R5324D SERIES

NO. EA-099-0301

OUTLINE

The R5324D Series are CMOS-based multi positive voltage regulator ICs with high output voltage accuracy, low supply current, low noise, low dropout and high ripple rejection. The R5324D Series contain three voltage regulators. Each of these voltage regulators in the R5324D Series consists of a voltage reference unit, an error amplifier, resistors for setting output voltage, a short current limit circuit, a chip enable circuit, and so on.

The chip enable function contributes to prolong battery life. Further, regulators in the R5324D Series are with low dropout voltage, excellent load transient response and line transient response, thus the R5324D series are very suitable for the power supply for hand-held communication equipment.

Since the package for these ICs is SON-8, high density mounting of the ICs on boards is possible.

FEATURES

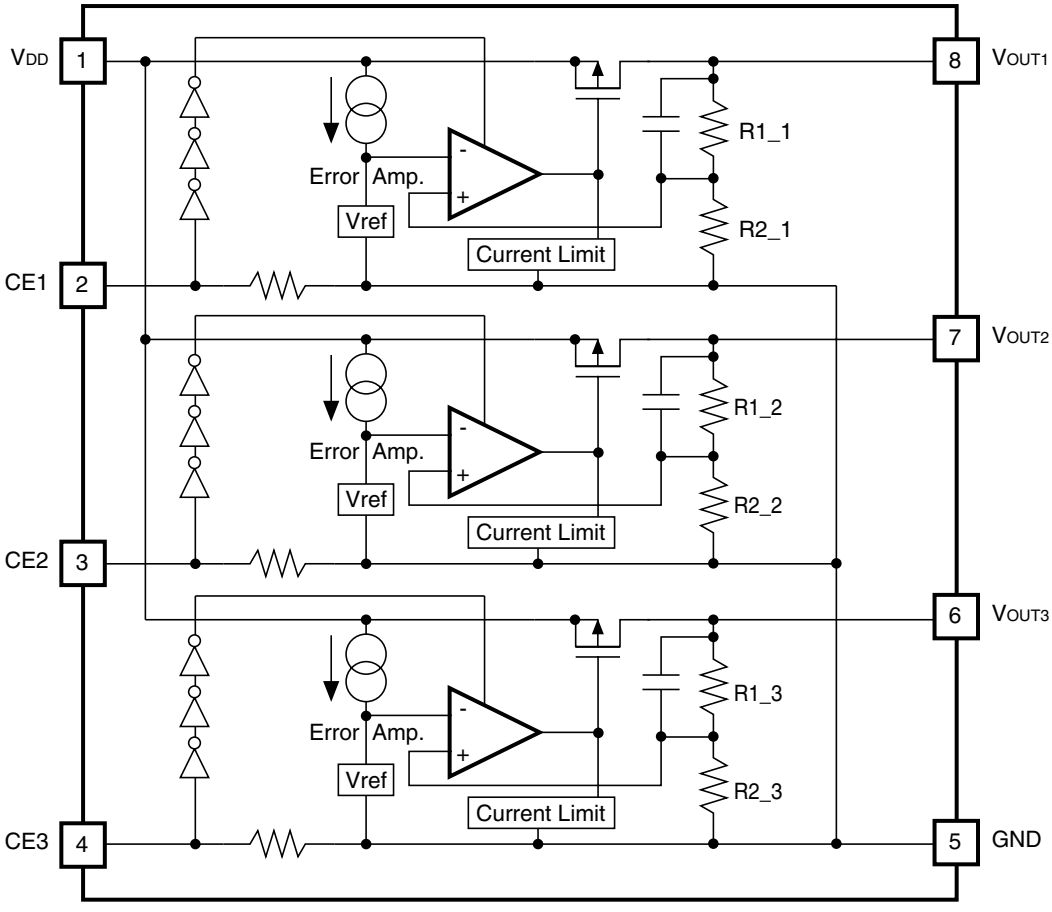
- Ultra-Low Supply Current .....Typ. 90μA: VR1, Typ. 90μA: VR2, Typ. 90μA: VR3
- Low Standby Current .....Typ. 0.1μA
- Low Dropout Voltage .....Typ. 0.23V (VR1) 0.22V(VR2) 0.15V (VR3)
  I_{OUT}=200mA: VR1, 150mA: VR2, 100mA: VR3
  (ex. for 3.0V Output Type)
- High Ripple Rejection .....Typ. 70dB (f=1kHz), 65dB (f=10kHz)
- High Output Voltage Accuracy .....±2.0%
- Excellent Load Transient Response and Line Transient Response
- Small Package SON-8
- Ceramic Capacitor Recommended for Output .....1.0μF or more

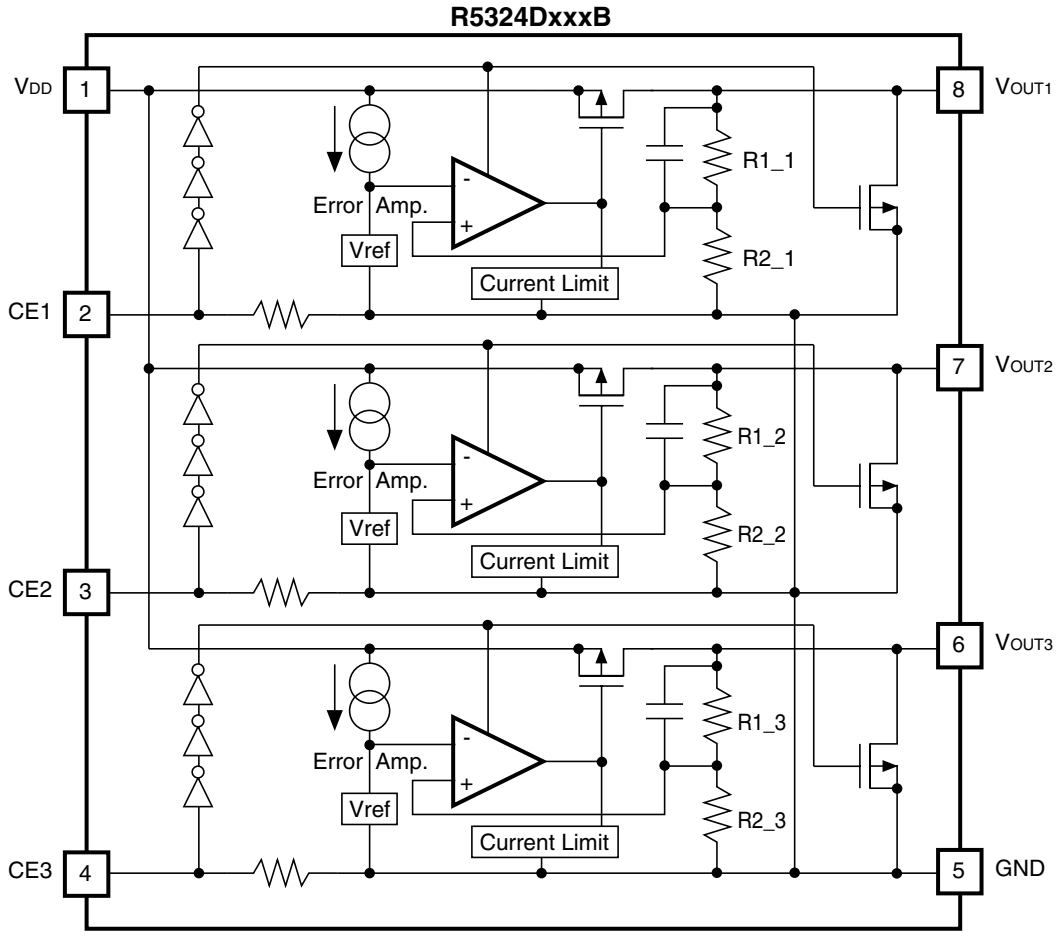
APPLICATIONS

- Power source for cellular phones and portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

R5324DxxxA





SELECTION GUIDE

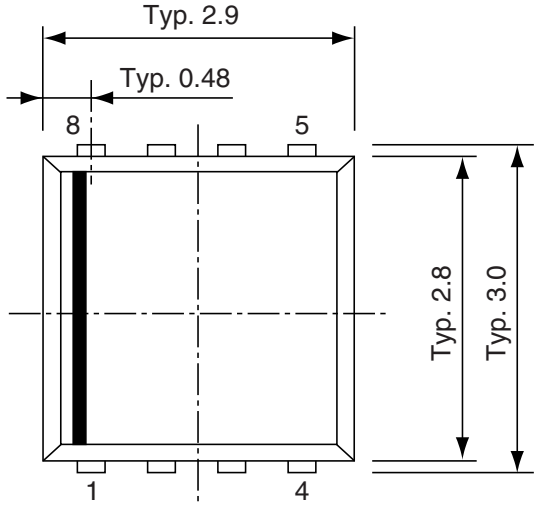
The selection can be made with designating the part number as shown below:

R5324Dxxxx-TR ←Part Number
↑ ↑ ↑
a b c

Code	Descriptions
a	Serial Number for Voltage setting from 001
b	Alphabetical Code for Mask Versions A: Standard B: With auto discharge function at off state
c	Designation of Taping Type (TR is described as standard.)

PIN CONFIGURATION

SON-8 Package



PIN DESCRIPTION

Pin No.	Symbol	Descriptions
1	V_{DD}	Input Pin
2	CE1	Chip Enable Pin 1
3	CE2	Chip Enable Pin 2
4	CE3	Chip Enable Pin 3
5	GND	Ground Pin
6	V_{OUT3}	Output Pin 3
7	V_{OUT2}	Output Pin 2
8	V_{OUT1}	Output Pin 1

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
CE	Input Voltage (CE Pin)	-0.3～V_{IN}+0.3	V
V_{OUT}	Output Voltage	-0.3～V_{IN}+0.3	V
I_{OUT1}	Output Current (V_{OUT1})	230	mA
I_{OUT2}	Output Current (V_{OUT2})	180	mA
I_{OUT3}	Output Current (V_{OUT3})	180	mA
P_D	Power Dissipation	300	mW
Topt	Operating Temperature Range	-40～85	°C
Tstg	Storage Temperature Range	-55～125	°C

ELECTRICAL CHARACTERISTICS

- **R5324DxxxA/B**

VR1 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	200			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN}-V_{OUT}=1.0V 1mA≤I_{OUT}≤200mA		25	50	mV
V_{DIF}	Dropout Voltage	Refer to Electrical Characteristic by Output Voltage (VR1)				
I_{SS}	Supply Current	V_{IN}-V_{OUT}=1.0V		90	140	μA
Istandby	Supply Current (Standby)	V_{IN}-V_{OUT}=1.0V, V_{CE}=GND		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT}+0.5V≤V_{IN}≤6.0V I_{OUT}=30mA (V_{OUT}≥2.0V: 2.2V≤V_{IN}≤6.0V)		0.02	0.10	%/V
RR	Ripple Rejection	f=1kHz f=10kHz f=10kHz (V_{OUT}≥2.5V) sinusoidal Ripple 0.5Vp-p V_{IN}-V_{OUT}=1.0V, I_{OUT}=30mA V_{OUT}≤1.7V V_{IN}-V_{OUT}=1.2V		70 65 60		dB
V_{IN}	Input Voltage		2.0		6.0	V
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	I_{OUT}=30mA -40°≤Topt≤85°C		±100		ppm/°C
I_{LIM}	Short Current Limit	V_{OUT}=0V		40		mA
R_{PD}	CE Pull-down Resistance		0.7	2.0	5.0	MΩ
V_{CEH}	CE Input Voltage "H"		1.5		V_{IN}	V
V_{CEL}	CE Input Voltage "L"		0.0		0.3	V
en	Output Noise	BW=10Hz~100kHz		30		μVrms
R_{LOW}	On Resistance of Nch Tr. for Auto-discharge (Applied to B version)	V_{CE}=0V		50		Ω

- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE (VR1)**

Topt=25°C

Output Voltage V_{OUT} (V)	Dropout Voltage		
	V_{DIF} (V)		
	Condition	Typ.	Max.
V_{OUT}=1.5	I_{OUT}=200mA	0.36	0.65
V_{OUT}=1.6		0.34	0.58
V_{OUT}=1.7		0.33	0.56
1.8≤V_{OUT}≤2.0		0.31	0.53
2.1≤V_{OUT}≤2.7		0.28	0.46
2.8≤V_{OUT}≤4.0		0.23	0.35

