Good Transient Response Low Voltage 500mA LDO

NO.EA-241-111228

OUTLINE

The RP111x Series are CMOS-based LDO regulators featuring 500mA output current. The input voltage is as low as 1.4V and the output voltage can be set from 0.7V. Due to a built-in 0.46Ω (at V_{OUT}=2.8V) on-resistor, RP111x can provide a low dropout voltage. RP111x also features an excellent line transient response, ripple rejection at 75dB, and low noise. The output voltage accuracy is as high as ±0.8% and the temperature drift coefficient of output voltage is low at ±30ppm/℃. The accuracy of the output voltage of RP111x includes the temperature characteristics and the load transient response has been improved. The typ. and max value of under/overshoot for various output current are shown in the typical characteristics in the datasheet, therefore the accuracy of the output voltage estimation will be easy on the actual operating cases.

In addition to a fold-back protection circuit built into conventional regulators, RP111x contains a thermal shutdown circuit and an inrush current limit circuit. SOT-23-5 and SOT-89-5 packages, a 1.2mm square DFN1212-6 package are available.

FEATURES

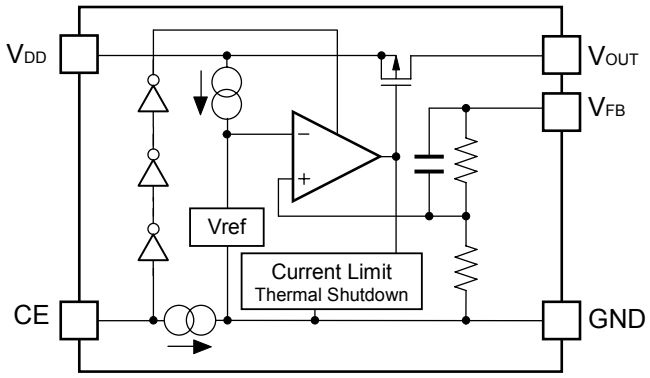
- Supply Current ..... Typ. 80μA
- Standby Current ..... Typ. 0.1μA
- Dropout Voltage ..... Typ. 0.23V (I_{OUT}=500mA, V_{OUT}=2.5V)
- Ripple Rejection ..... Typ. 75dB (f=1kHz)
  Typ. 70dB (f=10kHz)
- Output Voltage Accuracy ..... ±0.8% (V_{OUT} ≥1.8V)
- Output Voltage Temperature Coefficient ..... Typ. ±30ppm/°C (V_{OUT} ≥1.8V)
- Line Regulation ..... Typ. 0.02%/V
- Packages DFN1212-6, SOT-23-5, SOT-89-5,
- Input Voltage Range ..... 1.4V to 5.25V
- Output Voltage Range ..... 0.7V to 3.6V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Built-in Foldback Protection Circuit ..... Typ. 50mA (Current at short mode)
- Thermal Shutdown Temperature ..... 165°C
- Inrush Current Limit ..... Typ.400mA (for 180μs after start-up)
- Ceramic capacitors are recommended to be used with this IC ..... 1.0μF or more

APPLICATIONS

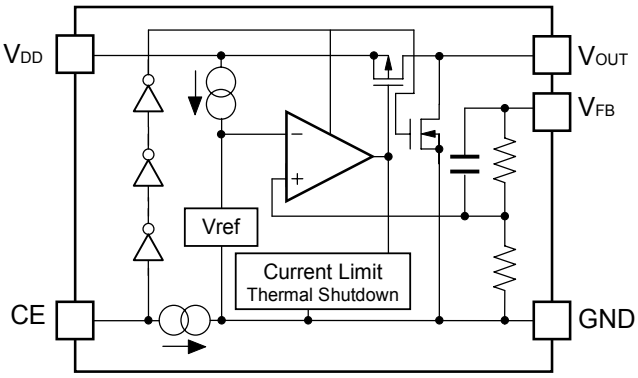
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipments.
- Power source for electrical home appliances.

BLOCK DIAGRAMS

RP111xxx1B



RP111xxx1D



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
RP111Lxx1∗-TR	DFN1212-6	5,000 pcs	Yes	Yes
RP111Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
RP111Hxx1∗-T1-FE	SOT-89-5	1,000 pcs	Yes	Yes

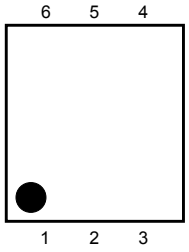
xxx: The output voltage can be designated in the range of 0.7V(07)to 3.6V(36)in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

∗ : Auto discharge function at off state are options as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state

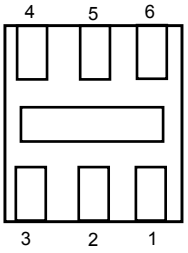
PIN CONFIGURATIONS

DFN1212-6

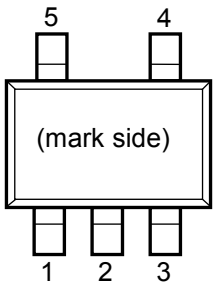
Top View



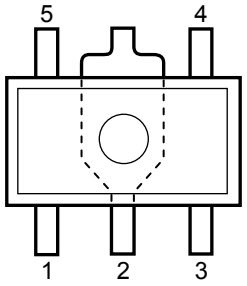
Bottom View



SOT-23-5



SOT-89-5



PIN DESCRIPTIONS

- **DFN1212-6**

Pin No.	Symbol	Description
1	V_{OUT}	Output Pin
2	V_{FB}	Feed Back Pin
3	GND	Ground Pin
4	CE	Chip Enable Pin ("H" Active)
5	NC	No connection
6	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.

- **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	V_{FB}	Feed Back Pin
5	V_{OUT}	Output Pin

- **SOT-89-5**

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

Under normal conditions, please connect the V_{OUT} pin to the V_{FB} pin. However, in the case of using the Adjustable Output Voltage Type, please follow the " Notes on the Adjustable Output Voltage Type Settings".

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.0	V
V_{CE}	Input Voltage (CE Pin)	-0.3～6.0	V
V_{OUT}	Output Voltage	–0.3 to V_{IN}–0.3	V
I_{OUT}	Output Current	510	mA
P_D	Power Dissipation (DFN1212-6)*	600	mW
	Power Dissipation (SOT-23-5) *	420	
	Power Dissipation (SOT-89-5)*	900	
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

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}=1.0µF.
☐ values indicate −40°C ≤ Topt ≤ 85°C, unless otherwise noted.

- **RP111xxx1B/D**

Topt=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Topt=25°C	$V_{OUT} \geq$ 1.8V	×0.992		×1.008	V
			V_{OUT} < 1.8V	−18		+18	mV
		-40°C ≤ Topt ≤ 85°C	$V_{OUT} \geq$ 1.8V	☐×0.985		☐×1.015	V
			V_{OUT} < 1.8V	☐−55		☐50	mV
I_{OUT}	Output Current			☐500			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	1mA ≤ I_{OUT} ≤ 500mA			1	☐20	mV
V_{TRLD}	Load Transient Response	I_{OUT} :1mA⇔250mA (tr=tf=0.5µs)	C_{OUT}=1µF		−75 +45		mV
			C_{OUT}=2.2µF		−55 +35		
		I_{OUT} 1mA⇔250mA (tr=tf=5.0µs)	C_{OUT}=1µF		−20 +15		
V_{DIF}	Dropout Voltage	Please refer to “Dropout Voltage”.					
I_{SS}	Supply Current	I_{OUT}=0mA			80	☐125	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
V_{TRLN}	Input Transient Response	V_{IN} : Set V_{OUT}+0.5V⇔ Set V_{OUT}+1.5V(tr=tf=5.0µs), V_{IN} ≥ 1.4V,I_{OUT}=30mA			−1.5 +1.5		mV
RR	Ripple Rejection	f=1kHz,Ripple0.2Vp-p, V_{IN}=Set V_{OUT}+1.0V,I_{OUT}=30mA ($V_{OUT} \leq$ 2.0V, V_{IN}=3.0V)			75		dB
V_{IN}	Input Voltage*			☐1.4		☐5.25	V
$\Delta V_{OUT}/\Delta$Topt	Output Voltage Temperature Coefficient	40°C ≤ Topt ≤ 85°C	$V_{OUT} \geq$ 1.8V		±30		ppm /°C
			V_{OUT} < 1.8V		±100		
I_{SC}	Short Current Limit	V_{OUT}=0V			50		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
T_{TSD}	Thermal Shutdown Temperature	Junction Temperature			165		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			100		
en	Output Noise	BW=10Hz~100kHz	$V_{OUT} \geq$ 1.8V		20× V_{OUT}		µVrms
			V_{OUT} < 1.8V		40× V_{OUT}		

ELECTRICAL CHARACTERISTICS

Unless otherwise noted, V_{IN}=Set V_{OUT} +1.0V(V_{OUT} >1.5), V_{IN}=2.5V(V_{OUT} ≤ 1.5V), I_{OUT}=1mA, C_{IN}=C_{OUT}=1.0μF.
☐ values indicate −40°C ≤ Topt ≤ 85°C, unless otherwise noted.

- **RP111xxx1B/D**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
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, Load Transient Response, Input Transient Response, Output Noise and Ripple Rejection.
∗) When Input Voltage is 5.5V, the total operational time must be within 500hrs.

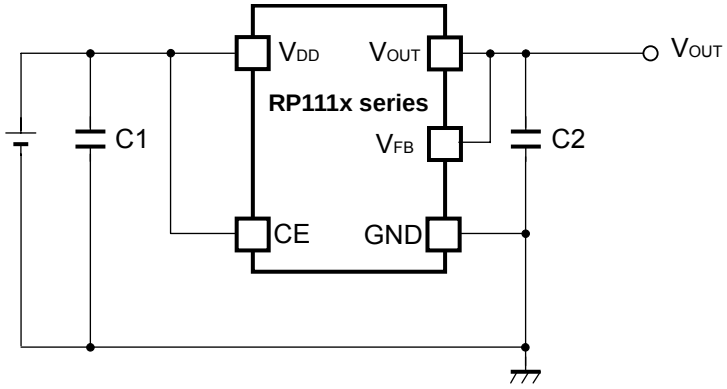
- **Dropout Voltage**

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
0.7 ≤ V_{OUT} < 0.8	I_{OUT}=500mA	0.58	0.88
0.8 ≤ V_{OUT} < 0.9		0.52	0.80
0.9 ≤ V_{OUT} < 1.0		0.45	0.70
1.0 ≤ V_{OUT} < 1.2		0.42	0.64
1.2 ≤ V_{OUT} < 1.4		0.35	0.53
1.4 ≤ V_{OUT} < 1.8		0.31	0.48
1.8 ≤ V_{OUT} < 2.1		0.27	0.41
2.1 ≤ V_{OUT} < 2.5		0.25	0.38
2.5 ≤ V_{OUT} < 3.0		0.23	0.34
3.0 ≤ V_{OUT} ≤ 3.6		0.22	0.32

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 1.0μF, Murata, GRM155B31A105KE15

Under normal conditions, please connect the V_{OUT} pin to the V_{FB} pin. However, in the case of using the Adjustable Output Voltage Type, please follow the " Notes on the Adjustable Output Voltage Type Settings".

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 1.0μF or more capacitor C2.

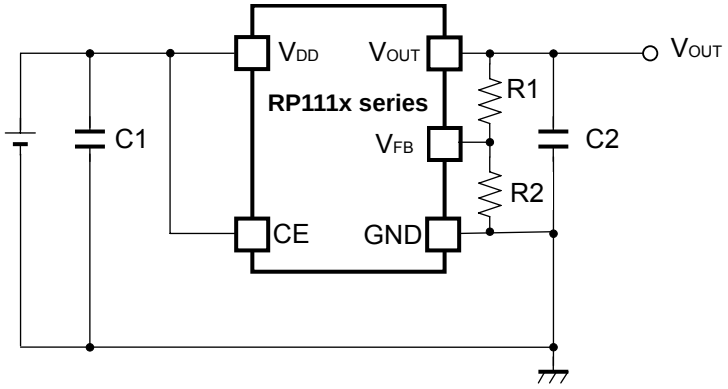
In case of using a tantalum capacitor, the output may be unstable due to inappropriate ESR. Therefore, the full range of operating conditions for the capacitor in the application should be considered.

PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 1.0μF 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.

TYPICAL APPLICATIONS for Adjustable Output Voltage Type



Please set 3.6V or less for the Adjustable Output Voltage Type. Also, please use 16kΩ or less for R2 resistor.

Phase Compensation

Similar to the Fixed Output Voltage Type, Phase compensation is made for the Adjustable Output Voltage Type for securing stable operation even if the load current is varied. For this purpose, use a 4.7μF or more capacitor C2 between V_{OUT} pin and GND pin, and as close as possible to the pins.

PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 1.0μF or more between V_{DD} and GND pin, and as close as possible to the pins.

Transient Response

When using the Adjustable Output Voltage Type, the transient response could be affected by the external resistors. Evaluate the circuit taking the actual conditions of use into account.

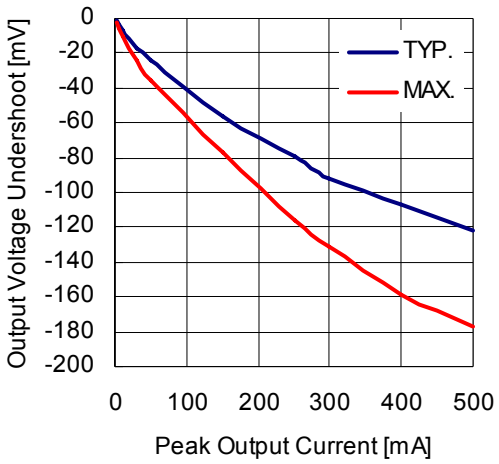
TRANSIENT RESPONSE

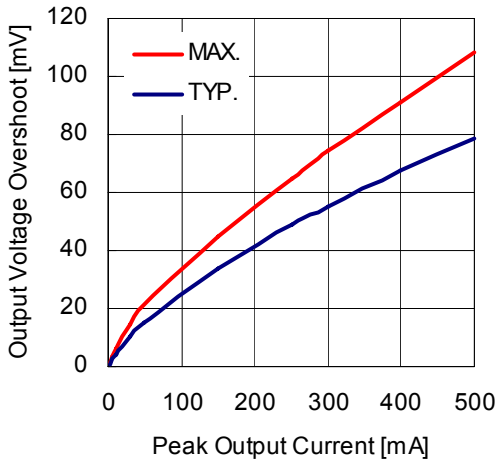
The RP111x Series have been improved in overall output voltage characteristics including temperature and transient response. The load transient response indicated under the Electrical Characteristics is guaranteed by design based on the condition when I_{OUT} changes from 1mA to 250mA or 250mA to1mA. The output voltage variations under the other load conditions, the characteristic examples are shown below.

