RICOH

300mA LDO REGULATOR

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

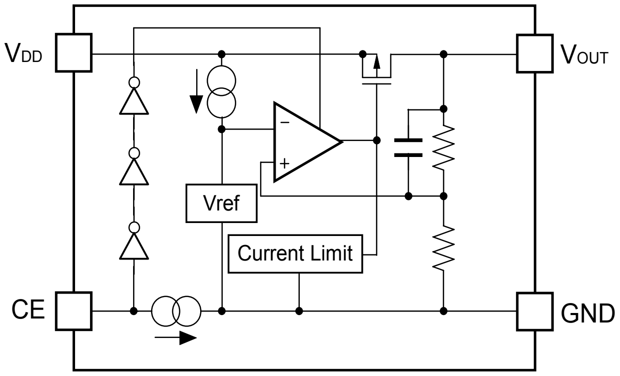
- Supply Current ....Typ. 50μA
- Standby Current ....Typ. 0.1μA
- Input Voltage Range...1.4V to 5.25V
- Output Voltage Range..0.8V to 3.6V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy..±1.0% (V_{SET}>2.0V, T_{opt}=25°C)
- Temperature-Drift Coefficient of Output Voltage ....Typ. ±80ppm/°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 .... 1.0μF or more

APPLICATIONS

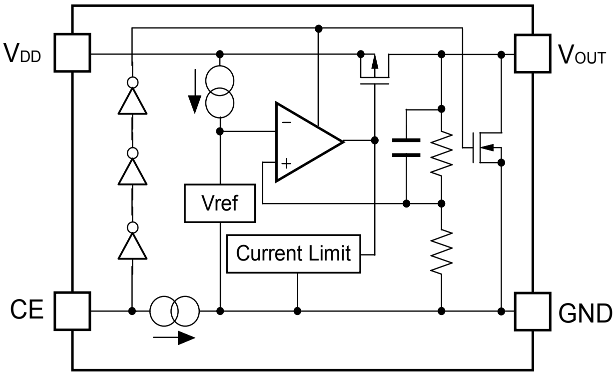
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

RP114xxxxB



RP114xxxxD



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.

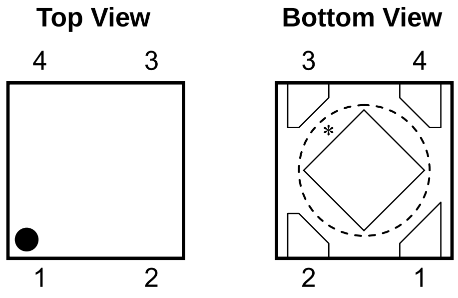
The second decimal point of the voltage is described as below.

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

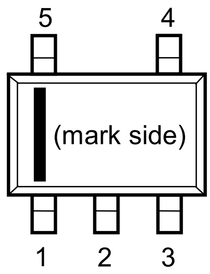
∗ : The auto discharge function at off state is options as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state

PIN CONFIGURATIONS

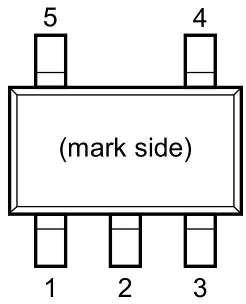
- DFN(PLP)1010-4



- SC-88A



- SOT-23-5



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	
Topt	Operating Temperature Range	–40 to 85	°C
Tstg	Storage Temperature Range	–55 to 125	°C

∗) For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS
Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

POWER DISSIPATION (DFN(PLP)1010-4)

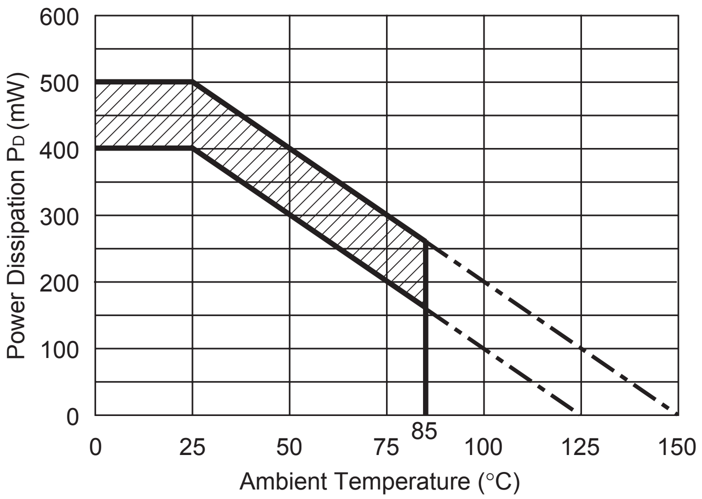
This specification is at mounted on board. Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

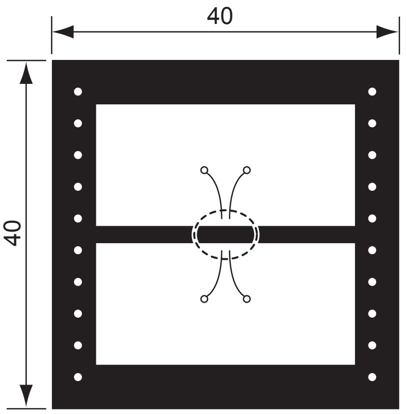
	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50% , Back side : Approx. 50%
Through-holes	φ0.54mm × 24pcs

Measurement Results (Topt=25°C, Tjmax=125°C)

	Standard Land Pattern
Power Dissipation	400mW
Thermal Resistance	θja=(125−25°C)/0.4W=250°C/W
Thermal Resistance	θjc=67°C/W



Power Dissipation



Measurement Board Pattern

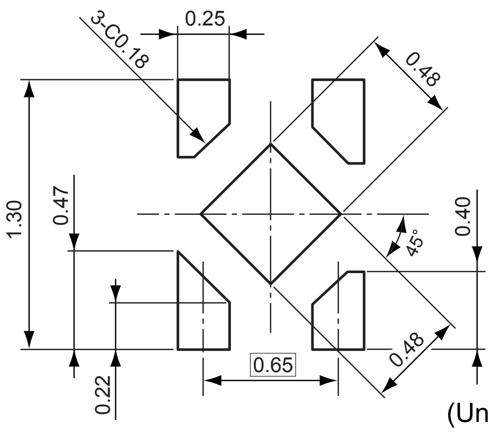
IC Mount Area (Unit: mm)

The above graph shows the Power Dissipation of the package based on Tjmax=125°C and Tjmax=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)

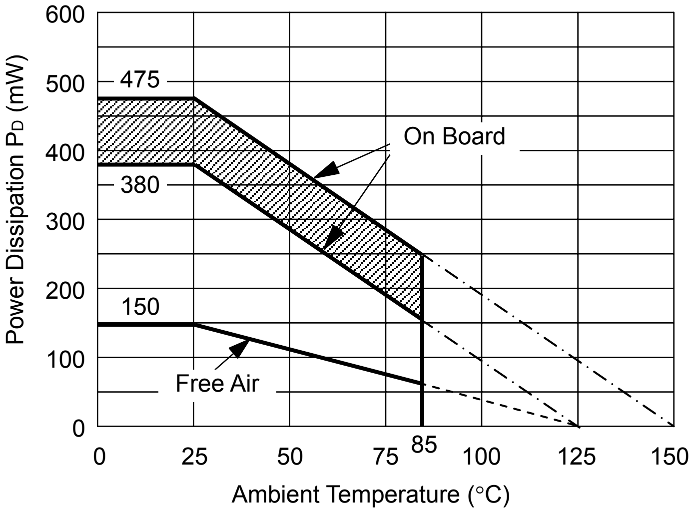
This specification is at mounted on board. Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

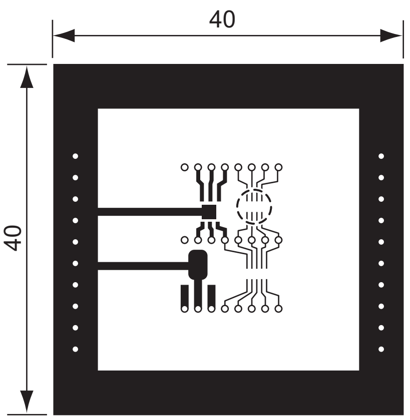
	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50%, Back side : Approx. 50%
Through-holes	φ0.5mm × 44pcs

Measurement Results (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	θja=(125−25°C)/0.15W=667°C/W
Thermal Resistance	θjc=75°C/W	−



