RICOH

RP105x SERIES

Low Voltage 400mA LDO Regulator

NO.EA-179-081028

OUTLINE

The RP105 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, 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 RP105 Series have the ultra low on resistance output driver, the on resistance is Typ. 0.4Ω (@0.8V output, 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, tr=0.5us, 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

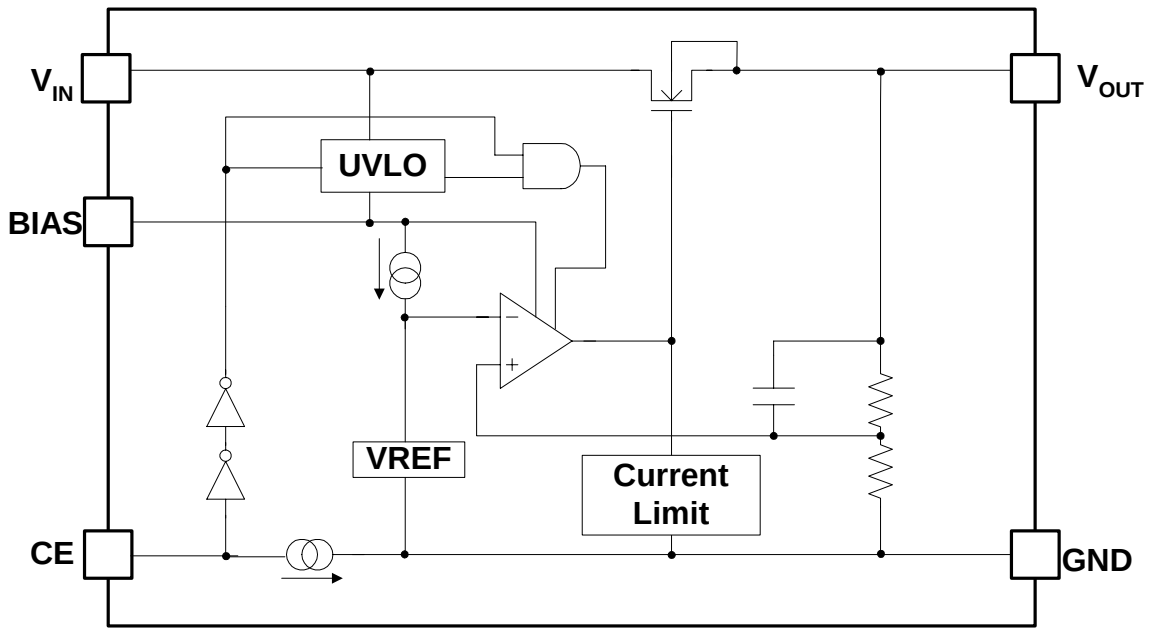
- Low Supply Current ..... Typ. 28μA
- Standby Mode ..... Typ. 0.1μA
- Low Dropout Voltage ..... Typ. 180mV (I_{OUT}=400mA, Bias=3.6V)
- High Ripple Rejection ..... Typ. 80dB (f =1kHz, V_{IN} Ripple)
  Typ. 50dB (f =1kHz, BIAS Ripple)
- High Output Voltage Accuracy..... ..... Typ. ±15mV (Ta=25 °C)
  Typ. ±20mV (−40°C ≦ Ta ≦ 85°C)
- Low Temperature-Drift Coefficient of Output Voltage ..... Typ. ±50ppm/°C
- Excellent Line Regulation ..... Typ. 0.1%/V
- Small Packages ..... DFN(PLP)1212-6, SOT-23-5,SC-88
- Output Voltage 0.6V, 0.7V, 0.8V, 0.9V, 1.0V, 1.2V, 1.3V, 1.4V, 1.5V
- Built-in Fold Back Protection Circuit ..... Typ. 120mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC ..... C_{BIAS}=C_{VIN}=1μF C_{VOUT}=2.2μF or more

APPLICATIONS

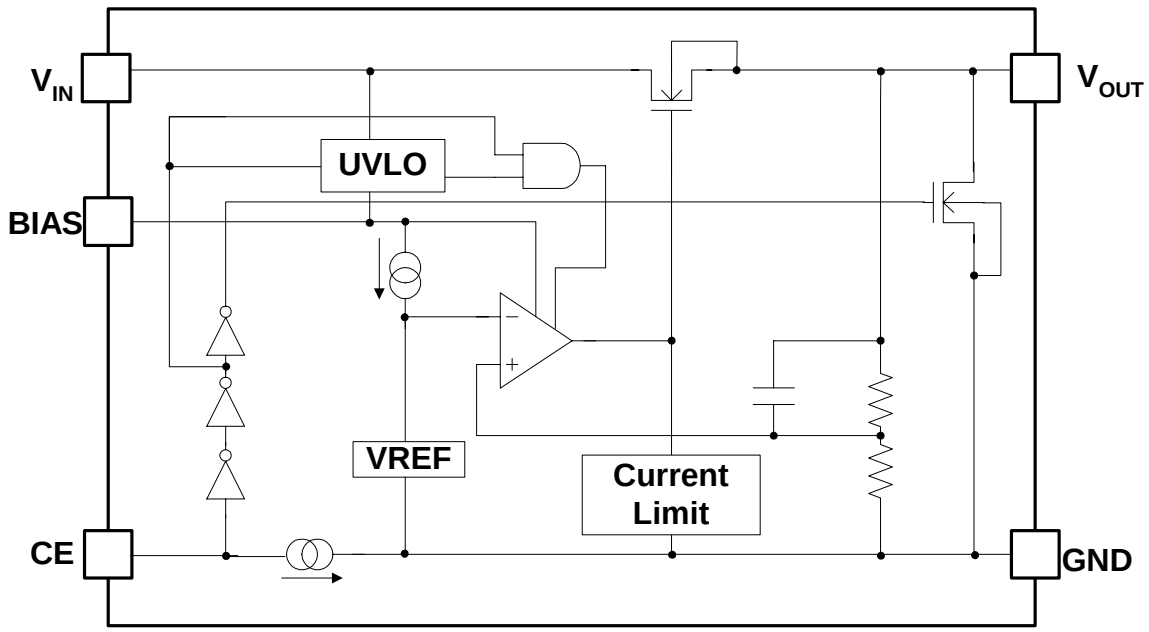
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

RP105xxx1B



RP105xxx1D



SELECTION GUIDE

The output voltage, version, and the taping type for the ICs can be selected at the user's request.
The selection can be made with designating the part number as shown below;

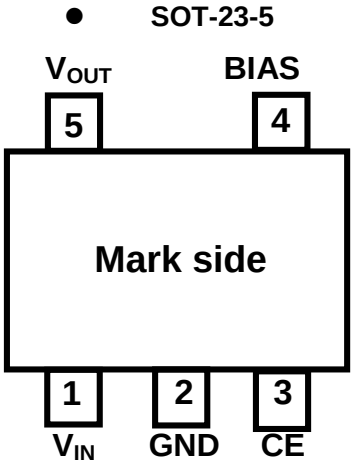
RP105xxx x x−xx ←Part Number
↑ ↑ ↑↑ ↑
a b a' c d

Code	Contents
a a'	Designation of Package Type: RP105Kxx1x-xx: DFN(PLP)1212-6 RP105Nxx1x-xx: SOT-23-5 RP105Qxx2x-xx: SC-88
b	Setting Output Voltage (V_{OUT}): 0.6V, 0.7V, 0.8V, 0.9V, 1.0V, 1.2V, 1.3V, 1.4V, 1.5V
c	Designation of Active Type: B: active high type * D: active high, with auto discharge *
d	Designation of Taping Type: Ex. TR (refer to Taping Specifications; TR type is the standard direction.)

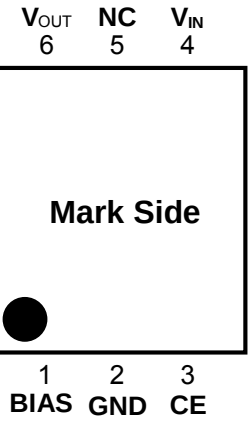
*When the mode is into standby with CE signal, auto-discharge transistor turns on, and it makes the turn-off speed faster than normal type.

PIN CONFIGURATION

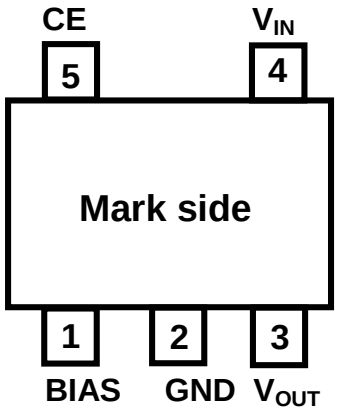
● SOT-23-5



● **DFN(PLP)1212-6**



● **SC-88**



PIN DESCRIPTIONS

● **RP105K**

Pin No.	Symbol	Description
1	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

Tab is GND level. (They are connected to the reverse side of this IC.)
Do not connect to other wires or land patterns.

- **RP105N**

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

- **RP105Q**

Pin No.	Symbol	Description
1	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)

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating		Unit
BIAS	Input Voltage	6.0		V
V_{IN}	Input Voltage (for Driver)	-0.3 ~ BIAS + 0.3		V
V_{CE}	Input Voltage (CE Pin)	6.0		V
V_{OUT}	Output Voltage	− 0.3 ~ V_{IN} + 0.3		V
I_{OUT}	Output Current	500		mA
P_D	Power Dissipation *	SOT-23-5	420	mW
		DFN(PLP)1212-6	400	
		SC-88	380	
Ta	Ambience Temperature Range	− 40 ~ 85		°C
Tstg	Storage Temperature Range	− 55 ~ 125		°C

- For Power Dissipation, please refer to PACKAGE INFORMATION to be described.

ELECTRICAL CHARACTERISTICS

- RP105xxx1B/D
- BIAS = V_{CE} = 3.6V,V_{IN} = $_{SET}V_{OUT}$ + 0.5V, I_{OUT} = 1mA, C $_{BIAS}$= C_{VIN} = 1.0µF C_{VOUT} = 2.2µF, unless otherwise noted.
- [ ] values indicate −40°C ≦ Ta ≦ 85°C, unless otherwise noted.

Ta=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage		$_{SET}V_{OUT}$ -15mV [V_{OUT} -20mV]		$_{SET}V_{OUT}$ +15mV [V_{OUT} +20mV]	V
I_{OUT}	Output Current		[400]			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	1mA ≦ I_{OUT} ≦ 400mA		30	[50]	mV
V_{DIF}	Dropout Voltage	Please see the data sheet on next page (p.8)				
I_{SS}	Supply Current	I_{OUT}=0mA		28	[40]	µA
Istandby	Supply Current (Standby)	V_{CE}=0V		0.1	3.0	µA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	2.4V ≦ V_{BIAS} ≦ 5.0V		0.02	[0.10]	%/V
		$_{SET}V_{OUT}$+0.3V ≦ V_{IN} ≦ 2.4V		0.02	[0.10]	
RR	Ripple Rejection	I_{OUT}=30mA,f=1kHz, V_{IN} Ripple 0.2Vp-p		80		dB
		I_{OUT}=30mA,f=1kHz, BIAS Ripple 0.2Vp-p		50		
BIAS	Input Voltage	V_{OUT}<0.8V	[2.4]		[5.25]	V
		V_{OUT}≥0.8V	[$_{SET}V_{OUT}$+1.6]			
V_{IN}	Input Voltage (for Driver)	V_{OUT}<0.8V	[0.9]		BIAS	V
		V_{OUT}≥0.8V	[$_{SET}V_{OUT}$+0.1]			
ΔV_{OUT} /ΔT	Output Voltage Temperature Coefficient	−40°C ≦ Ta ≦ 85°C		±50		ppm /°C
I_{LIM}	Short Current Limit	V_{OUT} = 0V		120		mA
I_{PD}	CE Pull-down Current			1.0		µA
V_{CEH}	CE Input Voltage ”H”		[0.8]			V
V_{CEL}	CE Input Voltage ”L”				[0.3]	V
V_{IN_UVLO}	VIN Under Voltage Lock Out	I_{OUT}=1.0µA		$_{SET}V_{OUT}$ +50mV	[$_{SET}V_{OUT}$ +100mV]	V
en	Output Noise	BM=10Hz to100kHz I_{OUT}=30mA $_{SET}V_{OUT}$=0.6V		70		µVrms
R_{LOW}	Nch On Resistance For auto discharge (only D version)	BIAS=3.6V CE=”L”		50		Ω

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

(2) The specification in [ ] is checked and guaranteed by design engineering. All of unit are tested and specified under load conditions such that Tj≈Ta=25°C except for Output Noise, Ripple Rejection and Output Voltage Temperature Coefficient items.

● **Dropout Voltage**

Vset	BIAS	Vgs	Vdif[mV@300mA]		Vdif[mV@400mA]	
			TYP	TYP	TYP	TYP
0.6V	3.6V	3.0V	115	180	180	320
0.7V	3.6V	2.9V	120	190	180	320
0.8V	3.6V	2.8V	120	190	180	300
0.9V	3.6V	2.7V	120	190	180	300
1.0V	3.6V	2.6V	120	190	180	280
1.2V	3.6V	2.4V	130	200	180	280
1.3V	3.6V	2.3V	130	200	180	260
1.4V	3.6V	2.2V	130	200	180	260
1.5V	3.6V	2.1V	130	200	180	260

● **Dropout Voltage[Vgs(V)/Vdif(mV)@200mA]** Ta=25°C

	BIAS=2.5V		BIAS=3.0V		BIAS =3.3V		BIAS =3.6V		BIAS =4.2V		BIAS =5.0V	
Unit(V)	Vgs	Vdif	Vgs	Vdif	Vgs	Vdif	Vgs	Vdif	Vgs	Vdif	Vgs	Vdif
Vset=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
Vset=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
Vset=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
Vset=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
Vset=1.0V			2.0	0.094	2.3	0.093	2.6	0.092	3.2	0.092	4.0	0.092
Vset=1.2V			1.8	0.098	2.1	0.096	2.4	0.095	3.0	0.095	3.8	0.094
Vset=1.3V			1.7	0.098	2.0	0.096	2.3	0.095	2.9	0.095	3.7	0.095
Vset=1.4V			1.6	0.098	1.9	0.096	2.2	0.095	2.8	0.095	3.6	0.095
Vset=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.

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

BIAS pin voltage must be equal or more than set VOUT+1.6V. Therefore, some combinations of BIAS pin voltage and Vset value above cannot be specified.

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 with the capacity of equal or more than 2.2μF C_{OUT}.

