

Low Noise 150mA LDO REGULATOR

NO.EA-258-111020

OUTLINE

The RP112x Series are CMOS-based voltage regulator (LDO) ICs, which have been developed using the CMOS process technology, with high output voltage accuracy, low-supply current, low On-resistance transistor, low noise output voltage and high ripple rejection. Each of the ICs is composed of the followings: a voltage reference unit, an error amplifier, a resistor-net for output voltage setting, a current limit circuit, and a chip enable circuit.

The RP112x features ultra low noise and its Ripple Rejection is as low as 80dB at $f=1\text{kHz}$, 75dB at $f=10\text{kHz}$ and 65dB at $f=100\text{kHz}$. The Output Noise is also as low as Typ. $10\mu\text{Vrms}$. It is kept the low level at any Output Voltage. RP112x is suitable for the power source for the portable music player and RF module that demands for higher level of noise reduction. SOT-23-5 and SC-88A packages, a 1mm square DFN(PLP)1010-4 package are available.

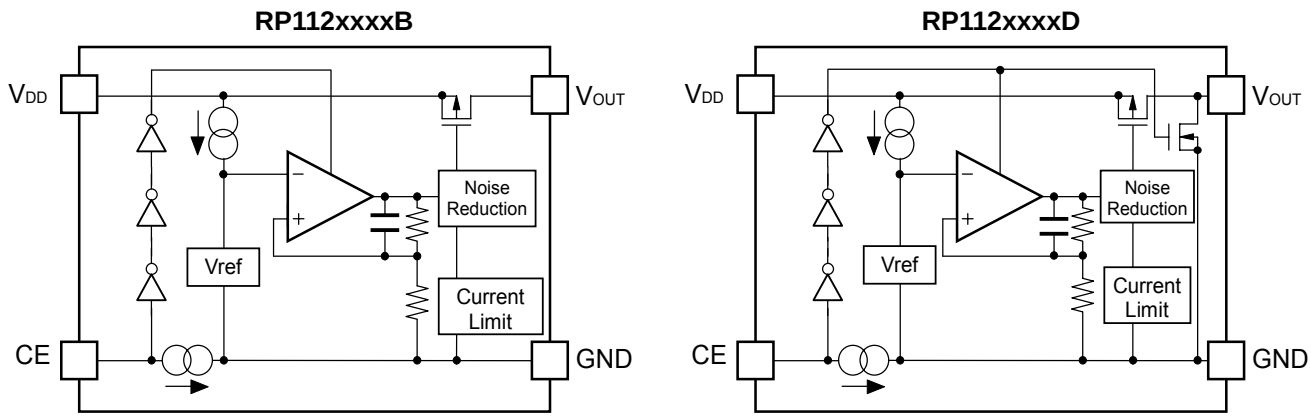
FEATURES

- Supply Current Typ. $75\mu\text{A}$
- Standby Current Typ. $0.1\mu\text{A}$
- Dropout Voltage Typ. 0.20V ($I_{\text{OUT}}=150\text{mA}$, $V_{\text{OUT}}=2.8\text{V}$)
- Ripple Rejection Typ. 80dB ($f=1\text{kHz}$)
Typ. 75dB ($f=10\text{kHz}$)
Typ. 65dB ($f=100\text{kHz}$)
- Output Voltage Accuracy $\pm 1.0\%$
- Output Voltage Temperature Coefficient Typ. $\pm 30\text{ppm}/^\circ\text{C}$
- Line Regulation Typ. $0.02\%/V$
- Packages DFN(PLP)1010-4, SC-88A, SOT-23-5
- Input Voltage Range 2.0V to 5.25V
- Output Voltage Range 1.2V to 4.8V (0.1V steps)
(For other voltages, please refer to MARK INFORMATION.)
- Short Current Limit Typ. 40mA
- Built-in Foldback Protection Circuit
- Output Noise Typ. $10\mu\text{Vrms}$
- Ceramic capacitors are recommended to be used with this IC $1.0\mu\text{F}$ or more

APPLICATIONS

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

BLOCK DIAGRAMS



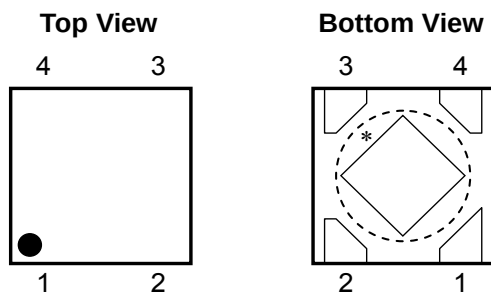
SELECTION GUIDE

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

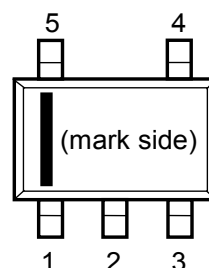
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP112Kxx1*-TR	DFN(PLP)1010-4	10,000 pcs	Yes	Yes
RP112Qxx2*-TR-FE	SC-88A	3,000 pcs	Yes	Yes
RP112Nxx1*-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
xx : The output voltage can be designated in the range of 1.2V(12) to 4.8V(48) in 0.1V steps. (For other voltages, please refer to MARK INFORMATION.)				
* : 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

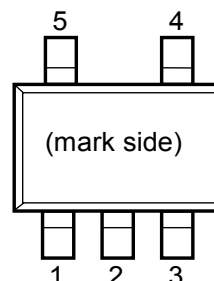
• DFN(PLP)1010-4



• SC-88A



• SOT-23-5



PIN DESCRIPTIONS

• DFN(PLP)1010-4

Pin No.	Symbol	Description
1	V_{OUT}	Output Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	V_{DD}	Input Pin

*) Tab is GND level. (They are connected to the reverse side of this IC.)

The tab is better to be connected to the GND, but leaving it open is also acceptable.

• SC-88A

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	NC	No Connection
5	V_{OUT}	Output Pin

• SOT-23-5

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	NC	No Connection
5	V_{OUT}	Output Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.0	V
V_{CE}	Input Voltage (CE Pin)	6.0	V
V_{OUT}	Output Voltage	-0.3 to $V_{IN} + 0.3$	V
I_{OUT}	Output Current	180	mA
P_D	Power Dissipation (DFN(PLP)1010-4)*	400	mW
	Power Dissipation (SC-88A)*	380	
	Power Dissipation (SOT-23-5)*	420	
T_{opt}	Operating Temperature Range	-40 to 85	$^{\circ}\text{C}$
T_{stg}	Storage Temperature Range	-55 to 125	$^{\circ}\text{C}$

*) 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

Unless otherwise noted, $V_{IN}=5.25V$ ($V_{OUT} \geq 4.1V$), $V_{IN}=\text{Set } V_{OUT}+1.0V$ ($1.5V < V_{OUT} < 4.1V$),
 $V_{IN}=2.5V$ ($V_{OUT} \leq 1.5V$), $I_{OUT}=1mA$, $C_{IN}=C_{OUT}=1.0\mu F$.

The values in are applicable under the condition of $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$.

● RP112xxxxB/D

$T_{opt}=25^{\circ}C$

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	$T_{opt}=25^{\circ}C$	$V_{OUT} \geq 2.0V$	$\times 0.99$	$\times 1.01$	V
			$V_{OUT} < 2.0V$	-20	+20	mV
		$-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$	$V_{OUT} \geq 2.0V$	$\times 0.985$	$\times 1.015$	V
			$V_{OUT} < 2.0V$	-30	+30	mV
I_{OUT}	Output Current		150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	$1mA \leq I_{OUT} \leq 150mA$	-14	0	14	mV
V_{DIF}	Dropout Voltage	Please refer to "Dropout Voltage".				
I_{SS}	Supply Current	$I_{OUT}=0mA$	$V_{OUT} \geq 4.1V$	80	100	μA
			$V_{OUT} < 4.1V$	75		
$I_{standby}$	Standby Current	$V_{CE}=0V$		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$\text{Set } V_{OUT}+0.3 \leq V_{IN} \leq 5.25V$	$V_{OUT} \geq 4.1V$	0.02	0.10	%V
		$\text{Set } V_{OUT}+0.5V \leq V_{IN} \leq 5.0V$	$1.7V \leq V_{OUT} \leq 4.1V$			
		$2.2V \leq V_{IN} \leq 5.0V$	$V_{OUT} < 1.7V$			
RR	Ripple Rejection	Ripple 0.2Vp-p, $I_{OUT}=30mA$, $V_{IN}=5.25V$ ($V_{OUT} \geq 4.1V$), $V_{IN}=\text{Set } V_{OUT}+1.0V$ ($V_{OUT} < 4.1V$)	$f=1kHz$	80		dB
			$f=10kHz$	75		
			$f=100kHz$	65		
V_{IN}	Input Voltage*		2.0		5.25	V
$\Delta V_{OUT}/\Delta T_{opt}$	Output Voltage Temperature Coefficient	$-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$		± 30		ppm/ $^{\circ}C$
I_{SC}	Short Current Limit	$V_{OUT}=0V$		40		mA
I_{PD}	CE Pull-down Current			0.3	0.6	μA
V_{CEH}	CE Input Voltage "H"		1.0			V
V_{CEL}	CE Input Voltage "L"				0.4	V
en	Output Noise	$BW=10Hz \sim 100kHz$, $I_{OUT}=30mA$		10		μV_{rms}
R_{LOW}	Auto-discharge Nch Tr. ON Resistance (D version)	$V_{IN}=4.0V$, $V_{CE}=0V$		60		Ω

The values in have been tested and guaranteed by Design Engineering.

All test categories were tested on the products under the pulse load condition ($T_j \approx T_{opt}=25^{\circ}C$) except for Output Voltage Temperature Coefficient, Output Noise and Ripple Rejection.

*) When Input Voltage is 5.5V, the total operational time must be within 500hrs.

• Dropout Voltage

T_{opt}=25°C

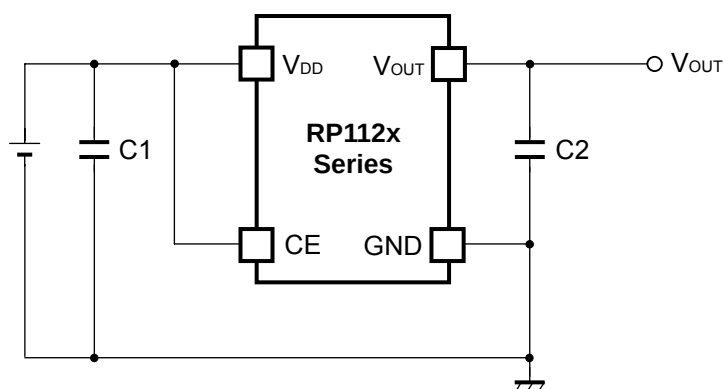
Output Voltage V _{OUT} (V)	Dropout Voltage V _{DIF} (V)		
	Condition	Typ.	Max.
1.2V ≤ V _{OUT} < 1.3V	I _{OUT} =150mA	0.39	0.80
1.3V ≤ V _{OUT} < 1.4V		0.37	0.70
1.4V ≤ V _{OUT} < 1.5V		0.34	0.60
1.5V ≤ V _{OUT} < 1.7V		0.32	0.50
1.7V ≤ V _{OUT} < 2.0V		0.29	0.41
2.0V ≤ V _{OUT} < 2.5V		0.25	0.36
2.5V ≤ V _{OUT} < 2.8V		0.22	0.31
2.8V ≤ V _{OUT} ≤ 4.8V		0.20	0.28

The values in have been tested and guaranteed by Design Engineering

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.

