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### LOW NOISE 150mA LDO REGULATOR

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NO. EA-126-111026

#### OUTLINE

The R1116x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, 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 short current limit circuit, a chip enable circuit, and so on.

These ICs perform with low dropout voltage and the chip-enable function. The supply current at no load of this IC is only 10 $\mu$ A, and the line transient response and the load transient response of the R1116x Series are excellent, thus these ICs are very suitable for the power supply for hand-held communication equipment.

The supply current at no load of R1116x Series is remarkably reduced compared with R1114x Series. The mode change signal to reduce the supply current is not necessary. The output voltage accuracy is also improved. ( $\pm 1.5\%$ )

The output voltage of these ICs is fixed with high accuracy. Since the packages for these ICs are SOT-23-5 and SON1612-6 therefore high density mounting of the ICs on boards is possible.

R1126N Series that a pin configuration differs from R1116N Series are available.

#### FEATURES

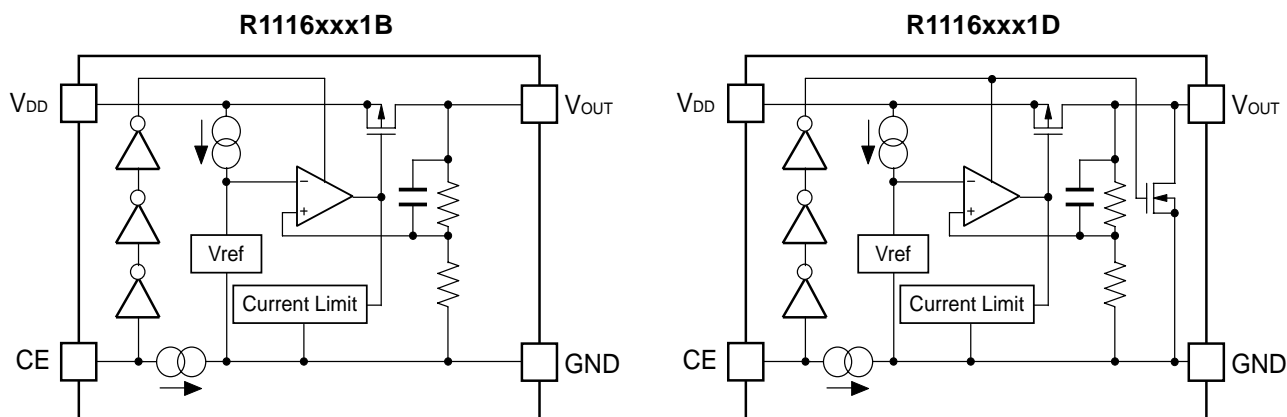
- Supply Current ..... Typ. 10 $\mu$ A
- Standby Current ..... Typ. 0.1 $\mu$ A
- Input Voltage Range ..... 1.8V to 6.0V
- Output Voltage Range ..... 1.5V to 4.0V (0.1V steps)  
(For other voltages, please refer to MARK INFORMATIONS.)
- Dropout Voltage ..... Typ. 0.29V ( $I_{OUT}=150\text{mA}, V_{OUT}=2.8\text{V}$ )
- Ripple Rejection ..... Typ. 70dB ( $f=1\text{kHz}, V_{OUT}=3.0\text{V}$ )  
Typ. 53dB ( $f=10\text{kHz}$ )
- Output Voltage Accuracy .....  $\pm 1.5\%$  ( $1.5\text{V} \leq V_{OUT} \leq 3.0\text{V}$ ),  $\pm 2.0\%$  ( $V_{OUT}>3.0\text{V}$ )
- Temperature-Drift Coefficient of Output Voltage ..... Typ.  $\pm 100\text{ppm}/^\circ\text{C}$
- Line Regulation ..... Typ. 0.02%/V
- Packages ..... SOT-23-5 , SON1612-6
- Built-in Fold Back Protection Circuit ..... Typ. 40mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC ...  $C_{IN}=C_{OUT}=1.0\mu\text{F}$  (Ceramic)

#### APPLICATIONS

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

## R1116x

### BLOCK DIAGRAMS



### SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1116Dxx1*-TR-FE	SON1612-6	4,000 pcs	Yes	Yes
R1116Nxx1*-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 1.5V(15) to 4.0V(40) in 0.1V steps.  
(For other voltages, please refer to MARK INFORMATIONS.)

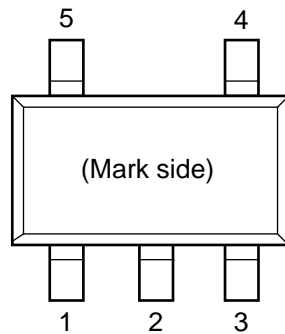
\* : CE pin polarity and auto discharge function at off state are options as follows.

(B) "H" active, without auto discharge function at off state

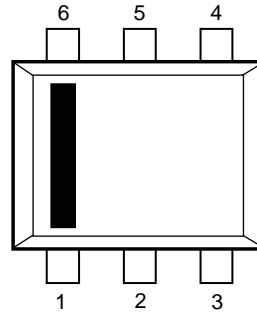
(D) "H" active, with auto discharge function at off state

## PIN CONFIGURATIONS

### ● SOT-23-5



### ● SON1612-6



## PIN DESCRIPTIONS

### ● SOT-23-5

Pin No.	Symbol	Description
1	V <sub>DD</sub>	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin
4	NC	No Connection
5	V <sub>OUT</sub>	Output pin

### ● SON1612-6

Pin No.	Symbol	Description
1	CE	Chip Enable Pin
2	GND	Ground Pin
3	V <sub>DD</sub>	Input Pin
4	V <sub>OUT</sub>	Output Pin
5	GND	Ground Pin
6	NC	No Connection

**R1116x**

**ABSOLUTE MAXIMUM RATINGS**

Symbol	Item	Rating	Unit
$V_{IN}$	Input Voltage	6.5	V
$V_{CE}$	Input Voltage (CE Pin)	6.5	V
$V_{OUT}$	Output Voltage	-0.3~ $V_{IN}+0.3$	V
$I_{OUT}$	Output Current	160	mA
$P_D$	Power Dissipation (SOT-23-5) *	420	mW
	Power Dissipation (SON1612-6)*	500	
$T_{opt}$	Operating Temperature Range	-40~85	°C
$T_{stg}$	Storage Temperature Range	-55~125	°C

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

**ABSOLUTE MAXIMUM RATINGS**

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

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

## ELECTRICAL CHARACTERISTICS

### • R1116xxx1B/D

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> ≤ 3.4V ×0.985		×1.015	V
			V <sub>OUT</sub> > 3.4V ×0.980		×1.020	
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> ≤ 150mA 1.5V ≤ V <sub>OUT</sub> < 2.0V 2.0V ≤ V <sub>OUT</sub> < 3.0V 3.0V ≤ V <sub>OUT</sub>		28 33 35	55 66 80	mV
V <sub>DIF</sub>	Dropout Voltage	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> =Set V <sub>OUT</sub> +1V, I <sub>OUT</sub> =0mA		10	18	μA
I <sub>standby</sub>	Supply Current (Standby)	V <sub>IN</sub> =Set V <sub>OUT</sub> +1V, V <sub>CE</sub> =V <sub>DD</sub>		0.1	1.0	μA
ΔV <sub>OUT</sub> / ΔV <sub>IN</sub>	Line Regulation	I <sub>OUT</sub> =30mA Set V <sub>OUT</sub> +0.5V ≤ V <sub>IN</sub> ≤ 6.0V		0.02	0.10	%/V
RR	Ripple Rejection	f=1kHz f=10kHz Ripple 0.2Vp-p V <sub>IN</sub> -V <sub>OUT</sub> =1.0V, I <sub>OUT</sub> =30mA		70 53		dB
V <sub>IN</sub>	Input Voltage		1.8		6.0	V
ΔV <sub>OUT</sub> / ΔT <sub>opt</sub>	Output Voltage Temperature Coefficient	I <sub>OUT</sub> =30mA -40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm /°C
I <sub>SC</sub>	Short Current Limit	V <sub>OUT</sub> =0V		40		mA
I <sub>PD</sub>	CE Pull-down Current			0.5		μA
V <sub>CEH</sub>	CE Input Voltage "H"		1.0		6.0	V
V <sub>CEL</sub>	CE Input Voltage "L"		0.0		0.3	V
en	Output Noise	BW=10Hz to 100kHz		30		μVrms
R <sub>LOW</sub>	On Resistance of Nch Tr. for auto-discharge (Only for D version)	V <sub>CE</sub> =0V		70		Ω

### 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.

\* R1116D (SON1612-6) is the non-promotion product. As of March in 2014.