VR2 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}-V_{OUT}=1.0V 1mA≤I_{OUT}≤150mA		15	40	mV
V_{DIF}	Dropout Voltage	Refer to Electrical Characteristics by Output Voltage (VR2)				
I_{SS}	Supply Current	V_{IN}-V_{OUT}=1.0V		90	120	μA
Istandby	Supply Current (Standby)	V_{IN}-V_{OUT}=1.0V, V_{CE}=GND		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT}+0.5V≤V_{IN}≤6V I_{OUT}=30mA (V_{OUT}≤1.6V: 2.2V≤V_{IN}≤6V)		0.02	0.10	%/V
RR	Ripple Rejection	f=1kHz f=10kHz f=10kHz (V_{OUT}≥2.5V) sinusoidal Ripple 0.5Vp-p V_{IN}-V_{OUT}=1.0V, I_{OUT}=30mA (V_{OUT}≤1.7V V_{IN}-V_{OUT}=1.2V)		70 65 60		dB
V_{IN}	Input Voltage		2.0		6.0	V
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	I_{OUT}=30mA -40°C≤Topt≤85°C		±100		ppm/°C
I_{LIM}	Short Current Limit	V_{OUT}=0V		40		mA
R_{PD}	CE Pull-down Resistance		0.7	2.0	5.0	MΩ
V_{CEH}	CE Input Voltage "H"		1.5		V_{IN}	V
V_{CEL}	CE Input Voltage "L"		0.00		0.30	V
en	Output Noise	BW=10Hz～100kHz		30		μVrms
R_{LOW}	On Resistance of Nch Tr. for Auto-discharge (Applied to B version)	V_{CE}=0V		50		Ω

- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE (VR2)**

Topt=25°C

Output Voltage V_{OUT} (V)	Dropout Voltage		
	V_{DIF} (V)		
	Condition	Typ.	Max.
V_{OUT}=1.5	I_{OUT}=150mA	0.34	0.60
V_{OUT}=1.6		0.32	0.56
V_{OUT}=1.7		0.31	0.53
1.8≤V_{OUT}≤2.0		0.29	0.50
2.1≤V_{OUT}≤2.7		0.26	0.44
2.8≤V_{OUT}≤4.0		0.22	0.33

VR3 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	100			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN}-V_{OUT}=1.0V 1mA≤I_{OUT}≤100mA		8	20	mV
V_{DIF}	Dropout Voltage	Refer to Electrical Characteristics by Dropout Voltage (VR3)				
I_{SS}	Supply Current	V_{IN}-V_{OUT}=1.0V		90	120	μA
Istandby	Supply Current (Standby)	V_{IN}-V_{OUT}=1.0V, V_{CE}=GND		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT}+0.5V≤V_{IN}≤6V I_{OUT}=30mA		0.02	0.10	%/V
RR	Ripple Rejection	f=1kHz f=10kHz f=10kHz (V_{OUT}≥2.5V) sinusoidal Ripple 0.5Vp-p V_{IN}-V_{OUT}=1.0V, I_{OUT}=30mA (V_{OUT}≤1.7V V_{IN}-V_{OUT}=1.2V)		70 65 60		dB
V_{IN}	Input Voltage		2.0		6.0	V
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	I_{OUT}=30mA -40°C≤Topt≤85°C		±100		ppm/°C
I_{LIM}	Short Current Limit	V_{OUT}=0V		40		mA
R_{PD}	CE Pull-down Resistance		0.7	2.0	5.0	MΩ
V_{CEH}	CE Input Voltage "H"		1.5		V_{IN}	V
V_{CEL}	CE Input Voltage "L"		0.0		0.3	V
en	Output Noise	BW=10Hz～100kHz		30		μVrms
R_{LOW}	On Resistance of Nch Tr. for Auto-discharge (Applied to B version)	V_{CE}=0V		50		Ω

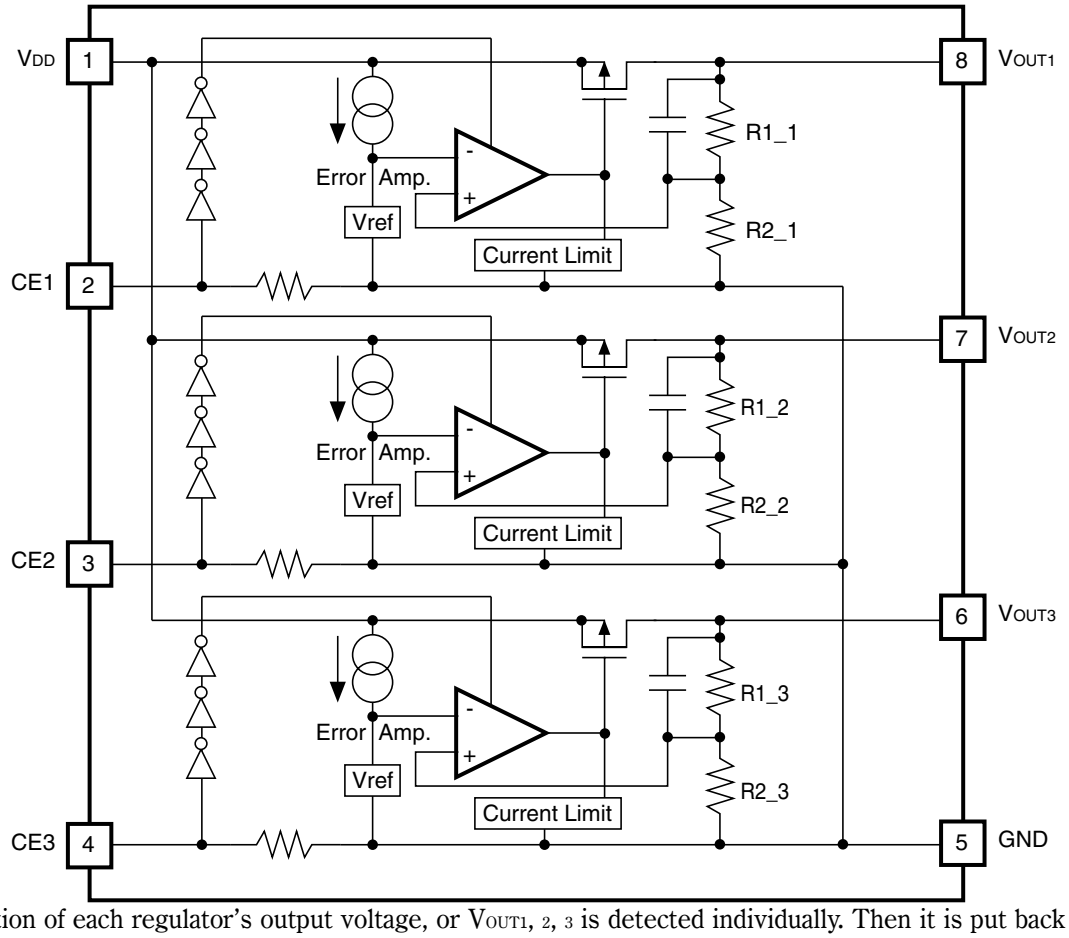
- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE (VR3)**

Topt=25°C

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
V_{OUT}=1.5	I_{OUT}=100mA	0.24	0.44
V_{OUT}=1.6		0.22	0.40
V_{OUT}=1.7		0.21	0.38
1.8≤V_{OUT}≤2.0		0.20	0.37
2.1≤V_{OUT}≤2.7		0.18	0.33
2.8≤V_{OUT}≤4.0		0.15	0.25

OPERATION

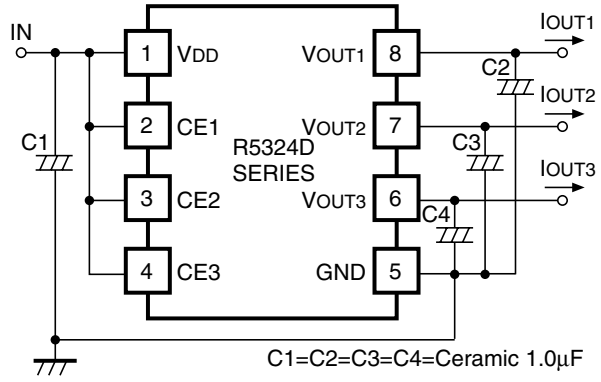
R5324DxxxA



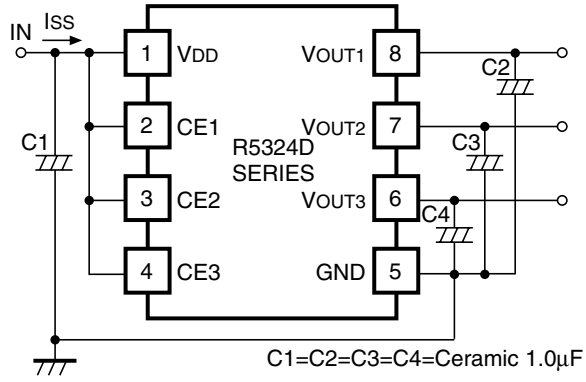
Fluctuation of each regulator's output voltage, or $V_{OUT1, 2, 3}$ is detected individually. Then it is put back to an error amplifier through feedback resistors, or R1_1, R2_1, R1_2, R2_2, R1_3, R2_3 and compared with a reference voltage and compensated for the result and make a constant voltage.

In each regulator, short protection is made with a current limit circuit and stand-by mode is available by a chip enable circuit.

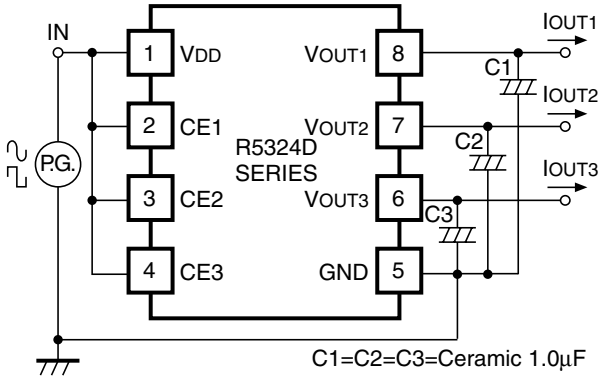
TEST CIRCUITS



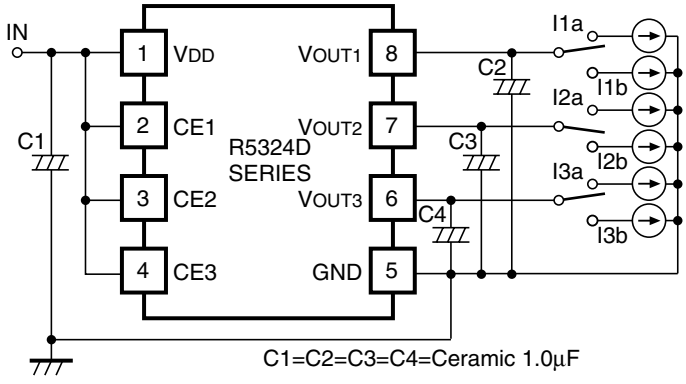
Standard Test Circuit



Supply Current Test Circuit



Ripple Rejection, Input Transient Response Test Circuit

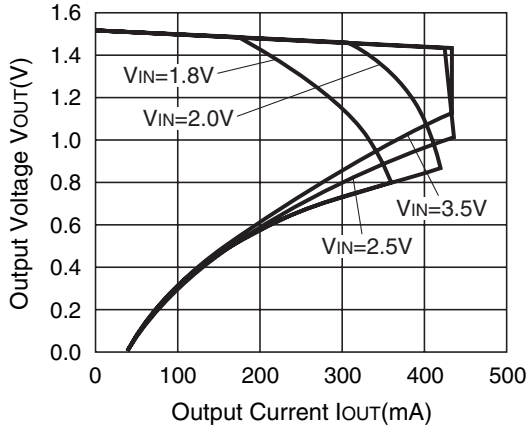


Load Transient Response Test Circuit

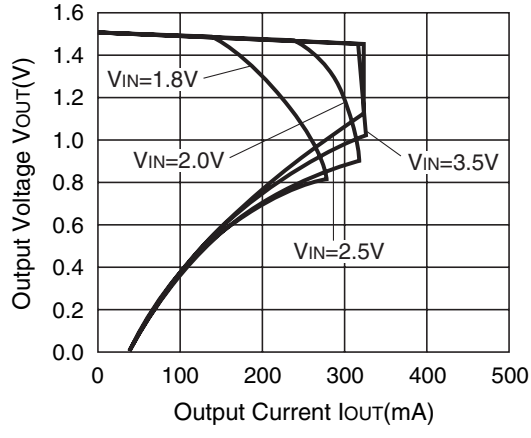
TYPICAL CHARACTERESTICS

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

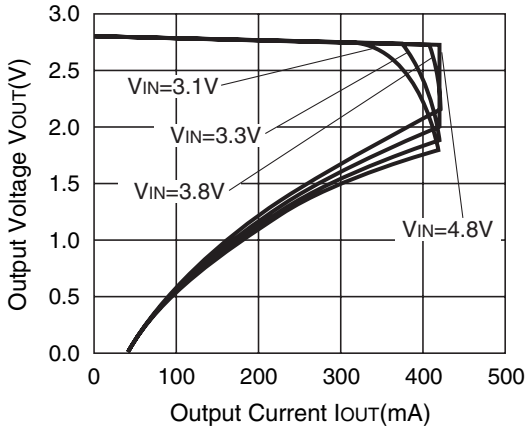
1.5V (VR1)