TYPICAL APPLICATIONS



External Parts Example:

C1, C2: Ceramic Capacitor 1.0 μ F, Murata, GRM155B31A105KE15

TECHNICAL NOTES

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 1.0 μ F or more capacitor C2.

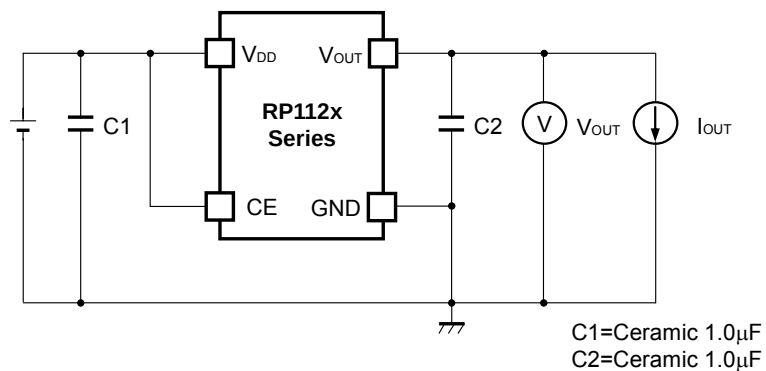
In case of using a tantalum capacitor, the output may be unstable due to inappropriate ESR. Therefore, the full range of operating conditions for the capacitor in the application should be considered.

PCB Layout

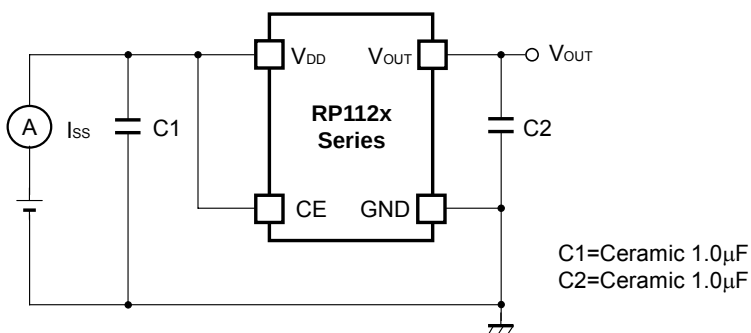
The high impedances of V_{DD} and GND could be a reason for the noise pickup and unstable operation. Therefore, it is imperative that the impedances of V_{DD} and GND be the lowest possible. Also, place a 1.0 μ F or more capacitor (C1) between V_{DD} pin and GND pin as close as possible to each other.

As for C2 output capacitor that is used for phase compensation, place it between V_{OUT} pin and GND as close as possible to each other (Refer to TYPICAL APPLICATIONS).

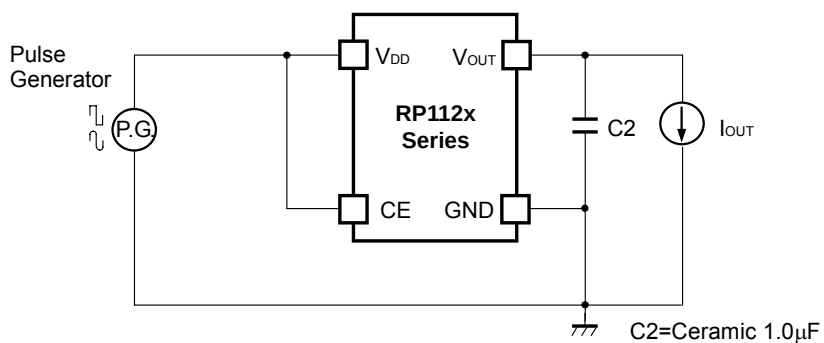
TEST CIRCUIT



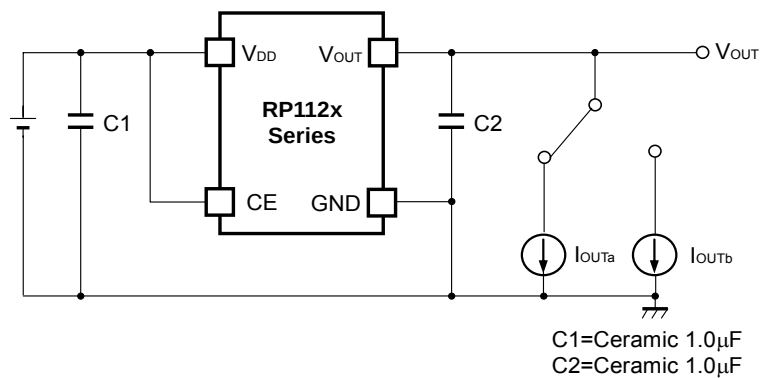
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection

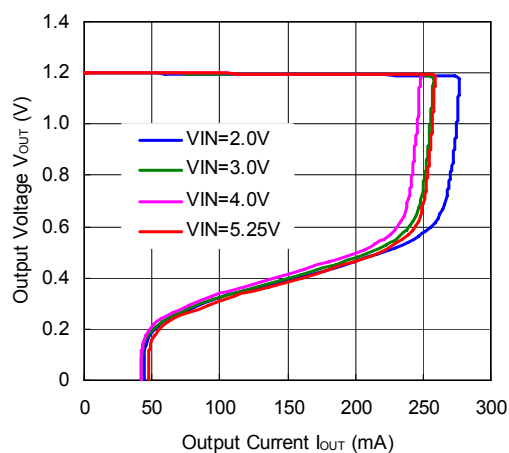


Test Circuit for Load Transient Response

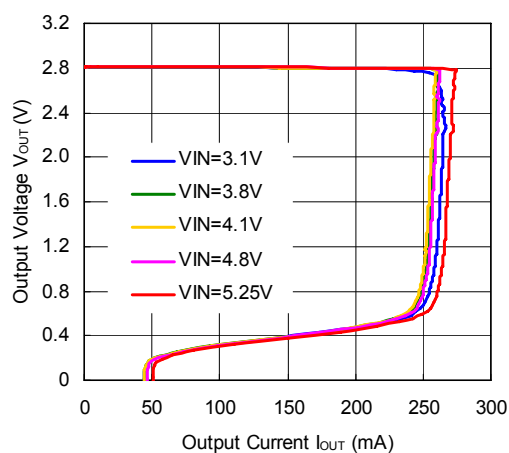
Typical Characteristics

1) Output Voltage vs. Output Current (C1=Ceramic 1.0 μ F, C2=Ceramic 1.0 μ F, T_{opt}=25°C)

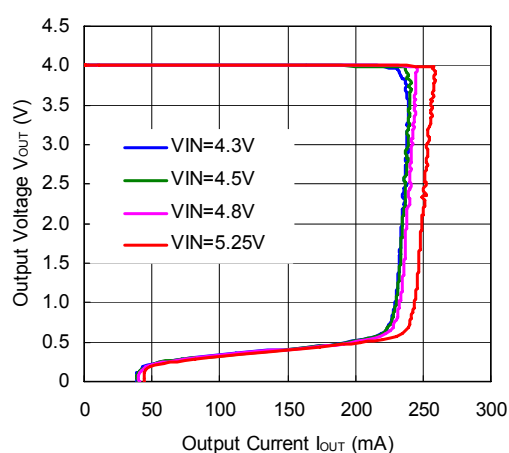
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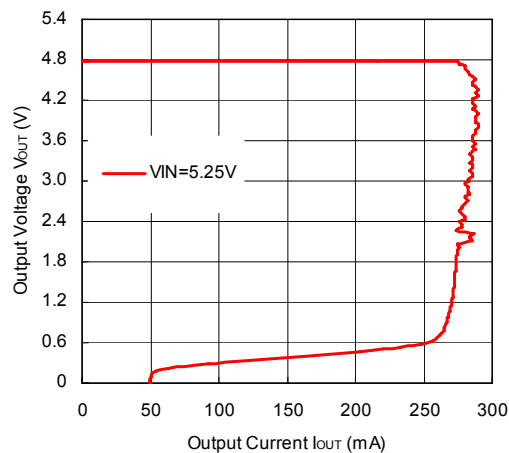
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RP112x40xx

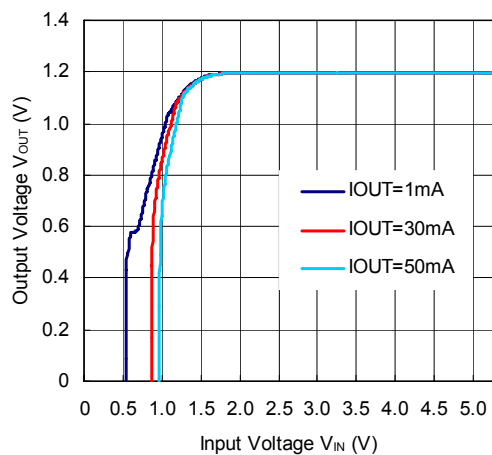


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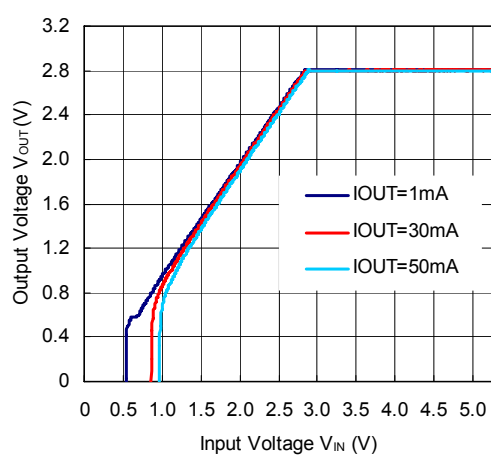


2) Output Voltage vs. Input Voltage (C1=Ceramic 1.0 μ F, C2=Ceramic 1.0 μ F, T_{opt}=25°C)

