

## 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.

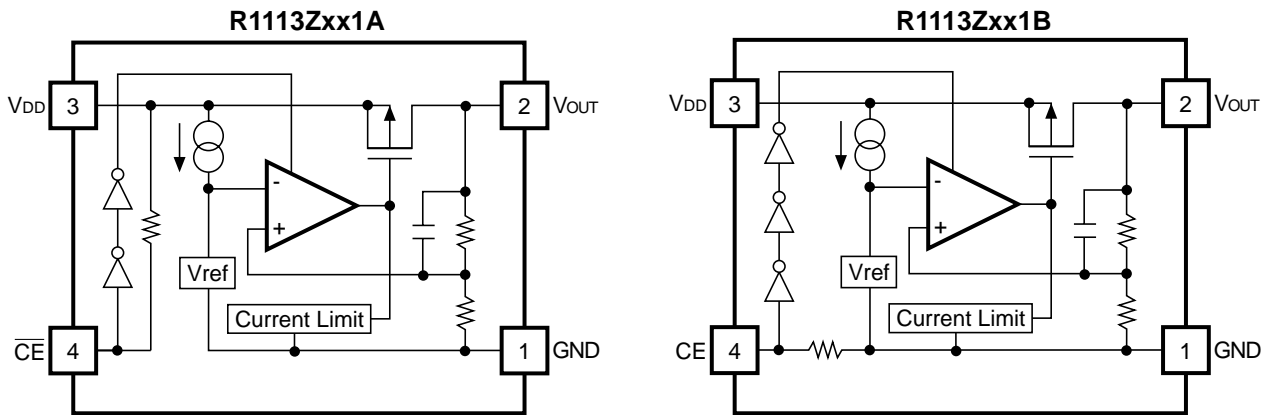
## FEATURES

- 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



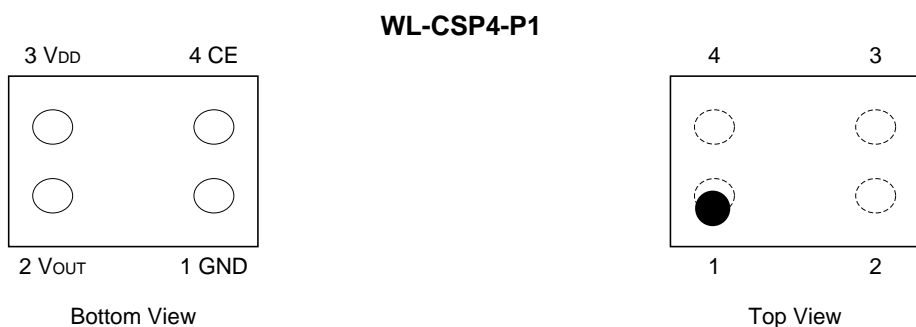
## SELECTION GUIDE

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 :<br>Z:WL-CSP4-P1 (Wafer Level CSP)  |
| b    | Setting Output Voltage ( $V_{OUT}$ ) :<br>Stepwise setting with a step of 0.1V in the range of 1.5V to 5.0V is possible. |
| c    | Designation of Active Type :<br>A : active low type<br>B : active high type  |
| d    | Designation of Taping Type :<br>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)

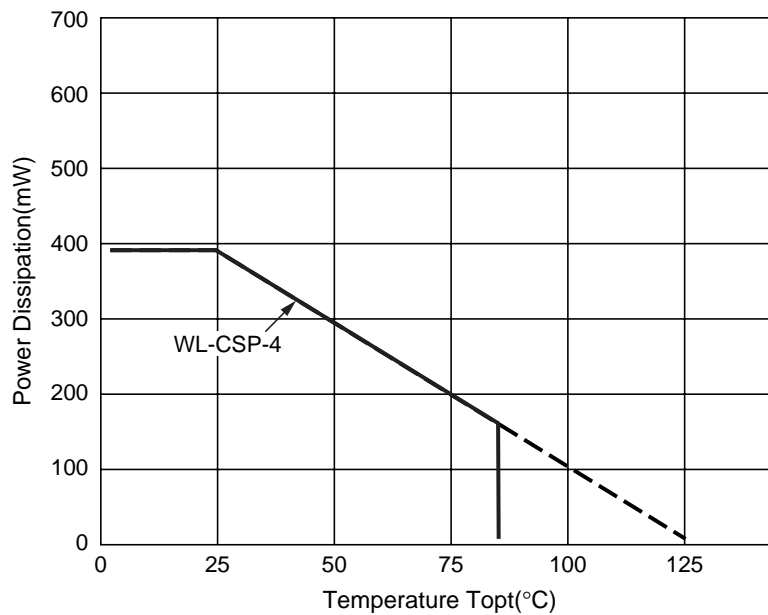
Board Size: 40mm×40mm×1.6mm

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<br>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

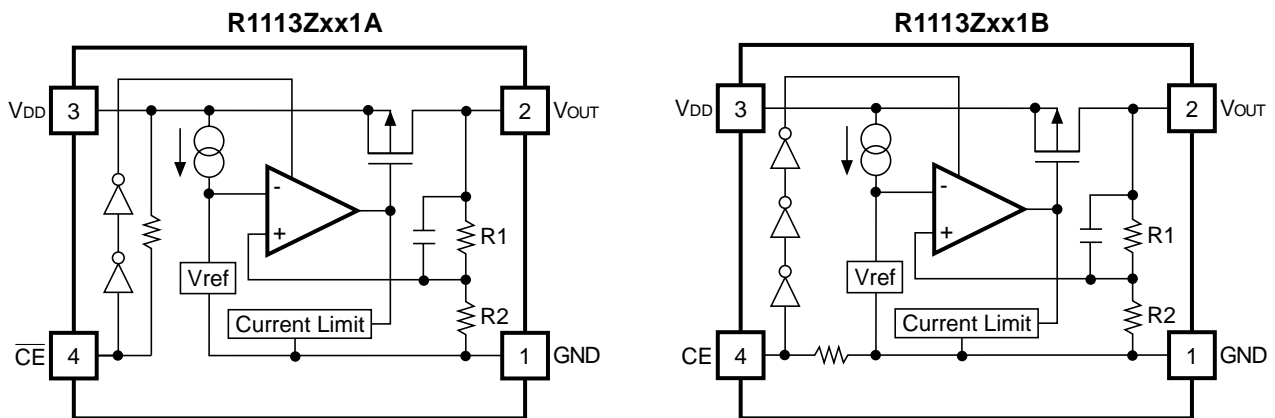
Topt = 25°C

| 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. |
| $1.5 \leq V_{OUT} \leq 4.0$  | $f = 1kHz, \text{Ripple } 0.5Vp-p$<br>$V_{IN} = \text{Set } V_{OUT} + 1V$ | 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

