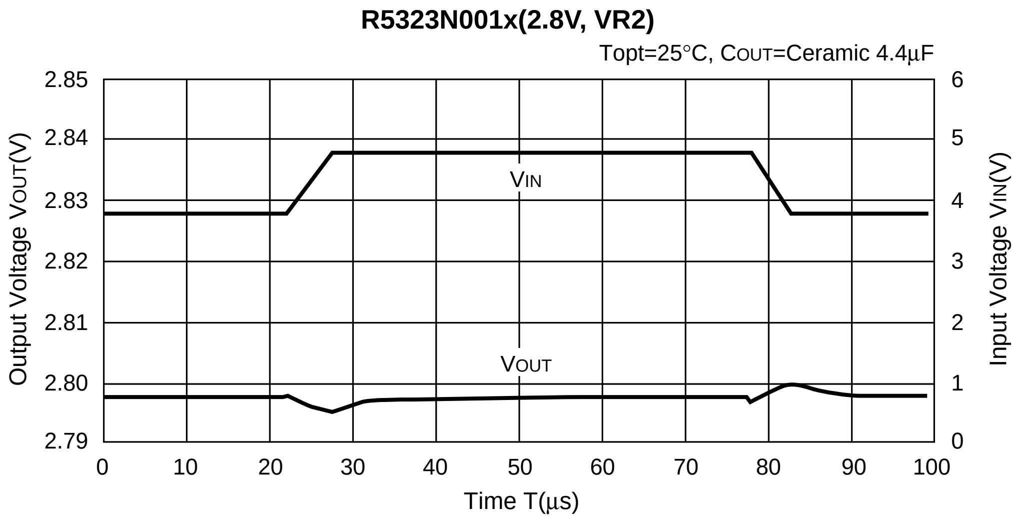







R5323N001x(2.8V, VR2)
Topt=25°C, COUT=Ceramic 1.0µF
Output Voltage VOUT(V)
Input Voltage VIN(V)
Time T(µs)
VIN
VOUT
2.85
2.84
2.83
2.82
2.81
2.80
2.79
6
5
4
3
2
1
0
0
10
20
30
40
50
60
70
80
90
100

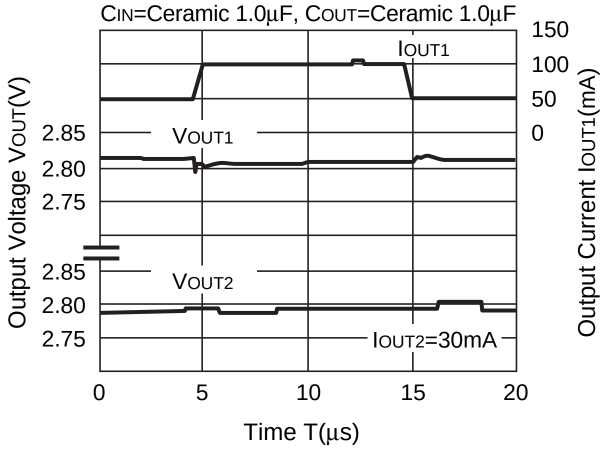

R5323N001x(2.8V, VR2)
Topt=25°C, COUT=Ceramic 2.2µF
Output Voltage VOUT(V)
Input Voltage VIN(V)
Time T(µs)
VIN
VOUT
2.85
2.84
2.83
2.82
2.81
2.80
2.79
6
5
4
3
2
1
0
0
10
20
30
40
50
60
70
80
90
100


R5323N001x(2.8V, VR2)
Topt=25°C, COUT=Ceramic 4.4µF
Output Voltage VOUT(V)
Input Voltage VIN(V)
Time T(µs)
VIN
VOUT
2.85
2.84
2.83
2.82
2.81
2.80
2.79
6
5
4
3
2
1
0
0
10
20
30
40
50
60
70
80
90
100

11) Load Transient Response

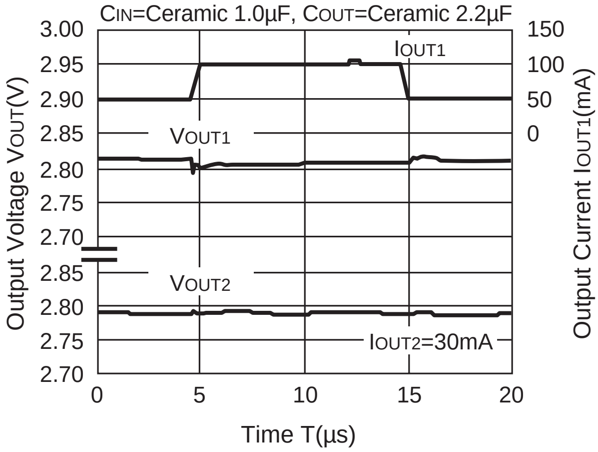
2.8V (VR1)