Power Dissipation



Measurement Board Pattem

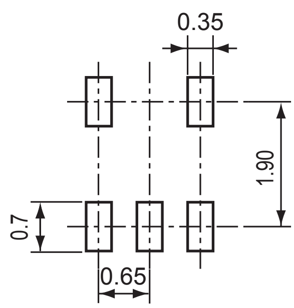
IC Mount Area (Unit: mm)

The above graph shows the Power Dissipation of the package based on Tjmax=125°C and Tjmax=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 (SOT-23-5)

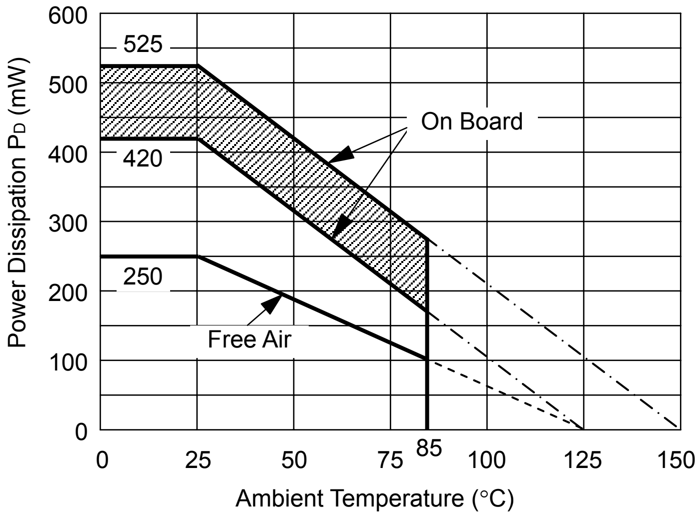
This specification is at mounted on board. Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:
(Power Dissipation (SOT-23-5) is substitution of SOT-23-6.)

Measurement Conditions

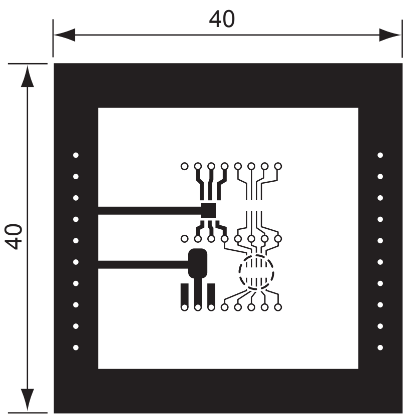
	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50% , Back side : Approx. 50%
Through-holes	ϕ0.5mm × 44pcs

Measurement Results (Topt=25°C, Tjmax=125°C)

	Standard Land Pattern	Free Air
Power Dissipation	420mW	250mW
Thermal Resistance	θja=(125−25°C)/0.42W=238°C/W	400°C/W



Power Dissipation



Measurement Board Pattern

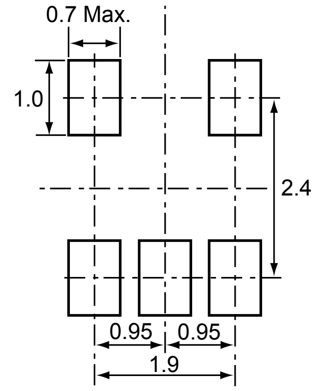
IC Mount Area (Unit: mm)

The above graph shows the Power Dissipation of the package based on Tjmax=125°C and Tjmax=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)

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 $-40°C \leq Topt \leq 85°C$.

Topt=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Topt=25°C	$V_{SET}>2.0V$	×0.99		×1.01	V
			$V_{SET}\leq 2.0V$	−20		+20	mV
		$-40°C \leq Topt \leq 85°C$	$V_{SET}>2.0V$	×0.97		×1.03	V
			$V_{SET}\leq 2.0V$	−60		+60	mV
I_{OUT}	Output Current			300			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	$1mA \leq I_{OUT} \leq 300mA$			15	40	mV
V_{DIF}	Dropout Voltage	Refer to the following table.					
I_{SS}	Supply Current	$I_{OUT}=0mA$			50	75	μA
Istandby	Standby Current	$V_{CE}=0V$			0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$V_{SET}+0.5V \leq V_{IN} \leq 5.25V$ ($V_{IN}\geq 1.4V$)			0.02	0.10	%/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*			1.4		5.25	V
$\Delta V_{OUT}/\Delta Topt$	Output Voltage Temperature Coefficient	$-40°C \leq Topt \leq 85°C$			±80		ppm/°C
I_{SC}	Short Current Limit	$V_{OUT}=0V$			60		mA
I_{PD}	CE Pull-down Current				0.3		μA
V_{CEH}	CE Input Voltage "H"			1.0			V
V_{CEL}	CE Input Voltage "L"					0.4	V
en	Output Noise	BW=10Hz to 100kHz, $I_{OUT}=30mA$			75		μVrms
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)	$V_{IN}=4.0V$, $V_{CE}=0V$			50		Ω

*) 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 Tj≈Topt=25°C except for Output Noise, Ripple Rejection, Output Voltage Temperature Coefficient.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

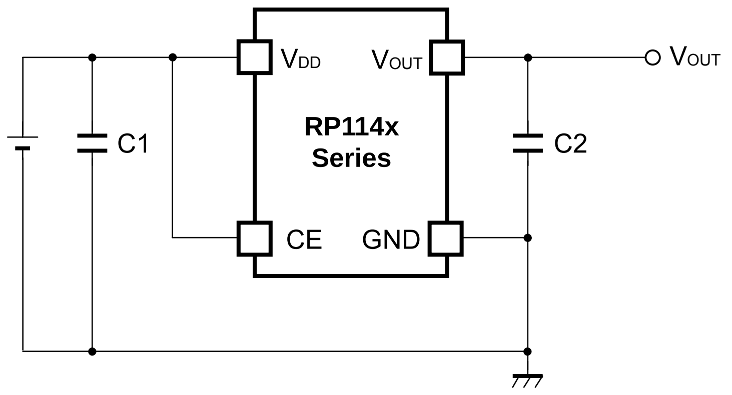
Dropout Voltage by Set Output Voltage

Topt=25°C

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

The specification in ☐ is checked and guaranteed by design engineering at -40°C ≤ Topt ≤ 85°C.

TYPICAL APPLICATIONS



(External Components)
C2 Ceramic 1.0μF MURATA: GRM155B31A105KE15

TECHNICAL NOTES

When using these ICs, consider the following points:

Phase Compensation

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 with 1.0μF or more and good ESR (Equivalent Series Resistance).

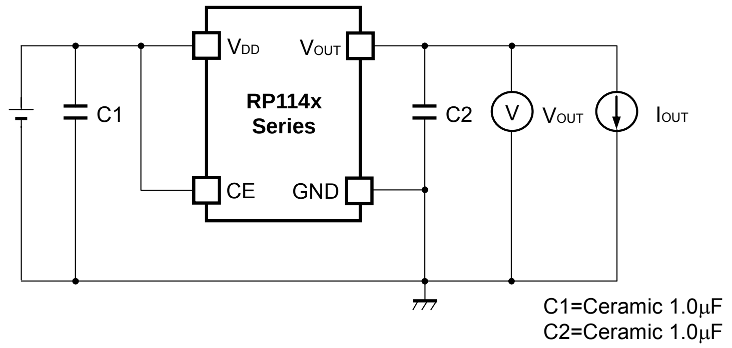
(Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

PCB Layout

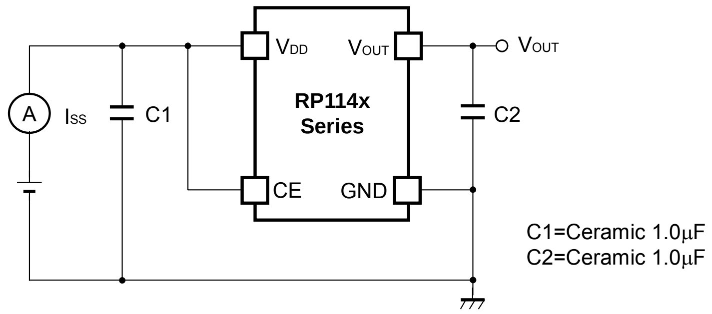
Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 1.0μF or more between V_{DD} and GND pin, and as close as possible to the pins.

