0.8%ACCURACY 0.7V OUTPUT 400mA LDO REGULATOR

NO.EA-180-111020

OUTLINE

The RP106x Series are low voltage 400mA voltage regulator. These ICs had been further improved of low-voltage capability compared with previous low-voltage product.

The input voltage is as low as Min. 1.0V and the output voltage can be set from 0.7V. The output voltage accuracy has been improved to ±0.8% and due to a built-in transistor with low on-resistance of 0.55Ω (at V_{OUT}=1.5V).

Each of these ICs consists of a voltage reference unit, an error amplifier, a resistor-net for voltage setting, and a current limit circuits for over-current for the destruction prevention by the over-current.

The CE pin can switch the regulator to standby mode. In addition to SOT-23-5 and SC-88A packages, a 0.69mm square WLCSP-4-P5 package and a 1.2mm square DFN(PLP)1212-6 are also available.

FEATURES

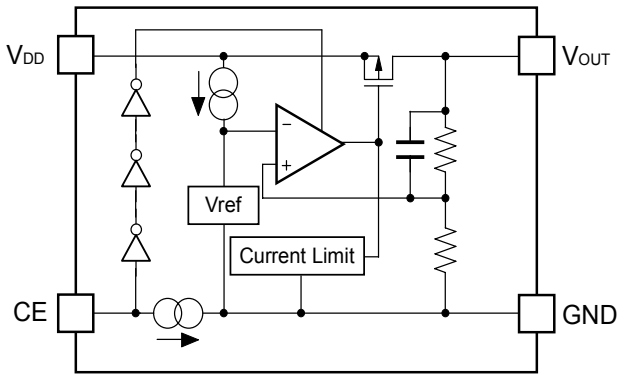
- Supply Current ..... Typ. 48μA
- Standby Current ..... Typ. 0.1μA
- Ripple Rejection ..... Typ. 60dB (f=10kHz)
- Input Voltage Range ..... 1.0V to 3.6V
- Output Voltage Range ..... 0.7V to 1.8V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy ..... ±0.8% (V_{OUT}≥1.0V, T_{opt}=25°C)
- Temperature-Drift Coefficient of Output Voltage ... Typ. ±60ppm/°C
- Dropout Voltage ..... Typ. 0.22V (V_{OUT}=1.5V)
- Line Regulation ..... Typ. 0.10%/V
- Packages ..... WLCSP-4-P5, DFN(PLP)1212-6, SC-88A, SOT-23-5
- Built-in Fold Back Protection Circuit ..... Typ. 110mA (Current at short mode)
- Built-in Constant Slope Circuit
- Ceramic capacitors are recommended to be used with this IC .....1.0μF or more

APPLICATIONS

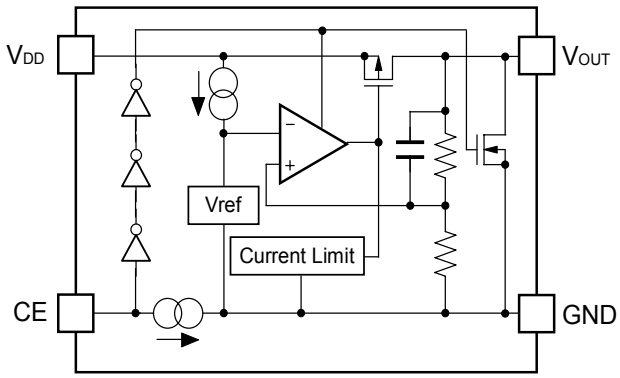
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

RP106xxxxB



RP106xxxxD



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.

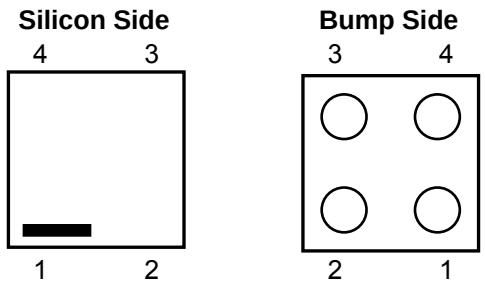
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP106Zxx1∗-TR-F	WLCSP-4-P5	5,000 pcs	Yes	Yes
RP106Kxx1∗-TR	DFN(PLP)1212-6	5,000 pcs	Yes	Yes
RP106Qxx2∗-TR-FE	SC-88A	3,000 pcs	Yes	Yes
RP106Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 0.7V(07) to 1.8V(18) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

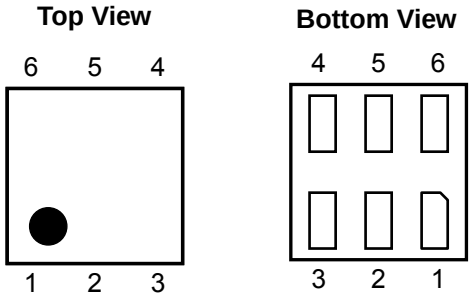
∗ : CE pin polarity and auto discharge function at off state are options as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state

PIN CONFIGURATIONS

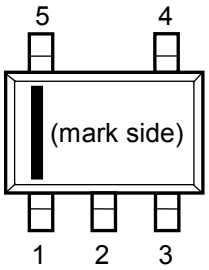
● **WLCSP-4-P5**



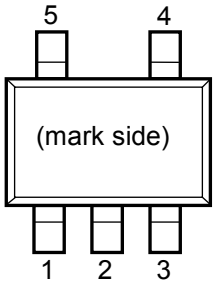
● **DFN(PLP)1212-6**



● **SC-88A**



● **SOT-23-5**



PIN DESCRIPTIONS

● **WLCSP-4-P5**

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

● **DFN(PLP)1212-6**

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

● **SC-88A**

Pin No.	Symbol	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	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	4.0	V
V_{CE}	Input Voltage (CE Pin)	−0.3 to 4.0	V
V_{OUT}	Output Voltage	−0.3 to V_{IN}+0.3	V
I_{OUT}	Output Current	500	mA
P_D	Power Dissipation (WLCSP-4-P5)*	278	mW
	Power Dissipation (DFN(PLP)1212-6)*	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

- **RP106x**

V_{IN}=Set V_{OUT}+1V, I_{OUT}=1mA, C_{IN}=C_{OUT}=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} ≥ 1.0V	×0.992		×1.008	V
			V_{OUT} < 1.0V	−8		8	mV
		−40°C ≤ Topt ≤ 85°C	V_{OUT} ≥ 1.0V	×0.983		×1.017	V
			V_{OUT} < 1.0V	−17		17	mV
I_{OUT}	Output Current			400			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	1mA ≤ I_{OUT} ≤ 400mA			25	45	mV
V_{DIF}	Dropout Voltage	Refer to the following table					
I_{SS}	Supply Current	I_{OUT}=0mA			48	75	μA
Istandby	Standby Current	V_{CE}=0V			0.1	8.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 3.6V In case that Set V_{OUT} < 0.8V, 1.3V ≤ V_{IN} ≤ 3.6V			0.10	0.25	%/V
RR	Ripple Rejection	f=10kHz, Ripple 0.2Vp-p V_{IN}=Set V_{OUT}+1V, I_{OUT}=30mA			60		dB
V_{IN}	Input Voltage*			1.0		3.6	V
$\Delta V_{OUT}/\Delta$Topt	Output Voltage Temperature Coefficient	−40°C ≤ Topt ≤ 85°C			±60		ppm /°C
I_{SC}	Short Current Limit	V_{OUT}=0V			110		mA
V_{CEH}	CE Input Voltage "H"			0.9			V
V_{CEL}	CE Input Voltage "L"					0.4	V
en	Output Noise	BW=10Hz to 100kHz I_{OUT}=30mA, V_{OUT}=0.7V			30		μVrms
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)	V_{IN}=2.0V, V_{CE}=0V			43		Ω

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.

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.

