150mA Low Supply Current LDO REGULATOR

NO.EA-239-111020

OUTLINE

The RP110x Series is a voltage regulator (LDO) IC, which has been developed using the CMOS process technology, with high output voltage accuracy, ultra-low supply current, and low ON-resistance transistor. The IC contains the following components: a voltage reference unit, an error amplifier, a resistor-net for output voltage setting, a current limit circuit for preventing short-circuit, a soft-start circuit, and a chip enable circuit.

By minimizing the supply current to 1μA, the IC is able to prolong the battery life of each system. The external capacitor is 0.1μF with phase compensation. The IC also has a constant slope circuit as a soft-start circuit, which does not require any external capacitor. It minimizes the inrush current and prevents the output voltage overshoot at the start-up.

In addition to the small packaged SOT-23-5 and SC-88A, the RP110x Series offers the ultra-small DFN(PLP)0808-4 package and DFN1010-4, which enables the high density mounting of LDO regulator.

FEATURES

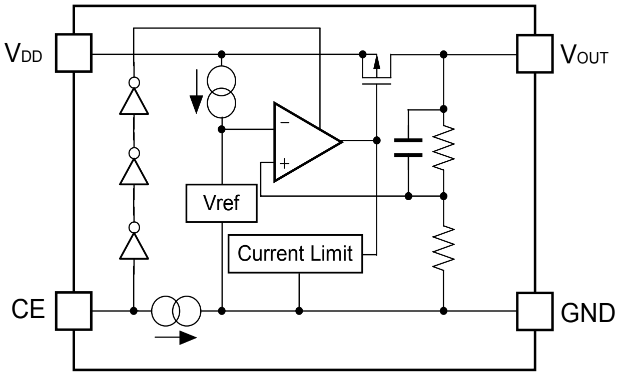
- Supply Current .... Typ. 1.0μA
  (Except the current through CE pull down circuit)
- Standby Current .... Typ. 0.1μA
- Dropout Voltage .... Typ. 0.28V (I_{OUT}=150mA, V_{OUT}=2.8V)
- Output Voltage Accuracy .... ±1.0%
- Temperature-Drift Coefficient of Output Voltage ... Typ. ±100ppm/°C
- Line Regulation .... Typ. 0.02%/V
- 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. 50mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC .....0.1μF or more
- Built-in Constant Slope Circuit

APPLICATIONS

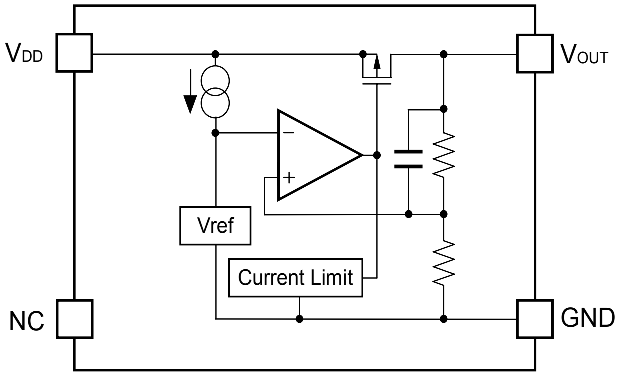
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

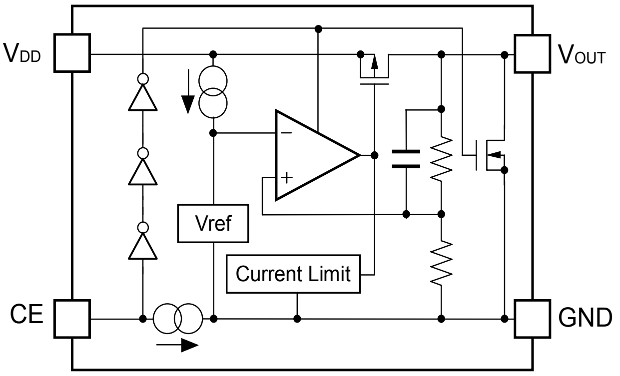
RP110xxxxB



RP110xxxxC



RP110xxxxD



SELECTION GUIDE

The output voltage, chip enable circuit, 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
RP110Kxx1∗-TR	DFN(PLP)0808-4	10,000 pcs	Yes	Yes
RP110Lxx1∗-TR	DFN1010-4	10,000 pcs	Yes	Yes
RP110Qxx2∗-TR-FE	SC-88A	3,000 pcs	Yes	Yes
RP110Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

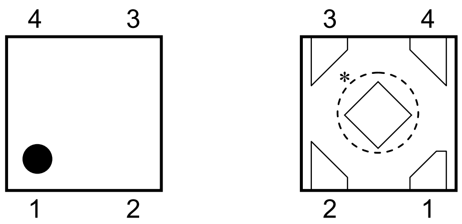
xx: The output voltage can be designated in the range from 0.8V(08) to 3.6V(36) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

∗ : CE pin polarity and auto discharge function at off state are options as follows.
(B) "H" active, without auto discharge function at off state
(C) without chip enable circuit, without auto discharge function at off state
(D) "H" active, with auto discharge function at off state

PIN CONFIGURATIONS

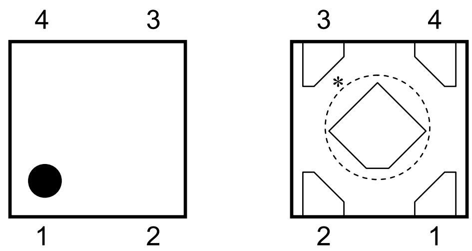
● DFN(PLP)0808-4

Top View　　Bottom View

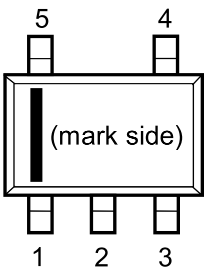


● DFN1010-4

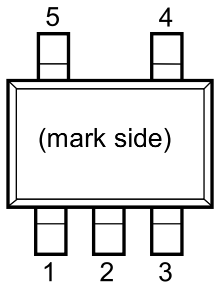
Top View　　Bottom View



● SC-88A



● SOT-23-5



PIN DESCRIPTIONS

● **DFN(PLP)0808-4**

Pin No	Symbol	Pin Description
1	V_{OUT}	Output Pin
2	GND	Ground Pin
3	CE / NC	Chip Enable Pin ("H" Active) / No connection
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.

● **DFN1010-4**

Pin No.	Symbol	Description
1	V_{OUT}	Output Pin
2	GND	Ground Pin
3	CE / NC	Chip Enable Pin ("H" Active) / No connection
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	Description
1	CE / NC	Chip Enable Pin ("H" Active) / No connection
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 / NC	Chip Enable Pin ("H" Active) / No connection
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.

ELECTRICAL CHARACTERISTICS

- **RP110x**

Unless otherwise noted, V_{IN}=Set V_{OUT} +1.0V(V_{OUT} >1.5), V_{IN}=2.5V($V_{OUT} \leq$ 1.5V), I_{OUT}=1mA, C_{IN}=C_{OUT}=0.1μF.
The load regulation differs depending on the packages.
[ ] values indicate −40°C ≤ Topt ≤ 85°C, unless otherwise noted.

Topt=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Topt=25°C	V_{OUT} > 2.0V	×0.99		×1.01	V
			V_{OUT} ≤ 2.0V	−20		20	mV
		-40°C≤Topt≤85°C	V_{OUT} > 2.0V	[×0.970]		[×1.025]	V
			V_{OUT} ≤ 2.0V	[−60]		[50]	mV
I_{OUT}	Output Current			[150]			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	1mA ≤ I_{OUT} ≤ 150mA		[−20]	0	[20]	mV
V_{DIF}	Dropout Voltage	Please refer to "Dropout Voltage".					
I_{SS}	Supply Current	I_{OUT}=0mA			1.0	[2.0]	μA
$I_{standby}$	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} ≤ 5.0V			0.02	[0.10]	%/V
V_{IN}	Input Voltage*			[1.4]		[5.25]	V
$\Delta V_{OUT}/\Delta T_{opt}$	Output Voltage Temperature Coefficient	−40°C ≤ Topt ≤ 85°C			±100		ppm /°C
I_{SC}	Short Current Limit	V_{OUT}=0V			50		mA
I_{PD}	CE Pull-down Current (B/D Version)				0.3		μA
V_{CEH}	CE Input Voltage "H" (B/D Version)			[1.0]			V
V_{CEL}	CE Input Voltage "L" (B/D Version)					[0.4]	V
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)	V_{IN}=4.0V, V_{CE}=0V			60		Ω

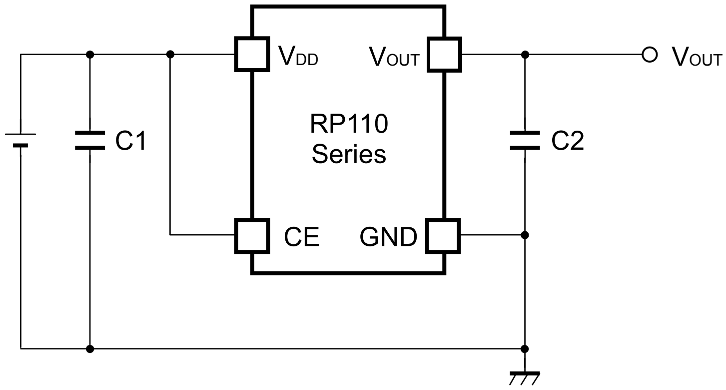
All of units are tested and specified under load conditions such that Tj≈Topt=25°C except for Output Voltage Temperature Coefficient.
∗) When Input Voltage is 5.5V, the total operational time must be within 500hrs.

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.

Dropout Voltage

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
$0.8 \leq V_{OUT} < 0.9$	I_{OUT}=150mA	0.96	1.40
$0.9 \leq V_{OUT} < 1.0$		0.87	1.25
$1.0 \leq V_{OUT} < 1.2$		0.78	1.15
$1.2 \leq V_{OUT} < 1.4$		0.64	1.00
$1.4 \leq V_{OUT} < 1.7$		0.52	0.80
$1.7 \leq V_{OUT} < 2.0$		0.40	0.60
$2.0 \leq V_{OUT} < 2.5$		0.32	0.48
$2.5 \leq V_{OUT} < 3.0$		0.28	0.40
$3.0 \leq V_{OUT} \leq 3.6$		0.25	0.35

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

PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor 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.