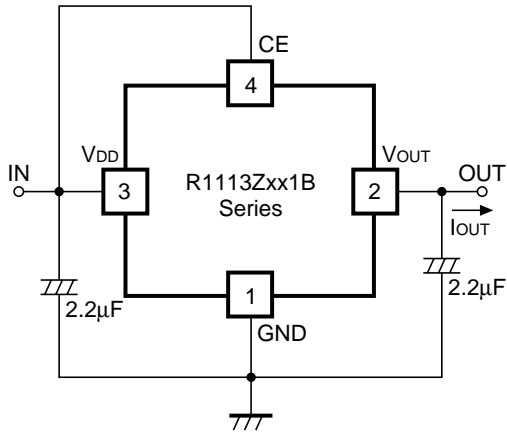


Fig.1 Standard test Circuit

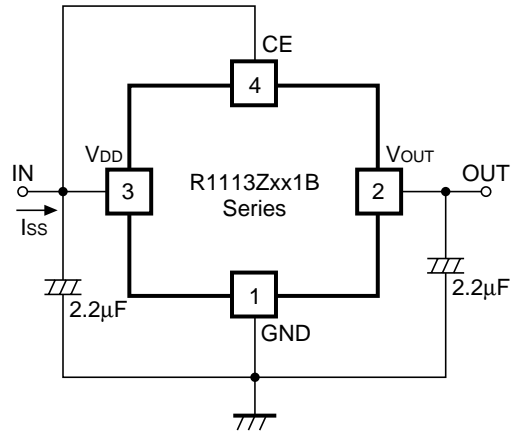


Fig.2 Supply Current Test Circuit

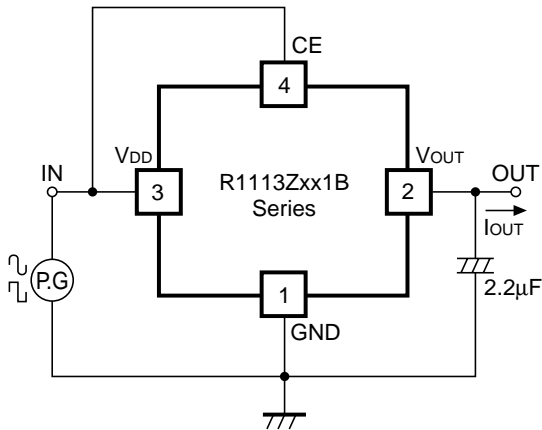


Fig.3 Ripple Rejection, Line Transient Response Test Circuit

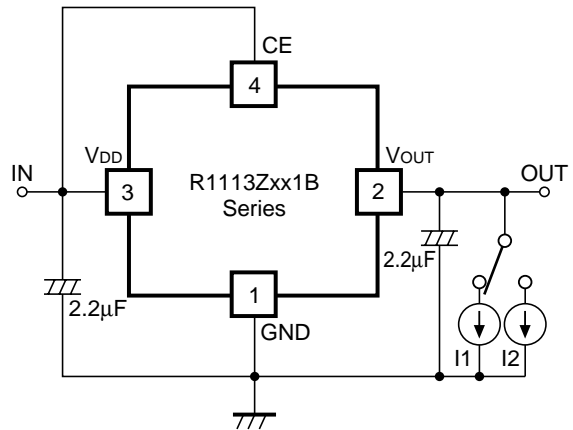
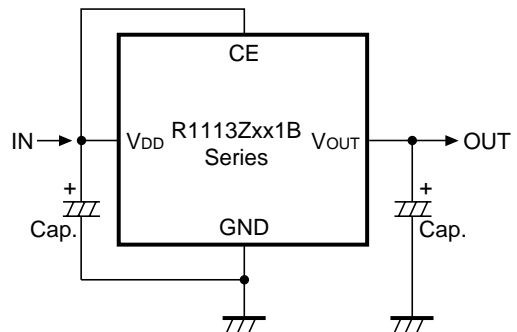
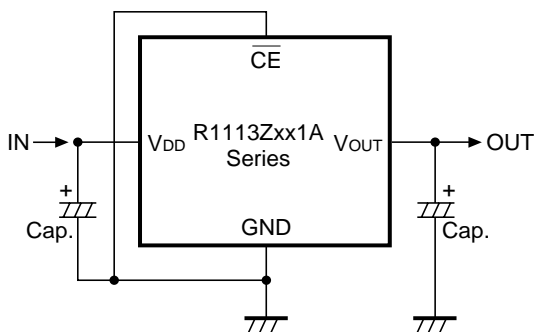