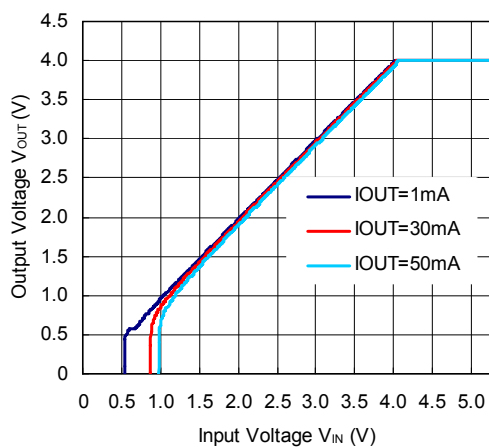
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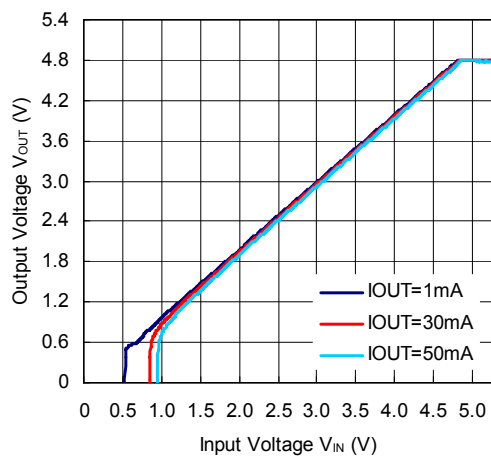
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RP112x40xx

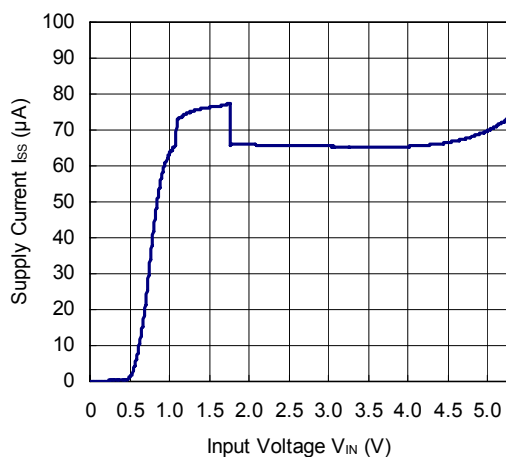


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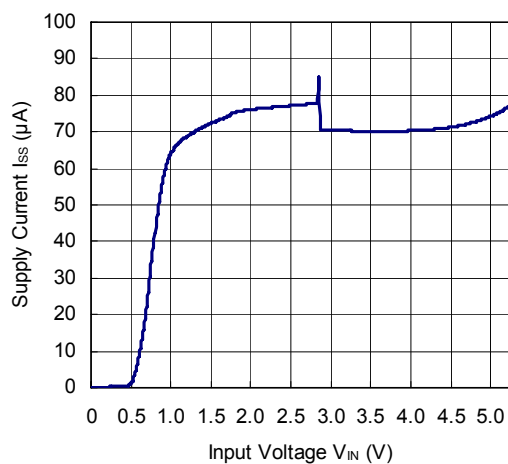


3) Supply Current vs. Input Voltage ($C1$ =Ceramic $1.0\mu\text{F}$, $C2$ =Ceramic $1.0\mu\text{F}$, $T_{opt}=25^\circ\text{C}$)

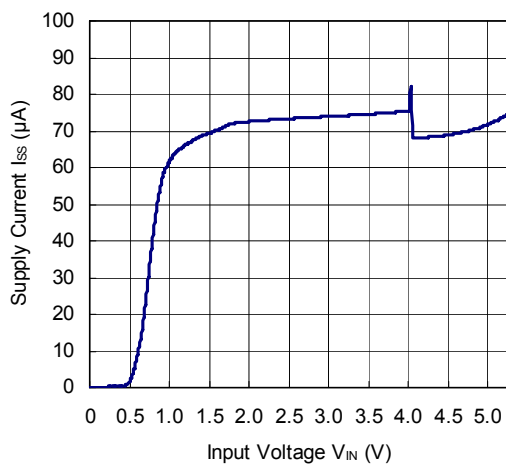
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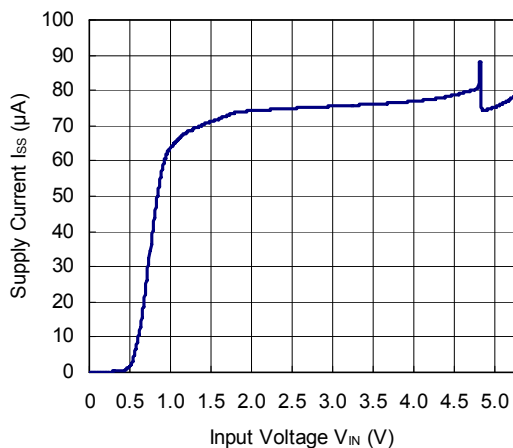
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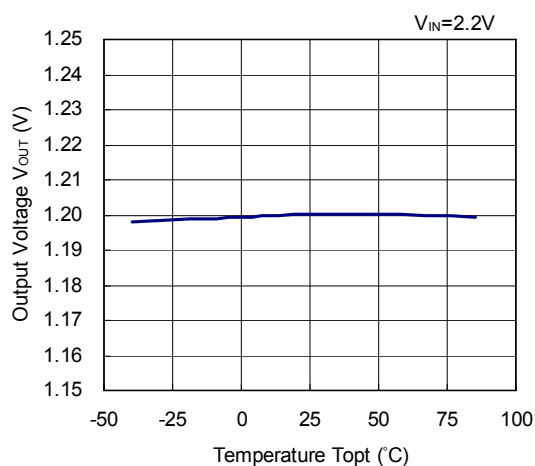


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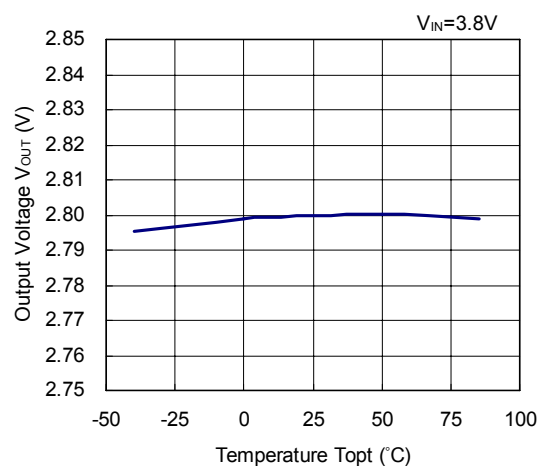


4) Output Voltage vs. Temperature (C1=Ceramic 1.0 μ F, C2=Ceramic 1.0 μ F, I_{OUT}=1mA)

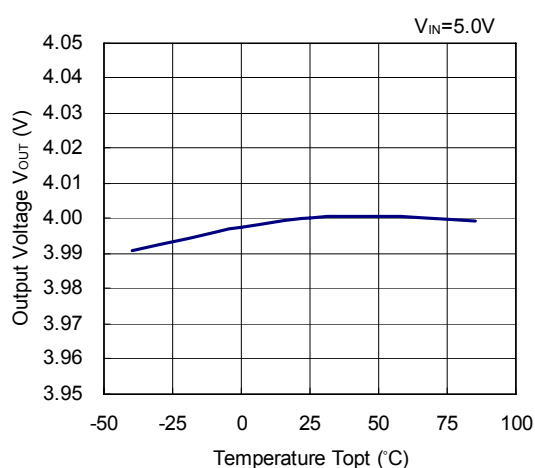
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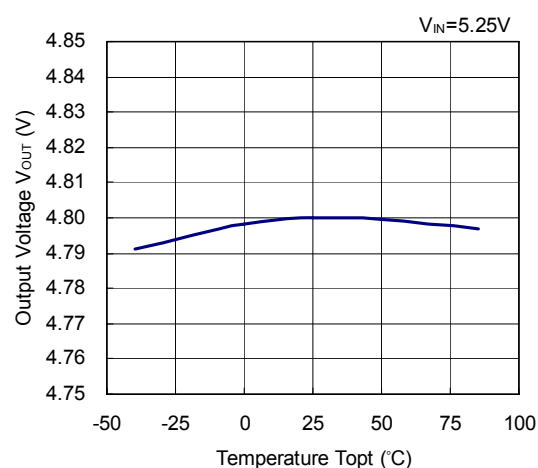
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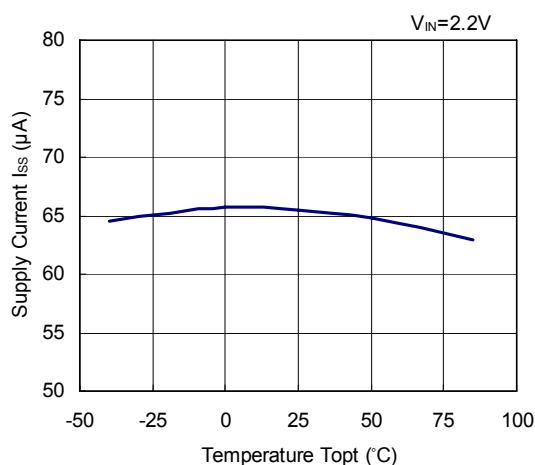


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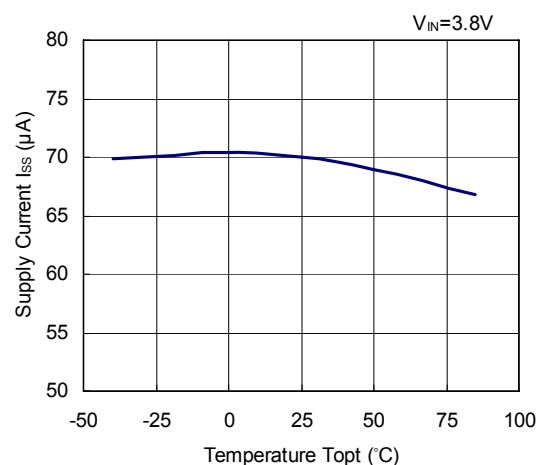


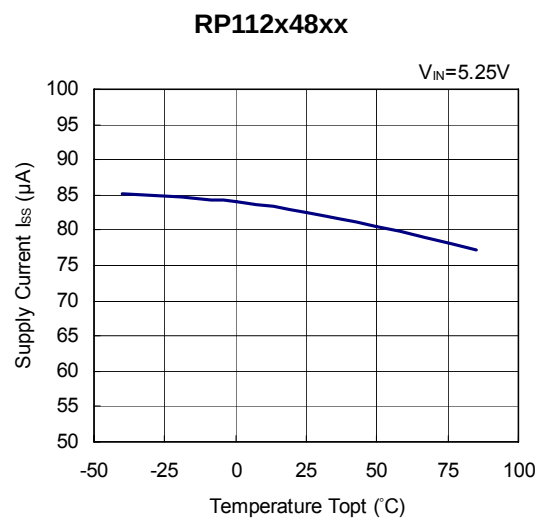
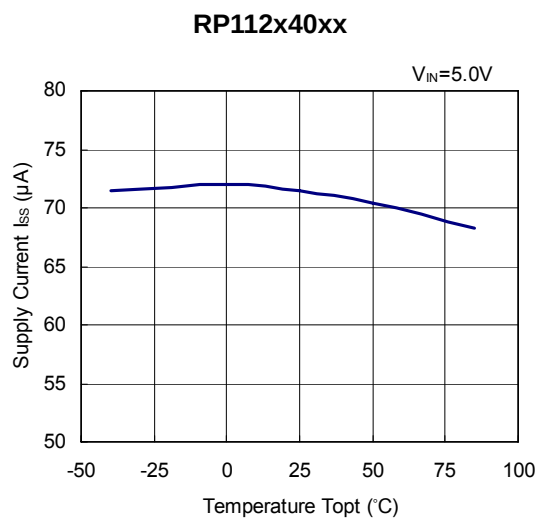
5) Supply Current vs. Temperature (C1=Ceramic 1.0 μ F, C2=Ceramic 1.0 μ F, I_{OUT}=0mA)