■ Constant Slope Circuits

The RP110x Series is equipped with a constant slope circuit as a soft-start circuit, which allows the output voltage to start up gradually when the CE is turned on.

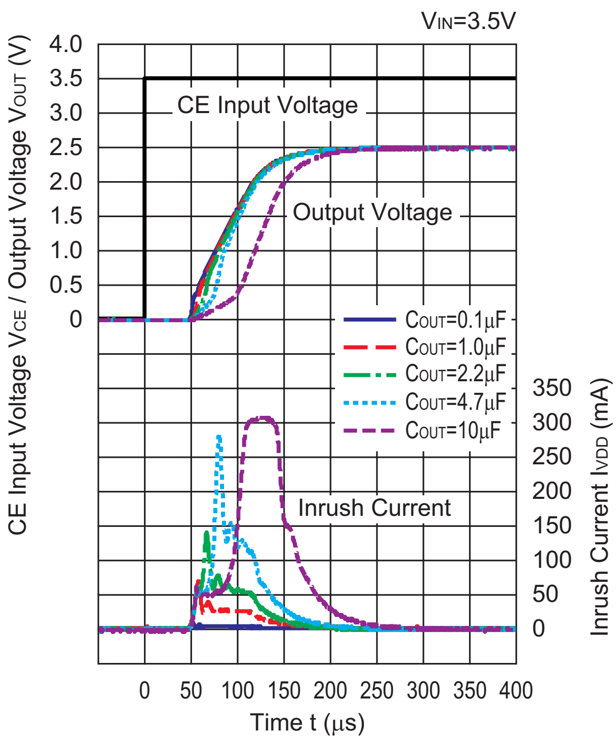
The constant slope circuit minimizes the inrush current at the start-up and also prevents the overshoot of the output voltage.

The capacitor to create the start-up slope is built in the IC that does not require any external components. The start-up time and the start-up slope angle are fixed inside the IC.

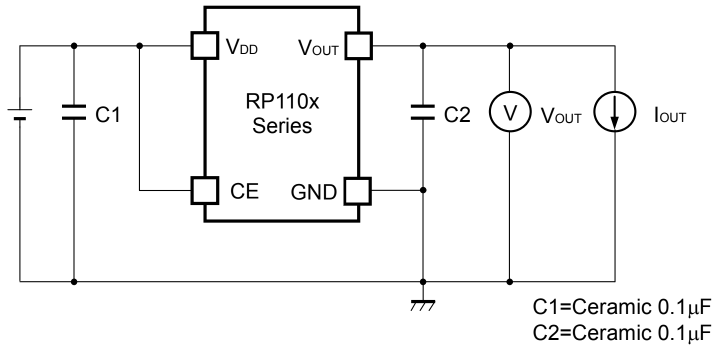
If the capacitance of the external output capacitor (C_{OUT}) becomes more than the certain capacitance, the output current limit circuit minimizes the incoming current of the output capacitor at the start-up. As a result, the start-up time becomes longer and the start-up slope angle becomes more gentle. As “Inrush Current Characteristics Example” below shows, if the C_{OUT} is less than 4.7µF, the constant slope circuit easily starts to function at the start-up, likewise, if the C_{OUT} is over 10µF, the output current limit circuit easily starts to function at the start-up. The boundary point of using these two circuits is inversely proportional to the output voltage. If the output voltage is higher, the output current limit circuit easily starts to function even if the C_{OUT} capacitance is small. For more details, please refer to the graph 14 of “Inrush Current Characteristics Example”.

Inrush Current Characteristics Example (C1=none, I_{OUT}=0mA, Topt=25ºC)

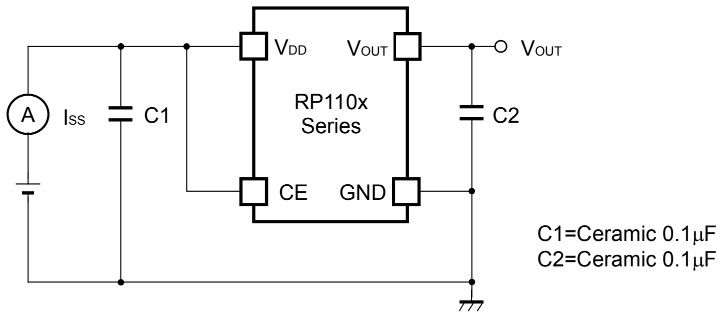
RP110x25xB/D



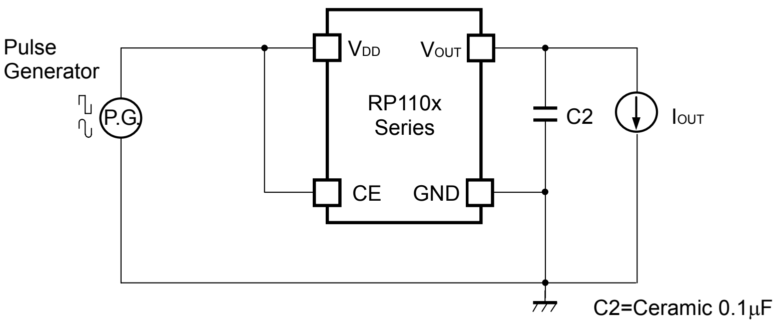
TEST CIRCUITS



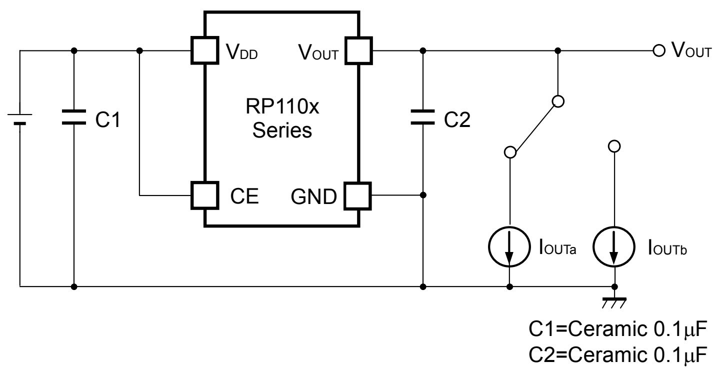
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection



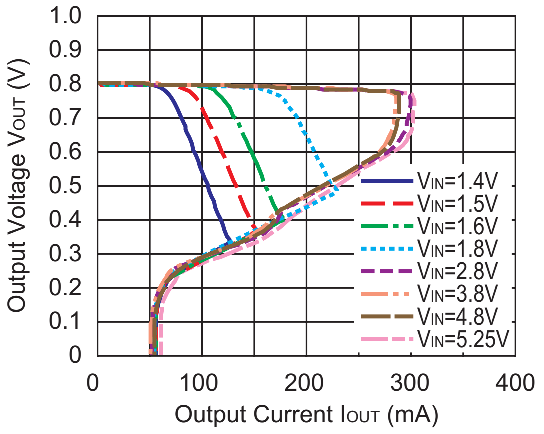
Test Circuit for Load Transient Response

RICOH

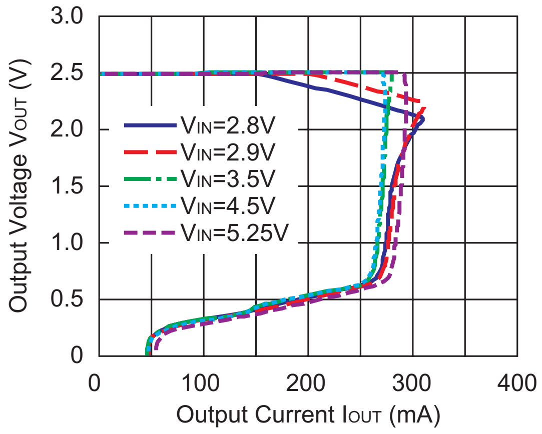
TYPICAL CHARACTERISTICS

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

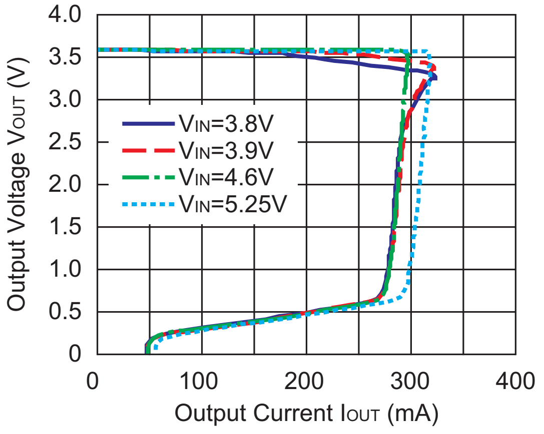
RP110x08xx



RP110x25xx

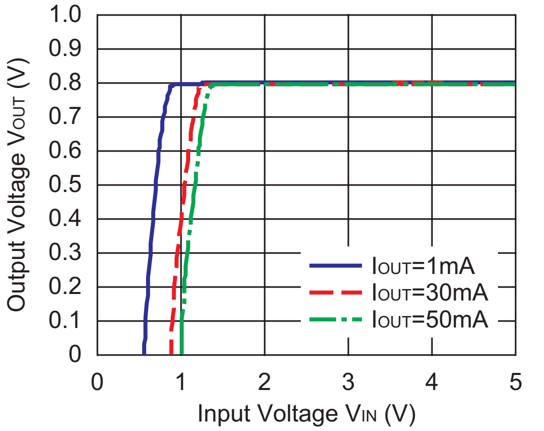


RP110x36xx

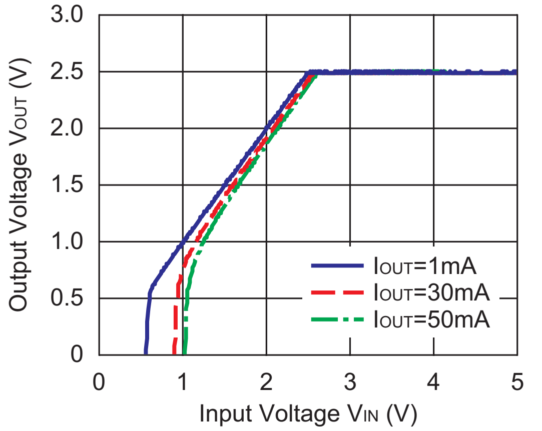


2) Output Voltage vs. Input Voltage (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, Topt=25°C)

