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## LOW NOISE 150mA LDO REGULATOR

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NO.EA-101-120404

### OUTLINE

The R1113Z 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 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 R1113Z 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 WL-CSP4-P1 (Wafer Level CSP), high density mounting of the ICs on boards is possible.

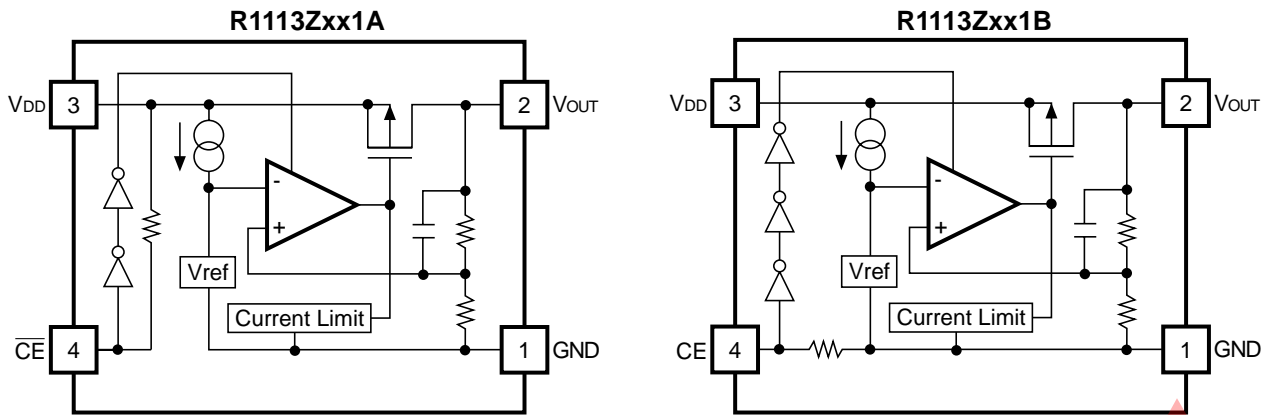
### FEATURES

- Ultra-Low Supply Current..... Typ. 100 $\mu$ A
- Standby Mode ..... Typ. 0.1 $\mu$ A
- Low Dropout Voltage..... Typ. 0.23V ( $I_{OUT}=100\text{mA}$  3.0V Output type)
- High Ripple Rejection ..... Typ. 80dB( $f=1\text{kHz}$  3.0V Output type)
- Low Temperature-Drift Coefficient of Output Voltage..... Typ.  $\pm 100\text{ppm}/^{\circ}\text{C}$
- Excellent Line Regulation ..... Typ. 0.05%/V
- High Output Voltage Accuracy .....  $\pm 2.0\%$
- Excellent Dynamic Response
- Small Package ..... WL-CSP4-P1 (Wafer Level CSP)
- Output Voltage ..... Stepwise setting with a step of 0.1V in the range of 1.5V to 5.0V is possible
- Built-in Chip Enable Circuit (2 types; A: active low, B: active high)
- Built-in Fold Back Protection Circuit ..... Typ. 30mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC

### APPLICATIONS

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

## BLOCK DIAGRAM



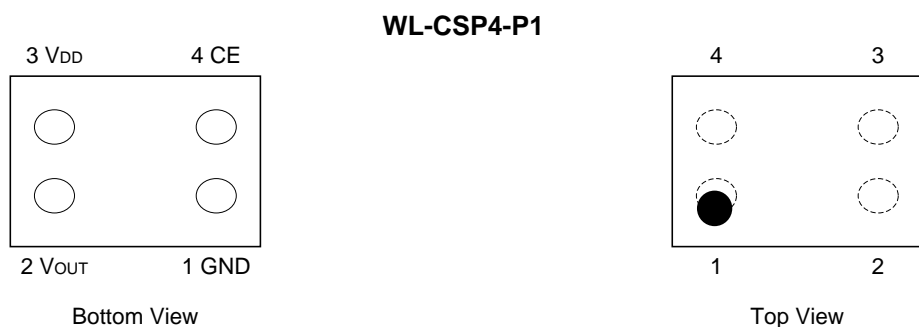
## SELECTION GUIDE

The output voltage, the active type, the packing type, and the taping type for the ICs can be selected at the user's request. The selection can be made with designating the part number as shown below;

R1113xxx1x-xx ←Part Number  
 ↑↑ ↑↑  
 a b c d

Code	Contents
a	Designation of Package Type : Z:WL-CSP4-P1 (Wafer Level CSP)
b	Setting Output Voltage ( $V_{out}$ ) : Stepwise setting with a step of 0.1V in the range of 1.5V to 5.0V is possible.
c	Designation of Active Type : A : active low type B : active high type
d	Designation of Taping Type : Ex. TR, TL (refer to Taping Specifications; TR type is the standard direction.)

## PIN CONFIGURATION



## PIN DESCRIPTION

Pin No	Symbol	Description
1	GND	Ground Pin
2	V <sub>OUT</sub>	Output pin
3	V <sub>DD</sub>	Input Pin
4	$\overline{\text{CE}}$ or CE	Chip Enable Pin

## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V <sub>IN</sub>	Input Voltage	7.0	V
V <sub>CE</sub>	Input Voltage( $\overline{\text{CE}}$ or CE Pin)	-0.3 ~ V <sub>IN</sub> +0.3	V
V <sub>OUT</sub>	Output Voltage	-0.3 ~ V <sub>IN</sub> +0.3	V
I <sub>OUT</sub>	Output Current	200	mA
P <sub>D</sub>	Power Dissipation	190	mW
T <sub>opt</sub>	Operating Temperature Range	-40 ~ 85	°C
T <sub>stg</sub>	Storage Temperature Range	-55 ~ 125	°C

## Power Dissipation

Typical Characteristics

### \*Measurement Conditions

Mounted on board (Wind velocity=0m/s)

Board Material: FR-4 (Double-layer)

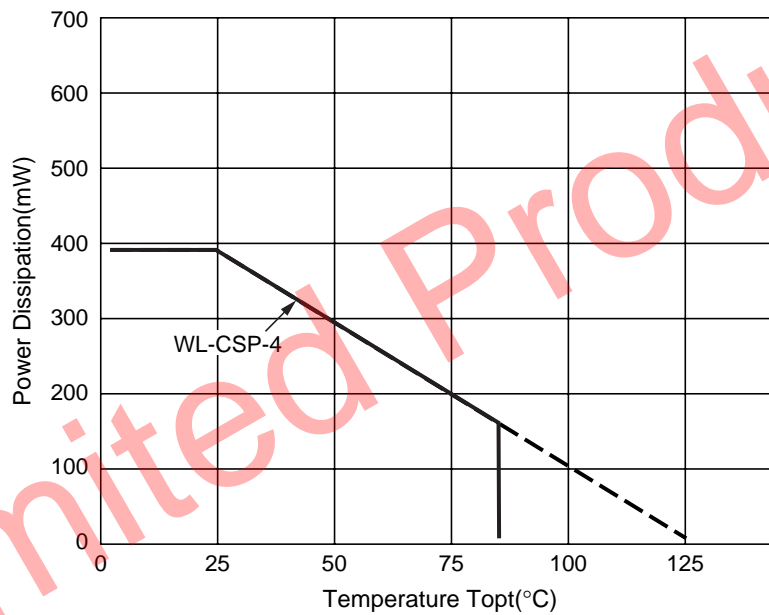
Board Size: 40mm×40mm×1.6mm

Wiring area ratio against the board: 50%

### \*Result

Power dissipation 465mW

Thermal Resistance 215°C/W



## ELECTRICAL CHARACTERISTICS

### • R1113Zxx1A

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	V <sub>IN</sub> - V <sub>OUT</sub> = 1.0V	150			mA
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		20	45	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		100	170	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> ≤ 6V I <sub>OUT</sub> = 30mA		0.05	0.20	%/V
RR	Ripple Rejection	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
V <sub>IN</sub>	Input Voltage		2.0		6.0	V
ΔV <sub>OUT</sub> /ΔT	Output Voltage Temperature Coefficient	I <sub>OUT</sub> = 30mA -40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm/°C
I <sub>LIM</sub>	Short Current Limit	V <sub>OUT</sub> = 0V		30		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"		0.00		0.25	V
e <sub>n</sub>	Output Noise	BW=10Hz to 100kHz		30		μVrms