RP111x151x

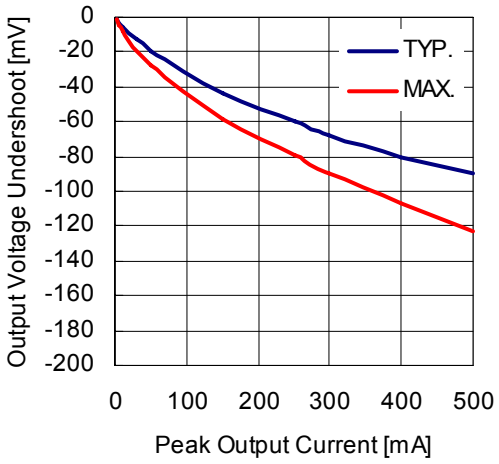
V_{IN}=2.5V, -40°C≦Topt≦85°C

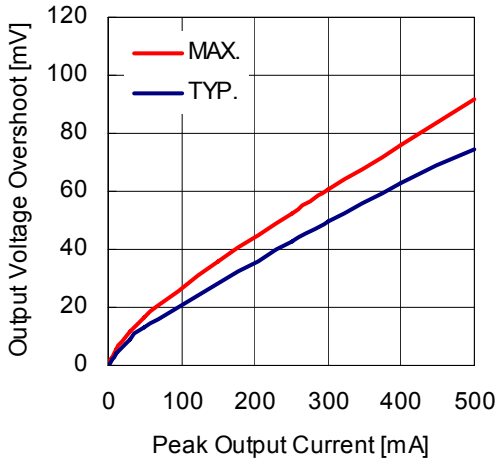
C_{IN}=1.0µF, C_{OUT}=1.0µF, I_{OUT}=1mA⇔500mA (tr=tf=0.5µs)



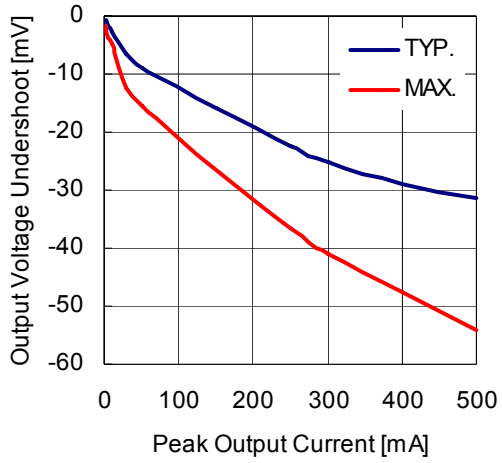


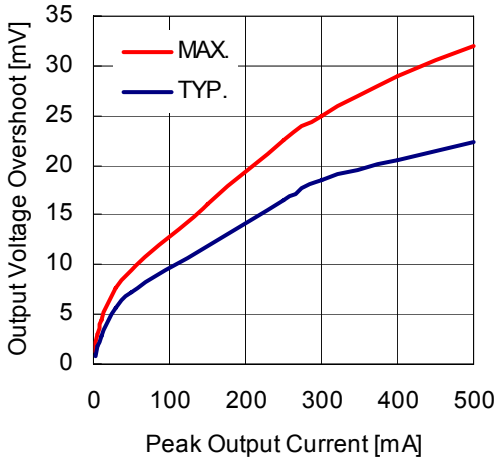
C_{IN}=1.0µF, C_{OUT}=2.2µF, I_{OUT}=1mA⇔500mA (tr=tf=0.5µs)





C_{IN}=1.0µF, C_{OUT}=1.0µF, I_{OUT}=1mA⇔500mA (tr=tf=5.0µs)

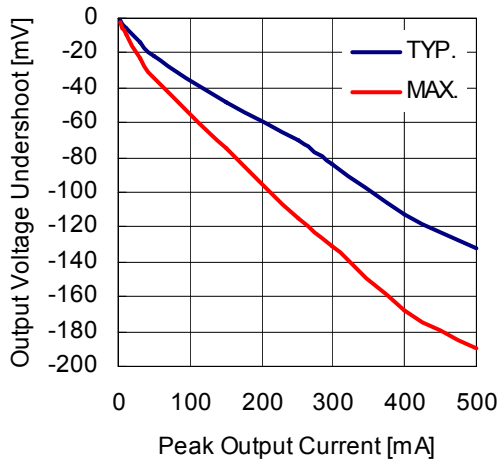


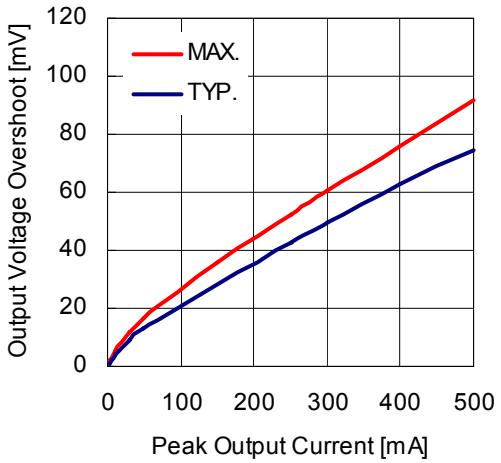


RP111x281x

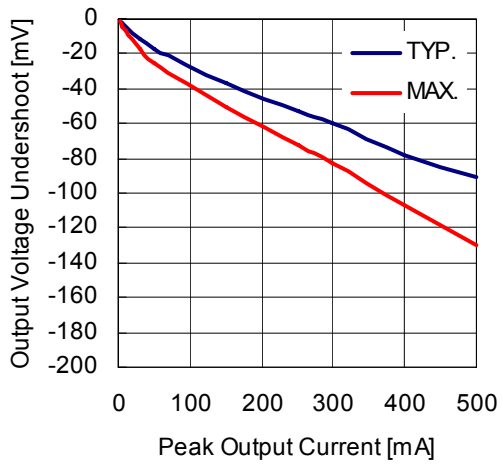
V_{IN}=3.8V, -40°C≦Topt≦85°C

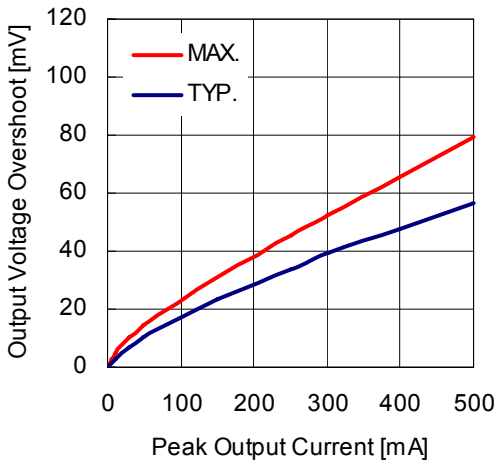
C_{IN}=1.0µF, C_{OUT}=1.0µF, I_{OUT}=1mA⇔500mA (tr=tf=0.5µs)



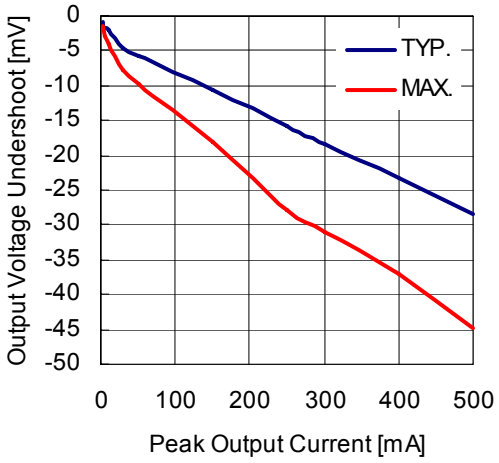


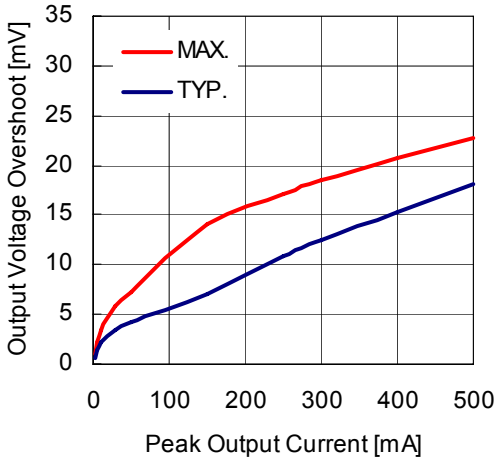
C_{IN}=1.0µF, C_{OUT}=2.2µF, I_{OUT}=1mA⇔500mA (tr=tf=0.5µs)





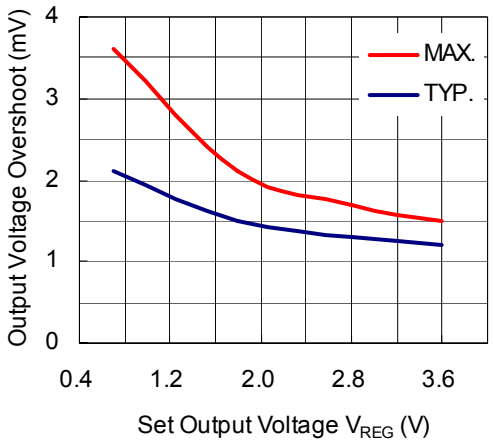
C_{IN}=1.0µF, C_{OUT}=1.0µF, I_{OUT}=1mA⇔500mA (tr=tf=5.0µs)

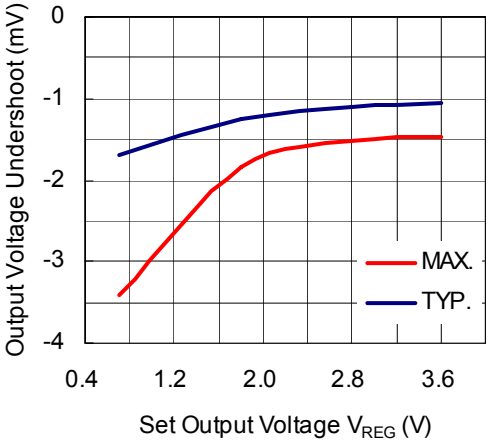




Input Transient Response has the output voltage dependency. Please refer to the characteristics examples below.

V_{IN}: Set V_{OUT}+0.5V⇔Set V_{OUT}+1.5V (tr=tf=5.0µs), V_{IN}≧1.4V,
C_{OUT}=1.0µF, I_{OUT}=30mA



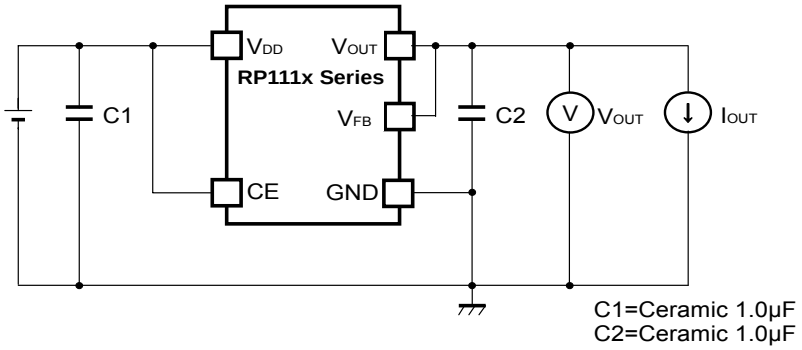


The graphs shown above are reference data.

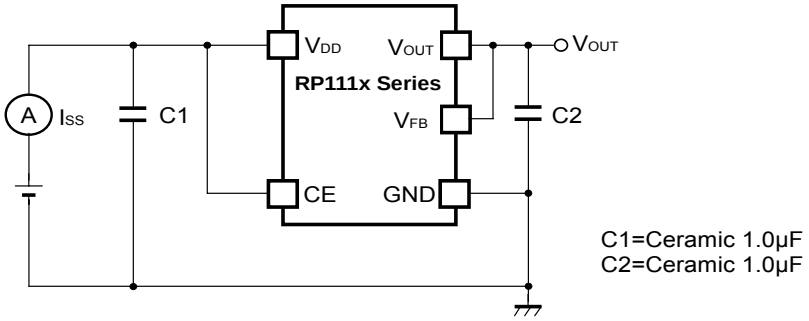
For the better transient response, a capacitor with higher capacitance is recommended and the wire impedance of GND and V_{OUT} should be minimized as possible .

The transient response characteristics depend on the external parts and PCB layout. Therefore, the operating conditions for the transient response in the application should be considered and evaluation is necessary.

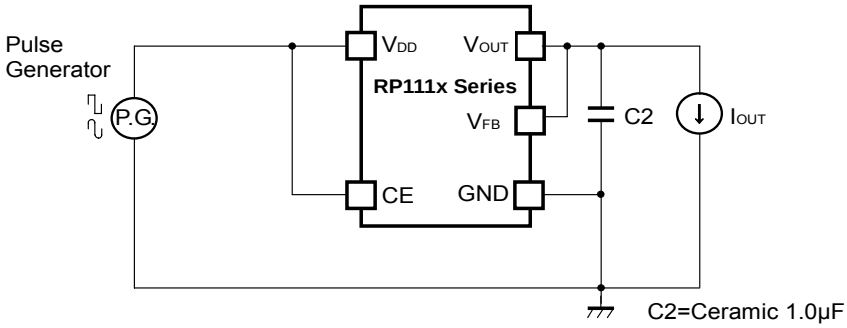
TEST CIRCUIT



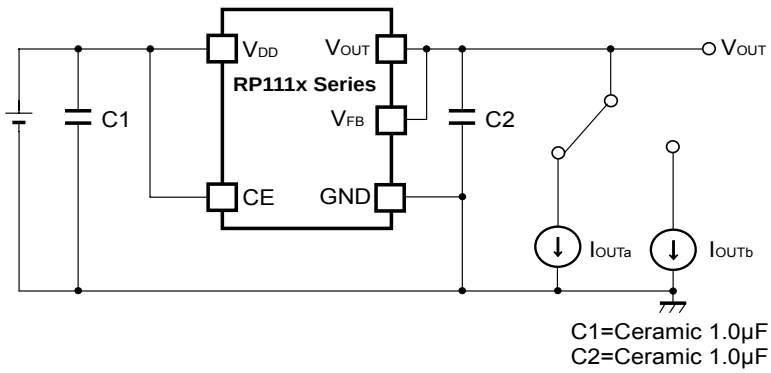
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection

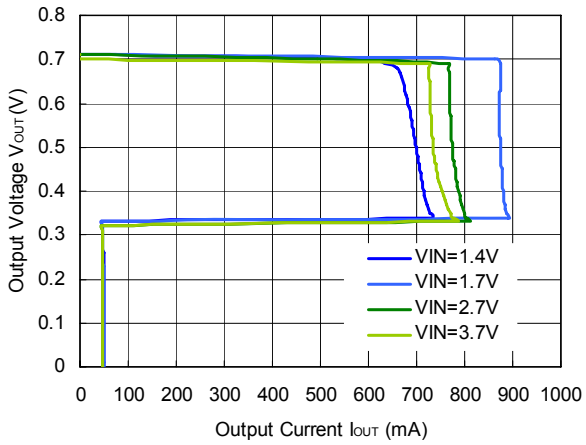


Test Circuit for Load Transient Response

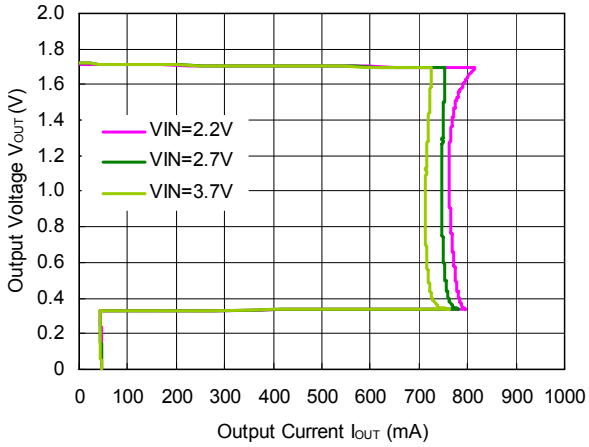
TYPICAL CHARACTERISTICS

1）Output Voltage vs. Output Current（C1=1.0μF, C2=Ceramic 1.0μF, Topt=25°C）

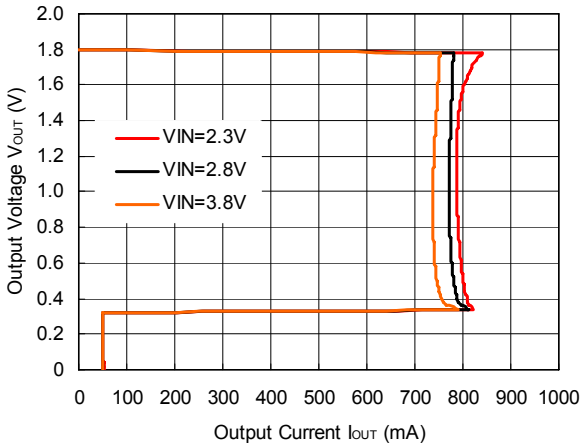
RP111x071x



RP111x171x



RP111x181x



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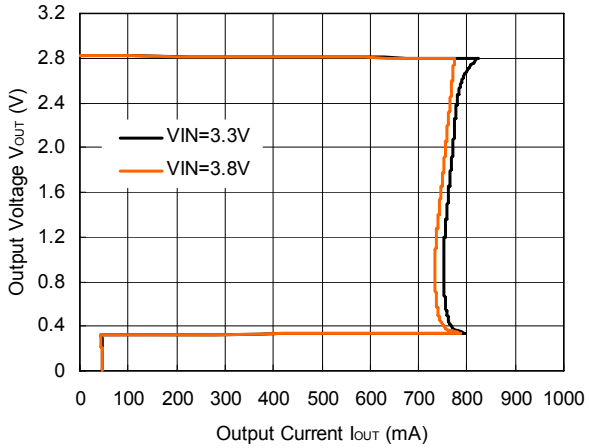

