RICOH

RP109x SERIES

LOW NOISE 150mA LDO REGULATOR

NO.EA-204-111020

OUTLINE

The RP109x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, extremely low supply current, low ON-resistance, and high ripple rejection. Each of these ICs consists of a voltage reference unit, an error amplifier, a 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 which prolong the battery life.

The line transient response and load transient response of the RP109x Series are excellent, thus these ICs are very suitable for the power supply for hand-held communication equipment. RP109x Series contributes to the downsizing of the hand-held equipment because it can use the 0.1μF ceramic capacitor.

In addition to SOT-23-5, SC-88A and DFN1010-4 packages, a 0.8mm square ultra compact DFN(PLP)0808-4 package is also available.

FEATURES

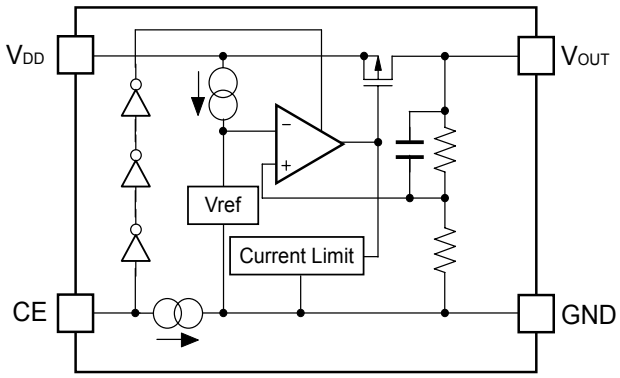
- Supply Current ..... Typ. 50μA
- Standby Mode ..... Typ. 0.1μA
- Dropout Voltage ..... Typ. 0.25V (I_{OUT}=150mA, V_{OUT}=2.5V)
- Ripple Rejection ..... Typ. 75dB (f=1kHz, V_{OUT}=2.5V)
- Temperature-Drift Coefficient of Output Voltage ..... Typ. ±100ppm/°C (V_{OUT}<1.8V)
  Typ. ±30ppm/°C (V_{OUT}≥1.8V)
- Line Regulation ..... Typ. 0.02%/V
- Output Voltage Accuracy ..... ±1.0%
- Packages ..... DFN(PLP)0808-4, DFN1010-4, SC-88A, SOT-23-5
- Input Voltage Range ..... 1.4V to 5.25V
- Output Voltage Range ..... 0.8V to 3.6V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Built-in Fold Back Protection Circuit ..... Typ. 40mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC .... 0.1μF or more

APPLICATIONS

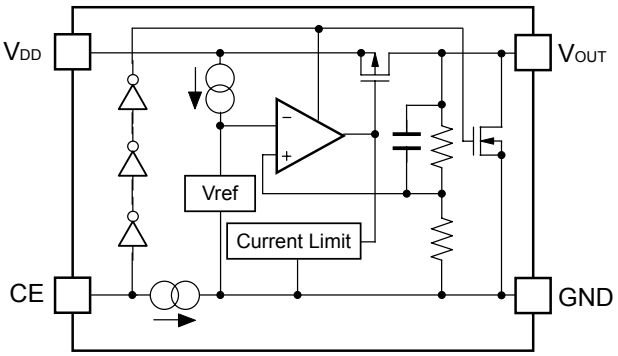
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.
- Power source for home appliances.

BLOCK DIAGRAMS

RP109xxxxB



RP109xxxxD



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
RP109Kxx1∗-TR	DFN(PLP)0808-4	10,000 pcs	Yes	Yes
RP109Lxx1∗-TR	DFN1010-4	10,000 pcs	Yes	Yes
RP109Qxx2∗-TR-FE	SC-88A	3,000 pcs	Yes	Yes
RP109Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

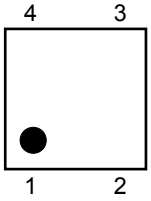
xx: The output voltage can be designated in the range from 0.8V(08) to 3.6V(36) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

∗ : 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

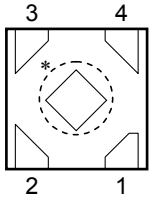
PIN CONFIGURATIONS

● **DFN(PLP)0808-4**

Top View

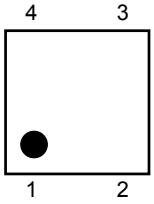


Bottom View

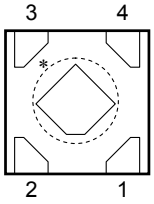


● **DFN1010-4**

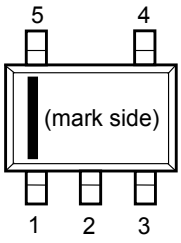
Top View



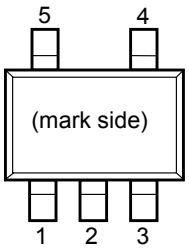
Bottom View



● **SC-88A**



● **SOT-23-5**



PIN DESCRIPTIONS

● **DFN(PLP)0808-4 / DFN1010-4**

Pin No	Symbol	Pin 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	CE	Chip Enable Pin ("H" Active)
2	NC	No Connection
3	GND	Ground Pin
4	V_{OUT}	Output Pin
5	V_{DD}	Input 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)0808-4)	286	mW
	Power Dissipation* (DFN1010-4)	400	
	Power Dissipation* (SC-88A)	380	
	Power Dissipation* (SOT-23-5)	420	
Topt	Operating Temperature Range	−40 to 85	°C
Tstg	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

- **RP109xxxxB/D**

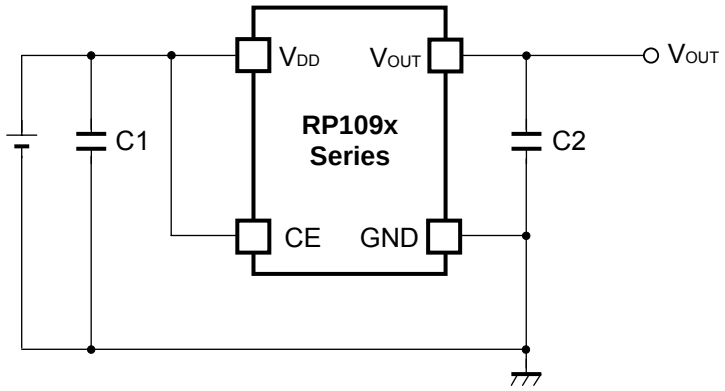
V_{IN}=Set V_{OUT}+1V (V_{OUT}>1.5V), V_{IN}=2.5V (V_{OUT}≤1.5V), I_{OUT}=1mA, C_{IN}=C_{OUT}=0.1μF, unless otherwise noted.
The specification in ☐ is checked and guaranteed by design engineering at –40°C≤Topt≤85°C. Topt=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Topt=25°C	V_{OUT} ≥ 1.8V	×0.99		×1.01	V
			V_{OUT} < 1.8V	–18		+18	mV
		–40°C ≤ Topt ≤ 85°C	V_{OUT} ≥ 1.8V	×0.985		×1.015	V
			V_{OUT} < 1.8V	–50		+50	mV
I_{OUT}	Output Current			150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	1mA ≤ I_{OUT} ≤ 150mA			5	30	mV
V_{DIF}	Dropout Voltage	I_{OUT}=150mA	V_{OUT}=0.8V		0.70	1.00	V
			V_{OUT}=0.9V		0.62	0.91	
			1.0V ≤ V_{OUT} < 1.2V		0.56	0.82	
			1.2V ≤ V_{OUT} < 1.4V		0.47	0.67	
			1.4V ≤ V_{OUT} < 1.8V		0.39	0.54	
			1.8V ≤ V_{OUT} < 2.1V		0.33	0.48	
			2.1V ≤ V_{OUT} < 2.5V		0.28	0.40	
			2.5V ≤ V_{OUT} < 3.0V		0.25	0.35	
			3.0V ≤ V_{OUT} ≤ 3.6V		0.23	0.32	
I_{SS}	Supply Current	I_{OUT}=0mA			50	70	μA
Istandby	Standby Current	V_{CE}=0V			0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 5.25V, V_{IN} ≥ 1.4V			0.02	0.10	%/V
RR	Ripple Rejection	f=1kHz, Ripple 0.2Vp-p, V_{IN}=Set V_{OUT}+1V, I_{OUT}=30mA			75		dB
V_{IN}	Input Voltage*			1.4		5.25	V
ΔV_{OUT} /ΔTopt	Output Voltage Temperature Coefficient	–40°C ≤ Topt ≤ 85°C	V_{OUT} < 1.8V		±100		ppm /°C
			V_{OUT} ≥ 1.8V		±30		
I_{SC}	Short Current Limit	V_{OUT}=0V			40		mA
I_{PD}	CE Pull-down Current				0.3		μA
V_{CEH}	CE Input Voltage "H"			1.0			V
V_{CEL}	CE Input Voltage "L"					0.4	V
en	Output Noise	BW=10Hz to 100kHz	V_{OUT} < 1.8V		40×V_{OUT}		μVrms
			V_{OUT} ≥ 1.8V		20×V_{OUT}		
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)	V_{IN}=4.0V V_{CE}=0V			60		Ω

*) The maximum Input Voltage of the ELECTRICAL CHARACTERISTICS is 5.25V. In case of exceeding this specification, the IC must be operated on condition that the Input Voltage is up to 5.5V and the total operating time is within 500hrs.

All of units are tested and specified under load conditions such that Tj≈Topt=25°C except for Output Noise, Ripple Rejection, Output Voltage Temperature Coefficient.

TYPICAL APPLICATION



(External Components)
C2 0.1μF MURATA: GRM155B31C104KA87B

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 with 0.1μF or more and good ESR (Equivalent Series Resistance).

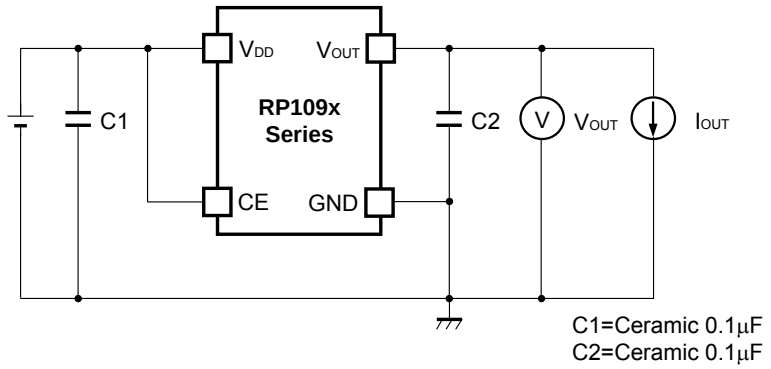
(Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

PCB Layout

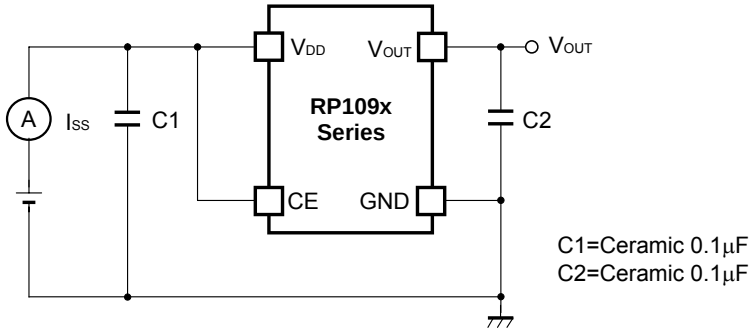
Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 0.1μF or more between V_{DD} and GND pin, and as close as possible to the pins.

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

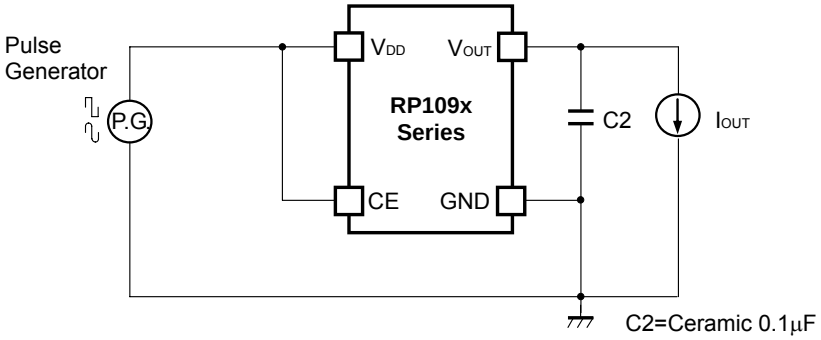
TEST CIRCUITS



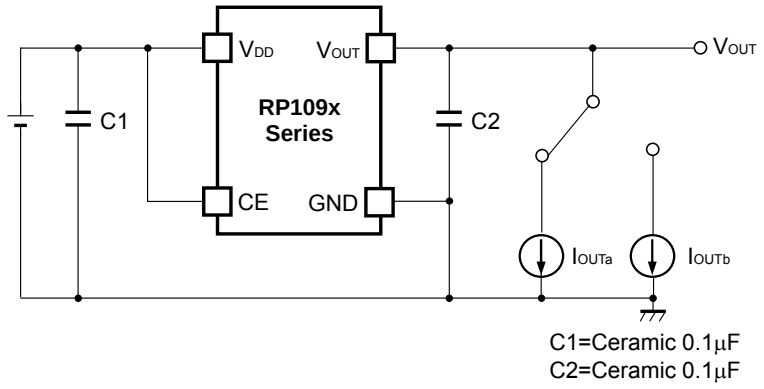
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection

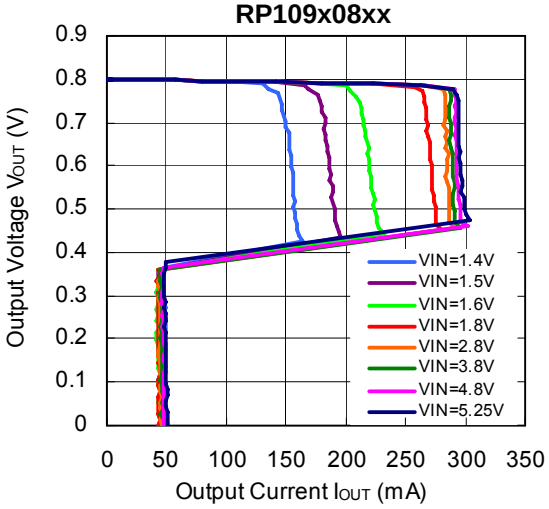


Test Circuit for Load Transient Response

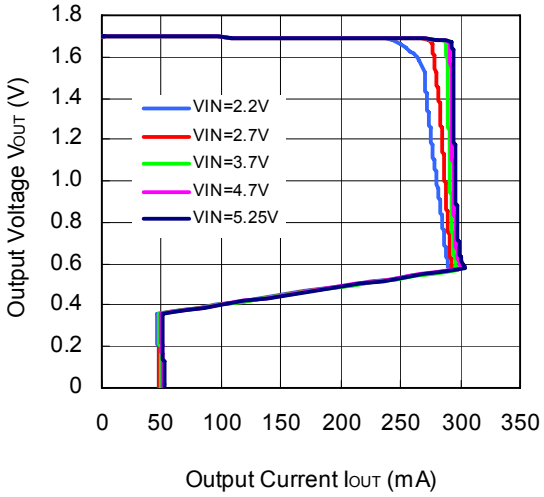
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (C1=0.1µF, C2=0.1µF, Topt=25°C)

