
LOW NOISE 150mA LDO Regulator

NO.EA-107-100202

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 package for these ICs is WLCSP-4-P4, therefore high density mounting of the ICs on boards is possible.

FEATURES

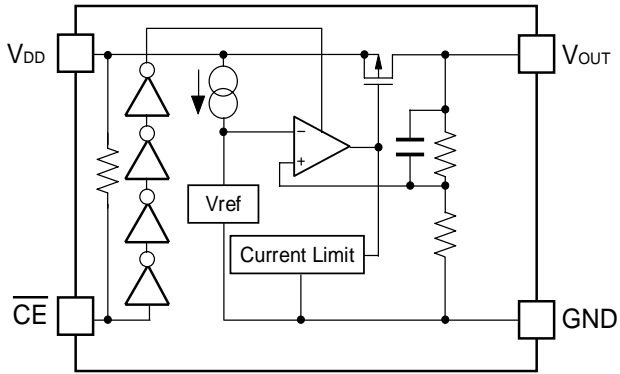
- Supply Current Typ. 75 μ A
- Standby Current Typ. 0.1 μ A
- Output Voltage Range..... 1.5V to 4.0V (0.1V steps)
(For other voltages, please refer to MARK INFORMATION.)
- Dropout Voltage Typ. 0.22V ($I_{OUT}=150\text{mA}$, $V_{OUT}=3.0\text{V}$)
- Ripple Rejection Typ. 70dB ($f=1\text{kHz}$)
Typ. 60dB ($f=10\text{kHz}$)
- Temperature-Drift Coefficient of Output Voltage Typ. $\pm 100\text{ppm}/^\circ\text{C}$
- Line Regulation Typ. 0.02%/V
- Output Voltage Accuracy $\pm 2.0\%$
- Package WLCSP-4-P4
- Built-in Fold Back Protection Circuit Typ. 40mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC ... $C_{IN}=C_{OUT}=1\mu\text{F}$ ($V_{OUT}<2.5\text{V}$)
 $C_{IN}=1\mu\text{F}$, $C_{OUT}=0.47\mu\text{F}$ ($V_{OUT} \geq 2.5\text{V}$)

APPLICATIONS

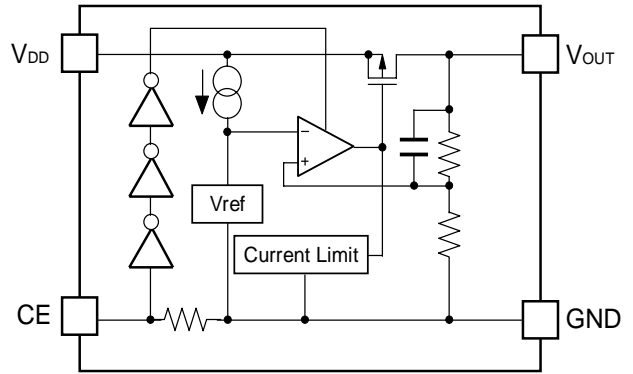
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

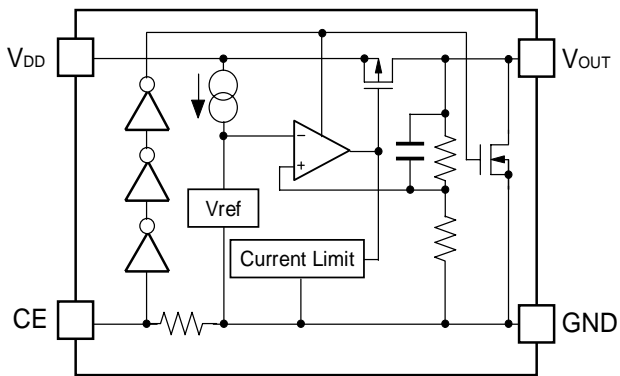
R1115Zxx1A



R1115Zxx1B



R1115Zxx1D



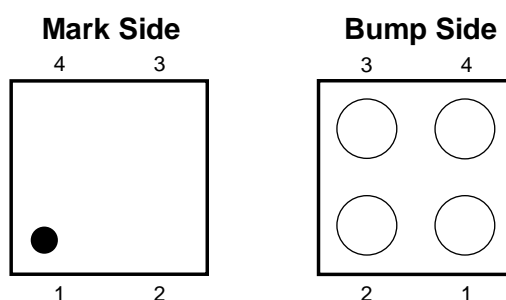
SELECTION GUIDE

The output voltage, auto discharge function, etc. for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1115Zxx1*-TR-F	WLCSP-4-P4	3,000 pcs	Yes	Yes
xx: The output voltage can be designated in the range from 1.5V(15) to 4.0V(40) in 0.1V steps. (For other voltages, please refer to MARK INFORMATIONS.)				
* : CE pin polarity and auto discharge function at off state are options as follows. (A) "L" active, without auto discharge function at off state (B) "H" active, without auto discharge function at off state (D) "H" active, with auto discharge function at off state				

PIN CONFIGURATION

● WLCSP-4-P4



PIN DESCRIPTION

● R1115Z

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

ABSOLUTE MAXIMUM RATING

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 to $V_{IN}+0.3$	V
I_{OUT}	Output Current	200	mA
P_D	Power Dissipation*	600	mW
T_{opt}	Operating Temperature Range	-40 to 85	°C
T_{stg}	Storage Temperature Range	-55 to 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.

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

• R1115Zxx1A

T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V _{OUT}	Output Voltage	V _{IN} =Set V _{OUT} +1V 1mA ≤ I _{OUT} ≤ 30mA	×0.98		×1.02	V	
I _{OUT}	Output Current	V _{IN} -V _{OUT} =1.0V	150			mA	
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	V _{IN} =Set V _{OUT} +1V 1mA ≤ I _{OUT} ≤ 150mA		22	40	mV	
V _{DIF}	Dropout Voltage	I _{OUT} =150mA	V _{OUT} = 1.5V		0.38	0.70	V
			V _{OUT} = 1.6V		0.36	0.65	
			V _{OUT} = 1.7V		0.34	0.60	
			1.8V ≤ V _{OUT} ≤ 2.0V		0.32	0.55	
			2.1V ≤ V _{OUT} ≤ 2.7V		0.28	0.50	
			2.8V ≤ V _{OUT} ≤ 4.0V		0.22	0.35	
I _{SS}	Supply Current	V _{IN} =Set V _{OUT} +1V, I _{OUT} =0mA		75	95	μA	
I _{standby}	Standby Current	V _{IN} =Set V _{OUT} +1V V _{CE} =V _{DD}		0.1	1.0	μA	
ΔV _{OUT} /ΔV _{IN}	Line Regulation	I _{OUT} =30mA V _{OUT} > 1.6V, Set V _{OUT} +0.5V ≤ V _{IN} ≤ 6.0V (V _{OUT} ≤ 1.6V, 2.2V ≤ V _{IN} ≤ 6.0V)		0.02	0.10	%/V	
RR	Ripple Rejection	Ripple 0.5Vp-p I _{OUT} =30mA V _{OUT} >1.7V, V _{IN} -V _{OUT} =1.0V (V _{OUT} ≤ 1.7V, V _{IN} -V _{OUT} =1.2V)	f=1kHz		70	dB	
			f=10kHz		60		
V _{IN}	Input Voltage		2.0		6.0	V	
ΔV _{OUT} /ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =30mA -40°C ≤ T _{opt} ≤ 85°C		±100		ppm/°C	
I _{SC}	Short Current Limit	V _{OUT} =0V		40		mA	
R _{PU}	\overline{CE} Pull-up Resistance		0.7	2.0	8.0	MΩ	
V _{CEH}	\overline{CE} Input Voltage "H"		1.5		6.0	V	
V _{CEL}	\overline{CE} Input Voltage "L"		0		0.3	V	
en	Output Noise	BW =10Hz to 100kHz		30		μVrms	