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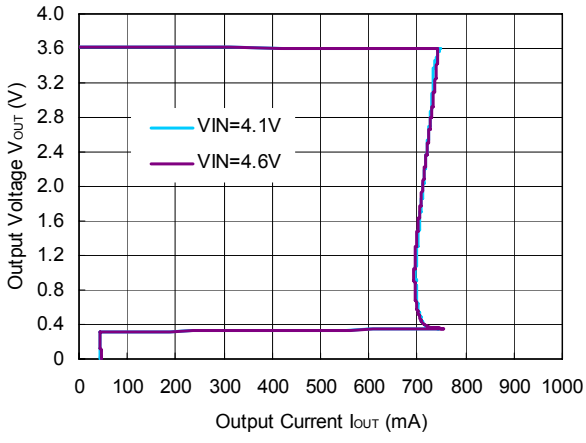
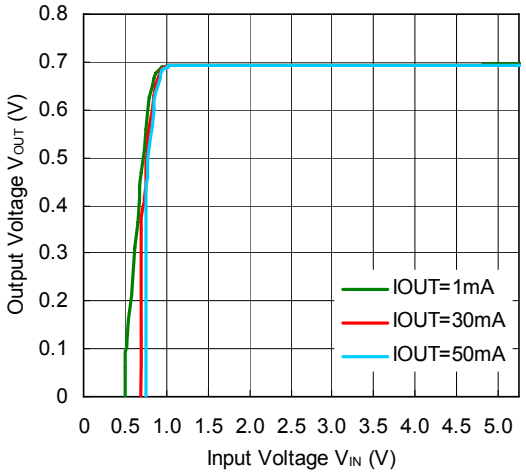


2）Output Voltage vs. Input Voltage（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, Topt=25°C）

RP111x071x



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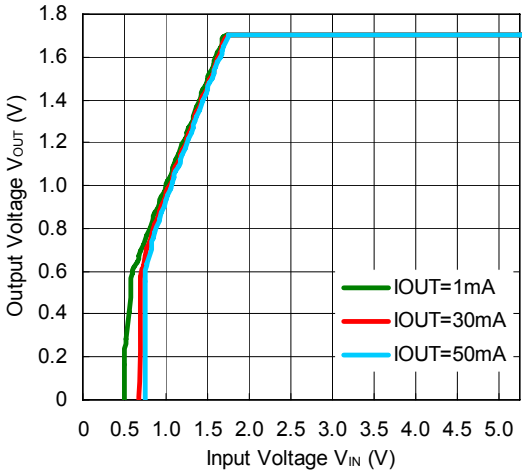

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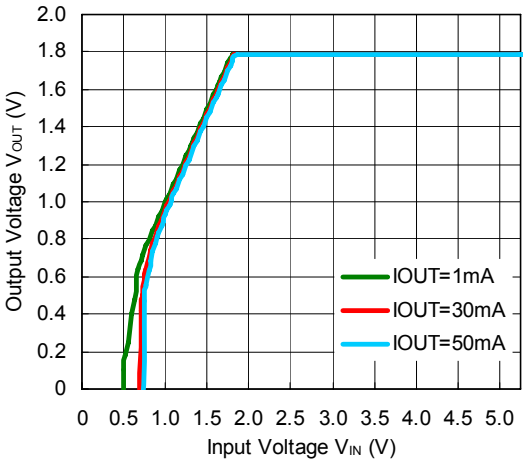

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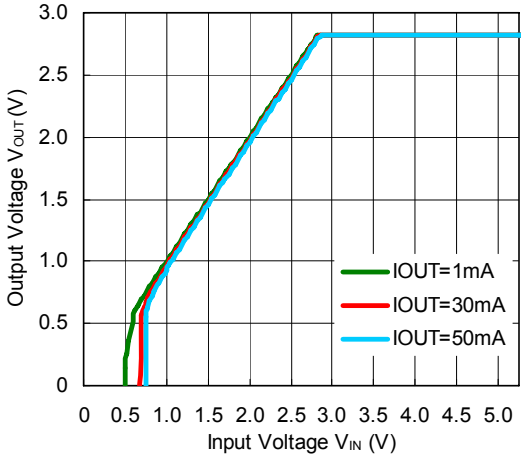

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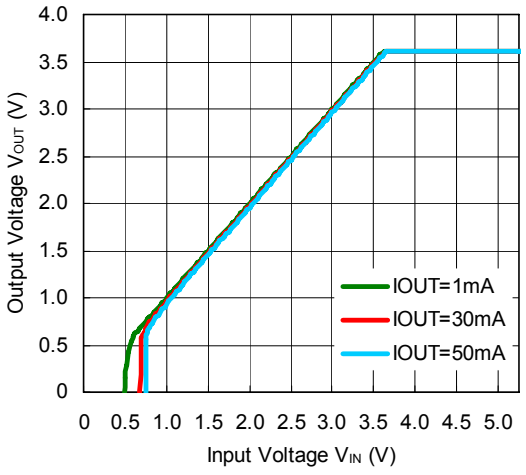
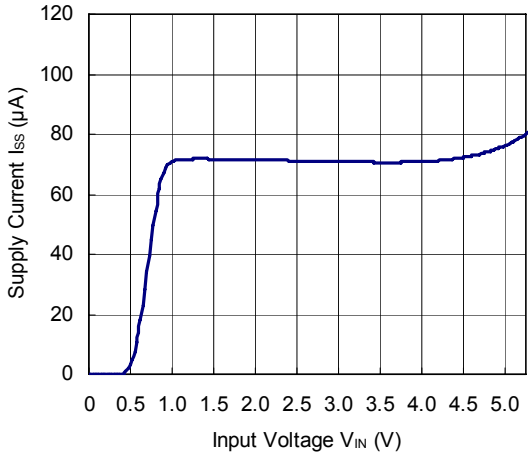


3）Supply Current vs. Input Voltage（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, Topt=25°C）

RP111x071x



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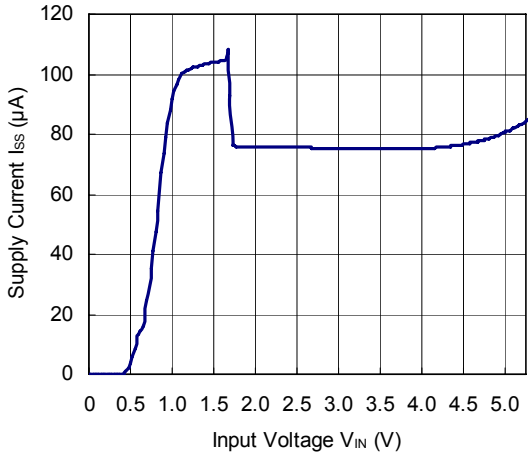

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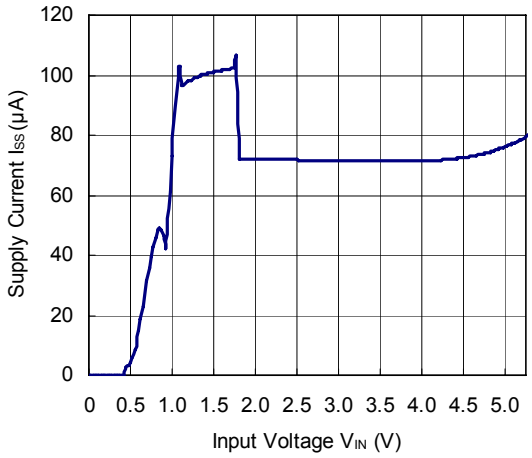

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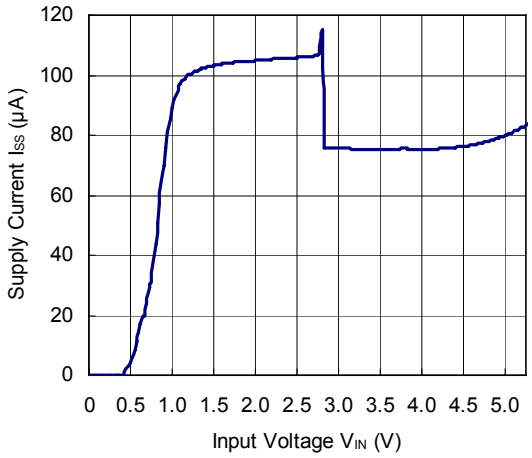

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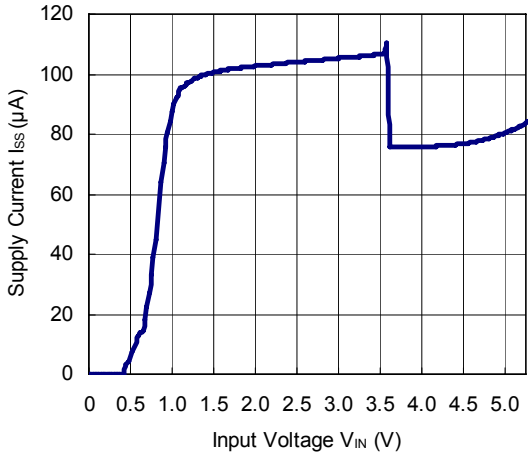
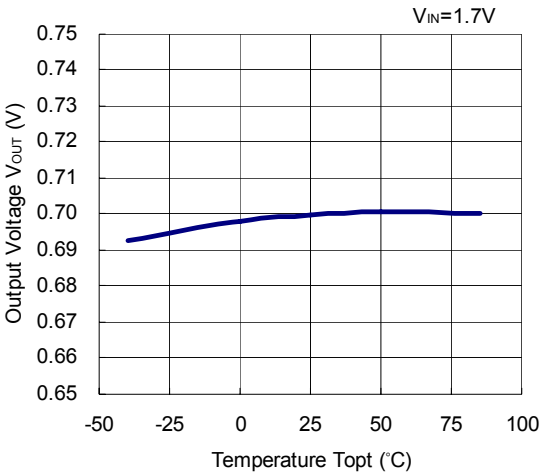


4）Output Voltage vs. Temperature（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, I_{OUT}=1mA）

RP111x071x



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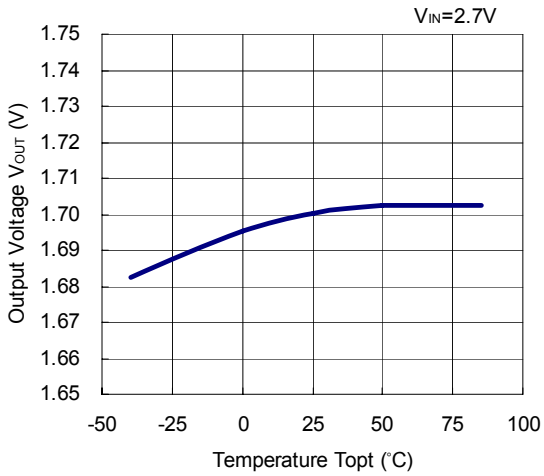

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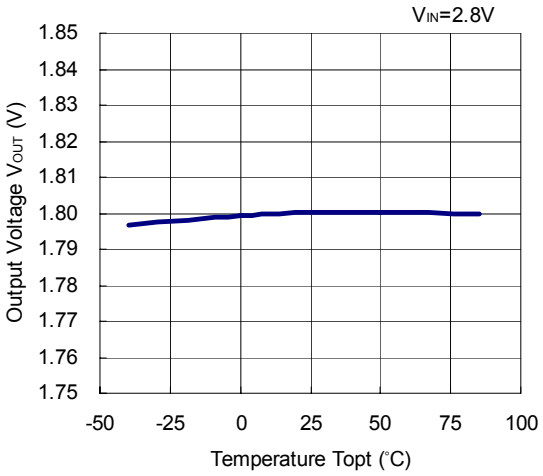

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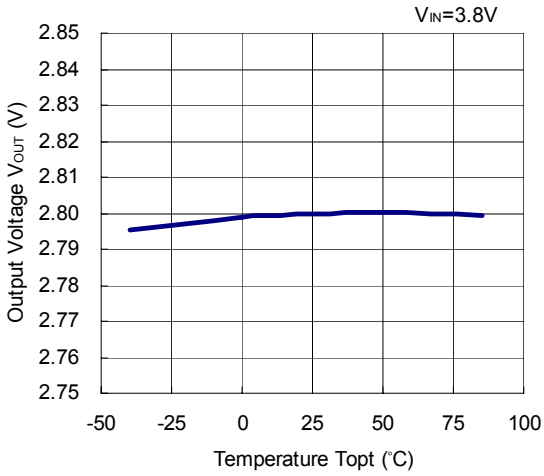

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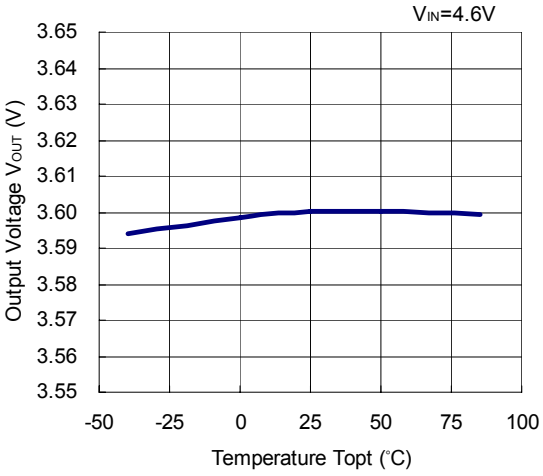
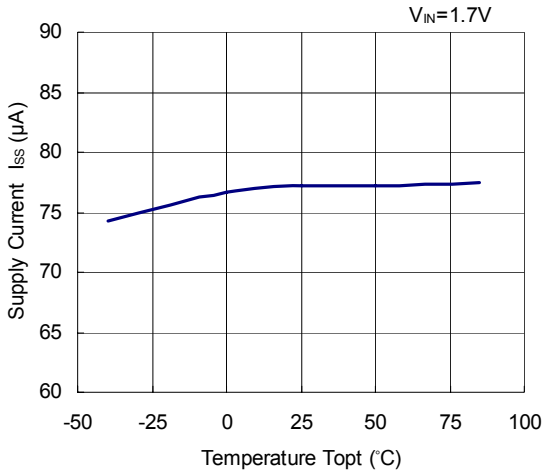


5）Supply Current vs. Temperature（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, I_{OUT}=0mA）

RP111x071x



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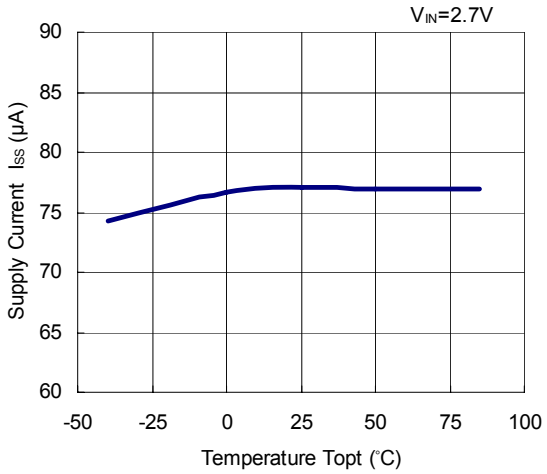

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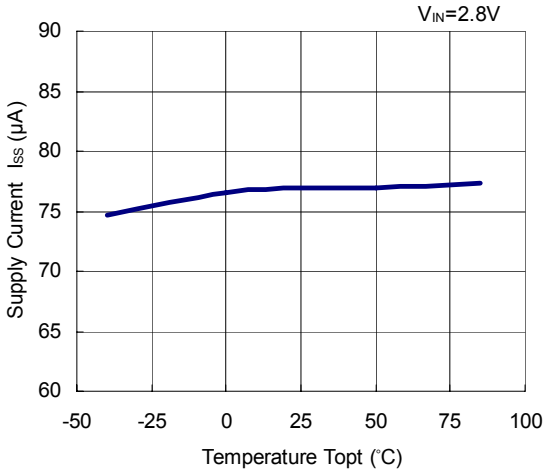

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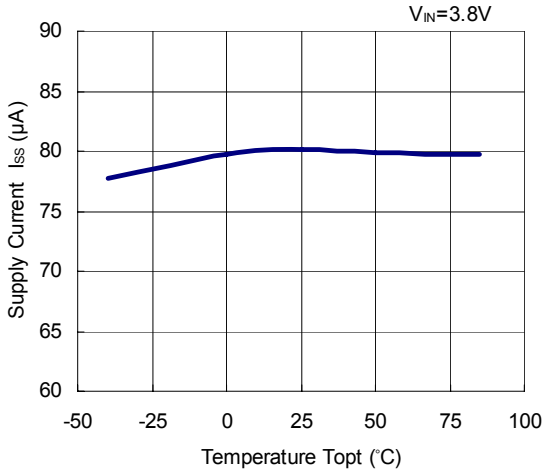