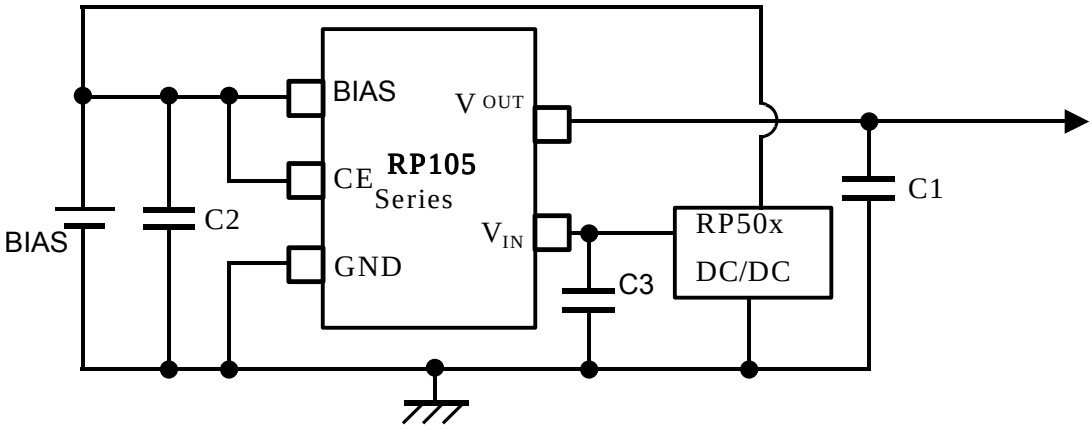
(Note: If a tantalum capacitors are connected as COUT, and if the equivalent series resister (ESR) value is large, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

PCB Layout

Make BIAS, VIN, 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 1.0μF or more between BIAS and GND pin, between VIN and GND, 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. VIN source is supposed to be the output of the DC/DC converter. The value should be equal or lower than BIAS voltage.

TYPICAL APPLICATION

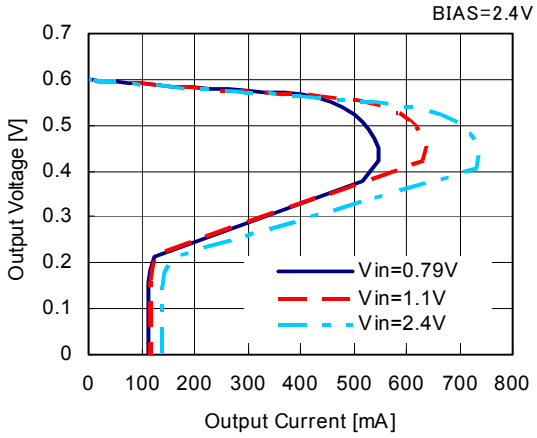


External Components examples:
C1 (COUT): 2.2µF GRM155B30J225ME15 (Murata)
C2, C3 (CBIAS, CVIN) 1.0µF GRM155B31A105KE15 (Murata)

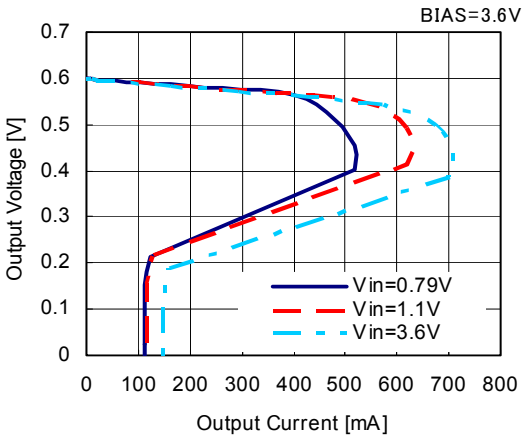
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (CBIAS=1.0uF,CVIN=COUT=2.2uF,Topt=25°C)

RP105x06xx



RP105x06xx



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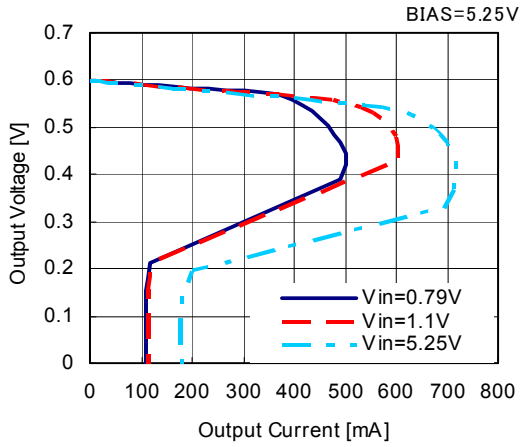
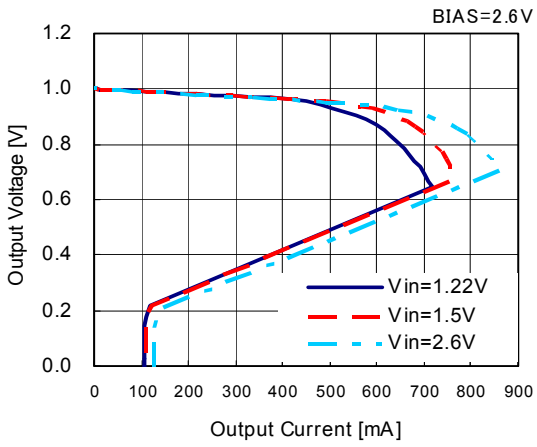


RP105x10xx



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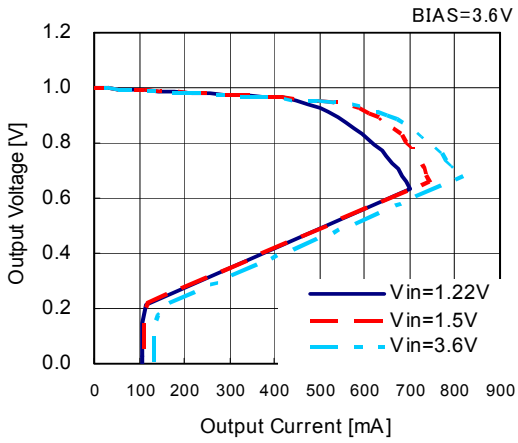

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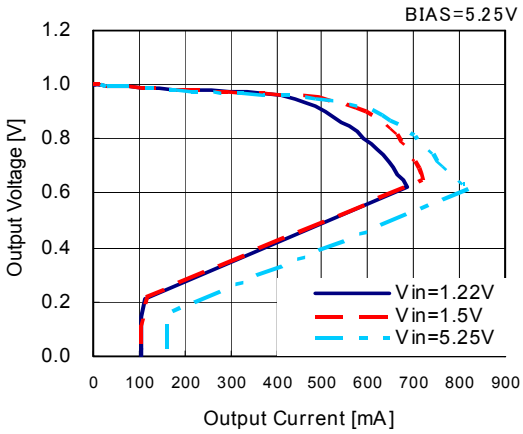
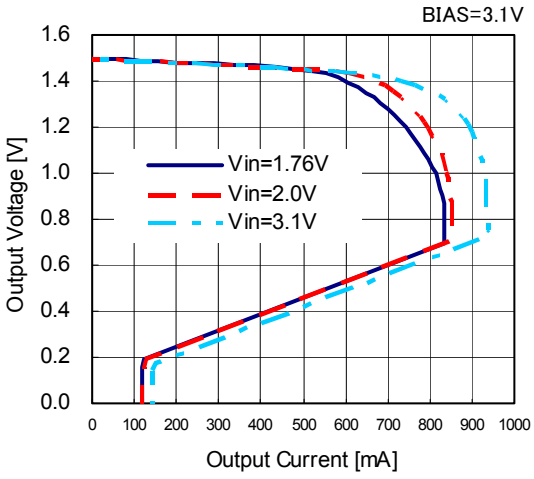


RP105x15xx



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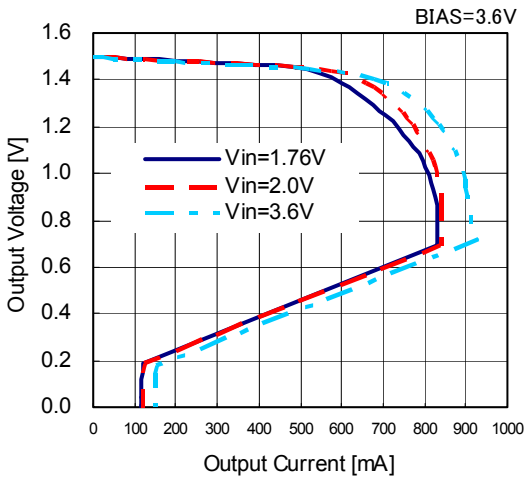

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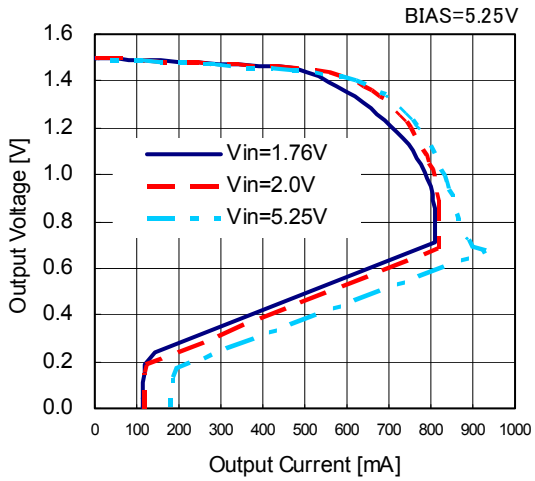
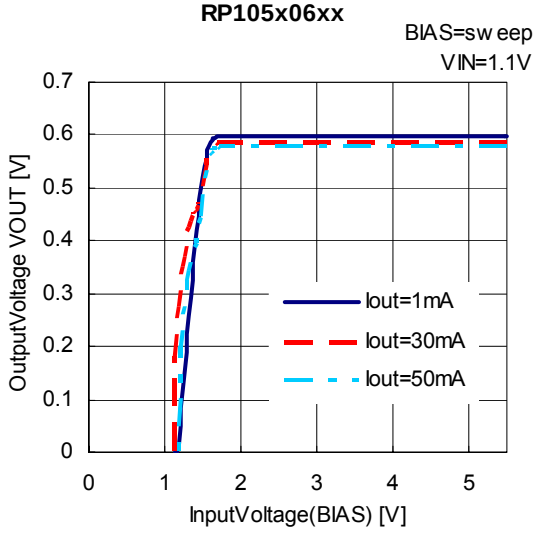


2) Output Voltage vs. Input Voltage (CBIAS=1.0uF,CVIN=COUT=2.2uF, Topt=25°C)

RP105x06xx



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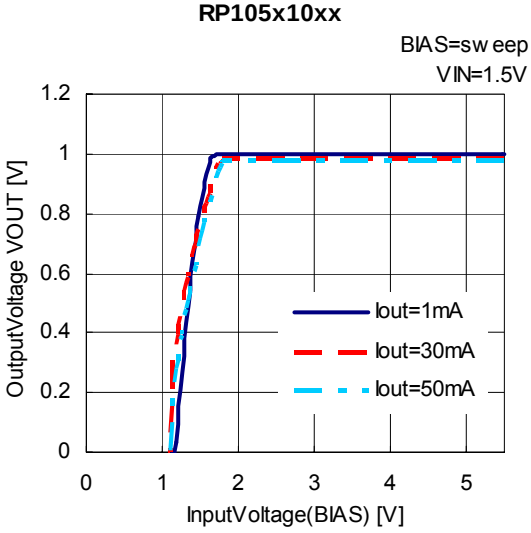

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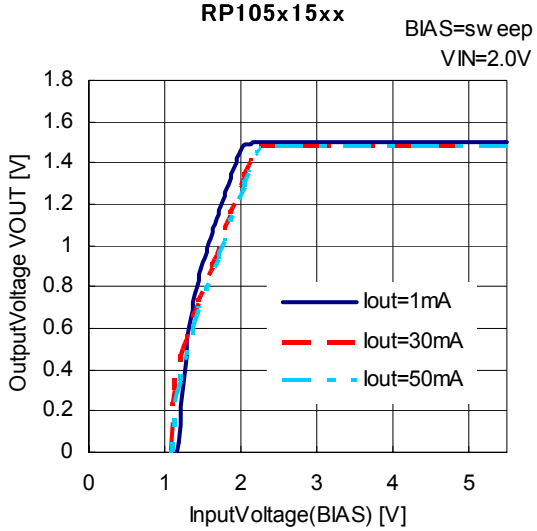

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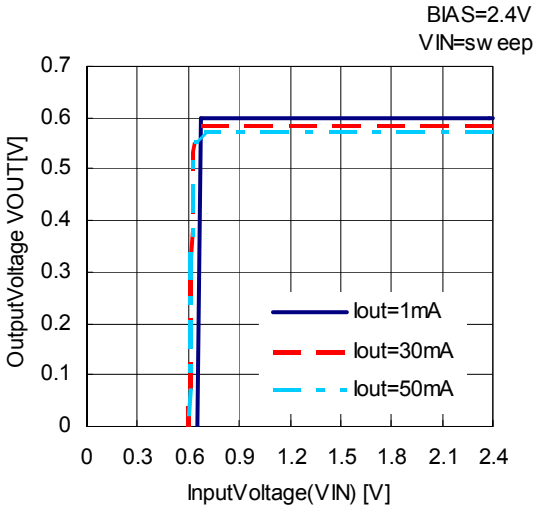
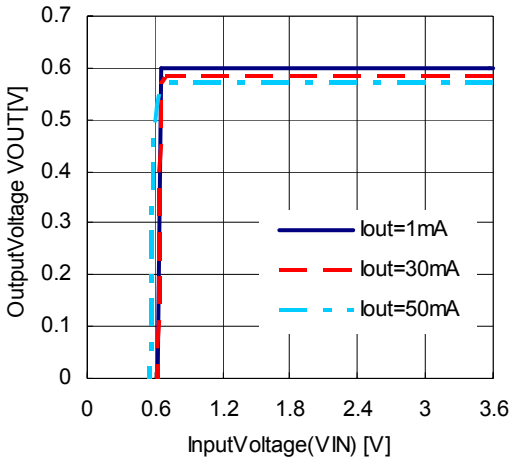


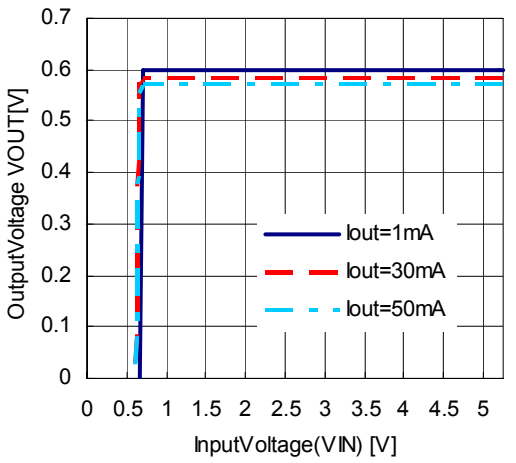
RP105x06xx

BIAS=3.6V
VIN=sweep



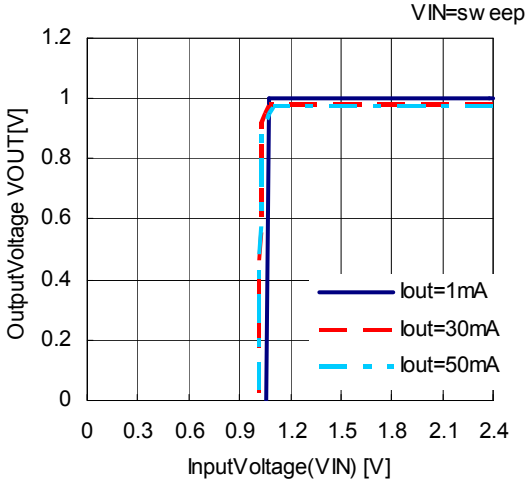
RP105x06xx

BIAS=5.25V
VIN=sweep



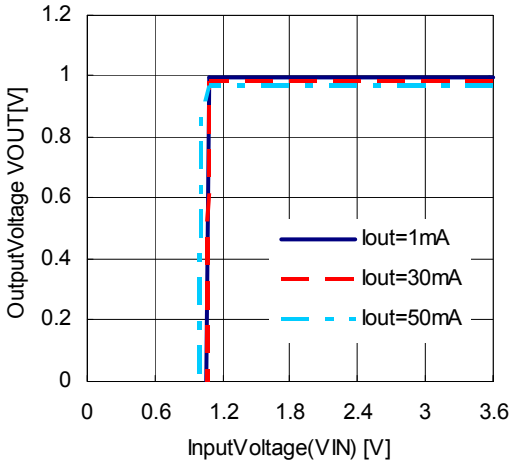
RP105x10xx

BIAS=2.4V
VIN=sweep



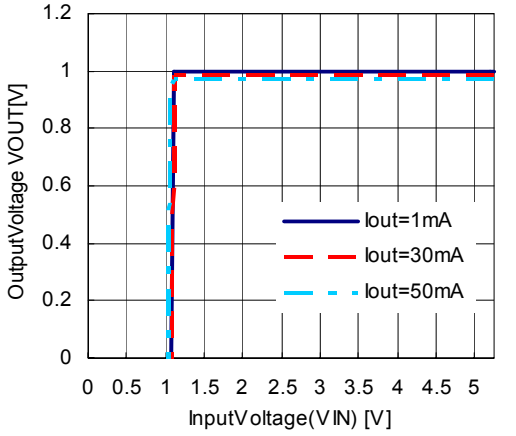
RP105x10xx

BIAS=3.6V
VIN=sweep



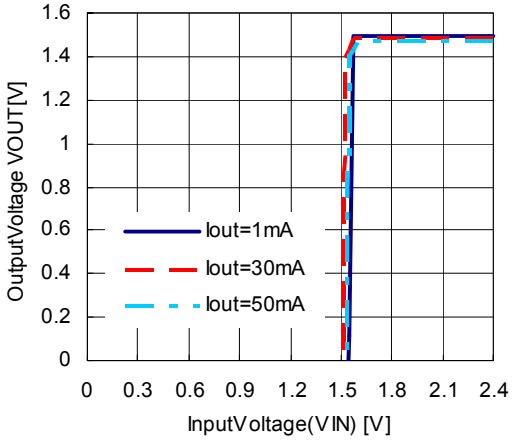
RP105x10xx

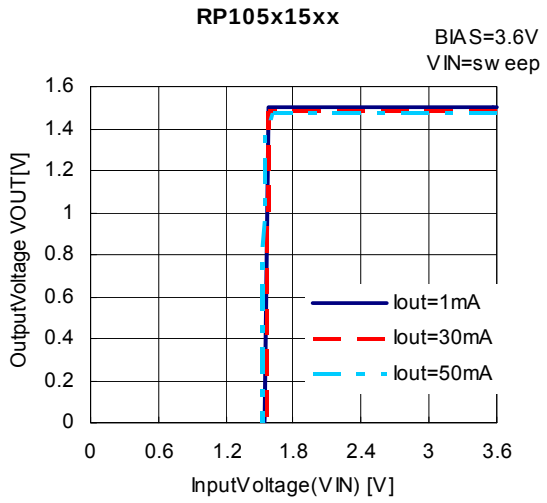
BIAS=5.25V
VIN=sweep

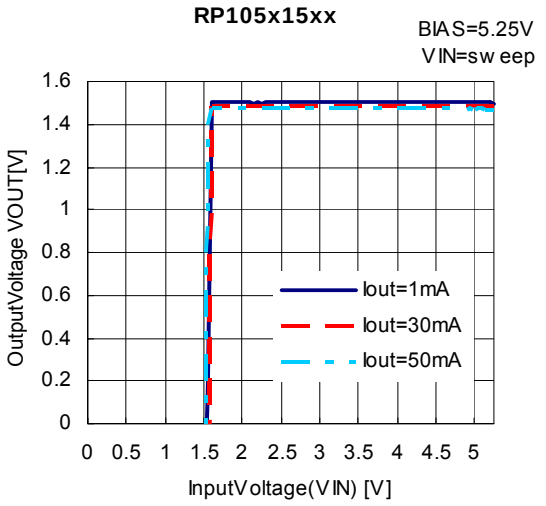


RP105x15xx

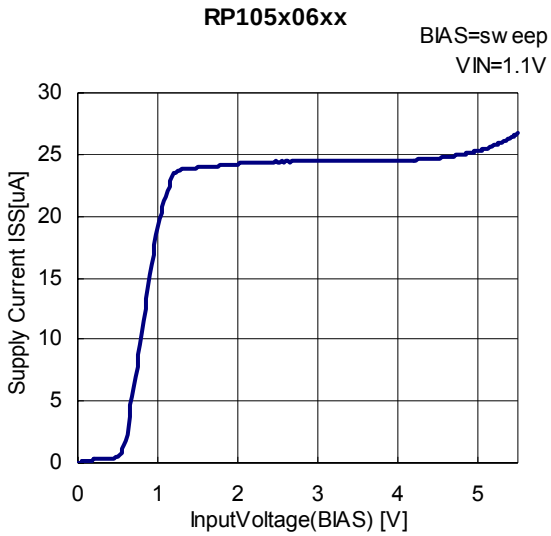
BIAS=2.4V
VIN=sweep

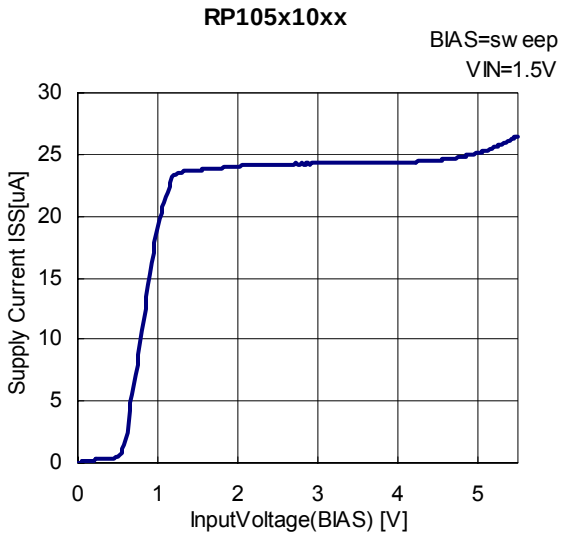


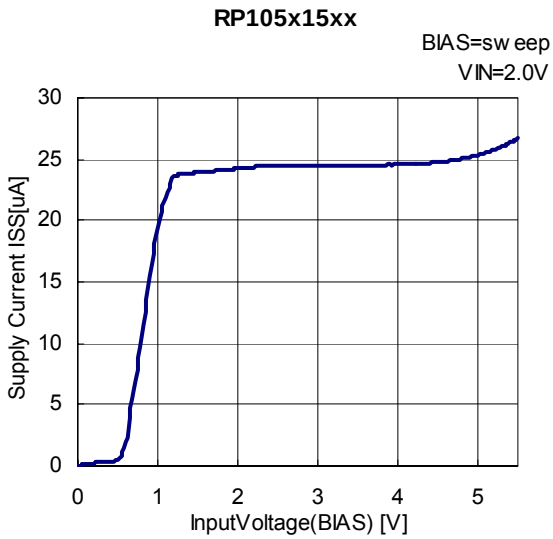


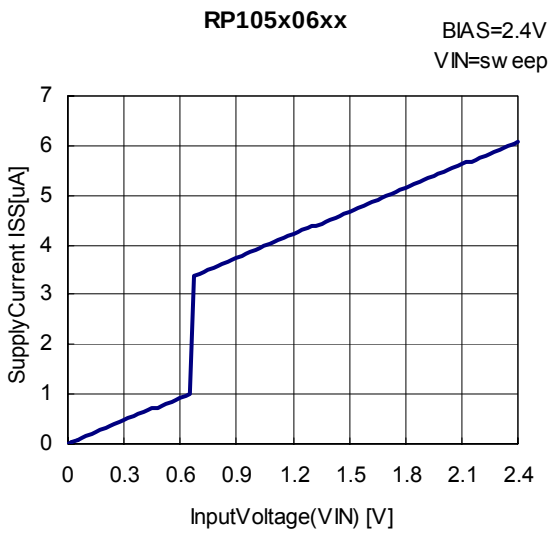


3) Supply Current vs. Input Voltage (C_{BIAS}=C_{VIN}=C_{OUT}=none, Topt=25°C)



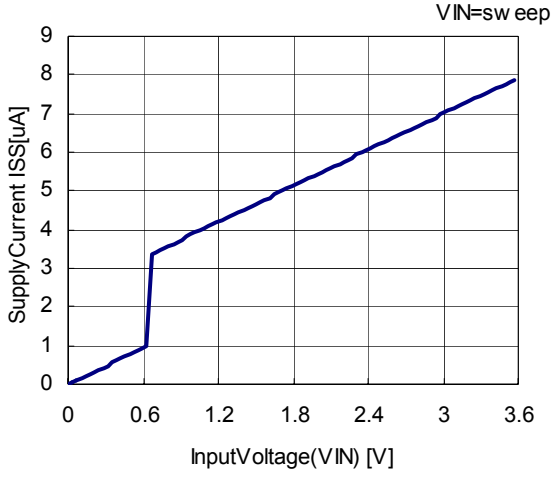






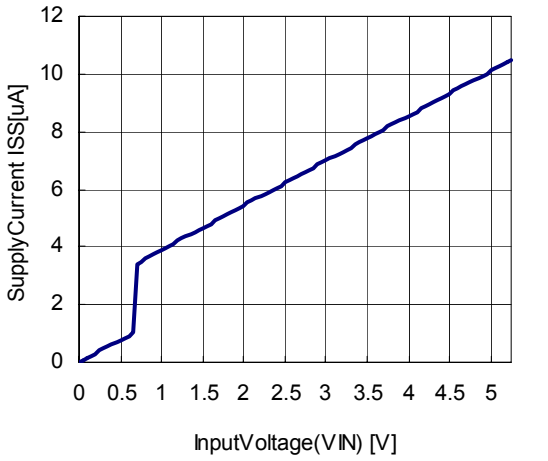
RP105x06xx

BIAS=3.6V
VIN=sweep



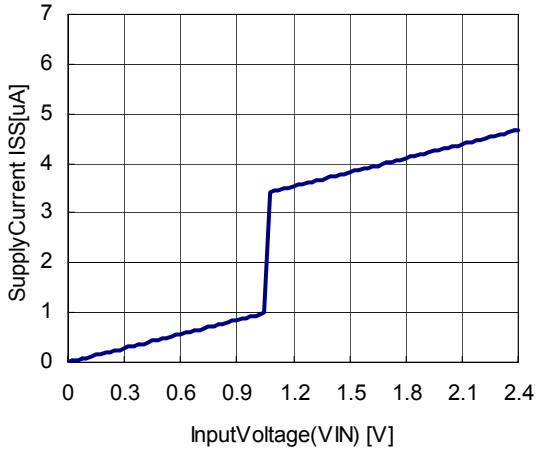
RP105x06xx

BIAS=5.25V
VIN=sweep



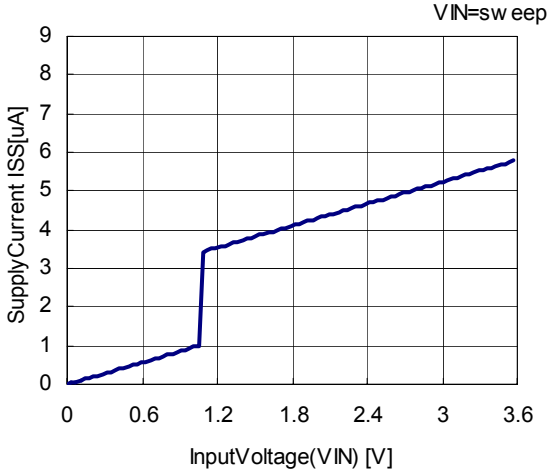
RP105x10xx

BIAS=2.4V
VIN=sweep



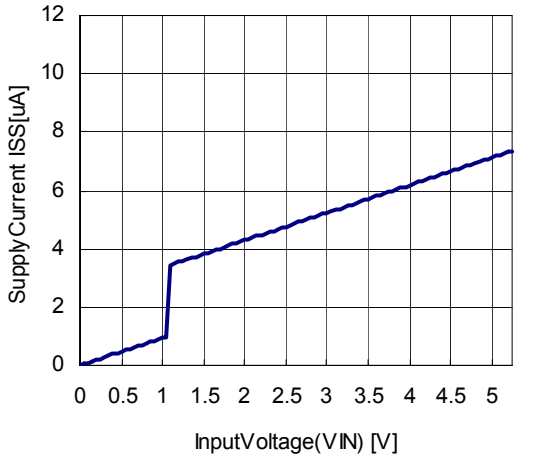
RP105x10xx

BIAS=3.6V
VIN=sweep



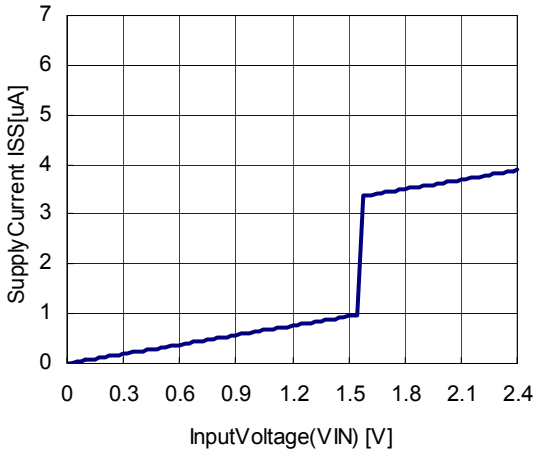
RP105x10xx

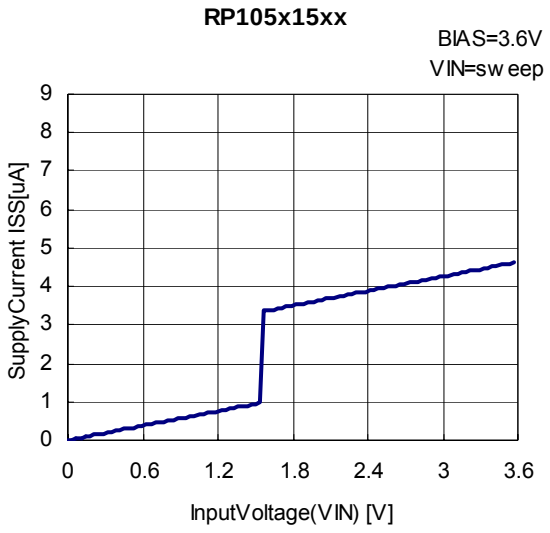
BIAS=5.25V
VIN=sweep

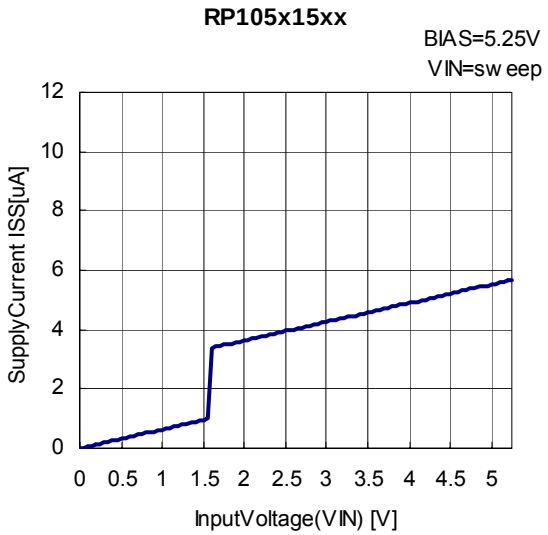


RP105x15xx

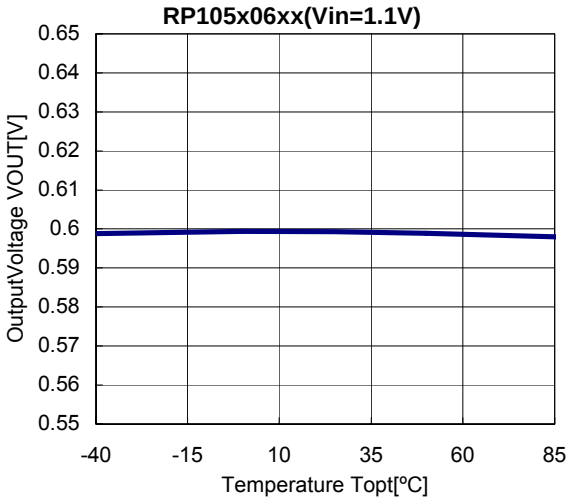
BIAS=2.4V
VIN=sweep

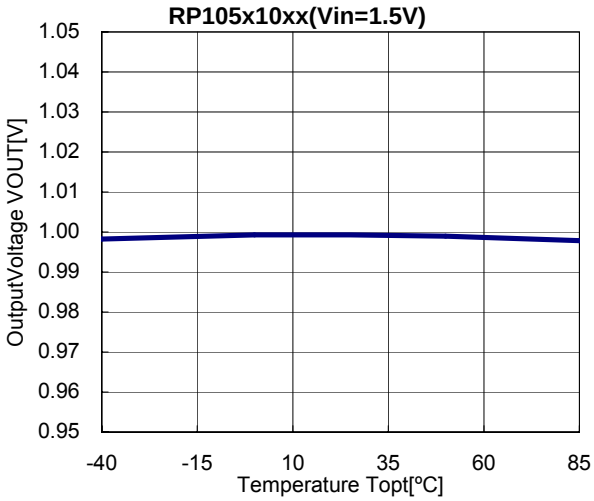


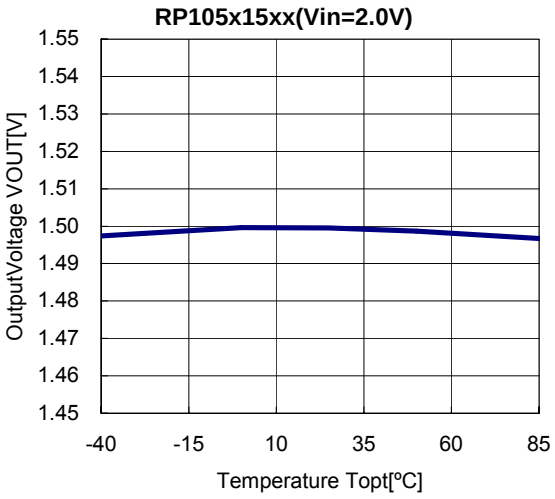




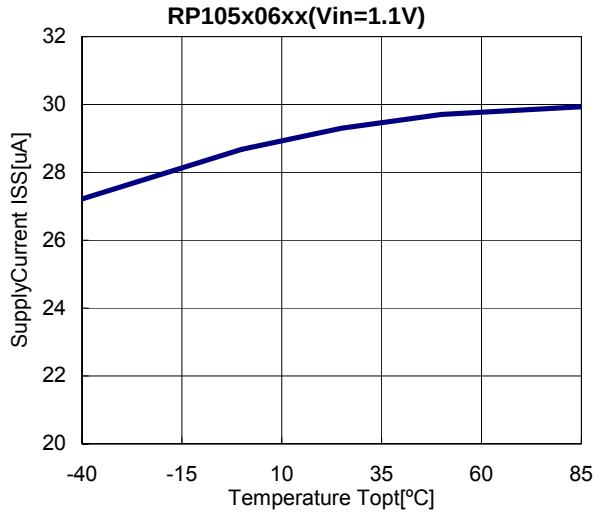
4) Output Voltage vs. Temperature (C_{BIAS}=1.0uF,C_{VIN}=C_{OUT}=2.2uF, I_{OUT}=1mA Bias=3.6V)

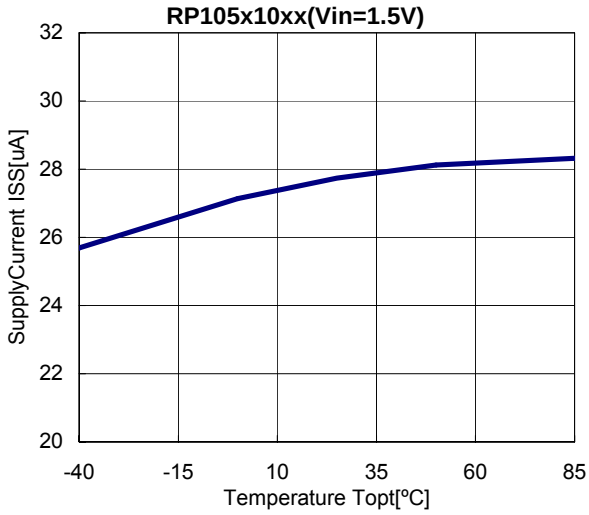


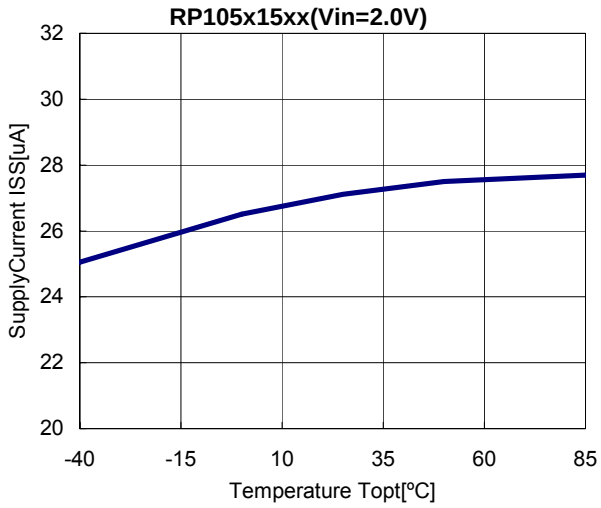




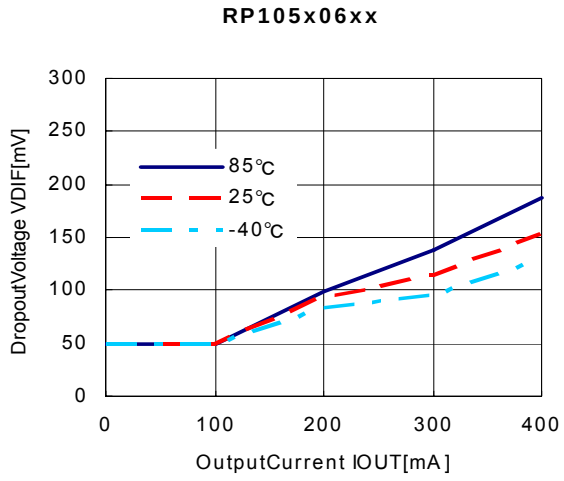
5) Supply Current vs. Temperature (C_{BIAS}=C_{VIN}=C_{OUT}=none, BIAS=3.6V)

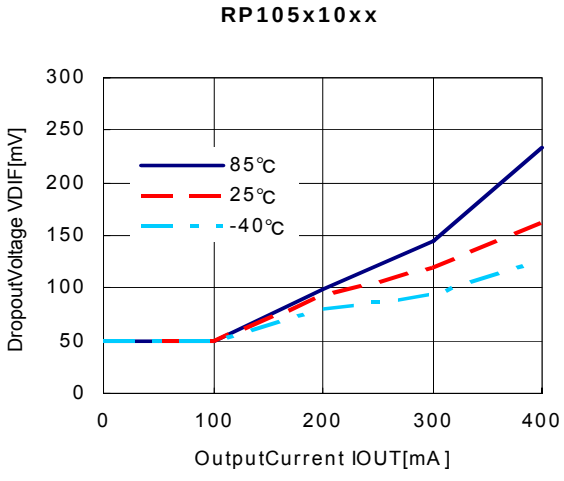




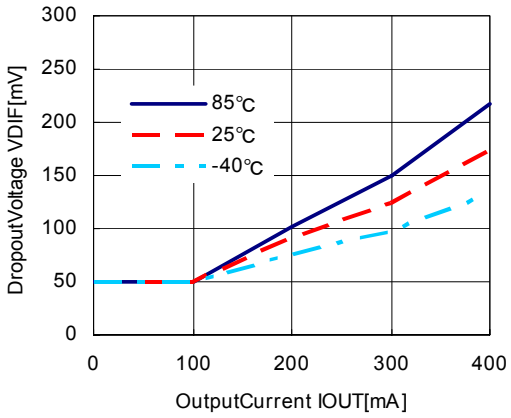


6) Dropout Voltage vs. Output Current (C_{BIAS}=1.0uF,C_{VIN}=C_{OUT}=2.2uF)

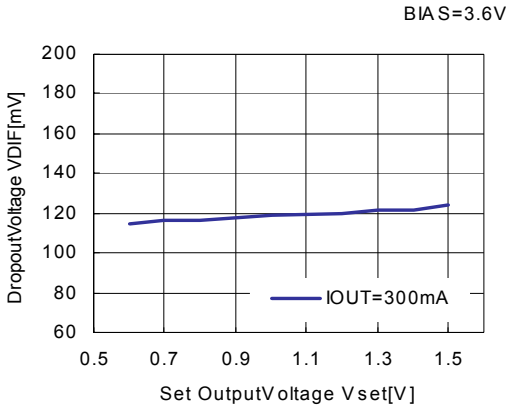




RP105x15xx

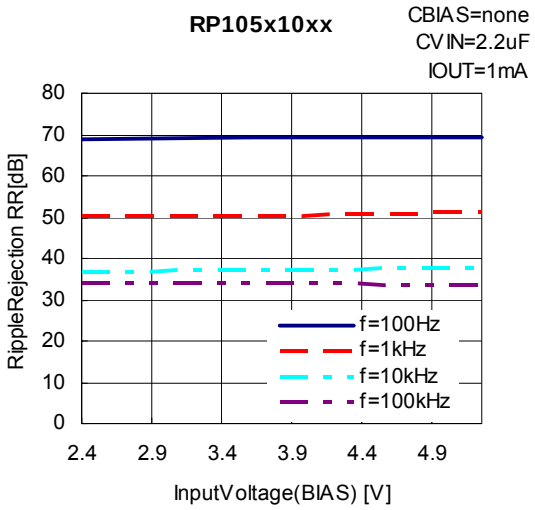


7:Dropout Voltage vs. Set Output Voltage

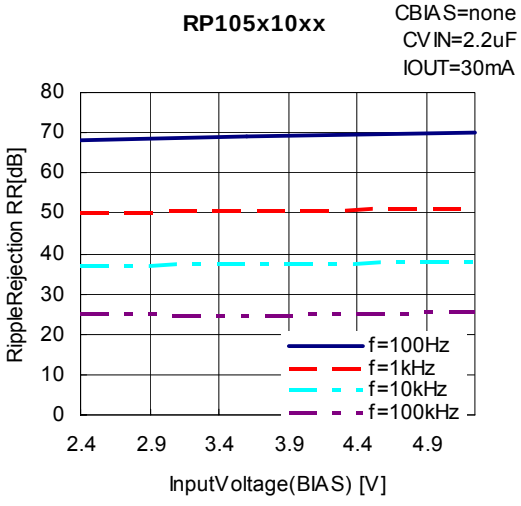


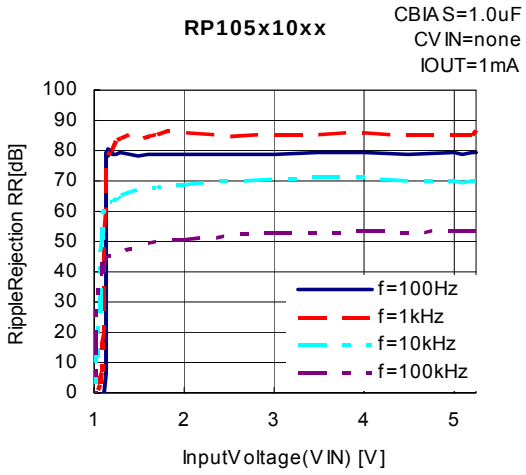
8) Ripple Rejection vs. Input Bias (Vp-p=0.2V,COUT=2.2uF,Topt=25°C)

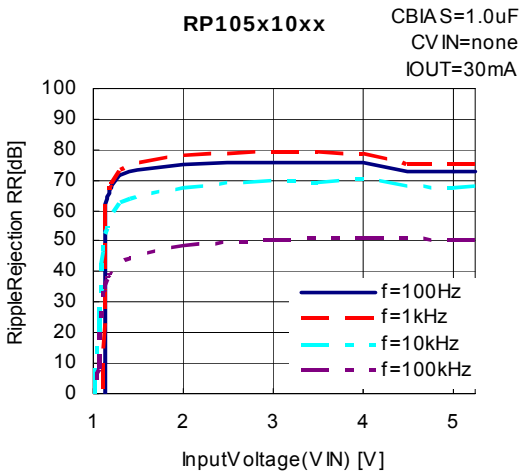
RP105x10xx



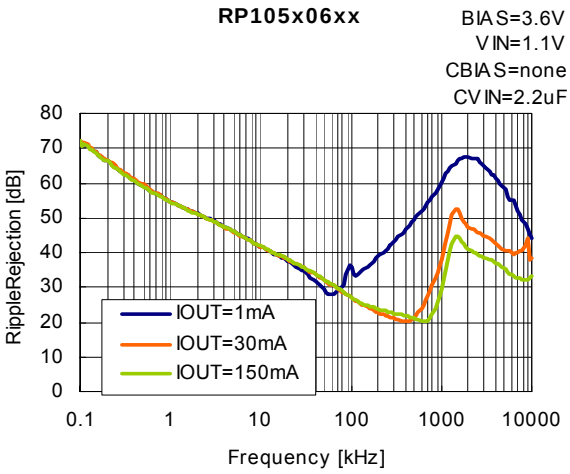
RP105x10xx

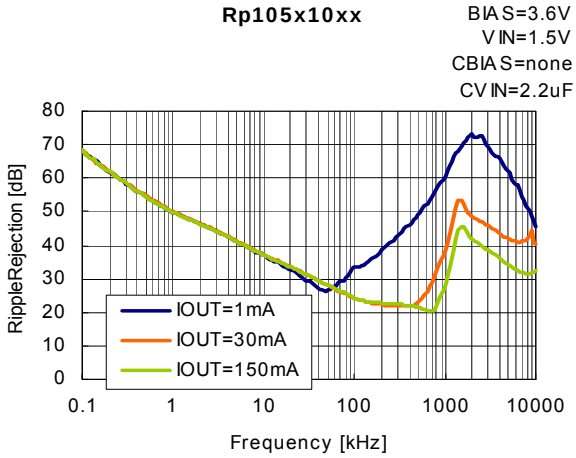


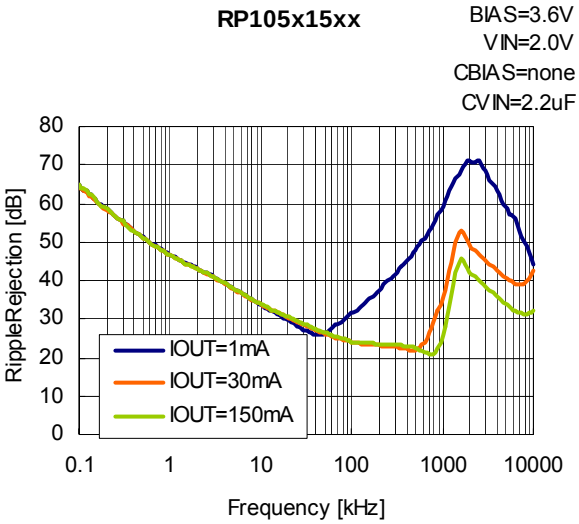


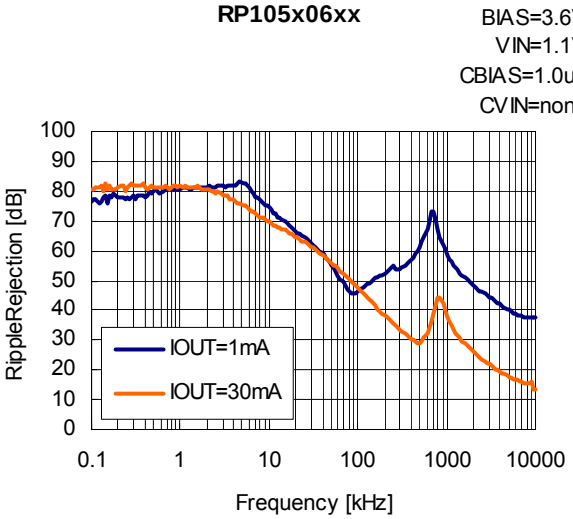


9) Ripple Rejection vs. Frequency (COUT=2.2uF,Topt=25°C)



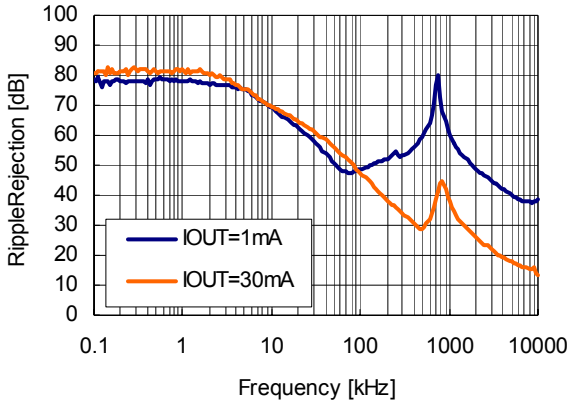






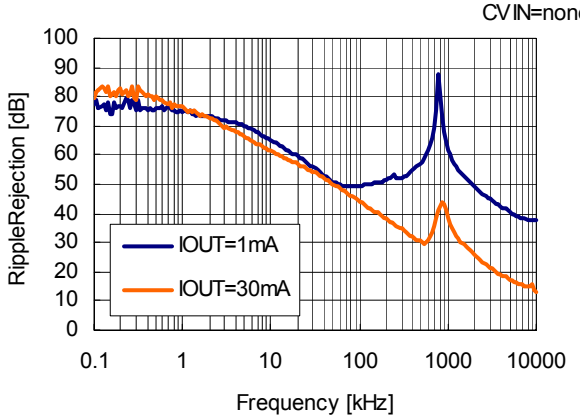
RP105x10xx

BIAS=3.6V
VIN=1.5V
CBIAS=1.0uF
CVIN=none



RP105x15xx

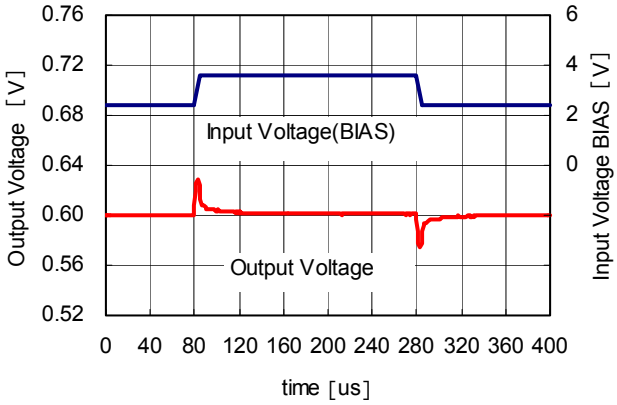
BIAS=3.6V
VIN=2.0V
CBIAS=1.0uF
CVIN=none



10) Input Transient Response (COUT=1.0uF,Tr=Tf=5us,Topt=25°C)

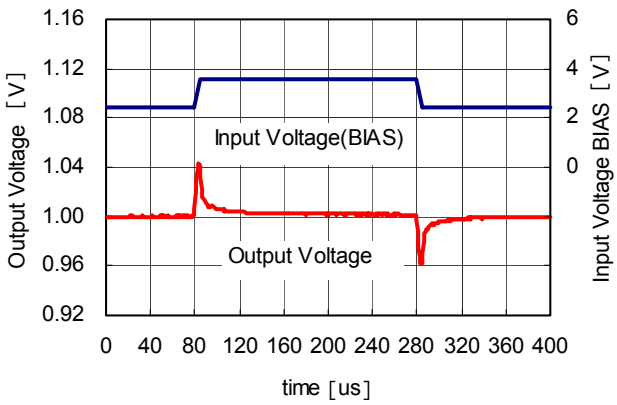
RP105x06xx

BIAS=2.4V<=>3.6V
VIN=1.1V
CBIAS=none
CVIN=2.2uF
IOUT=30mA



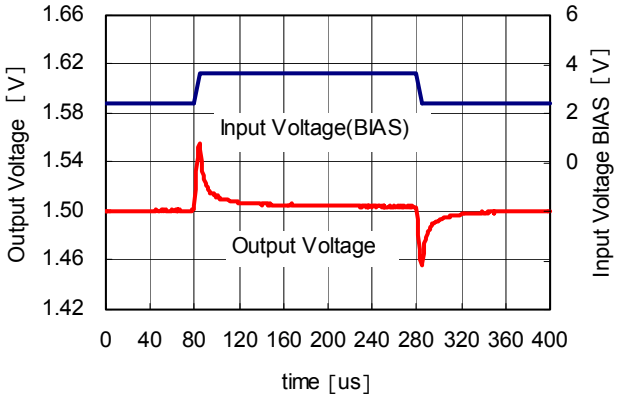
RP105x10xx

BIAS=2.4V<=>3.6V
VIN=1.5V
CBIAS=none
CVIN=2.2uF
IOUT=30mA



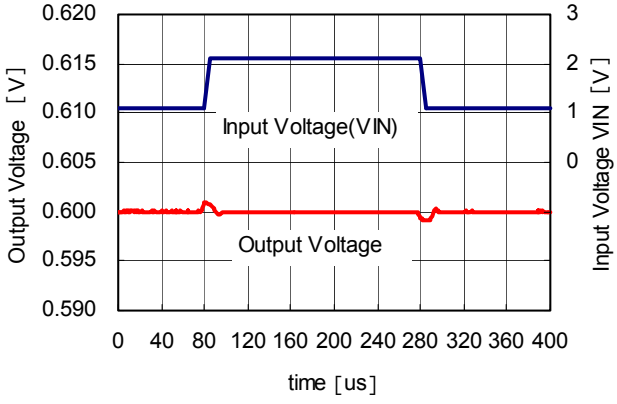
RP105x15xx

BIAS=2.4V<=>3.6V
VIN=2.0V
CBIAS=none
CVIN=2.2uF
IOUT=30mA



RP105x06xx

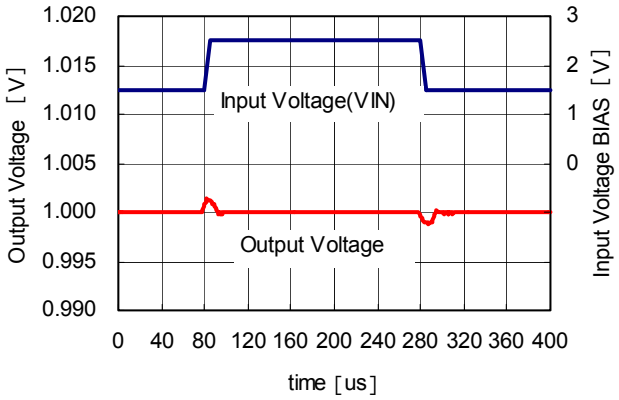
BIAS=3.6V
VIN=1.1V<=>2.1V
CBIAS=1.0uF
CVIN=none
IOUT=30mA



RICOH

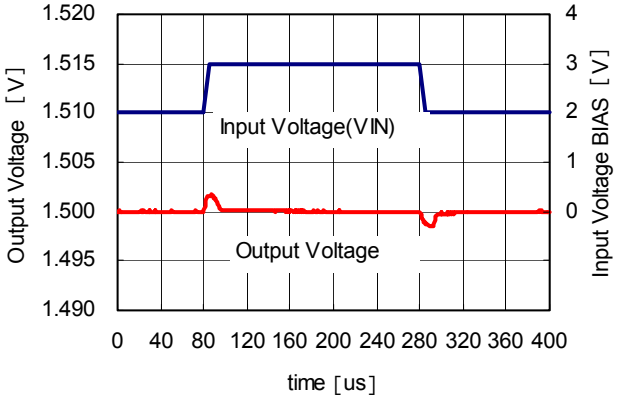
RP105x10xx

BIAS=3.6V
VIN=1.5V<=>2.5V
CBIAS=1.0uF
CVIN=none
IOUT=30mA



RP105x15xx

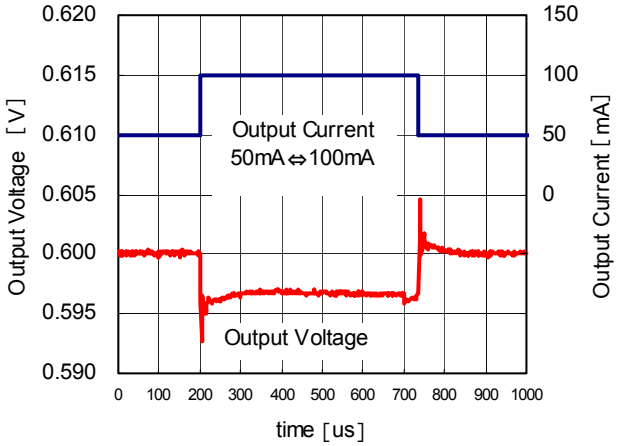
BIAS=3.6V
VIN=2.0V<=>3.0V
CBIAS=1.0uF
CVIN=none
IOUT=30mA



11) Load Transient Response (CBIAS=1.0uF,CVIN=COUT=2.2uF,Tr=Tf=0.5us,Topt=25°C)