RP110x08xx



RP110x25xx



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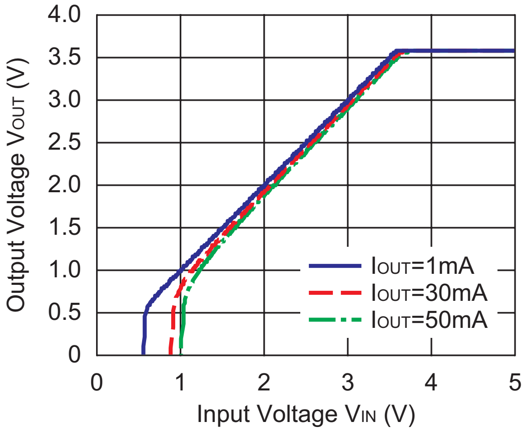
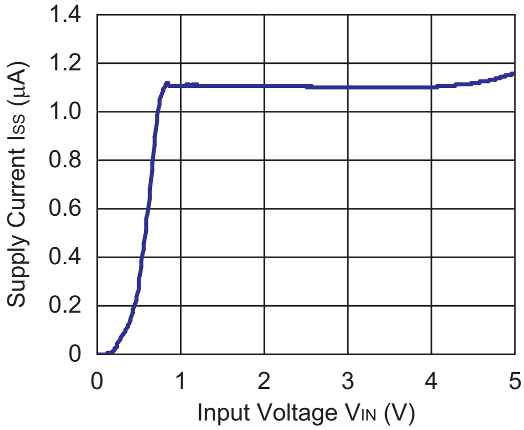


3) Supply Current vs. Input Voltage (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, Topt=25°C)

RP110x08xx



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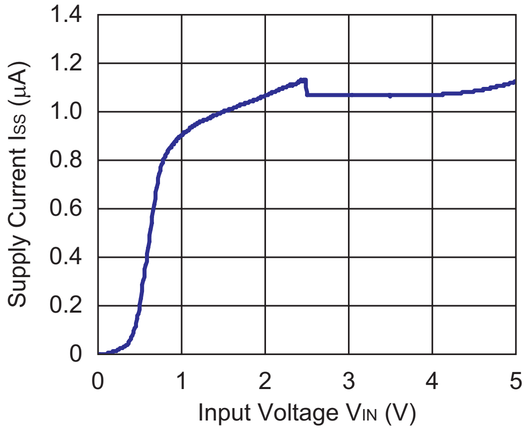

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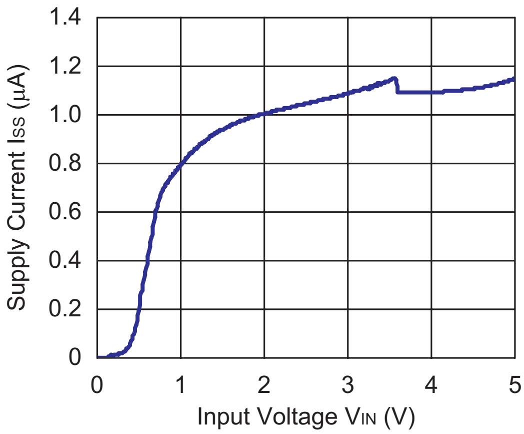
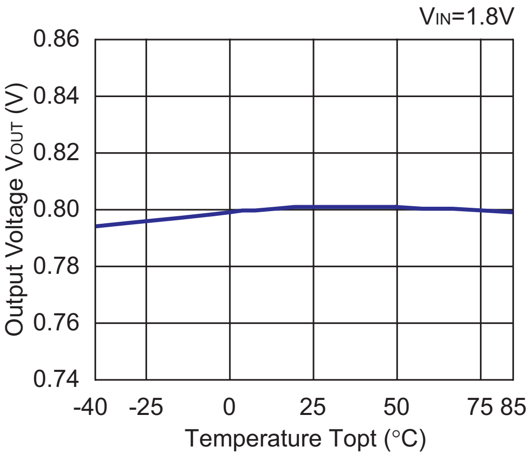


4) Output Voltage vs. Temperature (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, IOUT=1mA)

RP110x08xx



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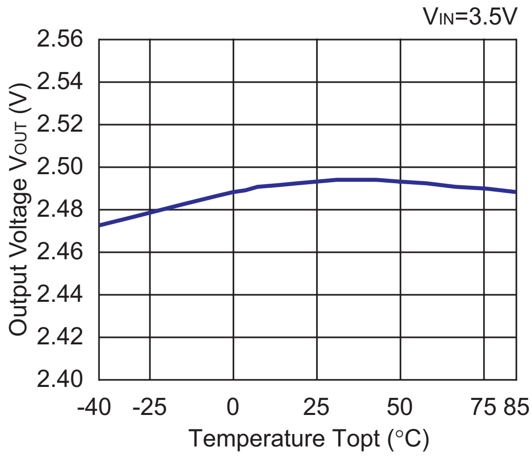

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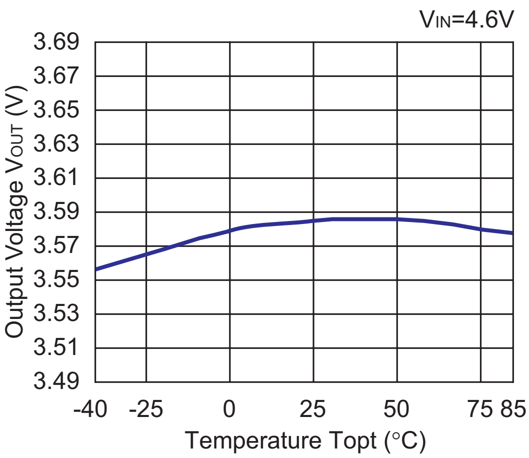
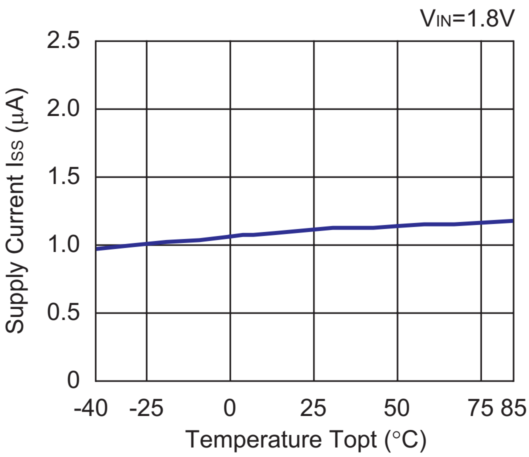


5) Supply Current vs. Temperature (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF)

RP110x08xx



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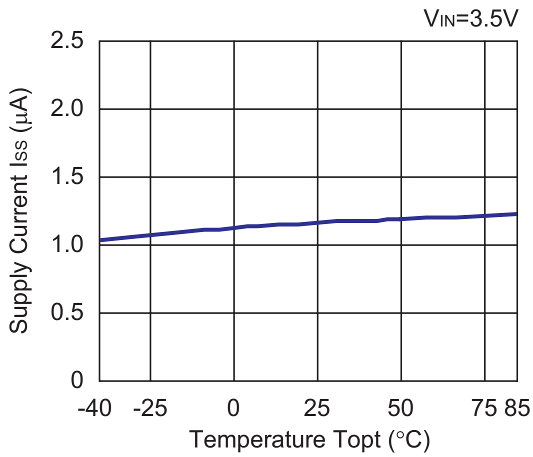
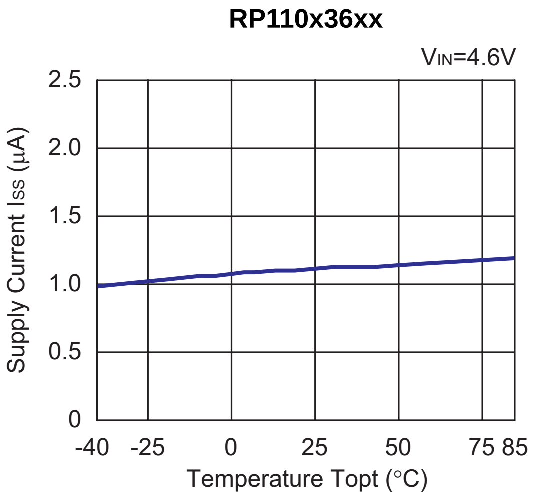
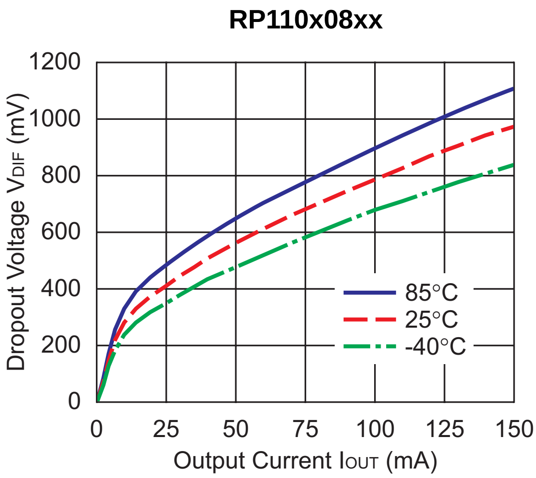
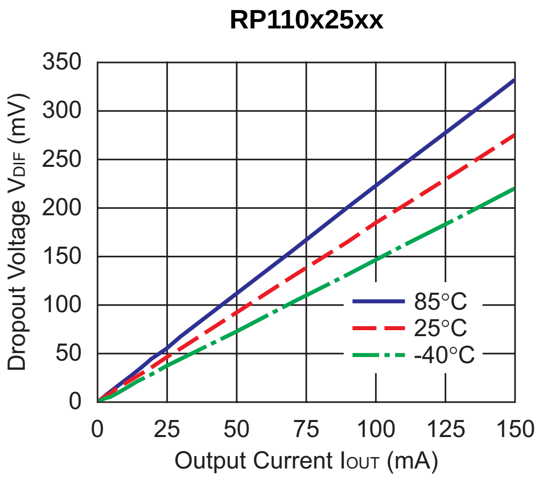
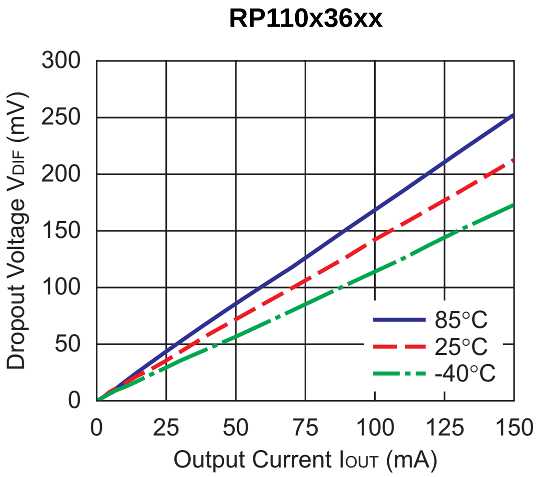




