RICOH

# R1115Z SERIES

## LOW NOISE 150mA WL-CSP LDO

NO.EA-107-0512

## OUTLINE

The R1115Z Series are CMOS-based voltage regulator ICs with extremely low supply current, low ON-resistance, and high ripple rejection. Each of these ICs consists of a voltage reference unit, an error amplifier, resistor-net for voltage setting, 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 R1115Z 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 packages for these ICs is WL-CSP4-P4, therefore high density mounting of the ICs on boards is possible.

## FEATURES

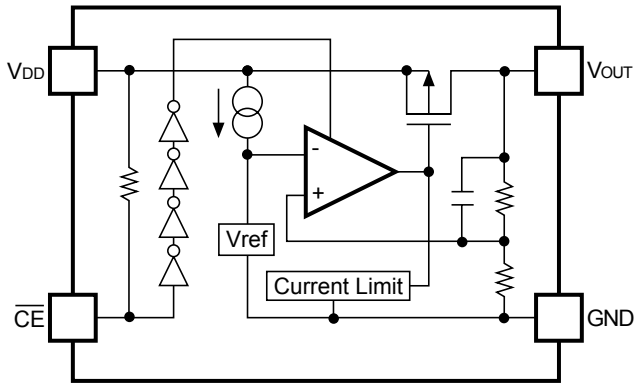
- Low Supply Current ..... Typ. 75μA
- Standby Mode ..... Typ. 0.1μA
- Low Dropout Voltage..... Typ. 0.22V ($I_{OUT}$=150mA 3.0V Output type)
- High Ripple Rejection ..... Typ. 70dB (f=1kHz 3.0V Output type)
  Typ. 60dB (f=10kHz)
- Low Temperature-Drift Coefficient of Output Voltage..... Typ. ±100ppm/°C
- Excellent Line Regulation ..... Typ. 0.02%/V
- High Output Voltage Accuracy ..... ±2.0%
- Small Packages ..... WL-CSP4-P4
- Output Voltage ..... Stepwise setting with a step of 0.1V in the range of 1.5V to 4.0V is possible
- Built-in Fold Back Protection Circuit ..... Typ. 40mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC ... $C_{IN}$=$C_{OUT}$=1μF ($V_{OUT}$<2.5V)
  $C_{IN}$=1μF, $C_{OUT}$=0.47μF ($V_{OUT}$ ≧ 2.5V)

## APPLICATIONS

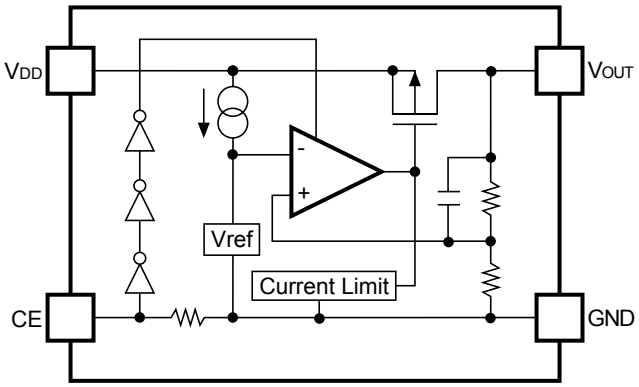
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

# BLOCK DIAGRAMS

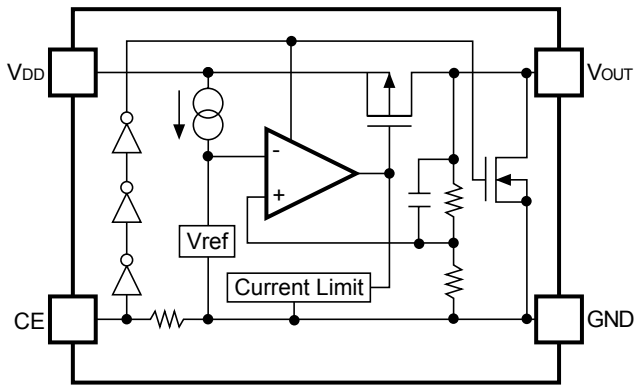
**R1115Zxx1A**




**R1115Zxx1B**




**R1115Zxx1D**




# SELECTION GUIDE

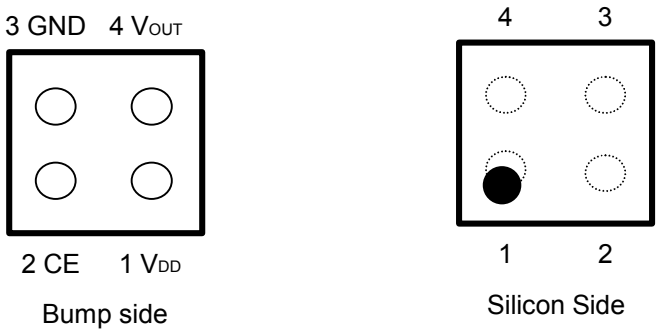
The output voltage, version, and the taping type for the ICs can be selected at the user's request.
The selection can be made with designating the part number as shown below;

R1115Z<u>xx</u>1x-<u>xx</u> ←Part Number
↑ ↑ ↑ ↑
a b c d

| Code | Contents |
|---|---|
| a | Designation of Package Type:<br>Z : WL-CSP4-P4 |
| b | Setting Output Voltage ($V_{OUT}$):<br>Stepwise setting with a step of 0.1V in the range of 1.5V to 4.0V is possible. |
| c | Designation of Active Type:<br>A: active low type<br>B: active high type<br>D: active high, with auto discharge |
| d | Designation of Taping Type:<br>Ex. TR (refer to Taping Specifications; TR type is the standard direction.) |

# PIN CONFIGURATION

- **WL-CSP4-P4**




# PIN DESCRIPTIONS

- **R1115Z**

| Pin No. | Symbol | Description |
|---|---|---|
| 1 | $V_{DD}$ | Input Pin |
| 2 | CE | Chip Enable Pin |
| 3 | GND | Ground Pin |
| 4 | $V_{OUT}$ | Output pin |

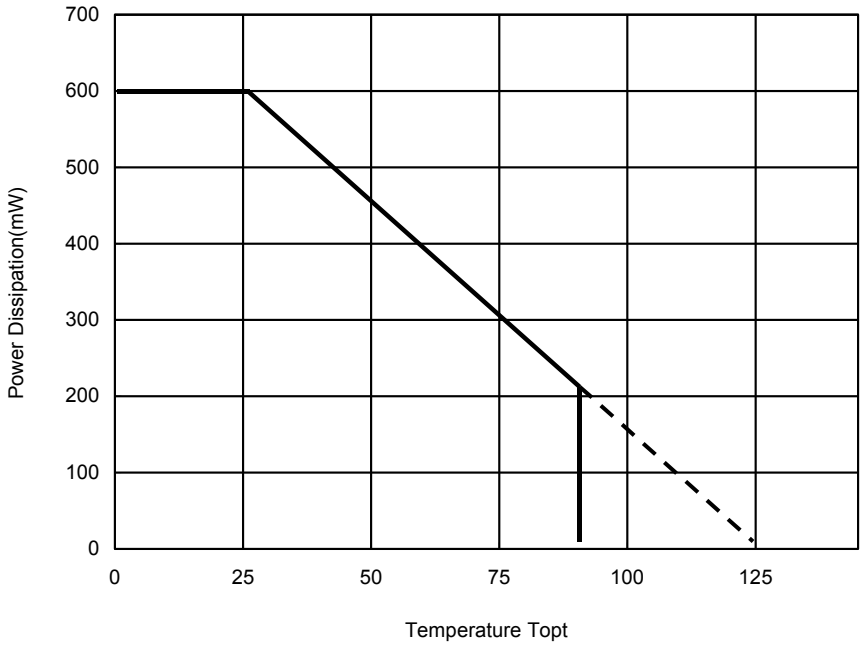
# ABSOLUTE MAXIMUM RATINGS

| Symbol | Item | Rating | Unit |
|---|---|---|---|
| $V_{IN}$ | Input Voltage | 6.5 | V |
| $V_{CE}$ | Input Voltage ( $\overline{CE}$ or CE Pin) | 6.5 | V |
| $V_{OUT}$ | Output Voltage | −0.3~$V_{IN}$+0.3 | V |
| $I_{OUT}$ | Output Current | 200 | mA |
| $P_D$ | Power Dissipation | *Note | mW |
| Topt | Operating Temperature Range | −40~85 | °C |
| Tstg | Storage Temperature Range | −55~125 | °C |

*Note :This specification is at mounted on board.

## Power Dissipation

∗Measurement Conditions
Test Conditions: Mounted on PCB (Wind velocity 0m/s)
Board Material: FR-4 (Double layer)
Board dimensions : 40mm× 40mm×t1.6mm
Metal Ratio :50%
*Result
$P_D$=600mW,Thermal Resistance 167℃/W