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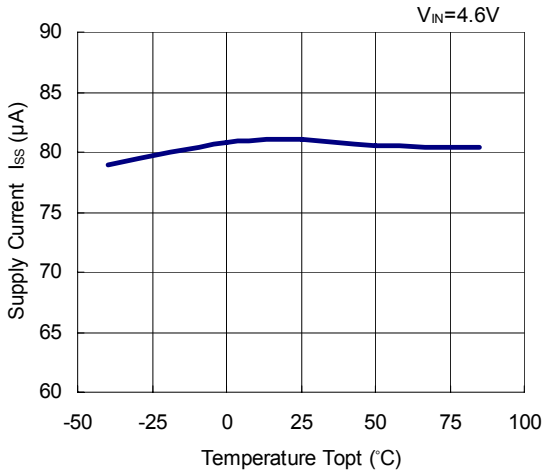
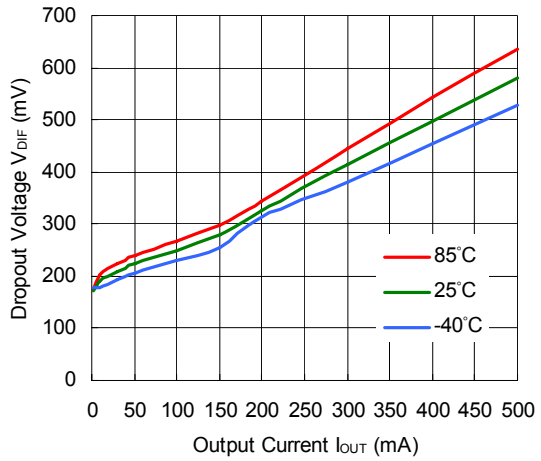
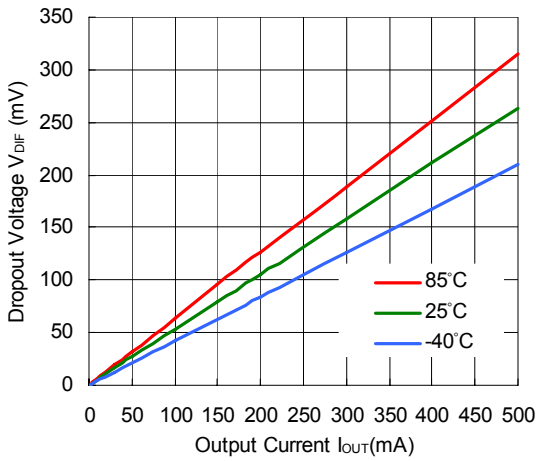


6）Dropout Voltage vs. Output Current（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF）

RP111x071x



RP111x171x



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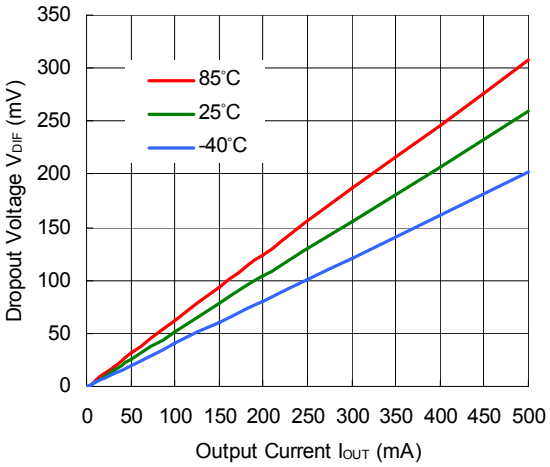

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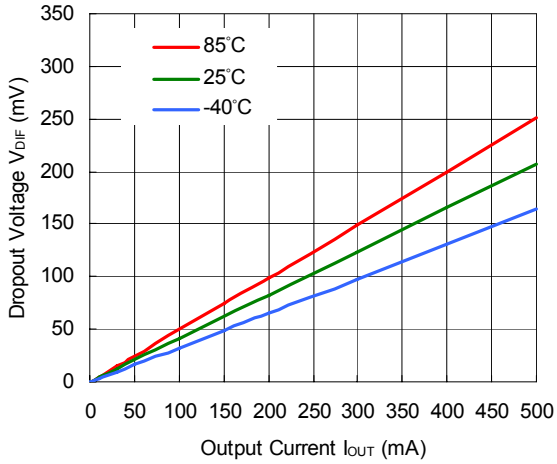

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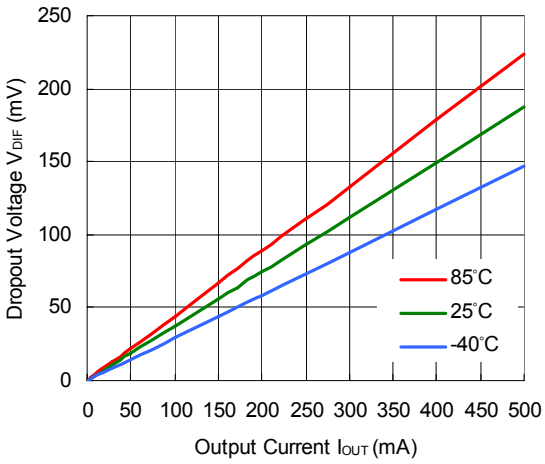
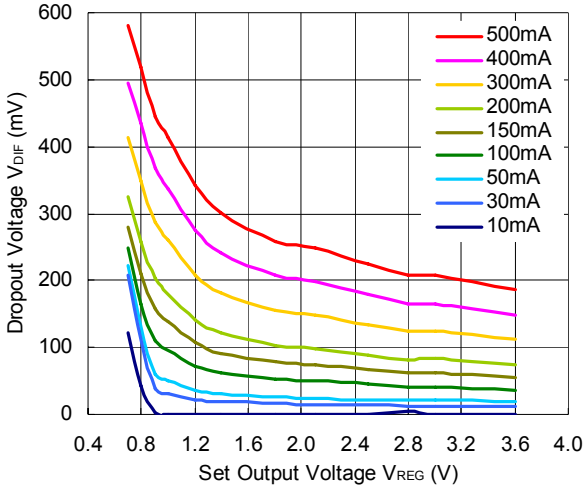
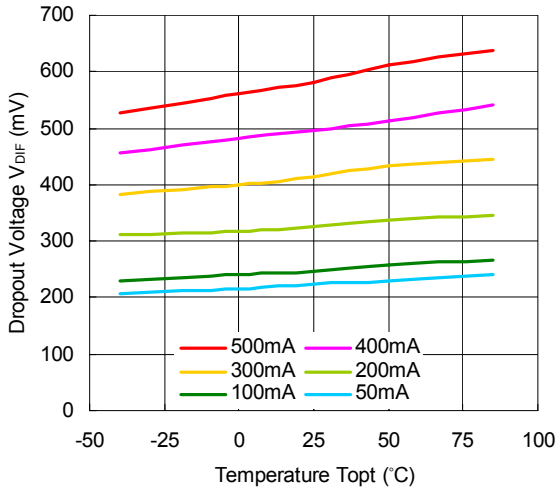


7）Dropout Voltage vs. Set Output Voltage（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, Topt=25°C）



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

RP111x071x



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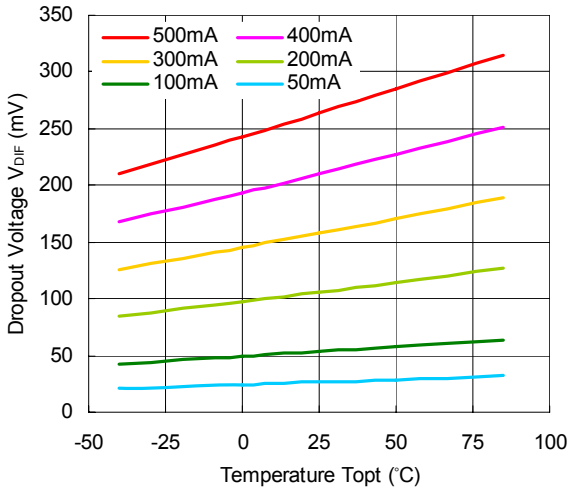

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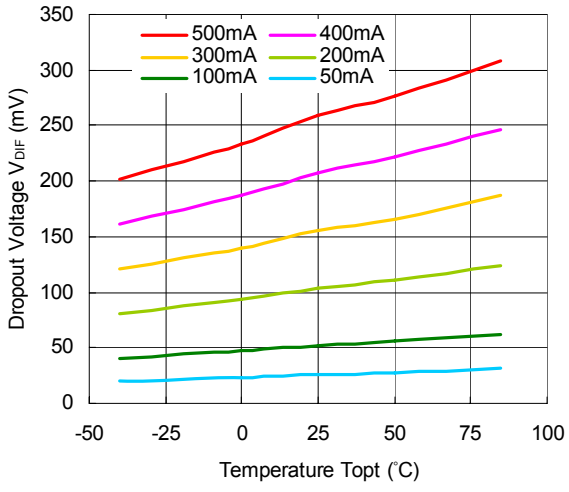

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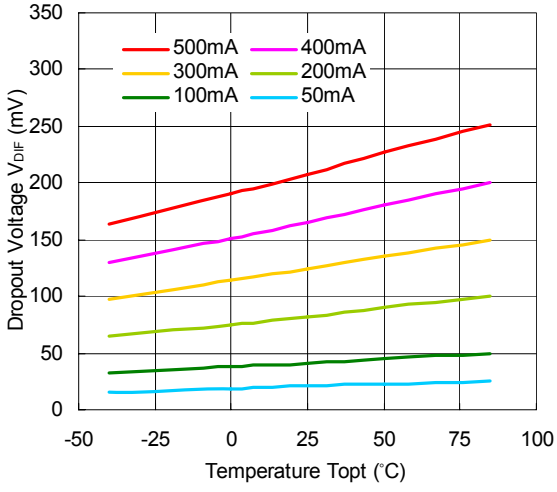

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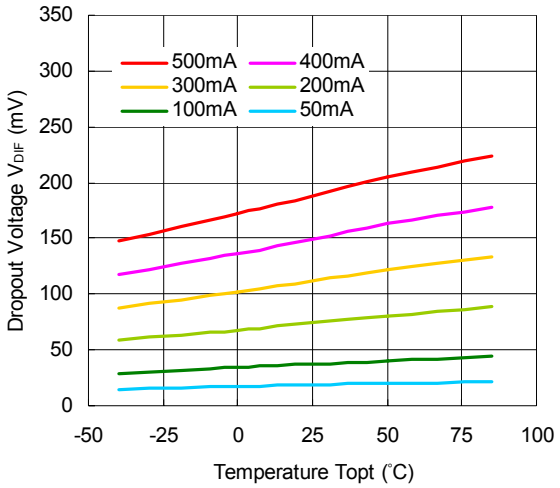
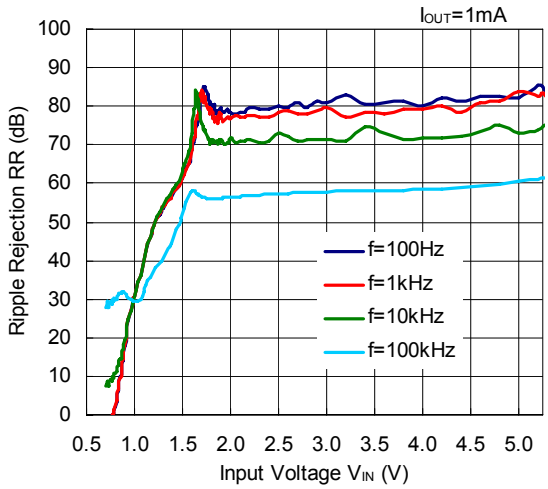


9）Ripple Rejection vs. Input Voltage（C1=none, C2=Ceramic 1.0μF, Ripple=0.2Vp-p, Topt=25°C）

RP111x071x



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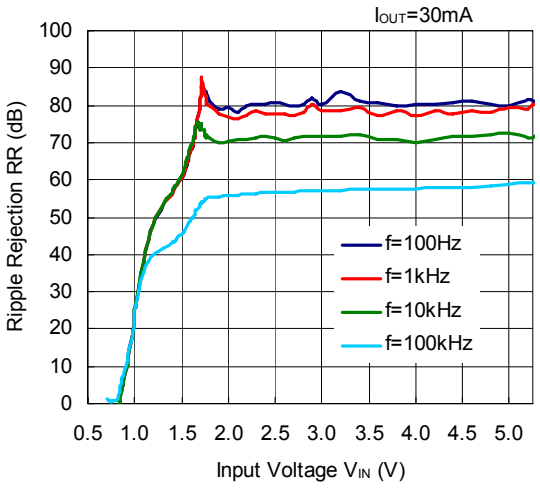

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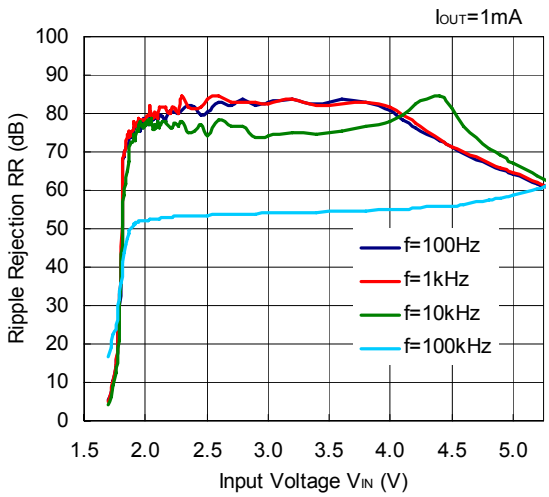

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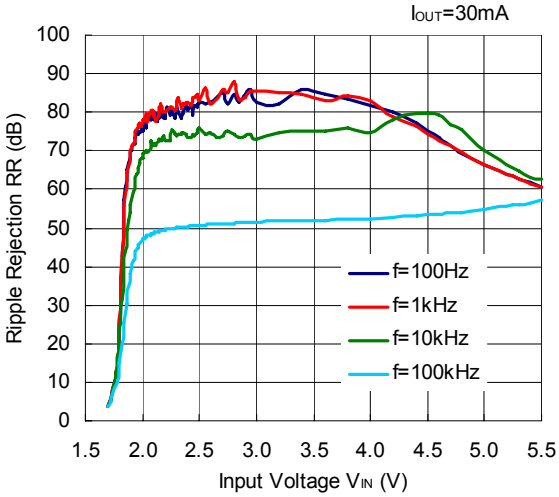

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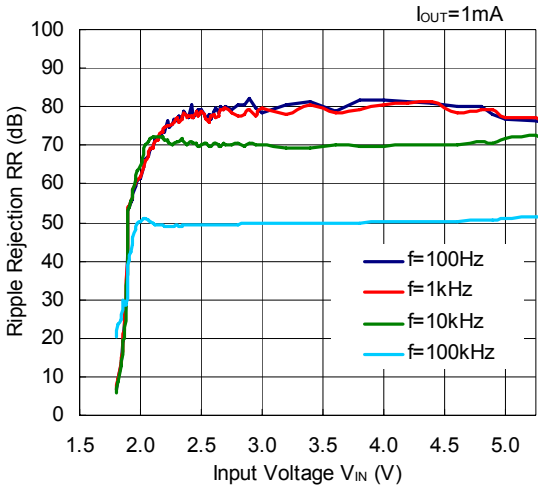

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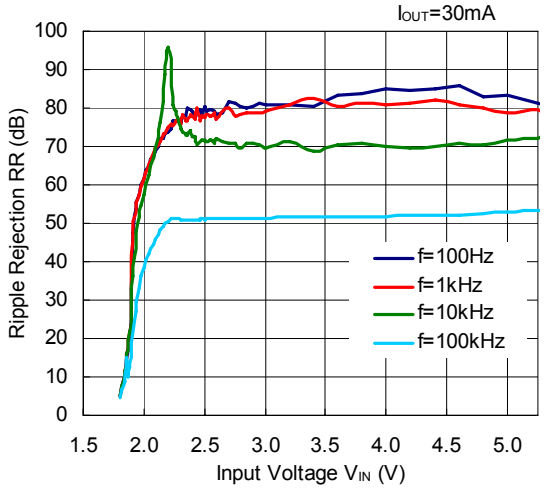