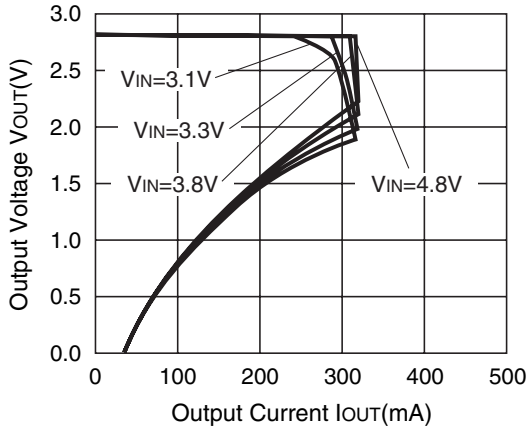
1.5V (VR2/VR3)



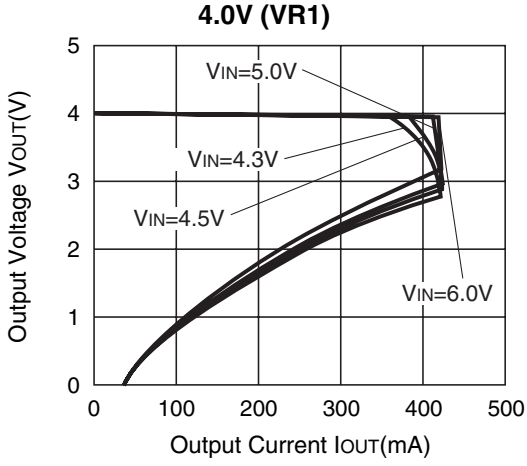
2.8V (VR1)



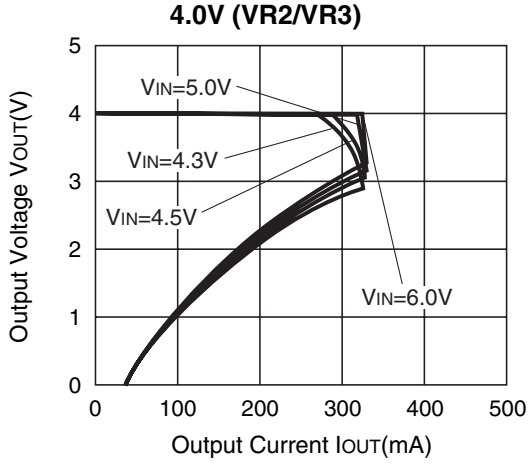
2.8V (VR2/VR3)



4.0V (VR1)

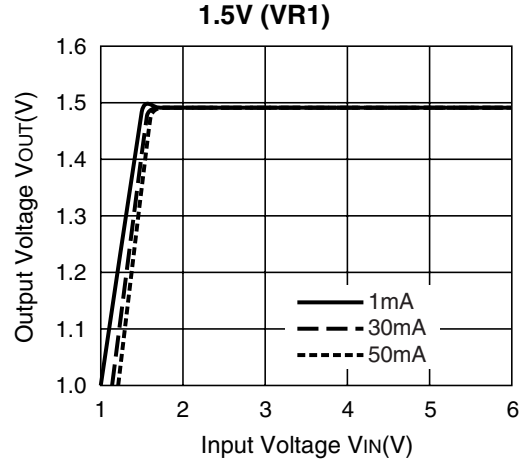


4.0V (VR2/VR3)

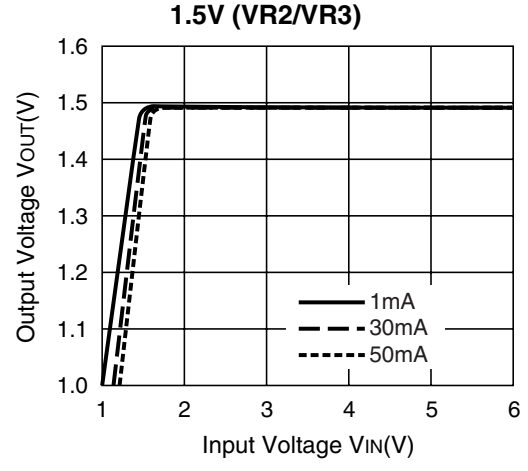


2) Output Voltage vs. Input Voltage (Topt=25°C)

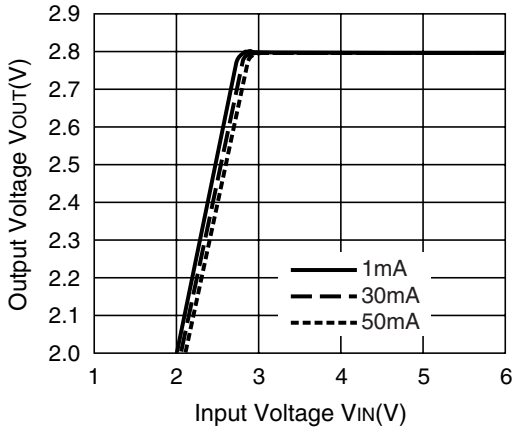
1.5V (VR1)



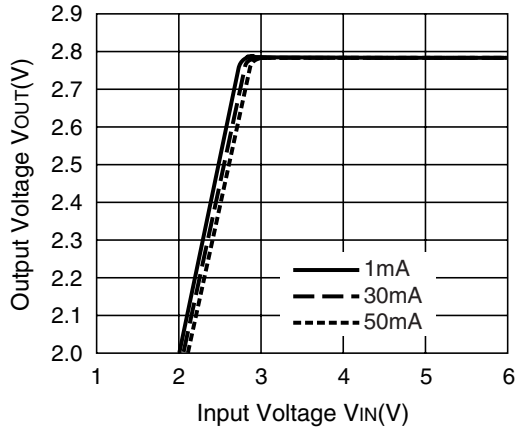
1.5V (VR2/VR3)



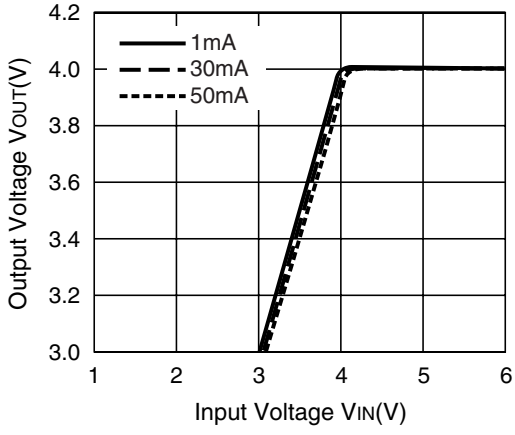
2.8V (VR1)



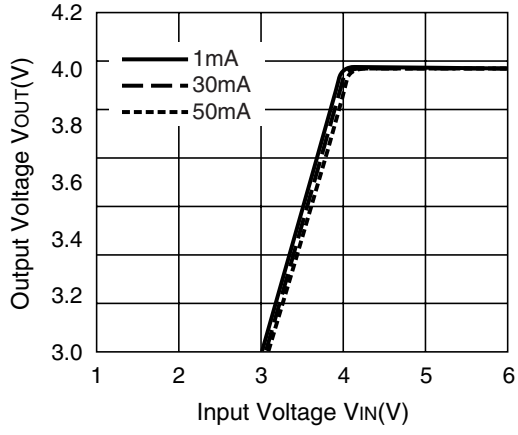
2.8V (VR2/VR3)



4.0V (VR1)

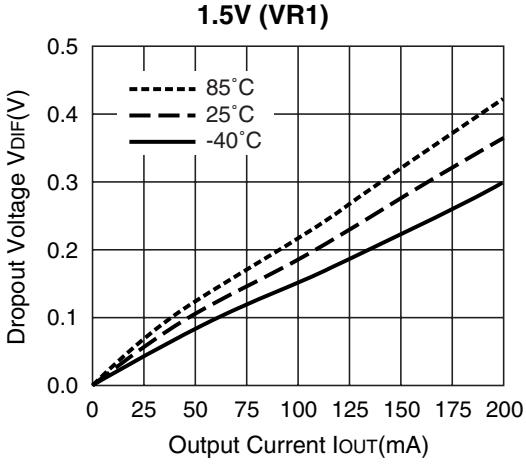


4.0V (VR2/VR3)

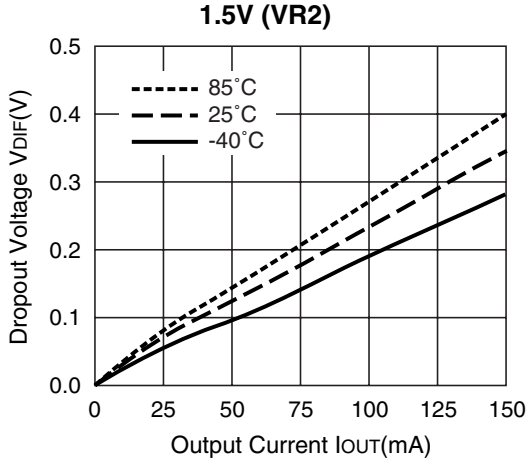


3) Dropout Voltage vs. Output Current

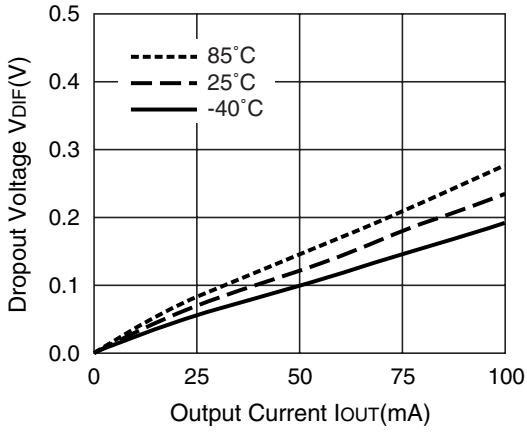
1.5V (VR1)



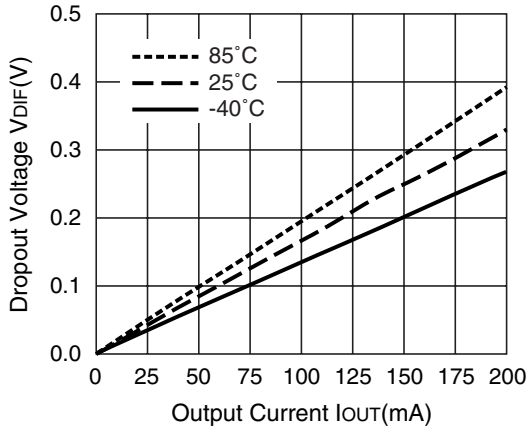
1.5V (VR2)



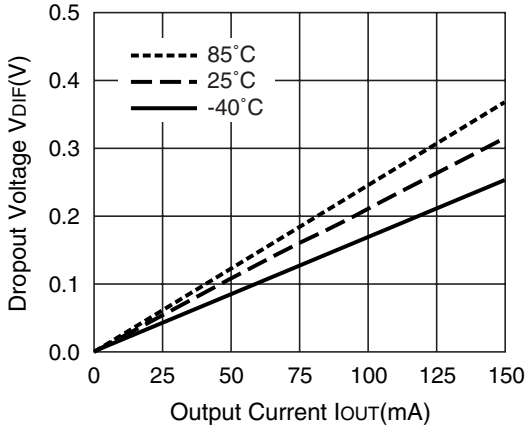
1.5V (VR3)