# ELECTRICAL CHARACTERISTICS

- **R1115Zxx1A**

Topt=25°C

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{OUT}$ | Output Voltage | $V_{IN}$ = Set $V_{OUT}$+1V<br>1mA ≦ $I_{OUT}$ ≦ 30mA | ×0.980 | | ×1.020 | V |
| $I_{OUT}$ | Output Current | $V_{IN}$–$V_{OUT}$ = 1.0V | 150 | | | mA |
| $\Delta V_{OUT}/\Delta I_{OUT}$ | Load Regulation | $V_{IN}$ = Set $V_{OUT}$+1V<br>1mA ≦ $I_{OUT}$ ≦ 150mA | | 22 | 40 | mV |
| $V_{DIF}$ | Dropout Voltage | Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE | | | | |
| $I_{SS}$ | Supply Current | $V_{IN}$ = Set $V_{OUT}$+1V, $I_{OUT}$ = 0mA | | 75 | 95 | μA |
| Istandby | Supply Current (Standby) | $V_{IN}$ = Set $V_{OUT}$+1V<br>$V_{CE}$ = $V_{DD}$ | | 0.1 | 1.0 | μA |
| $\Delta V_{OUT}/\Delta V_{IN}$ | Line Regulation | $V_{OUT}$ > 1.7V,<br>Set $V_{OUT}$+0.5V ≦ $V_{IN}$ ≦ 6.0V<br>($V_{OUT}$ ≦ 1.7V, 2.2V ≤ $V_{IN}$ ≦ 6.0V)<br>$I_{OUT}$ = 30mA | | 0.02 | 0.10 | %/V |
| RR | Ripple Rejection | f=1kHz<br>f=10kHz<br>Ripple 0.5Vp–p<br>$V_{OUT}$ > 1.7V, $V_{IN}$–$V_{OUT}$ = 1.0V<br>$V_{OUT}$ ≦ 1.7, $V_{IN}$–$V_{OUT}$ = 1.2V<br>$I_{OUT}$ = 30mA | | 70<br>60 | | dB |
| $V_{IN}$ | Input Voltage | | 2.0 | | 6.0 | V |
| $\Delta V_{OUT}/\Delta Topt$ | Output Voltage Temperature Coefficient | $I_{OUT}$ = 30mA<br>–40°C ≦ Topt ≦ 85°C | | ±100 | | ppm /°C |
| Ilimit | Short Current Limit | $V_{OUT}$ = 0V | | 40 | | mA |
| $R_{PU}$ | CE Pull-up Resistance | | 0.7 | 2.0 | 8.0 | MΩ |
| $V_{CEH}$ | CE Input Voltage “H” | | 1.5 | | 6.0 | V |
| $V_{CEL}$ | CE Input Voltage “L” | | 0.0 | | 0.3 | V |
| en | Output Noise | BW = 10Hz to 100kHz | | 30 | | μVrms |

- **R1115Zxx1B/D**

Topt=25°C

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{OUT}$ | Output Voltage | $V_{IN}$ = Set $V_{OUT}$+1V<br>1mA ≦ $I_{OUT}$ ≦ 30mA | ×0.980 | | ×1.020 | V |
| $I_{OUT}$ | Output Current | $V_{IN}$–$V_{OUT}$ = 1.0V | 150 | | | mA |
| $\Delta V_{OUT}/\Delta I_{OUT}$ | Load Regulation | $V_{IN}$ = Set $V_{OUT}$+1V<br>1mA ≦ $I_{OUT}$ ≦ 150mA | | 22 | 40 | mV |
| $V_{DIF}$ | Dropout Voltage | Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE | | | | |
| $I_{SS}$ | Supply Current | $V_{IN}$ = Set $V_{OUT}$+1V, $I_{OUT}$ = 0mA | | 75 | 95 | μA |
| Istandby | Supply Current (Standby) | $V_{IN}$ = Set $V_{OUT}$+1V<br>$V_{CE}$ = GND | | 0.1 | 1.0 | μA |
| $\Delta V_{OUT}/\Delta V_{IN}$ | Line Regulation | $V_{OUT}$ > 1.7V,<br>Set $V_{OUT}$+0.5V ≦ $V_{IN}$ ≦ 6.0V<br>($V_{OUT}$ ≦ 1.7V, 2.2V ≤<br>$V_{IN}$ ≦ 6.0V) $I_{OUT}$ = 30mA | | 0.02 | 0.10 | %/V |
| RR | Ripple Rejection | f=1kHz<br>f=10kHz<br>Ripple 0.5Vp–p<br>$V_{OUT}$ > 1.7V, $V_{IN}$–$V_{OUT}$ = 1.0V<br>$V_{OUT}$ ≦ 1.7, $V_{IN}$–$V_{OUT}$ = 1.2V<br>$I_{OUT}$ = 30mA | | 70<br>60 | | dB |
| $V_{IN}$ | Input Voltage | | 2.0 | | 6.0 | V |
| $\Delta V_{OUT}/\Delta Topt$ | Output Voltage Temperature Coefficient | $I_{OUT}$ = 30mA<br>–40°C ≦ Topt ≦ 85°C | | ±100 | | ppm/°C |
| Ilimit | Short Current Limit | $V_{OUT}$ = 0V | | 40 | | mA |
| $R_{PD}$ | CE Pull-down Resistance | | 0.7 | 2.0 | 8.0 | MΩ |
| $V_{CEH}$ | CE Input Voltage “H” | | 1.5 | | 6.0 | V |
| $V_{CEL}$ | CE Input Voltage “L” | | 0.0 | | 0.3 | V |
| en | Output Noise | BW = 10Hz to 100kHz | | 30 | | μVrms |
| $R_{LOW}$ | On Resistance of Nch for auto-discharge (Only for D version) | $V_{CE}$ = 0V | | 60 | | Ω |

- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE**

Topt = 25°C

| Output Voltage $V_{OUT}$ (V) | Dropout Voltage $V_{DIF}$ (V) | | |
|---|---|---|---|
| | Condition | Typ. | Max. |
| $V_{OUT}$ = 1.5 | $I_{OUT}$=150mA | 0.38 | 0.70 |
| $V_{OUT}$ = 1.6 | | 0.36 | 0.65 |
| $V_{OUT}$ = 1.7 | | 0.34 | 0.60 |
| 1.8 ≦ $V_{OUT}$ ≦ 2.0 | | 0.32 | 0.55 |
| 2.1 ≦ $V_{OUT}$ ≦ 2.7 | | 0.28 | 0.50 |
| 2.8 ≦ $V_{OUT}$ ≦ 4.0 | | 0.22 | 0.35 |

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

PCB Layout

Make $V_{DD}$ and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor with a capacitance value as much as 1.0μF or more between $V_{DD}$ and GND pin, and as close as possible to the pins.

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

# TEST CIRCUITS

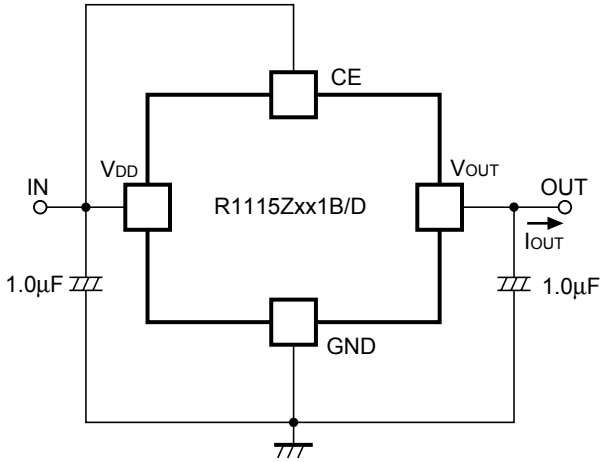



**Fig.1 Standard test Circuit**

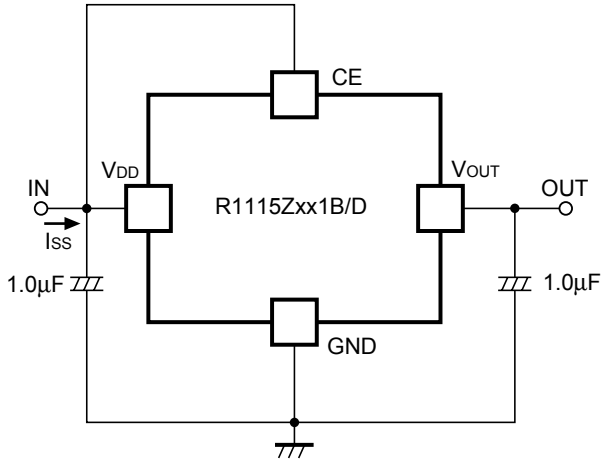



**Fig.2 Supply Current Test Circuit**

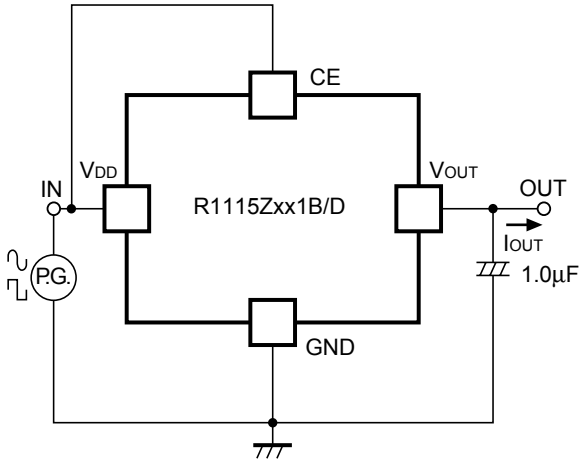



**Fig.3 Ripple Rejection, Line Transient Response Test Circuit**

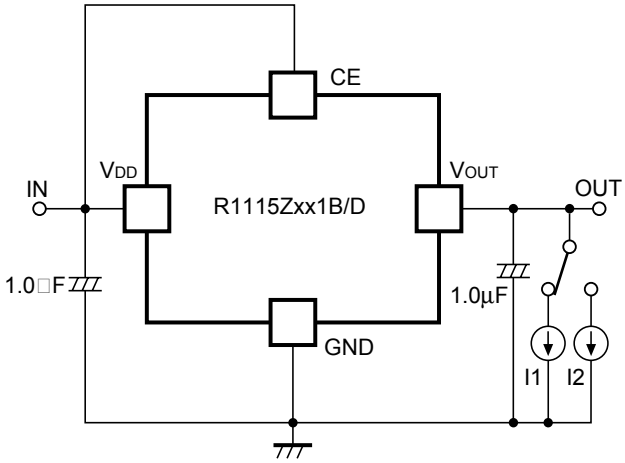
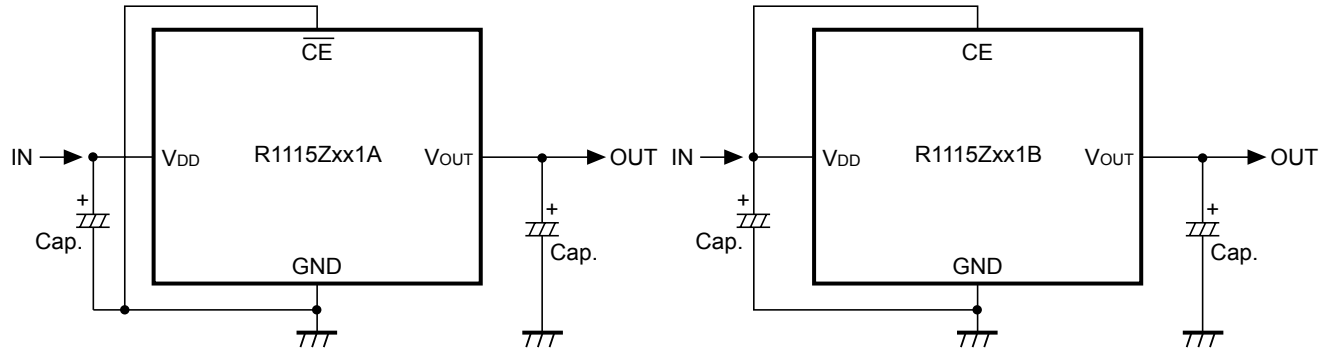



