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## 300mA LDO REGULATOR

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NO. EA-236-120613

### OUTLINE

The RP114x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, low supply current, low dropout, and high ripple rejection. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, resistors for setting output voltage, a short current limit circuit, a chip enable circuit, and so on.

RP114x features a minimum input voltage from 1.4V and the output voltage, which can be set from 0.8V to 3.6V (in 0.1V step). The output voltage of these ICs is internally fixed.

These ICs perform with low dropout voltage due to built-in transistor with low ON resistance. Low supply current and a chip enable function prolong the battery life of each system. The ripple rejection, line transient response and load transient response of the RP114x Series are excellent, thus these ICs are very suitable for the power supply for hand-held communication equipment.

Since the packages for these ICs are DFN(PLP)1010-4, SC-88A, SOT-23-5, therefore high density mounting of the ICs on boards is possible.

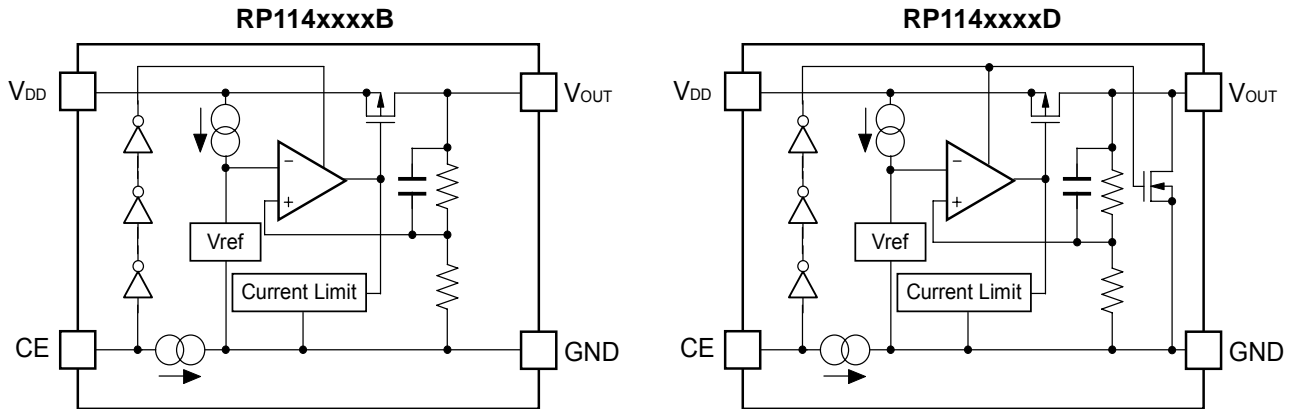
### FEATURES

- Supply Current .....Typ. 50 $\mu$ A
- Standby Current .....Typ. 0.1 $\mu$ A
- Input Voltage Range.....1.4V to 5.25V
- Output Voltage Range.....0.8V to 3.6V (0.1V steps)  
(For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy..... $\pm$ 1.0% ( $V_{SET}>2.0V$ ,  $T_{opt}=25^{\circ}C$ )
- Temperature-Drift Coefficient of Output Voltage .....Typ.  $\pm$ 80ppm/ $^{\circ}C$
- Dropout Voltage.....Typ. 0.25V ( $I_{OUT}=300mA$ ,  $V_{SET}=2.8V$ )
- Ripple Rejection .....Typ. 75dB ( $f=1kHz$ )
- Line Regulation .....Typ. 0.02%/V
- Packages .....DFN(PLP)1010-4, SC-88A, SOT-23-5
- Built-in Fold Back Protection Circuit.....Typ. 60mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC .... 1.0 $\mu$ F 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



## SELECTION GUIDE

The set output voltage, auto discharge function, and package, etc. for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP114Kxx1*-TR	DFN(PLP)1010-4	10,000 pcs	Yes	Yes
RP114Qxx2*-TR-FE	SC-88A	3,000 pcs	Yes	Yes
RP114Nxx1*-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx: The set output voltage can be selected from 0.8V(08) to 3.6V(36) in 0.1V steps.

The second decimal point of the voltage is described as below.

1.25V: RP114K121\*5-TR, RP114Q122\*5-TR-FE, RP114N121\*5-TR-FE

1.85V: RP114K181\*5-TR, PR114Q182\*5-TR-FE, RP114N181\*5-TR-FE

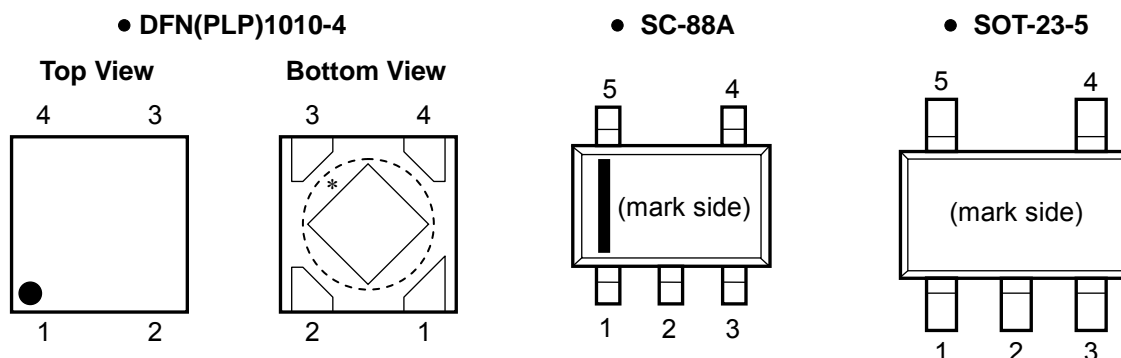
2.85V: RP114K281\*5-TR, PR114Q282\*5-TR-FE, RP114N281\*5-TR-FE

\* : The auto discharge function at off state is options as follows.

(B) without auto discharge function at off state

(D) with auto discharge function at off state

## PIN CONFIGURATIONS



## PIN DESCRIPTIONS

### • DFN(PLP)1010-4

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

\*) Tab is GND level. (They are connected to the reverse side of this IC.)

The tab is better to be connected to the GND, but leaving it open is also acceptable.

### • SC-88A

Pin No	Symbol	Pin 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	Pin 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	6.0	V
$V_{CE}$	Input Voltage (CE Pin)	-0.3 to 6.0	V
$V_{OUT}$	Output Voltage	-0.3 to $V_{IN}+0.3$	V
$I_{OUT}$	Output Current	400	mA
$P_D$	Power Dissipation (DFN(PLP)1010-4)*	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.

## POWER DISSIPATION (DFN(PLP)1010-4)

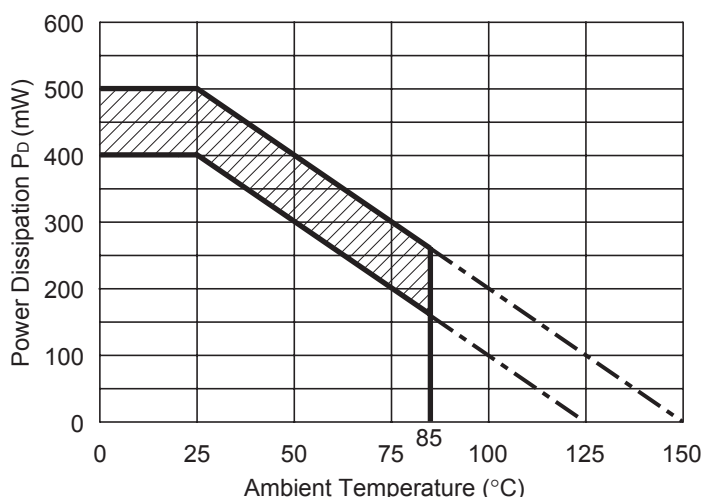
This specification is at mounted on board. Power Dissipation ( $P_D$ ) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

### Measurement Conditions

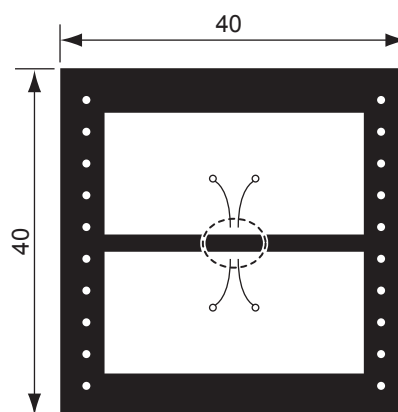
	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50% , Back side : Approx. 50%
Through-holes	φ0.54mm × 24pcs

### Measurement Results (T<sub>opt</sub>=25°C, T<sub>jmax</sub>=125°C)

	Standard Land Pattern
Power Dissipation	400mW
Thermal Resistance	$\theta_{ja}=(125-25^{\circ}\text{C})/0.4\text{W}=250^{\circ}\text{C}/\text{W}$
Thermal Resistance	$\theta_{jc}=67^{\circ}\text{C}/\text{W}$



**Power Dissipation**



**Measurement Board Pattern**

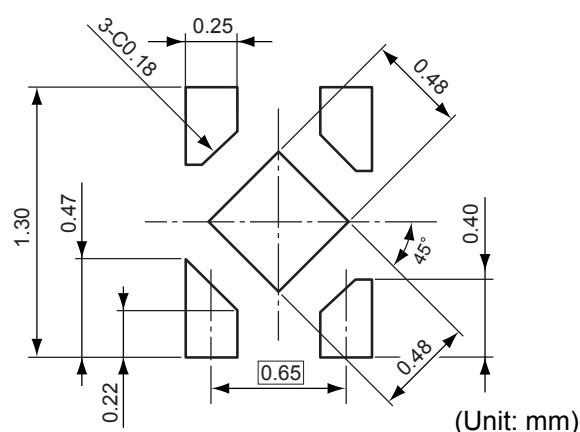
○ IC Mount Area (Unit: mm)

The above graph shows the Power Dissipation of the package based on T<sub>jmax</sub>=125°C and T<sub>jmax</sub>=150°C. Operating the IC in the shaded area in the graph might have an influence it's lifetime. Operating time must be within the time limit described in the table below, in case of operating in the shaded area.