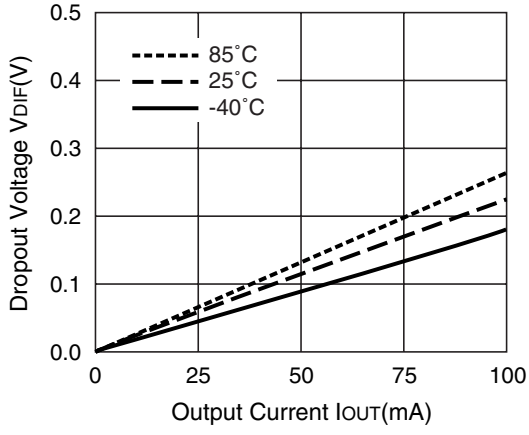
1.6V (VR1)



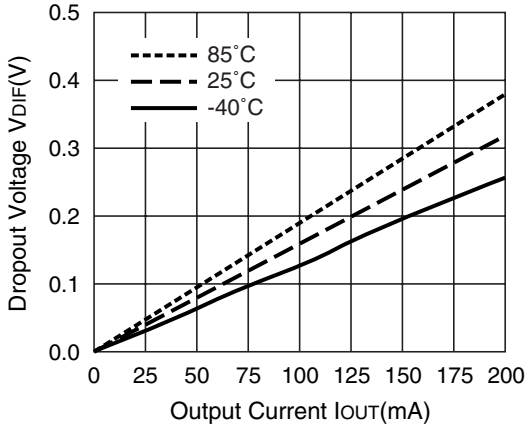
1.6V (VR2)



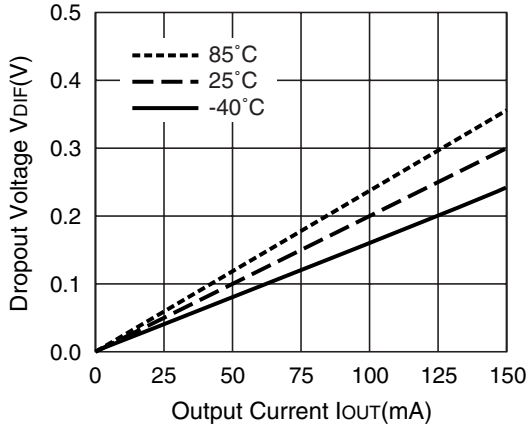
1.6V (VR3)



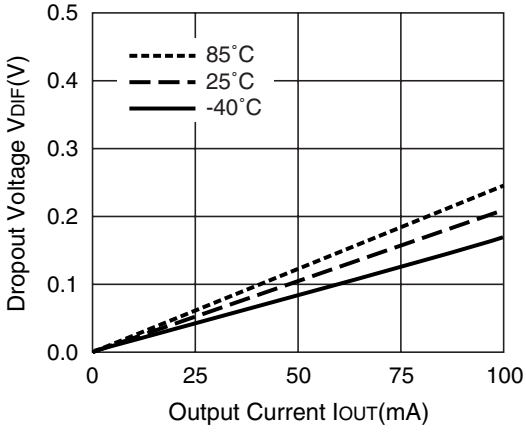
1.7V (VR1)



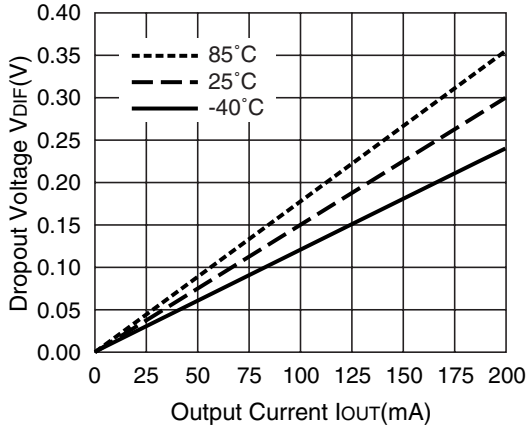
1.7V (VR2)



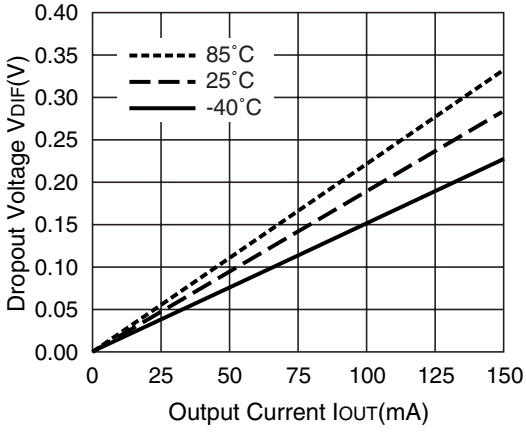
1.7V (VR3)



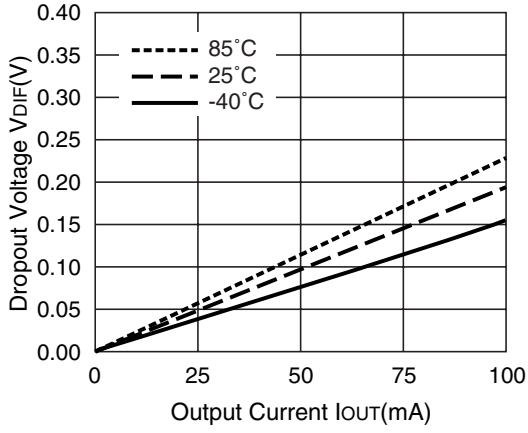
1.8V (VR1)



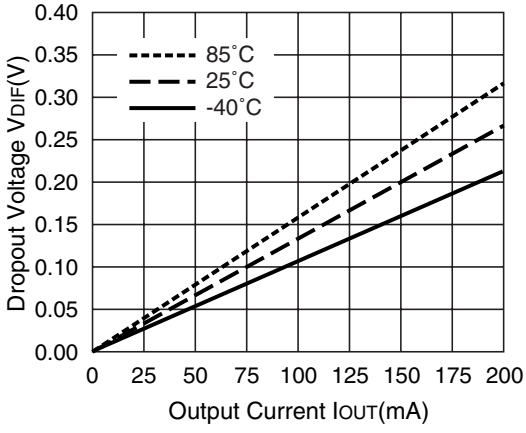
1.8V (VR2)



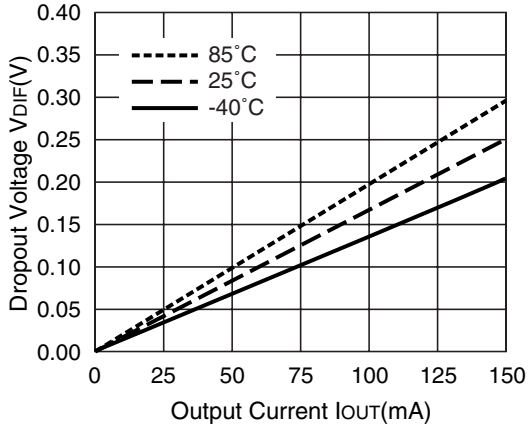
1.8V (VR3)



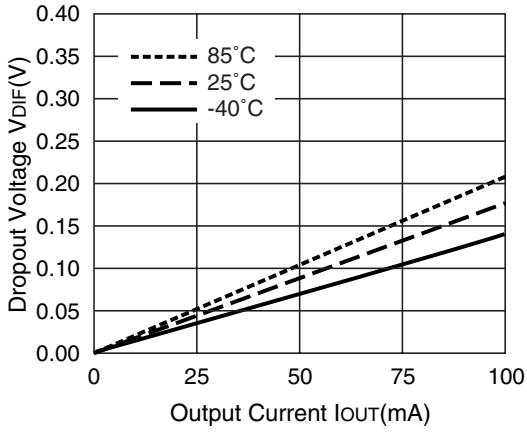
2.1V (VR1)



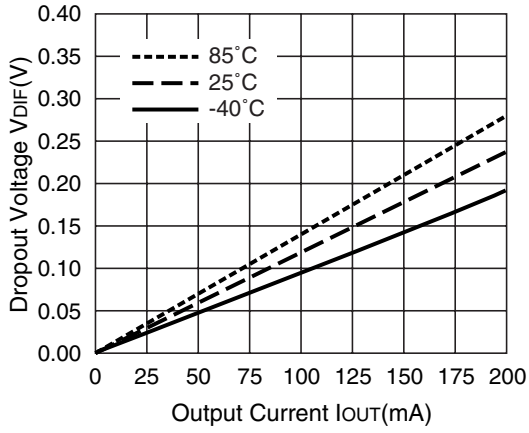
2.1V (VR2)



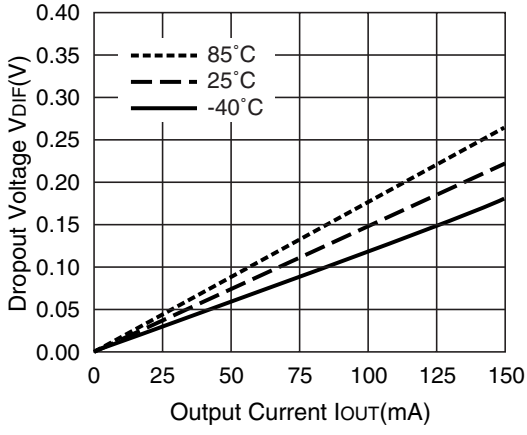
2.1V (VR3)



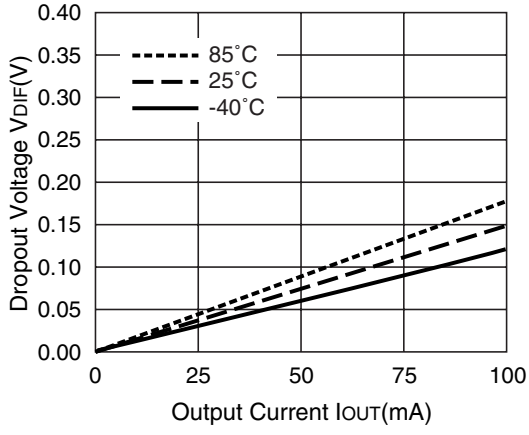
2.8V (VR1)



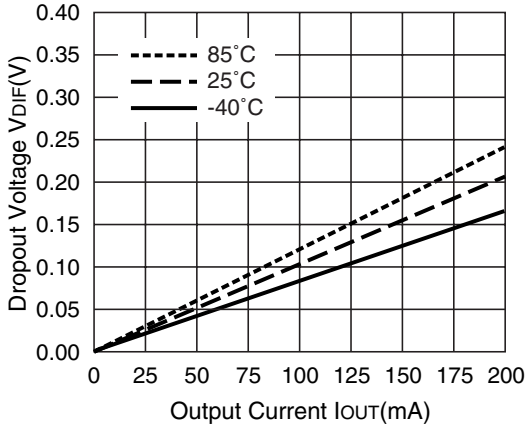
2.8V (VR2)



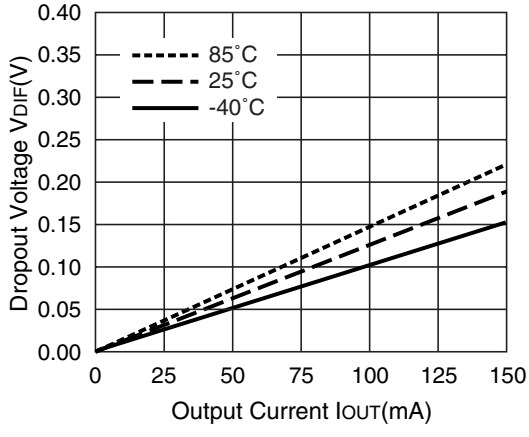
2.8V (VR3)