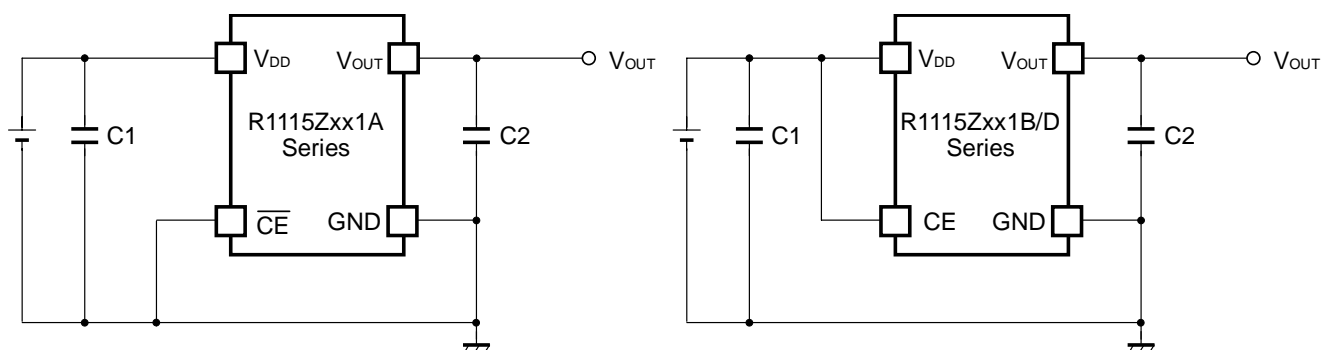
R1115Z

• R1115Zxx1B/D

T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V _{OUT}	Output Voltage	V _{IN} =Set V _{OUT} +1V 1mA ≤ I _{OUT} ≤ 30mA	×0.98		×1.02	V	
I _{OUT}	Output Current	V _{IN} -V _{OUT} =1.0V	150			mA	
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	V _{IN} =Set V _{OUT} +1V 1mA ≤ I _{OUT} ≤ 150mA		22	40	mV	
V _{DIF}	Dropout Voltage	I _{OUT} =150mA	V _{OUT} = 1.5V		0.38	0.70	V
			V _{OUT} = 1.6V		0.36	0.65	
			V _{OUT} = 1.7V		0.34	0.60	
			1.8V ≤ V _{OUT} ≤ 2.0V		0.32	0.55	
			2.1V ≤ V _{OUT} ≤ 2.7V		0.28	0.50	
			2.8V ≤ V _{OUT} ≤ 4.0V		0.22	0.35	
I _{SS}	Supply Current	V _{IN} =Set V _{OUT} +1V, I _{OUT} =0mA		75	95	μA	
I _{standby}	Standby Current	V _{IN} =Set V _{OUT} +1V, V _{CE} =GND		0.1	1.0	μA	
ΔV _{OUT} /ΔV _{IN}	Line Regulation	I _{OUT} =30mA V _{OUT} >1.6V, Set V _{OUT} +0.5V ≤ V _{IN} ≤ 6.0V (V _{OUT} ≤ 1.6V, 2.2V ≤ V _{IN} ≤ 6.0V)		0.02	0.10	%/V	
RR	Ripple Rejection	Ripple 0.5Vp-p I _{OUT} =30mA V _{OUT} >1.7V, V _{IN} -V _{OUT} =1.0V (V _{OUT} ≤ 1.7V, V _{IN} -V _{OUT} =1.2V)	f=1kHz		70	dB	
			f=10kHz		60		
V _{IN}	Input Voltage		2.0		6.0	V	
ΔV _{OUT} /ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =30mA -40°C ≤ T _{opt} ≤ 85°C		±100		ppm/°C	
I _{SC}	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		0.3	V	
e _n	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	

TYPICAL APPLICATIONS



(External Components)

Output Capacitor; Ceramic $0.47\mu\text{F}$ (Set Output Voltage in the range from 2.5 to 4.0V)

Ceramic $1.0\mu\text{F}$ (Set Output Voltage in the range from 1.5 to 2.4V)

Input Capacitor; Ceramic $1.0\mu\text{F}$

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 C2. Recommendation value is as follows:

If you use a tantalum type capacitor and ESR value of the capacitor is large, output might be unstable. Evaluate your circuit with considering frequency characteristics.

Output Voltage	C2 recommendation value
$V_{\text{OUT}} \leq 2.4\text{V}$	$1.0\mu\text{F}$ or more
$2.5 \leq V_{\text{OUT}}$	$0.47\mu\text{F}$ or more

PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as $1\mu\text{F}$ or more between V_{DD} and GND pin, and as close as possible to the pins.

Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

TEST CIRCUITS

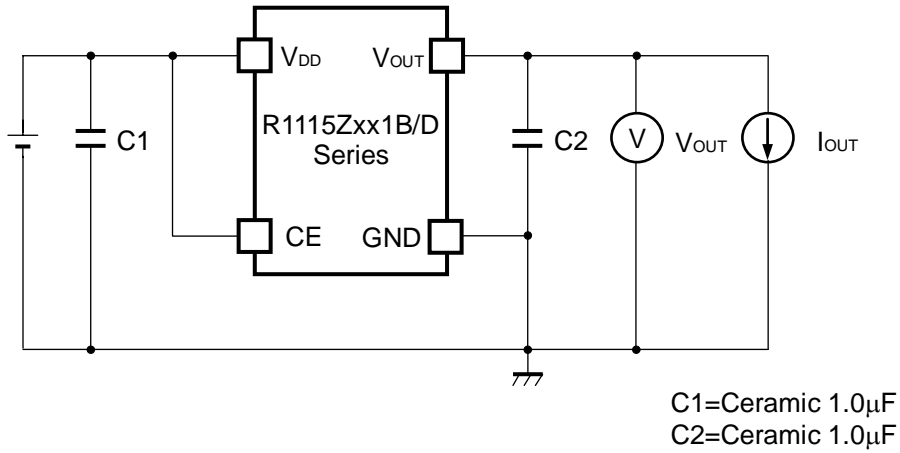


Fig.1 Standard test Circuit

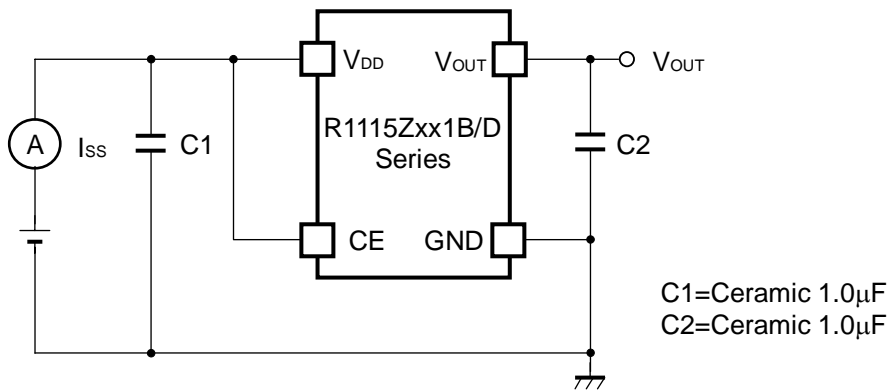


Fig.2 Supply Current Test Circuit

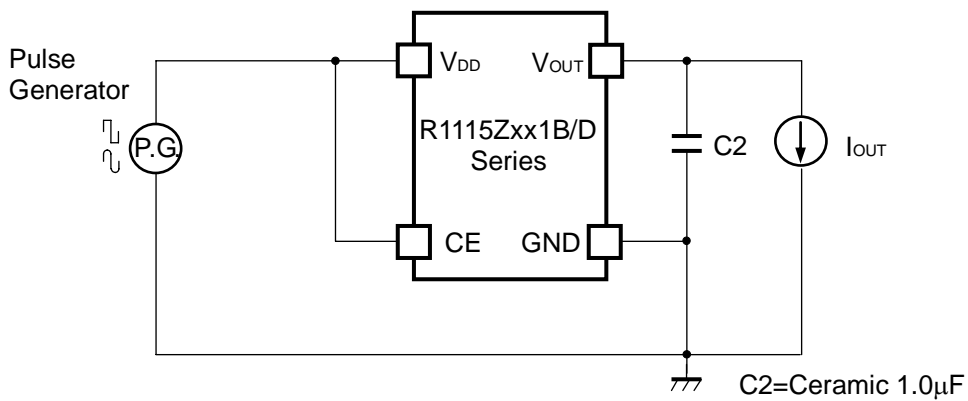


Fig.3 Ripple Rejection, Line Transient Response Test Circuit

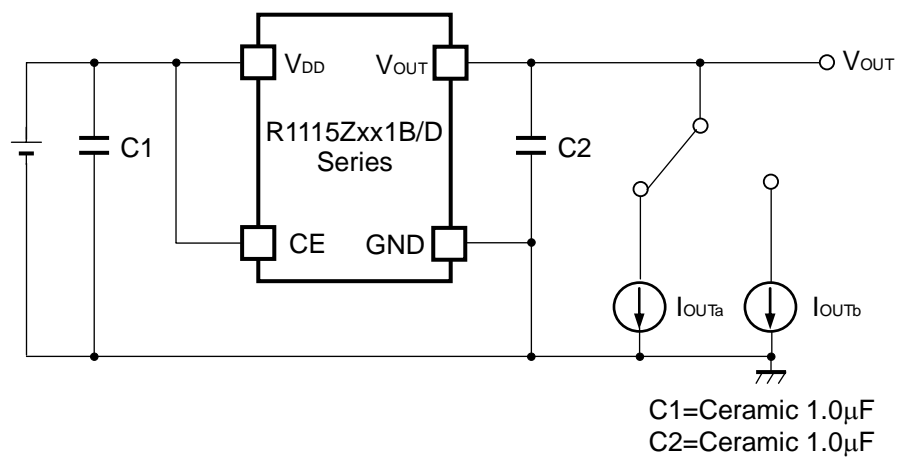
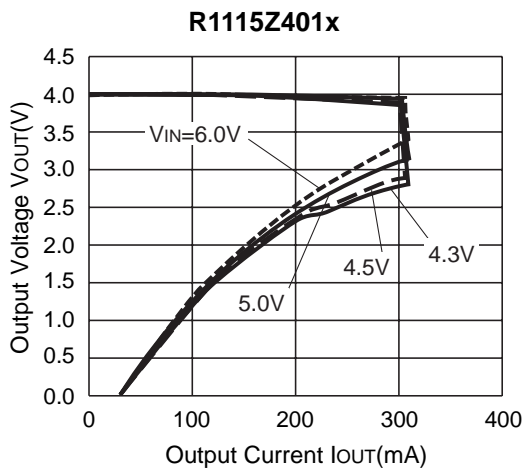
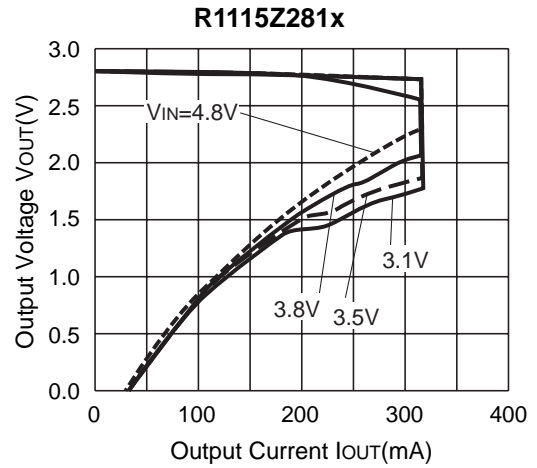
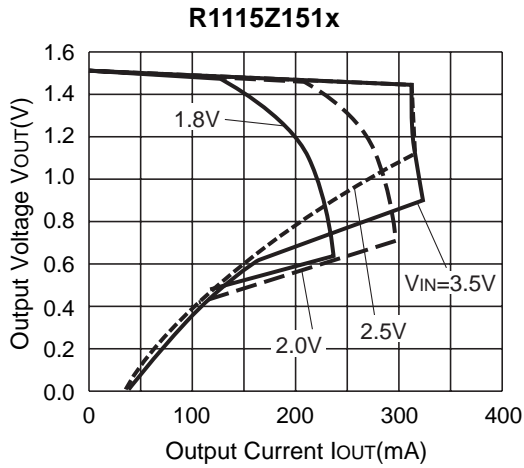


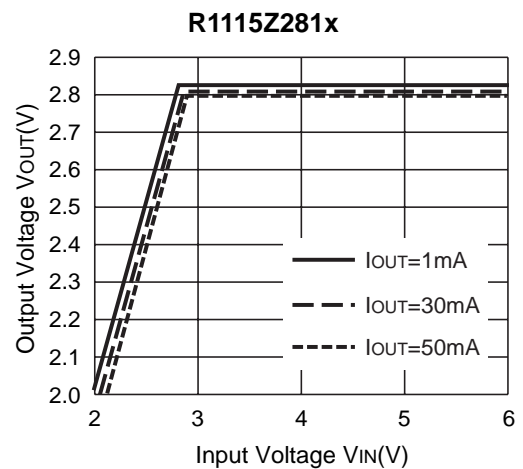
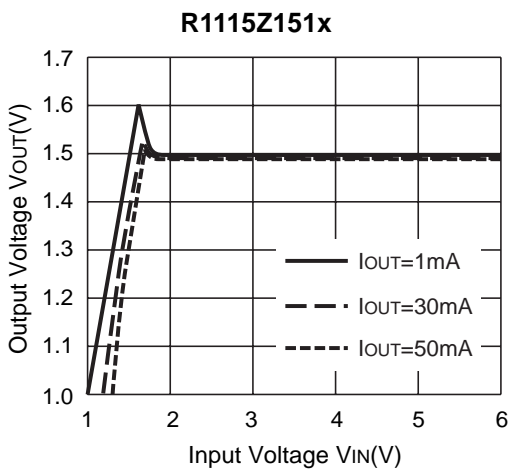
Fig.4 Load Transient Response Test Circuit

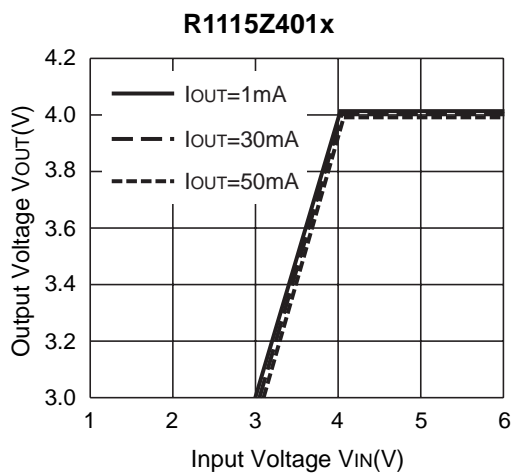
TYPICAL CHARACTERISTICS

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

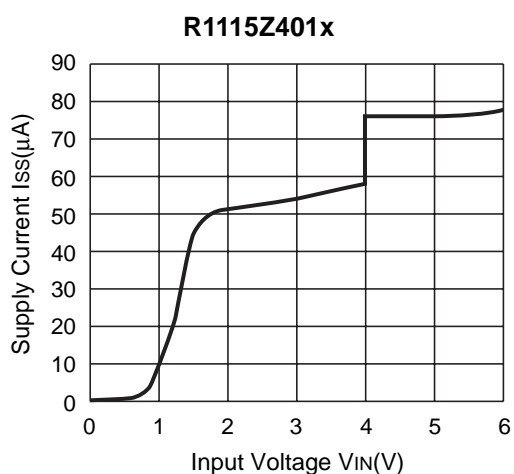
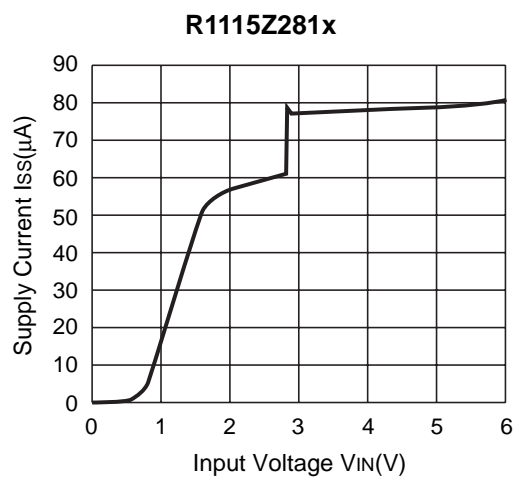
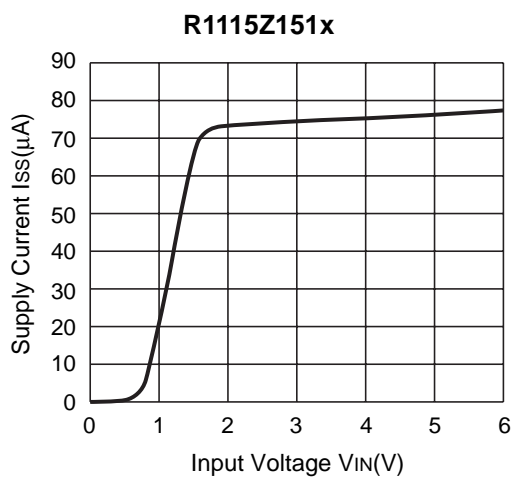


2) Output Voltage vs. Input Voltage ($T_{opt}=25^{\circ}\text{C}$)



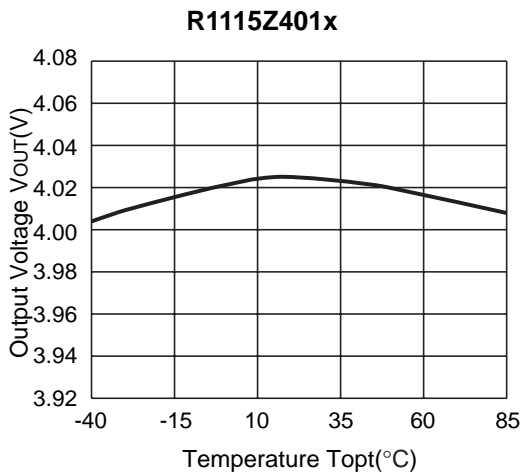
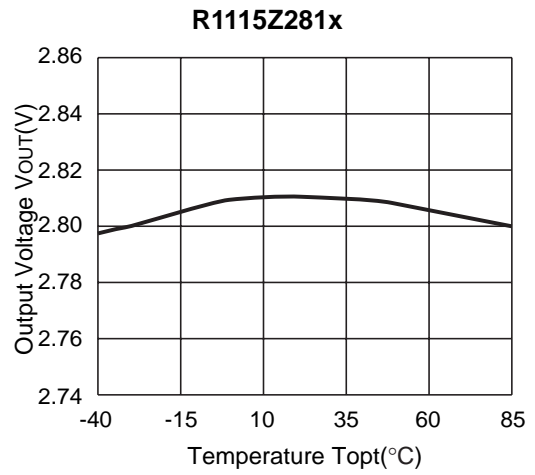
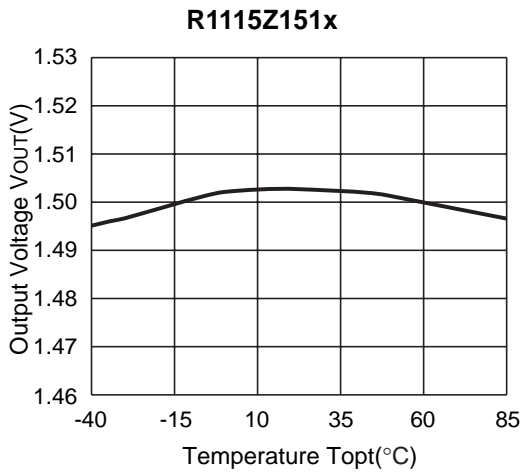