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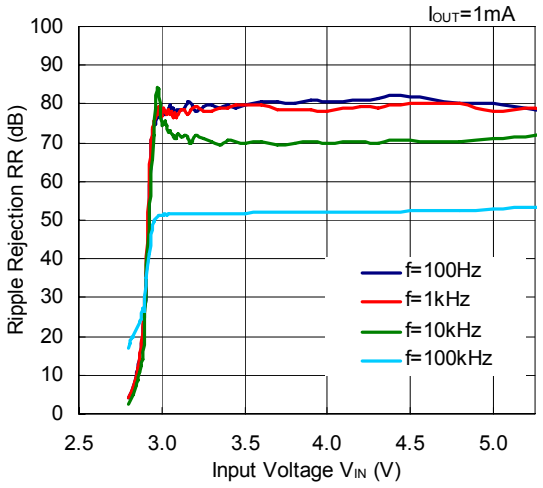

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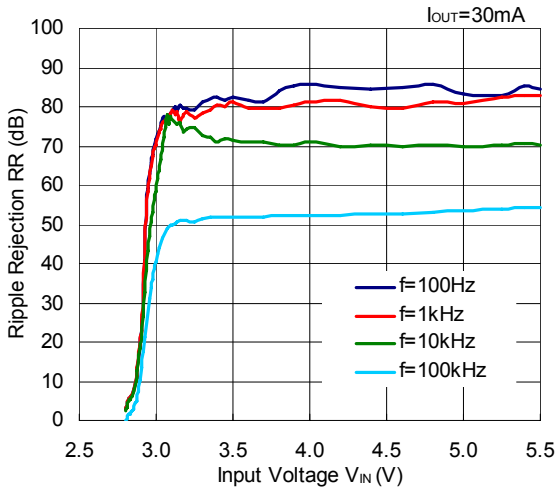

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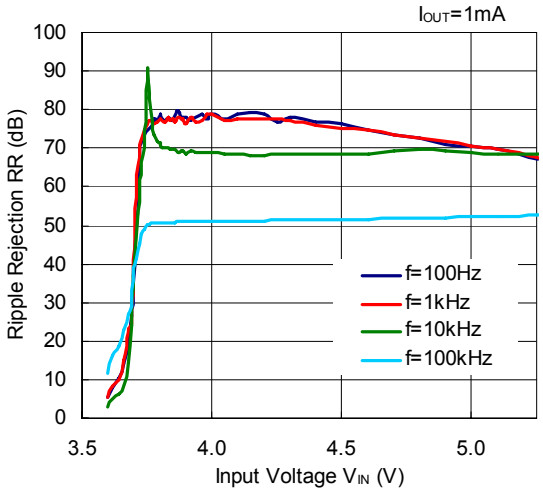

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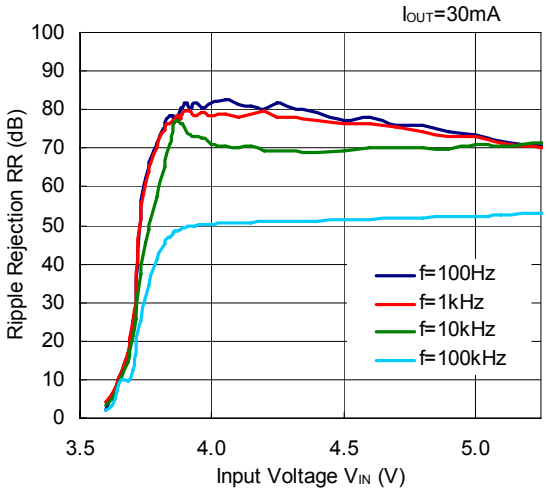
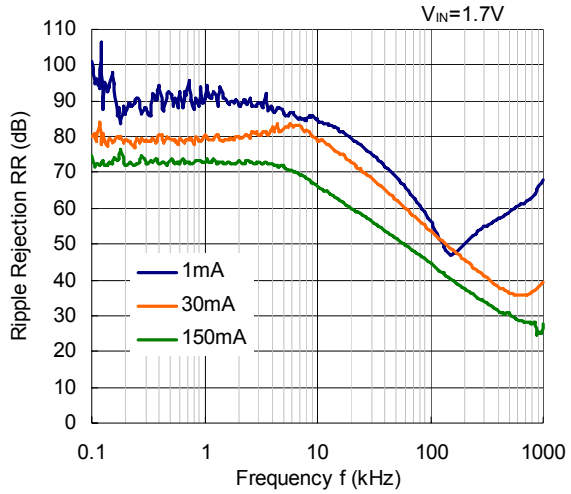


10）Ripple Rejection vs. Frequency（C1=none, C2=Ceramic 1.0μF, Ripple=0.2Vp-p, Topt=25°C）

RP111x071x



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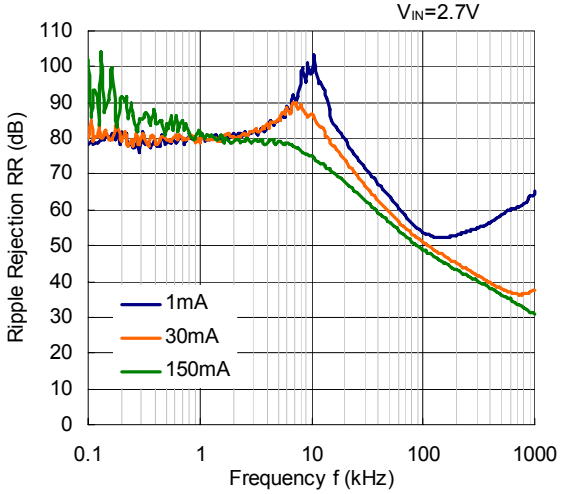

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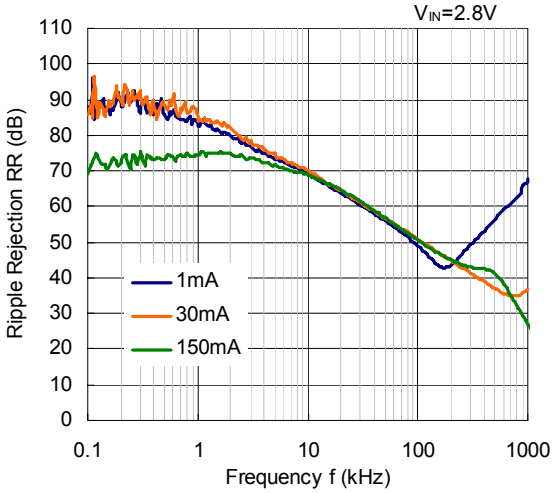

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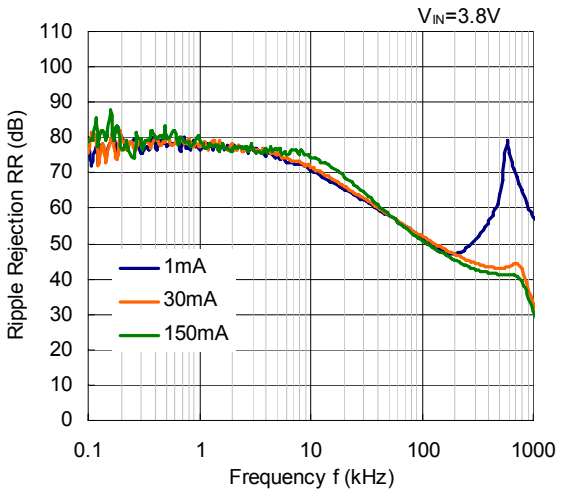

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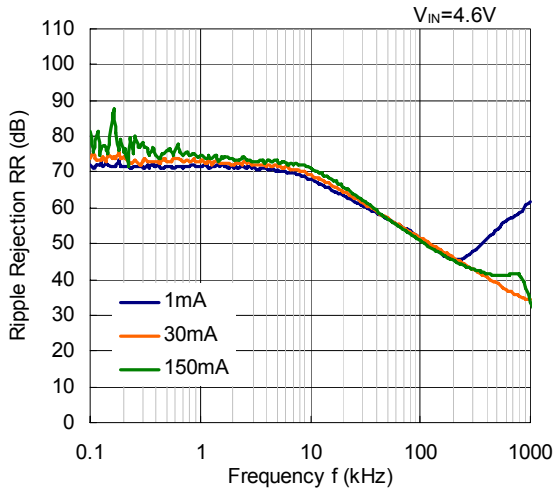
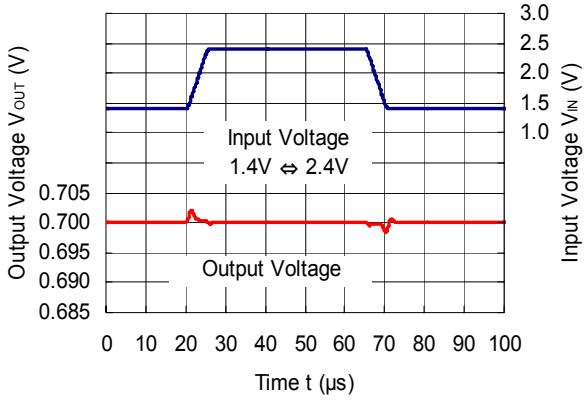


11）Input Transient Response（C1=none, C2=Ceramic 1.0μF, I_{OUT}=30mA, tr=tf=5μs, Topt=25°C）

RP111x071x



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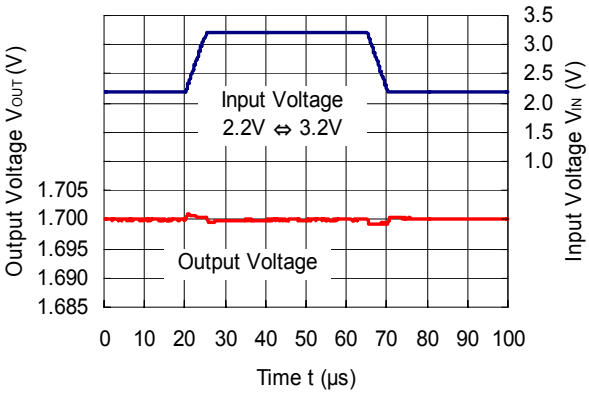

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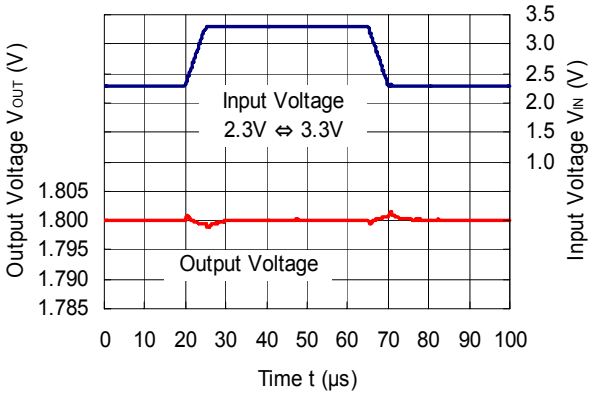

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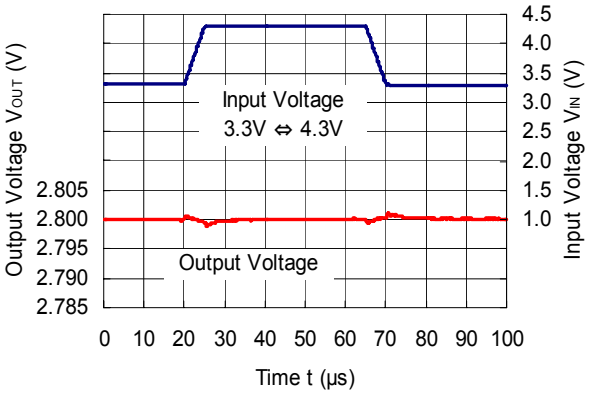

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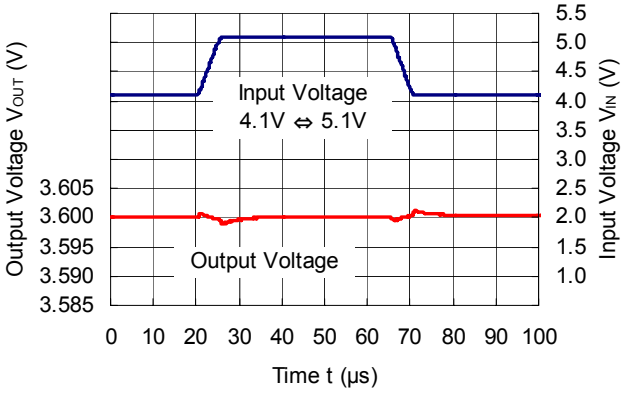
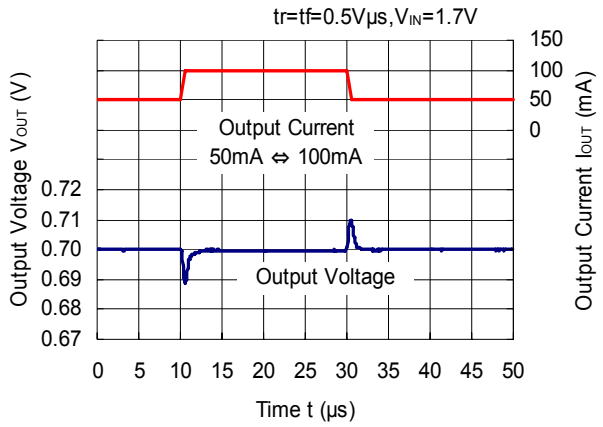


12）Load Transient Response（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, Topt=25°C）

RP111x071x



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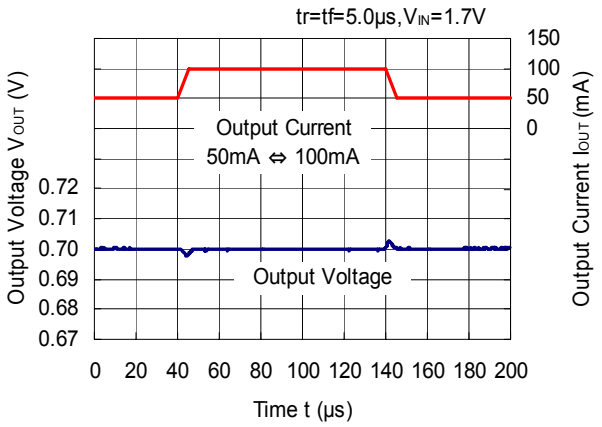

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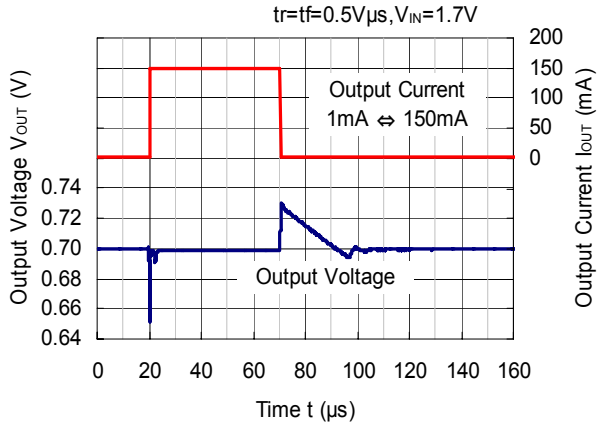

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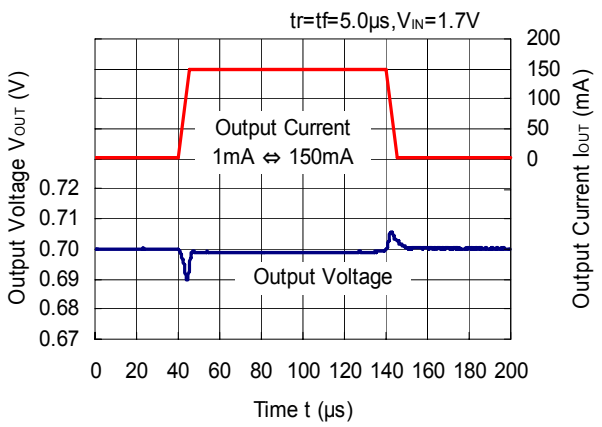

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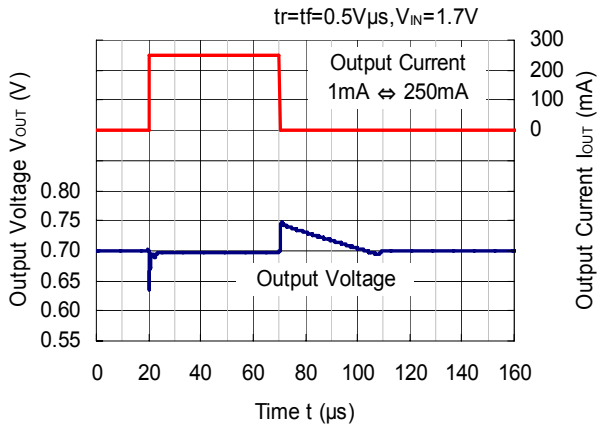