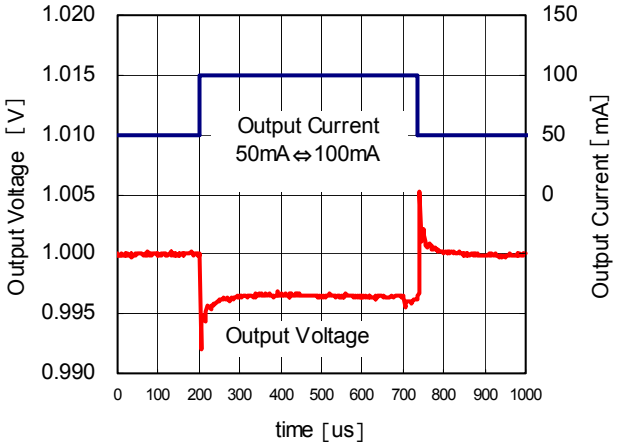
RP105x06xx

BIAS=3.6V
VIN=1.1V



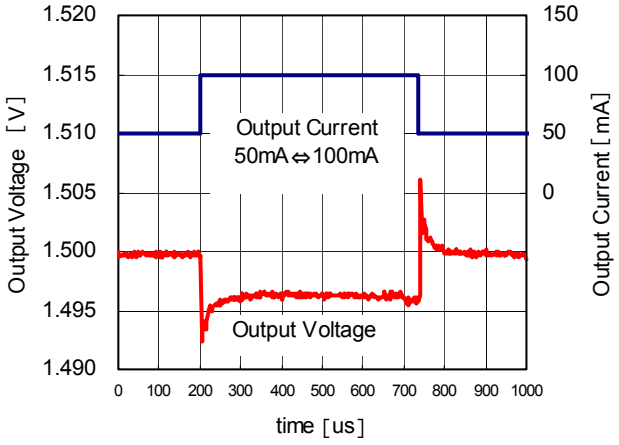
RP105x10xx

BIAS=3.6V
VIN=1.5V



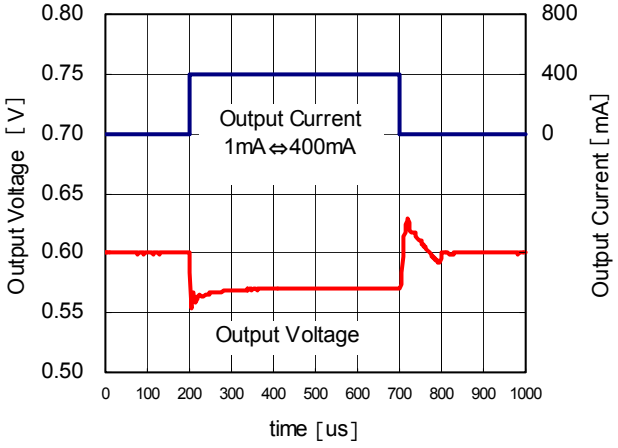
RP105x15xx

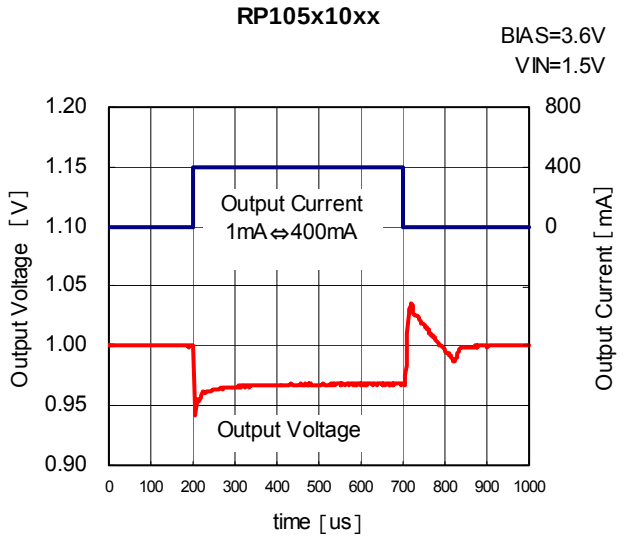
BIAS=3.6V
VIN=2.0V

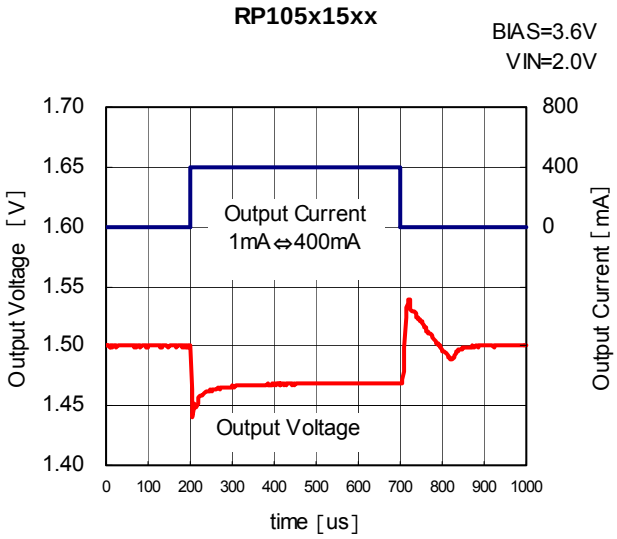


RP105x06xx

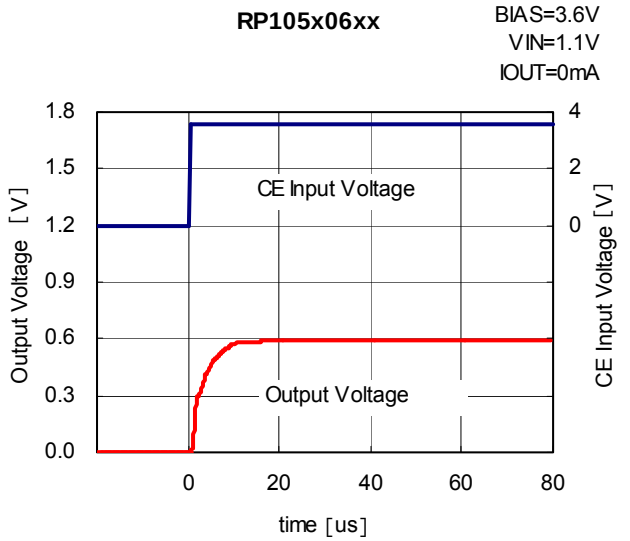
BIAS=3.6V
VIN=1.1V

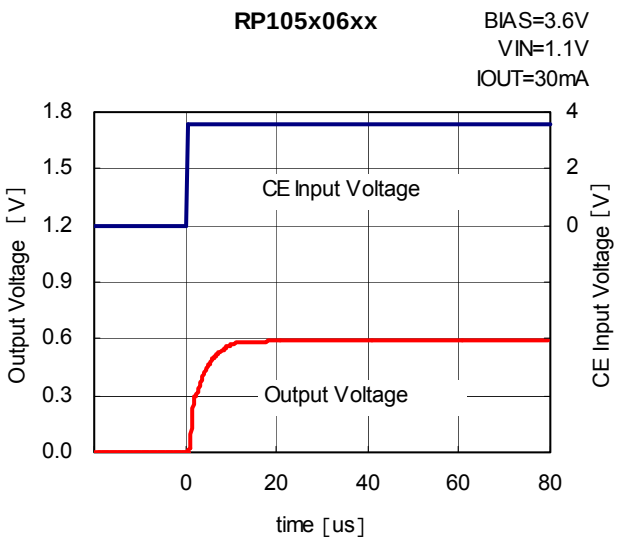


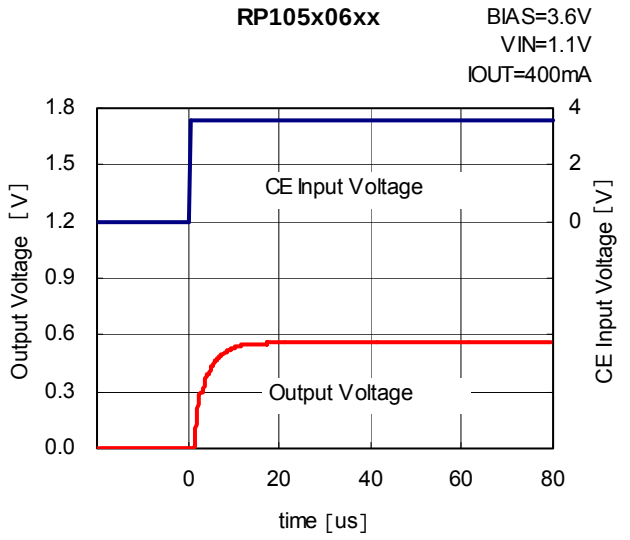


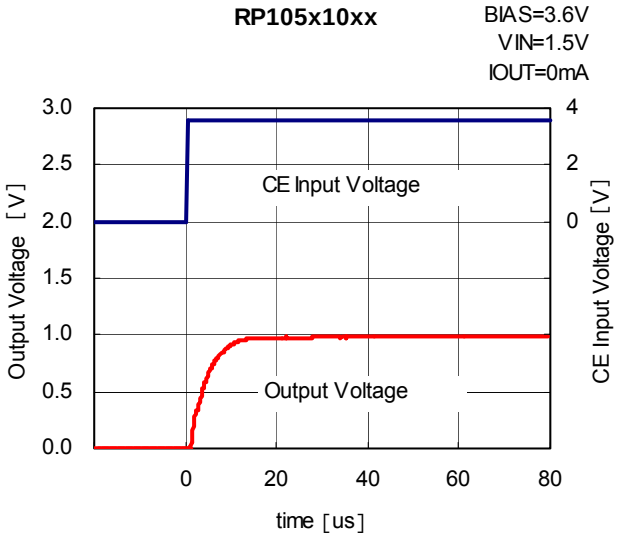


12) Turn On Speed with CE pin (C_{BIAS}=1.0uF,C_{VIN}=C_{OUT}=2.2uF,Topt=25°C)



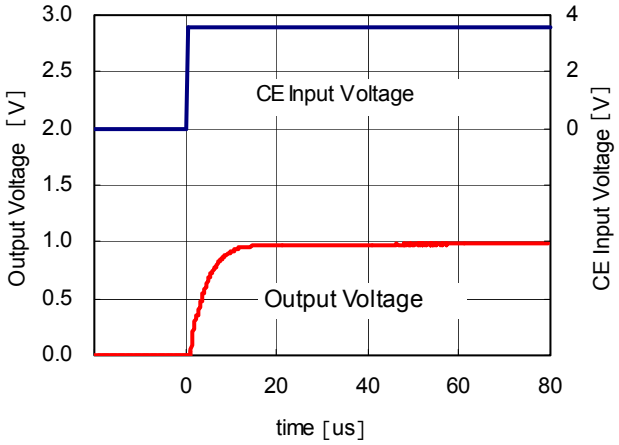






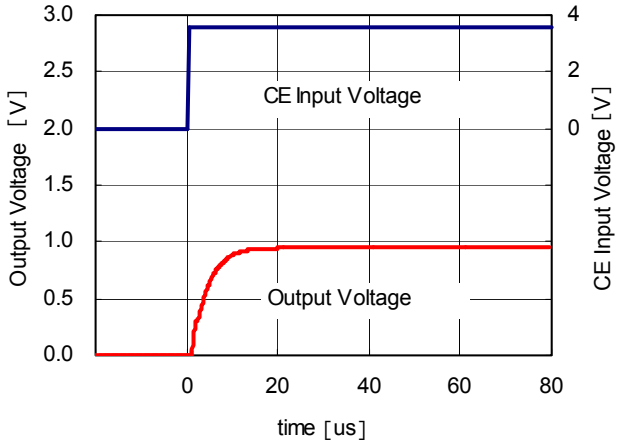
RP105x10xx

BIAS=3.6V
VIN=1.5V
IOUT=30mA



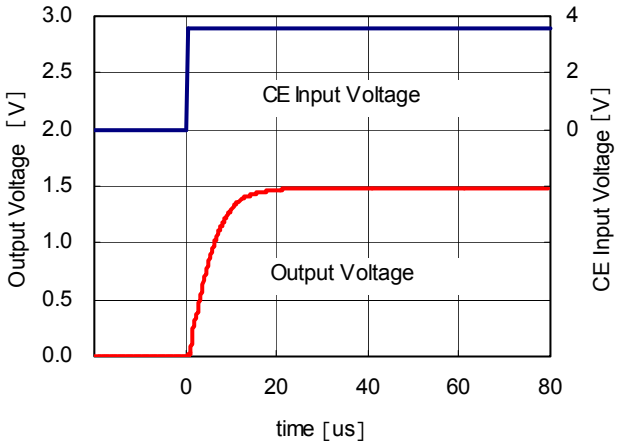
RP105x10xx

BIAS=3.6V
VIN=1.5V
IOUT=400mA



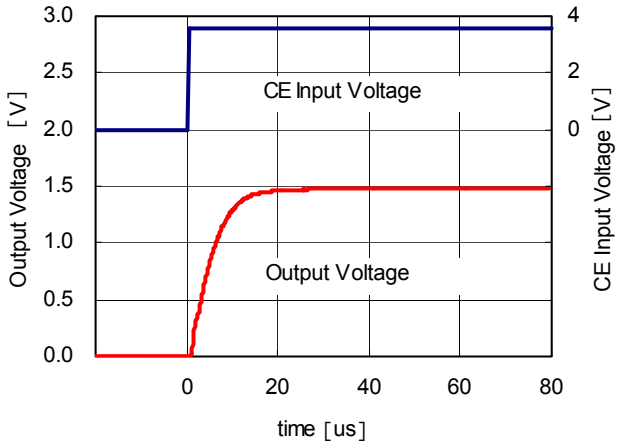
RP105x15xx

BIAS=3.6V
VIN=2.0V
IOUT=0mA



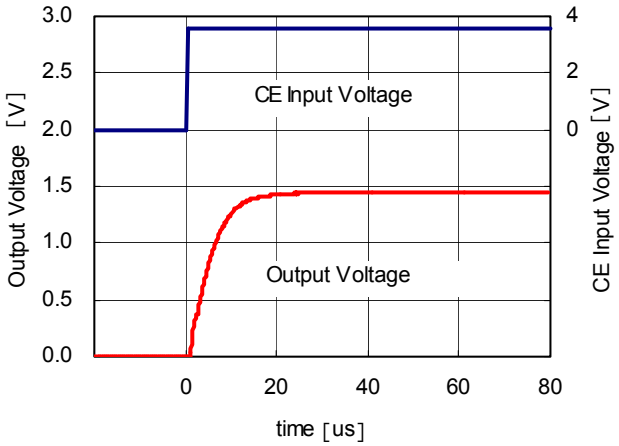
RP105x15xx

BIAS=3.6V
VIN=2.0V
IOUT=30mA



RP105x15xx

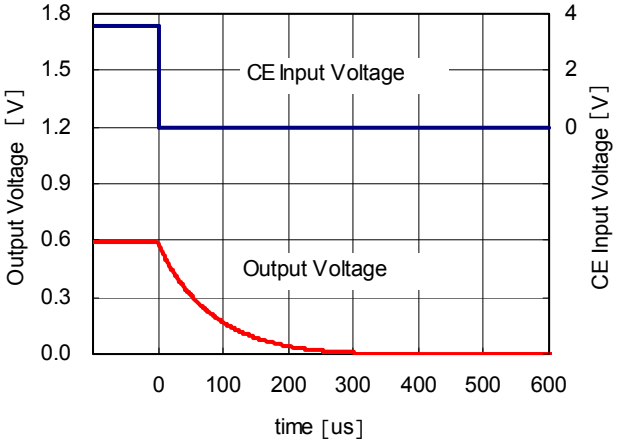
BIAS=3.6V
VIN=2.0V
IOUT=400mA



13) Turn Off Speed with CE pin (C_{BIAS}=1.0uF,C_{VIN}=C_{OUT}=2.2uF, Topt=25°C)

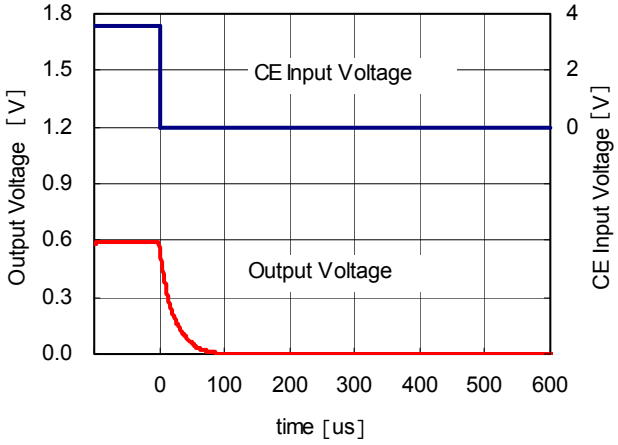
RP105x06xx

BIAS=3.6V
VIN=1.1V
IOUT=0mA



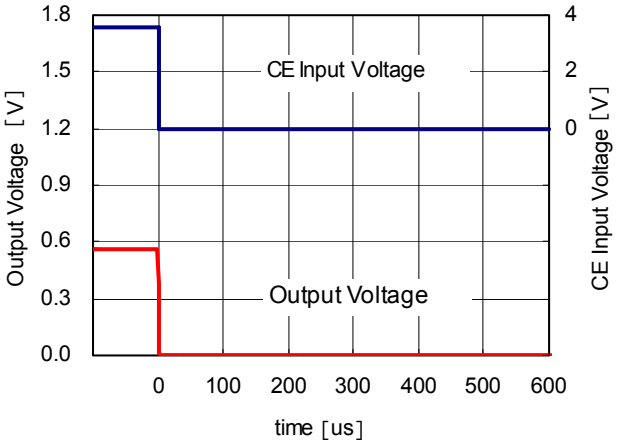
RP105x06xx

BIAS=3.6V
VIN=1.1V
IOUT=30mA



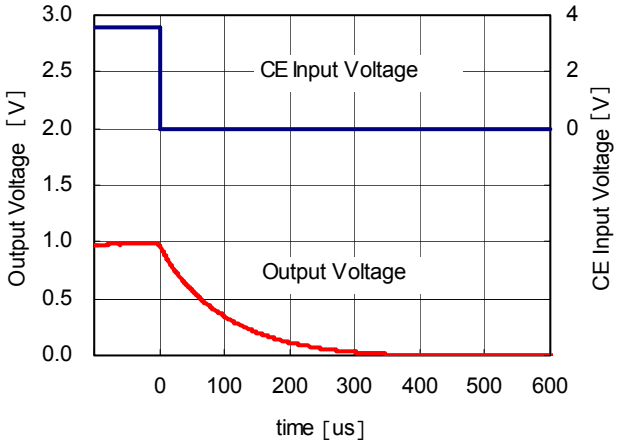
RP105x06xx

BIAS=3.6V
VIN=1.1V
IOUT=400mA



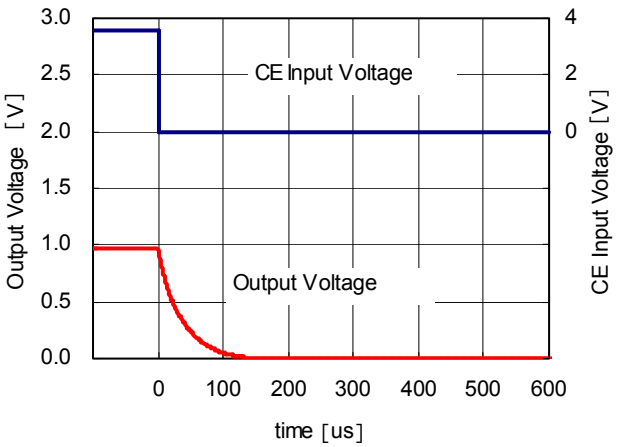
RP105x10xx

BIAS=3.6V
VIN=1.5V
IOUT=0mA



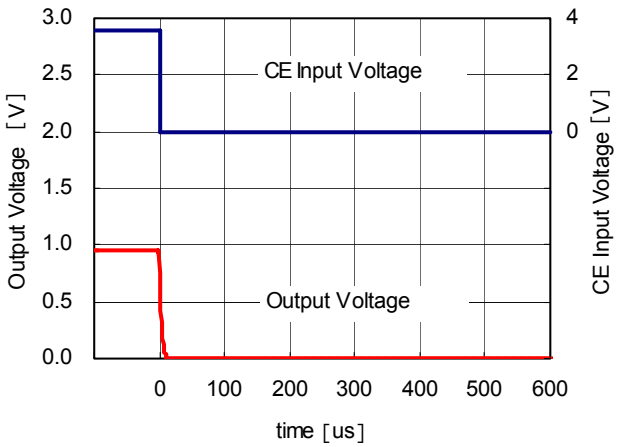
RP105x10xx

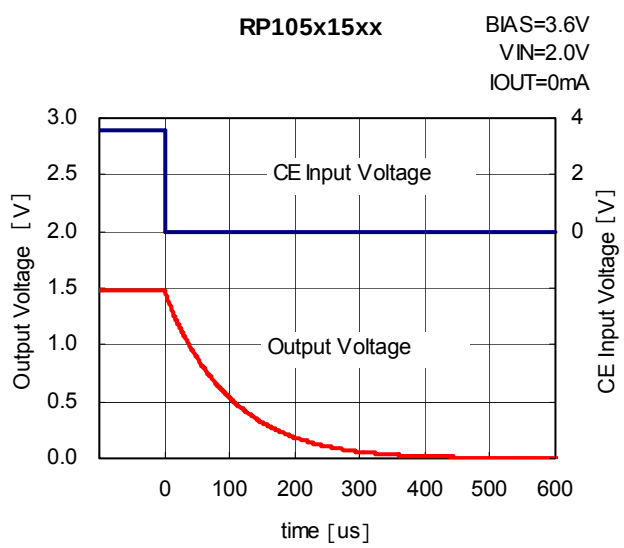
BIAS=3.6V
VIN=1.5V
IOUT=30mA

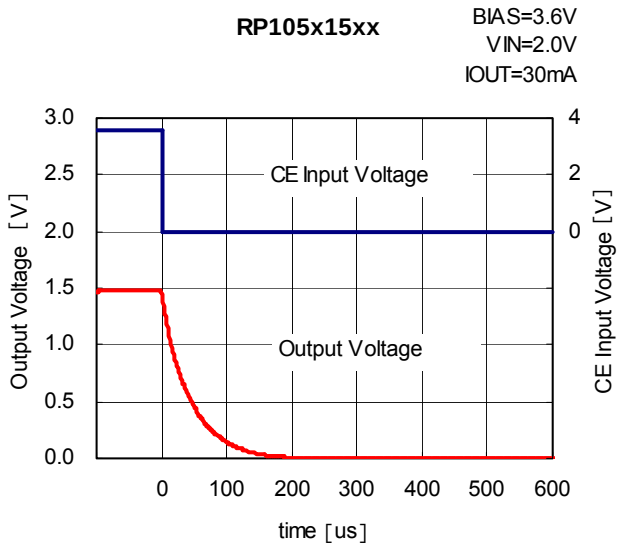


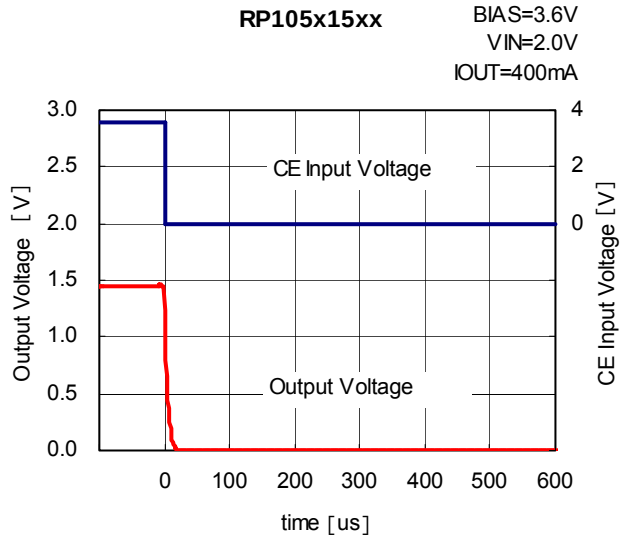
RP105x10xx

BIAS=3.6V
VIN=1.5V
IOUT=400mA

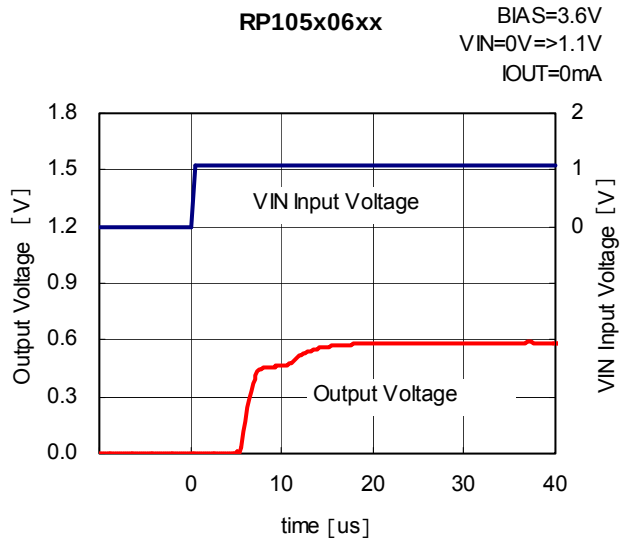


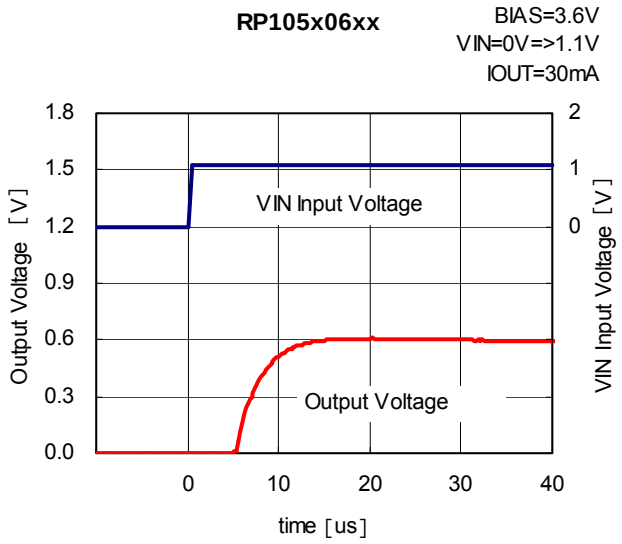


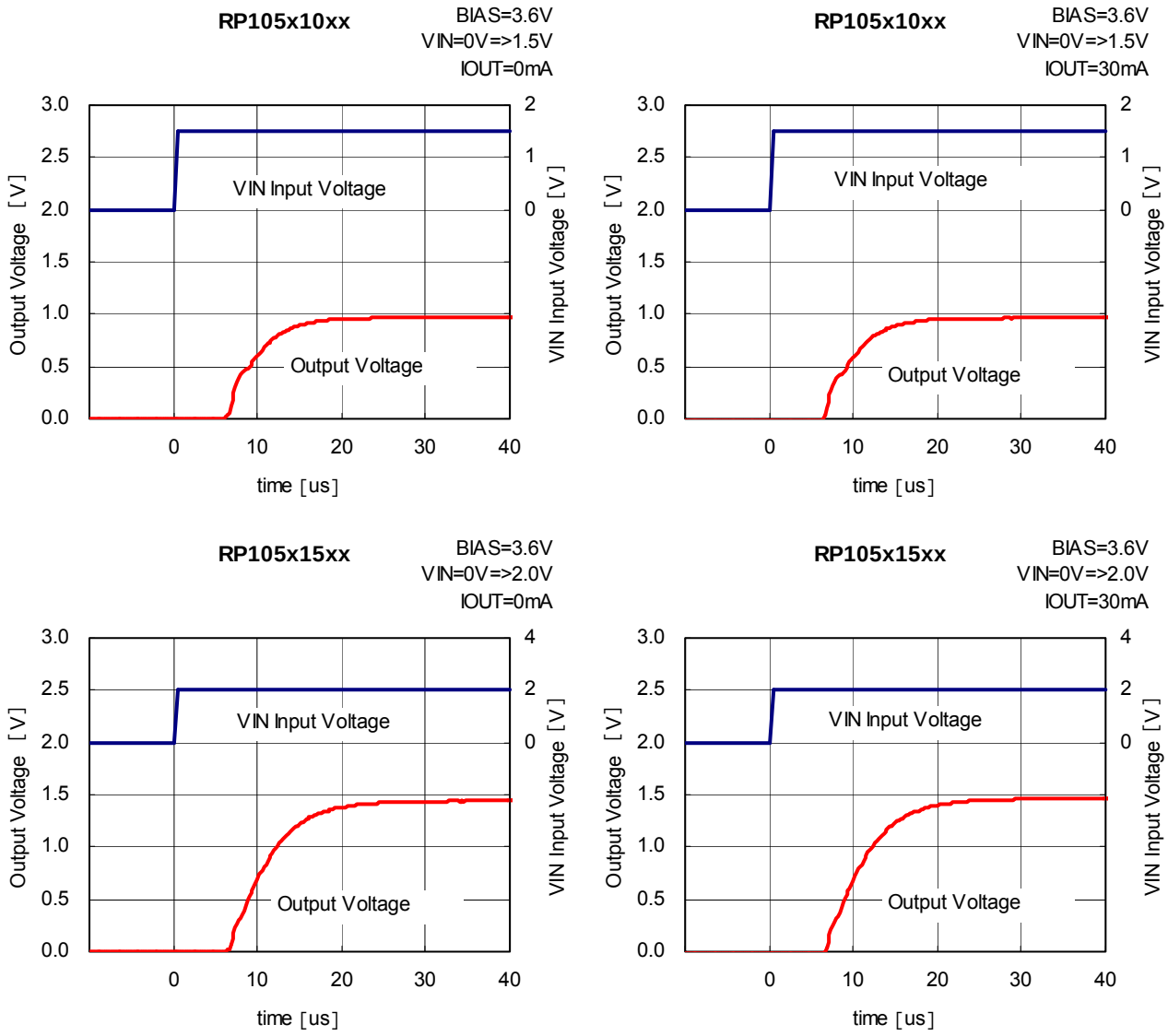




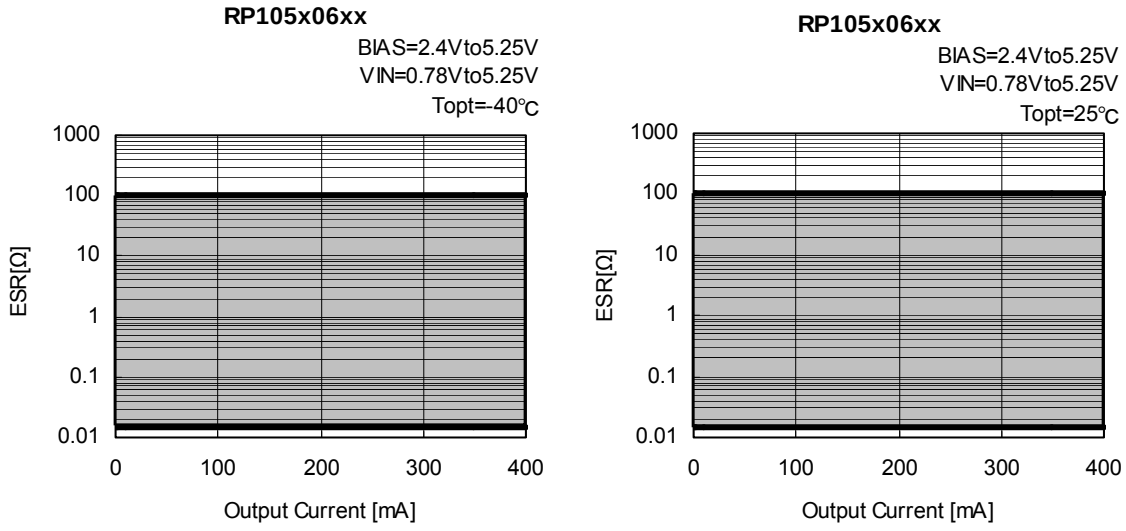
14) Turn On Transient with VIN pin (CBIAS=1.0uF,CVIN=none,COUT=2.2uF,Topt=25°C)



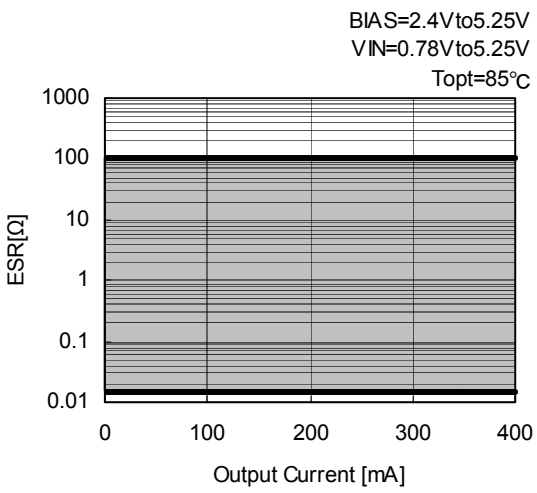




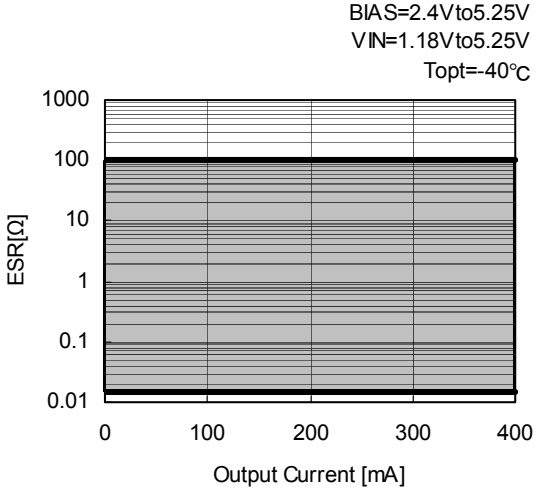
15) ESR vs. Output Current (C_{BIAS}=C_{VIN}=1.0uF, C_{OUT}=2.2uF)



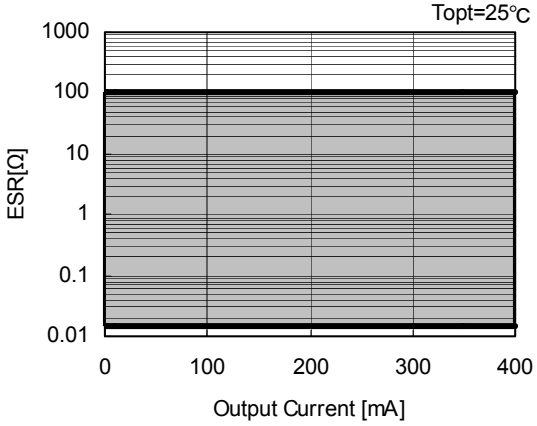
RP105x06xx



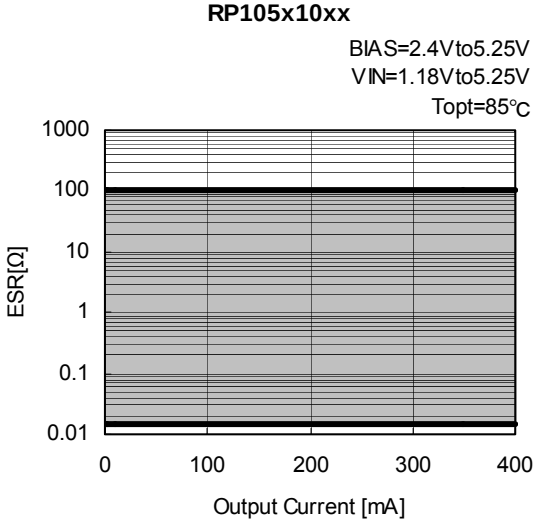
RP105x10xx



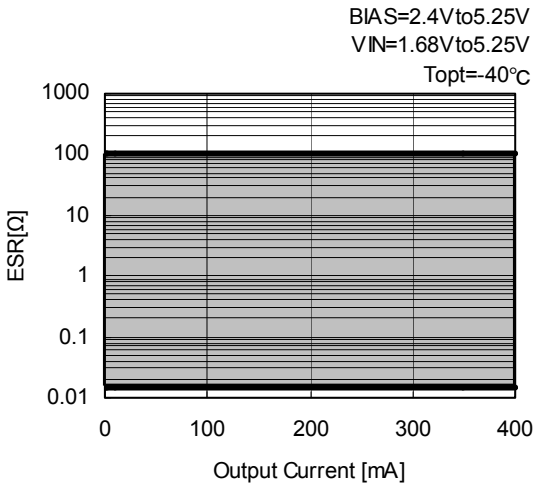
RP105x10xx



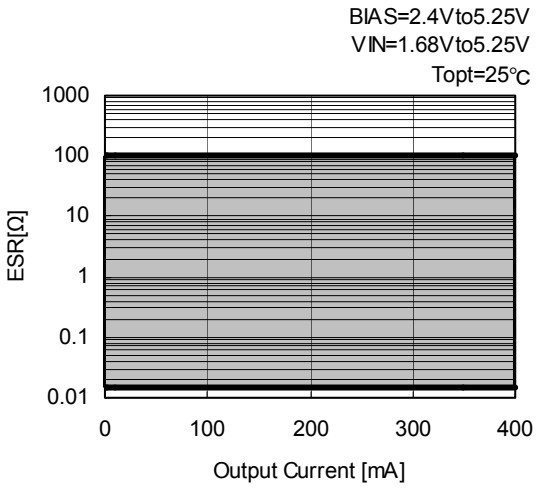
RP105x10xx

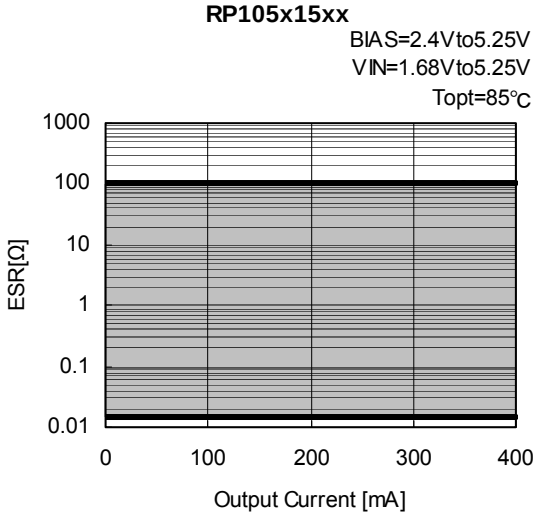


RP105x15xx



RP105x15xx




RP105x15xx
BIAS=2.4Vto5.25V
VIN=1.68Vto5.25V
Topt=85°C
1000
100
10
1
0.1
0.01
ESR[Ω]
0
100
200
300
400
Output Current [mA]

POWER DISSIPATION (DFN(PLP)1212-6)

Power dissipation depends on the conditions of mounting on board. This specification is based on the measurement at the conditions below:

Measurement Conditions

	Standard Test Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm*40mm*1.6mm