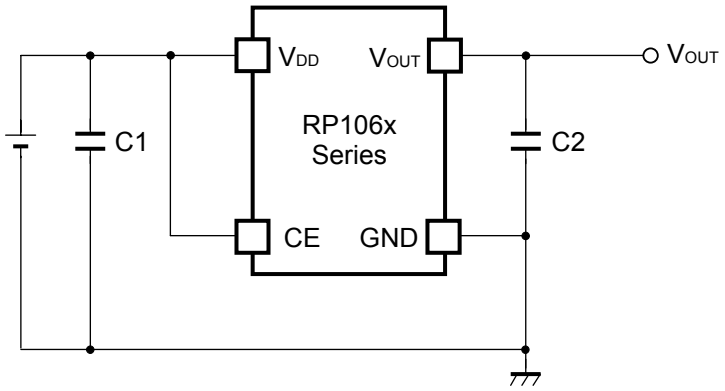
- **Dropout Voltage by Output Voltage**

Topt=25°C

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
$0.7 \leq V_{OUT} < 0.8$	I_{OUT}=400mA	0.48	0.62
$0.8 \leq V_{OUT} < 0.9$		0.40	0.54
$0.9 \leq V_{OUT} < 1.0$		0.36	0.47
$1.0 \leq V_{OUT} < 1.2$		0.32	0.45
$1.2 \leq V_{OUT} < 1.5$		0.28	0.38
$1.5 \leq V_{OUT}$		0.22	0.31

The specification in ☐ is checked and guaranteed by design engineering at −40°C ≤ T_{opt} ≤ 85°C.

TYPICAL APPLICATION



(External Components)
C1, C2 Ceramic 1.0μF MURATA: GRM155B31A105KE15

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 1.0μF or more.

If a tantalum capacitor is used, and its ESR (Equivalent Series Resistance) of C2 is large, the loop oscillation may result. Because of this, select C2 carefully considering its frequency characteristics.

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.

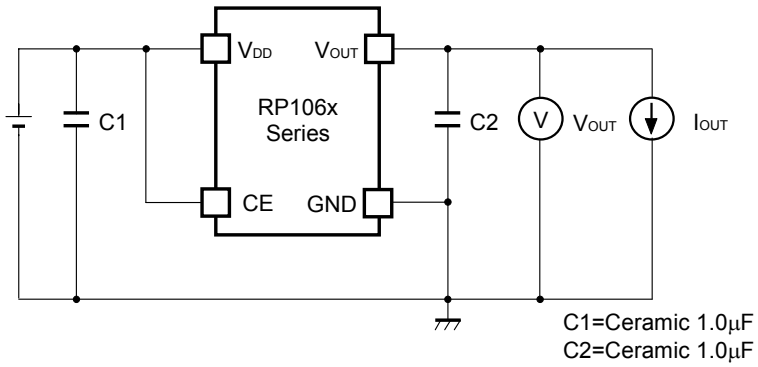
Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

Impedance of Input pin

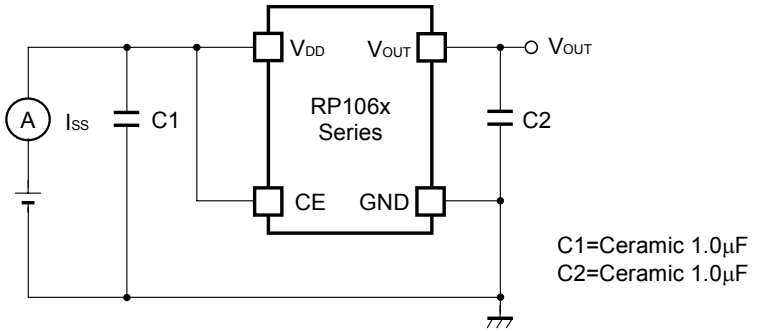
CE pull-down constant current circuit is built in the RP106x.

However, if the CE pin is floating and the wiring is long, the malfunction may occur by noise. Therefore, fully evaluation on the actual PCB is necessary.

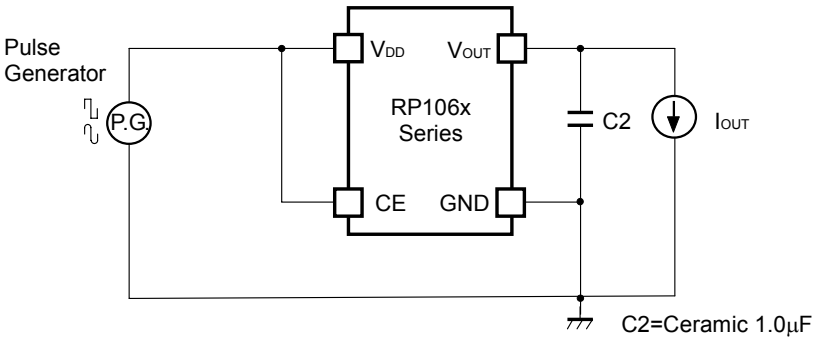
TEST CIRCUITS



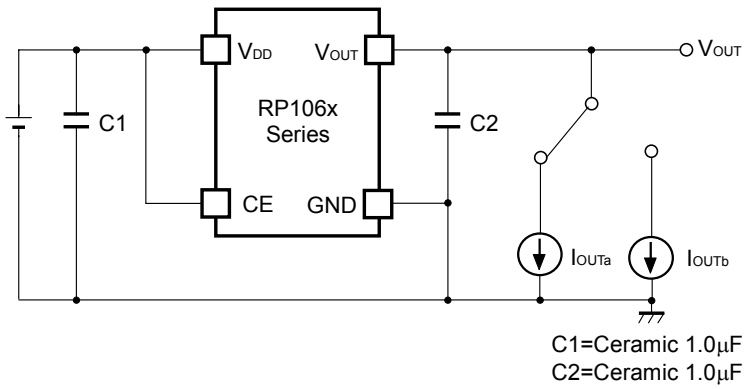
Basic Test Circuit



Supply Current Test Circuit



Ripple Rejection Test Circuit



Load Transient Response Test Circuit

■ Constant Slope Circuits

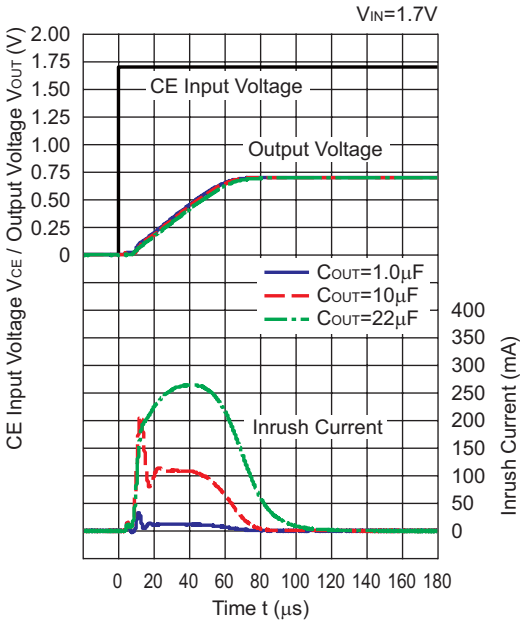
The RP106x Series is equipped with a constant slope circuit as a soft-start circuit, which allows the output voltage to start up gradually when the CE is turned on.

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

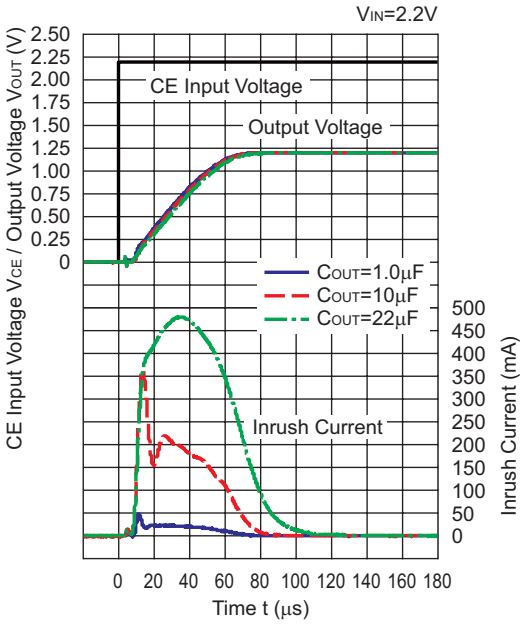
The capacitor to create the start-up slope is built in the IC that does not require any external components. The start-up time and the start-up slope angle are fixed inside the IC. For more details, please refer to the graph 15 of “Inrush Current Characteristics Example”.