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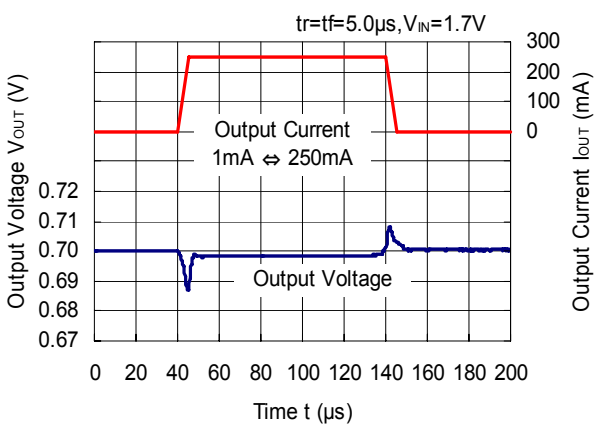

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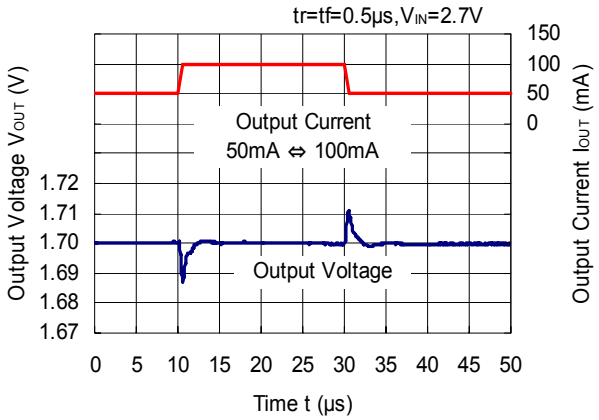

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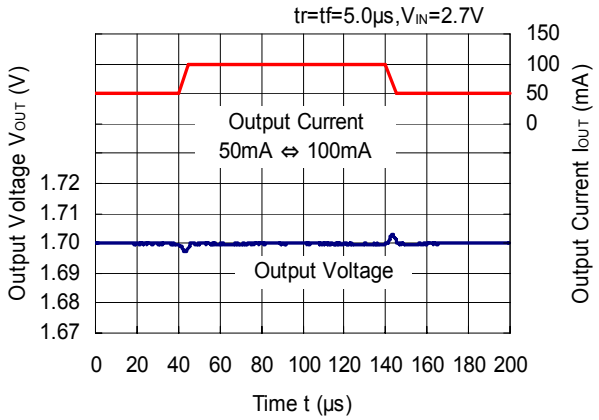

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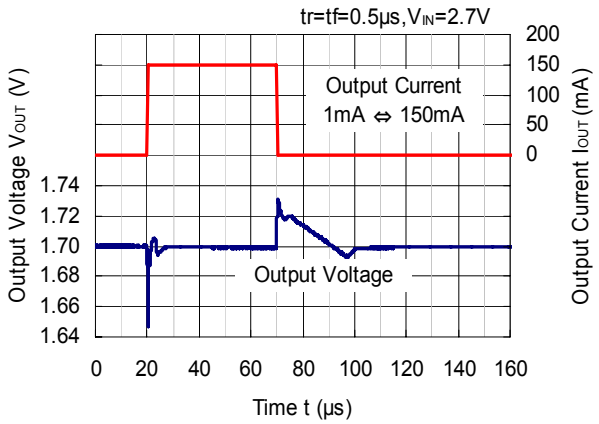

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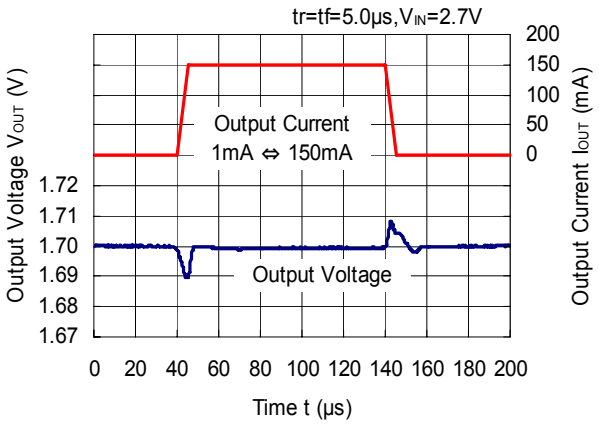

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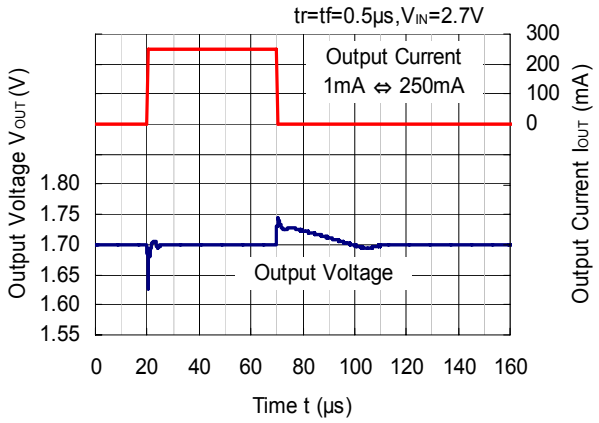

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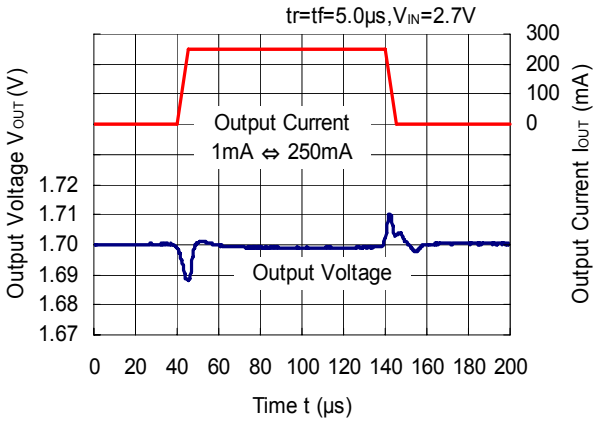

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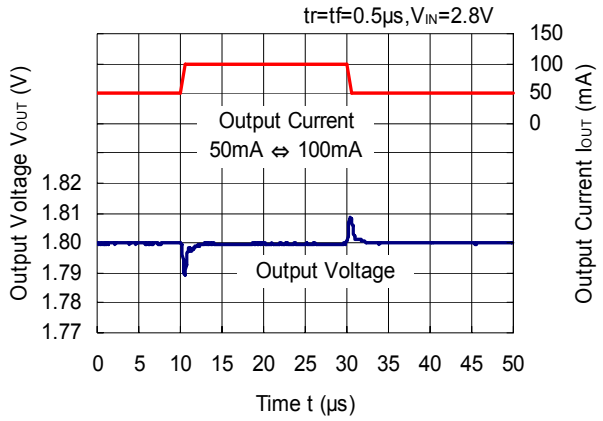

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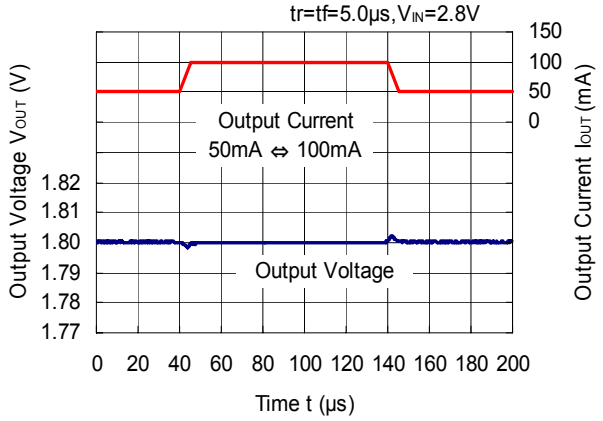

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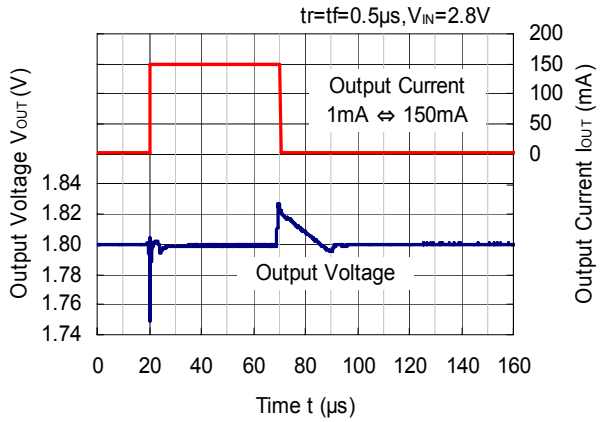

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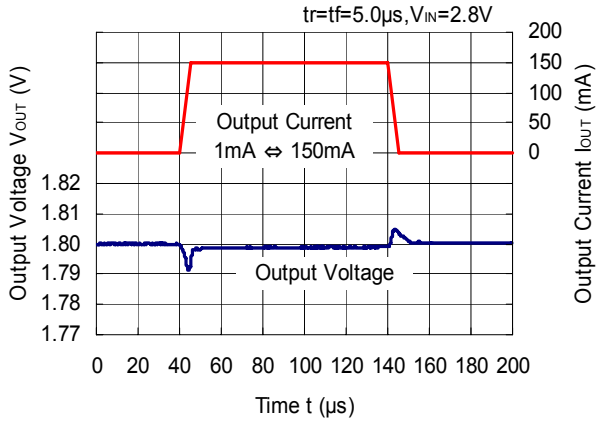

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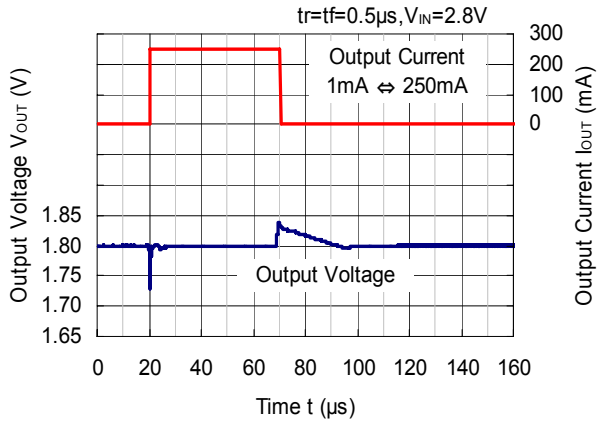

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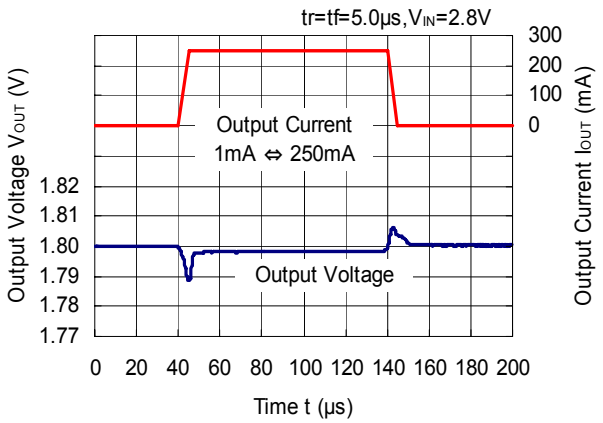

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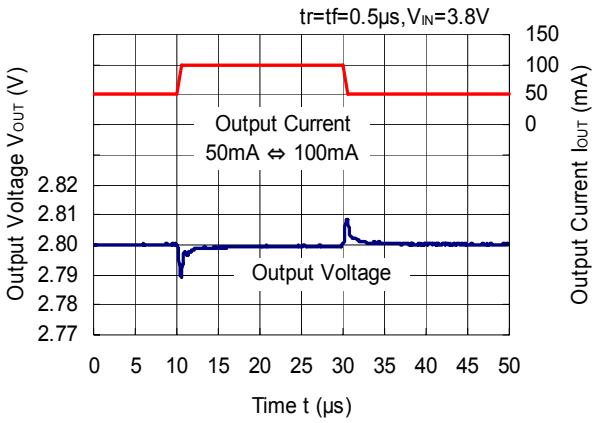

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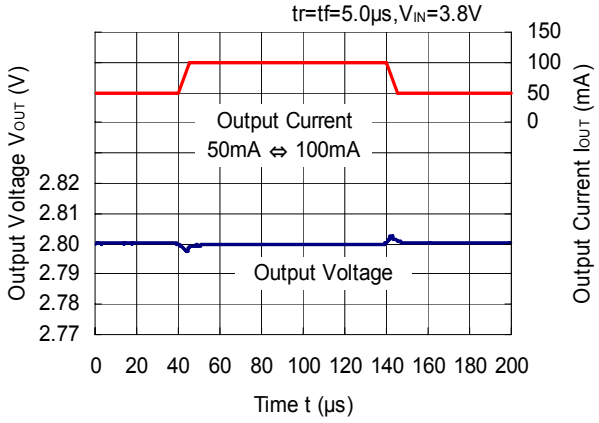

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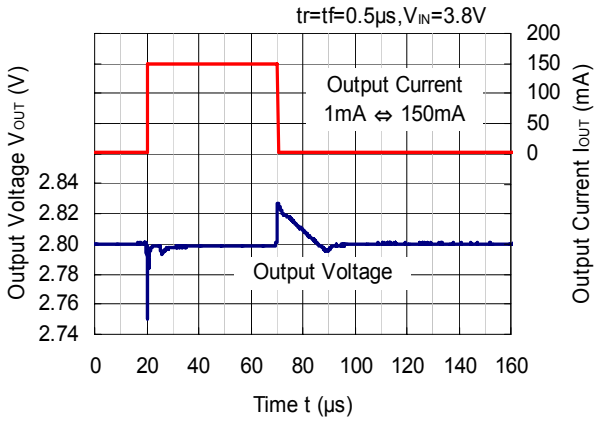

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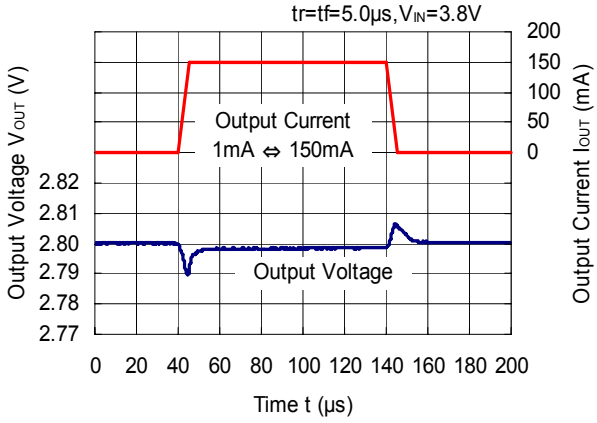

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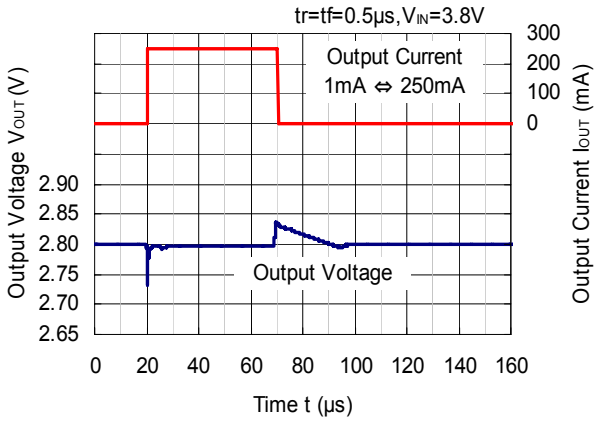

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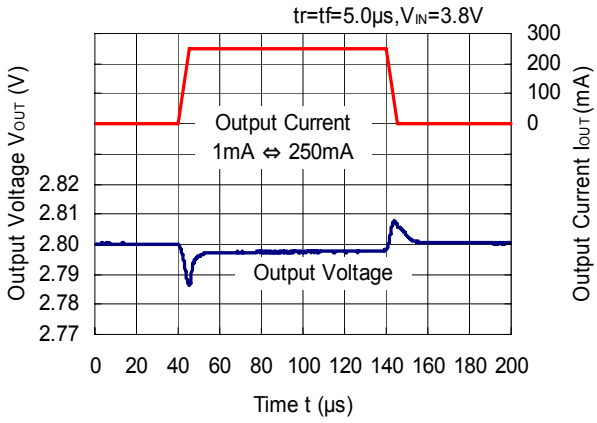