### • R1113Zxx1B

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	V <sub>IN</sub> - V <sub>OUT</sub> = 1.0V	150			mA
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		20	45	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		100	170	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> ≤ 6V I <sub>OUT</sub> = 30mA		0.05	0.20	%/V
RR	Ripple Rejection	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
V <sub>IN</sub>	Input Voltage		2.0		6.0	V
ΔV <sub>OUT</sub> /ΔT	Output Voltage Temperature Coefficient	I <sub>OUT</sub> = 30mA -40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm/°C
I <sub>LIM</sub>	Short Current Limit	V <sub>OUT</sub> = 0V		30		mA
R <sub>PU</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"		0.00		0.25	V
e <sub>n</sub>	Output Noise	BW=10Hz to 100kHz		30		μVrms

## ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE

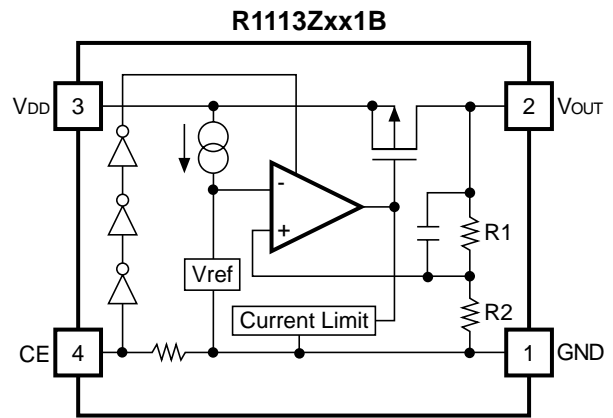
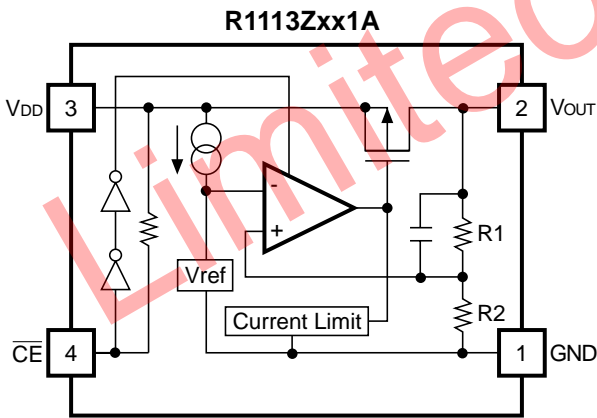
Topt = 25°C

Output Voltage $V_{OUT}$ (V)	Dropout Voltage		
	$V_{DIF}$ (V)		
	Condition	Typ.	Max.
1.5	$I_{OUT} = 100mA$	0.50	0.70
1.6		0.45	0.65
1.7		0.40	0.60
1.8		0.34	0.55
1.9		0.28	0.44
$2.0 \leq V_{OUT} \leq 2.3$		0.25	0.35
$2.4 \leq V_{OUT} \leq 2.7$		0.24	0.29
$2.8 \leq V_{OUT} \leq 5.0$		0.23	0.26

Topt = 25°C

Output Voltage $V_{OUT}$ (V)	Ripple Rejection		
	RR (dB)		
	Condition	Typ.	Max.
$1.5 \leq V_{OUT} \leq 4.0$	$f = 1kHz, \text{Ripple } 0.5V_{p-p}$ $V_{IN} = \text{Set } V_{OUT} + 1V$	80	
$4.1 \leq V_{OUT} \leq 5.0$		70	

## OPERATION



In these ICs, fluctuation of output voltage,  $V_{OUT}$  is detected by feedback 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 in short mode and a chip enable circuit, are included.

## 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  $C_{OUT}$  with good frequency characteristics and ESR (Equivalent Series Resistance).

We use Ceramic Capacitors for evaluation of these ICs.

Recommended Capacitors ; GRM40X5R225K6.3 (Murata)

GRM40-034X5R335K6.3 (Murata)

GRM40-034X5R475K6.3 (Murata)

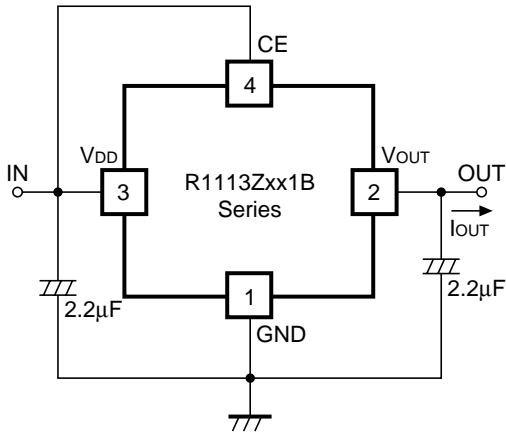
(Note: When the additional ceramic capacitors are connected to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

### PCB Layout

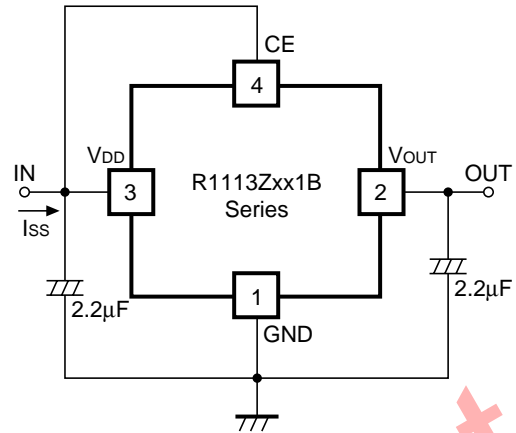
Make  $V_{DD}$  and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor with a capacitance value as much as  $2.2\mu\text{F}$  or more between  $V_{DD}$  and GND pin, and as close as possible to the pins.