Inrush Current Characteristics Example (C1=1.0µF, Topt=25ºC)

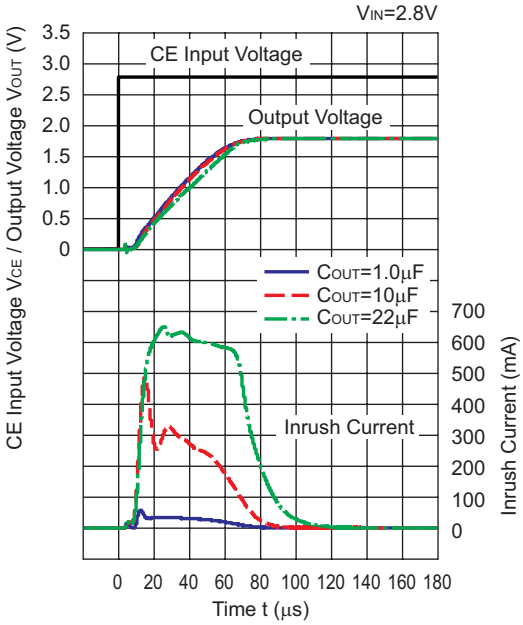
RP106x07xB/D



RP106x12xB/D



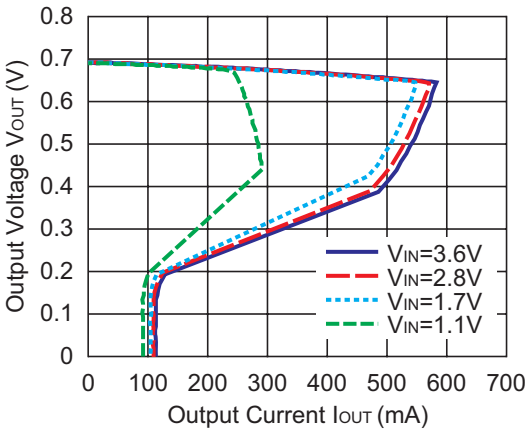
RP106x18xB/D



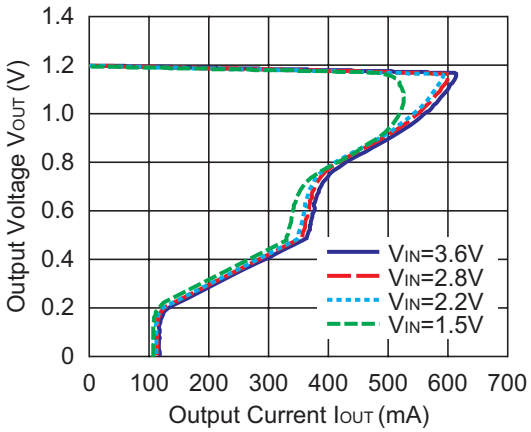
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (Topt=25°C)

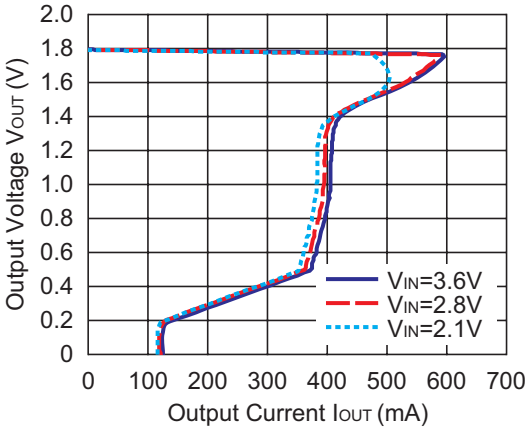
RP106x07xx



RP106x12xx

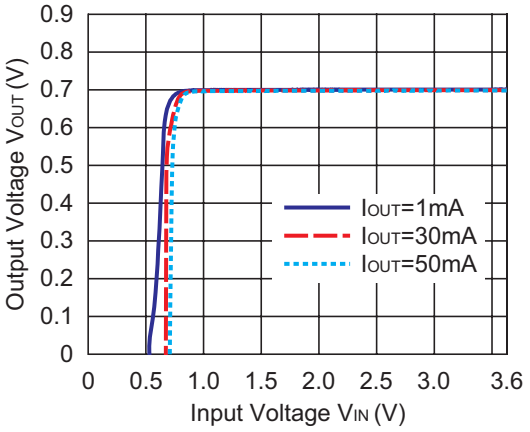


RP106x18xx

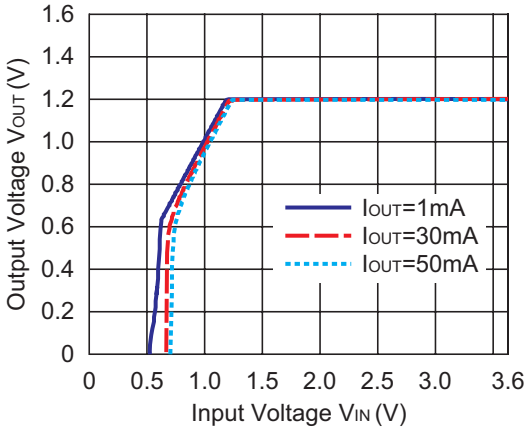


2) Output Voltage vs. Input Voltage (Topt=25°C)

RP106x07xx



RP106x12xx



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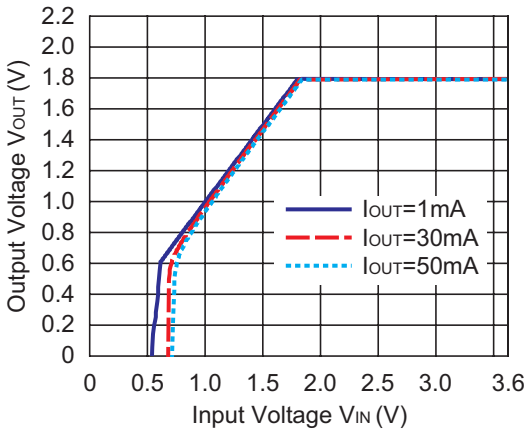
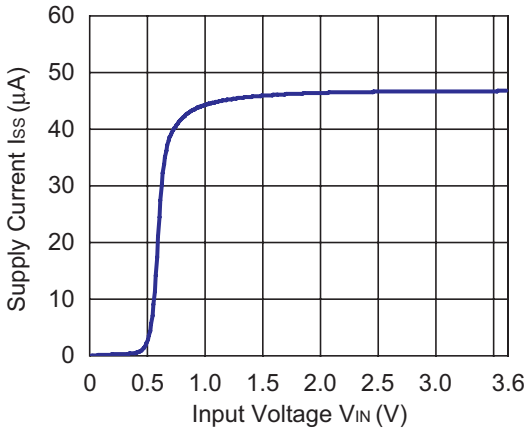


3) Supply Current vs. Input Voltage (Topt=25°C)

RP106x07xx



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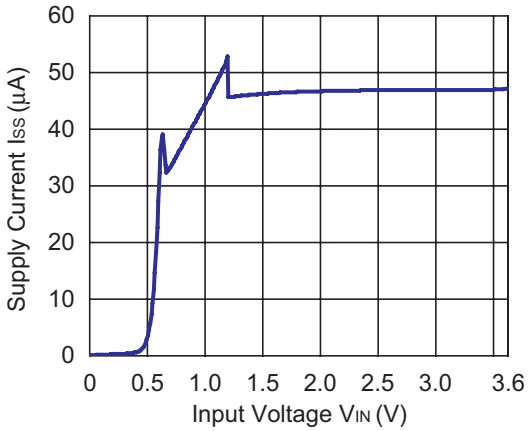
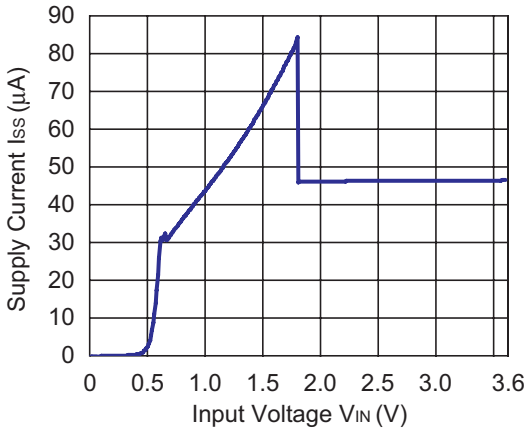
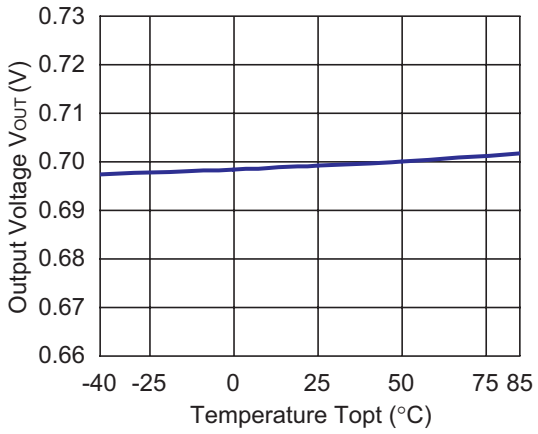