Operating time	Estimated years*
13,000hrs	9years

\*The volume is calculated on the supposition that operating four hours/day.

## RECOMMENDED LAND PATTERN



(Unit: mm)

## POWER DISSIPATION (SC-88A)

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:

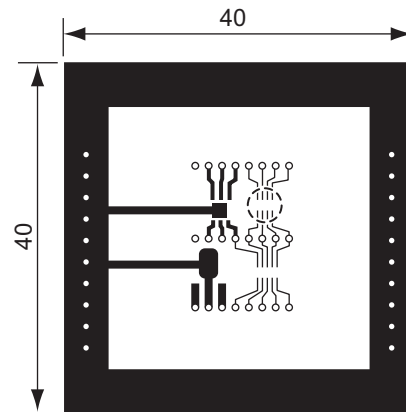
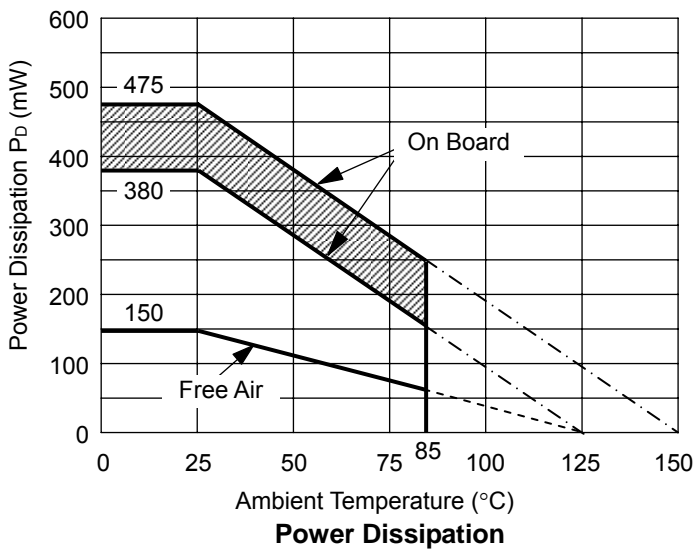
### Measurement Conditions

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

### Measurement Results

( $T_{opt}=25^{\circ}C$ ,  $T_{jmax}=125^{\circ}C$ )

	Standard Land Pattern	Free Air
Power Dissipation	380mW	150mW
Thermal Resistance	$\theta_{ja}=(125-25^{\circ}C)/0.38W=263^{\circ}C/W$	$\theta_{ja}=(125-25^{\circ}C)/0.15W=667^{\circ}C/W$
Thermal Resistance	$\theta_{jc}=75^{\circ}C/W$	-



**Measurement Board Pattern**  
 ○ IC Mount Area (Unit: mm)

The above graph shows the Power Dissipation of the package based on  $T_{jmax}=125^{\circ}C$  and  $T_{jmax}=150^{\circ}C$ .

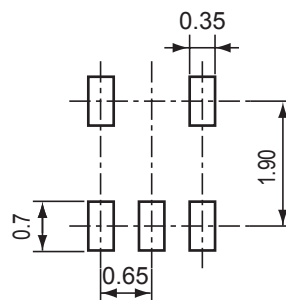
Operating the IC in the shaded area in the graph might have an influence it's lifetime.

Operating time must be within the time limit described in the table below, in case of operating in the shaded area.

Operating time	Estimated years*
13,000hrs	9years

\*The volume is calculated on the supposition that operating four hours/day.

## RECOMMENDED LAND PATTERN



(Unit: mm)

## 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

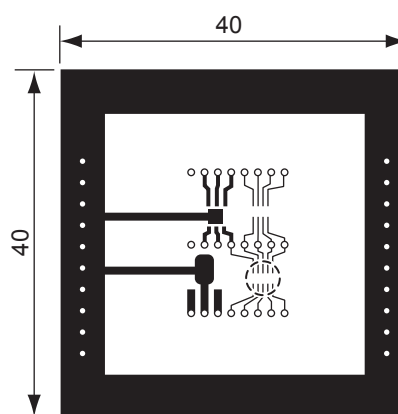
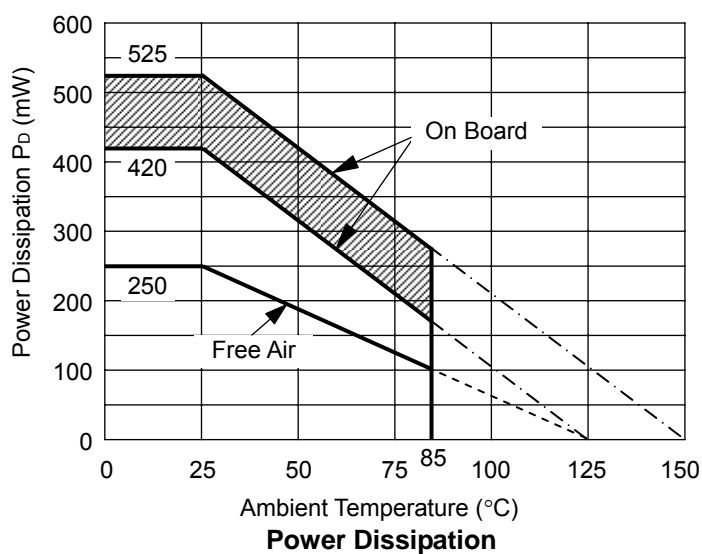
	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50% , Back side : Approx. 50%
Through-holes	φ0.5mm × 44pcs

### Measurement Results

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

$T_{jmax}=125^{\circ}C$ )

	Standard Land Pattern	Free Air
Power Dissipation	420mW	250mW
Thermal Resistance	$\theta_{ja}=(125-25^{\circ}C)/0.42W=238^{\circ}C/W$	400 $^{\circ}C/W$



Measurement Board Pattern

○ IC Mount Area (Unit: mm)

The above graph shows the Power Dissipation of the package based on  $T_{jmax}=125^{\circ}C$  and  $T_{jmax}=150^{\circ}C$ .

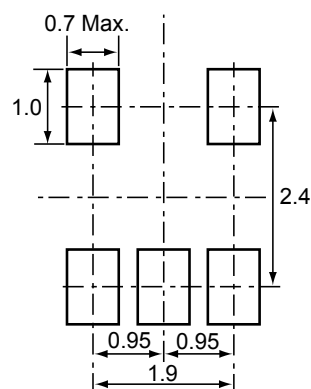
Operating the IC in the shaded area in the graph might have an influence it's lifetime.

Operating time must be within the time limit described in the table below, in case of operating in the shaded area.

Operating time	Estimated years*
13,000hrs	9years

\*The volume is calculated on the supposition that operating four hours/day.

## RECOMMENDED LAND PATTERN



(Unit: mm)

## ELECTRICAL CHARACTERISTICS

• **RP114x**

$V_{IN}=V_{SET}+1.0V$  ( $V_{SET} > 1.5V$ ),  $V_{IN}=2.5V$  ( $V_{SET} \leq 1.5V$ ),  $I_{OUT}=1mA$ ,  $C_{IN}=C_{OUT}=1.0\mu F$ , unless otherwise noted.

$V_{SET}$  is Set Output Voltage.

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

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

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
$V_{OUT}$	Output Voltage	$T_{opt}=25^{\circ}C$	$V_{SET} > 2.0V$	$\times 0.99$		$\times 1.01$	V
			$V_{SET} \leq 2.0V$	-20		+20	mV
		$-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$	$V_{SET} > 2.0V$	<span style="border: 1px solid black; padding: 0 2px;">×0.97</span>		<span style="border: 1px solid black; padding: 0 2px;">×1.03</span>	V
			$V_{SET} \leq 2.0V$	<span style="border: 1px solid black; padding: 0 2px;">-60</span>		<span style="border: 1px solid black; padding: 0 2px;">+60</span>	mV
$I_{OUT}$	Output Current		<span style="border: 1px solid black; padding: 0 2px;">300</span>			mA	
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	$1mA \leq I_{OUT} \leq 300mA$		15	<span style="border: 1px solid black; padding: 0 2px;">40</span>	mV	
$V_{DIF}$	Dropout Voltage	Refer to the following table.					
$I_{SS}$	Supply Current	$I_{OUT}=0mA$		50	<span style="border: 1px solid black; padding: 0 2px;">75</span>	$\mu A$	
$I_{standby}$	Standby Current	$V_{CE}=0V$		0.1	1.0	$\mu A$	
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$V_{SET}+0.5V \leq V_{IN} \leq 5.25V$ ( $V_{IN} \geq 1.4V$ )		0.02	<span style="border: 1px solid black; padding: 0 2px;">0.10</span>	%/V	
RR	Ripple Rejection	$f=1kHz$ , Ripple 0.2Vp-p $V_{IN}=V_{SET}+1V$ , $I_{OUT}=30mA$ (In case that $V_{SET} \leq 2.0V$ , $V_{IN}=3V$ )		75		dB	
$V_{IN}$	Input Voltage*		<span style="border: 1px solid black; padding: 0 2px;">1.4</span>		<span style="border: 1px solid black; padding: 0 2px;">5.25</span>	V	
$\Delta V_{OUT}/\Delta T_{opt}$	Output Voltage Temperature Coefficient	$-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$		$\pm 80$		ppm/ $^{\circ}C$	
$I_{SC}$	Short Current Limit	$V_{OUT}=0V$		60		mA	
$I_{PD}$	CE Pull-down Current			0.3		$\mu A$	
$V_{CEH}$	CE Input Voltage "H"		<span style="border: 1px solid black; padding: 0 2px;">1.0</span>			V	
$V_{CEL}$	CE Input Voltage "L"				<span style="border: 1px solid black; padding: 0 2px;">0.4</span>	V	
en	Output Noise	$BW=10Hz$ to $100kHz$ , $I_{OUT}=30mA$		75		$\mu V_{rms}$	
$R_{LOW}$	Low Output Nch Tr. ON Resistance (of D version)	$V_{IN}=4.0V$ , $V_{CE}=0V$		50		$\Omega$	

\*) The maximum Input Voltage of the ELECTRICAL CHARACTERISTICS is 5.25V. In case of exceeding this specification, the IC must be operated on condition that the Input Voltage is up to 5.5V and the total operating time is 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.