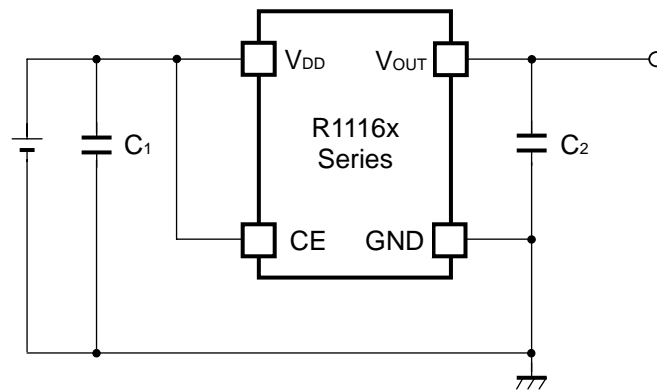
## R1116x

### • ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE

T<sub>opt</sub> = 25°C

Output Voltage V <sub>OUT</sub> (V)	Dropout Voltage V <sub>DIF</sub> (V)		
	Condition	Typ.	Max.
V <sub>OUT</sub> = 1.5V	I <sub>OUT</sub> =150mA	0.54	0.86
1.5V < V <sub>OUT</sub> ≤ 1.6V		0.50	0.75
1.6V < V <sub>OUT</sub> ≤ 1.7V		0.46	0.70
1.7V < V <sub>OUT</sub> ≤ 2.0V		0.44	0.65
2.0V < V <sub>OUT</sub> ≤ 2.7V		0.37	0.56
2.7V < V <sub>OUT</sub> ≤ 4.0V		0.29	0.46

### TYPICAL APPLICATIONS



(External Components)

C<sub>2</sub> Ceramic 1.0μF Ex. Murata GRM155B30J105KE18B  
Kyocera CM05X5R105K06AB

C<sub>1</sub> Ceramic 1.0μF

## TEST CIRCUITS

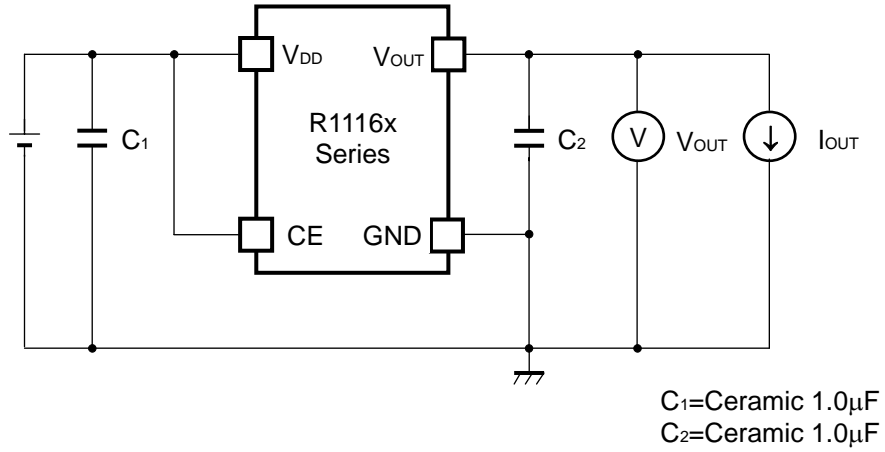


Fig.1 Standard test Circuit

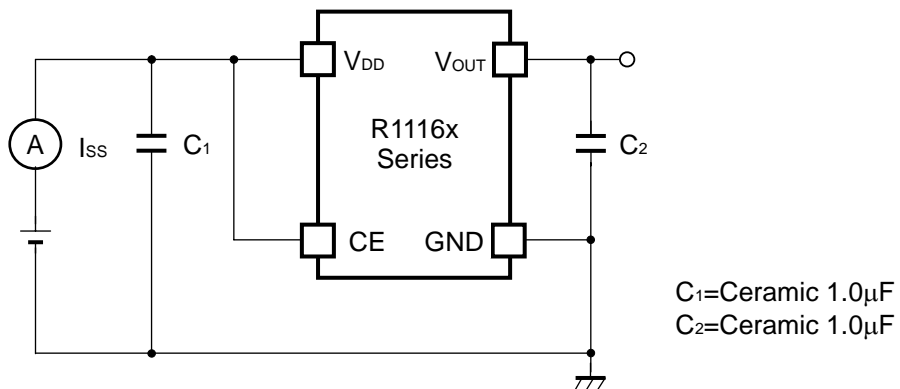


Fig.2 Supply Current Test Circuit

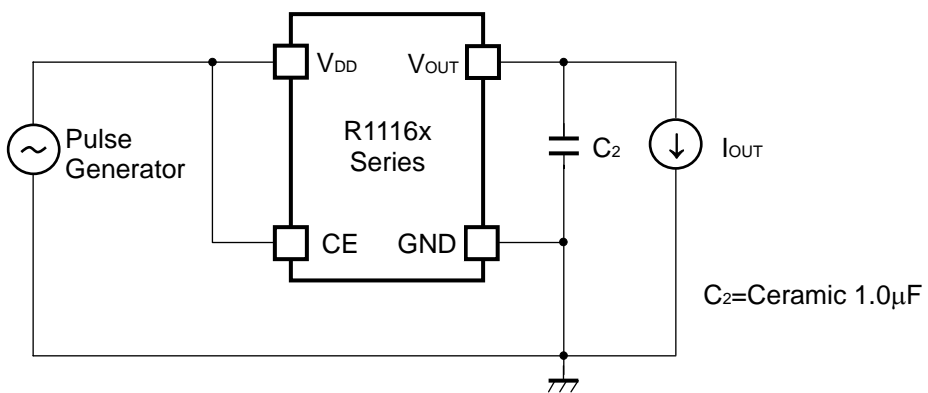
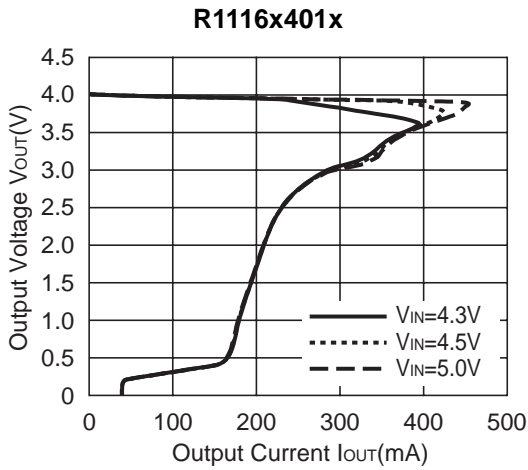
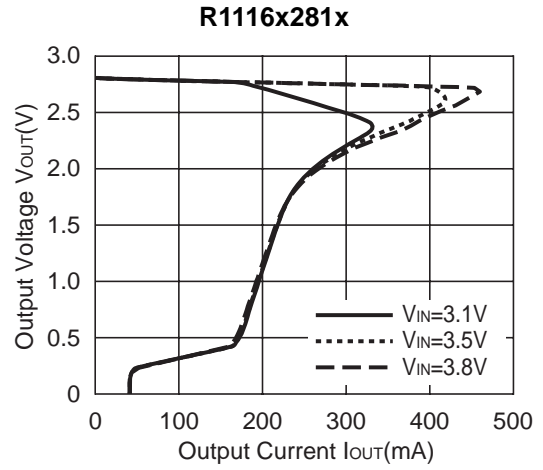
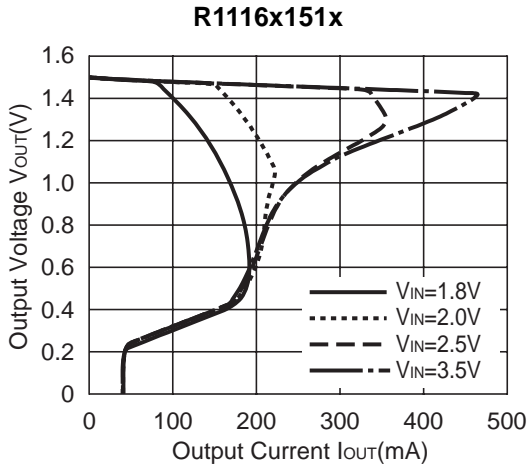


Fig.3 Ripple Rejection, Line Transient Response Test Circuit

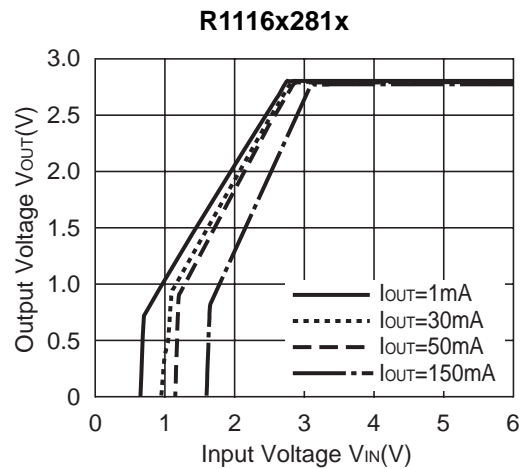
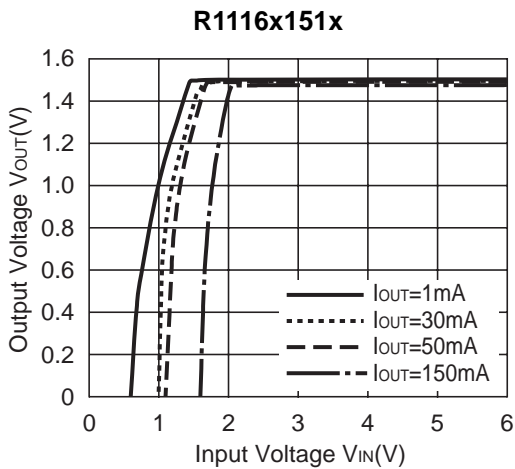
**R1116x**

