

## LOW NOISE 150mA LDO REGULATOR

NO.EA-057-111018

### OUTLINE

The R1111N Series are CMOS-based voltage regulator ICs with high output voltage accuracy, extremely low supply current, low ON-resistance, and high Ripple Rejection. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, resistors, a current limit circuit, and a chip enable circuit.

These ICs perform with low dropout voltage and a chip enable function. The line transient response and load transient response of the R1111N 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 fixed with high accuracy. Since the package for these ICs is SOT-23-5 (Mini-mold) package, high density mounting of the ICs on boards is possible.

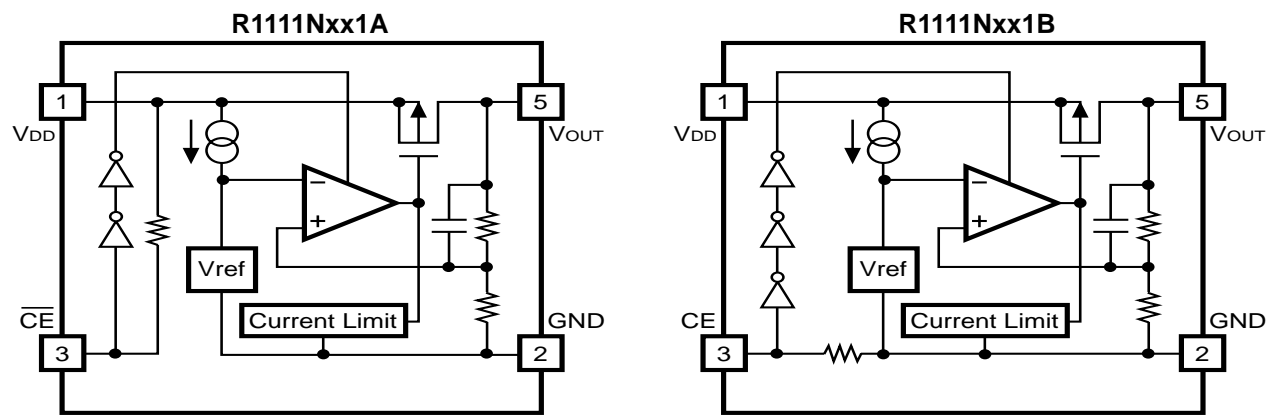
### FEATURES

- Supply Current ..... Typ. 35 $\mu$ A
- Standby Mode ..... Typ. 0.1 $\mu$ A
- Dropout Voltage ..... Typ. 0.2V ( $I_{OUT}=100mA$ )
- Ripple Rejection ..... Typ. 70dB( $f=1kHz$ )
- Output Voltage ..... 1.5V to 5.0V (0.1V steps)  
(For other voltages, please refer to MARK INFORMATION.)
- Output Voltage Accuracy .....  $\pm 2.0\%$
- Low Temperature-Drift Coefficient of Output Voltage.. Typ.  $\pm 100ppm/^{\circ}C$
- Line Regulation ..... Typ. 0.05%/V
- Package ..... SOT-23-5
- Built-in chip enable circuit (2 types; A: active "L", B: active "H")
- Built-in Fold Back Protection Circuit ..... Typ. 50mA (Current at short mode)
- Pin-out ..... Similar to the LP2980

### APPLICATIONS

- Power source for cellular phones such as GSM, CDMA and various kinds of PCSs.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAM



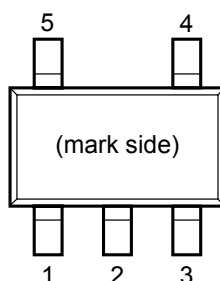
SELECTION GUIDE

The output voltage, the active type for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1111Nxx1*-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
xx: The output voltage can be designated in the range from 1.5V(15) to 5.0V(50) in 0.1V steps. (For other voltages, please refer to MARK INFORMATION.)				
* : Designation of Active Type (A) "L" active (B) "H" active				

## PIN CONFIGURATION

### • SOT-23-5



## PIN DESCRIPTION

### • SOT-23-5

Pin No	Symbol	Pin Description
1	$V_{DD}$	Input Pin
2	GND	Ground Pin
3	$\overline{CE}$ or CE	Chip Enable Pin
4	NC	No Connection
5	$V_{OUT}$	Output pin

## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
$V_{IN}$	Input Voltage	9.0	V
$V_{CE}$	Input Voltage( $\overline{CE}$ or CE Pin)	-0.3 ~ $V_{IN}+0.3$	V
$V_{OUT}$	Output Voltage	-0.3 ~ $V_{IN}+0.3$	V
$I_{OUT}$	Output Current	200	mA
$P_D$	Power Dissipation *	420	mW
$T_{opt}$	Operating Temperature Range	-40 ~ 85	°C
$T_{stg}$	Storage Temperature Range	-55 ~ 125	°C

\*) For Power Dissipation, please refer to PACKAGE INFORMATION.

### ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field.

The functional operation at or over these absolute maximum ratings is not assured.

## ELECTRICAL CHARACTERISTICS

## • R1111Nxx1A

T<sub>opt</sub>=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V 1mA ≤ I <sub>OUT</sub> ≤ 30mA	V <sub>OUT</sub> ×0.98		V <sub>OUT</sub> ×1.02	V
I <sub>OUT</sub>	Output Current	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub>	Load Regulation	V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V 1mA ≤ I <sub>OUT</sub> ≤ 80mA		12	40	mV
V <sub>DIF</sub>	Dropout Voltage	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V, I <sub>OUT</sub> = 0A		35	70	μA
I <sub>standby</sub>	Supply Current (Standby)	V <sub>IN</sub> = V <sub>CE</sub> = Set V <sub>OUT</sub> + 1V		0.1	1.0	μA
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line Regulation	Set V <sub>OUT</sub> +0.5V ≤ V <sub>IN</sub> ≤ 8.0V I <sub>OUT</sub> = 30mA		0.05	0.20	%/V
RR	Ripple Rejection	f = 1kHz, Ripple 0.5Vp-p V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V		70		dB
V <sub>IN</sub>	Input Voltage		2.0		8.0	V
ΔV <sub>OUT</sub> /ΔT <sub>opt</sub>	Output Voltage Temperature Coefficient	I <sub>OUT</sub> = 10mA −40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm/°C
I <sub>SC</sub>	Short Current Limit	V <sub>OUT</sub> = 0V		50		mA
R <sub>PU</sub>	$\overline{\text{CE}}$ Pull-up Resistance		2.5	5.0	10.0	MΩ
V <sub>CEH</sub>	$\overline{\text{CE}}$ Input Voltage "H"		1.5		V <sub>IN</sub>	V
V <sub>CEL</sub>	$\overline{\text{CE}}$ Input Voltage "L"		0		0.25	V
en	Output Noise	BW=10Hz to 100kHz		30		μVrms