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

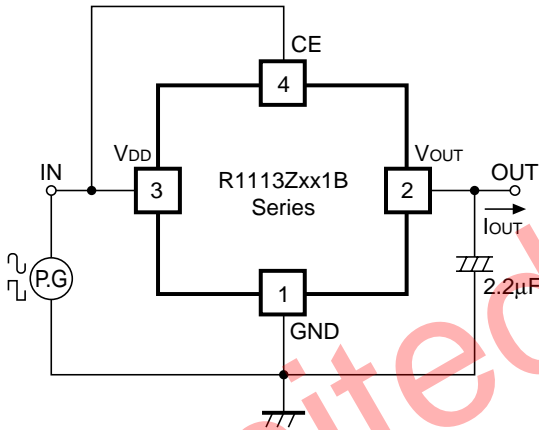
**TEST CIRCUITS**



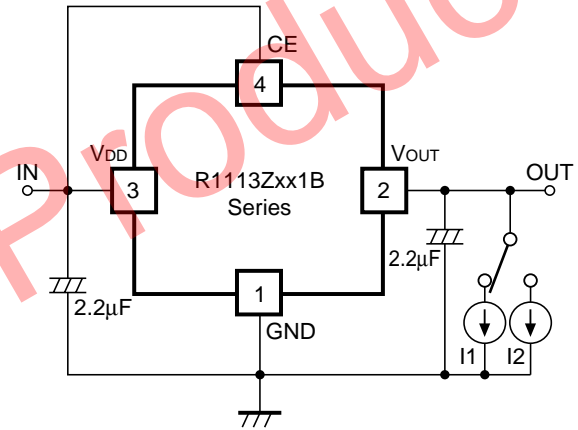
**Fig.1 Standard test Circuit**



**Fig.2 Supply Current Test Circuit**

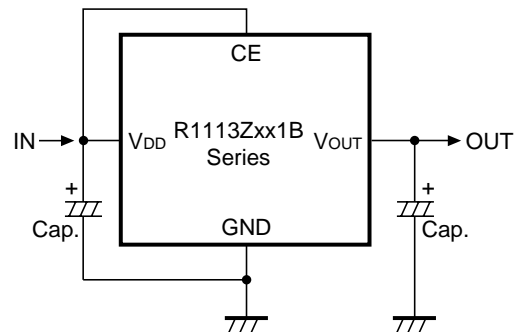
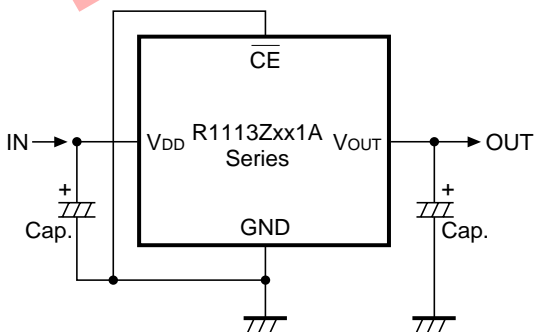


**Fig.3 Ripple Rejection, Line Transient Response Test Circuit**



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

**TYPICAL APPLICATION**



**(External Components)**

Output Capacitor ; Ceramic 2.2µF (Set Output Voltage in the range from 2.6 to 5.0V)

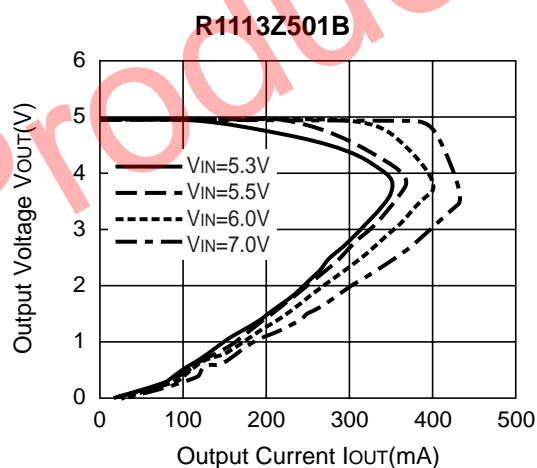
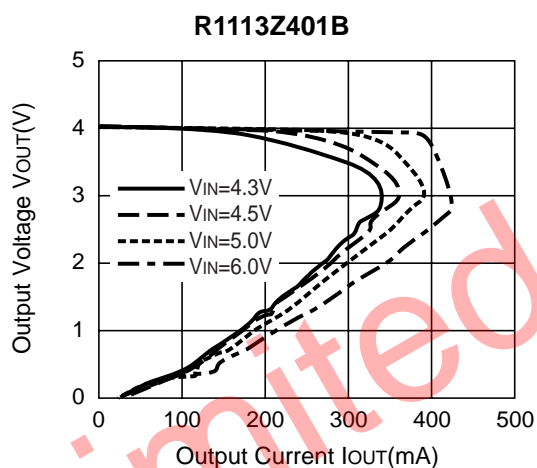
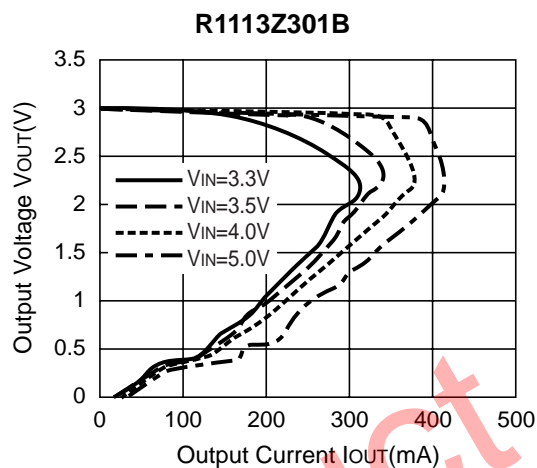
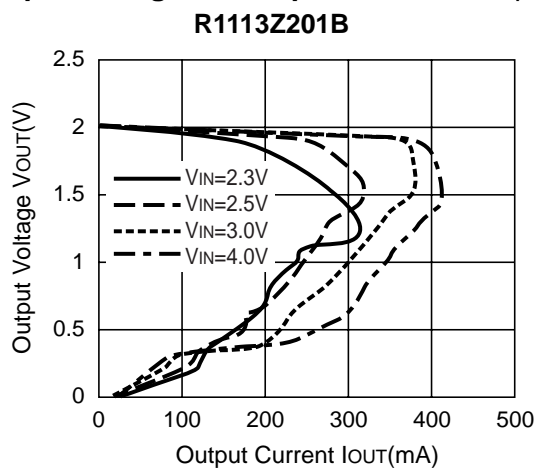
Ceramic 4.7µF (Set Output Voltage in the range from 1.5 to 2.5V)

Input Capacitor ; Ceramic 2.2µF

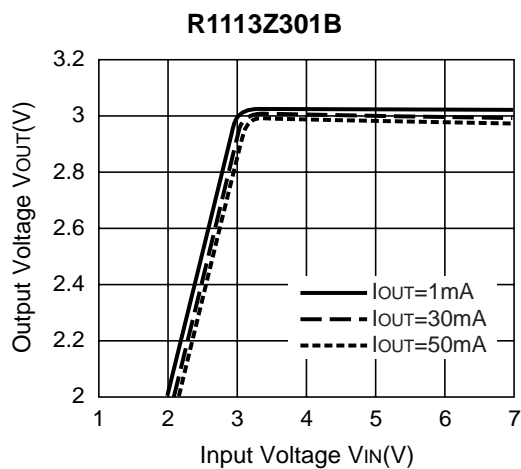
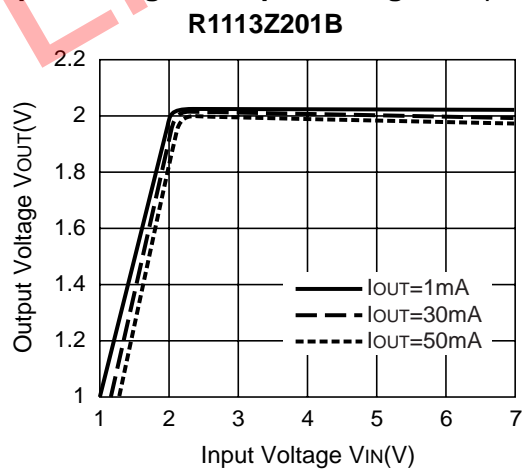