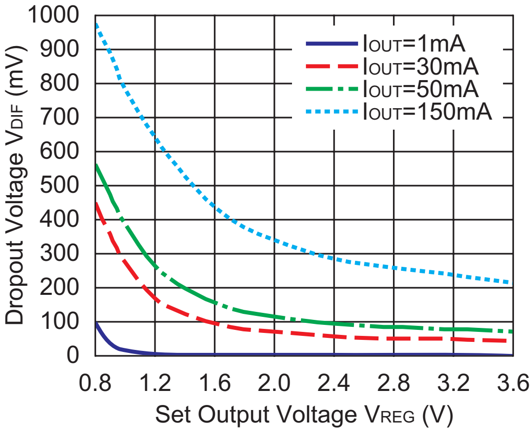
6) Dropout Voltage vs. Output Current (C1=Ceramic 0.1µF, C2=Ceramic 0.1µF, Topt=25°C)





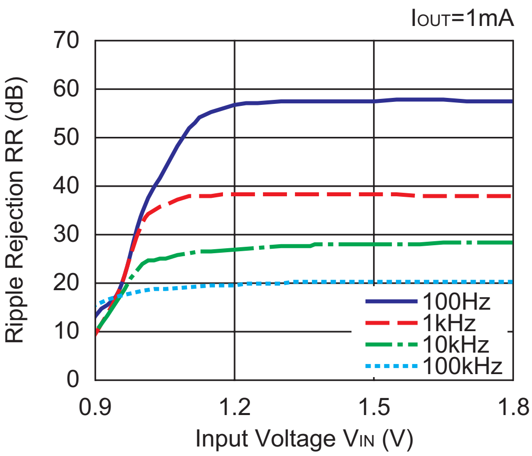


7) Dropout Voltage vs Set Output Voltage (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, Topt=25°C)

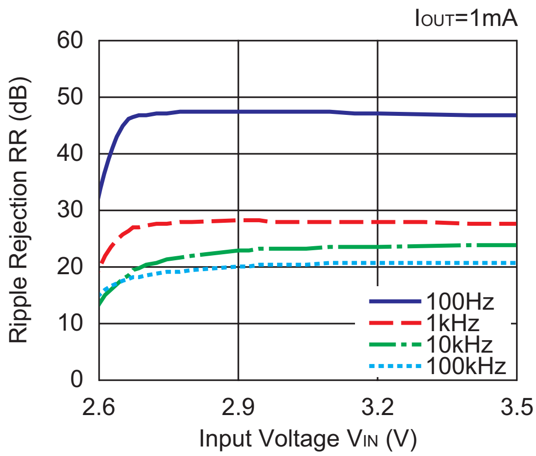


8) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=Ceramic 0.1μF, Ripple=0.2Vp-p,Topt=25°C)

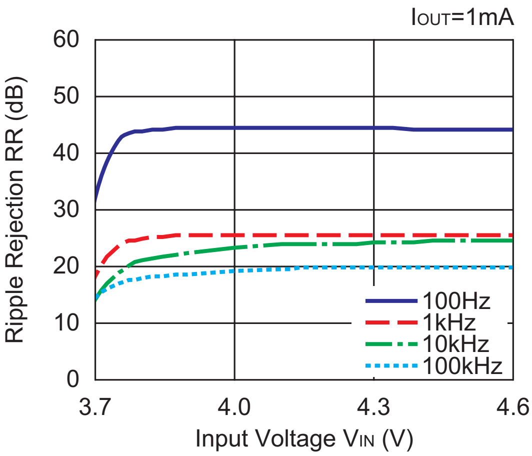
RP110x08xx



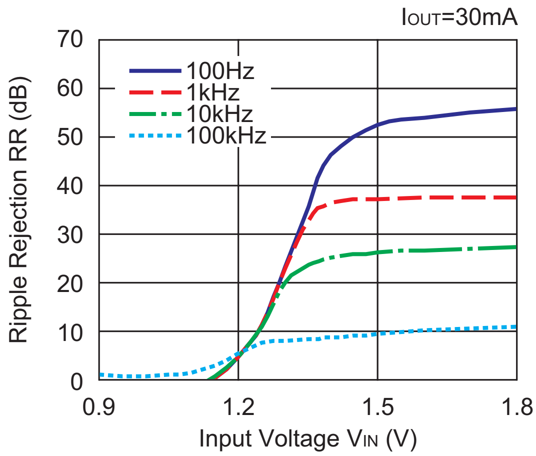
RP110x25xx



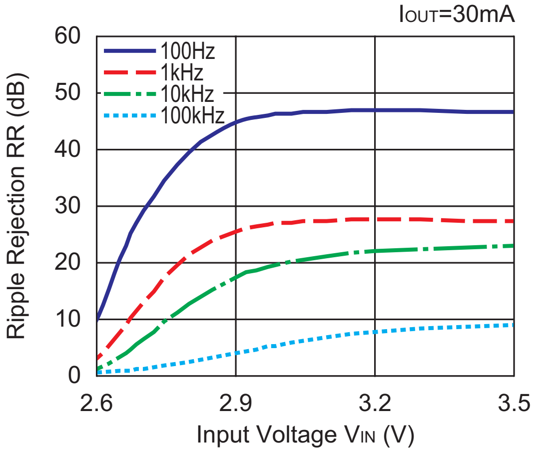
RP110x36xx



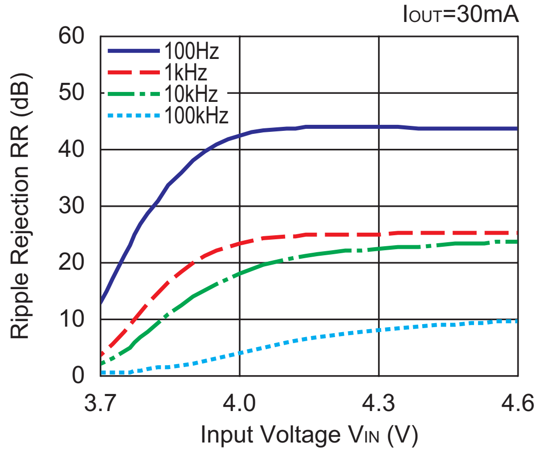
RP110x08xx



RP110x25xx

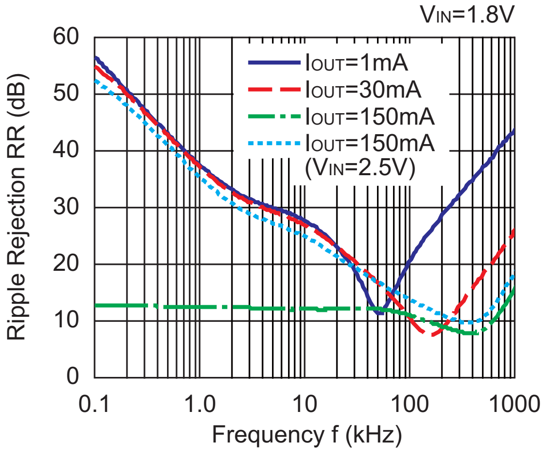


RP110x36xx



9) Ripple Rejection vs. Frequency (C1=none, C2=Ceramic 0.1µF, Ripple=0.2Vp-p, Topt=25°C)

RP110x08xx



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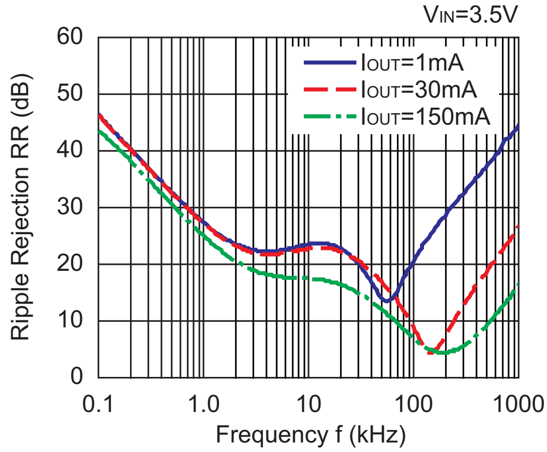
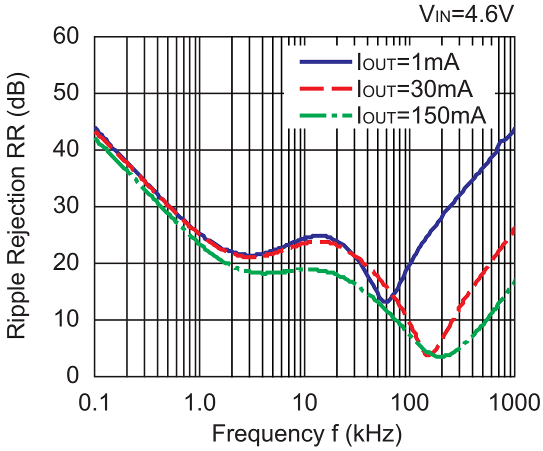
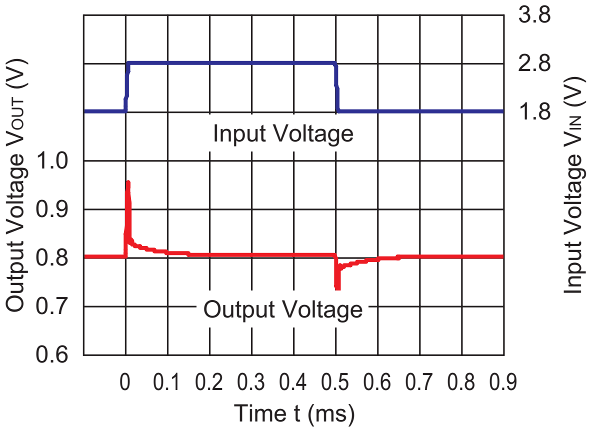