3) Supply Current vs. Input Voltage ($T_{opt}=25^{\circ}C$)

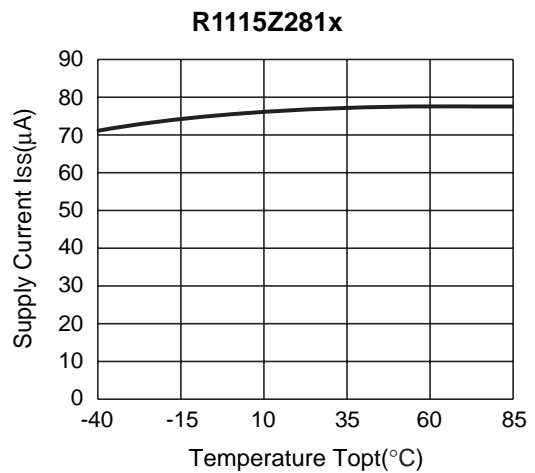
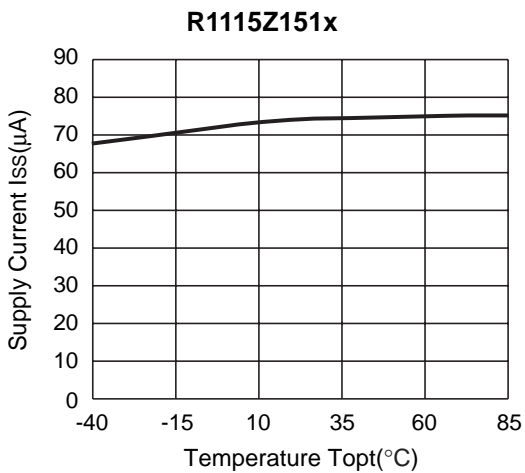


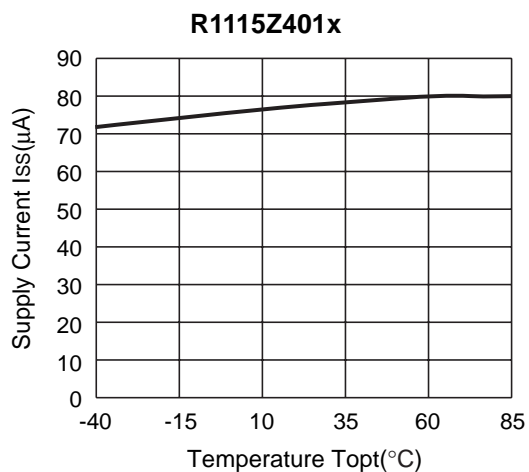
R1115Z

4) Output Voltage vs. Temperature

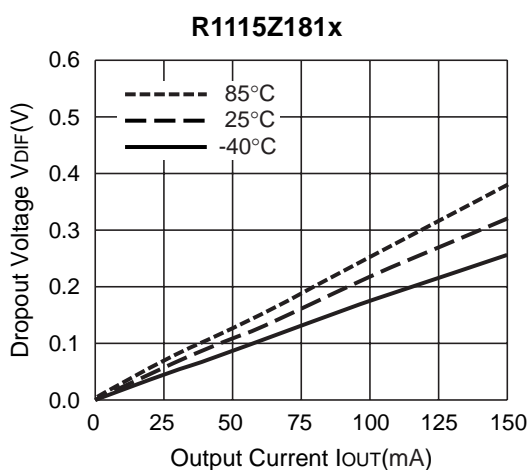
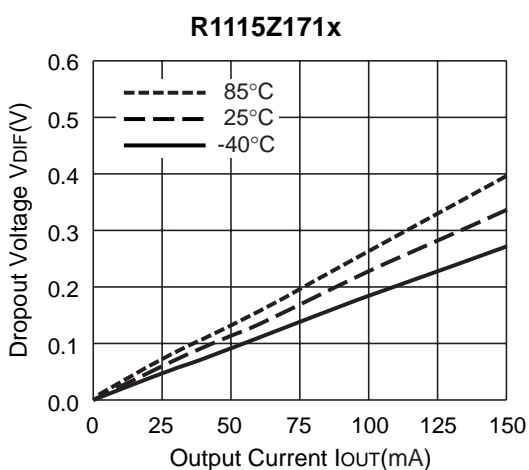
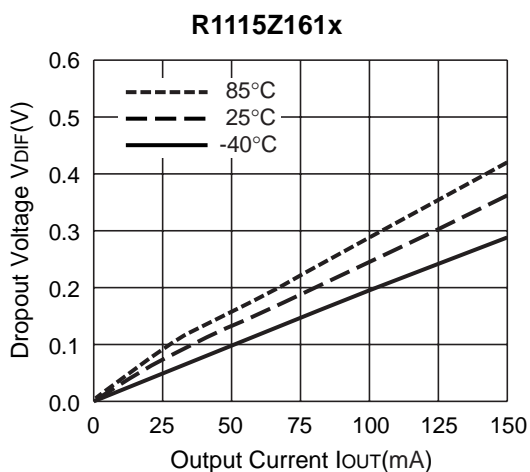
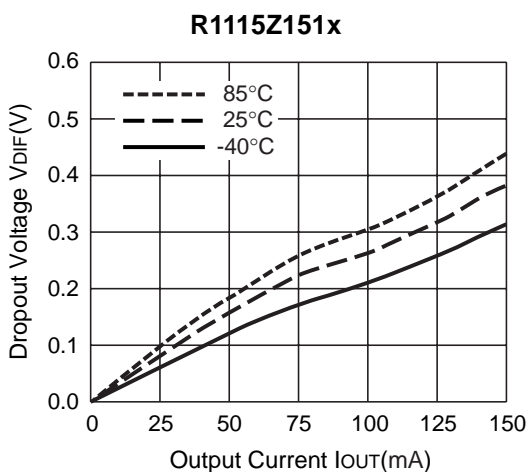


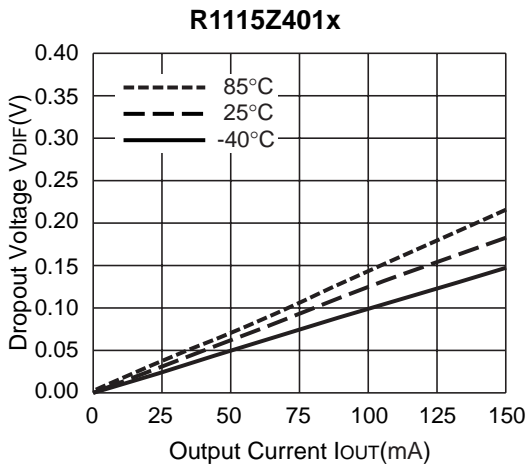
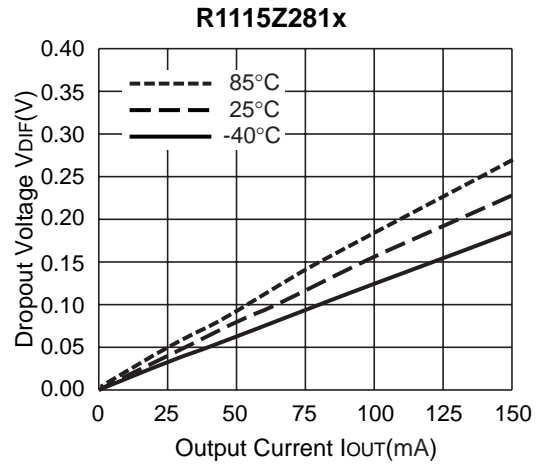
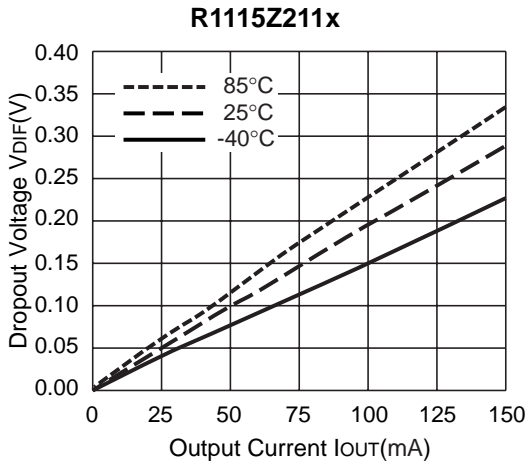
5) Supply Current vs. Temperature