Fig.4 Load Transient Response Test Circuit

## TYPICAL APPLICATION



### (External Components)

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

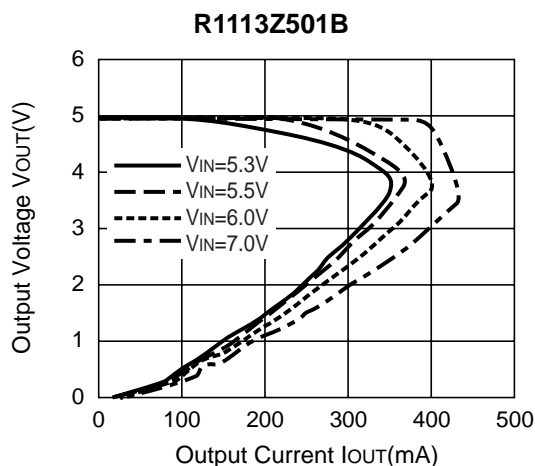
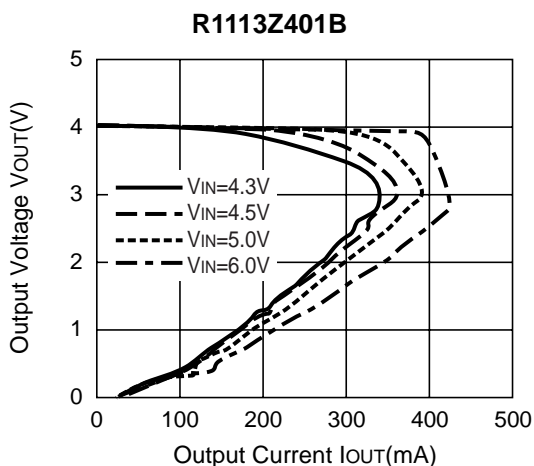
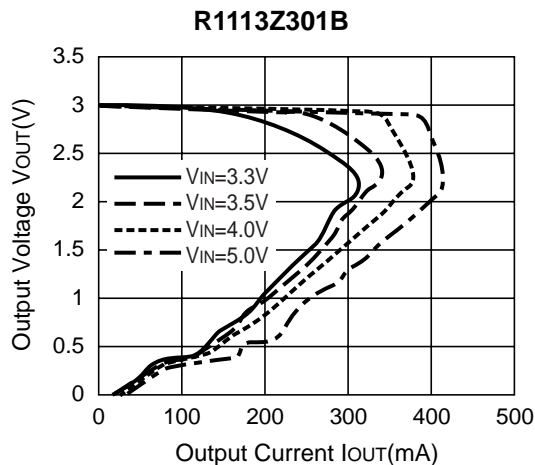
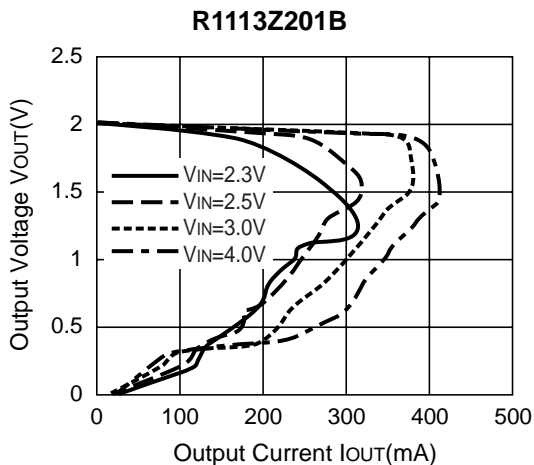
Ceramic 4.7µF (Set Output Voltage in the range from 1.5 to 2.5V)

Input Capacitor ; Ceramic 2.2µF

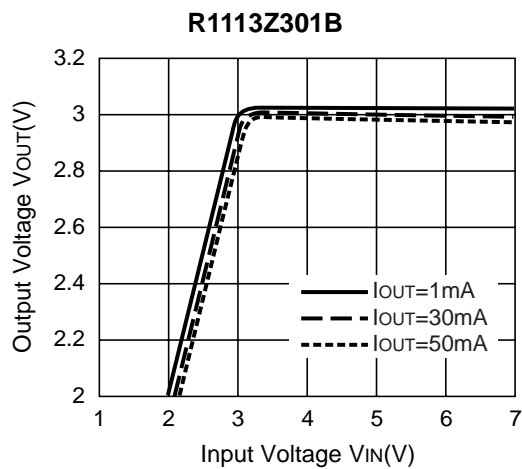
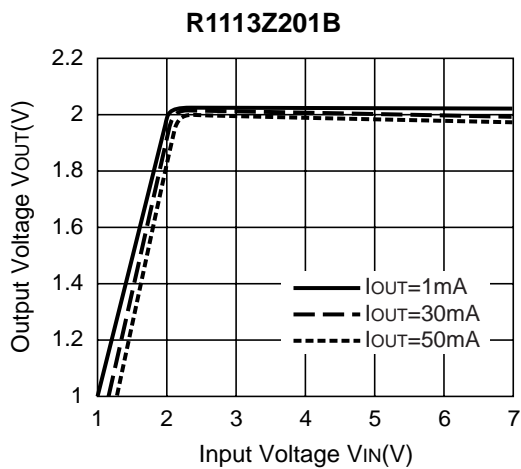


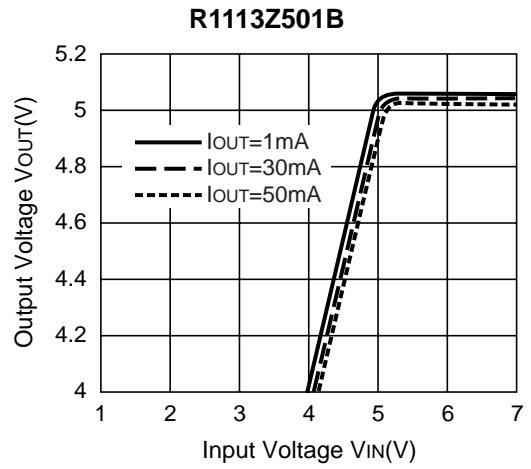
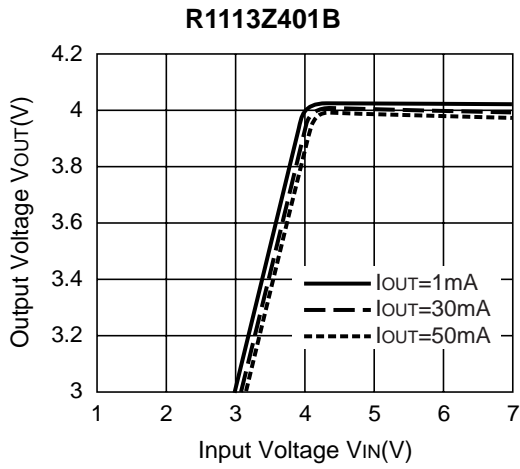
## TYPICAL CHARACTERISTICS