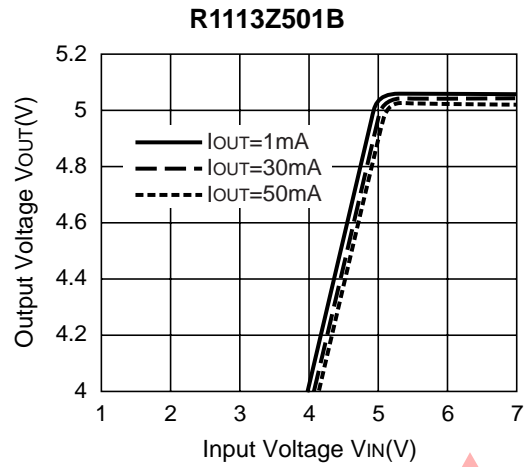
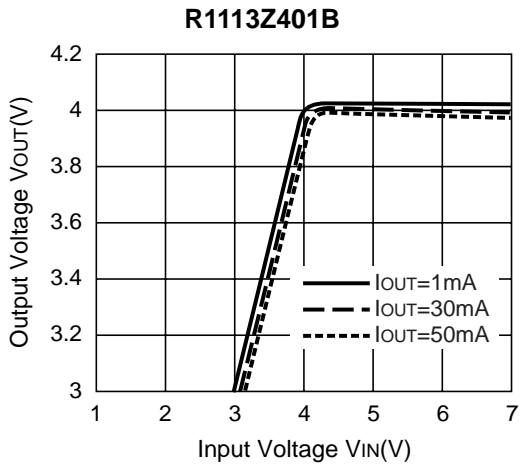
## TYPICAL CHARACTERISTICS

### 1) Output Voltage vs. Output Current $T_{opt}=25^{\circ}\text{C}$

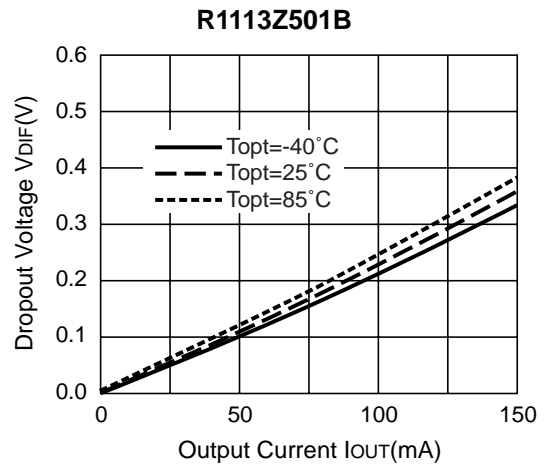
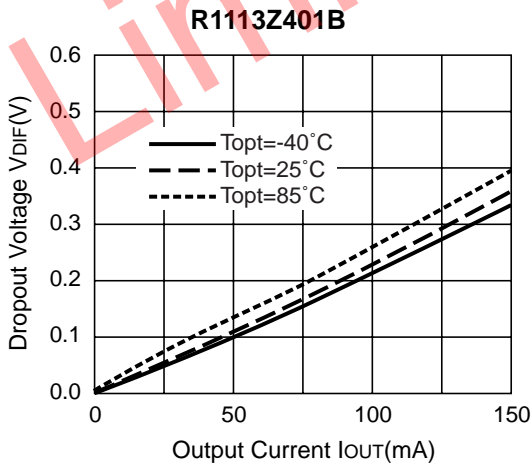
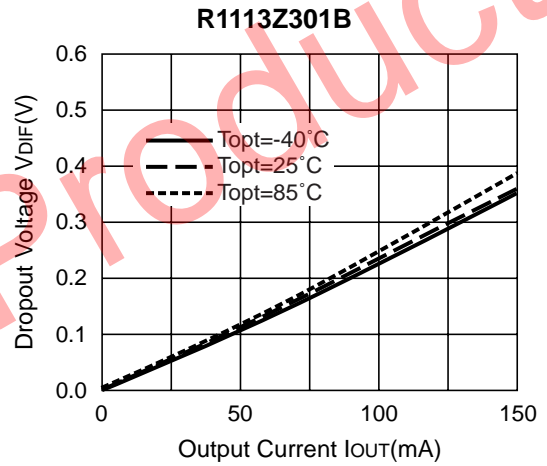
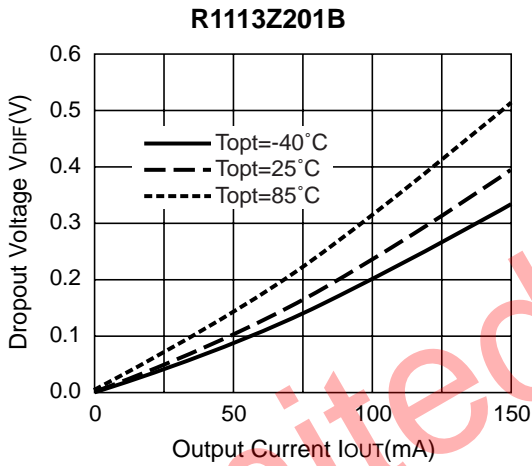


### 2) Output Voltage vs. Input Voltage $T_{opt}=25^{\circ}\text{C}$





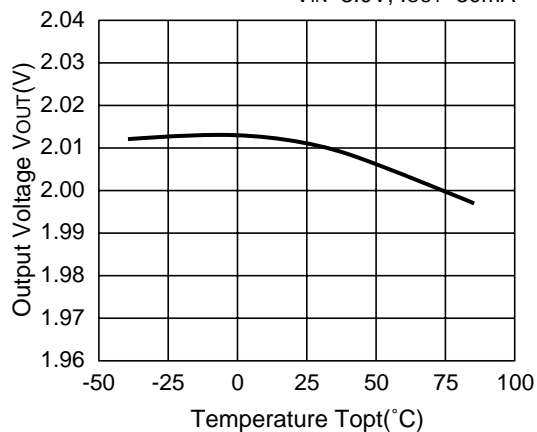
**3) Dropout Voltage vs. Output Current**