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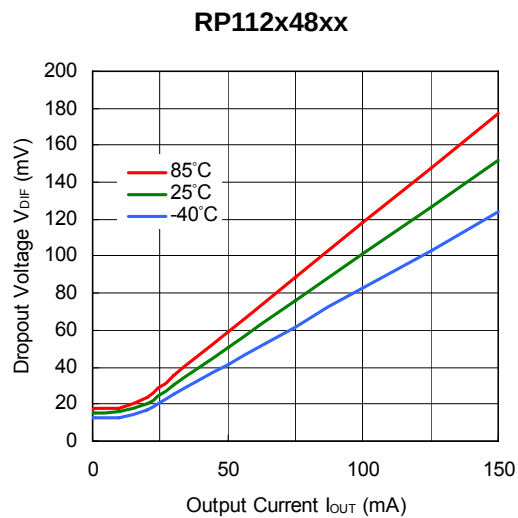
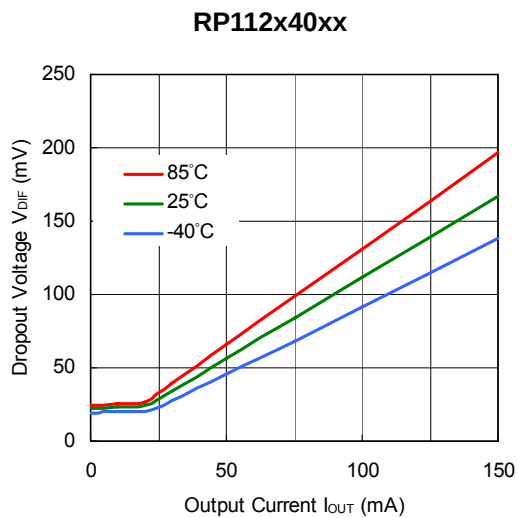
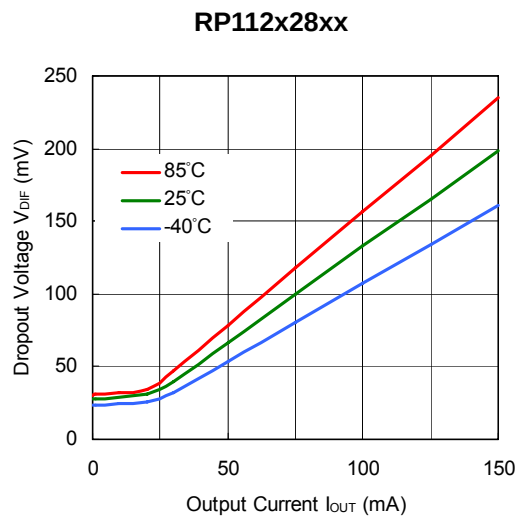


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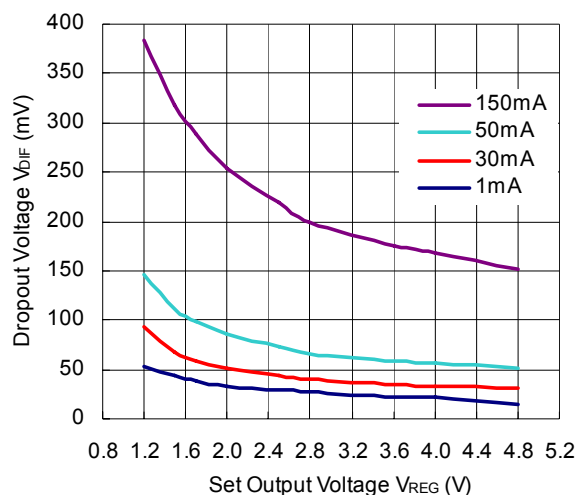




6) Dropout Voltage vs. Output Current (C1=Ceramic 1.0μF, C2=Ceramic 1.0μF)

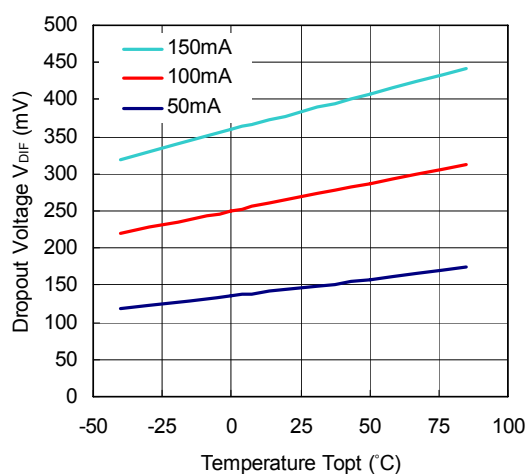


7) Dropout Voltage vs. Set Output Voltage (C1=Ceramic 1.0 μ F, C2=Ceramic 1.0 μ F, T_{opt}=25°C)

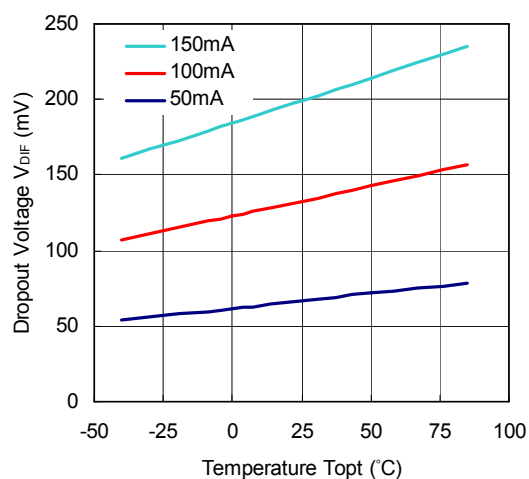


8) Dropout Voltage vs. Temperature (C1=Ceramic 1.0 μ F, C2=Ceramic 1.0 μ F)

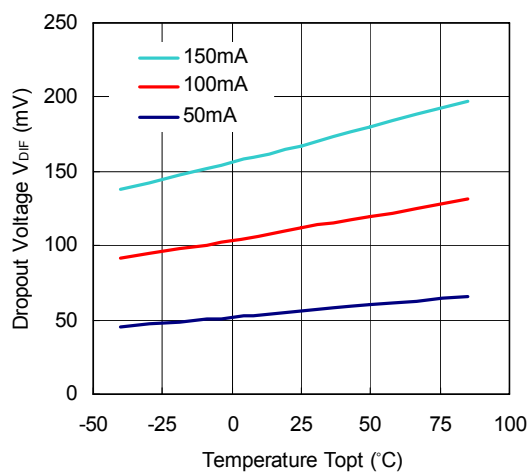
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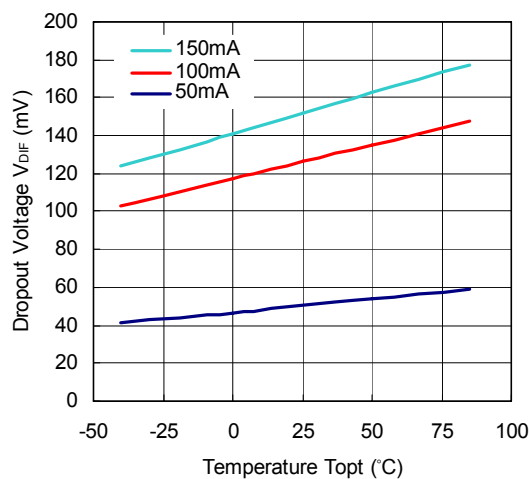
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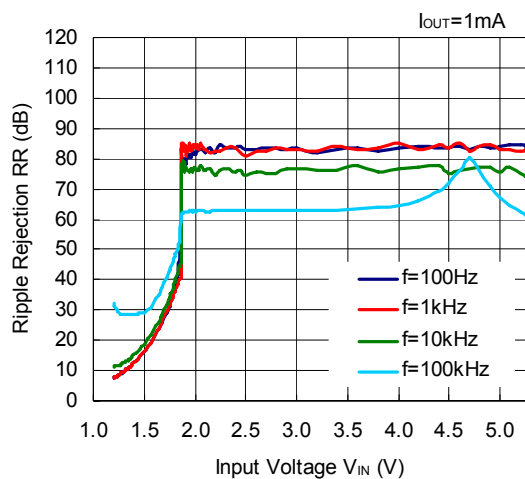


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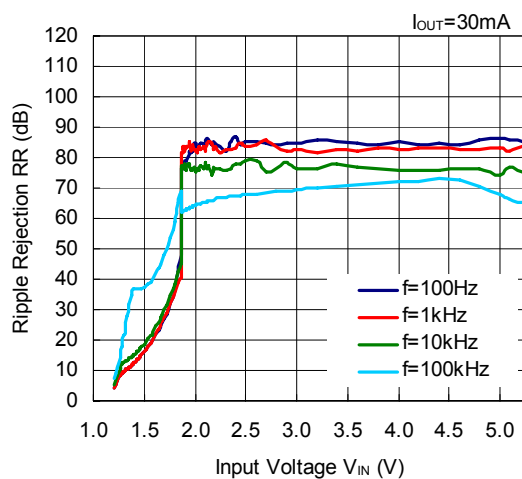


9) Ripple Rejection vs. Input Voltage (C1=none, C2=Ceramic 1.0 μ F, Ripple=0.2Vp-p, T_{opt}=25°C)