### 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.



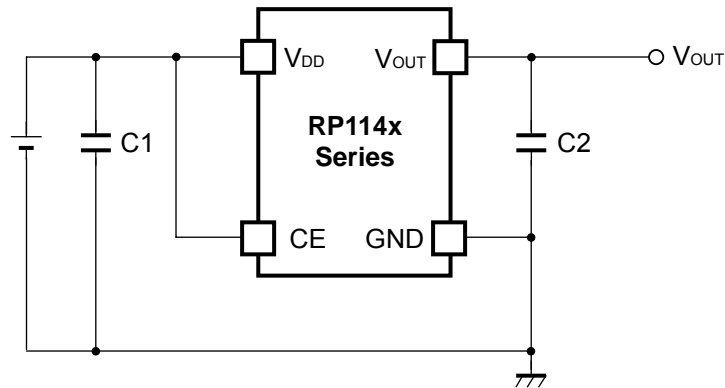
• Dropout Voltage by Set Output Voltage

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

Set Output Voltage $V_{SET}$ (V)	Dropout Voltage $V_{DIF}$ (V)		
	Condition	Typ.	Max.
$V_{SET}=0.8$	$I_{OUT}=300\text{mA}$	0.560	0.720
$V_{SET}=0.9$		0.510	0.650
$1.0 \leq V_{SET} < 1.2$		0.460	0.590
$1.2 \leq V_{SET} < 1.4$		0.390	0.500
$1.4 \leq V_{SET} < 1.7$		0.350	0.440
$1.7 \leq V_{SET} < 2.1$		0.300	0.390
$2.1 \leq V_{SET} < 2.5$		0.260	0.340
$2.5 \leq V_{SET} < 3.0$		0.250	0.300
$3.0 \leq V_{SET} \leq 3.6$		0.220	0.290

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

## TYPICAL APPLICATIONS



(External Components)

C2 Ceramic 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 C2 with 1.0 $\mu$ F or more and good ESR (Equivalent Series Resistance).

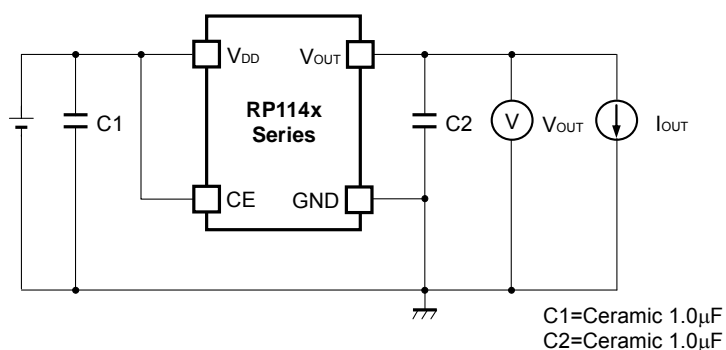
(Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

### PCB Layout

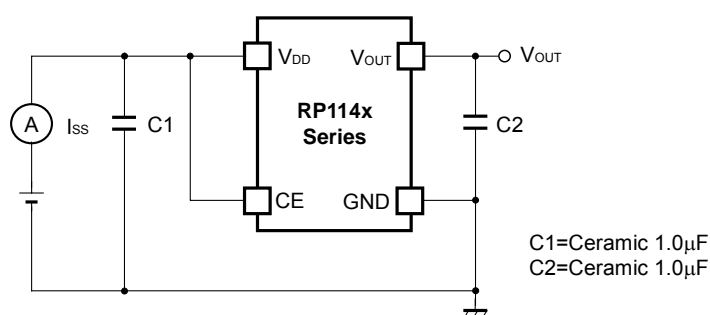
Make V<sub>DD</sub> and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 1.0 $\mu$ F or more between V<sub>DD</sub> and GND pin, and as close as possible to the pins.

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

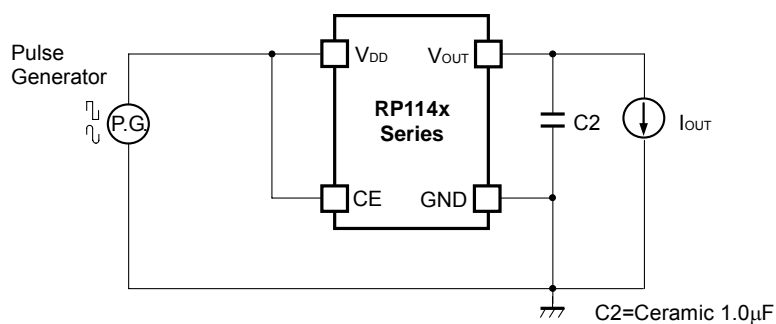
## TEST CIRCUITS



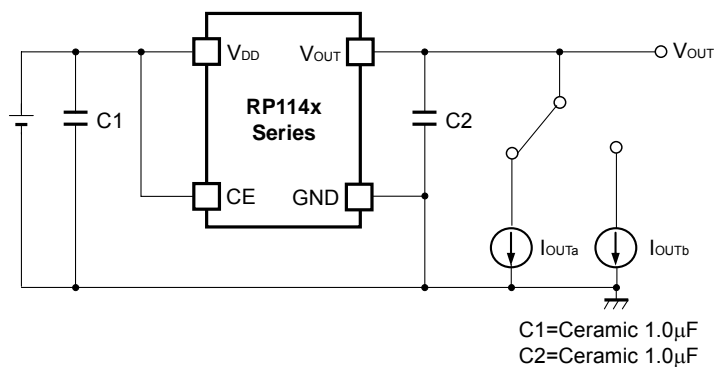
**Basic Test Circuit**



**Test Circuit for Supply Current**



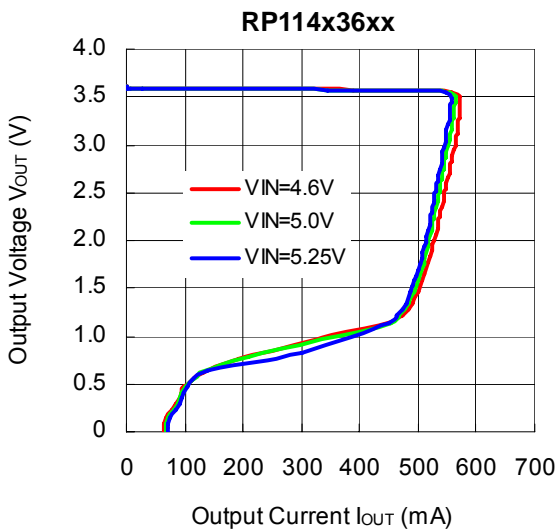
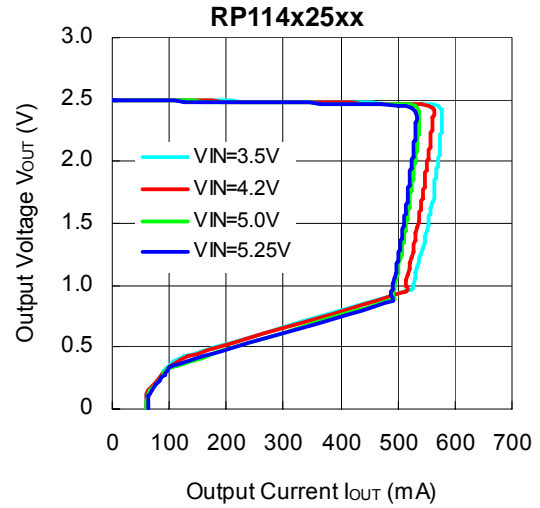
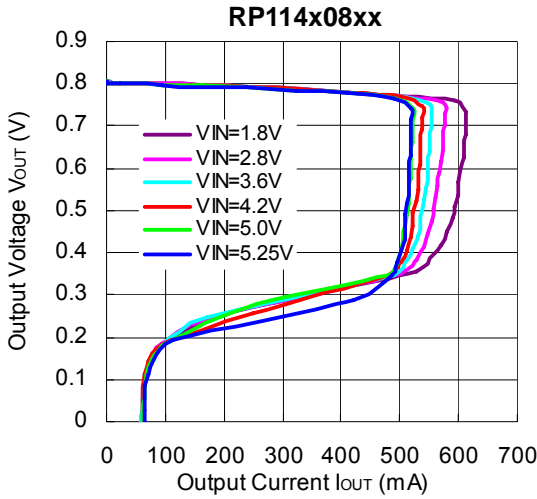
**Test Circuit for Ripple Rejection**