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

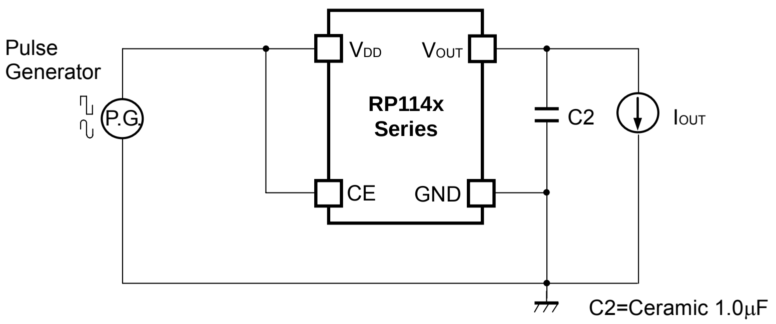
TEST CIRCUITS



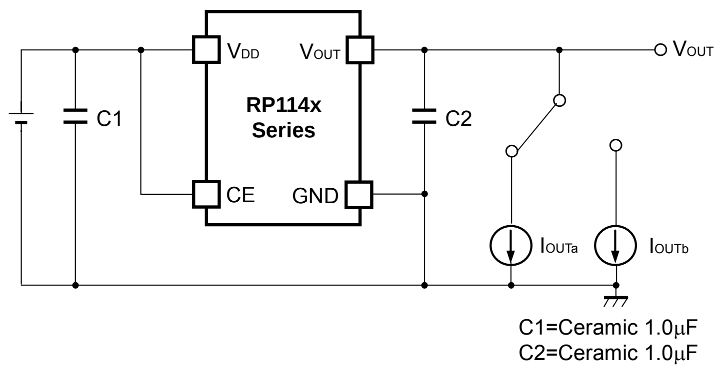
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection

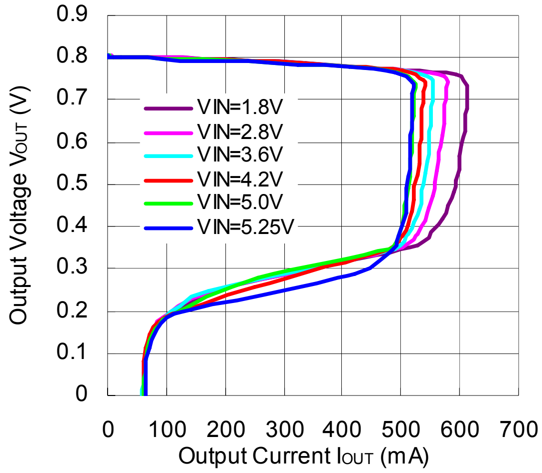


Test Circuit for Load Transient Response

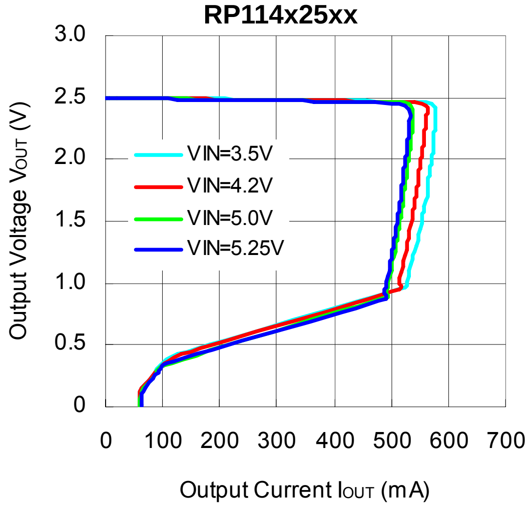
TYPICAL CHARACTERISTICS

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

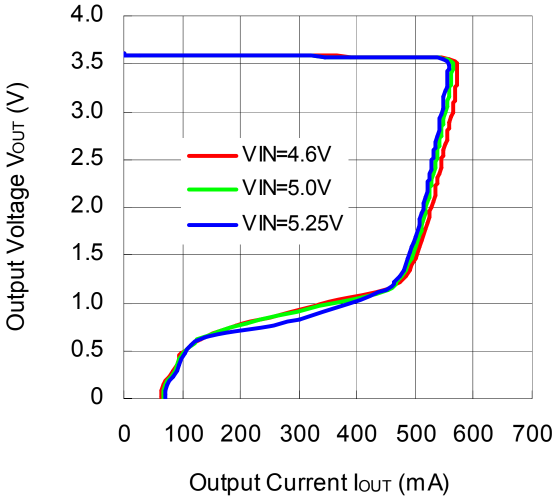
RP114x08xx



RP114x25xx

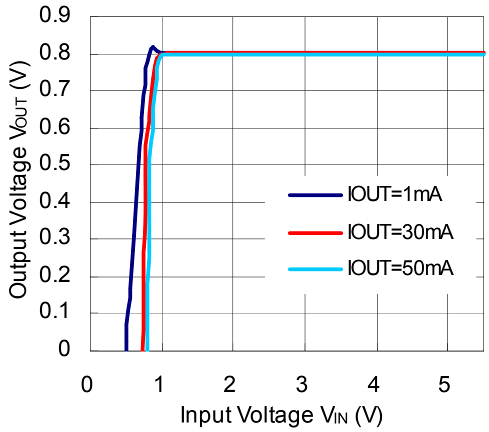


RP114x36xx

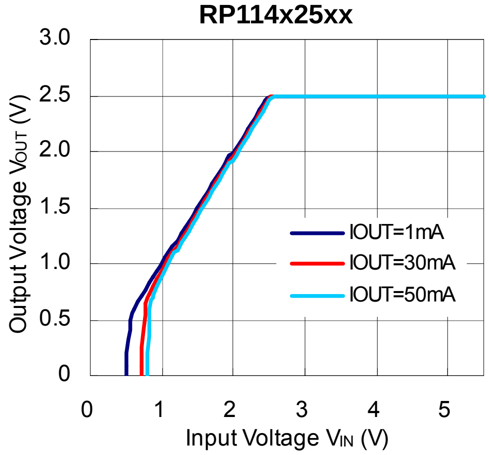


2) Output Voltage vs. Input Voltage (C1=1.0µF, C2=1.0µF, Topt=25°C)

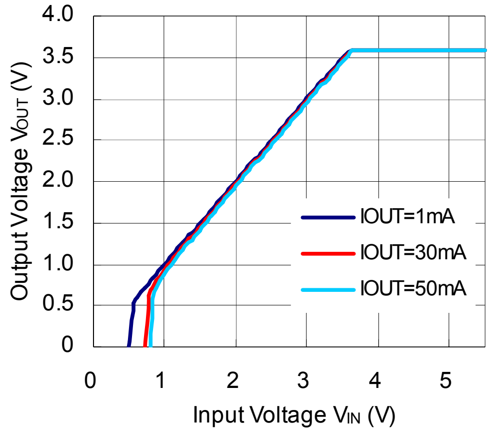
RP114x08xx



RP114x25xx

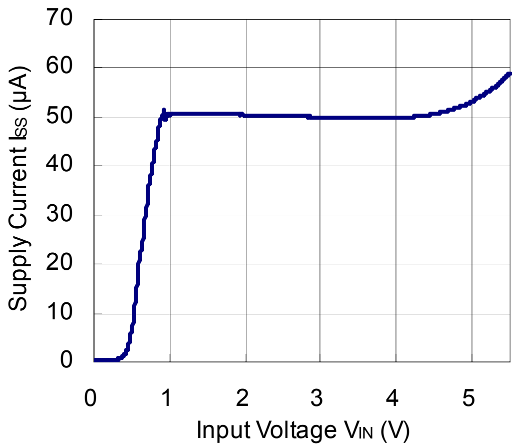


RP114x36xx

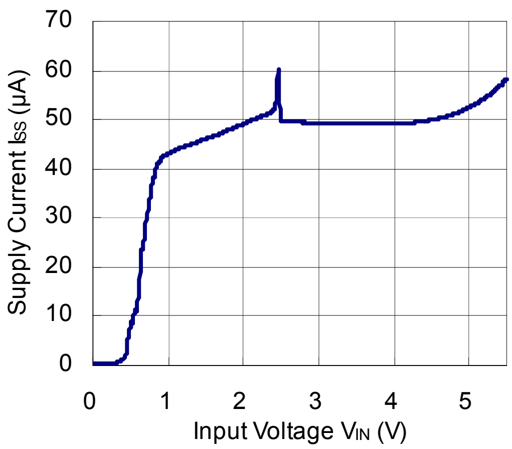


3) Supply Current vs. Input Voltage (C1=1.0µF, C2=1.0µF, Topt=25°C)