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

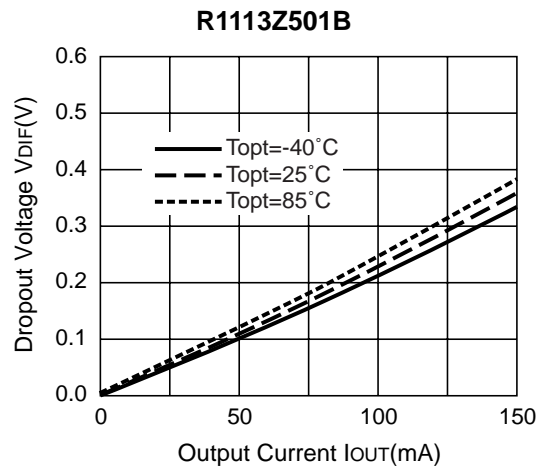
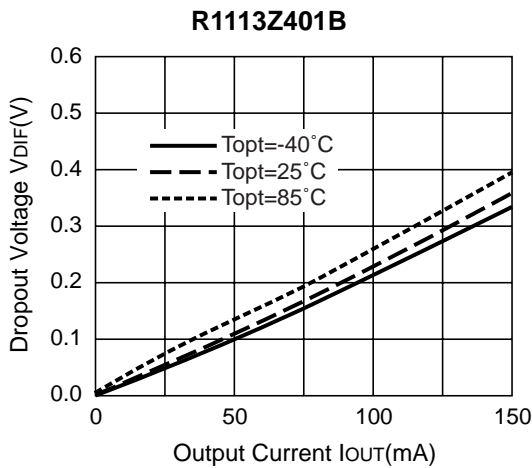
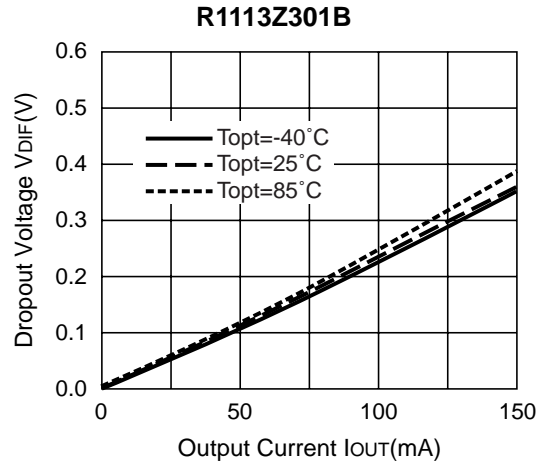
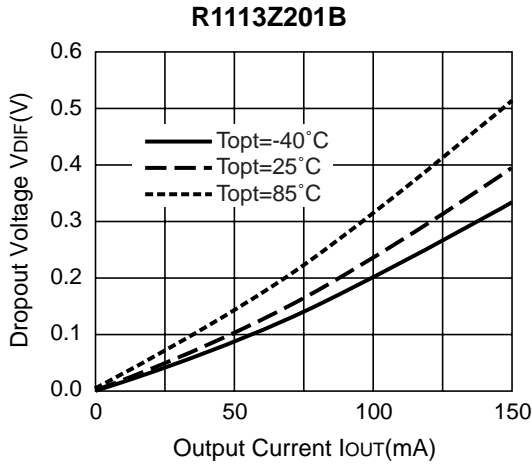


### 2) Output Voltage vs. Input Voltage $T_{opt}=25^{\circ}\text{C}$





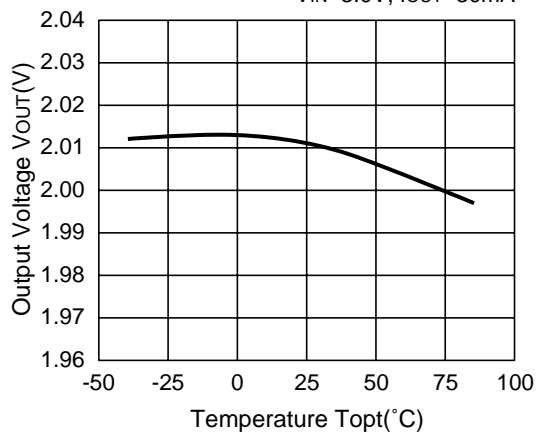
**3) Dropout Voltage vs. Output Current**