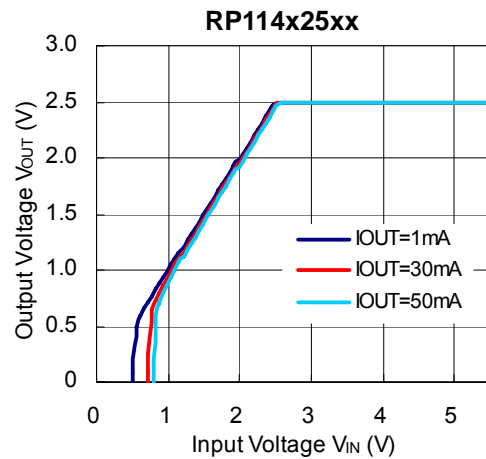
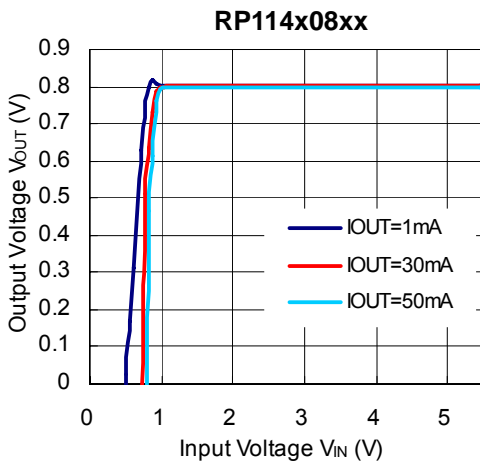
**Test Circuit for Load Transient Response**

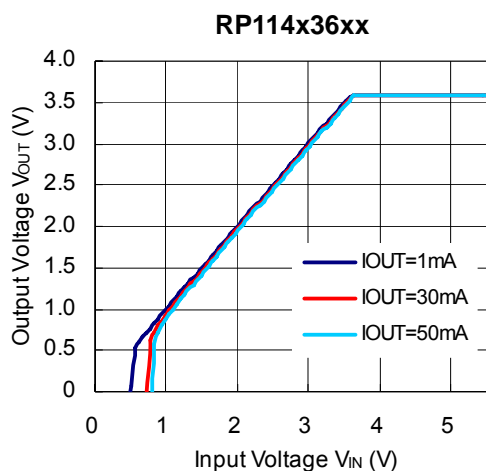
## TYPICAL CHARACTERISTICS

### 1) Output Voltage vs. Output Current ( $C1=1.0\mu\text{F}$ , $C2=1.0\mu\text{F}$ , $T_{\text{opt}}=25^\circ\text{C}$ )

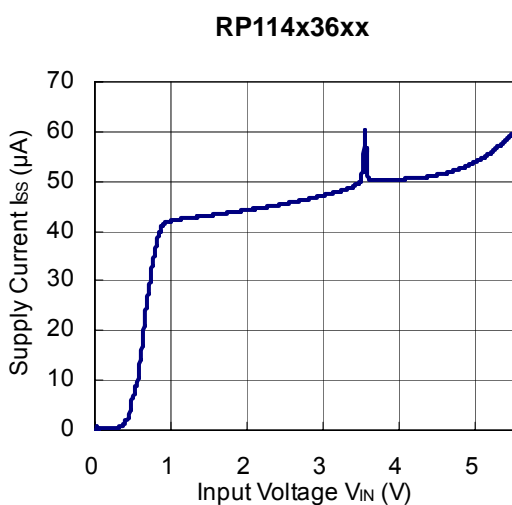
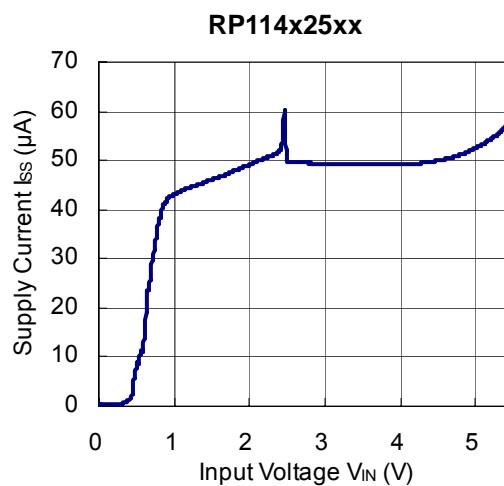
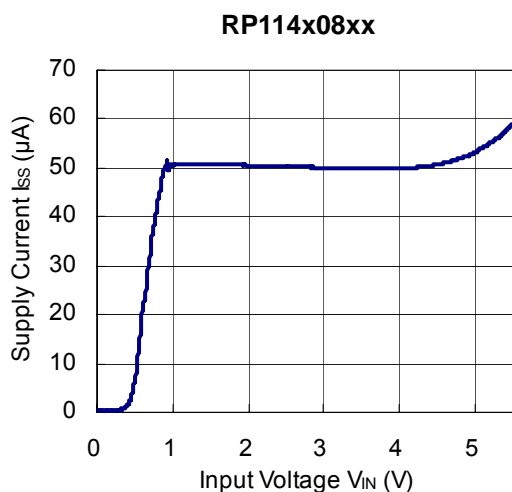


### 2) Output Voltage vs. Input Voltage ( $C1=1.0\mu\text{F}$ , $C2=1.0\mu\text{F}$ , $T_{\text{opt}}=25^\circ\text{C}$ )

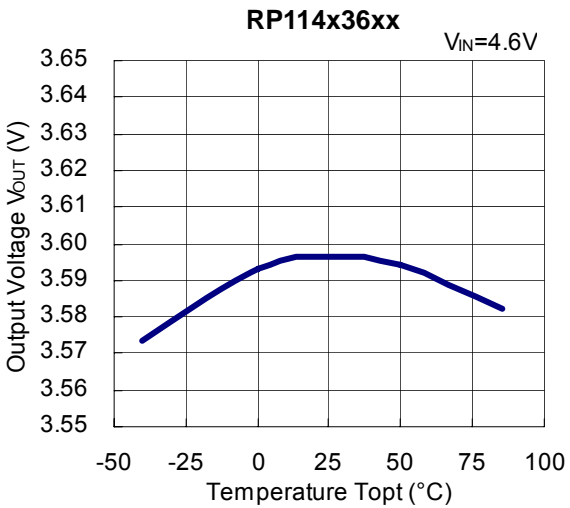
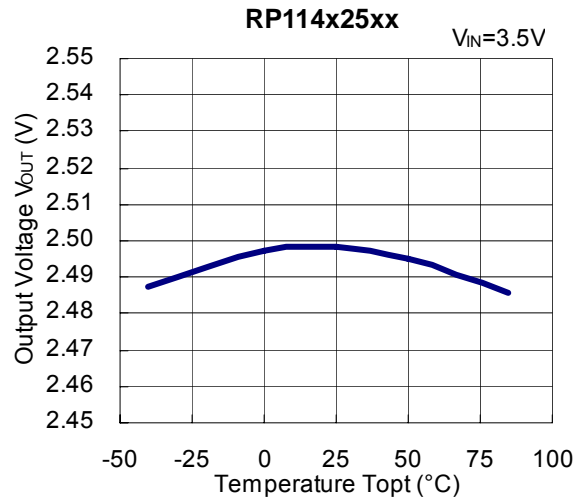
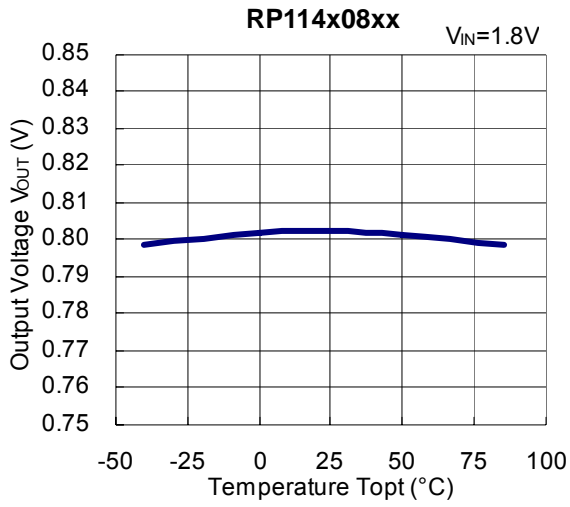




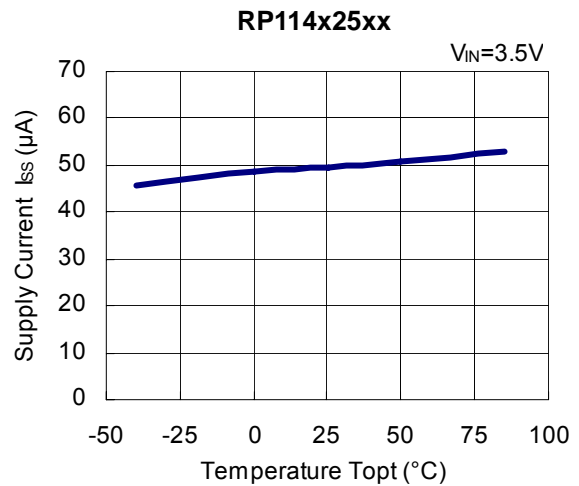
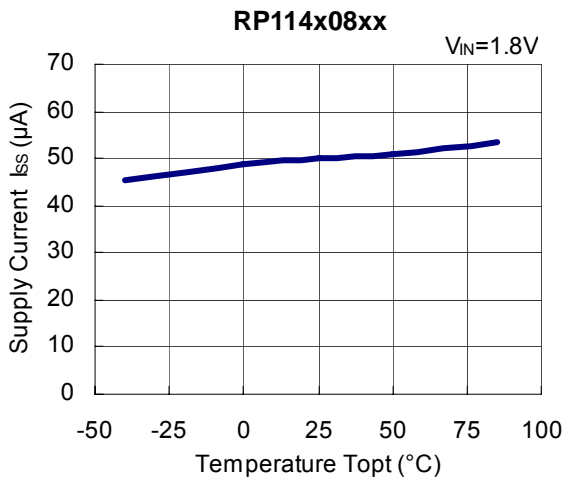
**3) Supply Current vs. Input Voltage (C1=1.0 $\mu$ F, C2=1.0 $\mu$ F, T<sub>opt</sub>=25°C)**