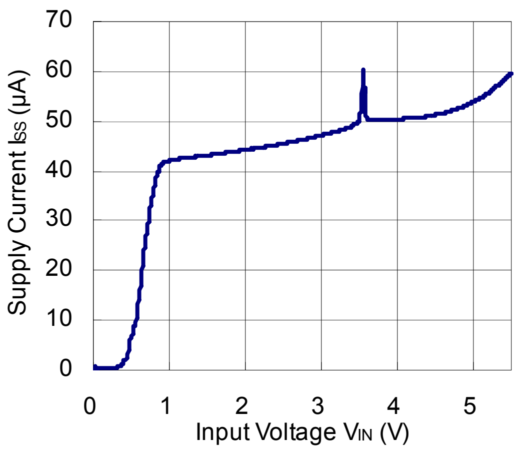
RP114x08xx



RP114x25xx

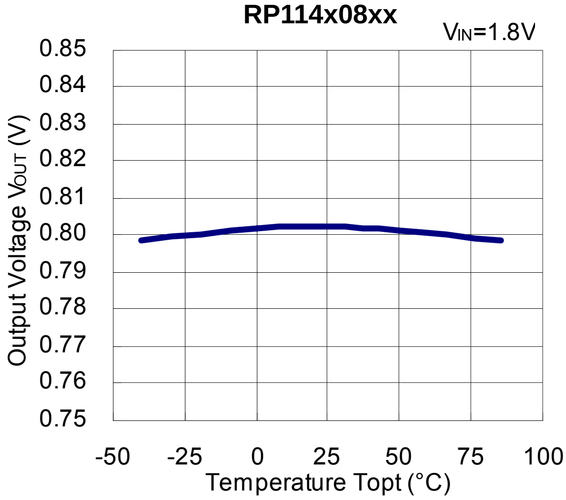


RP114x36xx

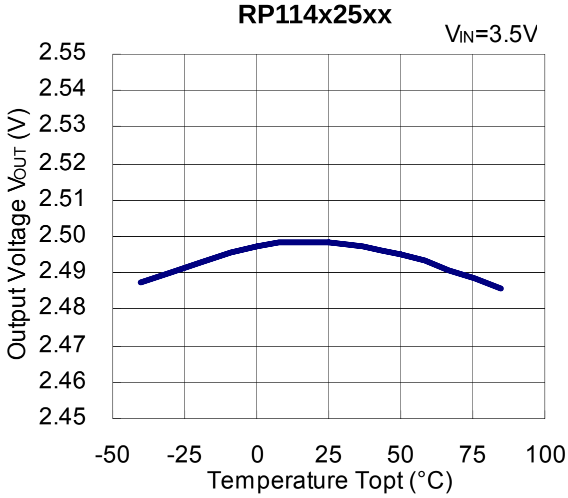


4) Output Voltage vs. Temperature (C1=1.0µF, C2=1.0µF, I_{OUT}=1mA)

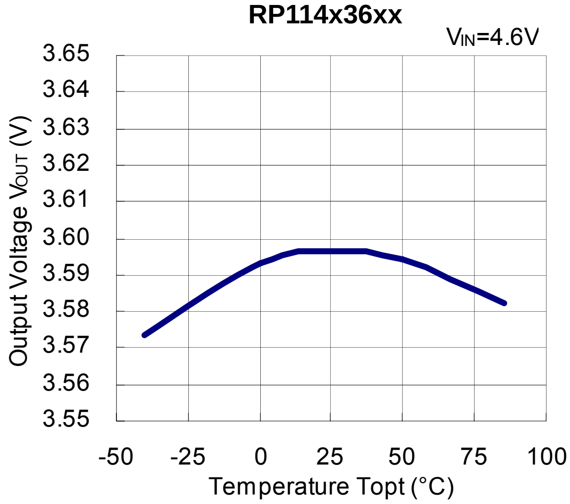
RP114x08xx



RP114x25xx

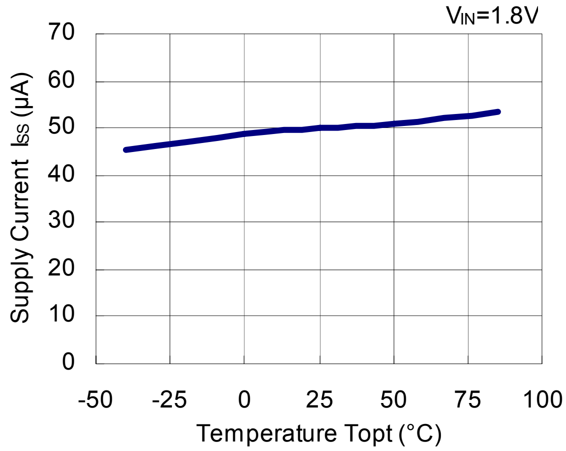


RP114x36xx

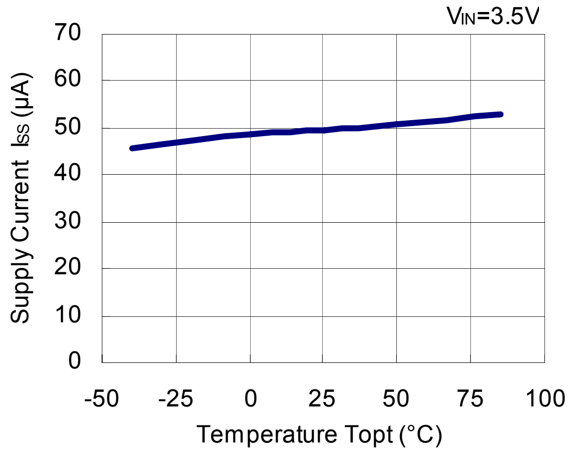


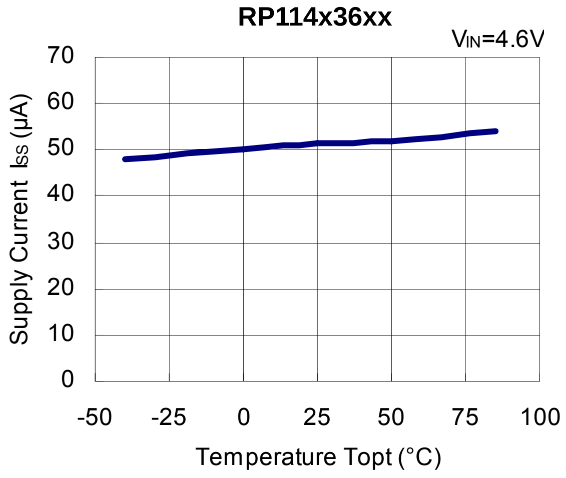
5) Supply Current vs. Temperature (C1=1.0µF, C2=1.0µF, I_{OUT}=0mA)