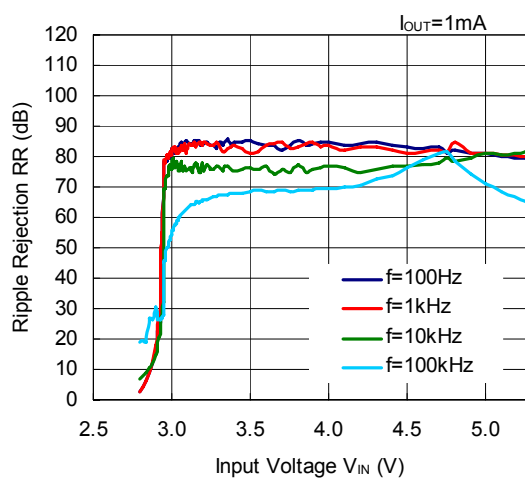
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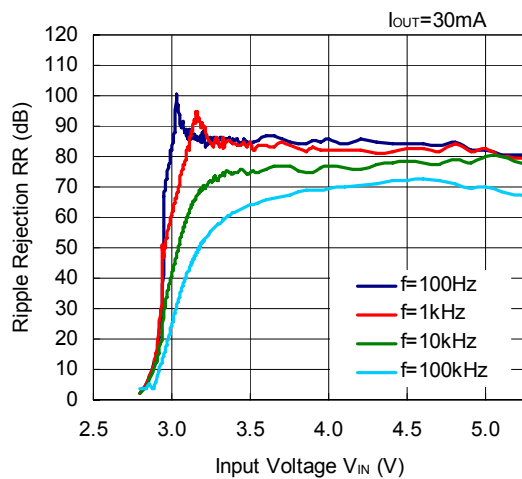
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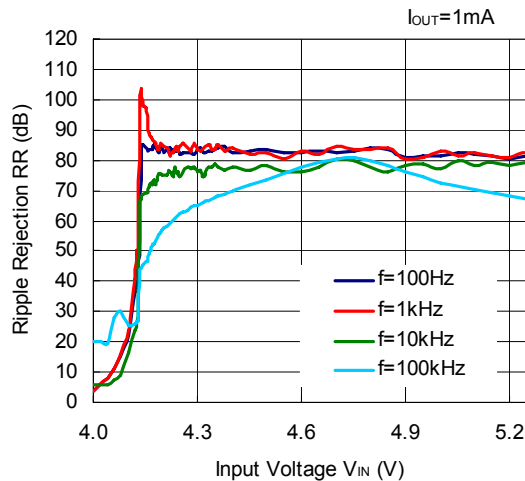
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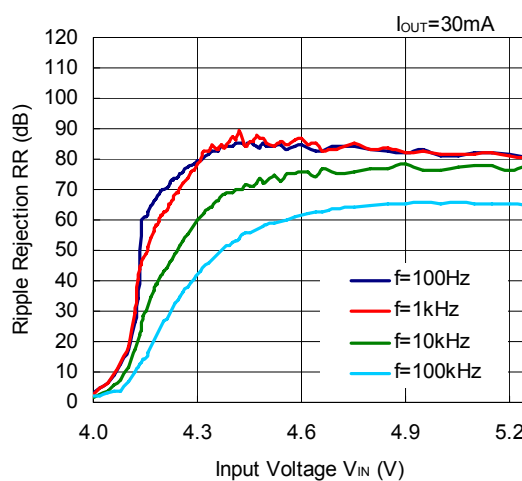
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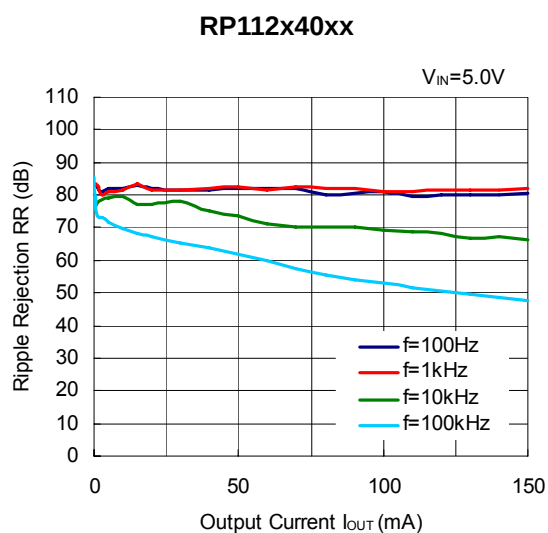
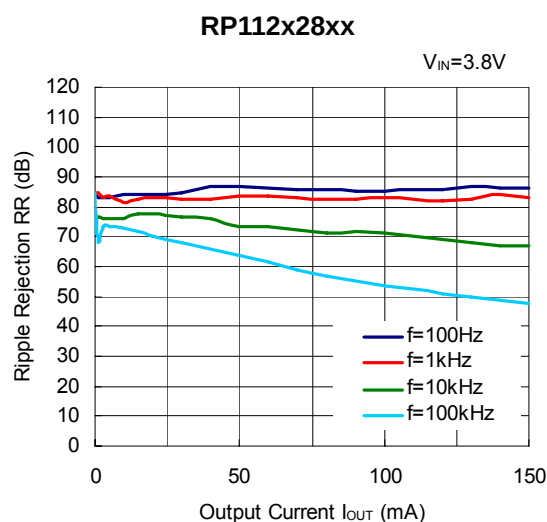
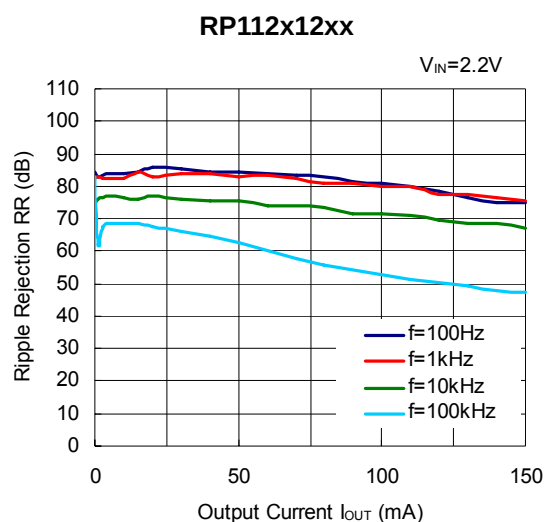
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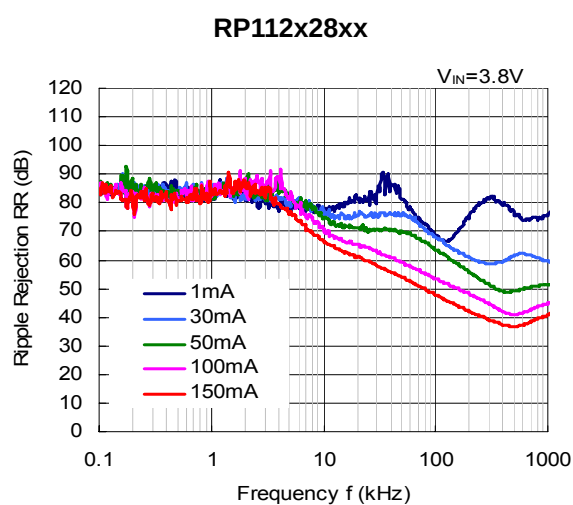
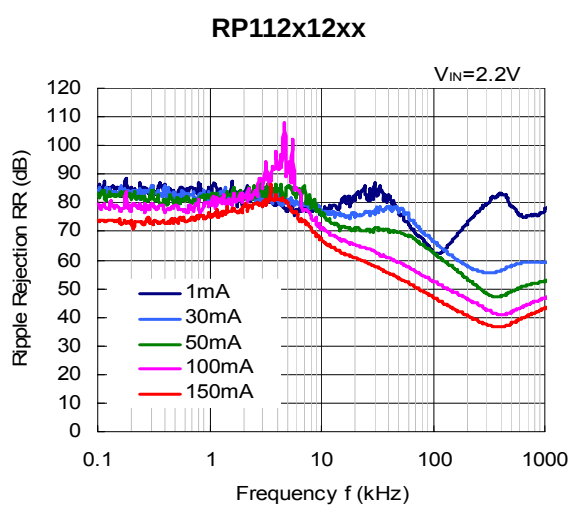
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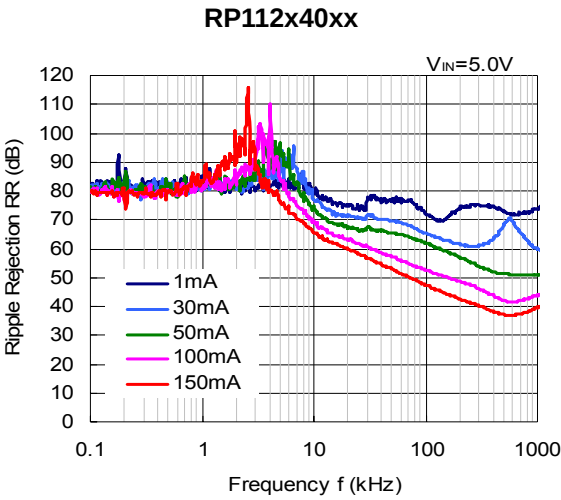


10) Ripple Rejection vs. Output Current (C1=none, C2=Ceramic 1.0 μ F, Ripple=0.2Vp-p, T_{opt}=25°C)

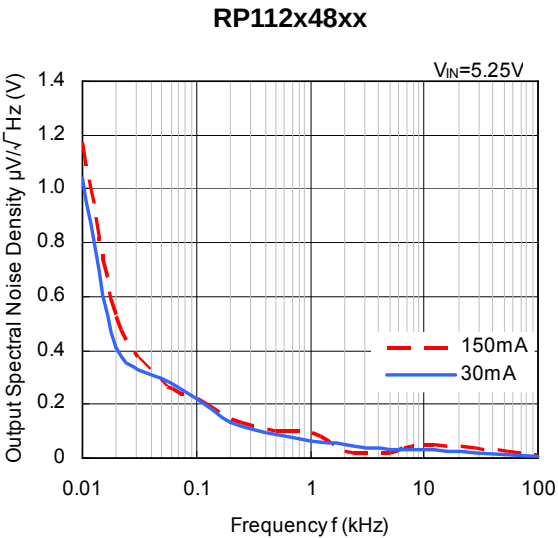
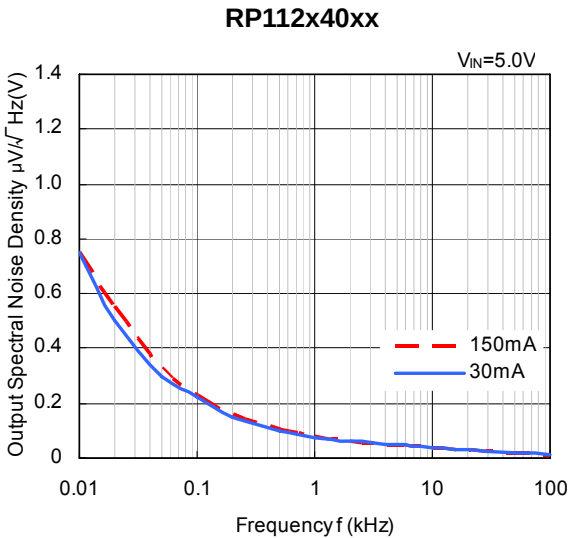
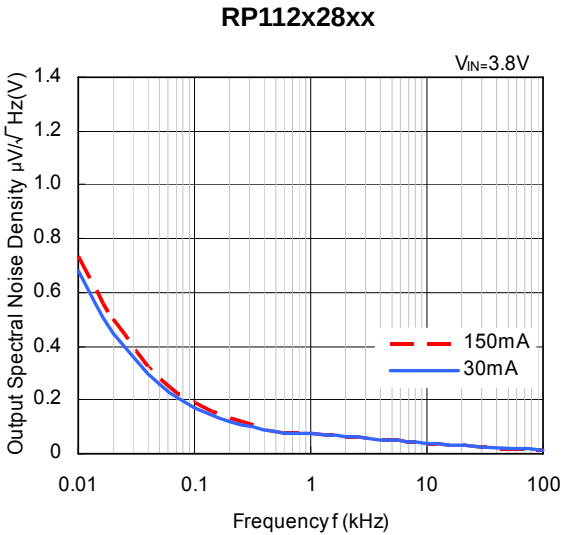
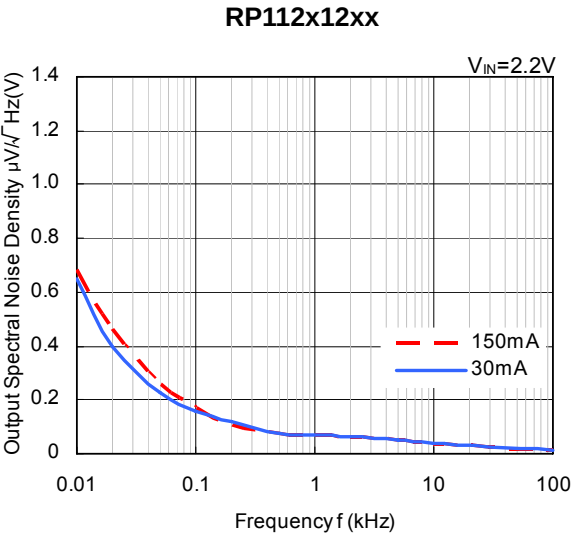