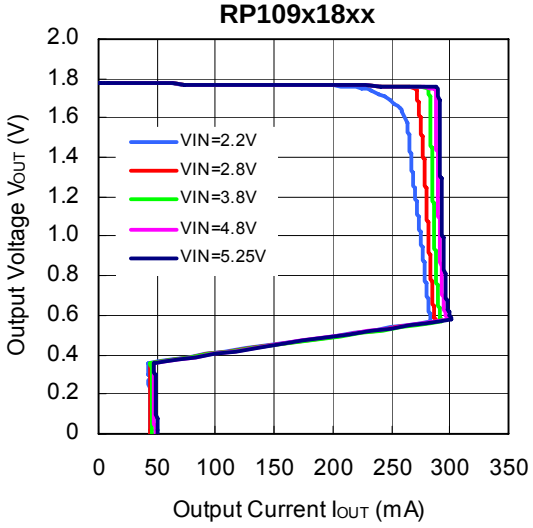
RP109x08xx



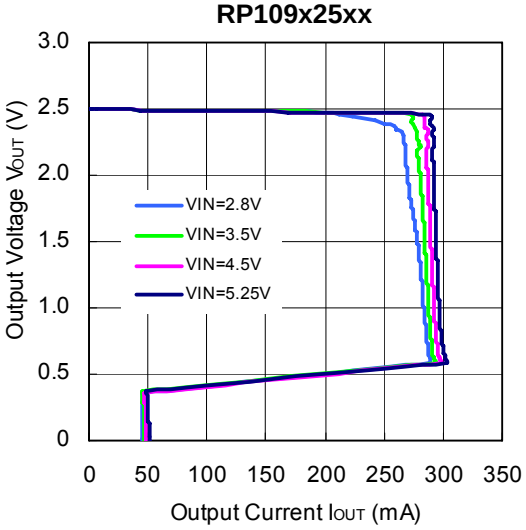
RP109x17xx



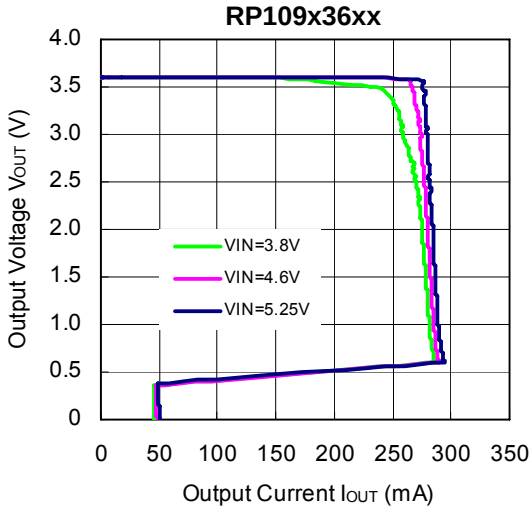
RP109x18xx



RP109x25xx



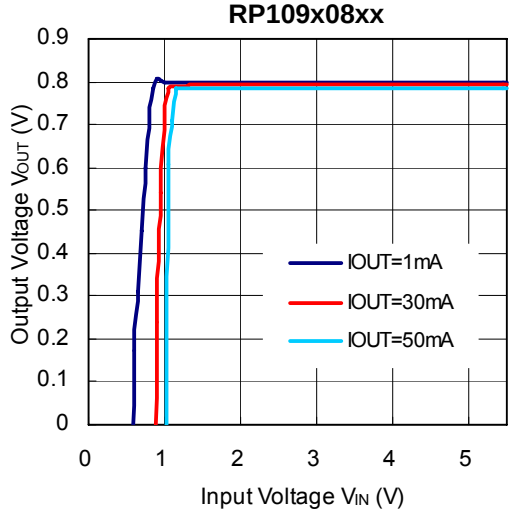
RP109x36xx



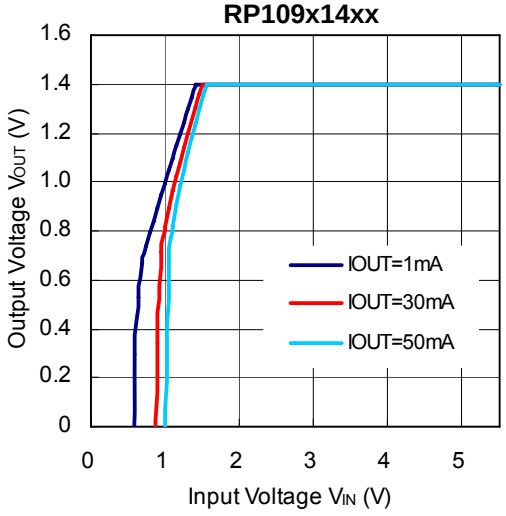
RICOH

2) Output Voltage vs. Input Voltage (C1=0.1µF, C2=0.1µF, Topt=25°C)

RP109x08xx



RP109x14xx



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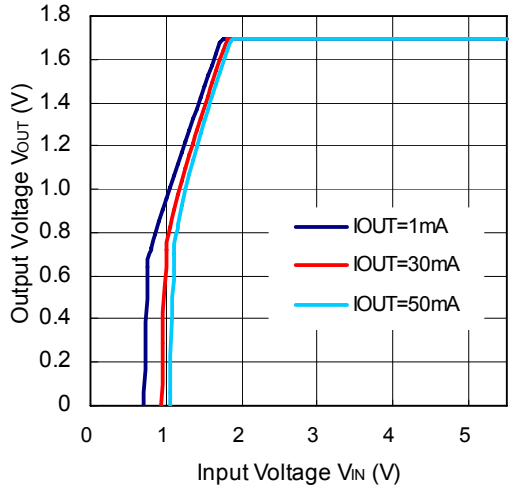

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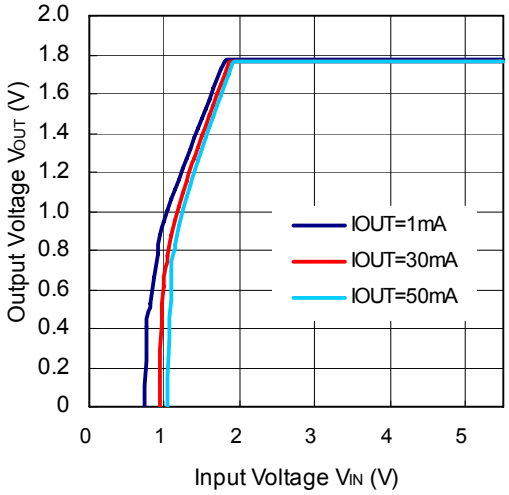
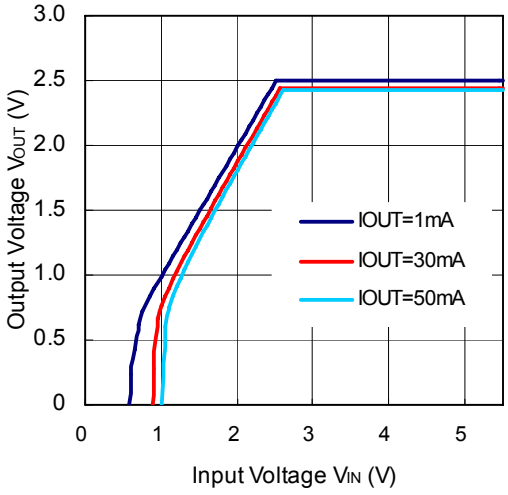


RP109x25xx



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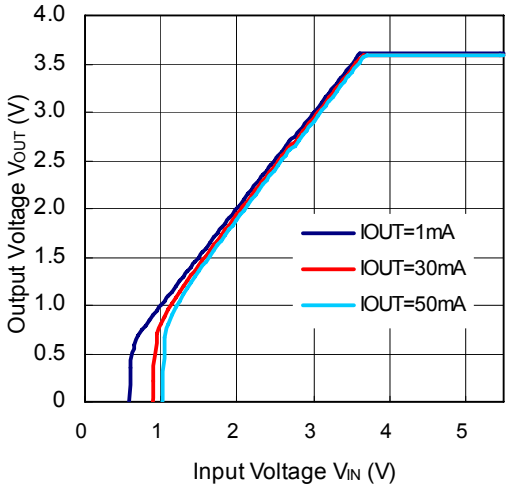
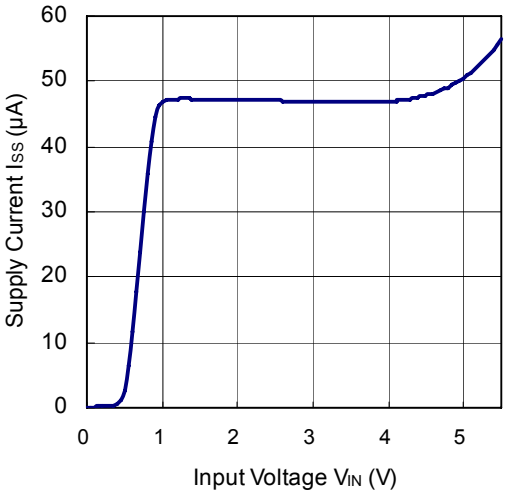


3) Supply Current vs. Input Voltage (C1=0.1μF, C2=0.1μF, Topt=25°C)

RP109x08xx



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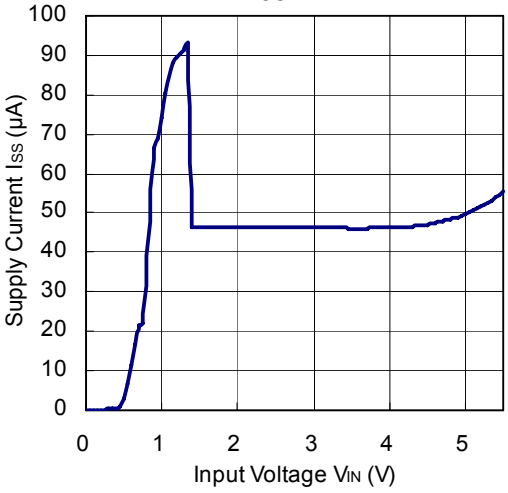

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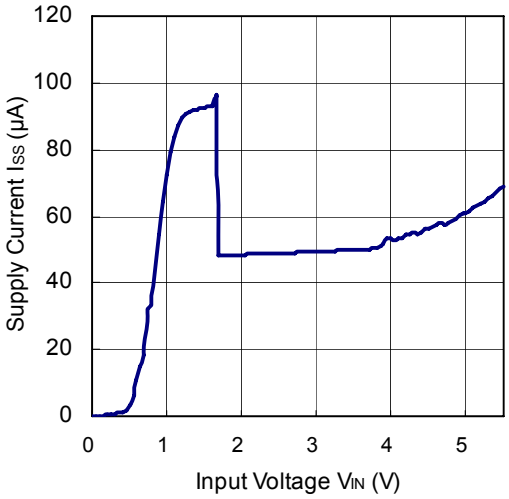

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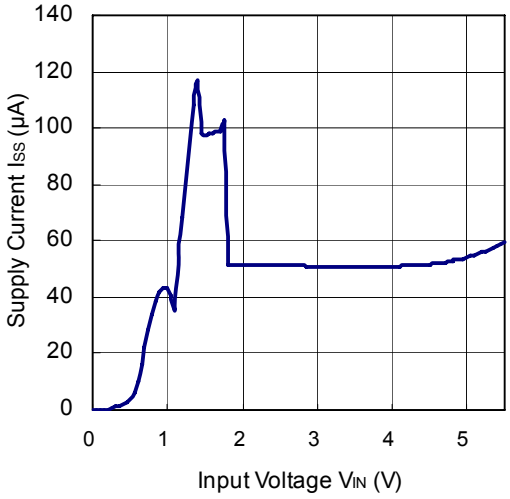

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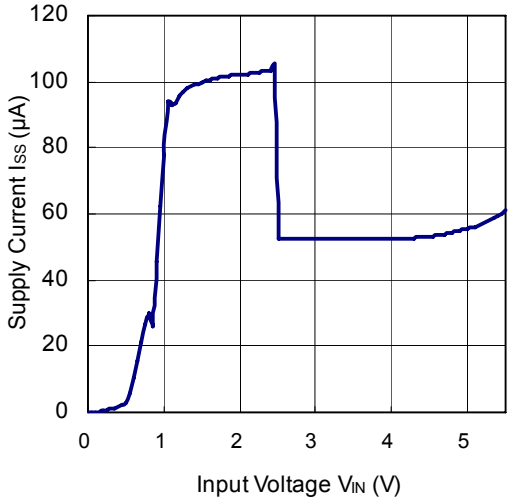

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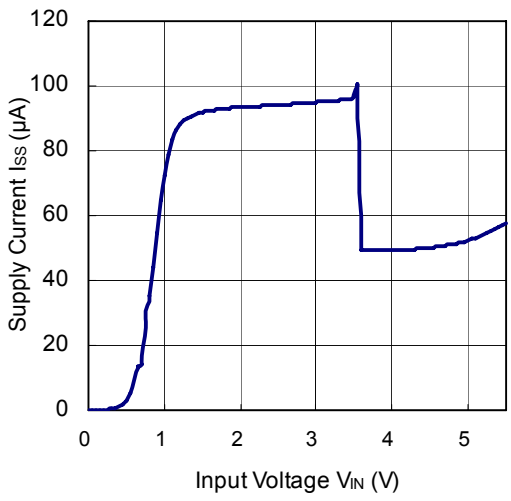
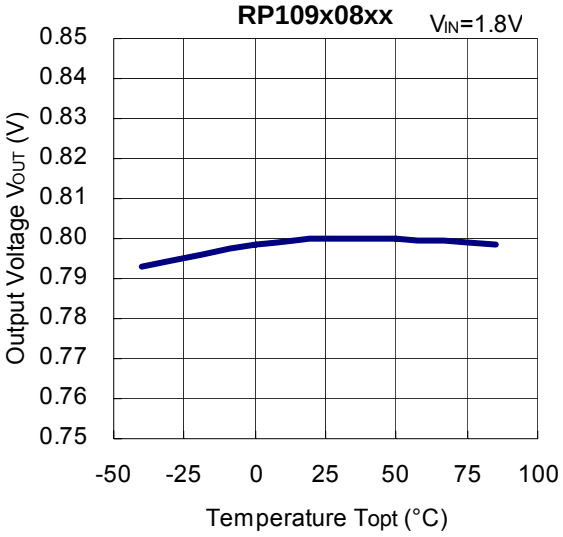
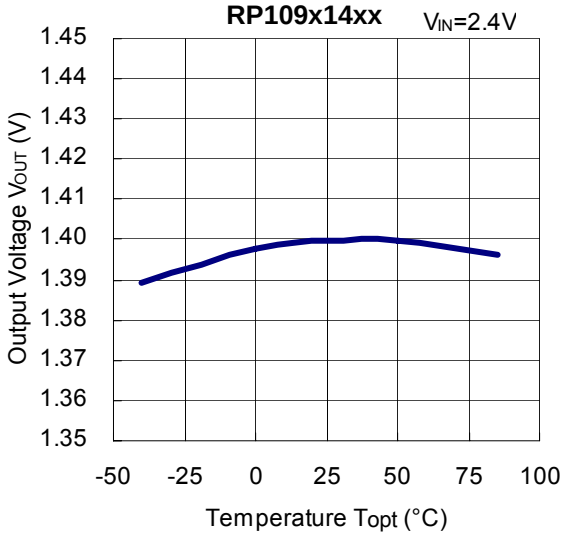
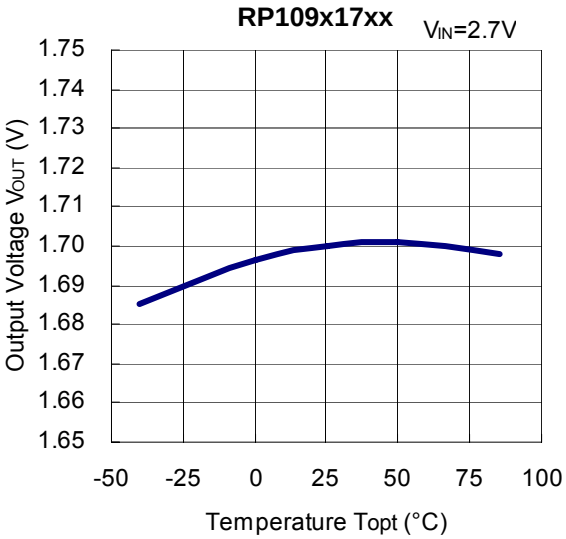
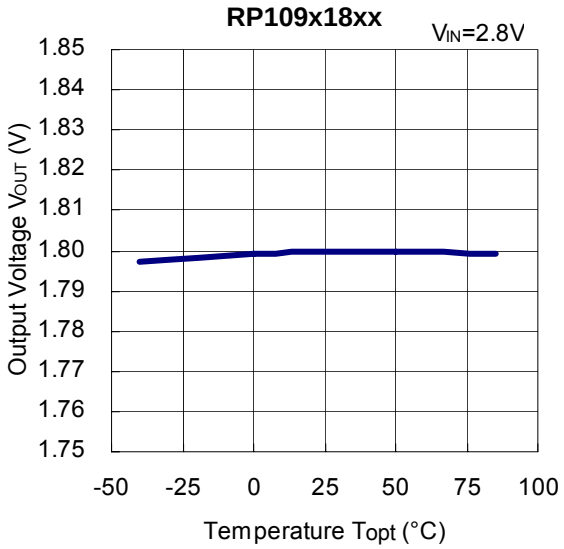