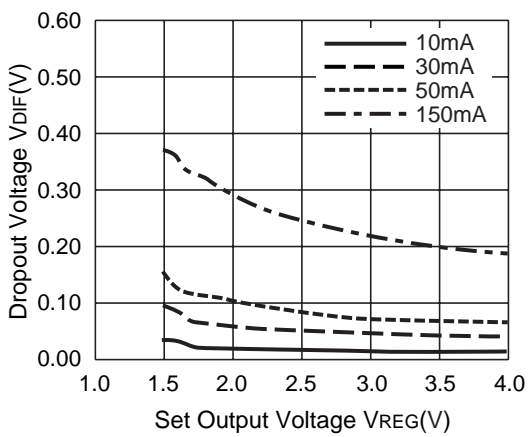


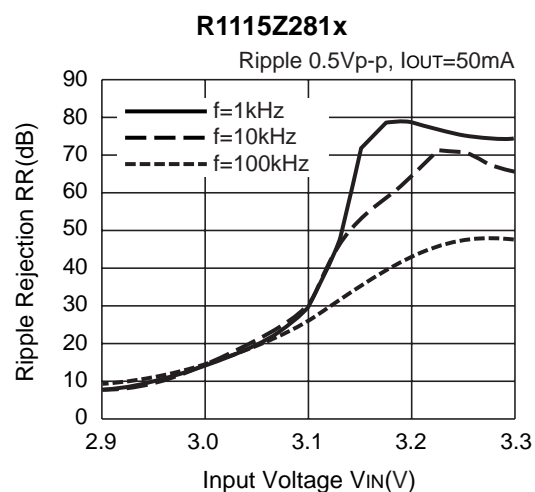
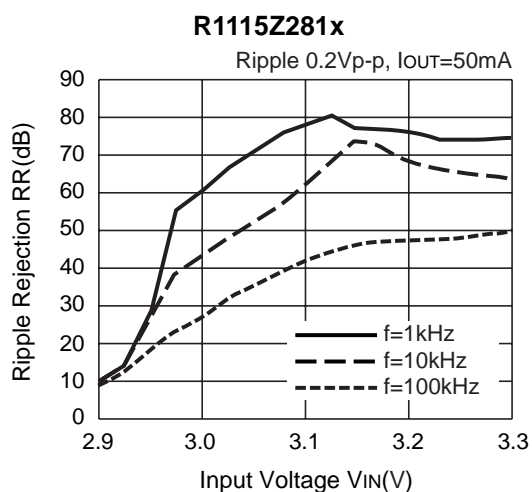
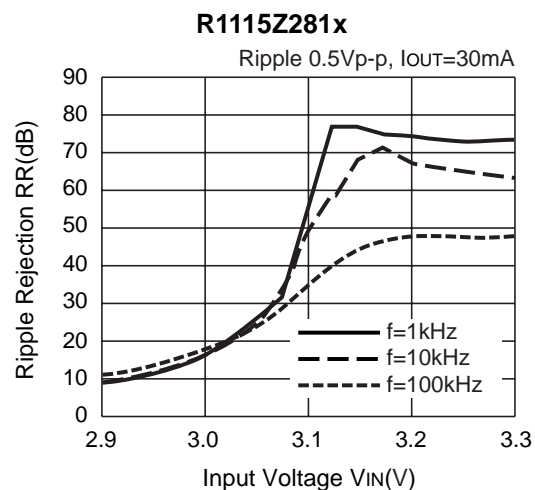
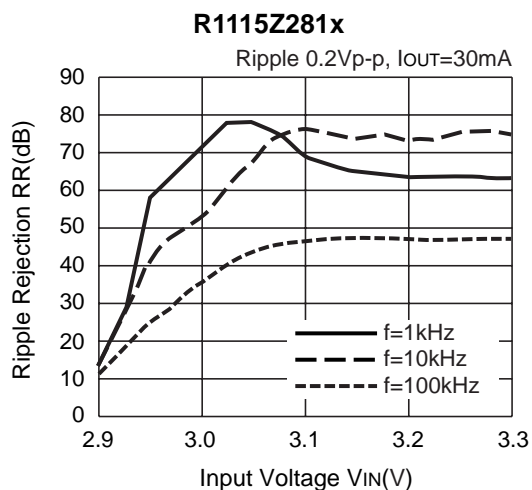
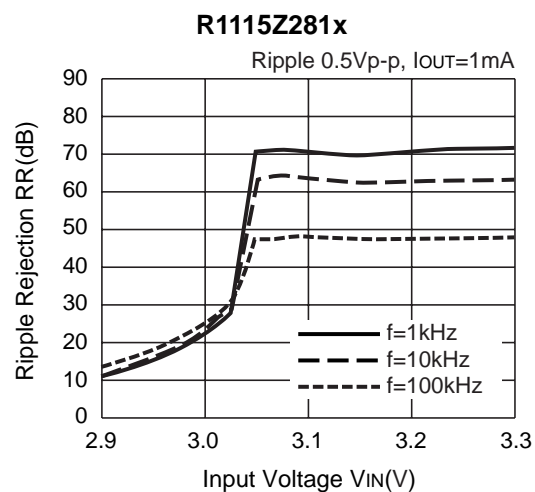
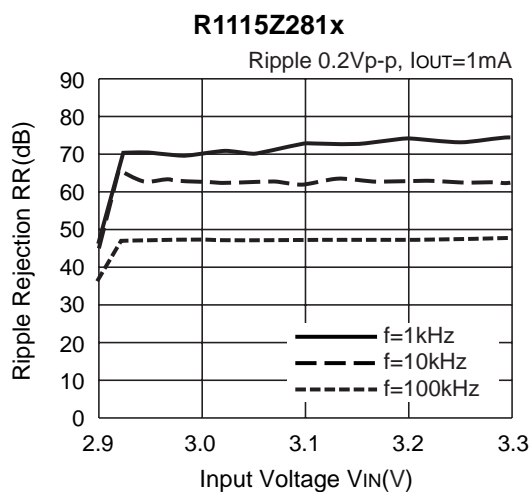
6) Dropout Voltage vs. Output Current