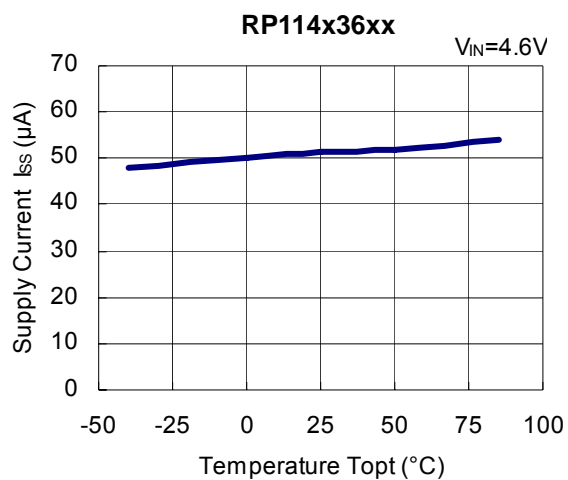


4) Output Voltage vs. Temperature (C1=1.0μF, C2=1.0μF, I<sub>OUT</sub>=1mA)

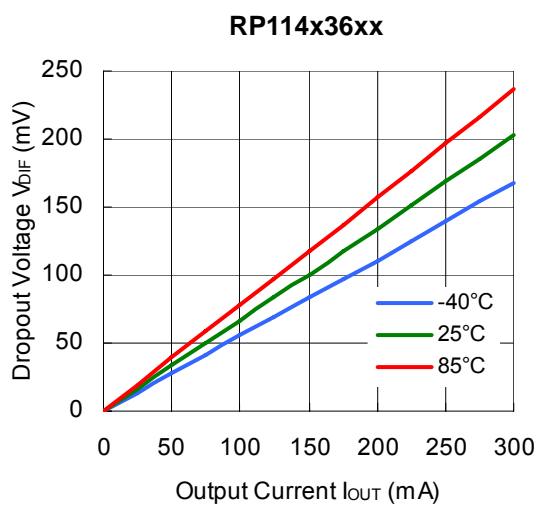
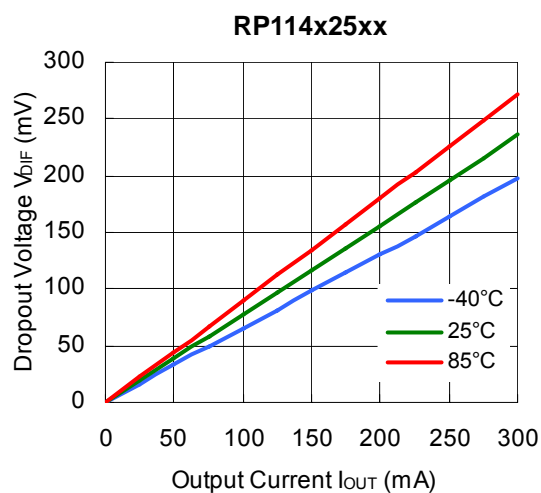
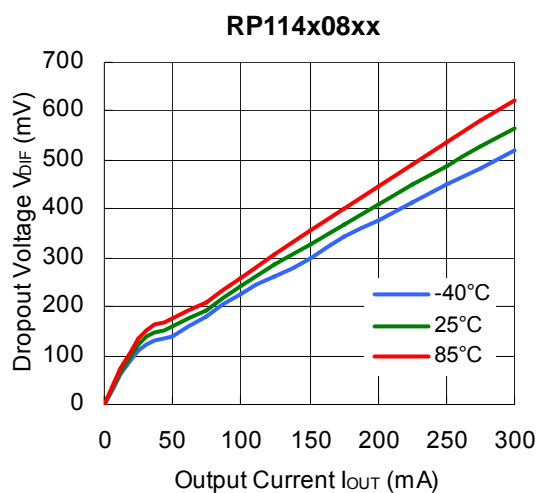


5) Supply Current vs. Temperature (C1=1.0μF, C2=1.0μF, I<sub>OUT</sub>=0mA)

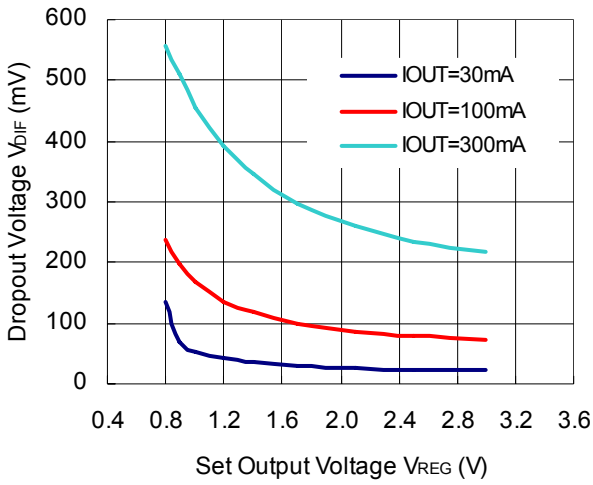




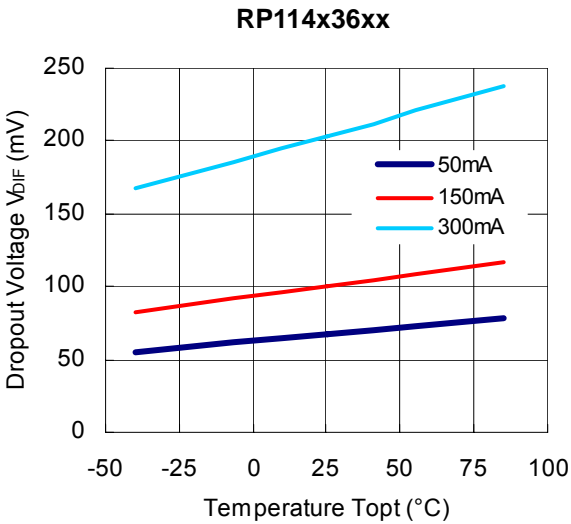
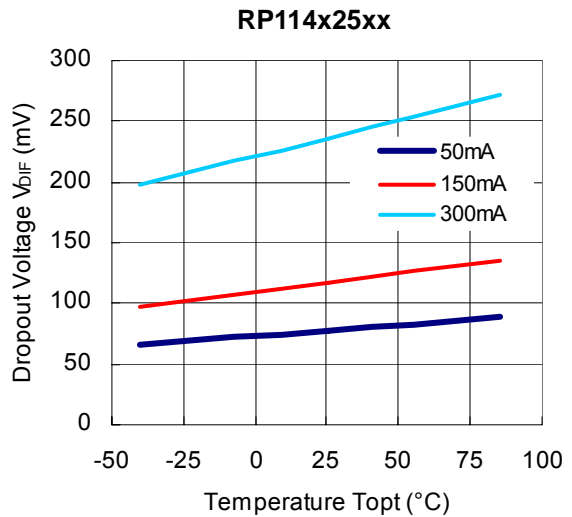
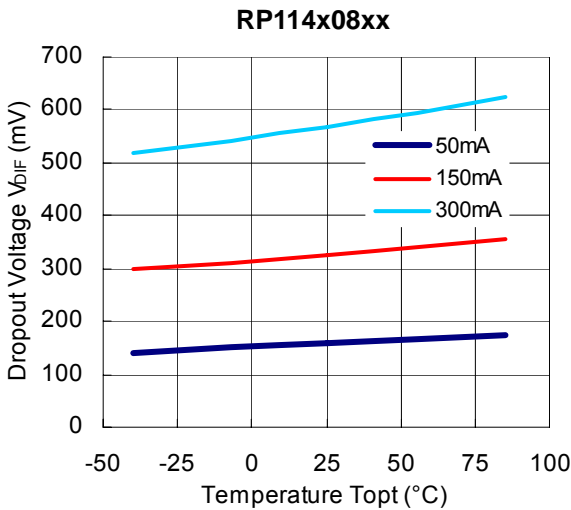
**6) Dropout Voltage vs. Output Current ( $C1=1.0\mu F$ ,  $C2=1.0\mu F$ )**



7) Dropout Voltage vs. Set Output Voltage (C1=1.0μF, C2=1.0μF, T<sub>opt</sub>=25°C)

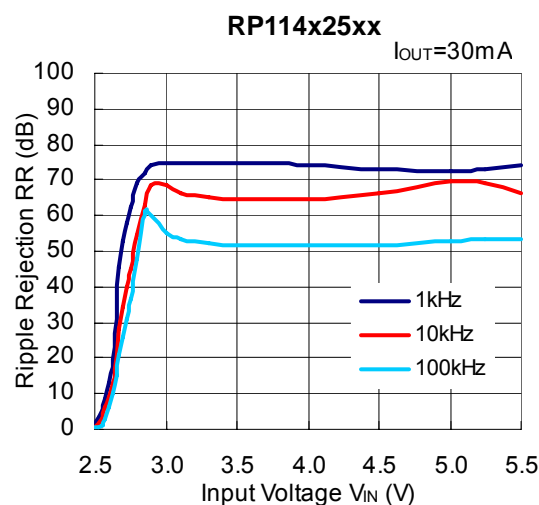
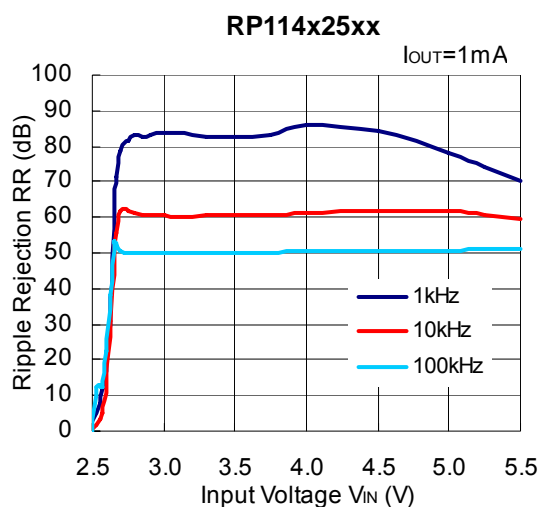