11) Ripple Rejection vs. Frequency (C1=none, C2=Ceramic 1.0 μ F, Ripple=0.2Vp-p, T_{opt}=25°C)

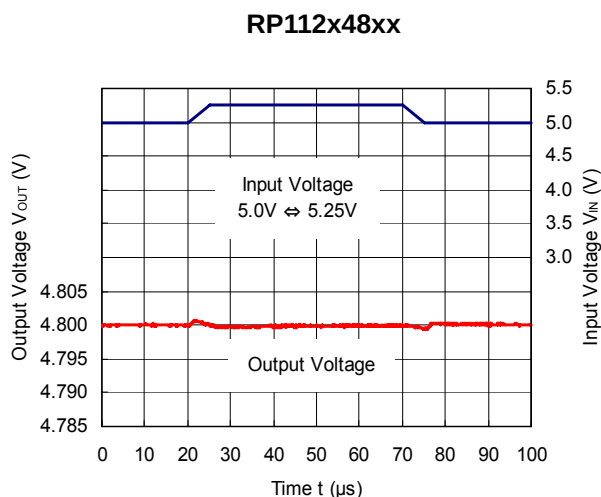
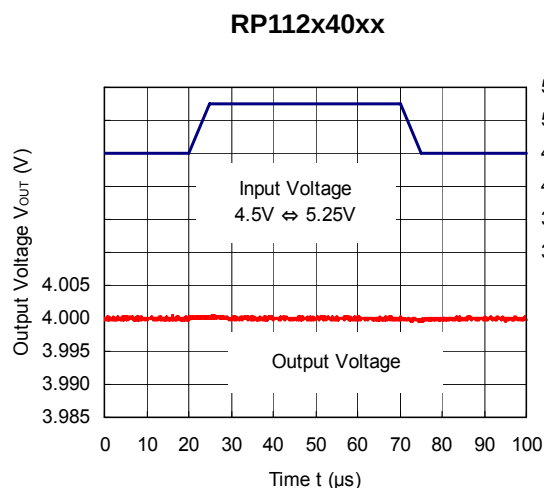
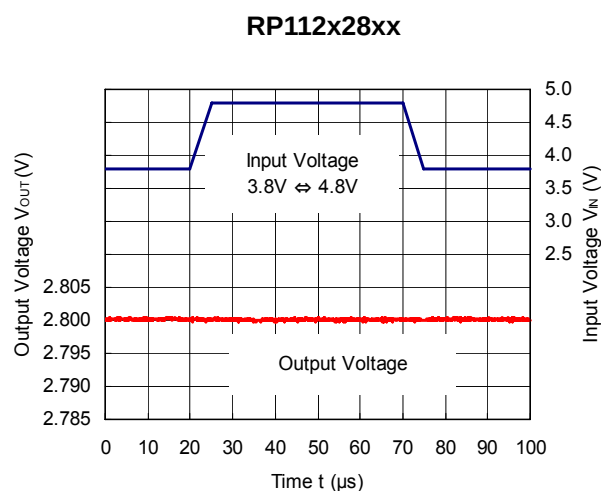
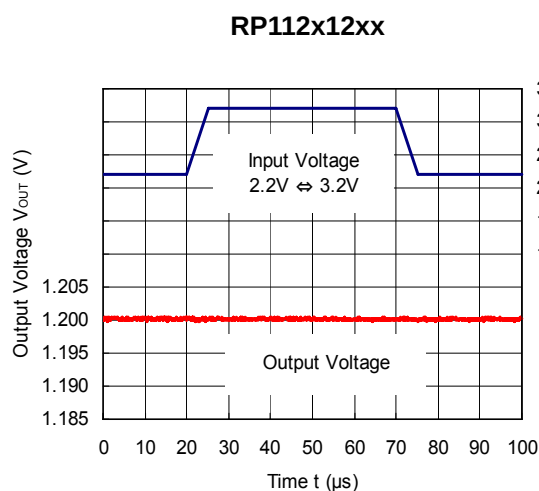




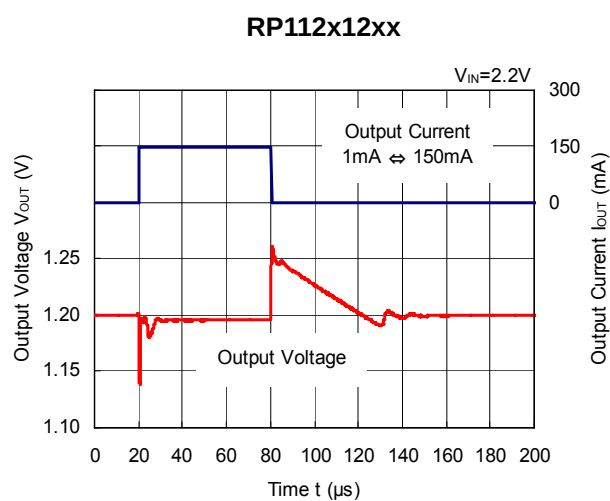
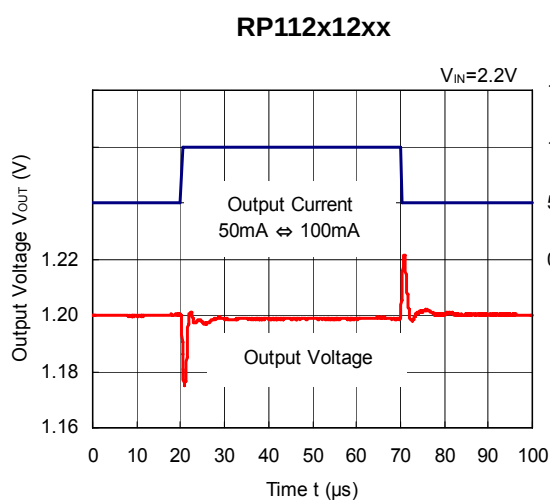
12) Output Spectral Noise Density vs. Frequency (C1=none, C2=Ceramic 1.0 μ F, T_{opt}=25°C)



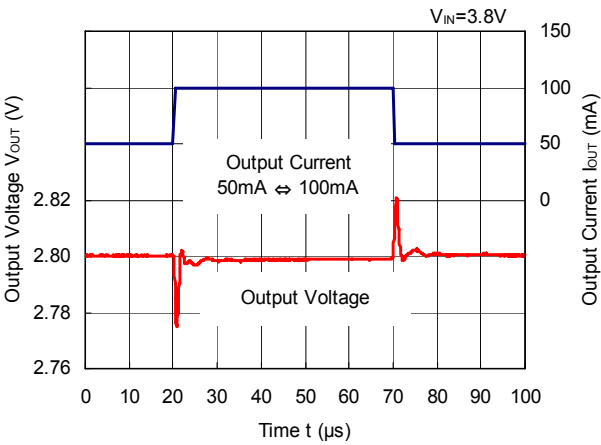
13) Input Transient Response (C_1 =none, C_2 =Ceramic $1.0\mu\text{F}$, $I_{\text{OUT}}=30\text{mA}$, $t_r=t_f=5.0\mu\text{s}$, $T_{\text{opt}}=25^\circ\text{C}$)



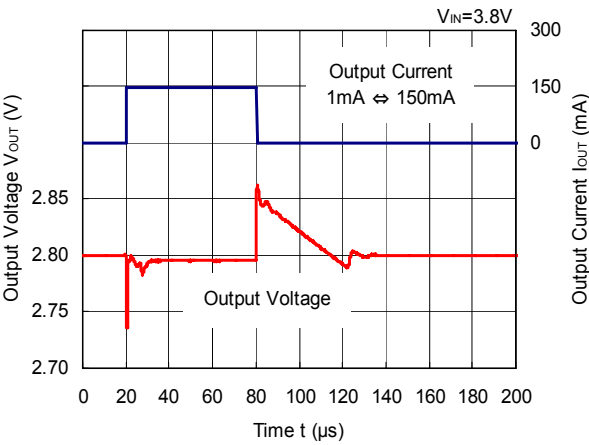
14) Load Transient Response (C_1 =Ceramic $1.0\mu\text{F}$, C_2 =Ceramic $1.0\mu\text{F}$, $t_r=t_f=0.5\mu\text{s}$, $T_{\text{opt}}=25^\circ\text{C}$)