## 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.

## • R1111Nxx1B

T<sub>opt</sub>=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V 1mA ≤ I <sub>OUT</sub> ≤ 30mA	V <sub>OUT</sub> ×0.98		V <sub>OUT</sub> ×1.02	V
I <sub>OUT</sub>	Output Current	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub>	Load Regulation	V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V 1mA ≤ I <sub>OUT</sub> ≤ 80mA		12	40	mV
V <sub>DIF</sub>	Dropout Voltage	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V		35	70	μA
I <sub>standby</sub>	Supply Current (Standby)	V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V V <sub>CE</sub> = GND		0.1	1.0	μA
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line Regulation	Set V <sub>OUT</sub> + 0.5V ≤ V <sub>IN</sub> ≤ 8.0V I <sub>OUT</sub> = 30mA		0.05	0.20	%/V
RR	Ripple Rejection	f = 1KHz, Ripple 0.5Vp-p V <sub>IN</sub> = Set V <sub>OUT</sub> + 1V		70		dB
V <sub>IN</sub>	Input Voltage		2.0		8.0	V
ΔV <sub>OUT</sub> /ΔT <sub>opt</sub>	Output Voltage Temperature Coefficient	I <sub>OUT</sub> = 10mA -40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm/°C
I <sub>SC</sub>	Short Current Limit	V <sub>OUT</sub> = 0V		50		mA
R <sub>PD</sub>	CE Pull-up Resistance		2.5	5.0	10.0	MΩ
V <sub>CEH</sub>	CE Input Voltage "H"		1.5		V <sub>IN</sub>	V
V <sub>CEL</sub>	CE Input Voltage "L"		0		0.25	V
en	Output Noise	BW=10Hz to 100kHz		30		μVrms

## 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 by OUTPUT VOLTAGE

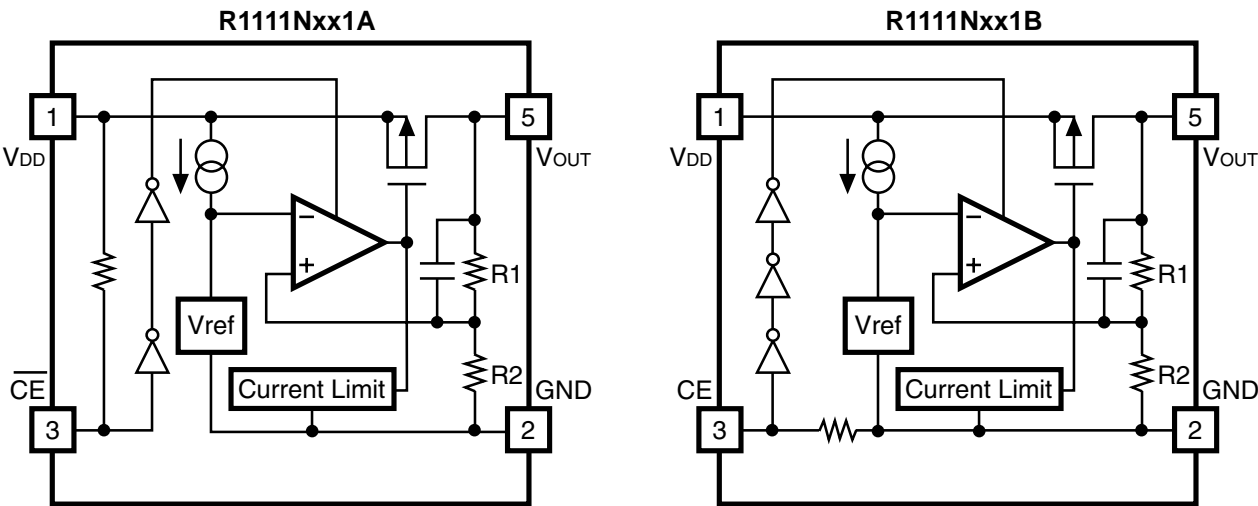
T<sub>opt</sub> = 25°C

Output Voltage V <sub>OUT</sub> (V)	Output Current	
	I <sub>OUT</sub> (mA)	
	Condition	Min.
1.5 ≤ V <sub>OUT</sub> ≤ 1.7	V <sub>IN</sub> - V <sub>OUT</sub> = 1.0V	100
1.8 ≤ V <sub>OUT</sub> ≤ 5.0		150

T<sub>opt</sub> = 25°C

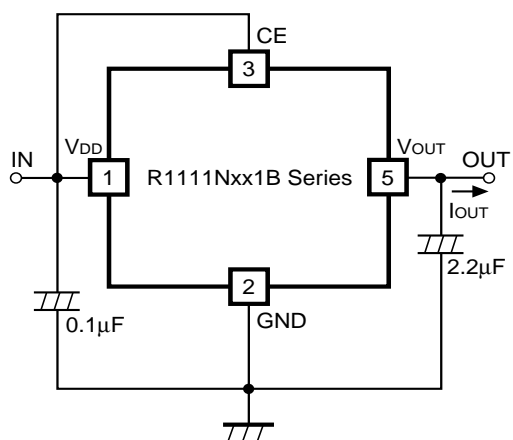
Output Voltage V <sub>OUT</sub> (V)	Dropout Voltage			
	V <sub>DIF</sub> (V)			
	Condition	Min.	Typ.	Max.
1.5	I <sub>OUT</sub> = 100mA	0.5		
1.6		0.4		
1.7		0.3		
1.8 ≤ V <sub>OUT</sub> ≤ 1.9			0.60	1.40
2.0 ≤ V <sub>OUT</sub> ≤ 2.4			0.35	0.70
2.5 ≤ V <sub>OUT</sub> ≤ 2.7			0.24	0.35
2.8 ≤ V <sub>OUT</sub> ≤ 3.3			0.20	0.30
3.4 ≤ V <sub>OUT</sub> ≤ 5.0			0.17	0.26

OPERATION

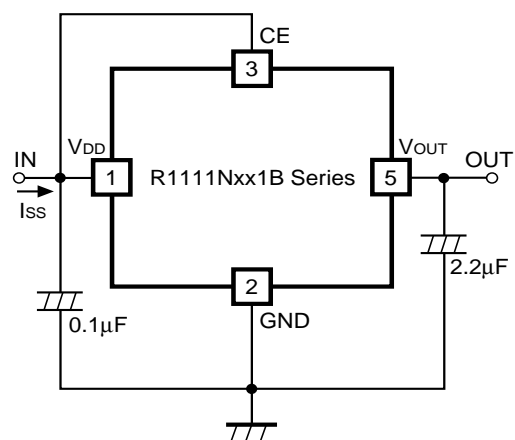


In these ICs, fluctuation of output voltage, V<sub>OUT</sub> is detected by feed-back registers R1, R2, and the result is compared with a reference voltage by the error amplifier, so that a constant voltage is output. A current limit circuit for protection at short mode and a chip enable circuit, are included.