RP106x18xx

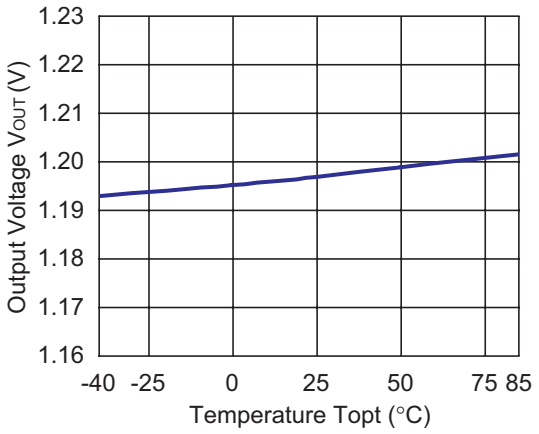


4) Output Voltage vs. Temperature

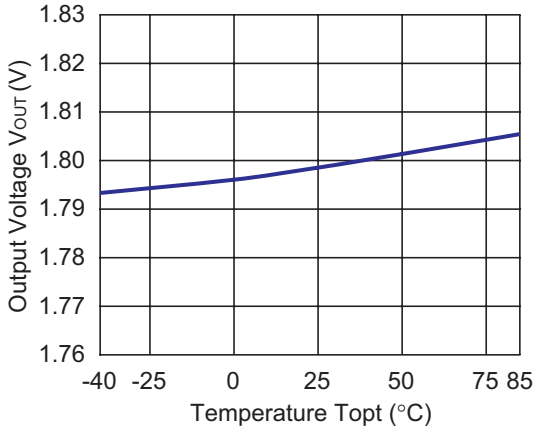
RP106x07xx



RP106x12xx

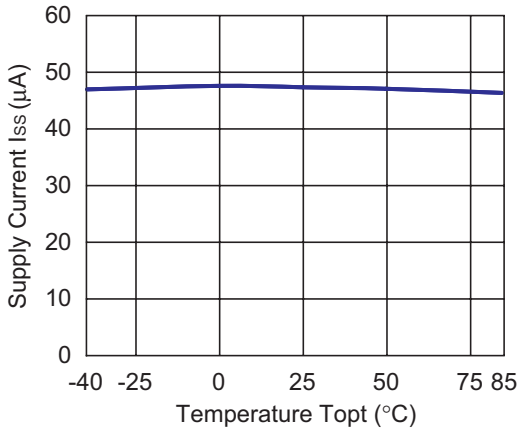


RP106x18xx

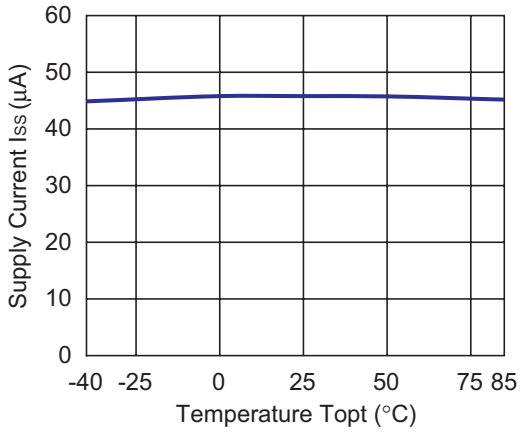


5) Supply Current vs. Temperature

RP106x07xx



RP106x12xx



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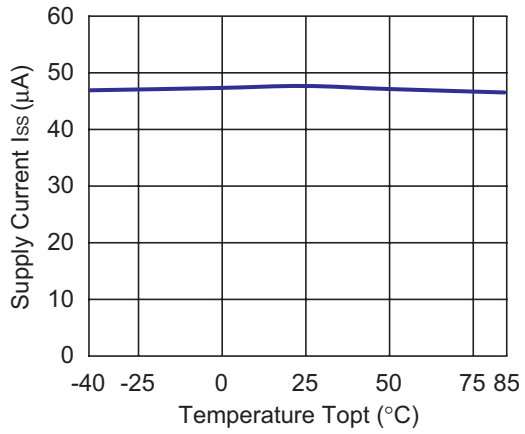
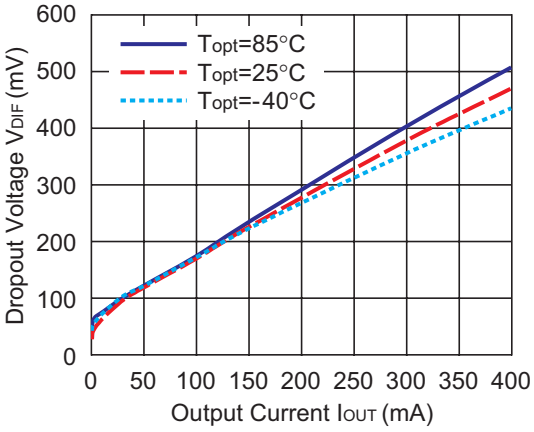
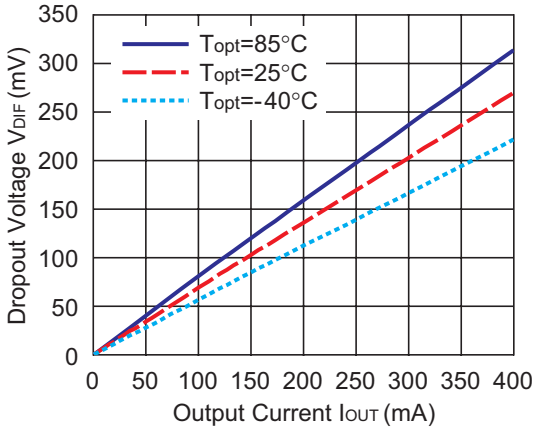


6) Dropout Voltage vs. Output Current

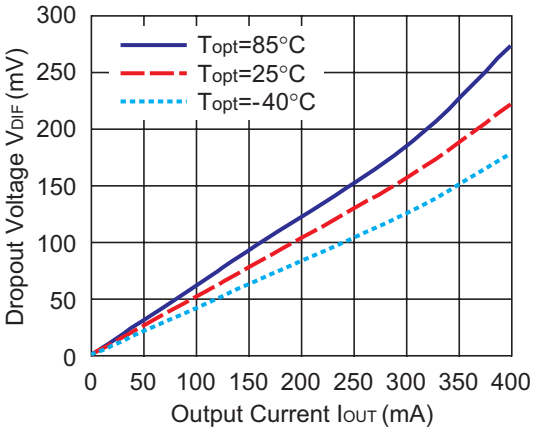
RP106x07xx



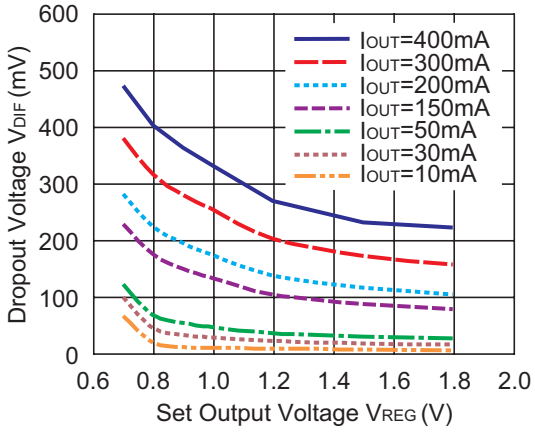
RP106x12xx



RP106x18xx

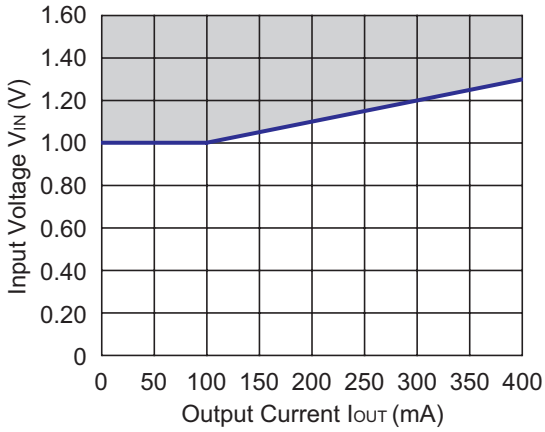


7) Dropout Voltage vs Set Output Voltage (Topt=25°C)