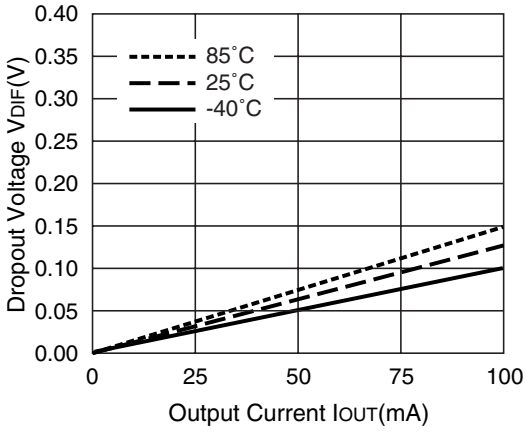
4.0V (VR1)



4.0V (VR2)

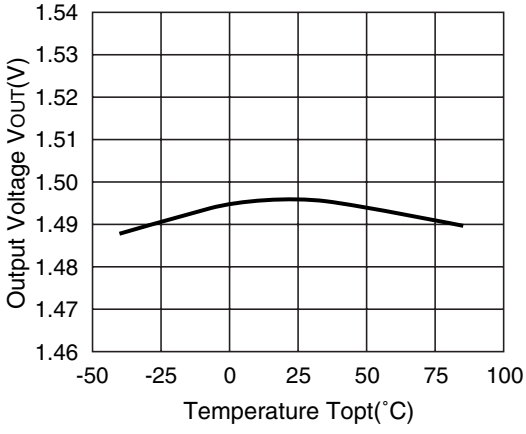


4.0V (VR3)

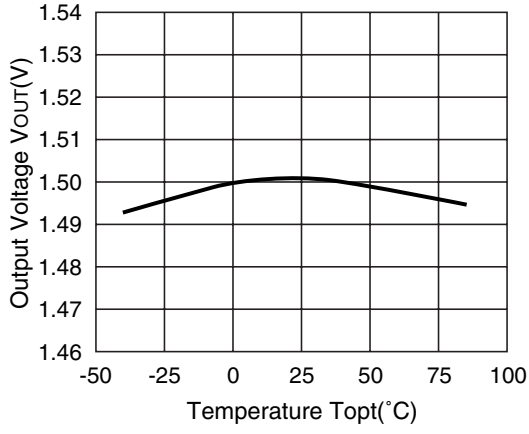


4) Output Voltage vs. Temperature (I_{OUT}=30mA)

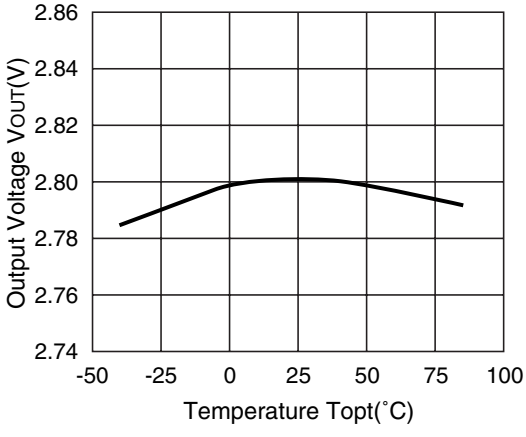
1.5V (VR1) V_{IN}=2.5V



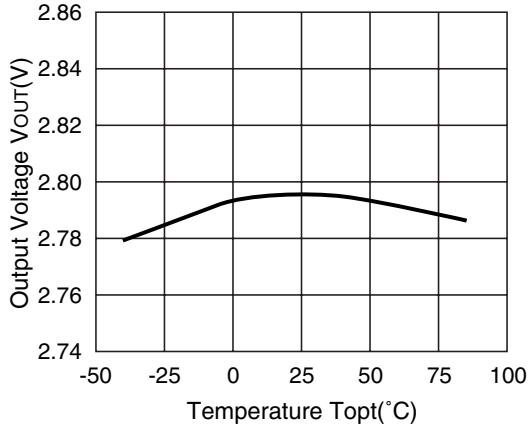
1.5V (VR2/VR3) V_{IN}=2.5V



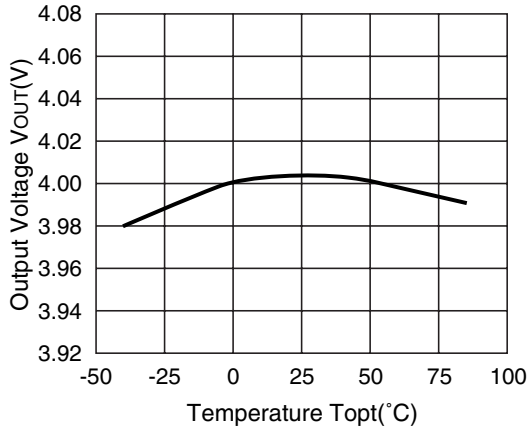
2.8V (VR1) V_{IN}=3.8V



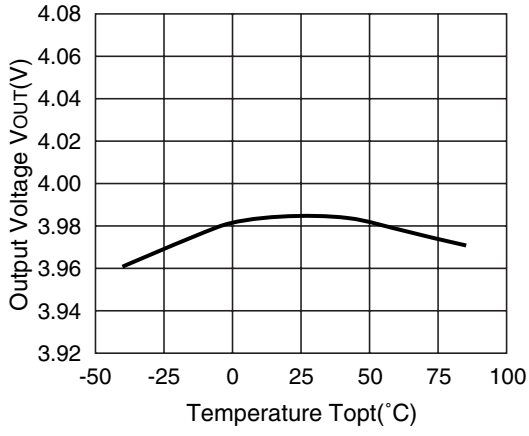
2.8V (VR2/VR3) V_{IN}=3.8V



4.0V (VR1) V_{IN}=5.0V

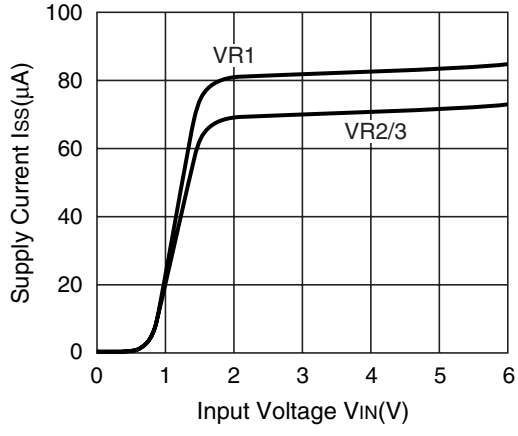


4.0V (VR2/VR3) V_{IN}=5.0V

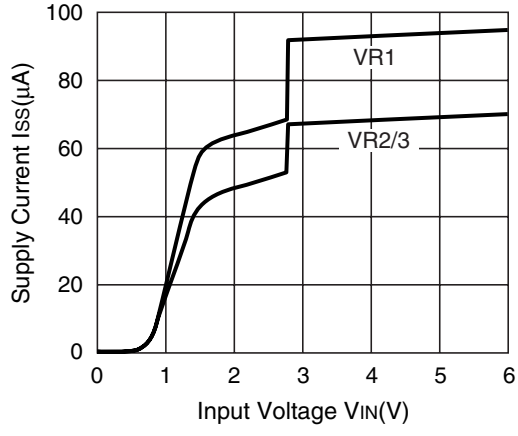


5) Supply Current vs. Input Voltage (Topt=25°C)