**Fig.4 Load Transient Response Test Circuit**

# TYPICAL APPLICATIONS

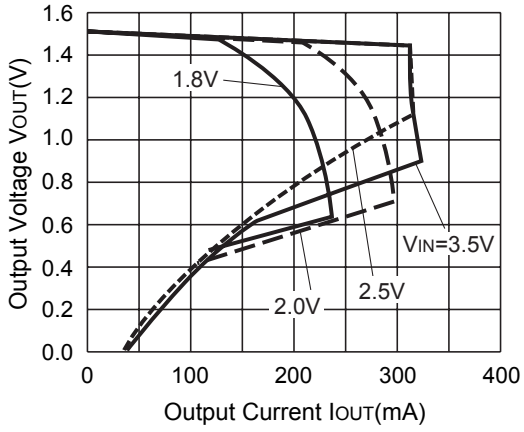



(External Components)
Output Capacitor; Ceramic 0.47μF (Set Output Voltage in the range from 2.5 to 4.0V)
Ceramic 1.0μF (Set Output Voltage in the range from 1.5 to 2.4V)
Input Capacitor; Ceramic 1.0μF

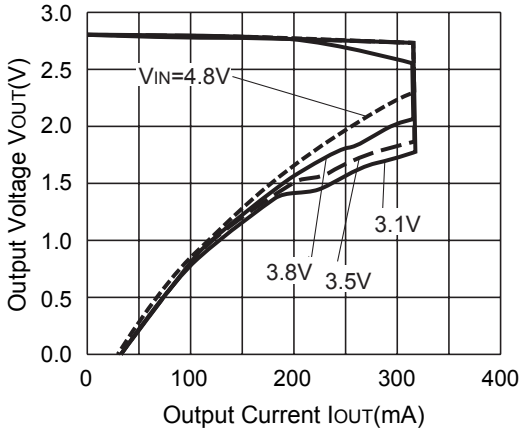
# TYPICAL CHARACTERISTICS

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

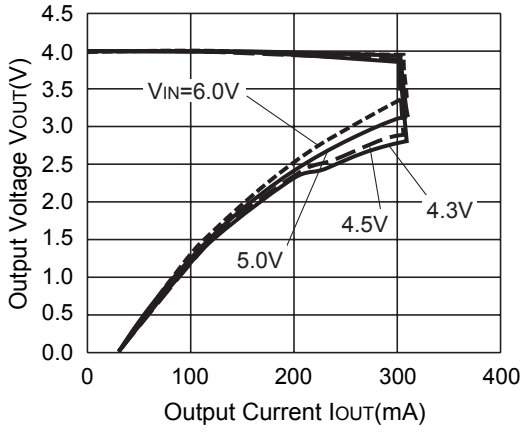
**R1115Z151x**




**R1115Z281x**

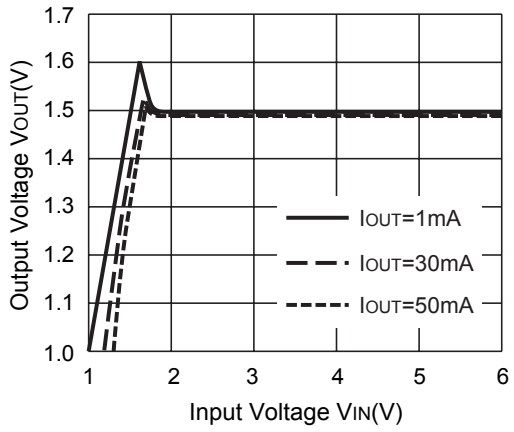



**R1115Z401x**

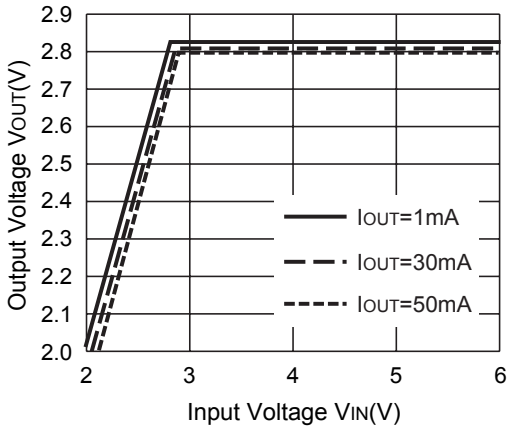


2) Output Voltage vs. Input Voltage (Topt=25°C)

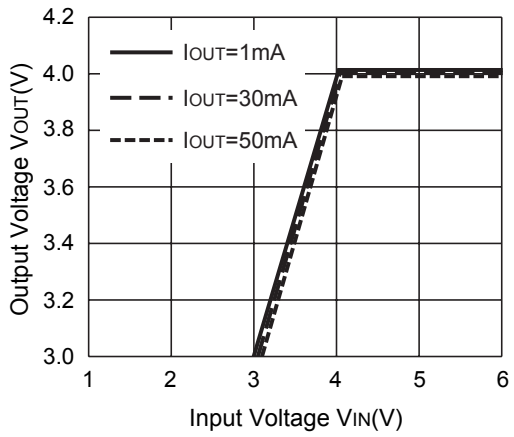
**R1115Z151x**




**R1115Z281x**

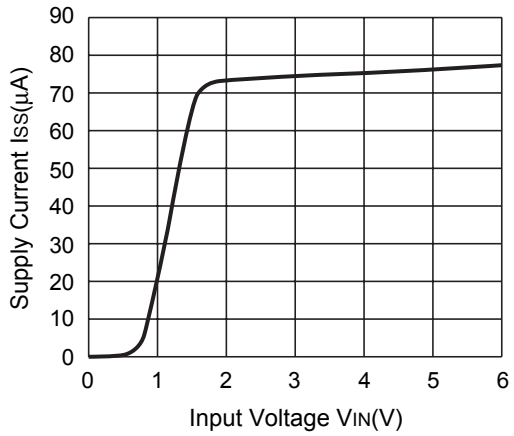



**R1115Z401x**

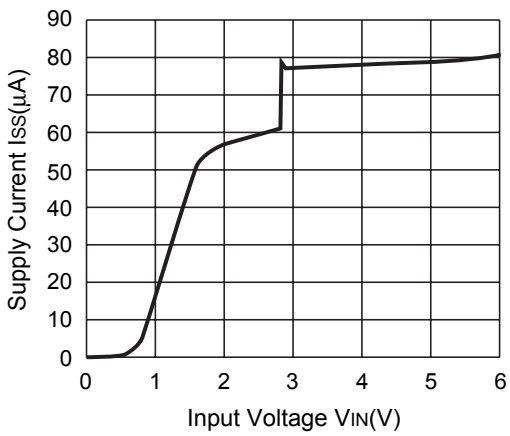



3) Supply Current vs. Input Voltage (Topt=25°C)

**R1115Z151x**




**R1115Z281x**



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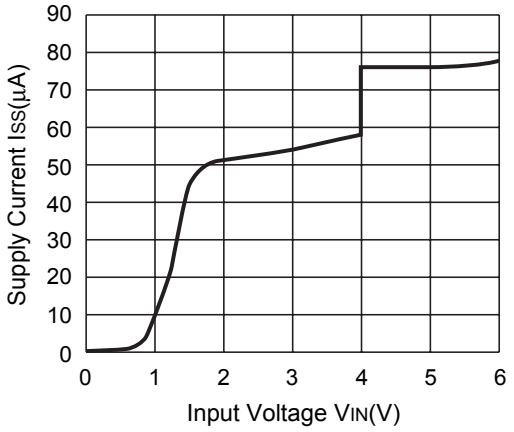
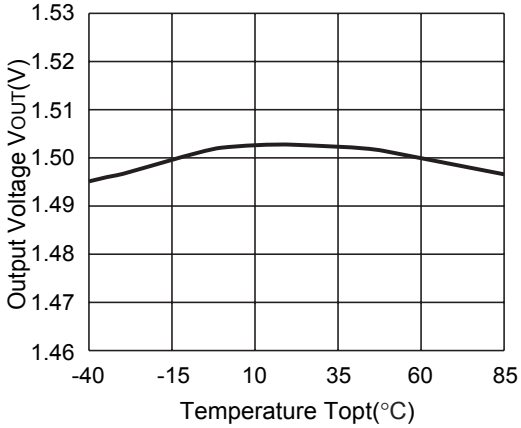



4) Output Voltage vs. Temperature

**R1115Z151x**

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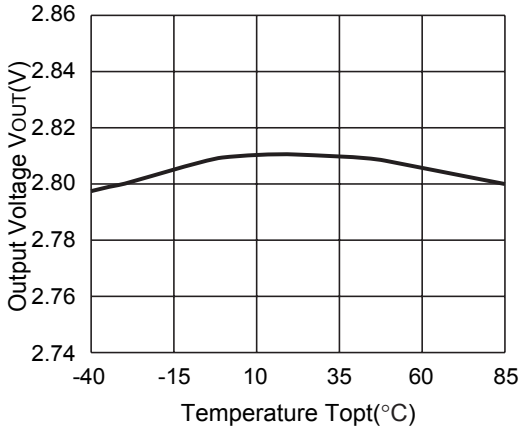