## 4) Output Voltage vs. Temperature

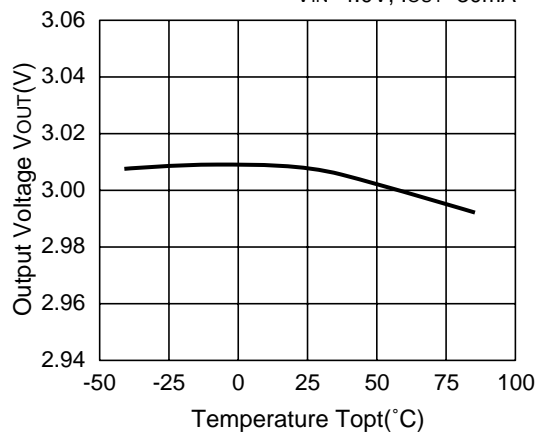
R1113Z201B

VIN=3.0V, IOUT=30mA



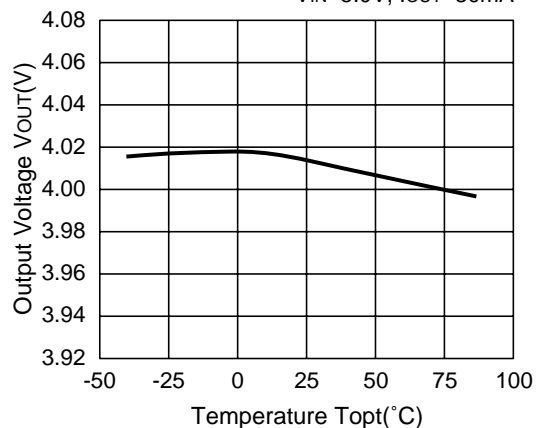
R1113Z301B

VIN=4.0V, IOUT=30mA



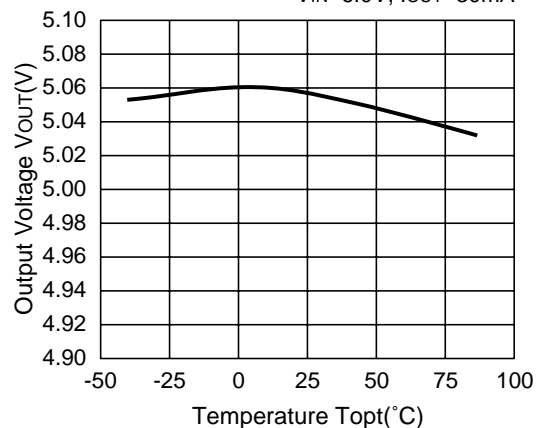
R1113Z401B

VIN=5.0V, IOUT=30mA



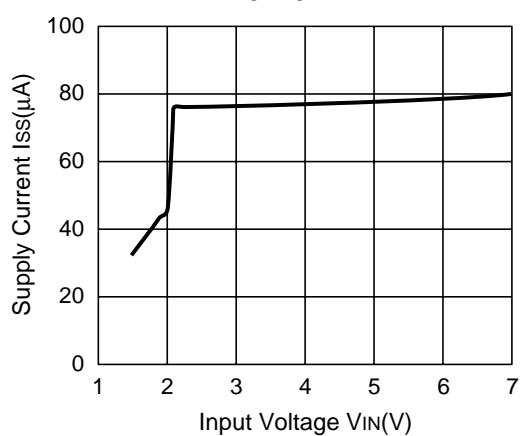
R1113Z501B

VIN=6.0V, IOUT=30mA

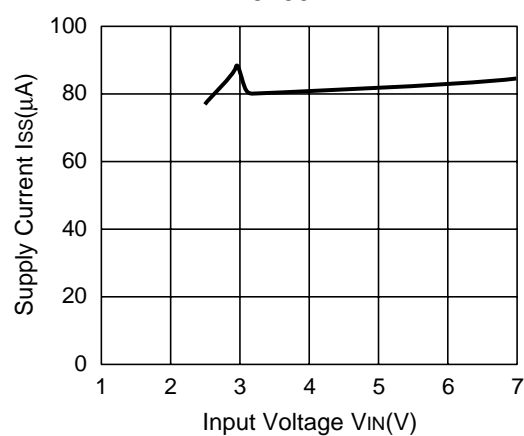


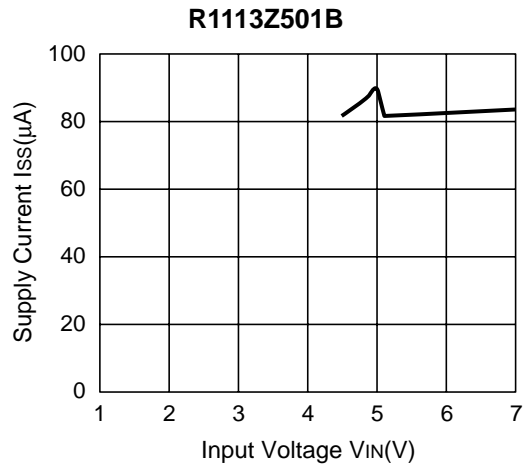
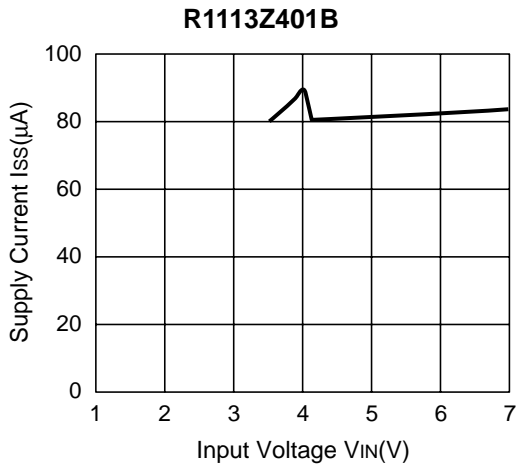
## 5) Supply Current vs. Input Voltage Topt=25°C

R1113Z201B

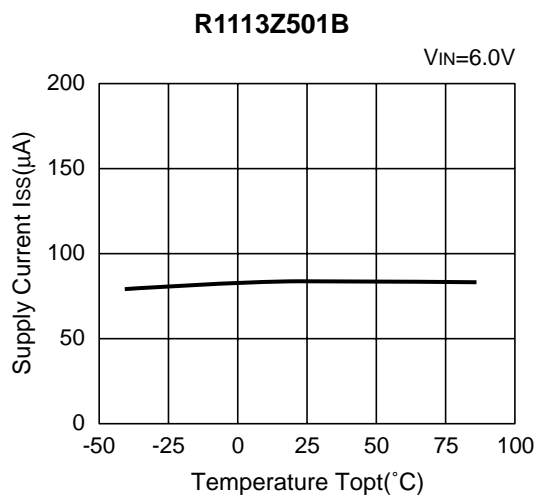
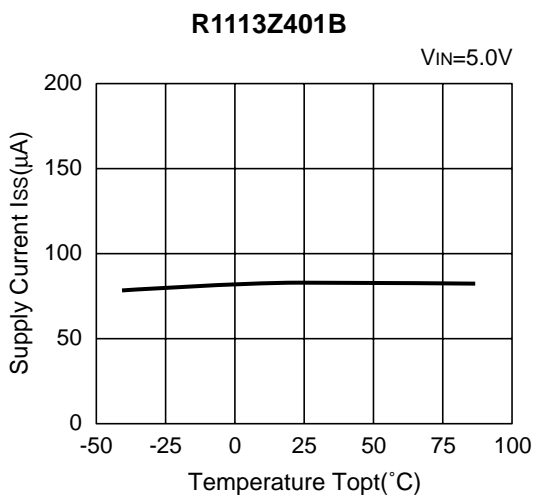
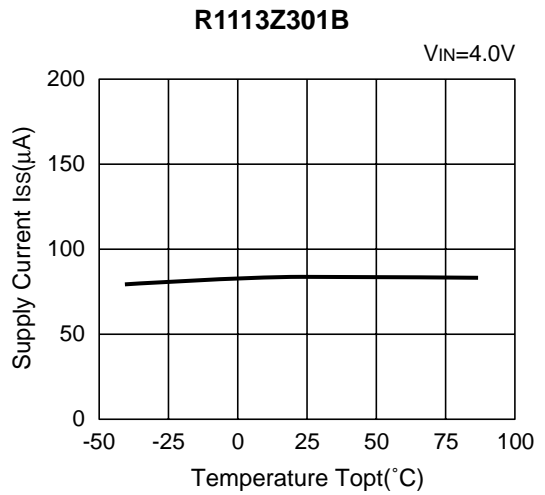
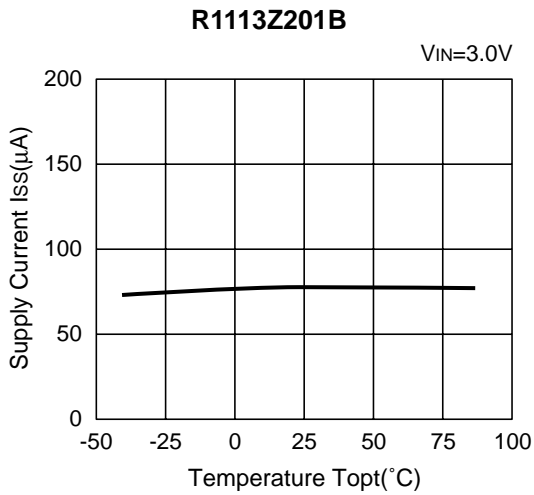