RP110x36xx

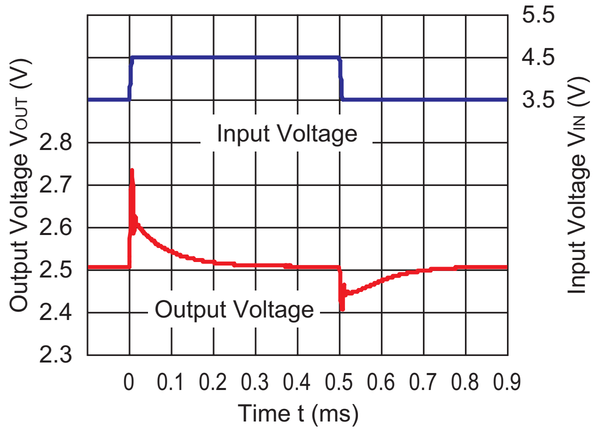


10) Input Transient Response (C1=none, C2=0.1μF, I_{OUT}=30mA, tr=tf=5μs, Topt=25°C)

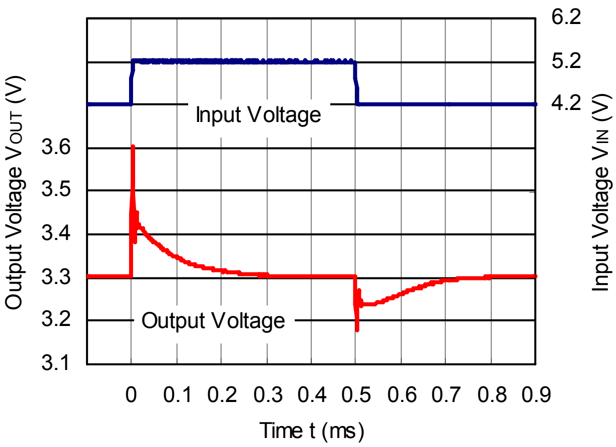
RP110x08xx



RP110x25xx

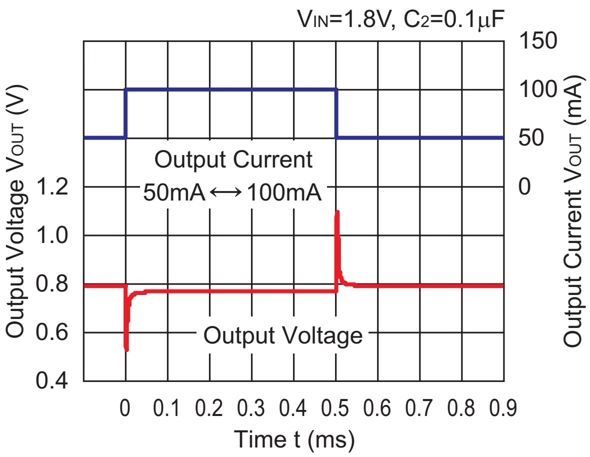


RP110x33xx

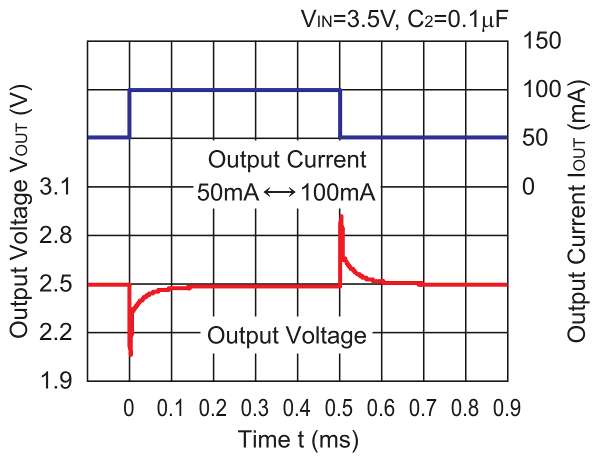


11) Load Transient Response (C1=none, tr=tf=5μs, Topt=25°C)

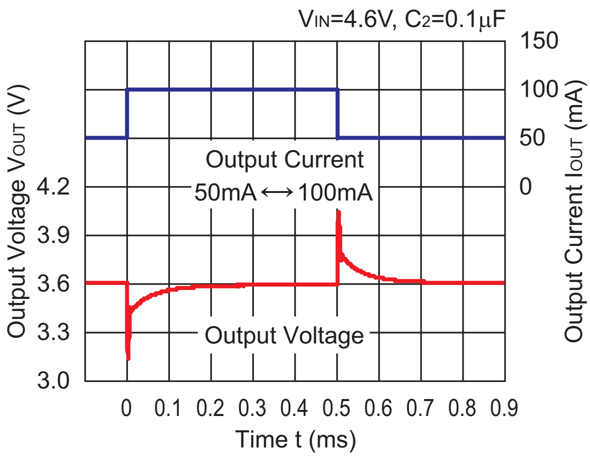
RP110x08xx



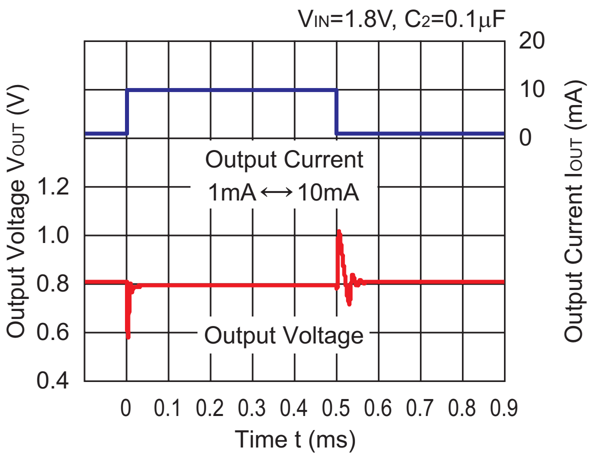
RP110x25xx



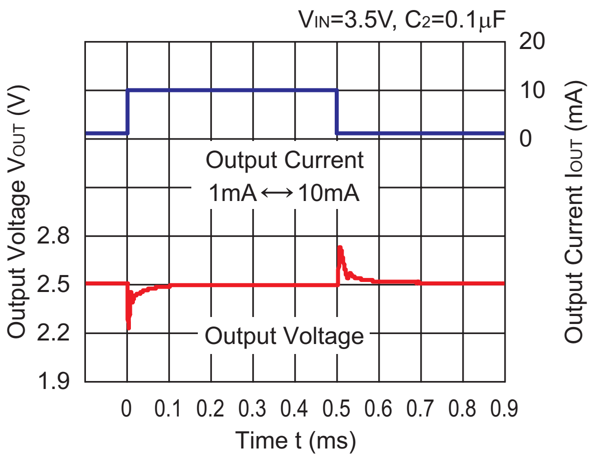
RP110x36xx



RP110x08xx



RP110x25xx



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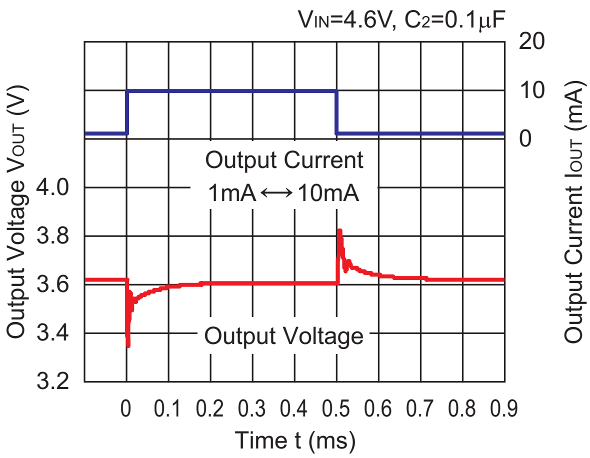

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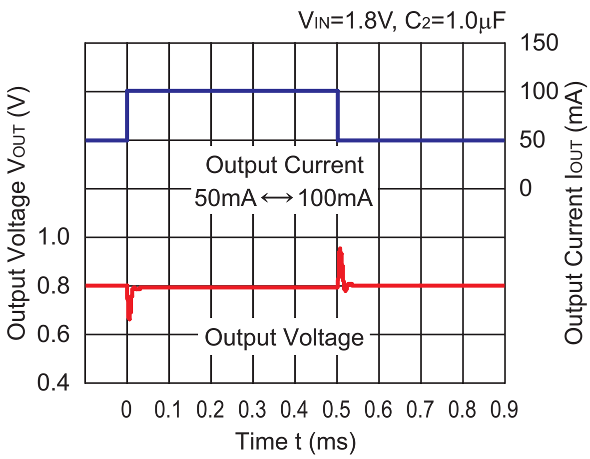
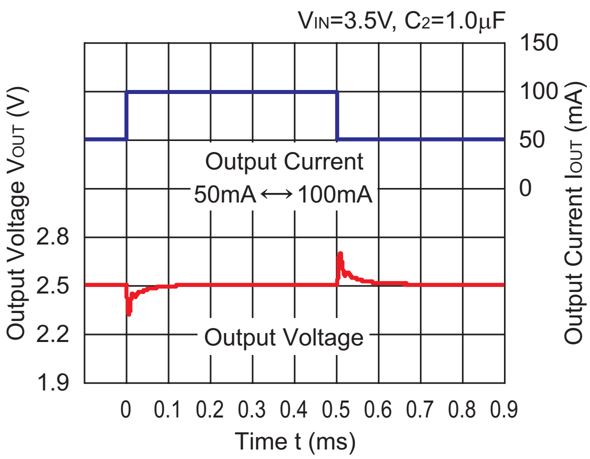