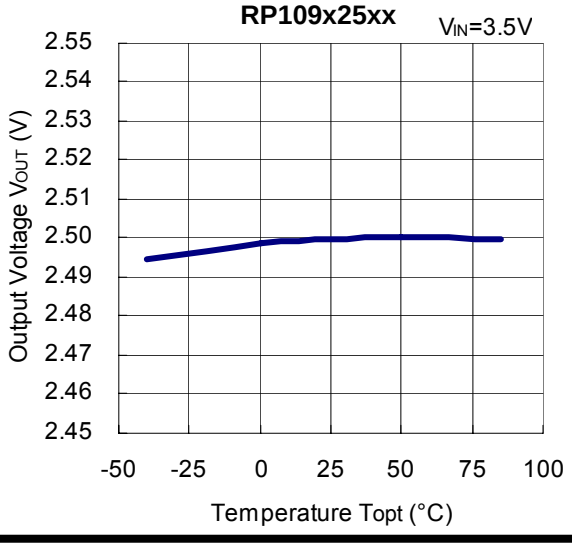
4) Output Voltage vs. Temperature (C1=0.1μF, C2=0.1μF, I_{OUT}=1mA)

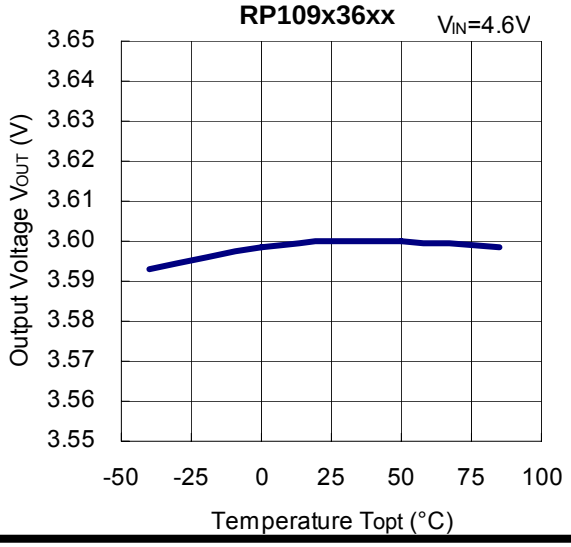






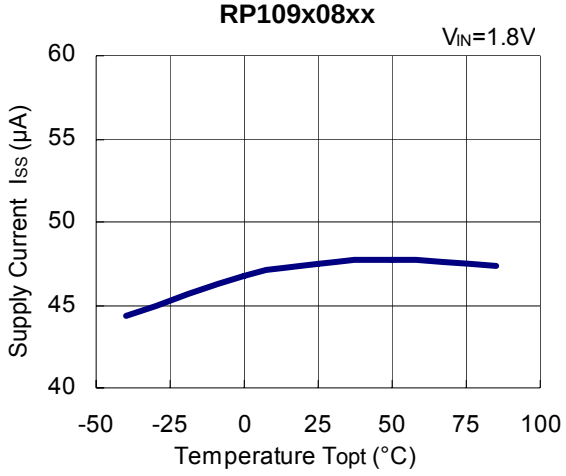




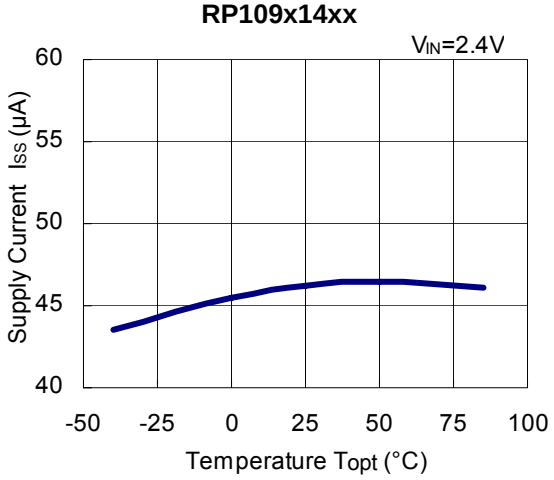


5) Supply Current vs. Temperature (C1=0.1µF, C2=0.1µF, I_{OUT}=0mA)

RP109x08xx



RP109x14xx



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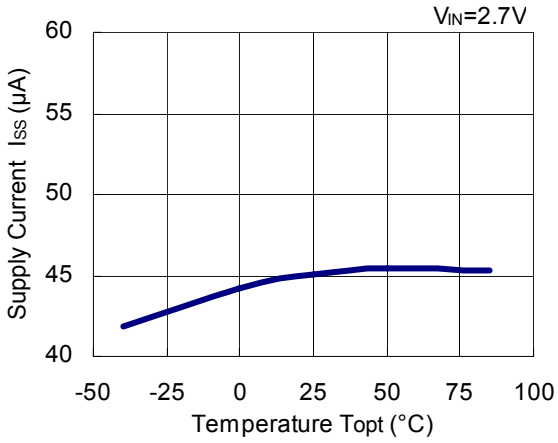

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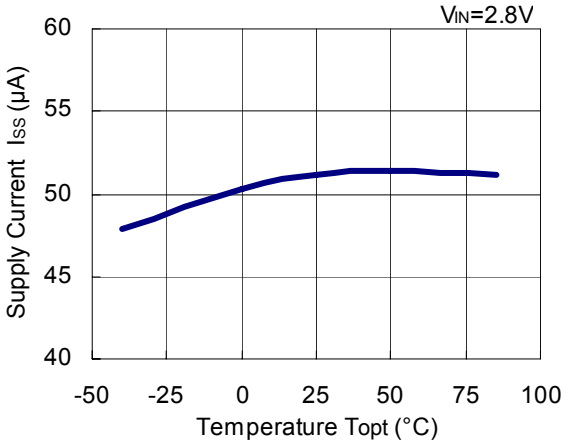
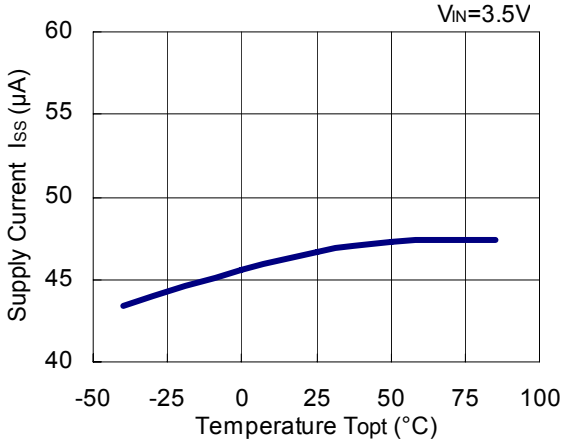
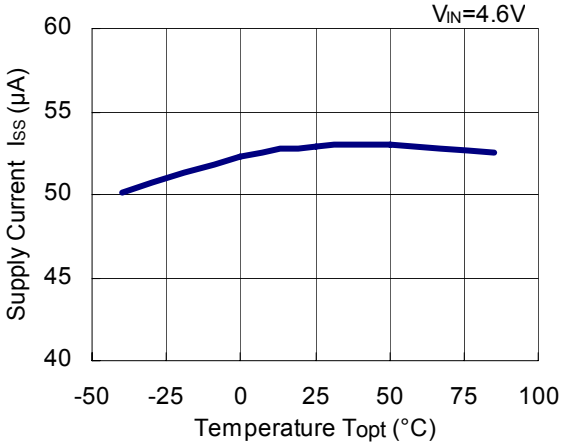


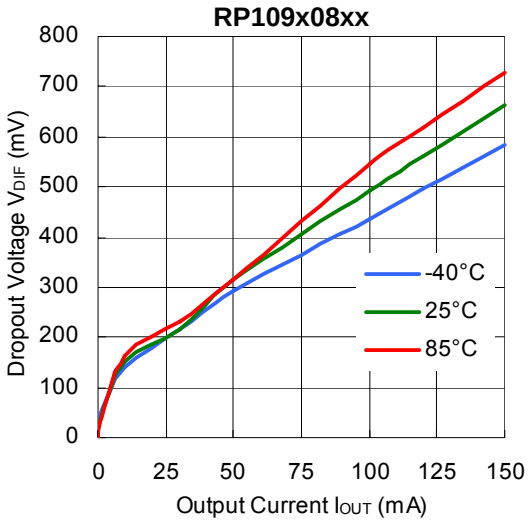
RP109x25xx

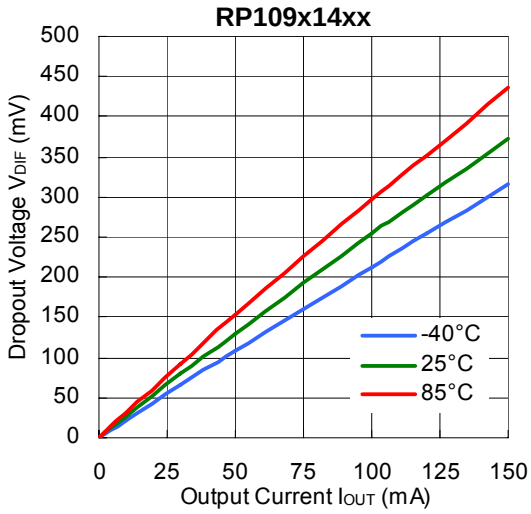


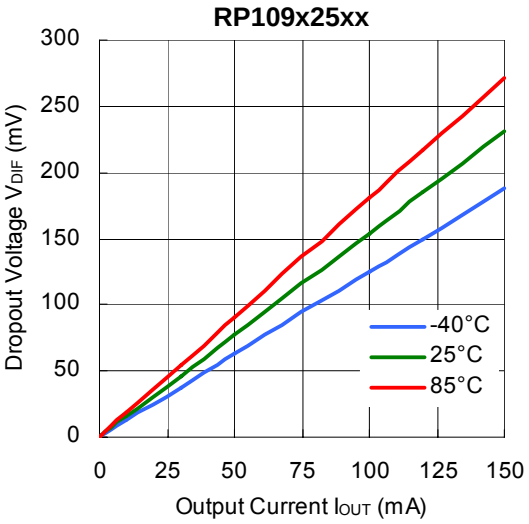
RP109x36xx

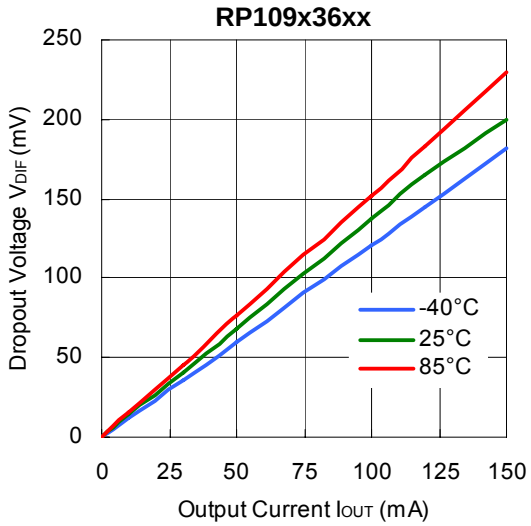


6) Dropout Voltage vs. Output Current (C1=0.1µF, C2=0.1µF)

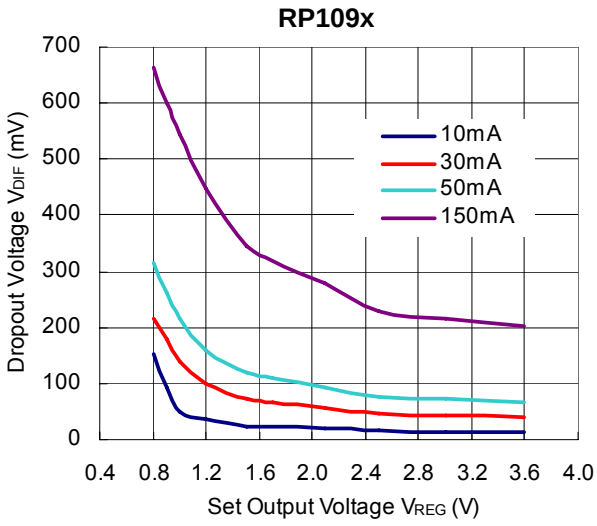




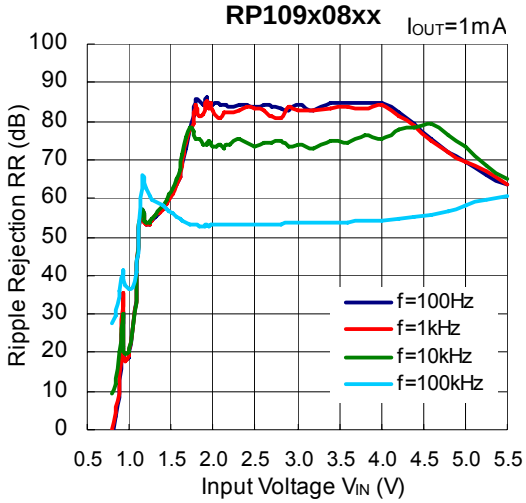


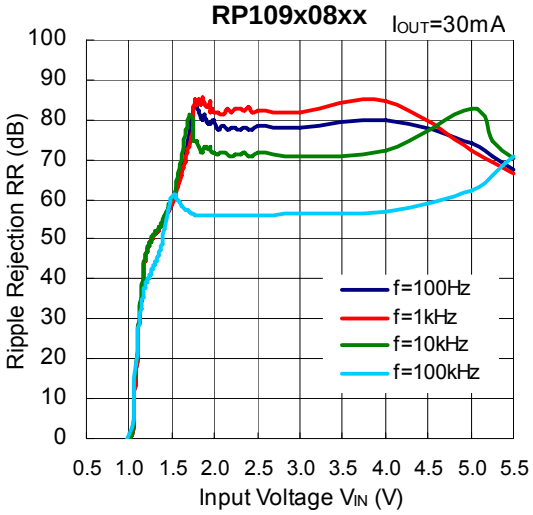


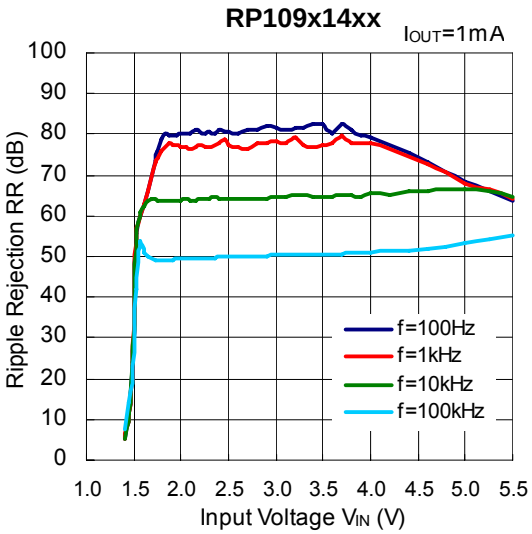
7) Dropout Voltage vs. Set Output Voltage (C1=0.1µF, C2=0.1µF, Topt=25°C)