## 4) Output Voltage vs. Temperature

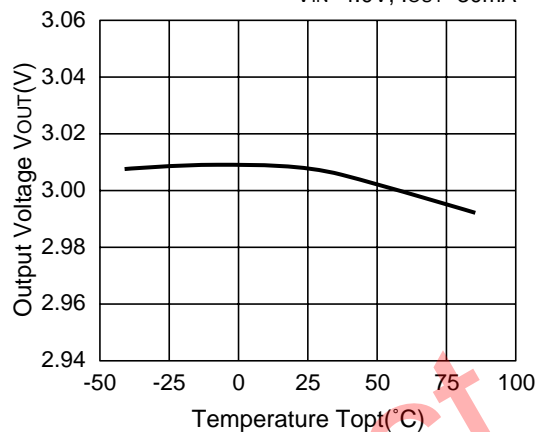
R1113Z201B

VIN=3.0V, IOUT=30mA



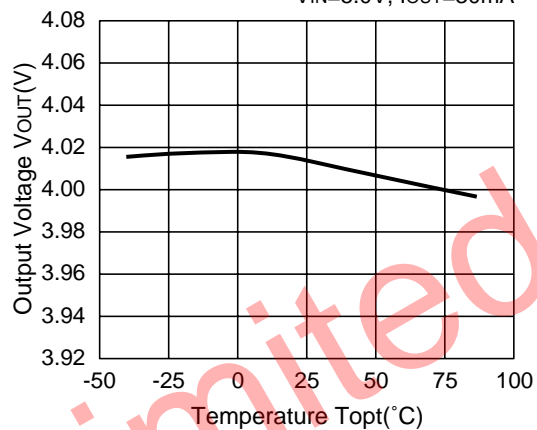
R1113Z301B

VIN=4.0V, IOUT=30mA



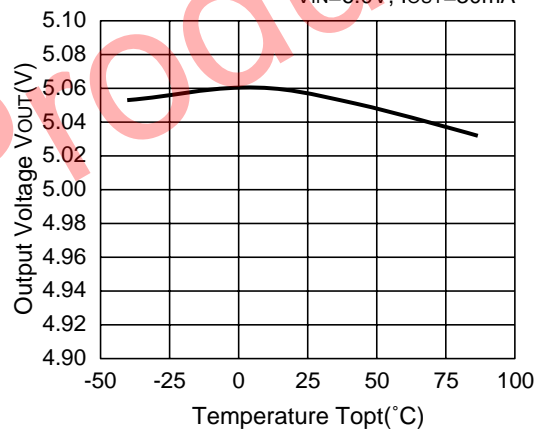
R1113Z401B

VIN=5.0V, IOUT=30mA

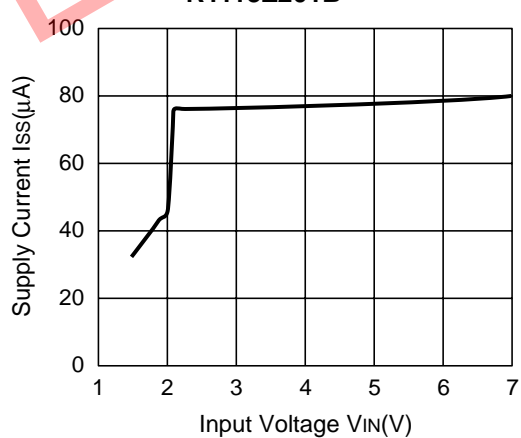


R1113Z501B

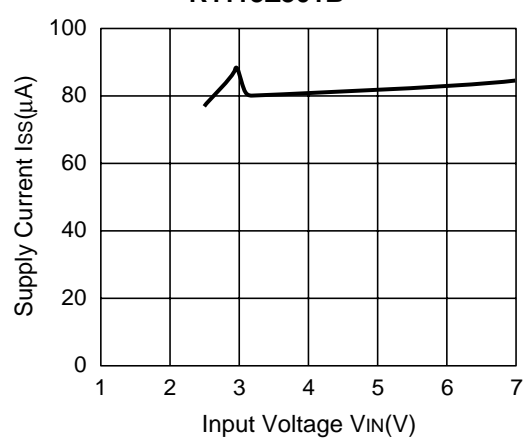
VIN=6.0V, IOUT=30mA

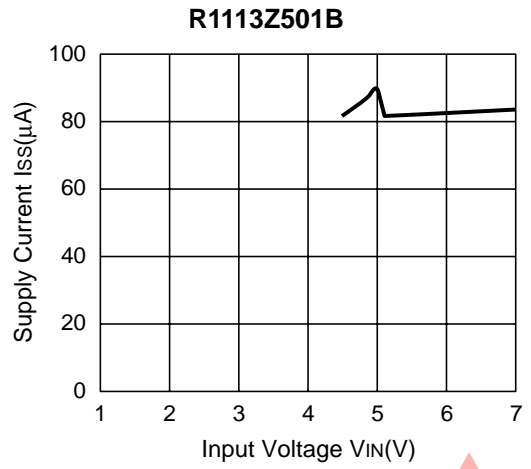
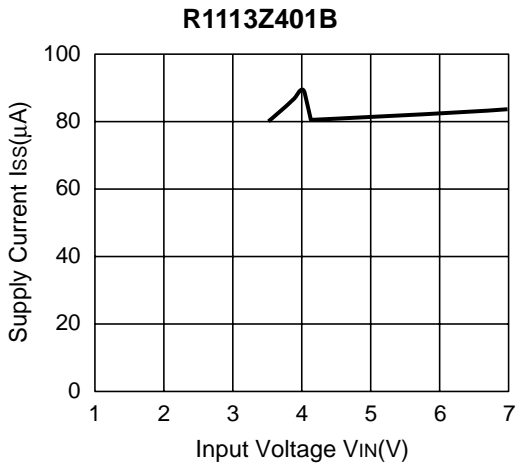
5) Supply Current vs. Input Voltage T<sub>opt</sub>=25°C

R1113Z201B

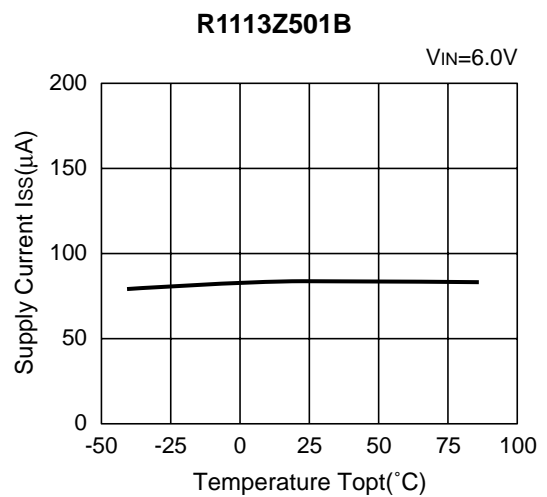
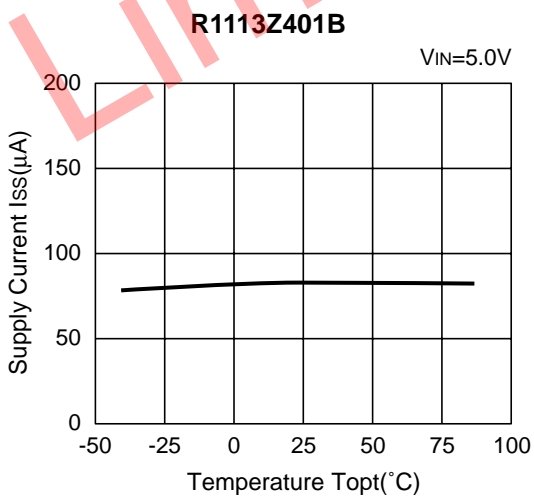
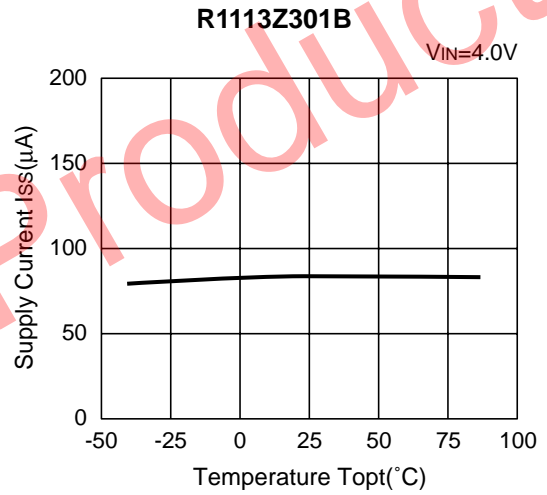
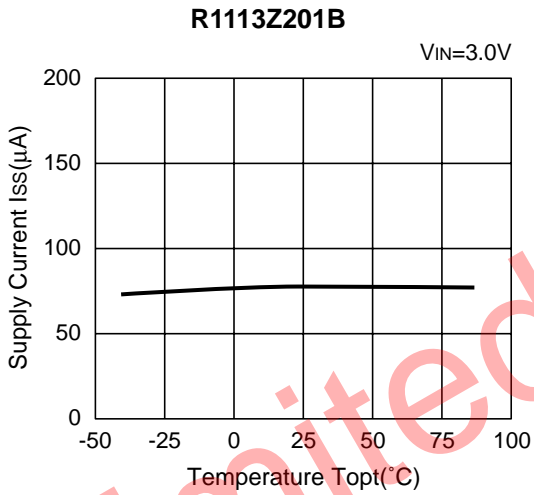


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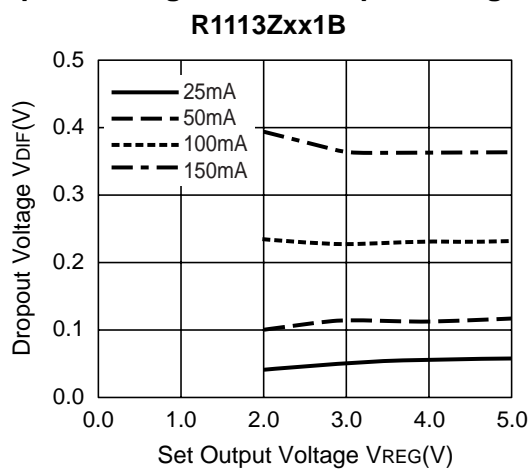