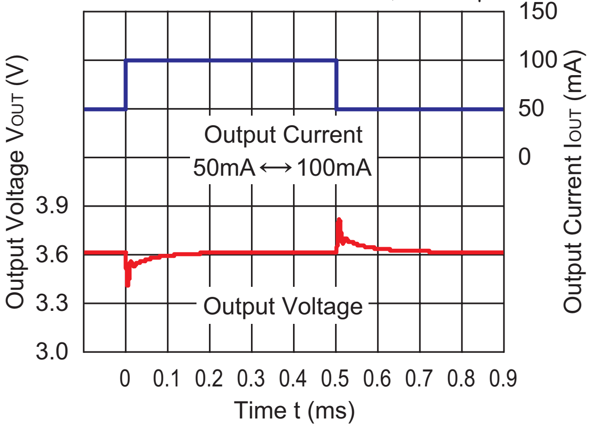
RP110x25xx



RICOH

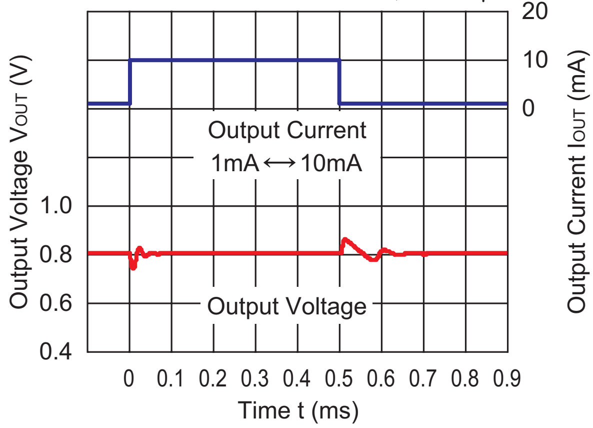
RP110x36xx

V_{IN}=4.6V, C_2=1.0µF



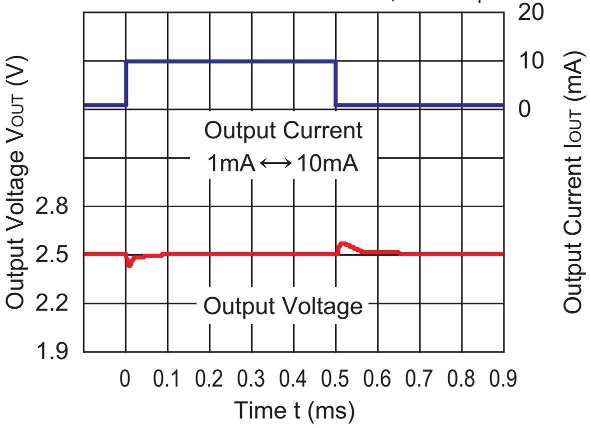
RP110x08xx

V_{IN}=1.8V, C_2=1.0µF



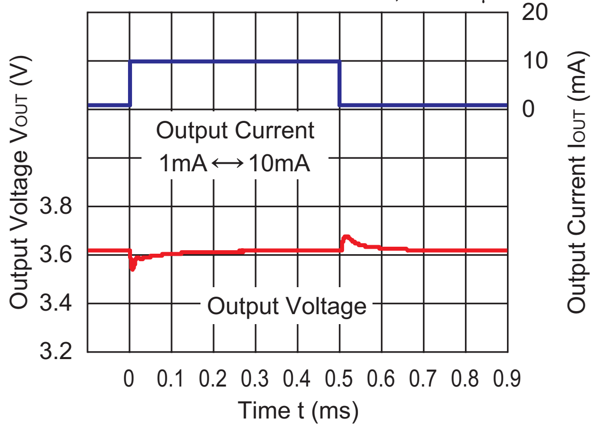
RP110x25xx

V_{IN}=3.5V, C_2=1.0µF



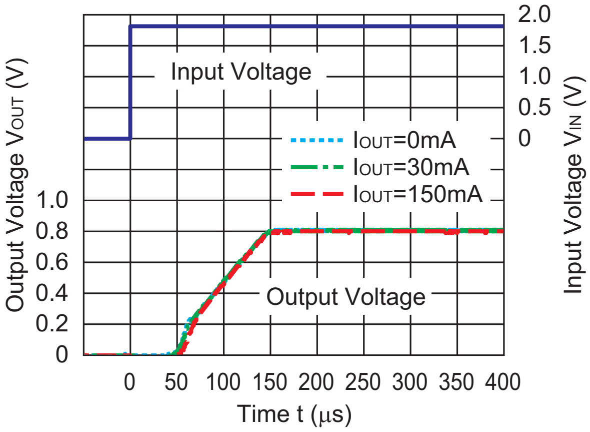
RP110x36xx

V_{IN}=4.6V, C_2=1.0µF



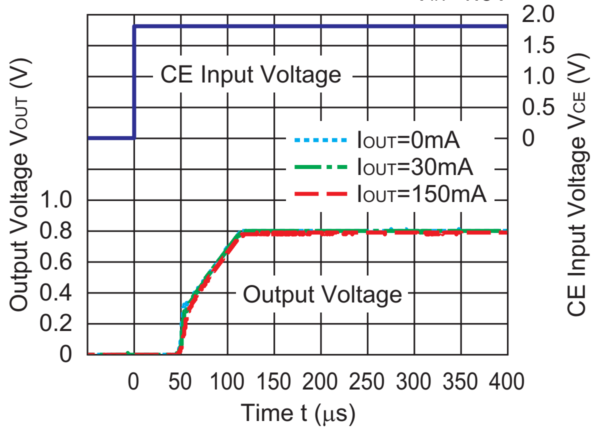
12) Turn On Speed (C1=Ceramic 0.1µF, C2=Ceramic 0.1µF, Topt=25°C)

RP110x08xC

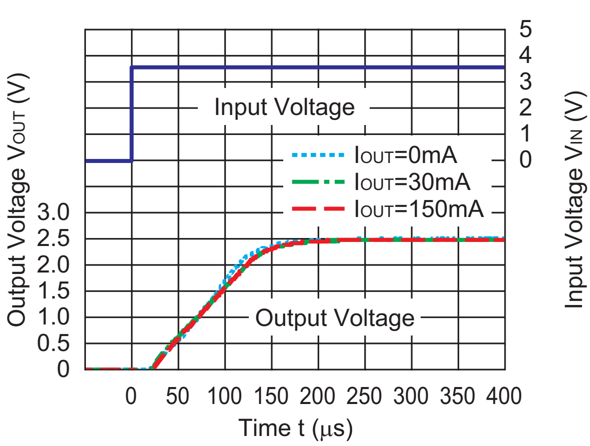


RP110x08xB/D

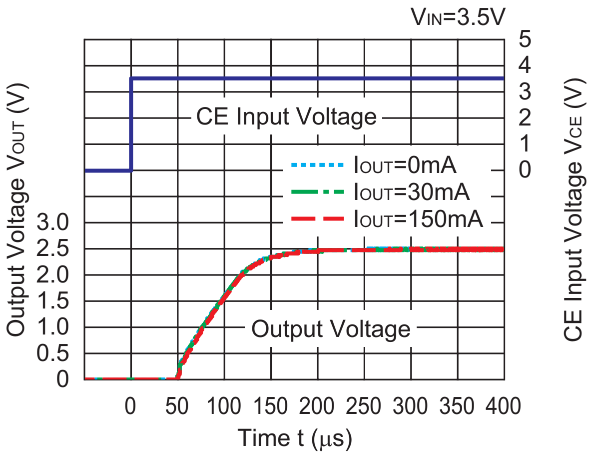
V_{IN}=1.8V



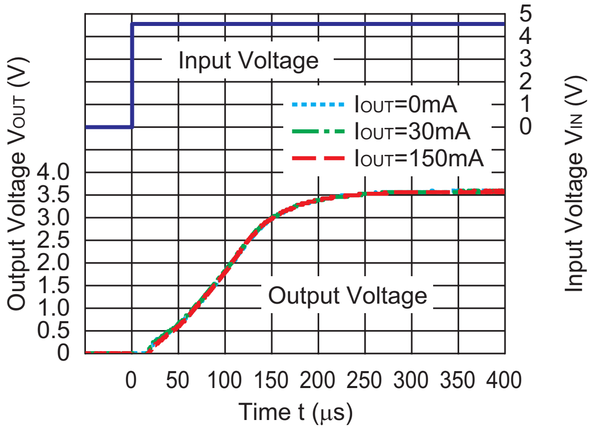
RP110x25xC



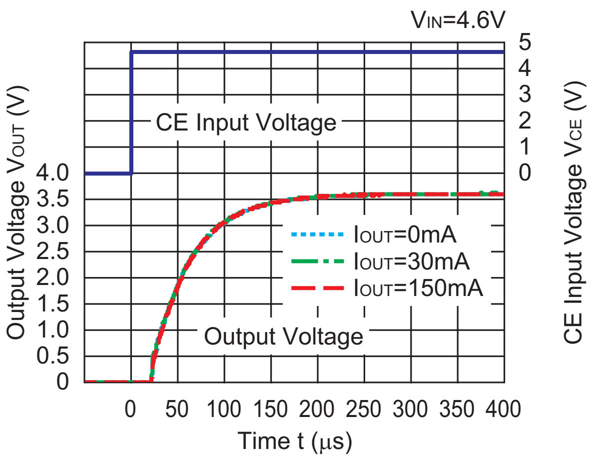
RP110x25xB/D



RP110x36xC

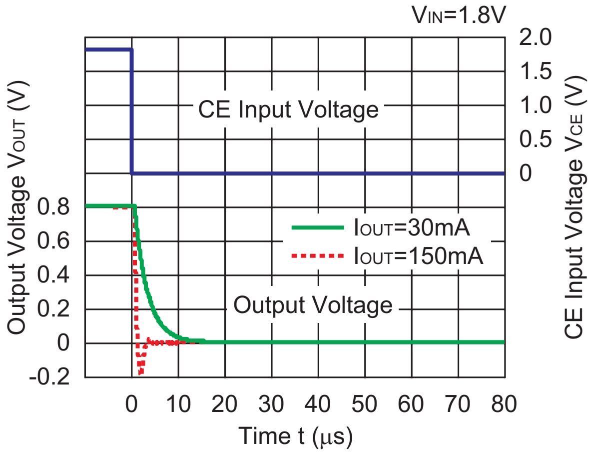


RP110x36xB/D

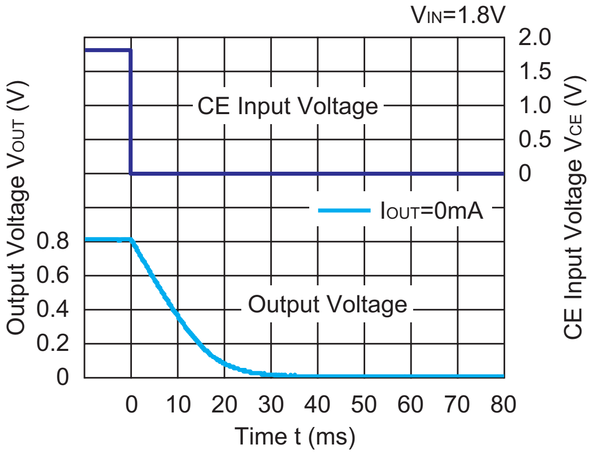


13) Turn Off Speed with CE pin (C1=Ceramic 0.1μF, C2=Ceramic 0.1μF, Topt=25°C)