CIN=Ceramic 1.0µF, COUT=Ceramic 1.0µF



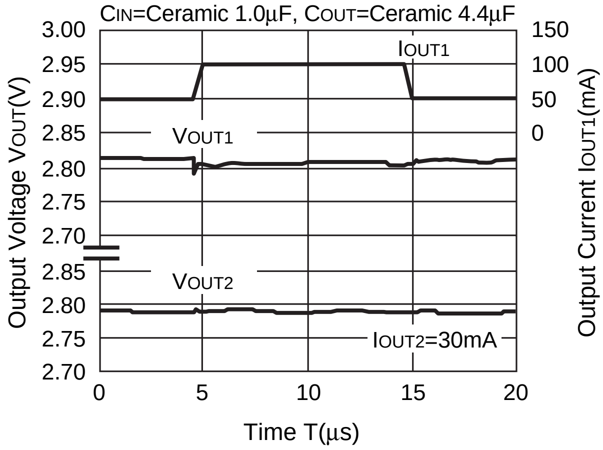
2.8V (VR1)

CIN=Ceramic 1.0µF, COUT=Ceramic 2.2µF



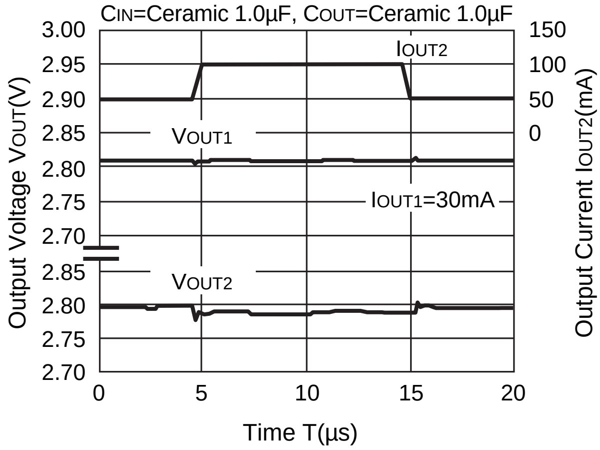
2.8V (VR1)

CIN=Ceramic 1.0µF, COUT=Ceramic 4.4µF



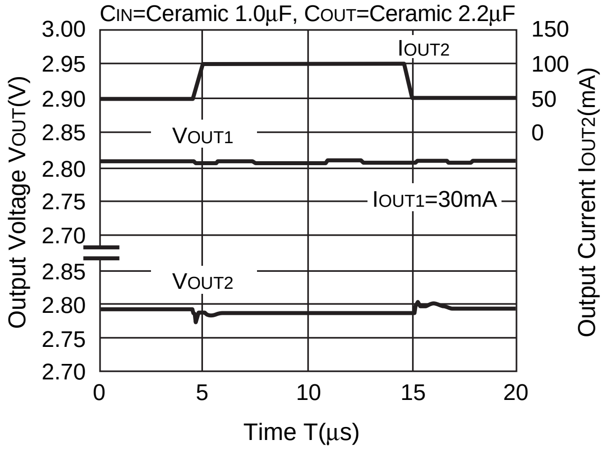
2.8V (VR2)

CIN=Ceramic 1.0µF, COUT=Ceramic 1.0µF



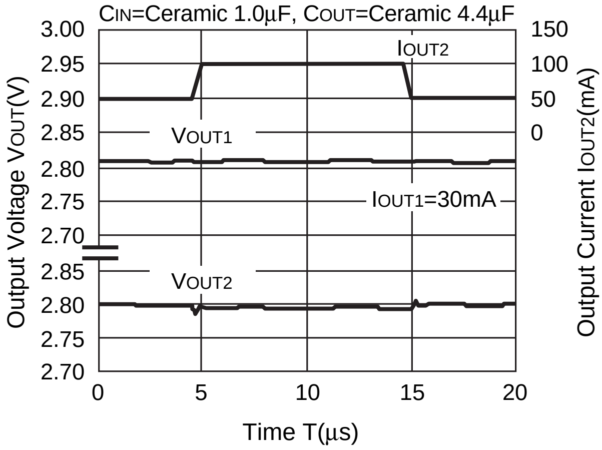
2.8V (VR2)