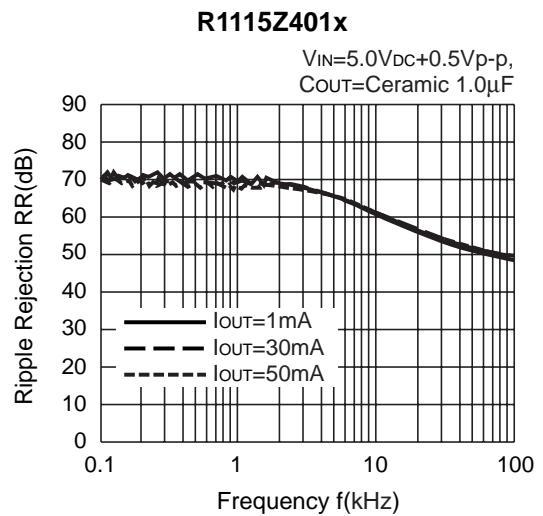
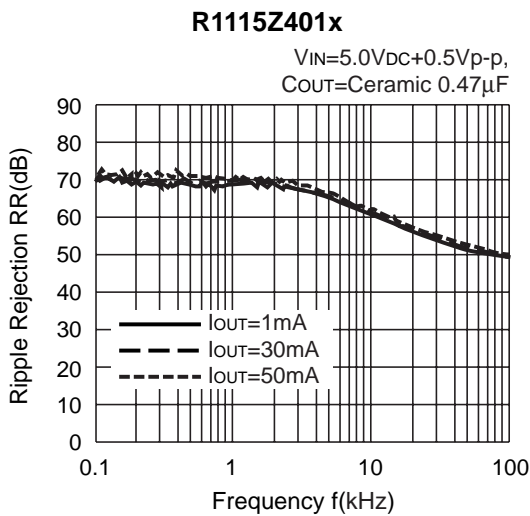
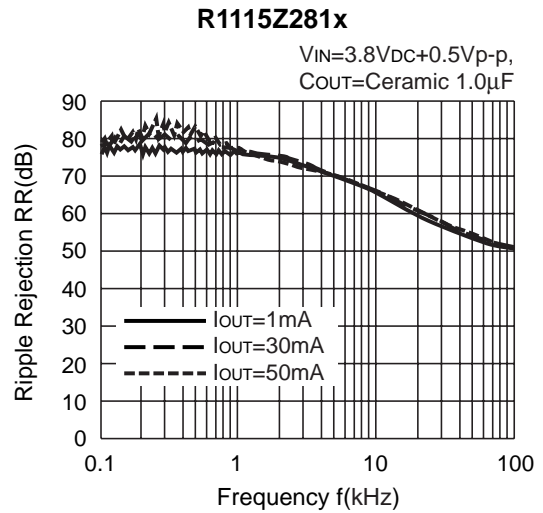
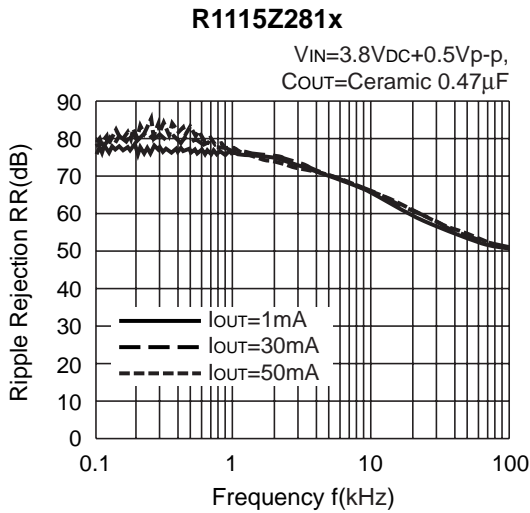
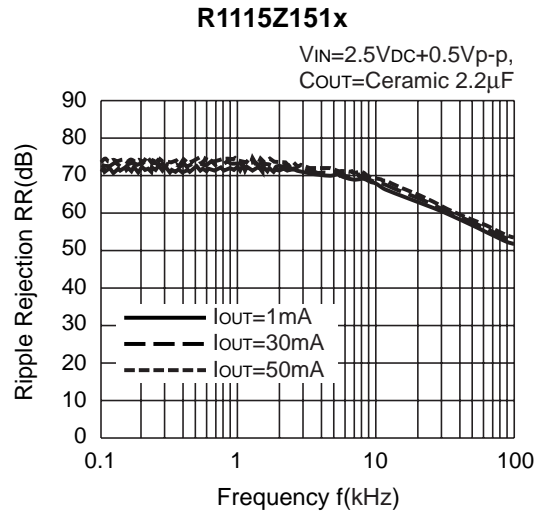
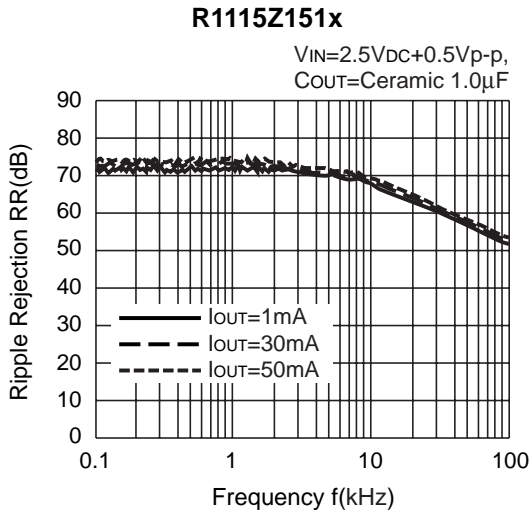


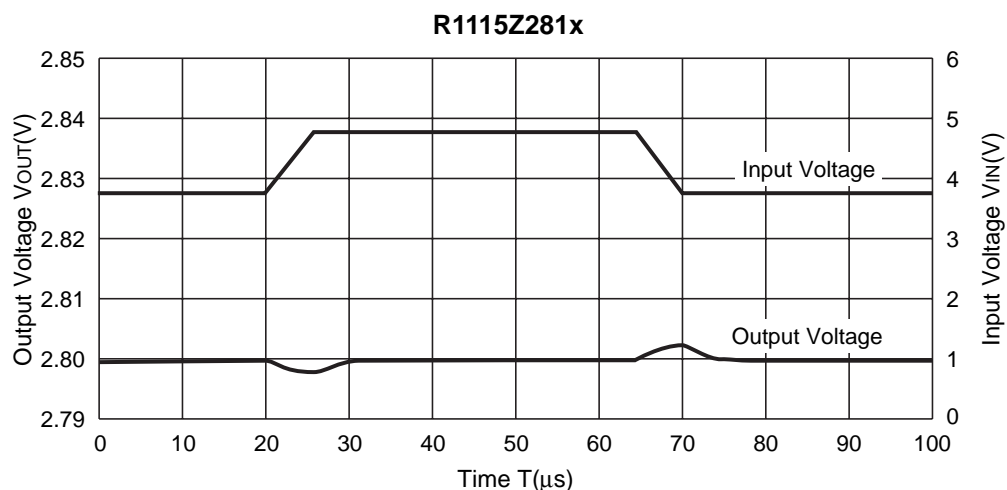
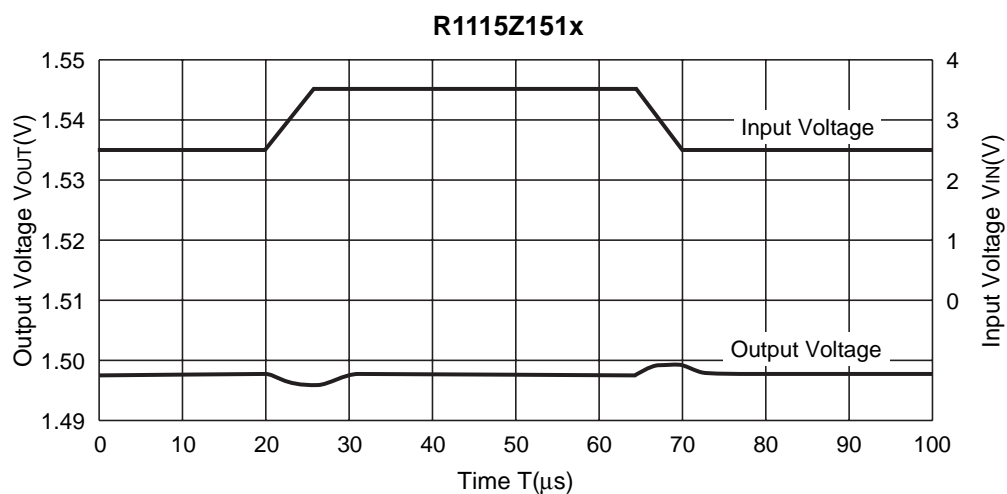
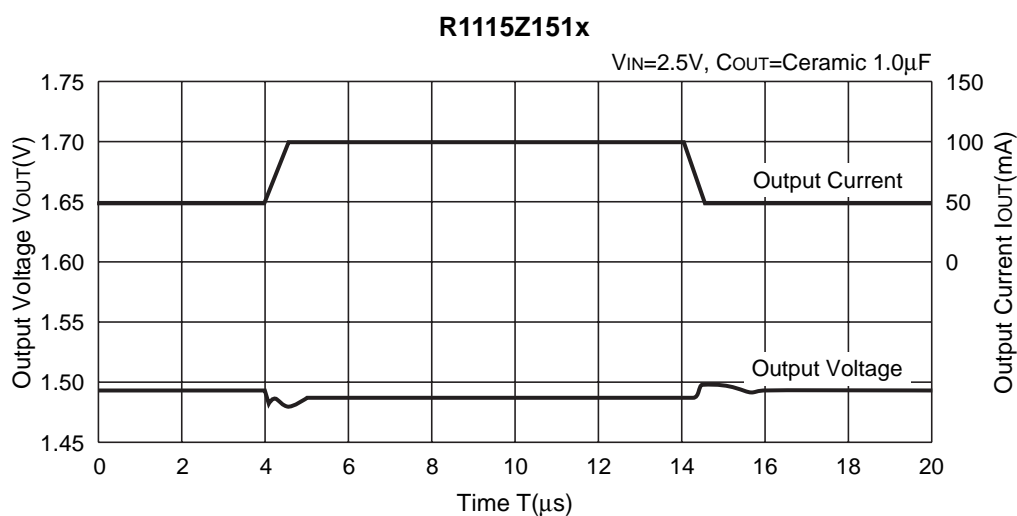
7) Dropout Voltage vs. Set Output Voltage ($T_{opt}=25^{\circ}C$)



8) Ripple Rejection vs. Input Bias Voltage ($T_{opt}=25^{\circ}\text{C}$, $C_{IN}=\text{none}$, $C_{OUT}=\text{ceramic } 0.47\mu\text{F}$)