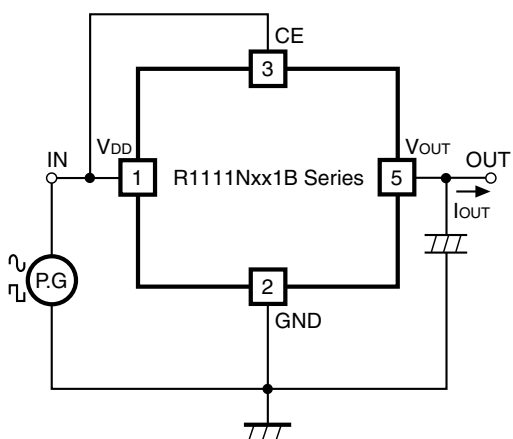
## TEST CIRCUITS



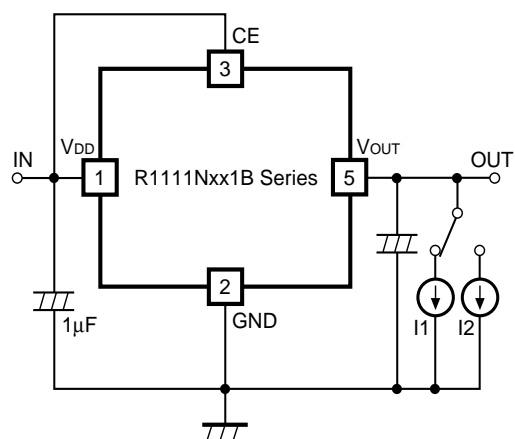
**Fig.1 Standard test Circuit**



**Fig.2 Supply Current Test Circuit**



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

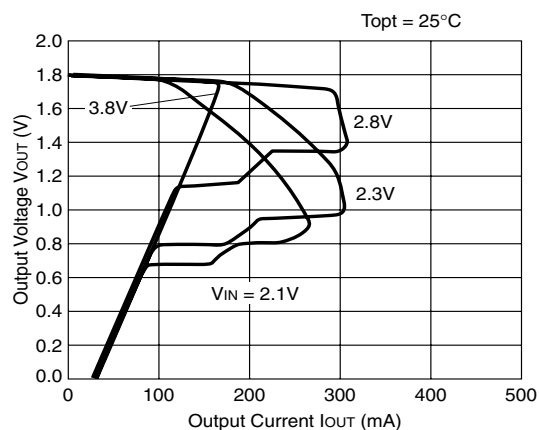


**Fig.4 Load Transient Response Test Circuit**

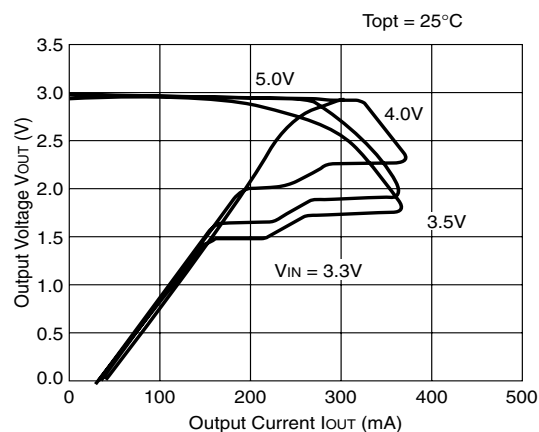
## TYPICAL CHARACTERISTICS

### 1) Output Voltage vs. Output Current

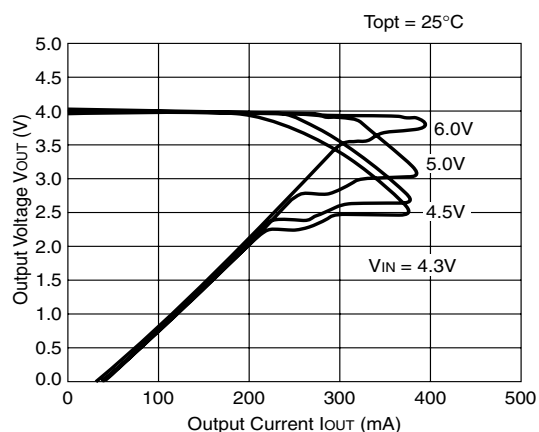
R1111N181B



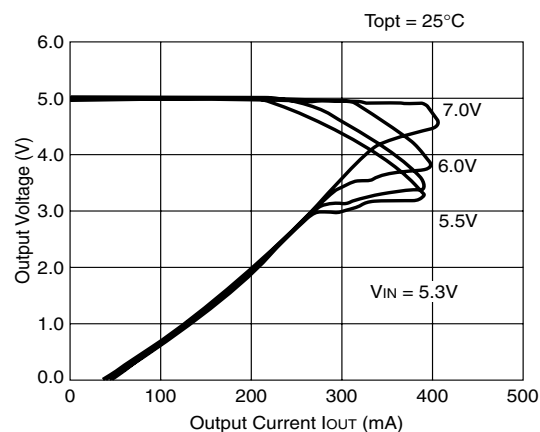
R1111N301B



R1111N401B

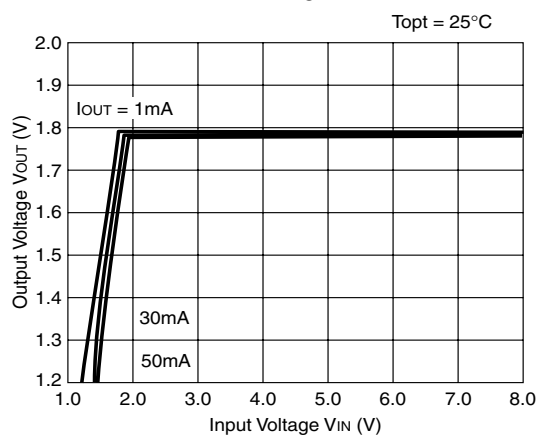


R1111N501B

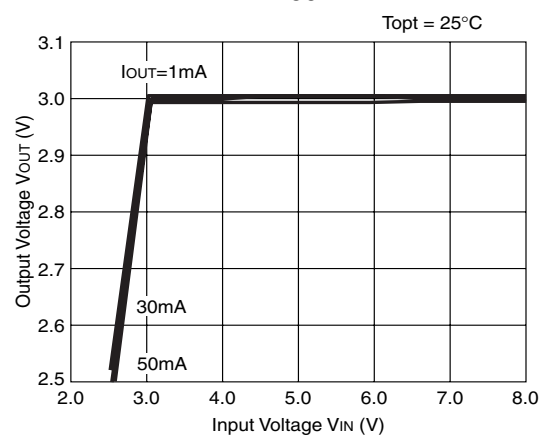


### 2) Output Voltage vs. Input Voltage

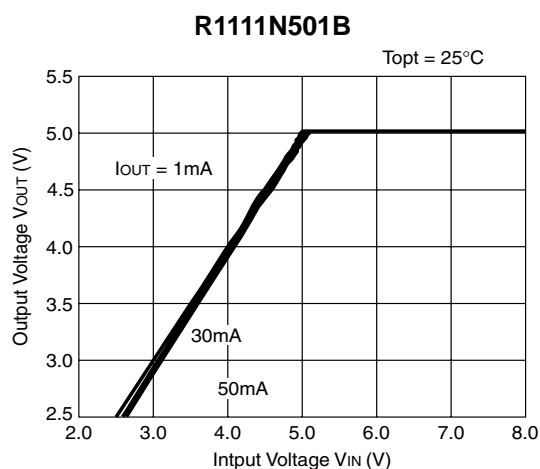
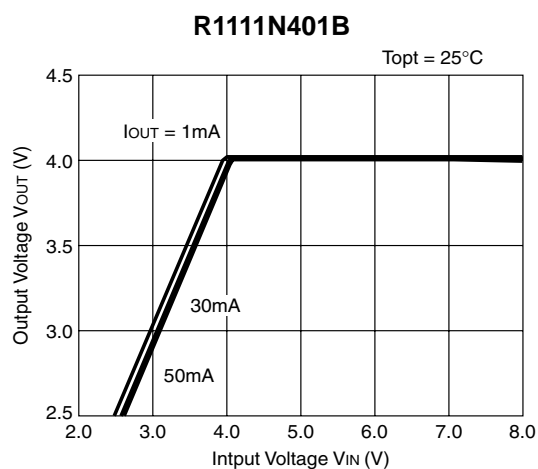
R1111N181B