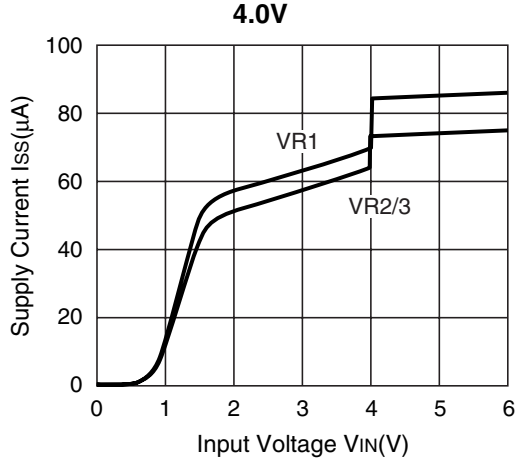
1.5V



2.8V

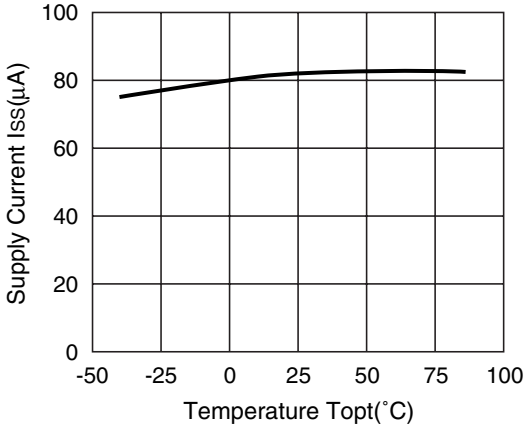


4.0V

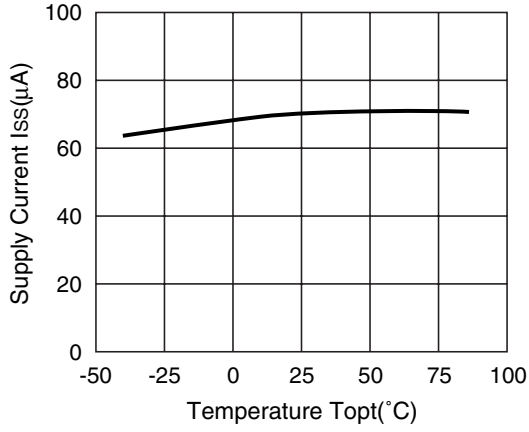


6) Supply Current vs. Temperature

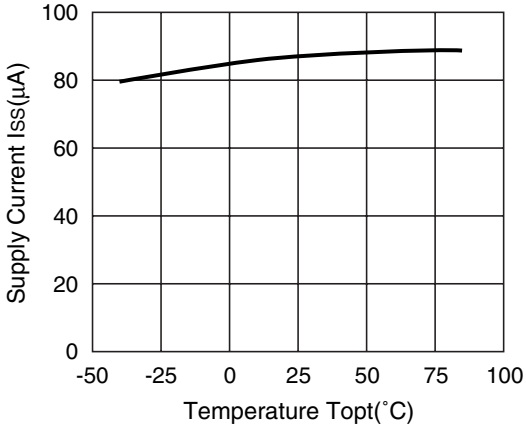
1.5V (VR1) V_{IN}=2.5V



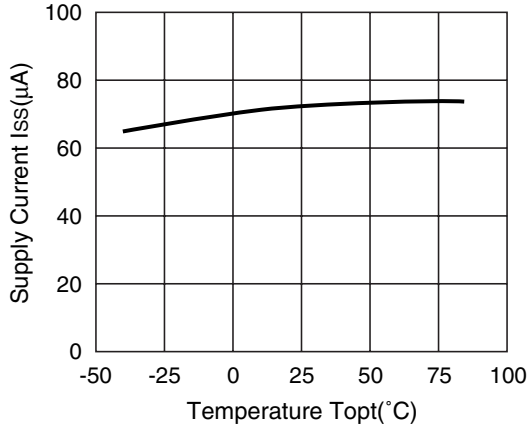
1.5V (VR2/VR3) V_{IN}=2.5V



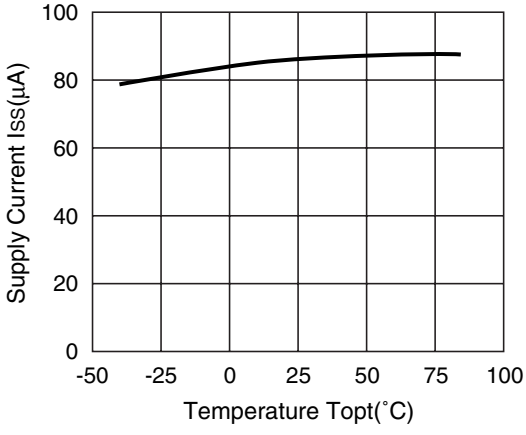
2.8V (VR1) V_{IN}=3.8V



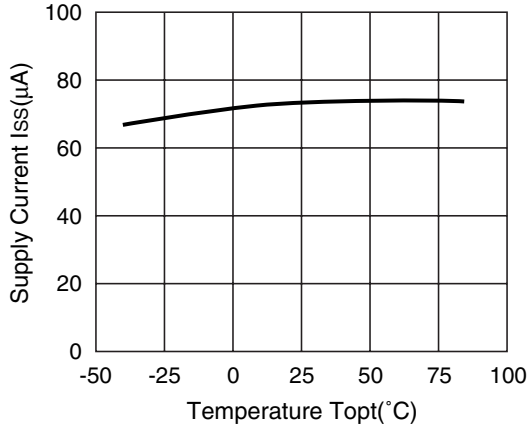
2.8V (VR2/VR3) V_{IN}=3.8V



4.0V (VR1) V_{IN}=5.0V

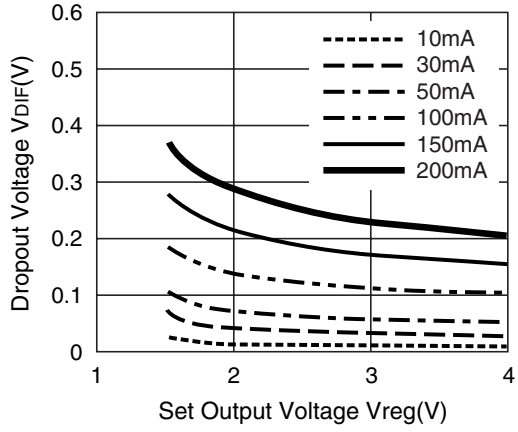


4.0V (VR2/VR3) V_{IN}=5.0V

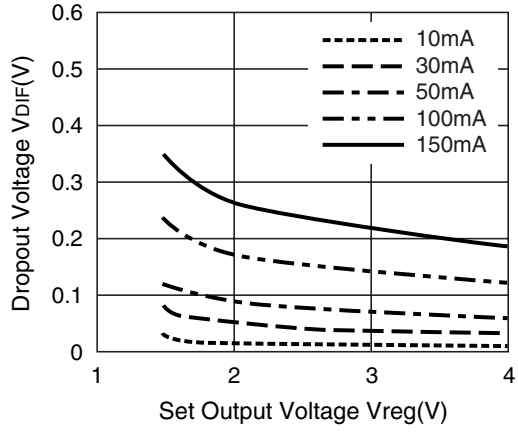


7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)

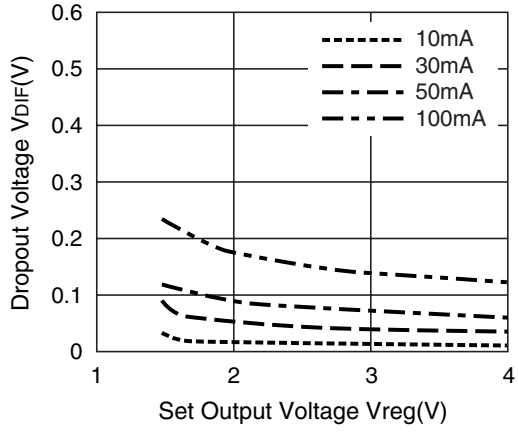
VR1



VR2

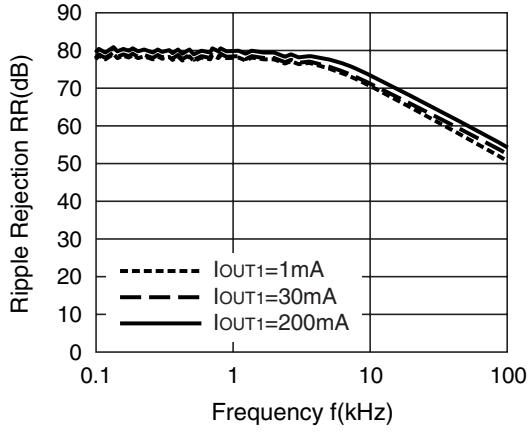


VR3

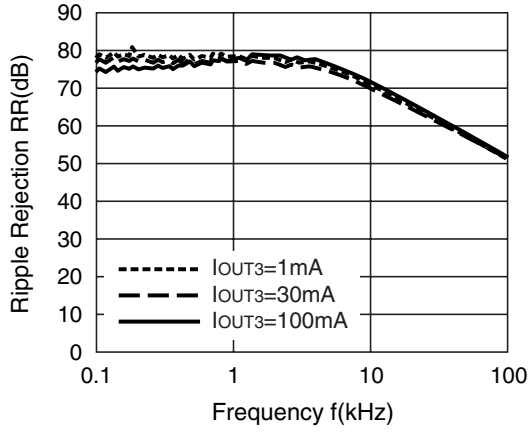


8) Ripple Rejection vs. Frequency (Topt=25°C, C_{OUT}=Ceramic 1.0µF)

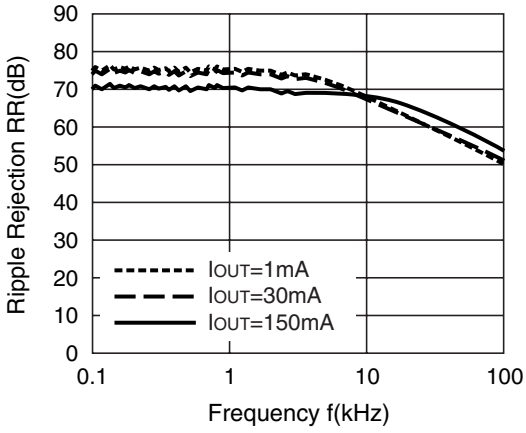
1.5V (VR1) V_{IN}=2.7V_{DC}+0.5Vp-p



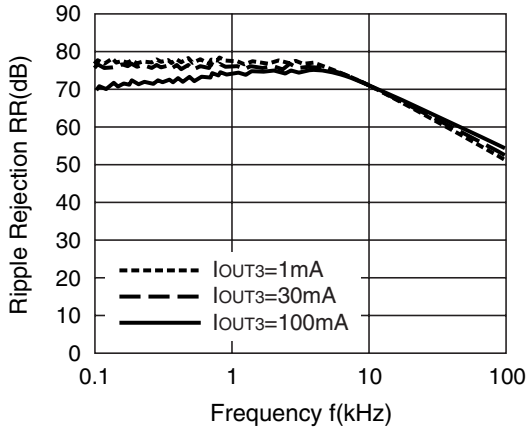
1.5V (VR1) (I_{OUT3} dependence) V_{IN}=2.7V_{DC}+0.5Vp-p



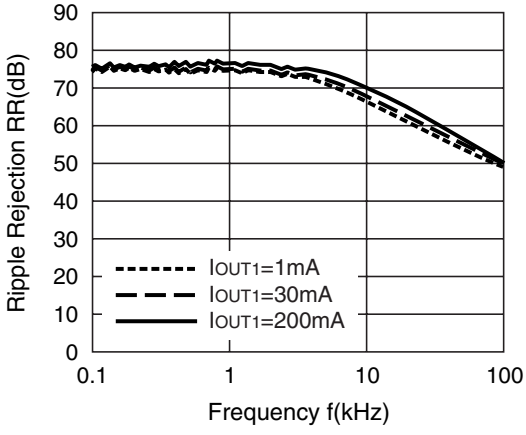
1.5V (VR2) V_{IN}=2.7V_{DC}+0.5Vp-p



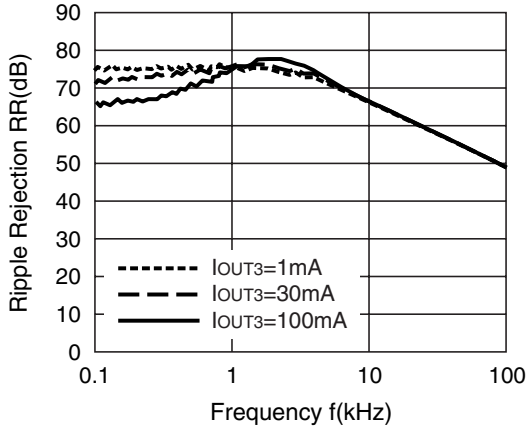
1.5V (VR3) V_{IN}=2.7V_{DC}+0.5Vp-p



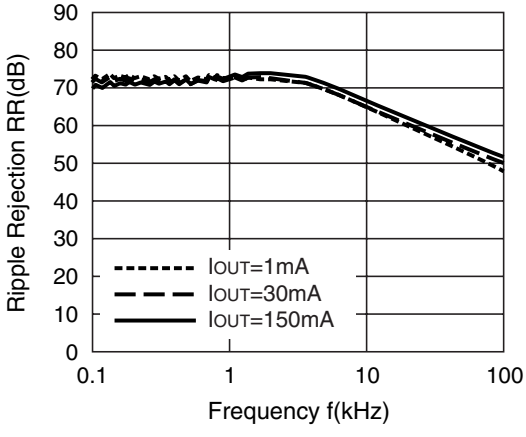
2.8V (VR1) V_{IN}=3.8V_{DC}+0.5Vp-p



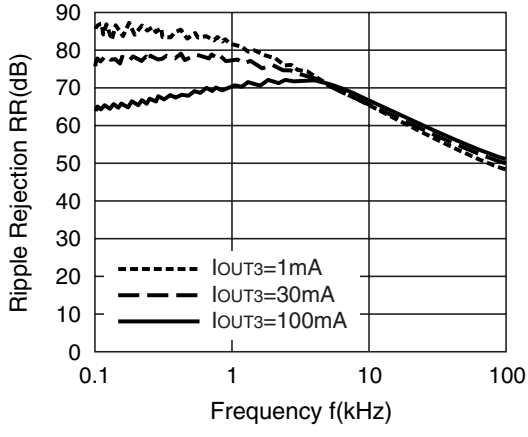
2.8V (VR1) (I_{OUT3} dependence) V_{IN}=3.8V_{DC}+0.5Vp-p



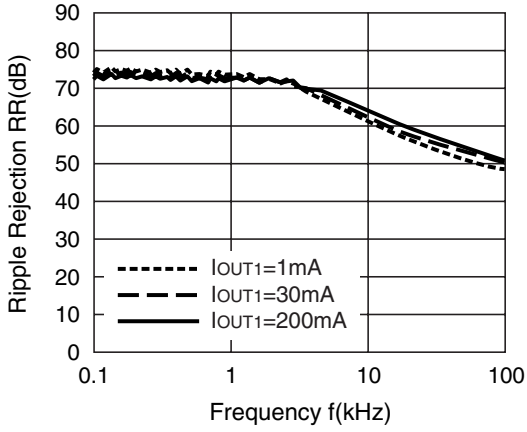
2.8V (VR2) V_{IN}=3.8V_{DC}+0.5Vp-p



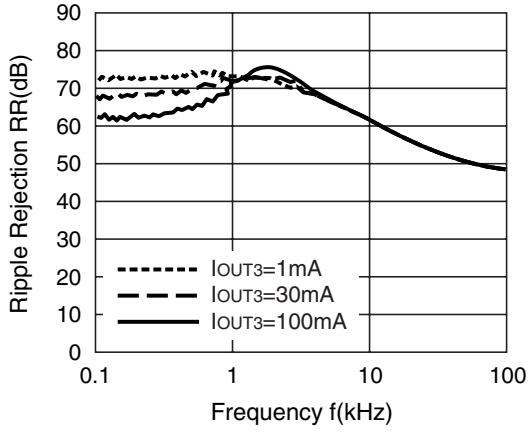
2.8V (VR3) V_{IN}=3.8V_{DC}+0.5Vp-p



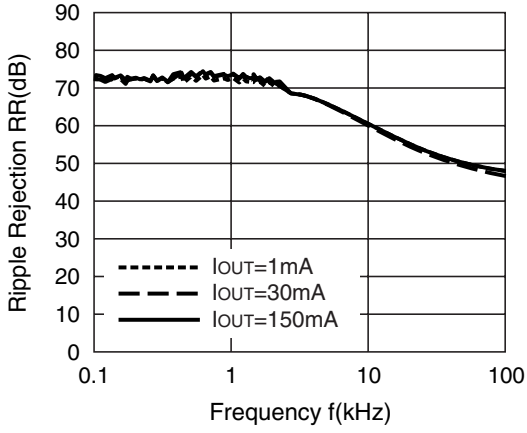
4.0V (VR1) V_{IN}=5.0V_{DC}+0.5Vp-p



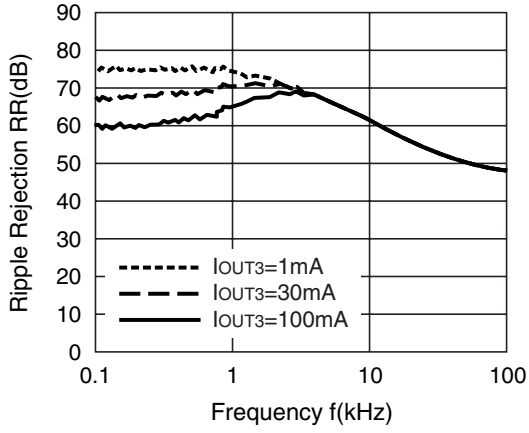
4.0V (VR1) (I_{OUT3} dependence) V_{IN}=5.0V_{DC}+0.5Vp-p