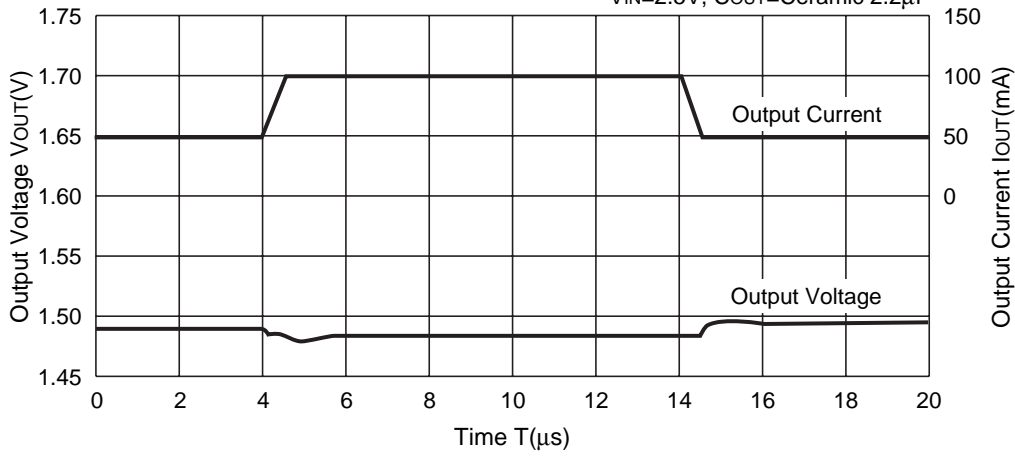
9) Ripple Rejection vs. Frequency (C_{IN} =none)



10) Input Transient Response ($I_{OUT}=30\text{mA}$, $C_{IN}=\text{none}$, $t_r=t_f=5\mu\text{s}$, $C_{OUT}=\text{Ceramic } 0.47\mu\text{F}$)11) Load Transient Response ($t_r=t_f=0.5\mu\text{s}$, $C_{IN}=\text{Ceramic } 1.0\mu\text{F}$)

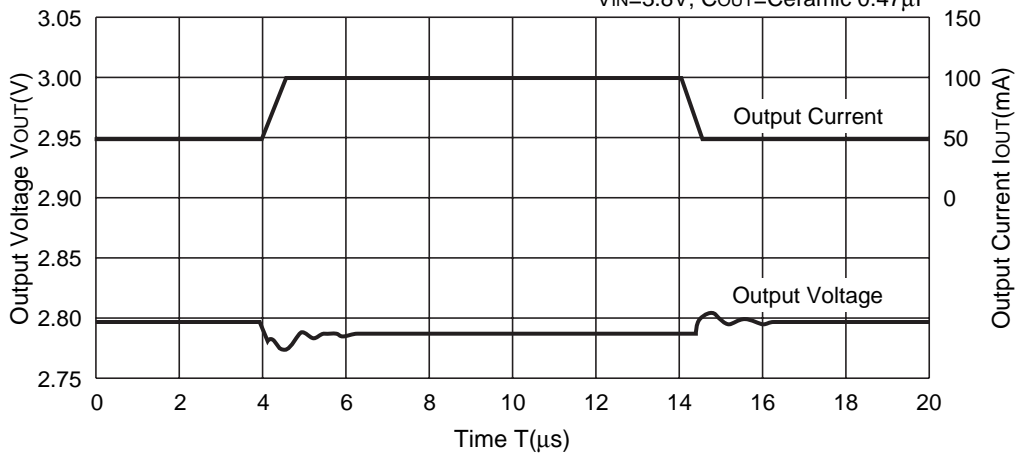
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$V_{IN}=2.5V$, $C_{OUT}=\text{Ceramic } 2.2\mu F$



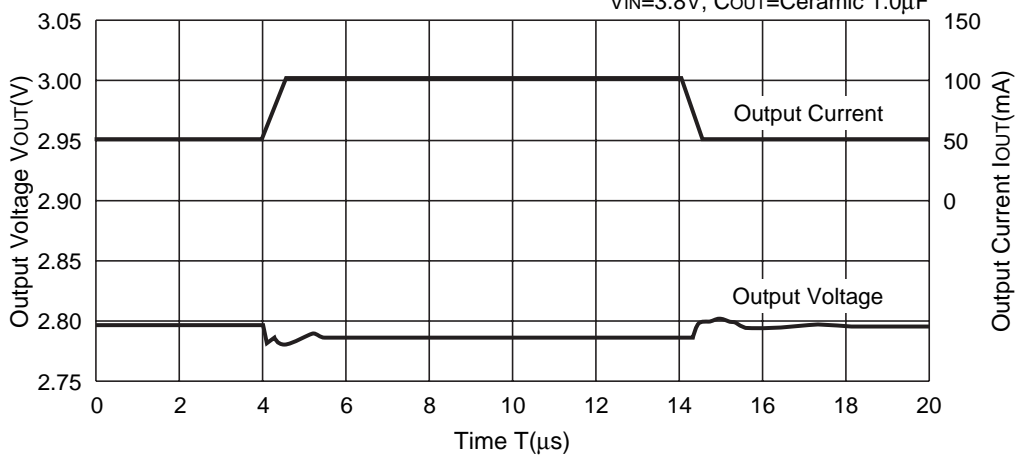
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$V_{IN}=3.8V$, $C_{OUT}=\text{Ceramic } 0.47\mu F$

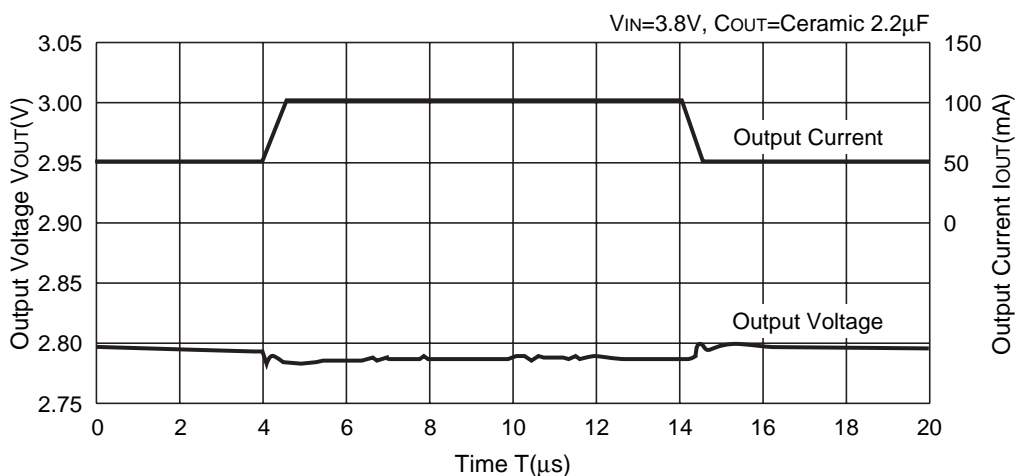


R1115Z281x

$V_{IN}=3.8V$, $C_{OUT}=\text{Ceramic } 1.0\mu F$

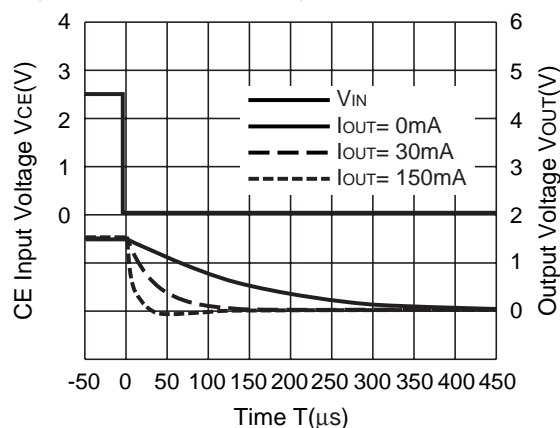
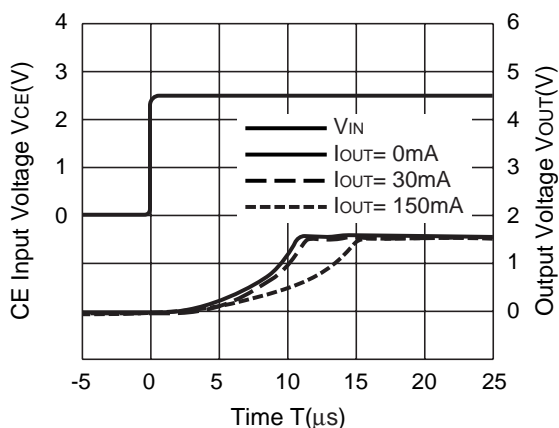


R1115Z281x

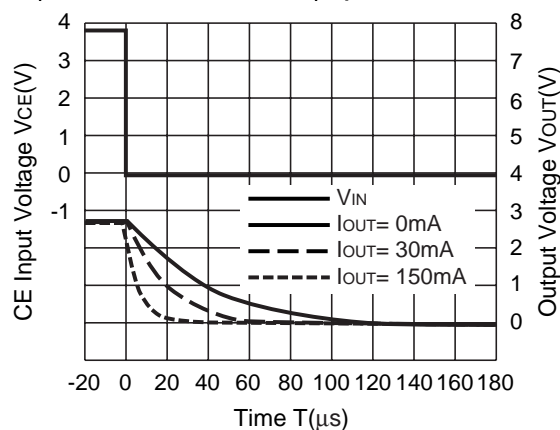
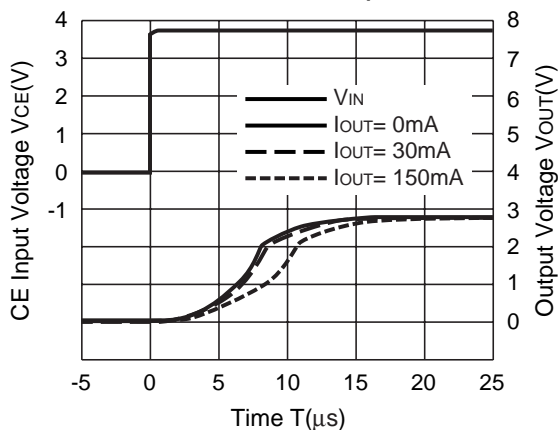