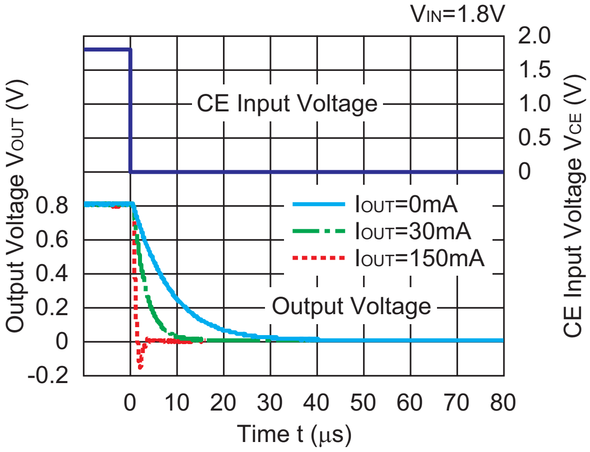
RP110x08xB



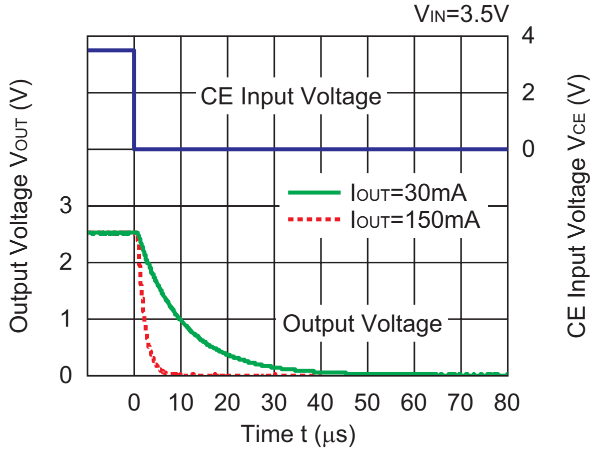
RP110x08xB



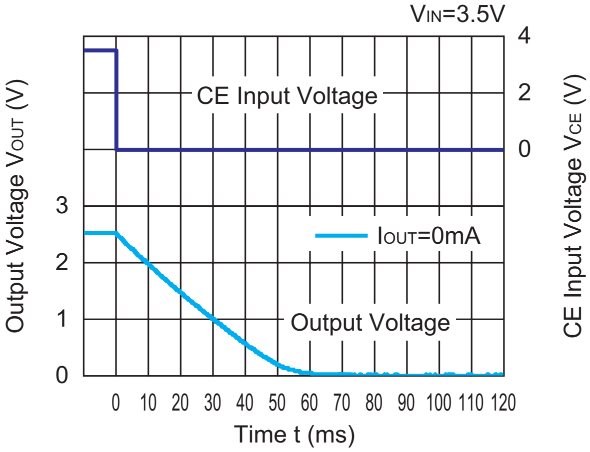
RP110x08xD



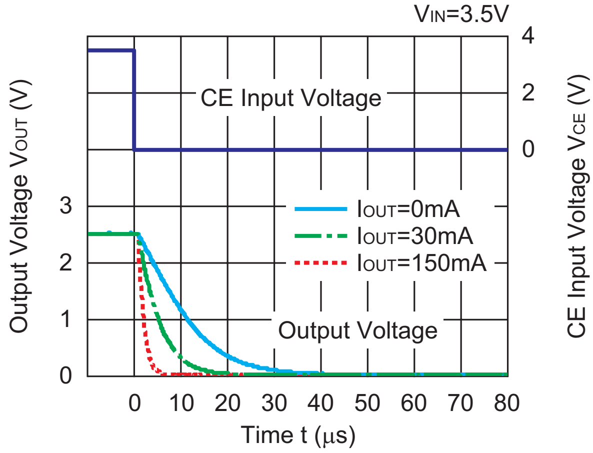
RP110x25xB



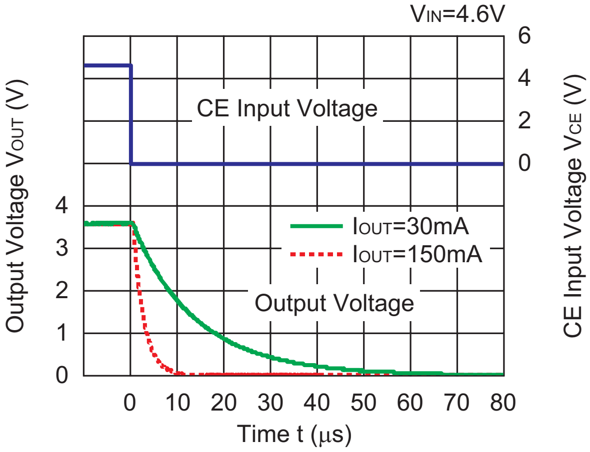
RP110x25xB



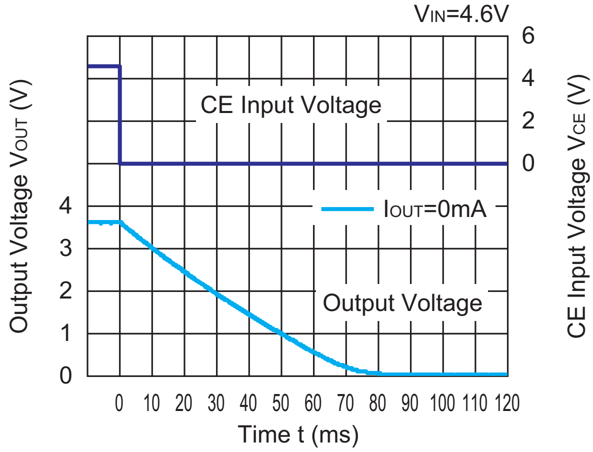
RP110x25xD

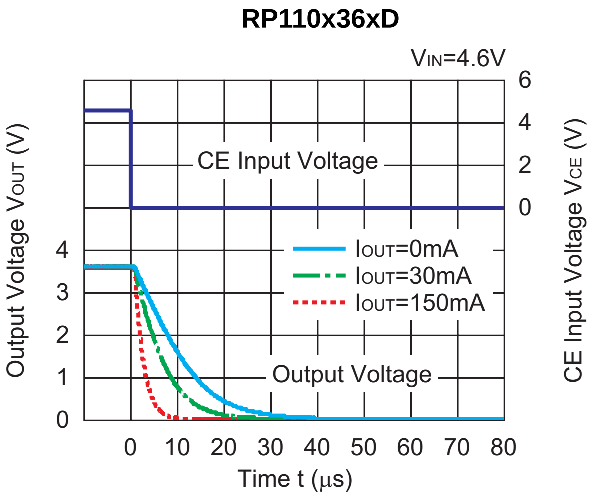


RP110x36xB

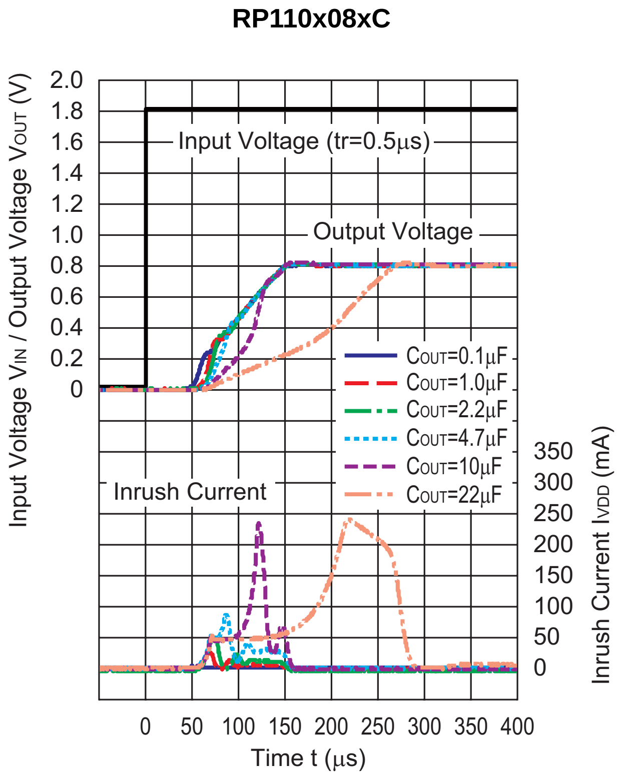


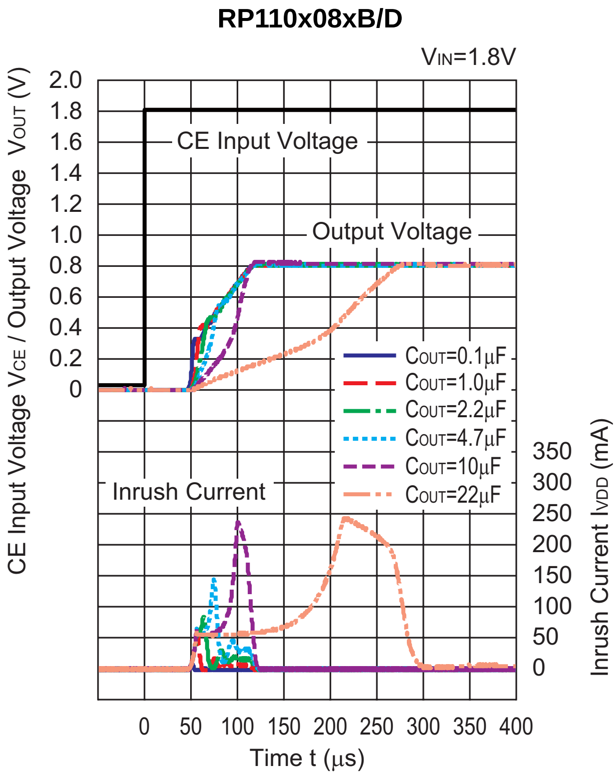
RP110x36xB



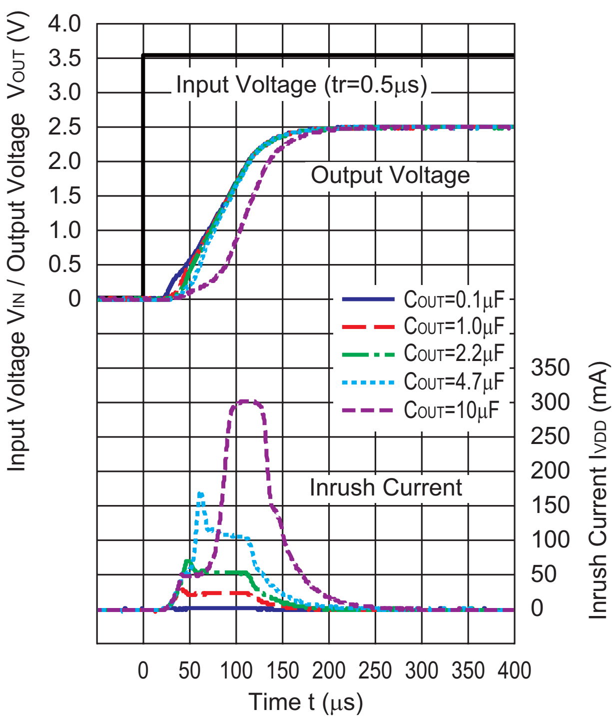


14) Inrush Current (C1=none, I_{OUT}=0mA, Topt=25°C)

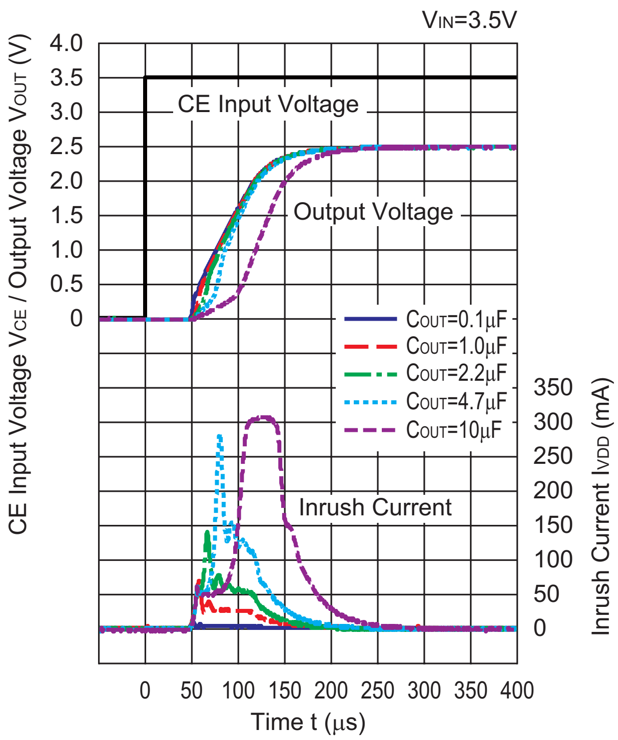




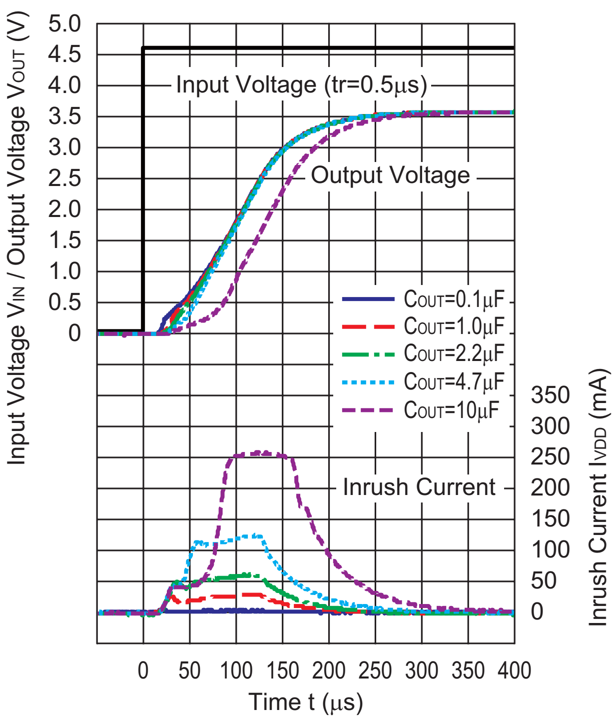
RP110x25xC



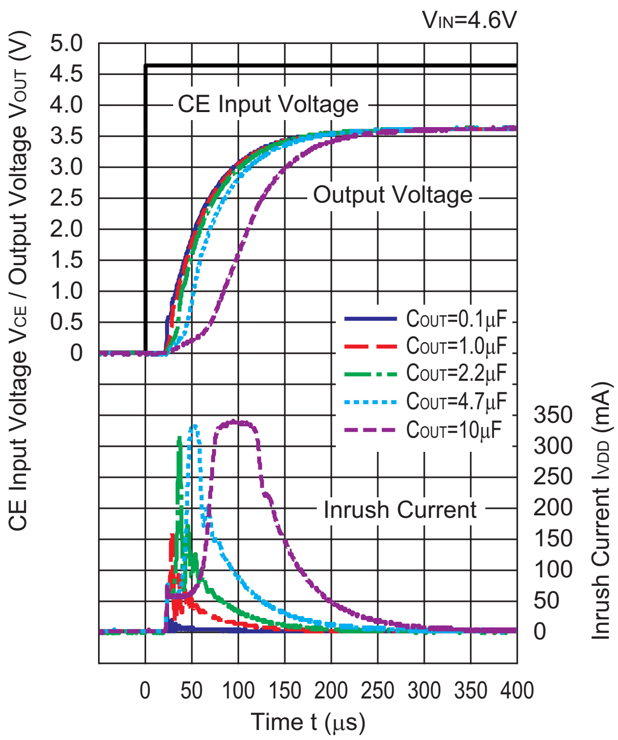
RP110x25xB/D



RP110x36xC



RP110x36xB/D



ESR vs. Output Current

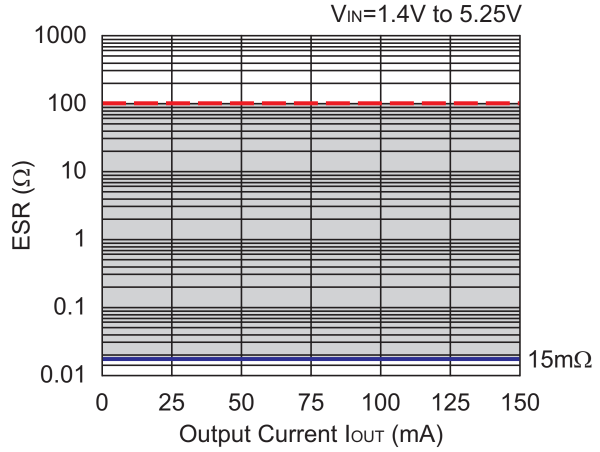
When using these ICs, consider the following points:

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.

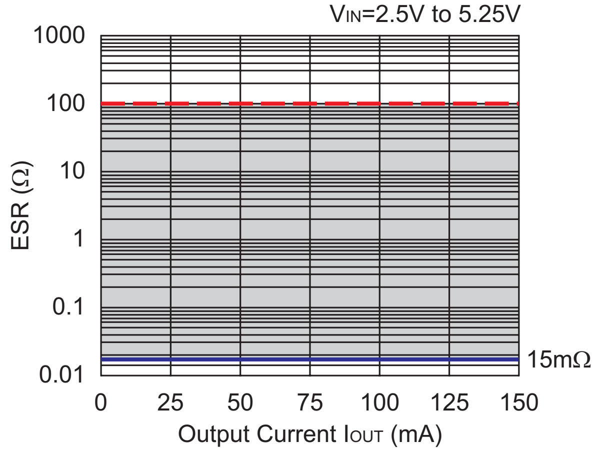