RP114x08xx

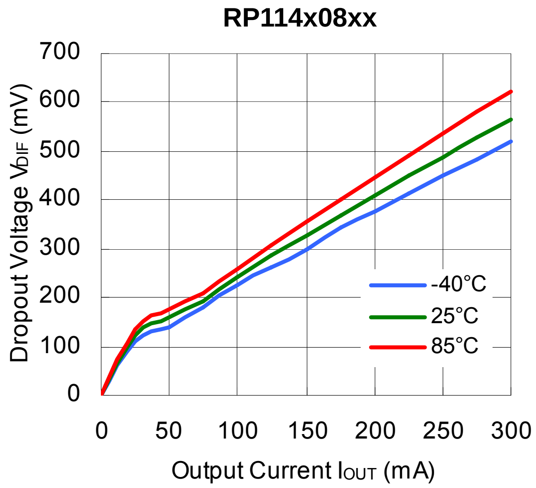


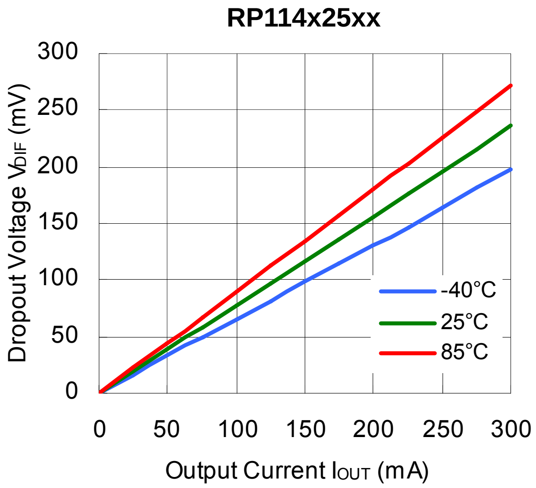
RP114x25xx

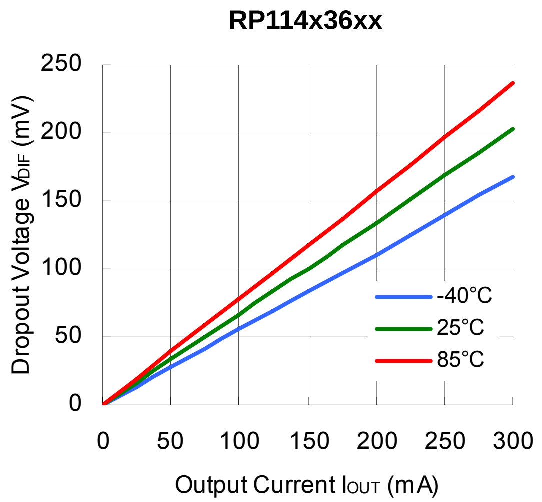




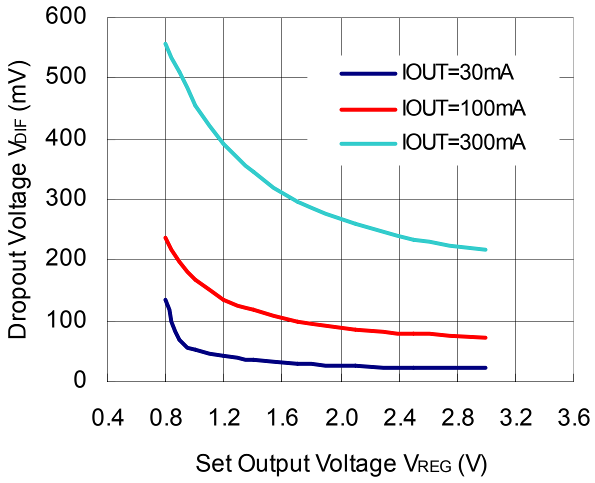
6) Dropout Voltage vs. Output Current (C1=1.0μF, C2=1.0μF)



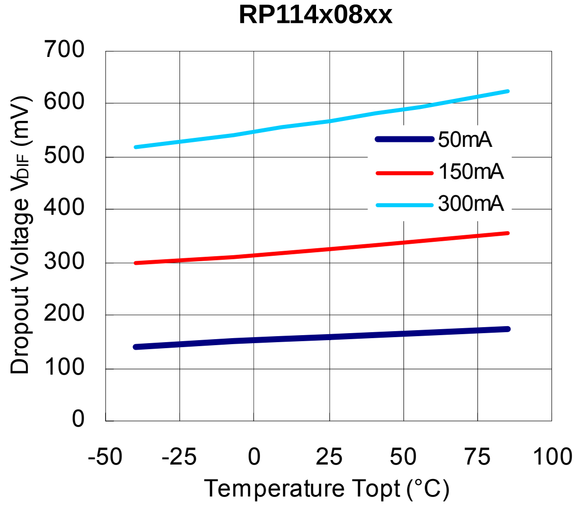


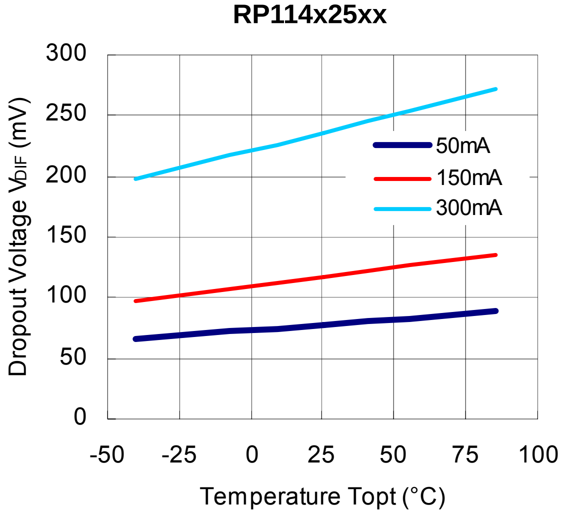


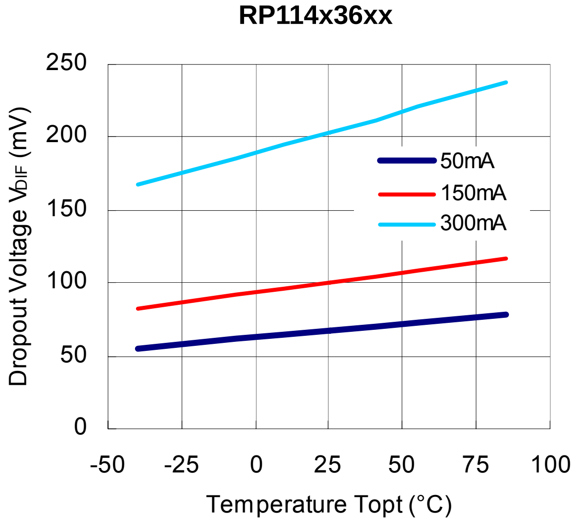
7) Dropout Voltage vs. Set Output Voltage (C1=1.0µF, C2=1.0µF, Topt=25°C)



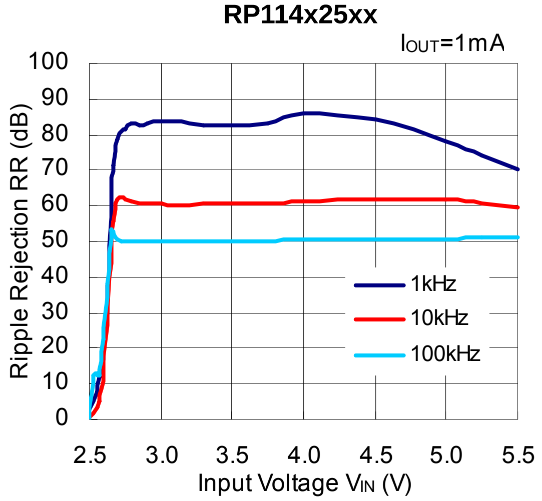
8) Dropout Voltage vs. Temperature (C1=none, C2=1.0µF)

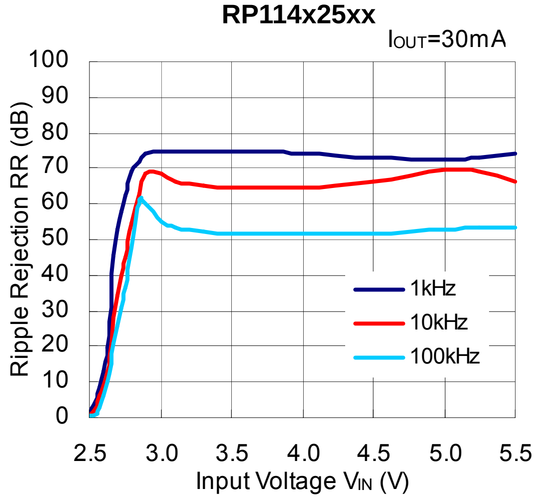




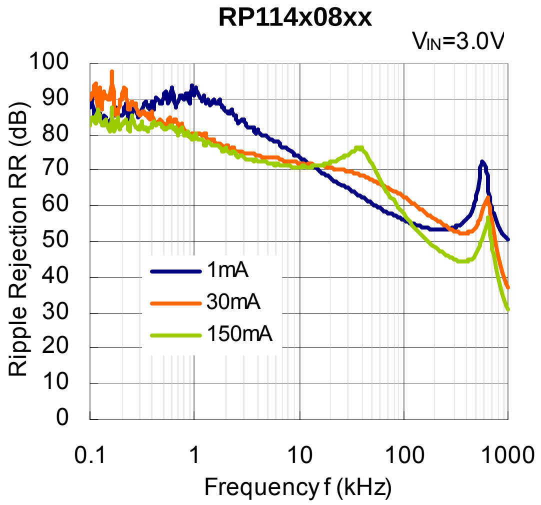


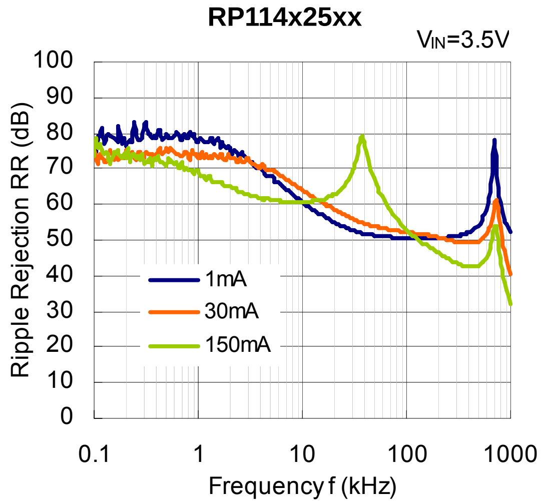
9) Ripple Rejection vs. Input Voltage (C1=none, C2=1.0µF, Ripple=0.2Vp-p, Topt=25°C)

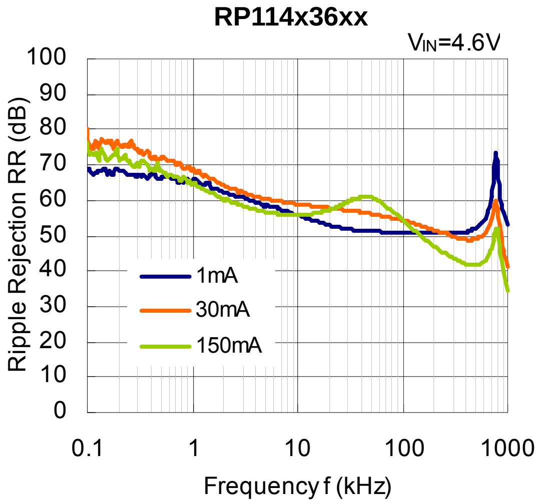




10) Ripple Rejection vs. Frequency (C1=none, C2=1.0µF, Topt=25°C)

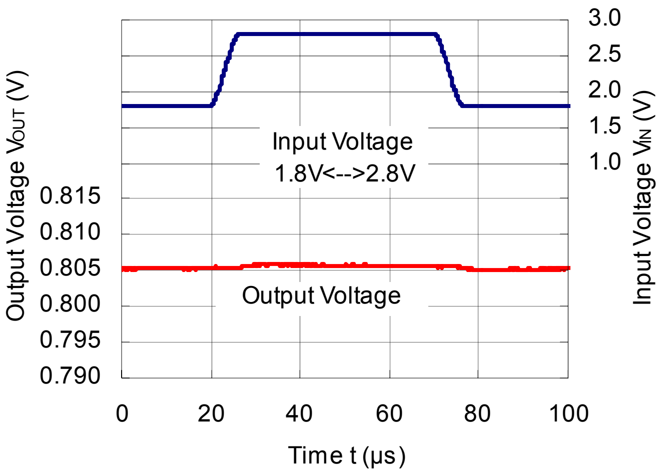




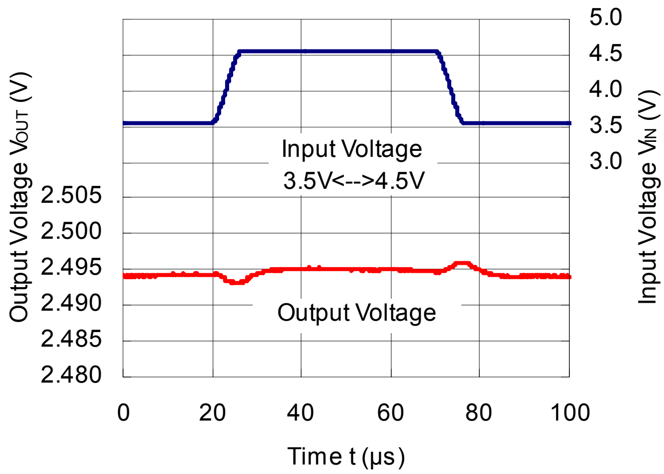


11) Input Transient Response (I_{OUT}=30mA, tr=tf=5μs, T_{opt}=25°C)

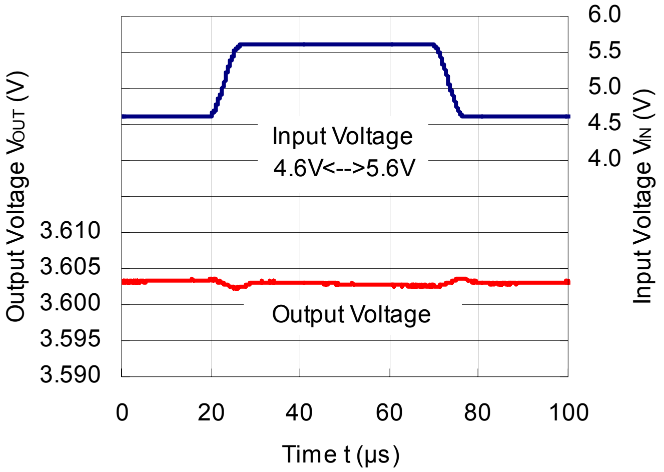
RP114x08xx



RP114x25xx

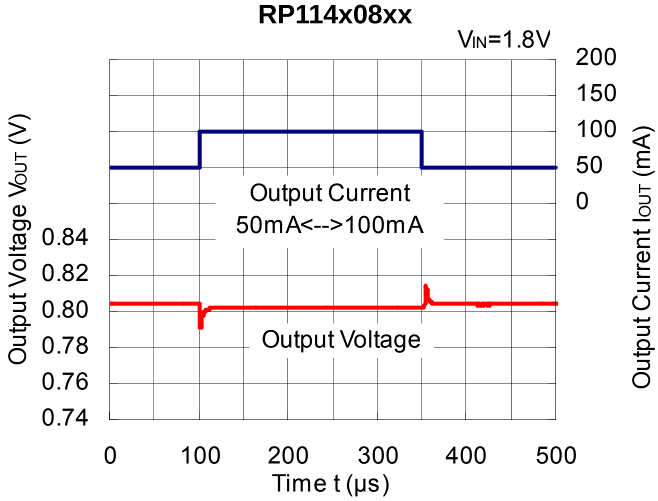


RP114x36xx

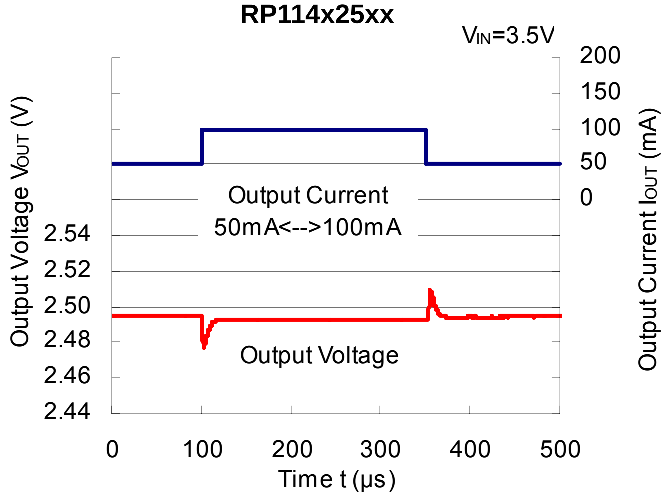


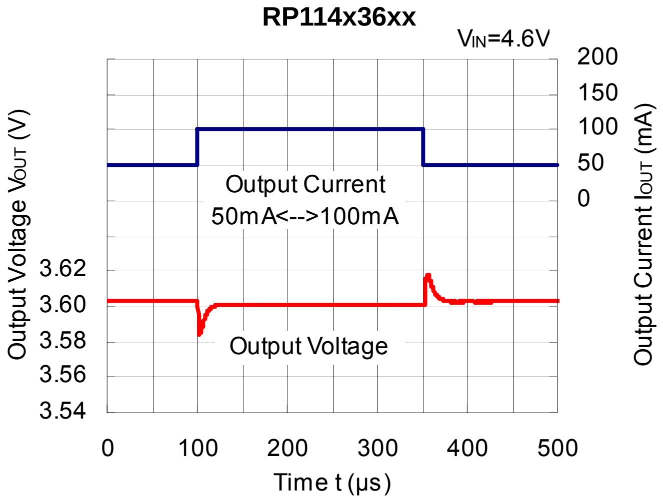
12) Load Transient Response (C1=1.0μF, C2=1.0μF, tr=tf=0.5μs, T_{opt}=25°C)

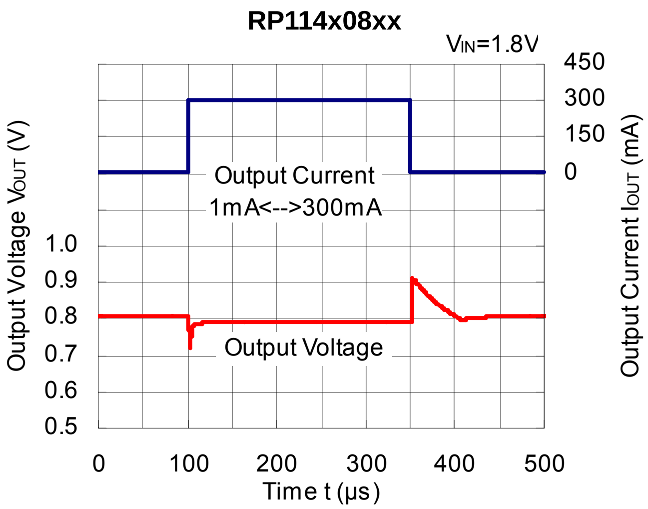
RP114x08xx

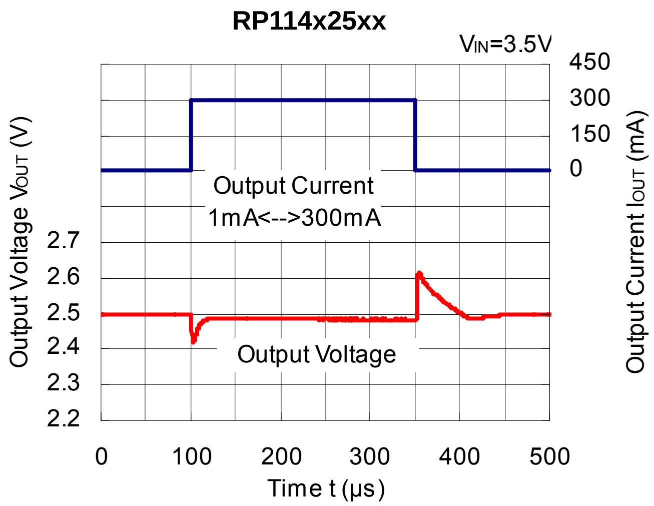


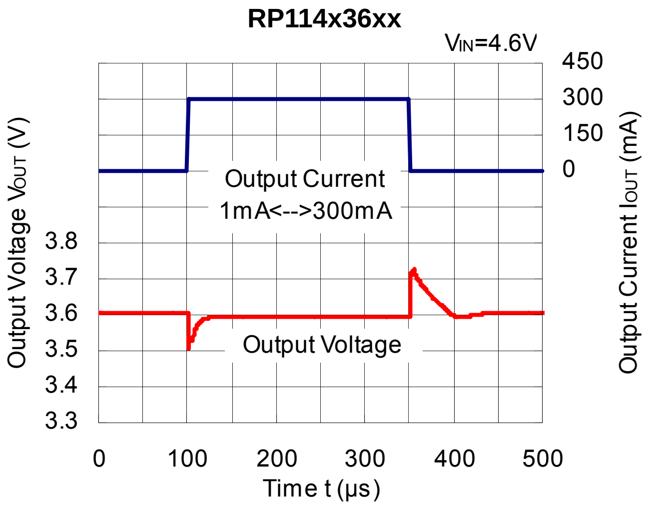
RP114x25xx



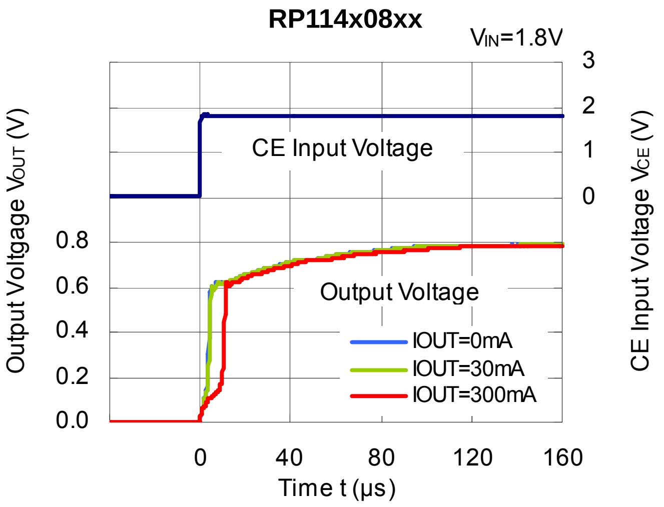

RP114x36xx
VIN=4.6V
Output Current
50mA<-->100mA
Output Voltage
Output Voltage VOUT (V)
Output Current IOUT (mA)
Time t (μs)
3.62
3.60
3.58
3.56
3.54
200
150
100
50
0
0
100
200
300
400
500

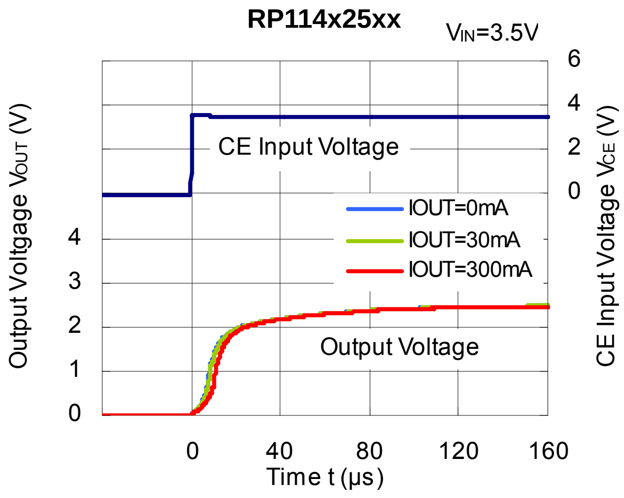

RP114x08xx
VIN=1.8V
Output Current
1mA<-->300mA
Output Voltage
Output Voltage VOUT (V)
Output Current IOUT (mA)
Time t (μs)
1.0
0.9
0.8
0.7
0.6
0.5
450
300
150
0
0
100
200
300
400
500

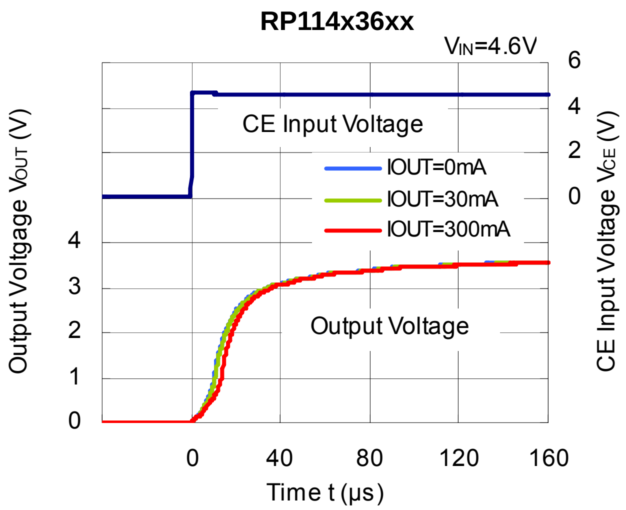

RP114x25xx
VIN=3.5V
Output Current
1mA<-->300mA
Output Voltage
Output Voltage VOUT (V)
Output Current IOUT (mA)
Time t (μs)
2.7
2.6
2.5
2.4
2.3
2.2
450
300
150
0
0
100
200
300
400
500


RP114x36xx
VIN=4.6V
Output Current
1mA<-->300mA
Output Voltage
Output Voltage VOUT (V)
Output Current IOUT (mA)
Time t (μs)
3.8
3.7
3.6
3.5
3.4
3.3
450
300
150
0
0
100
200
300
400
500

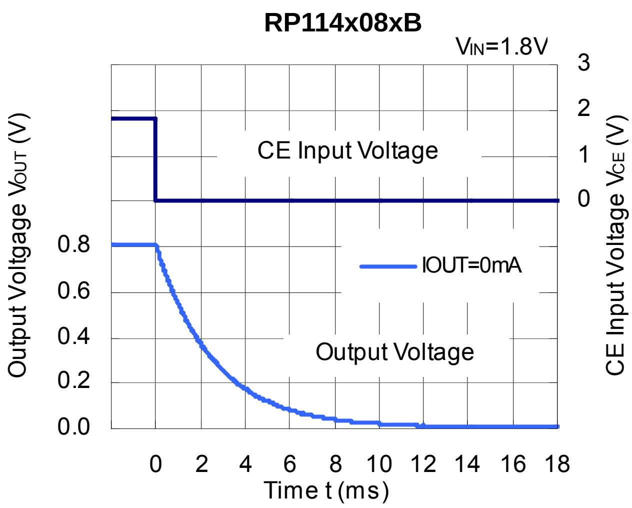
13) Turn On Speed with CE pin (C1=1.0µF, C2=1.0µF, Topt=25°C)

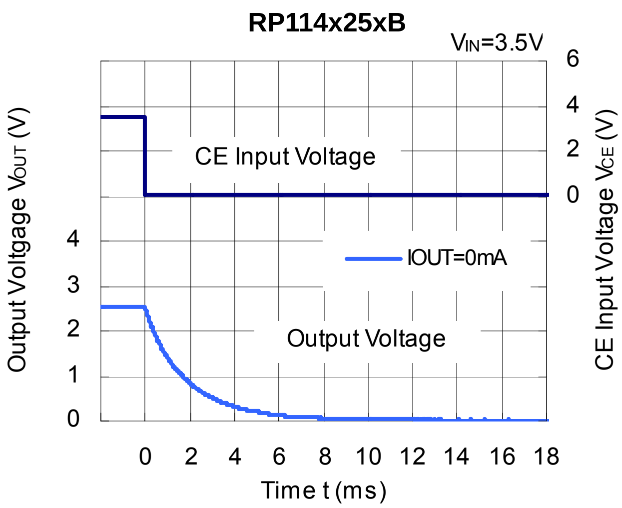


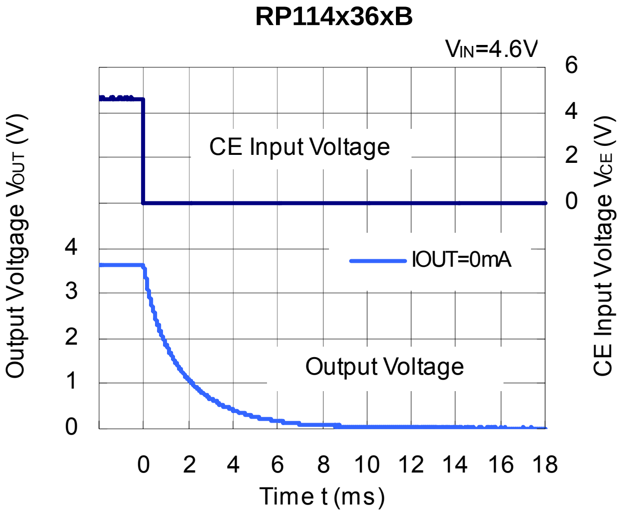




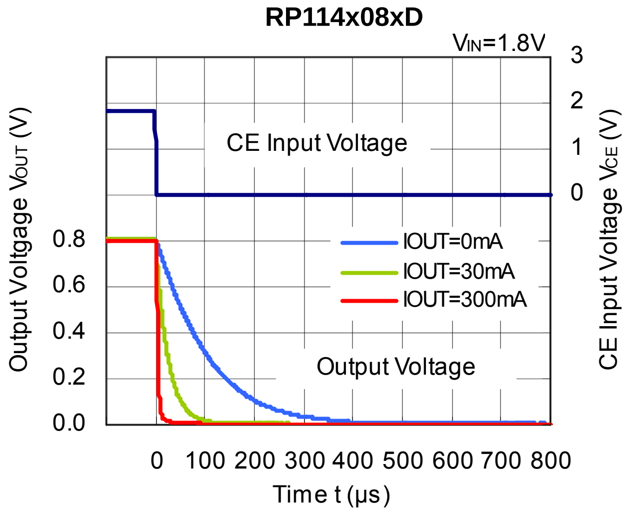
14) Turn Off Speed with CE pin (B version) (C1=1.0µF, C2=1.0µF, Topt=25°C)

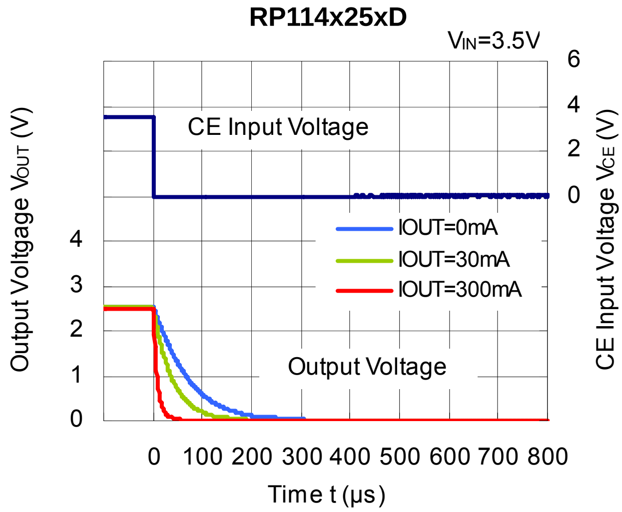


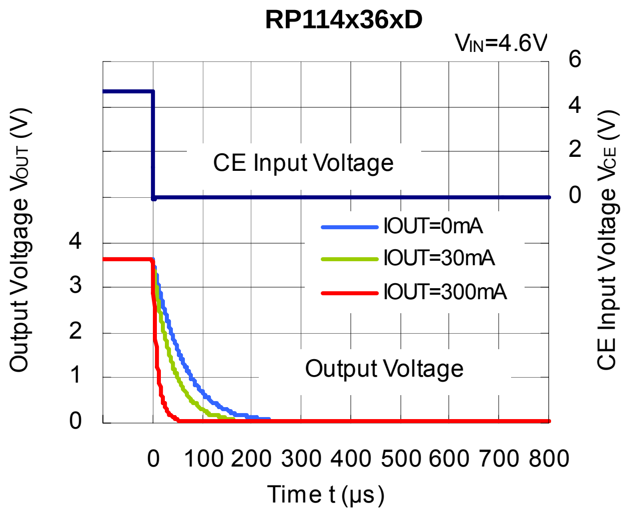




15) Turn Off Speed with CE pin (D version) (C1=1.0µF, C2=1.0µF, Topt=25°C)







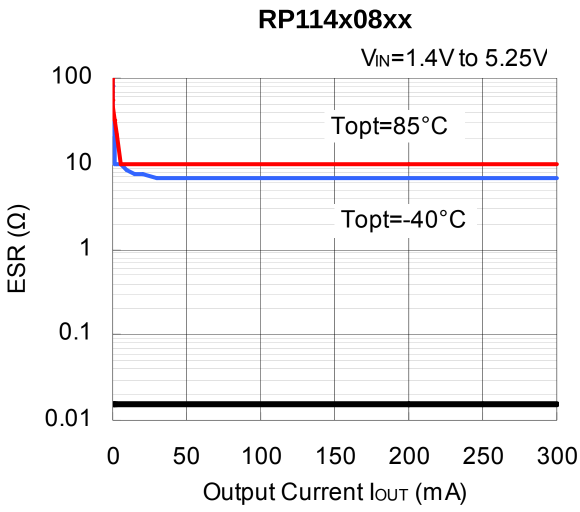
ESR vs. Output Current

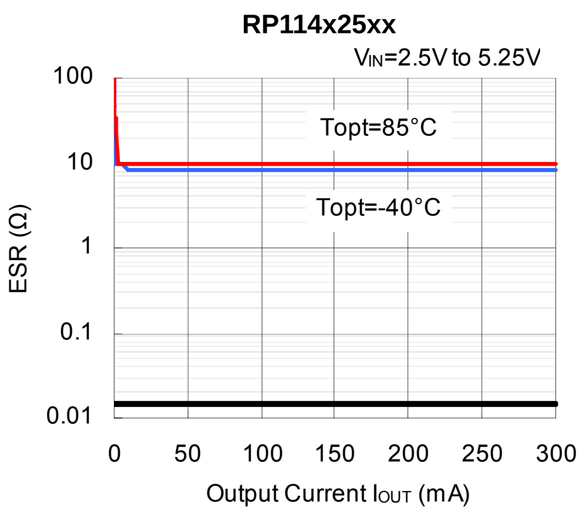
When using these ICs, consider the following points:

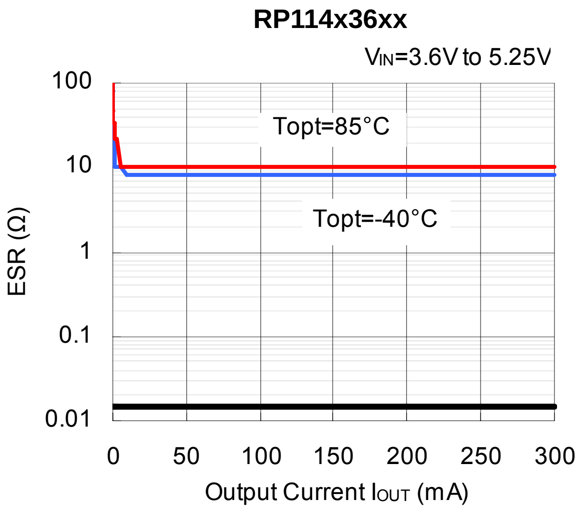
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is under 40µV (Avg.) are marked as the hatched area in the graph.

Measurement conditions

Frequency Band: 10Hz to 2MHz
Temperature : –40°C to 85°C
C1, C2 : 1.0µF







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