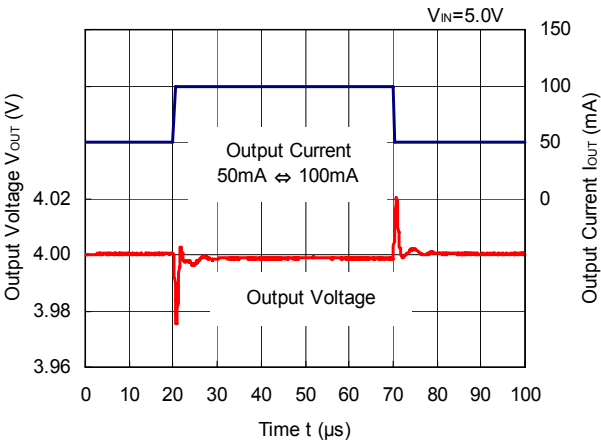
RP112x28xx



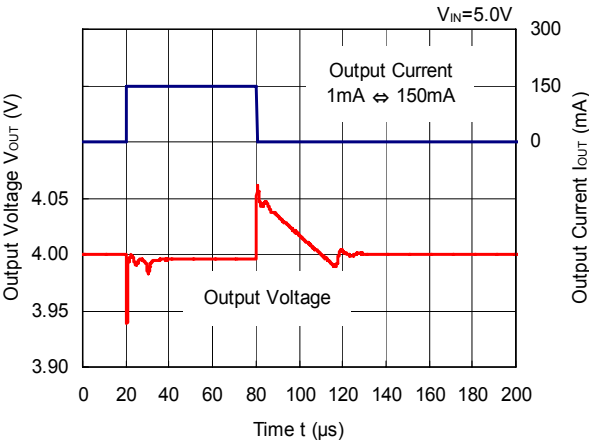
RP112x28xx



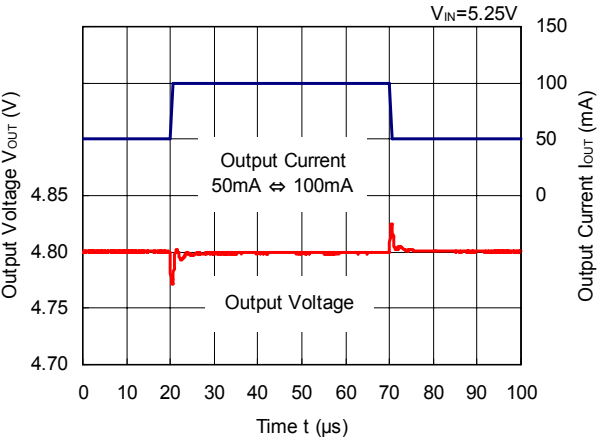
RP112x40xx



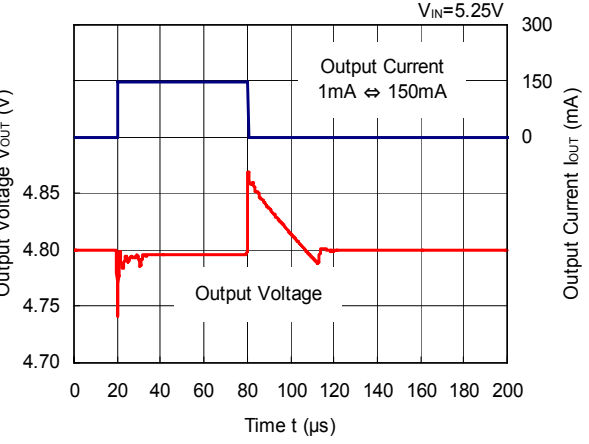
RP112x40xx



RP112x48xx

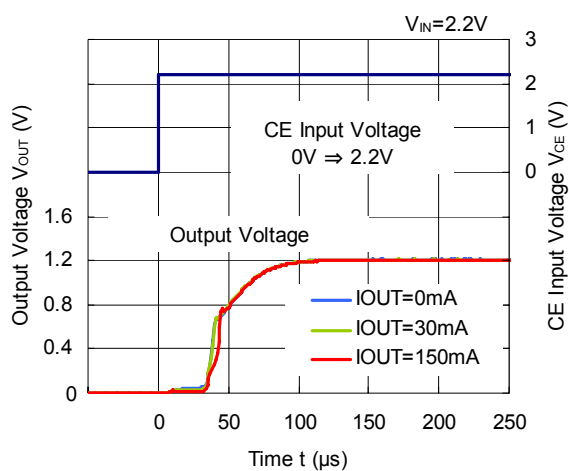


RP112x48xx

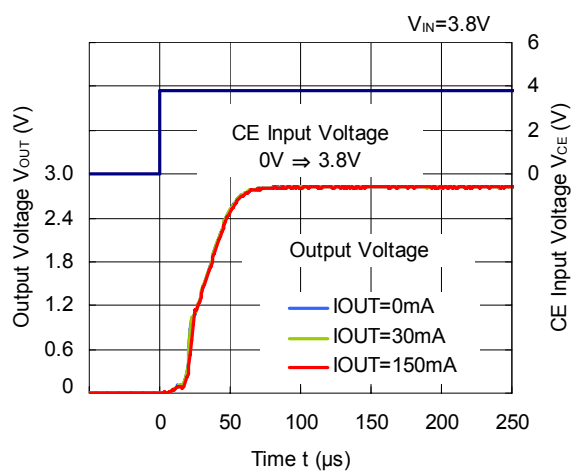


15) Turn on Speed with CE pin (C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, T_{opt}=25°C)

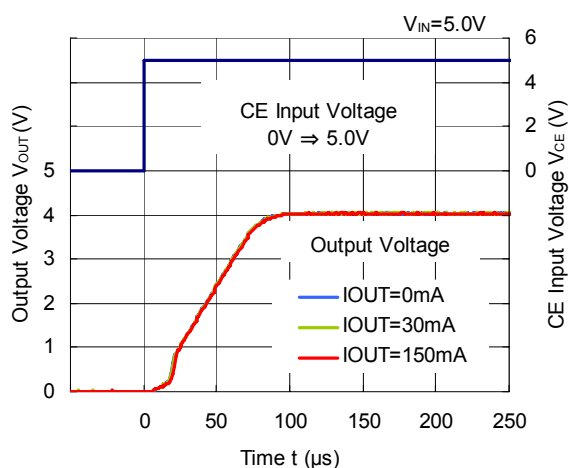
RP112x12xx



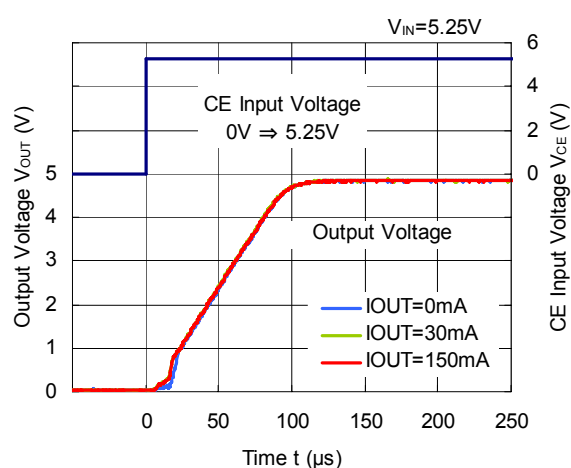
RP112x28xx



RP112x40xx

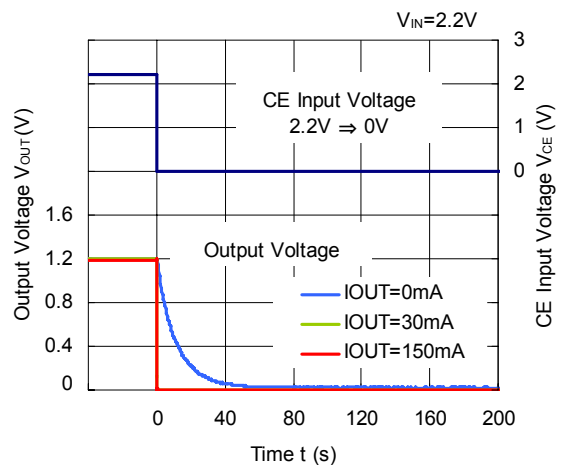


RP112x48xx

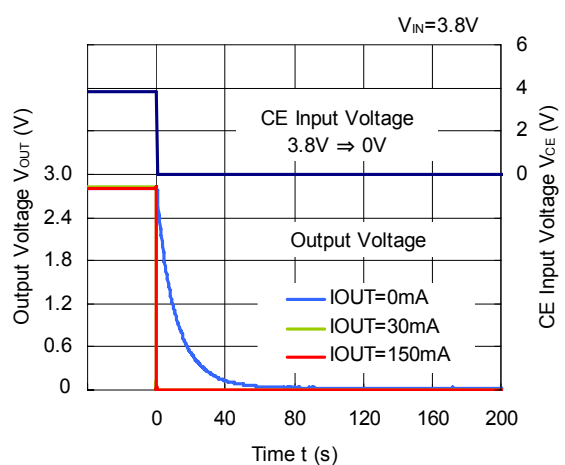


16) Turn off Speed with CE pin (B Version) (C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, T_{opt}=25°C)

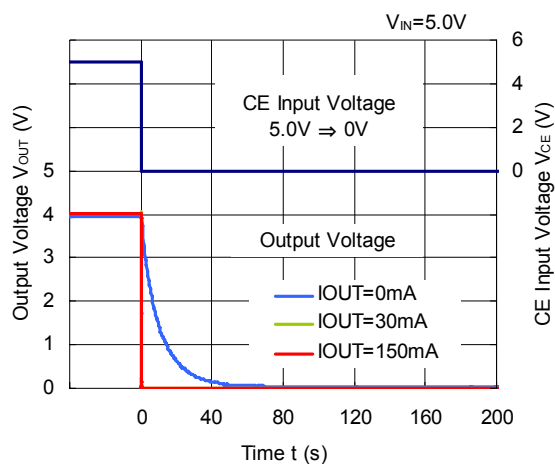
RP112x12xx



RP112x28xx

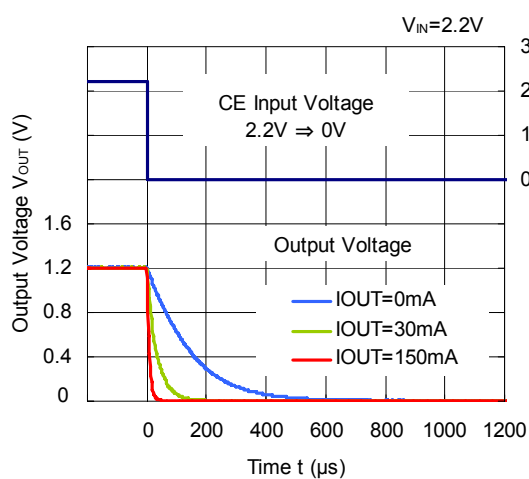


RP112x40xB

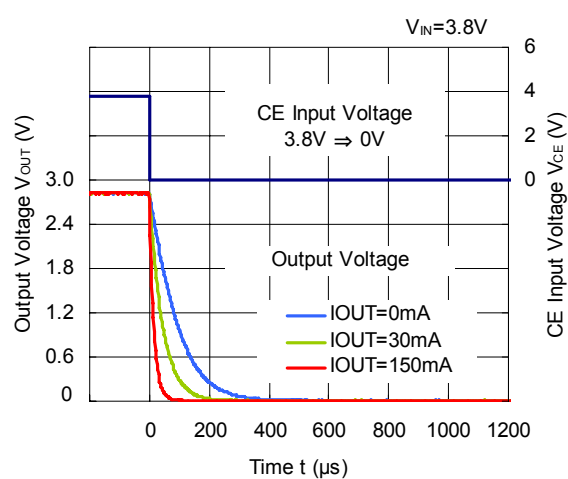


17) Turn off Speed with CE pin (D Version) (C1=Ceramic 1.0 μ F, C2=Ceramic 1.0 μ F, $T_{opt}=25^{\circ}C$)