CIN=Ceramic 1.0µF, COUT=Ceramic 2.2µF



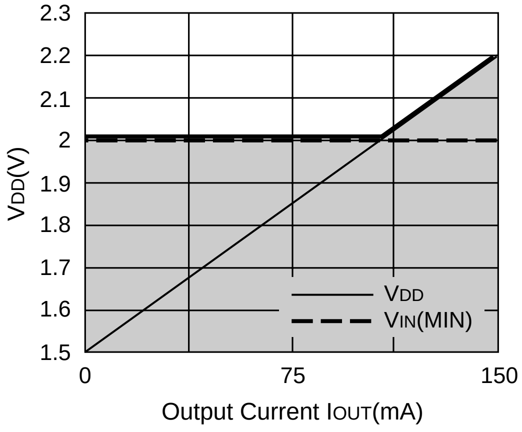
2.8V (VR2)

CIN=Ceramic 1.0µF, COUT=Ceramic 4.4µF



12) Minimum Operating Voltage

1.5V Minimum Operating Voltage Range

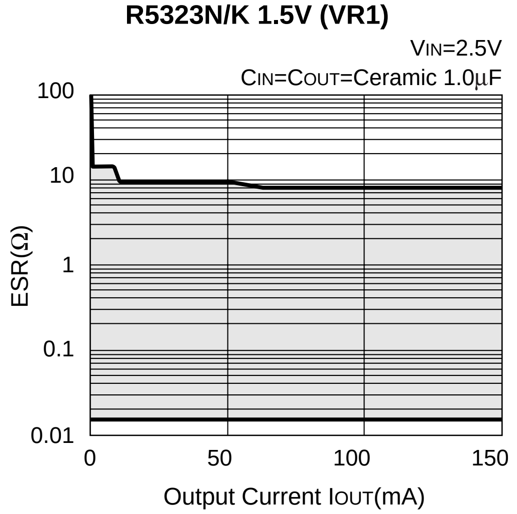


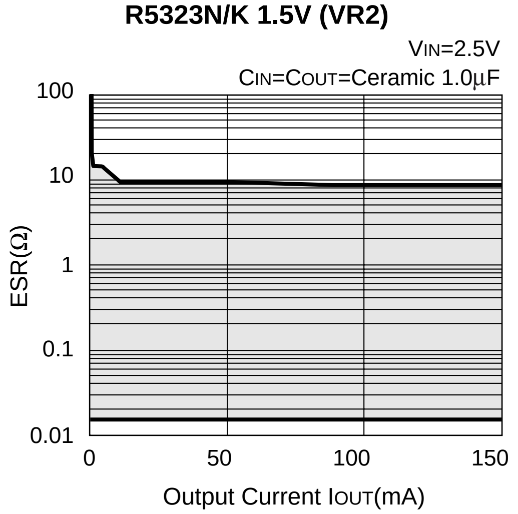
ESR vs. Output Current

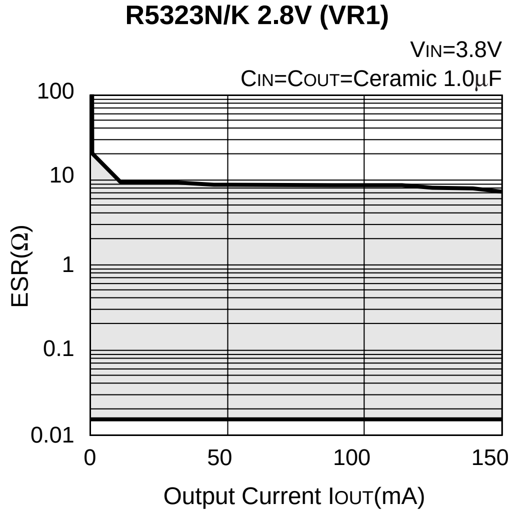
When using these ICs, consider the following points:
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is under 40µV (Avg.) are marked as the hatched area in the graph.