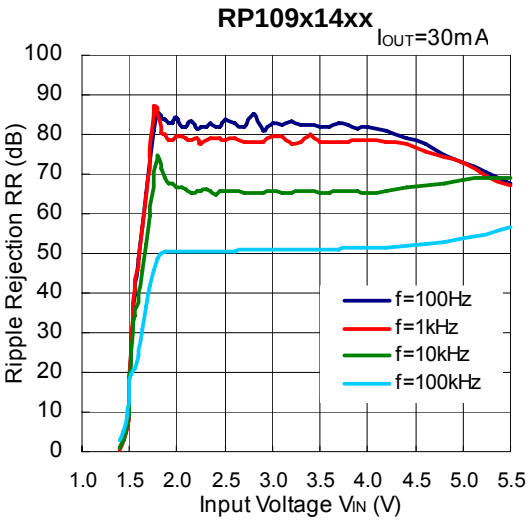


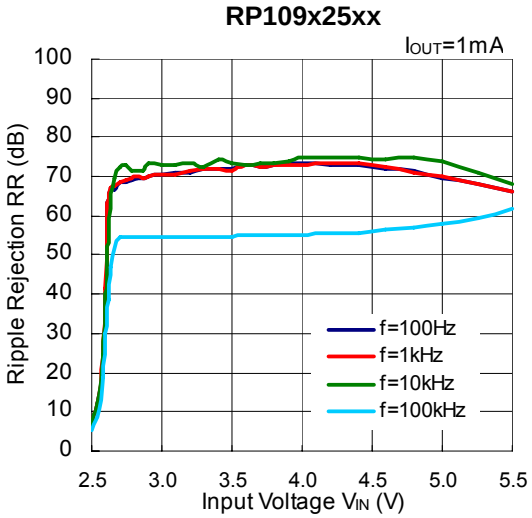
8) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=0.1µF, Ripple=0.2Vp-p, Topt=25°C)

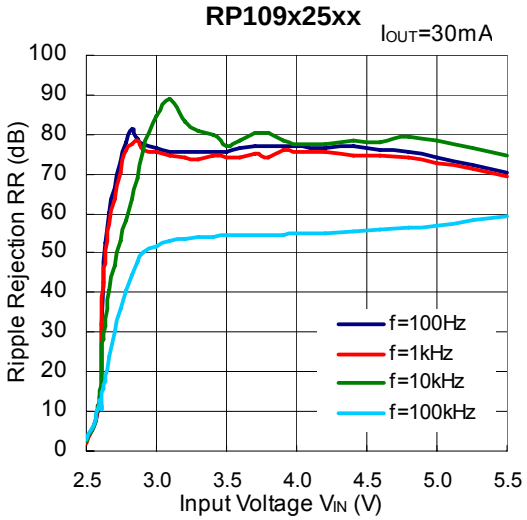


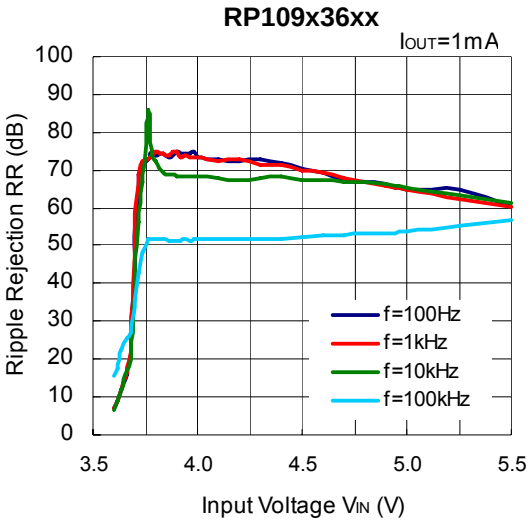


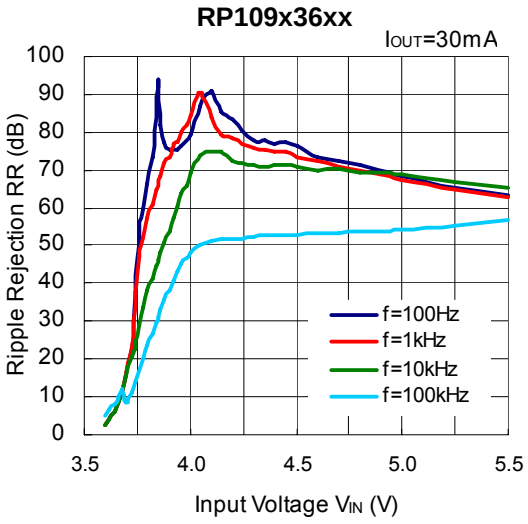




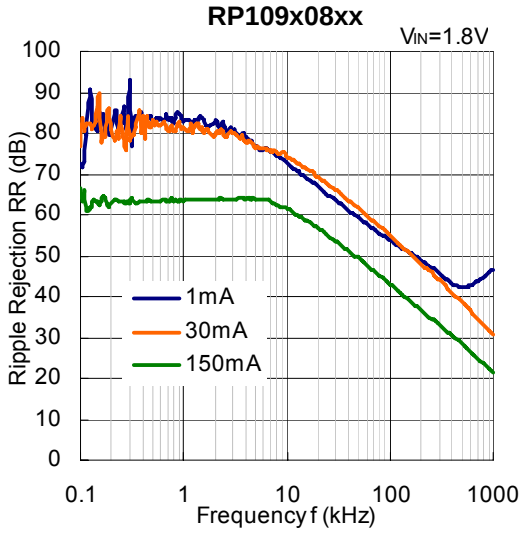


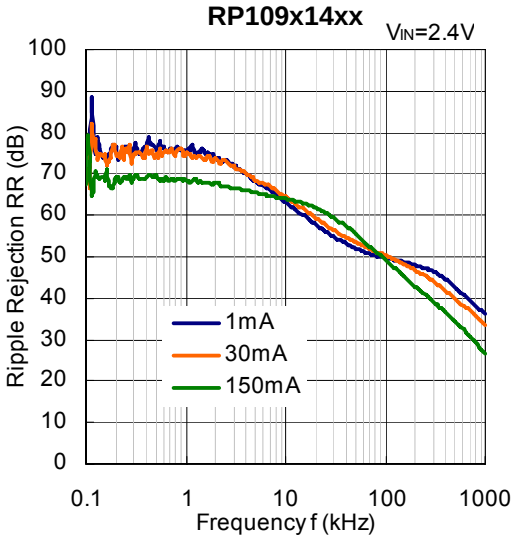


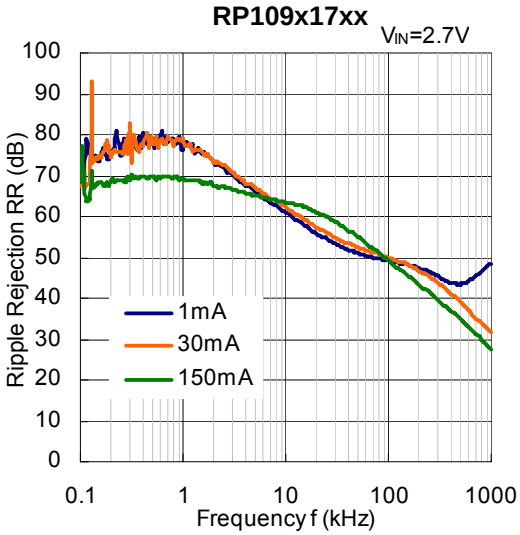


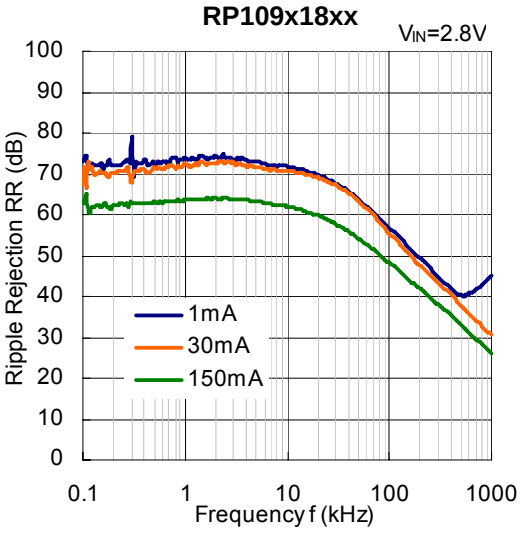


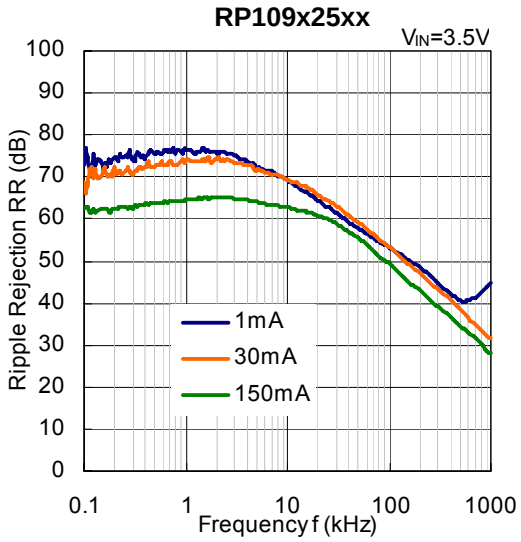
9) Ripple Rejection vs. Frequency (C1=none, C2=0.1µF, Ripple=0.2Vp-p)

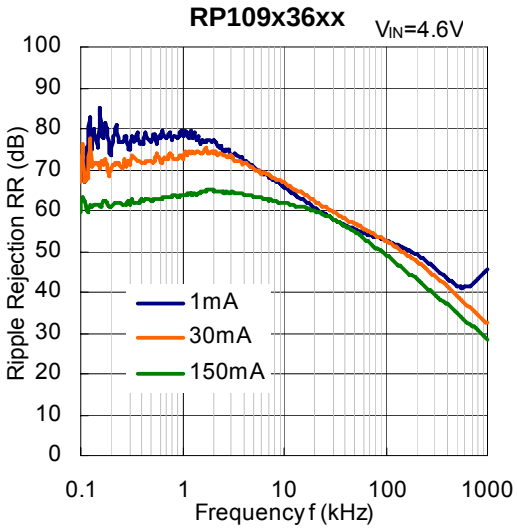




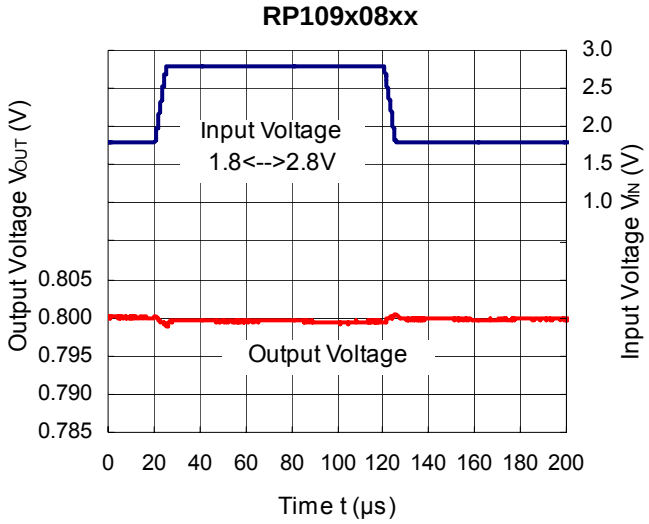


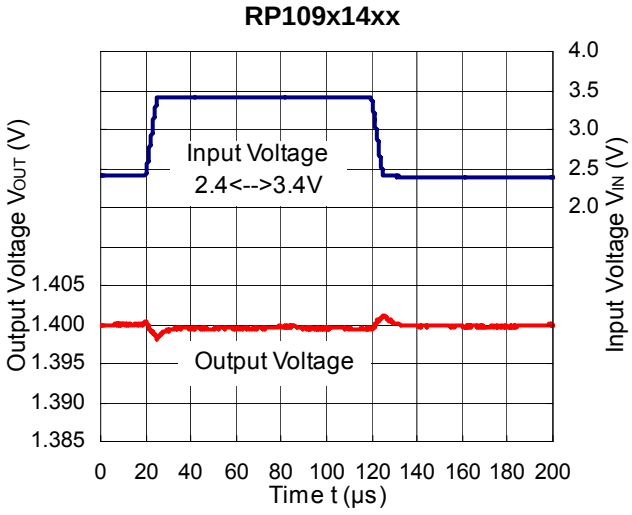


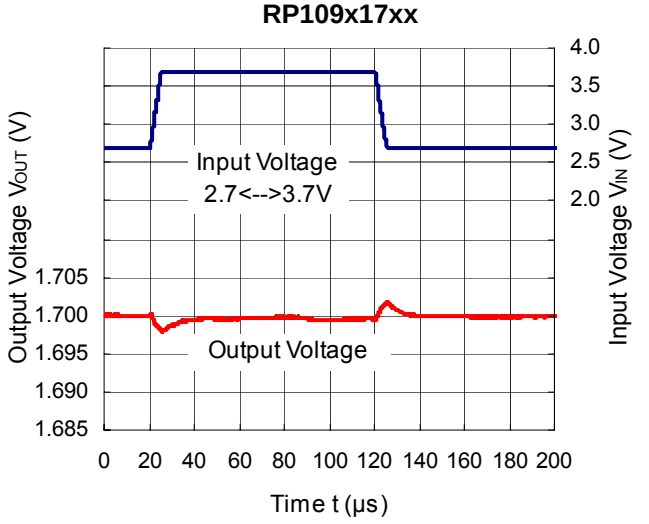


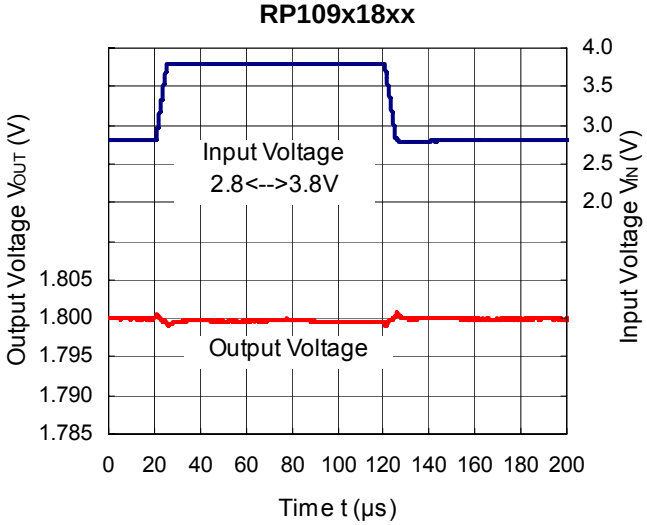


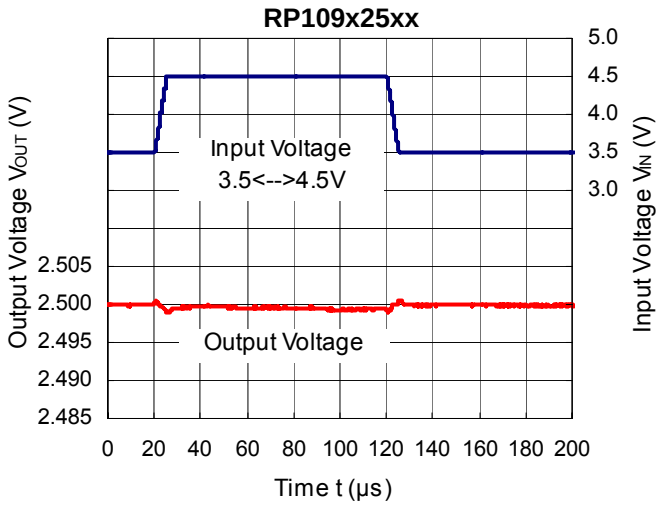
10) Input Transient Response (C1=none, C2=0.1µF, IOUT=30mA, tr=tf=5µs, Topt=25°C)