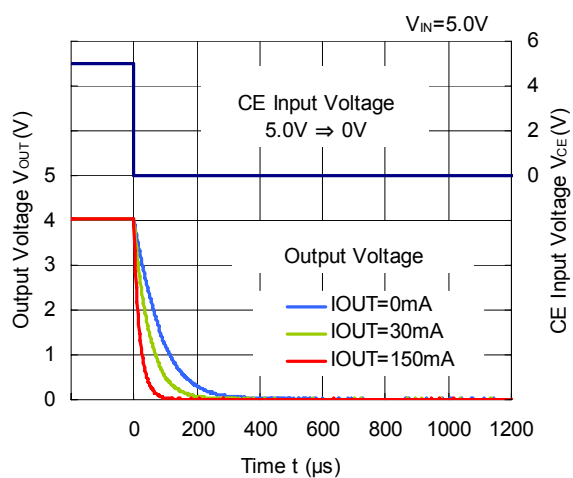
RP112x12xD



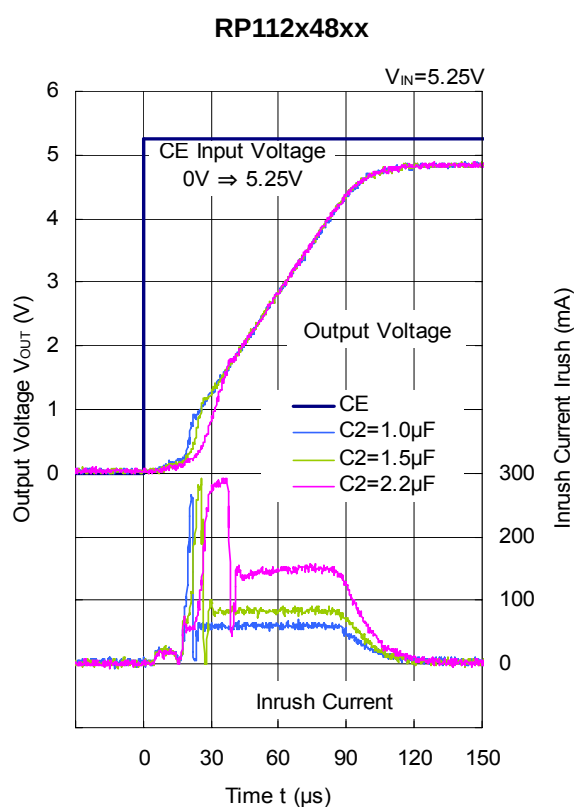
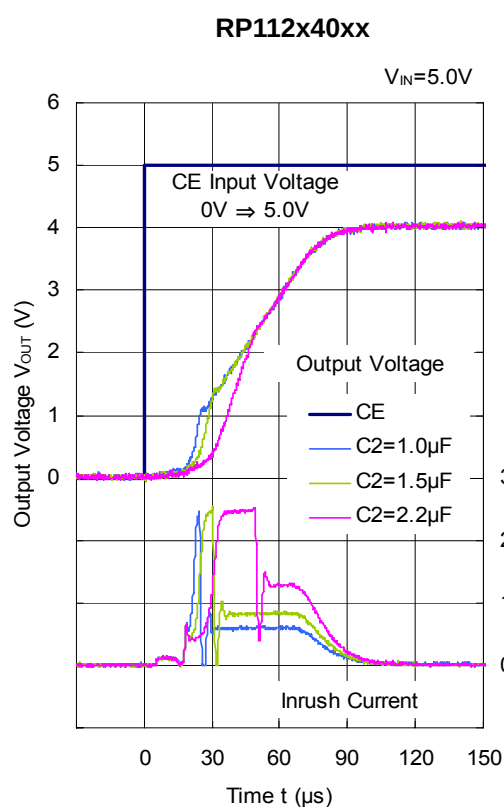
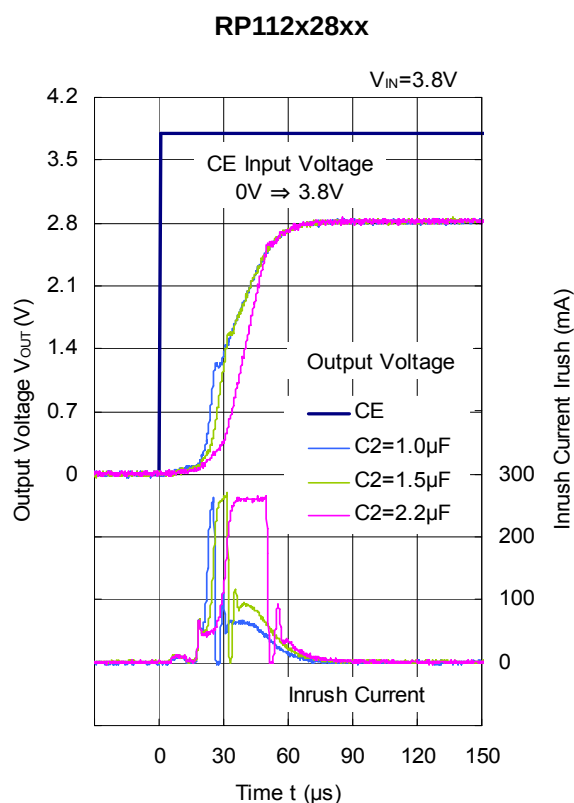
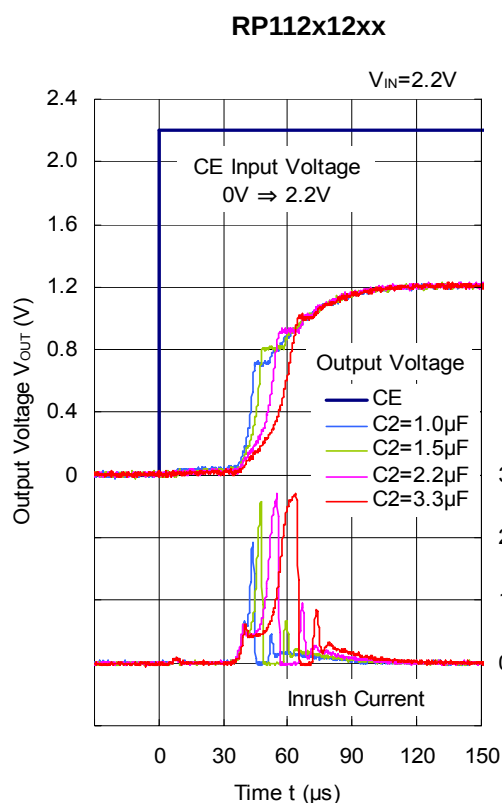
RP112x28xD



RP112x40xD



18) Inrush Current (C1=Ceramic 1.0 μ F, I_{OUT}=0mA, T_{opt}=25°C)



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 $40\mu V$ (Avg.) are marked as the hatched area in the graph.

Measurement Conditions

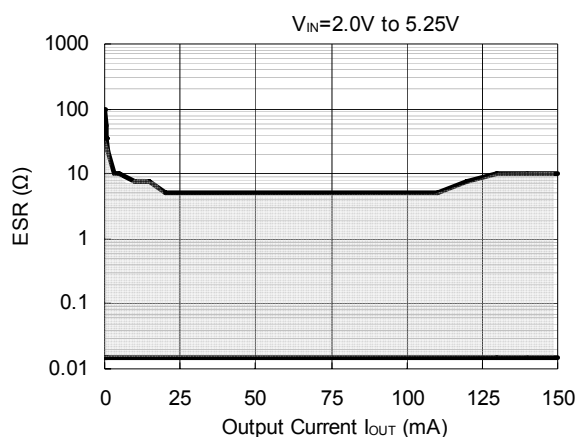
Frequency Band : 10Hz to 2MHz

Temperature : $-40^{\circ}C$ to $85^{\circ}C$

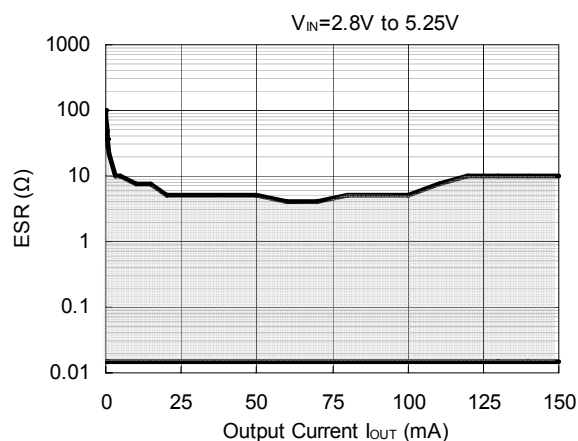
Hatched Area : Noise level is under $40\mu V$ (Avg.)

C1,C2 : $1.0\mu F$ or more

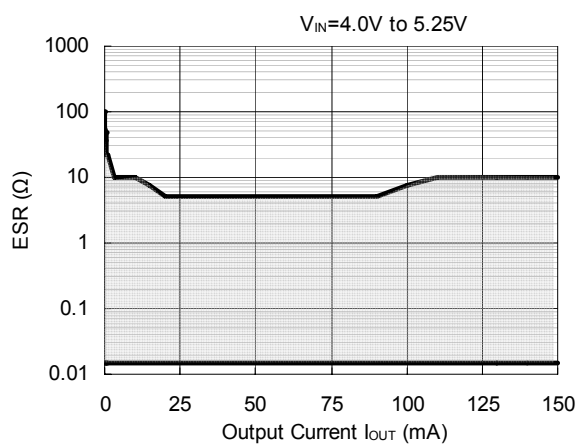
RP112x12xx



RP112x28xx



RP112x40xx





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RICOH COMPANY, LTD. Electronic Devices Company

● Higashi-Shinagawa Office (International Sales)
3-32-3, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140-8655, Japan
Phone: +81-3-5479-2857 Fax: +81-3-5479-0502

RICOH EUROPE (NETHERLANDS) B.V.

● Semiconductor Support Centre
Prof. W.H.Keesomlaan 1, 1183 DL Amstelveen, The Netherlands
P.O.Box 114, 1180 AC Amstelveen
Phone: +31-20-5474-309 Fax: +31-20-5474-791

RICOH ELECTRONIC DEVICES KOREA Co., Ltd.

11 floor, Haesung 1 building, 942, Daechidong, Gangnamgu, Seoul, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2135-5705

RICOH ELECTRONIC DEVICES SHANGHAI Co., Ltd.

Room403, No.2 Building, 690#Bi Bo Road, Pu Dong New district, Shanghai 201203,
People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

RICOH COMPANY, LTD. Electronic Devices Company

● Taipei office
Room109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623



Ricoh completed the organization of the Lead-free production for all of our products. After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive.