

## Low Voltage 400mA LDO Regulator

NO.EA-179-111020

### OUTLINE

The RP105x Series are 400mA output type CMOS-based voltage regulator ICs with capability of low input voltage (Min. 0.9V) and low output voltage (Min. 0.6V). These ICs are remarkably improved the performance at low input voltage compared with conventional low voltage LDOs, and two power supply voltage type. (Another power source,  $V_{BIAS}$  pin voltage must be Min. 2.4V). Each of these ICs consists of a voltage reference unit, an error amplifier, resistor-net for voltage setting, a current limit circuit to avoid the destruction, a UVLO circuit with monitoring input voltage, and so on.

The RP105x Series have the ultra low on resistance output driver, the on resistance is Typ.  $0.4\Omega$  ( $V_{OUT}=0.8V$ ,  $I_{OUT}=300mA$ ). The built-in driver is Nch MOSFET, thus the load transient response is excellent, (under the condition of the current between 1mA and 400mA,  $t_r=0.5\mu s$ , the undershoot level is approximately 50mV).

The output voltage of these ICs is fixed with high accuracy. Since the packages for these ICs are DFN(PLP)1212-6, SOT-23-5 and SC-88A therefore high density mounting of the ICs on boards is possible.

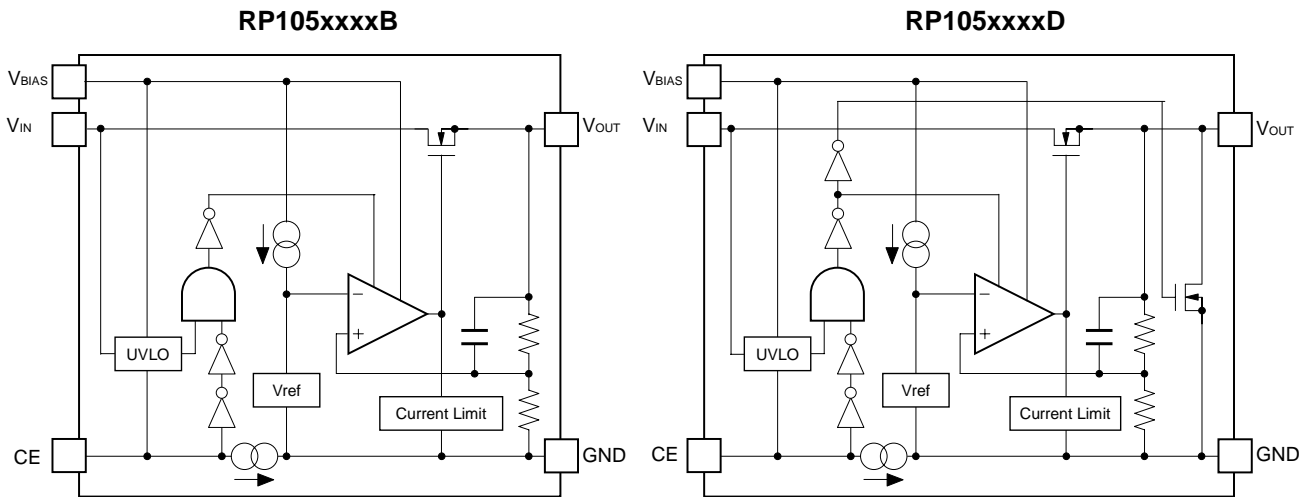
### FEATURES

- Supply Current ..... Typ.  $28\mu A$
- Supply Current (Standby Mode)..... Typ.  $0.1\mu A$
- Ripple Rejection ..... Typ. 80dB ( $f=1kHz$ ,  $V_{IN}$  Ripple)  
Typ. 50dB ( $f=1kHz$ ,  $V_{BIAS}$  Ripple)
- Output Voltage Range..... 0.6V to 1.5V (0.1V steps)  
(For other voltages, please refer to MARK INFORMATIONS.)
- Input Voltage Range ( $V_{BIAS}$ )..... 2.4V to 5.25V ( $V_{OUT} < 0.8V$ )  
Set  $V_{OUT}+1.6V$  to 5.25V ( $V_{OUT} \geq 0.8V$ )
- Input Voltage Range ( $V_{IN}$ ) ..... 0.9V to  $V_{BIAS}$  ( $V_{OUT} < 0.8V$ )  
Set  $V_{OUT}+0.1V$  to  $V_{BIAS}$  ( $V_{OUT} \geq 0.8V$ )
- Output Voltage Accuracy..... Typ.  $\pm 15mV$  ( $T_{opt}=25^{\circ}C$ )
- Temperature-Drift Coefficient of Output Voltage ..... Typ.  $\pm 50ppm/^{\circ}C$
- Dropout Voltage ..... Typ. 180mV ( $I_{OUT}=400mA$ ,  $V_{OUT}=1.5V$ ,  $V_{BIAS}=3.6V$ )
- Line Regulation ..... Typ. 0.02%/V
- Packages ..... DFN(PLP)1212-6, SC-88A, SOT-23-5
- Built-in Fold Back Protection Circuit ..... Typ. 120mA (Current at short mode)
- Ceramic capacitors are recommended.....  $C_{BIAS}=C_{IN}=1.0\mu F$  or more,  $C_{OUT}=2.2\mu F$  or more

### APPLICATIONS

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

## BLOCK DIAGRAMS



## 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
RP105Kxx1*-TR	DFN(PLP)1212-6	5,000 pcs	Yes	Yes
RP105Qxx2*-TR-FE	SC-88A	3,000 pcs	Yes	Yes
RP105Nxx1*-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

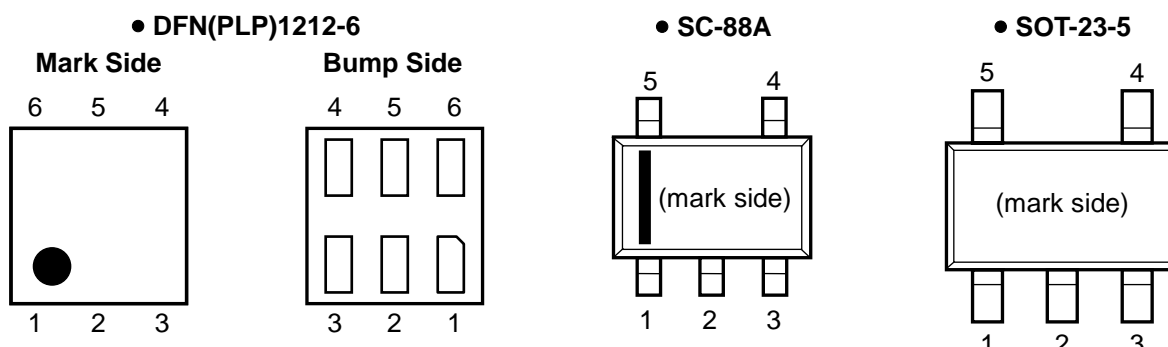
xx: The output voltage can be designated in the range from 0.6V(06) to 1.5V(15) in 0.1V steps.  
(For other voltages, please refer to MARK INFORMATION.)

\* : CE pin polarity and auto discharge function at off state are options as follows.

(B) "H" active, without auto discharge function at off state

(D) "H" active, with auto discharge function at off state

## PIN CONFIGURATIONS



## PIN DESCRIPTIONS

### • DFN(PLP)1212-6

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

### • SC-88A

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

### • SOT-23-5

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

## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
$V_{BIAS}$	Input Voltage	6.0	V
$V_{IN}$	Input Voltage (for Driver)	-0.3 to $V_{BIAS}+0.3$	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	500	mA
$P_D$	Power Dissipation (DFN(PLP)1212-6) *	400	mW
	Power Dissipation (SC-88A) *	380	
	Power Dissipation (SOT-23-5) *	420	
$T_{opt}$	Operating Temperature Range	-40 to 85	°C
$T_{stg}$	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

$V_{BIAS}=V_{CE}=3.6V$ ,  $V_{IN}=\text{Set } V_{OUT}+0.5V$ ,  $I_{OUT}=1mA$ ,  $C_{BIAS}=C_{IN}=1.0\mu F$ ,  $C_{OUT}=2.2\mu F$ , unless otherwise noted.

The specification in   is checked and guaranteed by design engineering at  $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ .

### • RP105x

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

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$V_{OUT}$	Output Voltage	$T_{opt}=25^{\circ}C$	Set $V_{OUT}$ -15mV		Set $V_{OUT}$ +15mV	V
		$-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$	Set $V_{OUT}$ -20mV		Set $V_{OUT}$ +20mV	V
$I_{OUT}$	Output Current		400			mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$1mA \leq I_{OUT} \leq 400mA$		30	50	mV
$V_{DIF}$	Dropout Voltage	Please refer to following data				
$I_{SS}$	Supply Current	$I_{OUT}=0mA$		28	40	$\mu A$
$I_{standby}$	Standby Current	$V_{CE}=0V$		0.1	3.0	$\mu A$
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$2.4V \leq V_{BIAS} \leq 5.0V$		0.02	0.1	%V
		Set $V_{OUT}+0.3V \leq V_{IN} \leq 2.4V$		0.02	0.1	
RR	Ripple Rejection	$I_{OUT}=30mA$ , $f=1kHz$ $V_{IN}$ Ripple 0.2Vp-p		80		dB
		$I_{OUT}=30mA$ , $f=1kHz$ $V_{BIAS}$ Ripple 0.2Vp-p		50		
$V_{BIAS}$	Input Voltage*	$V_{OUT} < 0.8V$	2.4		5.25	V
		$V_{OUT} \geq 0.8V$	Set $V_{OUT}+1.6$		5.25	
$V_{IN}$	Input Voltage (for Driver)*	$V_{OUT} < 0.8V$	0.9		$V_{BIAS}$	V
		$V_{OUT} \geq 0.8V$	Set $V_{OUT}+0.1$		$V_{BIAS}$	
$\frac{\Delta V_{OUT}}{\Delta T_{opt}}$	Output Voltage Temperature Coefficient	$-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$		$\pm 50$		ppm/ $^{\circ}C$
$I_{SC}$	Short Current Limit	$V_{OUT}=0V$		120		mA
$I_{CEPD}$	CE Pull-down Constant Current			1.0		$\mu A$
$V_{CEH}$	CE Input Voltage "H"		0.8			V
$V_{CEL}$	CE Input Voltage "L"				0.3	V
$V_{IN\_UVLO}$	$V_{IN}$ Under Voltage Lock Out	$I_{OUT}=1.0\mu A$		Set $V_{OUT}$ +50mV	Set $V_{OUT}$ +100mV	V
$t_{delay}$	Detector Delay Time			100		$\mu s$
$e_n$	Output Noise	BM=10Hz to 100kHz $I_{OUT}=30mA$ , Set $V_{OUT}=0.6V$		70		$\mu V_{rms}$
$R_{LOW}$	Nch On Resistance For auto discharge (only D version)	$V_{BIAS}=3.6V$ , $V_{CE}="L"$		50		$\Omega$

\*) If Input Voltage range is between 5.25V and 5.50V, the total operational time must be within 500hrs.

All of units are tested and specified under load conditions such that  $T_j \approx T_{opt}=25^{\circ}C$  except for Output Noise, Ripple Rejection, Output Voltage Temperature Coefficient.

• Dropout Voltage

Set $V_{OUT}$	$V_{BIAS}$	$V_{GS}$	$V_{DIF} (I_{OUT}=300mA) (V)$		$V_{DIF} (I_{OUT}=400mA) (V)$	
			Typ.	Max.	Typ.	Max.
0.6V	3.6V	3.0V	0.115	0.180	0.180	0.320
0.7V	3.6V	2.9V	0.120	0.190	0.180	0.320
0.8V	3.6V	2.8V	0.120	0.190	0.180	0.300
0.9V	3.6V	2.7V	0.120	0.190	0.180	0.300
1.0V	3.6V	2.6V	0.120	0.190	0.180	0.280
1.1V	3.6V	2.5V	0.130	0.200	0.180	0.280
1.2V	3.6V	2.4V	0.130	0.200	0.180	0.280
1.3V	3.6V	2.3V	0.130	0.200	0.180	0.260
1.4V	3.6V	2.2V	0.130	0.200	0.180	0.260
1.5V	3.6V	2.1V	0.130	0.200	0.180	0.260

• Dropout Voltage ( $V_{GS}(V)$ ,  $V_{DIF}(V)$ ,  $I_{OUT}=200mA$ )

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

Set $V_{OUT}$	$V_{BIAS}=2.5V$		$V_{BIAS}=3.0V$		$V_{BIAS}=3.3V$		$V_{BIAS}=3.6V$		$V_{BIAS}=4.2V$		$V_{BIAS}=5.0V$	
	$V_{GS} (V)$	$V_{DIF} (V)$	$V_{GS} (V)$	$V_{DIF} (V)$	$V_{GS} (V)$	$V_{DIF} (V)$	$V_{GS} (V)$	$V_{DIF} (V)$	$V_{GS} (V)$	$V_{DIF} (V)$	$V_{GS} (V)$	$V_{DIF} (V)$
0.6V	1.9	0.094	2.4	0.093	2.7	0.093	3.0	0.092	3.6	0.092	4.4	0.091
0.7V	1.8	0.094	2.3	0.093	2.6	0.093	2.9	0.092	3.5	0.092	4.3	0.092
0.8V	1.7	0.098	2.2	0.093	2.5	0.093	2.8	0.092	3.4	0.092	4.2	0.092
0.9V	1.6	0.098	2.1	0.094	2.4	0.093	2.7	0.092	3.3	0.092	4.1	0.092
1.0V			2.0	0.094	2.3	0.093	2.6	0.092	3.2	0.092	4.0	0.092
1.1V			1.9	0.096	2.2	0.094	2.5	0.094	3.1	0.093	3.9	0.093
1.2V			1.8	0.098	2.1	0.096	2.4	0.095	3.0	0.095	3.8	0.094
1.3V			1.7	0.098	2.0	0.096	2.3	0.095	2.9	0.095	3.7	0.095
1.4V			1.6	0.098	1.9	0.096	2.2	0.095	2.8	0.095	3.6	0.095
1.5V					1.8	0.096	2.1	0.095	2.7	0.095	3.5	0.095

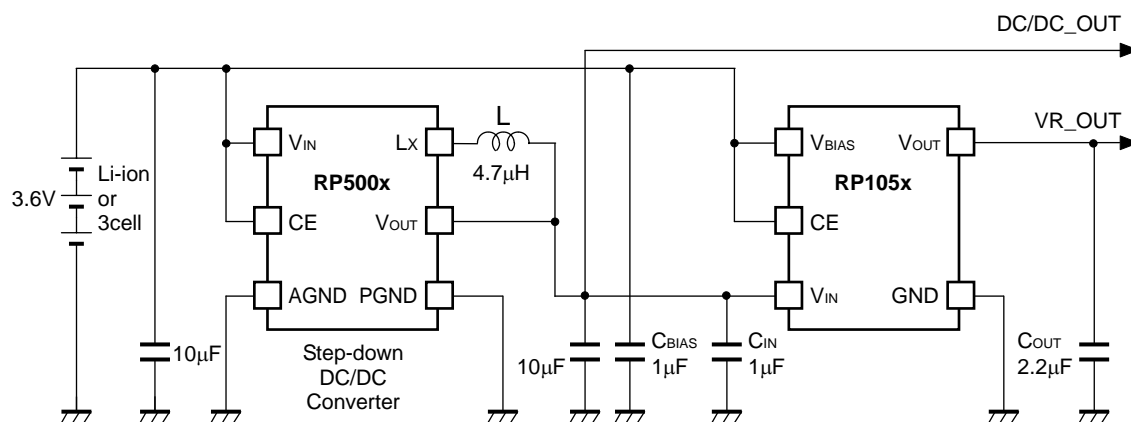
The specification in   is checked and guaranteed by design engineering at  $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ .  
 All of units are tested and specified under load conditions such that  $T_j \approx T_{opt} = 25^{\circ}C$  except for Output Noise, Ripple Rejection and Output Voltage Temperature Coefficient items.

   $V_{BIAS}$  pin voltage must be equal or more than Set  $V_{OUT} + 1.6V$ .

**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 APPLICATION



(External Components)

$C_{OUT}$	: Ceramic Capacitor	2.2 $\mu$ F	MURATA: GRM155B30J225ME15
$C_{BIAS}, C_{IN}$	: Ceramic Capacitor	1.0 $\mu$ F	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 for  $C_{OUT}$  with the capacity of equal or more than 2.2 $\mu$ F.

(Note: If tantalum capacitors are connected as  $C_{OUT}$ , and if the equivalent series resistor (ESR) value is large, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

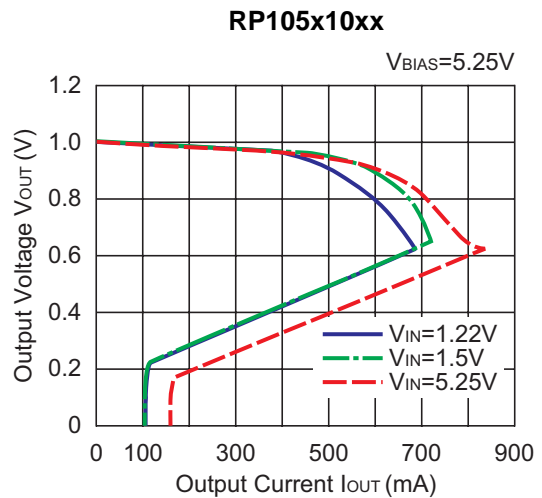
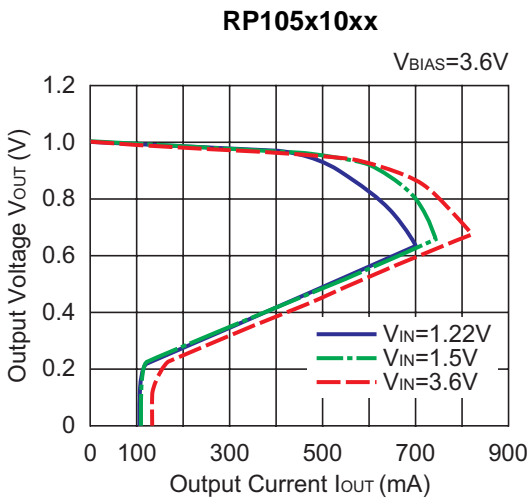
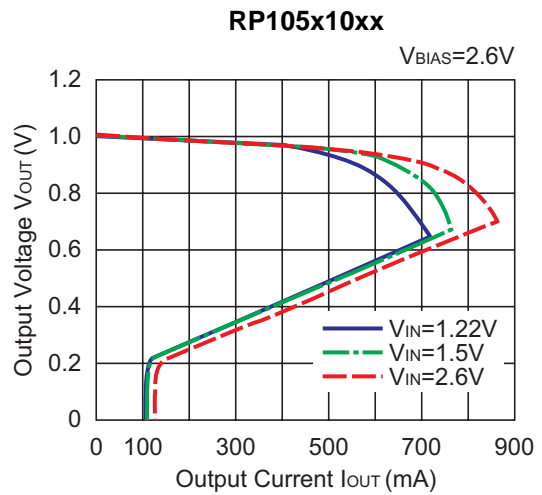
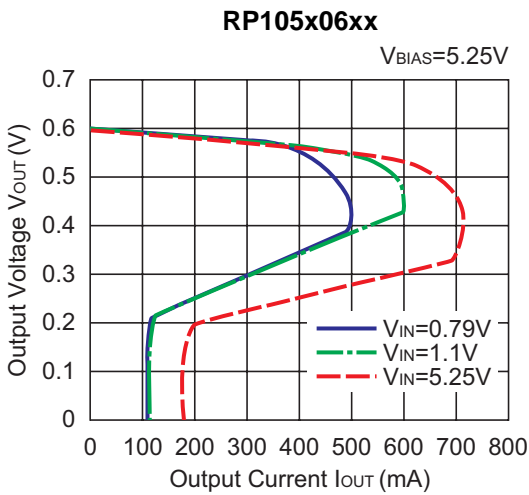
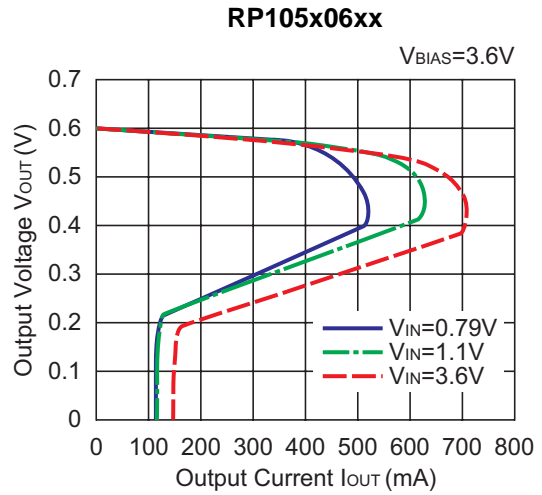
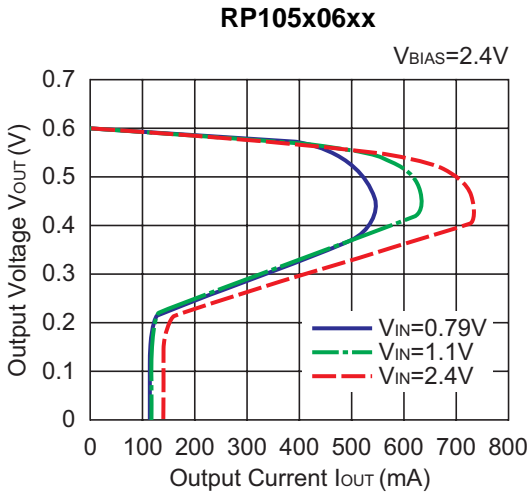
### PCB Layout

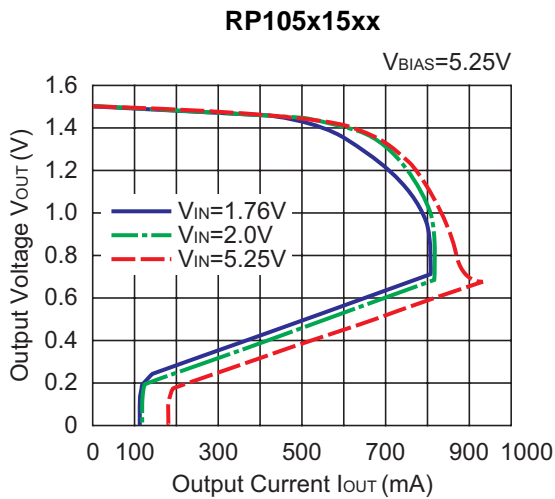
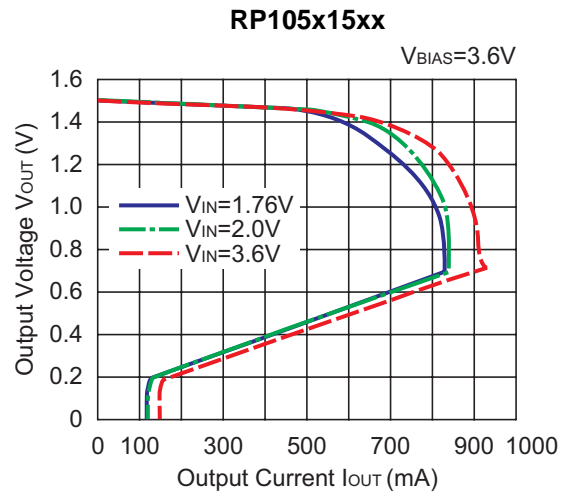
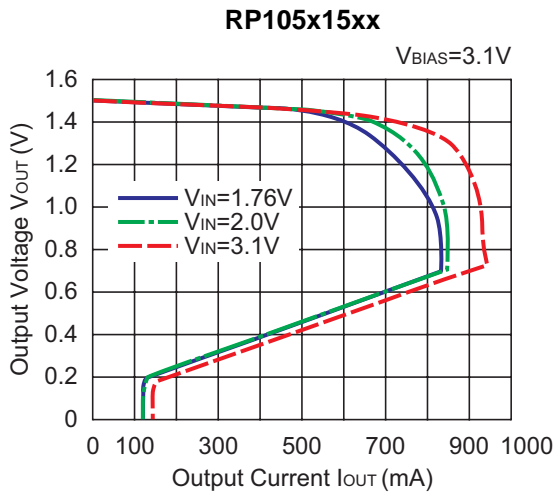
Make  $V_{BIAS}$ ,  $V_{IN}$ , and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor with a capacitance value as much as 1.0 $\mu$ F or more between  $V_{BIAS}$  pin and GND pin, between  $V_{IN}$  pin and GND pin, and as close as possible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

Set external components, especially the output capacitor, as close as possible to the ICs, and make wiring as short as possible.  $V_{IN}$  source is supposed to be the output of the DC/DC converter. The value should be equal or lower than  $V_{BIAS}$  voltage.

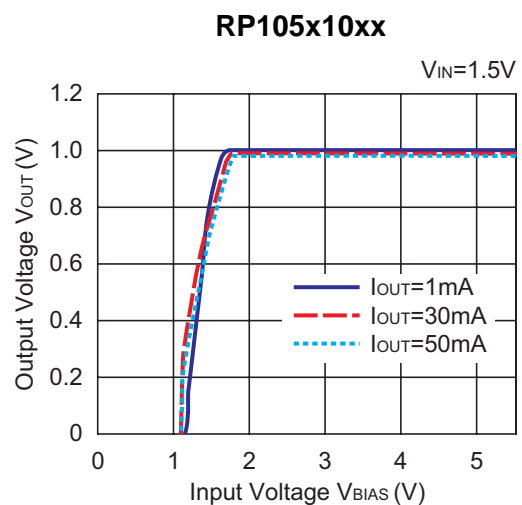
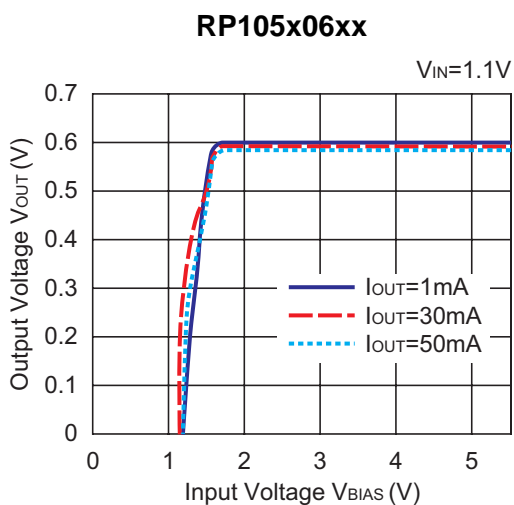
## TYPICAL CHARACTERISTICS

### 1) Output Voltage vs. Output Current ( $C_{BIAS}=1.0\mu F$ , $C_{IN}=C_{OUT}=2.2\mu F$ , $T_{opt}=25^\circ C$ )

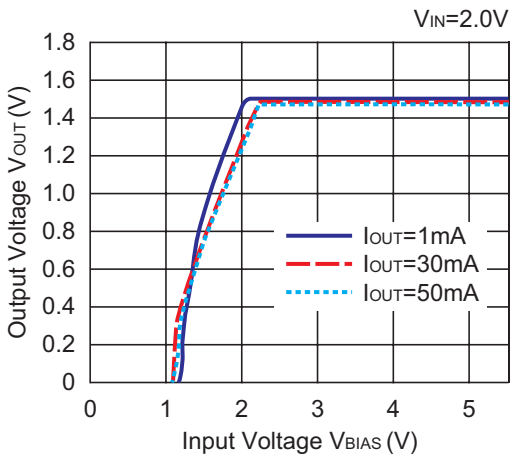




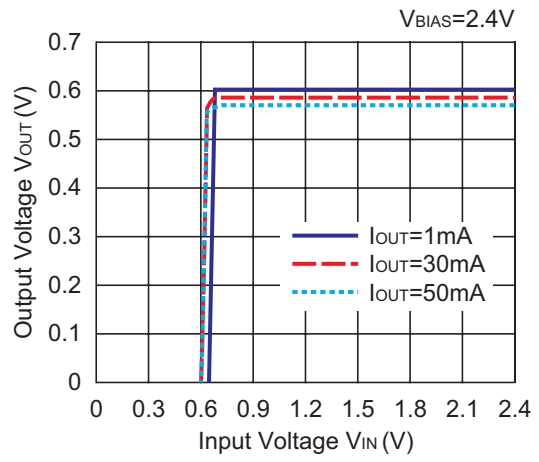
**2) Output Voltage vs. Input Voltage ( $C_{BIAS}=1.0\mu F$ ,  $C_{IN}=C_{OUT}=2.2\mu F$ ,  $T_{opt}=25^{\circ}C$ )**



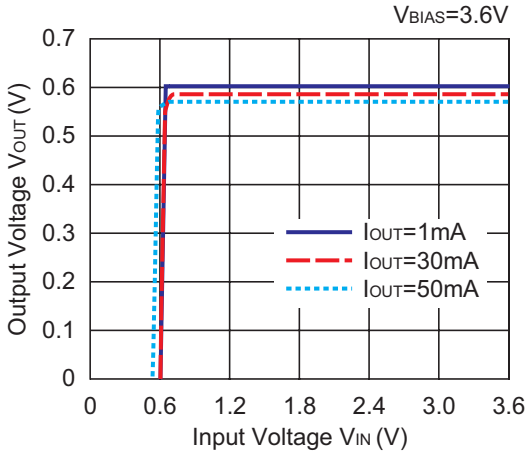
RP105x15xx



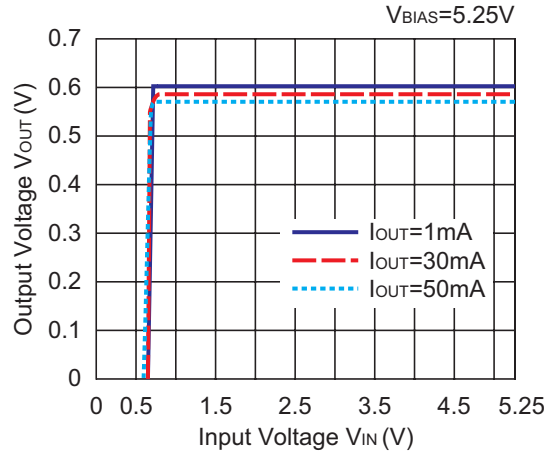
RP105x06xx



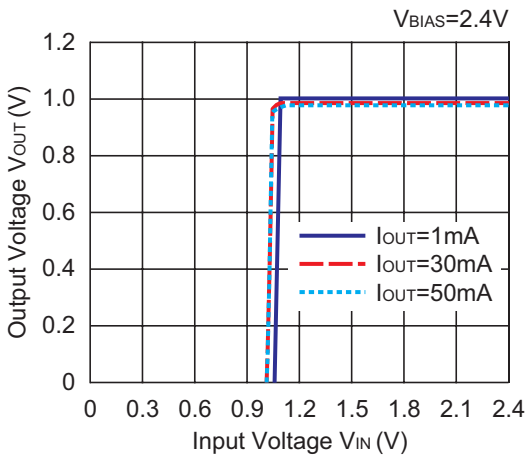
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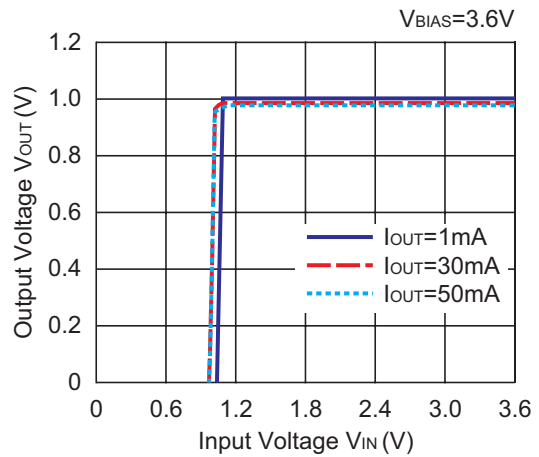
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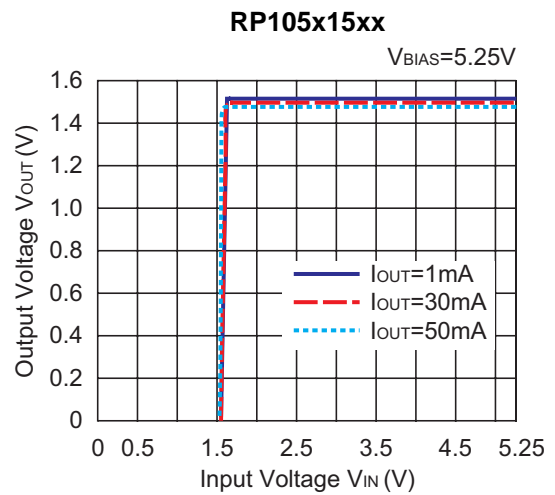
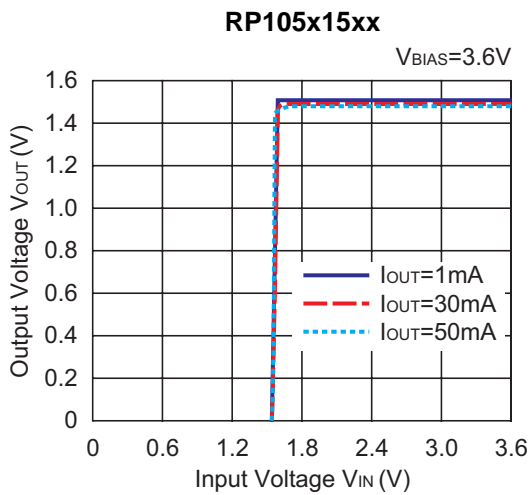
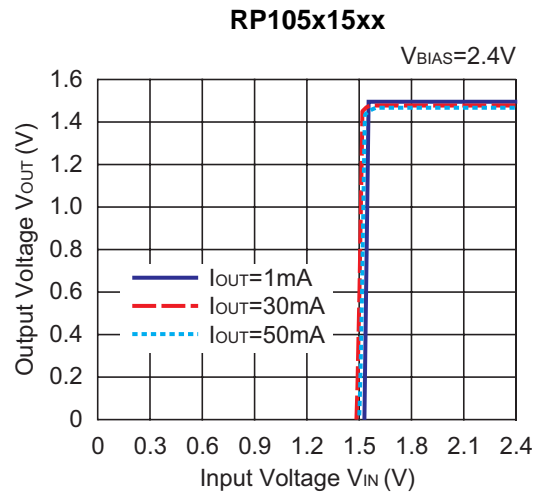
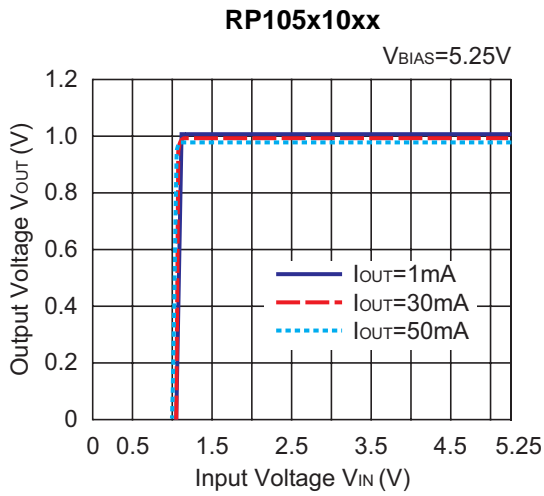


RP105x10xx

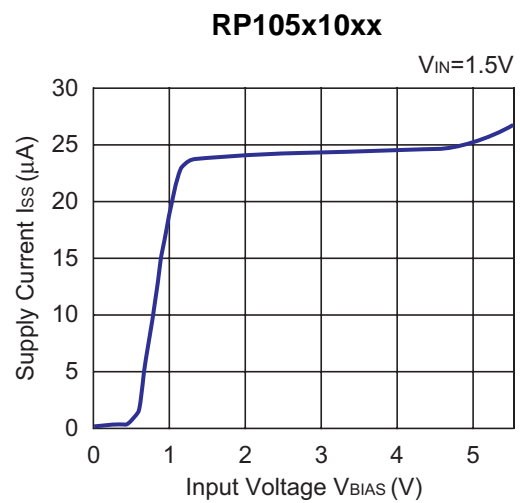
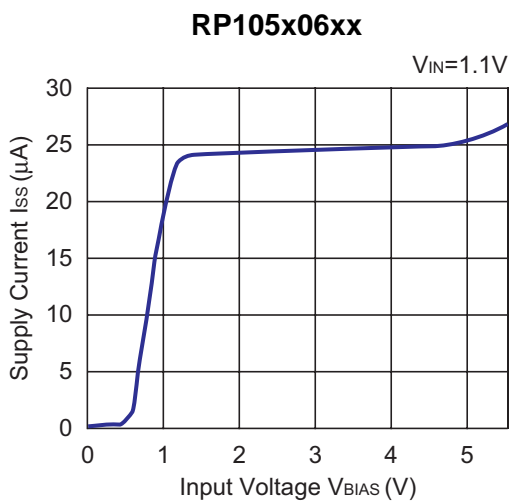


RP105x10xx



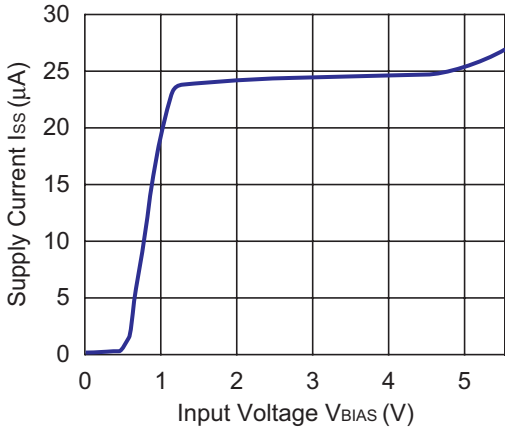


**3) Supply Current vs. Input Voltage ( $C_{BIAS}=C_{IN}=C_{OUT}=none$ ,  $T_{opt}=25^{\circ}C$ )**



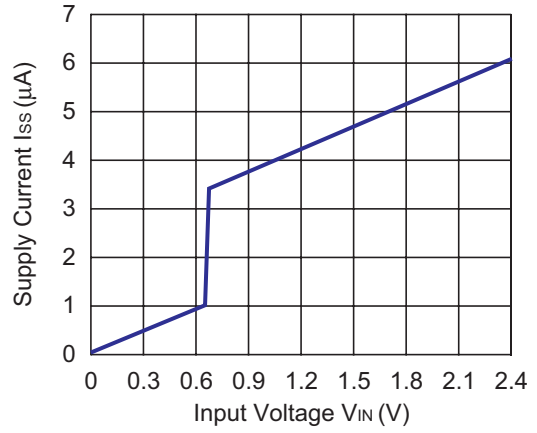
RP105x15xx

$V_{IN}=2.0V$



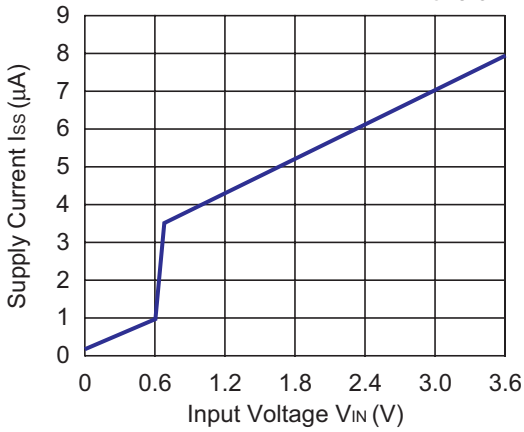
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$V_{BIAS}=2.4V$



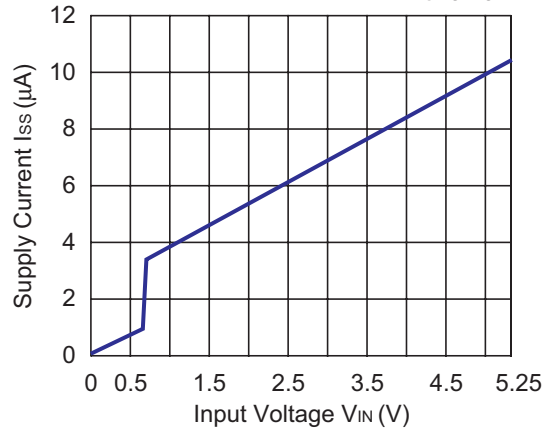
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$V_{BIAS}=3.6V$



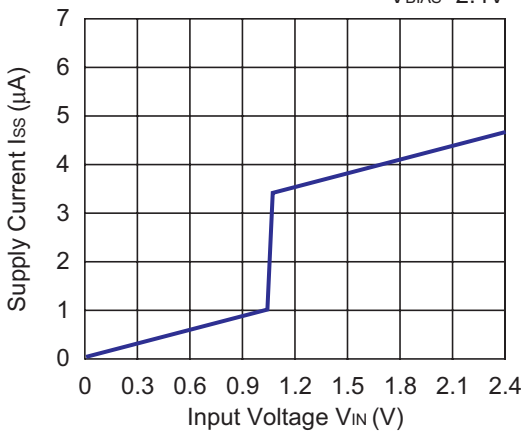
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$V_{BIAS}=5.25V$



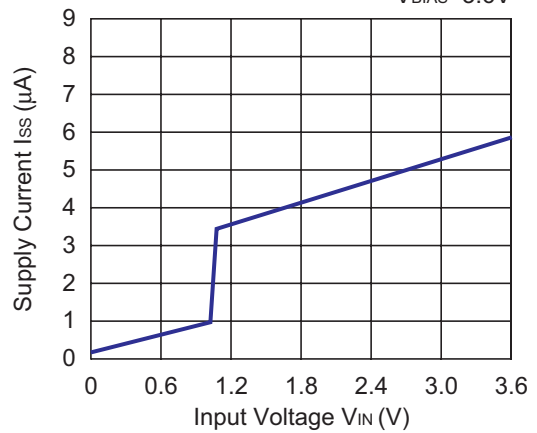
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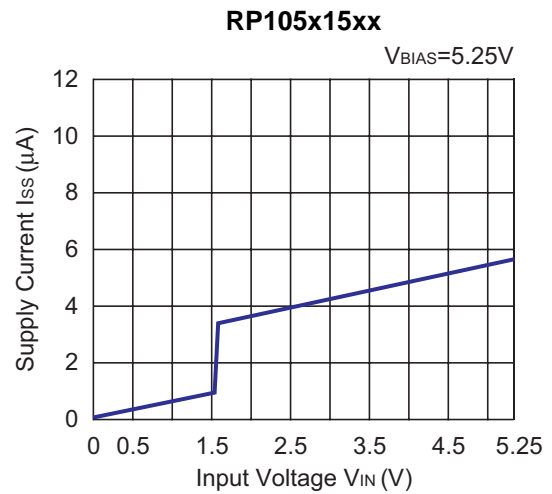
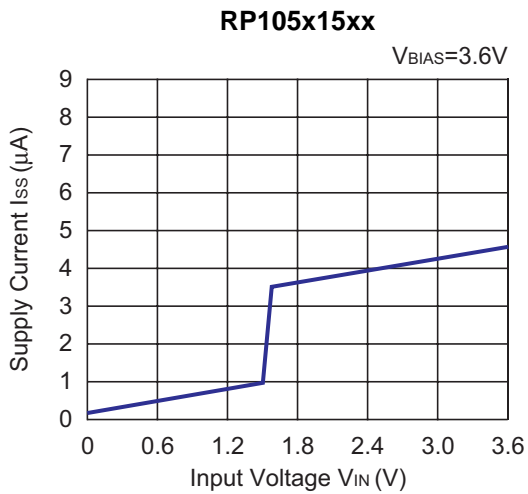
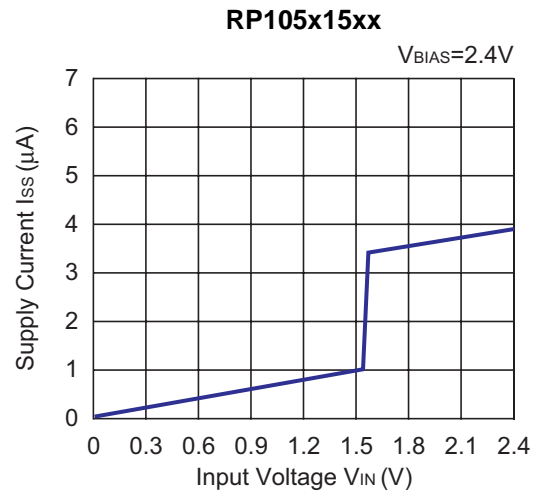
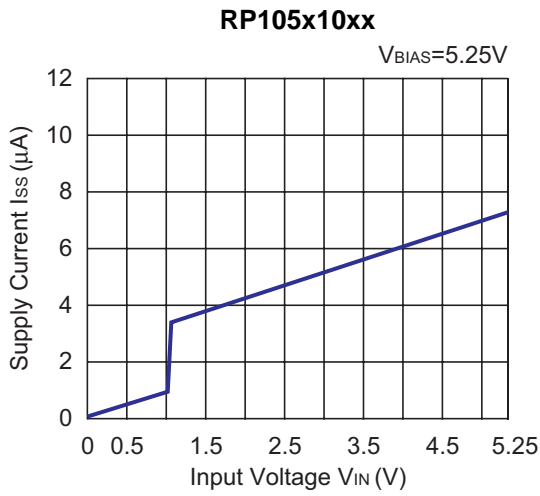
$V_{BIAS}=2.4V$



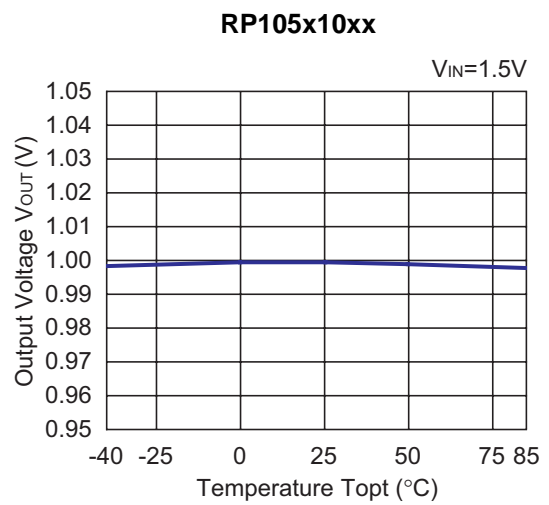
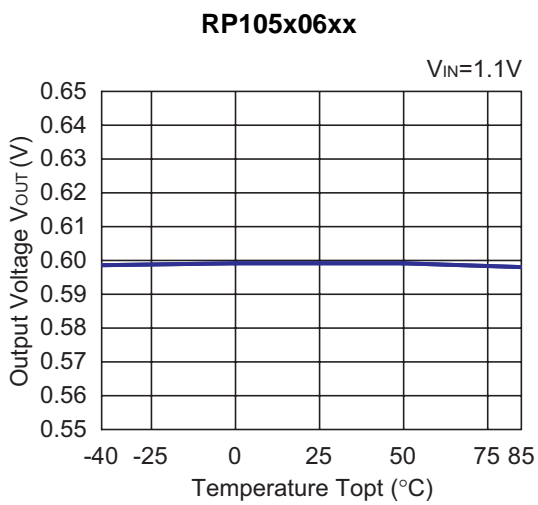
RP105x10xx

$V_{BIAS}=3.6V$

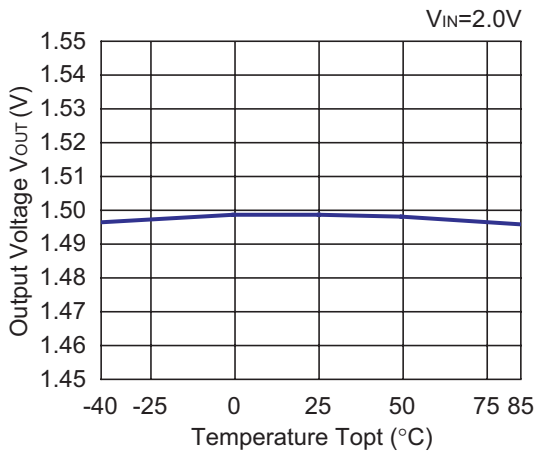




**4) Output Voltage vs. Temperature ( $C_{BIAS}=1.0\mu F$ ,  $C_{IN}=C_{OUT}=2.2\mu F$ ,  $I_{OUT}=1mA$ ,  $V_{BIAS}=3.6V$ )**

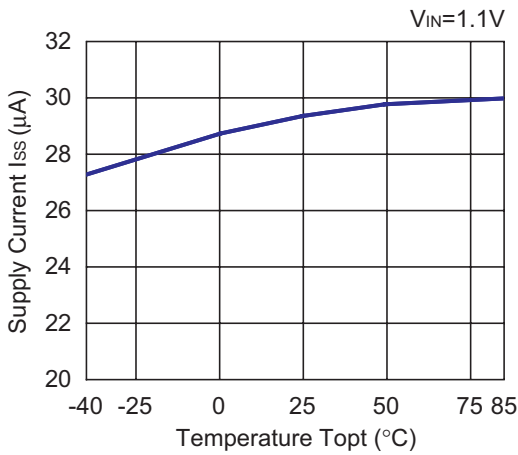


RP105x15xx

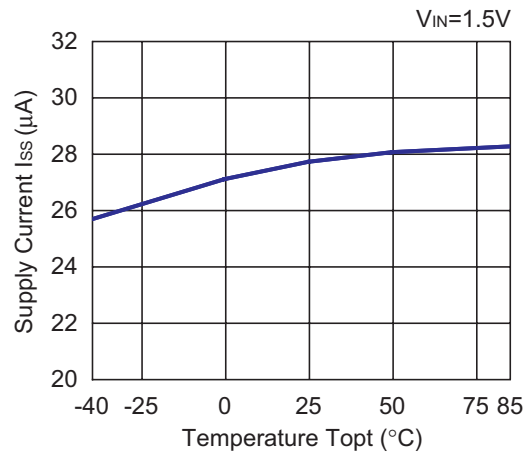


5) Supply Current vs. Temperature ( $C_{BIAS}=C_{IN}=C_{OUT}=none$ ,  $V_{BIAS}=3.6V$ )

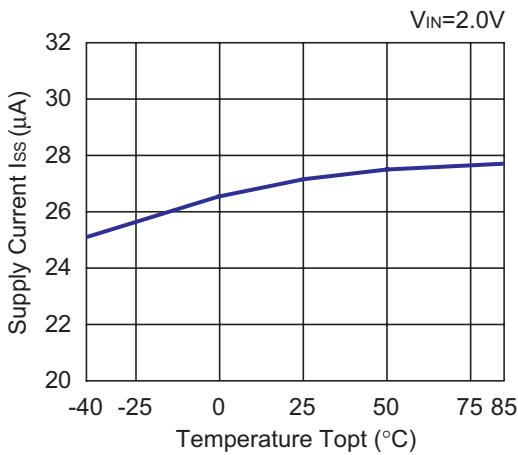
RP105x06xx



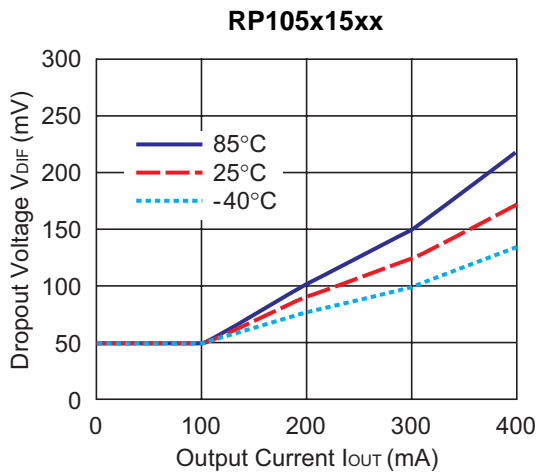
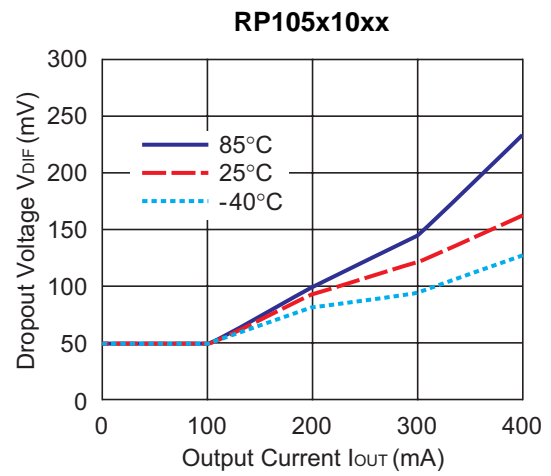
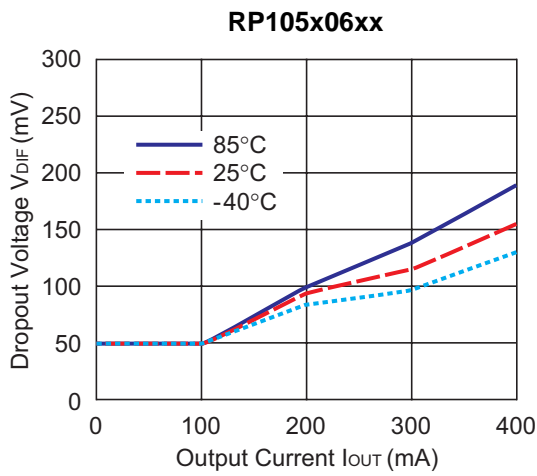
RP105x10xx



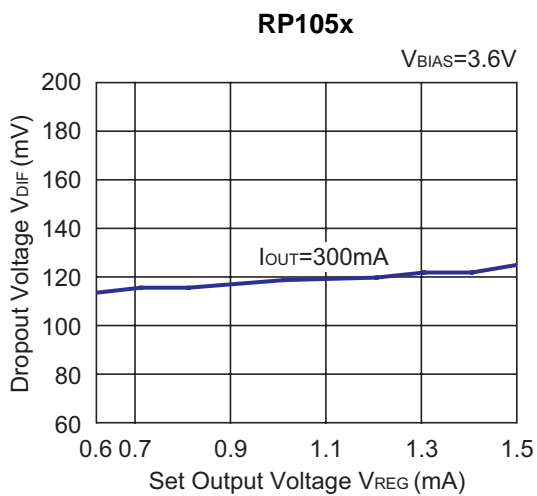
RP105x15xx



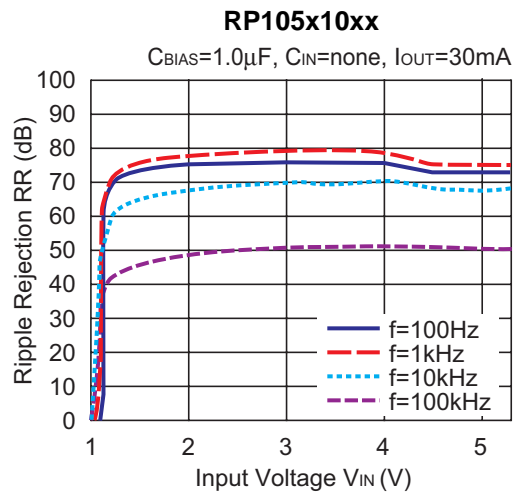
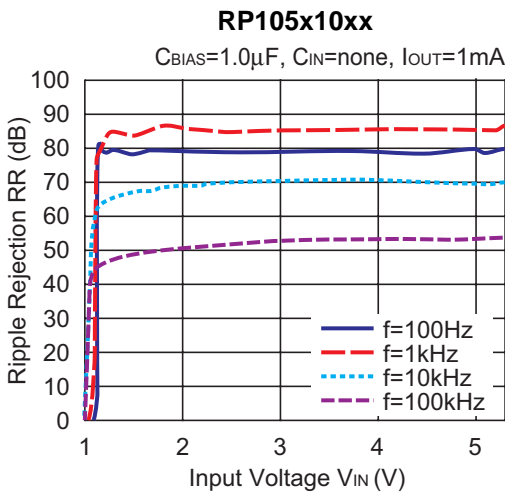
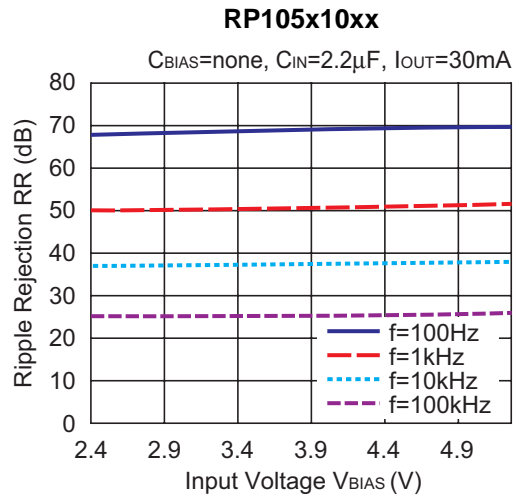
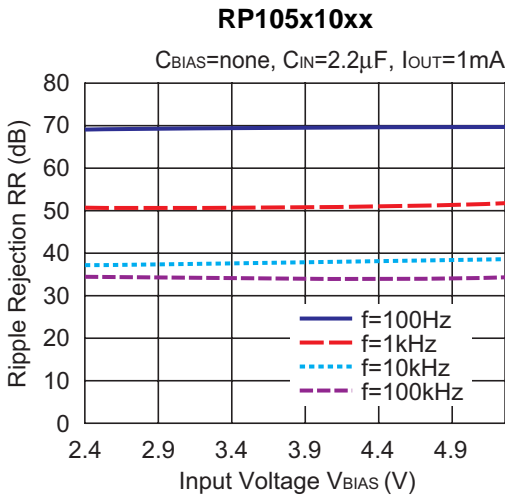
6) Dropout Voltage vs. Output Current ( $C_{BIAS}=1.0\mu F$ ,  $C_{IN}=C_{OUT}=2.2\mu F$ )



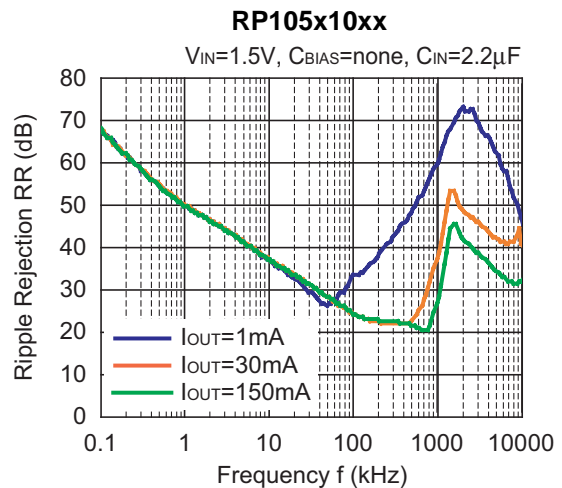
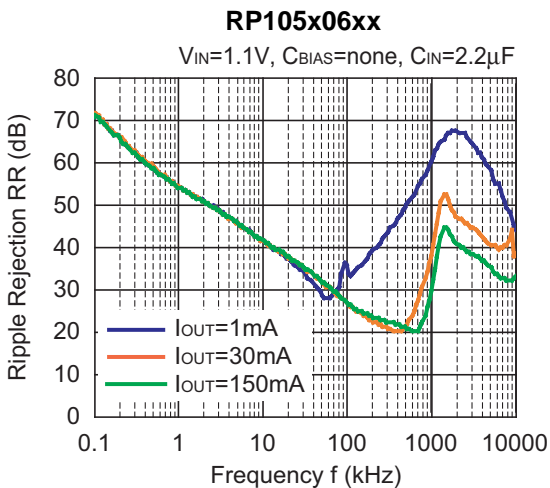
7) Dropout Voltage vs. Set Output Voltage

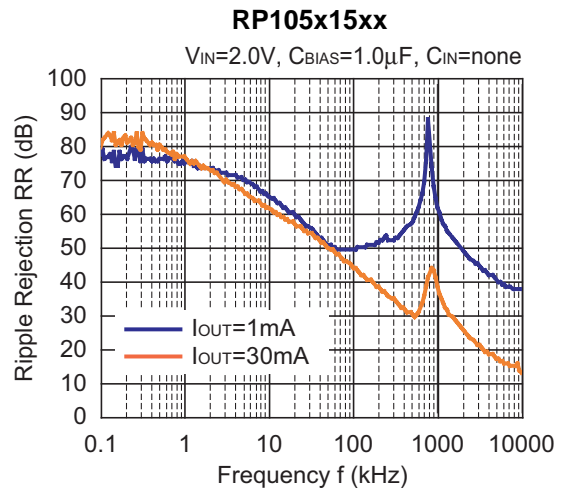
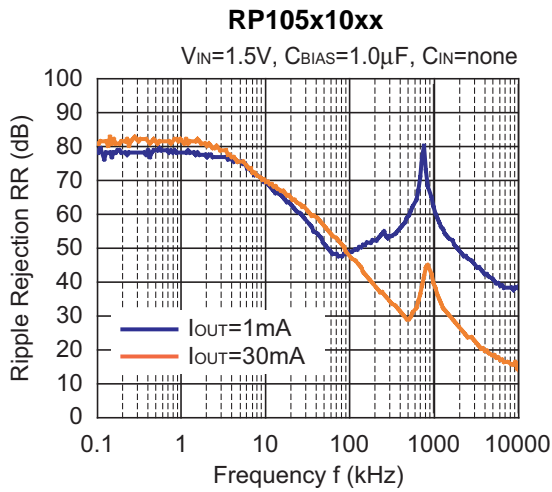
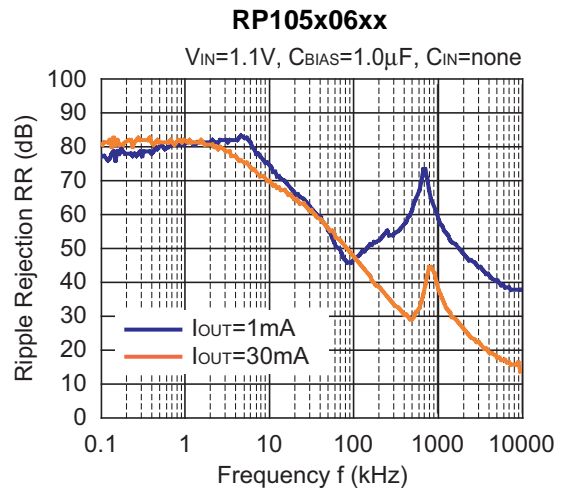
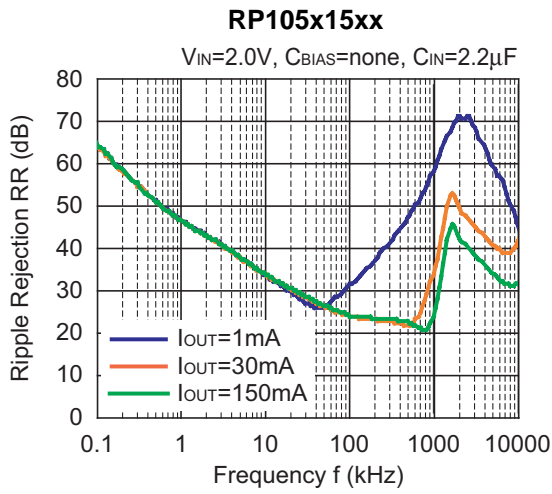


8) Ripple Rejection vs. Input Bias Voltage ( $C_{OUT}=2.2\mu F$ , Ripple=0.2Vp-p,  $T_{opt}=25^{\circ}C$ )

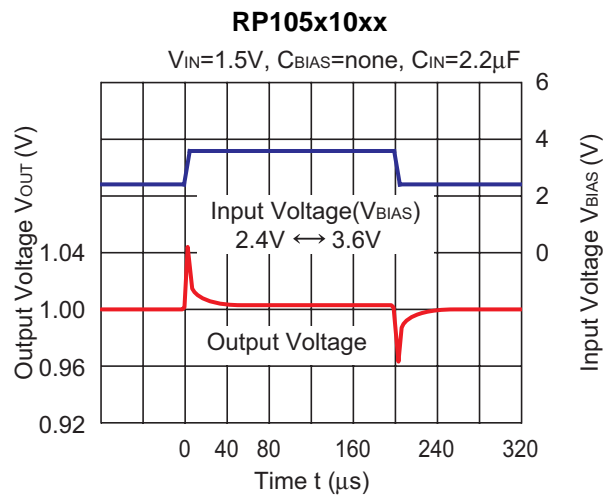
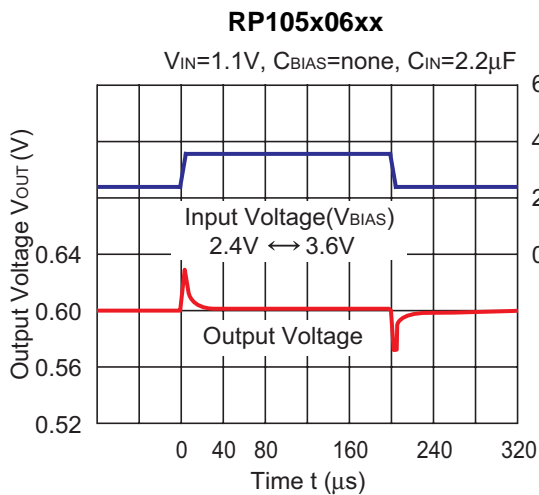


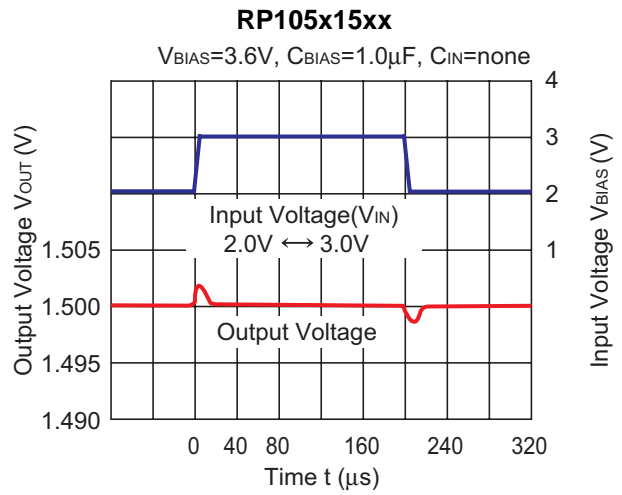
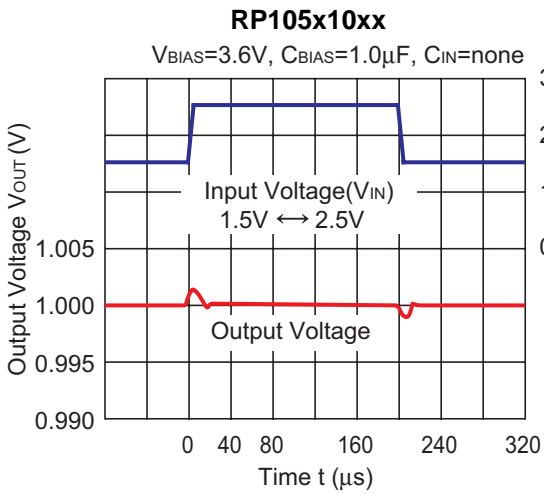
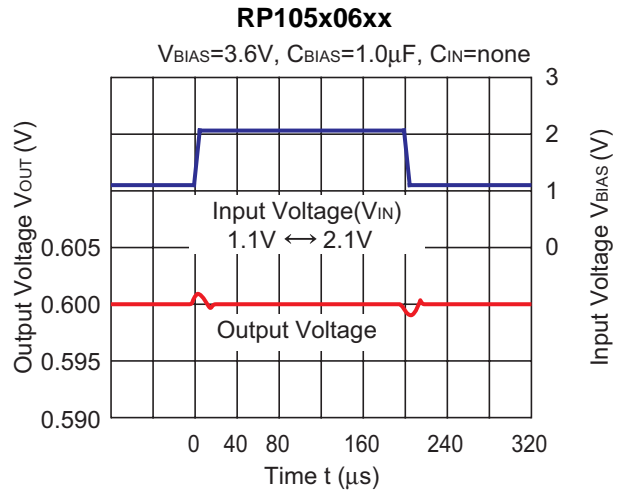
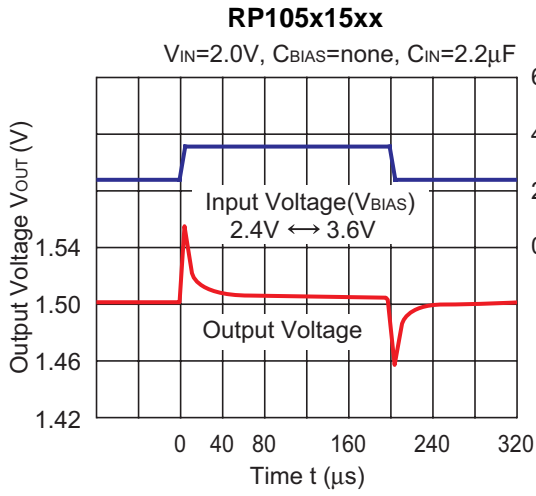
9) Ripple Rejection vs. Frequency ( $V_{BIAS}=3.6V$ ,  $C_{OUT}=2.2\mu F$ ,  $T_{opt}=25^{\circ}C$ )



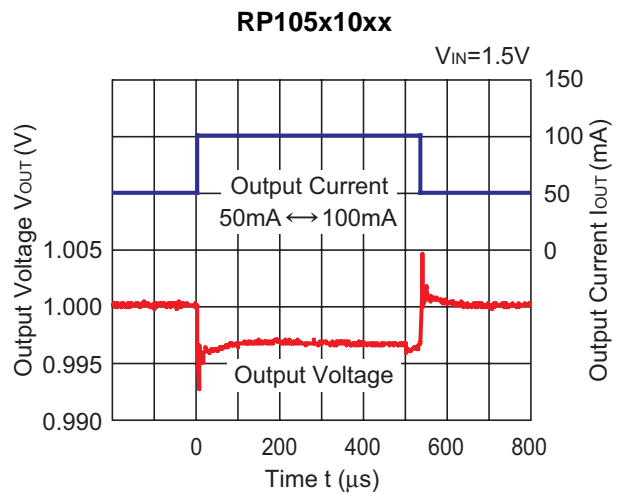
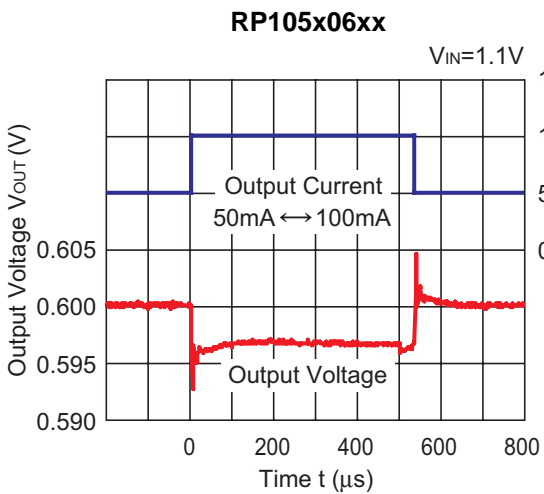


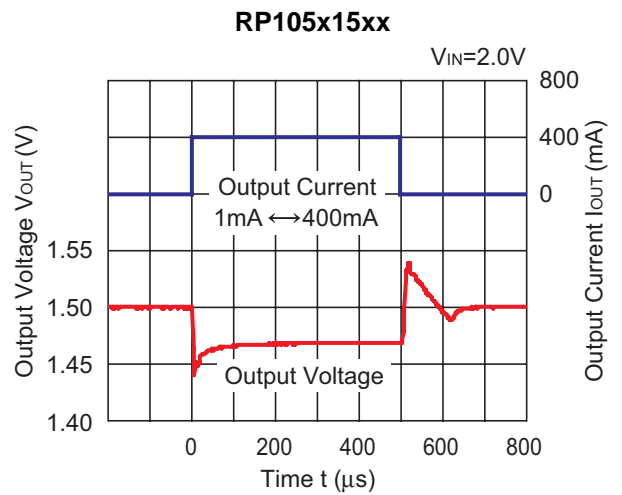
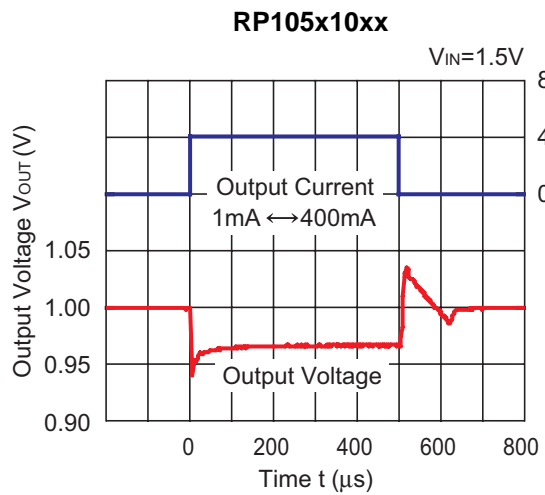
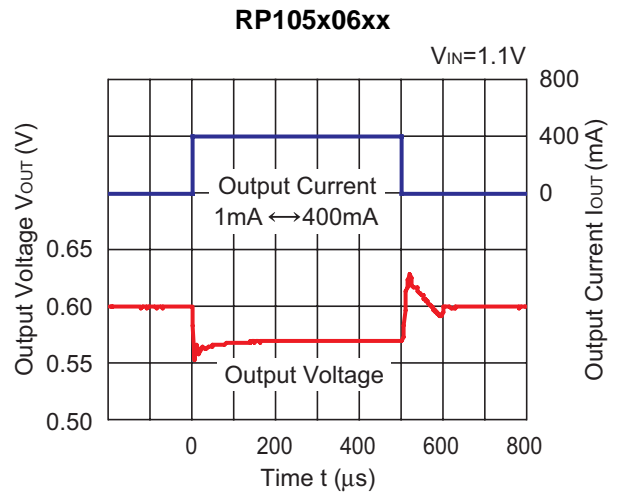
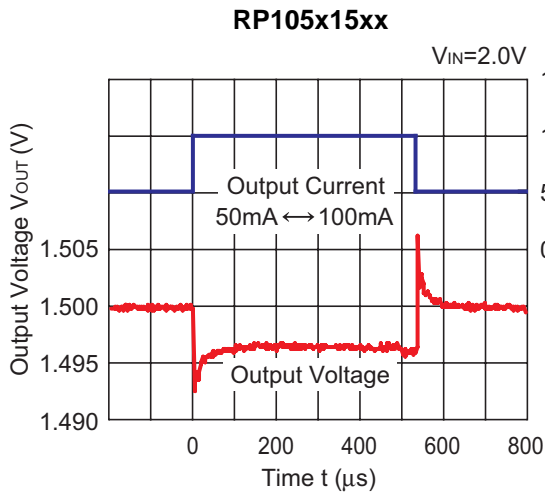
**10) Input Transient Response ( $I_{OUT}=30mA, C_{OUT}=1.0\mu F, t_r=t_f=5\mu s, T_{opt}=25^\circ C$ )**



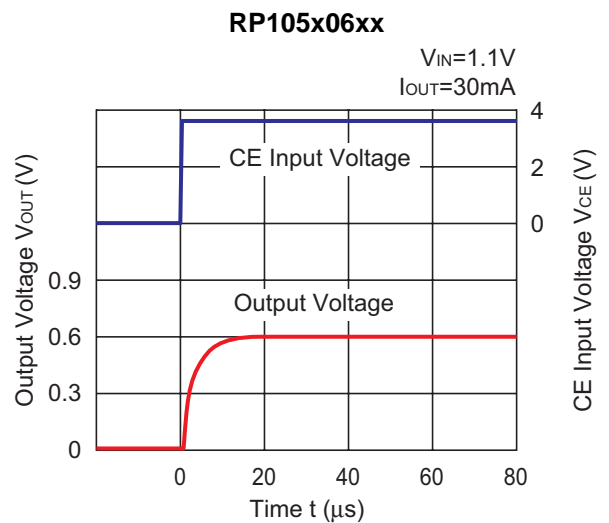
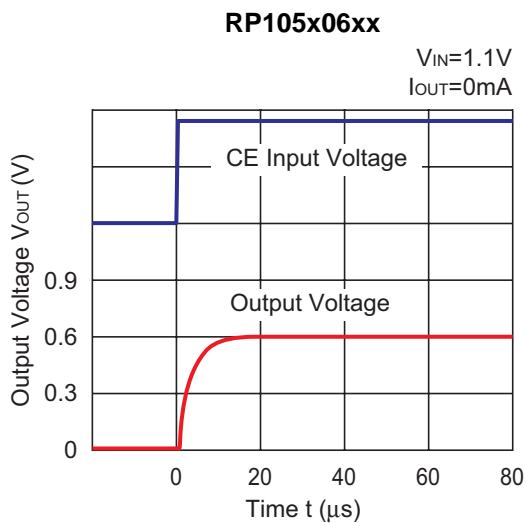


**11) Load Transient Response ( $V_{BIAS}=3.6V, C_{BIAS}=1.0\mu F, C_{IN}=C_{OUT}=2.2\mu F, tr=tf=0.5\mu s, T_{opt}=25^{\circ}C$ )**

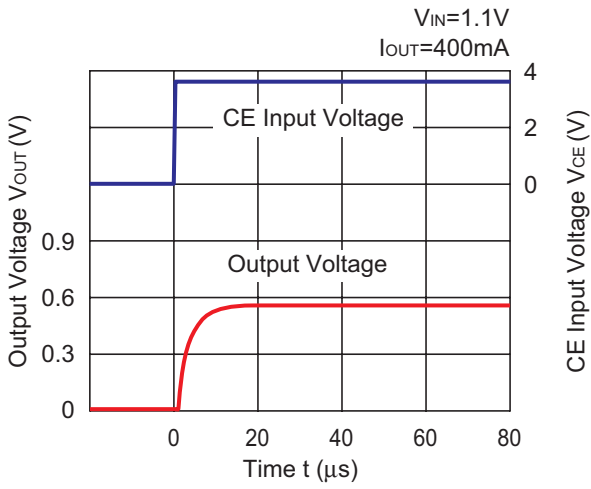




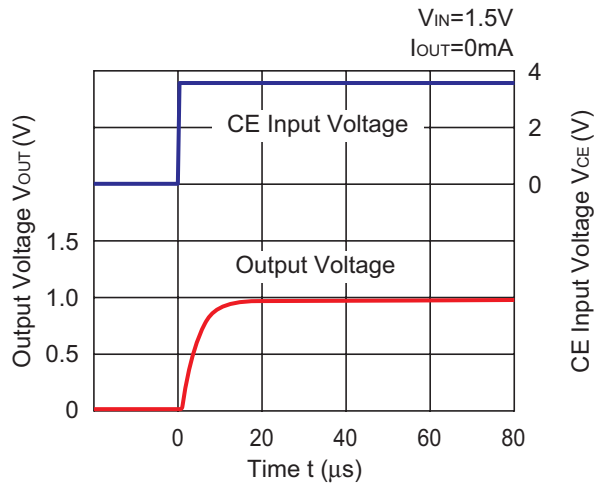
**12) Turn On Speed with CE pin ( $V_{BIAS}=3.6V$ ,  $C_{BIAS}=1.0\mu F$ ,  $C_{IN}=C_{OUT}=2.2\mu F$ ,  $T_{opt}=25^{\circ}C$ )**



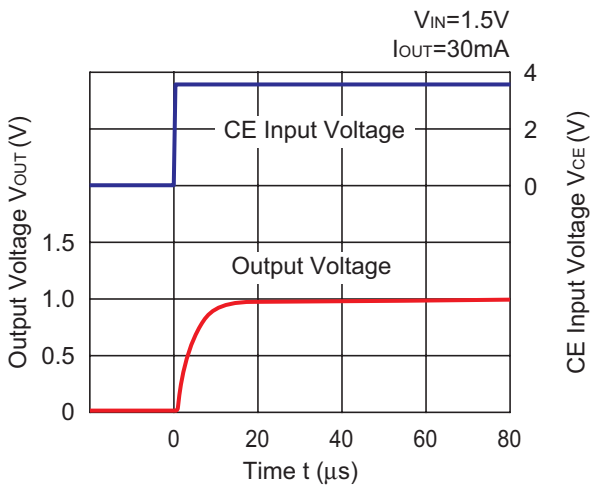
**RP105x06xx**



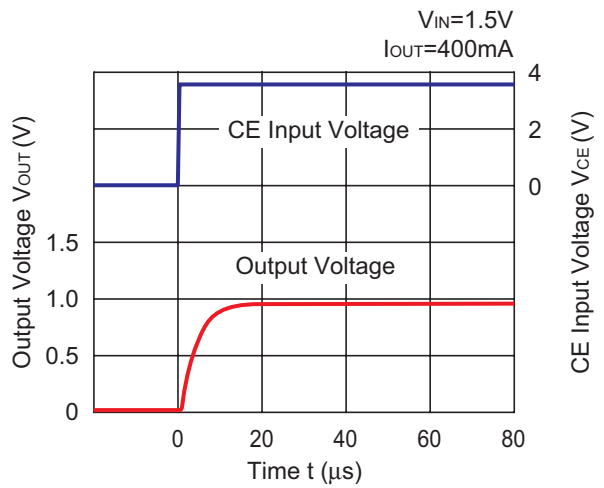
**RP105x10xx**



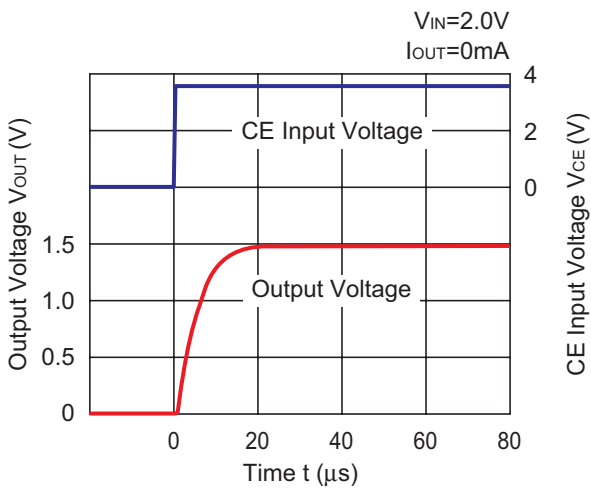
**RP105x10xx**



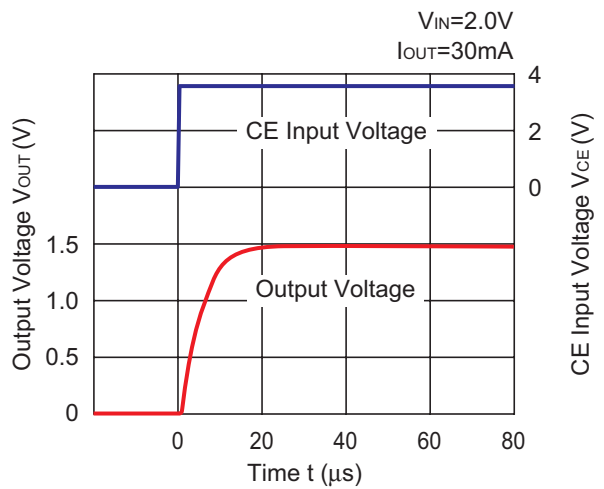
**RP105x10xx**

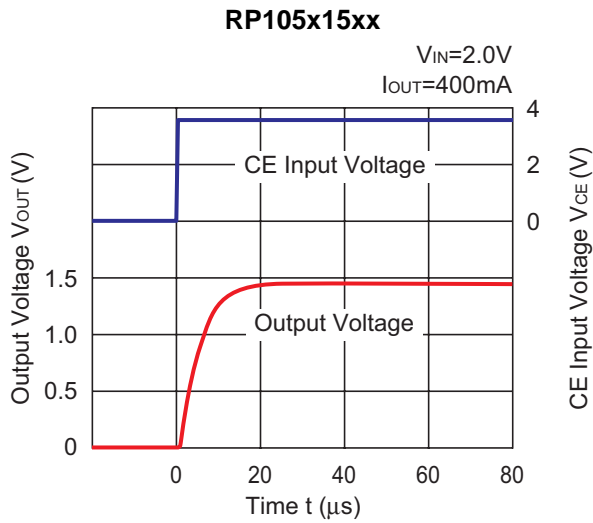


**RP105x15xx**

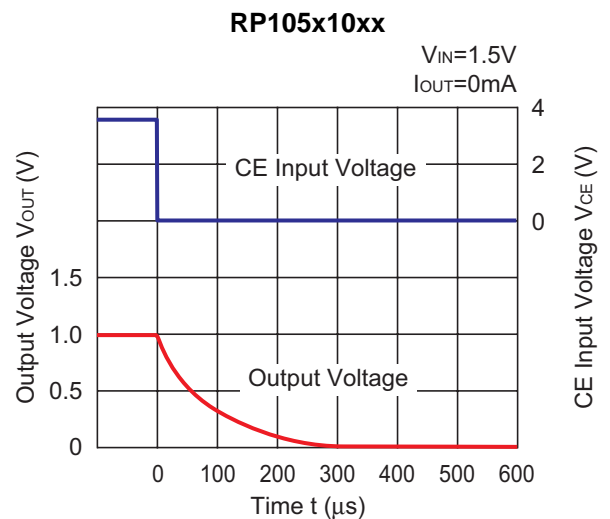
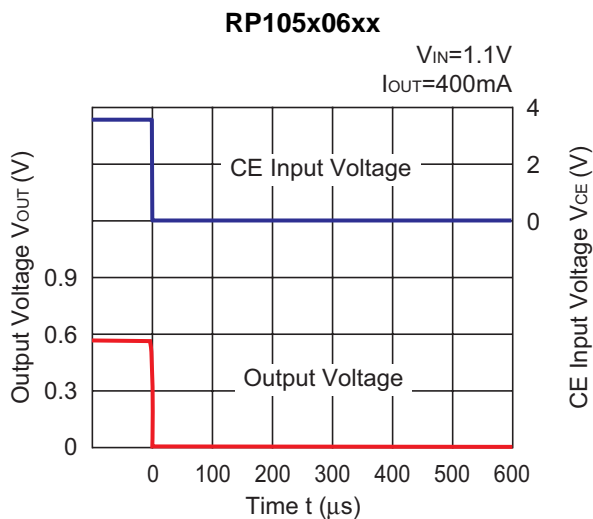
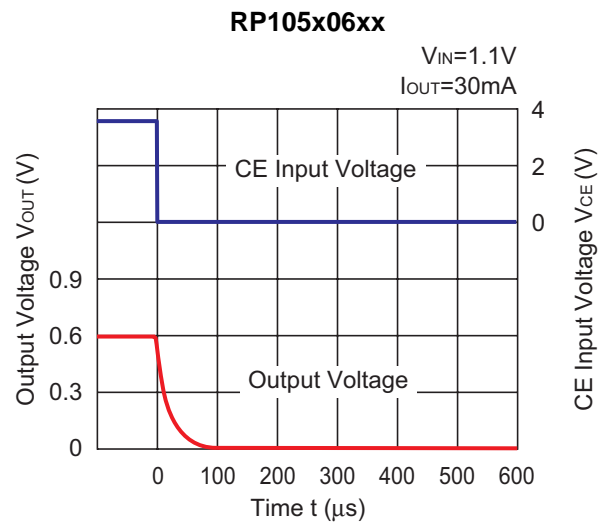
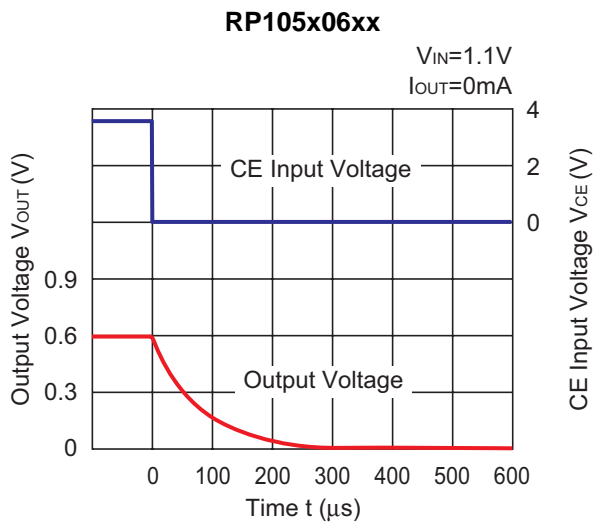


**RP105x15xx**



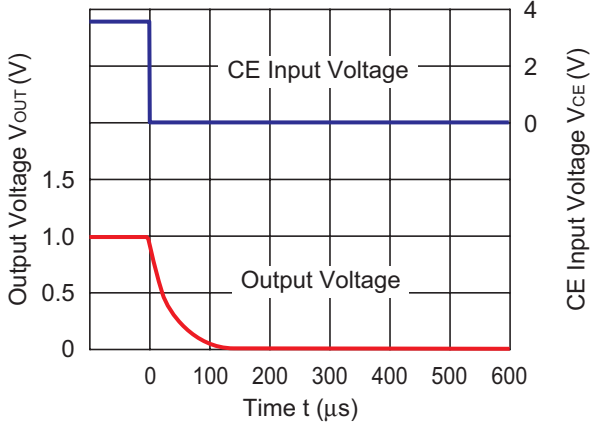


**13) Turn Off Speed with CE Pin ( $V_{BIAS}=3.6V$ ,  $C_{BIAS}=1.0\mu F$ ,  $C_{IN}=C_{OUT}=2.2\mu F$ ,  $T_{opt}=25^{\circ}C$ )**



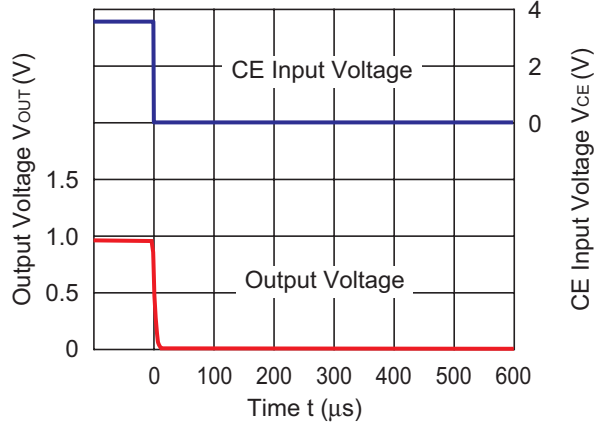
RP105x10xx

$V_{IN}=1.5V$   
 $I_{OUT}=30mA$



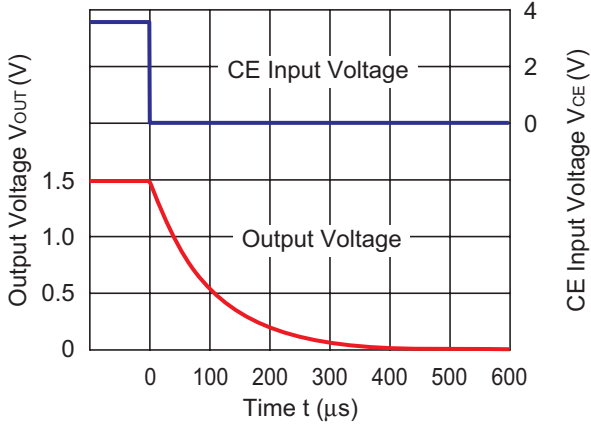
RP105x10xx

$V_{IN}=1.5V$   
 $I_{OUT}=400mA$



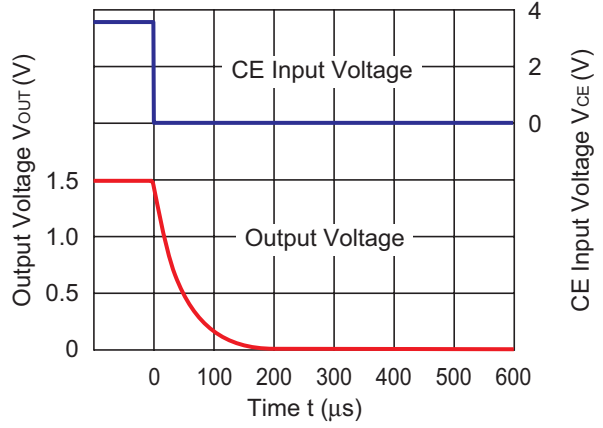
RP105x15xx

$V_{IN}=2.0V$   
 $I_{OUT}=0mA$



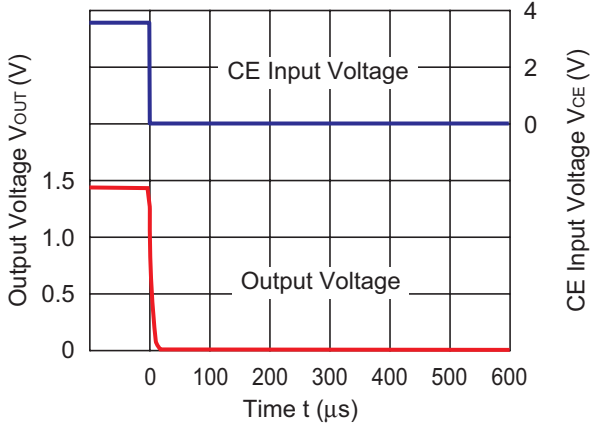
RP105x15xx

$V_{IN}=2.0V$   
 $I_{OUT}=30mA$

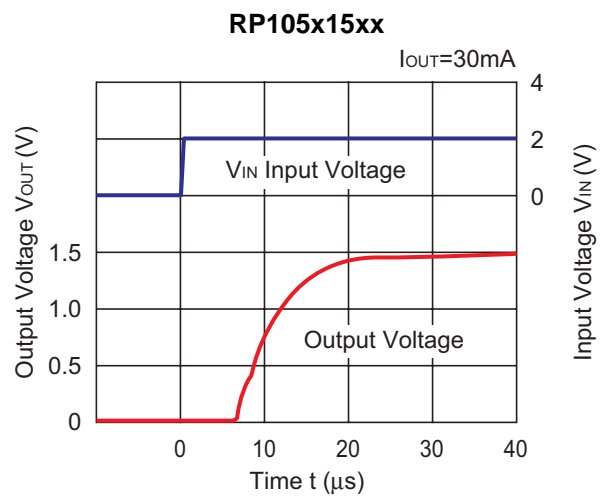
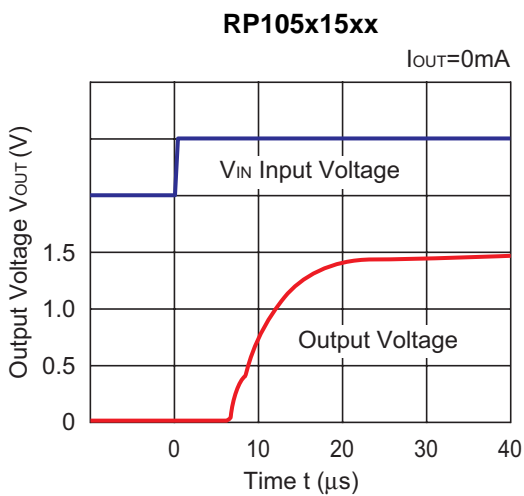
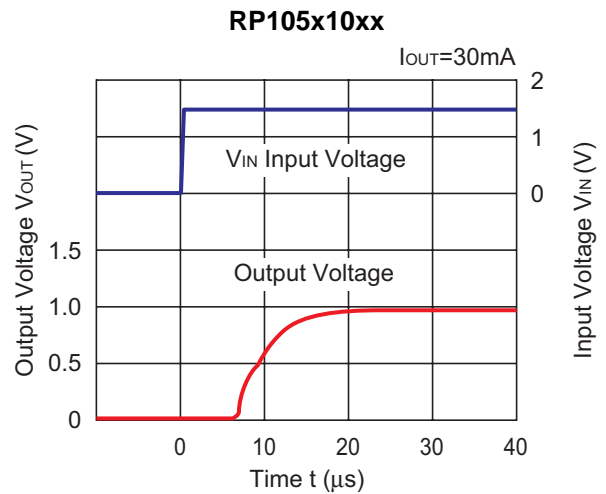
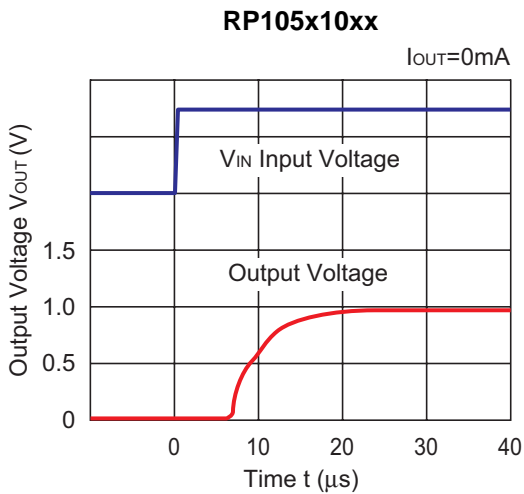
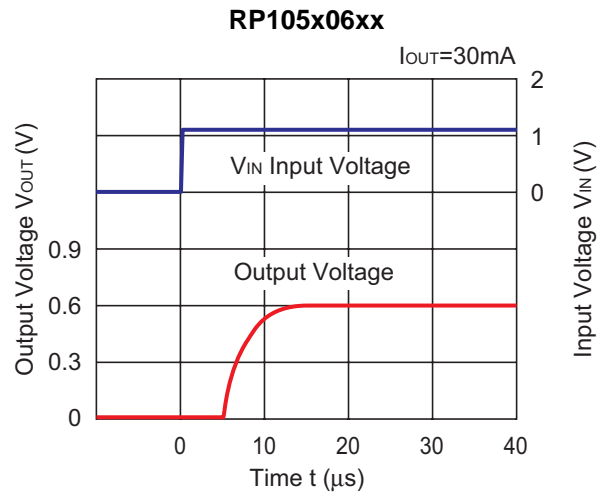
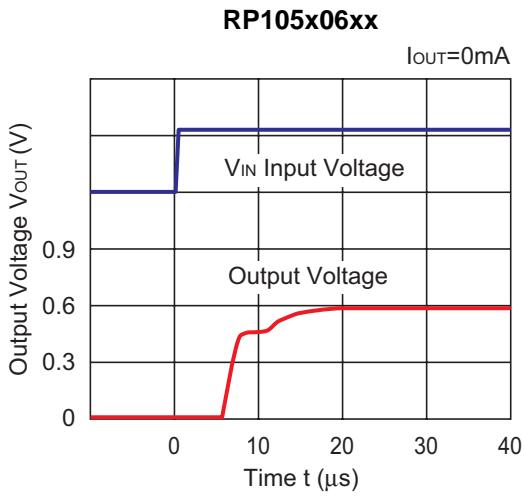


RP105x15xx

$V_{IN}=2.0V$   
 $I_{OUT}=400mA$



14) Turn On Transient with  $V_{IN}$  pin ( $V_{BIAS}=3.6V$ ,  $C_{BIAS}=1.0\mu F$ ,  $C_{IN}=none$ ,  $C_{OUT}=2.2\mu F$ ,  $T_{opt}=25^{\circ}C$ )



## ESR vs. Output Current

When using these ICs, consider the following points:

The relations between  $I_{OUT}$  (Output Current) and ESR of an output capacitor are shown below.

The conditions when the white noise level is under  $40\mu\text{V}$  (Avg.) are marked as the hatched area in the graph.

### Measurement conditions

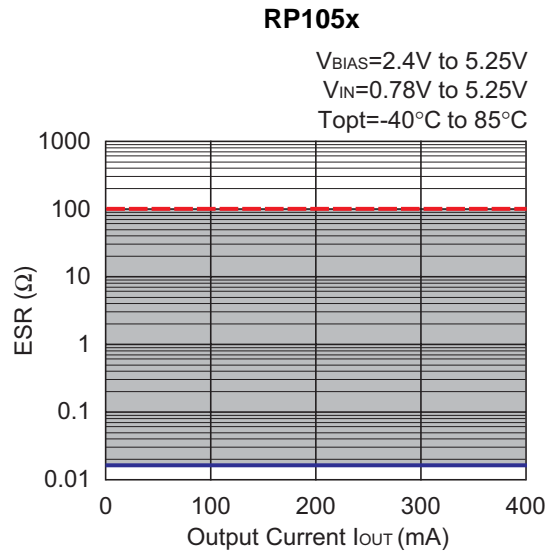
Frequency Band: 10Hz to 2MHz

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

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

$C_{BIAS}$ ,  $C_{IN}$  :  $1.0\mu\text{F}$

$C_{OUT}$  :  $2.2\mu\text{F}$





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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.

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