8) Dropout Voltage vs. Temperature (C1=none, C2=1.0μF)

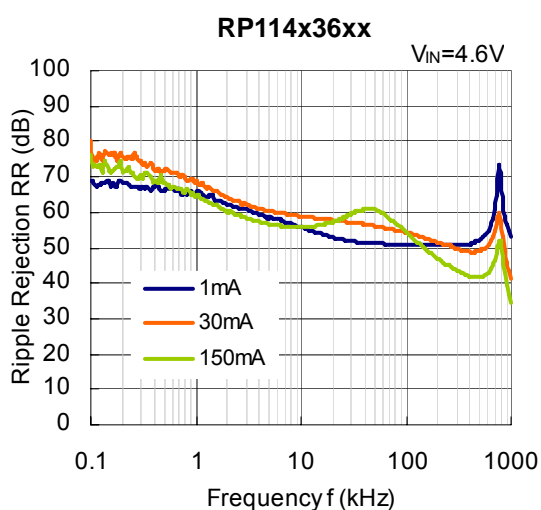
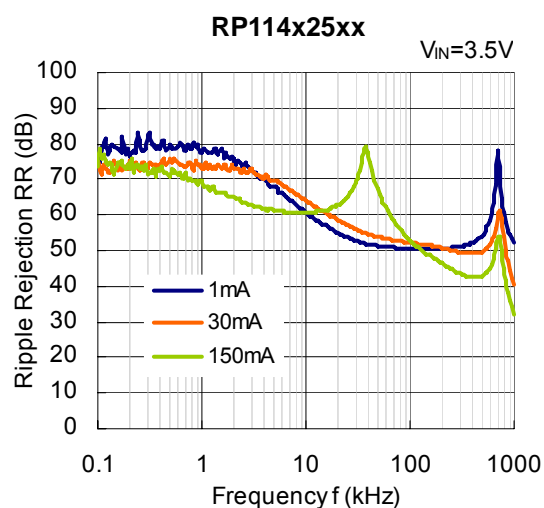
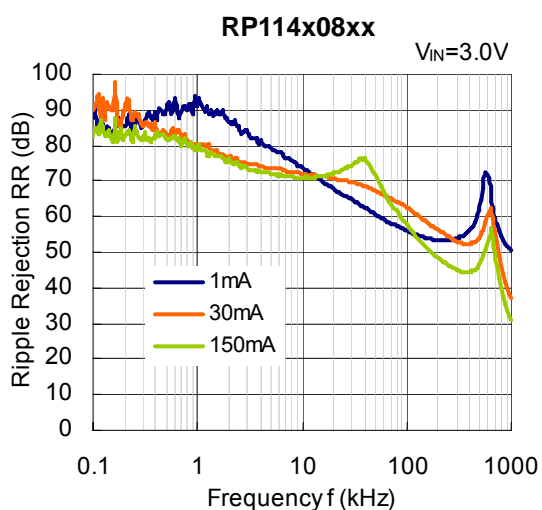




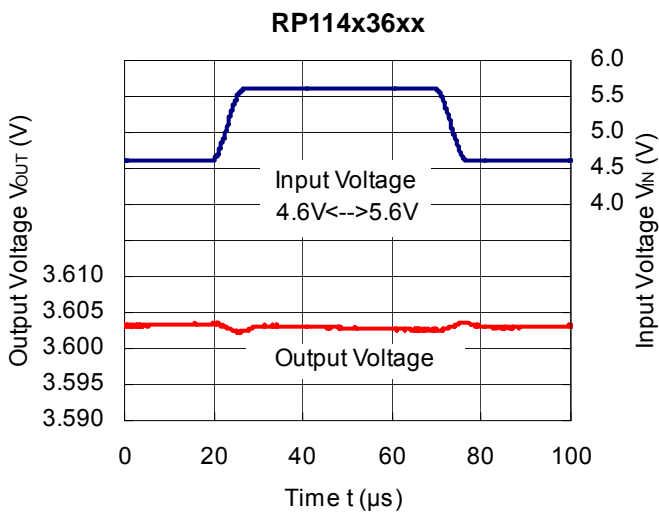
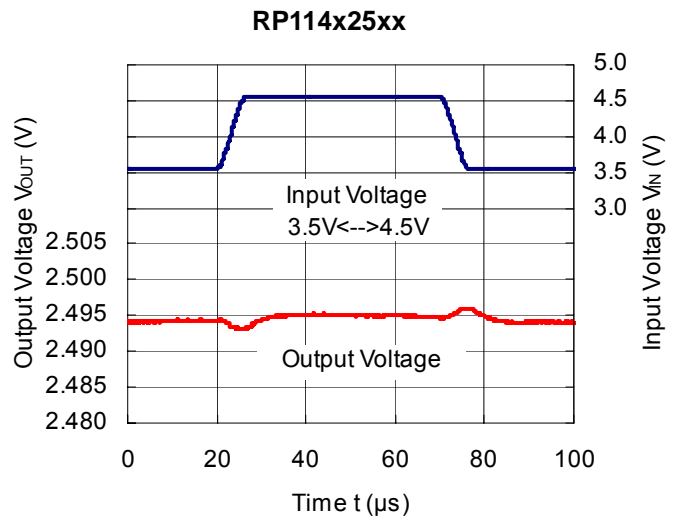
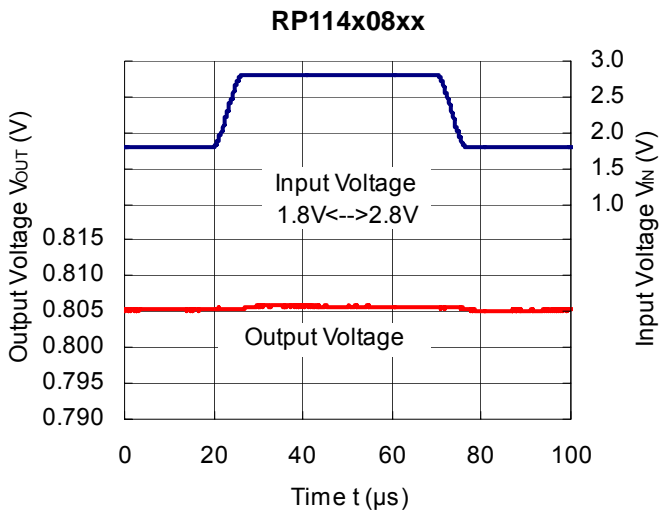
9) Ripple Rejection vs. Input Voltage (C1=none, C2=1.0μF, Ripple=0.2Vp-p, T<sub>opt</sub>=25°C)



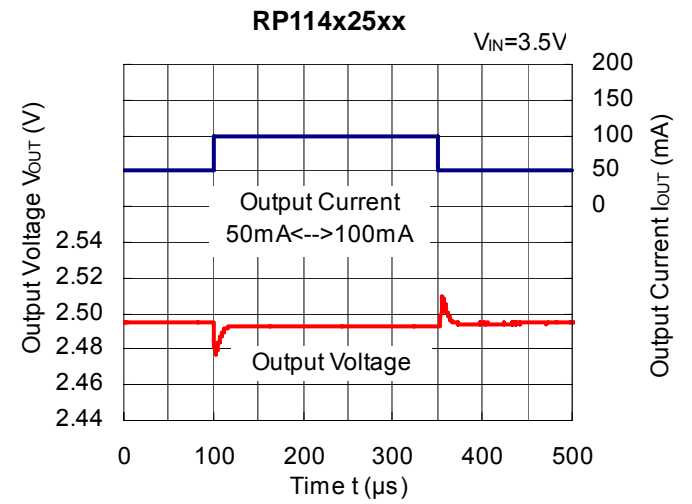
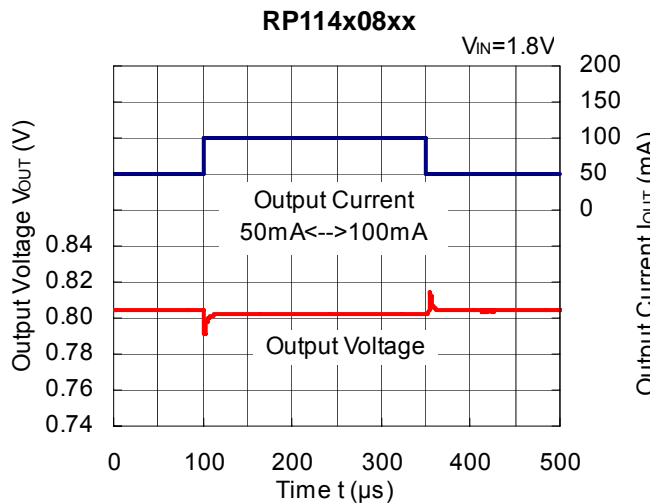
10) Ripple Rejection vs. Frequency (C1=none, C2=1.0μF, T<sub>opt</sub>=25°C)