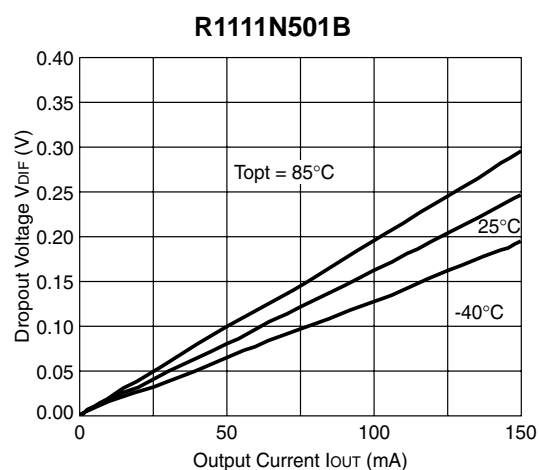
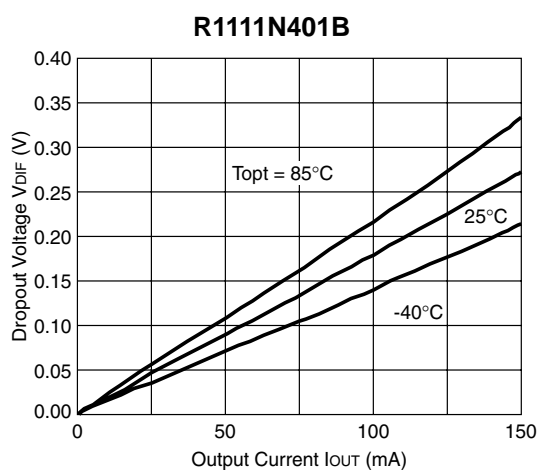
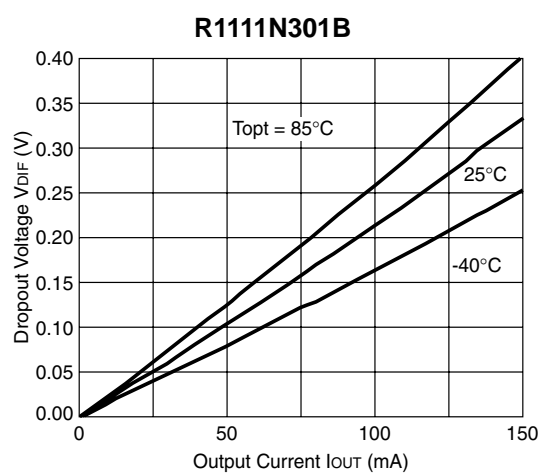
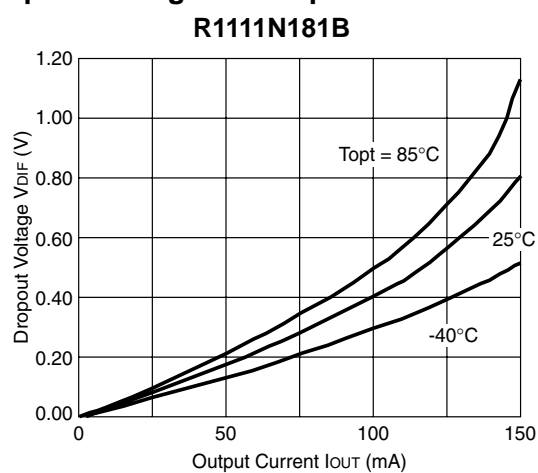
R1111N301B