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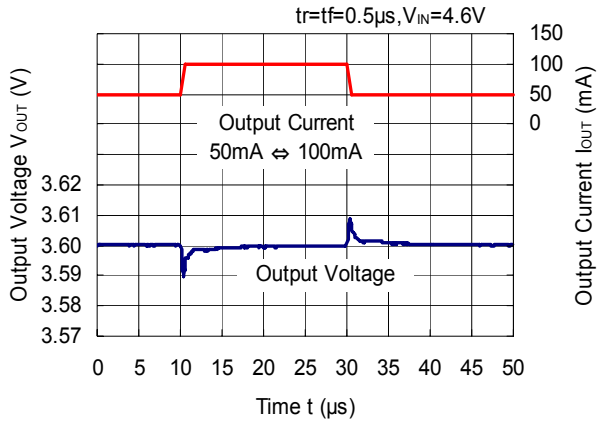

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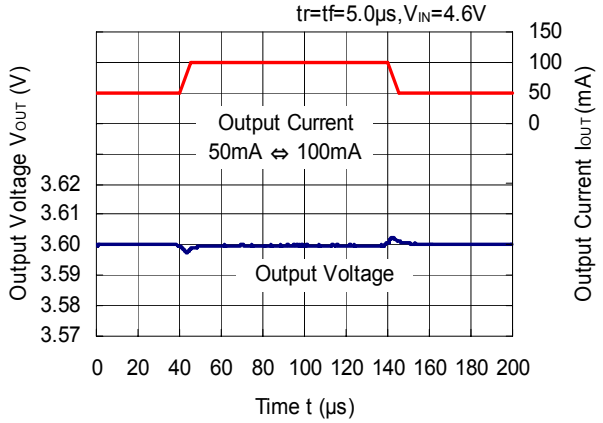

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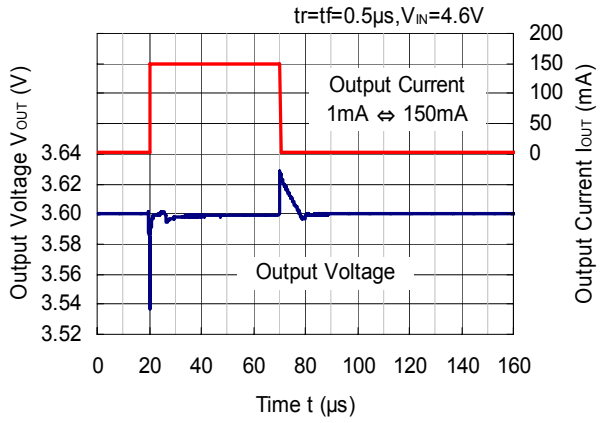

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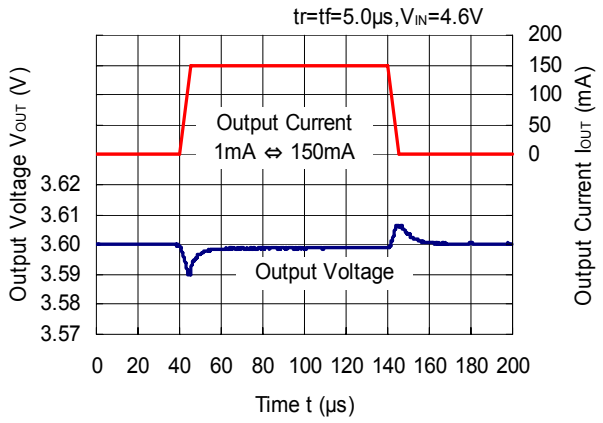

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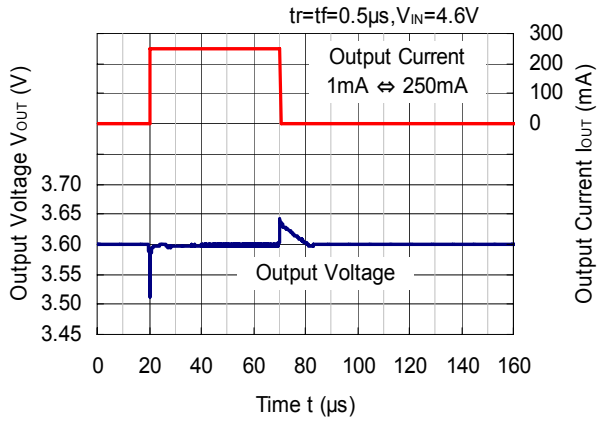

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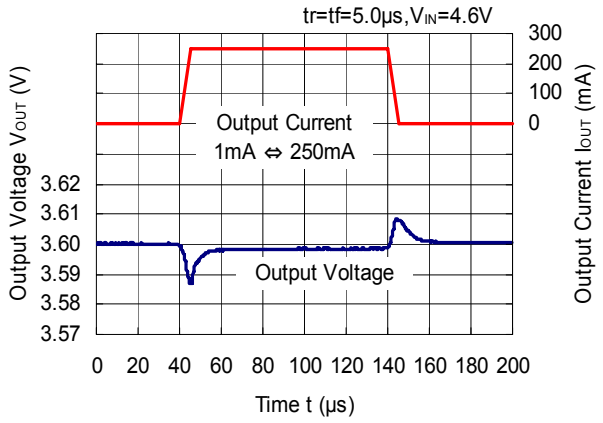
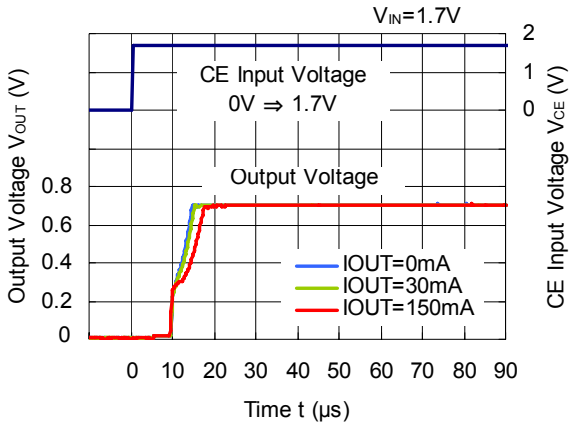


13）Turn on Speed with CE pin（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, Topt=25°C）

RP111x071x



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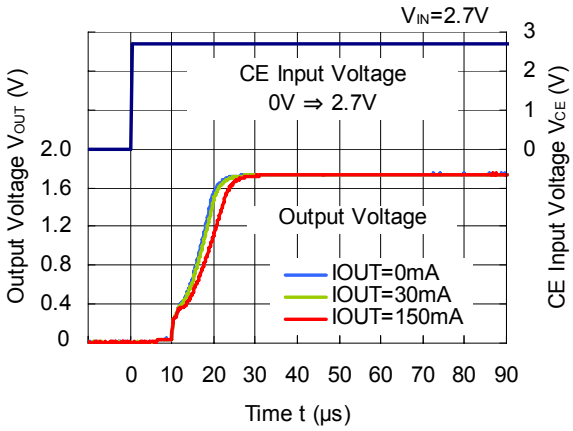

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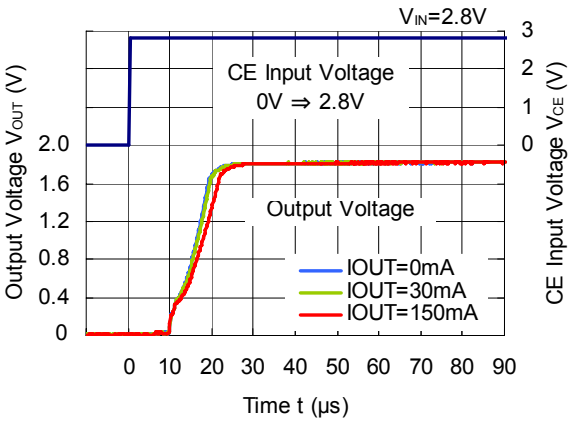

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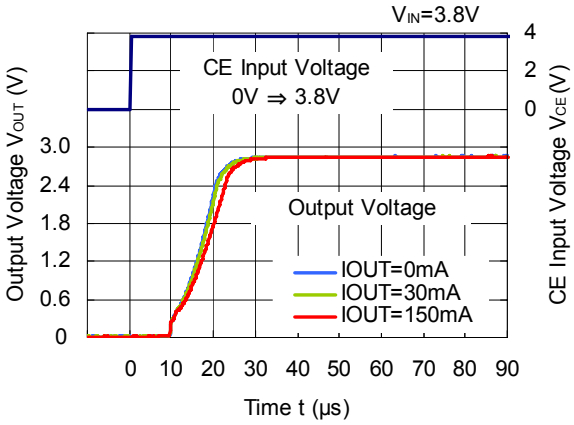

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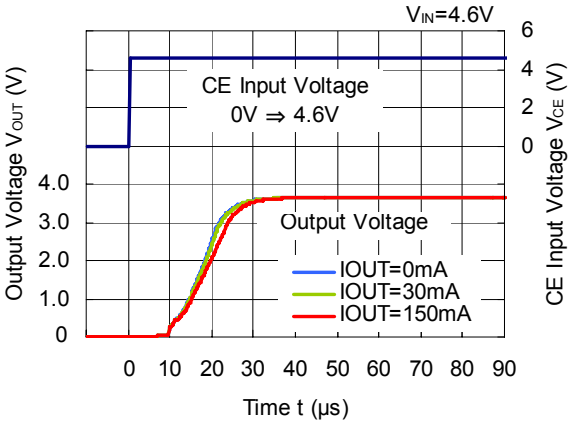
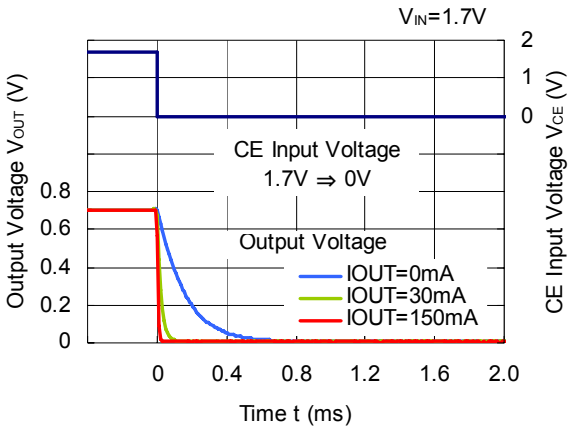


14) Turn off Speed with CE pin（C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, Topt=25°C）

RP111x071x



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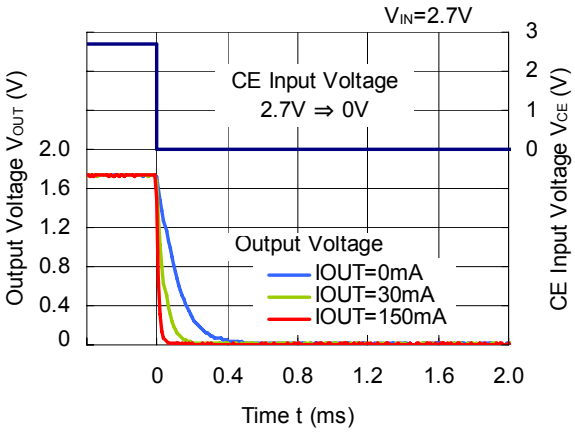

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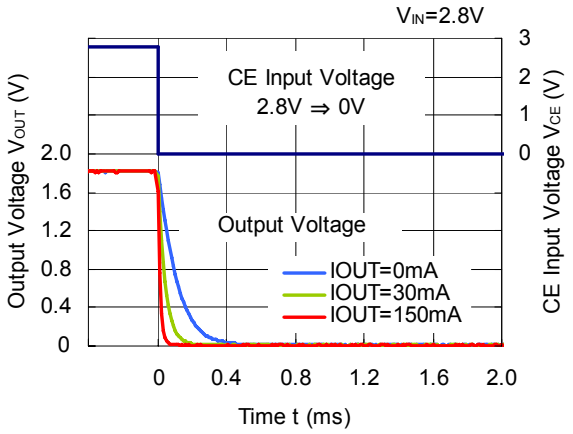

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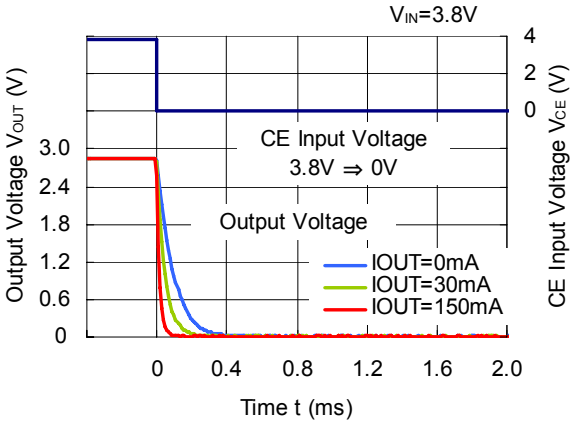

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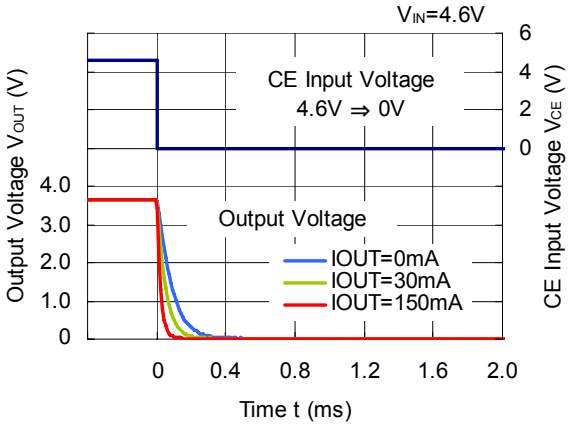
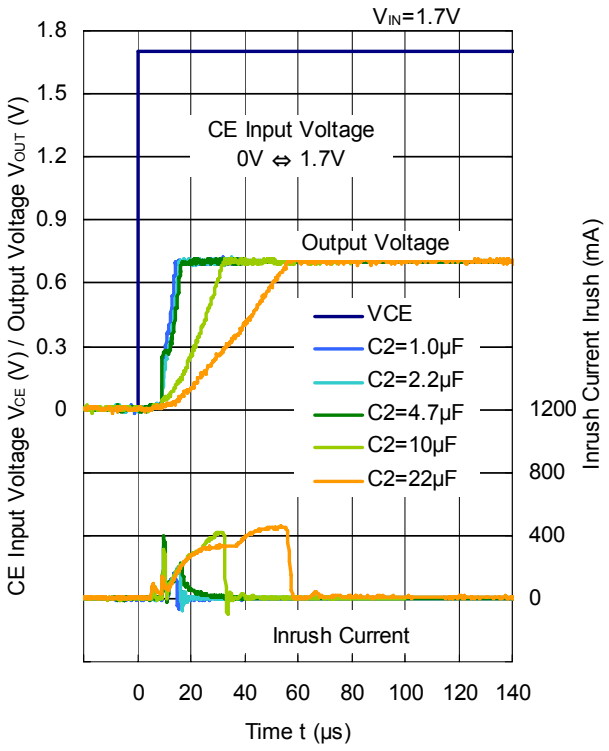


15）Inrush Current（C1=Ceramic 1.0μF, I_{OUT}=0mA, Topt=25°C）

RP111x071x



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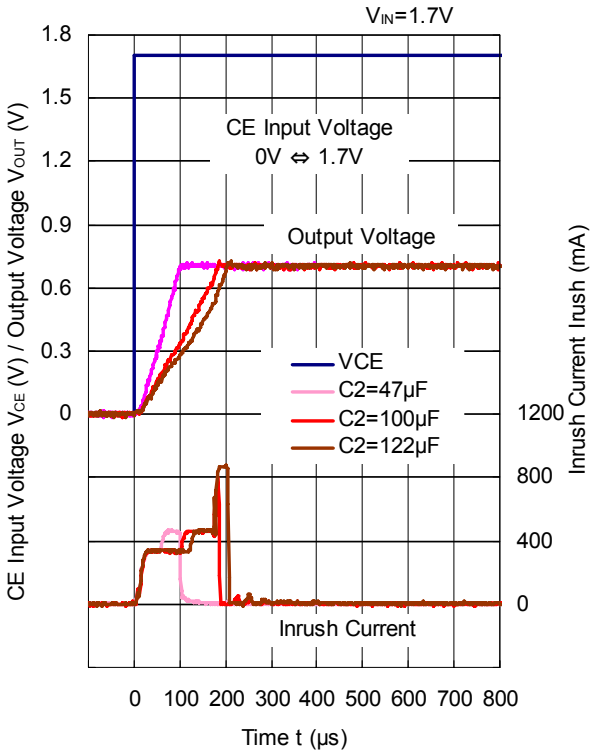