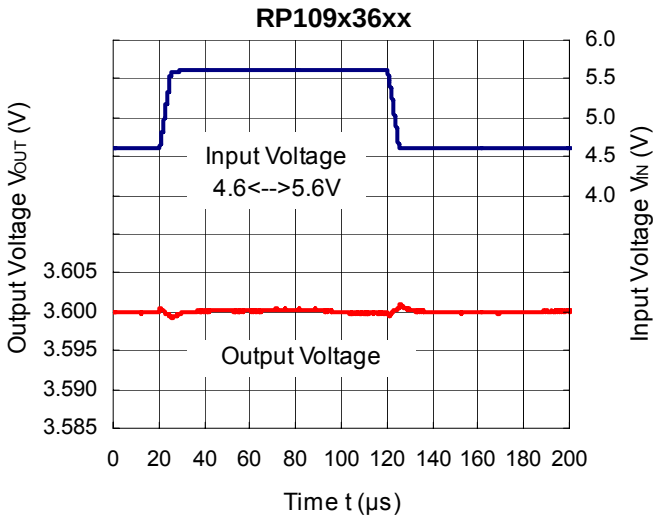




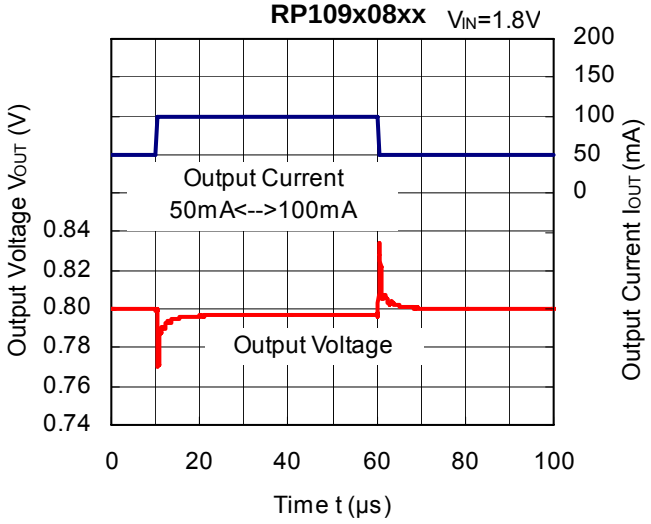


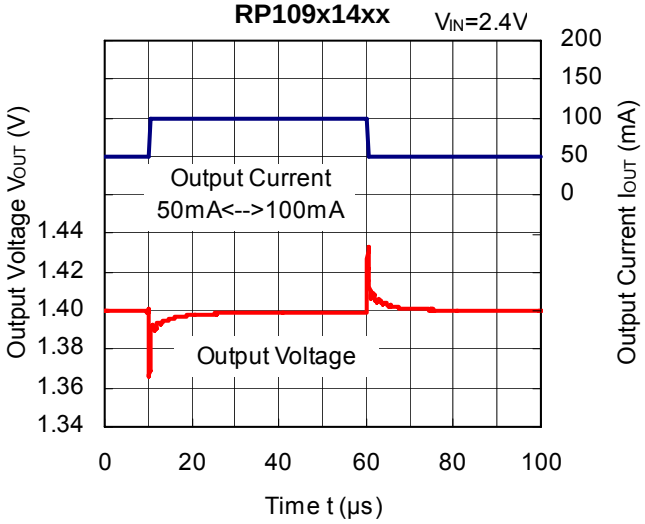


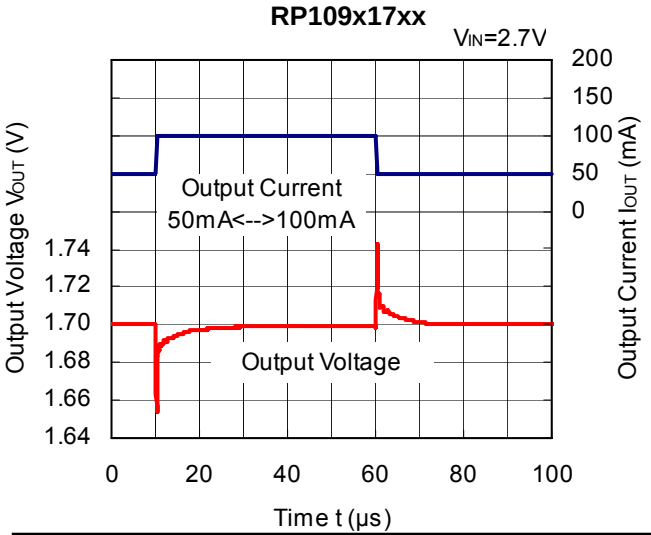


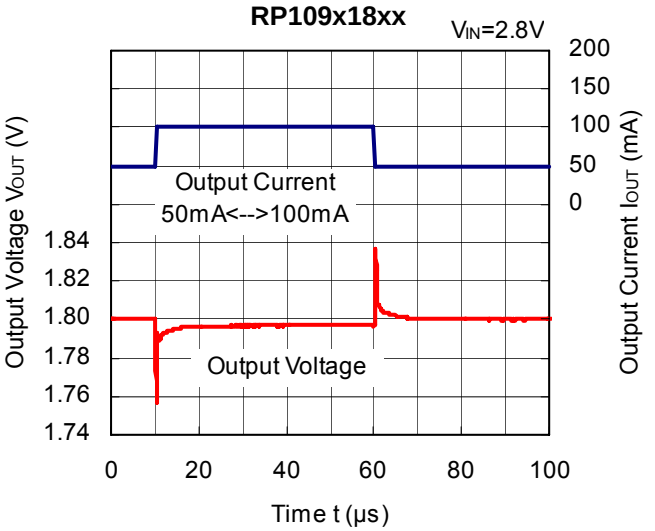


11) Load Transient Response (C1=0.1µF, C2=0.1µF, tr=tf=5µs, Topt=25°C)

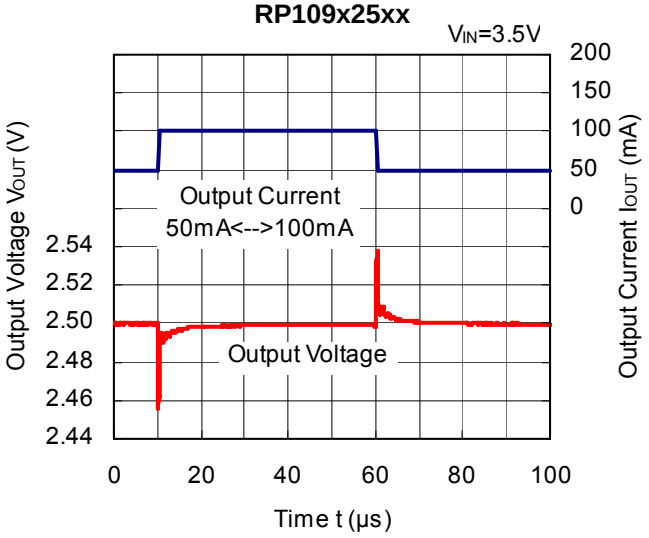








RP109x25xx



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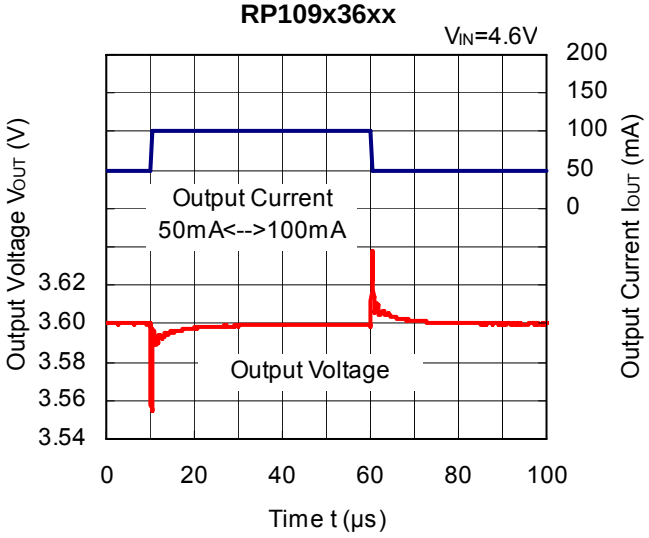

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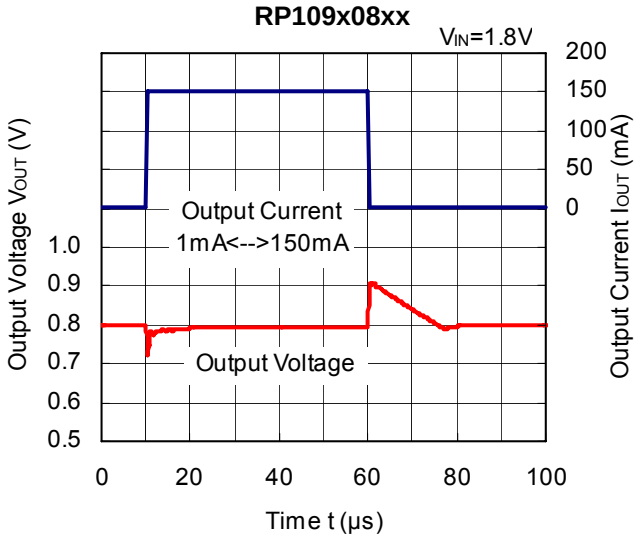

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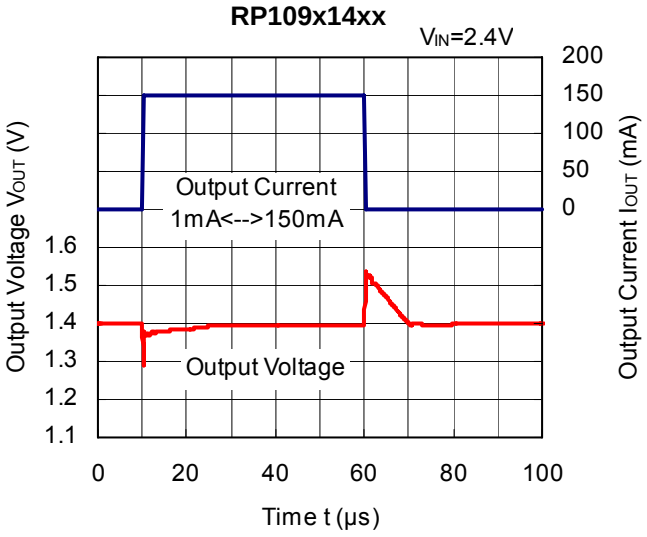
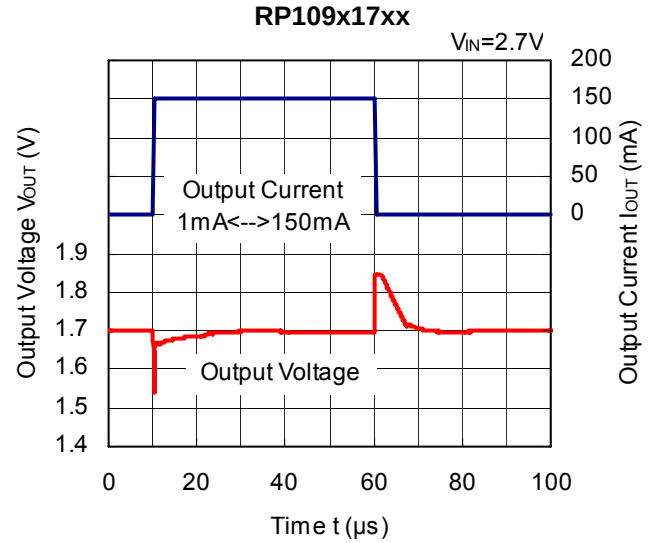


RP109x17xx



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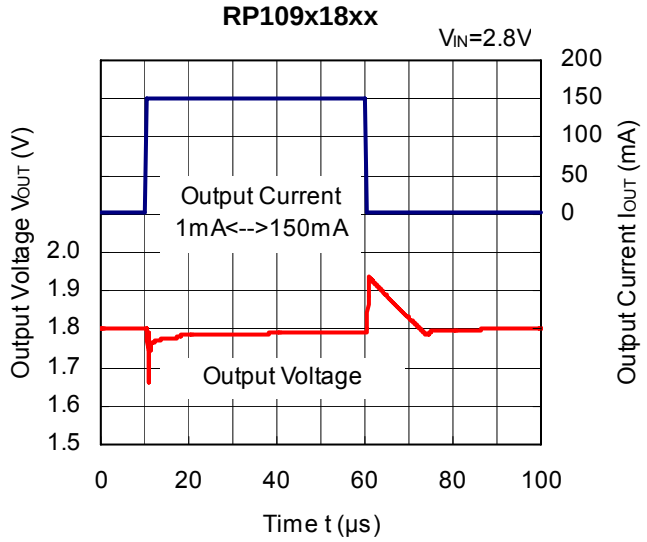

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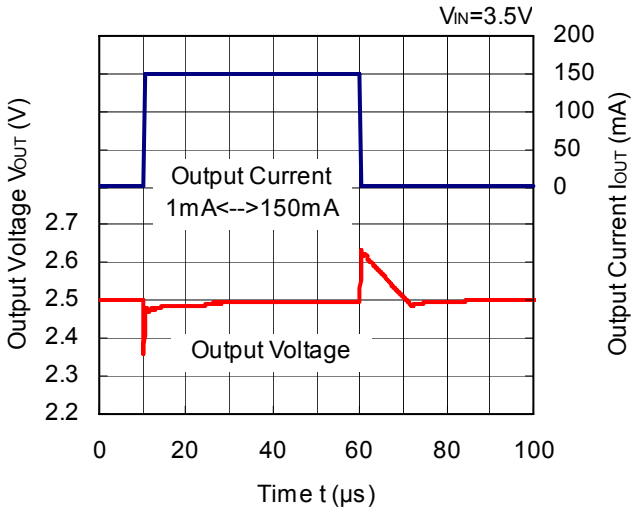