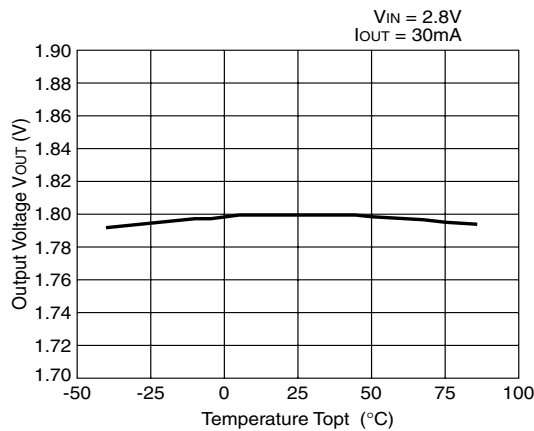


### 3) Dropout Voltage vs. Output Current

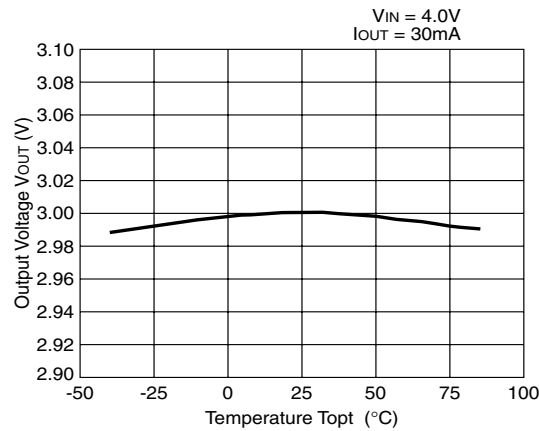


4) Output Voltage vs. Temperature

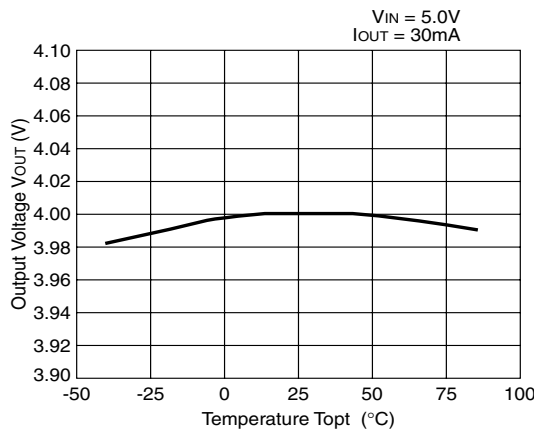
R1111N181B



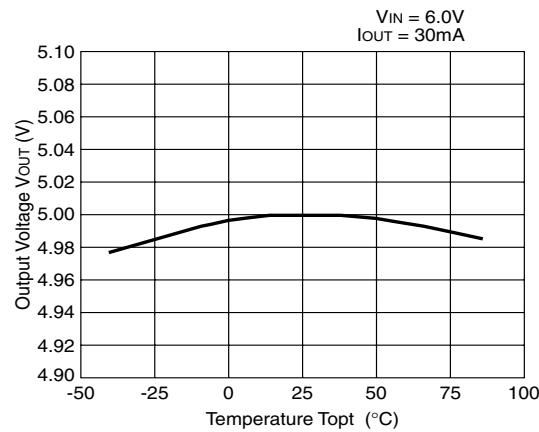
R1111N301B



R1111N401B

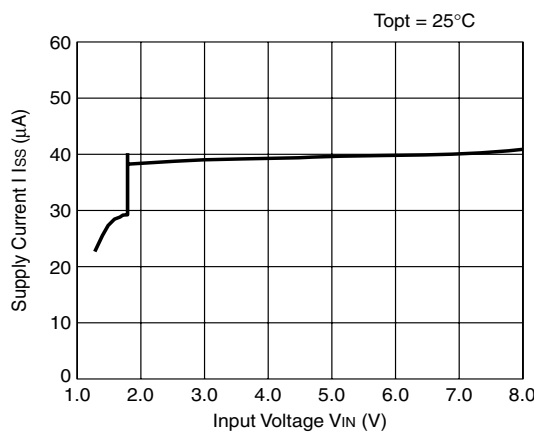


R1111N501B

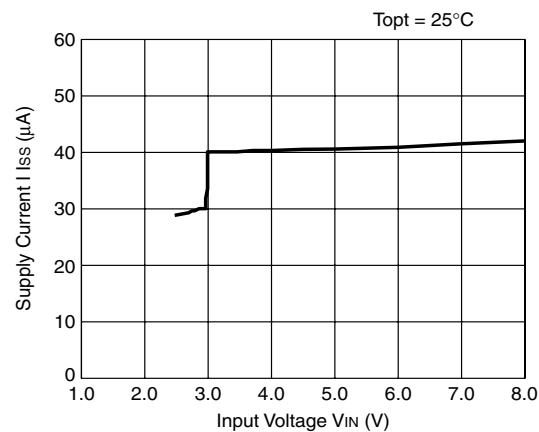


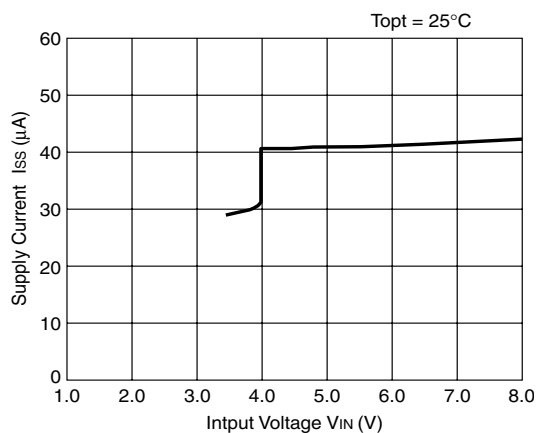
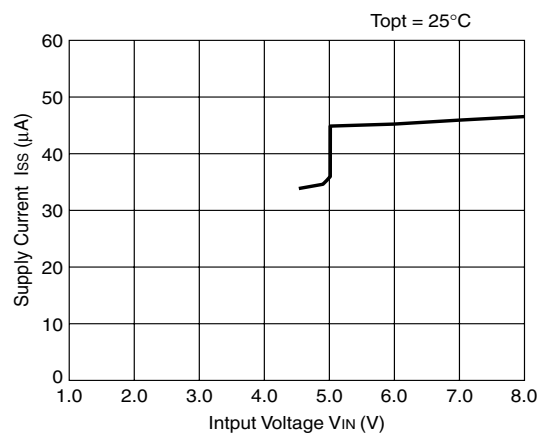
5) Supply Current vs. Input Voltage

R1111N181B

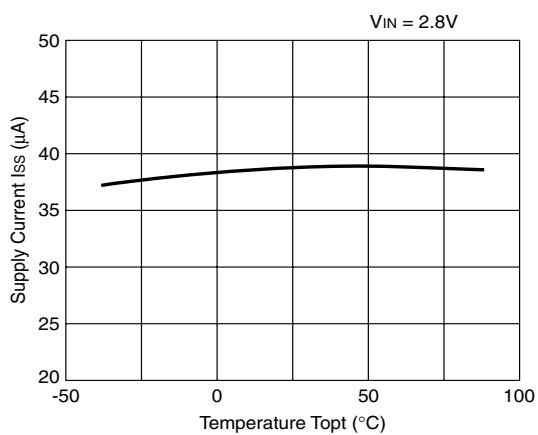
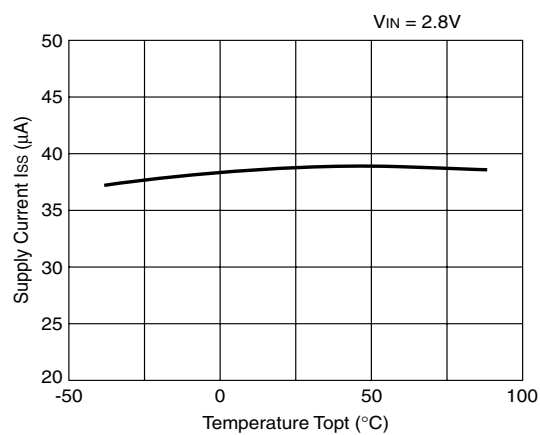
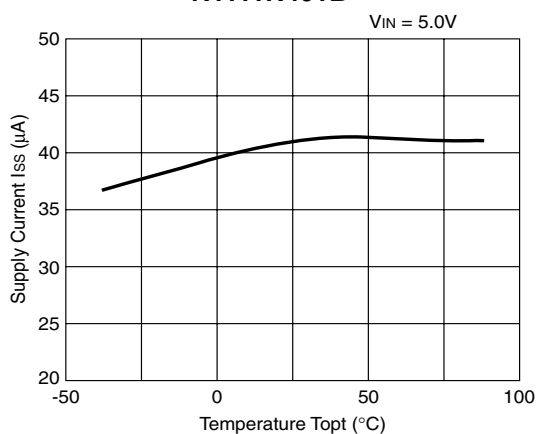
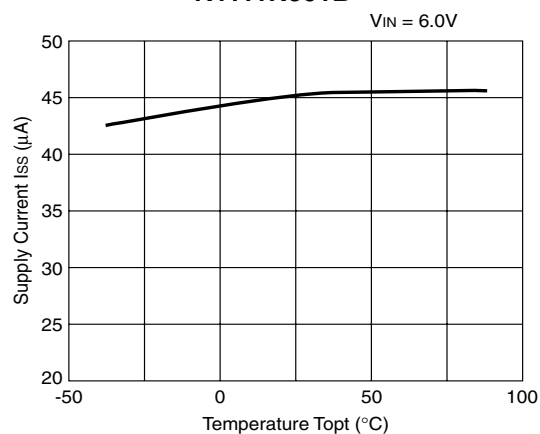


R1111N301B

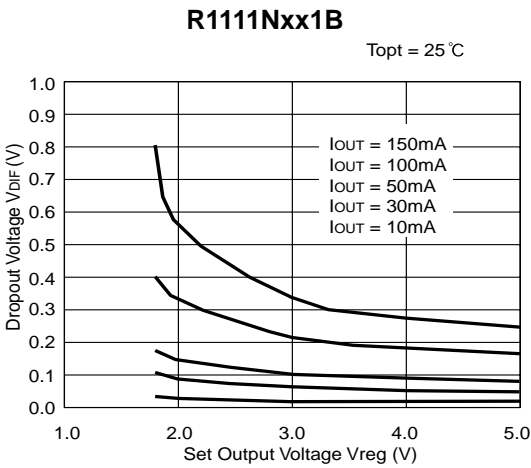


**R1111N401B****R1111N501B**

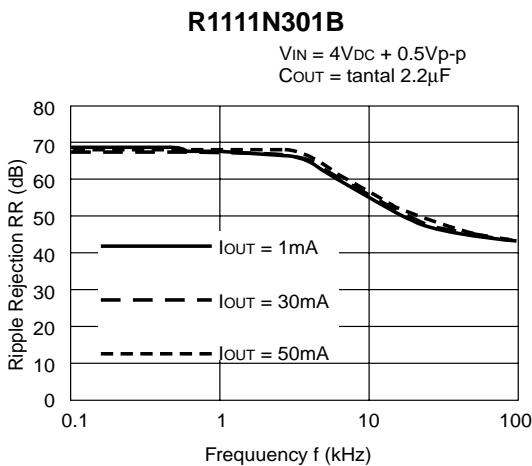
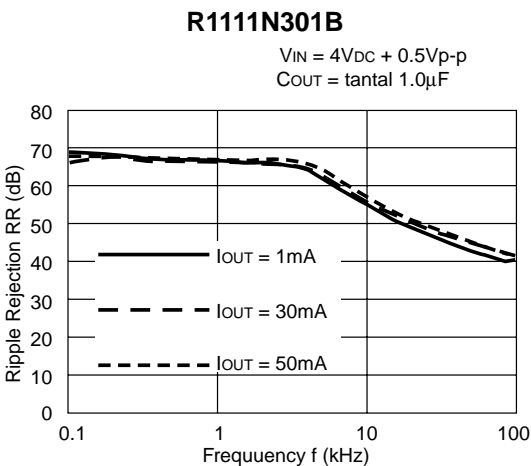
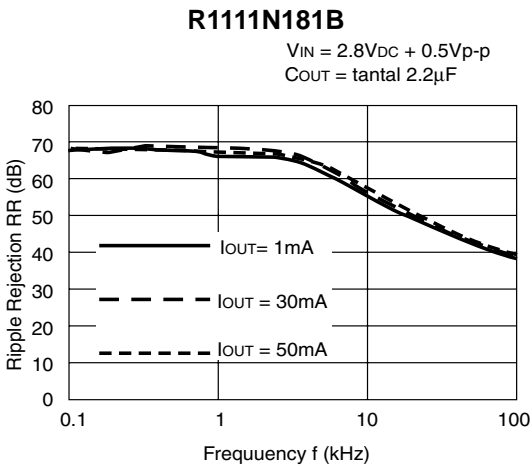
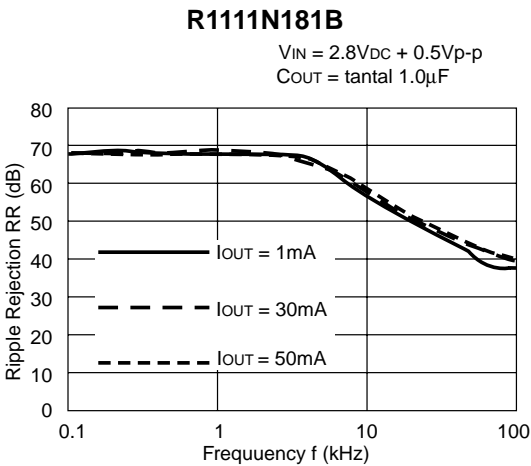
## 6) Supply Current vs. Temperature

**R1111N181B****R1111N301B****R1111N401B****R1111N501B**

7) Dropout Voltage vs. Set Output Voltage

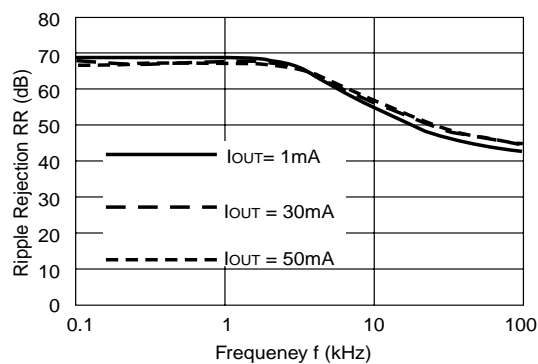


8) Ripple Rejection vs. Frequency

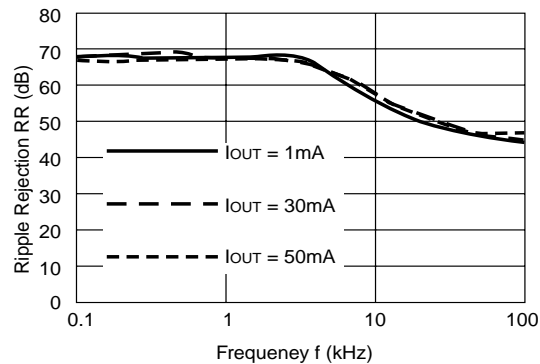


**R1111N401B**

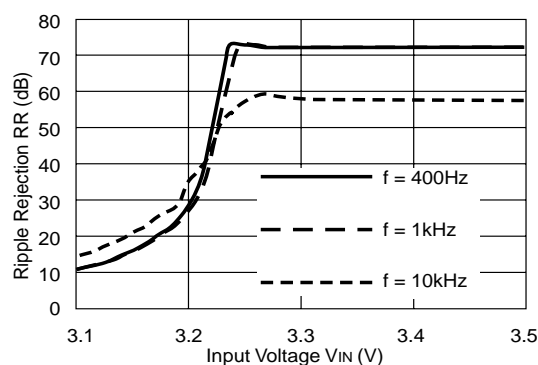
$V_{IN} = 5.0V_{DC} + 0.5V_{p-p}$   
 $C_{OUT} = \text{tantal } 1.0\mu F$

**R1111N401B**

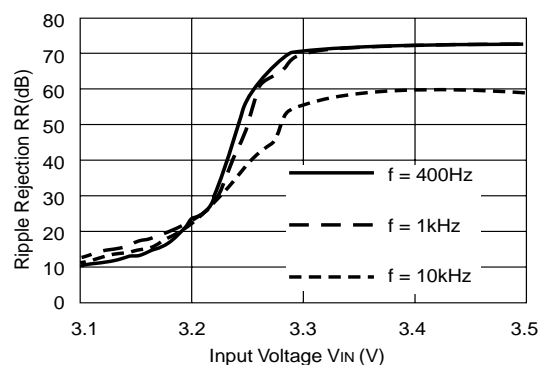
$V_{IN} = 5.0V_{DC} + 0.5V_{p-p}$   
 $C_{OUT} = \text{tantal } 2.2\mu F$

**9) Ripple Rejection vs. Input Voltage (DC bias)****R1111N301B**

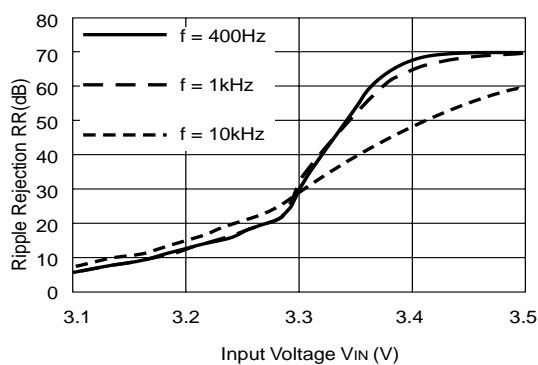
$I_{OUT} = 1mA$   
 $C_{OUT} = 2.2\mu F$