12) Turn-on/off speed with CE pin (D version)

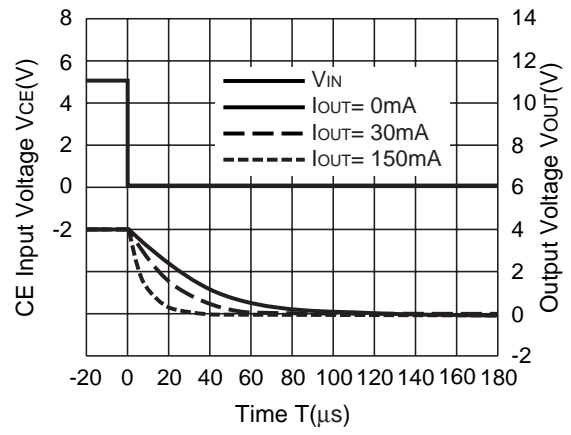
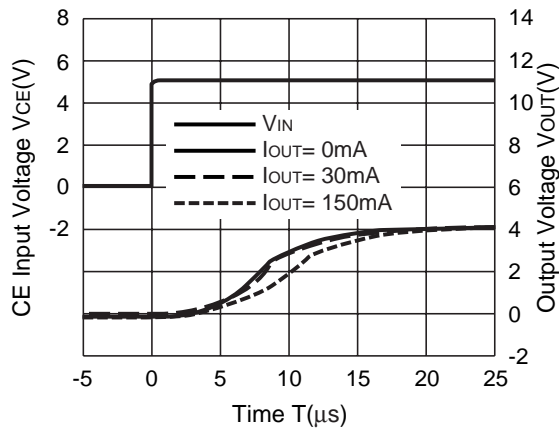
R1115Z151D ($V_{IN}=2.5V$, $C_{IN}=\text{Ceramic } 1.0\mu F$, $C_{OUT}=\text{Ceramic } 1.0\mu F$)



R1115Z281D ($V_{IN}=3.8V$, $C_{IN}=\text{Ceramic } 0.47\mu F$, $C_{OUT}=\text{Ceramic } 0.47\mu F$)



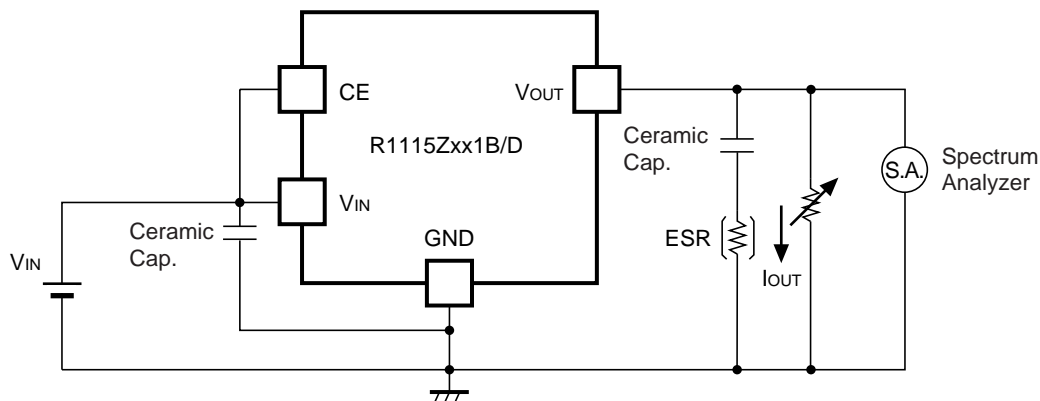
R1115Z401D ($V_{IN}=5.0V$, $C_{IN}=\text{Ceramic } 0.47\mu F$, $C_{OUT}=\text{Ceramic } 0.47\mu F$)



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:



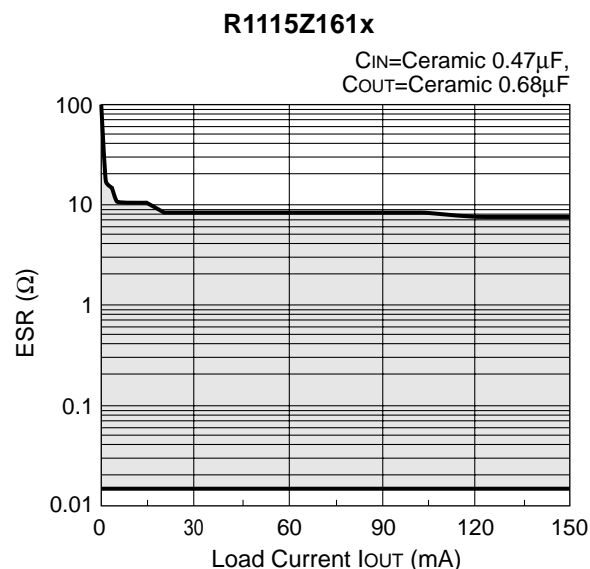
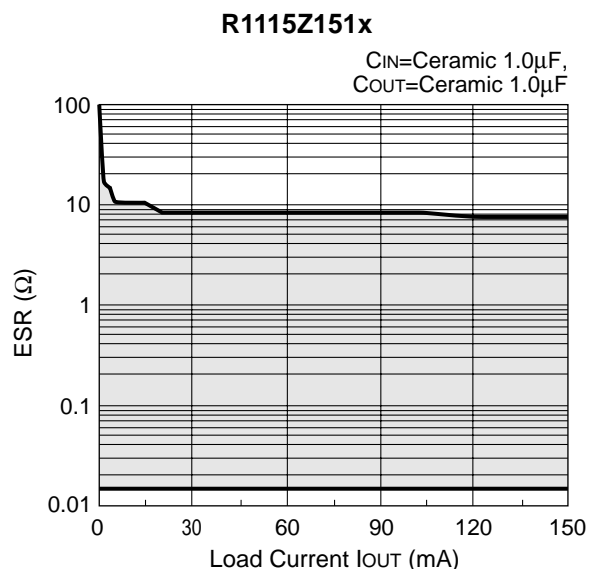
Measuring Circuit for white noise; R1115Zxx1B/D

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 $40\mu\text{V}$ (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.)

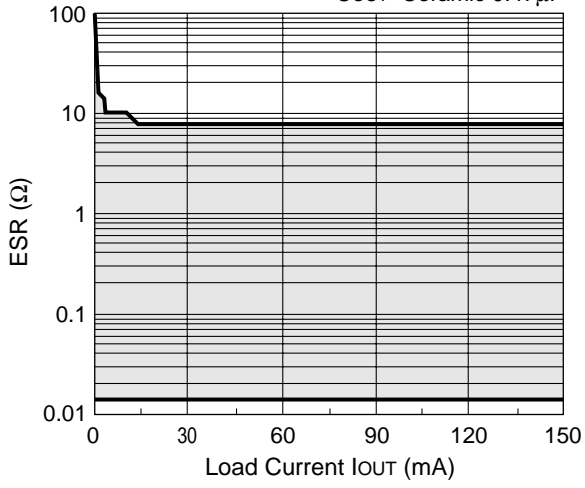
<Measurement conditions>

- (1) $V_{IN} = V_{OUT} + 1\text{V}$
- (2) Frequency Band: 10Hz to 2MHz
- (3) Temperature: -40°C to 25°C



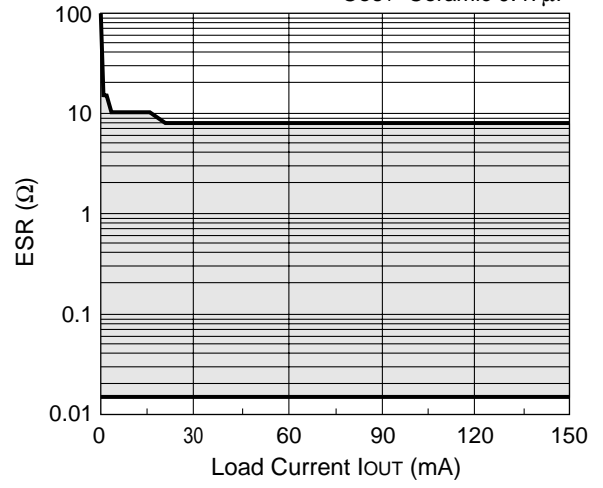
R1115Z211x

C_{IN}=Ceramic 0.47μF,
C_{OUT}=Ceramic 0.47μF



R1115Z281x

C_{IN}=Ceramic 0.47μF,
C_{OUT}=Ceramic 0.47μF





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