R1113Z301B

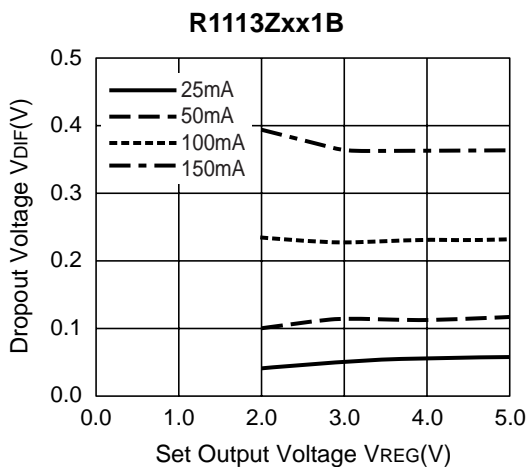




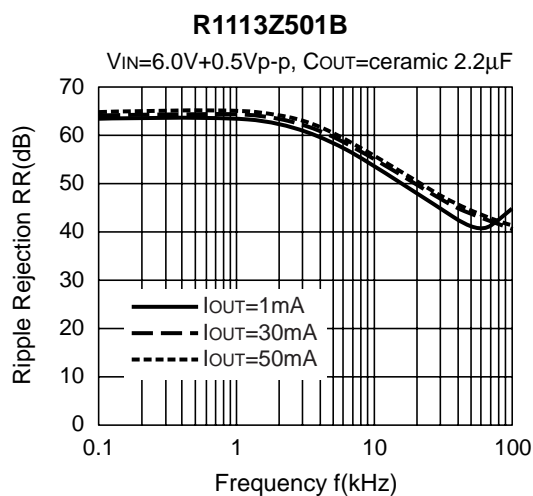
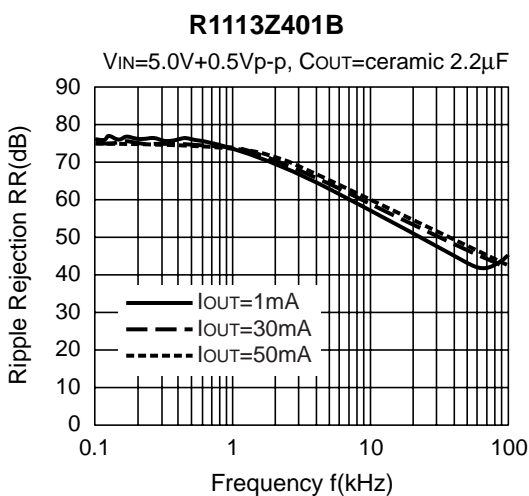
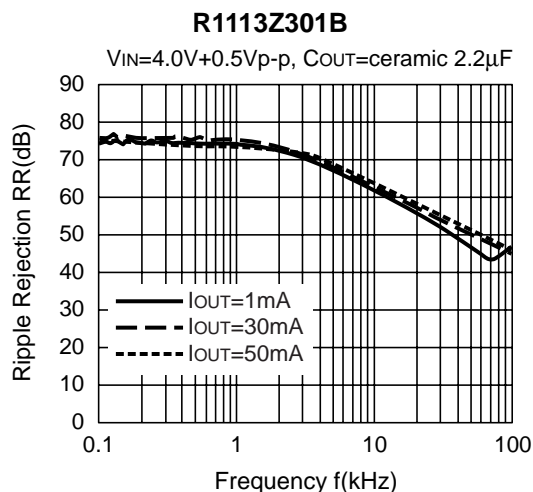
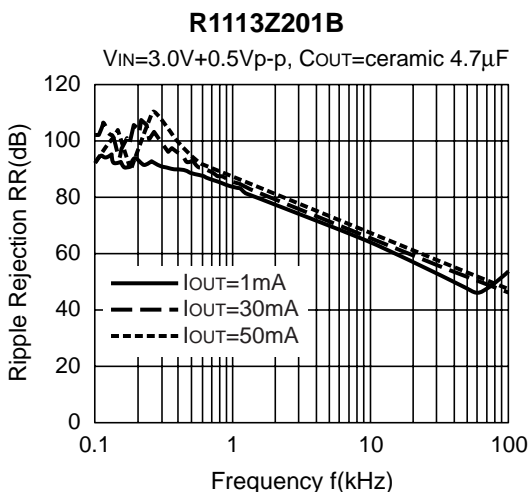
**6) Supply Current vs. Temperature**



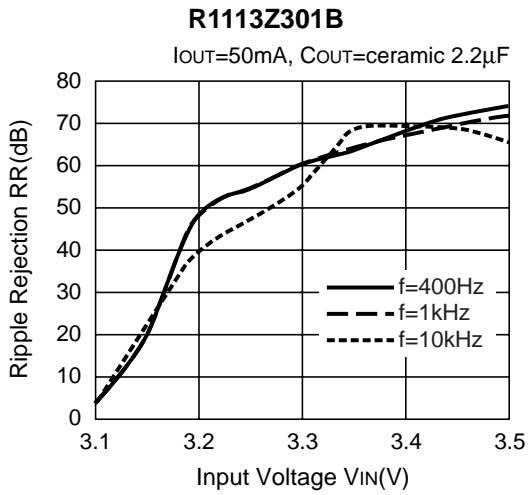
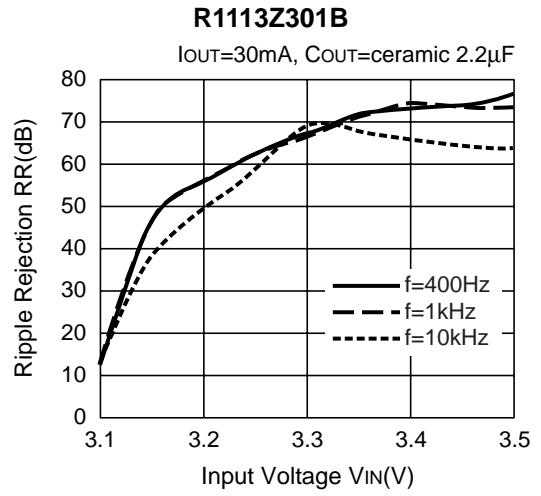
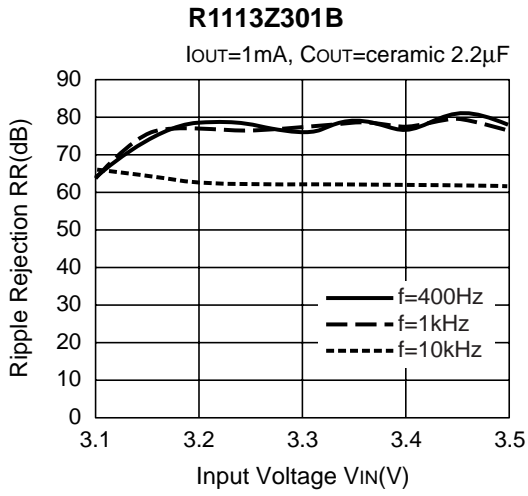
7) Dropout Voltage vs. Set Output Voltage