Copper Ratio	Top side: Approx. 50%, Back side: Approx. 50%
Through-holes	ϕ 0.54mm * 28pcs

Measurement Result: (Topt=25°C, Tjmax=125°C)

	Standard Test Land Pattern
Power Dissipation	400mW
Thermal Resistance	θja = (125-25°C)/0.4W= 259°C/W
	θjc = (125-25°C)/0.4W= 67°C/W

POWER DISSIPATION (SOT-23-5)

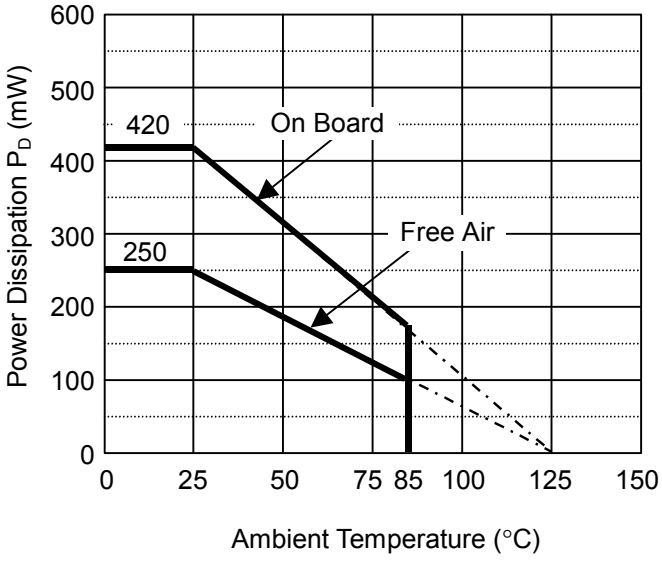
This specification is at mounted on board. Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:
(Power Dissipation (SOT-23-5) is substitution of SOT-23-6.)

Measurement Conditions

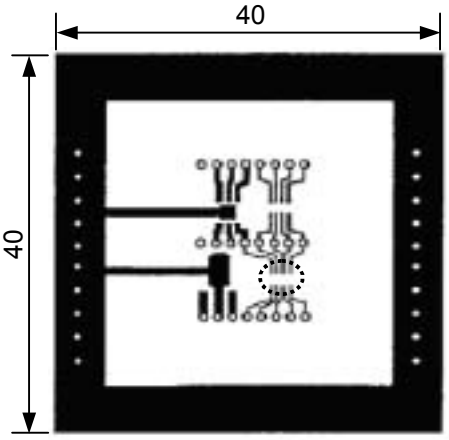
	Standard Test Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm*40mm*1.6mm
Copper Ratio	Top side: Approx. 50%, Back side: Approx. 50%
Through-holes	ϕ 0.5mm * 44pcs

Measurement Result: (Topt=25°C, Tjmax=125°C)

	Standard Test Land Pattern	Free Air
Power Dissipation	420mW	250mW
Thermal Resistance	θja = (125-25°C)/0.42W= 263°C/W	400°C/W



Power Dissipation



Measurement Board Pattern

IC Mount Area (Unit: mm)

POWER DISSIPATION (SC-88)

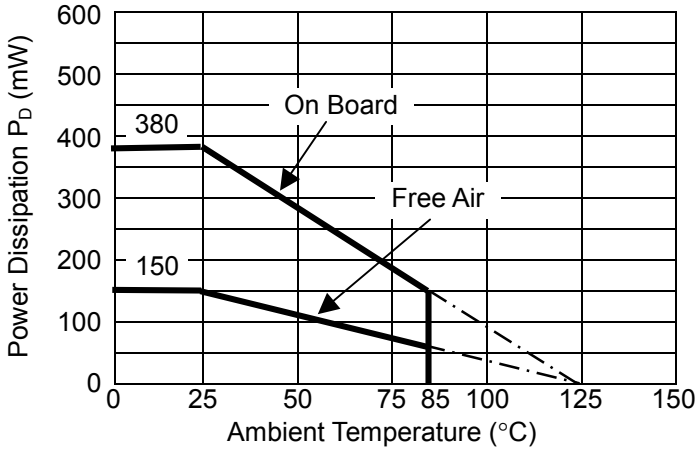
This specification is at mounted on board. Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below;

* Measurement Conditions

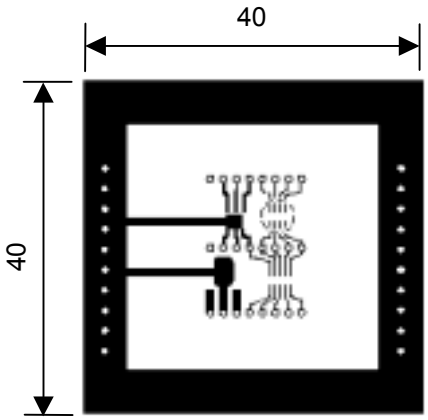
	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double Layers)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side: Approx. 50%, Back side: Approx. 50%
Through-hole	ϕ0.5mm × 44pcs

* Measurement Result (Topt=25°C, Tjmax=125°C)

	Standard Land Pattern	**Free Air**
Power Dissipation	380mW	150mW
Thermal Resistance	θja=(125-25°C)/0.38W=263°C/W	667°C/W
	θjc=75°C/W	



Power Dissipation



Measurment Board Pattern

IC Mount Area (Unit : mm)