8) Minimum Operating Voltage

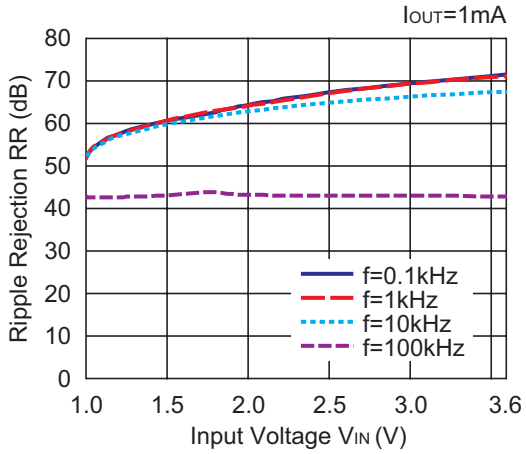
RP106x07xx



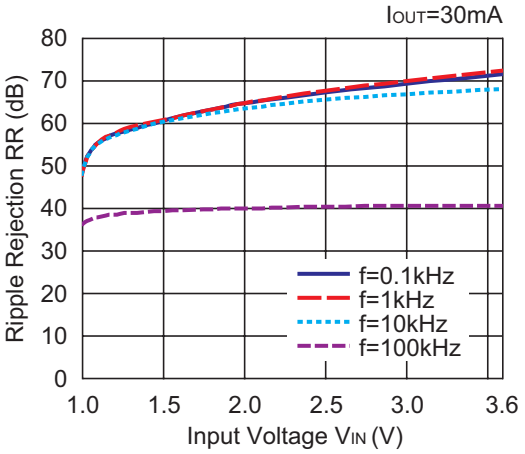
Hatched area is avaiable
for 0.7V output

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

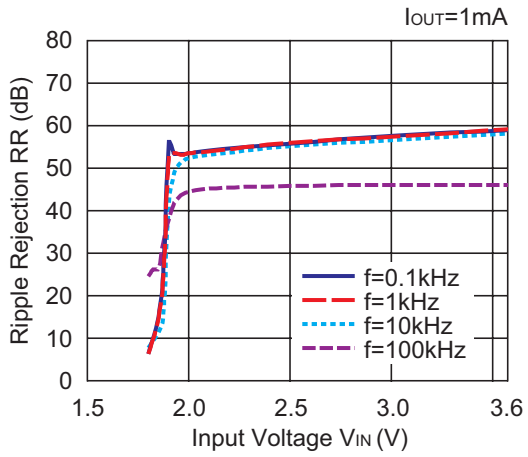
RP106x07xx



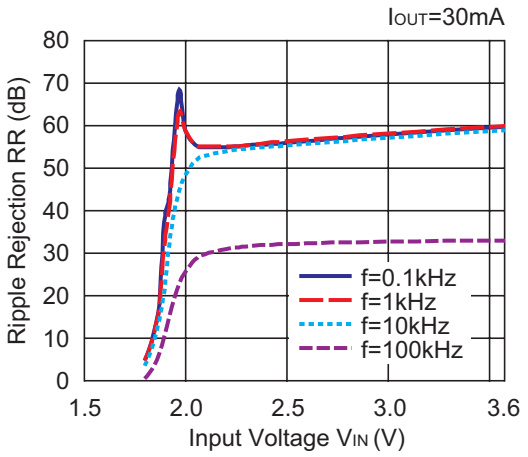
RP106x07xx



RP106x18xx

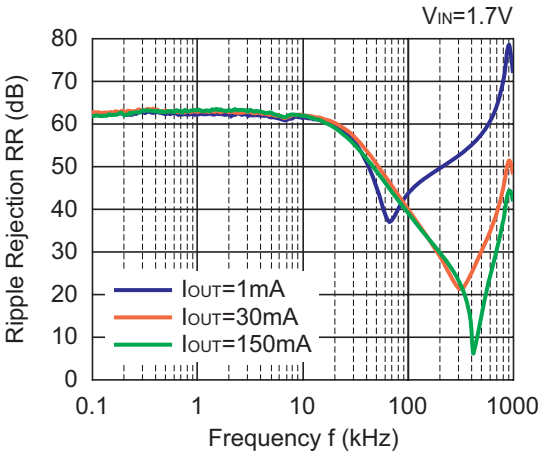


RP106x18xx



10) Ripple Rejection vs. Frequency (C1=none, C2=1.0μF, Ripple=0.1Vp-p, Topt=25°C)

RP106x07xx



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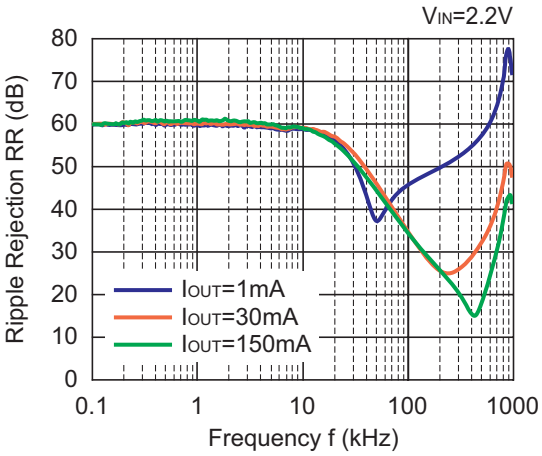

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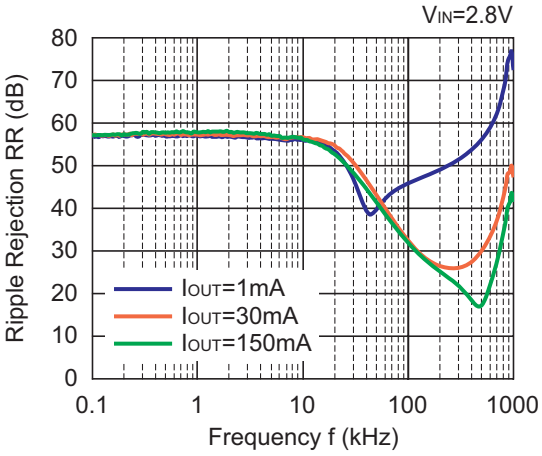
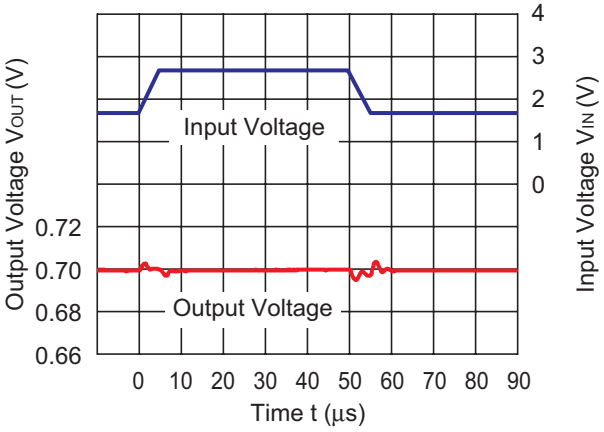


11) Input Transient Response (C1=none, C2=1.0µF, I_{OUT}=30mA, tr=tf=5µs, Topt=25°C)