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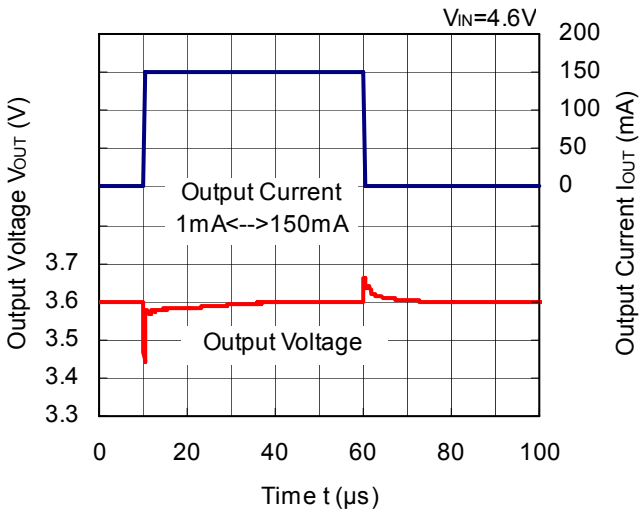
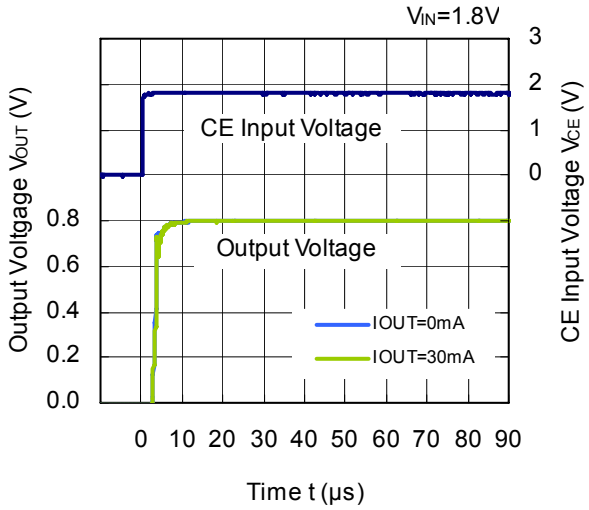
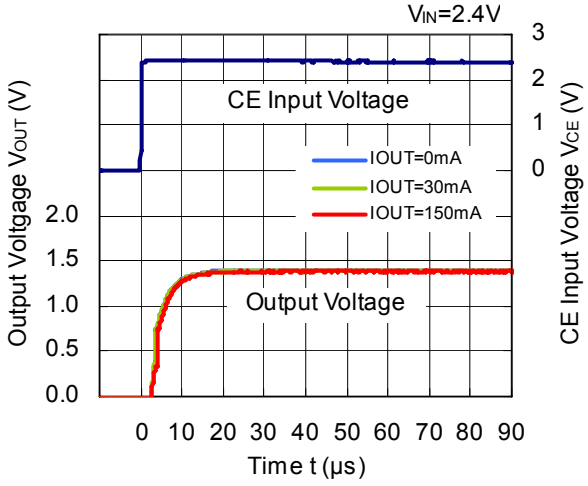


12) Turn On Speed with CE pin (C1=0.1µF, C2=0.1µF, Topt=25°C)

RP109x08xx



RP109x14xx



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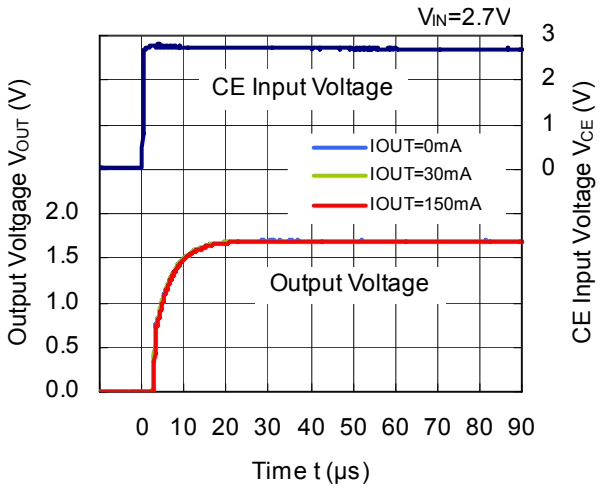

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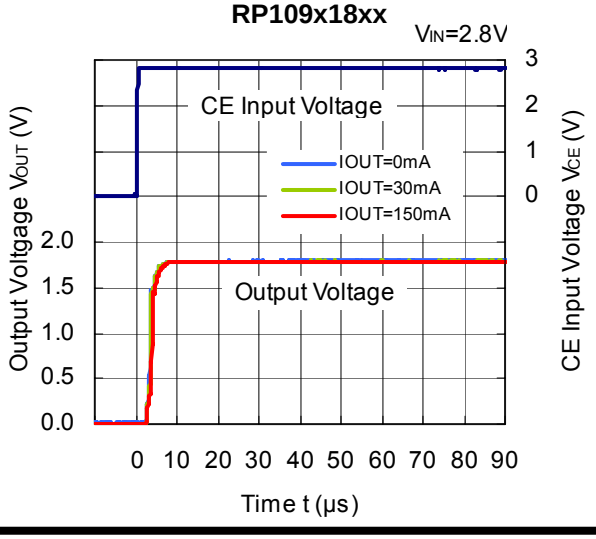
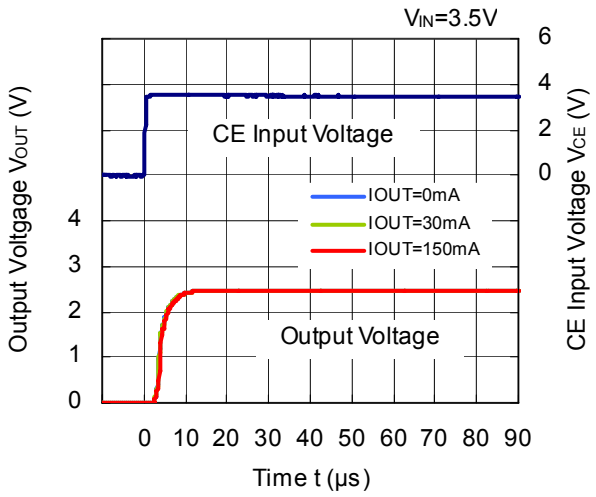


RP109x25xx



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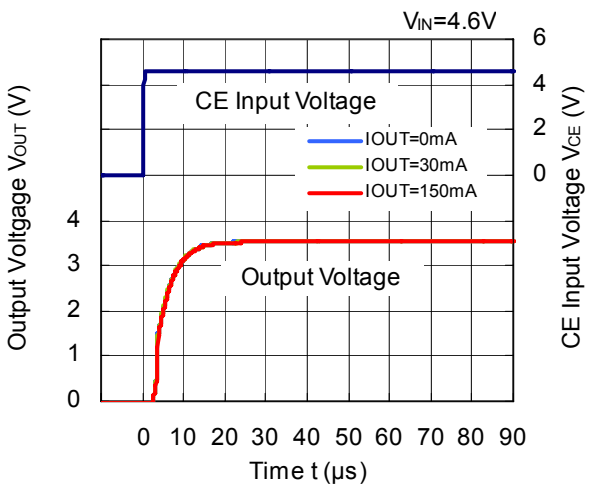
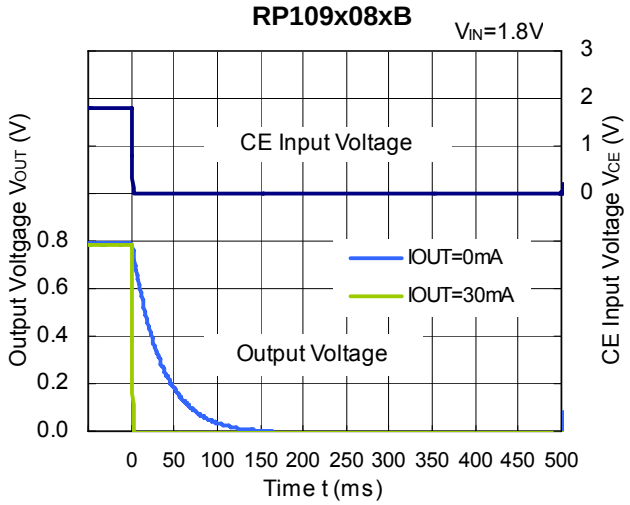
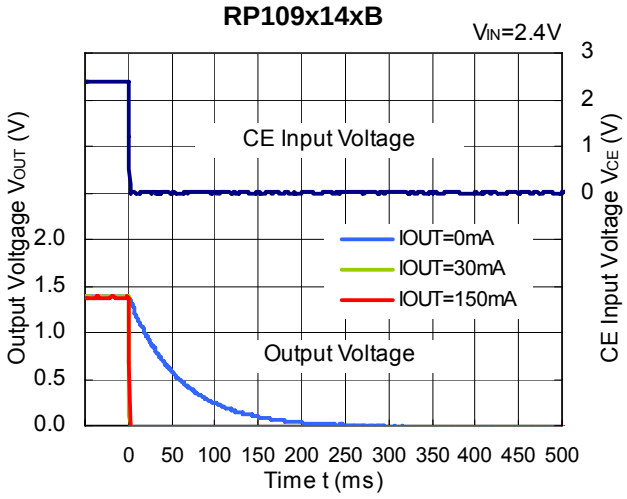


13) Turn Off Speed with CE pin (B Version) (C1=0.1µF, C2=0.1µF, Topt=25°C)

RP109x08xB



RP109x14xB



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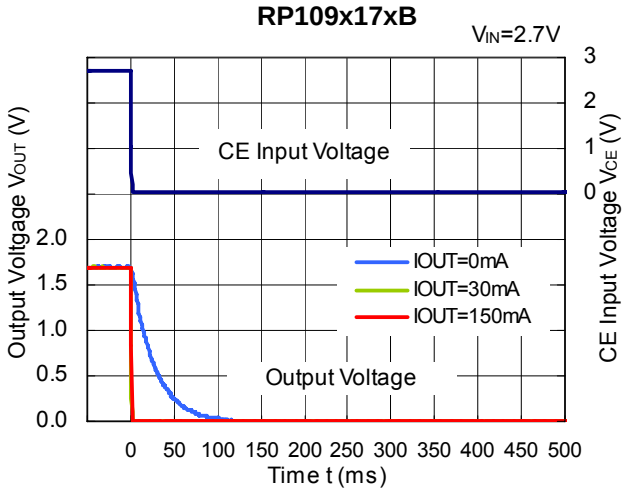

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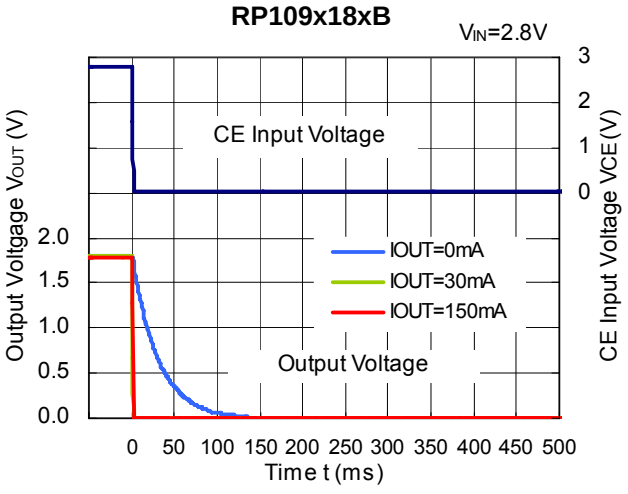
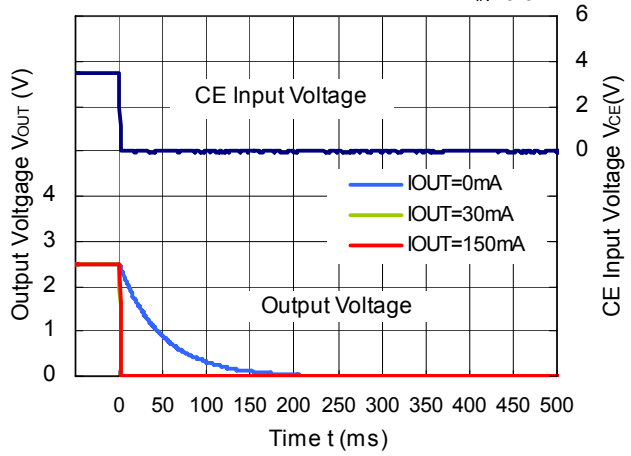
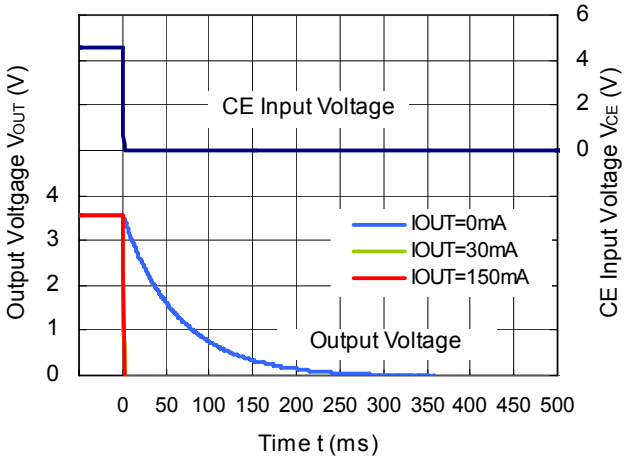


RP109x25xB

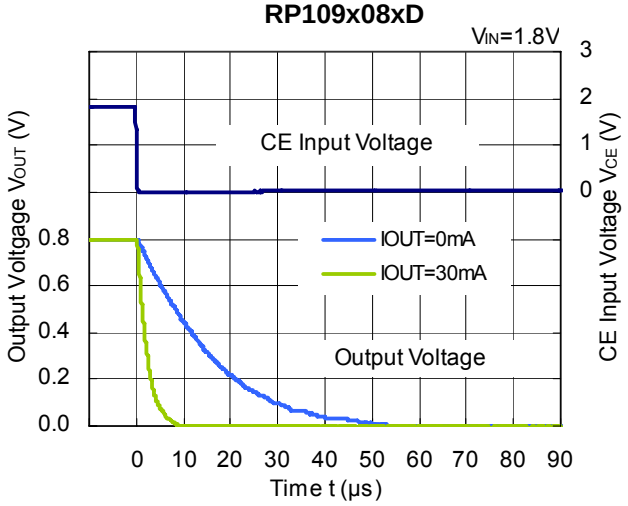


RP109x36xB

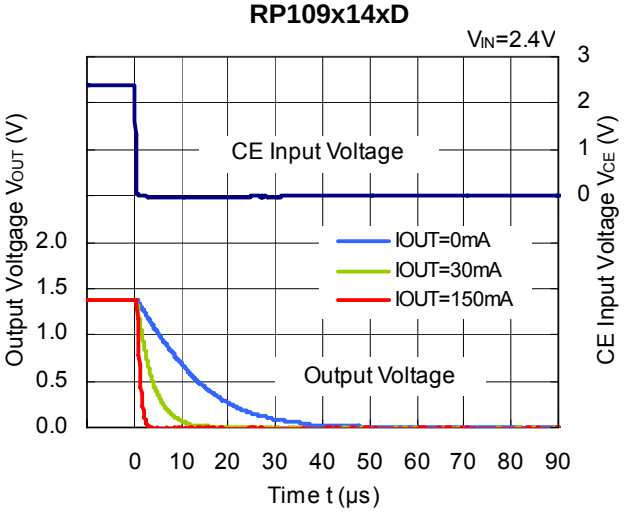


14) Turn Off Speed with CE pin (D Version) (C1=0.1µF, C2=0.1µF, Topt=25°C)