**TYPICAL CHARACTERISTICS**

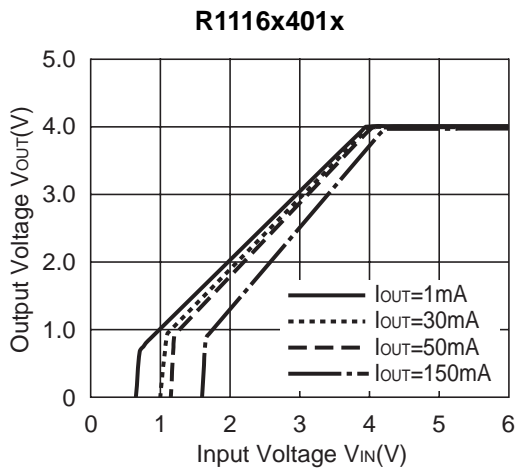
**1) Output Voltage vs. Output Current (T<sub>opt</sub>=25°C)**



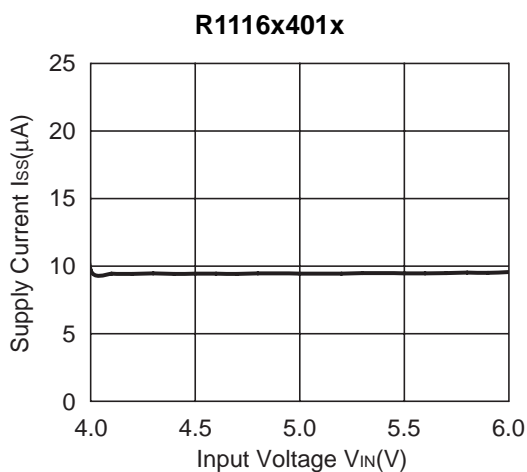
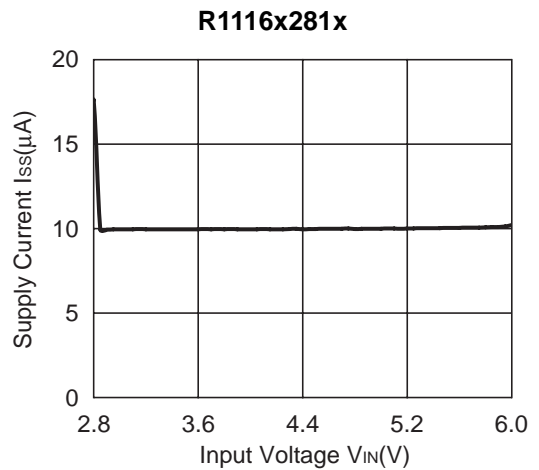
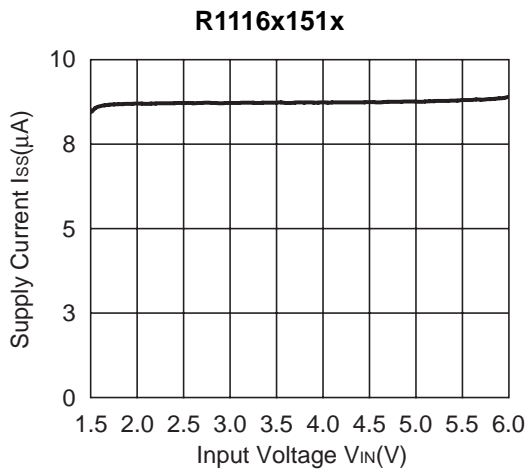
**2) Output Voltage vs. Input Voltage (T<sub>opt</sub>=25°C)**







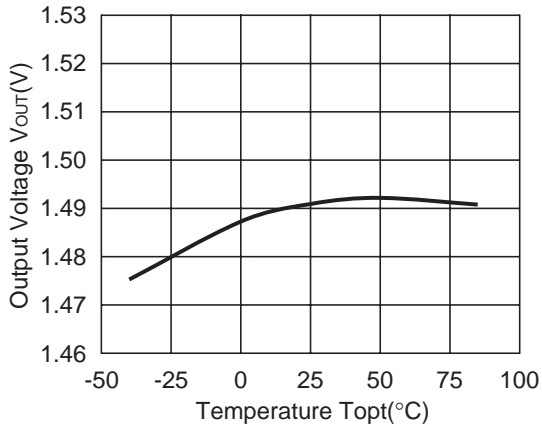
**3) Supply Current vs. Input Voltage ( $T_{opt}=25^{\circ}C$ )**