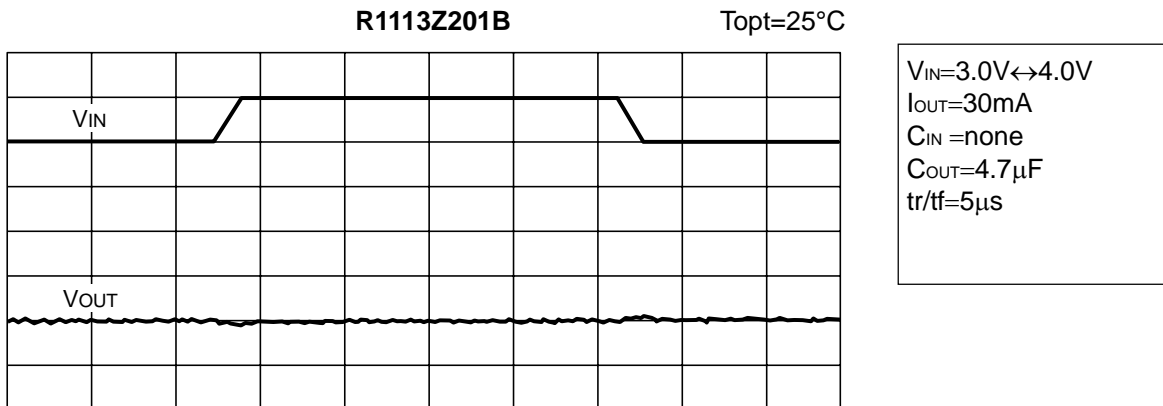
8) Ripple Rejection vs. Frequency



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

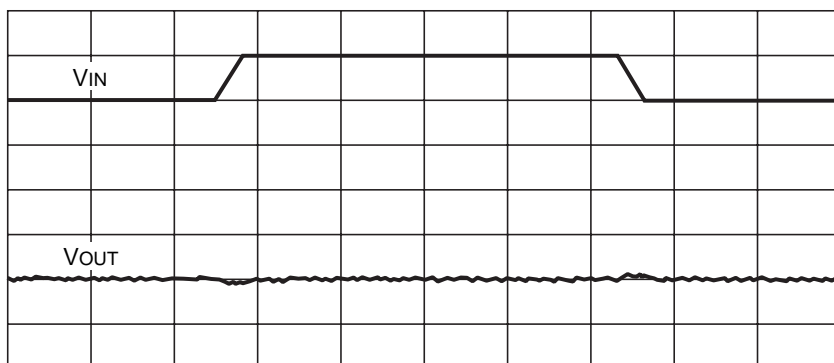


10) Input Transient Response



R1113Z301B

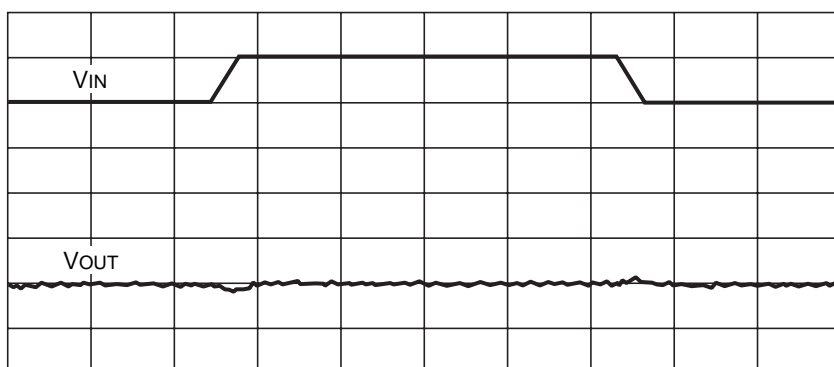
Topt=25°C



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

R1113Z401B

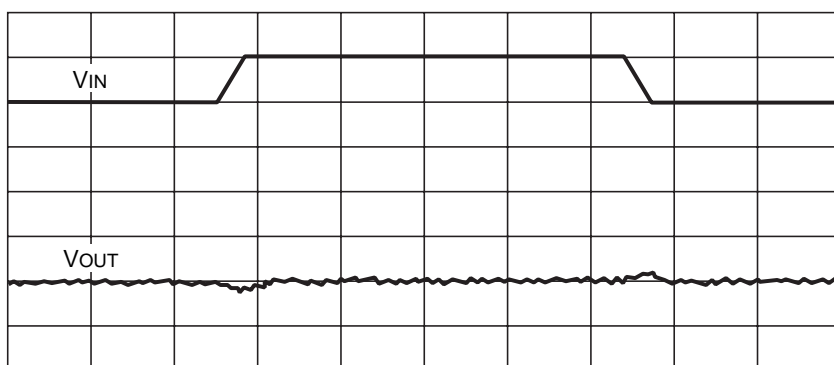
Topt=25°C



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

R1113Z501B

Topt=25°C

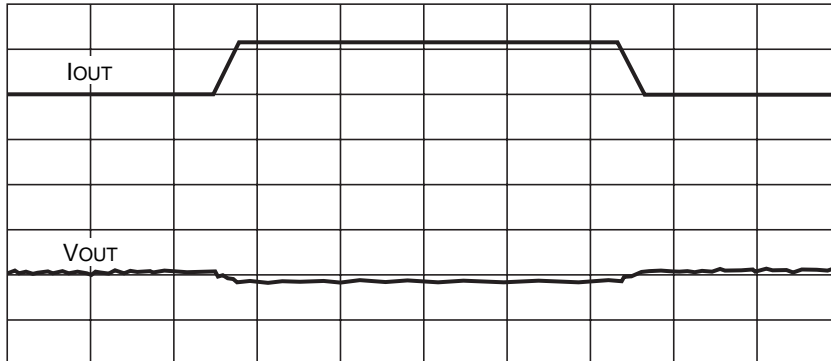


$V_{IN}=6.0V \leftrightarrow 7.0V$   
 $I_{OUT}=30mA$   
 $C_{IN}=\text{none}$   
 $C_{OUT}=2.2\mu F$   
 $t_r/t_f=5\mu s$