RP109x08xD



RP109x14xD



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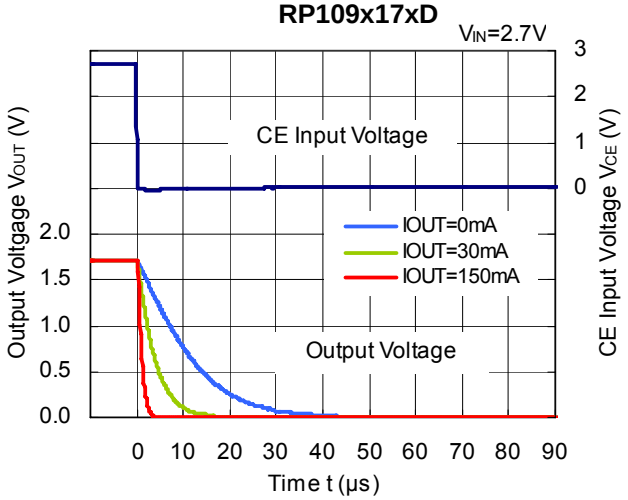

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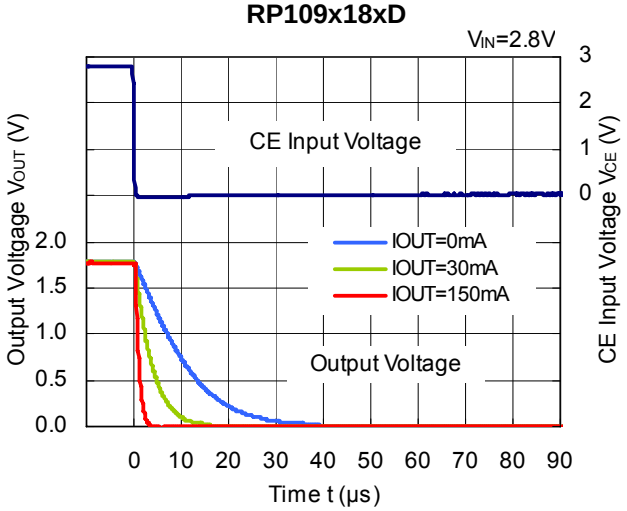
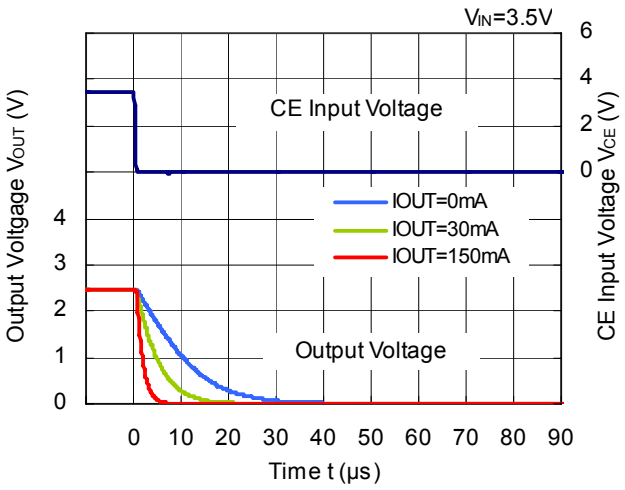
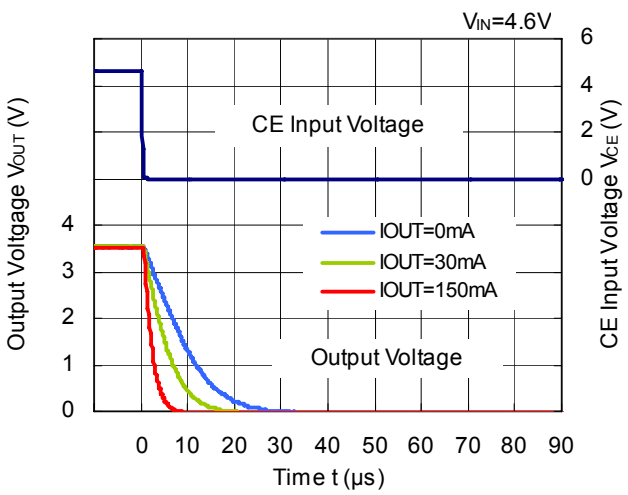


RP109x25xD

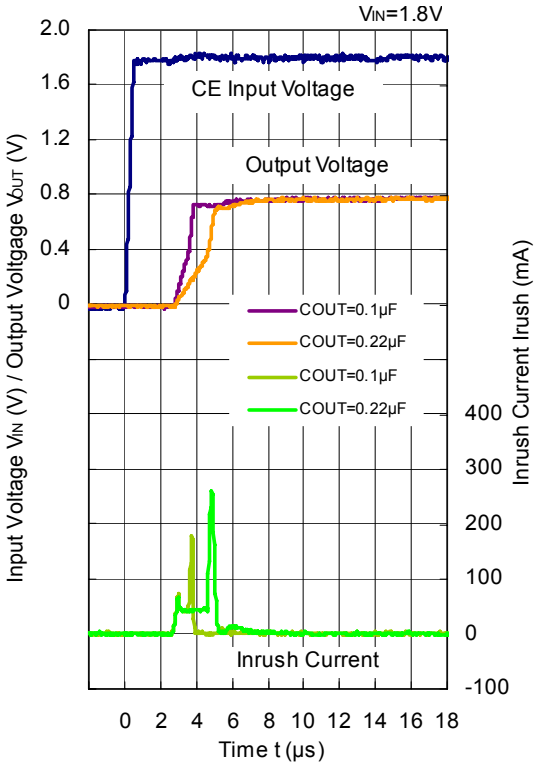


RP109x36xD

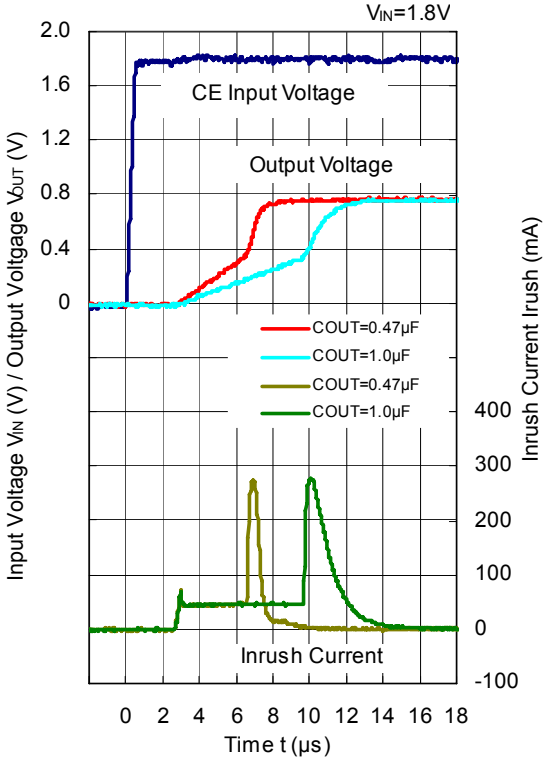


15) Inrush Current (C1=4.7µF, I_{OUT}=0mA, Topt=25°C)