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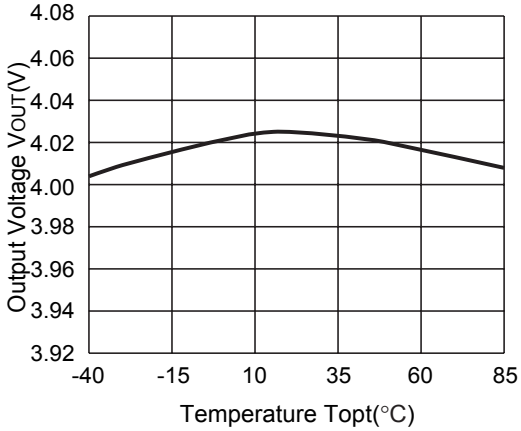
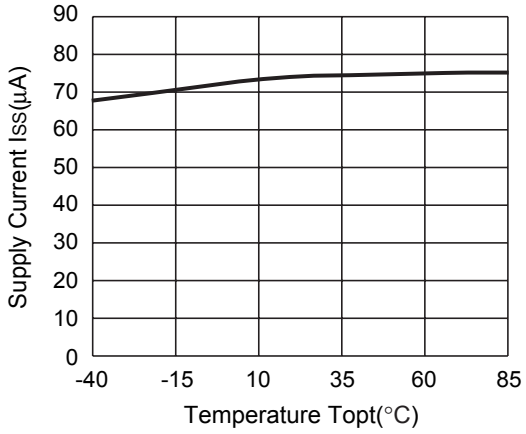


5) Supply Current vs. Temperature

**R1115Z151x**

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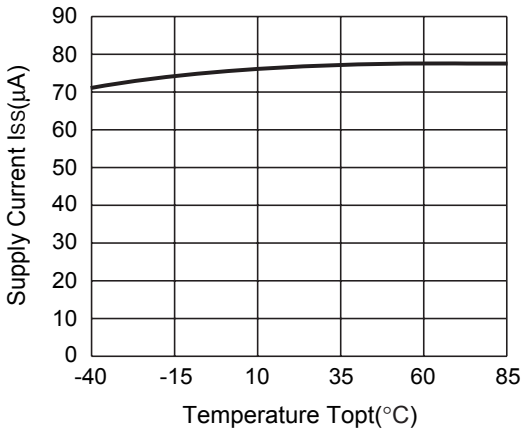


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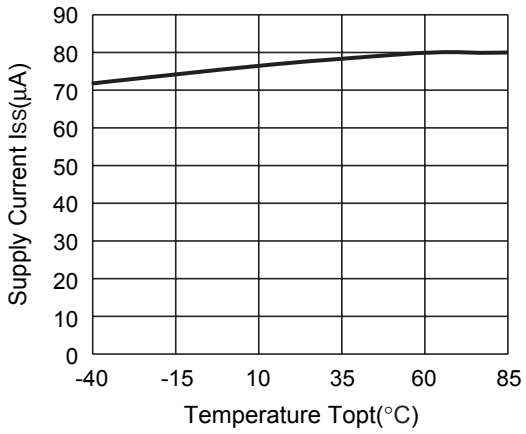
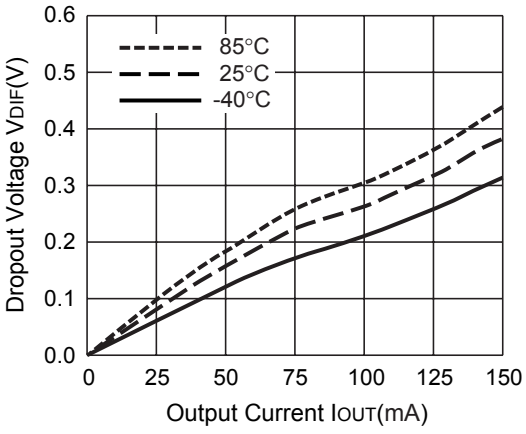
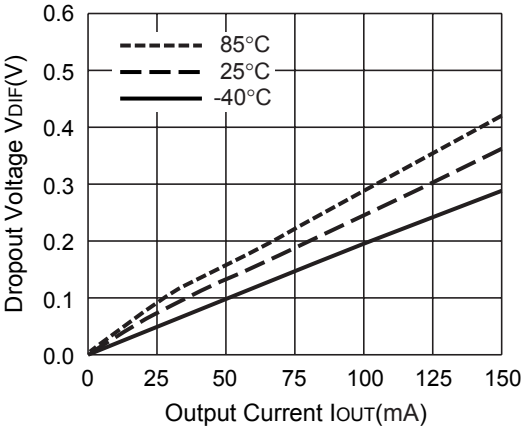



6) Dropout Voltage vs. Temperature

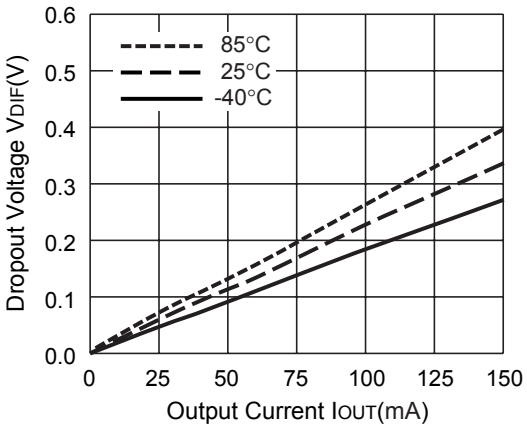
**R1115Z151x**



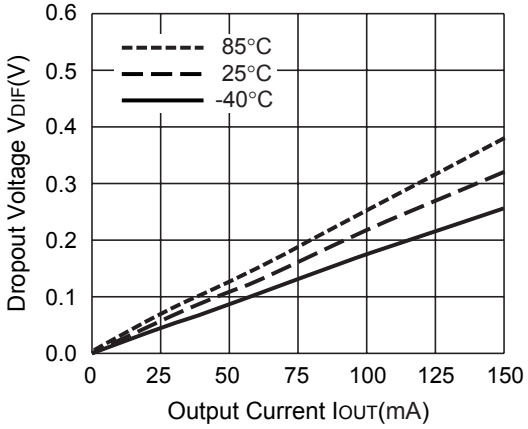

**R1115Z161x**



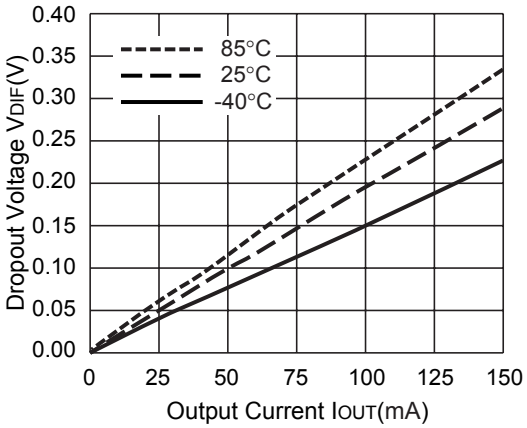
**R1115Z171x**



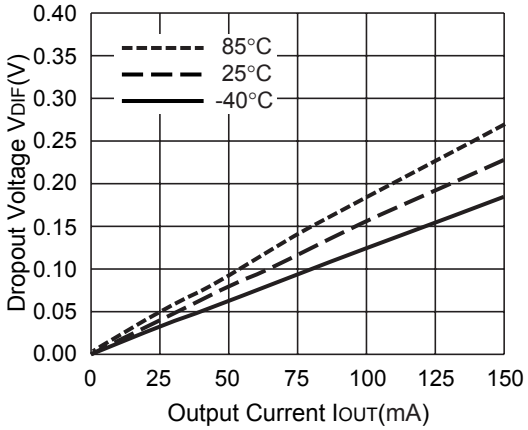

**R1115Z181x**



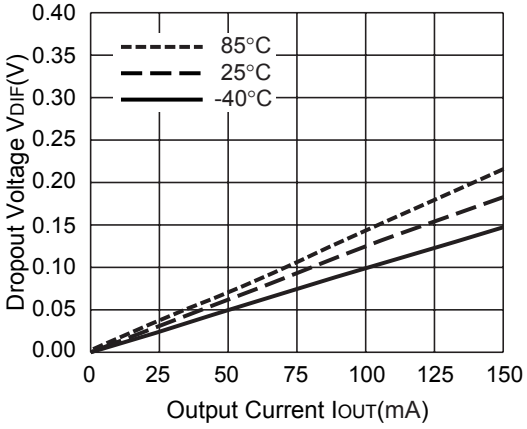

**R1115Z211x**



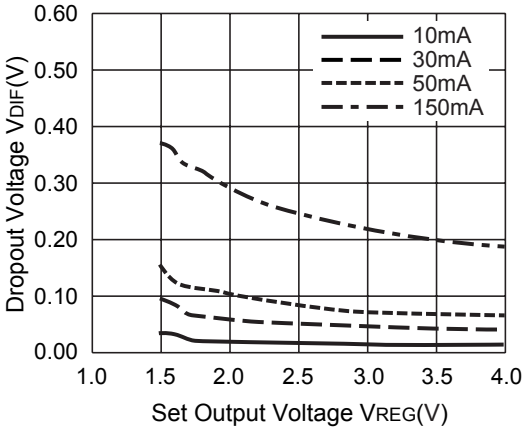

**R1115Z281x**




**R1115Z401x**

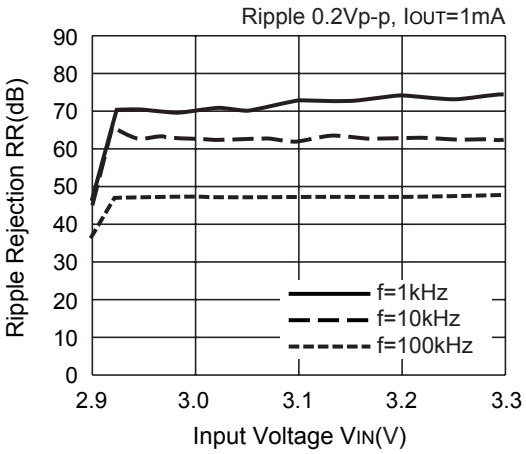


7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)

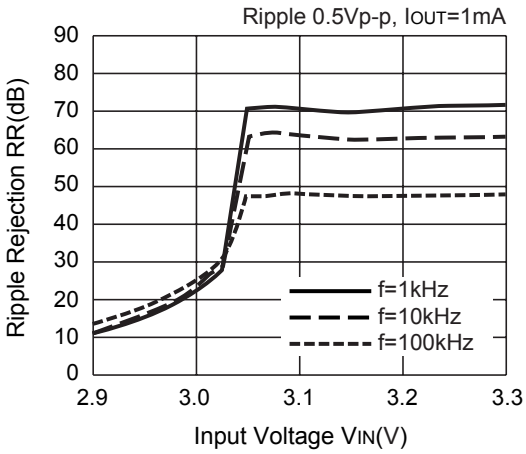



8) Ripple Rejection vs. Input Bias Voltage (Topt=25°C, CIN=none, COUT=ceramic0.47μF)

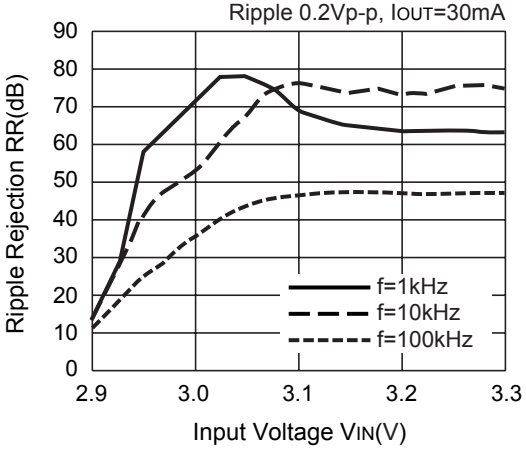
**R1115Z281x**



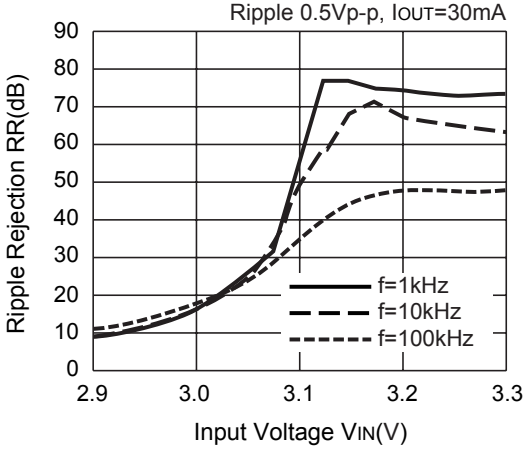

**R1115Z281x**



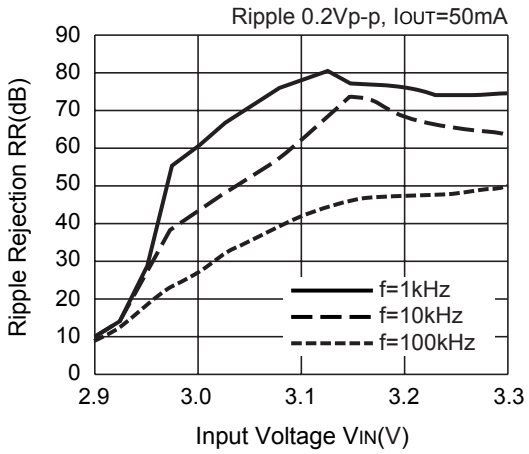

**R1115Z281x**



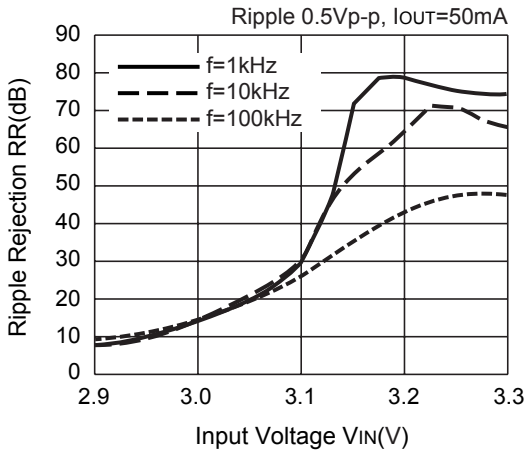

**R1115Z281x**



**R1115Z281x**

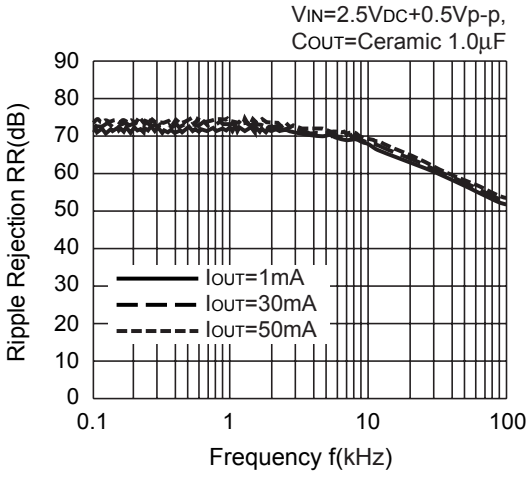



**R1115Z281x**

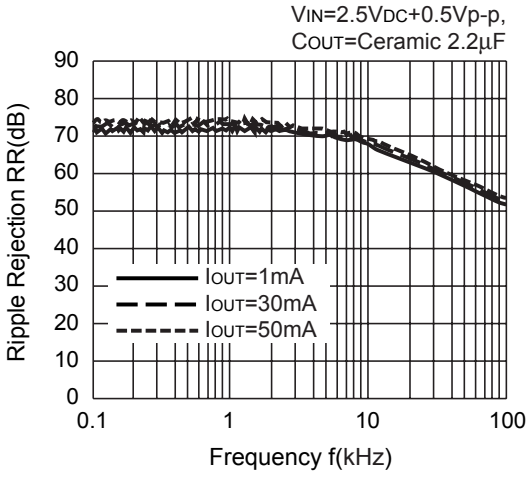



9) Ripple Rejection vs. Frequency ($C_{IN}$=none)

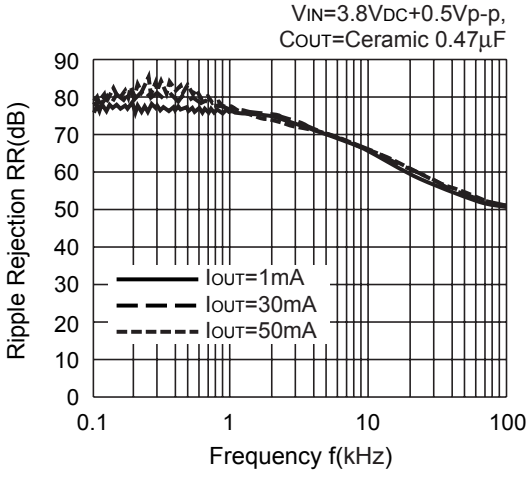
**R1115Z151x**



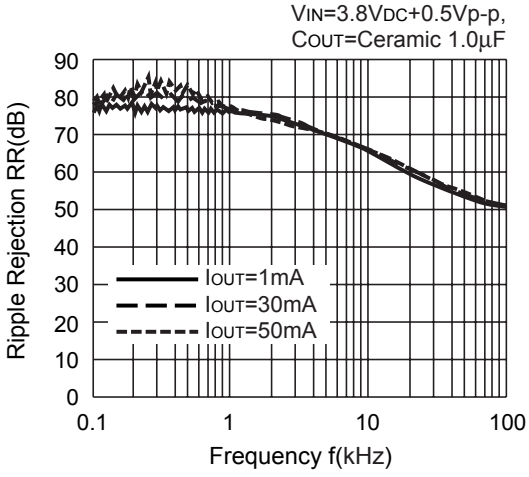

**R1115Z151x**



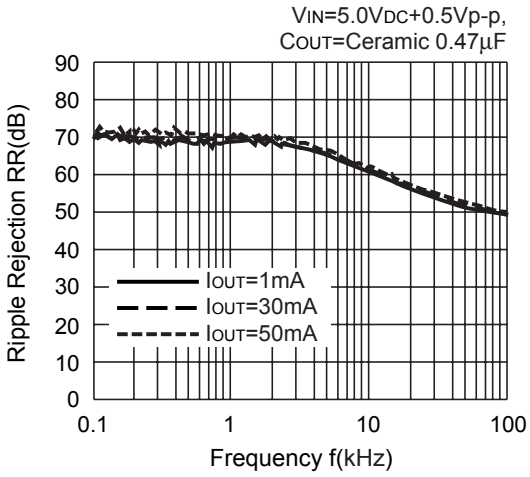

**R1115Z281x**



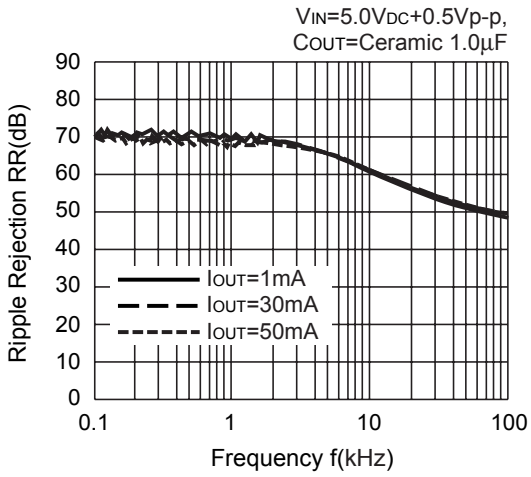

**R1115Z281x**



**R1115Z401x**

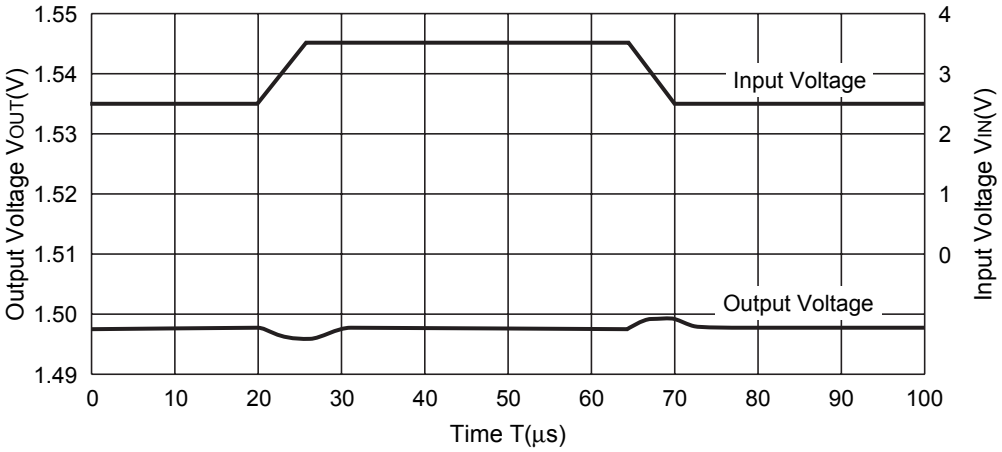



**R1115Z401x**

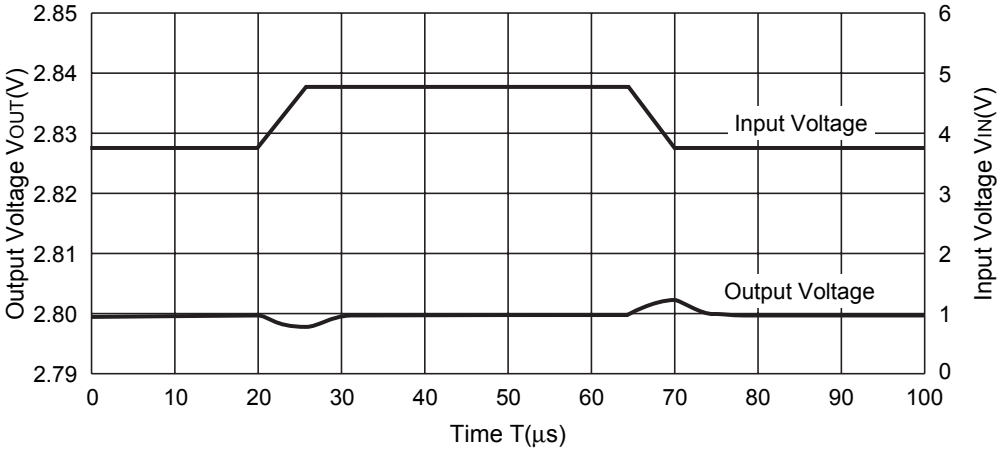



10) Input Transient Response ($I_{OUT}$=30mA, $C_{IN}$=none, tr=tf=5μs, $C_{OUT}$=Ceramic 0.47μF)

**R1115Z151x**

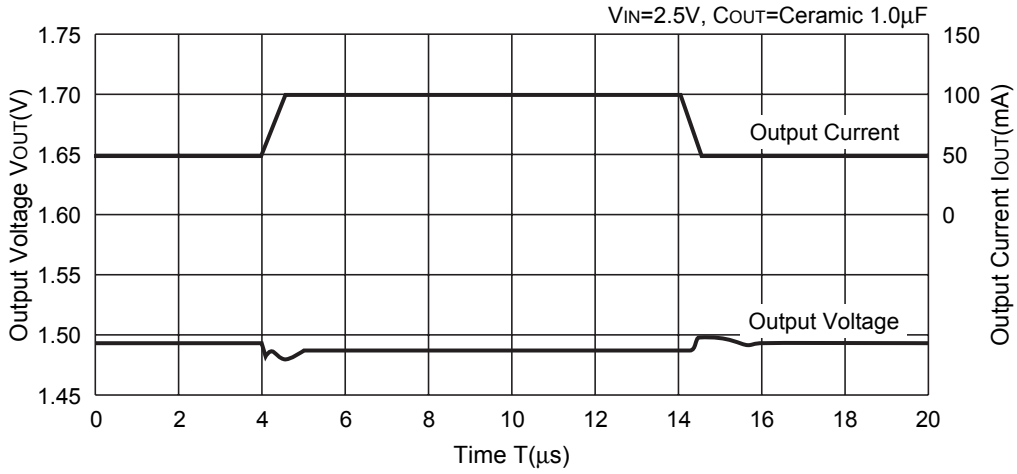



**R1115Z281x**

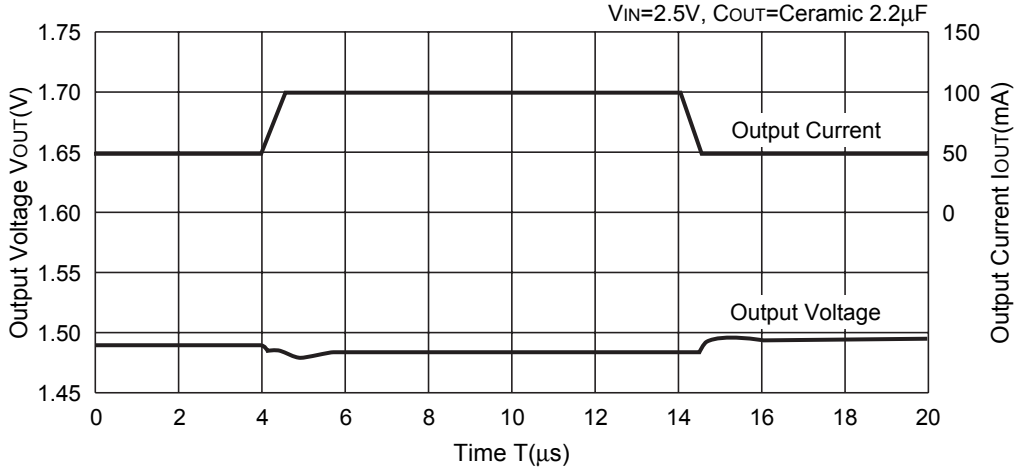


11) Load Transient Response (tr=tf=0.5µs, $C_{IN}$=Ceramic 1.0µF)