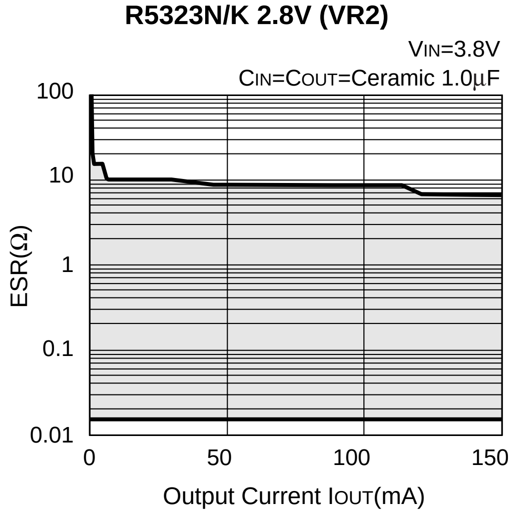
Measurement conditions

Frequency Band : 10Hz to 2MHz (BW=30Hz)
Temperature : 25°C

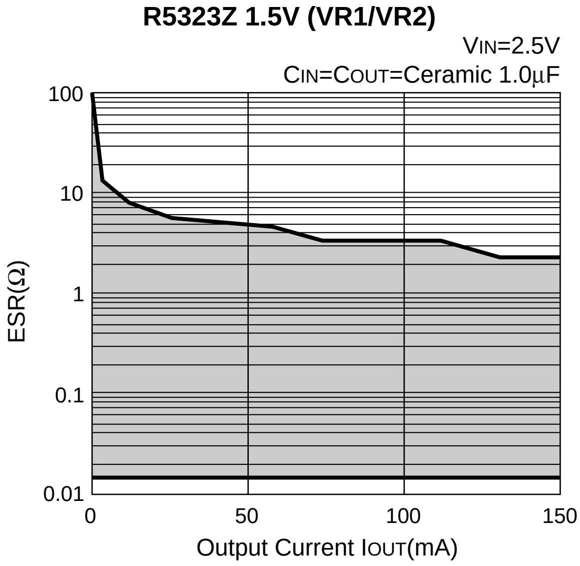


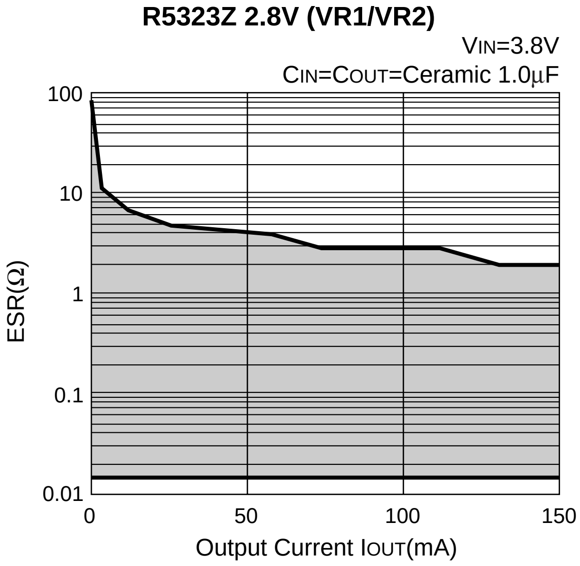






RICOH


R5323Z 1.5V (VR1/VR2)
VIN=2.5V
CIN=COUT=Ceramic 1.0μF
100
10
1
0.1
0.01
ESR(Ω)
0
50
100
150
Output Current IOUT(mA)


R5323Z 2.8V (VR1/VR2)
VIN=3.8V
CIN=COUT=Ceramic 1.0μF
100
10
1
0.1
0.01
ESR(Ω)
0
50
100
150
Output Current IOUT(mA)

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.
3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh's or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death (aircraft, spacevehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, 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

■**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.

日本経営品質賞 1999年度受賞

■**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/

RICOH COMPANY, LTD.
Electronic Devices Company
● Higashi-Shinagawa Office (International Sales)
3-32-3, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140-8655, Japan
Phone: +81-3-5479-2857 Fax: +81-3-5479-0502

RICOH EUROPE (NETHERLANDS) B.V.
● Semiconductor Support Centre
Prof. W.H.Keesomlaan 1, 1183 DL Amstelveen, The Netherlands
P.O.Box 114, 1180 AC Amstelveen
Phone: +31-20-5474-309 Fax: +31-20-5474-791

RICOH ELECTRONIC DEVICES KOREA Co., Ltd.
11 floor, Haesung 1 building, 942, Daechidong, Gangnamgu, Seoul, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2135-5705

RICOH ELECTRONIC DEVICES SHANGHAI Co., Ltd.
Room403, No.2 Building, 690#Bi Bo Road, Pu Dong New district, Shanghai 201203, People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

RICOH COMPANY, LTD.
Electronic Devices Company
● Taipei office
Room109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623