RP106x07xx



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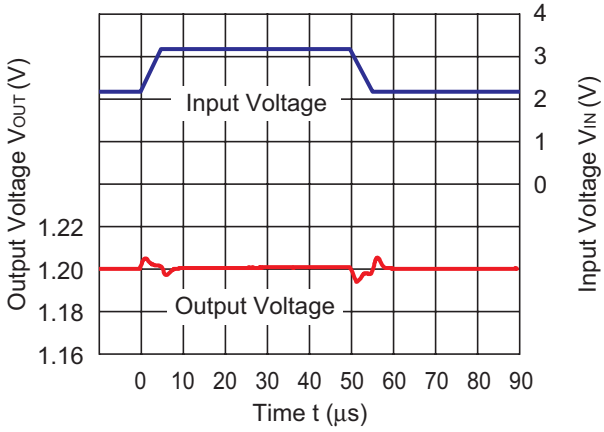

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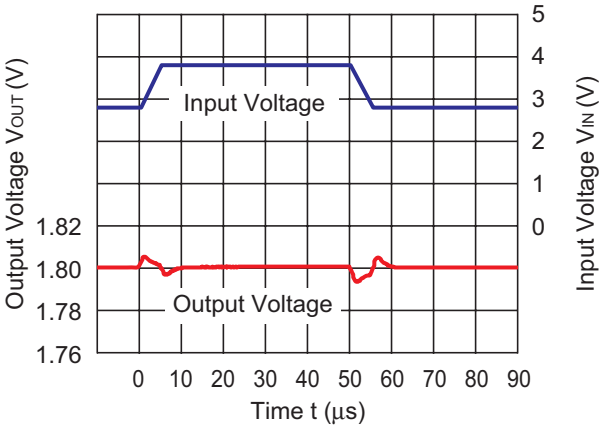
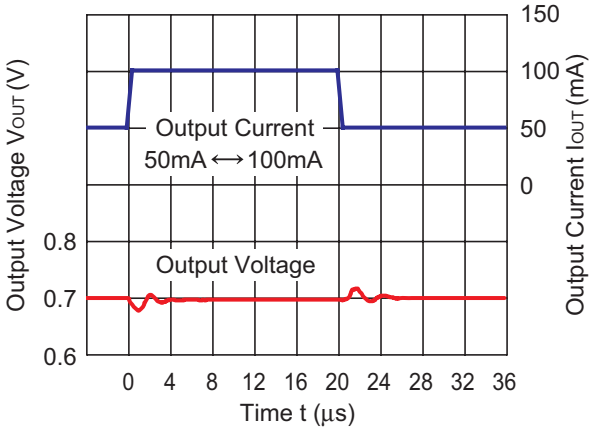


12) Load Transient Response (C1=C2=1.0µF, tr=tf=5µs, Topt=25°C)

RP106x07xx



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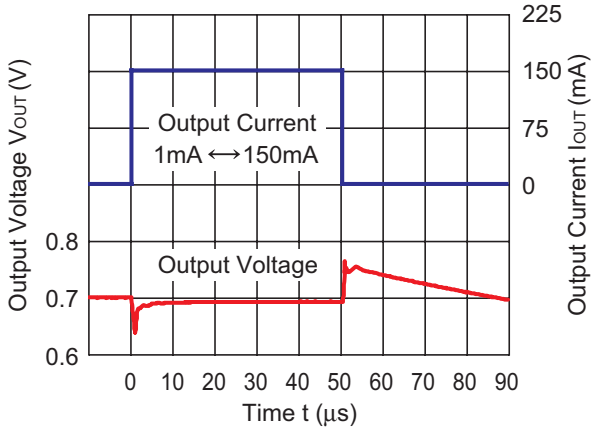

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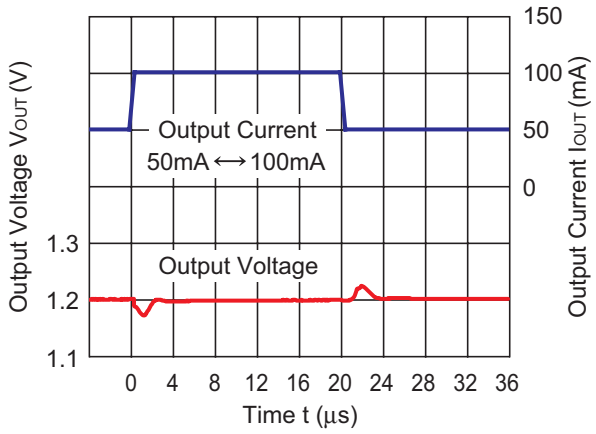

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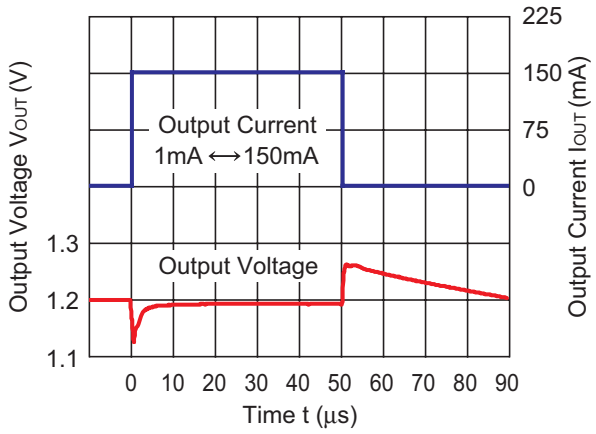

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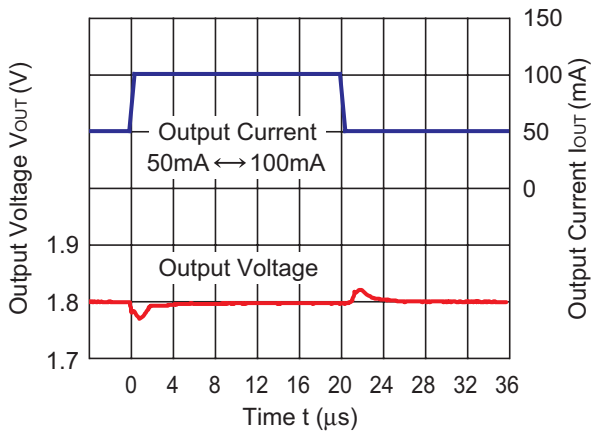

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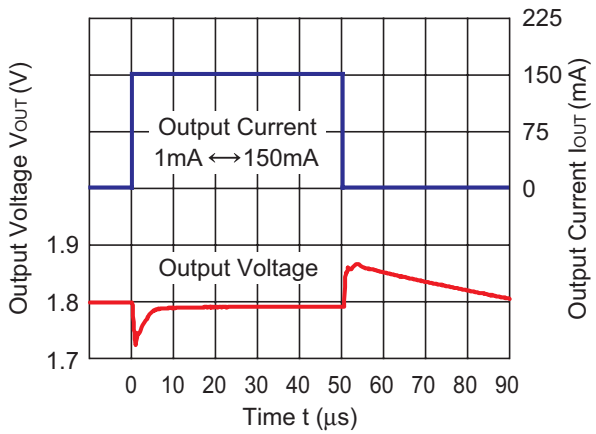
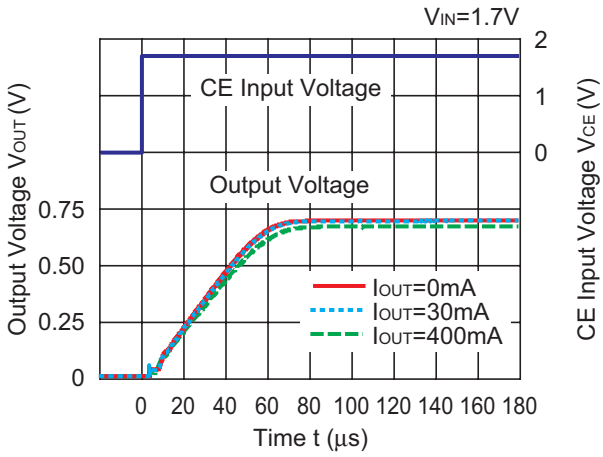


13) Turn On Speed with CE pin (C1=C2=1.0µF, Topt=25°C)

RP106x07xx



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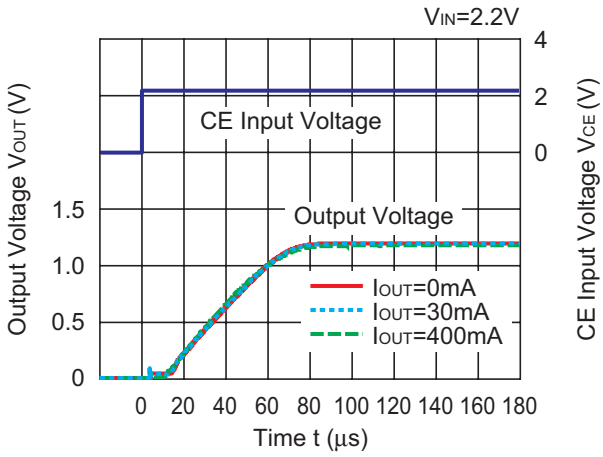

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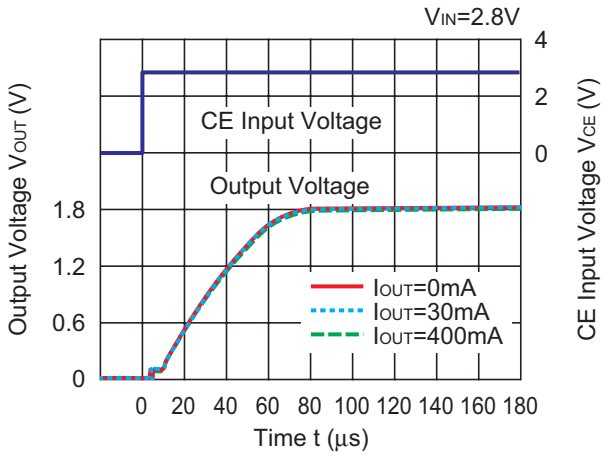
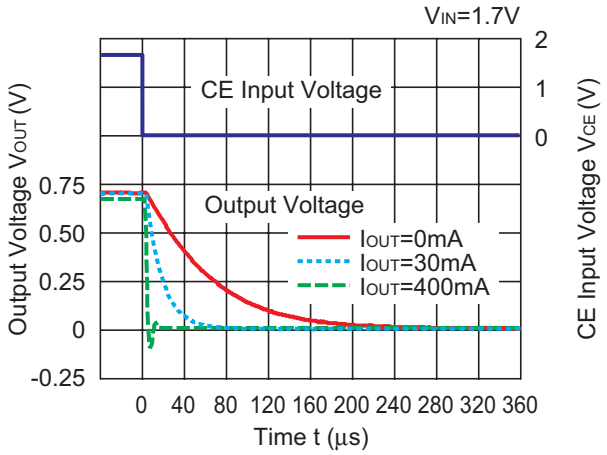


14) Turn Off Speed with CE pin (C1=C2=1.0µF, Topt=25°C)

RP106x07xx



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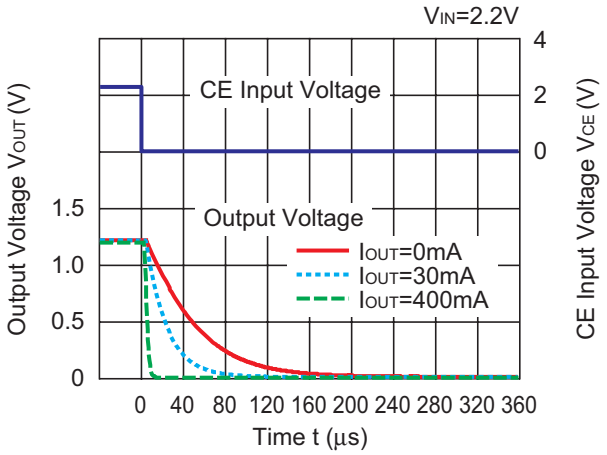

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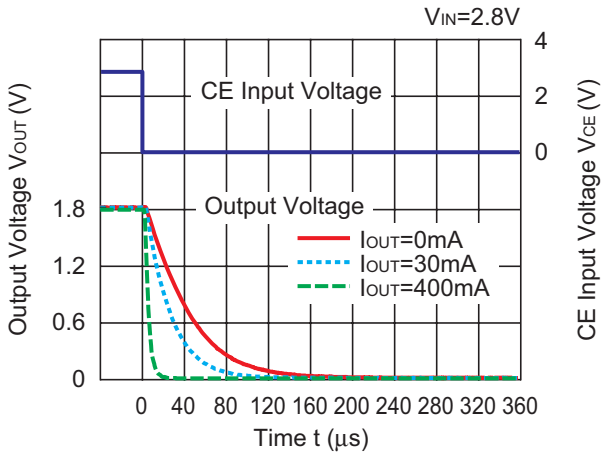
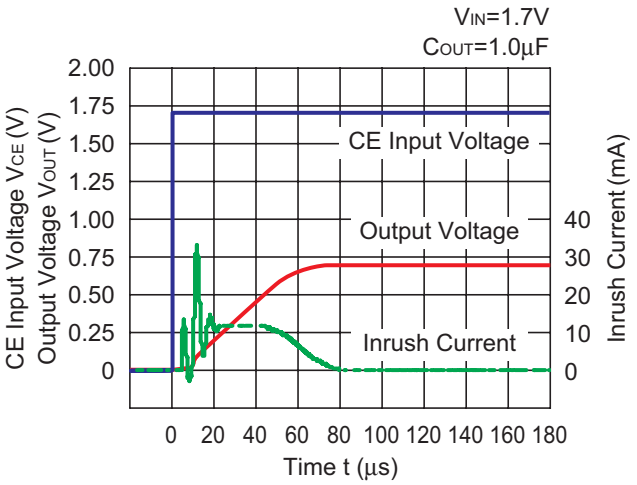


15) Inrush Current at Start up (C1=1.0µF, Topt=25°C)

RP106x07xx



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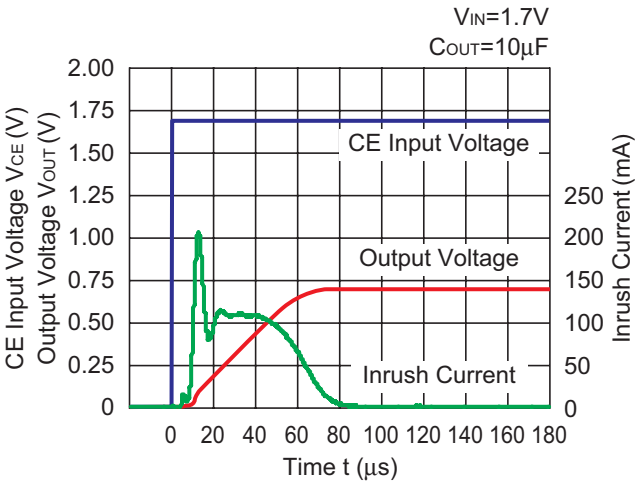

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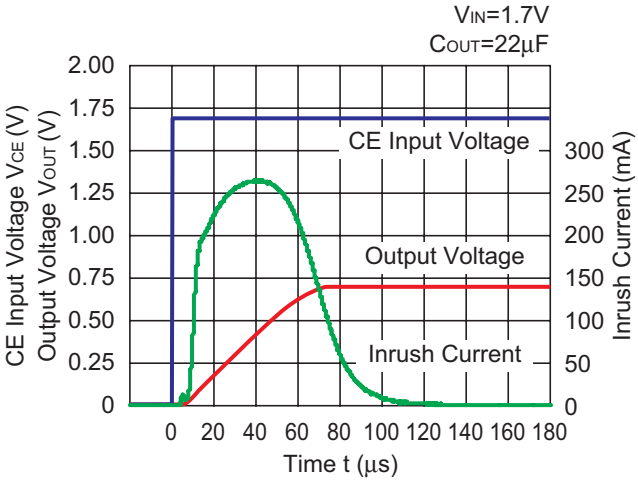