4.0V (VR2) V_{IN}=5.0V_{DC}+0.5Vp-p

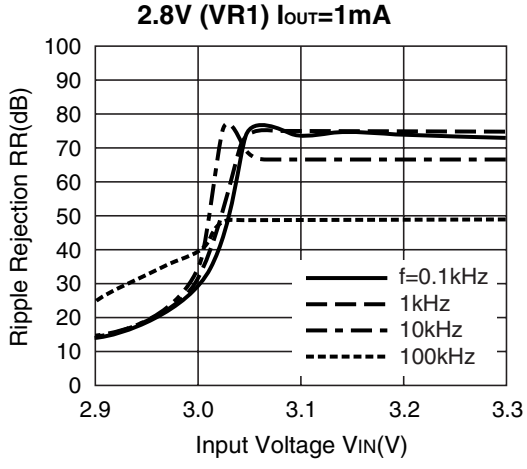


4.0V (VR3) V_{IN}=5.0V_{DC}+0.5Vp-p

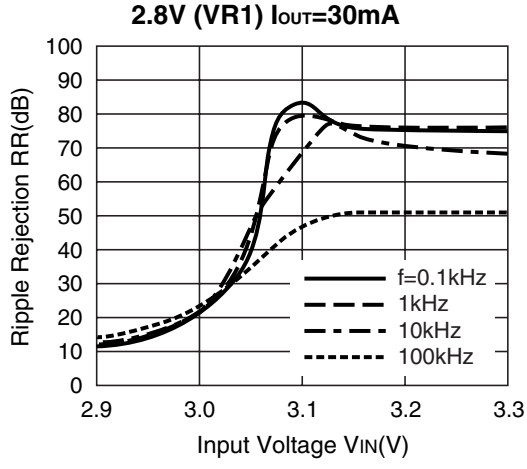


9) Ripple Rejection vs. DC Input Bias (Topt=25°C, C_{OUT}=1.0µF)

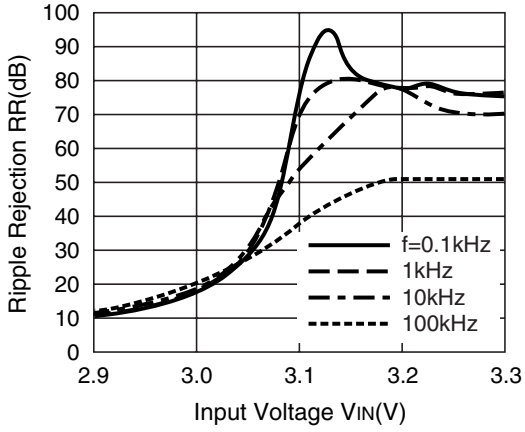
2.8V (VR1) I_{OUT}=1mA



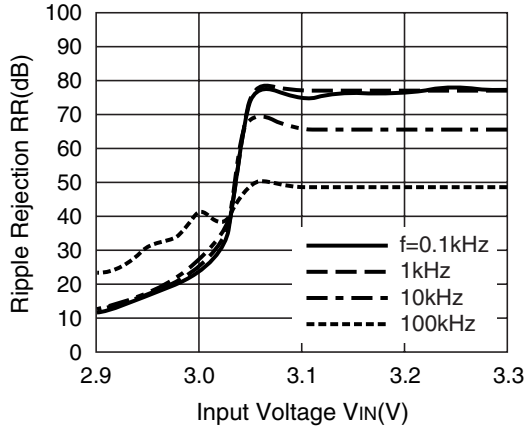
2.8V (VR1) I_{OUT}=30mA



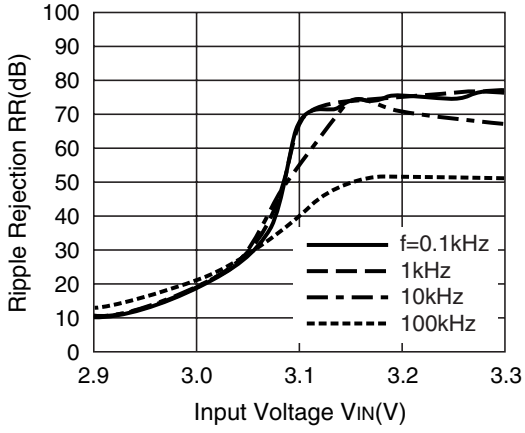
2.8V (VR1) I_{OUT}=50mA



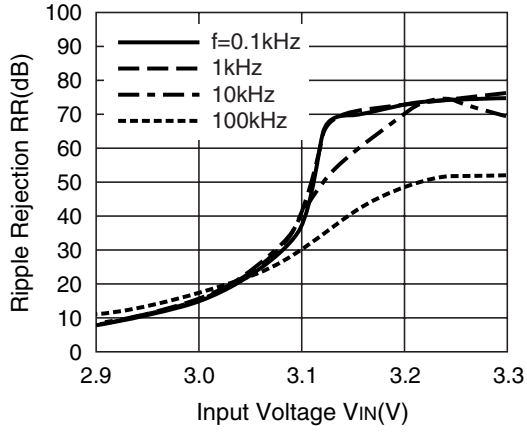
2.8V (VR2) I_{OUT}=1mA



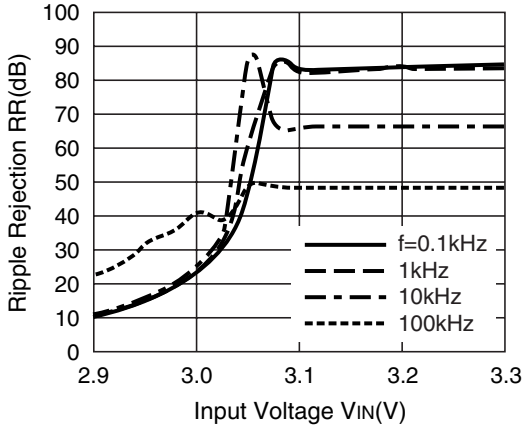
2.8V (VR2) I_{OUT}=30mA



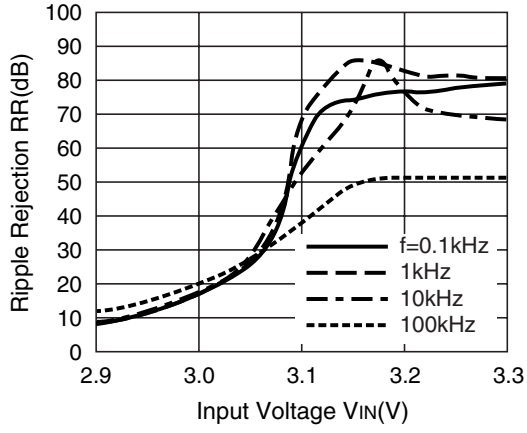
2.8V (VR2) I_{OUT}=50mA

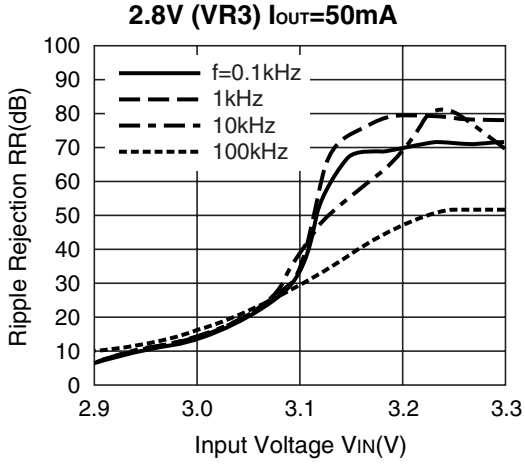


2.8V (VR3) I_{OUT}=1mA

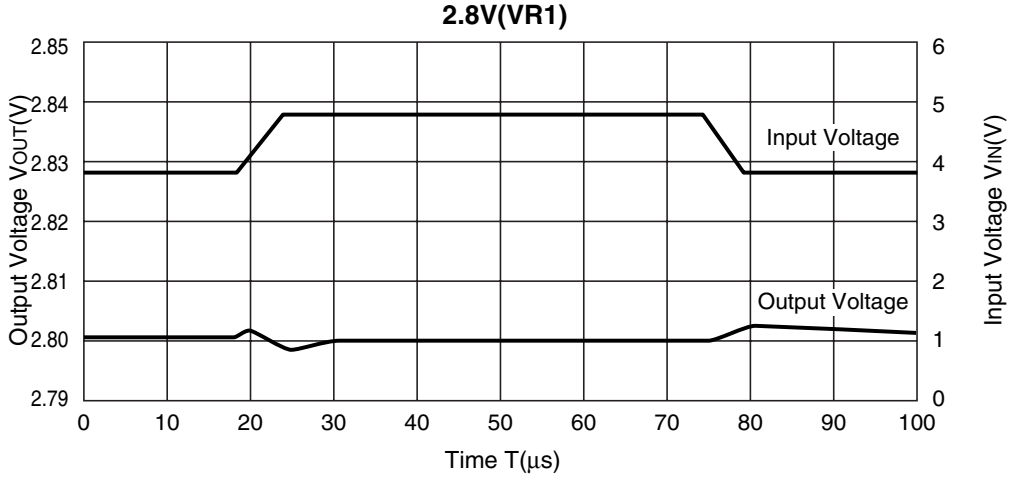


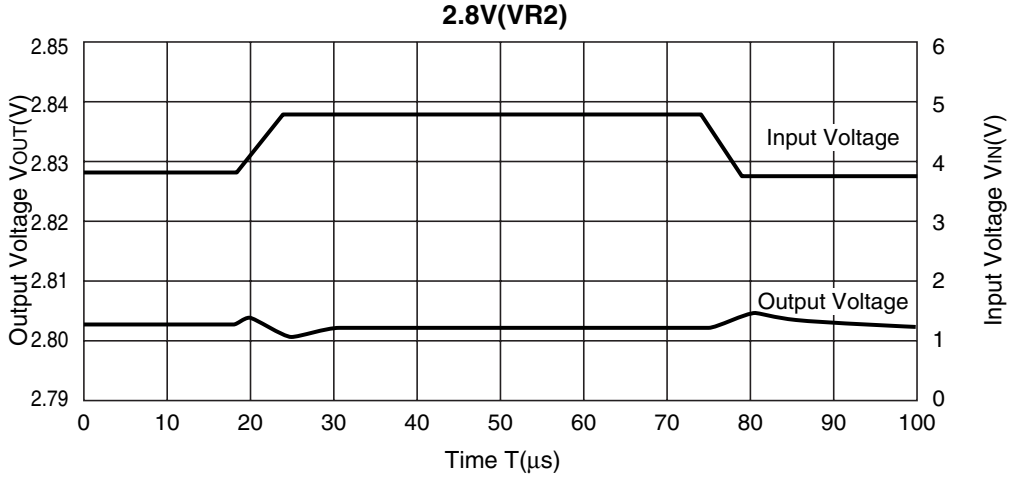
2.8V (VR3) I_{OUT}=30mA

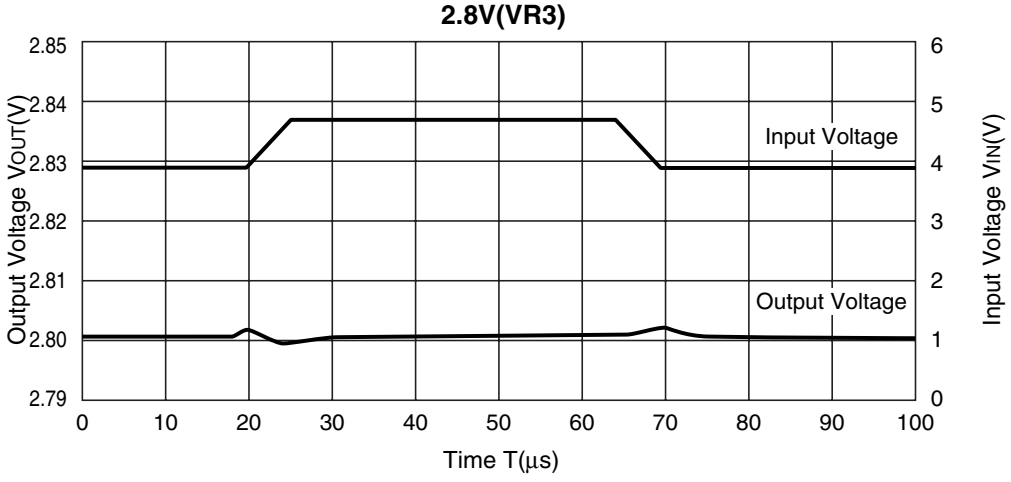




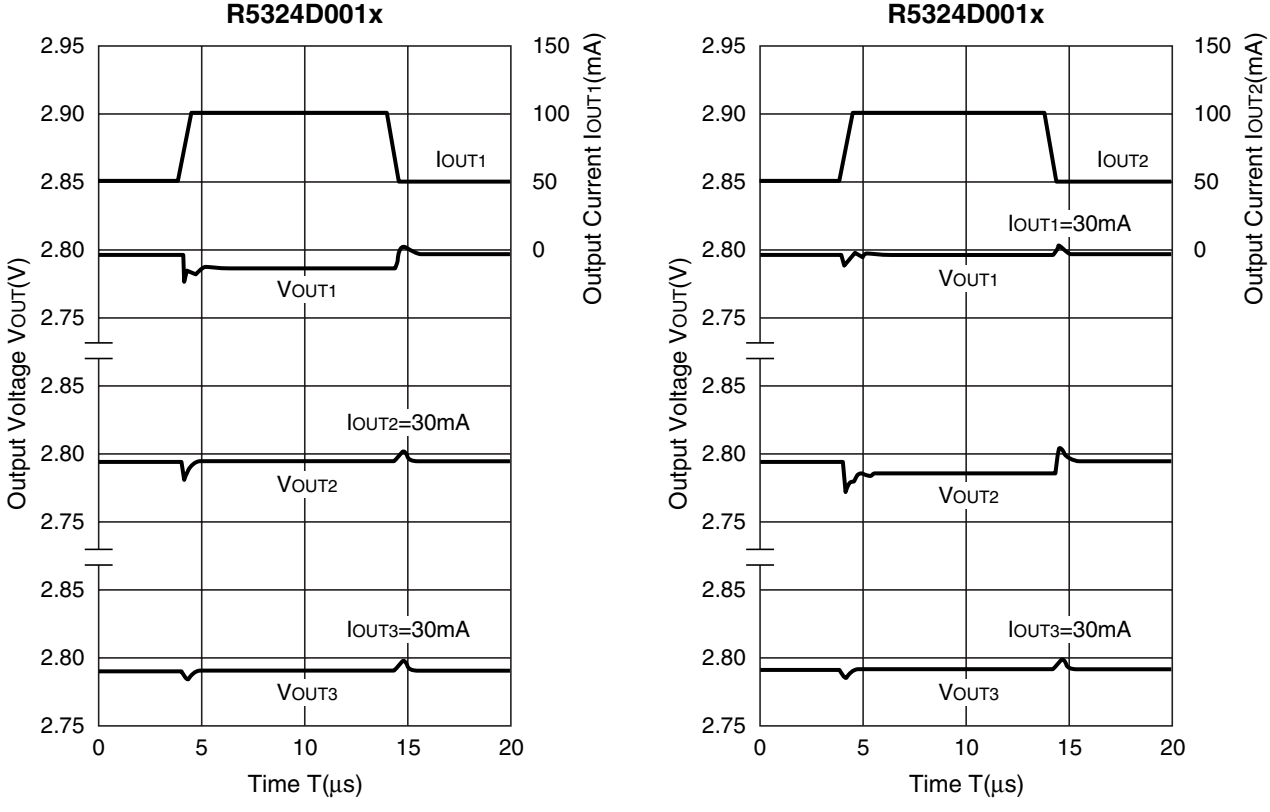
10) Line Transient Response (C_{IN}=none, I_{OUT}=30mA, tr=tf=5µs, C_{OUT}=Ceramic 1.0µF)

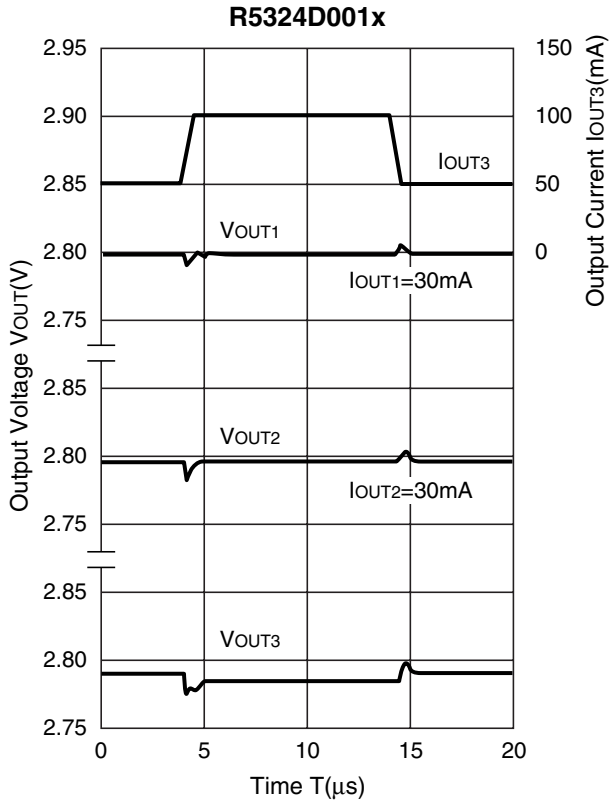






11) Load Transient Response (C_{IN}=Ceramic 1.0µF, C_{OUT}=Ceramic 1.0µF)

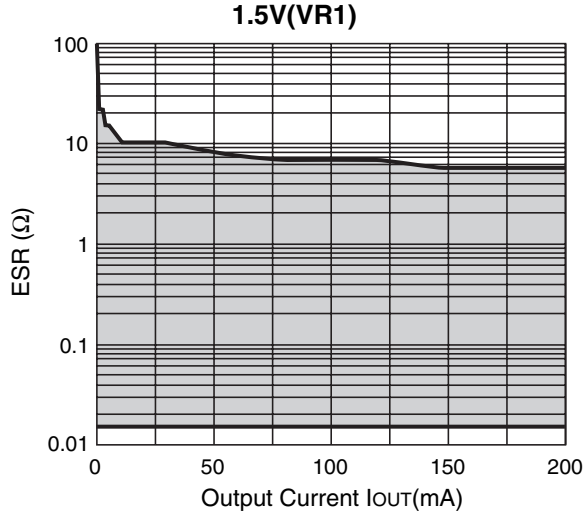


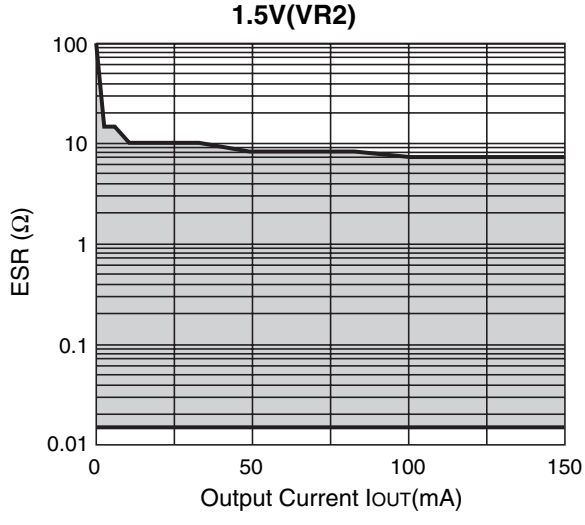


TECHNICAL NOTES

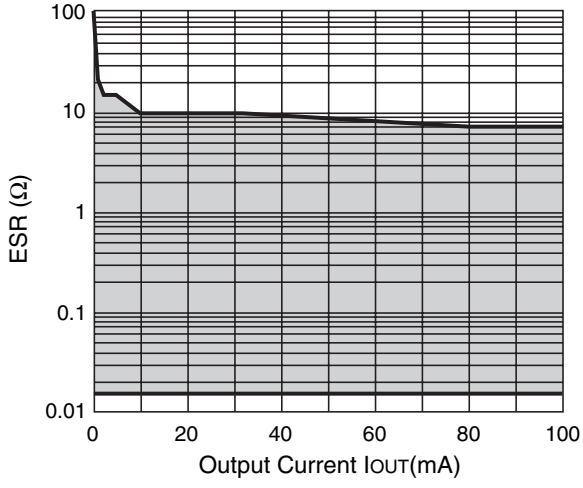
To use this IC, ESR of the output capacitors should be set in the range of the following graphs.

Noise level is measured with a spectrum analyzer and hatched area shows stable areas of which noise level is approximately equal or less than 40μV (Avg.). The relation between Load Current (I_{OUT}) and Equivalent Series Resistors (ESR) value of external output capacitor with the stable area is shown below;

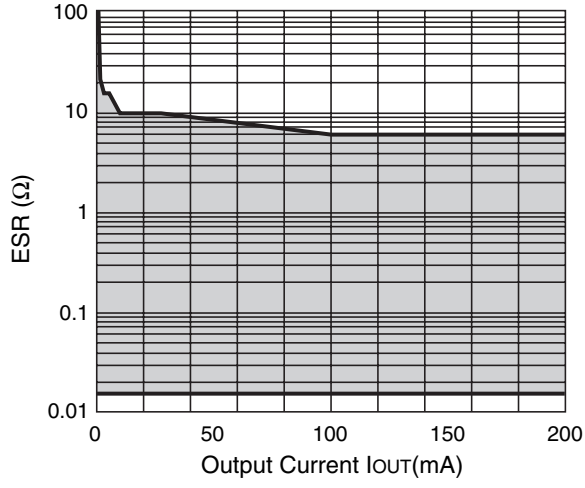




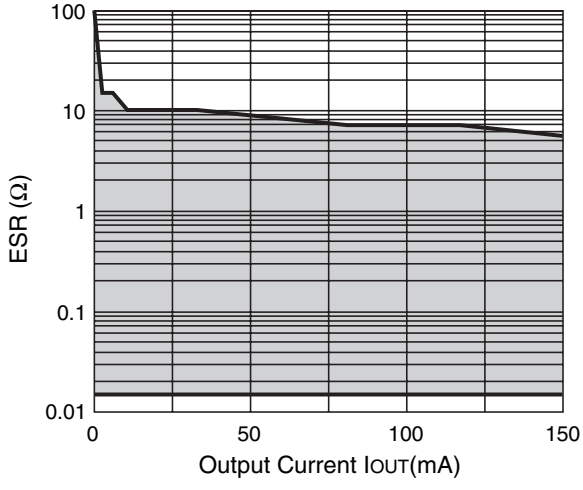
1.5V(VR3)



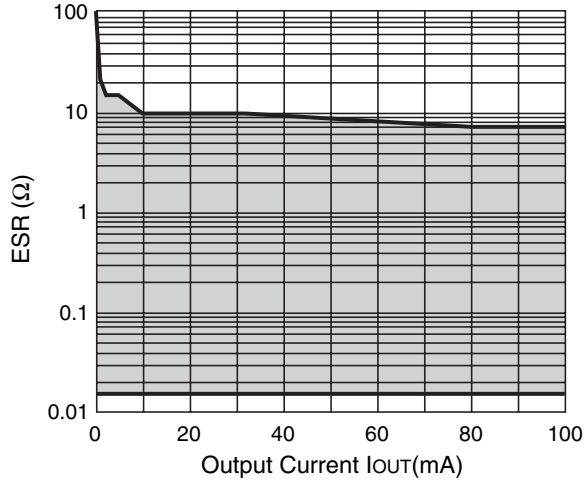
2.8V(VR1)



2.8V(VR2)



2.8V(VR3)



Measuring Conditions

Frequency Band : 10Hz to 2MHz

Temperature : -40°C to 85°C