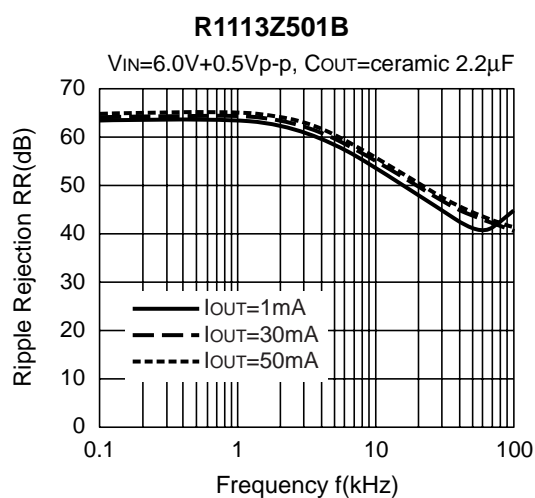
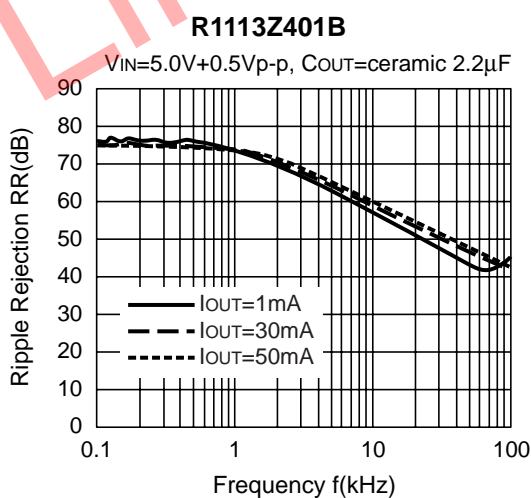
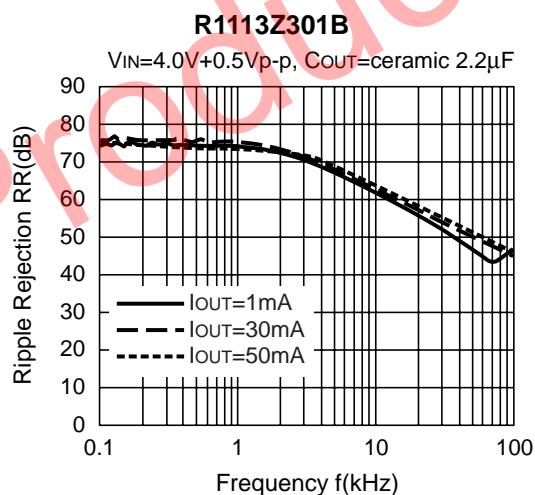
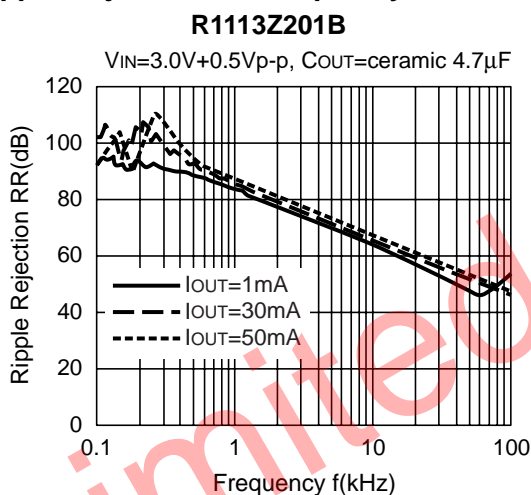
**6) Supply Current vs. Temperature**



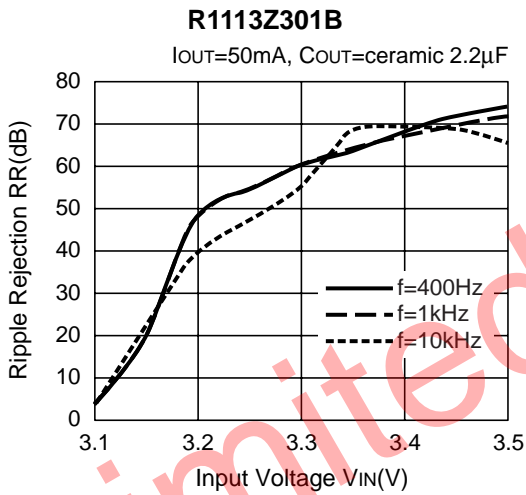
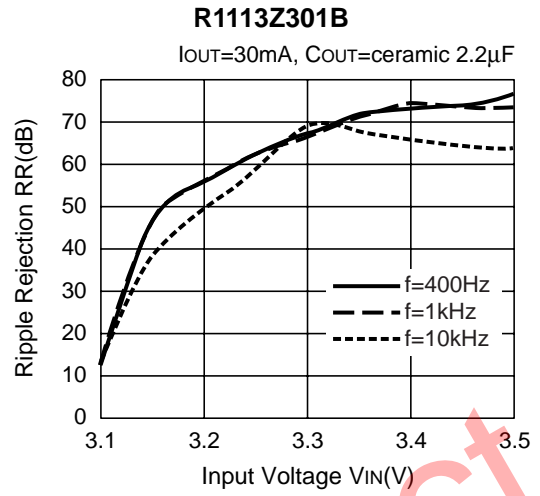
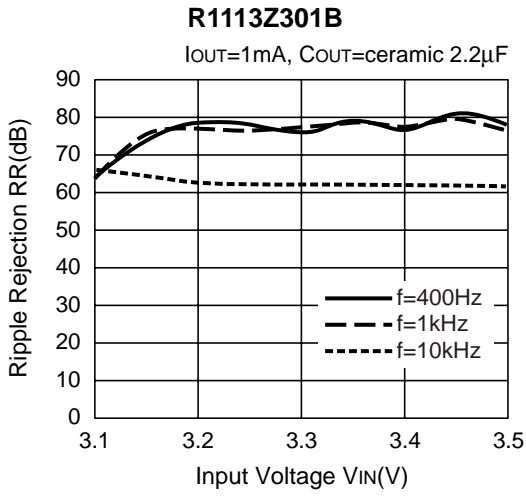
## 7) Dropout Voltage vs. Set Output Voltage