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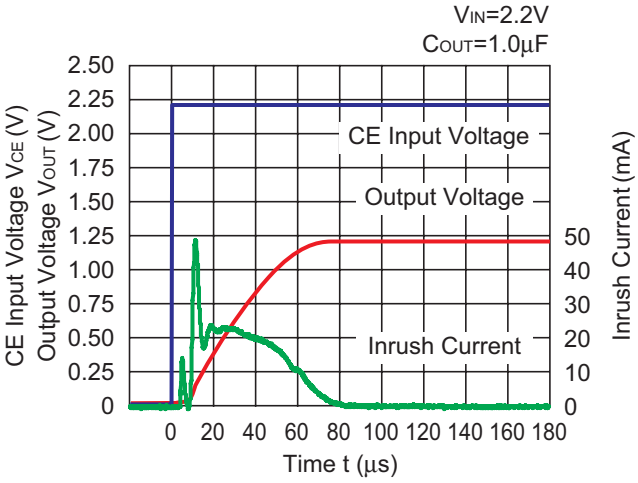

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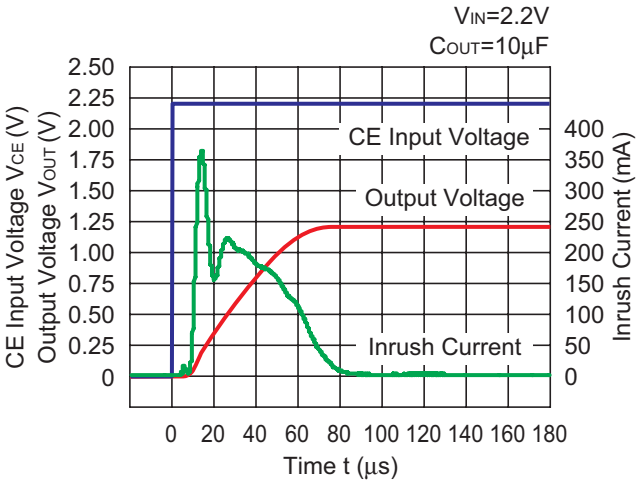

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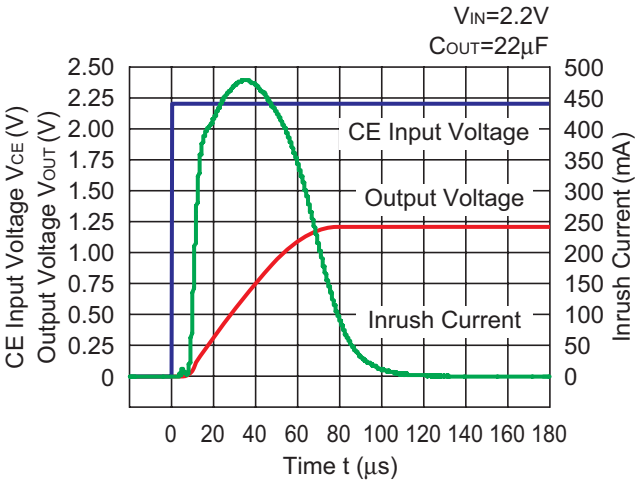

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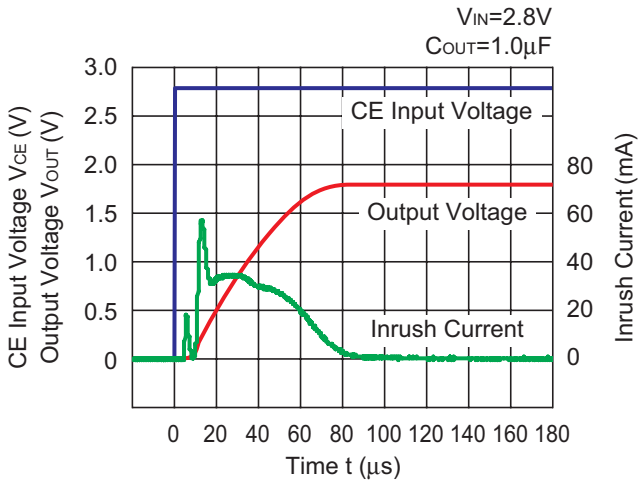

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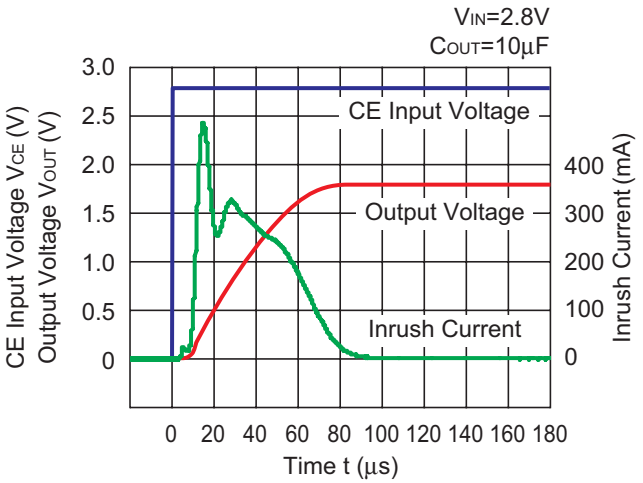

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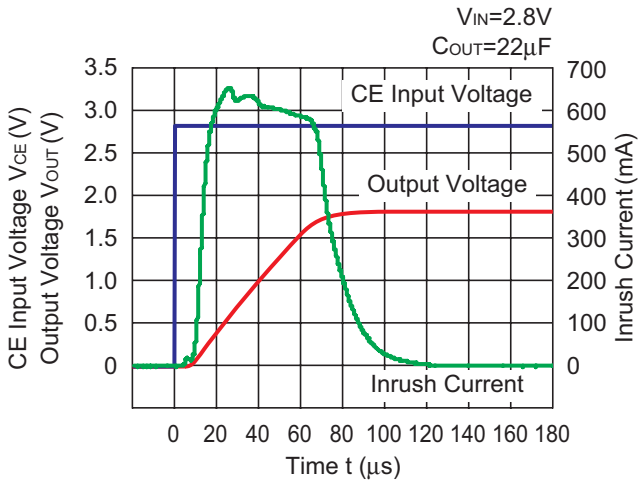


ESR vs. Output Current

When using these ICs, consider the following points:

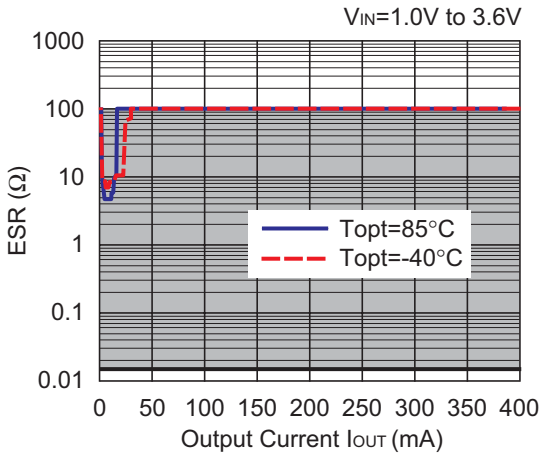
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is under 40μV (Avg.) are marked as the hatched area in the graph.

Measurement conditions

Frequency Band: 10Hz to 3MHz
Temperature : −40°C to 85°C
C1, C2 : 1.0μF MURATA GRM155B31A105KE15

If other than ceramic capacitors such as tantalum, the ESR of the capacitor might be higher than expected. This graph shows the stable area with ESR limit. In the actual evaluation, we used Murata GRM155B31A105KE15, therefore, bias characteristics of the same kind of ceramic capacitors are considered.

RP106x07xx



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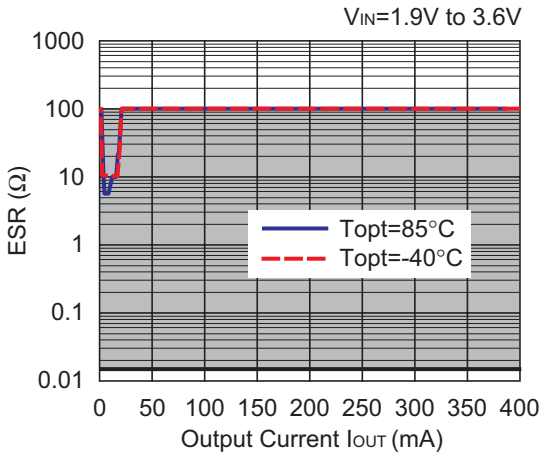

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