Measurement conditions

Frequency Band : 10Hz to 2MHz
Temperature : –40°C to 85°C
Hatched Area : Noise level is under 40μV(Avg.)
C_{IN},C_{OUT} : 0.1μF

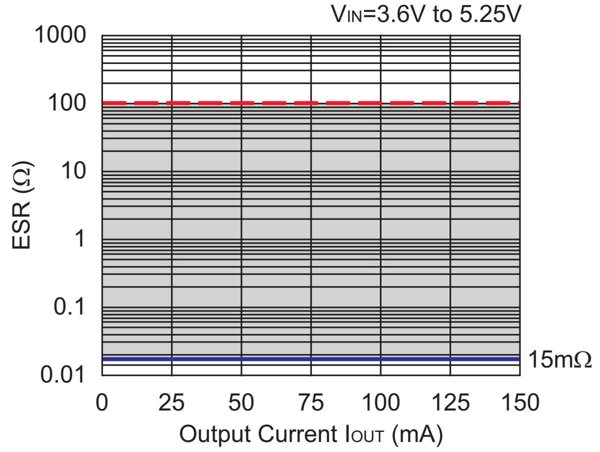
RP110x08xx



RP110x25xx



RP110x36xx



RICOH COMPANY., LTD. Electronic Devices Company

■Ricoh presented with the Japan Management Quality Award for 1999.
Ricoh continually strives to promote customer satisfaction, and shares the achievements of its management quality improvement program with people and society.

日本経営品質賞 1999年度受賞

■Ricoh awarded ISO 14001 certification.
The Ricoh Group was awarded ISO 14001 certification, which is an international standard for environmental management systems, at both its domestic and overseas production facilities. Our current aim is to obtain ISO 14001 certification for all of our business offices.

RoHS Compliant

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.

http://www.ricoh.com/LSI/

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