11) Load Transient Response

R1113Z201B

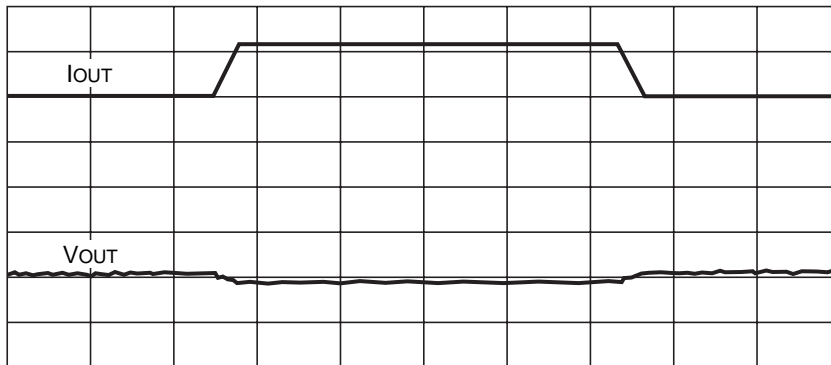
Topt=25°C



$I_{OUT}=50mA \leftrightarrow 100mA$   
 $V_{IN}=3.0V$   
 $C_{IN}=2.2\mu F$   
 $C_{OUT}=4.7\mu F$   
 $tr/tf=5\mu s$

R1113Z301B

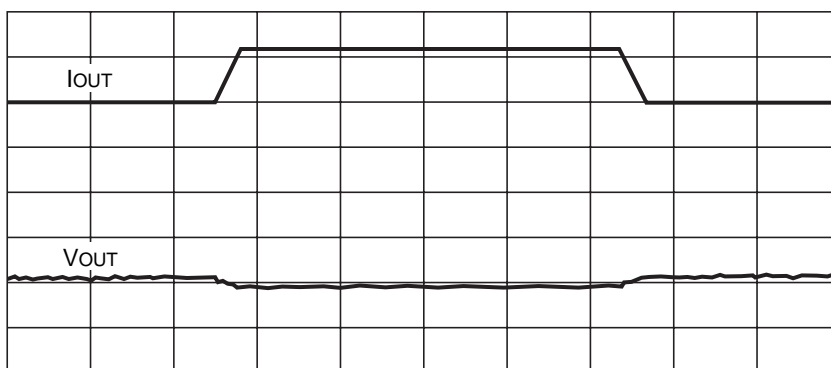
Topt=25°C



$I_{OUT}=50mA \leftrightarrow 100mA$   
 $V_{IN}=4.0V$   
 $C_{IN}=2.2\mu F$   
 $C_{OUT}=2.2\mu F$   
 $tr/tf=5\mu s$

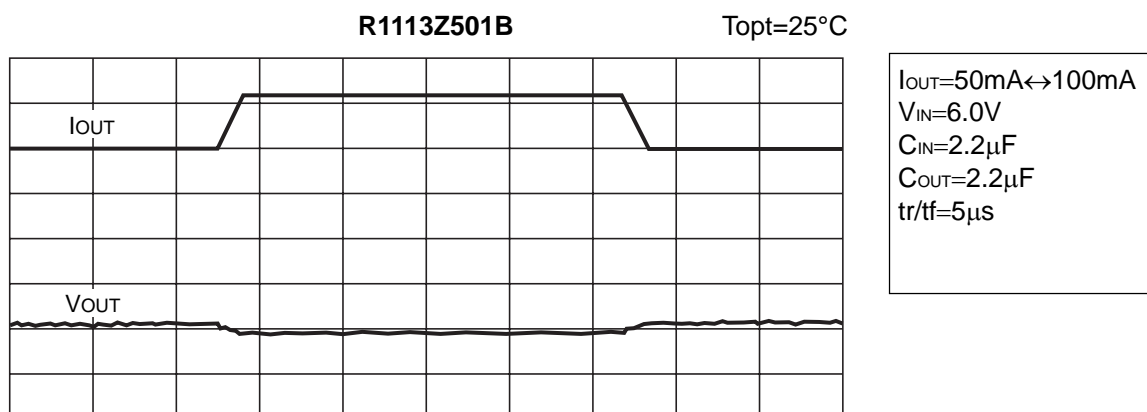
R1113Z401B

Topt=25°C



$I_{OUT}=50mA \leftrightarrow 100mA$   
 $V_{IN}=5.0V$   
 $C_{IN}=2.2\mu F$   
 $C_{OUT}=2.2\mu F$   
 $tr/tf=5\mu s$

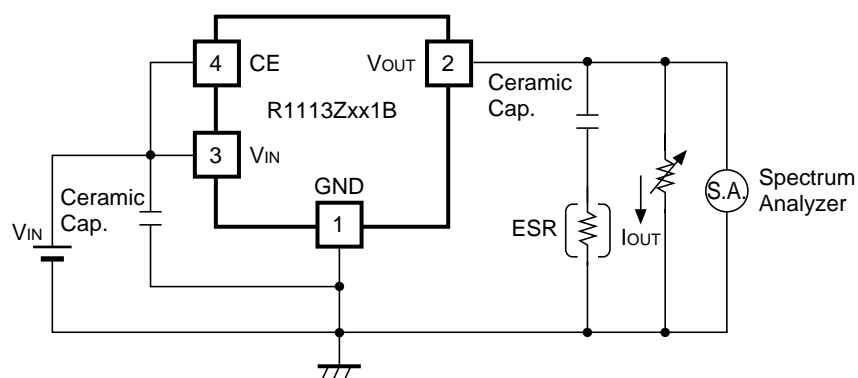




## TECHNICAL NOTES

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:  $25^{\circ}\text{C}$