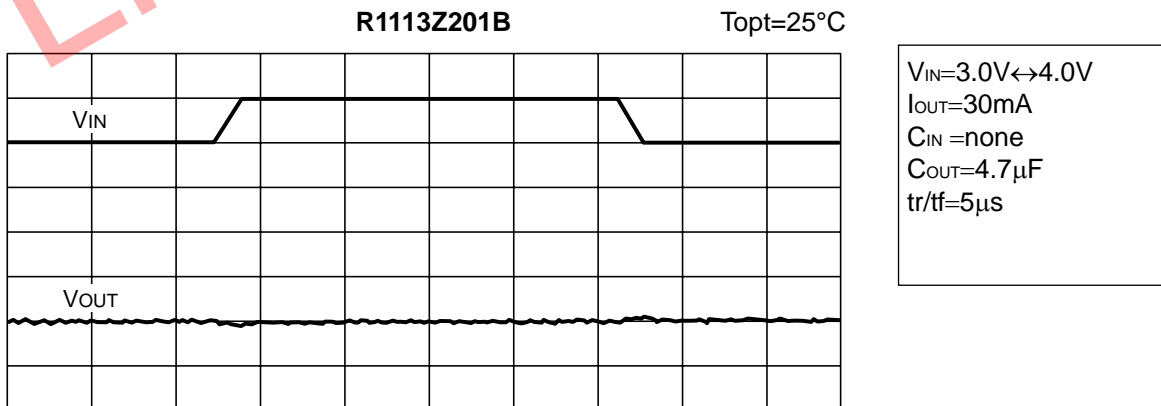
## 8) Ripple Rejection vs. Frequency



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

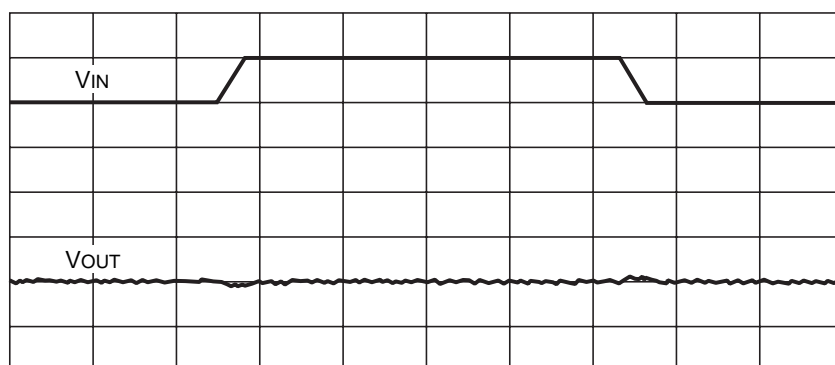


10) Input Transient Response



R1113Z301B

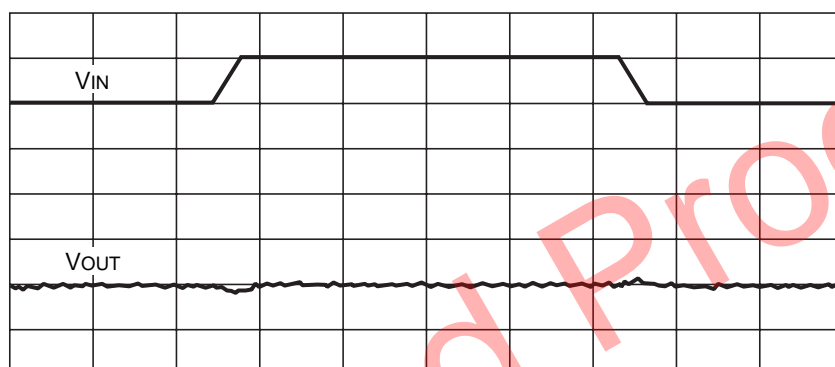
Topt=25°C



$V_{IN}=4.0V \leftrightarrow 5.0V$   
 $I_{OUT}=30mA$   
 $C_{IN}=\text{none}$   
 $C_{OUT}=2.2\mu F$   
 $t_r/t_f=5\mu s$

R1113Z401B

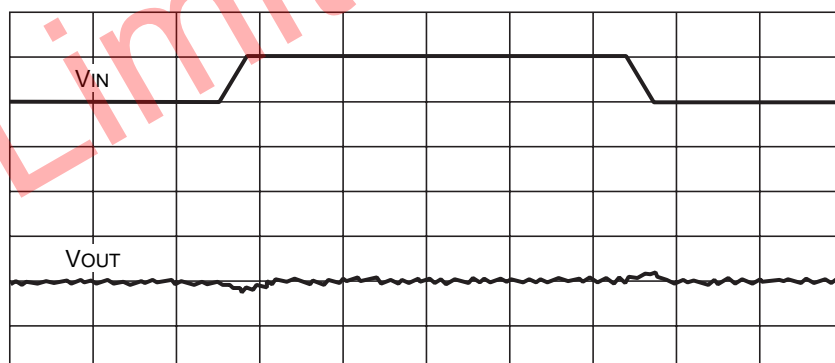
Topt=25°C



$V_{IN}=5.0V \leftrightarrow 6.0V$   
 $I_{OUT}=30mA$   
 $C_{IN}=\text{none}$   
 $C_{OUT}=2.2\mu F$   
 $t_r/t_f=5\mu s$

R1113Z501B

Topt=25°C

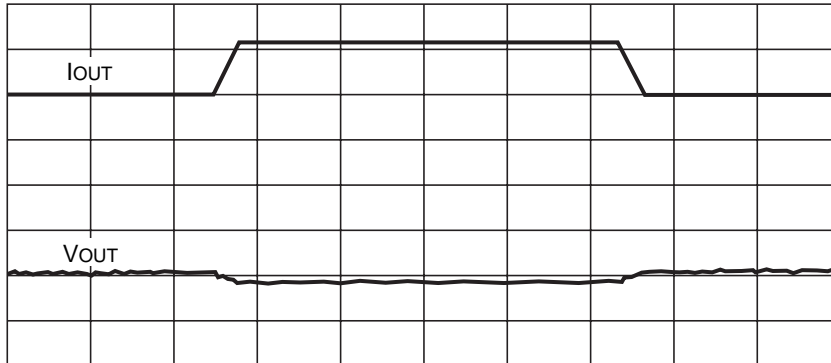


$V_{IN}=6.0V \leftrightarrow 7.0V$   
 $I_{OUT}=30mA$   
 $C_{IN}=\text{none}$   
 $C_{OUT}=2.2\mu F$   
 $t_r/t_f=5\mu s$

11) Load Transient Response

R1113Z201B

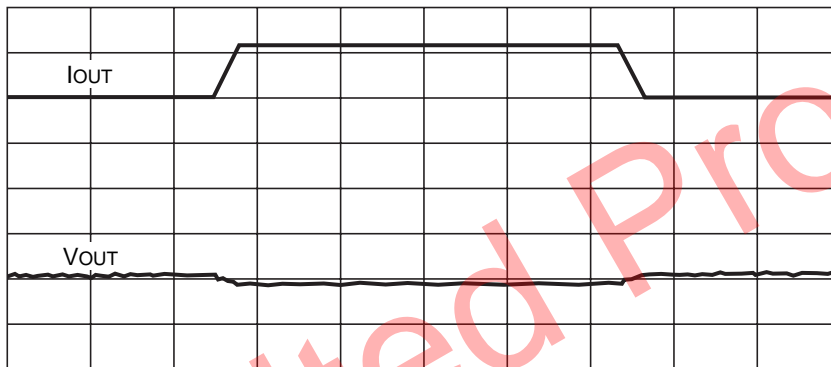
T<sub>opt</sub>=25°C



I<sub>OUT</sub>=50mA↔100mA  
 V<sub>IN</sub>=3.0V  
 C<sub>IN</sub>=2.2μF  
 C<sub>OUT</sub>=4.7μF  
 tr/tf=5μs

R1113Z301B

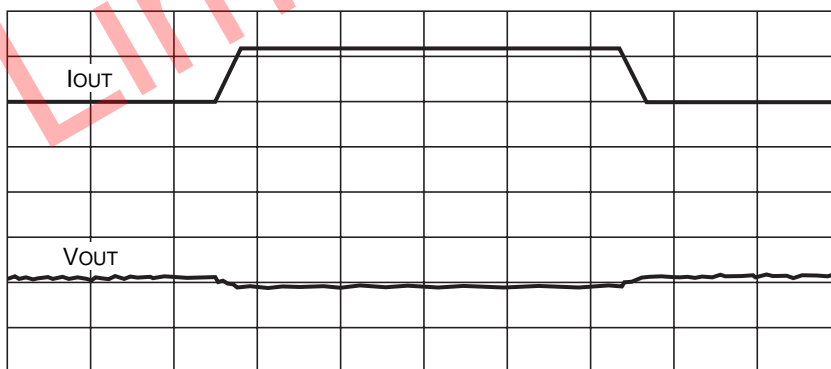
T<sub>opt</sub>=25°C



I<sub>OUT</sub>=50mA↔100mA  
 V<sub>IN</sub>=4.0V  
 C<sub>IN</sub>=2.2μF  
 C<sub>OUT</sub>=2.2μF  
 tr/tf=5μs