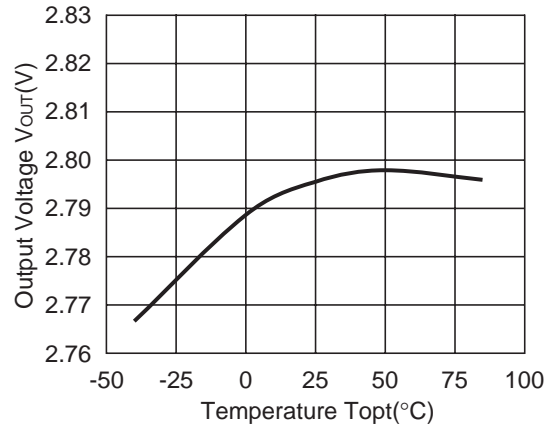
**R1116x**

**4) Output Voltage vs. Temperature**

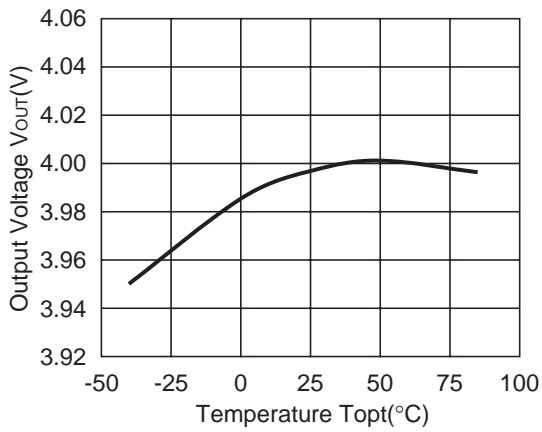
**R1116x151x**



**R1116x281x**

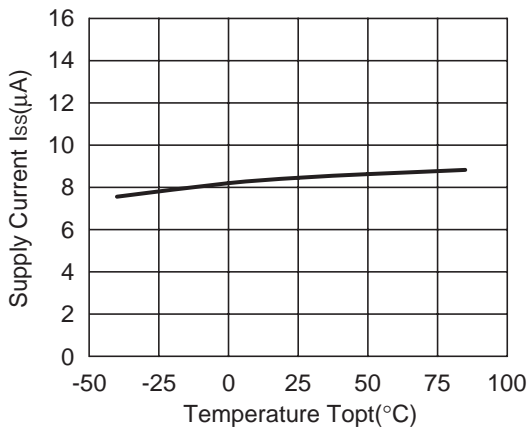


**R1116x401x**

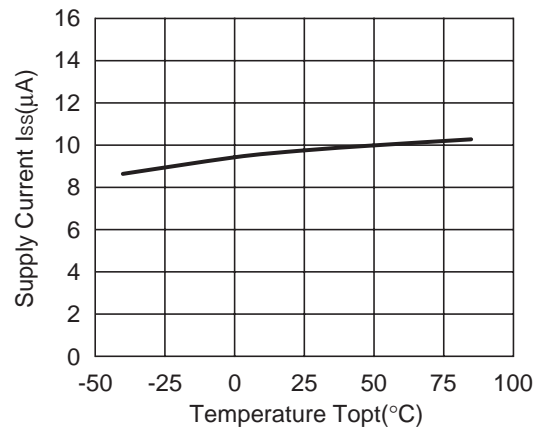


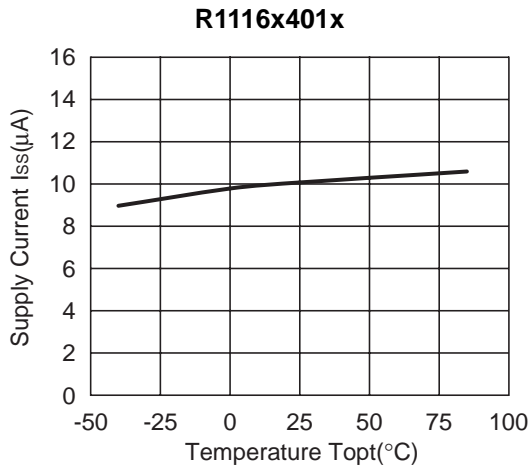
**5) Supply Current vs. Temperature**

**R1116x151x**

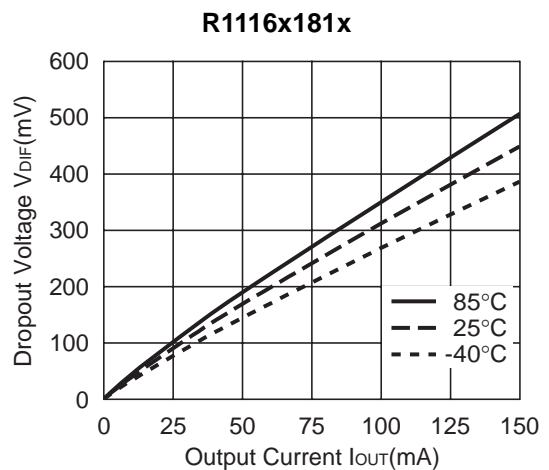
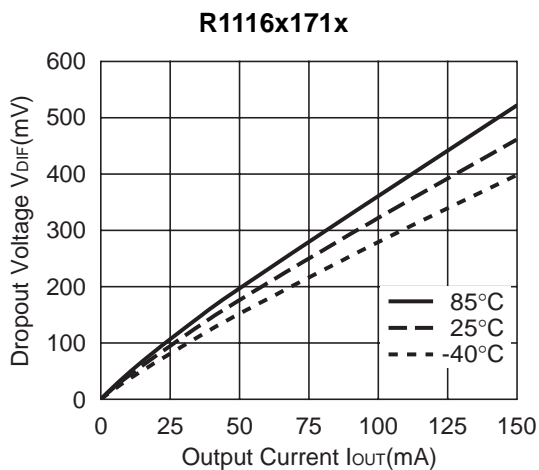
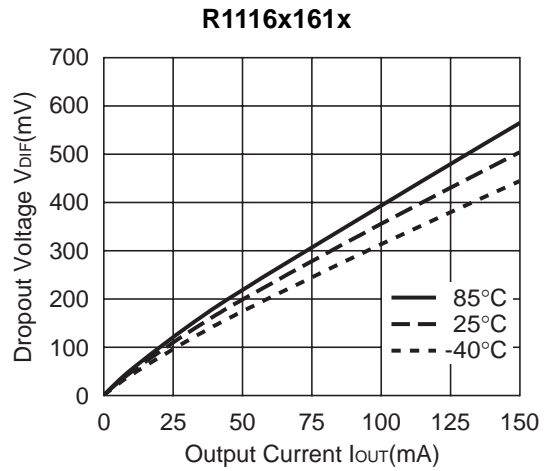
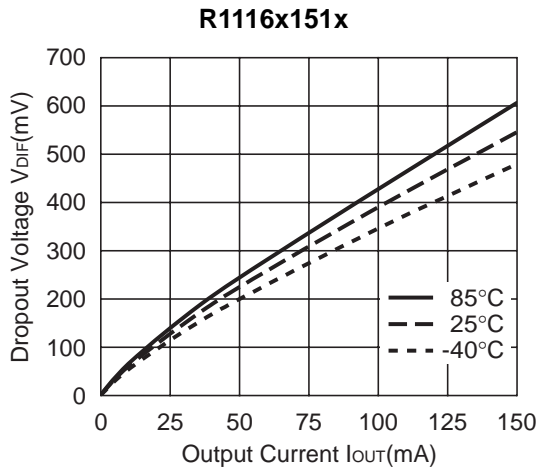


**R1116x281x**



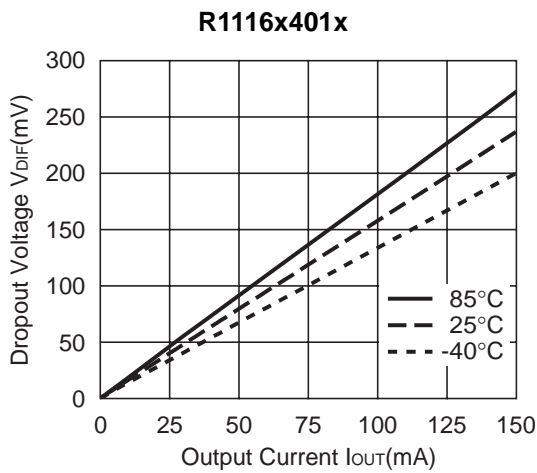
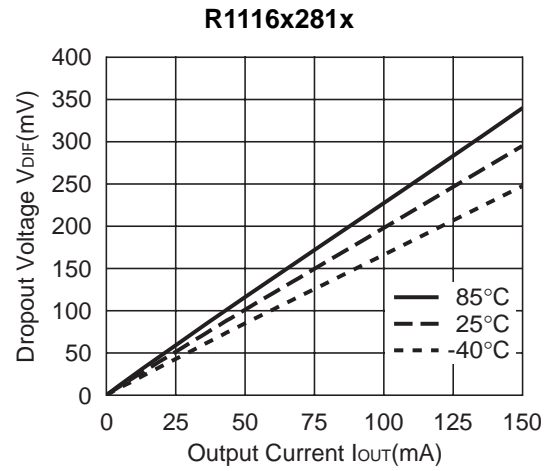
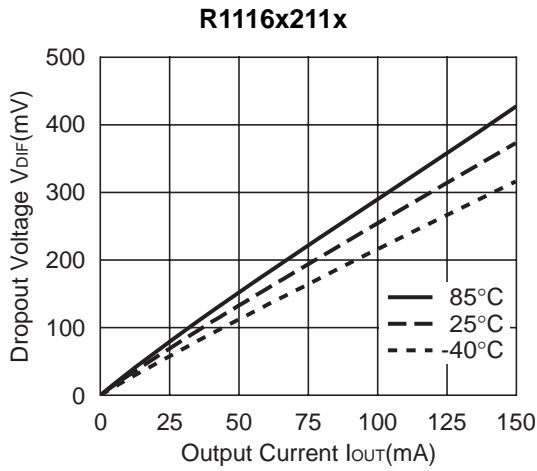


**6) Dropout Voltage vs. Temperature**

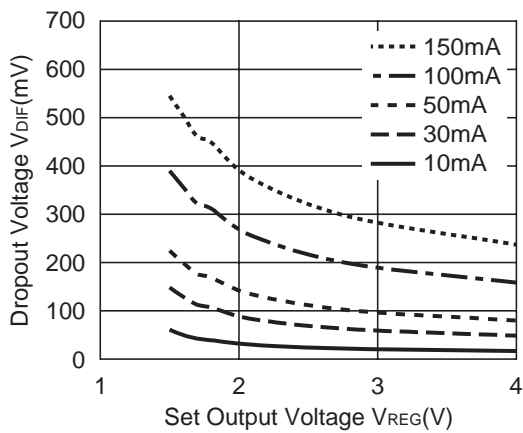


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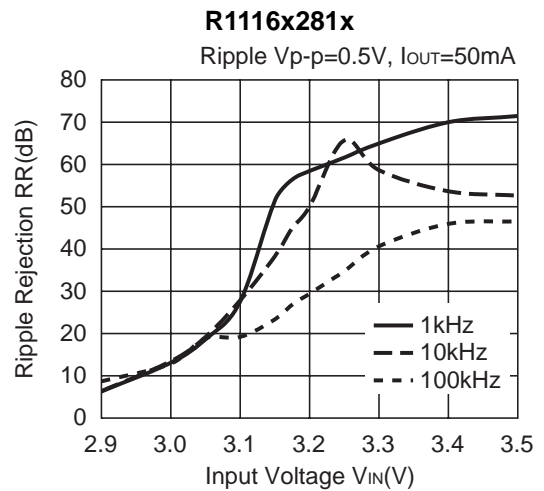
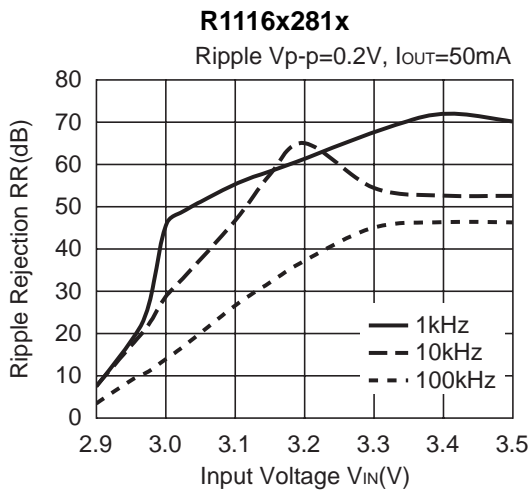
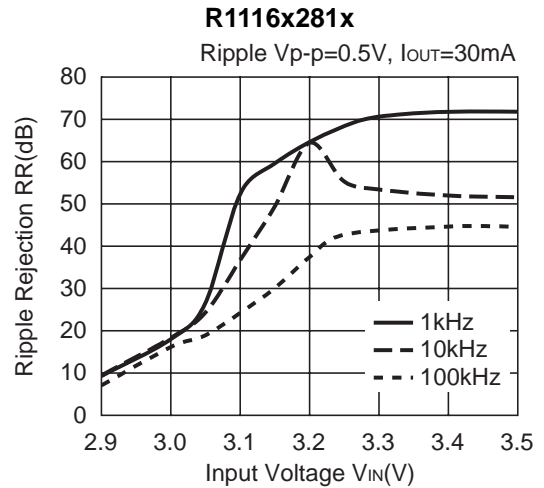
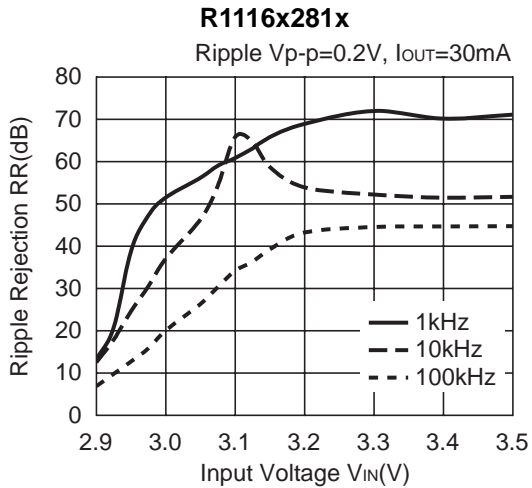
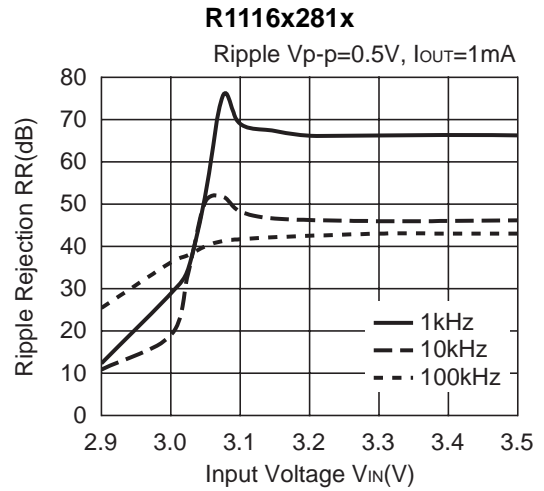
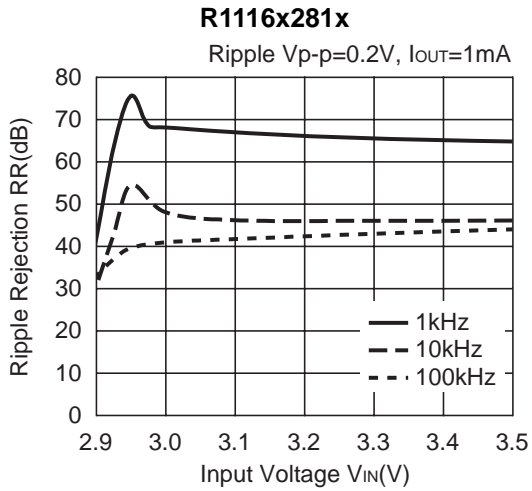
**R1116x**



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

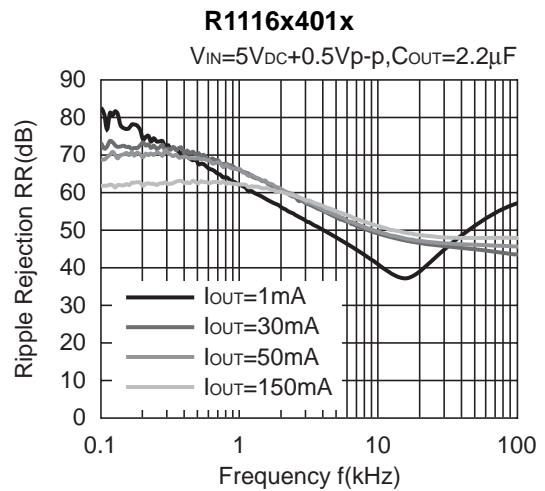
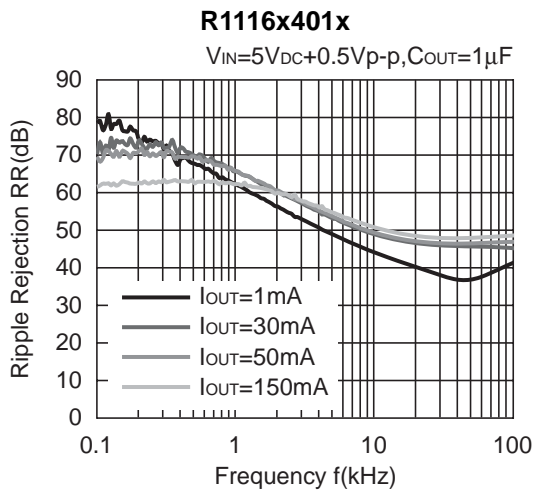
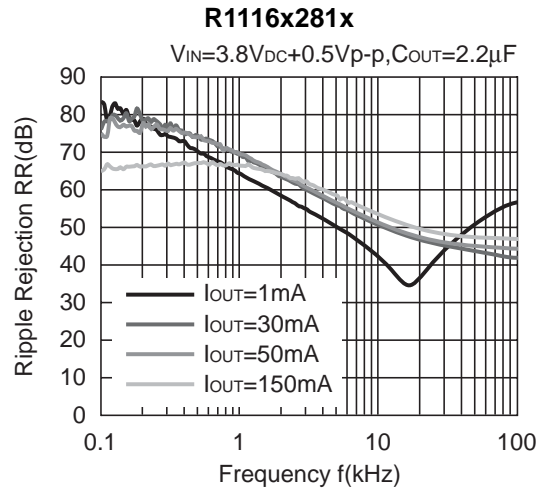
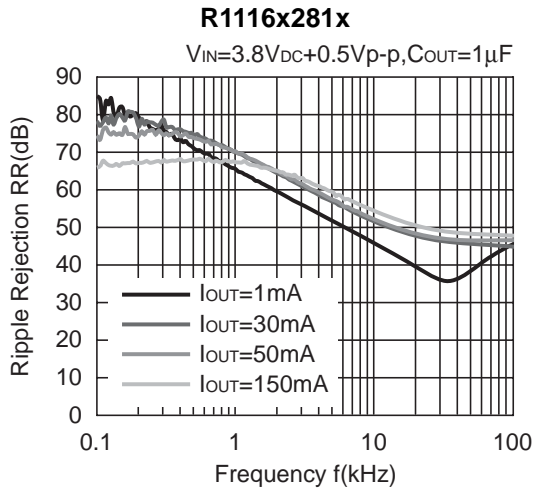
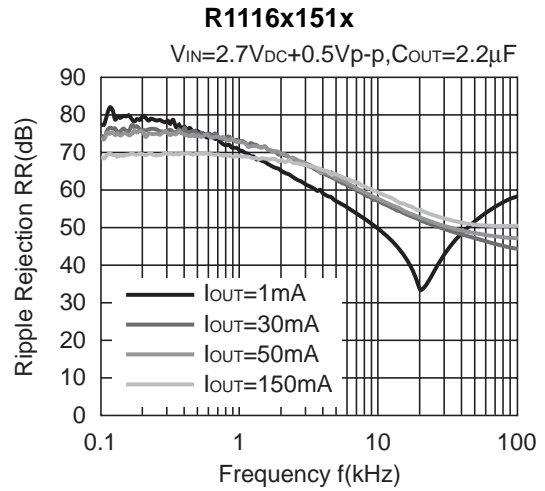
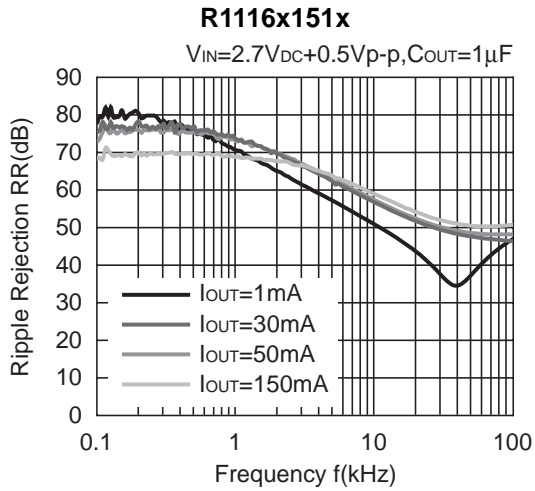


8) Ripple Rejection vs. Input Bias Voltage ( $T_{opt}=25^{\circ}\text{C}$ ,  $C_{IN} = \text{none}$ ,  $C_{OUT} = 1\mu\text{F}$ )

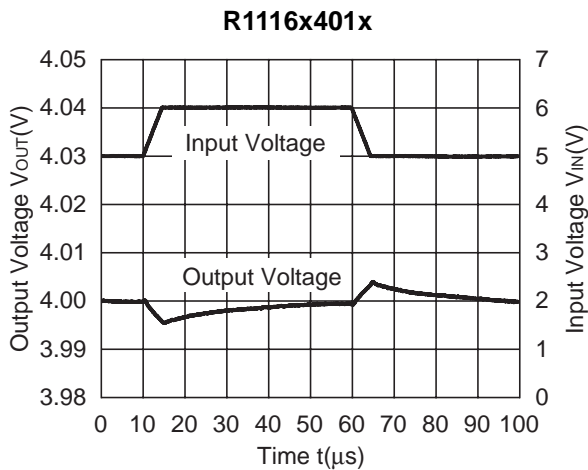
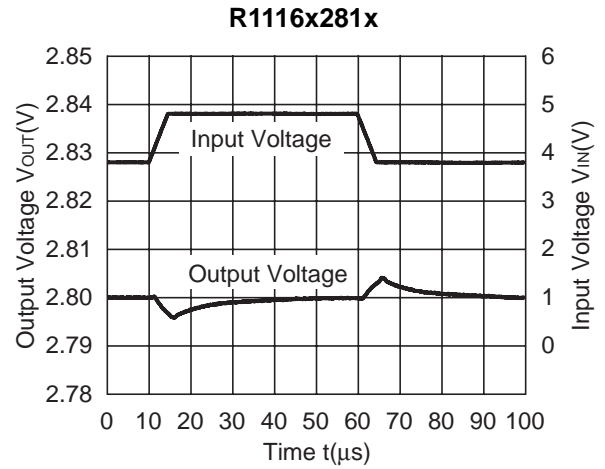
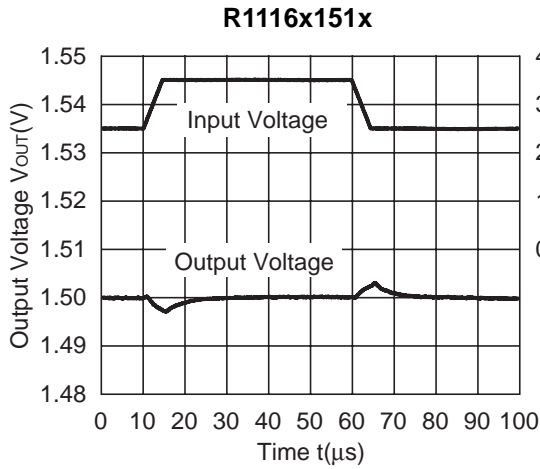


**R1116x**

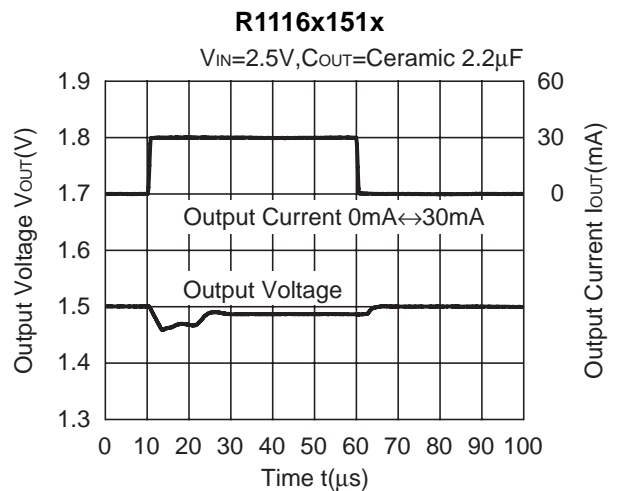
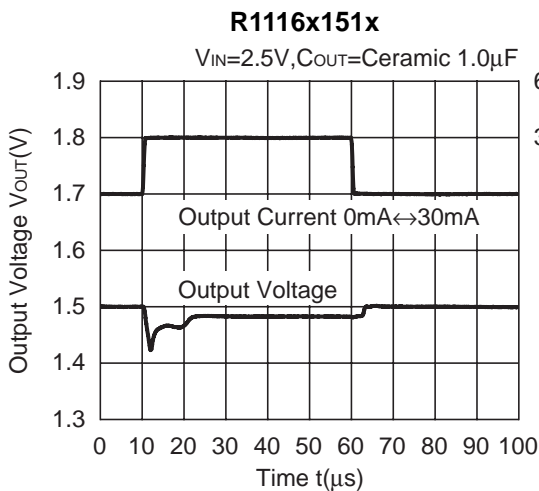
**9) Ripple Rejection vs. Frequency ( $C_{IN}=\text{none}$ )**



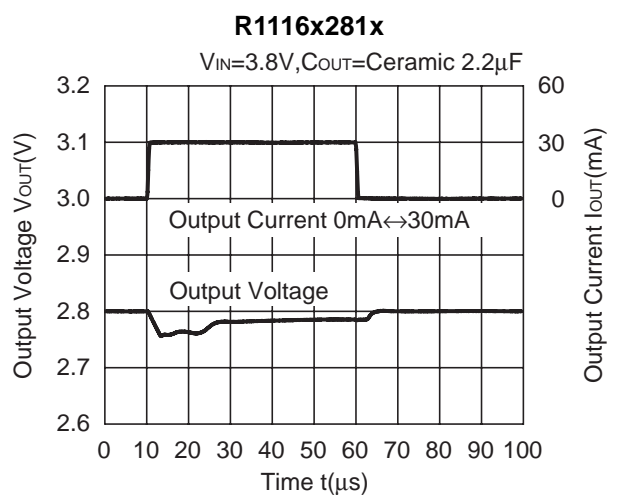
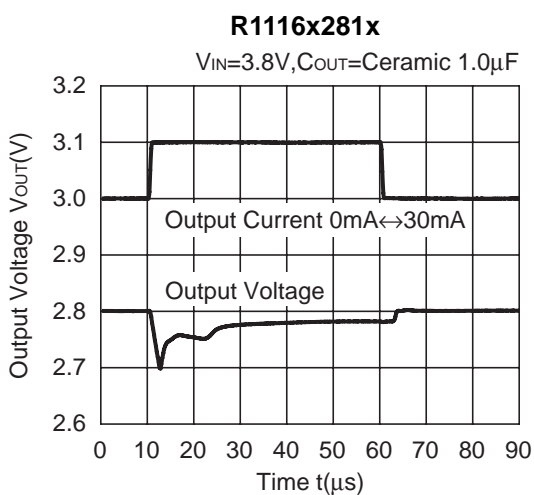
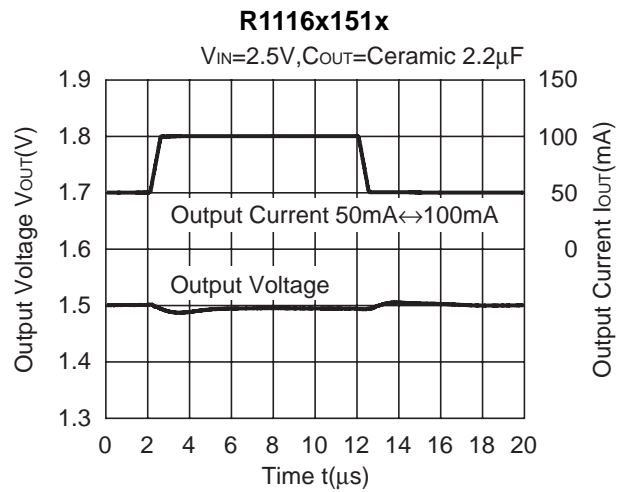
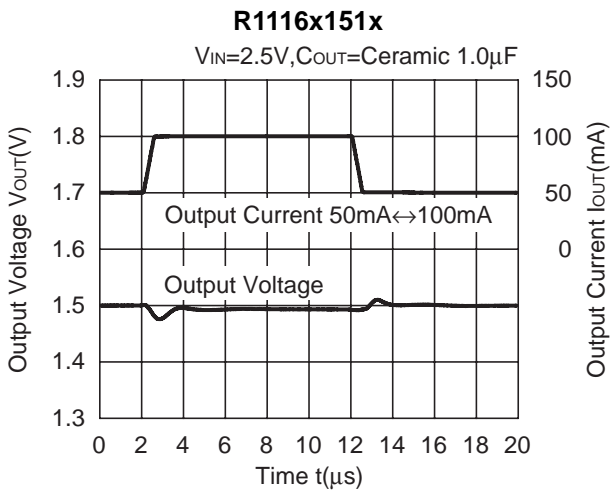
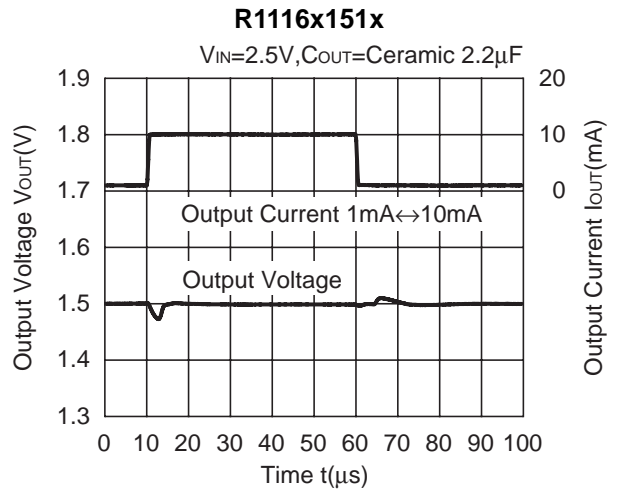
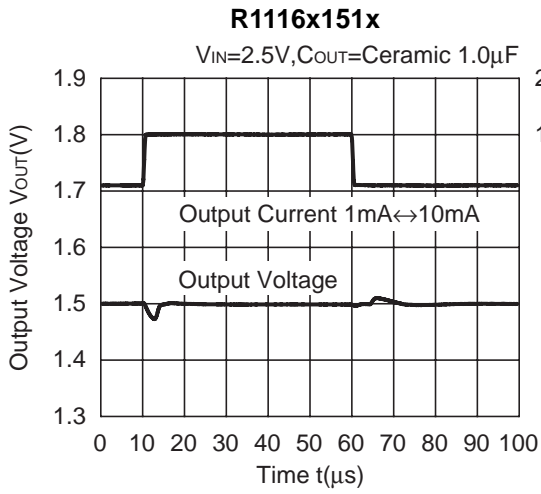
10) Input Transient Response ( $I_{OUT}=30mA$ ,  $C_{IN}=none$ ,  $t_r=t_f=5\mu s$ ,  $C_{OUT}=Ceramic\ 1\mu F$ )



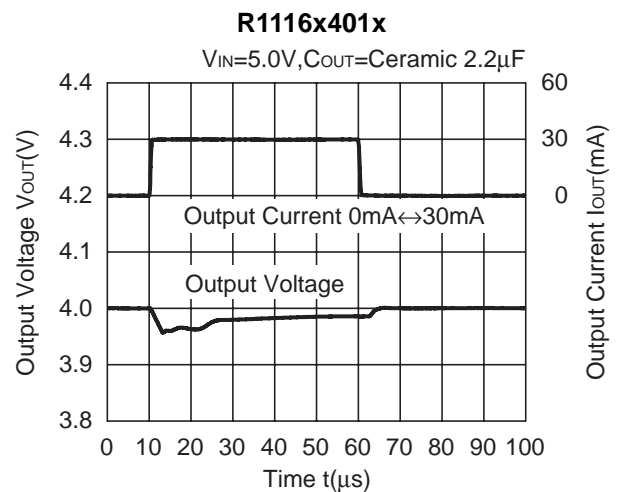
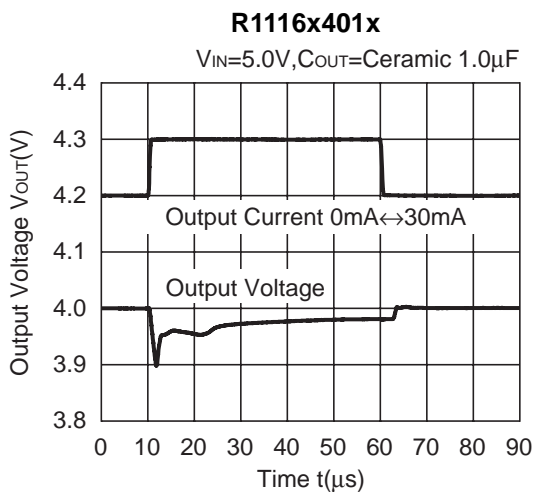
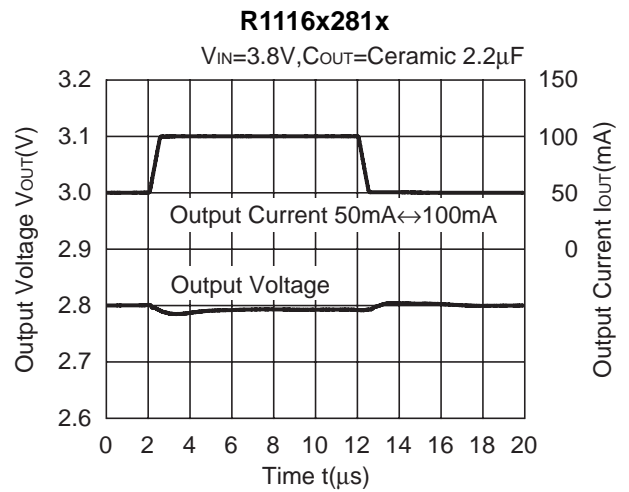
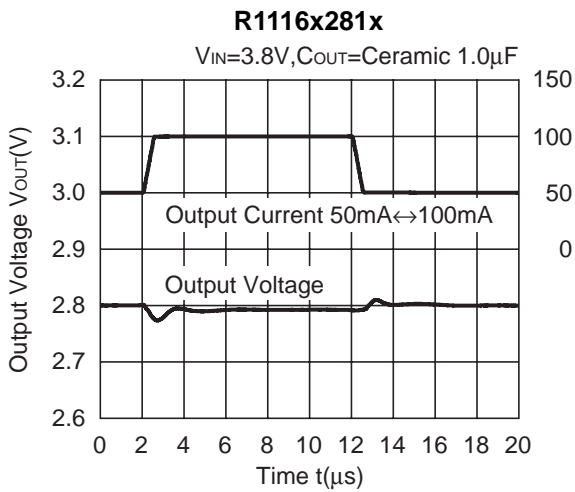
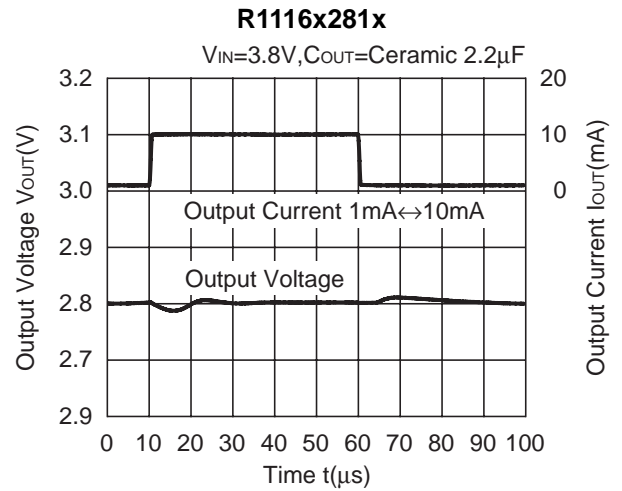
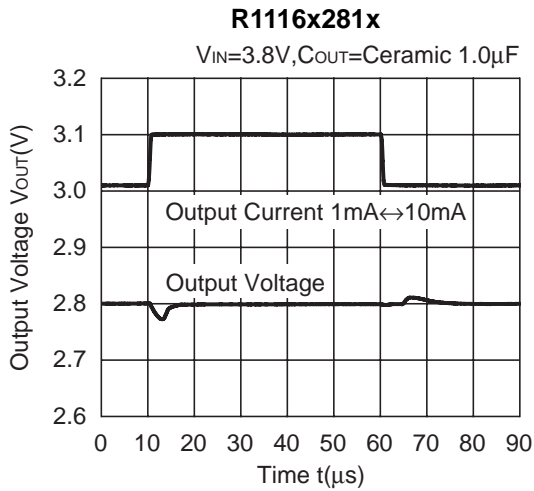
11) Load Transient Response ( $t_r=t_f=0.5\mu s$ ,  $C_{IN}=Ceramic\ 1\mu F$ )



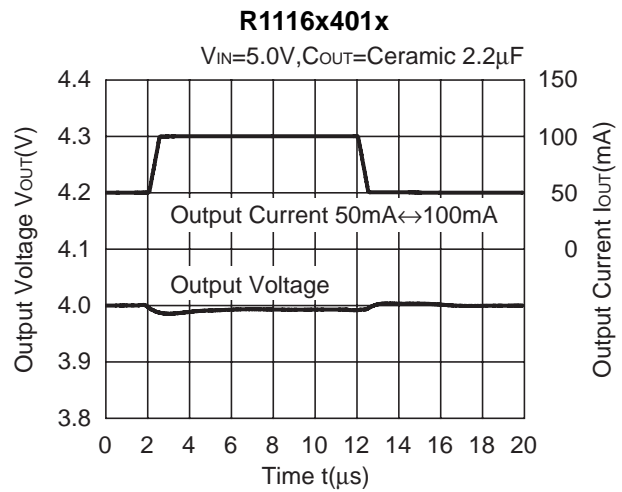
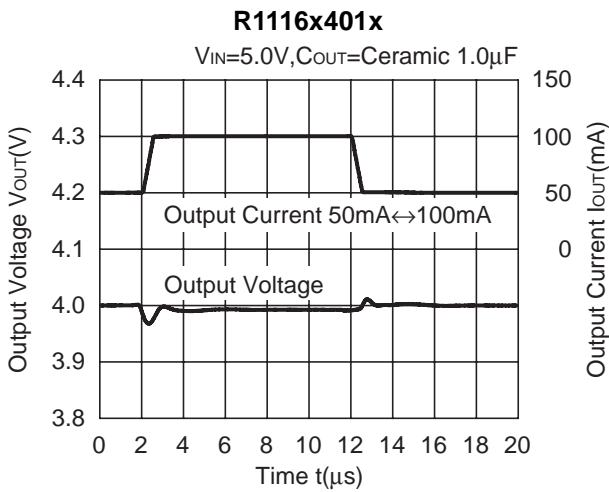
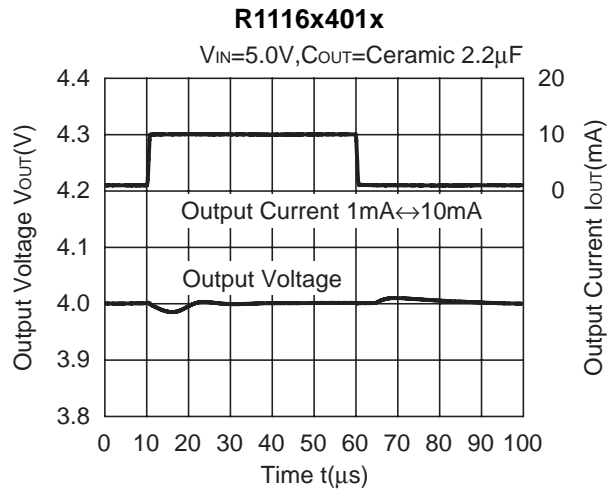
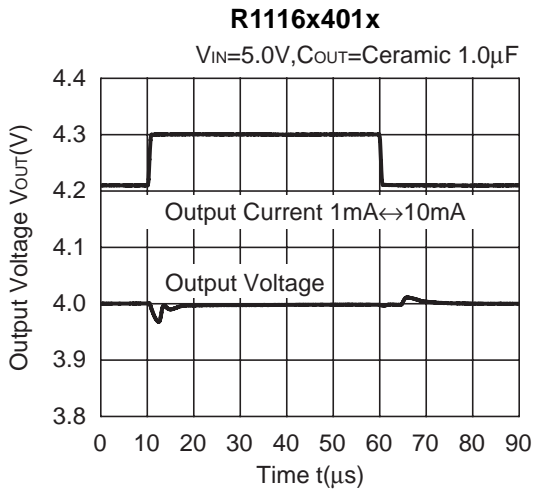
**R1116x**



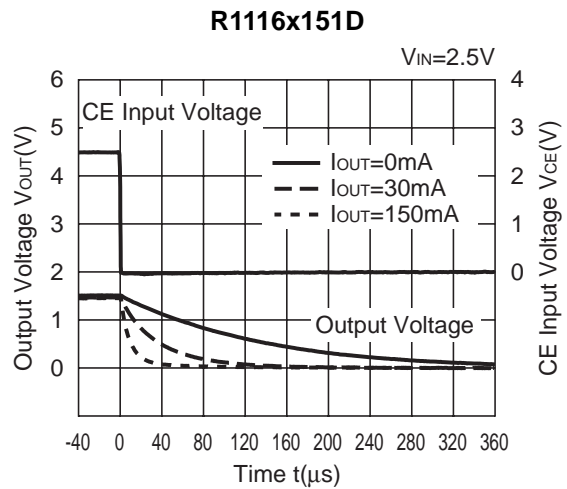
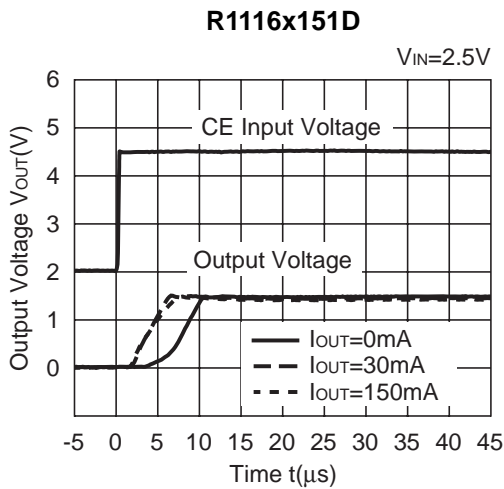




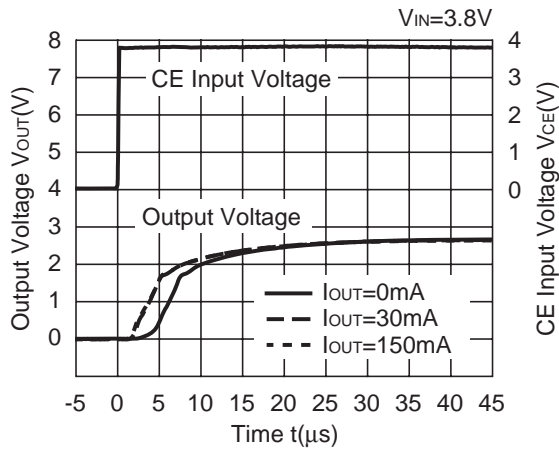
**R1116x**



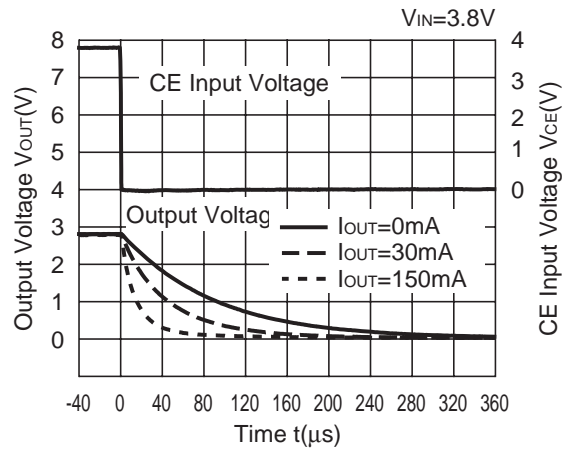
**12) Turn-on/off speed with CE pin (D version) ( $C_{IN}=\text{Ceramic } 1.0\mu F, C_{OUT}=\text{Ceramic } 1.0\mu F$ )**



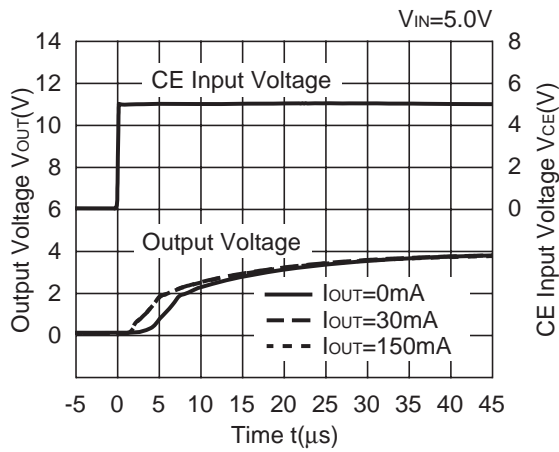
R1116x281D



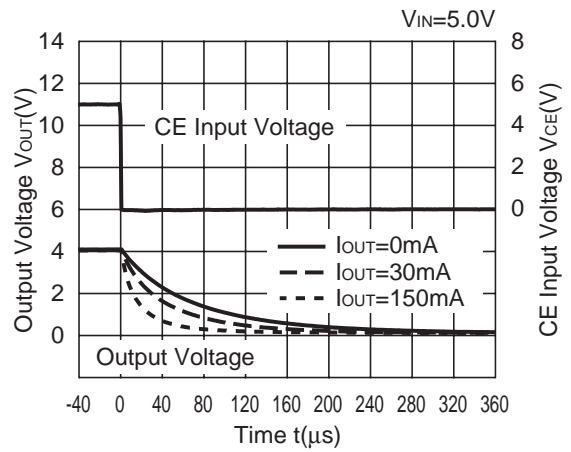
R1116x281D



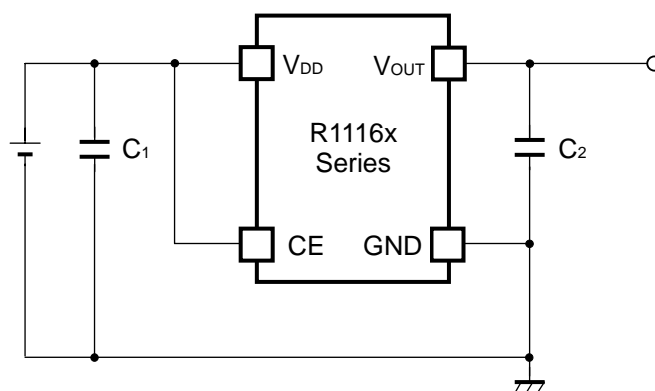
R1116x401D



R1116x401D



## TECHNICAL NOTES



(External Components)

C<sub>2</sub> Ceramic 1.0 $\mu$ F Ex. Murata GRM155B30J105KE18B  
Kyocera CM05X5R105K06AB

C<sub>1</sub> Ceramic 1.0 $\mu$ F

When using these ICs, consider the following points:

### 1. Mounting on PCB

Make V<sub>DD</sub> 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 1.0 $\mu$ F or more as C<sub>1</sub> between V<sub>DD</sub> 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.

### 2. 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<sub>2</sub> 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.)

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.

Depending on the capacitor size, manufacturer, and part number, the bias characteristics and temperature characteristics are different. Evaluate the circuit with actual using capacitors.

## ESR vs. Output Current

When using these ICs, consider the following points:

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.

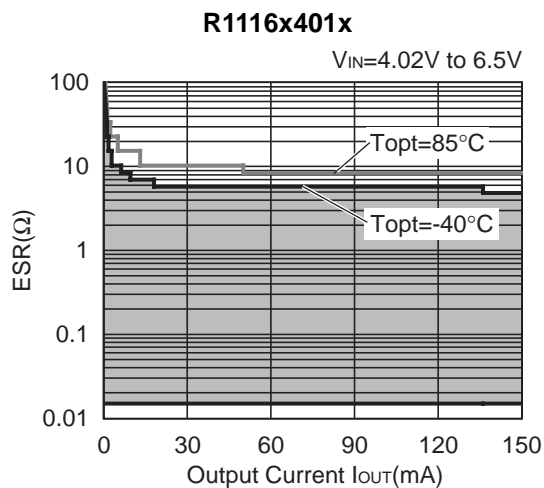
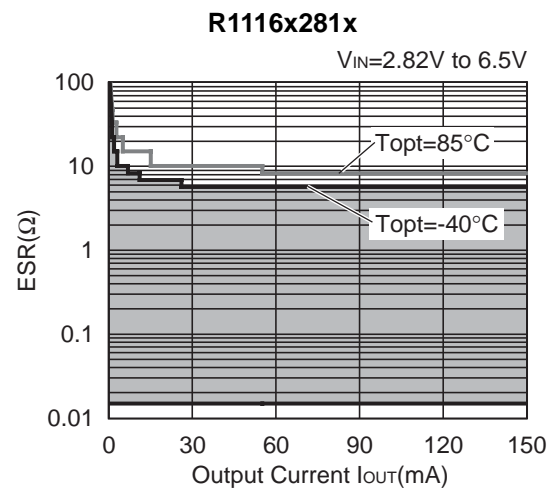
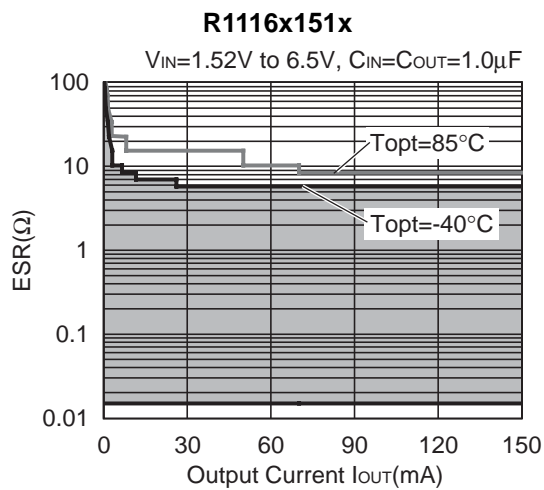
### Measurement conditions

$V_{IN}=V_{OUT}+1\text{V}$

$C_{OUT}$ : GRM155B30J105KE18B

Frequency Band: 10Hz to 2MHz

Temperature:  $-40^{\circ}\text{C}$  to  $25^{\circ}\text{C}$





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