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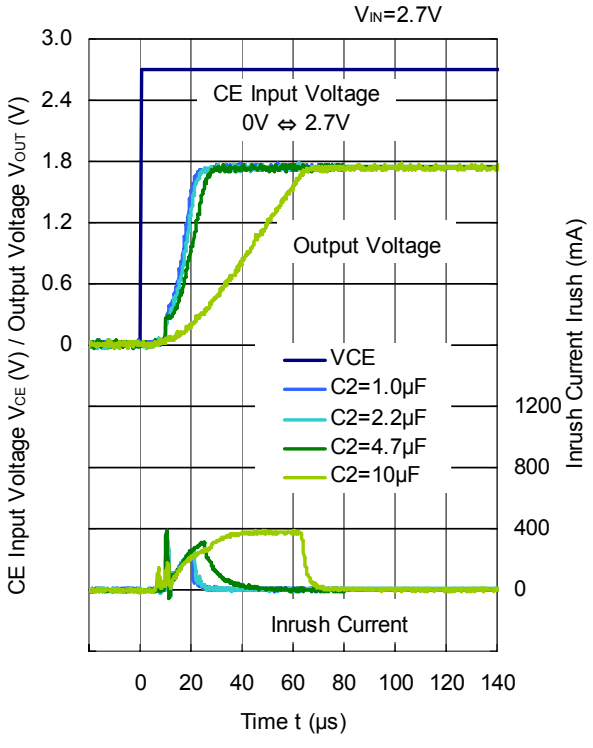

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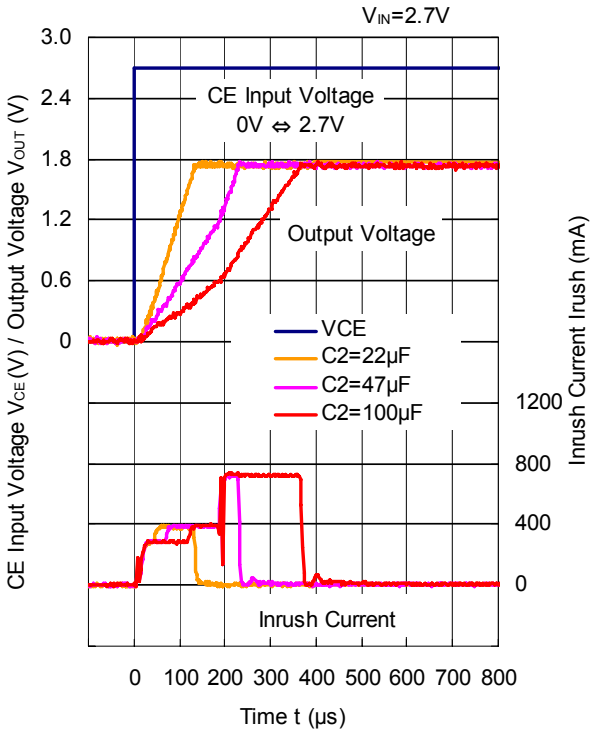

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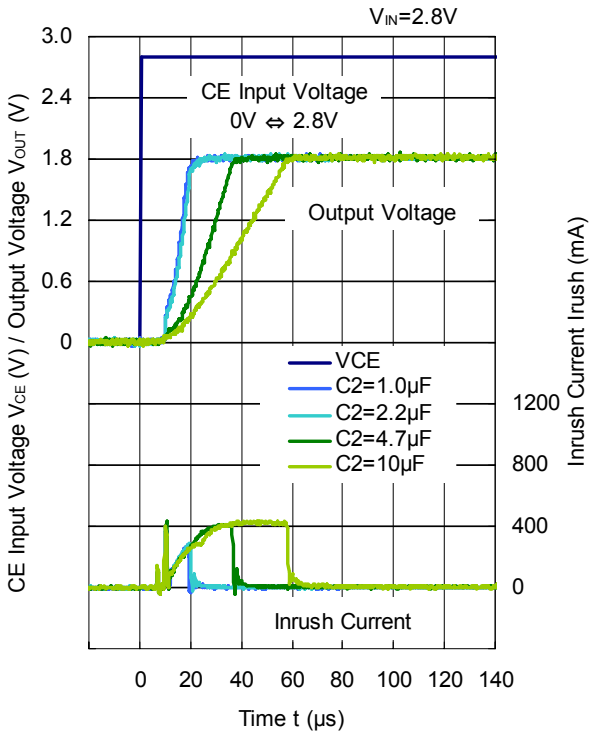

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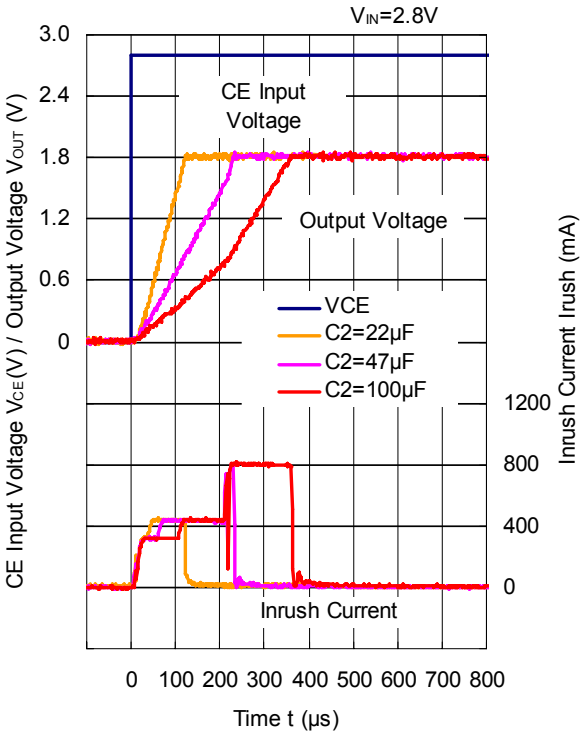

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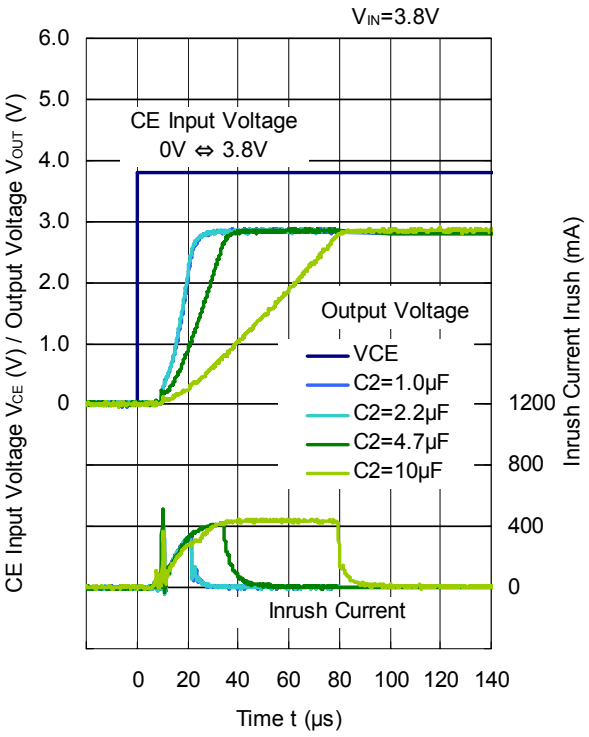

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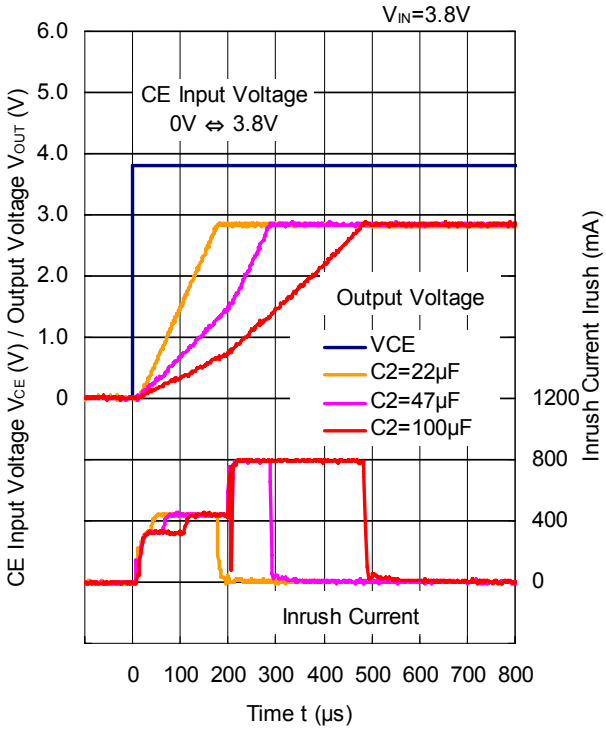

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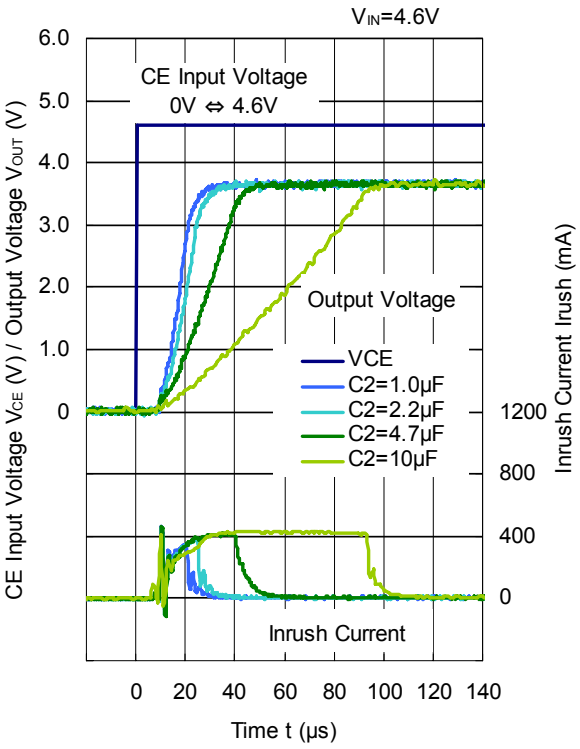

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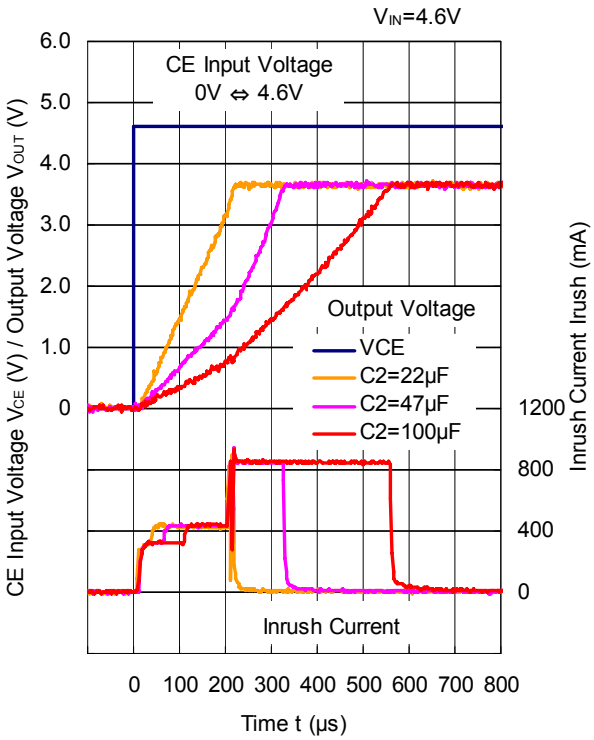


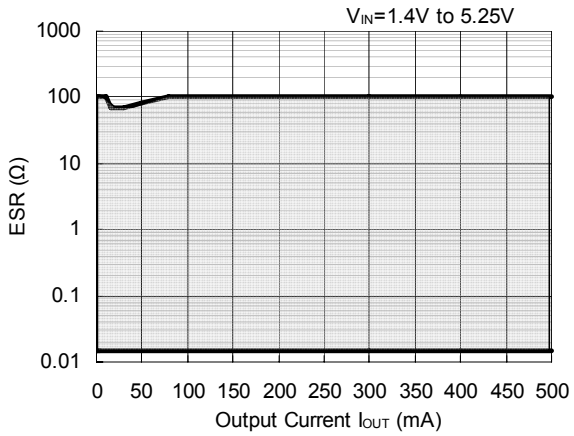
ESR vs. Output Current

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 :1.0μF or more

RP111x071x



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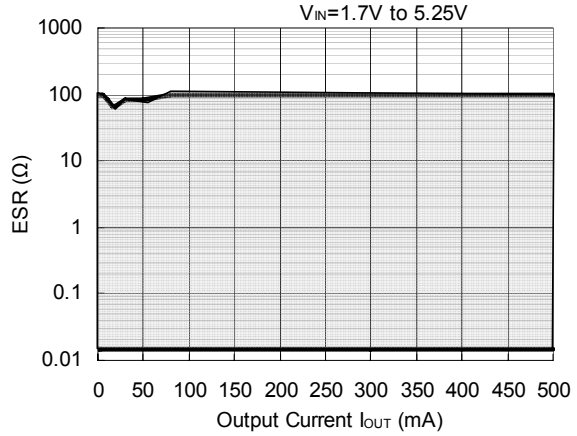

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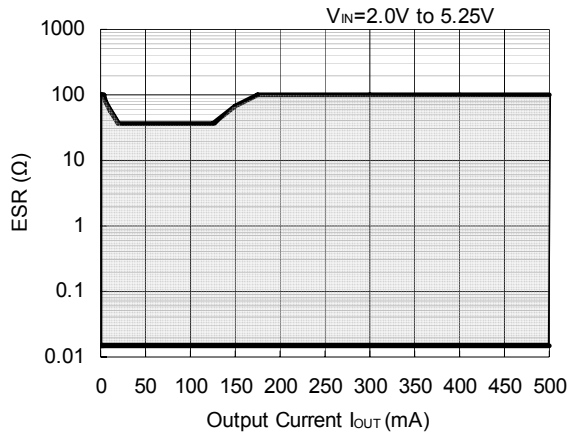

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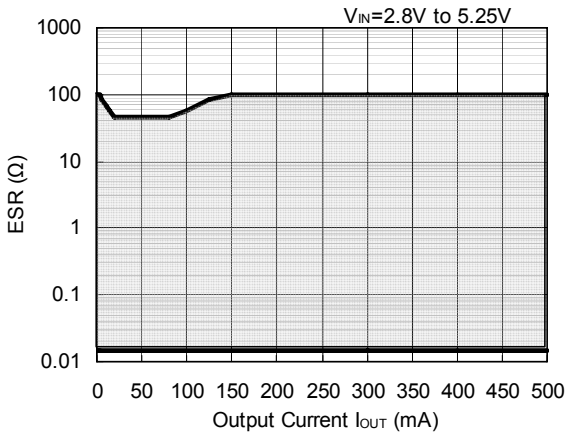

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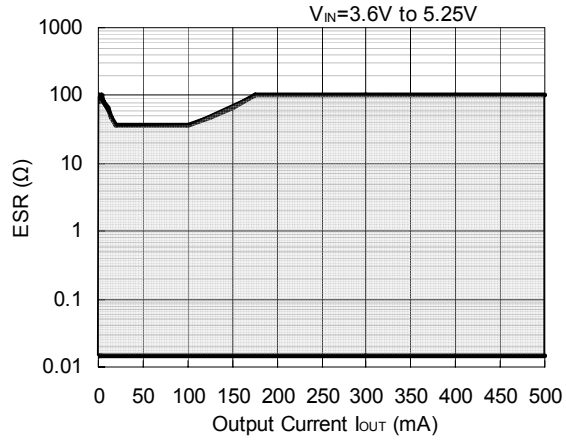

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RICOH COMPANY., LTD. Electronic Devices Company

■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.

■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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