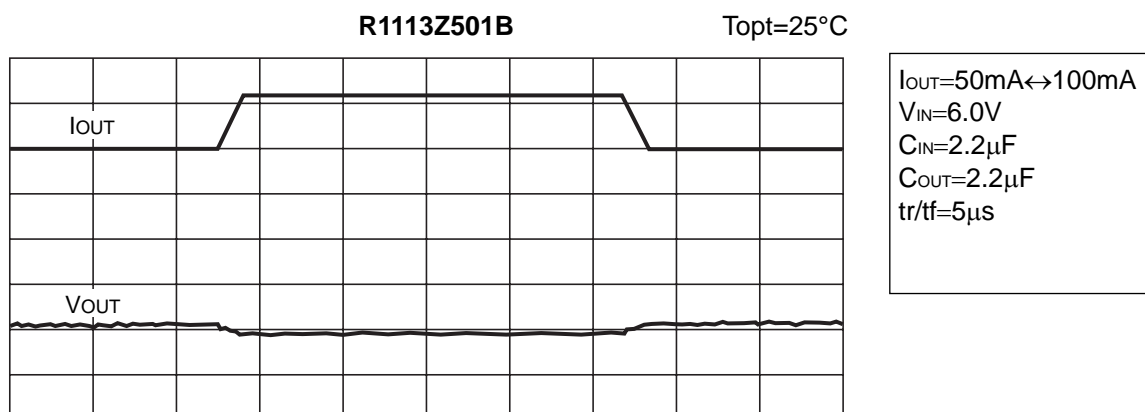
R1113Z401B

T<sub>opt</sub>=25°C



I<sub>OUT</sub>=50mA↔100mA  
 V<sub>IN</sub>=5.0V  
 C<sub>IN</sub>=2.2μF  
 C<sub>OUT</sub>=2.2μF  
 tr/tf=5μs

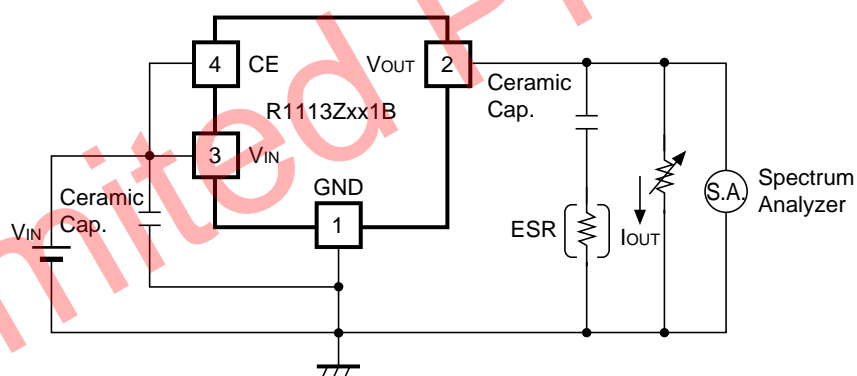




## TECHNICAL NOTES

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, 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; R1113Zxx1B**

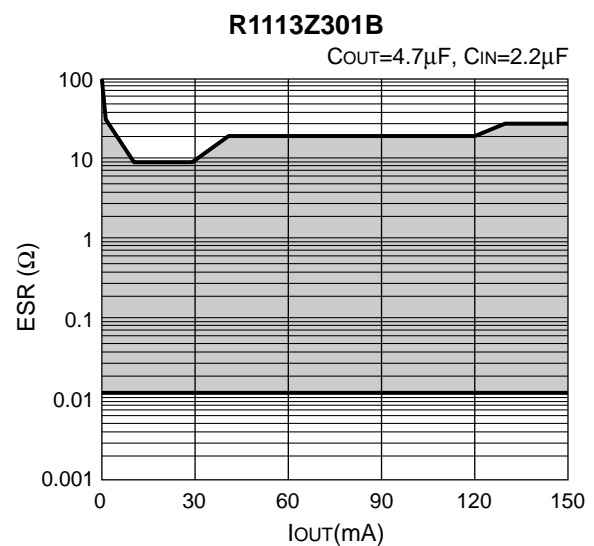
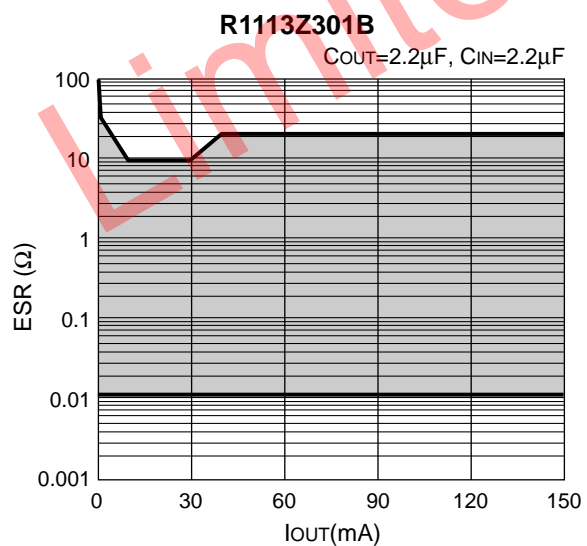
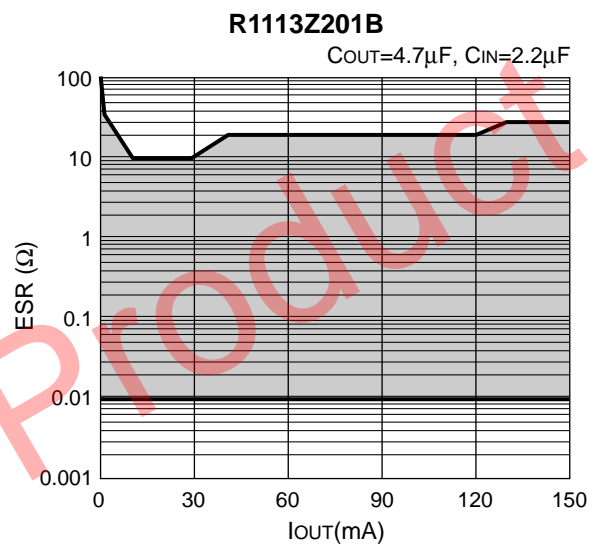
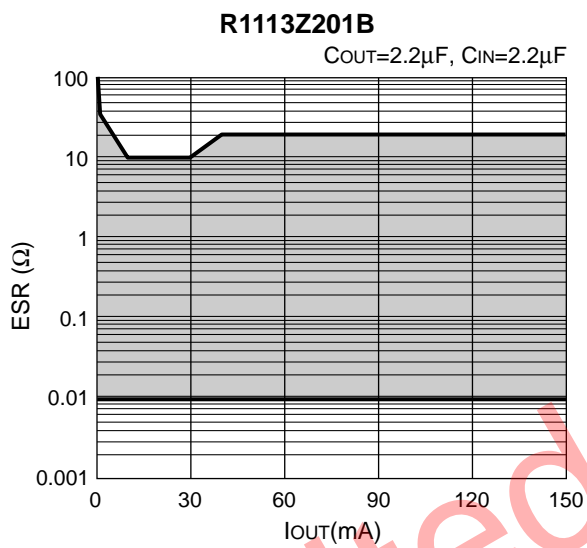
## R1113Z

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

(Note: If 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 same external components as ones to be used on the PCB.)

<Measurement conditions>

- (1)  $V_{IN}=V_{OUT}+1\text{V}$
- (2) Frequency Band: 10Hz to 1MHz
- (3) Temperature:  $25^{\circ}\text{C}$





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