**R1111N301B**

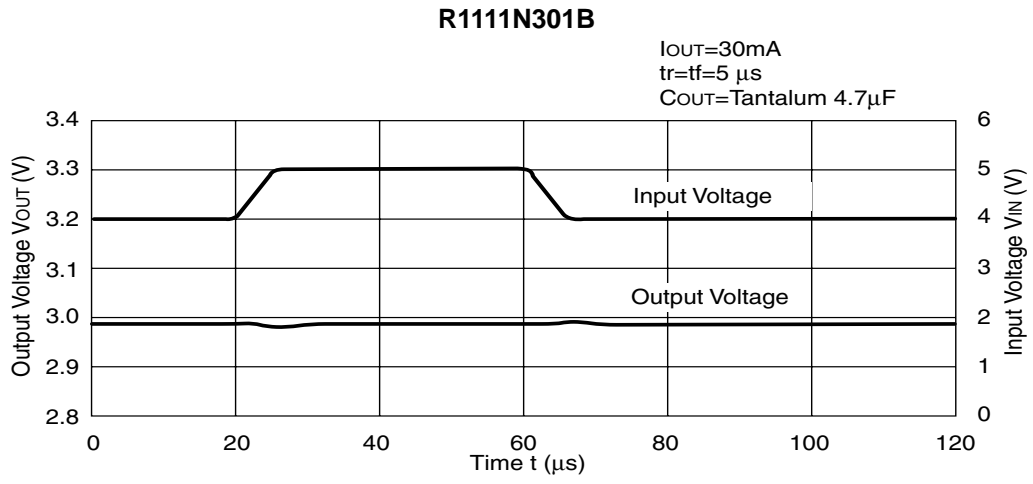
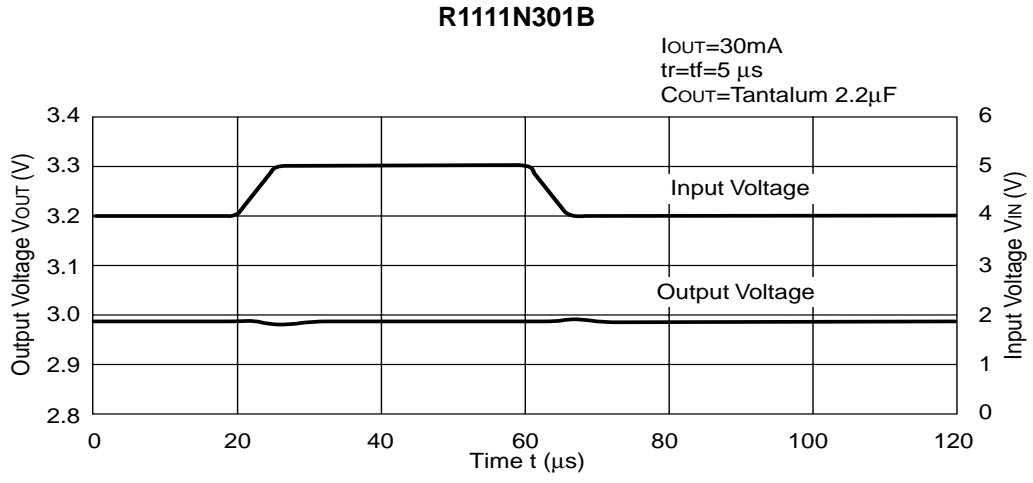
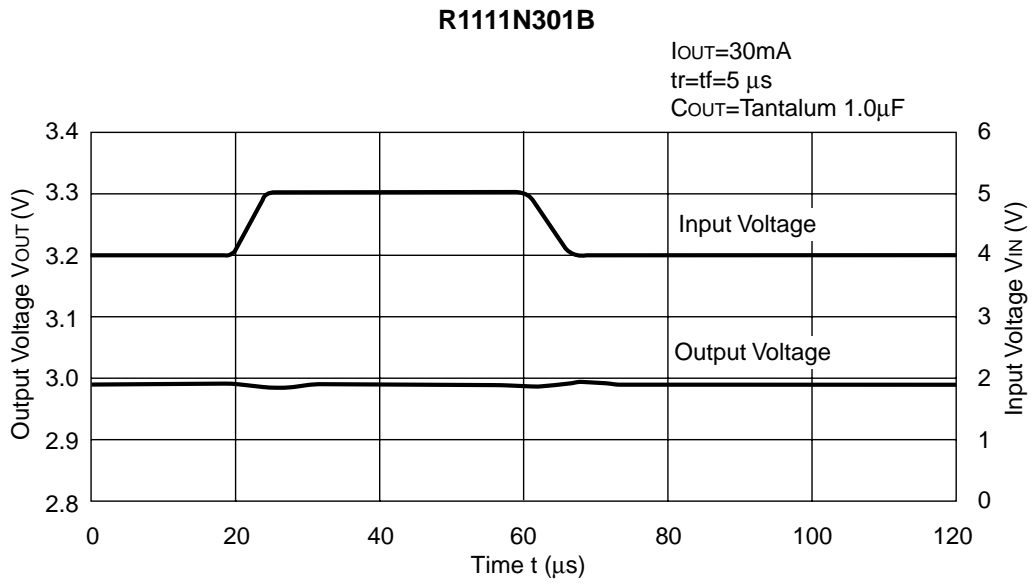
$I_{OUT} = 10mA$   
 $C_{OUT} = 2.2\mu F$

**R1111N301B**

$I_{OUT} = 50mA$   
 $C_{OUT} = 2.2\mu F$



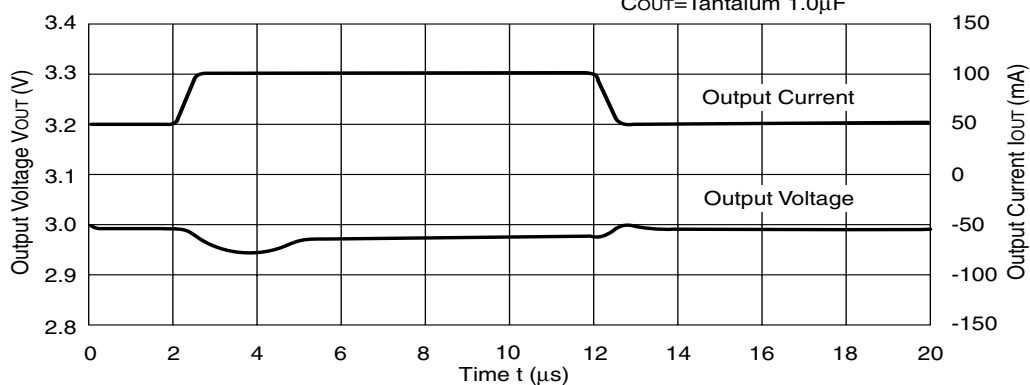
10) Input Transient Response



## 11) Load Transient Response

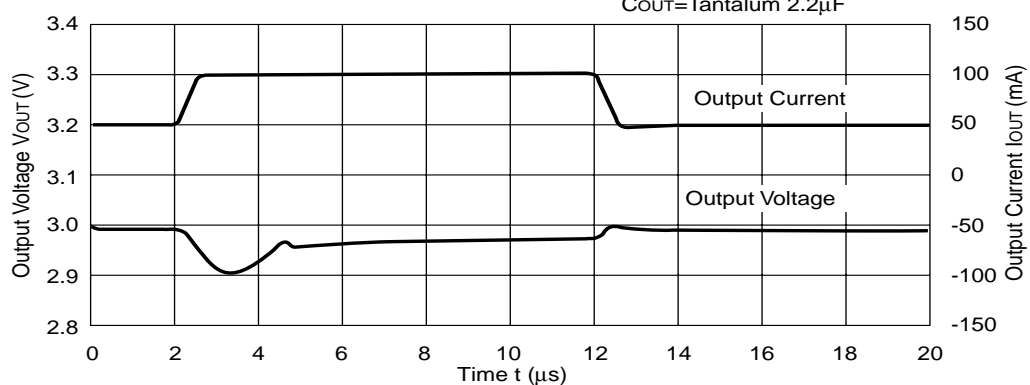
R1111N301B

$V_{IN}=4V$   
 $C_{IN}=\text{Tantalum } 1\mu F$   
 $C_{OUT}=\text{Tantalum } 1.0\mu F$