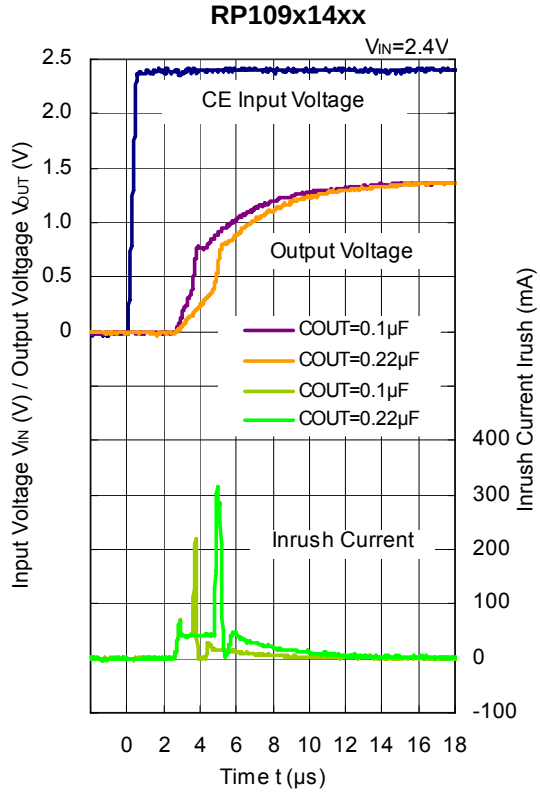
RP109x08xx



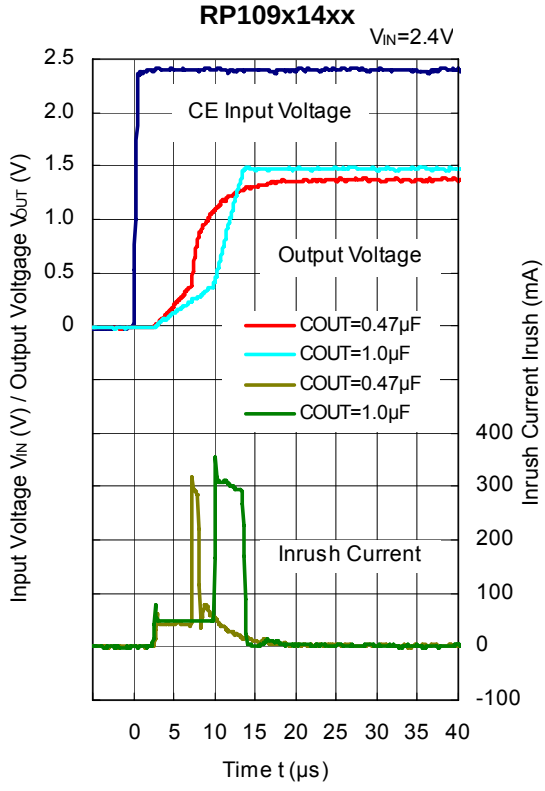
RP109x08xx



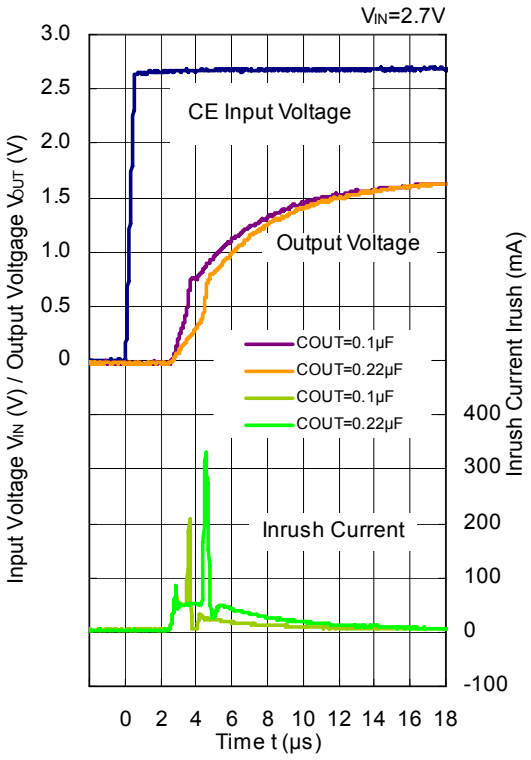
RP109x14xx



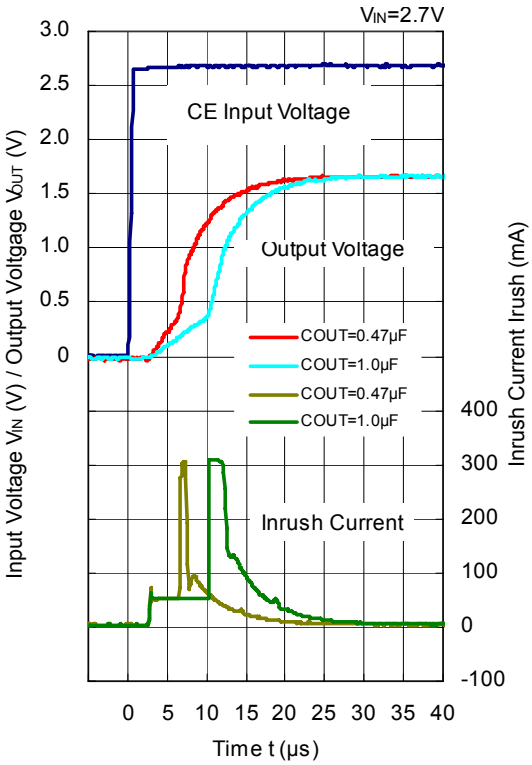
RP109x14xx



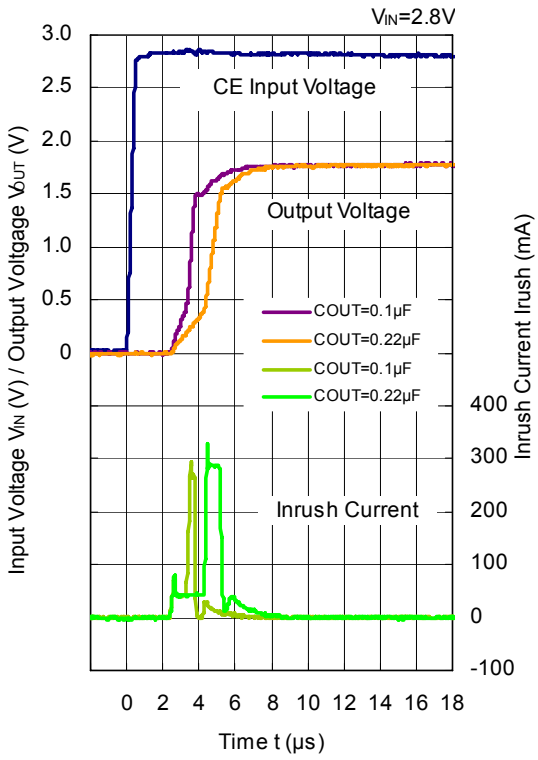
RP109x17xx



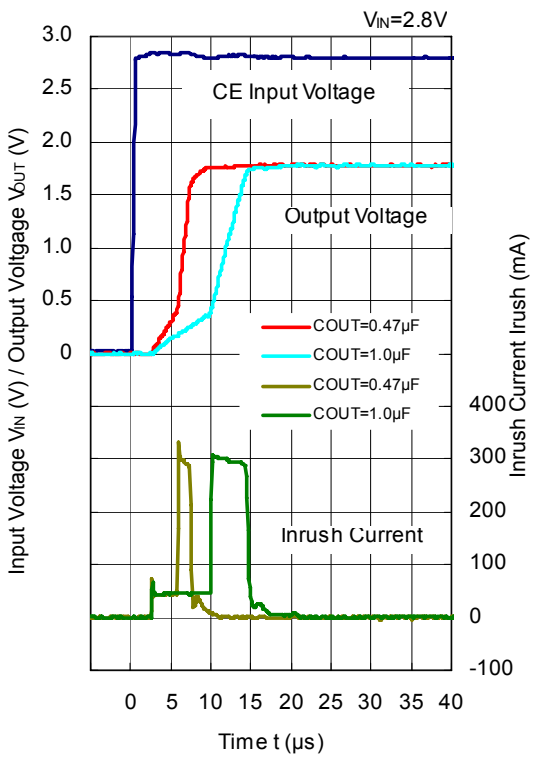
RP109x17xx



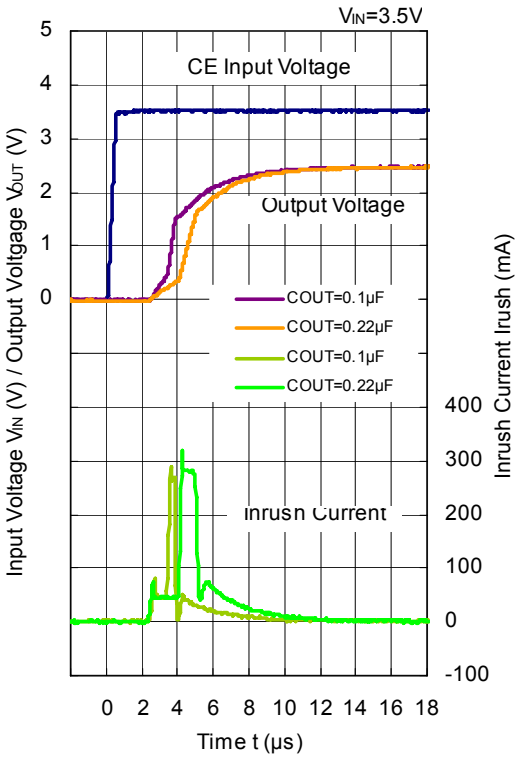
RP109x18xx



RP109x18xx



RP109x25xx



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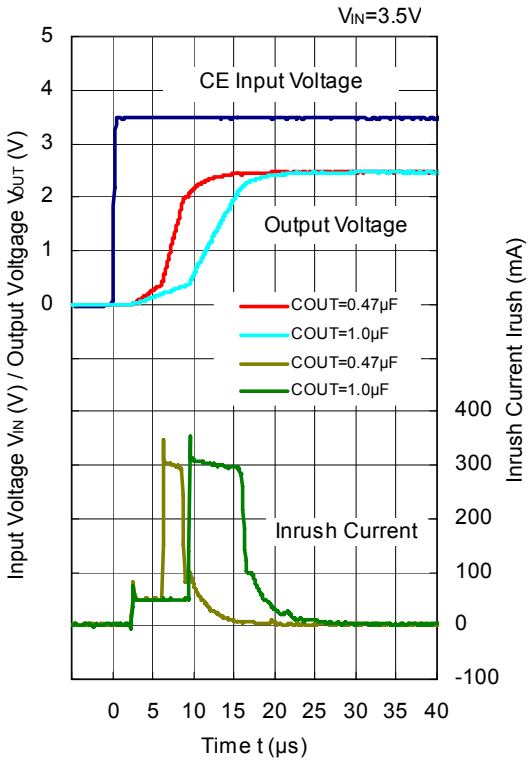

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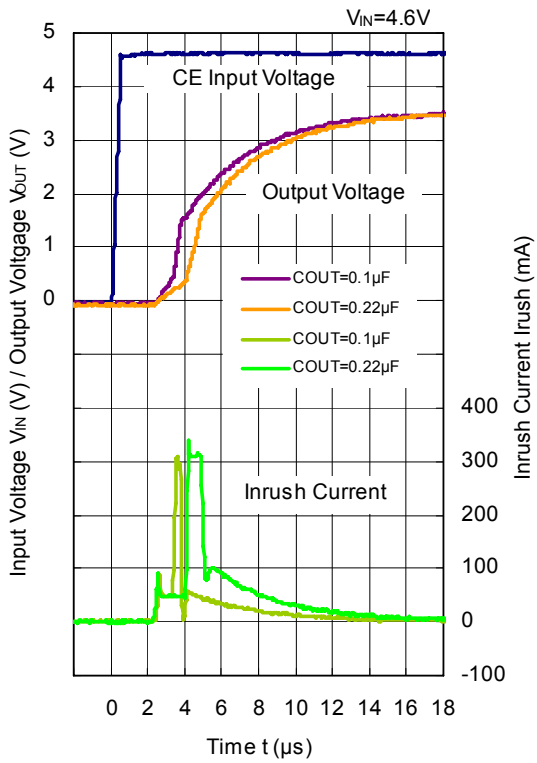

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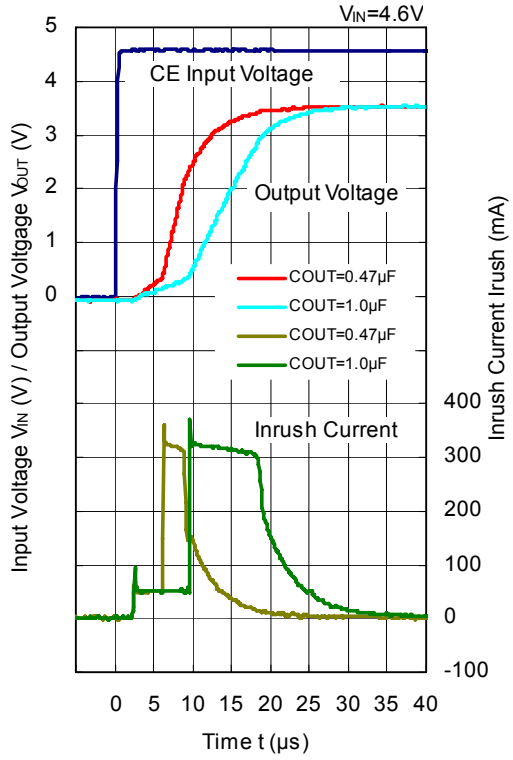
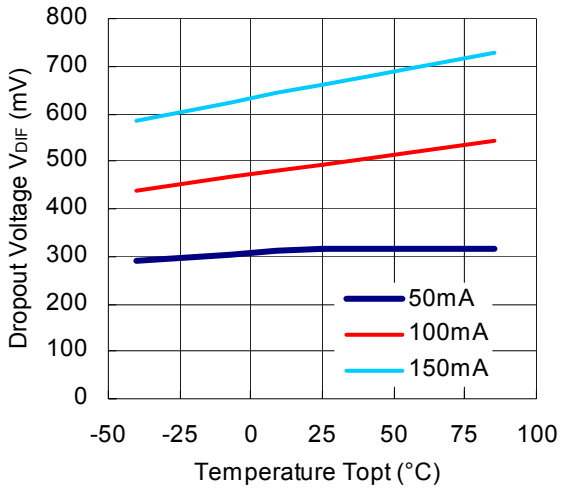
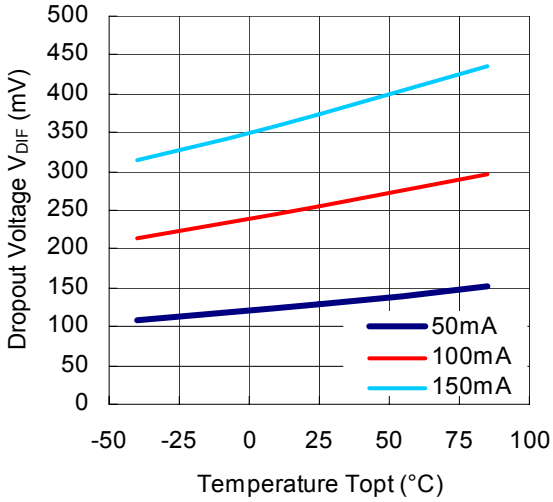


16) Dropout Voltage vs. Temperature (C1=0.1μF, C2=0.1μF)

RP109x08xx



RP109x14xx



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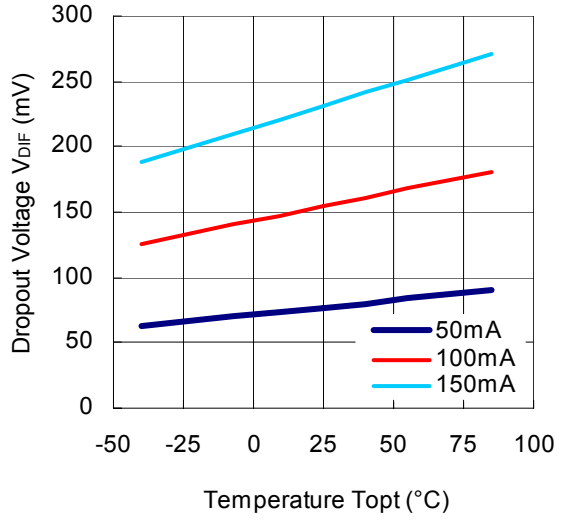

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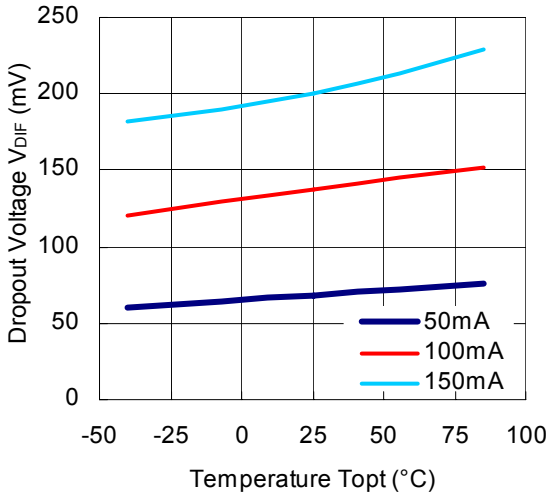


ESR vs. Output Current

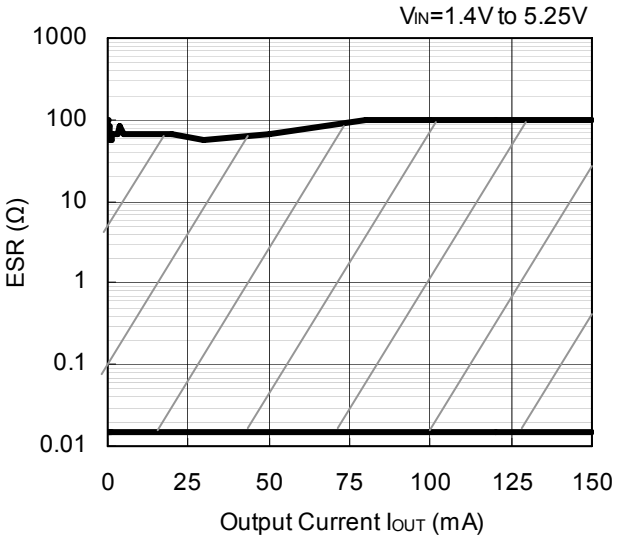
When using these ICs, consider the following points:

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 40μV (Avg.) are marked as the hatched area in the graph.

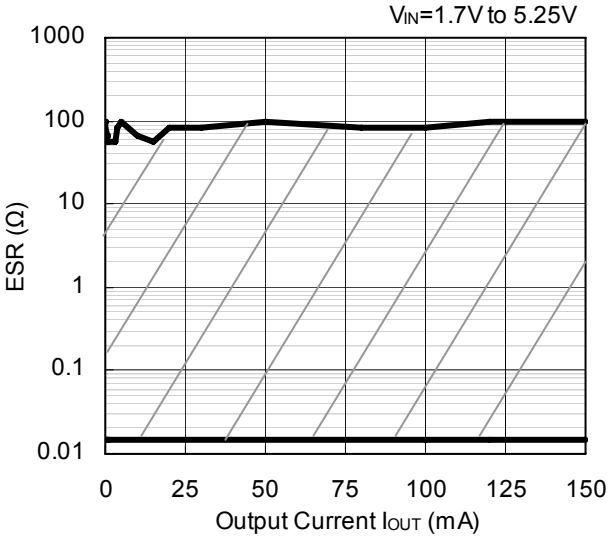
Measurement conditions

Frequency Band : 10Hz to 2MHz
Temperature : −40°C to 85°C
C1, C2 : Ceramic 0.1μF

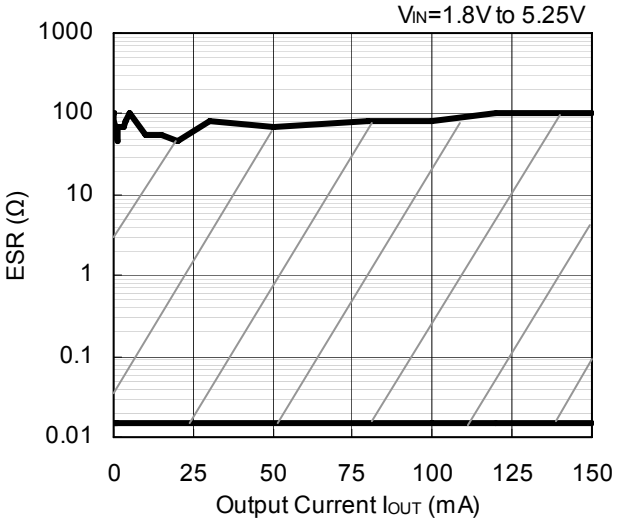
RP109x08xx



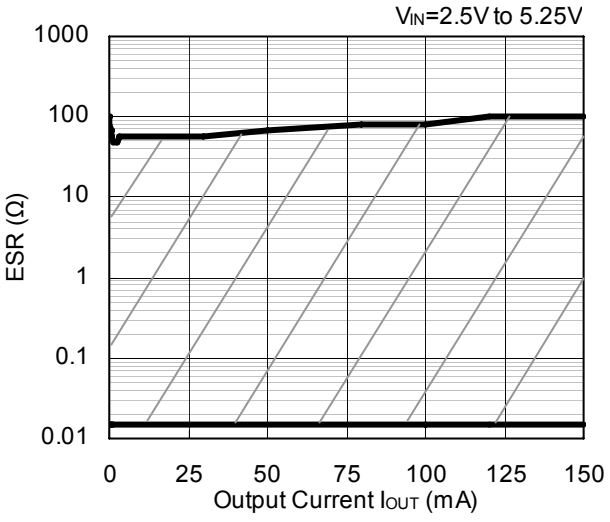
RP109x17xx



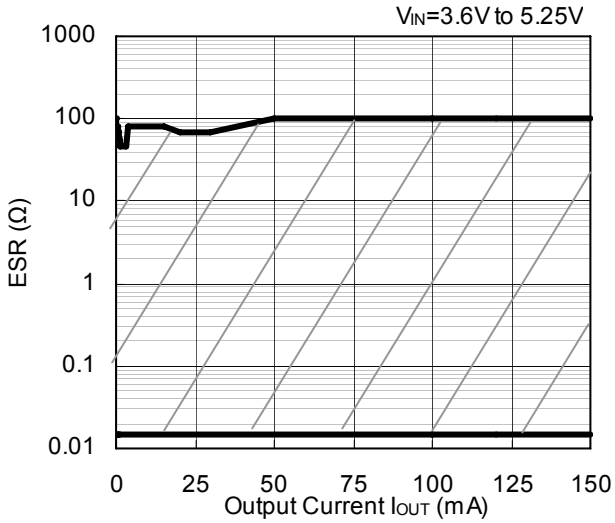
RP109x18xx



RP109x25xx



RP109x36xx


VIN=3.6V to 5.25V
1000
100
10
1
0.1
0.01
ESR (Ω)
0
25
50
75
100
125
150
Output Current IOUT (mA)

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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.

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