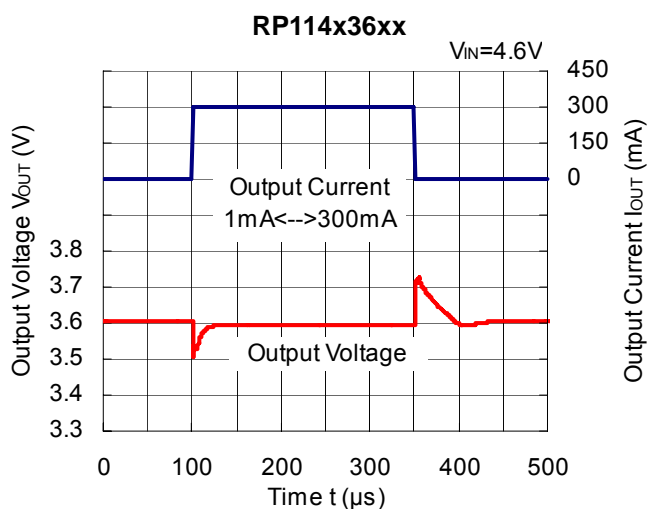
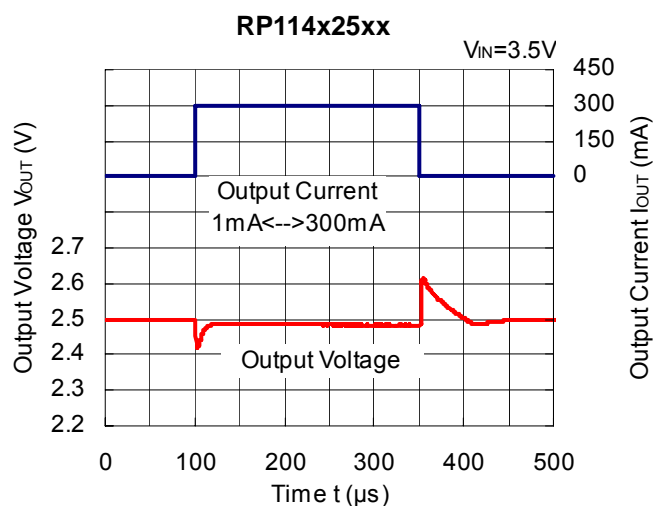
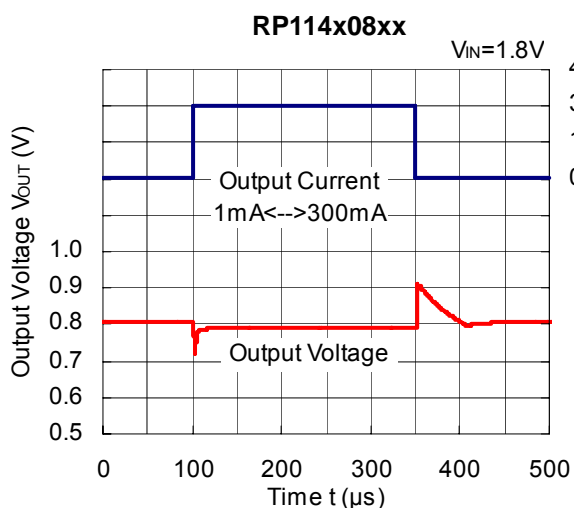
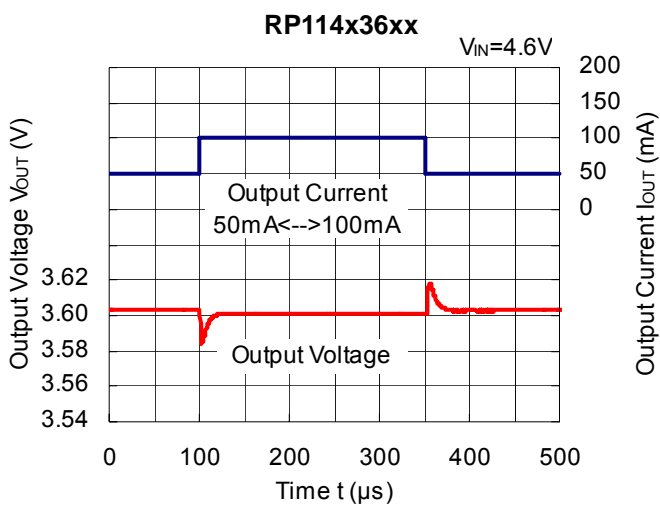


11) Input Transient Response ( $I_{OUT}=30mA$ ,  $t_r=t_f=5\mu s$ ,  $T_{opt}=25^\circ C$ )

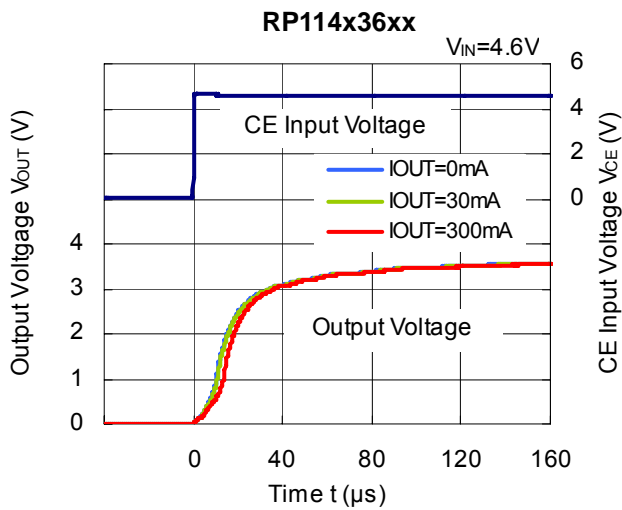
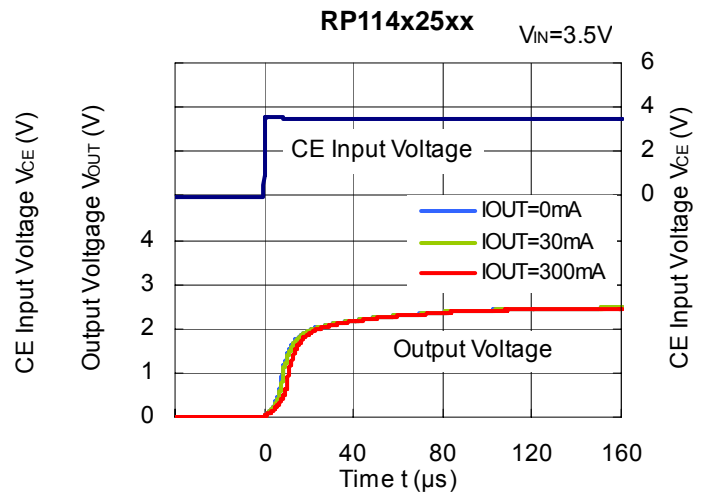
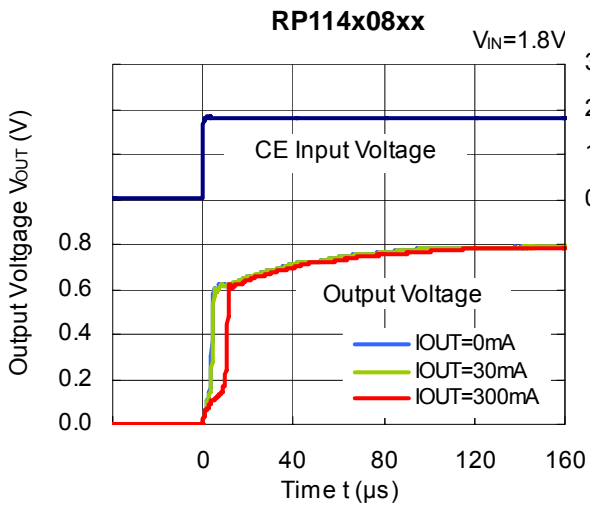


12) Load Transient Response ( $C_1=1.0\mu F$ ,  $C_2=1.0\mu F$ ,  $t_r=t_f=0.5\mu s$ ,  $T_{opt}=25^\circ C$ )

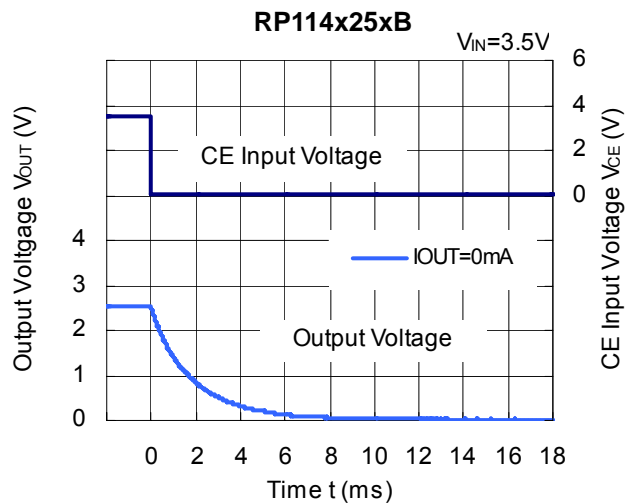
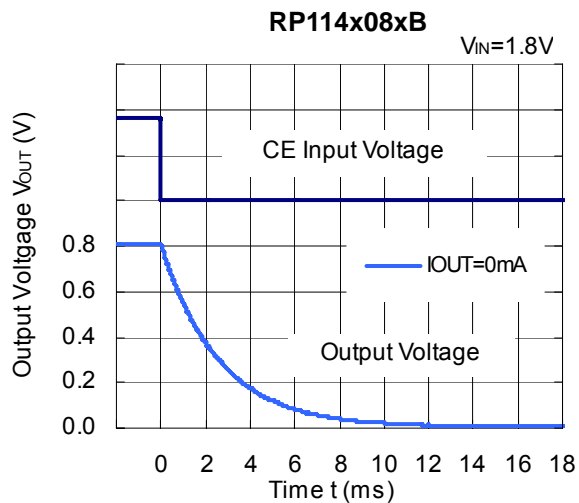


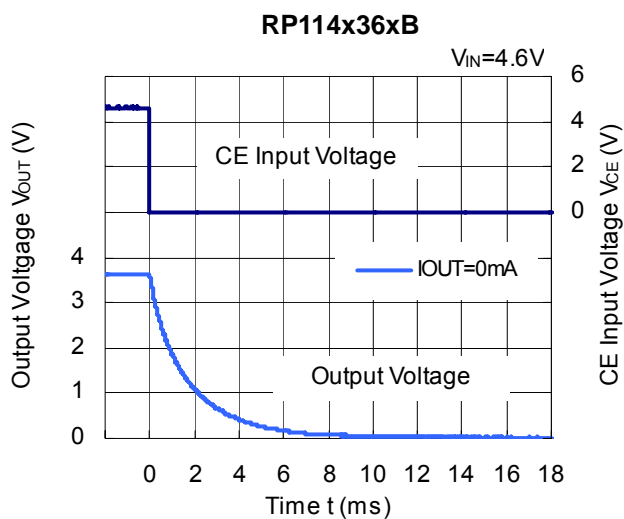


13) Turn On Speed with CE pin ( $C1=1.0\mu\text{F}$ ,  $C2=1.0\mu\text{F}$ ,  $T_{\text{opt}}=25^\circ\text{C}$ )

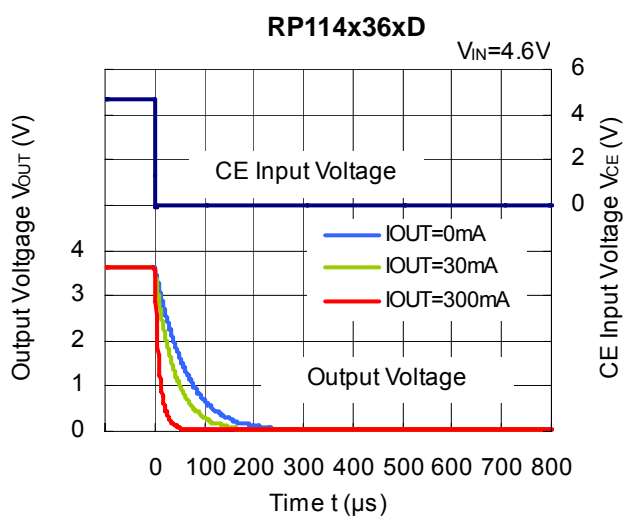
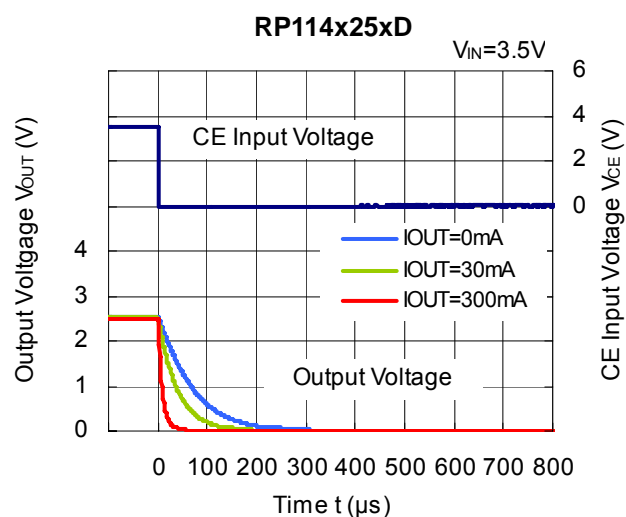
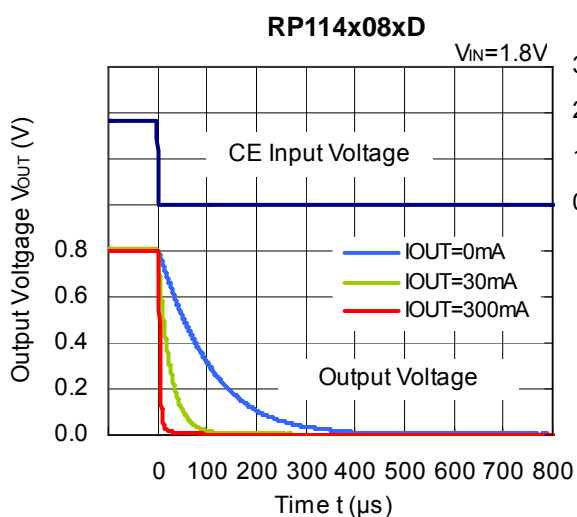


14) Turn Off Speed with CE pin (B version) ( $C1=1.0\mu\text{F}$ ,  $C2=1.0\mu\text{F}$ ,  $T_{\text{opt}}=25^\circ\text{C}$ )





**15) Turn Off Speed with CE pin (D version) ( $C_1=1.0\mu F$ ,  $C_2=1.0\mu F$ ,  $T_{opt}=25^\circ C$ )**



## 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.

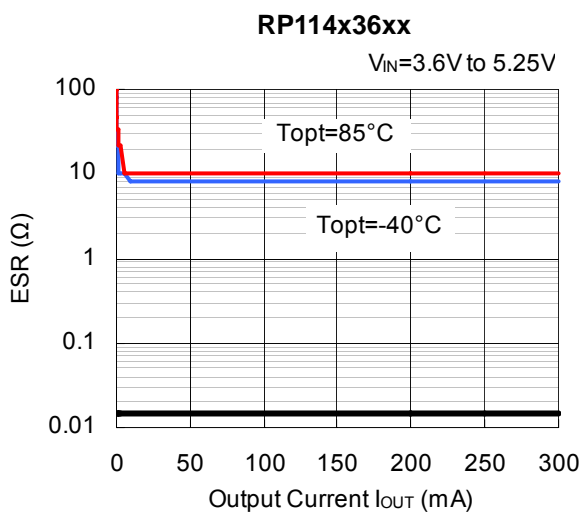
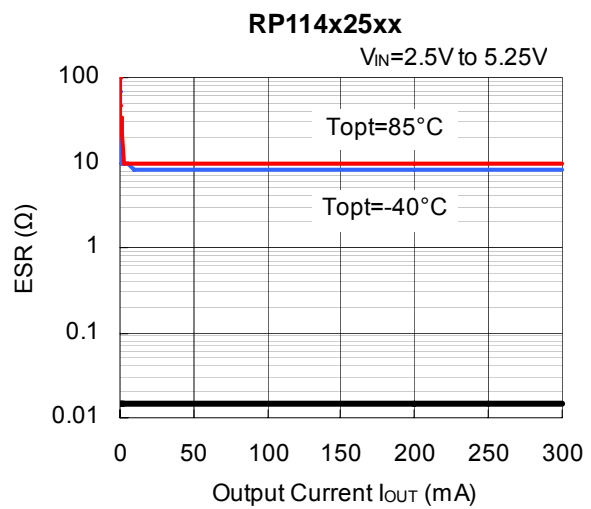
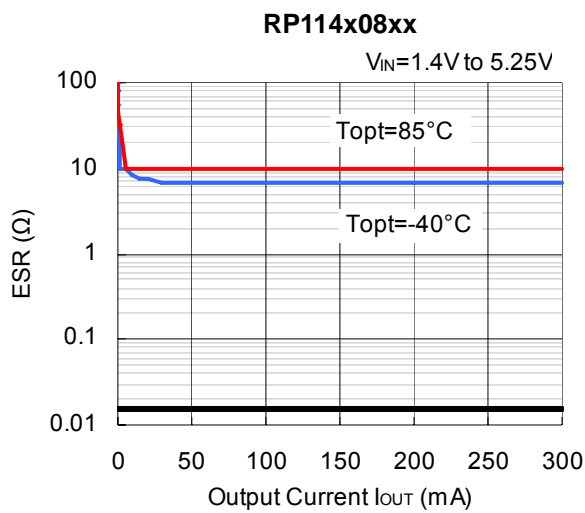
The conditions when the white noise level is under  $40\mu\text{V}$  (Avg.) are marked as the hatched area in the graph.

### Measurement conditions

Frequency Band: 10Hz to 2MHz

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

C1, C2 :  $1.0\mu\text{F}$





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### RICOH COMPANY, LTD. Electronic Devices Company

● Higashi-Shinagawa Office (International Sales)  
3-32-3, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140-8655, Japan  
Phone: +81-3-5479-2857 Fax: +81-3-5479-0502

### RICOH EUROPE (NETHERLANDS) B.V. ● Semiconductor Support Centre

Prof. W.H.Keesomlaan 1, 1183 DL Amstelveen, The Netherlands  
P.O.Box 114, 1180 AC Amstelveen  
Phone: +31-20-5474-309 Fax: +31-20-5474-791

### RICOH ELECTRONIC DEVICES KOREA Co., Ltd. 11 floor, Haesung 1 building, 942, Daechidong, Gangnamgu, Seoul, Korea

Phone: +82-2-2135-5700 Fax: +82-2-2135-5705

### RICOH ELECTRONIC DEVICES SHANGHAI Co., Ltd. Room403, No.2 Building, 690#Bi Bo Road, Pu Dong New district, Shanghai 201203, People's Republic of China

Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

### RICOH COMPANY, LTD. Electronic Devices Company

● Taipei office  
Room109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)  
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623



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