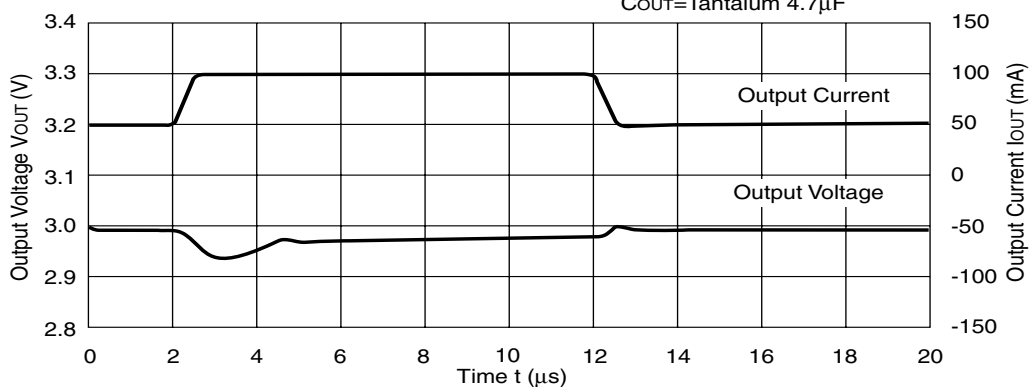
R1111N301B

$V_{IN}=4V$   
 $C_{IN}=\text{Tantalum } 1\mu F$   
 $C_{OUT}=\text{Tantalum } 2.2\mu F$



R1111N301B

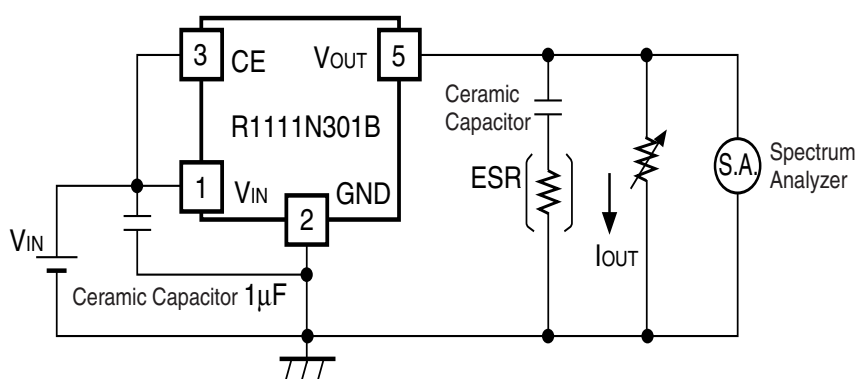
$V_{IN}=4V$   
 $C_{IN}=\text{Tantalum } 1\mu F$   
 $C_{OUT}=\text{Tantalum } 4.7\mu F$



## TECHNICAL NOTES

When using these ICs, consider the following points:

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, be sure to use a capacitor  $C_{OUT}$  with good frequency characteristics and ESR (Equivalent Series Resistance) of which is in the range described as follows:



**Measuring Circuit for white noise; R1111N301B**

The relationship between  $I_{OUT}$  (output current) and ESR of output capacitor is shown in the graphs below. The conditions when the white noise level is under 40mV (Avg.) are indicated by the hatched area in the graph.

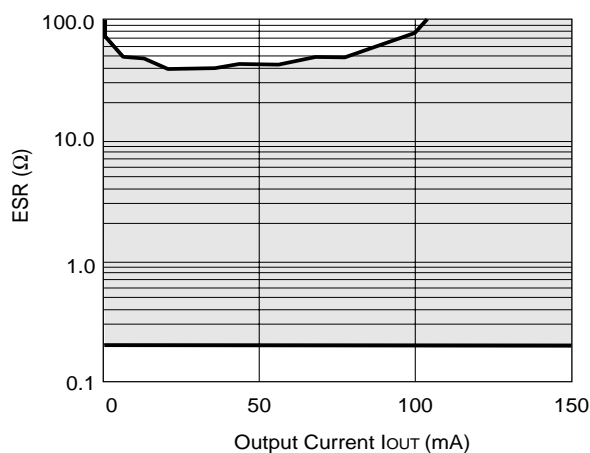
(note: When the additional ceramic capacitors are connected to the output pin with output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as the same external components as the ones to be used on the PCB.)

<Measurement conditions>

- (1)  $V_{IN}=4V$
- (2) Frequency Band: 10Hz to 1MHz
- (3) Temperature: 25°C

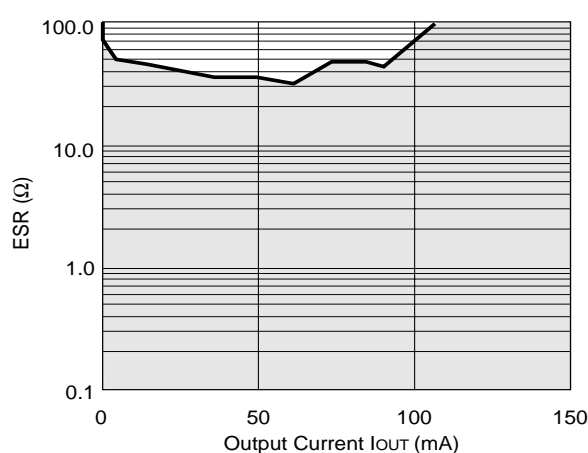
**R1111N301B**

Ceramic 1.0μF



**R1111N301B**

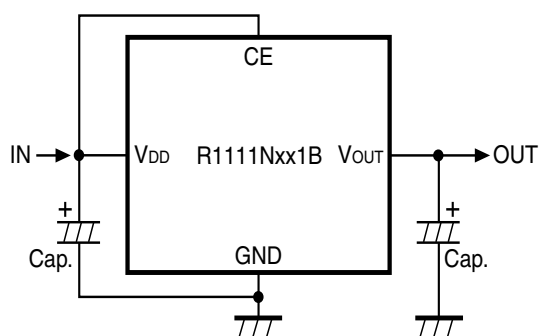
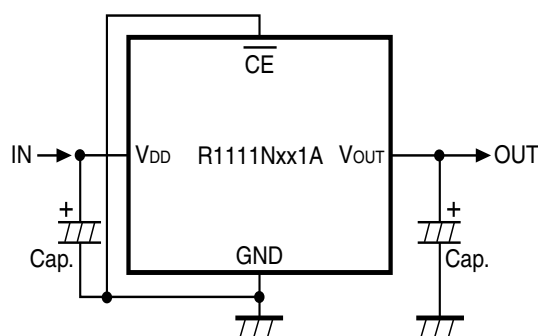
Ceramic 2.2μF





- Make  $V_{DD}$  and GND lines sufficient. If their impedance is high, noise pick up or incorrect operation may result.
- Connect the capacitor with a capacitance of  $1\mu\text{F}$  or more between  $V_{DD}$  and GND as close as possible.
- Set external components, especially the output capacitor, as close as possible to the ICs and make wiring as short as possible.

## TYPICAL APPLICATION





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.



■ 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.

<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



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.