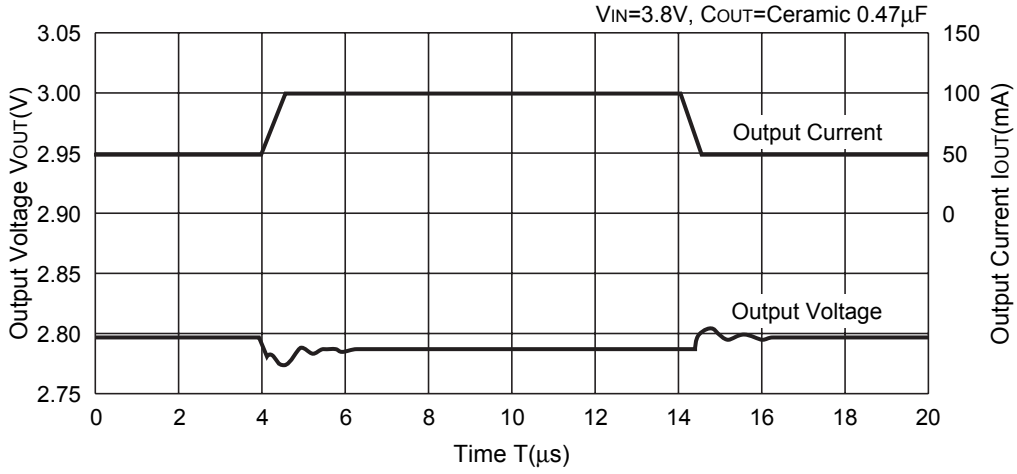
**R1115Z151x**



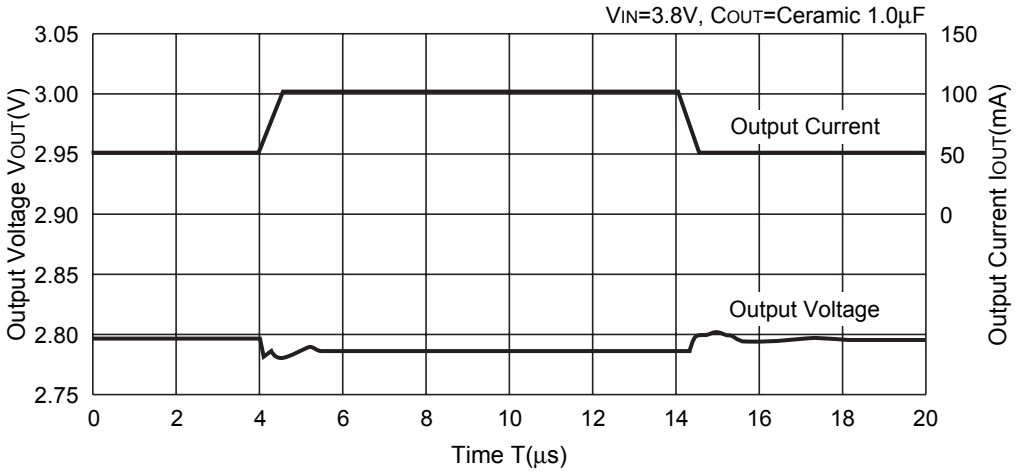

**R1115Z151x**



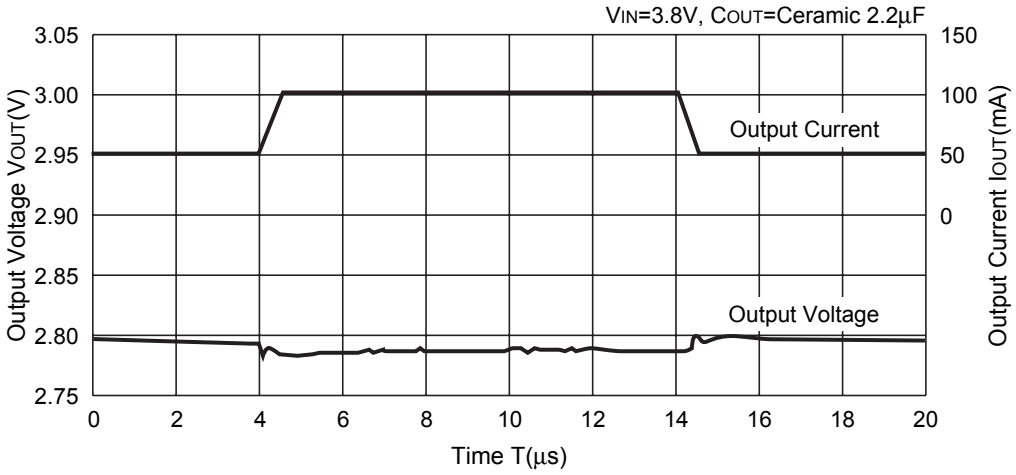

**R1115Z281x**



**R1115Z281x**

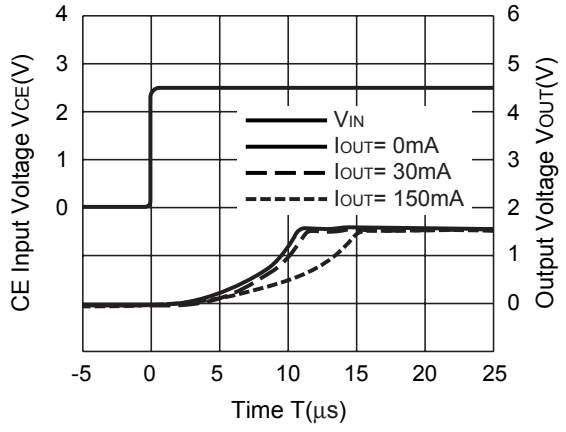


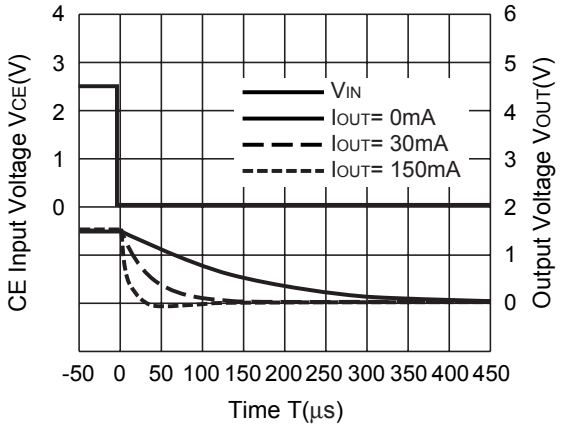

**R1115Z281x**



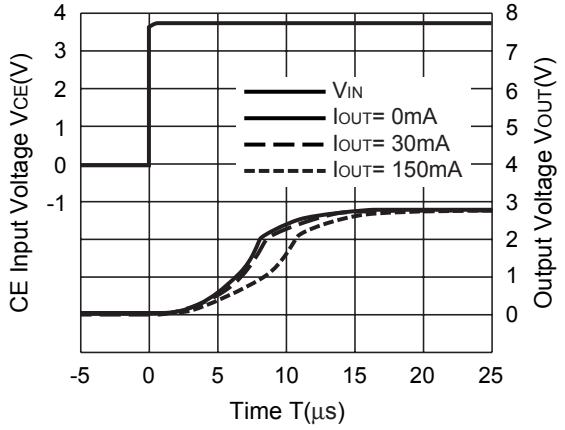

12) Turn-on/off speed with CE pin (D version)

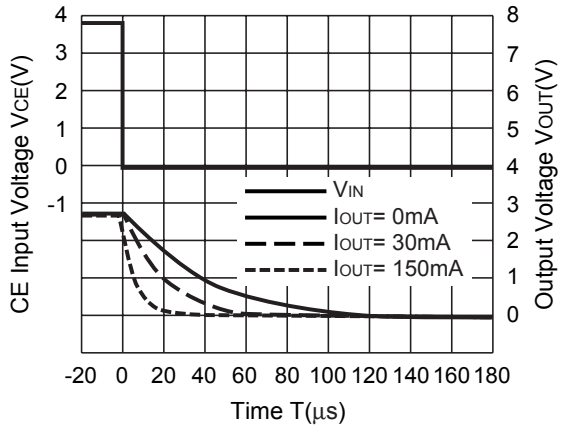
**R1115Z151D ($V_{IN}$=2.5V, $C_{IN}$=Ceramic 1.0µF, $C_{OUT}$=Ceramic 1.0µF)**



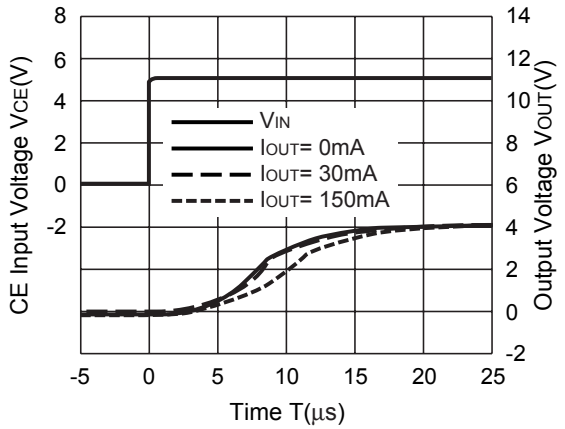



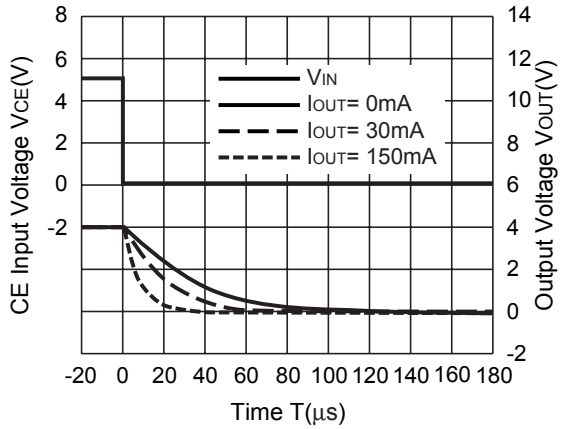
**R1115Z281D ($V_{IN}$=3.8V, $C_{IN}$=Ceramic 0.47μF, $C_{OUT}$=Ceramic 0.47μF)**




**R1115Z401D ($V_{IN}$=5.0V, $C_{IN}$=Ceramic 0.47μF, $C_{OUT}$=Ceramic 0.47μF)**

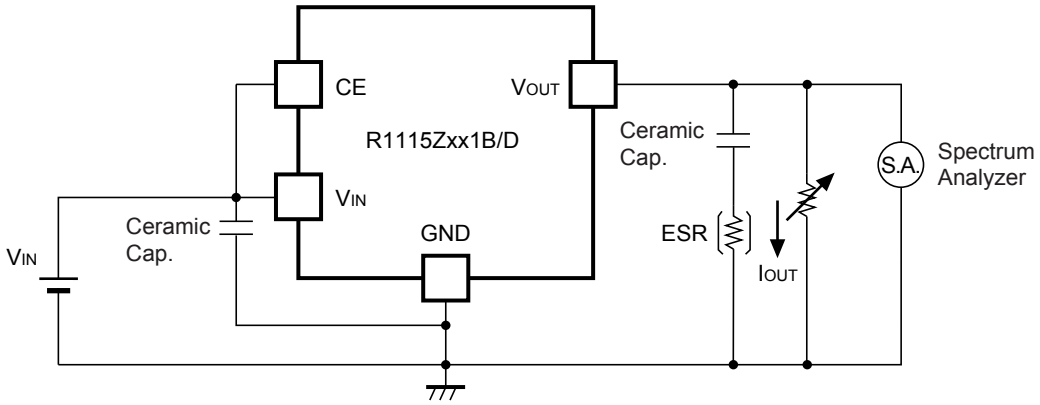


## ESR vs. Output Current

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; R1115Zxx1B/D**

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

(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.)

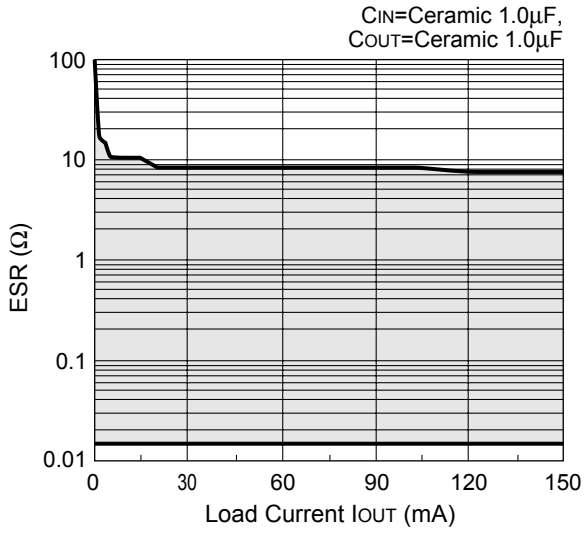
<Measurement conditions>

(1) $V_{IN}=V_{OUT}+1V$

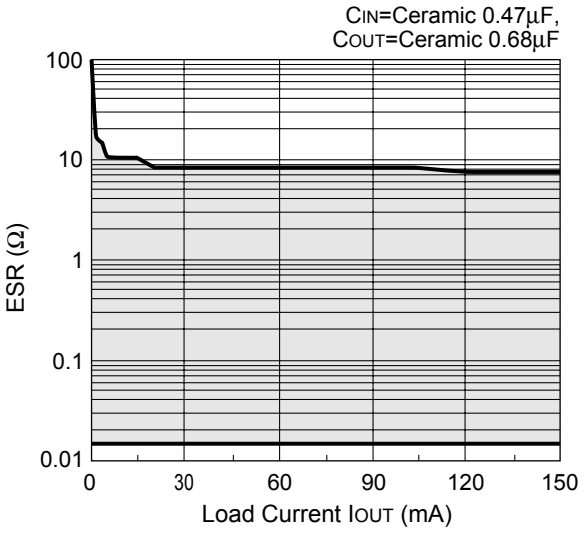
(2) Frequency Band: 10Hz to 2MHz

(3) Temperature: −40°C to 25°C

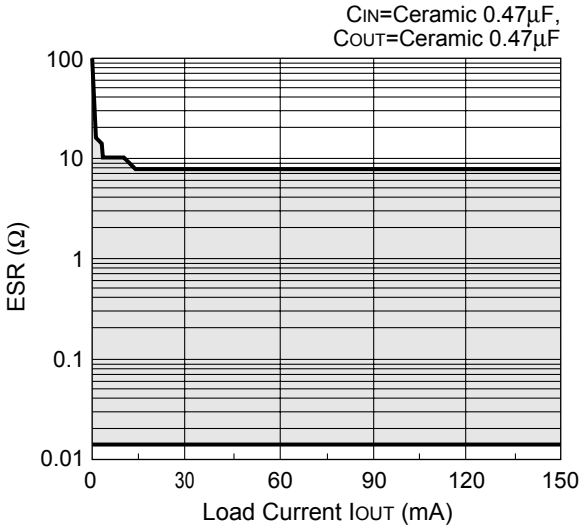
**R1115Z151x**



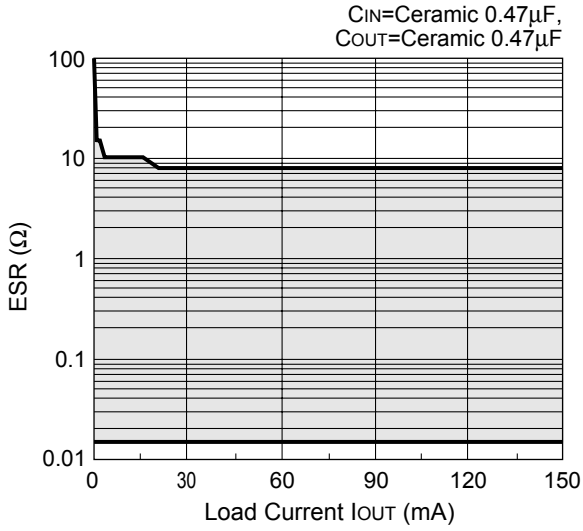

**R1115Z161x**



**R1115Z211x**



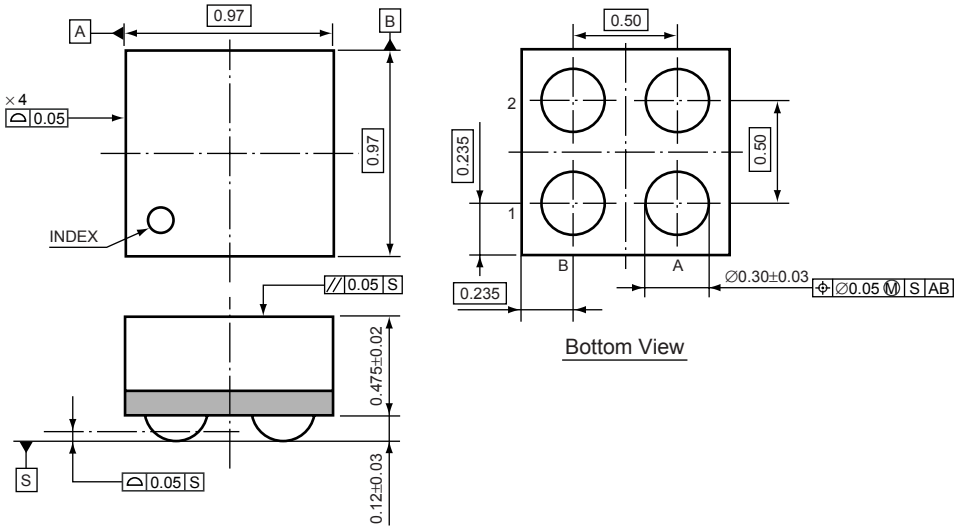

**R1115Z281x**



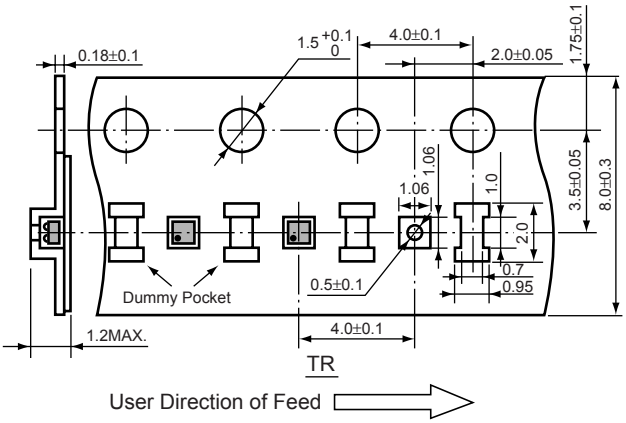
- **WL-CSP4-P4**

Unit: mm

# PACKAGE DIMENSIONS

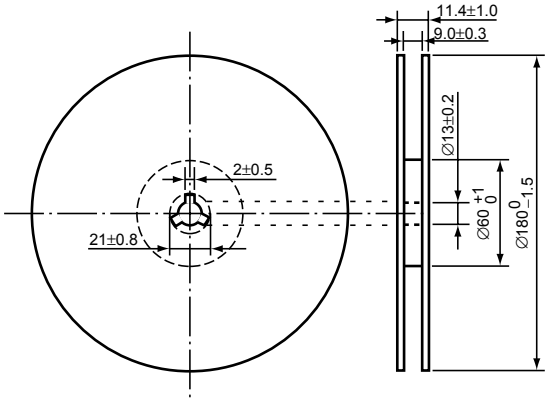



# TAPING SPECIFICATION



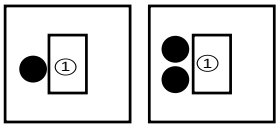

# TAPING REEL DIMENSIONS

(1reel=3000pcs)



# R1115Z SERIES MARK SPECIFICATION

- **WLCSP-4-P4**




① : Lot Number

- **Product Code vs. Marking**

| Part Number | Dot |
|---|---|
| R1115Z151A | ● or ●● |
| R1115Z161A | ● or ●● |
| R1115Z171A | ● or ●● |
| R1115Z181A | ● or ●● |
| R1115Z191A | ● or ●● |
| R1115Z201A | ● or ●● |
| R1115Z211A | ● or ●● |
| R1115Z221A | ● or ●● |
| R1115Z231A | ● or ●● |
| R1115Z241A | ● or ●● |
| R1115Z251A | ● or ●● |
| R1115Z261A | ● or ●● |
| R1115Z271A | ● or ●● |
| R1115Z281A | ● or ●● |
| R1115Z291A | ● or ●● |
| R1115Z301A | ● or ●● |
| R1115Z311A | ● or ●● |
| R1115Z321A | ● or ●● |
| R1115Z331A | ● or ●● |
| R1115Z341A | ● or ●● |
| R1115Z351A | ● or ●● |
| R1115Z361A | ● or ●● |
| R1115Z371A | ● or ●● |
| R1115Z381A | ● or ●● |
| R1115Z391A | ● or ●● |
| R1115Z401A | ● or ●● |
| R1115Z281A5 | ● or ●● |

| Part Number | Dot |
|---|---|
| R1115Z151B | ● or ●● |
| R1115Z161B | ● or ●● |
| R1115Z171B | ● or ●● |
| R1115Z181B | ● or ●● |
| R1115Z191B | ● or ●● |
| R1115Z201B | ● or ●● |
| R1115Z211B | ● or ●● |
| R1115Z221B | ● or ●● |
| R1115Z231B | ● or ●● |
| R1115Z241B | ● or ●● |
| R1115Z251B | ● or ●● |
| R1115Z261B | ● or ●● |
| R1115Z271B | ● or ●● |
| R1115Z281B | ● or ●● |
| R1115Z291B | ● or ●● |
| R1115Z301B | ● or ●● |
| R1115Z311B | ● or ●● |
| R1115Z321B | ● or ●● |
| R1115Z331B | ● or ●● |
| R1115Z341B | ● or ●● |
| R1115Z351B | ● or ●● |
| R1115Z361B | ● or ●● |
| R1115Z371B | ● or ●● |
| R1115Z381B | ● or ●● |
| R1115Z391B | ● or ●● |
| R1115Z401B | ● or ●● |
| R1115Z281B5 | ● or ●● |

| Part Number | Dot |
|---|---|
| R1115Z151D | ● or ●● |
| R1115Z161D | ● or ●● |
| R1115Z171D | ● or ●● |
| R1115Z181D | ● or ●● |
| R1115Z191D | ● or ●● |
| R1115Z201D | ● or ●● |
| R1115Z211D | ● or ●● |
| R1115Z221D | ● or ●● |
| R1115Z231D | ● or ●● |
| R1115Z241D | ● or ●● |
| R1115Z251D | ● or ●● |
| R1115Z261D | ● or ●● |
| R1115Z271D | ● or ●● |
| R1115Z281D | ● or ●● |
| R1115Z291D | ● or ●● |
| R1115Z301D | ● or ●● |
| R1115Z311D | ● or ●● |
| R1115Z321D | ● or ●● |
| R1115Z331D | ● or ●● |
| R1115Z341D | ● or ●● |
| R1115Z351D | ● or ●● |
| R1115Z361D | ● or ●● |
| R1115Z371D | ● or ●● |
| R1115Z381D | ● or ●● |
| R1115Z391D | ● or ●● |
| R1115Z401D | ● or ●● |
| R1115Z281D5 | ● or ●● |